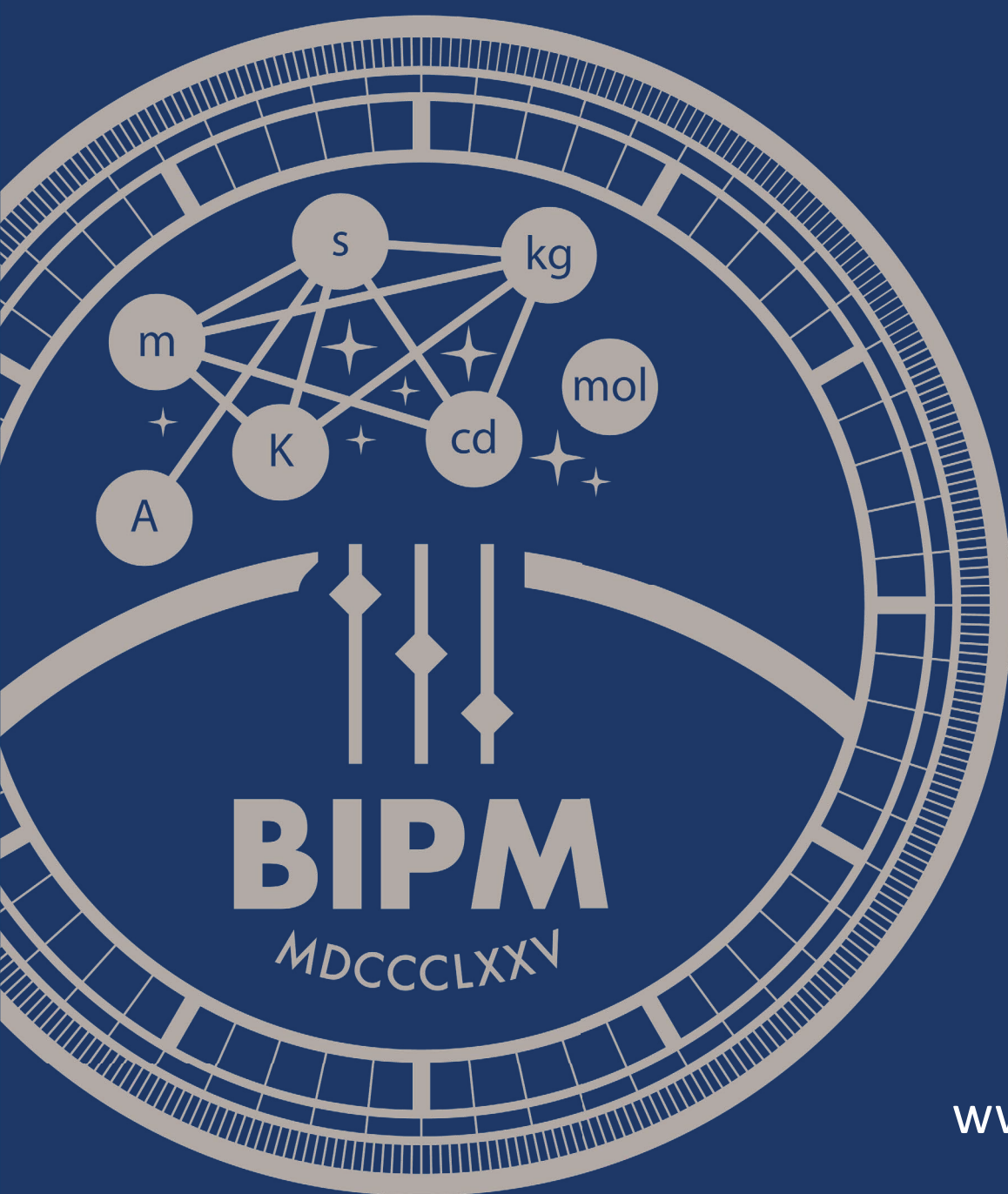


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Annual Review 2025



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The BIPM

The BIPM is an intergovernmental organization established by the Metre Convention, through which Member States act together on matters related to measurement science and measurement standards.

THE VISION AND MISSION OF THE BIPM

Its **vision** is to be universally recognized as the world focus for the international system of measurement.

Its **mission** is to work with the NMIs of its Member States, the RMOs and strategic partners world-wide and to use its international and impartial status to promote and advance the global comparability of measurements for:

- Scientific discovery and innovation,
- Industrial manufacturing and international trade,
- Improving the quality of life and sustaining the global environment.

THE OBJECTIVES OF THE BIPM

- To represent the world-wide measurement community, aiming to maximize its uptake and impact.
- To be a centre for scientific and technical collaboration between Member States, providing capabilities for international measurement comparisons on a shared-cost basis.
- To be the coordinator of the world-wide measurement system, ensuring it gives comparable and internationally accepted measurement results.

Fulfilling the BIPM mission and objectives is complemented by its work in:

- Capacity building, which aims to achieve a global balance between the metrology capabilities in Member States,
- Knowledge transfer, which ensures that the work of the BIPM has the greatest impact.

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Introduction

Marking the 150th anniversary of the Metre Convention, 2025 was a special year in the very proud history of the BIPM. Celebrations were held across the world to celebrate the milestone by taking a fresh look at what has been accomplished during those 150 years and by looking ahead to the challenges that lie in front of us. Highlights of the events hosted by the BIPM and UNESCO are given in a special section of this report.

Many other important achievements can also be counted in 2025. A notable highlight was the publication of the results of the third key comparison of kilogram realizations since the redefinition in 2019. It showed a significant improvement in agreement and paved the way forward to full implementation of the new definition.

The year also saw the transition to a new value for the ozone absorption cross section, improving the accuracy and comparability of measurements of this important atmospheric constituent. In June, following several months of operational testing, the BIPM began the routine production of an upgraded Rapid UTC, bringing its agreement with UTC to within a few nanoseconds and further strengthening confidence in the international interoperability of timing-dependent technologies.

The last day of the year also marked the departure of Dr Martin Milton as Director of the BIPM. During his tenure from 2013 to 2025 he had a profound impact on the Organization, building a high level of trust with Member States and establishing the BIPM as an institution recognized both for the excellence of its services and for the soundness of its financial management.

Under his leadership, the BIPM oversaw the historic redefinition of the International System of Units (SI), replacing artifact-based definitions with definitions based on fundamental constants of nature and establishing a new foundation for global measurement science. He strengthened collaboration with National Metrology Institutes and international organizations, established capacity-building activities to become a key enabler of comparability of measurements worldwide.

Dr Milton championed the role of metrology in addressing global challenges and the corresponding importance of universal adherence to the Metre

Convention. He also led the digital transformation of the BIPM, promoting the development of innovative services such as the SI Reference Point and other digital infrastructures to improve access to authoritative metrological information. Through these initiatives, he enhanced the relevance, reach, and impact of the BIPM.

As I take up the reins in 2026, I do so with gratitude to Martin and all those who have gone before him, appreciation for a dedicated and highly productive team in Sèvres (whose achievements are evident throughout this report), and a commitment to continue hold ourselves to the highest standards in service to our Members.



Photo credit BIPM

Dr Martin Milton on the occasion of his retirement with a specially commissioned plate from the Manufacture nationale de Sèvres

Dr Annette Koo
BIPM Director

Mass

The BIPM's mass laboratory supports the mise en pratique of the kilogram by coordinating CCM key comparisons of primary realizations held by NMIs. The laboratory also supports the dissemination of the kilogram by providing calibrations of mass standards to NMIs that have no access to a primary realization.

The mass metrology community made a huge step toward full implementation of the new definition of the kilogram this year. This was because the results of the third key comparison of kilogram realizations showed that the two institutes with the smallest uncertainties, whose earlier results had been discrepant, agreed within their expanded uncertainties [1].

Since 2021, the Consultative Committee for Mass and Related Quantities (CCM) has used a "consensus value" to disseminate the kilogram until sufficient agreement is achieved between independent realization methods, notably Kibble balances and the X-ray crystal density (XRCD) method. Two key comparisons, CCM.M-K8.2019 and CCM.M-K8.2021, established the first two consensus values.

The third comparison in the series, CCM.M-K8.2024, was launched in 2024 and involved six institutes operating Kibble balances (BIPM, LNE, METAS, NIST, NRC and UME), one institute using a Joule balance (NIM), and three institutes using the XRCD method (CMS/ITRI, NMII and PTB). Participants calibrated one or two 1 kg standards and submitted them to the BIPM for comparison against BIPM reference standards under equivalent environmental conditions. Calibration uncertainties ranged from 12 μg to 57 μg and the weighted mean of the participants' results differed by -0.0107 mg from the kilogram traceable to the IPK maintained by the BIPM.

Application of the CCM rules resulted in a third consensus value differing by $-5\text{ }\mu\text{g}$ from the second consensus value and by $-12\text{ }\mu\text{g}$ relative to the historical IPK-based kilogram. The third consensus value entered into force on 1 March 2026.

New quantum gravimeter measurement supports kilogram realization at the BIPM

In March 2025, a new absolute gravity measurement was carried out using an AQG-B01 quantum gravimeter in the Kibble balance laboratory at the BIPM. The result confirms the gravity value currently used in kilogram realization work and strengthens the gravimetry link with the LNE gravity reference station in Trappes — reinforcing the BIPM's site as a stable and reliable reference location.

This updated value contributed to the laboratory's result in the CCM.M-K8.2024 key comparison of kilogram realizations, coordinated by the BIPM.

The measurement was conducted in partnership with LNE-OP and PGravi in cooperation with Action Spécifique Gravimétrie Epos-France, as part of a continuing effort to maintain a precisely characterized reference environment for high-accuracy mass metrology.

Prototypes and standards

During 2025, the BIPM calibrated five platinum-iridium prototypes and eighteen stainless steel standards for thirteen National Metrology Institutes (NMIs), and performed four

centre-of-gravity measurements. Traceability was maintained through the second CCM consensus value introduced in 2023. The calibration uncertainty remained dominated by the 20 μg uncertainty associated with the consensus value.

BIPM Kibble balance

The BIPM Kibble balance underwent continued maintenance and refinement to support realization of the kilogram and participation in CCM key comparisons. In the CCM.M-K8.2024 key comparison, the BIPM achieved a standard uncertainty of 36 μg for a 1 kg platinum-iridium standard, an improvement from 41 μg in the previous comparison, primarily through improved vertical alignment of the interferometer laser. The largest remaining uncertainty contribution came from parasitic coil rotation during the dynamic phase. Simulation studies were also initiated to model balance operation and analyse measurement noise, confirming the suitability of the current data analysis methods. In parallel, development continued on a compact Kibble balance for masses of 1 kg and below. The new design combines the static and dynamic phases into a single mechanism to simplify operation and reduce alignment-related uncertainties. Progress included the design of the suspension system, optical sensors and interferometer, as well as testing of commercial time interval analysers for signal detection.

Sharing practical expertise: 2025 Kibble Balance Technical Meeting

The 2025 Kibble Balance Technical Meeting was held at the BIPM headquarters from 18 to 20 November, bringing together the international Kibble balance community to review technical progress, discuss emerging applications and strengthen knowledge transfer across the field of precision metrology.

The meeting attracted around 60 in-person participants, with a further 20 attendees joining on-line for the dedicated knowledge transfer programme. Delegates represented NMIs and university research groups working on high-precision mass measurement and related technologies.

The strong participation highlighted the continuing strategic importance of the Kibble balance in global metrology, both for realizing and maintaining the SI kilogram and for supporting new measurement capabilities in science and industry.

Across the first two days, presentations and technical discussions focused on key areas of current development, including NMI-level Kibble balances for kilogram realization, participation in the CCM.M-K8 key comparison of realization experiments, compact table-top systems for smaller mass ranges, and advances in mass, force and torque measurements for industrial applications.

A major addition to the 2025 programme was the introduction of a dedicated Knowledge Transfer Session. Six invited specialists delivered structured overviews of core Kibble balance technologies, providing practical guidance for NMIs and research groups developing new programmes or expanding existing capabilities.

The session covered foundational and advanced topics, including system design considerations, magnetic circuits, electrical metrology, mechanics and alignment, optical sensing, data synchronization, and the treatment of mass and gravity measurements.

Electricity

The BIPM's electricity laboratories support the comparison programme of the CCEM to demonstrate the capabilities of the NMIs and for knowledge transfer by scientists conducting on-site comparisons using dedicated travelling quantum standards. The laboratories also support NMIs that have no access to quantum standards by providing calibrations for electrical quantities and by knowledge transfer.

Voltage

In voltage metrology, the first two key comparisons of Josephson AC voltage standards under the new BIPM.EM-K10 protocol [2] were successfully completed with PTB and CENAM (see right). Additional studies continued in collaboration with NIST on leakage-current effects and sampler performance.

The BIPM also continued its programme of Zener voltage standard comparisons and calibrations. Reports on comparisons with SMD (Belgium), BEV (Austria) and EMI (United Arab Emirates) were published [4-6], and a further comparison with FTMC (Lithuania) was under way. Eight Zener voltage standards were calibrated for five NMIs during 2025.

Impedance

In impedance metrology, activities focused on calibration services, comparison programmes and modernization of measurement systems. Development progressed on a new 1 Hz bridge for on-site quantum Hall resistance (QHR) comparisons, including assembly and initial testing of a dual current source. Work also continued with the LNE on finite-element simulations of calculable capacitor alignment defects to support realization of the farad with uncertainties below 1×10^{-8} .

Fabrication of new transfer capacitance standards for the BIPM multifrequency quadrature bridge also began, based on surface-mount ceramic capacitors. Experimental studies examined thermal treatment and stabilization methods to optimize capacitance stability.

The BIPM received four graphene-based QHR samples from the PTB, two of which are dedicated to AC measurements. Due to time constraints in 2025, they could not be fully characterized, but the variation in their sheet resistance was monitored to track the potential evolution of their carrier density over time. Currently, these samples are stored using the method described by Shetty et al. [7] in a hermetically sealed container including moisture and oxygen absorbers.

The BIPM participated in and piloted the inner loop of the EURAMET.EM-K4 capacitance comparison and carried out two on-site QHR comparisons with PTB and CEM (Spain). **For the first time, graphene-based QHR devices were used alongside traditional gallium arsenide devices.** Results demonstrated equivalent performance while allowing operation under less demanding experimental conditions for graphene devices [8].

To maintain traceability for resistance and capacitance services, the BIPM realized the ohm and farad twice during 2025 using the quantum Hall effect and a multifrequency quadrature bridge. In total, 77 impedance calibrations were provided to 16 NMIs, including 54 resistance and 23 capacitance calibrations. In addition, the comparison reports for BIPM.EM-K13 and BIPM.EM-K14 with UME

TÜBITAK (Türkiye) and CENAM (Mexico) were completed and published in the KCDB [10 and 11].

First successful key comparison of Josephson voltage standards for AC voltage completed

A major milestone has been reached in electrical metrology with the successful completion of the first key comparison of Josephson voltage standards for AC voltage, carried out between the BIPM and the PTB (Germany).

The comparison, completed in 2025, covered AC voltage amplitudes of 0.75 V and 7 V across a frequency range from 62.5 Hz to 1.25 kHz, demonstrating agreement between the two systems at the level of a few tens of nanovolts per volt. Excellent agreement between the quantum voltage standards was achieved, reaching a few parts in 10^8 for AC measurements [3] and as low as a few parts in 10^{11} for DC measurements.



Photo by Krystal Kenney for the BIPM

Preparing the BIPM measurement setup used for the key comparison of Josephson standards for AC voltage

This comparison represents an important step in extending the international measurement infrastructure for electrical quantities, supporting traceability and equivalence for AC voltage at the highest level. It strengthens confidence that AC voltage measurements realized in different countries are consistent, comparable and anchored to the same quantum-defined reference.

The comparison was carried out using a stable AC voltage source as a transfer standard, which was alternatively measured by the PTB and BIPM AC quantum voltage standards. The AC quantum voltage standards generated a stepwise-approximated sinewave of the same frequency and the same nominal root-mean-square value as the transfer standard. The small voltage differences between the transfer standard and the AC quantum voltmeters were measured with a synchronized sampler. The measured voltage differences together with the predictable quantized voltages allowed the determination of the root-mean-square value of the signal from the transfer standard.

The results confirm the robustness and maturity of quantum-based AC voltage measurements.

Ionizing Radiation

The aim of the Ionizing Radiation Department's work is to maintain and develop services for comparing primary measurement standards for radiation dosimetry and the measurement of radioactivity. These centralized international services enable metrology institutes to demonstrate the accuracy of their primary standards easily and efficiently. Calibration services are also available for radiation dosimetry.

In 2025, the BIPM Ionizing Radiation Department continued to support the safe and effective use of ionizing radiation in healthcare, industry and environmental monitoring through its international metrology services, research and strategic development activities. The Department maintained its central role in radiation dosimetry and radionuclide metrology by providing bilateral comparisons and calibration services to Member States and partner institutes worldwide. A major achievement was the launch of the new BIPM.RI(II)-K5 comparison service based on the extension of the International Reference System (ESIR), with initial measurements carried out for Tc-99 and Pm-147. The Department also finalized its long-term metrology strategy following broad international consultation, in close coordination with the revision of the CCRI 2030+ strategy and supported through numerous international workshops and webinars.

Service activity remained high throughout the year. The Department conducted seven dosimetry comparisons for institutes in Italy, the United Kingdom, the Republic of Korea and Hungary, together with seventeen calibrations for institutes in Slovakia, Indonesia, Spain, Sweden, Czechia and Argentina, as well as two calibrations for the International Atomic Energy Agency (IAEA). These calibrations are particularly important for extending BIPM traceability to institutes outside the CIPM Mutual Recognition Arrangement (CIPM MRA). Several activities were carried out off-site, including comparisons using the DOSEO linear accelerator facility in Saclay (France) and the IAEA ^{137}Cs irradiation facility (see the box on the next page). Six dosimetry comparison reports were also published in the *Metrologia* Technical Supplement [12-17].

x-ray reference facilities

Significant progress was made in the modernization of the Department's x-ray reference facilities. The characterization of the new medium-energy x-ray facility was completed through the establishment of reference values for air kerma and absorbed dose to water. Validation measurements demonstrated agreement with the existing reference facility within standard uncertainties, ensuring continuity of BIPM calibration services. In parallel, refurbishment of the low-energy x-ray facility began with the design of a new calibration bench and testing of a new high-voltage x-ray generator, activities that will continue into 2026.

International collaboration and knowledge transfer

International collaboration and knowledge transfer remained central to the Department's activities. Staff continued to contribute actively to the work of the IAEA, the International Committee for Radionuclide Metrology (ICRM), the CCRI and regional metrology organizations through committee participation, technical meetings and workshops. The Department co-organized webinars and workshops on topics

Selective Sampling: bringing a proven technique into the digital era

A pioneering radioactivity measurement method has been brought into the 21st century through a joint project between the BIPM and the National Institute of Metrology (NIM), China.

Together, the institutes have modernized Selective Sampling, a technique first developed at the BIPM in the 1980s to improve the accuracy of activity measurements of beta-emitting radionuclides.



A secondee working on Digital Selective Sampling at the BIPM headquarters.

Selective sampling is a primary standardization technique for radionuclide activity measurements that provides an alternative to conventional coincidence counting. Revived through modern digital acquisition systems, it eliminates several complex corrections, improves robustness and uncertainty evaluation, and can now be implemented using commercially available instrumentation. This renewed technique offers National Metrology Institutes a reliable and accessible complementary primary standard, strengthening global measurement capabilities for radionuclides used in medicine, environmental monitoring, and industry.

The BIPM's $4\pi\beta(\text{LS})-\gamma$ detection system has been the central platform for applying this method. The upgrade replaces cumbersome analogue procedures with a streamlined digital system, using a high-speed CAEN digitizer and in-house software [24].

By simplifying the architecture, improving background correction, and making the system easier to operate, the project opens the door for more NMIs to benefit from a method that was once too complex to adopt.

including mass spectrometry in radionuclide metrology, high-energy neutron beams, brachytherapy standards, proton and hadron therapy, and medical applications of radiation. A special event marking 65 years of ionization metrology at the BIPM highlighted historical achievements and future strategic directions for the field.

The International Reference System

The International Reference System (SIR), which underpins international comparisons of national activity standards for gamma-ray-emitting radionuclides, supported measurements for nine radionuclides in 2025: ^{99}Mo , ^{134}Cs , ^{152}Eu , ^{161}Tb , ^{175}Yb , ^{177}Lu , ^{212}Pb and ^{225}Ac . During the year, an investigation identified a small effect related to the angular positioning of source holders in the SIR. Studies showed that the impact on historical measurements was negligible in most cases, although further investigation is required for very-low-energy emitters and very-high-energy beta emitters.

SIR 2.0

Major advances were also achieved for the future SIR 2.0 system. Mathematical modelling methods developed in collaboration with NPL (United Kingdom) enabled the transfer of key comparison reference values between ionization chambers without the need to measure samples of every radionuclide. The transition from ^{226}Ra to $^{166\text{m}}\text{Ho}$ reference sources was initiated, achieving repeatabilities between 1.5×10^{-4} and 2.3×10^{-4} . In parallel, developments using an ultra-low-noise current amplifier (ULCA) and a new “back-to-back” ionization chamber configuration demonstrated the potential to perform measurements at activity levels approximately ten times lower than those achievable with the current SIR.

SIRTI

The International Reference System Transfer Instrument (SIRTI), which enables comparisons of short-lived radionuclides directly at national laboratories, continued to expand its capabilities. In 2025, a hybrid remote/on-site comparison for ^{18}F was successfully conducted at NIM (China). Further developments included the implementation of a digital electronic acquisition system using a CAEN module and technical exchanges with NIM, NMII and EURAMET to support regional SIRTI implementation and knowledge transfer.

ESIR

The ESIR programme also progressed significantly. The addition of a chemistry specialist increased the Department's capacity for preparing liquid scintillation sources and supported studies to optimize scintillation cocktails for different radionuclides. A PhD project launched jointly with LNE-LNHB (France) focused on corrections for impurities in ESIR measurements and on improving the understanding of ballistic dependence in triple-to-double coincidence ratio (TDCR) measurements using surrogate optical models [20].

Digital transformation

In 2025, the Ionizing Radiation Department continued to advance the digital transformation of radionuclide metrology, modernizing legacy techniques. The growing use of algorithms and software solutions for processing data from digital acquisition systems has led to the development of a Radionuclide Metrology Algorithm Comparison Platform [21]. Reference list-mode digital datasets were generated using Geant4 Monte-Carlo simulations and published [22]. Complementing these advances, the scintiPulses Python package, a versatile tool for simulating scintillation detector pulse signals has been developed [23].

CCRI workshop: Past and future of ionizing radiation metrology

Ionizing radiation metrology celebrated several milestones in 2025: the 65th anniversary of the BIPM's Ionizing Radiation Department and the 130th anniversary of Wilhelm Röntgen's discovery of x-rays. To reflect on these achievements and look ahead to future priorities, experts from around the world gathered at the BIPM headquarters on 6 November for a dedicated Consultative Committee for Ionizing Radiation (CCRI) workshop.

More than 200 specialists joined the event, with 55 participants on-site and 152 attending on-line, highlighting global interest in the evolving roles of ionizing radiation metrology in medicine, environmental monitoring, public protection and emerging technologies.



Sessions at the workshop traced the development of ionizing radiation metrology from Marie Curie's creation of the first international radium standard, which laid the foundations for today's international standards. Speakers outlined the growth of global structures that support consistent radiation measurements, including the ICRU (defining the ionizing radiation units), CCRI, the BIPM Ionizing Radiation Department, ICRM and the world-wide SSDL network, with tributes to pioneering figures who shaped the field.

The workshop covered present and future demands in medical diagnostics, radiotherapy and environmental monitoring, including updated dosimetry protocols, new reference materials and improved testing capabilities. Fusion research also featured, particularly work on tritium and plasma diagnostics, alongside emerging approaches that combine advanced detection systems with AI-supported modelling to improve traceability in medicine, nuclear science and industry.

Chemistry

The aim of the BIPM Chemistry Department's work is to maintain and develop services for comparing chemical and biochemical standards and reference measurement capabilities as part of the global inter-laboratory comparisons coordinated through the CCQM, in addition to developing related knowledge transfer projects for Member States and Associates with emerging metrology systems, and promoting the development and use of SI traceable standards and measurements internationally.

The Department progressed with 13 inter-laboratory comparisons in 2025, focused on NMI capabilities for primary reference material and calibrator value assignment in small organics, peptides and proteins, binary gas mixtures, and light element isotope ratios. There were 61 NMI participations in the five comparisons coordinated by the BIPM that included measurements in this period. Capacity building activities expanded through a new e-learning module on instrumentation for gas standard analysis, while the visiting scientist programme hosted eleven scientists during the year. Department staff produced fourteen publications, including eight comparison reports and five peer-reviewed papers.

The Department hosted meetings of the Consultative Committee for Amount of Substance: Metrology in Chemistry and Biology (CCQM) working groups, the Joint Committee for Traceability in Laboratory Medicine (JCTLM), and a JCTLM stakeholder workshop on "Result harmonization in medical laboratories: accomplishments and challenges". The report of the 2024 CIPM Sectoral Task Group on Climate and Environment (CIPM-STG-CENV) stakeholder meeting was also published.

Gas metrology

Programmes on gas sensing, reactive gases and isotope ratios progressed substantially. In CO₂ gas metrology, the final report for the first participant in comparison BIPM.QM-K2.a/b was published [49] and measurements completed for a second participant. Absolute measurements were completed on two ensembles of nine CO₂-in-air standards maintained at the BIPM. A high-precision CO₂ gas comparison database was developed in collaboration with the University of Colorado and the National Oceanic and Atmospheric Administration (NOAA), and new least-squares regression algorithms accounting for correlations were implemented with VSL (Netherlands) for the future BIPM.QM-P5 comparison. Draft reports advanced for CCQM-K82.2023 on methane-in-air standards and CCQM-P239 on isotope ratios in CO₂-in-air mixtures. A paper introducing new definitions and formats for $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ isotope ratio scales was published [50]. New stable isotope reference gas generation and automated carbonate-acid reaction systems were completed, with reproducibility better than 0.01 ‰ demonstrated for $\delta^{13}\text{C}$ measurements.

Reactive gas comparison activities focused on ozone and nitrogen dioxide (NO₂). Two bilateral comparisons and a study note were completed for BIPM.QM-K1 ozone standards, resulting in four published reports [51-54]. The Department continued to support the CCQM Working Group on Gas Analysis (CCQM-GAWG) Task Group for Ozone Cross-Section in implementing updated ozone cross-sections worldwide

The BIPM leads the global transition to more accurate ground-level ozone measurements

Accurate ozone measurements are crucial for tracking air quality, assessing environmental health and informing policies aimed at mitigating pollution and protecting public health.

Surface ozone monitoring networks worldwide began transitioning to a new ozone absorption cross-section value for ground-level ozone measurements, starting in January 2025. This update marks a critical step forward in improving the accuracy and comparability of ozone data around the world, and **the BIPM is playing a key role in supporting this initiative.**

Ground-level ozone is measured using ultraviolet (UV) photometry, which quantifies ozone concentration based on its absorption of UV light at a wavelength of 253.65 nm. The updated cross-section value, CCQM.O3.2019, has been validated through extensive international research and reflects the latest advances in metrology.

This change reduces uncertainties in ozone measurement, ensuring that data collected by environmental agencies, research institutions and policymakers is more accurate and comparable.

The new cross section has been adopted for the international comparison of primary ozone photometers (BIPM.QM-K1) and is being used in the calibration services offered by NMIs for standard instruments operating in the range 0 nmol/mol to 1000 nmol/mol of ozone in air. The change has been coordinated with standardization organizations with implementation of the new cross section value in relevant normative standards including ISO 13964 and ISO 10313.

Guidance is being provided to ozone calibration laboratories, surface monitoring networks and instrument manufacturers, on how to implement the cross-section change, including the need for recalibration of instruments and meta-data provision.

– Guidance Document: [How to Implement the New Absorption Cross-Section for Ozone Concentration Measurements](#)

– Meta Data: [Change in the Value of the UV Ozone Absorption Cross Section Recommendations for Metadata Provision](#)

For NO₂, the comparison protocol for BIPM.QM-K6 at 10 µmol/mol was finalized and distributed, while stability measurements and software upgrades extended operational and analytical capability over the range 50 nmol/mol to 10 µmol/mol. A CBKT secondment sponsored by NPL (UK) supported work on ISO 6143-compliant gas standard analysis and development of an autosampler system, which was released as an e-learning module.

Primary calibrators for small organics

Within the programme on primary calibrators for small organics, final reports for comparisons CCQM-K148.b and CCQM-K179 on oxytetracycline hydrochloride and salt purity were published [42-43]. Work on mycotoxins progressed with characterization of ochratoxin A (OTA) material for comparison CCQM-K154.e, distribution of training samples to Capacity Building and Knowledge Transfer (CBKT) participants, and agreement of the comparison protocol with twelve NMIs registered. In pesticides, the final report for CCQM-K78.b on methoxychlor and trifluralin calibration solutions was published [44]. Preparations continued for CCQM-K203 on multicomponent pesticide calibration solutions, including development and validation of liquid chromatography–diode array detection–charged aerosol detection (LC-DAD-CAD) methods for atrazine, carbofuran and dimethoate [45-46]. Method development also began for the CCQM-K78.b2027 comparison on polar multicomponent calibration solutions, focusing on glyphosate and its metabolites. For the digitoxin therapeutic drug purity comparison (CCQM-K148.c), the protocol was finalized and samples distributed to eighteen participating NMIs and Designated Institutes (DIs).

Peptide and protein metrology

In peptide and protein metrology, work continued on primary calibrators and impurity characterization. A secondment supported development of a liquid chromatography–high resolution mass spectrometry (LC-HRMS) method for structurally related impurities in parathyroid hormone PTH(1–84). A liquid chromatography–mass spectrometry (LC-MS) method based on proteotypic peptide quantification was completed and applied to value assignment for CCQM-K155.d/P55.2.d samples, with all participant measurements completed. Technical discussions addressed key comparison reference value (KCRV) calculations, host cell protein quantification and intact protein analysis, together with implications for serum PTH(1–84) calibration hierarchies. Preparations also advanced for CCQM-K115.c.2026 on cyclosporin A purity and CCQM-K115.e on IgG monoclonal antibody materials, supported by nuclear magnetic resonance (NMR), LC-MS and quantitative NMR (qNMR) studies.

Joint Committee for Traceability in Laboratory Medicine

The Chemistry Department continued to support the Joint Committee for Traceability in Laboratory Medicine (JCTLM), by providing the secretariat, supported jointly by the IFCC. Development began on a web-based nomination and review system for the JCTLM database. During 2025, the secretariat prepared 132 nominations for review and published 62 new database entries from the 2024 review cycle. Two publications addressing future requirements for JCTLM database entries were also produced [47-48].

Metrology for safer food: how the BIPM helps protect global health

When you sit down to eat, you rarely think about the precise science that ensures your food is safe. But for scientists working in NMIs around the world, measurement is a frontline defence, particularly when it comes to invisible threats like mycotoxins.

To mark World Food Safety Day on 7 June 2025, the BIPM highlighted its Mycotoxin Metrology Capacity Building and Knowledge Transfer (MMCBKT) programme, an initiative that brings together dozens of countries to improve the reliability of food safety measurement.

Mycotoxins are naturally occurring toxic compounds produced by certain moulds, which can contaminate foodstuffs such as cereals, nuts and fruit. Exposure can lead to serious health risks and disrupt international trade when different countries apply inconsistent testing standards.

Since 2016, the BIPM has worked with NMIs and Designated Institutes (DIs) to:

- Coordinate international comparisons of mycotoxin calibration standards.
- Develop and publish methods for reference material characterization.
- Build critical measurement capabilities through hands-on secondments and training.

At the heart of this work is the BIPM's qNMR facility, which has hosted over a dozen visiting scientists from five continents. These experts receive intensive training in producing and validating reference materials, skills they return home with to strengthen national capabilities and local testing labs.



The purity of mycotoxin primary reference materials being measured with quantitative nuclear magnetic resonance (qNMR)

The programme has supported the development of calibration standards for several high-risk toxins: aflatoxin B1, zearalenone, deoxynivalenol, patulin, and ochratoxin A — each essential for reliable food safety monitoring.

The results of the programme: new Certified Reference Materials; published Purity Evaluation Guidelines and Calibrant Assessment Guidelines; and peer-reviewed technical papers, are already supporting food safety systems around the world.

Time

The BIPM Time Department calculates, disseminates, and improves the world reference time scale UTC through the integration of data from atomic clocks and time transfer measurements at the NMIs (including tests and inclusion of new types of standards and their comparison at long distance). It supports the development and best use of the new optical frequency standards and their high stability measurements at distance for the improvement of UTC and to support the future redefinition of the second. It also promotes the importance and benefits of a unique reference time scale ensuring traceable access to the SI second to the international industrial and scientific communities and other involved international organizations.

In 2025, the department implemented a significant upgrade to the Rapid UTC (UTC_r) algorithm and associated software to improve its accuracy versus UTC at the nanosecond level [24–25]. The revised approach introduced weekly recalculation of clock weights and gradual frequency steering, replacing the former use of abrupt time steps. Following six months of operational testing, the upgraded UTC_r entered routine production in June 2025 and has maintained agreement with UTC within 1 ns. Regular activities, including the collection of clock data, computation of UTC and UTC_r, and coordination of the CCTF-K001.UTC key comparison, continued without interruption. Azerbaijan (AZ) joined the international UTC collaboration as a new participating laboratory in 2025.

The department continued its work on the development and validation of GNSS Integer Precise Point Positioning (IPPP) techniques for time transfer, in collaboration with a postdoctoral researcher. The long-term objective is to establish a reliable platform for the routine integration of IPPP techniques into the monthly computation of UTC. Activities during the year focused on the assessment of open-source software solutions and validation against optical fibre time-transfer links.

In June 2025, the department initiated a new calibration campaign for GNSS receivers used by Group One (G1) laboratories designated by the Regional Metrology Organizations (RMOs), beginning with laboratories in the EURAMET region. The worldwide campaign is expected to continue over approximately three years. In accordance with guidance from the CCTF Working Group on GNSS Time Transfer (CCTF-WGGNSS), the calibration interval for G1 laboratories has been extended to three years, while support for Group Two (G2) calibrations continues. The department also collaborated with the CCTF-WGGNSS on studies of GNSS delay stability and the potential evolution and discontinuation of GPS transmission frequencies, both of which contributed to recommendations adopted by the CCTF in 2025 [26].

A new Time and Frequency Exchange Format (TFEX) was proposed to the international community as a flexible and extensible standard for time and frequency data exchange. During 2025, the department undertook compatibility testing with existing UTC computation software and legacy data formats.

Capacity-building and knowledge-transfer activities continued to expand. With the support of a secondeé, the department further developed e-learning resources and open-source

software tools for the analysis and validation of UTC(*k*) data. This initiative, launched in 2023 under the auspices of the CCTF and partially supported by the IEEE Ultrasonics, Ferroelectrics and Frequency Control (UFFC) Society, aims to strengthen the technical capabilities of UTC laboratories, NMIs and the wider time and frequency community. Six training courses were developed during 2024–2025, and two international summer schools were organized in 2025 to support dissemination and practical implementation of these tools.

The first summer school, hosted by CENAM in Mexico in May 2025, with support from the Inter-American Metrology System (SIM) and sponsorship from the IEEE UFFC Society, brought together 20 participants and 12 lecturers, primarily from the SIM region. The second was held at the BIPM headquarters in September 2025 and included 35 participants and 11 lecturers representing all RMOs (see page 11 for more details). In parallel, three new courses were added to the BIPM CBKT e-learning platform:

- Clock data checking
- Time scale algorithms: basics to applications
- Validating clock data format with BIPM convention.

An additional course addressing G2 calibration practices remains under development. The department also established a shared server infrastructure to support online CBKT tools for UTC laboratories and continued maintenance of an open-source software repository.

The department remained actively engaged in international work relating to the future evolution of UTC and the transition towards continuous UTC. Activities included support to the CCTF, participation in technical and user fora, and coordination with the International Telecommunication Union (ITU) regarding the implications of leap seconds, including the possibility of a negative leap second [28–29]. Contributions were made to meetings of ITU-R (Radiocommunication Sector) Working Party 7A, and, for the first time, the department participated in discussions of ITU-T (Telecommunication Standardization Sector) Study Group Q13/15 Network synchronization and time distribution performance. Studies were also undertaken concerning proposed frequency adjustments to UTC [30].

In collaboration with the International Earth Rotation and Reference Systems Service (IERS), the department organized an online workshop to assess the probability of a negative leap second. Experts from multiple disciplines agreed on and validated a stochastic model for predicting UT1–UTC using historical observations. The results informed discussions within user communities and international organizations and supported the emerging consensus to update UTC by extending the permitted tolerance between UT1 and UTC, thereby avoiding leap-second discontinuities over the long term. This work, together with contributions from the CCTF Task Group “Towards continuous UTC” (CCTF-TGUTC), contributed to Draft Resolution C, “*On the technical actions needed to ensure the continuity of UTC*”, for consideration at the 28th meeting of the CGPM in October 2026.

The department continued to support and chair the CCTF Task Group on Moon Timing (CCTF-TGMT), which is examining the establishment of an international lunar reference time scale

traceable to UTC. In response to requests from international space agencies, the department advanced studies of the relativistic framework required for lunar timekeeping and supported efforts to ensure interoperability among future lunar Positioning, Navigation and Timing (PNT) systems [31]. Extensive coordination activities were undertaken with relevant international organizations, including the International Astronomical Union (IAU), ITU, International Association of Geodesy (IAG), and International Committee on Global Navigation Satellite Systems (ICG) [32-33]. These activities contributed to Draft Resolution D, *“On the definition of an international lunar reference time scale and its traceability to UTC”*, for presentation to the 28th CGPM. Collaboration with the IAU also continued through BIPM leadership of an IAU Working Group on timing standards and participation in the IAU Symposium on reference frames held in La Plata, Argentina, in August 2025 [34-35].

In the field of frequency standards, the department refined an algorithm based on graph-model methods for estimating recommended frequency values used as secondary representations of the second. This work, carried out in collaboration with the Joint CCL-CCTF Working Group on Frequency Standards (WGFS), included comparisons with algorithms developed by NPL and NIST and supported the updated list of recommended frequency values adopted by the CCTF in September 2025.

Time metrology at BIPM150

Time metrology featured prominently at the events to celebrate the 150th anniversary of the signing of the metre Convention on 20 May 2025. A selection of interviews are given here.

Redefining the second and measuring time on the moon.

Dr Pascale Defraigne, Head of the Time and Frequency Service at the Royal Observatory of Belgium.



Overcoming challenges on the road to redefining the second

Dr Marina Gertszov of the National Research Council of Canada (NRC).



Timekeeping for satellites systems and space exploration

Dr Javier Benedicto, Director of Navigation at the European Space Agency (ESA).



The future of optical lattice clocks

Prof. Hidetoshi Katori (University of Tokyo).



UTC summer schools

The BIPM held two UTC summer schools in 2025.

BIPM–SIM UTC Summer School

The BIPM–SIM UTC Summer School, held in Querétaro, Mexico, in May 2025 and hosted by Mexico’s National Metrology Institute (CENAM), brought together participants from 18 countries for three days of expert-led training and technical exchanges. The initiative is part of the BIPM’s ongoing efforts to build capacity and support global contributions to Coordinated Universal Time (UTC).

Across much of the Inter-American Metrology System (SIM) region, NMIs have identified and expressed the need to address many of the same challenges: limited access to advanced infrastructure, constrained travel budgets, and a shortage of trained personnel to support ongoing UTC participation.

In response to these challenges, **the BIPM–SIM UTC Summer School offered a tailored programme of tutorials, lab demonstrations and peer learning.** It gave time metrologists the technical grounding, practical tools and community support to take on a greater role in UTC activities.

Participants trained in:

- GNSS time transfer and receiver calibration
- Timescale generation and analysis
- Time service distribution and national applications.

This Summer School was made possible thanks to the contributions of CENAM, the BIPM and the IEEE UFFC Society, each of which played a vital role in delivering, hosting and expanding access to the programme

BIPM UTC Summer School

The Time Department hosted a UTC Summer School at the BIPM headquarters on 9–11 September, which offered **a unique opportunity for participants to train directly with those responsible for the coordination of UTC.**

The BIPM Summer School was designed to equip early-career metrologists, secondees and technical experts with the knowledge and tools they need to support their institutes’ contributions to UTC(k).

The programme included tutorials, live demonstrations and hands-on analysis using the BIPM’s CBKT training tools. Across the three days, participants explored:

- UTC and UTC(k): Foundations of UTC, its computation, and traceability.
- GNSS: Clock comparisons, GNSS calibration, and practical demonstrations.
- Data Analysis: From timescale algorithms to Python-based Allan tools and topical discussions on the future of optical timescales.

International Liaison

Liaison with OECD

The BIPM and the Organisation for Economic Co-operation and Development (OECD) cooperate for effective dissemination of information on the importance of the quality infrastructure and particularly metrology as one of its key components.

The OECD report, *Reinforcing Regulatory Frameworks through Standards, Measurements and Assurance: Making Better Use of Quality Infrastructure in Policymaking*, was the outcome of an OECD-led project “*Interlinkages between regulation and quality infrastructure*” funded by the National Metrology Institute of Germany (PTB) was published in September 2025.

On 22 January 2026, the BIPM, the OECD, the PTB and the British Standards Institution (BSI), hosted a joint public webinar titled: “*Building Trust in Regulation: The Role of Standards, Measurement, and Assurance*”. The webinar was open to all members of the international quality infrastructure, regulatory and policy communities and was built on the recently published report which examines how quality infrastructure systems can better support regulatory objectives and policy outcomes.

Liaison with CIE

The BIPM and the International Commission on Illumination (CIE) have enjoyed an excellent and long-standing collaboration through their work with the Consultative Committee for Photometry and Radiometry (CCPR), established in 1933, and the Consultative Committee for Units (CCU), set up in 1964.

In 2007, this cooperation was further formalized when the first agreement was signed with CIE, marking nearly two decades of structured partnership in maintaining consistency in optical measurement science.

A new Memorandum of Understanding (MoU) was signed between the BIPM and CIE on 15 July 2025 in Varenna, Italy, by Martin Milton, Director of the BIPM and Diana Wernisch, Secretary General of the CIE. It updates and replaces the previous agreement signed in 2007. The MoU reinforces the joint commitment of two organizations to advancing global comparability in optical measurements, including photometry, radiometry and digital metrology. Their combined efforts ensure that measurements of light and radiation remain accurate, traceable and universally comparable. This renewed partnership reflects the BIPM's broader mission to strengthen international measurement systems and support scientific and technological progress across sectors.

Liaison with UNESCO

The BIPM and the United Nations Educational, Scientific and Cultural Organization (UNESCO) have cooperated since 1949, within the formal agreement, to facilitate effective dissemination of information on the importance of quality infrastructure, particularly metrology, in scientific, educational and societal contexts.

A new Memorandum of Understanding (MoU) was signed between the BIPM and UNESCO on 15 December 2025 at the UNESCO Headquarters in Paris (France) by Martin Milton, Director of the BIPM, and Lidia Brito, Assistant Director-General of UNESCO for Natural Sciences. It updates and replaces the previous agreement signed in 1949. The aim of the MoU is to confirm the collaboration on the annual celebration of 20 May - World Metrology Day - and open opportunities to promote metrology as part of advancing the 2030 Agenda for Sustainable Development in the fields of education, science, and communication and information. The renewed partnership seeks to support shared strategic objectives, including strengthening metrology, supporting international scientific cooperation and promoting science-based decision-making.



Martin Milton (left, seated) and Lidia Brito (right, seated) signing the MoU.

Liaison with WTO

Metrology - the science of measurement - plays a fundamental role in ensuring trust in products, compliance with standards, and the smooth flow of goods across borders. To explore this essential link between measurement and global trade, the World Trade Organization (WTO) held a Thematic Session on the Role of Metrology in Facilitating Trade on 11 November 2025, with participation from representatives of the international metrology community, including the BIPM.

This session took place in a milestone year, marking both the 150th anniversary of the Metre Convention and the 70th anniversary of the International Organization of Legal Metrology (OIML) Convention, two international agreements that continue to shape reliable and harmonized measurement worldwide.

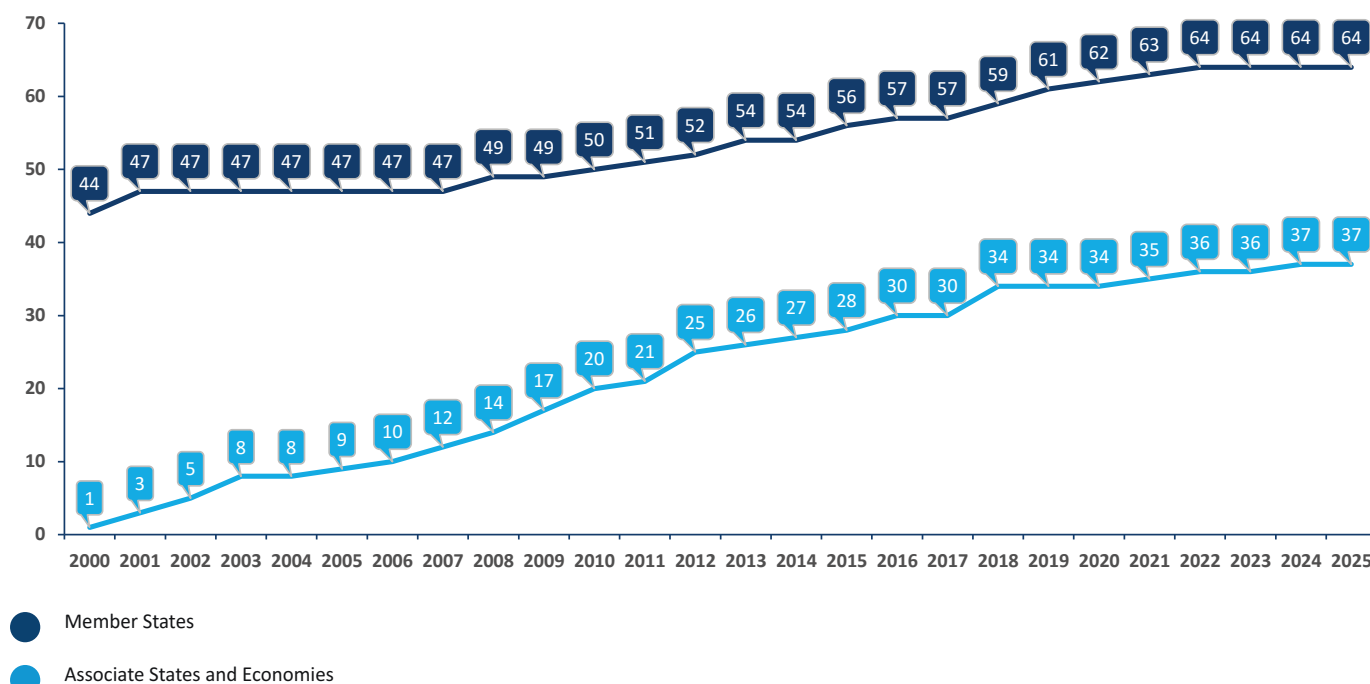
Speakers included representatives from NMIs and international organizations from around the world, sharing perspectives on the role of metrology in areas such as new technologies, environmental protection and health.

Discussions focused on how metrology supports the effective implementation of the WTO's Technical Barriers to Trade Agreement, reduces technical barriers, and enables developing and least-developed country Members to participate fully in the international measurement system. In this context, WTO Members discussed, among other things, barriers that hinder participation of developing and least-developed country Members in the international metrology system, and explored practices to overcome such barriers, including showcasing current and upcoming initiatives.

Watch a recording of the Thematic Session here:



Evolution in Member States and Associate States and Economies from 2000 to 2025



The BIPM advances the development of the Digital Framework for the International System of Units (SI)

The SI Digital Framework (SIDF) is the ecosystem of tools to make measurement data Findable, Accessible, Interoperable, and Reusable (FAIR). During 2025, the BIPM continued the development of the web services that provide access to the SIDF, available both as human-readable web pages and as machine-accessible Application Programming Interfaces (APIs), at

<https://si-digital-framework.org>

The metrological community has provided feedback to the BIPM requesting the extension of these services, and suitable solutions are being developed in response to the requirements identified.

The most fundamental part of the SIDF is the SI Reference Point (SIRP). It constitutes the authoritative digital knowledge model of the International System of Units, providing machine-readable, persistent identifier for SI units, prefixes, defining constants, and the decisions of the General Conference on Weights and Measures (CGPM). The beta version of the SIRP knowledge base was advanced during 2025. In parallel, a scientific paper describing the process that led to the beta version was prepared for submission to the journal *Metrologia*.

Capacity Building and Knowledge Transfer



The BIPM Capacity Building and Knowledge Transfer (CBKT) Programme aims to increase the effectiveness with which Member States and Associates engage in the world-wide coordinated metrological system.

The BIPM e-learning platform provides online assistance to National Metrology Institute (NMI)/Designated Institute (DI) staff from Member States and Associates to strengthen their capabilities, including their involvement in the CIPM MRA mechanisms.

The programme has a highly appreciated portfolio that continues to expand. The CBKT initiatives are delivered through various activities such as workshops, laboratory placements and remote-learning activities, including the BIPM e-learning platform, which also hosts knowledge transfer materials from the RMOs.

Successful 2025 Varenna Metrology School

The 2025 edition of the Metrology Summer School was held from 9–18 July in Varenna (Italy), and was organized by the Italian Physical Society (SIF) with support from the BIPM. The theme was *“Future needs for Metrology: Climate Science, Quantum Technologies and the Digital Revolution”*. The programme was structured as a series of modules, featuring a three-day core module, *“Module II: Fundamentals of metrology and the digital transformation of measurement”* alongside a choice of two three-day optional modules: *“Module I: Metrology for the quality of life and climate science”* and *“Module III: Physical and quantum metrology”*. The school welcomed 23 lecturers, including four from the BIPM.

A total of 43 applications were received for sponsorship, from which four young metrologists were selected and sponsored by the National Metrology Institute of Switzerland (METAS). These four young metrologists participated in the 2025 Varenna Summer School and subsequently completed a short placement at METAS. During their two-to-four-week placement, they received dedicated training and pursued specific metrology topics of interest, further enhancing their professional skills and expertise.

The BIPM acknowledges the generous contribution of METAS for providing the funding through the CBKT programme.

Pilot’s Guide to Measurement Comparisons

In 2025, a new e-learning course was launched to support comparison pilots and technical experts involved in the organization, execution and reporting of international comparisons under the CIPM MRA. The course provides practical guidance aligned with CIPM MRA-G-11 and related documents, helping users navigate the key stages of the comparison process.

The pilot institute (pilot), formally designated by the organizing body (e.g. a Consultative Committee, the BIPM, or an RMO), is entrusted with the coordination and implementation of the comparison exercise. The design and technical structure of the comparison, including the selection of artefacts, participants, measurands and the circulation scheme, are usually determined by a coordinating group or committee. The pilot’s role is to implement this agreed plan and ensure that the comparison proceeds smoothly and transparently.

The modules in this e-learning course guide those interested in learning how to pilot comparisons through each phase of the comparison process, using general examples to illustrate key concepts and practices.

To further enrich this resource, we invite experienced comparison pilots to contribute practical examples based on their experience in conducting specific CIPM MRA comparisons. These examples may be published on the e-learning platform to support future learners.

The template for the contribution is available on the e-learning course at: <https://e-learning.bipm.org/course/view.php?id=93>

For more information, please contact cbkt@bipm.org

BIPM/TÜBİTAK UME project placements

The BIPM/TÜBİTAK UME project placement initiative, organized by the BIPM and the National Metrology Institute of Turkey (TÜBİTAK UME), is designed to provide opportunities for young metrologists to gain in-depth knowledge and experience by conducting research on a subject of their interest in TÜBİTAK UME's laboratories. In addition, participants are able to expand their understanding of the international aspects of metrology through intensive CIPM MRA e-learning opportunities and seminars given by staff from the BIPM and TÜBİTAK UME.

Over the eight years (2018-2025) of this initiative, 76 participants from more than thirty countries across all regions have taken part, including ten young metrologists from all regions who completed their placements in September 2025 as part of cycle eight. This reflects the BIPM's shared vision of a global metrology system built on collaboration among NMIs.

In addition to their research, participants took part in a CIPM MRA seminar in October 2025, designed to reinforce their understanding of the international metrology system and strengthen global collaboration in scientific measurement.



Some of the participants from the BIPM–TÜBİTAK UME Project Placement Programme with BIPM and TÜBİTAK UME colleagues at the CIPM MRA Seminar (1-2 October).

Photo credit: Müge Atam

Building Capacity: a three-day KCDB training programme in Doha

The BIPM organized a training course on the Key Comparison Database (KCDB) in Doha (Qatar) from 20-22 October 2025. The course provided hands-on training to help metrologists build the knowledge and confidence needed to carry out the Calibration and Measurement Capabilities (CMC) submission process and strengthen their role in the global measurement system.

The three-day course, delivered in collaboration with the Gulf Association for Metrology (GULFMET), focused on the requirements of the CIPM MRA and the role of the KCDB in ensuring mutual recognition of national measurement standards.

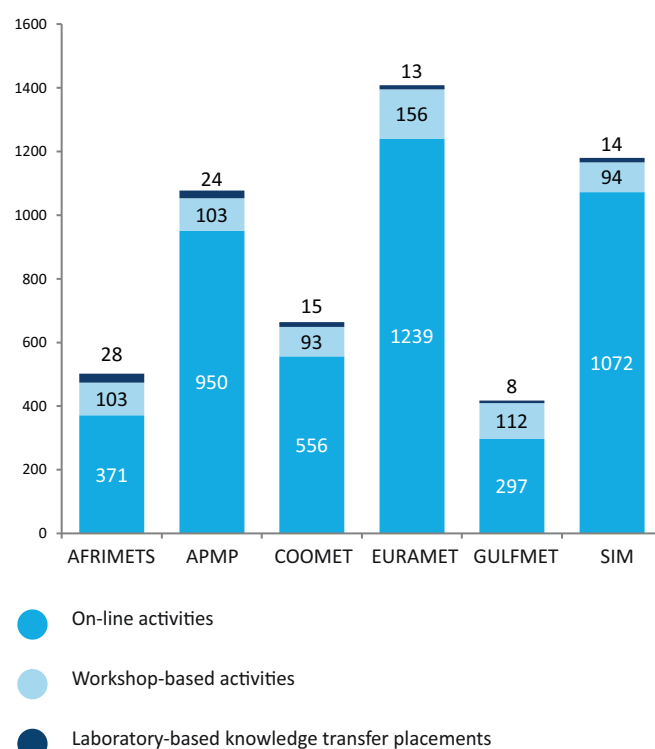
The course covered:

- The structure and use of the KCDB platform
- How to draft and submit CMCs for review
- Technical evidence requirements and comparison data
- Quality management system (QMS) expectations
- Common challenges and best practices for success
- GULFMET-specific regional procedures and expectations.

The programme included simulated CMC review exercises and interactive tutorials on the KCDB training platform, with guidance given in the latest procedural documents and tools available from the BIPM e-learning platform.

In addition to the technical content, the course reinforced the value of cross-border collaboration, mutual learning and trust in measurement science. The BIPM's CBKT programme ensures that all countries working within the CIPM MRA can play an active role in the international metrology system.

CBKT participation by RMO



The CIPM MRA

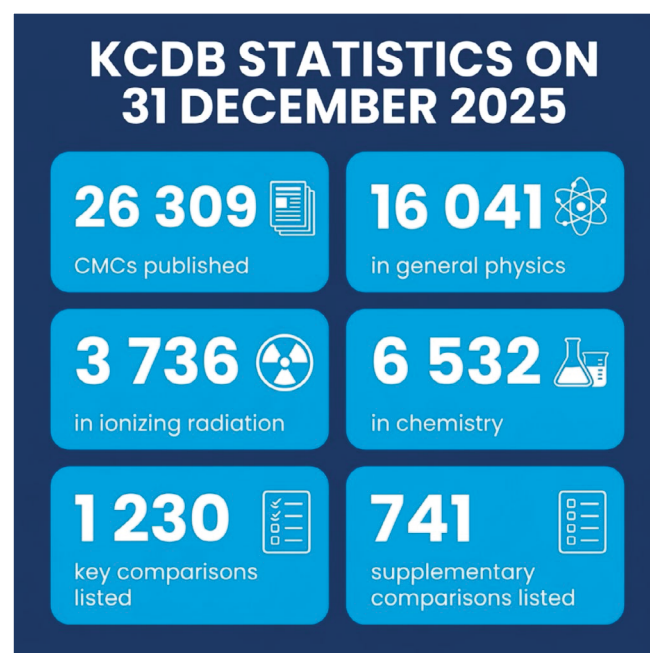
The CIPM Mutual Recognition Arrangement (CIPM MRA) provides a technical framework to the measurement community for comparability of measurement results and international recognition of metrological capabilities declared by NMIs around the world. Since its founding in 1999, participating institutes published more than 26 000 peer-reviewed calibration and measurement capabilities (CMCs) in the CIPM MRA database (Key Comparison Database (KCDB)). It is these capabilities and the technical evidence behind them that underpin the international acceptance of measurements.

CIPM MRA in numbers

As of today, more than 250 institutes participate in the CIPM MRA, and participating countries cover approximately 98 % of the world's GDP. All data listed in the KCDB has been reviewed by metrology experts and approved within the CIPM MRA framework.

The overall number of published CMCs remains largely stable, reflecting a long-term trend observed over the last decade. This stability reflects the increasing use of broader-scope CMCs, which offsets the addition of new capabilities. The performance of the KCDB review process also continues to show significant improvement compared with the period prior to the introduction of the KCDB 2.0.

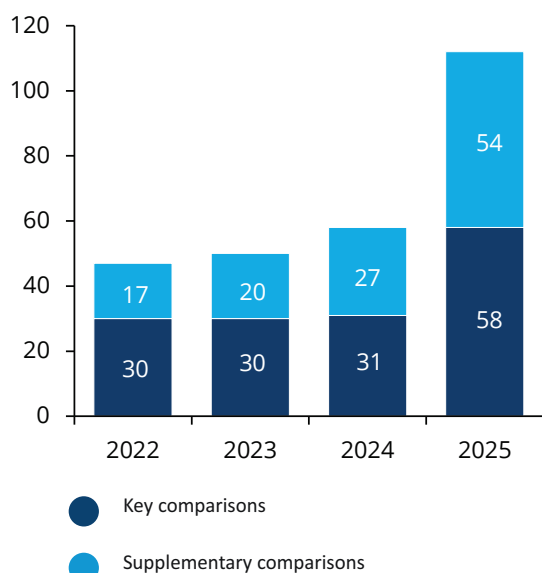
The KCDB continued to expand its coverage of scientific comparisons with a record number of new comparisons registered in 2025. This consisted primarily of RMO key comparisons and new supplementary comparisons, bringing the total number to almost 2 000 by the end of 2025. This is in addition to repeat CC comparisons that are organized to maintain the validity of CMCs. Supplementary comparisons now account for almost 40 % of all registered comparisons,



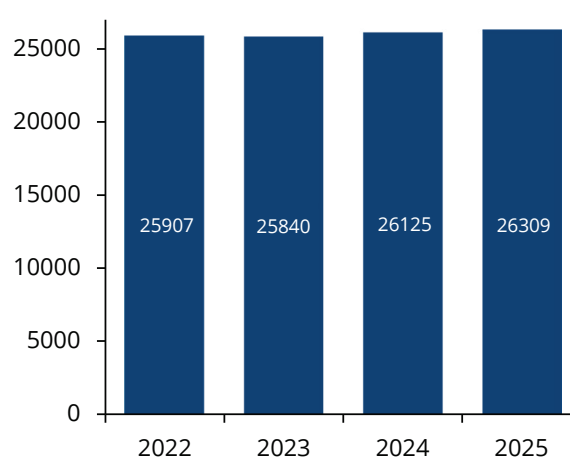
illustrating their growing importance in supporting regional and emerging measurement needs.

The KCDB continued to support the broader digital transformation of metrology. Significant developments included enhancements to the KCDB Application Programming Interface (API), support for the assignment of Digital Object Identifiers (DOIs) to CIPM MRA comparison reports, and continued work towards making KCDB data more Findable, Accessible, Interoperable and Reusable (FAIR). These developments strengthen the KCDB's role as a trusted resource for the international metrology community.

Number of new comparisons registered in the KCDB

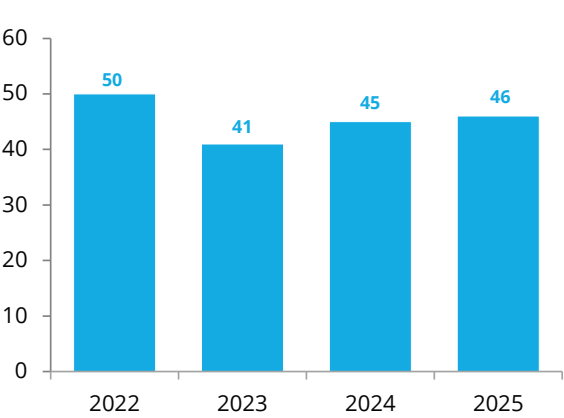


Total number of CMCs registered at 31st December

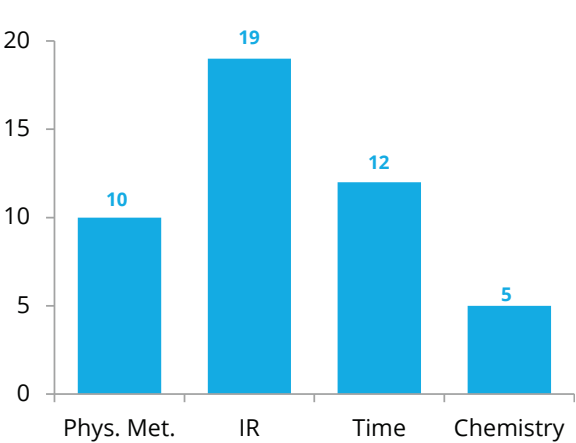


Comparisons and calibrations

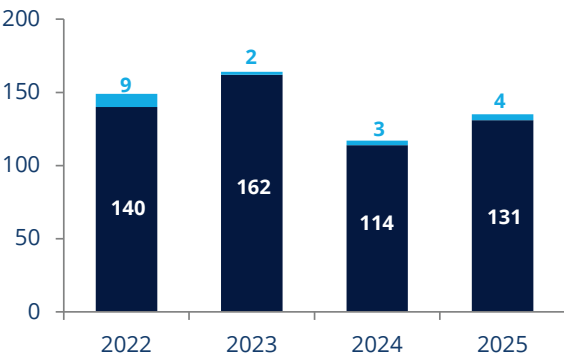
Comparisons coordinated by the BIPM in 2025



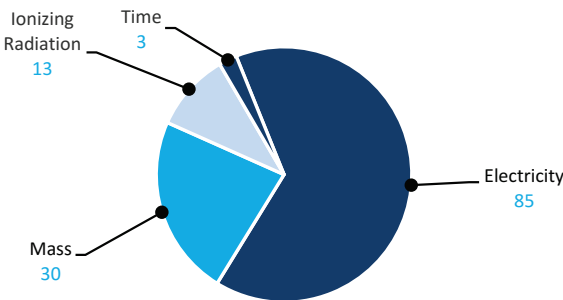
Breakdown of comparisons by department in 2025



Calibrations 2022 to 2025



Calibrations by metrology area in 2025



- Calibration certificates/characterizations
- Study notes

150th Anniversary of the Metre Convention

The global metrology community celebrated the **150th anniversary of the signing of the Metre Convention** in 2025 – a milestone that underscores a century and a half of scientific cooperation.

Events were centred on World Metrology Day, the annual celebration of the signature of the Metre Convention on 20 May 1875 by representatives of seventeen nations. The Convention set the framework for global collaboration in the science of measurement and in its industrial, commercial and societal applications. The original aim of the Metre Convention, the world-wide uniformity of measurement, remains as important today as it was in 1875.

The celebrations focused on the impact that accurate, reliable and internationally comparable measurements have had over the last 150 years, and the opportunities they offer in the future.



The official recognition of **World Metrology Day as a UNESCO International Day** represents an extraordinary opportunity to promote the central role of metrology in building a sustainable future.

150th Anniversary of the Metre Convention

From 20 to 22 May 2025, the global metrology community came together in Paris and Versailles to mark 150 years since the signing of the Metre Convention: a milestone that celebrated both the legacy and future of international scientific cooperation.

The #BIPM150 programme was more than a commemoration, it served as a platform for scientific exchange, policy dialogue and strategic reflection.

Over three days of keynote addresses, panel discussions and thematic sessions, speakers explored how metrology supports progress across trade, technology, sustainability and space science.

World Metrology Day symposium 150 Years of the Metre Convention: Science, Innovation and Global Impact

The celebrations commenced on 20 May 2025 with a symposium hosted at the UNESCO Headquarters in Paris. The event highlighted the importance of accurate measurement for global trade, sustainable development and scientific collaboration.

The symposium included two keynote addresses:

The SI - a tool for all humankind

Prof. William D. Phillips, Nobel Prize laureate 1997, NIST (USA)



Prof. William D. Phillips

Photo by Krystal Kenney for the BIPM.

From the Metric System to the Metre Convention

Prof. Ken Alder, Professor of History and author of *"The Measure of All Things"*, Northwestern University (USA)



Prof. Ken Alder

Photo by Krystal Kenney for the BIPM.

Panel discussions were held on:

- Navigating the future of metrology: addressing the challenges of scientific and technical multilateralism.
- Future challenges for global metrology.

The panel discussions allowed an exploration of emerging challenges and future directions in metrology and its role in addressing the UN Sustainable Development Goals (SDGs). In addition, they fostered multilateral dialogue among policymakers, scientists and international organizations on capacity building and innovation in metrology.

Highlighting the importance of accurate measurement for global trade, sustainable development and scientific collaboration

Many of the speakers mentioned the need to reinforce the message to policy makers and governments about the vital role of metrology to society, industry and innovation. This included detailed explanations of the economic impact of metrology.

One such message from Ms Amal Kasry, Chief of Section for Basic Science, Research, Innovation and Engineering, UNESCO, was that precision in measurement is the cornerstone of global progress and innovation.

Another message, put forward by Dr Henry Rotich, Director General, Kenya Bureau of Standards (KEBS), is that quality infrastructure (QI) is a driver of innovation in emerging economies and metrology is at its heart. Beyond this, metrology is also critical in adding value to raw materials and manufactured goods produced within Africa, particularly in the context of the African Continental Free Trade Area (AfCFTA).

Exploring emerging challenges and future directions in metrology and its role in addressing the United Nations Sustainable Development Goals (SDGs).

There was a common call during the events that global cooperation, equitable access and inclusive innovation must shape the next era of measurement. This aligns powerfully with the frameworks that guide the collective vision for metrology, particularly the International Decade of Sciences for Sustainable Development and the International Year of Quantum Science and Technology (IYQ).

Dr Nathalie von Siemens, Advisory Board Member, Physikalisch-Technische Bundesanstalt (PTB), Germany reinforced this by reminding us that meeting future challenges will require resilience, the ability to embrace complexity, to view challenges as opportunities and to learn from mistakes.

Beyond this, Prof. Alessandro de Angelis, Scientific Attaché at the Permanent Delegation of Italy to the International Organisations in Paris emphasized that the motivation and benefits must be explained for countries to participate in "big-science" projects such as CERN and the Square Kilometre Array (SKA).

Dr Pascale Defraigne, Time and Frequency Service, Royal Observatory of Belgium, added that the international time and frequency community needs to continue to build on the success of the reference time scale Universal Coordinated Time (UTC), a new definition of the second is needed to

150th Anniversary of the Metre Convention

account for data from new frequency standards and a reference time scale is required for the Moon.

Finally, Prof. Alessandro de Angelis reminded us that the BIPM's 150-year legacy reflects its strength in adapting to change, embracing digitalization and supporting open science.

Fostering multilateral dialogue on capacity building and innovation in metrology.

Cooperation has been a guiding principle of the BIPM over the last 150 years. To meet future challenges for global metrology it is essential to continue with this principle and to engage actively with young metrologists. The importance of education and understanding the needs of stakeholders are vital to meet future challenges in metrology.

On this topic, Mr Shaofeng Hu, Director, Division of Science Policy and Basic Sciences, Natural Sciences Sector, UNESCO, underlined the importance of reinforcing scientific diplomacy, local engagement and cross-sector collaboration.

The value of regional metrology cooperation in building quality infrastructure that benefits individual nations was also raised by Dr Sharonmae Smith-Walker, CEO, CARICOM Regional Organisation for Standards and Quality (CROSQ), Jamaica.

Prof. Alessandro de Angelis highlighted the value of 'open science' and the need to communicate the long-term societal value of international scientific cooperation; and Prof. Mustafa Çetintaş, Director, TÜBİTAK Ulusal Metroloji Enstitüsü (TÜBİTAK UME), Türkiye reminded us that capacity building and knowledge transfer must be prioritized.

Dr Nathalie von Siemens illustrated the importance of Science, Technology, Engineering, and Mathematics (STEM) education for improving public understanding of metrology.

And finally, a new BIPM membership category, "Observership", currently under discussion was mentioned multiple times in the context of bringing significant benefits to emerging economies.

BIPM Conference in Versailles: From units to the universe - future revolutions in metrology

The BIPM hosted a two-day conference at the Palais des Congrès in Versailles on 21-22 May 2025 to continue the celebrations. Sessions at the conference covered:

- Metrology in the quantum era
- Metrology for climate science
- The FAIR digital revolution
- New science and the definition of the second
- Future revolutions - measuring for the life sciences
- Future revolutions - metrology in space.

Each session featured presentations from leading experts and included a panel discussion on the strategic direction of metrology in the coming decades.

A poster preview session allowed the authors of nine outstanding posters selected by a panel of CIPM members to give two-minute presentations of their work. An additional tenth poster was selected from the contributions to the

"Young Metrologists' Vision 2050+", a foresight exercise that brought together young metrologists from around the world. More than 350 posters were submitted following an open invitation to show the state-of-the-art in the nine areas of metrology that were highlighted in the CIPM Strategy 2030+.



Panel discussion: New science and the definition of the second, featuring (left to right) Dr Noël Dimarcq, Prof. Hidetoshi Katori, Dr Marina Gertsvolf, and Prof. William D. Phillips.

Photo by Krystal Kenney for the BIPM.

Anniversary video playlists

This collection of sessions from the BIPM's anniversary events in May 2025 brings together every keynote speech, panel discussion, scientific presentation and special address from the events at UNESCO and Versailles.



The Expert Insights playlist brings together interviews with leading metrologists, captured during the BIPM's 150th anniversary year. These interviews offer a unique perspective on international coordination, scientific innovation, and the people driving metrology forward.



150th Anniversary of the Metre Convention

New book captures 150 years of measurement milestones

The newly published bilingual book *Le Bureau International des Poids et Mesures: 150 ans de mesures pour le monde / 150 years of measures for the world* is a richly illustrated history that brings the evolution of international metrology to life through photographs, stories and archival insight.

Launched at the Palais des Congrès in Versailles during the BIPM's 150th Anniversary Scientific Symposium on 21 May 2025, this commemorative publication celebrates the long, complex and deeply human story of building a global measurement system.

Written by Céline Fellag Ariouet, Head of the BIPM's Executive and Meetings Office, the book blends institutional access with personal perspective, retracing 150 years of BIPM history.

The book provides an illustrated history alongside a story told through archive documents, photographs and historical reflection, charting 150 years of scientific diplomacy and cooperation. Inside, readers will find:

- Rare archival material from the BIPM's own collections
- Behind-the-scenes glimpses of the BIPM laboratories
- Historical and modern portraits of the metrology community and famous scientists like Pierre and Marie Curie, Albert Einstein and Gustave Eiffel who have been involved in the work of the BIPM
- Accompanying stories that give voice to the people, instruments and events that shaped the global measurement system.

The book also includes a series of unique and historic images of the BIPM taken by the world-famous French photographer Robert Doisneau in 1942. These photographs had been stored in the BIPM archives until they were recently re-discovered.



The Author of the book, Céline Fellag Ariouet with Prof. Ken Alder

Sèvres vase presented to the BIPM to mark 150 years of the Metre Convention

A commemorative porcelain vase produced by the Manufacture nationale de Sèvres was presented to the BIPM to mark the 150th anniversary of the Metre Convention. The presentation reflects the long-standing link between the BIPM and Sèvres, where the organization has been based since its establishment in 1875.



Photo copyright: Audrey Falet, Sèvres-Manufacture nationale de céramique

The vase is a "Clermont" model traditionally used for official presentations. It features a deep cobalt blue ground ("bleu de Sèvres") with gold decoration, and includes references to international measurement cooperation, including the 150th anniversary emblem, the SI logo, and the inscription "Convention du Mètre".

The design draws on historical precedents. In 1872, porcelain vases produced by the Manufacture nationale de Sèvres were presented, at the initiative of the President of the French Republic, to members of the International Metre Commission, which laid the foundations for the Metre Convention.

The commemorative vase will be preserved at the BIPM.

Photo by Krystal Kenney for the BIPM.

150th Anniversary of the Metre Convention

Local outreach

On 19 May 2025, the BIPM hosted a reception at the Pavillon de Breteuil gathering many ambassadors from Member States and Associates and representatives from local authorities. The Maire de Sèvres and the Maire de Meudon as well as representatives from the *Domaine national de Saint-Cloud* attended the reception.



Photo by Krystal Kenney for the BIPM.

Grégoire de La Roncière, Maire de Sèvres, speaking at the reception hosted by the BIPM on 19 May 2025

Throughout 2025, the City of Sèvres worked in partnership with the BIPM to mark the 150th anniversary of the Metre Convention. Several exhibitions were organized. A photographic exhibition displayed outside the Hôtel de ville and on the Mezzanine level brought together the work of Robert Doisneau and Raphaël Dallaporta, highlighting their complementary perspectives on the BIPM's metrology laboratories.



BIPM staff, Raphaël Dallaporta and Grégoire de La Roncière in front of the photographic exhibition at the Town Hall in Sèvres

An educational exhibition trail was organized at the public library in Sèvres, tracing the history of the BIPM. The exhibition included artefacts and a scale model of the Pavillon de Breteuil, it also highlighted the BIPM's activities today. As part of the exhibition programme, outreach activities were conducted with two Year 9 classes of the *Collège international de Sèvres*.



The educational exhibition trail at the public library in Sèvres

A 32-page booklet on the history of the BIPM was written by Céline Fellag Ariouet and designed by the communications team at the Hôtel de ville in Sèvres. A total of 12 000 copies were printed and distributed to residents of Sèvres in September 2025 before the annual *Journées européennes du patrimoine* (European Heritage Days).



Clés pour comprendre

On 12 June, a special edition of the *Clés pour comprendre* ("Keys to Understanding") lecture series, entitled *Measuring the World*, was held beneath the Cupola of the Academy of Sciences, featuring Gérard Berry, Sandrine Bony, Jean-Marc Bordy and Céline Fellag Ariouet. Watch a recording of the lecture [here](#).



Meetings

Meetings help build consensus, allow the sharing and alignment of knowledge, and help to build trust and confidence internationally. The BIPM provides comprehensive support for the organization of meetings and institutional activities for the metrology community and beyond.

The BIPM's meeting activities include overseeing complex operational processes, such as the development of on-line forms supporting registrations, applications, nominations and surveys, and is also responsible for editing convocation and nomination forms for Consultative Committees of the CIPM.

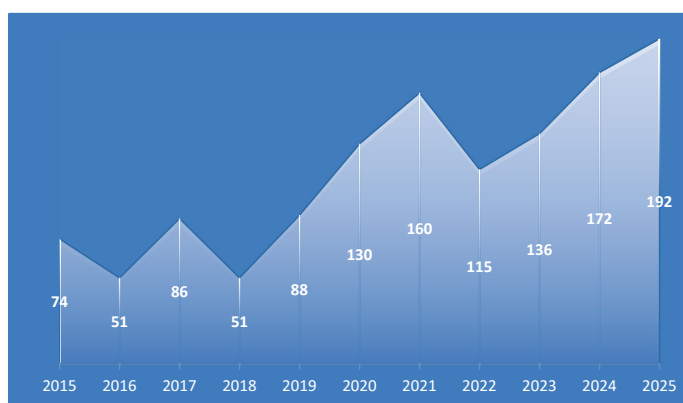
Services to support meetings include a database of up-to-date contact details and details of participants to all meetings hosted by the BIPM. This Database underpins the web presence for all meetings, supports the update of webpages and provides controlled access to working documents on the website.

The Meetings Office team manages events logistics by providing meeting rooms, catering services, visa support documentation for international delegates, coordination of visitors and technical support for on-site and on-line meetings.

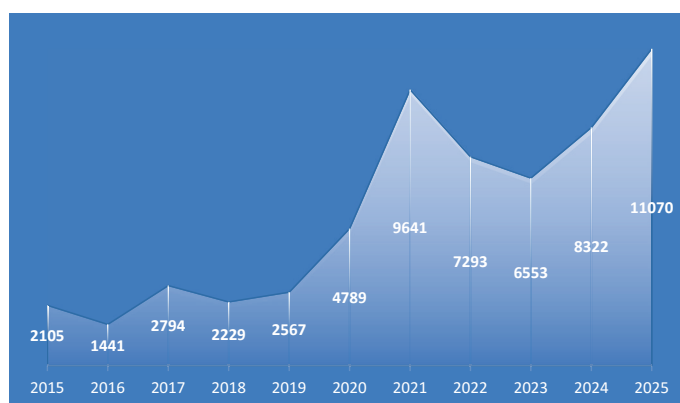
Meeting activity has expanded significantly in recent years. Following the COVID-19 pandemic, the BIPM has successfully transitioned to a hybrid meeting model, combining on-site and on-line participation. This approach has increased accessibility and overall engagement. The number of meetings hosted by the BIPM continues to grow year-on-year, as shown in the graphs below.



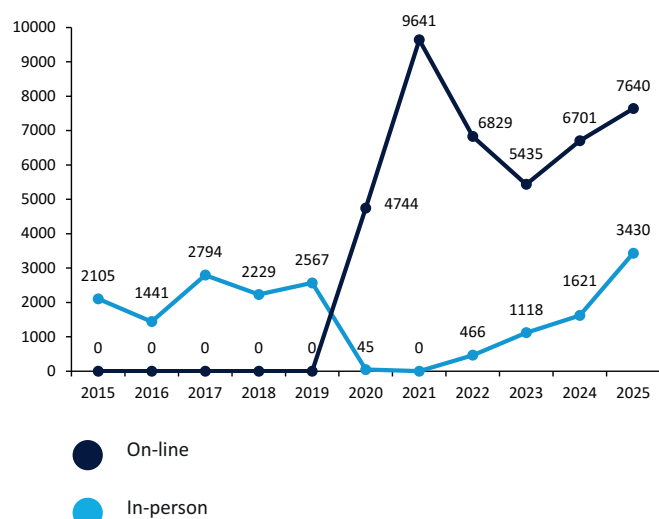
Number of meetings 2015-2025



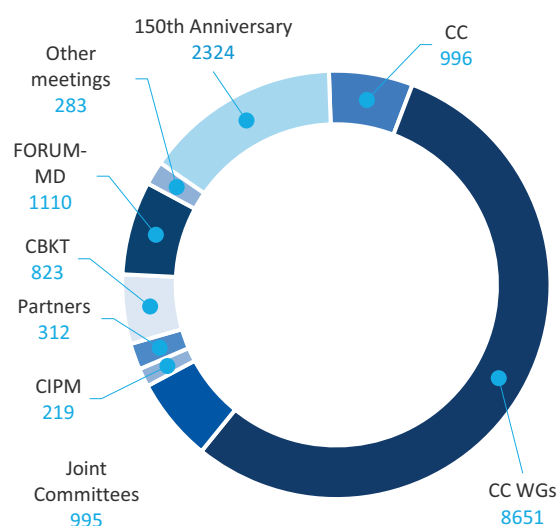
Total meeting participants 2015-2025



Number of participants on-line and in-person by meeting 2015-2025



Meeting attendance in 2025



Organizational structure

The CIPM

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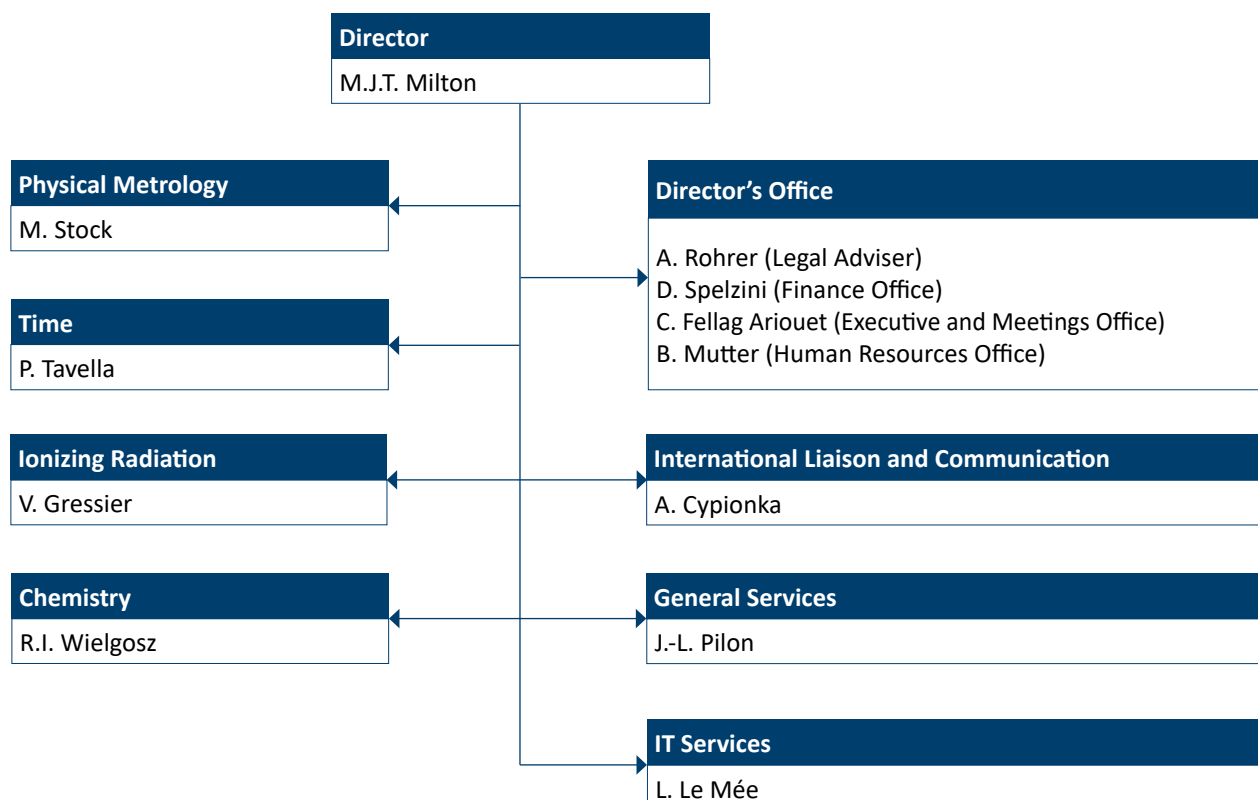
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P. Richard (Switzerland)

Other CIPM Members

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V. Coleman (Australia)
D. del Campo Maldonado (Spain)
C. Denz (Germany)
N. Dimarcq (France)
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J.T. Janssen (United Kingdom)
H. Laiz (Argentina)
G. Macdonald (Canada)
S.-R. Park (Republic of Korea)
J. Qu (China)
M.L. Rastello (Italy)
G. Rietveld (Netherlands)
G.P. Ripper (Brazil)

Organigram of Headquarters' Departments and Services



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Chemistry

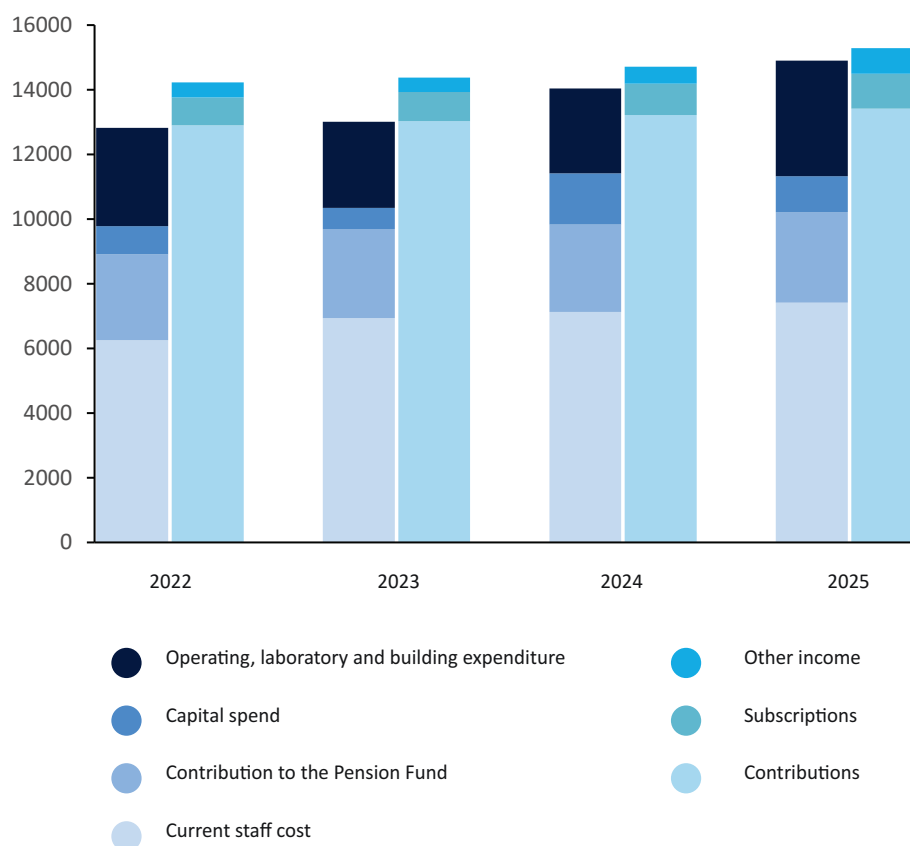
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Financial Summary

Revenue and expenditure (2022 to 2025)



in k€		2022	2023	2024	2025
	Operating, laboratory and building expenditure	3 045	2 657	2 623	3 578
	Capital spend	869	655	1 580	1 106
	Contribution to the Pension Fund	2 650	2 750	2 700	2 800
	Current staff cost	6 261	6 946	7 134	7 416
	Other income	466	442	522	790
	Subscriptions	867	906	968	1 077
	Contributions	12 897	13 026	13 221	13 419



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