Instrument Systems
KONICA MINOLTA Group

Burning position correction

for measurements with the turning luminaire LGS 1000

This application note describes the implementation of the auxiliary photometer method according to the new standard CIE S025 on the turning luminaire LGS 1000 and validates the corrected data for various different types of light source. The results of the sample measured in its recommended burning position are used for comparison. On this basis, recommendations are made for the appropriate use of the burning position correction to perform measurements of various light sources in conformance with the standard.

APPLICATION
NOTE

\\ 1. INTRODUCTION

Goniophotometers are normally used for determining luminous intensity distribution and measuring the total luminous flux by suitable numerical integration of these distributions. A turning luminaire, such as the LGS 1000 from Instrument Systems, is the most practical, space-saving and inexpensive version of a far-field goniophotometer. However, as the name implies, during measurement the luminaires are rotated around axes C and γ, thus changing their burning position. This could be a problem in the measurement of position sensitive light sources.

Fig. 1: Turning luminaire LGS 1000 (left) and stray light tube with the detector (photometer head or EOP) on a stand (right).

As semiconductor light sources, the LEDs used in solid state lighting (SSL) sources are in fact insensitive to positional changes. However, the passive heat sinks of SSL sources are usually optimized for the operating position of the proposed use. The convective air flow through the cooling fins guarantees the required cooling capacity and thus the desired operating temperature of the LEDs. Any hindrance to air convection, e.g. by operating the light source in a burning position different from that prescribed by the manufacturer, can influence the optical characteristics of the luminaire. In this case a correction of the goniophotometric measurement is necessary.

The new and first international standard CIE S025 [1] or its European counterpart EN 13032-4:2015 [2] in principle allows goniophotometric measurements to be carried out in a burning position other than specified. In order to conform to the requirements set forth in the standard, a suitable burning position correction must be performed, e.g. by the auxiliary photometer method. Based on this method, Instrument Systems offers an overall solution for the LGS 1000, which is described in more detail in the following.

\\ 2. PERFORMING A CORRECTION OF THE BURNING POSITION

The fundamental concept of the auxiliary photometer method is to monitor the relative photocurrent of the light source at a fixed point while the latter changes its orientation in space. The measured value in each position, weighted by the reference in the specified operating position, serves as a correction factor for the actual measurement with the turning luminaire.

In practice, initially an additional sample plate is mounted on the LGS 1000. The sample is adjusted and burned in, and a normal sequence is carried out with the turning luminaire. The advantage of the additional sample plate is that following the sequence measurement a positioning correction can be carried out without the need for major reconfiguration and without repeat burn-in of the sample. Only the photometer arm is mounted and connected together with the auxiliary photometer. A software wizard guides the user through the entire process to create a positioning correction file. First of all, the fixture is brought into the home position for a sequence measurement. In the first correction step, the same sequence is performed as for the previous measurement (Figure 2). Even if the previous measurement was performed with a spectroradiometer, the correction file is continuously recorded with the auxiliary photometer. It is only important that the same angle positions are logged. The additional measurement time required for positioning correction is thus minimized.

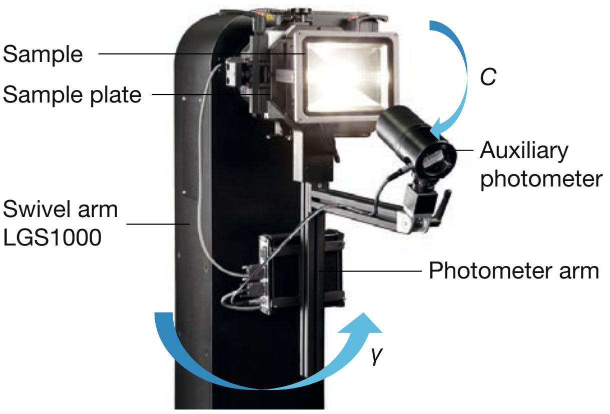

Fig. 2: Mounting an auxiliary photometer for performing the first correction step.

In the second correction step the sample is placed in the burning position prescribed by the manufacturer, in order to acquire the reference value with the auxiliary photometer (Figure 3). For this purpose a cantilever arm is mounted on the sample plate. The sample can slide along this arm in the switched-on state. The carriage is clamped at an adequate distance and the cantilever arm rotated by 90° to the C-axis and secured. Now the sample can be turned into the prescribed burning position with the aid of the motorized C axis. The user can specify the desired burning position by entering an angle. After a suitable stabilization time, the reference value can be recorded. This step completes the acquisition of the required correction factors and the positioning correction file thus created can be saved. The positioning correction file can then be used on the previously recorded sequence measurement with the turning luminaire, by which the values for the photometric integral (or luminous intensity) are multiplied by the respective correction factor. The luminous flux also changes accordingly as an integral sum. The positioning correction file can also be applied on other samples of the same type, saving valuable measuring time.

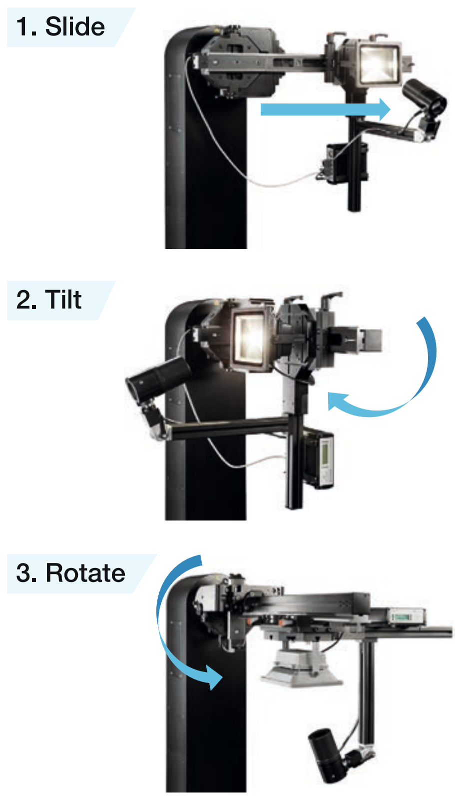

Fig. 3: The sample is placed in the prescribed burning position with the aid of a cantilever arm and the reference value taken for the positioning correction.

\\ 3. MEASUREMENT COMPARISON

To determine when a burning position correction is expedient, luminous flux measurements of various light sources using the so-called luminous flux integrator, by which the source did not change its burning position, were compared to the readings for the turning luminaire, by which the source changed position (Table 1). The readings of the luminous flux integrator with the photometer as a detector serve as reference values for the calculation of percentage deviations with the turning luminaire.

Since the measurement deviations for all tested SSL downlights and an LED module with inbuilt cooler with 1-2% are very small and clearly lie within the range of typical measurement uncertainties for the respective systems, a dependence on burning position cannot be concluded. Most users, however, have no opportunity to perform such comprehensive comparative measurements. Fast measurement of a positioning correction file as proof of no or negligible position dependence is thus a convenient solution. With this proof and accounting for the positional influence in the measurement uncertainty budget a standard CIE S025 compliant measurement can also be carried out with a turning luminaire.

Application of the burning position correction file is however worthwhile for the two other light sources 30 W LED floodlight and 300 W halogen sun lamp, in order to reduce measurement uncertainties due to position dependence.

Light source	Emission angle	Φ_v [lm] Luminous flux integrator	Φ_v [lm] Turning luminaire	
SSL downlight 1	97°	798.0	806.9	1.1%
SSL downlight 2	80°	665.3	671.9	1.0%
SSL downlight 3	52°	1834	1878	2.4%
SSL downlight 4	29°	403.0	409.4	1.6%
LED module with cooler	104°	1167	1178	0.9%
LED floodlight	103°	1697	1743	2.7%
Sun lamp (halogen)	32°	4150	4021	-3.1%

Table 1: Comparison of luminous fluxes measured with the luminous flux integrator and the turning luminaire for various light sources [3].

\\ 4. USE OF BURNING POSITION CORRECTION

A burning position correction file was recorded for all named light sources, as described in Chapter 2. Figure 4 shows an example. Following the software routine, first of all the individual C-planes are measured with exactly the same settings as for measurement with the turning luminaire. Subsequently, the luminaire is brought into the operating position and the reference value measured after the stabilization phase.

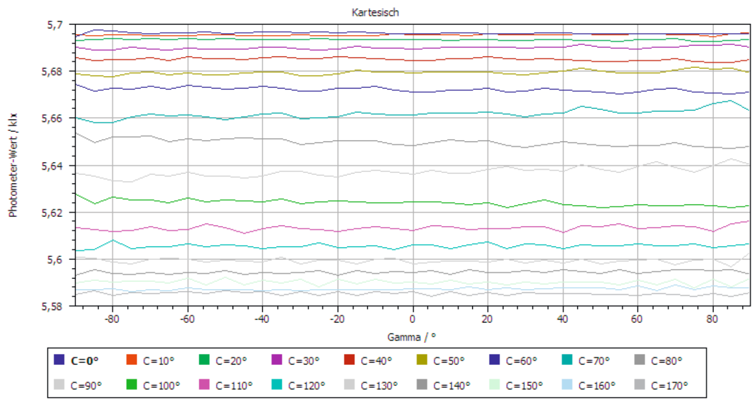

Fig. 4: Example of a burning position correction file shown in Cartesian coordinates.

During one scan (C-plane) of the positioning correction with the auxiliary photometer practically negligible oscillations are measured. The individual planes among one another, however, demonstrated deviations of up to 2 % for the LED floodlight and 3 % for the sun lamp, caused by the lamp (Figure 5). As expected, the SSL downlights show a negligible deviation of less than 1 %. It is not surprising that the rotation of the downlights around the C axis during measurement with the turning luminaire causes no change in the luminous flux, as the fins on the heat sink are symmetrically arranged around the luminaire. The LED module with cooler is likewise not position-dependent, due to active cooling. For these sources one could dispense with burning position correction of the C-planes for measurement purposes. This is however required by standard CIE S025, and the user must be able to correct all measurement steps.

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Light source	Φ_v [lm] Turning luminaire		Φ_v [lm] Turning luminaire with position correction	
LED floodlight	1743	2.7%	1702	0.3%
Sun lamp	4021	-3.1%	4111	-0.9%
SSL downlight 1 at 222 V	765.9	-4.0%	805.6	1.0%
SSL downlight 1 at 215 V	721.8	-9.5%	805.8	1.0%
SSL downlight 1 at 200 V	650.9	-18.4%	806.9	1.1%
SSL downlight 1 at 185 V	588.7	-26.2%	799.8	0.2%

Table 2: Application of burning position correction to measurements with the turning luminaire.

Upon application of the burning position correction on the measurements of the 30 W LED floodlight and 300 W halogen lamp with a gas mixture to simulate the sun, the corrected luminous fluxes showed an improvement compared to the luminous flux integrator and amount to only 0.3 % deviation for the LED floodlight and -0.9 % for the sun lamp (see Table 2). One reason for the position dependence of LED-floodlight could be the arrangement of the cooling fins on the heat sink, which run parallel in one direction and upon rotation on the turning luminaire can result in slightly differing cooling conditions. In the case of the sun lamp, rotation can lead to movement of the gas mixture within the lamp and consequently a measuring error.

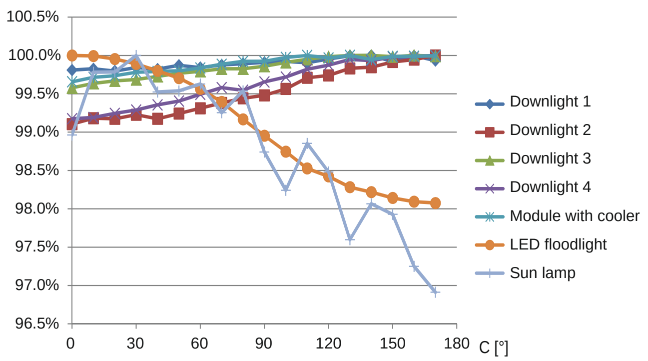

Fig. 5: Relative deviation of individual C-planes over angle C when γ=0°.

\\ 5. INDUCED POSITION DEPENDENCE

The observed effects are in part still within the typical measurement uncertainties, and the position dependence of the sample should be higher in order to show that the positioning correction can also be successfully applied in this case. Because an SSL downlight with a correspondingly high position dependence was not available, this was created artificially. SSL downlight 1 was measured at lower operating voltages (222, 215, 200 and 185 V) with the turning luminaire, which of course results in lower luminous fluxes (Table 2). For the subsequent burning position correction the reference value in the standard burning position at a nominal 230 V was recorded after a sufficient burn-in time. After each use of the position correction the high deviations of between -4 % and -26 % to the measurement with the luminous flux integrator were corrected to about 1 %. It is thus also possible to measure light sources which may demonstrate a high position dependence with the turning luminaire and subsequently perform a position correction according to CIE S025.

\\ 6. CONCLUSION

The correction of the burning position by the auxiliary photometer method permits goniophotometric measurements conforming to CIE S025 also for light sources with a high position dependence. Should a burning position correction not appear expedient, a simple proof of position independence can be provided with the measurement and measurement uncertainties in the budget thus reduced.

\\ REFERENCES

[1] *CIE S 025/E:2015, Test Method for LED Lamps, LED Luminaires, and LED Modules, CIE Vienna 2015.*
[2] *EN 13032-4:2015, Light and Lighting. Measurement and presentation of photometric data of lamps and luminaires. LED lamps, modules and luminaires.*
[3] *Konjhodzic D., Goniophotometry and spectral radiometry for SSL light sources, LICHT 03/2015, 73–77.*

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