Bureau International des Poids et Mesures

Consultative Committee for Photometry and Radiometry (CCPR)

Report of the 26th meeting
(3-7 June 2024)
to the International Committee for Weights and Measures

Comité international des poids et mesures

LIST OF MEMBERS OF THE
CONSULTATIVE COMMITTEE FOR PHOTOMETRY AND RADIOMETRY
as of 3 June 2024

President

Dr M. L. Rastello, member of the International Committee for Weights and Measures.

Executive Secretary

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

Members

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

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.

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.

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

National Institute of Metrological Research/Istituto Nazionale di Ricerca Metrologica [INRIM], Turin.

National Institute of Metrology [NIM], Beijing.

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

National Measurement Institute of Australia [NMIA], Lindfield.

National Metrology Centre, Agency for Science, Technology and Research [NMC, A*STAR], Singapore.

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

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

National Metrology Institute of Turkey /TÜBITAK Ulusal Metroloji Enstitüsü [UME], Gebze

National Physical Laboratory [NPL], Teddington.

National Research Council of Canada [NRC], Ottawa.

Norwegian Metrology Service/Justervesenet [JV], Kjeller

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

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig.

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

VSL Dutch Metrology Institute [VSL], Delft.

VTT Technical Research Centre of Finland Ltd, Centre for Metrology / Mittatekniikan keskus [MIKES], Espoo.

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

Observers

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

National Scientific Centre "Institute of Metrology"[NSC IM], Kharkiv.

Standards and Calibration Laboratory [SCL], Wanchai.

Liaisons

International Commission on Illumination [CIE].

World Meteorological Organization [WMO].

Representatives of Institutes from Member States invited to attend as Observers:

CSIR National Physical Laboratory of India [NPLI].

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

The Consultative Committee for Photometry and Radiometry (CCPR) held its 26th meeting on Thursday 6 and Friday 7 June 2024.

The meeting was chaired by the CCPR President, Dr M.L. Rastello (CIPM member).

The following delegates from member institutes were present: E. Atkison (NMIA), I.H. Bae (KRISS), Ö. Bazkir (UME), G. Borghi de Almeida (INMETRO), G. Brida (INRIM), J. Campos Acosta (IO-CSIC), H. Castillo Matadamas (CENAM), I. Couceiro (INMETRO), P. Dekker (VSL), J. Dubard (LNE), A. Dunaev (VNIIOFI), M. Dury (NPL), J. Echeverría-Villagómez (CENAM), F. Eloi (LNE), N. Fox (NPL), H. Gan (NIM), J. Gran (JV), J. Gröbner (PMOD), E. Ikonen (MIKES), J. Ireland (NPL), E. Ivashin (VNIIOFI), B. Khlevnoy (VNIIOFI), K. Kinoshita (NMIJ/AIST), J. Kosvanec (SMU), M. Krempasky (SMU), S. Kück (PTB), J. Lehman (NIST), S. Lim (KRISS), H. Liu (NIM), C. Matamoros Garcia (CENAM), A. Meda (INRIM), T. Menegotto (INMETRO), E. Molloy (MSL), J. Morel (METAS), M. Nadal (NIST), G. Obein (LNE-LCM/Cnam), Y. Ohno (NIST), M. Rastello (CCPR), M. Richter (PTB), H. Shitomi (NMIJ/AIST), M. Smid (CMI), A. Sperling (PTB), F. Stuker (METAS), N. Swift (MSL), M. Tanabe (NMIJ/AIST), A. Todd (NRC), J. Zhang (NMC, A*STAR), W. Zhao (NIM),

Observers: C. Chen (CMS/ITRI), M. Huriev (NSC-IM), S.L Steven Yang (SCL), B. Lam (SCL).

Liaisons : D-H Lee (CIE), I. Rüedi (WMO).

Representatives of Institutes from Member States invited to attend as Observers: V.K. Jaiswal (NPLI).

Invited: M. Al Fohaid (SASO-NMCC), J. Bábaro (INTI) A. Bescupschi (NMI (MD)), P. Blattner (METAS), A. Koo (MSL), D. Elouga (NMISA), E. Woolliams (NPL).

Also attending the meeting: J. Viallon (Executive Secretary of the CCPR, BIPM), M.J.T. Milton (Director of the BIPM).

Dr Rastello, the President of the CCPR, opened the 26th meeting of the CCPR and welcomed the participants. She introduced the CCPR officials, Dr Nadal (WG-SP chair), Dr Smid (WG-CMC chair), Dr Gan (WG-KC chair) and Dr Viallon (CCPR Executive Secretary) and thanked them for their excellent work. She welcomed the online participants and announced that the meeting will be recorded. She introduced the 25 members in alphabetical order by NMI and as the official delegate to introduce the delegation. She welcomed in specific JV (Norway) and INMETRO (Brazil) as new members of the CCPR and NSC-IM (Ukraine) as official observer according to Decision CIPM/111-9 (2022).

2. APPOINTMENT OF THE RAPPORTEUR

Dr Kück (PTB, Garmany) was appointed as rapporteur for the meeting.

3. APPROVAL OF THE AGENDA

Dr Rastello presented the agenda for both days. The sequence of the working group presentations was changed to give Dr Smid more time to prepare his report; the WG-CMC meeting had taken place in the morning. She asked for the approval of the agenda. All members agreed.

Another change was adopted at the end of the first day: agenda point 12 (report of the CCPR WG-SP workshop on the future of the candela) was discussed before agenda points 9 to 11 to accommodate the speakers for these points who only joined the meeting for the second day.

4. ACTIONS FROM THE 25TH MEETING

The action points from the 25th meeting of the CCPR were reviewed.

AP1. Dr Koo to send out a fresh invitation to refresh membership of the CCPR-WG-KC-TG3 on the use of the Mandel Paule process in comparison analysis.

This was done in May 2022. There are currently six people in CCPR-WG-KC-TG3.

AP2. Dr Smid to share the SIM document on the “CMC step-by-step guideline for reviewers” with all participants.

This was done in September 2022, the document was shared with the CCPR members for further discussion.

AP3. Mr Sieberhagen to reach out to Egyptian and Kenyan NMIs and convey the invitations for both institutions to participate in the next CCPR meeting as observers.

This could not be completed. Some discussions took place, however, the two NMIs were not formally invited. Dr Rastello suggested to follow-up on this action and extend the invitation to India. She noted that an alternative person is needed, because Mr Sieberhagen has left NMISA.

AP4. WG-SP to start a discussion forum on the new $V_F(\lambda)$ and plans for a workshop on the cone fundamentals and its impact.

This has been done following the creation of CCPR-WG-SP-TG16 “Cone Fundamental”, which organized a joint workshop with the CIE on 3 June 2024.

5. NEWS FROM THE CIPM AND CGPM

Dr Rastello gave a presentation about the 27th meeting of the CGPM (2022). In total seven resolutions were decided, which will lead the activities of the CIPM for the coming years. Dr Rastello briefly reported on all seven resolutions and focused on the three that were of most relevance to the CCPR:

Resolution 6 of the 27th CGPM (2022) *On universal adherence to the Metre Convention.* Currently there are 64 Member States and 36 Associates, which represent 98 % of the world's GDP. The intention is to further increase the number of Member States and Associates. Associates should be encouraged to become Member States (Resolution 4 of the 24th CGPM (2011)). Eighty-five countries are neither members nor associates, however, 60 of those countries participates in RMO activities. A further 25 countries do not participate in RMO activities. Dr Rastello stated that the CCPR has the goal to increase membership and it should take actions to achieve this. She mentioned Kenya, Egypt and India as being countries which the RMOs should contact in this respect.

Resolution 3 of the 27th CGPM (2022) adopted four new prefixes for the units, two to express very small numbers (ronto, quecto) and two to express very large numbers (ronna, quetta).

Resolution 2 of the 27th CGPM (2022) *On the global digital transformation and the International System of Units*. Dr Rastello pointed out the importance of global acceptance, the adoption of the FAIR principles and the implementation of Digital Calibration Certificates (DCC). The Forum on Metrology and Digitalization (FORUM-MD) was established in 2023 (Decision CIPM 112-38 (2023)). Dr Rastello called for participation, noting that the invitation is also to other institutions and organizations to be observers, in particular signatories of the *joint statement of intent on the digital transformation in the international scientific and quality infrastructure*. The first meeting was chaired by Prof. J. Ullrich, with Dr McDonald (NRC) acting as Vice-chair. Dr Rastello referred to agenda item 11 on this topic, presented by Dr Blattner.

Dr Rastello also referred to the confusion about the term "BIPM", which refers to the organization and not the technical staff at the Pavillon de Breteuil. She clarified that the term "BIPM headquarters" ("BIPM siege" in French) should be used in this latter case.

Dr Rastello informed the CCPR about CIPM Decision CIPM/112-11 (2023) to establish a "CIPM Sectorial Task Group on Climate Change and Environment". More information on this task group will be given on Friday in the presentation by Dr Woolliams.

Dr Rastello presented the results of the last election of CIPM members.

Finally, Dr Rastello gave details of the upcoming 150th anniversary of the signing of the Metre Convention. The celebrations will take place between 19–22 May 2025. There will be a reception, a celebration at the UNESCO headquarters and a conference entitled "From units to the universe – future revolutions in metrology". Topics at this conference, amongst others, will be Quantum Technology, Digitalization, and "New second".

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

Dr Nadal gave a presentation about the WG-SP meeting, which took place on 6–7 June 2024. There are currently 14 members, of which 13 members, the CCPR officials and 10 observers were present at the meeting (on-site or online).

Dr Nadal reported that all decisions and action points from the last meeting have been completed. There are currently 12 active task groups. She stated that there are new chairs for TG7 (Angela Gamouras, NRC) and TG12 (Zhao Weiqiang, NIM). New task groups have

been formed: TG15 The Impact of Digitalization on Matters Related to the CCPR, TG16 Cone Fundamentals, and TG17 Discussion Forum on Metrology for Satellite Observations. Dr Nadal presented the activities of all active TGs.

TG6 Discussion Forum on Fibre Optics, chaired by Jimmy Dubard: the terms of reference were all addressed, activities of the TG should be continued, however, a new chair to follow Dr Dubard is being sought.

TG7 Discussion Forum on Few Photons Metrology, chaired by Angela Gamouras: Dr Nadal emphasized that this is a large TG with 46 members from 14 countries. Recent activities included a presentation at the BIPM Workshop on Accelerating the adoption of Quantum Technologies through Measurements and Standards (21–22 March 2024). Further topics are the workforce development and the summer school "<Q|School Single Photonics Short Course: Sources, Detectors and Measurements" (6–9 August 2024, University of Colorado, Boulder).

TG8 Discussion Forum on THz Metrology, chaired by Andreas Steiger: The objective of this group is to carry out a pilot study of reflection measurements by means of THz time-domain spectroscopy. The comparison should start soon, and Dr Nadal invited interested participants to contact the chair, Dr Steiger (PTB).

TG9 OTDR Length Comparison, chaired by Jacques Morel: A first supplementary comparison on OTDR Length is in preparation.

TG10 CCPR Strategy Document, chaired by Maria Nadal: Dr Nadal reported on the CCPR strategy document and briefly presented the Vision and the Mission of the CCPR. A revision of the CCPR roadmap is planned for October 2025. Dr Nadal presented current updates of the CCPR roadmap, specifically updated goals, progress and highlights.

SI-future of the candela: a new task group, TG16 on Cone Fundamentals, was established in June 2022. A CIE-CCPR expert workshop on 100 Years of $V(\lambda)$ and the Future of Photometry was held on 3 June 2024, and a workshop on the Future of the Candela on 4 June 2024.

A new task group on the SI framework for digitalization in photometry and radiometry was established in April 2022: TG15, on the Impact of Digitalization on Matters Related to the CCPR.

Development of LED-based standard lamps to replace incandescent standard lamps in the field of photometry and radiometry: within TG12, a questionnaire to survey the field including activities related to the LED reference spectrum by CIE (L41) and research activities related to the LED-based calibration sources for photometry will be prepared.

A new task group for climate and environmental observations was established in October 2023 - TG 17: Discussion Forum on Metrology for Satellite Observations.

A chairperson needs to be selected, and a new task group formed for "Spectrally Resolving detector as primary Scale and as Transfer Standards for Radiometry and Photometry". The statement for the group was revised.

Activities for "few photons metrology" will be carried out by TG7: Discussion Forum on Few Photons Metrology. A survey on detectors and sources is planned.

The area of UV metrology (200 nm to 400 nm) will require a new task group. Cameron Miller (NIST) will take care of this and the next activity is to define the Terms of Reference.

The first task in the area of optical properties of materials will be the selection of three to five metrological areas of maximum importance to members, before considering more specific activities. Gael Obein will take care of this.

TG11 Single Photon Radiometry is chaired by Stefan Kück. A pilot study is ongoing with completion and a final report expected in June 2025.

TG12 Discussion Forum on the Use of White LED Sources for Photometry is chaired by Zhao Weiqiang. A new title was proposed to include radiometry: “Discussion Forum on the Use of LED sources for Radiometry and Radiometry”. A questionnaire is in preparation to better determine the needs in applications and a potential pilot study.

TG13 Optical Fibre Power Responsivity is chaired by John Lehman. The comparison on optical fibre power responsivity will restart in 2024.

TG14 Discussion Forum on Radiometry to Support Gravitational Wave Detection is chaired by John Lehman. A calibration “subway” map for the regular and necessary calibrations of the power meter standards for the gravitational wave detectors LIGO (located in the USA) and VIRGO (Italy) was implemented. In the future, the projects LAO (India) and KAGRA (Japan) will also be included.

TG15 The Impact of Digitalization on Matters Related to the CCPR has been chaired by Thiago Menegotto since May 2024, replacing Peter Blattner. The new TG started with a review of digitalization activities at NMIs and drafting their terms of reference. More information will be provided in a report to the CCPR by Peter Blattner in agenda item 11.

TG16 Cone Fundamentals is chaired by Yoshi Ohno. The TG organized a workshop on cone fundamentals on 3 June 2024. Dr Ohno will report in detail about the workshop in agenda item 12. A close collaboration with CIE RF05 is being sought.

TG17 Discussion Forum on Metrology for Satellite Observations is chaired by Emma Woolliams. The group agreed on its Terms of Reference, which are to provide a consistent and coordinated response from the NMI radiometry community to the needs of the satellite observation communities, particularly those related to climate change. CCPR WG-SP has created a task group on satellite observations with the responsibility of developing a roadmap for how metrology institutes can respond to the BIPM-WMO Metrology for Climate Action Workshop recommendations. Emma Woolliams will report in detail about the activities of this group in agenda item 10.

Dr Nadal discussed future meetings. In 2025 a venue is being sought for the CCPR WG meetings, possibly in combination with a conference and preferably at an NMI. The WG meetings in 2026 should be held in combination with NEWRAD 2026 or with the CIE Div 2 meeting.

Dr Rastello commented that in 2025 there will be a CIE convention in Vienna and the Austrian NMI, BEV, should be contacted. She noted that Austria is not a member of the CCPR but is active in EURAMET. Another possible location would be Prague (Czechia). Dr Smid expressed his willingness to host.

Dr Rastello thanked Dr Nadal for her presentation and asked for questions and comments. There were none.

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

Dr Gan, Chair of the Working Group on Key Comparisons, presented his report on its activities. The Working Group met on 5 June 2024 and there were 21 participants in person and 10 online. NMISA was the only missing member. Martin Dury acted as the recording secretary. The agenda was approved with small changes to allow Dr Koo from MSL to participate at an appropriate time, because of the large time difference with New Zealand.

Dr Gan stated that the meeting included Key Comparison progress reports; three from the TG chairs and the five from the RMO TC chairs.

Dr Gan reported on progress with the decisions and action points that were still active since the WG-KC meeting of 2023. They are:

- CCPR-WG-KC-TG2 (RMO linkage) is closed after the completion of its last action.
- CCPR-WG-KC-TG3 (Comparison Analysis) had been assigned a new task, to create a numerical tool for data analysis, which can be also used for RMO linkage. This is still on-going.
- WG-KC chair had been asked to revise guidelines G4 to clarify that the use of the artefacts from the previous comparison is only allowed when they are “not identified by the pilot nor by other participants”. Since then, the request was withdrawn as participants in the comparison CCPR-K1.b agreed that previous artefacts can be used.
- The previous chair Dong-Hoon Lee had been asked to re-send the review comments of CCPR WG-KC on CCPR-S3.x to the pilot lab NPL (Teresa Goodman), which he did after the 2023 meeting.
- Rheinhardt Sieberhagen had been asked to organize an online meeting of TG1 (with additionally interested participants NRC, MIKES, CMI, and NIM) to discuss the technical approach for a comparison. Due to the unavailability of Mr Sieberhagen, this has not been completed. Dr Gan will contact NMISA for advice.
- The WG-KC chair was requested to contact the CCPR Executive Secretary, Joële Viallon, to organize a change of contact person for TG1 from Natasha Nel-Sakharova to Rheinhardt Sieberhagen. This was done but a new chair needs to be found again since the resignation of Rheinhardt Sieberhagen from NMISA.
- Emma Woolliams had to revise CCPR guidelines G6 with a footnote to indicate caution with equation usage. A text was prepared and should be submitted to the WG-KC chair for approval by the working group.

Dr Gan reported that there has been a discussion on the membership criteria for WG-KC, it was concluded that there is not a problem for now.

Dr Gan presented the status of ongoing comparisons and noted that no final report has been published since the last meeting. He listed the progress with each comparison:

- CCPR-K4.2017: the Draft A2 is on hold due to strict export controls in Japan, which hinders a data transfer to the participants.
- CCPR-K2.b.2016 The Draft B report was submitted for review on 28 May 2024.
- CCPR-K2.a.2016: A proposal for the missing measurements at specific wavelengths was presented during the WG-KC meeting, i.e., an additional measurement round has to be carried out by the pilot.
- CCPR-K5.2019: There are delays due to strict regulations concerning exports and customs.
- CCPR-K1.b.2024: Final agreement on the technical protocol was reached in June 2024 and measurements are expected to take place at NIST between May and October 2025.
- CCPR-K2.c.202x: There are currently more than 12 possible participants. A procedure for reducing the number based on the Guideline G4 will be followed. A task group for the technical protocol needs to be formed.

Dr Gan presented an update on the status of the comparisons' review. He presented the current review requests and stated that some reviews are on hold because of time constraints and staff that are overloaded. Dr Gan suggested giving reviewers more time for the review process.

Dr Gan reported on the RMO reports. The RMO TC chairs gave their reports; there was no report from AFRIMETS. Dr Gan presented briefly the RMO reports from APMP, COOMET, EURAMET, GULFMET and SIM. Dr Gan stated that for GULFMET, the WG-KC gave advice for planning KCs.

Dr Gan reported on the activities of the task groups, which are:

TG1 Pilot comparison for spectral regular transmittance in the UV: the WG-KC chair has an action point to contact NMISA concerning the next steps.

TG2 RMO linkage: Dr Gan reported that Dr Woolliams worked on the differences between two calculation approaches and that she gave recommendations on how to address this in guideline G6. Dr Gan stated that there is an action on this. Dr Gan reported that there will be a project proposal on the software development for comparison analysis within the European Partnership on Metrology programme.

TG3 Comparison analysis: Dr Gan reported that different approaches to account for inconsistencies and dark uncertainties were presented and discussed. Four options were specifically discussed in the task group. Dr Gan reported that there was an intensive discussion on the choice of the best option, with a general feeling that the field of photometry and radiometry is still maturing.

TG4 Pilot study for the use of alternative standards for photometric comparisons: Dr Gan reported that the group agreed on the technical protocol to measure luminous flux but is still discussing how to compare luminous intensity measurements.

Dr Gan reported on necessary changes in the guidelines for Key Comparisons, because thus far tables about the number of participants from different groups of RMOs did not consider GULFMET. Dr Gan presented a recommendation from the WG-KC, which was unanimously supported by its members, i.e. Group 1: EURAMET + COOMET: 6, APMP + AFRIMETS + GULFMET: 4, SIM 2.

Dr Gan reported that WG-KC will follow the suggestion from CCPR regarding the next meeting dates.

Dr Gan thanked all participants for their contribution to the effective and efficient WG-KC meeting.

Dr Rastello thanked Dr Gan for his impressive work and achievements, emphasizing the fact that Dr Gan is an incoming chair.

Dr Rastello asked for questions and comments.

Dr Khlevnoy asked why VNIIOFI was not on the list of participants for CCPR-K2.c.202x. He stated that in the WG KC meeting, VNIIOFI was still listed. Dr Gan stated that he will check this, which was done before the end of this meeting, confirming that VNIIOFI was included in the list of participants. Dr Gan apologized for the confusion.

Dr Rastello asked for a decision from the CCPR members about the change in the group structure recommended by WG-KC in the guideline G3. She asked if anyone was against the modification on the group table. There were no objections, no abstentions and the modification in the group table in guideline G3 was approved:

> **CCPR Decision 1 (2024)** – CCPR Guidelines G3 section 2.2 shall be modified to include GULFMET in the table listing the maximum number of participants of each RMO. The three groups and participants limits will be: Group 1) EURAMET + COOMET: 6, Group 2) APMP + AFRIMETS + GULFMET: 4, Group 3) SIM: 2.

Dr Matamoros asked how many members of GULFMET are members or observers of the CCPR. Dr Fox commented that Dr Matamoros probably meant that including GULFMET in Guidelines G6 is just an academic question. Dr Smid stated that GULFMET is also mentioned, because it manifests the existence of GULFMET. Dr Viallon clarified that this change means that the total number of participants from the group 2 (APMP, AFRIMETS and GULFMET) is in total four, not solely from GULFMET.

After the coffee break the decision stated above for guideline G3 was extended to guideline G4.

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

Dr Smid presented the outcomes of the WG-CMC meeting, which took place on 6 June 2024. There have been two WG-CMC meetings since the last CCPR meeting, one in September 2023, the other was earlier in the day. Dr Smid reported that the WG-CMC has four Task Groups and reported on their activities.

TG1 Use of comparison results in assessment of CMC claims: Dr Smid reported that Guideline G8 was implemented, which considers the impact that the use of the Mandel-Paule method (or any other dark uncertainty method) will have on CMC claims. Dr Smid reported that four options were derived. After discussion in the WG-CMC, the position is that there is a preference for option 4, which finally culminates in option 3, when all potential review processes will be completed. The intention is to require all CMC claims to include any extra uncertainty. Dr Smid briefly presented the four options, stating their advantages and risks:

1. Do Nothing.
2. No need for consistency, just report the results raw, with the weighted mean, and leave the CMC question out of the comparison process.
3. Force consistency (for example Mandel Paule) and take corporate responsibility for divergence in CMC claims – i.e. everyone must increase CMCs by the amount of 'extra uncertainty' required to achieve consistency.
4. Open the analysis process to resolve issues as much as possible and reduce inconsistency – better review of uncertainty budgets, identify labs which appear as outliers and invite more scrutiny, maybe even improve and amend results during the process – minimize 'extra uncertainty' required).

Dr Smid stated that the WG-CMC notes that a possible exclusion and self-exclusion should still be considered.

Dr Fox commented that the WG responded to a draft report from WG-KC, which was not approved. Dr Smid responded that this is only information for the community.

TG2 Update Excel PR CMC Supporting evidence file and Classification of services in PR: Dr Smid stated the objectives and summarized the activities carried out since 2022 based on the objectives. The list of supporting evidence was updated. New structures for fibre optics and terrestrial irradiance were implemented.

Dr Smid reported on the second objective, the harmonization of CCPR's CMC entries. He reported that the RMO's TC chairs were asked to report about the status of the revisions for the inconsistency requests in the CMC database. Dr Smid thanked Dr Blattner for his work and support on this topic. Dr Smid further reported on the process, also for the upcoming service categories and stated that there are now 780 entries to be revised. He commented that problems may arise from changes in personnel. He emphasized that the advantage of harmonization is that the database will be more robust for machine reading and machine interpretability.

TG3 Clarify and harmonize CMC review process: Dr Smid presented the objectives of the TG and noted that the 3rd objective (to ensure these rules are consistently applied across the CCPR RMOs) is still ongoing. He presented the activities and emphasized the guideline G9 (Rules for review of CMC claims and requirements for supporting evidence), where SIM implemented instructions for CMC writers prior to CMC claim submission.

TG4 Recommending a CMC structure for fibre optics: Dr Smid recalled the background for this TG, i.e. that the service categories' structure did not match customer requests. He presented the objectives and the timeline for the restructuring. The new structure was

implemented on 10 July 2023; however, a revision was needed because of the misleading use of the term “Fibre” in front of all measurands, for example “Fibre responsivity”. Dr Smid stated that TG4 has become a natural point of contact for machine reading and for digitalization with respect to fibre optics.

Dr Rastello thanked Dr Smid for the presentation and asked for questions or comments.

9. APPLICATION TO BECOME A MEMBER OF THE CCPR BY NSC “INSTITUTE OF METROLOGY”

Mykola Huriev from NSC-IM (Ukraine) presented the activities of the National Scientific Centre “Institute of Metrology”, NSC-IM. He stated that the institute is continuing to operate using residual employees, who still work at the institute. The institute has seven scientific centres. NSC-IM has five CMCs in the field of photometry and radiometry and has established ten national standards. Mr Huriev reported on a recent publication in the field of LED photometry, which addressed the mismatch factor occurring when using an LED or a lamp, which will be published in June 2024. Specifically, Mr Huriev mentioned the use of filtered incandescent lamps for matching LED spectra. NSC-IM has participated in the comparison COOMET.PR-S11 on Colour reflected, and the final report has been published. NSC-IM claimed five CMCs from this comparison. Mr Huriev furthermore stated that NSC-IM participates in European metrology projects, for example in the framework of the European Metrology Research Programme on Innovation and Research. Mr Huriev stated that NSC-IM has been an Associate member of EURAMET since 2023. The institute published the *Ukrainian Metrological Journal*.

Dr Rastello thanked Mr Huriev for the presentation and stated that NSC-IM is currently an official observer and wishes to become a member. She opened the discussion stating that CCPR can approve the application of NSC-IM, however, the CIPM will take the final decision.

Dr Gan asked about other metrology laboratories in Ukraine. Mr Bescupschi responded that there are four designated institutes in Ukraine and that NSC-IM is one of them. CMCs within the CCPR are from NSC-IM and Ukrmetrteststandart.

Dr Khlevnoy asked whether NSC-IM is an Associated member of EURAMET. Dr Fox asked about whether NSC-IM can submit CMCs. Dr Kück stated that for the Ukraine the Ministry of Economy of Ukraine is listed under “Associated: Corresponding Applicants” and that CMC claims have recently been submitted.

Dr Rastello asked if there were any objections to the application by the Ukraine to become a member of the CCPR. There were no objections.

Dr Rastello concluded that the CCPR unanimously approves the application of NSC-IM as a member. She noted that the CIPM will meet in June 2024 and hopefully the CCPR will receive the CIPM decision soon.

10. REPORT OF THE CCPR-WG-SP WORKSHOP ON THE FUTURE OF THE CANDELA

Dr Rastello introduced the context with two slides from the CCPR/CIE Expert Workshop "100 Years of $V(\lambda)$ and Future of Photometry" which took place on Monday before the CCPR meeting. She presented a graph, which showed the difference between $V(\lambda)$ and the measurements from Gibson and Tyndall from 2024. She pointed out that if the data from Gibson and Tyndall had been chosen, there would not have been the necessity for a workshop on cone fundamentals. At the short wavelength part, the current deviation is about a factor of ten. She also reported that Lorne Whitehead stated in the workshop that this might become a problem for the reputation of the CIE and CCPR.

After this introduction, Dr Rastello reported on the workshop on the Future of the Candela and presented slides from the workshop presentations. She thanked the organizers and presented the agenda. After two introductory talks, six technical presentations were given.

Dr Rastello cited Richard Brown: "… on the discussion of unit redefinition, several questions need answering, when considering a change …", with which Dr Rastello agreed. Dr Rastello summarized the view from each of the six technical presentations, which had been planned by the organizing committee who then invited speakers to defend it. Dr Sperling took the view of no changes to the definition, arguing that deviations within humans is larger than the difference between $V(\lambda)$ and $V_F(\lambda)$. Dr Ohno took the view of adopting the Cone Fundamentals by changing the value of the constant K_{cd}, to limit the impact of changes in $V(\lambda)$ functions. Dr Obein defended the view of individual values for K_{cd}, to better account for the perception of the individual to whom the instruments are addressed. Dr Klevnoy presented ideas about using a blackbody-based definition, which could be adopted thanks to the development of a High-Temperature Fixed Point blackbody at VNIIOFI. Dr Kück and Dr Gamouras presented aspects about a photon-based candela definition, which would be a step towards more consistent measurements and terminology across the field of photometry and radiometry. From Dr Koo's presentation on "Thoughts on the SI", Dr Rastello concluded that there is an increasing need for physiological units. The last presentation of the workshop from Dr Lehman, entitled "Candela in the Wind", contemplated a disruptive change of the SI, limiting the number of base units to four from which all others would be derived.

After this overview, Dr Rastello went back to the questions raised by Dr Brown. She pointed out that a problem exists, which should be discussed. However, should the CCPR go to the big change from $V(\lambda)$ and $V_F(\lambda)$? She noted that further work on cone fundamental based colorimetry is needed and referred to the roadmap compiled in CIE 1-98. She mentioned the CIE RF 05 on the Implementation of cone fundamentals in photometry and colorimetry as well as CCPR WG-SP-TG16, Cone-fundamental-based photometry, and the consequences of a change. The change would be detrimental to manufacturers of photometers, but beneficial for the display industry. Furthermore, she raised questions about the possibility that industry starts to implement and use its own standards. Dr Rastello made it clear that these were her own views and hopes that CCPR understands the problem and the needs. Her conclusion was that there is no need to change the candela now, and that further research is needed. She stated that the workshop had been useful and that she had learned a lot.

Dr Fox stated that Dr Rastello gave an excellent summary of the workshop. Dr Khlevnoy clarified that in the candela definition he had to defend during the workshop, the blackbody itself was not the problem, but using a definition based on fixed points, which conflicts with the definition of the kelvin. Dr Rastello agreed with him.

The first day of the meeting ended at 18:00 CEST; Dr Rastello closed the session.

Day 2 – 7 June 2024

Dr Rastello welcomed all participants and opened the second day of the meeting at 9:00 CEST. She noted that there were more online participants and welcomed Emma Woolliams (NPL), Annette Koo (MSL. APMP chair), and Peter Blattner (METAS).

Dr Milton excused himself for being absent the first day of the meeting because of the obligation to be present at the EURAMET General Assembly.

Dr Rastello introduced Dr Woolliams to present the activities of the CIPM Sectorial Task Group on climate change and environment.

11. CIPM SECTORIAL TASK GROUP ON CLIMATE CHANGE AND ENVIRONMENT (CIPM-STG-CENV)

Dr Woolliams presented the activities of the CIPM Sectorial Task Group on Climate Change and Environment. Dr Woolliams stated that the CIPM-STG-CENV was established in 2022 as a result of Resolution 1 of the 27th CGPM (2022) that encouraged the CIPM to establish inter-disciplinary (“horizontal”) groups to address the new challenges to complement the existing quantity-based (“vertical”) structure of its Consultative Committees and the Recommendations of the BIPM-WMO workshop to establish joint working groups to deal with specific issues.

Dr Woolliams foresees a strong role for metrology institutes, the STG-CENV is complementary to CCs and that the core group of the STG is rather small. She reported on the workshop on Metrology for Climate Action, 26–30 September 2022, which had more than one thousand participants leading to more than hundred recommendations in nine new topical areas. There will be a follow-up workshop on 16–18 September 2024. She reported on the activities of the STG, which aims towards an overview of activities that are being undertaken to address recommendations; the identification of the organizations, committees and groups that are coordinating activities to address the recommendations; the identification of the recommendations where no activity has been initiated and reasons why it has not been done; an overview of new collaborative activities initiated between the Observation and Metrology communities; the identification of new initiatives that could be progressed through collaborative actions between the Observation and Metrology communities, and the groups that could coordinate this work; and the identification of any new actions to be undertaken by the CIPM-STG-CENV, with a focus on those actions that cannot be addressed by existing structures, which would enable progress to be made to tackle the BIPM-WMO 2022 workshop recommendations and new initiatives. She noted that the STG can create its own task groups. She furthermore reported on the BIPM observer status in Conference of the Parties (COP)

meetings; on the radiometric perspective (energy balance of the earth, different contributions); the need for satellite missions to improve the energy balance measurements; the need for the measurement of the essential climate variables; the necessity of pre-flight and in-flight calibrations including appropriate uncertainty analysis; and on quantum detectors for biosphere emphasizing the significance to take into account the response to photons, to the full spectrum and to take into accounts units such as Photosynthetically Active Photon Flux Density (PPFD). She emphasized the importance of metrologists participating in events like GCOS.

In summary, she stated the CIPM-STG-CENV was established in response to the BIPM-WMO workshop but acts as a simple secretarial group to coordinate broader activities, that there will be a follow up workshop (1st CIPM STG-CENV Stakeholder meeting) in September 2024 and that there are several recommendations related to radiometry, some directly, others indirectly.

Dr Rastello thanked Dr Woolliams for her presentation and asked for comments and questions.

Dr Milton thanked Dr Woolliams and asked whether the quantum sensor really measures single quanta and or if this is simply about converting. He also stated that with this respect "counting" comes into play. He stated that counting is "1, 2, 3, …" and that this is different from converting. Dr Rastello invited Dr Kück to briefly report on the 2023 workshop on counting, where Dr Kück presented the view of the CCPR on this subject. Dr Kück responded and gave a brief overview of his workshop presentation.

Dr Rastello asked Dr Woolliams to update the participants about activities of the recently created task group (TG17) within WG-SP. Dr Woolliams reported that this group had held one meeting, during which they identified members of a core group already working scientifically on these topics. This core group has been preparing a contribution to the 1st CIPM STG-CENV Stakeholder meeting in September 2024. She encouraged CCPR members to contact her to take part in the group and submit ideas to broaden its scope.

12. CIPM FORUM ON METROLOGY AND DIGITALIZATION (FORUM-MD)

Dr Blattner reported on the CIPM Forum on Metrology and Digitalization (FORUM-MD). The background to the creation of the FORUM-MD was Resolution 2 of the 27th CGPM (2022) *On the global digital transformation and International systems of Units*. The mission of the FORUM-MD is to advise the CIPM on the SI Digital Framework and the wider implications of the global digital transformation for metrology and for the international quality infrastructure; to harmonize internal processes related to digitalization between NMIs, CCs, RMOs and the BIPM headquarters; and to act as a forum to exchange information and to create synergies and opportunities for collaboration in this field, including, but not limited to, liaison with International QI Organizations, relevant International Organizations, international science organizations, relevant industry associations, and other stakeholders in digitalization. The FORUM-MD has been chaired by Cornelia Denz, PTB, since April 2023.

The forum currently has eleven members. Dr Blattner reported on the 1st meeting held on 8–9 March 2024 and gave an overview of the agenda. He stated that specific to CCPR are high-

dimensionality, the different types of observers, many different quantities as well as the many quantities with dimension 0, which causes difficulties for machine readability. Currently, digitalization is underway among stakeholders and machine learning/AI are widely used. Dr Blattner stated that the priorities are data formats, and the question is how to communicate correlations to the users. Furthermore, Dr Blattner pointed out the aspects of the $V(\lambda)$ function in correlation to standardization and diversity.

Dr Blattner reported on the following highlights with respect to digitalization, which were presented at the first meeting:

- New Digital Services from the BIPM, i.e. the SI Reference Point.
- Within ISO, the SMART standards initiative (https://www.iso.org/smart) and a "New digitalization initiative on terminology and semantics" was launched.
- At CODATA, DRUM (Digital Representation of Units of Measurement), a list of digital unit representation systems, is now available. (https://codata.org/wp-content/uploads/2022/12/DRUM_Units_Inventory_120522.pdf)

Dr Blattner reported on the outcome of the first meeting, during which eight sub-task groups were established, to deal with harmonizing DCCs and DRMC, FAIR data for Metrology, Metrological Semantics, Data Quality in Metrology, Secure and trustworthy AI, Coordination between RMOs, SI-digital Framework, and Coordination between CCs.

Dr Blattner reported that the topics of the FORUM-MD will specifically be addressed at two upcoming workshops, the first on "Metrological Traceability" during the IMEKO conference (26–29 August 2024, Hamburg, Germany) and a second on "Complex sensor networks" during the next International Metrology Congress (CIM, date to be determined).

Dr Blattner said that the next meeting of the FORUM-MD will be in the week 17–22 February 2025.

Dr Rastello thanked Dr Blattner for his report. She pointed out that digitalization in photometry and radiometry is an opportunity to change the approach to certificates, because full spectral and spatial information can be sent to a customer. Dr Blattner agreed and commented that sending the information electronically is better than printing it on paper and that this is already partly done. He raised the question about using a single format, because the needs of stakeholders are different. For even larger data sets, it would probably be better to transfer the data model to one that can be interpreted by machines and not the data itself. By doing this, all uncertainties and correlations are transported. He pointed out that digitalization should used as a possibility to bring benefits to stakeholders.

Dr Rastello asked Dr Blattner about the corresponding TG15 in the WG-SP (which he chaired before stepping down). Dr Blattner replied that several meetings took place with a focus on photometry and radiometry. The list of activities is being developed. Dr Blattner reported that one item was identified as a main priority, i.e. support to the BIPM and KCDB, and emphasized the problem that the CCPR has with entries with more than one quantity. Other priorities are data format, the possibility for a data model for BRDF and correlations.

Dr Rastello invited Dr Nadal to complement this information if appropriate. Dr Nadal replied that the new TG 15 chair, Dr Menegotto, gave a comprehensive overview at the WG-SP

meeting. She stated that it is important that the information flow is maintained to and from the CCPR and that work is also done on DCCs. Dr Blattner stated that he chairs the task group on the coordination of CCs and will therefore inform the CCPR.

Dr Milton thanked Dr Blattner for this work and stated that the work of the CCPR is highly visible. There are now nine CCs represented at the FORUM-MD, however, the BIPM headquarters cannot fulfil the requirements of all CCs; the priority will be those CCs that bring in support from the NMIs. Dr Milton encouraged the members to provide support, for example by sending secondees to the BIPM headquarters.

Dr Nadal commented that WG-SP-TG15 should also be active in capacity building and knowledge transfer. The aim is that all parties should agree the data format. TG15 will start with a workshop to gather information from different players.

13. REPORT ON THE CCPR/CIE EXPERT WORKSHOP "100 YEARS OF $V(\lambda)$ AND FUTURE OF PHOTOMETRY"

Dr Ohno gave a presentation on the workshop. He stated that Dr Rastello had already given a comprehensive overview and that he would provide more details. He reported on the members of CCPR WG-SP-TG16 (Cone fundamentals), the organizing committee, and the background arising from the documents CIE 170-1:2006 and CIE 170-2:2015, which define the cone fundamentals and colour matching functions and spectral luminous efficiency functions. He emphasized that cone fundamentals were not really known for a long time. He referred to the CIE TC 1-98 Roadmap and said that the report will be published in the next few months. It is expected that there will be proposals for new TCs. He mentioned CIE−RF05 (Research Forum) about the implementation of CIE 2006 cone fundamentals into photometry. He explained that research forums are established when it is necessary to gather information and knowledge about a specific topic. Dr Ohno explained the aims and organization of the workshop. The final programme was published in April 2024, the abstracts of the contributions were published prior to the workshop. There were 226 participants, 84 on-site and 142 online. Many of the participants were from CIE Divisions 1 and 2, and the CCPR.

Dr Ohno presented the content of the four sessions of the workshop. The first session dealt with the "History of $V(\lambda)$ and photometric units", followed by a session on the "History of CIE Colorimetry and Cone Fundamentals". He specifically thanked Dr Obein and his co-workers for their demonstration to measure the $V(\lambda)$ function during the afternoon of the workshop, proceeded by a session on "Photometry with Cone Fundamentals". The workshop concluded with a panel "Discussion for future directions for photometry and colorimetry". Dr Ohno thanked the organizers, speakers and participants for their efficient and active participation. Dr Ohno finished his report by summarizing the discussion points and conclusions from the workshop. He stated that the discussion points were summarized in the question "What are the problems to be solved?" The outcomes were: to consider the needs of display applications; considerations for daylight applications; associated costs for changing instruments; the statement that the current 2° $V(\lambda)$ is needed for essential tasks like reading and traffic applications; the question of whether the $V_{10}(\lambda)$ (from colorimetry) has a good

experimental basis; and that inputs are needed widely from other communities, i.e. from each Division of CIE. Dr Ohno stated that the conclusions he drew from the workshop and the discussions are that further research is needed for the needs, benefits, and impact in a wide range of applications, that the discussion should continue in CIE RF05 and CCPR WG-SP-TG16 and that cone-fundamental based colorimetry will continue in the CIE and that new TC proposals will be discussed in the CIE after the TC-98 report is published. He emphasized that CIE RF05 is open to anyone, and that the application form is available at cie.co.at (Research Strategy/Research Fora).

Dr Ohno concluded that the difference between $V_F(\lambda)(2°)$ and current $V(\lambda)$ seems small, whereas the difference between $V_{F,10}(\lambda)$ and current $V(\lambda)$ seems significant; that the 10° Colour Matching Functions from 1964 are widely used in colorimetry of objects, but not for light sources; and that the research direction is to use 10° Colour Matching Functions for colour specifications in lighting, i.e. there is the question whether photometry should go for 10° observer; whether the cone-fundamental functions (2° or 10°) will better represent visual perception in our daily life; whether there will be a large enough difference so that there are benefits for the change; and that the improvements of $V(\lambda)$ lead to better use of energy. Dr Ohno stated that the future plans of CCPR WG-SP-TG16 will be to post the presentations and to publish a summary of the workshop. The work with CIE RF05 to continue discussions, exchange information and research results will go on and the progress in CIE colorimetry following publication of the TC 1-98 report will be monitored. He emphasized that TG16 is open to further members. Dr Ohno concluded by stating that the Workshop was very successful and expressed thanks to the TG16 members, to the workshop organizing committee members, especially to Dr Viallon and the BIPM headquarters staff, to Dr Obein and to all the invited speakers.

Dr Rastello thanked Dr Ohno for his presentation, for the successful workshop and asked for questions and comments.

Dr Ikonen stated that Dr Ohno had given an excellent summary of the workshop. He proposed one possible way to proceed, which is that a new quantity could be defined and a new symbol, thus the units would remain untouched. This new quantity should better describe the physiology of the human eye.

Dr Ohno replied that the “Principles governing photometry” already defines four photometric $V(\lambda)$ functions. He agreed with Dr Ikonen that new quantities could be defined, but he was not sure that this would help.

Dr Fox stated that it was agreed that the CCPR is not ready for such a process. A sufficiently agreed function of the cone fundamentals should exist after that discussion. Dr Ikonen noted that the discussions will be at the CIE.

Dr Milton agreed that it had been a successful workshop. He stated that the value of the workshop will reside in a good summary document and added that the summary by Dr Ohno was very interesting. However, he did not understand the statement about saving energy, because the light will not be brighter, and that this argument may be too simplistic. Dr Milton emphasized another global challenge, which is the aging population, which will mean a distribution slowly drifting away from the standard observer behind the $V(\lambda)$ function.

Dr Ohno replied that CIE 170-1 provides a model for different ages, with 33 years of age being the average. He agreed that aging is an important point to be considered.

Dr Blattner thanked the CCPR, as a representative of CIE, for the successful workshop. He echoed the statement by Dr Milton about energy saving and stated that the other summary points addressed are fine. He commented that a better understanding is needed of all the efforts required.

Dr Ohno replied that he will be happy to further discuss the topics with the CIE.

Dr Obein commented on the age of the population, noting that the population is getting older in Europe or Japan, but there are other countries and regions with a young population. The result is that the median age of the world population is 35 years.

Dr Ohno thanked Dr Obein for his comment, and stated that the age progression of the world's population is still an important point.

There were no further questions and comments.

14. LIAISON WITH OTHER ORGANIZATIONS

COMMISSION INTERNATIONALE DE L'ECLAIRAGE

Dr Lee, CIE Division 2 director and liaison officer, gave the report of the CIE. He presented the CIE's governing board, technical management board and division directors. He thanked the BIPM for the workshop on $V(\lambda)$. He reported that he had received positive feedback from the members of CIE Division1. Dr Lee presented the list of recent CIE publications and focused on those related to the CCPR:

CIE 251:2023 *LED Reference Spectrum for Photometer Calibration*, which recommends "CIE reference spectrum L41" complementing CIE standard illuminant A, based on one of the new LED illuminants in CIE 015:2018 Colorimetry 4th edition. The goal is to minimize mismatch errors.

ISO/CIE 23539:2021 *Photometry –The CIE system of Physical Photometry*, which replaced ISO 23539:2005/CIE S 010:2004 to bring the standard up to date with recent developments. It includes: names, symbols and units for photometric quantities; the definition of Candela as revised in 2019; CIE Standard spectral luminous efficiency functions including mesopic and 10° photopic vision; basic formulae relating photometric quantities to radiometric quantities; tables of values of spectral luminous efficiency functions; and the CIE 2015 cone-fundamental-based spectral luminous efficiency functions (in an Annex).

CIE DIS 017-SP2:2023 *ILV: International Lighting Vocabulary –Supplement 2: Terms and Definitions for Horticultural Lighting*, which provides reference for terms and definitions in the field of horticultural lighting and intends to harmonize the terminology and measurement techniques as well as the interpretation of test results and inspection reports world-wide.

Dr Lee presented TCs that are nearing publication. These are: TC 2-67 Photometry of Lighting and Light-Signaling Devices for Road Vehicles; TC 2-78 The Goniophotometry of Lamps and Luminaires; and TC 2-79 Integrating sphere photometry and spectroradiometry. Newly

established TCs are: TC 2-98 Revision of CIE 130-1998 Practical Methods for the Measurement of Reflectance and Transmittance and TC 2-99 Standard File Format for Electronic Transfer of Optical Radiation Data for Luminaires, Lamps and LED. New reporterships are: DR 2-93 Implementing CIE198-SP2 using Monte Carlo Simulations and DR 2-94 Uncertainty evaluation of spectral integrals.

CIE Research Fora have the aim to facilitate ongoing knowledge exchange and research on a scientific topic or research area where there is insufficient completed scientific work to support the work of a TC. Current research fora connected to the work of the CCPR: are RF-05: Implementation of CIE 2006 Cone Fundamentals in Photometric and Colorimetric Measurements and RF-06: Toward a new CIE reference observer non-biological.

Dr Lee presented upcoming CIE events:

CIE midterm meeting 2025 (https://vienna2025.cie.co.at), Vienna (Austria) 4–11 July 2025 with workshop sessions, including on calibration with photometers in photometry and radiometry, and on glare measurements. Dr Lee asked whether it would be suitable to have the meeting in connection with the CCPR WG meetings and emphasized the advantage of having joint events for exchanges and discussions.

31st Quadrennial Session 2027 in Nanjing (China) on 9–17 July 2027.

Dr Lee concluded by presenting the CIE position to the CCPR and CCU regarding $V(\lambda)$:

> *Progress has been made in the field of colorimetry with the cone-fundamental-based functions, but a large-scale introduction will take more time. In the field of photometry, the benefits and impacts of the cone-fundamental-based functions are not sufficiently evaluated. At present, in the CIE's point of view, there is not a sufficient case to re-define the candela in terms of cone fundamentals – not until the cone fundamental functions are fully resolved, taking into account a more diverse cross-section of the human population than the current functions do. Furthermore, we need to ensure that the benefits of the change outweigh the disruption inherent in making the change. Work is ongoing in this space*.

Dr Rastello thanked Dr Lee for his report and commented that the suggestion for a joint meeting will be considered. She asked whether CIE would host the meeting for free. Dr Lee replied that this needs to be decided.

Dr Rastello asked if there were any questions or comments.

Dr Viallon said that the CIE report will be available on the website, together with the METAS position on the candela.

Dr Fox asked for clarification of the dates. Dr Rastello replied that these are associated with the CIE meeting, thus the dates are not fixed.

WORLD METEOROLOGY ORGANIZATION

Dr Rüedi (WMO) reported on activities of the WMO. She stated that Dr Woolliams already reported on satellite-related activities, so she will focus on other measurements and activities.

Dr Rüedi reminded the participants about known offsets in two reference groups of instruments, for solar (World Radiometric Reference) and terrestrial (WMO Infrared Standard

Group) irradiance measurements, maintained by PMOD/WRC. The WMO would like to proceed to a change of those references, leading to better traceability to the SI and reduced uncertainties. Dr Rüedi presented the nature and reporting lines of the WMO bodies in the recently modified structure. An Expert Team on Radiation References (ET-RR) is being re-established following INFCOM-3 to assess the current status of the solar and terrestrial radiation references and to deal with the implications of proposed changes to those references.

Dr Rüedi said that the WMO organizes regular pyrheliometer and pyrgeometer intercomparisons, on a five-yearly basis. Reports of previous intercomparisons were published, and demonstrated the stability of the references, i.e., International Pyrheliometer Comparison (IPC-XIII, 2021) and International Pyrgeometer Comparison (IPgC-III, 2021). The next intercomparisons are scheduled for 2025, for example the International Pyrheliometer Comparison (IPC-XIV) and International Pyrgeometer Comparison (IPgC-IV).

Dr Rüedi reported on the timeline with key WMO events relevant for radiation reference changes, including the two comparison campaigns presented above, a meeting of the Infrastructure Commission (INFCOM-4) in May 2027, and the 20th World Meteorological Congress (Cg-20). She stated that the next two years will be critical.

Dr Rüedi presented the conditions to be met before introducing a change in the reference for solar irradiance measurements, referring to the recommendation from INFCOM-2 (2022), approved by EC-76 (2023), which include full characterization of the instruments and their uncertainty budgets; comparison with an appropriate cryoradiometer from an NMI, continuous measurements with a standard group of ambient cavity radiometers and existence of procedures.

Dr Rüedi informed about the Guidelines on Radiometer Comparisons, which were adopted by INFCOM-3 in April 2024.

In context of possible change of references, Res. 31 (EC-76) Dr Rüedi called on the World Radiation Centre, radiation centres, and the metrology and research communities to publish the uncertainty budget of proposed solar and terrestrial reference instruments in the peer-reviewed literature, to perform intercomparisons of these instruments to demonstrate their performance and the stability of the proposed new references; and to develop other independent realizations of the solar irradiance reference and/or a second instrument of the same design as the Cryogenic Solar Absolute Radiometer (CSAR)/Monitor to Measure the Integral Transmittance of Windows (MITRA) to mitigate the risks linked with a technical failure of one single instrument.

Dr Rüedi presented the ongoing work towards change of artefact-based references for solar and terrestrial irradiance measurements and about the activities of the Expert Team on Radiation References (ET-RR) in coordinating activities in WMO/INFCOM. She expressed her thanks to the metrologists who work for ET-RR and invites even stronger involvement.

Dr Rastello thanked Dr Rüedi for her presentation. There were neither comments nor questions.

15. REPORTS BY RMO TC CHAIRS (~10 MIN EACH)

AFRIMETS: No representatives from AFRIMETS were present to report.

APMP: The TC chair, Dr Annette Koo, reported on the activities within the RMO APMP. She presented the members and the aims of APMP. There have been two TC.PR meetings and four workshops since the last CCPR meeting. The TC meeting took place in November 2022 (Online) and November 2023 in Shenzhen (China) as a hybrid meeting. The workshops were on Evidence for CMCs (May 2022), UVC Measurement (October 2022), Realization of the candela (APMP DEC) (July 2023), and Uncertainties in Photometry and Radiometry (November 2023). Dr Koo presented the plan for a pilot study for UVC measurement, the trial to combine on-site peer review with RMO CMC approval, the election of a new APMP chairperson, Dr Hiroshi Shitomi (NMIJ), who will become a chair in November 2024, a pilot programme for mentoring, and the work on updating CMCs for the purpose of harmonization.

Dr Koo reported on the decreasing numbers of CMCs approved by APMP, from close to 100 in 2022, to below 40 in 2023 and less than 10 in 2024.

Dr Koo stated that in terms of comparison activity the RMO struggles with aging comparisons and big delays, raising the question of having enough evidence for CMC claims. Two new comparisons on spectral irradiance and spectral responsivity are about to start: the K6 key comparison and a pilot study on UVC.

Dr Rastello thanked Dr Koo for the report and invited questions.

Dr Smid asked about the motivation for the pilot study on UVC. Dr Koo replied that this reflects an increasing demand since the Covid-19 pandemic with respect to germicides. She also stated that the development of new sources might be necessary.

Dr Rastello noted that there are several NMIs active in APMP comparisons that are not observers of the CCPR, noting that this applies to all RMOs. She asked whether the participants in the RMO comparison might be suitable as observers to the CCPR. Dr Koo replied that they are possibly interested and in the most part may participate online. She said that she would raise this at the next APMP meeting.

Dr Nadal commented that UV is a priority of the WG-SP, and that a new TG was founded. A call for participants is under way. Dr Koo replied that she will raise awareness of this.

COOMET: The TC chair Dr Alexander Dunaev presented activities within the TC. He presented the current list of active, former and partially active members. There are six ongoing and two new comparisons. There are 182 CMCs and about seven new claims per year. Dr Dunaev commented on the intention to reduce the loss of rights to review CMC claims from other RMOs. He reported about yearly meetings and knowledge transfer activities. Dr Dunaev thanked the former TC chair Mr Bescupschi for his work.

Dr Rastello thanked Dr Dunaev and Mr Bescupschi for their work.

EURAMET: The EURAMET TC-PR chair Dr Campos could not connect to the meeting as planned, so no presentation was given. However, Dr Campos had sent his presentation and this will be made available as a working document on the BIPM website.

SIM: The SIM TC chair Dr Juan Bábaro gave the presentation. He reported on members and contacts and the status of CMCs. There are currently 212 CMCs in PR, of which 16 have been approved since the last meeting. There were no new submissions since last year. CMCs from other RMOs were reviewed. SIM had compiled rules for CMC writers. He added that the harmonization process is not complete. Dr Bábaro reported on the comparisons: SIM.PR-K3 is ongoing and four others are planned and waiting for the corresponding CCPR comparison to be completed. No supplementary comparisons are planned but several SIM members expressed their interest in other RMO's comparisons. The list is included in the presentation, which is available as a working document.

Dr Rastello thanked Dr Bábaro and asked about the harmonization process, because there were no updates from the NRC. Dr Bábaro explained that there are internal discussions at the NRC concerning the harmonization process, which are not yet complete. Dr Rastello thanked Dr Bábaro for the clarification.

GULFMET: Mohamed AlFohaid reported on the activities of GULFMET, which was inaugurated in 2017. Ten meetings have taken place since then. Currently SASO is the only member of GULFMET with activities in photometry and radiometry. Oman and Qatar had no activities but participated in meetings. SASO participated in one comparison on luminous flux with NIS and UME (pilot), for which the Draft B was submitted. There are four planned comparisons.

Dr Rastello thanked Mr AlFohaid and expressed the following action point for RMO TC.PR chairs:

CCPR Action Point 1 (2024) − Dr Rastello asked all RMO chairs to invite RMO members to become observers within the CCPR. The process to follow is described in CIPM-D-01: Rules of procedure for the Consultative Committees (CCs) created by the CIPM, CC working groups and CC workshops, section 4.

16. REPORT TO THE CIPM AND RECOMMENDATIONS

Dr Rastello announced that the CIPM will meet in two weeks, where she will present the recommendation for the CIPM to approve the membership of NSC-IM to the CCPR:

CCPR Recommendation 1 (2024) − The CCPR recommends to the CIPM to approve the membership of NSC-IM in CCPR.

17. ANY OTHER BUSINESS

Dr Viallon commented that Dr Smid had chaired WG-CMC for about eight years. An open call will be sent out to find a successor. The change of chair for WG-SP will be in July 2026,

ready for the WG-KC meeting in September 2027. The terms are 4 years; in the future electronic voting will be possible.

Dr Fox acknowledged Dr Sperling, for whom it was the last CCPR meeting, for his contributions to the CCPR.

Dr Rastello acknowledged Dr Dubard, for whom it was the last CCPR meeting, for his contribution to the CCPR, especially his work on fibre optics, and for the TG 6 of WG-SP.

Dr Sperling stated that the meetings were really interesting and important.

Dr Dubard stated that he had enjoyed being a part of the CCPR, in which he had learnt a lot about developments in PR, and especially the work on fibre optics and photovoltaics which was his domain.

18. DATE OF THE NEXT MEETING

Dr Rastello announced that the next CCPR meeting will be in 2027. The date will be moved to September to avoid conflict with the EURAMET General Assembly as happened this time. She emphasized that RMOs should be aware of CC meetings which are planned several years in advance, before planning their general assembly. Dr Milton noted that the EURAMET General Assembly is usually at the beginning of June and that JCRB meetings are scheduled for September.

Dr Viallon announced that the presentations will be shared and that thus far 23 reports from NMIs are available.

Dr Rastello thanked everyone and closed the meeting at 12:35.

APPENDIX 1 - SUMMARY OF DECISIONS, ACTION POINTS AND RECOMMENDATIONS TO THE CIPM

CCPR Decision 1 (2024) – CCPR Guidelines G3 section 2.2 shall be modified to include GULFMET in the table listing the maximum number of participants of each RMO. The three groups and participants limits will be: Group 1) EURAMET + COOMET: 6, Group 2) APMP + AFRIMETS + GULFMET: 4, Group 3) SIM: 2.

CCPR Action Point 1 (2024) − Dr Rastello asks all RMO chairs to invite RMO members to become observers within CCPR. The process to follow is described in CIPM-D-01: Rules of procedure for the Consultative Committees (CCs) created by the CIPM, CC working groups and CC workshops, section 4.

CCPR Recommendation 1 (2024) − The CCPR recommends to the CIPM to approve the membership of NSC-IM in CCPR.

APPENDIX 2 - WORKING DOCUMENTS

WORKING DOCUMENTS SUBMITTED TO THE CCPR AT ITS 26TH MEETING

File	Title
CCPR-2024-01v3	Draft schedule of the CCPR week June 2024
CCPR-2024-02v4	Draft Agenda of CCPR 2024
CCPR-2024-03	Questionnaire CCPR 2024
CCPR-2024-03-01	Report on activities since 2022 - CSIR-NPLI
CCPR-2024-03-02	Report on activities since 2022 - SCL
CCPR-2024-03-03	Report on activities since 2022 - JV
CCPR-2024-03-04	Report on activities since 2022 - INMETRO
CCPR-2024-03-05	Report on activities since 2022 - VNIIOFI
CCPR-2024-03-06	Report on activities since 2022 - SMU
CCPR-2024-03-07	Report on activities since 2022 - NIM
CCPR-2024-03-08	Report on activities since 2022 - NMIJ
CCPR-2024-03-09	Report on activities since 2022 - IO-CSIC
CCPR-2024-03-10	Report on activities since 2022 - CMS-ITRI
CCPR-2024-03-11	Report on activities since 2022 - CENAM
CCPR-2024-03-12	Report on activities since 2022 - PTB
CCPR-2024-03-13	Report on activities since 2022 - LNE
CCPR-2024-03-14	Report on activities since 2022 - NPL
CCPR-2024-03-15	Report on activities since 2022 - VSL
CCPR-2024-03-16	Report on activities since 2022 - INRIM
CCPR-2024-03-17	Report on activities since 2022 - NIST
CCPR-2024-03-18	Report on activities since 2022 - METAS
CCPR-2024-03-19	Report on activities since 2022 - MSL
CCPR-2024-03-20	Report on activities since 2022 - NMIA
CCPR-2024-03-21	Report on activities since 2022 - KRISS
CCPR-2024-03-22	Report on activities since 2022 - NRC
CCPR-2024-03-23	Report on activities since 2022 - MIKES
CCPR-2024-04v2	METAS Statement on the candela definition

CCPR-2024-05	CIE Written Report to CCPR 2024
CCPR-2024-06	News from the CIPM and CGPM
CCPR-2024-07	Report of the Working Group on Strategic Planning
CCPR-2024-08	Report of the Working Group on Key Comparison
CCPR-2024-09	Report of the Working Group on CMCs
CCPR-2024-10	NSC-IM application to membership
CCPR-2024-11	Report of CIPM-STG-CENV to CCPR
CCPR-2024-12	Report from the first meeting of the FORUM-MD to CCPR
CCPR-2024-13	Report of the CCPR-CIE Expert Workshop on V(l)
CCPR-2024-14	Report of the WG-SP Workshop on the candela
CCPR-2024-15	CIE oral report to CCPR 2024
CCPR-2024-16	WMO oral report to CCPR 2024
CCPR-2024-17	APMP TCPR Report to CCPR 2024
CCPR-2024-18	COOMET.TC-PR report to CCPR 2024
CCPR-2024-19	EURAMET.TC-PR report to CCPR 2024
CCPR-2024-20	SIM.TC-PR Report to CCPR 2024
CCPR-2024-21	GULFMET.TC-PR Report to CCPR 2024