

Measurement of the performance of a prototype 'Ecat SKLed' lamp.

Giuseppe Levi

July 25, 2021



Abstract

As part of the contract between the Department of Physics and Leonardo Corporation have been carried out some measurements of the performance and light emission of a prototype of the lamp they produce called 'Ecat SKLed'. The measurements concerned the power consumption and illumination in Lux at different distances. This technical report contains the results of the measures done on that single prototype.

1 Introduction

The Ecat SKLed lamp looks like a cylinder with a diameter of 100 mm and a length of 165 mm. In the front part there is a lens with a diameter of 5.6 cm (see fig.1) that can be considered as the light source, in the rear part there is the power cable (220V 50Hz) and the potentiometer for adjusting the power.

In this measurement session it was decided, in agreement with the customer, to make a simple measurement of illuminance at various distances and in different points of the illuminated area.

A professional RS-PRO ILM-01 luxmeter[RS], which has a nominal accuracy of 3%, , and a model D52-2047 single-phase electrical power meter capable of measuring active power and power factor for loads from 0 to 10A and voltages from that 80 to 300V with an accuracy of 1% were used for the measurements[han].

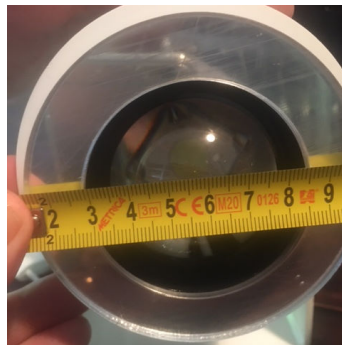


Figure 1: Image of the output lens of the SKLed lamp. The diameter of the light source is about $5.6 \pm 0.1\text{cm}$. Behind it is visible the round led on a square white base. Because the led is not accessible the lens itself can be considered as the light source with an area of 24.6 cm^2

2 Measures

In the fig. 2 is represented the structure of the illuminated spot generated by the lamp. As can be seen the illumination is not uniform with a less illuminated part in the center, a large more

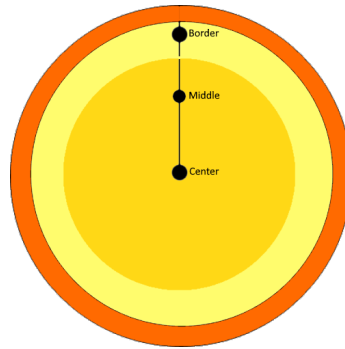


Figure 2: Schematic view of the illuminated area. The center is dimmer than the border. The brighter corona is surrounded by a dusky region. Illuminance measurements were taken at the center of the disk, at half the radius and in the brighter region at 4/5 of the radius.

illuminated corona and a zone of penumbra around this. Using the potentiometer on the lamp, the power consumption was adjusted, varying it from a minimum of 0.5W to a maximum of 4.8W.

The measurement points were repeated for three different distances, measured between the lens in the lamp and the screen, each time fixing 3 points on the screen where to make the illuminance measurement. The spot radius was measured at every distance and a beam aperture angle $\alpha = 2 * \arctan m = 44.4^\circ$ measured from the slope m . (see fig. 3)

The solid angle of the illuminated cone is then $\Omega = 2\pi(1 - \cos \frac{\alpha}{2}) = 0,466 \text{ sr}$.

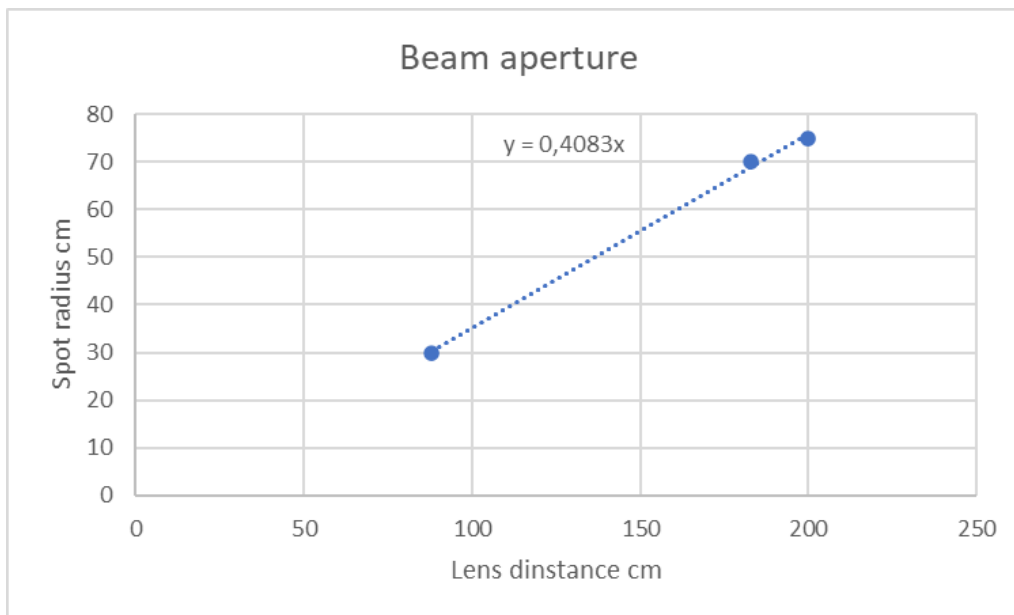


Figure 3: Radius of the illuminated spot vs distance of the lamp. Fitting the points a slope m can be calculated. The beam aperture radius is $\alpha = 2 * \arctan m$.

The following tables and graphs show the measurements obtained.



W	Cos phy	Center	Middle	Border
0,5	0,2	116	130	161
1	0,22	146	175	262
1,5	0,28	218	261	397
2	0,33	304	362	530
2,5	0,32	370	442	675
3	0,35	433	519	788
3,5	0,39	503	606	911
4	0,4	565	670	1086
4,5	0,41	647	764	1160
4,8	0,43	681	815	1212

Table 1: Data taken at 88cm. Illuminance data is expressed in lux. The total width of the spot was about 70 cm while the diameter of the fully illuminated area was about 60 cm.

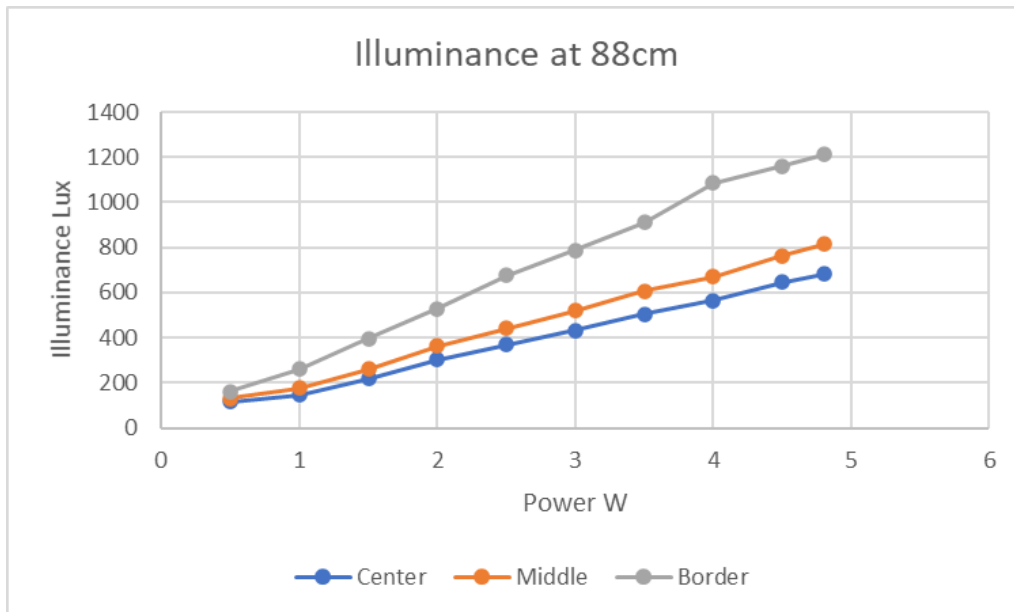


Figure 4: Graph of the illuminance as a function of power input.



W	Cos phy	Center	Middle	Border
1,5	0,29	65	79	120
2	0,35	70	84	137
2,5	0,37	84	103	167
3	0,37	100	122	200
3,5	0,38	105	140	220
4	0,42	129	158	252
4,8	0,43	143	170	294

Table 2: Data taken at 183cm. Illuminance data is expressed in lux. The illuminated disk has a diameter approx of 140cm

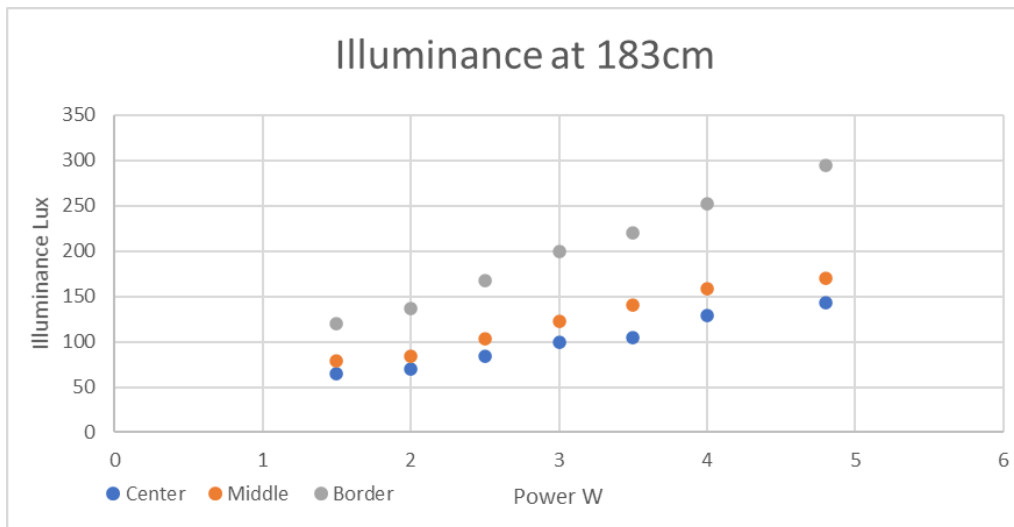


Figure 5: Graph of the illuminance as a function of power input.



W	Cos phy	Center	Middle	Border
0,5	0,18	22	36	41
1	0,23	30	36	58
1,5	0,26	47	54	90
2	0,3	59	68	115
2,5	0,35	72	82	140
3	0,38	84	95	157
3,5	0,39	99	115	190
4	0,39	108	124	202
4,8	0,42	130	145	244

Table 3: Data taken at 200cm. Illuminance data is expressed in lux. The illuminated disk has a diameter approx of 150cm

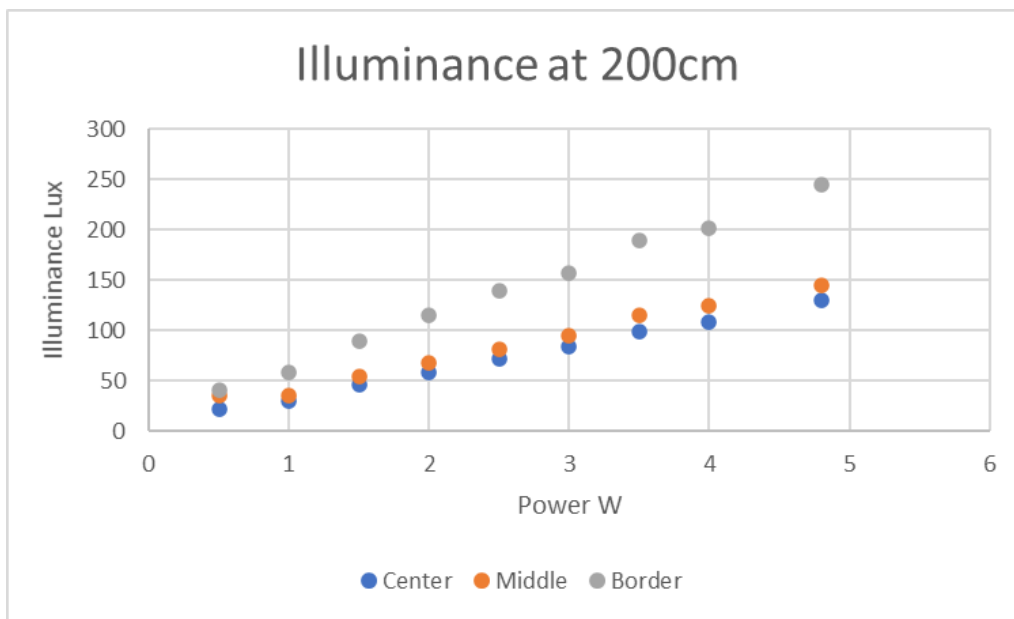


Figure 6: Graph of the illuminance as a function of power input.



A Luxmeter calibration

The luxmeter was calibrated by the "Nemco" laboratory. We reproduce here the results of their measurements. It is notable that the error of the luxmeter is always less than the 3% in the manual. So assuming a 3% error is correct prudent.

Taratura di Misuratore di Illuminamento <i>Illuminance Meter Calibration</i>					Verifica delle Specifiche <i>Specification Check</i>		
Illuminamento Applicato <i>Applied Illuminance</i>	Portata <i>Range</i>	Lettura <i>Reading</i>	Errore <i>Error</i>	Incertezza <i>Uncertainty</i>	Specifiche <i>Specification</i>	K=E/S	Risultato <i>Result</i>
11,31 lx	50,00 lx	11,60 lx	0,29 lx	0,18 lx	3%	83%	PASS
28,3 lx	50,00 lx	28,8 lx	0,5 lx	0,5 lx	3%	58%	PASS
45,2 lx	50,00 lx	45,8 lx	0,6 lx	0,7 lx	3%	44%	PASS
113,1 lx	500,0 lx	113,6 lx	0,5 lx	1,8 lx	3%	15%	PASS
452 lx	500,0 lx	455 lx	3 lx	7 lx	3%	22%	PASS
1.131 lx	5.000 lx	1.135 lx	4 lx	27 lx	3%	12%	PASS
2.828 lx	5.000 lx	2.825 lx	-3 lx	68 lx	3%	4%	PASS
4.525 lx	5.000 lx	4.480 lx	-45 lx	109 lx	3%	34%	PASS
8,48 klx	50,00 klx	8,36 klx	-0,12 klx	0,20 klx	3%	48%	PASS
17,0 klx	50,00 klx	16,8 klx	-0,2 klx	0,4 klx	3%	40%	PASS
28 klx	50 klx	28 klx	0 klx	1 klx	3%	0%	PASS
L'errore è espresso come (Lettura)-(Illuminamento Applicato) <i>Error is expressed as (Reading)-(Applied Illuminance)</i>					K > 100% FAIL K <= 100% PASS E = Errore (Error) S = Specifiche (Specification) S = %reading		

Figure 7: Table with the calibration results from the "Nemko" laboratory. Note that the $K = E/S$ column shows that the error of the luxmeter is always less than declared by the manufacturer.

Declaration of no Conflict of Interest

The author declares that there is no potential conflict of interest or any relationship of a financial or personal nature with any person, firm, or organization that would inappropriately influence the conduct and results of this work.

References

- [han] handsontec. D52-2047 user manual.
- [RS] RS. Ilm-01 user manual.