Bureau International des Poids et Mesures

Consultative Committee for Photometry and Radiometry (CCPR)

Report of the 23rd meeting
(22-23 September 2016)
to the International Committee for Weights and Measures

Comité international des poids et mesures

Note:

Following a decision made by the International Committee for Weights and Measures at its 92nd meeting in October 2003, Reports of meetings of Consultative Committees will henceforth be published only on the BIPM website in the form presented here.

Full bilingual printed versions in French and English will no longer appear.

M.J.T. Milton,
Director of the BIPM

LIST OF MEMBERS OF THE
CONSULTATIVE COMMITTEE FOR PHOTOMETRY AND RADIOMETRY
as of 22 September 2016

President

Dr T. Usuda, member of the International Committee for Weights and Measures, National Metrology Institute of Japan [NMIJ/AIST], Tsukuba.

Executive Secretary

Dr J. Viallon, International Bureau of Weights and Measures [BIPM], Sèvres.

Members

Agency for Science, Technology and Research [A*STAR], Singapore.

All Russian Research Institute for Optical and Physical Measurements, Rosstandart [VNIIOFI], Moscow.

Centre for Metrology and Accreditation [MIKES], Espoo.

Centro Nacional de Metrología [CENAM], Querétaro.

Czech Metrology Institute [CMI], Brno

Federal Institute of Metrology [METAS], Bern-Wabern.

Instituto de Optica “Daza de Valdés” [IO-CSIC], Madrid.

Istituto Nazionale di Ricerca Metrologica [INRIM], Turin.

Korea Research Institute of Standards and Science [KRISS], Daejeon.

Laboratoire National de Métrologie et d’Essais [LNE], Paris.

Measurement Standards Laboratory of New Zealand [MSL], Lower Hutt.

National Institute of Metrology [NIM], Beijing.

National Institute of Standards and Technology [NIST], Gaithersburg.

National Measurement Institute of Australia [NMIA], Lindfield.

National Metrology Institute of Japan, AIST [NMIJ/AIST], Tsukuba.

National Metrology Institute of South Africa [NMISA], Pretoria.

National Metrology Institute of Turkey [UME], Gebze-Kocaeli.

National Physical Laboratory [NPL], Teddington.

National Research Council of Canada [NRC], Ottawa.

Physikalisch-Meteorologisches Observatorium Davos and World Radiation Center [PMOD/WRC], Davos Dorf.

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig.

Slovak Institute of Metrology/Slovenský Metrologický Ústav [SMU], Bratislava.

VSL, [VSL], Delft.

The Director of the International Bureau of Weights and Measures [BIPM], Sèvres.

Observers

Industrial Technology Research Institute/Center for Measurement Standards [CMS/ITRI], Hsinchu

International Commission on Illumination [CIE], Vienna

Instituto Nacional de Metrologia, Qualidade e Tecnologia [INMETRO], Rio de Janeiro

World Meteorological Organization [WMO], Geneva

1. OPENING OF THE MEETING, MEMBERS AND OBSERVERS PRESENT, INTRODUCTIONS

The Consultative Committee for Photometry and Radiometry (CCPR) held its 23rd meeting at the International Bureau of Weights and Measures (BIPM) headquarters at Sèvres, France, on Thursday 22 September and Friday 23 September 2016.

The meeting was chaired by the CCPR President, Dr. T. Usuda (CIPM member).

The following delegates from member institutes were present: Ö. Bazkir (UME), P. Blattner (METAS and CIE), G. Brida (INRIM), J. Campos Acosta (IO-CSIC), M. Dowell (NIST), J. Dubard (LNE), G.T. Fraser (NIST), J.R. Filtz (LNE), N. Fox (NPL), A. Gamouras (NRC), T. Goodman (NPL), E. Ikonen (MIKES), S.K. Kim (KRISS), B. Khlevnoy (VNIOOFI), A. Koo (MSL), M. Krempasky (SMU), S. Kück (PTB), D.-H. Lee (KRISS), Y. Lin (NIM), P. Manson (NMIA), C. Matamoros (CENAM), M. Milton (Director of the BIPM), G. Obein (LNE-Cnam), Y. Ohno (NIST), V. Sapritsky (VNIIOFI), W. Schmutz (PMOD/WRC), R. Sieberhagen (NMISA), M. Smid (CMI), A. Sperling (PTB), G. Ulm (PTB), S. van den Berg (VSL), T. Zama (NMIJ), J. Zhang (A*STAR), J. Zwinkels (NRC).

Observers: T. Menegotto (INMETRO), K. Nield (CIE), I. Rüedi (WMO), K-N. Wu (CMS/ITRI).

Invited: M. AlFohaid (SASO), A. AlNahdi (SASO), J. Gran (EURAMET), D. Lee (SCL), M. Nadal (SIM).

Also attending the meeting: E. de Mirandés (BIPM), D. Olson (BIPM), S. Picard (BIPM), J. Viallon (Executive Secretary of the CCPR, BIPM).

Dr Usuda opened the meeting and began by welcoming everyone to the BIPM and introducing the new Executive Secretary of the CCPR, Dr Joële Viallon. Dr Milton then added his welcome as Director of the BIPM, after which all those present briefly introduced themselves. Dr Usuda emphasized that a key objective for the meeting was to consolidate discussions from the various Working Group (WG) meetings that had been held earlier in the week and to make any necessary decisions arising from these discussions.

2. APPOINTMENT OF THE RAPPORTEUR AND FINALIZATION OF THE AGENDA

Teresa Goodman was appointed rapporteur for the meeting.

Dr Usuda commented that the agenda had been circulated, and asked for any suggested changes. None were received and the agenda was therefore adopted.

3. APPROVAL OF AND MATTERS ARISING FROM THE MINUTES OF THE LAST MEETING

Dr Usuda invited Dr Viallon to review the action points from the previous CCPR meeting in 2014.

AP1: WG-CMC chair to include some slides related to the deadlines in CMC review from JCRB Secretary in the WG-CMC report.

The presentation given by Chingis Kuanbayev at the 2014 WG-CMC meeting has been added to the working documents as CCPR-WG-CMC/14-08. This includes all relevant information. The WG-CMC report makes reference to this document.

AP2: Dr Ohno to prepare the layout of a table for planned RMO supplementary and bilateral comparisons. Dr Stock to consider the appropriate place in the CCPR website and inform members.

The table was prepared and information received recently from RMO TC Chairs but it needs to be verified and revised before it can be published on the BIPM website (in open access).

AP3: Dr Ohno to send Dr Stock the final version of the G6 guideline for publication on the CCPR website.

Completed.

AP4: PMOD/WRC and WG-KC chair to prepare a proposal for the solar irradiance comparison.

A solar irradiance comparison organized by PMOD/WRC, named IPC-12, took place and is registered in the KCDB as supplementary comparison EURAMET.PR-S6. At the date of the CCPR meeting, the comparison report has not yet been sent to the Executive Secretary for review by the WG-KC.

AP5: Dr Blattner to give Dr Bich specific examples of complex distributions.

During the meeting, Dr Blattner reported that he is in contact with Dr Bich and that he will provide some more examples, in particular some examples from CIE Technical Reports.

AP6: Members to provide comments and examples related to the revision of the GUM, with examples suitable for inclusion in the new version.

The revision of the GUM has received many comments and discussions are still on-going, so that sending examples is no longer a priority.

AP7: Dr Stock to distribute the draft version of the new SI brochure. CCPR members to comment by the end of November.

Completed. Dr Stock sent a draft of the ninth SI brochure dated 16 December 2013 to CCPR members on 23 October 2014. Comments from Dr Zwinkels were received and forwarded to Dr Thomas, Executive Secretary of the CCU at that time.

Dr Usuda noted that the minutes of the 22nd meeting of the CCPR had been available for comment for some time. He then invited further comments and, there being none, declared that the minutes of the previous meeting were accepted.

4. DOCUMENTS PRESENTED TO THE MEETING

The list of documents shown to the meeting is included in Appendix 1. All documents are also available on the CCPR members' area of the BIPM website. There were no requests for additional documents to be presented. It was noted that not all member institute progress reports had been submitted before the meeting and it was requested that these should be supplied as soon as possible. Dr Milton mentioned that other CCs publish such reports in the open access area of the website and after some discussion it was agreed that CCPR should do likewise. Any confidential / copyright material can be removed before this is done and each member institute has the right to refuse publication of its own report if so wished; revised versions, if needed, should be submitted as soon as possible.

AP1: Missing progress reports to be supplied to Dr Viallon by the end of the year, together with any revisions to those reports already submitted. All reports will be published on the open access area of the BIPM website at the start of 2017 unless a specific request not to do so is received.

5. UPDATES FROM CGPM AND CIPM

Dr Usuda made a short presentation summarizing recent activities of the CGPM and CIPM. He highlighted the following points from 103rd CIPM meeting in November 2014: (a) updates to CCPR's membership were noted and approved (CMI (Czech Republic) was approved as a member, observer status was granted to CMS/ITRI (Chinese Taipei) and the resignation of MKEH (Hungary) was accepted); (b) the status of the *mise en pratique* for the candela was reviewed, including the joint drafting process undertaken with the CIE; (c) a presentation and poster for the CGPM were submitted, including information on the economic impact of the CCPR's areas of activity, priority technology areas and the contributions made to environmental observations. The latter presentation material was circulated to CCPR members for comment and has since been published on the BIPM website. Dr Usuda noted that it clearly demonstrated the breadth and importance of CCPR's work, the high level of stakeholder involvement, the excellent quality of the scientific work undertaken and its economic and societal importance. The 25th meeting of the CGPM took place in November 2014 and Dr Usuda mentioned that a total of five Resolutions had been approved, including one relating to the future revision of the International System of Units (SI) and another on the importance of the CIPM Mutual Recognition Arrangement (CIPM MRA).

Points of particular note from the 104th CIPM meeting in March 2015 were Dr Usuda's re-appointment as CCPR President for a 4-year term (subject to approval from NMIJ), the confirmation of the *mise en pratique* for the candela (subsequently published on the BIPM website), the provisional acceptance of GULFMET as a new RMO, the encouragement of the CCs to support developing NMIs and RMOs wherever possible, and the request that CCs should review the implementation and operation of the CIPM MRA in their individual areas. In relation to his Presidency of the CCPR, Dr Usuda said that since he is also President of the Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV) he has requested that the CIPM seek an appropriate candidate to replace him as CCPR President; he will continue in both roles until a new

appointment is made. Three vacancies have arisen on the CIPM as a result of resignations and once these have been filled (nominations close on 24 October 2016) it is hoped that new Presidents for both the CCPR and CCL will be appointed.

Dr Blattner asked what specific actions are expected from the CCPR in order to support developing NMIs. Dr Usuda said that he feels no special new initiatives are required but current practices, such as welcoming guest attendees at meetings and publishing guidelines on issues such as the practical realization of the candela and the analysis of the results of comparisons, should continue and be enhanced where possible.

At Dr Usuda's invitation, Dr Milton, Director of the BIPM, gave further information relating to the CGPM and CIPM. He mentioned that the report on the review of the CIPM MRA, which had been initiated by the CGPM in 2014, had been published on the BIPM website in August 2016 and that the next phase of the work is to implement the recommendations contained within it. It is expected that NMI Directors will discuss and prioritize these recommendations at their meeting in October 2016 and an action plan will then be drawn up – further details will be available in the 'Latest reports and announcements' section of the BIPM website. Dr Milton also highlighted that Slovenia had recently become the 58th member state of BIPM and that GULFMET had been granted provisional status as the 6th RMO within the CIPM MRA. The growing number of Member States and Associates had prompted the CC Presidents to discuss membership rules and some changes are expected as a result, to ensure effective engagement at CC meetings. In relation to the redefinition of the SI, Dr Milton stated that although the draft resolution was still being worked on by the Consultative Committee for Units (CCU), it was expected that it would be ready for presentation at the CIPM meeting in October 2016. Dr Usuda ended this part of the agenda by encouraging everyone to look at the BIPM website on a regular basis, since it contains much useful information relating to the CIPM MRA, CIPM and CGPM.

6. REPORT OF THE WORKING GROUP ON CALIBRATION AND MEASUREMENT CAPABILITIES (WG-CMC)

The report was presented by Dr Zama, current Chair of WG-CMC and APMP representative. The working group met on the morning of 20 September 2016 (chaired by Dr Zama with 36 participants) and held a workshop (chaired by Dr Manson) on the topic of the CMC review processes on the morning of 19 September.

Three additions to the list of service categories were agreed: 4.17.1 Refractive index, spectral, solid material; 4.18.1 Angle of rotation of plane of polarization, spectral, solid material; and 4.19 Ellipsometric angles, spectral, general material. A further four new service categories relating to fibre optics were also proposed (7.10.0 Optical fibre length; 7.10.1 Distance scale deviation, OTDR; 7.10.2 Location offset, OTDR; and 7.5.2 Loss deviation, OTDR) and it was agreed that unless objections were received within one month, these would also be added to the list. Several additional service categories relating to fibre optics are also under discussion and it was decided these should be referred to WG-SP TG6 for their opinion.

Several inconsistencies between the CMC Excel table and the service category list had been noted and necessary amendments have been made, together with some clarifications and simplifications.

The modified table will be reviewed by WG-CMC and WG-CMC-TG2 members. Service category 1.1.2 Luminous intensity, LED was discussed at length, since this is not a true luminous intensity but a measurement carried out using a specific, defined, geometry. It was agreed that this should be changed to a new service category, 5.9.1 Averaged luminous intensity, LED; the list will be updated accordingly. All NMIs with entries under 1.1.2 should update their CMC tables with the new number, making sure all required parameters are included, and send the new version to the relevant RMO TCC, copied to the BIPM key comparison database (KCDB) secretary.

AP2: All NMIs with entries under 1.1.2 should update their CMC tables with the new number. The relevant RMO TC Chair will report this CMC tables update at the next CMC-WG meeting.

Dr Zama then gave a brief summary of the outcomes of the CMC workshop before inviting Dr Manson to report in detail. Dr Manson mentioned that this workshop had been requested by WG-KC following its meeting in 2015, and had been intended to address the absence of guidelines relating to the use of KC results in the CMC review process. However, members of WG-CMC felt there were other more urgent issues to discuss and these had consequently taken priority. The first part of the workshop had therefore concentrated on the inter-regional review process and the delays that often resulted from this. Following some debate during the workshop, and again in the CCPR meeting, it was agreed that RMOs could, and should, remove individual CMCs that were proving difficult to agree during the inter-regional review, particularly those not supported by comparison evidence, and resubmit revised tables without these. These revised versions can then be approved quickly and the 'problematic' entries considered separately.

The second part of the workshop dealt with the issue of the appropriate breadth and depth of coverage of the CMCs for photometry and radiometry and the lack of clarity / guidelines for the review process. On behalf of EURAMET, Teresa Goodman presented an overview of the historical development of the service category list, emphasizing that it had not originally been intended that the CMC database should provide a comprehensive catalogue of the measurement services available at each NMI but rather a summary of the high level or 'underpinning' measurements that can be used to demonstrate general capability within each of the areas covered (detectors, sources, materials etc.). The consensus in the CCPR at the time the CMC database was first established had been that the focus should be on services closely linked to KC quantities and most of the debates at that time had been related to 'how far the light shines' from these KCs and hence how many service categories each one could support. Since then more and more subcategories have been added to the list of approved service categories, making it increasingly difficult to link these to KC quantities and leading to inconsistencies in the review process. The workshop attendees discussed the degree to which these original decisions were still valid and appropriate, with strong arguments being put forward on both sides. Those in favour of concentrating only on quantities with a clear link to a supporting KC cited the problems associated with reviewing services without objective (generally comparison) evidence, the lack of appetite for additional comparisons to ease this situation, and the burden associated with maintaining a broad-ranging database. Those in support of a comprehensive database including all, or most, of the services offered by all NMIs mentioned that some clients and accreditation bodies (particularly in the fibre optics area) rely on the CMC database as evidence of competence for specific measurement services. Restricting the database only to quantities with clear linkage to KCs might mean NMIs that take traceability from other NMIs could find it difficult to be included, and that the objective quality assurance provided by the CMC review process is particularly important to, and valued by, emerging NMIs.

These issues were further debated during the WG-CMC meeting, and again during the CCPR meeting. Dr Usuda and Dr Milton both mentioned that similar debates are being held by other CCs

and said that although there is a general desire to minimize the number of entries in the CMC database, it is also appreciated that it does form an important part of the Quality System for many NMIs. Dr Zwinkels suggested that it would be helpful to have better guidelines relating to the use of the CIPM MRA logo, which is highly regarded by many clients and accreditation bodies; it is not clear whether its use is restricted only to services which are individually listed in the CMC database or whether it could be used on certificates for 'sub-service categories' where only the primary service category is listed in the database. Dr Usuda said this issue is being discussed within the CIPM MRA working group.

The conclusion of these discussions was that three new Task Groups should be established by the CCPR WG-CMC, the first on use of comparison results in assessment of CMC claims (chaired by Annette Koo), the second to update the PR CMC supporting evidence Excel file and the associated list of supporting comparisons for each service category (chaired by Maria Nadal) and the third to clarify and harmonize the CMC review processes (including the requirements for supporting evidence for CMC claims) and establish written guidelines to ensure these are consistently applied across the CCPR (chaired by Teresa Goodman). It was also agreed that the Chair of WG-CMC should in future serve for a minimum period of 4 years and that the working group should generally meet each year.

According to the normal rotation of the Chair of CCPR WG-CMC, Dr Khlevnoy (COOMET) would be expected to take over from this meeting. However, in view of the extended period for which the chair will in future be expected to serve, coupled with his own heavy workload, Dr Khlevnoy stated that he must offer his immediate resignation from this role. After a long discussion on the responsibilities of the WG-CMC chair, as well as the membership criteria for WG-CMC and the new TGs, the following changes to the rules for WG-CMC were eventually agreed:

- The Chair of WG-CMC is nominated by WG-CMC and is appointed by the CCPR.
- Chairpersonship shall rotate among the RMOs.
- The term of chairperson office is 4 years, unless reappointed officially.
- The following shall be Members: Chairs of the Technical Committees of RMOs dealing with photometry and radiometry, the Chair of CCPR WG-CMC, and one expert appointed by each RMO TC Chair.
- WG-CMC TG chairs are invited to attend WG-CMC meetings as observers.
- Meeting attendance is by invitation only.

AP2: The rules governing membership of WG-CMC will be revised as agreed, with immediate effect. A new sheet, for Task Groups, in the WG-CMC section of the CCPR website, will be added.

7. REPORT OF THE WORKING GROUP ON KEY COMPARISONS (WG-KC)

The report was presented by Dr Ohno, Chair of WG-KC. The working group met in Beijing in October 2015 with 26 participants present and on 21 September 2016 with 41 participants. A workshop on key comparison analysis was also held in October 2015.

A new member of the WG-KC was approved in 2015 (NIM, China), bringing the total membership to 12 including MSL, New Zealand, as a temporary member as pilot of CCPR K6. The working group currently has four task groups.

Dr Ohno presented the current status of CCPR comparisons:

Completed since 2014: CCPR S3 Bilateral comparison on cryogenic radiometers between NPL and UME, piloted by NPL, and Pilot comparison on THz spectral responsivity, piloted by PTB with NIM, NIST and PTB as participants. Reports for both these comparisons have been published.

Ongoing Key Comparisons:

CCPR-K6-2010	Regular Spectral Transmittance (MSL)	Draft B approved
CCPR-K3 (2nd)	Luminous intensity (NRC)	Draft A in preparation
CCPR-K2.b (2nd)	Spectral Responsivity 300 – 1000 nm (KRISS)	Measurements in progress
CCPR-K2.a (2nd)	Spectral Responsivity 900 – 1600 nm (NPL)	Protocol approved
CCPR-K4 (2nd)	Luminous flux (NMIJ)	Protocol being finalized
CCPR-K1.a (2nd)	Spectral Irradiance 250 – 2500 nm (VNIIOFI)	Protocol being developed.

There was some discussion relating to K4, following NPL's announcement of withdrawal from participation as a result of a decision to close its goniophotometric laboratory from 2017. EURAMET PR TC is to decide whether to select a new NMI to fill this open position and will notify WG-KC and the pilot accordingly. It was noted that NPL has a number of GEC 200 W flux lamps available for purchase and anyone interested in these should contact Teresa Goodman for further information. It was also mentioned that the LNE has 31 GEC 200 W flux lamps from the BIPM, which are available for loan.

Dr Ohno summarized discussions that had taken place during the reports by the RMOs. The need to ensure that consistency checks are carried out following completion of KCs was highlighted and it was agreed that RMOs would be encouraged to report on the status of these checks at the annual WG-KC meeting. A list of planned RMO comparisons in photometry and radiometry has been prepared and this is to be posted on the public access area of the BIPM website. The list will be updated annually and it is hoped that it will help to reduce the number of comparisons, particularly bilaterals. The time schedule of the second round of CCPR KCs was also reviewed and updated.

Summaries of the work of the four task groups were presented. TG1, on a pilot comparison for regular spectral transmittance in the UV (200 nm – 400 nm), has prepared three sets of metallic neutral density filters of seven different densities. The comparison will involve four participants (NMISA, NPL, NRC and PTB) and measurements are expected to start in the first half of 2017.

Most of the work of TG2 on RMO linkage has been completed and published in the appendices to guidelines G5 and G6. The only remaining activity for this TG is to finalize the guidance for special cases, based on the approach used for COOMET.PR-K1.b.1.

Work in TG3 has also progressed well. A workshop was held in October 2015 in Beijing, chaired by Emma Woolliams, which considered issues such as the various models suitable for KC analysis, the treatment of inconsistent results / outliers, methods for linking regional comparisons to CCPR comparisons, and approaches for checking consistency between CMCs and KC results. The treatment of outliers was identified as a particular area of concern and it was noted that the current guidance is somewhat ambiguous. The need to establish clear procedures for consistency checks was referred to WG-CMC for further action and should be addressed as part of the work of the new TG2 noted above. The final recommendation from the TG3 workshop was to establish a sub-task group to revise guideline G2 to include guidance on the fixed effects model and least squares techniques. Following the workshop Emma Woolliams stood down as chair of TG3 and was succeeded by Annette Koo.

She reported at the WG-KC meeting that an appendix to G2 dealing with Generalized Least-Squares (GLS) models is nearly complete and that a proposal for revisions to G2 to make explicit reference to the fixed effects model should be available by the end of 2016. However she also emphasized that further research on this topic is needed and WG-KC therefore agreed that a workshop on models for comparison analysis should be organized at an appropriate opportunity in 2017, possibly in conjunction with the NEWRAD conference.

The final task group, TG4 on the use of alternative standards for photometric comparisons, has starting collating information on recent research into LED transfer standard artefacts. It was noted that this is of increasing urgency due to the limited availability of suitable tungsten lamps, but that the long-term stability of LED standards is not yet sufficiently well known for these to be used immediately as replacements.

Dr Ohno mentioned EURAMET Guide number 4, on comparisons, and the critical differences between the procedures given therein and those in the CCPR guidelines. The most significant differences are the need for participants to sign a commitment form and the time limit of two months allowed between completion of the measurements and the distribution of the Draft A report. Following this procedure removes the pre-Draft A process, which is a key feature of the CCPR guidelines. WG-KC therefore agreed to request the CCPR to make formal representation to EURAMET to resolve this conflict. This was discussed further at some length during the CCPR meeting and it was finally decided that a less formal approach might be more appropriate and successful.

AP4: Dr Ohno to send a letter on behalf of CCPR WG-KC to Dr Gran (EURAMET TC-PR Chair) highlighting the conflict between the EURAMET and CCPR guidelines, for discussion at the forthcoming meeting of EURAMET TC Chairs.

The next point of discussion during the WG-KC meeting was the status of the CCPR guidelines for comparisons, which are all available in the 'CCPR publications and bibliography' section of the BIPM website. Dr Ohno stated that a near-final draft is available for the last of the planned guides, CCPR-G7 on procedures for RMO PR supplementary comparisons, and that this is to be circulated to WG-KC for final checking ready for submission for CCPR approval by the end of 2016.

Dr Ohno finished by presenting the planned dates for the next meeting of WG-KC, which will be in Tokyo during the two and half days preceding the NEWRAD 2017 conference, which will be held on 13-16 June 2017. A full day will be allowed for the WG-KC meeting, with a further half-day workshop on models for comparison analysis.

8. REPORT OF THE WORKING GROUP ON STRATEGIC PLANNING (WG-SP)

The report was presented by Dr Zwinkels, Chair of WG-SP. The working group met on the afternoon of 20 September 2016, with 44 participants present, including representatives from 12 of the 13 member NMIs and Chairs of four of the five RMOs. The working group currently has 13 members plus the RMO TC PR Chairs and eight active task groups, plus a joint task group with the CIE.

Dr Zwinkels began by mentioning some of the highlights of the work of WG-SP since the last CCPR meeting, which included inputs to and review of the CCPR poster prepared for the 25th CGPM, a

workshop on metrology needs in fibre optics (held on the afternoon of 19 September 2016), and the publication of the *mise en pratique* for the candela. She then summarized the status of those task groups requiring decisions / inputs from the CCPR (details of the activity of all task groups are in the minutes of the WG-SP meeting).

- TG5 – SI. This task group had reviewed the draft of the 9th SI brochure and identified a number of inconsistencies in the stated date at which the candela was established as a base unit (dates of 1964, 1954 and 1948 were all given). It was also noted that the wording for the definition of the defining constant for photometry was imprecise and a query was raised relating to the wavelength in air for the definition of the candela (following discussion this was accepted as being correct but the inconsistency in the draft report from CIE JTC-2 needs to be corrected). Finally it was highlighted that Appendix 3 of the 8th edition of the SI brochure, relating to photobiological and photochemical units, had been removed in the draft of the 9th edition.
- TG6 – Discussion forum on fibre optics. The main activity of this task group since the last CCPR meeting was to organise a workshop on metrology needs for fibre optics. This was held on 19 September 2016 and attracted 40 participants, including one industry representative. Seven presentations were given and these will be posted in the open access area of the BIPM CCPR website. The workshop identified a number of challenges for metrology for fibre optics, particularly the need to improve uncertainties for fibre optic power meters (industry needs ~ 1 %, but typical uncertainties at present are around 6 % in many countries). A number of recommended actions were presented at the WG-SP meeting, including the establishment of a new task group to carry out a pilot study into the calibration of a fibre-coupled cryogenic radiometer to improve uncertainties for fibre power meters and another to perform a pilot study for single photon traceability.
- TG10 – CCPR strategic planning document. It was reported that the CCPR strategy document for the period 2013 – 2023 is available on the BIPM website. This needs to be updated on a regular basis, with the next formal update (for the period 2017-2027) to be completed in time for the next CGPM meeting in 2018. Key sections requiring an update are the summary table of comparisons, the list of required KCs and pilot studies, and the resource implications of the CIPM MRA.
- CIE JTC-2 (CIE-CCPR) – Principles governing photometry. The first complete draft was balloted in July 2015 but was not approved due to disagreements regarding the definitions of the photometric quantities. Since then, CIE Division 2 has agreed new wording for these definitions, which will also be used in ISO 80000-7. A new draft of the JTC-2 document has been prepared using these same definitions and this is now being checked by members prior to a formal ballot. It has been decided that the final report will be published concurrently with publication of the new SI (i.e. in 2018) so that it can use the new definition of the candela.

Dr Zwinkels presented the priority goals for WG-SP for the period 2016-2018: (a) to reach a consensus on the importance of a photon-based definition of the candela; (b) with the CIE, finalize and publish the JTC-2 document on Principles governing photometry; (c) update the CCPR strategy document for the CGPM meeting in 2018; and (d) continue to advance the aims of the task groups and discussion fora. She finished by presenting three recommendations from WG-SP to the CCPR, each of which was then discussed.

- *WG-SP recommendation 1:* Send a CCPR response to CCU on the review of the draft of the 9th SI brochure. Dr Milton said that the clarifications and corrections identified are clearly

important and should be sent to the CCU as a matter of urgency. It was agreed that Dr Zwinkels would do this immediately, with assistance from Dr Kück as required.

AP5: Dr Zwinkels to send points of clarification and correction relating to the candela to CCU immediately, for incorporation in the next draft of the 9th SI brochure.

- *WG-SP recommendation 2:* Send a CCPR recommendation to the CCU to reinstate Appendix 3 of the SI brochure. In support of this recommendation Dr Blattner voiced concerns from CIE Division 2 members regarding the removal of Appendix 3 in the latest draft and strongly recommended that it should not only be reinstated, but also updated. Dr Usuda asked whether it was still possible to make substantial changes to the draft and Dr Milton confirmed this could be done. Dr de Mirandés said that this Appendix had been removed in response to the CCU view that only SI units should be included and indicated that no objections had been received when the most recent draft was circulated for comment. However, Dr Zwinkels and Dr Blattner both stated that since the removal of the Appendix had not been highlighted, they had assumed it was still included; this view was reiterated by many of those present. Dr Blattner also emphasized that the CIE was trying to ensure correct use of the SI in photobiology and photochemistry and that being able to reference Appendix 3 of the SI brochure was essential for this; without it, there is a high likelihood of non-SI units becoming entrenched in these communities. It was agreed that a small group of CCPR and CIE representatives should prepare an updated version of Appendix 3 and send this to the CCU. Dr Milton also indicated that all CCs will have a further opportunity to review and comment on the 9th SI brochure when the next draft is circulated.

AP6: CCPR President to inform CCU that CCPR requests that Appendix 3 is reinstated in the 9th SI brochure.

- *WG-SP recommendation 3*: A new task group (TG13) should be created in WG-SP, relating to optical fibre power responsivity. This will conduct preparatory discussions for a possible pilot study on optical fibre power responsivity. There was some discussion regarding exactly what these ‘pilot studies’ would involve, as a result of which the objectives were clarified as being to conduct a pilot study comparison into optical fibre power responsivity measurements using a fibre-coupled cryogenic radiometer as the reference. The task group was approved on this basis.

9. UPDATE FROM THE CCU

The report was presented by Dr de Mirandés (BIPM), CCU Executive Secretary. She mentioned that a new CCU President had been appointed in January 2014, Prof. Joachim Ullrich, who is President of the PTB and Vice-President of the CIPM. She also stated that Dr Ian Mills (former CCU President) had been nominated as a CCU honorary member. The most recent meeting of the CCU, the 22nd, took place in June 2016 and Dr de Mirandés summarized the major topics of discussion at that meeting. One point of particular note was the progress towards the awaited revision of the SI in 2018, for which a firm closing date of 1 July 2017 has been announced for submission of data to define the exact values of h, e, k and N_A. Some initial publicity material has been prepared to raise awareness of the forthcoming revision, including two versions of a ‘SI logo’ which are available for use by all member states, and a task group has been set up under the auspices of the CIPM to develop further

communication tools for a wide range of different audiences, which will be made available for use via a dedicated web page. The key objectives of the publicity campaign are that each target group should understand the basic principles of the revised SI and the role of fundamental constants within this. It will also be emphasized that continuity is preserved for end users and for this reason the present set of seven base units will be maintained, but it will be made clear these are deduced from the seven defining constants.

The 9th SI brochure will be an important component of the dissemination of the new SI and Dr de Mirandés detailed the changes that have been made in relation to the 8th edition and the motivation for these. Several points are still under active discussion, including the definitions of the radian and steradian; a working group on angles and dimensionless quantities has been set up to provide advice on this issue. Comments on the most recent draft of the brochure will be discussed at the CIPM meeting in October 2016, following which a new draft will be prepared. It is planned that the final draft will be approved at the CCU meeting in September 2017, including the final values for the fixed constants, and that the brochure will be published in November 2018 in both French and English. The date for implementation of the new SI will be World Metrology Day, 20 May 2019.

Other points that Dr de Mirandés highlighted were the possible redefinition of the second, for which 2026 has been proposed as a tentative earliest date for a redefinition, and the adoption of the term "Kibble balance" in place of watt balance in all future CCU documents, in homage to Bryan Kibble.

Dr Blattner requested further clarification regarding the timeline for the 9th SI brochure and asked that the current draft should be sent to all CCPR members as soon as possible, so that any further changes required can be notified to the CCU in time for the next draft. Dr de Mirandés undertook to ensure this is done. Dr Milton said that issues already identified must be brought up at the forthcoming CIPM meeting and that the whole brochure should be circulated again to all CCs following that meeting. Dr Usuda stressed that a formal approach must be maintained when proposing any corrections and amendments (i.e. all communications to the CCU must come from the CCPR as a whole, not from individual members on an *ad hoc* basis).

10. REPORTS FROM RMO TC CHAIRS

AFRIMETS (presented by Mr Sieberhagen)

Mr Sieberhagen outlined progress in relation to the CCPR pilot comparison for UV transmittance, led by NMISA, and stated that the draft protocol for the comparison is to be available by 1 March 2017. The timetable for the APMP.PR-K5 comparison of diffuse reflectance is to be updated, following which the protocol will be submitted for approval by the participants. NMISA has received two enquiries from NIS (Egypt) regarding potential comparisons, one for luminous flux (also involving PTB) and the second for spectral responsivity in the range 300 nm – 10000 nm.

APMP (presented by Dr Zama)

There is a high level of activity in APMP, with six KCs (including three bilaterals) and four supplementary comparisons (including three bilaterals) in progress. Two pilot studies are also under way, for total spectral radiant flux and transmittance haze. Dr Zama mentioned that there has been

considerable debate recently in the APMP TC-PR regarding the heavy workload associated with comparisons, particularly for the pilot laboratory. It has been suggested that a participation fee should be charged, although this has not been agreed. The need for realistic timescales has also been emphasized, and it is essential that timescales are adhered to once agreed, to assist with resource planning. The principle stakeholder areas are energy efficiency, medical diagnostic equipment and climate change; each of these user groups has very different measurement requirements.

COOMET (presented by Dr Khlevnoy)

Two new members have joined the COOMET TC-PR since 2014 (Turkey and China), together with four new observers (Uzbekistan, Tajikistan, Azerbaijan and Georgia). Five new comparisons have been started and one completed in the past two years, bringing the total number of ongoing comparisons to ten (three KCs and seven SCs). The completed comparison was for refractive index; this had five participants, two from COOMET, two from EURAMET and one from APMP. Two further comparisons are at the planning stage (for surface colour and spectral irradiance).

EURAMET (presented by Dr Gran)

Dr Gran began by describing recent improvements that have been made to the EURAMET website, which are intended to help members share information more effectively. In particular, a new TC research area has been set up which allows users to browse all EURAMET projects, including comparisons and traceability projects, and the 'research / innovation' area has been improved with links to information on all EMRP and EMPIR projects. Dr Gran stated that there are 16 EMRP/EMPIR projects in the TC-PR area, covering topics such as solar UV, Earth observation and climate, LEDs, single photon sources, PQEDs, and measurements of the appearance of materials, and briefly described the objectives and current progress for some of these. Brief discussions followed of the technical details of the single-photon source being developed under the SIQUTE project and the various measurement scales for different attributes of appearance (sparkle, graininess etc.) being developed under the xDReflect project.

Eleven EURAMET TC-PR comparisons are currently under way and Dr Gran reviewed the current status for each of these. He also mentioned that in order to share the workload associated with piloting comparisons, it has been agreed that every member of TC-PR must pilot at least one EURAMET KC in each 20 year period – each NMI has therefore been asked to propose two comparisons that they volunteer to pilot.

SIM (presented by Dr Nadal)

Dr Nadal described recent work by SIM to train members in aspects such as quality systems, preparation of CMCs, and participation in comparisons. This training has been provided via workshops on specific topics, such as revisions to ISO 17025, comparison analysis, and fundamentals of metrology. She also mentioned the NIST-SIM engagement programme, under which representatives from other SIM member institutes can work at NIST for up to one year. Dr Manson asked whether the training in comparisons was intended to increase the number of laboratories willing to act as pilots for comparisons, but Dr Fraser said it was instead aimed at improving basic understanding. He also clarified that the training programmes are not supported financially by NIST, but indicated possible funding from the US government.

Four comparisons are currently under way under the auspices of SIM TC-PR and Dr Nadal briefly reviewed the progress with these. She also mentioned that reviews of the quality systems for SIM members in the area of photometry and radiometry are under way; three have been approved so far and another two (including NIST) will be approved early in 2017.

GULFMET (presented by Dr AlFohaid)

Dr AlFohaid presented the Saudi Standards, Metrology and Quality Organization (SASO), which is currently the only GULFMET laboratory with capability in the area of photometry and radiometry, concentrating on the work of the optics laboratory within the National Measurement and Calibration Center (CMCC). Although the photometry and radiometry team is small (four regular staff and one visiting expert), it covers a broad range of measurements, including spectral responsivity, laser power meter calibration, spectral reflectance and transmittance, luminous flux, luminous intensity, luminous responsivity and luminance. Planned work for the future includes establishment of a gloss scale, a new capability for colorimetric measurements, a facility for spectral irradiance, and a new spectrophotometer to allow measurements over an extended wavelength range (up to 3000 nm). The laboratory also plans to take part in comparisons with other NMIs, either on a bilateral basis or as part of a regional comparison. Dr Lee asked about the traceability of the scales currently disseminated and Dr Alfohaid clarified that this was from UME.

11. STATUS OF THE REVIEW OF THE CIPM MRA

Dr Usuda began by reminding everyone of the original purpose of the CIPM MRA, namely to encourage the mutual recognition of measurement standards and calibration and test certificates. At the time it was signed in 1999 it was expected that the additional workload would be limited to a few additional measurements each year related to intercomparisons and a small quantity of additional reporting. The reality has been a rapid proliferation in the number of CMCs coupled with a steadily increasing number of comparisons, with the burden for piloting these comparisons falling most heavily on a small group of NMIs. A workshop was held in October 2015 to review progress with the CIPM MRA, at which Dr Usuda provided feedback from the CCPR. The outcomes from this review have now been published and a number of recommendations have been made; Dr Usuda presented the first five of these recommendations in the context of the work of the CCPR:

Recommendation 1- On managing the level of participation in KCs more effectively. Work in response to this recommendation is split between all three of the CCPR WGs. WG-SP is responsible for selecting the minimum set of KCs which thoroughly covers the field and for defining the long-term timetable for these. WG-CMC maintains and updates the list of service categories and the rules governing these, including the allocation of supporting KCs. WG-KC conducts the comparisons and coordinates and monitors the KC plan.

Recommendation 2 – On providing better visibility of the services supported by the CMCs. It is recognized that a database containing a mixture of detailed, service-level categories (as is now the case) and broad-scope CMCs (as is now being discussed by several CCs and NMIs) would be confusing; discussions on this point are therefore to continue.

Recommendation 3 – On constraining the proliferation of CMCs. There is general agreement among NMIs that CMCs should represent an NMIs general capabilities rather than listing the details of all services offered. However, it is also appreciated that restricting CMCs to underpinning quantities would limit the ability of emerging NMIs to enter the CMC system. Dr Usuda noted that the CCPR has already started to discuss how to balance these opposing points of view and offered encouragement that these discussions should continue.

Recommendation 4 – On improving the efficiency of the CMC review processes. Dr Usuda noted that WG-CMC and the new Task Groups established during this meeting will take on responsibility for ensuring processes are efficient and followed consistently across the CCPR. In addition, general procedural changes to speed up CMC reviews are being discussed at the CIPM level.

Recommendation 5 - On encouraging and enabling states with developing metrology systems to become signatories and fully participate in the MRA. Dr Usuda indicated that the objective quality assurance provided by CMCs is a valuable tool for emerging NMIs in particular.

The next NMI Directors meeting will be held in October 2016 and Dr Usuda will provide feedback at this meeting on the recent discussions on CMCs by the CCPR. Dr Milton said that further ideas for implementing the recommendations from the CIPM MRA review are likely to emerge in the next six months.

12. LIAISON WITH OTHER ORGANIZATIONS

International Commission on Illumination (CIE) (presented by Dr Blattner)

Dr Blattner began by giving a short overview of the structure of the CIE, followed by a summary of the recently launched CIE research strategy. This strategy highlights ten key areas that the CIE has identified as requiring high-level, international research; of these, three are directly related to the CCPR's interests: calibration sources and illuminants for photometry, colorimetry and radiometry; visual appearance measurement and metrics; and metrology for advanced photometric and radiometric devices.

Dr Blattner then reported on progress towards the revision of the joint BIPM – CIE document "Principles governing photometry", which is being prepared by JTC-2 (CIE-CCPR). This revision will include definitions of new observer functions, for mesopic conditions and large field (10°) conditions, to supplement the photopic 2° and scotopic observers given in the current edition. The revised version will be published in 2018, in conjunction with the revised SI, and will present the new definition of the candela.

Issues related to the most appropriate quantities and units for non-visual retinal effects of light have had a high profile within CIE in recent years, following the discovery of a new class of retinal photoreceptor in 1990. As many as 15 new 'units' have been proposed by some photobiological experts and attempts have been made within CEN to standardize these, and the spectral responsivity curves for the five human photopigments. Dr Blattner reiterated the CIE's desire to ensure correct use of SI units in this field and initiatives undertaken to promote this, including the recent publication of a CIE statement on non-visual effects. The re-instatement, and updating, of Appendix 3 in the SI brochure is regarded as essential and the CIE will approach the CCU directly to raise this issue.

Most of the CIE's work that is of direct relevance to the CCPR falls under Division 2 and Dr Blattner gave a brief summary of the various activities of this Division. He highlighted in particular work towards the introduction of LED-based standard calibration sources for photometry, which is linked with the realization of a prototype transfer standard as part of the European Metrology Programme for Innovation and Research (EMPIR) 'photoLED' project.

The CIE has held several recent events of relevance to CCPR members, including symposia on LED measurements and on appearance metrology, and more are planned for the future; full details are available on the CIE website. Dr Blattner ended by showing a video on the many and varied achievements of the CIE since its inception in 1913, which had been prepared by CIE-UK as part of the 28th Session in 2015.

Council for Optical Radiation Measurements (CORM) (presented by Dr Ohno)

The 8th CORM report on pressing problems and projected national needs in optical radiation measurements has been approved and will shortly be made public; Dr Ohno said he will send a link to this to all CCPR members once it has been published. He presented some of the major findings and highlighted the need for better understanding of measurement uncertainty that had been expressed by a large number of the respondents.

World Meteorological Organization (WMO) (presented by Dr Rüedi)

The 12th international pyrheliometer comparison (IPC) took place at PMOD/WMO from 28 September to 12 October 2015, with participants from 33 countries and a total of 134 pyrheliometers. The comparison confirmed the stability of the World Radiometric Reference (WRR) since the last IPC. A short film to promote the IPC and the importance of traceability for optical radiation measurements for the meteorological community has been produced (https://vimeo.com/164968933) and a short version for the general public is being prepared.

A comparison between the WRR and the SI-traceable Cryogenic Solar Absolute Radiometer (CSAR)/Monitor to Measure the Integrated Transmittance (MITRA) of windows instruments has been carried out and the preliminary results confirm an offset of approximately 0.3 % between the two scales, with an uncertainty of ~ 200 ppm. Work is under way to reduce the uncertainty associated with the comparison still further, by reducing the zero offset due to residual temperature drifts through the use of a new MITRA with a third (dark) cavity.

The 2nd international pyrgeometer comparison has been carried out, using 33 instruments from 18 countries. Discrepancies between scales of about 4 W m^{-2} to 5 W m^{-2} were observed under clear conditions, with somewhat better agreement in cloudy conditions.

A Commission for Instruments and Methods of Observation (CIMO) Task Team on Radiation References (TT-RadRef) has been set up to consider the implications of proposed changes to the solar and terrestrial radiation references and to develop an implementation plan for their introduction. This will carry out its work over the next two years, with the aim of submitting recommendations to CIMO in 2018. It was emphasized that although the WMO is committed to ensuring traceability to the SI, it will be difficult to apply any change in reference to historical databases. There is also some concern amongst WMO members about the use of one type of instrument to establish the link to the SI and a desire to repeat the exercise with other instruments before making any change. Close collaboration with the CCPR and NMIs is essential if these concerns are to be overcome.

The status of recent work relating to determination of the absorption cross-sections of ozone (ACSO) was presented. This knowledge is essential to enable atmospheric ozone measurements from ground and from space to be correlated and to allow satellite measurements (which provide global coverage) to be validated using ground-based measurements. Different ACSO data sets are available, which lead to significant differences in atmospheric ozone concentrations from ground-based, airborne and satellite-based instruments and networks and resolving these discrepancies is therefore an urgent priority. Good progress has been made and recommendations have now been published for the UV to NIR region (see http://igaco-o3.fmi.fi/ACSO).

13. HIGHLIGHTS FROM CCPR MEMBERS ON SPECIFIC TOPICS

Dr Usuda explained that in order to make best use of the limited time available during the meeting, it had been decided that instead of progress summaries from each of the NMIs, a small number of more in-depth presentations should be given, detailing recent advances in key topic areas. The topic areas for future meetings could be different and Dr Usuda indicated that suggestions and volunteers will be sought in advance.

The presentations are included in the working documents of the meeting. The sections below summarize the discussions, if any, arising from the presentations.

13.1 Few photon metrology

Presentations were made by Dr Lee (KRISS) and Dr Kück (PTB). Dr Kück asked about the signal levels from the SPDs when used for direct comparison with silicon photodiodes at KRISS. Dr Lee stated that levels of at least several thousand counts per second were typical, with >10 000 cps being the ideal. Dr Zama asked about the discrepancy between the measurements made at the National University of Busan and those made at KRISS, shown in slide 6 of the presentation. Dr Lee explained these were thought to be due to differences in the optical set up and possible inter-reflection effects, which would be reduced by improved fibre coupling efficiency measurements in the future.

13.2 LED sources in photometry

This topic was presented by Dr Zama (NMIJ), Dr Ohno (NIST) and Dr Lin (NIM). Dr Sperling asked whether the LEDs used in the source developed by NMIJ and Nichia Corporation as a transfer standard for total spectral radiance flux measurements in 2π geometry are readily available and has the source been shown to be sufficiently stable for this purpose. Dr Zama indicated that the LEDs are commercially-available and that the stability is good. Following Dr Ohno's presentation, Dr Zama asked whether significant effects due to sphere paint fluorescence had been observed when evaluating the artefacts used in the NIST measurement assurance programme, MAP2. Dr Ohno said this had been checked and although it had been a problem with the small sphere, as previously reported, it was insignificant in the case of the 2.5 m sphere used in this exercise. Dr Lin was asked whether the LED filament lamps being developed in China for use as luminous flux transfer standards are

commercially available and explained that at present they are prototypes only and therefore specially made.

13.3 Radiometry metrology for Earth observation

Dr Schmutz (PMOD/WRC), Dr Fox (NPL) and Dr Sapritsky (VNIIOFI) presented this topic. Dr Schmutz described issues related to total solar irradiance (TSI) measurements and work at PMOD/WRC to assess and improve the long-term validity of TSI data, after which Dr Fraser asked whether he was now confident enough in the traceability of the latest satellite calibrations to the SI, so that even if a 20-year gap in measurements was to occur in the future, the TSI record could nevertheless be reproduced. Dr Schmutz confirmed this is the case. Dr Fox's presentation prompted Dr Fraser to highlight the potential impact of climate change on the World economy (trillions of USD) and to ask whether such arguments carried great weight when seeking funding for missions such as Traceable Radiometry Underpinning Terrestrial- and Helio-Studies (TRUTHS). Dr Fox said that in his experience more success is gained by giving specific examples of the possible impacts on people's lives and the environment.

14. MEMBERSHIP OF CCPR AND ITS WORKING GROUPS

Dr Usuda indicated that the SCL (Hong Kong (China)) has made an application to join the CCPR as an observer and invited Dr Lee, the Head of the SCL, to present an overview of the laboratory's work and its activities in the field of photometry and radiometry (his presentation is included in the working documents of the meeting). Dr Yin stated that he supported this application from a technical perspective and Dr Zama said that the SCL already participates in the work of APMP and he therefore also supports the application. All other delegates indicated their approval. Dr Usuda said this would be discussed at the next CIPM meeting.

Issues relating to the membership of WG-CMC had been discussed at length earlier in the meeting and Dr Usuda once more presented the decisions that had been reached, for final ratification. The new membership rules (see report on agenda item 6) were approved and it was agreed that there would be no change to the terms of reference for the WG. Dr Usuda also reiterated that although under the previous membership rules Dr Khlevnoy would have taken over as chair of this WG at this meeting, he had said that he was unable to accept this position and had therefore resigned with immediate effect. A new procedure will therefore be followed for this occasion only, whereby a call for nominations will be issued. If multiple nominations are received, the CCPR President will select an appropriate candidate based on experience of CMC work, capability, diversity, and other considerations. The appointed candidate will be announced by the Executive Secretary for endorsement by the CCPR members.

AP7: A call for nominations for the position of WG-CMC Chair will be issued by 30 September 2016, with a deadline of 30 October 2016.

15. RECOMMENDATIONS TO THE CIPM AND ANY OTHER BUSINESS

In response to the earlier discussion relating to the latest draft of the 9th SI brochure, Dr Usuda will formally advise CIPM and CCU of the CCPR's recommendation that Appendix 3 should be reinstated. There was no other business raised by any of the CCPR members.

16. DATE OF NEXT MEETING

It is proposed to organize the next meetings of the CCPR Working Groups in 2017 in Tokyo, in conjunction with the Newrad conference which will take place from Tuesday 13 to Friday 16 June. The Japanese delegate to the CCPR will ask the Executive Secretary to announce the official dates for the WG meetings once these have been finalized.

Dr Usuda asked Dr Milton whether the next CCPR meeting is planned for September 2018. Dr Milton replied that the date should be discussed once the new CCPR President has been appointed and that the selected date will need to take account of several events already planned to take place at the BIPM in September 2018, before the CGPM.

Dr Usuda closed the meeting by thanking everyone for attending and expressed the great pleasure it has been to chair the CCPR. He stated that radiometry opened a window to the quantum world at the beginning of the last century, and that photometry and radiometry together will continue to be at the forefront in future years.

Dr Usuda also said that he will support the WG meetings in Tokyo and wished success to the future CCPR President who will have many important tasks to fulfill, with the revision of both the CIPM MRA and the SI.

Dr Fox thanked Dr Usuda as he brought new insights to the photometry and radiometry community and demonstrated a real desire to be part of the process. This was really appreciated by all CCPR members and Dr Fox said he hopes Dr Usuda will maintain his interest in the CCPR activities into the future.

Dr Usuda finished by expressing his thanks to the previous Executive Secretary, Dr Michael Stock, and to the new one, Dr Joële Viallon. He asked Dr Milton to give his best regards to all the BIPM staff who made the meeting so comfortable.

APPENDIX 1

WORKING DOCUMENTS SUBMITTED TO THE CCPR AT ITS 23RD MEETING

Documents listed below were submitted to the CCPR meeting and can be accessed on the CCPR website. Access to documents indicated with a star* is limited to attendees of the meeting.

File	Title
CCPR/16-01*	convocation to the 23rd CCPR meeting
CCPR/16-02	Agenda of the CCPR 2016
CCPR/16-03*	Schedule of CCPR working group meetings 2016
CCPR/16-04*	Questionnaire on activities in radiometry and photometry
CCPR/16-05	Report of the 22nd meeting of the CCPR
CCPR/16-06	CENAM progress report
CCPR/16-07	NRC progress report
CCPR/16-08	PTB progress report
CCPR/16-09	UME progress report
CCPR/16-10	MSL progress report
CCPR/16-11	NIM progress report
CCPR/16-12	INMETRO progress report
CCPR/16-13	NIST progress report
CCPR/16-14	IO-CSIC progress report
CCPR/16-15	NMISA progress report
CCPR/16-16	NMIA progress report
CCPR/16-17	NPL progress report
CCPR/16-18	KRISS progress report
CCPR/16-19	CMS-ITRI progress report
CCPR/16-20	LNE progress report
CCPR/16-21	METAS progress report
CCPR/16-22	VSL progress report
CCPR/16-23	NMIJ progress report
CCPR/16-24	PMOD-WRC progress report
CCPR/16-25	MIKES progress report
CCPR/16-26	NMC-A*STAR progress report

CCPR/16-27	INRIM progress report
CCPR/16-28	SMU progress report
CCPR/16-29	CMI progress report
CCPR/16-30	VNIIOFI progress report
CCPR/16-31	Report of the WG-CMC to CCPR 2016
CCPR/16-32	CCPR WG-CMC Workshop on CMC Review Summary
CCPR/16-33	Report of the WG-KC to CCPR
CCPR/16-34	Report of the WG-SP to CCPR
CCPR/16-35*	News from the CCU to CCPR
CCPR/16-36	Report of AFRIMET TC-PR to CCPR
CCPR/16-37	Report of COOMET to CCPR
CCPR/16-38	Report of Euramet TC-PR to CCPR
CCPR/16-39	Report of SIM TC-PR to CCPR
CCPR/16-40	Photometry and Radiometry in SASO
CCPR/16-41	Liaison report from WMO to CCPR
CCPR/16-42	CIE report to CCPR
CCPR/16-43	CORM report to CCPR
CCPR/16-44*	Few photon metrology at KRISS
CCPR/16-45	Few Photon Metrology at PTB
CCPR/16-46	NMIJ research activities relevant to LED sources for photometry
CCPR/16-47	LED sources in photometry at NIST
CCPR/16-48	Development of LED filament standard lamps
CCPR/16-49	Measuring absolute total solar irradiance
CCPR/16-50	Earth observation and climate measurement
CCPR/16-51	VNIIOFI activities in radiometry and photometry for earth observation
CCPR/16-52	Presentation of SCL activities

APPENDIX 2

SUMMARY OF ACTION POINTS

AP1 (page 7): Missing progress reports to be supplied to Dr Viallon by the end of the year, together with any revisions to those reports already submitted. All reports will be published in the open access area of the BIPM website at the start of 2017 unless a specific request not to do so is received.

AP2 (page 9): All NMIs with entries under 1.1.2 should update their CMC tables with the new number. The relevant RMO TC Chair will report this CMC tables update at the next CMC-WG meeting.

AP2 (page 10): The rules governing membership of WG-CMC will be revised as agreed, with immediate effect. A new sheet, for Task Groups, in the WG-CMC section of the CCPR website, will be added.

AP4 (page 12): Dr Ohno to send a letter on behalf of CCPR WG-KC to Dr Gran (EURAMET TC-PR Chair) highlighting the conflict between the EURAMET and CCPR guidelines, for discussion at the forthcoming meeting of EURAMET TC Chairs.

AP5 (page 14): Dr Zwinkels to send points of clarification and correction relating to the candela to CCU immediately, for incorporation in the next draft of the 9th SI brochure.

AP6 (page 14): CCPR President to inform CCU that CCPR requests that Appendix 3 is reinstated in the 9th SI brochure.

AP7 (page 21): A call for nominations for the position of WG-CMC Chair will be issued by 30 September 2016, with a deadline of 30 October 2016.

APPENDIX 3

SUMMARY OF CCPR APPROVALS

- Establish 2 new Task Groups in WG-CMC: TG1 to update the PR CMC supporting evidence file (Chair: Maria Nadal. Members: Teresa Goodman; Boris Khlevnoy; Dong-Hoon Lee; Marek Šmíd). TG2 to prepare guidelines for CMC review in CCPR (Chair: Teresa Goodman. Members: to be confirmed).

- Establish a new task group in WG-SP, TG13, to conduct a pilot study comparison into optical fibre power responsivity measurements using a fibre-coupled cryogenic radiometer as the reference.

- Request to the CIPM that it approve HKSCL as an Official Observer of the CCPR.