Report of the WG on Strategic Planning (WG-SP)

to

23rd session of CCPR

22-23 September 2016

CCPR Working Group on Strategic Planning (WG-SP)

Status: 15 September 2016

- **Chair**: Dr J. Zwinkels, NRC
- **Members:** IO-CSIC, INRIM, KRISS, LNE, METAS, MSL, NIST, NMIJ AIST, NMISA, NPL, NRC, PTB,VSL , RMO TC PR Chairs
- **Observers:** Joele Viallon (CCPR Executive Secretary), Takashi Usuda (CCPR President)
- **Task Groups:**

– TG4 SI	Stephan Keuck (PTB)
– TG6 Discussion forum on fibre optics	Jimmy Dubard (LNE)
– TG7 Discussion forum on few-photon metrology	Dong-Hoon Lee (KRISS)
– TG8 Discussion forum on THz metrology	Marla Dowell (NIST)
– TG9 OTDR length comparison	Jacques Morel (METAS)
– TG10 CCPR Strategy document	Joanne Zwinkels (NRC)
– TG11 Few photon radiometry	Stephan Kueck (PTB)
– TG12 Discussion forum on white LED sources for photometry	Tatsuya Zama (NMIJ)
– CIE JTC-2 (CCPR/CIE) on "Principles Governing Photometry"	Yoshi Ohno (NIST)

____ changes since 2014 CCPR meeting

Highlights since 22nd CCPR meeting

- Two new TGs were created
  - TG11: Few photon radiometry
    - Carrying out a pilot study on the detection efficiency of single-photon detectors
  - TG12: Discussion forum on use of white LED sources for photometry
    - Recommended at 2015 WG-KC meeting
- Provided inputs/review to CCPR poster
  - including economic impacts (for 25th CGPM)
- Workshop on *Metrology Needs in Fibre Optics*
- *Mise en pratique* was published

Mise en pratique

SI Brochure Appendix 2. *Mise en pratique* for the definition of the candela and associated derived units

Mise en pratique for the definition of the candela and associated derived units for photometric and radiometric quantities in the International System of Units (SI)

Prepared by the CCPR Working Group on Strategic Planning (CCPR WG-SP) Task Group 5 (*mise en pratique*)

July 2015

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Guides, Standards and Conventions

Mise en pratique for the definition of the candela and associated derived units for photometric and radiometric quantities in the International System of Units (SI)

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CCPR WG-SP Meeting
14:00-18:45, 20 September 2016

- **44 Participants were present**
- **Members of WG-SP: 12 of 13 NMIs; 4 of 5 RMO TC PR Chairs**
- NRC: Joanne Zwinkels (Chair), Angela Gamouras
- IO-CSIC:: Joaquin Campos
- INRIM: Georgio Brida
- KRISS: Dong-Hoon Lee, Seung Kwan Kim
- LNE: Jimmy Dubard, Gael Obein, J-R Fitz
- METAS: Peter Blattner (CIE)
- MSL: Annette Koo
- NIST: Yoshi Ohno, Maria Nadal (SIM), Marla Dowell, Gerald Fraser
- NMIJ: Taksuya Zama (APMP)
- NPL: Nigel Fox, Teresa Goodman, Emma Woolliams
- PTB: Stefan Kueck, Armin Sperling, Gerhard Ulm
- VSL: Steven van den Berg
- COOMET:: Boris Khlevnoy; EURAMET: J. Gran
- **Ex-officio members:** Takashi Usuda, Joele Viallon
- **Observers: 10 NMIs, CIE, BIPM**
- CENAM: Carlos Matamoras; A*STAR: Jing Zhang; CMI: Marek Smid; CMS/ITRI: K-N Wu, SASO: M. Alffohaid, A. Alnahdi; INMETRO: T. Menegotto; MIKES: Erkki Ikonen ; NIM: Lin Yandong; NMIA: Peter Manson; VNIIOFI: V. Kratsov,; CIE: Katthy Nield; BIPM: E. de Mirandes

TG4: SI

Chair: Stephan Kueck (PTB)

Members: Nigel Fox (NPL), Yoshi Ohno (NIST), Joanne Zwinkels (NRC, ex-officio), Maria Luisa Rastello (INRIM), Peter Blattner (METAS), Annette Koo (MSL), Joaquin Campos (IO-CSIC)

- Change in NMI member at 2015 WG-SP meeting
- New NMI member at 2014 WG-SP meeting

Status:

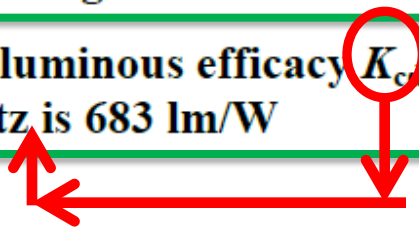
- Reviewed draft of 9th SI brochure regarding information on candela and other content relevant to interests of CCPR
- Reported at WG-SP 2016 meeting:
  - inconsistency in references to dates when candela was established as a base unit (1964, 1954, 1948)
  - Imprecise wording for definition of defining constant for photometry
- Question raised about wavelength in air corresponding to candela definition

Draft of 9th SI brochure

The seven constants are chosen in such a way that any unit of the SI can be written either through a defining constant itself or through products or ratios of defining constants.

The International System of Units, the SI, is the system of units in which

- **the unperturbed ground state hyperfine splitting frequency of the caesium 133 atom $\Delta\nu_{Cs}$ is 9 192 631 770 Hz,**
- **the speed of light in vacuum c is 299 792 458 m/s,**
- **the Planck constant h is 6.626 070 040 $\times 10^{-34}$ J s,**
- **the elementary charge e is 1.602 176 620 8 $\times 10^{-19}$ C,**
- **the Boltzmann constant k is 1.380 648 52 $\times 10^{-23}$ J/K,**
- **the Avogadro constant N_A is 6.022 140 857 $\times 10^{23}$ mol^{-1},**
- **the luminous efficacy K_{cd} of monochromatic radiation of frequency 540 $\times 10^{12}$ hertz is 683 lm/W**



The numerical values of the seven defining constants have no uncertainty.

2.2.5 Units for quantities that describe biological and physiological effects

Four of the SI units listed in tables 2 and 4 include physiological weighing factors: candela, lumen, lux, and sievert.

Lumen and lux are derived from the base unit candela. Like the candela they carry information about human vision. The candela was established as a base unit in 1964, acknowledging the importance of light in daily life.

The 10th CGPM (1954, Resolution 6; CR 80) adopted as base quantities and units fc practical system the following six quantities: length, mass, time, electric cu thermodynamic temperature, and luminous intensity, and the six corresponding base metre, kilogram, second, ampere, kelvin, and candela. After lengthy discussion bet physicists and chemists, the 14th CGPM (1971, Resolution 3, CR 78, and *Metrologia* **8**, 36) added amount of substance, unit mole, as the seventh base quantity and unit.

TG4: **SI**

Decisions and Recommendations:

- Question raised about wavelength in air
  - ➢ Satisfactorily addressed but inconsistency in JTC-2 document needs to be corrected.
- Editorial errors and inconsistencies re dates and K_{cd}
  - ➢ Recommend to CCPR that the CCPR Review of the 9th draft SI be sent to CCU with these editorial errors and inconsistencies
- Follow-up discussion on draft 9th SI brochure (after Report of CIE) re photobiological/photochemical units
  - ➢ Recommend to CCPR and CCU that Appendix 3 in 8th SI brochure be reinstated in 9th SI brochure
  - ➢ Time permitting, revise Appendix 3 to include concept these optical radiation measurements in photobiology/photochemistry are made in terms of spectral energy distribution or **spectral photon distribution** (already introduced in *mep*)

TG6: Discussion forum on fibre optics

Chair: Jimmy Dubard (LNE)

Participants: Erkki Ikonen (MIKES), Kathy Nield (MSL), Giorgio Brida (INRIM), Huang Xuebo (AStar), Juan Carlos Bermudez (CENAM), Kravtsov (VNIIOFI), Kuniaki Amemiya (NMIJ), Mariesa Nel (NMISA), Pedro Corredera (IFA), Seungkwan Kim (KRISS), Stefan Kueck (PTB), Jacques Morel (METAS), Joanne Zwinkels (NRC, ex-officio)

Status:

- 2016 –organized a Workshop on *Metrology Needs for Fibre Optics*
  - *40 participants, 1 from industry*
  - 7 presentations (will be posted at BIPM/CCPR public access web-site)

2016 Workshop on Metrology Needs in Fibre Optics

Issues raised:

- Lots of challenges for fiber optics, fiber optic instruments, photonics components, quantum metrology
- Short list of subjects from IEC 86:Fibre Optics

- **Improved calibration uncertainty of fibre optic power meters**
  - OPM manufacturers - need uncertainties of 1% (2σ) in range 700-1700 nm
  - c.f. currently calibration uncertainties ~6% in many countries
- Metrology of distributed fibre sensor
- Photonics Integrated Circuit measurements methods
- Multimode launch conditions (EF)
- Fiber amplifier high power and burst power measurements

2016 Workshop on Metrology Needs in Fibre Optics

Recommended actions presented at WG-SP 2016 meeting:

- Create a new TG for pilot study of calibration of fibre-coupled cryogenic radiometer (pilot=NIST)
- Perform a pilot study for single photon traceability (in relation to WG-SP/TG7)
- Establish liaison with IEC 86 Fibre Optics and change terms of reference for TG6 to include:
  - Monitor standards developments in IEC 86 Fibre Optics
- Try to organize TG6 meetings collocated with relevant industry conferences, e.g. CLEO-PR, OECC and PGC 2017, 31 July - 4 August 2017 in Singapore.
- http://www.photonics2017.org/index.php

TG10: Ad hoc on CCPR strategic planning document

Chair: Joanne Zwinkels (NRC)

Members: Maria-Luisa Rastello (INRIM), Dong-Hoon Lee (KRISS), Nigel Fox (NPL), Peter Blattner (METAS), Annette Koo (MSL), Joaquin Campos Acosta (IO-CSIC), Joele Viallon (BIPM, ex-officio)

New members since 22nd CCPR meeting

Status:

- CCPR Strategy Document for period 2013-2023 is available at BIPM web-site;
  - Version 0.0 (1 March 2013) at BIPM web-site: http://www.bipm.org/utils/en/pdf/CCPR-strategy-document.pdf

- Need to update this document was discussed at 2016 WG-SP meeting

TG10: Ad hoc on CCPR strategic planning document

Decisions regarding update of CCPR Strategy Document:

- Cover the period: 2017-2027
- Update is to be completed in time for the next CGPM meeting (Fall 2018)
- Key sections that need to be updated are:
  - Summary table of comparisons
  - List of "Required Key comparisons and pilot studies"
    - ✓ including assessment of whether the required resources are available in the community
- Include an analysis of any need for support (especially in light of the MRA review which is considering the level of resources required to support the system).

CIE JTC-2 (CIE/CCPR) Principles Governing Photometry

Chair: Yoshi Ohno (NIST)

Co-chair: Teresa Goodman (NPL)

Members: Armin Sperling (PTB), Joanne Zwinkels (NRC), Janos Schanda (HU)*, Peter Blattner (METAS), Hiroshi Shitomi (NMIJ)

* deceased

Progress:

- First complete draft (WD) balloted in July 2015. There were 3 disapproval votes.
- **Major issues have been the definitions of photometric quantities.**
  - The WD followed the definitions in ISO 80000-7, which was drafted mostly by the CIE experts (JTC-2 members).
- The definitions in the WD were inconsistent with the current ILV.
- **Decisions at CIE Div. 2 meeting in Melbourne, March 2016:**

➢ new ILV (JTC-8) will adopt, in principle, the definitions used in ISO 80000-7.

➢ JTC-2 document will be published after the new ILV is published.

➢ JTC-2 document will be published concurrent with publication of the new SI (2018).

Current Status:

- Draft 5.1 has been distributed to JTC-2 members for final check before WD2 vote and presented at WG-SP 2016 meeting (CCPR WG-SP/16-12)
- WD2 ballot will take place in October 2016.

Current ILV

The *luminance* (L_v) (in a given direction, at a given point of a real or imaginary surface) is defined by the formula

$$L_v = \frac{\mathrm{d}\phi_v}{\mathrm{d}\ \Omega \cdot \mathrm{d}A\cos\theta} \qquad (2)$$

where

$\mathrm{d}\Phi_v$ is the luminous flux transmitted by an elementary beam passing through the given point and propagating in the solid angle $\mathrm{d}\Omega$ containing the given direction;

$\mathrm{d}A$ is the area of a section of that beam containing the given point;

θ is the angle between the normal to that section and the direction of the beam.

ISO 80000-7

Ver 5.1

The *luminance* L_v (at a point on a surface in a given direction) is defined by the formula

$$L_v = \frac{\mathrm{d}I_v}{\mathrm{d}A \cdot \cos\alpha} \qquad (2)$$

where

I_v is the luminous intensity in the given direction;

A is the area containing the given point;

α is the angle between the normal to the surface of the area and the given direction.

CIE JTC-2 (CIE/CCPR) Principles Governing Photometry

Next steps:

- Separate documents will be published for CIE and CCPR, having the same technical contents.
  - For CIE, it will be revision of CIE 18.2, thus CIE 18.3 (The Basis of Physical Photometry).
  - For CCPR, it will be revision of “Principles Governing Photometry” (BIPM Monographie xxxx).
- Each document will have approval process in CIE and CCPR.
- To be published concurrent with the new SI in 2018, so this document has the new definition of the candela.

WG-SP Priority Goals for 2016-2018

- **Find consensus** on the importance of **photon based definition for candela**
- **Finalize and publish the BIPM document:**
  - Update of « *Principles Governing Photometry* » together with CIE
- **Update CCPR Strategy Document before next CGPM meeting in 2018**
  - to cover period 2017-2027
- **Advance aims of Task Groups & Discussion Forums:**
  - Create new technical-based TG(s) on priority metrology need(s) for fibre optics (identified in 2016 Workshop on this topic)
  - Prioritize activities of other Discussion fora: Few Photon Metrology, THz metrology, White LED sources
  - Organize measurement comparisons; workshops, conduct surveys of needs (e.g. traceability, comparisons, etc.)

Recommendation to CCPR:

WG-SP/16-R1: Send a CCPR response to CCU on the review of the present version of the 9th SI brochure with corrections and clarifications to text

Recommendation to CCPR:

WG-SP/16-R2: Send a CCPR Recommendation to CCU to re-instate Appendix 3 of the SI-brochure related to photo-biological and photo-chemical effects

Recommendation to CCPR:

WG-SP/16-R3: Creation of new WG-SP Task Group, TG13:

Title: Optical Fibre Power Responsivity

TG13 Chair: Marla Dowell (NIST)

Initial Members: Marek Smid (CMI), Jacques Morel (METAS), Giorgio Brida (INRIM)

Terms of Reference:

- to discuss about a pilot study on optical fibre power responsivity to improve calibration uncertainties;
- to create a questionnaire about a pilot study on optical fibre power responsivity for possible additional participants of such a pilot study;
- to organize and carry out a pilot comparison on optical fibre power responsivity using fibre-coupled cryogenic radiometer

Report of WG-SP

Thank You for your attention

Questions?

CCPR WG-SP Membership Criteria

Approved by CCPR 2012

1. General rules

1.1. The membership of WG-SP is by NMI. Each member NMI appoints an individual who represents the NMI. Correspondence is kept with the individuals. †

1.2. The President and Executive Secretary of the CCPR are ex-officio members of WG-SP.†

2. Criteria for membership

2.1. Member NMIs must be members of the CCPR.

2.2. Member NMIs must be prepared to support their delegate to fulfill the responsibilities in 3.

3. Responsibilities

3.1. Attend WG-SP meetings (absence in two consecutive meetings will mean automatic loss of membership)

3.2. Participate actively in the Task Groups of the WG-SP

3.3. Participate actively in e-mail discussions in between physical meetings.

4. Change of membership

4.1. Change of WG-SP Membership needs to be approved by the CCPR†.

4.2. Membership is reviewed annually at each WG-SP meeting, and WG-SP may propose to drop those members that have not fulfilled their responsibilities.

4.3. New Members wishing to join the WG-SP must write to the WG-SP Chair, copied to the CCPR President and Executive Secretary giving a clear commitment to actively participate in the work of the WG-SP (if accepted as a WG-SP Member) and stating:

a. Whatever expertise they have in the area covered by the Terms of Reference of the WG-SP.

b. What specific aspects of the work of the WG-SP they feel best able to contribute.

† from CCPR Code of Procedures for CCPR Working Groups and Task Groups

TERMS OF REFERENCE

Approved by CCPR 2010

- To establish and maintain a strategic planning document for the CCPR in line with the CIPM guidance document for CCs; (TG10)
- To advise the CCPR on the optimal operational structure; (TG3)
- To draft and maintain admission criteria for membership of CCPR and its working groups; (TG2)
- To monitor and to respond to developments with respect to the future of the SI; (TG4)
- To regularly review and update, as needed, the *mise-en-pratique* for the candela. (TG5)

- Review of Terms of Reference (TG1)