

## **Abstracts – CCAUV Workshop: “The contribution of CCAUV to the “Evolving needs in Metrology””**

### **Data-driven metrology for advanced manufacturing and structure health monitoring.**

*[Dr Cui Shan (NMC, Singapore)]*

Wide adoption of Industrial Internet-of-Things (IIoT) is happening. Many sensors are installed to monitor manufacturing processes, machine health, product quality, structural health and more. Quality, i.e. accuracy and reliability, of the sensing data becomes critical in ensuring reliable control, planning and safety. How to ensure sensing data quality and reliability of IIoT sustainably with minimal resources becomes important for sustainable implementation of IIoT in the long run. NMC has developed a data-driven approach to enable autonomous quality assurance of sensing data. By doing so, sensor health is monitored continuously, and errors compensated in-line. This approach minimises lab-based calibration, which could be labour intensive and interruptive to factory operation. It supports sustainable manufacturing by minimising resources needed in maintaining the IIoT sensing performance and also reducing wastage in production due to sensor errors. It also helps ensure structural health and operational safety.

### **The PTB's approach to the digital calibration certificate concerning A and V.**

*[Dr Thomas Bruns (PTB, Germany)]*

In response to the general demand for digitalization of documents, PTB put a significant effort in the development of an XML-based digital calibration certificate (DCC). Beyond the generic challenge to provide an omnipotent scheme to transmit machine-interpretable digital documents for calibration data conforming to ISO 17025, the developments needs some community specific conventions or good practices for an efficient use in terms of generation and parsing. The presentation will give an introduction to the DCC in general and the A and V conventions specifically.

### **Evolving needs in Rotational Speed Metrology.**

*[Dr Qiao Sun (NIM, China)]*

Ever-increasing demands for rotational speed metrology from health and life sciences, energy, advanced manufacturing and digital transformation can be obviously seen in recent years. This presentation aims to develop a long-term vision for an international metrology solution that addresses new global metrological challenges related with rotational speed measurement. Metrological backgrounds of rotational speed are introduced with three typical examples of everyday life, cutting-edge technology and advanced medical equipment. Then, proposal for new service category of rotational speed and APMP comparisons for tachometer are discussed with sufficient details. Rotational speed, a dynamic quantity of mechanics, is suggested to be established as a subfield of vibration under CCAUV instead of CCTF or CCM.

### **Comparison of the calibration results based on acoustical and optical methods for MEMS and LS2P microphones.**

*Dr. Wan-Ho Cho (KRISS, Korea), Dr. Triantafillos Koukoulas (NRC, Canada) and Dr. Fabio Saba (INRIM, Italy)*

In 2019, metrology entered a new era as all seven SI base units were established with traceability to fundamental constants rather than artefacts. However, this does not cascade by default to SI

derived units and there are areas, such as acoustics, where the unit of sound pressure (Pa) needs to be realised directly and the calibration method not to rely on artefacts (LS microphone and coupler). Going further, new calibration methods that can accommodate microphones of existing but also new technologies, e.g. MEMS, need to be established. In this presentation, two new optical and acoustical calibration methods will be discussed – the photon correlation and acoustical substitution method respectively. Two MEMS microphones were calibrated independently by each method in free-field acoustical chambers. An LS2P microphone was also calibrated by both methods as well as by the international calibration method based on pressure reciprocity using an anechoic box as well as acoustic couplers. The results of this collaborative project present the level of agreement in the frequency range 630 Hz – 8 kHz and identify the steps of further research for higher frequencies.

**Recent advancements in the development of acoustic transfer admittance calculation of couplers in achieving primary measurement standards for sound pressure.**

*Dr Rodrigues Dominique (LNE, France)*

The pressure reciprocity calibration method, as specified in the International Electrotechnical Commission (IEC) Standard 61 094-2, is currently used worldwide for the absolute pressure calibration of microphones, and provides the basis for primary measurement standards for sound pressure. Recently, particular interest has arisen in the calculable pistonphone method, as specified in IEC Technical Report 61 094-10, as a complementary primary calibration method, especially for infrasonic frequencies. The calculation of acoustic transfer admittance in couplers is a key aspect in these primary calibration methods. Extensive research and discussions have been documented in the literature, addressing the influence of both heat conduction and viscous losses. Notably, significant efforts have been made to enhance the applicability of the low-frequency formulation to frequencies below 2 Hz, thus paving the way for new traceable calibration services at infrasonic frequencies. However, it is essential to note that the IEC standards currently provide three models for calculating acoustic transfer admittance in couplers, each adapted to specific frequency ranges. It is established that neither of these models is correct for all frequencies routinely considered in many National Metrology Institutes, so that a transition must be made. A recent study published in *Metrologia* aims to provide a unified formulation of the acoustic transfer admittance for cylindrical cavities, free from assumptions about the relative size of the wavelength and coupler dimensions. In this presentation, we will focus on the key aspects of these recent developments achieved at LNE.

**Current status of seismometer evaluation technologies that contribute to improving the accuracy of seismic observation networks.**

*Dr Hideaki NOZATO (NMIJ, Japan)*

In addition to the IMS owned by CTBTO, a wide range of seismic observation networks are in operation in Japan, where large earthquakes occur frequently. This presentation reports on the current status of seismometer evaluation technologies from the viewpoint of improving the accuracy of seismic observation networks for the purpose of quickly grasping changes in the global situation.

**(Almost) final results of the European Infra-AUV joint research project.**

*Dr Leonard Klaus (PTB), Dominique Rodriguez (LNE), Stephen Robinson (NPL).*

The joint European research project “Metrology for low-frequency sound and vibration”, Infra-

AUV strives to improve the availability of primary and secondary calibration services for very low frequencies in the field of AUV on the level of NMIs. Towards the end of its run-time, a series of three topical presentations should provide information about the accomplishments and experiences from the project to the wider metrological community of CCAUV.