



International Commission on Illumination  
Commission Internationale de l'Eclairage  
Internationale Beleuchtungskommission

## 9 Metrology for Advanced Photometric and Radiometric Devices

### 9.1 Description of research

In the past CIE has published technical reports and standards defining procedures for characterization, calibration and testing of photometric and radiometric devices and measurement systems such as illuminance meters, luminance meters, integrating spheres and goniophotometers. Due to technological progress new types of photometric and radiometric measurement devices have appeared on the market, including

- imaging luminance measurement devices (ILMDs) and hyperspectral measurement devices (spectrally resolved ILMDs);
- LED-based spectrophotometers;
- imaging luminance-based near-field goniophotometers;
- gonio-spectroradiometers and sphere-spectroradiometers;
- robot-goniophotometers;
- imaging sphere photometers;
- combined measurement devices using spectroradiometers and broadband measurement devices;
- high-speed measurement systems to quantify fast-varying (pulsing, modulating, flickering) optical signals, etc.;
- measurement devices for quantifying photochemical and photobiological (including non-visual) effects.

For some of these devices new CIE technical committees have been established and others are to follow. However, in most cases additional research is still necessary and the period of time allowed to finalize a report or standard is often too short. In spite of this, there is an immediate need to define quality criteria and calibration procedures for devices such as near-field goniophotometers and array spectroradiometers, as such devices are becoming more widely used in practice. Hence, it becomes urgent not only to participate in a technical committee to offer knowledge but also to offer practical research on the open topics to feed in to the technical committees. Having more research groups operating in parallel can enable a technical committee to perform its work more efficiently.

### 9.2 Key research questions

- What are the relevant quality indices to characterize advanced photometric and radiometric devices? How do these indices relate to the measurement uncertainty in typical lighting measurement situations?
- How to describe the measurement equations describing the measurement procedure?
- What would a standard measurement uncertainty budget look like for measurements on particular types of equipment?
- How to calibrate these new types of devices? What are the best artefacts to transfer the photometric quantities to the measurement device?
- How to assess temporal exposures of the eye from sources that may flicker (up to about 1 kHz) or where the source and observer move in relation to each other generating a temporally-changing exposure at the eye?
- How can these topics be divided into different parallel threads to improve the efficiency of the respective TCs?

### 9.3 Justification of the need for the proposed research topic

New challenges like “smart lighting” (i.e. adaptive and sensor-based lighting) and the implementation of the other research topics within the CIE Research Strategy priority list imply on the one hand the need to completely characterize a given lighting situation, including daylight and artificial light from various sources, and on the other hand to thoroughly characterize the used light sources or luminaires with respect to spectral and spatial properties. Absolute traceability of measurement results is mandatory to combine such source-based and detector-based measurements under various environmental conditions. New devices and measurement systems as described above are needed to meet these challenges. The outcome of this research will increase the quality of photometric and radiometric measurements in general and therefore increase confidence in lighting products. The availability of reliable and traceable measurements is also a prerequisite to develop and verify intelligent sensor systems used to enable smart and adaptive lighting.

### 9.4 Related current activities in CIE

<a href="#">TC 2-29</a>	<a href="#">Measurement of Detector Linearity</a>
<a href="#">TC 2-59</a>	<a href="#">Characterisation of Imaging Luminance Measurement Devices</a>
<a href="#">TC 2-62</a>	<a href="#">Imaging-Photometer-Based Near-Field Goniophotometry</a>
<a href="#">TC 2-69</a>	<a href="#">CIE Classification Systems of Illuminance and Luminance Meters</a>
<a href="#">TC 2-74</a>	<a href="#">Goniospectroradiometry of Optical Radiation Sources</a>
<a href="#">TC 2-78</a>	<a href="#">The Goniophotometry of Lamps and Luminaires</a>
<a href="#">TC 2-79</a>	<a href="#">Integrating Sphere Photometry and Spectroradiometry</a>
<a href="#">JTC 5 (CIE-IEC)</a>	<a href="#">Review of IEC 62471/CIE S009</a>
DR 2-69	TN on the validation of a near-field goniophotometer
DR 2-57	Monitoring Progress of IEC TR 62778

### 9.5 Existing CIE publications

<a href="#">CIE 053-1982</a>	<a href="#">Methods of Characterizing the Performance of Radiometers and Photometers</a>
<a href="#">CIE 063-1984</a>	<a href="#">The Spectroradiometric Measurement of Light Sources</a>
<a href="#">CIE 084-1989</a>	<a href="#">Measurement of Luminous Flux</a>
<a href="#">CIE 121-1996</a>	<a href="#">The Photometry and Goniophotometry of Luminaire</a>
<a href="#">CIE 179:2007</a>	<a href="#">Methods for characterising tristimulus colorimeters for measuring the colour of light</a>
<a href="#">CIE 198:2011</a>	<a href="#">Determination of Measurement Uncertainties in Photometry</a>
<a href="#">CIE 198-SP1:2011</a>	<a href="#">Determination of Measurement Uncertainties in Photometry - Supplement 1: Modules and Examples for the Determination of Measurement Uncertainties</a>
<a href="#">CIE 202:2011</a>	<a href="#">Spectral Responsivity Measurement of Detectors, Radiometers and Photometers</a>
<a href="#">CIE 210:2014</a>	<a href="#">Photometry Using V(λ)-Corrected Detectors as Reference and Transfer Standards</a>
<a href="#">ISO/CIE 19476:2011</a>	<a href="#">Characterization of the Performance of Illuminance Meters and Luminance Meters</a>