Agenda for the 29th meeting of CCT – Session 4

Online meeting

Start: Tuesday 19 January 2021 13:00 (UTC+1, CET)

1. Welcome by the CCT President, Dr Yuning Duan, and the Director of the BIPM, Dr Martin J. T. Milton
2. Approval of the agenda
3. Approval of *Rapporteur*
4. Feedback from the WG-CTh meeting and recent activities, C. Gaiser – PTB
5. On thermodynamic temperature data (CCT/20-50)
6. Feedback from the WG-Hu meeting and recent activities, S. Bell – NPL
7. AOB
8. Presentation by G. Machin – NPL

Realising the redefined kelvin – a EURAMET perspective

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In the post kelvin redefinition era instead of temperature traceability being achieved through the calibration of sensors to the defined temperature scales the user is presented with a more nuanced traceability choice through the mise en pratique for the definition of the kelvin (MeP-K-19). The user may desire to achieve temperature traceability to primary thermometry, linked directly to the redefined kelvin, without any recourse to intermediary defined scales.
This talk will focus on thermometry research within Europe which is seeking to turn the MeP-K-19 into a reality. This research is being spearheaded by the EMPIR Realising the redefined kelvin project (Real-K) which has four main objectives:
1) To demonstrate and establish traceability directly to the redefined kelvin from ~1300 K to ~3000 K. Low uncertainty thermodynamic temperatures of four new HTFPs will be established. Then, through the mechanism of the MeP-K-19, HTFPs will be used to realise and disseminate thermodynamic temperature with uncertainties competitive with the defined scale (the ITS-90)
2) To demonstrate practical primary thermometry for realisation and dissemination of temperature below 25 K and so demonstrate that primary thermometry can be used: to replace the currently complex ITS-90 scale realisation arrangement below 25 K and to ensure a smooth transition to the PLTS-2000 range below 1 K (target U = 0.2 mK at 25 K and <1% at 1 K).
3) To extend the life of the current defined scale (ITS-90) giving users continued access to low uncertainty realisations of the scale whilst allowing time for primary thermometry methods to mature. Scale non-uniqueness will be investigated, with the objective of reducing its uncertainty by 30 %. A possible replacement fixed-point for the mercury triple point will be identified, constructed and tested and the issue of integration within the ITS-90 will be addressed.
4) To reduce the uncertainty in a number of different gas based primary thermometry methods, approved for use in the MeP-K-19, and so begin to facilitate an extension of their applicability for temperature realisation and dissemination into the temperature region 25 K and above. This will be facilitated through reducing the uncertainties of the calculated thermophysical properties of gases (e.g. He, Ne, Ar) used in primary thermometers.

This approach will enable temperature metrologists to continue to fulfil their main role; that is ensuring the global user community has continual access to the best traceable temperatures, even if the traceability route evolves over time from defined scales to direct linkage to primary thermometry.
The Real-K consortium members hold the view that unforced changes to the ITS-90 will be un-necessarily disruptive as there is no significant user group requiring a new temperature scale, either from the point of view of an improved thermodynamic consistency (the very small number of users that need T can get it from the T-T90 data) or different interpolation functions (which makes no practical difference to accessing the temperature scale).

Graham Machin is the science leader of the NPL Temperature and Humidity Group and an NPL Fellow. He is visiting Professor in Photonic thermometry (University of Strathclyde) and Clinical Thermal Imaging (University of South Wales) and Distinguished Visiting Fellow (University of Valladolid). He represents the UK on the Consultative Committee of Thermometry (CCT) and IMEKO TC12, chairs the CCT working group for Noncontact thermometry and is an international invited expert on the CAS "very low temperature thermometry" project (2017-2022). He was President of the UK Institute of Measurement and Control (2018-2019), chair of the Euramet Technical Committee for Thermometry from (2014-2018) and served on the EPSRC Physical Sciences Strategic Advisory Team (2014-2017).

Graham was awarded the Institute of Measurement and Control (InstMC) Callendar medal (2012) for "outstanding contributions to the art of temperature measurement", and elected Honorary Scientist of the Chinese Academy of Sciences (CAS) and Fellow of the Royal Academy of Engineering (2019).

Current research interests are primary thermometry, radiation thermometry and thermal imaging, new thermocouples, sensor self-validation methods, reliable clinical thermometry, reliable temperature (and other) measurements in hostile environments (especially aerospace and nuclear decommissioning). He is the coordinator of the EMPIR "Realising the redefined kelvin" (Sep 2019-Aug 2022) project, founder member of the UK "Body Temperature Initiative" aiming to improve clinical thermometry in the NHS and leads NPL's metrology activity for nuclear decommissioning.