



1. General Aspects

This report summarises activities of the EURAMET Technical Committee for Acoustics, Ultrasound and Vibration (TC-AUV) for 2017-2018.

TC-AUV has representatives from 25 of the members of EURAMET.

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

SC-A "Sound in Air":	15 members
SC-U "Ultrasound and Underwater Acoustics":	4 members
SC-V "Vibration and Acceleration":	14 members

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 aspects coming from EURAMET, technical activities cutting across all three AUV themes, and EMPIR activities in particular.

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 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. As there have recently arisen doubts regarding the correctness of the low frequency model the first goal can no longer be achieved at justifiable expenses at the current time. The project has been delayed somewhat by lack of available resource, but the coordinator will now register an updated protocol and gather feedback for Euramet project 1281 to be able to start by September 2018.

Coordinating Institute: DFM (Denmark); Participating Partners: BKSVDPLA (Denmark), CEM (Spain), INRIM (Italy), LNE (France), METAS (Switzerland), PTB (Germany).

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 accelerometers, 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 in 2017. 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), BKSVDPLA (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).

Potential future projects under discussion

The following were discussed at recent TC-AUV meetings:

- Pressure calibration of type WS3 (quarter-inch) microphones (SC-A)
- Validation of heat conduction models for close-coupler reciprocity calibration (SC-A)
- (Extraneous) vibration sensitivity of sound level meters and microphones (SC-A)
- Calibration methods for transducers with digital or embedded acquisition (cross-cutting all SCs)
- Key comparison reference curves (cross-cutting all SCs)
- Dosimetry for cosmetic ultrasound treatment (SC-U)
- Bilateral comparison in underwater acoustic, CNR-IDASC and NPL (SC-U)

3. Comparisons

EURAMET.AUV.A-K5 *Pressure calibration of laboratory standard microphone.* This will link to the KCRV established in CCAUV.A-K5. Measurements at 12 EURAMET NMIs were completed in 2015. The pilot laboratory, NPL, had agreement from CCAUV to hold back publication of the Draft A until all results from AFRIMETS.AUV.A-K5 had been confirmed, since this project used the same microphones to increase efficiency and reliability. Several iterations of the Draft A report incorporating minor modifications were circulated among the participants. After the shutdown of sound in air activities at NPL, Stephen Robinson accepted responsibility to see the report through its final stages. In this comparison several laboratories (LNE, METAS, NPL as well as PTB) measured down to 2 Hz and presented rather consistent results. There seems to be, however, some systematic discrepancies with respect to the key comparison reference values in the CCAUV.A-K5 comparison. The final Draft B report has now been reviewed by the CCAUV KCWG with minor modifications adopted, and this will be submitted for publication in early summer 2018.

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 may be withdrawn from the comparison. The Draft A report has been drafted.



CCAUV Key Comparisons

During 2016-2017, EURAMET TC-AUV 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, and China. Korea have withdrawn from the comparison, but they have been replaced by South Africa (with an eighth participant from India as a guest participant). Only South Africa are still to undertake calibrations, and the measurement phase should be completed by summer 2018, and the comparison completed by the end of 2018.

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 will start in 2018.

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 early in 2019.

Future Key Comparisons

LNE (France) will pilot 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.

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.

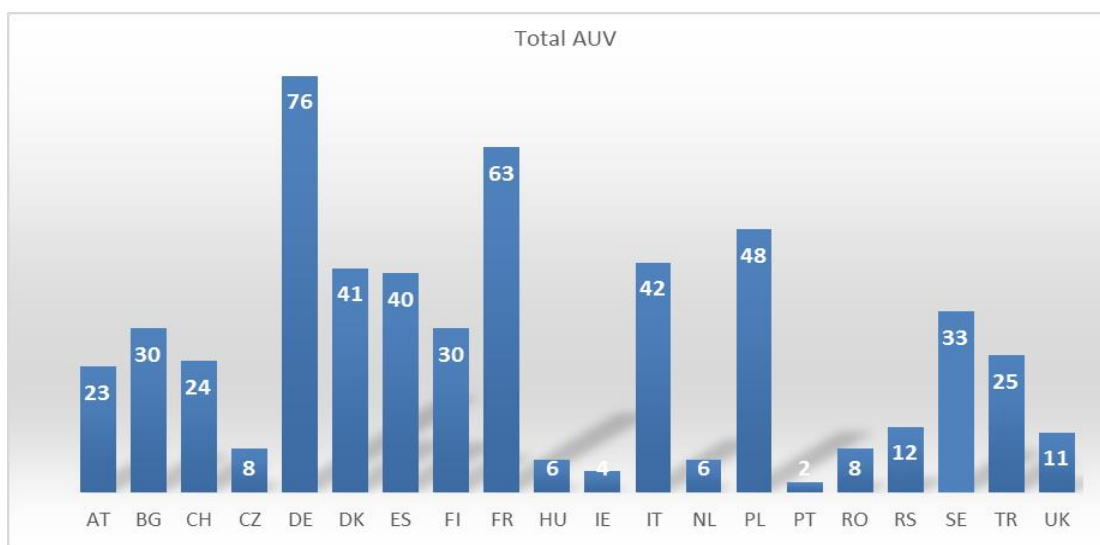
4. CMCs

20 EURAMET NMIs & DIs have a total of 532 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 532 EURAMET CMCs, 297 are Sound in Air, 216 are for Vibration, and 19 are for Ultrasound and Underwater Acoustics. The total number of CMCs for 2018 shows a slight increase compared to the value for the previous year (525), mainly due to the increased number of CMCs for Vibration for Denmark.

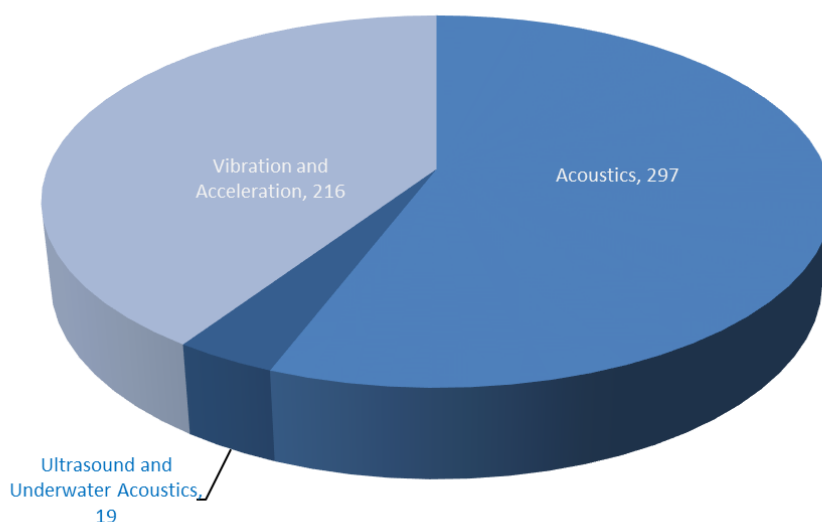
In 2017, some questions were raised about the CMCs in Vibration for BIM (Bulgaria). Although they have reported a recent upgrade in facilities, they have not participated in a recent comparison and may have lost expert staff members. This matter has been discussed in EURAMET TC-Q and within

SC-V at the 2018 TC-AUV meeting, where BIM presented their current capabilities. TC-AUV agreed an action plan 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.

The completion of the second wave of CCAUV KCs is beginning to trigger a number of CMC updates in all fields. Those countries re-submitting CMCs in the 2017-2018 period include Denmark, Germany, Turkey and Serbia. 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.



Number of EURAMET AUV CMC entries in the KCDB by country



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

5. Activities of the Subcommittees

In 2018, in accordance with EURAMET procedures, a review of SCs within TC-AUV took place with the appropriate form completed and submitted to EURAMET.

The activities of each Sub-Committee are coordinated by the appointed Convener. 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 4 official members listed on the EURAMET web-site, 15 people attended the recent SC-U meeting in May 2018. Each Sub-Committee meets annually. The work of the Sub-Committees is reflected mostly in the variety of past collaborative TC- projects. However it has been noted by all SCs that recent focus on EMRP and EMPIR has reduced the capacity for initiating new TC-projects. Issues around the calibration of digital sensors was also raised separately in all three SCs and brought together in the new cross-SC project proposal.

6. Participation in EMRP/ EMPIR

There are currently two AUV projects funded by EMPIR.

EARS2 continues its successful work as an EMPIR Health project. 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 measurement 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.

UNAC-LOW: Underwater Acoustics RPT. The UNAC-LOW aim is 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. Progress includes 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. Current work involves comparison of the methods developed by different partners. As a project output, a calibration service has been launched in the UK (selected by EURAMET as a good news story), and a contributions have been made to ISO and IEC standards (including the registering of a new work item proposal).

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

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

A 2017 JRP Research Potential proposal was also submitted on development of capabilities for medical ultrasound in emerging NMIs, but this was unsuccessful. Some of the planned work is still urgently required and is currently being pursued by NMIs outside EMPIR/EURAMET.

Tanasko Tasic presented at the 2018 TC-AUV meeting on capacity building initiatives. Delegates made a note of the possibility of Researcher Mobility Grants for future JRP projects. With regard to HI-CB training courses, the demand for training in air acoustic metrology expressed to Tanasko was noted by TC-AUV and discussed at the SC-A meeting. Tanasko will collate information on the training need, including named contacts, and this will be followed up by the SC-A Convener. We will investigate whether there is enough interest to generate a Research Potential project.

Some demand has been expressed to NPL for training in underwater acoustic metrology, and where this is expressed by EURAMET NMIs, we will investigate whether this could be done as part of a CB project.

8. Meetings

The TCAUV and the three Sub-Committees meet typically on a yearly basis. In recent years the objective has been to hold meetings of the TC and all SCs together, providing greater opportunities for cross-theme discussions and greater exposure of all delegates to wider EURAMET issues.

The 2018 meetings were held at NPL, UK on 14th – 15th May 2018 and followed the now well-established 2-day format consisting of Plenary and Sub-committee sessions.



Delegates at the 2018 TC-AUV meeting at NPL, UK on 14th – 15th May 2018

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 EURAMET General Secretary, Duncan Jarvis, who presented on a number of matters including European Metrology Networks, and Tanasko Tasic who presented on Capacity Building. The meeting was also attended by Dagmar Auerbach, EMPIR programme manager.

This year, the main points discussed were:

- a) European Metrology Networks

- b) Capacity Building initiatives
- c) Review of the MRA – report from CCAUV
- d) NMI strategic goals and road maps

9. Issues

The repercussions of the withdrawal of NPL from the metrology area of Sound in Air are still felt but are gradually subsiding. The TC-AUV committee are still concerned that the metrology assets currently owned by NPL (microphones used in previous Key Comparisons, reference impedance head, etc) should be made available for use by the EURAMET AUV community (rather than be lost to metrology). NPL is willing to explore ways of making these artefacts available to other TC-AUV NMIs for use in metrology.

The TC-AUV committee responded to the draft Environment EMPIR call for 2019 which may exclude some topics relevant to acoustics. The response to the suggested call (circulated in November 2017) was prepared by the committee and submitted to the EMPIR programme manager.

10. Strategic Planning

There is concern that the AUV field remains very under-represented in EMPIR, despite a small number of very successful projects, and the submission of well-developed PRTs that align with strategic goals and strong support from a wide range of stakeholders. In spite of this, the TC-AUV committee remain confident in the wider benefit of the 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 greater success in the future.

The road maps for AUV are currently under review, and progress has been made since the last TC-AUV meeting. Different ways of formulating and displaying road maps are being explored including the use of mind maps, and better graphical representation. It is intended that the road map revision be completed during September 2018.

One 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 vary widely, for example renewable energy developers, and the Comprehensive test Ban Treaty Organisation. A PRT from TC-AUV will be generated on this topic for the 2019 EMPIR calls.

11. Outlook for 2018/2019

TC-AUV received an invitation from PTB, UK to host the 2019 meeting in Braunschweig in April or May 2019.

BEV offered to host the TC-AUV meeting in Vienna in 2020.

Stephen P. Robinson
EURAMET TC-AUV Chair