

CCT member and observer Activity Report

Period: June 2024 to April 2026

Institute: NMIJ/AIST

State economy: APMP

Number of persons involved in thermometry of the institute:

Short summary of research and development:

Contact thermometry

- Evaluation of $T-T_{90}$ between the melting point of Ga down to the triple point of Hg using acoustic thermometry [C6, C8].
- Development of low temperature thermometers and investigation of long term stability and non-uniqueness of SPRTs below TPW [C10, C13, C14].
- Evaluation of the temperature of the triple points of Xe, SF6 and CO2 as alternative candidates to the triple point of mercury for the fixed point of the ITS-90 [C10, C13, C14].
- Development of cryocooler for cryogenic thermometer calibration [C5].
- Construction and evaluation of gallium point cells [C9].
- Development of high temperature SPRT up to the freezing point of Ag [C7, C2].
- Development of metal-carbon eutectic fixed points for calibration of thermocouples [C1, C3, C4, C11].
- The stability of chip-size thermistors for miniature atomic clocks [C12].

Non-contact thermometry

- Research on the Optical frequency comb thermometry [R1].
- Research on terahertz spectroscopic thermometry [R2, R3, R4].
- Development of high emissivity microcavity type blackbody sheet and flat-plate reference radiator.
- Research for improving the reliability of non-contact body temperature measurement.

- Research on the radiometric temperature measurement by incoherent digital holography.
- Performance evaluation of high-temperature fixed points.
- Research on radiation thermometry.

Humidity

- Development of moisture analyzer based on laser spectroscopy [H1-H8].
- Improvement of primary high-humidity standard generator [H9].

Thermophysical quantities

- Development of measurement techniques for Thermophysical quantities [T1-T7].
- Supply of certified reference material (CRM) for thermophysical quantities [T8].

Short summary of recent comparison activity:

Contact thermometry

- Participating CCT-K1.1, APMP.T-K9, APMP.T-S16 [C1], APMP.T-K7.2021.1.

Non-contact thermometry

- Lead APMP T-S11 and T-S12.

Humidity

- Copilot APMP.T-K6.2013, APMP.T-S13, participating CCT-K8 [H10], CCT-K6.2021, APMP.T-S13.

Thermophysical quantities

- Lead APMP. T-S9 and CCT-S3 (Thermal Diffusivity).

Link to bibliography or list of bibliography (last 5 years):

[C1] F. Jahan, M. J. Ballico, Z. Wei, D. D. Shivagan, A. Achmadi, H. Ogura, Y. G. Kim, Y. Fan, E. Ejigu, O. Ongrai, "Final report on the APMP regional comparison of type R thermocouples calibration at Cu, Co-C and Pd fixed points, APMP.T-S16", Metrologia (2025) 62:03003.

- [C2] J. V. Widiatmo, M-K. Ho, I. Saito, "Study of Zinc Point based on Pilot Comparison between NMIJ and NMIA", presented at TEMPMEKO-ISHM 2025, France, 2025.
- [C3] H. Ogura, R. Ono, "Deviation Functions for Type R Thermocouples Calibrated Using Metal-Carbon Eutectic Points", presented at TEMPMEKO-ISHM 2025, France, 2025.
- [C4] R. Ono, H. Ogura, "Development of an Evaluation System for the Seebeck Coefficient of Thermocouples at High Temperatures", presented at TEMPMEKO-ISHM 2025, France, 2025.
- [C5] T. Shimazaki, H. Nakagawa, "Development of a heat exchanger with distributed Joule-Thomson effect for a closed-cycle cryocooler", presented at 2025 Cryogenic Engineering Conference (CEC) and International Cryogenic Materials Conference (ICMC), USA, 2025.
- [C6] J. V. Widiatmo, T. Misawa, I. Saito, T. Nakano, H. Ogura, Y. Kawamura, "Thermodynamic Temperature Measurements from the Melting Point of Gallium Down to the Triple Point of Mercury", *International Journal of Thermophysics* 45:105 (2024).
- [C7] M-K. Ho, J. V. Widiatmo, "Comparison of local realizations of Silver freezing-point temperatures between NMIA and NMIJ AIST", *Metrologia* 61:1A (2024).
- [C8] J. V. Widiatmo, T. Misawa, I. Saito, T. Nakano, Y. Kawamura, " $T-T_{90}$ measurements using acoustic gas thermometer up to gallium melting point in neon gas", *Temperature: Its Measurement and Control in Science and Industry*, Vol 9, AIP Conf. Proc. 3230, 030002 (2024).
- [C9] I. Saito, J. V. Widiatmo, H. Ogura, "Construction and evaluation of gallium point cells", *Temperature: Its Measurement and Control in Science and Industry*, Vol 9, AIP Conf. Proc. 3230, 050011 (2024).
- [C10] Y. Kawamura, N. Matsumoto, T. Nakano, "Investigation to replace the triple point of Hg in the ITS-90", *Temperature: Its Measurement and Control in Science and Industry*, Vol 9, AIP Conf. Proc. 3230, 060004 (2024).
- [C11] H. Ogura, I. Saito, "Evaluation of the Realization of Rh-C Eutectic Point for Thermocouple Calibration", *Temperature: Its Measurement and Control in Science and Industry*, Vol. 9, AIP Conf. Proc. 3230, 070003 (2024).
- [C12] I. Saito, H. Ogura, S. Yanagimachi, "The stability of chip-size thermistors for miniature atomic clocks", *Temperature: Its Measurement and Control in Science and Industry*, Vol. 9, AIP Conf. Proc. 3230, 130007 (2024).
- [C13] Y. Kawamura, T. Nakano, "Non-uniqueness and propagating uncertainties of the temperature scale

realized using the triple point of sulfur hexafluoride”, Measurement: Sensors 24 100464 (2022).

[C14] Y. Kawamura, T. Nakano, “Evaluation of the temperature scale of SPRT calibrated at the triple point of sulfur hexafluoride”, Measurement: Sensors 18 100211 (2021).

[R1] Y. Shimizu, S.Okubo and H. Inaba "Molecular gas thermometry using dual-comb spectroscopy: Rotational-state Distribution Thermometry: RDT", presented at TEMPMEKO-ISHM 2025, France, 2025.

[R2] S. Tachikawa, M. Kinoshita, and Y. Shimizu, "Non-contact temperature measurement through opaque containers using THz spectroscopy", presented at S-FTS 2024, Japan, 2024.

[R3] S. Tachikawa, M. Kinoshita, N. Ishiwata and Y. Shimizu, "Non-contact temperature sensing through non-transparent containers by THz spectroscopy", presented at IRMMWTHz 2025, Finland, 2025.

[R4] S. Tachikawa, N. Ishiwata, M. Kinoshita and Y. Shimizu, "Non-contact temperature and humidity sensing through opaque containers using THz spectroscopy", presented at TEMPMEKO-ISHM 2025, France, 2025.

[H1] Koji Hashiguchi, Minami Amano, Agata Cygan, Daniel Lisak, Roman Ciuryło, Hisashi Abe, “SI-traceable measurement of trace moisture in Ar gas using a primary standard: Comparison of H₂O absorption coefficients in Ar and N₂ gases near 7181 cm⁻¹”, J. Quant. Spectrosc. Radiat. Transf., 361 109982 (2026).

[H2] Norihiko Nishizawa, Shotaro Kitajima, Hideki Tomita, Hisashi Abe, "Spectral Peaked Optical Frequency Comb for Highly Sensitive Spectroscopy", Adv. Photonics Res., 2025, e202500022 (2025).

[H3] N. Nishizawa, S. Kitajima, H. Tomita, H. Abe, "Development of freely controllable optical frequency comb based on ultrashort pulse fiber laser for highly sensitive spectroscopy applications", Advanced Lasers, High-Power Lasers, and Applications, XVI, 5 (2025).

[H4] Hisashi ABE, Koji HASHIGUCHI, Minami AMANO, Agata CYGAN, Daniel LISAK, Roman CIURYŁO, "SI-Traceable Line Intensity of H₂O near 1.393 μm", Plasma and Fusion 20, 2401002 (2025).

[H5] Hisashi Abe, Shinichi Honda, Kenichi Itabashi, Masahiro Kawasaki, "A dew-point hygrometer based on tunable diode laser absorption spectroscopy", AIP Conf. Proc., 3230, 140006 (2024).

[H6] Minami Amano, Norihiko Nishizawa, Hideki Tomita, Hisashi Abe, "Development of a trace-moisture analyzer based on rapid-scan cavity ring-down spectroscopy", AIP Conf. Proc., 3230, 140005 (2024).

[H7] Koji Hashiguchi, Minami Amano, Agata Cygan, Daniel Lisak, Roman Ciuryło, Hisashi Abe, "Improvement of the cavity in CRDS for high-precision measurement of trace moisture", AIP Conf. Proc., 3230, 140004 (2024).

[H8] H. Abe, "Water measurement on the moon", AIP Conf. Proc., 3230, 140003 (2024).

- [H9] N. Ishiwata, H. Abe, "Uncertainty analysis of NMIJ high-humidity standard revisited", AIP Conf. Proc., 3230, 140002 (2024).
- [H10] J. G. Gallegos, H. Mitter, H. Abe, S. Bell, R. Benyon, P. Carroll, B. I. Choi, R. Deschermeier, V. Ebert, V. Fericola, L. Wang, C. Meyer, .D Smorgon, T. Vincent, "Final report to the CCT on key comparison CCT-K8 - comparison of local realisations of dew-point temperature of humid gas in the range 30 °C to 95 °C", Metrologia, 62, 03001 (2025).
- [T1] Y. Zhou, K. Hirao, M. Fukushima, H. Abe, M. Akoshima, T. Yagi, "Effect of graphite coating on measurement of thermal diffusivity of high-thermal-conductivity silicon nitride thin substrates by flash method", Ceramics International, doi: <https://doi.org/10.1016/j.ceramint.2026.05.066> (2026).
- [T2] M. Akoshima, "Proposal on how to use Reference Materials to Obtain more Reliable Thermal Diffusivity by Flash Method", presented at TEMPMEKO-ISHM 2025, France, 2025.
- [T3] M. Akoshima, S. Takahashi, Thermal aging effect on in-plane and cross-plane thermal diffusivities of plasma-sprayed thermal barrier coating, Int. J. Thermophys., 44, 54 (2023).
- [T4] M. Ryu, M. Akoshima, J. Morikawa, Probe-based microscale measurement setup for the thermal diffusivity of soft materials, Rev. Sci. Inst., 93, 044901 (2022).
- [T5] I. Orikasa, H. Watanabe, "High-Speed Shadowgraph Imaging for Measuring the Thermal Expansion of Niobium Under Pulsed-Current Heating Beyond 2000 K" Int. J. Thermophys. 46, 166 (2025).
- [T6] H. Watanabe, "Multi-stepwise pulse calorimetry for enthalpy and emissivity measurements on tantalum, considering gas–metal reactions at elevated temperatures", Thermochimica Acta 728, (2023).
- [T7] H. Arima, Y. Yamashita, T. Yagi, "Time-domain thermoreflectance technique using multiple delayed probe pulses for high-throughput data acquisition and analysis", Sci. Technol. Adv. Mater. 26, 2523240 (2025).
- [T8] <https://unit.aist.go.jp/nmij/english/refmate/>