

INTERNATIONAL REPORT

News from the BIPM—2008

Andrew Wallard

Director, Bureau International des Poids et Mesures (BIPM), Sèvres, France

A review of the year

In the year following a meeting of the General Conference on Weights and Measures (CGPM), much of the work of the management team is inevitably directed towards dealing with the financial and other consequences of its decisions. Laboratory work also continues and the BIPM staff remain heavily engaged in the management and piloting of comparisons as well as the development and evolution of reference facilities and the research needed to deliver the work programme approved by the CGPM.

As before, this report to readers of *Metrologia* first concentrates on an overview of many—but far from all—of the major activities and events of the past year. It concludes with a review of the scientific work.

BIPM's Programme of work for 2009–2012

In the light of the financial outcome of the 23rd meeting of the CGPM, it was clear that it would not be possible to implement the increased programme of work originally proposed for the period 2009–2012. Priorities therefore had to be set to match the work and resources to the financial income expected from Member States, Associates, and other sources. Whilst I am pleased to say that the vast majority of the BIPM's core scientific work will continue, some projects will be delayed until resources allow and some current activities will be terminated to allow the launch of higher priority projects.

The General Conference requested the BIPM Director and the CIPM to set priorities for the programme of work that will start in January 2009. This was achieved at the last meeting of the CIPM, in October 2008. Although a number of changes were made to the initially proposed programme, the BIPM will still deliver the majority of its proposed activities. This confidence is based on various assumptions about income from additional Member States, additional voluntary financial and other contributions, and a selective use of the reserves to fund major infrastructure projects or essential investments. I am especially grateful to a number of National Metrology Institutes (NMIs) and Member States who have supported the BIPM in bilateral arrangements, in aligning programmes of work to achieve common objectives, and in the supply of staff on secondment.

The top-priority scientific activities are our work on the watt balance and on the preparations for a redefinition of the kilogram. In the new programme, we shall collaborate closely with the National Physical Laboratory in the UK on a project concerned with the set of artefacts that will eventually represent the international prototype. The BIPM's watt balance will have an enlarged team and I aim to maintain the momentum because the BIPM's long-term commitment to a watt balance will be of increased importance as a number of NMIs with a watt balance currently assess their own commitments. We shall address the main challenges in time and frequency by adapting our scientific programme and making a number of internal financial savings, and will start a new project to investigate new ways of calibrating GPS and other receivers so as to reduce uncertainties in national time scales. A continuing project will also address the challenges of 'optical clocks' and their contribution to TAI. We will host the 2009 international comparison of gravimeters. The electrical metrology work programme will be adjusted so as to meet the scientific opportunities offered by new Josephson devices and the consequent needs for on-site comparisons. We also expect the demand for similar comparisons of quantum Hall devices to be satisfied. In parallel, we shall continue our work on an international reference facility based on the calculable capacitor. Chemical metrology will continue to grow, particularly organic chemistry. There will also be close collaborations with a number of NMIs. Ionizing Radiation work will focus on improvements to existing facilities and on the preparation of proposals to the next meeting of the CGPM for ways in which the challenge of linear-accelerator (linac) based dosimetry can be addressed. In the meantime, we shall carry out a number of linac-based measurements when there is time available on national machines.

In order to fund the new programme, and as a result of the prioritization, a number of activities have, inevitably, been stopped or delayed. Others will remain options for the 2013–2016 programme which will be proposed to the 2011 meeting of the CGPM. The facility for iodine cell preparation will close at the end of 2008, and the BIPM is discussing alternative arrangements for those NMIs and other users of this service who require iodine cells for stabilized lasers and gravimetry equipment. A number of other projects in gas metrology, electricity and ionizing radiation will not be pursued.

Despite these savings and the prioritization of the programme of work, the BIPM's scientific programme remains strong with a number of new staff to replace planned retirements, the recruitment of staff on short-term contracts, and some postdoctoral appointments. We shall also pursue our successful programme of secondments and are grateful to NMIs who are prepared to make their staff available to the BIPM.

The BIPM is planning an exciting series of workshops during the next four years. These include meetings to address needs in physiological quantities and to identify priorities for nanotechnology, and a number of other focused workshops.

The International System of Units (SI)

Little has changed in the overall approach to a potential redefinition of a number of SI units since the meeting of the Consultative Committee for Units (CCU) in June 2007. The position remains, therefore, that a kilogram redefinition based on the Planck constant, h , is to be preferred to one based on the Avogadro constant, N_A . The CCU also agreed with the Consultative Committee for Electricity and Magnetism (CCEM) that a definition of the ampere should be based on a fixed value of the elementary charge, e . The thermometry community, represented by the Consultative Committee for Thermometry (CCT), is actively addressing a redefinition of the kelvin based on the value of the Boltzmann constant, k_B . Within the next few years, new measurements of this constant are expected to allow an improved CODATA value.

At the time of writing, there is still not satisfactory convergence of the results from watt balance experiments and from the International Avogadro Coordination project which would give confidence in the selection of a value for the Planck constant. Both approaches are expected to produce new results in the next year or so, and the CIPM will continue to consider whether the time is right for a redefinition and for proposals to be made to the CGPM.

The CIPM Mutual Recognition Arrangement (CIPM MRA) and the JCRB

During the year, the number of signatories of the CIPM MRA rose to 74, from 45 Member States, 27 Associates of the CGPM and two international organizations, and it covers a further 122 Designated Institutes. Worldwide interest in the demonstrable equivalence between the realizations of the SI is increasing amongst accreditors, companies and other user communities. The BIPM therefore continues to promote the concept of traceability to the SI through the realizations made at NMIs and designated institutes, rather than to named institutes. This subtle but important step supports the contribution of the CIPM MRA to the reduction of technical barriers to trade.

At the time of writing, the number of CMC entries in the Key Comparison Database (KCDB) has risen to over 20 000.

The *KCDB Newsletter*—now in its tenth edition—continues to be used for the promotion of the work of the BIPM and the successes of the CIPM MRA in helping reduce

costs through the use of local NMIs as well as the scientific benefits of increased confidence in measurement capabilities.

As the CIPM and the International Laboratory Accreditation Cooperation (ILAC) have agreed on a common definition and understanding of the term Calibration and Measurement Capability (CMC), this term will gradually replace Best Measurement Capability (BMC) which has been in use in the accreditation community for many years. Both the CIPM and the ILAC hope that any confusion in the marketplace will now be avoided and that the NMI and accredited laboratory communities can work together to ensure robust traceability of measurement results from accredited laboratories to the SI through its realizations by the NMIs. In consequence, the CIPM's Consultative Committees are now studying related initiatives to address the contribution of the 'device under test' to the uncertainties which should be associated with calibrations. They are also identifying a broader range of service level categories for CMCs which will help meet the needs of a number of NMIs as well as harmonize the scopes of accredited laboratories with the CMCs declared by NMIs.

During the past year, the CIPM also approved two web-based documents: a guide to current policy decisions in relation to the CIPM MRA, and a summary of the procedures for creating and processing CMCs. These documents are available in the CIPM MRA area of the BIPM's website (www.bipm.org/en/cipm-mra/documents/).

The Joint Committee of the BIPM and the Regional Metrology Organizations (JCRB) continues to oversee the operational aspects of the CIPM MRA. I am pleased to note the creation of AFRIMETS in the African continent, as a result of which a number of States are expressing interest in becoming either a Member State of the BIPM or an Associate of the CGPM. Similar initiatives are afoot in the Gulf Region and the JCRB has met with representatives of GULFMET.

Member States and Associates

The number of Members of the BIPM remains static at 51. However, there has been an increase to 27 in the number of Associate States and Economies, with the association of Bolivia and Georgia to the CGPM during 2008. The BIPM is in touch with a number of other States that have declared their intention to become either Members of the BIPM or Associates of the CGPM as well as with some current Associates that are considering becoming Members. I am therefore very optimistic that, in the December 2009 report to *Metrologia*, I shall be able to report the first increase in the number of Members since the accessions of Greece and Malaysia in 2001.

Meeting of the CIPM

The 97th meeting of the CIPM took place in October 2008. Drs Kwang Hwa Chung, Hector Nava Jaimes and Willie E May took up their seats for the first time, and we welcome them to the Committee.

As reported above, the main decisions concerned the prioritization of the BIPM's programme of work for 2009–2012. However, the CIPM also approved the new Regional

Metrology Organization, AFRIMETS, as a successor to SADC MET and as a member of the JCRB. It also approved plans for a major event to mark a decade of the CIPM MRA through a major conference and workshop in October 2009.

Other policy decisions and discussions included the criteria to be used to approve new RMOs, the policy to be adopted by NMIs when stating their traceability to the SI when they declare CMCs, and a number of issues relating to the application of the CIPM MRA.

Joint Committee for Guides in Metrology (JCGM)

A major achievement of the year was the finalization, and publication on the BIPM website, of the 3rd edition of the VIM (*International Vocabulary of Metrology—Basic and General Concepts and Associated Terms*). This edition changes the treatment of measurement uncertainty from an Error Approach (sometimes called Traditional Approach or True Value Approach) to an Uncertainty Approach and therefore necessitated reconsideration of some of the related concepts appearing in the 2nd edition of the VIM. It also took the opportunity of including more terms of value to the chemical community. The ‘VIM3’ has been adopted by the BIPM and placed on its website for free access by the metrology community (www.bipm.org/en/publications/guides/; see JCGM 200:2008). The Working Group on the Expression of Uncertainty in Measurement, the GUM, also finalized its work on a first supplement to the GUM, dealing with Monte Carlo methods. This supplement to the GUM has also been adopted by the BIPM and published on its website (www.bipm.org/en/publications/guides/; see JCGM 101:2008).

At the meeting of the JCGM in December 2008, approval was given to a proposal to review the GUM and a proposal to review and eventually update the VIM. The latter would take several years and initial consideration would be given to whether ordinal and nominal terms should be included. The JCGM approved the establishment of an *ad hoc* working group to consider a number of activities in relation to metrological software.

Joint Committee for Traceability in Laboratory Medicine (JCTLM)

In December 2008, the Executive Committee of the JCTLM discussed reports from its two working groups and reviewed the status of the revisions of ISO 15194 and 15193, both of which are key to the Joint Committee’s work. The Committee was also concerned to see faster progress on the accreditation of reference laboratories to ISO 15195. The Executive Committee meeting was followed by a workshop on the current state of national and international systems for traceability and discussed options for the preparation of a policy and discussion paper for decision makers on the need for greater attention to traceability in the clinical and laboratory medicine communities.

Liaison with intergovernmental organizations and international bodies

International coordination and liaison continues to consume some 20% of our resources, distributed between general liaison activity and technical knowledge transfer from the science sections.

I am pleased to report further progress on the study by the CIPM on measurement and traceability needs in materials science. This led to a decision to ask VAMAS to identify priority topics and for a liaison to be created between VAMAS and the relevant Consultative Committees. With this in mind, a Memorandum of Understanding has been signed between the BIPM and VAMAS. Similarly, progress has been made with the WMO in moving towards agreement on the arrangements for their signature of the CIPM MRA. These special arrangements are necessary since the WMO, unlike the other international bodies which have become signatories, has no laboratories of its own. The BIPM is also working with the WMO to plan a meeting on metrology and climate change in 2010. Finally, the BIPM has also signed a Memorandum of Understanding with the United Nations Industrial Development Organization (UNIDO) within which the two organizations will collaborate on UNIDO-funded activities to help strengthen metrology infrastructures in a number of regions and also to promote the relevance of metrology to trade and capacity building.

BIPM Metrology Summer School

I am delighted to report a very successful Second BIPM Metrology Summer School in July 2008. Ninety students from some 30 countries spent two weeks at the BIPM, during which there were 45 lectures and workshops. Speakers were largely drawn from NMIs but also included three Nobel Prize winners and other special guest speakers. The feedback has been excellent, with a high level of satisfaction among students as well as among the lecturers, several of whom spent several days at the BIPM. Although the organization of a Summer School like this consumes considerable staff and financial resources, I believe it is a valuable service for the NMIs of Member States and Associates, and is a unique opportunity for young metrologists to gain a wide perspective of the current state of the art.

World Metrology Day (WMD)

The 2008 theme was ‘No games without measurements’, capitalizing on the Beijing Olympic Games. The success of, and enthusiasm for, this event has surpassed all my expectations. The BIPM is working with a greater number of NMIs and other partners; the BIPM Director’s message was translated into 28 different languages and there were 84 different language versions of the posters that were produced. I received many reports of national events that were built around WMD and look forward to expanding its impact and the collaborators in 2009 when the central theme will be structured around metrology and commerce, and will celebrate nearly ten years of the CIPM MRA.

BIPM's measurement services and Quality System

The BIPM continues to provide a limited number of measurement services for NMIs from Member States. All its external, as well as a number of its internal, services satisfy the requirements of the BIPM's self-declared ISO/IEC 17025 Quality System. The BIPM will present its Quality System to RMO experts at a meeting in 2009.

The CIPM also approved a proposal to place the uncertainties associated with the BIPM's calibration and measurement services clearly on the BIPM website, to have them reviewed by Consultative Committees, and to create a link between the relevant pages on the KCDB and this list of uncertainties. This will be implemented early in 2009.

BIPM staff matters

In May 2008, a new set of Staff Regulations and Rules came into force after approval by the CIPM in February 2008. The new Regulations, which were the subject of extensive and thorough consultation with the relevant staff commissions, brought the previous Statute up to date and clarified a number of areas.

In June 2008, an Amendment to the Headquarters Agreement between the BIPM and the French Government was ratified by the French Parliament. The Amendment, amongst other things, provides for the recognition of the jurisdiction of an international administrative tribunal for staff disputes. In the case of the BIPM, as with many other intergovernmental organizations, the BIPM now recognizes the jurisdiction of the Administrative Tribunal of the International Labour Organization (ILO).

Science at the BIPM

Mass

Much of our work may be viewed as preparation for a possible redefinition of the kilogram, which may occur as early as 2011. We continue to lead the tasks involving mass metrology within the framework of the International Avogadro Coordination (IAC) project. This work has recently been complemented by our participation in the iMERA-Plus project of EURAMET. Experience gained in the Avogadro work is directly relevant to the development of the *mise en pratique* for a new kilogram definition. Our future work in this area will be in close coordination with a new Task Groups of the CCM Working Group on Mass Standards. Both Task Groups held their first organizational meetings in April 2008. Other pertinent work this year includes provision of sorption artefacts to interested laboratories working on watt balances and the IAC, and installation of a glove box that will form part of a system to transfer mass standards maintained under an inert atmosphere.

We have continued to perform calibrations of 1 kg prototypes and other mass standards. However, routine quality checks of these measurements revealed unexpected changes to our working standards. The issuing of certificates has therefore been suspended until the recent history of our working standards is re-established.

At the request of the NPL, we have compared the so-called 'BIPM method' for cleaning/washing 1 kg prototypes with a method developed by the NPL based on ultraviolet light and ozone. The NPL cleaning apparatus was transported to the BIPM for this study. The results are still being evaluated, but should provide useful information for the Task Groups mentioned above.

An automated weight exchanger has been installed for our 100 g balance and is being instrumented. When completed, the new facility will increase our efficiency in providing internal calibrations in the range 100 g to 5 g, for ourselves and other scientific sections.

Two notable publications this year have been the new CIPM-2007 formula for the density of moist air and the report of a supplementary comparison with the LNE to validate our internal pressure calibrations.

Three of our staff of five persons have devoted between 60% and 100% of their time to the watt balance experiment.

Time, frequency and gravimetry

The international time scales TAI and UTC are computed each month, and the results are published in *Circular T*, which serves as the monthly update of key comparison CCTF-K001.UTC (new name given for CCTF-K2001UTC). The stability of TAI, expressed in terms of an Allan deviation, is estimated to be at, or below, 0.4×10^{-15} for averaging times of one month. Twelve primary frequency standards contributed during the period of this report to improving the accuracy of TAI, including eight caesium fountains (IT CSF1, LNE-SYRTE FO1, LNE-SYRTE FO2, LNE-SYRTE FOM, NICT CSF1, NIST-F1, NMIJ F1 and NPL CSF1). A total correction of -3.6×10^{-15} has been applied throughout the year to $[f(\text{EAL}) - f(\text{TAI})]$. Since July 2007, the scale unit of TAI has been estimated to match the SI second to about 1×10^{-15} .

Studies on the use of phase measurements along with the code measurements of geodetic-type GPS receivers have concluded, and solutions based on this method (TAI PPP) have been computed in the Section since October 2007 to complete the analysis. In April 2008, a pilot experiment started with the participation of 25 laboratories for studying the introduction of PPP links in TAI. Extensive comparisons of the different techniques and methods for clock comparisons are computed regularly and published on the internet.

Calibration programmes of different types of GPS receivers have been organized and run by the Section. The implementation of a method for the calibration of GLONASS equipment in cooperation with a national laboratory has been concluded, and routine calibrations are in preparation for the second half of 2008.

Support has been provided to the Joint CCL/CCTF Frequency Standards Working Group, in which some members of the staff have responsibilities.

Research work in the Section is dedicated to space-time reference systems. The cooperation with the USNO (United States) for the provision of the Conventions Product Centre of the International Earth Rotation and Reference

Systems Service (IERS) is continuing; a workshop on the IERS Conventions took place at the BIPM in September 2007.

Based on the new protocol elaborated by staff of the Section, the key comparison of stabilized lasers renamed CCL-K11 took place in the MIKES (Finland) with the BEV (Austria) acting as pilot laboratory. A member of staff attended the first run of this comparison to provide expertise. The Section has also provided calibration and measurement service of lasers for both internal and external users.

An important number of requests for iodine cells have been satisfied in the year covered by this report. Many of the demands concern specially designed cells with particular geometries.

The work on the gravimeter FG5-108 being made in cooperation with the VNIIM (Russian Federation) is progressing. In particular, the system for delivering the laser light to the interferometer is under development, and the dropping chamber has been repaired and tested.

Members of the staff participate in activities linked to the special projects at the BIPM. Preliminary studies on the gravimetric equipment and environmental effects on gravity for the watt balance have begun. Work on the construction of the interferometer for the length measurement in the calculable capacitor has progressed during the period of this report.

The Section's staff remained very active in the field of international coordination needed to accomplish the tasks conferred by the Member States. As part of this activity, the physicists of the Section have been widely invited to give lectures at conferences and invited to visit national laboratories. A significant number of articles have been written within the period of this report, and 19 have recently been published with another nine in press at the moment of writing this report.

Special attention has been provided to training activities for physicists and technicians with the aim of broadening their capacities for the work for which they are responsible.

Electricity

During the period of this report, the Electricity section carried out two on-site Josephson comparisons, three comparisons with Zener voltage transfer standards, three comparisons with resistance transfer standards and two comparisons with capacitance transfer standards. The resistance comparison with the NIST will allow us to link the results of the SIM.EM-K1 comparison, with six participants, to the ongoing BIPM key comparison BIPM.EM-K13.a. The capacitance comparison with the NIST had been initiated by the BIPM to verify our measurement uncertainties after the recent changes of staff and the modifications of the measurement systems.

The key comparison of the conventional Josephson arrays of the BIPM and the LNE was followed by a 'scientific' comparison of our 10 V programmable SINIS array, offered by PTB, with the conventional array of the LNE. Both arrays were found to be in excellent agreement within an exceptionally small uncertainty. This is only the second time that agreement between the voltages realized with the traditional arrays and the new type of programmable SINIS arrays has been demonstrated at the level of 10 V.

In the field of impedance metrology, new ac–dc transfer resistors with improved stability have been introduced in the work with the quadrature bridge. This reduces the main uncertainty component in the traceability chain from the quantum Hall resistance standard to capacitance. Statistical techniques, which were developed recently in the section to treat correlated time series, were applied to measurements made with our impedance bridges and led to a better understanding of their statistical uncertainties. A good agreement was obtained between the predictions of these techniques on the influence of a low pass filter, and experiment. These studies allow reliable determinations of Type A uncertainties of our bridge measurements in the presence of time correlations.

The preparations for the start of measurements with the calculable capacitor are now finished and we are waiting for the instrument to arrive. Work has started on the fabrication of a Josephson voltage standard for the watt balance experiment, based on an SNS array, offered by NIST.

During the year 2007 the Electricity section has provided 49 calibrations certificates and three study notes for 15 NMIs of Member States. Calibrations are carried out for voltage (1.018 V and 10 V), resistance (1 Ω , 100 Ω and 10 k Ω) and capacitance (1 pF, 10 pF and 100 pF) and are offered mainly to smaller NMIs that do not yet possess their own primary standards.

Calculable capacitor. In collaboration with the NMIA of Australia, the BIPM is building two calculable capacitors of an improved design to measure the von Klitzing constant with an uncertainty of the order of 1 part in 10^8 to contribute to the next CODATA adjustment of the fundamental constants.

In September 2007 we received the two frequency doubled Nd:YVO₄ lasers needed to measure, by interferometry, the electrode spacing in the two instruments. The characteristics of the laser beams have been studied with a wavefront sensor to determine the optical system needed to couple the laser beam into a fibre delivering the light to the interferometer. A test bench for studying the properties of the interferometer has been set up and first measurements of the interference fringes were made. The electrical measurement systems, which will link the quantized Hall resistance with the calculable capacitance, have been improved to reduce the related uncertainty, which is expected to dominate the uncertainty of this experiment. The workshop of the BIPM has continued to fabricate a large number of parts.

Watt balance. During the period of this report, the staffing situation has improved with the arrival of an assistant, who works nearly full-time on the project, a research fellow on a two-year contract and a secondment from the NMIJ who worked at the BIPM for seven months. We have continued the development of the room temperature experiment, which will be followed at a later stage by a cryogenic experiment, to test the feasibility of simultaneous force and velocity measurements.

The main objective of the year 2007 was to carry out the first measurements of the voltage/velocity ratio, which

has been achieved with a relative standard deviation between different measurements of the order of 1 part in 10^4 . The coil suspension has been improved to reduce the undesired coil movement in the five degrees of freedom resulting from a non-perfect vertical movement. Further work on the current source has allowed us to reduce its long-term drift to about 1 part in 10^9 per minute, and to achieve a satisfactory short-term stability. A technique needed to separate the voltage induced in the coil from the voltage drop due to the current flow, based on the use of a second, non-inductive coil, has been tested and is being integrated into the apparatus.

Work has started on the geometrical and magnetic characterization of a large precision solenoid which will become the reference for the magnetic field alignment.

The collaboration with the Machine Tools Department of the Technical University of Aachen (RWTH/WZL) on the fabrication of the magnet is continuing. During the year 2008, detailed mechanical drawings for the fabrication of the magnetic circuit and the assembly devices will be provided. Preparations have been made for the installation of a vibration isolation base in the future watt balance laboratory.

Ionizing radiation

The new value for air kerma in ^{60}Co gamma fields for radiotherapy was adopted on 1 November 2007 following the publication of the re-evaluation of the BIPM standard in *Metrologia*. This was in accordance with the recommendation of the CCRI. In parallel, the higher activity (CIS-Bio) ^{60}Co source was adopted as the reference field. A new series of BIPM graphite cavity primary standards is under construction and the first chambers agree with the variable-volume chamber at the level of 2 parts in 10^4 .

The results of a study of low pressure (60 kPa) effects on graphite cavity standards, which was carried out in conjunction with some calibrations for the ININ (Mexico), have implications for all graphite-walled standards at the level of several parts in 10^3 , and further work is planned.

The results of a significant study of aperture effects (transmission, scatter and fluorescence) were presented to the KCWG(I) and have been prepared for publication prior to proposing a change of up to 7 parts in 10^3 to the medium-energy air-kerma standard at the CCRI in 2009.

The prototype graphite calorimeter for absorbed dose to water is now constructed and the first trials show that the novel design works well in practice in terms of absorbed dose to graphite. The CCRI Accelerator Dosimetry Working Group has recommended recently that the BIPM calorimeter be used in a series of bilateral comparisons at the eight NMIs that have accelerators. The calorimeter will be tested in a trial comparison at the LNE-LNHB (France) later this year before this series of on-going comparisons is launched.

The primary standard free air chamber for mammography dosimetry does not appear to be as stable as the existing low-energy free air standard and this is under investigation. The mammography comparison facility will then be completed.

Three new dosimetry comparisons have been made and three other comparison reports have been published. We have

just now succeeded in obtaining a guest scientist, from the ININ (Mexico), for the project on the CCRI brachytherapy comparisons, so progress should now be made. Twenty-eight national secondary standards have been calibrated and the Quality System for calibrations successfully underwent its internal audit. Support for the IAEA continues with regular irradiations for their TLD measurement service.

Last year, only five laboratories submitted eleven ampoules to eight of the BIPM ongoing activity comparisons using the International Reference System (SIR). The implication is that the NMIs are finding it more difficult to comply with the transport regulations and may now be relying more on the 'Measurement methods grouping criteria for radionuclides', to support their CMCs. However, as 24 old comparison results will disappear from the KCDB this year there may be a resurgence of submissions next year. Impurity activity levels were measured using the BIPM Ge(Li) gamma spectrometer for four radionuclides submitted for comparisons, and a guest worker from Albania is presently calibrating the replacement HpGe spectrometer. The BIPM is grateful to the NPL (UK) for their generous donation of over 5000 glass ampoules which will assure the SIR's continuation. An internal audit of the SIR was successful and the new SIR measurement system has been adopted with the final verification due at the end of 2008.

Studies of ^{85}Kr measurements in the SIR are continuing and the SIR Transfer Instrument has been tested for the short-lived $^{99}\text{Tc}^m$ radionuclide at the NPL prior to making comparisons at more distant NMIs. We have devoted much effort to the extension of the SIR for pure beta emitters and the system should be in place by the end of the present programme. The BIPM is presently piloting two CCRI key comparisons and completing the reports for some earlier radionuclide activity comparisons.

Chemistry

The Chemistry section has consolidated its programme in gas metrology in support of the international comparability of gas standards for air quality and greenhouse gas monitoring, and in primary calibrator comparisons for organic analytes in support of clinical, food analysis and forensic applications. The Section is running or has completed six international comparisons in support of these areas during the time period covered by the report. The BIPM Chemistry section actively supports the Consultative Committee for Amount of Substance (CCQM), participating in its yearly meetings and biannual meetings of its working groups.

The first two-year cycle of the on-going key comparison BIPM.QM-K1—Ozone at ambient level—was launched in January 2007, and since July 2007, eight laboratories have brought their ozone standards to the BIPM, and two others have participated in linking RMO comparisons. Two national ozone reference standards have had upgrade kits fitted to them in order to correct for systematic biases identified by the BIPM and the NIST.

The programme to develop a candidate primary ozone photometer based on a laser light source has continued, with

a strong focus on reducing the noise level of the system. The frequency doubling crystal included in the argon laser head has been replaced by one at the shorter wavelength of 244 nm, and measured ozone mole fractions are within 5% of the values obtained using the Hg lamp-based standard reference photometer (SRP).

A third validation study of the NO₂ facility in support of the BIPM-coordinated pilot study (CCQM-P110—Nitrogen dioxide 10 μmol/mol) has been completed. It includes the comparison of five NO₂ primary gas standards with dynamic gas mixtures produced by the NO₂ facility, and on-line measurements using the FTIR facility, which has been improved.

The final report of the BIPM coordinated study, CCQM-P73 on nitrogen monoxide standards, performed over the period August 2006–October 2007, was published in the *Metrologia Technical Supplement*.

The Organic Analysis Programme within the Chemistry section coordinates CCQM comparisons of the purity assessment of organic compounds, for use as primary calibrators. The analytical capabilities within the Programme were enhanced in 2007–2008 by the acquisition of a photo-ionisation source for use with the existing QTrap LC-MS/MS system, a stand-alone Agilent Rapid Resolution LC-UV system and a dynamic vapour sorption balance.

Development and validation of analytical methods required for use in the characterization and production of the cardiac glycoside CCQM-P20.f pilot study material have been completed, and validation activities broadened to incorporate the planned CCQM-K55.a key comparison on pure steroid hormones.

In the second half of 2007, the homogeneity and stability assessments of the digoxin candidate materials for CCQM-P20.f, the second CCQM comparison coordinated by BIPM, were completed, and the material distributed to NMIs. A significant level of residual organic solvent was also present

in the material, but detected only by a small number of laboratories. The Draft B report is currently in preparation.

The first round of the organic purity assignment key comparison, CCQM-K55.a, will be coordinated by the BIPM. The steroid 17β-estradiol will be the principal component of the study material. The candidate material has been prepared by and supplied to the BIPM by collaborators from the Organic Analytical Chemistry division at the NMIJ (Japan), and is currently undergoing characterization at the BIPM.

As part of their planning for future key comparisons, the CCQM Organic Analysis Working Group (OAWG) identified purity assessment as being a core technical capability. The OAWG has recommended that participation in CCQM-K55 be compulsory for all NMIs which have activities or make CMC claims in the area of organic analysis.

As part of the activities in support of the JCTLM, a symposium on ‘Activities and Challenges for Traceability and Standardization in Laboratory Medicine’ was organized in Beijing in October 2007, in collaboration with colleagues from the NIM and the NIST. Procedures for the operation of the JCTLM Secretariat were presented to the JCTLM Executive for their approval, during their sixth meeting. The JCTLM Database website available at www.bipm.org/jctlm/ was modified to include the reference measurement laboratory services as a searchable category to the database. The total number of external connections to the JCTLM Database website has increased from July 2007 to May 2008. This corresponds to about 1300 visits each month as of May 2008.

A workshop on ‘Method Performance and Measurement Uncertainty’ was organized by the BIPM Chemistry section in collaboration with other international organizations for Government delegates to the Codex Alimentarius Commission’s Committee on Methods of Analysis and Sampling in April 2008. In November 2008 a successful workshop was held in conjunction with the US Pharmacopoeia.