TC-AUV Chair Annual Report 2018 - 2019

TC for Acoustics, Ultrasound and Vibration (AUV)
TC Chair: Stephen Robinson
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1. General Aspects

This report summarises activities of the EURAMET Technical Committee for Acoustics, Ultrasound and Vibration (TC-AUV) for 2018-2019.

TC-AUV has representatives from 24 of the members of EURAMET.

Three Sub-Committees (SCs) are organised under the Technical Committee covering different technical areas. These Sub-Committees are:

Sub-committee	Convenor	No. members
SC-A “Sound in Air”	Erling Sandemann-Olson (DPLA)	15
SC-U “Ultrasound and Underwater Acoustics”	Gianni Durando (INRIM)	6
SC-V “Vibration and Acceleration”	Thomas Bruns (PTB)	14

The SCs assume responsibility for technical activities within their own specialisms and are coordinated by an appointed Convener, whereas the TC is concerned with general issues including apects coming from EURAMET, technical activities cutting across all three AUV themes, and EMPIR activities in particular.

TC-AUV also has a Working Group consisting of members from each Sub-Commmittee for review of CMCs (within EURAMET and between RMOs).

2. Projects

Project 1281 *Reference data for pressure reciprocity calibration according to the standard IEC 61094-2:2009***.**
Pressure reciprocity calibration is the most widespread method for realising the unit for acoustic pressure, the pascal (Pa), via the determination of the sensitivity of a microphone. This means that this type of calibration is the support of nearly every single sound pressure measurement made anywhere. Pressure reciprocity calibration is also described in the international Standard 61094-2 published by the International Electrotechnical Commission (IEC). A new version of the standard was published in 2009, superseding the previous version. The changes in the standard must be implemented in the software used for calculating the acoustic transfer impedance, and the pressure sensitivity. A way of validating the changes is to use a set of reference data that can be in introduced in the software, and to compare the obtained sensitivity to the “reference” sensitivity.

This project should allow us to validate the correct implementation of the physical models involved in the reciprocity calculations (such as the model taking into account the thermal conductivity as well as the viscosity of the gas affecting the low frequency behaviour) and to check the degree of equivalence of the implementation of the calculations. The project has been delayed somewhat by lack of available resource.
Coordinating Institute: DFM (Denmark); Participating Partners: BKSV-DPLA (Denmark), CEM (Spain), INRIM (Italy), LNE (France), METAS (Switzerland), PTB (Germany).

Acoustics, Ultrasound and Vibration

Project 1302: *Comparison of secondary free-field calibration of WS2 microphones according with IEC 61094-8:2012*.
The EURAMET.AUV.A-S2 is a Supplementary comparison realised under the auspices of the CCAUV-BIPM. The standards circulated among the laboratories were two WS2 microphones of the type Brüel & Kjær 4191. The microphones had to be calibrated using a secondary free-field method, particularly the method described in the International Standard IEC 61094-8 (2012) in the frequency range from 500 Hz to 20 kHz (optionally up to 25 Hz and/or 40 kHz). Eight national measurement institutes took part (LNE, BEV, DFM, INMETRO, INRiM, PTB, and NPL) and LNE (France) piloted the project. The measurements took place between February 2014 and June 2016. Two WS2 microphones were circulated. The Draft A report has been produced and circulated. NPL asked to withdraw their data from the comparison after the capability for air acoustic metrology was closed down.

Project 1418: *Primary calibration of accelerometers in medium and high frequencies.*
The specific task of this comparison is the measurement of the magnitude and phase of the complex voltage sensitivity of two accelerometer, one single-ended and one back-to-back, in medium and high frequency domain (10 to 20 000 Hz). This comparison will be linked to the key comparison CCAUV.V-K5 which is under progress. The voltage sensitivity shall be calculated as the ratio of the amplitude of the output of the accelerometer to the amplitude of the acceleration at its reference surface with primary means in accordance with ISO 16063-11: 1999 "Methods for the calibration of vibration and shock transducers - Part 11: Primary vibration calibration by laser interferometry". The project started in 2017 and the participating laboratories are: LNE (France) (Coordinator), BKSV-DPLA (Denmark), CEM (Spain), CMI (Czech Republic), GUM (Poland), INRIM (Italy), METAS (Switzerland), MIKES (Finland), PTB (Germany), RISE (Sweden), UME (Turkey). Further partners may include NSAI (South Africa).

Project 1464: Bilateral comparison in primary calibration of accelerometers
The specific task of this bilateral comparison is the measurement of the magnitude of the complex charge sensitivity of two accelerometers (SE and BB) in frequency range from 10 Hz to 1 kHz). There are two participants: GUM and BIM. BIM is motivated to participate in this bilateral comparison in order to confirm technical competence and to get an evidence for BIM CMCs at primary calibration of vibration transducers. The sensitivity of accelerometer shall be calculated as the ratio of the amplitude of the output of the accelerometer to the amplitude of the acceleration at its reference surface with primary means in accordance with ISO 16063-11 : 1999 “Methods for the calibration of vibration and shock transducers - Part 11: Primary vibration calibration by laser interferometry”. The project is registered in the KCDB as EURAMET.AUV.V-K2.

Project 1474: *Pressure calibration of laboratory standard microphones in the frequency range from 2 Hz to 10 kHz*
This project is registered in the KCDB as EURAMET.AUV.A-K5. Measurements at 12 EURAMET NMIs were completed in 2015. The project was led by NPL, but after the closing of the capability for air acoustics at NPL in 2016, there was a delay in completing the analysis and the Draft B report. The project is now complete and the report is available on the KCDB.

3. Comparisons

EURAMET.AUV.A-K5 *Pressure calibration of laboratory standard microphone*. Measurements at 12 EURAMET NMIs were completed in 2015. The project was led by NPL, but after the closing of the capability for air acoustics at NPL in 2016, there was a delay in completing the analysis and the Draft B report. The project is now complete and the report is available on the KCDB. This comparison links

to the KCRV established in CCAUV.A-K5. In this comparison several laboratories (LNE, METAS, NPL as well as PTB) measured down to 2 Hz and presented rather consistent results.

EURAMET.AUV.A-S2 (EURAMET Project 1302) *Secondary free-field calibration of working standard microphones*. LNE has calculated the final results for the artefacts used in this comparison. One of the B&K 4192 exhibited an excellent stability, while the other expressed a slight drift over the period of comparison. The comparison promises to reveal useful results. Now that NPL has withdrawn CMCs and capability on air acoustics, the results of NPL are not relevant and have been withdrawn from the comparison. The Draft A report has been drafted and circulated.

CCAUV Key Comparisons

During 2018-2019, EURAMET has also been participating in the following CCAUV comparisons

CCAUV.W-K2 *Comparison of free-field hydrophone calibrations in water.*
This key comparison of hydrophones covers an extended frequency range of 250 Hz – 500 kHz and is piloted by NPL. It has seven participants including two from EURAMET (UK and Turkey), along with USA, Russia, Brazil, China and South Africa (with an eighth participant from India as a guest participant). All participants have now undertaken calibrations. Because some calibrations were undertaken at warmer water temperatures than prescribed by the protocol, NPL has agreed to undertake calibrations over the required temperature range to evaluate the influence of this factor on the results. The Draft A report should be circulated by late summer 2019.

CCAUV.V-K4 *Comparison of accelerometer shock calibration.*
CCAUV.V-K4, a comparison on accelerometer shock calibration, has 9 participants: NIM (pilot), NMIJ/AIST (co-pilot), KRISS, CENAM, PTB, INMETRO, NMIA, NMISA, VNIIM. V-K4. Technical protocol of the comparison has been approved by the CCAUV and circulation of accelerometers has begun.

CCAUV.V-K5 *Comparison of calibrations of accelerometers in the frequency range from 10 Hz to 20 kHz.*
This is a comparison of calibrations of accelerometers in the frequency range from 10 Hz to 20 kHz with three accelerometers used, Brüel & Kjaer (B&K) type 8305, type 8305-001 and type 4371 as transfer standards in the comparison. Participants of the comparison are: PTB (pilot), DPLA, CEM, METAS, NIST, CENAM, INMETRO, NIM, NMIJ, NMIA, NMC/A*STAR, NMISA, UkrMet and VNIIM. Measurements within the comparison started in spring 2016. The comparison was running smoothly, but recently some delay occurred due to custom problems and time schedule of the comparison was updated. Some peculiarities were detected for B&K type 4371 accelerometer. It is expected that measurements will finish in 2019.

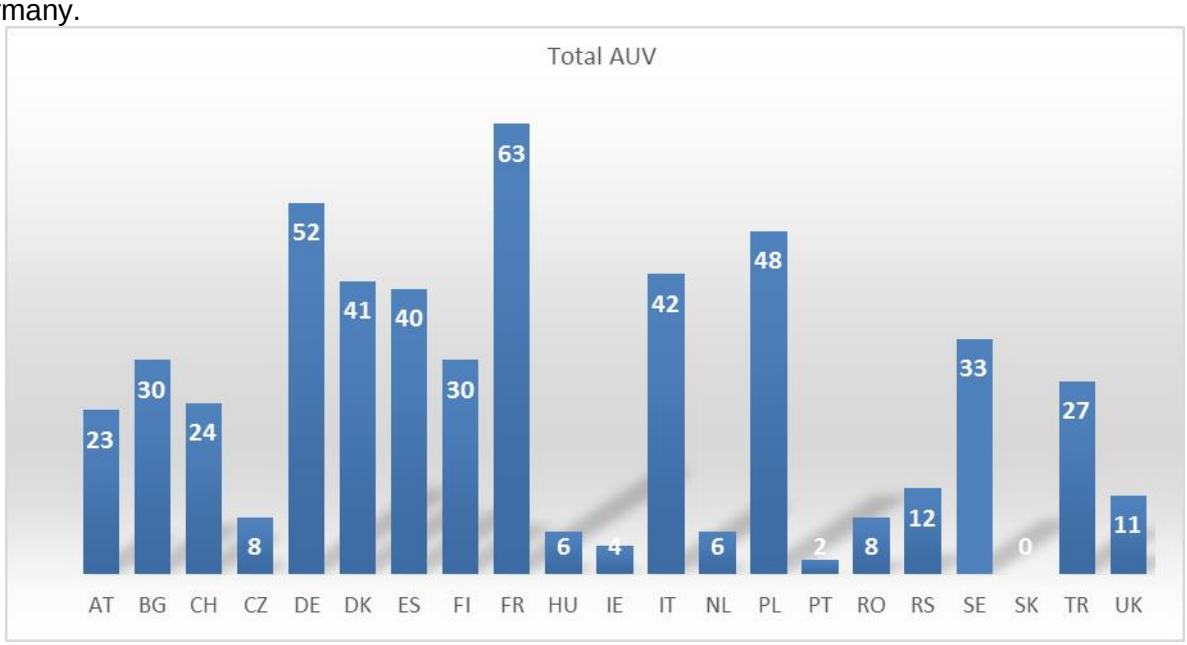
CCAUV.A-K6 *Comparison of calibration of LS2P microphones in the frequency range from 20 Hz to 25 kHz*
LNE (France) are piloting the key comparison CCAUV.A-K6 on calibration of LS2P microphones in the frequency range from 20 Hz to 25 kHz with an option to make calibrations down to 2 Hz. It is early days in the work, but the protocol has been drafted and circulated.

Future Key Comparisons

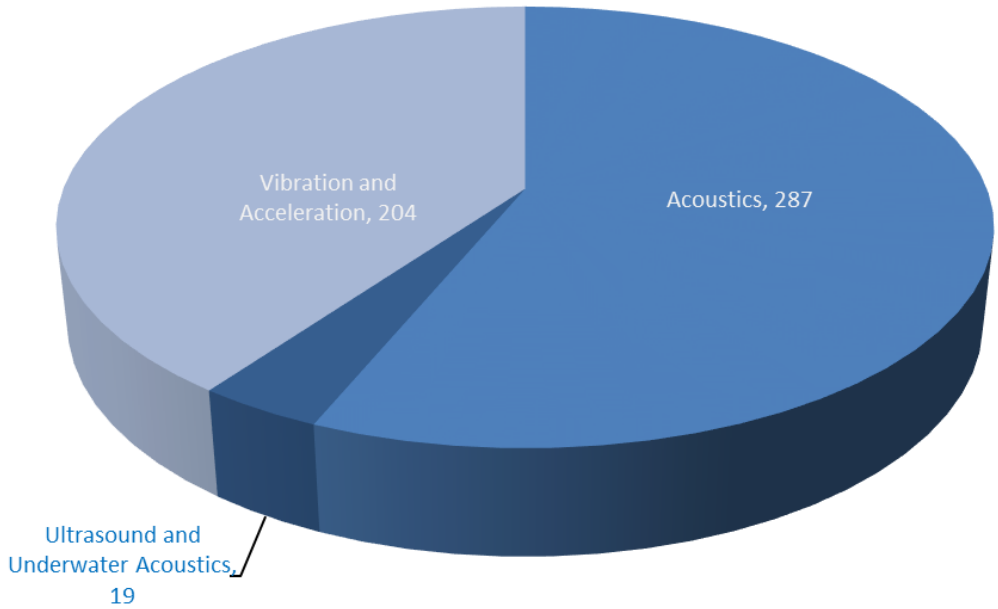
DFM (Denmark) will pilot the key comparison CCAUV.A-K7 on free – field calibration of LS2p microphones in the frequency range from 1 kHz to 40 kHz, which will start in 2020.

4. CMCs

20 EURAMET NMIs & DIs have a total of 510 CMC entries approved and published on the BIPM KCDB. The distribution by country and technical area is shown below in the figures below. Of the 510 EURAMET CMCs, 287 are Sound in Air, 204 are for Vibration, and 19 are for Ultrasound and Underwater Acoustics. The total number of CMCs for 2018 shows a slight decrease compared to the value for the previous year (532), mainly due to the consolidation of the CMC entries for Germany.



Number of EURAMET AUV CMC entries in the KCDB by country



Number of EURAMET AUV CMC entries in the KCDB by technical area

Those countries updating CMCs in the 2018-2019 period include Germany and Turkey, with Serbia, Poland and Austria in process. Overall, the number of CMCs appearing for review is not excessive, and the situation is manageable. However TC-AUV's position is to resist expansion of the service categories into tertiary application area as sometimes promoted by other RMOs.

The questions raised about the CMCs in Vibration for BIM (Bulgaria) due to loss of expert staff are being addressed within SC-V. TC-AUV agreed an action plan at the 2018 TC-AUV meeting (with an update at the 2019 TC-AUV meeting) for the verification of their capability and to ensure the validity of services including: (i) participation in a comparison; (ii) submitting to peer review; and (iii) engaging in capacity building actions. EURAMET project 1464 addresses this issue by providing for a bilateral comparison with GUM.

5. Activities of the Subcommittees

The activities of each Sub-Committee are coordinated by the appointed Convener. In 2019, the Convener of SC-V, Claire Bartoli (LNE), stepped down due to a change of job whereby she moved to another metrology field. A new SC-V Convener was elected at the 2019 TC-AUV meeting: Thomas Bruns (PTB).
The level of membership in Sub-Committees varies significantly, and it is common for invited guests from other RMOs and additional technical experts to attend as observers. As an example, although SC-U has only 6 official members listed on the EURAMET web-site, 11 people attended the recent SC-U meeting in April 2019, including two from COOMET. Each Sub-Committee meets annually. The work of the Sub-Committees is reflected mostly in the variety of past collaborative TC-projects.

6. Participation in EMRP/ EMPIR

There are currently four projects funded by EMPIR which have AUV content.

EMPIR 15HLT03 EARS2. This EMPIR Health project has now been completed at the end of April 2019. Progress in the project has included specification for new ear simulator family set, followed by design and construction of new demonstrators. With regard to airborne ultrasound, the requirements and specification for new methods are defined, reference workplace designed and representative fields measured, new calibration procedure established and new practical measure-ment methods developed, with measurements made at real workplaces (Coca Cola, Ferrero). Regarding perception of infrasound, EEG signals have been found at 11 Hz illustrating that humans can perceive infrasound, and the project has shown that using combination of sound and infrasound changes the infrasound hearing threshold but not the hearing one.

EMPIR 15RPT02 UNAC-LOW. UNAC-LOW has the aim to develop traceable measurement capabilities to meet the need for calibration of hydrophones at frequencies between 20 Hz and 1 kHz, to develop calibration methods which provide traceable measurement capabilities to meet the need for calibration of autonomous underwater acoustic noise recording systems, and to develop a strategy for long-term operation of the developed measurement capabilities. In the project, achievements include the development of new pressure calibration methods for hydrophones in Turkey, extension of free-field calibrations for hydrophones in UK, and development of pressure and free-field calibrations in UK, Sweden and Turkey. Three participants (NPL, TUBITAK and DFM) are launching new calibration services for stakeholders. A comparison has been made of the methods developed by different partners, and a contributions have been made to ISO and IEC standards (including the registering of a new work item proposal).

EMPIR 17IND12 Met4FoF Metrology for the Factory of the Future The project aims to develop calibration framework for sensors with digital pre-processed output and internal signal processing, reference system for in-situ calibration of MEMS measuring ambient conditions, develop a metrological infrastructure for real-time data aggregation and machine learning in industrial sensor networks, and implement the methods and frameworks developed in industry-like test environments. The project includes some aspects which cover accel;eration and vibration sensing. The project began in June 2018.

EMPIR 18HLT06 RaCHy Project.
The aim of this project is to provide a reliable metrology framework for the evaluation of a class of radiation-based therapies coupled with hyperthermia induced by Therapeutic Ultrasound (TUS), conventional Electromagnetic Radiation (EMR), magnetic nano particles (MNPs). There are 11 partners in 5 different countries and the project begins on 1st June 2019.

In 2019, a number of PRTs were submitted with AUV content, including a Normative PRT titled "Sound insulation of facades - new standardised measurement procedure for low frequencies", a Research Potential PRT titled "Development of expanded metrological capability for medical ultrasound", and an Environment PRT titled "Metrology for low-frequency sound and vibration for disaster warning and global environmental monitoring of nuclear testing and climate change". In addition, two Network PRTs have AUV content: "European metrology network on environmental monitoring" and "European network for medical device metrology".

7. Capacity Building: Activities of the last year and future needs

TC-AUV has had a Research Potential project, UNAC-LOW, which developed strategies for long-term capability building supporting research collaborations, contributing to development of a coherent metrology strategy for Europe within this field.

A 2019 JRP Research Potential proposal was submitted on Development of expanded metrological capability for medical ultrasound.

In September 2018, Tanasko Tasic prepared a questionnaire for planning capacity building activities in the field of AUV among BOD-WGCB and TC-AUV (Sep 2018). A response was obtained from TR, UK, PO, RS, EE, GR, MK, ES, IE, BG, MD. Turkey and Poland offered to host training courses, and the first will be held in air acoustics at GUM in June 2019.

Some demand has been expressed to NPL for training in underwater acoustic metrology. Initially, this is likely to be followed up bilaterally between NPL and GUM.

8. Meetings

The TCAUV and the three Sub-Committees meet on an annual basis. In recent years, the meetings of the TC and all SCs have been held together, providing greater opportunities for cross-theme discussions and greater exposure of all delegates to wider EURAMET issues.

The 2019 meetings were held at PTB in Braunschweig, Germany 4th – 5th April 2019. The meetings followed the now well-established 2-day format consisting of Plenary and Sub-committee sessions.

The Plenary sessions provided the opportunity to report on and discuss general EURAMET matters and information arising from the joint meetings of the Board of Directors and TC-Chairs. The plenary

was attended by the Tanasko Tasic, who presented on a number of matters including Capacity Building and by Jörn Stenger on European Metrology Networks. Part of the meeting was also attended by Dagmar Auerbach, EMPIR programme manager.

Delegates at the 2019 TC-AUV meeting at PTB on 4th – 5th April 2019

This year, the main points discussed at the plenary were: EURAMET Guidelines for TC projects; Strategic Planning of comparisons; Procedures for periodic CMC review; CMC revisions – updates; Hybrid comparisons; Calibration Guides for AUV; Succession planning (future TC Chair, new SC-V Chair), and the revision of ISO 80000-8.

9. Issues

It was agreed at the TC-AUV meeting that the metrology assets currently owned by NPL (microphones used in previous Key Comparisons, reference impedance head, etc) will be made available for use by the EURAMET AUV community (rather than be lost to metrology). NPL is transfer these to other NMIs for safe keeping.

10. Strategic Planning

A significant issue that has been raised by a number of stakeholders is that of the metrology need in low frequency AUV, both for airborne infrasound, vibration and very low frequency marine acoustics. In this area, metrology is relatively weak and is hindering progress with research. Stakeholders in this field vary widely, ranging (for example) from renewable energy developers, and atmospheric researchers to the Comprehensive test Ban Treaty Organisation. A PRT from TC-AUV has been generated on this topic for the 2019 EMPIR calls.

The road maps for Ultrasound and Underwater Acoustics are currently under review, and progress has been made since the last TC-AUV meeting.

The TC-AUV committee remain confident in the wider benefit of the metrology work to the stakeholder community and wider society. A number of new project proposals have been produced as topics for PRTs in the future EMPIR calls, and the committee is hopeful of improved success in the future.

11. Outlook for 2018/2019

The venue for the next TC-AUV meeting has not yet been decided, but a provisional offer has been made by Ireland. The date will be April or May of 2020.

TC-AUV received an invitation from BEV offered to host the TC-AUV meeting in 2021 in Vienna.

Stephen P. Robinson
EURAMET TC-AUV Chair