Dissemination of the redefined kelvin

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700 K

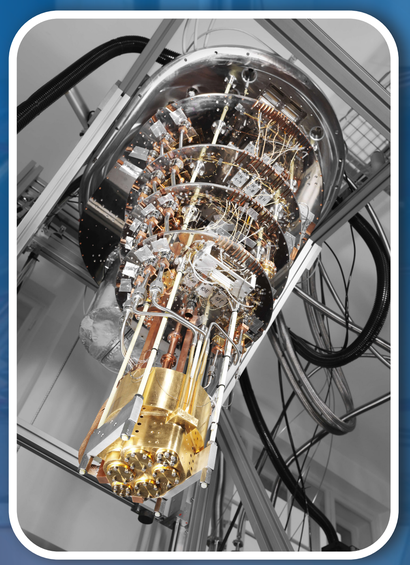
303 K

25 K

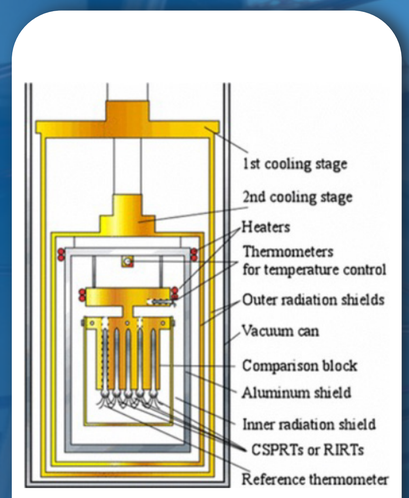
4 K

WP4: Establishing primary thermometry capability from 300 K to 700 K

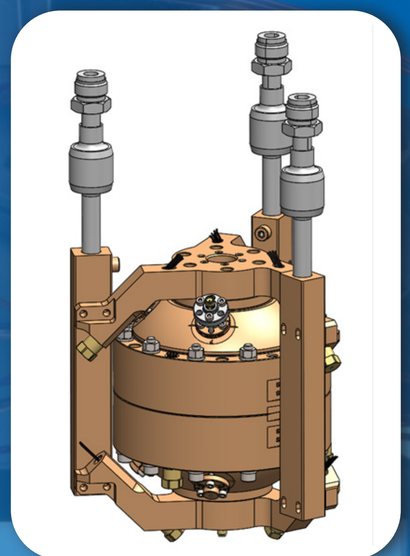
- ***New*** European primary thermometry capability (AGT) for the realisation and ultimately dissemination of thermodynamic temperature (*T*) in range 300 K - 700 K target $u(k=1)$ 0.6 mK (300 K); 7 mK (700 K)
- ***New*** values of $T\text{-}T_{90}$ in range as required by CCT recommendation T1 2021



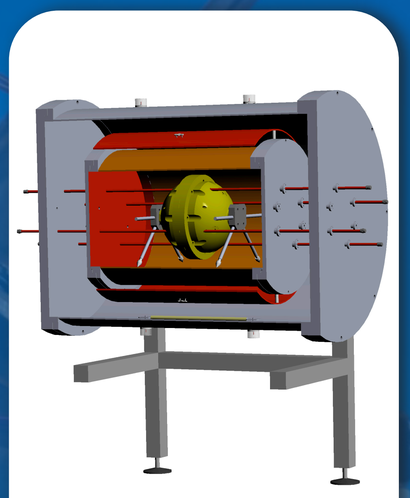
PTB dielectric constant gas thermometer



Cryogenic comparator for sensor calibration 4 K - 25 K



Design of acoustic thermometer for high temperature operation



High temperature acoustic gas thermometer

WP2: Dissemination of primary thermometry between 25 K and 303 K

- ***First ever*** dissemination of thermodynamic temperature (*T*) in range 25 K-303 K; target $u(k=1)$ 0.25 mK (25 K) and 0.6 mK (303 K)
- Two *MeP*-K-19 primary thermometry methods (AGT and DCGT) to minimise systematic uncertainty
- Two European NMIs with ***new capability*** to disseminate *T* in range (CMI, UL) and two with ***new primary thermometry (AGT) capability*** (CMI, TUBITAK)

WP1: Practical thermodynamic temperature dissemination between 4 K and 25 K

- ***First ever*** dissemination of thermodynamic temperature (*T*) in range 4 K-25 K; target $u(k=1)$ 0.3 mK
- Three *mise en pratique* for the definition of the kelvin (*MeP*-K-19) primary thermometry methods (AGT, DCGT and RIGT) to minimise systematic uncertainty
- Two European NMIs with ***new capability*** to disseminate *T* in range (NPL, INTiBS)

WP3: Assessment of traceability and dissemination of thermodynamic temperature (4 K to 303 K)

- ***First ever*** framework to ensure consistent dissemination of temperature (whether thermodynamic temperature (*T*) or defined scale (ITS-90)
- ***First ever*** documented level of equivalence for dissemination and traceability between *T* and T_{90}
- Recommendation report to CCT on how to realise and disseminate *T* in range, and proposals for future revision of the *MeP*-K-19

Impact

- Processes and equipment in place, undergirded by CCT recommendation, for realisation and dissemination of thermodynamic temperature between 4 K and 303 K, and background capability developed to do the same at higher temperatures
- Very close cooperation with key stakeholders, especially CCT, with at least 7 key inputs into CCT by the project completion, and RMO TC-Ts with annual progress reports (oral at Euramet TC-T)
- Close engagement with scientific/metrology community through OA papers (at least 15) and conference presentations (at least 20) and wider stakeholder community through project webpage, e-newsletter and LinkedIn group
- Engage global primary thermometry community through ***high-level summer school*** addressing contemporary issues in primary thermometry
- Stronger more integrated European temperature metrology community with increased capacity in both thermodynamic temperature dissemination capability (3 new NMIs) and primary thermometry capability (2 new NMIs)
- In the long term provide consistent thermodynamic thermometry as required by climate science, fundamental materials research and hydrogen liquefaction and processing technology

Letters of Support

There were 34 letters of support from a broad spectrum of stakeholders including CIPM CCT president, IMEKO president, 5 RMO chairs, as well as companies, accreditation bodies, other NMIs and leaders in the field

> *“.. this project will make step change contributions to primary thermometry and globally important contributions to progress dissemination of the redefined kelvin”*
>
> Duan Yuning, President of the CCT

> *“.. all of the projects objectives are important to the international community .. this work will lead to more widespread use of primary thermometry which in turn will deliver better temperature metrology to industry”*
>
> Prof Eric May CEO, Future Energy Exports, University of Western Australia

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