

Lamp measurement report – 2 Feb 2010

Led 12V 3W Spot Light GU5.3

by

Tuono Lighting



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Summary measurement data

parameter	meas. result	remark
Color temperature	2827 K	Warm white
Luminous intensity I_v	479 Cd	Measured straight underneath the lamp
Beam angle	29 deg	29° for the all C planes as the light bulb is symmetrical over its height axis.
Power P	3.0 W	Follow the link for more electrical and temperature properties.
Power Factor	0.69	For every 1 kWh net power consumed, there has been 1.0 kVAhr for reactive power.
Luminous flux	136 Lm	
Luminous efficacy	45 Lm/W	This result is valid for direct 12 V AC power, so without transformer.
CRI_Ra	80	Color Rendering Index.
Coordinates chromaticity diagram	x=0.4503 and y=0.4089	
Fitting	GU5.3/MR16	
PAR-value	4.6 $\mu\text{Mol/s/m}^2$	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	1.2	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 H external dimensions	50 x 43 mm	External dimensions of the lamp (D = diameter, H = Height without pins).
D luminous area	31 mm	Dimensions of the luminous area (used in Eulumdat file). This is equal to the surface of area of the transparent front behind which are the leds.




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General remarks		<p>The ambient temperature during the whole set of measurements was 23.5-25.5 deg C. The heat sink of the light bulb gets about 33 degrees hotter than ambient.</p> <p>Warm up effect: during the warm up time the illuminance decreases 6 % and the consumed power 4 %.</p> <p>Voltage dependency: the power consumption and illuminance do not vary significantly when the voltage is varied.</p>

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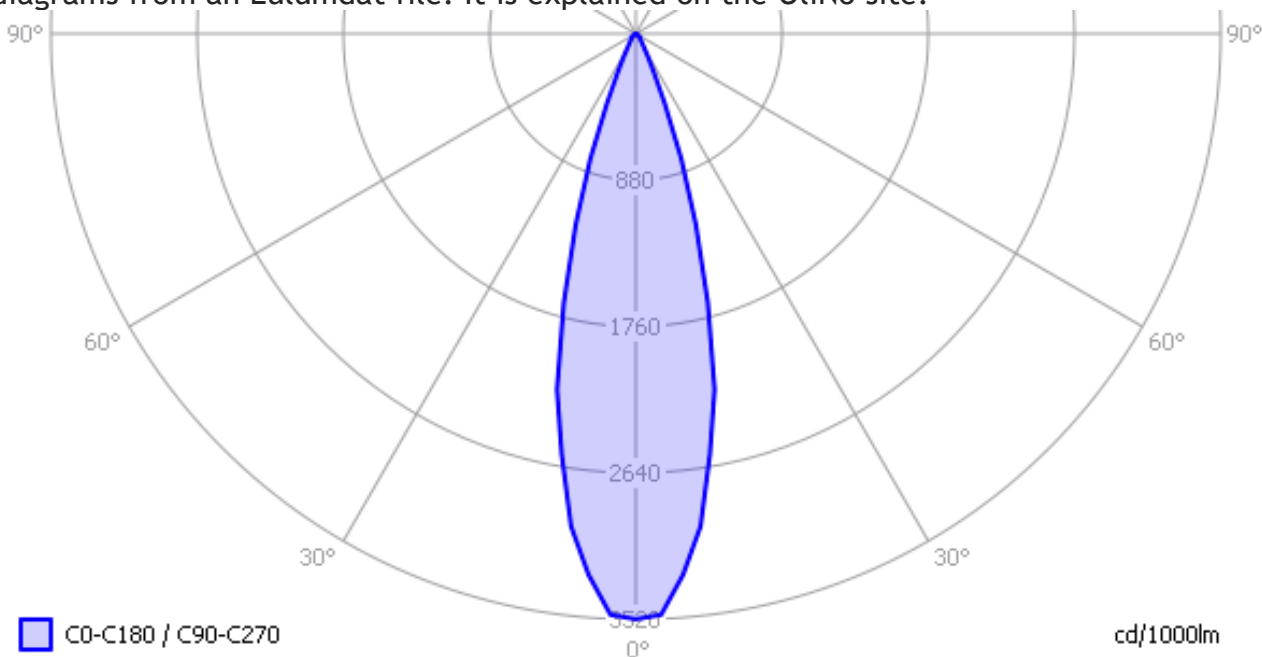
Overview table

m.	Ø 50%		CO-180: 29° C90-270: 29°	E (lux)	Luminaire Efficacy
	CO-180	C90-270			44 (lumens per Watt)
0.25	0.13	0.13		7661	Half-peak diam CO-180
0.5	0.26	0.26		1915	0.52 x diameter(m)
1	0.52	0.52		479	Half-peak diam C90-270
1.5	0.78	0.78		213	0.52 x diameter(m)
3	1.56	1.56		53	Illuminance
4	2.08	2.08		30	479 / distance ² (lux)
5	2.6	2.6		19	Total Output
					136 (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 31 mm ≈ 150 mm. Within this distance from the lamp, the measured lux values will be less than the computed values in this overview as the measurements are then within the near field of the lamp.

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.



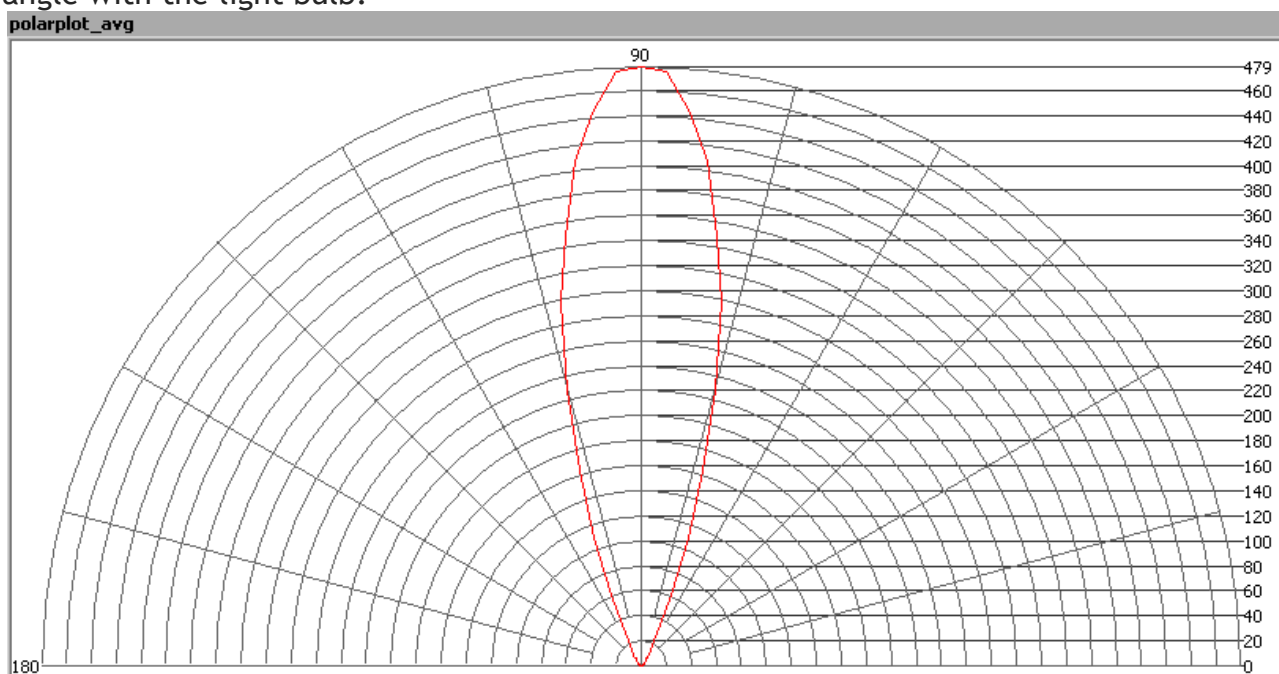
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The light diagram giving the radiation pattern.

It indicates the luminous intensity around the light bulb. All C-planes have the same pattern.

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.

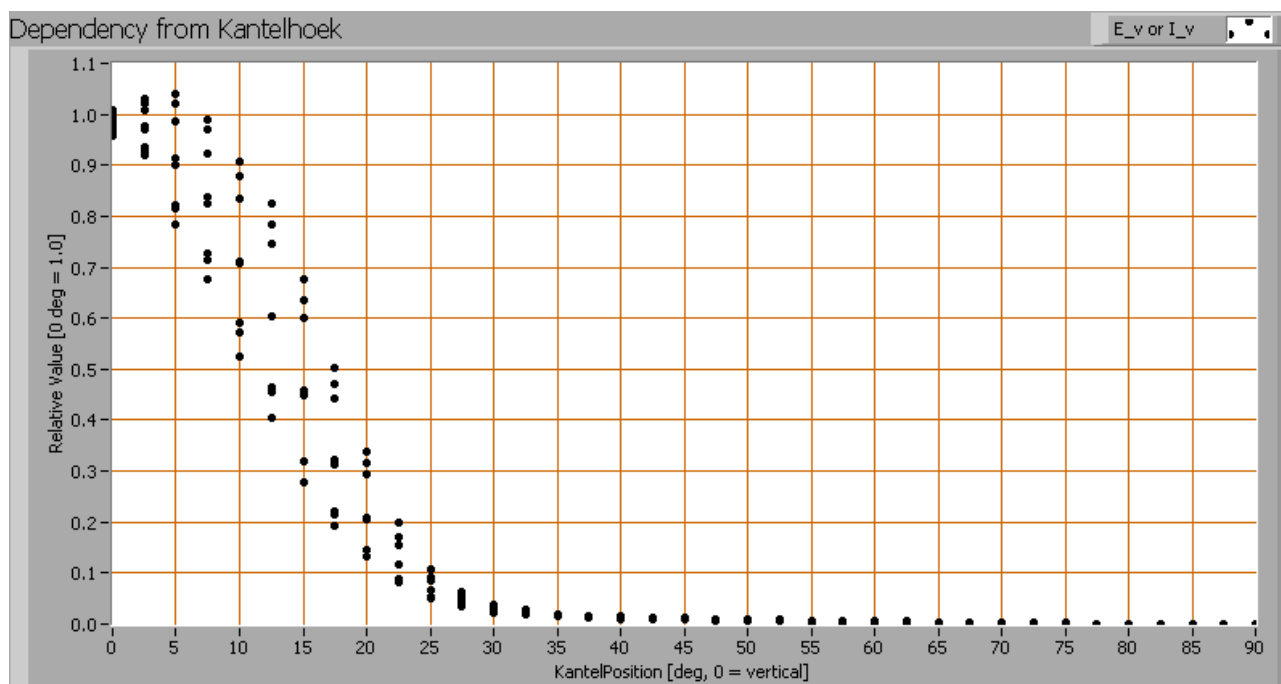


The radiation pattern of the light bulb.

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 29°.

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 136 Lm.

Luminous efficacy

The luminous flux being 136 Lm, and the power of the light bulb being 3.0 W, yields a luminous efficacy of 45 Lm/W.

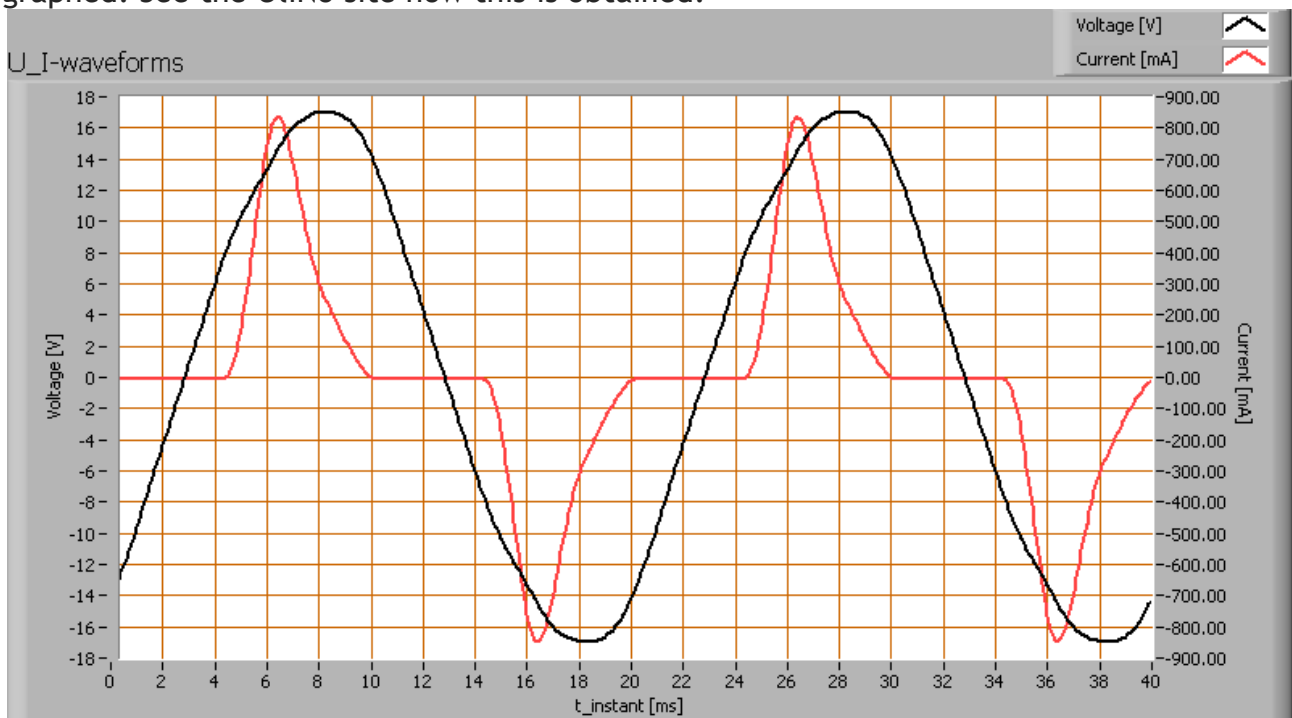
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Electrical properties

A power factor of 0.69 means that for every 1 kWh net power consumed, a reactive component of 1.0 kVAr was needed.

Lamp voltage	12.0 VAC
Lamp current	368 mA
Power P	3.0 W
Apparent power S	4.4 VA
Power factor	0.69

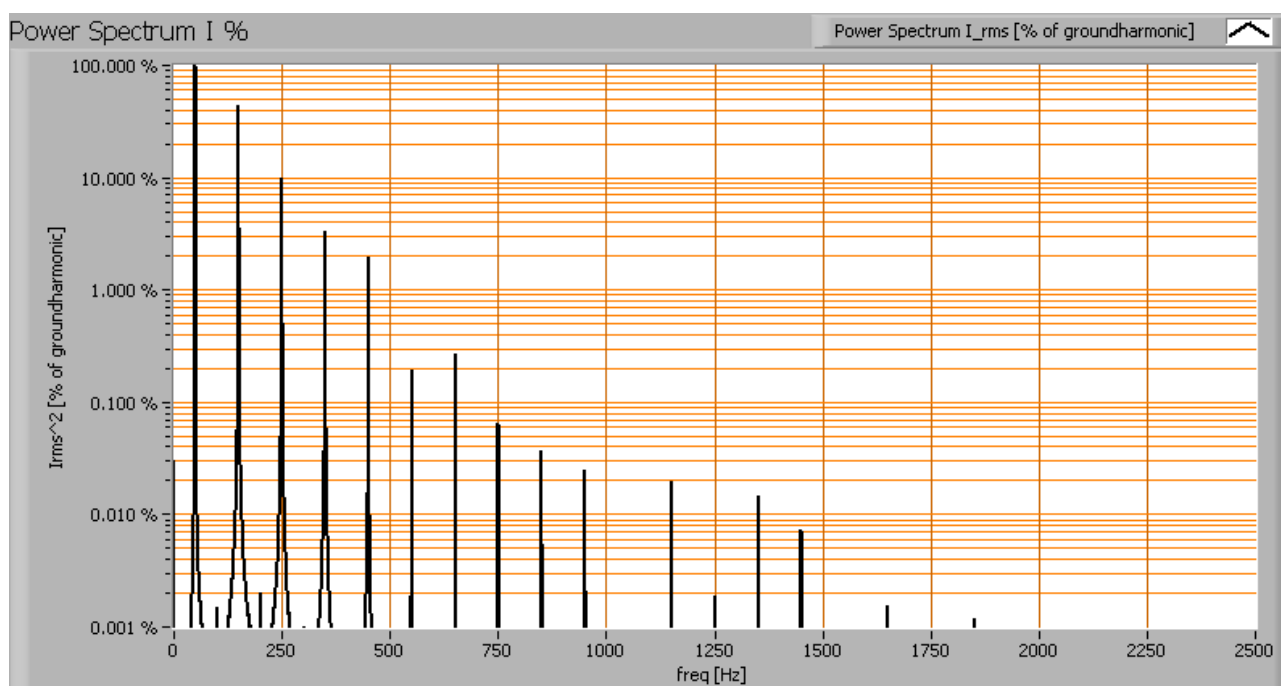
Of this light bulb the voltage across and the resulting current through it are measured and graphed. See the OLiNo site how this is obtained.



Voltage across and current through the lightbulb

Also the powerspectrum has been recorded.

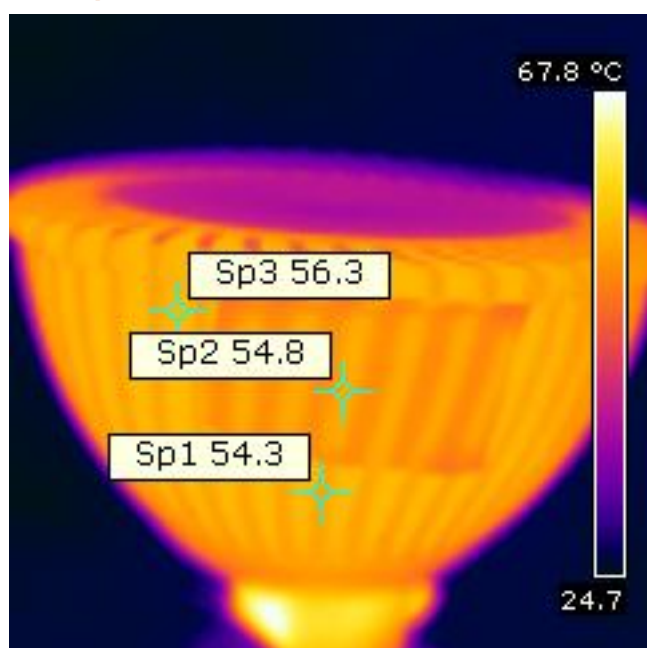
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The current power spectrum, with the squared harmonics (in % of the 1st harmonic at 50 Hz)

The Total Harmonic Distortion of the current is computed as 88 %.

Temperature measurements lamp



Temperature image of the light bulb



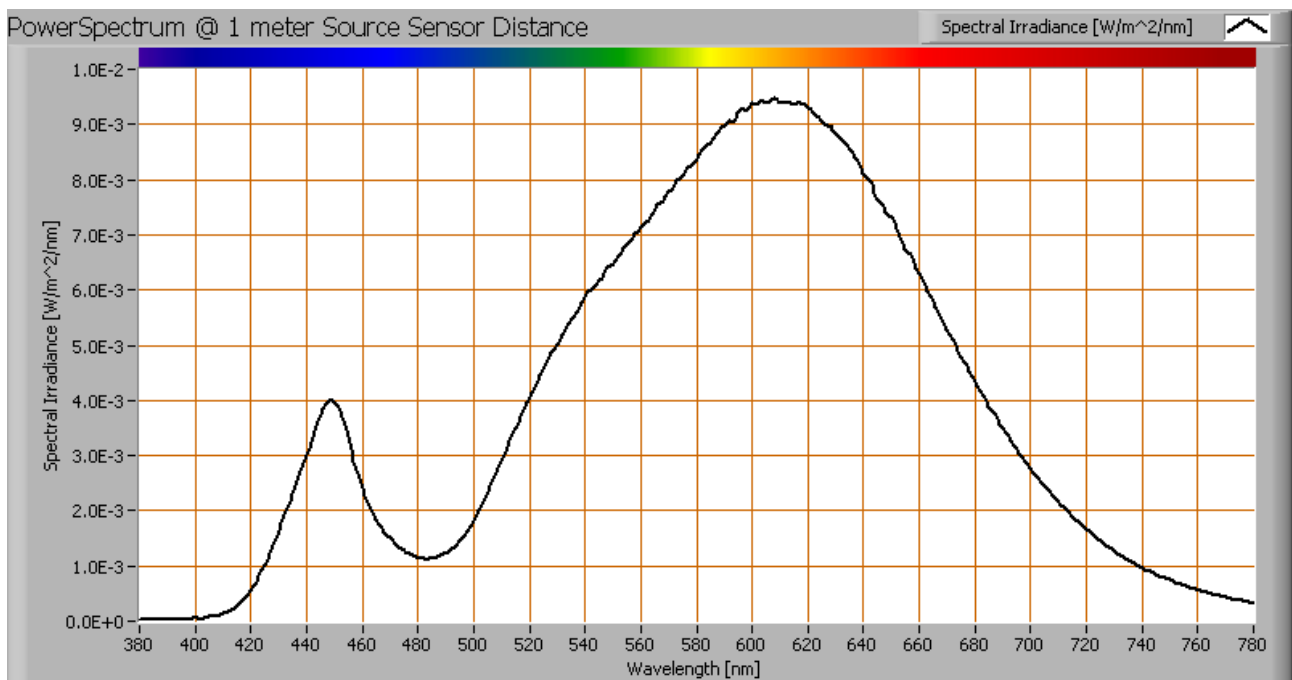
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Tape is put on the heat sink, to record the temperature of the blades. Then also the temperature is measured between the blades. This is done directly as it is assumed that the emissivity of the area between two blades is around 0.95. This assumption is made since the depth of the space between the ribs is about 5x longer than the width between the ribs and as a rule of thumb one can then assume a high emissivity.

status lamp	> 2 hours on
ambient temperature	22 deg C
reflected background temperature	22 deg C
camera	Flir B-CAM Western S
emissivity	0.95 ⁽¹⁾
measurement distance	0.20 m
IFOV _{geometric}	0.7 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 temperature on its heat sink gets to about 56 deg C.

Color temperature and Spectral power distribution

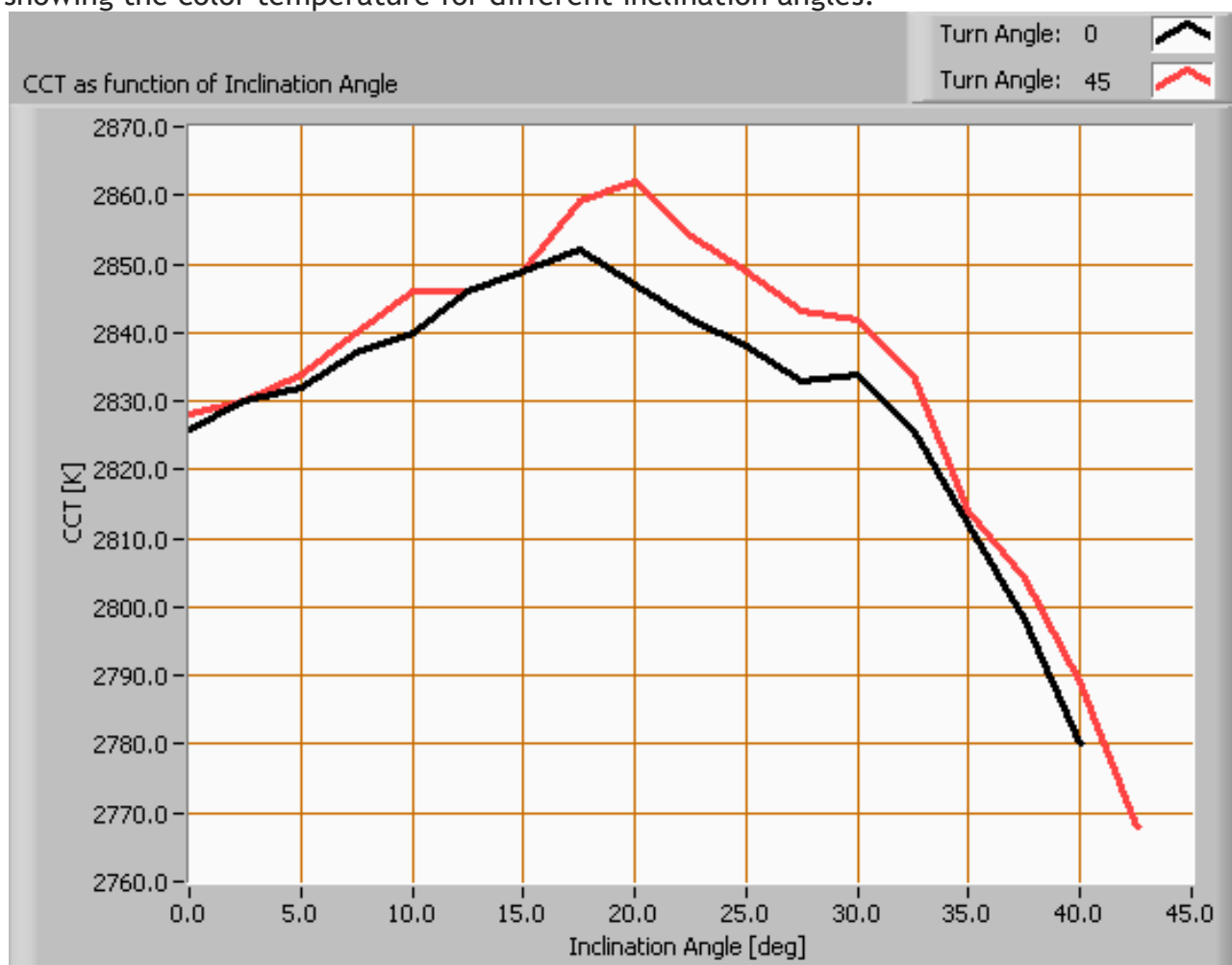


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The spectral power distribution of this light bulb, energies on y-axis valid at 1 m distance.

The measured color temperature is about 2825 K which is warm white.

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



Color temperature as a function of inclination angle.

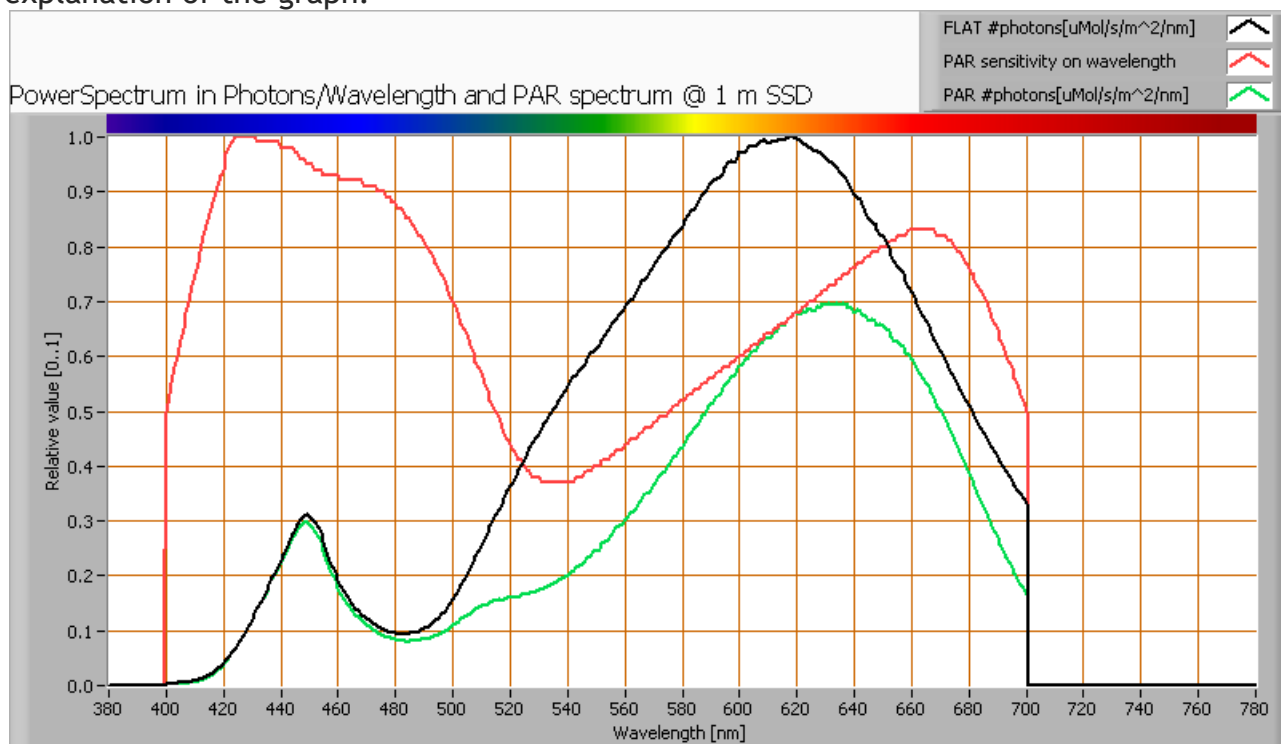
The measurement of CCT is measured for inclination angles up to 40° since then the illuminance value was decreased to very low values (< 5 lux).

The beam angle is 29°, meaning a 14.5° inclination angle. In this area the majority of the light is present. The variation in correlated color temperature in this area is $\approx 1\%$.

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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

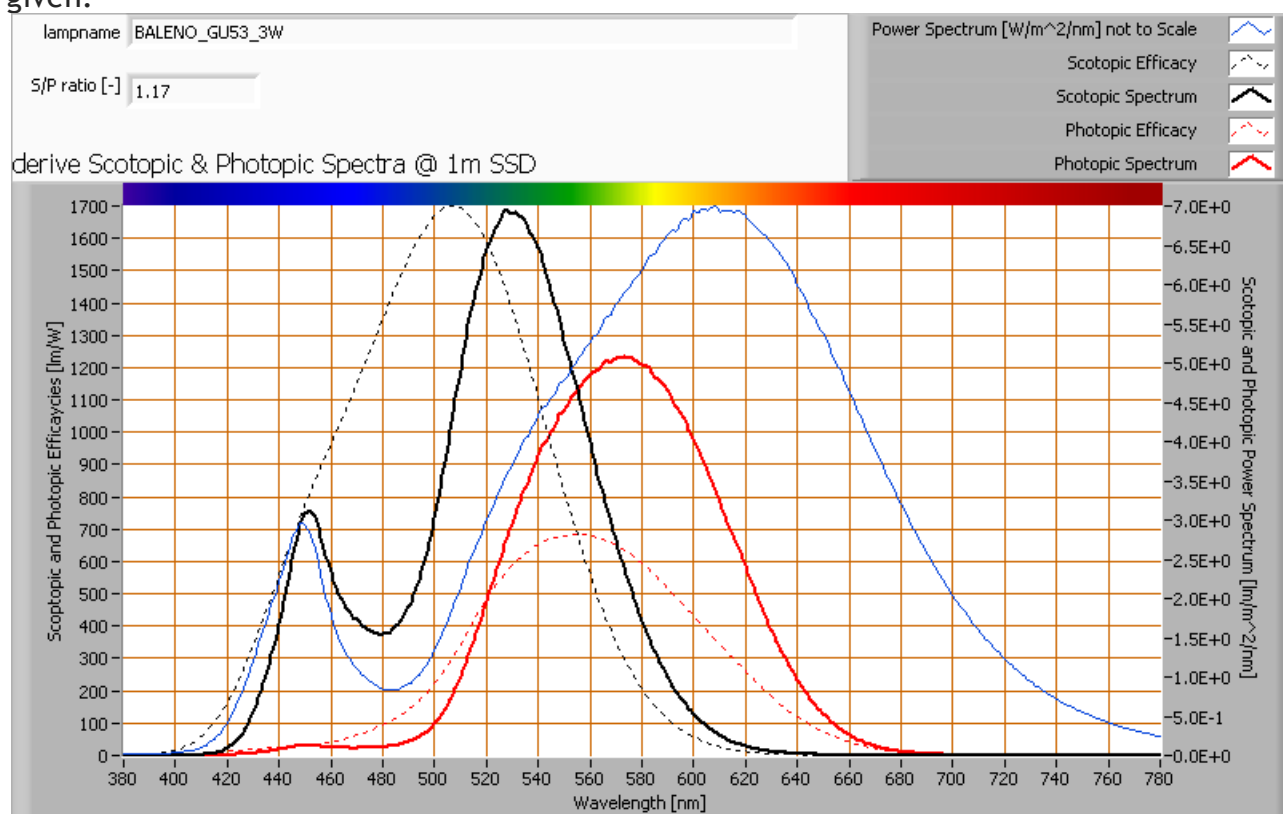
parameter	value	unit
PAR-number	4.6	μMol/s/m ²

The PAR efficiency is 64 % (valid for the PAR wave length range of 400 - 700 nm). So maximally 64 % 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.



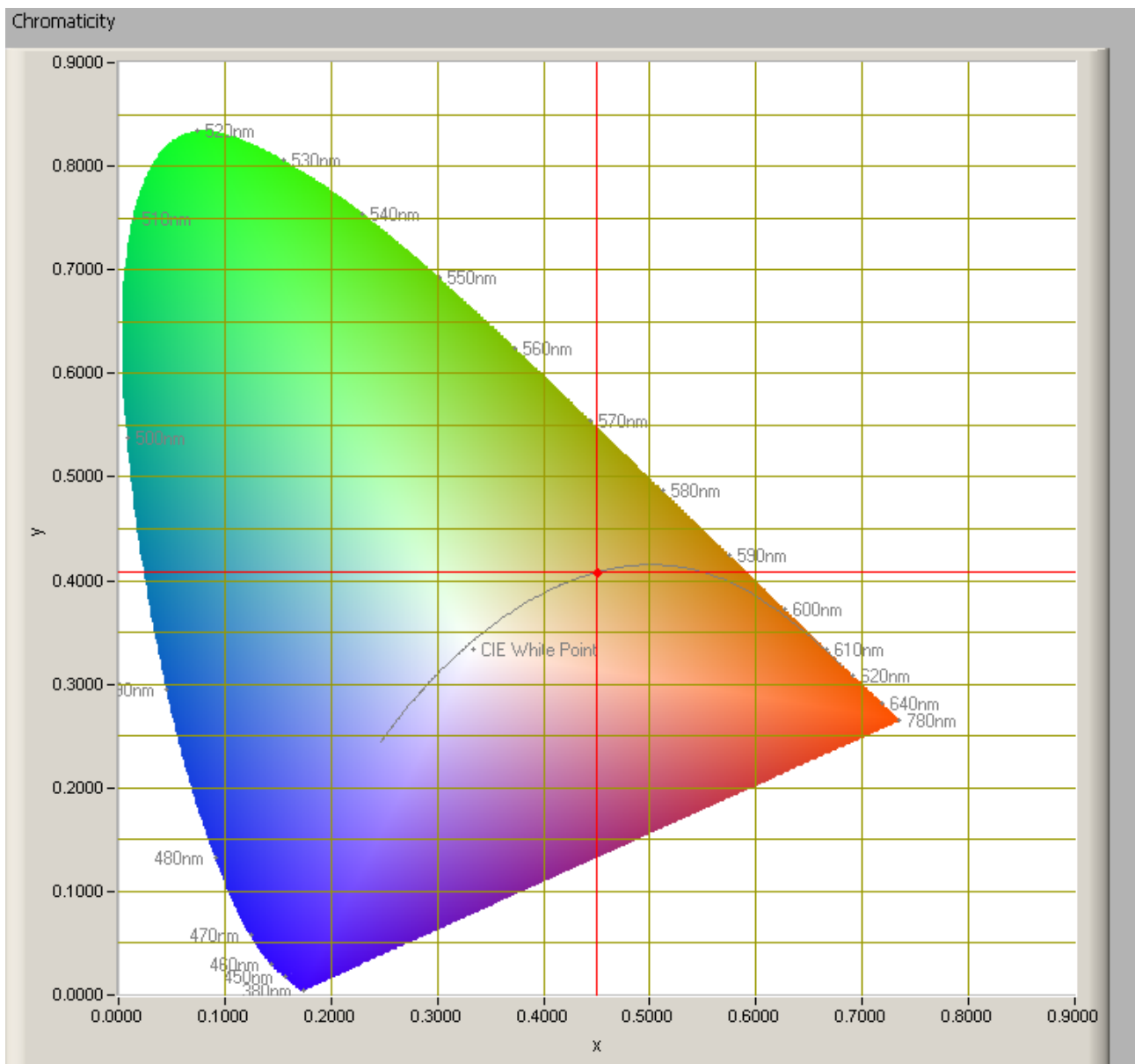
The power spectrum, sensitivity curves and resulting scotopic and photopic spectra (spectra energy content defined at 1 m distance).

The S/P ratio is 1.2.

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 on top of the Planckian Locus (the black path in the graph).

Its coordinates are $x=0.4503$ and $y=0.4089$.

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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 Rx, and the first 8 indexes (R1 .. R8) are averaged to compute the Ra which is equivalent to the CRI.

☐ manual

Reference Illuminant: Planckian radiator CCT: 2827 K

Chromaticity Difference DC= 2.7E-4

R1= 78.9		R8= 65.6	
R2= 85.7		R9= 20.3	
R3= 90.1		R10= 65.2	
R4= 79.1		R11= 74.6	
R5= 77.2		R12= 57.9	
R6= 79.4		R13= 79.7	
R7= 86.2		R14= 93.5	

Ra
(mean value of R1 - R8)
80.3

CRI of the light of this lightbulb.

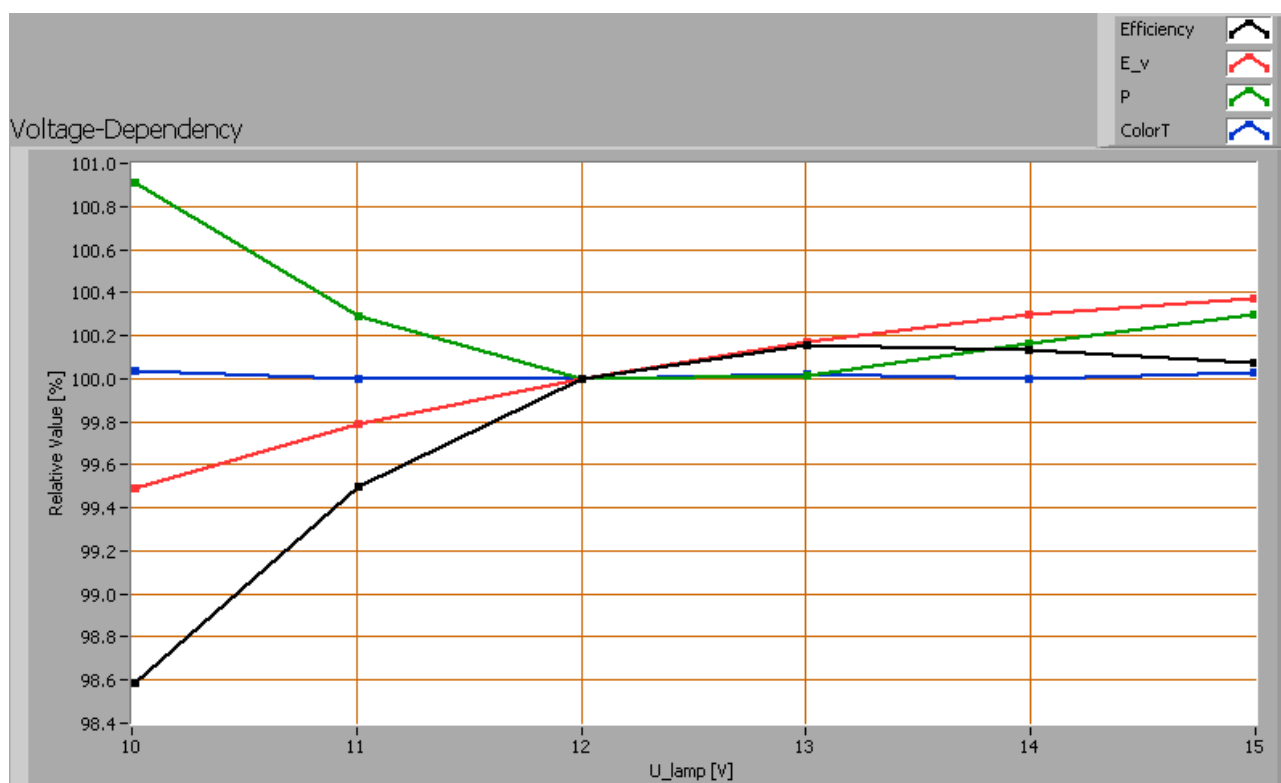
The value of 80 is the same as 80 which is considered a minimum value for indoor usage.

Note: the chromaticity difference is 0.0003 indicates the distance to the Planckian Locus. There is no norm yet that states what the max deviation from white light is allowed to be.

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 12 V is taken as 100 %.

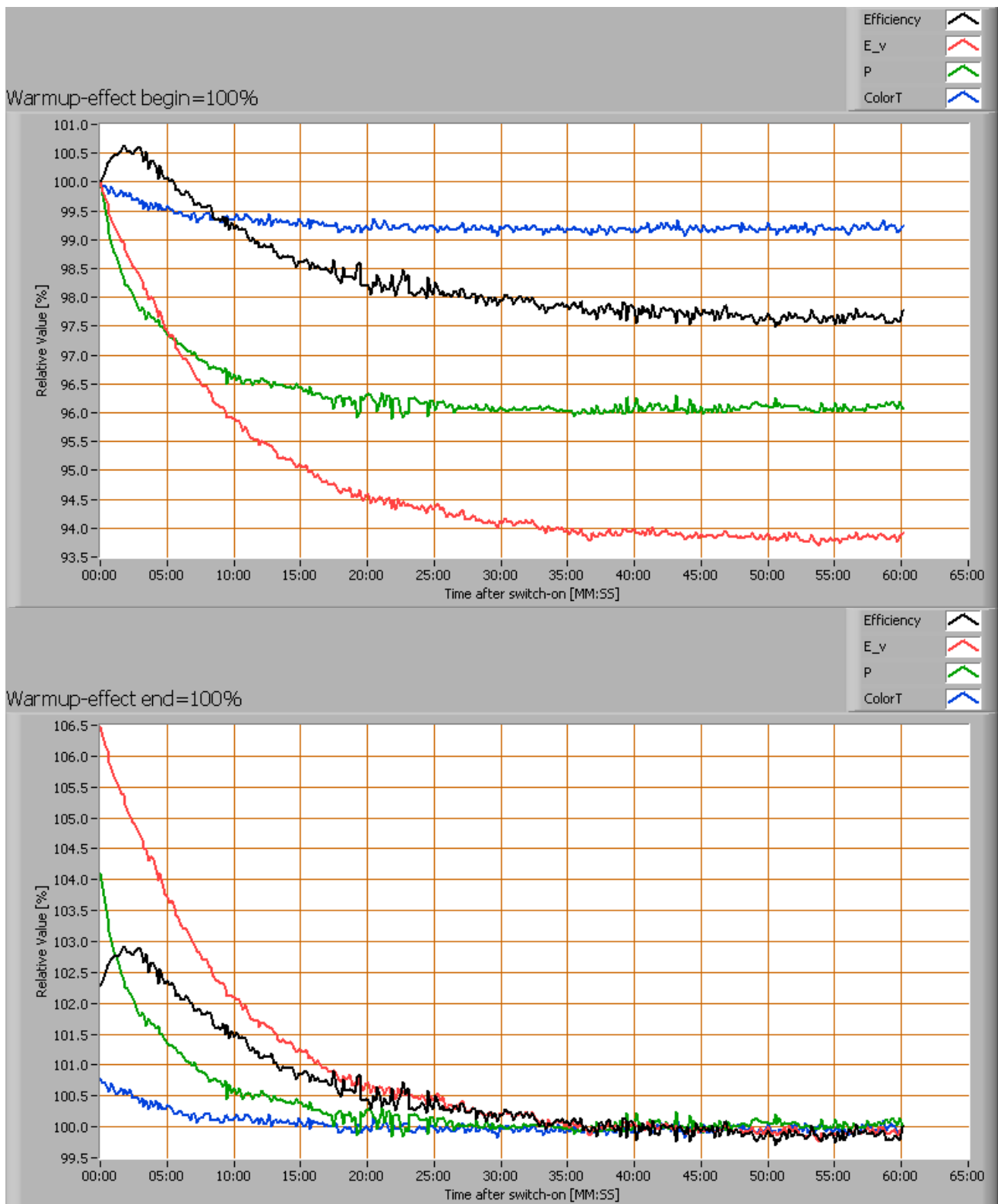
The illuminance and consumed power do not vary significantly when the voltage is varied widely.

When the voltage at 12 V varies with + and - 0.25 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 35 minutes. During that time the illuminance decreases with 6 % and the consumed power with 4 %.

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