Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Nationales Metrologieinstitut

Report of WG-CTh

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Anatolii Pokhodun, Patrick Rourke, Wes Tew, Rod White, Inseok Yang, Jintao Zhang

CCT-28
BIPM, 2nd June 2017

Summary

WG Contact Thermometry met twice since last CCT:
Zakopane, Poland, after TEMPMEKO 2016, 1 JULY 2016
BIPM, before CCT-28, 1 June 2017

Key Comparisons:
K2: refer to recent star intercomparison
K4: bilateral comparison
K7: highest priority, NMIs to consider piloting, to start 2018-2019

Contact thermometry split into WG-CTh and TG-K
(see Bernd´s presentation)

Supplementary material for $T - T_{90}$ (subgroup led by M. de Podesta)
ITS-XX (CCT/17-17)
Report on $T - T_{90}$

Int J Thermophys (2011) 32:12–25
DOI 10.1007/s10765-011-0922-1

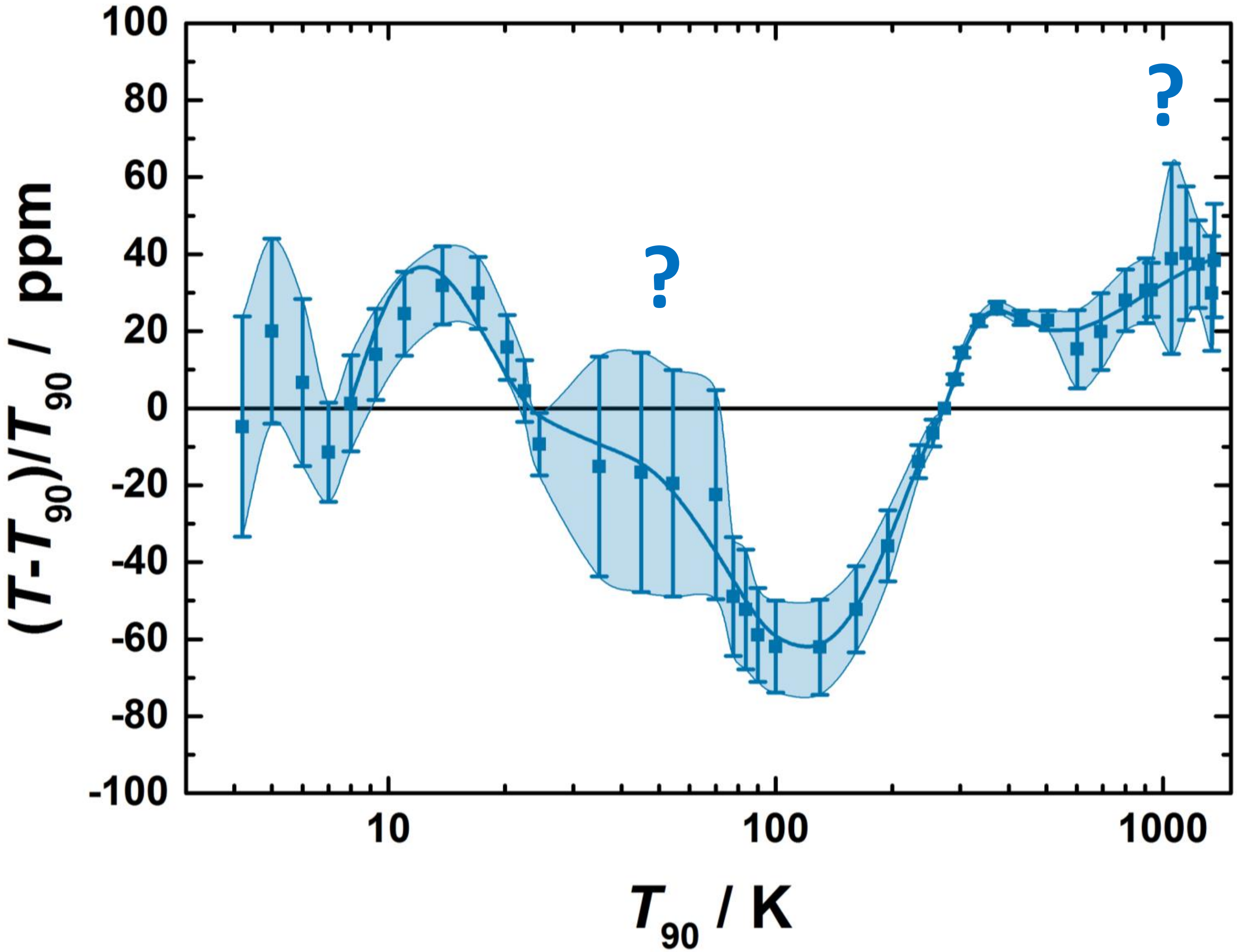
Present Estimates of the Differences Between Thermodynamic Temperatures and the ITS-90

J. Fischer · M. de Podesta · K. D. Hill · M. Moldover · L. Pitre · R. Rusby · P. Steur · O. Tamura · R. White · L. Wolber

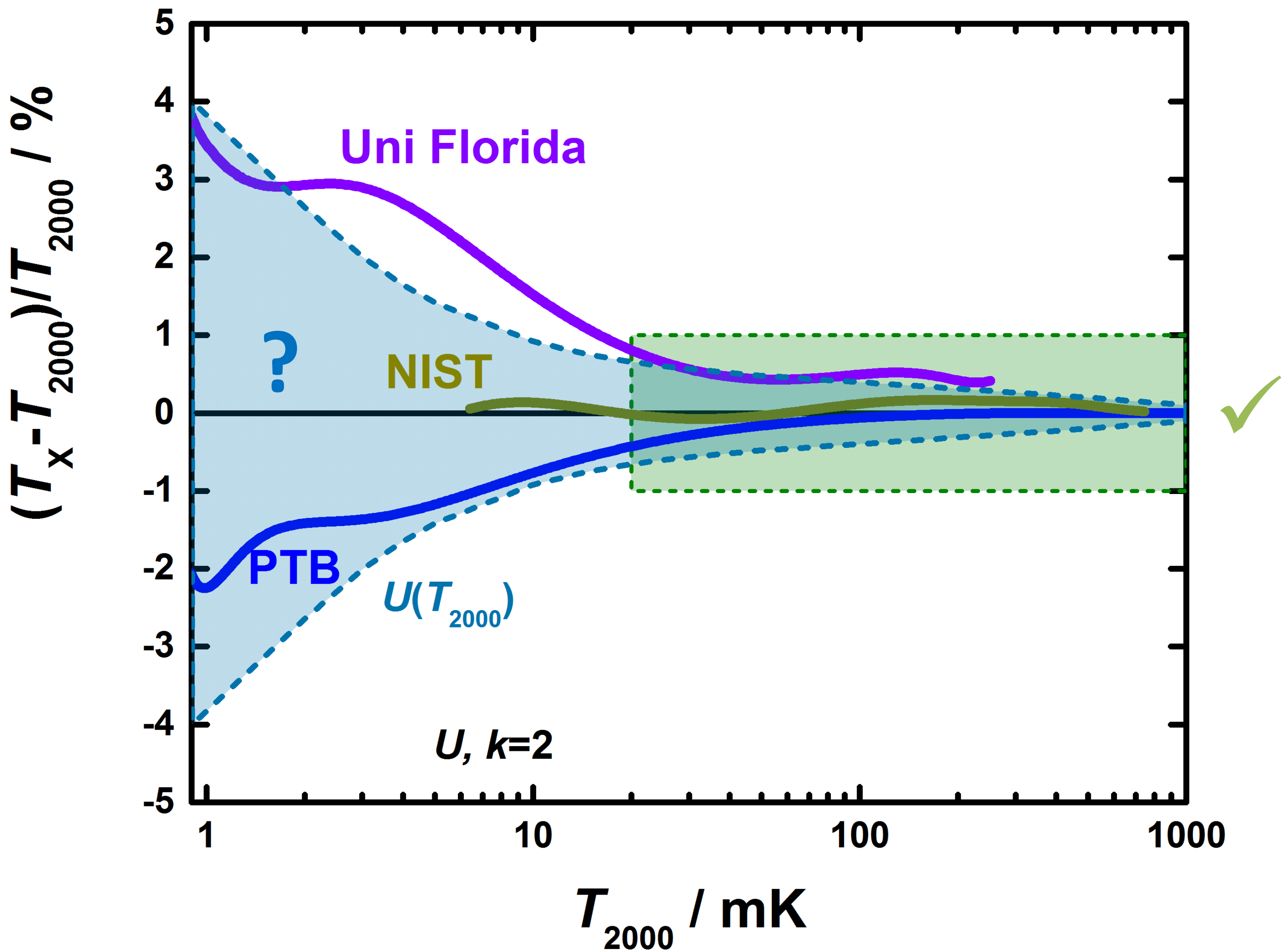
At CCT's request, WG4 critically reviewed all available measurements of $T - T_{90}$ and published report in 2011

Consensus estimates provided for $T - T_{90}$ for selected measurements from 4.2 K to 1358 K, as well as recommendation for **analytic** approximations to $T - T_{90}$ from 0.65 K to 1358 K

Uncertainty of consensus estimate $T - T_{90}$



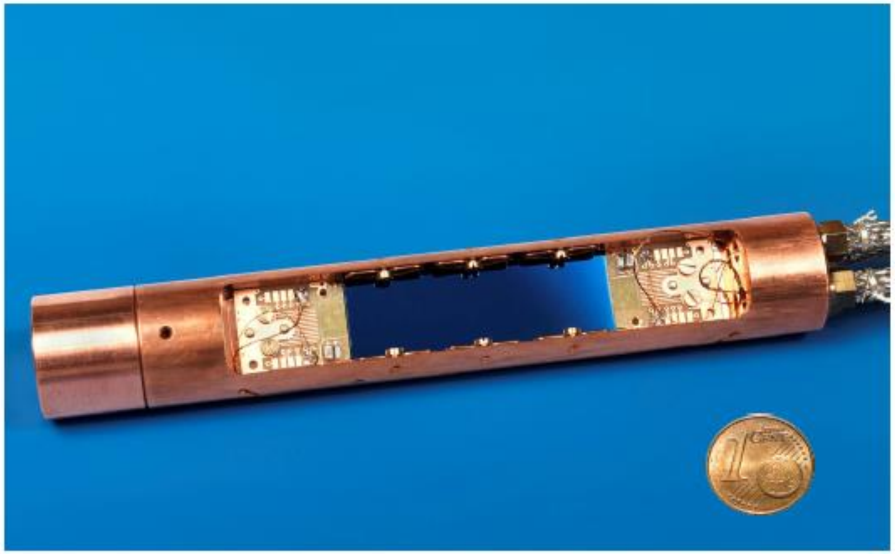
Uncertainty of $T - T_{2000}$



Superconducting QUantum Interference Devices (SQUIDs) with resolution near to the quantum limit

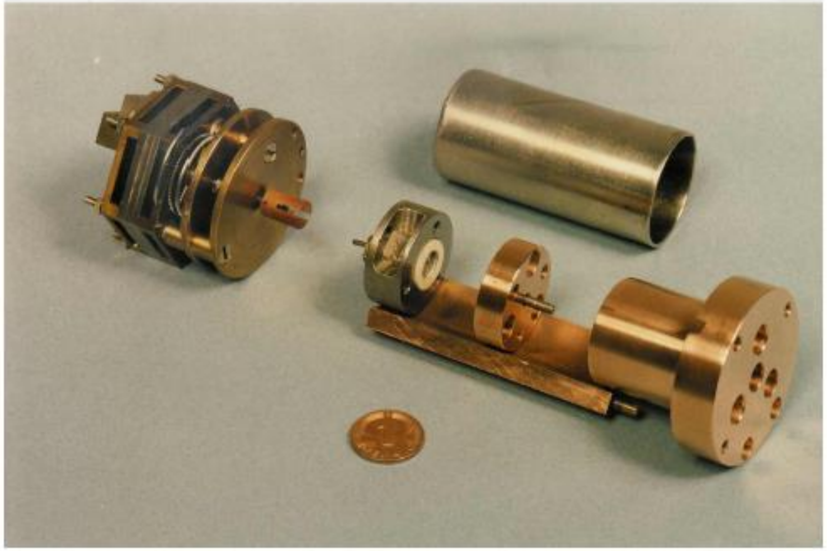
Noise Thermometers: New primary MFFT has replaced obsolete Josephson junction noise thermometer, which contributed to the PLTS-2000

2014



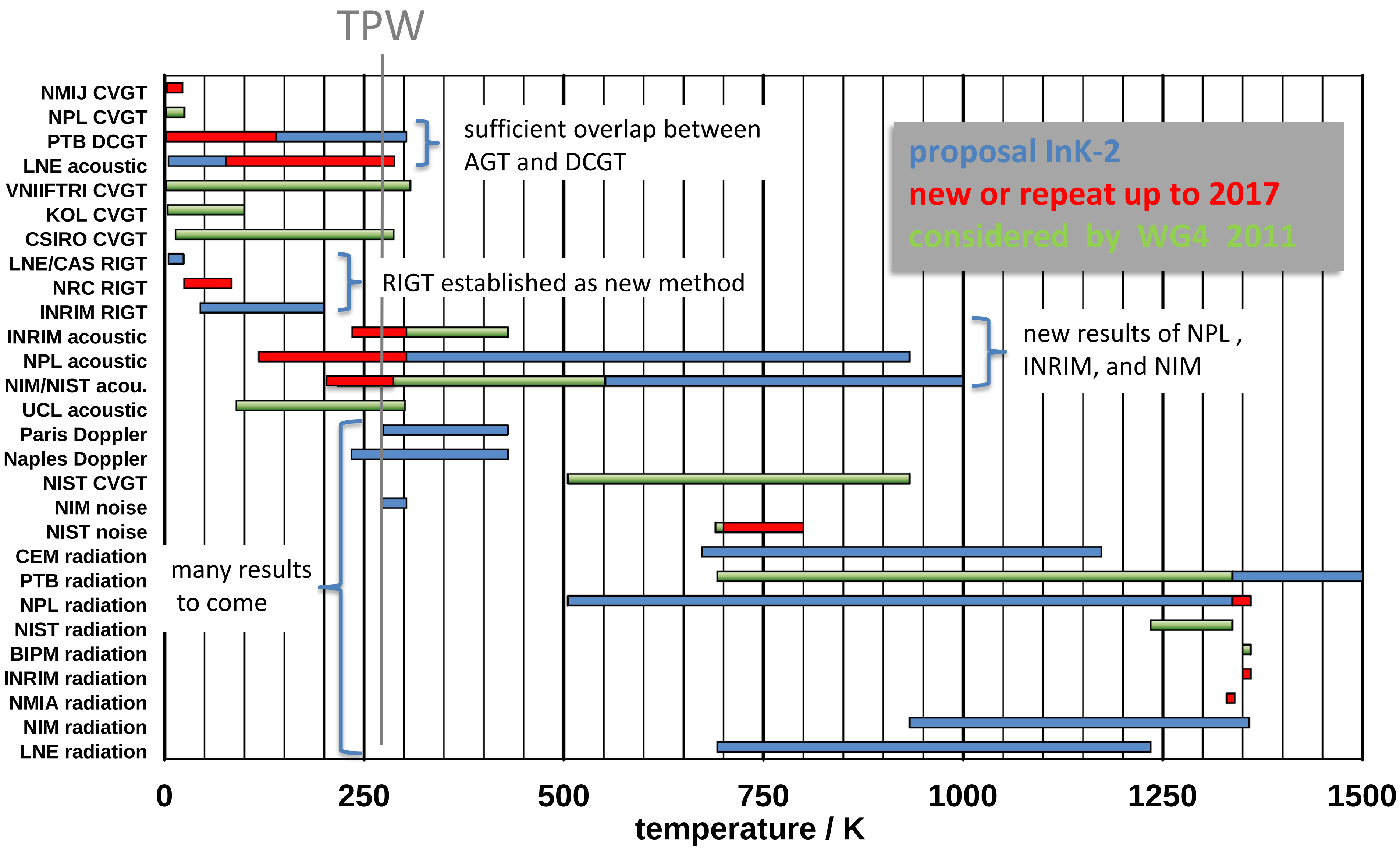
pMFFT with two thin-film dc SQUIDs for cross-correlation

1984

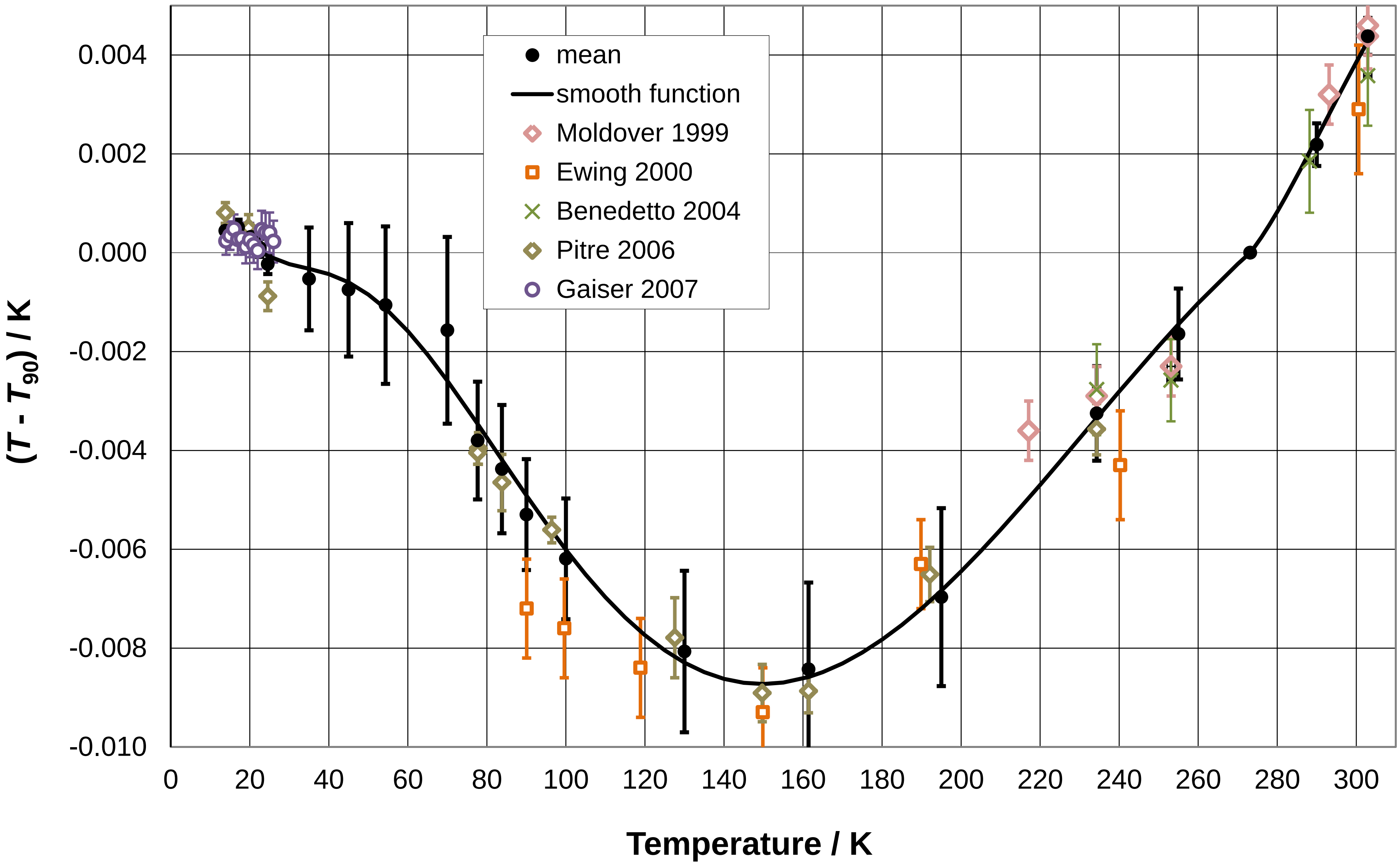


JNT with bulk rf R-SQUID and superconducting step motor to adjust the Josephson point contact

2017 state of T - T_{90} measurements



Comparison of recent results with 2011 estimate: what we know



New results to date

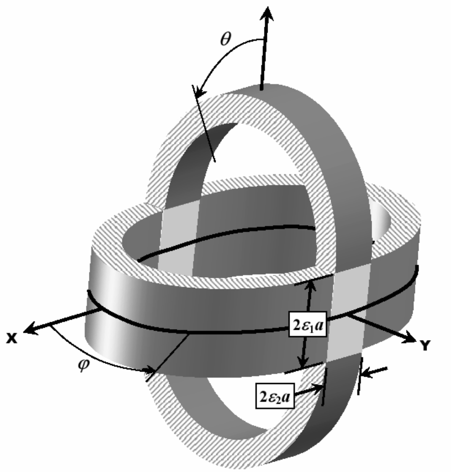
T. Nakano, O. Tamura, T. Shimazaki	REPRODUCIBILITY OF THE HELIUM-3 CONSTANT-VOLUME GAS THERMOMETRY AND NEW DATA DOWN TO 1.9 K AT NMIJ/AIST	Int. J. Thermophys. 38, 105 (2017)	CVGT	1.9 K – 24.5 K
P. M. C. Rourke	NRC MICROWAVE REFRACTIVE INDEX GAS THERMOMETRY IMPLEMEN-TATION BETWEEN 24.5 K AND 84 K	Int. J. Thermophys. 38, 107 (2017)	RIGT	24.5 K – 84 K
C. Gaiser, B. Fellmuth, N. Haft	DIELECTRIC-CONSTANT GAS THERMOMETRY WITH NEON AND HELIUM FROM 30 K TO 140 K	Metrologia 54, 141-147 (2017)	DCGT	30 K – 140 K
V. Kytin, G. Kytin, E. Aslanyan, S. Osadchiy, B. Potapov, A. Schipunov	VNIIFTRI ACOUSTIC GAS THERMOMETRY FOR TEMPERATURES FROM 5.2 K TO 273.16 K	*to be submitted to Metrologia*	AGT	162 K, 234 K
R. Underwood, M. de Podesta, G. Sutton, L. Stanger, R. Rusby, P. Harris, P. Morantz, G. Machin	FURTHER ESTIMATES OF $T - T_{90}$ CLOSE TO THE TRIPLE POINT OF WATER	Int. J. Thermophys. 38, 44 (2017)	AGT	118 K – 303 K
R. M. Gavioso, D. Madonna Ripa, P. P. M. Steur, R. Dematteis, F. Bertiglia, L. Pitre	ACOUSTIC DETERMINATIONS OF THE THERMODYNAMIC TEMPERATURE IN HELIUM BETWEEN 234 K AND 430 K	Metrologia 54, … (2017)	AGT	234 K - 430 K
J. Zhang, K. Zhang, X. Feng, H. Lin	CYLINDRICAL ACOUSTIC GAS THERMOMETER IN THE TEMPERATURES FROM 230 K TO 310 K	*to be submitted to Metrologia*	c-AGT	234 K – 303 K
L. Pitre, F. Sparasci, L. Risegari, C. Guianvarc'h, M. Plimmer	ACOUSTIC THERMOMETRY WITH A 3 LITRE COPPER QUASI-SPHERE FROM 220 K TO 303 K AT LNE-CNAM	*to be submitted to Metrologia*	AGT	220 K – 303 K

PTB

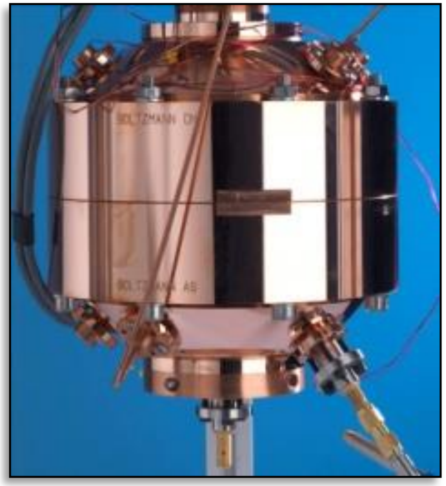
NRC-CNRC

NPL National Physical Laboratory

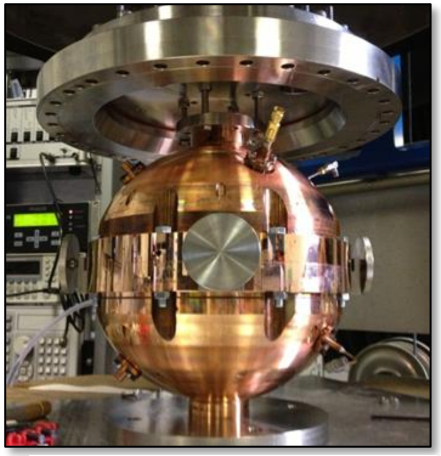
INRiM ISTITUTO NAZIONALE DI RICERCA METROLOGICA



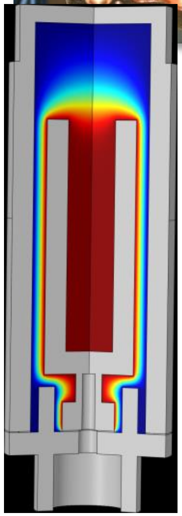
0.5-litre copper „race-track“ quasi-sphere, microwave-only twin of Pitre 2006, on loan from NIST



1-litre copper triaxial ellipsoid



misaligned 3-litre copper sphere



cylindrical capacitors with $u_r(\kappa_{\mathrm{eff}}) = 0.4\%$

$3\ \mathrm{K} < T < 300\ \mathrm{K}$

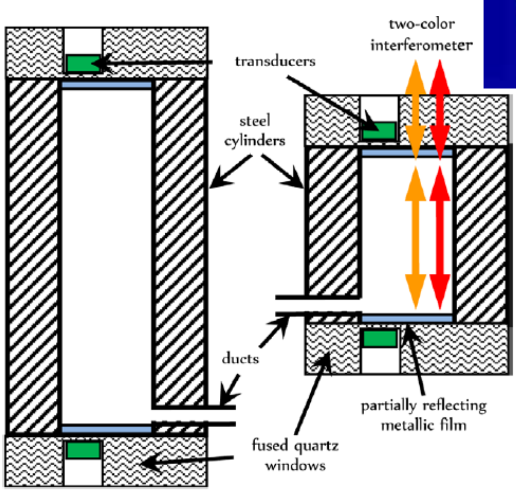


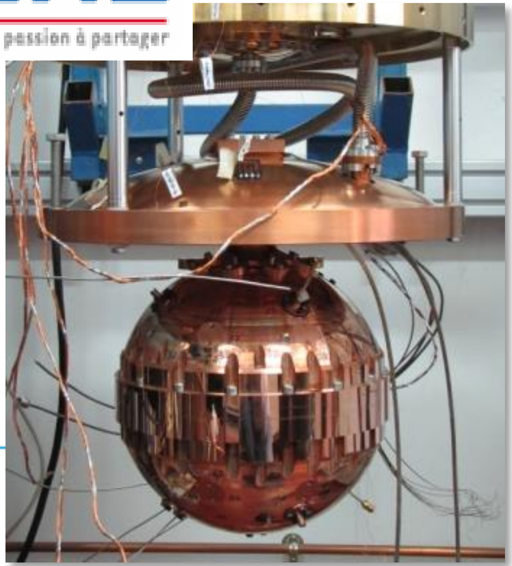
Figure 1. Schematic diagram of two resonators used to make a virtual resonator.

NIM

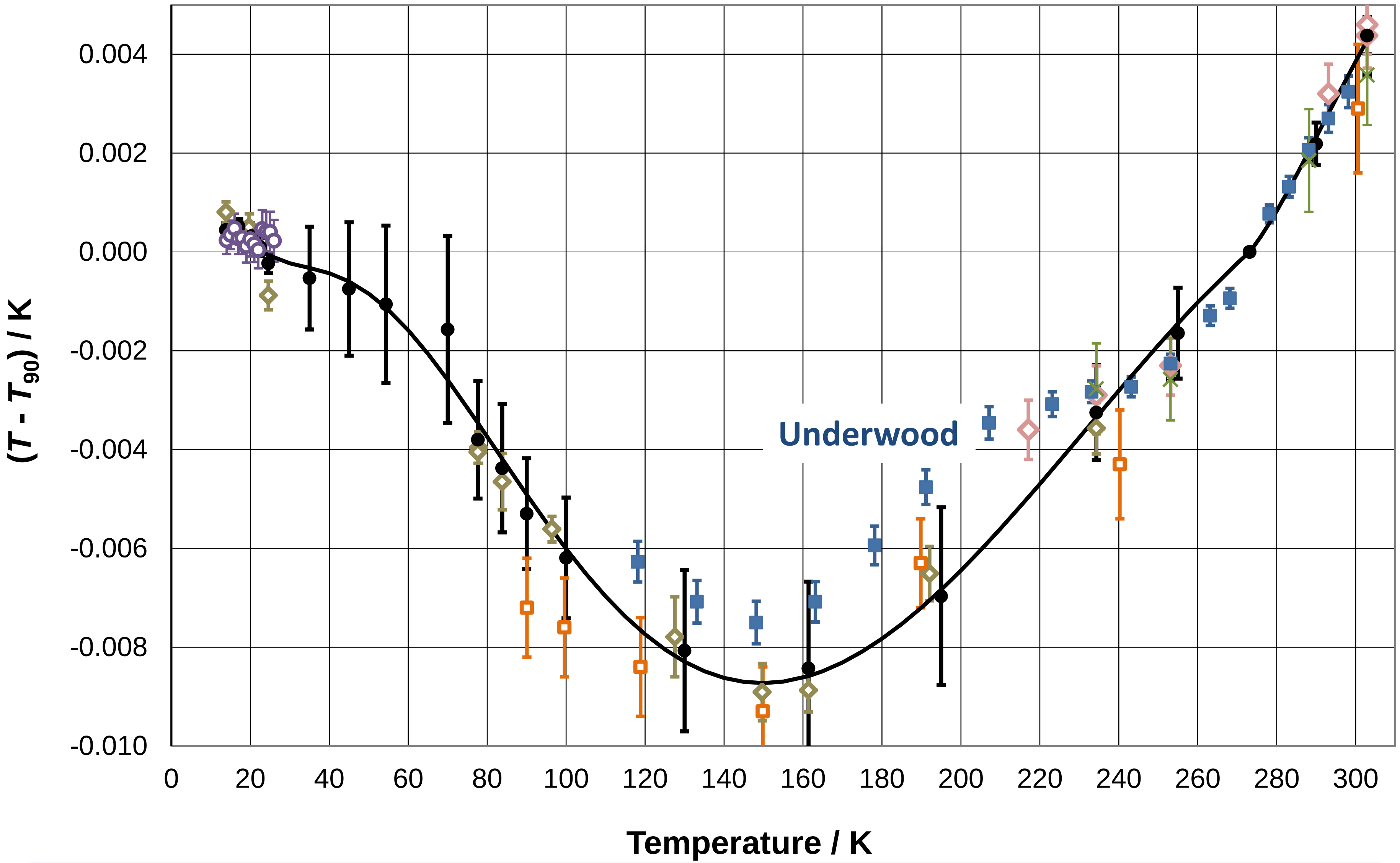
LNE Le progrès, une passion à partager

Cnam CONSERVATOIRE NATIONAL DES ARTS ET METIERS

3.1-litre copper triaxial ellipsoid



Comparison of recent results with 2011 estimate



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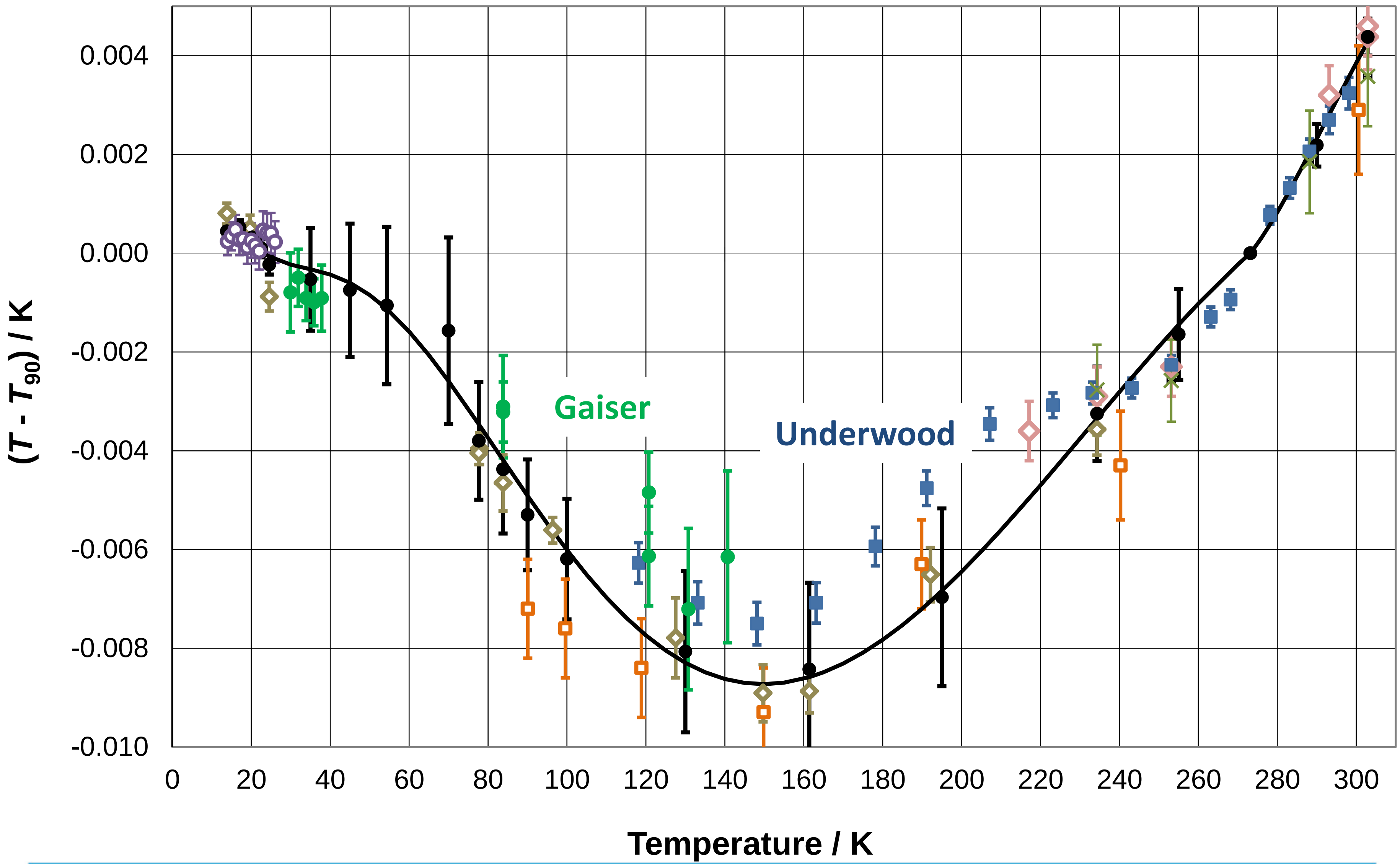
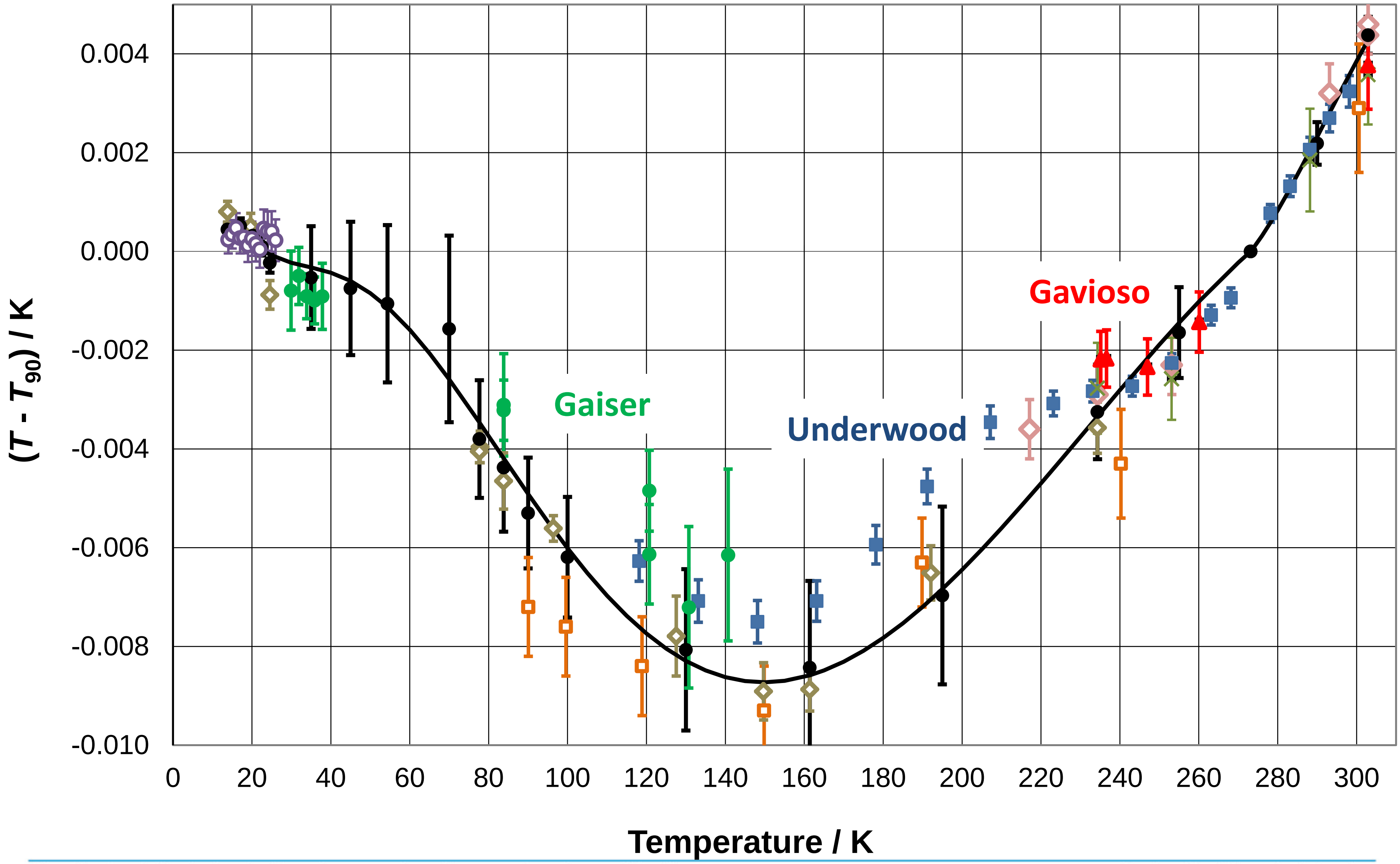
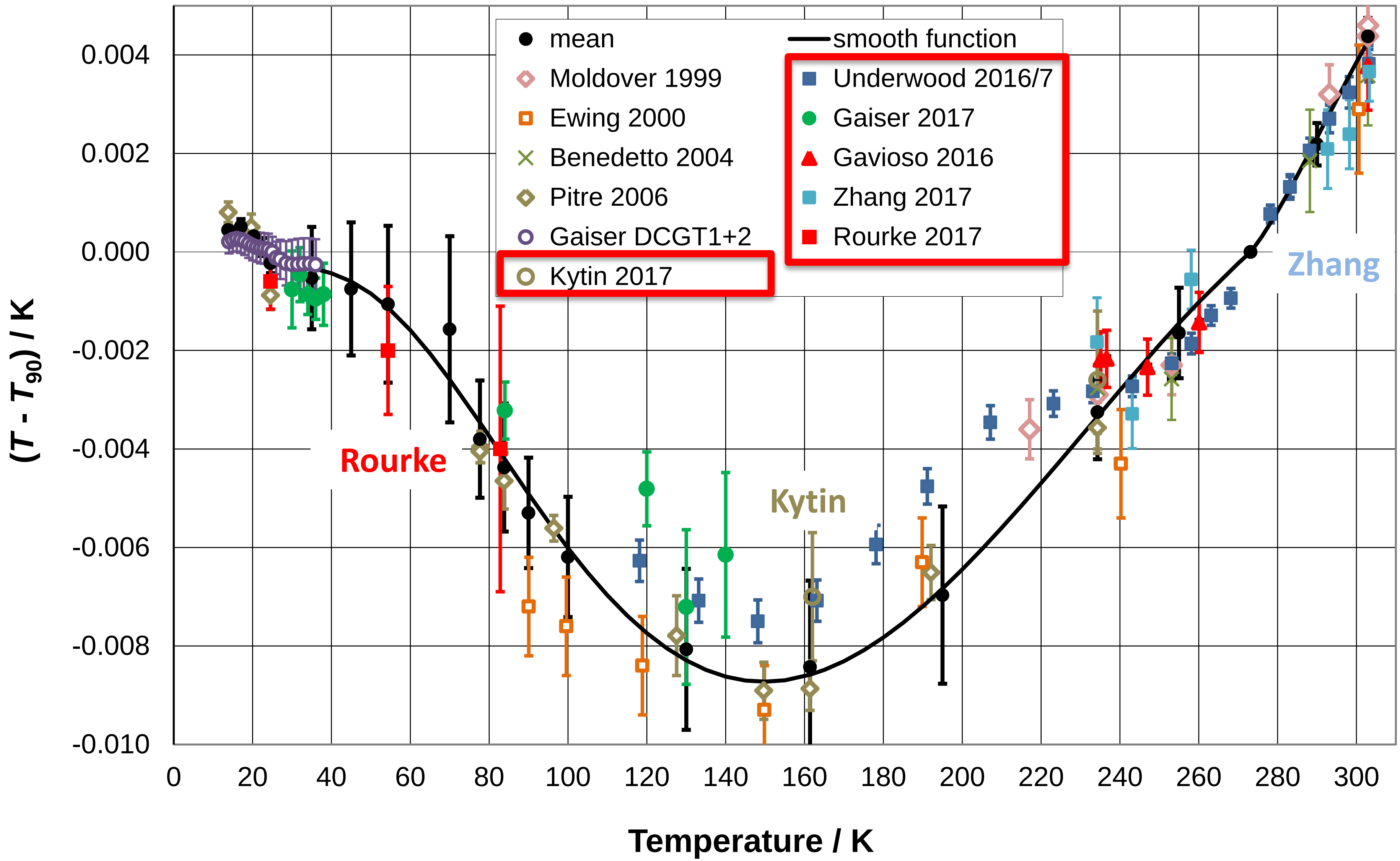


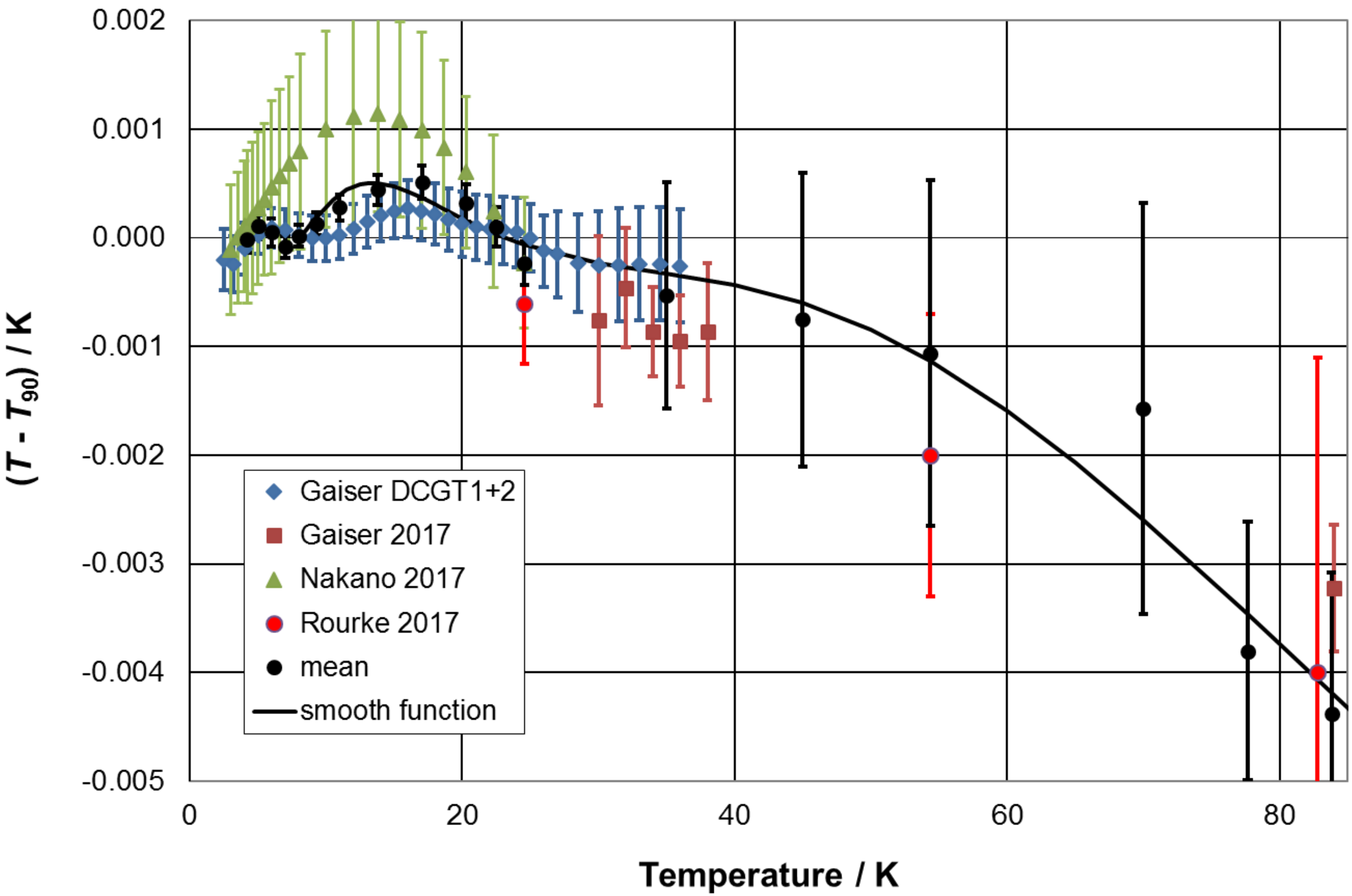
Comparison of recent results with 2011 estimate



Comparison of recent results with 2011 estimate



Comparison of recent results with 2011 estimate



Conclusions

Results of **NPL AGT** between **120 K and 220 K** and **PTB DCGT** between **120 K and 140 K** clearly above WG4 consensus estimate

Still paucity of data between **40 K and 77 K**

In contrast to consensus estimate new AGT results reveal **no change of slope at triple point of water**

For **spectral radiation thermometry** in the region **above 500 K** wait for InK-2 results; only Copper point recently determined