



CCPR President's Report

27th CGPM (2022)

A large, decorative graphic consisting of numerous overlapping, curved lines in a variety of colors including red, orange, yellow, green, blue, and purple. The lines are arranged in a circular, swirling pattern that fills most of the lower half of the page.

Working together to
promote and advance
the global comparability
of measurement

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Report by the President of the CCPR

Dr Maria Luisa Rastello, President of the Consultative Committee for Photometry and Radiometry (*Comité consultatif de photométrie et radiométrie*, CCPR) presented her report on the activities of the CCPR since the 26th meeting of the CGPM (2018).

CCPR Executive summary

Established as the Consultative Committee for Photometry in 1933, and further extended to include Radiometry in 1971, the CCPR now covers metrological aspects of optical radiation, which range from well-known measurements to very advanced research fields. Between 1997 and 2005, the CCPR established three Working Groups (WGs) to deal with specific topics as outlined in their names: Strategic Planning (CCPR-WG-SP), Key Comparisons (CCPR-WG-KC), and Calibration and Measurement Capabilities (CCPR-WG-CMC). In each of the three WGs, there are several Task Groups (TGs) and Discussion Forums (DFs) that are not permanent but address specific metrological needs or pressing issues.

Since the 26th CGPM meeting (2018), CCPR members have contributed to:

- The finalization of key documents related to the Candela definition and its *mise en pratique*.
- The definition of a longer-term strategic objective to implement a scientifically rigorous photometric system based on cone-fundamentals to provide a new link between photometric and radiometric quantities.
- The adoption of a risk-based approach for reviewing requirements and provides further guidance regarding the scope of Key Comparisons in terms of CMC support (“how far the light shines”). Flowcharts and checklists are included to ensure all requirements are clear and aid reviewers.

Scope of the CCPR

The responsibilities of the CCPR are to:

- provide advice to the CIPM on all matters concerned with photometry and radiometry.
- establish global compatibility of related photometric and radiometric measurements through promoting traceability to the SI photometric unit, the candela, and associated derived units for photometric and radiometric quantities.
- contribute to the establishment of a globally recognized system of national measurement standards for photometry and radiometry and development of absolute radiometry methods and facilities.
- contribute to the implementation and maintenance of the CIPM MRA in the field of photometry and radiometry.
- review and advise the CIPM on the uncertainties of the photometry and radiometry calibration and measurement capabilities as published on the BIPM website.
- act as a forum for the exchange of information about the photometry and radiometry activities of the CCPR members and observers.
- create opportunities for collaboration in the field of photometry and radiometry.

Strategy

The strategy developed by CCPR members to cover the responsibilities listed above are detailed in the **Strategy document**, which was recently updated to cover the period 2022 to 2032. A brief summary is provided below.

The CCPR strategic goals for the 2022-2032 period are to:

- contribute to the resolution of global challenges in photometry and radiometry.
- promote the uptake of metrologically-traceable photometric and optical radiometric measurements.
- progress the state of the art of photometry and optical radiometry measurement science.
- improve efficiency and efficacy of the global system of comparisons for photometry and optical radiometry.
- continue evolving the set of Calibration and Measurement Capabilities (CMCs) to meet stakeholders needs.
- maintain organizational vitality, regularly review and, if necessary, update the CCPR structure so it can perform its mission.

Activities and achievements since the last meeting of the CGPM

Membership

Two new members joined the CCPR in 2022: Justervesenet (JV, Norway) and INMETRO (Brazil), and one new observer: National Scientific Centre “Institute of Metrology” (NSC-IM, Ukraine). All three institutes delegated experts to present their activities at the 25th CCPR meeting, and their membership was recommended to the CIPM who adopted the proposal during its June 2022 meeting.

Meetings and workshops

Since November 2018, the CCPR has held two plenary sessions, in September 2019 (BIPM, Sèvres) and May 2022 (on-line). The September 2019 session included several selected talks on advances in PR metrology. This was not repeated during the online 2022 session in view of the limited timing.

No specific CCPR workshops were organized due to the Covid-19 pandemic. However, the conference NEWRAD was held online and the BIPM-WMO “Metrology for Climate Action” workshop was held in September 2022, with CCPR member involvement.

Advising the CIPM and promoting traceability to the candela

The candela and related documents

At the 26th meeting of the CGPM, CCPR members presented the results of major revisions of key documents related to the Candela definition and its *mise en pratique*. This document was finalized after the 26th CGPM, for official publication in May 2019, together with the SI Brochure Appendix 3: Units for photochemical and photobiological quantities. It was complemented with the publication of the Principles governing photometry, revised in a joint effort with the International Commission on Illumination (CIE) to include standard spectral luminous efficiency functions for mesopic vision (twilight), and to ensure consistency with the new SI adopted in 2018. These publications were produced within three Task Groups of the Strategy Working Group, which were officially closed during the 25th meeting of the CCPR (May 2022).

Cone-fundamentals systems:

The CCPR has continued to reflect on the candela since the revision of the SI in 2019. This was summarized by Dr Rastello in a presentation entitled “Key Scientific questions in the definition of the SI unit of luminous intensity, the candela”, given at the 25th meeting of the CCU (2021). There is an agreement within the CCPR that the present definition serves very well all practical requirements for global trade, science and society. However, there is a key scientific challenge related to the defining constant K_{cd} linking photometric and radiometric quantities, which has no fundamental character. Potential changes may arise from recent and future progress made in vision science and artificial intelligence, bringing a much better understanding of the luminous perception using the cone-fundamentals system. CCPR members gave themselves a longer-term strategic objective to implement a scientifically rigorous photometric system based on cone-fundamentals to provide a new link between photometric and radiometric quantities. This could have a significant impact on measurement devices, manufacturers, regulations and standardization that are based on the present definition of the candela (2018) with the defining constant K_{cd} . A new Task Group was created at the 25th CCPR meeting to start discussions on this topic.

Digitalization:

At the 25th meeting of the CCPR, WG-SP proposed a new TG on “discussion on the impact on digitalization on matters related to the CCPR”. Dr Blattner will chair the task group. The proposed Terms of Reference are to monitor activities related to digitalization in the field of photometry and radiometry and to support and coordinate the implementation of the SI digital framework in the field of photometry and radiometry.

Ensuring global compatibility of measurements

In accordance with its policy, international comparisons on key quantities currently undertaken at the CCPR level are repeats of the set of ten “cycle 1” comparisons. The ten “cycle 2” comparisons are at various stages of progress, with CCPR-K3.2014 published in 2022 and measurements completed for four other comparisons. During the last CCPR meeting in May 2022, delays in conducting comparisons were reported by several members, first due to laboratories being closed during the Covid-19 pandemic, and then due to restrictions in communication and cooperation between some countries linked with the situation in Ukraine.

Meanwhile, RMOs published the reports of five comparisons to demonstrate the compatibility of more laboratories around the world, and measurements started for five others. This includes the first comparison conducted within GULFMET, GULFMET.PR-K4.2012 by UME (Türkiye), with NIS (Egypt) and SASO-MNCC (Saudi Arabia) as participants.

In addition, supplementary comparisons were carried out within the RMOs to underpin measurements related to the use of optical fibres, notably within COOMET. A comparison was also conducted by PMOD in its role of World Radiation Center for WMO on total solar irradiance. The instrument used, the Cryogenic Solar Absolute Radiometer (CSAR) has been developed by NPL (UK), PMOD/WRC and METAS (Switzerland).

Improvements in the CIPM-MRA

The efforts started after the 25th CGPM meeting (2014) to improve the processes of the CIPM MRA continued over the four years to 2022, with a focus on guidelines to rationalize the CMC claims and their evaluation. This task was conducted within a Task Group (WG-CMC-TG3) of the CMC Working Group, which produced new guidelines, CCPR-G9 “*Rules for review of CMC claims and requirements for supporting evidence*”. The new guidelines were approved and published in June 2021. The guidelines adopt a risk-based approach for reviewing requirements and provide further guidance regarding the scope of Key Comparisons in terms of CMC support (“how far the light shines”). Flowcharts and checklists

are included to ensure all requirements are clear and aid reviewers. Consequently, the associated document “*Supporting evidence for CMCs in PR*” was updated to comply with the new rules.

Challenges and difficulties

CCPR members reported in late 2021 that the Covid-19 lockdowns experienced in 2020 and 2021 severely impacted research and delayed calibration services. International collaborations have also been severely impacted by the pandemic due to travel restrictions, and since February 2022 by additional communication restrictions linked with the geopolitical situation. This situation has impacts on conducting Key Comparisons, which are being dealt with case by case by participants.

Outlook in the short and long term

In the short term, CCPR members will focus on completing the second round of the existing portfolio of key comparisons, which are still considered to be adequate to underpin the needs of the CCPR community. Meanwhile, a number of Pilot Studies have started that will help to understand the need for future comparisons and to verify the practicability of the comparisons. Five such activities have already started to:

- investigate the extension of the wavelength range of the existing KC CCPR-K6.
- investigate LED-based standard lamps for existing KCs.
- investigate a comparison of spectral responsivity in the THz spectral range.
- investigate a comparison on detection efficiency of single-photon detectors.
- investigate a comparison on optical fibre power responsivity using a fibre-coupled cryogenic radiometer.

After the recent progress made in guidelines to review CMCs, the system will be maintained but no major revision should be required in the next five years. A discussion around the mathematical treatment of Key Comparison results to reach equivalence (additional variance) and its impact on CMCs, started in 2021 within the Key Comparisons and CMC working groups, will continue and will be treated within relevant Task Groups meetings and workshops. Likewise, methods to link RMO and CCPR comparisons started to be scrutinized two years ago, and more guidelines are expected in the coming years.

A comprehensive survey was conducted by Task Group 10 of the CCPR-WG-SP to gather the needs and expectations of CCPR members on all topics covered by the CC in photometry and radiometry. While the outcomes of this survey are still under analysis, trends clearly show the need to organize several workshops, create new task groups and launch pilot studies in domains of high interest to members, such as LED-based standards, UV metrology, few photon metrology, photovoltaic standards, optical properties of materials, and climate and environmental observations.

A workshop on the cone-fundamentals system and the impact on future PR measurements is already planned for the next CCPR meeting in 2024. It reflects the high interest of CCPR members in this domain in which the CIE is also involved. Related activities are still considered as research, but developments will be monitored to prepare the measurement systems for potentially important changes. Likewise, the new Task Group on digitalization will be a forum to discuss how digitalization will impact the work of the CC, considering possibilities to produce machine-readable documents under the responsibility of the CC or to interrogate the KDCB with devoted APIs and automate associated work of CC member institutes.

CCPR Data

CCPR set up in 1933

President: M.L. Rastello

Executive secretary: J. Viallon

Membership:

25 members, 2 liaisons and 4 observers

List of CCPR members and observers:

<https://www.bipm.org/en/committees/cc/ccpr/members>

Meetings since the 26th CGPM meeting:

19-20 September 2019, 10-11 May 2022

Full reports of the CCPR meetings:

<https://www.bipm.org/en/committees/cc/ccpr/publications>

Three Working Groups:

<https://www.bipm.org/en/committees/cc/ccpr>

- Key Comparisons (CCPR-WG-KC)
- CMC (CCPR-WG-CMC)
- Strategic Planning (CCPR-WG-SP)

CCPR Comparison activity	Completed	In progress	Planned [period]
CCPR key comparisons (and supplementary comparisons)	12 KC, plus 3 SC, 3 before MRA, 1 repeat, 4 bilateral	4 KC	4 KC [2022-2026]
BIPM comparisons	3	0	0
CC pilot studies	3	2	3
CMCs	1 345 CMCs in 85 service categories registered in the KCDB		