

Lamp measurement report – 12 Dec 2009

Led Tube 150cm Led Acqua Tube by Oxxy Light

Photo courtesy by www.OliNo.org



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Summary measurement data

parameter	meas. result	remark
Color temperature	4406 K	neutral white
Luminous intensity I_v	769 Cd	Measured straight underneath the lamp
Beam angle	101 deg	101° for the C0-C180 plane (crosses the length direction of the tube), and 95° for C90-C270 plane (along the length direction of tube).
Power P	22.3 W	
Power Factor	0.78	For every 1 kWh net power consumed, there has been 0.8 kVAhr for reactive power.
Luminous flux	1908 Lm	
Luminous efficacy	86 Lm/W	
CRI_Ra	73	Color Rendering Index.
Coordinates chromaticity diagram	x=0.3625 and y=0.3577	
Fitting	FL-tube	This tube is directly connected to the mains voltage (230V).
PAR-value	6.9 $\mu\text{Mol/s/m}^2$	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.
S/P ratio	1.6	This factor indicates the amount of times more efficient the light of this light bulb is perceived under scotopic circumstances (ow environmental light level).
D x L external dimensions	37 x 1500 mm	External dimensions of the tube (D = diameter). Excluding the pins.




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L x W luminous area	1330 x 33 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 23.5-25 deg C.</p> <p>Warm up effect: during the warm up time the illuminance decreases with $\approx 14\%$ and the consumed power with $\approx 12\%$.</p> <p>Voltage dependency: the power consumption and illuminance do depend on the voltage when it is varied from 200 - 250 V.</p>

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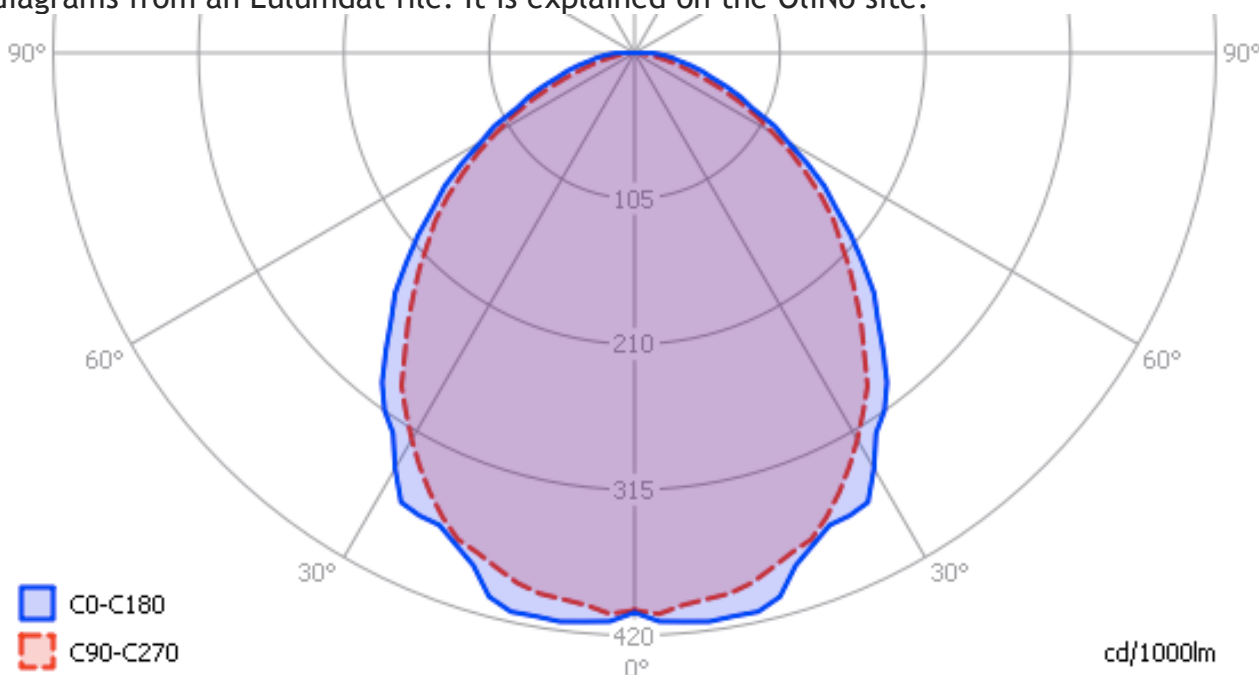
Overview table

m.	Ø 50%		C0-180: 101° C90-270: 95°	E (lux)	Luminaire Efficacy	
	C0-180	C90-270			86	(lumens per Watt)
0.25	0.6	0.55		12296	Half-peak diam C0-180	
0.5	1.2	1.1		3074	2.41 x diameter(m)	
1	2.41	2.2		769	Half-peak diam C90-270	
1.5	3.61	3.3		342	2.2 x diameter(m)	
3	7.22	6.6		85	Illuminance	
4	9.62	8.8		48	769 / distance ² (lux)	
5	12.03	11		31	Total Output	
					1908 (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, as the distances 0.25 - 5 m are in the near field of the tube; real measured lux values will be lower than here computed.

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.



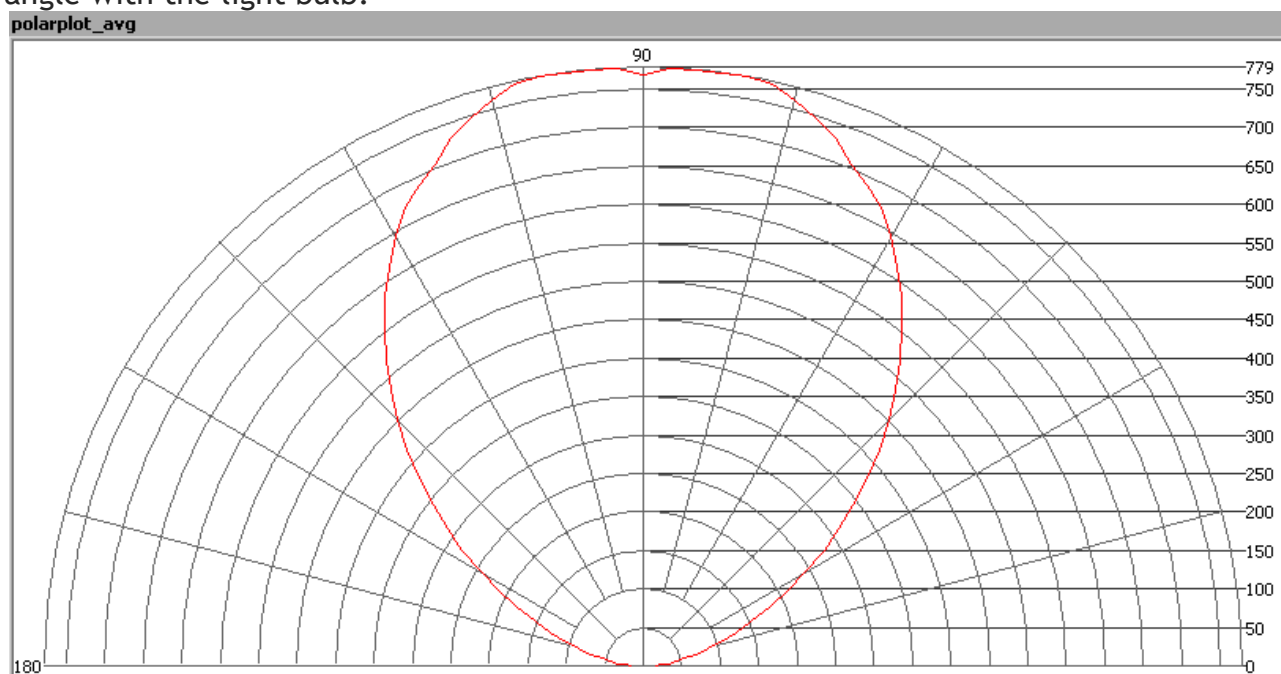
The light diagram giving the radiation pattern.

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It indicates the luminous intensity around the light bulb. In the length direction (C90-C270) the beam angle is almost 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.

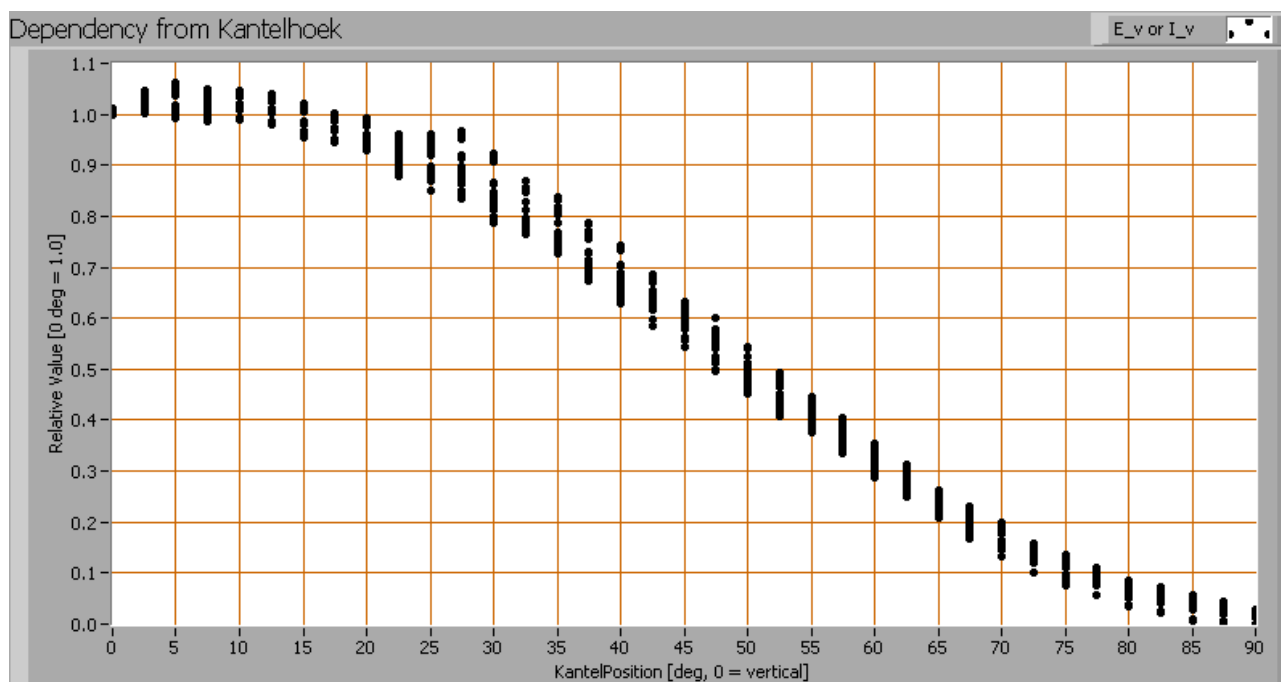


The radiation pattern of the light bulb.

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 95-101° 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 1908 Lm.

Luminous efficacy

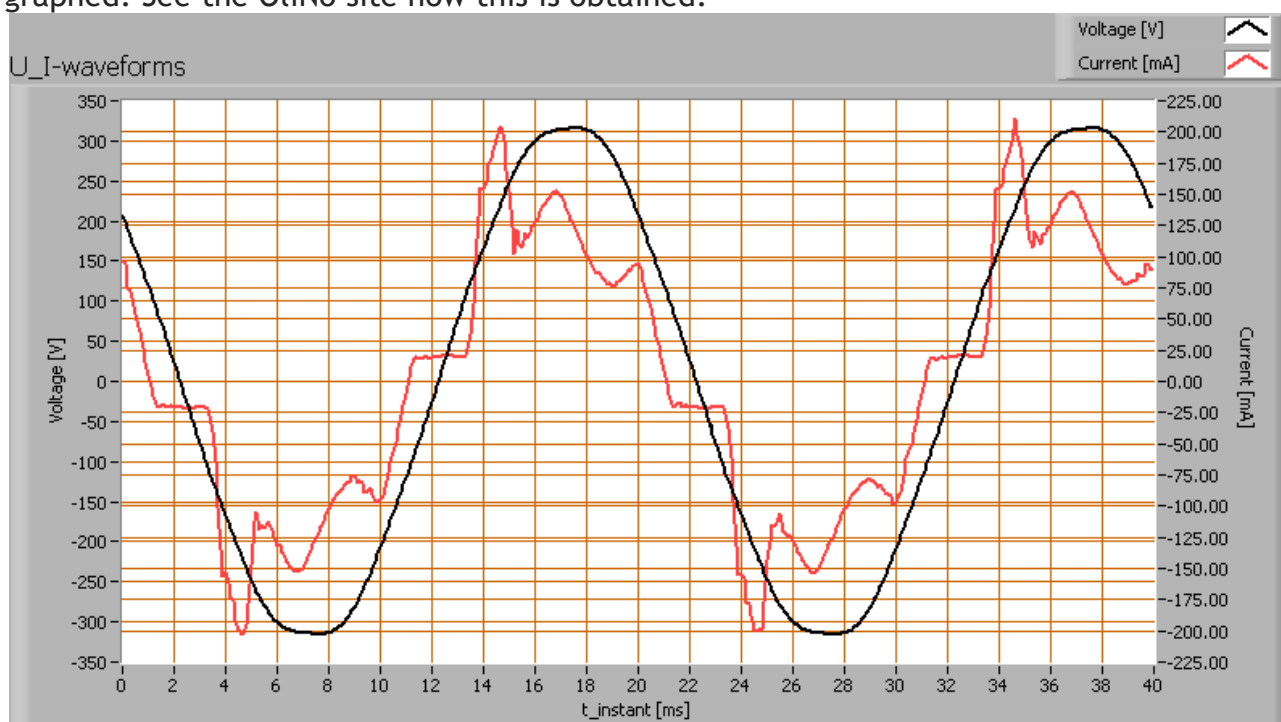
The luminous flux being 1908 Lm, and the power of the light bulb being 22.3 W, yields a luminous efficacy of 86 Lm/W.

A power factor of 0.78 means that for every 1 kWh net power consumed, a reactive component of 0.8 kVAr was needed.

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Light bulb voltage (used on power supply!)	230 VAC
Light bulb current	125 mA
Power P	22.3 W
Apparent power S	28.7 VA
Power factor	0.78

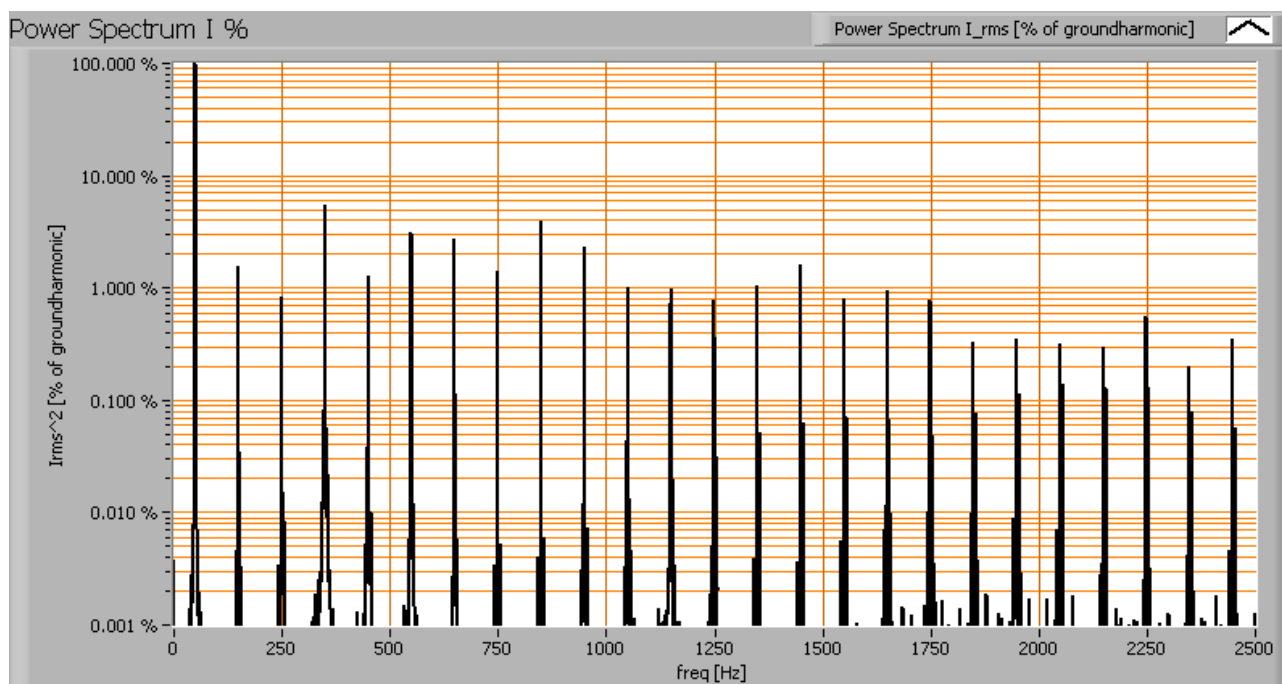
Of this light bulb the voltage across and the resulting current through it are measured and graphed. See the OliNo site how this is obtained.



Voltage across and current through the lightbulb

The current does not have a sine form, but tries to approach it. The phase of the current is leading a bit the phase of the voltage. The power factor is good, about 0.8. Also the power spectrum of the current is determined.

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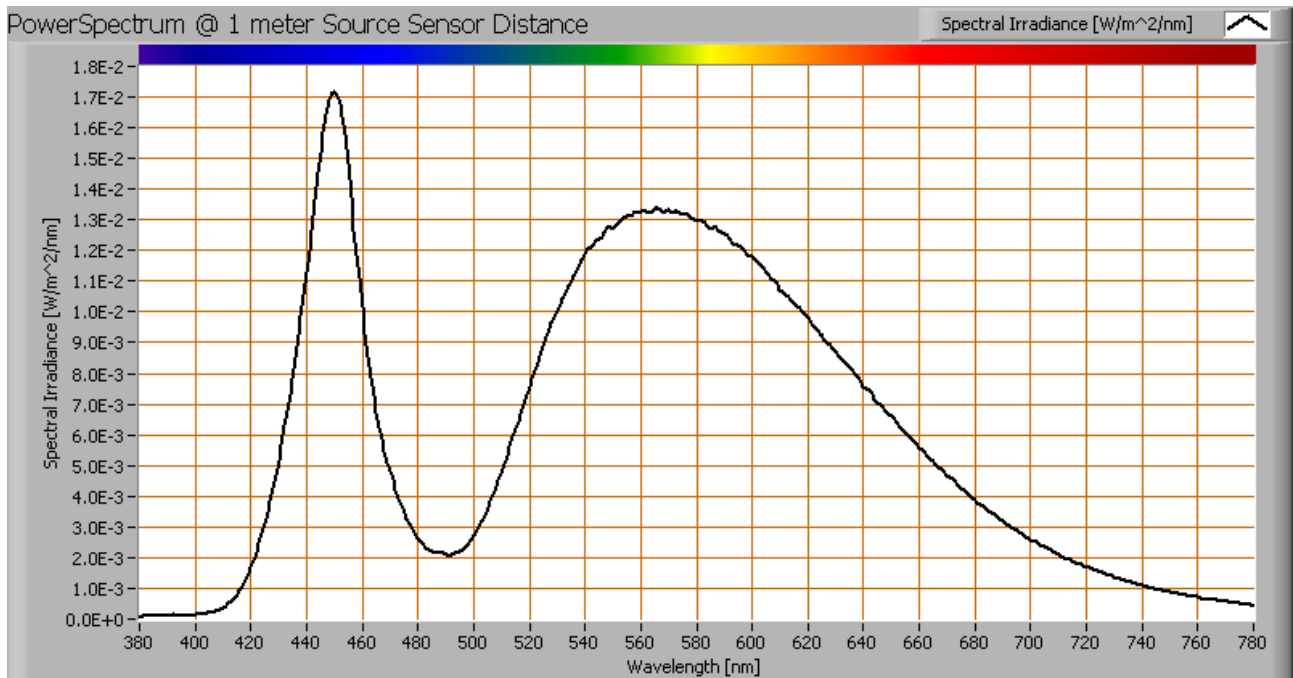
Squared amplitudes of higher harmonics related to the first harmonic (50 Hz).

Due to steep edges in the current, there are many higher harmonics.

The Total Harmonic Distortion of the current is 67 %.

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Color temperature and Spectral power distribution

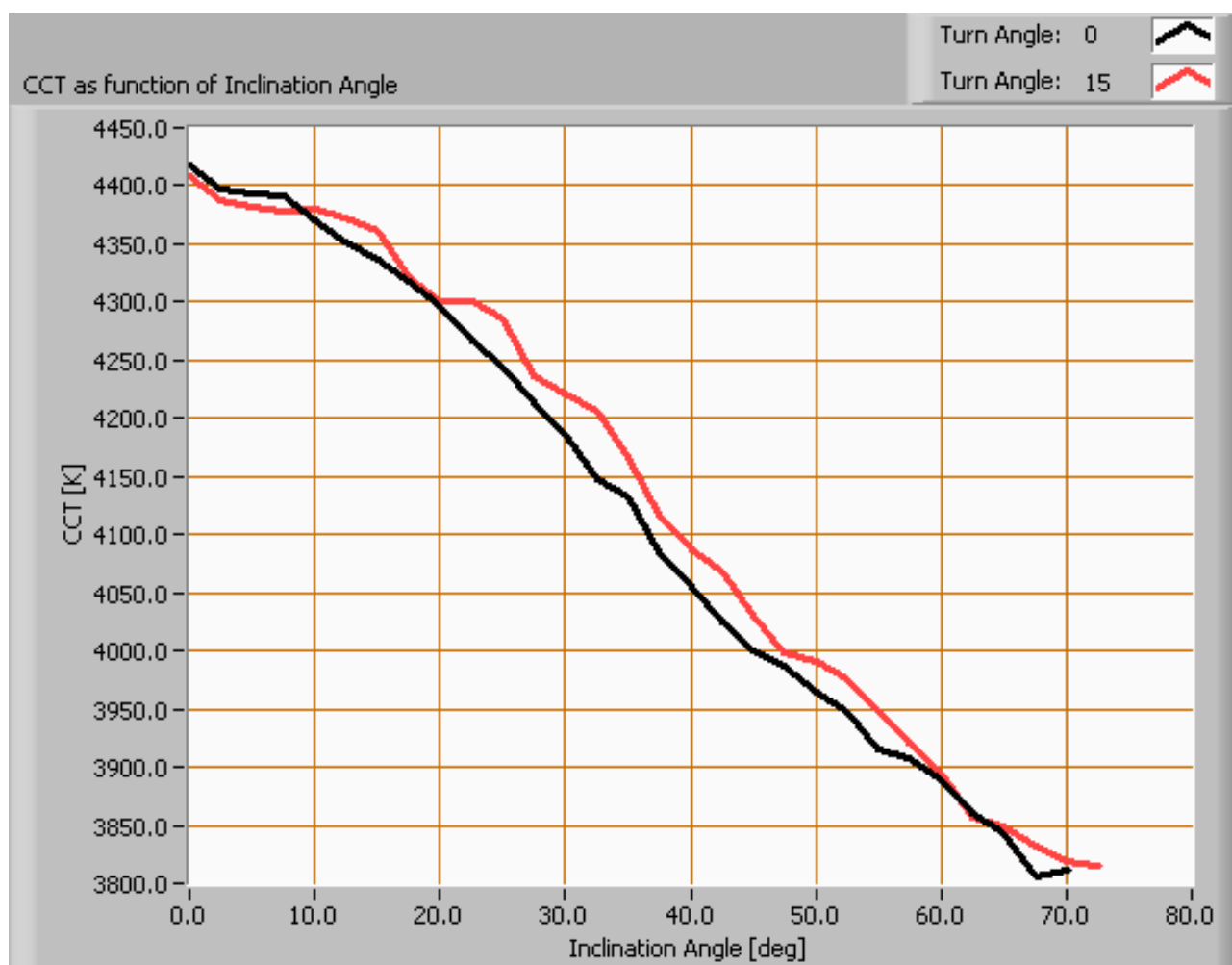


The spectral power distribution of this light bulb, energies on y-axis valid at 1 m distance.

The measured color temperature is about 4400 K which is neutral 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.

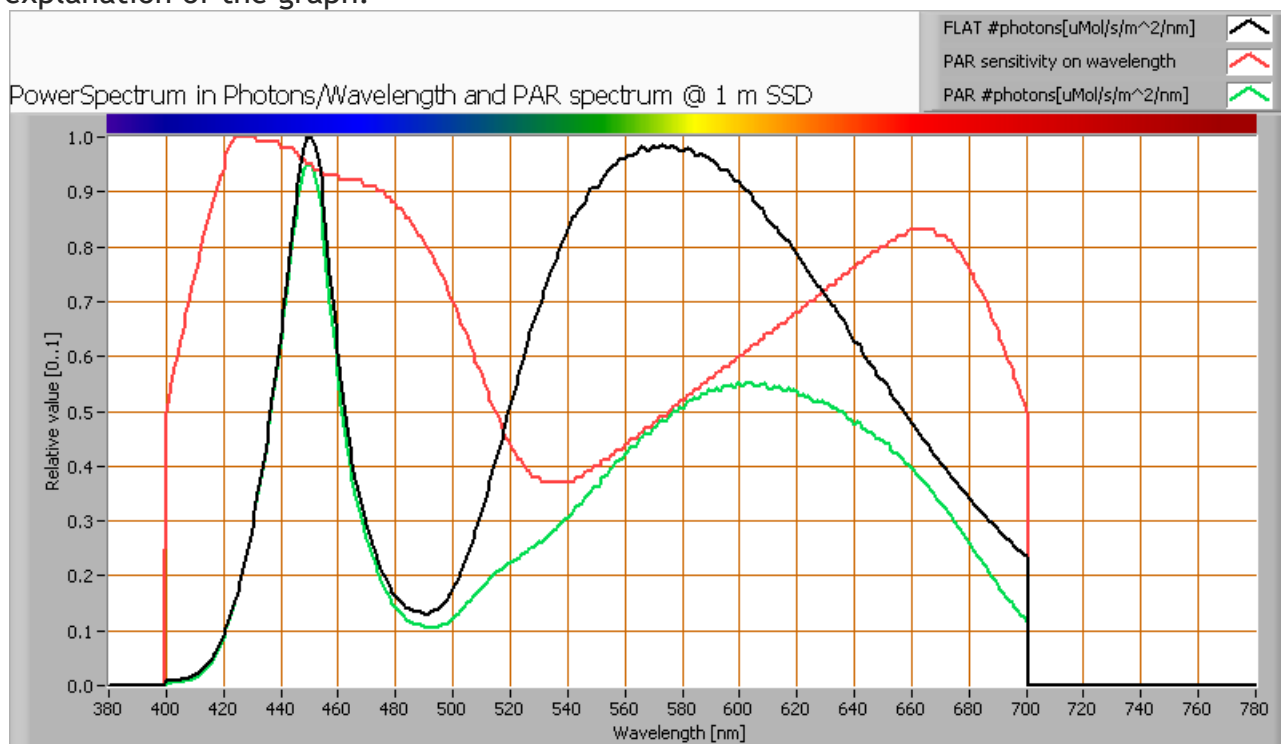
The measurement of CCT is measured for inclination angles up to 70° since then the illuminance value was decreased to very low values (< 5 lux).

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 10 %.

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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

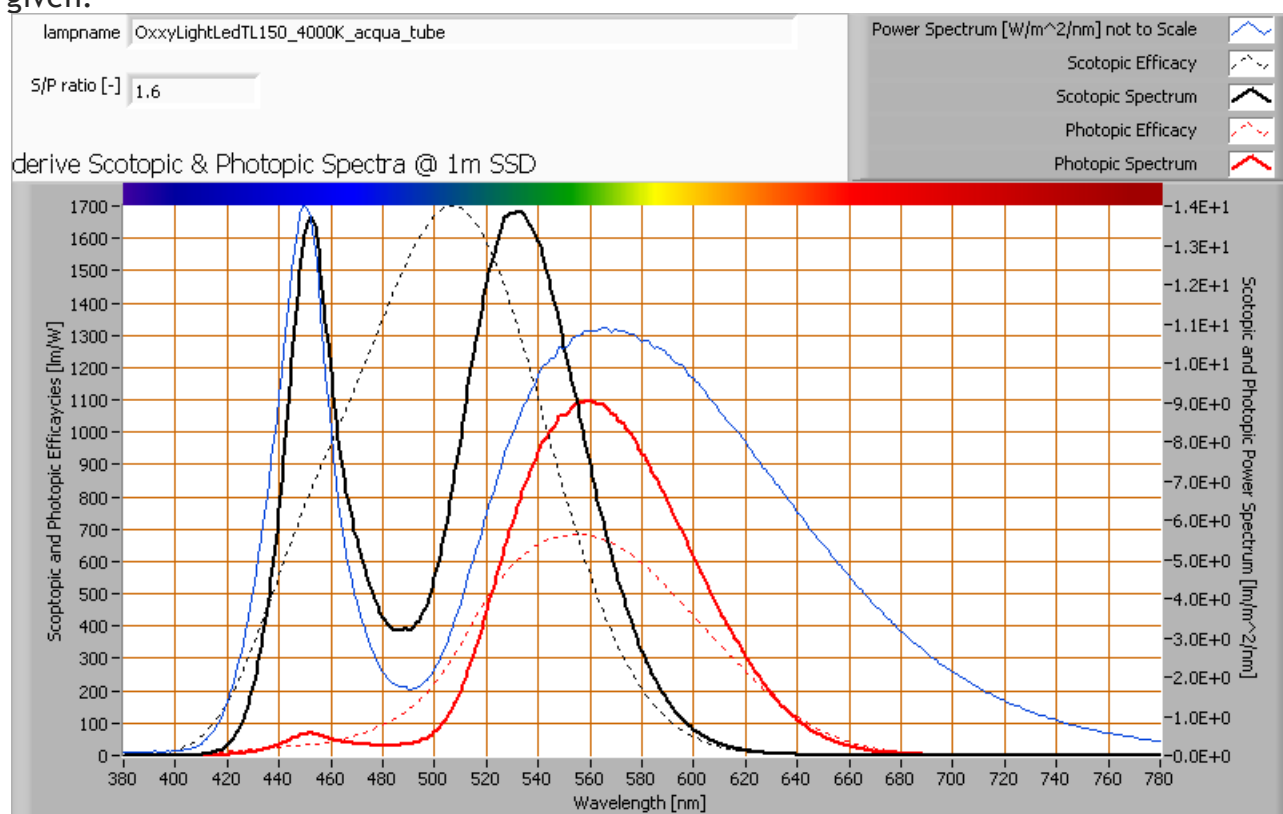
The PAR number for this light results in 6.9 $\mu\text{Mol/s/m}^2$. This value is valid at 1 m distance from the light bulb and valid roughly inside its beam angle.

The PAR efficiency is 65 % (valid for the PAR wave length range of 400 - 700 nm). So maximally 65 % 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.



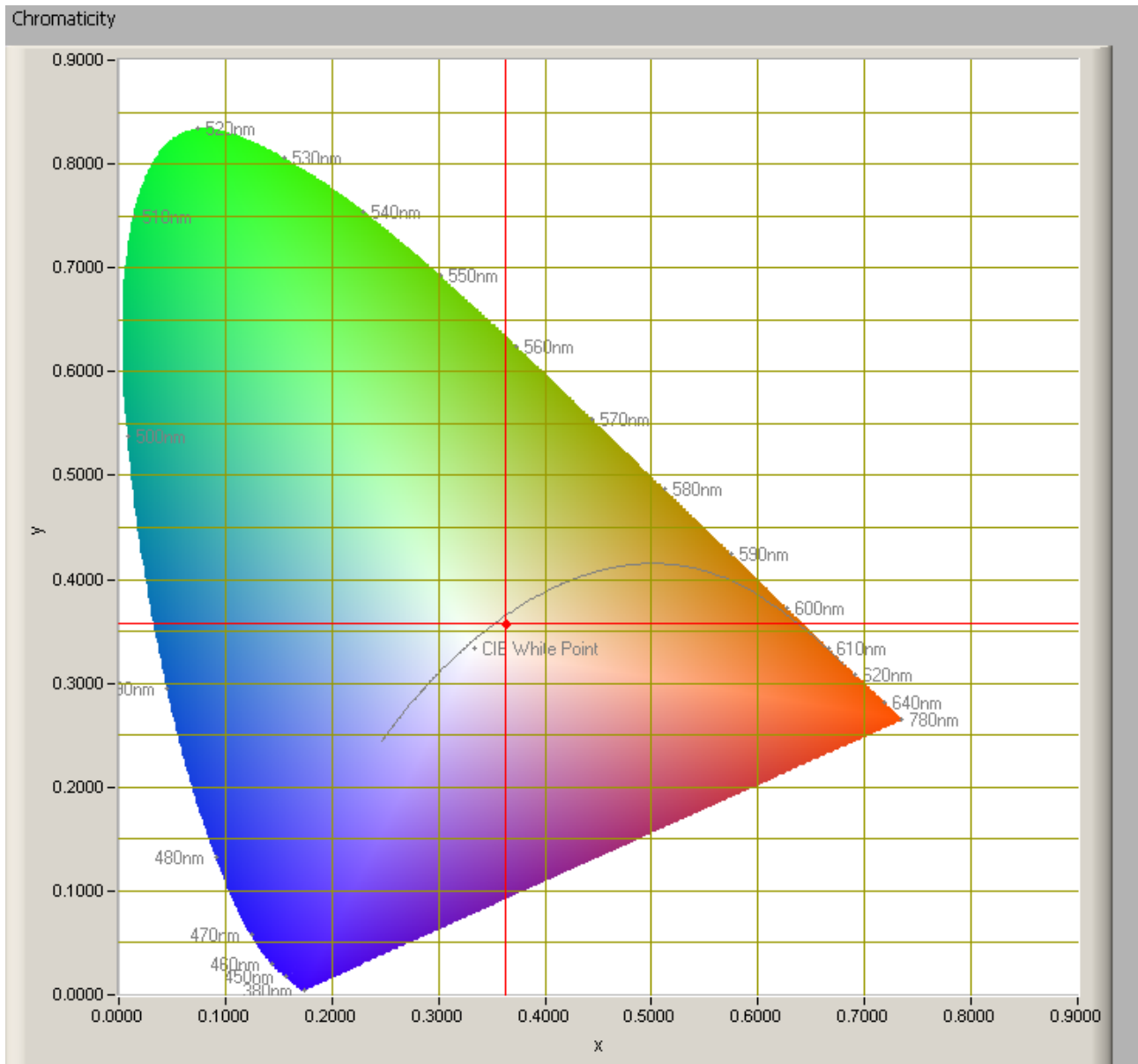
The power spectrum, sensitivity curves and resulting scotopic and photopic spectra (spectra energy content defined at 1 m distance).

The S/P ratio is 1.6

More info will come in a separate article.

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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 somewhat distant from the Planckian Locus (the black path in the graph).

Its coordinates are $x=0.3625$ and $y=0.3577$.

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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

4406

 K

Chromaticity Difference DC=

3.5E-3

R1= 70.9		R8= 62.3		R_a (mean value of R1 - R8) <div>72.5</div>
R2= 77.9		R9= -6.3		
R3= 79		R10= 43.5		
R4= 71.1		R11= 63		
R5= 69.5		R12= 37.4		
R6= 66		R13= 71.5		
R7= 82.8		R14= 87.5		

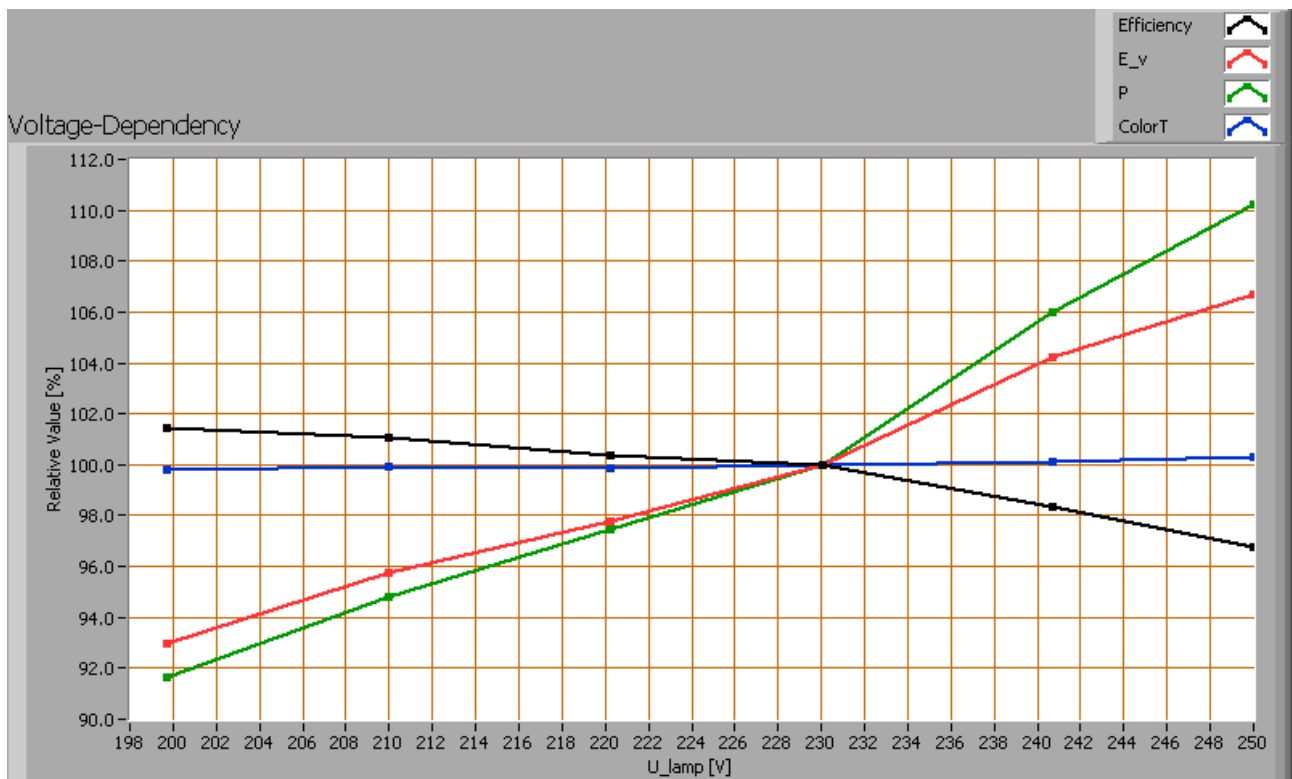
CRI of the light of this lightbulb.

The value of 73 is lower than 80 which is considered a minimum value for indoor usage. Note: the chromaticity difference is 0.0035 indicates the distance to the Planckian Locus. Its value is lower than 0.0054, which means that the calculated CRI result is 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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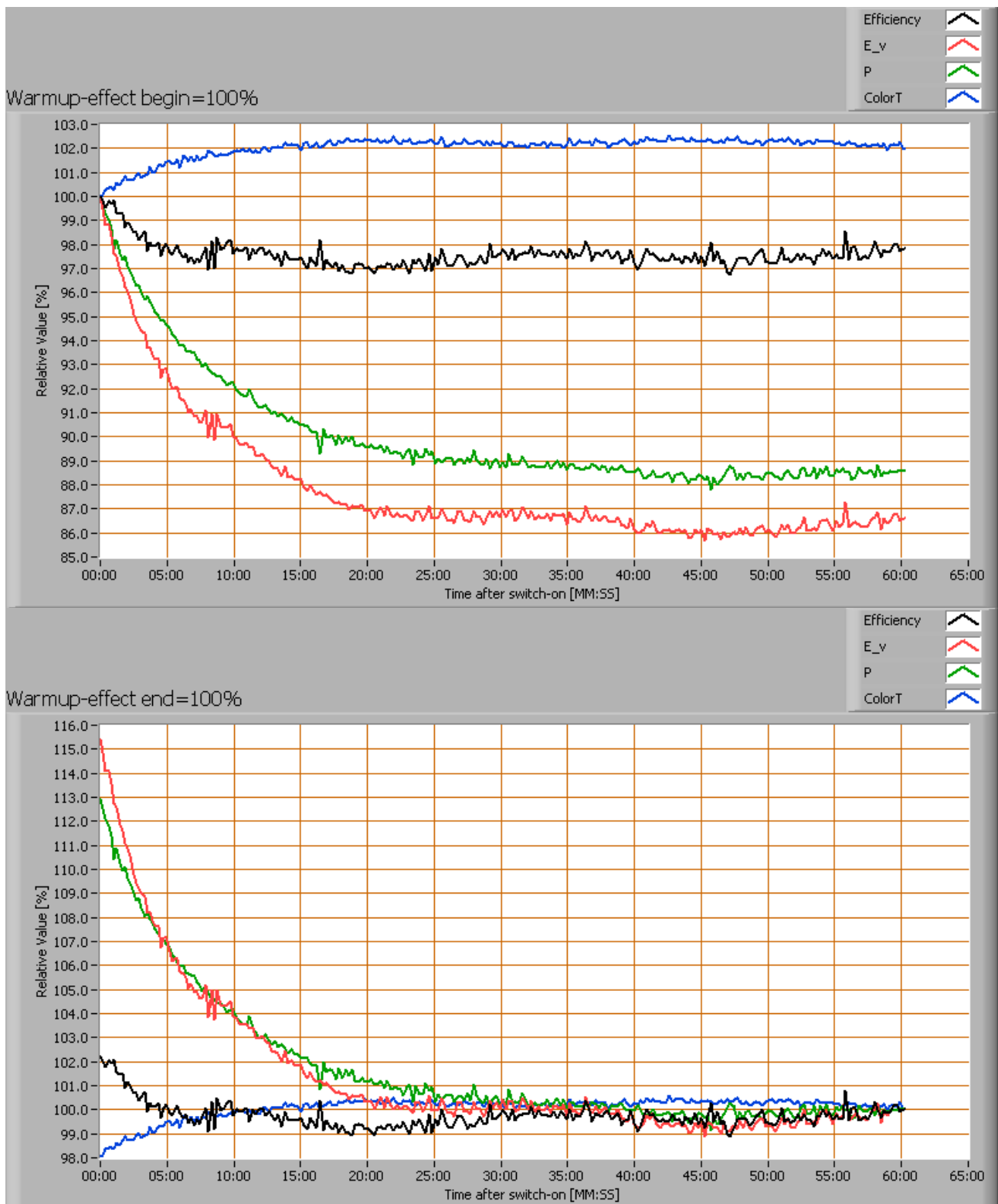
Lamp voltage dependencies of certain light bulb parameters, where the value at 230 V is taken as 100 %.

The illuminance and consumed power do vary linearly when the voltage is varied. When the voltage at 230 V varies with + and - 5 V, then the illuminance varies $\approx 2\%$, 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 $\approx 14\%$ and the consumed power with $\approx 12\%$.

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