CORM/CIE-USNC Joint Annual Conference
November 12-14, 2024

Recent developments in CIE Division 2
- Physical Measurement of Light and Radiation

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Division 2 Officers, 2019-2023

Division Director	Tony Bergen (AU)
Division Secretary	Dong-Hoon Lee (KR)
Division Editor	Thiago Menegotto (BR)
Associate Director	Hiroshi Shitomi (JP)
Associate Director	Armin Sperling (DE)
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Division 2 Officers, 2023-2027

Division Director	Dong-Hoon Lee (KR)
Division Secretary	Gael Obein (FR)
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Associate Director	Armin Sperling (DE)
Associate Director	Hiroshi Shitomi (JP)
Associate Director	Anders Thorseth (DK)
Associate Director	Tobias Schneider (DE)
Associate Director	Qian Li (CN)

D2 Meeting in 2023-2024

Saturday, June 1, 2024, Paris, FRANCE

- reviewing past activities.
- planning future activities.

In connection with the CCPR/CIE Expert Workshop "100 Years of $V(\lambda)$ and Future of Photometry", June 3, 2024, BIPM, Sevres, FRANCE.

- **Yuqin Zong represented USA**

D2 Technical Committee (TC) Meetings in Paris, FRANCE:

Friday, May 31, 2024, D2 Technical Committee meetings.

TC 2-77, Fundamental Concepts, Tony Bergen (AU)
TC 2-78, The Goniophotometry of Lamps and Luminaires, Tony Bergen (AU)
TC 2-85, Recommendation on the geometrical parameters for the measurement of the Bidirectional Reflectance Distribution Function (BRDF), Gaël Obein (FR)
TC 2-89, Measurement of Temporal Light Modulation of Light Sources and Lighting Systems, Qian Li (CN)
TC 2-95, Measurement of Obtrusive Light and Sky Glow, Constantinos Bouroussis (CH)
TC 2-96, Revision of ISO/CIE 19476: 2014 Characterisation of the performance of illuminance meters and luminance meters, Armin Sperling (DE)
TC 2-97, Revision of CIE S 025/E:2015 Test Method for LED Lamps, LED Luminaires and LED Modules and its supplement, Anders Thorseth (DK)

TC meetings are held in-person or virtual: typically 2 to 4 times per year.

D2 TCs

- **TC 2-62** Imaging-Photometer-Based Near-Field Goniophotometry (Knut Bredemeier)
- **TC 2-67** Photometry of lighting and light-signaling devices for road vehicles (Thomas Reiners)
- **TC 2-68** Optical Measurement Methods for OLEDs used for Lighting (Hiroshi Shitomi)
- **TC 2-77** Fundamental Concepts (Tony Bergen)
- **TC 2-78** The Goniophotometry of Lamps and Luminaires (Tony Bergen)
- **TC 2-79** Integrating sphere photometry and spectroradiometry (Dong-Hoon Lee)
- **TC 2-81** Update of CIE 065:1985 (Absolute Radiometers) (Marek Smid → Geiland Porrovecchio)
- **TC 2-84** Recommendations on LED package test data reporting (Andras Poppe)
- **TC 2-85** Recommendation on the geometrical parameters for the measurement of the Bidirectional Reflectance Distribution Function (BRDF) (Gael Obein → Lou Gevaux)
- **TC 2-86** Glare Measurement by Imaging Luminance Measurement Device (ILMD) (Jan Wienold) (Urgent)

D2 TCs (cont'd)

- **TC 2-89** Measurement of Temporal Light Modulation of Light Sources and Lighting Systems (Qian Li) (Urgent)
- **TC 2-91** Optical measurement methods of LED packages and LED arrays (Markus Schneider)
- **TC 2-94** Measurement of total transmittance, diffuse transmittance and transmittance haze (Hsueh-Ling Yu)
- **TC 2-95** Measurement of obtrusive light and sky glow (Constantinos Bouroussis)
- **TC 2-96** Revision of ISO/CIE 19476:2014 Characterisation of the performance of illuminance meters and luminance meters (Armin Sperling) (Urgent TC)
- **TC 2-97** Revision of CIE S 025/E:2015 Test Method for LED Lamps, LED Luminaires and LED Modules and its supplement (Anders Thorseth)
- **TC 2-98** Revision of CIE 130-1998 Practical Methods for the Measurement of Reflectance and Transmittance (Catherine Cooksey)
- **TC 2-99** Standard File Format for Electronic Transfer of Optical Radiation Data for Luminaires, Lamps and LED modules (Danilo Giannetti) **(NEW)**
- **TC 2-100** Software Validation Spectra, Derived Quantities and Metrics (Kevin Smet) **(NEW)**

D2 Reporterships

- **DR 2-64,** Review of Draft TC 2-28 in preparation of archiving it as a D2 internal report, Edwin Mofokeng.
- **DR 2-69,** TN on the validation of a near-field goniophotometer in support of CIE S 025, Johannes Ledig.
- **DR 2-80,** Metrology of laser-based lighting, Anders Thorseth.
- **DR 2-81,** Flash effective intensity calculation, Dennis Couzin.
- **DR 2-82,** TN on clarification of the difference between adjustment, calibration and verification, Thiago Menegotto.
- **DR 2-87,** Terminology in single/few photon metrology, Dong-Hoon Lee.
- **DR 2-91,** Appropriate calibration and use of UV radiometers, Tony Bergen.
- **DR 2-92,** Recommendation for standardization of the maximum luminous efficacy for a given photometric condition, Tobias Schneider. (Closed after an internal D2 report)
- **DR 2-93,** Implementing CIE198-SP2 using Monte Carlo Simulations, Udo Kruger.
- **DR 2-94,** Uncertainty evaluation of spectral integrals, Erkki Ikonen, **(NEW)**

Joint TCs

- **JTC 01 (D4/D1/D2),** Implementation of CIE 191:2010 Mesopic Photometry in Outdoor Lighting, **Stuart Mucklejohn (GB).**
- **JTC 08 (D1/D2/D3/D4/D6/D8)**, Terminology in light and lighting, **Peter Zwick (DE).**
- **JTC 12 (D2/D1/D8),** The measurement of sparkle and graininess, **Alejandro Ferrero (ES).**
- **JTC 17 (D1/D2/D8),** Gloss measurement and gloss perception: A framework for the definition and standardization of visual cues to gloss, **Frédéric Leloup (BE).**
- **JTC 20 (D6/D2),** Wearable alpha-opic dosimetry and light logging methods, limitations, device calibration and data schemes, **Manuel Spitschan (DE).**

CCPR and CIE joint Workshop
'100 Years of *V*(*λ*) and the Future of Photometry'

https://www.bipm.org/en/committees/cc/ccpr/wg/ccpr-ws/2024-06-03

June 3, 2024, BIPM, Sevres, FRANCE

- Yoshi Ohno (Chair), Maria Luisa Rastello (CCPR), Jennifer Veitch (CIE), Joële Viallon (BIPM)
- 84 participants (in person)
- 142 participants (online)
- 12 presentations

The workshop will commemorate 100th anniversary of V(λ), overview the history of spectral luminous efficiency functions and CIE colorimetry, and introduce the cone fundamentals published by CIE (2006, 2015), then will discuss the future of photometry and colorimetry with cone-fundamental-based spectral luminous efficiency functions and color-matching functions.

CCPR and CIE joint Workshop Program

Session 1 - History of *V*(*λ*) and photometric units, Moderator: Maria Luisa Rastello

- **Jennifer Veitch,** "A short history of light measurement in the CIE".
- **Celine Fellag Ariouet,** "The BIPM and the CIE: 100 years of cooperation - An overview of the main developments in the definition of the photometric units".
- **Yoshi Ohno,** "Derivation of 1924 *V*(*λ*) and other spectral luminous efficiency functions".
- **Peter Blattner, & Gael Obein,** "High level objective of photometry and SI definition of the candela".

Session 2 - History of CIE Colorimetry and Cone Fundamentals, Moderator: Kaida Xiao

- **Sophie Jost,** "History of CIE 1931 and 1964 standard colorimetric systems".
- **Andrew Stockman,** "Development of cone fundamentals – CIE 170-1 and CIE 170-2".
- **Lorne Whitehead,** "CIE's direction for cone-fundamental based colorimetry".
- **Gael Obein,** "Demonstration of V(λ)".

CCPR and CIE joint Workshop Program (cont'd)

Session 3 - Photometry with Cone Fundamentals, Moderator: Dong-Hoon Lee

- **Tony Bergen,** "CIE's direction for cone-fundamental based photometry".
- **Hiroshi Shitomi,** "Impact of introducing cone-fundamental-based $V_F(\lambda)$ or $V_{F10}(\lambda)$ in applications".
- **Jiaye Li,** "Vision experiment on brightness comparison for 1924 V(λ) and VF10(λ)".
- **Dorukalp Durmus,** "Estimating brightness perception using the current standard and cone-fundamental-based spectral luminous efficiency functions".

Session 4 - Discussion for future directions for photometry and colorimetry, Moderator: Yoshi Ohno

Panelists: A. Stockman, L. Whitehead, P. Blattner, M.L. Rastello, T. Bergen.

- Open discussions.
- Conclusions and future actions.

Closing

- **Jennifer Veitch,** Announcement of winners of CIE 100 years of $V(\lambda)$ Art Competition.
- **Martin Milton (BIPM Director), closing remarks**

CCPR and CIE joint Workshop Program (cont'd)

Session 4 - Discussion for future directions for photometry and colorimetry, Moderator: Yoshi Ohno

Panelists: A. Stockman, L. Whitehead, P. Blattner, M.L. Rastello, T. Bergen.

Open discussions

- What are the problems to be solved?
- Needs from display applications (2° $V(\lambda)$ problem).
- Consideration for daylight applications (windows measurement, etc.)
- Associated costs for changing instruments (photometers and spectroradiometers).
- Current 2° $V(\lambda)$ is needed for essential tasks (reading, traffic applications).
- $V_{10}(\lambda)$ (from colorimetry) does not have good experimental basis?
- Inputs needed widely from other communities, each Division of CIE.

Conclusions and future actions

- What are the problems to be solved? Further research is needed for the needs, benefits, and impact in a wide range of applications.
- Discussion should continue in CIE RF-05 and CCPR WG-SP TG16.
- Cone-fundamental based colorimetry will go on in CIE - new TC proposals will be discussed in CIE after TC-98 report published.

New JTC proposal (in ballot)

- **Title**: **Data representation space for spectral imaging**
- **Terms of Reference:**

  To introduce common representation spaces of spectral data suitable for multi-/hyper-spectral imaging. To study the transformations between common representation spaces and device and/or application dependent spaces. To recommend data formats for multi-/hyper-spectral images in common spectral presentation spaces.

- **Scope:**

  The TC will study representation spaces in which raw data from multi-/hyper-spectral cameras can be transformed. The spectral range covered by this recommendation will be 360 to 1100 nm to cover standard silicon technologies. The TC will not address electromagnetic range beyond 1100 nm (short-wave infrared range and above). The proposed spaces should contain connections to related CIE standards and recommendations in the fields of colorimetry and photometry. The TC will address how the new data should be stored in a file with a metadata-header that announces the number of bands addressed in the image. This file should also keep track of transforms from sensor raw data to the new space, accuracy of spectral reconstruction, and colour transform. Methods to address these features should be recommended by the TC. The TC will propose also methods to evaluate the existing and proposed representation spaces. The TC will propose one or several spaces. One proposal may be that the new representation space be assimilated to a “standard spectral observer”, containing some predetermined bands e.g. LMS sensitivities, action spectra, $V(\lambda)$, $V'(\lambda)$, with a strategy to determine the number and characteristics of additional bands.

- **Proposed TCC:** Jean-Baptiste THOMAS (FR)

Call for Experts

CIE Research Forum RF-05 - Implementation of CIE 2006 cone fundamentals in photometric and colorimetric measurements

Establishment: Tuesday, April 25, 2023

Convener: Tony Bergen (AU)

Since its beginning, colorimetry and photometry were directly related through the CIE colour matching function Y of the CIE 1931 standard colorimetric system which was set to be identical with the spectral luminous efficiency function for photopic vision, $V(\lambda)$. It is also well known that $V(\lambda)$ is not a perfect match to human vision and in particular it underestimates the visual response in the blue region. The physiology-based function, known as the cone-fundamental-based spectral luminous efficiency function, $V_F(\lambda)$, is based on the latest research and again relates photometry to modern (i.e. cone-fundamental based) colorimetry.

The RF shall consider the impact of cone fundamentals on measurement of fundamental quantities, including:

- The replacement or supplementation of the spectral luminous efficiency function for photopic vision V(lambda) by a cone-fundamental-based spectral luminous efficiency function $V_F(\lambda)$ in photometric measurements, …

Brief description is at https://cie.co.at/researchforum/rf-05

Recent D2 Publications

Technical Reports/ Technical Notes:

- **ISO/CIE 23539:2023** *Photometry — The CIE system of physical photometry*

  - from TC 2-93; TCC: Anders Thorseth (DK)

- **ISO/CIE TR.3092.2023** Light and lighting — Energy performance of lighting in buildings — Explanation and justification of ISO/CIE 20086

- **CIE 251:2023** *LED Reference Spectrum for Photometer Calibration*

  - from TC 2-90; TCC: Tuomas Poikonen (FI)

- **CIE DIS 017-SP2:2023** *ILV: International Lighting Vocabulary –Supplement 2: Terms and Definitions for Horticultural Lighting*

  - from JTC 19 (D6/D2); TCC: Paul Dekker (NL)

Current US participations in D2 activities

	Participation
Burns, David	TC 2-88 (member)
Cooksey, Catherine	TC 2-98 (chair)
Hulett, Jeff	TC 2-91 (member)
Lehman, John	TC 2-81 (member)
Muray, Kathleen	TC 2-84 (member)
Nadal, Maria	TC 2-85 (member)
Ohno, Yoshi	TCs 2-77, 2-79, 2-93, 2-97, JTC 1 (members), L 2-01 (CCPR)
Parkinson, Jay	JTC 5 (member)
Patrick, Heather	TC 2-85 (member)
Pierson, Clotilde	TC 2-86 (member)
Wyble, David	TC 2-98 (member)
Rykowski, Ron	TC 2-62 (member)
Tan, Jianchuan	TC 2-89 (member), RF 4 (member)
Verdu, Francisco Miguel Martinez	TC 2-85 (member), JTC 12 (member?)
Wang, Taoning	TC 2-86 (member)
Ward, Gregory	TC 2-86 (member)

Current US participations in D2 activities (cont'd)

	Participation
Hung, Po-Chieh	TC 2-77 (member)
Carter, Ellen	TC 2-77 (member)
Inanici, Mehlika	TC 2-86 (member)
Li, Jiaye	TC 2-89 (member)
Ford, Melissa	TC 2-77 (member)
Scharpf, Daniel	TC 2-98 (member)
Zong, Yuqin	D2 (official member), TCs 2-62, 2-77, 2-79, 2-84, 2-90, 2-91, 2-96, 2-97 (members)

Future D2 Meetings and Workshops

2025 **D2 meetings** in connection with **CIE 2025 (Midterm Conference)**,
July 4-11, 2025, Vienna, AUSTRIA.

2026 **D2 meetings,** calling for a host, may be in connection with NewRAD 2026 in Jeju, SOUTH KOREA?

2027 **D2 meetings** in connection with **CIE 2027 (31st Quadrennial Session)**,
July 9-14, 2027, Nanjing, CHINA

Thank you