CCT Technical Workshop on "Traceability and Dissemination"
Thursday 16th May, 2024 h 14;10

h 14;10 – h 14;15: Introduction (Andrea Peruzzi, NRC)

h 14;15 – h 14;45: Naohiko Sasajima, NMIJ/AIST, "*Dissemination and international comparison of thermodynamic temperature in non-contact thermometry*"

h 14;45 – h 15;15: Roberto Gavioso, INRiM, "*Perspectives for the dissemination of thermodynamic temperature in contact thermometry*"

h 15;15 – h 15;45: Jonathan Pearce, NPL, "*Approaches to in-situ SI traceability of temperature measurements through self-validation and practical primary thermometry*"

h 15;45 – h 16;15: Coffee break

h 16;15 – h 16;45: Patrick Rourke, NRC, "*Traceability in a mixed dissemination environment*"

h 16;45 – h 17;15: Jeff Gust, Fluke Corp., "*The Benefits of a Potential Revision of ITS-90 for Industry*"

h 17;15 – h 17;30: Discussion

“Dissemination and international comparison of thermodynamic temperature in contact thermometry”

Naohiko Sasajima, National Metrology Institute of Japan, AIST, Japan

Abstract

The *Mise en Pratique* of the realization of the kelvin (*MeP*-K-19) provides a practical guide to the realization of thermodynamic temperature by absolute and relative primary radiometric thermometry. In the relative method, thermodynamic temperature is determined using one or more temperature fixed-point blackbodies, each of which has a known thermodynamic temperature. Using this method, NMIJ has been disseminating thermodynamic temperature in the temperature range of 960 °C to 2800 °C using a copper point and three types of high-temperature fixed points since 2019. This workshop will present how NMIJ disseminates thermodynamic temperature above 960 °C and how NMIJ plans to extend the dissemination of thermodynamic temperature down to the Indium point. In addition, an outlook on the future key comparisons in non-contact thermometry will be discussed.

Speaker Bio

Dr. Naohiko Sasajima joined the National Laboratory of Metrology (currently the National Metrology Institute of Japan) in 2000, and since then has been engaged in research on high-temperature fixed points (HTFPs) of metal-carbon systems, and has realized the dissemination of thermodynamic temperature by relative methods using HTFPs. From 2004 to 2006, he worked as guest researcher at NIST in the USA. He has conducted many international comparisons and is currently responsible for radiation temperature scales from 160 °C to 2800 °C in Japan, preparing the IEC draft for the two-color ratio thermometers, and researching emissivity-free radiation thermometry. He is a member of the APMP TCT, the CCT working group for non-contact thermometry, and a member of the IEC Standards Committee.

"Perspectives for the dissemination of thermodynamic temperature in contact thermometry"

Roberto Gavioso, National Metrology Institute of Italy, Italy

Abstract

Progress achieved in the development of primary gas thermometry methods suggests their use for the dissemination of the redefined kelvin. This possibility is being explored, within EURAMET's funding programme, by the DireK-T research project. DireK-T scheduled activities include: an international comparison of thermodynamic temperature realizations, in the range between 4 K and 304 K, using capsule-type resistance thermometers as transfer standards; the development of acoustic gas thermometry methods to become suitable for use up to 700 K; tests aiming at ensure consistency of dissemination whether it is by thermodynamic temperature or the defined scale (ITS-90). These objectives are presented by discussing the scientific challenges involved and the future impact on temperature traceability.

Speaker Bio

Dr. Roberto Gavioso is a senior research scientist at INRiM with a long-term experience in the application of acoustic and microwave techniques to the development of temperature, pressure and humidity standards.

His achievements in the field include a low-uncertainty determination of the Boltzmann constant based on measurements of speed of sound in helium using a spherical resonator and, as a guest researcher at the National Institute of Standards and Technology (NIST), a determination of the polarizability of He which demonstrated a primary pressure standard based on the calculated properties of He.

He is a member of the Working Group for Contact Thermometry (WG-CTh) of the CCT.

He is a Lecturer in Physical Acoustics at the University of Torino.

“Approaches to *in-situ* SI traceability of temperature measurements through self-validation and practical primary thermometry”

Jonathan Pearce, National Physical Laboratory, UK

Abstract

Accurate, traceable thermometry for process control and monitoring is synonymous with energy efficiency, reduced greenhouse gas and toxic gas emissions, product yield, and safety. Once a conventional thermometer (e.g. a resistance thermometer or thermocouple) is placed in service the user must assume this calibration remains valid, whereas in reality the calibration will ‘drift’ resulting in a progressively increasing, and unknown, measurement error. Three ways to mitigate this effect and retain SI traceability *in-situ* are described, namely two types of self-validation based on miniature fixed-point cells (self-validating thermocouples and embedded miniature fixed points), and new practical primary thermometers including those based on Johnson noise, Doppler broadening, and ring resonators. The implications of these techniques on traceability to the SI kelvin will be discussed.

Speaker Bio

Dr. Jonathan Pearce leads the contact thermometry technical area of the Temperature & Humidity Group at the UK’s National Physical Laboratory. He is also Head of Science for NPL’s Thermal and Radiometric Metrology department. He has published over 160 articles on measurement issues. Research highlights include the development and optimisation of new and existing thermocouples and fixed points for contact thermometry, introducing new techniques for overcoming calibration drift including self-validating sensors, low-drift thermometry, supporting the development of practical primary Johnson noise thermometry, modelling physical systems, and developing digital approaches to temperature metrology. He is the UK representative on the EURAMET Technical Committee for Thermometry (TC-T) and represents the UK in various BIPM Consultative Committee for Thermometry (CCT) and EURAMET TC-T working/task groups. He serves on various standards committees including those of the BSI and IEC. He is a Fellow of the Institute of Physics.

““Traceability in a mixed dissemination environment””

Patrick Rourke, National Research Council of Canada, Canada

Abstract

The CCT has encouraged member state NMIs to directly disseminate thermodynamic temperature T according to the new definition of the kelvin, and has published a *mise en pratique* containing endorsed methods of doing so. The CCT anticipates that T dissemination will start at the extremes of temperature, and gradually replace ITS-90 temperature T_{90} dissemination.

Research is ongoing to improve and compare primary thermometers, but the transition from universal T_{90} dissemination to universal T dissemination will take a very long time, especially in the middle part of the scale. As some NMIs begin to disseminate T while others continue to disseminate T_{90}, thermometers carrying T calibrations will begin coexist with those carrying T_{90} calibrations out in the world. This global Mixed Dissemination Environment (MDE) will fluctuate over many decades as different NMIs develop and expand primary thermometry capabilities at different times.

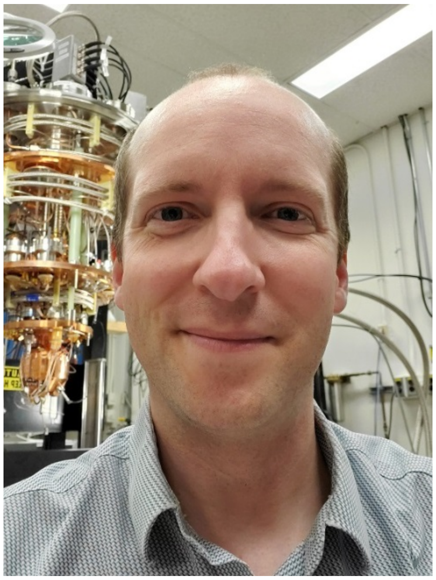
Unfortunately, T calibrations disagree with T_{90} calibrations by more than 10x LSPRT T_{90} calibration uncertainties. Any path from T_{90} dissemination to T dissemination will be disruptive, because the temperatures reported by users' thermometers will shift by an order of magnitude more than their uncertainties. If this dissemination transition takes place in the patchwork MDE way, the disruption will extend over decades, and also burden users with keeping track of which thermometers give T_{90} and which give T at any given moment. Revising the ITS-90 so that it agrees with T could help by consolidating the temperature shift into a single coordinated changeover and supporting long-term scale users during the MDE transition. By keeping the mathematical structure of the scale the same, NMIs everywhere could implement it on day one, with existing equipment, by updating tables of coefficients and fixed point values. Then further moves to direct T dissemination by individual NMIs would be transparent to the users. While such a scale revision would come with adoption costs, it offers the path of least net disruption through the coming MDE without unduly constraining progress in direct realization of the new kelvin.

Speaker Bio

Dr. Patrick Rourke received his Ph.D. from the University of Toronto and held a Postdoctoral Fellowship at the University of Bristol before joining the NRC Thermometry & Radiometry team in 2012.

His research focuses are primary thermometry, temperature scales, and the interplay between them. This has included work on refractive-index gas thermometry, acoustic gas thermometry, the present and future of the International Temperature Scale of 1990, alternatives to mercury fixed points, and implications of coexisting T and T_{90} disseminations.

Dr. Rourke is currently the Canadian delegate to the CCT, member of the CCT Working Group for Contact Thermometry, chair of the CCT Task Group on Digitalization, and CCT Digitalization Representative to the CIPM Forum on Metrology and Digitalization.



“The Benefits of a Potential Revision of ITS-90 for Industry”

Jeff Gust, Fluke Corp., USA

Abstract

There have been significant advances in metrology, temperature measurement technology, and technologies requiring temperature measurements at extremes since the introduction of ITS-90. Industry’s ability to directly realize the SI increases by the day. Industry needs an extension of a contact thermometry scale past 1233 to 1673 kelvins as well as below 3 to 5 kelvins. Environmental concerns are discouraging the use of Mercury fixed point cells. Our company believes that the benefits outweigh the challenges of revising the International Temperature Scale. This presentation provides an overview of both challenges and benefits that could be brought with a revision of ITS-90.

Speaker Bio

Mr. Jeff Gust is the Chief Corporate Metrologist for Fluke. Since joining in 2010, he has driven improvements in measurement quality for engineering, manufacturing and service activities for Fluke and Fortive Corporate (parent company of Fluke) organizations around the world. He has been a key contributor to development of international standards and practices for calibration laboratories, and a writing group member for ISO 17025:2017, ISO 17043:2010 and ILAC P14-2020. Mr. Gust is the chair of the ILAC Stakeholder Forum and is a member of the ILAC Executive. In 2011 Jeff was recognized by the Measurement Science Conference for outstanding contributions and leadership in metrology, and in 2017 was named a Fluke Fellow, the highest technical award for the company. Prior to joining Fluke, Jeff has co-authored publications with NIST and served as a consultant to NIST and UNIDO. Jeff has a bachelor’s degree from Purdue University in physics.