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

Selected Research Topic number: **SRT-s13**
Version: 1.0

Title: Implementing the new kelvin

Abstract

The redefinition of the kelvin in terms of the Boltzmann constant opens up exciting possibilities for:

- A fundamental realisation of the kelvin directly linked to the new definition,
- Opportunities of a direct dissemination of the new kelvin to the user community, particularly at the extremes of temperature, and
- Essential primary thermometry that will provide a sound foundation for the "Mise en Pratique" for the definition of the kelvin.

This topic addresses these objectives through an appropriate mix of primary thermometry methods both to measure T and, where appropriate, $T - T_{90}$ and/or $T - T_{2000}$.

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 page 12.

Keywords

Thermometry, Primary Thermometry, *mise en pratique*, Kelvin

Background to the Metrological Challenges

Currently temperature measurement around the world is based on traceability to a defined scale i.e. International Temperature Scale of 1990 (ITS-90) or the Provisional Low Temperature Scale of 2000 (PLTS-2000). This is because primary methods, whilst more fundamental, have been intrinsically less reliable, with higher uncertainties.

The practical measurement of temperature can be linked to the new kelvin definition by developing thermometry to a more fundamental level, realising thermodynamic temperature at the extremes of temperature and developing new primary thermometry dissemination routes. This requires the development and validation of primary methods that can challenge and indeed be demonstrated to supplant the defined scale at very high (>1000 °C) and very low temperatures (<10 K).

Any proposal should take the whole practice of thermometry to a more fundamental level linking directly to the new definition, realising thermodynamic temperature at the extremes of temperature and developing new primary thermometry dissemination routes of any independent defined scale.

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 establishing the methodology for the mise en pratique for the kelvin following the expected redefinition of the kelvin in terms of the Boltzmann constant, and to enable the improved dissemination of the temperature scale to the stakeholder community.

EURAMET, EMRP-MSU
National Physical Laboratory
Hampton Road, Teddington,
Middlesex, TW11 0LW, UK

Phone: +44 20 8943 6666
emrpA169@npl.co.uk
www.euramet.org

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The specific objectives are:

1. Assign thermodynamic temperatures to high temperature fixed points above 1000 °C. Select and prioritise the fixed points according to documented external stakeholder needs and their target uncertainties.
2. Realisation and dissemination of *T* instead of ITS-90 at high temperatures
3. Determination of $T - T_{90}$ with lowest ever uncertainties by bringing together different primary thermometry methods in a single coherent project to minimise systematic effects
4. Develop primary methods of realising and disseminating *T* below 4 K and resolve the long standing discrepancy between the background data on which the PLTS-2000 is based

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 following funded EMRP projects

- T1 J1.4 Boltzmann constant: Determination of the Boltzmann constant for the redefinition of the Kelvin
- 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 (e.g. 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 manufacturing, cryogenics industry, health, earth observation and meteorology 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.