

Title: Metrology of light pollution in the night time environment

Abstract

Light pollution is produced from lighting installations that are installed outdoors. In recent years the new lighting technologies have increased the adverse effects of artificial light in the environment. Due to an absence of a standardised metrology measuring system knowledge is currently fragmented across the industry, leading to the usage of diverse instruments, methods and metrics for the measurement and assessment of light pollution. Therefore, there is a need for a standardised measuring system for the measurement and assessment of light pollution in the environment.

Keywords

Light pollution, obtrusive light, artificial light, environmental impact, ecosystems, dark sky, skyglow, measurement metrics, metrology system, optical instrumentation

Background to the Metrological Challenges

Light pollution has become a major focus and to better evaluate the relevance of environmental impact on human and ecosystem it is crucial to understand both the natural and artificial components of lights in the atmosphere, land, and water under all weather conditions using a common metrology system. Urbanisation of light technologies increases the density of light installations whilst the introduction of cost-effective LED luminaires tends to increase the number of illuminated areas. Currently no standardised method is available, and a variety of instruments are used to assess light pollution such as imaging luminance measurement devices (ILMDs), commercial cameras with fisheye lenses, and remote sensing instrumentation.

The absence of a standardised method heavily impacts astronomic observations. The international astronomical Union (IAU) works to protect the existing and potential observatory sites from pollution at all wavelengths of the electromagnetic spectrum and the international commission on illumination (CIE) deals with problems of light pollution from lighting installations and its impact on the environment. A major challenge is that while the problem is interdisciplinary, due to its complexity and novelty it is still mainly addressed within disciplines, e.g., ecology and astronomy separately. The use of different methods is leading to missing uncertainty evaluation, validation and SI traceability and consequently preventing comparability of measurement results and creation of a unified monitoring network.

Currently, no agreed metrics exist for the measurement and assessment of light pollution and only limited guidelines and commonly accepted methods are available for the measurement of light pollution related parameters (e.g. night sky luminance, background luminance, vertical illuminance, glare, flicker, etc.). In most cases, photometric quantities and correlated colour temperature have been used as commonly reported metrics. The currently revised technical report CIE 150:2017 is mainly focused on obtrusive light due to static, quasi-steady state and constant-colour lighting and its limitations. Effects of light pollution in the night time environment (humans, species and ecosystems) are assessed only in a limited range thus, the need for a standardised method.

A common metrology system for the measurement and assessment of light pollution will aid the international standardisation bodies CIE, CEN and IEC to produce new written standards. This will also help communities as a unified traceable measuring system for measuring and assessing light pollution could help increase the awareness of light pollution globally. It could potentially lead lighting industry to develop and promote lighting products that minimise light pollution and also enable Instrument industry to improve the development of new instruments. A standardised methodology would significantly improve measures to counteract light pollution impact on human and ecosystems.

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 light pollution in the environment.

The specific objectives are

1. To establish suitable metrics for the assessment of light pollution in the environment taking into account wildlife and human related issues and spectral, spatial and temporal aspects.
2. To identify limits of detection, spectral resolution, dynamic range, and capability to measure temporally modulated lighting/flickering for the sky and landscape brightness. In addition, to investigate minimum radiance levels measurable by different types of commercially available instruments.
3. To develop traceable instrumentation and measurement methods of light pollution for imaging-based measurement devices with specific spectral weighting and for hyperspectral imaging devices.
4. To act as a reference point for inter-comparison and traceability for a unified European monitoring network for short-term and long-term monitoring of light pollution.
5. To facilitate the uptake of the technology and measurement infrastructure developed in the project by the standard developing organisations (CIE (e.g. CIE TC4-58, CIE TC4-59), CEN, ISO, IEC) and end users (e.g. environmental conservation bodies (IUCN), International astronomical union (IAU)).

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. To enhance the impact of the research, the involvement of the appropriate user community such as industry, standardisation and regulatory bodies is strongly recommended, both prior to and during methodology development.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 2.0 M€, and has defined an upper limit of 2.3 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 35 % of the total EU Contribution across all selected projects in this TP.

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 lighting 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.