Realising the redefined kelvin

Need and objectives of the project

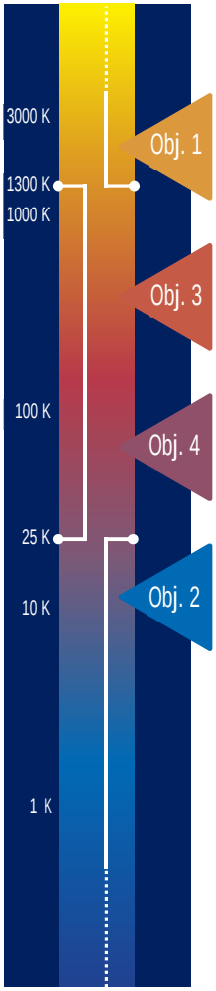
On May 20, 2019, the implementation phase of the redefinition of the international system of units (the SI) was completed and the new unit definitions came into force. For the SI quantity temperature, this means that its unit kelvin is now defined in terms of a fixed value of the Boltzmann constant (k). However, extensive research is still required in order to turn the kelvin redefinition and its associated Mise en Pratique into a reality.

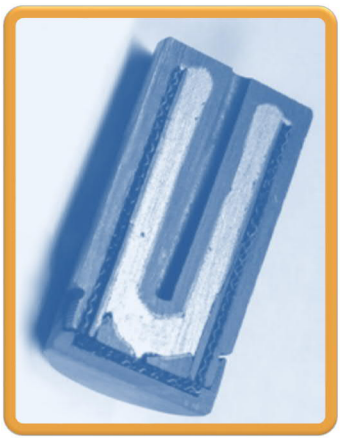
Currently nearly all temperature measurements performed around the world are traceable to one of the two defined scales (either the ITS-90 or the specialist low temperature scale, the PLTS-2000). However, with the impetus given by the redefinition there will be a rise in primary thermometry approaches for realising and disseminating temperature, directly linked to the redefined kelvin.

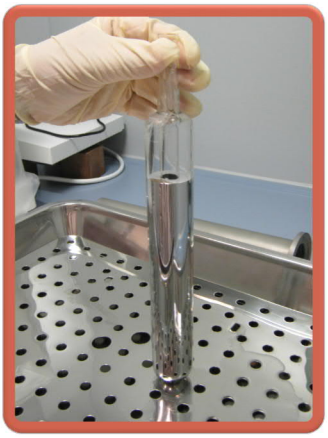
The Real-K project will take the kelvin redefinition and its associated Mise en Pratique (MeP-K) and begin to turn it into a reality by the following objectives

1. developing primary thermometry approaches at temperatures greater than 1300 K
2. demonstrating practical primary thermometry for temperatures below 25 K
3. extending the life of the currently defined scale to allow time for primary methods to develop and identifying a replacement for the mercury triple point
4. reducing the uncertainty in a number of different primary thermometry methods.

The ultimate goal is that primary thermometry will be the basis of temperature traceability throughout the entire range. Easing the transition to primary thermometry in this way should enable in-situ traceability at lower cost, in applications such as remote monitoring in manufacturing and the nuclear power sector.







TURNING THE KELVIN REDEFINITION IN TO REALITY

EMPIR EURAMET

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

Progress beyond the state of the art and expected results

The project targets to deliver major contributions for the future revision of the MeP-K by using primary thermometry for temperature realisation and dissemination at temperatures >1300 K and <25 K, reducing non-uniqueness uncertainties in the realisation of the ITS-90 by 30 % and identifying a replacement for the mercury triple point.

- Realisation and dissemination of the redefined kelvin >1300 K
  - Assigning definitive thermodynamic temperatures to the HTFPs: Fe-C (1426 K), Pd-C (1765 K), Ru-C (2226 K) and WC-C (3020 K); target standard uncertainty from 0.1 K to 0.4 K.
  - The first practical outworking of the Mise en Pratique by indirect primary radiometry (>1300 K).
- Realisation and dissemination of the redefined kelvin <25 K
  - Primary thermometers covering the entire range from 1 K to 25 K that significantly reduce the complexity of realisation and dissemination of temperature (target uncertainty <1 %)
  - Greatly improved reliability in scale realisation and dissemination by enabling a direct check of different realisation techniques of the currently used temperature scales.
- Extending the life of the International Temperature Scale of 1990
  - Substantially increased knowledge of Type 1 and 3 non-uniqueness in ITS-90 calibrations (target: 30 % uncertainty reduction).
  - Identified and characterised a suitable replacement for the mercury triple point.
- Facilitating full range primary thermometry
  - Reduced ab initio calculation uncertainty of the thermodynamic non-ideality of monatomic gases. Target uncertainty reduction (factor 10) in these properties for Ar and Ne. Validation of calculations through low-uncertainty thermodynamic measurements over wide ranges of temperature (10 K to 350 K) and pressures (up to 100 MPa).
  - Traceability to thermodynamic temperature through trial calibration of thermometers.

Consortium and contact information

The consortium consisting of national metrology, research institutes and universities brings together a critical mass of recognised world leaders in the field.

Project coordinator: Graham Machin (graham.machin@npl.co.uk).

Project website: https://real-k.aalto.fi.

Newsletter: Every nine months an e-Newsletter will be available via the project website.

To register as a project stakeholder, contact Kaj Nyholm (kaj.nyholm@vtt.fi).

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