Impact of New SSL Standards on Goniospectroradiometric Measurements

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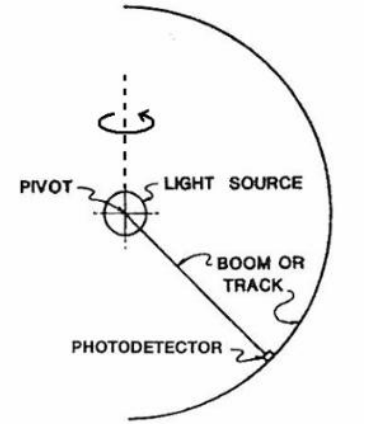
light measurement

Outline

- Goniophotometry and goniophotometer types
- LM-79-08 review
- New standards EN 13032-4 and CIE S 025
- Resulting requirements on measurement equipment
- Example: Correction of burning position
- Solution for turning luminaire
- Comparative application study

Moving detector & mirror goniophotometer

- Moving detector type
  - Detector moves around the source on an arm or rail
  - Large samples require large space for far field measurements
  - Not best solution for luminous intensity but good for luminous flux integration



- Moving mirror type
  - Detector is fixed
  - Luminaire turns around the vertical axis only
  - Mirror moves around luminaire
  - Polarisation sensitive
  - Very large and expensive systems

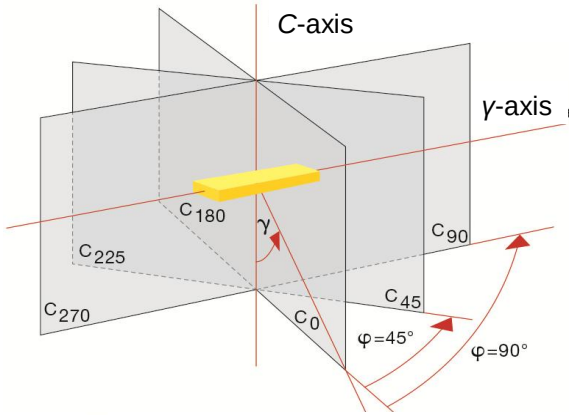
Turning Luminaire Goniophotometer

- Horizontal optical axis in conformity with *C,γ* - coordinate system (CIE 121-1996)

- Advantages:
  - Relatively small and compact envelope
  - Far field measurement can be easily realized even for large samples
  - Less expensive than moving mirror type

- Disadvantage:
  - Burning position not maintained

- Solution:
  - Correction of the burning position in conformity with new standards EN 13032-4 and CIE S 025



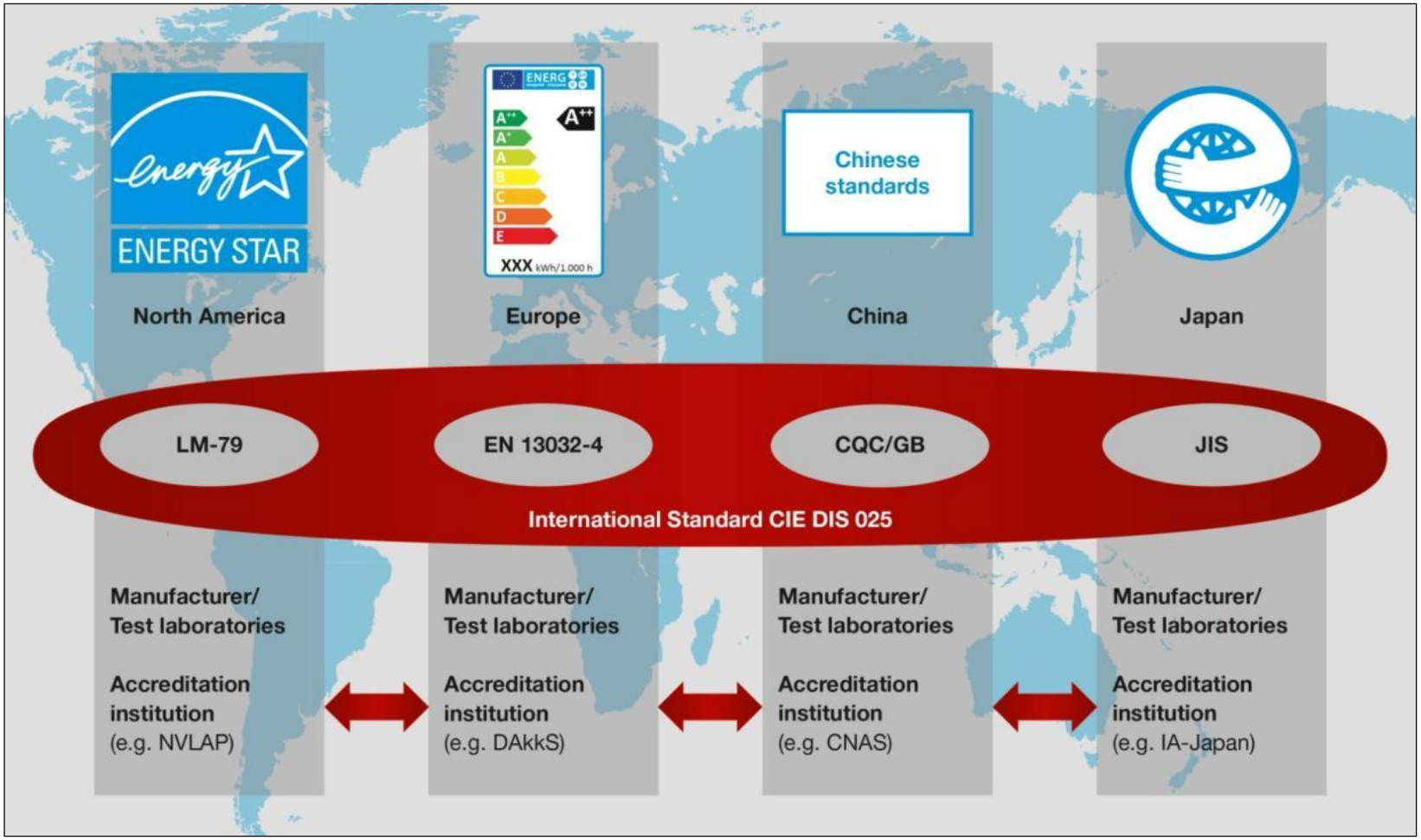
LM-79: Goniophotometer requirements

- Type C geometry maintaining the burning position
- Detector distance ≥ 5 x sample diameter (less for flux)
- No ventilation from air flow affecting the measurement (speed dependent!)
- Ambient temperature 25°C ± 1°C, measured up to 1 m away from the SSL product, same height
- Stabilization / warming up: typ. 30 min – 2 h until stable within 0,5 % when 15 min apart
- Sample orientation as intended by the manufacturer

New standards EN 13032-4 and CIE S 025

- Draft of an European standard EN 13032-4 has been published end 2013. Final standard published in August 2015.
- International Standard CIE S 025:2015 has been published in March 2015.
- Both standards have identical technical content.
- CIE S 025 is planned as an ISO/CIE/IEC „Triple Logo“ standard.
- It is the first international guideline to cover the measurement procedures for SSL products and will exert a significant influence on the proposed harmonization.

Worldwide impact of CIE S 025



Coverage of the standard

- Standard covers photometric and colorimetric measurements of LED lamps, LED modules (light engines) and LED luminaires (DIN 5032-9 covers OLEDs).
- It includes total (partial) luminous flux, luminous efficacy, luminous intensity distributions, center-beam intensity, luminance and luminance distribution, chromaticity coordinates, CCT, CRI and angular color uniformity.

Scope and principles of measurements

- No restrictions on the used measurement technique. Techniques other than the explicitly mentioned are acceptable if demonstrated to produce equivalent results.
- Specific requirements on test equipment and test conditions are given by a set value and a tolerance interval.
- The test result has to be within the acceptance interval or a correction has to be applied.
- The user has to set up an uncertainty budget according to ISO/IEC Guide 98-3 or CIE 198.
- Further guidance will be prepared as a supplement to the standard and published as a “technical note“.

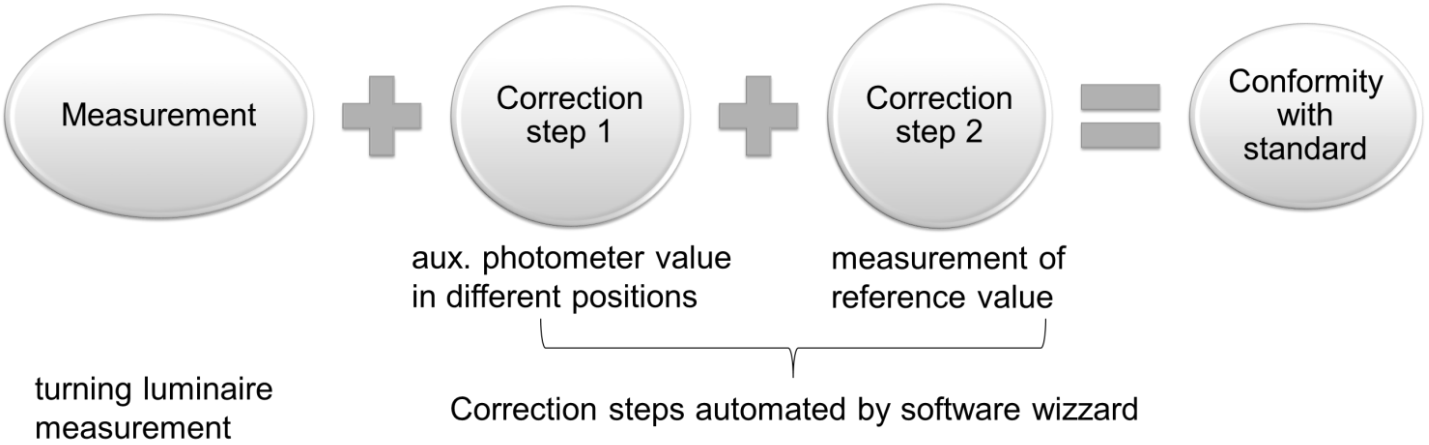
Standard test conditions

	Set value	Tolerance Interval	Applicable for
Ambient Temperature	25.0 °C	±1.2 °C	LED-Lamps/Luminaires, Light Engines
Surface Temperature	Rated performance temperature t_p	±2.5 °C	LED-modules
Air Movement	Still air	0 m/s to 0.25 m/s	
Test Voltage and Current	Rated supply voltage or current	±0.4 % for root mean square AC voltage; ±0.2 % for DC voltage and current	

- Standard test conditions given by a set value and a tolerance interval

Example: Correction of burning position

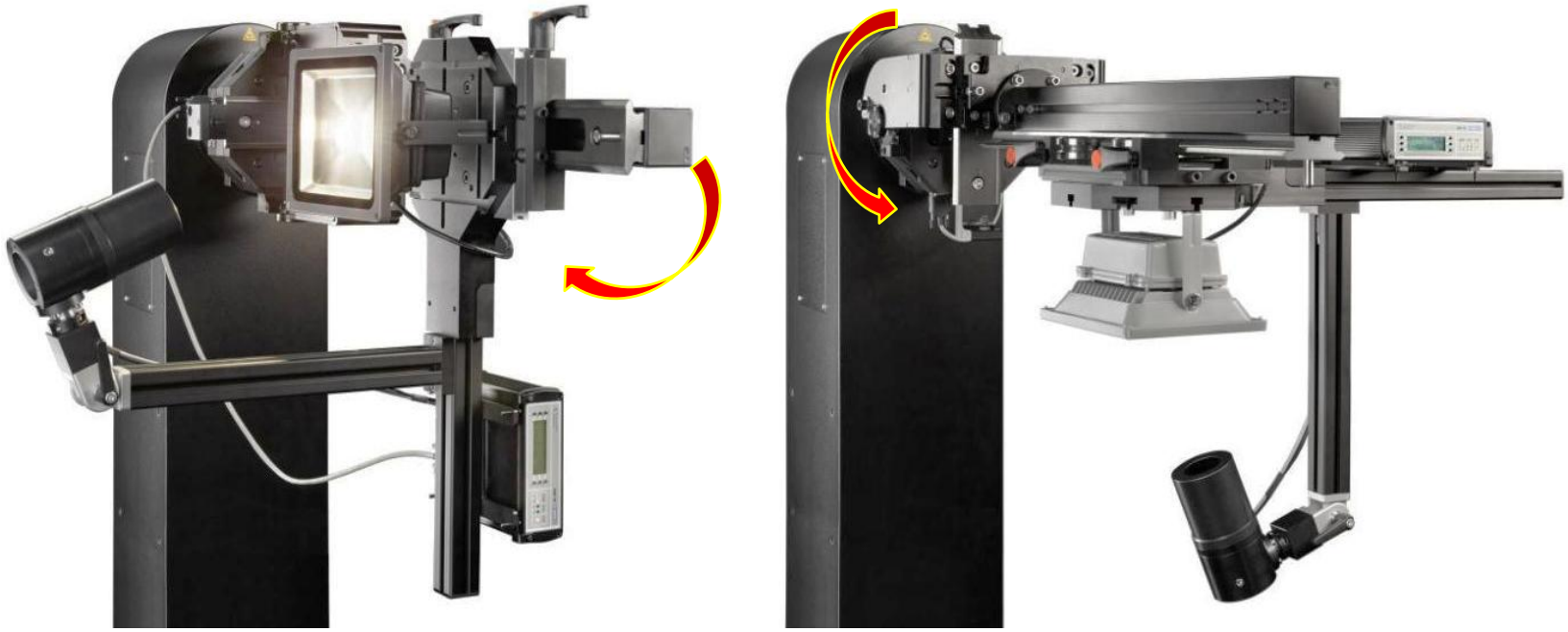
- Some special requirements may be corrected, e.g. burning position
- CIE S 025 allows goniometric measurements to be performed in an orientation other than the designed burning position, if corrected.
- Turning-luminaire type may be used.
- One possible correction is the auxiliary photometer method.
- This method is implemented by a short additional test with correction steps that are easily automated in software.



Auxiliary photometer method

- An adapter with an auxiliary photometer fixed to the mounting plate.
- A change in luminous flux of the DUT, caused by changing the burning position, results in a proportional photocurrent.

Auxiliary photometer method



- Additional cantilever allows turning the sample into designed burning position even when it is switched on.
- The subsequent measurement of a reference without interruption.

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Setup for Turning Luminaire

- Photometer head or a probe for spectroradiometer as detector
- Stray light tube as a shield
- Distance min. 10 x source dimension
- Correction of the burning position using the auxiliary photometer method in conformity with CIE S 025

Setup for Luminous Flux Integrator

- Transformation to a goniometer with a rotating detector
- Additional sample holder maintains the burning position
- Photometer or / and spectrometer as detector
- For small light sources all spatial radiation patterns can be measured

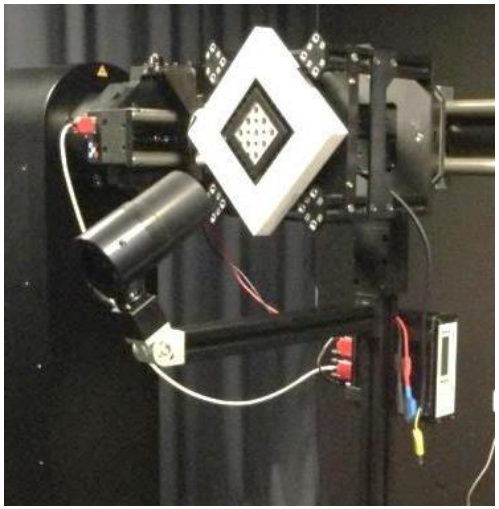
Test comparison

Light source	beam angle	Φ_v [lm] lum. flux integrator	Φ_v [lm] luminous flux integrator		Φ_v [lm] turning luminaire	
		Photometer	Spectrometer		Photometer	
SSL downlight 1	97°	798.0	806.0	1.0%	806.9	1.1%
SSL downlight 2	80°	665.3	673.5	1.2%	671.9	1.0%
SSL downlight 3	52°	1834	1854	1.1%	1878	2.4%
SSL downlight 4	29°	403.0	408.7	1.4%	409.4	1.6%
LED module with cooler	104°	1167	1181	1.2%	1178	0.9%
LED floodlight	103°	1697	1693	-0.2%	1743	2.7%
Sun lamp (halogen)	32°	4150	4231	2.0%	4021	-3.1%

- SSL downlights → The deviations within measurement uncertainties
- Other sources → The deviations are still low but a position correction can be applied

Correction of the burning position

Light source	Φ_v [lm] turning luminaire		Φ_v [lm] turning luminaire corrected	
LED floodlight	1743	2.7%	1702	0.3%
Sun lamp (halogen)	4021	-3.1%	4111	-0.9%
SSL downlight 1 @ 215 V	721.8	-9.5%	805.8	1.0%
SSL downlight 1 @ 200 V	650.9	-18.4%	806.9	1.1%



- **Induced position dependence for SSL downlights:**

  SSL downlight 1 was measured at lower operating voltages (215 and 200 V). The reference value was recorded in the designed burning position at the rated voltage of 230 V and used for position correction.

Conclusions

- New standards EN 13032-4 and CIE S 025 allow goniophotometric measurements in a luminaire orientation other than the designed burning position, if properly corrected.
- Correction with an auxiliary photometer method presented.
- Turning luminaire with a compact footprint provides a genuine alternative to a large and expensive rotating mirror goniophotometer even for position sensitive samples.

Thank you for your attention!

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