

NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)



National Metrology Institute of Japan



Greetings from the Director General

USUDA Takashi

Director General of NMIJ Executive Officer of AIST

Measurement standards play a vital role in society by guaranteeing the reliability of acts of measurement, and the results of such acts, which make up the infrastructure of daily life, industry, research, and much more. The National Metrology Institute of Japan (NMIJ), which is the national metrology institute (NMI) in Japan, was established in 2001 as a part of the National Institute of Advanced Industrial Science and Technology (AIST) to integrate all former national research institutes and related offices. Since then, NMIJ has actively engaged in the establishment and dissemination of internationally equivalent measurement standards to society.

With the support and understanding of the stakeholders and industries, calibration services that are traceable to the NMIJ have become widespread under the Japan Calibration Service System (JCSS). Additionally, we were heavily involved in the determination of the Planck constant for the kilogram, which was one of the base units of the International System of Units (SI) redefined in May 2019. The NMIJ has contributed to the development of the international measurement standards and has also carried out other fundamental, essential research efforts that will be vital to the next generation of metrology and measurement standards.

However, as the state of the industrial world has grown more challenging, the demand for ever more precise measurements has grown beyond all initial expectations. As a result, the need for ever more precise measurement standards, as well as fast and simple calibration services, has blossomed as well. We even see this in our daily domestic lives, where there are ongoing requirements to improve the reliability of commercial transactions involving new types of consumption, such as subscription services and the digital economy.

With these points in mind, the NMIJ will continue to work earnestly on the development and dissemination of the measurement standards that meet both the demands of industry and the trends in our modern consumer society. At the same time, we will continue our work on the development of measurements and analysis technologies required by modern industry and endeavor to ensure the reliability of measurements used in commercial transactions in legal metrology.

AIST entered its 5-year-midterm period on April 1, 2020. AIST has been pioneering solutions to social issues and developing innovations that contribute to strengthening economic growth and industrial competitiveness. Looking ahead, AIST is focusing on the following three themes:

- Enhancing research and development that lead to innovations aimed at solving societal issues
- Strengthening innovation ecosystems through the expansion of "bridging" functions
- Developing the infrastructure underpinning innovation ecosystems

The NMIJ will continue to work on research and development in collaboration with other AIST research departments and external organizations to contribute to solving these societal issues.

Accordingly, we would like to ask for your continued understanding, support, and cooperation as we look ahead to the future.



Activities Related to Measurement Standards and Legal Metrology

The NMIJ, in collaboration with other NMIs, is working on the smooth supply, dissemination, and enlightenment of measurement standards, the quality control of supply services, the training of certified measurers, and the execution of legal metrology services. To facilitate those efforts, we actively support numerous activities, including those listed below.

Technical Seminars, Publications, and Personnel Training for Metrology

Technical Seminar and Publications

The NMIJ organizes a variety of activities such as seminars, lectures, symposium, NMIJ measurement club and presents displays at exhibitions, to

promote the utilization of the measurement standards and to enlighten on the need for metrological traceability. In addition, NMIJ disseminates the outcome of the activities related to metrology and measurement technologies via website and brochures.



Exhibition display

Personnel Training for Metrology

While the primary mission of our Metrology Training Center is to train applicants for the national qualification of certified measurer, it also provides

various training activities to support metrology-related personnel employed by prefectural and city governments, as well as engineers in private companies. These opportunities include general measurement training, special measurement training, environmental measurement special training, and short-term measurement training.



General measurement training

International Activities



In the current era of economic globalization, measuring instruments, calibration certificates, and the results of type approval tests in legal metrology have become mutually recognized by many countries as part of efforts to remove barriers to international trade. These mutual recognitions are based on the premise that international equivalences in national measurement standards and testing capabilities must be mutually confirmed and approved among the participating countries. To make this system function more effectively, the NMIJ is actively engaged in building cooperative relationships with international organizations and other NMIs, and conducting international comparisons. We are also actively holding international conferences and workshops, hosting overseas researchers, and supporting developing countries by providing trainings.

The Emerging Scientist Workshop 2017, which was joined by young researchers from NMIJ, KRISS (Korea), and NIM (China)

Dissemination of the Measurement Standards

Calibration and Testing Services

The results of our research and development efforts for measurement standards are disseminated to society through calibration and testing services. We also conduct calibration of reference standards and testing services for customers at our calibration laboratories. These services are conducted under a management system based on ISO/IEC 17025, thus ensuring their reliability and international equivalence.

Distribution of the Certified Reference Materials

The NMIJ produces and distributes Certified Reference Materials (NMIJ CRMs), which are produced by the NMIJ's management system to comply with ISO 17034 and ISO/IEC 17025. The CRMs are intended to facilitate the calibration of analytical instruments and for use in the evaluation of analytical methods.

NMIJ Certified Reference Materials

 **ISO/IEC 17025
 General requirements for the competence of testing and calibration laboratories

 **ISO 17034
 General requirements for the competence of reference material producers







 Radiated, radio-frequency, electromagnetic field immunity tests

 Test equipment for high-capacity load cells In Japan, non-automatic weighing instruments (NAWI), automatic weighing instruments (AWI), water meters, taximeters, and other measuring instruments that contribute significantly to the reliability of transactions and certifications are stipulated in the Measurement Act as specified measuring instruments, and type approval for such instruments is required. The NMIJ is responsible for issuing type approval for most of the specified measuring instruments and the inspection of verification standards. As a member of the International Organization of Legal Metrology (OIML) Certification System (CS), the NMIJ is also responsible for maintaining a testing laboratory as well as serving as an issuing authority in the instrument categories on R 60 (load cells) and R 76 (non-automatic weighing instrument) in Scheme A. OIML certificates issued in other countries may be accepted based on the mutual recognition arrangements made under OIML-CS.

Developing, Maintaining, Disseminating, and Promoting Utilization of Measurement Standards

The NMIJ develops next-generation measurement standards based on the redefinition of the SI units, develops and maintains measurement standards that meet industrial and social needs, and reliably disseminates established measurement standards. Furthermore, the NMIJ pursues a sophisticated measurement traceability system to promote the utilization of measurement standards in the areas mentioned below.

Time

The SI unit of time, the second, is defined by taking the fixed numerical value of the caesium frequency $\Delta \nu_{cs}$ to be 9 192 631 770 when in the unit Hz, which is equal to s-We are now in the process of develo ed in the optica attices, as part of efforts to achieve much lower uncertainty than the Optical lattice clock present definitio

Mass

The SI unit of mass, the kilogram, is defined by the Planck constant, which is a fundamenta physical constant associated with the mass o one atom. We have already succeeded developing the technology to accurate ount the atoms in a silicon sphere, which necessary to create a mass standard wit the highest level of accuracy in the world

Thermodynamic temperature

The SI unit of ther the triple point of water, has been redefined by taking the fixed numerical value of the Boltzmann constant k to be 1.380 649 \times 10⁻²³ when expressed in the unit J K⁻¹. We are now in the process of develop /stem that will make therr urements applicable

Luminous intensity

The SI unit of luminous intensity, the candela, is defined by taking the fixed numerical value of the luminous efficacy of monochromatic adiation of frequency 540 \times 10¹² Hz, K₋, to be 683 when expressed in the unit Im W-1. The luminous efficacy represents the sity is a quantity that lescribes light intensity emitted to a specific direction, and its scale is

Derived quantities

The NMIJ is maintaining and disseminating the measurement standards for derived quantities, such as flow rate (m³/h), torque (N·m), density (kg/m³), pressure (Pa), electric field strength V/m), absorbed dose (Gy), and so on, which are essential for daily life and use in industrie



Length he SI unit of length, the metre, is

fined by the speed of light in vacuum. The length standards are eloped and disseminated based on equencies calibrated by an ency comb with an accuracy of 10⁻¹³. The optical frequency comb links the optical frequencies to the microwave ency standard

Electric current

The SI unit of electric current, the ampere, is defined by taking a fixed umerical value of the elementary harge, which is the magnitude of the ectric charge for one electron. We are h the Josephson Voltage Standard and th

Amount of substance

he SI unit of amount of substanc he mole, is defined by the Avogadr nstant. We are now developing anced technologies, such as nuclear hat can measure amount of substance kly and accuratel



Support for Manufacturing and Services

The NMIJ is developing measurement technologies that are indispensable for ensuring the reliability of IoT, next-generation communication infrastructures that support high-quality product manufacturing, and emerging trends in various manufacturing industries such as automobiles.

Millimeter and Terahertz Waves Measurement Technology

We are working on technological developments in the fields power measurement, attenuation measurement, circuit testing, and material characterizations in the millimeter and terahertz wavebands – all of which are expected to have important applications in various fields such as next-generation



Speed of sound and relative

The speed of sound and the relative permittivity of a novel refrigerant with low global warming potential are simultaneously measured to evaluate its performance in the thermodynamic cycle.



• Transition of Units and Standards

1940

 Sanction of the international prototypes of the metre and the kilogram (1889)
 Revision of the International Temperature Scale (1948) Japan becomes a member state of the "Metre Convention (Convention du Mètre)" (1885) Definition of thermodynamic temperature by the triple point of water (1954)

 Development of Weston voltage standard cell (1892) Promulgation of the Weights and Measures Act (1891)





The national prototype of the metre of Japan

kilogram of Japan



Support for Biological, Medical, and Agricultural Industries

The NMIJ is developing medical radiation evaluation technology that supports improvements to medical equipment, quantitative evaluation and functional analysis technology that enables the expansion of the use of biological components, and food-related measurement technology that will become indispensable for our future safe living environments.



Promulgation of the Electrical Measurement Act (1910) Enforcement of the Measurement Act (1952)





Krypton amp

Josephson voltage standard device

odine stabilized He-Ne lase



Optical frequency comb

1 kg silicon single-crystal sphere to

Development of Advanced Measurement and Evaluation Technology

The NMIJ is aiming at the realization of advanced measurement and evaluation technologies that will lead to the creation of new value for objects that are difficult to measure by extending existing technologies. These include quantum measurements, ultra-trace measurements, and extreme state measurements.

Overall view of AIST Tsukuba Central

AIST Tsukuba Central 3-1 Building

AIST Tsukuba Central 3-9 Building

Organization





[Director General] USUDA Takashi



[Deputy Director General] HOSAKA Kazumoto

Research Planning Office of NMIJ

The Research Planning Office (RPO) decides on research policies and strategies, and then creates research projects and their budgets. The RPO also serves as a liaison with other AIST research departments, the Ministry of Economy, Tade and Industry (METI),

other national research and development agencies, universities, and other related organizations.



[Director, Research Planning Office] AMEMIYA Kuniaki

Collaboration Promotion Office of NMIJ

The Collaboration Promotion Office (CPO) plans and promotes collaboration with external organizations such as companies, regarding research activities of the NMIJ. The CPO also promotes and supports technology transfers to companies, as well as conducts research

and development activities on a Cooperative Research Laboratory.



[Director, Collaboration Promotion Office] SHITOMI Hiroshi

Research Institute for Engineering Measurement

Development of measurement technologies and national standards contributing to manufacturing industries URL : https://unit.aist.go.jp/riem/en/intro/

Among our missions is the development of measurement technologies and measurement standards such as dimension, mass, mechanics, flow, and their related quantities, which are indispensable for creating high-quality products in the manufacturing industries. These efforts include work aimed at solving social issues such as technological developments and standardization to facilitate the advancement and expansion of hydrogen infrastructure, along with promoting technological developments for extending infrastructure lifespans. In the realization of mass based on new SI unit definitions, we will cooperate with countries around the world to promote the spread of the new kilogram. In addition, we will actively promote the development of next-generation measurement standards, such as microforce technology, and also continue contributing to industrial standardization, conformity assessment, and accreditation efforts. Another mission in our institute is to conduct type approval and inspection of verification standards in legal metrology, which help to protect consumers in commercial transactions.

Length Standards Group Dimensional Standards Group Mass Standards Group Force and Torque Standards Group Pressure and Vacuum Standards Group Acoustics, Ultrasound and Vibration Standards Research Group Liquid Flow Standards Group Gas Flow Standards Group Research Group on Data Science for Metrology Type Approval Group Testing and Inspection Group Legal Weighing Metrology Group Legal Flow Metrology Group Dynamic Mechanical Measurement Research Group



[Director] OTA Akihiro

Research Institute for Physical Measurement

Measurement standards and measurement technologies in the fields of electricity, time and frequency, temperature, and optical radiation – all of which support industrial infrastructure URL : https://unit.aist.go.jp/ripm/en/

The Research Institute for Physical Measurement (RIPM) is responsible for the development and dissemination of national measurement standards in the fields of electricity, time and frequency, temperature, and optical radiation – all of which underpin the industrial competitiveness, product reliability, and safety in our daily lives. To that end, the RIPM is engaged in cutting-edge research and development (R&D) for measurement standards such as optical lattice clocks towards the redefinition of the second, and quantum current standards using single-electron pump devices for quantum metrology triangle experiments. The RIPM also develops measurement technologies for promoting industrial innovations, such as the generation and application of optical frequency combs, single-photon detection/imaging, material characterization and sensing technologies using electromagnetic waves, and precise electric measurements for thermoelectric devices.

Time Standards Group Optical Frequency Measurement Group Quantum Electrical Standards Group Applied Electrical Standards Group Radio-Frequency Standards Group Electromagnetic Measurement Group Electromagnetic Fields Standards Group Thermometry Research Group Optical Thermometry Group Photometry and Radiometry Research Group Applied Optical Measurement Group Quantum Sensor Measurement Research Group



[Director] NAKANO Tohru



Pressure calibration system for high-pressure gas



of a silicon wafer



Balances (inspection of verification standards)



measurement system

LED-based standard source



measurement system

Center for Quality Management of Metrology

Dissemination of measurement standards that ensure the quality of metrological traceability

URL : https://unit.aist.go.jp/nmij/english/info/center/

The Center for Quality Management of Metrology (CQMM), which is responsible for administrative support tasks in NMIJ, has an important role of promoting the results of activities related to metrology and measurement to our society while ensuring the proper dissemination of measurement standards. The CQMM performs public relations and consulting related to measurement standards and legal metrology in collaboration with international organizations such as NMIs and other international legal metrology organizations. The CQMM also provides administrative support for issues pertaining to calibration, testing, and verification services, distributes certified reference materials, and cooperates with central and local governments both to ensure the integrity of the national legal metrology system and provide training related to metrology and measurement.



[Director] TAKETOSHI Naoyuki

NMIJ Public Relations Office NMIJ International Cooperation Office Metrology Metrology Quality Office Reference Materials Office Legal Metrology Management Office Metrology Training Center Metrology DX Promotion Office

Research Institute for Material and Chemical Measurement

Establishment of dependable measurement infrastructure via material and chemical metrology

URL : https://unit.aist.go.jp/mcml/en/intro/

The Research Institute for Material and Chemical Measurement develops and disseminates certified reference materials that support the basics of chemical analysis, and conducts research and development on measurement, analysis and evaluation technologies for chemical industries. Typical certified reference materials include pH standard solutions and elemental standard solutions, which support the basis of chemical analysis; biological or composition-based reference materials, which are indispensable to ensure safety of our life and foods; and reference materials for advanced materials used in the development and production of high-quality industrial products. In addition, comprehensive databases with stated reliability, which are useful in the field of materials, metrology and evaluation technologies, are provided and further improvement of the databases is being pursued.

Inorganic Standards Group Reference Material Evaluation Group Gas and Humidity Standards Group Organic Analytical Standards Group Organic Primary Standards Group Bio-medical Standards Group Nanodimensional Standards Group Particle Measurement Research Group Thermophysical Property Standards Group Advanced thermal analysis research group



INAGAKI Kazumi

Research Institute for Measurement and Analytical Instrumentation

Measurement standards and advanced measurement technologies supporting industrial analysis and inspection URL : https://unit.aist.go.jp/rima/en/

Our mission is to develop and disseminate national measurement standards for ionizing radiation, acoustics, and vibration, which are supplied to users in healthcare and a wide range of industries. National measurement standards for ionizing radiation and radioactivity have been disseminated for radiation therapy facilities and radiation protection, while advanced standardized neutron technologies are under development for novel boron-neutron capture therapy (BNCT). In addition, the improvement of acoustic and vibration standards has been carried out for environmental evaluations and infrastructural diagnoses. We are also engaged in research and development aimed at advanced measurement methods and instruments, such as a positron annihilation lifetime technique for advanced material science. Furthermore, non-destructive diagnostic techniques involving X-ray imaging as well as optical phase analysis methods are currently being intensively investigated to address industry needs. These research results are disseminated to analytical and testing industries, thus ensuring that our institute contributes to making society safer and more prosperous.

Ionizing Radiation Standards Group Radioactivity and Neutron Standards Group Advanced Beam Measurement Group Radiation Imaging Measurement Group Non-destructive Measurement Group Applied Nanoscopic Measurement Group Nanomaterial measurement research group



[Director] GONDA Satoshi



Ultra-high sensitive trace-moisture measurement in gas



aser transient absorption spectroscopy



Standard gases



Acoustic anechoic room



High dose rate gamma-ray irradiation system



appulatus



Map of AIST Tsukuba Central



Inquires to: NMIJ Public Relations Office, Center for Quality Management of Metrology, National Metrology Institute of Japan (NMIJ), National Institute of Advanced Industrial Science and Technology (AIST) AIST Tsukuba Central 3, 1-1-1 Umezono, Tsukuba, Ibaraki 305-8563, Japan TEL +81-29-861-4346 FAX +81-29-861-4099 URL: https://unit.aist.go.jp/nmij/english/info/inquiry/



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