# TC Chair Annual Report 2016 - 2017

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 2016-2017.

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:

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|---|---|
| SC-A “Sound in Air”: | 16 members |
| SC-U “Ultrasound and Underwater Acoustics”: | 6 members |
| SC-V “Vibration and Acceleration”: | 16 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 apects 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 in introduced in the software, and to compare the obtained sensitivity to the “reference” sensitivity. This project should allow us on one hand 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). This goal could be achieved by performing a reverse calculation of an "ideal" electrical trans-impedance based on idealized (theoretical) microphone sensitivity curves. On the other hand the project should allow us 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. Rather than delaying the project further, SC-A decided to achieve at least the second goal and have redefined the project accordingly.

Coordinating Institute: DFM (Denmark); Participating Partners: BKSV-DPLA (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 project 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). The 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 was only initiated 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).

**Potential future projects under discussion**

The following were discussed at the 2016 and 2017 TC-AUV meetings:

- Pressure calibration of type WS3 (quarter-inch) microphones (SC-A)
- Validation of heat conductions 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. However 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. The final report is about to be published. 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.

**EURAMET.AUV.A-S2** (EURAMET Project 1302) *Secondary free-field calibration of working standard microphones*. LNE has presented preliminary results of the stability of 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. The Draft A report is expected to be circulated by March-April 2017.

During 2016-2017, EURAMET TC-AUV has also been participating in the following CCAUV and RMO comparisons

**CCAUV.U-K4** *Comparison of laboratory reference hydrophone calibrations.* This key comparison was an update of CCAUV.U-K2 but with enhanced

scope (0.5 MHz – 20 MHz). The participating EURAMET NMIs were NPL (UK), and PTB (DE), with just one other (NIM, CN) taking part. NPL was the pilot laboratory. The comparison is now completed, with Draft B report agreed, and results accepted for equivalence on the BIPM Key Comparison database.

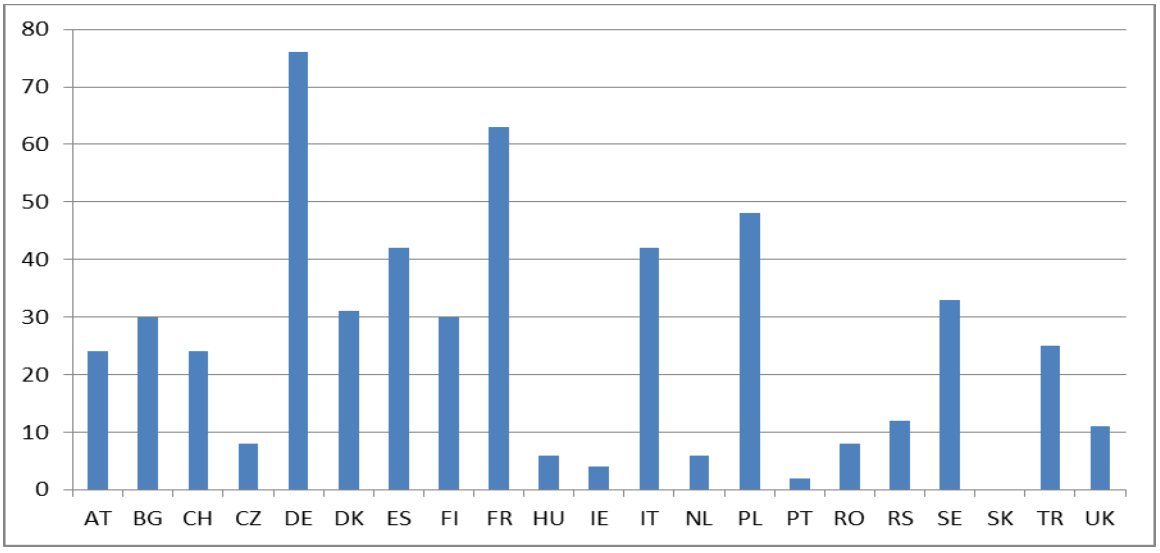
**CCAUV.W-K2** *Comparison of free-field hydrophone calibrations in water.* This key comparison of hydrophones covers the frequency range 250 Hz – 500 kHz and is piloted by NPL. It has seven participants including two from EURAMET, UK and Turkey, along with USA, Russia, Brazil, Korea and China (with India as a possible eighth participant). A total of five participants have completed calibrations, and the measurement phase should be completed by late summer 2017, and Draft A report circulated by autumn 2017.

**CCAUV.V-K3** *Complex acceleration sensitivity.* This project had 14 participants. NIM (China) was the principal pilot laboratory, with NMISA (S. Africa) and LNE (France) acting as co-pilot laboratories. Accelerometer measurements in the frequency range 0.1 to 40 Hz were undertaken. The comparison is now completed, with Draft B report agreed, and results accepted for equivalence on the BIPM Key Comparison database.

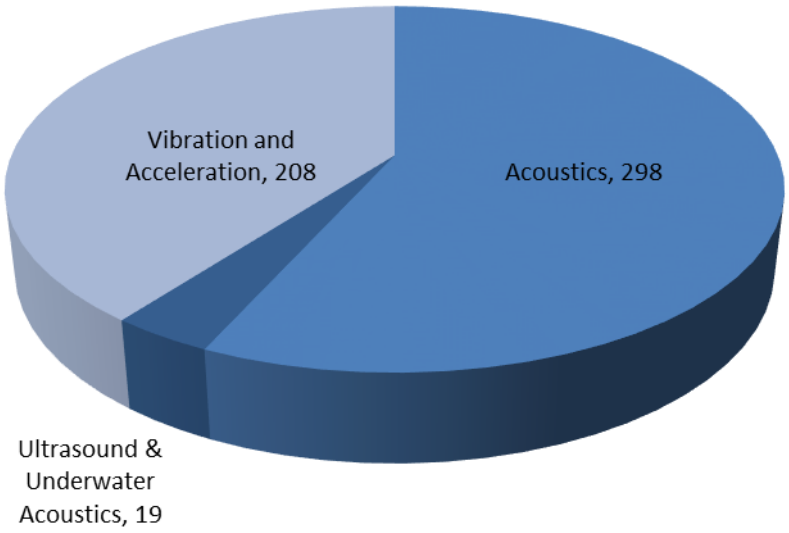
**AFRIMETS.AUV.A-K5** links to the KCRV established in CCAUV.A-K5. It had five participants three of which are from EURAMET. CMI were unable to participate in the EURAMET KC and MIKES did not perform low frequency measurements at the time. NPL assisted NMISA, South Africa in piloting the project and is the linking laboratory. Due to the small number of participants it was decided to use the same microphones used in EURAMET.AUV.A-K5, as they had proven stability. The comparison has now progressed form Draft B status to Final Report, which was circulated to all CCAUV members on 31 March 2017 with a deadline for comments of 8 May 2017.

## 4. CMCs

21 EURAMET NMIs & DIs have a total of 525 CMC entries approved and published on the BIPM KCDB. The distribution by country and technical area is shown below.




*Number of EURAMET AUV CMC entries in the KCDB by country*




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

The total number of CMCs for 2017 shows a reduction compared to the value for the previous year (559). This is mainly due to the removal of the CMCs for Sound in Air belonging to NPL.

Some questions have been 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 is in discussion with EURAMET TC-Q.

Of the 525 EURAMET CMCs, 298 are Sound in Air, 208 are for Vibration, and 19 are for Ultrasound and Underwater Acoustics.

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 completion of the second wave of CCAUV KCs is expected to trigger a number of CMC updates in all fields.

**5. Activities of the Subcommittees**

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. Each Sub-Committee meets annually. The work of the Sub-Committees is reflected mostly in the variety of past collaborative TC- projects. However is 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, which has been the topic of an EMPIR PRT.

## 6. Participation in EMRP/ EMPIR

The SoundPwr Broader SI EMPIR project was completed in mid-2016. The project developed a new optically based primary realisation of the sound power unit (the watt), enabling the quantity to be realised independent of sound pressure.

EARS2 continued the work of the very successful original EARS1 project, under the EMPIR Health Call (with the project achieving top ranking in the 2015 Health call). It is clear that the stakeholder community places the high value in this work. The project aims to develop metrology for modern hearing assessment based on the universal ear simulator concept and novel calibration methods, provide robust normative data and validated technical performance underpinning the next generation of standards, increase understanding of perception mechanisms and impact of infrasound and ultrasound on hearing, mental health and wellbeing, and promote innovation in assessing such noise hazards in public and workplace environments with new instrumentation and methods. The new project has introduced additional NMIs and academic partners into the consortium compared to the first project.

UNAC-LOW: Underwater Acoustics RPT
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 used for long-term ocean acoustic monitoring at frequencies between 20 Hz and 1 kHz, and to develop a strategies for long-term operation of the developed measurement capabilities including regulatory support, research collaborations, quality schemes and accreditation, contributing to development of a coherent metrology strategy for Europe within this field. It is the first underwater acoustics project to feature in EMRP or EMPIR. It is led by TUBITAK (Turkey).

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

The presentation on behalf of the EURAMET BoD at the 2017 TC-AUV in Helsinki meeting generated some interesting discussion. Some within TC-AUV still see a conflict between the goals for Capacity Building and efforts to avoid duplication of capability and foster greater co-ordination across NMIs.

Several proposals were generated for RMGs to be utilized in the EARS2 project, each involving NPL. However, these plans had to be abandoned when NPL withdrew from the Sound in Air metrology area, and had to withdraw from the EARS2 project. Ideas for other RMGs are currently under discussion within the EARS2 consortium, but since the researcher must originate from an NMI/DI and be hosted by an NMI/DI, the options are limited.

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

During the January meeting, a proposal was put forward from the SC-U sub-committee for another Research Potential project to develop metrological capacity in medical ultrasound. This idea was subsequently worked up into a PRT which was submitted by GUM (Poland) for the 2017 EMPIR calls.

## 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 2017 meetings were held at MIKES, Finland, on 2nd – 3rd 2017 and 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 EURAMET General Assembly and joint meetings of the Board of Directors and TC-Chairs. This year, the main points discussed were:

a) Update on the future calls within EMPIR
b) Capacity Building initiatives
c) EURAMET Coordination Study
d) NMI strategic goals and road maps

## 9. Issues

The major change in the last year has been the withdrawal of NPL from the metrology area of Sound in Air. This is regarded by the TC-AUV committee as a major blow to European metrology in the field (and in the world as a whole, where EURAMET NMIs playing a leading role in AUV metrology).

As a result of the NPL withdrawal, TC-AUV a new Chair has been proposed and elected: Stephen Robinson, NPL. NPL have agreed to support him in this post until 2019. The TC-AUV committee are grateful for NPL's continued support for the position of Chair, and in the fields of ultrasound, and underwater acoustics.

The TC-AUV committee gave particular thanks to the outgoing Chair, Richard Barham, who has made a significant contribution to acoustic metrology within EURAMET and CCAUV. His expertise (and friendship) will be sorely missed.

The TC-AUV committee were 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). The Chair pointed out that NPL no longer provided resource for the maintenance of these artefacts, and so could not maintain their calibration. However, NPL is willing to explore ways of making these artefacts available to other TC-AUV NMIs for use in metrology.

The TC-AUV committee were concerned about the potential for a more restrictive Health EMPIR call in 2018 which may exclude some topics relevant to acoustics. A response to the suggested call (presented at the January 2017 BOD meeting) was prepared by the committee and submitted to the EURAMET Chair.

## 10. Strategic Planning

Despite a small number of very successful projects, well developed PRTs that align with strategic goals, and strong support from a wide range of stakeholders, the AUV field remains very under-represented in EMPR and EMPIR. Attempts to change perceptions about this technical area within the EMPIR Committee appear to be ineffective. 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 recent TC-AUV meeting in January 2017. 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 mid-2017.

## 11. Outlook for 2017/2018

TC-AUV received an invitation from NPL, UK to host the 2018 meeting.

The TC-AUV agreed that we would move away from a January/February meeting and instead move toward a meeting in April or May (before the annual General Assembly).

Stephen Robinson
EURAMET TC-AUV Chair