

**International Committee
for Weights and Measures**
Proceedings of the 107th meeting
(20-22 June 2018)

Executive Summary

The 107th meeting of the CIPM (20-22 June 2018)

BIPM Pension and Provident Fund

The CIPM noted the steps taken to implement its decisions regarding the future of the BIPM Pension Fund and re-iterated its commitment to achieve its long-term financial stability.

The CIPM requested the BIPM Director to commission an independent report presenting a range of options for the BIPM staff and operations, in the case that the planned measures to achieve long-term financial stability cannot be implemented in an effective and timely manner.

Terminology

The CIPM recalled decision CIPM/104-48 and confirmed that informal discussions about the terminology used to refer to the BIPM serve to diminish the reputation of the organization and have the potential to damage confidence in its legal certainty. It confirmed that such discussions are closed.

Revision of CIPM-D-01

Three decisions relating to the revision of document CIPM-D-01 “Rules of procedure for the Consultative Committees (CCs), CC working groups and CC workshops” were approved.

Draft BIPM Work programme 2020-2023

The CIPM endorsed the draft Work Programme (2020-2023) presented by the BIPM Director and Department Directors, and asked them to reconcile the scope of the activities with the long-term financial plans for the BIPM and the expected level of the dotation.

26th meeting of the CGPM

Plans for the 26th meeting of the CGPM in November 2018 were presented.

CIPM *ad hoc* Working Group on Implementing the Recommendations from the Review of the CIPM MRA

The CIPM decided that the CIPM *ad hoc* Working Group on Implementing the Recommendations from the Review of the CIPM MRA had completed its tasks and therefore is closed.

Role of metrology in improving the reproducibility of research data

The CIPM decided to establish an *ad hoc* working group to consider the role of metrology in improving the reproducibility of research data and related topics.

**MEMBERS OF THE
INTERNATIONAL COMMITTEE FOR WEIGHTS AND MEASURES**

As of 20 June 2018

President

B. Inglis, Sydney, Australia.

Secretary

J.W. McLaren, Ottawa, Canada.

Members

F. Bulygin, Moscow, Russian Federation.

M. Buzoianu, Bucharest, Romania.

I. Castelazo, Querétaro, Mexico.

Y. Duan, Beijing, China.

L. Érard, Paris, France.

D.-I. Kang, Daejeon, Republic of Korea.

H. Laiz, Buenos Aires, Argentina.

T. Liew, Singapore.

W. Louw, Pretoria, South Africa.

W.E. May, Gaithersburg, United States of America. *CIPM Vice-President.*

M.L. Rastello, Turin, Italy.

P. Richard, Bern-Wabern, Switzerland.

G. Rietveld, Delft, the Netherlands.

M. Sené, Teddington, United Kingdom.

J. Ullrich, Braunschweig, Germany. *CIPM Vice-President.*

T. Usuda, Tsukuba, Japan.

Honorary members

W.R. Blevin, Berry, Australia.

L.M. Branscomb, La Jolla, United States of America.

E.O. Göbel, Braunschweig, Germany.

K. Iizuka, Tokyo, Japan.

R. Kaarls, Zoeterwoude, the Netherlands.

J. Kovalevsky, Grasse, France.

J. Skákala, Bratislava, Slovakia.

Agenda

1. Opening of the session, quorum and approval of the agenda
2. Confirmation of the minutes of the 106th meeting and list of decisions
3. Report on the work of the CIPM bureau by the CIPM Secretary
4. Update on the activities of the BIPM by the Director
5. Finance
6. Issues with Member States and Associate States/Economies
7. The BIPM Pension and Provident Fund
8. Review of meeting outcomes
9. Reports from the BIPM Ionizing Radiation Department, CCRI, CCAUV and CCT
10. Reports from the BIPM Time Department, CCTF and CCL
11. Reports from the BIPM Physical Metrology Department, CCEM, CCM and CCPR
12. Reports from the BIPM Chemistry Department, JCTLM and CCQM
13. Report from the CCU
14. Report from the Task Group for the promotion of the SI
15. Summary of applications for Membership and Observership of the CCs
16. Revision of CIPM-D-01
17. Report from the BIPM International Liaison and Communication Department
18. Review of the draft BIPM Work Programme (2020-2023) and comments received
19. Development of a long-term financial plan for the BIPM
20. Review of the agenda and timetable for the 26th meeting of the CGPM
21. Preparation for the election of the CIPM (and the CEC) at the 26th meeting of the CGPM
22. CIPM matters
23. Reports from the JCGM, JCRB and issues not covered above
24. Dates for future meetings
25. Any other business

1. **OPENING OF THE SESSION; QUORUM; AGENDA**

The International Committee for Weights and Measures (CIPM) held its 107th meeting on Wednesday 20 (PM) to Friday 22 June 2018 at the International Bureau of Weights and Measures (BIPM).

Present: F. Bulygin, M. Buzoianu, I. Castelazo, Y. Duan, L. Énard, B. Inglis, D.-I. Kang, H. Laiz, T. Liew, W. Louw, J.W. McLaren, M.J.T. Milton (Director of the BIPM), M.L. Rastello, P. Richard, G. Rietveld, J. Ullrich and T. Usuda.

Apologies for absence: W.E. May and M. Sené.

Also attending the meeting were: C. Fellag Ariouet (Personal Assistant to the Director and Head of the Secretariat and Housekeeping Office), C. Planche (Librarian and Drafting Officer) and R. Sitton (Publications Officer).

The following were in attendance for parts of the meeting: S. Arlen (Head of Legal Services), H. Fang (Executive Secretary of the CCM), A. Henson (Director of the International Liaison and Communication Department), S. Judge (Director of the Ionizing Radiation Department and Executive Secretary of the CCRI), E. de Mirandés (Executive Secretary of the CCU), G. Panfilo (Executive Secretary of the CCAUV and CCL), S. Picard (KCDB Coordinator and Executive Secretary of the CCT), T.J. Quinn (Emeritus Director), M. Stock (Director of the Physical Metrology Department and Executive Secretary of the CCEM), P. Tavella (Director of the Time Department and Executive Secretary of the CCTF), J. Viallon (Executive Secretary of the CCPR), and R. Wielgosz (Director of the Chemistry Department and Executive Secretary of the CCQM and JCTLM).

Dr Inglis, President of the CIPM, opened the session. He said that Dr May and Dr Sené had sent their apologies and were unable to attend the meeting and Prof. Ullrich will not be present for the session on Friday 22 June. With 16 members present the quorum was satisfied according to Article 12 of the Regulations annexed to the Metre Convention.

He suggested that agenda items 21 “preparation for the election of the CIPM (and the CEC) at the 26th meeting of the CGPM” and 23.1 “the definitions of unit and measurement” should be brought forward in the agenda to allow Prof. Ullrich to participate in the discussions.

The President led the tributes to Prof. Dieter Kind, a former CIPM member and President, who had died on 10 June 2018. Prof. Kind was elected to the CIPM in 1976. He served as President of the CIPM from 1984 to 1996 and President of the CCEM from 1992 to 1996. Prof. Ullrich said that Prof. Kind was born in Bohemia (now part of the Czech Republic) in 1929. He was appointed as President of the PTB in 1975, where he oversaw the integration of parts of the former German Democratic Republic Office for Standardization, Metrology and Quality Control (ASMW) into the PTB following the reunification of Germany. He was also instrumental in founding EUROMET (now known as EURAMET). Prof. Ullrich added that he will attend the funeral on 22 June. Dr Quinn and Dr Laiz also paid tribute to Prof. Kind. A minute’s silence was observed as a mark of respect.

2. CONFIRMATION OF THE MINUTES OF THE 106TH MEETING AND LIST OF DECISIONS

The minutes of the 106th meeting (2017) had been approved by correspondence and were accepted as a true record.

Decision CIPM/107-01 The CIPM accepted the minutes of the 106th meeting of the CIPM as a true record.

There were no comments on the decisions from the 106th meeting (2017) and the President commented that all the actions associated with the decisions had either been completed or will be dealt with later in the agenda.

The Director asked the CIPM to recall that it had made one decision by correspondence since its previous session:

Decision CIPM/107-02 The CIPM noted the decision taken by correspondence on 15 June 2018 amending clause 18.6 of the BIPM Regulations, Rules and Instructions (RRI) to increase the period within which the advisory opinion of the Appeals Committee is delivered from 45 to 60 days if exceptional or unforeseen circumstances warrant so.

3. REPORT ON THE WORK OF THE CIPM BUREAU BY THE CIPM SECRETARY

Dr McLaren, Secretary of the CIPM, gave his report (see Appendix 1). The verbal report covered the bureau meeting held on 18 June 2018. The report of the meeting held on 8-9 March 2018 was available on the CIPM webpage. In addition to the bureau meetings, these reports also covered the Secretary's attendance at the annual Management Review meetings for the BIPM Quality Management System and the Health and Safety System, the annual BIPM/ILAC and BIPM/OIML bilateral meetings and the annual BIPM/ILAC/OIML/ISO quadrilateral meeting, all of which were held in March 2018.

There was a brief discussion on the bureau's attendance at the BIPM/ILAC and BIPM/OIML bilateral meetings and the annual BIPM/ILAC/OIML/ISO quadrilateral meeting to be held in March 2019. The Secretary's report suggested that the "outgoing" bureau should attend the meetings and then report to the "incoming" CIPM that will be elected during Session I of the 108th meeting of the CIPM (20-21 March 2019). There was a proposal that the incoming bureau should attend the meetings, rather than the outgoing bureau. The practical argument against this was that the incoming bureau will not be elected until after the bilateral and quadrilateral meetings have been held and therefore the composition of the bureau will not be known. It was suggested that observers could attend from the newly-elected CIPM, although this was cautioned against as it could be perceived as pre-empting the membership of the bureau and could cause an imbalance in representation at the meetings between CIPM members and representatives from the other organizations. Dr Milton recalled that he and Mr Henson attend all four of the meetings in question and, as such, provide the necessary continuity. The President concluded that the timing of these meetings in a year when a newly-elected CIPM takes its seats cannot be addressed for 2019 as the dates have already been agreed. (See Decision CIPM/107-21)

4. UPDATE ON THE ACTIVITIES OF THE BIPM BY THE DIRECTOR

Dr Milton reported on activities since the last meeting of the CIPM in October 2017.

He started his report by recalling the situation amongst the BIPM staff at the beginning of 2018. In his speech to all staff to welcome the New Year he announced that he had said that "*the opportunity ... to .. explore with the CIPM the possibility of the BIPM making a further contribution to the Pension Fund. I am pleased to say*

that the CIPM were sympathetic to my plan for a very substantial transfer... I cannot promise you at this stage that this will happen, nor tell you more about this at present because the details have not been agreed, but I hope to do so soon." This announcement coincided with the implementation of the freeze on pensions in payment decided upon at the last CIPM meeting and the continuation of the stepped increases in the staff contribution rate decided upon by the CIPM back in 2016. At the same time, the Director was working hard with the directors of the departments: to prepare the BIPM's proposals for the work programme for 2020 to 2023, to plan the General Conference as well as delivering the BIPM commitments to its current work programme and many new commitments to capacity building activities.

As will be explained in §7, the Director's plans for 2018 had to change significantly in order to respond to a series of legal challenges made by retired and active staff. These legal challenges are complex and time-consuming to address and have used a very large proportion of his time and all of the time for the BIPM legal advisor for the last three and a half months. The Director said that he did not want to give the details now because they will be discussed later and he did not want to overshadow the excellent progress that is being made by all of the BIPM staff in so many ways.

Planning for the 26th meeting of the CGPM is well under way. World Metrology Day was celebrated, as usual, on 20 May and was particularly significant because it marked the start of the period when we planned to start promoting the new definitions expected to be agreed at the CGPM. The necessary formal steps to establish the CGPM have been met: the Convocation was published in February 2018 to meet the requirement for 9-months' notice and the draft BIPM Work Programme 2020-2023 was circulated for comment on 10 April 2018. In terms of organization, a dedicated webpage has been launched and a significant amount of liaison work with the venue and the receptions at the *Musee des Arts et Metiers* and the *Academie in Paris* has been carried out by Ms Fellag Ariouet.

The Director said that he has started to travel to visit officials in Member States to explain the plans for the next Work Programme and the possible dotation. Visits have included those to MITI (Japan), The State Department (USA) and the Department for Business, Energy and Industrial Strategy (UK). Future visits are planned to Beijing, Paris and China, as well to other Member States if required.

Activities in Capacity Building and Knowledge Transfer are ongoing and continue to be major highlights. Since the last meeting of the CIPM, there have been courses at the BIPM entitled "Sound beginning in the CIPM MRA" in November 2017; "Effective participation in Coordinated Universal Time (UTC)" in February 2018 and "Train the trainer: transitioning to ISO/IEC 17025:2017 in the CIPM MRA" in May 2018. In addition, Mr Henson and Mr Kuanbayev have delivered seminars in Nigeria, Russia and Turkey. The BIPM's capacity building work also includes technical activities under the "Metrology for Safe Food and Feed" project coordinated by the BIPM Chemistry Department that supports NMIs in strengthening their national infrastructure for mycotoxin analysis and standards. In this context, a successful conference was held with stakeholders in South Africa in May 2018, which will be reported on later in the agenda. The Director added that capacity-building activities have triggered an increase in the number of visitors to the BIPM. He highlighted two current visitors to the International Liaison and Communication (ILC) Department: Dr Sally Bruce from NIST (USA) and Ms Ada Juan Cai from NIM (China). The Director commented on the work of the ILC Department with the International Organization of Legal Metrology (OIML), particularly an invitation for Ms Guliyeva to represent the OIML at the forthcoming World Trade Organization (WTO) meeting on Technical Barriers to Trade (TBT) and the support by the BIPM's HR staff for the employment of a secondee at the BIML. He commented that further highlights from the ILC Department will be presented by Mr Henson later in the agenda.

There have been two retirements since the last meeting of the CIPM: Mr Carlos Maggi in December 2017 and Dr Lennart Robertsson in March 2018. Dr Jiang Zhang will retire in July 2018 and details of the handover of

the T-soft software will be reported during the presentation by the Director of the Time Department. Mr Stephen Keochakian (Quality, Health and Safety Manager) joined the BIPM in December 2017 and Ms Cécilia de Jonckere (Secretary) joined on a two-year contract in February 2018. New staff members will join the Ionizing Radiation, Physical Metrology and Time Departments in July and September 2018. The Director added that Ms Sigrid Arlen (Legal Advisor) had resigned and will leave the BIPM on 16 July 2018. She will be replaced by Mr Felipe Rojas Ceballos who joins the BIPM with 10 years of experience working on legal HR matters at the International Criminal Court (ICC) in The Hague. At the end of 2018 the BIPM will have exactly the headcount of 74 approved at the 25th meeting of the CGPM.

The Director reported that the BIPM suffered a disruption to its operations on 15 December 2017 when its 630 kVa transformer was badly damaged by successive power failures from the national EDF electricity network. Damage to the transformer necessitated its replacement, which was completed on 4 January 2018. A large-capacity diesel generator was rented to maintain the BIPM power supply before the installation of the replacement transformer. Lessons learned from the incident include verification that the well-rehearsed procedure for closing-down the BIPM's IT systems worked efficiently; that there is a need for a larger stand-by generator; and that the high-voltage switchboard needs to be replaced with one that can facilitate "load-shedding".

He added that Mr Keochakian has also been working with Dr Judge, Director of the Ionizing Radiation Department, to plan the decommissioning of three sealed radiation sources and the clear-up of legacy radioactive waste. This is now commissioned and in progress to the full satisfaction of the national regulator in France.

The Director concluded by saying that the last year has been extremely busy for him and for the BIPM and he reflected upon the reasons why. This increase in the workload is justified in part by the 26th meeting of the CGPM in November 2018. With the plans for the expected redefinition under way; there has never been a more important time to have a BIPM that carries out coordination, liaison and technical roles effectively for the benefit of its Member States. He then returned to the point made at the beginning of his report. Defending the implementation of the CIPM decisions relating to the reform of the BIPM Pension Fund has been very time consuming over recent months.

The President thanked the Director and invited questions and comments. The Director and all those involved in the preparation of the draft BIPM Work Programme 2020-2023 were congratulated on the quality of the work programme and for the careful and detailed answers to the questions raised while it has been available for comment. The Director was asked if the cost of the replacement transformer is to be borne by the BIPM or if it is the responsibility of EDF. He confirmed that it will be paid for by the BIPM.

Mr Henson joined the meeting.

5. FINANCE

Report from the Chair of the CIPM Sub-Committee on Finance

Dr McLaren gave the report on behalf of the Chair, Dr Sené, who had been unable to attend the meeting of the Sub-Committee on Finance on 18 June 2018. He said that the preparation of the accounts by the BIPM Finance Service had been completed on time with the support of the external accountant from InExtenso. The accounts were audited by KPMG and signed off on 31 May 2018 with no qualifications apart from a note on the ongoing actuarial liability for the Pension and Provident Fund.

Dr McLaren gave a few highlights of the financial performance in 2017. Income was in line with the forecast at 13 833 k€. Operating expenses in 2017 included an increase in staff costs to 6 652 k€ (from 5 948 k€) due partially to the BIPM's contribution to secondments and an agreed increase in the contribution to the BIPM Pension and Provident Fund to 2 800 k€ (from 2 400 k€). Capital expenditure for 2017 was lower than forecast due to the late delivery of a 400 k€ mass spectrometer, which will be carried over to the 2018 accounts. In terms of operating expenditure, including capital expenditure, the opportunities for making further cost savings are more limited following three-years of continuous efforts. Under current assets the BIPM's cash and cash equivalents decreased by 826 k€ from 15 975 k€ in 2016 to 15 149 k€ in 2017. EBITDA (Earnings Before Interest Tax, Depreciation and Amortisation) decreased from 1 985 k€ in 2016 to 1 608 k€ in 2017, reflecting the increase in costs.

The Sub-Committee commended the Director and the BIPM staff on their prudent financial controls, which have enabled the BIPM to continue to deliver its activities, despite the flat-cash dotation over the last six years, through careful control of operational and capital expenditure. This has been achieved while maintaining the required reserves and cash balance.

The President thanked Dr McLaren for his presentation and for acting as Chairman at the last meeting of the Sub-Committee. He invited questions and comments. It was asked how many guest workers had been hosted by the BIPM in 2017 and the level of financial support they receive? The Director replied that there had been 30 guest workers at the BIPM in 2017, amounting to 14 full-time equivalent staff. The level of support they received depended on the situation at their host institute. There are three levels of support based on whether or not a guest worker is fully-funded by their home institute, the purchasing power of their salaries and whether or not they have families. He added that there is a practical limitation on the number of projects, with the limit being the available space in each department and retaining a ratio of not less than two BIPM scientists for each guest worker. The Director noted that there are two types of guest workers: those involved in programme delivery and those involved in capacity building. The figures shown in the work programme for guest workers are for those involved in programme delivery as they provide support to progress the work in the laboratories. Capacity building guest workers are hosted at the BIPM while they develop their own capabilities; they do not progress the work in the laboratories. In addition, the latter group are externally funded. The Director said that the increase in operating costs to support the CBKT programme have been offset by the increase in income, so the net cost of running the programme is neutral.

Quietus for the 2017 Financial Report

The Director requested quietus for the audited financial statements of the BIPM and of the BIPM Pension Fund for 2017. The Sub-Committee on Finance had unanimously agreed at its meeting on 18 June 2017 that the accounts should be recommended for approval by the CIPM and that the Director be granted quietus. After a brief discussion, the CIPM granted the BIPM Director quietus for the 2017 exercise.

Decision CIPM/107-03 The CIPM confirmed its approval of the audited financial statements of the BIPM and of the BIPM Pension and Provident Fund which were reviewed by the CIPM Sub Committee on Finance in June 2018. The CIPM granted the BIPM Director quietus for the 2017 exercise.

Approval of the budget for 2019

The Director said that the budget for 2019 had been presented and discussed at the 106th meeting of the CIPM and now required approval. It was asked if the budget takes account of the fact that there are only limited further opportunities for cost savings and how this will be managed. The Director replied that he had discussed this issue with Dr Sené and the BIPM department directors. The crossover point when expenses will exceed income is expected to occur in 2022 or 2023, so the current budget is not affected. He added that the financial

situation in the next work programme is a concern and will be discussed later in the meeting. The CIPM approved the budget.

Decision CIPM/107-04 The CIPM approved the budget proposed by the Director for 2019.

6. ISSUES WITH MEMBER STATES AND ASSOCIATE STATES/ECONOMIES

Ms Arlen, Ms Guliyeva and Mr Henson joined the meeting.

Mr Henson stated that as of 20 June 2018 there were 59 Member States and 42 Associates, which cover approximately 98 % of the world's GDP. The remaining ~80 states recognised by the UN that are not members only cover 2 % of the world's GDP and therefore, future new members will have relatively small economies. Interest in participation in the activities of the BIPM remains strong.

Montenegro became a Member State on 1 January 2018, after having been an Associate since 2011. Ethiopia and Tanzania became Associates on 1 January and Kuwait became an Associate on 23 March 2018. Unfortunately, Yemen was excluded on 1 January 2018 following 3 years of defaulting on its subscription.

He noted that a decision will be needed at the 26th CGPM meeting to exclude Venezuela, unless it settles at least a minimum amount of its arrears before the meeting. The BIPM has attempted to work with Venezuela to resolve the situation. In April 2018 it had requested further invoices be sent. Mr Henson cautioned that this has happened before but without any subsequent payment being received. He said he would come back to this issue.

Mr Henson recalled the long-term debt situation with the Islamic Republic of Iran, which remains a Member State with a frozen rescheduling arrangement, and the historic debt situation regarding the exclusion of three Member States (Cameroon, Democratic People's Republic of Korea and Dominican Republic).

He noted that Resolution 8 adopted by the CGPM at its 23rd meeting in 2007 partly addressed the situation by ending the practice of debts accumulating for decades, but that experience had shown that other problems remained, including possible inequality of treatment. It was now apparent that it would be better for all parties if future practice could revert to a strict application of Article 6 (1921) of the Annexed Regulations of the Metre Convention; that is to say exclusion for a state after 6 years of arrears. As a result, Draft Resolution E "*On the financial arrears of Member States and the process of exclusion*" has been drafted to address this point of principle and to restore clarity to the exclusion process.

He then recalled the misunderstanding between Lithuania and the French Ministry of Foreign Affairs regarding its date of accession to the Metre Convention. The details have been reported to the CIPM at previous meetings. Lithuania has now paid all of its outstanding contributions as a Member State, including 2015, and it is hoped that the matter has been resolved. Unless the BIPM hears otherwise from the French Ministry of Foreign Affairs, Lithuania will continue to be listed as a Member State as from 16 April 2015, in accordance with the formal notification to the BIPM by the French Ministry of Foreign Affairs.

Mr Henson referred to Decision CIPM/106-20, which addressed the issue of micro-CEEMs¹ and the consequences of their entry onto the 'escalator' mechanism (see §18 of the report of the 106th meeting of the CIPM). Before this decision was taken in October 2017, there were 20 Associates on the escalator mechanism,

¹ Associate States of the CGPM with a UN coefficient of 0.02 or less. The acronym CEEMs refers to Countries and Economies with Emerging Metrology Systems.

with an additional three that were due to enter the mechanism at the start of 2018. Decision CIPM/106-20 had been taken to set criteria to avoid the likelihood that some ‘smaller’ Associates would default on their subscriptions as they increased, and because others had indicated that they may have to withdraw if entered onto the escalator. The decision was applied to the existing Associates on the escalator mechanism, resulting in a reduction to eight Associates on step 5 and three on step 3. Of the Associates remaining on the escalator, Ukraine has made most progress and can realistically be expected to become a Member State in the near future.

Member States with notable outstanding contributions as of 20 June 2018 were Brazil, Mexico, Pakistan and Tunisia. Brazil is in default for 2017 and 2018 but information received indicates that it intends to avoid suspension, having made a partial payment on 15 June 2018. Nonetheless, Brazil still owes the BIPM in excess of 1.2 M€ for 2017 and 2018. The situation with the outstanding contributions from Mexico is expected to be resolved in the near future as the problem reportedly resulted from an internal change in responsibility for making the payment. Pakistan paid its 2016 contribution in March 2018 and Tunisia has outstanding contributions for 2017 and 2018.

Associates with notable outstanding subscriptions as of 20 June 2018 were Jamaica, Syria, Zimbabwe and Cuba. Jamaica had formally written to the BIPM to say that the consequences of the escalator mechanism were such that it would likely result in its withdrawal. This situation has now been alleviated by Decision CIPM/106-21, which states that “*an Associate that does not meet the criteria set in Decision CIPM/106-20 and that has already been encouraged to accede to the Metre Convention, and as a result is paying an increased subscription, shall have its subscription reduced to the minimum for an Associate State.*” As a result, Jamaica has agreed a rescheduling arrangement. Syria has experienced difficulties in transferring its subscriptions. Zimbabwe is an active Associate that is working on CMCs; however the situation regarding the payment of its subscriptions is unclear. The status of Cuba’s outstanding subscriptions is a cause for concern as it not been in contact with the BIPM for some time, and it has paid about two fifths of its 2016 subscription, and nothing for 2017 or 2018. Mr Henson summarized by stating that despite the aforementioned situations, overall the situation regarding outstanding contributions and subscriptions is, excluding the long term issues, currently very good. This is due in part to the significant amount of work carried out by Ms Fellag Ariouet and Ms Guliyeva.

He reminded the CIPM again that a decision will be needed at the 26th CGPM meeting to exclude Venezuela unless it settles at least a minimum amount of its arrears before the meeting. A decision was therefore needed by the CIPM in order to proceed to taking the case for exclusion to the CGPM. Clarification was sought as to whether the exclusion of Venezuela actually requires a decision by the CGPM. Mr Henson replied that this is the case at the moment because Resolution 8 of the 23rd CGPM (2007) is in place and it specifically requires a decision in each case by the CGPM before a Member State in arrears can be excluded. Draft Resolution E “*On the financial arrears of Member States and the process of exclusion*”, which will be presented to the 26th CGPM meeting, aims to rectify this situation and will allow the CIPM to implement Article 6 paragraph 8 of the Annexed Regulations. In Article 6 the provisions for exclusion are clear: the prerogatives and advantages of a defaulting Member State are suspended after three years in arrears, and it is excluded after a further three years in arrears. If Draft Resolution E is approved, future exclusions will come under the remit of the CIPM and will be implemented automatically according to the criteria and without the need for a decision by the CGPM. However, at the moment, Resolution 8 of the 23rd CGPM (2007) is still in force and its other provisions, such as attempting to agree a rescheduling agreement with Venezuela, have also been properly applied.

The President thanked Mr Henson and asked the CIPM if it supported the decision to recommend to the CGPM at its 26th meeting to take a decision with regard to the exclusion of the Bolivarian Republic of Venezuela in accordance with Article 6 of the Regulations annexed to the Metre Convention. He noted that

should Venezuela in the meantime settle its debts, the issue would not be brought to the CGPM. The CIPM supported the following decision with one abstention.

Decision CIPM/107-05 The CIPM noted that the Bolivarian Republic of Venezuela has not paid its contributions for six years. Pursuant to Resolution 8 adopted by the CGPM at its 23rd meeting (2007) it has been sent a formal notification inviting it to fulfil its financial obligations and reminding it of the procedure governing the recovery of arrears and exclusion. The CIPM decided to recommend to the CGPM at its 26th meeting to take a decision with regard to the exclusion of the Bolivarian Republic of Venezuela in accordance with Article 6 of the Regulations annexed to the Metre Convention.

7. THE BIPM PENSION AND PROVIDENT FUND

Item 7 was held *in camera*. Ms Arlen joined the meeting.

Mr Énard, Chair of the Pension Fund Advisory Board (PFAB), gave a report on its activities since the last meeting of the CIPM. He presented data that had been discussed at previous CIPM meetings, including the Pension and Provident Fund asset value projections, which had been made by Mercer and presented to the CIPM in October 2016, and details of the measures implemented in January 2017. He continued by saying that, after all of the necessary consultation, the CIPM had decided on further measures in October 2017 that had been implemented in January 2018. (See Decisions CIPM/106-5 to CIPM/106-8).

Since these measures were implemented on 1 January 2018, some cases have been submitted by pensioners to the Administrative Tribunal of the International Labour Organization (ILOAT) in Geneva and some requests for “administrative review” had been submitted to the Director by serving staff members. Mr Énard then reported on the June 2018 meeting of the PFAB. Both the pensioners’ representative and the staff representatives had had a series of questions all of which had been discussed. They had asked what would happen if no consensus was reached at the PFAB on a point of importance. In response, it was proposed that the same method should be used if no consensus is reached as during Consultative Committee (CC) meetings, which is that the CIPM will be informed about dissenting views on significant topics.

Mr Énard said that the staff representatives had suggested that an alternative to the “pension point” should be considered, although they did not propose what such an alternative should be. They had also suggested that the planned increases in contributions should be deferred until after 2019, although this was not consistent with the commitment made by the CIPM to demonstrate to the 26th CGPM meeting that the Pension Fund has been placed on a financially sustainable basis in order that it should be sufficient to support pension benefits in the long term. He added that an actuarial review of the Pension and Provident Fund will be carried out in 2019.

The PFAB *ad hoc* investment committee, consisting of Mr Énard, the Director and a representative from Mercer, met with representatives of HSBC to review the investment policy of the Pension and Provident Fund and the options for investing the reserves of the fund. Following this meeting and discussions within the CIPM Sub-Committee on Finance, it was recommended that the reserves of Pension and Provident Fund should be invested in an HSBC Mutual Fund.

Mr Énard completed his presentation by asking the CIPM to reaffirm its support for the PFAB to continue with its work, this support was confirmed. The President thanked Mr Énard.

Ms Arlen, the BIPM Legal Adviser, gave the CIPM an overview of the timeline and procedure for an administrative appeal at the BIPM. At the end of this process, and following the final decision by the Director,

staff members then have the possibility to appeal to the ILOAT, the jurisdiction of which was granted to the BIPM in 2008, in view of its status as an intergovernmental organization. ILOAT judgments are final and without appeal. She commented that an ILOAT judgment can take up to 2 years from the end of the written procedure and therefore up to 3 years after the original decision.

The President thanked Ms Arlen and invited questions from CIPM members. There was discussion about the need to identify what alternative actions might be available to the CIPM if the Member States did not consider that sufficient progress had been made towards achieving long-term financial stability. The Director reported that this topic had been discussed within the CIPM bureau and at the Sub-Committee on Finance. Both discussions had led to a proposal that an independent study be commissioned to look into possible financial options. It was agreed that such a study should be commissioned whilst any outstanding legal action was concluded.

The Director made some concluding remarks. He noted that the CIPM has taken decisions to address the long-term financial stability of the pension fund. One of the claims by the appellants in the administrative appeal referred to by Ms Arlen was that the CIPM had not followed its own procedures. The CIPM has been successfully defended against this claim so far, but it serves as a reminder that the BIPM must work within its 'legal order'. This legal order and status, as recognized by the ILO, is why the BIPM is obliged to follow the processes that it has established. The ILOAT accepts the use of its jurisdiction because the BIPM is an intergovernmental organization. The Director added that in order to progress with this work with full confidence, the full support of the CIPM is required on this important legal and institutional issue. He asked the CIPM to recognise that the circulation of informal correspondence can serve to undermine the BIPM and he asked the CIPM to endorse its understanding of the legal status of the BIPM.

A decision had been prepared in this respect, which was read by the President. After some discussion amongst the CIPM, the President noted his own appreciation and that of the CIPM for the significant efforts put into defending the BIPM against these claims by Ms Arlen and the Director.

Decision CIPM/107-06 The CIPM expressed its appreciation and support for the work of the Chair of the Pension Fund Advisory Board (PFAB), the BIPM Director and Legal Advisor in respect of the implementation of its decisions, in particular concerning the long-term financial stability of the BIPM Pension Fund.

The CIPM recalled the decision in 2008 of the Governing Body of the International Labour Organization (ILO) that observed that the BIPM, as an intergovernmental organization established by treaty, recognized the jurisdiction of the ILO Administrative Tribunal (ILOAT). The CIPM recognized the legal status of the BIPM as an intergovernmental organization and instructed the BIPM Director to continue to ensure as much as possible the legal certainty necessary for the implementation of its decisions.

The CIPM recalled decision CIPM/104-48 and confirmed that informal discussions about the terminology used to refer to the BIPM serve to diminish the reputation of the organization and have the potential to damage confidence in its legal certainty. It confirmed that such discussions are closed.

The President reiterated that the recognition of the BIPM as an intergovernmental organization is the basis of the ILOAT accepting the use of its jurisdiction by the BIPM. Prof. Ullrich stated that he has a mandate to represent the German government in matters of metrology but not for legal issues relating to the BIPM. He was therefore unable to endorse Decision CIPM/107-06. Dr Rietveld recalled that membership of the CIPM is based on support for and knowledge of international metrology and is not to represent the views of any NMI or government. Dr Bulygin added that Decision CIPM/107-06 is intended to stop discussions on terminology,

which are undermining the legal status of the BIPM, and not to clarify its legal status.

Ms Arlen commented that the legal status of the BIPM as an intergovernmental organization has been observed and recognized throughout the legal world, as is evidenced by the acceptance by the ILOAT of the use of its jurisdiction by the BIPM. Another example of many is the protection of the BIPM logo by the World Intellectual Property Organization (WIPO), which also recognizes the BIPM as an international organization. The President summed up by stating that the CIPM is not required to take a legal decision, it is simply acknowledging decisions that have been made throughout the legal world that recognize the legal status of the BIPM as an IGO. Ms Arlen confirmed that the terms “intergovernmental organization” and “international organization” are equivalent in this case. Following a brief discussion to refine the wording of the draft decision, the CIPM adopted Decision CIPM/107-06 by consensus, noting that there was one abstention.

The Director introduced two further decisions relating to the Pension and Provident Fund. He commented that Decision CIPM/107-07 had been drafted to reiterate and reinforce the CIPM’s ongoing commitment to the pension reform process. There was a brief discussion and the decision was adopted.

Decision CIPM/107-07 The CIPM noted the steps taken to implement its decisions regarding the future of the BIPM Pension Fund and re-iterated its commitment to achieve its long-term financial stability.

Decision CIPM/107-08 had been drafted following the discussion about the need to commission an independent report to review the options for the BIPM staff and operations if the Member States did not consider that sufficient progress had been made towards achieving long-term financial stability for the Pension Fund. Following a brief discussion it was adopted.

Decision CIPM/107-08 The CIPM requested the BIPM Director to commission an independent report presenting a range of options for the BIPM staff and operations, in the case that the planned measures to achieve long-term financial stability cannot be implemented in an effective and timely manner.

8. REVIEW OF MEETING OUTCOMES

CC Presidents

The President recalled the discussions at the meeting of CC Presidents, which had been held immediately before the CIPM meeting. He said that an item should be added to the agenda for the next meeting of the CIPM to review the purpose of the CC Presidents meeting, its agenda and whether or not to retain the meeting.

Decision CIPM/107-9 The CIPM decided to review the purpose and agenda of the meeting of the CC Presidents at the next meeting of the CIPM.

THE 106TH MEETING OF THE CIPM – SECOND DAY – 21 JUNE 2018

The President welcomed the CIPM to the second day of its meeting, which was joined by Dr Fang, Mr Henson, Dr Judge, Dr Panfilo, Dr Picard, Dr Stock, Dr Tavella, Dr Viallon, Dr Wielgosz and Dr Quinn.

9. REPORTS FROM THE BIPM IONIZING RADIATION DEPARTMENT, CCRI, CCAUV AND CCT

BIPM Ionizing Radiation Department

Dr Judge set the context for the need for ionizing radiation metrology in five words: keeping ionizing radiation under control. He highlighted the impact of ionizing radiation metrology on healthcare; every year there are 4.7 million radiotherapy treatments, 3.6 billion diagnostic x-rays, 40 million diagnostic images using radionuclides and 4 million nuclear medicine treatments carried out world-wide. In addition, there are 11 million workers exposed to ionizing radiation, and 11 % of the world's electricity is generated by 450 nuclear power plants. Ionizing radiation metrology is needed to ensure effective cancer therapy, patient safety, the safety of radiation workers and the protection of the environment. He added that three factors help to disseminate accurate metrology in the field: firstly, it is well regulated; secondly, the NMIs and DIs provide the primary standards and promote accurate metrology; and thirdly, the International Atomic Energy Agency (IAEA) supports ionizing radiation metrology in developing countries.

He gave an overview of the staff in the Ionising Radiation Department, noting that its work is carried out in the two areas of radioactivity and dosimetry. In addition to the permanent staff, the department is currently hosting one long-term secondee and four more long-term secondments are planned for 2018 and 2019.

Dr Judge said that the dosimetry section has taken part in comparisons with six NMIs since the last meeting of the CIPM as part of an agreed 15-year cycle. Each comparison exercise usually covers several instruments and several different energy radiation beams; the energies for the comparison exercises have been chosen carefully by the CCRI so that one exercise may be used to support several CMCs. The collaborative agreement with CEA-LIST for access to the DOSEO facility at Saclay has enabled the BIPM to establish a new service to match the growing work at NMIs on radiotherapy using high-energy photons from accelerators at NMIs. This growth is being driven by this type of radiotherapy increasingly replacing ^{60}Co sources; there are now around 12 000 linear accelerators in use around the world, compared to 2000 ^{60}Co sources. He noted that there has been rapid progress at DOSEO; the BIPM has installed its equipment; quality control studies have been completed; successful comparisons with KRISS (Republic of Korea) and METAS (Switzerland) have been completed; and improvements to the software have been implemented, allowing rapid on-site data analysis.

In the area of radioactivity, Dr Judge noted that one radionuclide comparison 'shines the light' on other radionuclides defined in the CCRI Section II Measurement Methods Matrix (MMM). There are 150 accessible radionuclides and it is not possible to carry out a comparison for each one; the MMM enables a comparison for one radionuclide to be accepted for several radionuclides. A modified system may need to be developed over the next few years to allow one comparison for one radionuclide to support other CMCs. Radioactivity comparisons have been carried out for seven NMIs since the last meeting of the CIPM: many of the radionuclides concerned have medical applications.

Dr Judge commented that the stringent regulatory framework within which the ionizing radiation sector operates presents challenges to all users, including the BIPM. There are increasingly rigorous regulations concerning sealed radioactive sources and the shipping of radioactive materials is becoming complex. This regulatory framework is being strengthened by Governments around the world. He said that the Ionizing Radiation Department has initiated several projects to address these challenges. To ensure that the SIR can

continue to be used in the long term, a project is under way to replace the five radium sources without incurring any loss in precision. This project is being undertaken in partnership with IRA (Switzerland), NPL (UK) and Triskem (France). A suitable alternative radionuclide, $^{166\text{m}}\text{Ho}$, has been identified and a construction method for the sources is being tested. New sources will be constructed and validated over the next two years to ensure that measurements can be reproduced. When the approach has been validated at the BIPM it will be disseminated to NMIs that are facing similar challenges. A longer-term aim is to future-proof the SIR by reducing the number of sources needed from five to one. Five are currently needed because the linearity of the measurements in ionizing chambers is not as precise as required. It is expected that this goal will be achieved by using new electrical current measurement technology; following discussions with NIST and members of the Consultative Committee for Electricity and Magnetism (CCEM), an initial workshop will be held at NIST in September 2018 to discuss the options and to plan the next stages. It is hoped that this technology could be used by the NMIs if the project is successful.

The new regulatory environment in France has resulted in the discontinuation of the services based on the ^{137}Cs irradiator. There is a need to replace these services with no significant increase in their uncertainties since this is one of the key energies used for calibrating and comparing instruments for radiation protection and is particularly important to the IAEA. Under the terms of an existing Memorandum of Understanding, the BIPM is in discussions with the IAEA about using its ^{137}Cs facility. The IAEA has confirmed that it is interested and it is expected that the practical challenges can be solved. The service to ensure comparisons and calibrations for high-energy photon radiation protection standards should therefore be re-established soon. In addition, Dr Judge commented that the department's radiotherapy services have been transferred from the old ^{60}Co irradiator to the BIPM Theratron ^{60}Co irradiator by Dr Kessler, with no interruption to services and with no impact on uncertainties.

In order to reduce the burden on NMIs and DIs associated with shipping radioactive materials, there is an ongoing project within the department to reduce the need for large-scale comparisons via two projects. The first project involves a broader scope of BIPM comparison services through the extension of the radionuclide standard comparison service to cover pure beta-emitters. This collaborative project with the LNE-LNHB (France), NPL (UK), POLATOM (Poland) and PTB (Germany) will restart on 3 September 2018. The aim of the project is to have a working system for the majority of radionuclides by the end of 2019. The second project is to make a step-change in the timescale for reporting results; improvements to the SIR hardware and software are under way and new analysis software will be developed by a secondee starting in October 2018.

Dr Judge concluded by presenting the Ionizing Radiation Department's engagement with stakeholders. Since the last meeting of the CIPM, the department's collaborative work with the IAEA has included contributing to the update of a dosimetry code of practice (IAEA-TRS-398); serving on a scientific committee for IAEA/World Health Organization (WHO) network of dosimetry laboratories; taking part in the organizing committee for the IAEA IDOS2019 conference; and carrying out calibrations of IAEA dosimeters. A new liaison has been established with ISO/TC85/SC 2, which is concerned with radiological measurements largely for the nuclear industry. International Organization for Standardization (ISO) standards in this area generally cover users and may have some focus on NMIs as they include guidance on how to realize some primary standards; the standards are complemented by the CIPM MRA. The aim of this liaison is to develop an integrated and fully documented system for calibrated and traceable instruments. He added that there is an ongoing collaboration with the International Commission on Radiation Units and Measurements (ICRU).

The President thanked Dr Judge and invited questions and comments. He was asked if the booklet on radiation decay data will continue to be published. Dr Judge confirmed that this is part of the Decay Data Evaluation Project, which is run by the LNE-LNHB, and that the *monographie* that is produced from this project will continue to be published by the BIPM.

Consultative Committee for Ionizing Radiation (CCRI)

Dr Louw recalled the changes that have been made to the CCRI over the last four years, resulting in a CC that is now more inclusive and communicates effectively with its three main stakeholders. The CCRI has also spent a considerable amount of time looking at its future strategy: the arrangement with CEA-LIST for access to the DOSEO facility was cited as an example of the direction the CCRI and the Ionizing Radiation Department should be taking. The arrangement does incur a cost to the BIPM; however this is less than purchasing and running a linear accelerator at the BIPM.

The CCRI is looking at the challenges that are expected to be faced in ionizing radiation and some measures have already been taken in the department to address these, such as the possibility of replacing the department's ^{137}Cs irradiator-based services through access to the IAEA's ^{137}Cs facility. Dr Louw commented that Dr Judge has been very effective in making sure the department understands its role and the best application of the BIPM's resources in the field of ionizing radiation.

The work of the CCRI RMO Working Group on IR CMCs (RMOWG) is being reinvigorated in order to ensure that all RMOs are represented and that the issues with ionizing radiation CMCs are fully discussed. The RMOWG held its second meeting in March 2018. Dr Louw recalled that it had been noted at the CC Presidents meeting that, although there are many IR CMCs in the KCDB, few of these are new CMCs and as such the streamlining of the review process for new CMCs is not a priority but rather the re-review of CMCs older than 5 years. The CCRI is also looking at how to reduce the number of IR CMCs and how to conduct more efficient reviews of the existing CMCs, as was suggested in the recommendations from the Working Group on the Implementation and Operation of the CIPM MRA.

Dr Louw said that the large number of CMCs in radioactivity stems from the fact that each radionuclide standard has an entry in the KCDB and in dosimetry, the number of CMCs required depends on the interpretation of a CMC by different NMIs. EURAMET has made a proposal to reduce the number of CMCs, which relies on only having CMCs for core quantities. He commented that although this may work for larger laboratories, the second-level laboratories need a more direct relationship between their services and the CMCs and the proposal will not work as well. One consideration would be to refer to core quantities as national standards, rather than primary standards, as a national standard in an NMI may also be a secondary standard. The CCRI recognizes the need to simplify the system and is exploring how aspects of the EURAMET proposal can be implemented, whilst recognizing that the definition of a CMC cannot be changed at the CCRI level. The CCRI strategy recognizes this proposal but it will be implemented carefully to ensure that all the NMIs can have the CMCs they need for their particular situations in the KCDB. A pilot study is being carried out by EURAMET and the PTB to determine how its services can be linked in a clear way to a core quantity CMC.

Dr Louw stated that although the CCRI issued a general guidance document on reviewing CMCs in 2017, there is still work to be done to harmonize the review procedure to take account of the differences that exist between the RMOs. In addition, the procedure will need to incorporate a risk-based approach to CMC reviews as noted in both the recommendations from the Working Group on the Implementation and Operation of the CIPM MRA and ISO/IEC 17025:2017.

He concluded by briefly mentioning the radioactivity Measurement Methods Matrix (MMM), which may need to be readdressed to prevent it from becoming over-complicated. He also mentioned the need for a clear process to support the BIPM in agreeing the major external facilities to be used in support of its work, for example DOSEO and IAEA. A proposal for this will be developed by the CCRI President and the Executive Secretary for discussion.

The President thanked Dr Louw.

Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV)

Dr Usuda said that there had not been a meeting of the CCAUV since the last meeting of the CIPM and that the Focus issue of *Metrologia* on ‘Metrology for dynamic measurements’ had been published. He commented that this focus issue had been produced in response to the increasing importance of dynamic measurements in industry and the guest editors were Dr Usuda and Dr Bruns (PTB).

The CCAUV had agreed to update its “service category” at its meeting in September 2017. The CCAUV members had expressed an interest in adding new entries to the list of categories and a “dynamic force” section will be added after an agreement is reached with the CCM for a similar entry. Publication of a revised list of entries is expected in the near future.

Dr Usuda commented that the CCAUV strategic plan for 2017 to 2027 and its summary have been published. The key areas that the strategic plan focuses on are: applications in environmental monitoring, medical and diagnostics, occupational safety, engineering and production; emerging applications in MEMS sensors; and the importance of relationships with other international organizations such as ISO, the International Electrotechnical Commission (IEC) and the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO). The relationship between the CCAUV and the CTBTO is developing and there is regular dialogue concerning infrasound and low-frequency vibration traceability of its International Monitoring System (IMS).

He presented the current situation of the implementation of the CIPM MRA with regard to the CCAUV. There is no significant work in progress for reviewing current CMCs but plans are to pursue a risk-based assessment approach towards reviewing them in the future. The planning process for key comparisons (KCs) involves careful deliberation to optimize the resource requirements needed to respond to the needs of the CCAUV’s stakeholders. Some mature KCs have reached the stage where repeats of CC KCs, normally in a 10-year cycle, are being conducted to assess them as well as to extend their calibration range.

Dr Usuda concluded by saying that the key messages to the 26th CGPM meeting from the CCAUV are the global comparability of measurements for safety and health and its role as a global forum for progressing the state-of-the-art on innovations. He noted that the President of the *Académie des sciences*, Prof. Sébastien Candel, who will be chairing the 26th CGPM meeting, has an interest in acoustics, ultrasound and vibration.

The President thanked Dr Usuda. Dr Rietveld said that dynamic force is also of interest to the CCEM. He noted that similar, or the same, quantities may be of interest to different CCs and a discussion is probably needed to give consideration to where they belong. He cited the case of electrical conductivity, which could be included in the CCEM; however it is increasingly used in chemistry given the particular measurement challenges presently facing CMCs mainly in the CCQM. He asked if there are problems with reviewing CMCs for dynamic force. Dr Usuda replied that for dynamic force, the measurements are only for mechanical impedance and the issue was thoroughly discussed by the relevant CCAUV working groups. He agreed that the wider issue of inter-disciplinary CMCs should be discussed at a future meeting of CC Presidents.

Consultative Committee for Thermometry (CCT)

Dr Duan reported on progress within the CCT since the last meeting of the CIPM in October 2017. The most recent meeting of the CCT had been held in June 2017 and its outcomes had been reported to the CIPM at its last meeting. He reiterated that the criteria set in CCT Recommendation 2014 “*On a new definition of the kelvin*” had been met. The main text of the *mise en pratique* for the kelvin has been modified to conform to the new standard format and has been published on the BIPM website and the first revision of the CCT strategic plan has been completed.

The CCT Task Group for Emerging Technologies (CCT TG-CTh-ET) has identified six new focus areas for the CCT, grouped under the headings of primary thermometers (optomechanical thermometry, optical thermometry, nanoelectronics-based thermometry and quantum conductance) and ITS-90 traceable thermometry (optical thermometry resonators and photonic thermometry). The CCT Working Group for Environment (CCT-WG-Env) has been involved in collaborative work with a number of its stakeholders, including the WMO. For example experts from the CCT-WG-Env have been involved in the WMO Commission for Instruments and Methods of Observation (CIMO) inter-laboratory comparisons, particularly in the area of instrument inter-comparisons. Dr Duan noted that the TEMPMEKO 2019 conference will be held in China.

Dr Duan said that the recommendations from the CIPM *ad hoc* Working Group on Implementing the Recommendations from the Review of the CIPM MRA have been studied and that a “risk-based” approach for inter-RMO CMC review has already been implemented by the CCT. He noted that some RMOs have a tendency to apply stricter comparison requirements than others and, in addition, the re-review of CMCs has not yet been carried out. Both issues are being discussed within the CCT Working Group for Calibration and Measurement Capabilities (CCT-WG-CMC).

The President thanked Dr Duan.

10. REPORTS FROM THE BIPM TIME DEPARTMENT, CCTF AND CCL

BIPM Time Department

Dr Tavella said that three staff members have retired from the department since the last meeting of the CIPM: Dr Arias, Dr Jiang and Dr Robertsson. Following the retirement of Dr Jiang, the responsibility for the T-soft software, the main software that computes UTC from individual clocks to a steered and verified timescale will be transferred to Ms Harmegnies. Details of the reorganization of responsibilities within the department to cover the retirements were given. A new physicist, Dr Meynadier, will start work on 1 July 2018. In addition, there is presently one post-doc student, one part-time secondee and one student working in the department. Collaboration agreements are being finalized with SYRTE, for a secondee to work on a new synchronization system, and the European Space Agency (ESA) for a secondee on receiver calibration.

The work being carried out to improve UTC and time and frequency transfer methods was presented. One such technique being pursued is known as the software-defined radio receiver (SDR). The SDR technique is showing good results, with a reduced diurnal and measurement noise when compared to Two-Way Satellite Time and Frequency Transfer (TWSTFT) using a standard modem. A BIPM and CCTF Working Group on Two-Way Satellite Time and Frequency Transfer (WGTWSTFT) pilot study on using SDR receivers for TWSTFT, in the framework of the realization of International Atomic Time (TAI), was launched in January 2016. So far, 15 TWSTFT laboratories have installed SDR equipment and Recommendation CCTF 5 (2017) “*On improving the uncertainty of Two-Way Satellite Time and Frequency Transfer (TWSTFT) for UTC Generation*” was approved. Network calibration and further developments with the SDR technique are in progress and there is the possibility of collaboration with SYRTE and other NMIs in this area. A comparison of the use of SDR receivers against SATRE modems in TWSTFT between the OP (France) and the PTB (Germany) showed a significant improvement in time stability.

Dr Tavella commented that two new Global Navigation Satellite Systems: Galileo (Europe) and BeiDou (China) are coming online; these are in addition to the existing GPS and GLONASS systems. Initial tests with Galileo have established that when used in “Standard BIPM processing” (All-in-view, IGS precise orbits/clocks), Galileo links are at least as good as, or better than, GPS links even though the number of observations are about 50 % fewer. A comparison of GPS and Galileo between SG (Singapore) and

ORB (Belgium) over a 10 500 km baseline found that the diurnal signatures present in GPS were not visible when using Galileo. An agreement is under discussion with the ESA for support to calibrate the Galileo receiver. A pilot experiment using time transfer for UTC via the BeiDou system is under way. The NIM BeiDou receivers were installed and tested at the BIPM by Dr Liang, who was on secondment to the Time Department between January and December 2017. The initial test have been encouraging and testing of UTC time transfer using BeiDou is expected to be completed in 2018.

Dr Tavella said that the time transfer using GNSS is achieved using Precise Point Positioning (PPP) where code and carrier phase signals are measured and, *a posteriori*, precise orbit and clocks estimates are used. However, this technique may have jumps due to the ambiguity in the phase resolution. A promising new technique, Precise Point Positioning with integer ambiguity resolution (IPPP), is intended to fix an entire number of cycles in the ambiguity resolution: a comparison of IPPP to Time Transfer by Laser Link (T2L2) found a sub 100 ps agreement. The work on IPPP is being carried out in collaboration with Ms Leute as part of a CNRS-BIPM framework programme.

One of the drivers for the Time Department's work is "*to promote the importance and benefits to the international telecommunications, astronomy and earth science communities of UTC as unique reference time scale.*" Dr Tavella noted that in this respect, the department is involved in the UN International Committee on GNSS, which held a workshop in Vienna (Austria) on 20 June 2018. The workshop was organized to address the challenge of different time scales being used by the growing number of different GNSS systems such as GPS, Galileo, BeiDou, GLONASS etc. If a user wishes to use different GNSS systems together in a unique receiver, it is necessary to know the time offsets between the different systems' time scales. The committee is considering defining a new common reference time scale to be used by all the navigation systems. The BIPM is working with the committee to try and avoid the development of another new time scale, instead it proposes using one of the existing scales to enforce interoperability and to avoid a proliferation of time scales.

Dr Tavella recalled that the Time Department held a CBKT course on "Effective participation in Coordinated Universal Time (UTC)" on 13-14 February 2018 with support from METAS (Switzerland). The course was successful and will be repeated as it is considered important for relatively new and small time laboratories to understand how to provide good quality data to the realization of UTC. She concluded by noting that *Circular T* had celebrated its 30th anniversary in March 2018 and that Dr Arias, the former Director of the Time Department, had recently received the European Frequency and Time Forum (EFTF) Marcel Ecabert Award 2018 in recognition of her initiative and leadership in the development and realization of international atomic time.

The President thanked Dr Tavella and invited questions. The likelihood of UTC being adopted as the common reference time scale by the UN International Committee on GNSS was raised. Dr Tavella replied that there is a technical problem in that UTC is not available in real-time: a system is needed that is readily available. In addition, there is a question of responsibility: if a defined system is used for positioning and a problem develops, the responsibility is on the navigation system. If an external organization becomes involved, the question of responsibility becomes more complex. The position being taken by the BIPM at the UN International Committee on GNSS is to explain that the way to proceed is not to rush into the development of a new time scale, because something suitable may already exist and, in addition, developing a real-time time scale would present a serious technical challenge.

The Director added that there are constraints arising from the participation in the UTC system being linked to the rules of the CIPM MRA and hence defining traceability to the SI second via the MRA. The rules for the CIPM MRA exclude some of the major players associated with GNSS systems from participating in it, which is not an ideal situation as they should be included. This merits future discussion by the CIPM. The CCTF President is aware of the situation. Mr Érard, in his role as CCTF President, asked if the major GNSS should be included in the CIPM MRA or not, noting that ESA is a signatory to the MRA. The Director replied that this is a complex issue that creates and an anomaly between Galileo, which is operated by ESA, and the other

GNSS systems. He suggested that ultimately a decision is needed by the CCTF on the possible traceability of GNSS related institutions and time scales.

Dr McLaren suggested that the Time Department could use the move from ground-based aids to air navigation to satellite-based systems as an example of the significant economic impact and importance of the work it is carrying out.

Consultative Committee for Time and Frequency (CCTF)

Mr Énard said that the 21st meeting of the CCTF had been held in June 2017 and had been reported at the last meeting of the CIPM. Its next meeting is scheduled for 2020. Three CCTF Working Groups had met since the last meeting of the CIPM: the CCTF Working Group on Coordination of the Development of Advanced Time and Frequency Transfer Techniques (WGATFT) met during the European Frequency and Time Forum in Torino (Italy) on 11 April 2018; the CCTF Working Group on Two-Way Satellite Time and Frequency Transfer (WGTWSTFT) held its annual meeting at GUM, Warsaw (Poland) on 7-8 June 2018; and the CCL-CCTF Frequency Standards Working group (CCL-CCTF-WGFS) had met at the BIPM on 14 June 2018.

He noted that he had attended the CCL-CCTF-WGFS meeting and that it is working on new secondary realizations of the second and the frequencies used in the *mise en pratique* of the metre on the CCTF side, whilst the CCL side is focused on issues related to the results of the CCL-K11 comparison. The co-chairs, one from the CCTF and one from the CCL, divide the work accordingly. It has been suggested that the CCL-CCTF-WGFS should be divided into two parts to improve the focus on these separate areas; however this idea was rejected by the CCL Working Group on Strategic Planning (CCL-WG-S). Mr Énard said that any future decision to split the CCL-CCTF-WGFS may require discussion by the CIPM.

The CCTF Working Groups have issued four publications since the last meeting of the CIPM. The CCTF Guidelines for Planning, Organizing, Conducting and Reporting Key, Supplementary and Pilot Comparisons, Version 1 were published in May 2018. In addition, Guideline 6: Requirements for participation in the computation of UTC at the BIPM; Guideline 8: Technical requirements for the time laboratories for the participation in UTC; and Guideline 9: CCTF criteria for obtaining traceability in time and frequency have been published. The latter document will need to be readdressed if there is a decision to change the way that the UTC system is operated through the CIPM MRA and its traceability to the SI second via the MRA.

The CCTF Working Group on TAI (CCTF-WGTAI) has reactivated its activities at the request of the CCTF Working Group on Strategic Planning (WGSP); the new Chair will be Dr Gertsolf (NRC). The CCTF-WGTAI is developing terms of reference and a new membership list; it acts as a forum for laboratories that contribute to TAI.

Mr Énard completed his presentation by commenting on the progress made by the CCTF with its actions since its 21st meeting. Work by the WGSP to define milestones for the roadmap for the redefinition of the second, to ensure accessibility and dissemination of the second is ongoing. This activity will take account of the latest results from experiments with optical clocks. The action to update the *mises en pratique* (currently online as Appendix 2 of the SI Brochure) has been completed and they will be reformatted to comply with the new standard template by late 2018/early 2019. The action to discuss and update the CIPM MRA document on ‘Classification of services in Time and Frequency’ by including an additional branch that deals with phase noise measurements is ongoing. Phase noise measurements can qualify the quality of oscillators and the measurements are made using radiofrequency techniques, which are used by the CCEM: joint discussions are under way.

The President thanked Mr Énard and asked if the CCTF had any indication of when the redefinition of the second is likely to happen. He replied that it may be ready for the 28th CGPM meeting, although this depended on five main criteria being met. He mentioned that some of these criteria represent major technological challenges, such as the ability to compare optical clocks on different continents.

Consultative Committee for Length (CCL)

Dr Castelazo said that the CCL had held its 17th meeting on 14-15 June 2018. It had received two applications for observership, GUM (Poland) and NIS (Egypt), which will be discussed in §15. He noted that the CCL has nine discussion groups that are broadly aligned to its key comparisons. The purpose of these discussion groups is to undertake scientific discussion, complementing the working groups that focus on the CIPM MRA. He added that the CCL does not expect to add new key comparisons to its portfolio in the near future, although the area of nanometrology is of growing importance and some pilot studies are under way; a supplementary comparison in nanometrology is being carried out in APMP and this may eventually evolve into a key comparison. He noted that there are 1641 CMC relating to length published in the KCDB.

The CCL strategy document is being revised and was discussed during its meeting. The latest draft will be circulated for final comments and it is expected that it will be published before the 26th CGPM meeting. The *mise en pratique* for the metre has been drafted and formatted to follow the new template. Dr Castelazo noted that there had not previously been a MeP for the metre on the BIPM website; instead there was a list of frequencies. The MeP will include concepts such as ‘time of flight’ and interferometry. He said that the MeP will also include a secondary representation of the metre for nano-dimensional measurements. Recommendation CCL-WG-N 1 (2018) ‘On the entry of the Si (220) lattice parameter into the *mise en pratique*’ recommends that member laboratories of the CCL increase their efforts towards making the Si (220) lattice spacing an available standard for use in providing traceability to the SI metre for dimensional nanometrology applications in the broader sense. The CCL has approved the inclusion of the Si (220) lattice spacing in the MeP for the metre and it will be circulated to the CCL members for comment before it is approved by a decision of the CCL Working Group Chairs and the CCL President.

Dr Castelazo commented that the CCL Working Group on the CIPM MRA (CCL-WG-MRA) has received approval from the CCL for its guideline CCL-D-06 on flexible scope of CMCs “Standards of 1D point-to-point dimensions”. This guideline clarifies the extent of the flexibility and resolves the overlap that exists between ‘conventional’ and ‘flexible’ CMCs. In addition, the CCL-WG-MRA request “on the use of quantity equations in the KCDB” was presented to the meeting of Consultative Committee Presidents in June 2018 and has been accepted. He said that the other outcome of note from the CCL-WG-MRA was that the Terms of Reference of its two sub groups: the sub working group on key comparisons, sWG-KC; and the sub working group on CMCs, sWG-CMC have been modified.

He recalled that a major outcome from the meeting of the CCL-CCTF Frequency Standards Working Group (WGFS) was Recommendation CCL-CCTF-WGFS 1 (2018) ‘on the revision of the 2009 CCL-K11 protocol’. The protocol document will be further developed by the WGFS and the CCL has delegated approval of this document to the WGFS. In addition, the guidance document CCL-GD-08, which is concerned with alternative arrangements for reviewing CMCs in the field of laser frequency will be further developed and finalized by the WGFS for approval by the CCL.

Dr Castelazo concluded by saying that the CCL had mandated him to ask the President of the CCT to request the CCT to issue clear guidance on the issue of temperature scale changes under the revised SI and any potential effects that this may have on length metrology, which uses a reference temperature of 20 °C for dimensional metrology.

The President thanked Dr Castelazo and commented that he had attended the 17th meeting of the CCL meeting and had been very impressed with the technical knowledge of the members and how they had interacted during the meeting. He invited questions and comments. The Director said that the plan to recognise the Si lattice spacing as a secondary representation of the metre for nanometrology will be a historic decision and added that it seems to have been well received within the CCL. The practical guidance on how and when this will be implemented is eagerly awaited. Dr Castelazo added that at present the semiconductor industry requires traceability to half a nanometre, so it is time the CCL is involved. He was asked if Au lattice spacing had been considered as an alternative to Si lattice spacing. It was clarified that although Au lattice spacing may offer a more practical solution, Si lattice spacing offers a better metrological solution.

11. REPORTS FROM THE BIPM PHYSICAL METROLOGY DEPARTMENT, CCEM, CCM AND CCPR

BIPM Physical Metrology Department

Dr Stock presented the changes to the staff of the Physical Metrology Department since the last meeting of the CIPM. A physicist, Dr Moreno, has been recruited to work in the impedance laboratory to replace Mr Fletcher, who left in 2017: he will start work on 1 September 2018. In the mass calibration laboratory, there is one staff member on long-term sick leave and a recently recruited technician will leave at the end of his probationary period on 14 July 2018. The recruitment process for a replacement is ongoing. There are currently three secondees working in the department, with two in the impedance laboratory and one in the voltage laboratory.

Dr Stock gave an overview of the extensive comparison programme in electricity, noting that the BIPM is a member of the support group and a participant in the GULFMET. comparison of Zener voltage standards. In addition, the department is collaborating in a pilot comparison of ac Josephson voltage standards with PTB and NPL within the EMPIR project ACQ-PRO in preparation for a future BIPM comparison. Dr Stock recalled that the CCEM had asked the department to restart the on-site quantum Hall resistance key comparisons (BIPM.EM-K12) in 2010-2011. This comparison programme has been gaining momentum with on-site comparisons at CMI (Czech Republic) and METAS (Switzerland) in 2017 and the NRC (Canada) and NMIJ (Japan) in 2018. An additional five on-site (BIPM.EM-K12) comparisons are planned during 2019-2021 and a further ten NMIs have expressed an interest in participating. Measurements for the CCEM-K4: capacitance, 10 pF and 100 pF (optional) comparison started in March 2017 and were completed in October 2017; the Draft B report is expected soon. This was the first CCEM comparison to be carried out using the “star scheme”. This scheme allows faster completion (less than 12 months) and is more robust against transport problems. In addition to being the pilot laboratory, the BIPM was one of the eight participants in the comparison.

The electricity laboratory is involved in the project to verify one of the foundations of the *mise en pratique* for the ampere: the equation for the quantum hall effect that links the von Klitzing constant, the Planck constant and the elementary charge. To verify that the equation is correct, a calculable capacitor is used as a primary standard for capacitance. The project has been under way for several years, but had stalled due to staffing problems with the development of the calculable capacitor. The project is now under way again thanks to the work of two secondees: Dr Norihiko Sakamoto (NMIJ) is developing an improved wideband impedance bridge and Dr Huang Lu (NIM) is working on improved AC/DC calculable resistors. A total of six resistors will be fabricated; two will be for the BIPM, two for the LNE and two for NIM. The LNE and NIM will pay for the workshop time required to fabricate their resistors.

Dr Stock gave an overview of the proposed measurement scheme for the future on-site comparison of ac Josephson systems. He said that three pilot studies have been undertaken with CENAM (Mexico), PTB (Germany) and NPL (UK). Further studies are needed to investigate the influence of the sampler, to optimize the ac source and to synchronize the ac source and the PJVS. The work is being assisted by a secondee, Dr Mun-Seog Kim (KRISS).

He completed his presentation on the electricity work by noting that a considerable number of calibrations are carried out, in addition to the comparison programme.

Dr Stock subsequently gave an overview of the work in the BIPM mass laboratories. He said that the 1 kg prototype no. 107 was delivered to NPSL (Pakistan) in 2017. One more prototype (no. 112) has been completed but has not yet been attributed: an informal request has however been received for its purchase. Prototypes no. 113 to no. 115 are at various stages of fabrication. Since the last meeting of the CIPM, a Pt-Ir prototype has been calibrated for BKFH (Hungary) and six stainless steel prototypes have been calibrated for LATU (Uruguay), KIM-LIPI (Indonesia), EIM (Greece), HMI (Croatia), DMDM (Serbia) and VSL (the Netherlands). In addition, the BIPM has participated in the EURAMET.M.M-K4 comparison of 1 kg stainless steel mass standards as the link laboratory to CCM.M-K4, which it has piloted.

He recalled the CCM Pilot Study, comparison of future realizations of the kilogram and the subsequent challenges that resulted from the unexpectedly discrepant data, which had been discussed extensively in previous CIPM meetings. For the purposes of the 2017 CODATA Special Fundamental Constants Adjustment, the CODATA TGFC applied an expansion factor of 1.7 to the uncertainties for h . This did not however solve the challenge of how to disseminate a uniform kilogram after the revision of the SI because of the discrepant data from some realization experiments. The situation was discussed by the CCM at its meeting in 2017 and CCM Recommendation G1 (2017) stated that dissemination from the NMIs and the BIPM shall be internationally coordinated based on a consensus value derived from key comparisons of kilogram realizations and the BIPM ensemble of reference mass standards (ERMS). A diagram showing the multiple traceability paths to the kilogram after its redefinition was presented. Dr Stock said that the BIPM will retain an important role after the redefinition of the kilogram: it will ensure the uniform world-wide and stable dissemination of the kilogram; it will contribute to the primary realization of the kilogram via its Kibble balance; it will organize key comparisons of the kilogram; it will provide a stable mass reference; and it will continue to provide mass calibrations. Full details of the maintenance and dissemination of the kilogram after its redefinition have been published in *Metrologia*.²

Dr Stock gave an overview of the ERMS, noting that it is fully operational and the first report on its stability and operation will be made to the CCM in 2019. The standards are traceable to the IPK and had been compared indirectly to the standards of the participants in the pilot study in 2016.

The BIPM Kibble balance has undergone a number of refinements since the start of 2018. The most significant being the installation of a modified suspension with the objective of achieving more accurate and easier alignment, independent of all components. He noted that theoretical modelling of the new coil alignment method found that it agrees with observed behaviour and the stiffness and stability of the mechanical set up have been found to be satisfactory. The verticality of the laser beams in the three interferometers in vacuum has been verified and the PJVS for voltage measurement is in routine use and has been found to work very well. The Kibble balance can now be aligned accurately and the alignment remains stable. Following many years of dedicated work by the Kibble balance team the apparatus can now be operated automatically and a set of preliminary measurements were made from 12 to 18 June 2018: the results agree with those of other experiments with an uncertainty of $1-2 \times 10^{-7}$. The Type B uncertainty remains to be calculated. Further improvements are foreseen to reduce the uncertainty in the 10^{-8} range.

The President thanked Dr Stock for his presentation and invited questions. He was asked when the Kibble balance will be ready for use in comparison campaigns. He replied that this will depend on the detailed comparison protocol, in particular on the required uncertainty. This will be discussed in the near future and the next comparison of primary realizations may be in 2019-2020: the pilot study has already been undertaken and the threshold uncertainty for participation was 2 parts in 10^7 . The BIPM Kibble balance is operating within this range so it is expected that it will be able to participate in the next CCM comparison of primary realizations. Dr Quinn paid tribute to the work of the Kibble balance team and made a special mention of Mr Alain Picard. He also asked if there are plans to develop a cryogenic Kibble balance. Dr Stock replied that future developments may include the development of a simplified “table top” Kibble balance rather than a cryogenic apparatus due to the potential complexity. He added that development of a simplified system for routine use and easier dissemination is in the next Work Programme. It was suggested that the BIPM Kibble balance should be promoted at the 26th CGPM meeting as a primary realization that is operated on behalf of, and for the benefit of, all Member States. The Director commented that this is a useful suggestion and noted that the opportunities for secondees in the Physical Metrology Department are increasing, with three people currently involved in its work. The secondee programme should possibly be extended to cover the Kibble balance in the future to emphasize that it is operated for all Member States. He added that visiting scientists may be particularly interested in the development of a “table top” Kibble balance. The Director congratulated the

²M. Stock, S. Davidson, H. Fang, M. Milton, E. de Mirandés, P. Richard, C. Sutton, Maintaining and disseminating the kilogram following its redefinition. 2017, *Metrologia*, 54, S99.

entire Kibble balance team for their accomplishments and for the excellent results that have been achieved. The President added his own congratulations to the Kibble balance team as well as on behalf of the entire CIPM.

In a final question, the values of the frequencies chosen for the comparison of capacitance were queried and why they were not integers. Dr Stock said that most institutes realize the farad starting with the ohm from the quantum hall resistance using a quadrature bridge. The subsequent mathematics requires the use of the frequencies that were chosen and a decimal value would not be suitable.

Consultative Committee for Electricity and Magnetism (CCEM)

Dr Rietveld began by congratulating the BIPM Physical Metrology Department on its work programme, particularly its comparison programme in electricity. He emphasized that Dr Stock's presentation on electricity comparisons underlines why the BIPM's electricity work is of vital importance to the electricity community. He highlighted the CCEM-K4.2017 comparison, adding that it has proven to be a very efficient comparison. The excellent results also demonstrate the quality of the science being undertaken by the BIPM in the background. The science activities carried out in the BIPM electricity laboratories have helped to rectify the discrepancy in the area of capacitance measurements that existed in the past. Work at the BIPM has pioneered highly-accurate links between the AC quantum Hall effect and capacitance. Over the years this has enabled the BIPM to report stable results that have been disseminated to the NMI community, which has allowed them to sort out similar issues with capacitance measurements that they had been experiencing.

Dr Rietveld commented that the CCEM had held its last meeting in March 2017, the outcomes of which had been presented to the CIPM in October 2017. Since the last meeting of the CIPM the CCEM has been occupied with the active monitoring of its key comparison programme and it has finalized the *mise en pratique* for the definition of the ampere and other electric units in the SI.

He added that the CCEM is pleased to support the CCRI in the joint BIPM-NIST workshop on the future-proofing the SIR by using new electrical current measurement technology, as explained by Dr Judge in §9. This is an excellent example of cooperation between two CCs to tackle a specific measurement challenge with the ultimate goal of improving efficiency.

Dr Rietveld said that the CCEM Working Group on Electrical Methods to Monitor the Stability of the Kilogram (WGKG) and the CCEM Working Group on RMO Coordination (CCEM-WGRMO) will meet during the CPEM conference, to be held in Paris from 8 to 13 July 2018. He commented that work on updating the CCEM strategy is ongoing and will be completed ready for presentation at the next CCEM meeting in March 2019.

He concluded by saying that his aim is to bring science to the forefront of CCEM meetings. A workshop on future challenges had been held in 2017 and it has been agreed that a technical workshop should be held in March 2019 at the next CCEM meeting: the theme has yet to be decided. He added that the revised SI will be on the agenda for the CCEM meeting in March 2019, but the importance of this subject will clearly be less than in past CCEM meetings. The discussion is expected to focus on the next steps, such as easier to use Kibble balances and the world-wide progress with Kibble balance results.

The President thanked Dr Rietveld and invited questions. The Director commented that the joint BIPM-NIST workshop on the future-proofing the SIR had been triggered by discussions between a speaker from NIST and Dr Judge at the workshop on "The quantum revolution in metrology", held at the BIPM on 28-29 September 2017. This is a good example of the value of workshops and how they can bring different communities together and how good discussions can lead to progress.

Consultative Committee for Mass and Related Quantities (CCM)

Dr Richard said that the most recent meeting of the CCM had been held in May 2017 and its outcomes had been reported at the previous meeting of the CIPM. He presented an updated version of the Joint CCM and CCU roadmap for the revision of the SI, which included the promotion campaign, starting on 20 May 2018 and ending on 20 May 2019.

He said that the final version of the “*mise en pratique* for the definition of the kilogram in the SI” had been edited to conform to the common BIPM format and had been approved by the CCM by correspondence. The document will undergo a minor editorial change: in the illustration of the traceability chain from the definition of the kilogram to primary and secondary mass standards, “primary mass standards” will be replaced by “mass standards realized using a primary method”. Dr Richard noted that the final version of the “*CCM short note on the dissemination process after the proposed redefinition of the kilogram*” had been presented to the CIPM at its meeting in October 2017. A revised version, incorporating a few comments by the CIPM, was then submitted to the CCM for approval by correspondence: the CCM made minor comments, which have now been included. An “extended note” is now in preparation.

The newly-created CCM Task Group on the Phases for the Dissemination of the kilogram following redefinition (TGPfD-kg) will hold its first official meeting during the CPEM conference in July 2018. The terms of reference for the TGPfD-kg were presented.

Dr Richard concluded by commenting that following the review of the CIPM MRA, the CCM has drafted two new documents: “*Guidelines for Submission and Review of Calibration and Measurement Capabilities*” and a “*Key Comparison Report Template*”. He thanked Dr Fang for her support as Executive Secretary of the CCM and congratulated the BIPM Kibble balance team for the significant progress that they have made.

The President thanked Dr Richard.

Consultative Committee for Photometry and Radiometry (CCPR)

Dr Rastello said that the last meeting of the CCPR had been held in September 2016. In July 2018 the Chair of the CCPR Working Group on Strategic Planning (WG-SP) will change from Dr Zwinkels (NRC) to Dr Nadal-Laracuente (NIST) and the same time, the Chair of the CCPR Working Group on Key Comparisons (WG-KC) will change from Dr Ohno (NIST) to Dr Dong-Hoon Lee (KRISS). She noted that the Chair of the CCPR Working Group on CMCs (WG-CMC) has been Dr Smid (CMI) since 2017, which gives a good representation of RMOs among the Chairs. She noted that the CCPR Working Groups will meet at the BIPM on 2-4 July 2018 and the 24th meeting of the CCPR is scheduled for 19-20 September 2019.

Dr Rastello commented that the CCPR strategy document is being revised following the recommendations from the Working Group on the Implementation and Operation of the CIPM MRA. The final version is scheduled for completion in July 2018, ready for the Working Group meetings. The summary document on the CCPR strategy will be updated when this is complete. The CCPR has reviewed its policy for participation in sequential CC key comparisons: there is now a limit of 12 participants with equal weight given to representation from among the RMOs. In addition, a guidance document “Supporting evidence for CMCs in PR” has been published on the CCPR webpage. It addresses the issue of ‘how far the light shines’ by clarifying the link between KCs and CMCs.

She commented that the suggestion from the review of the CIPM MRA to develop concise CMCs has been discussed by the CCPR and no clear consensus has yet been reached. The recommendation to adopt a risk-based approach for CMC review procedures will be discussed by a Task Group on the CMC review process (CCPR WG-CMC TG3).

Dr Rastello concluded by saying that guidance is now available on the CCPR website on evidence to support CMCs when they are not covered by a comparison and guidance tools are available for comparisons and

CMCs. A policy on open access to CCPR documents has been implemented, with almost all documents being openly available.

The President thanked Dr Rastello and invited questions and comments. Dr Usuda commented that he was pleased to see the documents on the CCPR webpage being made openly available, as there are documents which may be of interest to other CCs.

12. REPORTS FROM THE BIPM CHEMISTRY DEPARTMENT, CCQM AND JCTLM

BIPM Chemistry Department

Dr Wielgosz began by presenting two brief impact studies for analytes that had been the focus of key comparisons that the Chemistry Department and NMIs were working on, underlining the global importance of the activities. Glycated haemoglobin, C-peptide and glucose are measured to monitor and ensure the health of people with diabetes. There are some 450 million people with diabetes, which represents 8 % of the world's population. This is expected to increase to 10 % over the next 20 years. Consequentially, the diagnostics and therapeutics sectors related to diabetes constitute a substantial industrial sector, where the work carried out by the BIPM addresses the metrological traceability systems used. He also mentioned air quality gases, particularly nitrogen oxides in relation to recent diesel emission scandals. As diesel engines emission regulations became more stringent in Europe, whereby NO_x emissions should have been reduced, traceable air quality measurements showed that NO_x levels were in fact not dropping as expected. Certain automobile manufacturers are now faced with having to make payments of US\$30 billion in compensation. These highlight the importance of metrology and its impact on society and industry.

The Chemistry Department now has 10.5 full time equivalent (FTE) staff and a characteristic of the department is the significant amount of support it receives from visiting scientists on secondment. In 2017 the department hosted 20 visiting scientists, from 14 nations, for periods of three to eighteen months, adding an extra seven to eight FTEs to the department. Fourteen of the 20 visiting scientists were funded by their home institute or external voluntary funds. Dr Wielgosz commented that the visiting scientists had contributed to the development of a very dynamic chemistry programme, which is supported by and involves interaction with many of the Member States.

The Chemistry Department is coordinating six comparisons in gas metrology in the 2016-2019 work programme, all of which are progressing according to schedule. There is a long-term requirement to monitor standards and to mitigate emissions of CO₂ around the world and there are major research programmes being carried out globally to reduce the uncertainty of these measurements. The carbon dioxide in air comparison coordinated by the BIPM, CCQM-K120 (2016), demonstrated greatly improved performance by the NMIs in comparison to results 10 years previously as CCQM-K52 (2006). The uncertainty of the reference value $u(\text{ref})$ was reduced by a factor of 4, with the measurements having been carried out at the BIPM, and the DoE spread was reduced by a factor of 3 from 0.3 $\mu\text{mol/mol}$ to 0.1 $\mu\text{mol/mol}$. The WMO-GAW Data Quality objective is $\pm 0.1 \mu\text{mol/mol}$ for equivalence among its monitoring sites in order to have reliable data that can be put into models for monitoring CO₂ levels. The CCQM-K120 (2016) comparison programme highlighted the difficulties of running a comparison with 46 standards. An alternative approach, being adopted for the BIPM-QM-K2 ongoing comparison for CO₂ in air standards, is to have a primary facility at the BIPM based on a system that measures CO₂ concentration in an absolute sense by measuring pressure/volume ratios. Dr Wielgosz added that the BIPM CO₂ PVT facility had been largely developed in collaboration with a series of secondees from the NMIs.

The department is active in primary standard comparisons for organic compounds, which cover a range of applications in the food and health areas. In 2018, the third year of the 2016-2019 work programme, the folic acid comparison (CCQM-55.d) and the C-peptide comparison (CCQM-K115) were completed. Samples for the

oxytocin purity comparison (CCQM-K115.b) were distributed on 5 June 2018. Among other projects, the department is working on standards for glycosylated haemoglobin in association with HSA (Singapore).

Dr Wielgosz said that the department has published five papers since the last meeting of the CIPM in November 2017 and it has taken its first step into the area of reference data through the publication of the initial qNMR Internal Standard Reference Data (ISRD) document, in this case for maleic acid. This is part of a set of seven ‘universal calibrators’ for qNMR that were developed in association with NMIJ (Japan). The “universal calibrators” are intended to be used as internal standards for measuring organic compound purity using qNMR.

He commented that there is considerable interest in measuring isotope ratios of CO₂, in particular the measurement of not just the total amount of CO₂ but also the ratio of isotopologues. This is of growing importance because the CO₂ from vehicle exhausts, for example, has a different isotopic signature to that emitted from natural sources. It is therefore possible to determine the impact of certain human activities on greenhouse gases by measuring isotope ratios. In addition, new laser-based optical instruments for CO₂ isotope analysis are being developed that can measure individual isotopologue absorptions in the infrared, which require new calibration gases. On this basis, the Chemistry Department has set up a Stable Isotope Reference Mixture Generator (SIRM-GEN) facility in association with the IAEA and the NMIJ, the latter of which has supplied pure CO₂ CRMs. This facility has been supported by secondees from NIM (China), INRIM (Italy) and VNIIM (Russian Federation). A number of NMIs have active R&D projects in this area and ten NMIs that are members of the CCQM GAWG have requested validation samples from the BIPM to help progress their research activities. A comparison of pure CO₂ isotope ratio measurement capabilities will be coordinated by the BIPM in 2020.

Dr Wielgosz said that the CBKT programme in the Chemistry Department has grown significantly since the last meeting of the CIPM, particularly in the “Metrology for Safe Food and Feed” programme focusing on mycotoxin standards and reference materials. He commented that mycotoxin standards are expensive and not easy to source and there is growing interest in the programme. The year 2018 marked the third year of the mycotoxin metrology programme and the NRC (Canada) and CODEX Alimentarius attended the meeting, held on 13 April 2018, for the first time. Eight visiting scientists attended mycotoxin training secondments at the BIPM in 2017, all of which were funded externally, with the PTB (Germany) funding four of the secondees. Dr Wielgosz particularly thanked NIM (China) for supplying a visiting scientist for the mycotoxin programme every year for the last three years. This has enabled the department to develop the methods for use in the training programme before they are disseminated to the NMIs in the countries that have participated in the training. The Chemistry Department participates in workshops to facilitate even wider knowledge transfer. The most recent was the “Workshop on Standards and Methods of Analysis for Mycotoxins” held in Pretoria (South Africa) from 4-8 June 2018. This workshop had 293 participants from 54 countries: a total of 34 African countries were represented. The department will also contribute to the “SIM Mycotoxin Metrology Workshop” to be held at INTI, Buenos Aires (Argentina) from 18-20 September 2018.

In the area of “metrology for clean air” the BIPM continues to pass on knowledge related to the use of FTIR to value assign gas standards and its proprietary software to analyse spectra. This programme started in 2016; in 2017 four visiting scientists participated and in 2018 the department will host an additional six scientists to learn how to use the equipment and software and how to adapt it to their own systems. This programme is not simply aimed at NMIs from developing economies; the expertise developed at the BIPM is a speciality that is of use to any NMI that wishes to use FTIR for the value-assignment of gas standards. Dr Wielgosz thanked the NPL (UK) for the financial support that has allowed the BIPM to host visiting scientists and to provide them with standards that can be taken back to their home institutes to validate their systems.

The President thanked Dr Wielgosz and invited questions and comments. Dr Laiz congratulated Dr Wielgosz and the BIPM on its strategy for disseminating its work on mycotoxins. He said that it is particularly useful for Argentina, which is a major producer of cereals, as well as for the other SIM countries. He commented that

this demonstrates the unique work of the BIPM in disseminating its knowledge. Dr Wielgosz commented that the BIPM has been pleased to see how, what started out as a small project, has developed through dissemination to a wide area, through working with the NMIs and RMOs. Dr Louw commented that the IAEA had sponsored 80 to 90 attendees to participate in the Workshop on Standards and Methods of Analysis for Mycotoxins, which demonstrated good collaboration between the chemistry and ionizing radiation departments at the NMISA. Dr Wielgosz commented that this was a good example of how the BIPM acts as a catalyst to initiate projects in areas such as mycotoxin metrology and then NMIs and regions have the necessary contacts to find additional sources of funding for capacity building. Dr McLaren said that NMIs with small but growing capabilities in the chemistry area can learn from the BIPM Chemistry Department that it is possible for a relatively small group to have a global impact if the objectives are clear and the focus remains tight.

It was asked if there is any way to monitor the performance of visiting scientists when they return to their home institutes to ensure that the capacity building and knowledge transfer process is successful. Dr Wielgosz said that training is always followed by a comparison; therefore the home institute is tested, rather than the person, ensuring that the knowledge has been passed on successfully. The Director added that the same applies to all of CBKT courses: the success of the “Effective participation in Coordinated Universal Time (UTC)” course for example will be monitored by determining whether there is an improvement in the data submitted the laboratories that attended. This type of metric is very important to show sponsors that there has been a positive impact. Dr Duan commented that NIM has benefitted from the Metrology for Safe Food and Feed programme and has set up a food safety laboratory. It was stated that the BIPM Chemistry Department’s CBKT programme has benefitted both the NMI community and the sponsors. The positive impact of the CBKT programme should be recorded as it reflects global cooperation between the NMIs and it also creates an impact in meeting the needs of many countries that are experiencing particular difficulties in the food safety area. The President summed up by congratulating Dr Wielgosz and the Chemistry Department and encouraged them to continue with their efforts. Dr Wielgosz added that for the Metrology for Safe Food and Feed programme there is an annual stakeholders meeting and at the end of the four-year programme, a document will be produced to capture the impact, which will include feedback from the countries. It is hoped that this will be used as a model for similar programmes in the future.

Consultative Committee for Amount of Substance: Metrology in Chemistry and Biology (CCQM)

Dr Wielgosz gave the presentation on behalf of Dr May. He said that the 24th meeting of the CCQM had been held in April 2018 and gave a brief overview of the current organizational structure of the committee. He commented that the current CCQM President, Dr May, will be stepping down at the 25th meeting in April 2019, and will co-Chair the meeting with the incoming President and to hand over his responsibilities.

The CCQM Strategy Document (2017-2026) has been revised and was published on 17 January 2018. The strategy was reconfigured to take account of the objectives published in Decision CIPM/106-16. The new objectives allowed the CCQM to include work under the new headings of: progressing the state of the art for chemical and biological measurement science; reaching out to new and established stakeholders; and demonstrating the global comparability of chemical and biological measurement standards. The strategy document also includes an annex of impact studies of CCQM comparisons carried out during 2012-2016.

Dr Wielgosz commented that the CCQM Working Groups have been very active in organizing workshops over the last 4 years. These workshops contribute towards progressing the state of the art for chemical and biological measurement science through acting as a forum for exchange of information on technical activities. In addition, research and development activities in the NMIs are stimulated by the CCQM comparison programme, as is evidenced by the publication of 25 papers related to 21 CCQM comparisons over the last 4 years. For example BIPM.QM-K1 (Ozone), resulted in publications in *Atmospheric Measurement*

Techniques [2], 2015 and *Analytical Chemistry* [3], 2016, providing new measurements of ozone absorption cross sections in the UV by independent methods and with the smallest reported uncertainties to date for accurate measurements of ozone in the atmosphere.

A CCQM workshop on advances in metrology in chemistry and biology will be held on 10 April 2019. The outcomes of the workshop will be published in a special edition of *Metrologia*. It is hoped that this special edition will provide a good range of papers that will summarize the ongoing research work in the NMIs related to progressing the state of the art in metrology in chemistry and biology.

Dr Wielgosz said that there is an ongoing programme to plan and monitor CCQM comparisons. In the new strategy (2017-2026), 12 new key comparisons are expected to be organized each year with four or five pilot studies: this represents a 20-25 % reduction compared to the 2013-2023 strategy. The CCQM is therefore underpinning more measurement capabilities with fewer comparisons due to the strategy of pursuing core comparisons.

The CCQM *ad hoc* Working Group on the mole has liaised closely with the International Union of Pure and Applied Chemistry (IUPAC) to successfully develop a new definition of the mole, following a wide consultation process. The CCQM now has the full support of IUPAC for the redefinition of the mole and the revised wording.

Dr Wielgosz said that the CCQM has proposed the establishment of a Working Group on Isotope Ratio Measurement and presented the proposed terms of reference. He commented that there is strong support from the NMI community, for the setting up of the working group, as was confirmed by the results of a questionnaire that was sent to 25 NMIs/DIs that are active in the area. Dr Wielgosz added that there is only one traceability exception in the CIPM MRA and it relates to isotope ratios. This is a consequence of the fact that it is easier to measure changes in isotope ratios than absolute isotope ratios. He asked the CIPM for approval of the CCQM decision to establish the CCQM Working Group on Isotope Ratio Measurement. There was a brief discussion and approval was granted.

Decision CIPM/107-10 The CIPM approved the proposal of the CCQM to establish a CCQM Working Group on Isotope Ratio Measurement.

The April 2018 meeting of the CCQM was attended by observers from GULFMET for the first time, where they gave a presentation on activities in metrology in chemistry in the region. Dr Wielgosz commented that chemical metrology is currently a minor area within GULFMET, with only NMCC (Saudi Arabia) having any activities in the field. It is however seen as a major growth area and requests have been received from GULFMET for capacity building assistance in chemical metrology.

Dr Wielgosz concluded by saying that there is doubt about whether the European Commission Joint Research Centre [JRC] (formerly the IRMM and one of the six organizations in liaison with the CCQM) will continue to participate in the CIPM MRA. The JRC has withdrawn from EURAMET, which means that it no longer has an automatic system to review its CMCs. As a result, its CMCs will be “greyed-out” in the KCDB. This has an impact as the JRC is the world’s second largest producer of certified reference materials (CRMs). The CCQM is trying to determine whether or not the JRC intends to continue to participate in the CIPM MRA or if it intends to continue to make CRMs but outside the CIPM MRA process. There are challenges associated with how to manage these different scenarios and there is an action on the CCQM President to write to the JRC to request clarification on their future involvement in CCQM and CIPM MRA activities.

The President thanked Dr Wielgosz and invited questions and comments. The President asked about the background to the withdrawal of the JRC from EURAMET and its future participation in the CIPM MRA. The Director replied that it resulted from a high-level change of policy within the European Commission.

Dr Wielgosz added that, at the moment, the best course of action is to request clarification on their future involvement.

Joint Committee for Traceability in Laboratory Medicine (JCTLM)

Dr Wielgosz gave an overview of the work and membership of the JCTLM. He commented that four new national and regional members have been approved: the Canadian Society of Clinical Chemists/*Société Canadienne de Clinico-Chimistes* (CSCC/SCCC); All Russian Scientific Research Institute for Metrological Service, (VNIIMS); All Russian Scientific Research Institute for Optical and Physical Measurements, Rosstandart (VNIIOFI); and D.I. Mendeleev Institute for Metrology (VNIIM). In addition 14 new stakeholder member organizations have been approved since the last meeting of the CIPM. He commented that these organizations include IVD manufacturers and EQA scheme organizers.

The JCTLM is investigating ways to expand its Executive Member organizations. At the moment the Executive Committee Member Organizations are the BIPM, IFCC and ILAC. The laboratory medicine sector consists of many different disciplines and the aim is to incorporate more of these into the JCTLM. One such organization is the International Council for Standardization in Haematology (ICSH), which developed the methods and tools used by industry to standardize measurements in haematological procedures, such as cell counting. The JCTLM is involved in discussions with the ICSH to nominate its methods and materials for inclusion in the JCTLM database.

Dr Wielgosz said that the NMIs are heavily involved in the JCTLM. Of the 296 CRMs listed in the JCTLM database, 95 % are listed from NMIs and DIs and of the 12 producers of CRMs, 11 are NMIs or DIs. The database also contains 194 reference methods and 176 reference measurement services. So far in 2018, 132 nominations have been received for the database, consisting of: 96 materials; 12 methods; and 24 services.

The JCTLM held its biennial members and stakeholders meeting on 4-5 December 2017 at the BIPM. The meeting included the “Accurate results for patient care workshop 2017” and attracted 117 participants from 27 countries. The attendees included medical researchers, NMI and EQAS representatives and laboratory medicine specialists.

He concluded by saying that the Protein and Peptide Therapeutics and Diagnostics Workshop (PPTD-2018) in Chengdu (China) on 10-12 October 2018 is being organized jointly by the NIM (China), the National Institute of Food and Drugs Control (China) and the BIPM and under the auspices of the JCTLM. The workshop is expected to have 800-1000 participants and will focus on standardization related to diagnostics and therapeutics in the protein area. The 12th International Scientific Meeting of the Centre of Metrological Traceability in Laboratory Medicine (CIRME) Milan (Italy) on 29 November 2018, is also to be organized under the auspices of the JCTLM.

The President thanked Dr Wielgosz.

Dr Fang, Dr Panfilo, Dr Picard, Dr Viallon and Dr Wielgosz left the meeting, which was joined by Dr de Mirandés.

13. REPORT FROM THE CCU

Prof. Ullrich reported on the activities of the CCU since October 2017 and noted that it had not met during this period. The next meeting of the CCU will be held on 8-9 October 2019. The CCU Working Group on Strategy (CCU-WG-S) held its first meeting in January 2018 where its Terms of Reference were drafted. The Working Group has produced the first draft of its strategy for 2019-2030: the final draft will be submitted to the CCU for approval in 2019.

Prof. Ullrich said that an outcome of the CCU-WG-S meeting was that the committee had noted the significant number of changes had been made between the 8th edition of the SI Brochure and the 9th edition and it had proposed that a short document should be produced detailing the changes. He said that he would raise the issue of whether or not such a document was needed with the CIPM. He added that the final draft of the 9th edition of the SI Brochure is available on the BIPM website for comment and that the French translation is under way. One particular point that arose from the comments was a recommendation in the SI brochure that “*for numbers with many digits, the digits may be divided into groups of three by a thin space, in order to facilitate reading.*” He commented that this recommendation had not been followed in the SI Brochure so the editing team had suggested that a “space” be used to divide groups of three digits rather than a “thin space”.

He said that Appendix 1 “Decisions of the CGPM and the CIPM” of the 9th edition of the SI Brochure has been updated to include, among other things, recent CIPM Recommendations and Decisions, and recent CGPM decisions, including those planned for the 26th CGPM meeting. This appendix is still to be translated into French. The final draft of Appendix 3 “Units for photochemical and photobiological quantities”, which was prepared by the CCPR, has been published on the BIPM website and its translation into French, in collaboration with the CCPR, is pending. The Concise Summary of the 9th edition of the SI Brochure is complete and has been translated. Prof. Ullrich thanked the editing team for its work on the 9th edition of the SI Brochure and paused for comments and questions. There was a brief discussion on whether or not a document should be drafted to detail the changes between the 8th and 9th editions of the SI Brochure. There was general agreement that this was not necessary as users should refer to the new edition after it is published.

The BIPM Director asked Prof. Ullrich about the formalities of the relationship between the CCU and the CODATA Task Group on Fundamental Constants (TGFC), acknowledging that there is a close and essential cooperation between the two groups; at present, the TGFC is simply invited to CCU meetings. The Director noted that liaisons are invited to CGPM meetings; however the link between the CCU and the TGFC is not on a formal basis. He suggested that he would discuss the matter with the BIPM Legal Advisor to explore options to formalize the BIPM liaison with the CODATA TGFC. The following decision was agreed.

Decision CIPM/107-11 The CIPM asked the BIPM Director and Legal Advisor to explore options to formalize the BIPM liaison with the CODATA Task Group on Fundamental Constants.

The CIPM President gave a brief summary of a discrepancy relating to the definition of the term “unit” between the draft 9th edition of the SI Brochure and the 8th edition that had been brought to the attention of the CIPM. He recalled that the CIPM had approved the 9th edition at its meeting in October 2017. The essence of the change being proposed is to define a unit as a “quantity value”, rather than as a “quantity”. All three editions of the VIM, as well as the current 8th edition of the SI Brochure, define unit as a “quantity”. He further recalled that the due processes had been followed in the CCU and that the CCU President had consulted widely on the issue.

A letter had subsequently been received from the Convenor of JCGM WG2 (VIM) conveying a message from the WG2 members present at its meeting held in May 2017 concerning the new definition of ‘unit’ being proposed in the ISO/DIS ISO 80000-1:2017, and in the current draft 9th edition of the SI Brochure. The letter stated that “no rationale seems to have been provided by ISO or the developers of the current Draft 9th edition of the SI Brochure for making such a radical change to the definition of ‘unit of measurement’”. The WG2 members believe that a rationale should be provided and openly debated before proposing such a change in any official document. The nine WG2 members present at its May 2017 meeting unanimously expressed their

disagreement with the change being proposed. In addition a communication has been received from ISO/TC12, which had held a ballot on 17 June 2018 to vote on Resolution 112 (WebEx 1/2018) – Definition of unit, ISO/FDIS 80000-1:2018, 3.9 “*The ISO/TC 12 members attending the meeting resolve that “Units” are “Quantities”, as defined in the ISO/IEC Guide 99 (VIM), and not “Quantity values”, as defined in the current draft of ISO/FDIS 80000-1:2018. Accordingly, the definition of Unit in ISO/FDIS 80000-1:2018, 3.9, will be changed before proceeding to FDIS ballot. This change has to be consistently reflected in the entire document, as needed.*” Twelve members of ISO/TC12 agreed with the resolution, one disagreed and four abstained. ISO/TC12 felt that there had not been adequate discussion and requested that publication of the 9th edition should be postponed until after the issue has been discussed more widely. The CIPM President added that Dr May and Dr Sené had indicated to him that they would prefer to retain the existing definition. He commented that after reviewing the literature, he could see no reason to change the definition.

Prof. Ullrich gave a detailed explanation of the scientific background to the change to the definition of the term “unit” and the rationale for making the change. He pointed out and demonstrated that for the revised SI, the definition of the “unit” as a value of a quantity is fundamental and not just about “terminology” or “vocabulary” for which the JCGM WG2 has responsibility. Taking the example of fixing the numerical value of the speed of light by the equation $c = 299\,792\,458$ m/s in order to define the unit 1 m in the revised SI he showed that it is essential that it is allowed to rearrange this equation, meaning that it is an identity and not a defining equation. From this it clearly follows that the unit is a specific value of a quantity. He explained that these arguments have been openly exchanged with all Members and Guests of the CCU in October 2016 and he pointed out that no official comment against such a change had been received.

He further elucidated that there is a distinct divergence in the VIM between the English and French versions in the definition of a unit. In particular, the term “quantity” should be translated using the French “quantite” and not “grandeur” as in the VIM, the latter of which can have two meanings. He further showed that the VIM definition of a unit as a “real scalar quantity”, itself being a “property” (according to the VIM English version) results in meaningless sentences when inserted. Prof. Ullrich supported his scientific arguments with references to the works of Louis Couturat, James Clark Maxwell, Hermann von Helmholtz, Bertrand Russel and Jan de Boer. The latter stated that “*In the past and even today many scientists use the name ‘unit’ for what now should properly be called a ‘standard’ for a unit. A standard for the unit of a particular quantity is realized by a real physical system for which the numerical value of the quantity concerned is equal to 1.*”³

He also presented the procedure and timeline that had been followed for drafting the 9th edition of the SI Brochure. He commented that the above rationale had been discussed thoroughly within the CCU Drafting team and that this discussion was openly shared with all members and guests of the CCU in October 2016. A written summary of the rationale for the definition in the 9th Brochure developed during that discussion was placed on the restricted CCU website. During this process, no official concerns of any member organization of the CCU had been raised about the discrepancy relating to the definition of the term “unit” between the draft 9th edition of the SI Brochure and the 8th edition. There are now two documents: the draft 9th edition of the SI Brochure and the ISO/DIS ISO 80000 document, which had been approved on the basis of what had been decided by the CIPM. Prof. Ullrich suggested that the 9th edition of the SI Brochure should not be changed at the last minute, particularly considering that an open and transparent procedure had been followed during the drafting process. He concluded by commenting that making changes now is not in the spirit of transparency and is being made at the request of the Convenor of JCGM WG2, who had been represented during the consultation process and, as such, had had the opportunity to comment.

The President thanked Prof. Ullrich and asked the CIPM for comments. There was a comprehensive discussion with views divided between using the wording in the draft 9th edition of the SI Brochure and retaining that

³ De Boer J. On the History of Quantity Calculus and the International System, *Metrologia*, 1995, **31**, 405

used in the 8th edition. It was proposed that the change should be deferred until after there has been a further broad-based discussion. Concerns were raised that if the wording of the draft 9th edition is retained, the document will not be in line with the ISO documents and differences should be avoided at this level. The Director said that the ramifications of the proposed change to define a unit as a quantity value, rather than as a quantity in the 9th edition of the SI Brochure, had not been fully understood when the draft had been produced and reviewed. It is therefore difficult to decide on this issue without further technical discussion. It was suggested that the technical expertise required to come to an authoritative decision is maintained within the CCU and not the CIPM, and this is where further discussions should be held. The CCU could then advise the CIPM of its decision. There was some support for the opinion expressed by Prof. Ullrich that the consultation process for the draft of the 9th edition of the SI Brochure had been open for many months and that making changes at this late stage may be detrimental and could be considered as being non-transparent. It was however felt that any changes in response to the requests by ISO and JCGM WG2 should be thoroughly discussed by the CCU, as the opinions of these organizations cannot be ignored. Prof. Ullrich proposed the establishment of a Task Group to review the issue in order to come to a scientific decision, in addition to consulting the CCU.

It was proposed to Prof. Ullrich that the matter could be dealt with by a vote by correspondence among the CCU members to decide whether to retain the wording of the draft 9th edition or to revert to the wording of the 8th edition. The President said that such a vote among the members of the CCU would be beneficial as it would allow him to go back to ISO and JCGM WG2 with a definitive decision. The Secretary added that although the CIPM respects the work that has been done by the CCU, the discrepancy relating to the term “unit”, that has been brought to the attention of the CIPM, needs to be resolved. He added that to put the issue in context, it is only one small part of the 9th edition. Prof. Ullrich replied that even though being “only one small part” it is a fundamentally important part. The timetable for publishing the 9th edition of the SI Brochure was queried. The Director said that the 26th CGPM meeting will ask the CIPM to update the SI Brochure in draft Resolution A; it does not therefore need to be published until after the meeting. Prof. Ullrich asked for a mandate for the CCU to carry out a deeper investigation into the issue, independent to the outcome of the vote, to ensure its position with regard to the VIM is clearer, particularly over areas such as units, quantity, measurement, traceability etc. This suggestion was supported, particularly the need for a more thorough discussion, as it could avoid problems with future revisions of the SI Brochure. At the end of the discussion, the CIPM came to the following decisions.

Decision CIPM/107-12 It was brought to the attention of the CIPM that there is a discrepancy relating to the definition of the term “unit” between the draft 9th edition of the SI Brochure and the 8th edition. The CIPM asked the CCU President to organize a vote by correspondence among the CCU members, with a deadline of the end of August 2018, as to whether to retain the wording of the draft 9th edition or to revert to the wording of the 8th edition, and to report back to the CIPM President for further action (if necessary).

Decision CIPM/107-13 The CIPM agreed with the proposal from the CCU President to establish a Task Group to review further the issue concerning the definition of the term “unit” in the SI Brochure

14. REPORT FROM THE TASK GROUP FOR THE PROMOTION OF THE SI

Dr de Mirandés, Secretary of the Task Group, reported that it had held its most recent meeting on 18 January 2018. A significant amount of work has been carried out to prepare for the promotion campaign for the revised SI, which will run from 20 May 2018 to 20 May 2019. This work has included the publication of an updated version of the SI Brand Book in April 2018 and the production of a new press pack for the NMIs, which includes FAQs, facts and figures. The press pack was updated in May 2018 and was sent to NMIs ready for the launch of the campaign. The NMIs have developed and shared promotional materials, which are available on

the dedicated page of the BIPM website, and the RMOs and NMIs have organized many promotional workshops. In addition, the joint CC statement has been translated into French, Spanish and German and distributed within NMIs, the trailer for the NIST-sponsored film “The last artifact” has been released and the SI logo is now being used widely around the world. Dr de Mirandés added that the Task Group has produced “speaking notes” and key messages to address questions relating to the revised SI.

Two decisions by the Task Group were presented to the CIPM for consideration:

- The Task Group recommends to the CIPM that they encourage RMOs to designate liaisons/communications officers to enhance the extent of the promotion of the SI.
- The Task Group recommends to the CIPM to consider the possibility that RMOs carry out coordinated posters/exhibits during the 26th CGPM meeting in the space adjacent to the conference room.

Dr de Mirandés concluded by saying that the next meeting of the Task Group will be held in January 2019 and its aim will be how to close the campaign. The President thanked Dr de Mirandés and commented that the two decisions had been noted. He asked for comments and questions. It was asked if the Task Group should be sent links to articles relating to the revised SI that appear in the world’s press. Dr de Mirandés confirmed that this would be useful as there is a page on the dedicated website for links. The Director added that Mrs Fiona Auty (NPL and rapporteur for the PR Expert Group) will spend 2 or 3 days each month at the BIPM during the campaign to work on the press coverage, including collecting articles in the press and sharing these among the NMIs.

The meeting was joined by Mr Henson and Mr Kuanbayev. Dr de Mirandés left.

15. SUMMARY OF APPLICATIONS FOR MEMBERSHIP AND OBSERVERSHIP OF THE CCs

Applications for membership and observership of the CCs were discussed, with the following outcomes.

Decision CIPM/107-17 The CIPM accepted the proposal that GUM (Poland) and NIS (Egypt) should become observers at the CCL.

16. REVISION OF CIPM-D-01

The Director said that three decisions relating to the revision of document CIPM-D-01 “Rules of procedure for the Consultative Committees (CCs), CC working groups and CC workshops” had been drafted and discussed at the meeting of NMI Directors on 20 June 2018. These decisions required formal approval by the CIPM. The decisions were read out and were approved following a brief discussion.

Decision CIPM/107-14 The CIPM confirmed the working practice of inviting the Chairs of relevant Regional Technical Committees to the plenary sessions of the relevant Consultative Committees. The CIPM decided that when any Chair is not from a Member or Observer organization of the relevant Consultative Committee then he/she will be formally invited to participate as a guest of the President of the Consultative Committee.

Decision CIPM/107-15 The CIPM decided to adopt the following definition of consensus (which originates from the ISO/IEC Directives) for use in the Consultative Committees, Sub-committees and ad hoc Working Groups:

Consensus - "General agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments. Consensus need not imply unanimity."

Document CIPM-D-01 will be updated accordingly.

Decision CIPM/107-16 The CIPM agreed the revised version of CIPM-D-01.

17. REPORT FROM THE BIPM INTERNATIONAL LIAISON AND COMMUNICATION DEPARTMENT

Mr Henson presented the staff in the department, noting the contributions of two secondees that are currently working in the department. Dr Sally Bruce (NIST) is on a 3-month secondment (until 6 July 2018) to work on the next generation of CIPM MRA documentation. This task has involved an initial clean-up of the existing documents and executing a JCRB action to deal with the transition arrangement and developing with the department a structure for the documents that will enable the post CIPM MRA review practices to be effectively implemented. It was noted that the CIPM has encouraged the ILC Department to continue with the preparatory work for the documentation as well as the other aspects for the implementation phase (See §23). Ms Juan Cai (NIM) is on secondment for one year (until 25 March 2019) to help with preparations for the 26th CGPM meeting and to take the lead on a BIPM/Organisation for Economic Co-operation and Development (OECD) study, which will describe the BIPM and the routes to impact for metrology, including the CIPM MRA. The study is scheduled to be published as an OECD document in 2019.

Mr Henson said that there are more than 30 organizations in liaison with the BIPM that have extensive interactions and another ten organizations in liaison via informal interactions. He added that liaisons can be divided into: Quality Infrastructure (QI) liaisons including the 'first tier' liaisons (OIML, ISO and ILAC) as well as the other International Network for Quality Infrastructure (INetQI) members, the World Trade Organization (WTO) and the World Bank; "door opening" liaisons for specific topics or via *ad hoc* liaisons, for example with the European Aviation Safety Agency (EASA) and the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO); and long-term, measurement related topic-based liaisons, for example with the World Meteorological Organization (WMO) and World Health Organization (WHO). He noted that International Network for Quality Infrastructure (INetQI) is the new name for the former DCMAS Network: its terms of reference are being broadened so that its work is not limited to developing countries. It is anticipated that the World Bank and the WTO will become partners in the INetQI: the World Bank had previously participated in the joint definition of quality infrastructure (QI) adopted by all members in 2017.

He recalled that in 2015 the CIPM had adopted a position paper that identified three key principles that formed the major components of the CIPM position on the revision of ISO/IEC 17025:2005. (See Session I of the 104th meeting of the CIPM, §17) The position paper included an additional three points to ensure consistency with existing CIPM policy and guidance. ISO/IEC 17025:2017 has now been published and he was pleased to report that all of these objectives have been met. This position paper highlighted that some liaisons and issues require a clear position from the CIPM due to their importance to the BIPM and the wider metrology community.

Mr Henson presented the key outcomes of the ILC Department's cooperation activities with liaisons between October 2017 and June 2018. Contributions towards the revision of the D1 agreement with the OIML Advisory Group on CEEMS and the development of the "World Bank QI Toolkit" are ongoing. The department has been contributing to the "UNIDO Guiding principles for Quality Policy Development" document, which will be launched in June 2018. Collaboration with the EASA has resulted in the revision of the "EASA Handbook" allowing recognition of CMCs under the CIPM MRA, and thus as a basis of accepting NMI/DI calibrations at aircraft repair shops world-wide. The handbook is in the final stages prior to publication.

ILC Department staff members participated in: the IAF/ILAC Joint Annual Meetings in October 2017 and in the Joint IAF-ILAC mid-term meeting in April 2018; the WTO TBT Committee meetings held in November 2017, March and June 2018 and delivery of BIPM statements at the WTO TBT Committee; RMO General Assemblies and associated meetings; and the Annual meeting and Working Group sessions within the OECD "IO Partnership for effective rulemaking" held at the UN Headquarters in Geneva. ILC Department staff also participated in and delivered a presentation on the capacity building experience at the "Technical Assistance" session of the "WTO Advanced Thematic Course on the TBT Agreement" in March 2018. Mr Henson mentioned that the Departments CBKT activities would be reported separately.

Mr Henson thanked METAS for designing the World Metrology Day poster for 2018, which had been well received. The poster had the title "Constant evolution" and has been translated into 17 languages. The design for the 2019 World Metrology Day poster is under way in partnership with the APMP. The APMP solicited designs for the poster via a competition and four designs have been received so far. The winning design will be selected by a vote within APMP. Both ISO and ILAC published feature articles on World Metrology Day 2018 on their websites, highlighting the deepening relationship within the global quality infrastructure. He paused for comments.

It was noted that the CIPM position paper on the revision of ISO/IEC 17025 had been appreciated by the CIPM, as it had made it clear what the ILC Department's plan was for the discussions as well as its objectives for the revision. Mr Henson commented that the mandate received from the CIPM in the form of the position paper had been used successfully during discussions in the ISO CASCO Working Group 44 on the revision of ISO/IEC 17025, particularly the difficult but successful campaign to avoid calibration being classed as a "conformity assessment activity" *per se*. He added that the BIPM's strong relationship with ISO also helped during the discussions in the ISO Working Group.

Dr Louw said that a considerable amount of QI material has been developed in Africa by the four partners in the Pan-African Quality Infrastructure (PAQI) initiative, in association with NMIs, particularly the PTB. He suggested that this QI material could be made available to the BIPM. Mr Henson thanked Dr Louw and said that the PAQI initiative has been a good conduit that has allowed the BIPM to access an audience that would not normally be accessible to the metrology community. Prof. Ullrich said that the PAQI initiative is a significant achievement and will be a great benefit to metrology in Africa. Dr Liew added that the PAQI initiative has prompted talks between the metrology expert group of ten nations in South-East Asia and the legal metrology group (ACCSQ) to form a South-East Asia Quality Infrastructure discussion group. The President welcomed the reinvigoration of the DCMAS Network and its renaming as the INetQI.

Mr Henson continued his presentation by giving an overview of the BIPM Capacity Building and Knowledge Transfer (CBKT) Programme and recalled that the aim of the programme is to increase the effectiveness by which Member States and Associates engage in the world-wide coordinated metrological system. So far, eleven CBKT initiatives have been completed, four are ongoing and five are planned. A total of 255 participants (124 at the BIPM) from 76 countries have participated in CBKT training courses as of June 2018. CBKT initiatives carried out in 2018 have been: "Effective participation in Universal Coordinated Time

(UTC)”; the BIPM–COOMET “Sound beginning in the CIPM MRA” Workshop; BIPM-TÜBİTAK UME project placements; and “Train the trainer”: transitioning to ISO/IEC 17025:2017 in the CIPM MRA. The four ongoing initiatives are the 2016-2019 “Metrology for safe food and feed project”; the 2016-2019 “Metrology for clean air project”; the 2017-2018 support for the GULFMET key comparison of Zener voltage standards; and the 2019 BIPM-TÜBİTAK UME project placements. Two of the five planned initiatives have been confirmed: 2018 AFRIMETS–COOMET “Sound beginning in the CIPM MRA” Workshop; and the 2019 BIPM–COOMET TC Workshop. Mr Henson noted that the BIPM has an arrangement for low-cost accommodation for attendees at course-based initiatives at the *Centre international d'études pédagogiques* (CIEP) in Sèvres. This arrangement has made it possible for the BIPM to run cost-effective courses.

A brief overview of the selection process for CBKT initiatives was presented. He reminded the CIPM that the CBKT activities are sponsor funded, and thanked the sponsors. Mr Henson displayed the geographic spread of lecturers that have been involved in the courses so far, and noted that 56 invited lecturers from 27 countries have contributed to the training courses. Lecturers are often self-funded, limiting the cost and thus allowing more participants to be supported. He said that all participants on CBKT courses are invited to provide feedback, and for the longer courses, a full report is requested. Three Associates: Namibia, Zambia and Zimbabwe had made no progress on developing CMCs despite being Associates for some years. After attending the 2017 “Sound beginning in the CIPM MRA” course all three Associates have now submitted CMCs into the review system, providing an indicator of the success of the programme.

He recalled that Resolution 4 of the 25th CGPM (2014) encouraged external voluntary in-kind and cash support to allow participation in the activities of the BIPM, but the resolution did not explicitly give the BIPM a mandate to run CBKT activities. Draft Resolution C to the 26th CGPM meeting aims to address this omission by including the following text: (from the BIPM Objectives adopted by the CIPM): *[confirms] that fulfilling the BIPM mission and objectives is complemented by its work in: capacity building, which aims to achieve a global balance between the metrology capabilities in Member States; knowledge transfer, which ensures that the work of the BIPM has the greatest impact.* Mr Henson added that the JCRB has been supportive of the CBKT programme and passed a resolution (JCRB Resolution 39/1) to this effect, as had a number of the RMOs at their General Assemblies.

Mr Henson concluded by giving an overview of the approach being adopted for the 2020-2023 work programme. Feedback had confirmed that the world-wide metrology community believe that the training associated with running the CIPM MRA effectively and efficiently was sufficiently important that it should become a formal part of the work programme, and thus not have to rely on securing sponsors. Therefore, in the work programme proposal these CBKT activities would be included in a ‘core’ funded element, with the topic based activities continuing on a sponsor-based approach.

He thanked the key sponsors again for their support, Mr Kuanbayev for his hard work in organizing the initiatives, the laboratory staff and the BIPM Meetings Office for their support in the running of the courses. The President congratulated Mr Henson and his team for its outstanding and impressive work programme and encouraged him to continue the initiative. He also acknowledged the work carried out in the scientific departments towards running their CBKT programmes.

THE 106TH MEETING OF THE CIPM – THIRD DAY – 22 JUNE 2018

The President welcomed the CIPM to the third day of its meeting.

18. REVIEW OF THE DRAFT BIPM WORK PROGRAMME (2020-2023) AND COMMENTS RECEIVED

The Director gave a brief presentation on the draft Work Programme (2020-2023) and displayed the timetable that had been agreed for its development in October 2016. He noted that all the deadlines had been met so far and the sets of comments received from METAS and NMIJ have been actioned. These changes, along with a few changes suggested internally, require the approval of the CIPM; the document will then be republished to the BIPM website for further comment. It is expected that a “near-final version” of the Work Programme will be available on the website in September 2018.

The changes to the document were displayed. The President asked the CIPM if there were any comments on the proposed changes. There were none and the following decision was approved with a note to reconcile the scope of the activities with the long-term financial plans for the BIPM and the expected level of the dotation.

Decision CIPM/107-18 The CIPM endorsed the draft Work Programme (2020-2023) presented by the BIPM Director and Department Directors, and asked them to reconcile the scope of the activities with the long-term financial plans for the BIPM and the expected level of the dotation.

19. DEVELOPMENT OF A LONG-TERM FINANCIAL PLAN FOR THE BIPM

The Director recalled that the 25th meeting of the CGPM had agreed no increase in the dotation for 2016-2019. During the period 2016-2019 the BIPM achieved a 6 % reduction in costs and the financial performance has been better than predicted at the 25th CGPM meeting, albeit with a slight increase in costs in 2017.

The current long-term financial plan is for the period 2020-2023. Modelling of the finances for the remainder of the current Work Programme and the next Work Programmes has been carried out considering a balance of staff costs that only includes necessary replacement of retiring staff and taking account of pension costs. Modelling also assumes an operating expenditure for activities that is close to the current level, except for additional CBKT activities. Assumptions have been made for inflation and a plan is in place for capital expenditure, based on some building refurbishment, although the current building refurbishment programme is almost complete. An IT infrastructure renewal project is planned for the work programme following 2023 as the core of the IT hardware system will then be 8-10 years old. Other sources of income, such as sponsorship for CBKT projects, are netted against corresponding additional costs. No specific assumptions have been made about the technical balance of the Work Programme, except that operating and investment spends are retained at close to the current levels. A detailed list of other assumptions was displayed.

The Director said that revenue is growing very slightly as a consequence of the planned extra subscriptions from Associates as they move up the escalator mechanism and from the very few States that become Member States directly. He presented the projected staff levels in the departments for the period 2020-2023 in terms of person months, including seconded person months for programme delivery. There will be a slight decrease in BIPM FTE person months due to retirements, although this will be offset by an increase in the number of personnel seconded to the BIPM for programme delivery. In total over the four-year period, personnel seconded to the BIPM for capacity building are expected to increase to a total of 100 person months. He noted that these capacity building secondments are not included in the figures as they do not contribute to programme delivery. Operating costs are expected to rise and have been modelled carefully.

The Director said that the “working assumption” used when drafting the work programme for 2020-2023 was that there would be no increase in dotation and that if there was an opportunity for additional dotation this would be to support new activities. The Director has discussed the issue with the US State Department as well as having talks in Japan and London to lobby for the 1 % increase. Early indications are that a 1 % increase may be acceptable and the Director said that he will continue to visit Member States to lobby for it. The 1% increase had been included in draft Resolution D for the 26th CGPM meeting, although at the time it was drafted it could not have been known whether it would be supported.

The long-term financial plan will be adjusted to reflect a possible increase. The Work Programme 2020-2023 will be developed further and will be made available on the BIPM website for comments by the CIPM during July-August 2018. In September a document will be drafted to summarize the key points of the Work Programme 2020-2023 and the Long-Term Financial Plan. This document will be sent to the Member States. Mr Henson added that the laboratory secondment months shown in the Long-Term Financial Plan are not funded and rely on sponsorship.

The Director invited questions and comments. It was asked if the proposed 1 % increase in the dotation is for the four-year period or compound. The Director replied that the assumption is for a 1 % compound increase, although this is a matter for the Member States to decide. He was asked to clarify if the projected increase in income shown in the Long-Term Financial Plan was accounted for by the possible 1 % increase in the dotation or if it includes increases in subscriptions and contributions. The Director replied that the models for income include subscriptions from possible new Associates, contributions from those that transition to Member States from the escalator and even the likelihood of any Associates that may leave. Mr Henson added that any new Member States are likely to come from the escalator and it is possible to predict when this may happen.

The cost of secondments was questioned and how this will be managed going forward, particularly now that these costs are increasing. The Director replied that the BIPM has almost reached the limit for capacity building secondees across the organization due to physical constraints such as space in the laboratories and BIPM staff available for their supervision. A concern was raised that the growing number of secondees, even with an upper limit on their numbers, will place an additional burden on the BIPM permanent staff and this burden needs to be carefully managed in the future. This problem may be exacerbated if retiring staff are not replaced. The Director commented that no additional retirements are expected until the end of the 2020-2023 Work Programme and the BIPM workforce will be maintained at a steady number. The President noted that the cost of secondees does not take account of the cost, in terms of staff time, for supporting new secondees. Mr Henson added that in the chemistry CBKT programme, the programme delivery secondees often oversee the work of the capacity building secondees, which eases the work of BIPM scientists.

The importance of recording the money spent on the CBKT programme in the balance sheets was stressed, noting that this is vital in order to show sponsors that the funding they provide for is used exclusively for the CBKT programme. The Director replied that the sponsors always ask for information to show how the sponsorship is spent and it is all accounted for in great detail. In addition, the secondees fill in detailed timesheets to account for their time. Mr Henson added that at the end of each secondment, a final report is submitted to the donor, including a summary of how the sponsorship funding was spent. It was queried to what extent the CBKT programme could be funded from the 1 % increase in the dotation, if it were to be approved. Mr Henson replied that the cost of the CBKT programme to the BIPM has been included in the models for the Long-Term Financial Plan.

It was suggested that different Member States were interested in different types of information about the Long-Term Financial Plan ahead of the 26th CGPM meeting. It should be made clear that the CBKT programme is “ring-fenced” and requires support from sponsors. There is a risk that if it were mistakenly thought that the CBKT programme is funded from the dotation, then further sponsorship may not be forthcoming.

20. REVIEW OF THE AGENDA AND TIMETABLE FOR THE 26TH MEETING OF THE CGPM

The Director presented an overview of the proposed agenda and timetable for the 26th CGPM meeting and said that the meeting will be opened at 9.30 on 13 November 2018 by Prof. Candel, the President of the *Académie des sciences*. The CIPM President commented that his speech to the CGPM will include reference to how the BIPM has fulfilled its obligations to review the CIPM MRA and the actions taken as it was charged to do in Resolution 5 of the 25th CGPM “*On the importance of the CIPM Mutual Recognition Arrangement*”. Talks by the CC Presidents will then provide specific examples of how this has been carried out.

The Director said that the meeting of the Working Group on the BIPM Dotation will take place in a closed session in the afternoon of 14 November. He was asked if the Working Group will be open to all Member States. He replied that it is a Working Group of the CGPM and as such the conference decides who should attend, however, in the past, no Member States had been excluded if they expressed a desire to attend. There would however be a limit of two delegates from each Member State. It was asked if CIPM members can attend the Working Group. The Director said that CIPM members will be able to attend.

The open session on 16 November will be opened by Prof. Candel or the CIPM President at 8.45. At 10.50 a webcast will start with four keynote lectures followed by an introduction to Draft Resolution A “*On the revision of the International System of Units (SI)*”. There was a brief discussion on how the very full timetable for the open session can run smoothly. It was suggested that the CC Presidents must ensure that they adhere strictly to their allotted times and not overrun. If necessary, the lunch break could be shortened, although a press conference is scheduled during this break. The Director said that an electronic registration form will be made available on the BIPM website. He confirmed that members of the official delegations will not need to apply for tickets.

Mrs Fellag Ariouet presented the events that are planned around the CGPM meeting. The BIPM is a partner in a major exhibition at the *Musée des arts et métiers* under the title “*Sur mesure, les sept unités du monde*.” The BIPM has been working closely with the *Musée* over a long period and its contributions include an article: “*From the 1799 prototypes to physical constants: Key events in the history of the International System of Units (SI)*”, which will be included in the official catalogue for the exhibition. The exhibition and book will include a series of photographs of the BIPM laboratories and staff dated 1942, which were taken by the eminent French photographer Robert Doisneau. These photographs were rediscovered recently in the BIPM archives. On 14 November a reception will be held at the *Musée des arts et métiers* for delegates to the CGPM. The delegates will also be invited to attend a reception at the *Académie des sciences* in Paris on 13 November which will include a tour of the *Académie*.

In order to promote the revision of the SI to a wider public, the BIPM and the LNE are partners in a competition “*Français et Sciences*” (French Language and Sciences), with the theme “Weights and Measures” in 2018. The competition was launched on World Metrology Day (20 May 2018) and will end a few days before the CGPM meeting. The competition is open to French teachers in France and abroad, cultural centres, “*Instituts français*” or “*Alliances françaises*”, libraries, museums or French language teaching centres. It is estimated that the competition will be seen by approximately 20 000 people, offering a significant opportunity to raise the profile of the revisions to the SI. The President thanked Mrs Fellag Ariouet for the considerable efforts she has put into organizing these events.

The Director presented the proposed attendance policy for the 26th CGPM meeting. He commented that the rules for attendance are the same as for the previous meeting except that there will be an open session. All participants in the closed sessions will be entitled to attend the open session. Additionally, the BIPM will make available tickets to attend the open session to the following: members of the press; employees of the NMIs duly nominated by their management; members of the BIPM staff (duly nominated by the BIPM Director) and

other interested persons. There was a brief discussion and the attendance policy was approved.

Decision CIPM/107-19 The CIPM approved the attendance policy for the 26th meeting of the CGPM.

21. PREPARATION FOR THE ELECTION OF THE CIPM (AND THE CEC) AT THE 26TH MEETING OF THE CGPM

This item was held *in camera*. The following decision was agreed.

Decision CIPM/107-20 The CIPM agreed on a “recommended list” of candidates for election to the CIPM and asked the CIPM Secretary to send it to the Chair of the Committee for CIPM Election.

The Secretary presented a document “Guidelines for Election of the CIPM Bureau”, which was intended to provide guidance to the incoming CIPM. The document was discussed and the following decision was agreed.

Decision CIPM/107-21 The CIPM approved the Guidelines for Election of the CIPM bureau.

22. CIPM MATTERS

Review of the Terms of Reference of the CIPM Working Groups and Sub-Committees

The President said that the Terms of Reference for each of the CIPM Working Groups and Sub-Committees required review to determine if any of them should be closed or if new ones are needed. There was a brief discussion on whether the CIPM *ad hoc* Working Group on Conditions of Employment should be closed as it had not met recently. The Chair, Dr McLaren, commented that the *ad hoc* Working Group had carried out a salary survey. The majority of the work had been carried out by consultants, with the *ad hoc* Working Group giving oversight. Another salary survey is required in 2019, so the CIPM *ad hoc* Working Group on Conditions of Employment should be retained in order to provide oversight.

The President said that the CIPM *ad hoc* Working Group on Implementing the Recommendations from the Review of the CIPM MRA had been discussed at the meeting of CC Presidents and it was agreed that its work had been successful and its mission was complete. Based on the discussions in the meeting, the President recommended that it should be closed, noting that some of its activities are still being implemented. The CIPM thanked the members of the *ad hoc* Working Group for their contributions to the success of its work and approved the closure. The following decision was agreed.

Decision CIPM/107-22 The CIPM decided that the CIPM *ad hoc* Working Group on Implementing the Recommendations from the Review of the CIPM MRA had completed its tasks and therefore is closed. It thanked all who had participated for their contributions to the success of its work.

It was agreed that the other CIPM Working Groups and Sub-Committees should be retained.

Request to provide draft CIPM decisions in advance

The President said that this topic had been discussed by the bureau. There is a practical problem in that the bureau aims to review the agenda of each CIPM meeting but it only meets immediately before the CIPM meetings. He added that in addition, many of the decisions come out of discussions at the CIPM meetings and it is not possible to anticipate the outcome of discussions. The current situation is that as many decisions as

possible are made available before each meeting of the CIPM. Dr Richard, who had originally raised this issue, said that he is satisfied with the situation, but will continue to ask for decisions in advance.

Outcomes of a workshop on “Improving reproducibility in research” and proposal for a Consultative Committee on Data

Dr Liew said that he had attended a workshop on “Improving Reproducibility in Research: The Role of Measurement Science”, which had been held at the NPL on 1-3 May 2018. Dr Sené and the BIPM Director had also attended. The workshop had focused on research data, but was also relevant to other areas that had been discussed at the NMI Directors meeting in October 2017, namely the role of metrology in the world of “Big Data”; with increasing digitization and increasing volumes of data leading to issues of confidence in industry and in the reproducibility of the results of research. The workshop triggered a wider debate about the role of metrology in the digital economy and maintaining metrological rigour when faced with the challenge posed by increasing data volumes in both industry and research.

A theme from the workshop was that NMIs are well placed to improve reproducibility in research due to their expertise in measurement and associated measurement uncertainties and their role as impartial and independent bodies. A draft executive summary of the workshop and the key recommendations from the “road mapping” session has been produced and a full report is in preparation. The summary highlighted a number of recommendations to the NMIs and two specific recommendations to the CIPM:

- to establish a cross-cutting advisory committee to address metrology issues arising from increasing volumes of data and specifically to consider how the Findable Accessible Interoperable and Reusable (FAIR) principles could be embedded in the activities of the BIPM, RMOs and the wider international metrology community.
- for the same group to consider the role of the metrology community in the challenge of providing the internationally accepted and standardized infrastructure for provenance of data, digital calibration certificates and accepted ontologies for machine readable methods.

Dr Liew asked the CIPM to consider a response to these recommendations and specifically whether it is appropriate to form an “*ad hoc* group” to address the issues.

The President thanked Dr Liew and said that Dr Sené had agreed to serve on such an *ad hoc* group, which would be chaired by Dr Liew. He invited questions and comments. There was broad support for the establishment of an *ad hoc* group and it was noted that there is already a considerable amount of work being carried out by the NMIs in the area of metrology for the digital economy. The CIPM agreed that the topic of the role of metrology in improving the reproducibility of research data and related topics should also be on the agenda for the CIPM Sub-Committee for Strategy. It was considered too early to establish a Consultative Committee on Data.

The Director said that there is an urgent need to form such an *ad hoc* group to start working as soon as possible; this decision should not wait until the next CIPM meeting in March 2019. He added that the Chief Executive of the FAIR initiative had attended the workshop at the NPL and during his presentation had noted that there are 250 NMIs world-wide that could get involved. The metrology community should therefore take the initiative and start work immediately to consider the role of metrology in improving the reproducibility of research data and related topics.

The President concluded that there was consensus among the CIPM to establish an *ad hoc* working group and called for volunteers to join the group. It was agreed that Dr Liew will be the Chair. Other members will be

Dr Bulygin, Dr Castelazo, Dr Laiz, Dr Rastello, Dr Sené and Dr Milton. He suggested that Terms of Reference should be developed by correspondence, taking account of views by the CIPM Sub-Committee for Strategy, and a draft should be circulated to the CIPM by the end of August 2018. The Terms of Reference should acknowledge the fact that the work of the *ad hoc* group is much wider than simply considering the role of metrology in improving the reproducibility of research data: it should encompass the role of metrology in the entire digital economy and all of its ramifications. It was noted that Dr May and Prof. Ullrich were absent and the group should possibly include representation from the PTB and NIST. The Director commented that other members can be added at a later date. The following decision was agreed.

Decision CIPM/107-23 The CIPM decided to establish an *ad hoc* working group to consider the role of metrology in improving the reproducibility of research data and related topics, and appointed Dr Liew as the Chair. Drs Bulygin, Castelazo, Laiz, Rastello, Sené and Milton agreed to be members. Dr Liew will circulate a draft name and terms of reference for the group to the CIPM by the end of August 2018.

Report from the CIPM Sub-Committee on Awards

Dr Bulygin presented a revised set of regulations for a metrology awards scheme, which incorporated the comments and suggestions made by the CIPM since their last meeting following a request in Decision CIPM/106-28. He commented that one of the most challenging items will be the selection of candidates and winners and ran through the proposed selection and evaluation criteria, and the proposed reward process. Dr Bulygin concluded by suggesting that the regulations will require one more round of revisions by the CIPM before they are adopted.

The President thanked Dr Bulygin and asked the CIPM for their views on whether such an award scheme is required, and its purpose and value. He cautioned that the proposed awards scheme is a big exercise and could become difficult to manage. Additionally he said that if an award is made each year, the process could become devalued and care is needed to ensure that very high standards are maintained. Dr Liew recalled that there are similar award schemes in COOMET and APMP; the latter operates two schemes, the IIZUKA Young Metrologist Prize and an award for candidates from developing economies. He added that these are awarded according to strict criteria and are only awarded on merit: the award is not necessarily made every year. The President suggested that the criteria for the APMP awards should be studied by the Sub-Committee.

The President initiated a discussion to elicit the views of all CIPM members. There was a wide range of views on whether awards should focus on scientific achievements, or the quality of publications and how the age of recipients should be considered. There was some consensus that awards should focus on metrologists who are at an early stage in their careers, particularly from developing economies. The imposition of an age limit was however challenged, as this could exclude the possibility of rewarding scientific achievements. The Secretary suggested that the workload for evaluating the nominations could be reduced considerably by using a template with different criteria that must be met before submission. He added that it may be necessary to rethink what kind of achievements are to be rewarded and what is the rationale. There was some concern that any awards scheme should be unique and therefore different from all other competitions and awards schemes. Dr Bulygin replied that the scheme is different in the way that the nominations are described in the context of the world-wide metrology system.

The Director asked for clarification as to whether the proposed scheme is an award for a paper or a person. He added that if the award is for a paper it would be very difficult to capture metrologists at an early stage in their careers, particularly from developing countries, as they often do not have the opportunity to write papers. He recalled that the scheme was originally intended to reward people for their early-career engagement in metrology. In addition, if an

award scheme is based on quality of papers, it would tend to be biased towards the largest and best-funded groups. More thought is needed on how to assess metrologists who are in the early stages of their careers and how to take account of the work being done in developing economies; this is not an easy task. The Secretary suggested that an award could be considered for an “achievement” and its impact. This could be particularly pertinent to developing economies where a specific achievement could have a significant impact. There was a consensus that awards should not be presented at CGPM meetings due to the lack of time.

The President suggested that the preparation of award certificates cannot be undertaken by the BIPM in 2018 due to the heavy workload before the 26th CGPM meeting. He thanked Dr Bulygin and said that the Sub-Committee for Awards should review the comments made by the CIPM and refine its proposals. He also suggested that care should be exercised to ensure that the scheme does not become over-ambitious. The CIPM adopted the following decision.

Decision CIPM/107-24 The CIPM thanked the Chair of the Sub-Committee for Awards for his report and asked him to take account of the comments made by the CIPM and refine the proposals of the Sub Committee for the next meeting of the CIPM.

23. REPORTS FROM THE JCGM, JCRB AND ISSUES NOT COVERED ABOVE

The definition of “measurement”

The Director recalled that he had circulated a paper to the CIPM from the JCGM Working Group (WG2) on the International Vocabulary of Metrology (VIM) relating to the definition of the term “measurement”. The paper had been sent to the Director in his role as the Chair of the JCGM, by the Convenor of WG2, Dr Ehrlich. The drafting of this paper followed a new practice which was a direct consequence of the CIPM position paper sent to WG2, which reiterated that the CIPM would like to see the VIM extended to include a limited number of terms for ordinal properties. The proposal from WG2 is that in order to encompass this, the term ‘measurement’ should include nominal properties. He added that a group at NIST, that has been working on this issue and which was consulted by Dr Ehrlich, is also in favour of both nominal and ordinal properties being included in the term ‘measurement’.

The Director asked the CIPM if there were any comments relating to the paper, as it will be discussed at the JCGM plenary meeting in December 2018. Any input would be taken into consideration by WG2 as it progresses with the development of the committee draft of the VIM4. He added that this paper on broadening the definition of measurement will hopefully prevent any major changes, which could be controversial and have negative consequences, from being included in the VIM without first being brought to the attention of the CIPM. Broadening the definition of measurement, which is core to the VIM, may have significant ramifications.

There was support for the inclusion of ordinal and nominal properties in the definition of the term ‘measurement’ particularly in view of the significant and growing amount of work being undertaken in these areas by the NMIs and the wider scientific community. For example, assessing and calibrating the sensory qualities of food and identifying cells in cell counting laboratories. It was noted that the CIPM recognized merit in the proposal and expressed its thanks to WG2 for bringing this issue to its attention. It was cautioned that broadening the scope of the definition of ‘measurement’ could have consequences for other definitions, and this should be considered by WG2. The Director added that this proposed change is at an early stage and reiterated that WG2 had been encouraged to bring forward any issues in advance of making major changes to allow consideration before the draft VIM4 is circulated for consultation. The proposal has both negative and

positive implications: there is an argument that a measurement should have a value and an uncertainty and the understanding of uncertainties for nominal and ordinal properties is not well developed, however it is of much interest and is the subject of research.

Dr Rietveld commented that the CIPM is a governing body and may not include the necessary expertise and that detailed decisions about the definition of individual terms should possibly be referred to an expert forum such as the CCU. He suggested that WG2 should continue to inform the CIPM about similar matters in the future and the CIPM will decide whether to discuss such issues or forward them to the CCU. The Director said that, as the Chair of the JCGM, he will relay the CIPM's comments to the plenary meeting. The following decision was agreed.

Decision CIPM/107-25 The CIPM noted the letter from the Chair of the JCGM Working Group on the VIM (WG2) on the proposed broader definition of the term “measurement” to include ordinal and nominal properties. It expressed thanks for being given early information about an important topic under discussion by WG2. The CIPM concluded that there is merit in the proposed definition and asked WG2 to keep it informed of future developments with the definition.

Update of CIPM MRA documents for revision of ISO standards

The CIPM noted that CIPM MRA documents that make reference to ISO/IEC 17025:2017 and or ISO 17034:2016 will be updated in accordance with JCRB Decision 39/4, to reflect the implementation period of standards adopted by the JCRB in JCRB Decision 39/3.

The CIPM welcomed the work currently being undertaken at the BIPM by Dr Sally Bruce (on secondment from NIST) to rationalize the suite of CIPM documents and confirms that this can be done under the guidance and approval of the JCRB, noting that any changes that impact on policy, other than changes agreed through the CIPM MRA review process, should be referred back to the CIPM. The CIPM noted that many of the CIPM MRA documents will first undergo minor editorial improvement prior to the major rationalization exercise.

24. DATES OF FUTURE MEETINGS

2019

20-21 March	108th meeting of the CIPM (Session I)
22 March	Meeting of the newly-elected CIPM bureau
Week 42	108th meeting of the CIPM (Session II)

25. ANY OTHER BUSINESS

Mr Énard asked for confirmation of the deadlines for submitting documents for the 26th CGPM meeting, including CC posters. The Director replied that an email will be sent to all parties with the deadlines.

Dr Richard suggested that any decisions taken by correspondence between CIPM meetings should be officially recorded at the next meeting so that they are properly documented. He said that this is particularly important in relation to staff issues. The Director agreed that this should be the practice in the future.

Dr Rietveld said that it was the last meeting for a number of CIPM members and in particular he thanked the departing bureau members: Dr Inglis, Dr May and Dr McLaren, for their contributions and support. The President added that Dr Buzoianu, Mr Énard and Dr Kang were also stepping down from the CIPM and he thanked them for their contributions. The Director added his special thanks to the BIPM staff for their support and to Mr Énard for his support to the BIPM over the years. He has provided considerable support with regard to the pension fund discussions. Dr Buzoianu thanked the CIPM for their kindness during her time on the CIPM and noted that she has learned a great deal from the discussions.

The President expressed his thanks on behalf of the CIPM to Ms Planche and Mr Sitton for the considerable efforts they put into preparing the report of the meeting. He also gave a special mention to Mr Henson and his team and noted the CIPM's appreciation for the considerable amount of work that has been carried out towards establishing the CBKT programme. Finally, he thanked Ms Fellag Ariouet and her team for organizing the CIPM meetings and their considerable support for the CIPM. He concluded by thanking the entire CIPM for their contributions over the years and for their support, not only to himself, but also to the bureau.

The President closed the meeting.

Appendix 1

REPORT OF THE SECRETARY AND ACTIVITIES OF THE BUREAU OF THE CIPM

(October 2017 - June 2018)

The CIPM bureau met at the BIPM on 9-10 March 2018 and on the afternoon of 17 June and morning of 18 June 2018. Earlier in the week in March, the Secretary attended the Management Review meetings of the BIPM Quality and Occupational Health and Safety Systems. In addition, the President, Secretary and one of the Vice-Presidents attended the annual bilateral meeting with ILAC and the quadripartite BIPM/OIML/ILAC/ISO meeting.

The agenda of the bureau meetings included the usual administrative and financial matters; the following paragraphs summarize other agenda items.

BIPM Pension Plan

Since the PFAB President (Mr Énard) was unable to attend the bureau meeting in March 2018, the BIPM Director gave an update. He said that the PFAB had not met since the last CIPM meeting and that the process for electing two additional staff representatives was under way.

The Director reported that some letters about the freeze of the “pension point” had been received from pensioners and formal complaints have been received from some staff members.

The PFAB President (Mr Énard) and the BIPM Legal Adviser (Ms Arlen) attended this part of the meeting in June 2018. The BIPM Director gave an update on the status of various legal challenges by current and retired BIPM staff to the pension plan reforms approved by the CIPM.

The Director noted that continuing informal discussions about whether the BIPM is solely the name of the scientific and administrative entity located in Sèvres rather than the name of the entire intergovernmental organization created by the Metre Convention risk undermining the enormous amount of work he and Ms Arlen have done to respond effectively to challenges to the pension plan reforms. The bureau supported his request for a CIPM decision to encourage him to continue to ensure as much as possible the legal certainty necessary for the implementation of its decisions about changes to the pension plan.

The bureau considered a presentation on non-financial compensation prepared by the Commission for Conditions of Employment (CCE) and decided that no reaction was necessary at this time.

BIPM Finances

In March 2018, the bureau reviewed an unaudited summary of the financial results for 2017 that indicated total expenditure of 13 343 574 € - about 2 % less than the budgeted figure. The audit of the 2017 results was begun within the next few weeks. Expenditures to date in 2018 were in line with the budget.

In June 2018, Ms Spelzini Etter attended this part of the meeting to present a report on income and expenditures to date. Expenditures thus far in 2018 were in line with the budget. Dotation contributions were arriving at a pace similar to that seen in 2017.

BIPM Staff

Dr Patrizia Tavella (formerly of INRIM) joined the BIPM on 1 November 2017 as the new Director of the Time Department. Mr Stephen Keochakian joined the staff in December to succeed Mr Carlos Maggi as the

QS and OH&S Officer. Ms Cécilia De Jonckere joined the Secretariat on a 2-year fixed-term appointment in February 2018 to fill a vacancy created by a resignation in 2017. As of March, recruitments were under way in the Time, Physical Metrology and Ionizing Radiation Departments to fill vacancies created by retirements or resignations. These recruitments will bring the total staff complement to 74, as anticipated in the 2016-2019 Work Programme.

Mr Imbert attended this part of the meeting in June 2018 to provide an update on changes to the staff. Notable among these is the departure of Ms Arlen in July. Recruitment of a new Legal Adviser had recently been completed. The bureau thanked Ms Arlen for excellent work done for the organization and her outstanding performance in the past, congratulated her on her new position and wished her all the best for the future.

BIPM Work Programme (2020-2023)

In March 2018 the bureau reviewed a draft Work Programme for 2020-2023 prepared by the Director and his staff and complimented him on the very well-organized and clear presentation of the information. An updated draft was posted to the BIPM website for comment within the next month, after some minor revisions suggested by the bureau and addition of the final resource figures.

Some of the Capacity Building and Knowledge Transfer (CBKT) activities that have been covered by external funding in the current (2016-2019) period have been included in the draft work programme for 2020-2023.

In June 2018, the Director reported that the current version of the Work Programme 2020-2023 takes into account suggestions received from two NMIs. After approval by the CIPM during its 107th meeting, this final version was posted to the BIPM website.

Preparations for the 26th CGPM

The Director gave a progress report on logistical preparations for the 26th CGPM and led the bureau through a detailed review of the programme for the meeting. In addition, the bureau met with M Sébastien Candel, President of the French *Académie des Sciences*, to brief him on his role as Chair of the meeting.

At the June bureau meeting, The Director and Mr Henson gave an updated progress report on preparations for the 26th CGPM meeting and presented a detailed review of the programme for the meeting. An exciting week of presentations culminating with an “open” session on the final morning is planned. There will be evening receptions on the first two days of the meeting, one hosted by the *Académie des Sciences*, the other hosted by the *Musée des Arts et Métiers*.

The bureau reviewed a policy document on eligibility for attendance at the meeting. It differs from the policy in place for the 2014 meeting only in attendance at the open session.

CIPM 2018 Election

In March, the bureau discussed some details of the process for the 2018 CIPM election that are not completely defined in the election process document on the BIPM website. It was suggested that the list of the 18 candidates recommended by the CIPM to the Committee for Election of the CIPM (CEC) should be developed at the June 2018 CIPM meeting by means of a secret ballot after a thorough discussion of the qualifications of new candidates and of particular needs arising from expected vacancies in CC Presidencies and Sub-Committee Chairs. It was suggested that the list recommended by the CIPM to the CEC remain confidential until feedback from the CEC is received.

Some details of the transition from the “old” CIPM to the newly elected CIPM at its first meeting (probably in March 2019) also need to be specified. The current bureau members recommended that they attend at least the

first part of this meeting, i.e., at least until the new bureau is elected. (With appropriate scheduling, this would allow the current bureau members to represent the CIPM at the usual March BIPM-ILAC bilateral and BIPM-ILAC-OIML-ISO quadripartite meetings in the same week as the CIPM meeting, then subsequently brief the new bureau members). It was also recommended that bureau members should be elected by a clear majority (i.e. by 10 or more votes) by exhaustive ballot and successive elimination of candidates with the least number of votes if necessary. Dr May was asked to develop revised text for the election process document for consideration by the CIPM at its June meeting.

In June 2018, the Secretary reported that the 22 nominations for election to the CIPM later in the year were made available to both the CIPM and the CEC in early April. After discussion of the nominations later in the 107th session, the CIPM prepared a list of “preferred candidates” by means of a secret ballot. The results of this vote were communicated to the CEC but will remain confidential until a final “slate” of candidates that is endorsed by both the CIPM and CEC has been agreed.

Some details of the transition from the “old” CIPM to a newly elected CIPM at its first meeting, in particular the election of the bureau members, are not specified in the CIPM Election Process document that was approved at the 2014 CGPM meeting and posted to the BIPM website. The bureau discussed the following guidelines and proposed them to the CIPM at its the June meeting.

The bureau recommended that these guidelines be kept separate from the election process document in order to avoid the need for CGPM approval of a revised version of that document.

Guidelines for Election of a New Bureau

Election of the members of a new CIPM Bureau (President, Secretary, and two Vice Presidents) should proceed according to the following guidelines.

- All voting will take place by secret ballot.
- Elections will take place in the following order: President; Secretary; and two Vice Presidents, elected sequentially*. For all positions, there should be successive rounds of voting until a candidate receives a majority of the votes cast, with the candidate having the fewest votes in each round dropping out.
- In the case of only one candidate a vote will be held to see whether the candidate is assured of sufficient support by the CIPM Members, demonstrated through positive votes from a majority.

* This order of voting is essential to allow unsuccessful candidates for the Presidency to compete for the Secretary position. Similarly, unsuccessful candidates for the Secretary position will be eligible for election to either of the Vice President positions.

Visit to the BIPM Kibble Balance Laboratory

The bureau made a brief visit to the BIPM Kibble Balance Laboratory in June 2018 to meet and congratulate the staff on excellent progress made in recent weeks. The balance is now operating under vacuum and under computer control. Uncertainty in measurements has been reduced to 1×10^{-7} .