Title: Metrology for manufacturing, installing and characterising smart lighting

Abstract

Solid State Lighting (SSL) is flexible to lighting level, colour, and geometry, and enables smart lighting and energy saving due to adaptation to lighting needs. Smart lighting involves digital control by smart sensors and communication between luminaires and with surroundings. However, reliable measurement methods to assess the real performance of smart lighting systems are currently missing. Therefore, proposals in response to this SRT should address this issue by developing instruments, traceability and methodology to characterise smart lighting components and the complex lighting environment, as well as validated methods to assess the performance of smart lighting systems for both lighting quality and energy saving.

Keywords

Smart lighting, Solid state lighting, eco-design, energy efficiency, lighting quality, building, road safety, autonomous driving, Internet of Things

Background to the Metrological Challenges

Smart control of lighting in a modern building environment improves energy efficiency by sensing the presence of people and switching off or dimming the lighting to the level needed. Illuminance or colour sensors also provide feedback either to adjust lighting to maintain constant lighting levels, or to adapt it under varying external lighting conditions, and luminaires within a network exchange information with others and their surroundings to optimise lighting. Similarly, smart lighting systems are used for exterior applications, such as road lighting, where the road luminance is the target quantity in the case of motorised traffic. The new technology offers promising opportunities for companies developing smart lighting systems.

Solid state lighting (SSL), which comprises both non-organic semiconductor-based Light Emitting Diodes (LEDs) and organic LEDs, has clear advantages in energy efficiency over conventional lighting technologies. Quality metrics for energy efficiency of lighting are important tools that can be used to assess energy efficiency, environmental cost, comfort, and safety and presently there are a variety of standards being used for lighting. For example, at the European level EN 15193 is under revision and at the international level International Organisation for Standardisation (ISO) TC274 WG1 is working in collaboration with International Commission on Illumination (CIE) JTC6. In terms of road lighting adaptive systems, EN 13201-4 provides guidelines for instrument characteristics, however standard requirements are still needed and must be integrated with test procedures.

Technical Note CIE TN 006 and the new CIE report being prepared by CIE TC1-83 focus on the determination of visible effects, such as flicker, stroboscopic and phantom-array effects, and non-visible effects of temporal light modulation, such as neuro-biological effects. However, the measurement of beat effects of high frequency modulation in distributed lighting systems has not yet been studied and there is currently no calibration services for temporal light modulation or spectral measurements of modulated light sources. In addition, there are no accepted test procedures or acceptance criteria for presence, light level, or colour sensors. Hence if a lighting control system is not calibrated correctly, it is unlikely that the design intent – occupant comfort and satisfaction, and energy saving – will be achieved.

In many lighting standards, spatial distributions of light sources require that photometric and radiometric measurements are carried out in semi-spherical, cylindrical, or semi-cylindrical coordinate systems. For example EN 12464-1 requires a minimum cylindrical illuminance in activity spaces in interior lighting to be measured, while EN 13201-2 defines the need of measuring the minimum semi-cylindrical illuminance on pedestrian areas for purposes of improving facial recognition and for increasing the feeling of safety.

However, currently such measurement devices are rarely available and their calibrations are problematic due to missing calibration setups and procedures.

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on the traceable measurement and characterisation of smart lighting components and lighting environments.

The specific objectives are

1. To develop reliable and validated methods to assess the performance of smart lighting systems in buildings in terms of energy use, user-experienced lighting comfort and networking performance of luminaires. In addition, to develop quality metrics for energy efficient safety-supporting road lighting, and considering autonomous driving.
2. To assess the metrological specifications for factors and conditions affecting smart lighting including surface properties, light sources and sensors, standby power, lifetime with smart control, glare, perception of external conditions and health issues.
3. To develop validated measurement, calibration and testing methods for smart lighting, ranging from single LED chips to final smart lighting systems and to lit environments. The target calibration uncertainties are 1 % for static and 2 % for modulated light, in order to achieve 3 % uncertainty for systems under different conditions.
4. To develop accurate and reliable instruments for characterising smart lighting systems. This should include radiometers and photometers for measuring cylindrical and semi-spherical coordinate systems with a target uncertainty of 3 %, and handheld instruments for measuring time modulated spectra and flicker with a target uncertainty of 3 %.
5. To facilitate the take up of the technology and measurement infrastructure developed in the project by the measurement supply chain, standards developing organisations (e.g. ISO TC274, and CIE JTC6 - Energy Performance of Lighting in Buildings), and end users (e.g. the lighting, automotive and construction industry).

Proposers shall give priority to work that meets documented industrial needs and include measures to support transfer into industry by cooperation and by standardisation. An active involvement of industrial stakeholders is expected in order to align the project with their needs – both through project steering boards and participation in the research activities.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this. In particular, proposers should outline the achievements of the EMRP project ENG05, EMRP project ENG62 and EMPIR project 15SIB07 and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 1.5 M€, and has defined an upper limit of 1.8 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,

- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the automotive and construction sector.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.