

European Metrology
Programme for Innovation
and Research

Delivering Impact



Reducing the detrimental effects caused by “flicker” in luminaires based on LEDs

In 1993 white LED’s were introduced. Consuming at least 75% less energy than standard incandescent lamps, LED-based lamps lead to enormous energy savings. However, LEDs instantaneously respond to fluctuations in the power supply, which can cause the lights to “flicker” much more and at high levels, this can trigger migraines and epileptic seizures. However, prior to 2021, instruments to detect this phenomena lacked traceability to the SI.

Europe’s National Measurement Institutes working together

The European Metrology Programme for Innovation and Research (EMPIR) has been developed as part of Horizon 2020, the EU Framework Programme for Research and Innovation. EMPIR funding is drawn from 28 participating EURAMET member states to support collaborative research between Measurement Institutes, academia and industry both within and outside Europe to address key metrology challenges and ensure that measurement science meets the future.

Challenge

The EU's Energy Efficiency Directive of 2023 committed all member states to a further 11.7% reduction in energy consumption by 2030. Fully transitioning to lighting using light emitting diodes (LEDs) could save Europe €65 billion in energy costs annually and reduce carbon dioxide emissions by 51 million tonnes.

White LEDs are up to 75% more efficient than older filament bulbs, last 25x longer and provide 50 000 hours of light. A main disadvantage with these is a greater sensitivity to fluctuations in the power supply than filament bulbs, causing the light to "flicker".

This "temporal light modulation" (TLM) can lead to increased fatigue and acute health problems such as migraines or epileptic seizures. The Ecodesign directive limits short term flicker perceptibility (Pst LM) to <1.0 as measured by instruments such as photometers.

However, real environments are often illuminated with a combination of multiple light sources - presenting various contrasts and complex patterns of TLM. In addition, although international standards exist for measuring flicker, such as IEC TR 61547-1:2020, these do not consider traceability or measurement uncertainty and prior to the start of the [MetTLM](#) project in 2021, validated methods for measuring flicker and other forms of TLM were not available.

Solution

During MetTLM, inspired by the project's requirement for a versatile meter for specific light sources in a scene, a new, slimline flicker meter was developed by consortium member Gigahertz Optik.

Based upon the company's high accuracy BTS256-EF illuminance and colour meter it was used in an interlaboratory comparison on traceable flicker and stroboscopic effect measurements with seven other participants.

Coordinated by VSL, the National Metrology Institute (NMI) of the Netherlands, eleven temporal light artifacts (TLAs) were assessed including seven pre-aged LED lamps and four waveforms generated by a TLA box. Parameters measured included voltage, current, power, temperature, humidity, flicker and stroboscopic effects.

Consistent results were provided by the TLA box indicating this as an ideal method for validating measurements against Ecodesign regulations. Lamp measurements showed good agreement overall, with the largest measurement uncertainty arising from the external power supplies.

Impact

Gigahertz Optik is a world leader in light measurement devices, products, and services with a long history of innovation and participation in EURAMET projects. The new flicker meter, the PFL-200, is quick, cost-effective and able to measure both flicker (Pst) and stroboscopic (SVM) effects. Containing a quick release cable connector (BNC), it can be paired with various detector heads to expand its capabilities. This can include an integrating sphere for luminance flux measurements or the company's CT-4501 to create a unique meter allowing high-speed measurements of tristimulus waveforms and the temporal evaluation of colour coordinates, such as Red-Green-

Blue or tuneable white LED-based lamps. During MetTLM it was equipped with a photometer head or a luminance photometer head and used by PTB, the NMI of Germany, to test its performance in real-world scenarios, including measuring streetlights and lighting at the Am Hammergrund sports field in Germany. In 2025 it was also used in the [HiDyn](#) project to measure lighting at a building façade in Bern and the Apostolos Nikolaidis Stadion in Athens. In these environments the PFL-200 resolved individual lights up to 100 m distance- making it ideal for measurements in hard-to-reach places using a detector for spot luminance measurements.

Through the work of MetTLM validated and SI-traceable methods and instruments now exist for flicker measurements. This will help lamp manufacturers demonstrate compliance to European directives and protect EU citizens against potentially negative health effects resulting from modulated light sources.

Providing the metrology to accurately measure temporal light modulation effects

The MetTLM project:

- provided SI traceability to TLM measurements for short-term flicker severity (PstLM) and stroboscopic visibility measure (SVM).
- went beyond the state-of-the-art by investigating high-speed imaging as a new approach to measure TLM distribution of luminaires in extended scenes.
- investigated and developed methods to quantify colour and (multi)spectral TLM.
- provided the first steps for a model on the phantom array effect.
- implemented multiple models for flicker and stroboscopic effect and published a data set of computer-generated and real-life waveforms, allowing end users to calculate uncertainty budgets.
- performed an interlaboratory comparison to validate the capabilities for measuring flicker and stroboscopic effects produced by different types of artefacts.
- provided data for a revision of the international standard ISO/CIE 19476 on the characterisation of the performance of illuminance meters and luminance meters.

New calibration services and devices now exist in Europe, to support the health of citizens and reduce the energy consumption from industrial and domestic lighting.



The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

www.euramet.org/project-20NRM01

Paul Dekker

VSL, Netherlands
pdekker@vsl.nl