

Lamp measurement report – 21 Dec 2009

TL Pro 100 740 120cm DIPLED

by

Luxerna

Photo courtesy by www.OliNo.org



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Summary measurement data


parameter	meas. result	remark
Color temperature	8385 K	cold white
Luminous intensity I_v	662 Cd	Measured straight underneath the lamp
Beam angle	105 deg	105° for the C0-C180 plane (crosses the length direction of the tube), and 102° for C90-C270 plane (along the length direction of tube).
Power P	17.0 W	
Power Factor	0.95	For every 1 kWh net power consumed, there has been 0.3 kVAhr for reactive power.
Luminous flux	1697 Lm	
Luminous efficacy	100 Lm/W	
CRI_Ra	81	Color Rendering Index.
Coordinates chromaticity diagram	x=0.2939 and y=0.2950	
Fitting	FL-tube	This tube is used in a normal luminaire for fluorescent tube light, where the starter is exchanged for a new type that shorts its pins.
PAR-value	6.7 $\mu\text{Mol/s/m}^2$	The number of photons seen by an average plant when it is lit by the light of this light bulb. Value valid at 1 m distance from light bulb.
PAR-photon efficacy	1.0 $\mu\text{Mol/s/W}_e$	The total emitted number of photons by this light, divided by its consumption in W. It indicates a kind of efficacy in generating photons.
S/P ratio	2.4	This factor indicates the amount of times more efficient the light of this light bulb is perceived under scotopic circumstances (low environmental light level).

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D x L external dimensions	28 x 1200 mm	External dimensions of the tube (D = diameter). Excluding the pins.
L x W luminous area	1105 x 17 mm	Dimensions of the luminous area (used in Eulumdat file). This is equal to the surface of the plate on which the leds are mounted.
General remarks		<p>The ambient temperature during the whole set of measurements was 24.5 deg C. The maximum temperature of the tube light gets about 16 degrees hotter than ambient.</p> <p>Warm up effect: during the warm up time the illuminance decreases with ≈8 % and the consumed power with ≈6 %.</p> <p>Voltage dependency: the power consumption and illuminance do not significantly depend on the voltage when it is varied from 200 - 250 V.</p>

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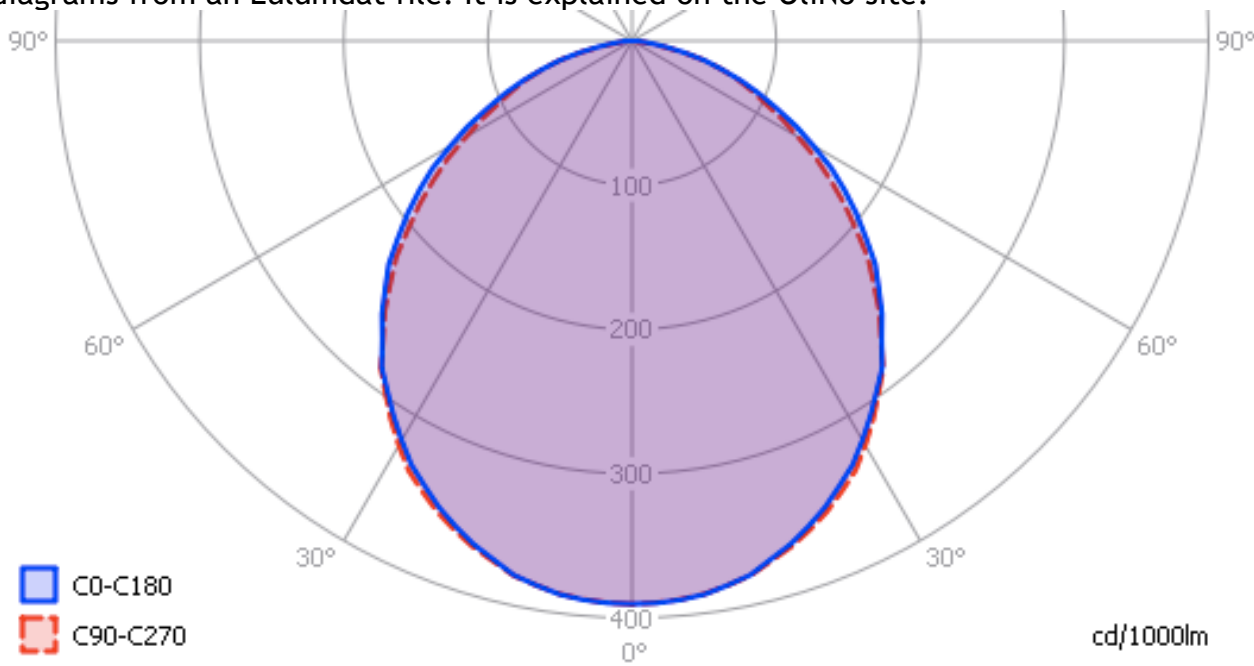
Overview table

m.	Ø 50%		CO-180: 105° C90-270: 102°	E (lux)	Luminaire Efficacy
	CO-180	C90-270			100 (lumens per Watt)
0.25	0.66	0.62		10599	Half-peak diam CO-180
0.5	1.31	1.24		2650	2.62 x diameter(m)
1	2.62	2.48		662	Half-peak diam C90-270
1.5	3.93	3.72		294	2.48 x diameter(m)
3	7.87	7.43		74	Illuminance
4	10.49	9.91		41	662 / distance ² (lux)
5	13.11	12.39		26	Total Output
					1697 (lumens)

The overview table is explained on the OLiNo website. Please note that this overview table makes use of calculations, use this data with care as explained on the OLiNo site. E (lux) values are not accurate, when within 5 x 1105 mm = 5510 mm. Measured lux values will be less than the computed values in this overview as the measurements are then within the near field of the tube.

Eulumdat light diagram

This light diagram below comes from the program Qlumedit, that extracts these diagrams from an Eulumdat file. It is explained on the OLiNo site.



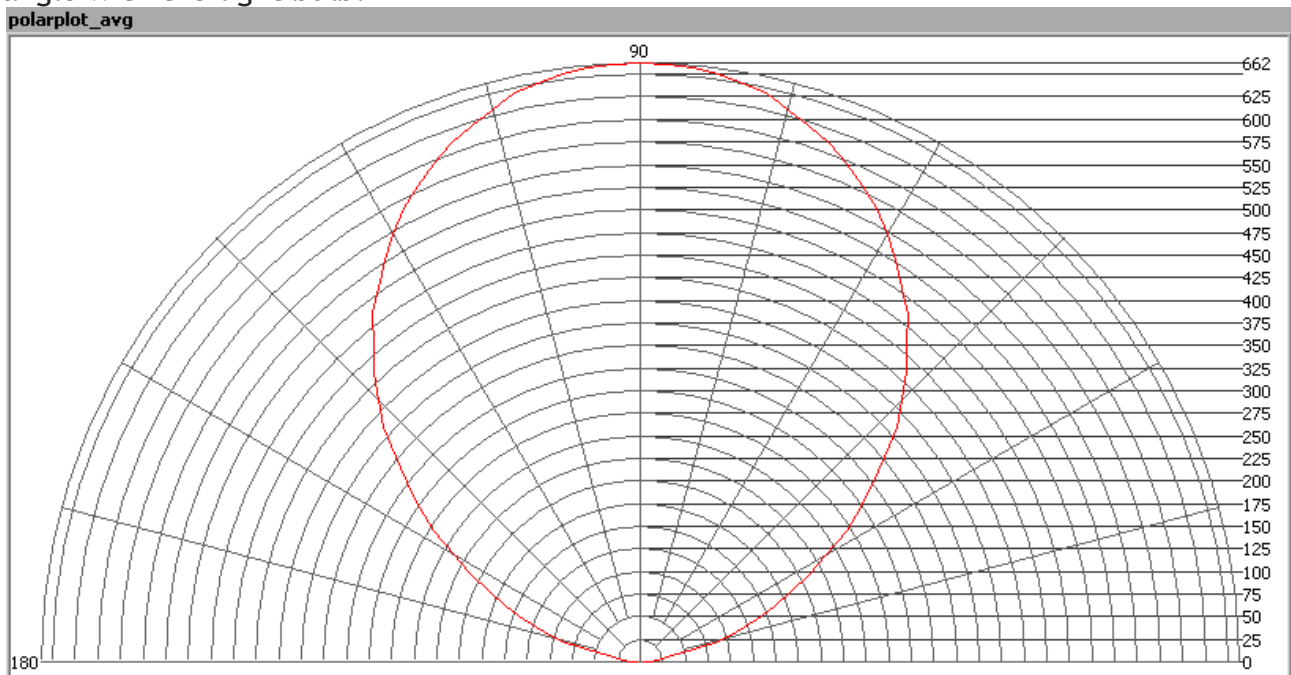
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The light diagram giving the radiation pattern.

It indicates the luminous intensity around the light bulb. In the length direction (C90-C270) the beam angle is the same as in the direction crossing the length direction (C0-C180).

Illuminance E_v at 1 m distance, or luminous intensity I_v

Herewith the plot of the *averaged* luminous intensity I_v as a function of the inclination angle with the light bulb.

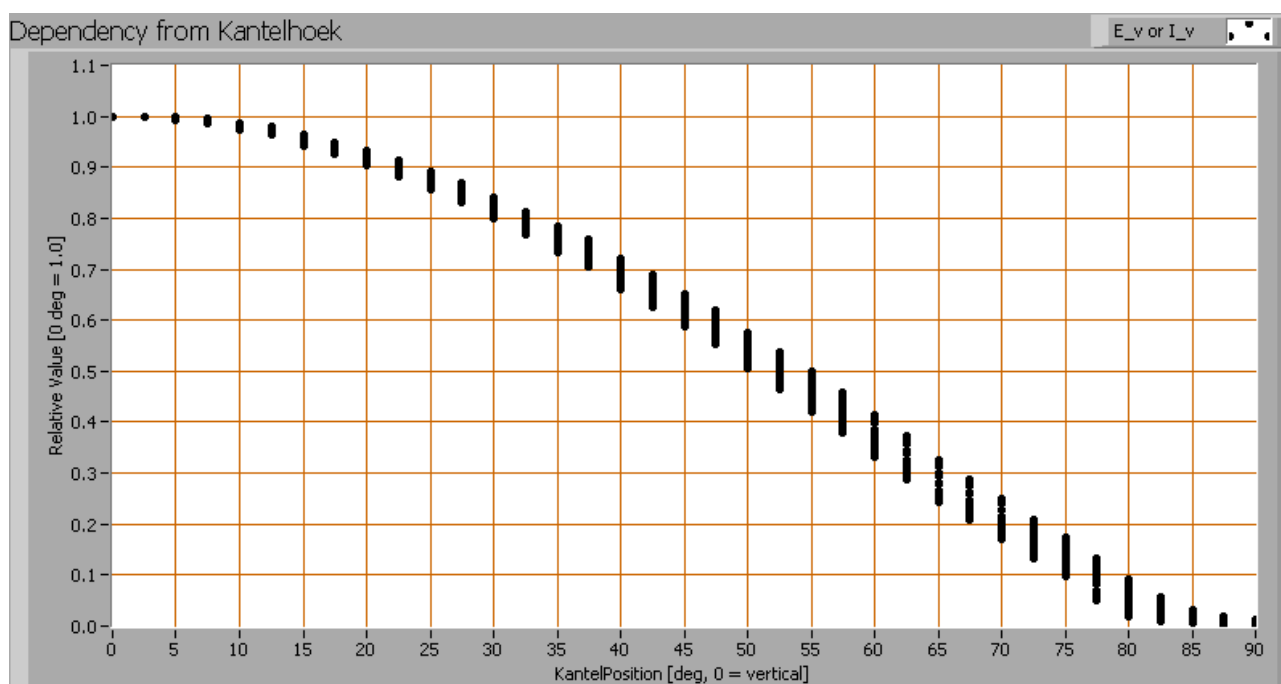


The radiation pattern of the light bulb.

This radiation pattern is the average of the light output of the light diagram given earlier. Also, in this graph the luminous intensity is given in Cd.

These averaged values are used (later) to compute the lumen output.

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Intensity data of every measured turn angle at each inclination angle.

This plot shows per inclination angle the intensity measurement results for each turn angle at that inclination angle. There normally are differences in illuminance values for different turn angles. However for further calculations the averaged values will be used. When using the average values per inclination angle, the beam angle can be computed, being 102-105° depending on the reference plane.

Luminous flux

With the averaged illuminance data at 1 m distance, taken from the graph showing the averaged radiation pattern, it is possible to compute the luminous flux.

The result of this computation for this light spot is a luminous flux of 1416 Lm.

Luminous efficacy

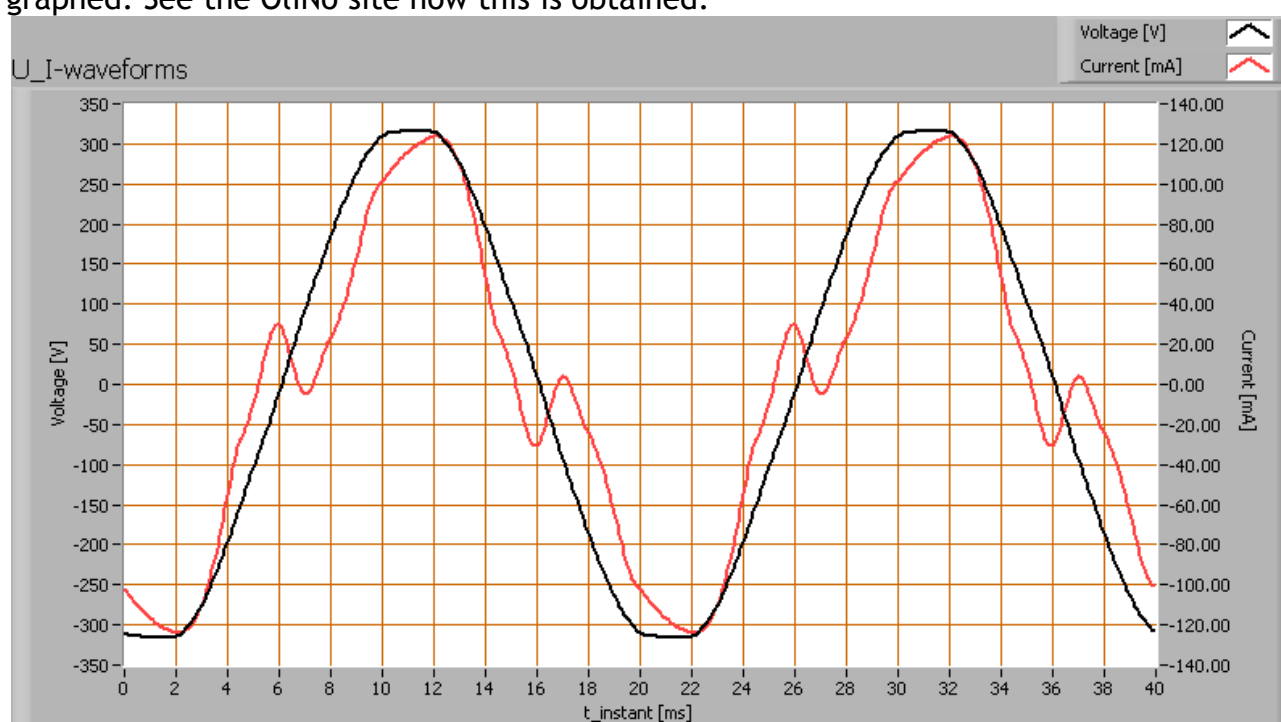
The luminous flux being 1697 Lm, and the power of the light bulb being 17.0 W, yields a luminous efficacy of 100 Lm/W.

A power factor of 0.95 means that for every 1 kWh net power consumed, a reactive component of 0.3 kVar was needed.

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Light bulb voltage (used on power supply!)	230 VAC
Light bulb current	78 mA
Power P	17.0 W
Apparent power S	17.9 VA
Power factor	0.95

Of this light bulb the voltage across and the resulting current through it are measured and graphed. See the OliNo site how this is obtained.



Voltage across and current through the lightbulb

The current does have a sine form, with some irregularities around the 0-crossings. The phase is the same as the phase of the voltage. The powerfactor is almost perfect with a value of 0.95.

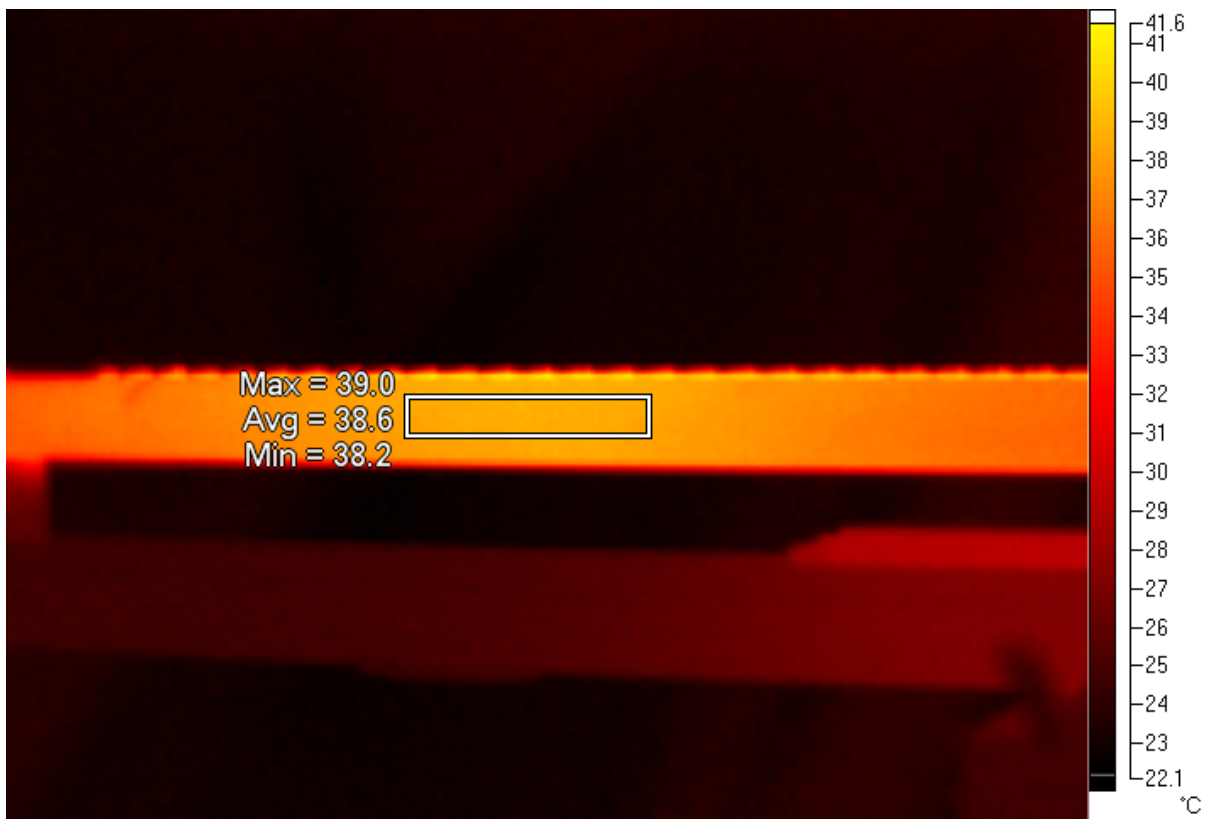
Also the power spectrum of the current is determined.

Squared amplitudes of higher harmonics related to the first harmonic (50 Hz).

Due to the irregularities at the 0-crossings there are a few higher harmonics. The Total Harmonic Distortion of the current is 32 %.

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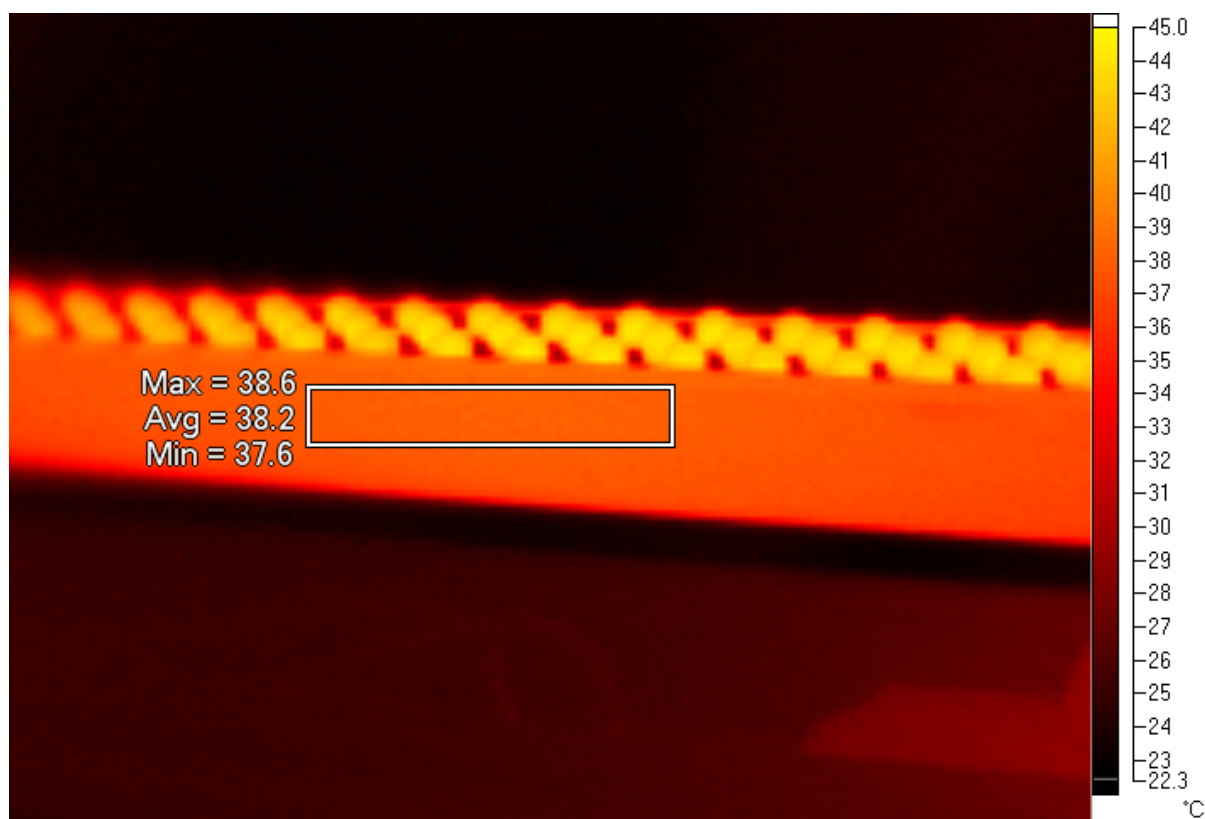
Temperature measurements lamp



Temperature image after warm up period, overview

Images from relatively far away were made to find the hotspots of the tube.

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Temperature image after warm up period, detail

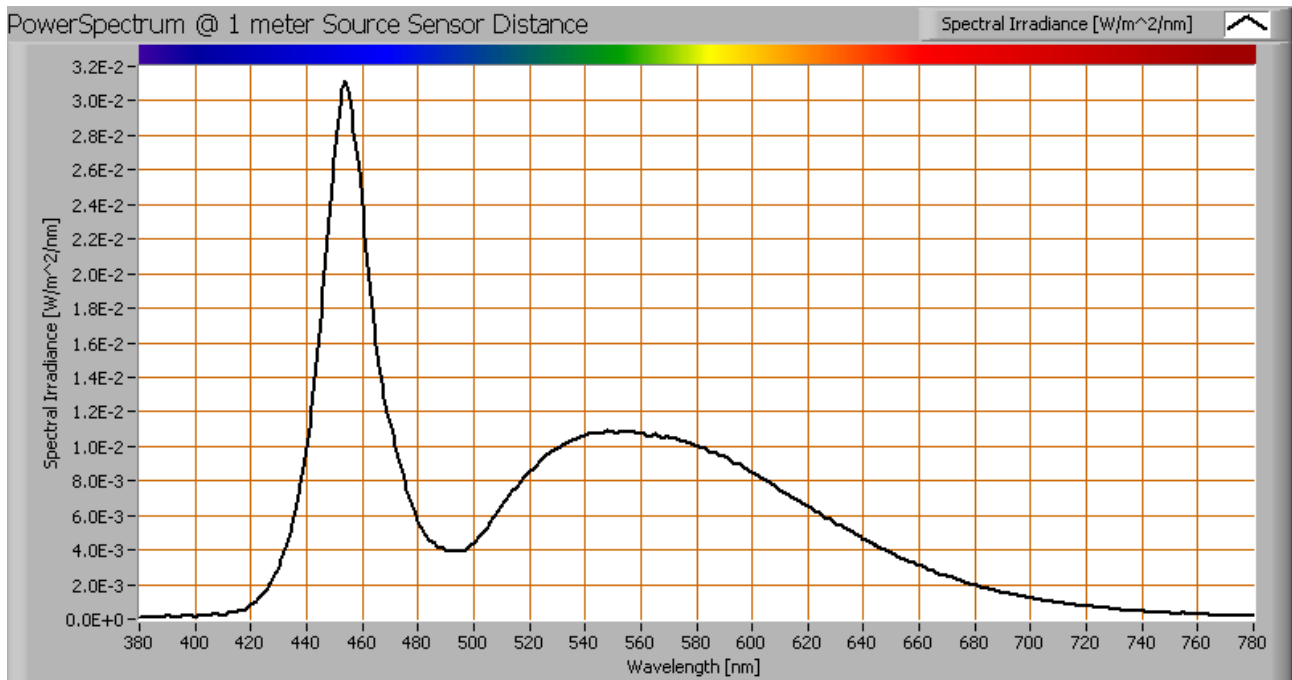
Tape is put on the hotspot and then zoomed in to measure its temperature.

status lamp	> 2 hours on
ambient temperature	24 deg C
reflected background temperature	24 deg C
camera	Fluke Ti25
emissivity	0.95 ⁽¹⁾
measurement distance	0.20 m
IFOV _{geometric}	0.5 mm
NETD (thermal sensitivity)	100 mK

⁽¹⁾ The emissivity of the masking tape is used which is about 0.95. The masking tape is so thin that it quickly takes the same temperature as the light bulb's heat sink.
The tube on its hottest place gets no warmer than warm-to-the-touch.

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Color temperature and Spectral power distribution

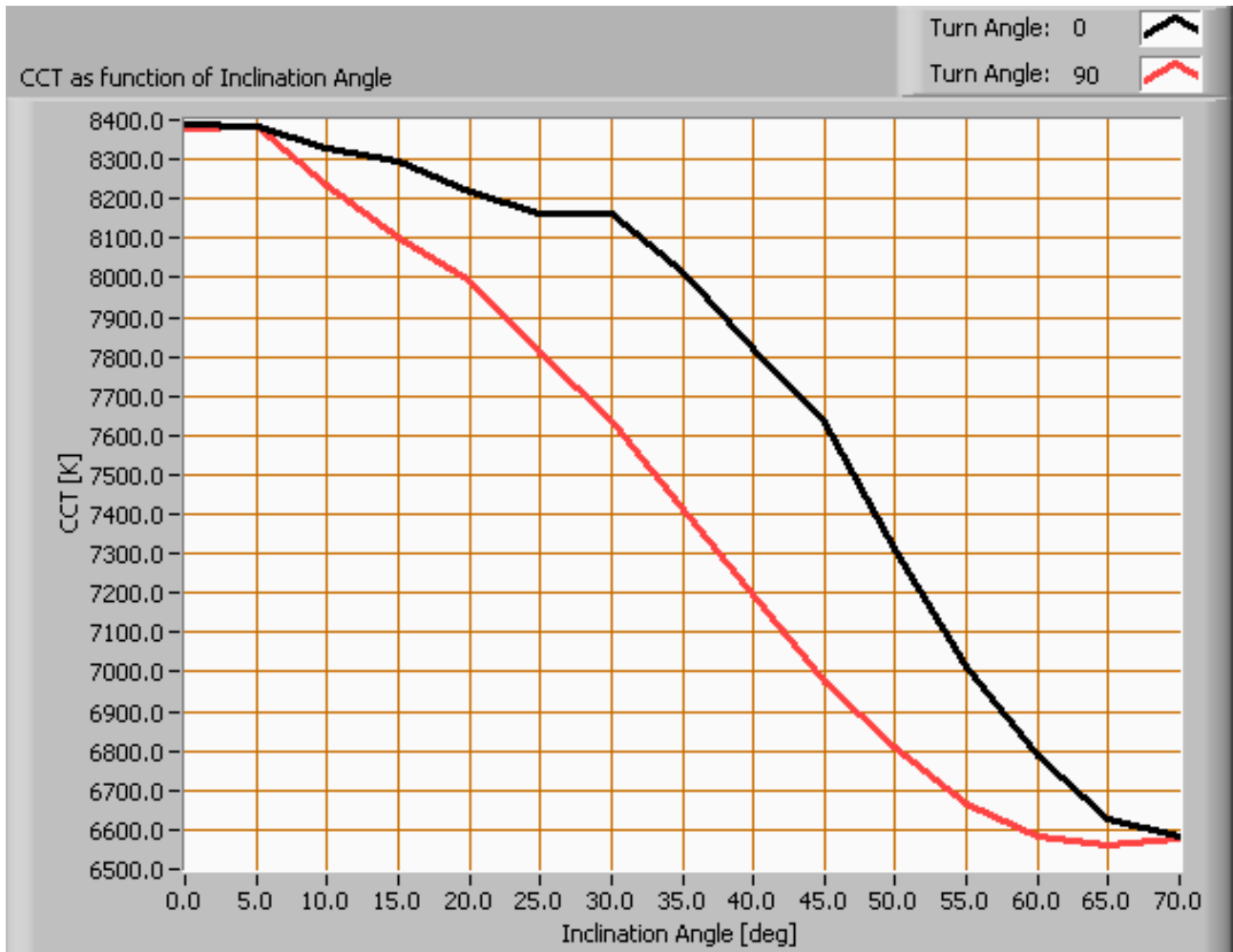


The spectral power distribution of this light bulb, energies on y-axis valid at 1 m distance.

The measured color temperature is about 8375 K which is cold white.

This color temperature is measured straight underneath the light bulb. Below a graph showing the color temperature for different inclination angles.

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Color temperature as a function of inclination angle.

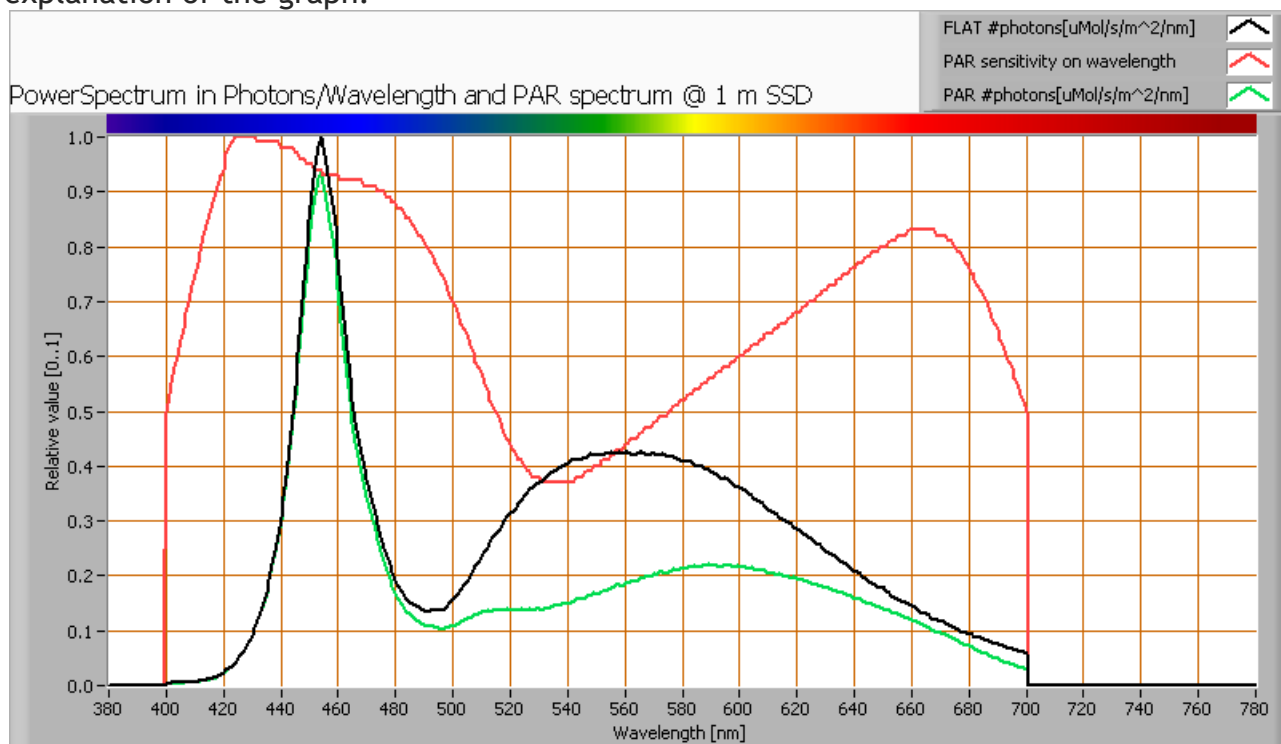
The measurement of CCT is measured for inclination angles up to 70° since then the illuminance value was decreased to very low values (< 5 lux).

The beam angle is maximally 105°, meaning a 52.5° inclination angle. In this area the majority of the light is present. The variation in correlated color temperature in this area is about 20 %.

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PAR value and PAR spectrum

To make a statement how well the light of this light bulb is for growing plants, the PAR-area needs to be determined. See the OLiNo website how this all is determined and the explanation of the graph.



The photon spectrum, then the sensitivity curve and as result the final PAR spectrum of the light of this light bulb

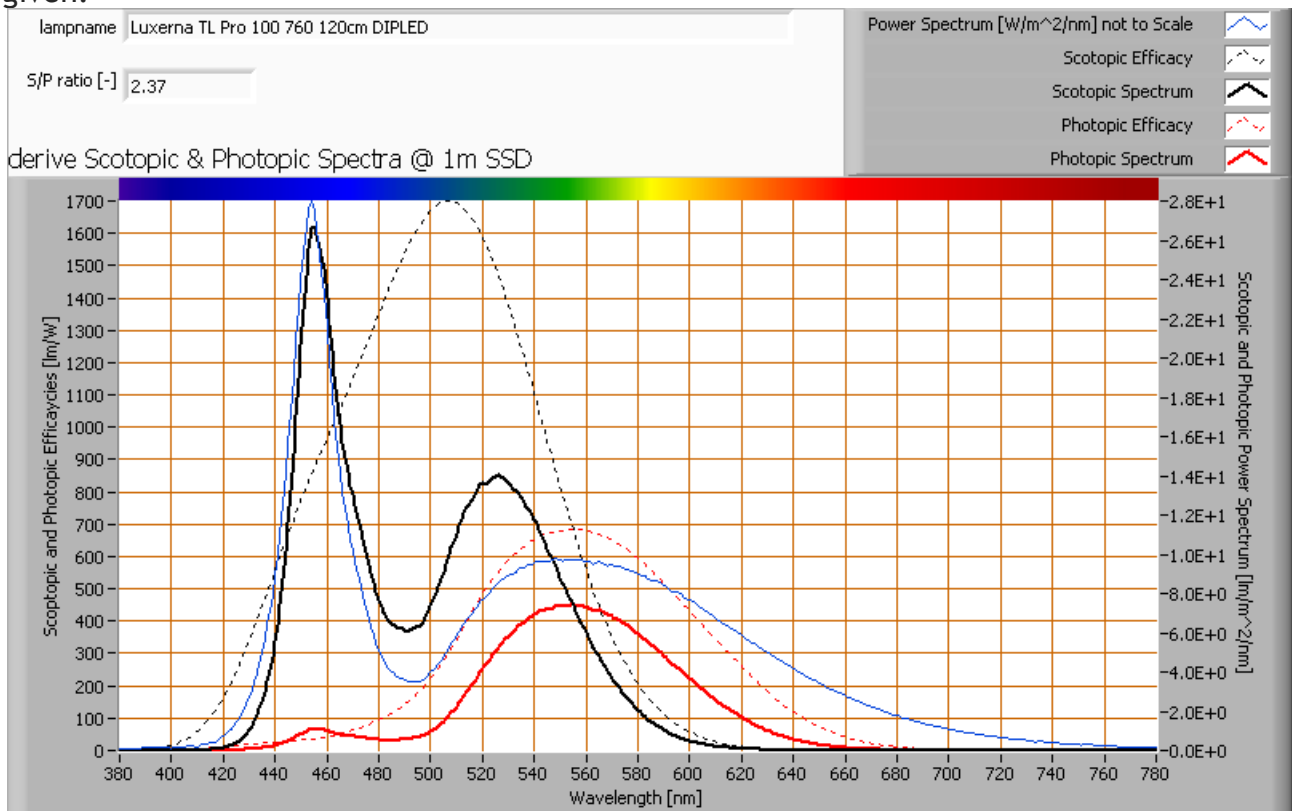
parameter	waarde	eenheid
PAR-number	6.7	μMol/s/m ²
PAR-photon current	17.2	μMol/s
PAR-photon efficacy	1.0	μMol/s/W

The PAR efficiency is 68 % (valid for the PAR wave length range of 400 - 700 nm). So maximally 68 % of the total of photons in the light is effectively used by the average plant (since the plant might not take 100 % of the photons at the frequency where its relative sensitivity is 100 %).

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S/P ratio

The S/P ratio and measurement is explained on the OliNo website. Here the results are given.



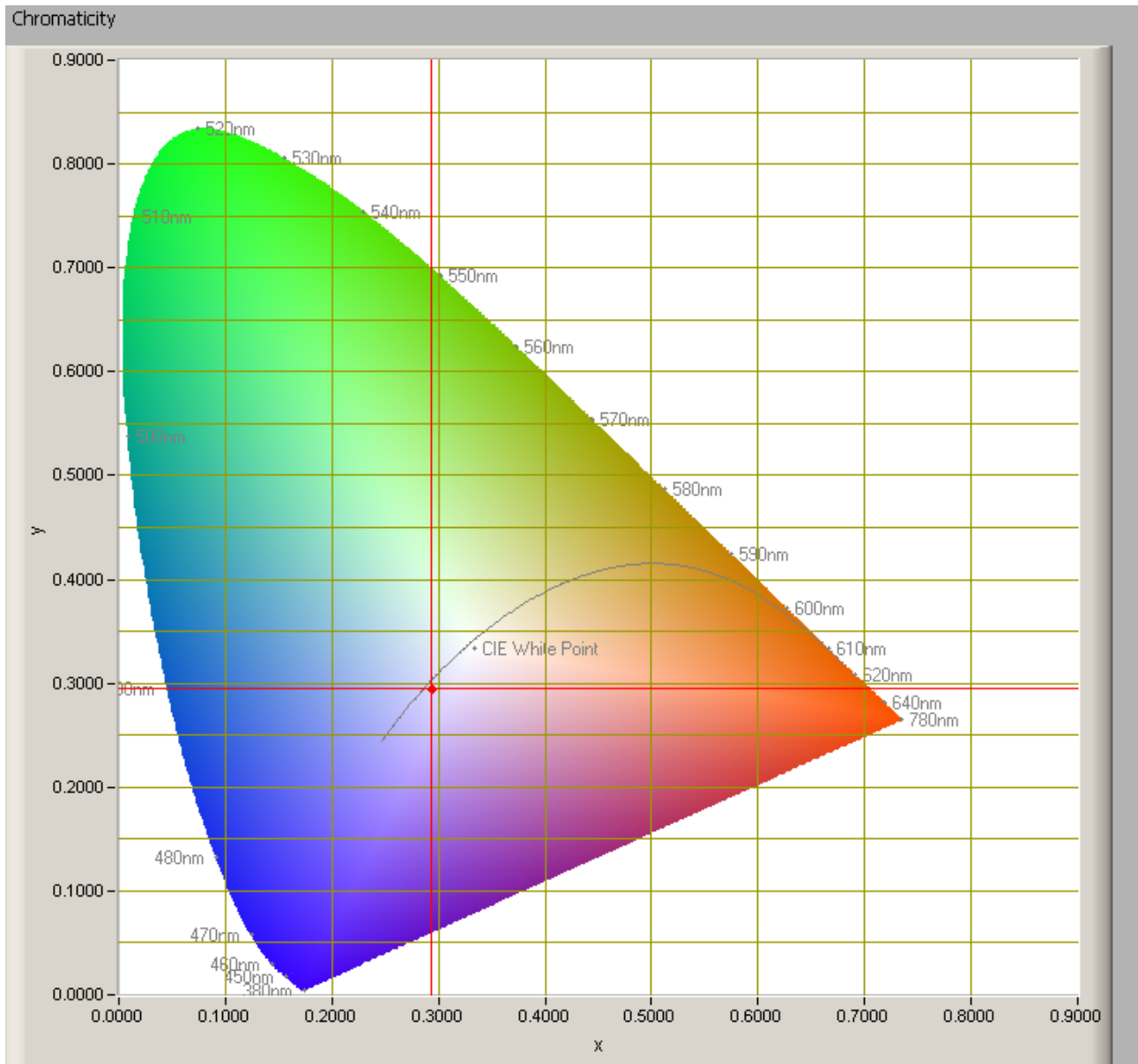
The power spectrum, sensitivity curves and resulting scotopic and photopic spectra (spectra energy content defined at 1 m distance).

The S/P ratio is 2.4

More info on S/P ratio can be found on the OliNo website.

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Chromaticity diagram



The chromaticity space and the position of the lamp's color coordinates in it.

The light coming from this lamp is close to the Planckian Locus (the black path in the graph).

Its coordinates are $x=0.2939$ and $y=0.2950$.

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Color Rendering Index (CRI) or also Ra

Herewith the image showing the CRI as well as how well different colors are represented (rendered). The higher the number, the better the resemblance with the color when a black body radiator would have been used (the sun, or an incandescent lamp). Practical information and also some critics about the CRI can be found on the OLiNo website.

Each color has an index R_x , and the first 8 indexes ($R_1 \dots R_8$) are averaged to compute the R_a which is equivalent to the CRI.

☐ manual

Reference Illuminant

Planckian radiator















 CCT

8385

 K

Chromaticity Difference DC=

7.7E-3

R1= 81.7		R8= 75.1	
R2= 86.3		R9= 19.9	
R3= 82.4		R10= 61.2	
R4= 80.3		R11= 76.1	
R5= 79.6		R12= 44.3	
R6= 75.6		R13= 83.8	
R7= 88.8		R14= 89.9	

Ra
 (mean value of $R_1 - R_8$)

81.2

CRI of the light of this lightbulb.

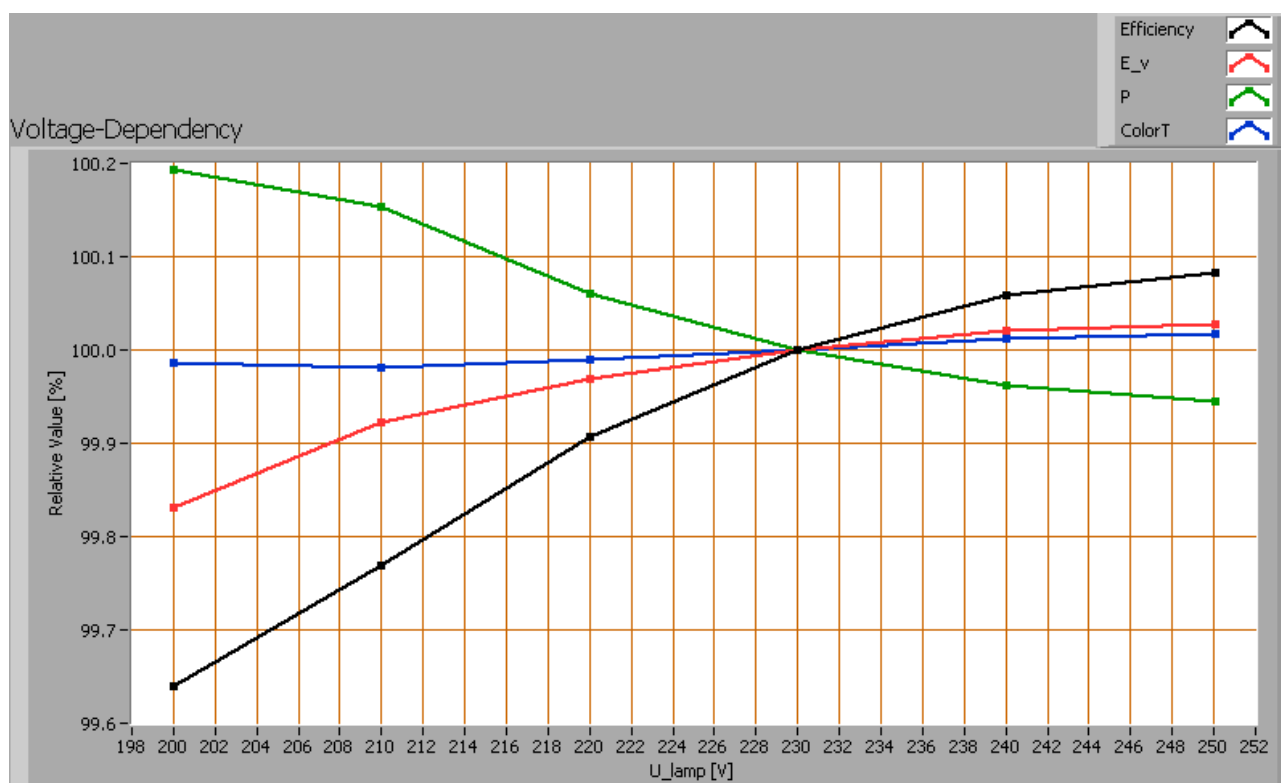
The value of 81 is higher than 80 which is considered a minimum value for indoor usage.

Note: the chromaticity difference is 0.0077 indicates the distance to the Planckian Locus. Its value is higher than 0.0054, which means that the calculated CRI result is not meaningful.

Voltage dependency

The dependency of a number of lamp parameters on the lamp voltage is determined. For this, the lamp voltage has been varied and its effect on the following light bulb parameters measured: illuminance E_v [lx], the lamp power P [W], the (Correlated) Color Temperature [K] and the luminous efficacy [lm/W].

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Lamp voltage dependencies of certain light bulb parameters, where the value at 230 V is taken as 100 %.

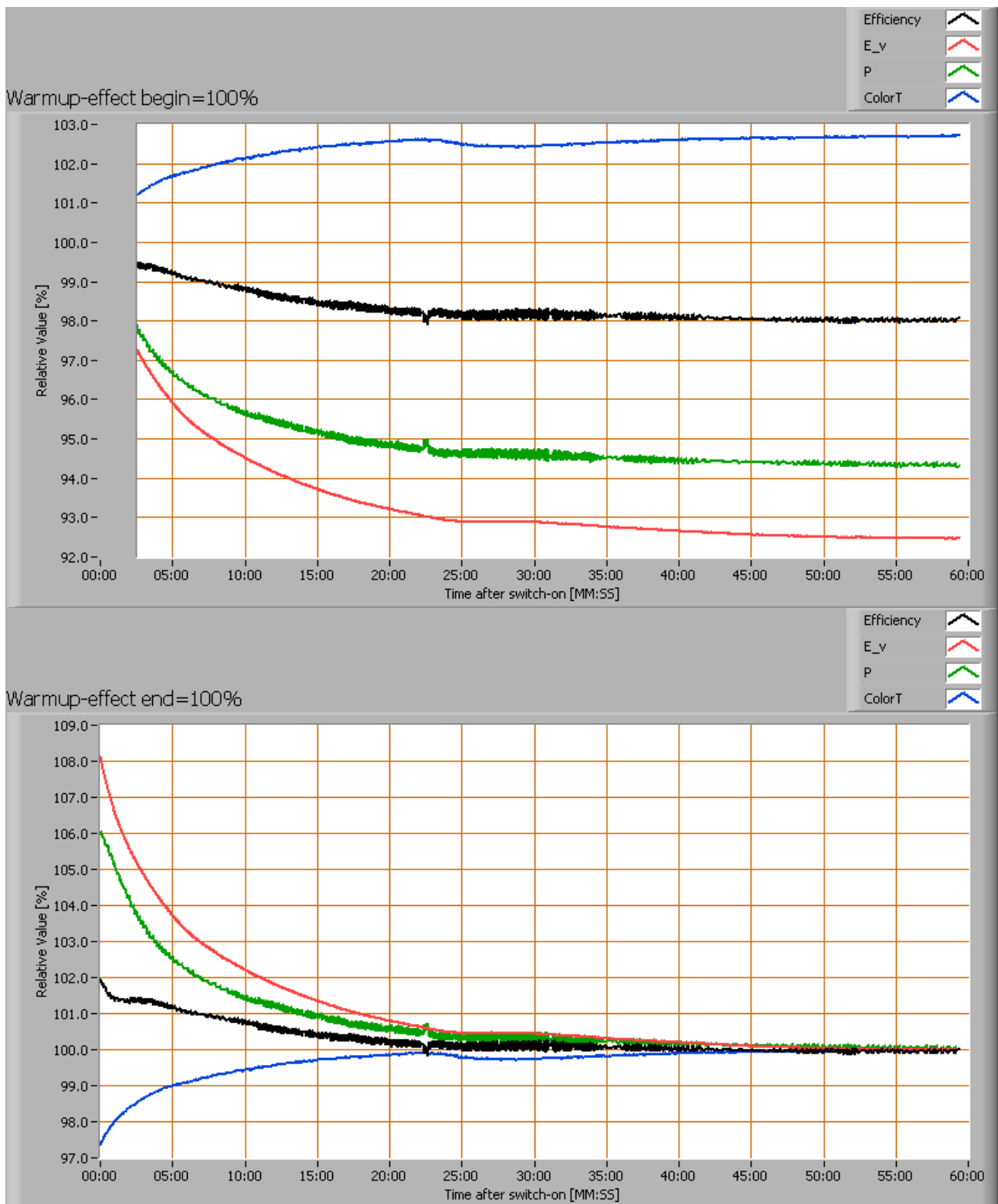
The illuminance and consumed power do not vary significantly when the voltage is varied.

When the voltage at 230 V varies with + and - 5 V, then the illuminance varies < 0.1 %, so when abrupt voltage changes occur this effect is not visible in the illuminance output.

Warm up effects

After switch on of a cold lamp, the effect of heating up of the lamp is measured on illuminance E_v [lx], color temperature CT or correlated color temperature CCT [K], the lamp power P [W] and the luminous efficacy [lm/W].

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Effect of warming up on different light bulb parameters. At top the 100 % level is put at begin, and at bottom at the end.



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The warm up time is about 20 minutes. During that time the illuminance decreases with $\approx 8\%$ and the consumed power with $\approx 6\%$.

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