



TC-AUV Highlights and forward look

Stephen Robinson

Madrid and Tres Cantos, Spain
15 – 18 May 2017



Summary



- TC-AUV
 - Introduction
 - General activities
- Highlights
 - Projects
- Emerging metrology challenges



Overview of TC-AUV



- Sub-committees:
 - SC-**A**: Sound in **A**ir
 - SC-**U**: **U**ltrasound & **U**nderwater acoustics
 - SC-**V**: Vibration & acceleration
 - CMC review
 - Strategy (road maps –ad hoc)
- Members: 24
- Meetings: February 2-3, 2017
 - MIKES, Espoo, Finland
 - Guest delegates
 - GULFMET, COOMET...
- New Chair of TC-AUV
 - Stephen Robinson, NPL



Delegates at 2017 meeting of TC-AUV at MIKES, Finland

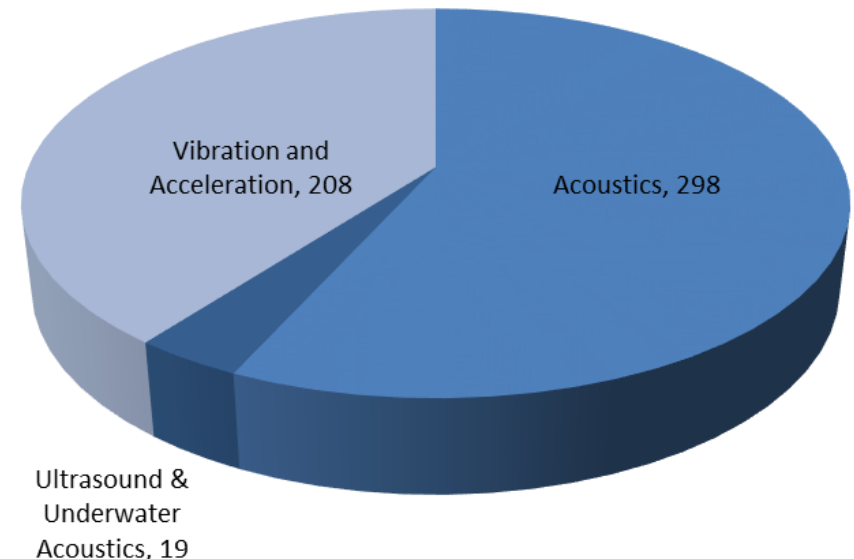
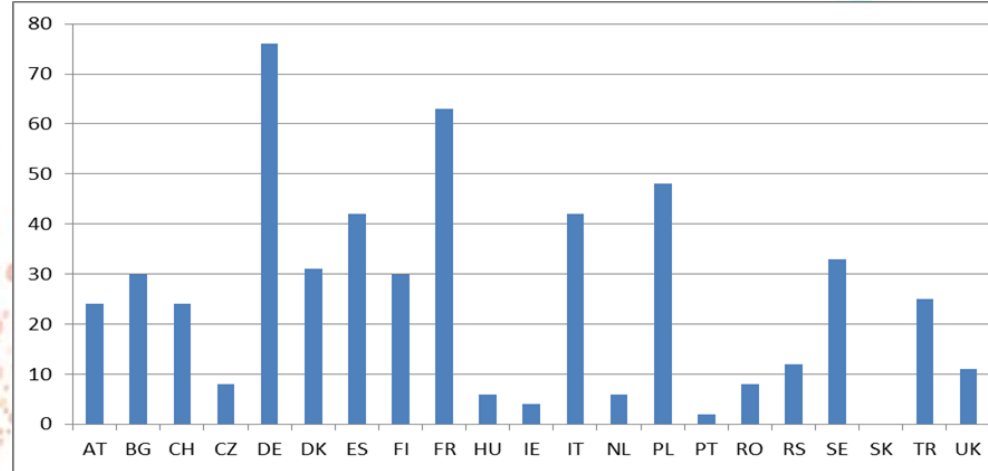
Convenors:

- SC-A; Erling Sandemann-Olsen (DPLA)
- SC-U: Gianni Durando (INRIM)
- SC-V: Claire Bartoli (LNE)

General activities



- 21 EURAMET NMIs & DIs have 525 CMC entries on BIPM KCDB
 - reduction compared to 2016 - mainly due to the removal of the CMCs for NPL Sound in Air
- Recent comparisons:
- CCAUV.V-K3 EURAMET.AUV.A-K5, EURAMET.AUV.A-S2, CCAUV.U-K4, AFRIMETS.AUV.A-K5, **CCAUV.W-K2**
- Road maps being updated
- RMO CMC review
- Active projects (non-EMPIR):
 - Project 1281 – reference data for microphone calibration (IEC61094-2)
 - Project 1418 – calibration of accelerometers at MF and HF



Acoustics, Ultrasound
and Vibration

15HLT03

Metrology for modern hearing
assessment and protecting public
health from emerging noise sources

EARS II

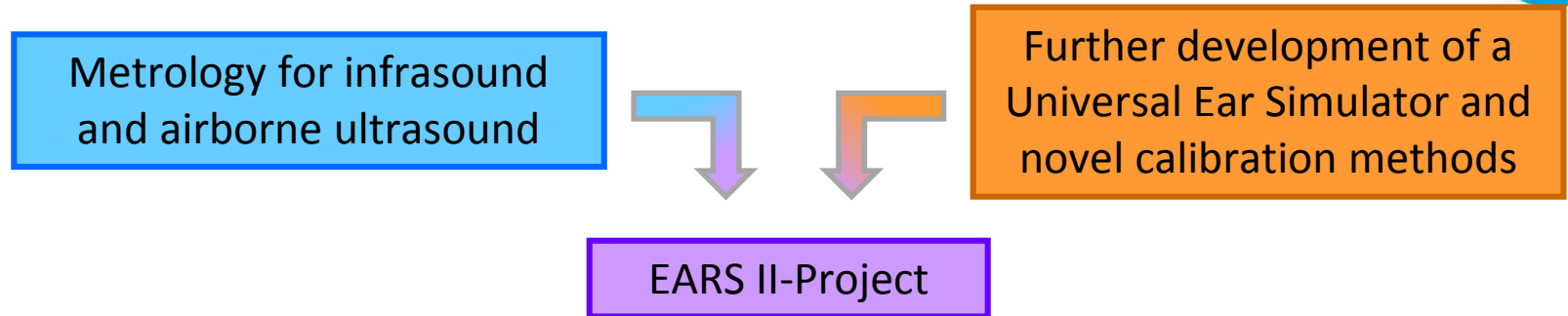
May 2016 – April 2019



New metrology and strategies will be implemented for improved diagnosis and conservation of hearing, leading to better quality of life for all. This will be achieved by:

- **Metrology for modern hearing assessment** based on the universal ear simulator concept and novel calibration methods
- Robust normative data and validated technical performance underpinning the next generation of standards
- **Understanding perception mechanisms** and impact of **infrasound** and **ultrasound** on hearing, mental health and wellbeing
- Innovation in assessing such noise hazards in public and workplace environments with new instrumentation and methods

EARS II: summary



- 5+6 partners from 6 countries: CH, DK, DE, UK, SI, TK
- Official start: 1 May 2016
- Withdrawal of NPL from Project to end of September
- Subcontract with Acoustic Sensor Networks Ltd
- Last project meeting was in Ljubljana 16 – 18 January 2017

EARS II: Progress



- Re-evaluation of specification of ear simulator: matching calibration with **patient characteristics**; **universal ear simulator**: reduction of number of devices to three; concept for **transient calibration**
- **Ultrasound measurement** systems based on single microphones established and tested; Workplaces and public sites as **potential application locations** for measurements are characterised and chosen; **Calibration procedures** at ultrasound frequencies
- Source for distortion-free generation of **infrasound** and audible sound developed; **First pilot study** about interaction of infrasound with audible sound; new **ultrasound source** for application in **MEG** and **fMRT** has been developed



15PRT02

Underwater acoustic calibration
standards for frequencies below
1 kHz

UNAC-LOW

May 2016 – April 2019



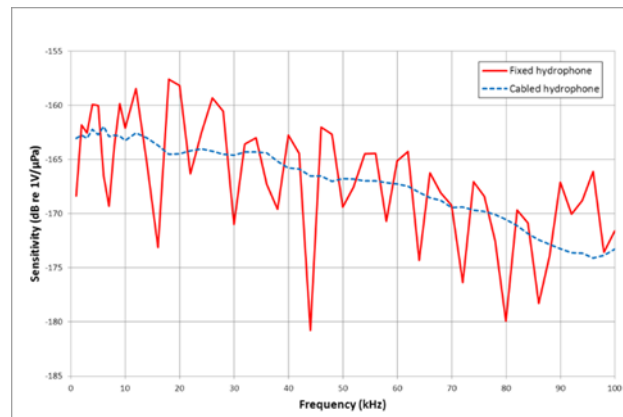
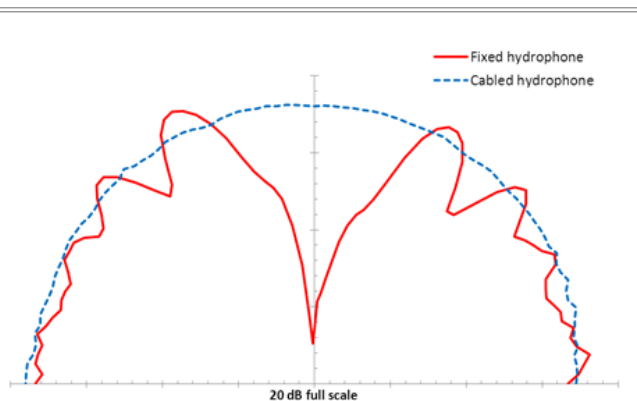
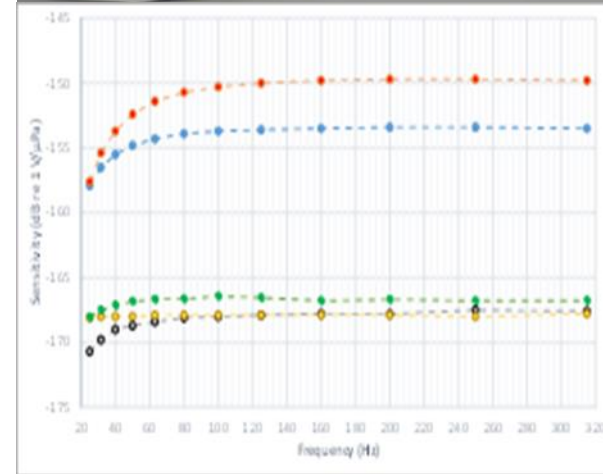
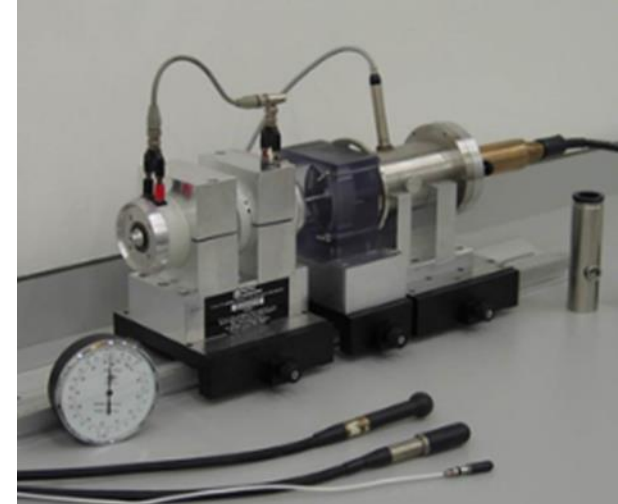
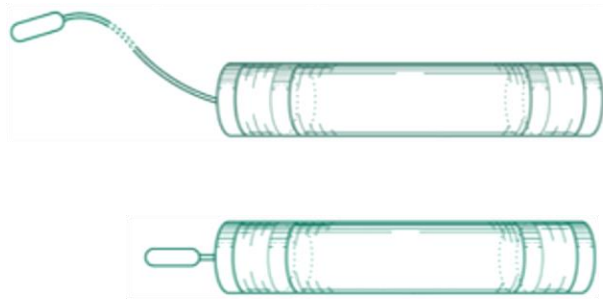
UNAC-LOW: drivers & objectives



- TUBITAK – MAM (TR), NPL (UK), DFM (DK),
- FOI (SE), CNR & ISPRA (IT)
- Increasing need for low frequency measurements of sound in the ocean to satisfy **environmental regulation**
- Recent developments in **instrumentation** (autonomous recorders)
- Only one European NMI with comprehensive capability
- Objectives
- Develop traceable measurement capabilities for calibration of **hydrophones** and **autonomous sound recorders and systems**
 - low frequency region from **20 Hz to 1 kHz** including the 63 Hz and 125 Hz third-octave bands cited by the EU **Marine Strategy Framework Directive**.
- Develop a **coherent strategy** for long-term operation of the developed measurement capabilities,
 - provide a coherent approach to traceability for absolute acoustic measurements in the ocean, establish a European research capability

Calibration of hydrophones and marine autonomous recorders

- Pressure calibration by absolute or relative method by comparison in small chamber
- Free field calibration in tanks and open water facilities



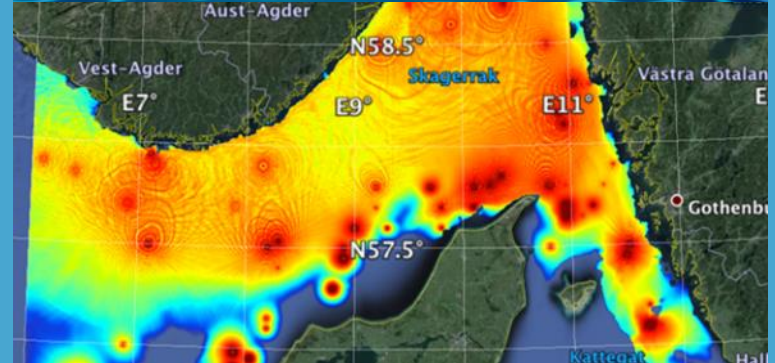
Further progress



- Last meeting: March 2017, London, UK
- **Stakeholder Group** formed
 - more than 20 so far from manufacturers, academia, users, regulators, metrology and standards community
- Input to standards and calibration committee of International Quiet Oceans Experiment
- Underpinning work for **North Sea noise monitoring** proposals (JOMOPANS)
- New Work Item agreed in principle at **IEC TC87 WG15**
- NPL launched **new LF calibration service** for recorders
- Presentation at national underwater sound forums
- Abstracts submitted for two 2017 conferences (journal paper in preparation)
- Input to European metrology strategy via TC-AUV

TC-AUV

Emerging metrology
challenges



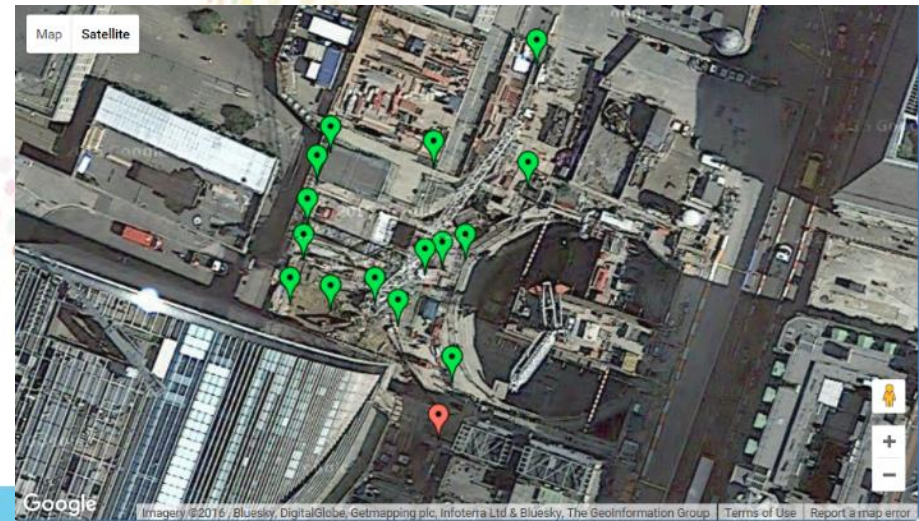
AUV sensor networks - metrology challenges



- The measurement paradigm for many AUV quantities is moving rapidly towards the use of **sensor networks**
- Multiple, remotely deployed, low cost sensors with known performance
- Methods of maintaining traceability
 - In-situ calibration
 - Analysis of network stability
 - Exploiting redundancy
- Network design, optimisation and deployment
- Multi-modal or multi-parameter real-time network – big data!

Data --> Knowledge

- Exploiting synergy & correlation more than the sum of the parts
- Trend analysis and prediction
- Estimating confidence in the knowledge to better inform decision processes



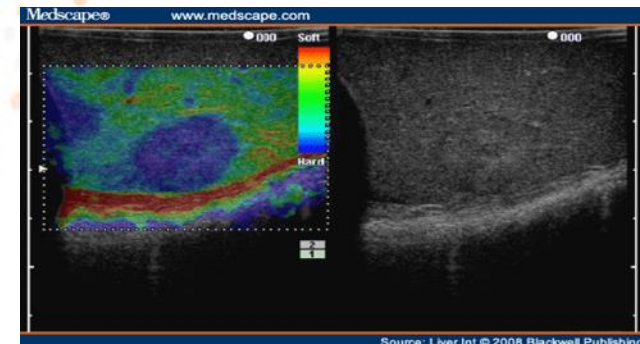
Extended frequency ranges

- Air acoustics: infrasound and ultrasound are topics of research (EARS II)
- Medical ultrasound: high MHz used for eye, skin and intravascular scans
- Vibration: LF for seismic and tsunami detection
- Marine acoustics: low frequency monitoring
- Example: CTBTO
 - Needs traceability for global sensor network for vibration, hydroacoustics, infrasound



Quantitative acoustic imaging

- Medical ultrasound and marine acoustics
- Ability to relate image to physical properties
- Important for:
 - comparison between images (before and after)
 - classification of image features



Digital sensor calibration



- Sensors play a vital part in AUV metrology and applications
 - Microphones for sound in air
 - Hydrophones for ultrasound and underwater acoustics
 - Accelerometers for vibration measurement
- Increasingly the transducers used in practical sensing and measurement applications have digital outputs
- Devices are often embedded into their surroundings and cannot be separated for calibration (no access to analogue signals)
- The challenge of traceable dynamic calibration of digital sensors cuts across all AUV themes
- Work in TC-AUV to examine the issues in preparation for more pre-normative work



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Thank you