EMRP Call 2011 - Health, SI Broader Scope & New Technologies

Selected Research Topic number: **SRT-s12**
Version: 1.0

Title: Novel techniques for traceable temperature dissemination

Abstract

The “Mise en Pratique” for the definition of the kelvin (MeP-K) was created in 2006 by the Consultative Committee for Thermometry (CCT) to give a guide for the practical realisation of the unit in accordance with the International System of Units (SI). This topic focuses on the development of new techniques to provide and sustain traceability to the kelvin for the benefit of the stakeholder community. This should be achieved by optimising the realisation of ITS-90 and by developing methods of traceability to the kelvin.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Health, New Technologies & Fundamental Metrology on pages12, 27 and 35.

Keywords

Fundamental thermometry, applied thermometry, *Mise en Pratique* for the kelvin, thermodynamic temperature, ITS-90, novel sensors, fixed points, standard platinum resistance thermometers, thermocouples, gas thermometry.

Background to the Metrological Challenges

Current state of the art in temperature measurement includes the defined scales: International Temperature Scale of 1990 (ITS-90) and the Provisional Low Temperature Scale of 2000 (PLTS-2000), which rely on specified procedures, fixed points, artefacts and sensors. The fixed points have unsolved thermal and impurity issues while the scale itself suffers from non-uniqueness. Between the triple point of hydrogen (13.8033 K) and the freezing point of silver (961.78 ºC) the standard platinum resistance thermometer (SPRT) is the interpolating instrument specified by the ITS-90. However, these thermometers have a critical limitation in practical applications: their sensitivity to mechanical shocks often prevents them from meeting the required measurement uncertainty. A change of several millikelvins at the triple point of water is not unusual, and causes unacceptable propagated errors. Above the freezing point of aluminium (660.323 ºC) the high-temperature SPRT has been repeatedly called into question suffering from problems like instabilities due to mechanical stress and contamination.

MeP-K aims to update and to expand the thermometric methods, to meet stakeholder needs, without the expense of changing the ITS-90. To achieve the envisaged expansion and flexibility of the MeP-K, research is needed to facilitate the inclusion of new methods whilst assuring compatibility with the ones currently in use.

Scientific and Technological 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 JRP-Protocol.

The JRP shall focus on the development of new techniques to provide and sustain traceability to the kelvin for the benefit of the stakeholder community.

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The specific objectives are:

1. To optimise the realisation of the ITS-90:
   - Resolve the key issues in the defining fixed points (thermal and impurity effects, phase transition modelling).
   - Ensure scale uniqueness.
   - Optimise calibration processes.
2. To develop and validate new methods to provide traceability to the kelvin. This may include developing alternative instruments and procedures.
   - Develop and validate new fixed points in temperature ranges where large temperature gaps exist between established fixed points (e.g. between -38.8344 ºC and -189.3442 ºC).
   - Establish and validate an approximation to the kelvin in the range from 660 ºC to 1000 ºC.
   - Develop and validate methods for direct calibration and alternatives of standard platinum resistance thermometers (SPRTs).

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 work, the involvement of the larger community of metrology R&D resources outside Europe is recommended.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this, including the currently funded EMRP projects:

- ENG06 Powerplants Metrology for Improved Power Plant Efficiency
- IND01 HiTeMS High temperature metrology for industrial applications (>1000 °C)

The total eligible cost of any proposal received for this SRT is expected to be around the 2.7 M€ guideline for proposals in this call.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the “end user” community (eg letters of support) is encouraged.

You should detail other impacts of your proposed JRP as detailed in the document “Guide 4: Writing a Joint Research Project”

You should detail how your JRP results are going to:

- feed into the development of urgent documentary standards through appropriate standards bodies
- transfer knowledge to the aerospace, energy generation, and pharmaceutical sectors.

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology. 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 Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased
- outside researchers & research organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration