Inter-Noise 2026 — Book of Abstracts

This is a supplement of the main Inter-Noise 2026 Digital Booklet.

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1.1.1 Physical Acoustics & Elastic Waves: General

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16:20: Paper 301 — Assessment of a 2D NPE Propagation for Military Jet-Noise Applications — *Mr Davide De Carvalho*

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16:00 **Paper 831 — Acoustic Characterization of Agarose Hydrogels for Ultrasonic Imaging Applications**

Prof Nico Declercq, ***Ms Esma Tuzovic***

We have investigated the use of agarose hydrogels for acoustic non-destructive evaluation. Agarose samples with concentrations ranging from 0.5% to 2.0% were prepared and analyzed using contact transducers for A-scans and immersion transducers for Cscans. The velocity of sound and acoustic attenuation of the hydrogel samples were measured in the 0.5-1.5 MHz frequency range. The results showed that agarose hydrogels exhibit acoustic properties similar to those of water while maintaining sufficient signal amplitude for ultrasonic inspection. Cscan imaging showed that the principal features of embedded specimens were preserved, particularly in the lower-concentration hydrogels. Tests were also conducted to investigate the possibility of preserving acoustic wave patterns in the hydrogel during solidification, but no definitive structures were observed. These results suggest that agarose hydrogels can effectively mimic water for ultrasonic non-destructive testing application.

16:20 **Paper 301 — Assessment of a 2D NPE Propagation for Military Jet-Noise Applications**

Mr Davide De Carvalho*, Prof Benoît G. Marinus, Prof Kristof Harri, Prof Francis Moiny*

High-power military jet exhaust produces sustained broadband noise and is a major environmental burden around airbases. Many prediction toolchains couple source models with ray-tracing/Gaussian-beam modules or parabolic-equation solvers; these capture refraction but are not always set up to benchmark 2D diffraction and rigid-ground interference for broadband continuous signals. We propose a 2D framework that starts from a prescribed pressure field at a reference range, decoupling propagation physics from source modeling via wave-field extrapolation. We test whether the 2D Nonlinear Progressive Wave Equation (NPE), run in linear, lossless mode, can propagate a military-jet-like broadband signal in free field and over rigid ground. These results are compared with a Helmholtz benchmark obtained by Hankel-based range extrapolation of the same field (cylindrical near-field acoustical holography). Free-field propagation uses the free-space Green function, while rigid ground uses a Neumann image-source construction. Initial conditions use a jet-noise surrogate: band-limited, peak-normalized white Gaussian noise mapped to a 2D field using frequency-domain Green-function projection. Padding and angular-spectrum trimming limit FFT artifacts and satisfy NPE assumptions. Comparisons show Leq levels within 2 dB and similar trends in 1/3-octave spectra. Additionally, the paper reports SPL, 1/3-octave, psychoacoustic metrics, sensitivity to grid resolution, domain size, signal duration, and propagation distance.

16:40 **Paper 455 — Influence of size and orientation of rigid elliptical object on acoustic scattering patterns at different frequencies**

Dr. Avijit Majee*, Mr Dinesh Chand Foujdar, Mr Vikas Sablaniya, Dr. Amrita Puri*

Acoustic scattering describes how sound waves interact with objects and change their direction after hitting the object. This scattering behaviour depends on various factors. In this study, the effects of object orientation, object size, and the

frequency of the incident sound field on the scattered sound field are systematically investigated. The scattering behaviour of sound-hard objects is analysed using COMSOL Multiphysics with a plane wave source. To understand how frequency of incident field influences the scattering strength, simulations are performed over a range of tonal signal frequencies. Results of scattered field are presented in terms of acoustic pressure plots and sound pressure level plots. Scattering patterns are explained using concepts of Rayleigh and Mie scattering.

17:00 **Paper 537 — Weakly nonlinear multimodal wave propagation in a two-dimensional flexible waveguide carrying a fluid with mean flow**

***Mr Manish Dwivedi**, Dr Venkata R. Sonti*

In this study, the multimodal propagation of nonlinear waves in a two-dimensional waveguide is examined. The upper boundary of the waveguide is a flexible plate, while the lower boundary is rigid. The waveguide contains an acoustic fluid having a mean flow. The system is described using nonlinear acoustic and structural equations. The regular perturbation method is applied to separate the governing equations into the first- and the second-order equations. At the first order, the dispersion equation yields the primary waves; it is shown that the magnitude of the primary wavenumbers decreases with increasing Mach number. At the second-order order, modal interactions, namely the self- and the cross-mode interactions of the waves are analysed. Conditions for the resonances and the spatial beats are established. The influence of the Mach number and the flexibility on the resonances and the beats is also investigated.

17:20 **Paper 599 — Acoustic Properties of a Multi-layered Solid-Fluid Material**

***Mr Karthik Modur**, Professor Alexei Skvortsov, Dr Ian MacGillivray, Dr Gyani Sharma, Prof. Nicole Kessissoglou*

Acoustic wave propagation through a multi-layered solid-fluid material composed of alternating layers of a soft viscoelastic medium and a viscous fluid is examined. The system is modelled as an equivalent homogeneous medium with effective acoustic properties. An analytical solution is derived for the velocity of a longitudinal wave propagating within the homogenised medium, from which the reflection and transmission coefficients are then calculated using the transfer matrix method. Further, the reflection and transmission coefficients obtained analytically are compared with those obtained

numerically using the finite element method. The results demonstrate that the homogenised model accurately captures the acoustic response of the layered solid-fluid system in the low frequency limit,

where the acoustic wavelength is large compared to the period of the unit cell.

17:40 **Paper 603 — Mixing-induced changes in granular material sound absorption explained by modified porous-frame geometrical parameters**

*Mr Yousif Badri, Dr George Dodd, Prof John Edward Cater, **Dr Andrew Hall***

Recent studies indicate that the sound absorption of granular materials (GMs) arises from thermoviscous losses when their porous frame is effectively stationary. Additional poro-elastic attenuation can occur when the frame resonates, particularly for powders with low equivalent stiffness. Their absorption can therefore be described using non-acoustical porous parameters (e.g., porosity and airflow resistivity) together with an equivalent stiffness. Changes in these governing parameters are usually examined by comparing different granular materials, or the same material with different particle-size distributions. In this study, we propose a simplified approach in which mixing constituent materials modifies the pore geometry and, in turn, changes the absorption profile of granular materials. We compare three granular materials with particle sizes spanning 1 to 7 mm and their mixtures. Two mixture types were studied: bi-modal and tri-mixtures. Mixtures were evaluated against their respective constituent materials using impedance-tube sound absorption measurements. Equivalent-fluid and fluid-solid coupled acoustic-impedance models tailored to granular materials were then used with a sensitivity analysis to identify which parameters are most affected by mixing, and how these changes explain the observed differences in sound absorption relative to the mono-granular cases.

1.1.5 Acoustic & Elastic Metamaterials

Mon 14:00–15:20 — Riverbank Room 2 (Chair: Wonju Jeon, Andrew Hall)

14:00: Paper 15 — Research on Global Non-Local Coupling for Enhanced Sound Absorption in Acoustic Metamaterials — *Mr Xiaowei Zhang*

14:20: Paper 215 — Diffuse sound absorption of finite Helmholtz resonator metasurfaces — *Prof Xianhui Li*

14:40: Paper 673 — Broadband sound absorption using tunable acoustic metasurface with asymmetric adjustable apertures — *Dr Jiwan Kim*

15:00: Paper 809 — Design and sound absorption mechanism of bio-inspired hierarchical honeycomb acoustic metamaterials — *Dr Xinte Wang*

14:00 **Paper 15 — Research on Global Non-Local Coupling for Enhanced Sound Absorption in Acoustic Metamaterials**

1 Chunping Niu, ***Mr Xiaowei Zhang****, Professor Xiaopeng Wang*

Non-local coupled acoustic metamaterials utilize direct connections between subunits to generate strong interactions, offering significant potential for acoustic manipulation. However, existing designs primarily rely on localized connections between specific adjacent units, lacking a comprehensive framework for global interactions. To fully exploit the potential of non-local coupling, this paper proposes a global non-local acoustic metamaterial (GNAM) model that integrates multiple units through a shared medium. The structure is systematically investigated through theoretical modeling, numerical simulations, and experimental validation. Results demonstrate frequency-independent coupling behaviors among all GNAM components, which collectively drive a downward shift in resonance frequencies. This low-frequency shift, which directly improves broadband absorption, scales with the number of participating subunits. As an application, an absorber targeting the 50–100 Hz range was designed and tested. The experimental data show an average absorption coefficient of approximately 0.9 with a deep-subwavelength thickness of only 1/24 of the maximum operating wavelength. This study elucidates the physical mechanisms of global non-local coupling, providing a scalable approach for designing advanced low-frequency acoustic metamaterials.

14:20 **Paper 215 — Diffuse sound absorption of finite Helmholtz resonator metasurfaces**

Prof Xianhui Li*, Xingjie Lai, Tuo Xing, Yifan Zhang, Dr. Xiaoling Gai*

While acoustic metasurfaces are frequently tuned using normal-incidence impedance targets, this approach neglects the complex diffraction phenomena inherent to finite-sized structures in reverberant fields. This work systematically examines the divergence between normal and diffuse sound absorption coefficients for a small, baffled Helmholtz resonator array. By employing a matrix-based formulation, we calculate the diffuse sound absorption coefficient of the HR array, rigorously accounting for the finite-size radiation impedance that standard infinite-periodic models ignore. The results quantify how edge effects and inter-resonator coupling alter the absorption magnitude compared to normal-incidence predictions. We identify two distinct impedance-matching regimes—individual versus array-averaged radiation resistance—governed by the density of the resonator layout. Furthermore, the theoretical limit of absorption is shown to scale with the squared wavelength. This analysis offers a physics-based correction method, allowing researchers to predict realistic diffuse-field performance from small-scale prototypes that fall below the minimum size requirements of ISO 354 reverberation chamber standards.

14:40 **Paper 673 — Broadband sound absorption using tunable acoustic metasurface with asymmetric adjustable apertures**

Dr Jiwan Kim*, Yerin Shim, Dr Wonju Jeon*

We present a novel tunable acoustic metasurface that enables low-frequency broadband sound absorption through mechanically adjustable apertures. The metasurface is composed of sub-wavelength Helmholtz resonators, each incorporating an adjustable aperture within the neck region. Asymmetric control of the aperture closure between adjacent resonators introduces geometrical asymmetry, which induces hybrid resonance and facilitates impedance matching at target frequencies. A metasurface sample employing iris-diaphragm-inspired adjustable apertures is fabricated using three-dimensional

printing, and its near-perfect absorption at selected frequencies within a tunable range of 400–540 Hz is experimentally validated through impedance tube measurements. Furthermore, by assembling unit cells with independently controlled apertures, the metasurface achieves high absorption exceeding 90% over a one-third octave band (390–485 Hz) while retaining its tunable characteristics.

15:00 **Paper 809 — Design and sound absorption mechanism of bio-inspired hierarchical honeycomb acoustic metamaterials**

Dr Xinte Wang, *Dr Xinbiao Xiao*

Controlling low-frequency broadband noise in confined spaces remains a major engineering challenge. This paper outlines a systematic design roadmap and the structural evolution of bio-inspired hierarchical honeycomb acoustic metamaterials. The methodology progresses from fundamental property analysis to the exploration of unidirectional topological evolutions, including outward vertex-substitution and inward spiderweb-inspired nesting. To resolve the discrete absorption dips inherent in pure parallel configurations, a series-parallel coupled architecture inspired by the multi-scale tissues of banana pseudostems is synthesized. As a further advancement, a bidirectional topological reconfiguration method is introduced, which integrates inward nesting and outward vertex-substitution within a unified honeycomb matrix. By employing independent scaling factors for both topological directions, this approach achieves a higher degree of structural freedom to induce tight coupling between complementary resonance modes. To manage the resulting high-dimensional parameter space, the Marine Predators Algorithm (MPA) is implemented for target-driven inverse design. This comprehensive review demonstrates how the precise coupling of diverse resonance modes achieves continuous broadband impedance matching from 0 to 4 kHz without increasing the overall structural thickness. The summarized framework establishes a pathway to transform passive load-bearing honeycombs into active broadband acoustic modulators for complex engineering applications.

Mon 16:00–17:20 — Riverbank Room 2 (Chair: Wonju Jeon, Andrew Hall)

16:00: Paper 579 — Inverse Design of Mode-Conversion Metasurfaces for Multifunctional Elastic Wavefront Manipulation — *Mrs Jiarui Li*

16:20: Paper 687 — Realization of triple-negative complementary metamaterial for ultrasound transmission through elastic barrier — *Dr Wonju Jeon*

16:40: Paper 106 — Dual-functional modular acoustic metamaterial for on-demand noise and vibration control: A numerical study — *Mr Hongshan Pan*

17:00: Paper 796 — Waveguide absorbers based on spiral acoustic black holes for broadband vibration reduction — *Mr Dongheon Jo*

16:00 **Paper 579 — Inverse Design of Mode-Conversion Metasurfaces for Multifunctional Elastic Wavefront Manipulation**

Mrs Jiarui Li, *Mrs Ali Chen, Prof. Yue-Sheng Wang*

In ultrasonic non-destructive testing, the mechanism of P-wave incidence and SV-wave reception is fundamental for identifying internal cracks. However, conventional piezoelectric transducers face two critical bottlenecks: low mode conversion efficiency and the inability to manipulate the transmitted wavefront, which severely restricts the signal-to-noise ratio and spatial resolution of detection. This study proposes an elastic metasurface that achieves high-efficiency P-to-SV mode conversion while simultaneously enabling wavefront manipulation of the transmitted SV-wave through synergistic design of parameter optimization and topology optimization. A set of eight unit cells covering a 2π phase range was designed, all achieving P-to-SV mode conversion efficiency exceeding 97% at the operating frequency of 1.04 MHz. Based on the generalized Snell's law, phase gradients were arranged using these unit cells, successfully achieving directional deflection and focusing in COMSOL simulations. The results demonstrate that the designed metasurface achieves precise manipulation of the transmitted SV-wavefront while completing mode conversion. This study provides a passive, ultra-thin, high-transmission-efficiency wavefront manipulation device for the front-end of ultrasonic phased array probes, with clear application prospects in structural health monitoring and non-destructive evaluation.

16:20 **Paper 687 — Realization of triple-negative complementary metamaterial for ultrasound transmission through elastic barrier**

Dr Ki Yong Lee, Mr Chankyu Kim, ***Dr Wonju Jeon***

In this study, a complementary metamaterial is proposed for ultrasonic transmission through an elastic barrier. The proposed metamaterial exhibits triple-negative effective properties of mass density, bulk modulus, and shear modulus, which play an important role in acoustically canceling out the existence of the barrier. Its unit cell consists of a monolithic aluminum frame with systematically arranged local resonators, each comprising an inertial mass linked to the surrounding matrix via slender flexural beams. This unit cell is tailored to induce multiple resonances, which are the origins of the triple negativities. The transmissibility of ultrasound through the barrier, when the metamaterial is attached to a single side of the barrier, is increased by fourfold in transmitted acoustic intensity compared to the bare barrier. Reciprocity verification under the reverse direction of the input plane wave implies over a 16× increase in the intensity of the returning echo, indicating the potential applicability of this technology in ultrasonic brain imaging or non-destructive evaluation.

16:40 **Paper 106 — Dual-functional modular acoustic metamaterial for on-demand noise and vibration control: A numerical study**

Mr Hongshan Pan*, Prof Xiang Yu, Prof Kai Zhou*

Noise and vibration frequently coexist in engineering environments, adversely impacting human well-being and system performance. Acoustic metamaterials offer a promising approach for simultaneous control of both phenomena, enabling low-frequency sound absorption and vibration suppression. However, the acoustic and vibrational properties of existing multifunctional designs are fixed after fabrication and inherently coupled, which prevents independent, on-demand performance design and optimization. To overcome these limitations, this study proposes a modular metamaterial that decouples sound absorption from vibration bandgaps. The design integrates a supporting base plate with interchangeable acoustic units based on Helmholtz resonators, connected by an adjustable column. Numerical analyses demonstrate that replacing acoustic units with different geometries allows precise tuning of sound absorption without altering the vibration bandgap. Conversely, adjusting the height of the connecting column simply using a bolt shifts the bandgap frequency while leaving acoustic absorption largely unaffected. This clear decoupling of functions enables flexible and adaptive control of noise and vibration. The proposed architecture holds significant potential for real-world applications where dynamic operating conditions require reconfigurable solutions. It is particularly suited for transportation systems and building structures that demand efficient, dual-functional mitigation of both noise and vibration.

17:00 **Paper 796 — Waveguide absorbers based on spiral acoustic black holes for broadband vibration reduction**

Mr Dongheon Jo*, Mr Taehwan Son, Dr Wonju Jeon*

A waveguide absorber (WGA) based on a spiral acoustic black hole (ABH) has been proposed as a compact form of an ABH that can be locally mounted on the surface of a vibrating structure without compromising the structural integrity of the vibrating structure. Vibration isolation platforms are widely used to reduce vibration transmission from machinery mounted on the platforms to the host structures on which the platforms are installed. In this study, a solution using WGAs based on spiral ABHs is proposed to reduce the structural vibration of a vibration isolation platform and the resulting vibration-induced noise radiated from the host structure. The attachment positions and directions of the WGAs are determined based on the elastic wave energy flow in the vibration isolation platform, taking into account the spatial constraints of the installation space. In addition, a non-identical WGA configuration is considered to reduce the total mass of the WGA solution for practical applications. Numerical results show that the WGAs reduce structural vibration and vibration-induced noise over a broad frequency range. Experimental validation using a simplified vibration isolation platform model demonstrates that the proposed solution reduces vibration transmitted to the host structure and the resulting vibration-induced noise.

Tue 09:00–10:00 — Riverbank Room 2 (Chair: Wonju Jeon, Andrew Hall)

09:00: Paper 132 — Tunable Multi-resonant Sonic Crystal for optimized industrial noise attenuation — *Mr Chetan Chalurkar*

09:20: Paper 773 — Compact acoustic metasurfaces with complex impedances for reducing low-frequency tonal noise generated by rotating point forces — *Ms Eunjin Yang*

09:40: Paper 443 — Broadband Acoustic Attenuation using Helmholtz Resonator Combinations — *Mr. Jin-Je Park*

09:00 **Paper 132 — Tunable Multi-resonant Sonic Crystal for optimized industrial noise attenuation**

Mr Chetan Chalurkar, *Dr Sneha Singh*

Multi-resonant sonic crystal (MRSC) provides an effective alternative for industrial noise control solutions due to multiple complete band gaps, low to mid frequency attenuation, and compactness with ventilation. This study analyses the noise generated by the blower of heavy machinery to determine the targeted frequencies for noise attenuation. The proposed design of MRSC consists of two concentric C-shaped resonant scatterers where the acoustic properties of the MRSC are tuned by varying the orientation angles of the slits of the scatterers. The effect of the orientation is investigated with numerical analysis. The opposite orientation of the slit of the scatterers minimizes central frequency and generates multiple complete band gaps due to local resonance for enhanced broadband noise reduction at the low-mid frequency range. A multi-objective algorithm is used to tune these angles for optimized sound attenuation at the targeted frequency ranges. Additionally, optimization algorithm is validated numerically with a mean error of 1.91% for the central frequency and 3.67% for the bandwidth of the first and second complete band gaps. This study proposes a fine-tuning approach for multiple frequency-selective and application-oriented noise control strategies without changing the overall dimension of the structure.

09:20 **Paper 773 — Compact acoustic metasurfaces with complex impedances for reducing low-frequency tonal noise generated by rotating point forces**

Ms Eunjin Yang, *Dr Jiwan Kim, Dr Wonju Jeon*

We present a compact acoustic metasurface with complex-valued surface impedances for reducing low-frequency tonal noise generated by rotating point forces in a short duct. A time-domain analysis is conducted in conjunction with spatial and spectral analyses to account for the unsteady radiation characteristics of noise from rotating point forces arising from rotational motion and time-varying aerodynamic loading. The metasurface is implemented on the inner duct wall with unit cells containing sub-wavelength Helmholtz resonators, whose effective impedances are tuned to complex values that minimize the radiated power, based on a theoretical model that accounts for visco-thermal losses in narrow orifices. Numerical results show that the metasurface can effectively confine acoustic energy to a near-wall region and markedly attenuate radiation through the duct opening at the tonal frequency. By incorporating multiple types of unit cells tailored to different target harmonics, the design method is further extended to address multi-frequency tonal noise. These results suggest that the compact metasurface with optimally tuned complex impedances can offer practical applicability to tonal noise mitigation in ducted rotors and fans.

09:40 **Paper 443 — Broadband Acoustic Attenuation using Helmholtz Resonator Combinations**

Mr. Jin-Je Park, *Prof Sung-hwan Shin*

Efficient suppression of low-frequency noise (below 2 kHz) within HVAC duct systems remains a significant challenge due to the inherent narrowband characteristics of conventional passive treatments. To address this, we propose a cylindrical rainbow-trapping absorber (CRTA) architecture: an axially oriented Helmholtz-resonator (AO-HR) array. The acoustic performance of this configuration was evaluated using the transfer matrix method (TMM) to determine transmission and reflection behavior. To achieve optimal broadband performance, the geometric parameters of the resonators were meticulously tuned using a sequential quadratic programming (SQP) algorithm, focusing on maximizing and leveling the absorption coefficient across the target frequency spectrum. The optimized AO-HR achieved a notable average absorption of 0.85 within the 300–1000 Hz range, although its spectral efficiency was constrained by axial space requirements. These results underscore the critical role of spatial arrangement and resonator tuning in enhancing impedance matching and achieving robust noise control in cylindrical waveguides.

Tue 10:40–12:00 — Riverbank Room 2 (Chair: Wonju Jeon, Andrew Hall)

10:40: Paper 616 — Acoustic metasurfaces with complex-valued impedances for indoor sound-field uniformity — *Ms Eunji Choi*

11:00: Paper 671 — Compact lens-free acoustic computer based on bilayer metagrating — *Mr Chankyu Kim*

11:20: Paper 187 — A comparative analysis of acoustic scattering from sound-hard objects under diverse excitation schemes — *Mr Avijit Majee*

11:40: Paper 134 — Effect of Channel Geometry on the Acoustic Performance and Size of Coplanar Labyrinthine Acoustic Metamaterial — *Mr Siddharth Shrivastava*

10:40 **Paper 616 — Acoustic metasurfaces with complex-valued impedances for indoor sound-field uniformity**

Ms Eunji Choi, *Dr Jiwan Kim, Dr Wonju Jeon*

Uneven low-frequency sound in enclosed spaces remains a key issue in compact listening environments, where modal behavior drives large differences in sound pressure level according to listening position. We propose acoustic metasurfaces that control the room response by presenting a complex-valued impedance at a localized region. This metasurface improves sound-field uniformity while avoiding excessive attenuation of acoustic energy. The desired impedance value is implemented using sub-wavelength Helmholtz resonators with different neck radii, whose geometrical parameters are delicately adjusted to satisfy both the desired impedance and compactness constraints. The acoustic performance is predicted from full-wave numerical simulations that include important characteristics at low frequencies, which are wave scattering from the local treatment and thermo-viscous losses inside narrow tudes. The results show that a localized installation of thin metasurfaces can markedly reduce the spatial variation of sound level in a listener region at a target low frequency, despite using only a minute volume relative to the room compared with conventional bulky treatments. We then experimentally validate the predicted uniformity improvement of the designed metasurface by using a scaled-down prototype.

11:00 **Paper 671 — Compact lens-free acoustic computer based on bilayer metagrating**

Mr Chankyu Kim, *Dr Wonju Jeon*

We propose a lens-free approach for acoustic analog computing based on a bilayer metagrating, with a specific focus on implementing first-order spatial differentiation. Unlike conventional Fourier-based acoustic analog computers that require bulky lens systems for spatial–wavenumber domain conversion, the proposed design performs differentiation directly in the spatial domain. The operating principle of the bilayer metagrating is investigated using an effective-medium analysis, revealing that cascading two metagrating layers with opposing phase gradients compensates for the diffraction-induced transverse wavenumber shift and results in a linear response with respect to the transverse wavenumber. As a result, the structure exhibits key characteristics of first-order spatial differentiation. The proposed concept is further examined through the design of a practical structure based on space-coiled unit cells. Full-wave simulations demonstrate spatial differentiation of the acoustic fields in the presence of visco-thermal losses. The proposed compact analog computer offers a pathway toward acoustic signal-processing implementations for real-time, low-power operation.

11:20 **Paper 187 — A comparative analysis of acoustic scattering from sound-hard objects under diverse excitation schemes**

Mr Dinesh Chand Foujdar, ***Mr Avijit Majee***, *Dr. Amrita Puri*

Acoustic scattering plays a crucial role in the process of identifying objects. Acoustic scattering patterns depend on the characteristics of the incident acoustic field and on its interaction with the object geometry. Conventional methods in this field analyse the scattering fields of well-known object geometries. However, different acoustic fields produce distinct scattering patterns for different objects' geometries. This study presents a comparative analysis of the scattering effects produced by the interaction of various acoustic fields with distinct sound-hard object geometries. The different types of acoustic field considered here are tonal, multitonal, narrowband, and broadband, respectively. The object geometries considered are circular, elliptical, and square-shaped objects for the sharp corner effect, as well as arbitrary polygons for studying asymmetric geometry. The simulation framework was conducted in COMSOL Multiphysics. For a comparative analysis of objects' scattering behaviour, key metrics, such as surface maximum pressure, spatial variance, and directivity index, are evaluated for each acoustic field. The results describe object-specific scattering patterns and how scattering is influenced by geometry, shape, and incident acoustic field.

11:40 **Paper 134 — Effect of Channel Geometry on the Acoustic Performance and Size of Coplanar Labyrinthine Acoustic Metamaterial**

Mr Siddharth Shrivastava*, Prof Sneha Singh*

Achieving efficient low-frequency sound absorption below 500 Hz using compact structures remains a fundamental challenge in acoustic metamaterial engineering. While passive acoustic metamaterials (AMMs) demonstrate strong potential for low-frequency noise control, their practical implementation is often hindered by intrinsically narrow absorption bandwidths and the need for bulky, thick configurations. To address these limitations, we propose the Rectangular Coplanar Labyrinthine Acoustic Metamaterial with Multiple Holes (RECLAMMH). The design employs a coplanar straight-folded labyrinth integrated with an array of millimeter-scale perforations to enhance impedance matching and energy dissipation. Acoustic performance is systematically investigated using COMSOL Multiphysics through a virtual two-microphone impedance-tube transfer-function method. Parametric analyses demonstrate that channel geometry provides effective control over resonant absorption. In particular, increasing channel width and channel depth shifts the resonance toward lower frequencies, by modifying the effective acoustic path and wave propagation characteristics within the structure, Furthermore, increasing the number of coplanar channels introduces multiple resonant pathways, which can improve impedance matching and enhance low-frequency absorption. These results confirm deep subwavelength absorption within a compact thickness, demonstrating RECLAMMH's potential for efficient, space-saving low-frequency noise mitigation.

1.2.1 Measurement Methods: General

Tue 14:00–15:20 — Panorama Room 1 (Chair: Wan-Ho Cho, Con Doolan)

14:00: Paper 27 — Average Maximum Sound Level: A Complementary Metric for Environmental Noise Assessment — *Mr Ben Hall*

14:20: Paper 64 — A Two-Microphone Standing Wave Tube Method for Measuring the Transmission Loss of Symmetric Systems — *Prof J. Stuart Bolton*

14:40: Paper 423 — Vibration Measurement Methodologies: Mounting Techniques and Effectiveness — *Mr Andrew Durrer*

15:00: Paper 439 — Characterization of porous media in extended frequencies in tube measurements: A Bayesian approach — *Mr Ziqi Chen*

14:00 **Paper 27 — Average Maximum Sound Level: A Complementary Metric for Environmental Noise Assessment**

Mr Ben Hall

Many existing environmental approvals and licence conditions in Australia specify noise limits as an A-weighted 'average maximum' or 'LAmax,adj,T'. These descriptors originated in an era when analogue sound level meters were used and compliance was assessed by observing and informally averaging meter needle peak excursions. Modern digital sound level meters do not reproduce that observational process directly, and practitioners have commonly adopted the LA10 despite it being a time-exceedance percentile rather than an average of maxima. This paper presents the Average Maximum Sound Level (LAFmax,T), a repeatable empirical method for calculating the arithmetic mean of maximum levels over consecutive time intervals. The method provides a practical and repeatable approximation of the historical "average maximum" concept, reduces subjective variability, and offers a more appropriate legacy-assessment descriptor than LA10 in environments characterised by recurring maxima. A formal technical specification, ILTS-AC-001:2025, has been developed to support consistent implementation.

14:20 **Paper 64 — A Two-Microphone Standing Wave Tube Method for Measuring the Transmission Loss of Symmetric Systems**

Dr. Guochenhao Song, Prof Tongyang Shi, ***Prof J. Stuart Bolton***

Acoustic insulation material is widely used in noise control applications ranging from architectural acoustics to automotive noise vibration and harshness (NVH). Sound transmission loss (STL) is the key parameter used to judge the performance of acoustic insulation systems, and the four-microphone impedance tube transfer matrix method is widely used to measure the STL following the ASTM E2611 standard. That testing procedure is relatively complicated and requires extra set-up and equipment when compared with the two-microphone impedance tube measurement following the ASTM E1050 standard. It is then of interest to determine whether the STL can be measured with two-microphone set-up, which would expand the application of the two-microphone impedance tube configuration and also provide the possibility of measuring the STL and sound absorption coefficient of a sample simultaneously. Therefore, in the present work, a closed-form expression has been derived to compute the transmission loss of symmetric systems based on two surface normal impedance measurements with different backing conditions, thus offering a practical and efficient alternative to the four-microphone procedure. The accuracy of this approach has been validated through comparisons with STL predictions obtained from both simulations and real measurements.

14:40 **Paper 423 — Vibration Measurement Methodologies: Mounting Techniques and Effectiveness**

Mr Andrew Durrer

Ground vibration measurements are widely used in acoustics and environmental assessments to evaluate vibration impact from sources such as construction, transportation, industrial activity and more. The accuracy of triaxial ground vibration data depends strongly on the mounting technique used to couple sensors to the ground and this paper's goal is to assess the commonly used mounting techniques and compare to some more creative yet easy to access mounting techniques (ie. Ground screws). Measurements are completed at multiple sites representing typical ground conditions, comparing surface-mounted, shallow-buried, mechanically anchored, and foundation mounted sensor installations. The influence

of mounting technique on coupling quality, frequency response, measurement errors and measurement repeatability is evaluated under a controlled environment. This paper hopes to provide practical recommendations for field deployment of triaxial vibration sensors and support improved consistency and comparability of ground vibration measurements in acoustics and environmental assessments.

15:00 **Paper 439 — Characterization of porous media in extended frequencies in tube measurements: A Bayesian approach**

***Mr Ziqi Chen**, Prof. Ning Xiang*

The study builds on the three-microphone impedance tube method used for characterizing porous media. Using multiple microphones, this work extends the frequency range for measuring characteristic impedance. A challenge arises in the wavenumber spectrum due to discontinuities from the inverse cosine function. To resolve this, this work applies Bayesian inference sequentially to unwrap the complex-valued wavenumber spectrum, thereby determining the propagation coefficient and characteristic impedance of a porous material under test. Preliminary results suggest this approach offers a principled and flexible method for broadband characterization of porous media, even when inversion ambiguities are present.

Tue 16:20–17:40 — Panorama Room 1 (Chair: Wan-Ho Cho, Con Doolan)

16:20: Paper 441 — Measurement Method for Vibration and Structure-Borne Noise in Steel Staircases Using Impact Ball Excitation — *Mr Ren Yamamoto*

16:40: Paper 497 — A hybrid synchronisation framework integrating acoustic reference events and pulse-per-second signals for scalable acoustic recording platforms — *Mr Jin Xuan Teh*

17:00: Paper 520 — Spatial Variability and Convergence of Damping Loss Factor for a Thin Panel from Structural Reverberation Time — *Mr Yousif Badri*

17:20: Paper 615 — Development of guidelines for requirements and performance evaluation procedures for appropriate use of hearing evaluation booths in various environmental conditions — *Dr Wan-Ho Cho*

16:20 **Paper 441 — Measurement Method for Vibration and Structure-Borne Noise in Steel Staircases Using Impact Ball Excitation**

***Mr Ren Yamamoto**, Dr Aakriti Shrestha, Mr Keiju Kojima, Mr Toshiaki Ogura, Mr Kosuke Hashima, Mr Kuruna Kurosawa, Dr Takafumi Shimizu*

Steel staircases with slender designs, long spans, and lightweight construction are increasingly used in contemporary buildings, often causing vibration and structure-borne noise issues that affect occupant comfort. Systematic evaluation methods remain limited, as finite element analysis requires detailed model construction and careful boundary-condition settings, making it impractical for routine design practice. This study introduces an impact ball excitation method for assessing vibration and structure-borne noise in steel staircases under consistent testing conditions. A composite waveform synthesized by releasing an impact ball from a 5 cm height onto each tread replicated human-induced vibrations across all tested conditions—walking and running, both up and down—by remaining within the fluctuation range of measured human-induced accelerations. This indicates adequate engineering equivalence for vibration assessment. However, discrepancies were observed in the structure-borne noise evaluation. In the acoustically relevant frequency range of 63–500 Hz, differences of 5 dB or more were observed between synthesized and human-induced waveforms. Since floor impact sound ratings in JIS A 1419-2 are evaluated in 5 dB steps, these discrepancies are practically significant, suggesting that further validation is required before applying the method to noise assessment.

16:40 **Paper 497 — A hybrid synchronisation framework integrating acoustic reference events and pulse-per-second signals for scalable acoustic recording platforms**

*Miss Siyu Zhang, **Mr Jin Xuan Teh**, Mr. Mingxue Song, A/Prof Yusuke Hioka*

Accurate time synchronisation is essential for enabling recordings from multiple acoustic recording platforms to be temporally aligned and jointly processed for wide-area acoustic data collection. Acoustic events can provide a common temporal

anchor to align recordings from different platforms, however, they typically achieve only coarse alignment. In contrast, pulse-per-second signals provide a stable timing reference tied to Coordinated Universal Time, but in many practical recording platforms, absolute timestamps are not explicitly logged, leaving the initial alignment ambiguous. This paper presents a practical hybrid synchronisation framework that integrates an acoustic event with pulse-per-second signals to achieve reliable alignment across multiple acoustic platforms. The acoustic event is first used to establish a consistent temporal reference across platforms and to identify the corresponding pulse-per-second epochs. The pulse-per-second signals are then integrated to construct a consistent time mapping between platforms. Two model variants are considered: an affine model that accounts for sampling rate offset, and a constant-offset model. The proposed synchronisation framework is evaluated using sound source localisation as a representative example for assessing synchronisation performance. Simulation and experimental results demonstrate that the proposed framework improves synchronisation accuracy and enables stable performance in acoustic analysis tasks requiring high-precision time alignment.

17:00 **Paper 520 — Spatial Variability and Convergence of Damping Loss Factor for a Thin Panel from Structural Reverberation Time**

Mr Yousif Badri*, Mr Gian Schmid, A/Prof Michael Kingan, Dr George Dodd, Prof Brian Mace*

This project has been prompted by measuring rainfall noise in the laboratory according to relevant ISO Standards (e.g., ISO 10848-1 and the ISO 10140 series). The test set up is calibrated using a reference glazing element with prescribed properties, dimensions, and boundary conditions. If these cannot be confirmed or differ, suitability is verified by measuring its damping loss factor from structural reverberation time. In such a case the ISO standard specifies the sensor and exciter separations to be used but this limits the possible specimen geometries. We have set out to determine a more general acquisition method by assessing the spatial variability of the loss factor for a nominally homogeneous, isotropic aluminium panel, and hence determine the minimum number of excitation/measurement points required for a stable estimate. The panel was 2 mm thick, with an effective surface area of 1.4m × 1.2m, and was clamped along three edges using wooden beams. We sampled over 30 random spatial configurations using uniform sampling with minimum separation and edge-spacing constraints, using one excitation point and two accelerometers per configuration. Results show no strong spatial dependence of loss factor, but frequency-dependent loss factor convergence to a stable mean as the number of points increases.

17:20 **Paper 615 — Development of guidelines for requirements and performance evaluation procedures for appropriate use of hearing evaluation booths in various environmental conditions**

Dr Wan-Ho Cho*, Mr Dong-Hyuk Lee, Prof. Young Joon Seo*

The result of field survey on the situation of audiometric test booths being used in various fields is presented and the guidelines on required specifications and evaluation methods are investigated for their appropriate application. Requirements on background noise for audiometric tests are specified in ISO 8253-1. However, soundproof booths for audiometric test have fundamental limitation in sound insulation in the low frequency range. This may cause problems that the range that satisfies measurement standards is narrowed depending on environmental conditions in actual sites. Recently, attempts to apply smart devices or kiosks to audiometric tests are increasing to expand accessibility of hearing screening test. However, it may also increase number of tests under non-conformed conditions in comparison with the tests conducted in general clinics. To improve the reliability of test, the proper assessment of environmental condition and the clarification of requirements for appropriate testing should be conducted in on-site. Here, the measurements of background conditions in various environments where booths will be installed are conducted, and the requirements of the booth are investigated according to the required test range and precision. In addition, the procedures and considerations for appropriate evaluation in on-site condition are investigated.

Wed 08:40–09:40 — Panorama Room 1 (Chair: Wan-Ho Cho)

08:40: Paper 737 — Investigating Acoustic Modal Analysis — *Dr Dale Smith*

09:00: Paper 783 — Absolute Measurement of sound pressure and particle velocity using a cardioid microphone in a standing wave tube — *Prof Kazuma Hoshi*

09:20: Paper 832 — New investigations into the dynamics of axisymmetric rings — *Mr Mahdi Mohammadi*

08:40 **Paper 737 — Investigating Acoustic Modal Analysis**

***Dr Dale Smith**, Mr Oscar Carter, Mr Paul Kirkwood*

Modal analysis is widely used to understand the dynamic properties of a structure and forms a critical part of validating a structures design and in the diagnosis of noise and vibration problems. Modal analysis is typically carried out by instrumenting a structure with an array of accelerometers. However, there can be a number of challenges associated with this approach, including gaining access to a structure, inability to affix sensors to the structure or added mass effects. Further, instrumentation can be time consuming. There is therefore a need for a more efficient approach that can also overcome issues associated with access. In this contribution, we explore the capability of near-field acoustic holography for evaluating the modal parameters of structures. The modal properties of two simplified structures are investigated using an accelerometer-based approach, an acoustic camera with acoustic holography processing, and a finite element analysis. The results from each are compared in order to evaluate the ability of the acoustic method to compute the modal properties of the studied structures.

09:00 **Paper 783 — Absolute Measurement of sound pressure and particle velocity using a cardioid microphone in a standing wave tube**

***Prof Kazuma Hoshi**, Prof Toshiki Hanyu*

We have been developing a new probe for receiving sound pressure and particle velocity using a combination of cardioid microphones. A methodology for correcting both the sound pressure and particle velocity sensitivities of a cardioid microphone has been proposed. Furthermore, measurement results of the absorption coefficient of porous materials obtained using a cardioid microphone in an impedance tube have been reported.

In the present study, to ascertain the capability of a cardioid microphone, absolute-value measurement tests were conducted in a standing wave tube. Two distinct terminal conditions and two different receiving positions were prepared to examine whether a cardioid microphone could accurately measure both physical quantities under various conditions. Several types of cardioid microphones were used in the experiments, and an omnidirectional microphone as well as a Microflown P–U probe were employed as reference sensors. As a result, the sound pressure and particle velocity characteristics could be obtained using any type of cardioid microphone under all tested conditions within the controlled frequency range. The differences between the results obtained with the cardioid microphones and those from the reference sensors were very small.

09:20 **Paper 832 — New investigations into the dynamics of axisymmetric rings**

*Dr Benjamin Halkon, Miss Ella Covington, Dr Robert Perrin, **Mr Mahdi Mohammadi***

Axisymmetric structures are extremely common in a range of industries such as automotive and (aero)space, Defence, process industries etc.. As such, much previous work has gone into measuring and understanding the dynamic properties of these structures. This paper builds on earlier contributions by describing experimental modal analysis experiments conducted using scanning laser Doppler vibrometry (SLDV) and associated solutions for a pair of mild steel, square cross-section, axisymmetric rings of differing dimensions. This experimentation has enabled a degree of spatial resolution and quality of results which can now be readily compared with finite element analysis (FEA) results in terms of eigenfrequency and eigenvector prediction for vibration modes which are dominated by on-axis vibration (namely axial and torsional modes). The agreement between simulation and this new experimentation is found to be very strong. The importance of being able to correctly identify and classify experimental mode shapes using their equivalents from FEA – especially for the higher frequency modes and as the aspect ratio of the rings vary – is highlighted. Comparison of these new results is made to previously published work, again with excellent agreement. Ultimately, the previously proposed threshold of the “generalized thin ring condition” is questioned with recommendations for future work included.

1.2.2 Microphone and Loudspeaker Array Techniques

Tue 09:00–10:20 — City Room 3 (Chair: Yusuke Hioka)

09:00: Paper 24 — Rotational speed and direction estimation for rotating beamforming using a planar microphone array — *Mr Cheng Wei Lee*

09:20: Paper 68 — Research on Measurement Methods for Spatial Resolution of Spherical Microphone Arrays — *Dr Feng Niu*

09:40: Paper 85 — Simultaneous Estimation of Acoustic Power and Directivity of Multiple Industrial Noise Sources Using Microphone Arrays — *Mr Loïc Boileau*

10:00: Paper 111 — Physics-Informed Deep Learning for Spatial Interpolation in Sparse Microphone Arrays — *Dr Agustinus Oey*

09:00 **Paper 24 — Rotational speed and direction estimation for rotating beamforming using a planar microphone array**

***Mr Cheng Wei Lee**, Dr. Wei Ma*

Rotating beamforming methods rely on accurate rotational speed and direction, yet these inputs are often unavailable, unsynchronized, or uncertain in practical measurements. A preprocessing framework is presented to infer the rotational speed and direction directly from planar microphone array measurements without additional sensors or a coaxial array–axis arrangement. Rotational speed is estimated using two complementary multi-channel cues, cepstrum analysis and Hilbert-envelope spectral analysis, and fused using peak-significance metrics for robustness across different spectral characteristics and noise conditions. Rotation direction is inferred from the sign of the first azimuthal spatial mode of the envelope field using each microphone's polar angle around a known rotation center. Simulations and experiments demonstrate that the inferred rotational speed and direction are accurate enough to support rotating beamforming without relying on dedicated speed sensors.

09:20 **Paper 68 — Research on Measurement Methods for Spatial Resolution of Spherical Microphone Arrays**

***Dr Feng Niu**, Mr Zhuo Qian, Mr Longbiao He, Ms Zhaoqi Qin*

Research was conducted on the measurement and calibration of azimuthal resolution for full-space sound source localization systems using spherical microphone array beamforming. Two sound sources were placed symmetrically, and two incoherent pure-tone signals with a frequency difference were employed as test signals to circumvent coherent interference, while the array was positioned on the perpendicular bisector of the two sound sources. With the system's display dynamic range fixed at 3 dB, the measurement of azimuthal resolution index and the evaluation of its measurement uncertainty were achieved in an anechoic chamber by precisely adjusting the coordinate positions of the two sound sources. Experimental results indicate that the proposed method exhibits excellent repeatability. This work provides a scientific and feasible technical scheme for the quantitative evaluation of azimuthal resolution of spherical arrays, offering methodological support for the development of relevant metrological standards and engineering applications.

09:40 **Paper 85 — Simultaneous Estimation of Acoustic Power and Directivity of Multiple Industrial Noise Sources Using Microphone Arrays**

***Mr Loïc Boileau**, Dr Pierre Grandjean, Prof. François Grondin, Dr. Thomas Padois, Prof. Nicolas Quaegebeur*

Accurately characterizing the radiation of acoustic sources remains a critical requirement for the development of effective noise-mitigation strategies. However, estimating the acoustic power and directivity of in situ industrial sources is particularly challenging (complex plant environments, strong reverberation, multi-source interference); conditions that prevent the application of standard characterization methods. This work proposes a method for the simultaneous estimation of acoustic power and far-field directivity of multiple noise sources using microphone arrays. These arrays enhance observability in multi-source scenarios and provide an enclosure-free alternative to standard in situ techniques, which are typically limited to single-source measurements. Based on an inverse spherical harmonic expansion, the radiated field of each source is approximated by a truncated set of spherical harmonic modes. This low-order representation assumes that the dominant radiated energy is captured by monopole, dipole, and quadrupole components—an assumption well suited to the low-frequency regime (below 500 Hz) prevalent in industrial noise. Numerical results show estimation errors below 1 dB

for acoustic power and below 5 % for surface-averaged directivity when characterizing three simultaneously active sources at a signal-to-noise ratio of 30 dB, using 96 microphones distributed across planar and spherical arrays. Experimental validation will be investigated in future work.

10:00 **Paper 111 — Physics-Informed Deep Learning for Spatial Interpolation in Sparse Microphone Arrays**
***Dr Agustinus Oey**, Dr Benjamin Soenarko, Dr. Jiho Chang, Dr Indra Sihar, Mr. Juho Jung*

A physics-informed, data-driven framework for enhancing acoustic imaging performance using sparse microphone arrays is presented. The method addresses spatial sampling limitations of compact array configurations without increasing sensor count or modifying array hardware. The approach is inspired by the Equivalent Source Method (ESM). To improve numerical stability and reduce source redundancy, candidate equivalent source locations are generated in the far field, and an optimized subset is selected based on conditioning criteria.

The resulting physically consistent interpolation operator is reformulated as a structured neural network, with parameters initialized from the ESM solution and further refined through data-driven training using randomly generated acoustic scenes. A physical 4×4 microphone array with a 178 mm aperture size is adopted as the base sensing configuration in simulation and experimental design.

Simulation and experimental results demonstrate the proposed network successfully extrapolates 16-microphone physical data to a 72-microphone concentric virtual array, sharpening main lobes and suppressing spatial aliasing. Monte Carlo evaluations across 1,000 random scenes confirm highly accurate wavefield reconstruction, achieving mean RMS errors of 1.43 dB at 2 kHz and 1.80 dB at 5 kHz. These findings suggest that physics-guided learning provides a practical pathway for improving acoustic imaging with sparse microphone arrays.

Tue 11:00–12:00 — City Room 3 (Chair: Yusuke Hioka)

11:00: Paper 248 — Post-refinement of MVDR beamforming using spatially informed independent component analysis for underdetermined source separation in reverberant environments — *Mr Jin Xuan Teh*

11:20: Paper 279 — Hear, There, or Everywhere: Compact Acoustic Vector Sensor Arrays for Sound Source Localisation — *Ms Lorian Marshall*

11:40: Paper 582 — Three-Dimensional Near-Field Acoustic Source Localization with an Offset Microphone Array — *Mr Patel Shreyas*

11:00 **Paper 248 — Post-refinement of MVDR beamforming using spatially informed independent component analysis for underdetermined source separation in reverberant environments**
***Mr Jin Xuan Teh**, Assistant Professor Kouei Yamaoka, Professor Hiroshi Saruwatari, A/Prof Yusuke Hioka*

This paper investigates whether time-varying minimum-variance distortionless response (MVDR) beamforming weights can be used to form local subproblems with fewer effectively active sources for source separation in underdetermined reverberant environments. We propose spatially informed clustered frequency-domain independent component analysis (FD-ICA) guided by MVDR beamforming weights for underdetermined reverberant source separation. For each source and frequency bin, time frames are clustered according to the similarity of the MVDR weights. Then, FD-ICA is subsequently applied to the original microphone observation within each cluster, initialised by the average MVDR weight vector of that cluster. This preserves the spatial prior and source ordering provided by MVDR while relaxing the fixed steering-vector assumption of the initial MVDR model through cluster-wise statistical optimisation. Experiments using measured room impulse responses show that the proposed method consistently improves separation performance, achieving 12 - 13 dB signal-to-interference ratio improvement and 0.31 - 0.36 short-time objective intelligibility improvement in a seminar-room condition (C = 15.9 dB) for a three-microphone array and mixtures containing three to seven sources. These results indicate that the method preserves performance close to the determined case even when the mixture is underdetermined.

11:20 **Paper 279 — Hear, There, or Everywhere: Compact Acoustic Vector Sensor Arrays for Sound Source Localisation**

***Ms Lorian Marshall**, Dr Dave Matthews, Dr Chaoying Bao, Dr Jie Pan*

Compact autonomous platforms such as unmanned aerial vehicles (UAVs) and mobile robots demand acoustic sensing capabilities that conventional microphone arrays cannot deliver. Standard arrays trade aperture for accuracy. Resolving directional ambiguity requires large spatial separation, which limits deployment in size-constrained applications. Acoustic vector sensors (AVS) measure sound pressure and particle velocity at co-located points, offering superior directional resolution. Yet systematic implementation and characterisation of AVS-based localisation remains largely absent from the literature.

This work demonstrates sound localisation of a point source utilising a single AVS and a two-element configuration. The analytical beam pattern is derived for both far-field and near-field regimes, establishing that a single element resolves both bearing and near-field range, the latter carried by the pressure-velocity phase rotation rather than spatial aperture. Two spatially separated elements localise arbitrary source positions by triangulation, extending the operational envelope beyond the single-element near-field limit.

Performance is compared against a uniform linear array (ULA) under identical Minimum Variance Distortionless Response (MVDR) beamforming. Angular error and range resolution are characterised across multiple frequencies and validated experimentally. By providing systematic AVS implementation and performance characterisation, this study addresses a key barrier preventing adoption of vector sensing in aperture-constrained platforms.

11:40 **Paper 582 — Three-Dimensional Near-Field Acoustic Source Localization with an Offset Microphone Array**

***Mr Patel Shreyas**, Mr Sreeram Barathula, Prof. K. Srinivasan*

Equivalent source method (ESM) has emerged as an effective approach for near-field acoustic source localization (ASL) due to its high spatial resolution, particularly in low-frequency regimes and complex acoustic environments. In many real-world situations, sound sources are not confined to a single plane but are distributed across different depths, highlighting the challenge of three-dimensional source localization in acoustic diagnostics and engineering analysis. This study addresses this challenge by investigating the localization of multiple sound sources positioned at different depths using a planar microphone array, with emphasis on the influence of source depth variation on localization performance and sound field reconstruction. Image source method–based simulations are employed to systematically analyze these effects under noise-free conditions as well as in the presence of gaussian noise, while accounting for offset microphone array configurations where the array is not directly aligned with the sources. Both sparsity-based and non-sparsity-based regularization techniques are applied to mitigate the inherent ill-posed nature of the ESM framework. The results indicate that reliable three-dimensional source localization is achievable even at gaussian noise levels up to 20% under low-frequency conditions. These findings provide insight into low-frequency ASL under three-dimensional measurement conditions.

1.2.4 New Developments with Basic Machinery Noise Emission Standards

Mon 14:00–15:00 — Panorama Room 1 (Chair: Volker Wittstock)

14:00: Paper 223 — Some remarks on the uncertainty concepts used in ISO-standards on sound emission — *Prof Volker Wittstock*

14:20: Paper 274 — Project LpScan – developing a simplified sound power measurement method based on sound pressure scanning — *Mrs Deborah Brosig*

14:40: Paper 326 — Quantification of Structure-Borne and Airborne Electric Machine Noise Shares in the Interior of a Battery Electric Vehicle — *Mr Simon Böld*

14:00 **Paper 223 — Some remarks on the uncertainty concepts used in ISO-standards on sound emission**
Prof Volker Wittstock

Airborne sound emission of machinery is characterised by the sound power level or the emission sound pressure level. ISO standards define how these quantities and their uncertainties are to be determined. In principle, two different approaches exist for the uncertainty determination. The first is to use the reproducibility standard deviation as derived from interlaboratory tests. Such uncertainties are given in the respective standards. The second approach is to derive a detailed model of the measurement, and to establish an uncertainty budget. This second approach used to be contained in annexes of the respective ISO-standards, but it is now shifted to the newly published ISO 5114-1. In both approaches, possible variations in the measurand due to instabilities in operating and mounting conditions are covered by a separate standard deviation. The contribution explains both existing concepts and discusses possible consequences.

14:20 **Paper 274 — Project LpScan – developing a simplified sound power measurement method based on sound pressure scanning**
Mrs Deborah Brosig*, Prof Volker Wittstock, Dr Fabian Heisterkamp*

To reduce noise and noise pollution at work as well as at home, the Sell & Buy Quiet concept has been introduced. Employers and other buyers give preference to quieter machines and other products during procurement, while manufacturers develop and market comparatively quiet machines and other products with reliable noise emission declarations. A key quantity to enable this concept for employers and consumers is the sound power level, which is determined and declared for machinery, household appliances, outdoor equipment, etc. However, the established and standardized methods for determining the sound power level are often time-consuming or require expensive equipment. In practice, although not standardized yet, the sound power level is already measured using a single microphone that is moved over the measurement surface. This method aims to be standardized as an ISO standard, supplementing the existing standards, i.e., the ISO 9614 series and the ISO 3740 series. This contribution presents the joint research project F 2571 of the Federal Institute for Occupational Safety and Health (BAuA) and the Physikalisch-Technische Bundesanstalt. First analytical results regarding the form of the scanning path, measurement distance, and different shapes of measurement surfaces are discussed. Additionally, measurement results from laboratory and in-situ measurements are presented.

14:40 **Paper 326 — Quantification of Structure-Borne and Airborne Electric Machine Noise Shares in the Interior of a Battery Electric Vehicle**
Mr Simon Böld*, Mr Tongfang Fu, Mr Philipp Diel, Mr Lin Gu, Dr.-Ing. Christoph Steffens, apl. Prof. Dr.-Ing. Marco Günther, Prof. Dr.-Ing. Stefan Pischinger*

In battery electric vehicles (BEV), the absence of masking combustion noise increases the perceptibility of tonal interior noise generated by the electric drive unit (EDU). Identifying the noise root causes requires quantifying the relative contributions of structure-borne and airborne transmission paths, which is challenging due to the high complexity of the vehicle system.

This study presents an experimental quantification of EDU-related interior noise shares in operating conditions in a BEV, distinguishing between structure-borne and airborne transmission mechanisms. Unlike conventional vehicle NVH studies that threat these mechanisms separately, the proposed approach allows their combined assessment.

Structure-borne noise contributions are evaluated using a transfer path analysis framework. Virtual point transformation is applied at the mechanical connection points between the EDU and vehicle body. Stationary frequency response functions are combined with operational vibration data to determine structural excitations and corresponding interior noise contributions.

Airborne noise and panel contributions are assessed through reciprocal, volume-velocity-based acoustic transfer functions between interior receiver positions, vehicle panels, and the EDU, combined with operational sound pressure and panel velocity measurements.

The method is demonstrated on a series-production BEV, revealing order- and frequency-dependent dominance of structure-borne and airborne noise contributions. The proposed methodology supports targeted NVH optimization of electric powertrains.

1.2.6 Tone Definition and Evaluation

Tue 14:00–15:40 — Panorama Room 3 (Chair: Doug Manvell, Lars Sommer Søndergaard)

14:00: Paper 40 — The search for a common ISO tonal noise assessment methodology — *Mr Doug Manvell*

14:20: Paper 739 — AI Based Approaches to Noise Annoyance and Tonal Audibility Using Listening Tests and Insights from Standardization Work — *Mr Lars Sommer Søndergaard*

14:40: Paper 754 — Tonal audibility, tonality criteria for rating adjustments, and narrow band tone emergence with ISO 1996-2 engineering and survey methods — *Mr Colin Tickell*

15:00: Paper 534 — Reliability of engineering-method noise software for tonal audibility assessment of stationary industrial sources, with a focus on BESS — *Dr Alireza Moazen Ahmadi*

15:20: Paper 707 — Auralisation Based Analysis of Tonality Assessment Procedures and Associated Outcomes — *Mr Artur Moreira*

14:00 **Paper 40 — The search for a common ISO tonal noise assessment methodology**

Mr Doug Manvell

The idea for a common tonal methodology for noise assessment arose in 2005. A group including expertise within office machine standards and environmental noise standards was formed to develop a common tone detection method which could be applied to all SC1's immission standards. This resulted in a unified procedure based on the existing ISO 1996 FFT method.

In 2016, ISO/PAS 20065 "Acoustics – Objective method for assessing the audibility of tones in noise – Engineering method" was published, and in 2020 converted into a Technical Specification to enable continued referral from ISO 1996-2. In 2018, the ISO 7779 revision was completed but with a different method.

In 2015, DIN German standards began preparing an international engineering grade standard on assessing tonal prominence for acoustics, intended to be the common tonal methodology.

In 2024, ISO TC43 SC1 established an international Ad Hoc Group to determine the need, interest and scope for a common ISO tonal standard, with membership open to experts from ISO, IEC and ECMA. The Ad-Hoc Group's first milestone is to report to the ISO Noise plenary meeting in August 2026.

This paper describes the background for and the initial results of the Ad-Hoc Group.

14:20 **Paper 739 — AI Based Approaches to Noise Annoyance and Tonal Audibility Using Listening Tests and Insights from Standardization Work**

Mr Lars Sommer Søndergaard*, Mr Torben Holm Pedersen*

Audible tonal components in noise are known to increase the perceived annoyance compared to broadband noise with the same overall level. Many national regulations therefore apply tonal "penalties" to the measured noise levels to account for the additional annoyance caused by clearly audible tones. Although several objective, psychoacoustically based methods exist to assess tonal audibility, their results often diverge. This diversity can be explained partly by regional differences and partly by different application areas such as office equipment, ventilation systems, wind turbines, and general environmental noise.

In 2024, ISO/TC43/SC1 established an international Ad Hoc Group to evaluate the need, interest, and scope for developing a unified ISO standard for tonal assessment. The group's first milestone is a progress report to the ISO Noise Plenary in August 2026.

Parallel to this, an ongoing project on Intelligent Sound Perception with AI investigates the relationship between noise and annoyance using complex, multidimensional datasets, including acoustic measurements and subjective feedback. The project explores intelligent analytical and computational tools for annoyance assessment based on established models and metrics, with tonal audibility as a central parameter.

This paper summarizes the ongoing progress.

14:40 **Paper 754 — Tonal audibility, tonality criteria for rating adjustments, and narrow band tone emergence with ISO 1996-2 engineering and survey methods**

Mr Colin Tickell*, Mr Stephen Collings*

ISO 1996-1, AS1055 and other national Standards for environmental noise assessment provide for adjustment of a measured LAeq,t sound level by addition of adjustments for potentially annoying characteristics such as tonality, impulsivity, intermittency and similar. The adjusted sound level is called the rating sound level for comparison with environmental noise objectives. For tonality, ISO 1996-2 provides two methods to determine an adjustment; the engineering method based on tonal audibility determined by ISO/PAS 20065 with narrow-band spectral analysis results, and a survey method based on one-third octave band differences between adjacent band levels and this is used in AS1055:2018. This paper compares the level of narrow-band tone emergence above the adjacent frequencies to tonal audibility in ISO/PAS 20065 and the associated one-third octave band method, for four different narrow-band frequency resolutions. This is done while adjusting a typical modified industrial noise spectrum for single frequency tones at the specific frequency resolution. The intention is to determine if a ready-reckoner can be provided for assessing if tonal criteria are exceeded based on the narrow-band tone emergence value.

15:00 **Paper 534 — Reliability of engineering-method noise software for tonal audibility assessment of stationary industrial sources, with a focus on BESS**

Dr Alireza Moazen Ahmadi*, Dr Shahrokh Sepehrirahnama*

Battery Energy Storage Systems (BESS), often exhibiting unique tonal characteristics, are expanding rapidly and are increasingly proposed close to noise-sensitive receivers. As tonal characteristics can attract up to 6 dB penalties, reliable prediction of tonal audibility is critical to feasibility, mitigation design, and operational limits. Contemporary environmental noise assessments for BESS commonly use energy-based, octave-band ray-tracing models, e.g., as per ISO 9613-2, CONCAWE. Although efficient and widely accepted, these methods were not developed to evaluate tones as defined in ISO 1996-2 and can therefore misrepresent tonal audibility. This paper explains why such models can systematically mis-predict tonal characteristics and quantifies the resulting uncertainty. Three coupled mechanisms are shown to dominate: (1) octave-band spectral averaging that obscures narrowband tonal peaks; (2) incoherent energy summation that removes ground-reflection phase interference governing the tone-to-noise ratio; and (3) simplified barrier-diffraction treatments that suppress frequency-dependent insertion-loss variations that are critical for pure tones. A parametric numerical study, benchmarked against Parabolic Equation and Boundary Element Method predictions, tracks how these effects impact compounded errors propagate into tonal-characteristic calculations and identifies conditions under which conventional models are likely to under- or over-predict tonal penalties.

15:20 **Paper 707 — Auralisation Based Analysis of Tonality Assessment Procedures and Associated Outcomes**

Mr Artur Moreira

Tonality is widely regarded as a significant contributor to the perceived annoyance of noise in all settings. As a result, many noise regulations incorporate a tonal penalty into the measured noise level to account for the increased annoyance caused by tonal components.

A common procedure for assessing tonality is outlined in ISO 1996-2, which compares the level of a specific frequency band with its adjacent bands to detect tonal components. While widely adopted (particularly in environmental assessments in countries such as the USA, Ireland, and Australia), this method may not be sufficient for all tonal scenarios, especially when tonal characteristics fall between 1/3-octave bands or involve subtle tonal features.

This study explores the limitations of methods such as the 1/3-octave method through the generation of auralisations. By auralising noise data with varying tonal characteristics, we demonstrate how 1/3-octave band analysis may fail to capture fine tonal detail and harmonic complexity, thereby underscoring the method's limitations in nuanced acoustic environments.

The findings suggest the need for a more refined approach to tonal assessment, capable of addressing a broader range of tonal scenarios, particularly where narrowband analysis or higher frequency resolution techniques are required for precise tonal identification.

1.3.1 Modeling & Simulation Techniques: General

Wed 14:00–15:40 — Panorama Room 1 (Chair: Elke Deckers, Massimo Garai)

14:00: Paper 255 — Contemporary Noise and Vibration Tool for Metro Systems — *Mr Rukmangad Sanjay Barad*

14:20: Paper 559 — Topology optimization of vibration band gaps in a metamaterial plate for low-frequency vibration isolation — *Chandramouli Padmanabhan*

14:40: Paper 690 — The Lombard effect - Further validation of prediction parameters for the expanded model of patron conversational noise levels. — *Mr Glenn Leembruggen*

15:00: Paper 708 — Damping Performance and Variability of Sub-Millimeter Particle Dampers Based on Cycle-Resolved Energy Dissipation — *Mr Sachito Nakano*

15:20: Paper 763 — Modelling and Mitigation of Isolator Surge Modes in Vibration Isolation Systems — *Mr Ben White*

14:00 **Paper 255 — Contemporary Noise and Vibration Tool for Metro Systems**

Mr Rukmangad Sanjay Barad, *Mr Parsa Mofrad*

This paper outlines the development of a contemporary noise and vibration tool for rapid prediction and optimisation of track-form for metro/subway systems operating in tunnels, viaducts or at-grade. The tool was developed for Sydney Metro, initially for the City and Southwest alignments, and subsequently applied to the West and Airport alignments. It was thereafter adapted to suit North-American assessment methods. The tool integrates a 3D geographical-database (GIS), including sub-surface geotechnical parameters and 3D lithology, with 3D metro/subway alignments models (BIM). It allows for the rapid prediction of all noise and vibration metrics (in-tunnel, in-car, ground-borne, structure-borne and airborne), and assesses cumulative effects across project delivery contracts (line-wide, LW; trains, systems, operations and maintenance, TSOM; stations and over-station developments, integrated or otherwise).

14:20 **Paper 559 — Topology optimization of vibration band gaps in a metamaterial plate for low-frequency vibration isolation**

Chandramouli Padmanabhan, *Chaitanya Morey, Prof Tahsin Khajah, Sundararajan Natarajan*

Attenuation of low-frequency vibration in machines remains a challenge due to long flexural wavelengths. A topology optimization framework is presented for thin elastic metamaterial plates that exhibit band gaps in the first 3-4 flexural modes. Reissner-Mindlin plate theory accounts for transverse shear deformation, while shear locking is mitigated using the discrete shear gap technique. Dispersion relations are computed using the finite element method with Bloch-Floquet periodic boundary conditions, enabling direct evaluation of bandgap formation within a prescribed low-frequency range.

The optimization objective is to maximize bandgap width while satisfying material volume constraints. The topology is iteratively updated using a density-based topology optimization approach. To accurately capture the evolving geometry and reduce computational burden, the approach proposed by Arrutselvi and Natarajan [1] is adopted. This approach ensures improved boundary representation and reduces numerical inaccuracies associated with distorted or non-conforming elements during the optimization process.

The proposed integration of topology optimization, dispersion analysis, and adaptive meshing provides an efficient and robust framework for designing lightweight metamaterial plates for low-frequency vibration and noise control applications.

[1] M Arrutselvi, S Natarajan, A Cartesian mesh approach to embedded interface problems using the virtual element method, Journal of Computational Physics, v 508, 112997, 2024.

14:40 **Paper 690 — The Lombard effect - Further validation of prediction parameters for the expanded model of patron conversational noise levels.**

Mr Glenn Leembruggen

In 2021, the author introduced an extension to the simple model that J. H. Rindel developed to predict conversational patron noise in social gatherings. The extended model includes calculations in octave bands, the direct sound field of talkers, sound absorption from people, room constants and changes in speech spectrum with talker level. Two parameters

having a large influence on predicted patron noise levels are the speaking group size and the Lombard ratio, both of which could vary significantly. With a view to determining typical values for these parameters, further measurements of noise levels from gatherings of patrons were compared with predictions using the extended model. With single values for each of these parameters, the predictions show a high degree of similarity with the measurements.

15:00 **Paper 708 — Damping Performance and Variability of Sub-Millimeter Particle Dampers Based on Cycle-Resolved Energy Dissipation**

Mr Sachito Nakano

Selective Laser Melting (SLM) retains raw powder (particle size: tens of micrometers) within a sealed chamber, enabling the embedding of particle dampers (PD) within structures manufactured by SLM. However, most previous PD research has focused on large particles larger than 1 mm and low-frequency ranges below 100 Hz. Consequently, evaluation and modeling of PD damping characteristics and particle behavior in the particle size range from tens of micrometers to submillimeters and in the 100–1000 Hz frequency band remain underdeveloped. In this study, the input load and vibration acceleration (9–148 m/s^2 (rms)) of particle dampers composed of spherical zirconia balls with nominal diameters of 0.05, 0.10, 0.20, and 0.40 mm were measured at different frequencies (100–800 Hz). Equivalent viscous damping coefficients were identified on a cycle-by-cycle basis using the dissipated energy obtained from force-displacement hysteresis loops. The results showed that 0.05 mm particles maintained a standard deviation ratio close to unity relative to the empty container while achieving the highest variability-penalized damping score. In contrast, larger particles exhibited substantially higher variability and lower scores. These findings indicate that fine particles can provide both effective damping and reproducible performance through the collective averaging of numerous small contact events.

15:20 **Paper 763 — Modelling and Mitigation of Isolator Surge Modes in Vibration Isolation Systems**

Mr Ben White

This paper presents the design of an isolation system for sensitive medical imaging equipment in a hospital to address a ground-borne vibration problem with a 5 Hz dominant frequency. To achieve sufficient isolation performance in both the horizontal and vertical axes with a passive system, coil springs were used. The system was predicted to achieve the desired performance, but with a spring surge mode corresponding to common pump operating frequencies and footfall induced vibration of the base structure. The surge frequency is dictated by the mass and stiffness of the active coils of the spring and can nullify the benefit of the isolation system if not adequately damped. This paper presents the modelling approach which was used to calculate isolation system transmissibility accounting for the effect of isolator surge modes. The modelling approach showed that commonly specified approaches to counteract surge modes such as rubber pads beneath the isolators would be ineffective. An alternative approach was developed using the model to damp the spring surge modes and counteract their detrimental effect on the isolation system performance while minimizing added stiffness.

1.3.3 Acoustics and Vibration modeling of Electrical Machines

Tue 16:20–17:40 — Panorama Room 3 (Chair: Will Robertson, Anthony Zander)

16:20: Paper 399 — Time-Domain Prediction of Experimentally Measured Multirotor Noise Using Gaussian Process Models — *Mr Minhyuk Kim*

16:40: Paper 653 — Energy-Based Electro-Mechanical Design Framework for Noise and Vibration in Power Electronic PCBs — *Ms Sae Higemoto*

17:00: Paper 674 — Multi-Physics Simulation for Vibration-Noise Analysis of an EV Coolant Actuator — *Mr JuYoung Kim*

17:20: Paper 710 — Electromagnetic Vibration and Noise Analysis of Servo Motors Using Finite Element Method — *Mr Hayato Naojima*

16:20 **Paper 399 — Time-Domain Prediction of Experimentally Measured Multirotor Noise Using Gaussian Process Models**

Mr Minhyuk Kim, *Prof Jeongwoo Ko*

A Gaussian Process (GP)–based framework is presented for probabilistic modeling and prediction of multirotor noise measured in real-world environments under hovering and forward-flightconditions. Building on previous GP modeling developed using simulated multirotor noise, this study extends the framework to experimentally measured data. To enable effective GP learning from experimental measurements, a data modulation and preprocessing procedure is proposed. The measured noise time signals are processed through modulation, filtering, and signal decomposition to isolate tonal and broadband components to condition signals for modeling while preserving the acoustic characteristics of the original signal. These processed signals are used to train the GP model, enabling uncertainty-aware prediction of time-domain acoustic pressure signals. The realism of the GP-based predictions is evaluated by comparing raw measured signals, processed signals, and GP-predicted signals using acoustic and psychoacoustic metrics. Furthermore, the probabilistic nature of the GP framework is exploited for uncertainty quantification, allowing uncertainties inherent in experimentally measured multirotor noise to be assessed and propagated through the prediction process providing reliable interpretation of noise predictions. The results demonstrate that the proposed approach achieves perceptually realistic noise predictions when applied with experimentally measured data and supports its application to urban air mobility noise assessment under uncertain operating conditions.

16:40 **Paper 653 — Energy-Based Electro-Mechanical Design Framework for Noise and Vibration in Power Electronic PCBs**

Ms Sae Higemoto, *Prof Toru Yamazaki, Mr Yoshihiro Shirahashi, Mr Tateki Oka*

In modern electronic systems, printed circuit boards (PCBs) are no longer passive mechanical supports, but key structures where vibration, noise, and energy transmission interact. Mounted power components such as coils and capacitors can act as excitation sources, leading to structure-borne noise and vibrational energy propagation across the board.

In current practice, PCB design is mainly driven by electrical and thermal requirements, while vibration and acoustic aspects are often treated as secondary concerns. Therefore, a unified methodology that connects component placement with vibrational energy flow remains limited.

This study proposes a framework for noise- and vibration-aware design based on Analytical Statistical Energy Analysis (Analytical SEA). By modeling the PCB as a mechanical medium and a pathway for vibrational energy propagation, the proposed approach provides a holistic view of how excitation conditions and mounting locations influence vibration energy distribution and transfer.

The main contribution of this work is the introduction of a design concept based on energy transmission, integrating electrical components and structural vibration behavior within a unified framework. This foundation supports future quantitative investigations and practical guidelines for vibration-conscious PCB layout design. In future work, the framework will be extended toward multi-physics perspectives, incorporating thermal effects alongside noise and vibration considerations.

17:00 **Paper 674 — Multi-Physics Simulation for Vibration-Noise Analysis of an EV Coolant Actuator**

***Mr JuYoung Kim**, Mr Jeongwoo Woo, Mr Chan woo Park, Mr Hong min Jang, Prof Yeon June Kang*

Electric-vehicle (EV) coolant-control actuators integrating a BLDC motor and multi-stage plastic gears can radiate audible tonal noise. Accurate prediction of both motor-rotating tonal frequencies and gear mesh frequency (GMF) components is therefore critical for early NVH assessment and design optimization.

This paper proposes a multi-physics simulation workflow that couples electromagnetic excitation to drivetrain dynamics and acoustic radiation. Electromagnetic forces are first computed in ANSYS Electronics Maxwell 2D using transient analysis. The time-domain radial force acting on the stator is extracted over electrical cycles and exported for system-level use. This force is then imported and mapped in ANSYS Motion, where the full actuator system is modeled as a multi-body drivetrain including plastic gears. The simulation provides time-domain responses such as housing vibration, and post-processing of order spectra identifies motor orders, GMF, and their harmonics; the housing response is further used for free-field sound pressure prediction.

The predicted vibration response of the actuator housing is in reasonable agreement with measurement in terms of dominant peak frequencies, indicating that the proposed workflow can capture key excitation orders and structural amplification. The developed process offers a practical foundation for NVH assessment and design optimization of small actuator systems.

17:20 **Paper 710 — Electromagnetic Vibration and Noise Analysis of Servo Motors Using Finite Element Method**

***Mr Hayato Naojima**, Mr Kazuhiko Ohno*

The miniaturization and efficiency improvements of motors have heightened the demand for noise reduction. Motor noise can be categorized into mechanical, aerodynamic, and electromagnetic noise. Servo motors, widely used in semiconductor manufacturing equipment, industrial robots, and machine tools, often suffer from electromagnetic vibration and noise. These issues arise due to the resonance between the electromagnetic forces and structural eigenmodes of the stator. To predict such vibration and noise during the design stage, it is essential to accurately model the electromagnetic forces and vibration characteristics of the stator. This study employs an electromagnetic–structural–acoustic analysis based on the finite element method to evaluate the generation and propagation of electromagnetic noise. Traditionally, the vibration characteristics of laminated stator cores have been identified experimentally. However, changes in geometry or material often compromise accuracy, requiring repeated experiments and lowering development efficiency. To address this, we apply an analytical method based on contact-stiffness modeling to identify vibration characteristics more effectively. The applied method is validated by comparing numerical analysis results with experimental data for servo motors, achieving a noise prediction accuracy of approximately 3 dB. These results demonstrate its potential to enhance the design process, improve efficiency, and reduce noise in servo motors.

1.3.5 Artificial Intelligence and Machine Learning for Diagnosis in Acoustics & Vibration

Wed 14:00–15:20 — Riverbank Room 4 (Chair: Adrian Morris)

14:00: Paper 209 — Deep learning-based filtering of cross-spectral matrices using generative adversarial networks — *Dr Christof Puhle*

14:20: Paper 659 — Transfer Learning-Based Multi-Fidelity Deep Neural Network Modeling for Aerodynamic and Noise Optimization of a Dryer Centrifugal Fan System — *Mr Mun Seong Hwang*

14:40: Paper 741 — Vibration-Based Fault Diagnosis of Vehicle Axle with Physics-Guided Deep Neural Network: A mathematical Approach — *Mr Jaewon Song*

15:00: Paper 768 — Validation of bending wave speed of viscoelastic panels using a transfer function method — *Prof. Ning Xiang*

14:00 **Paper 209 — Deep learning-based filtering of cross-spectral matrices using generative adversarial networks**

Dr Christof Puhle

In this paper, we present a deep-learning method to filter out effects such as ambient noise, reflections, or source directivity from microphone array data represented as cross-spectral matrices. Specifically, we focus on a generative adversarial network (GAN) architecture designed to transform fixed-size cross-spectral matrices. Theses models were trained using sound pressure simulations of varying complexity developed for this purpose. Based on the results from applying these methods in a hyperparameter optimization of an auto-encoding task, we trained the optimized model to perform five distinct transformation tasks derived from different complexities inherent in our sound pressure simulations.

14:20 **Paper 659 — Transfer Learning-Based Multi-Fidelity Deep Neural Network Modeling for Aerodynamic and Noise Optimization of a Dryer Centrifugal Fan System**

Mr Mun Seong Hwang

This study introduces a deep-learning-based multi-fidelity design process to improve aerodynamic performance and noise prediction accuracy in an appliance dryer's multi-blade centrifugal fan and scroll. Ten key geometric design variables for the fan and scroll were used to build a surrogate model that expands the design space while capturing parameters that dominate drying performance. To lower the computational cost of generating data in this expanded space, we adopted transfer learning by first pretraining a surrogate model on a primary database, then refining it with a larger, higher-fidelity secondary database. The resulting deep neural network surrogate was optimized using automated machine learning. This framework yields high predictive reliability and greater data efficiency compared with conventional multi-fidelity models. Optimization results show that the fan design generated by the model increases flow rate and reduces noise relative to the baseline. Overall, the proposed methodology provides an effective means of optimizing centrifugal fan systems while managing the computational resources needed for training deep learning models.

14:40 **Paper 741 — Vibration-Based Fault Diagnosis of Vehicle Axle with Physics-Guided Deep Neural Network: A mathematical Approach**

Mr Jaewon Song, *Prof Byeongil Kim*

Vehicle axles are subjected to cyclic stresses caused by repetitive loads and external excitations during operation. These stresses may induce faults in spline joints and bearings, which are difficult to detect at an early stage and may lead to structural damage if left unaddressed. Therefore, reliable early fault diagnosis is essential. This study proposes an RPM-aware Orbit Physics-Guided Network (OPG-Net) for vibration-based fault diagnosis of vehicle axles. The axle is modeled as a half shaft, and faults in bearings and spline joints are incorporated into the dynamic model. Vibration responses are analyzed, and orbit images extracted at the location exhibiting the maximum response amplitude are used as inputs to OPG-Net. The proposed network performs multi-task learning by simultaneously classifying fault types and estimating geometric orbit parameters, including aspect ratio, area, and orientation, while incorporating rotational speed information as

an additional input. Compared with a conventional orbit-based classifier trained solely for fault classification, the proposed method achieved higher classification accuracy. The results demonstrate that incorporating orbit geometry and rotational speed information enables stable fault classification under varying speed and fault conditions, contributing to reliable early diagnosis of vehicle axles.

15:00 **Paper 768 — Validation of bending wave speed of viscoelastic panels using a transfer function method**
Prof. Ning Xiang

Experimental characterization of bending wave properties of viscoelastic panels plays a central role in prediction bending wave propagation through the constrained damping layers for noise control engineering. A transfer function method has been developed to determine the bending wave properties of viscoelastic panels. This work continues the previous effort [Xiang et al. (InterNoise 2025)] but focuses on an experimental approach to bending wave propagation coefficient, being of central importance for the prediction of the wave propagation. At the same time, it represents the key function of deriving other bending wave properties, including the bending phase speed, Young's modulus, and the loss factor of viscoelastic panels. The experimental method under investigation involves a laser Doppler vibrometer (LDV). The laser beam of the LDV senses the bending velocities of two surface points on the panel under test. This work estimates the propagation coefficient as a primary quantity to derive other bending wave properties including the bending phase speed, Young's modulus, and the loss factor. After a brief introduction of the theoretical basis, this paper discusses how to validate the bending phase speed experimentally measured using this method, with the intention of determining the other parameters from the propagation coefficient measurements.

1.3.6 Data-driven and Machine Learning Methods for Modeling and Design in Acoustics & Vibration

Tue 11:00–12:20 — Panorama Room 1 (Chair: Shahrokh Sepehrirahnama, Claus Claeys)

11:00: Paper 198 — Transfer Learning for Tonal Noise Prediction in VRF Units Using Thermodynamic and Vibration Signals — *Dr Zhiwei Su*

11:20: Paper 191 — Data-driven approximation of high-frequency vibrational energy distributions: A transfer operator approach — *Dr Lama Hamadeh*

11:40: Paper 328 — Invertible Neural Operators for Generative Design of Acoustic Metamaterials — *Mr Mert Dogu*

12:00: Paper 760 — AI-based stochastic optimization of compact mufflers for aerospace duct noise reduction — *Miss Lilliana Wang*

11:00 **Paper 198 — Transfer Learning for Tonal Noise Prediction in VRF Units Using Thermodynamic and Vibration Signals**

***Dr Zhiwei Su**, Dr Yang Qiao, Dr Ding Wang, Dr Hongjun Cao*

The 2nd harmonic (2f) noise generated by twin-rotary compressors is the dominant noise source in variable refrigerant flow(VRF) units due to its high energy. However, under variable operating conditions, such as environmental changes and valve opening adjustments, this noise exhibits significant variability, making it difficult to assess using traditional physical models. This paper proposes an unsupervised transfer learning framework based on Domain-invariant Partial Least Squares (DiPLS) to accurately predict 2f noise levels under new conditions using different signals. Prediction models utilizing thermodynamic signals and acceleration signals are constructed respectively, and the generalization performance of the proposed DiPLS is systematically compared with traditional Partial Least Squares (PLS). Results demonstrate that DiPLS significantly outperforms PLS by extracting cross-condition common features and minimizing the distribution discrepancy between the source and target domains. Specifically, the acceleration-based DiPLS model achieves the best performance, maintaining prediction errors within 3 dB for all test cases. This superiority over thermodynamic-based models highlights a physical insight: while thermodynamic states drive dynamic changes, structural vibration possesses a stronger and more direct causal link to acoustic radiation.

11:20 **Paper 191 — Data-driven approximation of high-frequency vibrational energy distributions: A transfer operator approach**

***Dr Lama Hamadeh**, Dr David Chappell*

Accurate prediction of high-frequency noise and vibration in complex built-up structures remains a key challenge. Such phenomena are governed by highly oscillatory equations, for which standard numerical methods become prohibitively expensive at high frequencies. Energy-based approaches, including Statistical Energy Analysis and ray tracing, offer computationally viable alternatives in certain circumstances. Dynamical Energy Analysis (DEA) bridges the gap between these methods by describing the evolution of ray densities in phase-space via a transfer operator. As such, DEA provides a ray-based approach that is not limited by reflection order.

This work presents a data-driven implementation of DEA using Extended Dynamic Mode Decomposition (EDMD). Phase-space data are partitioned into locally smooth clusters, within which the transfer operator is efficiently approximated. Improved accuracy is achieved by employing Legendre polynomial approximations within these data clusters and/or through an additional sub-division of the phase-space along the directional axis. This yields a versatile and accurate DEA framework that is made computationally tractable through the data-driven construction of the transfer operator.

11:40 **Paper 328 — Invertible Neural Operators for Generative Design of Acoustic Metamaterials**

***Mr Mert Dogu**, Jonas M. Schmid, Johannes D. Schmid, Mr Markus Mörwald, Prof Steffen Marburg*

Acoustic metamaterials offer powerful opportunities to control acoustic wave propagation by exploiting engineered subwavelength architectures. However, their practical design is complicated by highly nonlinear parameter dependencies, strong modal interactions, and the high cost of computing acoustic responses across broad frequency ranges. These challenges

motivate the adoption of alternative design strategies beyond conventional optimization and surrogate-based approaches. This contribution presents a generative design framework for acoustic metamaterials based on invertible neural operators. The proposed approach learns a bijective mapping between metamaterial design parameters and their frequency-domain acoustic response, enabling both forward prediction and generative design within a unified model. The framework generates a distribution of feasible metamaterial configurations for a given target response by representing design ambiguity through low-dimensional latent variables. Once trained, the invertible neural network enables rapid exploration of the design space, real-time prediction of responses, and generation of diverse design candidates that meet specified acoustic performance objectives. The results demonstrate that invertible neural networks provide an efficient and flexible tool for generative design of acoustic metamaterials, significantly reducing computational effort. This approach opens new possibilities for interactive design and scalable deployment of acoustic metamaterial concepts in real-world applications.

12:00 **Paper 760 — AI-based stochastic optimization of compact mufflers for aerospace duct noise reduction**

Miss Lilliana Wang*, Jason Zhang, Prof Zhaoyan Zhang*

Traditional aerospace duct systems generate noise levels that often exceed acoustic requirements, impairing speech intelligibility, increasing the risk of hearing damage, and posing a serious safety concern in space exploration environments where reliable communication is essential. Currently, there is limited research on artificial intelligence (AI) based optimization of compact acoustic muffler designs for aerospace duct systems, where strict size and weight constraints significantly restrict feasible solutions. This study evaluates the effectiveness of three stochastic AI optimization algorithms—Genetic Algorithm (GA), Particle Swarm Optimization (PSO), and Differential Evolution (DE)—for constrained optimization of muffler chamber geometry. An optimization framework is developed to minimize added weight while satisfying a transmission loss (TL) target, subject to bounds on chamber length and diameter. TL is computed using a closed-form equation or transfer-matrix model, and a feedforward neural network surrogate model is introduced to enable efficient evaluation of more complex designs. Algorithms are tested across three cases involving single- and multi-chamber configurations, and performance is evaluated and compared based on the feasibility of optimized geometries. Results demonstrate that AI-based optimization can efficiently generate initial muffler designs, reducing the time and cost required for computationally intensive finite element analysis of complex designs within fast design iteration cycles.

1.3.7 Acoustic Design using Optimization Methods

Tue 16:20–17:40 — City Room 2 (Chair: Tongyang Shi, Yangfan Liu)

16:20: Paper 120 — Inverse Design of the Perforated Plate with Tube-Bundles Using a Tandem Neural Network — *Prof Tongyang Shi*

16:40: Paper 129 — An effective non-gradient topology optimization approach for acoustic structure design — *Prof Jingwen Guo*

17:00: Paper 155 — Fast Neural Network–Based Inverse Design of Acoustic Devices Using Topology-Optimized Datasets — *Miss Zhaohua Li*

17:20: Paper 164 — Topology optimization using reinforcement learning for designing the inside layout of a muffler — *Dr Kee Seung Oh*

16:20 **Paper 120 — Inverse Design of the Perforated Plate with Tube-Bundles Using a Tandem Neural Network**

Mr. Tonglin Xiang, Dr Zhongjian Mei, ***Prof Tongyang Shi***

The Perforated Plate with Tube-Bundles (PPTB) is a resonant sound-absorbing structure that shows great potential in the field of noise control, and wideband near-perfect sound absorption can be achieved by combining multiple PPTB units with different geometric parameters. However, the geometric parameters of a single unit as well as the coupling mechanism between different units pose challenges for accurate inverse design. In the present work, a deep learning (DL) framework based on a Tandem Neural Network (TNN) was proposed to tackle the inverse design of PPTB for a given sound absorption curve. The framework is composed of a forward network and an inverse network. The forward network predicts the surface impedance of the resonant units to characterize their corresponding sound absorption performance, while the coupling between different resonant units is incorporated in the Physical Information Layer (PIL) to enhance prediction accuracy. Then the inverse network is trained to design PPTB units, and the number of resonant units can be adaptively adjusted according to the desired sound absorption curves, enabling flexible design and optimization of PPTB structures for broadband low-frequency sound absorption.

16:40 **Paper 129 — An effective non-gradient topology optimization approach for acoustic structure design**

Pengpeng Cui, ***Prof Jingwen Guo***

This study presents a non-gradient topology optimization framework for the design of acoustic structure. By parameterizing the material distribution using Radial Basis Function Neural Networks (RBFNNs), the proposed approach effectively reduces the dimensionality of the design variables. Crucially, Ensemble Kalman Inversion (EKI) enhanced with regularization is employed to update the network parameters, thereby circumventing the need for complex sensitivity analyses required in traditional gradient-based topology optimization methods. The framework is successfully applied to acoustic field design, demonstrating efficacy in addressing complex sound control objectives. Numerical experiments show that the strategy achieves robust convergence and yields promising results in terms of acoustic efficiency and device performance, offering a viable alternative to conventional gradient-based topology optimization approaches.

17:00 **Paper 155 — Fast Neural Network–Based Inverse Design of Acoustic Devices Using Topology-Optimized Datasets**

Miss Zhaohua Li*, Mr Yuanze Li, Prof Xiang Yu*

This study presents a hybrid inverse-design method for designing sound attenuation structures by combining topology-optimization-generated data with a lightweight fully connected neural network. Conventional fixed-size expansion chambers provide only limited transmission loss (TL), and their attenuation characteristics are difficult to tailor without modifying the chamber dimensions. To address this limitation, topology optimization is first employed to generate a high-quality dataset of expansion-chambers whose internal topologies are optimized to achieve targeted attenuation over prescribed frequency bands. Each optimized structure is paired with its corresponding TL spectrum, providing physically consistent structure–performance data for network training. A fully connected neural network is then trained to learn the inverse mapping from target TL spectra to material distributions within the chamber. Despite its simple architecture, the model achieves a topology prediction accuracy of 98% and a Dice coefficient of 0.97 on the test set. Acoustic simulations further show that the TL responses of the predicted structures closely agree with those of the topology-optimized ground-truth structures. The

proposed framework combines the physical reliability of topology optimization with the computational efficiency of machine learning, offering a fast and practical route for the inverse design of compact acoustic attenuation devices.

17:20 **Paper 164 — Topology optimization using reinforcement learning for designing the inside layout of a muffler**

Dr Kee Seung Oh*, Dr Yoon Young Kim, Dr Hayoung Chung, Dr Joo Hwan Oh*

We propose an artificial intelligence (AI)-assisted topology optimization method for designing acoustic muffler layouts. Conventional muffler topology optimization has been hindered by local minima, often yielding designs with insufficient acoustic performance. Although recent AI-based topology optimization methods offer new opportunities, most have focused on structural problems and are not well-suited to acoustic design, where disconnected configurations can be acceptable. To address these issues, we develop a reinforcement learning (RL)-based acoustic topology optimization framework that alleviates local-minimum trapping and supports disconnected layouts and multi-objective optimization. The muffler design task is formulated as a Markov decision process (MDP), with appropriate definitions of the agent's actions, states, and rewards. The proposed method is validated through diverse optimization problems, including benchmark test functions and practical muffler design cases. Comparisons with typical optimization approaches demonstrate that our method consistently achieves superior solutions over conventional gradient-based methods, confirming its effectiveness. We further discuss the obtained solutions in terms of the RL process and the acoustic relevance of the optimized internal muffler layouts.

1.4.1 Vibro-acoustics & Structure-Borne Noise: General

Mon 14:00–14:40 — City Room 2 (Chair: Mahmoud Karimi)

14:00: Paper 477 — Vibroacoustic Characterization of Cross-Laminated Timber Floor under Different Impact Excitation Sources — *Mr Mohammad Hossein Asadi Jafari*

14:20: Paper 531 — Contact Topology Modulation of Impulse Transmission in Granular Chains — *Mr Marcos Espinosa Cuartas*

14:00 **Paper 477 — Vibroacoustic Characterization of Cross-Laminated Timber Floor under Different Impact Excitation Sources**

***Mr Mohammad Hossein Asadi Jafari**, Dr Jianhui Zhou*

Cross-laminated timber (CLT) use is often limited by low-frequency impact noise, which standard ratings do not reliably capture. Assessing this behaviour with sound pressure level (SPL) measurements is challenging because room acoustics dominate below 100 Hz. This research investigates the vibroacoustic performance of CLT floor systems by combining operational modal

analysis (OMA) and the integral transform method (ITM) using a shared measurement dataset, linking structural modal response directly to radiated sound power. Unlike conventional methods,

ITM provides room-independent sound power estimates from surface velocity and captures near-field radiation components not included in sound intensity measurements. The effects of three excitation sources—a tapping machine, rubber ball, and human footfall—were evaluated. Results show the tapping machine does not adequately excite the first structural mode due to limited low-frequency energy and produces spatially incoherent mode shapes below 70 Hz. In contrast, the rubber ball shows spectral and wavenumber characteristics closely matching human footfall. These findings identify the rubber ball as a better proxy for realistic impact excitation and demonstrate that ITM is a valuable methodology for accurately characterising low-frequency vibroacoustic performance in mass timber floor systems.

14:20 **Paper 531 — Contact Topology Modulation of Impulse Transmission in Granular Chains**

***Mr Marcos Espinosa Cuartas**, Prof Raj Das, Dr Emilio Calius, Dr Andrew Hall, Dr George Dodd*

Granular chains are a benchmark system for strongly nonlinear wave propagation, where impulse transmission is typically controlled through mass, material, or lattice design. Here, we introduce contact topology as a new and experimentally accessible control parameter. By locally tuning contact geometry, we directly modify the nonlinear force–displacement law and realise exponent-driven contact defects without altering particle mass or material.

Combining controlled experiments with discrete element simulations, we show that local variations in the interaction exponent induce amplitude-dependent scattering, delay, pulse splitting, and energy redistribution. When multiple defects are introduced, their interactions are non-additive: upstream defects condition the waveform before it reaches downstream ones, enabling tunable attenuation, programmable delay, and passive directional transmission asymmetry.

These results establish exponent engineering via contact topology as a practical design approach for granular metamaterials, opening new pathways for compact impact mitigation, waveform conditioning, and nonlinear mechanical signal control.

1.4.2 Numerical Methods in Vibro-acoustics

Tue 10:40–11:40 — Riverbank Room 8 (Chair: Jamie Kha, Konstantinos Tsigklifis)

10:40: Paper 204 — High-frequency vibration response prediction of orthotropic plates in thermal environments based on radiative energy transfer method — *Mr Wenjie Zhang*

11:00: Paper 478 — Numerical Prediction of Low-Frequency Impact Sound of CLT Floors under Different Excitations — *Mr Mohammad Hossein Asadi Jafari*

11:20: Paper 688 — High-Fidelity Transfer Function Modeling for Virtual Prediction of Noise and Vibration in a Front-Loading Washing Machine — *Mr Sangjun Lee*

10:40 **Paper 204 — High-frequency vibration response prediction of orthotropic plates in thermal environments based on radiative energy transfer method**

***Mr Wenjie Zhang**, Prof. Haibo Chen*

The high-frequency vibration analysis of orthotropic plates in thermal environments presents a formidable challenge due to the prohibitive computational cost of traditional deterministic approaches. To address this, this paper presents an efficient energy flow model based on the radiative energy transfer method (RETM). In this framework, both the temperature-dependent material properties and the thermal stresses induced by the thermal environment are explicitly incorporated. Subsequently, the high-frequency energy distribution is modeled by superposing the direct energy field from actual excitation sources and the reflected fields induced by fictitious sources at the boundaries. To validate the accuracy of the proposed model, numerical comparisons are conducted against the modal superposition method. The results demonstrate that the RETM can accurately and efficiently predict the high-frequency energy response of orthotropic plates considering thermal effects, providing a promising alternative for the dynamic analysis of complex engineering structures.

11:00 **Paper 478 — Numerical Prediction of Low-Frequency Impact Sound of CLT Floors under Different Excitations**

***Mr Mohammad Hossein Asadi Jafari**, Dr Jianhui Zhou*

Cross-laminated timber floors are increasingly used in mass timber buildings, but their impact-sound prediction remains uncertain because low-frequency radiation depends on structural modes,

screw-joint restraint, and excitation force. This paper evaluates a finite element and integral transform workflow for predicting the 20–315 Hz radiated sound power of a full-scale three-panel

cross-laminated timber floor under tapping-machine, rubber-ball, and human-footfall excitation. Ceiling-side vibration responses were measured on a 10 × 14 grid, the model was calibrated against operational modal analysis, and computed surface velocities were converted to radiated sound power. The calibrated model matched the first four measured natural frequencies within 3%. When the tapping-machine force was reconstructed from the frequency-response function, the average discrepancy across all bands was +0.5 dB, though per-band errors varied systematically; applying the analytical tapping-machine force directly gave approximately−17 dB. The rubber-ball and footfall cases underpredicted the measured sound power by about 7 and 9 dB, respectively. The results show that, once the main structural modes are captured, force characterisation controls much of the remaining prediction uncertainty for lightweight timber floor impact-sound modelling.

11:20 **Paper 688 — High-Fidelity Transfer Function Modeling for Virtual Prediction of Noise and Vibration in a Front-Loading Washing Machine**

***Mr Sangjun Lee**, Prof Cheolung Cheong, Mr Junghoon Cho, Mr Kiyong An*

A robust virtual product development (VPD) environment is critical for efficient design of household appliances. Beyond conventional 3D computer-aided engineering (CAE) tools, a flexible framework that combines 1D system simulation with data-driven models is required for rapid evaluation of design changes. Transfer-function-based system modeling uses a database of transfer characteristics to predict vibration and noise responses at target locations, thereby eliminating the need for repeated physical experiments—a major advantage for appliances such as washing machines. This study develops a high-fidelity transfer function model for a front-loading washing machine by defining the drum, tub and cabinet as

primary subsystems. A 3D finite-element model is built and validated against experimental modal data, enabling most of the modeling work to be performed numerically and reducing the experimental effort.

Frequency-response-function (FRF) correlation metrics are devised to quantify agreement between experimental and numerical transfer functions. These metrics are used to calibrate material properties, damping parameters and joint modeling, resulting in a model that faithfully reproduces the measured behaviour. The enhanced transfer function model correlates well with experimental results and provides a reliable basis for predicting vibration and noise responses under design modifications, demonstrating the viability of system-level transfer function modeling within a VPD framework.

1.4.3 Experiments in Vibro-acoustics

Mon 09:00–10:00 — Riverbank Room 6 (Chair: Stephen Moore, Shahrokh Sepehrirahnama)

09:00: Paper 54 — Homogenized Material Modeling of Anisotropic Composite Discs: An Integrated Experimental–Numerical Approach — *Dr Michal Kozupa*

09:20: Paper 307 — System Model Based Virtual Development Process for PE Structure-Borne Noise — *Mr Sangyoung Park*

09:40: Paper 764 — Curtain Wall Flanking Paths: Insights from Vibration Measurements — *Mr Ben White*

09:00 **Paper 54 — Homogenized Material Modeling of Anisotropic Composite Discs: An Integrated Experimental–Numerical Approach**

Dr Michal Kozupa, *Dr Mostafa Barzegar, Ms. Jadwiga Hyla*

Representing the dynamic behavior of complex composite structures, such as a disc composed of 105 thin steel wedges bonded with epoxy, poses significant challenges for finite element (FE) analysis due to inherent anisotropy. This study proposes a novel methodology to approximate this behavior using simplified, homogenized material properties. Experimental Modal Analysis (EMA) was conducted using a scanning Laser Doppler Vibrometer (SLDV) to precisely characterize the disc's natural frequencies and mode shapes. These experimental benchmarks served as the foundation for a reverse-engineering parametric optimization within ANSYS. By employing a reduced FE model featuring 60 steel–epoxy wedge elements, the material properties were iteratively tuned to achieve a high-fidelity orthotropic/isotropic approximation. The calibrated model demonstrates excellent correlation with experimental modal data, confirming that complex multi-wedge anisotropy can be effectively captured through homogenization. This approach significantly reduces computational overhead while maintaining high predictive accuracy, offering a scalable solution for the structural dynamic analysis of complex composite systems.

09:20 **Paper 307 — System Model Based Virtual Development Process for PE Structure-Borne Noise**

Mr Sangyoung Park, *Prof Yeon June Kang, Mr. Jeong Min Nam, Mr. Dirickx Tom*

To optimize noise performance of electric vehicles (EVs), significant efforts have been made to integrate system-level testing and simulation models for Power Electric(PE)-induced noise. Among key components, the dynamic stiffness of PE bushing must be characterized under various static preload conditions, particularly across high frequency ranges. While commercial bushing testers exist for this purpose, their high-cost limits practical deployment. In this study, we developed a custom test rig utilizing Inverse Substructuring (IS) techniques to measure 3-directional dynamic stiffness up to 1.5 kHz under variable static loads. To satisfy theoretical assumptions, the test jig was designed to minimize crosstalk between the active and passive jigs. The measurement results were validated against those from conventional bushing testers, demonstrating good correlation. The IS tester was then used to assess the impact of internal flip structure on bushing stiffness. A dedicated simulation program that combines PE blocked force, FRF, bushing stiffness and body FRF to predict cabin noise quantified the contribution of bushing stiffness to interior noise and confirmed that tuning the PE bracket structure resonance and bushing dip frequencies enables robust control of structure-borne PE noise during the early development phase.

09:40 **Paper 764 — Curtain Wall Flanking Paths: Insights from Vibration Measurements**

Mr Ben White

Flanking sound transmission through mullions and curtain walls is a commonly encountered problem in building acoustics. Measurements are available from various sources which provide the flanking transmission loss of curtain wall assemblies. However, these curtain walls are tested as a monolithic unit (Dn,f per ISO 10848-1).

This paper presents the results of vibration (Dv,ij) measurements conducted on various components of typical curtain wall assemblies including mullions and glazing panes using a simplified method designed to be practical for field testing. Although not strictly compliant with the ISO 10848 test standard, the results provide deeper insight into the contribution of different curtain wall components to the flanking transmission loss. It is hoped that the insights obtained will allow flanking control measures for curtain walls to be developed and applied with greater confidence.

1.4.4 Vibration and Acoustics in Pipeline Monitoring: Advances in Leak Detection

Tue 11:00–12:00 — Panorama Room 3 (Chair: Ben Cazzolato)

11:00: Paper 282 — A Dual-Task Framework with Conformer and Weight Sharing for Pipeline Leak Detection and Localization — *Dr shilun Feng*

11:20: Paper 563 — Denoising Using Deep Residual Learning for Urban Acoustic Leak Monitoring — *Mr Xiang Wang*

11:40: Paper 643 — Dynamic Modelling of Water-filled Riser-Hydrant System for Acoustic Leak Detection in Water Pipes — *Mr Musab Hajalfadul*

11:00 **Paper 282 — A Dual-Task Framework with Conformer and Weight Sharing for Pipeline Leak Detection and Localization**

Mr Zhilong Zhou, Mr Shouao Gu, Mr Yongping Kong, Mr Ke Lin, ***Dr shilun Feng****, Prof Jun Tang*

Urban water pipeline leaks cause severe resource waste and economic losses annually. Current detection relies on manual inspection using listening rods to capture acoustic signals, but it cannot reliably identify leak conditions and is ineffective for deeply buried pipelines. Meanwhile, cross-correlation-based localization is highly sensitive to environmental noise, often yielding inaccurate results. In this work, we propose a two-stage framework for pipeline leak localization and multi-class leak classification that integrates a controlled experimental platform with a deep learning–based acoustic perception model.The leak localization stage leverages only leak signals, where a Conformer learns leak-specific representations from inter-channel time-delay features for localization. The subsequent leak condition diagnosis stage performs multi-class classification using dual-channel Mel-spectrograms fused with representations from localization.To evaluate the approach under realistic conditions, a 60 m closed-loop pipeline platform was constructed, and acoustic data were collected under various leak conditions—including normal (no-leak) scenarios and leaks with different orifice sizes—yielding approximately 12 hours of leak signals and 8 hours of normal data. The results show that our model accurately identifies leaks and distinguishes between orifice types, achieving a localization average precision of 0.314 m.

11:20 **Paper 563 — Denoising Using Deep Residual Learning for Urban Acoustic Leak Monitoring**

Mr Xiang Wang*, Doctor Wei Zeng, Prof Ben Cazzolato, Professor Martin Lambert*

Urban IoT acoustic monitoring is increasingly used for leak detection in water distribution systems, but field-recorded signals are often affected by intermittent noise that degrades signal quality. This paper presents a DnCNN-based residual denoising framework for suppressing intermittent inference in urban acoustic leak monitoring data. The method operates on spectrogram representations of acoustic data and estimates the noise component directly from noisy inputs through residual learning. The denoising performance is evaluated using qualitative visualisation and quantitative metrics. The results show that the denoised spectrograms exhibit clearer spectro-temporal structures and achieve improved spectral quality compared with the noisy inputs. However, the denoising effect is limited when the inference becomes denser or more extended in time. These findings indicate that DnCNN can serve as a practical denoising method for noisy urban acoustic monitoring conditions.

11:40 **Paper 643 — Dynamic Modelling of Water-filled Riser-Hydrant System for Acoustic Leak Detection in Water Pipes**

Mr Musab Hajalfadul*, Prof. Jen Muggleton, Prof. Phillip Joseph*

Water leakage in distribution networks is a major challenge for effective resource management. Leak localization commonly relies on acoustic cross-correlation, which estimates the time delay of leak noise arriving at two sensors, typically mounted on hydrants. The accuracy of this method depends strongly on the measurement bandwidth, which is affected by the dynamic behaviour of the coupled riser–hydrant system.

Previous research has shown that hydrants behave like lumped masses, particularly below 1 kHz. However, the dynamic interaction between the riser pipe and the attached hydrant, especially the influence of hydrant geometry, has not been thoroughly examined.

This study develops a simplified analytical model of a riser-hydrant assembly. The riser is represented as both a rod and a Timoshenko beam, while the hydrant is modelled as a lumped mass with rotational inertia. The model also accounts for offsets between the hydrant's centre of mass and the riser axis. Boundary conditions are derived for axial fluid-borne wave, as well as structure-borne, bending (in-plane and out-of-plane), and torsional waves. Analytical predictions are validated against three-dimensional simulations of a water-filled pipe–hydrant system in COMSOL Multiphysics.

The results establish a basis for analysing wave transmission from leak sources to hydrants, including wave-type coupling at junctions.

1.4.6 Passive Control of Noise & Vibration Using Acoustic Black Hole Effect

Tue 14:00–15:40 — City Room 2 (Chair: Shahrokh Sepehrirahnama, Adrien Pelat)

14:00: Paper 485 — Underwater Sound Absorption Using Rubber Enhanced Sonic Black Hole — *Mr Yuanze Li*

14:20: Paper 525 — Vibration reduction in infinite plates using acoustic black hole stiffener designs — *Dr Jamie Kha*

14:40: Paper 791 — Vortex-shaped acoustic black holes for low-frequency broadband vibration suppression — *Mr Taehwan Son*

15:00: Paper 803 — Broadband vibration and sound attenuation in honeycomb sandwich panels using Acoustic Black Holes — *Prof Adrien Pelat*

15:20: Paper 830 — Folded Sonic Black Holes for Broadband Low-Frequency Sound Absorption — *Professor Tian Ran (Terry) Lin*

14:00 **Paper 485 — Underwater Sound Absorption Using Rubber Enhanced Sonic Black Hole**

Mr Yuanze Li

The absorption of sound waves underwater is important for the development of underwater vehicles and equipment. However, achieving broadband sound absorption in such an environment presents significant challenges. In recent years, Sonic Black Hole (SBH) has attracted growing attention owing to its excellent ability for sound absorption in air, yet its effectiveness and potential for underwater applications remain unexplored. This paper proposes a novel slow-sound structure designed for broadband underwater sound absorption. We first demonstrate that directly transferring the original airborne SBH to water is not feasible. To overcome the issue, rubber insertions are incorporated into the cavities of SBH. Analytical and numerical models are developed to predict sound absorption characteristics. Our findings indicate that rubber not only enhances energy dissipation, but also greatly reduces vibrations and structure-borne sound transmission across the SBH structure, thereby preserving the advantageous features of SBH. The results and experiment confirm the feasibility of broadband absorption, and detailed analyses of the underlying mechanisms are provided. This study advances the understanding of underwater SBH physics and its potential for sound absorption, potentially paving the way for the development of optimized underwater acoustic devices and opening new avenues for practical applications.

14:20 **Paper 525 — Vibration reduction in infinite plates using acoustic black hole stiffener designs**

Dr Jamie Kha*, Dr Daniel Martins, Dr Mahmoud Karimi, A/Prof Laurent Maxit, Prof Oriol Guasch, Dr Valentin Meyer*

Stiffening plates enhances the structural integrity of various engineering systems, including civil structures and industrial machinery housings. The introduction of periodic stiffeners generates the well-known Bloch-Floquet waves, characterised by pass-band and stop-band frequency regions that control the transmission of vibratory energy through the structure. This study investigates how the geometry of the stiffening elements can be designed to reduce the vibration of the stiffened structure. The acoustic black hole principle is applied to a variety of designs to investigate its effectiveness in vibration reduction. Firstly, a hybrid numerical-analytical model is developed for a point-excited infinite plate that is coupled to regularly spaced periodic stiffening elements. The host infinite plate is represented by an analytical thin plate model, while the stiffening elements are described by a finite element model. The coupled system is then resolved in the wavenumber domain. An inverse Fourier transform is employed to reconstruct the physical space distribution of the structural response. Finally, vibratory fields from various stiffener designs are compared to determine the most effective.

14:40 **Paper 791 — Vortex-shaped acoustic black holes for low-frequency broadband vibration suppression**

Mr Taehwan Son*, Dr Wonju Jeon*

Acoustic black holes (ABHs) have been studied for vibration suppression due to their ability to absorb broadband flexural waves at frequencies above a specific frequency known as the cut-on frequency; however, reducing the cut-on frequency requires an impractically large ABH configuration. To overcome this limitation, vortex-shaped ABHs are proposed to achieve both a compact configuration and a low cut-on frequency. The vortex-shaped ABHs are designed by coiling multiple concave-shaped ABHs and rotationally arranging the coiled ABHs along a circumference, enabling long wave propagation paths to be accommodated within a compact installation space while allowing absorption of waves incident from any direction. The proposed vortex-shaped ABHs achieve a significantly lower cut-on frequency and enhance vibration

suppression performance compared to a conventional 2D ABH occupying the same installation space. These advantages are validated through both numerical simulations and experiments. Moreover, the damping performance is further improved at specific frequencies by breaking the rotational symmetry of the vortex-shaped configuration.

15:00 **Paper 803 — Broadband vibration and sound attenuation in honeycomb sandwich panels using Acoustic Black Holes**

***Prof Adrien Pelat**, Dr Alex Besse, Dr Omar Aklouche, Dr Frédéric Ablitzer, Prof François Gautier*

Lightweight honeycomb sandwich panels are widely used in aerospace structures for their high stiffness-to-weight ratio, although they generally exhibit limited intrinsic damping. This study explores the vibration and sound attenuation achieved by integrating circular Acoustic Black Holes (ABHs) into fiberglass honeycomb sandwich panels, whose bending stiffness becomes frequency-dependent due to shear-induced softening. The experimentally identified mechanical properties are incorporated into a wave-based model of a circular ABH to investigate trapped modes and associated absorption mechanisms. Comparison with an equivalent solid panel demonstrates that the shear-induced softening specific to sandwich structures enhances ABH performance. A parametric analysis based on critical coupling conditions shows that optimized damping can reduce reflection minima towards zero, thereby maximizing broadband absorption. Experimental results obtained on industrial inspired prototypes show significant reductions in averaged mobility, structure-borne radiated sound, as well as aerial sound transmission loss, highlighting the potential of ABH techniques for industrial lightweight applications.

15:20 **Paper 830 — Folded Sonic Black Holes for Broadband Low-Frequency Sound Absorption**

***Professor Tian Ran (Terry) Lin**, Mr Shifa Wang, Dr Kai Zhang*

To overcome the inherent trade-off between low-frequency sound absorption and geometrical length of conventional straight sonic black holes (SBH), we propose two types of folded sonic black hole (FSBH) structures, a continuous type and a series type. Transfer matrix method (TMM) is used to establish the theoretical analysis model based on the plane wave theory and the theoretical prediction is validated by the finite element simulation result. It is shown that the folded SBH design can effectively extend the sound propagation length leading to wave compression and enhanced energy dissipation. The continuous-type FSBH exhibits broadband sound absorption whilst the series-type FSBH generates distinct acoustic bandgaps leading to good sound insulation within specific frequency bands. Parametric analysis reveals the influence of key geometric parameters, including the power-law exponent, truncation half-height, and number of folded ducts, on the sound absorption performance. Finally, impedance tube experiments confirm that the measured sound absorption coefficient agree well with the theoretical prediction.

1.5.1 Signal Processing, Reproduction & Diagnostics: General

Mon 09:00–10:00 — Panorama Room 3 (Chair: Thushara Abhayapala, Amy Bastine)

09:00: Paper 11 — Measurement of acoustic sensitivity of automotive drum brake to multiple faults — *Mr Milind Shripad*

09:20: Paper 114 — Physics-Informed Auralization of Vehicle Noise from 1/3 Octave Bands via Iso-energetic Harmonic Sharpening — *Mr Yuyang Zhang*

09:40: Paper 412 — Acoustic-Based Quality Inspection for Automotive Harness Assembly Using Hierarchical Event Detection — *Mr Duo Li*

09:00 **Paper 11 — Measurement of acoustic sensitivity of automotive drum brake to multiple faults**

Mr Milind Shripad, *Dr Akash Yella, Dr Sriram Sundar*

Multiple faults can occur over time in drum brakes, which are commonly used on the rear side of heavy vehicles and two-wheelers, compromising passenger safety and ergonomics. Given the recent success of artificial intelligence in fault diagnosis, it can be effectively applied to automotive brakes during operation when combined with advanced measurement techniques. Nevertheless, monitoring the dynamic behavior of a drum brake in motion is challenging due to the rotational motion of its components and the limited space available for sensor placement. Consequently, this study investigates the use of the measured noise radiated from drum brakes (instead of vibrations) to detect faults. A test bench mimicking typical on-road braking dynamics has been developed to operate in a controlled environment with predetermined fault levels. This setup is capable of measuring acoustic signals during transient brake events. Acoustic responses from several experiments involving three common brake fault conditions are measured. The acoustic sensitivity to each fault is estimated (along with its physical interpretation) by using time and frequency domain features. Subsequently, unique signatures indicative of specific fault types have been identified. These results are promising as they could facilitate the development of a novel non-contact acoustics-based in-situ health monitoring system for brakes.

09:20 **Paper 114 — Physics-Informed Auralization of Vehicle Noise from 1/3 Octave Bands via Iso-energetic Harmonic Sharpening**

Mr Yuyang Zhang

Automotive NVH simulations often provide only one-third-octave-band results, which lack fine spectral structure and phase and thus cannot be directly used for high-fidelity auralization. This paper proposes a physical-prior-based signal reconstruction framework. The magnitude spectrum is recovered through optimal interpolation and equal-energy harmonic sharpening: engine speed guides a Gaussian mask to reconstruct order-related components, and a bandwise energy constraint enforces exact matching of RMS energy in each band to the original data. Phase is then efficiently reconstructed using a momentum-accelerated fast Griffin–Lim algorithm (FGLA), suppressing artifacts while preserving temporal continuity. For evaluation, we develop a composite similarity metric fusing psychoacoustic parameters (e.g., loudness, sharpness) with subjective preference probabilities quantified by a Bradley–Terry model from pairwise listening tests. Validations under wide-open-throttle and steady-state conditions show consistently high scores on the proposed metric, demonstrating dual advantages in reconstruction accuracy and perceptual consistency. The framework enables practical auralization of rotating machinery noise from 1/3-octave-band data in data-constrained scenarios.

09:40 **Paper 412 — Acoustic-Based Quality Inspection for Automotive Harness Assembly Using Hierarchical Event Detection**

Mr Duo Li, *Prof. Xu Zheng*

Harness connection quality in automotive assembly directly affects the reliability and safety of vehicle electrical systems. Acoustic-based non-destructive inspection exploits the characteristic ”click” sound generated upon full connector locking, yet deployment in real workshop environments faces challenges of high ambient noise, high inter-class similarity among acoustic events, and edge-device computational constraints. This paper proposes a three-stage hierarchical acoustic event detection method. Stage 1 employs the Teager-Kaiser Energy Operator (TKEO) for high-sensitivity transient capture. Stage 2 rapidly filters spurious events using three lightweight physical features: energy ratio, event duration and kurtosis. Stage 3 applies a MiniRocket classifier for fine-grained discrimination of six target connector click sounds. A fixed-sequence

finite-state machine performs assembly quality logic diagnosis. Validation on 199 real operation sequences recorded in an automotive assembly plant yields an overall sequence diagnostic accuracy of 95.0%, with all six fault sequences correctly identified, achieving a 100% fault sequence diagnostic accuracy., substantially outperforming SVM+EMD, 1D-CNN, and 1D-ResNet18 baselines. The algorithmic framework is designed toward future wearable MEMS microphone platforms; the current study uses professional-grade equipment to establish performance benchmarks.

Mon 10:40–12:00 — Panorama Room 3 (Chair: Thushara Abhayapala, Amy Bastine)

10:40: Paper 179 — Probabilistic Reconstruction of Spatiotemporal Sound Field from Rigid Spherical Microphone Array Measurements — *Dr Peihong Jiang*

11:00: Paper 180 — Uncertainty-aware sound field estimation using physics-informed Kolmogorov-Arnold networks — *Dr Yanli Liu*

11:20: Paper 145 — Personalized Speech Enhancement Using Sub-Band Processing and Constrained-Gain Noise Reduction — *Mr Qi-Lin Han*

11:40: Paper 344 — Array-Centric Inverse Image Source Model for Off-Grid Source Localization with Compact Acoustic Vector Sensor Arrays — *Dr Jun Zhang*

10:40 **Paper 179 — Probabilistic Reconstruction of Spatiotemporal Sound Field from Rigid Spherical Microphone Array Measurements**

Dr Peihong Jiang, *Prof Zhigang Chu*

Rigid spherical microphone arrays (RSMAs) are attractive for in-vehicle, immersive audio, and spatial sound field acquisition owing to their compact geometry and analytically tractable scattering. This study proposes a Gaussian process (GP)-based sound field reconstruction method for RSMAs, enabling probabilistic estimation of the incident sound pressure at arbitrary positions and time instants. The sound field is modeled as a spatiotemporal linear superposition of equivalent sources located outside the array, with their weights expanded are expanded over discrete time atoms. We then derive an analytical time-domain relationship between the equivalent-source weights and spherical-harmonic observations on the array surface using the Neumann-Green function, thereby establishing a linear Gaussian observation model that explicitly accounts for RSMA scattering. With a group-sparse prior, the group variances and noise variance are jointly estimated via expectation–maximization to identify active equivalent sources and temporal supports. The learned group variances parameterize the covariance of the equivalent-source weights and induce the incident-field GP, whose posterior mean and variance provide reconstruction and uncertainty estimates. Monopole-field simulations validate the accuracy, extrapolation stability, and interpretability of the proposed method.

11:00 **Paper 180 — Uncertainty-aware sound field estimation using physics-informed Kolmogorov-Arnold networks**

Dr Yanli Liu, *Prof Zhigang Chu*

Accurate sound field estimation in enclosed spaces is essential for sound field analysis and control, yet remains challenging due to sparse spatial measurements and environmental noise. Recent physics-informed neural network approaches have improved reconstruction accuracy by using trainable activation functions, but they typically provide only point estimates without quantifying the reliability of these predictions. This paper presents an uncertainty-aware sound field estimation framework that combines a physics-informed Kolmogorov-Arnold network with a Bayesian learning paradigm to reconstruct sound pressure fields from limited microphone measurements. Numerical simulations in enclosed acoustic environments demonstrate that the proposed framework achieves accurate sound field reconstruction while simultaneously producing spatial uncertainty maps. Regions with sparse measurements consistently exhibit higher predicted uncertainty, confirming the model's ability to identify poorly constrained areas and guide potential sensor placement. However, the empirical coverage rates fall below nominal levels under the current fixed hyperparameter settings. These findings demonstrate the potential of physics-informed uncertainty-aware estimation for sound field estimation, with future work focusing on experimental validation and empirical coverage improvements.

11:20 **Paper 145 — Personalized Speech Enhancement Using Sub-Band Processing and Constrained-Gain Noise Reduction**

***Mr Qi-Lin Han**, Dr Fan-Jie Kung, Mr. Yu-He Lin*

Speech enhancement (SE) plays a crucial role in improving speech intelligibility and quality in noisy acoustic environments. Although conventional single-channel SE algorithms are effective in suppressing background noise, these algorithms often overestimate the noise power spectral density (PSD), which may lead to speech distortion and intelligibility degradation. To address this limitation, this paper proposes a personalized speech enhancement framework that integrates sub-band enhancement with a constrained-gain noise reduction algorithm. The proposed approach first divides the speech spectrum, which ranges from 32.70 to 3951.07 Hz, into nine sub-bands. A hearing assessment is then conducted to identify frequency regions in which individual listeners experience reduced sensitivity, enabling personalized enhancement strategies across sub-bands. To further improve noise suppression while preserving speech components, the constrained-gain noise reduction algorithm is applied prior to the sub-band enhancement stage. Both the Fourier and wavelet transforms are employed to support the proposed processing framework. Listening test results demonstrate that, compared with unprocessed signals, the proposed method effectively improves speech quality and intelligibility, highlighting its potential for personalized speech enhancement applications in adverse acoustic conditions.

11:40 **Paper 344 — Array-Centric Inverse Image Source Model for Off-Grid Source Localization with Compact Acoustic Vector Sensor Arrays**

Dr Jun Zhang

To address the challenges of multipath interference and grid mismatch for compact acoustic vector sensor arrays (AVSs) in reverberant environments, we propose a high-resolution localization algorithm named AC-IISM-SBL. The algorithm is grounded in a novel array-centric inverse image source model (AC-IISM), explicitly formulated to incorporate the directional response of AVSAs. Unlike traditional source-centric image source models (ISMs), AC-IISM exploits the principle of acoustic reciprocity to transpose the source-receiver geometry, allowing for the synthesis of virtual arrays while correcting for vector sensor directivity. This physical decoupling of the source position from the multipath structure significantly reduces the analytical complexity of first-order linearization, thereby facilitating robust off-grid corrections. Building on this model, a multi-snapshot off-grid joint sparse framework is established using sparse Bayesian learning (SBL). By leveraging the temporal joint sparsity structure, the algorithm effectively suppresses incoherent diffuse reverberation and random noise, while iteratively compensating for grid quantization errors. Experimental results validate the robustness and high localization accuracy of the proposed algorithm, particularly in challenging scenarios characterized by low signal-to-noise ratio (SNR) and strong reverberation.

Tue 09:00–10:20 — Panorama Room 3 (Chair: Thushara Abhayapala, Amy Bastine)

09:00: Paper 822 — Optimisation of the ACCL technique for gear diagnostics — *Prof Robert Randall*

09:20: Paper 422 — Multi Sideband Linear Matrix Demodulation for Rotating Machinery Vibration Analysis — *Dr Mohamed Ridha Ouamane*

09:40: Paper 139 — Analysis of key signal features of construction noise sources in Northern India — *Miss Moh Moh Myint Thu*

10:00: Paper 719 — The Analysis of Violin Directivity — *Mr Sangkyou Park*

09:00 **Paper 822 — Optimisation of the ACCL technique for gear diagnostics**

***Prof Robert Randall**, Ms Aida Daman, Dr Wade Smith, Prof Zhongxiao Peng*

The ACCL (angle cepstrum comb liftering) technique was originally developed for application to acceleration signals from faulty gears. The ACCL process was found to remove both the dynamic transfer function (in the frequency domain) from the static transmission error (STE) at the source to the vibration at the response measurement points, and also the mesh transfer function (MTF) in the order domain, which means that the result is quite similar (except for some extra noise) to the STE. Recent work has shown that the ACCL technique can give even better results when applied to the dynamic TE (DTE), i.e. angular displacement, and it was thought that a similar benefit might be achieved by analysing the displacement signal, obtained by double integration of the acceleration, but it was found not to be the case because the automatically

removed transfer function included the double integration characteristic. The new work also found that very similar results could be obtained, for acceleration/displacement and TE signals, over a very wide range of input speeds, from 5 Hz to 20 Hz, including constant and variable (± 20%) speeds, but that this required modification of the originally proposed analysis parameters to optimise this conformity of results.

09:20 **Paper 422 — Multi Sideband Linear Matrix Demodulation for Rotating Machinery Vibration Analysis**

***Dr Mohamed Ridha Ouamane**, Dr Amadou Assoumane, Dr Khelil Sidi Brahim, Dr Edgard Sekko*

Rotating machines may experience failures related to damage to gears or bearings. The occurrence of this type of defect induces complex amplitude and phase modulations in vibration signals. In the spectral analysis of such signals, these modulations are observed to typically give rise to multiple sidebands surrounding the carrier components; consequently, conventional demodulation techniques that consider only a single sideband are sometimes insufficient for reliable fault detection. To overcome this limitation, this paper proposes a linear matrix-based model that explicitly incorporates multiple sidebands into the demodulation framework. By formulating the multi-sideband representation within a linear algebraic structure, the proposed approach enables the joint estimation of modulation components while maintaining physical interpretability. A dedicated identification procedure is developed to extract sideband signatures. Numerical simulations and experimental results demonstrate that the proposed multi-sideband approach allows for enhanced fault feature extraction and ensures more reliable condition monitoring.

09:40 **Paper 139 — Analysis of key signal features of construction noise sources in Northern India**

***Miss Moh Moh Myint Thu**, Dr Sneha Singh*

Construction noise pollution is a significant hazardous issue for both the environment and worker health. Accurate measurements, signal processing and analysis of construction site noise are crucial for mitigating its harmful effects. However, in-depth analysis of key acoustic features in construction sites is missing from current research. This study aims to address this gap by analysing and identifying the key time-domain and frequency-domain acoustic features of various construction noise sources. Noise signals were captured from drilling, hammering, earthwork, tiling, yielding, backhoe loading, concrete machines, and welding activities at active construction sites. Key acoustic features were extracted namely, (i) time domain features such as shape factor, sound pressure level, root mean square value, kurtosis, and skewness and (ii) frequency domain features such as one-third octave band spectrum, FFT spectrum, spectral centroid, spectral spread, spectral skewness, spectral kurtosis, and harmonic-to-noise ratio (HNR). These features will be useful to assess the noise's signal energy, spectral composition, and temporal complexity. The resulting data provides a full, detailed acoustic profile of construction operations, which can be used for the identification of different construction activities, noise exposure assessments, and future studies on auditory and non-auditory health impacts.

10:00 **Paper 719 — The Analysis of Violin Directivity**

Mr Sangkyou Park

Previous directivity studies have relied on averaged patterns across frequency ranges with limited spatial resolution. While recent research employed 22-microphone arrays, detailed measurements in critical radiation zones remain insufficient.

This study measured violin directivity using a strategically designed 16-microphone spherical array. Unlike uniform distributions, microphones were concentrated between -30° and 30° elevation where primary acoustic energy radiates. Measurements covered 12 azimuthal positions across 16 elevation angles, with individual string analysis (G, D, A, E) and multiple repetitions. Data were analyzed through 1/3 octave bands, contour mapping, 3D polar visualization, and smoothed patterns. Principal Component Analysis (PCA) compressed the high-dimensional directivity data.

Results confirm omnidirectional radiation below 500 Hz with pronounced directivity at higher frequencies. Energy concentrates within ±30° elevation, validating the array design. Critically, each string exhibits distinct directional characteristics, revealing spectral-spatial variations absent in averaged representations. PCA successfully reduced dimensionality while preserving essential directional information. These string-specific, frequency-dependent patterns provide substantially more detail than traditional averaged data, enabling improved room acoustic simulations and auralization applications.

1.5.2 Signal Processing for Sound Reproduction and Spatial Audio

Mon 10:40–12:00 — City Room 4 (Chair: Qiaoxi Zhu)

10:40: Paper 234 — An alternative format for 3D sound recording — *Dr Mark Poletti*

11:00: Paper 594 — AmbDiff: 3D Ambisonics Sound Field Reconstruction from Partial Pressure using a Diffusion Transformer — *Mr Yang Xiao*

11:20: Paper 778 — Direction-preserving Spatial Audio Signal Enhancement in The Spherical Harmonic Domain — *Mr Huawei Zhang*

11:40: Paper 806 — HRTF individualization method based on combinatorial optimization — *Ms Mayumi Kakuno*

10:40 **Paper 234 — An alternative format for 3D sound recording**

Dr Mark Poletti

Three-dimensional sound fields can be recorded using a microphone array that produces polar responses which are spherical harmonics. These polar responses differ from typical microphone responses in that they have multiple main lobes of equal magnitude, so that each response has no preferred direction. There are several definitions of spherical harmonics which affect the sign and magnitude of the lobes (but not the shape), further complicating their use.

An equivalent approach is to use a set of directional responses to record sound fields. These would aim in directions which sample the sphere equally, would ideally have identical polar responses and would be orthonormal. A method for developing such responses is described which produces identical responses, and which are exactly orthonormal in some cases. For those cases where the responses are not orthonormal, a method is provided for improving the orthonormality, in which case the polar responses are no longer identical.

11:00 **Paper 594 — AmbDiff: 3D Ambisonics Sound Field Reconstruction from Partial Pressure using a Diffusion Transformer**

Ms Bing Zhu, Dr. Yichen Yang, Ms. Xueqin Luo, ***Mr Yang Xiao****, Wen Zhang, Prof. Jingdong Chen*

Three-dimensional (3D) sound field reconstruction is a fundamental problem in acoustic signal processing, with applications in immersive audio and spatial sound reproduction. In practice, acoustic measurements are typically sparse and limited to scalar pressure responses acquired by omnidirectional microphones, whereas capturing Ambisonic sound fields with sufficient spatial resolution requires dense spatial sampling and specialized, costly microphone arrays.

This study addresses the gap by proposing a novel framework for reconstructing the Ambisonic sound fields from sparse sound pressure observation. We formulate the task as a conditional generative problem and develop a diffusion Transformer-based model that learns to map pressure observations to Ambisonic representations.

The Transformer architecture captures long-range spatial dependencies and inter-channel correlations, while the diffusion-based iterative denoising process mitigates the over-smoothing effects commonly observed in regression-based approaches, enabling the recovery of fine spatial details and high-frequency components. Experimental results demonstrate that the proposed method achieves superior

reconstruction accuracy and spatial resolution compared to the baseline method.

11:20 **Paper 778 — Direction-preserving Spatial Audio Signal Enhancement in The Spherical Harmonic Domain**

Mr Huawei Zhang*, Dr Aimee Zhang, Dr Huiyuan Sun, A/Prof Prasanga Samarasinghe*

Spatial audio signal enhancement (SASE) aims to separate a desired soundfield from interference and noise while preserving its spatial cues. However, existing algorithms pay limited attention to preserving the spatial cues of the residual interference, which reduces their effectiveness in practical applications. In this paper, we propose a direction-preserving SASE algorithm based on multi-output beamforming. The proposed algorithm extracts the desired soundfield while preserving the spatial cues of both the desired soundfield and the residual interference soundfield. The simulation study shows that the proposed algorithm achieves performance comparable to the existing SASE algorithm in terms of Error, while it better preserves the spatial cues of the residual interference within a region of interest, in a noisy and reverberant environment.

11:40 **Paper 806 — HRTF individualization method based on combinatorial optimization**

***Ms Mayumi Kakuno**, Dr Shota Toyooka, Prof Yoshinobu Kajikawa*

This paper proposes an individualization framework for median–plane head–related transfer functions (HRTFs) based on combinatorial optimization. In the proposed method, the presentation order of HRTF candidates is formulated as a combinatorial optimization problem to determine an optimal evaluation sequence for perceptual testing. Using the perceptual response data obtained from this sequence, the HRTFs are parameterized and modeled as a varying spectral model. Results of sound localization experiments show that, while individual differences remain and improvements are not uniform across all listeners, the proposed method significantly reduces front–back confusions and vertical localization errors compared to conventional dummy–head HRTFs.

1.6.1 Aero- & Thermo-Acoustics: General

Mon 09:00–10:00 — Panorama Room 1 (Chair: Danielle Moreau, Cheolung Cheong)

09:00: Paper 47 — Study of a Herschel-Quincke tube : effects of the branch pipe diameter to the sound transmission loss — *Mr Terdphong Chauykaew*

09:20: Paper 82 — Unit-to-System Transmission Prediction and Spacing Design for Ducts with Multiple Side-Branch Resonators — *Mr Jinze Li*

09:40: Paper 170 — Direct aeroacoustic analysis of louvers using the lattice Boltzmann method — *Mr Kisho Hatakenaka*

09:00 **Paper 47 — Study of a Herschel-Quincke tube : effects of the branch pipe diameter to the sound transmission loss**

***Mr Terdphong Chauykaew**, Dr. -Ing. Alexander Brezing, Asst.Prof. Khemapat Tontiwattanakul*

A passive noise reduction device is widely used for noise noise control of a machinery due to its simple structure, high reliability, and effectiveness in a design frequency range. Herschel–Quincke tube (HQ tube) is a type of passive silencer composed of the main pipe and a branch pipe such that the two have difference in length. The principle of HQ tube is based on the destructive interference of the waves propagating along the two ducts. In this work, the effect of the dimension of the branch-pipe diameter on the acoustic performance of the system is investigated. The design of HQ tube is presented using an analytical model via the transfer matrix method (TMM). The transmission loss is measured by an impedance tube in order to evaluate the performance of the silencer. The result indicates that variations in the branch-pipe diameter mainly correspond to the shift of transmission loss peaks. The behavior of HQ tubes with various branch pipe's diameter and the technique to design HQ tube for best performance in a given frequency range is discussed.

09:20 **Paper 82 — Unit-to-System Transmission Prediction and Spacing Design for Ducts with Multiple Side-Branch Resonators**

***Mr Jinze Li**, Prof Li Cheng*

Side-branch resonators are widely used for duct noise control, yet design methods that quantify inter-unit coupling and enable efficient integration of multiple units remain underexplored. We develop a fully coupled analytical model for ducts with multiple side-branch resonators, a systematic method to predict system transmission from units' acoustic properties, and a design strategy optimizing TL via inter-unit spacing. The system transmission can often be obtained by direct or modified superposition of unit transmission coefficients; fully coupled modeling is only needed when units are strongly coupled in both frequency and space. For resonators with close resonant frequencies, setting the inter-unit spacing to a quarter of the resonant wavelength enhances the system TL. Using an External Sonic Black Hole (E-SBH) as an example, the proposed strategy yields a simpler structure with higher TL in the target band, as confirmed experimentally. This work provides a design framework for systematic integration of side-branch resonators into ducts, along with physical insights and optimization guidelines for high-performance mufflers based on frequency and spatial coupling.

09:40 **Paper 170 — Direct aeroacoustic analysis of louvers using the lattice Boltzmann method**

***Mr Kisho Hatakenaka**, Dr Kazuya Kusano, Prof. Koji Shimoyama*

In air conditioning systems, plate fin-type heat exchangers with staggered tubes and numerous thin fins are commonly used. To enhance performance, these heat exchangers often feature louvered fins with multiple cutouts to promote heat transfer. However, when air flows through these louver shapes at certain velocities, significant noise can occur at specific frequencies. In addition to the fact that the louvers cannot be treated as simple geometries, the conditions for generating aeroacoustic noise vary with flow velocity and louver dimensions, making it difficult to categorize the noise produced by the louvers in the same manner as well-known phenomena such as Aeolian tones and cavity tones. Therefore, this study aims to elucidate the mechanisms underlying the noise generated solely by the louvers. A large-scale three-dimensional aeroacoustic problem is solved using the lattice Boltzmann method. A fast Fourier transform is applied to the simulated acoustic field to extract the sound pressure levels of the aeroacoustic noise across various frequencies. Additionally, a detailed analysis of the flow field in the vicinity of the louvered fins is conducted.

Mon 10:40–12:00 — Panorama Room 1 (Chair: Danielle Moreau, Cheolung Cheong)

10:40: Paper 689 — Multi-Chamber Air-Suspension Flow-Induced Noise: Integrated CFD–FE Simulation and Experimental Validation under Speed-Bump Excitation — *Mr Yonguk Lee*

11:00: Paper 766 — Acoustic Response of Bias-Flow Perforated Screens: An Incompressible Flow Approach — *Dr You Wei Ho*

11:20: Paper 45 — Tonal Noise Prediction Model for Vertical-Axis Wind Turbines — *Mr Baqer Alkuraysi*

11:40: Paper 391 — High-order Cartesian LES of rotor-stator aeroacoustics based on an efficient volume penalization method — *Dr Sinforiano Cantos*

10:40 **Paper 689 — Multi-Chamber Air-Suspension Flow-Induced Noise: Integrated CFD–FE Simulation and Experimental Validation under Speed-Bump Excitation**

***Mr Yonguk Lee**, Mr Gwongi Lee, Prof Cheolung Cheong, Mr Janghyun Oh, Mr Bongkeun Choi*

With the rapid electrification of vehicles, the reduction of engine-noise masking has made the NVH performance of auxiliary components increasingly important. In particular, flow-induced noise generated by complex internal airflows can directly affect cabin quietness.

This study proposes an integrated numerical methodology to predict flow-induced vibration and radiated noise in a multi-chamber air-suspension system under a speed-bump condition. The framework combines time-accurate Computational Fluid Dynamics (CFD), Finite Element (FE)-based structural frequency response analysis, and acoustic radiation prediction. Compressible Large Eddy Simulation (LES) was employed to capture unsteady internal flow and wall-pressure fluctuations (WPF), while dynamic mesh morphing was applied to reproduce the compression and expansion of the air chambers during speed-bump operation. The resulting flow-induced loads were mapped onto the structural FE model to predict the vibro-acoustic response.

The methodology was validated by comparison with experimental acceleration and sound pressure measurements. The results showed reasonable agreement in spectral shape and magnitude, particularly in the mid- and high-frequency ranges. These findings demonstrate the applicability of the integrated CFD–FE approach as a virtual design tool for predicting flow-induced noise in air-suspension systems.

11:00 **Paper 766 — Acoustic Response of Bias-Flow Perforated Screens: An Incompressible Flow Approach**

***Dr You Wei Ho**, Dr Long Wu, Prof Edward Richardson*

Perforated screens with bias flow enhance acoustic energy dissipation and are widely used in aerospace and automotive applications, including combustion instability control and the design of mufflers or exhaust silencers. The associated damping is closely related to the Rayleigh conductivity, which characterises the acoustic response of apertures with bias jet flows. In this work, we develop an incompressible flow simulation-based framework (low Mach number M « 1) to predict the Rayleigh conductivity of bias-flow apertures under acoustically compact assumptions (low Helmholtz number He « 1). A parametric investigation of perforated screens with regular slit arrays is conducted using two-dimensional computational models, revealing that the Rayleigh conductivity depends on the Strouhal number, the slit thickness-to-width ratio, and the open area ratio. The zero-thickness results are then applied to a benchmark configuration, yielding improved predictions of the absorption coefficients of a slit screen backed by a cavity at two bias-flow velocities. The validated methodology offers a computationally efficient tool for designing bias-flow liners and dampers in regimes where acoustic energy dissipation is dominated by vorticity convection, as encountered in many engineering applications.

11:20 **Paper 45 — Tonal Noise Prediction Model for Vertical-Axis Wind Turbines**

***Mr Baqer Alkuraysi**, Dr Charitha de Silva, Dr Danielle Moreau, Prof Con Doolan*

Vertical-axis wind turbines (VAWTs) are suitable for urban installation due to their omnidirectional wind acceptance, low installation and maintenance costs, and favourable aesthetic. However, their proximity to populated areas raises concerns about the noise and vibration they produce. To help understand, predict and control tonal noise from VAWTs, a mathematical acoustic model has been

developed. Aerodynamic forces obtained from Computational Fluid Mechanics (CFD) simulations of the Savonius turbine, are used as inputs to the acoustic model. The model demonstrates good agreement with experimental measurements, with an overall sound pressure level difference between the experiment and model of 3 dB for the tip speed ratio 0.8 case.

11:40 **Paper 391 — High-order Cartesian LES of rotor-stator aeroacoustics based on an efficient volume penalization method**

Dr Sinforiano Cantos, *Prof Siyang Zhong*

The accurate and efficient prediction of flow interactions and noise generated by moving boundaries remains challenging in computational aeroacoustics. To address this, a high-order Cartesian solver is developed, which combines optimized finite difference schemes with selective explicit filtering, ensuring the low dissipation and dispersion properties required for large eddy simulations (LES). The solver handles complex moving boundaries using a volume penalization method, where rigid body motion is updated with a time-dependent signed distance function. With this approach, the simulation of the aero-engine rotor-stator interaction is performed on fixed Cartesian grids without using sliding mesh interfaces or body-fitted remeshing. A linear compressor cascade using a single-passage domain is simulated in off-design conditions with spanwise periodicity. The results show that the proposed framework successfully captures wake shedding from the rotor and its impingement on the stator, quantifying the associated tonal and broadband interaction noise by solving the Ffowcs-Williams and Hawkings equation with a new implementation targeting volume penalization methods.

Mon 15:40–17:20 — Panorama Room 1 (Chair: Danielle Moreau, Cheolung Cheong)

15:40: Paper 88 — Experimental Investigation of Tip Clearance Noise from a NACA 0012 Blade — *Mr Andre Vumbaca*

16:00: Paper 101 — Aeroacoustic Characterization and Experimental Validation of a Multi-Blade Centrifugal Range Hood using a Hybrid CFD-BEM Approach — *Dr Li Wang*

16:20: Paper 522 — Effects of Rotor Unbalance on Noise and Vibration Characteristics in a Ducting System — *Dr Chengyang Wang*

16:40: Paper 530 — Noise Radiation from Tip Leakage Flows under a Streamwise Adverse Pressure Gradient — *Dr Manuj Awasthi*

17:00: Paper 686 — Aerodynamic Noise Characterization of a High-Speed Hair Dryer System Using High-Fidelity Computational AeroAcoustic Methods — *Mr Junmo Lee*

15:40 **Paper 88 — Experimental Investigation of Tip Clearance Noise from a NACA 0012 Blade**

Mr Andre Vumbaca, *Dr Manuj Awasthi, Dr Charitha de Silva, Dr Danielle Moreau, Prof Con Doolan*

This study presents an experimental investigation of tip clearance noise from a stationary NACA 0012 airfoil, focusing on Mach number scaling. Acoustic measurements were conducted in an anechoic wind tunnel using a phased microphone array at a fixed geometric angle of attack of 12 degrees for three chord-based Reynolds numbers between 201,000–470,000 and five clearance heights between 4–83% of the incoming boundary layer thickness. The results reveal multiple aeroacoustic mechanisms with different scaling behaviours. Noise radiating from the midchord and leading edge–tip clearance subregions dominates the mid-frequency range (3–9kHz) of the noise spectra, and this source was found to scale on the seventh power of Mach number and dimensional frequency. Outside this frequency range, the spectra collapse under a fifth power Mach number scaling, with this noise radiating from the trailing edge–tip clearance subregion. The smallest clearance demonstrated a pronounced tonal response that radiates from the midchord–tip clearance subregion and scales on the third power of Mach number. These findings are the first to explore the acoustic response of a thin, symmetric blade with a tip clearance and highlight the complex nature of this noise and its sensitivity to operating conditions.

16:00 **Paper 101 — Aeroacoustic Characterization and Experimental Validation of a Multi-Blade Centrifugal Range Hood using a Hybrid CFD-BEM Approach**

Dr Li Wang, *Dr Zhihua Wang, Dr Ben Zhang, Dr Wenjun Wu*

Abstract: Acoustic performance represent a primary performance metric for domestic range hoods, primarily driven by the aeroacoustic behavior of the internal multi-blade centrifugal fan . This study presents a combined numerical and experimental investigation of a range hood prototype . A hybrid computational framework was established, utilizing Large Eddy Simulation (LES) to capture transient flow field pressure pulsations, which were then mapped as equivalent dipole sound sources for Boundary Element Method (BEM) acoustic analysis .Simulation results identified the impeller hub support area as a primary noise source region . Validation experiments conducted in a semi-anechoic room demonstrated high predictive accuracy . The numerical prediction of volumetric flow rate exhibited a 1.9% deviation from experimental data, and the total sound pressure level difference between simulation and experiment was 1.9 dB(A) . Spectral analysis revealed that the radiated noise is dominated by a broadband spectrum centered around 1000 Hz, with negligible discrete tonal components at the blade passing frequency . This study validates the effectiveness of the CFD-BEM approach for optimizing range hood acoustics .

16:20 **Paper 522 — Effects of Rotor Unbalance on Noise and Vibration Characteristics in a Ducting System**

Dr Chengyang Wang*, Professor Siji Wang, Prof Yat-Sze Choy*

Rotor unbalance is a common and unavoidable excitation in ducted turbomachinery, which often leads to excessive casing vibration and significant noise radiation. However, the coupled vibro-acoustic behavior under unbalance excitation remains insufficiently understood, hindering the development of integrated noise control solutions. This study investigates the effects of rotor unbalance on the noise and vibration characteristics of a ducted rotor-casing system. A coupled dynamic model is established for the rotor-bearing-casing system, incorporating rotor unbalance excitation, bearing forces, casing vibration, and acoustic radiation. Numerical simulations are conducted to examine the influence of key parameters: casing aspect ratio, casing-to-air density ratio, and unbalance mass magnitude. Results show that the aspect ratio reshapes acoustic directivity at mid-to-high frequencies, while the density ratio primarily affects low-frequency peak levels. The unbalance mass proportionally increases the overall sound pressure level without altering modal frequencies or directivity patterns. Based on these findings, a hybrid noise reduction strategy combining micro-perforated panels (MPP) and structural damping is proposed. The MPP effectively suppresses cavity-mode dominated noise at mid-to-high frequencies, whereas damping is essential for mitigating low-frequency radiation caused by rotor-induced vibration. The combined approach achieves broadband noise reduction, offering theoretical guidance for low-noise design of ducted rotor systems.

16:40 **Paper 530 — Noise Radiation from Tip Leakage Flows under a Streamwise Adverse Pressure Gradient**

Dr Manuj Awasthi*, Dr Tingyi Zhang, Mr Andre Vumbaca, Prof Con Doolan, Dr Danielle Moreau*

Tip leakage flows are significant, yet poorly understood, engineering noise sources found in a wide range of applications including compressors, turbines, propulsion systems and shrouded fans. This work will examine the effect of the noise radiation from tip leakage flows under a streamwise adverse pressure gradient (APG). The tip leakage flow is generated by placing a stationary airfoil blade tip with rounded edges adjacent to a static wall in an anechoic open-jet facility. A purpose-built test rig is employed to modify the pressure gradient of the incoming flow in the test-section. The rig can generate variable APG up to a Clauser pressure gradient parameter (β) of 1.1. In this work, we will consider the noise radiation from two pressure gradient configurations of β = 0 (zero pressure gradient (ZPG)) and β = 1.1 (APG). For both configurations, measurements are conducted at the same effective angle of attack, determined by accounting for the open-jet deflection angle under each pressure-gradient condition. The far-field sound is measured using a 64-microphone phased array whose response is beamformed to reveal the spatial distribution of the noise sources and their strength.

17:00 **Paper 686 — Aerodynamic Noise Characterization of a High-Speed Hair Dryer System Using High-Fidelity Computational AeroAcoustic Methods**

Mr Junmo Lee

To meet the growing demand for quieter household appliances, this study characterizes the aerodynamic noise of a high-speed hair dryer using high-fidelity computational aeroacoustic methods. A high-fidelity large-eddy simulation (LES)–based CFD approach was employed to resolve the unsteady flow field throughout the dryer—including the intake multi-perforated plate, honeycomb flow straightener, vane-axial fan stages, and heat exchanger—and the resulting data were used to compute vortex sound source terms. An adjoint-based sensitivity analysis assessed how geometric variations influence acoustic

source strengths without multiple full CFD runs. The simulations show that the vane-axial fan, heat exchanger, multi-perforated plate and honeycomb structure are the dominant noise-generating components. To illustrate the framework, a design modification was applied to the honeycomb flow straightener: flow acceleration and vortex shedding at the honeycomb edges produce strong pressure fluctuations that are amplified by the fan, and sensitivity maps highlight leading edges and cell boundaries as regions of high acoustic sensitivity. Subsequent experiments and numerical simulations confirmed the validity of the computational framework. These findings demonstrate that high-fidelity computational aeroacoustic techniques can accurately characterize aerodynamic noise in compact, complex air-moving devices and guide targeted design modifications to reduce noise in high-speed hair dryers and other household appliances.

1.7.1 Active Systems for Noise & Vibration Control: General

Mon 10:40–12:00 — City Room 2 (Chair: Sipei Zhao, Woon-Seng Gan)

10:40: Paper 10 — Calmfloor Active Mass Damper (AMD) Vibration Control — *Mr Pablo Reboredo Gasalla*

11:00: Paper 205 — Pretrained RPM-Scheduled Feedforward Control for Engine Order Noise — *Mr Yushu Qian*

11:20: Paper 369 — A Comparative Subjective Evaluation of Perceived Comfort and Listening Effort: Open vs. Closed-Fitting Earbud Architectures — *Mr Zhen Ting Ong*

11:40: Paper 644 — A Parameter Identification Active Bearing Control Framework for Lateral Vibration Suppression in Rotor Systems — *Dr Dunant Halim*

10:40 **Paper 10 — Calmfloor Active Mass Damper (AMD) Vibration Control**

***Mr Pablo Reboredo Gasalla**, Dr Mahbub Sheikh*

Floors in buildings can have large spans, especially in some open offices, resulting in low natural frequencies. Experience has shown that composite structures with a natural frequency of less than 8 Hz may be prone to annoying walking vibrations.

How many building users complain of excessive vibration? Are these floors acceptable to the occupants? The effects on people include discomfort, apprehension as to the structural safety of the building, loss of concentration, and, occasionally, a feeling of seasickness.

Retrofitting these structures have a significant impact on the carbon footprint and they are less attractive to owners and architects due to its high cost. New trends in construction materials and technologies have significantly improved system performance in recent decades. This trend has increased the importance of damping technology to mitigate vibrations.

Calmfloor is the patented, low-cost, low-carbon active mass damper (AMD) solution that's changing the way everyone in construction is thinking about building design and serviceability. Calmfloor resolves vibrations without structural intervention and the associated disruption, downtime, cost and carbon impact. Reduce floor vibration in new, existing and repurposed buildings by up to 90%. This abstract presents an overview of Calmfloor technology, including recent case studies on commercial buildings in Australia.

11:00 **Paper 205 — Pretrained RPM-Scheduled Feedforward Control for Engine Order Noise**

***Mr Yushu Qian**, Dr Xu Zheng, Ms Xuexian Liu, Mr Wenxuan Xu, Mr Zhicheng Zhang*

Adaptive notch FxLMS algorithms are widely employed for active control of vehicle interior engine noise. However, under non-stationary conditions involving rapid speed variations, these algorithms suffer from slow convergence and limited RPM tracking capability. Furthermore, their reliance on error microphone signals renders them susceptible to uncorrelated disturbances at the error sensor. To address these limitations, this paper proposes a pretrained RPM-scheduled feedforward control strategy that decouples weight optimization from the real-time control loop. Optimal control weights are determined offline at discrete steady-state engine speeds using the adaptive notch FxLMS algorithm, constructing an RPM-indexed weight library. During online operation, the instantaneous phase of each target engine order is extracted from the primary noise via synchronous I/Q demodulation, and control weights are obtained by interpolating within the weight library according to real-time RPM, without requiring error microphone feedback. Simulation results demonstrate that the proposed method achieves noise reduction comparable to that of the adaptive notch FxLMS algorithm under steady-state conditions, while delivering significantly superior performance under non-stationary conditions such as wide-open-throttle acceleration, where conventional adaptive algorithms suffer from pronounced convergence lag.

11:20 **Paper 369 — A Comparative Subjective Evaluation of Perceived Comfort and Listening Effort: Open vs. Closed-Fitting Earbud Architectures**

***Mr Zhen Ting Ong**, Ms Santi Peksi, Mr Tsunoda Naotaka, Prof Woon-Seng Gan*

The rapid evolution of Active Noise Control (ANC) and Hear-Through (transparency) technologies has led to their deployment in two primary form factors: closed-fitting and open-fitting earbuds. While closed-fitting designs provide superior passive isolation, they often induce occlusion effect and increased intra-aural pressure. Conversely, open-fitting designs

prioritize physical comfort and situational awareness but face significant challenges regarding acoustic leakage and low-frequency noise roll-off.

This paper presents a rigorous subjective study comparing the perceptual comfort and intelligibility of these two distinct architectures. A/B listening tests exposed subjects to simulated aircraft and ambient social (pub) noise at levels of 50, 60, and 70 dBA. To evaluate performance under high-stress conditions, speech and music stimuli were presented at a Signal-to-Noise Ratio of -10dB relative to the ambient noise floor. Participants assessed three key perceptual metrics: perceived background noise loudness, listening effort required for intelligibility, and the subjective urge to increase media volume.

Statistical analysis using ANOVA examined the effects and interactions. The study highlights a critical divergence in user ”comfort”: open-fitting designs necessitate more aggressive ANC algorithms to compensate for the lack of passive isolation, which may compromise acoustic comfort, whereas closed-fitting designs are primarily limited by the physical pressure inherent in their seal.

11:40 **Paper 644 — A Parameter Identification Active Bearing Control Framework for Lateral Vibration Suppression in Rotor Systems**

*Mr. Tingyu Lin, **Dr Dunant Halim**, Dr. Zhuang Xu, Dr. Thein Chung Ket*

Lateral vibration induced by imbalance and eccentricity is a critical challenge in high-speed rotor systems. Traditional active bearing control often relies on fixed-gain strategies, which lack adaptability to real-time variations in rotor dynamics. This paper presents a parameter-aware active control framework that integrates real-time parameter identification with Active Disturbance Rejection Control (ADRC). The core of the framework is a Parameter Identification Extended State Observer (PIESO), which online estimates key rotor states (e.g., equivalent imbalance) and mechanical parameters. These estimates are then fed into the ADRC law to dynamically adjust the piezoelectric bearing actuation forces, enabling the controller to adapt to changes in rotor geometry, eccentricity, and operational speed. The proposed identification-in-the-loop methodology shifts the paradigm from static compensation to adaptive, model-informed vibration suppression. Simulation and experimental studies demonstrate the framework’s effectiveness in stabilizing the system and suppressing lateral vibrations, highlighting its potential for enhancing the robustness and performance of active rotor-bearing systems.

1.7.2 Hybrid Active-Passive Systems for Noise & Vibration Control

Tue 11:00–12:20 — City Room 2 (Chair: Jia-xin Zhong, Jing Lu)

11:00: Paper 39 — Performance evaluation for vibration isolation systems based on shunt inertial actuators — *Mr Wenyu Mao*

11:20: Paper 319 — Wave control using hybrid mass damper with Frequency-Shaped Linear Quadratic Regulator — *Mr Takeroh Yasuoka*

11:40: Paper 325 — Design of a Vehicle Door Vibration Absorber Based on Nonlinear Energy Sink — *Miss Anya Dai*

12:00: Paper 598 — Vibration control using virtual vibration absorbers — *Mr Nathan Wendt*

11:00 **Paper 39 — Performance evaluation for vibration isolation systems based on shunt inertial actuators**

Mr Wenyu Mao

An inertial actuator typically possesses the ability to convert mechanical energy into electrical energy, and vice versa. This study presents a theoretical investigation of a vibration isolation system (VIS) based on inertial actuator with various shunt circuits. Firstly, the governing equation of a single-degree-of-freedom (SDOF) VIS system based on shunt inertial actuator is derived. It is demonstrated that adding positive resistor alone to the VIS provides no benefits for the control performance. This implies the necessity of introducing negative resistance (NR) together with shunt circuit to the VIS. Six different shunt circuits are presented and compared by using NR together with different arrangements between capacitor, inductor and resistor. The optimal parameters for different shunt circuits are discussed based on numerical calculations. The control performances with different shunt circuits are presented. Numerical simulations are presented to verify the control performances for different shunt circuits.

11:20 **Paper 319 — Wave control using hybrid mass damper with Frequency-Shaped Linear Quadratic Regulator**

Mr Takeroh Yasuoka

Hybrid mass damper (HMD) is a device that reduces the vibration by using both passive and active methods, therefore it is anticipated to improve the control performance and efficiency. In this study, a wave control is adopted as the method for deriving a control law and parameters to absorb positive travelling waves from the target structure. The wave control keeps the vibration modes inactive by treating the vibration phenomena as waves, however the bias is observed when actively applied in the framework of the dynamic vibration absorber. From this viewpoint, a control theory which is an extension of the linear quadratic regulator (LQR) to the frequency domain is applied to wave control using HMD. The bias is observed near zero Hz, therefore the bias is reduced by shaping the control force in the frequency domain. While this system achieves the wave control and reduces bias simultaneously, the vulnerability appears at the frequency where the sensor location coincides with a modal node of the vibration mode. A peak is observed at the designated frequency from vulnerability at the target system. Tuning the parameters to absorb the wave at the designated frequency improves the control performance and efficiency.

11:40 **Paper 325 — Design of a Vehicle Door Vibration Absorber Based on Nonlinear Energy Sink**

Miss Anya Dai*, A/Prof Jianwang Shao, Mr Jiawei Wang, Mr. Yichong Li, Mr. Weiguang Wang*

To address the challenge of suppressing the low-frequency, small-amplitude vibrations with multiple orders and wide bandwidth in vehicle doors, this study proposes a novel vehicle door vibration absorber with nonlinear stiffness characteristics based on the operating principle of nonlinear energy sink (NES). First, a coupled dynamic model of the vehicle door's multi-order modes and the NES-based vibration absorber is established and numerical methods were used to derive the target NES parameters required to suppress the low-frequency and small-amplitude vibrations in vehicle doors.Subsequently, a structure with nonlinear stiffness characteristics is designed, based on the target nonlinear stiffness of the vehicle door vibration absorbor, and its key parameters,specifically nonlinear stiffness and its bracket natural frequencies ,are simulated and analyzed using the finite element method. Finally, the effect of the key structural parameters for both the linear and nonlinear stiffness of the vehicle door vibration absorbor are analysed based on the simulation results.

12:00 **Paper 598 — Vibration control using virtual vibration absorbers**

***Mr Nathan Wendt**, Mr Yuki Takahashi, Prof Hiroyuki Iwamoto, Dr Cikai Lin, Prof. Nicole Kessissoglou*

Vibration control using virtual vibration absorbers is presented. To this end, velocity feedback control is employed to emulate single or multiple absorbers attached to various primary systems, corresponding to a flexible plate and a cylindrical shell. The dynamic illusion of an attached absorber is generated using a controller, where the feedback control gain is based on the mechanical impedance of the absorber. Comparison of the dynamic responses of the primary systems before and after control demonstrates suppression of the primary system resonances. The structurally radiated sound from the cylindrical shell is also examined. Using virtual vibration absorbers, acoustic illusions arising from structure-borne sound are observed.

1.7.3 Signal Processing & Algorithms for Noise & Vibration Control

Mon 14:00–15:00 — Panorama Room 3 (Chair: Prasanga Samarasinghe, ZhengDing Luo)

14:00: Paper 146 — An Improved Multi-Channel FxLMS Algorithm Based on Phased Array and Amplitude Constraint for Global Active Noise Control — *Mr Liqiang Yang*

14:20: Paper 113 — A Variable Step-Size Filtered-x Least Mean p-Power Algorithm for Active Noise Control — *Mr Qingyu Li*

14:40: Paper 147 — An Improved Multi-Channel FxLMS Algorithm Based on Phased Array and Multi-Weighted Error Fusion for Expanding Effective Active Noise Control Space — *Mr Liqiang Yang*

14:00 **Paper 146 — An Improved Multi-Channel FxLMS Algorithm Based on Phased Array and Amplitude Constraint for Global Active Noise Control**

Mr Liqiang Yang, *A/Prof Jianwang Shao, Mr Sen Wang, Mr. Qingran Li, Mr Chang Jin, Dr.Prof Xian Wu*

An active noise control (ANC) system can reduce noise in a designated control area, but its secondary field can have a negative effect on areas outside the control area. To alleviate this, this study proposes an improved multi-channel filtered-x least mean square algorithm based on phased array and amplitude constraint (PA-AC-FxLMS). The phases and amplitudes of the control signals are manipulated via phased array technique and scaling factors respectively, which can orient the secondary field. The parameters including step sizes, filter lengths and scaling factors are optimized by genetic algorithm. To validate the performance of the proposed algorithm, an experimentally verified three-dimensional cavity numerical model is established based on the automotive cabin configuration with door-mounted secondary speakers. After ANC using the proposed algorithm, compared with the traditional FxLMS and PA-FxLMS algorithms, the target ANC areas increase by up to 24.45% and 12.92%, respectively. At certain heights, noise enhancement zones have no impact on all passengers. These results demonstrate that: under the condition of a constant sound field area, the proposed PA-AC-FxLMS algorithm can effectively expand the noise reduction zone and decrease the noise enhancement zone. It is capable of achieving global active noise control inside a cabin.

14:20 **Paper 113 — A Variable Step-Size Filtered-x Least Mean p-Power Algorithm for Active Noise Control**

Mr Qingyu Li, *Ms Jing Chen, Mr Wei Gao, Dr Minxin Huang*

Impulsive noise exhibits distinct non-Gaussian characteristics, such as strong impulsivity and high-amplitude bursts, which severely compromise the stability of conventional active noise control (ANC) algorithms. The filtered-x least mean p-power (FxLMP) algorithm effectively mitigates control algorithm stability issues by minimizing least mean p-power of the error signal. However, it suffers from slow convergence when large impulsive spikes cause the weight update magnitude to diminish significantly. To address this problem, this paper incorporates a variable step size based on the Sigmoid function into the FxLMP algorithm. It can nonlinearly adjust the step factor according to the amplitude of the error signal, so as to accelerate the convergence when the error is large, and keep the stability when the error is small. Simulation experiments under standard α-stable impulsive noise were conducted to evaluate the proposed algorithm, with noise reduction performance measured by average noise reduction (ANR). Simulation results verify that the proposed algorithm not only overcomes the sensitivity of the filtered-x least mean square (FxLMS) algorithm to impulsive noise, but also addresses the slow convergence of the FxLMP algorithm, thereby offering a viable solution for high-performance active noise control in complex noise environments.

14:40 **Paper 147 — An Improved Multi-Channel FxLMS Algorithm Based on Phased Array and Multi-Weighted Error Fusion for Expanding Effective Active Noise Control Space**

Mr Liqiang Yang, *Dr. Jianwang Shao, Mr Sen Wang, Mr. Qingran Li, Mr Chang Jin, Dr. Xian Wu*

For automotive cabin active noise control (ANC), the multi-channel filtered-x least mean square algorithm based on phased array (PA-FxLMS) can expand noise reduction zone but results in a lower noise reduction level. To alleviate this drawback, this study proposes an improved multi-channel FxLMS algorithm based on phased array and multi-weighted error fusion (PA-MWEF-FxLMS). Its control signals are delayed using a variable fractional delay filter to orient the secondary field. To enhance the noise reduction level, multiple weighted error signals within the co-driver's head motion range are merged into the cost function of the FxLMS structure. To validate the performance of this algorithm, an experimentally verified

three-dimensional cavity numerical model is established based on the automotive cabin configuration with door-mounted secondary speakers. After ANC using the proposed algorithm, compared with the FxLMS algorithm, noise reduction area increases by 27.45%. Compared with the PA-FxLMS algorithm, the average noise reduction at the location of the co-driver raises by 3.12 dB. These results demonstrate that: under the condition of a constant sound field area, the proposed PA-MWEF-FxLMS algorithm can effectively expand the noise reduction zone. Meanwhile, it achieves an enhanced noise reduction in a designated control area.

Mon 15:40–18:00 — Panorama Room 3 (Chair: Prasanga Samarasinghe, Woon-Seng Gan)

15:40: Paper 574 — Balancing acoustic contrast and directivity control for Personal Sound Zones — *Mr Bingcong Lyu*

16:00: Paper 298 — Adaptive active control of line spectral noise based on frequency-domain robust estimation — *Mr Yi Tao*

16:20: Paper 755 — Multichannel Dual Active Noise Control System — *Dr Shota Toyooka*

16:40: Paper 177 — Multichannel Narrowband Active Noise Control with Coarse-to-Fine Frequency Estimation — *Miss Jiayi Sun*

17:00: Paper 781 — An overview of distributed active noise control — *Dr Sipei Zhao*

17:20: Paper 536 — Low-Rank Approximation for Computational Complexity Reduction in FxLMS-Based Active Road Noise Control — *Dr Zhe Zhang*

17:40: Paper 816 — Active control of periodic cabin noise with time-varying frequency using the Extended Delayed-X Harmonics Synthesizer — *Prof Toshihiko Komatsuzaki*

15:40 **Paper 574 — Balancing acoustic contrast and directivity control for Personal Sound Zones**

Mr Bingcong Lyu, *Dr Sipei Zhao, A/Prof Eva Cheng*

The generation of personal sound zones (PSZ) has gained significant research interest due to its potential application in public areas, car cabins and personal devices. While Acoustic Contrast Control (ACC) and Pressure Matching (PM) provide theoretical extremes for maximizing contrast and minimizing distortion, respectively, some studies have proposed trading off between signal distortion in the bright zone and energy leakage to the dark zone. However, existing trade-off approaches either fail to fully span these performance conditions or require complex multi-parameter frameworks. This paper presents an alternative hybrid cost function with a single tunable parameter to balance between maximizing the acoustic contrast between the bright and dark zones and controlling the directivity of the desired sound in the bright zone. Simulation is performed with measured room impulse responses and the results demonstrate that by adjusting the tunable parameter, the proposed approach can effectively bridge the gap between high acoustic contrast (ACC-like) and high reproduction fidelity (PM-like), offering a flexible and simplified control strategy.

16:00 **Paper 298 — Adaptive active control of line spectral noise based on frequency-domain robust estimation**

Mr Yi Tao, *Mr Hongsen He, Mr Yi Yu, Ms Limin Zhang*

Mechanical equipment in operation typically generates various types of noise. Line spectral noise, which is a common mechanical noise generated by the periodic vibration of rotating machines, usually leads to fatigue and damage of mechanical equipment and does harm to the physical and mental health of operators. To address this challenge, this paper proposes a robust adaptive active noise control method. A Huber estimator is used to define a frequency-domain cost function, from which a robust frequency-domain adaptive filtering algorithm is established. The ability of the frequency-domain Huber estimator to distinguish discrete pulses in line spectral noise is employed to improve the noise reduction performance of this algorithm. To cope with non-stationary line spectral noise, a variable step size is introduced into the update equation of the adaptive filter to construct a normalized robust frequency-domain adaptive control algorithm. Simulation results show that the proposed algorithms achieve faster convergence rate and better steady-state performance than typical algorithms.

16:20 **Paper 755 — Multichannel Dual Active Noise Control System**

Dr Shota Toyooka, *Mr Takuma Sendo, Prof Kenta Iwai, Prof Yoshinobu Kajikawa*

This paper proposes a multichannel dual active noise control (ANC) system for reducing undesired sound transmitted between adjacent spaces separated by a partition.

The proposed system extends a conventional single-channel dual active noise control system, in which each microphone functions as both a reference and an error microphone, to a multichannel configuration.

By deploying two microphones and two secondary sources in each space, the proposed system enables simultaneous noise reduction at two control points in each region, corresponding to the listener's ear positions.

The performance of the proposed system is evaluated through simulations using experimentally measured impulse responses.

The results demonstrate that the proposed system achieves approximately 15~dB reduction of undesired diffracted sound while preserving the desired direct sound.

16:40 **Paper 177 — Multichannel Narrowband Active Noise Control with Coarse-to-Fine Frequency Estimation**

***Miss Jiayi Sun**, Mr Chen Gong, Ms Jing Chen, Mr Wei Gao*

The noise reduction performance of narrowband active noise control (NANC) systems is highly sensitive to frequency mismatch, which can lead to severe performance degradation. Effectively suppressing this mismatch necessitates high-precision frequency estimation, which in turn presents the challenge of balancing estimation accuracy and computational complexity. To address this challenge, this paper proposes a filtered-x least-mean-square algorithm based on a coarse-to-fine q-shift frequency estimation scheme (Fx-CFQSE-LMS), to improve the noise reduction performance of multichannel NANC systems. The algorithm adopts a two-phase frequency estimation framework and achieves adaptive frequency tracking using theoretically optimized interpolation parameters. It obviates the need for both preset initial frequencies and manual adjustment of the estimator step size, while effectively addressing the issue of frequency mismatch. Simulation results demonstrate that the proposed NANC system achieves faster and more accurate tracking of multiple frequencies, leading to a significant improvement in noise reduction performance.

17:00 **Paper 781 — An overview of distributed active noise control**

Dr Sipei Zhao

Active Noise Control (ANC) has witnessed great success in consumer electronics in the past decades but its broader application over larger spatial regions still faces challenges due to the large number of channels required. Distributed ANC (DANC), including decentralised ANC, is a potential solution for massive channel active control due to its computational efficiency, robustness, and scalability, hence it has attracted much attention recently. This paper reviews existing decentralised and distributed ANC algorithms and discusses their respective pros and cons. Different distribution strategies are compared with a discussion of their potential practical applications. An outlook into the future research of DANC, focusing on the adaptive algorithms and potential issues in practically desired large scale active noise control systems, is also presented to stimulate more discussions and research on this topic.

17:20 **Paper 536 — Low-Rank Approximation for Computational Complexity Reduction in FxLMS-Based Active Road Noise Control**

***Dr Zhe Zhang**, Mr Xiao Lv, Mr Dehua Cai, Mr Zihong Ling, Mr Chenlu Shi*

This paper presents a novel and efficient implementation of an active noise control (ANC) system, specifically targeting the high computational and memory demands of traditional Filtered-x Least Mean Square (FxLMS)-based Road Noise Control (RNC). The core of the presented approach lies in applying low-rank approximation to the large secondary path matrix, which is a primary computational bottleneck. By decomposing this matrix and retaining only the most significant singular values and vectors, we achieve a substantial reduction in model complexity. Experimental results demonstrate that the proposed low-rank approximation model reduces the computational load and memory footprint substantially compared to the standard method, with only a marginal performance penalty. The study suggetsts that low-rank approximation is a highly effective technique for streamlining RNC systems, enabling their practical deployment in resource-constrained embedded platforms without significantly compromising the noise cancellation performance.

17:40 **Paper 816 — Active control of periodic cabin noise with time-varying frequency using the Extended Delayed-X Harmonics Synthesizer**

Prof Toshihiko Komatsuzaki, *Mr Jotaro Goto, Mr Seiya Hamaguchi, Mr Naoki Kimura, Mr Hiroyuki Yoshida, Ms Ayaka Mageshi, Mr Hirofumi Wada, Mr Shigeaki Usui, Mr Shuichi Osawa*

In recent years, due to engine noise reduction and replacement with electric motors in construction machinery, noises from hydraulic pumps and electric motors—previously drowned out by engine noise and unnoticed by operators—have become significantly more noticeable by operators inside the cabin. In this study, an extended Delayed-X harmonics synthesizer (DXHS), one type of active noise control (ANC) algorithm capable of tracking periodic noise frequency changes, was introduced to reduce high frequency harmonic noise originating from pump motors, which exhibits significant frequency variation among the various noises emitted by construction machinery. The proposed system outputs independently controlled sounds from two speakers, simultaneously performing noise cancellation at the operator's ear positions. The performance of the multi-channel frequency-tracking ANC method was evaluated for the reduction of unpleasant noise inside the cabin. The results showed that the proposed method can simultaneously and effectively reduce noise at both ear positions.

1.7.4 New Applications of Active Control

Wed 14:00–15:40 — Riverbank Room 3 (Chair: Stefan Jacob)

14:00: Paper 143 — A Method for Optimizing the Position of Secondary Sound Sources in Vehicle Active Noise Control Based on Particle Swarm Optimization — *Mr Sen Wang*

14:20: Paper 144 — Numerical Simulation and Experimental validation of Active Control of Vehicle Interior Air Conditioning Noise Based on FxLMS — *Mr Sen Wang*

14:40: Paper 333 — Practical Application of Spatial ANC Systems to Mitigate Inter-floor Noise — *Dr Youngmin Kwon*

15:00: Paper 355 — Time-domain simulation of wave-based active structural cloaking on a flexible beam using adaptive feedforward control — *Mr Yuki Takahashi*

15:20: Paper 570 — Combined Active Noise Control and Hear-Through Designs to Improve Speech Clarity in an In-Ear Headphone — *Mr Chong-Rui Huang*

14:00 **Paper 143 — A Method for Optimizing the Position of Secondary Sound Sources in Vehicle Active Noise Control Based on Particle Swarm Optimization**

A/Prof Jianwang Shao, ***Mr Sen Wang****, Mr Liqiang Yang, Mr. Yuyang Zhang, Dr.Prof Xian Wu, Mr Chang Jin*

The application of active noise control (ANC) in vehicle interiors is transitioning from theoretical research to practical engineering. To achieve better noise reduction performance and larger quiet zone inside the vehicle, multiple speakers are usually deployed as secondary sound sources. However, the placement of secondary sound sources will significantly influence the overall performance of the system. In this paper, we propose a method for optimizing the position of the secondary sound sources based on particle swarm optimization (PSO), and a rectangular test bench is taken as an example which with a size similar to that of the entire vehicle's acoustic cavity in a semi-anechoic chamber. This method estimates the secondary paths under semi-free-field conditions via the Helmholtz equation and calculates the sound pressure at the error microphone using the filtered-x least mean square (FxLMS) algorithm. The simulation results demonstrate that the optimized speaker arrangement can significantly increase the noise reduction capacity of the system. This work provides a new method for finding the optimal position of secondary sound sources.

14:20 **Paper 144 — Numerical Simulation and Experimental validation of Active Control of Vehicle Interior Air Conditioning Noise Based on FxLMS**

A/Prof Jianwang Shao, ***Mr Sen Wang****, Mr Liqiang Yang, Mr Yuyang Zhang, Dr.Prof Xian Wu, Mr Chang Jin*

Given the relatively stable frequency spectrum of vehicle interior air conditioning noise and the limited applicability of passive control measures, active noise control (ANC) presents a more suitable solution. This paper investigates a test bench within a semi-anechoic chamber environment. The system employs the primary path and secondary paths measured on the test bench, coordinating one reference sensor, four secondary speakers, and one error microphone to implement a multichannel feedforward control structure. The system is built on the normalized filtered-x least mean square (FxLMS) algorithm and uses the actual recorded vehicle interior air conditioning noise as the primary source. The simulation and experimental results indicate that the ANC system can achieve a certain level of control over the vehicle interior air conditioning noise, yet there remains considerable room for improvement. This work successfully validates the FxLMS-based approach for controlling vehicle interior air conditioning noise, confirming its potential for integration into automotive sound management systems.

14:40 **Paper 333 — Practical Application of Spatial ANC Systems to Mitigate Inter-floor Noise**

Dr Youngmin Kwon*, Seongmo Jung, Jinmu Lee, Hyounsuk Kim, Jinho Joo*

Nearly everyone who resides in multistory residential buildings throughout Korea has experienced inter-floor noise issue at least once in their lifetime and yet many of them suffer from ineffective sound insulation of their building structure. Among many efforts that have made to please sound insulation performance of residential buildings, a spatial active noise control (ANC) scheme has been developed to proactively cut down on vibration-induced airborne noise. In the course of its implementation, a few serious practical challenges have been posed: spaceless ceilings that do not fit for ANC hardware systems to accommodate; and interior design aesthetic. In the meantime, the completed system incorporating a controller,

vibration sensors, error microphones and processed anti-phase signal generating audio transducers must be functional and systematical in low-latency synchronization to coherently align signals. Different types of spatial ANC scheme were developed and applied in a living testbed, and tests on their noise reduction performance were conducted. To summarize the test results, fairly consistent noise reduction was attained over space up to 8dB on average according to spectral analyses across 30Hz through 500Hz. This paper further discusses how to deal with the above-mentioned challenges faced and how to practically situate the systems in the space.

15:00 **Paper 355 — Time-domain simulation of wave-based active structural cloaking on a flexible beam using adaptive feedforward control**

***Mr Yuki Takahashi**, Prof Hiroyuki Iwamoto, Mr. Nathan Wendt, Prof. Nicole Kessissoglou*

This study investigates active cloaking of a 1DOF system attached to a flexible beam. The target output of the coupled system is the response of the beam in the absence of the attached structure, i.e., that of the main structure only. To realize active cloaking, it is necessary to match the positive traveling wave coming from the left with that exiting to the right at the point connected with the attached structure. From the equation of motion of the beam, the general solution is derived. The general solution is expressed as the sum of four terms: the positive traveling wave, the negative traveling wave, and the near-field components from both ends. Therefore, by evaluating the general solution at four positions, these four unknown terms can be solved for. However, because the frequency responses of the individual wave components are not rational functions of s (the Laplace variable), they are approximated. In this study, we employ adaptive feedforward control in the time domain. First, the secondary path is identified, and then the target system is controlled. As a result, the proposed method brings the response of the main structure closer to the target response in time-domain simulations.

15:20 **Paper 570 — Combined Active Noise Control and Hear-Through Designs to Improve Speech Clarity in an In-Ear Headphone**

***Mr Chong-Rui Huang**, Prof Cheng-Yuan Chang*

Active noise cancellation (ANC) is widely used to reduce low-frequency ambient noise, while hearing-through (HT) aims to preserve the perception of external sounds for environmental awareness in headphones. Many commercial headphones incorporate both functionalities as separate operating modes. However, such mode-based implementations often fail to reduce low-frequency noise during HT operation, resulting in residual low-frequency noise that degrades perceived speech clarity. To address this limitation, this paper proposes an acoustic equalization control (AEC) system based on a unified feedforward control architecture, enabling joint operation of ANC and HT within a single framework. The proposed system improves speech clarity in low-frequency noise environments by allowing flexible and user-adjustable control of ANC performance, including tunable operating bandwidth, while preserving the intended HT functionality. The proposed filter design and control strategy are implemented on a real-time digital signal processor (DSP) platform for in-ear headphone applications. The effectiveness of the proposed system is validated through objective performance evaluations and subjective listening tests.

1.7.5 Artificial Intelligence for Active Systems in Noise & Vibration Control

Mon 15:40–17:40 — City Room 2 (Chair: Yoshinobu Kajikawa)

15:40: Paper 29 — Integrated Active Noise Control for Rotor-Based Low-Altitude Aircraft — *A/Prof Lei Luo*

16:00: Paper 52 — Development of AI Reinforcement Learning based Calibration Tool for Motor Whine Noise — *Mr Yohan Cho*

16:20: Paper 227 — Transformer-based End-to-End Generative Fixed-Filter Active Noise Control — *Dr Zhengding Luo*

16:40: Paper 291 — Fast-Converging Hybrid ANC with Joint Meta-Initialization — *Mr Wenxuan Xu*

17:00: Paper 293 — Frequency-Domain FxLMS Algorithm with Meta-Learning-Based Initialization for Active Noise Control — *Miss XUEXIAN LIU*

17:20: Paper 456 — Inverse design of dual Helmholtz resonator using deep learning techniques — *Mr Vikas Sablaniya*

15:40 **Paper 29 — Integrated Active Noise Control for Rotor-Based Low-Altitude Aircraft**

A/Prof Lei Luo

With the rapid development of the low altitude economy, noise generated by low altitude aircraft has become a critical concern. This paper presents an integrated active noise control (ANC) method and device specifically designed for rotor noise to mitigate its impact on ground activities. A COMSOL model is developed to optimize the sensor layout across varying flight altitudes. The rotating sound source is equivalently represented by multiple point sources arranged at half the rotor radius, effectively reconstructing the acoustic field in the target region located 5 m to 10 m below the rotor. Based on this equivalent model, a virtual microphone-based ANC strategy is adopted. Results demonstrate noise reductions of approximately 18 dB, 17 dB, and 12 dB in the target area at flight altitudes of 5 m, 8 m, and 10 m, respectively. The proposed integrated ANC approach offers a promising pathway toward “silent flight” for rotor-based low altitude aircraft

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16:00 **Paper 52 — Development of AI Reinforcement Learning based Calibration Tool for Motor Whine Noise**

Mr Yohan Cho

As the automotive industry continues to shift toward electrification, reduction of high-frequency noise in electrified vehicles has become an important issue in noise, vibration, and harshness development. One of the major concerns is 6th-harmonic motor whine caused by torque ripple and current ripple during motor operation. A widely used method for reducing this noise is 6th-harmonic feedforward compensation, in which compensation voltage is injected to reduce ripple. However, calibration of the phase and amplitude of the compensation voltage requires repeated evaluations and considerable engineering effort. In this paper, a reinforcement learning based artificial intelligence model is proposed to improve calibration efficiency for motor whine noise reduction. The proposed approach was applied under vehicle test conditions to optimize compensation parameters by minimizing current ripple. The results showed meaningful reward improvement, corresponding to current ripple reduction, within a limited learning period. These results indicate that the proposed method can improve calibration efficiency and has potential for broader application in motor noise, vibration, and related optimization tasks.

16:20 **Paper 227 — Transformer-based End-to-End Generative Fixed-Filter Active Noise Control**

Mr Ziyi Yang, Mr Yisong Zhou, ***Dr Zhengding Luo****, Mr Boxiang Wang, Prof Woon-Seng Gan*

To address the limitations of existing Generative Fixed-Filter Active Noise Control (GFANC) methods, which rely on filter decomposition and recombination and require supervised learning with labeled data, this paper proposes a Transformer-based end-to-end GFANC framework. Unlike previous approaches that predict combination weights of sub control filters, the proposed method directly generates control filters in an unsupervised manner by integrating the co-processor and real-time controller into a fully differentiable ANC system, where the accumulated error signal is used as the training objective. By abandoning the decomposition–reconstruction process, the proposed design simplifies the control pipeline and avoids error accumulation, while the Transformer architecture effectively captures global and dynamic noise characteristics through its attention mechanism. Numerical simulations on real-recorded noises demonstrate that the proposed method achieves improved noise reduction performance and adaptability to different types of noises compared with the original GFANC framework.

16:40 **Paper 291 — Fast-Converging Hybrid ANC with Joint Meta-Initialization**

***Mr Wenxuan Xu**, Dr Xu Zheng, Ms Xuexian Liu, Mr Yushu Qian, Mr Zhicheng Zhang*

This paper proposes a meta-learning-based fast-convergence active noise control algorithm for hybrid noise during rapid acceleration, which contains significant road noise components and frequency-varying engine noise. Conventional approaches typically combine a broadband adaptive filter with a narrowband adaptive notch filter to handle broad-frequency road noise and engine harmonic components respectively. However, under rapid engine speed variations, both types of filters suffer from slow convergence and tracking lag, leading to degraded overall noise reduction performance. To overcome this limitation, an improved Model-Agnostic Meta-Learning framework is adopted to jointly train the initial parameters of both the broadband filter and the narrowband notch filter offline, using historical noise data covering diverse operating conditions. The obtained meta-initialization enables the filters to start online adaptation from a near-optimal point when encountering new acceleration scenarios, thereby accelerating the convergence of both broadband noise suppression and harmonic tracking simultaneously. Simulations under various rapid acceleration and combined road-noise conditions demonstrate that the proposed method achieves significantly faster convergence, more accurate harmonic frequency tracking, and improved steady-state noise attenuation compared with conventional hybrid broadband narrowband ANC algorithms.

17:00 **Paper 293 — Frequency-Domain FxLMS Algorithm with Meta-Learning-Based Initialization for Active Noise Control**

***Miss XUEXIAN LIU**, Dr. Xu Zheng, Mr. Ziyi Yang, Mr Wenxuan Xu, Mr Yushu Qian, Dr. Chi Liu, Prof Woon-Seng Gan*

Active noise control (ANC) systems employing multiple control channels and operating at high sampling rates are required to suppress broadband and low-frequency noise in practical applications, which imposes a significant computational burden on adaptive algorithms. The frequency-domain filtered-x least mean square (FD-FxLMS) algorithm is therefore commonly adopted in in-vehicle ANC applications. In practical operating conditions, the convergence speed of FD-FxLMS plays an important role in establishing effective noise reduction, and slow convergence may lead to reduced noise attenuation when acoustic conditions vary. This paper proposes a meta-learning-based initialization strategy for frequency-domain FxLMS to improve the convergence behavior of multichannel in-vehicle ANC systems. An improved model-agnostic meta-learning (MAML) framework is employed to learn shared frequency-domain initialization parameters from multiple in-vehicle noise scenarios. The learned initialization provides a more informative starting point for the control filters, contributing to improved adaptation behavior of FD-FxLMS under changing operating conditions. The proposed approach combines the computational efficiency of frequency-domain adaptive control with the fast adaptation capability of meta-learning, without increasing online computational cost. Simulation results demonstrate that the proposed method achieves faster convergence and improved noise reduction performance compared with conventional FD-FxLMS in multichannel in-vehicle ANC scenarios, indicating its effectiveness and practical applicability.

17:20 **Paper 456 — Inverse design of dual Helmholtz resonator using deep learning techniques**

***Mr Vikas Sablaniya**, Mr. Anoop Kumar Singh, Mr Avijit Majee, Dr. Amrita Puri*

Helmholtz resonator (HR) comprises of a neck and a cavity. It acts as an acoustic energy-absorbing structure. The structure is utilized in design of muers, room panels, musical instruments etc. Conventionally, design of cylindrical neck and volume of the cavity of HR has been carried out using analytical expressions of its resonant frequency. Recently, the design of single Helmholtz resonator has been explored using deep learning techniques. This paper explores the design of dual Helmholtz resonators using deep learning techniques. A feedforward deep neural network (DNN) has been proposed to model the inverse relationship between the acoustic performance and geometric parameters. The model takes resonance frequencies and corresponding transmission loss values as input and predicts the geometric dimensions of the dual Helmholtz resonator. The resulting designs have been validated with the help of Ansys, and their response in terms of transmission loss (dB) over the desired frequency range has been studied.

Stream 2: Industrial & Transportation Applications

2.1.1 Aircraft Noise: General

Mon 15:40–17:40 — Panorama Room 2 (Chair: Michael Bauer)

15:40: Paper 56 — Aircraft noise annoyance control by design: an extended model to compose an aircraft's annoyance from its single components' contributions — *Dr Michael Bauer*

16:00: Paper 72 — Numerical analysis of noise generated by collision of a sonic boom and a single Rankine vortex — *Prof Takao Tsuchiya*

16:20: Paper 149 — Analysis and Control of Dynamic Acoustic Loads on aero-structure from Near-Ground vertical jet during take-off — *Prof Qun Yan*

16:40: Paper 527 — Noise Study Beyond Metrics – Gulfstream Acoustics Simulator — *Dr Tongan Wang*

17:00: Paper 800 — The next generation of aeroacoustic measurements: MEMS based sensor scaling — *Dr Carsten Spehr*

17:20: Paper 453 — Noise Considerations for New Spaceport Developments: Assessing Impacts on Humans and Fauna — *Mr Nicholas Henrys*

15:40 **Paper 56 — Aircraft noise annoyance control by design: an extended model to compose an aircraft's annoyance from its single components' contributions**

Dr Michael Bauer

The description of an annoyance-friendly aircraft design has been discussed for two decades ore even more. Nevertheless, a realistic inclusion of annoyance relevant metrics into the design process is still far away from its technical application. One reason is that yet there are no adequate tools which allow the acoustically modification of relevant aircraft noise sources, and thus their individual annoyance level, without time consuming re-assessment of its impact on the overall aircraft's noise annoyance. To overcome this gap, a first model was suggested, which proved to be capable to describe a realistic aircraft's annoyance by composing it from its single components' contributions. Because this first approach was established only by focusing on one certification relevant sideline position, mostly influenced by the aircraft's take-off condition, an extension to certification points, representative for additional major power and performance settings, such as approach and flyover, was regarded to be the next logical step. The work presented here shows the results of such an enhanced model, describing design related annoyance predictions in early stages of aircraft and component development or for estimations of retrofits' impacts on annoyance.

16:00 **Paper 72 — Numerical analysis of noise generated by collision of a sonic boom and a single Rankine vortex**

Prof Takao Tsuchiya*, Dr Masashi Kanamori*

This paper shows numerical analyses of noise generated by collision of a sonic boom and a single Rankine vortex. A two-dimensional hybrid method that treats boom signature analysis and noise propagation analysis separately is applied to noise analysis. The relationship between the vortex and the disturbed noise is investigated by some numerical experiments. As a result, it was found that the disturbed noise has a sharp directivity in the direction of incoming boom propagation. It was also found that the disturbed noise radiated from the vortex at a small angle from the horizontal plane is cutoff, while noise radiated at the minimum angle without cutoff reaches the ground with large amplitude.

16:20 **Paper 149 — Analysis and Control of Dynamic Acoustic Loads on aero-structure from Near-Ground vertical jet during take-off**

Prof Qun Yan*, Prof Xiao dong Li, Mr Xing qiang Liu, Dr Zhi guang Yue*

During rocket launch, the aero-structure and onboard payloads are disturbed by dynamical acoustics loads from intense impingement jet noise. At the initial near-ground lift-off stage, some original design of the bottom diversion channel is unsatisfactory, resulting in excessive noise loads. Based on the fundamental theories of jet noise propagation and shock wave dynamics, this paper establishes a correlation model between the geometric parameters of the Launch Pad Deflector

Trench (LPDT) and the acoustic loads in the concerned areas of the rocket. Combining full-scale numerical simulation with offshore field tests, the current paper optimizes and verifies the channel design, with key geometric parameters as variables and the minimization of shock wave overpressure on the payload fairing and broadband jet noise amplitude as optimization objectives. This method realizes the coordinated control of impingement shockwave and jet noise, reducing the peak shock wave overpressure on the rocket by more than 50% and achieving a significant drop in broadband noise. It has been directly applied to the engineering design of one specific offshore LPDT and acoustic load control for rocket launches.

16:40 **Paper 527 — Noise Study Beyond Metrics – Gulfstream Acoustics Simulator**
Dr Tongan Wang

Aircraft cabin noise, which can be generated by many sources during flight, significantly impacts passenger comfort and speech intelligibility. Extensive analyses and tests have been conducted to reduce cabin noise, and the results have typically been characterized using various standard noise metrics. Single-value noise metrics, however, do not convey the full listening experience, as two aircraft may sound very different despite having the same noise metrics. To bridge this gap, an immersive acoustics simulator has been developed to enable the listener to experience the full spectrum of the sound field subjectively. This paper first reviews different auralization technologies, then discusses the approach to developing the acoustics simulator at Gulfstream Aerospace. The simulator accurately reproduces the acoustic environment in a representative three-dimensional space and creates a truly immersive experience from multiple perspectives. It serves as an important platform for developing innovative solutions that improve cabin comfort and speech intelligibility beyond noise metrics for engineering analysis and conceptual development.

17:00 **Paper 800 — The next generation of aeroacoustic measurements: MEMS based sensor scaling**
Dr Carsten Spehr*, Dr. Daniel Ernst, Dr. Thomas Ahlefeldt, Dr. Armin Goudarzi, Florian Philipp, Dr. Reinhard Geisler*

Increasing the number of sensors can improve the signal-to-noise ratio (SNR) of measurements. The small sensor size also enables high spatial resolution beneath the turbulent boundary layer, while the low thickness and cost allow flexible integration within microphone arrays or direct installation on aeroacoustic models.

We present a modular microphone array system with an integrated data acquisition platform capable of handling 200 MEMS sensors per module. The architecture supports time-synchronized measurements from an arbitrary number of sensors, maintaining reasonable cost and installation effort.

The PDM bitstreams are synchronously acquired by an FPGA and transmitted together with metadata (e.g., timestamps, status information) as User Datagram Protocol (UDP) packets to a server at a continuous data rate of approximately 620 Mbit s^{1}.

Reference airframe noise measurements have been conducted in the low-speed wind tunnel DNW-NWB (Braunschweig, Germany) using 7,200 MEMS microphones over a 6 m × 3 m aperture. A second test employed 12,000 MEMS microphones over a 6 m × 5 m aperture in an open wind tunnel setup at DNW-LLF. Additional tests with 200 sensors were performed in the transonic wind tunnel in Göttingen (TWG) and on the fuselage of an aircraft in flight.

17:20 **Paper 453 — Noise Considerations for New Spaceport Developments: Assessing Impacts on Humans and Fauna**
Mr Nicholas Henrys*, Mr Darren Jurevicius, Mr Lloyd Damp*

The rapid growth of the commercial space industry and demand for space services is driving a wave of proposed spaceports worldwide, many of which are located in previously undeveloped or areas of actual or perceived environmental sensitivity. These facilities introduce a fundamentally different noise profile to traditional industry and infrastructure, characterised by very high sound levels that typically occur infrequently and over short durations. As a result, noise is often a primary focus for regulators and local communities during environmental assessment and approvals, reflecting both the novelty of spaceports as a noise source in many regions, and concerns regarding potential impacts on human amenity and biodiversity.

This paper presents Australian case studies that highlight key challenges in assessing noise impacts from proposed spaceports. These include regulatory frameworks that are poorly suited to high-intensity, low-frequency noise events such as

space vehicle launches, and a lack of relevant species-specific literature on potential behavioural and physiological effects on protected fauna. The paper also examines the importance of clear communication of technical noise modelling concepts and results, and the interrelationships between noise assessment, social licence and community trust.

2.1.3 Aircraft Exterior Noise

Wed 10:20–12:00 — Panorama Room 1 (Chair: Michael Bauer)

10:20: Paper 28 — Experimental Investigation and Validation of the Acoustic Radiation from a Duct — *Dr Ben Baddour*

10:40: Paper 348 — Prediction of Jet–Surface Interaction Noise Using a Three-Dimensional Finite Pressure-Footprint Model — *Mr Lin Liu*

11:00: Paper 395 — Aeroacoustic Mitigation of Slat Cove Noise via Integrated Metamaterial Liners — *Mr Hanjie Yang*

11:20: Paper 469 — Analysis of the Grazing Airflow Impacts on the Sound Attenuation of Acoustic Metamaterials — *Dr Tenon Charly Kone*

11:40: Paper 677 — Recent Developments in J-FRAIN: Toward Parameter Estimation of Engine Noise Models Based on Acoustically Derived N1 — *Tomohiro Kobayashi*

10:20 **Paper 28 — Experimental Investigation and Validation of the Acoustic Radiation from a Duct**

Dr Ben Baddour, *Dr Christos Karatsovis, Dr Laurence Wilmshurst, Dr Chaitanya Paruchuri*

This paper details the results of an experiment conducted to measure the acoustic radiation from a duct. Ducts are a key feature in the propulsion systems of aeroengines. They are usually included to improve aerodynamic efficiency. The effect of ducts on acoustic radiation has been studied for several decades, this work presents a validation of existing models via means of an experiment. Comparisons are shown between mathematical predictions and the experimental results. The acoustic radiation from a point axial dipole inside a finite length duct was represented by two loudspeakers mounted out of phase and a plastic pipe. This study was motivated by a requirement to understand the effect of ducts on acoustic radiation from aeroengines. This work allows for improved understanding of modelling techniques which can ultimately lead towards reduction of radiated acoustic noise from ducted aeroengines.

10:40 **Paper 348 — Prediction of Jet–Surface Interaction Noise Using a Three-Dimensional Finite Pressure-Footprint Model**

Mr Lin Liu, *Prof Xiao dong Li*

Jet-surface interaction noise is governed by the conversion of hydrodynamic near-field pressure into sound at a trailing edge, so prediction depends on both the edge response and the spatial statistics of the pressure footprint. Existing Amiet-type implementations often use infinite-span, modal, or stripwise inputs, which compress the spanwise extent and coherence of this excitation into restrictive assumptions.

This paper formulates a three-dimensional Finite Pressure-Footprint Model in which a localized two-point pressure spectrum drives the trailing-edge radiation integral. The physical-space expression retains finite aperture, footprint width, and cross-span coherence explicitly; its wavenumber-space interpretation is a finite-aperture projection rather than a single matched spanwise wavenumber. Coherent-strip, incoherent-strip, and infinite-span models then appear as limiting reductions of the same cross-spectral formulation.

The method is assessed for a published finite-span jet–plate configuration. A fully coherent modal pressure footprint recovers the coherent finite-span result, while a reconstructed finite-coherence pressure spectrum changes the low-frequency spectral shape and directivity. These comparisons identify cross-span coherence within the pressure footprint as a controlling element of the incident-field model.

11:00 **Paper 395 — Aeroacoustic Mitigation of Slat Cove Noise via Integrated Metamaterial Liners**

Mr Hanjie Yang, *Associate Professor Huanxian Bu, Xiao Song, Yifeng Sun, Professor Jie Zhou*

Slat cove noise is a primary component of airframe noise during the approach phase of large civil aircraft. Conventional acoustic liners are often constrained by their physical thickness, rendering them less effective at suppressing low-to-mid frequency noise within the geometrically confined spaces of the slat cove. To address this, acoustic metamaterials offer a promising alternative for low-frequency broadband attenuation. This study presents the design of customized acoustic metamaterial liners integrated into the slat cove and the leading edge of the main wing, followed by an extensive experimental exploration of their aeroacoustic performance. Progressive experimental campaigns were conducted: initially on

a 1:5.3 scale 2D airfoil in the FL-52 aeroacoustic wind tunnel (2 m × 1.5 m), followed by a 1:4 scale semi-span model in the FL-10 aeroacoustic wind tunnel (8 m × 6 m). A far-field linear microphone array to evaluate the overall noise reduction capacity and a multi-arm spiral array for sound source integration to specifically quantify noise suppression within the slat cove region.

11:20 **Paper 469 — Analysis of the Grazing Airflow Impacts on the Sound Attenuation of Acoustic Metamaterials**

Dr Tenon Charly Kone*, Dr Sebastien Ghinet, Dr Zacharie Laly, Dr. Anant Grewal*

This study investigates the influence of grazing airflow on the acoustic performance of a metamaterial composed of multiple quarter-wave resonators arranged in a circular configuration with four central “pancake” elements. The sample is tested under high-intensity excitation (up to 150 dB SPL) in a rectangular holder (2 × 10 in^2) with controlled grazing flow at different Mach numbers. A four-microphone method is used to measure the grazing absorption coefficient and transmission loss (TL), with and without a resistive screen.

At M = 0, peak absorption reaches 0.96 at 1840 Hz and decreases to 0.93 at M = 0.2. The TL peak drops from 15 dB to 12 dB. Both metrics decrease with increasing Mach number, regardless of the resistive screen, although broadband performance is maintained. The resistive screen enhances low-frequency damping and partially compensates for flow-induced degradation.

These results show that grazing flow modifies resonant absorption and TL while preserving broadband effectiveness, providing insight for designing acoustic metamaterials in applications involving significant airflow, such as ventilation systems and aircraft cabins.

11:40 **Paper 677 — Recent Developments in J-FRAIN: Toward Parameter Estimation of Engine Noise Models Based on Acoustically Derived N1**

Tomohiro Kobayashi*, Takatoshi Yokota, Koichi Makino, Toshiyasu Nakazawa, Mr Naoaki Shinohara*

We have been developing an aircraft noise simulation framework, J-FRAIN, to precisely predict aircraft noise at ground observation points during the landing approach phase. J-FRAIN incorporates component-wise regression sound source models created from field measurement data using a large-diameter microphone array system and enables detailed prediction of the time history of noise from individual aircraft components. In J-FRAIN, noise sources are categorized into four types: engines, landing gears, flaps, and slats. Engine noise is modeled as a function of engine rotational speed N1, since the radiated sound power strongly depends on N1. However, obtaining N1 is generally difficult in practice. Even when microphone array measurements are available, creating engine noise models may not be feasible without onboard data such as N1. To mitigate this limitation, we investigate the feasibility of estimating N1 from ground-based acoustic measurements and creating engine noise models based on the estimated N1.

2.1.4 Airport Noise

Tue 14:00–15:20 — Riverbank Room 5 (Chair: Karina Einicke, Naoaki Shinohara)

14:00: Paper 212 — Preliminary Methodology for Airport Ground Noise Source Characterization — *Dr Karina Einicke*

14:20: Paper 259 — Highly automated aircraft noise determination combining multiple classification methods — *Mr Taichi Higashioka*

14:40: Paper 280 — Quantifying Noise Benefits from Narrow-Body Fleet Modernization: A Case Study at Zurich Airport — *Mr Stefan Schalcher*

15:00: Paper 394 — A Consideration of Altitude Profiles and NPD Data in Relation to Inter-Airport Variations in Aircraft Noise Prediction — *Mr Kazuyuki Hanaka*

14:00 **Paper 212 — Preliminary Methodology for Airport Ground Noise Source Characterization**

Dr Karina Einicke, *Edith Hug*

Airport ground noise represents an important component of overall airport noise exposure, particularly for communities located in close proximity to airport boundaries. However, ground noise is often insufficiently represented in conventional airport noise modeling, which typically focuses on aircraft flight operations. This paper presents a methodology for the calculation of airport ground noise sources, addressing the most relevant stationary and mobile noise sources.

The methodology covers APU, GPU, GSE, airside traffic, engine test runs, engine test cells, as well as parking lots and multistory parking garages. For each source category, simplified source representations are proposed to reduce computational effort while preserving spatial and acoustic relevance. Depending on the physical and operational characteristics of the sources, point, line, vertical area, and horizontal area source models are applied.

The overall calculation approach is outlined, including source definition, spatial allocation, operational assumptions, and integration within standard environmental noise modeling frameworks.

The proposed methodology enables efficient and consistent modeling of airport ground noise sources and improves the representation of near-airport noise exposure. It provides a practical basis for evaluating ground noise contributions and supports the development of targeted noise mitigation strategies.

14:20 **Paper 259 — Highly automated aircraft noise determination combining multiple classification methods**

Mr Taichi Higashioka, *Mr Yukihiro Katoh, Mr Kyuhwang Shim, Mr Takahiro Mizuno, Mr Kazuki Tamura*

The evaluation of airport noise in Japan involves installing measuring instruments at representative locations around airports and using the actual measured aircraft noise levels at those points. Therefore, conducting accurate noise measurements at each point is crucial. Although several aircraft noise classification methods have been developed and are used, each method has its advantages and limitations. To overcome these disadvantages, extensive manual verification of actual measured data is required. This has been a significant operational issue.

In this paper, we propose an accurate aircraft noise determination framework that integrates multiple classification methods, including transponder-based classification, sound source detection, and flight track-based classification, with AI-based aircraft noise classification. This integration enabled substantial labor savings for the meticulous review work previously required to maintain accuracy. Furthermore, by customizing the combination of these modules, we achieved versatility that

allows optimizing the determination process for each monitoring station, adjusting to its specific characteristics such as the aircraft classification data available and the noise environment at that location.

14:40 **Paper 280 — Quantifying Noise Benefits from Narrow-Body Fleet Modernization: A Case Study at Zurich Airport**

Mr Stefan Schalcher, *Edith Hug*

This study investigates the impact of fleet modernization on measured aircraft noise levels using real-world data from Zurich Airport, an environment characterized by a mixed fleet, complex procedures, and stringent noise regulations. Noise measurements of conventional Airbus A320 and A321 are compared with their A320neo and A321neo successors, representing a major technological transition in current airline fleets.

The influence of propulsion technology is examined by contrasting established engines such as the CFM56-5B with modern systems including the CFM LEAP and PW1100G. A large-sample statistical analysis quantifies differences in noise levels, evaluates measurement variability, and assesses the statistical significance of observed changes. The results show that neo aircraft are, on average, quieter under comparable operating conditions; however, the magnitude of noise reduction varies substantially between individual engine types and can, in some cases, reach several decibels, with additional variability driven by operational and environmental factors.

Finally, measured operational noise levels are compared with ICAO certification data to evaluate how well certification metrics represent real-world noise performance. The findings highlight both the potential and limitations of linking certification data to real-world noise reductions achieved through fleet renewal.

15:00 **Paper 394 — A Consideration of Altitude Profiles and NPD Data in Relation to Inter-Airport Variations in Aircraft Noise Prediction**

Mr Kazuyuki Hanaka, *Mr Naoaki Shinohara, Mr Toshiyasu Nakazawa*

The present study focuses particularly on how altitude profiles and NPD data differ among airports and how these differences influence noise-prediction results. In our previous report, we described the development of a simple prediction model based on actual observations of noise and flight paths. In this approach, the noise-propagation calculations employ a simplified prediction method compared with conventional models, while still accounting for factors such as lateral ground attenuation, atmospheric absorption, and variations in flight paths. Among the components of the prediction database, altitude profiles and NPD data are particularly important, as they have a significant influence on the prediction results. Altitude profiles—namely the operational procedures for takeoff and landing—vary from airport to airport. Examples include cases where steep climb-out is required during takeoff, or differences in the altitude at which aircraft intercept the ILS during landing. Differences in operational procedures are also expected to affect the observed noise levels. In constructing the prediction database, measurement results from several airports were referenced. In the present study, additional measurement data from other airports were incorporated to further examine these inter-airport variations.

Tue 16:00–17:20 — Riverbank Room 5 (Chair: Karina Einicke, Naoaki Shinohara)

16:00: Paper 462 — Introduction of New Flight Routes for Capacity Expansion at Kansai and Enhanced Kobe Airport Utilization and Aircraft Noise Impact Assessment — *Ms Makiko Inoue*

16:20: Paper 562 — Comparative Analysis of Perspectives and Strategies for Aircraft Noise Monitoring and information disclosure among countries — *Mr Naoaki Shinohara*

16:40: Paper 624 — Active Noise Control of Aircraft Takeoff Roll Noise – Simulation versus Measurement — *Mr Joseph Czech*

17:00: Paper 699 — Long-term annoyance evaluation around military and joint-use airports considering daily fluctuations in aircraft noise exposure — *Mr Koichi Makino*

16:00 **Paper 462 — Introduction of New Flight Routes for Capacity Expansion at Kansai and Enhanced Kobe Airport Utilization and Aircraft Noise Impact Assessment**

Ms Makiko Inoue, *Mr Yoshio Nishino, Mr Kenji Matsubara, Mr Masanori Kida*

In the Kansai region, securing an annual capacity of 500,000 aircraft movements across the three airports by around 2030 is a key objective. To achieve this, capacity expansion at Kansai International Airport and further utilization of Kobe Airport as a complementary facility have been promoted. These efforts were realized through agreement on the introduction of new flight routes, based on the core principle of an offshore airport “free from environmental pollution” and with the utmost consideration for local residents.

From an environmental perspective, operational measures were implemented by the national government to raise flight altitudes while ensuring safety. Stakeholders also established a strengthened monitoring system for the new routes, including additional noise monitoring sites, enhanced and publicly accessible flight information systems, improved consultation and complaint-handling services, and coordination meetings among related parties.

This study evaluated aircraft noise impacts from the new flight routes by comparing measured noise data with pre-introduction predictions. Results confirmed that current noise levels remain well below environmental standards and are lower than initial forecasts. However, with future increases in flight operations expected, continued monitoring and careful communication with local communities will be necessary, with ongoing collaboration among all stakeholders.

16:20 **Paper 562 — Comparative Analysis of Perspectives and Strategies for Aircraft Noise Monitoring and information disclosure among countries**

***Mr Naoaki Shinohara**, Mr Toshiyasu Nakazawa, Mr Shigeki Tsuchiya*

Aircraft noise issues around airports recently extends to low noise levels, with complaints arising over a wide area even from the airports. Airports worldwide facing noise issues often implement continuous monitoring around surrounding areas, with the number of installations due to the expanding scope of problem areas. In Japan, the results of aircraft noise measurements are prioritized and used for comparison with environmental standards. Japanese manufacturers put considerable effort into developing mechanisms for identifying aircraft noise. However, considering that European countries comply with ISO standards for proper installation and measurement according to specifications and manuals, the level of intent in Japan might be lower.

This report examines noise monitoring systems in Japan and other countries, such as Europe, and considers the objectives and perspectives of monitoring. It also compares strategies for information disclosure.

16:40 **Paper 624 — Active Noise Control of Aircraft Takeoff Roll Noise – Simulation versus Measurement**

***Mr Joseph Czech**, Prof Chris Fuller*

Installing Active Noise Control (ANC) systems for quieting the start of takeoff roll at US airports can be less costly than traditional residential sound insulation programs. To reduce costs further, maximizing the system’s effectiveness and approximating its performance by design can be accomplished with computer-based simulation. This paper describes the development of a computer-based simulation model for ANC and compares the model’s results with those from live measurements. The model utilizes frequency domain matrix equations to derive the optimal control values. The jet noise spectra were obtained for in-situ measurements. The necessary transfer functions from the control source to the error microphones were calculated using the Advanced Acoustic Model for ground propagation. The testing utilized a digital time domain Filtered X feedforward control approach in conjunction with a bank of four 3,000-Watt speaker systems wired into two channels and three error microphones. The intention was to attenuate takeoff noise in sector downstream of the error mics and defined by their width of placement. Reasonable agreement between the model and testing was obtained and performance controlling aspects of the test were determined. These will be discussed in the presentation and paper.

17:00 **Paper 699 — Long-term annoyance evaluation around military and joint-use airports considering daily fluctuations in aircraft noise exposure**

***Mr Koichi Makino**, Ph.D Makoto Morinaga*

This paper presents the results of a reanalysis that focuses on the daily fluctuations in noise exposure from a social survey conducted by the authors around military and joint-use airports in 2014. The Japanese Environmental Quality Standards for Aircraft Noise are predicated on the yearly average of Lden, which is the cumulative noise index. The daily fluctuations in flight operations at military airports can be attributed to various factors, including training flights and other operational

activities. Consequently, the level of noise exposure in the vicinity of military airports may undergo substantial fluctuations from one day to another. Previous studies have shown that people are more annoyed by aircraft noise at military airports than at civil airports. The discrepancy in exposure-annoyance responses between military and civil airports appears to be attributable to the impact of exposure frequency. This paper expounds on the daily variation, frequency distribution, and deviation of noise exposure levels (Lden) derived from noise monitoring data collected around four military and joint-use airports during the social survey period. Additionally, it presents the findings of a reanalysis of social survey data for exposure-annoyance responses, with a particular emphasis on the daily fluctuations in noise exposure levels.

2.2.2 Drone Noise Measurement, Modelling and Assessment

Mon 09:00–10:00 — City Room 1 (Chair: Siyang Zhong)

09:00: Paper 22 — Time-averaged and instantaneous broadband noise characteristics of UAV propellers — *Miss Jiaying Liu*

09:20: Paper 360 — Aeroacoustic characteristics of a small-scale rim-driven thruster — *Mr. Boxi Li*

09:40: Paper 396 — Aerodynamic and acoustic analysis of asymmetric rotors with anti-phase trailing edges — *Mr Inkyu Kweon*

09:00 **Paper 22 — Time-averaged and instantaneous broadband noise characteristics of UAV propellers**

***Miss Jiaying Liu**, A/Prof Michael Kingan, Mr. Huachen Zhu, Mr Xianghao Kong, Mr Jin Xuan Teh*

This study investigates the time-averaged and instantaneous broadband noise of a UAV propeller through a combination of experimental and theoretical approaches. A revised Amiet-based model is employed to predict the time-varying broadband noise for rotating propellers, while in the experiments, a rotary encoder is used to identify each revolution, enabling the extraction of phase-synchronized instantaneous spectra. Both the predicted and measured results reveal spectral variations of up to 10 dB throughout a revolution, highlighting the strong influence of the blade position on the noise. Analysis of the noise variation as the blade approaches and recedes from the observer confirms that the UAV propeller exhibits distinct swishing-like characteristics. Furthermore, the results indicate that the near-tip blade segments play a dominant role in the instantaneous noise radiation.

09:20 **Paper 360 — Aeroacoustic characteristics of a small-scale rim-driven thruster**

*Dr Teng Zhou, **Mr. Boxi Li***

As the market of unmanned aerial vehicles (UAVs) rapidly expands, noise problems have drawn more and more attention in recent years. The blade tip noise is one of the primary noise sources on the UAV rotors, and it is highly associated with the convection of tip vortices. In this study, a small-scale rim-driven rotor is developed, whose blade tips are merged with a rim, and the generation of tip vortices is suppressed. The free-field noise level of the rim-driven rotor was measured using an arc microphone array and compared with a conventional rotor with the same size and blade profile. The intensity of the tip noise source was evaluated using a planar microphone array and the beamforming algorithm. To learn the effects on the aerodynamic performance, the hot-wire anemometry was employed to plot the wake profile. It was found that due to the presence of the rim, the noise source near the blade tip is mitigated, and the spanwise maximum aerodynamic load position is slightly moved towards the tip. This research provides insight into the aeroacoustic features of the rim-driven rotor configuration, based on which a new low-noise aerial propulsion system will be developed in the future.

09:40 **Paper 396 — Aerodynamic and acoustic analysis of asymmetric rotors with anti-phase trailing edges**

***Mr Inkyu Kweon**, Mr Sunwoong Kim, Mr Gyungjoo Ban, Prof Jeongwoo Ko*

The rapid proliferation of Urban Air Mobility (UAM) has underscored aeroacoustic noise mitigation as a paramount design objective for ensuring public acceptance. Consequently, understanding and alleviating the complex noise sources inherent to multi-rotor systems is essential for the development of community-friendly aircraft. Recent research has explored Uneven Blade Spacing (UBS) to scatter high-amplitude Blade Passing Frequency (BPF) tonal energy into multiple lower-amplitude harmonics, reducing perceived annoyance. However, this concept often leads to a significant aerodynamic penalty, with thrust reduction of 5–10% at narrow spacing angles due to intensified Blade-Wake Interaction (BWI). This study proposes a novel hybrid propeller design that integrates the UBS concept with anti-phase trailing edge technology. We hypothesize that the anti-phase mechanism, designed to vertically displace wake trajectories, can effectively mitigate the BWI-induced performance loss. This paper presents the numerical methodology (Vortex Particle Method and coupled CFD-CAA high-fidelity simulations) and preliminary results confirming the performance penalty of UBS. The expected synergistic benefits of the hybrid configuration—recovering thrust while simultaneously achieving superior tonal and broadband noise reduction—are discussed, positioning this design as a promising solution for quiet and efficient UAM propulsion.

Mon 10:40–12:00 — City Room 1 (Chair: Marion Burgess)

10:40: Paper 400 — Machine Learning based efficient rotor noise prediction — *Mr Jiahua He*

11:00: Paper 466 — Near-field-informed prediction of far-field acoustic directivity for multi-rotor UAV systems — *Mr Yuqi Xiao*

11:20: Paper 500 — On the tonal noise produced by a propeller operating upstream of a porous strut — *A/Prof Michael Kingan*

11:40: Paper 63 — Delivery drone swarm simulations and why flight path optimisation by noise metrics may not work — *Dr Michael Bauer*

10:40 **Paper 400 — Machine Learning based efficient rotor noise prediction**

***Mr Jiahua He**, Mr Zhicheng Zhang, Dr Qichen Tan, Professor Peng Zhou, Professor Xin Zhang*

Urban Air Mobility (UAM) plays a key role for Low-altitude economy. However, the noise emissions pose a substantial barrier to their widespread adoption. Traditional noise assessment methods, such as experiments and numerical simulations (including empirical models and compute fluid dynamic methods), can generate results of varying degree of accuracy but can consume expensive computation resources for each operational condition. The diverse configurations and operational states of UAM in urban environments call for efficient noise modelling methods for fast propagation evaluation. Existing machine learning (ML) techniques for rotor noise prediction lack generalization and complete sound directivity modelling, limiting their ability to prediction UAM operations noise. This work introduces a novel neural network architecture, which combines Artificial Neural Networks (ANNs) and Convolutional Neural Networks (CNNs), called ACN, to efficiently predict the spherical distribution of rotor noise. Training data is generated using boundary element/momentum theory (BEMT) approach coupled with the Hanson model. The ACN input incorporates blade geometry and arbitrary aerofoil profile information. Results demonstrate that the ACN model accurately predicts noise directivity for varying rotor blade profiles and operating conditions. Specifically, the model achieves high accuracy (less than 3 dB) in predicting the first tonal noise component while preserving phase information.

11:00 **Paper 466 — Near-field-informed prediction of far-field acoustic directivity for multi-rotor UAV systems**

***Mr Yuqi Xiao**, Mr Zhicheng Zhang, Mr Jiahua He, Mr Hongsen Bao, Mr Yuzhe Dun, Professor Qichen Tan, Dr Peng Zhou, Prof Xin Zhang*

Accurate acquisition of Unmanned Aerial Vehicles (UAVs) far-field sound directivity is challenging. Specifically, experimental measurements under controllable conditions are often constrained by the dimensions of anechoic chambers. As an alternative, outdoor measurements may be influenced by unexpected reflection and background noise. Besides, Computational Fluid Dynamics is cost-consuming and should be validated by experiments. Predicting far-field noise based on noise-filed noise of UAVs collected in experiments is a promising method with high fidelity and efficiency. To address this issue, we proposed a Graph-based Acoustic Radiation Directivity Extrapolation Network (GARDEN) to establish the relationship between near-field and far-field directivity. We constructed a dataset covering various multi-rotor configurations. The near-field and far-field noise data were efficiently calculated using the Blade Element Momentum Theory combined with Hanson's method. This dataset was then used to train GARDEN, enabling it to predict the amplitude and phase of far-field tonal noise based on near-field tonal noise. The proposed approach achieves promising results. In contrast, the conventional acoustic holography based on Equivalent Source Methods or Spherical Harmonic Expansion fails under same conditions. This study presents a feasible solution for the efficient and accurate acquisition of UAVs far-field acoustic directivity spheres.

11:20 **Paper 500 — On the tonal noise produced by a propeller operating upstream of a porous strut**

*Mr Huachen Zhu, **A/Prof Michael Kingan**, Mr Xianghao Kong*

Multirotor unmanned aerial vehicles are typically powered by a number of propellers which are connected to the airframe via struts which are usually located downstream of the propeller. The interaction of the flow generated by the propeller with the strut can generate significant levels of tonal noise. This paper investigates the effectiveness of using a porous strut to mitigate this noise and discusses methods for predicting this noise. Noise is generated by the unsteady loading on the propeller blades due to their interaction with the bound potential field produced by the flow over the strut, and also by the aeroacoustic sources caused by the flow passing over and through the porous strut. Standard analytical methods exist for predicting the loading on the propeller blades and the resulting noise. However, novel methods are required to model the

noise radiated from the aeroacoustic sources on and within the strut. This paper presents a brief description of models for predicting these sources.

11:40 **Paper 63 — Delivery drone swarm simulations and why flight path optimisation by noise metrics may not work**

Dr Michael Bauer

While a broader commercial use of air taxis will still take some time, delivery drones appear to be operated much earlier, as such services are already established in some regions but limited to certain local areas. Logically, as described in earlier studies on air taxis' flight path optimisation for the mitigation of community noise, the discussion for similar applications on delivery drones has started. But contrarily to air taxis, delivery drones may be linked to much higher numbers of flight movements per day. Once a highly developed application in logistics will be established, several hundred drones, leaving and approaching a delivery hub, can be expected. The situation will then resemble more a swarm-like air traffic than moving on well-defined and limited trajectories or air corridors. The work presented here is based on noise community simulations for several neighboring delivery hubs as a use case in the greater Munich area, which are surrounded by drone swarms. The results will show the upcoming challenges, if noise metrics will be further intended to be used for flight management.

Mon 14:00–15:00 — City Room 1 (Chair: Xin Zhang, Marion Burgess)

14:00: Paper 327 — Influence of Duct Lip Rib Design on Rotor Aerodynamic Noise — *Dr Guoming Deng*

14:20: Paper 468 — Assessing the Effect of Maximum Take-Off Weight on Drone Noise Emission and Community Noise Impact — *Prof Antonio J Torija Martinez*

14:40: Paper 696 — Noise Characterization of Multi-Rotor UAS: Outdoor Field Measurements and Analysis — *Dr Zhida Ma*

14:00 **Paper 327 — Influence of Duct Lip Rib Design on Rotor Aerodynamic Noise**

Dr Guoming Deng*, Prof Zhengwei Ma*

Aerodynamic noise of electric vertical take-off and landing unmanned aerial vehicles is one of the obstacles to their application in the development of the urban low-altitude economy. While ducts contribute to improving aerodynamic efficiency, the rotor and the duct lip are the primary sources of aerodynamic noise. Shape design and optimization of rotor and duct have been extensively studied to improve aerodynamic efficiency, whereas research on utilizing ribs to mitigate aerodynamic noise is still in exploration. This study addresses the issue of strong fluctuating pressure generated by the rotor tip and the duct lip by designing ribs on the lip to reduce aerodynamic noise. The aerodynamic thrust and far-field noise produced by a ducted propeller under hover condition are predicted using the IDDES method and the FW-H equation, and validated by experimental data from an anechoic wind tunnel. Subsequently, the simulation method is employed to compare the effects of rib position, and its dimensionless height and width on aerodynamic noise, providing engineering guidance for aerodynamic noise reduction in ducts and laying the foundation for further multi-parameter optimization design of rotor aerodynamic noise reduction.

14:20 **Paper 468 — Assessing the Effect of Maximum Take-Off Weight on Drone Noise Emission and Community Noise Impact**

Prof Antonio J Torija Martinez*, Mr Nathan Greeen, Dr Carlos Ramos-Romero*

The rapid expansion of drone-based delivery services is accelerating the need for effective noise management to ensure sustainable urban integration. Noise has emerged as one of the principal barriers to the wider deployment of drone operations, and both industry and regulators require robust evidence to incorporate noise considerations into route planning and operational guidelines. Previous research has demonstrated a strong relationship between a drone's maximum take-off weight (MTOW) and its emitted sound level; however, community response to drone noise is shaped not only by loudness but also by sound qualities such as high-frequency content, tonality, and temporal characteristics. This paper presents an experimental investigation into how changes in MTOW influence drone noise emission and other sound quality features. By systematically varying payload in a series of representative multirotor drone measurements, the resulting changes in loudness and key sound quality features are presented. The paper also presents an assessment of community noise impact

by modelling a series of scenarios with defined routes for drones with varying maximum take-off weight. The findings of this research will support drone operators and regulators in identifying the operational requirements necessary to minimise community noise impacts associated with drone operations.

14:40 **Paper 696 — Noise Characterization of Multi-Rotor UAS: Outdoor Field Measurements and Analysis**
***Dr Zhida Ma**, Mr Zhenjun Peng, Mr Runzhen Cao, Mr Nick Shum, Dr Guangsheng Liu, Mr Jiahua He, Dr Peng Zhou, Dr Wangqiao Chen, Prof Xin Zhang*

Noise issue from unmanned aircraft systems (UAS) hinders the development of low-altitude economy. The Hong Kong University of Science and Technology (HKUST) proposed a project within the Hong Kong government's "Low-altitude Economy Regulatory Sandbox" which characterizes the noise and assesses noise impact of different types of UAS. In this paper, the outdoor noise test of a 7kg-class multi-rotor UAS under diverse flight conditions is presented. Experimental setup, test protocols and data post-processing methods are detailed. Acoustic measurements are taken across various relative positions through a ground-based microphone array, alongside with UAS position data recorded for combined analysis of ground noise contour and noise directivity hemisphere. Key acoustic parameters are quantified including Sound Pressure Level (SPL) and Sound Exposure Level (SEL). The results reveal significant variations in noise profile and its impact under different flight parameters. These findings supply critical evidence for noise-related certification and regulation of low-altitude UAS operations.

Mon 15:40–17:20 — City Room 1 (Chair: Xin Zhang)

15:40: Paper 709 — Study on Aircraft Noise Calculation Model for Helicopters and Advanced Air Mobility — *Mr Toshiyasu Nakazawa*

16:20: Paper 71 — Delivery Drone Impacts on Communities: Forecasting Noise Exposure in Adelaide, Australia — *Dr Ryan S. Mckay*

16:40: Paper 262 — Evaluation of eVTOL Noise and Community Annoyance for Urban Air Mobility Integration — *Mr Henry Chan*

17:00: Paper 553 — Systematic review of drone noise effects — *Mr Joel Li*

15:40 **Paper 709 — Study on Aircraft Noise Calculation Model for Helicopters and Advanced Air Mobility**
***Mr Toshiyasu Nakazawa**, Mr Naoaki Shinohara*

Currently, new aircraft called Advanced Air Mobility, such as eVTOL, are being developed. These aircraft are expected to fly at lower altitudes than passenger aircraft. This airspace has traditionally been used by helicopters and other aircraft, raising concerns about noise exposure in urban areas.

The number of flights by these rotor aircraft is expected to increase in the future, making it necessary to consider the impact of noise. However, it is difficult to apply existing segment noise calculation methods for fixed-wing aircraft.

Therefore, a calculation model was constructed to calculate the noise of these rotorcraft. In this calculation model, the rotorcraft is regarded as a point source with a three-dimensional hemispherical sound source directivity, and the noise at the receiving point can be calculated from the three-dimensional position of the aircraft and the rotor power every 0.5 seconds. Additionally, a helicopter was measured at the airport, and a sound source model for the aircraft was prepared for the calculation model.

Furthermore, to verify the model's validity, helicopter noise was measured and compared with the model's calculation results for single noise events.

16:20 **Paper 71 — Delivery Drone Impacts on Communities: Forecasting Noise Exposure in Adelaide, Australia**
***Dr Ryan S. Mckay**, Mr Nicholas Henrys, Mr Darren Jurevicius*

Uncrewed aircraft system (UAS) operations are forecast to expand rapidly in Australia, with logistics-related flights expected to dominate urban activity. However, little research on the noise impacts on communities has been undertaken, despite this being a major public concern. This paper predicts the noise exposure of delivery drones across an urban area, with a case

study of Adelaide, Australia. Forecast flight numbers are taken from available projections and allocated in proportion to the population served under a hub-and-spoke model centred on shopping centres. Acoustic inputs are based on available measurements for commercial UAS operated in Australia. The cumulative noise impacts from flyovers and hovering during delivery were predicted using a stochastic simulation, in which flights were randomly allocated to dwellings within each hub catchment and iterated until per-dwelling event counts converged. These outputs are compared against background noise levels to estimate the number of audible flights residents will typically be exposed to and quantify the number of noise exposure events above various thresholds. The Adelaide case study is used to demonstrate implementation and explore potential noise impacts in residential areas, which are compared to impacts from traditional aviation.

16:40 **Paper 262 — Evaluation of eVTOL Noise and Community Annoyance for Urban Air Mobility Integration**

Dr Ho Ting Ng, Mr Xinyao Chen, Mr Po Lai Tam, ***Mr Henry Chan****, Professor Kin Che Lam, Dr Chi Wing Law, Mr Ka Wai Chan*

Commissioned by the Environmental Protection Department of the Government of the HKSAR, this study aims to establish a comprehensive framework for evaluating human annoyance responses to the sounds of Unmanned Aerial Vehicles (UAVs) and electric Vertical Take-off and Landing (eVTOL) aircraft in urban environments. Standard noise measurement protocols and ISO survey methodologies for human annoyance were employed. The study assessed several technologically advanced and locally available UAV and eVTOL models across various operational phases—including take-off, landing, cruising, and hovering. Acoustic measurements were conducted in accordance with ISO 5320:2024 standards. A cohort of 200 participants was recruited to listen to recordings of these sounds in a laboratory designed to emulate a typical household environment. Participants rated their annoyance levels on an 11-point numerical scale (ISO TS 15666, 2003) for each operational mode. Statistical analyses were performed to develop annoyance response curves, relating perceived annoyance to objective noise exposure metrics. The findings will help define critical noise thresholds for effective noise planning and management in urban contexts. By advancing understanding of UAV and eVTOL noise impacts, this research provides a scientific basis for regulatory frameworks aimed at mitigating adverse noise effects and enhancing the quality of life in cities.

17:00 **Paper 553 — Systematic review of drone noise effects**

Mr Joel Li*, Professor Brett Molesworth, A/Prof Marion Burgess*

The use of drones is expanding, in all areas, including recreational, commercial, and defence. In civil aviation, there are plans to incorporate drones into regular passenger transport. For the expansion of drone operations and management of the noise, an understanding of the effects of drone noise on people is required. This paper presents findings from a systematic review on the effects of drone noise on people following the PRISMA-ScR protocol. This involved a search for full text peer reviewed papers in English published over the period 1960 to 2025. The initial search identified 10,780 publications, from which after applying the detailed eligibility criteria, 24 papers were found to be relevant for review. In these 24 papers, subjective effects of annoyance (13 papers), threat (6 papers), and other emotional, mood, or attitudinal (10 papers) were identified in humans while objective effects such as changes to the performance of individuals in hearing and cognitive tests were identified in two papers. These effects on humans were identified to be influenced by changes in six drone design and operation related categories: noise source (or the model of the drone), noise characteristics, drone operation, surrounding environment, drone visual, and other variables.

2.2.4 Noise Impact and Control for Low-Altitude Aviation

Wed 10:20–11:40 — Panorama Room 2 (Chair: Siyang Zhong, Peng Zhou)

10:20: Paper 492 — Data Quality of an App-Based Noise Perception Assessment for Distributed Electrified Propulsion Systems — *Mr David Straub*

10:40: Paper 503 — An experimental study of micro vortex generators on rotor performance enhancement under multiple operating conditions — *Dr Xiangtian Li*

11:00: Paper 518 — Synergistic aeroacoustic effects of owl-inspired multi-scale wing adaptations — *Prof Hao Liu*

11:20: Paper 732 — Comparative Analysis of Subjective Annoyance between sUAS and Helicopter Noise: A Study on the Korean Public Response — *Mr Seokhyeon Shin*

10:20 **Paper 492 — Data Quality of an App-Based Noise Perception Assessment for Distributed Electrified Propulsion Systems**

***Mr David Straub**, Mr. Rahman Al Mahmudur, Ms. Carla Bubeck, Dr. Clémence Dubois, Dr. Susanne Bartels, Dr. Stephen Schade*

Public acceptance is critical for Urban Air Mobility (UAM), especially among residents exposed to its noise. Noise emissions primarily arise from the design and setup of propulsion systems, but how technical parameters translate into perceived unpleasantness and disturbance requires further study.

To address this, we developed an app to efficiently collect subjective assessments of noise from aircraft with distributed electrified propulsion systems. Stimuli were created with an analytical auralization process, accounting for interference, atmospheric effects, and ground reflections.

App users set engine parameters, listen to the corresponding sounds, and rate them on a standardized scale. A loudness calibration procedure ensures comparable sound exposure across participants, mobile devices, and headphones, and we compare its effectiveness to a similar procedure in the literature. Usability was assessed with the short version of the User Experience Questionnaire (UEQ-S). We present sound perception data gathered with the app from different participant groups, demonstrating the feasibility of a scalable tool for studying UAM noise perception.

10:40 **Paper 503 — An experimental study of micro vortex generators on rotor performance enhancement under multiple operating conditions**

***Dr Xiangtian Li**, Dr Bao Chen, Dr Puyuan Wang, Dr Wangqiao Chen, Dr Peng Zhou, Prof Xin Zhang*

Flow separation and stall are significant challenges for rotor-powered aircraft operating at low Reynolds numbers, particularly under off-design conditions. These flow phenomena adversely affect both aerodynamic and acoustic performance, as well as operation safety. In this study, micro vortex generators (MVGs) are employed to alleviate these detrimental flow phenomena and the associated rotor noise. Boundary layer transition-based distributions of vane-type MVGs are designed to installed on the rotor blade surface. A series of aerodynamic and acoustic measurements are conducted for both baseline and MVG-equipped rotors in an anechoic wind tunnel. The ascending and forward flight conditions of these rotors are selected for the tests, and two distributions of MVGs are applied along the spanwise direction of the rotor. The force results show that a slight aerodynamic improvement when the MVG-equipped rotors operates at the low rotational speeds. The far-field noise results demonstrate that the MVGs can significantly reduce broadband noise across a wide range of operating conditions. Notably, the reduction in overall sound pressure level reaches a maximum value of 4.2 dB. This study provides useful insights into the impact of MVGs on rotor noise generation, contributing to advancements in the development of rotor-powered aircraft in low-altitude economy.

11:00 **Paper 518 — Synergistic aeroacoustic effects of owl-inspired multi-scale wing adaptations**

*Dr Jiaxin Rong, Mr Syun Taguchi, Mrs Aoi Kurosaki, **Prof Hao Liu***

Owls have evolved remarkable adaptations for near-silent flight, making them a compelling model for understanding aerodynamic noise reduction and developing bio-inspired solutions for engineering applications. Their unique morphological features—such as leading-edge serrations and trailing-edge fringes—have often been studied in isolation and are typically

found to reduce noise at the expense of aerodynamic performance, suggesting a fundamental trade-off. In this study, we integrate macro-scale wing morphologies (curved leading edges, wavy trailing edges, wing camber, and slotted wingtips) with micro-scale serrations, implemented using both rigid and flexible structures in owl-inspired wing models. Wind tunnel experiments combined with large-eddy simulations reveal that these multi-scale wing adaptations act synergistically to suppress aerodynamic noise without degrading lift or drag performance. Our findings reveal a bio-inspired aeroacoustic strategy in which the integration of multiple mechanisms effectively overcomes the traditional noise–efficiency trade-off. This work provides new insight into the physics of silent flight and offers practical guidance for the design of quieter aircraft and drones for low-altitude aviation.

11:20 **Paper 732 — Comparative Analysis of Subjective Annoyance between sUAS and Helicopter Noise: A Study on the Korean Public Response**

Mr Seokhyeon Shin, *Dr Yeongmin Jo*

This study compares annoyance responses to hovering noise from three small Unmanned Aircraft Systems (sUAS) and one helicopter through an online listening test with Korean participants. To this end, we measured the sUAS sounds and used Robinson R44 helicopter data recorded during the Korean Urban Air Mobility Grand Challenge Dry-run. We edited all stimuli to 10 s and normalized them to the same A-weighted equivalent sound level. To improve the reliability of the online listening test, participants adjusted playback level using a hand-rubbing reference sound, and we applied predefined validity criteria to exclude invalid responses. After applying these criteria, we retained 45 valid responses. Participants rated four rotorcraft sounds on an 11-point annoyance scale. The results showed that the sUAS sounds tended to produce higher annoyance ratings than the helicopter sound under level-normalized conditions. Moreover, free-text responses frequently included descriptors such as sharp, irregular, beeping, and metallic, suggesting possible links to sharpness, fluctuation, and tonality. In addition, participants identified the helicopter source more often, and this stimulus showed relatively lower annoyance ratings. Overall, these findings suggest that source recognizability or familiarity may be relevant to annoyance judgments and support online listening tests for comparative rotorcraft-noise evaluation.

Wed 14:00–15:00 — Panorama Room 2 (Chair: Peng Zhou, Siyang Zhong)

14:00: Paper 372 — Impact of flight protocols on noise exposure of nearby people during take-off and landing phases of lift-cruise eVTOLs — *Dr Zhengguang Li*

14:20: Paper 373 — On the noise reduction mechanisms of coaxial rotors with unequal radii — *Prof Siyang Zhong*

14:40: Paper 378 — Acoustic Challenges in Future Mobility – Insights from Vertiport Design — *Mr Christian Vossart*

14:00 **Paper 372 — Impact of flight protocols on noise exposure of nearby people during take-off and landing phases of lift-cruise eVTOLs**

Dr Zhengguang Li, *Dr Zhi Zhang, Yaoyao Jiang*

The lift-cruise eVTOL is one of three prevailing configuration categories. It holds significant potential for future urban and intercity passenger and cargo transport. However, the noise it makes may constrain its further development and widespread adoption due to its impact on the surrounding environment. During take-off and landing, eVTOLs operate closest to the ground, with lift generated entirely by lift propellors. This results in the greatest outward noise emission and the maximum environmental impact. Flight parameters such as vertical take-off/landing velocity and altitude, as well as transition phase acceleration rates, determine noise levels and duration at nearby reception points on the ground. These parameters directly influence noise exposure for nearby people and warrant careful consideration. This study field-recorded the whole-aircraft noise during the take-off and landing of a lift-cruise eVTOL, as well as noise from the lift and cruise propellers operating independently under various conditions. The corresponding noises at typical nearby receiving points under different take-off and landing flight procedures were simulated. The impact of different flight protocols on noise exposure for nearby people during these phases was then compared. From an environmental acoustics perspective, recommendations are proposed for the take-off and landing flight protocols of lift-cruise eVTOLs.

14:20 **Paper 373 — On the noise reduction mechanisms of coaxial rotors with unequal radii**

Mr Zimo Wang, Dr Han Wu, Dr Sinforiano Cantos, Dr Peng Zhou, ***Prof Siyang Zhong***

Coaxial counter-rotating rotors can be used in unmanned aircraft systems (UASs) due to their high efficiency and stability characteristics. However, the strong aerodynamic interactions between the two rotors introduce complex wake dynamics and raise challenges for noise reduction. In conventional coaxial configurations, the lower rotor operates within the contracted wake flow of the upper rotor, which leads to abrupt blade loading variations, as well as pronounced interactions between the lower blades and the tip vortices shed from the upper rotor. To mitigate these effects, this study investigates coaxial rotors with unequal radii, in which the lower rotor is fully enveloped within the wake flow of the upper rotor. A prediction framework that combines an extended free vortex wake method and blade element momentum theory with momentum coupling is developed to model the interactions between the two rotors. Unsteady airfoil theory is applied to capture time-varying blade loads, while the noise emissions are calculated using an acoustic analogy. In the full-length paper, the predicted results will be compared against experimental tests and high-fidelity simulations for validation. The method is expected to provide insights into the low-noise design of coaxial propulsion systems in early UAS design.

14:40 **Paper 378 — Acoustic Challenges in Future Mobility – Insights from Vertiport Design**

Mr Christian Vossart*, Mr Ullas Karicherry, Mr Cheuk Yei Ho*

Urban Air Mobility (UAM) introduces drones and electric Vertical Take-Off and Landing (eVTOL) passenger-aircraft into dense urban environments, bringing acoustic challenges not seen from conventional aviation. These vehicles operate at low altitudes and use multiple rotors, creating tonal, broadband, and highly modulated noise signatures that directly influence community acceptance and operational feasibility.

This paper gives an overview of these challenges, using real flight-test results for passenger-aircraft and lessons learned from the United Arab Emirates Vertiport programme in Dubai. It outlines how noise is generated; why psychoacoustic factors such as loudness, sharpness, tonality, and fluctuation strength are critical to human perception; and why predicting noise in complex urban environments remains difficult.

The paper also summarises key research findings and highlights the current gaps in guidance from European Union Aviation Safety Agency (EASA) SC-VTOL standards, North American Space Agency (NASA) Urban Air Mobility framework, and the International Civil Aviation Organisation's (ICAO) Annex 16. The goal is to provide an understanding of developing UAM acoustic requirements, and the engineering considerations needed to support vertiport planning, façade design, and upcoming regulatory frameworks.

2.3.1 Ground Transportation Noise & Vibration: General

Mon 16:00–17:40 — Riverbank Room 6 (Chair: Seonghyeon Kim)

16:00: Paper 299 — A Hybrid Acoustic Transfer Function Synthesis Framework for Evaluating Exterior Trim Effects on Airborne Tire Noise — *Mr Hyunwoo Kim*

16:20: Paper 541 — Self-powered and self-sensing electromagnetic shunt damper for semi-active vibration control — *Dr Ruqi Sun*

16:40: Paper 550 — Transportation Noise Auralisation for Public Meetings — *Mr Scott Noel*

17:00: Paper 578 — A review of efforts to use acoustic pass-by measurements to regulate transport vehicle noise objectives in Australia — *A/Prof Jeffrey Parnell*

17:20: Paper 733 — Improving Tire/Road Noise Evaluation by Incorporating Sound Directivity — *Mr Yoshihiro Shirahashi*

16:00 **Paper 299 — A Hybrid Acoustic Transfer Function Synthesis Framework for Evaluating Exterior Trim Effects on Airborne Tire Noise**

Mr Hyunwoo Kim, *Dr Kisang Chae, Mr Jinung Jang, Dr Munseok Lee*

This study presents a hybrid acoustic transfer function (ATF) synthesis framework to assess airborne tire noise transmission into the vehicle interior.

In vehicle NVH development, experimental ATF measurements provide reliable system-level responses but are limited in assessing design variations, while fully numerical approaches require extensive modeling effort and validation.To overcome these limitations, a hybrid framework is proposed, where exterior transfer functions are obtained from FE-based exterior sound field analysis and interior transfer functions are derived from vehicle-level measurements. These components are combined using a power-based ATF synthesis formulation to estimate overall noise transmission characteristics.

The framework is applied to wheel guards and bumper pads, which are dominant contributors along airborne tire noise paths. Model credibility is assessed based on the consistency of frequency-dependent trends and panel contribution behaviors between simulation and measurement.

Using the validated framework, a parametric study is conducted by varying key design parameters such as material type, thickness, density, airflow resistivity, and coverage. The results reveal frequency-band-dependent sensitivities and provide practical engineering guidelines for exterior trim design. The proposed framework enables efficient comparison of design alternatives in early development stages.

16:20 **Paper 541 — Self-powered and self-sensing electromagnetic shunt damper for semi-active vibration control**

Dr Ruqi Sun, *Mr Qiheng Xu, Prof Xuan Zhao, Dr Jinyang Li, Prof Li Cheng*

Electromagnetic transducers can be utilized as the actuators, sensors or even power sources for vibration control. Tunable electromagnetic shunt dampers (EMSDs) with different control strategies can effectively improve the vibration control performance. However, the energy required for vibration control systems and the sensors for control strategies pose significant challenges in energy-scarce and space-constrained applications. This study developed an EMSD with self-powered and self-sensing capabilities. The energy harvesting performance under ultra-low-frequency vibration excitation and a data-based self-sensing enhancement algorithm were both verified with experiments. Under ultra-low-frequency and large amplitude vibration excitation, a microcontroller unit (MCU) adjusts the EMSD external resistance by switching a relay group. Simultaneously, an energy harvesting circuit captures the vibration energy and stores it in a capacitor. When vibration amplitude decreases or stops, the capacitor charges the MCU's power supply, enabling the closed-loop self-powering. Since the induced electromotive force of the electromagnetic damper is proportional to relative velocity, real-time voltage measurements at the external impedance terminal provide the required velocity data for calculating the damping force to the control system, which allows the system semi-active vibration control implementation without additional sensors.

16:40 **Paper 550 — Transportation Noise Auralisation for Public Meetings**
Mr Scott Noel

Communicating transportation noise impacts and mitigation strategies during environmental permitting can be a significant challenge. This paper introduces a specialized tool designed to auralize and visualize noise from highway, rail, and aviation sources. By utilizing tablets and noise-canceling headphones, the tool allows stakeholders at public outreach events to experience immersive ”before and after” scenarios. The platform effectively demonstrates the impact of proposed projects and the efficacy of abatement measures, such as sound barriers and residential insulation, through integrated audio-visual renderings of both base and mitigated conditions.

17:00 **Paper 578 — A review of efforts to use acoustic pass-by measurements to regulate transport vehicle noise objectives in Australia**
A/Prof Jeffrey Parnell*, Dr Benjamin Halkon, Dr Qiaoxi Zhu*

Most government regulators set objectives for noise generated by the operational use of transport infrastructure within their jurisdiction. Invariably, these objectives are based on long-term averaging metrics such as Leq(15h) Day, L (18h) or Lden. Comparisons are then made to dose / response type relationships such as those proposed by Schultz in the 1970's to quantify the level of expected annoyance. These dose / response curves have been remarkably resilient over 50 years however, they depend on statistical averaging of large data sets and were not designed to account for the small number of outliers that may cause increased outrage due to either higher sound pressure levels or because of excessively annoying characteristics. Examples often raised include heavy vehicle engine brakes, faulty or modified exhaust systems, driver behaviour and rail wheel squeal. This review paper examines efforts undertaken in Australia to address community concerns regarding what is often believed to be unnecessary noise by identifying individual offending vehicles in the traffic stream using acoustical means.

17:20 **Paper 733 — Improving Tire/Road Noise Evaluation by Incorporating Sound Directivity**
Mr Yoshihiro Shirahashi*, Mr. Shun Uchida, Prof Toru Yamazaki*

The increasing penetration of electric and hybrid vehicles has shifted the primary source of road traffic noise toward tire/road interaction, highlighting the need for more accurate tire/road noise prediction models. Current evaluation methods, which estimate the acoustic power level of tire noise from maximum pass-by levels, may underestimate the sound exposure level (SEL) required to calculate Leq for road traffic noise. This underestimation is thought to arise from the directivity characteristics of tire–road noise. In addition, in the CPX method for measuring close-proximity tire noise, studies have examined microphone placement that account for source directivity. This study aims to improve methods for evaluating tire/road noise and to develop a noise model that incorporates directivity effects. To clarify the radiation characteristics of directional sound generated at the contact patch, a simplified tire–road surface model was analyzed using FEM, and directivity was modeled based on the results. Through this modeling, the mechanisms leading to SEL underestimation can be understood, and proposals for improving the evaluation methods used to develop tire/road noise models are made.

2.3.2 Measurement Methods for Tire/Road Noise

Mon 16:00–17:40 — Riverbank Room 8 (Chair: Paul Donavan, Judy Rochat)

16:00: Paper 308 — Raising the standard: getting more from tyre/road noise measurements — *Mr Richard Jackett*

16:20: Paper 127 — A Method for Assessing Acoustic Environmental Quality of Regional Traffic Network Noise — *Ms Shu Fang Huang*

16:40: Paper 310 — The effect of asphalt thickness, texture, and void content on tyre/road noise — *Dr Robin Wareing*

17:00: Paper 493 — Laboratory Assessment of Tyre–Road Rolling Noise Using the Rubber Plate Impact Method: Limits and Perspectives — *Prof Filippo Praticò*

17:20: Paper 821 — Examination of the time delays between maximum overall A-weighted levels and one-third octave band levels for sinusoidal rumble strips — *Dr Paul Donavan*

16:00 **Paper 308 — Raising the standard: getting more from tyre/road noise measurements**

Mr Richard Jackett, *John Bull, Rob Wareing, Dr George Bell, Stephen Chiles*

Noise control for highways usually depends on managing the physical properties of the road surface, where noise reductions of 10 dB or more are possible. The close-proximity (CPX) noise measurement method isolates the tyre/road emission, enabling research and development of quieter road surfaces, and providing a route to acoustic certification of road surfaces or surface types.

While the CPX standard ISO 11819-2:2017 was being drafted during the 2010s, New Zealand was developing its own compliant CPX measurement system. Continued refinement of that system over the last 10 years has resulted in improvements to the quality, efficiency, and reproducibility of CPX measurements. Consequently, this paper presents recommendations for a revision of the ISO 11819-2 standard.

The standard allows broad freedom in CPX system design (powered vs towed, open vs enclosed) but experiments show that its correction procedures can fail to account for even relatively small physical variations. A subset of the calibration procedures are unsafe or impractical to perform for some system designs, but can be replaced by alternative methods without degrading performance. Minor changes to the default system configuration in the standard could unlock some of the most valuable data, including one-third octave band spectra, and more sensitive microphone positioning.

16:20 **Paper 127 — A Method for Assessing Acoustic Environmental Quality of Regional Traffic Network Noise**

Ms Shu Fang Huang, *Mr Min Min Yuan, Mr She Gang Shao, ShuiYin Wang*

To address the limitations of traditional highway traffic noise evaluation—which often prioritizes ”compliance” over ”quality,” emphasizes ”single points” over ”regions,” and struggles to balance management efficiency with soundscape value—this study proposes a multi-factor integrated quality assessment method for highway traffic networks and their surrounding acoustic environments. It focuses on introducing four key management elements: traffic noise source characteristics (traffic volume, vehicle type ratio), regional spatial management attributes (acoustic environment functional zones), scale of protected targets (area proportion of acoustic environment protection targets), and natural soundscape preservation. By constructing a traffic noise impact index, a functional zone coordination index, a protected target pressure index, and a natural soundscape quality index—and using expert weighting and the Analytic Hierarchy Process—a weighted summation formula is developed. This formula enables quantitative and graded evaluation of the acoustic environmental quality around highway traffic networks.An empirical study in a typical highway network area shows that this method shifts from ”single-limit compliance judgment” to ”multi-objective synergistic management effectiveness evaluation.” It provides a quantitative tool for noise zoning control, low-noise planning, and ”quiet zone” designation.The management-oriented nature of the evaluation results is significantly superior to traditional assessment methods.

16:40 **Paper 310 — The effect of asphalt thickness, texture, and void content on tyre/road noise**

Dr Robin Wareing, *Dr George Bell, Stephen Chiles, John Bull, Mr Richard Jackett*

Over the past 10 years New Zealand has been undertaking regular surveys of tyre-road noise using the Close-Proximity (CPX) method to assist in the development of low noise road surfaces. A detailed analysis of the CPX and associated data

has been undertaken, and the findings are presented in this paper.

The analysis presented focuses on the effects of porous asphalt layer thickness, mean profile depth (MPD), and void fraction, drawing on several tens of kilometres of CPX data on several New Zealand motorways and applying both univariate and multivariable regression.

Across all projects and surface types, thickness was identified as the dominant parameter influencing tyre/road noise, exhibiting a negative correlation with overall LCPX. MPD was generally positively correlated with LCPX. Void fraction exhibited a non-linear relationship with LCPX, with a local minimum observed at approximately 15% void content, reflecting competing mechanisms associated with surface texture excitation and acoustic absorption.

Analyses of the one-third-octave bands revealed complex, thickness-dependent behaviour in the 630–2,000 Hz range, consistent with characteristics of porous absorbers. MPD was positively correlated with tyre/road noise in the low- to mid-frequency bands, while void fraction was negatively correlated with noise levels in the higher-frequency bands.

17:00 **Paper 493 — Laboratory Assessment of Tyre–Road Rolling Noise Using the Rubber Plate Impact Method: Limits and Perspectives**

***Prof Filippo Praticò**, Dr- Vamsi Navya Krishna Mypati*

Rolling noise has become a dominant source of urban traffic noise, also at lower speeds, as vehicle powertrain noise continues to decrease due to improvements in internal combustion engines or transition towards electric vehicles.

Laboratory-based methods play a key role in evaluating pavement acoustic behaviour under controlled conditions and in supporting early-stage material optimisation. Despite this, questions remain regarding their reliability and representativeness.

Consequently, this study focuses on a laboratory investigation of the rubber plate impact (RPI) method to characterise the acoustic response of pavement surfaces. Indeed, as is well known, the RPI method is supposed to simulate tyre–road interaction through the folding impact of a treaded rubber plate, reproducing fundamental noise-generation mechanisms such as tread impact and air pumping.

To this end, conventional dense asphalt concrete and rubberised pavement surfaces were examined under controlled indoor conditions.

Acoustic responses were analysed using A-weighted equivalent sound pressure levels and one-third-octave band frequency spectra, with results interpreted in relation to dominant generation mechanisms. Findings confirm the sensitivity of the RPI method to pavement material characteristics and demonstrate its effectiveness as a rapid laboratory tool for comparative assessment of tyre–road noise performance. Limits and perspectives of the method were outlined.

17:20 **Paper 821 — Examination of the time delays between maximum overall A-weighted levels and one-third octave band levels for sinusoidal rumble strips**

***Dr Paul Donavan**, Ms. Carrie Janello*

In a recently completed National Cooperative Highway Research Program project, light vehicle pass-by measurements were completed on 20 sinusoidal rumble strips ranging from 30.5 to 61 centimeters in wavelength at vehicle speeds of 96.6 and 72.4 km/h. The measurements included four vehicles ranging from a full-size sport utility vehicle to a subcompact. It was found that there were consistent delays between the maximum overall A-weighted levels and the maximum levels produced in the one-third octave band corresponding to the repetition rate of the specific sinusoidal strips. At 96.6 km/h, the average delay across all four test vehicles and the 20 sinusoidal rumble strips was 0.8 seconds. Generally, larger delays (0.9 to 1.3 seconds) occurred for the longer wavelengths, 38.1 to 61 cm, with the only exception being the shortest wavelength of 30.5 cm at 0.9 seconds. The 35.6 cm strips consistently produced the shortest delays of 0.5 to 0.7 seconds. Conversely, at 72.4 km/h, the 35.6 cm strips typically produced the longest delays of 1.1 seconds. Effects of constructive and destructive interference are also indicated in the time histories in the lower frequencies associated with the repetition rate of strips.

2.3.3 Acoustic Properties of Road Pavements

Wed 14:00–15:40 — Riverbank Room 7 (Chair: Paul Donavan, Ulf Sandberg)

14:00: Paper 727 — Noise-reducing pavements 100-200 years ago: The wood block story — *Ulf Sandberg*

14:20: Paper 406 — Leveraging Data Analytics to Map Traffic Noise Variability: A Framework for Urban Noise Management — *Mrs Oluwafisayo Adeolu*

14:40: Paper 802 — Development and Noise Reduction Performance of a Pelletized Reactive Crumb Rubber Modifier for Dry-Process Asphalt Pavements — *Mrs Hyunjin Kim*

15:00: Paper 296 — Prediction and Control of Traffic Noise from Highway Overpasses –A Case Study of the Xintang TOD Project in Guangzhou — *Miss Sijia Fang*

15:20: Paper 810 — Assessment of Tire Inflation Pressure Effects on Two-Wheeler Tire–Pavement Interaction Noise Using an Adapted On-Board Sound Intensity Methodology — *Mr Sanjay Chandrasekar*

14:00 **Paper 727 — Noise-reducing pavements 100-200 years ago: The wood block story**
Ulf Sandberg

Many may think that noise-reducing pavements are tools used only in modern noise abatement. The truth is that the subject was hot already 100-200 years ago by the application of wood block pavements in the busiest cities of the industrialized world—preferably for noise reduction. Streets were commonly paved with cobble or paving stones and when wagons with iron-clad wheels were pulled over these uneven stones by horses with iron horseshoes clattering on the stones, noise from traffic became a nuisance which could make shops uncomfortable to visit. Shop owners and residents wanted street departments to replace the stone pavement with flatter and quieter wood blocks that had been invented around 1840. This eventually became a big paving industry, especially by the finding that certain Australian trees gave longer pavement life-times, and/or enhanced when impreg-nated with creosote. Another noise-reducing strategy was to cover stone pavements with straw.

The paper will provide a quick trip through the history of wood block pavements from its invention around 1840 to its demise in the 1920's when asphalt pavements provided similar noise reduction but with better longevity. The author shows examples of where wood block pavements can be seen today, albeit as historical artifacts.

14:20 **Paper 406 — Leveraging Data Analytics to Map Traffic Noise Variability: A Framework for Urban Noise Management**
Mrs Oluwafisayo Adeolu*, Adekemisola Olufunmilayo Asahiah, Oludare Adegbola Owolabi*

Urban noise management traditionally relies on static noise maps and time-averaged metrics like Leq, which often mask significant temporal variability in traffic patterns. As urban environments grow denser, these conventional averages fail to capture disruptive peak noise events that adversely affect public health. This paper proposes a novel framework leveraging data analytics and visualization to map traffic noise variability across diverse urban settings.

The framework utilizes high-resolution datasets and employs statistical modeling and temporal analysis to measure noise fluctuations beyond simple averages. It emphasizes the correlation between traffic flow dynamics and intermittent noise indicators, specifically L10, L90, and Lmax, enabling a granular understanding of the acoustic environment. Central to this approach is the amalgamation of analytical and visualization technologies, namely R and Tableau to convert longitudinal data into comprehensible spatial heatmaps for planners.

Results demonstrate that this variability-based framework identifies noise hotspots overlooked by traditional Leq maps, particularly during transitional periods like dawn and dusk. This study provides authorities with a methodical approach to implement dynamic mitigation strategies, comprising adaptive traffic routing and optimized barrier placement. By bridging the gap between raw data and actionable policy, the framework offers a scalable solution for developing quieter and more resilient smart cities.

14:40 **Paper 802 — Development and Noise Reduction Performance of a Pelletized Reactive Crumb Rubber Modifier for Dry-Process Asphalt Pavements**

***Mrs Hyunjin Kim**, Dr. Jae Eung Lee, Mr Byungchae Kim*

While rubberized asphalt effectively reduces traffic noise, the Dry Process often faces performance limitations due to inconsistent mixture quality. This study proposes a novel Reactive Crumb Rubber Modifier (RCRM) produced by reacting Ground Tire Rubber (GTR) with functional additives to form a stable, gel-like modified surface layer. This structural modification ensures rapid, uniform dispersion and superior interfacial bonding with the asphalt binder, fundamentally overcoming conventional issues of particle agglomeration.

The resulting gelled layer enhances elastic recovery and internal damping, allowing the GTR to function as an active Reactive Modifier rather than a passive filler. To ensure practical handling, the RCRM is manufactured in pelletized form, minimizing dust and moisture absorption. The noise reduction performance was evaluated using the Close Proximity (CPX) method at 60 km/h across three test sections of 10mm aggregate mixture. Compared to standard SMA pavements, the proposed mixture achieved a significant noise reduction of 8.7 dBA immediately after construction and maintained a robust reduction of 5.8 dBA after three years. These results demonstrate the technology's effectiveness in providing long-term service stability and superior acoustic performance.

15:00 **Paper 296 — Prediction and Control of Traffic Noise from Highway Overpasses –A Case Study of the Xintang TOD Project in Guangzhou**

*Prof. Hongwei Wang, **Miss Sijia Fang**, Mr. Enhe Wu*

This study investigates traffic-noise prediction and mitigation for a highway-deck complex using the Xintang TOD project in Guangzhou as a representative case. Based on the built condition, road operation status, and project layout, the dominant noise sources were identified as the expressway mainline, ramps, and adjacent urban roads, and the acoustic characteristics of the deck zone, landing zone, and tunnel-portal areas were clarified. A 24 h environmental noise monitoring campaign was conducted using an AWA5688 integrating sound level meter, and the measured indices, including Leq, L10, L50, L90, Lmax, Lmin, and standard deviation, were used to validate a three-dimensional Cadna/A model. Parametric simulations were then carried out to evaluate the effectiveness of sound-insulating canopies installed at tunnel portals. The results show that the tunnel portals and adjacent landing zones are the critical acoustic weak points in highway-deck developments, and that canopy geometry, particularly extension length, is a decisive design parameter. The proposed workflow integrating field measurement, model validation, and parametric optimization can support acoustic prediction and noise-control design for similar highway-oriented TOD projects.

Keywords: transit-oriented development; acoustic environment prediction; traffic noise control; Cadna/A; field measurement; parametric simulation

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15:20 **Paper 810 — Assessment of Tire Inflation Pressure Effects on Two-Wheeler Tire–Pavement Interaction Noise Using an Adapted On-Board Sound Intensity Methodology**

***Mr Sanjay Chandrasekar**, Dr Radhika B, Dr Sriram Sundar, Prof Krishna Prapoorna Biligiri*

Tire-pavement interaction noise constitutes a dominant component of traffic noise at moderate to high operating speeds; however, its characterization in two-wheelers remains underexplored compared to passenger cars and trucks. In particular, the influence of tire inflation pressure on tire-road noise generation in single-track vehicles has received limited attention. This study presents a systematic experimental assessment of tire-pavement interaction noise in a two-wheeler using an adapted On-Board Sound Intensity (OBSI) measurement methodology. Measurements were conducted on asphalt pavement surface under controlled multiple speed conditions for various tire inflation pressures. The recorded sound intensity data were processed to obtain A-weighted overall levels and frequency-domain spectra within the primary tire-road excitation range. The investigation aimed to quantify potential variations in the overall noise levels and spectral distribution associated with pressure-induced changes in tire tread pattern and pavement interaction behavior. Preliminary observations indicated an approximate increase of 4 dB(A) in the overall sound intensity level for each 10 km/h increase in vehicle speed, within the tested operating range at 30 psi tire pressure. The developed OBSI fixture and measurement framework establishes a robust experimental foundation for future parametric analyses and advanced characterization of tire-pavement interaction noise in two-wheelers.

2.3.5 Vehicle Acoustics

Mon 09:00–10:00 — Panorama Room 2 (Chair: James McIntosh, Steve Sorenson)

09:00: Paper 19 — Virtual multi-attribute balancing calibration for NVH optimization in electric powertrain systems — *Mr Ki Hwa Lee*

09:20: Paper 207 — A method for multi-dimensional driving condition recognition in vehicle NVH using integrated high-precision raw data analysis and speed separation — *Tao Wang*

09:40: Paper 87 — Parameterized Tire Model Development and Novel Characterization of Tire Mode Shapes for NVH Analysis — *Dr Jin Hong Kim*

09:00 **Paper 19 — Virtual multi-attribute balancing calibration for NVH optimization in electric powertrain systems**

***Mr Ki Hwa Lee**, Mr Sebastian Ciceo, Mr Lokesh Gorantla*

In this study, a virtual NVH calibration process for electric vehicle power systems is presented within a multi-attribute balancing framework. A high-fidelity, system-level model couples inverter and control dynamics with a voltage-driven 1D PMSM model reduced from 2D electromagnetic FEA, and an analytical stator vibro-acoustic model driven by forces derived from the Maxwell stress tensor. A test-based updating method using vehicle-level measurements is introduced to enhance predictive accuracy. A design space exploration of key control parameters-current-regulator time constants, PWM strategy and switching-frequency randomization, and 6th-order voltage harmonic injection-is conducted, and sensitivity analyses across different attributes (torque-ripple harmonics, switching sidebands, the 24th mechanical order, and efficiency) are presented. Finally, the optimal parameter set across the full torque-speed range for a specific target attribute is reported, with improvements observed in specific operating regions of the electric drive. The workflow enables efficient pre calibration, clarifies cause-effect linkages between calibration parameters and KPIs, and guides test bench and in-vehicle effort by highlighting high value regions.

09:20 **Paper 207 — A method for multi-dimensional driving condition recognition in vehicle NVH using integrated high-precision raw data analysis and speed separation**

***Tao Wang**, Professor Zhien Liu, Dr Wan Chen, Professor Chihua Lu, Dr Menglei Sun*

With the deepening of digital transformation in vehicle noise, vibration, and harshness (NVH), a vast amount of historical test data has been accumulated. Effectively mining complex and implicit noise features and their correlations with operating conditions from original data is crucial for enhancing the intelligence of NVH performance evaluation. To this end, this study first proposes a high-precision parsing method for raw test data to accurately extract key information, laying the groundwork for in-depth data mining. Next, a multi-dimensional driving condition identification strategy based on vehicle speed decoupling is introduced, covering acceleration, deceleration, and constant-speed conditions (40/60/80/100/120 km/h), and combined with a modified least squares regression (M-LSR) model to enable efficient identification of complex conditions. A driving condition simulation model is further constructed to quantitatively evaluate the effectiveness of the proposed approach. By integrating high-precision data parsing with the M-LSR model, a condition recognition method based on raw data is developed. Validation using real vehicle test data confirms the method's effectiveness in condition recognition, providing key methodological support for the development of an intelligent NVH performance evaluation system.

09:40 **Paper 87 — Parameterized Tire Model Development and Novel Characterization of Tire Mode Shapes for NVH Analysis**

***Dr Jin Hong Kim**, Mr. Hyunyoung Lee, Mr. Hoyoung Uhm, Mr. Marc Brughmans, Mrs Anneleen von Gils*

This study presents a parameterized tire modeling approach designed to enhance vehicle-level noise and vibration prediction. The tire is divided into six distinct regions across the tread and sidewall, with each region assigned independent elastic modulus and density values. These material properties are identified through an optimization process using experimental modal data.

The tire models are integrated into full vehicle simulations to evaluate their impact on NVH(Noise, Vibration and Harsh-

ness) performance. Modal Assurance Criterion (MAC) analysis is used to correlate individual tire modes with vehicle-level vibration modes, identifying those that significantly influence dynamic behavior. Sensitivity analysis further highlights key stiffness and density parameters in the tread and sidewall regions that affect vehicle response.

In addition, a novel method for tire mode shape classification is proposed. While conventional approaches rely on sine functions in the circumferential direction and polynomial functions in the meridional direction, particularly for the tread, this study introduces a new functional representation that captures deformation characteristics in both the tread and sidewall. This enhanced classification framework provides deeper insight into suspension excitation mechanisms driven by tire dynamics.

Mon 10:40–11:40 — Panorama Room 2 (Chair: Steve Sorenson)

10:40: Paper 427 — Assessment of BSR noise in a Vehicle Cabin and Its Prevention method — *Dr Su-hyun SHIN*

11:00: Paper 73 — Development of a Test Method for Door Trim BSR under Rapid Thermal Shock — *Mr Mikwon Jeong*

11:20: Paper 110 — A Study on the AI Model for Predicting the Natural Frequency of Knuckle System Using Image — *Mr ILSOO Jeong*

10:40 **Paper 427 — Assessment of BSR noise in a Vehicle Cabin and Its Prevention method**

***Dr Su-hyun SHIN**, Mr Dong Hun PARK, Dr Hwan Chul YU, Dr Seok Ho OH*

To solve the BSR noise in a vehicle cabin, requirements for test procedure and systems should be presented in terms of potential noise source detection, time-frequency and sound pressure analysis, and sound quality analysis of the noise. The primary mechanisms responsible for BSR noise are frictional interactions and intermittent impacts between contacting components. These mechanisms are governed by material properties, contact conditions, and the level of transmitted kinetic energy. Since relative motion between components is unavoidable during vehicle operation due to road-induced vibration and structural deformation, a systematic characterization of material contact pairs and their frictional behavior is required.

In this study, an integrated approach for mitigating BSR noise caused by frictional interactions in vehicles is proposed. Also, advanced measurement systems and sound quality analysis techniques are employed to quantify squeak and rattle noises using both subjective and objective evaluation methods. In particular, noise source identification techniques. The occurrence of stick–slip behavior during relative motion induces friction-driven oscillations, which act as primary excitation source for noise generation. Furthermore, the amplitude of the stick–slip response is strongly correlated with the noise generation tendency, suggesting that it can be used as quantitative indicator for evaluating the acoustic performance of material pairs.

11:00 **Paper 73 — Development of a Test Method for Door Trim BSR under Rapid Thermal Shock**

***Mr Mikwon Jeong**, Mr Jongsoo Kim*

As vehicle interior quietness has improved and customer expectations for perceived quality have increased, buzz, squeak, and rattle (BSR) phenomena in interior components have emerged as major quality issues. In particular, door trim components are located close to occupants, making BSR issues more likely to result customer dissatisfaction. Although various BSR evaluation methods have been proposed, most are conducted under static temperature conditions and therefore have limited capability to represent rapid thermal shock environments encountered during actual vehicle use.

This study aims to evaluate the effects of rapid temperature changes on BSR occurrence in door trim components and to develop a corresponding test method. Two environmental factors—temperature change rate and extreme temperature exposure duration—were defined as independent variables, and BSR occurrence was evaluated under various thermal conditions. The test setup was designed to reflect realistic in-vehicle thermal shock scenarios, and BSR occurrence was quantitatively measured using microphones and frequency analysis equipment.

The results indicate that the probability of BSR occurrence increases significantly under specific conditions. This study provides a fundamental experimental analysis of key variables influencing BSR occurrence in door trim components under thermal shock environments and offers a basis for the development of systematic BSR evaluation methods.

11:20 **Paper 110 — A Study on the AI Model for Predicting the Natural Frequency of Knuckle System Using Image**

***Mr ILSOO Jeong**, Mr Sungho Kang, Dr Jin Hong Kim*

In this study, we propose an AI model that predicts the natural frequency of the knuckle using images and design specifications. Natural frequency is a critical aspect of NVH performance, and AI model can predict this performance without the need for an FE model. This allows designers to quickly assess the knuckles' performance in the early stages of development. This AI model utilizes features from knuckle images as learning data to improve prediction accuracy. As a result, the AI-based natural frequency prediction model can significantly increase efficiency in the early stages of vehicle development.

Mon 14:00–15:00 — Panorama Room 2 (Chair: Aaron Miller, Steve Sorenson)

14:00: Paper 338 — Design analysis and optimization for noise reduction of external rotor in-wheel motor — *Mr Lei Chen*

14:20: Paper 486 — Experimental Monitoring and Modelling of the Dynamic and Acoustic Behavior of a Motorcycle with Engine Displacement Above 250 cm3 — *Mr Miguel Santos*

14:40: Paper 302 — Influence of Engine Speed Time History on Subjective Engine Noise Perception Across Different Driving Environments — *Mr Shinichi Suganuma*

14:00 **Paper 338 — Design analysis and optimization for noise reduction of external rotor in-wheel motor**

***Mr Lei Chen**, Mr Lei Chen, Dr.Prof Xian Wu, A/Prof Jianwang Shao*

This paper presents the design analysis and optimization for noise reduction of external rotor in-wheel motor. The electromagnetic design parameter and performance are analyzed. For the specific order harmonic current, the control strategy is analyzed and optimization method is proposed. In order to reduce the electromagnetic force, the external rotor topology is analyzed and optimization is proposed. The Finite element model for the mechanical structure is established and corresponding modal shape is presented. The electromagnetic vibro-acoustic simulation model is established and analyzed, the verification testing is performed by measuring the one-meter sound pressure level of the in-wheel motor.

14:20 **Paper 486 — Experimental Monitoring and Modelling of the Dynamic and Acoustic Behavior of a Motorcycle with Engine Displacement Above 250 cm3**

***Mr Miguel Santos**, Dr Paulo Fernandes, Dr Antonio Pascale*

Noise modeling has evolved from statistical approaches to advanced frameworks combining Noise Emission Models (NEMs) for sound power level (LW) estimation with sound propagation models. While research has focused on light-duty vehicles, covering internal combustion, hybrid, and electric powertrains, motorcycles received comparatively limited attention within NEM development. The existing motorcycle noise models (e.g. CNOSSOS-EU) lack for representative of contemporary vehicles. This study aims to derive updated noise emission data for motorcycles with engine displacements greater than 250 cm^3 based on pass-by measurements. The proposed approach estimates LW using backward propagation formulations derived from maximum A-weighted sound pressure levels. Measurements were conducted at speeds ranging from 20 to 90 km/h under different gear-engagement conditions on a flat road section. The resulting noise emission curves from the two methods are compared to assess their consistency and potential integration into existing NEMs, such as the Vehicle Noise Specific Power model.

14:40 **Paper 302 — Influence of Engine Speed Time History on Subjective Engine Noise Perception Across Different Driving Environments**

***Mr Shinichi Suganuma**, Mr Shimpei Nagae, Dr Takeshi Toi*

In hybrid vehicles, the acoustic contrast between engine-off and engine-on states makes engine noise more noticeable. In particular, in series hybrid vehicles, the engine is used only for power generation and does not always correspond to the driving state, which can cause annoyance under certain conditions. To improve engine sound quality, it is important to quantitatively identify the factors contributing to engine noise perception.

To this end, driving experiments were conducted in Japan, the United States, and the United Kingdom using series hybrid vehicles and battery-electric vehicles equipped with synthesized engine sounds. Vehicle parameters and three-level subjective ratings (“Not noisy,” “Noisy,” and “Very noisy”) were synchronously collected, and random forest classifiers were constructed to predict engine noise perception.

Across all regions, incorporating several seconds (3–7 s) of engine-speed time history improved prediction accuracy. Temporal analysis showed a common tendency across regions: increasing engine speed tended to be perceived as noisier, whereas decreasing engine speed tended to be perceived as quieter.

These results indicate that temporal changes in engine speed are an important factor in engine noise perception across different regions.

2.3.6 Railway Noise & Vibration

Mon 09:00–10:20 — Riverbank Room 5 (Chair: Aaron Miller)

09:00: Paper 196 — Prediction of Low Frequency Vibration Propagation from Operating Rail Tunnels — *Mr Bill Dawson*

09:20: Paper 337 — Experimental Analysis of the Influence of Base Elastic Cushions Thickness on Environmental Vibration Control Effect in Buildings Adjacent to Railway — *Dr Qin'e Zeng*

09:40: Paper 507 — Vibration and noise testing and analysis of buildings over a metro station——a case study — *Prof Lei He*

10:00: Paper 273 — Acoustic Effect of Platform Screen Doors: A Case Study of İMES Metro Station, Istanbul — *Mr Burak Ayva*

09:00 **Paper 196 — Prediction of Low Frequency Vibration Propagation from Operating Rail Tunnels**

***Mr Bill Dawson**, Mr David Timms, Dr David Larner, Dr Graham Brown*

Predicting the propagation of vibrations from rail tunnels is important for quantifying and mitigating the environmental impacts of operating railways. In the general case, vibrations propagating from rail tunnels are attenuated by material damping and geometric effects. Often these effects are aggregated in empirical or numerical models which offer little insight into the physical behaviours that are involved and may be limited in terms of their applicability according to frequency range and tunnel-receiver geometry. This paper examines the aspects of low frequency vibration propagation from rail tunnels that are of relevance to predicting tactile vibration impacts and the influence of operating railway vibrations on sensitive imaging equipment. Fundamental geometric considerations and numerical models are used to determine the influence of pseudo-static effects, source-receiver geometry, layered ground and material damping effects, and the relationship between average and maximum vibration levels that are dependent upon source-receiver distance.

09:20 **Paper 337 — Experimental Analysis of the Influence of Base Elastic Cushions Thickness on Environmental Vibration Control Effect in Buildings Adjacent to Railway**

***Dr Qin'e Zeng**, Dr Yubin Wu, Prof Ruixiang Song, Dr Jing Zhang, Mr Yanan Wu, Prof Lei He, Research Associate Qin'e Zeng, Ms Na Zhao*

Base-installed elastic pads have become an important strategy for mitigating micro-environmental vibrations in buildings located adjacent to railway lines. To investigate the extent to which increasing pad thickness improves vibration mitigation performance, this study presents a comparative in-situ experimental analysis of floor vibrations in a steel-frame building model constructed near an operating railway. Three loading conditions, namely appropriate overloading, normal loading, and moderate underloading, together with two pad thicknesses (25 mm and 50 mm), were considered. The results indicate that increasing the load on the elastic pad is equivalent to increasing the mass of the superstructure in the isolation system. In addition, increasing the thickness of the vibration isolation pad effectively reduces the natural frequency of the isolation system, thereby lowering the low-frequency cut-on threshold at which vibration mitigation becomes effective. As a result, both the peak acceleration and the maximum Z-vibration level of the isolated structure are reduced. The results further show that a greater pad thickness corresponds to a lower low-frequency cut-on frequency. Under normal loading conditions, the low-frequency cut-on frequencies of the 25mm and 50mm pads are 22.5Hz and 18Hz, respectively. Under appropriate overloading conditions, the corresponding frequencies are reduced to 20Hz and 13.5Hz, respectively.

09:40 **Paper 507 — Vibration and noise testing and analysis of buildings over a metro station——a case study**

***Prof Lei He**, Researcher Ruixiang Song, Researcher Yubin Wu, Senior Engineer Dan Wu, Research Associate Qin'e Zeng*

With the increasingly intensive development of major cities in China, underground urban rail complexes have become critical infrastructure, characterized by complex functional layouts and significant challenges in vibration and noise control. This study focuses on a commercial-residential building connected to a subway station via a passageway. Synchronous measurements and analyses of subway-induced vibrations and structure-borne noise were conducted. The results show that the dominant vibration frequency of the building is approximately 63 Hz, and the dominant frequency of secondary radiated noise is also concentrated around 63 Hz. This frequency range is where noise levels significantly exceed background levels. Structure-borne noise is particularly prominent on the first underground floor and decreases notably on the first to third above-ground floors. This attenuation is primarily attributed to differences in indoor sound reflection conditions

between these floors, particularly the reverberation time. This research provides fundamental data to support vibration and noise testing and evaluation in similar urban rail complexes.

10:00 **Paper 273 — Acoustic Effect of Platform Screen Doors: A Case Study of İMES Metro Station, Istanbul**
***Mr Burak Ayva**, Dr. Ali Sercan Kesten, Mr Samuel Wong, Mr Beau Daniel Weyers*

The acoustic design of metro stations is critical for regulatory compliance, passenger comfort, and safety. This paper presents an acoustic engineering case study of the İMES Station on Istanbul's Söğütlüçeşme-Yenidoğan Metro Line, demonstrating how Platform Screen Doors (PSDs) transformed the acoustic environment and treatment requirements. A detailed acoustic model of the platform level was created, and predictions were conducted against the Turkish Environmental Noise Regulation and TS 12127 standards, identifying a key deficiency: insufficient reverberation control threatened announcement clarity. A pivotal finding was the multi-functional role of the Platform Screen Doors as a design solution. Primarily a safety feature, the PSD system additionally provided critical acoustic isolation, drastically reducing train noise transmission to the concourse and thereby lowering noise impact levels. This isolation effect also reduced the acoustic treatment burden elsewhere, allowing for more optimized and cost-effective material specifications. Simulations confirmed the success of the integrated strategy: reverberation times were reduced to compliant levels and Speech Transmission Index (STI) values stayed within acceptable levels, indicating acceptable intelligibility at a lower treatment cost, without the need to upgrade announcement system. This case study highlights how integrated design with features like PSDs can simplify the achievement of acoustic goals in metro stations.

Mon 11:00–12:00 — Riverbank Room 5 (Chair: Aaron Miller)

11:00: Paper 35 — Study on the external aerodynamic characteristics of 160 km/h high-speed train based on the LBM — *Mr Liang Fu*

11:20: Paper 133 — Assessment of Chinese Speech Intelligibility in High-Speed Train Interiors at Operating Speeds up to 400 km/h — *Mr Xudong Liu*

11:40: Paper 554 — Approaching Structure-Borne Railway Noise with Embedded Elastic Elements in Slab Track: In-Track Performance and Isolation Design Strategies — *Mr Hayagreeve Raman*

11:00 **Paper 35 — Study on the external aerodynamic characteristics of 160 km/h high-speed train based on the LBM**
*Mr Jiankun Xie, Mr Minkai Pan, Mr Cheng Zhu, Mr Haiju Wei, **Mr Liang Fu**, Mr Haibin Lai, Mr Qi Li, Mr Yixin Li*

This paper employs PowerFLOW software (based on Lattice Boltzmann Method) to simulate the external flow field of a 160 km/h urban train, aiming to evaluate its internal noise and aerodynamic characteristics under open-track conditions. It examines the train-body vorticity distribution, longitudinal symmetric-plane flow velocity, and surface sound pressure. Results show that vorticity concentrates at air conditioners, pantographs, bogies and inter-carriage joints, heavily affecting aerodynamic noise. The nose surface has the highest sound pressure (peak 83.23 dB, a key noise source), while the rear windshield is ~20 dB lower. Pantograph noise is dominated by 0–800 Hz low frequencies. These findings offer critical guidance for urban train noise-reduction design and optimization.

11:20 **Paper 133 — Assessment of Chinese Speech Intelligibility in High-Speed Train Interiors at Operating Speeds up to 400 km/h**
*Mr Yihang Yu, Mr Zongcai Liu, Mr Xiaoyang Gao, **Mr Xudong Liu***

Speech communication in high-speed trains is strongly affected by high background noise, particularly under very high operating speeds. In this study, on-site STIPA measurements were carried out in different interior spaces of a high-speed train under operating speeds up to 400 km/h, including open track and tunnel conditions.

An acoustic model based on ray-tracing was established and validated through comparison with the measured STIPA results. The validated model was further used to estimate STIPA values under different signal-to-noise ratio (SNR) conditions that cannot be practically achieved in on-site measurements.

A subjective speech intelligibility experiment was conducted using Chinese phonetically balanced (PB) word lists. Background noise was recorded in situ using an artificial head, and speech intelligibility scores were obtained for experimental conditions covering different operating environments and SNR levels. A consistent relationship between STIPA and subjective speech intelligibility was observed under high-speed operating conditions. The results indicate that STIPA, supported by validated acoustic simulation, is applicable for evaluating speech intelligibility in high-speed train interiors at operating speeds up to 400 km/h.

11:40 **Paper 554 — Approaching Structure-Borne Railway Noise with Embedded Elastic Elements in Slab Track: In-Track Performance and Isolation Design Strategies**
Mr Hayagreeve Raman

Designing vibration-isolating slab track systems poses major challenges where emission limits must be met without established design baselines. This is especially critical when planning occurs post-structure, i.e after tunnels, viaducts, or complex curves are already built. Increasingly stringent acoustic requirements, low target natural frequencies, and severe environmental conditions demand innovative, field-proven solutions.

This presentation highlights long-term in-track performance results from Mass-Spring Systems (MSS) using polyurethane (PUR) elastic layers. It includes detailed on-site measurements, structural integration, and lessons learned across three distinct case studies:

•East London Line (UK): MSS installed post-construction in complex geometries like tight curves, steel bridges, and viaducts using LVT booted blocks.

•Samedan Line (Switzerland): MSS implementation under alpine climatic extremes, incorporating heating and drainage systems.

•ÖBB Römerberg and Zammer Tunnels (Austria): 6–7 year post-installation data showing MSS resilience and track quality retention.

This session offers valuable insight into real-world system durability, vibration mitigation efficacy, and life-cycle advantages in acoustically sensitive urban rail corridors.

Mon 14:00–15:20 — Riverbank Room 5 (Chair: Linli Zhang, Xiaozhen Sheng)

14:00: Paper 380 — Preliminary Nord2000 noise results for Queensland NGR trains — *Mr Asbjorn Hansen*

14:20: Paper 548 — Railway Noise Prediction based on Noise Source Identification and Acoustic Transfer Function with Point Noise Source — *Mr Tsugutoshi Kawaguchi*

14:40: Paper 393 — Environmental Noise Characteristics of Freight, Conventional and High-Speed Trains on an Indian Rail Corridor — *Mr Anand Priy*

15:00: Paper 342 — Measurement-based noise prediction and control for urban interstitial sites exposed to bidirectional railway traffic — *Miss Yiquan Xu*

14:00 **Paper 380 — Preliminary Nord2000 noise results for Queensland NGR trains**
Mr Asbjorn Hansen

A sizable noise measurement programme was undertaken prior to the construction of a large infrastructure project in Southeast Queensland. The data acquired prior to any construction was used for the verification of a rail noise model where the Kilde calculation algorithm was used for the noise predictions and model verification.

The data obtained in the pre-construction phase included video recordings with simultaneously recorded noise levels near the rail track. The acquired noise data also include noise levels recorded at the facades of twelve dwellings situated from 50 m to 270 m from the rail tracks. It should be noted that the rail corridor only is used for passenger trains and that the majority of trains operating on the tracks are NGR trains.

The data was at a later stage revisited to develop the Nord2000 rail coefficients for the NGR trains and compare predicted noise levels at the facades of the dwellings when using the two different calculation algorithms.

This paper compares the predicted noise levels of the Kilde and the Nord2000 calculation algorithms to the measured noise levels.

14:20 **Paper 548 — Railway Noise Prediction based on Noise Source Identification and Acoustic Transfer Function with Point Noise Source**

***Mr Tsugutoshi Kawaguchi**, Dr Toki Uda, Mr Yosuke Hachiya*

The environmental quality standards for noise for Japan's bullet trains are among the most stringent in the world. To reduce railway noise while satisfying these standards, it is important to determine the contribution ratio of each noise source to the total noise at the observation point defined in the standards (typically 25 m from the nearest track). This paper proposes a method to evaluate the contribution ratio by combining noise source identification with an acoustic experiment or simulation based on the point noise source. A two-dimensional microphone array employed in this study clearly measured the noise source distribution around a vehicle using the signal processing of the DC algorithm. Then, the transfer function of the radiated sound between the point sources and the observation point is determined in a scale model experiment or hybrid simulation combining the FEM and a geometrical acoustics model. In the experiment, a proposed material simulating the sound absorption characteristics of a ballast is adopted. The predicted wayside noise and contribution ratio agree with the measurement results. The findings of this study indicate that the contribution ratio can help evaluate noise reduction effect obtained from shape modifications, e.g., bogie covers.

14:40 **Paper 393 — Environmental Noise Characteristics of Freight, Conventional and High-Speed Trains on an Indian Rail Corridor**

***Mr Anand Priy**, Dr Anil Kumar, Prof MANORANJAN PARIDA*

Railway noise is an increasing environmental concern in rapidly expanding rail networks, particularly in densely populated regions. Motivated by the growing deployment of high-speed trains and the development of new railway corridors, this study aims to support sustainable rail planning and community noise management.

This study presents a generalized field-based assessment of environmental noise emissions from representative categories of rail traffic, namely freight, conventional passenger, and high-speed Vande Bharat trains, along a busy Indian rail corridor. Noise measurements were conducted at a representative trackside location using calibrated sound level meters in accordance with national environmental noise assessment guidelines. The analysis considers standard acoustic indicators, including equivalent continuous sound level (Leq), maximum sound pressure level (Lmax) etc., to compare characteristic noise profiles across train categories.

The results reveal clear variability in noise emissions, with freight trains typically producing higher peak levels, while high-speed services exhibit comparatively lower overall noise levels, reflecting recent technological and aerodynamic advancements. The findings address community exposure to railway noise under increasing traffic density and operating speeds, and provide evidence relevant to environmental impact assessment of emerging railway corridors. The study also establishes a framework for integrated analysis linking airborne noise and vibration.

15:00 **Paper 342 — Measurement-based noise prediction and control for urban interstitial sites exposed to bidirectional railway traffic**

***Miss Yiquan Xu**, Mr. Xiaodong Sha, Prof. Hequn Min, Ms Yajing Di, Mr. Jushang Wang, Mr. Songyuan Ma, Miss. Yun Yang, Mr. Wei Zhou*

This study investigates an integrated noise control strategy for interstitial sites between dual railway corridors through numerical simulations and in-situ measurements. Temporal-spectral analysis of in-situ measurements from bidirectional rail traffic revealed dynamic noise radiation patterns throughout complete train pass-by cycles. Based on these measurements, a dynamic sound power mapping model employing temporal-spatial decomposition was developed to predict noise distribution across the site. Physical simulations subsequently evaluated the performance of boundary control measure, examining barrier design optimization. Results demonstrate that the integrated control measures effectively reduces railway noise

impact on surrounding buildings. The prediction model achieved 2-3 dB(A) higher accuracy than conventional empirical method, with enhanced spatial resolution for noise assessment. This integrated strategy provides practical guidelines for noise mitigation in railway-adjacent urban sites.

Mon 16:00–17:40 — Riverbank Room 5 (Chair: Linli Zhang, Xiaozhen Sheng)

16:00: Paper 542 — Effects of Incoming Turbulence on Aerodynamic Noise Generated in a High-Speed Train Bogie Cavity Under Wind-Tunnel Flow Conditions — *Mr Hideo Fukuyama*

16:20: Paper 76 — Ground-borne Noise and Vibration Commissioning Studies for the Sydney Metro's City Alignment — *Dr Neil Mackenzie*

16:40: Paper 75 — Track-form Optimisation for In-Tunnel and In-Car Noise Control — *Dr Neil Mackenzie*

17:00: Paper 779 — Influence of dynamic stiffness on the acoustic absorption of railway ballast as a poro-elastic medium — *Dr Xianying Zhang*

17:20: Paper 467 — A proposed validation methodology for digital acoustic twins of underground tunnels — *Dr Shahrokh Sepehrirahnama*

16:00 **Paper 542 — Effects of Incoming Turbulence on Aerodynamic Noise Generated in a High-Speed Train Bogie Cavity Under Wind-Tunnel Flow Conditions**

Mr Hideo Fukuyama, *Mr Tatusya Tonai, Dr Toki Uda*

This study investigates the effects of incoming turbulence on the integrated aerodynamic noise levels measured in a region of interest (ROI) surrounding the downstream bogie section of a high-speed train. We conducted wind-tunnel tests using a 1:5-scale model of a high-speed train featuring two adjacent bogie sections. The geometry of the upstream underfloor area was modified to control the inflow toward the downstream bogie section. We measured underfloor mean velocity and turbulence intensity (TI) using a hot-wire anemometer, and aerodynamic noise was recorded using a 66-channel microphone array in conjunction with a deconvolution method. For each one-third-octave band, we integrated the source power over the ROI around the downstream bogie section to calculate the integrated sound pressure level (SPL). The results reveal two main trends. First, the integrated SPL tended to vary with the underfloor mean velocity. Second, under nearly identical mean-velocity conditions, the integrated SPL was higher at increased TIs. Specifically, at TIs of approximately 10%–15%, the SPL was approximately 2–4 dB greater than at 5%. These findings indicate that incoming turbulence may affect the aerodynamic noise characteristics observed around bogie sections under similar mean-flow conditions.

16:20 **Paper 76 — Ground-borne Noise and Vibration Commissioning Studies for the Sydney Metro's City Alignment**

Dr Neil Mackenzie, *Mr Moharis Kamis, Mr Gabriel McGrane*

A new 30km metro line extending metro rail from the end of Sydney Metro Northwest (opened in 2019) at Chatswood (northern corridor) diving into twin-bore tunnels under north Sydney (2 underground stations) progressing under Sydney Harbour, through 5 new underground CBD stations emerging as a surface track on the upgraded southwest section from Sydenham to Bankstown. This paper will discuss the approach to validation of ground-borne noise and vibration during the design stage, through construction and at commissioning of the City section of the alignment.

16:40 **Paper 75 — Track-form Optimisation for In-Tunnel and In-Car Noise Control**

Dr Neil Mackenzie, *Mr Moharis Kamis*

The conventional approach to controlling ground-borne noise and vibration in Australia is to use soft rail fasteners on a slab track. This however results in high levels of noise radiated from the rail, affecting in-tunnel and in-car noise. Noise control is then applied using rail dampers and acoustic lining (to the tunnel walls and track). This can be avoided by properly designing the track-form to control noise radiated from the rail. This paper reviews work carried out on a booted sleeper track-form to optimise under-sleeper pads and rail pads to control in-tunnel and in-car noise.

17:00 **Paper 779 — Influence of dynamic stiffness on the acoustic absorption of railway ballast as a poro-elastic medium**

Dr Xianying Zhang, *Xiaoqing Hou, Dr David Thompson, Dr Giacomo Squicciarini*

Railway ballast has both mechanical and absorptive properties that are important for the vibration and noise of the railway system. Stiffness is a key parameter in the modelling ballast as a poro-elastic medium. To understand its poro-elastic behaviour under the dynamic loads of passing trains, an analytical method is proposed which takes account of both its depth-dependent and frequency-dependent dynamic stiffness, based on granular media theory. The validation of this model is then carried out by comparison with measurement data. Finally, its effect on the absorption coefficient of the railway ballast is investigated. The results are compared with existing classic absorptive models.

17:20 **Paper 467 — A proposed validation methodology for digital acoustic twins of underground tunnels**

Dr Shahrokh Sepehrirahnama, *Dr. Paul Williams, Mr Aaron Miller, Dr Briony Croft, Mr. Jorge Reverter, Mr. Jeffrey Parnell, Dr Mahmoud Karimi*

Digital twins are increasingly used across various fields, including civil engineering, as a cost effective approach to virtual system health monitoring. Developing a digital twin requires a one-to-one computational representation of the system's geometry with an appropriate level of detail, and accurate information on material properties, boundary conditions, and static or dynamic external loads. A properly validated digital twin includes all critical information for health monitoring within the model, providing a basis for more realistic simulations of unwanted conditions on the target system. In this paper, we present an acoustic measurement methodology suitable for the digital acoustic twinning of underground railway tunnels. The novelty of the proposed methodology lies in characterising noise absorption and noise decay to validate the digital twin model, in conjunction with calibrating the predicted sound pressure fields. The decay assessment indicated a 0-4dB/s increase that was attributable to tunnel lining along with a contribution of <30% to the tunnel decay gradient. By validating the digital twin with decay characteristic and calibrated sound pressure field, the model can potentially become a standard approach for in-situ tunnel noise testing in digital-twinning applications, with the aim of enabling track health monitoring based on analysis of variations in tunnel noise.

Wed 10:40–12:00 — Riverbank Room 5 (Chair: Aaron Miller, Granger Bennett)

10:40: Paper 128 — Measurement and Analysis of Interior and Exterior Noise of Railway Vehicles — *Dr Tsung Hsien Tu*

11:00: Paper 722 — Acoustic Assessment of a Hydrogen-Converted Rail Engine Integrated with a Powerpack System — *Dr Prasad Braj Bhushan*

11:20: Paper 407 — Regime Stratified Multiple Linear Regression Framework for Quantifying Honking-Induced Railway Noise Increment in Urban Corridors — *Mr Ravi Pratap Singh Jadon*

11:40: Paper 102 — A study on the influence of fasteners and close-fitting sound barriers on rail acoustic radiation using PABEM — *Miss Rong Deng*

10:40 **Paper 128 — Measurement and Analysis of Interior and Exterior Noise of Railway Vehicles**

Dr Tsung Hsien Tu

Railway noise assessment is a core engineering task for vehicle design validation, acceptance testing, and environmental compliance. Standardized methodologies based on ISO 3381 and ISO 3095 are applied and critically interpreted from a practical engineering perspective, rather than treated solely as prescriptive procedures. Three representative noise exposure scenarios are addressed: residents along railway corridors, passengers waiting on platforms, and passengers inside vehicles. Particular attention is given to the structural alignment between recent editions of ISO 3381 and ISO 3095 and to the implications of this alignment for integrated interior-exterior noise assessment. Field measurement campaigns are analyzed with respect to vehicle configuration, geometric symmetry, and the justified reduction of redundant measurement points. This paper presents an engineering-oriented approach demonstrating that, when ISO-defined boundary conditions are respected, optimized measurement layouts can achieve deviations within typical engineering tolerances relative to full layouts. The study concludes with explicit engineering takeaways that support efficient, reproducible, and credible railway noise assessment for large-scale rolling stock projects.

11:00 **Paper 722 — Acoustic Assessment of a Hydrogen-Converted Rail Engine Integrated with a Powerpack System**

***Dr Prasad Braj Bhushan**, Dr Tommy Luft, Dr Hermann Rottengruber*

This study investigates the acoustic performance of a diesel engine converted to run on hydrogen and integrated into a dedicated powerpack. Its main objective is to evaluate whether the modified propulsion unit complies with the acoustic limits required for railway use before it is installed in a full train system. The analysis focuses on how hydrogen combustion and the additional interfaces introduced by the powerpack affect both structure-borne and airborne noise. A comprehensive measurement setup is used, featuring triaxial acceleration sensors mounted on selected positions of the engine block and key mounting points, along with microphones and sound-intensity probes placed around the powerpack. Structure-borne noise is examined through acceleration and velocity spectra, while airborne noise is assessed using sound-pressure and sound-intensity maps. These measurements make it possible to identify dominant excitation orders, operating conditions that produce the highest noise levels, and the specific influence of hydrogen-related components. The results indicate whether the current engine and powerpack configuration can satisfy railway acoustic standards and highlight which elements most strongly shape the noise characteristics of the hydrogen conversion. Overall, the findings provide valuable guidance for improving future hydrogen propulsion systems for rail applications.

11:20 **Paper 407 — Regime Stratified Multiple Linear Regression Framework for Quantifying Honking-Induced Railway Noise Increment in Urban Corridors**

***Mr Ravi Pratap Singh Jadon**, Dr Rajeev Kumar Mishra, Dr Nasim Akhtar*

Railway noise prediction can be complex due to diverse acoustic responses arising from varying operational conditions, particularly regarding behavioral noise sources, such as train honking, which are often underrepresented in conventional models. To address this, the present study proposes a regime-stratified modeling framework for estimating the equivalent continuous sound level, incorporating operational parameters including source–receiver distance, train speed, railcar count, and honking status. The analysis is grounded in 972 field observations collected across heterogeneous operating scenarios. To discern structural differences in noise generation, interaction tests were conducted within a unified modeling framework instead of relying on a single global relationship. F-tests reveal that operational regimes exhibit significantly different acoustic behaviors ($p < 0.001$), thereby supporting the adoption of a stratified approach to model development. Physics-informed feature engineering incorporates logarithmic transformations of distance and railcar count. Diagnostic checks include variance inflation factor analysis, heteroscedasticity testing with robust standard errors, and a 1,000-iteration bootstrap resampling procedure. The findings indicate that honking is associated with a statistically significant increase in equivalent continuous sound level of 3.21 ± 0.28 dB(A) for passenger trains and 3.79 ± 0.37 dB(A) for freight trains, with coefficient of determination values approaching 0.84.

11:40 **Paper 102 — A study on the influence of fasteners and close-fitting sound barriers on rail acoustic radiation using PABEM**

***Miss Rong Deng**, Dr. Gong Cheng, Prof Xiaozhen Sheng*

Currently, sound radiation from the rail of a high-speed slab railway track is predicted using the two-and-half-boundary element method (2.5D BEM), assuming a homogeneous gap in the track direction between the rail and the slab. In fact, the gap between the rail and the slab are blocked regularly at sleeper spacing by fasteners, forming an infinitely long periodic structure. Sound radiation from such a structure may be addressed using the Periodic Acoustic Boundary Element Method (PABEM) developed recently by the authors. In this paper, after a brief introduction to PABEM, the method is applied to investigate the influence of the periodically installed fasteners on rail acoustic radiation and compare results from 2.5D BEM. The comparison shows significant differences depending on the field point location, frequency and wavenumber. The method is further applied to analyse the effectiveness in rail noise reduction of rail close-fitting sound barriers, which, while wrapping the lower part of the rail from the two sides of the rail and filling up the gaps between the fasteners, does not contact with the rail.

Wed 14:00–15:20 — Riverbank Room 5 (Chair: Linli Zhang, Xiaozhen Sheng)

14:00: Paper 415 — Deep Learning–Based Rail Corrugation Identification Using Onboard Interior Vibration and Noise Data — *Dr Xiao-zhou Liu*

14:20: Paper 730 — Efficient identification of special audible characteristics in wheel-rail interface noise — *Mr Philip Setton*

14:40: Paper 402 — Unidirectionally Coupled Vehicle–Track and Rolling-Contact Finite Element Modeling for Curve Passing Noise — *Dr yuanpeng He*

15:00: Paper 266 — Prediction of Viscous Mode Coupling Squeal Noise Amplitude Under Combined Lateral and Longitudinal Creepage — *Mr Ratabhat Wangtawesap*

14:00 **Paper 415 — Deep Learning–Based Rail Corrugation Identification Using Onboard Interior Vibration and Noise Data**

***Dr Xiao-zhou Liu**, Mr. Huanheng Li, Ms. Yan Zhang*

Rail corrugation is a common rail surface irregularity that increases wheel-rail vibration, interior noise, and maintenance demand in urban rail transit systems. This study investigates the feasibility of identifying rail corrugation using onboard interior noise measured during regular train operation. Acoustic and vibration signals were collected from an in-service metro line, and corrugation labels were obtained from field measurements. After mileage calibration and spatial alignment, synchronized noise samples were constructed and analyzed in the time and frequency domains. Results show that corrugation-related acoustic responses exhibit stronger fluctuations and enhanced mid-to-high-frequency energy, especially around 500-1000 Hz. Based on these characteristics, three models with different input representations were compared: an SVM using band-pass-filtered RMS features, a one-dimensional CNN using raw waveforms, and a two-dimensional CNN using STFT spectrograms. All three models identified corrugation sections to different extents, confirming that onboard interior noise contains effective diagnostic information. Among them, the STFT-based 2D-CNN achieved the best overall performance, while the raw-waveform 1D-CNN also showed competitive results. These findings demonstrate the potential of onboard interior noise for practical rail corrugation identification and condition monitoring.

14:20 **Paper 730 — Efficient identification of special audible characteristics in wheel-rail interface noise**

Mr Philip Setton

Special audible characteristics (SACs) from the wheel-rail interface such as flanging noise and wheel-squeal are known to be causes of complaint in the community. Recent complaints of rail noise (later classified as including SACs) were received along a defined section of curved track, and options for mitigation treatment explored with the rail operator and a mitigation measures including a top-of-rail-friction-modifier implemented. To quantify the effectiveness of these mitigations a

measurement and analysis methodology was developed. The methodology is examined in this paper and its suitability for other projects where wheel-rail interface noise may include similar SACs is discussed. Practical knowledge regarding possible causes of these SACs and other mitigation options

are also explored, as it applied to this case.

14:40 **Paper 402 — Unidirectionally Coupled Vehicle–Track and Rolling-Contact Finite Element Modeling for Curve Passing Noise**

Dr yuanpeng He

Curve passing noise is a major source of structure-borne noise in urban rail transit systems and can substantially degrade the acoustic environment of nearby communities. Time-domain multibody dynamics models are computationally efficient, but they often lack sufficient physical fidelity to represent detailed wheel–rail contact mechanics. In contrast, three-dimensional rolling contact finite element models can capture nonlinear contact behavior and friction-induced excitation at the wheel–rail interface, yet their high computational cost limits long-duration simulations. To reconcile this accuracy–efficiency trade-off, this study develops a multiscale, unidirectionally coupled modeling framework for curve passing noise. The framework links a global vehicle–track multibody dynamics model with a local three-dimensional wheel–rail rolling contact finite element model through one-way data transfer. Wheelset responses during curve negotiation, including lateral displacement, lateral velocity, and normal load, are first extracted from the global model. The curve passing process is then

segmented into representative dynamic states using a density-based spatial clustering algorithm. Finally, the parameters for each state are imposed as boundary conditions in a local explicit–implicit hybrid finite element model to resolve nonlinear contact dynamics and frictional excitation. The resulting wheel–rail contact forces are used to quantify source strength and spectral characteristics of curve passing noise.

15:00 **Paper 266 — Prediction of Viscous Mode Coupling Squeal Noise Amplitude Under Combined Lateral and Longitudinal Creepage**

Mr Ratabhat Wangtawesap, *Prof. Paul A. Meehan*

Viscous mode-coupling squeal vibration amplitude and sound pressure level under the effects of combined longitudinal and lateral creepage are investigated in this study. Using an energy-based formulation and a bilinear approximation of the creep curve, a closed-form analytical prediction of viscous mode-coupling squeal amplitude under combined longitudinal and lateral creepage is developed. The analytical results revealed that higher level of longitudinal creepage are required for squeal suppression under maximum viscous mode-coupling amplification at larger angles of attack. The predicted sound pressure levels trends show good agreement with numerical results with discrepancies within 10dB for angles of angles of attack below 10 mrad and within 5dB at higher angles of attack. A stability map was constructed and demonstrates that increase in longitudinal creepage significantly reduces the unstable squeal region and may found to be useful in designing squeal mitigation strategies.

2.3.7 Noise Barriers and Noise Mitigation Methods

Wed 10:40–12:00 — Riverbank Room 6 (Chair: Jean-Pierre Clairbois, Massimo Garai)

10:40: Paper 231 — Investigation of the Sound Absorption Performance of Acoustic Metamaterials under High Sound Pressure Excitations — *Dr Sebastien Ghinet*

11:00: Paper 103 — Toward the characterization of low-height noise barriers for railways — *Prof Massimo Garai*

11:20: Paper 167 — An efficient algorithm to calculate the diffracted sound field by a barrier with non-negligible thickness on a ground — *Mr Ling Yang*

11:40: Paper 228 — Testing and verification concept to ensure the stability of noise barriers including laminated safety glass for use along railway lines — *Dr Immanuel Wojan*

10:40 **Paper 231 — Investigation of the Sound Absorption Performance of Acoustic Metamaterials under High Sound Pressure Excitations**

Dr Sebastien Ghinet

This study examines the acoustic performance of a metamaterial composed of multiple parallel quarter-wave resonators arranged circularly with four central “pancake” elements under high sound pressure levels (SPLs). A resistive screen is optionally placed at the inlet to control acoustic damping. Experiments are conducted in a high-SPL impedance tube under both normal and grazing incidence conditions. Normal incidence absorption, measured using the two-microphone method, exhibits broadband performance up to 140 dB. Without the resistive screen, three resonant peaks appear near 820 Hz, 1140 Hz, and 1390 Hz, with peak amplitudes decreasing as SPL increases, while absorption above 1700 Hz remains above 0.8 with minimal SPL dependence. With the resistive screen, SPL-dependent effects are mainly confined to 700–2000 Hz, indicating improved linearity at higher frequencies.

Grazing incidence absorption, measured using a four-microphone two-source method, reveals a resonance near 1140 Hz that slightly weakens with increasing SPL for the bare metamaterial. In contrast, the resistive screen yields nearly SPL-invariant grazing absorption. These results show that the resistive screen effectively reduces nonlinear effects and improves the robustness of acoustic performance under both normal and oblique incidence.

11:00 **Paper 103 — Toward the characterization of low-height noise barriers for railways**

Prof Massimo Garai*, Dr Domenico De Salvio, Prof Paolo Guidorzi*

One of the objectives, the European project LIFE SILENT aims at improving the acoustic performance of low-height noise barriers (LHNB) for railways to mitigate rail-wheel noise. LHNB have a height smaller than 1 m and are installed at a close distance from the track. They are easier to install than conventional noise barriers, at a reduced cost and with reduced visual impact. However, LHNB should be sound-absorbing to mitigate the sound bouncing repeatedly between the LHNB and the train body, finally overcoming the barrier, but traditional sound-absorbing materials deteriorate rapidly when outdoors close to the track. Moreover, standard test methods for high-rise noise barriers (EN 16272 series) cannot be applied to LHNBs. Therefore, a tile composed of different metamaterials has been designed for application as a surface layer to existing LHNBs to improve their sound absorption across the relevant frequency range. Metamaterials can be made of nonporous raw materials, like plastic or rubber, which can guarantee a long service life. Furthermore, a new measurement procedure is being developed, to be applied both in the laboratory and on site in railway operating conditions. Preliminary results could be measured with the new method, suggesting encouraging improvements for characterizing and improving LHNBs.

11:20 **Paper 167 — An efficient algorithm to calculate the diffracted sound field by a barrier with non-negligible thickness on a ground**

Mr Ling Yang*, Dr Sipei Zhao, Dr Benjamin Halkon*

A theoretical method to calculate the diffracted sound field by a barrier with finite thickness on a ground is derived, and an efficient algorithm for numerical solution is developed by utilizing Fourier transform. The proposed method can simultaneously calculate the amplitude and phase of the sound field, which has a great significance for applications that rely

on phase information such as spatial active noise control. By comparing the solutions with those from COMSOL simulations, the differences between the two methods are observed to be within an acceptable range, validating the feasibility and accuracy of the proposed method. Furthermore, the effect of the barrier thickness on the barrier's sound attenuation performance is mathematically analysed using the proposed method, providing a theoretical basis for the simplification of the sound barrier models for the design.

11:40 **Paper 228 — Testing and verification concept to ensure the stability of noise barriers including laminated safety glass for use along railway lines**
Dr Immanuel Wojan

Noise barriers are built to shield the environment from unwanted sound. Furthermore, they should satisfy aesthetic criteria; in this regard, transparent noise barriers have less visual impact and are more widely accepted by the public. Laminated safety glass (LSG) is becoming increasingly established to be a viable alternative to PMMA due to its high rigidity and transparency, comparatively low dirt accumulation, high chemical and physical resistance and also for sustainability reasons.

Along railway lines, noise barriers must meet strict requirements for structural integrity, usability and fatigue safety. Especially a failure due to dynamic loadings from passing trains must be prevented. There are standardized tests and calculations for conventional elements for noise barriers, like metallic cassettes, concrete panels etc. (EN 16727-2-1 and -2-2) ; however, there is no corresponding testing and verification concept for elements for noise barriers with infill of LSG.

MFPA Leipzig GmbH was commissioned by the German Centre for Rail Traffic Research at the Federal Railway Authority to develop and evaluate possible methods to prove the usability of LSG for noise barriers along high-speed railway lines. The paper presents the project, the main findings, the resulting testing and verification concept and the open challenges still to be addressed.

Wed 14:00–15:40 — Riverbank Room 6 (Chair: Daljeet Singh)

14:00: Paper 484 — About the determination of the acoustic effectiveness of crown elements on noise barriers at a greater distance using close-proximity measurements — *Prof Jörn Hübelt*

14:20: Paper 230 — Broadband Inverse Design of Acoustic Metamaterials Using a Hybrid Conv-Dense Autoencoder — *Dr Tenon Charly Kone*

14:40: Paper 343 — Inclination-optimized ventilated curtain wall for railway noise mitigation in urban buildings — *Ms Yajing Di*

15:00: Paper 30 — Research Study on the Acoustic Performance Associated with Deformation of metal noise insulation plate — *Kimikazu Ikeya*

15:20: Paper 775 — Calculation of sound diffraction around a thick barrier using a practical calculation method for the ground reflection between double barriers — *Prof Yosuke Yasuda*

14:00 **Paper 484 — About the determination of the acoustic effectiveness of crown elements on noise barriers at a greater distance using close-proximity measurements**
Prof Jörn Hübelt*, Dr. Christian Schulze, Mirko Ruhnau, Arved Thies, Dr. Fabio Strigari, Robert Putzger*

To consider the noise reduction potential of the crown attachments on noise barriers at different receiving points, an accurate calculation model including information on the acoustic effectiveness of the diffractors is required. The main objective of the research project presented here, was therefore to develop a method for the determination of the acoustic effectiveness, the insertion loss, caused by the diffractors using simple measurements in close proximity to the wall. To derive a proposal for calculating the effect, both measurements on actual attachments and FE simulations were carried out. In the proposed procedure the measurements can be performed in close proximity to the barriers according to the European standard EN 1793-4. In order to determine the acoustic effectiveness of crown elements at greater distances, an angle-dependent correction term was introduced. The results obtained are to be used to classify the crown elements and thus serve as an additional tool for calculating the sound propagation according to the German Guidelines for Noise Protection on Roads – RLS-19.

14:20 **Paper 230 — Broadband Inverse Design of Acoustic Metamaterials Using a Hybrid Conv-Dense Autoencoder**

***Dr Tenon Charly Kone**, Dr Sebastien Ghinet, Dr. Anant Grewal*

A hybrid Conv-Dense deep autoencoder is proposed for the broadband reconstruction of sound absorption spectra and simultaneous estimation of geometric parameters of resonator-based acoustic metamaterials. Achieving broadband noise reduction requires accurate modeling across wide frequency ranges. However conventional inverse-design approaches rely on iterative simulations or optimization, which are computationally intensive and often lack generalization.

The proposed model combines convolutional layers to capture local spectral features with dense layers to encode global correlations and physical constraints, producing a compact latent representation that decodes into both the full broadband absorption spectrum and corresponding design parameters. Training utilizes an extensive numerically generated dataset of over 55,000 samples comprising broadband SAC responses and normalized resonator geometries. A joint Huber-based loss guides simultaneous spectral reconstruction and parameter regression, ensuring stable latent-space representation and physically consistent predictions.

Performance evaluation demonstrates high predictive accuracy across the broadband range, with reconstruction errors below 1% and parameter estimation errors below 0.02 across the test set. This dual-task surrogate model enables fast, near-real-time inverse design of resonator-based broadband absorbers and is scalable to more complex geometries. The framework extablishes a foundation for AI-driven pipelines targeting broadband noise mitigation in aeronautics, automotive, and advanced metamaterials applications.

14:40 **Paper 343 — Inclination-optimized ventilated curtain wall for railway noise mitigation in urban buildings**

***Ms Yajing Di**, Mr. Xiaodong Sha, Prof Hequn Min, Miss Yiquan Xu, Wanqian Yu, Zhilan Wang, Wensheng Wang*

Railway network expansion has increased noise exposure at corridor sites. Existing mitigation through conventional sealed facades inadequately integrates acoustic performance with ventilation requirements. This study presents an integrated envelope design framework featuring frequency-dependent curtain wall inclination optimization under ventilation constraints and strategic sound-absorbing material allocation. Coupled acoustic-structural-ventilation analysis is performed using finite element methods. A real-world railway infill site near Nanjing Railway Station, China, validates the framework. Results show that ground-level barriers with heights of 3 m to 4 m effectively reduce exterior sound pressure levels at lower and middle building stories, with reductions of 3 dB to 5 dB. When curtain wall inclination reaches 90°to 95° relative to incident noise direction, reflected noise in mid-to-high frequency ranges (500-2000 Hz) is minimized, reaching 4 dB to 7 dB reduction, exceeding that achieved by 60°-85° configurations. High-performance sound-absorbing materials (0.15 m² per floor) provide an additional 2-3 dB reduction at mid-to-high frequencies. Compared to conventional sealed double-glazing systems, the proposed ventilated curtain wall achieves comparable acoustic performance while maintaining natural ventilation. The framework enables coordinated optimization of building functionality and acoustic performance, and provides design guidance for railway-adjacent urban developments.

15:00 **Paper 30 — Research Study on the Acoustic Performance Associated with Deformation of metal noise insulation plate**

***Kimikazu Ikeya**, Mr Satoshi Obara, Mr Tatsuaki Mori, Dr Hiroshi Iwabuki, Mr Go Oosawa, Ms Emi Toyoda*

In NEXCO, we are studying the aging of noise barriers and the renewal criteria for the purpose of renewal planning. In this report, I focused on the metal noise insulation plate, which is the main component for noise barrier, and studied the secular change of its acoustic performance. It was confirmed that the acoustic performance satisfies the initial performance standard even after 40 years if the appearance of the metal plate is relatively good. It was shown that the secular change in the acoustic performance of the metal plate can be evaluated by investigating the appearance and the like based on the maintenance inspection procedure prescribed by NEXCO. Furthermore, the extent of the damage was assumed, and the impact on acoustic performance was examined through indoor tests to determine at what level of damage replacement of the metal noise insulation plate would be necessary. As a result, it was found that if the back steel plate of noise barrier is damaged to some extent, it could potentially affect acoustic performance. It was also confirmed that temporarily applying an aluminum tape to the damaged area can restore satisfactory acoustic performance.

15:20 **Paper 775 — Calculation of sound diffraction around a thick barrier using a practical calculation method for the ground reflection between double barriers**

***Prof Yosuke Yasuda**, Master Haruto Kobayashi, Ph.D. Jinyu Liu, Dr. Eng. Akinori Fukushima*

In Japan, the ASJ RTN-Model, proposed by The Acoustical Society of Japan (ASJ), has long been widely adopted as a practical prediction model for road traffic noise. In this model, double diffraction around double barriers can be calculated, although the effect of the ground surface between the barriers is not considered. In this paper, we report the effect of the ground surface between double barriers on diffracted sound fields obtained through wave-based numerical analysis, and introduce a practical calculation method to account for this effect. This method may be applicable to diffracted sound fields around a thick barrier because a thick barrier is acoustically identical to the corresponding double barriers with the ground surface between them located at the top of the barriers. Using this method, we calculate a diffracted sound field around a thick barrier and evaluate the effectiveness of the method by comparing with the wave-based numerical results. We also compare the results with those obtained using the calculation method for double diffraction around a thick barrier presented in the ASJ RTN-Model.

2.3.9 Vibration from Ground Transportation: Sources and Propagation

Tue 09:00–10:20 — Panorama Room 1 (Chair: Aaron Miller, Kym Burgemeister)

09:00: Paper 464 — Vibration impacts from tunnel boring machines: detailed case study of two conjoined multi-storey buildings in Sydney — *Mr Aaron Miller*

09:20: Paper 506 — Assessment of Environmental Vibration Impacts on Sensitive Buildings Adjacent to Subways and Vibration Mitigation Measures: A Case Study — *Ms Dan Wu*

09:40: Paper 799 — Outdoor-to-indoor vibration transfer measurements for vibration and ground-borne noise assessment of metro rail construction and operations — *Mr David Timms*

10:00: Paper 752 — Influence of TBM Speed on Ground-Borne Vibration: Insights From Sydney Tunnelling Project — *Ms Tracy Gowen*

09:00 **Paper 464 — Vibration impacts from tunnel boring machines: detailed case study of two conjoined multi-storey buildings in Sydney**

***Mr Aaron Miller**, Dr Briony Croft, A/Prof Jeffrey Parnell, Dr Joseph Spagnol*

The construction of underground roads and railways necessitates extensive tunnelling, typically using tunnel boring machines (TBMs) to excavate the mainlines. In urban and suburban settings, the operation of TBMs can generate ground-borne noise and vibration, potentially affecting nearby sensitive receivers, such as commercial buildings and residences.

This paper presents a case study measuring vibration levels caused by two TBMs operating in sandstone. One TBM was positioned directly beneath two conjoined multi-storey commercial buildings with pile foundations settled in shale, at a minimum distance of 5 metres from the foundations. The other TBM was located 22 metres away from the foundations under an adjacent empty site. We present detailed monitoring conducted at four locations across the footprint of the two conjoined buildings during the approach and departure of both TBMs, and at five additional locations spanning multiple floors of one of the buildings when one TBM was directly underneath. This monitoring encompasses several relevant metrics, including PPV, one-third octave band velocity, A-weighted RMS velocity levels, and frequency-weighted root-mean-quad accelerations, which were used to calculate vibration dose values.

09:20 **Paper 506 — Assessment of Environmental Vibration Impacts on Sensitive Buildings Adjacent to Subways and Vibration Mitigation Measures: A Case Study**

***Ms Dan Wu**, Prof Lei He, Researcher Ruixiang Song, Researcher Yubin Wu, Researcher Liang Wang*

This study takes a new building adjacent to a subway as the research object. By combining field measurement with numerical simulation, the environmental vibration and indoor vibration response of the proposed building are analyzed, predicted, and evaluated. Based on the evaluation results, a vibration mitigation measure using isolation pads for the sensitive building is proposed. Following the completion of the project, in-situ measurements of indoor vibration and secondary radiated noise were conducted. The measured data indicate that the implemented vibration mitigation measures effectively reduce indoor vibrations induced by subway train operations, and the vibration reduction performance meets the design expectations.

09:40 **Paper 799 — Outdoor-to-indoor vibration transfer measurements for vibration and ground-borne noise assessment of metro rail construction and operations**

***Mr David Timms**, Dr David Larner, Mr Bill Dawson, Dr Graham Brown*

This paper presents a programme of building dynamics testing to characterise outdoor-to-indoor vibration transfer, undertaken to improve confidence in vibration and ground-borne noise predictions for construction and operation of metro rail tunnels. The methodology employs a portable dropped-weight rig to generate impulsive excitation at multiple exterior locations, with simultaneous exterior and interior measurements using accelerometers and one-third-octave analysis across the relevant frequency range. Transfer functions (combined building coupling loss and slab amplification) are derived from repeated impacts, with data normalised for transducer mounting, axes combined vectorially, and impulse peak selection informed by time-of-arrival checks and signal-to-noise screening. Room-specific transfer functions are assembled by selecting the most conservative dataset at each frequency and reporting the mean and associated standard deviation

for subsequent uncertainty analysis. Results from the building dynamics testing demonstrate a practical and repeatable protocol that captures the building response needed for both construction and operational assessments of vibration and ground-borne noise.

10:00 **Paper 752 — Influence of TBM Speed on Ground-Borne Vibration: Insights From Sydney Tunnelling Project**

Ms Tracy Gowen*, Mr Abhinav Rajagopal*

Excavation with tunnel boring machines (TBMs) generates ground-borne vibration due to the interaction between the TBM cutterhead and the tunnel face. The level of vibration experienced at the surface is influenced by several factors including receiver type (e.g. slab on ground construction), distance between the receiver and the cutting face, and intervening geotechnical conditions. Studies also indicate that the TBM speed influences the vibration generated, and that changing the TBM thrust, cutter head torque, cutter head speed, and penetration can influence vibration levels.

A recent tunnelling project in Sydney enabled the review of vibration monitoring data from two TBM pass bys and comparison with cutter torque at varying distances from a monitoring location. This paper reviews the results of this analysis including consideration for the operational feasibility of slowing the TBM as a vibration mitigation measure and discusses whether such adjustments are practical for managing vibration and ground-borne noise on tunnelling projects.

2.4.1 Industrial Noise & Vibration: General

Wed 10:20–12:00 — Riverbank Room 8 (Chair: Ali Ahmadi, Tim Trewin)

10:20: Paper 9 — A Validated Framework for Far-Field Noise Prediction of Containerized BESS: From Optimized Sound Power Measurement to Simulation — *Dr Xueying Xu*

10:40: Paper 38 — Influence of manufactured flank waviness on the excitation behavior of gear teeth — *Mr Alois Wenig*

11:00: Paper 57 — The application of the indoor adjustment for the assessment of industry noise in Victoria — *Dr Marc Buret*

11:20: Paper 125 — Clamp-Integrated Tuned Mass Damper for Vibration and Noise Reduction in Converter Transformers — *Mr yi Wang*

11:40: Paper 539 — Handling sound power level uncertainty with certainty: avoiding overconservative noise modelling in BESS and other arrayed facilities — *Mr Jet Kye Chong*

10:20 **Paper 9 — A Validated Framework for Far-Field Noise Prediction of Containerized BESS: From Optimized Sound Power Measurement to Simulation**

Caijun Ma, Guofu Li, ***Dr Xueying Xu***

The proliferation of large-scale Battery Energy Storage System (BESS) stations poses significant environmental noise challenges, necessitating accurate far-field noise prediction in the early design stages. The accuracy of these predictions is critically dependent on precise sound source data of individual BESS containers. This paper presents a novel framework using a mobile robotic arm to perform high-resolution sound intensity scanning (ISO 9614-2) across the container's surfaces. This method enables the precise identification of noise-contributing areas, yielding a high-resolution source map that is used to create a high-fidelity area source model in CadnaA. The model's predictions were validated against on-site measurements at a receiver 71.2 m from the source, achieving a prediction error in overall SPL of only 1.5 dB. In contrast, a conventional model based on the ISO 3744 standard yielded a prediction error of 7.5 dB in the same scenario. The proposed framework thus significantly enhances noise prediction accuracy, providing a more reliable tool for designing effective noise control measures for BESS facilities.

10:40 **Paper 38 — Influence of manufactured flank waviness on the excitation behavior of gear teeth**

Mr Alois Wenig*, Mr Markus Rothemund, Dr. Ing. Michael Otto, Prof. Dr. Ing. Karsten Stahl*

Gear noise is one of the predominant NVH problems in transmissions. To positively influence the excitation behavior of gears in terms of noise, flank modifications in the form of flank waviness offer an effective option.

According to the state of the art, standardized tolerance classes allow deviations of several micrometers, there are currently no statements regarding the magnitude at which waviness becomes noticeable in terms of excitation behavior and acoustics. Therefore, this work investigates gears with waviness amplitudes from 0.282 µm to 2 µm.

The manufacturing of such waviness is considered highly challenging in industry, as very high manufacturing quality must be achieved. For this reason, this manufacturing option for flank modifications has not yet been widely implemented. The influence of such small modifications has not been sufficiently investigated. However, vibration measurements demonstrate clear effects of small amplitudes on the excitation behavior of gear meshes.

To analyze the excitation behavior of the gears under quasi-static conditions the transmission error is used. Under dynamic operating conditions, the tangential and radial accelerations of the pinion and the gear are evaluated.

The aim of this work is to be able to make a statement regarding the influence of the magnitude of waviness amplitudes.

11:00 **Paper 57 — The application of the indoor adjustment for the assessment of industry noise in Victoria**

Dr Marc Buret*, Dr Elaine Just*

Under the Environment Protection Regulations 2021 (Vic), industry noise levels are required to be maintained within limits that specifically apply outdoors within noise sensitive areas and thereby protect both indoor and outdoor spaces. Noise must be assessed following the procedures relevant to industry noise specified in EPA Victoria's Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues (publication

1826.5). In some circumstances such as when the intrusive noise is transmitted through a floor, ceiling or wall with no opening, noise levels are measured indoors, and a specific 'indoor adjustment' applies. Where the noise reduction performance of the building envelope is not known, this adjustment takes a generic value. However, the intent is to allow assessing against the [outdoor] noise limits. The indoor adjustment is not meant to be used to define 'indoor noise limits' from which requirements for the construction of buildings exposed to industrial noise are derived. This is not always well understood. This paper summarises how the indoor adjustment was established, how and where it applies and how exposure of new sensitive uses to pre-existing industry noise should be considered and assessed.

11:20 **Paper 125 — Clamp-Integrated Tuned Mass Damper for Vibration and Noise Reduction in Converter Transformers**

Mr yi Wang, *A/Prof Yurong Wang, Mr Liangfeng Liu*

Vibration in converter transformer structural configurations arises from nonlinear magnetostrictive effects coupled with structural dynamics, resulting in significant vibro-acoustic noise. Traditional tank-based damping offers limited effectiveness and fails to mitigate internal fault risks induced by vibration. Given that internal clamps are adjacent to vibration sources and serve as critical transmission paths, this study explores the feasibility of a clamp-integrated Tuned Mass Damper (TMD) for suppressing this noise. A multiphysics finite element model of a 10 kVA single-phase two-limb transformer was established. Under a single-frequency electrical excitation (50 Hz), magnetostrictive nonlinearity generates multiple higher-order harmonic responses, among which a dominant radiated sound power peak is observed at 400 Hz. Addressing this dominant radiation region, a TMD integrated into the clamp was designed. Leveraging the geometric shape-factor effect to enhance viscoelastic stiffness, the device achieves an effective operating region around 400 Hz within spatial constraints. Coupled simulation of the TMD and core models demonstrates suppression of the dominant frequency and adjacent harmonic components, reducing total radiated sound power (0–1000 Hz) by 30.1% (from 5.74×10 W to 4.01×10 W). The proposed clamp-integrated absorber thus offers significant noise reduction potential and provides a promising approach for mitigating vibration-induced internal fault risks.

11:40 **Paper 539 — Handling sound power level uncertainty with certainty: avoiding overconservative noise modelling in BESS and other arrayed facilities**

Mr Jet Kye Chong, *Mr Oskar Wesley-Smith, MR Alexander Stoker*

Predicting noise levels under typical worst-case conditions is standard practice in environmental noise assessment. However, overly conservative modelling can lead to unnecessary mitigation measures or an inability to demonstrate compliance for planning purposes. In many assessments, source sound power level uncertainty (specified by manufacturers as described in ISO 5114-1:2024) is conservatively added to the sound power level of each source. However, for facilities consisting of many identical noise sources, such as battery energy storage systems (BESS), this approach was found to consistently overestimate noise levels when compared to a statistical analysis of the uncertainty. This paper quantifies and analyses the overestimation via the Fenton-Wilkinson approximation method, validates the approximation using Monte Carlo simulations, and provides reference charts and tables for more accurate calculation based on the nominated uncertainty and number of sources.

Wed 14:00–15:20 — Riverbank Room 8 (Chair: Tim Trewin, Xueying Xu)

14:00: Paper 745 — Selected methods for modelling noise around large industrial plants — *A/Prof Bartlomiej Stepien*

14:20: Paper 321 — Time-Domain Aeroacoustic Analysis and Source Identification of Sirocco Fan — *Mr Kenji Oe*

14:40: Paper 789 — Rating background noise levels and the NPfI intrusive noise criteria — *Mr Rodney Phillips*

15:00: Paper 243 — An Improved WGAN-GP-Based Data Augmentation Method for Acoustic Signals — *M. S. Yiqi Wang*

14:00 **Paper 745 — Selected methods for modelling noise around large industrial plants**

A/Prof Tadeusz Wszolek, ***A/Prof Bartlomiej Stepien***

Acoustic modelling of large industrial plants is a key tool in assessing the impact of noise on the environment and in planning

effective noise reduction measures. Verification measurements carried out around the modelled plant are an important part of the whole project. They are used both to verify the correctness of simulation results.

The calculations are performed using various noise propagation algorithms. In Europe, commonly used calculation algorithms include the methodology described in ISO 9613-2, the CNOSSOS-EU, and Nord2000 algorithms. Each of these algorithms considers the impact of meteorological conditions on model calculation results in a different way.

This paper presents the results of model calculations around the large industrial plants, carried out according to the ISO 9613-2, CNOSSOS-EU and Nord2000 algorithms, which were compared with measurement results at selected control points in the vicinity of the plant under various meteorological conditions. Additional sources of errors in industrial noise modelling were also identified, as well as difficulties in performing reliable emission measurements at control points in conditions of interference from other installations not part of the modelled plant.

This research has been founded by the Polish Ministry of Science and Higher Education - project No. 10000 501.00 130000.

14:20 **Paper 321 — Time-Domain Aeroacoustic Analysis and Source Identification of Sirocco Fan**

***Mr Kenji Oe**, A/Prof Tsukasa Yoshinaga, Prof Akiyoshi Iida*

Centrifugal fans are widely used in various industrial applications. Their development requires both high performance and low noise levels. The Sirocco fan, a type of centrifugal fan, features volute casing and forward-curved rotating blades. Aerodynamic noise originates not only from the blades but also from the interior of the casing and the interaction between blades and casing. However, the contribution of each component has not been clearly demonstrated. Aerodynamic noise analysis using the hybrid decomposition method is typically performed in the frequency domain, making it difficult to quantitatively show the influence of rotating parts. To elucidate the aerodynamic noise mechanism of Sirocco fans, we developed a time-domain hybrid decomposition method based on linearized Euler equations incorporating moving boundaries. Through accuracy verification via direct numerical simulation, we demonstrate that the interaction noise between the rotating blades and the casing can be predicted. In blade-passing frequency analysis, noise sources were decomposed into blade and casing regions using spatial filters. The results revealed that not only the tongue-related noise sources, which are known as the primary noise sources of Sirocco fans, but also the blade noise sources before passing the tongue were significant.

14:40 **Paper 789 — Rating background noise levels and the NPfI intrusive noise criteria**

***Mr Rodney Phillips**, Mr Angus Leslie*

The NSW Environment Protection Authority (EPA) has a long established practice of using a two-part criteria for assessing industrial noise, as scientific literature indicates that both the increase in noise level above background levels, as well as the absolute level of noise are important factors in how a community will respond to noise from industrial sources. The NSW EPA Noise Policy for Industry (NPfI) establishes intrusive noise criteria for industrial developments to address the emergence above the background noise level through the establishment of a Rating Background Level (RBL). The RBL is a single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period, which is typically a minimum of seven days of valid monitoring.

This paper reviews the established approach for background noise monitoring, by reviewing multiple long-term unattended noise monitoring data sets undertaken over several months. The review aims to identify issues, limitations and considerations for the current method, as this can result in materially different outcomes for the assessment criteria. A comparative review of industrial noise policy frameworks in selected Australian states and international jurisdictions has also been undertaken to identify merits in alternative or adjusted approaches.

15:00 **Paper 243 — An Improved WGAN-GP-Based Data Augmentation Method for Acoustic Signals**

***M. S. Yiqi Wang**, A/Prof Yongsheng Yu, Prof Linke Zhang*

In the fields of audio signal processing and acoustic event recognition, the performance of deep learning models often relies on large-scale labeled datasets. However, practical scenarios are often characterized by sample scarcity and imbalanced distributions, which can impair the generalization ability and robustness of these models. To address these issues, we propose an optimized WGAN-GP-based audio data augmentation method to expand the dataset and mitigate distributional imbalance. Built upon the WGAN-GP framework, the method integrates a self-attention mechanism into both the generator

and discriminator to enhance the modeling of global time-frequency dependencies, thereby overcoming the limited receptive field of convolutional operations. Furthermore, a multi-scale spectral-domain reconstruction loss is introduced to preserve critical acoustic details—such as harmonics, sidebands, and impulsive components—by constraining spectral distributions across multiple resolutions. Experimental results on the UrbanSound8K dataset demonstrate that the samples generated by the proposed method exhibit improved time-frequency fidelity. Its application to data augmentation for classification tasks effectively mitigates class imbalance and improves the classification accuracy of baseline models.

2.4.2 Industrial Noise Control

Mon 09:00–10:00 — Riverbank Room 7 (Chair: Ali Ahmadi, Xueying Xu)

09:00: Paper 499 — Audible corona discharge noise from a 132 kV transmission line: insulator-design comparison from continuous unattended monitoring — *Mr Gurkirat Singh*

09:20: Paper 284 — Research on Low-Frequency Abnormal Sound Identification Method for Substation Equipment Based on Spherical Microphone Array Fusing B-CLEAN-SC and Sparse Sampling — *Dr Haoyang Tian*

09:40: Paper 359 — Transformer noise reduction after retrofilling mineral oil with natural/synthetic ester liquids — *Mr Ruifeng Wang*

09:00 **Paper 499 — Audible corona discharge noise from a 132 kV transmission line: insulator-design comparison from continuous unattended monitoring**

Mr Gurkirat Singh, *Mr Tom Evans, Mr Darren Jurevicius*

Audible corona discharge noise from high-voltage transmission lines is a common community-noise concern where lines pass near residences. Published field measurements are dominated by AC lines at 220 kV and above. Operational data at lower transmission voltages is limited. This paper presents continuous unattended noise monitoring at three tower locations along a single 132 kV double-circuit overhead line in regional Australia, with distinct insulator designs at each location (silicon-coated glass, non-ceramic long rod, and standard glass). Audible corona was identified using spectral correlation against reference signals drawn from published literature and prior Resonate project measurements, combined with a prominence filter on the 100 Hz and high-frequency bands. Audible corona was identified on approximately 32 percent of night-time dry monitoring hours at the standard-glass tower and 2.5 percent at the non-ceramic long-rod tower. Audible corona at the silicon-coated glass insulator tower was observed to be negligible during the monitoring period. The findings indicate that tower construction and design conditions materially affect audible corona emission at 132 kV.

09:20 **Paper 284 — Research on Low-Frequency Abnormal Sound Identification Method for Substation Equipment Based on Spherical Microphone Array Fusing B-CLEAN-SC and Sparse Sampling**

Mr Jian Zhou, Mr Hongjun Shi, ***Dr Haoyang Tian****, Mr Wei Peng, Mr mingyu jin, Mr xinye wu*

Panoramic identification of abnormal sound sources in substation equipment is conventionally achieved using compressive spherical beamforming. However, this method exhibits limitations in localizing low-frequency anomalies from critical equipment, such as transformers, particularly in portable applications characterized by a limited number of microphones and small array apertures. To overcome these challenges, this paper proposes a novel sound source enhancement and identification approach that integrates broadband coherent subspace cleaning (B-CLEAN-SC) with sparse sampling on spherical microphone arrays. The proposed method initially estimates the azimuth of the anomaly via B-CLEAN-SC, followed by the construction of an overcomplete steering vector dictionary based on spherical harmonic expansion. Ultimately, robust source localization is achieved through L1 regularization-based sparse sampling. Numerical simulations, semi-anechoic chamber experiments, and field tests on an actual substation transformer demonstrate that the proposed method significantly outperforms conventional spherical harmonic beamforming and L0 norm-based compressive spherical beamforming in terms of both localization accuracy and spatial resolution within the targeted frequency band.

09:40 **Paper 359 — Transformer noise reduction after retrofilling mineral oil with natural/synthetic ester liquids**

Prof Feipeng Wang, Dr. Ruifeng Wang, Zhiqiang Huang, Dr. Kevin James Rapp, ***Mr Ruifeng Wang***

Transformer audible noise is traditionally treated as a “core-and-structure” problem dominated by magnetostriction-driven core vibration and its transmission/radiation through the tank. However, field retrofilling experience increasingly indicates that the insulating liquid itself can measurably alter sound pressure and sound power, even when the active part design remains unchanged. This paper consolidates two evidence streams: (i) a documented 220 kV / 16 MVA power transformer comparison test before/after retrofilling with a soybean-based natural ester (FR3), and (ii) supplementary distribution-transformer observations (10 kV class) across different core materials. In the 220 kV case, the A-weighted sound pressure level at 2 m reduced from 65 dB(A) to 61 dB(A), and the reported sound power reduced from 87 dB(A) to 84 dB(A) after retrofilling. We interpret these results using a fluid–structure–acoustic coupling perspective: ester liquids (natural and

synthetic) exhibit higher density and typically higher viscosity than mineral oil, which can increase hydrodynamic damping and mass loading of tank vibration—shifting resonance response and reducing radiated noise in certain designs. The distribution-transformer dataset suggests the noise change sign may depend on core material/system dynamics, motivating a standardized experimental protocol that separates (a) source vibration, (b) tank response, and (c) radiated acoustic fields.

Mon 11:00–12:20 — Riverbank Room 7 (Chair: Ali Ahmadi, Xueying Xu)

11:00: Paper 317 — A Temporal Attention-Based Method for Remaining Useful Life Prediction of Rolling Bearings — *Yuchen Guo*

11:20: Paper 428 — A Method for Wind Turbine Bearing Fault Diagnosis for Edge Deployment — *Mr Haowei Dong*

11:40: Paper 593 — Programmable Microperforated Panel Coupled with Panel Resonators Incorporating Helmholtz Neck Absorbers for Low-Frequency Industrial Noise Mitigation — *Dr Dunant Halim*

12:00: Paper 252 — A Sound Field Prediction Method for Complex Barriers Using Physics-Informed Graph Neural Networks — *Xinyuan Cui*

11:00 **Paper 317 — A Temporal Attention-Based Method for Remaining Useful Life Prediction of Rolling Bearings**

Yuchen Guo, *Prof Chunqiu Tang, A/Prof Yongsheng Yu*

Rolling bearings are critical components in rotating machinery, and their degradation directly affects operational safety and maintenance decisions. To address insufficient use of temporal degradation information, inadequate attention to critical degradation stages, and unstable cross-bearing generalization in remaining useful life prediction, this paper proposes a method integrating a Temporal Attention Fusion Module (TAFM) and a Degradation-Aware Loss Module (DALM). First, 65-dimensional degradation features related to time-domain, frequency-domain, and fault-frequency-band information are extracted from the XJTU-SY full-life bearing dataset, and full-life normalized RUL labels are constructed. Second, an LSTM-based feature-sequence prediction model is used as the baseline, where sliding windows form feature sequences and a BiLSTM models temporal dependencies. TAFM then adaptively fuses different time steps within each window, while DALM dynamically reweights samples according to their true normalized RUL stage. Experiments on the XJTU-SY dataset show that the proposed TAFM-DALM model achieves average RMSE and MAE values of 0.130 and 0.105, reducing the errors by 31.44% and 29.66% relative to the LSTM baseline.

11:20 **Paper 428 — A Method for Wind Turbine Bearing Fault Diagnosis for Edge Deployment**

Mr Haowei Dong, *Prof Chunqiu Tang, A/Prof Yongsheng Yu*

To address the challenges of fault feature extraction at the edge of wind turbines in low signal-to noise ratio environments, as well as the difficulty in deploying deep learning models due to limited edge computing power, this paper proposes a lightweight method for wind turbine bearing fault diagnosis based on multi-wavelet basis fusion and dual-channel gated second-order convolution. Adopting a ”strong signal preprocessing + sophisticated feature interaction” paradigm, the method achieves high-precision diagnosis while significantly reducing model complexity. The method first utilizes parallel decomposition with multiple wavelet bases to transform fault impacts into explicit time-frequency features, then suppresses noise through dual-channel fusion, and finally employs gated multi-branch convolutions to accurately capture weak faults with minimal parameter overhead. Experimental results on public bearing datasets demonstrate that the proposed method maintains excellent performance even under extreme low signal-to-noise ratio conditions. Furthermore, compared to deep learning models required to achieve equivalent accuracy, the proposed method significantly reduces the number of parameters and computational overhead (FLOPs), laying the

foundation for cloud-edge collaboration.

11:40 **Paper 593 — Programmable Microperforated Panel Coupled with Panel Resonators Incorporating Helmholtz Neck Absorbers for Low-Frequency Industrial Noise Mitigation**

Mr. Zihao Xiong, Dr. Wai Yeen Yeang, ***Dr Dunant Halim****, Dr. Xiaosu Yi, Dr. Nai Yeen Gavin Lai*

While microperforated panels (MPPs) have been widely recognized as an alternative to porous sound absorption materials, their industrial implementation is currently limited. To meet the rigors of diverse engineering environments, enhancing their low-frequency efficiency and functional adaptivity remains a critical research imperative. Prior studies have utilized panel resonators that were incorporated with Helmholtz necks (PRH) for enhancing MPP through structural-acoustic interaction. The present work introduces an MPP-PRH structure in a multi-cell configuration that allows for the targeting of specific frequency ranges, providing an adaptable solution for broadband low frequency noise control in industrial environments. A corrugated model of sound absorber was developed to establish a customizable response profile. This allows the absorber to be ”programmed” for distinct frequency peaks depending on the dominant noise signature of the environment, while simultaneously ensuring sufficient structural stiffness. Experiment results demonstrate that the ratio between the wavelength of half-absorption frequency and absorber thickness exceeds 20, with low-frequency performance enhanced by more than 280% (250 Hz- 500 Hz). This research provides a space-efficient, adaptive solution for demanding industrial noise suppression scenarios.

12:00 **Paper 252 — A Sound Field Prediction Method for Complex Barriers Using Physics-Informed Graph Neural Networks**

Xinyuan Cui*, Prof Fucai Hu, A/Prof Yongsheng Yu*

To address the issue of insufficient modeling accuracy in traditional equivalent source methods for industrial noise prediction within complex barrier environments, we proposes a novel sound field prediction framework based on Physics-Informed Graph Neural Networks (PI-GNN). This method models the geometric relationships among key elements such as sound sources, barriers, and measurement points using graph neural networks, constructing a graph structure capable of representing complex spatial topologies. Furthermore, it transforms the Fresnel number calculation model from acoustic diffraction theory and empirical formulas for noise barrier attenuation into differentiable physical constraint modules. These modules are integrated as crucial components of the loss function, guiding the network to strictly adhere to known physical laws while learning data mappings. By optimizing the balance between the physical constraint loss and data fitting loss, efficient training of network parameters is achieved. Experimental results demonstrate that this framework enhances computational efficiency and adaptability to sparse measurement point data while maintaining the physical plausibility of traditional methods. It provides a new perspective for rapid noise assessment and optimal noise barrier design in complex industrial environments.

2.4.3 Wind Turbine Noise

Wed 08:40–10:00 — Riverbank Room 5 (Chair: Stefan Jacob, Tom Evans)

08:40: Paper 185 — Measurement of low frequency noise emission from wind turbines with acoustic measurement drones — *Dr Stefan Jacob*

09:00: Paper 609 — Temperature Inversions Affecting Propagation of Wind Turbine Noise: A Long-Term Monitoring and Modelling Study — *Mr Duncan Halstead*

09:20: Paper 634 — A Statistical Approach to Wind Energy Facility Alternative Monitoring Locations — *Mr Kai Fisher*

09:40: Paper 825 — Effect of Vegetation Cover on Wind Turbine Noise Propagation in the Caatinga Biome, Brazil — *Mr Jarbas Souza Filho*

08:40 **Paper 185 — Measurement of low frequency noise emission from wind turbines with acoustic measurement drones**

Mr Ramesh Raja Subramanyam, Mr Christian van Aswegen, Mr Criostoir Gerasch, Prof Volker Wittstock, ***Dr Stefan Jacob***

Aerodynamic and structure-borne noise generated by wind turbines contains low-frequency components that can propagate over a long range. It is difficult to fully characterise the acoustics of wind turbines with only ground-based measurements. For this reason, a drone-based measurement platform is developed for performing remote measurements of a 20 Hz tone radiated by a wind turbine's nacelle. Therefore, the noise radiation behaviour of the wind turbine in the downwind direction is mapped by measuring at discrete points of increasing altitude. Although atmospheric turbulence masks the acoustical signal at low frequencies near the ground, the noise levels measured by the drone at higher altitudes were comparable to those of a reference ground microphone signal. The measurement procedure can be used to identify sources and their mechanisms for large outdoor emitters, providing a useful addition to standardized noise assessment procedures such as IEC 61400.

09:00 **Paper 609 — Temperature Inversions Affecting Propagation of Wind Turbine Noise: A Long-Term Monitoring and Modelling Study**

Mr Duncan Halstead*, Mr Allan Munro, Ms Brooklynn Bennitt*

Atmospheric refraction plays an important role in environmental noise propagation, particularly during temperature inversions, where vertical temperature gradients alter the effective speed of sound, refracting acoustic energy downwards. Such conditions could have a major impact on wind turbine noise propagation – given the elevated position of the noise source – where downward refraction can greatly increase the perceived levels at receptors.

This paper investigates measurement data collected near a wind farm located in a rural area with flat topography that was found to experience strong and well-developed temperature inversions more often than expected during the measurement period. The primary objective of this investigation is to quantify the influence of these temperature inversions on wind turbine noise propagation. Long-term sound level measurements captured over a three-month period are analysed alongside turbine SCADA data and multi-height meteorological tower data to examine the relationships between inversion strength and measured sound level. The analysis is compared with predictions from conventional modelling techniques to assess the conservatism of standard assumptions under moderate to extreme downward-refracting conditions.

09:20 **Paper 634 — A Statistical Approach to Wind Energy Facility Alternative Monitoring Locations**

Mr Kai Fisher*, Mr Tristan Desombre, Ms Sophie Gleeson, Dr Kym Burgemeister*

Operational noise assessments for wind energy facility (WEF) emissions, following the NZS 6808:2010 or similar standards, generally rely on extended monitoring at sensitive receptors to demonstrate compliance. In some cases, especially where ongoing or regular monitoring may be required in future, relying on extended monitoring at residential premises can be costly and have logistical challenges. In some jurisdictions, notably in Victoria, Australia, alternative monitoring locations may be used for ongoing compliance assessments instead of the original primary monitoring location at dwellings.

Without background noise measurements (with the WEF not operating) at the alternative monitoring locations, it is difficult to assess the contribution from the WEF using standard methods.

This paper presents a method to overcome some of these challenges by determining a combined background sound / WEF operation level as a limit, derived from statistical analysis of long-term datasets obtained during periods of confirmed compliant operation. The method is repeatable and computationally robust, enabling ongoing assessment without requiring separate background-only measurements at the alternative location.

09:40 **Paper 825 — Effect of Vegetation Cover on Wind Turbine Noise Propagation in the Caatinga Biome, Brazil**

Mr Jarbas Souza Filho

This study investigates the influence of vegetation cover, quantified by the Normalized Difference Vegetation Index (NDVI — a satellite-derived measure of vegetation density), on wind turbine noise propagation in the semi-arid Caatinga biome of northeastern Brazil. Equivalent continuous A-weighted sound pressure levels (LAeq) were measured at 225 residential receptors surrounding a wind farm during the rainy season. Wind turbine-specific sound pressure levels (Lsp) were calculated by logarithmic energetic subtraction. NDVI values were derived from Sentinel-2 imagery (10 m resolution) and averaged within a 100 m buffer around each receptor. Results indicate a statistically significant association between NDVI and specific sound pressure levels. After controlling for distance and wind speed, an increase of 0.1 NDVI units was associated with a reduction of approximately −0.77 dB. The effect was distance-dependent, with the strongest attenuation observed at intermediate distances (301–400 m), where model-based projections suggested potential reductions of up to approximately 8.8 dB across the observed NDVI gradient. These findings support the integration of ecological variables into environmental noise assessment frameworks and suggest that vegetation restoration may represent a complementary nature-based mitigation strategy for wind farms in ecologically sensitive regions.

2.4.4 Road Traffic Noise Assessment and Modelling

Tue 09:00–10:00 — Riverbank Room 6 (Chair: Daljeet Singh, Claudio Guarnaccia)

09:00: Paper 523 — A Cellular Automata Model for Traffic Noise Prediction in Multiple Lanes Roads with Traffic Lights — *Prof Claudio Guarnaccia*

09:20: Paper 471 — Predicting Road Traffic Noise through a Hybrid SARIMA and Stochastic Microscopic Modelling Approach — *Prof Claudio Guarnaccia*

09:40: Paper 69 — Modernizing vehicle noise emissions for highway traffic noise prediction in the U.S. — *Dr Judith L. Rochat*

09:00 **Paper 523 — A Cellular Automata Model for Traffic Noise Prediction in Multiple Lanes Roads with Traffic Lights**

PhD Domenico Rossi, Mr. Gaspard Hamelin, MEng Aurora Mascolo, PhD Roberta Di Pace, PhD Stefano de Luca, PhD Jean-François Petiot, ***Prof Claudio Guarnaccia***

Traffic noise is a fundamental component of environmental acoustics, particularly in urban areas where complex road layouts and traffic lights significantly influence sound emissions. This paper presents a Cellular Automata (CA) model designed to simulate traffic flow and predict associated noise levels on multi-lane roads with or without traffic lights. The model represents the road as a discrete grid in which vehicles evolve according to transition rules that capture acceleration, deceleration, queue formation, and stop and go dynamics. By integrating traffic light cycles and lane changing behavior, the proposed CA framework reproduces realistic traffic states, ranging from free-flow to congested conditions.

Noise emission is estimated through the coupling between single vehicle states and a standard microscopic acoustic emission model. The CA simulation provides time-resolved traffic patterns that feed the noise model to produce noise levels in a given receiver. This approach allows the analysis of how traffic light timing and traffic parameters jointly affect noise levels.

The model's computational efficiency enables various simulations and scenario testing, offering a valuable tool for urban planners and environmental engineers. It can be used for optimizing traffic light coordination and lane management strategies, aiming at reducing traffic noise levels in urban and extra-urban corridors.

09:20 **Paper 471 — Predicting Road Traffic Noise through a Hybrid SARIMA and Stochastic Microscopic Modelling Approach**

MEng Aurora Mascolo, PhD Domenico Rossi, ***Prof Claudio Guarnaccia***

Road traffic noise is a primary environmental pollutant, yet predicting its impact during infrastructure design is challenging due to the lack of direct observations. This study presents a hybrid framework integrating SARIMA time-series forecasting with a stochastic microscopic noise model. By training on historical or comparable data, the model forecasts hourly traffic inputs, namely volumes and mean speeds, in periods lacking direct observations, to enable noise levels predictions.

Within the stochastic core, each vehicle is treated as a discrete moving source with its individual speed, which is assigned by randomly sampling from a proper speed distribution curve. Sound power levels are determined using the CNOSSOS-EU Noise Emission Model, propagated at the receiver and aggregated considering the traffic flow, to obtain equivalent sound levels on the observation period.

Validated using a motorway dataset, the hybrid approach achieved high predictive accuracy, assessed with common error metrics. Comparison with the macroscopic CNOSSOS-EU benchmark confirms that the hybrid framework better captures temporal fluctuations and acoustic variability rather than a macroscopic approach. This methodology provides a robust, computationally efficient tool that preserves the physical resolution of real-world traffic while capturing the acoustic variability and complex temporal dynamics inherent in individual vehicle behaviour.

09:40 **Paper 69 — Modernizing vehicle noise emissions for highway traffic noise prediction in the U.S.**

Dr Judith L. Rochat*, Herbert L. Singleton Jr, Dr Blaine M. Harker, Dr Micah M. Downing*

The Federal Highway Administration Traffic Noise Model and similar software use vehicle noise emissions data collected in the 1990s for noise predictions in the United States. Through the National Academies National Cooperative Highway

Research Program, data were collected in 2024 and 2025 to evaluate the current vehicle fleet in the U.S. for the purpose of updating models and examining vehicle types and characteristics. Wayside broadband and 1/3-octave band maximum sound levels and time histories were captured at multiple distances from the road and heights above the roadway plane for over 6800 vehicle pass-by events in five general regions across the U.S. In addition, an optimized phased-array/beamforming method was applied to identify vehicle subsource locations over a broad frequency range, including low frequency sources. During the measurements, meteorological, speed, and photographic/video data were captured. On-board sound intensity data were collected to quantify tire-pavement noise, and effective flow resistivity data were collected to help evaluate sound absorption of the ground adjacent to the roadway. Preliminary analysis highlights differences among types of automobiles and heavy trucks, examines vehicle characteristics such as propulsion type and exhaust position, and evaluates heavy truck noise subsources.

Tue 10:40–12:00 — Riverbank Room 6 (Chair: Daljeet Singh, Claudio Guarnaccia)

10:40: Paper 651 — A comparison of CoRTN and CNOSSOS-EU road traffic modelling methodologies in SoundPLAN — *Mr Scott Henley*

11:00: Paper 642 — Noise Perception Study of Electric Vehicles in the Indian Background Noise — *Prof Arpan Gupta*

11:20: Paper 736 — Environmental Noise Assessment of Electric Rickshaws: A Measurement-Based Investigation on a University Campus — *Dr. Daljeet Singh*

11:40: Paper 758 — Multi-stage road noise consents: Model-once, consent many — *Mr George Van Hout*

10:40 **Paper 651 — A comparison of CoRTN and CNOSSOS-EU road traffic modelling methodologies in SoundPLAN**

Mr Scott Henley, *Mr Nicholas Netterville*

While the UK-developed CoRTN (Calculation of Road Traffic Noise) modelling methodology is widely used around the globe to predict road traffic noise levels, the methodology dates back to 1975 and often requires several empirical corrections to account for local conditions. This is particularly notable in Australia, where consideration of local road traffic noise quality has resulted in numerous adjustment methods which vary from State to State.

This study compares acoustic models of a representative motorway corridor in southeast Queensland developed in SoundPLAN v8.2. The model is run using both CoRTN and CNOSSOS-EU modelling methodologies, with CoRTN assessed against Queensland Department of Transport and Main Roads LA10(18hr) criteria and CNOSSOS-EU assessed against NSW Road Noise Policy LAeq-based day and night criteria. The results of the modelling predictions are compared against each other, with a particular focus on the differences in noise abatement requirements.

11:00 **Paper 642 — Noise Perception Study of Electric Vehicles in the Indian Background Noise**

Prof Arpan Gupta, *Prof. Anoop Chawla, Prof. Sudipto Mukherjee*

In this research work, the sound measurements from different Indian two-wheelers – ICE and EV have been measured in an anechoic chamber. The tests are made on a dynamometer and in running condition (at constant speeds of 10 kmph and 20 kmph). The noise measurements are then used to recreate the acoustic environment in an anechoic chamber by superimposing vehicle noise with the environmental background noise. Perception of human subjects to different vehicle sounds was found in various backgrounds. It is found that in general, if the SPL difference is more than 10 dB, the sound is clearly audible. For difference less than 10 dB, it also depends on the frequency content of the sound. The perception also depends on the human subject. The current study is part of a work to evaluate the need for AVAS (acoustic vehicle alert system) in the Indian scenario for two-wheeler electric vehicles.

11:20 **Paper 736 — Environmental Noise Assessment of Electric Rickshaws: A Measurement-Based Investigation on a University Campus**

Dr. Daljeet Singh, *Mr. Vivek Jain, Mr. Mayank Kakkar, Prof. J.S. Saini, Dr. Vishal Gupta, Prof Claudio Guarnaccia*

Electric rickshaws (e-rickshaws) are increasingly deployed on Indian university campuses as a low-emission transport solution; however, their acoustic impact in otherwise quiet academic environments remains insufficiently quantified. This study presents an experimental investigation of e-rickshaw noise characteristics based on systematic field measurements conducted within an Indian academic campus. Noise data were collected at selected campus road segments and building-adjacent zones using a Class 1 sound level meter, following standardized pass-by and stationary measurement protocols. Measurements were performed under controlled operating conditions including constant-speed motion (10–30 km/h), with concurrent documentation of traffic flow and background noise levels. Acoustic descriptors including Leq(A), Lmax and one-third octave band spectra were analyzed to isolate dominant noise components. Results show that e-rickshaw pass-by noise levels typically range between 65-85 dB(A). Spectral analysis reveals pronounced tonal peaks associated with electric motor harmonics around 800 Hz. Although overall sound pressure levels are lower than those of conventional auto-rickshaws, repeated exposure and tonal characteristics contribute to increased auditory salience in low ambient noise environments such as academic and residential zones.

11:40 **Paper 758 — Multi-stage road noise consents: Model-once, consent many**

Mr George Van Hout

New Zealand's 'Roads of National Significance' (RoNS) have gone though route analysis and consenting though the last couple of years. Many of these roads, along with previous large road upgrade packages are consented or constructed in stages. This risks duplication of assessments at receptors and can lead of inconsistencies on the predicted noise levels and associated effects are considered. This paper outlines the Authors experience in a 'model once, report many' framework where the road alignment in its entirety is modelled and noise and vibration effects considered, but reported on over many reports when considering the staged approach to consent and/or construction. This paper presents the development of a one-model improving traceability across programme milestones. We then outline how this relates to the current planning process in New Zealand (Resource Management Act 1991) and new planning frameworks (Fast Track, RMA 1991 reforms, and National Policy Statements) in an acoustics context.

2.5.1 Underwater, Ship & Offshore Acoustics: General

Mon 14:00–15:20 — Riverbank Room 7 (Chair: Joseph Cuschieri, Richard Howell)

14:00: Paper 756 — Testing of high acoustic transmission loss ship bulkheads — *Mr Matthew Tripodi*

14:20: Paper 824 — Robust Time-Domain Wideband Beamforming Based on Compact Worst-Case Performance Optimization — *Miss Yuxi Deng*

14:40: Paper 93 — Aspect-Dependent Analysis of Ship-Radiated Noise from Shallow-Water Measurements — *Mr Wonjun Yang*

15:00: Paper 241 — Radiated-Noise Characteristics of a Controllable Pitch Propeller Ship at Different Speeds — *Mr Jeongwoo Lee*

14:00 **Paper 756 — Testing of high acoustic transmission loss ship bulkheads**

Mr Matthew Tripodi

Ship bulkheads perform several functions which often include physical separation of compartments, providing watertight boundaries, providing thermal and fire-rated boundaries as well as acoustic barriers. Additional engineering considerations when designing bulkheads are weight which may impact buoyancy and stability margins as well as space which may impact on usability and human factors.

In certain applications, a high acoustic transmission loss may be required between compartments. To achieve this, it is often required to improve the acoustic performance of bulkheads, decks, deckheads, traversing HVAC, doors and penetrations.

This paper details the development and testing of a high acoustic transmission ship bulkhead.

14:20 **Paper 824 — Robust Time-Domain Wideband Beamforming Based on Compact Worst-Case Performance Optimization**

Liamg An, ***Miss Yuxi Deng***

Conventional time-domain wideband beamforming is sensitive to steering vector mismatch,

and worst-case performance optimization is commonly adopted to enhance robustness. However, the conventional worst-case constraint usually yields an overly conservative bound, which limits the available degrees of freedom and degrades overall beamforming performance.

To address this issue, a robust time-domain wideband beamformer is proposed, in which the conventional worst-case constraint is compactly reformulated and integrated with the response variation element, while a sparse constraint is incorporated for sidelobe suppression.

By constructing a tighter upper bound on the response error, the proposed beamformer reduces the conservativeness of the robust constraint, improving interference suppression and mainlobe frequency-response consistency.

Simulation results show that, under steering vector mismatch, the proposed beamformer improves the output signal-to-interference-plus-noise ratio by 19.93 dB and 13.61 dB and reduces the average sidelobe level by 12.63 dB and 4.63 dB, compared with the Capon beamformer and the Chebyshev weighting-based beamformer, respectively.

14:40 **Paper 93 — Aspect-Dependent Analysis of Ship-Radiated Noise from Shallow-Water Measurements**

Mr Wonjun Yang*, Professor Dong-Gyun Han, Prof Jee Woong Choi*

Horizontal directivity of ship-radiated noise is an important source characteristic for underwater noise prediction and impact assessment. However, the horizontal directivity of ship noise at kilometer-scale ranges is not often emphasized in practical shallow-water observations. In this study, the horizontal directivity of R/V Onnuri is estimated using long-range measurements obtained during the Shallow-water Acoustic Variability Experiment 2015 (SAVEX15).

During the experiment, ship noise was recorded by two 16-element vertical line arrays in approximately 100 m water depth, south of Jeju Island, Korea. The ship transited along multiple tracks, providing observations over a wide range of bearings

and source–receiver distances of approximately 1–8 km. To enable comparison of ship noise levels across different bearings, received levels measured at various ranges were corrected using a representative transmission loss derived from measurements obtained at a fixed ship bearing with varying source–receiver range. Horizontal noise levels were then analyzed as a function of ship bearing to estimate source directivity.

The estimated horizontal directivity exhibits bearing-dependant patterns that remain observable across different source-receiver geometries and ranges, even at long ranges in shallow-water measurements. The observed directivity patterns and their implications will be discussed.

15:00 **Paper 241 — Radiated-Noise Characteristics of a Controllable Pitch Propeller Ship at Different Speeds**
Mr Jeongwoo Lee, *Prof Jee Woong Choi, Professor Dong-Gyun Han*

Controllable pitch propellers enable ship speed control by adjusting the propeller pitch angle while maintaining a shaft rotation direction and speed. Despite its distinct mechanical operating principle compared to conventional propeller systems, studies on the impact of controllable pitch propeller operation on underwater radiated noise remain limited. In this study, the acoustic characteristics of the R/V Onnuri, which is equipped with controllable pitch propeller, are analyzed using measurements obtained during the Shallow-water Acoustic Variability Experiment 2015 (SAVEX15). Acoustic data were recorded using two 16-element vertical line arrays spanning depths from approximately 25 to 81 m in the water column, deployed in waters of approximately 100 m, south of Jeju Island, Korea, as the ship transited along multiple tracks. The spectral characteristics of the radiated noise were analyzed using LOFAR and DEMON analyses, focusing on speed-dependent variations in propulsion-related spectral components. The analysis reveals that tonal components related to the crankshaft and propeller shaft rates remain largely invariant with ship speed under constant-RPM operation. This behavior contrasts with that of fixed-pitch propeller ships and reflects distinct acoustic characteristics arising from controllable pitch propeller operation. In this presentation, these results are discussed through comparison with the acoustic characteristics of fixed-pitch propeller ships.

Mon 16:00–17:40 — Riverbank Room 7 (Chair: Richard Howell, James Forrest)

16:00: Paper 158 — A Time-Frequency Reconstruction Network with FSMN and Learnable Sampling for Underwater Denoising — *Dr shilun Feng*

16:20: Paper 188 — Comparison of analytical and numerical results for acoustic scattering from a 2D rigid circular object — *Mr Avijit Majee*

16:40: Paper 49 — Running Aground: Feasibility, Observability, and the Field Reality of Passive Acoustic Monitoring in Nearshore MPAs — *Ms Andrea Hempshall*

17:00: Paper 31 — Construction of Dynamic Maps of Underwater Radiated Noise from ships in Inland Waterways Based on AIS Data and Acoustic Models — *Dr Zonglin Lei*

17:20: Paper 37 — Time evolution of radiated noise from RV Investigator and comparison with DNV Silent R standard — *Dr Cristina Tollefsen*

16:00 **Paper 158 — A Time-Frequency Reconstruction Network with FSMN and Learnable Sampling for Underwater Denoising**
Mr Shouao Gu, Mr Zitong Li, ***Dr shilun Feng****, Prof Jun Tang*

Uncontrolled anthropogenic noise in the ocean, particularly ship-radiated noise, poses a significant threat to marine ecosystems, necessitating precise extraction of ship acoustic signatures for source characterization and environmental monitoring. However, in practical ocean environments, recordings of target ship signals are inevitably contaminated by non-stationary ambient noise, which significantly hinders effective signal extraction. This paper proposes FocuS-MN, an end-to-end framework designed to enhance ship-radiated signals by suppressing interfering background noise through advanced sequence modeling.The architecture leverages bidirectional Feedforward Sequential Memory Networks (FSMN) to capture extended temporal contexts and stable ship-related features that are often masked by chaotic ambient noise. To optimize long-range sequence modeling, a learnable downsampling module facilitates the extraction of deep temporal semantics by the FSMN, followed by upsampling to restore the original time–frequency resolution. In addition, a Dilated DenseNet-based encoder is

employed to jointly encode magnitude and phase spectra. Experimental results on the Shipsear dataset show that FocuS-MN achieves a competitive SDR of 3.77 dB under a −5 dB SNR condition, demonstrating its capability in high-fidelity ship signal enhancement.

16:20 **Paper 188 — Comparison of analytical and numerical results for acoustic scattering from a 2D rigid circular object**

Mr Dinesh Chand Foujdar, ***Mr Avijit Majee****, Dr. Amrita Puri*

This paper presents a comparison of analytical and numerical studies of acoustic scattering of plane waves and circular waves by a rigid circular object. Starting from expression of plane waves in terms of circular harmonics, expression for coefficients of circular harmonics of scattered sound field are obtained by imposing the interface condition at the surface of rigid circular object. A similar analysis is carried out to obtain analytical solution of acoustic scattering for a point source (excitation source). Numerical results are obtained using COMSOL Multiphysics. The scattering patterns are explored in air and water at different frequencies. Results of analytical and numerical studies are presented in acoustic pressure field plots, sound pressure level (dB) plots and radiation plots. There is a close match between results obtained from analytical study and numerical study.

16:40 **Paper 49 — Running Aground: Feasibility, Observability, and the Field Reality of Passive Acoustic Monitoring in Nearshore MPAs**

Ms Andrea Hempshall

Passive acoustic monitoring (PAM) is increasingly included in baseline surveys to establish pre-project conditions and infer the state of the environment. Yet for Marine Protected Areas (MPAs) in tidal, shallow-water environments, the physical and operational realities that govern whether meaningful acoustic patterns are observable are rarely acknowledged. As a result, many PAM frameworks, especially those adapted from offshore contexts, assume operating conditions that nearshore environments do not provide. This paper identifies the regulatory, environmental, and methodological gaps to present a technical position for when PAM in nearshore MPAs becomes meaningful, and when it does not.

Drawing on Victorian measurements over summer and winter within Ricketts Point Marine Sanctuary, we examine approaches to characterise acoustic habitat loss and environmental state in shallow water and present what is readily interpretable with low-cost equipment, providing park managers and planners a pathway to apply PAM in coastal waters. We also explore the future directions required to translate SEL, LSR and other detection metrics into defensible EES findings for nearshore MPAs.

17:00 **Paper 31 — Construction of Dynamic Maps of Underwater Radiated Noise from ships in Inland Waterways Based on AIS Data and Acoustic Models**

Dr Zonglin Lei*, Professor Wenjie Li, Associate Professor Hongbo Du, Professor Yu Wan*

To assess the spatio-temporal distribution of underwater radiated noise (URN) from ships navigating inland waterways, this study proposes a method for constructing dynamic noise maps based on Automatic Identification System (AIS) data. First, obtain the 24-hour AIS data and water area boundaries of the study section, and rasterise the study water area. Based on source spectrum model of ships, combined with parameters such as speed and length provided by AIS, predict the source spectrum of ships. Furthermore, by integrating the sediment types of the study river section with acoustic propagation models, estimate transmission losses (TL) at different distances. AIS data is framed at one-minute intervals, with the sound pressure level (SPL) at each grid point calculated frame-by-frame for every ship. Employing the principle of energy superposition to fuse the noise contributions from multiple ships, a 24-hour dynamic noise distribution sequence is generated, enabling the dynamic visualisation of noise variations throughout the day. Ultimately, through the accumulation of acoustic fields from multiple ships, an all-directional equivalent continuous SPL noise map can be generated. This enables the spatiotemporal visualisation and quantitative assessment of underwater noise, providing both theoretical foundations and data support for the coordinated advancement of shipping development and ecological conservation.

17:20 **Paper 37 — Time evolution of radiated noise from RV Investigator and comparison with DNV Silent R standard**

Dr Cristina Tollefsen*, Philippe Vandenbossche*

Repeated measurements of underwater radiated noise (URN) from Australia's scientific research vessel RV Investigator were made on five separate occasions from 2015 to 2025. Measurement methodology was developed and refined over the multiple experiments to adhere as closely as practicable to the Det Norske Veritas (DNV) Silent R (research) noise standard. The intent of the measurements was to compare with the DNV Silent R standard as well as to detect any changes to the vessel's noise signature over the years. In the most recent version of the experiment, two internally recording OceanSonics hydrophones were mounted 165 mm apart on a metal frame which was deployed on the bottom of Storm Bay, Tasmania, in 35 m water depth. Ship passes were made on reciprocal headings at speeds of 8 kn and 11 kn in a variety of machinery states. Noise sources that were observed on some (but not all) measurements included: cavitation noise (2020), a suspected "singing" propeller (2023), and anomalous noise between 78 Hz and 185 Hz that was observed on only one of the two hydrophones (2024).

2.5.2 Underwater Marine System Noise Radiation and Control

Wed 10:40–12:00 — Riverbank Room 7 (Chair: Xia Pan, Ming Jin)

10:40: Paper 77 — A new finite acoustic duct model and comparison with experiment in water — *Dr Richard Howell*

11:00: Paper 109 — Reduced-frequency end-correction model for predicting the transfer impedance of underwater micro-perforated panels with large perforations — *Prof Kai Zhou*

11:20: Paper 175 — Active Control of Vibration and Sound Radiation at the Stern of Underwater Vehicles Induced by Propeller Excitation — *Ms Cong Zhang*

11:40: Paper 612 — Efficient Underwater Noise Prediction Using an H-Matrix Direct BEM Solver for Partially Submerged Vessels — *Mr Massimiliano Calloni*

10:40 **Paper 77 — A new finite acoustic duct model and comparison with experiment in water**

Dr Richard Howell, *Dr. Orddom Leav, Dr. Kostas Tsigklifis, Mr Karthik Modur, Dr Ian MacGillivray, Mr Jeffrey Seers, Mr Zach Drinkall, Dr Stephen Moore*

We present a computational and experimental study of a monopole source in an aluminium duct with two open ends submerged in water. Updates to our previously published method of images duct model are detailed along with a new transmission matrix model that captures solely the longitudinal modes of the duct. Predictions from these analytical models are compared with predictions from boundary element and finite element models, and experimental results from hydroacoustic experiments conducted in a large water tank. The numerical and experimental results demonstrate that the vibro-acoustic coupling of the duct wall with the fluid leads to a change in the effective speed sound of sound in the duct and consequently the resonant frequency of the system. Therefore, using a rigid duct approximation would lead to an over prediction in the effective speed of sound in the duct and, for the example presented in the paper, an over prediction in the relative gain in sound power from placing a monopole in the duct. The method of images and transmission matrix models are shown to accurately predict the relative gain in sound power for a rigid duct.

11:00 **Paper 109 — Reduced-frequency end-correction model for predicting the transfer impedance of underwater micro-perforated panels with large perforations**

Dr Jiayu Wang, Prof Xiang Yu, ***Prof Kai Zhou***

Micro-perforated panels (MPPs) are increasingly considered for underwater noise reduction. For practical underwater applications, fabrication constraints motivate the use of relatively large perforations combined with low porosity, which can reduce manufacturing complexity and cost. However, the applicability of existing resistive and reactive end-correction coefficients to underwater MPPs remains unvalidated, as these coefficients were primarily developed for air-filled conditions and sub-millimeter holes. In this work, the transfer impedance of underwater MPPs with circular, sharp-edged perforations is investigated using three-dimensional thermoviscous finite-element modelling. A parametric set of geometries is established to quantify the influence of perforation diameter and panel thickness on the resistive and reactive end-correction coefficients. The numerical results show systematic deviations from air-based predictions, with discrepancies increasing as the perforation diameter increases from 2 to 4 mm. To address this limitation, a reduced-frequency scaling framework is introduced with power-law dependencies on diameter and thickness. Using the reduced frequency and the corresponding scaled end-correction coefficients, results from all geometrical cases collapse onto unified master curves. Closed-form expressions fitted to these master curves accurately predict the transfer impedance of underwater MPPs over 100–500 Hz for perforation diameters of 2–4 mm, providing a practical tool for designing low-frequency MPP absorbers with large perforations.

11:20 **Paper 175 — Active Control of Vibration and Sound Radiation at the Stern of Underwater Vehicles Induced by Propeller Excitation**

Mr Yaqi Tian, ***Ms Cong Zhang****, Mr Lei Yang, Mr Xincong Zhou*

To address the vibration and noise radiation issues caused by propeller excitation at the stern of underwater vehicles, this study focuses on active control technology, aiming to explore its feasibility and implementation pathways from a dynamic perspective. For this purpose, dynamic models of the underwater hull and propulsion shaft system were established based

on Flügge shell theory and Euler-Bernoulli beam theory, respectively. A coupled dynamic model reflecting the shaft-hull coupling mechanism was constructed through the force balance relationship at the bearing locations. On this basis, an active control system for the stern of the underwater vehicle was developed by incorporating actuators. By systematically investigating the influence mechanisms of actuator configurations, error signal types, and control strategies on the control effectiveness of vibration and sound radiation under propeller excitation, this study provides foundations for designing efficient and stable active control solutions for the stern of underwater vehicles.

11:40 **Paper 612 — Efficient Underwater Noise Prediction Using an H-Matrix Direct BEM Solver for Partially Submerged Vessels**

Mr Massimiliano Calloni*, Mr. Kamel Amichi, Mr Chadwyck Musser, Mr Pinak Salvekar*

Underwater noise radiation is a critical factor in assessing the acoustic impact of marine vessels, particularly as regulatory and environmental pressures continue to increase. This work presents an efficient numerical approach for predicting the radiated acoustic field of a partially submerged vessel by employing an H-Matrix Direct Boundary Element Method solver. Unlike traditional BEM formulations, the H-Matrix accelerated solver significantly reduces both computational time and memory consumption. These performance gains enable the analysis of higher frequencies and larger models than previously achievable with the traditional solver,

The method retains the full accuracy of a direct BEM solution while leveraging hierarchical matrix compression to handle dense system matrices more efficiently.

The simulation setup includes a detailed representation of a vessel hull interacting with the surrounding fluid domain. A pressure release plane is incorporated to model the free surface boundary at the waterline. This configuration allows the solver to account for complex wave interactions, including reflections, scattering, and diffraction effects near the surface.

The results demonstrate the capability of the H-Matrix Direct BEM solver to deliver accurate underwater noise predictions with substantially improved performance, highlighting its suitability for design evaluation, compliance verification, and vibroacoustic optimization of next generation marine vessels.

2.5.3 Underwater Acoustic Propagation

Wed 08:40–10:00 — Riverbank Room 7 (Chair: Sichen Chang, Paul Donavan)

08:40: Paper 283 — Scaling Bellhop Acoustic Field Simulation Beyond RAM: A DiskCached Pipeline for Time-Reversal Underwater Field Visualisation — *Mr Chung T. C. Fang*

09:00: Paper 292 — Arctic Underwater Acoustic Denoising Using a Multi-α FrFT Feature Bank and Parallel-GRU Self-Attention — *Dr Dawoon Lee*

09:20: Paper 452 — Introducing aubellhop: a modern Python interface to the Bellhop underwater acoustics ray tracing tool — *A/Prof Will Robertson*

09:40: Paper 735 — Distributed Acoustic Sensing of the Ocean using Subsea Fibre-Optic Cables: Calibrating the System to Sound Pressure — *Dr Evgeny Sidenko*

08:40 **Paper 283 — Scaling Bellhop Acoustic Field Simulation Beyond RAM: A DiskCached Pipeline for Time-Reversal Underwater Field Visualisation**

Mr Chung T. C. Fang, *Prof Anthony Zander, Mr. Eyad Hassan, Dr. Stephen Franklin, A/Prof Will Robertson*

Time-reversal acoustic focusing requires evaluation of the underwater pressure field across a dense receiver grid from multiple emitters. Even with the ray-accumulation method previously demonstrated by the authors, the per-source ray-arrival datasets become too large to hold simultaneously in RAM as resolution and source counts grow. This paper extends that work with a disk-cached execution path that stores each source's arrival data as a depth-chunked Zarr compressed array on solid-state storage, then iterates depth-first through the receiver grid loading exactly one chunk per source per iteration. Combined with shared-memory worker parallelisation and the established no-impulse-response ray-accumulation method, peak memory consumption becomes proportional to the size of a single depth slice rather than the full simulation extent. End-to-end measurement on an eight-source validation configuration produced bit-equivalent field outputs from the in-memory and disk-cached paths, while reducing peak resident memory from 82.9 GB to 237 MB, a factor of approximately 350.

09:00 **Paper 292 — Arctic Underwater Acoustic Denoising Using a Multi-α FrFT Feature Bank and Parallel-GRU Self-Attention**

Dr Dawoon Lee, *Dr Ho Seuk Bae, Prof Wookeen Chung, Prof Wonki Kim*

The Arctic underwater acoustic environment is dominated by strong low-frequency noise from ice collisions and complex ambient sources, hindering extraction of signals of interest in active and passive measurements. Since this noise spans the full spectrum, isolating targets is challenging. We propose a denoising method that combines fractional Fourier transform (FrFT) feature expansion with a Parallel-GRU network augmented by self-attention. FrFT features provide time-frequency diversity, enabling robust characterization of noise beyond single time-series analysis. Using Arctic recordings, training datasets were synthesized by superimposing simulated target signals (CW and FM) onto background-noise-only segments. Experiments show effective noise suppression with signal preservation. Compared with the stacked-BiLSTM in prior work, which over-suppresses low frequencies, introduces artifacts, and is too slow for real-time applications, our method provides balanced, natural suppression across the band, delivers +2.86/4.10 dB SNR gains for CW/FM signals, and reduces processing latency by a factor of 2.57 while preserving waveform integrity.

09:20 **Paper 452 — Introducing aubellhop: a modern Python interface to the Bellhop underwater acoustics ray tracing tool**

A/Prof Will Robertson, *A/Prof Mandar Chitre, Mr Chung T. C. Fang, Prof Anthony Zander*

Bellhop is widely used for modelling underwater acoustic propagation using ray/beam-tracing. As part of The Acoustics Toolbox, Bellhop was written in Fortran by Michael B. Porter and colleagues, as part of a suite of open source underwater acoustics modelling tools, and others have reimplemented it in C++/CUDA for multithreaded operation. Interfaces to Bellhop have been developed for several languages, including Matlab, Python, and Julia, but these tools sometimes only provide access to a subset of Bellhop's features, and often assume that the Bellhop executable is already installed. This paper introduces a modern Python interface to Bellhop, which can be used both by users who wish to run Bellhop simulations,

or by developers who wish to adapt or extend the Bellhop codebase. As with the Julia interface, the Bellhop executable is included in the installation. Features of the package include: a comprehensive test suite with coverage reports against both Python and Fortran sources; detailed, online documentation of the Fortran and Python sources; automatic code quality checking as part of the repository workflows; and a series of tutorials demonstrating the main use cases of the simulation tools.

09:40 **Paper 735 — Distributed Acoustic Sensing of the Ocean using Subsea Fibre-Optic Cables: Calibrating the System to Sound Pressure**

Henry A. Debens, Denise McCorry, ***Dr Evgeny Sidenko****, Dr Alexander Gavrilov, Prof Christine Erbe, Robert McCauley*

Distributed acoustic sensing (DAS) implemented on subsea fibre optic communication cables offers a promising capability for large scale ocean monitoring. However, the sensitivity of DAS to underwater sound is poorly understood, and hence, the conversion of DAS signals to sound pressure remains challenging. We present a calibration study for an offshore DAS system using two independent acoustic sources: low-frequency signals from a distant earthquake and broadband underwater noise from a large commercial ship. Sound pressure levels were measured in situ with co-located calibrated underwater sound recorders. We demonstrate the workflow of how to express the DAS response as strain rate per unit sound pressure. The earthquake signal provided frequency dependent sensitivity estimates at a fixed arrival angle, while the ship signal allowed assessment of both frequency and angular dependence. Results show reduced DAS sensitivity below 8–10 Hz and a significant dependence on incidence angle relative to the cable axis, with minimum sensitivity near normal incidence—as expected. Sensitivity estimates derived from the ship signals were several decibels higher than those obtained from the earthquake signal. The cause of such discrepancy remains unresolved and will be discussed.

2.6.1 Flow-induced Noise & Vibrations: General

Tue 10:40–12:00 — Riverbank Room 7 (Chair: Carsten Spehr, Carl Howard)

10:40: Paper 33 — Vibro-acoustic performance of a centrifugal pump and variable frequency drive — *Prof Carl Howard*

11:00: Paper 3 — Effect of an alternate material inducer by rapid prototyping on noise characteristics of a centrifugal pump — *Mr Shinichiro Ejiri*

11:20: Paper 34 — Acoustic Measurements of Single-Hole, Multi-Hole, and Stacked Orifice Plates in Water-Filled Pipes — *Mr Lloyd Button*

11:40: Paper 95 — Study of Airframe Noise Using an 8%-Scale High-Lift Common Research Model — *Dr Takehisa Takaishi*

10:40 **Paper 33 — Vibro-acoustic performance of a centrifugal pump and variable frequency drive**

***Prof Carl Howard**, Mr Lloyd Button, Dr Stephen Moore, Dr. Oddom Leav, Dr James Forrest*

Experiments were undertaken with water flowing through DN100 steel pipes driven by a centrifugal water-pump and a 3-phase electric motor with variable frequency drive (VFD). The in-pipe sound pressure, acceleration on the casing of the motor and pump, electrical voltage and current from the mains supply and from the VFD to the motor, and air-borne sound pressure were sampled at 51,200 Hz, with the data analysed between 0 to 20,000 Hz. This paper identifies the characteristic vibration and acoustic tones produced by the pump, motor, and variable frequency drive. It was found that harmonic content of the current and voltage from the VFD propagated into the measured vibration, in-pipe and radiated sound pressure, with some tones occurring at a reduced frequency due to the electrical-to-mechanical slip that occurs in the motor.

11:00 **Paper 3 — Effect of an alternate material inducer by rapid prototyping on noise characteristics of a centrifugal pump**

Mr Shinichiro Ejiri

In product development in industry, rapid action is required. The utilization of additive manufacturing is one such means. This includes methods that intentionally reduce the safety factor for strength and then evaluate functionality using components made from low-cost materials. In this study, the focus is on an industrial centrifugal pump with an inducer. The fluid performance of a pump is determined by the geometry of components such as blades, however, discussions regarding differences in noise characteristics with different materials for these components are limited. The purpose of this study is to provide knowledge for appropriately reflecting experimental data obtained during low-cost rapid prototyping using additive manufacturing into the final product. A comparative experiment was conducted when attaching either a metal or a resin inducer to a pump. No significant difference confirmed in pump performance and internal flow, however, difference was confirmed in airborne noise. This is considered to be a change in mechanical noise and flow-induced noise caused by the material of one component differing from the original in the assembly. In conclusion, the low-cost rapid prototyping method can enough evaluate fluid performance, but they have limitations in performing detailed noise characterization, therefore it should be utilized with full understanding.

11:20 **Paper 34 — Acoustic Measurements of Single-Hole, Multi-Hole, and Stacked Orifice Plates in Water-Filled Pipes**

*Prof Carl Howard, **Mr Lloyd Button**, Dr Stephen Moore, Dr. Oddom Leav, Dr James Forrest*

Orifice plates are installed in piping systems to introduce a pressure drop across the device. This paper presents experimental measurements and comparisons of the acoustic response of single-hole, multi-hole, and stacked single-hole, and stacked multi-hole orifice plates installed between two instrumented water-filled DN100 pipe sections. The geometries of the orifice plates were selected to have equivalent open areas, to enable comparison of their performance parameters. The results presented include the (mean) pressure drop, in-pipe sound pressure levels, acoustic transmission loss, and the identification of the onset of cavitation. It was found that stacked multi-hole orifice plates generated less sound than stacked single-hole plates for the same open area and flow conditions. The predicted and measured pressure drop of the various orifice plate configurations had good agreement.

11:40 **Paper 95 — Study of Airframe Noise Using an 8%-Scale High-Lift Common Research Model**
***Dr Takehisa Takaishi**, Dr Mitsuhiro Murayama, Dr Yasushi Ito, Mr Masataka Kohzai, Dr Yo Murata, Dr Yuta Ozawa*

During aircraft landing approach, airframe noise accounts for a large proportion of overall aircraft noise, and its reduction has become an urgent societal issue. In this study, we report wind tunnel test results obtained using the High-Lift Common Research Model (CRM-HL) proposed by NASA and Boeing, focusing on the aerodynamic noise generated by its high-lift devices and main landing gear. A newly fabricated semi-span model at 8% scale of a generic passenger aircraft was installed in a closed-section wind tunnel. In addition to measuring aerodynamic data such as forces and surface pressures, acoustic measurements were conducted using a microphone array installed on the test section wall to investigate noise source locations and the underlying noise-generation mechanisms. The results show that strong noise sources were observed along the slats and their brackets, as well as at the outboard flap tip. When the main landing gear was deployed, noise sources were identified around the truck beam. Furthermore, Particle Image Velocimetry (PIV) measurements were conducted to clarify the complex flow structures responsible for aerodynamic noise generation.

Tue 14:00–15:40 — Riverbank Room 7 (Chair: Carl Howard, Carsten Spehr)

14:00: Paper 99 — Noise reduction of ducted contra-rotating rotor systems through duct mode manipulation — *Mr Zhiheng Zhao*

14:20: Paper 154 — Spatial Coherence of Flow-induced Noise for Multiple Compliant layers covered point hydrophone array — *Dr Dengfeng Wu*

14:40: Paper 487 — Effect of Grid-generated and Cylinder-wake Turbulence on the Surface Pressure Fluctuations of a Flat-Plate Leading edge — *Miss Sophia Nicole Rueda Pablo*

15:00: Paper 526 — Aerodynamic Performance Optimization and Noise Control of the Toroidal Impeller Based on the Box-Behnken Response Surface Method — *Mr Xianpeng Wu*

15:20: Paper 682 — Optimization of Noise Mitigation Performance of Metasurface Acoustic Liner Using Genetic Algorithm in Grazing Flow — *Prof Randolph Chi Kin Leung*

14:00 **Paper 99 — Noise reduction of ducted contra-rotating rotor systems through duct mode manipulation**
***Mr Zhiheng Zhao**, Dr. Cheng Yang*

Ducted contra-rotating rotor UAVs are compact propulsion systems with inherent noise-reduction potential. However, their acoustic benefits depend on rotor-rotor interaction noise and its modal propagation within the duct. Aerodynamically generated sound is radiated through discrete duct modes, whose circumferential orders govern acoustic attenuation via the duct cut-off effect. While the Tyler–Sofrin criterion predicts rotor–strut interaction modes, a framework for rotor–rotor interaction is still lacking. This study proposes a modified Tyler–Sofrin criterion to describe the modal scattering of rotor-rotor interaction noise. Based on spatiotemporal relative motion between rotors, the theory predicts circumferential mode orders using blade numbers, rotational speeds, and BPFs. The modal structure comprises a dominant component from blade-number combinations and a secondary scattering component governed by the speed ratio. Numerical simulations confirm the validity of the theory, as the extracted modal distributions align closely with analytical results. Building on this, a tonal noise reduction strategy is developed, in which rotor blade numbers and speed ratios are selected to shift dominant modes into rapidly attenuating higher-order duct modes. Experimental results demonstrate that modified configurations consistently reduce tonal noise across operating conditions while maintaining equivalent thrust and torque.

14:20 **Paper 154 — Spatial Coherence of Flow-induced Noise for Multiple Compliant layers covered point hydrophone array**
***Dr Dengfeng Wu**, Dr Mengsa Yu, Dr Qi Shen, Dr Zhengguo Bai*

In this paper, the hydrodynamic self-noise spatial coherence of flush-mounted point hydrophone array mounted on multilayer baffles is calculated. The analysis is based on the frequency-wavenumber method and transfer matrix method. The spatial filtering characteristics of array function and compliant layer transfer function are analyzed, and the influence of different parameters on the spatial coherence of noise of rectangular hydrophone array is discussed. The numerical results show that the spatial filtering effect of the array and the compliant layer can reduce the hydrodynamic self-noise and have little effect on the spatial coherence.

14:40 **Paper 487 — Effect of Grid-generated and Cylinder-wake Turbulence on the Surface Pressure Fluctuations of a Flat-Plate Leading edge**

Miss Sophia Nicole Rueda Pablo, *Prof Con Doolan, Dr Charitha de Silva, Dr Danielle Moreau*

Leading-edge noise is an important source of environmental noise pollution, commonly generated by wind turbines, engines, fans, rotors, and propellers. It is produced by the interaction of incoming turbulence with the leading edge of an aerodynamic surface. The unsteady surface pressure (USP) at the leading edge is a source term in far-field noise generation and thus is a key factor in understanding leading-edge noise. While studies of leading-edge noise exist for homogeneous and isotropic inflows, few studies have examined real-world inhomogeneous, anisotropic flows. Therefore, this study aims to investigate the surface pressure response of a flat-plate leading edge in flows with varying degrees of anisotropy. To this end, the remote microphone technique was used to measure the USP on a straight leading edge, conducted in the UNSW Anechoic Wind Tunnel. Two types of turbulent inflows were studied: the wake of a cylinder placed upstream of the edge and a grid-generated inflow intended to produce a nearly isotropic flow. With this experimental configuration, the unsteady surface pressure fluctuations at the leading edge were characterised to better understand the noise radiation process when an edge encounters different types of inflow turbulence.

15:00 **Paper 526 — Aerodynamic Performance Optimization and Noise Control of the Toroidal Impeller Based on the Box-Behnken Response Surface Method**

Mr Xianpeng Wu, *Dr Chenye Tian, Miss Bingyue Duan, Miss Dan Luo, Mr Ruixiang Kang, Prof Xiaomin Liu*

To improve the aerodynamic performance of the axial fan and reduce the noise, a new type of toroidal impeller is proposed in this study. The structural design method of the toroidal impeller is described and the key parameters are defined, including the circumferential angle and axial distance. Then the effects of the key parameters on the aerodynamic performance are studied by numerical simulations. 54 numerical cases are analyzed by using the Box-Behnken response surface method. Numerical results show that, the circumferential angle at mid-blade and the axial distance at top-blade significantly affect the wind velocity. Under appropriate parameter settings, the vortex near the toroidal impeller is suppressed and the turbulence kinetic energy near the leading and trailing edges of blades is also reduced. After using the optimal toroidal impeller, the delivery distance of the high-speed airflow (>240 m•min-1) is increased by 16% and the loss of wind velocity on the same distance is reduced by 48%. Finally, the experimental testing is conducted to verify the aerodynamic performance of the optimal toroidal impeller. Under the same impeller rotational speed, the maximum wind velocity is increased by 12% and the sound pressure level is reduced by 2.8 dB(A).

15:20 **Paper 682 — Optimization of Noise Mitigation Performance of Metasurface Acoustic Liner Using Genetic Algorithm in Grazing Flow**

Mr Adrian Wai Kit Lam, Mr Ali Abdullah, ***Prof Randolph Chi Kin Leung***

Optimization of the noise-mitigation performance of a metasurface acoustic liner (MSAL) comprising five cavity-backed elastic panel units arranged in tandem is performed for both no-flow and grazing-flow conditions. This is achieved by combining a genetic algorithm with an analytical model that accurately captures the aeroacoustic-structural responses of the MSAL, optimizing the cavity depth and panel tension of each unit. Both the no-flow-optimized and flow-optimized MSALs are capable of attaining a transmission loss (TL) exceeding 10 dB across the 1300 Hz frequency range from 200 Hz to 1500 Hz through coupled structural resonances, demonstrating the robustness and superior noise-mitigation performance of this structure even under grazing flow. Compared to the baseline configuration consisting of five identical uniform units, which yields average TL values of 14.5 dB (no flow) and 17.1 dB (with flow), the optimized MSAL achieves an average TL of approximately 20 dB under both conditions – representing an improvement of 17–38%. Notably, the no-flow-optimized MSAL suffers severe degradation when flow is introduced (even exhibiting negative TL values), underscoring the necessity of incorporating flow conditions into the optimization process. Importantly, the optimized liner length is compact, measuring just approximately 40% of the wavelength at the lowest targeted frequency.

2.6.3 Computation methods in Flow-induced Noise & Vibration

Mon 11:00–12:00 — Riverbank Room 4 (Chair: Sparsh Sharma, Cheolung Cheong)

11:00: Paper 151 — Assessment of CFD methods in predicting unsteady flows and flow-induced noise around a cylinder — *Dr Fei Zhu*

11:20: Paper 780 — Assessing weak compressibility effects in aeroacoustic simulations of small-scale drone rotors — *Mr Zhicheng Zhang*

11:40: Paper 814 — Blockage coefficient of complex shape objects in the viscous flow in a tube — *Dr Konstantinos Tsigklifis*

11:00 **Paper 151 — Assessment of CFD methods in predicting unsteady flows and flow-induced noise around a cylinder**

Dr Fei Zhu

The wake flow and aeroacoustic phenomena of circular cylinders, prevalent across various engineering disciplines, have been extensively investigated. This study examines the influence of different computational fluid dynamics (CFD) methods on unsteady flow fields and flow-induced noise for a cylinder at a Reynolds number of 10000, which is based on the free-stream velocity and the diameter of cylinder. The examined flow solvers include Large Eddy Simulation (LES), Reynolds-Averaged Navier-Stokes (RANS), Detached Eddy Simulation (DES), Delayed DES (DDES), and Improved Delayed DES (IDDES). Acoustic analysis is conducted using the Ffowcs Williams-Hawkings (FW-H) equation. Method validation was performed with LES as the benchmark, demonstrating good agreement with prior numerical and experimental results. Computational results reveal that SA(Spalart-Allmaras)-based DDES and IDDES methods underpredicted both flow fluctuation magnitudes and sound pressure levels, and the SA-based IDDES method underestimates the fluctuation intensity most significantly. Additionally, the wake recovery region for cylinders under these two methods exhibited prolonged length compared to other approaches. Replacing the SA turbulence model with the k-omega SST model effectively resolved these discrepancies.

11:20 **Paper 780 — Assessing weak compressibility effects in aeroacoustic simulations of small-scale drone rotors**

Mr Zhicheng Zhang, *Mr Yuqi Xiao, Dr Peng Zhou, Dr Bao Chen*

Aeroacoustic simulations of drone rotors have been widely used to understand noise-generation mechanisms and to guide low-noise design. Because of low tip Mach numbers, common approaches use incompressible Navier-Stokes solvers with impermeable Ffowcs Williams-Hawkings integrals to balance computational accuracy and efficiency. However, it cannot capture near-field sound wave propagation due to the underlying incompressible assumption. To address this gap, prior studies have proposed an acoustic-wave-preserved artificial compressibility method that shows great potential for improving noise predictions compared to conventional incompressible approaches. In this study, we assess the weak compressibility effects in rotor noise simulations by comparing the incompressible and the artificial-compressibility solvers. The emphasis is placed on examining noise sources and near-field flows when the weak compressibility is considered. We first validate our numerical setup with experiments, which shows good agreement in thrust and far-field noise. Then, we study the noise sources at different tip Mach numbers. The results reveal that steady loading noise dominates on the rotor disk plane, while unsteady loading noise dominates at the upstream and downstream directions. The two solvers predict comparable far-field noise when an impermeable integral surface is employed, while the artificial-compressibility solver performs better when a permeable surface is used.

11:40 **Paper 814 — Blockage coefficient of complex shape objects in the viscous flow in a tube**

Dr Konstantinos Tsigklifis, *Dr Gyani Sharma, Dr Ian MacGillivray, Dr Paul Dylejko, Professor Alexei Skvortsov*

This paper deals with the Poiseuille flow in an infinite cylindrical tube in the presence of a blocker. The properties of the blocker associated with its size, shape and length are defined by one aggregated parameter known as the blockage coefficient. This allows the use of the circuit theory, leading to simple analytical framework of the blockage effects in a complex networking system. Formulae for the blockage coefficient of simple shaped objects in the presence of potential flow in a cylindrical tube exist in the literature. In this work, we combine some of these formulae with the circuit and

boundary homogenisation theories to calculate the drag force of a complex axisymmetric finite length blocker in a tube, the total resistance and thus the flow rate in the tube. The drag force predicted by our analytical model compares favourably with computational fluid dynamic simulations for a range of cylindrical blocker shapes and its length in the tube. The proposed approach was demonstrated by a test case scenario – the vibration of a complex-shape blocking body in a turbulent flow in circular tube.

2.7.1 Noise & Impacts on biodiversity: General

Mon 09:00–09:40 — City Room 2 (Chair: Cristina Tollefsen)

09:00: Paper 535 — Grey-Headed Flying Fox (GHFF) – Assessing Noise Impacts to and from GHFF Colonies — *Mr Desmond Raymond*

09:20: Paper 610 — From science to policy: Preventing the harmful effects of anthropogenic noise on biodiversity — *Prof Dick Botteldooren*

09:00 **Paper 535 — Grey-Headed Flying Fox (GHFF) – Assessing Noise Impacts to and from GHFF Colonies**

Mr Desmond Raymond, *Mr Camilo Castillo*

This paper is presented as a case study into the noise impact into a Grey-Headed Flying Fox (GHFF) colony from a proposed childcare centre facility and the centre construction activities. The noise investigation also looks into the noise impact from the GHFF colony into the outdoor play area of the centre.

09:20 **Paper 610 — From science to policy: Preventing the harmful effects of anthropogenic noise on biodiversity**

Prof Dick Botteldooren, *Prof. Dr. ir. Timothy Van Renterghem, Prof. Dr. Micheal Wood, Prof. Dr. Camila Palhares Teixeira, Dr. Vinícius Donisete Lima Rodrigues Goulart, Ms. Catherine Barnett, Prof. Dr. Hendrik Schoukens, Prof. Dr. Geert Van Hoorick*

PLAN-B, a Horizon Europe project, recently released a policy brief that provides strategic guidance for the European Union on addressing noise pollution by explicitly recognizing its adverse effects on biodiversity and promoting science-based regulation. The policy brief argues that noise policy should move beyond its traditional anthropocentric focus and that noise action plans should prioritise measures benefiting both biodiversity and human wellbeing. To this end, it calls for innovation in environmental impact assessment methodologies and the adoption of a One Health perspective on soundscapes.

This paper elaborates on the scientific evidence and reasoning underpinning the policy brief. It (1) reviews current knowledge on the impacts of anthropogenic noise on species, habitats, and ecosystems; (2) discusses the development of biodiversity-relevant noise assessment approaches that extend beyond conventional relevant noise assessment approaches that extend beyond conventional human metrics; (3) explores opportunities and limitations within the existing EU regulatory framework; and (4) evaluates mitigation measures from both biodiversity and human wellbeing perspectives. The paper concludes by identifying key knowledge gaps and outlining priorities for further research and tool development needed to support the effective integration of biodiversity considerations into noise policy.

2.7.4 Ecoacoustics and Analysis of Soundscape

Tue 11:00–12:00 — City Room 1 (Chair: Jesse Budel)

11:00: Paper 401 — Assessing the Relationship Between Weather Conditions and Acoustic Activity of Insects and Fauna Using Noise Monitoring — *Ms Lizeth Valderrama*

11:20: Paper 590 — Automated detection and classification of mysticete (baleen whale) sounds in Australian marine soundscapes — *Prof Christine Erbe*

11:40: Paper 703 — Pygmy blue whale tracks in north-western Australia based on a passive acoustic tracking array during their northern migration. — *Prof Robert Mccauley*

11:00 **Paper 401 — Assessing the Relationship Between Weather Conditions and Acoustic Activity of Insects and Fauna Using Noise Monitoring**

Ms Lizeth Valderrama

This paper investigates the relationship between weather conditions and environmental noise generated by fauna and insects at a site in Queensland, Australia, characterised by dense vegetation and proximity to a significant water source. Twelve months of continuous environmental noise monitoring (April 2025 to March 2026) were analysed to examine how temperature, humidity, rainfall and wind are associated with diel and seasonal acoustic activity across species. Audio recordings were processed with an Artificial Intelligence (AI) based tool programmed for audio recognition to identify vertebrate fauna and insect callers; detections were aggregated by hour and month alongside meteorological variables and noise descriptors. Spearman correlations were computed at hour of day resolution per month and pooled annually across all twelve months. Nineteen vertebrate and insect taxa were detected, and three independent acoustic guilds were identified: a temperature-driven daytime cicada chorus, a wind- and rain-tolerant bird dawn chorus, and a humidity-loving nocturnal owl and frog signal. Anthropogenic noise was negligible. The study demonstrates the value of long-term passive acoustic monitoring combined with the AI audio recognition tool for characterising species activity and environmental noise patterns in ecologically sensitive environments

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11:20 **Paper 590 — Automated detection and classification of mysticete (baleen whale) sounds in Australian marine soundscapes**

Prof Christine Erbe*, Mr Lachlan Gill, Prof Robert D. McCauley, Dr Alexander Gavrilov, Dr Evgeny Sidenko, Dr Paul Nguyen Hong Duc, Dr Shyam Madhusudhana*

Offshore development (e.g., for blue economy) in Australia requires environmental impact assessments (EIAs). EIAs inform environmental plans (EPs), which minimise and mitigate potential impacts, so that industrial development may proceed in a sustainable way. EIAs typically involve at least one year of passive acoustic monitoring (PAM) to characterise the baseline soundscape and ambient noise, and to identify the presence of marine fauna and their functional behaviours. Within the development area, a handful or more sites are typically monitored. PAM analysis occurs under great time pressure, as results are needed for the writing of EPs. To aid PAM analysis, and specifically, to quantify fauna presence and behaviour, we have developed a suite of algorithms as part of our publicly available software CHORUS. While AI is the buzz word of the season, Australian mysticetes make stereotypical sounds which can reliably be detected and classified with simple and fast algorithms. We present codes to find Antarctic and pygmy blue whales, southern and pygmy right whales, Antarctic and dwarf minke whales, fin whales, Omura's whales, and others.

11:40 **Paper 703 — Pygmy blue whale tracks in north-western Australia based on a passive acoustic tracking array during their northern migration.**

Prof Robert Mccauley*, Prof Christine Erbe, Curt Jenner, Micheline Nicole Jenner, Ciara Browne, Dr Alexander Gavrilov, Dr. Michele Thums*

The south east Indian Ocean pygmy blue whale pass along the Western Australian coast northbound during the Austral autumn and winter, head to Indonesian and Timor Leste waters, spend several months in the Banda Sea then return south over September to January. The proportion of SEIOPB which do not follow the WA coast but head directly from northern waters to the central, southern Indian Ocean or vice-versa is not known. Here we present SEIOPB acoustic detections and

tracks from a grid of passive acoustic recorders set 60 km west of the Australian continental shelf edge during a northward migration. The grid showed for animals with defined track headings, 57% were heading NE towards the western side of Timor Leste as expected while 43% were heading in the opposite SW direction. Many animals arrived from a south or south west direction suggesting cohorts arriving from the Australian continental shelf edge and the central Indian Ocean. The prevalence of animals heading SW was believed as male singers travelling along a migratory heading minimise probability of interacting with different females, whereas backtracking maximises this. A knowledge of singer heading and proportions is crucial for estimating SEIOPB abundance using any survey technique.

Stream 3: Material, Architectural & Environmental Applications

3.1.1 Urban Acoustics and Outdoor Sound Propagation: General

Tue 14:00–15:20 — Riverbank Room 3 (Chair: Timothy Van Renterghem, Stephen Lyons)

14:00: Paper 25 — Sound Level Differences: ISO 9613-2: 2024 vs. ISO 9613-2: 1996 — *Mr Scott Noel*

14:20: Paper 192 — Changes introduced in ISO 9613-2:2024 — *Mr Simon Shilton*

14:40: Paper 94 — Shielding road traffic noise with a vegetation belt — *Dr Luc Goubert*

15:00: Paper 84 — Reconstruction of Outdoor Acoustic Fields — *Mr Rafael Castro Mota*

14:00 **Paper 25 — Sound Level Differences: ISO 9613-2: 2024 vs. ISO 9613-2: 1996**

Mr Scott Noel

Significant changes were made in 2024 to the International Organization for Standardization (ISO) 9613-2 Acoustics — Attenuation of sound during propagation outdoors — Part 2, commonly known as ISO 9613-2. The last update to the standard was in 1996 and since it has been used widely across multiple sectors such as energy production, industrial uses, water infrastructure, and entertainment. This paper and presentation provide examples of how the changes in the standard can result in different sound levels at noise sensitive receptors and discusses how this may influence environmental permitting and mitigation strategies for several different projects across multiple industries.

14:20 **Paper 192 — Changes introduced in ISO 9613-2:2024**

Mr Simon Shilton*, Dr Wolfgang Probst*

Published in 2024 the second version of International Standard ISO 9613-2 revised and replaced the first version from 1996, and introduced fifteen main changes compared to the first version from 1996. The changes to the methodology have been introduced to either address known issues with the original methodology, or to support the widened scope to include higher sources, such as wind turbines. The most significant changes had previously been published as additional recommendations within ISO/TR 17534-3:2015 to enable consistent implementation within noise calculation software, and self-certification of compliance with 19 test cases. These additional recommendations, plus informative annexes on meteorological corrections and calculation of sound from wind turbines, have been incorporated into the revision of ISO 9613-2, published in 2024. In particular, changes related to the treatment of barriers and ground effects can lead to changes in the calculated noise levels between the 1996 and 2024 versions of the standard. This presentation will summarise the main changes between the two versions of ISO 9613-2, illustrating the difference in results and highlighting where possible the reason for the change.

14:40 **Paper 94 — Shielding road traffic noise with a vegetation belt**

Dr Luc Goubert

Road traffic noise is already decades considered a widespread form of noise pollution significantly contributing to the overall noise nuisance. Noise abatement measures (noise screens, low noise pavements…) generally require major investments and maintenance, that's why a belt of vegetation (trees and shrubs) may seem an attractive alternative, as it comes with numerous other advantages, such as shadowing, cooling, CO2 capture, biodiversity, aesthetics etc. The effect of vegetation on the propagation of noise started in the 1940ties and numerous studies has been published since, not always correct nor consistent. This contribution comprises a review of the relevant studies. Belts of 11 up to 25 m wide with deciduous plants are reported to reduce traffic noise with 1.7 up to 5.6 dB, whereas simulations of the effect of a 15 m wide belt yield an insertion loss of 3.6 up to 3.9 dB. The second part of this paper deals with a recent, own measurement campaign. The insertion loss of vegetation belts along secondary roads in Belgium was determined with pass-by measurements. The scattering effect of leaves and twigs of high frequency noise (> 2 kHz) is clearly demonstrated, but also the ground (absorption) effect quite efficiently abating low frequency noise.

15:00 **Paper 84 — Reconstruction of Outdoor Acoustic Fields**

***Mr Rafael Castro Mota**, Mr Ramesh Subramanyam, Mr Christian Van Aswegen, Dr Stefan Jacob*

The reconstruction of outdoor acoustic fields from discrete experimental samples has many applications in outdoor acoustics. The accuracy is, however, limited by the inclusion of atmospheric conditions in the employed model and uncertainty in the input parameters. Normal-mode solutions have been regularly used for acoustic field reconstruction in underwater acoustics and can serve an analogous objective in outdoor acoustics. Furthermore, normal-mode solutions can be efficiently computed with the SAFE method for a wide range of atmospheric conditions. In this article, we conduct a numerical outlook on reconstruction of outdoor acoustic field under downward-refracting atmospheric conditions. As such, a normal-mode basis computed with the SAFE is matched to samples probed in two vertical lines, Additionally, we study the sensitivity of the near-ground results to uncertainties in two input parameters: sample positions and the wind vertical profile. We concluded that, although the overall trend of transmission with range was preserved in the two studies, the results were significantly more sensitive to the use of erroneous wind profiles, making it important to adequately characterize them.

Tue 16:00–18:00 — Riverbank Room 3 (Chair: Timothy Van Renterghem, Stephen Lyons)

16:00: Paper 257 — Low-frequency noise emissions from a large open-pit mine operation: insights from long-term field monitoring — *Dr Binghui Li*

16:20: Paper 270 — Assessment Criteria for Concert Noise Events — *Mr Abeer Ahmed*

16:40: Paper 294 — National coverage road traffic noise mapping with CNOSSOS-EU — *Mr Simon Shilton*

17:00: Paper 459 — Quantifying the Silence: A National Strategic Transport Noise Map and its Implications for Public Health and Property Economics in Australia — *Mr Ben Hinze*

17:20: Paper 521 — Experimental Study on Outdoor Sound Absorption Devices in Subtropical Countries — *Miss Yi Hsing Chang*

17:40: Paper 798 — Change of the waveform of impulsive sound due to air absorption — *Dr Till Kuehner*

16:00 **Paper 257 — Low-frequency noise emissions from a large open-pit mine operation: insights from long-term field monitoring**

***Dr Binghui Li**, Mr Heath Sturgess*

Low frequency noise (LFN) from large-scale mining operations is an increasing source of community concern, particularly where continuous operations occur near rural townships. In Western Australia, the absence of dedicated regulatory criteria for LFN presents challenges in objectively assessing impacts and attributing sources. This paper presents the findings of a field investigation into LFN emissions from a major open-pit lithium mining and processing operation in Western Australia. Long-term continuous noise monitoring was conducted at three locations: a near-field monitor to characterise source emissions, and two far-field monitors (external and internal) at a rural residence approximately 10 km from the site. One-third octave band sound pressure levels from 10 Hz to 160 Hz were analysed and assessed using international best-practice methods, including low-frequency dominance screening based on LCeq–LAeq differences and comparison against established LFN threshold curves. Results show persistent low-frequency components, with dominant spectral contributions typically between 50 Hz and 125 Hz. Far-field measurements exhibited periods of low-frequency dominance and repeated outdoor threshold exceedances, with fewer exceedances observed indoors. Clear temporal and spectral correlations were identified between near-field and far-field measurements.

16:20 **Paper 270 — Assessment Criteria for Concert Noise Events**

***Mr Abeer Ahmed**, Dr Neil Mackenzie, Mr Moharis Kamis*

Recent expansion of stadia within dense urban surrounds in Australia have led to enlivened city environs and prosperous commercial outcomes for hospitality traders, with however potential adverse noise effects on residents and sensitive use in close proximity. This has led to the development of criteria specific to noise emissions from sports and music events. This paper will review recent developments, specifically with regard to the Hobart Stadium development at Macquarie Point, located near hotels, apartments and uniquely the Tasmanian Symphony Orchestra's concert hall and practice facilities.

16:40 **Paper 294 — National coverage road traffic noise mapping with CNOSSOS-EU**
***Mr Simon Shilton**, Mr James Trow, Ms Hilary Notley*

The United Kingdom Department for Environment, Food and Rural Affairs (Defra) commissioned the design and build of an environmental noise modelling system (NMS). The NMS has been developed to support Defra in preparing its environmental noise evidence base by preparing national road and railway noise models. This paper provides an overview of the process undertaken to develop and implement national coverage road traffic noise modelling using CNOSSOS-EU in England. This includes input data sourcing, sensitivity testing of the road source emission models, developing localised input data for road traffic flows, road surfaces & road junctions; development of propagation model datasets; calculation settings for propagation modelling; and analysis and reporting of results.

17:00 **Paper 459 — Quantifying the Silence: A National Strategic Transport Noise Map and its Implications for Public Health and Property Economics in Australia**
Mr Ben Hinze

Until recently, Australia lacked a comprehensive dataset to quantify transport noise exposure, limiting epidemiological research, property valuation analysis, development costing, and strategic planning. Ambient Maps, in collaboration with Virid AU has developed Australia's first national strategic transport noise map. The model incorporates terrain, buildings, barriers, validated against measurements. It assesses all roads, all rail corridors, and all trackable aircraft movements, calculating road, rail, and aircraft noise for day, evening, and night across all façades and storeys of >15 million buildings nationwide.

Victoria was selected as a case study to examine health and property value impacts. Health analysis indicates that 48% of the population is exposed to road traffic noise above the 2018 WHO guidelines, with 10%/11% above WHO aircraft/rail noise recommendations respectively; levels comparable to highly affected European jurisdictions.

A semi-WHO compliant health burden assessment suggests that transport noise may contribute approximately 130,000–135,000 DALYs per annum in Australia, indicating a material but under-recognised environmental health burden. Property analysis with REA Group's PropTrack shows that a 10 dB(A) increase in noise is associated with property value reductions of up to 6% for road noise, 4% for rail, and up to 9% for aircraft noise, consistent with previous Australian studies.

17:20 **Paper 521 — Experimental Study on Outdoor Sound Absorption Devices in Subtropical Countries**
***Miss Yi Hsing Chang**, Miss PIN CHIEH CHEN, Miss Ching-Ya Tseng, Mr. Yen-Chieh Yu, Prof. Yaw-Shyan Tsay*

In high-density urban areas, elevated roadways significantly increase traffic noise and reduce the quality of life in surrounding communities. Installing outdoor sound-absorbing devices beneath elevated roads has therefore become an important noise mitigation strategy. However, in subtropical climates characterized by high temperature, humidity, and frequent rainfall, material selection and structural design must ensure long-term durability and stable acoustic performance.

This study proposes an outdoor sound-absorbing device using expanded metal mesh as the outer casing and foamed cement containing recycled glass as the absorbing material. Acoustic performance was evaluated according to ISO 354 under different structural configurations. Results show that incorporating an internal air cavity increases the effective absorbing area and significantly enhances performance. Compared with designs without an air cavity, the sound absorption coefficient increased by approximately 1.5 times, with improvements up to 1.8 times at mid-to-high frequencies. In addition, lateral sealing conditions strongly influence performance. Fully sealing the sides with wooden boards reduces effectiveness to a level similar to that of cavity-free designs, whereas permeable expanded metal mesh maintains high absorption efficiency. The findings of this research will be applied to the development of new acoustic products in the future work.

17:40 **Paper 798 — Change of the waveform of impulsive sound due to air absorption**
Dr Till Kuehner

At the moment of generation, impulsive sound signals exhibit characteristic waveform shapes with a steep rise to a peak sound pressure followed by a rapid decay. While this initial waveform is similar for different sources, such as mechanical

impacts or explosive events, it exists only briefly at the source.

During propagation, the waveform is modified by several effects. Geometrical spreading reduces the overall amplitude without altering the waveform, whereas air absorption introduces frequency-dependent attenuation, leading to a progressive smoothing of the signal. High-frequency components are increasingly attenuated, resulting in a reduced steepness of the leading edge.

In this study, the effect of air absorption is modelled using causal transfer functions derived from ISO 9613-1. Since the standard provides only magnitude information, a Padé approximation is used to construct a rational transfer function with consistent phase behaviour.

The results show that air absorption significantly modifies the waveform of impulsive sounds, particularly the leading edge and the peak value. The peak sound pressure level decreases more rapidly with distance than the sound exposure level, with differences of several decibels.

3.1.2 Urban Sound Propagation

Tue 09:00–10:20 — City Room 1 (Chair: Timothy Van Renterghem, Marc Buret)

09:00: Paper 97 — Propagation of mobile noise measurements from in-road to façade levels — *Mr Ruikang Zhang*

09:20: Paper 148 — Predicting complex noise propagation behind buildings from elevated sources: model establishment and applicability examination — *Mr Qiyuan Wang*

09:40: Paper 561 — Before and after the greening: in-situ measurements of sound propagation in an urban street. — *Prof Timothy Van Renterghem*

10:00: Paper 622 — Using point cloud data to approximate building heights for large-scale urban noise modelling — *Mr Brandan Cotton*

09:00 **Paper 97 — Propagation of mobile noise measurements from in-road to façade levels**

***Mr Ruikang Zhang**, Dr Andreu Balastegui, Dr Teresa Pàmies, Dr Guillermo Quintero*

Mobile measurement systems can be used to collect urban noise data efficiently for noise mapping. These measurements correspond to noise levels at a position in the road and around 1.5 m height, R , however, noise maps, according to the European Directive 2002/49/EC, need to plot the noise levels at the façade and at 4 m height, R . The present study estimates the transfer function between these two points, as ΔL = R - R , for different street configurations, as a function of the height of the buildings and the width of the street. Results of ray tracing simulations following the CNOSSOS-EU model are also compared with experimental data in order to test the validity of the estimation fits.

09:20 **Paper 148 — Predicting complex noise propagation behind buildings from elevated sources: model establishment and applicability examination**

***Mr Qiyuan Wang**, Prof. Ken Anai, Prof. Hiroo Yano, Prof. Shinichi Sakamoto*

The assessment of environmental noise in urban areas is challenged by the issue of effectively modelling complex noise propagation among buildings. As one of the solutions, the ASJ RTN-Model 2023 includes an effective calculation model for predicting road traffic noise propagation behind buildings from geometric parameters without heavy computational burden. However, it only applies to noise sources at ground level with the frequency characteristic of road traffic noise. In this work, we report the attempts to extend the application range of this prediction model to support various configurations of the noise source. Specifically, an adjusted model is developed that applies to elevated noise sources. The adjusted model does not significantly change the structure of the original method while only re-determines the parameters within. The performances of the adjusted model are examined under the various building conditions based on a series of scale model experiments.

09:40 **Paper 561 — Before and after the greening: in-situ measurements of sound propagation in an urban street.**

***Prof Timothy Van Renterghem**, Dr Pieter Thomas*

Narrow urban streets are known to strongly amplify street sounds, resulting in limited sound pressure level decay along the street axis and elevated reverberation times. This study investigates the impact of street greening on the sound field, implemented through the partial removal of paving near building façades to allow plant growth and the introduction of reinforced grass strips. In situ real-life acoustic measurements were conducted before and after the greening intervention, enabling direct comparison. Test signals with sufficient signal-to-noise ratio were emitted by a loudspeaker and recorded at multiple positions along the street. At the 1 and 2 kHz octave bands, the greening intervention provided an additional noise reduction of 2-3 dB over an additional propagation distance of 50 m, whereas no measurable effect was observed below 500 Hz or above 4 kHz. Reverberation times were reduced by approximately 0.2-0.3 s. These observations can be reasonably explained by the absorption characteristics of moist topsoil. Even for the relatively easy-to-implement street greening scenario investigated here, a clear and positive impact on the street acoustics is demonstrated.

10:00 **Paper 622 — Using point cloud data to approximate building heights for large-scale urban noise modelling**

***Mr Brandan Cotton**, Mr Simon Moore*

Determining suitable approximations for buildings with complex geometries can be a time-consuming process when developing environmental noise models. For large projects in urban or industrial areas, manually reviewing hundreds (or thousands) of buildings is often impractical. A method is presented that allows for partially automating the estimation of building heights using lidar-derived point cloud data, which is often freely available. The study investigates various statistical descriptors for a flat-roof height approximation to characterise a generic building with complex geometry, such as a pitched-roof building. The method is evaluated using SoundPLANnoise software and common noise modelling standards.

3.1.6 Advances in Noise Mapping

Tue 14:00–15:00 — Riverbank Room 6 (Chair: Ben Hinze, Gaetano Licitra)

14:00: Paper 117 — Optimisation of the Number of Vehicles and Trajectory Distribution Using Traffic Simulations for Mobile Noise Mapping Campaigns — *Mr Franck Vásquez*

14:20: Paper 474 — Automatic identification and quantification of non-traffic sound sources for mobile noise measurements — *Dr Guillermo Quintero Perez*

14:40: Paper 661 — A Multidisciplinary Approach to Developing a Web-Based Noise Prediction Tool — *Mr Lance Jenkin*

14:00 **Paper 117 — Optimisation of the Number of Vehicles and Trajectory Distribution Using Traffic Simulations for Mobile Noise Mapping Campaigns**

Mr Franck Vásquez, *Dr Andreu Balastegui, Dr Teresa Pàmies, Dr Guillermo Quintero Perez*

Mobile noise monitoring using delivery vehicles is a cost-effective, scalable alternative to traditional fixed sensor networks for urban noise assessment. This study presents traffic simulations in which mobile measurement modules are deployed on delivery vehicles to collect environmental noise data across the urban street network, with the objective of identifying which delivery service provides the most effective contribution to noise sampling coverage within the city. Different delivery models, including postal services, large-scale logistics, and on-demand platforms, are evaluated.

The simulation output provides insight into the spatio-temporal coverage of mobile measurements, i.e., the total measured time in each street segment within the city. The resulting statistical distribution of accumulated measurement times is used to estimate the minimum fleet size required to produce accurate annual noise levels to plot a city noise map.

14:20 **Paper 474 — Automatic identification and quantification of non-traffic sound sources for mobile noise measurements**

Dr Guillermo Quintero Perez, *Dr Andreu Balastegui, Erick Gutierrez Zeferino*

Mobile noise mapping strategies frequently rely on low-cost sensors that primarily output one-third octave band spectra. However, the accurate characterization of acoustic environments requires distinguishing between dominant background noise and specific local events. Automatic identification of non-traffic sources is therefore essential for filtering anomalous events to reduce measurement uncertainty and enrich the semantic analysis of urban soundscapes. While robust pre-trained models are capable of classifying a vast array of urban sound sources, such extensive taxonomies are computationally inefficient and overly complex for the limited data format of low-cost sensors. Consequently, this paper focuses on identifying a reduced, context-specific subset of the most prevalent non-traffic sound sources. By evaluating pre-trained models on audio recordings from field measurements and web-based repositories, this study seeks to determine a minimal set of classes that could later be compatible with simplified spectral descriptors. It is anticipated that this optimization will provide a dual advantage: enhancing classification success rates by focusing on relevant sources, and considerably reducing the complexity of the recognition algorithm. This establishes a pathway for the future implementation of real-time recognition systems based on spectral descriptors within low-cost devices.

14:40 **Paper 661 — A Multidisciplinary Approach to Developing a Web-Based Noise Prediction Tool**

Mr Lance Jenkin

The prediction of construction noise levels is often divided between two extremes: simple spreadsheets prone to user error, and complex proprietary software requiring specialist expertise. Recently, web-based interfaces have become popular for projects requiring instant predictions requiring more accuracy than a spreadsheet. A significant drawback of these current web-based solutions is the extensive lead time required between data submission and tool deployment. This paper describes the development of a web-based tool designed to provide non-specialists to generate noise predictions quickly. The development process was guided by three core disciplines: software engineering, computer science, and acoustics.

By applying software engineering principles such as modularity and clear separation of concerns, the tool ensures robust testability and maintainability. From a computer science perspective, the calculation and path finding engine was optimised for the web environment. Computationally expensive operations, such as reflections, were omitted to maintain a real-time

interactive user experience. These technical trade-offs were balanced against acoustic rigor to ensure that the resulting tool provided ”reasonable accuracy” for rapid impact assessments.

The deployment of the tool shows that by calculating only the most significant attenuation factors and using suitable geospatial algorithms it is possible to create an accessible, real-time noise prediction interface.

3.2.1 Building Acoustics: General

Mon 09:00–10:00 — City Room 3 (Chair: Andrew Hall, Jeffrey Mahn)

09:00: Paper 160 — Atlantic Science Enterprise Centre (ASEC), Moncton Canada (Case Study) — *Ms Amanda Robinson*

09:20: Paper 184 — Numerical and experimental study on low-frequency sound reduction using a pipe array absorber in a small room — *Mr Tetsushi Suzuki*

09:40: Paper 250 — Evaluation of the impact changes to dimensions and mounting options have on the acoustic performance baffle arrays. — *Mr Robert Jones*

09:00 **Paper 160 — Atlantic Science Enterprise Centre (ASEC), Moncton Canada (Case Study)**
Ms Amanda Robinson

ATLANTIC SCIENCE ENTERPRISE CENTRE (ASEC) (CASE STUDY)

Atlantic Science Enterprise Centre (ASEC) has almost every possible combination of acoustic intricacy in one building: heritage listed façade, sensitive laboratory equipment, CLT construction, and indigenous collaboration and gathering spaces.

Aercoustics role in the project has been to support the architect and design team to deliver against the Repeatable Laboratory Design Framework and performance requirements for Laboratories Canada and Public Services Procurement Canada. The project also celebrates the Mi'kmaq clan culture and the former occupants of the heritage building, Sisters of Notre-Dame-du-Sacré-Coeur, who started the first Francophone post-secondary educational institution for women in the Maritimes.

This paper presents a case study about how you can achieve acoustic performance standards through high levels of collaboration with the design team and the end users, utilising technical knowhow and looking at ways to complement the structural, architectural and mechanical systems.

09:20 **Paper 184 — Numerical and experimental study on low-frequency sound reduction using a pipe array absorber in a small room**
Mr Tetsushi Suzuki*, Prof Tetsuya Sakuma*

In small rooms, low-frequency noise is amplified around the natural frequencies, which possibly causes occupants' annoyance and sleep disturbance. To mitigate this problem, space-saving low-frequency absorbers are required, and acoustic tube resonators could be one option. This study focuses on pipe array absorbers composed of thin pipes and glass wool, and numerically and experimentally investigates its effect in suppressing low-frequency normal modes in a small room. First, a numerical study was done for various types of pipe array absorber by FEM. The results showed that the type with glass wool installed in the middle of open pipes is most effective and reduces indoor sound pressure levels in a wide frequency range below 100 Hz. Next, an experimental study was done in a small living room, where open-pipe array absorbers with different installations of glass wool are tested. Compared to the vacant condition, it was confirmed that the absorber reduces indoor sound pressure levels by up to 7 dB around the natural frequencies. In addition, it was observed that sound pressure and particle velocity are increased in the middle of the hollow pipes, which may be related to the absorption when filled with glass wool.

09:40 **Paper 250 — Evaluation of the impact changes to dimensions and mounting options have on the acoustic performance baffle arrays.**
Mr Robert Jones

The acoustic performance of buildings is increasingly assessed alongside sustainability, health, and occupant well-being outcomes. Suspended, vertically mounted acoustic baffle arrays are gaining popularity due to their design flexibility, material efficiency, and suitability for adaptive reuse. However, variations in baffle dimensions, spacing, suspension height, and mounting depths influence measured and predicted sound absorption, creating challenges for consistent performance assessment.

This paper evaluates how changes in physical configuration and mounting conditions affect the acoustic performance of baffle array systems. It compares outcomes derived from currently used laboratory test methods and potential calculation approaches, highlighting differences that arise when systems are installed in configurations that differ from those originally tested. The study also identifies the key physical and geometric parameters required to help estimate sound absorption for non-standard layouts.

By clarifying the relationship between configuration variables and acoustic outcomes, this work supports more accurate specification, performance prediction, and post-installation verification of baffle systems, particularly where products are reconfigured for adaptive reuse in evolving interior environments.

Mon 10:40–12:00 — City Room 3 (Chair: Andrew Hall, Jeffrey Mahn)

10:40: Paper 275 — Acoustic Design of ETFE Roofed, Naturally Ventilated Stadia — *Mr Moharis Kamis*

11:00: Paper 431 — BIM-Supported Acoustic Simulation Workflows: A Diagnostic Analysis of Professional Practice in Brazil — *Ms Maria Fernanda Pinheiro Assunção*

11:20: Paper 649 — Sound Leakage Through Openings and Fittings — *Dr Michael Hayne*

11:40: Paper 683 — Beyond CAC: A Component-Based Specification Framework for Asymmetric Suspended-Ceiling Fit-outs — *Mr Richard Latimer*

10:40 Paper 275 — Acoustic Design of ETFE Roofed, Naturally Ventilated Stadia

***Mr Moharis Kamis**, Mr Abeer Ahmed, Dr Neil Mackenzie*

Challenges for enclosed stadia with natural turf are ensuring adequate ventilation and light transparency for turf health. Ventilation and light transparency affect thermal comfort for spectators, noise emissions and internal sound reverberation. Transparency is achieved using lightweight roof cladding inclined to maximise turf irradiation, which is also acoustically transparent at low frequencies. This paper reviews these effects with lessons learned from Forsyth Barr Stadium (Dunedin, New Zealand), used to inform Canterbury Multi-Use Arena (aka Te Kaha in Christchurch, New Zealand) and the proposed Macquarie Point Multipurpose Stadium at Hobart (Tasmania).

11:00 Paper 431 — BIM-Supported Acoustic Simulation Workflows: A Diagnostic Analysis of Professional Practice in Brazil

***Ms Maria Fernanda Pinheiro Assunção**, Dr Mariane Garcia Unanue, Mr Rodrigo de Almeida Spinelli Pinto*

This study investigates the integration of architectural acoustic simulation within Building Information Modeling (BIM) environments, addressing the fragmentation between digital design workflows and performance-based acoustic analysis. Although BIM has become a central framework for interdisciplinary coordination in the Architecture, Engineering, Construction, and Operations (AECO) industry, its application in acoustic design remains limited. The research analyzes the Brazilian professional context to identify challenges and opportunities for incorporating BIM into architectural acoustics. The methodology combines a literature review with a qualitative case study of a small-sized acoustic consultancy firm, examining workflows, data exchange processes, and technological limitations. The findings reveal critical interoperability gaps, particularly in the Industry Foundation Classes (IFC) schema, which prioritizes geometric data while underrepresenting acoustic parameters. The study also highlights limitations in the Brazilian market, including the low availability of parametric BIM objects among acoustic product suppliers. At the same time, computational approaches such as scripting and automated data transformation emerge as opportunities to improve workflow efficiency. The paper contributes by proposing a diagnostic framework to support more integrated and data-driven acoustic design processes.

11:20 Paper 649 — Sound Leakage Through Openings and Fittings

***Dr Michael Hayne**, Mr Andrew Steel, Mr Richard Devereux*

A parametric study has been conducted in the Acran Sound Control Acoustic Testing Laboratory to quantify the sound reduction performance of various sized openings and fittings such as power points, downlights and exhaust fans. The parametric study involved drilling holes in 13mm and 16 mm FireStop plasterboard to investigate the impact of increasing

hole size. Larger openings were cut in the plasterboard to match common downlight sizes and the testing repeated with and without downlights installed to determine whether sound leakage through downlights is significant. Finally, a range of fittings such as power points, exhaust fan and speaker were tested to determine their influence on sound leakage

11:40 **Paper 683 — Beyond CAC: A Component-Based Specification Framework for Asymmetric Suspended-Ceiling Fit-outs**

***Mr Richard Latimer**, Mr Daniel Natoli*

Ceiling Attenuation Class (CAC, ASTM E1414) remains the default single-number descriptor for inter-room speech-privacy performance of suspended ceiling systems. This paper identifies a structural failure in that practice. The problem is not only that installed ceilings perform differently from laboratory specimens; it is that CAC is defined for a symmetric, identical-tile, services-free reference assembly, while commercial fit-outs routinely introduce asymmetric service loading, mixed ceiling-tile pairs and warehouse-and-office shells with no receiver-side ceiling. ASTM E1414 and the nearest ISO counterpart, ISO 10848-2, both constrain the reference geometry and caution against direct field interpretation outside that envelope. Published evidence shows that service-element loading alone can reduce measured performance by 10 CAC points wide-band and 15 to 22 dB at 1 to 4 kHz. In Australia, the specification gap is amplified by regulation and capability: National Construction Code (NCC) Part F7 does not cover commercial classes, AS/NZS 2107:2016 specifies no ceiling test method, and no National Association of Testing Authorities (NATA)-accredited Australian commercial laboratory was located with active scope for ASTM E1414 or ISO 10848-2. We propose Apparent Ceiling Sound Insulation (ACSI), a component-based specification framework using ISO 10140-2 transmission loss, ISO 354 absorption, ISO 10848-2 lateral attenuation and ISO 12354-1 path prediction.

3.2.2 Requirements, Classification Schemes & Standards in Building Acoustics

Mon 14:00–15:00 — Riverbank Room 8 (Chair: Darren Jurevicius, Marc Buret)

14:00: Paper 517 — New classification criteria and methodologies to measure and evaluate indoor quietness in apartment houses — *Prof Tetsuya Sakuma*

14:20: Paper 655 — Comparing National Codes for Acoustic Performance Between Units in Multi-Unit Residential Buildings — *Miss Lidan Hou*

14:40: Paper 819 — Agile At-Receiver Noise Mitigation: Integrating Acoustic Curtains into State Road Traffic Noise Policy — *Prof Ben Cazzolato*

14:00 **Paper 517 — New classification criteria and methodologies to measure and evaluate indoor quietness in apartment houses**

***Prof Tetsuya Sakuma**, Ph.D Makoto Morinaga, Mr Masayuki Ikegami*

The Architectural Institute of Japan is currently establishing a new standard and its design guidelines for sound environment in apartment houses, where classification criteria are specified for indoor quietness, airborne sound insulation, and floor impact sound insulation. Regarding indoor quietness, new methodologies are specified for measuring and evaluating environmental noise and service equipment noise transmitted into a habitable room. For environmental noise, 24-hour continuous measurements are required in the room, and the indoor quietness is evaluated separately for day and night, basically by LAeq for total noise, and additionally by LASmax if the effect of intermittent noise is significant. This paper firstly outlines the criteria and methodologies to measure and evaluate indoor quietness, as well as their background. Then, some assessment examples are presented for environmental noise, which are measured in houses exposed to railway and aircraft noise, and the validity of the methodology is discussed especially for incorporating LASmax.

14:20 **Paper 655 — Comparing National Codes for Acoustic Performance Between Units in Multi-Unit Residential Buildings**

***Miss Lidan Hou**, A/Prof Marion Burgess, Prof. Hazel Easthope, Dr. Caitlin Buckle*

Multi-unit residential buildings play an important role in accommodating housing demand, and adequate acoustic privacy between dwelling units is important for the wellbeing of residents. As buildings are constructed to meet minimum regulatory requirements, national building codes play a key role in shaping the level of acoustic performance achieved in practice. This study compares national codes related to sound transmission in multi-unit residential buildings across six countries: Australia, the United States, Canada, the United Kingdom, Germany and China. The analysis focuses on two aspects: sound transmission through separating structures (e.g., walls and floors) and sound transmission through other building elements (e.g. building services and structural penetrations). The study compares standards, performance indicators and limit values, as well as verification and compliance methods adopted in these codes. Findings show that most countries impose mandatory sound insulation requirements for walls and floors separating dwelling units, while the regulatory coverage of other sound transmission paths varies and is often addressed through recommended guidance rather than strict quantitative limits. These findings reflect different national approaches to identifying noise transmission paths and governing acoustic performance. They also provide a reference for comparative studies and local adaptation of national building codes for multi-unit residential buildings.

14:40 **Paper 819 — Agile At-Receiver Noise Mitigation: Integrating Acoustic Curtains into State Road Traffic Noise Policy**

*Peter Watkins, **Prof Ben Cazzolato**, Mr Cameron West, Mr Darren Jurevicius*

Governments need to manage the impact of infrastructure projects while delivering critical infrastructure. Traditional treatments are slow, invasive and expensive. This paper evaluates acoustic curtains as an agile, cost-effective retrofit within road noise policy frameworks. Research draws on 76 laboratory tests across 4 mm, 6.38 mm, and 10.38 mm glazing. Combining 1500 GSM mass-loaded vinyl interlinings with absorptive surfaces (adding ~2kg/m^2) achieved weighted sound reduction index improvements (ΔRW) of up to 13 dB. Performance is high in the mid-to-high frequency range (500–2000 Hz) - critical for reducing sleep disturbance. Finally, the paper explores how to integrate these findings into guidelines, such

as the South Australian Department for Infrastructure and Transport Road Traffic Noise Guidelines. For scenarios constrained by cost, constructability or heritage, acoustic curtains provide a scalable, resident-preferred pathway for managing infrastructure noise.

3.2.3 Measurement and Prediction of Airborne and Impact Sound Insulation

Tue 14:00–15:20 — Riverbank Room 2 (Chair: Yousif Badri, Peter Pirozek)

14:00: Paper 303 — A Comparative Evaluation of Machine Learning Models for Predicting the Sound Insulation of Mass Timber Floors — *Mr Markus Mörwald*

14:20: Paper 138 — Discrepancies in airborne sound insulation performance between INSUL predictions and laboratory measurements of single-stud partitions (timber and steel) — *Mr Maro Puljizevic*

14:40: Paper 641 — Accuracy of prediction methods for the sound reduction of light weight walls with timber stud or steel stud framing — *Mr Daniel Griffin*

15:00: Paper 390 — A High-Efficiency WaveBoard Trex Noise Control Frame System for Rapid Construction and High-Performance Sound Insulation — *Mr Vicky Halim Maulana*

14:00 **Paper 303 — A Comparative Evaluation of Machine Learning Models for Predicting the Sound Insulation of Mass Timber Floors**

***Mr Markus Mörwald**, Mr Luca Reitberger, Mr Mert Dogu, Prof Steffen Marburg*

As timber construction gains importance owing to its ecological and economic advantages, accurately predicting sound insulation in wooden partitions remains challenging. In wooden floors, the structural design measures implemented to attain sufficient insulation against airborne and impact noise differ from those employed in traditional floor systems. The multilayer, lightweight construction yields complex insulation characteristics that traditional models cannot reliably predict without extensive modeling and detailed material data. Therefore, empirical validation of floor assemblies remains crucial. The resulting measurement data offer a valuable basis for creating data-driven predictive models. This study compares feed-forward neural network and tree-ensemble architectures in predicting the sound insulation of mass timber floors. The models learn complex relationships from training data, enabling them to generalize and make accurate predictions even when some material properties or interface conditions are unknown. A substantial amount of airborne and impact sound insulation measurements has been compiled from various laboratories to create a labeled dataset. Based on this, the networks are trained to predict sound insulation spectra in one-third-octave bands from 50 to 5000 Hz using floor configurations as input. These models assist decision-making in mass timber floor development by offering efficient, informed estimates of the floors' acoustic performance.

14:20 **Paper 138 — Discrepancies in airborne sound insulation performance between INSUL predictions and laboratory measurements of single-stud partitions (timber and steel)**

***Mr Maro Puljizevic**, Mr Milan Grasic, Mr Tadej Poljansek*

INSUL is one of the industry standard tools for predicting sound insulation of building systems. Its relative accuracy and easy-to-use interface make it particularly suitable for estimating airborne sound insulation of partitions. Airborne sound insulation of single-stud partitions is governed by various factors, such as the type of lining (typically gypsum boards), studs, partition thickness and absorptive cavity infill. The latter is arguably the least researched contributor to the overall airborne sound insulation. This work focuses on the effects of different absorptive cavity infill and examines discrepancies between INSUL predictions and laboratory measurements for single-stud partitions with timber and steel frames. Large number of single-stud partitions (timber and steel) were measured, varying the airflow resistivity and density of mineral wool used as the absorptive infill. Observed effects were compared with corresponding INSUL predictions, respecting relevant software inputs required to describe the material (thickness, airflow resistivity and density). Results indicate discrepancies between INSUL predictions and laboratory measurements, occurring predominantly in the low to mid frequency region. Evidently, INSUL predictions do not account for effects which can be caused by stiffness of the absorptive infill. As highlighted in the paper, such effects can be detrimental and eventually reduce the single number rating.

14:40 **Paper 641 — Accuracy of prediction methods for the sound reduction of light weight walls with timber stud or steel stud framing**

Mr Daniel Griffin

Light weight walls, comprising a timber stud or steel stud frame with plasterboard or similar linings, are ubiquitous. The

sound insulation features and performance ratings for these walls can be assessed using the comparatively large amount of published laboratory sound reduction test data. Nonetheless, there can still be a need to predict the sound reduction of specific arrangements of light weight walls. The usefulness of the predictions depends on how accurate they are. This paper provides a brief outline of some available prediction methods for the sound reduction of light weight walls. Prediction results are compared with a broad set of laboratory test data to assess the reliability and accuracy of the prediction methods. Particular consideration is given to the influence of stud spacing and mass-air-mass resonance on sound insulation performance.

15:00 **Paper 390 — A High-Efficiency WaveBoard Trex Noise Control Frame System for Rapid Construction and High-Performance Sound Insulation**

Dr Denny Hermawanto, ***Mr Vicky Halim Maulana***

Effective noise control implementation in building construction is often constrained by construction speed, structural load, and cost efficiency. These limitations primarily result from insufficient early-stage integration of noise control considerations and weak coordination between architectural and structural disciplines. Consequently, critical parameters are frequently addressed only at late construction stages, leading to rework and cost overruns. This paper presents a framed noise control construction technique, referred to as the Trex system, developed to overcome these challenges through a lightweight and modular approach. The system employs a galvaneal steel backbone as the primary structural frame, providing stiffness, alignment, and reliable load transfer. Prefabricated joint modules enable precise assembly and rapid installation while maintaining consistent acoustic performance. A comparative evaluation against conventional masonry wall construction is conducted in terms of construction speed, dead load, and cost. The results demonstrate an estimated 70% reduction in construction time. With a dead load of 40.6 kg/m², the system is approximately 93% lighter than a masonry wall achieving equivalent noise control performance (STC 63). These improvements offer significant cost benefits through reduced labor, lower site overhead, and potentially reduced structural and foundation requirements.

Tue 16:00–17:20 — Riverbank Room 2 (Chair: Yousif Badri, Peter Pirozek)

16:00: Paper 104 — Reduction of floor vibration related to heavy-weight floor impact sound by using dry-construction method walls — *Mr Tomoaki Uemura*

16:20: Paper 36 — Research on the Impact Sound Insulation Enhancement of Floor Slabs Using PVC Flooring. — *Tiantian Shen*

16:40: Paper 334 — Study on a Floor Impact Sound Measurement Method Using Rubber Ball Excitation to Reproduce the Frequency Characteristics of Tire Excitation — *Prof Ryuta Tomita*

17:00: Paper 604 — Frequency Characteristics and Excitation-Position Variability of Heavyweight Floor Impact Sound by Dwelling-Size Class in Apartment Buildings — *Mr Ki Sun Bae*

16:00 **Paper 104 — Reduction of floor vibration related to heavy-weight floor impact sound by using dry-construction method walls**

Mr Tomoaki Uemura*, Dr Norihisa Hashimoto, Mr Masatoshi Harada, Dr Shinji Ito*

Changes in floor vibration characteristics were investigated before and after the installation of dry-construction method walls in pure framed structures with reinforced concrete, and several examples of significant reduction of floor vibration when the floor slab was subjected to heavy-weight impact were observed. Measurement results of floor vibration characteristics before and after installing dry-construction method walls showed that the response amplitude spectrum decreased significantly, by up to approximately one-tenth, owing to the presence of the walls. Changes in the amplitude spectrum characteristics were also observed. An analytical method capable of quantitatively evaluating the effects of dry-construction method walls was investigated using these measurement results. The results confirmed that while the conventional translational spring model used for dry-construction method walls evaluation cannot accurately represent the actual physical phenomena, the newly developed double-layer model can express them with high precision. Comparison of the floor vibration characteristics determined using the method under various floor structure and dry-construction method wall conditions demonstrates the possibility of controlling floor vibrations related to heavy-weight floor impact sound.

16:20 **Paper 36 — Research on the Impact Sound Insulation Enhancement of Floor Slabs Using PVC Flooring.**
***Tiantian Shen**, Prof Haitao Sun*

To investigate the sound insulation performance improvement of foamed PVC flooring under impact loading, this study conducted impact sound insulation tests and spectral analysis on two types of foamed PVC flooring with different thicknesses under standard laboratory conditions. The normalized impact sound pressure level was measured, and the weighted impact sound improvement ΔLw was calculated according to ISO 717-2. Results demonstrated that foamed PVC flooring exhibits significant attenuation of mid-to-high frequency impact sounds, with enhanced improvement effects as thickness increases. However, the improvement capability remains limited in the low-frequency range (approximately 100–400 Hz), showing no significant differences across sample thicknesses. Spectral analysis and adverse deviation analysis revealed that low-frequency adverse deviations consistently dominate the evaluation of ΔLw, leading to diminishing marginal effects when relying solely on increasing surface layer thickness. The study indicates that foamed PVC flooring demonstrates certain advantages in impact sound control. To achieve more balanced and effective sound insulation improvements, it is necessary to integrate elastic vibration isolation layers or composite construction designs to enhance low-frequency sound insulation performance. The findings provide references for the selection and structural design of PVC flooring in public buildings for impact sound control.

16:40 **Paper 334 — Study on a Floor Impact Sound Measurement Method Using Rubber Ball Excitation to Reproduce the Frequency Characteristics of Tire Excitation**
***Prof Ryuta Tomita**, Mr Yuta Okuyama*

In Japan, two types of standardized heavy impact sources, namely a tire and a rubber ball, are specified for the evaluation of floor impact sound. However, the frequency characteristics of the impact force differ significantly between the tire and the rubber ball. Consequently, when floor impact sound insulation performance is evaluated using grade curves widely applied in Japan, the determining frequency band for the evaluation also differs. In addition, it has been pointed out that, depending on the floor finishing or floor structure, the peak impact force of the tire may be excessively large during excitation. To address this issue, the authors proposed a vibration isolator that enables reproduction of the impact force frequency characteristics of a tire dropped from a height of 20 cm using rubber ball excitation, such that the peak impact force is approximately halved. It was also clarified that the resulting frequency characteristics of floor impact sound are nearly equivalent. In this paper, the validity of the proposed method is examined. Furthermore, as a case study, a method for estimating floor impact sound results corresponding to a tire dropped from the height specified in JIS standards using the vibration isolator and rubber ball excitation is investigated.

17:00 **Paper 604 — Frequency Characteristics and Excitation-Position Variability of Heavyweight Floor Impact Sound by Dwelling-Size Class in Apartment Buildings**
***Mr Ki Sun Bae**, Mr Yun Jae Lee, Prof Yong Hee Kim, Mr Sang Hyun Lee, Miss So Hyeon Baek*

Heavyweight floor impact sound in apartment buildings is commonly evaluated using a single-number quantity (SNQ), but a single rating can obscure the frequency bands and excitation positions that control the result. This study analyzed field measurements from 46 dwelling units under bare-slab and post-installation floor-system conditions. A-weighted maximum floor impact sound pressure levels from 50 to 630 Hz were evaluated, and frequency contribution ratios were calculated for each dwelling-size class and excitation position. Under bare-slab conditions, the determining frequency band was mainly 160–200 Hz. After installation, reductions above 100 Hz were larger than those at 50–80 Hz, shifting the determining band toward low frequencies. The shift was most pronounced in medium-size units, where the 50 Hz contribution increased from 4.1% to 48.8% and reached 60.4% at one excitation position. The results show that post-installation performance should be interpreted using both the determining frequency band and excitation-position-dependent contribution ratios, particularly when selecting remedial measures for low-frequency-dominated dwellings.

3.2.4 Structure-borne Sound and Equipment Noise in Buildings

Wed 14:00–15:00 — Panorama Room 3 (Chair: Siu-Kit Lau, George Dodd)

14:00: Paper 258 — Study on the target frequency range for vibration evaluation based on measurements of real detached houses exposed to traffic vibrations — *Dr Toru Matsuda*

14:20: Paper 626 — Acoustic performance of floating floors in gyms: a comprehensive analysis of point bearings build-ups under weight drop excitation — *Mr Arthur Deschamps*

14:40: Paper 639 — Field Investigation of Impact Acoustic Performance of a 280 mm BubbleDeck Slab Under Early Construction Conditions — *Ms Emma Linnea Gjers*

14:00 **Paper 258 — Study on the target frequency range for vibration evaluation based on measurements of real detached houses exposed to traffic vibrations**

Dr Toru Matsuda, *Prof Ryuta Tomita*

In Japan, 90% of the complaints regarding vibrations are related to sensory and psychological effects. When considering detached houses alone, vibrations from road and rail transport account for 80% of the vibration sources causing complaints.

AIJES-V0001, published by the Architectural Institute of Japan, is the Japanese standard for evaluating vibrations inside buildings, based on human perception. However, the frequency range covered by AIJES-V0001 differs from that covered by ISO 2631-2, which specifies 1 to 80 Hz for both horizontal and vertical vibrations. AIJES-V0001, however, covers 1.5 to 10 Hz for horizontal vibrations and 3 to 30 Hz for vertical vibrations.

Previous studies by the authors have reported that extending the AIJES-V0001 frequency range to 80 Hz can improve the correspondence with the perceived vibrations. However, these studies have considered only vertical vibrations.

Therefore, in this work, we examine the frequency range using measurement examples from five real houses.

Extending the target frequencies for horizontal and vertical vibrations, to 80 Hz for evaluation, shifts the determining frequency to a value higher than the upper-limit frequency of AIJES-V0001. This increases the acceleration level weighted by the AIJES-V0001 curve.

14:20 **Paper 626 — Acoustic performance of floating floors in gyms: a comprehensive analysis of point bearings build-ups under weight drop excitation**

Mr Arthur Deschamps

Gym facilities in mixed-used buildings are facing high acoustic challenges from weight drop excitation, generating disruptive noise and vibrations through the structure. Full-surface shock absorbing treatments, while effective considering their low thickness, often exhibit limitations in performance under high-energy impacts.

This paper explores the alternative approach of point bearing floating floor build-ups. After addressing the system components and discussing the design of punctual bearings, comparative acoustic tests results from laboratory setup using weight drops are presented.

The findings highlight performance differences between full-surface treatments and both dry lightweight and heavy concrete point bearing build-ups, demonstrating the importance of tailored acoustic solutions in gym environments.

14:40 **Paper 639 — Field Investigation of Impact Acoustic Performance of a 280 mm BubbleDeck Slab Under Early Construction Conditions**

Ms Emma Linnea Gjers

Voided biaxial slab systems such as BubbleDeck are increasingly used in residential construction because they reduce structural self-weight while maintaining structural efficiency. However, publicly available field data describing their impact sound performance under early construction conditions remains limited. This paper presents field impact sound insulation testing of a 280 mm BubbleDeck slab in a residential prototype in South Australia to inform floor build-up selection for apartment use. Five floor systems were assessed: a bare slab, a thin adhered vinyl plank with integrated resilient acoustic

underlay, a thin adhered vinyl finish over a 3 mm adhered resilient acoustic underlay, a 5 mm loose-laid resilient acoustic underlay, and a 5 mm loose-laid resilient acoustic underlay with a loose-laid vinyl plank above. The bare slab returned L'nT,w 77 dB. The directly adhered finish improved the rating to L'nT,w 69 dB but did not satisfy the adopted apartment impact criterion. Systems incorporating a separate resilient acoustic underlay achieved L'nT,w values of 54, 46, and 46 dB respectively. The results show that the tested BubbleDeck slab alone did not provide adequate impact sound insulation without an appropriate floor build-up.

3.2.5 Addressing Noise and Vibration Problems in Buildings

Wed 08:40–09:40 — Riverbank Room 3 (Chair: Volker Wittstock, Gian Schmid)

08:40: Paper 251 — Swimming pool structure-borne noise characterisation and mitigation: a case study — *Mr Bojan Todorovski*

09:00: Paper 458 — Room Acoustics and Occupied Noise Levels in Maximum-Security Prison Remand Units: An Observational Field Study in New South Wales — *Mr Luke Strong*

09:20: Paper 580 — User comfort in unexpected acoustic environments — *Mrs Megan Short*

08:40 **Paper 251 — Swimming pool structure-borne noise characterisation and mitigation: a case study**

Ms Sara Mccafferty, Mr Bradley Thompson, Mr Sasho Temelkoski, ***Mr Bojan Todorovski***

Noise and vibration generated by swimming pools and associated pool activities are a concern in multi-residential buildings where tenants occupy adjacent spaces. As many buildings look to put pools on elevated levels near to residential uses, these suspended slabs and increased acoustic sensitivities pose a potential challenge.

This paper looks at a recently completed pool isolated with a continuous recycled rubber isolation system and works to characterise the noise and vibration generated by swimming pools by testing several pool activities including walking on the bottom, pushing off the sides, diving and more. Vibration measurements and sound pressure levels in the adjacent spaces were collected to characterise the impacts on the acoustic amenity in laterally and vertically adjacent spaces. These post-completion measurements aim to identify activities that are especially problematic and evaluate the in-situ performance of the isolation system.

09:00 **Paper 458 — Room Acoustics and Occupied Noise Levels in Maximum-Security Prison Remand Units: An Observational Field Study in New South Wales**

Mr Luke Strong*, Dr Densil Cabrera, Dr Yoshimi Hasegawa, Dr Rohan Lulham*

Custodial environments have long been noted as “noisy and unpleasant”. Secure construction practices usually involve hard, reflective surfaces that exacerbate reverberation and contribute to noise build-up and reduced speech intelligibility. Institutional bodies generally acknowledge these risks, with American Correctional Association standards requiring occupied noise levels in prison units to not exceed 70 dB(A). Despite this, published field evidence of occupied noise levels and measured room-acoustic conditions in operational prisons remains limited. This paper presents the findings of an observational field study of acoustical conditions in 11 fully operational maximum-security prison remand units across 4 correctional centres in New South Wales. The study involved approximately 14 days of long-term noise logging per unit (total 141 complete days) supported by impulse response measurements and indirect measurements of speech transmission index in each prison unit. The results show significant variation in occupied noise levels, reverberation time, clarity index (C50) and speech transmission index. Absorptive treatment was associated with shorter reverberation times and improved clarity but did not necessarily produce better speech-communication conditions where background noise from building services remained high. The findings indicate that prison acoustic design should consider reverberation control and building services noise as joint contributors to the occupied sound environment.

09:20 **Paper 580 — User comfort in unexpected acoustic environments**

Mrs Megan Short*, Mr Michael Waddington, Mr Philip Faccenda*

This paper investigates the efficacy of sound masking in non-traditional settings to enhance occupant wellbeing. Through three diverse case studies—a warehouse impacted by industrial noise in Perth, a government building impacted by traffic noise in Adelaide, and a home impacted by road construction noise in Melbourne—we evaluate the impact of sound masking interventions. Using pre- and post-installation measurements, the study demonstrates significant improvements in perceived comfort from end users. Findings suggest that prioritising user experience leads to superior environmental satisfaction in complex, real-world acoustic landscapes.

Wed 10:40–12:00 — Riverbank Room 3 (Chair: Volker Wittstock, Gian Schmid)

10:40: Paper 368 — What can we do about LF impact noise complaints? — *Dr Filip Verbandt*

11:00: Paper 605 — Improving client understanding of impact noise using auralisations — *Mr Vaishnav Balaji*

11:20: Paper 784 — Reduction of Floor Impact Noise Using Acoustic Metamaterial Ceiling Panels and Measurement of Their Impact Sound Insulation Performance — *Dr Jeongho Jeong*

11:40: Paper 509 — On the uncertainty of velocity level difference measurements — *Dr Jeffrey Mahn*

10:40 **Paper 368 — What can we do about LF impact noise complaints?**

Dr Filip Verbandt

The ISO 10140-3 standard allows the use of a standard tapping machine or a rubber ball to measure the impact noise between dwellings. The countries are free to choose the degree of comfort they want to give to their citizens. LF impact noise complaints are not only noted from people living in adjacent apartments, but also from habitants walking within their own rooms. The differences between the tapping machine and the rubber ball have been discussed in many papers. The rubber ball relates the best to LF complaints. But what can we do about it? This paper describes measurements of different in situ test setups and presents calculation results with the new software 'Soprano' that uses mTMM (modal Transfer Matrix Method).

11:00 **Paper 605 — Improving client understanding of impact noise using auralisations**

Mr Vaishnav Balaji*, Mr Alex Foster, Mr. Peter Harris*

Impact sound insulation is an important aspect of acoustic design in multi-storey buildings and in Australia it is typically specified as the standardized weighted impact noise level (LnT,w) with a lower rating level indicating higher performance.

For residential buildings, the minimum requirement for impact isolation between dwellings is LnT,w 62 dB (BCA). In practice, this level often does not provide high amenity, with footfall and other impact sounds commonly audible in the receiving space. However, justifying performance above the mandated minimum can be challenging due to cost impacts and because acoustic reporting is usually presented in decibel values and technical terminology that can be difficult for clients to interpret.

The Resonate AuralEyes project addresses this by providing an audible demonstration of various domestic noise sources on a selection of floor finishes, alongside the corresponding measured LnTw. The LnTw ratings were measured for a 150mm bare slab and incrementally improved using selected finishes ranging between LnT,w 70 and LnT,w 40. Audio was recorded for representative domestic noise sources on each floor system, including footfall, moving furniture, and vacuuming.

The measurements and recordings aim to provide an accurate comparison between impact ratings, enabling clients to make better informed decisions.

11:20 **Paper 784 — Reduction of Floor Impact Noise Using Acoustic Metamaterial Ceiling Panels and Measurement of Their Impact Sound Insulation Performance**

Dr Jeongho Jeong*, Vice President Junhyuk Kwak, President Jongjin Park, Dr Hyojin Lee*

Complaints about low-frequency floor impact noise in apartment buildings continue in South Korea. Since 2022, mitigation measures have included the use of a rubber-ball impact source standardised in ISO, with 2% of newly built units sampled and a minimum performance criterion of LiA,Fmax 49 dB applied. Although most Korean apartments use floating floor systems with resilient materials, further improvements to ceiling structures are needed to enhance low-frequency impact sound insulation.

To address this, acoustic metamaterial ceiling panels were developed to improve impact noise performance. Previous laboratory tests demonstrated a 4 dB reduction in rubber-ball impact noise. The panels employ a continuously repeating lattice structure that generates anti-resonance modes within the target frequency band, reducing acoustic radiation. The lattice design was further optimised to enhance low-frequency performance.

In this study, the improved panels were installed in four completed apartment units with floating floors. Measurements showed a maximum reduction of up to 5 dB and an average additional reduction exceeding 2 dB. Ceiling-based mitigation

offers a practical solution for dwellings with excessive floor impact noise and can be incorporated into interior finishing and renovation works. Accordingly, KS F 2865 was revised to evaluate ceiling systems, highlighting the need for future ISO standardisation.

11:40 **Paper 509 — On the uncertainty of velocity level difference measurements**

Dr Jeffrey Mahn

The standard ISO10848 for the measurement of the velocity level difference of junctions is currently under revision. As part of the revision, the number of excitation and measurement positions required for different types of elements is being updated. The update is based on the uncertainty of the measurements of the time and spatially mean squared velocity which is propagated through to the calculation of the velocity level difference and its invariant counterparts. The uncertainty was evaluated using the Guide to the Expression of Uncertainty and Monte Carlo simulations. The calculations are only based on the Type A uncertainty of the velocity measurements and not on the various Type B uncertainties inherent in the measurements.

3.2.7 Acoustics of Wooden Buildings

Mon 11:00–12:20 — Riverbank Room 6 (Chair: Jean-Luc Kouyoumji, Jianhui Zhou)

11:00: Paper 195 — Assessment of Standard Impact Sound Testing Methods for Mass Timber Floors Based on Subjective Annoyance Perception — *Dr Jianhui Zhou*

11:20: Paper 654 — A draft evaluation method standard for an equivalent slab thickness for heavy-weight floor impact sound in CLT floors — *Dr Atsuo Hiramitsu*

11:40: Paper 504 — Imporovement of Floor Impact Sound Insulation Performance by Appliying of Hybrid TCC Floor Configurations Using a CLT Mock-Up House — *Dr Hyung Woo Lee*

12:00: Paper 505 — Current Status of Regulations and R&D on Impact Sound Insulation for Realizing Timber-Based Multi-Residential Building in Korea — *Dr Sang-joon Lee*

11:00 **Paper 195 — Assessment of Standard Impact Sound Testing Methods for Mass Timber Floors Based on Subjective Annoyance Perception**

Ms Jaclyn Xu, Mr Mohammad Hossein Asadi Jafari, ***Dr Jianhui Zhou***

Mass timber construction is expanding globally, yet standardized impact sound measurement methods were developed primarily for concrete buildings. This study investigates whether current acoustic standards adequately predict human perception and cognitive response to floor impact sounds in cross-laminated timber (CLT) buildings.

Ten CLT floor configurations with various isolation materials and toppings were tested using three impact sources: the ISO tapping machine, JIS rubber ball, and real walking (hard-soled shoes). Approximately 30 participants evaluated each configuration, providing subjective ratings (annoyance, noisiness, disturbance, amenity) and completing Stroop cognitive interference tasks during sound exposure.

Results revealed that walking-induced annoyance was predominantly driven by low-frequency content (25–63 Hz), where rubber ball measurements showed strong correlation. However, cognitive interference correlated with mid-high frequencies (250–630 Hz), a range where rubber ball measurements failed to predict human response despite spectral similarity to walking sounds. This finding suggests that spectral similarity between measurement methods and real sources does not guarantee perceptual relevance.

The study demonstrates that current single-number ratings may inadequately characterize floor performance for occupant wellbeing, particularly regarding cognitive impacts. Recommendations for supplementary measurement approaches addressing the full frequency range are discussed.

11:20 **Paper 654 — A draft evaluation method standard for an equivalent slab thickness for heavy-weight floor impact sound in CLT floors**

Dr Atsuo Hiramitsu*, Dr Susumu Hirakawa, Mr Masakazu Ishizuka*

ABSTRACT

The Japanese Housing Performance Indication System employs two indicators to evaluate heavy-weight floor impact sound insulation performance: the heavy-weight floor impact sound control grade and the equivalent slab thickness (heavy-weight floor impact sound). To promote the use of wood, the current system provides notified equivalent slab thickness cross sections for timber floor configurations, including two specifications for timber framework construction and two for wood-framed construction. However, Cross Laminated Timber (CLT) has not yet been incorporated into these standardized notified specifications. To address this gap, experimental investigations were conducted to develop evaluation criteria for CLT floors, with the aim of integrating specific CLT floor cross sections into the official Evaluation Method Standard. The experiments were conducted in a test building, where the cross-sectional specifications of the floor structure above the CLT floor and the ceiling structure below the CLT floor were varied. This paper presents an overview of the Housing Performance Indication System and proposes three CLT floor configurations that achieve a floor impact sound insulation performance of Li,Fmax,r,H(1)-65, corresponding to an equivalent slab thickness

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11:40 **Paper 504 — Imporovement of Floor Impact Sound Insulation Performance by Appliying of Hybrid TCC Floor Configurations Using a CLT Mock-Up House**

***Dr Hyung Woo Lee**, Dr Sang-joon Lee, Dr Chul-Ki Kim, Dr Beom Yeol Yun, Dr In-Hwan Lee, Dr. Jiho Chang, Dr Hyojin Lee*

In South Korea, floor impact noise is recognized as a major social issue, and strict sound insulation requirements are applied, limiting both lightweight and heavyweight impact sound levels to 49 dB or less. In particular, achieving sufficient heavyweight impact sound insulation is technically challenging. Traditionally, regulatory compliance has relied on reinforced concrete slabs with thicknesses of 210 mm or greater. Although regulatory revisions in 2024 have allowed the application of timber floor systems, timber floors inherently have lower mass than concrete structures, making it difficult to satisfy heavyweight impact sound requirements.

In this study, a timber–concrete composite (TCC) floor system was developed as part of efforts to create timber hybrid floor configurations with improved sound insulation performance. Structural considerations were first conducted to enable long-span floor applications, such as those required for educational facilities. The effects of resilient layer configurations were analyzed by considering both TCC and floating floor systems. To evaluate the influence of ceiling and wall boundary conditions of the receiving room, a CLT mock-up test building was constructed and utilized. Ongoing research includes investigations of various floor configurations, construction conditions, and the application of prediction programs.

12:00 **Paper 505 — Current Status of Regulations and R&D on Impact Sound Insulation for Realizing Timber-Based Multi-Residential Building in Korea**

Dr Sang-joon Lee

In South Korea, impact sound control in multi-residential buildings is governed by a dual regulatory framework requiring compliance with both specification-based and performance-based criteria. The specification-based pre-certification system evaluates floor structures at the design stage based on predefined configurations through accredited institutions, whereas the performance-based post-construction verification system verifies compliance through on-site measurements prior to occupancy approval. Under the current framework, a stringent criterion of 49 dB or less is applied to both lightweight and heavyweight impact sound, representing one of the most demanding standards worldwide.

The National Institute of Forest Science conducts research addressing impact sound regulations for timber-based multi-residential buildings. For the specification-based pre-certification system, CLT hybrid floor configurations incorporating various wood species, joint types, and resilient materials are being developed. Based on these outcomes, the regulations were revised in July 2024 to allow timber floor systems within the specification-based criteria, previously limited to reinforced concrete floors. In collaboration with accredited institutions, a standard sound insulation test building for certification is under construction. For the performance-based post-construction verification system, mock-up test building studies focus on floor–wall connections, resilient layers, and ceiling structures beneath the floor.

Mon 14:00–15:00 — Riverbank Room 6 (Chair: Jean-Luc Kouyoumji, Jianhui Zhou)

14:00: Paper 602 — Comparison of Discrete, Smeared, and Granular Added Mass for Sound Insulation in Lightweight Floors — *Dr George Dodd*

14:20: Paper 481 — Sound Field Characteristics of a Traditional Wooden Shrine Worship Hall Used for Iwami Kagura Performances — *Dr Takafumi Shimizu*

14:40: Paper 529 — Effect of curing and drying on the vibration response of CLT floors with floating gyp-crete and cement concrete toppings — *Dr Jianhui Zhou*

14:00 **Paper 602 — Comparison of Discrete, Smeared, and Granular Added Mass for Sound Insulation in Lightweight Floors**

*Mr Yousif Badri, **Dr George Dodd**, Prof John Edward Cater, Dr Andrew Hall*

In principle, the sound insulation of a lightweight floor can be improved by increasing the floor panel's mass per unit area, whether applied uniformly or as localised inertial loading, though effectiveness depends on specific conditions. In practice,

added mass is usually applied as a continuous topping layer, which can also modify floor stiffness. Floor studies treat mass addition as a change to the top surface, disregarding its influence on input mobility. In conventional lightweight timber floor systems, added-mass treatments should consider their effect on the radiating element (the bottom panel) rather than the walking surface. This study compares three mass-addition approaches placed within the floor cavity with equal total mass: (i) discrete weights, (ii) a solid continuous ”smeared”, and (iii) granular infill. STL was measured in accordance with ISO standards. Results showed that discrete loading provides a modest 1 to 4 dB improvement below 200 Hz, reducing to 1 dB at higher frequencies. In contrast, both smeared and granular distributions provide broadband STL increases exceeding 6 dB across the measured frequency range (5 kHz). Granular infill's combined damping and acoustic impedance contributions further improve mid-frequency STL over smeared mass (about 2–8 dB) between 250 Hz and 1 kHz.

14:20 **Paper 481 — Sound Field Characteristics of a Traditional Wooden Shrine Worship Hall Used for Iwami Kagura Performances**

Dr Takafumi Shimizu*, Dr Aakriti Shrestha, Luca Sassi, Masahiko Kishimoto, Dr. Yasuhito Kawai*

Iwami Kagura, a traditional performing art practiced in the Iwami region of western Shimane Prefecture, Japan, is performed in shrine worship halls characterized by distinctive wooden architectural forms. The interaction between the performance and the wooden interior contributes to a sacred and immersive spatial atmosphere, in which acoustic conditions play a central role. In Iwami Kagura performances, narratives are conveyed through live music using traditional instruments, such as flutes and taiko drums, together with spoken narration; therefore, the acoustic characteristics of the space are critical to both musical clarity and speech transmission. Furthermore, the fast-paced and highly dynamic nature of the performance places additional demands on performer audibility and audience listening conditions. However, these traditional wooden shrine worship halls were not originally designed as performance venues, and systematic acoustic design or evaluation is generally lacking. In recent years, many Iwami Kagura groups have introduced electroacoustic reinforcement systems, highlighting the need to understand the inherent acoustic properties of these heritage spaces. Accordingly, this study measured the sound field of a traditional wooden shrine worship hall used for Iwami Kagura performances and evaluated its acoustic characteristics using temporal, level-related, and spatial indicators to support heritage-conscious acoustic improvement.

14:40 **Paper 529 — Effect of curing and drying on the vibration response of CLT floors with floating gyp-crete and cement concrete toppings**

Mr Mohammad Hossein Asadi Jafari, Ms Aimee Ramfjord, Ms. Evelyn Way, Mr Simon Edwards, ***Dr Jianhui Zhou***

The use of floating cementitious toppings, such as gypsum concrete and other types of concrete, is a common practice for improving the acoustic and fire performance of cross-laminated timber (CLT) floor systems. However, the dynamic properties of these floor assemblies change significantly during the initial installation phase. This study investigates the effect of both concrete curing and gypsum concrete drying processes on the vibration response of CLT floor assemblies. Experimental data were collected from two campaigns: a dynamic evolution study of a fast-set concrete topping on a 1.5 m × 1.5 m CLT panel, and a 37-day observation of a full-scale 3.0 m × 3.6 m gypsum concrete-topped assembly subjected to excitation via a standard tapping machine. Vibration response at the CLT underside decreased to 98.8 dB by Day 7 and remained stable within 0.1 dB through Day 28. A consistent 21-23 dB top-bottom separation confirmed effective acoustic isolation from Day 7. In contrast, the gypsum system showed progressive increases over 37 days till stabilization. These findings suggest early testing may misrepresent final vibration performance. A minimum waiting period of 7 days is sufficient for fast-set concrete; for gypsum concrete, testing may proceed once the moisture reading falls below 5.

3.2.8 Low-carbon Acoustic Treatments and Design Solutions

Tue 14:00–15:40 — City Room 1 (Chair: Deb James, Amanda Robinson)

14:00: Paper 55 — An investigation of the sound and thermal insulation of facades' wood assemblies by considering environmental impact aspects — *Mr Ibrahim Jaber*

14:20: Paper 232 — Sound insulation and sustainability: Analysing the trends in global warming potential and sound insulation for acoustically rated walls — *Mr George Edgar*

14:40: Paper 245 — Lifecycle assessment, circularity, and acoustic design. — *Janae Featherstone*

15:00: Paper 514 — Impact noise fibrous insulation material made from recycled dryer lint — *Prof Jorge P. Arenas*

15:20: Paper 782 — Acoustic Performance of Low-Carbon Hempcrete: Experimental Transmission Loss Analysis of Alternative Binder Systems — *Dr Qiaoxi Zhu*

14:00 **Paper 55 — An investigation of the sound and thermal insulation of facades' wood assemblies by considering environmental impact aspects**

Mr Ibrahim Jaber, *Dr Sylvain Menard, Dr Mohamad Bader Eddin*

Timber facade assemblies are increasingly used in residential construction for their lower environmental footprint. However, adequate acoustic performance in lightweight assemblies requires additional materials, which affect both thermal performance and embodied carbon. This study investigates the trade-offs between airborne sound insulation (Rw), thermal transmittance (Uvalue), and embodied carbon in timber facade assemblies. 269 assemblies, organized into four families, were compiled from literature. Correlation and Pareto-based multi-objective analyses were applied to evaluate the relationships among the three-performance metrics. Findings indicate a positive correlation between acoustic and thermal performance across all families, with R^2 values ranging from 0.69 to 0.88. Nevertheless, no correlation was found between acoustic insulation and embodied carbon, indicating that acoustic improvements can be achieved without proportional increases in environmental impact. Pareto analysis identified 30 optimized assemblies representing the best achievable trade-offs between the three criteria. Insulation thickness was found to be the dominant parameter. Increasing insulation thickness from 120 to 300 mm improves acoustic and thermal performance by 1 dB and 0.02-0.04 W/m²K per 40 mm increase, respectively, with an embodied carbon cost of 2-3 kg CO eq/m². Based on Pareto-optimal set, a catalogue of four representative assemblies is included in the article as a practical design reference.

14:20 **Paper 232 — Sound insulation and sustainability: Analysing the trends in global warming potential and sound insulation for acoustically rated walls**

Mr George Edgar, *Mr Malcolm Dunn, Mr Daniel Griffin, Mr Matt Johnston*

The building industry is responsible for up to 35-40% of global carbon emissions. This highlights the importance of sustainability in building design. Global Warming Potential (GWP) is a measure of greenhouse gas emissions commonly used to assess the environmental impact of building materials. This study analyses the correlation between GWP and sound insulation performance for acoustically rated walls. Although GWP generally increases alongside sound insulation performance, the materials used, and construction type of a wall greatly influence the balance of the two metrics. The practical implications of these trends are highlighted with the aim of bringing a greater environmental awareness to the acoustic design of buildings.

14:40 **Paper 245 — Lifecycle assessment, circularity, and acoustic design.**

Janae Featherstone

People spend roughly 80–90% of their lives indoors. 95 % of human activity is shaped or constrained by the built environment. Why not make it freaking epic!

Our material choices and specifications directly affect the quality of our daily lives.

This paper looks at the whole of life material pathways of common acoustic materials, highlighting the impacts, benefits, and opportunities for improvement.

Concluding with considerations for the future of acoustic material design.

15:00 **Paper 514 — Impact noise fibrous insulation material made from recycled dryer lint**

Mr Cristian Benavides, ***Prof Jorge P. Arenas***

Floating floors help reduce impact noise in buildings by using an underlayment that prevents direct contact between the floor and the structural slab. The system's resonance frequency, influenced by the layer's viscoelastic properties, should be low to improve noise isolation. Several materials are available as underlay options, including eco-friendly options such as recycled clothing fibers, rubber, cork, and foam. However, most underlayments are typically synthetic. The tons of waste generated by electric dryers worldwide are a significant source of microplastics polluting water sources. Thus, recycling this waste is important to prevent it from ending up in landfills. This work explored the potential of using dryer lint to manufacture an underlayment for floating floors, such as engineered hardwood, vinyl, or laminated planks. Raw lint was collected from local dryers, cleaned, blended, and mechanically thermopressed with a synthetic rubber-based adhesive, yielding thicknesses of 3, 5, and 10 mm. A fireproof treatment was then applied, and dynamic stiffness and loss damping factor measurements were taken in accordance with ISO 9052-1. The results indicated that the fireproof treatment did not significantly alter the material's properties. The dynamic stiffness and damping of the new material were comparable to those of commercially available eco-friendly underlayments.

15:20 **Paper 782 — Acoustic Performance of Low-Carbon Hempcrete: Experimental Transmission Loss Analysis of Alternative Binder Systems**

Dr Qiaoxi Zhu*, Siddharth Nair, Dr Mahmoud Karimi, Quang Dieu Nguyen, Dr Danielle Moreau, Arnaud Castel*

Acoustic performance is a key requirement for evaluating building materials used to control noise and maintain occupant privacy. Hempcrete, a bio-composite made from industrial hemp, is emerging as a sustainable construction material due to its carbon sequestration capacity and low thermal conductivity; however, conventional lime-based binders remain carbon intensive. This study examines the acoustic behaviour of hempcrete produced with two binder systems: HL-Ref (100% hydrated lime) and HL–CC (50% hydrated lime and 50% calcined clay). Although hempcrete's sound absorption properties are well documented, experimental data on sound transmission loss remain limited. This paper presents normal-incidence sound transmission loss measurements for these two binder formulations and demonstrates how calcined clay substitution affects airborne sound insulation performance, addressing a key gap in sound insulation data for low-carbon hempcrete.

3.2.9 Sound Insulation of Facades and Facade Elements

Tue 16:20–18:00 — Panorama Room 2 (Chair: Lars Sommer Søndergaard, Chiara Scrosati)

16:20: Paper 78 — Experimental Investigation on Sound Insulation Performance of Curved Glass — *Ms Ayame Sato*

16:40: Paper 738 — Sound insulation of partially open windows: Experiences applied for a new Annex in ISO 16283-3 — *Mr Lars Sommer Søndergaard*

17:00: Paper 728 — Element and global method comparison for sound insulation measurements on partially open windows according to ISO 16283-3 — *Dr Chiara Scrosati*

17:20: Paper 751 — What happens inside when the outside changes: Indoor levels in Toronto. — *Mr Nicholas Sylvestre-williams*

17:40: Paper 545 — Acoustic, thermal and daylighting performances of non-balcony style apartment façades with louver-type sunshade profiles — *Ms Sang-eun Jun*

16:20 **Paper 78 — Experimental Investigation on Sound Insulation Performance of Curved Glass**

***Ms Ayame Sato**, Dr Takashi Ishizuka*

In recent years, large and complexly shaped curved glass is increasingly adopted as exterior facade materials due to advancements in glass processing technology. However, comprehensive knowledge regarding their sound insulation performance remains limited.

This report aims to provide basic data on the sound insulation performance of curved façades obtained by full-scale sound transmission loss measurements, conducted in accordance with ISO 140-3:1995. Test specimens consisted of three single-pane glass types: one flat and two cylindrical curved, differing in curvature. The measured results show that bending the glass led to a decrease of more than 5 dB in sound transmission loss at low frequencies. Furthermore, increasing the curvature shifted the frequency band of decreased sound transmission loss towards higher frequencies. Additionally, measurements on a two-layer configuration assuming a double-skin structure revealed that combining flat and curved glass exhibited an increase in sound transmission loss above the coincidence frequency, compared to a simple double-skin façade consisting of two flat glasses.

These experimental results provide important fundamental knowledge for understanding the sound insulation characteristics of curved facades and will serve as a basis for future theoretical analysis.

16:40 **Paper 738 — Sound insulation of partially open windows: Experiences applied for a new Annex in ISO 16283-3**

***Mr Lars Sommer Søndergaard**, Birgit Rasmussen*

Sound-insulating windows are widely used in traffic-exposed residential areas to reduce indoor noise levels. However, most windows are designed to provide sound insulation only when closed, while many occupants prefer open windows for ventilation or for a sense of connection to the surroundings. Since high nighttime noise levels can adversely affect comfort and health, there is a need for window solutions that offer sound insulation in partially open positions.

In Denmark, this need has gained particular attention following the Danish Environmental Protection Agency's guideline Noise from Roads (2007), which introduces indoor noise limits assuming an open-window equivalent opening of 0.35 m². However, traditional façade insulation regulations and measurements remain focused on closed windows. Thus, revision of the ISO standard with procedures for sound insulation testing of partially open windows is essential.

ISO 16283-3:2016 provides a field method for testing sound insulation of façades and façade elements, but it was developed for closed windows and shows limitations when applied to partially open configurations. Danish research and practical experiences have contributed to the development of a new informative annex in the revision of ISO 16283-3 to address these issues. This paper summarizes the experiences and insights applied for the upcoming new annex.

17:00 **Paper 728 — Element and global method comparison for sound insulation measurements on partially open windows according to ISO 16283-3**

***Dr Chiara Scrosati**, Mr Lars Sommer Søndergaard, Dr Francesco Bianco, Mr Rasmus Stahlfest Holck Skov*

The global method and the element method are the two measurement approaches included in ISO 16283-3:2016 for determining the sound insulation of façades and façade elements. These methods serve different purposes: the global method assesses the performance of the entire façade, while the element method focuses on individual façade components such as windows.

Each method has specific advantages and limitations. In particular, the element loudspeaker method aims to estimate the sound reduction index of a single façade element and, under certain conditions, can be compared with laboratory measurements performed in accordance with ISO 10140. The global method, by contrast, evaluates the overall acoustic performance of a receiving room façade, including all associated flanking transmission paths.

From a metrological standpoint, it is important to examine both methods, especially in relation to partially open windows, which are addressed for the first time in a new informative annex in the upcoming revision of ISO 16283-3. This paper presents an analysis of the applicability of the two methods to partially open windows, based on several case studies from Italy and Denmark.

17:20 **Paper 751 — What happens inside when the outside changes: Indoor levels in Toronto.**

Mr Nicholas Sylvestre-williams

In Ontario, indoor noise limits for residential buildings are based on long-duration A-weighted equivalent sound levels (16-hour daytime and 8-hour nighttime Leq) derived from conservatively predicted exterior traffic noise and assumed façade performance. In dense cities, however, intermittent sources such as sirens, horns, and transit operations may be more relevant to occupant experience than steady traffic averages. This raises a practical question: how much do indoor sound levels actually vary over time in typical urban residential suites?

This paper analyzes short-duration indoor noise measurements collected across hundreds of residential suites with documented façade constructions. Measurements were conducted at varying times of day with mechanical systems deactivated. Suites span a wide range of exterior exposure conditions, from shielded locations to sites adjacent to major highways and rail corridors. Octave-band sound levels and NC ratings are evaluated to quantify in-suite variability, between-suite variability, and their relationship to Leq-based compliance thresholds.

The results provide field-tested data on the variation of indoor noise levels in a dense city, and examine whether long-duration, traffic-based Leq criteria meaningfully reflect measured indoor conditions once façade compliance is achieved. The findings also inform whether complementary short-duration, frequency-dependent assessments may better characterize façade performance in high-rise environments.

17:40 **Paper 545 — Acoustic, thermal and daylighting performances of non-balcony style apartment façades with louver-type sunshade profiles**

***Ms Sang-eun Jun**, Ph.D. Yong-hee Kim, Mr. Jun-young Kim*

This study investigates the performance of louver-type sunshade profiles in a non-balcony multi-unit apartment building, focusing on their potential to reduce outdoor noise under natural ventilation and their impacts on thermal and daylighting conditions using computer simulations. Louver vertical spacing (H) and width (W) were selected as key design variables, and their combined effects on acoustic, thermal, and daylighting performance were examined through simulations. Acoustic performance was evaluated in terms of floor-level sound pressure level reduction. For mid- and high-rise floors, noise reduction tendencies varied with the H–W combination. At smaller spacings, the marginal noise reduction benefit decreased as louver width increased, whereas at larger spacings, increased width partly compensated for the reduced shielding effect. Thermal performance was assessed using cooling loads to examine how louver geometry influences overall thermal behavior. Daylighting performance was evaluated using UDI; the results indicate that louver installation improves illuminance uniformity, with louver width emerging as a key design variable. Finally, a Pareto-based multi-objective assessment normalized the three performance indicators, yielding candidate designs that offer balanced performance. Overall, the findings suggest that louver-based façade configurations support residential façade design by considering acoustic, thermal, and daylighting performance concurrently.

3.3.1 Room Acoustics: General

Mon 14:00–15:20 — Riverbank Room 3 (Chair: Deb James, Amanda Robinson)

14:00: Paper 17 — Acoustic and Vibration Strategies for Effective Healthcare Environments — *Dr Mahbub Sheikh*

14:20: Paper 58 — Swept sine measurement of the decay rates and level differences in reverberant rooms — *Prof John Davy*

14:40: Paper 74 — Low-Frequency Noise Mitigation in Hospital Equipment and Plant Rooms: The New Footscray Hospital Case Study — *Dr Harvey Law*

15:00: Paper 311 — Where silence is a gift: acoustic design for Australian war memorials — *Mr Matthew Ottley*

14:00 **Paper 17 — Acoustic and Vibration Strategies for Effective Healthcare Environments**

Mr Pablo Reboredo Gasalla, ***Dr Mahbub Sheikh***

Acoustic and vibration design is fundamental to patient safety, comfort, and clinical performance in hospitals. Effective control of noise, vibration, and speech intelligibility is critical across hospital spaces, from high-activity emergency department (ED) triage areas to sensitive inpatient and critical-care units. This paper presents two case studies illustrating the value of integrated acoustic and vibration strategies. The first examines speech intelligibility at triage counters in a busy urban ED. Environmental assessments and staff consultations identified high background noise, inadequate acoustic absorption, protective barriers, and poor speaker–listener geometry as primary contributors to communication breakdowns. These factors led to repeated verbal exchanges, triage delays, staff vocal fatigue, and reduced comprehension among elderly patients and those with limited English proficiency. Multidisciplinary interventions improved speech clarity and communication efficiency. The second case study investigates structure-borne noise in inpatient areas above mechanical plantrooms. Continuous low-frequency vibrations transmitted through the building structure would potentially risk patient comfort and recovery. Mitigation strategies including floor isolation and coordinated architectural–engineering solutions—were evaluated against healthcare noise and vibration guidelines. Together, these studies demonstrate that integrated acoustic and vibration design enhances patient wellbeing, supports staff performance, and improves healthcare delivery, emphasizing the importance of coordinated, multidisciplinary planning in hospital design.

14:20 **Paper 58 — Swept sine measurement of the decay rates and level differences in reverberant rooms**

Prof John Davy

In December 2023, ASTM published E3359–23 “Standard Practice for Measurement of Sound Pressure Level Differences and Decay Curves Using the Impulse Response Method with Swept Sinusoidal Signals”. The author has developed C# software to implement the methods described in this standard using a HBK Pulse Lanxi module Type 3160-A-4/2. The room is excited with a sinusoidal exponential or linear frequency sweep signal of at least 20 s. The complex ratios of the frequency spectra of the room sound signals to the spectra of the sweep signal are calculated using FFTs. These ratios are transformed to the impulse responses of the room using inverse FFTs. The impulse responses are truncated at 12 s and filtered into fractional octave bands. An iterative method is used to determine the intersection times when the filtered impulse responses are equal to their background noise. The filtered impulse responses are squared and backward integrated from their intersection times to give the decay curves. The decay curve backward integrations which are used to calculate the decay rates have corrections for the effect of background noise and truncation. The level differences are the differences between the backward integrations at the start of the filtered impulse responses.

14:40 **Paper 74 — Low-Frequency Noise Mitigation in Hospital Equipment and Plant Rooms: The New Footscray Hospital Case Study**

Dr Harvey Law*, Dr James Heddle*

This paper presents an engineering case study of a major acoustic design challenge and its resolution for the AUD$2 billion New Footscray Hospital project in Melbourne, Australia.

A very large plant room located beneath noise-sensitive clinical and occupied spaces was originally designed with a high-performance ceiling sound isolation system comprising a concrete floor slab, an air cavity, and resiliently suspended plasterboard layers.

During construction development, the Joint Venture HVAC team requested the removal of the suspended plasterboard ceiling due to the significant practical difficulties associated with installing hundreds of suspension points around extensive plant and services. Subsequent acoustic analysis of the revised configuration demonstrated a substantial reduction in airborne sound isolation performance. Predicted noise levels in the rooms above were found to significantly exceed the specified dBA noise criteria, with exceedances dominated by the 125 Hz octave band.

This paper outlines the complex project constraints, the detailed acoustic assessment undertaken, and the alternative mitigation measures developed to address the low-frequency noise transmission while accommodating construction, fire, and services coordination requirements.

15:00 **Paper 311 — Where silence is a gift: acoustic design for Australian war memorials**
Mr Matthew Ottley

Modern Australian war memorials present a unique set of challenges for acousticians. They are solemn spaces for citizens and veterans to reflect on the sacrifices of war. They are also museums, spaces for teaching and learning, often to large groups including school children. These two uses present a potential acoustic conflict between meditative reflection and active engaged discussion. This paper identifies some of the particular acoustic needs of war memorials and discusses acoustic design approaches. The application of these approaches is examined with three case studies, the ANZAC Memorial Centenary Project in Sydney, the Shrine of Remembrance in Melbourne and the Sir John Monash Centre Australian National Memorial in Villers-Bretonneux France.

Mon 16:00–17:20 — Riverbank Room 3 (Chair: Deb James, Amanda Robinson)

16:00: Paper 350 — A low-complexity speech dereverberation approach based on two-layer filter matrix decomposition — *Mr Ye Zheng*

16:20: Paper 440 — Sound Absorption Efficiency: Definition and Effects of Absorber and Diffuser Placement — *Prof Toshiki Hanyu*

16:40: Paper 532 — Wind Induced Acoustic Resonance Within Buildings — *Mr Gabriel McGrane*

17:00: Paper 628 — Fabrication and Acoustic Characterization of Sound-Absorbing Materials from Paper-Mill Waste for Effective Utilization — *Mr Hiroki Eda*

16:00 **Paper 350 — A low-complexity speech dereverberation approach based on two-layer filter matrix decomposition**
Mr Ye Zheng*, Mr Hongsen He, Mr Yi Yu*

The weighted prediction-error (WPE) method, which uses variance-normalized multichannel delayed linear prediction to suppress the reverberation component of microphone signals, is one of the most effective algorithms for speech dereverberation. The prediction-error filter in WPE, however, has to be long enough to estimate accurately the reverberation component, which results in a high computational complexity. In this paper, a low-complexity speech dereverberation approach based on two-layer filter matrix decomposition is proposed. The first layer is to factorize the multichannel dereverberation filter matrix into a linear combination of the outer products of two sets of sub-filter vectors. The second layer is to further decompose one of the two sets of vectors into a linear combination of two sets of shorter sub-filter vectors through Kronecker product. As a result, the multichannel dereverberation filter matrix is decomposed into three sets of shorter sub-filter vectors, significantly reducing the computational load of the presented speech dereverberation algorithm. The effectiveness and computational efficiency of the proposed method are validated through simulations.

16:20 **Paper 440 — Sound Absorption Efficiency: Definition and Effects of Absorber and Diffuser Placement**
Prof Toshiki Hanyu*, Prof Kazuma Hoshi, Ryoichi Suzuki*

One of the authors previously proposed a revised reverberation theory that corrects the Sabine and Eyring theories (T. Hanyu, Acoust. Sci. & Tech. 45, 3, 2024). In the present study, this revised theory is used to newly define sound absorption efficiency as a quantitative index for evaluating the effectiveness of sound-absorbing materials installed in architectural

spaces. Sound absorption efficiency is defined as the ratio of the equivalent sound absorption area under actual usage conditions to that under perfectly diffuse conditions for a given absorber.

It is well known that non-uniform distributions of absorbing surfaces cause discrepancies between reverberation times calculated under the diffuse-field assumption and those obtained from measurements, and that reverberation time varies with absorber placement even when the total absorption area is identical. Previous studies have also reported that the use of diffusers reduces the influence of uneven absorption distribution. In this paper, the effects of absorption non-uniformity and diffuser installation in a rectangular room are investigated using a ray-tracing simulation method. The results demonstrate that differences in absorption performance arising from various configurations of absorbers and diffusers can be quantitatively evaluated using sound absorption efficiency.

16:40 **Paper 532 — Wind Induced Acoustic Resonance Within Buildings**
***Mr Gabriel McGrane**, Mr Parsa Mofrad, Dr Neil Mackenzie*

The theory of Helmholtz resonance of enclosed volumes with openings is well understood within the acoustic domain. Excitation mechanisms can be airborne noise (eg. wind turbines), vibration (eg. blasts or explosions), peak pressures (eg. sonic booms), or wind induced. Wind induced acoustic resonance not only has the potential to generate audible infrasound, but also to increase wind loads on light-weight structures. This paper compares physical to computational results for a reference building, and thereafter a typical industrial building.

17:00 **Paper 628 — Fabrication and Acoustic Characterization of Sound-Absorbing Materials from Paper-Mill Waste for Effective Utilization**
***Mr Hiroki Eda**, Dr Akiko Sugahara, Mr Masayuki Morioka, Mr Hiroki Okada, Mr Takanori Kitamura*

Paper-mill sludge (PS) is a major byproduct generated during wastewater treatment in the pulp and paper industry. It typically contains a large amount of water and is mainly composed of short cellulose fibers, forming a porous fibrous structure. PS is often incinerated for volume reduction and energy recovery and then landfilled, which can increase environmental impacts and treatment costs. Although this work is motivated by the current PS generation and management situation in Japan, similar challenges are shared globally, and value-added utilization routes are needed. Developing low-impact acoustic materials for buildings offers a scalable pathway to divert PS from disposal while improving indoor sound environments.

In this study, PS is regarded as a porous material and its potential as a sound-absorbing material is investigated. Granular specimens were fabricated, and the effects of particle size distribution and bulk density on normal-incidence sound absorption were evaluated using impedance-tube measurements. In addition, reverberation-room absorption measurements were conducted for granular PS specimens to examine how forming and mounting methods affect absorption performance under application-relevant conditions. Practical insights into controllable factors-particle size, bulk density, and installation conditions-are provided, demonstrating the potential of PS as a novel circular sound-absorbing material.

Tue 09:00–10:00 — Riverbank Room 3 (Chair: Deb James, Amanda Robinson)

09:00: Paper 640 — Room-Impulse Response Recording in Three Dimensions with an Autonomous Mobile Robot — *Dr Dhong Fhel Gom-os*

09:20: Paper 805 — Sound absorption characteristics of materials using spherical cellulose beads: Comparison with other granular materials and application to a small room — *A/Prof Noriko Okamoto*

09:40: Paper 124 — Are rotating diffusors better than static? — *Dr George Dodd*

09:00 **Paper 640 — Room-Impulse Response Recording in Three Dimensions with an Autonomous Mobile Robot**
***Dr Dhong Fhel Gom-os**, Prof Anthony Zander, A/Prof Will Robertson*

Recording room-impulse responses (RIRs) in an actual physical space (the gold standard over simulated RIRs) require repeated tripod setup of microphones and loudspeakers. This makes dense three-dimensional measurements laborious. This is critical for applications such as six-degrees-of-freedom auralisation and virtual reality, which demand spatially dense

sampling of complex acoustic fields. Although recent studies have introduced mobile robots to automate the RIR acquisition, these systems are still restricted to two horizontal dimensions. A mobile robotic platform was developed, equipped with an ambisonic microphone, field recorder, and a telescoping mechanism for autonomous RIR recording in both two and three dimensions. The system also records room geometry using LiDAR and camera sensors. Experiments show that the platform can record RIRs over uniform 2D and 3D grids efficiently. Grid accuracy depends heavily on the robot's navigation and localisation performance. SLAM and Nav2 provided viable mapping and localisation, though parameter tuning is essential to improve reliability. A Bluetooth speaker wirelessly interfaced with the robot proved practical for large spaces. Continuous recording is required due to limited programmatic control of the recorder. These results support the long term goal of developing a fully autonomous system capable of adaptive 3D acoustic and geometry mapping.

09:20 **Paper 805 — Sound absorption characteristics of materials using spherical cellulose beads: Comparison with other granular materials and application to a small room**

A/Prof Noriko Okamoto*, Prof Reiji Tomiku, Mr. Koji Fukuyama, Prof Toru Otsuru, Mrs. Mana Yamazoe*

The cellulose is a biodegradable biomass material that is produced and accumulated in the greatest quantities on Earth. Previous reports by the authors have investigated the applicability of spherical cellulose beads as sound-absorbing materials using the EA method, an in-situ sound absorption measurement technique easily applicable during the material development stage. In this study, to understand its characteristics as a material, the impedance tube method and the EA method are used to compare its sound absorption properties with those of other granular material, expanded polystyrene beads. Regardless of the measurement method used, for particle sizes of 2 mm and 4 mm, while the sound absorption coefficient of polystyrene beads varied with particle size, no significant change in the sound absorption coefficient of spherical cellulose beads was observed. Subsequently, sound-absorbing materials using spherical cellulose beads are installed in a real room, and their sound absorption effect is confirmed by measuring the room impulse response.

09:40 **Paper 124 — Are rotating diffusors better than static?**

Dr George Dodd

Round Robin exercises have shown that reverberation chambers which meet the requirements of international standards are not guaranteed to provide similar measurement results. This is usually blamed on differing degrees of diffusion in their sound fields. Here, we present a case study on Auckland University's large reverberation chamber which differs from the majority of chambers in being equipped with a large rotating diffusor. With either the diffusor stationary or rotating the chamber meets the ISO test for adequacy of diffusion but we find there are significant low frequency differences in what is measured between the time stationary (diffusor static) and the non-time stationary (diffusor rotating) conditions. We present the first part of a detailed investigation into whether the non-time-stationary conditions are producing a beneficial phase randomisation of the sound field and how this can be visualised and quantified.

3.3.2 Measurement and Prediction of Sound Absorption in Reverberation Rooms

Tue 14:00–15:40 — City Room 3 (Chair: John Davy, Chiara Scrosati)

14:00: Paper 80 — Application of the perimeter-to-area method to the prediction of sound absorption coefficients of sound baffles — *Ms Yebin Moon*

14:20: Paper 219 — Evaluating Spaciousness in Peking Opera Theatres: The Role of Key Acoustic Indicators3 — *Ms Chenshuo Liu*

14:40: Paper 290 — Validity of Non-Standard Room Impulse Response Measurements in Room Acoustics and Auralization — *Prof Kristian Jambrošić*

15:00: Paper 589 — Numerical evaluation of the diffuseness of incidence directivity upon an absorbing specimen in a reverberation room — *Mr Ryo Hagiwara*

15:20: Paper 597 — A reconsideration on the in-situ measurement method using the ensemble averaging technique and two microphones — *Prof Toru Otsuru*

14:00 **Paper 80 — Application of the perimeter-to-area method to the prediction of sound absorption coefficients of sound baffles**

Ms Yebin Moon, *Prof Daeup Jeong*

The sound absorption of discrete absorptive elements, such as baffles and acoustic clouds, is commonly evaluated using reverberation room methods defined in ASTM C423 and ISO 354. However, discrepancies are often observed between laboratory predictions and in situ measurements. This study examines the applicability of the perimeter-to-area (P/A) method for predicting the sound absorption coefficient (SAC) of baffle arrays via scale-model experiments and compares its performance with that of the ISO method. Laboratory-based predictions were evaluated against measurements obtained in real rooms equipped with baffle arrays. The results indicate that the P/A method can provide accurate SAC estimates when the array edges are fully exposed, and that similar performance was observed for both rectangular and circular array configurations. However, when the side surfaces of the array were partially or fully unexposed, predictions based on the ISO method showed closer agreement with measured values. These results suggest that array geometry and edge exposure may influence the predictive performance of reverberation-based evaluation methods and should be considered when selecting an appropriate approach for discrete sound absorbers.

14:20 **Paper 219 — Evaluating Spaciousness in Peking Opera Theatres: The Role of Key Acoustic Indicators3**

Ms Chenshuo Liu, *Chao Wang, Hui Ma*

As the most representative genre of traditional Chinese drama, Peking opera relies on theatre spaces with appropriate acoustic conditions for its preservation and dissemination. It is essential to re-evaluate how spaciousness is perceived when Peking opera moves to modern enclosed theaters. This study examined the influence of three key indicators, IACCE3, LFE4 and Glow, on the perception of spaciousness in Peking opera theaters. Experimental stimuli were generated by convolving 10 representative Peking opera clips with simulated theater impulse responses. These stimuli were then evaluated by 30 university students via paired-comparison tests. Results demonstrated that IACCE3 exhibited the largest effect size in the evaluation of spaciousness for both singing and speech groups. While all three indicators significantly affected spaciousness perception, IACCE3 and LFE4 played a highly dominant role together. In contrast, the influence of Glow was minimal. This study provides preliminary theoretical foundations for improving Peking opera theater acoustic design standards.

14:40 **Paper 290 — Validity of Non-Standard Room Impulse Response Measurements in Room Acoustics and Auralization**

Prof Kristian Jambrošić, *Prof Marko Horvat, Dr Vedran Planinec, Ivan Ucović*

Room impulse response (RIR) measurement is a fundamental engineering method for the characterization of room acoustics and the determination of key parameters such as reverberation time, in accordance with ISO 3382. Standardized measurement procedures prescribe the use of calibrated omnidirectional sound sources; however, in practical situations,

acousticians and non-experts frequently rely on informal transient sound sources, such as hand claps or balloon bursts, to obtain a rapid qualitative impression of a room's acoustic behavior.

This paper investigates the suitability of several informal transient sound sources for RIR acquisition in two acoustically contrasting environments: a highly reverberant and a strongly damped room. Measurements are conducted using a standardized omnidirectional loudspeaker as a reference, alongside alternative impulse sources including hand claps and balloon bursts. RIRs are captured using both ambisonics and binaural microphones to examine the influence of source directivity on the measured impulse responses.

The resulting RIRs are evaluated in terms of decay curve characteristics, frequency-dependent signal-to-noise ratio, directional properties, and measurement repeatability. In addition, perceptual relevance is assessed using just-noticeable difference criteria and comparative auralization tests. The results provide practical guidance on the applicability and limitations of informal impulse sources for rapid room-acoustic assessment and spatial audio measurements.

15:00 **Paper 589 — Numerical evaluation of the diffuseness of incidence directivity upon an absorbing specimen in a reverberation room**

Mr Ryo Hagiwara*, Prof Tetsuya Sakuma*

In a previous study, two kinds of sound field diffusion indices regarding the isotropy of traveling sound waves were revised to improve their physical and mathematical consistency. Furthermore, a method of incidence directivity analysis for a hemisphere region on a boundary surface was established in FMBEM calculation. This study attempts to evaluate the diffuseness of incidence directivity upon a test specimen of absorbing material in a reverberation room using the numerical method. In particular, the diffusion indices in all directions are modified to quantify the deviation of directional incident energy from perfectly diffuse incidence. In addition, the mean incidence angle is introduced as a new index to evaluate the bias of incidence angle. Numerical simulations are conducted for rectangular and irregularly shaped reverberation rooms containing specimens with different absorption coefficients. The results demonstrate the effects of room geometry and specimen's absorption on the incidence directivity and the above indices, and the discrepancy and bias from perfectly diffuse incidence are quantitatively discussed.

15:20 **Paper 597 — A reconsideration on the in-situ measurement method using the ensemble averaging technique and two microphones**

Prof Toru Otsuru*, Prof Reiji Tomiku, A/Prof Noriko Okamoto*

In our earlier papers, we proposed an in-situ measurement method for sound absorption characteristics of materials using the ensemble averaging technique and we named it EA method, for short. At the beginning stage of the study, two microphones and ambient noise were utilized. After PU sensors have come to be available for public use, we focused on the applications of the PU sensor in various EA method measurements. Owing to the PU sensor's simplicity in measurement mechanics comparing to the method using two microphones, robust and reproducible results have been obtained by the EA method with a PU sensor provided the sensor is stable and well calibrated. Recent microphones for scientific measurements usually have satisfactory accuracy as well as stability in measurements not only at laboratories but also at field environments. Here, we present a reconsideration on the applicability of the EA method using two microphones. At first, theoretical basis is summarized briefly and, next, several results by example applications are given to show the plausibility of the method.

3.3.4 Acoustics of Performing Arts and Listening Spaces

Tue 09:00–10:20 — Panorama Room 2 (Chair: Thomas Scelo, Jose Augusto Nepomuceno)

09:00: Paper 153 — Acoustic Evaluation of a Traditional Japanese Kura for Music Use: Measurement Condition Effects and Spatial Variability — *Dr Aakriti Shrestha*

09:20: Paper 408 — Room Acoustic Clarity of Mosque Dome Configurations Using Energy-Based Metrics — *Mr Omar Faez*

09:40: Paper 546 — Design interventions for improving acoustic performance of a circular-shaped rooftop open-air performance space — *Mr Kim Junyoung*

10:00: Paper 826 — Intervention on historical buildings for the performing arts and acoustics — *Mr Jose Augusto Nepomuceno*

09:00 **Paper 153 — Acoustic Evaluation of a Traditional Japanese Kura for Music Use: Measurement Condition Effects and Spatial Variability**

***Dr Aakriti Shrestha**, Dr. Thomas Weiser, Yasuyo Tsunemine, Dr Takafumi Shimizu*

Traditional wooden buildings are increasingly being repurposed as music studios and small performance venues as part of cultural preservation and urban revitalization. However, their acoustic behavior differs from modern performance spaces due to complex geometries and heterogeneous materials, leading to position-dependent sound fields. This study investigates how measurement conditions and spatial configuration influence room-acoustic parameters in a traditional wooden storehouse (kura). Impulse response measurements were conducted using combinations of omnidirectional and directional sound sources and omnidirectional and Ambisonics microphones, with multiple source positions and receiver locations. Early decay time (EDT) and clarity (C80) were analyzed in terms of frequency dependence, spatial variability, and equipment-induced differences. Results show that both EDT and C80 are strongly influenced by source directivity, receiver type, and source position, particularly at low frequencies. While mid-frequency values exhibit relative consistency, significant variations and spatial non-uniformity are observed across receiver locations. Spatial mapping further reveals that source placement can produce either uniform or highly localized clarity distributions. These findings demonstrate that acoustic evaluation in traditional wooden spaces requires distribution-based approaches and careful consideration of measurement conditions, supporting their adaptive reuse as music facilities.

09:20 **Paper 408 — Room Acoustic Clarity of Mosque Dome Configurations Using Energy-Based Metrics**

Mr Omar Faez

Domed prayer halls are a defining architectural feature of many mosques, yet their acoustic performance is often challenging due to large volumes and curved geometries. Excessive reverberation and late energy reflections can reduce acoustic clarity, adversely affecting spoken sermons and Qur'anic recitation. Existing research on mosque acoustics is largely case-study based, with limited comparative evaluation of different dome configurations.

This study presents an applied framework for evaluating room acoustic clarity in mosques with different dome configurations, focusing on energy-based room acoustic metrics rather than electro-acoustic intelligibility measures. Three common typologies are investigated: a single large primary dome, multiple smaller domes, and hybrid configurations combining a dominant central dome with secondary domes. Dome configuration is treated as the primary variable, with other geometric and material parameters held constant. The assessment focuses on the natural, unreinforced acoustic behaviour of the spaces to characterise intrinsic performance and inform sound reinforcement system design. Room acoustic modelling is used to evaluate C50 and D50, relevant to speech, and C80 and D80, relevant to recitation, enabling comparison of early-to-late energy balance.

The study is expected to identify relative differences in clarity performance between dome typologies and geometrical conditions that are acoustically favourable, supporting early-stage mosque design.

09:40 **Paper 546 — Design interventions for improving acoustic performance of a circular-shaped rooftop open-air performance space**

***Mr Kim Junyoung**, MS Jun Sang-Eun, Ph.D. Kim Yong-Hee, Dr Yong Chul Chun*

This study investigates design strategies to improve the acoustic environment of a circular-walled rooftop open-air performance space in a dense urban setting exposed to road-traffic noise. Field measurements showed high background noise on the rooftop (about 62 dB) and lower levels inside the enclosure (about 54 dB), confirming partial shielding by the surrounding walls. Sound-field mapping with alternative source positions demonstrated that a perimeter-stage condition produces a highly non-uniform distribution consistent with whispering-gallery-like behavior, whereas a central-stage condition yields a more gradual level decay. An acoustic simulation model was developed and refined through acoustic fitting to match the measured acoustic characteristics. Parametric case studies then evaluated architectural interventions in terms of background-noise reduction, sound pressure level distribution, and room-acoustic indicators based on ISO 3382-1:2025 Annex D, including efficiency (E), sound strength (G), definition (D50), and centre time (Ts), together with reverberation time. The comparative results show clear performance differences across configurations and stage locations, and identify design combinations that enhance noise control and sound-field quality simultaneously. The findings provide a measurement-informed basis for design and assessment of rooftop performance spaces requiring both noise mitigation and acoustic support.

10:00 **Paper 826 — Intervention on historical buildings for the performing arts and acoustics**
Mr Jose Augusto Nepomuceno

The retrofit or renovation of historic theaters, or the conversion of historic spaces into performing arts venues, presents unique challenges. Often, there are requirements to update the building infrastructure, address comfort issues, comply with safety standards, enhance acoustics, new stage technology, and so on. The scope of the intervention in such spaces varies depending on their acoustical qualities, the building's general condition, and local preservation standards. It is worth considering that a building's identity also includes its acoustical characteristics, which are particularly important in cases of exemplary acoustic signatures. However, one aspect that often drives the renovation of historic theaters is the need to resolve acoustic issues, creating potential conflict with preservation rules. This article presents cases of interventions in historic spaces including the lounge of a railway station converted into a concert hall recital; the correction of the acoustic response between 63 and 250 Hz in an existing recital hall; the development of a recital hall on the site that burned down, of which only the Foyer remained; a house from mid 1700s that got in ruins after successive changes and converted in a small recital hall.

Tue 14:00–15:20 — Panorama Room 2 (Chair: Thomas Scelo, Jose Augusto Nepomuceno)

14:00: Paper 557 — Diagnosis and Mitigation of Friction-Induced Structural Noise in a Concert Hall — *Mr Mark Yi Nuo Chao*

14:20: Paper 573 — Acoustic Tuning of an Orchestral Rehearsal Studio Using Principles of Directed Reflection Sequence Rooms — *Mr Peter Exton*

14:40: Paper 675 — Improving acoustic conditions for sound art exhibitions in contemporary museums with melamine foam absorbers — *Prof Yong Hee Kim*

15:00: Paper 552 — From Reflection to Presence: Visualising Dynamic Source–Room Interaction in Auditorium Design — *Dr Thomas Scelo*

14:00 **Paper 557 — Diagnosis and Mitigation of Friction-Induced Structural Noise in a Concert Hall**
Mr Mark Yi Nuo Chao

This study investigates persistent unidentified noise that emerged approximately 20 years after the commissioning of a 2,000-seat concert hall in Taipei. The noise occurs primarily during summer performances and is perceived as wood cracking, impact, and friction. A three-stage diagnostic methodology is adopted. First, controlled "simulation of actual performances" tests confirm a strong correlation between the noise and air-conditioning operation. Second, synchronized measurements of temperature and structural displacement show that a decrease of approximately 4°C in the surface temperature of the catwalk steel structure corresponds to a maximum horizontal displacement of 1.0 mm, with spatial distribution consistent with noise occurrence. Finally, a portable acoustic camera with a 40-channel Micro-Electro-Mechanical Systems (MEMS) microphone array is employed for source visualization and localization. The noise originates from the contact interface between the coffered ceiling and the proscenium frame, where temperature-induced relative displacement causes intermittent stick–slip motion and generates impulsive and broadband noise. The unintended contact is attributed

to the progressive loss of the original clearance due to long-term structural creep. Restoration of the clearance significantly reduces the noise, and the combined use of structural monitoring and acoustic imaging proves effective for diagnosing concealed noise in complex buildings.

14:20 **Paper 573 — Acoustic Tuning of an Orchestral Rehearsal Studio Using Principles of Directed Reflection Sequence Rooms**

Mr Peter Exton

The acoustic design of rehearsal rooms for use by symphony orchestras presents challenges, particularly with the control of noise exposure for musicians and creating conditions which allow them to assess their own individual sound quality and the sound of the whole ensemble.

Previous design experience with Harold Marshall together with recent discussions with Anders Gade, Eckhard Kahle and others has led to a strategy for the separate control of early and later sound fields to vary the room response in large rehearsal rooms.

Acoustic tuning sessions in November 2025 at the ABC Studio in Brisbane with the Queensland Symphony Orchestra involved adjusting overhead reflectors and varying the extent of operable absorption to vary the strength of direct reflections for the musicians and the level of sound energy in the later reverberant field.

Documented feedback from listeners and musicians provided insights into the subjective room response for ensembles ranging from a string quartet to the full orchestra as adjustments were made.

This paper comments on these findings with reference to recent work on early stage support and the importance of the later room response for musicians.

14:40 **Paper 675 — Improving acoustic conditions for sound art exhibitions in contemporary museums with melamine foam absorbers**

Prof Yong Hee Kim*, Ms Sang-eun Jun, Mr Kim Junyoung, Dr Yong Chul Chun, Mr Young Jae Chun, Ms Hyo Jin Kim, Mr Yong Hoon Lee*

As contemporary art exhibitions increasingly incorporate multimedia technologies, the acoustic environment of museum galleries has become increasingly important, particularly for sound artworks presented through loudspeaker reproduction. This study evaluates whether melamine-foam absorbers can improve the acoustic conditions of museum galleries used for sound art exhibitions. Field measurements were conducted before and after absorber installation or removal in two galleries of different spatial scales, following ISO 3382-1. The effects were assessed using reverberation time, early decay time, speech clarity, definition, and sound pressure level. In the small-scale gallery, stepwise installation of ceiling- and wall-mounted absorptive modules reduced the mid-frequency reverberation time from 2.06 to 0.86 s and improved clarity-related parameters. In the large-scale gallery, the untreated condition showed a mid-frequency reverberation time of 1.87–1.88 s and limited acoustic clarity. After absorber installation, the reverberation time decreased to 1.01–1.09 s, while clarity-related parameters increased substantially. The treatment also moderately reduced sound pressure level, indicating reduced reverberant energy within the gallery. These results demonstrate that melamine-foam absorbers offer a practical, reversible strategy for improving loudspeaker-based sound art reproduction while preserving curatorial flexibility. The study further identifies requirements for future predictive procedures and minimum sound-insulation planning in flexible museum exhibition spaces with adjacent zones.

15:00 **Paper 552 — From Reflection to Presence: Visualising Dynamic Source–Room Interaction in Auditorium Design**

Dr Thomas Scelo

Concert hall designs must provide good sound projection and support for the entire stage area to achieve orchestral sound balance and avoid noticeable variations between orchestra sections. In previous papers, the author highlighted the importance of assessing the evenness of whole stage imaging. It was suggested that the whole stage imaging requires the analysis to be carried out from the receiver's point of view. A new visual ray-tracing tool was introduced for such analyses that informs the acoustician quickly without significant modelling efforts. This tool was also found to clearly illustrate this

design quality to architects, without the need for advanced scientific terminology. In this follow-up paper, we first share successful uses of this technique, each including variations of the visualisation to include time gating based on perceptual thresholds (from pianissimo to fortissimo), segregation of source and room presence, and relationship with a reverse G[early] calculation.

3.3.5 Acoustics of Education Spaces

Mon 09:00–10:20 — Riverbank Room 3 (Chair: Young-Ji Choi, Kiri Mealings)

09:00: Paper 59 — Speech intelligibility in active Korean classrooms — *Prof Young-ji Choi*

09:20: Paper 60 — A research synthesis of the effect of the classroom environment on listening, learning, and wellbeing applying the L3 Assessment Framework — *Dr Kiri Mealings*

09:40: Paper 67 — Event-Based Noise Disturbance and Perceived Cognitive Load in Academic Learning Spaces — *Mr Hansraj Gautam*

10:00: Paper 171 — Reverberation in classroom environments may be sufficient to reduce binaural benefits for speech perception for CI users — *Dr Justin Aronoff*

09:00 **Paper 59 — Speech intelligibility in active Korean classrooms**
Prof Young-ji Choi

The present work reports on the acoustic environment in 49 active classrooms from elementary school to university, providing insights into the conditions required to achieve optimal speech intelligibility, and also recommends for Korean acoustic standards considering occupied conditions. Firstly, the acoustical measurements in both occupied and unoccupied classrooms were carried out. The speech and noise levels were also measured during 106 actural classes. Next, the effects of student's age and teaching activities on the speech and noise levels in active classrooms were examined. Finally, the Useful-to-detrimental ratios (U50) for speech intelligibility were estimated from both measured C50 and SNR values in the active classrooms, and the results were compared to examine how these two parameters influence speech intelligibility.

09:20 **Paper 60 — A research synthesis of the effect of the classroom environment on listening, learning, and wellbeing applying the L3 Assessment Framework**
Dr Aniebietabasi Ackley, ***Dr Kiri Mealings****, Ms Steph Watts-Pointer*

The Listen to Learn for Life Assessment Framework (L3) provides a framework to systematically assess the links between the classroom environment and students' listening, learning, and wellbeing. The three main components of the L3 are 1) Characterisation of Activity, 2) Functioning Assessment, and 3) Impact, all of which are affected by Internal Influences and External Influences. This paper provides an overview of the L3 and what we do and do not know about each of the components. This includes how the classroom environment perceptual setting is characterised during lecture, group work, and independent work, and what types of functioning assessments are available to assess listening, comprehending, and communicating, along with a critical appraisal of these assessments. It also discusses how characterised classroom activity perceptual settings affect performance on the functioning assessments and impact learning and wellbeing, for typically developing students as well as students with different internal influences such as different ages, ADHD, autism, hearing/listening difficulties, language difficulties, First Nations status, and multilingualism. Finally, it synthesises reviews on the effectiveness of interventions aiming to improve the classroom listening environment such as acoustic treatment and sound-field amplification.

09:40 **Paper 67 — Event-Based Noise Disturbance and Perceived Cognitive Load in Academic Learning Spaces**
Mr Hansraj Gautam*, Mr Bhanu Chaudhary, Dr. Bhaven Tandel*

Indoor acoustic assessment in learning environments is still dominated by equivalent continuous sound level, even though classroom and laboratory soundscapes are rarely stationary. Short-duration acoustic events, temporal instability, and repeated exceedances can interrupt speech processing. increase listening effort, and elevate perceived cognitive load despite similar mean sound levels. This manuscript develops a submission-ready field methodology for examining event-based noise disturbance across undergraduate classrooms, postgraduate classrooms, and laboratories under real teaching conditions. The proposed framework combines continuous 1-s acoustic logging with temporal

descriptors including event frequency, exceedance duration, intermittency ratio, percentile spread, and maximum A-weighted level. Perceived cognitive load is captured through validated post-session instruments, namely the NASA Task Load Index and a structured cognitive-load questionnaire, supplemented by targeted event-recovery items. A mixed-effects modelling

strategy is specified to test whether event-based descriptors explain perceived disturbance more effectively than LAeq alone, while accounting for room type, activity pattern, and learner-level clustering. The manuscript also proposes a data-driven Classroom Noise Disturbance Index in which weights are derived from standardised

regression effects rather than arbitrary scoring. By shifting attention from average level to temporal structure, the study offers a rigorous framework for learning-oriented acoustic evaluation and for

future design standards in higher education spaces.

10:00 **Paper 171 — Reverberation in classroom environments may be sufficient to reduce binaural benefits for speech perception for CI users**

***Dr Justin Aronoff**, Prajna BK, Itunu Oyebamiji, Josephine LaPapa, Dr. Z. Ellen Peng*

Binaural benefits for speech perception in noise rely, in part, on two abilities: the ability to combine correlated signals between the ears into a single auditory percept (binaural fusion), and the ability to perceive the target and masker as originating from different locations in space. Reverberant environments can distort the cues underlying these abilities. Cochlear implant (CI) users, with limited access and reduced sensitivity to binaural cues, may be especially vulnerable to reverberation. The goal of this study was to determine how reverberant environments with RT60 times, consistent with those found in classrooms, affect the ability to combine signals delivered to the ear and perceive spatial information for typical hearing (TH) and CI users. 20 TH participants and three CI users listened to multi-speaker babble in a simulated reverberant environment, with sources at 0 degrees or 90 degrees to the left or right. For RT60s typical of classrooms, CI users perceived unified auditory images for each of the three sources, however, they were localized to approximately the same location. In contrast, TH listeners' accurate source localization persisted at greater RT60s. These results suggest low reverberant environments found in classrooms could disproportionately impair binaural benefits for speech perception in CI users.

Mon 11:00–12:20 — Riverbank Room 3 (Chair: Young-Ji Choi, Kiri Mealings)

11:00: Paper 354 — Improved classroom voice support from focusing retroreflectors: effects of number and arrangement — *Mr Chang Hyok Cha*

11:20: Paper 229 — Acoustic optimization of a curved stepped lecture hall: numerical prediction and field validation at HKUST (Guangzhou) — *Mr Weihong Xu*

11:40: Paper 483 — Study on the Spatial Uniformity of Speech Intelligibility in a Large-Scale University Lecture Hall Based on Ray Tracing Simulation — *Mr Wei Sun*

12:00: Paper 473 — First steps towards processing and interpreting the largest classroom acoustics dataset to date — *Mr James Whitlock*

11:00 **Paper 354 — Improved classroom voice support from focusing retroreflectors: effects of number and arrangement**

***Mr Chang Hyok Cha**, Dr Densil Cabrera, A/Prof Shuai Lu*

Previous studies have shown that talkers can receive a high level of voice support (ST_V) from focusing retroreflectors, particularly at 2 kHz and above. ST_V is the degree of gain in the talker's own voice provided by reflections from room elements, and it can be measured via oral-binaural room impulse responses (OBRIRs). This study presents measurements in nine university classrooms using physical focusing retroreflectors to quantify the increase in ST_V values for a talker at various teaching positions by varying the number of retroreflectors (0–4) and their arrangement. The results show a noticeable increase in ST_V from 1 kHz and above as the number of retroreflectors increases. Overall, a consistent upward trend in ST_V is found across all classrooms with focusing retroreflectors, regardless of each classroom's reverberation time or baseline voice support level. The results imply that focusing retroreflectors may allow reverberant classrooms to be treated with additional absorption to improve speech intelligibility while maintaining an adequate level of ST_V for the talker. These findings indicate that focusing retroreflectors could serve as an effective classroom treatment to improve voice support for teachers and foster a more acoustically supportive classroom environment.

11:20 **Paper 229 — Acoustic optimization of a curved stepped lecture hall: numerical prediction and field validation at HKUST (Guangzhou)**

***Mr Weihong Xu**, Mr. Jun Peng, Prof. Hongwei Wang*

Curved lecture halls can improve visual orientation and spatial enclosure, but large concave boundaries may generate acoustic focusing and non-uniform speech conditions. This study presents the acoustic redesign of a 200-seat curved stepped lecture hall at Hong Kong University of Science and Technology (Guangzhou). A combined diffusion-absorption strategy was developed to preserve useful early reflections while suppressing late destructive reflections from concave boundaries. The platform and near-audience side walls were treated as diffusion-dominated surfaces, whereas the rear concave wall was treated with a perforated aluminium absorber backed by a 100-mm cavity and 50-mm glass wool. ODEON simulations were used to evaluate reverberation time, speech clarity, lateral energy and sound pressure distribution. Field measurements were then conducted in the completed empty room according to ISO 3382-1 and GB/T 50076. The measured empty-room mid-frequency reverberation time was 0.815s, and Eyring-based occupancy extrapolation gave an 80% occupied value of 0.62 s, within the design target of 0.50-0.65 s. The measured average speech transmission index was 0.66, and the average D50 values at 500 and 1000 Hz were 0.66 and 0.67, respectively. The results demonstrate that boundary-specific diffusion and absorption can remove acoustic focusing while maintaining speech-supportive early energy in compact curved teaching spaces.

11:40 **Paper 483 — Study on the Spatial Uniformity of Speech Intelligibility in a Large-Scale University Lecture Hall Based on Ray Tracing Simulation**

*Prof. Hongwei Wang, **Mr Wei Sun**, Mr. Enhe Wu*

With the evolution of higher education pedagogical models, the functional requirements of university auditoriums have transitioned from basic speech transmission to multi-functional spaces accommodating academic conferences, multimedia teaching, and small-scale performances. The large-volume characteristics of such spaces often lead to significant sound energy attenuation over distance, resulting in diminished speech intelligibility in rear seating areas and uneven sound field distribution.Taking the auditorium of the Future College Library at Anhui University as an empirical case study, this paper utilizes the ODEON simulation software to conduct full-band ray-tracing modeling based on geometric acoustic principles.Moving beyond simple reverberation time (T30) assessment, the study examines the spatial distribution of Early Decay Time (EDT), Speech Transmission Index (STI), Definition (D50), and Lateral Fraction (LF).Results indicate that a strategy combining directional ceiling reflections with mid-frequency wall absorption achieved an optimal T30 of 1.07s (500Hz) and an average STI of 0.62. The study reveals that the decoupling mechanism between EDT and T30 is a critical physical driver for enhancing speech intelligibility in large spaces. Furthermore, it validates the efficacy of geometric ceiling reflectors for far-field energy compensation, offering theoretical guidelines for the acoustic design of large educational buildings.

12:00 **Paper 473 — First steps towards processing and interpreting the largest classroom acoustics dataset to date**

***Mr James Whitlock**, Dr Aniebietabasi Ackley, Ms Steph Watts-Pointer, Ms Renelle Gronert*

In 2020, the New Zealand Ministry of Education (MoE) launched Ngā Iti Kahurangi, a $266m programme aimed at improving the property conditions of 934 small or remote schools. The initiative's title, meaning "small and highly valued treasures" in Māori, reflects its focus on supporting communities that are often under-served in national datasets.

As part of the programme, more than 3,000 teaching spaces have undergone acoustic assessment using a mobile ambisonic IRIS measurement system. This effort has generated what is believed to be the largest and most comprehensive classroom acoustics dataset ever collected, spanning a wide range of pedagogical spaces, building typologies, and environmental contexts.

This paper outlines the Ngā Iti Kahurangi programme, describes the IRIS methodology, and presents initial high level observations emerging from early-stage data exploration. Given the unprecedented scale, diversity, and complexity of the measurements, our analysis focuses on identifying broad trends and establishing robust frameworks for deeper future inquiry. Insights gained from this early analysis are already informing updates to New Zealand's school acoustic standards and guiding practical design and remediation strategies to improve learning conditions nationwide.

We welcome feedback from the international acoustics community on how this dataset might be analysed further.

Tue 10:40–12:00 — Riverbank Room 3 (Chair: Young-Ji Choi, Kiri Mealings)

10:40: Paper 513 — The Classroom Sound Burden: What Influences Noise Perception in Pre-service Teachers? — *Prof Lady Catherine Cantor Cutiva*

11:00: Paper 670 — Mixed-Effects Analysis of Acoustic Bias in Listening Scores from Multi-Year Institutional Administrations of Standardized English Proficiency Tests — *Dr Makito Kawata*

11:20: Paper 693 — Application of field-measured student sound absorption for predicting optimal reverberation times in Korean classrooms — *Mr Heejun Lim*

11:40: Paper 795 — A survey on the effect of room sound absorption to improve communication for students' on-site educational practice in preschools — *Prof Keiji Kawai*

10:40 **Paper 513 — The Classroom Sound Burden: What Influences Noise Perception in Pre-service Teachers?**
Prof Lady Catherine Cantor Cutiva, *Dr. Carlos Manzano, Dr. Adriana Diaz, Dra. Maria Celina Malebran, Prof. Alejandro Morales, Prof. Eric Hunter*

This cross-sectional study collected data from pre-service teachers in Chile, Colombia, Uruguay, and Mexico. Participants completed an online survey in which they reported sociodemographic information, their perceptions of the physical and organizational conditions of their practicum placement sites, and any voice symptoms they experienced. The perception of background noise was measured on a 0–100 scale using the following instruction: "If you consider the place to be very noisy, move the slider toward Very Much Noise. Conversely, if the place is very quiet, move it toward Nothing at All".

Results: 613 respondents who were currently completing practicum placements were included. At the univariate level, six variables were significantly associated with perceived background noise. In the multivariate model, pre-service teachers in their second year of training ($\beta = 10.04$) and those reporting voice symptoms ($\beta = 8.69$) rated background noise nearly 20 points higher (on the 0–100 scale). Conversely, participants from Mexico reported significantly lower perceived background noise ($\beta = -8.93$) compared with those from Chile.

Conclusion: Early practicum experiences and the presence of voice symptoms are key drivers of how pre-service teachers perceive background noise. These results highlight the need for early training on classroom acoustics and voice care.

11:00 **Paper 670 — Mixed-Effects Analysis of Acoustic Bias in Listening Scores from Multi-Year Institutional Administrations of Standardized English Proficiency Tests**
Dr Makito Kawata

Non-native listeners are vulnerable to degraded speech transmission conditions, yet many educational spaces fall short of conditions needed to mitigate such difficulties. When standardized English proficiency tests are administered across venues with inconsistent acoustic profiles, room effects may bias listening outcomes. The present study re-examined a dataset of TOEIC Listening (L) and Reading (R) IP scores ($n \approx 20{,}000$) conducted across eight test rooms at a national university in Japan over an eight year period. Linear mixed-effects models were fitted to quantify between-room differences in L scores while controlling for baseline proficiency (R score), CEFR level, faculty, session season, and time indices accounting for repeated attempts and long-term score drift. After adjustment, the analysis revealed that L scores differed significantly by room, with the largest estimated marginal means reaching 10.28 points between Room 2 (239.39) and Room 3 (249.67), $p < 0.001$. Models replacing room indicators with measured STI and reverberation time (RT) parameters showed that both were significant predictors of L scores (+4.93 points per +0.1 STI; −3.11 points per +0.1 s RT0.5–2 kHz; all $p < 0.001$). The findings support incorporating acoustic criteria into administration policies to ensure equitable listening conditions for standardized English proficiency tests.

11:20 **Paper 693 — Application of field-measured student sound absorption for predicting optimal reverberation times in Korean classrooms**
Mr Heejun Lim, *Prof Young-ji Choi*

This study investigates the prediction of optimal reverberation times (RTs) in Korean classrooms based on field-measured sound absorption of students. Occupied and unoccupied RTs were measured in a total of eight elementary and high school classrooms. From these measurements, the mean sound absorption per student was calculated. The calculated optimal RTs for unoccupied classrooms were then compared with the measured values. The results show that the calculated RT values of classrooms closely align with the measured RTs when the occupied RTs approach the optimal reverberation times.

11:40 **Paper 795 — A survey on the effect of room sound absorption to improve communication for students' on-site educational practice in preschools**

Prof Keiji Kawai*, Dr Tomoko Katakawa, Prof Arata Yoshida*

On-site educational practice is an important exercise for students in the training to become a childcare provider. For students whose childcare skills are still in immature stages, on-site educational practice drills conversational communication with children and listening to children's voices to understand their feelings. If sound-absorbing finishes are not used in that childcare room, reverberation potentially reduce the clarity of conversation and disrupt communication. To examine this, a questionnaire survey was conducted for students practicing childcare on-site, as well as photographs of the ceiling of the classroom in which they practiced were taken by the students or researchers to determine whether the finishes are sound absorptive or not. The relationship between the presence or absence of sound absorption and their responses was analyzed. As a result, there was some tendency toward better ratings by the students practiced in the classrooms with sound absorption for the communication and understanding with children.

3.3.7 Computational Tools for Room Acoustics Prediction

Mon 09:00–10:00 — Riverbank Room 4 (Chair: Densil Cabrera, Yuxiao Chen)

09:00: Paper 137 — A fundamental study on absorption boundary conditions and arbitrary geometries in the time-domain element-free Galerkin method for room acoustic analysis — *Mr Jun Sasaoka*

09:20: Paper 277 — Directional source modeling for wave-based room acoustic simulations with frequency-domain FEM — *Dr Takumi Yoshida*

09:40: Paper 547 — Genetic Algorithm–Based Optimisation of Absorption Coefficients for the Calibration of Measured vs Simulated Room Impulse Responses — *Mr Daniel Castro*

09:00 **Paper 137 — A fundamental study on absorption boundary conditions and arbitrary geometries in the time-domain element-free Galerkin method for room acoustic analysis**

Mr Jun Sasaoka, *Prof Keiji Kawai*

This study presents the formulation and implementation of the time-domain element-free Galerkin method for room acoustic analysis, focusing on its applicability to complex geometries and absorbing boundary conditions. While the finite element method is widely used, it often faces challenges with mesh generation and computational accuracy in non-rectangular enclosures. As a mesh-free alternative, the element-free Galerkin method eliminates nodal connectivity requirements, offering high flexibility in spatial discretization. In this study, the governing equation is discretized in the time domain using the Newmarkβ method, and absorbing boundaries are incorporated using the global damping matrix. Numerical experiments are conducted on two models: a standard cubic enclosure (Architectural Institute of Japan. Benchmark Platform on Computational Methods for Architectural/Environmental Acoustics: B0-1T) and a non-rectangular reverberation room. The results demonstrate that the time-domain element-free Galerkin method achieves computational accuracy comparable to first-order hexahedral finite element method and effectively suppresses numerical noise observed in tetrahedral finite element method simulations. Although the time-domain element-free Galerkin method requires a higher number of iterations than the finite element method due to increased matrix density, its higher numerical stability and adaptability to arbitrary geometries make it a promising tool for broadband sound field predictions in practical acoustic environments.

09:20 **Paper 277 — Directional source modeling for wave-based room acoustic simulations with frequency-domain FEM**

Dr Takumi Yoshida, *Dr Mads Jensen*

Room acoustic simulation is an indispensable tool for room acoustic design, evaluating audio performance, and creating immersive virtual spaces. Especially, wave-based methods such as FEM and BEM are gaining much attention because of their inherent accuracy. Realistic simulations require considering the directivity of the sound source. The straightforward approach for modeling the source directivity is to incorporate the geometry of the source object and the relevant physics. However, this approach often results in a large computational burden. Approximating an arbitrary directional source with a point source model is a desired approach for efficient simulations. This paper proposes frequency-domain modeling of directional point source for wave-based room acoustics simulations based on a combination of a spherical harmonics expansion and a scattered field formulation. This approach decomposes a directivity pattern of an arbitrary sound source into the spherical harmonics expansion coefficients, first. Using these expansion coefficients, the directional source can be approximated by a point source model. Finally, the directional point source is incorporated into the frequency-domain FEM with the scattered field formulation. The proposing approach is verified via a room acoustic simulation with a cardioid speaker.

09:40 **Paper 547 — Genetic Algorithm–Based Optimisation of Absorption Coefficients for the Calibration of Measured vs Simulated Room Impulse Responses**

Mr Daniel Castro

Discrepancies between simulated room acoustic models and in-situ measurements are common when calibrating three-dimensional digital twins of existing spaces. These mismatches arise from multiple sources, including geometric simplifications, incomplete construction information, and site constraints; however, among available input parameters, frequency-

dependent absorption coefficients typically result in the greatest influence on agreement between measured and simulated results. In practice, engineers address this through manual, iterative trial-and-error adjustment, a process that is time-consuming, subjective, and non-optimal. This paper presents an automated calibration framework based on genetic algorithm optimisation of absorption coefficients to improve alignment between simulated and measured room impulse responses. A Python-based genetic algorithm is coupled with geometrical room acoustic simulations performed using Treble SDK, using a priori absorption database values as constrained search bounds. The optimisation refines octave-band absorption parameters within physically plausible limits using frequency anchors to minimise error between simulated and measured acoustic metrics.

3.4.1 Materials & Passive Treatments: General

Mon 09:00–10:20 — Riverbank Room 8 (Chair: Yat-Sze Choy, Tim Trewin)

09:00: Paper 83 — Optimization of TPMS structures for broadband sound absorption — *Ms Xueying Guan*

09:20: Paper 374 — Tunable Porous Acoustic Metamaterials Inspired by Natural Pattern Formation — *Ms Kara Hardy*

09:40: Paper 181 — Effects of surface coatings on the sound absorption and impact damage of yakisugi, traditional Japanese charred cedar — *Dr Akiko Sugahara*

10:00: Paper 203 — Effects of Hydrostatic Pressure on Perforated Viscoelastic Composites Containing Shelled Microspheres — *Dr Van Tan Truong*

09:00 **Paper 83 — Optimization of TPMS structures for broadband sound absorption**

Ms Xueying Guan, *Prof. Just Herder, Dr Jieun Yang*

Triply periodic minimal surface (TPMS) structures have attracted significant attention in various engineering domains, including the development of lightweight, porous materials for sound absorption. While prior studies have primarily focused on the fabrication and experimental characterization of TPMS-based acoustic absorbers, the underlying structure–property relationships that govern their acoustic performance remain less explored. In this work, we present a systematic numerical analysis of four representative TPMS geometries—Primitive, Gyroid, Diamond, and IWP—to investigate how geometric features and porosity distribution influence acoustic dissipation. We show that structures with higher geometric complexity and broader porosity ranges, such as Diamond and IWP, offer enhanced tunability in sound absorption performance compared to Primitive and Gyroid. These attributes directly impact the control of modal behavior and energy dissipation across a broad frequency spectrum. These findings provide a design strategy applicable beyond TPMS-based porous absorbers.

09:20 **Paper 374 — Tunable Porous Acoustic Metamaterials Inspired by Natural Pattern Formation**

Ms Kara Hardy, *Dr Bhisham Sharma*

From the spots of leopards to the ripples of sand dunes and the networks of coral reefs, nature abounds with self-organized patterns. These structures, refined over millions of years, offer a largely untapped blueprint for engineering advanced porous acoustic materials. This work introduces a generative framework for producing bio-inspired structures using Turing systems, a class of partial differential equation models capable of reproducing a wide range of natural patterning phenomena. By varying system parameters, diverse morphologies can be generated, enabling systematic control of pore topology and spatial organization. These variations influence the resulting acoustic and mechanical properties, allowing for tunable performance. The resulting geometries are compatible with modern additive manufacturing techniques, enabling direct fabrication of complex, bio-inspired architectures. This approach offers a pathway toward lightweight, customizable acoustic metamaterials that leverage the multifunctional advantages of biological design while maintaining engineering precision.

09:40 **Paper 181 — Effects of surface coatings on the sound absorption and impact damage of yakisugi, traditional Japanese charred cedar**

Dr Akiko Sugahara, *Prof. Yasuhiro Hiraguri, Prof. Kentaro Okamura*

Yakisugi is produced by charring the surface of a cedar board to form a thin carbonized layer, which is known to improve durability, weatherability, and fire resistance. Although yakisugi is primarily an exterior cladding and not designed as an acoustic material, our previous impedance-tube measurements suggested measurable high-frequency sound absorption due to the porous carbonized layer. For interior applications, however, the carbonized surface often requires a protective finish to prevent surface shedding and delamination. When a protective finish is applied, it remains unclear (i) how surface coating affect the sound absorption of yakisugi, (ii) to what extent they mitigate impact-induced damage, and (iii) how the resulting damage, when it occurs, alters the sound absorption performance. In this study, sound absorption coefficients are measured using an impedance tube for uncoated and coated yakisugi specimens with two representative coating types: penetrating and film-forming coatings. Controlled low-energy impacts are then applied to evaluate coating-dependent resistance to shedding/delamination, and the damage is quantified using a simple assessment. Sound absorption is re-measured after impact to characterize post-damage changes. The results clarify coating-dependent trade-offs between

initial absorption and impact durability, providing basic data for evaluating yakisugi as an interior material from acoustic and durability perspectives.

10:00 **Paper 203 — Effects of Hydrostatic Pressure on Perforated Viscoelastic Composites Containing Shelled Microspheres**

***Dr Van Tan Truong**, Dr Stephen Burke, Dr Ian MacGillivray*

Transmission-loss materials for underwater vehicles are commonly fabricated from polymer composites, most often polyurethane embedded with soft-shelled microspheres that serve as effective sound-scattering elements. Although these composites perform well in underwater environments, the microspheres are highly susceptible to hydrostatic pressure. Under such loading, the microspheres can shrink or collapse, reducing their effective volume fraction. This degradation leads to two major consequences: (1) reduced acoustic scattering performance and (2) changes in overall buoyancy of the material. In this study, two theoretical approaches are employed to estimate the effective bulk modulus of a polymer composite containing shelled microspheres. Corresponding quantitative formulations are then developed to predict the pressure induced reduction in microsphere volume fraction by applying the relationship between hydrostatic stress and volumetric strain through mathematical integration of the bulk modulus. The resulting predictions of hydrostatic pressure effects are compared. In addition, the original two component formulation (viscoelastic matrix and microspheres) is extended to a three component system by incorporating a third phase consisting of metallic or oxide hard particles.

Mon 11:00–12:00 — Riverbank Room 8 (Chair: Yat-Sze Choy, Tim Trewin)

11:00: Paper 329 — Research and Application of Labyrinthine Acoustic Metamaterials Based on Bionic Design — *Dr Jindi Fan*

11:20: Paper 100 — Enhanced low-frequency absorption of the perforated panel with tube bundles with granular activated carbon — *Dr Zhongjian Mei*

11:40: Paper 774 — Oblique-Incidence Transmission Simulations of Isotropic Acoustic Bandgaps in Finite-Thickness Gyroid Structures — *Mr Takumi Yano*

11:00 **Paper 329 — Research and Application of Labyrinthine Acoustic Metamaterials Based on Bionic Design**

***Dr Jindi Fan**, Associate Professor Zhiwei Guo*

Low-frequency sound absorption has always been an extremely important yet difficult problem to solve in the field of noise control. The labyrinthine acoustic metamaterials extend the sound propagation path through subwavelength-scale folded labyrinth channels, and they can achieve low-frequency sound absorption by wall dissipation and phase control. This study draws on the folding structure of the cerebral cortex to biomimetically optimize the configuration of labyrinth channels to maximize the sound wave propagation path within a limited space and further enhance the low-frequency sound absorption performance. Through modeling and numerical simulation, this paper systematically studies the impact of key parameters of bionic folded structures, including size, quantity, and complexity, on low-frequency sound absorption performance, such as resonance frequency, sound absorption bandwidth, and peak sound absorption coefficient. Research shows that the designed bionic structures have significantly better low-frequency sound absorption performance than traditional structures, and the sound absorption frequency band can be flexibly adjusted by controlling the structural parameters. Finally, based on parametric analysis, metamaterial unit cells with different resonant frequencies were constructed and periodically combined, achieving efficient broadband absorption of sound waves at specific frequencies on a deep subwavelength scale, providing new ideas and design methods for low-frequency noise control.

11:20 **Paper 100 — Enhanced low-frequency absorption of the perforated panel with tube bundles with granular activated carbon**

***Dr Zhongjian Mei**, Mr Peng Deng, Prof Tongyang Shi*

The perforated panel with tube bundles (PPTB) is a typical resonant sound-absorbing structure that exhibits good low-frequency acoustic performance. However, its unit cell design suffers from a narrow low-frequency sound absorption bandwidth. This study proposed to combine PPTB with granular activated carbon (GAC), which exhibits excellent low-frequency

absorption properties, to enhance the low-frequency absorption bandwidth. In the present work, GAC was applied in various positions of PPTB, such as filling the cavity and adhering to the tubes. Using an established theoretical model, the influence of GAC filling position on the acoustic performance of PPTB was systematically investigated. The results indicated that filling GAC into the backing cavity of PPTB is more effective in broadening the low-frequency absorption band compared to placing it inside the tubes. The experimental results were in good agreement with the theoretical predictions, confirming the effectiveness of improving the sound absorption performance by filling the cavity with GAC to regulate the acoustic impedance matching. This study provides a feasible composite design approach for optimizing the low-frequency performance of resonant sound-absorbing structures.

11:40 **Paper 774 — Oblique-Incidence Transmission Simulations of Isotropic Acoustic Bandgaps in Finite-Thickness Gyroid Structures**

***Mr Takumi Yano**, Dr Akiko Sugahara, Prof. Yasuhiro Hiraguri*

Some butterfly wings are composed of a three-dimensionally periodic structure known as a gyroid. Due to its periodicity, the gyroid reflects and scatters light of specific wavelengths, forming a bandgap that prevents waves from penetrating the structure, thereby creating the vivid colors of butterfly wings. We considered that this phenomenon related to light could be applied to sound insulation. Based on this background, this research aims to develop useful sound-insulating materials using gyroids.

In our previous study, we confirmed the presence of an isotropic acoustic bandgap in gyroid structures using band-structure calculations based on an infinitely periodic model. In addition, transmission loss simulations under normal incidence for a finite-thickness gyroid structure revealed a bandgap at the same frequency range as predicted by the band-structure analysis, demonstrating that the bandgap effect persists even in a finite structure.

In this paper, we investigate whether the isotropic acoustic bandgap is maintained in a finite-thickness gyroid structure by extending the transmission loss simulations from normal incidence to oblique incidence. The results confirm that the isotropic bandgap persists even for oblique incidence. However, an anisotropic bandgap predicted by the band diagram was not observed in the oblique-incidence simulations.

3.4.3 Acoustic Multi-dynamic Materials and Metamaterials

Mon 09:00–10:20 — Riverbank Room 2 (Chair: Liangzhou Wang , Long Chen)

09:00: Paper 53 — Design of a hybrid sonic black hole absorber by using shunt loudspeaker — *Prof Qibo Mao*

09:20: Paper 92 — Programmable double layer acoustic panel for acoustic focusing — *Mr Liangzhou Wang*

09:40: Paper 306 — Shape Optimization of Periodic Decreasing Hole Profiles for Enhanced Broadband Sound Absorption in Porous Materials — *Dr Zacharie Laly*

10:00: Paper 86 — Improved lightweight floor insulation with granular material infill — *Mr Yousif Badri*

09:00 **Paper 53 — Design of a hybrid sonic black hole absorber by using shunt loudspeaker**

Prof Qibo Mao

Sonic black hole (SBH) and shunt loudspeaker have been individually studied for sound absorption, yet their combined potential for the design of tunable sound absorber remains largely unexplored. This study introduces a novel tunable SBH absorber that integrates both mechanisms: a SBH consisting of parallel rigid thin rings with decaying inner radius for broadband sound absorption and a shunt loudspeaker replaced the SBH bottom panel for tunable low-frequency noise control. the tunability of the proposed hybrid SBH is explored by adjusting the shunt circuit parameters. Numerical calculations based on transfer matrix method (TMM) are performed to evaluate the efficiency of the proposed hybrid SBH. Furthermore, the physical parameters of the hybrid SBH effect on sound absorption performance are presented in detail. The proposed hybrid SBH demonstrates broadband and tunable sound absorption performance, making it a promising solution for developing high-performance sound absorber with customizable noise control capability.

09:20 **Paper 92 — Programmable double layer acoustic panel for acoustic focusing**

Mr Liangzhou Wang*, A/Prof Liangfen Du*

Acoustic metasurfaces have demonstrated significant potential for wavefront manipulation; however, most existing designs rely on fixed and often bulky geometries, which severely limit their adaptability and practical applicability. This paper proposes a Programmable Double-Layer Acoustic Panel (P-DLAP) capable of acoustic focusing in three-dimensional (3D) space. The P-DLAP comprises two layers of identical square patches, each of which can be independently switched between open and closed states, represented by binary bits “0” and “1”, respectively. By optimizing the configuration (i.e., the coding sequence) of the two layers, the energy of transmitted acoustic waves can be concentrated within a predefined focal region. Specifically, the surface coupling approach (SCA) will be employed to predict the wave propagation manipulated by the P-DLAP under arbitrary coding sequences. Based on the validated SCA model, a genetic algorithm is then used to optimize the coding sequences to achieve acoustic focusing in the target region. In practice, the proposed P-DLAP offers broad application potential, including enhanced acoustic energy harvesting at focal regions, redirection of sound away from noise-sensitive residential areas, and the creation of controllable “quiet zones” in complex acoustic environments.

09:40 **Paper 306 — Shape Optimization of Periodic Decreasing Hole Profiles for Enhanced Broadband Sound Absorption in Porous Materials**

Dr Zacharie Laly*, Dr Raymond Panneton, Dr Kevin Verdière*

Porous materials, such as foams and fibers are widely used in several engineering applications such as construction, transport, and manufacturing to mitigate noise. Their sound absorption performance at low frequency is limited reaching an asymptotic limit when the thickness is equal to the acoustic penetration depth. Recent works showed that their low frequency sound absorption can be improved by integrating periodic holes with decreasing profiles. In this study, the shape of the periodic hole profile is optimized to improve the sound absorption performance. Shape optimization is performed with COMSOL Multiphysics to determine for a specific material and a given thickness, the best decreasing hole profile in order to maximize the sound absorption in a target frequency range. The objective function for the optimization problem is the sound absorption coefficient that is maximized where lower and upper bounds are set as constraints. The optimized hole shape within the porous layer presents improved sound absorption performance.

10:00 **Paper 86 — Improved lightweight floor insulation with granular material infill**

Mr Yousif Badri, *Dr George Dodd, Prof John Edward Cater, Mr Gian Schmid, Dr Grant Emms, Dr Andrew Hall*

This study uses small-scale tests to identify the damping and acoustic impedance of granular material (GM), then applies the results to interpret full-scale floor performance. Three infill configurations were investigated: pea-metal aggregate, rubber granules, and a bi-modal mixture of both, using small-scale measurements (a vibrating routed-cavity panel and impedance-tube test), and full-scale impact insulation testing. To isolate the added-mass effect at full scale, an acrylic-panel infill with mass equivalent to the heaviest GM (pea-metal) was tested, nearly doubling the empty-floor mass and yielding ~6 dB sound transmission loss (STL) improvement across the measured frequencies (50 Hz-5 kHz). A new STL improvement metric was defined to separate the added-mass effect from the granular-specific attenuation. Using this metric, pea-metal showed an additional 5 to 10 dB improvement at frequencies above the mass-air-mass resonance and below the coincidence region. Relative to pea-metal, the mixture provided an increased improvement (1-3 dB) at frequencies below 200 Hz, and a small benefit (0.8-2 dB) at frequencies above 2 kHz. This shows that GM can improve impact insulation beyond added mass, and that their effective attenuation band can be tuned based on different porous-frame geometries and frequency dependence of interparticle losses available by choosing different mixture compositions.

Mon 11:00–12:20 — Riverbank Room 2 (Chair: Liangzhou Wang , Long Chen)

11:00: Paper 62 — An environmentally friendly ventilated meta-barrier for noise reduction and sustainable soundscapes — *Miss Yuwei Xu*

11:20: Paper 345 — Impedance-gradient waveguide silencer for ventilated broadband noise control — *Ms Yuchen Zhao*

11:40: Paper 218 — Development of Advanced Acoustic Metamaterial in Construction Noise Management in Hong Kong — *Mr Yat Ken Lam*

12:00: Paper 351 — Spatial optimization of multi-sized acoustic black hole arrays for enhanced sound insulation — *Mr Qifeng Wu*

11:00 **Paper 62 — An environmentally friendly ventilated meta-barrier for noise reduction and sustainable soundscapes**

Miss Yuwei Xu, *Prof Jie Zhu, Assoc. Prof. Zhongming Gu*

Urban noise pollution poses increasing challenges to sustainable living environments, motivating the development of control solutions that integrate acoustic performance with ecological and functional considerations. In this study, an environmentally friendly ventilated meta-barrier is proposed to achieve broadband noise mitigation while promoting sustainable soundscape design. By integrating a rainwater recycling system, the proposed meta-barrier achieves over 90% sound energy reduction from 300 to 1600 Hz, corresponding to a fractional bandwidth of approximately 136%. This performance is realized through a composite-resonant configuration optimized for broadband operation. Beyond the primary structural sound attenuation mechanism, hydroponic plants placed within the acoustic cavities provide additional sound reduction through combined acoustic dissipation and wave scattering, while also promoting a more pleasant sensory environment. The proposed system also incorporates ventilation and thermal insulation capabilities, addressing practical requirements for outdoor and urban applications. Numerical simulations and experimental measurements conducted on a full-scale sample demonstrate good agreement and validate the effectiveness of the proposed design. By integrating broadband noise reduction, ecological functions, and environmental adaptability within a single structural system, the proposed ventilated meta-barrier provides a versatile and sustainable solution for urban noise control and environmental infrastructure development.

11:20 **Paper 345 — Impedance-gradient waveguide silencer for ventilated broadband noise control**

Ms Yuchen Zhao, *Prof Hequn Min, Mr Houcang Tian, Mr Ruiyi Zhang, Wenxiang Li*

Broadband noise attenuation in the low-to-mid frequency range (250-1000 Hz) remains challenging in ventilated duct systems. This paper proposes an impedance-gradient waveguide silencer based on an acoustic black hole-micro-perforated panel (ABH-MPP) structure. The design combines axially varying geometry with micro-perforated sidewalls, enabling progressive impedance matching and spatially distributed viscothermal dissipation while maintaining unobstructed airflow. An analytical one-dimensional model based on the transfer matrix method is developed to describe sound propagation in

impedance-gradient waveguides and is applicable to both open and closed terminations. Its accuracy is verified through comparison with finite element simulations and experimental data reported in the literature. Numerical results demonstrate broadband sound power dissipation associated with enhanced viscothermal effects. Parametric studies further reveal the roles of axial dimensions and sidewall impedance in tuning the effective frequency range and spectral characteristics. The proposed approach provides a scalable and physically interpretable solution for low-frequency noise control in ventilated duct systems and can be readily adapted to different design constraints.

11:40 **Paper 218 — Development of Advanced Acoustic Metamaterial in Construction Noise Management in Hong Kong**

***Mr Yat Ken Lam**, Ms Mei Chi Wong, Ms Huimin, Selena Yang, Mr Ka Wai Chan, Dr Chi Wing Law, Ho Yiu Mak, Songwen Xiao, Wai Lung Law, Min Yang, Shuyu Chen*

A lightweight, high-efficiency acoustic metamaterial manufactured from recycled plastics, marking a significant step forward in both acoustic technology and sustainability. The Environmental Protection Department (EPD) of the Government of the Hong Kong Special Administrative Region (HKSAR) has introduced this innovative acoustic metamaterial barriers/enclosures as a solution for managing construction noise. This noise reduction solution has been proven successfully to improve the noise environment in various construction activities, such as concreting and associated works, foundation works, and nighttime road works by effectively minimizing the noise nuisance to the neighbors. Compared to conventional heavy noise enclosures made from fibre material and wrapped by steel or wood, this lightweight, low-cost option greatly enhances flexibility and usability in construction sites. Its new user-friendly modular design allows for easy installation and modification in various scenarios of construction activities. This development establishes another level of benchmark in the materials industry by achieving ”two-way environmental protection” through recycling and noise reduction, as well as ”two-way carbon reduction” by replacing traditional infilled acoustic materials. This paper discusses the development of this novel noise-absorbing technology and demonstrates its design and application in construction noise management in Hong Kong.

12:00 **Paper 351 — Spatial optimization of multi-sized acoustic black hole arrays for enhanced sound insulation**

***Mr Qifeng Wu**, Prof. Hequn Min, Miss Xiao Wen, Mr Hui Zhang, Mr Houcang Tian*

Environmental noise pollution has emerged as a critical factor restricting the improvement of residents' quality of life and work efficiency. Achieving technological breakthroughs in lightweight sound-insulating materials holds significant practical value for enhancing urban acoustic environments. As a novel type of lightweight, high-loss structure, the unique wave-modulation mechanisms of the Acoustic Black Hole have sparked extensive academic discussion. However, for plates embedded with ABHs, the influence mechanisms of the spatial distribution of these units on sound insulation characteristics have yet to be systematically addressed.To bridge this gap, this study constructs a multi-scale layout optimization model using Monte Carlo random sampling. Through finite element simulations in COMSOL Multiphysics, we analyze the regulatory mechanisms of the spatial positioning of ABH units, as well as the combination strategies of single-sized and multi-sized units, on the acoustic performance of aluminum plates. The findings reveal that different spatial layouts of ABHs exert a significant impact on the Sound Transmission Loss of the plates. Furthermore, a rationally optimized layout can achieve effective broadband control over sound insulation characteristics. This research provides essential references and guidance for determining the optimal spatial distribution and combination strategies of multi-sized ABHs in practical engineering applications.

Wed 08:40–10:00 — Riverbank Room 2 (Chair: Liangzhou Wang , Long Chen)

08:40: Paper 356 — Topology-optimized stochastic porous materials with tortuous channels for broadband low-frequency absorption — *Ms Ningning Rong*

09:00: Paper 620 — Acoustic performance of microperforated panel absorber under water flow — *Prof Yat-Sze Choy*

09:20: Paper 363 — Reconfigurable Membrane–Fiber Acoustic Metamaterials for Lightweight Noise Control — *Mr William Johnston*

09:40: Paper 358 — Low-frequency sound absorption of hierarchical double porosity materials with sinusoidal slit — *Wenxiang Li*

08:40 **Paper 356 — Topology-optimized stochastic porous materials with tortuous channels for broadband low-frequency absorption**

Ms Ningning Rong, *Prof Hequn Min, Mr Houcang Tian, Mr Ruiyi Zhang, Mr Wenxiang Li, Ms Yuchen Zhao, Mr Mingliang Zeng*

Low-frequency sound absorption of conventional porous absorbers is typically constrained by material thickness, limiting their practical deployment in space-restricted applications. To overcome this limitation, this study proposes a novel concept of topology-optimized stochastic porous materials with tailored porosity distributions and irregular tortuous channels that enhance acoustic dissipation mechanisms. Unlike conventional periodic perforated structures or deterministic fractal designs that rely on geometric regularity, the proposed stochastic channel network exhibits hierarchically organized topology that substantially increases acoustic path length and tortuosity. A finite element model is established to validate the acoustic performance, demonstrating that tortuous channels strengthen viscous and thermal losses through enhanced wave-material interactions. Building upon the validated physics, a Physics-Informed Neural Network (PINN) framework is developed for topology optimization, where PINN couples the governing acoustic equations with FEM-generated training data to enable frequency-dependent inverse design of porosity and channel distributions. This approach addresses the challenge of optimizing stochastic heterogeneous structures that are difficult to model analytically. Results demonstrate the effectiveness of irregular penetrating channels for broadband low-frequency absorption enhancement. The learning-assisted inverse design paradigm provides a computationally efficient pathway for optimizing complex porous architectures tailored to specific frequency-dependent acoustic requirements.

09:00 **Paper 620 — Acoustic performance of microperforated panel absorber under water flow**

Prof Yat-Sze Choy, *Dr Ying Li, Mr Chengyang Wang*

Recent studies have increasingly focused on underwater applications of microperforated panels (MPPs). However, the in-orifice flow dynamics and acoustic performance of MPP absorbers under underwater grazing flow remain inadequately understood. This study numerically explores the acoustic and aerodynamic characteristics of an MPP with a compact backing cavity with underwater grazing flow. A three-dimensional time-domain computational fluid dynamics (CFD) method is adopted to capture the hydrodynamic response of the MPP orifice, incorporating the flow-acoustic coupling effects within the orifice and its backing cavity. Numerical results indicate that vertical shear layers form within the orifice-cavity system and impinge on the cavity bottom, which modifies the flow-acoustic coupling characteristics. Furthermore, a systematic comparison of the distinct features of the flow-acoustic coupling mechanism is conducted, aiming to reveal the similarities and differences between the coupling mechanisms under aerodynamic(air) and hydrodynamic(water) conditions. Notably, compared with air environments, the vertical shear layer exerts a significantly enhanced influence on in-orifice flow dynamics, which in turn leads to more pronounced flow-induced variations in orifice impedance with water environments. The practical significance of this work lies in clarifying the effects of the sound-vortex interaction of MPPs with underwater grazing flow. These findings may advance the underwater acoustic metamaterials design.

09:20 **Paper 363 — Reconfigurable Membrane–Fiber Acoustic Metamaterials for Lightweight Noise Control**

Mr William Johnston, *Dr Bhisham Sharma*

Membrane-type acoustic metamaterials offer lightweight sound control, but tuning their stiffness, porosity, and internal features typically requires separate fabrication and post-assembly steps within existing additive manufacturing workflows, limiting scalability and system-level integration. This work introduces a reconfigurable, lightweight membrane–fiber stack architecture that integrates multiple thin 3D-printed membranes and programmable fibrous interlayers into a single modular cartridge. The workflow enables independent control over membrane thickness, microporosity, interlayer spacing, and fiber density and placement within a unified sample. Inspired by multilayer architectures that enhance dissipation through controlled spacing and internal geometry, the stack is designed to simultaneously tailor sound absorption and sound transmission loss while minimizing added mass. Acoustic performance is quantified using a normal-incidence impedance tube to measure the absorption coefficient and transmission loss. Printed membrane–fiber stacks achieve up to 80% sound absorption while maintaining porosities above 77%. At the microscale, pore sizes as small as 55 ± 10 µm are achieved. The resulting workflow provides a practical pathway for lightweight passive noise treatments that can be rapidly tuned for application-specific requirements.

09:40 **Paper 358 — Low-frequency sound absorption of hierarchical double porosity materials with sinusoidal slit**

Wenxiang Li

Achieving subwavelength low-frequency absorption in thin porous layers remains challenging due to the long acoustic wavelength. This paper proposes a hierarchical double porosity material that perforates a microporous matrix with spatially-periodic sinusoidal slits. A generalized semi-analytical model, integrating the Johnson-Champoux-Allard JCA model and double porosity theory, is developed to predict the acoustic performance. It explicitly accounts for the permeability mismatch between macroscopic slits and microscopic pores. Theoretical and numerical investigations reveal that the continuous slits bifurcate into Constant Horizontal Width (CHW) and Constant Normal Width (CNW) topological paradigms. Specifically, the CHW configuration generates localized viscous bottlenecks that drastically amplify fluid inertia and flow resistance. This decelerates the equivalent sound speed, shifting the quasi-perfect absorption peak to a remarkably lower frequency compared to the CNW counterpart. Validated by finite element simulations, results confirm that the permeability contrast drives acoustic energy laterally into the matrix via pressure diffusion, maximizing energy dissipation. This work provides robust design guidelines and a generalized theoretical tool for highly efficient subwavelength acoustic absorbers.

Wed 10:40–11:40 — Riverbank Room 2 (Chair: Liangzhou Wang , Long Chen)

10:40: Paper 424 — Topologically controlled metamaterial waveguides for acoustic delay line — *A/Prof Tian-Xue Ma*

11:00: Paper 556 — The potential of practical dihedral focusing acoustic retroreflectors — *Dr Densil Cabrera*

11:20: Paper 436 — Hybrid Acoustic Metamaterials for Large-Area Topological Corner States — *Miss Caixia Du*

10:40 **Paper 424 — Topologically controlled metamaterial waveguides for acoustic delay line**

Mr. Xing Liu, Miss Caixia Du, ***A/Prof Tian-Xue Ma****, Prof. Yue-Sheng Wang*

Topological acoustics has recently emerged as a powerful mechanism for achieving unprecedent wave control in acoustic metamaterials. Topological metamaterials provide enhanced robustness against to geometric imperfections and precise guidance of wave propagation. In this work, we design a two-dimensional triangular-latticed metamaterial with rotated scatterers for the manipulation of acoustic waves. Valley locked interface states emerge at the Dirac metamaterial between two metamaterials with different valley Chern numbers, which support robust waveguiding exclusively in the K or K valley for opposite propagation directions. The guided acoustic waves are further manipulated by introducing rigid reflecting boundaries, resulting in phase transition and significant acoustic delay phenomenon. The delay effects are validated by frequency-domain analysis and time-domain wave propagation. The demonstrated topologically controlled waveguiding and delay scheme provides a promising platform for enhanced energy localization, offering potential for acoustic energy harvesting and sensing applications.

11:00 **Paper 556 — The potential of practical dihedral focusing acoustic retroreflectors**

Dr Densil Cabrera*, A/Prof Shuai Lu, Mr Chang Hyok Cha, Mr Ricardo Hernandez Vallejo*

A focusing acoustic retroreflector reflects sound back to the source, also concentrating the reflected sound on the source. Dihedral focusing acoustic retroreflectors based on confocal conics have been shown to be effective in the reflector's vicinity. Concentration is especially strong along the 'auto-caustic' curve, the form of which is determined by the reflector's face-pair curvatures. Although geometric dispersion in the third dimension inevitably renders a focusing dihedron less efficient than an ideal focusing retroreflector, dihedral focusing retroreflectors may be helpful because they are comparatively simple to fabricate. Furthermore, simple augmentation with fins can boost retroreflection strength. This paper examines the performance of practically sized dihedral focusing retroreflectors with a view to architectural acoustics contexts. Physical prototypes (a parabolic dihedron, and a convex hyperbolic-elliptic dihedron, both with a 2 m focal length) were tested with and without fins using a head and torso simulator as source-receiver. Retroreflection for collocated source-receivers was evaluated using finite-difference time-domain simulation. Results show substantial strengthening of retroreflection by fins in the target area. Envisaged applications include increased acoustic voice support for speech and supporting human echolocation, possibly by incorporation in furniture or as simple architectural elements.

11:20 **Paper 436 — Hybrid Acoustic Metamaterials for Large-Area Topological Corner States**

***Miss Caixia Du**, A/Prof Tian-Xue Ma, Prof. YueSheng Wang*

Higher-order topological insulators support wave localization at higher-codimension boundaries through generalized bulk–boundary correspondence. In contrast to conventional edge states, topological corner states feature tighter confinement and improved robustness, enabling advanced functionalities such as wave trapping and selective energy localization. In this work, we propose a two-dimensional hybrid acoustic metamaterial and realize higher-order topological corner states. The corner state is realized by assembling metamaterials with opposite topological characteristics based on the acoustic valley effect, while Dirac metamaterials are introduced to enable the spatial expansion of the localized states. The resulting large-area corner state originates from the hybridization between Dirac-point modes and in-gap topological corner states. Owing to its topological origin, the hybridized corner state exhibits pronounced robustness against structural disorders. This work provides a versatile platform for exploring higher-order topological phenomena in acoustic systems and offers potential applications in wave manipulation and integrated acoustic devices.

Wed 14:00–15:00 — Riverbank Room 2 (Chair: Liangzhou Wang , Long Chen)

14:00: Paper 540 — More Than Meets the Ear: Perceptual Gains from Acoustic Metamaterials in Lightweight Construction — *Dr Andrew Hall*

14:20: Paper 721 — Model-Based Investigation of Meta-Structures for Micro-Slit Panel Absorbers — *Prof. Ning Xiang*

14:40: Paper 660 — Symmetry Reduction–Induced Isotropic Bandgap Broadening via Degeneracy Splitting in Hierarchical Sonic Crystals — *Mr Masahiro Izumi*

14:00 **Paper 540 — More Than Meets the Ear: Perceptual Gains from Acoustic Metamaterials in Lightweight Construction**

***Dr Andrew Hall**, Dr George Dodd, Mr Gian Schmid, Dr Vladislav Sorokin*

Acoustic metamaterials offer frequency-selective transmission loss improvements through local resonance and periodic structural mechanisms, yet their inherently tonal, resonance-based character raises an important question: do the narrowband gains they introduce translate into genuine listener comfort, or does spectral coloration from sharp resonant peaks offset their benefits? Standard single-number metrics such as STC and Rw cannot answer this.

Transmission-loss data from six metamaterial systems were implemented as digital filters applied to four everyday sound types. Thirty-six participants completed structured listening tests across eight test sets, providing rank-order judgments, pairwise difference scores, and quantitative ratings of loudness, annoyance, and harshness.

Despite their resonance-based spectral character, metamaterial configurations were consistently preferred over both standard and equivalent-mass references, with quantitative ratings typically one to three points lower in loudness and annoyance. Equivalent-mass references did not replicate this performance, confirming that frequency-selective mechanisms rather than added mass drove the improvements. Perceptual gains were greatest where designs achieved coincidence-band smoothing and well-placed low-frequency notches, while designs introducing new spectral peaks showed reduced advantages.

These findings support specification practices that complement STC and Rw with frequency-resolved data, and motivate metamaterial designs that balance resonant attenuation against spectral smoothness for residential applications.

14:20 **Paper 721 — Model-Based Investigation of Meta-Structures for Micro-Slit Panel Absorbers**

*Mr Ralph Oscar Peterson-Veatch, Mr Ziqi Chen, Mr. Bryn Peterson, **Prof. Ning Xiang***

This paper presents an experimental investigation of absorptive meta-materials, focusing on the development of micro-slit panels (MSP) combined with baffled chamber back cavities (BC) to achieve effective sound absorption while maintaining minimal thickness. Conventional MSP designs are typically limited to narrowband absorption, and their effectiveness at low frequencies often requires deep posterior cavities, which restricts practical applications. This study examines existing theoretical models for meta-structures composed of MSPs and BCs. Bayesian probabilistic inversion is employed to analyze MSP parameters and assess the predictive capability of these models. The interdependence of model parameters reveals

potential design flexibilities that can be exploited to optimize meta-structure configurations and their acoustic performance. Computational expense of the BC model is investigated intending to achieve high efficiency of the model-based absorber design and causal analysis for potential sources of model errors and manufacturing inaccuracies. Based on the existing models, corrections accounting for fabrication

tolerances can be introduced into an iterative framework to enhance model predictability.

14:40 **Paper 660 — Symmetry Reduction–Induced Isotropic Bandgap Broadening via Degeneracy Splitting in Hierarchical Sonic Crystals**

Mr Masahiro Izumi*, Dr Akiko Sugahara, Prof. Yasuhiro Hiraguri*

This study investigates the formation and broadband enhancement of isotropic sonic bandgaps (SBG) in two-dimensional triangular-lattice hierarchical sonic crystals (HSCs). While conventional sonic crystals exhibit narrow and angle-dependent bandgaps governed primarily by Bragg scattering, their practical application as sound insulation materials is limited by strong anisotropy. To address this issue, we introduce controlled geometric asymmetry within the unit cell by systematically varying the radius ratio of embedded cylinders while maintaining a constant filling factor. This approach enables symmetry reduction without breaking translational periodicity.

Band structure analysis demonstrates that symmetry reduction induces degeneracy splitting at high-symmetry points in the first Brillouin zone. The separation of originally degenerate eigenmodes leads to the emergence of new bandgaps and contributes to the broadband expansion of isotropic SBG. Notably, beyond a critical radius ratio, multiple isotropic SBGs are observed to merge and widen, indicating a strong correlation between geometric asymmetry and bandgap evolution.

The agreement between band structure analysis and numerical simulations confirms the fundamental role of symmetry-controlled degeneracy splitting in governing isotropic bandgap formation.

These findings provide physical insight into bandgap engineering in hierarchical periodic structures and establish a symmetry-based design framework for achieving angle-independent sound insulation.

3.4.4 Measurements and Characterization Methods for Acoustical Materials

Tue 14:00–15:20 — Riverbank Room 8 (Chair: Shanjun Liang, Long Chen)

14:00: Paper 365 — Physics-based inverse method for acoustic characterization of rigid ceramics with log-normal porosity — *Mr Mingliang Zeng*

14:20: Paper 420 — Experimental and theoretical estimation of sound absorption coefficients from CT scan images of long-grain rice straw — *Dr Shuichi Sakamoto*

14:40: Paper 491 — Airflow-Transparent Noise Barriers under Curvilinear Coordinate Systems — *Dr Shanjun Liang*

15:00: Paper 577 — Acoustic characterization and in-situ performance evaluation of a plaster-coated sound-absorbing system using recycled materials — *Dr Aakriti Shrestha*

14:00 **Paper 365 — Physics-based inverse method for acoustic characterization of rigid ceramics with log-normal porosity**

Mr Mingliang Zeng, *Prof Hequn Min, Doctor Ningning Rong, Mr Wenxiang Li, Mr. Suogui Zhang*

Rigid ceramic materials are widely used in filtration, catalysis, and acoustic applications, yet their acoustic parameter characterization remains challenging. While the Horoshenkov three-parameter model has been validated for foams and fibrous materials, its applicability to rigid ceramics with distinct pore morphologies has not been explored. This study develops a physics-based inverse characterization method for rigid ceramics using the three-parameter acoustic model. Micro-CT scanning confirms that ceramic pore size distribution follows a log-normal law, validating the model applicability. This inversion method exhibits high fidelity for rigid porous ceramics with intermediate porosity (30–50%), with the error between predicted normalized impedance and experimental measurements remaining below 0.1. By reducing parameter space from five in Johnson-Champoux-Allard (JCA) model to three, which are porosity, median pore size, and pore size standard deviation, the inversion mitigates ill-posedness and enables deterministic solutions without stochastic optimization. The retrieved parameters directly correspond to ceramic microstructure, offering clearer physical interpretation than abstract JCA model parameters. This work establishes measurable microstructural targets for acoustic-driven ceramic fabrication optimization.

14:20 **Paper 420 — Experimental and theoretical estimation of sound absorption coefficients from CT scan images of long-grain rice straw**

Dr Shuichi Sakamoto, *Mr. Yoshiaki Kojima, Mr. Kenta Saito, Mr. Zulhafiz Syazmi Bin Roslan, Mr. Shui Miyata, Mr. Ryuki Kiuchi*

Rice straw is produced annually in quantities ranging from 80 to 100 million tons. However, a significant portion is either incinerated or discarded without being utilized, leading to environmental problems. This study focuses on rice straw from the IR8 variety, a long-grain rice known for its high yield per unit area. First, the sound absorption coefficient was measured for three different bulk densities of bundled rice straw structures. Subsequently, cross-sectional images of the straw were obtained using a micro-CT scanner, which facilitated the theoretical estimation of the sound absorption coefficient. CT images, captured in cross-sections perpendicular to the direction of the incident sound wave, were modeled as a clearance between two planes. Based on this model, the characteristic impedance and propagation constant were calculated, and the normal incident sound absorption coefficient was derived using the transfer matrix method, with the measured tortuosity incorporated into the theoretical values. A comparison of experimental and theoretical values indicated similar trends regarding the differences in the sound absorption peaks across different bulk densities. In addition, a parameter study was conducted by scaling cross-sectional images based on the diameter ratios of short-grain Japanese Koshihikari rice straw and Nagano Prefecture Yumekaori wheat straw relative to IR8.

14:40 **Paper 491 — Airflow-Transparent Noise Barriers under Curvilinear Coordinate Systems**

Dr Shanjun Liang, *Dr Sun-pui Zerance Ng*

Noise insulation is a long-standing challenge that requires continuous attention. At the same time, natural ventilation is often necessary while blocking broadband noise. Among passive treatments, alternating geometries can induce Fano interference, enabling perfect insulation at the balance point between monopole and dipole modes. However, most existing

realizations of Fano unit cells are based on rectangular coordinate systems, leaving a gap in applications involving curved boundaries, such as noise filtering in circular pipelines, curved windows, and irregularly shaped ventilating covers.

Here, we present a systematic design scheme for constructing ventilating noise barriers that can conform to nearly arbitrary boundary shapes. This is achieved using hybrid quasi-unit cells composed of adjusted Archimedean spirals and open areas. Eigenstate analysis is employed to build an analytical model that reveals the perfect insulation points and the corresponding transmission spectra. A bandwidth of nearly one octave is achieved. The proposed design is further validated through experiments conducted in laboratory-made chambers.

15:00 **Paper 577 — Acoustic characterization and in-situ performance evaluation of a plaster-coated sound-absorbing system using recycled materials**

Dr Aakriti Shrestha, *Mr. Kenji Matsuzaki, Prof. Kimie Yoshitani, Mr. Helge Hansen, Mr. Sagun Shrestha, Dr Takafumi Shimizu*

Improving acoustic environments in educational buildings requires solutions that are both acoustically effective and environmentally responsible. This study investigates a plaster-coated sound-absorbing system using recycled and fiber-based materials, applied as a projector wall in a university entrance hall. First, the sound absorption characteristics of plaster-based composite specimens with different substrate materials were evaluated using impedance tube measurements. Among the tested specimens, the plaster-coated rock wool board exhibited stable and high absorption in the mid-frequency range relevant to speech communication and was therefore selected for field application. In situ measurements were conducted before and after installation using a dodecahedron loudspeaker and an ambisonics microphone under two representative source conditions. The results show reductions in reverberation time (T20) and A-weighted sound pressure level after treatment, although the T20 response varied depending on the source condition and receiving position. In addition, C50 decreased after treatment, suggesting a change in the balance between early and late sound energy rather than a direct improvement in speech clarity. The findings demonstrate that integrating plaster-based acoustic materials into functional architectural elements provides a practical approach to improving acoustic environments while supporting sustainable architectural design.

Tue 16:00–17:40 — Riverbank Room 8 (Chair: Shanjun Liang, Long Chen)

16:00: Paper 656 — Absorption of textiles, curtains and perforated panels: updated comparison of theory, measurement and practice — *Mr Cameron Hough*

16:20: Paper 672 — Distribution-Based Microstructural Modeling for Sound Absorption Prediction in Fibrous Porous Materials — *Mr Do Yong Kim*

16:40: Paper 697 — Strategies for reducing air leaks and edge constraints in transmission loss measurements of rigid, non-porous, dense materials in impedance tubes — *Mr Jonty Mago*

17:00: Paper 681 — Sound Absorption Characteristics of Hybrid Acoustic Meta-Surfaces Comprising Triply periodic minimal surfaces and Helmholtz Resonators — *Mr Keigo Kuwata*

17:20: Paper 698 — Diffuse-field sound transmission loss estimation for multilayer composite panels developed from end-of-life high-density polyethylene shampoo bottles and jute caddies — *Mr Jonty Mago*

16:00 **Paper 656 — Absorption of textiles, curtains and perforated panels: updated comparison of theory, measurement and practice**

Mr Cameron Hough, *Dr Harvey Law*

Understanding the absorptive properties of surfaces is essential to an understanding of the acoustic performance of a room. Protective facings in the form of fabrics or perforated/slotted facings are often used to cover acoustic absorbers and sometimes act as absorbers in their own right. While the performance of these facings can often be predicted with good accuracy by existing transfer matrix theory and commercial software packages, the agreement with measurements is less good for perforated facings, for very low or high flow resistivity fabrics or for fabrics sewn with fullness. Building on recent research by the authors evaluating the accuracy of engineering methods for predicting or measuring textile sound absorption, this paper extends the discussion to investigate the effect of the fabric pleat geometry on curtain absorption. A

comparison of predicted and measured absorption coefficients of pleated fabric and fabric with perforated facings is made comparing theory, in-situ measurements and measurements within a reduced size AlphaCabin and full-scale reverberation chamber.

16:20 **Paper 672 — Distribution-Based Microstructural Modeling for Sound Absorption Prediction in Fibrous Porous Materials**

***Mr Do Yong Kim**, Mr Jung Wook Lee, Mr Jin Hyung Lee, Prof Yeon June Kang*

Sound absorption prediction in fibrous porous materials depends strongly on how microstructural information is represented in the modeling process. Conventional microstructure-informed approaches often rely on a single representative section to characterize the material, implicitly neglecting spatial variability inherent to fibrous media. This simplification can limit predictive accuracy even when physically sound equivalent-fluid models are employed.

In this study, a distribution-based microstructure modeling approach is presented to investigate the effect of patch-to-patch variability on sound absorption prediction. High-resolution micro-CT images of PET felt materials were segmented into multiple overlapping patches, from which microstructural descriptors were extracted. Patch-wise non-acoustic transport parameters were obtained using pore-scale finite-element simulations.

The ensemble of patch-level transport parameters was propagated through the Johnson–Champoux–Allard equivalent-fluid model to predict macroscopic normal-incidence sound absorption. Predicted absorption coefficients were compared with impedance-tube measurements.

The results demonstrate that explicitly accounting for microstructural variability improves agreement with experimental absorption data compared with representative-section approaches, highlighting the importance of distribution-aware modeling for fibrous porous materials.

16:40 **Paper 697 — Strategies for reducing air leaks and edge constraints in transmission loss measurements of rigid, non-porous, dense materials in impedance tubes**

***Mr Jonty Mago**, Prof J. Stuart Bolton, Dr. S. Fatima*

Accurate measurements of normal-incidence sound transmission loss (STL) for rigid, non-porous, dense materials in an impedance tube require control of boundary conditions to ensure results align with the Mass Law. In practice, two mounting issues were observed: air leaks occurred when specimens were cut slightly smaller than the tube diameter, and edge-constraint effects arose when specimens fit too tightly, preventing a free–free boundary condition. In this study, normal-incidence STL was measured for commercial 6 mm-thick polycarbonate and acrylic panels, and for recycled polypropylene panels, using a four-microphone impedance tube and the two-load method (ASTM E2611). Several mounting strategies were evaluated. Circumferential sealing with Teflon tape (3–5 layers) and 3D-printed ring holders of varying diameters reduced leakage; however, these methods introduced edge stiffness and did not consistently demonstrate Mass Law behavior across frequencies. Petroleum jelly was tested as a sealant, but its high viscosity limited its penetration into peripheral gaps, leading to unreliable results. In contrast, a low-viscosity, water-based lubricant effectively penetrated edge gaps and provided sealing without artificial stiffening. With water-based lubricant sealing, measured STL followed Mass Law predictions for all three materials and was repeatable across tube sizes. Based on these findings, a step-by-step mounting protocol was developed.

17:00 **Paper 681 — Sound Absorption Characteristics of Hybrid Acoustic Meta-Surfaces Comprising Triply periodic minimal surfaces and Helmholtz Resonators**

***Mr Keigo Kuwata**, Dr Akiko Sugahara, Prof. Yasuhiro Hiraguri*

Composite structures combining porous materials and resonators are expected to achieve broadband sound absorption, including at low frequencies. This study proposes a Hybrid Acoustic Meta-Surfaces that integrates Triply Periodic Minimal Surfaces (TPMS) with a helmholtz resonator using additive manufacturing technology. TPMS is a class of three-dimensional periodic structures composed of mathematically defined smooth minimal surfaces.

First, numerical analysis was conducted to examine the relationship between geometric parameters and sound absorption characteristics for various TPMS types (e.g., Gyroid), with the lattice size and porosity fixed at 4 mm and 70%, respectively.

The results revealed that while there were no significant differences in the peak absorption frequencies, geometries with larger surface areas exhibited higher sound absorption coefficients due to enhanced viscous dissipation. Furthermore, decreasing the lattice size improved the peak absorption, while reducing the porosity shifted the absorption peak toward lower frequencies and increased its sharpness, likely due to an increase in effective density.

Next, the hybrid structure, featuring TPMS arranged around the resonator's neck, exhibited two distinct sound absorption peaks. These results demonstrate that the proposed Hybrid Acoustic Meta-Surfaces achieves a significantly broader absorption bandwidth compared to a single resonator.

17:20 **Paper 698 — Diffuse-field sound transmission loss estimation for multilayer composite panels developed from end-of-life high-density polyethylene shampoo bottles and jute caddies**

Mr Jonty Mago*, Prof J. Stuart Bolton, Dr. S. Fatima*

Two challenges have increased the demand for sustainable sound-insulating materials: environmental noise pollution and the growing generation of solid waste, including post-consumer plastics, agro-residues, and electronic waste. Although sound-insulating materials, such as steel and concrete, are effective at reducing noise, they are heavy and resource-intensive. In response, multilayer composite panels were fabricated using end-of-life high-density polyethylene bottles and jute caddies through compression molding. The normal-incidence sound transmission loss (STL) of these panels was measured using a four-microphone impedance tube (ASTM E2611) and verified against the Mass Law. In practical environments, since sound impinges from multiple directions, diffuse-field (random-incidence) STL is required to assess sound insulation performance. However, for novel materials, direct diffuse-field STL testing is not feasible at the development stage because it requires larger panels. Therefore, the diffuse-field STL was estimated using the Cremer–Heckl model. The panels were characterized to provide inputs for diffuse-field calculations, including density (ASTM D792), tensile modulus (ASTM D638), and damping ratio (ASTM E756). The estimated diffuse-field STL was benchmarked against polycarbonate and acrylic panels.

Stream 4: Human Factors

4.1.1 Community Noise & Health: General

Tue 09:00–09:40 — Riverbank Room 5 (Chair: Tin Oberman, Stefan Jacob)

09:00: Paper 8 — Extreme-Event Dynamics in Noise and Traffic as Determinants of Occupational Strain in Traffic policemen at Urban Traffic Junctions — *Mr Bhanu Chaudhary*

09:20: Paper 776 — Field survey on sound exposure of instructors in after-school childcare activities using personal noise dosimeter — *Dr Sakae Yokoyama*

09:00 **Paper 8 — Extreme-Event Dynamics in Noise and Traffic as Determinants of Occupational Strain in Traffic policemen at Urban Traffic Junctions**

Mr Bhanu Chaudhary, *Dr. Bhaven Tandel, Dr Manoranjan Parida*

Urban traffic junctions represent complex environments where sudden fluctuations in vehicle flow produce short-duration noise spikes that may impose substantial physiological and psychological burdens on exposed personnel. This study examines extreme-event dynamics in noise and traffic as determinants of strain among traffic policemen at signal-controlled junctions in a major Indian city. Noise monitoring was conducted using a Class-1 sound level meter and noise-dose instrumentation, capturing continuous levels (Leq), maximum sound pressure levels (Lmax), temporal peak excursions, and dose accumulation across duty hours. Parallel traffic counts quantified Vehicular volume, composition, and flow irregularities were analyzed to characterize burst-based dynamics. Occupational strain was assessed through physiological indicators, psychometric responses, and self-reported discomfort. Preliminary results indicate that peak acoustic excursions, rather than average noise levels alone, have a stronger correlation with acute fatigue, irritability, and reduced alertness. Duty zones with erratic traffic bursts and a high percentage of heavy vehicles generated more frequent extreme noise events, leading to increased strain markers. These findings highlight the limitations of traditional noise metrics for assessing health risks among frontline staff and underscore the importance of peak-sensitive exposure standards and fatigue-aware deployment strategies. The study provides a human-centered perspective for urban acoustic health policies in developing cities.

09:20 **Paper 776 — Field survey on sound exposure of instructors in after-school childcare activities using personal noise dosimeter**

Dr Sakae Yokoyama, *Tomohiro Kobayashi, Professor Hisao Funaba*

In Japan, after-school care facilities are often very overcrowded and noisy. The authors conducted a field survey of childcare instructor's noise exposure during after-school activities using personal noise dosimeter, focusing on noise-induced hearing loss in noisy workplaces. A questionnaire survey was also conducted among the instructors regarding the impact of the sound environment during childcare activities on their own and the children's hearing. The survey results showed that the averaged noise exposure level was around 80 dB, and the instructors were concerned about the impact on their own and the children's hearing. Some childcare instructors also experienced symptoms such as tinnitus. One of the reasons for this situation is thought to be a lack of sound absorption in after-school care facilities, as there are no established guidelines for maintaining an appropriate sound environment like in elementary schools and nurseries. In this study, porous sound absorption material was installed on the walls of the after-school care facility and the physical and subjective effects were also investigated. Results indicated that the reverberation time in the room was shorter than before the sound absorption was implemented, and instructors noted that the reverberation was reduced, making it easier to hear children's voices.

Tue 10:40–11:40 — Riverbank Room 5 (Chair: Arvind Deivasigamani, James Mcintosh)

10:40: Paper 538 — Questionnaire survey on auditory stimulation in public transport facilities: Comparison between HSP and non-HSP — *Dr Hanui Yu*

11:00: Paper 646 — Towards quantifying the disease burden of road traffic noise in Japanese cities: exploring a DALY-based approach — *Dr Kazunori Harada*

11:20: Paper 260 — A framework for health-based road-traffic noise assessments in New Zealand — *Mr Michael Smith*

10:40 **Paper 538 — Questionnaire survey on auditory stimulation in public transport facilities: Comparison between HSP and non-HSP**

***Dr Hanui Yu**, Ms. Xiaoya Xu, Prof Tetsuya Sakuma*

Sound environments in public transport facilities are generally designed for typical users; however, individuals with a highly sensitive temperament, such as Highly Sensitive Persons (HSPs), may experience greater discomfort and fatigue in response to the same auditory stimuli. This study aims to investigate differences between HSP and non-HSP users in perceptions of auditory stimulation caused by specific noise sources in public transport facilities, and to identify the acoustic characteristics of rest areas preferred by HSPs. An online survey was conducted among public transport users in Japan, collecting 317 responses. The questionnaire included measures of sensitivity to major noise sources, avoidance and coping behaviors in response to auditory stimuli, preferred acoustic features of rest areas, and the Japanese version of the Highly Sensitive Person Scale (HSPS-J19). Respondents were classified into HSP and non-HSP groups based on HSPS-J19 scores. This study explores distinct trends in auditory discomfort and coping behaviors between the two groups and examines how HSP traits may relate to perception of environmental noise in public transport facilities. The findings are expected to provide insights into designing inclusive acoustic environments and rest spaces within public transport facilities that accommodate users with heightened sensory sensitivity.

11:00 **Paper 646 — Towards quantifying the disease burden of road traffic noise in Japanese cities: exploring a DALY-based approach**

***Dr Kazunori Harada**, Prof. Yasuhiro Hiraguri, Dr Takuya Oshima, Dr Yoshinori Saito, Dr Satoshi Atobe, Dr Shinichi Sakamoto*

Based on recent studies regarding road traffic noise mapping in Tennoji Ward and Higashiosaka City, which evaluated High Annoyance (HA) and Ischaemic Heart Disease (IHD) separately, this study extends the analysis to a unified health metric. Disability-Adjusted Life Years (DALYs), which combine mortality and morbidity into a single index, were estimated for both HA and IHD under a reference scenario and three noise mitigation scenarios in each city. Building-level population estimates derived from open data were used in conjunction with strategic noise maps based on the ASJ RTN-Model 2018. In the reference scenario, HA-attributable DALYs were estimated at 197 per 100,000 population in Tennoji Ward and 97 per 100,000 in Higashiosaka City, approximately 19 and 12 times larger than the corresponding IHD values (10 and 8 per 100,000), respectively. The most effective mitigation scenario reduced HA-attributable DALYs by 6.4% (light vehicle noise reduction) in Tennoji Ward and by 2.3% (porous asphalt pavement) in Higashiosaka City, demonstrating that the optimal mitigation strategy depends on urban morphology.

11:20 **Paper 260 — A framework for health-based road-traffic noise assessments in New Zealand**

Mr Michael Smith

Acoustics assessments for road-traffic projects in New Zealand traditionally seek to determine what noise levels are 'reasonable'. That judgement embeds assumptions about public benefit without evidence-based justification, and conflates technical evaluation with value judgements about project appropriateness. It should belong with decision-makers who weigh community impacts against project benefits. Some jurisdictions avoid the question by applying prescriptive mitigation rules, but these do not provide decision-makers with evidence of the residual noise effect.

This paper presents an alternative framework that removes reasonableness judgements from technical assessment. It quantifies public health impacts using disability-adjusted life years (DALYs) for annoyance, sleep disturbance, and ischaemic heart disease. It characterises likely subjective response using five ordered categories: not present, present

and not intrusive, present and intrusive, present and disruptive, and present and very disruptive. Categories are informed by absolute predicted levels and the existing acoustic environment. Neither output reaches a conclusion on acceptability, which sits with the decision-maker.

The framework has been applied to a New Zealand state highway project in parallel with the traditional approach. The paper describes the framework, its evidence basis, the application, and open questions including the role of public health interpretation, where local expertise is often limited.

4.1.3 Sound Driven Place Making and Urban Planning

Wed 08:40–09:40 — Panorama Room 3 (Chair: Jesse Budel, Luigi Maffei)

08:40: Paper 48 — Subjective experiences and acoustic metrics in a small urban village — *Prof Luigi Maffei*

09:00: Paper 253 — Unveiling tranquility in urban public space and its influencing factors at the community scale — *Dr Shan Shu*

09:20: Paper 98 — Designing with acoustics, not after it: integrating acoustic analysis into BIM as a continuous design input — *Mr Joshua Winning*

08:40 **Paper 48 — Subjective experiences and acoustic metrics in a small urban village**

Prof Luigi Maffei*, Prof Massimiliano Masullo, Dr Roxana Adina Toma*

The main sources of environmental noise in urban environments are road traffic and human activity; these factors are more intense in large urban agglomerations than in small urban centers, with varying impacts on the regulation of subjective experience. Moreover, in recent decades, research on urban environments has focused primarily on three key areas: small urban green parks, cultural/historical spaces, and urban recreational spaces, to enhance a sense of well-being and facilitate socialization and interaction between individuals.

To investigate the aforementioned key areas and the variations in subjective experiences in small urban contexts, this study was conducted in the tiny village of Sant'Agata de' Goti. The aim was to highlight the relationship between acoustic/psychoacoustic metrics, the environment's ability to be regenerative, and its influence on people's experiences.

Results indicate that the Equivalent Sound Levels and Loudness metrics are negatively correlated with the sense of Being-Away of individuals, while increases in Roughness are associated with a deterioration of perceptual/emotional experience.

09:00 **Paper 253 — Unveiling tranquility in urban public space and its influencing factors at the community scale**

Dr Shan Shu*, Mengxue Wang, Dr Xuechuan Geng*

Urban tranquil spaces are important components of high-density urban environments, and their quality plays a key role in residents' mental and physical well-being. However, the characteristics and influencing factors of urban tranquility have not been thoroughly explored at community scales. In this study, 33 candidate tranquil spaces in the central urban area of Qingdao, were selected and assessed through multi-source data. Preliminary results indicate a three-tier classification: fully tranquil (12), potential tranquil (10), and non-tranquil spaces (11), with significant differences in perceived tranquility and restorative outcomes across space types. Principal component analysis of semantic evaluations identifies three perceptual dimensions—emotional friendliness, acoustic naturalness, and visual richness—accounting for 57.68% of total variance, with emotional friendliness being the dominant factor. Individual characteristics, particularly noise sensitivity, also significantly moderated tranquility perception. The noise contrast (difference between central and boundary LAeq) was the most influencial acoustic factor for the tranquil perception of public space. These findings provide empirical guidance for the identification and optimization of urban tranquil spaces and highlight the value of integrating multi-source data in urban noise management and health-oriented public space planning.

09:20 **Paper 98 — Designing with acoustics, not after it: integrating acoustic analysis into BIM as a continuous design input**

Mr Joshua Winning

Architectural acoustic analysis is routinely performed as a downstream verification task, applied after key design decisions have been made, limiting the ability of acoustic considerations to influence design outcomes and reducing the capacity for acoustic feedback to keep pace with design development. This paper describes a framework for integrating acoustic analysis directly within a building information modelling environment, enabling assessment to occur continuously throughout the design process. The framework interprets room functions, building elements, and adjacency relationships from structured model data, maps these to acoustic performance criteria derived from applicable standards, and embeds analysis outputs

directly into the design model. Results update automatically as the design changes, removing the need for repeated manual data extraction. The framework is demonstrated through application to a multi-room commercial building layout, where room classification, partition performance requirements, and compliance status are determined and visualised within the live model. Comparison with conventional workflows highlights reductions in data preparation effort and improvements in analytical consistency. By positioning acoustic analysis as a continuous design input, the framework enables acoustic performance to be considered at the point where design decisions remain open to change.

Wed 10:20–11:40 — Panorama Room 3 (Chair: Jesse Budel, Luigi Maffei)

10:20: Paper 384 — Impact of Acoustic Environments on User Experience in Podium Roof Gardens within High-Density Districts — *A/Prof Zhixiao Deng*

10:40: Paper 425 — Exploring Participatory Sound Practices as Reflective Tools in Sound-driven Placemaking and Urban Planning — *Ms Sissel Raahede Lundgård*

11:00: Paper 519 — An Overview of Noise Control Regulations in Shanghai and Acoustic Environment Analysis in Typical Acoustic Functional Zone — *Dr Xiaonan Wang*

11:20: Paper 544 — Characterising urban open public spaces through acoustic, environmental and neighbourhood properties to determine potential quiet areas in European cities — *Ms Núria Blanes Guàrdia*

10:20 **Paper 384 — Impact of Acoustic Environments on User Experience in Podium Roof Gardens within High-Density Districts**

A/Prof Zhixiao Deng

As vital urban green spaces, roof gardens serve to mitigate heat islands and facilitate psychological restoration. However, in high-density blocks, podium roofs often face complex acoustic environments where equipment and traffic noise severely limit spatial quality and usage frequency. This study investigates 12 typical podium roof gardens in downtown Kunming using field measurements, image analysis, and ISO/TS 12913-2 aligned surveys (n = 187) to analyze acoustic characteristics and user perception. Results indicate that: (1) The acoustic environment was dominated by traffic, equipment, and construction noise, with Leq levels of 53.9–65.9 dB(A) and spectral energy concentrated in the low-frequency range (25–500 Hz), coupled with a scarcity of natural sounds; (2) These noise sources significantly reduced Acoustic Satisfaction (AS) and Overall Satisfaction (OS), whereas exposure to natural sounds enhanced pleasantness and calmness; and (3) Both AS and OS were negatively correlated with the building view factor but positively correlated with the Sky View Factor (SVF). The study suggests prioritizing low-frequency noise mitigation and audio-visual co-design to balance dynamism with tranquility.

10:40 **Paper 425 — Exploring Participatory Sound Practices as Reflective Tools in Sound-driven Placemaking and Urban Planning**

Ms Sissel Raahede Lundgård

The soundscape approach has emphasized perception and lived experience in understanding urban acoustic environments. However, methodological challenges remain in accessing the socio-cultural dimensions of listening experience and translating such knowledge into sound-driven urban design. While participatory methods such as soundwalks are widely used for evaluation, fewer studies examine how participatory sound practices may function both as tools for eliciting experiential knowledge and as reflective tools within design-oriented processes.

This paper explores this dual methodological potential through participatory listening, recording, and soundscape composition, investigating how such practices may operate as generative mechanisms for translating situated and embodied listening experience into early-stage design thinking. A small-scale workshop with audio design students serves as a methodological experiment in developing participatory sound practices as reflective tools for sound-driven placemaking and urban planning.

Drawing on design theory, the workshop is framed as a generative device through which knowledge emerges in and through making, enabling the articulation and negotiation of current and alternative sonic futures. Addressing the persistent gap between soundscape theory and practice, the paper argues for a turn towards research-through-design as a framework in which inquiry and design are understood as intertwined, mutually informing processes.

11:00 **Paper 519 — An Overview of Noise Control Regulations in Shanghai and Acoustic Environment Analysis in Typical Acoustic Functional Zone**

***Dr Xiaonan Wang**, Mr Changqing Liu, Ms Weichen Zhang, Ms Yiping Chu, Ms Jiahong Wu*

This paper provides a systematic overview of noise control regulations and acoustic environmental analysis in Shanghai. Based on China's national environmental noise prevention and control law, the local regulatory framework in Shanghai, including specific ordinances and management measures targeting the four major noise sources: transportation, social activity, industrial, and construction noise is introduced. These regulations adopt an integrated approach combining planning control, engineering solutions, time restrictions, and administrative supervision.

On this basis, the study selects several typical acoustic functional zones in Shanghai according to the nation's acoustic zoning system. Using long-term noise monitoring data, the acoustic environmental characteristics of these zones are analyzed. All selected zones exhibit recurring nighttime noise exceedances, reflecting a widespread challenge in urban noise management. Through noise source identification and classification, the study further examines the causes of exceedances based on the characteristics of dominant noise sources in each zone and discusses further improvement strategies. The findings offer practical references for urban noise control planning and policy refinement in Shanghai and other high-density cities, contributing to the global discussion on sustainable urban soundscape management.

11:20 **Paper 544 — Characterising urban open public spaces through acoustic, environmental and neighbourhood properties to determine potential quiet areas in European cities**

***Ms Núria Blanes Guàrdia**, Mr Miquel Sáinz de la Maza, Ms Anna Badia*

This paper presents an integrated acoustic and non-acoustic assessment of urban open public spaces in European cities, aiming to broaden the range of areas that may be designated as quiet areas under the Environmental Noise Directive (2002/49/EC) and potentially incorporated in the noise action plans. Barcelona is used as a demonstration case, but the methodology uses European-scale datasets ensuring its applicability to any city in Europe.

The END highlights the need to preserve quiet areas inside urban areas and in open country. Current European assessments are largely focused on assessing quietness in green urban areas. Soundscape research examines the physical and environmental characteristics of the area in combination with acoustic properties, highlighting as well, the influence of surrounding neighbourhoods on perceived sound quality.

Building on these insights, this paper proposes a methodological framework that focuses on the characterisation of open public spaces, while situating them within their immediate urban context, defined as each space's accessible service area, will be addressed in a later stage of the research. Spatial analysis is used to derive the acoustic, environmental, spatial, and physical characteristics of the public space itself, providing an integrated basis to support the identification of potential quiet urban areas.

4.1.4 Environmental Impact Assessment

Tue 09:00–09:40 — Riverbank Room 8 (Chair: Norm Broner, Arvind Deivasigamani)

09:00: Paper 271 — AI-Based Classification of Construction Vibration Waveforms for Environmental Management Applications — *Dr Aryan Sharma*

09:20: Paper 734 — Spatio-temporal and Frequency-domain Assessment of Residential Outdoor Noise during Festive Fireworks in Urban India — *Dr Harish C. Phuleria*

09:00 **Paper 271 — AI-Based Classification of Construction Vibration Waveforms for Environmental Management Applications**

***Dr Aryan Sharma**, Mr Michael Manraj Darroch, Mister Ben Cooper-Woolley, Dr Benjamin Halkon, Mr Aaron Miller*

Environmental vibration monitoring on construction sites relies on exceedance-based metrics such as Peak Particle Velocity, yet interpretation of these exceedances remains manual and context-dependent. In practice, exceedances may arise from genuine construction activity, non-construction sources, or incidental human interaction with monitoring equipment. This ambiguity presents challenges for environmental practitioners, particularly where vibration standards apply more stringent criteria to continuous vibration sources.

This paper presents a proof-of-concept application of machine learning techniques to classify vibration exceedance waveforms using time–frequency representations. Vibration time-series captured during exceedance events were transformed into spectrograms and used as inputs to a convolutional neural network trained to distinguish construction-related vibration from non-construction or human-induced events. The approach draws on methodologies previously demonstrated for AI-based construction noise classification, adapted here to vibration monitoring data.

Initial results indicate that impulsive, short-duration events and sustained construction vibration exhibit distinct spectral characteristics that can be separated using spectrogram-based models. While dataset size limits conclusions regarding generalisation, the findings demonstrate the feasibility of vibration waveform classification as a decision-support tool. The proposed approach has potential to assist practitioners in triaging exceedances, identifying continuous vibration behaviour relevant to standards such as BS 7385-2, and improving the efficiency and transparency of vibration impact management.

09:20 **Paper 734 — Spatio-temporal and Frequency-domain Assessment of Residential Outdoor Noise during Festive Fireworks in Urban India**

*Dr Avnish Shukla, Mr. Ravi Kiran Dharavath, **Dr Harish C. Phuleria***

Festive celebrations involving fireworks cause a short-term, but intense, increase in environmental noise, raising concerns about exposure and its associated public health impacts. This study characterizes the temporal, spatial, and frequency-domain variability of ambient noise during the Diwali festival in India. Continuous sound level monitoring was conducted over six days at the façade level (balconies) of five residential apartments in Mumbai, covering pre-festival, festival, and post-festival phases using calibrated sound level meters.

Results indicate an 8-15dB(A) increase in sound levels during the festival period compared to pre-festival conditions, with maximum levels frequently exceeding 75-85dB(A) during evening and nighttime hours. Octave-band analysis showed enhanced sound energy in the 500Hz-4kHz range, with peaks at 630Hz, 1kHz, and 2kHz, indicating dominant impulsive firecracker noise harmful to human hearing. Post-festival measurements showed a gradual return toward baseline levels, confirming the episodic nature of festival-related noise exposure. A linear mixed-effects model with monitoring site as a random intercept confirmed a significant increase in LAeq during the festival relative to pre-festival conditions (ΔLAeq = +1.67 dB; 95% CI: 0.07–3.27 dB; p = 0.04), with substantial inter-site variability. These findings highlight the need for targeted noise control and enforcement strategies during festive periods in urban environments.

4.1.5 Community Response to Noise

Mon 16:00–17:20 — Riverbank Room 4 (Chair: Norm Broner, Lars Sommer Søndergaard)

16:00: Paper 214 — Research on Chinese Residents' Subjective Evaluation of Impact Sound in Residential Buildings — *Miss Yuying Zou*

16:20: Paper 190 — The correlation between brain responses and subjective annoyance under natural sound masking of road traffic noise based on fNIRS — *A/Prof Jun Cai*

16:40: Paper 731 — Investigation of Resident Perception of Noise and Vibration from a New Open Metro Line in Ho Chi Minh City, Vietnam — *Mr Takumi Shimomura*

17:00: Paper 216 — Research on residents' subjective evaluation of airborne sound insulation performance in Chinese residential buildings — *Miss Mengjin Liu*

16:00 **Paper 214 — Research on Chinese Residents' Subjective Evaluation of Impact Sound in Residential Buildings**

***Miss Yuying Zou**, Dr. Chao Wang, Prof. Jian Kang, Prof Hui Ma*

The updated GB 55038-2025 Residential Project Specifications stipulated that the weighted normalized impact sound pressure level of floor slabs shall not exceed 65 dB. However, previous research indicated that even when objective test results meet the standard requirements, residents still experience annoyance. This study conducted a questionnaire among Chinese residents, using annoyance to assess perceived acoustic environments and to investigate factors influencing subjective evaluations of impact sound. Statistical analyses indicated that Chinese residents reported significantly higher annoyance from sounds such as dragging furniture, dropping objects, and running or jumping, and the type and time period of impact sounds exerted an interactive effect on annoyance evaluation. Among non-acoustic factors, noise sensitivity showed a significant negative correlation with annoyance, while age and gender also exhibited observable trends influencing annoyance. In addition, residents' subjective evaluations of commonly used sound insulation measures were investigated, showing a preference for solutions that are easy to install. Given that current noise control policies rarely incorporate subjective evaluations, the findings suggest that such policies should account for differences in impact sound sources, temporal characteristics, and population-related factors to support more targeted improvements, while also considering residents' subjective responses and the practicality of mitigation measures in daily use.

16:20 **Paper 190 — The correlation between brain responses and subjective annoyance under natural sound masking of road traffic noise based on fNIRS**

*Mr. Yuxuan Song, Mr. Pengfei Li, **A/Prof Jun Cai***

Urban road traffic noise is a growing environmental concern, and noise masking offers a alternative solution. However, the underlying neural mechanisms of natural sound masking of noise remain unclear. Here, the brain's physiological responses to natural sound masking (birdsong and water sound) was explored by utilizing functional near-infrared spectroscopy (fNIRS). And the subjective annoyance was correlated with brain activation and functional connectivity. Results revealed that masking conditions significantly reduced annoyance compared to road traffic noise condition. Birdsong and water sound masking increased activation in right superior temporal gyrus and right middle temporal gyrus, which are positively correlated with the annoyance reduction percentage. Birdsong masking globally decreased the connections between brain regions and neighboring brain regions at the group level, which is negative correlated with the annoyance reduction percentage. These findings demonstrate that natural sound masking can modulates brain network topology and functional connectivity, offering insights into effective noise-masking strategies.

16:40 **Paper 731 — Investigation of Resident Perception of Noise and Vibration from a New Open Metro Line in Ho Chi Minh City, Vietnam**

Mr Takumi Shimomura

Traffic noise has become increasingly serious in many Asian countries due to rapid economic development, while effective countermeasures remain limited because of insufficient survey data. In Ho Chi Minh City (HCM), motorcycle traffic is a major noise source, and the introduction of a new metro system is expected to further affect residents' perceptions. This study

investigates the exposure–response relationship for railway and its interaction with road traffic noise. Field measurements of noise and vibration were conducted over 24 hours, alongside a questionnaire survey on noise annoyance. The results indicate that railway noise may induce higher annoyance than road traffic noise at the same noise level, suggesting the absence of a "Railway bonus". In addition, longer time spent at home was associated with increased annoyance for both noise sources. For road traffic noise, environmental vibration was found to influence annoyance, potentially reflecting traffic characteristics, beyond noise level alone. These findings have implications for urban noise management and future metro planning in HCM, suggesting the need to consider not only noise levels but also residents' exposure patterns and the interaction between noise and vibration when designing mitigation measures such as noise barriers and traffic management strategies.

17:00 **Paper 216 — Research on residents' subjective evaluation of airborne sound insulation performance in Chinese residential buildings**

***Miss Mengjin Liu**, Dr. Chao Wang, Prof Hui Ma*

In 2025, China introduced the "Good House" policy nationwide. Acoustic environment is one of the most crucial parts in residential buildings, influencing the satisfaction and happiness of residents. To investigate the current situation of airborne sound insulation and the factors influencing subjective evaluation, this study conducted an online questionnaire. A total of 826 valid questionnaires were collected. Statistical analysis revealed that noises transmitted through windows caused the highest annoyance. For neighbor noises, when the noises were clearer and easier to distinguish, they caused higher annoyance, and respondents felt more annoyed when they could tell the direction of the noises. Among non-acoustic factors, noise sensitivity significantly affected the overall evaluation of the acoustic environment. The more sensitive respondents were to noise, the lower their satisfaction with the acoustic environment. This effect was highly stable across different age and gender groups. The above analysis indicated that to improve airborne sound insulation, the sound insulation performance of windows and exterior walls needed to be enhanced first. Noise evaluation should consider incorporating the clarity and distinguishability of noises to better assess the influence of neighbor noises. Finally, the characteristics of specific groups, such as noise-sensitive people, should also be gradually incorporated into noise policies.

Tue 16:00–17:20 — Riverbank Room 4 (Chair: Norm Broner, Granger Bennett)

16:00: Paper 695 — Identification of Metrics to Assess Community Response to Live Amplified Outdoor Music — *Ms Dana Lodico*

16:20: Paper 700 — Noise Annoyance Modelling for the Heterogeneous Transportation System: A Psychoacoustic Approach — *Dr Manish Manohare*

16:40: Paper 450 — Temporal Noise Exposure as a Hidden Driver of Urban Stress and Fatigue — *Mr Jeremiah Akinlade*

17:00: Paper 811 — A calibration method of noise annoyance data from listening tests — *A/Prof Guoqing Di*

16:00 **Paper 695 — Identification of Metrics to Assess Community Response to Live Amplified Outdoor Music**

Ms Dana Lodico

Sounds from outdoor amplified music concerts, including low frequency sounds, are a common cause of noise complaints in urban and suburban areas. These are generally not well addressed by existing noise ordinance limits and regulations, as indicated by neighborhood complaints persisting even when event sound levels are below background levels. This paper describes metrics that may better represent community acceptance of these facilities.

16:20 **Paper 700 — Noise Annoyance Modelling for the Heterogeneous Transportation System: A Psychoacoustic Approach**

Dr Manish Manohare

Road traffic noise is a major contributor to the urban acoustic environment, particularly in developing countries such as India, where transportation systems are highly heterogeneous. Indian urban streets are characterised by a mix of two, three and four wheelers, irregular lane discipline, variable speeds and frequent honking, leading to complex and highly modulated noise conditions. This study models annoyance responses to such traffic environments using a controlled

laboratory listening experiment. Sixty participants participated in rating annoyance level associated with traffic noise stimuli recorded from different street types in India. Psychoacoustic parameters, including loudness, sharpness and roughness, were extracted and analysed using a linear regression framework to estimate the noise annoyance. The results show that loudness is the dominant predictor ($\beta = 2.302$, $p < 0.001$). Fluctuation strength ($\beta = 0.228$, $p < 0.001$) and roughness ($\beta = 0.156$, $p = 0.004$) also significantly increased annoyance probability, while demographic factors such as age and noise sensitivity exhibited comparatively smaller effects. The model explained 52.2% of the variance in annoyance responses ($R^2 = 0.522$), supporting a psychoacoustic-based exposure–response framework for complex urban transport environments.

16:40 **Paper 450 — Temporal Noise Exposure as a Hidden Driver of Urban Stress and Fatigue**

Mr Jeremiah Akinlade*, Dr Oludare Owolabi*

Urban noise assessment has long relied on instrumental sound metrics that overlook how residents experience and interpret noise in daily life. This study explores temporal noise exposure as a perceived contributor to urban stress and fatigue through in depth feedback from individuals living in diverse urban neighborhoods. Residents across areas with contrasting land use patterns, activity rhythms, and socioeconomic conditions are being engaged using structured questionnaires and semi structured interviews. The survey design captures perceived noise variability, unpredictability, timing of disturbance, and recovery periods alongside self reported stress, fatigue, sleep disturbance, and perceived control over the acoustic environment. Rather than concentrating on environmental loudness, the analysis examines how noise unfolds over time from the perspective of those exposed. Early evidence suggests that intermittent and unpredictable noise is experienced as more exhausting and stressful than consistently elevated sound levels. Responses further indicate that residents in historically underserved communities report reduced ability to anticipate or respond to disruptive temporal noise, revealing an experience based dimension of acoustic inequality. By foregrounding lived experience and community voice, this work reframes environmental noise as a temporal and social exposure rather than a purely physical quantity. Ongoing analysis seeks to inform more inclusive noise evaluation practices.

17:00 **Paper 811 — A calibration method of noise annoyance data from listening tests**

A/Prof Guoqing Di

Annoyance is one person's individual adverse reaction to noise. Noise annoyance is an important basis for determining the acceptability of environmental noise exposure and formulating environmental noise standards. Short-term noise annoyance can be determined through listening tests in laboratory. Subjects act as measuring instruments in listening tests of noise annoyance. However, noise annoyance of different subjects induced by an identical noise sample or noise annoyance of a same subject induced by a same noise sample in different experimental groups are different due to the varying psychological scale of subjects. To unify subjects' psychological scale and accurately determine noise annoyance, it is necessary to calibrate the noise annoyance data from listening tests. A previous study compared three kinds of annoyance data calibration methods, i.e., individual annoyance data calibration, sound sample annoyance data calibration, and a combination of both methods, which showed individual annoyance data calibration was the most effective among the three calibration methods. To facilitate readers' better applying the individual annoyance data calibration method, this paper provides a detailed introduction to the corresponding process of listening tests and data calibration.

4.1.6 Acoustics of Safety

Tue 16:20–18:00 — Riverbank Room 7 (Chair: Jeongho Jeong, Glenn Leembruggen)

16:20: Paper 685 — Study on emergency public address system designs considering for vulnerable individuals — *Dr Hyojin Lee*

16:40: Paper 706 — Influence of Wall Absorption Characteristics on Emergency Speech Intelligibility in Noise Barrier Tunnels — *Dr Soonseong Moon*

17:00: Paper 785 — Evaluation of Speech Intelligibility of Firefighter Radio Communication Assistive Devices — *Dr Jeongho Jeong*

17:20: Paper 786 — A Comparative Study on Airborne Sound Transmission Characteristics According to Installation Conditions of Fire Compartment Penetrations — *Dr Seungjea Lee*

17:40: Paper 787 — Acoustic Insulation and Fire Safety Performance of Membrane Materials for Application in Noise Barrier Tunnels — *Dr Jeongho Jeong*

16:20 **Paper 685 — Study on emergency public address system designs considering for vulnerable individuals**

Dr Hyojin Lee, *Dr Jeongho Jeong*

In order to minimize human casualties during a fire, it is important to evacuate as quickly as possible. Fire alarm systems are operated in various ways to alert building occupants of emergencies and urge people to evacuate. In South Korea, these fire alarm systems are generally categorized into siren-based bells and loudspeaker-based emergency public address (PA) systems. However, standardized acoustic guidelines for emergency PA systems remain insufficient. Moreover, the fire alarm systems currently in use are primarily designed for individuals with normal evacuation capabilities, without consideration for vulnerable individuals. This study aims to optimize emergency PA systems by specifically considering the elderly people.

We investigated the auditory characteristics of the Korean elderly and the acoustics features of loudspeakers used in emergency PA systems. Moreover, we conducted an online survey targeting individuals who have experienced fire alarms and emergency broadcasts. The survey investigated fire alarm perception and the critical information needed to initiate early evacuation.

16:40 **Paper 706 — Influence of Wall Absorption Characteristics on Emergency Speech Intelligibility in Noise Barrier Tunnels**

Mr Wanki Moon, ***Dr Soonseong Moon****, Mr Junoh Yeon, Mr Heemo Goo*

This study investigates the measurement and evaluation of speech intelligibility in emergency broadcasting systems installed in noise barrier tunnels under fire emergency conditions, based on the Speech Transmission Index method defined in IEC 60268-16. In enclosed tunnel environments, effective transmission of emergency messages is critical for evacuation safety, while acoustic performance is strongly affected by installation geometry and sound propagation characteristics. Measurements were conducted for two types of directional loudspeakers in both a semi-anechoic chamber and an in-situ noise barrier tunnel. The evaluation considered key parameters including mounting height, loudspeaker orientation, and source-to-receiver distance. Sound pressure levels were also measured under identical conditions to verify compliance with emergency broadcasting requirements. Speech intelligibility was assessed using the STIPA method in accordance with IEC 60268-16, employing both modulated noise signals radiated from the loudspeakers and a standardized speech signal generated by a talk box. The results indicate that sound pressure levels exceeded 80 dB across the tested conditions. In addition, the measured STIPA values were greater than 0.60, corresponding to acceptable intelligibility performance. These results demonstrate that appropriate loudspeaker configuration can ensure both sufficient sound pressure and reliable speech intelligibility, contributing to improved evacuation communication performance in noise barrier tunnels.

17:00 **Paper 785 — Evaluation of Speech Intelligibility of Firefighter Radio Communication Assistive Devices**

Dr Jeongho Jeong, *Dr Soyun Lee, Dr Hyojin Lee, Dr Insu Yeom*

Two-way radios are essential for rapid response and firefighter safety at fire and disaster scenes. Modern systems have evolved into smartphone-type devices that support integrated communication among multiple agencies via data networks. However, firefighter radios must maintain clear voice transmission despite high ambient noise and water exposure during

suppression activities. Previous research has shown that environmental noise and water reduce the Speech Transmission Index (STI), indicating decreased speech intelligibility.

To address these challenges, firefighters use communication assistive devices. This study measured the STI of three devices used with firefighter radios under realistic fireground noise conditions: (1) a communication unit integrated with a self-contained breathing apparatus (SCBA), (2) a personal portable Bluetooth speaker, and (3) Bluetooth earphones.

Results showed that Bluetooth earphones achieved the highest STI among the tested devices. The ranking of STI values aligned with firefighters' subjective evaluations of speech clarity. When fireground noise conditions were included, STI values for all devices decreased.

Improving speech intelligibility in firefighter radio systems requires both hardware enhancements and the adoption of AI-based audio processing technologies. However, the most urgent need is the standardisation of speech intelligibility measurement methods that accurately reflect real-world operational environments.

17:20 **Paper 786 — A Comparative Study on Airborne Sound Transmission Characteristics According to Installation Conditions of Fire Compartment Penetrations**

Dr Jeongho Jeong, ***Dr Seungjea Lee****, Dr Daehoi Kim, Dr Hyojin Lee, Director Inkwon Kim*

In August 2022, a hospital fire in Korea caused five fatalities and 42 injuries due to smoke inhalation. The fire spread from the third to the fourth floor through service penetrations, highlighting the importance of proper installation and maintenance of fire compartment penetration sealing systems. These penetrations must use certified systems that meet the required fire-resistance rating, typically consisting of tightly packed infill materials and surface-applied sealants. However, verifying proper installation has traditionally required destructive inspection, creating the need for a non-destructive assessment method.

This study proposes evaluating the condition of fire compartment penetrations using airborne sound transmission characteristics. Properly sealed penetrations generally provide high airborne sound insulation, particularly at high frequencies. In contrast, penetrations with gaps or insufficient infill show reduced insulation in the mid- to high-frequency range. Airborne sound insulation was measured in accordance with KS F ISO 10140-2 for pipe, duct, cable tray, and bus duct penetrations under various installation conditions. Results over the 100 Hz–5 kHz range showed reduced mid- and high-frequency insulation for defective penetrations. Extending measurements to 20 kHz further clarified performance differences. Acoustic camera imaging successfully identified sound leakage locations, supporting objective inspection and targeted remedial action.

17:40 **Paper 787 — Acoustic Insulation and Fire Safety Performance of Membrane Materials for Application in Noise Barrier Tunnels**

Dr Jeongho Jeong*, Dr Gyewon Park, Dr Myeonghyeon Noh, President Seongjun Choi, President Jangbok Lee*

Following the fire at the noise barrier tunnel on the overpass on the expressway in 2022, public concern regarding the fire safety of noise barrier facilities has increased, particularly in relation to electric vehicle fires. Conventional noise barrier tunnels have primarily been constructed using transparent panels made of PMMA or PC. PC offers improved fire resistance compared with PMMA, further advancements in fire-safe noise barrier tunnel remain necessary. Therefore, alternative materials are required that provide superior fire resistance, minimise acoustic leakage.

Membrane systems are lightweight and can be installed rapidly after erection of the supporting structure. Although the measured sound insulation performance of membrane materials was lower than that of conventional 8–10 mm thick PMMA and PC panels, their relatively small thicknesses (0.8 mm, 1.2 mm) indicate potential advantages in terms of material efficiency.

To investigate fire safety performance, both small-scale and full-scale fire tests were conducted on PMMA, PC, and membrane materials (PVF, PTFE). In small-scale tests, PMMA exhibited the poorest fire performance. PVF membrane material demonstrated a very low fire load and burned rapidly upon flame exposure. Full-scale fire experiments using a model noise barrier tunnel showed that PC performed better than PMMA in terms of fire safety.

4.1.7 Noise and Health in Children

Wed 08:40–10:00 — Riverbank Room 4 (Chair: Jan Spilski, Kanako Ueno)

08:40: Paper 182 — Aircraft Noise Exposure and Reading Performance: The Moderating Role of Teacher Voice Problems in children with migration background — *Mr Jan Spilski*

09:00: Paper 461 — Review of Effects of Environmental Noise on Children's Sleep, Learning, and Physical Fitness and the Benefits of Sleep Improvement Interventions — *Prof Yosiaki Sasazawa*

09:20: Paper 560 — Does moderate exposure to noise at home and school help shaping attentional skills? — *Prof Timothy Van Renterghem*

09:40: Paper 366 — Differential Effects of Biophilic, Social, and Traffic Sounds on Children's Cognitive Performance — *Dr Fei Qu*

08:40 **Paper 182 — Aircraft Noise Exposure and Reading Performance: The Moderating Role of Teacher Voice Problems in children with migration background**

***Mr Jan Spilski**, Dr. Kirstin Bergstroem, Prof. Dr. Thomas Lachmann, Prof. Dr. Maria Klatte*

Previous studies have predominantly reported poorer reading performance among children exposed to high levels of aircraft noise. However, statistically significant aircraft noise effects are often absent for children with a migration background or for children whose first language differs from the language of instruction. This may reflect the fact that prior studies emphasized the direct rather than the indirect effects of aircraft noise on children with a migrant background. To address this research gap, a theory-driven post hoc analysis was conducted, that extended the prediction models of previous studies by adding two influencing factors: teacher voice problems and children's phonological processing functions. Both of these factors can be affected by aircraft noise and are known predictors of reading performance. Associations were tested using a multilevel model with cross-level interactions and robust estimation methods. The analysis was based on data from 1,090 primary school children (651 with a migration background) nested within 84 classes. As expected, a significant cross-level interaction emerged; higher aircraft noise exposure was associated with more frequent teacher voice problems. Teacher voice problems (at the classroom level), in turn, moderated the relationship between phonological processing functions and reading performance, but only in children with a migration background.

09:00 **Paper 461 — Review of Effects of Environmental Noise on Children's Sleep, Learning, and Physical Fitness and the Benefits of Sleep Improvement Interventions**

***Prof Yosiaki Sasazawa**, Prof Thulan Nguyen, Ph.D Makoto Morinaga, Ph.D Dongshik Kang, Master of Education Minoru Kobayashi, Ph.D Yasunori Oka*

Children are sensitive to environmental noise and exhibit both subjective discomfort and physiological stress responses. Daytime noise exposure has been associated with attention deficits and hyperactivity in children, as well as poorer performance on reading comprehension and memory tests. In addition, nocturnal noise exposure disrupts children's sleep, adversely affecting daytime alertness, emotional regulation, learning processes, and immune system function. Epidemiological studies have reported that children residing in areas exposed to aircraft noise demonstrate reduced academic achievement and an increased prevalence of behavioral problems.

Compared with children in other countries, Japanese children have shorter sleep duration and a higher prevalence of insomnia symptoms, indicating widespread chronic sleep insufficiency. Evidence suggests that these sleep problems are associated with declines in academic performance and physical fitness. Furthermore, we report the results of a sleep improvement program implemented among children in Okinawa Prefecture, where environmental noise levels are elevated due to U.S. military base activities. Following the intervention, improvements in sleep parameters were observed, accompanied by gains in academic achievement and physical exercise performance. These findings underscore the potential public health value of sleep-focused interventions in mitigating the adverse developmental and health effects of environmental noise exposure in children.

09:20 **Paper 560 — Does moderate exposure to noise at home and school help shaping attentional skills?**
***Prof Timothy Van Renterghem**, Dr Nele De Poortere, Dr Pieter Thomas, Prof Hannah Keppler, Prof Sarah Verhulst, Prof Dick Botteldooren*

Children at young age undergo rapid cognitive development, yet the role of everyday sound exposure during this stage remains unclear. This study focusses on attentional skills assessed before and after the first year of elementary education, together with personalized monitoring of sound exposure at home and school. While selective attention was mainly related to individual performance, the more complex process of divided attention showed associations with the noise exposure, however in a nuanced way. Higher classroom noise levels at school entry were linked to lower initial divided attention scores, but children exposed to higher levels demonstrated greater improvement over time. Sound exposure at home did not show clear baseline effects, though it interacted with the developmental changes across the year. This research contributes to the growing understanding that in a world filled with noise, developing adaptive strategies with relation to environmental sounds might be useful for cognitive development.

09:40 **Paper 366 — Differential Effects of Biophilic, Social, and Traffic Sounds on Children's Cognitive Performance**
***Dr Fei Qu**, Miss Yun Bai, Dr Cynthia Hou*

Elementary school public spaces critically influence children's cognitive and emotional development. This study employs virtual reality simulations of campus corridors and overhead semi-open spaces to investigate how distinct soundscapes affect cognitive focus and emotional regulation. Child participants were exposed to four acoustic conditions: biophilic sounds, anthropogenic campus sounds (e.g., laughter, ball games), instructional signals, and traffic noise. Eye-tracking and physiological monitoring elucidate the underlying cognitive-affective mechanisms.

Results demonstrate that biophilic acoustic environments facilitate low-arousal cognitive restoration. Anthropogenic sounds significantly enhance involuntary attention and positive affect, whereas instructional signals elevate cognitive load and psychosocial stress. Notably, traffic noise suppresses visual exploration rates and vagal tone, indicating increased mental fatigue risk. In semi-open elevated spaces, anthropogenic sounds exhibit superior restorative effects on attention and emotion compared to biophilic stimuli.

These findings provide empirical insights into child-acoustic environment interactions and offer evidence-based guidelines for designing cognitively supportive school environments.

Wed 10:40–12:00 — Riverbank Room 4 (Chair: Jan Spilski, Kanako Ueno)

10:40: Paper 21 — Supplementary Hearing Assessment Screening Method for Classical Music Students — *Prof Stephen Dance*
11:00: Paper 449 — Auditory-friendly activities for hypersensitive people with autism spectrum disorder in Japan — *Prof Hidetoshi Takahashi*
11:20: Paper 701 — Acoustic Environment and the Effects of Sound Absorption in an After-school Activity Space — *Dr Ayako Matsuo*
11:40: Paper 702 — A two-year field experiment on the effect of sound absorption on acclimation of children to kindergarten life — *Ms Ikuri Matsuoka*

10:40 **Paper 21 — Supplementary Hearing Assessment Screening Method for Classical Music Students**
***Prof Stephen Dance**, Mr Ruben Vazquez-Amos*

Since the introduction of the UK's Control of Noise at Work Regulations research has been undertaken in collaboration with a leading conservatoire investigating the hearing acuity of more than 7000 students between 2007 and 2025. This paper outlines the results (2021-2025) of a supplementary hearing assessment method based on comparing the results of 1427 musicians taking a standard audiometric screening Bekesy test and an otoacoustic emission based (OAE) hearing assessment, n=1290, using Hearing Coach firmware/software, Results will be presented comparing the success rate of each methodology, the distribution of hearing health categories, and the consistency and reproducibility of each test, n=38. Finally, the benefits of each test methodology will be given along with how the results compare to those from the general population.

11:00 **Paper 449 — Auditory-friendly activities for hypersensitive people with autism spectrum disorder in Japan**

***Prof Hidetoshi Takahashi**, Prof Kanako Ueno, Prof Nozomu Yoshizawa*

Autism Spectrum Disorder (ASD) is associated with persistent impairments in adaptive functioning across multiple domains including social, communicative, occupational, and other important areas of daily life. Sensory abnormalities have often been reported as symptoms of ASD, and auditory over-responsiveness (AOR) is the most common sensory-perceptual abnormality in individuals with ASD. Recently, we reported that a greater magnitude of acoustic startle reflex in response to weak stimuli of 65-85 dB was found in children with ASD compared to those with typical development. This index was related to various clinical features, including sensory problems, autistic traits, emotional/behavioral difficulties, and adaptive/maladaptive behaviors in ASD children. This intensity level of acoustic stimuli is frequently experienced in everyday situations environment. Noise affects several aspects of both physical and mental health and those with AOR might be affected more by their daily environment. Thus, for the healthy development of ASD children with AOR it is important to create an auditory-friendly environment. We have conducted several auditory-friendly activities for hyper-sensitive people with ASD in Japan, particularly at recreational facilities in Kochi Prefecture, such as museums, aquariums, and zoos. These activities might raise awareness about AOR of people with ASD as well as promote their social participation.

11:20 **Paper 701 — Acoustic Environment and the Effects of Sound Absorption in an After-school Activity Space**

***Dr Ayako Matsuo**, Prof Kanako Ueno, Mr. Rento Tanase, Ms. Sakiho Shiraiwa*

This study examined the acoustic environment of an after-school activity space where children stay after school, aiming to clarify current conditions and evaluate the effects of acoustic improvements.

First, acoustic conditions and operational difficulties were identified through sound measurements and staff interviews. Results showed that during the operating period, the sound level (LAeq,1min) exceeded 75 dB for more than half the time. The room also exhibited highly reverberant characteristics, with a reverberation time of 1.4 s and an average sound absorption coefficient of 0.08, which indicates insufficient absorption compared with the recommended value of 0.25 for nursery rooms in the Architectural Institute of Japan Environmental Standards (AIJES). Staff also reported that some children covered their ears and that verbal communication was difficult, indicating the need for improvement. Second, to improve the acoustic conditions, panel-type sound-absorbing materials and curtains were installed on the walls, reducing the reverberation time to 0.8 s and increasing the average absorption coefficient to 0.13. Evaluations based on sound environment measurements, questionnaire surveys of staff and children, and staff interviews confirmed reductions in discomfort from environment measurements and reverberation, along with improvements in the ease of communications and the smoothness of program operation.

11:40 **Paper 702 — A two-year field experiment on the effect of sound absorption on acclimation of children to kindergarten life**

***Ms Ikuri Matsuoka**, Mr. Nozomu Noguchi, Prof Keiji Kawai*

A field experiment in an actual kindergarten has been being carried out since April 2024 with temporary installation of sound absorbing materials to the classrooms, where the effect of sound absorption on acclimation of children entering kindergarten for the first time or moving up to the next grade to their kindergarten life has been examined. Target classrooms were two 2-year-old classes and two 3-year-old classes. Sound absorbing materials were temporary installed in one of the two rooms in each age classes in April, the beginning of the school year in Japan, and were removed to equalize conditions in all classrooms in November. By the installation, the reverberation time at 1 kHz band of the rooms was reduced from around 0.7-0.8 s to 0.4-0.5 s.

In the analysis, the crying time ratio in 2-year-old classrooms during morning gatherings in April and May and SPLs of children's voice between 11:00 a.m. to 1:00 p.m. daily for each age group were observed. High crying time ratios and high voice levels were occasionally observed in rooms without sound absorption, but the results were inconsistent, and further experiments are needed to examine them.

4.1.9 Measurement Methods for Smart Cities and Noise Monitoring

Mon 14:00–15:00 — City Room 4 (Chair: Doug Manvell, Granger Bennett)

14:00: Paper 564 — Difficulties in complying with ISO 9612 and its limitations on outlining an occupational prevention plan suitable for noise risk situations. — *Mr Rafael Sanchez-Guardamino Elorriaga*

14:20: Paper 168 — Non-Contact Occupational Noise Dosimetry via Spatial Acoustic Mapping and Real-Time Worker Localization — *Mr Xinzhang Xiong*

14:40: Paper 617 — Designing Institutional-Grade Noise Governance Systems: Platform Infrastructure, Evidence Chains, and Accountability Structures in High-Scrutiny Urban Environments — *Mr James Choi*

14:00 **Paper 564 — Difficulties in complying with ISO 9612 and its limitations on outlining an occupational prevention plan suitable for noise risk situations.**

Mr Rafael Sanchez-Guardamino Elorriaga, *Mrs. María José García Tomás*

A field study was carried out by INSST through 40 companies and 107 workstations aimed at checking both, how ISO 9612:2009 behaves and its concordance with the occupational prevention noise assessment in those situations where the results were between 80 dB(A) and 85 dB(A). Slight shifts in production conditions during noise measurements may lead to uncertainty range overtaking the milestone of 85 dB(A), which is the threshold that obliged companies to undertake technical or organizational measures to control noise risks.

From this study, whose on-sites work stage was dated from 2023 to 2024, some experience on the difficulties arisen during the “in situ” assessment according to ISO 9612:2009, such as unforeseen events in the production line (breakdowns, changing production mix, adjusting output to demand …), unproper Homogenous Noise Exposure Group setting up, instrumental and human resources management, etc.

14:20 **Paper 168 — Non-Contact Occupational Noise Dosimetry via Spatial Acoustic Mapping and Real-Time Worker Localization**

Mr Xinzhang Xiong, *Mr Yongjun Zhang, Mr Wei Wang, Mr Wenbo Xiong*

Occupational noise dose measurement currently uses personal noise dosimeters (PNDs) and sound level meters (SLMs), each presenting limitations. PNDs are vulnerable to artifacts from worker behavior (vocalization, microphone contact) and compliance issues (device removal, intermittent wear), while area-based SLMs introduce substantial uncertainty (±3-5 dB) due to spatial variability and worker mobility. This paper introduces a non-contact noise dose estimation methodology combining spatial acoustic mapping with real-time personnel tracking. The system architecture comprises (1) initial workplace noise field characterization via mobile acoustic survey, wherein a calibrated portable measurement device is traversed throughout the workspace to generate a noise map, (2) continuous worker localization using wireless positioning technologies, and (3) real-time noise map correction using fixed microphones positioned close to dominant noise sources. Validation against ISO 9612-compliant PND measurements yielded mean differences in daily Lex,8h of less than 3.5 dB. The non-contact approach eliminated interference-related artifacts observed in conventional PND data while maintaining compliance with occupational exposure limit assessment protocols. This methodology enables continuous, artifact-resistant occupational noise exposure assessment with improved accuracy over body-worn and area-based monitoring, elimination of human-induced measurement errors, and enhanced worker comfort through non-contact operations.

14:40 **Paper 617 — Designing Institutional-Grade Noise Governance Systems: Platform Infrastructure, Evidence Chains, and Accountability Structures in High-Scrutiny Urban Environments**

Mr James Choi, *Mr Andy Chung*

Urban noise management is increasingly exposed to public scrutiny, regulatory review, and legal challenge. While advances in measurement and modelling have strengthened technical assessment, many noise management systems remain vulnerable when confronted with disputes or institutional accountability pressures. Compliance-oriented monitoring alone is often insufficient in high-exposure environments.

This paper proposes a regulatory-grade noise governance framework for urban contexts where decisions must remain defensible under audit or complaint. The framework is structured around three interdependent layers: (1) platform infrastructure enabling continuous regulatory operation and policy adaptation; (2) evidence chain architecture that converts monitoring data into traceable, reviewable, and context-aware records; and (3) accountability structures that clarify decision authority, response thresholds, and responsibility allocation among stakeholders.

Applied examples from construction-intensive districts and large-scale public activity environments are used to illustrate how the transition from project-based acoustic services to institutional-grade governance systems enhances resilience under scrutiny. Particular attention is given to the transformation of raw data into structured evidence packages capable of supporting regulatory and investigative processes.

The paper argues that the future role of acoustics in cities extends beyond technical compliance toward governance system design that sustains public trust.

Mon 15:40–17:40 — City Room 4 (Chair: Doug Manvell, Granger Bennett)

15:40: Paper 705 — Traffic Noise Exposure in Rural Peri-Urban Areas near Highways: Noise Monitoring, Noise Mapping, and Health Risk Evaluation — *Mr Anirudh Mishra*

16:00: Paper 288 — Net4Cities: A Real-Time Network of Noise Monitoring Terminals in European Cities — *Mr Jonathan Phillips*

16:20: Paper 512 — Source-aware characterisation of sound environments from a city-wide sensor deployment — *Mr Lion Cassens*

16:40: Paper 494 — Estimating construction noise source location using classified directional noise data — *Mr Adrian Morris*

17:00: Paper 608 — The next gen Predictive Environmental Noise Intelligence Platform (PENI) — *Mr Granger Bennett*

17:20: Paper 744 — An Update on Evaluating Sound Pressure Levels of Noise Sources in Busy Noise Environments with Deep Learning — *Mr Clayton Sparke*

15:40 **Paper 705 — Traffic Noise Exposure in Rural Peri-Urban Areas near Highways: Noise Monitoring, Noise Mapping, and Health Risk Evaluation**

***Mr Anirudh Mishra**, Mr Parth Parmar, Ms. Jinal Morad, Dr. Bhaven Tandel*

Highway traffic noise has emerged as a critical environmental concern in rural residential areas, where expanding transportation highways intersect closely with exposed populations. This study aims to investigate noise levels and their associated impacts on residents near highway stretches in Surat, India, by employing noise monitoring, traffic composition analysis, and noise mapping using SoundPLAN version 8. Daytime noise levels ranged from 55.35 to 62.02 dB, while nighttime levels ranged from 45.97 to 56.78 dB, exceeding CPCB residential noise limits. Furthermore, noise maps revealed extensive propagation of high-intensity sound (55–65 dB) up to 50-150 m from highways. Objective impact assessment revealed that 4% to 9% of the population had sleep disturbance (%HSD), while 53% of the residents had higher annoyance (%HA). PLS-SEM analysis revealed a strong association between individual noise sensitivity and resident annoyance levels. The findings highlight that rural communities adjacent to major highways are subjected to continuous, harmful noise exposure, with implications for comfort, sleep quality, and long-term health. The study emphasizes the need for targeted mitigation such as vegetative buffers, acoustic barriers, speed regulation, and improved land-use planning to safeguard rural residential well-being.

16:00 **Paper 288 — Net4Cities: A Real-Time Network of Noise Monitoring Terminals in European Cities**

***Mr Jonathan Phillips**, Mr. Craig Storey, Erika von Schneidemesser, MSc. Lorena Vega García, Dr.-Ing. Arne Henning, Itziar Aspuru Soloaga, Pilar Fernandez Alcala*

In support of the European Union's Zero Pollution Action Plan, the Net4Cities project aims to collect and analyse real-time transport-related noise and air quality data across 11 major European cities. The EU's zero-pollution framework targets a 30% reduction in the population chronically exposed to harmful transport noise by 2030.

Net4Cities is implemented by a multidisciplinary consortium of academic institutions, private-sector partners, and public environmental authorities, and involves the deployment of a harmonised network of permanent noise monitoring stations

across diverse urban environments.

The monitoring infrastructure enables the continuous acquisition of acoustic data, supporting the assessment of transport-related emissions and the identification of noise sources with potential adverse health impacts. Data is processed via a web-based platform that provides real-time reporting of noise indicators, facilitating evidence-based analysis and the development of mitigation strategies, including adaptive traffic management approaches.

This paper describes the system architecture, sensor technologies and data-processing methodologies employed within the Net4Cities framework and presents preliminary findings from the early stages of this three-year project.

16:20 **Paper 512 — Source-aware characterisation of sound environments from a city-wide sensor deployment**
Mr Lion Cassens*, Dr.ir. Maarten Kroesen, Dr.ir. Simeon Calvert, Dr.ir. Sander van Cranenburgh*

The perception of a sound environment depends not only on the overall sound level. Day-night patterns, intermittency, and sound event composition are all important factors for the human response to noise. Yet most monitoring efforts still rely solely on equivalent sound level indicators, thereby overlooking perceptually relevant differences between sound sources.

To enable a source-aware analysis, we deployed 38 low-cost open-hardware sensors in a medium-sized Dutch city. Each sensor measures loudness levels and acoustic sharpness and runs a machine learning model to detect the presence of 11 common urban sound sources. The collected data are used to investigate spatial and temporal variations in the urban sound environment, including the distribution of sound events and intermittency ratios. We further examine which sound events are most commonly associated with high intermittency. Lastly, an unsupervised clustering approach is applied to group measurement locations based on their sound characteristics, providing a structured perspective on sound heterogeneity across the city.

The results highlight substantial differences between locations in terms of intermittency, sound event composition, and day–night patterns, illustrating the heterogeneous nature of the urban sound environment and the complementary insights provided by source-aware metrics.

16:40 **Paper 494 — Estimating construction noise source location using classified directional noise data**
Mr Adrian Morris*, Mr Nicholas Henrys, Mr John Boga*

Unattended noise monitors are increasingly being deployed to construction sites to assist with understanding and managing impacts on surrounding communities. Providing an indication of the direction of arrival of a sound recorded by an unattended noise monitor may assist with understanding the cause of noise impacts. Audio classification can also provide insights into the plant/equipment items detected in the noise monitoring data, along with other details such as their mode of operation and duration of use within a given measurement period. However, the distance between source (construction plant/equipment) and receiver (monitoring device) is also required to make a meaningful comparison between measurements and predictions. These comparisons can enhance the overall management of noise impacts by allowing for incremental improvement and refinement of prediction methods based on monitoring data, which then allows for more accurate forecasting of the expected noise impacts, resulting in sustainable and targeted mitigation, management and community engagement.

This paper outlines a probabilistic approach to using directional, classified noise data to estimate the location of a noise source within a construction site. Stochastic methods used in the data analysis are discussed, as well as the requirements and limitations of this approach.

17:00 **Paper 608 — The next gen Predictive Environmental Noise Intelligence Platform (PENI)**
Mr Granger Bennett

Environmental management in industry remains largely reactive, relying on short-term monitoring that is vulnerable to contamination, offers limited spatial context, and provides minimal value for operational planning, compliance, or community engagement. This paper presents a next-generation Predictive Environmental Noise Intelligence platform that shifts environmental management from measurement to foresight.

The system integrates Large Environmental Noise and Dust Models (LENDM) with extensive operational, meteorological, and spatial datasets to quantify received noise and dust at sensitive receptors across entire communities. The platform

delivers forward-looking, real-time intelligence, enabling operators to anticipate impacts before they occur.

Live analytics identify dominant sources, explain causation, and provide actionable recommendations that allow adaptive operational control . Visual outputs support rapid response to complaints and improve transparency in regulatory engagement. The platform integrates with existing monitoring networks and site systems, requiring no additional hardware.

Results demonstrate improved risk management across planning and operational phases, enhanced stakeholder confidence, and reduced compliance uncertainty. The approach represents a shift from reactive compliance monitoring toward predictive environmental stewardship, providing a comprehensive and continuous understanding of industrial noise impacts.

17:20 **Paper 744 — An Update on Evaluating Sound Pressure Levels of Noise Sources in Busy Noise Environments with Deep Learning**

Mr Clayton Sparke

Building on earlier work in source specific sound pressure level (SPL) estimation, this study investigates the impact of progressive dataset expansion on the accuracy and generalisability of deep learning models for environmental sound classification. An enlarged corpus of field recorded monitoring data (recorded audio and 1/3 octave SPL) was assembled, incorporating greater variation in sensor locations, environmental conditions and sound source distributions. We examined impacts on classification performance and source specific SPL prediction error. This work underscores the value of large, diverse datasets for environmentally focused machine learning applications and provides practical guidance for scaling acoustic intelligence systems intended for automated monitoring and real time noise source attribution.

4.2.1 Soundscape: General

Mon 14:00–15:00 — City Room 3 (Chair: Tin Oberman, Koji Nagahata)

14:00: Paper 621 — Enhancing acoustic environments through building envelope design: a case study. — *Ms Eleni Chrysafis*

14:20: Paper 410 — Evaluating the Reproducibility of In-Situ Soundscape Perception using Group and Online Listening Tests — *Ms Michaela Marxt*

14:40: Paper 267 — Modelling and predicting authenticity perception in historic district soundscape through acoustic characteristics — *Dr Yiming Hu*

14:00 **Paper 621 — Enhancing acoustic environments through building envelope design: a case study.**
Ms Eleni Chrysafis

The Eden Gardens Development Application involved alterations and additions to an existing Garden Centre to construct an 18-storey office building. A Development Application Objection was lodged by community members concerned about potential adverse impacts on Lane Cove National Park and its habitat. investigation was undertaken to provide objective evidence regarding these concerns.

As part of the investigation, extensive acoustic surveys at the development site and surrounding noise sensitive receivers were undertaken. Results showed that a large area of Lane Cove National Park adjacent to the site was significantly affected by road traffic noise from Lane Cove Road and the Hills Motorway.

To assess the potential acoustic impact of the proposed development, a CADNAA model incorporating detailed topographic data was prepared. Using the measured acoustic data, 3D noise maps illustrating existing noise conditions were generated and then the proposed building envelope was modelled to evaluate changes in noise distribution.

The modelling demonstrated that the new development would function as an effective noise barrier, resulting in a substantial reduction in noise levels in the land behind it. The findings suggest that proposed developments could improve the acoustic environment and contribute positively to the habitat quality of noise affected land.

14:20 **Paper 410 — Evaluating the Reproducibility of In-Situ Soundscape Perception using Group and Online Listening Tests**
Ms Michaela Marxt*, Ms Judith Waas, Prof. Dr. Thomas Bäumer, Prof. Dr.-Ing. Berndt Zeitler*

Soundscape research has gained relevance, as urban acoustic environments cannot be adequately characterized by sound pressure level measurements alone. Within the ISO 12913 framework, in situ assessments and listening tests are established methods for capturing perceptual responses to acoustic environments. Listening tests according to ISO 12913-2 Method A are widely applied and based on ratings of the eight adjectives related to perceived affective quality. However, listening tests conducted in individual sessions are resource-intensive and typically yield small sample sizes, indicating potential for methodological optimization. Against this background, this study presents a methodological comparison of listening test approaches regarding their ability to reflect soundscape perception assessed in the field. Field studies with in situ questionnaires are conducted at three public places in Stuttgart. Binaural recordings from these locations are used in subsequent listening tests. Two approaches are examined: group listening tests under laboratory conditions and online listening tests in participants' own environments. Results show very good agreement between group and online listening tests. Compared to field studies, both formats exhibit attenuated adjective ratings while preserving consistent patterns. Overall, the findings indicate that listening tests can complement field studies and that online listening tests represent a promising alternative to laboratory-based listening tests.

14:40 **Paper 267 — Modelling and predicting authenticity perception in historic district soundscape through acoustic characteristics**
Dr Yiming Hu*, Prof. Qi Meng, Lecturer Mengmeng Li, Assistant Professor Da Yang, Dr Chunshuo Qu, Miss Yuxin Yin*

As vital carriers of urban architectural heritage, historic districts have drawn increasing attention regarding the preservation of their authenticity. However, current research predominantly emphasises visual perception and design interventions, of-

ten overlooking the unique role of sound in shaping authenticity. To investigate the influence of acoustic characteristics on authenticity evaluation and to establish a predictive control approach, this study employs an interactive soundscape design experiment in which participants actively adjust acoustic characteristic parameters, while corresponding authenticity evaluations are collected. Firstly, the relationships between acoustic characteristics and authenticity evaluation are examined, and sensitivity differences among acoustic parameters are analysed. Secondly, quantitative optimal parameter ranges are identified to define operational boundaries for enhancing authenticity. Taking cultural fusion spaces as an example, when the background sound level (LAeq) ranges from 40 to 52 dB, the optimal LAeq of the dominant sound is 52-64 dB, the dominant sound tempo falls within 65-80 BPM, and the fidelity level requires a signal-to-noise ratio (SNR) above 28 dB. Finally, an authenticity prediction model is developed to predict authenticity evaluations under different acoustic characteristics. The results provide an efficient and fine-grained operational framework for soundscape design in historic districts.

Mon 15:40–17:20 — City Room 3 (Chair: Tin Oberman, Koji Nagahata)

15:40: Paper 414 — A perceptual structure of acoustic environments in space stations: a grounded theory approach with big data — *Miss Yan Zhang*

16:00: Paper 430 — Does Language Shape Soundscape? A Cantonese Language Study Comparing Hong Kong and Perth — *Dr Louisa Ly Cheung*

16:20: Paper 528 — Establishing Special Entertainment Precinct Criteria for the City of Sydney — *Dr Yuxiao Chen*

16:40: Paper 679 — Differences in Soundscape Evaluations Among Shopping Streets: Effects of Arcade Presence, Visitor Characteristics, and Context — *Ms Ayana Kudo*

17:00: Paper 633 — Soundscape approaches for health and wellbeing in care environments: a systematised review. — *Mr Sebastien Fijac*

15:40 **Paper 414 — A perceptual structure of acoustic environments in space stations: a grounded theory approach with big data**

Miss Yan Zhang, *Professor Lei Yu, Prof. Jian Kang*

The interior of a space station, as a prototypical isolated and confined environment, poses critical challenges for habitability and human factors, influencing astronauts' cognitive performance, work efficiency, emotional and behavioral health. Among these, the acoustic environment holds considerable potential for active design. Following the soundscape approach, this study aims to investigate how astronauts perceive acoustic environments in space stations and how they articulate perspectives on acoustic environments. Using grounded theory, we analyzed 365 media texts related to acoustic environments, released by 43 astronauts—26 from NASA, 8 from ESA, 7 from JAXA, and 2 from CNSA—each during one complete mission cycle aboard space stations. The dataset includes all astronauts whose social media hyperlinks were publicly available on NASA's official website. Coding resulted in a taxonomy with four dimensions and their corresponding manifestations: User–acoustic environment interaction issues — subjective agency toward acoustic environments, functions of acoustic environments, activity types involving acoustic environments; Source of invocation — being present, memory, anticipation; Processing mechanisms — comparison, synesthesia, perspective switching, self-state reference, atmosphere framing; and Perceptual outcomes — descriptions and evaluations of acoustic environments, mentioned sound sources and their layers, mentioned acoustic devices, mentioned sound cues, expressed feelings, expressed reactions (impacts and actions).

16:00 **Paper 430 — Does Language Shape Soundscape? A Cantonese Language Study Comparing Hong Kong and Perth**

Dr Louisa Ly Cheung

Soundscape, as defined in ISO 12913, is a perceptual and context-dependent appraisal of the acoustic environment, shaped by individual, social, and cultural factors. While soundscape research has increasingly examined cross-cultural perception, relatively little is known about how relocation - and the accompanying changes in living and language environment - influence the way people interpret everyday sounds. This gap is particularly relevant for migrant communities who must navigate new acoustic, social, and linguistic contexts simultaneously.

To investigate these dynamics, this study focuses on Cantonese (Yue) speakers, who relocated from Hong Kong to for

different period of time, two cities with distinct urban forms, sound sources, and cultural–linguistic environments. A structured soundscape survey was conducted, using Cantonese translated perceptual attributes aligned with the ISO 12913 framework.

The study compares the similarities and differences in the acoustic environments of the two cities and explores how changes in culture, linguistic context, and daily sound exposure shape soundscape perception.

16:20 **Paper 528 — Establishing Special Entertainment Precinct Criteria for the City of Sydney**

***Dr Yuxiao Chen**, Ms Sav Shimada, Mr Jason Cameron, Mr Dave Anderson*

Sydney is bringing back its night life! Since the NSW Vibrancy Reforms legislation changes starting in 2023, many Councils have been working towards establishing Special Entertainment Precincts (SEPs) with special sound criteria that aim to promote entertainment activities, and that includes the City of Sydney. The SEPs extend beyond the CBD and encompass a range of distinct acoustic environments within the "City of Villages". This paper summarizes our extensive process in determining suitable sound criteria for the City of Sydney SEPs, including review of existing criteria, literature, and noise monitoring data; a large number of site measurements and observations including "soundwalks", long-term noise logging, and short-term attended measurements; and City of Sydney's strategic aims to balance promoting 24/7 economy and protecting community acoustic amenity.

16:40 **Paper 679 — Differences in Soundscape Evaluations Among Shopping Streets: Effects of Arcade Presence, Visitor Characteristics, and Context**

***Ms Ayana Kudo**, Prof Takeshi Akita*

This study demonstrates that differences in soundscape evaluations among shopping streets are strongly influenced by arcade presence, visitor characteristics, and contextual factors. The purpose of this research was to examine how soundscape evaluations vary across four shopping streets categorized by the presence or absence of arcades and by visitor characteristics, with particular attention to contextual influences. Soundwalks were conducted with sixteen participants using the Caption Evaluation Method (CEM) in four shopping streets in Tokyo. The results showed that streets with arcades had higher equivalent sound pressure levels and L50 than those without arcades. Based on the ISO 12913-2 classification, streets with a higher proportion of tourists generated more responses related to voice & instrument, likely reflecting conversational sounds produced by tourists moving in groups. For sounds classified as Human movement, evaluations varied widely; for example, shop interior sounds were described positively as exciting due to liveliness, while others described them negatively as unpleasant due to noisiness. These contrasting tendencies indicate that CEM successfully captured the influence of contextual differences on soundscape evaluations. The findings suggest that sound environment planning should consider not only noise control and visitor attributes but also the contextual factors that shape individual soundscape evaluations.

17:00 **Paper 633 — Soundscape approaches for health and wellbeing in care environments: a systematised review.**

Mr Sebastien Fijac

Hospitals and other care settings are acoustically complex environments where reducing sound levels can conflict with clinical monitoring and communication needs. Using a soundscape perspective that foregrounds perception-in-context, this systematised review synthesises evidence on interventions designed to improve perceived acoustic quality and related health outcomes in care environments. It aimed to classify intervention types and intended effects, and to evaluate how soundscape-oriented strategies support positive outcomes for occupants.

Peer-reviewed English-language studies (1990–2025) were identified in Scopus, Web of Science and PubMed. Screening and reporting followed PRISMA, whereas meta-analysis was not conducted due to methodological diversity. Twenty studies met the inclusion criteria, showing substantial heterogeneity in settings, designs and outcome measures. Three intervention categories were identified: sound-based, music-based, and noise-control interventions implemented through behaviour/operations, physical design and technology. Natural sounds and slow instrumental music most consistently improved pleasantness, relaxation and overall environmental appraisals. Noise-control interventions showed more variable effects but may deliver meaningful benefits when feasible and embedded within local operational and spatial constraints.

Overall, low-risk soundscape modifications can improve subjective acoustic experience in hospitals, especially in short-term care contexts, but inconsistent terminology, limited standardisation of perceptual metrics, and mixed outcome reporting hinder synthesis and translation into actionable design guidance.

4.2.3 Psychological and Physiological Evaluation in Soundscape Studies

Tue 09:00–10:00 — Riverbank Room 4 (Chair: Manish Manohare)

09:00: Paper 18 — The Impact of Environmental Noise on Student Learning and Emotional Regulation in the Classroom Setting: An EEG-Based Study — *Dr Cynthia Hou*

09:20: Paper 777 — Individual differences in psychological and physiological responses to indoor sound environments: an EEG study — *Dr Dadi Zhang*

09:40: Paper 176 — Differential facial responses in thermal-acoustic perception: A comparative study of music versus mechanical noise — *Xin Wen*

09:00 **Paper 18 — The Impact of Environmental Noise on Student Learning and Emotional Regulation in the Classroom Setting: An EEG-Based Study**
Dr Cynthia Hou

Environmental noise is a pervasive factor influencing students' learning efficiency and mental health, particularly in places like Hong Kong, where school teaching buildings are among densely populated urban areas. This study investigated how different types and intensities of classroom noise—specifically air-conditioning and road traffic noise—affect cognitive performance and neural activity. We recruited multiple university students to complete four cognitive tasks (attention, multi-object attention, complex decision-making, and information extraction) under six noise conditions while EEG signals were simultaneously recorded. Behavioral results revealed an inverted-U relationship between noise intensity and task performance: moderate air-conditioning noise (55–60 dBA) enhanced accuracy and efficiency, whereas high-level traffic noise (65 dBA) impaired performance. EEG spectral analysis indicated significant effects mainly in the Theta, Beta, and Delta bands, showing that noise type and level jointly modulated cortical activation patterns. These findings suggest that moderate, steady background noise facilitates optimal attention and cognitive engagement, while intense or fluctuating noise induces neural overload and stress.

09:20 **Paper 777 — Individual differences in psychological and physiological responses to indoor sound environments: an EEG study**
Dr Dadi Zhang*, Prof. Kwok-Wai Mui, Prof. Ling-Tim Wong*

This study investigates the impacts of background sound types and personal characteristics on subjects' psychological and physiological responses. A mixed-methods approach combining electroencephalography (EEG) and self-assessments was applied. Thirty-nine participants were exposed to four sound conditions (music, classroom noise, traffic, and no sound) while rating their sound perceptions and satisfaction. EEG data were analyzed to extract key brainwave bands (alpha, beta, theta) and event-related potentials (P300, N300, LPP). Additionally, comparative statistical tests and fuzzy-set qualitative comparative analysis (fsQCA) were conducted to unpack the individual and combined effects.

Results show that gender and sound sensitivity drive distinct neurocognitive patterns. Specifically, females exhibit lower alpha/beta ratios and higher N300 amplitudes, while sound-sensitive individuals show enhanced Event-Related Potential (ERP) responses. fsQCA reveals several equifinal pathways: positive mood in no sound environments predicts perceived quietness and satisfaction for males, whereas low sound sensitivity in music sound environments fosters relaxed brain states for females. These findings underscore that human responses to sound emerge from the interplay of environmental and personal factors, with tailored design strategies needed to optimize both perceptual satisfaction and neurocognitive well-being in indoor spaces.

09:40 **Paper 176 — Differential facial responses in thermal-acoustic perception: A comparative study of music versus mechanical noise**
Xin Wen*, Professor Qi Meng*

The interaction between thermal and acoustic environments plays a critical role in human comfort perception. While Facial Action Units (AUs) effectively predict comfort under mechanical noise, unknown facial responses to positive sound sources risk inaccurate automated comfort predictions. This study investigates the differential facial responses in com-

bined thermal-acoustic environments, comparing the effects of music versus fan noise across temperatures from 18 to 28 C, revealing distinct interactive mechanisms. First, music stimuli elicited more pronounced facial fluctuations compared to the flat responses under fan noise, specifically triggering increased intensities of AU15 (Lip Corner Depressor) and AU20 (Lip Stretcher) under cold stress (18-20 C). Second, a significant correlation inversion was identified: while AU12 (Smile) positively correlates with comfort under noise, it exhibits a strong negative correlation under music in uncomfortable conditions. This suggests that in stressed thermal-acoustic contexts, the ”smile” muscle reflects a ”grimacing” coping mechanism rather than satisfaction. Furthermore, a Random Forest classifier trained on these facial features achieved high accuracy in classifying the sound source as either music or fan noise. These findings demonstrate that facial indicators of comfort perception are highly dependent on the sound source type, highlighting the necessity for developing context-aware multimodal comfort models.

Tue 10:40–11:20 — Riverbank Room 4 (Chair: Manish Manohare)

10:40: Paper 199 — Facial Expression Portrait as a Complementary Method for Urban Soundscape Assessment — *Miss Yuxin Yin*

11:00: Paper 105 — Perceived Restorativeness of Soundscapes in Nursing Homes: The Role of Psychoacoustic Indicators — *Dr Xiaojie Long*

10:40 **Paper 199 — Facial Expression Portrait as a Complementary Method for Urban Soundscape Assessment**

***Miss Yuxin Yin**, Miss Xuejun Hu, Dr Yiming Hu, Prof. Qi Meng*

Traditional urban soundscape assessments primarily rely on questionnaires. These depend on verbal indicators and rating scales but lack visual representation and holistic expression. This study introduces the Facial Expression Portrait (FExP) as a complementary tool. Natural and traffic urban scenes were presented under auditory-only and audiovisual conditions. Participants expressed their perceptions by adjusting the facial expressions of a virtual character and also completed questionnaires. The relationship between FExP and questionnaire results, as well as their performance across sensory conditions, was analysed. Results indicate that both methods effectively differentiate positive from negative stimuli but have limitations in distinguishing auditory-only from audiovisual conditions. Notably, FExP provides a more intuitive visual representation of differences between sensory conditions. Under audiovisual conditions, both soundscape and landscape indicators provide strong explanatory power for FExP, indicating that it reflects an outcome resulting from the combined influence of multisensory cues. Most FExP indicators show significant correlations with soundscape indicators, while correlations with landscape indicators are only partial, suggesting that auditory cues play a more prominent role in audiovisual emotional expression. Overall, this study supports FExP as an effective supplement to questionnaire methods, offering a holistic and intuitive approach for evaluating urban audiovisual environments.

11:00 **Paper 105 — Perceived Restorativeness of Soundscapes in Nursing Homes: The Role of Psychoacoustic Indicators**

***Dr Xiaojie Long**, Dr Yuliang Lei, A/Prof Nazli Bin Che Din, Dr Norhayati Binti Mahyuddin*

Understanding how psychoacoustic characteristics influence the perceived restorativeness of soundscapes is essential for improving acoustic environments in nursing homes. However, the specific roles of different psychoacoustic indicators in shaping restorative perception among older adults remain insufficiently understood. This study investigated the effects of psychoacoustic indicators on the perceived restorativeness of soundscapes (PRSS) in outdoor spaces of nursing homes using immersive virtual reality (VR). Audio–visual recordings from six typical outdoor settings were reproduced in a laboratory-based VR environment. Older adult participants experienced the soundscapes and evaluated their restorative potential using the PRSS. Key psychoacoustic indicators—including loudness, sharpness, roughness, and tonality—were extracted from the recordings, and structural equation modeling (SEM) was employed to examine their relationships with PRSS. The results indicate that psychoacoustic indicators have distinct and differential effects on perceived restorativeness. Increased loudness was associated with a significant reduction in PRSS, whereas sharpness and tonality showed significant positive associations under specific soundscape contexts. Roughness did not exhibit a significant effect. These findings provide evidence-based insights for psychoacoustic-oriented soundscape design and support the development of restorative outdoor environments in nursing homes.

4.2.6 Innovative and Multisensory Approaches in Soundscape Studies

Tue 16:20–17:20 — City Room 1 (Chair: Tin Oberman, Koji Nagahata)

16:20: Paper 437 — Soundscape Design for Gait Rehabilitation in Children with Cerebral Palsy: A Multisensory Field Experiment — *Ms Xue Bai*

16:40: Paper 629 — Unveiling the Soundscape Tapestry: Exploring Visual Creativity through Sonic Workshops — *Prof Gerald Estadieu*

17:00: Paper 712 — Characterising Visual Context for Soundscape Assessment Practices Using Eyetracking in Virtual Reality — *Dr Tin Oberman*

16:20 **Paper 437 — Soundscape Design for Gait Rehabilitation in Children with Cerebral Palsy: A Multisensory Field Experiment**

***Ms Xue Bai**, Prof. Yue Wu*

Children with cerebral palsy require long-term, systematic rehabilitation due to abnormal muscle tone and postural control difficulties. Existing studies suggest that sensory stimuli in the therapy room significantly influence children's training engagement and functional rehabilitation outcomes. Therefore, this study established five sensory experimental conditions involving visual, auditory, and tactile stimuli to examine the role of soundscape design in gait training within a multisensory integration framework. Participants were required to complete a 7 m L-shaped walking task under each experimental condition. A three-dimensional optical motion capture system was used to collect spatiotemporal gait parameters, while a five-point Likert scale was employed to assess the children's soundscape comfort, training concentration and training engagement. The results showed that auditory stimulation significantly enhanced children's soundscape comfort and training engagement, with greater improvements in gait performance observed in the preschool group. Compared with high-groove music, rhythmic auditory stimulation was more effective in enhancing training concentration, whereas high-groove music showed greater advantages in improving walking efficiency. Tactile guidance in an audiovisual environment significantly improved training concentration and engagement. The findings provide empirical evidence for optimizing multisensory soundscape design in gait rehabilitation training environments for children with cerebral palsy.

16:40 **Paper 629 — Unveiling the Soundscape Tapestry: Exploring Visual Creativity through Sonic Workshops**

***Prof Gerald Estadieu**, Prof Sandra Olga Ka Man Ng, Senior Lecturer Jung-Chul Hur, Prof Carlos Sena Caires*

This research investigates the potential of sonic workshops to foster visual creativity and cultivate a deeper engagement with soundscapes. Through a three-workshop series conducted with university students in Bangkok, Thailand, we explored the relationship between auditory perception and artistic interpretation within the context of Macao's complex sound environment. The workshops aimed to empower participants to critically analyse and creatively respond to unfamiliar sonic landscapes, culminating in the creation of a diverse range of artworks – including graphic design, digital paintings, and photographic interpretations – for an exhibition. Analysis of survey data revealed that participants significantly increased their awareness of sound's influence on creative processes and demonstrated an ability to translate sound into visual forms. The study highlights the value of immersive, experiential learning in fostering a nuanced understanding of soundscapes, their cultural significance, and their potential as artistic inspiration.

17:00 **Paper 712 — Characterising Visual Context for Soundscape Assessment Practices Using Eyetracking in Virtual Reality**

***Dr Tin Oberman**, Ms Yuqi Liang, Dr Andrew Mitchell, Dr Francesco Aletta, Prof. Jian Kang*

ISO 12913 series put context in the focus of soundscape assessment practices, covering interrelationships between space, place, time, activities and people. Space and place are concepts difficult to quantify and currently the ISO series recommend documenting these in as holistic way as possible. This includes a non-exhaustive list of factors such as land use and geographic features but also an understanding whether place attachment is affected by sounds. The importance of visual stimuli is also stressed together with personal contextual factors. We argue that for a successful implementation of soundscape assessments in practice, a clear way to characterise visual context and capture features tied to experience

of a place is needed. Based on experimental studies in virtual reality, employing eye-tracking, gaze data and image segmentation analyses, we suggest a way to efficiently address contextual factors that drive perceptual outcomes. This allows practitioners to address contextual complexity and integrate it together with a typical acoustic environment characterisation into an actionable assessment.

4.2.7 Soundscapes from the Perspective of Arts/Human Sciences

Wed 08:40–10:00 — Riverbank Room 6 (Chair: Nazli Bin Che Din)

08:40: Paper 41 — Acoustic Immersion, Materiality, and Critical Spatial Practice at Fallingwater — *Dr Liyana Hasnan*

09:00: Paper 43 — Architectural Acoustic Filters for Integrating Orchestral Sound into Urban Soundscapes: A Case Study of Bukit Bintang — *A/Prof Nazli Bin Che Din*

09:20: Paper 44 — What Lies Beneath the Noise: How Dominant Soundscape Conditions Shape Listening, Use, and Access in Dorchester Square, Montréal — *Mr Joey Zaurrini*

09:40: Paper 767 — Creative Intervention for Affective Perception of Technology-Dominated Soundscapes — *Mrs Siyu Wu*

08:40 **Paper 41 — Acoustic Immersion, Materiality, and Critical Spatial Practice at Fallingwater**

Dr Liyana Hasnan, *A/Prof Nazli Bin Che Din*

This paper examines Frank Lloyd Wright's Fallingwater through the lens of critical spatial practice, foregrounding the intersections of theory and practice, and art and architecture. Moving beyond its canonical visual readings, the study positions the house as a neurological–acoustic instrument in which sound and materiality actively shape perception. The constant waterfall functions as an environmental mask, saturating the auditory field and modulating domestic noise to produce a continuous, immersive soundscape. Materiality, expressed through rough stone, exposed concrete, and untreated surfaces, further mediates this condition, absorbing and reflecting sound unevenly to generate a textured acoustic environment. Architecture here operates neurologically, shaping attention and experience without technological mediation. The soundscape, while seemingly natural, is carefully orchestrated, blurring boundaries between environmental presence and architectural control. Listening becomes reciprocal: the house listens as much as it is listened to, exposing tensions between agency and design. By situating Fallingwater at the nexus of sound, materiality, and critical spatial practice, this paper argues for an expanded understanding of architectural design, one that treats auditory experience as central and interrogates the risks and potentials of immersive, multi-sensory inhabitation.

09:00 **Paper 43 — Architectural Acoustic Filters for Integrating Orchestral Sound into Urban Soundscapes: A Case Study of Bukit Bintang**

A/Prof Nazli Bin Che Din, *Ms Lee Chiao Ying*

This research investigates the potential of outdoor acoustic filters as architectural mediators between urban noise and orchestral soundscapes in Kuala Lumpur's Bukit Bintang district. Within the city's dense commercial sound environment, orchestral music is typically confined to enclosed concert halls, resulting in both acoustic isolation and cultural detachment from everyday urban life. This study examines how architectural design through spatial modulation, material articulation, and environmental acoustic strategies can facilitate the coexistence of orchestral performance and urban noise in open public settings. Employing a mixed-method approach that combines a systematic literature review, in-situ sound analysis, and comparative case studies of precedent projects, the research identifies key acoustic and spatial parameters that support sound filtering, diffusion, and contextual integration. The findings aim to inform a set of design principles for incorporating orchestral sound into urban environments, contributing to emerging discourse on soundscape-driven architecture and the cultural activation of public space within Malaysia's rapidly evolving urban context.

09:20 **Paper 44 — What Lies Beneath the Noise: How Dominant Soundscape Conditions Shape Listening, Use, and Access in Dorchester Square, Montréal**

Mr Joey Zaurrini

Public squares are acoustically rich microcosms that mirror and amplify the sonic and social character of a city. This paper examines how noise conditions structure use, perception, and access in urban public squares, often through the selective tolerance of noise rather than its regulation. The study focuses on Dorchester Square in Montréal, a public space in the city's historic downtown built atop the former Saint Antoine Cemetery, where layers of civic life unfold above buried histories. The square draws a flow of commuters, tourists, and residents, yet its soundscape is saturated by traffic, construction, and other forms of industrial noise routinely sanctioned through urban by-laws. During the summer, tour buses intensify these conditions, reinforcing circulation and commercial priorities. The study combines situated listening, repeated soundwalks,

and node-based field recordings conducted across the square. Recordings were collected at acoustic nodes and analyzed spectrally to identify dominant noise sources, then translated into soundmaps tracing relationships between infrastructural noise and quieter sonic activity. By attending to the square's soundscape, Dorchester Square appears less as a neutral backdrop for urban activity and more as a contested acoustic environment where policy, infrastructure, and everyday life intersect.

09:40 **Paper 767 — Creative Intervention for Affective Perception of Technology-Dominated Soundscapes**

Mrs Siyu Wu

Technology-dominated soundscapes are consistently evaluated as unpleasant according to soundscape descriptors within the Affective Perceived Quality framework(APQ), often associated with traffic and mechanical noise. Rather than focusing solely on noise reduction, this study investigates whether creative sound interventions can reshape how such acoustic environments are perceived and experienced.

The research adopts a two-stage design integrating laboratory-based participatory co-design with on-site experimentation. In the first stage, an interactive soundscape simulation system enables participants to explore two intervention strategies: artistic transformation, which reshapes pitch, timbre, and rhythm of technological sounds into harmonically organised textures; and artistic augmentation, which adds minimal melodic or biophilic layers that follow the dynamics of the original noise. This stage builds on a prior interactive urban soundscape simulation case study, in which a controlled virtual environment functioned as a prototyping platform for creative intervention strategies. The second stage extends this process into real-world technology-dominated contexts, informed by a public immersive sound interaction case study that demonstrates how artistic sound designs translate into site-responsive interventions.

By bridging artistic sound practice and soundscape research, this study explores how creative interventions may expand the affective potential of technology-dominated environments.

4.2.9 Sound as a Service for Sustainable Environments

Tue 14:00–15:00 — Riverbank Room 4 (Chair: Andy Chung, Linus Ang)

14:00: Paper 142 — A Data-Driven Approach for Measuring Residential Soundscape and Implications for Urban Practice: Evidence from Suzhou, China — *Dr Jingwen Cao*

14:20: Paper 244 — A Pilot Study on the Relationship between Perceived Auditory Biodiversity and Soundscape Evaluation — *Prof Koji Nagahata*

14:40: Paper 269 — Applying ISO/TS 12913-2:2018 Soundwalk Method for Soundscape Assessment in the Heritage Streets of Melaka: A Pilot Study — *Dr Nurul Amira Abd Jalil*

14:00 **Paper 142 — A Data-Driven Approach for Measuring Residential Soundscape and Implications for Urban Practice: Evidence from Suzhou, China**

***Dr Jingwen Cao**, Yafei Gu, Dr Pingping Dou*

Community noise has emerged as a critical urban governance challenge in China's high - density cities. Inspired by EU's "Quiet Areas" initiative, China launched the "Quiet Communities" construction plan in 2024 to improve residential acoustic environments. However, the implementation of this program is hindered by the lack of established soundscape evaluation methods, as "quietness" is inherently perception - based.Therefore, this study attempts to utilize noise complaint data from Suzhou, China in 2024 as a basis for assessing residential soundscape and to analyze the influences of related building attributes. Exact noise locations were extracted from the reported data, and impact distances were assigned based on noise source ranges to compute a Residential Perceived Noise Value (RPNV) for each residential community. Affected communities (RPNV > 0) were analyzed for attributes including administrative district, housing price, age, capacity rate, greenery rate, ownership type, construction type, and building height. Results show that affected communities are predominantly high-value neighbourhood. Administrative location is the decisive factor for RPNV, yet within the same district, newer communities exhibit significantly higher perceived noise levels. It suggests that soundscape of residential communities in China is more closely linked to urban development phases and spatial planning than to internal community design.

14:20 **Paper 244 — A Pilot Study on the Relationship between Perceived Auditory Biodiversity and Soundscape Evaluation**

***Prof Koji Nagahata**, Ms. Sahara Matsui, Ms. Mizuka Yoshida*

Biodiversity can also be perceived through the auditory sense and is thought to influence the evaluation of soundscapes. This pilot study investigates the relationship between perceived auditory biodiversity and soundscape evaluations, including perceived affective quality and perceived restorativeness. In this study, eight soundscape excerpts recorded in greenery areas near suburban residential zones were examined. These excerpts were evaluated using the Perceived Affective Quality Scale (PAQS) and the Perceived Restorativeness Soundscape Scale (PRSS). Perceived auditory biodiversity for each excerpt was estimated using the method of pair comparison. Our preliminary results indicate that perceived auditory biodiversity correlates with the arousing qualities of soundscapes.

14:40 **Paper 269 — Applying ISO/TS 12913-2:2018 Soundwalk Method for Soundscape Assessment in the Heritage Streets of Melaka: A Pilot Study**

***Dr Nurul Amira Abd Jalil**, A/Prof Nazli Bin Che Din, Dr Zalina Samadi*

Melaka is one of two cities in Malaysia inscribed as a UNESCO World Heritage Site (WHS) in 2008. Its unique architectural and cultural townscape has been widely studied. However, previous research has largely overlooked the intangible cultural dimension of the urban environment, particularly the soundscape. This study forms part of a broader research effort to address this gap by examining the urban soundscape of Melaka. As a preliminary investigation, this pilot study aims to evaluate the feasibility of the soundscape assessment methodology recommended in ISO/TS 12913-2:2018. The soundwalk method was applied at selected locations within the heritage streets of Melaka, incorporating both acoustic measurements and questionnaire surveys. The findings indicate that the soundscape of the study area is predominantly influenced by human activities, including vehicular movement, pedestrian flow, and cultural and commercial activities. Given that the

vibrancy of Melaka's heritage streets varies according to shop operating hours and seasonal cultural events, the study highlights the critical importance of careful selection of measurement locations and timing in soundscape assessment. These observations provide useful methodological insights for future soundscape studies in heritage urban contexts.

4.3.1 Perceptual Evaluation of Sounds and Product Noise: General

Mon 14:00–15:00 — Riverbank Room 4 (Chair: Ercan Altinsoy, Katsuya Yamauchi)

14:00: Paper 23 — Investigating performance of speech intelligibility improvement for drone audio broadcasting — *A/Prof Yusuke Hioka*

14:20: Paper 470 — Eyes open or closed? Cortical criticality metrics reflects visual influence on auditory detection in noisy environments — *Prof Yu Huang*

14:40: Paper 576 — Contribution of Air Conduction to the Perception of Very High Frequency (VHF) Sounds: A Study Using Earplugs — *A/Prof Mari Ueda*

14:00 **Paper 23 — Investigating performance of speech intelligibility improvement for drone audio broadcasting**

*Mr Kevin Shi, **A/Prof Yusuke Hioka**, Dr Wageesha Manamperi, Dr C. T. Justine Hui*

Drone audio broadcasting can enable rapid, flexible speech communication in scenarios such as search and rescue, disaster response, and public safety. However, speech played from drones is contaminated by its own intense, time-varying rotor noise, while linearly increasing playback level is often undesirable as it raises privacy concerns and noise pollution. Speech intelligibility improvement methods could be used to improve the intelligibility of speech under noise by maintaining its sound level. To date, most methods have been evaluated by conventional maskers such as speech shaped noise or babble noise, not by the unique drone noise. This study performs a subjective listening test with native New Zealand English listeners, that investigates the performance of four modern speech intelligibility improvement methods under varying input signal-to-noise ratio (SNRs) with two recorded drone noise. The results show the spectral shaping and dynamic range compression (SSDRC) and its variant consistently achieved better

performance marking a 72% intelligibility gain from the unmodified speech at the -16 dB input SNR, but difference in performance between methods decreased as the input SNR improved. Performance difference between drone type was marginal while their ranking between the evaluated methods was consistent.

14:20 **Paper 470 — Eyes open or closed? Cortical criticality metrics reflects visual influence on auditory detection in noisy environments**

*Miss Ke Ni, **Prof Yu Huang**, Mr Haijun Wu*

Recent research established that increasing visual engagement (from eyes closed to dynamic viewing) progressively lowers auditory detection thresholds for noise-masked sounds, and proposed that the Avalanche Criticality Index (ACI) effectively mirrors this cortical state shift. This study further evaluates ACI using EEG recordings from 12 participants exposed to five ecological sounds (i.e., canoe paddle, drum, lark chirping, train, and keyboard) under four visual conditions in both quiet and 70 dB(A) pink noise. In the quiet condition, ACI exhibited a clear gradient reflecting behavioral trends: eye closure induced the lowest ACI (approaching cortical criticality), while dynamic visual engagement shifted the cortex to the highest ACI regime. However, this distinct pattern collapsed under masking noise. While ACI in the eyes-closed condition generally remained lower than in eyes-open conditions for most stimuli, this trend lost statistical significance. This suggests that the stochastic noise elevated global neural excitability, pushing the brain towards a disordered regime that overwhelmed the cortical state shift induced by visual conditions. We propose that while ACI effectively captures baseline cross-modal modulation (auditory modulated by visual), its reliability as an online neural monitor is limited in high-noise environments.

14:40 **Paper 576 — Contribution of Air Conduction to the Perception of Very High Frequency (VHF) Sounds: A Study Using Earplugs**

***A/Prof Mari Ueda**, Student Asahi Kuboya, Student Shuki Matsushita, Student Kanami Konodo, Professor Kentaro Nakamura, Researcher Masaaki Hiroe*

This study investigates the contribution of air conduction to the perception of very high frequency (VHF) sounds above 20 kHz, a mechanism that remains a subject of debate in acoustics. To clarify whether these sounds are perceived via air conduction or other pathways like bone conduction, hearing thresholds from 1 kHz to 20 kHz were measured for nine participants in a semi-anechoic field. Two conditions were compared: an open-ear condition and an earplug condition

using silicone plugs reinforced with polymer clay to ensure maximum acoustic insulation in the VHF range. The results showed that while all participants could perceive sounds below 12 kHz in both conditions, the audibility in the VHF range was significantly altered by earplug use. Specifically, in the open-ear condition, six out of nine participants could perceive 20 kHz sounds, but this number dropped to zero when earplugs were worn. These findings provide strong evidence that air conduction is the primary pathway for VHF sound perception, contributing to a deeper understanding of human high-frequency hearing mechanisms.

4.3.3 Product Sound Quality

Tue 09:00–10:20 — City Room 2 (Chair: Yu Huang, Seonghyeon Kim)

09:00: Paper 197 — Towards Sound Quality Foundation Models: A Perceptual Data Augmentation Approach for Small-Sample Aircraft-Cabin Noise Prediction — *Mr Fancheng Liu*

09:20: Paper 208 — Sound exploration methodology for interactive evaluation of electric motor noise — *Miss Salomé Wanty*

09:40: Paper 568 — Subjective-Objective Evaluation of Interior Sound Quality of Power-Concentrated EMUs — *Mr Zhanpeng Wang*

10:00: Paper 434 — Quantifying the Effect of the forms of the amplitude envelope on Fluctuation Strength — *Ms Nozomiko Yasui*

09:00 **Paper 197 — Towards Sound Quality Foundation Models: A Perceptual Data Augmentation Approach for Small-Sample Aircraft-Cabin Noise Prediction**

Mr Fancheng Liu, *Prof. Ke'an Chen, Mr Tong Gao, Mr Jianfeng Luo*

Psychoacoustic metrics (PMs) serve as core quantitative indicators of auditory perception. Although recent standards such as ECMA 418-2 define standardized calculation procedures, algorithmic implementations vary across different analysis software and their versions in industrial practice, leading to discrepancies in PM calculation results. Furthermore, constrained by the high costs of subjective evaluation experiments and listener fatigue, sound quality research commonly suffers from scarce subjectively annotated data, severely limiting the generalization capability of predictive models. Focusing on aircraft cabin noise, this study first evaluates the discrepancies in PM calculations between Head Artemis versions 11.6 and 17.5 and their impact on annoyance prediction models. To address data scarcity, a perceptually consistent noise injection method (PCNIM) is proposed for data augmentation. Unlike conventional augmentation techniques, this approach expands the dataset while ensuring that the underlying mechanism of annoyance generation remains consistent between augmented data and corresponding labels. K-fold cross-validation demonstrates that end-to-end Convolutional Neural Networks (CNNs) effectively mitigate biases from manual PM extraction, while PCNIM significantly enhances model robustness and scalability for large-scale sound quality assessment.

09:20 **Paper 208 — Sound exploration methodology for interactive evaluation of electric motor noise**

Miss Salomé Wanty, *Etienne Parizet, Nicolas Totaro, Martin Glesser*

The noise emitted by an electric motor depends on its geometry, its operating point, and its supply strategy. Considering the variation of these parameters is necessary to assess the sound quality of the motor noise. Conducting a sound perception experiment with all possible parameter combinations would be highly time-consuming. Literature shows a general limitation of existing studies to a single parameter variation. However, this choice can introduce a bias. Consequently, it is difficult to draw a general conclusion from the findings resulting from a limited case study.

The authors propose a novel experimental methodology based on the exploration of a continuous space of sound configurations. An interface was developed to make sound vary in accordance with the cursor's movement on the screen. The surface to be explored was defined by two supply parameters known to modify the noise spectrum of electric motors: the pulse width modulation strategy and the modulation index. Participants were instructed to listen to all possible configurations before selecting the most pleasant one. Following the exploration, there was an open discussion to gather the participants' impressions of the positions in which they had spent most of their time. The results will be presented during the conference.

09:40 **Paper 568 — Subjective-Objective Evaluation of Interior Sound Quality of Power-Concentrated EMUs**

Dr. Kun Qian, ***Mr Zhanpeng Wang****, Mr. Yong Liu, Mr. Yunpeng Liu, Mr. Xinxin Zhang, Mr Xikang Du, Ms. Jiying Duan, Mr Ke Liu*

The interior sound quality of power-concentrated electric multiple units (EMUs) directly determines passenger ride comfort, and rigorous subjective and objective evaluations of this quality are critical to the optimization of vehicle noise, vibration, and harshness (NVH) performance. To realize effective evaluation of interior sound quality, this study acquires interior noise

samples of power-concentrated EMUs under various operating conditions, systematically extracts objective psychoacoustic parameters, and constructs a comprehensive dataset by integrating the aforementioned objective data with subjective annoyance evaluation results. Based on this dataset, a linear regression model is employed to establish a quantitative relationship between the subjective and objective evaluations of sound quality, thus achieving accurate mapping from objective psychoacoustic parameters to subjective annoyance evaluation results. The research results demonstrate that the linear regression model is capable of effectively establishing robust correlations between the subjective and objective indicators of sound quality. Furthermore, the evaluation process is simple and efficient, without complex parameter debugging, and exhibits excellent engineering applicability. Consequently, it can partially substitute for traditional subjective evaluation assessments and offer intuitive and actionable technical support for the sound design optimization of power-concentrated EMUs.

10:00 **Paper 434 — Quantifying the Effect of the forms of the amplitude envelope on Fluctuation Strength**

Ms Nozomiko Yasui

Previous study showed that procedure for estimating Fluctuation Strength (FS) observing both constant fluctuation and deviation for time and amplitude approximately estimated the hearing sensation of fluctuation from tremolo played on the mandolin and marimba. Moreover, another one presented another procedure for estimating FS from exhaust sound of various motorbikes by proposing new indexes about the form of amplitude envelope. However, this procedure has been applied only to recorded motorcycle exhaust sounds. It didn't clarify the relationship between the perceived fluctuation and the form of the amplitude envelope, a method for calculating fluctuation strength based on this relationship has not yet been established.

Here, this paper explores acoustic characteristics represent the form of amplitude envelope and investigates relationship between those characteristics and sensation hearing of fluctuation and method of Quantifying Fluctuation Strength based on the relationship.

Investigations were carried out by using amplitude-fluctuated white noise which were designed to have various acoustic characteristics of the form. Those noises have characteristics of amplitude fluctuations in motorbikes. Then, the hearing sensation of fluctuation on those sounds were assessed, investigated relationship between those characteristics and the sensation hearing. Results showed that those characteristics, especially form for rising, influence the hearing sensation of fluctuation.

4.3.5 Sound Design

Wed 08:40–09:40 — Panorama Room 2 (Chair: Seonghyeon Kim, Yu Huang)

08:40: Paper 202 — Adaptive audio injection method for reducing cabin noise annoyance — *Mr Jianfeng Luo*

09:00: Paper 664 — Perceptual Evaluation of Electric Bus Alert Sounds Using Immersive 360-Degree Virtual Reality Psychoacoustic Testing Environments — *Prof Andrew Johnston*

09:20: Paper 746 — Evaluation of Electric Bus Alert Sounds: A Detection Distance Field Study — *Dr Ian Stevenson*

08:40 **Paper 202 — Adaptive audio injection method for reducing cabin noise annoyance**

***Mr Jianfeng Luo**, Prof Kean Chen, Mr Hao Li, Mr Fancheng Liu, Ms Yunyun Deng, Ms Huanqi Zhao*

With technological and societal development, cabin noise has become a significant issue, drawing greater attention to noise comfort. Traditional noise control methods that reduce noise energy have limitations in improving subjective perception. The audio injection method (AIM) reduces annoyance by injecting specific sounds into the target sound. However, its effectiveness depends on the selection of controllable sounds and parameter design. Additionally, existing methods still lack adaptability in non-stationary noise environments.

This study proposes an adaptive AIM that integrates the annoyance model with a control framework based on ”perceptual evaluation—dynamic decision-making—real-time adjustment.” First, the annoyance model quantitatively evaluates the contribution of each critical band of the target sound to perceived annoyance, guiding the selection of controllable sound. Then, an auto-selection mechanism is introduced that considers both spectral similarity and the minimum energy criterion, enabling the automatic selection of the preferred controllable sound from a preselected database of high-quality sounds. Additionally, a dynamic adjustment mechanism integrates spectral equalization with a smooth time domain transition, enabling precise control of the controllable sound and avoiding the ”pumping” effect from sudden gain changes. Simulations indicate that the proposed method effectively reduces range hood noise annoyance, confirming its feasibility in enhancing cabin noise comfort.

09:00 **Paper 664 — Perceptual Evaluation of Electric Bus Alert Sounds Using Immersive 360-Degree Virtual Reality Psychoacoustic Testing Environments**

***Prof Andrew Johnston**, Dr Ian Stevenson, A/Prof Sam Ferguson, Dr. Baki Kocaballi, Mr Jacob Hedges, Professor Anjum Naweed, Emeritus Prof Judy Edworthy, Dr Christina Kirsch*

The transition to electric buses reduces vehicle noise, introducing new safety challenges for pedestrians and cyclists, particularly in complex urban environments. Acoustic Vehicle Alerting Systems (AVAS) are intended to address this risk; however, poorly designed sounds can lead to annoyance, reduced acceptance, or misinterpretation. This study reports on psychoacoustic testing of candidate AVAS sounds for zero-emission buses using an immersive 360-degree virtual reality (VR) environment.

Perceptual evaluations were conducted in the University of Technology Sydney’s Data Arena, a cylindrical VR cave enabling realistic audiovisual simulation of urban soundscapes. Participants were exposed to optimised AVAS sound candidates within dynamic traffic scenarios and assessed them across key human factors criteria, including salience, distinctiveness, appropriateness, suitability for urban contexts, identifiability as a bus, perceived safety, urgency, and affective response.

Results demonstrate that immersive VR-based testing provides ecological validity, allowing nuanced assessment of auditory perception, contextual interpretation, and affective response. Findings highlight trade-offs between detectability and affective response and show that sounds perceived as contextually appropriate were more likely to be associated with a sense of safety and correct source identification. The study demonstrates the value of immersive psychoacoustic evaluation for designing safety-critical vehicle sounds that balance detectability, user acceptance, and urban sound quality.

09:20 **Paper 746 — Evaluation of Electric Bus Alert Sounds: A Detection Distance Field Study**

***Dr Ian Stevenson**, Mr Jacob Hedges, A/Prof Sam Ferguson, Emeritus Prof Judy Edworthy, Professor Anjum Naweed, Dr Christina Kirsch*

Acoustic Vehicle Alert Systems address the risk to pedestrians and vulnerable road users caused by the near-silent operation of electric vehicles at low speeds. This study evaluated the effectiveness of a set of candidate sounds in roadside conditions by comparing the detection distance of each sound from a moving electric bus. Candidate sounds were designed with the aim of developing a uniform sound for all publicly operated electric buses to enhance recognition and balance detectability with annoyance.

The study was conducted on a roadway at the Transport for NSW Crash Lab, using an AVAS system on a standard 12.5m 44-seat passenger bus. Participants were positioned blindfolded beside the roadway and used a button-press to register initial detection of each sound at vehicle speeds of 10 and 20 km/h. Subjective perceptual evaluations of the sounds were also collected.

Average detection distances were compared to the estimated stopping distance of the vehicle as a measure of effectiveness. Statistically significant differences were found between the seven sounds tested with three sounds exhibiting adequate detection distance and one sound showing superior performance to the others. These results show that sounds that conform to the relevant standards may diverge in their effectiveness as safety alerts.

4.3.6 Perception and Sound Design for Electric Vehicles

Tue 16:20–18:00 — City Room 3 (Chair: Christina Kirsch, Katsuya Yamauchi)

16:20: Paper 498 — Multi-method Approach to the Testing and Evaluation of an AVAS sound — *Dr Christina Kirsch*

16:40: Paper 314 — Reinforcement Learning–Guided CNN Modeling of Perceptually Relevant Time–Frequency Mechanisms for Interior Sound Quality Evaluation of Electric Vehicles — *Mr Ke Liu*

17:00: Paper 632 — Conveying vehicle state through manipulations of acoustic vehicle alert system sounds — *A/Prof Sam Ferguson*

17:20: Paper 585 — Reinforcement Learning–Based Parameter Optimization of CNN Models for Spectrogram-Based Interior Sound Quality Evaluation of Electric Vehicles — *Mr Ke Liu*

17:40: Paper 650 — Detectability and Localisation of Electric Bus Alert Sounds in a Simulated Sound Field — *Mr Jacob Hedges*

16:20 **Paper 498 — Multi-method Approach to the Testing and Evaluation of an AVAS sound**

Dr Christina Kirsch, *Prof Andrew Johnston, A/Prof Sam Ferguson, Dr. Baki Kocaballi, Mr Jacob Hedges, Professor Anjum Naweed, Emeritus Prof Judy Edworthy, Dr Ian Stevenson*

Acoustic Vehicle Alerting Systems (AVAS) are mandated for electric vehicles to compensate for reduced low-speed auditory detectability; however, regulatory compliance alone does not ensure that an AVAS sound is perceptually effective, operationally appropriate, and behaviourally safe within complex transport environments. Evaluating AVAS sound performance requires evidence beyond single-method laboratory audibility testing.

This paper presents a comprehensive multi-method framework for the development, testing, and selection of an AVAS sound for electric buses in Australia. The framework combined psychoacoustic masking and localisation studies, subjective assessments in an immersive virtual environment, online listener evaluation, time-to-collision studies, on-bus operational trials, and repeated perceptual validation across two iterative design rounds. To support decision-making, findings from these heterogeneous evidence sources were integrated using Multi-Criteria Decision Analysis (MCDA), enabling balancing detectability, urgency, semantic appropriateness, user acceptance, and operational suitability.

Results demonstrate that no individual test method was sufficient to determine AVAS sound performance in isolation: candidate sounds that performed strongly in controlled audibility tests did not necessarily produce optimal behavioural response or public acceptance under realistic conditions. The proposed multi-method and MCDA-based evaluation framework provides a robust basis for AVAS sound selection in safety-critical public transport applications and offers a transferable methodology for future AVAS sound design.

16:40 **Paper 314 — Reinforcement Learning–Guided CNN Modeling of Perceptually Relevant Time–Frequency Mechanisms for Interior Sound Quality Evaluation of Electric Vehicles**

Dr. Kun Qian, ***Mr Ke Liu****, Mr Mengen Xin, Mr Zhenlei Li, Mr Baoheng Wang, Mr Hao Wang, Mr Ke Liu*

Human perception of interior sound quality in electric vehicles is strongly influenced by selective attention to specific time–frequency characteristics rather than uniform integration of acoustic information. However, most existing CNN-based sound quality evaluation models for electric vehicles process spectrogram inputs in a fixed and uniform manner, which limits their ability to reflect perceptual selectivity observed in subjective listening experiments. This study investigates the use of reinforcement learning (RL) as a perceptual mechanism learning strategy to guide CNN-based interior sound quality evaluation models for electric vehicles toward perceptually relevant time–frequency characteristics. In the proposed framework, reinforcement learning adaptively regulates the model's focus on different time–frequency regions based on their contribution to subjective sound quality ratings obtained from listening experiments. Instead of manually defining perceptual importance, the model learns a data-driven perception strategy through reward feedback derived from subjective evaluation consistency. Experimental results based on electric vehicle interior noise datasets reveal that the RL-guided model develops structured preferences for specific non-stationary and frequency-dependent components closely associated with sound quality degradation. Comparative analysis demonstrates that the proposed approach improves both prediction performance and interpretability, providing valuable insights into the perceptual mechanisms underlying data-driven interior sound quality evaluation for electric vehicles.

17:00 **Paper 632 — Conveying vehicle state through manipulations of acoustic vehicle alert system sounds**

***A/Prof Sam Ferguson**, Emeritus Prof Judy Edworthy, Dr Ian Stevenson, Mr Jacob Hedges, Prof Andrew Johnston, Dr Christina Kirsch, Professor Anjum Naweed*

This investigation examined the effectiveness of six candidate Acoustic Vehicle Alerting System (AVAS) sounds in conveying the 'meaning' of four bus states, without prior instruction. AVAS sound states were represented by specific sound manipulations: accelerating sounds increased in frequency, decelerating sounds decreased, constant sounds remained steady, and stationary sounds omitted rhythmic components, with these sound manipulations designed to conform to the ECE R138 standard. Analysis focused on whether users were able to distinguish the different states, as this determines whether they can appropriately respond and take action in the environment. An online subjective listening test used a four-alternative forced choice design where 21 participants identified an intended state from five-second sound presentations. A three-way ANOVA examined effects of sound state, candidate sound set, and trial order on accuracy, revealing a significant effect of sound state, a significant effect of sound set, and an interaction between these factors, while trial order had no significant effect. Accelerating sounds were most accurately identified, while stationary sounds were the hardest to detect correctly. Accuracy and d' scores were computed to evaluate participant performance and suggest that some participants may require training or informational materials to interpret AVAS signals effectively.

17:20 **Paper 585 — Reinforcement Learning–Based Parameter Optimization of CNN Models for Spectrogram-Based Interior Sound Quality Evaluation of Electric Vehicles**

*Dr. Kun Qian, **Mr Ke Liu**, Dr. Yang Mao, Ms. Jiying Duan, Mr Xikang Du, Mr Zhanpeng Wang, Mr. Xinxin Zhang, Mr Ke Liu*

In recent years, convolutional neural networks (CNNs) have been increasingly adopted for interior sound quality evaluation of electric vehicles (EVs) based on time–frequency representations. However, under small-sample and non-stationary acoustic conditions typical of EV interior noise, the performance of CNN-based models is highly sensitive to spectrogram configuration parameters and network hyperparameters. Conventional parameter tuning approaches, such as grid search or heuristic optimization, are often computationally inefficient and lack adaptability to complex acoustic characteristics. This paper proposes a reinforcement learning (RL)–based parameter optimization framework for CNN-driven interior sound quality evaluation of electric vehicles using spectrogram inputs. The parameter tuning process is formulated as a sequential decision-making problem, in which an RL agent adaptively adjusts key spectrogram construction parameters and CNN architecture-related parameters. The reward function is defined based on prediction accuracy with respect to subjective sound quality ratings and model robustness. Experimental results based on electric vehicle interior noise datasets and corresponding subjective evaluation experiments demonstrate that the proposed RL-based optimization strategy consistently outperforms conventional parameter tuning methods in terms of prediction accuracy and stability. The results indicate that reinforcement learning provides an effective and flexible solution for optimizing CNN-based interior sound quality evaluation models for electric vehicle applications.

17:40 **Paper 650 — Detectability and Localisation of Electric Bus Alert Sounds in a Simulated Sound Field**

***Mr Jacob Hedges**, Dr Ian Stevenson, Dr Sipei Zhao, A/Prof Sam Ferguson, Prof Andrew Johnston, Emeritus Prof Judy Edworthy, Professor Anjum Naweed, Dr Christina Kirsch*

Effective Acoustic Vehicle Alert Systems (AVAS) must perform well in a variety of ambient sound conditions and enable road users to identify the direction and location of an approaching vehicle. The aim of this study was to compare the detectability and localisation of moving AVAS sounds and a simulated internal combustion engine (ICE) in controlled acoustic conditions using spatially accurate simulations of roadside soundfields. The ability of 25 participants to detect the direction of approach, position and detection time of candidate sounds in background noise was measured. Subjective evaluations of the sounds were also collected.

Results show that the ability to perceive the correct direction of approach was not affected by differences in the sounds tested. Statistically significant differences in position and detection time were not seen in all comparisons between AVAS sounds but were found between the AVAS sounds and the simulated ICE sound. This shows that particular characteristics of AVAS sounds can affect detection, and that the ICE sound was more difficult to discriminate in traffic ambience. The study demonstrates the value of controlled listening tests as an element in a comprehensive design process for new vehicle alert sounds.

4.3.7 Psychological Evaluation of Transportation Noise: Train, Aircraft, and Road Traffic Noise

Tue 10:40–12:20 — City Room 4 (Chair: Yu Huang, Katsuya Yamauchi)

10:40: Paper 131 — Influence of Tonal Components in Critical Bands on Interior Noise Annoyance of High-Speed Trains — *Mr Xudong Liu*

11:00: Paper 482 — ECG-based driver stress assessment using CNN with attention mechanisms in real driving environments — *Mr Seonghyeon Kim*

11:20: Paper 352 — UAV Path Optimization in Urban Low-Altitude Environments Based on Noise Exposure — *Mr Xin Zhao*

11:40: Paper 591 — Psychoacoustic Evaluation of Changes in Perceived Road Traffic Noise under Controlled Environmental Configurations Using Virtual Reality — *A/Prof Alfred C. H. Tan*

12:00: Paper 770 — Correspondence between LAeq and Perceived Noisiness of Road Traffic Noise: Effects of Background Level and Event Prominence — *Prof Katsuya Yamauchi*

10:40 **Paper 131 — Influence of Tonal Components in Critical Bands on Interior Noise Annoyance of High-Speed Trains**

Mr Zongcai Liu, Mr Yihang Yu, ***Mr Xudong Liu***

Interior noise annoyance is a key factor affecting passenger comfort in high-speed trains, while traditional energy-based indicators do not adequately capture subjective auditory perception. This study investigates the influence of tonal components in critical bands on perceived annoyance of high-speed train interior noise, with an emphasis on efficient experimental design under practical listening constraints. Interior noise signals were recorded in situ using an artificial head and reproduced using a high-fidelity playback system for subjective annoyance evaluations. A neural network model was established to predict annoyance from psychoacoustic parameters, including loudness, sharpness, roughness, fluctuation strength, and tonality. The model was employed as a sample pre-selection tool to guide subsequent listening experiments. To examine frequency-dependent tonal effects, a representative interior noise sample recorded at 400 km/h was processed using FIR filtering to selectively enhance tonal components within individual critical bands. The results indicate that tonal enhancement in low critical bands leads to a pronounced increase in annoyance, while sensitivity to tonal gain decreases with increasing frequency. Annoyance growth exhibits nonlinear and asymmetric characteristics with respect to gain direction. These findings underscore the importance of critical-band-dependent tonal control in the interior noise design of high-speed trains.

11:00 **Paper 482 — ECG-based driver stress assessment using CNN with attention mechanisms in real driving environments**

Mr Seonghyeon Kim*, Keewon Shin, Prof Ercan Altinsoy*

As vehicle-induced noise, vibration, and dynamic driving conditions increasingly affect driver comfort in electrified and automated vehicles, developing robust physiological monitoring methods for real-world driving environments has become a critical challenge. Real-world driving conditions expose drivers to varying environmental stimuli that influence physiological stress responses. This study presents a CNN-based framework with attention mechanisms for driver stress assessment using electrocardiogram signals collected during real-world vehicle operation. We evaluated CNN architectures with various attention mechanisms on ECG data from 10 drivers across stationary, highway, and urban driving scenarios. One-dimensional DenseNet models augmented with different attention modules including channel-based, spatial, and frequency-domain approaches were individually evaluated using leave-one-subject-out cross-validation for three-level stress classification: rest, low-stress, and high-stress states. Frequency-domain attention mechanisms demonstrated superior performance, significantly outperforming baseline models. These results indicate that frequency-domain approaches effectively capture stress-related ECG patterns. This framework provides a foundation for integrating physiological measures into vehicle comfort evaluation. Ongoing work extends this approach by incorporating acoustic and vibration measurements to relate physiological stress responses to acoustic and vibrational characteristics in vehicle environments.

11:20 **Paper 352 — UAV Path Optimization in Urban Low-Altitude Environments Based on Noise Exposure**

***Mr Xin Zhao**, Prof. Qi Meng, Assistant Professor Da Yang, Lecturer Mengmeng Li*

To address the issue of noise disturbance caused by urban low-altitude UAV operations to ground populations, this study proposes a path optimization method based on noise exposure metrics. First, considering flight energy consumption and safety as constraints, a multi-objective cost function is constructed by coupling ground traffic noise, acoustic functional zone classifications, and population density. Subsequently, the Multi-Objective Particle Swarm Optimization (MOPSO) algorithm is employed for simulation and path planning within typical urban block scenarios in Harbin. The results indicate that the proposed method effectively guides UAVs to fly along main ground traffic arteries, utilizing background traffic noise to mask flight noise. Furthermore, the approach successfully circumvents noise-sensitive areas and significantly reduces the noise exposure levels of ground populations. Compared with traditional shortest-path strategies, this research achieves an optimal trade-off between UAV flight efficiency and acoustic impact, providing valuable decision support for the assessment and management of urban low-altitude traffic noise.

11:40 **Paper 591 — Psychoacoustic Evaluation of Changes in Perceived Road Traffic Noise under Controlled Environmental Configurations Using Virtual Reality**

***A/Prof Alfred C. H. Tan**, Mr Muhammad Mu'izzuddin Malek, Mr Kian Leong Yong*

Rapid urbanisation has increased environmental noise challenges in high-density cities, where traditional engineering solutions often fail to address the subjective human experience. This research investigates the psychoacoustic potential of biophilic urban design in mitigating perceived expressway noise adjacent to high-rise residential environments. Utilising an immersive Virtual Reality framework, thirty participants evaluated twelve distinct visual configurations from a vertical perspective while exposed to a generated constant traffic noise stimulus of 67-70 dB. The experimental variables included VR scenes of plant diversity, building density, and the presence of water features. Statistical analysis reveals a significant disconnect between physical sound pressure levels and human perception, demonstrating that the visual environment serves as a powerful modulator of acoustic stress. Results identify the combination of greenery and water as the most effective strategy for psychological traffic noise masking. Specifically, configurations featuring widened water canals and higher plant biodiversity consistently yielded the highest visual comfort and lowest perceived noise ratings. These findings provide a possible template for urban planners, suggesting that multisensory design strategies can effectively complement traditional acoustic engineering to enhance residential liveability in dense tropical urban environments.

12:00 **Paper 770 — Correspondence between LAeq and Perceived Noisiness of Road Traffic Noise: Effects of Background Level and Event Prominence**

***Prof Katsuya Yamauchi**, Masayuki Kito*

The equivalent continuous A-weighted sound pressure level (LAeq) is widely used for environmental noise assessment; however, in the presence of intermittent events highly prominent above a low-level background, LAeq may not adequately reflect perceived noisiness. This study investigated the influence of background noise and specific noise events on perceived noisiness of road traffic noise and examined the conditions under which LAeq appropriately represents subjective response.

Two laboratory experiments were conducted using controlled stimuli in which the background level and the prominence of specific events relative to the background were systematically varied. The results showed that when event prominence exceeded 30 dB and the temporal proportion of background noise was greater than 75%, LAeq tended to overestimate noisiness compared with an equivalent steady noise. Under these conditions, the correspondence between LAeq and perceived noisiness was reduced.

Simulations of noise level variations under different traffic conditions were performed to examine the circumstances in which these conditions occur. The results indicated that such overestimation of noisiness arises only in limited situations with extremely low traffic volumes. Overall, LAeq provides a reasonable indicator of noisiness in most road traffic conditions, although alternative or corrected metrics may be required in specific cases.

4.4.1 Art, Music & Science: General

Tue 14:00–15:20 — City Room 4 (Chair: Jose Augusto Nepomuceno)

14:00: Paper 66 — Acoustics, Music Education and Ski-hill Graph Pedagogy — *Mrs Andrea Calilhanna*

14:20: Paper 136 — Investigation of the Impact of Inter-Performer Distance on Stage Acoustics: Focusing on Directional Early Reflection Energy from Other Performers — *Ms Hitomi Yatani*

14:40: Paper 235 — Opera, Media, and Sound Technology — *Mrs Juliana Spector*

15:00: Paper 480 — Acoustic Transmission Characteristics of Traditional Japanese Paper Masks Used in Iwami Kagura Performances — *Dr Takafumi Shimizu*

14:00 **Paper 66 — Acoustics, Music Education and Ski-hill Graph Pedagogy**

Mrs Andrea Calilhanna

Listening is a musical experience, yet music education rarely frames it within the scientific context of acoustics. Conventional metre fundamentals pedagogy often privileges symbolic representations such as time signatures and notation, overlooking the perceptual processes that listeners respond to rhythmic sound. Research in psychoacoustics and cognitive neuroscience shows that the auditory system processes metre through entrainment and predictive timing, enabling the perception of hierarchical temporal relationships. Entrainment involves synchronising internal metre timing with external rhythmic cues, while metre may be understood mathematically as simple temporal ratios analogous to pitch relationships in the frequency domain. This paper examines metre pedagogy through Ski-hill Graph Pedagogy Metre Fundamentals (SHGP), inspired by Richard Cohn's comprehensive metre theory. SHGP prioritises sound before symbol and conceptualises metre as initiated from listeners' responses to rhythmic acoustics. Central to the approach is the visualisation of temporal ratios, such as 2:1 duple metre and 3:1 triple metre, through ski-hill graphs that model nested pulse hierarchies. Through the three-stage framework of Clap, Tap, and Map, learners engage metre through the embodied movement, coordination, and visual modelling. The Ski-hill Graph Pedagogy processes support metre perception and provide additional interpretive information applicable to performance timing and musical expression.

14:20 **Paper 136 — Investigation of the Impact of Inter-Performer Distance on Stage Acoustics: Focusing on Directional Early Reflection Energy from Other Performers**

Ms Hitomi Yatani*, Dr Aakriti Shrestha, Dr Takafumi Shimizu*

Stage acoustics critically influence ensemble precision and performer comfort. Although the extended inter-performer distancing during the COVID-19 pandemic reduced masking from other instruments, it concurrently impaired tempo synchronization and tonal blending, as evidenced by both literature and field investigations. Our previous research, combining subjective evaluation with acoustic simulation, established a preferred distance range by clarifying the impact of spacing on early reflections. However, these findings also exposed the limitations of traditional omnidirectional parameters in capturing spatial acoustic characteristics. This study addresses this gap by integrating First-Order Ambisonics (FOA) acoustic measurements in a concert hall with a preliminary questionnaire administered to amateur orchestras. The survey responses quantified the adverse effects of distancing, particularly the degradation of ensemble blend and timing. Subsequent physical measurements on a concert hall stage utilized directional impulse responses extracted from B-format signals to analyze the spatial distribution of early reflection energy. The results demonstrate that increased distance induces spectral imbalances in the early reflection energy arriving from other performers. These physical variations quantitatively explain the reported ”mutual hearing difficulties.” Consequently, this paper highlights the necessity of novel stage acoustic parameters grounded in directional energy balance to better represent subjective experiences.

14:40 **Paper 235 — Opera, Media, and Sound Technology**

Mrs Juliana Spector

This paper examines contemporary opera as a site of advanced acoustic control, where live vocal sound is increasingly shaped by technological systems designed to meet perceptual expectations formed through recorded listening. While opera is traditionally grounded in unamplified vocal projection and architectural acoustics, modern audiences often expect levels

of clarity, balance, and intelligibility associated with highly controlled studio sound. These expectations present a noise-control challenge in large theatrical environments characterized by orchestral masking, spatial variability, and performer movement.

To address these conditions, contemporary opera productions employ discreet sound reinforcement systems that function less as amplification and more as tools of sound management. Microphone capture, digital signal processing, time alignment, and distributed loudspeaker systems are used to stabilize vocal presence and minimize perceptual noise. Crucially, these interventions are designed to remain perceptually concealed, producing the impression of natural acoustic sound. The study examines operatic reinforcement as a problem of perceptual noise control and auditory fusion rather than loudness enhancement.

15:00 **Paper 480 — Acoustic Transmission Characteristics of Traditional Japanese Paper Masks Used in Iwami Kagura Performances**

Dr Takafumi Shimizu*, Dr Aakriti Shrestha, Damjan Pecioski, Dr. Simona Markovska, Kenji Kakita*

Iwami Kagura is a traditional Japanese performing art originating in the Iwami region of western Shimane Prefecture, characterized by vigorous movement, rapid choreography, and dynamic spoken narration. Central to these performances are Iwami Kagura masks, traditionally handcrafted from Sekishu washi using Kōzo fibers. These masks are lightweight and durable, and their forms and production methods have been refined through long-established craftsmanship. They are currently used by more than 200 kagura groups, representing a rare large-scale and continuous use of washi-based masks in live performance practice. Performers have long noted that wearing these masks alters voice transmission and affects speech audibility during performances; however, their acoustic behavior has not been quantitatively examined. This study investigates the acoustic transmission characteristics of a Susanoo mask used in Iwami Kagura performances. Acoustic measurements were conducted to evaluate frequency-dependent spectral modification, relative level differences, and directivity characteristics caused by the presence of the mask. The results reveal systematic variations in relative level difference and spectral shaping of the Susanoo mask, particularly in speech-related frequency bands. These findings provide measurement-based insight into speech transmission through traditional paper masks and contribute to the acoustic understanding of traditional performing arts.

4.4.3 Vibration and Acoustic Measurements of Musical and Sound Sources

Tue 11:00–12:00 — Panorama Room 2 (Chair: Will Robertson, Anthony Zander)

11:00: Paper 1 — Vibration of asymmetrically clipped Bundengan strings — *Dr Gea Oswah Fatah Parikesit*

11:20: Paper 635 — The Australian Aboriginal Yidaki: Acoustic Recordings and a 3D Geometric Model Derived from Computed Tomography — *Dr Matthew Forbes*

11:40: Paper 815 — Experimental Investigation of Cello Bridge Design Using 3D-Printed Models — *Dr Andrew Hall*

11:00 **Paper 1 — Vibration of asymmetrically clipped Bundengan strings**

Dr Gea Oswah Fatah Parikesit, *Dr Indraswari Kusumaningtyas*

The Bundengan is a rare musical instrument from the Wonosobo Regency in Central Java, Indonesia. When playing the instrument, the Bundengan musician imitates the sounds of metal gongs in the Gamelan ensemble by plucking a set of strings equipped with small bamboo clips. By tuning the masses and the positions of the clips, the musician controls the non-homogeneity of the string densities, and hence the non-harmonicity of the string frequency spectra. Our previous investigations were centered around the simple cases where the strings have either only one clip or two symmetrical clips. Here we expand our study to include more complex cases where the strings have two asymmetrical clips. Our results show how the Bundengan player can use the clips asymmetry as an extra tuning tool for their musical performance.

11:20 **Paper 635 — The Australian Aboriginal Yidaki: Acoustic Recordings and a 3D Geometric Model Derived from Computed Tomography**

Dr Matthew Forbes, *A/Prof Will Robertson, Dr Dhong Fhel Gom-os, Dr Anthea Skinner, Dr Nicole Tse, Dr Aaron Corn*

The yidaki is a tubular wind instrument of Australian Aboriginal peoples, traditionally crafted from a eucalyptus tree that has been hollowed out by termites. The yidaki sound is modelled as a coupled system, starting from the lungs of the player, going through the vocal tract and lip-valve, into the instrument (approximated as a closed-open pipe). A 'good-sounding' yidaki cannot be determined from its outer appearance (length, shape). Prior work suggests that the irregular internal structure should yield low input acoustic impedance in the same frequency band (formant region) as the vocal tract impedance resonance (1-2 kHz). In this work, a high-spatial-resolution 3D geometric model of the internal structure of a yidaki is derived from computed tomography (CT), together with experimental sound recordings and numerical modelling. This exploratory study quantifies internal features (surface roughness, wall thickness, density) critical to this yidaki's acoustics that are often only qualitatively assessed, with the instrument treated as a black box. Our motivation is to understand the internal geometric requirements for reproducing this instrument, whether by 3D printing or cast moulding. With accurate 3D models, this instrument can be reproduced in a form appropriate for travel, made accessible for research and education, and/or digitally conserved.

11:40 **Paper 815 — Experimental Investigation of Cello Bridge Design Using 3D-Printed Models**

Miss Christine Zhou, ***Dr Andrew Hall****, Dr George Dodd*

The bridge of the cello is a key component for transferring string vibrations to the instrument body. This study experimentally investigates the vibrational response of a cello fitted with its original wooden bridge and compares it with responses obtained when the instrument was sequentially fitted with different 3D-printed bridges.

To enable controlled comparison, 3D-printing was employed to minimise variability inherent in traditional hand-crafted wooden bridges, which are subject to natural material inconsistencies. String excitation was provided using an electronic bow (E-bow) held in a fixed position. The E-bow detects string vibration via a pickup coil, amplifies the signal, and generates a magnetic field to sustain oscillation, ensuring repeatable input conditions. Vibrational responses were measured at multiple locations on the bridge and body using a Laser Doppler Vibrometer (LDV).

The primary objective is to develop and evaluate a novel, repeatable testing methodology to systematically assess how bridge design influences the overall response of a cello, offering insights into bridge design, modifications, or adjustments.

4.5.1 Education & Popularization: General

Mon 09:00–09:40 — City Room 4 (Chair: Matthew Forbes)

09:00: Paper 388 — Research through design: investigating acoustic thinking in design education — *Mr Mathew Garland*

09:20: Paper 305 — Teaching Expanded Listening: Strategies, Resources, and Outcomes — *Mx Lindsey French*

09:00 **Paper 388 — Research through design: investigating acoustic thinking in design education**

Mr Mathew Garland, *Dr Jeffrey Hannam*

Acoustics is an interdisciplinary field that brings together specialist knowledge strongly aligned with physics, mathematics, engineering, music and architecture. Despite this broad applicability, opportunities to present acoustics within noncognate, visual-centric design disciplines remain limited. This paper investigates how acoustic thinking can be integrated into design education through experiential, design-led pedagogies that promote critical and creative engagement. Two case studies, undertaken as design studios within the Master of Design Innovation and Technology program at RMIT University, form the central framework for this inquiry. Each studio positioned acoustics not merely as a technical subject but as an active and generative design driver, enabling students from diverse disciplinary backgrounds to engage with sound as both a material and spatial phenomenon. Adopting a research through design approach involving listening-based inquiry, iterative experimentation, and collaborative design processes, students developed embodied and situated understandings of acoustics extending beyond conventional quantitative approaches and technical instruction. The student outcomes demonstrated that integrating acoustic principles within design pedagogy cultivated a distinctive form of engagement with acoustic concepts. This research highlights the value of experiential, cross-disciplinary approaches in cultivating new forms of acoustic literacy and expanding the role of acoustics within contemporary design education and practice.

09:20 **Paper 305 — Teaching Expanded Listening: Strategies, Resources, and Outcomes**

Mx Lindsey French

This presentation focuses on pedagogical strategies for “Expanded Listening Practices,” a topics course I delivered in Fall 2024 at the University of Maine in the Intermedia program (an interdisciplinary program focused on creative research and technological engagement). This emphasis on listening rather than sound follows a turn in sound studies to consider listening as situated and embodied experience, preparing students for nuanced understandings of cultural contexts related to acoustics. The course employed critical and practical approaches to listening practices within the development, production, and presentation of creative work. Students experimented with technological, ecological, social, and embodied approaches including soundwalking, field recording, radio transmission and reception, building specialized microphones and listening devices, creating tactile and multisensory listening experiences, and designing environments for listening. The course drew on contemporary theorists and practitioners to ground discussion in decolonial listening, listening positionality, acoustic ecology, multi-species listening, and practices beyond the aural. By course end, students effectively considered the role of listening in social, technological, and artistic contexts. I highlight specific pedagogical strategies including active experimentation and alternative assessment, present a co-edited Open Educational Resource supporting open use and modification, and share student outcomes and reflections for potential adoption in university or other learning settings.

4.6.1 Noise Control & Social Sciences: General

Tue 16:20–18:00 — City Room 4 (Chair: Bhaven Tandel, James Mcintosh)

16:20: Paper 14 — Simulation analysis on traffic noise control and noise reduction performance of urban elevated roads and expressways in China — *Miss Kexin Lu*

16:40: Paper 96 — History and Application of the VicRoads Traffic Noise Reduction Policy — *Mr James Mcintosh*

17:00: Paper 385 — Acoustic Criteria, Administrative Sanctions, and Health in Environmental Noise Adjudication: Empirical Evidence from Chile — *Mr Nicolás Rendón Álvarez*

17:20: Paper 501 — Effectiveness Evaluation of Acoustic Camera Enforcement for Vehicle Noise in Dense Metropolitan Area of Taiwan — *Mr Yi-Hui Hsieh*

17:40: Paper 665 — Quantifying decibel-denominated differences in community attitudes towards wind turbines from a community survey — *Mr Kenneth Kaliski*

16:20 **Paper 14 — Simulation analysis on traffic noise control and noise reduction performance of urban elevated roads and expressways in China**

***Miss Kexin Lu**, Mr Minmin Yuan, Mr Xiaodong Shang, Yanqin Wang, Shufang Huang*

With the accelerated urbanization process in China, the construction of urban elevated roads and expressways has significantly relieved urban traffic congestion. However, it has also triggered severe traffic noise pollution issues, which have a notable impact on the quality of life of residents living along these routes. This paper aims to explore comprehensive control measures for traffic noise generated by urban elevated roads and expressways in China. By employing a combined approach of field monitoring, data analysis, and model simulation, we propose targeted noise reduction strategies. The study focuses on the noise reduction performance of sound barriers and verifies their effectiveness through Cadna/A simulation modeling, providing scientific evidence and technical support for traffic noise control in urban elevated roads and expressways in China.

16:40 **Paper 96 — History and Application of the VicRoads Traffic Noise Reduction Policy**

Mr James Mcintosh

The VicRoads Traffic Noise Reduction Policy sets out the requirements for managing noise from traffic on public roads in the Australian state of Victoria. The current version was published in 2005, but it was publicly reviewed without change in 2015/16. This paper will present the history of the policy which allows us to under-stand the thinking behind its drafting, which will in turn assist in its implementation and inform future reviews of the policy. There will also be a discussion of some of the more ambiguous elements of the policy and how they might be interpreted.

17:00 **Paper 385 — Acoustic Criteria, Administrative Sanctions, and Health in Environmental Noise Adjudication: Empirical Evidence from Chile**

Mr Nicolás Rendón Álvarez

Chile offers a distinctive institutional setting to examine how environmental noise conflicts are resolved once they reach formal decision-making stages. The system combines a specific noise emission standard, public complaint mechanisms, and judicial review by specialized Environmental Courts, enabling detailed observation of how acoustic evidence is assessed in contested cases.

This study examines decisions issued by Chile's Environmental Courts in legal challenges against administrative sanctions for violations of the national noise emission regulation. The analysis includes quantitative assessment of case volume, measured sound pressure levels, magnitude of regulatory exceedances, and sanction amounts, complemented by qualitative examination of recurrent reasoning patterns.

Findings indicate that acoustic measurements and procedural requirements are generally applied consistently across the cases analyzed. Out of approximately twenty decisions reviewed, only three present identifiable issues related to measurement procedures or technical compliance. However, no direct relationship is observed between the level of regulatory

exceedance and the magnitude of sanctions imposed. Judicial reasoning also shows substantial variability in how noise-related health impacts are addressed, relying on heterogeneous scientific references and evaluative approaches.

The results suggest that acoustic exceedance represents only one component in the resolution of noise disputes, revealing enduring tensions between technical measurement, health-related considerations, and legal reasoning.

17:20 **Paper 501 — Effectiveness Evaluation of Acoustic Camera Enforcement for Vehicle Noise in Dense Metropolitan Area of Taiwan**

Mr Yi-Hui Hsieh*, 1 Pei, Hsiou Ding*

With rapid urbanization, the Greater Taipei Area has evolved into Taiwan's most densely populated region with the highest vehicle density, making vehicle noise a primary source of environmental complaints and public concern. As the first country in Asia to implement acoustic camera enforcement, Taiwan utilizes technology that integrates Automatic License Plate Recognition with precision noise measurement systems to conduct vehicle noise inspections.

Taiwan launched the acoustic camera enforcement policy in 2021, which has significantly enhanced enforcement efficiency, and garnered a high public support rate of 90%. As of in 2026, 343 acoustic camera systems have been deployed nationwide, resulting in over 23,000 citations. This study reveals a significant reduction in vehicle noise complaints in the Greater Taipei Area following the policy's implementation. However, the findings also suggest that current enforcement capacity requires strengthening and that techniques must be refined to meet the growing public expectation for a tranquil environment.

The Ministry of Environment has established the "Smart and Livable Homeland Management Plan," which will integrate Geographic Information Systems and Artificial Intelligence to construct dynamic noise maps and identify hotspots. These advancements will assist environmental authorities in executing precision governance to mitigate noise and maintain a quiet living environment.

17:40 **Paper 665 — Quantifying decibel-denominated differences in community attitudes towards wind turbines from a community survey**

Mr Kenneth Kaliski*, Mr. Ryan Haac, Dr. Ben Hoen*

Using data from the U.S. national survey of wind turbine attitudes (Hoen et al 2019; Haac et al. 2019), we analyze the differences in wind turbine noise tolerance between different communities. In this case, "communities" are not restricted to geographical boundaries, but rather social subgroups of respondents. For example, we differentiate the noise tolerance of uncompensated versus compensated individuals, those that took the survey via mail versus phone and those that live near a new vs old wind project, or, separately, moved in after the turbines were erected vs before.

To derive a decibel-denominated difference between these communities, we use the Community Tolerance Level (CTL) methodology. In particular, we use a newly developed tool to fit the segmented data to the CTL exposure response curve.

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