

## **Title: Metrology for low-frequency sound and vibration**

### **Abstract**

The evaluation of intensity and propagation of infrasound in the atmosphere and low frequency acoustics in the oceans is important to understand and quantify climate change and noise pollution. Global seismic activity is monitored to predict and detect natural disasters (earthquakes, tsunamis, volcanic eruptions etc.) and for monitoring the adherence to the nuclear test ban treaty. The established regional and internationally operated measurement stations, however, lack traceability to the SI due to non-appropriate calibration infrastructure and validated on-site calibration methods.

### **Keywords**

Seismometer, seismic monitoring, underwater acoustics, infrasound, low frequency sound, international monitoring system, sound emission, infrasound noise measurement

### **Background to the Metrological Challenges**

Measurement of seismic and infrasound activity is very important for monitoring extreme events such as volcanic eruptions, earthquakes, tsunamis or nuclear explosions. Low frequency monitoring technologies using infrasound, seismic and ocean acoustic measurements are well-established, but the sensors are often used for specific and local applications only.

Regarding the acoustical metrology, the currently used method throughout the world, as the basis for calibration of primary standard microphones, is the absolute pressure reciprocity calibration method, as specified in the international standard IEC 61094-2. For frequencies below the 2 Hz limit no established calibration methods exist. An additional complication is the fact that microphones constructed for infrasound measurements are by design incompatible with the use of closed acoustical couplers. Hence, for the transfer of the calibration from reference standard microphones to infrasound microphones, new transfer calibration methods have to be developed and validated. This problem is not limited to the frequencies below 2 Hz but is also relevant between 2 Hz and 20 Hz where technical sources are in the focus.

For underwater acoustics, the primary calibration of hydrophones is provided by the free-field reciprocity calibration method, as specified in the international standard IEC 60565. No European NMI has the capability to calibrate hydrophones at low frequencies as a function of water temperature and depth, a key requirement for deep-ocean applications. Addressing these needs requires developments of methods and devices for primary and secondary calibrations of hydrophones.

In vibration metrology, including seismic measurements, traceability to the SI is either achieved by primary calibration using Laser interferometry (ISO 16063-11) or by comparison to a reference vibration sensor (ISO 16063-21) in the laboratory. Documentary standards or primary calibration facilities coping with lower frequency range requirements are not available.

### **Objectives**

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on the traceable measurement and characterisation of low frequency performed in the seismic, infrasound and ocean acoustic domains.

The specific objectives are

- 1 To develop methods and devices for primary calibration of sound in air, underwater acoustics and vibration sensing systems at low frequencies (< 0.1 Hz for acoustic and seismic).
- 2 To disseminate primary standards of measuring transducers by developing specific methods and facilities for on-site calibration and improve the behaviour of in-situ sensors including stability behaviour, positioning effects, installation conditions and sensitivity to environment.
- 3 To improve the outcomes from existing deployment strategies of networks of sensors and investigate the impact of propagation of uncertainties in models and parameters for these applications.
- 4 To engage with stakeholders to facilitate the take-up of the results, including regulators, sensor manufacturers, network providers, users of the traceable data and authorities responsible for developing and implementing EC Directives related to the environment.

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. To enhance the impact of the research, the involvement of the appropriate user community such as industry, standardisation and regulatory bodies is strongly recommended, both prior to and during methodology development.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 2.0 M€, and has defined an upper limit of 2.3 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 35 % of the total EU Contribution across all selected projects in this TP.

## Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the acoustics sector.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically, the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work.

## Time-scale

The project should be of up to 3 years duration.