Bureau International des Poids et Mesures

Consultative Committee for Photometry and Radiometry (CCPR)

Report of the 22nd meeting
(17-18 September 2014)
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 17 September 2014

President

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

Executive Secretary

Dr M. Stock, 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.

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

International Commission on Illumination [CIE], Vienna

Czech Metrology Institute [CMI], Brno

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 22nd meeting at the International Bureau of Weights and Measures (BIPM) headquarters at Sèvres, France, on Wednesday 17 September and Thursday 18 September 2014.

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

The following delegates from member institutes were present: P. Blattner (METAS), J. Campos Acosta (IO-CSIC), J.R. Filtz (LNE), N. Fox (NPL), E. Ikonen (MIKES), M. Krempasky (SMU), S. Kück (PTB), D.-H. Lee (KRISS), Y. Lin (NIM), Y. Liu (A*STAR), P. Manson (NMIA), C. Matamoros (CENAM), M. Milton (Director of the BIPM), K. Nield (MSL), Y. Ohno (NIST), M.L. Rastello (INRIM), F. Sametoglu (UME), V.I. Sapritsky (VNIIOFI), W. Schmutz (PMOD/WRC), R. Sieberhagen (NMISA), S. van den Berg (VSL), T. Zama (NMIJ), J. Zwinkels (NRC).

Experts from member institutes: S. Anevsky (VNIIOFI), H.A. Castillo (CENAM), M. Dowell (NIST), J. Dubard (LNE), G.T. Fraser (NIST), T. Goodman (NPL), B. Khlevnoy (VNIIOFI), M. Nadal (NIST), G. Obein (LNE-Cnam), B. Rougié (LNE-Cnam), A. Sperling (PTB), L.L. Tay (NRC), G. Ulm (PTB).

Observers: A.P. Alvarenga (INMETRO), I. Rüedi (WMO), M. Smid (CMI).

Guests: H.L. Yu (CMS/ITRI), W. Bich (INRIM).

Also attending the meeting: M. Stock (Executive Secretary of the CCPR, BIPM), C. Thomas (Coordinator of the KCDB, BIPM).

Apologies were received from T. Gerlai (MKEH), Natasha Nel-Sakharova (NMISA).

Dr Usuda opened the meeting and began by introducing himself. He has been a CIPM member since 2012 and he had taken over the Chairmanship of the CCPR at the start of 2013. He then invited those present to introduce themselves. Dr Usuda noted the new member from Physikalisch-Meteorologisches Observatorium Davos and World Radiation Center [PMOD/WRC] and the observers.

Dr Usuda then invited Dr Milton, Director of the BIPM, to present some issues and highlights from the BIPM. The points raised by Dr Milton included the General Conference on Weights and Measures (November 2014) which is expected to endorse the progress towards the redefinition of the SI, the focus on long-term strategy for BIPM and CIPM, including the strategic planning documents prepared by all the Consultative Committees and the focus in the BIPM's work programme on coordinating the work of the Consultative Committees and the work of the BIPM laboratories which focuses on the coordination of comparisons and development of related techniques. He also described the proposed visitor Visitor Programme at the BIPM, the planned measurement campaign using the International Prototype of the Kilogram in the Mass Department and two workshops proposed for 2015, one on measurement uncertainty and the new GUM and the other on carbon measurements.

2. APPOINTMENT OF THE RAPPORTEUR AND FINALIZATION OF THE AGENDA

Dr Manson was appointed rapporteur for the meeting.

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

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

Dr Usuda invited Dr Stock to review the action points from the previous CCPR meeting in 2012.

AP1: Dr Hengstberger will discuss with the CCL President the best location for refractive index and related CMCs and report back to the CCPR.

Completed: This had been discussed at the CCPR WG-CMC meeting held earlier in the week. The Consultative Committee for Length has agreed that CMCs for refractive index should be managed by the CCPR. There are two existing CMCs for refractive index – these should be transferred to the CCPR and the CCPR should create the related service categories in its own list.

AP2: TG for comparison analysis (part of the WG-KC) to investigate the relationship between Birge ratio and chi-squared.

This was not discussed during the WG-KC meeting earlier in the week. Dr Ohno pointed out that a workshop on comparison analysis is planned for 2015 and that this issue will be resolved then.

AP3: Dr Ohno to proceed to a final check of CCPR-G2 Rev. 3 and publication on the CCPR website.

Completed: The guideline has been published.

AP4: CCPR-G4 and CCPR-G5 to be reviewed by WG-KC and to be submitted to the CCPR for approval for publication by email.

Completed: Both guidelines have been published.

AP5: Availability of BIPM for WG-KC and WG-SP meetings 22 to 23 April 2013 to be confirmed (Dr Stock).

Completed.

AP6: WG-SP membership criteria v1.3a will become CCPR-G8 and will be published on the CCPR website.

The guidelines have been approved but have not yet been published as a CCPR guidance document on the CCPR web site. After a brief discussion it was concluded that this is not appropriate.

AP7: Dr Ohno and Dr Zwinkels to propose modified terms of reference and to coordinate the work on the *mise en pratique* for the definition of the candela (1-3 pages) with the work of updating the document on "Principles Governing Photometry".

In progress. This was discussed at the WG-SP meeting earlier in the week and is included in the report of that Working Group.

AP8: Joint TG of the CCPR/CIE be formed, chaired by Dr Ohno, to produce a revised publication on "Principles governing photometry".

Completed. The joint technical committee, JTC-2 (CIE-CCPR) Principles Governing Photometry, chaired by Dr Ohno, was formed within the CIE in April 2012, and the work is in progress.

AP9: Enquire as to logistic for holding CCPR-WG meetings at the CIE mid-term meeting venue or at LNE.

Completed.

Dr Usuda noted that the minutes 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. There were no requests for additional documents to be presented.

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

The report was presented by Mr Sieberhagen, Acting Chair of WG-CMC and AFRIMETS representative. The working group met on 15 September 2014 at the BIPM. The meeting was chaired by Mr Sieberhagen, and representatives from AFRIMETS, APMP, COOMET, EURAMET and SIM were present along with 28 observers.

Three service classifications have been updated following the last meeting – 2.7 Responsivity, solar, irradiance; 3.5 Radiant flux, spectral; and 5.8 Radiant flux, total.

Inconsistencies between the service category list and the Excel table were discussed at the meeting. The meeting established two related action points: the Excel table is to be reviewed, clarified and simplified and the RMO TC Chairs are to complete the table for submission to the KCDB (once it has been approved).

Two new service categories were discussed at the meeting. The first was related to Optical Time-Domain Reflectometry (OTDR). Currently there is only one service category (7.10.1: Length,

OTDR), however it would be preferable for the service categories to match commonly used calibration procedures and to include the attenuation scale of OTDR instruments. The proposed modified service category structure is:

7.10.1	Distance scale deviation	OTDR
7.10.2	Location offset	OTDR
7.10.3	Attenuation	OTDR

The TC Chairs are to ask their members for comments on the proposal.

There was discussion during the WG-CMC meeting about the consistency in the categories, with an action point to ensure the wording is consistent.

The second service category discussed at the meeting was related to refractive index and related quantities. It was agreed that the CCPR would create the following service categories:

Refractive index
Angle of rotation of plane of polarization
Ellipsometric angles.

The WG-CMC meeting agreed that the BIPM should contact institutes that currently hold CMCs related to refractive index (GUM and NMIJ) to ensure that they agree with the proposed transfer from the CCL to the CCPR. It was also agreed that a written proposal for the introduction of the new service categories should be prepared by Dr Khlevnoy within one month.

The WG-CMC meeting then discussed the CMC review process, following a presentation from the JCRB, given by Dr C. Kuanbayev, which included Recommendations 30/1, 30/2 and 30/3 and Action 30/1 of the JCRB. This discussion included a paper prepared by a Task Group within EURAMET related to possible changes to the implementation of the CIPM MRA with a view to improving its efficiency. It was agreed that a task group consisting of the RMO TC Chairs should be formed with the task of preparing a document on this subject for discussion within the CCPR and eventual adoption as the CCPR's position.

The WG-CMC meeting discussed the process of checking the consistency of CMCs with comparison results. There were remaining questions about how consistency was checked and whether uncertainty should be considered. The conclusion was that a guidance document is needed, and the WG-CMC Chair is to arrange a group to prepare a draft.

Dr Usuda then invited comments and questions on the WG-CMC report. Dr Milton asked whether the CCPR has responded to the JCRB recommendations 30/1 and 30/2 – they were requests to the Consultative Committees to consider whether more efficient processes could be implemented. There was general agreement that it had not. Dr Usuda raised a question about whether there is effective communication between RMO representatives and TC Chairs. Communication of JCRB decisions to RMO TC Chairs was briefly discussed, Dr Usuda emphasized that hand-over to subsequent TC Chairs could cause additional communication problems.

AP 1: WG-CMC Chair to include some slides related to the deadlines in CMC review from JCRB Secretary in the WG-CMC report.

Dr Milton pointed out that the EURAMET paper is a proposal for long-term changes whereas the JCRB recommendations are shorter term, practical proposals. After further discussion, the subject was closed with Dr Usuda informing the meeting that there will be a workshop to review the effectiveness of the practical implementation of the CIPM MRA in conjunction with the NMI Directors' meeting in 2015.

After a brief discussion it was confirmed that the APMP TC chair will be the next Chair of the WG-CMC, effective from the end of the WG-CMC meeting.

6. 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 on the afternoon of 15 September and the morning of 16 September 2014 at the BIPM. The meeting was chaired by Dr Ohno with 12 members and 21 observers present.

A request for membership of WG-KC has been received from LNE-Cnam. Dr Ohno displayed the criteria for membership, pointing out that LNE-Cnam piloted the first round CCPR-K6 comparison and has committed to piloting future comparisons including K6 and K3. WG-KC agreed that LNE-Cnam satisfies the criteria and therefore approved the membership application. Dr Ohno asked the CCPR to approve the membership and it agreed to the request.

Dr Ohno reviewed the status of key comparisons:

First round of comparisons

CCPR-K2.c	Spectral responsivity 200 nm – 400 nm	completed and published
CCPR-K5	Spectral diffuse reflectance	completed and published

Second round of comparisons

CCPR-K6	Spectral regular transmittance	measurements completed Nov. 2014
CCPR-K3	Luminous intensity	measurements under way
CCPR-K4	Luminous flux	protocol to be finalized soon
CCPR-K2.b	Spectral responsivity 300 nm – 1000 nm	protocol to be finalized soon
CCPR-K2.a	Spectral responsivity 900 nm – 1600 nm	protocol to be finalized soon
CCPR-K1.a	Spectral irradiance 250 nm – 2500 nm	task group formed

The pilots of CCPR-K4, of CCPR-K2.b and CCPR-K2.a are to submit the relevant protocols to WG-KC by February 2015, December 2014 and December 2014 respectively.

Selection of participants in CCPR-K1.a was discussed during the WG-KC meeting since thirteen applications had been received. This number was reduced to twelve by applying the selection criteria previously agreed. A Task Group for preparing the protocol has been formed and Dr Ohno requested CCPR approval of the membership. The CCPR agreed to this request.

Although the CCPR no longer runs supplementary comparisons, there are two S3 bilateral comparisons that are still under way. The pilot (common to both comparisons) is to publish both reports by the next WG-KC meeting.

Dr Ohno outlined discussions that had occurred during the reports by RMOs. These included the need to share information related to planned supplementary and bilateral comparisons between the RMOs. As a result of this discussion, COOMET is to distribute announcements of supplementary comparisons on surface colour and transmitted colour to all CCPR members. There was a further discussion at the WG-KC meeting about a more general mechanism for disseminating this

information. A table format is to be developed by the Chair of WG-KC for RMO TC Chairs to update every six months for posting on the CCPR website.

Dr Usuda asked which section of the website would be used, noting that NMIs which are not members do not have access to the restricted section of the website so RMO TC Chairs are encouraged to circulate the information widely within their TCs.

AP 2: 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.

Dr Ohno discussed proposals for new comparisons. The PTB and NIST have proposed a comparison on detector responsivity in the terahertz frequency region. WG-KC agreed to establish a Task Group for a pilot study on terahertz measurements with the PTB, NIST, and NIM as members. Dr Ohno requested CCPR approval of the membership. The CCPR agreed to this request.

Dr Ohno noted that the possibility of a comparison on spectral regular transmittance (K6) in the UV region is under investigation by a task group led by the NMISA.

As part of the agenda item related to the needs for supplementary comparisons, a proposal was made to the WG-KC meeting for a pilot study on the realization of photometric units without V(λ) filters. After discussion, WG-KC agreed to reduce the scope of the proposal and to form a Task Group on a pilot study for the use of white LED sources as transfer standards for comparisons of photometric quantities. WG-KC also agreed to start a Discussion Group on the subject. The Discussion Group has the advantage that its membership is not limited to members of WG-KC. Dr Ohno requested CCPR approval for the formation of the Task Group and the Discussion Group. The CCPR agreed to this request.

Dr Ohno presented the proposed timetable for second-round key comparisons, outlining changes to the proposed start dates of K4, K2.b, K1.a and K1.b.

Summaries of the work of three Task Groups were presented. The status of the Task Group on a pilot comparison for spectral regular transmittance in the UV is included in the report of the AFRIMETS RMO below. The Task Group on RMO Linkage has developed a rigorous treatment for linking the results of RMO KCs to CCPR KCs. This has been included in the guideline document "*Guidelines for RMO PR Key Comparisons*" (G6) as Appendix A. WG-KC has agreed a further workshop on comparison analysis requested by the Task Group on Comparison Analysis. This will take place in conjunction with the next meeting of WG-KC. Dr Ohno summarized the issues related to identification of outliers, specifically in the context of the recently completed K2.c comparison.

Dr Ohno presented the status of the guideline documents, noting that G3 has been incorporated into G4 and should therefore be removed and that G6 is almost complete. Guideline G6 was approved by WG-KC and Dr Ohno requested that CCPR approval be given, either at the meeting or by email. Following discussion about the urgency of this guideline, its previous availability on the website and the need to include a configuration relevant to a recent COOMET comparison, it was decided that the CCPR would approve the G6 guideline in its current form and that extra material to cover the additional configuration would be developed for a subsequent version.

AP 3: Dr Ohno to send Dr Stock the final version of the G6 guideline for publication on the CCPR website.

As part of the discussion on G6, there was brief discussion on whether RMO comparisons must use the same artefact as the corresponding CCPR comparison. The conclusion was that this is not necessary, and that RMO comparisons have the flexibility to trade-off artefact selection, wavelength

range, etc to optimize participation opportunities noting the possible restrictions on CMC coverage that may arise.

There was discussion at the WG-KC meeting and also in the CCPR meeting about a comparison, proposed by VNIIOFI and PMOD, on solar irradiance using the sun. Details had previously been circulated and the AIST and NIM had expressed interest. Prof. Schmutz confirmed that the comparison will go ahead, and that the call for participants will be prepared soon. There was a discussion about whether it will be an RMO Supplementary Comparison and how it will relate to the ongoing World Meteorological Organization (WMO) comparisons. Prof. Schmutz agreed that the CCPR guidelines on RMO comparisons would be followed by the relevant participants.

AP 4: PMOD and WG-KC Chair to prepare a proposal for the solar irradiance comparison.

7. 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 16 September 2014 at the BIPM. The meeting was chaired by Dr Zwinkels; 31 members and observers were present.

Dr Zwinkels summarized the status of WG-SP and its Task Groups. There are seven active Task Groups (which includes three Discussion Fora) and a joint Task Group with the CIE.

- TG4 – SI

  A workshop on SI units for Photometry and Radiometry was held in 2013, with experts from CIE invited. Decisions related to the *mise en pratique* and "*Principles Governing Photometry*" were made. Input to the report from CCPR to the 21st meeting of CCU was prepared.

- TG5 – *mise en pratique*

  Decisions included linking to photon units in the *mise en pratique* and to finalize it using the current definition of the candela and update it when the revision of the SI - including the reformulation of the candela definition - is adopted by the CGPM.

- TG6 – discussion forum on fibre optics

  A comparison on optical time domain reflectometry (OTDR) has been a major subject of discussion, with the resulting establishment of the TG9 OTDR Length Comparison.

- TG7 – discussion forum on few-photon metrology

  Proposed the formation of a new technical Task Group on single-photon metrology, with proposed terms of reference presented to the WG-SP planning meeting.

- TG8 – discussion forum on THz metrology

  Organizing a pilot comparison on THz laser power measurement, and this work has now been transferred to WG-KC. A decision was made to prepare a survey on needs related to radiometric applications focussing on space and astronomy.

- TG9 – OTDR length comparison

  The protocol for a comparison on optical fibre length has been prepared. Participants have been identified and the comparison structure determined.

- TG10 – ad hoc task group on the CCPR strategic planning document
  The CCPR strategic plan was developed in response to a CIPM request and submitted, following discussion and approval by the CCPR. The Task Group continues to monitor requirements related to new technologies.
- CIE JTC-2 – Publication "*Principles Governing Photometry*" (jointly with the CIE)
  A number of draft versions have been prepared and discussed. Significant emphasis was placed on the appendix with proposed changes to symbols and definitions. The WG-SP meeting decided that a draft should be prepared by the end of 2014 for ballot by the CIE.

Dr Zwinkels summarized the decisions of the WG-SP regarding the timeframe for completion of the *mise en pratique*. The goal is to make it available for the next CIPM/CGPM meeting in November 2014. This version will be updated when the new SI is adopted.

The WG-SP agreed on goals and priorities for 2014-2015:

- Consensus on the importance of a photon-based definition of the candela
- Completion of the *mise en pratique* and "*Principles Governing Photometry*"
- Prepare material related to the economic impact of CMCs for Dr Usuda's presentation at the 2014 CGPM meeting
- Advance the aims of the discussion fora.

Dr Zwinkels then presented three recommendations to the CCPR from WG-SP and asked for CCPR approval.

- Creation of a new WG-SP Task Group (TG11) on single-photon radiometry
- Change of the terms of reference for TG7
- That IO-CSIC be accepted as member of WG-SP.

The CCPR approved all three recommendations unanimously.

Dr Milton asked how the consensus on the photon-based definition of the candela could be reached. Dr Zwinkels replied that TG4 (SI) is tasked with continually reporting to WG-SP on the needs for traceability of this community and whether there is an industry sector or stakeholder that requires traceability to photon-based units. At this stage it is anticipated that consensus will be achieved, but in the interim the regular information gathering process is a key activity. Dr Usuda noted that he has been asked for regular updates by the CIPM and CCU regarding the unanimity (or lack thereof) in the CCPR regarding the photon-based definition. Dr Zwinkels noted that the lack of unanimity in CCPR was the primary reason for the CCU's rejection of the inclusion of a photon-based component in the proposed definition. The issue remains an active topic of discussion in WG-SP.

Dr Kück commented that the initial motivation for the formation of TG11 (single photon radiometry) was the need in industry (identified in the survey) for a pilot study on single-photon detector efficiency given that such detectors are commercially available.

After some discussion about the reasoning behind the proposal to change the terms of reference of TG7 (discussion forum on few-photon metrology), including the motivation to create a broader expert network in the field, Dr Usuda highlighted the importance of the work of the Task Groups in WG-SP's activities and asked that a broader survey of industries or regulators be carried out. The aim is to incorporate the results into the strategic planning process.

8. UPDATE ON THE EXPECTED CHANGES TO THE SI

Dr Stock presented the proposed changes to the SI. Consultative Committees have been invited to comment on the draft of the 9th edition of the SI brochure and Dr Stock proposed that members send comments to him to be passed to the CCU. Dr Thomas noted that a supplement to the current SI brochure (the 8th edition) has been prepared. This updates a number of aspects and making some corrections.

Dr Blattner asked about the uncertainties in the mass evolution of the official copies relative to the International Prototype of the Kilogram. Dr Stock replied that they are of the order of a couple of µg, and although they are not well known for the earlier comparisons they do not account for the apparent drift before the 3rd Periodic Verification (1988-1992).

Dr Lee questioned the order of the alternative versions of the SI unit for the luminous efficacy (i.e. $\mathrm{lm\,W^{-1}}$ and $\mathrm{cd\,sr\,W^{-1}}$), saying the opposite order to the current proposed text was more logical. Dr Zwinkels pointed out that the opposite order was used in the CCPR report to the CCU presented in 2013. Dr Thomas commented that there is a system behind the selection of the order of alternative unit expressions that is the result of extended discussions within the CCU. Dr Usuda encouraged CCPR members to submit comments on the draft, making contact with stakeholders within members' economies and RMOs.

9. PLANS FOR THE REVISION OF THE GUM[1]

Dr Walter Bich, convenor of JCGM-WG1 (Working Group on the Expression of Uncertainty in Measurement), gave a presentation on the proposed changes to the GUM (Guide to the Expression of Uncertainty in Measurement). The presentation is included in the working documents of the meeting. The paragraphs below summarize discussions arising from the presentation.

Dr Blattner reported that a recent International Commission on Illumination (CIE) workshop included a course on Monte Carlo simulation; he asked Dr Bich whether it would be better just to teach Monte Carlo simulation and eliminate the mathematics. Dr Bich replied that there has been some discussion on this subject but that it was not the preferred method – people are happier propagating variances and covariances. He opined that propagation calculations will still be in favour in the future. Dr Blattner pointed out that in some fields the models are nonlinear or non-symmetric. Dr Bich replied that in these cases it is necessary to use Supplement 1. Dr Blattner said that more guidance on how to distinguish such cases will be necessary and Dr Bich replied that he realized that there is a need for guidance on how to report uncertainties when there are many results. He added that consideration should be given to using non-symmetric CMCs.

Dr Ohno noted that industry people try to use the GUM (the main document, not the supplements) and find it very difficult to evaluate uncertainties for colour quantities, such as CCT (correlated colour temperature) and CRI (colour rendering index). The uncertainties have to be calculated from

[1] Agenda item 9, Plans for revision of the GUM, was discussed on 18 September when the speaker was present

the spectral data, with major uncertainty contributions from systematic components, such as stray light effects of spectroradiometers, which create asymmetric probability distributions. He has not found any treatment in the GUM to combine such asymmetric probability distributions and to calculate expanded uncertainties. He wondered if this could be addressed in the new GUM. Dr Bich commented that the concept of expanded uncertainty implies a symmetric distribution – in the asymmetric case it is not possible to specify the coverage interval as a multiple of the standard uncertainty. That is why the standard uncertainty is emphasized in the GUM. Dr Blattner added that this provides more reason to prefer Monte Carlo calculations. He also said that guidance is needed on how to deal with cases where distributions are unusually shaped. Dr Bich replied that this is beyond the scope of the GUM.

AP 5: Dr Blattner to give Dr Bich specific examples of complex distributions.

Dr Zama observed that spectral data are a problem and that many people working in industry are unfamiliar with the higher mathematical techniques related to Monte Carlo simulations. He asked whether it is possible for the new GUM to give simplified methods for industry and calibration laboratories to follow. Dr Blattner said that correlations have to be considered when photometric quantities are calculated from spectral data – the new GUM will not be able to simplify that aspect of the process. Dr Ohno added that colour uncertainty calculations can be done using the step-by-step approach extended from the GUM, which will be easier than Monte Carlo techniques for the industry people. There is a plan to compare the step-by-step calculations with Monte Carlo results. Dr Bich said that this should be done at least once to check agreement between Monte Carlo results and the GUM. If the GUM is sufficient then it should be used, but this check should be made for every different application.

Dr Ohno noted that, when evaluating the uncertainty in colour or photometric quantities from spectral data, it is necessary to start with the uncertainties of the standard lamp and a very important component is the correlation between values at different wavelengths. If these data are not available, calculating uncertainties is difficult. However, such correlation data are not generally provided by NMIs in their calibration reports. He would encourage NMIs to provide correlation matrices when providing calibration of spectral quantities. Dr Bich noted that some thought had been given to inserting more information about covariances.

Dr Usuda asked about the timeframe for the publication of the revised GUM. Dr Bich replied that there will be a meeting of the drafting committee in late September 2014 and the hope was that the result will become the first committee draft. He expected this draft to be circulated by the end of 2014. Comments will be collected by April 2015 and then the committee will meet to implement changes related to the comments. The second (final) circulation to member organizations will follow, and final approval may be completed by the end of 2016.

Dr Thomas said that in her opinion the proposed changes create a degree of fear in the community, particularly related statements about problems with the KCDB and CMCs. She noted that Dr Bich had given an example in his presentation where the changes have no effect, but suggested that the Consultative Committees should be asked for examples where there is a change so that the community can examine the significance of the changes. Dr Usuda suggested that empirical information should be collected about where the revision will affect the KCDB, and Dr Thomas added that it is not suficient to say that there will be an impact. The impact should be analysed with specific examples – if this is not done concerns will arise.

Dr Usuda added that other colleagues may have concerns and he encouraged members to collect and submit those concerns to the Executive Secretary of the JCGM (Dr Thomas) or Dr Bich.

Dr Bich pointed out that the NMIs will be asked for comment (using a custom template) and these comments will go to JCGM WG1 for discussion. He asked for examples which are suitable to be inserted into the new GUM.

AP 6: Members to provide comments and examples related to the revision to the GUM, with examples suitable for inclusion in the new version.

10. REPORTS BY RMO TC CHAIRS

AFRIMETS (presented by Mr Sieberhagen)

The NMISA is leading the WG-KC Task Group on a pilot comparison for spectral regular transmittance in the UV. The artefacts for the comparison have been received and initial measurements are expected to start in November 2014.

The NMISA is piloting APMP.PR-K5 (spectral diffuse reflectance). One set of artefacts has been received but the other set has only been dispatched recently from the manufacturer. Finalization of the protocol is expected to start in November 2014.

The AFRIMETS.PR-K3.a comparison on luminous intensity is delayed because there has been no response from NIS, Egypt.

APMP (presented by Dr Manson)

The attendance at the annual meetings of TCPR has been relatively stable. On several occasions new members have attended the meetings, but unfortunately have not been able to sustain their attendance in subsequent years.

Several key and supplementary comparisons and pilot studies are under way, with pilot study P1 (luminous flux of LED luminaires) being completed during the preceding two years. Two supplementary comparisons (S2, fibre optic power responsivity and S5, laser power responsivity of trap detectors) are in the report preparation stage. The supplementary comparison on spectral radiance (S6) is in the measurement stage, while those on grey-scale diffuse reflectance (S7) and optical fibre length (S8) are in the planning stage. The optical fibre length comparison is being run in close collaboration with WG-SP TG9. Pilot study P2 on total spectral radiant flux is in the measurement phase while the artefacts are being purchased for P3 on transmittance haze.

APMP has an active programme of peer reviews, with the majority of reviewers coming from within APMP, but a number of reviewers from other RMOs have also taken part.

COOMET (presented by Dr Khlevnoy)

Since the last CCPR meeting, Bosnia Herzegovina and Turkey have joined COOMET, and Moldova has joined the TCPR.

Since the last CCPR meeting, comparisons on laser power responsivity (S4) and fibre optics power responsivity (S6) have been completed. COOMET.PR-K3.a (luminous intensity) is in progress, although some problems have been found which will require additional measurements. Four supplementary comparisons (S1 on whiteness and brightness, S2 on angle of rotation of plane of polarization, S3 on refractive index and S5 on spectral regular transmittance) are in the early stages of

report preparation. A supplementary comparison on laser power responsivity (S7) is in the measurement stage. Comparisons on surface colour, transmitted colour, spectral irradiance (200 nm - 400 nm), spectral radiance using a sphere source and a bilateral comparison on luminous flux are being planned.

Since the last CCPR meeting, COOMET TCPR has completed five intra-RMO and four inter-RMO reviews of CMCs and 64 new CMCs have been registered.

EURAMET (presented by Dr Smid)

Since the last CCPR meeting, one Designated Institute (DI) has terminated DI status in EURAMET and three have been accepted as new DIs.

Dr Smid discussed the new EMPIR programme, describing its history, starting in 2002, and evolving through the iMERA and EMRP programmes. The EMPIR programme will formally start in 2015, although calls have already been opened.

As part of the preparation for EMPIR, TCPR has developed four roadmaps covering four areas of emphasis. Dr Smid then summarized these areas.

Basic Science and Quantum Optics

The Predictable Quantum Efficiency Detector (PQED) is being developed and promoted as a method of providing highest level realizations of radiometric scales combined with shorter calibration chains to reduce cost. The SIQUTE project aims to develop single photon sources for quantum technology for use in applications such as quantum communication and quantum computation. The MIQC project, which has recently been completed, developed measurement infrastructure for standards for commercial quantum key distribution.

Climate and Environments Monitoring

The MetEOC project (Metrology for Earth Observation and Climate) was extremely successful, mostly in calibrations at the pre-launch stage. The follow-up project, MetEOC-2, concentrates on post-launch calibration. A project entitled '*Traceability for Surface Spectral Solar Ultraviolet Radiation*' has been completed. It was coordinated by PMOD and aimed at enhancing the reliability of spectral solar UV measurements at the Earth surface. A follow-up project aimed at traceable measurements of the total column ozone has commenced.

Industry and Innovations, and Energy Efficiency

The Multidimensional Reflectometry for Industry project, which has applications in appearance metrology, is aimed at improving the metrology and primary measurement capabilities for multi-dimensional reflectometry and other outputs related to the bidirectional reflectance distribution function (BRDF). Development of a new parameter for photovoltaic classification is the aim of the PhotoClass project. Following on from a previous project related to solid state lighting is a new project, which intends to deliver an advanced metrological framework for novel solid-state lighting, including LEDs and OLEDs.

A brief summary of EURAMET's comparison activities followed. Five (K1.a, K2.b, K3.a, K4 and K5) out of the six RMO key comparisons have been completed in the last two years, and a number of supplementary comparisons are under way.

Dr Usuda asked how the completed projects have been evaluated. It was explained that they are evaluated by experts from external stakeholders. These experts review the deliverables and assess the project; in some cases this also happens during the project.

Dr Fraser asked how the themes are chosen, particularly with many nations involved with different priorities. Dr Smid answered that there are a number of stages. The first involves a five-page submission by a team of collaborators; approximately one-third of these submissions are selected by the first stage committee. The second stage is a meeting where participants contribute ideas about the project, the coordinator is selected and the project structure is determined. The third step involves a reviewing committee that selects the projects to be funded.

Dr Usuda asked whether there is any mechanism for public comment, e.g. from industry. It was explained that although different projects work in different ways, 'project impact' has become more important in the selection of projects recently. At the proposal stage, applicants are encouraged to provide formal letters of support. External collaborators are encouraged, although they do not receive any funding, and some projects have stakeholder and independent expert committees for ongoing evaluation. These mid-term evaluations are aimed at improving the projects results during its lifetime.

SIM (presented by Dr Nadal)

SIM is divided into five sub-regions and has 34 members. There are five active members of the TCPR.

Dr Nadal summarized the comparison and other activity of each SIM member.

CENAM-Mexico

Participating in SIM-PR.K4 comparison, which is at the Draft B stage. It plans to participate in SIM.PR-K6:2014, SIM.PR-K3 and APMP.PR-S7 and would like to participate in comparisons on spectral responsivity and spectral irradiance. Two new calibration services are planned: improvements to the wavelength range for responsivity based on new laser lines for cryogenic radiometry and a new system for solar irradiance.

INMETRO-Brazil

Participating in SIM.PR-S3.1 (a bilateral with NIST) and COOMET.PR-S5, for which the report is being finalized. It plans to participate in SIM.PR-K6.2014. A comprehensive revision of all PR CMCs is under way, and a number of new CMCs will be submitted over the next few years.

NIST-Boulder

A comparison with NIM China on laser power has been completed, measurement for the COOMET.PR-S7 comparison on laser power at 10.6 μm are in progress, and measurements for the APMP comparison on laser power responsivity have been completed. A pilot comparison on THz laser radiometry is under development, as is a plan to provide calibration services in this area. All CMCs have been reviewed and approved by the SIM Quality System Task Force (QSTF) in 2014.

NIST-Gaithersburg

Participating in CCPR-K3.2014, CCPR-K6.2010 and CCPR-K4.2014 and piloting SIM.PR-S3.1, which is in the pre-Draft A stage. It plans to participate in 2nd round CCPR-K1.a, CCPR-K2.a, CCPR-K2.b and APMP.PR-S7 as well as piloting SIM.PR-K6.2014 and SIM.PR-K3. The PR CMCs are undergoing a comprehensive internal review and will be submitted to SIM for review. Three new calibration services are planned: total spectral radiant flux using 2π reflector lamps as transfer standards, a new realization of the candela based on a

tuneable optical parametric oscillator (OPO) laser, and a service for characterization and correction of stray light for spectrometers using the same laser system.

NRC-Canada

Piloting CCPR-K3.2014, the first round of measurements for which are already completed, and participating in CCPR-K4.2014 and CCPR-K6.2010. It plans to participate in the 2nd round of CCPR-K1.a, CCPR-K2.a, and CCPR-K2.b and SIM.PR-K6.2014. The CMCs were audited by external experts in 2013 and extensions to service category 4.13.0 were approved by the SIM QSTF. Three new calibration services are planned: a wavelength extension for fluorescence calibration, sphere-based fluorescence in the UV-visible range, and to add new CMCs for spectral diffuse transmittance which are currently greyed-out.

Dr Blattner asked about collaborations or research projects other than comparisons. Dr Nadal replied that there are some informal collaborations and there is a programme of guest researchers within SIM. Dr Fraser commented that the SIM had run a Metrology Summer School that broadly covered activities of all the TCs. Dr Nadal added that it consisted of a week-long programme of both lectures and practical work in laboratories. Dr Fraser recalled that the NIST operates a programme to fund guest researchers from SIM countries to spend up to six months at NIST on collaborative projects.

11. REVIEW OF THE CIPM MRA

Dr Usuda introduced this agenda item stating that since the CIPM MRA has been in operation for fifteen years it is appropriate to review it and to consider whether it should be changed in any way. One of the original ideas related to the review was to circulate a common questionnaire to all CCs. This idea was rejected because the CC Presidents decided that there are specific issues for each CC so a common questionnaire was not appropriate. Each CC was therefore requested to collect feedback. Dr Usuda therefore included two questions (related to CMC successes and use) in the questionnaire on laboratory progress completed by member NMIs before the meeting. Dr Zwinkels, Chair of WG-SP, had some findings related to the answers received, which she presented.

Dr Zwinkels first presented the two new questions, the first relating to feedback from stakeholders that currently use the CMC section of the KCDB and the second asking for success stories related to the CIPM MRA. She then summarized the replies to the first question:

LNE

Space/environment industry in relation to the Meteosat 3rd generation satellite instruments.

KRISS

Formal commendation from two major manufacturers of LED chips, specifically mentioning piloting comparisons.

METAS

Feedback from NMIs outside CCPR and private manufacturers of high precision instruments who were aware of the CMC database. Dr Blattner mentioned that a lot of the awareness of CMCs comes through the CIE.

For the second question:

MSL

Characterization of linearity and wavelength on spectrophotometers underpin many chemical assay tests required of New Zealand's biggest exporter of dairy products; traceable measurements of optical power required for photobiological safety testing of appliances incorporating LED or laser diode technologies.

PMOD/WRC

PREMOS (PREcision MOnitoring Sensor) on the French satellite PICARD is the first space-borne absolute radiometer measuring Total Solar Irradiance that was calibrated in vacuum with traceability to the SI.

Dr Usuda commented that it would be helpful to find some further successes of the CIPM MRA, such as the international harmonization of metrology which is of great benefit to stakeholders. Dr Lee commented that the existence of CMCs and the supplementary comparisons was a key factor in the acceptance of KRISS' technical competence by Samsung.

Dr Usuda invited Dr Milton to make a presentation on the review of the CIPM MRA. Dr Milton that because the CIPM MRA has been in operation for nearly fifteen years, discussions have started on how it could be refined or improved and how this might be carried out. Since it is an agreement between NMI Directors, the appropriate forum for a review is a meeting of NMI Directors. Such a meeting is planned for September 2015 and the intention is to gather the necessary information for that review in advance of the meeting. He emphasized that it is important that the views of the CCs, NMIs, the JCRB and the RMOs are available at the meeting. This is particularly important since one of the possible criticisms of the CIPM MRA is the lack of communication with stakeholders, and that senior staff within a stakeholder organization may have different views to those of junior employees. Dr Milton further emphasized that it is important that the view of CCPR is represented. After the Director's meeting the CIPM will establish a Working Group to carry out the review. The whole process is expected to be captured by a resolution of the CGPM in November 2014.

Dr Usuda encouraged all members to become involved in this review of the CIPM MRA. He noted that, based on observations during the working group meetings, most CCPR comparisons are going well, and that a number of guideline documents have been prepared. Dr Usuda believes that the CIPM MRA maintenance costs and its outcomes can be justified in the photometry and radiometry community. However, it would be worthwhile to document some specific outcomes of the CIPM MRA or the activities of CCPR so these can be brought to the attention of stakeholders. Dr Usuda encouraged CCPR members to establish close contact with stakeholders, especially industry and regulators.

Dr Ohno was of the opinion that that the CIPM MRA is not well known in industry or by regulators. He commented that he is involved in a programme run by the International Energy Agency (IEA) on solid state lighting, and noted that this programme works with regulators. Some regulations in lighting refer to national standards and not to the SI, so in these cases the CIPM MRA is not used. This prohibits the use of other national standards. Regulation has a big influence on traceability practice. If we establish communication with regulators we may be able to promote the CIPM MRA.

Dr Zwinkels presented an actual example. She is the Convenor of ISO TC6 on Paper, Board and Pulp. This committee is currently rewriting an authoritative document which describes the criteria for the evaluation of the competency of authorized laboratories for measurements of optical properties. The standardizing laboratories are required to have CMCs for the primary standards referenced in the

document. This means that the paper industry is already becoming aware of the benefits of the BIPM database.

Dr Usuda commented that in his opinion regulators should refer to the CMCs as the best practice in measurement. Otherwise, the regulation may not be feasible, becoming solely a document without technical resources. He encouraged members to make contact with local regulators.

12. REPORT ON LIAISON WITH CCT WORKING GROUP 5 "RADIATION THERMOMETRY"

The report was presented by Dr Fox on behalf of Dr Woolliams. The CCPR/CCT liaison working group was established in early 2000 with the intention of linking the CCPR and CCT Working Group 5 (related to radiation thermometry), recognizing that many absolute techniques being developed in the radiometry community were relevant to the thermometry community and that the necessary interactions between the communities were not necessarily happening. This was relevant both for the requirement to measure higher temperatures in the temperature community and the need in the radiometry community to measure the temperatures of high-temperature blackbodies. At that time, new fixed points (eutectics) were being developed in the temperature community, and the radiometry community was investigating absolute characterization of filter radiometers against cryogenic radiometers to provide absolute radiance measurements. More recently, the effort has been related to defining the new kelvin, working on all the different components in different stages and different research groups. This will lead ultimately to a round-robin type of activity to assign definitive temperatures and a new *mise en pratique* text for the new kelvin. A programme of comparison activity, with a challenging timetable, is under way with the aim of assigning thermodynamic temperature values to the cells. The results from the programme will then need to be combined in order to assign community consensus values to the various fixed points.

Dr Fox continued by stating that the members of CCT WG 5 considered that there is no longer a need for the liaison with the CCPR. At the 2014 meeting of CCT, all working groups were dissolved and new ones formed. Working Group 5 was replaced by CCT WG-NCTh (non-contact thermometry). It is now felt that there is a significant number of radiometrists contributing to the work of the WG, to make the formal liaison unnecessary.

13. LIAISON WITH OTHER ORGANIZATIONS (CIE, WMO, CORM, ETC.)

International Commission on Illumination (CIE)

The report was presented by Dr Blattner, Director of CIE Division 2.

Dr Blattner began by commenting that many fields of application are common to both organizations. Although there could be concerns about competition between the two organizations arising as a result, this is not the case here because there is a clear statement of the tasks of the two organizations

in the MoU signed in 2007.

Dr Blattner briefly mentioned the overall structure of the CIE, and then focused on Division 2, "*Physical Measurement of Light and Radiation*". He outlined the strategy of Division 2, describing the technical committee work which is focused on some relevant topics (updating basic documents and LED photometry), the symposia that are being organized on selected topics (such as Monte Carlo simulation, sampling theory etc) and the running of tutorials and lectures which are increasingly demanded by industry.

He then summarized technical committee activities, noting that they are divided into four areas: Instruments, Applications, Products and Fundamentals. He presented a list of CIE Technical Reports published in 2014, showing that the work of some TCs is complete, allowing new opportunities to be investigated.

He looked in more detail at some reports that were recently published and some standards or draft standards, highlighting the recent move to combined document numbering when publishing joint ISO/CIE standards. A major emphasis was placed on the new CIE DIS 025:2014 standard entitled "*Test method for LED lamps, LED luminaires and LED modules*" which is the first world-wide test method for LED lamps, luminaries and modules. Dr Blattner discussed the new approaches related to tolerance and uncertainties, noting that this contributed to the length of time taken to complete the standard, and to reach the consensus for the CIE approach.

Two new reporterships are proposed: File format for LIDs and LED-based standards for photometry.

Dr Blattner commented that symposia and lectures during the last two years have concentrated on measurement uncertainties for industry, particularly the JCGM documents related to the GUM. He particularly emphasized the importance to industry of JCGM 106:2012 entitled "*Evaluation of measurement data – The role of measurement uncertainty in conformity assessment*". He summarized the conclusions of the most recent symposium, and noted that providing traceability is not sufficient to create an impact. It is also important to prepare guidance documents (e.g. technical reports), to participate in standardization and regulation work (accepting consensus views) and provide knowledge to stakeholders through training.

World Meteorological Organization (WMO)

The report was presented by Dr Rüedi, WMO.

Dr Rüedi began by noting the two WMO Technical Commissions which are the most relevant to the CCPR: Commission for Instruments and Methods (CIMO) and Commission for Atmospheric Sciences (CAS). The role of Technical Commissions is to develop methods and standards for WMO.

WMO does not own any calibration laboratories, but has designated the Physikalisch-Meteorologisches Observatorium Davos (PMOD) as its World Radiation Centre, and as a designated institute in the context of the CIPM MRA. The PMOD/WRC maintains the World Standard Group to realize the World Radiometric Reference (WRR), serves as a calibration centre and regularly organizes the International Pyrheliometer Intercomparisons (IPC). Dr Rüedi summarized the operation of the World Radiometric Reference, noting that it is maintained by PMOD through a group of instruments and is disseminated world-wide using intercomparisons held every five years (IPCs). The WRR is a conventional primary standard. The WMO is interested in the continuity of its observations so it is interested in tracing their instruments. It may therefore be necessary to make some changes to the way measurements are done in the future.

CIMO is responsible for oversight of the WRR work. A meeting was held in July 2014 at which a

slightly modified structure was established, including the reinstatement of the Task Team on Radiation References, together with existing Task Teams on Instrument Intercomparisons and Operational Metrology. The outcomes of the CIMO meeting included:

> Noting that recent solar irradiance measurements using SI-traceable cryogenic radiometers differ from the WRR and deciding to address this difference;
>
> Noting that new reference infrared radiometers have been developed and they provide terrestrial measurements directly traceable to the SI and recommending comparisons of these new instruments with the World Infrared Standard Group;
>
> Planning for the next IPC in September and October 2015, and conducting the infrared radiometer comparison at the same time.

Some outcomes of the CIMO meeting were specifically related to collaboration with the BIPM.

> Requested close collaboration with the BIPM/CCPR on the evaluation of the possible difference between the WRR and the SI as well as on the traceability of longwave radiation measurements to the SI;
>
> Requested that the best practices established by the BIPM in preparing and conducting a reference change must be duly taken into account while developing a recommendation on whether a reference change is needed, and if so, in determining how to proceed to ensure continuity of radiation records in the future.

In order to achieve these results, a Task Team on Radiation References was established. The terms of reference include:

> reviewing and reporting to CIMO on recent developments in reference instruments for solar and terrestrial radiation;
>
> assessing the potential impact and consequences of a change;
>
> making recommendations on requirements and timeliness for a modification of the current references;
>
> providing regular progress reports.

This Task Team includes a representative from BIPM/CCPR. Dr Fox has been approached about fulfilling this role.

Dr Rüedi briefly discussed the work of the CAS. It has collaborated with CIE to publish the technical report entitled "*Rationalizing nomenclature for UV doses and effects on humans*", and it has been involved with a number of EMRP projects.

Dr Usuda asked who was representing the CCPR on the CIMO, and Dr Fox replied that he and Prof. Schmutz are the representatives. Dr Milton asked about the magnitude of the differences in the WRR and Dr Fox replied that it was approximately 0.3 % which is a similar magnitude to the difference in space-based measurements between SI-traceable results and others.

Council for Optical Radiation Measurements (CORM)

The report was presented by Dr Ohno.

Dr Ohno began by giving a brief summary of the function of the Council for Optical Radiation Measurements (CORM). CORM has members from the United States, Canada and Mexico and provides a forum for discussion related to optical radiation measurements and a link between

members and national laboratories. It organizes an annual conference with typically 50 to 60 attendees, which is much smaller than some years ago. Sessions typically cover solid state lighting, optical properties of materials, spectroradiometry, etc. CORM also publishes a newsletter twice a year, which includes reports from the NMIs. Every few years CORM also publishes CORM reports, based on a survey of pressing needs in the field of optical radiation measurements. Dr Ohno believes that the next edition of this report will be useful for the CCPR community.

Dr Usuda commented that information from other standardization or regulation bodies would be welcome. Dr Ohno reported on the comparison on solid state lighting (SSL) run by the Solid State Lighting Annex of the International Energy Agency (IEA), which consists of country governmental members. This was a very large scale intercomparison on measurements of SSL products, involving 110 laboratories. The report[2] was published the week before this meeting. A total of 54 laboratories participated directly, with links to another 56 laboratories from the Asia Pacific Laboratory Accreditation Cooperation (APLAC) and National Voluntary Laboratory Accreditation Program (NVLAP) proficiency test programmes. Each participant measured four or five LED lamps of different types, measuring eight quantities, including electrical quantities. Although uncertainties were much larger than those in a CCPR comparison (e.g., variation in luminous flux of approximately ±5 %), the purpose of the comparison is different with the eventual goal of reducing uncertainties of measurements of LED lighting products in the industry.

Dr Blattner pointed out that ISO has created a new TC, ISO TC 274, which will deal with application standards in lighting situations such as a world-wide standard for road lighting. The relationship with the CIE has been established with a memorandum of understanding. The CIE will continue to prepare technical reports on fundamental science and standardization of measurements. Dr Blattner commented that he did not believe that it is necessary to have a formal link between this ISO TC and the CCPR, but confirmed that he would include information related to this TC in future reports from the CIE.

14. REVIEW OF PROGRESS MADE BY CCPR MEMBER LABORATORIES SINCE THE 21ST MEETING

The progress reports and presentations are included in the working documents of the meeting. The sections below summarize discussions arising from the presentations if they occurred.

CENAM: The report was presented by Mr Matamoros.

Dr Dubard asked about the wavelength of the LEDs for UV calibration and Mr Matamoros replied that they were 365 nm LEDs, adding that they were quite wideband.

INMETRO: The report was presented by Dr Alvarenga.

Dr Usuda asked whether the interval for peer reviews was fixed and Dr Alvarenga replied that it is set by the accreditation authority at four to five years. Ing. Krempasky asked whether the two transfer standards from each participant in the cryogenic radiometer comparison were of the same type, however Dr Alvarenga was uncertain about this point.

[2] The report can be accessed via http://ssl.iea-4e.org.

INRIM: The report was presented by Dr Rastello.

Dr Fox commented that the statement that cryogenic radiometers cannot achieve lower uncertainties was not true: it can be done but there is no need for it. He added that one needs to consider carefully the benefits of a direct transfer to photometers. Dr Rastello replied that better performance from cryogenic radiometry would be helpful to this project, and Dr Blattner added that it would require uncertainties at the level of a few parts in 10^8 to contribute to the redefinition of some of the SI base units. A robust discussion followed about the need for the uncertainties claimed for the Predictable Quantum Efficient Detector (PQED).

NMC A*STAR: The report was presented by Mr Liu.

IO-CSIC: The report was presented by Dr Campos.

KRISS: The report was presented by Dr Lee.

Dr Kück asked whether the results of the two in-house setups have been compared. Dr Lee replied that this has not yet been done.

LNE: The report was presented by Dr Filtz.

METAS: The report was presented by Dr Blattner.

Before proceeding with the next report, Dr Usuda noted that the process for an NMI to become a member of a Consultative Committee is described in the document *CIPM–D-01*. The CCPR has received two applications, from CMI and CMS/ITRI. The CMI, Czech Republic, is currently an observer and has applied for member status while the CMS/ITRI, Chinese Taipei, has applied to become an observer. The CCPR President is required to propose membership changes to the CIPM for approval. Dr Usuda pointed out that the CMS/ITRI is an Associate of the General Conference (and not a Member State) but that in this particular case it does not cause a problem for observer status because it is not eligible to become a Member State. He invited the two NMIs to present their activities to allow the CCPR members to discuss their applications.

CMI: The report was presented by Dr Smid.

Dr Usuda asked how many staff members were involved in radiometry and photometry at the CMI. Dr Smid replied that there are ten staff. Dr Usuda asked if any EURAMET members had any specific comments. There were no comments from EURAMET members but Dr Dowell noted that she has been impressed with Dr Smid's leadership of the EURAMET TCPR.

CMS/ITRI: The report was presented by Dr Yu.

Dr Usuda asked how many staff members were involved in radiometry and photometry at the CMS. Dr Yu replied that there are eighteen staff members. Dr Usuda asked about the nature of the SEMI standards and Dr Yu replied that they are mostly related to displays.

Dr Usuda then asked both representatives to leave the room. He indicated that, in his opinion, the CCPR should ask the CIPM to approve both applications. He then asked if there were any comments or objections, and there were none. The CCPR therefore unanimously recommends that both applications be approved. When the two representatives returned to the meeting, Dr Usuda informed both that their applications had been approved by the CCPR and that he will ask the CIPM for approval. He therefore expects that the CMI will become a member of the CCPR and the CMS/ITRI will become an observer effective from the next meeting.

Dr Usuda commented that a notice had been received from MKEH, Hungary, indicating that it will

withdraw from the CCPR because it no longer has any activities in photometry and radiometry. The meeting then continued with presentations on the progress made by member NMIs.

MIKES: The report was presented by Prof. Ikonen.

Dr Ohno commented that some LED lamps use active feedback control for stabilization. Prof. Ikonen noted that one lamp type was stable, a set of four lamps being within ±1 %. Dr Lee asked about the stability of the spectroradiometer used for that measurement and Prof. Ikonen replied that the measurements were made using an integrating sphere and scanning monochromators so the measurement system effects were included.

MSL: The report was presented by Ms Nield.

NIM: The report was presented by Mr Lin.

NIST: The report was presented by Dr Fraser.

Dr Zama asked about the outcomes of the human skin reflectance measurements and Dr Fraser replied that the study is ongoing, including finding candidates and obtaining the necessary approvals. There will be a SPIE publication on the work.

SMU: The report was presented by Ing. Krempasky.

NMIA: The report was presented by Dr Manson.

NMIJ: The report was presented by Dr Zama.

Dr Kück asked about the uncertainty in the detection efficiency calibration of single-photon detectors. Dr Zama replied that it was currently approximately ±10 % and work is under way to improve it.

NPL: The report was presented by Dr Fox.

NRC: The report was presented by Dr Zwinkels.

PMOD/WRC: The report was presented by Prof. Schmutz.

PTB: The report was presented by Dr Kück and Dr Ulm.

VNIIOFI: The report was presented by Prof. Anevsky.

VSL: The report was presented by Dr van den Berg.

Following the NMI reports, there was discussion about how reporting should be done in the future, to allow more effective exchange of information and to leave more time for discussion. One possibility would be to select topics and ask for summaries of those topics from NMIs, with a lead presenter providing a summary during the meeting. The conclusion was that Dr Usuda and Dr Stock will consider the options.

15. MEMBERSHIP ISSUES OF CCPR AND ITS WORKING GROUPS

As noted above, CCPR recommends that CMI's membership of CCPR be approved and that CMS/ITRI be approved as an observer.

Also noted above is the receipt of notice from MKEH, Hungary, that they will withdraw from CCPR

since they no longer have any activities in photometry and radiometry.

16. ANY OTHER BUSINESS

Dr Stock commented that draft version of chapters 1 to 3 of the future SI brochure are available for comments and he will distribute it.

AP 7: Dr Stock to distribute the draft version of the new SI brochure. CCPR members to comment by the end of November.

17. REPORT TO THE CGPM, THE CIPM AND RECOMMENDATIONS

Dr Usuda summarized the results of the survey of CCPR members regarding stakeholder feedback and success stories of the CIPM MRA. The main points arising from the survey are summarized below:

- There is little stakeholder feedback and only a few explicit success stories in contrast with great demands of measurement.
- A few companies (mainly related to LED displays and lighting) obtained benefits from the CIPM MRA and requested their NMIs to maintain CMCs so they could claim equivalency of their products.
- Photobiological safety testing and the space and environment sectors were noted as sectors where uncertainty and traceability were relevant to stakeholders.

Dr Usuda highlighted that, although there are many measurements related to photometry and radiometry in industry, there are few CMC users. It is possible that relevant industries such as lithography, fibre photonics, etc. are highly vertically integrated so they do not need to use CMCs within their product chain. Conversely, horizontally integrated industries such as LED display and lighting may rely on rating systems such as Energy Star or Eco-Label, and CMCs could support such verifications.

18. DATE OF NEXT MEETING

Dr Usuda noted that the next CCPR meeting is expected to be in 2016, tentatively scheduled for September. Working group meetings (WG-KC and WG-SP) are held annually. Proposals to host the working group meetings in 2015 have been received from the NIM, China, and PTB, Germany. Provisional agreement to hold the meetings in China was reached, with the NIM and the WG Chairs

to negotiate the arrangements. If there are problems with holding the meetings at the NIM, the PTB offer will be taken up. Dr Ohno commented that the meetings should be held during the northern-hemisphere autumn because of the CIE meeting in Manchester, UK, in June-July and the NIM is proposing to hold the meetings at the end of October. He added that he would like to discuss the arrangements with Dr Woolliams, because she is planning to organize a workshop on comparison analysis and may want to invite experts from outside the NMI sector.

To conclude the meeting, Dr Usuda invited Dr Milton to make some comments. He thanked Dr Usuda for his successful organization and preparation for the meeting, and thanked Dr Stock as Executive Secretary and Mrs de Hargues for the organization of the meeting. He also thanked the Chairs and rapporteurs of each of the meetings.

APPENDIX 1
WORKING DOCUMENTS SUBMITTED TO THE CCPR MEETING AT ITS 22ND MEETING

Documents restricted to Committee members can be accessed on the restricted–access CCPR website. There are no open working documents of this meeting.

File	Title
CCPR/14-01	Convocation for the 22nd meeting of the CCPR
CCPR/14-02	Draft Agenda, V2.0
CCPR/14-03	Schedule for CCPR WG meetings, V2.0
CCPR/14-04	Report of the CCPR meeting in 2012
CCPR/14-05	Questionnaire on laboratory progress
CCPR/14-06	Update on expected changes to the SI
CCPR/14-GUM	Revision of the GUM: why and how?
CCPR/14-liaison-CIE	Report from the CIE
CCPR/14-pres-A*STAR	A*STAR presentation
CCPR/14-pres-CENAM	CENAM presentation
CCPR/14-pres-CMI	CMI presentation
CCPR/14-pres-CMS	CMS presentation
CCPR/14-pres-INMETRO	INMETRO presentation
CCPR/14-pres-INRIM	INRIM presentation
CCPR/14-pres-IO-CSIC	IO-CSIC presentation
CCPR/14-pres-LNE	LNE presentation
CCPR/14-pres-METAS	METAS presentation
CCPR/14-pres-MIKES	MIKES presentation
CCPR/14-pres-MSL	MSL presentation
CCPR/14-pres-NIM	NIM presentation
CCPR/14-pres-NIST	NIST presentation
CCPR/14-pres-NMIJ	NMIJ presentation
CCPR/14-pres-NMISA	NMISA presentation
CCPR/14-pres-NPL	NPL presentation
CCPR/14-pres-NRC	NRC presentation

CCPR/14-pres-PMOD	PMOD/WRC presentation
CCPR/14-pres-PTB	PTB presentation
CCPR/14-pres-SMU	SMU presentation
CCPR/14-pres-VNIIOFI	VNIIOFI presentation
CCPR/14-pres-VSL	VSL presentation
CCPR/14-pres-WMO	Report from the WMO
CCPR/14-report-A*STAR	A*STAR progress report
CCPR/14-report-CENAM	CENAM progress report
CCPR/14-report-CMI	CMI progress report (request of member status)
CCPR/14-report-CMS	Activity report from CMS/ITRI (request for observer status)
CCPR/14-report-INMETRO	INMETRO progress report
CCPR/14-report-INRIM	INRIM progress report
CCPR/14-report-IO-CSIC	IO-CSIC progress report
CCPR/14-report-KRISS	KRISS progress report
CCPR/14-report-LNE	LNE progress report
CCPR/14-report-METAS	METAS progress report
CCPR/14-report-MIKES	MIKES progress report
CCPR/14-report-MSL	MSL progress report
CCPR/14-report-NIM	NIM progress report
CCPR/14-report-NIST	NIST progress report
CCPR/14-report-NMIA	NMIA progress report
CCPR/14-report-NMIJ	NMIJ progress report
CCPR/14-report-NMISA	NMISA progress report
CCPR/14-report-NPL	NPL progress report
CCPR/14-report-NRC	NRC progress report
CCPR/14-report-PMODWRC	PMOD/WRC progress report
CCPR/14-report-PTB	PTB progress report
CCPR/14-report-SMU	SMU progress report
CCPR/14-report-UME	UME progress report
CCPR/14-report-VNIIOFI	VNIIOFI progress report
CCPR/14-report-VSL	VSL progress report
CCPR/14-RMO-AFRIMETS	Report from AFRIMETS
CCPR/14-RMO-APMP	Report from APMP

CCPR/14-RMO-COOMET	Report from COOMET
CCPR/14-RMO-EURAMET	Report from EURAMET
CCPR/14-RMO-SIM	Report from SIM
CCPR/14-WG-CMC	WG-CMC report to CCPR
CCPR/14-WG-KC	WG-KC report to CCPR
CCPR/14-WG-SP	WG-SP report to CCPR

APPENDIX 2

Summary of Action Points

AP 1 (page 8): WG-CMC Chair to include some slides related to the deadlines in CMC review from JCRB Secretary in the WG-CMC report.

AP 2 (page 10): Dr Ohno to prepare layout of a table for planned RMO supplementary and bilateral comparisons. Dr Stock to consider the appropriate place in the CCPR website and to inform members.

AP 3 (page 10): Dr Ohno to send Dr Stock the final version of the G6 guideline for publication on the CCPR website.

AP 4 (page 11): PMOD and WG-KC Chair to prepare a proposal for the solar irradiance comparison.

AP 5 (page 14): Dr Blattner to give Dr Bich specific examples of complex distributions.

AP 6 (page 15): Members to provide comments and examples related to the revision to the GUM, with examples suitable for inclusion in the new version

AP 7 (page 26): Dr Stock to distribute the draft version of the new SI brochure. CCPR members to comment by the end of November.

APPENDIX 3

Summary of CCPR approvals

LNE-Cnam membership of WG-KC

Membership of the WG-KC Task Group to prepare the protocol for CCPR-K1.a

Membership of the WG-KC Task Group to prepare a pilot study on THz measurement

Formation of WG-KC Task Group to prepare a comparison using white LED sources as transfer standards and a related Discussion Group

Guideline G6 titled Guidelines for RMO PR Key Comparisons

Creation of a new WG-SP Task Group (TG11) on single-photon metrology

Change of the terms of reference for WG-SP TG7

IO-CSIC membership of WG-SP

Request to CIPM that it approve CMI as a member of CCPR

Request to CIPM that it approve CMS/ITRI as an Official Observer of CCPR