Bureau international des poids et mesures

Director's Report on the Activity and Management of the International Bureau of Weights and Measures

(1 July 2010 – 31 December 2011)

Note on the use of the English text

To make its work more widely accessible the International Committee for Weights and Measures publishes an English version of these reports.

Readers should note that the official record is always that of the French text. This must be used when an authoritative reference is required or when there is doubt about the interpretation of the text.

I am pleased to present the Director's Report on the Activity and Management of the International Bureau of Weights and Measures (BIPM) for the period 1 July 2010 to 31 December 2011. Readers will notice that the report has been produced in a new format which I hope presents the information in a more concise and readable manner.

Readers will also note that this report covers an 18 month period (1 July 2010 to 31 December 2011) rather than the traditional period of July to June. The current Director's Report is a transitional edition which will allow future editions to cover full calendar years. This change to cover full calendar years allows synchronization of the Director's Report with other BIPM reports which cover calendar years (for example the *Rapport annuel aux Gouvernements des Hautes Parties contractantes sur la situation administrative et financière du Bureau international des poids et mesures*).

Section 2 of this report includes summaries of the work of the BIPM's scientific Departments (Mass, Time, Electricity, Ionizing Radiation and Chemistry) and the watt balance. With this and future editions of the Director's Report, full reports of the activities undertaken by each scientific department, which were previously included in the printed report, will be available in electronic format only on the BIPM website at www.bipm.org/en/publications/directors_report/.

TABLE OF CONTENTS

STATES PARTIES TO THE METRE CONVENTION AND ASSOCIATES OF THE GENERAL CONFERENCE ON WEIGHTS AND MEASURES

as of 31 December 2011

States Parties to the Metre Convention

Argentina
Australia
Austria
Belgium
Brazil
Bulgaria
Cameroon
Canada
Chile
China
Croatia
Czech Republic
Democratic People's Republic of Korea
Denmark
Dominican Republic
Egypt
Finland
France
Germany
Greece
Hungary
India
Indonesia
Iran (Islamic Republic of)
Ireland
Israel
Italy
Japan
Kazakhstan
Kenya
Malaysia
Mexico
Netherlands
New Zealand
Norway
Pakistan
Poland
Portugal
Republic of Korea
Romania
Russian Federation
Saudi Arabia
Serbia
Singapore
Slovakia
South Africa
Spain
Sweden
Switzerland
Thailand
Turkey
United Kingdom of Great Britain and Northern Ireland
United States of America
Uruguay
Venezuela (Bolivarian Republic of)

Associates of the General Conference on Weights and Measures

Albania
Bangladesh
Belarus
Bolivia (Plurinational State of)
Bosnia and Herzegovina
CARICOM
Chinese Taipei
Costa Rica
Cuba
Ecuador
Estonia
Georgia
Ghana
Hong Kong (China)
Jamaica
Latvia
Lithuania
Malta
Mauritius
Montenegro
Panama
Paraguay
Peru
Philippines
Republic of Moldova
Seychelles
Slovenia
Sri Lanka
The former Yugoslav Republic of Macedonia
Tunisia
Ukraine
Viet Nam
Zambia
Zimbabwe

THE BIPM

International Bureau of Weights and Measures (BIPM)

The International Bureau of Weights and Measures (BIPM) was created by the Metre Convention signed in Paris on 20 May 1875 by seventeen States during the final session of the diplomatic Conference of the Metre. This Convention was amended in 1921. As at 31 December 2011, there were 55 States Parties to the Metre Convention and 34 Associate States and Economies of the General Conference on Weights and Measures (CGPM).

The BIPM has its headquarters near Paris, in the grounds of the Pavillon de Breteuil (Domaine national de Saint-Cloud) placed at its disposal by the French Government; its upkeep is financed jointly by the Member States.

The task of the BIPM is to ensure world-wide uniformity of measurement; its function is thus to:

- establish fundamental standards and reference scales for the measurement of a number of principal physical quantities and maintain the international prototypes;
- carry out comparisons of national standards maintained by its Member States, using unique international reference facilities;
- ensure the coordination of the development of appropriate measurement techniques;
- carry out and coordinate measurements of the fundamental physical constants relevant to these activities.

The BIPM operates under the exclusive direction and supervision of the International Committee for Weights and Measures (CIPM), which itself comes under the authority of the CGPM and reports to it on the work accomplished by the BIPM.

The activities of the BIPM, which in the beginning were limited to measurements of length and mass, and to metrological studies in relation to these quantities, have been extended to standards of measurement of electricity (1927), photometry and radiometry (1937), ionizing radiation (1960), time scales (1988) and to chemistry (2000). To this end the original laboratories, built in 1876 -1878, were enlarged in 1929; new buildings were constructed in 1963-1964 for the ionizing radiation laboratories, in 1984 for the laser work and in 1988 for a library and offices. In 2001 a new building for the workshop, offices and meeting rooms was opened.

More than 70 staff members, including scientists, work at the BIPM. The scientific staff members mainly conduct international comparisons of national realizations of units, calibrations of standards and scientific work in the field of metrology. This annual report, entitled *Director's Report on the Activity and Management of the International Bureau of Weights and Measures*, gives details of the work in progress.

International Committee for Weights and Measures (CIPM)

The International Committee for Weights and Measures (CIPM) is the supervisory organ of the BIPM. It has eighteen members each being of different nationality and, at present, meets every year.

The CIPM submits to the Governments of the Member States an annual report on the administrative and financial situation of the BIPM and drafts the resolutions to be deliberated at the meetings of the CGPM.

The bureau of the CIPM is made up of the President, Secretary and Vice-Presidents of the CIPM. It meets with the BIPM Director generally three times a year. The bureau prepares the agenda and papers for the CIPM meeting as well as advising the Director on matters related to the running of the BIPM and decisions of the CIPM.

The President of the CIPM presents a report to the General Conference at each meeting on activities since the previous CGPM.

The General Conference on Weights and Measures (CGPM)

The CGPM is made up of delegates from all Member States and meets usually every four years. Its mission is to:

- discuss and initiate the arrangements required to ensure the propagation and improvement of the International System of Units (SI), which is the modern form of the metric system;
- confirm the results of new fundamental metrological determinations and various scientific resolutions of international scope;
- take all major decisions concerning the finance, organization and development of the BIPM.

Consultative Committees (CCs)

Following the extension of the work entrusted to the BIPM in 1927, the CIPM has set up bodies, known as Consultative Committees, whose function is to provide it with information on matters that it refers to them for study and advice. These Consultative Committees, which may form temporary or permanent working groups to study special topics, are responsible for coordinating the international work carried out in their respective fields and for proposing recommendations to the CIPM concerning units.

The Consultative Committees have common regulations (*Rules of procedure for the Consultative Committees (CCs) created by the CIPM, CC working groups and CC workshops*, 2009, CIPM-D-01). They meet at irregular intervals. The president of each Consultative Committee is designated by the CIPM and is normally a member of the CIPM. The Director of the BIPM is a member, *ex officio*, of all Consultative Committees. The members of the Consultative Committees are metrology laboratories and specialized institutes, agreed by the CIPM, which send delegates of their choice. In addition, there are individual members appointed by the CIPM. The Executive Secretaries of the Consultative Committees are members of the scientific staff of the BIPM.

At present, there are ten such committees:

1. The Consultative Committee for Electricity and Magnetism (CCEM), new name given in 1997 to the Consultative Committee for Electricity (CCE) set up in 1927.
2. The Consultative Committee for Photometry and Radiometry (CCPR), new name given in 1971 to the Consultative Committee for Photometry (CCP) set up in 1933 (between 1930 and 1933 the CCE dealt with matters concerning photometry).
3. The Consultative Committee for Thermometry (CCT), set up in 1937.
4. The Consultative Committee for Length (CCL), new name given in 1997 to the Consultative Committee for the Definition of the Metre (CCDM), set up in 1952.
5. The Consultative Committee for Time and Frequency (CCTF), new name given in 1997 to the Consultative Committee for the Definition of the Second (CCDS) set up in 1956.

6. The Consultative Committee for Ionizing Radiation (CCRI), new name given in 1997 to the Consultative Committee for Standards of Ionizing Radiation (CCEMRI) set up in 1958 (in 1969 this committee established four sections: Section I (X- and γ-rays, charged particles), Section II (Measurement of radionuclides), Section III (Neutron measurements), Section IV (α-energy standards); in 1975 this last section was dissolved and Section II was made responsible for its field of activity).
7. The Consultative Committee for Units (CCU), set up in 1964 (this committee replaced the "Commission for the System of Units" set up by the CIPM in 1954).
8. The Consultative Committee for Mass and Related Quantities (CCM), set up in 1980.
9. The Consultative Committee for Amount of Substance: Metrology in chemistry (CCQM), set up in 1993.
10. The Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV), set up in 1999.

Publications of the BIPM

The proceedings of the meetings of the General Conference and the CIPM are published in the following series:

- *Comptes rendus des séances de la Conférence générale des poids et mesures*;
- *Procès-verbaux des séances du Comité international des poids et mesures.*

The CIPM decided in 2003 that the reports of meetings of the Consultative Committees should no longer be printed, but would be published on the BIPM website, in their original language.

The BIPM also publishes monographs on special metrological subjects, and a brochure entitled *The International System of Units* (*SI*), in which are collected all the decisions and recommendations concerning units.

The scientific work of the BIPM is published in the open scientific literature and an annual list of publications appears in the *Director's Report on the Activity and Management of the International Bureau of Weights and Measures*.

Since 1965 *Metrologia*, an international journal published under the auspices of the CIPM, has printed articles dealing with scientific metrology, improvements in methods of measurement, work on standards and units, as well as reports concerning the activities, decisions and recommendations of the BIPM.

CIPM Mutual Recognition Arrangement (CIPM MRA) and the BIPM key comparison database (KCDB)

In 1999, the CIPM established a Mutual Recognition Arrangement of national measurement standards and of calibration and measurement certificates issued by National Metrology Institutes (NMI) (CIPM MRA). Signature of this Arrangement commits NMIs to:

- accept the process specified in the CIPM MRA for establishing a database, which is maintained by the BIPM and publicly available on the Web;
- recognize the results of comparisons published in the database;
- recognize the calibration and measurement capabilities of other participating NMIs as stated in the database.

The BIPM key comparison database (KCDB) is managed by the BIPM and is openly available on the Web. It constitutes the technical basis for the CIPM MRA, giving access to the list of participating laboratories, and including the results of international comparisons, once interpreted in terms of equivalence, and also the approved Calibration and Measurement Capabilities (CMCs).

STAFF OF THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES

as of 31 December 2011

Director: Prof. M. Kühne

Mass: Mr A. Picard

Ms P. Barat, Dr H. Fang, Mrs C. Goyon-Taillade, Mr F. Idrees[1], Mr A. Kiss, Dr E. de Mirandés

Time: Dr E.F. Arias

Ms A. Harmegnies, Dr Z. Jiang, Ms H. Konaté, Dr W. Lewandowski, Dr G. Panfilo, Dr G. Petit, Dr L. Robertsson, Mr L. Tisserand

Electricity: Dr M. Stock

Mr R. Chayramy, Mr N.E. Fletcher, Mr R. Goebel, Mr A. Jaouen[2], Mr B. Rolland, Dr S. Solve

Ionizing radiation: Dr P.J. Allisy-Roberts

Dr D.T. Burns, Mr S. Courte, Ms C. Kessler, Dr C. Michotte, Mr M. Nonis, Dr S. Picard, Dr G. Ratel, Mr P. Roger

Chemistry: Dr R.I. Wielgosz

Ms T. Choteau, Ms A. Daireaux, Dr E. Flores Jardines, Dr R.D. Josephs, Mr P. Moussay, Dr N. Stoppacher, Dr J. Viallon, Dr S.W. Westwood

Finance, administration and general services: Mrs B. Perent

Ms I. Andernack, Ms S. Arlen, Mr F. Ausset, Mrs A. Da Ponte, Mrs L. Dell'Oro, Mr C. Dias Nunes, Mrs D. Etter, Mrs M.-J. Fernandes, Mrs M.-J. Martin, Mrs A. Mendes de Matos, Mrs I. Neves, Mr A. Zongo

Communication and information: Mrs F. Joly

Ms N. De Sousa Dias, Mrs C. Fellag Ariouet, Mrs F. de Hargues, Mr L. Le Mée, Dr J.R. Miles, Mr T. Nguyen, Ms C. Planche, Mr R. Sitton

Quality, Health and Safety: Mr B. Coehlo

International coordination and liaison

Mr A.S. Henson, Dr S. Maniguet[1], Dr C. Thomas[3]

1 Also Chemistry

2 Under the invalidity scheme

3 Also Publications

Workshop and site maintenance: Mr A. Dupire

Mr P. Benoit, Mr F. Boyer, Mr M. de Carvalho[2], Mr E. Dominguez[4], Mr P. Lemartrier, Mr C. Neves[4], Mr S. Segura, Mr B. Vincent

Emeritus directors: Dr T.J. Quinn, Prof. A.J. Wallard

Honorary Principal Research Physicist: Dr R.S. Davis

2 Under the invalidity scheme

4 Also General Services

Director's Report
on the Activity and Management
of the International Bureau
# of Weights and Measures

(1 July 2010 – 31 December 2011)

1 INTRODUCTION

1.1 General introduction and overview of the period 1 July 2010 to 31 December 2011

As I have only recently taken up the position of Director of the BIPM, on 1 January 2011, I would like to briefly introduce myself before turning to the annual report. I am a physicist who, after obtaining a PhD from the University of Hannover in Germany in 1977, started my working life as a metrologist at the Physikalisch-Technische Bundesanstalt (PTB), the German national metrology institute. I worked initially in the field of EUV-radiometry and then in 1991 moved to thermometry. In 2003 I joined the senior management team of PTB, becoming a Member of the Presidential Board (equivalent to second vice-president). In 2006 I was elected as Chairperson of EUROMET and in 2007 became the Chairperson of EURAMET, its successor organization. My major task at EURAMET was to prepare the structures and processes that were needed for the realization of the European Metrology Research Programme (EMRP). In 2009 I joined the BIPM as Director Designate and Deputy Director.

In this report, I present the work of the BIPM, which has a mission to provide support to, and improve uniformity of measurement world-wide. Obtaining such uniformity of measurement will support, in particular, international commerce and trade, the monitoring of climate change and the environment, human health and safety, medicine, food, and scientific research and development. The BIPM fulfils this role by operating scientific laboratories, and through its collaboration with many intergovernmental organizations and international bodies, and its coordination of activities of the National Metrology Institutes (NMIs) of States Parties to the Metre Convention. The BIPM maintains scientific facilities in the fields of mass, time, electricity, ionizing radiation, and chemistry. It also undertakes metrological comparisons and calibrations in these areas, providing the results to NMIs to support the traceability of measurements to the International System of Units (SI). An important role of the BIPM is to coordinate global metrology, which it does, in particular, through the operation of the Mutual Recognition Arrangement for national measurement standards and for calibration and measurement certificates issued for National Metrology Institutes (CIPM MRA).

The main event during the period of this report was the 24th meeting of the General Conference on Weights and Measures (CGPM), which was held in Paris in October. Full details of the CGPM are given in §4.2 of this report. In preparation for this meeting of the conference several meetings took place at the BIPM headquarters during May 2011:

- Session I of the 100th meeting of the International Committee on Weights and Measures (CIPM) on 24 May 2011,
- Meeting of National Metrology Institute Directors on 25 May 2011,
- Meeting of Representatives of States Parties to the Metre Convention on 26 and 27 May 2011.

The main purpose of these meetings was to review the BIPM's proposed Programme of Work and budget for the years 2013 to 2016 and to discuss different possible funding arrangements.

At its 98th meeting (2009), the CIPM had remarked that it was unlikely that all the scientific activities proposed in the Programme of Work could be fully funded because of the difficult economic situation globally. In response, the BIPM developed four different potential funding scenarios, which ranged from full funding for the proposed Programme of Work, including a medical linear accelerator that would provide traceability for radio-therapeutic cancer treatment, through to a 'worst case' scenario which would require the BIPM to make cuts to its core activities. These different scenarios were first thoroughly discussed and examined by the CIPM before their presentation at the meeting of NMI Directors and at the meeting of representatives of the States Parties to the Metre Convention. The CIPM,

NMI Directors and government representatives also considered whether there was a need for the BIPM to update its long-term strategy.

Several conclusions were reached: that increased liaison is needed between the BIPM, NMI Directors and the States Parties to the Metre Convention; that the governance of the BIPM should be reviewed and revised if necessary; and that the CIPM MRA was considered to be an unequivocal success.

The BIPM was presented with the views of government representatives of the States Parties to the Metre Convention on its Programme of Work, funding proposals and draft resolutions. All strongly supported and appreciated the activities carried out under the auspices of the Metre Convention and the work of the BIPM, particularly praising the development of the CIPM MRA. Their views on the proposed funding scenarios ranged from full support for the BIPM's proposed Programme of Work to a reduction in BIPM activities to a level below those currently performed. Strong support was received for the suggestion by the BIPM that it takes a stronger strategic direction in its activities, with clear priorities, which would be developed jointly by the CIPM, NMI Directors and States Parties to the Metre Convention. A focus of the new strategy will be to consider the role adopted by the BIPM, Regional Metrology Organizations (RMOs) and NMIs.

The May 2011 meetings were applauded for their valuable contribution to the preparation for the 24th meeting of the CGPM. It was recommended that these meetings continue to be held as a forum to facilitate communication between the BIPM, its governing bodies and Member States and Associates of the CGPM.

Full details of the meeting of National Metrology Institute Directors and the meeting of Representatives of States Parties to the Metre Convention are given in §4.1.

1.2 100th meeting of the CIPM

The 100th meeting of the CIPM was held in two Sessions.

Session I

Session I took place on 24 May 2011 at the BIPM prior to the meeting of National Metrology Institute (NMI) Directors and the informal meeting of representatives of States Parties to the Metre Convention. It was decided that future meetings of the CIPM will be held in May-June of each year. This change will allow the approval of the BIPM financial statements by the CIPM, shortly after the auditors' report is issued.

The main topics of Session I of the 100th meeting of the CIPM were the BIPM's Programme of Work and budget for the years 2013 to 2016, the alternative funding scenarios and the approval of the financial statements of the BIPM and of the BIPM Pension and Provident Fund. A detailed presentation of the 2010 BIPM financial statements and of the 2010 Pension and Provident Fund financial statements was made to the CIPM. After the external auditor presented his report to the CIPM on the BIPM financial statements, the CIPM unanimously gave quietus to the Director and the Financial and Administrative Director of the BIPM for the 2010 financial statements of the BIPM and of the BIPM Pension and Provident Fund. The 2009 financial statements restated according to IPSAS on an accrual basis were also approved.

Another important topic discussed at Session I of the meeting of the CIPM was the governance of the BIPM. This followed the submission of three draft Resolutions on the governance of the BIPM by Switzerland (Draft Resolution K); the United Kingdom of Great Britain and Northern Ireland (Draft Resolution L); and France (Draft Resolution M). The CIPM concluded that a review of the governance and long-term strategy of the BIPM was needed and, as a result, the CIPM has prepared an additional

Draft Resolution on the role, mission, objectives, long-term strategy and governance of the BIPM States (Draft Resolution N) which was duly circulated to the Member for consideration during the 24th meeting of the CGPM in October 2011.

Preparations for the Meeting of NMI Directors on 25 May 2011 and the informal meeting of representatives of States Parties to the Metre Convention on 26 to 27 May 2011 were discussed at Session I of the 100th meeting of the CIPM.

Finally, the CIPM decided on the procedure for the appointment of the next Director of the BIPM to ensure that a successor is in place when I retire.

Session II

Session II of the 100th meeting of the CIPM took place from 12 to 14 October 2011, immediately before the 24th meeting of the CGPM. Preparations for this meeting were again the core of discussions at the CIPM meeting, particularly the proposed redefinition of four of the seven SI base units (the kilogram, the ampere, the kelvin and the mole), and the status of the CIPM MRA, both of which are discussed later in this report.

An addendum to the CIPM MRA containing in particular an update to the referenced international standards and the joint BIPM-International Laboratory Accreditation Cooperation (ILAC) definition of the term 'Calibration and Measurement Capability' (CMC) was sent to all signatories on 3 August 2011 for signature. Contacts with other intergovernmental organizations and international bodies were reported, including in particular the situation on the cooperation between the BIPM and the International Organization of Legal Metrology (OIML). I reported during the meeting about the BIPM Quality System which underwent a successful external audit in September 2011.

A number of policy documents related to cooperation with other international bodies and intergovernmental organizations were approved. Session II of the 100th meeting of the CIPM ended with a discussion of the role, mission, objectives, long-term strategy and governance of the BIPM.

1.3 The 24th meeting of the General Conference on Weights and Measures (CGPM)

The 24th meeting of the CGPM was held in Paris on 17 to 21 October 2011. Delegates from forty-three of the fifty-five States Parties to the Metre Convention, twelve Associates of the CGPM, and representatives of six intergovernmental organizations and other international bodies were present.

The main subjects on the agenda of the meeting were: the BIPM Programme of Work for the years 2013 to 2016; the role, mission, objectives, long-term strategy and governance of the BIPM; and the possible redefinition of a number of base units of the SI. Ten Resolutions were adopted, including a historic and unanimous vote in favour of Resolution 1 'On the possible future revision of the International System of Units, the SI'. Full details of the 24th meeting of the CGPM are given in §4.2 of this report.

1.4 Scientific support for the New SI

It is not sufficient only to select a set of seven constants with which to construct the New SI. In addition it is necessary to provide information on how the new definitions can be realized. Resolution 1 therefore also refers to the establishment of *mises en pratique* for the redefined units, describing for each base unit how the definition can be realized with the highest practical accuracy. This is the essential step which will allow NMIs to disseminate the redefined units. The BIPM is involved, to varying degrees, in three of the four fields of metrology which will be affected: mass (through the redefinition of the kilogram),

electricity (through the redefinition of the ampere) and chemistry (through the redefinition of the mole). Each of these fields of metrology has its own concerns:

- When the redefinitions take place, the *mise en pratique* for the definition of the kilogram will be closely related to the experiments which, prior to redefinition, were capable of measuring the Planck constant to high accuracy. According to the 2010 CODATA adjustment, the Planck constant is known with a relative standard uncertainty of 4.4×10^{-8} (equivalent to 44 µg/kg) which is based, primarily, on data provided by watt balances and the International Avogadro Coordination project (IAC), continuing within a working group of the Consultative Committee for Mass and Related Quantities (CCM). Not all specifications of CCM Recommendation G1 (2010) (www.bipm.org/utils/common/pdf/CCM12.pdf#page=23) have been met but work to resolve the remaining gaps is well advanced. Work on the BIPM's own watt balance, although some years from completion, is advancing steadily. It is important to the *mise en pratique* that a sufficient number of watt balances are available to realize the kilogram definition whenever required. In addition, CGPM Resolution 1 allocates to the BIPM the role of assembling an ensemble of 1 kg reference standards to aid the dissemination of the mass unit after redefinition. Work is progressing on this project within the Mass Department, in close collaboration with CCM partners. Prior to the redefinition of the kilogram, the international prototype of the kilogram (IPK) will be used to link the results of all operational watt balances, the Avogadro experiment and the BIPM ensemble of reference mass standards to the present definition of the mass unit. The BIPM is preparing for this task and is contributing to the draft *mise en pratique*.

- The uncertainty of the Josephson constant, K_J, in the present SI led to the adoption of the 1990 representation of this constant, $K_{J\text{-}90}$, which has a conventional (non-SI) value with no uncertainty. Similarly, the SI value of the von Klitzing constant, R_K, is rarely used in favour of its 1990 representation, $R_{K\text{-}90}$, which also has a conventional (non-SI) value with no uncertainty. In the New SI, both K_J and R_K, will become exact, because both the Planck constant, h, and the elementary electrical charge, e, will have exactly defined values. Thus the conventional representations become obsolete. The ampere can then be realized by Ohm's law or, sometime in the future, directly by electron transport. This approach has been incorporated in a draft *mise en pratique* produced in 2009 by the Consultative Committee for Electricity and Magnetism (CCEM) (www.bipm.org/cc/CCEM/Allowed/26/CCEM-09-05.pdf). Within the BIPM Electricity Department, the calculable capacitor project will help verify the relation between fundamental constants $R_K = h/e^2$, on which the *mise en pratique* depends. The calculable capacitor experiment can also be combined with watt balance data and the existing kilogram definition to give an SI value of K_J. This value, analysed with the new data from the IAC measurement of the Avogadro constant, can produce a useful test of the second relation $K_J = 2e/h$ (which is also assumed to be exact in the *mise en pratique*).

- In the New SI, the Avogadro constant will have a fixed numerical value. If it was chosen instead to retain the current definition of the mole based on a fixed value for the molar mass constant, M_u, and to fix the value of h to redefine the kilogram, as will be done, then the Avogadro constant would have a relative uncertainty of 7×10^{-10}. This uncertainty, which is small compared to the needs of metrology in chemistry, illustrates that the choice to fix the numerical value of the Avogadro constant to redefine the mole will involve a debate over logic and pedagogy. No new measurements are required but the *mise en pratique* is being carefully drafted within the Consultative Committee for Amount of Substance – Metrology in Chemistry (CCQM), with input and advice from the BIPM Chemistry Department.

1.5 Science at the BIPM

To carry out its mission the BIPM operates laboratories in the fields of mass, time, electricity, ionizing radiation and chemistry. At the core of the BIPM's activities are the provision of traceability to the SI both by direct dissemination, as is carried out in the Mass Department and Time Department, and through the coordination of comparisons of national measurement standards as is carried out in the Electricity, Ionizing Radiation and Chemistry Departments.

A summary of the work of each Department from 1 July 2010 to 31 December 2011 can be found in §2 of this report. Full details of the work of each Department are available on the BIPM website (http://www.bipm.org/en/publications/directors_report/).

1.6 Travel (conferences, lectures and presentations, visits)

M. Kühne in his position as Deputy Director until 31 December 2010, to:

- Turin (Italy), 5-6 July 2010, to give a lecture with Dr Bich, chairman of the JCGM Working Group on the GUM, on "The intended new definitions in the International System of Units", at the Euroscience Open Forum (ESOF).
- NIM (China), 24-27 August 2010, to attend the Advisory Board meeting of the Institute.
- Pattaya (Thailand), 14-20 November 2010, to the Asia Pacific Metrology Programme (APMP) Workshop and General Assembly.

M. Kühne in his position as Director since 1 January 2011, to:

- Nairobi (Kenya), 5-9 February 2011, to attend the AFRIMETS Metrology School and give a lecture.
- NPL (United Kingdom of Great Britain and Northern Ireland), 13-14 February 2011.
- NIST (United States of America), 21-24 February 2011.
- Germany, 29 March 2011, to visit the German Minister of Economy.
- BEV (Austria), 20 May 2011, to give a presentation on World Metrology Day.
- METAS (Switzerland), 31 May 2011, to participate in an OIML Working Group meeting on the New SI.
- Institut de France, Paris (France), 6 June 2011, with C. Thomas, KCDB Coordinator, for a meeting of the *Comité "Science et métrologie" de l'Académie des Sciences*.
- NIM (China), 21-28 August 2011, to attend the Advisory Board meeting of the Institute.
- Vienna (Austria), 14-15 September 2011, with O. Altan, JCRB Executive Secretary, A. Henson, International Liaison Officer of the BIPM, and C. Thomas, KCDB Coordinator, for the 27th JCRB meeting.
- Brussels (Belgium), 15 December 2011, for a meeting of the EMRP Science council.

2 LABORATORY WORK AT THE BIPM

2.1 Mass

The Mass Department is actively involved in the preparations for the redefinition of the kilogram. In particular, the Mass Department is working on the draft of the *mise en pratique* of the new definition of the kilogram. The Department focused on ensuring that it will in time for the practical realization of the new definition of the kilogram with its watt balance and the ensemble of reference standards.

In addition to the permanent activities such as the conservation of the primary standard of mass (the IPK) and the dissemination of the unit of mass, as well as the provision of scientific and organizational support to the Consultative Committee for Mass and Related Quantities (CCM) and to the Consultative Committee for Thermometry (CCT), the CGPM assigned in 2007 a number of specific tasks to the Mass Department for the period 2009–2012 as part of the BIPM Programme of Work.

Specific activities in the Mass Department between 1 July 2010 and 31 December 2011 included preparations for the redefinition of the kilogram. It was decided at the 24th meeting of the CGPM in 2011 that the new definition of the kilogram will be based on a fixed numerical value of the Planck constant *h*. The BIPM is in an advanced state of developing a watt balance to ensure that an international primary realization of the new kilogram will be available at the BIPM to continue the dissemination of the kilogram to all NMIs at the highest possible metrological level after the redefinition. The Mass Department staff are major contributors to the development of the BIPM watt balance.

The Mass Department continues to contribute to the International Avogadro Coordination Project. A special study has been conducted to evaluate physical and chemical water sorption effects on the spheres used in the project between air-vacuum cycles, using a 1 kg natural silicon sphere with a 0.2 µm thermal oxide layer, supplied by PTB. Preliminary results showed physical and chemical sorption coefficients of about 50 ng/cm^2 and 10 ng/cm^2, respectively. The work is ongoing.

The Mass Department is developing an ensemble of mass standards to facilitate the dissemination of the unit of mass after the expected redefinition of the kilogram. (Resolution 1 of the 24th meeting of the CGPM, 2011). The ensemble is composed of sixteen 1 kg mass standards of different materials (Pt-Ir, stainless steel and silicon) stored under different conditions (in a pure argon flow, in a pure nitrogen flow, in vacuum and in air). The mass storage containers have been manufactured by the BIPM Workshop Section. Construction of the storage network for the mass standards, inside a thermally isolated cabin, is under way. The argon gas storage network has been completed and a preliminary vacuum storage network has been built. Ultrapure argon and nitrogen gas are supplied by gas bottles and a nitrogen generator has also been installed. Gas analysers have been purchased to measure the evolution of the concentration of impurities (water, oxygen and hydrocarbons) in the argon and nitrogen gases. The first measurements to characterize the background purity of the gas supply have been carried out. A residual gas analyser has been purchased to identify and quantify traces of impurities present in the vacuum storage network. A mathematical algorithm has been developed to compute the weighted average of the masses of the elements of the ensemble.

Calibrations of twenty-three 1 kg mass standards, either Pt/Ir prototypes or stainless steel standards, were carried out for more than a dozen NMIs during 1 July 2010 to 31 December 2011. The renovation of a laboratory for 1 kg mass calibrations (room 104) was completed in July 2010. The Metrotec mass comparator, which had been temporarily moved to room 105, was reinstalled in room 104 in August 2010 and successfully re-commissioned. A new M-one 6V-LL mass comparator from Mettler-Toledo was installed in room 104 in December 2010 to replace the obsolete HK1000 MC balance. Air density determination in both laboratories has also been verified by comparing

two independent methods. Auxiliary determinations of the volume, the location of the centre of gravity and the magnetic properties of these standards, are made upon request.

Measurement facilities used to support calibration and research programmes have been improved in accordance with the BIPM Quality Management System.

The BIPM continues the trilateral cooperation among the BIPM, NPL (United Kingdom of Great Britain and Northern Ireland), and METAS (Switzerland) in the framework of the *mise en pratique* of the new kilogram. Different materials have been purchased by the BIPM and studies of silicon, Pt-Ir, stainless steel and gold alloy are under way. These studies include cleaning efficiency, recontamination and sorption effect between air and vacuum.

For a full report on the activities of the Mass Department during 1 July 2010 to 31 December 2011 please see the website http://www.bipm.org/utils/common/pdf/DIR2011/mass2011.pdf.

2.1.1 External publications

1. Berry J., Davidson S., Barat P., Davis R., Comparison of UV/ozone cleaning of platinum/iridium kilogram mass standards with nettoyage-lavage cleaning, *Metrologia*, 2011, **48**(3), 181–186.
2. Andreas B., *et al.*, Determination of the Avogadro Constant by Counting the Atoms in a ^{28}Si Crystal, *Phys. Rev. Lett.*, 2011, **106**(3), 030801.
3. Andreas B., *et al.*, Counting the atoms in a ^{28}Si crystal for a new kilogram definition, *Metrologia*, 2011, **48**(2), S1–S13.
4. Picard A., *et al.*, State-of-the-art mass determination of ^{28}Si spheres for the Avogadro project, *Metrologia*, 2011, **48**(2), S112–S119.

2.2 Time

The Time Department continues to provide traceability to the SI second via Coordinated Universal Time (UTC) through the monthly *Circular T* within a few days of receiving all the data from the contributing laboratories. It represents the only key comparison on time CCTF-K001.UTC. It is the most frequent key comparison, with an evaluation of the key comparison reference value UTC and the degrees of equivalence [$UTC - UTC(k)$] every five days for almost 70 participants. The BIPM has sole responsibility for the calculation and publication of results, as established by the Consultative Committee for Time and Frequency (CCTF). Some 13 primary frequency standards now contribute to International Atomic Time (TAI) and its stability is estimated to be 4 parts in 10^{16} for averaging times of one month. The GPS Precise Positioning Technique (PPP) is now in use for TAI clock comparisons in some 20 links, where the statistical uncertainty of time transfer is less than 1 ns. At the beginning of 2011 the BIPM introduced links calculated by a combination of techniques, and in particular Global Positioning System (GPS) and Global Navigation Satellite System (GLONASS), in anticipation of the routine use of a multi-system time comparison when the new GNSS becomes operational.

A major change has been introduced to the algorithm for the calculation of TAI/UTC; studies conducted over the last two years concluded that the development of a new model for the prediction of clock frequency results in a correction of the drift that was affecting the time scale, which favourably impacts the maintenance of local representations of UTC in the contributing laboratories.

Another major improvement is the possibility of making a rapid evaluation of UTC that will allow access to a representation of the reference time scale with a shorter delay. In the final months of 2011 the Time Department staff concentrated on the preparation of the algorithms, software and procedures. A pilot

experiment for testing the feasibility of this new product, with data contributed from most laboratories participating in TAI, will take place between January and September 2012.

International coordination has been a major activity in the Time Department, in particular in work with the International Telecommunication Union (ITU) on the recommendation for a new definition of UTC without leap seconds.

A list of frequencies, mostly in the optical domain, has been recommended for secondary representations of the second. These will provide the basis for future discussion of the redefinition of the second. The optical frequency standards, accurate to parts in 10^{17}, can be compared but full advantage of their qualities can only be taken if time and frequency transfer improves by about two orders. A CCTF workshop will be held at the BIPM headquarters in 2012 to discuss the present status of highly accurate time and frequency transfer and future improvements.

For a full report on the activities of the Time Department during 1 July 2010 to 31 December 2011 please see the website http://www.bipm.org/utils/common/pdf/DIR2011/time2011.pdf.

2.2.1 External publications

1. Arias E.F., The BIPM – International coordination for Earth sciences, *Proc. IAG Scientific Assembly*, IAG 134, Springer, 2011, 1023–1028.
2. Arias E.F., Bauch A., Metrology of Time and Frequency. In Gläser M., Kochsiek M., (Eds.), *Handbook of Metrology*, Wiley-VCH, Berlin, 2010, pp 317–346.
3. Arias E.F., Panfilo G., Impact of new frequency standards on the international timescales, *Proc. IAU*, 2010, **5**, Highlights H15, 223–224.
4. Arias E.F., Panfilo G., Petit G., Timescales at the BIPM, *Metrologia*, 2011, 48(4), S145–S153.
5. D'Agostino G., Robertsson L., Zucco M., Pisani M., Germak A., A low-finesse Fabry–Pérot interferometer for use in displacement measurements with applications in absolute gravimetry, *Appl. Phys. B: Lasers Opt*. http://dx.doi.org/ 10.1007/s00340-011-4747-1, published online 12 October 2011.
6. D'Agostino G., Robertsson L., Relative beam misalignment errors in high accuracy displacement interferometers: calculation and detection, *Appl. Phys. B: Lasers Opt.*, 2011, **103**(2), 357–361.
7. Defraigne P., Harmegnies A., Petit G., Time and frequency transfer combining GLONASS and GPS data, *Proc. Joint Meeting of the EFTF and IEEE FCS*, 2011, 676–680.
8. Defraigne P., Baire Q., Harmegnies A., Time and frequency transfer combining GLONASS and GPS data, *Proc. 42nd PTTI Meeting* 2010, 263–274.
9. Fang H., Kiss A., Robertsson L., de Mirandes E., Solve S., Picard A. and Stock M., Improvements in the BIPM Watt Balance, *15th Congress of Metrology*, 3-6 October 2011, Paris, France, 2011.
10. Fang H., Kiss A., Robertsson L., Bradley M., de Mirandes E., Picard A., Solve S., Stock M., Acquisition et synchronisation des données pour la balance de watt du BIPM, *15th Congress of Metrology*, 3-6 October 2011, Paris, France, 2011.
11. Jiang Z., Arias E.F., Lewandowski W., Petit G., Toward unified TWSTFT and GNSS delay characterization for UTC time transfer, *Proc. EFTF 2010*, http://www.congrex.nl/EFTF_Proceedings/.
12. Jiang Z., Piester D., Liang K., Restoring a TWSTFT Calibration with a GPS Bridge - a standard procedure for UTC time transfer, *Proc. EFTF 2010*, http://www.congrex.nl/EFTF_Proceedings/.

13. Jiang Z., Interpolation of TW time transfer from measured points onto standard MJD for UTC generation, *Proc. EFTF 2010*, http://www.congrex.nl/EFTF_Proceedings/.

14. Jiang Z., Arias F., Lewandowski W., Petit G., Toward new procedures in TWSTFT and GNSS delay characterization for UTC time transfer?, *Proc. EFTF 2010*, http://www.congrex.nl/EFTF_Proceedings/.

15. Jiang Z., Tisserand L., Kessler-Schulz K.U., Schulz H.R., Palinkas V., Rothleitner C., Francis O., Jousset P., Lequin D., Merlet S., Mäkinen J., Becker M., Preliminary Result of the BIPM Relative Gravity Measurement Campaign during the 8th International Comparison of Absolute Gravimeters, *IAG Symposium on Terrestrial Gravimetry: Static and mobile measurements (TG-SMM 2010)*, 22-25 June 2010, St Petersburg, Russian Federation, pp 125–133.

16. Jiang Z,. Arias E.F., Tisserand L., Kessler-Schulz K.U., Schulz, H.R., Palinkas V., Rothleitner, C., Francis O., Becker, M., The Updated Precise Gravity Network at the BIPM, *Proc. IAG Scientific Assembly*, IAG 134, Springer, 2011, 263–272.

17. Jiang Z., Arias F., Tisserand L., *et al.*, The updating precise gravity network at BIPM, *Proc. IAG Scientific Assembly*, IAG 134, Springer, 2011, 1023–1028.

18. Jiang Z., Arias F., Lewandowski W., Petit G., BIPM Calibration Scheme for UTC Time Links, *Proc. EFTF 2011*, 1064–1069.

19. Jiang Z., Lewandowski W., Some remarks on the CCTF CGGTTS format, *Proc. EFTF 2011*, 317-322.

20. Jiang Z., Petit G., Harmegnies A., Lewandowski W., Tisserand L., Comparison of the GLONASS Orbit Products for UTC Time Transfer, *Proc. Joint Meeting of the EFTF and IEEE FCS*, 2011, 323-328.

21. Jiang Z., Francis O., Vitushkin L., Palinkas V., Germak A., Becker M., D'Agostino G., Amalvict M., Bayer R., Bilker-Koivula M., Desogus S., Faller J., Falk R., Hinderer J., Gagnon C., Jakob T., Kalish E., Kostelecky J., Lee C., Liard J., Lokshyn Y., Luck B., Mäkinen J., Mizushima S., Le Moigne N., Origlia C., Pujol E.R., Richard P., Robertsson L., Ruess D., Schmerge D., Stus Y., Svitlov S., Thies S., Ullrich C., Van Camp M., Vitushkin A., Ji W., Wilmes H., Final report on the Seventh International Comparison of Absolute Gravimeters (ICAG-2005) - a pilot study for the CIPM Key Comparisons, *Metrologia*, 2011, **48**, 246–260.

22. Matus M., Nyholm K., Madej A.A., Bernard J.E., Walczuk J., Crepinšek Lipuš L., Castillo H.A., Pichardo Vega R., Bastida K.B., Griselda Mingolla M., Malinovski I., Tarelho L., França R., Hamid R., Sahin E., Katic M., Šimunovic V., Robertsson L.[BEV, MIKES, INMS/NRC, GUM, MIRS, CENAM, INTI, INMETRO, UME, DCM/LFSB, BIPM]. Final report for the period 2007-2009 on the CCL-K11 ongoing key comparison, *Metrologia*, 2010, **47**, *Tech. Suppl.*, 04009.

23. Panfilo G., Parker T.E., A theoretical and experimental analysis of frequency transfer uncertainty, including frequency transfer into TAI, *Metrologia*, 2010, **47**(5), 552–560.

24. Panfilo G., Harmegnies A., Tisserand L., A new prediction algorithm for EAL, *Proc. Joint Meeting of the EFTF and IEEE FCS*, 2011, 850–855.

25. Petit G., Atomic time scales TAI and TT(BIPM): present performances and prospects, *Proc. IAU*, 2010, **5**, Highlights H15, 220–221.

26. Petit G., Luzum B., The 2010 reference edition of the IERS Conventions, *Proc. Of the IAG Commission 1 Symposium 2010 Reference Frames for Applications in Geosciences (REFAG2010)*, 2010.

27. Petit G., Luzum B. (eds.), The IERS Conventions (2010), *(IERS Technical Note; 36) Frankfurt am Main: Verlag des Bundesamts für Kartographie und Geodäsie*, 2010. 179 pp.

28. Petit G., Harmegnies A., Mercier F., Perosanz F., Loyer S., The time stability of PPP links for TAI, *Proc. Joint Meeting of the EFTF and IEEE FCS*, 2011, 1041–1045.

29. Petit G., The new edition of the IERS Conventions: conventional reference systems and constants, *Proc. Journées 2010 SRST*, 2011, 6–11.

30. Petit G., Luzum B., The IERS Conventions (2010), *Geophysical Research Abstracts*, 2011, **13**.

31. Petit G., Cognard I., How can millisecond pulsars transfer the accuracy of atomic time? *General Assembly and Scientific Symposium 2011 XXXth URSI*, http://dx.doi.org/10.1109/URSIGASS.2011.6050334.

32. Petit G., Progress in multi-GNSS time transfer: Some results with GPS and GLONASS, *Proc. 3rd Int. Colloq. on scientific and fundamental aspects of Galileo*, 2011, CD-Rom.

2.2.2 BIPM publications

33. BIPM Annual Report on Time Activities for 2009, 2010, 4, 104 pp., available only at http://www.bipm.org/utils/en/pdf/time_ann_rep/Time_annual_report_2009.pdf.

34. *Circular T* (monthly), 7 pp.

35. Bauch A., Piester D., Fujieda M., Lewandowski W., Directive for operational use and data handling in two-way satellite time and frequency transfer (TWSTFT), *Rapport BIPM*-2011/01, 25 pp.

2.3 Electricity

The work of the Electricity Department from 1 July 2010 to 31 December 2011 focused on the comparison programme to validate national primary standards for fundamental electrical quantities, conducting calibrations for NMIs of States Parties to the Metre Convention, support for the BIPM watt balance and on the calculable capacitor, which has been developed in collaboration with the NMIA (Australia). In addition, a scientific collaboration was carried out with the NPL (United Kingdom of Great Britain and Northern Ireland) on the quantum Hall effect in graphene.

During the reporting period 19 comparisons were undertaken with NMIs in the fields of voltage, resistance, and capacitance measurements. The Department participated in an Asia Pacific Metrology Programme (APMP) voltage key comparison, to link APMP results to the BIPM comparison, and in a EURAMET capacitance supplementary comparison, carried out within the framework of research on quantum current standards. The Electricity Department issued 78 calibration certificates and three study notes for 20 NMIs. Calibrations are provided for the same quantities for which the Electricity Department carry out comparisons. Both activities are based on the same BIPM primary standards, thus providing a basis for uniform electrical measurements world-wide.

Significant progress has been made towards the dedicated Josephson voltage standard for the watt balance. The electronics to independently select the quantized voltages of each of the thirteen segments of the Josephson array have been assembled and tested. This system is entirely battery-operated to facilitate its integration into the electrical environment of the watt balance. The SNS Josephson array is not functioning properly at the moment and will be investigated by the NIST (United States of America).

Preparations to resume the on-site comparisons of quantized Hall resistance standards are ongoing. A new 1 Hz resistance ratio bridge has been built, and thermally stabilized enclosures for working standards are being developed.

The BIPM and the NMIA (Australia) are collaborating on the construction of two calculable capacitors of improved design which will measure the von Klitzing constant with an uncertainty of the order of 1 part in 10^8, a highly relevant result for the *mise en pratique* of the electrical units. During trial assembly of the BIPM instrument in early 2010 with the assistance of John Fiander, NMIA, a number of necessary changes were found. New parts, designed at the NMIA and fabricated by the BIPM workshop, mostly work well within the BIPM instrument. However, the lower mirror mount has been found to be very sensitive to ground vibrations, causing the interference pattern to become very perturbed. Techniques to stiffen the mount and isolate the experiment from external vibrations are being investigated.

In recent years the metrology community has become interested in single-layer carbon atom graphene, particularly the observed quantum Hall effect (QHE) in graphene. The charge carriers in graphene behave very differently from those in the semiconductor GaAs, so that the comparison of the von Klitzing constant R_K measured in graphene and in GaAs samples provides an interesting test of the material independence of R_K. The NPL invited the BIPM to jointly carry out such a comparison at the highest accuracy level, using the BIPM transportable QHE system. Agreement of the quantized Hall resistance values of graphene and GaAs, within an experimental uncertainty estimated to about 1 part in 10^{10}, has been demonstrated. This agreement places the tightest limits yet on possible material dependence of R_K. This demonstrates that graphene has the potential to be used in future QHE systems, which will operate at lower magnetic field and higher temperatures, enabling the potential future use of QHE outside NMIs.

For a full report on the activities of the Electricity Department during 1 July 2010 to 31 December 2011 please see the website http://www.bipm.org/utils/common/pdf/DIR2011/elec2011.pdf.

2.3.1 External publications

1. Solve S., Chayramy R., The BIPM Compact Josephson Voltage Standard, *IEEE Trans. Instrum. Meas.*, 2011, **60**(7), 2366–2371.
2. Tang Yi-hua, Solve S., Witt T.J., Allan Variance Analysis of Josephson Voltage Standard Comparison for Data Taken at Unequal Time Intervals, *IEEE Trans. Instrum. Meas.*, 2011, **60**(7), 2248–2254.
3. Power O., Solve S., Chayramy R., Stock M., Bilateral comparison of 1.018 V and 10 V standards between the NSAI (Ireland) and the BIPM, March to April 2010 (part of the ongoing BIPM key comparison BIPM.EM-K11.a and b), *Metrologia*, 2010, **47**, *Tech. Suppl.*, 01017.
4. Goebel R., Fletcher N., Stock M., Dudek E., Domanska-Mysliwiec D., Mosiadz M., Orzepowski M., Bilateral comparison of 1 Ω standards between the GUM (Poland) and the BIPM, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 01001.
5. Goebel R., Fletcher N., Stock M., Dudek E., Domanska-Mysliwiec D., Mosiadz M., Orzepowski M., Bilateral comparison of 10 kΩ standards between the GUM (Poland) and the BIPM, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 01002.
6. Power O., Solve S., Chayramy R., Stock M., Bilateral comparison of 10 V standards between the NSAI (Ireland) and the BIPM, March 2011 (part of the ongoing BIPM key comparison BIPM.EM-K11.b), *Metrologia*, 2011, **48**, *Tech. Suppl.*, 01010.
7. Solve S., Chayramy R., Stock M., Katkov A., Comparison of the Josephson voltage standards of the VNIIM and the BIPM (part of the ongoing BIPM key comparison BIPM.EM-K10.b), *Metrologia*, 2011, **48**, *Tech. Suppl.*, 01007.

8. Solve S., Chayramy R., Stock M., *et al*., Comparison of the Josephson voltage standards of the NMC A*STAR and the BIPM (part of the ongoing BIPM key comparisons BIPM.EM-K10.a and b), *Metrologia*, 2011, **48**, *Tech. Suppl.*, 01006.

9. Witt T.J., Fletcher N.E., Standard deviation of the mean and other time series properties of voltages measured with a digital lock-in amplifier, *Metrologia*, 2010, **47**(5), 616–630.

10. Janssen T.J.B.M., Fletcher N.E., Goebel R., Williams J.M., Tzalenchuk A., Yakimova R., Kubatkin S., Lara-Avila S., Falko V.I., Graphene, universality of the quantum Hall effect and redefinition of the SI system, *New J. Phys.*, 2011, **13** 093026.

11. Stock M., Review article: The watt balance: determination of the Planck constant and redefinition of the kilogram, *Phil. Trans. R. Soc. A*, 2011, **369**, 3936-3953.

2.3.2 BIPM publications

12. Solve S., Chayramy R., Stock M., The BIPM 1.018 V Zener Measurement Set-up, *Rapport BIPM*-2011/05, 32 pp.

2.4 Watt balance

Significant progress has been made during the period 1 July 2010 to 31 December 2011 on the measurement of the coil velocity of the watt balance. The previous interferometer measured the coil displacement along one vertical axis. This has been replaced by an interferometer which measures along three different vertical axes, thus allowing the determination of the velocity of the electrical centre of the coil. Vibration-related noises in velocity and voltage measurements are now better correlated, which has led to a reduction of the standard deviation of the voltage-to-velocity ratio by a factor of ten. This translates into an improvement in the reproducibility of the Planck constant by a factor of five, to 1 part in 10^6.

An aluminium vacuum chamber for the watt balance has been designed and will be installed in the new watt balance laboratory in 2012. Several functional components, including a mass exchanger, will be added to the experiment when the watt balance is transferred from its current location into the vacuum enclosure. These will allow a higher degree of automation, higher versatility and a reduced measurement uncertainty to be obtained.

The Sm_2Co_{17} magnets for the definitive magnetic circuit have been fabricated. All parts for the yoke have been pre-machined in the BIPM workshop. A company has been identified to undertake the final precision-machining. A mechanical system for the final assembly of the magnetic circuit is close to completion in the workshop.

As part of a feasibility study into a future cryogenic watt balance, the phenomenon of trapped magnetic flux in superconducting wires has been investigated. This effect leads to magnetic forces on the coil in a magnetic field and the consequences to a watt balance experiment are not yet understood. Theoretical work and measurements made at the NIST magnetics laboratory in Boulder, Colorado (United States of America) by a BIPM staff member concluded that this effect should not be a limiting factor for a cryogenic watt balance. A prototype experiment of a superconducting moving coil apparatus has been set up to investigate the behaviour of superconducting wires in magnetic fields. This experiment will allow us to understand if superconducting wires exhibiting the Meissner effect show the same behaviour as normal wires, as far as is relevant for the operation of a watt balance.

For a full report on the watt balance during 1 July 2010 to 31 December 2011 please see the website http://www.bipm.org/utils/common/pdf/DIR2011/wb2011.pdf.

2.4.1 External publications

1. de Mirandés E., Fang H., Kiss A., Solve S., Stock M., Picard A., Alignment procedure used in the BIPM watt balance, *IEEE Trans. Instrum. Meas*., **60**(7), 2011, 2415–2421.

2. Picard A., Bradley M.P., Fang H., Kiss A., de Mirandés E., Parker B., Solve S., Stock M., The BIPM watt balance: Improvements and developments, *IEEE Trans. Instrum. Meas.*, **60**(7), 2011, 2378-2386.

3. Stock M., Review article: The watt balance: determination of the Planck constant and redefinition of the kilogram, *Phil. Trans. R. Soc. A*, 2011, **369**, 3936–3953.

2.5 Ionizing radiation

The Ionizing Radiation Department improved the volume estimation of its graphite cavity standards and verified the consistency of the ensemble of its ionometric standards for air kerma and absorbed dose to water within 8 parts in 10^4. Four new primary standard graphite-cavity chambers have been constructed, including one for ININ (Mexico).

The BIPM calorimeter for absorbed dose to water has a long-term stability established to 4 parts in 10^4. The first two accelerator dosimetry comparisons using the calorimeter, with the NRC (Canada) in 2009 and the PTB in 2010 have been published and the report of the comparison with the NIST in 2010 is close to completion. Two comparisons scheduled for 2011 were postponed due to equipment failures. However, measurements to verify the ion recombination correction of the transfer chamber in accelerator beams were made by the BIPM at the LNE-LNHB (France), and a second calorimeter core and jacket to provide independent verification of absorbed dose and to act as a back-up instrument is under development. Combining BIPM measurements and calculations has enabled comprehensive uncertainty analysis of the conversion of the absorbed dose to graphite in the calorimeter to absorbed dose to water and this is now better than 2.5 parts in 10^3.

The new primary standard for mammography dosimetry with the associated beams have been used for two more comparisons and three other national standards were characterized one in the latter part of 2010 and two in 2011. This facility is now included in the BIPM Quality Management System (QMS) and has already been subject to an internal audit.

Work has continued on the best evaluation for the physical constant W_a for air, and also the I_c-value for graphite using BIPM experiments and Monte Carlo calculations to determine the product $W_a s_{c,a}$ as 33.84 (6) J C^{-1} which has been added to existing published data to provide a robust estimate of 33.72 (3) J C^{-1} that is likely to be adopted by the International Commission on Radiation Units and Measurements (ICRU) with a concomitant change in the I_c-value from 78 eV to 82 (2) eV, as presented to the CCRI(I) in May 2011.

Measurements to identify a radiation scatter parameter were made in preparation for the installation of the replacement ^{60}Co reference beam of the BIPM. The installation has been assured with the fitting of new fire doors and an external wall for additional shielding. The irradiator has been installed ready to receive the source even though the BIPM is still awaiting authorization from the French authorities to import and load the source.

A comparison was made at the PTB as part of the BIPM ongoing off-site high-dose-rate brachytherapy comparison series. The results are currently being analysed together with those obtained by three previous participating NMIs.

In total, fifteen dosimetry comparisons have been carried out and eleven reports of previous comparisons have been published from 1 July 2010 to 31 December 2011. Twenty-five national secondary standards have been characterized in terms of dosimetric quantities and support for the International Atomic Energy Agency (IAEA) has continued with regular irradiations of dosimeters for the IAEA/World Health Organization (WHO) measurement service. In addition, a series of irradiations was made for the PTB as a verification of their alanine dosimetry at radiotherapy levels.

Internal audits of the dosimetry services provided by the Department were carried out at the end of 2010 and 2011. Maintaining and improving the radiation standards' facilities, in accordance with the BIPM QMS, represents a significant part of the Department's work.

A total of twenty-four ampoules were submitted to the BIPM ongoing activity comparisons using the International Reference System (SIR) in 2010 and 2011. Only one result prior to 2011 has not yet been registered in the SIR master file; this result and all but one from 2011 are awaiting data to be submitted. Two radionuclides were measured for the first time: ^{125}Sb in 2010 and ^{11}C in 2011, the latter having a half-life of only 20 min.

Fifteen SIR comparisons, covering nine radionuclides from nine different NMIs were published. Impurity activity levels for seven ampoules submitted for the comparisons were measured using the BIPM Ge(Li) gamma spectrometer. The replacement of this system by the High-Purity Germanium Spectrometer (HPGe) is under way. Internal audits of the SIR within the BIPM QMS were carried out in late 2010 and 2011.

The BIPM has been instrumental in developing appropriate methods to evaluate key comparison reference values for radionuclide activity comparisons. One of these methods, based on a Mandel-Paule mean, has been chosen by the CCRI Section (II) Key Comparison Working Group for further investigation.

The BIPM.RI(II)-K4.Tc-99m comparisons of this short-lived radionuclide ($T_{½}$ about 6 h) are now running smoothly although logistically only two comparisons per year using the SIR Transfer Instrument (SIRTI) off-site are possible. Reports of the first two comparisons, with the NIST and KRISS (Republic of Korea), are now published and the SIRTI was taken to Japan in the autumn of 2011, the comparison having been postponed due to the aftermath of the major earthquake. Developments to extend the SIRTI to ^{18}F ($T_{½}$ about 1.8 h) are under way.

The extension of the SIR to pure beta emitters made a major step forward in 2011 through the participation of the BIPM in a pilot comparison of ^{63}Ni organized by the CIEMAT (Spain) for the Extended SIR Working Group of the CCRI(II). Nine participants submitted ampoules to both the BIPM and the CIEMAT, and two measurement methods were proposed. One method uses commercial liquid scintillation spectrometers and an evaluated universal efficiency curve and the other uses the triple-to-double coincidence ratio technique (TDCR) for activity measurement. The results are being evaluated to determine the optimum quenching conditions. The results of the comparison have been analysed with respect to the universal efficiency curve and are in agreement to within only 3 % indicating that much work is still needed, possibly in the primary measurements at the NMIs, to reduce this spread. The results obtained using the TDCR method are undergoing final analysis.

A significant number of earlier CCRI(II) comparison reports are still awaiting publication, cover for staff absence in the SIR and the work on extending the SIR to beta emitters having taken priority. The Draft A report of the ^{89}Sr comparison is ready for circulation, the Draft A report for the ^{241}Pu and the Draft B reports for the ^{85}Kr and ^{3}H comparisons have also been prepared. The Draft B report of the CCRI(II) comparison of uncertainty evaluation piloted by the IRA-METAS (Switzerland) in which the BIPM participated successfully, is undergoing final approval.

The Ionizing Radiation Department is responsible for the internal calibration of BIPM standard platinum resistance thermometers (SPRTs). A bilateral SPRT comparison with the LNE-INM (France) which served to validate the updated quality system has been published following an internal audit, and to date three calibration campaigns have been run for BIPM Departments.

Finally, in spite of two staff absences in 2011, significant progress has been made in all of the areas of work covered by the Ionizing Radiation Department.

For a full report on the activities of the Ionizing Radiation Department during 1 July 2010 to 31 December 2011 please see the website http://www.bipm.org/utils/common/pdf/DIR2011/RI2011.pdf.

2.5.1 External publications

1. Allisy-Roberts P.J., Kessler C., Burns D.T., Derlaciński M., Kokociński J., Comparisons of the standards for air kerma of the GUM and the BIPM for ^{60}Co and ^{137}Cs gamma radiation, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06015.

2. Burns D.T., Lye J.E., Kessler C., Roger P., Butler D.J., Key comparison BIPM.RI(I)-K2 of the air-kerma standards of the ARPANSA and the BIPM in low-energy x-rays, *Metrologia*, 2010, **47**, *Tech. Suppl.*, 06023.

3. Burns D.T., Allisy-Roberts P.J., Desrosiers M.F., Sharpe P.H.G., Pimpinella M., Lourenço V., Zhang Y.L., Miller A., Generalova V., Sochor V., Supplementary comparison CCRI(I)-S2 of standards for absorbed dose to water in ^{60}Co gamma radiation at radiation processing dose levels, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06009.

4. Burns D.T., Csete I., Roger P., Key comparison BIPM.RI(I)-K3 of the air-kerma standards of the MKEH, Hungary and the BIPM in medium-energy x-rays, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06017.

5. Burns D.T., Kessler C., McCaffrey J.P., Key comparison BIPM.RI(I)-K2 of the air-kerma standards of the NRC, Canada and the BIPM in low-energy x-rays, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06002.

6. Burns D.T., Kessler C., Roger P., Toni M.P., Pinto M., Bovi M., Cappadozzi G., Silvestri C., Key comparison BIPM.RI(I)-K2 of the air-kerma standards of the ENEA-INMRI, Italy and the BIPM in low-energy x-rays, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06010.

7. Burns D.T., Kessler C., Villevalde A.Y., Oborin A.V., Key comparison BIPM.RI(I)-K3 of the air-kerma standards of the VNIIM, Russian Federation and the BIPM in medium-energy x-rays, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06004.

8. Burns D.T., Roger P., Denozière M., Leroy E., Key comparison BIPM.RI(I)-K2 of the air-kerma standards of the LNE-LNHB, France and the BIPM in low-energy x-rays, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06013.

9. Burns D.T., Roger P., Saito N., Kurosawa T., Morishita Y., Key comparison BIPM.RI(I)-K3 of the air-kerma standards of the NMIJ, Japan and the BIPM in medium-energy x-rays, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06012.

10. Kessler C., Roger P., Allisy-Roberts P.J., Yi C.-Y., Comparison of the standards for air kerma of the KRISS and the BIPM for ^{137}Cs gamma radiation, *Metrologia*, 2010, **47**, *Tech. Suppl.*, 06022.

11. Kessler C., Yi C-Y., Chung J-P., Roger P., Allisy-Roberts P.J., Comparison of the standards for air kerma of the KRISS and the BIPM for ^{60}Co gamma radiation, *Metrologia*, 2010, **47**, *Tech. Suppl.*, 06021.

12. Kessler C., Allisy-Roberts P.J., Lye J., Oliver C., Comparison of the standards for air kerma of the ARPANSA and the BIPM for ^{60}Co gamma radiation, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06016.

13. Kessler C., Allisy-Roberts P.J., Morishita Y., Kato M., Takata N., Kurosawa T., Tanaka T., Saito N., Comparison of the standards for absorbed dose to water of the NMIJ and the BIPM for ^{60}Co γ-ray beams, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06008.

14. Kessler C., Allisy-Roberts P.J., Oborin A.V., Villevalde A.Y., Comparison of the standards for air kerma of the VNIIM and the BIPM for ^{60}Co gamma radiation, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06001.

15. Kessler C., Allisy-Roberts P.J., Oborin A.V., Villevalde A.Y., Comparison of the standards for air kerma of the VNIIM and the BIPM for ^{137}Cs gamma radiation, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06003.

16. Kessler C., Burns D.T., Büermann L., Key comparison BIPM.RI(I)-K7 of the air-kerma standards of the PTB, Germany and the BIPM in mammography x-rays, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06011.

17. Kessler C., Burns D.T., O'Brien M., Key comparison BIPM.RI(I)-K7 of the air-kerma standards of the NIST, USA and the BIPM in mammography x-rays, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06014.

18. Kessler C., Burns D.T., McCaffrey J.P., Key comparison BIPM.RI(I)-K7 of the air-kerma standards of the NRC, Canada and the BIPM in mammography x-rays, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06022.

19. Michotte C., Courte S., Ratel G., Kossert K., Nähle O., Update of the ongoing comparison BIPM.RI(II)-K1.Y-88 to include recent activity measurements of the radionuclide ^{88}Y by the PTB, Germany, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06006.

20. Michotte C., Ratel G., Kossert K., Nähle O., Maringer F.J., Update of the BIPM comparison BIPM.RI(II)-K1.Ce-139 of activity measurements of the radionuclide ^{139}Ce to include the 2008 results of the PTB, Germany and the BEV, Austria, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06019.

21. Michotte C., Ratel G., Moune M., Bobin C., Activity measurements of the radionuclide ^{124}Sb by the LNE-LNHB, France for the ongoing comparison BIPM.RI(II)-K1.Sb-124, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06021.

22. Michotte C., Courte S., Ratel G., Moune M., Bobin C., Update of the ongoing comparison BIPM.RI(II)-K1.Se-75 to include recent activity measurements of the radionuclide ^{75}Se by the LNE-LNHB (France), *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06007.

23. Michotte C., Ratel G., Courte S., Garcia-Toraño E., Kossert K., Nähle O., van Wyngaardt W.M., Simpson B.R.S., Update report of the BIPM comparison BIPM.RI(II)-K1.Na-22 of activity measurements of the radionuclide ^{22}Na to include the CIEMAT, PTB and the NMISA, *Metrologia*, 2010, **47**, *Tech. Suppl.*, 06001.

24. Michotte C., Courte S., Ratel G., Sahagia M., Wätjen A.C., Fitzgerald R., Maringer F-J., Update of the ongoing comparison BIPM.RI(II)-K1.Co-60 including activity measurements of the radionuclide ^{60}Co for the IFIN-HH (Romania), NIST (USA) and the BEV (Austria), *Metrologia*, 2010, **47**, *Tech. Suppl.*, 06010.

25. Michotte C., Courte S., Ratel G., Sochorová J., Update of the comparison BIPM.RI(II)-K1.Co-56 of activity measurements of the radionuclide ^{56}Co to include the result of the CMI-IIR, *Metrologia*, 2010, **47**, *Tech. Suppl.*, 06011.

26. Michotte C., Ratel G., Courte S., Verdeau E., Amiot M-N., Activity measurements of the radionuclide ^{111}In for the LNE-LNHB, France in the ongoing comparison BIPM.RI(II)-K1.In-111, *Metrologia*, 2010, **47**, *Tech. Suppl.*, 06019.

27. Michotte C., Courte S., Ratel G., Moune M., Johansson L., Keightley J., Update of the BIPM.RI(II)-K1.Tc-99m comparison of activity measurements for the radionuclide ^{99m}Tc to include new results for the LNE-LNHB and the NPL, *Metrologia*, 2010, **47**, *Tech. Suppl.*, 06026.

28. Picard S., Burns D.T. , Roger P., Allisy-Roberts P.J., McEwen M.R., Cojocaru C.D., Ross C.K., Comparison of the standards for absorbed dose to water of the NRC and the BIPM for accelerator photon beams, *Metrologia*, 2010, **47**, *Tech. Suppl.*, 06025.

29. Picard S., Burns D.T., Roger P., Allisy-Roberts P.J., Kapsch R.P., Krauss A., Key comparison BIPM.RI(I)-K6 of the standards for absorbed dose to water of the PTB, Germany and the BIPM in accelerator photon beams, *Metrologia*, 2011, **48**, *Tech. Suppl.*, 06020.

30. Picard S., Nonis M., Solve S., Allisy-Roberts P. J., Renaot E., Martin C., Subsequent Bilateral Comparison to CCT-K3; CIPM Key comparison CCT-K3.1: Comparison of Standard Platinum Resistance Thermometers at the Triple Point of Water (T = 273.16 K) and at the Melting Point of Gallium (T = 302.9146 K), *Metrologia*, 2011, **48**, *Tech. Suppl.*, 03001.

2.5.2 BIPM publications

31. Allisy-Roberts P.J., Burns D.T., Kessler C., Measuring conditions and uncertainties for the comparison and calibration of national dosimetric standards at the BIPM, *Rapport BIPM*-2011/04, 21 pp.

32. Picard S., Burns D.T., Ostrowsky A., Determination of the recombination correction for the BIPM parallel-plate ionization chamber type in a pulsed photon beam, *Rapport BIPM*-2011/06, 9 pp.

2.6 Chemistry

The Chemistry Department continues to make significant progress in its three core areas of activity: international equivalence of gas standards for air quality and climate change monitoring; international equivalence of primary organic calibrators for health, food, forensics, pharmaceuticals, and environmental monitoring; and support for CCQM and Joint Committee for Traceability in Laboratory Medicine (JCTLM) activities and liaison with intergovernmental organizations.

In the area of gas metrology, the BIPM coordinates the surface ozone reference standard key comparison (BIPM.QM-K1) with seven laboratories having participated in comparisons at the BIPM headquarters, and two further laboratories having received calibrations. Development of laser-based standard reference photometer (SRP) and ozone absorption cross-section measurements continue, with new relative measurements at three wavelengths in the UV completed and submitted for publication. The Draft B reports of the CCQM-K74 and CCQM-P110 comparisons for nitrogen dioxide standards were completed following a successful workshop held during the CCQM Working Group on Gas Analysis (GAWG) meeting in November 2010. The validation of BIPM facilities for the coordination of CCQM-K82 on methane at ambient levels has continued and is nearing completion. The BIPM facility for the generation of formaldehyde (HCHO) in nitrogen standards has been completed and stability tests on cylinder transfer standards for the coordination of CCQM-K90 have started.

The BIPM's organic programme forms an essential and integral part of the CCQM Working Group on Organic Analysis (OAWG) strategy for core competency comparison studies which will support NMIs with CMC claims in organic analysis under the CIPM MRA. The BIPM has an ongoing role as the coordinating laboratory for comparisons that underpin core competencies for the provision of primary calibration reference services. This role requires the BIPM to continue to coordinate the CCQM-K55 series of comparisons for the purity assessment of pure organic compounds and to commence the CCQM-K78 series for the assignment of the mass fraction content of standard solutions of high-purity organics. In 2011, BIPM completed the CCQM-K55.b comparison, which was undertaken in the second half of 2010, and has made substantial progress in preparing the candidate material for the CCQM-K55.c study.

In 2012, the BIPM will coordinate the key comparison CCQM-K55.c to assign the mass fraction content of a pure sample of the amino acid (L)-Valine, will undertake initial studies for the CCQM-K55.d purity comparison, and carry out the first organic calibration solution comparison.

The BIPM has made progress in the investigation of pure material characterization methods for analytes of higher molecular weight and complexity that are of direct relevance to the CCQM. Angiotensin I was the focus of initial efforts aided by a collaboration with NIST. Six pure amino acids have been value assigned in preparation for an amino acid characterization of the peptide material. A high accuracy mass spectrometer installed at the BIPM has been used to identify peptide impurities within the materials studied. Impurity quantification methods have been developed.

The JCTLM database was updated in March 2011 to include WG1 Cycle 7 reference materials, and measurement methods, and WG2 Cycle 5 reference measurement laboratory services which were approved by the Executive Committee during its 9th annual meeting, held on 2-3 December 2010. As of December 2011 the JCTLM database contained: 247 available certified reference materials; 152 reference measurement methods or procedures representing about 80 different analytes; and 86 reference measurement services. The WG1 Cycle 8 call for nominations of higher order reference materials and reference measurement methods or procedures, and the WG2 Cycle 6 call for nominations of reference measurement laboratory services were announced on the JCTLM website in January 2011, resulting in 40 nominations for materials, 7 nominations for procedures and 5 nominations for services.

The contract to deliver a BIPM defined study entitled "Study of Measurement Service and Comparison Needs for an International Measurement Infrastructure for the Biosciences and Biotechnology" has been completed. The report of this study has been published and is available on the BIPM website (http://www.bipm.org/utils/common/pdf/rapportBIPM/2011/02.pdf).

For a full report on the activities of the Chemistry Department during 1 July 2010 to 31 December 2011 please see the website http://www.bipm.org/utils/common/pdf/DIR2011/chem2011.pdf.

2.6.1 External publications

1. Viallon J., Moussay P., Idrees F., Wielgosz R.I., Rakowska A., Final report on the on-going key comparison BIPM.QM-K1: Ozone at ambient level, comparison with VSL, 2008, *Metrologia*, 2010, **47**, *Tech. Suppl*., 08024.

2. Viallon J., Moussay P., Idrees F., Wielgosz R., Novak J. and Vokoun M., Final report on the ongoing key comparison BIPM.QM-K1: Ozone at ambient level, comparison with CHMI, 2009, *Metrologia*, 2011, **48**, *Tech. Suppl*., 08001.

3. Viallon J., Moussay P., Idrees F., Wielgosz R. and Fentanes O., Final report on the ongoing key comparison BIPM.QM-K1: Ozone at ambient level, comparison with CENICA (October 2010), *Metrologia*, 2011, **48**, *Tech. Suppl*., 08003.

4. Viallon J., Moussay P., Idrees F., Wielgosz R., Gomez P.M., Sanchez C., Final report on the ongoing key comparison BIPM.QM-K1: Ozone at ambient level, comparison with ISCIII (December 2010), *Metrologia*, 2011, **48**, *Tech. Suppl*., 08005.

5. Viallon J., Moussay P., Idrees F., Wielgosz R., Norris J.E. and Guenther F.R., Final report on the ongoing key comparison BIPM.QM-K1: Ozone at ambient level, comparison with NIST (June 2009), *Metrologia*, 2011, **48**, *Tech. Suppl*., 08006.

6. Viallon J., Moussay P., Idrees F., Wielgosz R., Botha A., Final report on the ongoing key comparison BIPM.QM-K1: Ozone at ambient level, comparison with NMISA (August 2010), *Metrologia*, 2011, **48**, *Tech. Suppl*., 08007.

7. Viallon J., Moussay P., Idrees F., Wielgosz R., Heikens D., Wessel R., Final report on the ongoing key comparison BIPM.QM-K1: Ozone at ambient level, comparison with VSL (December 2010), *Metrologia*, 2011, **48**, *Tech. Suppl*., 08008.

8. Viallon J., Moussay P., Idrees F., Wielgosz R., Rakowska A., Chin-Chye T., Final report on the ongoing key comparison BIPM.QM-K1: Ozone at ambient level, comparison with NMC, A*STAR (December 2010), *Metrologia*, 2011, **48**, *Tech. Suppl.*, 08017.

9. Viallon J., Moussay P., Idrees F., Wielgosz R., Froehlich M., Wolf A., Final report on the ongoing key comparison BIPM.QM-K1: Ozone at ambient level, comparison with EAA (September 2011), *Metrologia*, 2011, **48**, *Tech. Suppl*., 08018.

10. Westwood S., Josephs R., Choteau T., Mesquida C., Daireaux A., Wielgosz R., Davies S., Windust A., Kang M., Ting H., Kato K., Frias E., Pérez M., Apps P., Fernandes-Whaley M., Wiangnon K., Ruangrittinon N., Wood S., LeGoff T., Duewer D., Schantz M., Siekmann L., Esker J., An international comparison of mass fraction purity assignment of digoxin: CCQM Pilot Study CCQM-P20.f (Digoxin), *Metrologia*, 2011, **48**, *Tech. Suppl.*, 08103.

2.6.2 BIPM publications

11. Viallon J., Moussay P., Idrees F., Wielgosz R.I. and Ross G., Comparison of Ozone Reference Standards of the DECCW and the BIPM, December 2010, *Rapport BIPM*-2011/03, 18 pp.

2.7 Comparisons

During the period 1 July 2010 to 31 December 2011, there were a total of 62 BIPM coordinated comparisons, with 224 NMI participations.

2.7.1 Mass

The Mass Department launched one key comparison (CCM-M-K4) with 16 participants during the period 1 July 2010 to 31 December 2011.

Comparison	Description	No. of NMI Participations
CCM.M-K4	Comparison of stainless steel mass standards	16

2.7.2 Time

The Time Department pilots the key comparison CCTF-K001.UTC, published through the monthly *Circular T*. Between 1 July 2010 and 31 December 2011, about 100 key comparisons (one every five days) were carried out with 69 participants.

Comparison	Description	No. of NMI Participations
CCTF-K001.UTC	Calculation of the reference time scale UTC	69

2.7.3 Electricity

During the period 1 July 2010 to 31 December 2011 the Electricity Department piloted 9 ongoing key BIPM comparisons. In addition it participated in the APMP key comparison APMP.EM.BIPM-K11.3 (Zener voltage at 1.018 V and 10 V) and in the EURAMET supplementary comparison EURAMET.EM-S31 (capacitance at 10 pF and 100 pF).

Comparison	Description	No. of NMI Participations
BIPM.EM-K11	DC voltage, Zener diode: (a) 1.018 V; (b) 10 V	1
BIPM.EM-K13	Comparison of resistance standards: (a) 1 Ω; (b) 10 kΩ	5
BIPM.EM-K14	Comparison of capacitors: (a) 10 pF; (b) 100 pF	4
BIPM.EM-K10	DC voltage, Josephson standards: (a) 1.018 V; (b) 10 V	7
BIPM.EM-K12	Quantum Hall resistance standards and their scaling to other resistance values	0
	Total	**17**

2.7.4 Ionizing Radiation

The Ionizing Radiation Department piloted 22 BIPM ongoing key comparisons from 1 July 2010 to 31 December 2011. In addition, the Department took part in two other bi-lateral comparisons with LNE-LNHB and the PTB.

Comparison	Description	No. of NMI Participations
BIPM.RI(II)-K1.Cs-134	Activity of radionuclide Cs-134	1
BIPM.RI(II)-K1.Cs-137	Activity of radionuclide Cs-137	2
BIPM.RI(II)-K1.Sn-113	Activity of radionuclide Sn-113	2
BIPM.RI(II)-K1.F-18	Activity of radionuclide F-18	1
BIPM.RI(II)-K1.I-123	Activity of radionuclide I-123	1
BIPM.RI(II)-K1.Co-60	Activity of radionuclide Co-60	1
BIPM.RI(II)-K1.Cu-64	Activity of radionuclide Cu-64	1
BIPM.RI(II)-K1.Mo-99	Activity of radionuclide Mo-99	1
BIPM.RI(II)-K1.Ag-111	Activity of radionuclide Ag-111	1
BIPM.RI(II)-K1.Sb-125	Activity of radionuclide Sb-125	1
BIPM.RI(II)-K1.Eu-152	Activity of radionuclide Eu-152	1
BIPM.RI(II)-K1.Tl-201	Activity of radionuclide Tl-201	1
BIPM.RI(II)-K1.Am-241	Activity of radionuclide Am-241	2
BIPM.RI(II)-K1.C-11	Activity of radionuclide C-11	1
BIPM.RI(I)-K1	Measurement of air kerma for Co-60 gamma-rays	3
BIPM.RI(I)-K2	Measurement of air kerma for low energy x-rays	5
BIPM.RI(I)-K3	Measurement of air kerma for medium energy x-rays	4
BIPM.RI(I)-K4	Measurement of absorbed dose to water for Co-60	1
BIPM.RI(I)-K5	Measurement of air kerma for Cs-137 gamma-rays	3
BIPM.RI(I)-K6	Measurement of absorbed dose to water for high-energy beams	2
BIPM.RI(I)-K7	Measurement of air kerma for mammography beams	2
BIPM.RI(I)-K8	Measurement of reference air kerma rate for high dose-rate brachytherapy	1
	Total	**38**

2.7.5 Chemistry

During 1 July 2010 to 31 December 2011, the Chemistry Department worked on four key comparisons and three pilot studies (all coordinated by the BIPM). The Chemistry Department also undertook preparatory/validation work for three more comparisons which are planned for 2012/2013.

Comparison	Description	No. of NMI participations
BIPM.QM-K1	Ozone ambient level	7
CCQM-K74	Nitrogen dioxide 10 µmol/mol	16
CCQM-P110	Nitrogen dioxide 10 µmol/mol: spectroscopic study	19
CCQM-K55.a	Estradiol: purity analysis	20
CCQM-P117a	Estradiol: purity analysis	
CCQM-K55.b	Aldrin: purity analysis	22
CCQM-P117b	Aldrin: purity analysis	
	Total	**84**

2.8 Calibrations

In the period from 1 July 2010 to 31 December 2011, 130 Certificates and 5 Study Notes were issued.

A complete list of certificates is provided in the French version only (see annex p78).

3 THE CIPM MRA

As of 31 December 2011, the CIPM MRA has been signed by the representatives of 87 institutes – from 50 States Parties to the Metre Convention, 34 Associates of the CGPM, and 3 international organizations – and covers a further 138 institutes designated by the signatory bodies.

3.1 The BIPM key comparison database, KCDB

Bi-annual reports on KCDB work are available on the BIPM website at http://www.bipm.org/jsp/en/ViewKCDBReport.jsp. Readers are encouraged to consult these documents for detailed information concerning publication, in the KCDB, of key and supplementary comparisons and for approved sets of CMCs.

3.1.1 Content of the KCDB

3.1.1.1 Key and supplementary comparisons

On 22 November 2011, the key and supplementary comparisons database covered 769 key comparisons (84 from the BIPM, 383 from the CCs, and 302 from RMOs) and 285 supplementary comparisons. Two new BIPM key comparisons were registered in the KCDB over the period covered by this report, namely BIPM.RI(I)-K8 and BIPM.RI(II)-K1.Sb-125, registered on 8 July 2010 and 14 February 2011, respectively, and which correspond to novel work undertaken by the BIPM Ionizing Radiation Department in brachytherapy and in the SIR measurement of radionuclide Sb-125.

On average, 40 new key comparisons and 27 new supplementary comparisons are registered each year.

Updated graphs illustrating participation in key and supplementary comparisons were made available on the statistics page of the KCDB on 24 November 2011.

On 22 November 2011, of the 769 key comparisons registered:

- 88 corresponded to exercises carried out prior to the entry into force of the CIPM MRA, and which therefore will never have results published in the KCDB; they have been "Approved for provisional equivalence".
- 74 of the 84 ongoing BIPM key comparisons had results published in the KCDB.
- a further 358 CC and RMO key comparisons had their final reports approved and were posted on the KCDB website, with corresponding tables of numbers and graphs entered in the database.

At that date, 1 720 graphs of equivalence were displayed in the KCDB.

The results of 149 RMO key comparisons (54 conducted by APMP, 16 by COOMET, 64 by EURAMET, and 15 by SIM) were published in the KCDB, and linkage had also been carried out for 40 bilateral key comparisons subsequent to full-scale CC key comparisons; their results are included in the appropriate graphs of equivalence.

The KCDB now contains one example of a family of eight key comparisons linked together: M.M-K1 (one kg stainless steel standards), including 82 degrees of equivalence relative to the CCM.M-K1 key comparison reference value. These results span more than 10 years and a new central CIPM key comparison, CCM.M-K4, has been launched with the BIPM acting as the pilot laboratory. Other examples gathering six or seven linked key comparisons can be found in the KCDB.

Final reports for 161 of the 285 supplementary comparisons registered in the KCDB had been posted as of 22 November 2011.

Altogether 65 % of the comparisons registered in the KCDB were complete. The final reports have been posted in the KCDB, and are generally published in the *Metrologia Technical Supplement*. This percentage has been stable over several years.

3.1.1.2 Calibration and Measurement Capabilities – CMCs

On 22 November 2011, the KCDB included a total of 24 247 CMCs:

- 15 497 in General Physics,
- 3 909 in Ionizing Radiation,
- 4 841 in Chemistry.

During 1 July 2010 to 31 December 2011, 46 newly approved sets of CMCs were published, equivalent to an additional 1 300 CMCs.

The first sets of CMCs declared by Viet Nam (5 CMCs in Time and Frequency), Peru (19 CMCs in Mass Standards), Paraguay (23 CMCs in Mass Standards), and Ecuador (20 CMCs also in Mass Standards) were published on 21 July 2010, 3 August 2010, 31 January 2011 and 16 September 2011, respectively. Institutes from Viet Nam, Peru, Paraguay and Ecuador signed the CIPM MRA on 16 September 2004, 17 November 2009, 27 October 2009 and 15 April 2001, respectively. This time frame indicates that to complete the whole CIPM MRA scheme to publish CMCs may be a long and difficult process.

There was progress towards the temporary removal and re-instatement of CMCs, and the total number of "greyed-out" CMCs decreased: from 449 CMCs greyed-out as of 22 July 2010, to 184 on 22 November 2011. This mainly results from two actions:

- The JCRB, at its 26th meeting in March 2011, agreed a procedure to deal with CMCs that had been greyed-out for more than five years, namely deleting them in a definitive way or allowing them a one-year period of grace for decision about re-instatement or definitive deletion. This resulted in rationalization of the several hundreds of CMCs concerned (see §3.2.3).
- The JCRB, at its 27th meeting in September 2011, resolved that "the CMCs of those institutes removed from Appendix A will automatically be deleted from the KCDB". It followed that the 143 CMCs in ionizing radiation from Latvia, declared by RMTC, which ceased to be a Designated Institute on 10 March 2010, were definitively deleted on 16 September 2011.

The KCDB office also dealt with numerous corrections, namely editorial changes, deletion of services that are no longer available, and changes in laboratory names and acronyms.

Details of the number of CMCs currently published in the KCDB, by country and by metrology area, and the situation regarding greyed-out CMCs, are available in real-time from the statistics page of the KCDB. An Excel file which records the history of CMC publications (including greying-out and re-instatement following QS approval) is available, in real-time, on a restricted-access section of the JCRB CMC website. Following a request by the JCRB at its 24th meeting, the dates of greying-out of CMCs are included in this file.

3.1.2 Visits to the KCDB website

The average number of monthly visits to the KCDB website remained constant at ~7 200 throughout 2010. The average number of pages consulted during each visit increased significantly, compared to 2009, as did the average duration of each visit.

The log-on statistics recorded for January to October 2011 indicate a slight increase in the average number of monthly visits to 7 800, and a consistent number of approximately 100 000 KCDB web pages were visited each month.

The KCDB website continues to attract key communities: NMIs, regulators, accreditors, commercial and industrial companies.

3.1.3 Modification of the KCDB website

The KCDB web system concerning CMCs in chemistry was modified on 31 August 2011. The acronym "QM" and the expression "Amount of substance", are generally not familiar to the industrial community have been replaced by the word "Chemistry". The CMCs covering physics and chemistry have been clearly separated, and some new functionality has been added to facilitate access to information in this area. The BIPM free-text search engine has been inserted into the pages of CMCs in chemistry to enable services linked to a given CRM to be searched directly.

3.1.4 KCDB Newsletters

The KCDB is mainly publicized through the *KCDB Newsletter*. Issues 14, 15 and 16 of the *KCDB Newsletter* were published on 14 December 2010, 15 June 2011 and 15 December 2011, respectively.

3.2 JCRB (Joint Committee of the Regional Metrology Organizations and the BIPM)

Three JCRB meetings were held between 1 July 2010 and 31 December 2011:

- The 25th meeting of the JCRB was held in Sharm al-Sheik, Egypt, on 21–22 September 2010;
- The 26th meeting of the JCRB was held at the BIPM headquarters on 21–22 March 2011;
- The 27th meeting of the JCRB was held in Vienna, Austria, on 14–15 September 2011.

3.2.1 New CIPM MRA signatories

The following institutions signed the CIPM MRA between 1 July 2010 and 31 December 2011:

- Seychelles Bureau of Standards (SBS) on 12 November 2010;
- National Metrology Institute (NMI-SIRDC), Zimbabwe, on 14 January 2011;
- Zambia Bureau of Standards (ZABS) on 3 February 2011;
- Mauritius Standards Bureau (MSB) on 9 March 2011;
- National Metrology Laboratory, Bangladesh Standards and Testing Institution (NML-BSTI) on 25 March 2011;
- Saudi Standards, Metrology and Quality Organization (SASO) on 25 May 2011;
- Institute of Metrology of Bosnia and Herzegovina (IMBiH) on 15 June 2011;
- National Physical and Standards Laboratory (NPSL), Pakistan, on 6 July 2011;
- Bureau of Metrology (BMM), Montenegro, on 19 October 2011.

3.2.2 CIPM MRA documents and policies

Updates and revisions have been made to the following CIPM MRA documents and guidelines:

- CIPM MRA-P-01 Procedure for approval of the entry of a new RMO to the JCRB;
- CIPM MRA-D-04 Calibration and Measurement Capabilities in the context of the CIPM MRA;
- CIPM MRA-D-05 Measurement comparisons in the CIPM MRA;
- CIPM MRA-G-02 JCRB guidelines for the monitoring and reporting of the operation of quality systems by RMOs.

The JCRB has recommended a new document on CIPM MRA guidelines for authorship of key, supplementary and pilot study comparison reports for approval by the CIPM.

3.2.3 Status of CMCs temporarily removed from KCDB

The JCRB has approved a new procedure for the permanent removal of CMCs which have been temporarily removed from the KCDB. According the procedure, once CMCs have been temporarily removed from the KCDB for a period of five years, a notice will be sent to the RMO and the NMI that the CMCs in question will be permanently deleted, unless action is taken to restore the CMCs to the KCDB within the following year.

3.2.4 Designated Institutes

The BIPM will cooperate with RMOs to ensure better integration of Designated Institutes (DIs) into CIPM MRA activities. To this end, the BIPM will send information to new DIs concerning the expectation that they participate fully in CIPM MRA activities with the purpose of declaring CMCs in their areas of designation. The BIPM will also begin to require information on the areas of designation of all new DIs in order to improve the quality of information available in Appendix A of the CIPM MRA.

The JCRB has resolved that the CMCs of any DI whose designation is revoked by national authorities will be automatically and definitively removed from the KCDB subsequent to receipt of the notice by the BIPM.

3.2.5 Initiatives for a new RMO in the Middle East

The JCRB has been informed of several initiatives to form a new RMO encompassing a number of countries in the Middle East or the Middle East and North Africa. Communication between the JCRB and parties responsible for the initiatives will continue with a view towards ensuring that any new RMO has sufficient capability to carry out the functions required of it by the CIPM MRA.

4 MEETINGS AND PROMOTION OF THE METRE CONVENTION

4.1 Meeting of NMI Directors and meeting of representatives of States Parties to the Metre Convention

4.1.1 Meeting of NMI Directors

A meeting of NMI Directors was held at the BIPM headquarters on 25 May 2011. The four main areas of discussion were: the present situation of the redefinition of some base units of the SI and on the draft Resolution of the CIPM on the possible future revision of the SI; the BIPM's Programme of Work 2013 to 2016 and the long-term perspective for the BIPM; update of the CIPM MRA; and the present situation on the rapprochement between the BIPM and OIML.

The results of the discussions are summarized as follows:

- Clarification was provided on the future role of the BIPM and the impact on the BIPM Programme of Work of the future redefinition of certain base units of the SI; and the importance of publicizing issues relating to the redefinitions was highlighted. The timetable for the redefinitions was discussed, with 2015 suggested as the earliest possible date as the situation stands at the moment.
- The BIPM's Programme of Work and budget for 2013 to 2016 was described in detail, and four different potential funding scenarios were presented (see §4.1.2). In particular, the worst case scenario would represent a major change for the BIPM as it would require the present level of expenditure to be reduced by 1.4 M Euros with a corresponding reduction in core activities. A clear statement of the consequences of adopting such a scenario is needed. The measures that would need to be implemented under this funding scenario would result in loss of expertise for the BIPM.
- The need for an updated long-term strategy for the BIPM was stressed. It is essential that this strategy is prepared before the CGPM meeting in 2015. Development of a 'World metrology strategic plan' for the entire world-wide metrological community was suggested.
- The unique and invaluable work that the BIPM undertakes on the metrology of pure organic chemicals was highlighted by participants.
- All participants agreed that the CIPM MRA is a success. The various points of an addendum to the CIPM MRA were presented and discussed. The revised addendum will be sent out for written approval.
- Discussions involving a potential rapprochement between the BIPM and OIML are ongoing.

The three draft Resolutions on the governance of the BIPM submitted by Switzerland (Draft Resolution K), the United Kingdom of Great Britain and Northern Ireland (Draft Resolution L), and France (Draft Resolution M), were presented to the NMI Directors. All three proposals stem mainly from the strategic issue of the role of the BIPM in relation to the NMIs. The main points of the discussions on the draft Resolutions were:

- More contact is needed between the Member States, NMI Directors and the BIPM, and the Member States and the NMI Directors would like to be consulted more regularly.
- Accountability, decision making and transparency within the CIPM were suggested as areas for improvement.
- The governance of the BIPM should be revised. There is a need to develop an updated long-term strategy in order to be able to agree on the short- and medium-term development of, and investments in, the BIPM.

4.1.2 Meeting of representatives of States Parties to the Metre Convention

A meeting of representatives of States Parties to the Metre Convention to discuss the BIPM Programme of Work and the corresponding budget for 2013 to 2016 took place at the BIPM headquarters from 26 to 27 May 2011. The agenda included presentations of the activities of the BIPM scientific departments and a tour of the BIPM laboratories. As well as discussing the Programme of Work and budget, the four different funding scenarios with their long-term consequences for the future of the BIPM were presented:

Scenario I Proposed Programme of Work.

Scenario II Proposed Programme of Work with the option of financing the linear accelerator (LINAC) by voluntary contributions.

Scenario III Continuation of present activities with an adjustment for inflation to allow the current level of effort to be maintained.

Scenario IV No increase in contributions from Member States, no inflationary increase and consequently a reduction or discontinuation of activities.

During a closed session (without the presence of any CIPM members who were not part of a government delegation and without any BIPM staff members) the representatives discussed the BIPM's Programme of Work for 2013-2016, the funding scenarios and other issues. The results of the closed session were summarized by the representatives of the Member States as follows:

1. All states strongly support and appreciate the Metre Convention and the work of the BIPM, noting that it is moving forward, for example with the development of the CIPM MRA.
2. The range of views on funding scenarios stretched from support for scenario I and II to a desire for a less than scenario IV, with the majority tending to be around III or IV. Some member states indicated that they are willing to support the BIPM with additional voluntary contributions. Other Member States expressed their view that such contributions should not incur continuing obligations.
3. There was unanimous support for a new and stronger strategic direction for BIPM with a clear idea of priorities, developed jointly between Member States, NMIs and the CIPM.
4. Some member states question the current balance between coordinating activities and scientific and technical work and whether it is still appropriate for the future.
5. A key aspect of the new strategy will be consideration of the appropriate roles of BIPM, regional metrology organizations and NMIs.
6. One interesting recommendation was that BIPM should consider whether it would be appropriate to charge for some of their services and to share costs for joint activities with other organizations.
7. Discussions on the modernization of governance structures should go in parallel with strategic developments.
8. There is a strong feeling that changes should not wait until the next scheduled CGPM in 2015.

The three government-initiated draft Resolutions related to the governance of the BIPM that were presented and discussed at the meeting, provided valuable feedback to the CIPM over concerns expressed by a number of delegations. The CIPM initiated an additional draft Resolution on governance issues (Resolution N) for consideration during the 24th meeting of the CGPM in October 2011. Overall, the meeting of representatives of States Parties to the Metre Convention proved to be very successful and was seen as a valuable communication forum. It was recommended that it should be held on a regular basis, perhaps annually.

4.2 24th meeting of the General Conference on Weights and Measures (CGPM)

The 24th meeting of the CGPM was held in Paris, from 17 to 21 October 2011. Delegates from forty-three of the fifty-five States Parties to the Metre Convention were represented at the meeting of the CGPM. The meeting was also attended by representatives from twelve Associates of the CGPM and representatives of six intergovernmental organizations and international bodies.

The opening session was attended by Prof. Alain Carpentier, president of *the Académie des sciences,* who handed over the Chairmanship of the meeting to Prof. Christian Bordé, member of the *Académie des Sciences*. A speech was given on behalf of His Excellency the *Ministre des Affaires Étrangères et Européennes de la République Française* by Mr Pierre Sellal, *Secrétaire Général of the Ministère des Affaires Étrangères et Européennes de la République Française*. Dr Robert Kaarls, CIPM Secretary, was nominated Secretary of the Conference. The President of the CIPM, Dr Barry Inglis, presented the CIPM report on the work accomplished since the 23rd meeting of the CGPM. Reports were presented on collaboration between the BIPM and intergovernmental organizations and international bodies by representatives from the International Commission on Illumination (CIE), International Atomic Energy Agency (IAEA), International Laboratory Accreditation Cooperation (ILAC), International Organization of Legal Metrology (OIML), World Health Organization (WHO) and World Meteorological Organization (WMO).

Reports and discussions took place on the following topics: the possible redefinition of a number of base units of the SI (Draft Resolution A); the role, mission, objectives, long-term strategy and governance of the BIPM (Draft Resolutions K, L, M and N); the BIPM Programme of Work for the years 2013 to 2016 and the proposed dotation. As usual, the Working Group on the dotation was appointed by the CGPM to discuss the proposed dotation (Draft Resolution C).

The following Draft Resolutions were presented and discussed: 'On the importance of international collaboration so as to place measurements to monitor climate change on an SI traceable basis' (Draft Resolution B); 'On the status of Associate State of the General Conference' (Draft Resolution D); 'On the acceptance of Economies as Associate of the General Conference' (Draft Resolution E); 'On financial arrears of States Parties to the Metre Convention' (Draft Resolutions F); 'On rescheduling agreements between the International Committee for Weights and Measures and defaulting States Parties to the Metre Convention for the payment of their financial arrears' (Draft Resolutions G); 'On the revision of the *mise en pratique* of the metre and the development of new optical frequency standards' (Draft Resolution I) and 'On the adoption of a common terrestrial reference system' (Draft Resolution J).

The renewal of half of the CIPM was carried out by secret ballot. All the Draft Resolutions subject to voting at the CGPM meeting were adopted except Draft Resolution H 'On a Convention on the privileges and immunities of the BIPM', which was withdrawn and will be reformulated and presented at the next meeting of the CGPM. The Draft Resolutions adopted included a historic and unanimous vote in favour of Resolution 1 'On the possible future revision of the International System of Units, the SI'. Delegates to the CGPM were invited to the BIPM headquarters for a tour of the BIPM laboratories.

4.2.1 Resolutions adopted at the 24th meeting of the General Conference on Weights and Measures

The full text of the resolutions is available on the BIPM website at http://www.bipm.org/jsp/en/ListCGPMResolution.jsp?CGPM=24

1. On the possible future revision of the International System of Units, the SI.
2. On the importance of international collaboration so as to place measurements to monitor climate change on an SI traceable basis.
3. Dotation of the BIPM for the years 2013 to 2015.

4. On the status of Associate State of the General Conference.
5. On the acceptance of Economies as Associate of the General Conference.
6. On financial arrears of States Parties to the Metre Convention.
7. On rescheduling agreements between the International Committee for Weights and Measures and defaulting States Parties to the Metre Convention for the payment of their financial arrears.
8. On the revision of the *mise en pratique* of the metre and the development of new optical frequency standards.
9. On the adoption of a common terrestrial reference system.
10. On the role, mission, objectives, long-term strategy and governance of the BIPM.

4.2.2 *Ad hoc* Working Group on the role, mission, objectives, long-term financial stability, strategic direction and governance of the BIPM

One of the major outcomes of the meetings of NMI Directors and of the representatives of States Parties to the Metre Convention which took place in May 2011 (see §4.1) and of the CGPM meeting in October 2011 was that there will be a comprehensive review of the governance of the BIPM. Indeed Resolution 10 invites:

- The CIPM to establish an *ad hoc* Working Group under the Chairmanship of the President of the CIPM, with representation from the CIPM, States Parties to the Metre Convention (with maximum, intermediary and minimum contributions) and NMIs, properly balanced to represent all regions, and the Director of the BIPM, charged with conducting a Review of the role, mission, objectives, long-term financial stability, strategic direction and governance of the BIPM.
- The *ad hoc* Working Group to present the findings of this Review to the CIPM, States Parties to the Metre Convention and NMI Directors in October 2012.
- The CIPM to formulate proposed actions on the basis of the findings of the *ad hoc* Working Group and implement those within its authority, subject to support from the representatives of States Parties to the Metre Convention and NMI Directors, during the 2013-2014 timeframe.
- The CIPM to report to the CGPM at its 25th meeting on recommendations from the Review of the *ad hoc* Working Group, actions consequently taken by the CIPM and proposals for additional actions that require the approval of the CGPM.

4.2.3 Approval of possible changes to the International System of Units, including redefinition of the kilogram

The CGPM took a major step towards the revision of the International System of Units, including redefinition of the kilogram, by unanimously adopting Resolution 1 'On the possible future revision of the International System of Units, the SI' and thereby highlighting the need for revising the SI, and encouraging the metrology community for the final completion of this project. The text of Resolution 1 is essentially that of Draft Resolution A, which had been publicly available for some months before the meeting of the CGPM on the BIPM 'New SI' website (http://www.bipm.org/en/si/new_si/), with a few changes proposed by delegates during the meeting of the CGPM. One of these changes invites the CIPM to continue its work to render the language of the New SI as far as possible understandable for users in general, while maintaining scientific rigour and clarity and without altering the basic content and structure of the New SI as set forth in Resolution 1. Final approval of the New SI with a date for its implementation will be made by the CGPM after its prerequisite conditions have been met, this will not be before 2014. This historic decision represents the culmination of many years of work, particularly by

the Consultative Committee for Units (CCU) and its President, Prof. Ian Mills (see http://www.bipm.org/en/CGPM/db/24/1/).

4.2.4 Dotation of the BIPM for the years 2013 to 2015

The CGPM adopted the BIPM dotation for the years 2013-2015 (Resolution 3) on the basis of the dotation voted by the CGPM in 2007 for 2012, with the addition of the 2012 contributions of the States which acceded to the Metre Convention since the 23rd meeting of the CGPM. The CGPM voted an annual increase of 1 % for inflation. This represents a change to the long standing practice to adopt a dotation for a quadrennium. As a consequence, the CGPM decided that its 25th meeting will be held in 2014. The CGPM also did not include in Resolution 3 an additional discretionary contribution to support the increasing workload of the BIPM, although States Parties to the Metre Convention, international organizations, private organizations and foundations were urged to provide additional voluntary financial support of all kinds to support specific BIPM mission-related activities.

The adoption of a 3-year dotation requires an adjustment of the Programme of Work for the period 2013 to 2015. The adjusted Programme of Work will be discussed by the CIPM at its meeting in June 2012 (see http://www.bipm.org/en/CGPM/db/24/3/).

4.2.5 The status of Associate State of the General Conference

Resolution 4 'On the status of Associate State of the General Conference' recalls that the status of Associate State of the CGPM could constitute a first step to accede to the Metre Convention and that an Associate State can benefit from some services available to States Parties to the Metre Convention while the effective costs for the States Parties to the Metre Convention of these benefits for the Associate States are increasing.

Resolution 4 provides new provisions related to the subscriptions of the Associate States (see http://www.bipm.org/en/CGPM/db/24/4/).

4.2.6 The acceptance of Economies as Associate of the General Conference

Resolution 5 'On the acceptance of Economies as Associate of the General Conference' clarifies the situation regarding the status of Associate Economy. The decision of the CGPM to grant unanimously the status of Associate Economy will be on a case-by-case basis, based on the following criteria:

- an Associate Economy must be a Territorial Entity,
- the Territorial Entity must possess its own Metrology Institute within its territory,
- the participation of the Territorial Entity in the activities of the BIPM must be considered beneficial for the strengthening of the world's measurement system.

The CIPM was invited to consider further appropriate means by which intergovernmental organizations, in particular those from regions without well-developed metrology infrastructure, can be involved in the work of the BIPM and will bring forward proposals to the next meeting of the CGPM on how this can best be achieved (see http://www.bipm.org/en/CGPM/db/24/5/).

4.2.7 Financial arrears of States Parties to the Metre Convention and rescheduling agreements for the payment of arrears

Resolution 6 'On financial arrears of States Parties to the Metre Convention' reaffirms the absolute necessity that contributions of States Parties to the Metre Convention be paid timely and consistently to allow the BIPM to fulfil its mission and to avoid financial problems in its day-to-day operation. Resolution 6 stipulates that States Parties in financial arrears for more than 6 years are granted a period of 12 months from the date of adoption of the Resolution to conclude with the CIPM a rescheduling

agreement. If a rescheduling agreement is not concluded within 12 months, those States will automatically be excluded, and the CIPM will inform, in writing, the French Ministry of Foreign and European Affairs for notification to this effect to those States and to all States Parties to the Metre Convention on behalf of the CGPM. The calculation of contributions will then be re-established in accordance with the applicable provisions in the most immediate calendar year after exclusion (see http://www.bipm.org/en/CGPM/db/24/6/).

Resolution 7 'On rescheduling agreements between the International Committee for Weights and Measures and defaulting States Parties to the Metre Convention for the payment of their financial arrears' lays down the provisions related to the conclusion of a rescheduling agreement between the CIPM and defaulting States Parties to the Metre Convention (see http://www.bipm.org/en/CGPM/db/24/7/).

4.3 Promotion of the Metre Convention

4.3.1 New States Parties to the Metre Convention (Member States) and new Associates of the CGPM (Associates)

As of the end of 2011, there are 55 States Parties to the Metre Convention and 34 Associates of the CGPM.

New States Parties to the Metre Convention:

- The Kingdom of Saudi Arabia acceded to the Metre Convention on 11 February 2011.

New Associates of the CGPM:

- The Republic of the Seychelles became an Associate of the CGPM on 10 September 2010;
- The Republic of Zimbabwe became an Associate of the CGPM on 14 September 2010;
- The Republic of Mauritius became an Associate of the CGPM on 5 October 2010;
- The Republic of Zambia became an Associate of the CGPM on 10 December 2010;
- Bosnia and Herzegovina became an Associate of the CGPM on 24 May 2011;
- Montenegro became an Associate of the CGPM on 1 August 2011.

4.3.2 World Metrology Day – 20 May 2011

World Metrology Day (20 May) has featured on the calendar for more than a decade, and because 2011 was declared the UNESCO International Year of Chemistry, World Metrology Day celebrated the importance and impact of chemical measurements on our daily lives. The 2011 International Year of Chemistry also celebrated the centenary of the award of the Nobel Prize in Chemistry to Marie Skłodowska Curie, recognizing her discovery of the elements radium and polonium. Photographs taken at the BIPM in 1904 of Marie Curie, her husband Pierre Curie, their daughter Irène Curie, and Charles-Edouard Guillaume, at that time Deputy Director of the BIPM can be seen on the BIPM website (www.bipm.org/en/si/history-si/radioactivity/familles_curie_guillaume.html). All four were either already Nobel Laureates, or would become Nobel Laureates (twice in the case of Marie Curie). The BIPM was the custodian of the original radium standard prepared in 1911 by Marie Curie and used for the very first activity comparisons in the field of ionizing radiation. Today, although the original radium standard no longer exists, the BIPM maintains the international reference standards in ionizing radiation for both dosimetry and activity measurements.

The centrepiece of the joint BIPM-OIML website http://www.worldmetrologyday.org/ is the World Metrology Day poster, developed in collaboration with the PTB, Germany, with supporting material such

as a press release, aligned messages from the Directors of the BIPM and OIML, and an events log. NMIs and other organizations wishing to celebrate World Metrology Day were able to download the poster, translate it and add their own logo. The web pages, that were redesigned and upgraded in 2011, also include supporting information in the form of frequently asked questions and copyright policy. World Metrology Day provided a useful platform for raising awareness of metrology, and in total some 17 language versions of the poster were made available with more than 2 600 poster downloads. The events log included events listed in 23 countries. An indication of the growing recognition of the World Metrology Day "brand" can be seen by entering a Google search on "world metrology day", this returns more than 1.2 million results.

4.3.3 BIPM Bulletin

The BIPM Bulletin is intended to increase the level of communication between the BIPM and the States Parties to the Metre Convention. It supplements the formal reports required under the Metre Convention and highlights some key recent issues and achievements. Three issues of the BIPM Bulletin were published between 1 July 2010 and 31 December 2011. The November 2010 issue focused on news from the 99th meeting of the CIPM. The August 2011 issue covered the highlights of Session I of the 100th meeting of the CIPM, the meeting of National Metrology Institute Directors and the meeting of representatives of States Parties to the Metre Convention. The November 2011 issue concentrated on news from Session II of the 100th meeting of the CIPM and the 24th meeting of the CGPM.

4.3.4 New SI

At its 24th meeting in October 2011 the CGPM adopted Resolution 1 (see §4.2.3) on the possible future revision of the SI. This Resolution takes note of the CIPM's intention to propose a revision of the SI, and sets out a detailed road-map towards the future changes.

In the 'New SI' four of the SI base units, namely the kilogram, the ampere, the kelvin and the mole, will be redefined in terms of invariants of nature; the new definitions will be based on fixed numerical values of the Planck constant (h), the elementary charge (e), the Boltzmann constant (k), and the Avogadro constant (N_A), respectively. Further, the definitions of all seven base units of the SI will also be uniformly expressed using the explicit-constant formulation, and specific *mises en pratique* will be drawn up to explain the realization of the definitions of each of the base units in a practical way.

While remarkable progress has been made over the last few years, the conditions for adopting the redefinitions, as set by the CGPM at its 23rd meeting (2007), have not yet been fully met. The CGPM encourages NMIs, the BIPM and academic institutions to maintain their efforts towards the experimental determination of the fundamental constants h, e, k and N_A. See §1.4 for information about scientific support for the New SI.

5 RELATIONS WITH INTERGOVERNMENTAL ORGANIZATIONS AND INTERNATIONAL BODIES

5.1 Collaboration with other intergovernmental organizations and international bodies

5.1.1 Four-partite meeting (BIPM, OIML, ILAC and ISO)

A four-partite meeting between the BIPM, ILAC, the OIML and ISO is held annually. ISO was unable to attend the meeting held in March 2011. The purpose of the four-partite meetings is primarily to exchange information, but also to provide a discussion forum. The main output from the March 2011 meeting was that BIPM, OIML, ILAC and ISO will continue to develop the joint policy on traceability. The resulting document "*Joint BIPM, OIML, ILAC and ISO Declaration on Metrological Traceability*" was signed on 9 November 2011 and is published on the BIPM website at http://www.bipm.org/en/bipm/mou/bipm-oiml-ilac-iso_joint_declaration.html.

5.1.2 ILAC

The annual bipartite meeting between the BIPM and ILAC was held in March 2011. The main outputs of the meeting were:

- ILAC will inform the BIPM of developments in its relationship with the WHO.
- The BIPM offered to host the DCMAS Network meeting in 2012 in conjunction with the ILAC, OIML and four-partite meetings.
- ILAC attended the CCQM Workshop on the Role for Reliable Traceable Microbiological Measurements to Ensure Food Quality and Safety, held at the BIPM in April 2011.
- Noting the 10th anniversary of the signing of the CIPM/ILAC MoU in 2011, work began to re-sign/refresh the MoU with the idea of marking the event at the November 2011 ILAC/International Accreditation Forum (IAF) General Conference scheduled to be held in Bangkok, but which was cancelled due to the floods in Thailand.
- The BIPM will request that all RMOs make publicly available their requirements for CIPM MRA on-site peer reviewers.
- The BIPM and ILAC will continue to develop the Joint ILAC-CIPM Communication on Accreditation of Calibration and Measurement Services of NMIs.
- The BIPM will continue to provide input to the ILAC P10 Review Policy on Traceability of Measurement Results, and will consult the JCRB to ascertain its views.
- The Joint Task Group JTG-RAP, looking at peer review and accreditation between the two communities, had broadly completed its task and was disbanded.
- ILAC and the BIPM agreed to jointly support World Metrology Day on 20 May 2011 and World Accreditation Day on 9 June 2011.

The BIPM was an active participant in the relevant work undertaken by the ILAC Accreditation Committee (AIC) and attended the meeting held in Montreux, Switzerland, in April 2011. Key documentation under discussion included the Joint ILAC-CIPM Communication regarding the Accreditation of Calibration and Measurement Services of NMIs and the ILAC P10 Review Policy on Traceability of Measurement Results.

5.1.3 ISO

Although ISO was unable to attend the four-partite meeting in March 2011, it has contributed to the development of the Joint BIPM, OIML, ILAC and ISO Declaration on Metrological Traceability. The BIPM participated in the ISO CASCO meetings held in June 2010 (Paris) and June 2011 (Geneva) monitoring the development of a suite of ISO 17000 series documents. The BIPM maintains a watching brief, in so far as is possible, related to ISO TC12 (Quantities and Units). The BIPM took an active role in ISO TC 229 (Nanotechnologies) until the end of 2010, for example by attending the TC meetings. However, in 2011 a decision was taken that further involvement would be limited to a watching brief but without active participation, due to resource constraints.

5.1.4 OIML

The day-to-day cooperation between the BIPM and the OIML increased significantly and has ranged from collaboration on administrative matters (administrative procedures, human resources issues, information technology), agreement on the approach to information provision supporting the OIML "rapprochement" study, through to detailed cooperation on technical issues, particularly the revision of OIML D1 "Law on Metrology". A joint BIPM-OIML website www.metrologyinfo.org has been fully integrated and provides new or enhanced format and content on:

- Metrology and the environment;
- Metrology and trade;
- Metrology and health;
- Metrology and safety.

The joint website also hosts the World Metrology Day web pages (reported in more detail in §4.3.2). The BIPM continues to be responsible for the overall project management of World Metrology Day, but for the first time the International Bureau of Legal Metrology (BIML) provided the IT platform and conducted the bulk of the administration for the project. An indication of the degree of integration of delivery between the BIPM and the BIML is that while most downloadable content is delivered from the BIML servers, large data design files (necessary to allow publication of high-quality posters available in several languages) are delivered from the BIPM servers due to their greater download capability. This delivery from the servers of the two organizations is completely seamless and invisible to external users.

The BIPM and the OIML meet annually in March, although from early 2011, more regular meetings have been convened to progress work, and to this end, the BIPM and BIML Directors maintain regular contact. In practice there is usually some sort of exchange between the organizations on an almost daily basis. Issues range from the redefinition of the kilogram to collaboration on the VIM and the GUM through to "back room" collaboration on IT and matters of common interest related to the effective operation of international organizations.

BIPM staff members attended the International Committee of Legal Metrology (CIML) meetings in 2010 and 2011, and both the President of the CIML and the Director of the BIML attended the 24th meeting of the CGPM (2011).

5.1.5 WMO

The WMO and the BIPM held a joint workshop in March/April 2010 at the WMO headquarters in Geneva, Switzerland: "WMO-BIPM workshop on Measurement Challenges for Global Observation Systems for Climate Change Monitoring: Traceability, Stability and Uncertainty".

Consultations between the WMO and the BIPM during late 2010 and the first half of 2011 led to a meeting with the WMO in Geneva in July 2011 with the objective of identifying how to further implement the Report's recommendations. A series of actions were identified and a WMO-BIPM Joint Liaison Group (JLG) was established to oversee these actions. The option of upgrading the JLG to a full Joint Committee will be considered in the light of available resources and as the work progresses. The JLG will meet at least annually and teleconferencing will be used between the main meetings to exchange information. The second meeting of the JLG, provisionally scheduled for early 2012, will be conducted face-to-face. The JLG is exploring the attractiveness and value of a second WMO-BIPM workshop, possibly in spring 2014, to take stock of progress, reinvigorate ongoing actions, and identify new actions. JLG activities have already resulted in a request by the WMO to invite the local NMI to attend a WMO Metrology Workshop for WMO members (specifically for instrument calibration specialists) which will be held in the South West Pacific in November 2011.

5.1.6 UNIDO

The relationship between the BIPM and the United Nations Industrial Development Organization (UNIDO) is ongoing, particularly related to the development of metrology infrastructure in Africa. Andy Henson, the BIPM International Liaison Officer, is a member of the UNIDO-AFRIMETS project steering committee and has contributed to the development of the AFRIMETS Roadmap. Prof. Kühne, Director of the BIPM, Mr Henson, International Liaison Officer of the BIPM, and Dr Davis, Honorary Principal Research Physicist, BIPM, participated in, and lectured at, the ten day AFRIMETS Metrology School held in Nairobi, Kenya, in early February 2011 (with Mr Henson and Dr Davis' costs covered by UNIDO). The Metrology School was attended by some 80 participants from almost 40 countries and was very well received by the participants, AFRIMETS, UNIDO and NORAD, the ultimate funding agency for much of the project costs. The Metrology School is the centrepiece of a broader UNIDO project in the region, and in addition to providing desperately needed training for young metrologists in the region, the event gave AFRIMETS a significant boost in terms of progress, credibility and political support. The School provided an opportunity to present the Metre Convention and the work of the BIPM, and also an occasion to discuss informally the situation for metrology development with representatives from the attending countries. In some countries there has been significant progress in developing the metrology infrastructure. However, in many countries there is currently little metrology infrastructure, or at best very basic weights and measures capability. Nevertheless, ambitions are running high and a number of African countries have medium-/long-term ambitions to participate in the activities of the Metre Convention. Discussions held at the UNIDO headquarters in September 2011 laid the foundations for continued support from UNIDO and its donors to the region. Discussions have also taken place around the conceptual idea of UNIDO supporting metrology schools in other regions where they are actively involved in trade capacity building. The BIPM has supported UNIDO in the development of reports and written materials explaining the value of a sound technical infrastructure for developing countries.

5.2 Joint Committees

5.2.1 Joint Committee for Guides in Metrology (JCGM)

The representatives of the eight member organizations of the JCGM met on 1 December 2010 and on 7 December 2011 for their annual plenary sessions. Two decisions were adopted at the December 2010 meeting, namely that the BIPM is invited to act as the chair of the JCGM for the years 2011, 2012 and 2013, and that the Drafts of JCGM Guides to be circulated officially by the JCGM Chairman to Member Organizations shall be labelled as "Draft Guides", watermarked on each page, and carry a warning about their use on the front page. The detailed wording of the watermark and of the warning was agreed at the December 2011 meeting. At the same meeting, the JCGM decided to dissolve its *ad hoc* group on measurement software.

The JCGM also discussed the need for promoting the use of the *International Vocabulary of Metrology – Basic and General Concepts and Associated Terms* (VIM3), and of the *Guide to the Expression of Uncertainty in Measurement* (GUM) and its Supplements and received the annual reports from its Working Groups.

5.2.2 Joint Committee for Traceability in Laboratory Medicine (JCTLM)

The annual JCTLM Working Group 1 and 2 joint meetings, and *ad hoc* Working Group 3 meetings were held in conjunction with the American Association for Clinical Chemistry (AACC) meetings in Anaheim, United States of America, in July 2010, and in Atlanta, United States of America, in July 2011. For the two annual review cycles (cycle 7 (2010) and cycle 8 (2011)), the JCTLM review teams used the newly-implemented nomination and review process. This had been modified to ensure consistency with the requirements of the revised harmonized standards EN/ISO 15194:2009 and 15193:2009 published in the Official Journal of the European Community.

The 9th and 10th meetings of the Executive Committee of the JCTLM were held at the BIPM headquarters on 2-3 December 2010, and on 8-9 December 2011, respectively. The Declaration of Cooperation between the CIPM, International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) and ILAC revised for consistency with current JCTLM processes was approved. Appendix III was modified to provide references to the dated international standards used by the Working Groups for the evaluation for compliance of the nominations, and a statement for the obligations of Member Status was added to Appendix IV.

The list of the JCTLM review teams of Working Group 1 was updated to include the review team member appointed for the review of nominations for nucleic acids. The document for the terms of reference for each review team was revised for harmonization by the Quality Review Team Leader.

WG2 procedures have been updated to include the extended criteria for reference measurement service providers with respect to their regular participation in the EQAS Scheme for the listed measurands for which they offer a service.

The JCTLM Database was updated in March 2011 to include WG1 Cycle 7 reference materials, and measurement methods, and WG2 Cycle 5 reference measurement laboratory services approved by the Executive Committee during its 9th annual meeting held at the BIPM headquarters on 2-3 December 2010.

As of December 2011 the JCTLM Database contains:

- 247 available certified reference materials that cover 12 categories of analytes. Among these reference materials, 33 are currently listed in List II (List II includes reference materials

value-assigned using an internationally agreed-upon protocol), and 3 are listed in List III (List III covers reference materials having nominal properties).

- 152 reference measurement methods or procedures that represent about 80 different analytes for eight categories of analytes.
- 86 reference measurement services that can be delivered by 10 reference laboratories from six countries covering six categories of analytes.

The WG1 Cycle 8 call for nominations of higher order reference materials and reference measurement methods or procedures, and the WG2 Cycle 6 call for nominations of reference measurement laboratory services were announced on the JCTLM website in January 2011, and email notification sent to about 300 JCTLM potential contributors. As of July 2011, 40 nominations for materials, 7 nominations for procedures and 5 nominations for services were received and sent to Review Teams for evaluation.

5.3 Scientific liaison with intergovernmental organizations and international bodies

5.3.1 Director's Office

Prof. M. Kühne is a member of the German Physical Society (DPG) and a Fellow of the Institute of Physics, United Kingdom of Great Britain and Northern Ireland. He is an adjunct Professor at the Faculty of Mathematics and Physics of Leibniz University, Hanover, Germany. As Director of the BIPM, Prof. M. Kühne is Chairman of the JCRB and the JCGM.

C. Thomas acts as the Scientific Secretary and is a member of the permanent Committee "*Science et métrologie*" of the French *Académie des Sciences*. She was a member of the Technical and Scientific Committee of the 15th International Congress of Metrology, held in Paris in October 2011. C. Thomas acts as the BIPM Liaison for the CODATA Task group on Fundamental Constants and for the ISO TC 12 "Quantities and Units", and also as the BIPM Contact for the JCGM and its WG2 (VIM).

5.3.2 Mass

A. Picard acts as the BIPM liaison with IAC, IMEKO TC3 and EURAMET TC-M and TC-T.

5.3.3 Time

E.F. Arias is a member of the International Astronomical Union (IAU) and participates in its working group on the International Celestial Reference System. She is an associate member of the International Earth Rotation and Reference Systems Service (IERS), a member of the International Celestial Reference System Centre, and of the Conventions Centre of the IERS. She is a member of the International VLBI Service (IVS), and of its Analysis Working Group on the International Celestial Reference Frame. She is the BIPM representative to the Governing Board of the International GNSS Service (IGS). She is the BIPM representative to the International Committee for GNSS and she is the chairperson of the Task Force on Time References. She represents the BIPM in the Global Geodetic Observing System (GGOS) Steering Committee, a scientific service of the International Association of Geodesy (IAG). She is a member of the Argentine Council of Research (CONICET) and an associated astronomer at the LNE-SYRTE, Paris Observatory. She is a corresponding member of the Bureau des longitudes. She is the BIPM representative to the Working Party 7A of the Study Group 7 of the ITU Radiocommunication Sector (ITU-R).

W. Lewandowski is the BIPM representative to the Civil GPS Service Interface Committee and chairman of its Timing Sub-Committee. He is a member of the Scientific Council of the Space Research Centre of the Polish Academy of Sciences. He is also a member of a consultative Group on the Reform of Metrology at the Polish Ministry of Economy, an adviser to a Parliamentary Group on Space, and a

member of the Committee on Research on Space Techniques of the Polish Academy of Sciences. He is member of European Commission Advisory Group on Galileo Time Infrastructure. Together with E.F. Arias, he is the BIPM representative to the Working Party 7A of the Study Group 7 of the ITU-R, and the UN International Committee on GNSS (ICG).

G. Petit is co-director of the Conventions Centre of the IERS. He is president of the IAU Commission 52 'Relativity in Fundamental Astronomy', member of the IAU Working Group on Numerical Standards in Fundamental Astronomy, of the IGS Working Group on Clock Products, of the GNSS Science Advisory Committee of the European Space Agency (ESA), and of the Fundamental Physics Group of the *Centre National d'Études Spatiales* (CNES).

G. Panfilo collaborates with the Working Group 1 (WG1) on the Expression of uncertainty in Measurement (GUM) of the Joint Committee for Guides in Metrology (JCGM) to provide an example for the new version of the GUM.

5.3.4 Electricity

M. Stock is a member of the Conference on Precision Electromagnetic Measurements (CPEM) Executive Committee. N. Fletcher and M. Stock are members of the Technical Committee of CPEM 2012.

M. Stock is the contact person for the BIPM liaison with the International Commission on Illumination (CIE). The annual coordination meeting was held on 27 October 2011 at the BIPM headquarters. The main topic was the planned collaboration between the CCPR and the CIE on the publication of the new *mise en pratique* for the photometric units.

5.3.5 Ionizing Radiation

P.J. Allisy-Roberts is the BIPM representative on the IAEA Secondary Standards Dosimetry Laboratories (SSDL) Scientific Committee which she currently chairs. She is a member of the Working Group for the UK National Measurement System (NMS) Programme for Ionizing Radiation and Acoustics and of the *Comité scientifique rayonnements ionisants* (LNE, France). She is a member of the editorial board of the *Journal of Radiological Protection* and of the *Revue Française de Métrologie*. She was elected to the Board of the European Federation of Medical Physicists where she currently serves as the European Matters Committee Chairman.

D.T. Burns is the BIPM representative at the ICRU, a member of the ICRU Committee on Fundamental Quantities and Units and a member of two ICRU Report Committees, on Key Data for Dosimetry and on Operational Quantities for Radiation Protection. He is the BIPM contact person for the EURAMET-TC for ionizing radiation. He was elected to Fellowship of the Institute of Physics (United Kingdom of Great Britain and Northern Ireland) in 2011.

C. Kessler acted as the external peer reviewer for the dosimetry services at the CNEA, Argentina, in January 2011.

G. Ratel is the BIPM representative on the International Committee for Radionuclide Metrology (ICRM) and is the President of the ICRM Nominating Committee. He also reviews papers for *Metrologia*.

5.3.6 Chemistry

R.I. Wielgosz is a BIPM representative to the International Union of Pure and Applied Chemistry (IUPAC) Interdivisional Committee on Terminology, Nomenclature and Symbols (ICTNS), ISO TC 212, Clinical laboratory testing and *in vitro* diagnostic test systems, Working Group 2 on Reference Systems, and ISO TC 146 on Air Quality, and is a member of the editorial board of *Accreditation and Quality Assurance*. He is a member of the WMO-BIPM Joint Liaison Group.

S. Westwood is the BIPM and CCQM liaison to the ISO-REMCO and is a member of the World Anti-Doping Agency (WADA) Laboratory Committee.

R. Josephs is the BIPM representative to the Inter-Agency Meeting and the Codex Committee on Methods of Analysis and Sampling (CCMAS) of the Codex Alimentarius Commission.

6 ACTIVITIES RELATED TO THE WORK OF CONSULTATIVE COMMITTEES

6.1 Units

C. Thomas is the Executive Secretary of the CCU. She is a member of the CCEM working groups on proposed modifications of the SI (CCEM WG SI) and on coordination of the RMOs (CCEM RMO WG), a member of the CCM Working Group on the SI kilogram (CCM WGSI kg), a member of the CCRI RMO Working Group for RI CMCs, and observer of the CCT Working Group on Key Comparisons (WG 7).

Over the period covered by this report, C. Thomas participated in a large number of Consultative Committee, Working Group and others held at the BIPM headquarters. She also attended the 24th meeting of the CGPM held in Paris in October 2011.

C. Thomas is responsible for the organization of seminars at the BIPM.

6.2 Mass / Thermometry

R. Davis was Executive Secretary of the CCM and the CCT and a member of several working groups and task groups of these CCs until the end of October 2010.

A. Picard was promoted to Director of the Mass Department on 1 November 2010 and nominated Executive Secretary of the CCM and the CCT and a member of several working groups and task groups of these CCs. In addition he is coordinator for mass measurements in the former International Avogadro Coordination project/CCM Working Group on the Avogadro Constant.

6.3 Length / Time and Frequency

E.F. Arias is Executive Secretary of the CCTF and shares with L. Robertsson the Secretariat of the CCL/CCTF Frequency Standards Working Group. She is a member of the CCTF WG on Two-Way Satellite Time and Frequency Transfer (TWSTFT), the CCTF WG on Primary Frequency Standards (WGPFS) and the CCTF WG on TAI.

Z. Jiang is a member of the CCTF WG on TWSTFT.

W. Lewandowski is Secretary of the CCTF WG on TWSTFT and Secretary of the CCTF WG on Global Navigation Satellite Systems Time-Transfer Standards (CGGTTS).

G. Panfilo is a member of the CCTF WGPFS and of the Sub-Group on Algorithms of the CCTF WG on TAI and collaborates with the CCTF WGMRA.

G. Petit is a member of the CCTF WG on TAI and its Sub-Group on Algorithms, of the WGPFS, and of the CGGTTS.

L. Robertsson is Executive Secretary of the CCL and a member of the CCL WG on strategic planning and of the Discussion group DG-11 (Lasers). He is the BIPM representative on the Working Group on Gravimetry of the CCM.

6.4 Electricity and Magnetism / Photometry and Radiometry

M. Stock is the Executive Secretary of the CCEM and the CCPR and a member of several of their working groups. The 27th CCEM meeting was held on 17-18 March 2011.

R. Goebel organizes the review of comparison reports and protocols within the CCPR Key Comparison Working Group (WG-KC).

6.5 Ionizing Radiation / Acoustics, Ultrasound and Vibration

P.J. Allisy-Roberts is Executive Secretary of the CCRI and its three Sections, the CCRI(III) in March 2011, CCRI(I) in May 2011, CCRI(II) and the CCRI itself in June 2011. In addition there have been eleven Working Group meetings during the 18 month period including the RMO WG in May 2011.

P.J. Allisy-Roberts and D.T. Burns are members of the KCWG(I), ADWG(I) and BSWG(I). The KCWG(I) and the ADWG(I) met together in May 2011 and C. Kessler and S. Picard also participated. D.T. Burns is also a member of an *ad hoc* group evaluating the effect of excess charge on the value for W_{air}.

C. Michotte is the coordinator of the CCRI(II) Working Group on the SIR Transfer Instrument and a member of the KCWG(II) which met in November 2010, June and November 2011. She is also the contact person at the BIPM and *rapporteur* for the JCGM/WG1 that met in November 2010, May and November/December 2011.

G. Ratel is a member of the CCRI(II) working group on the extension of the SIR to beta emitters, which met on 5 November 2010 and 16 November 2011, the KCWG(II) which met on 4 November 2010, in June and November 2011, the UCWG(II), which met on 3 November 2010 prior to its merger with the KCWG(II) in June 2011, and the BqWG(II) which met on 2 November 2010, 18 April 2011 and 16 November 2011.

S. Picard is Executive Secretary of the CCAUV.

6.6 Chemistry

R.I. Wielgosz is the Executive Secretary of the CCQM. The CCQM held its 17th meeting at the BIPM headquarters (14-15 April 2011), and was preceded by meetings of its working groups. CCQM workshops on 'Metrology and the need for reliable microbial measurement/testing results' and 'Relative molecular mass measurements for the identification of peptides, proteins and other molecules' and were held at the BIPM headquarters on 6-7 and 13 April 2010 respectively.

S. Westwood is a member of the CCQM Organic Analysis Working Group and of the CCQM Organic Analysis Working Group Taskforce on Core Key Competencies.

R. Josephs is a member of the CCQM Bioanalysis and Organic Analysis Working Groups.

J. Viallon is a member of the CCQM Working Group on Gas Analysis.

E. Flores is a member of the CCQM Working Group on Gas Analysis.

S. Maniguet is a member of the CCQM Organic Analysis Working Group and Key Comparison Working Group.

7 WORKSHOPS AND OTHER MEETINGS AT THE BIPM HEADQUARTERS

7.1 Workshop on the CCQM-K74 and CCQM–P110 comparisons: NO_2 in nitrogen

1-2 November 2010

During the workshop of the 24th meeting of the CCQM Working Group on Gas Analysis (GAWG) in November 2010, the BIPM, in its role as coordinating laboratory of the key comparison CCQM-K74, was asked to investigate additional sources of uncertainty in its measurement results which had been proposed as reference values for the key comparison. The additional sources of uncertainty investigated were the impurity analysis uncertainties, the reaction of NO_2 to HNO_3 in the BIPM permeation facility, the stability of the gas concentration of the transfer standards (cylinders), and the contributions from flow measurements.

As a response, in April 2011, a new report which summarized the results of the series of new investigations entitled "*Proposed u(KCRV) for the Draft B report of CCQM-K74: Nitrogen dioxide, 10 μmol/mol*" was distributed and presented during the 25th meeting of the CCQM GAWG. A further reviewed version (0.2) of this report was distributed in July 2011, and after being approved, the first version of the Draft B CCQM-K74 report was submitted to the CCQM GAWG. Comments from reviewers were received in September 2011 and the final report is being finalized by the BIPM.

The Draft B reports for the pilot studies CCQM-P110 protocols B1 and B2, were distributed within the participating laboratories in September 2011. The reports were presented during the 26th Meeting of the CCQM GAWG in Boulder, Colorado, United States of America. Due the potential impact of both, the BIPM was asked to present a revised version of the reports including new features and a new title for the CCQM-P110 protocol B1 study. New versions of both reports are currently being drafted by the BIPM.

7.2 CCQM workshop on the role for reliable traceable microbiological measurements to ensure food quality and safety

6-7 April 2011

The workshop was held at the BIPM headquarters and focused on food quality and safety. A wide stakeholder community (45) from around the globe attended, representing farms and the food industry, food testing laboratories, food testing kit manufacturers, the International Dairy Federation, regulators and food safety authorities (FDA, USDA), members of APEC, standardization bodies (AOAC, ISO/CEN), CRM producers (ATCC, IRMM, LGC), proficiency providers and NMIs. The attendees discussed current measurement problems/issues relating to sampling, cell/organism growth, colony count, detection, isolation, identification, characterization, reference methodologies and assay techniques for the assessment of pathogens (bacteria, viruses, fungi, moulds, yeasts, etc). Problems associated with ill-defined measurands, unsound (metrological) reference methods, insufficient global harmonization, lack of calibration chain/hierarchy and a lack of CRMs were identified. It was unanimously agreed that urgent cooperation between the metrology and the microbial food communities is desirable and, as a consequence of this agreement, an *ad hoc* joint steering group will be created to further this aim. The CCQM agreed to organize the steering group by appointing a group chair (a metrologist) from one of the participating NMIs.

7.3 Workshop on development of advanced time and frequency transfer techniques

28-29 June 2011

During the past decade significant advances have been made in the field of optical frequency metrology, concerning both ultra-stable optical frequency standards as well as local frequency comparisons using the optical comb technique. This has lead to the establishment by the CCTF of a list of secondary representations of the second and to serious consideration of a future redefinition of the second. These developments imply strong requirements on remote time and frequency transfer techniques, which are not satisfied by the methods currently in common use, and it is urgent to focus attention on this aspect.

The objectives of the workshop were to survey the current situation of time and frequency transfer, to project future needs and to study the perspectives for satisfying them. The workshop included a more general session to provide information for interested organizations and stakeholders. The workshop was organized by the CCTF Working Group on Coordination of the Development of Advanced Time and Frequency Transfer Techniques (WGATFT) and served as a basis for further work by the WG in support of preparations for future improvements of the SI second and of time scales.

7.4 Meetings organized by the BIPM

The following meetings were held at the BIPM headquarters between 1 July 2010 and 31 December 2011:

- The CODATA Task Group on Fundamental Constants (TGFC) met on 13 September 2010.
- The 20th meeting of the CCU and the CCU/IUPAP SUNAMCO commission meeting was held on 14-16 September 2010.
- The 99th meeting of the CIPM took place on 12-15 October 2010, preceded by a meeting of the bureau of the CIPM on 11 October 2010.
- The 7th meeting of the CCAUV and meetings of the CCAUV Working Groups were held during 18-21 October 2010.
- The CCRI(II) Working Group on the Realization of the Becquerel met on 2 November 2010 followed by the CCRI(II) Uncertainties Working Group on 3 November 2010, the CCRI(II) Key Comparisons Working Group on 4 November 2010 and the CCRI(II) Working Group on Extension of the SIR to β-emitters using liquid scintillation on 5 November 2010.
- The JCGM met on 1 December 2010, preceded by the meeting of the JCGM-WG1 (GUM) on 23-26 November 2010 and the JCGM-WG2 (VIM) on 29-30 November 2010.
- The JCTLM Executive Committee met on 2-3 December 2010.
- The bureau the CIPM met on 7-8 March 2011 and 23-24 May 2011.
- A four-partite meeting of the BIPM, ILAC, ISO and OIML and a bilateral meeting of the BIPM and OIML was held on 9 March 2011, followed by a BIPM and ILAC meeting on 11 March 2011.
- The 27th meeting of the CCEM and the CCEM Working Groups took place on 14-18 March 2011.
- The 26th meeting of the JCRB was held on 21-22 March 2011.
- The 19th meeting of the CCRI(III) took place on 30 March to 1 April 2011.

- The 17th meeting of the CCQM took place on 13-15 April 2011, preceded by the CCQM Workshop on Microbiology on 6-7 April 2011, the CCQM Working Group on Key Comparisons and CMC Quality on 8-9 April 2011 and the Working Groups on Gas Analysis, Electrochemical Analysis, Inorganic Analysis, Bioanalysis, Surface Analysis on 11-13 April 2011.
- The CCRI(II) Working Group on the Realization of the Becquerel met on 18 April 2011.
- The 20th meeting of the CCRI(I) took place on 4-6 May 2011, preceded by the CCRI RMO Working Group on IR CMCs on 2 May 2011 and the CCRI(I) Key Comparisons Working Group on 3 May 2011.
- The 13th meeting of the CCM took place on 12-13 May 2011, preceded by meetings of the CCM Working Groups on 9-11 May 2011.
- The JCGM-WG2 (VIM) met on 18-20 May 2011.
- The JCGM-WG1 (GUM) met on 24-27 May 2011.
- Session I of the 100th meeting of the CIPM took place on 24 May 2011.
- A meeting of NMI Directors was held on 25 May 2011.
- A meeting of Representatives of States Parties to the Metre Convention was held on 26-27 May 2011.
- The CODATA TGFC took place on 17 June 2011.
- Meeting of the CCRI took place on 24 June 2011, preceded by meetings of the CCRI(II) Working Groups on Key Comparisons and Uncertainties on 20 June 2011 and CCRI(II) meeting on 21-23 June 2011.
- The CCM Working Group on Hardness took place on 21 September 2011.
- Session II of the 100th meeting of the CIPM took place on 10-14 October 2011.
- The 24th meeting of the CGPM took place on 17-21 October 2011[1].
- The CCRI(II) Working Groups on the Realization of the Becquerel and Extension of the SIR to β-emitters using liquid scintillation met on 16 November 2011 followed by the CCRI(II) Key Comparisons Working Group on 17-18 November 2011.
- The JCGM-WG1 (GUM) met on 29 November to 2 December 2011.
- The JCGM-WG2 (VIM) met on 5-6 and 8 December 2011.
- The JCGM plenary meeting was held on 7 December 2011.
- The JCTLM Executive Committee met on 8-9 December 2011.

[1] Meeting held in Paris

7.5 Presentations at the BIPM headquarters

- S. Picard, D. Burns, (BIPM) 'The BIPM calorimeter: design, construction and use for the accelerator dosimetry comparisons', 7 September 2010.
- F. Cassier (NAG), '*Présentation des outils logiciels NAG pour le calcul scientifique*', 26 October 2010.
- A. Picard (BIPM), '*Où en est-on de la détermination de la valeur de la constante d'Avogadro*?', 16 November 2010.
- C. Kessler (BIPM), 'The BIPM mammography dosimetry programme', 7 December 2010.
- P. Cladé (LKB), 'New determination of the fine structure constant', 3 February 2011.
- N. Fletcher (BIPM), 'A physicist's view of the SI', 1 March 2011.
- T. Usuda (NMIJ), 'New approach for estimating the economic impact of international metrology', 21 April 2011.
- M. Kühne, R.I. Wielgosz, B. Coelho (BIPM), 'The BIPM Health and Safety Management System – what, why, who, how and when?', 3 May2011.
- B. Coelho (BIPM), 'The BIPM Quality Management System', 7 June 2011.
- E.F. Arias (BIPM), 'Who needs leap seconds in UTC?', 15 June 2011.
- R. Feistel (IOW), 'TEOS-10: A new international oceanographic standard for seawater, ice, fluid water and humid air', 30 August 2011.
- J. Chavaudra (IGR, INSTN), 'Linear accelerators for radio therapy: clinical interest and related metrological problems', 28 September 2011.
- C. Michotte (BIPM), 'Application of the Mandel-Paule method to the computation of key comparison reference values', 13 December 2011.

8 SECONDEES, GUEST WORKERS, VISITORS AND BIPM TRAVEL

8.1 Secondees and Guest Workers

Time

- A. Proia (Ph.D. student), to work on her Ph.D. on absolute calibration of GNSS receivers, 11-15 October 2010 and 28 February to 11 March 2011.

Ionizing Radiation

- J. Alvarez Romero (ININ), on an IAEA Fellowship, 10 April to 12 July 2010.
- J. de Pooter (VSL), on secondment, 19 July to 12 August 2010.

Chemistry

- P. Mitchell (NMIA), on secondment to the Chemistry Department's Organic Analysis Programme, 1 July to 30 September 2011.

International Liaison and Communication

- T. Usuda (NMIJ/AIST), on secondment to review the economical impact of international metrology, 26 August 2010 to 20 December 2011.
- A.Ö. Altan (UME), on secondment as the JCRB Executive Secretary, 10 December 2010 to 9 December 2012.

8.2 Other visitors to the BIPM

More than 170 experts from over 80 states spent a total of 145 days in technical visits at the BIPM headquarters. For further details about these visits please see the website www.bipm.org/en/publications/directors_report/visitors.html.

8.3 BIPM presence at external conferences and meetings

BIPM staff members attended over 110 conferences and meetings. Attendance totalled approximately 460 working days and involved 29 members of the BIPM staff. For further details about these visits please see the website www.bipm.org/en/publications/directors_report/travel.html.

8.4 Other visits by BIPM staff

More than 340 working days involving 27 members of the BIPM staff were spent in technical visits to 25 states.

9 PUBLICATIONS

9.1 BIPM publications (1 July 2010 to 31 December 2011)

- International Committee for Weights and Measures, 98th meeting (2009), 2010, **77**, 268 pp.
- International Committee for Weights and Measures, 99th meeting (2010), 2011, **78**, 204 pp.
- Director's Report on the Activity and Management of the BIPM (2010), 2011, **11**, 372pp.
- Convocation to the 24th meeting of the CGPM, 2010, 130pp.
- Programme of work and budget 2013-2016, 2010, 66pp.
- *Rapport annuel aux Gouvernements des Hautes Parties contractantes sur la situation administrative et financière du Bureau international des poids et mesures en 2010*, 2011, 200pp.
- CIPM President's Report to the 24th meeting of the CGPM, 2011, 64pp.
- Consultative Committee for Acoustics, Ultrasound and Vibration, 6th meeting (2008), 2010, 26pp.
- Consultative Committee for Acoustics, Ultrasound and Vibration, 7th meeting (2010), 2011, 37pp.
- Consultative Committee for Amount of Substance - Metrology in Chemistry, 16th meeting (2010), 2010, 50pp.

- Consultative Committee for Amount of Substance - Metrology in Chemistry, 17th meeting (2011), 2011, 59pp.
- Consultative Committee for Electricity and Magnetism, 27th meeting (2011), 2011, 60pp.
- Consultative Committee for Length, 14th meeting (2009), 2010, 38pp.
- Consultative Committee for Mass and Related Quantities, 12th meeting (2010), 2010, 26pp.
- Consultative Committee for Mass and Related Quantities, 13th meeting (2011), 2011, 37pp.
- Consultative Committee for Photometry and Radiometry, 20th meeting (2009), 2010, 31pp.
- Consultative Committee for Thermometry, 25th meeting (2010), 2010, 56pp.
- Consultative Committee for Units, 20th meeting (2010), 2010, 24pp.
- *Notification des parts contributives dues par les Gouvernements des Hautes Parties contractantes pour l'entretien du Bureau international des poids et mesures et des souscriptions des États et Entités Économiques associés à la Conférence générale en 2011*, 4pp.
- *Notification des parts contributives dues par les Gouvernements des Hautes Parties contractantes pour l'entretien du Bureau international des poids et mesures et des souscriptions des États et Entités Économiques associés à la Conférence générale en 2012*, 4pp.
- Report on the WMO-BIPM workshop on Measurement Challenges for Global Observation Systems for Climate Change Monitoring (2010), 2010, 96pp (*Rapport BIPM*-2010/08).
- Final Report – Study of Measurement Service and Comparison Needs for an International Measurement Infrastructure for the Biosciences and Biotechnology: Input for the BIPM Work Programme (2011), 2011, 108pp (*Rapport BIPM*-2011/02).
- BIPM Bulletins (November 2010, August 2011 and November 2011).
- *Monographie* BIPM-5, Vol. 6.
- SI appendix2 2010.
- BIPM Annual Report on Time Activities (2010), 2011, 110pp.
- *Rapports* BIPM:
  - 2010: 2010/05 (5 pp); 2010/06 (22 pp); 2010/07 (16 pp); 2010/09 (18 pp); 2010/10 (8 pp); 2010/11 (13 pp).
  - 2011: 2011/01 (25 pp); 2011/03 (18 pp); 2011/04 (21 pp); 2011/05 (32 pp); 2011/06 (9 pp).

Following a decision of the CIPM in October 2003, reports of meetings of the Consultative Committees no longer appear in print, but are published in their original language on the BIPM website. As of 2010, the BIPM Annual Report on Time Activities is similarly published only in electronic form.

The scientific publications of the BIPM are listed by Department in §2 of this report.

9.2 *Metrologia*

Since the beginning of 2003, *Metrologia* has been produced in partnership with Institute of Physics Publishing (IOPP) Ltd., the publishing arm of the Institute of Physics. A renewed publishing arrangement has been negotiated with IOPP during the period of this report, and is in place with effect from 1 January 2011.

During the temporary absence of Dr Miles, Editor of the journal, for part of 2011, Dr Quinn, Emeritus Director of the BIPM, was appointed as Acting Editor assisted by Dr Davis (Honorary Principal Research Physicist, BIPM).

The Impact Factor[2] of *Metrologia* remains the highest amongst the related journals, and stands at 1.688 for 2010.

Special issues of *Metrologia* devoted to subjects of timely interest continue to be organized by invited specialist editors in cooperation with the Editor at the BIPM. In the period covered by this report, three special issues have been published: issue **48**(2) on the International determination of the Avogadro constant, issue **48**(4) on Modern Applications of Time Scales, and issue **48**(6) on Neutron Metrology. The input of the Guest Editors in producing these important reference volumes is much appreciated. We note that the neutron issue forms the third tome of a trilogy on ionizing radiation, which has already featured radiation dosimetry (**46**(2)) and radionuclide metrology (**44**(4)).

Submissions to the journal remain high; in 2011 the Editorial Office received over 240 papers. *Metrologia*'s online Technical Supplement is also doing well, with an average of one or two new reports added per week.

9.3 The BIPM website

The BIPM website continues to be the BIPM's primary means of communication; it contains a wealth of information and attracts interest from a diverse audience.

Towards the end of 2011 the BIPM metrology portal has been modified, so that it no longer covers the websites of all the laboratories participating in the CIPM MRA, but is a more efficient search engine of the BIPM website and the KCDB.

A new section dedicated to the "New SI" was added to the website early in 2011, in order to encourage communication, awareness and debate on the possible revision of the SI. Other new areas of the website include: pages dedicated to the BIPM Bulletins; to the biannual KCDB reports published by the KCDB Office; and collated links to resources concerning impact studies, case studies and evaluations related to metrology.

During the period covered by this report, most of the sections of the website describing the laboratory work of the BIPM have been revised and/or extended, including in particular parts relating to the BIPM watt balance, the International Avogadro Coordination, the creation of an ensemble of reference mass standards, and the construction of a calculable capacitor, these being the key projects linked to the revision of the SI.

10 FINANCIAL AND ADMINISTRATIVE MATTERS

The Finance, Administration and General Services Department is responsible for the financial and administrative management of the BIPM as well as a wide range of support services. The Department oversees financial, human resources, legal and other services and relations with the Host State's authorities, with States Parties to the Metre Convention and Associates of the CGPM, and with other States, intergovernmental organizations and international bodies. The Department's work covers financial, legal and administrative affairs and the negotiation and daily management of all contracts and agreements entered into by the BIPM.

[2] The Impact Factor is defined as being the number of citations in the current year to papers published in the previous two years, divided by the number of papers published in the previous two years.

During the reporting period, the Finance, Administration and General Services Department made the successful transition from a cash accounting basis to an accrual accounting system under the International Public Sector Accounting Standards (IPSAS). The Department also prepared the 2010 BIPM Financial Statements and the 2010 Financial Statements of the BIPM Pension and Provident Fund under IPSAS. The Financial Regulations of the BIPM Pension and Provident Fund were finalized and submitted to the CIPM at its 100th session and approved on 14 October 2011. They entered into force on their adoption.

The 24th meeting of the CGPM was held in October 2011, which considerably increased the workload of the Department. The Department worked on various funding scenarios for the 2013-2016 BIPM Programme of Work and, in addition to handling the organizational aspects of the meeting, the Department provided support to the Director and to the CGPM on issues related to institutional and financial matters, which were addressed in six Resolutions out of the ten Resolutions adopted by the CGPM at its 24th meeting.

The Finance, Administration and General Services Department was in contact with the authorities of the States Parties to the Metre Convention that were in financial arrears for more than 3 years, with a view to discussing the conditions for the settlement of such arrears pursuant to the applicable provisions of the Metre Convention and its Annexed Regulations, Resolution 8 adopted by the CGPM at its 23rd meeting, and Resolution 6 adopted by the CGPM at its 24th meeting.

The Department launched a number of calls for tender for the purchase of equipment and services, and arranged several contracts and agreements.

Another key task of the Finance, Administration and General Services Department is to review, on a regular basis, the operational activities of the BIPM and to make improvements in terms of efficiency and savings. An example is the recent reductions in costs related to BIPM publications and site maintenance (e.g. cleaning).

The Finance, Administration and General Services Department worked on revised financial rules and policies related, in particular, to procurement to maximize both value for money and transparency in selection of suppliers.

During 1 July 2010 to 31 December 2011 the Department arranged more than 145 customs operations in particular for import and export of standards for calibrations and comparisons, worked on the arrangements for seven recruitments on a limited-term and permanent basis, as well as various secondments and internships.

Finally, the Finance, Administration and General Services Department has supported the Communication and Information Section in the review of BIPM publications.

10.1 Accounts

Details of the accounts for 2010 can be found in the "*Rapport annuel aux Gouvernements des Hautes parties contractantes sur la situation administrative et financière du Bureau international des poids et mesures*".

10.2 Staff

10.2.1 Appointments

- Ms Isabelle Andernack, born 7 July 1972 in Paris (France), French nationality, previously auditor in a French private auditing company, was appointed *administrateur comptable* in the Finance, Administration and General Services Department from 1 July 2010.
- Mr Benjamin Rolland, born 17 December 1982 in Orsay (France), French nationality, previously a technician in a French private company, was engaged as *technicien* in the Electricity Department from 1 August 2010.
- Mr Aldo Dupire, born 24 April 1958 in Corbeil-Essonnes (France), French nationality, previously Head of Workshop in a French private company, was appointed from 1 September 2010. He took up his duties as *Chef de la section Atelier* from 1 January 2011.
- Dr Estefania de Mirandés, born 23 October 1980 in Barcelona (Spain), Spanish nationality, previously Research Fellow in the Electricity Department since 7 January 2008, was appointed *physicien principal* in the Mass Department from 1 November 2010.
- Mr Phouc Thierry Nguyen, born 6 January 1975 in Saigon (Viet Nam), French nationality, previously IT engineer in an intergovernmental organization, was appointed as *informaticien* in the Communication and Information Section from 2 May 2011.
- Ms Faïza Kebache, born 25 April 1976 in Hussein-Dey (Algeria), Algerian nationality, previously an assistant in a French private company, was engaged as *secrétaire* in the Finance, Administration and General Services Department for a duration of 7 months from 21 July 2011.
- Mr Bruno Amaro Coelho, appointed as Quality, Health and Safety Manager since 4 September 2009, had his two-year appointment extended for an additional year until 31 December 2012.
- Ms Nina De Sousa Dias, appointed as *secrétaire* in the Communication and Information Section since 15 April 2010, had her two-year appointment extended for an additional year until 14 April 2013.

10.2.2 Promotions and change of grade

- Prof. Dr Michael Kühne, *directeur désigné*, took up the post of *directeur* of the BIPM from 1 January 2011 pursuant to the decision of the CIPM during its 96th session in November 2007.
- Mr Alain Picard, previously *adjoint au directeur du Département des masses*, took up the post of *directeur du Département des masses* from 1 November 2010.
- Dr Carine Michotte, *physicien* in the Ionizing Radiation Department, was promoted *physicien principal* from 1 January 2011.
- Dr Joële Viallon, *chimiste* in the Chemistry Department, was promoted *chimiste principal* from 1 January 2011.
- Dr Ralf Josephs, *chimiste* in the Chemistry Department, was promoted *chimiste principal* from 1 January 2011.
- Mr Philippe Roger, *technician principal* in the Ionizing Radiation Department, was promoted *technician metrologiste* from 1 January 2011.
- Mr Laurent Tisserand, *technician* in the Time Department, was promoted *technician principal* from 1 January 2011.

- Mr Bruno Vincent, *mécanicien* in the Workshop Section, was promoted *mécanicien principal* from 1 January 2011.

10.2.3 Changes of post and transfer

- Ms Frédérique de Hargues, *secrétaire* within the Communication and Information Section, was assigned on a half-time basis to the position of *secrétaire* within the Finance, Administration and General Services Department for a duration of 5 months from 1 September 2011.

10.2.4 Research fellows

- Dr Norbert Stoppacher, born 6 August 1975 in Tulln (Austria), Austrian nationality, previously Post Doctorate Research Fellow at the Institute Christian Doppler Laboratory for Rapid Test Systems for Allergenic Food Contaminants (Austria), was appointed as Research Fellow in the Chemistry Department from 3 January 2011.
- Dr Michael Petersen, Research Fellow in the Chemistry Department since 2 March 2009, left the BIPM on 28 February 2011 at the end of his contract.
- Dr Michael Bradley, Research Fellow in the Electricity Department since 3 September 2009, left the BIPM on 31 August 2011 at the end of his contract.

10.2.5 Invalidity

- Mr Manuel de Carvalho, *mécanicien* in the Workshop Section, has been placed under the BIPM's invalidity scheme from 21 June 2010.
- Mr Alain Jaouen, *technicien principal* in the Electricity Department, has been placed under the BIPM's invalidity scheme from 30 June 2010.

10.2.6 Departures

- Dr Richard Davis, *directeur du Département des masses*, retired on 31 October 2010 after nearly 20 years of service.
- Mr José Sanjaime, *chef de la Section Atelier*, retired on 31 December 2010 after 23 years of service.

On their retirement, the Director thanked each of these staff members for the effective and devoted service during their years at the BIPM.

The CIPM decided at its 99th session to assign the status of Honorary Principal Research Physicist for Dr Davis on his retirement in recognition of his outstanding contribution to the work of the BIPM.

- Prof. Andrew J. Wallard, *directeur* of the BIPM since 1 January 2004, retired on 31 December 2010 after about 8 years of service.

The CIPM decided at its 99th session to assign Prof. Wallard the status of Director Emeritus for his achievements during his tenure as Director of the BIPM.

- Ms Faïza Kebache, *secrétaire* in the Finance, Administration and General Services Department since 21 July 2011, left the BIPM on 12 August 2011.

10.3 Buildings

10.3.1 Grand Pavillon

- Replacement of the boiler.
- Redecoration of the Director's apartment including the replacement of two windows.
- Replacement of two entrance doors.

10.3.2 Petit Pavillon

- Renovation of the roof.

10.3.3 Observatoire

- Completion of the renovation of room 104.
- Repair to the hoist.

10.3.4 Ionizing Radiation building

- Refurbishment of rooms R14, R15 and R16 on the first floor.
- Redecoration of office R9 on the first floor.
- Setting up a new storage site for radioactive sources.
- Replacement of two fire doors in room S9.
- Construction of a small surrounding wall in front of the building to attenuate rays from the new source.

10.3.5. The Laser building

- Partial renovation of the building for the installation of laboratories for the Chemistry Department on the ground floor and the transfer of the Time laboratory from the Observatoire on the first floor.
- Technical and financial feasibility study for the transfer of the platform for the antennas used for time receivers from the roof of the Observatoire.
- Replacement of three doors in the reception area.
- Replacement of the floor in the infirmary.

10.3.6 Nouveau Pavillon

- Refurbishment of an office in the library.
- Installation of three offices in the library.
- Replacement of the carpet in the corridor on the ground floor.
- Redecoration of the Director's office.
- Painting of the staircase walls.
- Investigation of problems resulting from ground movements on level −2.

10.3.7 All buildings

- Audit of the network traffic at the BIPM in anticipation of modernization of the IT infrastructure.

10.3.8 Outbuildings and park

- A hedge near the Ionizing Radiation building was cut.

10.4 Travel: Finance, Administration and General Services Department

B. Perent attended a seminar on Cost management in International Health Care held in Antwerp (Belgium), 16-17 June 2011.

B. Perent and S. Arlen attended a colloquium on "New Developments in the Legal Protection of International and European Civil Servants" in Luxembourg on 1-2 April 2011.

11 OTHER SUPPORT ACTIVITIES

11.1 Communication and Information Section

11.1.1 Secretariat

Within the Communication and Information Section, the BIPM Secretariat duties involve providing secretarial support to the Director, Director Designate (when in place) and staff members. It also deals with numerous secretarial matters related to the large number of meetings held at the BIPM headquarters, as well as dealing with visitors and telephone enquiries.

The workload linked to the meetings held at the BIPM headquarters is heavy (see §7.4). Meetings are essentially those of the Consultative Committees and their Working Groups, but also include the CIPM and CIPM bureau, Joint Committee meetings and various special Workshops, which can be held either on the BIPM's premises or off-site. In collaboration with the Finance, Administration and General Services Department, the Secretariat ensures the smooth running of all these meetings along with sending the associated documents and BIPM publications. Certain meetings are large and involve parallel sessions across the BIPM premises and even in locations off-site. Logistically, the meeting of the CCQM presents the greatest challenge for the BIPM Secretariat, with meetings that span a weekend with parallel Working Group sessions both on- and off-site. In 2011, meetings of Directors of National Metrology Institutes (see §4.1.1) and Representatives of States Parties to the Metre Convention (see §4.2) were held. In October 2011, there was an additional major off-site meeting, namely the 24th meeting of the CGPM (see §4.2) that was attended by 200 participants.

The Secretariat publishes reports and communications which it makes available to States Parties to the Metre Convention, Associates of the CGPM, NMI Directors, Consultative Committees and Working Groups via the BIPM website.

Among its other responsibilities, the BIPM Secretariat maintains records of the BIPM's wide range and growing number of international contacts.

11.1.2 Library

Within the Communication and Information Section, the library is an essential component of the BIPM's infrastructure in the efficient pursuit of its scientific work.

In recognition of the increased use of electronic resources over traditional printed publications, several journal subscriptions were converted to electronic-only versions during the 18 month period covered by this report.

11.1.3 Information Technology

Within the Communication and Information Section, the IT group has implemented a collaborative messaging solution that allows BIPM staff members to manage their emails and tasks, and share calendars and contacts. A webmail interface based on Web 2.0 technologies has been set-up and is widely used by BIPM staff members. This new tool and the secure remote connection using VPN technology, enables BIPM staff members to remotely access information. This system was installed on a virtualized platform.

The IT group updated all the file-sharing programs and created a collaborative directory as part of the Windows 7 integration on BIPM computers. One third of the BIPM's computers are now equipped with the Windows 7 operating system.

An audit of the BIPM IT network was outsourced to a private company. The results of the audit enabled the IT group to define a target network architecture that will support voice-over IP data transport and extend/scale up the BIPM WiFi network. This network will be entirely secure.

New applications have been developed on the BIPM intranet site, using the latest advances in Web 2.0 technology.

The installation, administration and maintenance of about 30 servers and 200 office- or laboratory-based PCs, as well as a dozen network printers has been undertaken by the IT group.

11.2 Quality, Health and Safety

11.2.1 The BIPM Quality System

The focus of activities in the BIPM Quality System during the reporting period was related to the improvement of the BIPM Quality Management System (QMS) and preparation for the global external audit in September 2011.

Version 4.0 of the BIPM Quality Manual was published in April 2011 and the internal Quality Group met four times during the period to discuss the BIPM Quality System and to review the results of quality audits. Annual Quality Management System Review meetings were held on 8 September 2010 and 23 September 2011.

The external global audit of the BIPM QMS took place on 19-21 September 2011. The audit was performed by Ms Ajchara Charoensook, Head of Electrical Metrology at NIMT, Thailand, and the former Chair of the APMP Technical Committee on Quality Systems. The audit was a success and found no non-conformities. Only one observation and one suggestion were made. The external auditor's report concluded: "Based on the results of the audit, it is expressed that the BIPM's Quality Management System is fully implemented and committed to the development and continual improvements of its effectiveness. The auditor is impressed with the technical competence of scientists working at the BIPM."

11.2.2 Health and Safety

The BIPM is committed to respecting its obligations in the area of Health and Safety very seriously. A modern Health and Safety Management System (HSMS) is under development which will have a similar structure to the BIPM Quality Management System. An accompanying revised manual will be available in 2012. The annual radiation protection audit was successfully completed and training for staff in the area of Health and Safety is ongoing

11.3 Mechanical Workshop and Site Maintenance Section

The BIPM Workshop Section provides support for all BIPM experimental work, including support for visiting scientists during comparisons and calibrations, in addition to its role in site maintenance and planning services. During the reporting period, of particular note has been the continuing effort devoted to the construction and improvement of the BIPM watt balance and work on ancillary equipment for the Ionizing Radiation Department. The workshop's expertise provides essential support for the Mass Department through its unique facilities for the manufacture of kilogram artefacts and vacuum apparatus.

LIST OF ACRONYMS AND INITIALISMS USED IN THE PRESENT VOLUME

AACC	American Association for Clinical Chemistry, Washington DC (USA)
ADWG(I)	CCRI(I) Accelerator Dosimetry Working Group
AFRIMETS	Inter-Africa Metrology System
AIC	ILAC Accreditation Issues Committee
AOAC	International Association of Analytical Communities
APEC	Asia-Pacific Economic Cooperation
APMP	Asia/Pacific Metrology Programme
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency, Sydney and Melbourne (Australia)
ATCC	American Type Culture Collection
ATFTT	Advanced Time and Frequency Transfer Techniques
BEV	Bundesamt für Eich- und Vermessungswesen, Vienna (Austria)
BIML	International Bureau of Legal Metrology/*Bureau International de Métrologie Légale*
BIPM	International Bureau of Weights and Measures/*Bureau International des Poids et Mesures*
BMM	Bureau of Metrology (Montenegro)
BqWG(II)	CCRI(II) Working Group on the realization of the becquerel
BSWG(I)	CCRI(I) Brachytherapy Standards Working Group
CC	Consultative Committee of the CIPM
CCAUV	Consultative Committee for Acoustics, Ultrasound and Vibration/*Comité Consultatif de l'Acoustique, des Ultrasons et des Vibrations*
CCEM	Consultative Committee for Electricity and Magnetism/*Comité Consultatif d'Électricité et Magnétisme*
CCL	Consultative Committee for Length/*Comité Consultatif des Longueurs*
CCM	Consultative Committee for Mass and Related Quantities/*Comité Consultatif pour la Masse et les Grandeurs Apparentées*
CCMAS	Codex Committee on Methods of Analysis and Sampling
CCPR	Consultative Committee for Photometry and Radiometry/*Comité Consultatif de Photométrie et Radiométrie*
CCQM	Consultative Committee for Amount of Substance: Metrology in Chemistry/*Comité Consultatif pour la Quantité de Matière : Métrologie en Chimie*
CCRI	Consultative Committee for Ionizing Radiation/*Comité Consultatif des Rayonnements Ionisants*
CCRI(I)	CCRI Section I: x- and gamma rays, charged particles
CCRI(II)	CCRI Section II: Measurement of radionuclides
CCRI(III)	CCRI Section III: Neutron measurements
CCT	Consultative Committee for Thermometry/*Comité Consultatif de Thermométrie*

CCTF	Consultative Committee for Time and Frequency/*Comité Consultatif du Temps et des Fréquences*
CCU	Consultative Committee for Units/*Comité Consultatif des Unités*
CEN	European Committee for Standardization
CENAM	Centro Nacional de Metrología, Querétaro (Mexico)
CENICA	Centro Nacional de Investigación y Capacitación Ambiental (Mexico)
CGGTTS	CCTF Group on GNSS Time-Transfer Standards
CGPM	General Conference on Weights and Measures/*Conférence Générale des Poids et Mesures*
CHMI	Czech Hydrometeorological Institute/*Český hydrometeorologický ústav* (Czech Rep.)
CIE	International Commission on Illumination
CIEMAT	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, Madrid (Spain)
CIML	International Committee of Legal Metrology
CIPM	International Committee for Weights and Measures/*Comité International des Poids et Mesures*
CIPM MRA	CIPM Mutual Recognition Arrangement
CMC	Calibration and Measurement Capability
CMI-IIR	Czech Metrological Institute, Inspectorate for Ionizing Radiation/*Český Metrologický Institut, Inspektorát Pro Ionizující Záření* (Czech Rep.)
CNEA	Comisión Nacional de Energía Atómica, Buenos Aires (Argentina)
CNES	Centre National d'Études Spatiales, Toulouse (France)
CODATA	Committee on Data for Science and Technology
Codex Alimentarius: Commission under the Joint FAO/WHO Food Standards Programme	
CONICET	Argentine Council of Research
COOMET	Cooperation in Metrology among the Central European Countries
CPEM	Conference on Precision Electromagnetic Measurements
CRM	Certified Reference Materials
DECCW	Department of Environment, Climate Change and Water, NSW (Australia)
DI	Designated Institute
EAA	Environment Agency Austria (Austria)
EAL	Free Atomic Time Scale/*Échelle Atomique Libre*
EFTF	European Frequency and Time Forum
EMRP	European Metrology Research Programme
ENEA	Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile, Rome (Italy)
EQAS	External Quality Assessment Scheme
ESA	European Space Agency
ESOF	Euroscience Open Forum
EU	European Union
EUV	Extreme Ultraviolet
EURAMET	(the former EUROMET) European Association of National Metrology Institutes

FDA	Food and Drug Administration
GAWG	CCQM Working Group on Gas Analysis
GGOS	Global Geodetic Observing System
GLONASS	Global Navigation Satellite System
GNSS	Global Navigation Satellite System(s)
GPS	Global Positioning System
GUM	Central Office of Measures/*Glówny Urzad Miar, Warsaw* (Poland)
GUM	Guide to the Expression of Uncertainty in Measurement
HCHO	Formaldehyde
HPGe	High-Purity Germanium Spectrometer
HSMS	Health and Safety Management System
IAC	International Avogadro Coordination
IAEA	International Atomic Energy Agency
IAF	International Accreditation Forum
IAG	International Association of Geodesy
IAU	International Astronomical Union
ICAG	International Comparison of Absolute Gravimeters
ICG	International Committee on GNSS
ICRM	International Committee for Radionuclide Metrology
ICRU	International Commission on Radiation Units and Measurements
ICTNS	(IUPAC) Interdivisional Committee on Terminology, Nomenclature and Symbols
IEEE	Institute of Electrical and Electronics Engineers, Piscataway, NJ (USA)
IERS	International Earth Rotation and Reference Systems Service
IFCC	International Federation of Clinical Chemistry and Laboratory Medicine
IFIN-HH	"Horia Halubei" National Institute of Research and Development for Physics and Nuclear Engineering, Bucharest (Romania)
IGR	Institut Gustave-Roussy, Villejuif (France)
IGS	International GNSS Service
ILAC	International Laboratory Accreditation Cooperation
IMBiH	Institute of Metrology of Bosnia and Herzegovina (Bosnia and Herzegovina)
IMEKO	International Measurement Confederation
ININ	Instituto Nacional de Investigaciones Nucleares, Mexico (Mexico)
INMETRO	Instituto Nacional de Metrologia, Normalizaçao e Qualidade Industrial, Rio de Janeiro (Brazil)
INMS/NRC	Institute for National Measurement Standards, NRC, Ottawa (Canada)
INSTN	Institut National des Sciences et Techniques Nucléaires, CEA, Paris (France)
INTI	Instituto Nacional de Tecnología Industrial, Buenos Aires (Argentina)
IOPP	Institute of Physics Publishing, Bristol (UK)
IOW	Leibniz-Institute for Baltic Sea Research/*Leibniz-Institut für Ostseeforschung Warnemünde* (Germany)
IPK	International prototype of the kilogram

IPSAS	International Public Sector Accounting Standard
IRA	Institut Universitaire de Radiophysique Appliquée (Switzerland)
IRMM	Institute for Reference Materials and Measurements, European Commission, Geel (Belgium)
ISCIII	Instituto de Salud Carlos III (Spain)
ISO	International Organization for Standardization
ISO CASCO	ISO Committee on Conformity Assessment
ISO REMCO	ISO Committee on Reference Materials
IT	Information Technology
ITN	Instituto Tecnológico e Nuclear, Savacém (Portugal)
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication Sector
IUPAC	International Union of Pure and Applied Chemistry
IVS	International VLBI Service
JCGM	Joint Committee for Guides in Metrology
JCRB	Joint Committee of the Regional Metrology Organizations and the BIPM
JCTLM	Joint Committee for Traceability in Laboratory Medicine
JLG	Joint Liaison Group
JVS	Josephson Voltage Standard
KCDB	BIPM Key Comparison Database
KCRV	Key Comparison Reference Value
KCWG	Key Comparisons Working Group
KRISS	Korea Research Institute of Standards and Science, Daejeon (Rep. of Korea)
LGC	LGC (formerly Laboratory of the Government Chemist), Teddington (UK)
LINAC	Linear accelerator
LKB	Laboratoire Kastler Brossel, Paris (France)
LNE	Laboratoire National de Métrologie et d'Essais, Paris (France)
LNE-INM	LNE Institut National de Métrologie, Paris (France)
LNE-LNHB	LNE Laboratoire National Henri Becquerel, Gif-sur-Yvette (France)
LNE-SYRTE	LNE Systèmes de Référence Temps Espace, Paris (France)
METAS	Federal Office of Metrology, Bern-Wabern (Switzerland)
MIKES	Centre for Metrology and Accreditation/*Mittatekniikan Keskus*, Helsinki (Finland)
MIRS	Metrology Institute of the Republic of Slovenia (Slovenia)
MKEH	Hungarian Trade Licensing Office, Budapest (Hungary)
MoU	Memorandum of Understanding
MSB	Mauritius Standards Bureau (Mauritius)
NIM	National Institute of Metrology, Beijing (China)
NIMT	National Institute of Metrology, Pathumthani (Thailand)
NIST	National Institute of Standards and Technology, Gaithersburg, Md. (USA)
NMC, A*STAR	National Metrology Centre, Agency for Science, Technology and Research (Singapore)
NMI	National Metrology Institute

NMIA	National Measurement Institute, Australia, Lindfield (Australia)
NMIJ AIST	National Metrology Institute of Japan, National Institute of Advanced Industrial Science and Technology, Tsukuba (Japan)
NMISA	National Metrology Institute of South Africa, Pretoria and Cape Town (South Africa)
NMI-SIRDC	National Metrology Institute (Zimbabwe)
NML-BSTI	National Metrology Laboratory, Bangladesh Standards and Testing Institution (Bangladesh)
NMS	National Measurement System
NORAD	Norwegian Agency for Development Cooperation
NPL	National Physical Laboratory, Teddington (UK)
NPSL	National Physical and Standards Laboratory (Pakistan)
NRC	National Research Council of Canada, Ottawa (Canada)
NSAI	National Standards Authority of Ireland, Dublin (Ireland)
OAWG	CCQM Working Group on Organic Analysis
OIML	International Organization of Legal Metrology/*Organisation Internationale de Métrologie Légale*
PPP	Precise Point Positioning
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig and Berlin (Germany)
PTTI	Precise Time & Time Interval
QHE	Quantum Hall Effect
QMS	Quality Management System
QS	Quality System
RMO	Regional Metrology Organization
RMTC	Radiation Metrology Testing Centre (Latvia)
SASO	Saudi Standards, Metrology and Quality Organization (Saudi Arabia)
SBS	Seychelles Bureau of Standards (Seychelles)
SI	International System of Units/*Système International d'Unités*
SIM	Inter-American Metrology System/*Sistema Interamericano de Metrología*
SIR	International Reference System for gamma-ray emitting radionuclides/*Système International de Référence pour les mesures d'activité d'émetteurs de rayonnement gamma*
SIRTI	Transfer Instrument of the International Reference System
SNS	Superconductor-normal metal-superconductor
SPRT	Standard Platinum Resistance Thermometer
SRP	Standard Reference Photometer
SSDL	Secondary Standards Dosimetry Laboratories
SUNAMCO	IUPAC-C.2 Commission on Symbols, Units, Nomenclature, Atomic Masses and Fundamental Constants
TAI	International Atomic Time/Temps Atomique International
TC	Technical Committee
TDCR	Triple-to-Double Coincidence Ratio Technique
TEOS-10	Thermodynamic Equation Of Seawater - 2010

TG	Task Group
TGFC	Task Group on Fundamental Constants
TG-SI	CCT Task Group on the SI
TT	Terrestrial Time
TWSTFT	Two-Way Satellite Time and Frequency Transfer
UCWG(II)	CCRI(II) Uncertainties Working Group
UK	United Kingdom of Great Britain and Northern Ireland
UME	*Ulusal Metroloji Enstitüsü*/National Metrology Institute, Gebze-Kocaeli (Turkey)
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
USDA	United States Department of Agriculture
USA	United States of America
UTC	Coordinated Universal Time
UV	Ultraviolet
VIM	International Vocabulary of Metrology, Basic and General Concepts and Associated Terms (3rd edition)
VNIIM	D.I. Mendeleyev Institute for Metrology, Rostekhregulirovaniye of Russia, St Petersburg (Russian Fed.)
VPN	Virtual Private Network
VSL	VSL (formerly NMi-VSL), Delft (Netherlands)
WADA	World Anti-Doping Agency
WG	Working Group
WGATFT	Working Group on Coordination of the Development of Advanced Time and Frequency Transfer Techniques
WGMRA	Working Group on the CIPM MRA
WGPFS	Working Group on Primary Frequency Standards
WHO	World Health Organization
WMO	World Meteorological Organization
ZABS	Zambia Bureau of Standards (Zambia)

Imprimerie Centrale
15, rue du Commerce, L-1351 Luxembourg
ISBN 978-92-822-2247-8
ISSN 1606-3740
Achevé d’imprimer : août 2012