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Update on Progress with the Radiation Thermometry Key Comparison CCT-K10

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Background to the comparison

Key comparisons (KCs) are required to ensure equivalence between laboratories and to substantiate Calibration and Measurement Capabilities (CMCs)

The previous radiation thermometry KC (CCT-K5) finished in 1999 and used tungsten ribbon lamps as the transfer instruments. These were not ideal:

- their radiance temperature is strongly wavelength dependent, so corrections had to be applied to the results to account for the different measurement wavelengths
- the target size of lamps is small (typically 1.5 mm width) compared to the field-of-view of many radiation thermometers
- the inherent uncertainties associated with lamps tend to be large
- the upper temperature of the comparison was 1700 °C whereas many laboratories can now achieve up to 2500 °C or even 3000 °C.

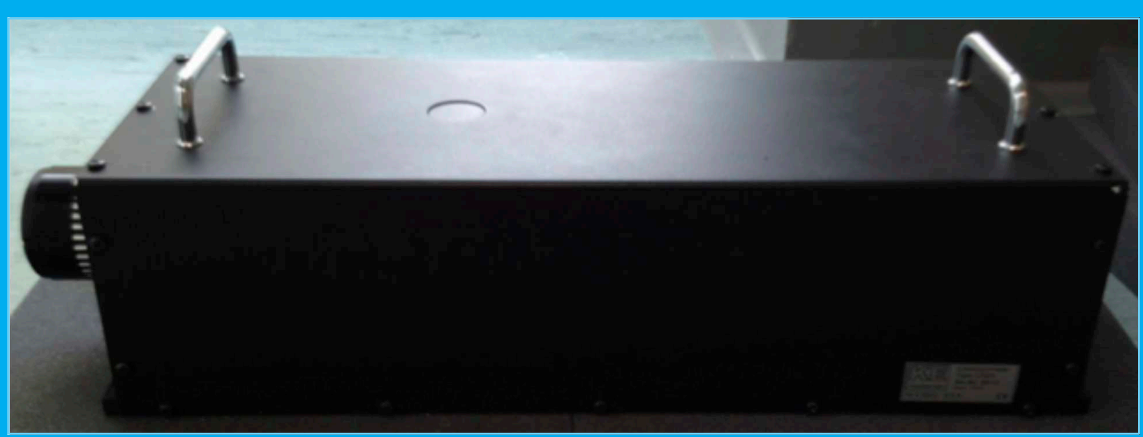
The CCT-K10 comparison

A new KC is underway – CCT-K10 – with the transfer instruments being two radiation thermometers (an IKE LP3 and a Chino thermometer IR-RST, both operating at 650 nm), and a set of three High Temperature Fixed-Point (HTFP) blackbody sources (WC-C, Ru-C and either doped Ni-C or doped Co-C); along with a transportable Cu fixed-point unit to determine corrections for any instability of the transfer radiation thermometers.

Figure 1: *The Chino IR-RST radiation thermometer*

Figure 2: *A high temperature fixed-point blackbody*

Figure 3: *The Linear Pyrometer LP3*

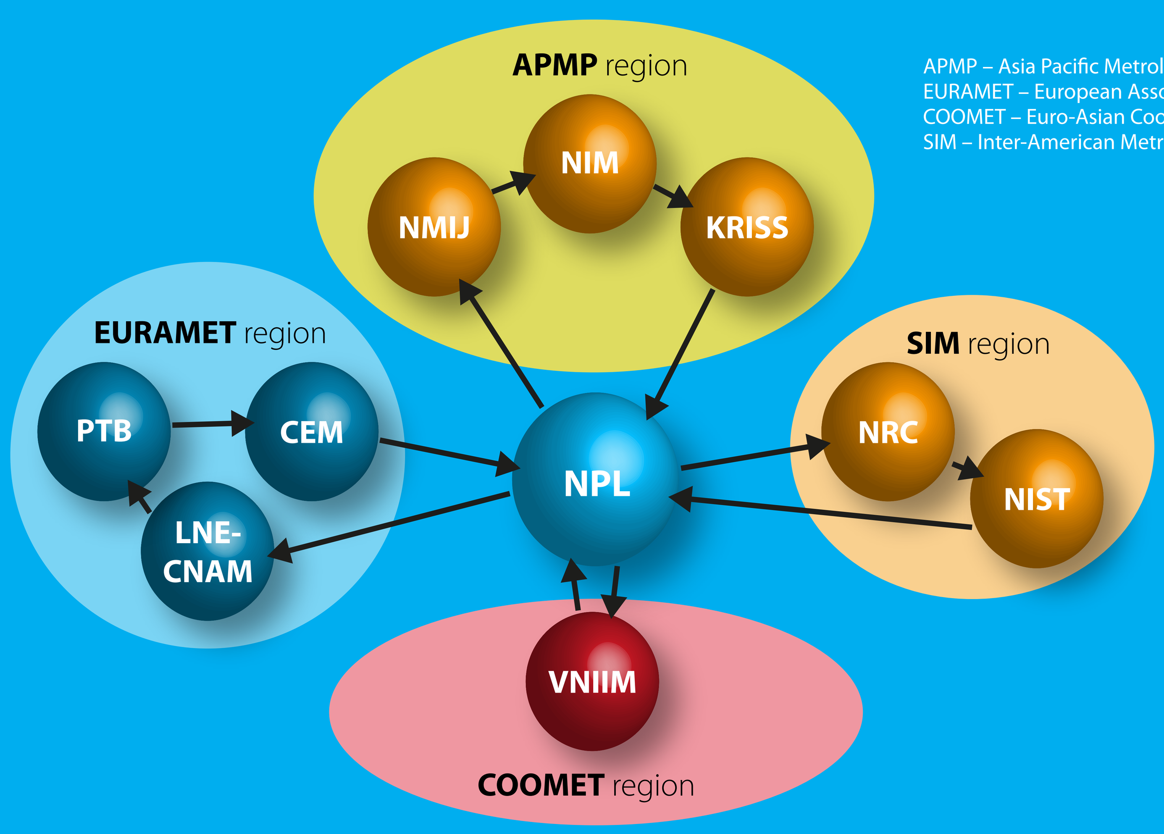


There are two parts to the KC:

- ITS-90 calibration of the two transfer radiation thermometers from 962 °C to 3000 °C using variable high temperature blackbody sources
- measurement of the ITS-90 temperatures of the HTFP blackbodies (WC-C (~2750 °C), Ru-C (~1953 °C) and either doped Ni-C or doped Co-C (both ~1330 °C dependent on doping levels)).

This approach should address the limitations of the previous KC, by extending the comparison to much higher temperatures, by using methodologies (blackbody sources) which are much less sensitive to measuring wavelength and by using comparison artefacts which have improved uncertainties compared to the lamps. In addition, the HTFPs are low-uncertainty driftless artefacts which will enable ITS-90 realisation uncertainties to be probed to an unprecedented level.

Schematic of circulation of instruments



APMP – Asia Pacific Metrology Programme
EURAMET – European Association of Metrology Institutes
COOMET – Euro-Asian Cooperation of National Metrological Institutions
SIM – Inter-American Metrology System

Analysis of the results

1) For the radiation thermometer measurements Key Comparison Reference Values (KCRVs) will be determined for each of the comparison temperatures using the weighted mean with cut-off* of the participant results (i.e. thermometer signal versus ITS-90 temperature) after correcting for any thermometer drift

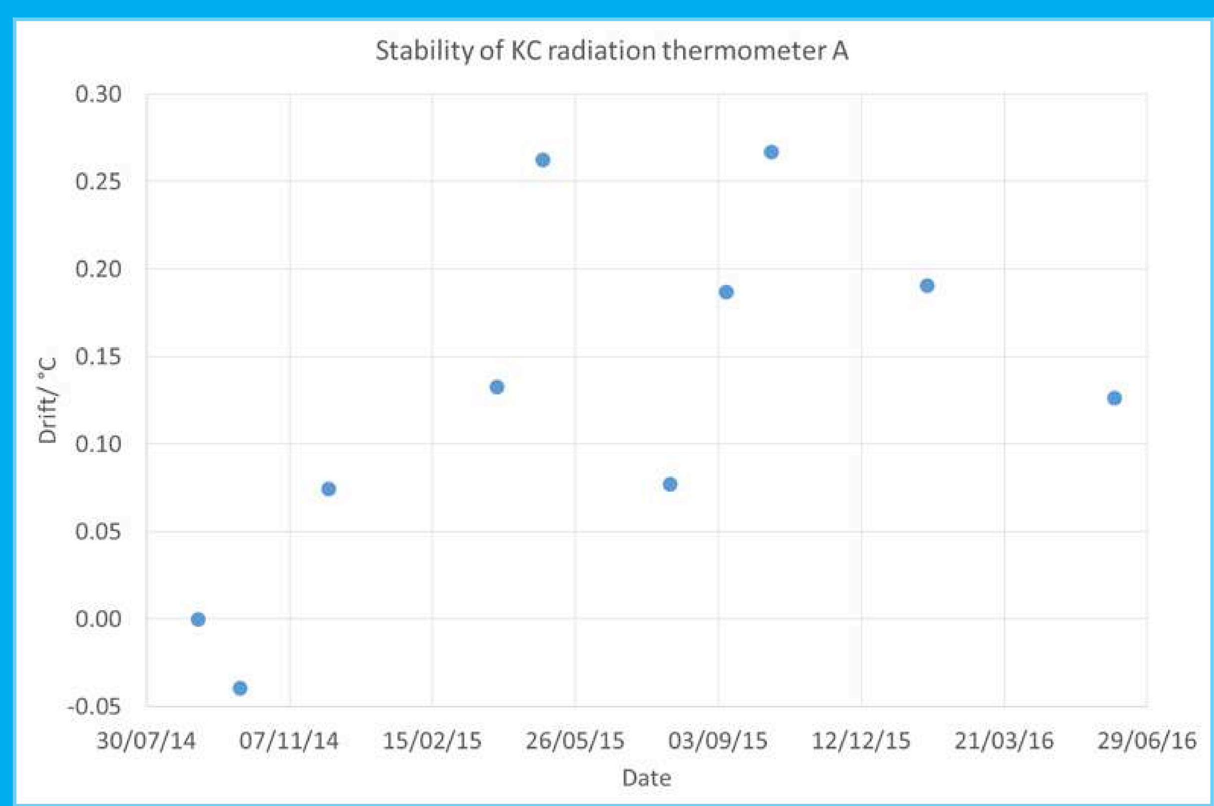
2) For the HTFP measurements the KCRV will be determined for each HTFP using the weighted mean with cut-off* of the t_{90} temperatures of each of the cells

Progress to date with circulation of instruments

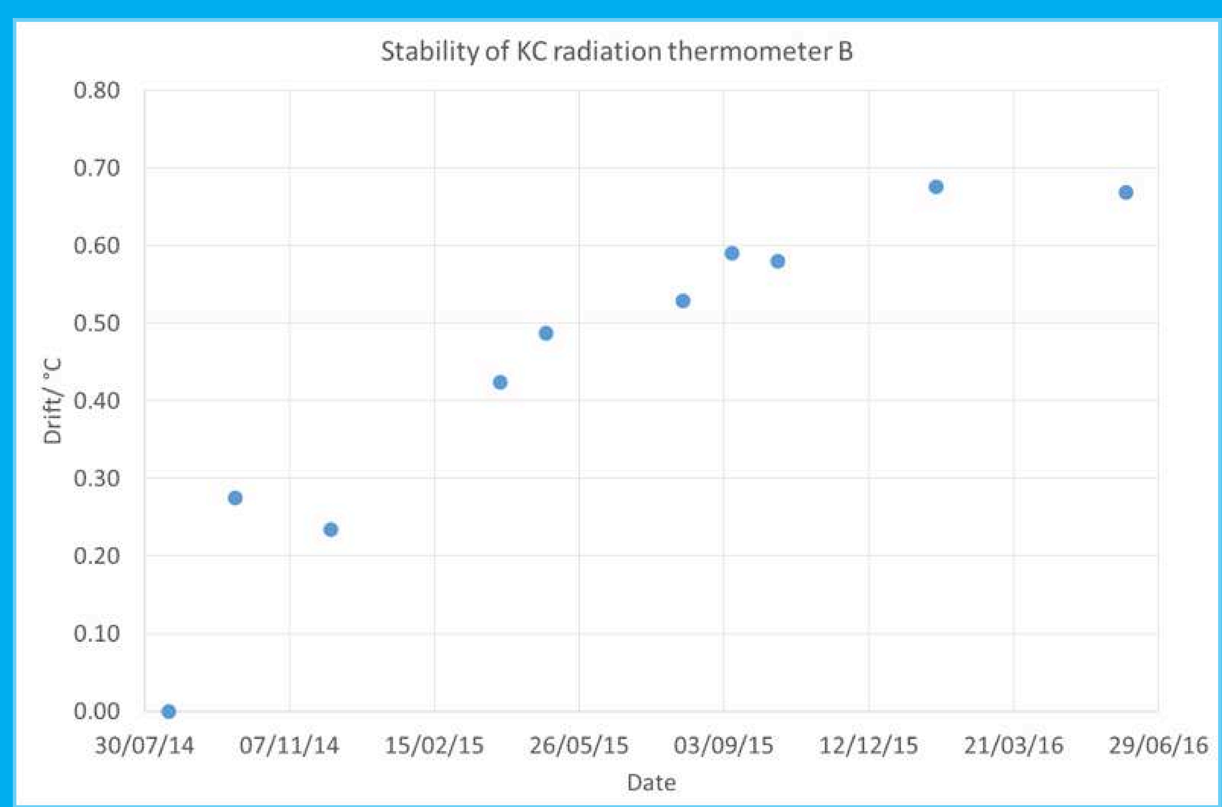
NMI	Original Timetable	Complete?
NPL (pilot)	to end Sept 14	✓
NMIJ	mid-Oct 14 to end Nov 14	✓
NIM	mid-Dec 14 to mid-Feb 15	✓
KRISS	Mar 15 to mid-Apr 15	✓
NPL (pilot)	May 15	✓
NIST	mid-June 15 to mid-July 15	✓
NRC	Aug 15	✓
NPL (pilot)	mid-Sept to mid-Oct 15	
VNIIM	Nov 15 to mid-Dec 15	
NPL (pilot)	Jan 16	
LNE-Cnam	mid-Feb 16 to mid-Mar 16	
PTB	Apr 16	
CEM	mid-May to mid-June	
NPL (pilot)	July 16 to Aug 16	

Issues/challenges

- The comparison is currently running about 10 months behind the original schedule due to customs/ transportation delays, issues within particular laboratories and issues with the circulating equipment, and is now currently due to finish around the end of June 2017
- The doped Ni-C cells, which were originally chosen for one of the HTFP types, suffered several breakages so this HTFP type has been replaced with a doped Co-C cell. This will introduce an extra challenge with linkage between participants
- The transfer radiation thermometer results will need to be corrected for drift based on the results of the Cu point checks, and this is likely to be a significant correction.



Graph 1: *Stability of the KC radiation thermometer A, based on the Cu fixed point checks.*



Graph 2: *Stability of the KC radiation thermometer B, based on the Cu fixed point checks.*

(* the weight is $1/u^2$ where u is the standard uncertainty of the participant's measurements at the comparison temperature, or for the HTFP measurements. The cut-off values for the weights will be the average of the uncertainty values of those participants that reported uncertainties smaller than or equal to the median uncertainty of all the participants.)

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