Lamp measurement report – 19 March 2010

GT60/4100

by

GreenTubes

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Summary measurement data

parameter	meas. result	remark
Color temperature	4145 K	Neutral white
Luminous intensity I_v	200 Cd	Measured straight underneath the lamp.
Illumination modulation index	24 %	Measured straight underneath the lamp. Is a measure for the amount of flickering.
Beam angle	141 deg	141° for the C0-C180 plane (crossing length direction of the tube) and 106° for the C90-C270 plane (length direction). This is virtually the same value.
Power P	11.8 W	
Power Factor	0.90	For every 1 kWh net power consumed, there has been 0.5 kVAhr for reactive power.
THD	11 %	Total Harmonic Distortion
Luminous flux	725 Lm	
Luminous efficacy	61 Lm/W	
CRI_Ra	83	Color Rendering Index.
Coordinates chromaticity diagram	x=0.3777 and y=0.3871	
Fitting	FL-tube	This Tube Light is connected directly to the 230 V grid voltage.
PAR-value	1.6 µMol/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	0.5 µMol/s/W_e	The toal emitted number of photons by this light, divided by its consumption in W. It indicates a kind of efficacy in generating photons.

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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).
L x D external dimensions	586 x 32 mm	External dimensions of the lamp (L = length, without the pins).
L x W x H luminous area	495 x 30 x 7 mm	Dimensions of the luminous area (used in Eulumdat file). The height is equal to the surface of the T5 tube coming above the reflector. The width and the length is equal to the width and length of the frontal opening of the reflector.
General remarks		The ambient temperature during the whole set of measurements was 24-27 deg C. The temperature of the lamp gets about 16 degrees hotter than ambient. Warm up effect: during the warm up time the illuminance increases until 150 %. Voltage dependency: the power consumption and illuminance vary linarly when the voltage is varied from 200 - 250 V.
Color temperature	4145 K	Cold white

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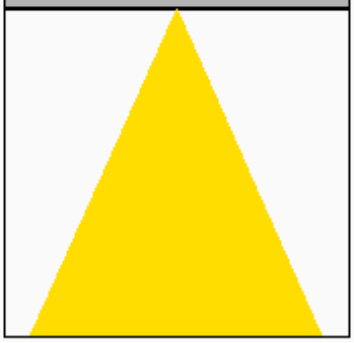
Overview table

m.	Ø 50% C0-180	Ø 50% C90-270
0.25	1.39	0.66
0.5	2.79	1.33
1	5.57	2.66
1.5	8.36	3.98
3	16.71	7.97
4	22.29	10.62
5	27.86	13.28

C0-180: 141°
C90-270: 106°



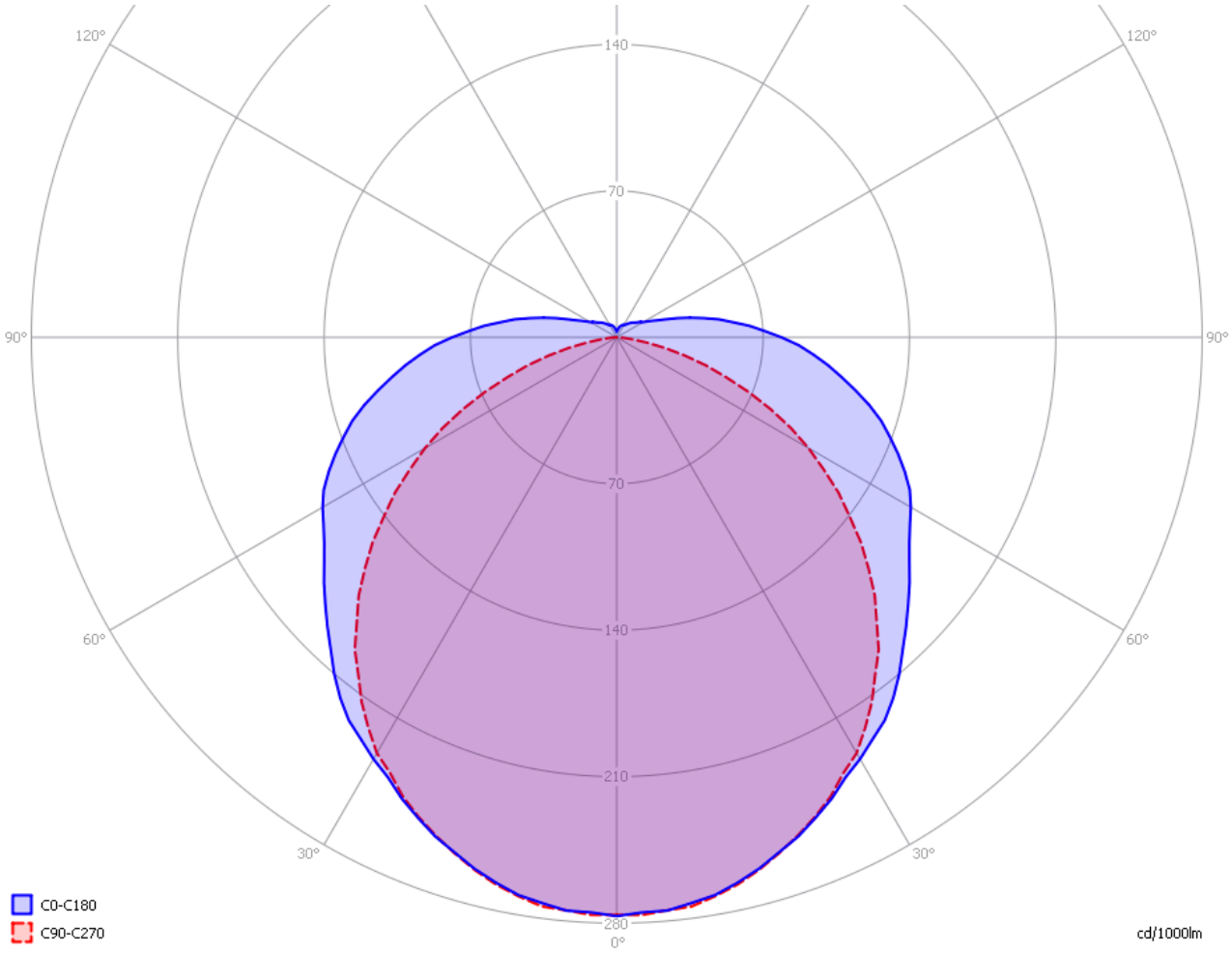
E (lux)
3199
800
200
89
22
12
8

Luminaire Efficacy
61 (lumens per Watt)
Half-peak diam C_{0-180}
5.57 x diameter(m)
Half-peak diam C_{90-270}
2.66 x diameter(m)
Illuminance
200 / distance² (lux)
Total Output
725 (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 495 mm ≈ 2500 mm. Within this distance from the lamp, the measured lux values willl 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.



The light diagram giving the radiation pattern.

It indicates the luminous intensity around the light bulb. The plane C90-C270 has a smaller beam than the C0-C180.

Illuminance Ev at 1 m distance, or luminous intensity Iv

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

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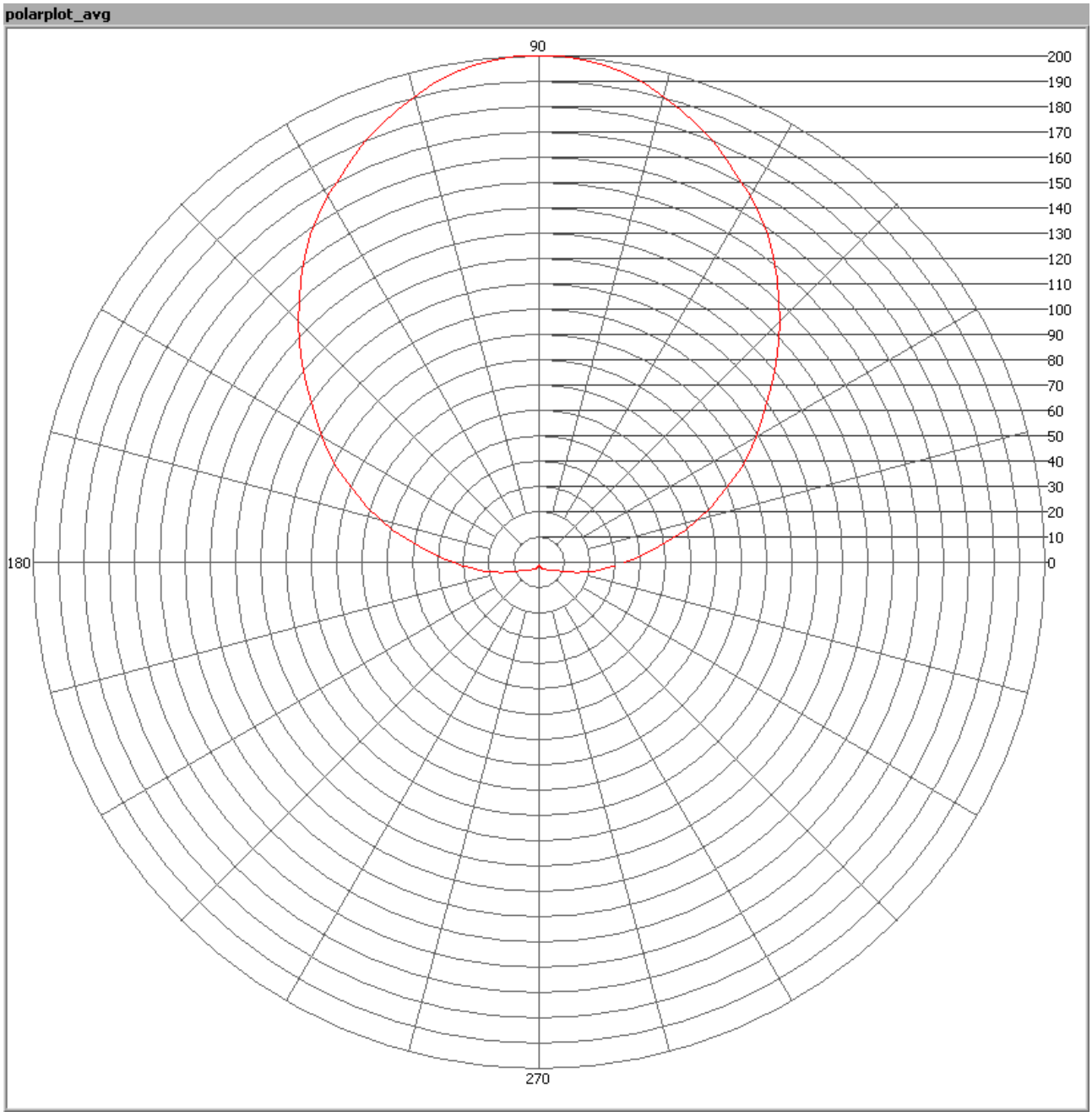
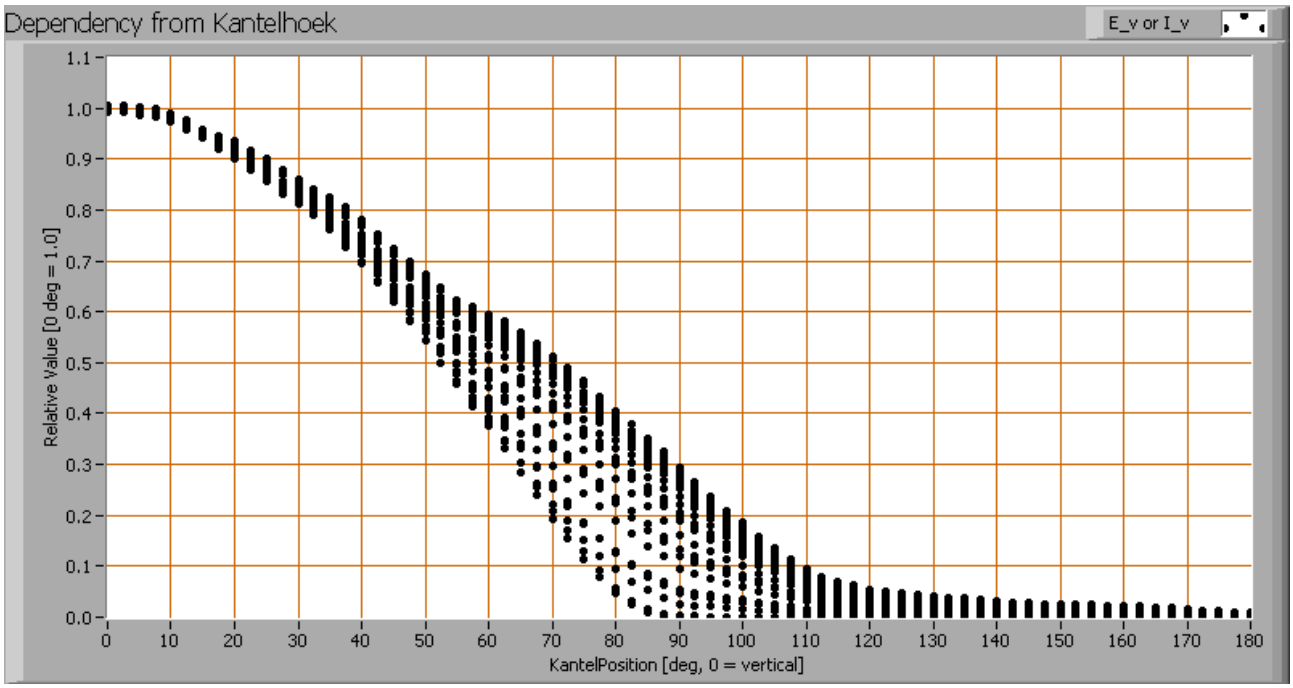


The radiation pattern of the light bulb.

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.



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 141°-106° depending on the plane looked at (resp. the C0-C180 plane and the C90-C270 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 725 Lm.

Luminous efficacy

The luminous flux being 725 Lm, and the power of the light bulb being 11.8 W, yields a luminous efficacy of 61 Lm/W.

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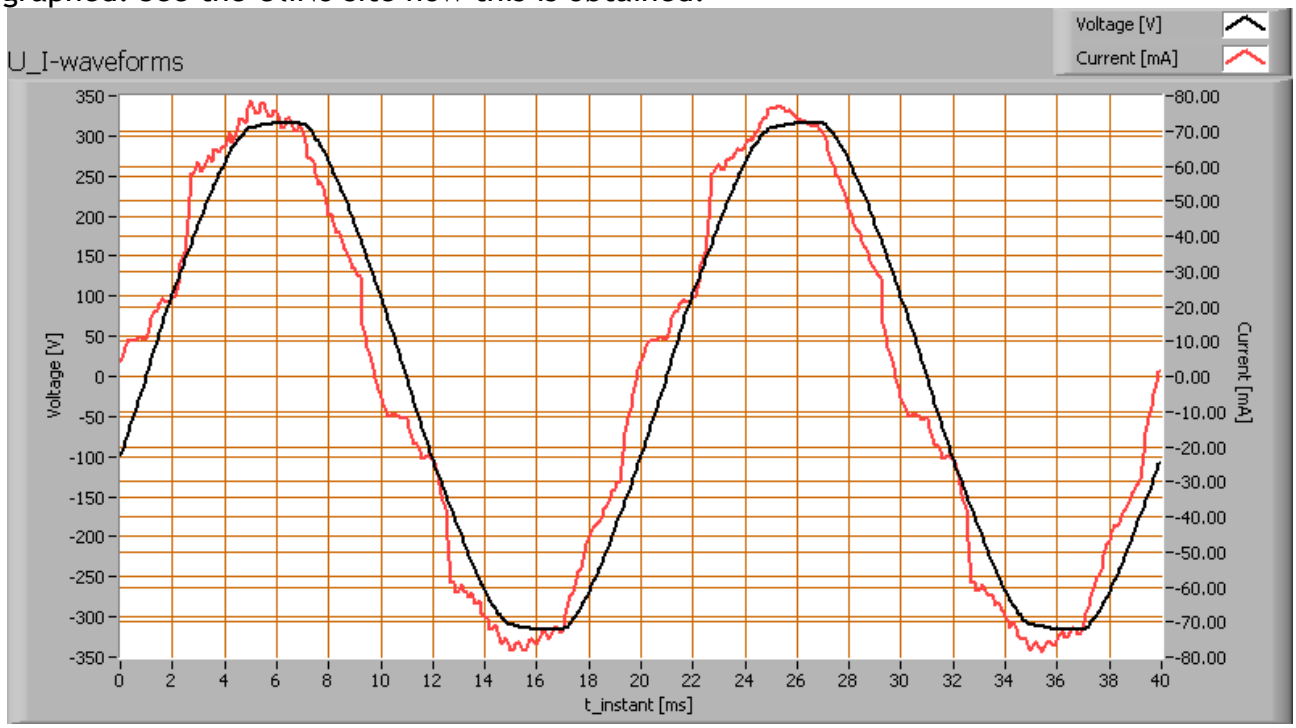
Electrical properties

A power factor of 0.90 means that for every 1 kWh net power consumed, a reactive component of 0.5 kVAr was needed.

Lamp voltage	230 VAC
Lamp current	57 mA
Power P	11.8 W
Apparent power S	13.1 VA
Power factor	0.90

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



Voltage across and current through the lightbulb

This waveforms have been checked on requirements posed by the norm IEC 61000-3-2:2006 (including up to A2:2009). See also the explanation on the OliNo website.

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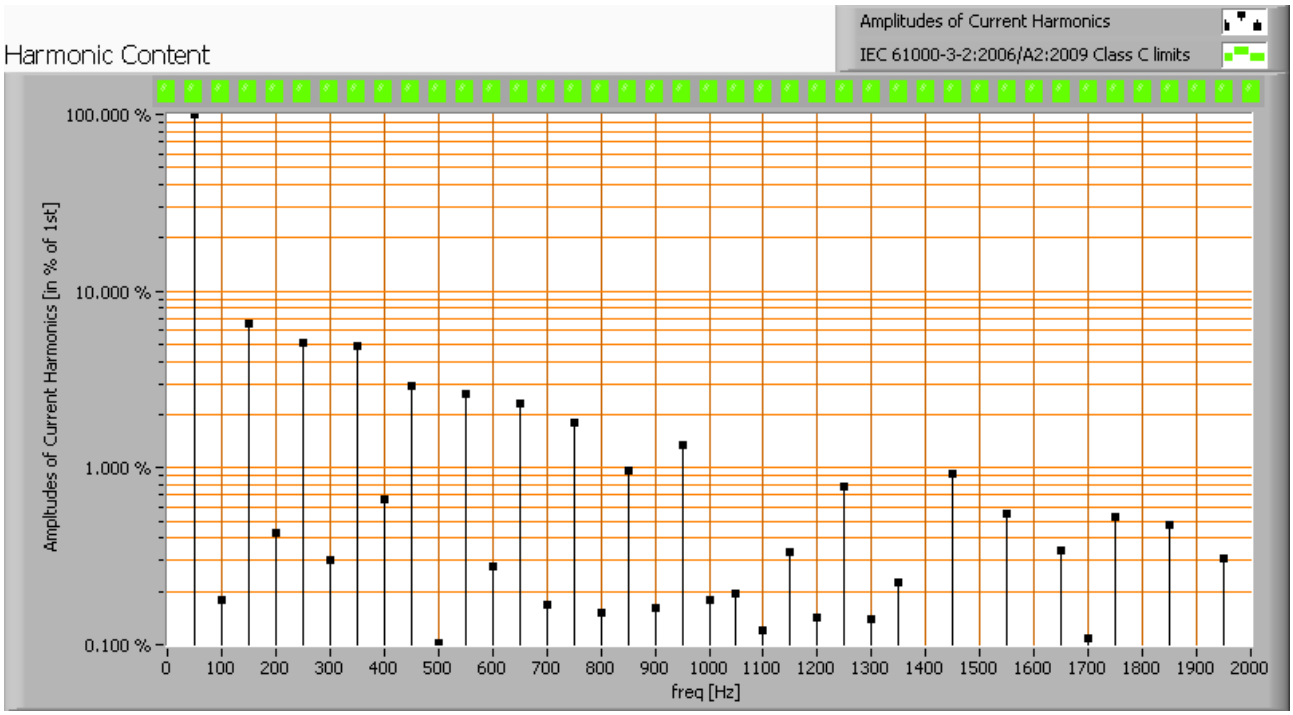

Harmonics in in the current waveform and checked against IEC61000-3-2:2006

There are no limits for the harmonics for lighting equipment <= 25 W.
The Total Harmonic Distortion of the current is computed as 11 %.

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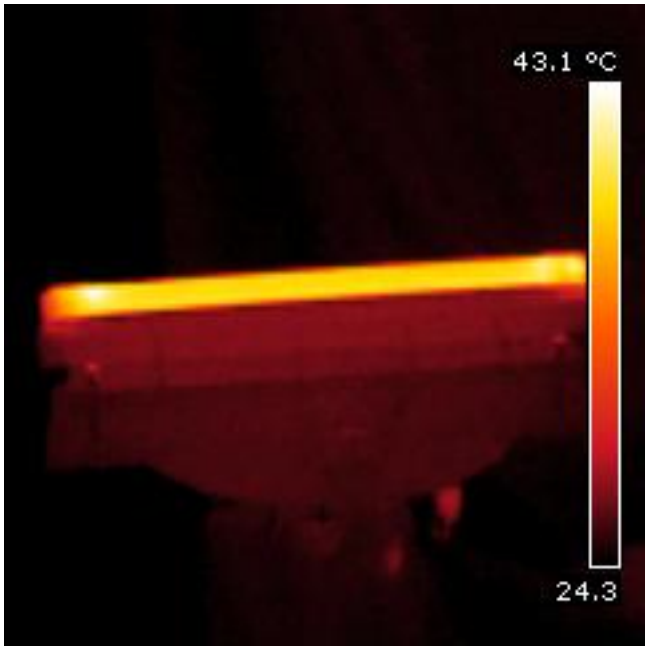
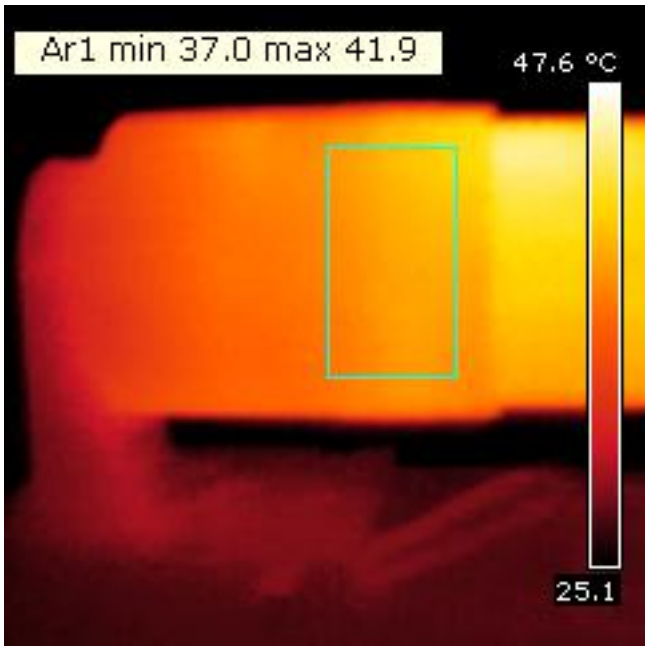
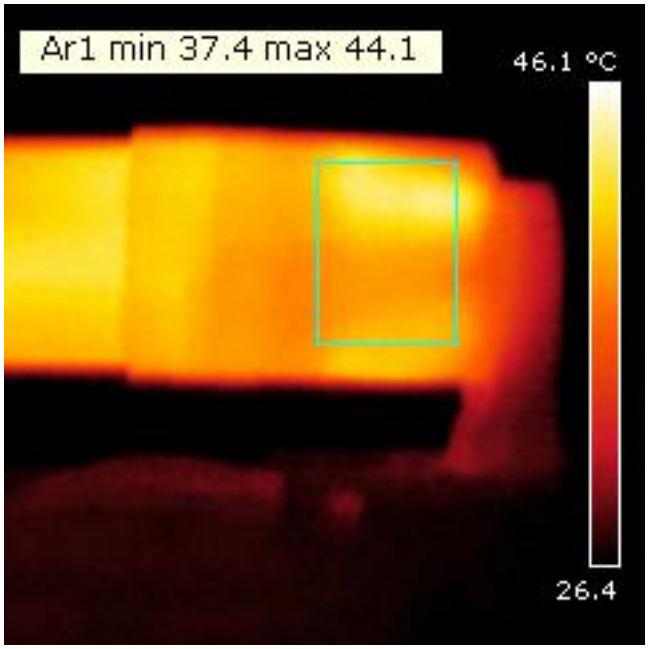
Temperature measurements lamp



Temperature image (overview) of the light bulb. Looking for the hottest spots





Hottest spot on the tube, measured on masking tape

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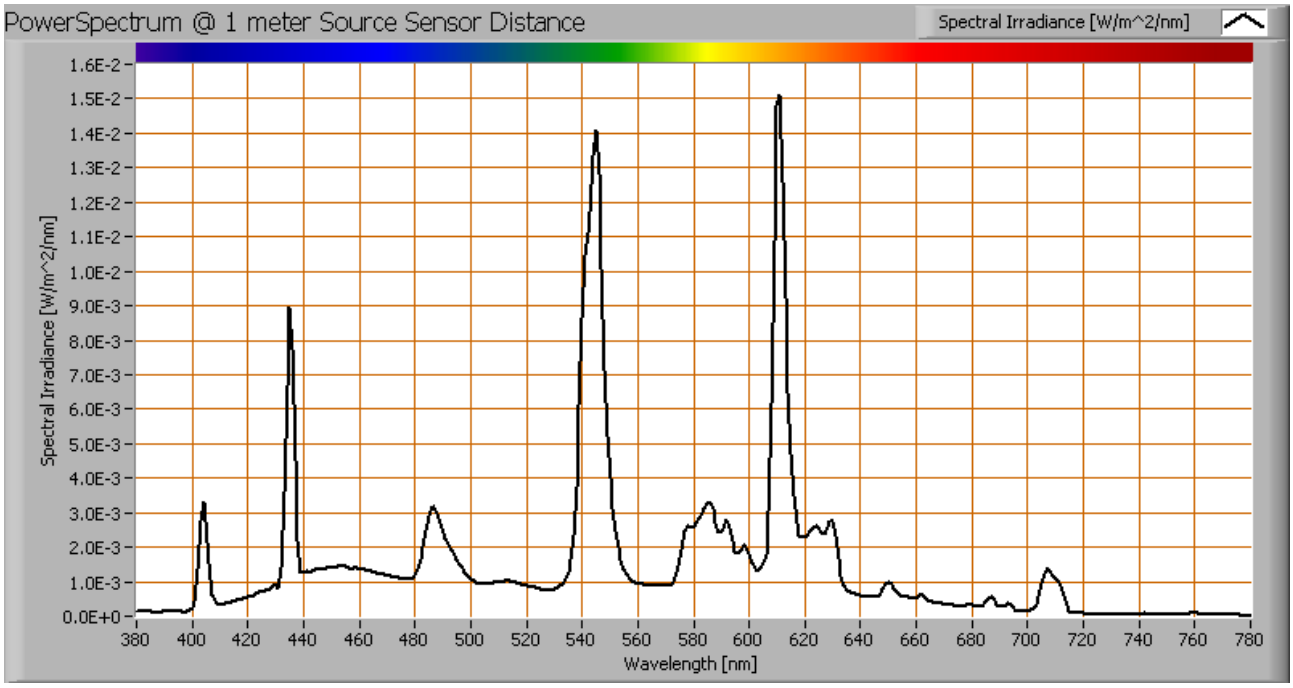
status lamp	> 2 hours on
ambient temperature	24 deg C
reflected background temperature	24 deg C
camera	Flir BCAM
emissivity	0.95[1]
measurement distance	0.20 m
$IFOV_{geometric}$	0.7 mm
NETD (thermal sensitivity)	100 mK

[1] The emissivity is set at 0.95 which is close to the value of the masking tape that was used.

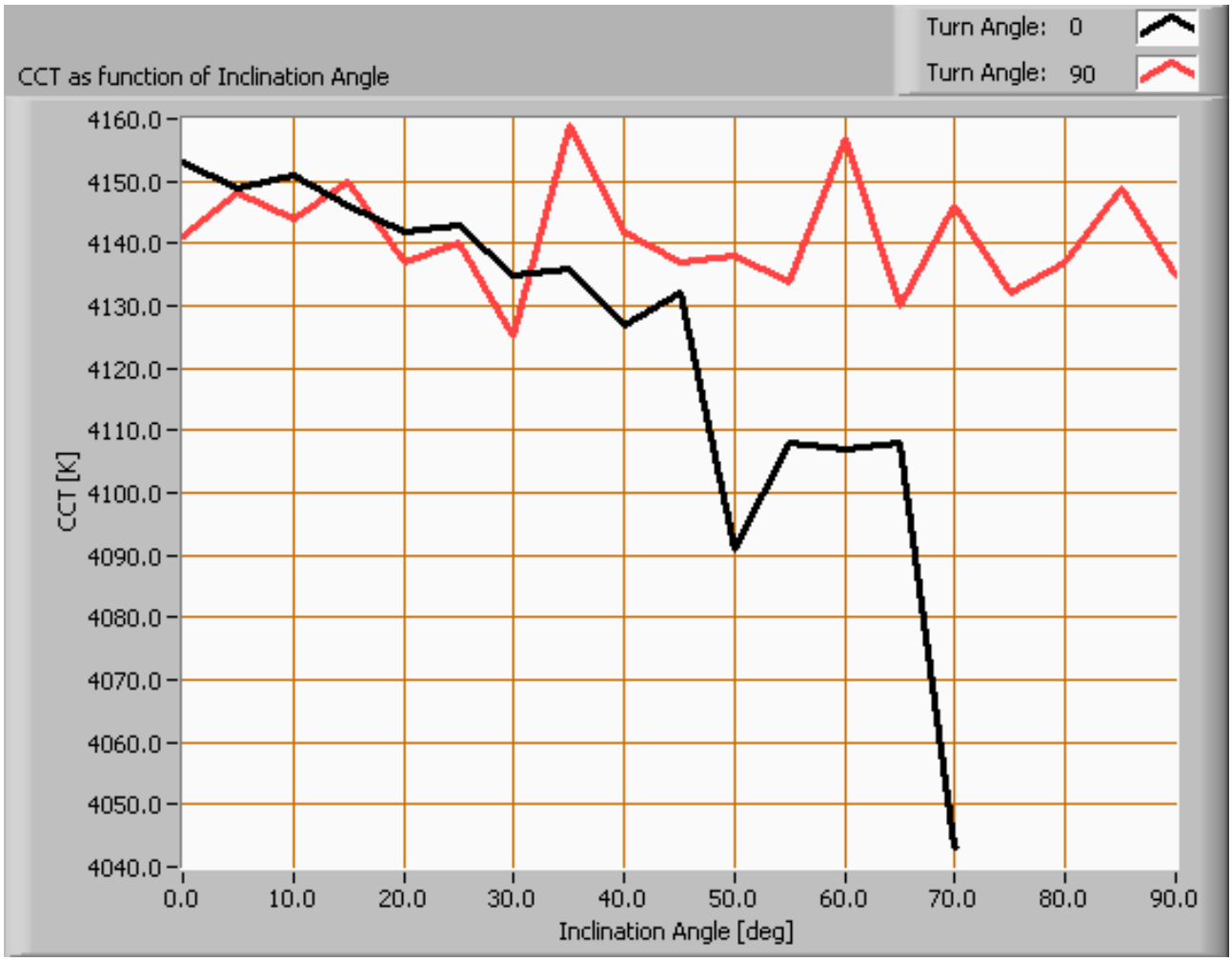
The hottest temperature on the tube is about warm-to-the-touch.

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 4150 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.



Color temperature as a function of inclination angle.

The measurement of CCT is measured for inclination angles up to 70° and beyond the illuminance value gets very low (< 5 lux).
The beam angle for the C0-C180 plane is 141°, meaning a 70.5° inclination angle. In this area most of the light is present. The variation in correlated color temperature in this area is less than 1 %.
Looking at the C90-C270 plane the beam angle is 106°, meaning a 53° inclination angle. Here the variation in (correlated) color temperature is about 1 %.

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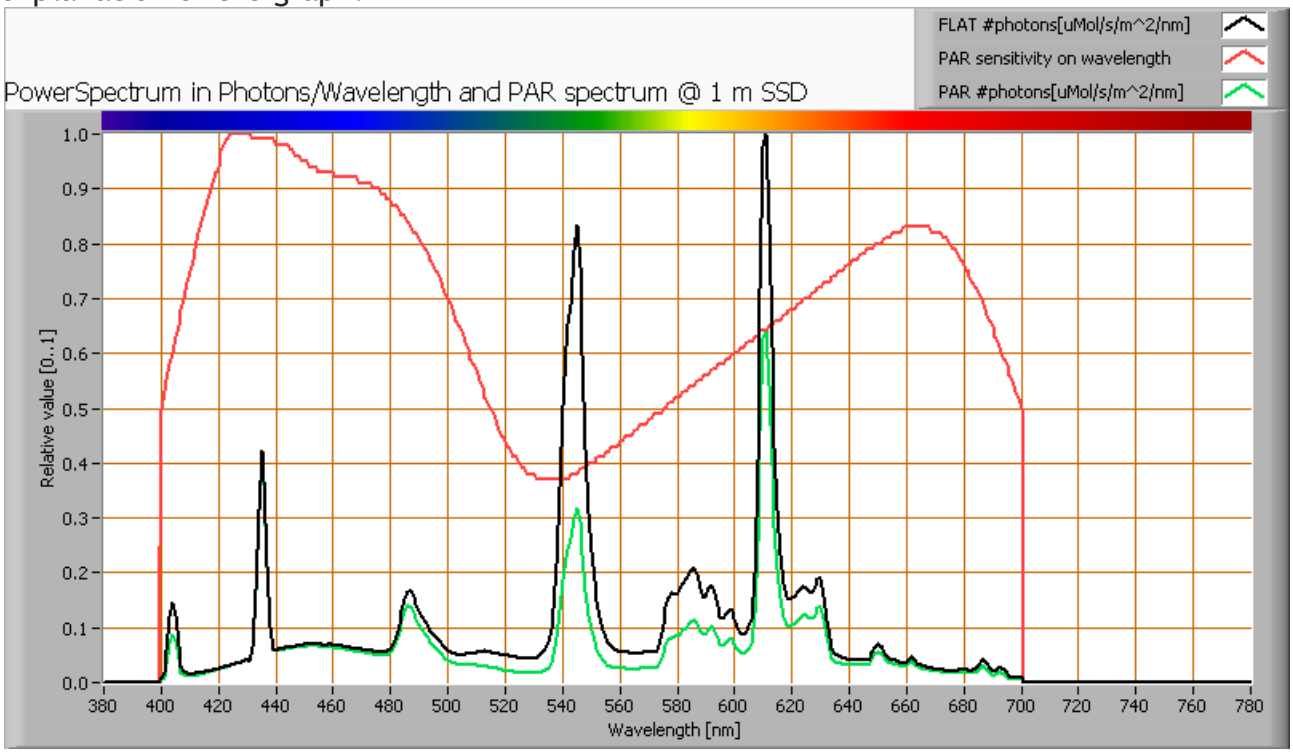
PAR value and PAR spectrum

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	1.6	µMol/s/m²
PAR-photon current	5.9	µMol/s
PAR-photon efficacy	0.5	µMol/s/W

The PAR efficiency is 62 % (valid for the PAR wave length range of 400 - 700 nm). So maximally 62 % 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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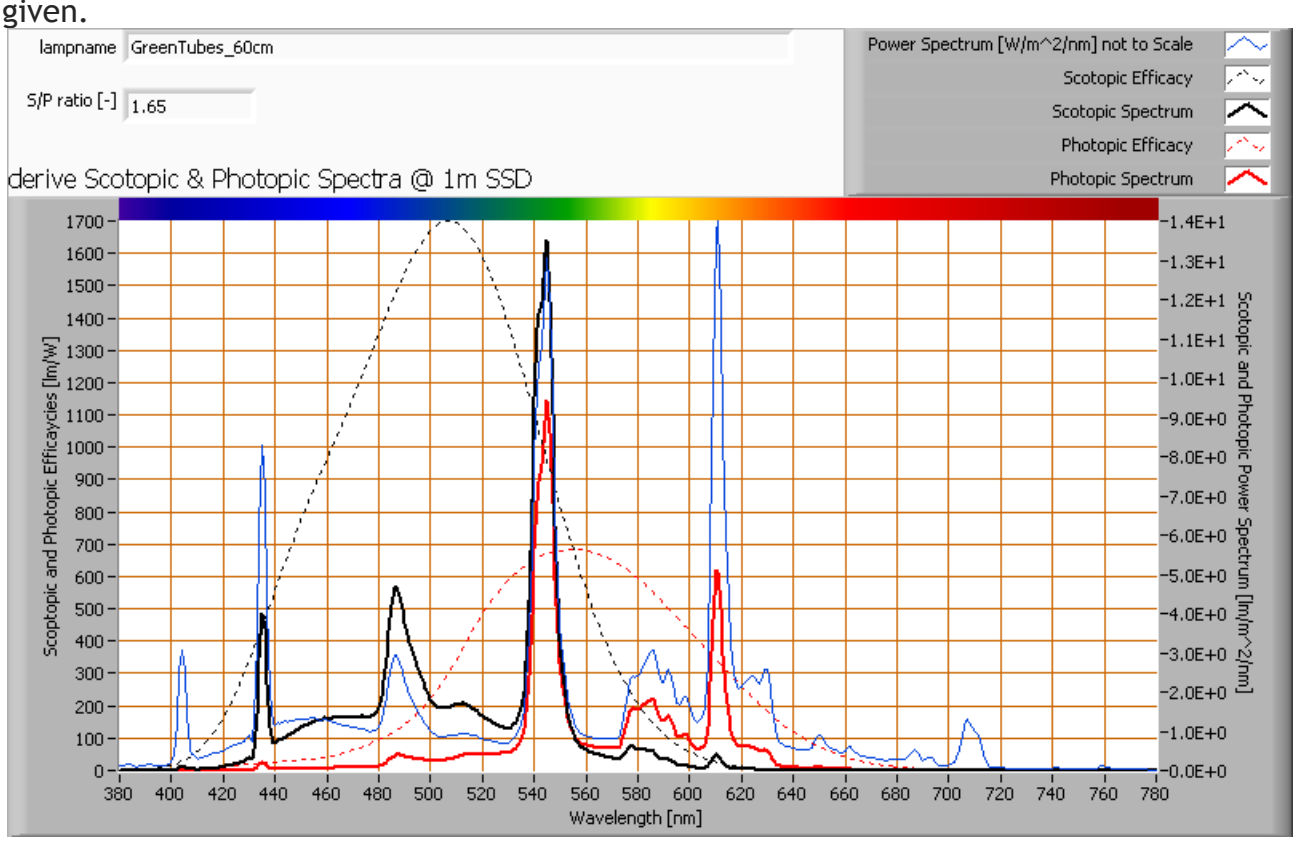
S/P ratio

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

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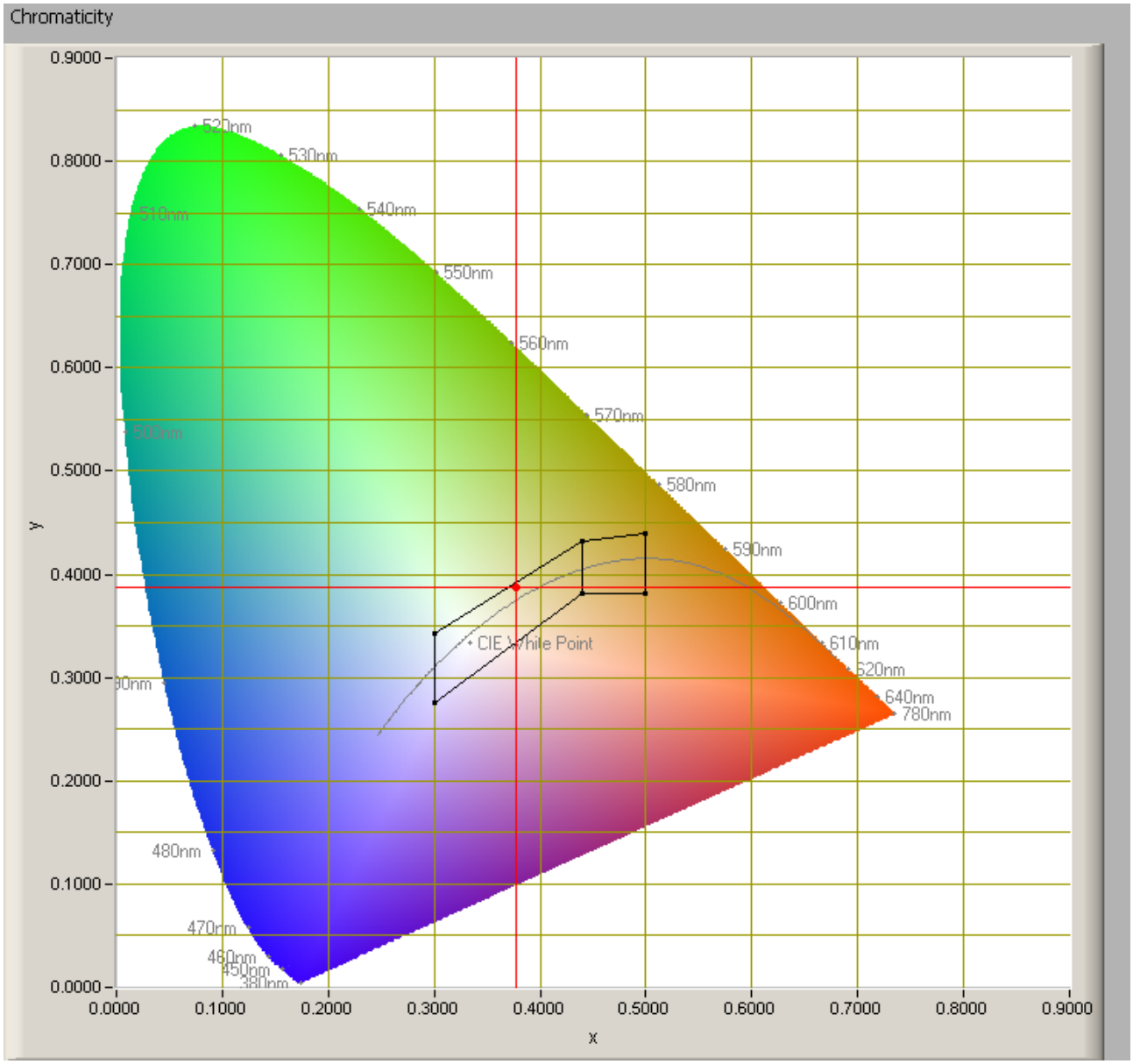
Chromaticity diagram

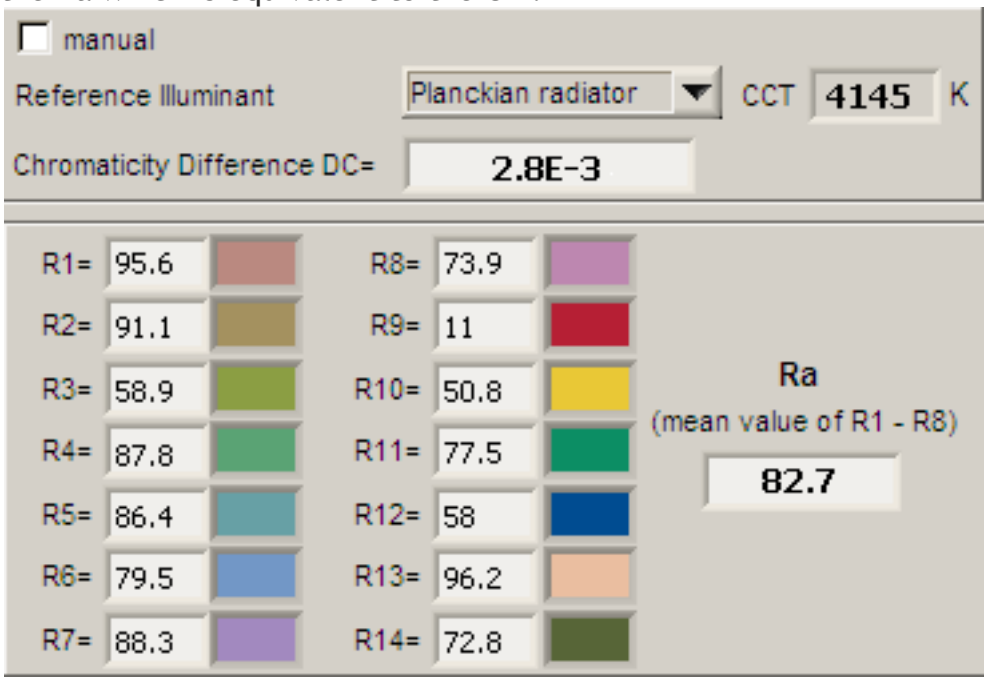


The chromaticity space and the position of the lamp's color coordinates in it.

The light coming from this lamp is at the border of the area designated with class A. This class A is an area that is defined for signal lamps, see also the OliNo website. Its coordinates are x=0.3777 and y=0.3871.

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.



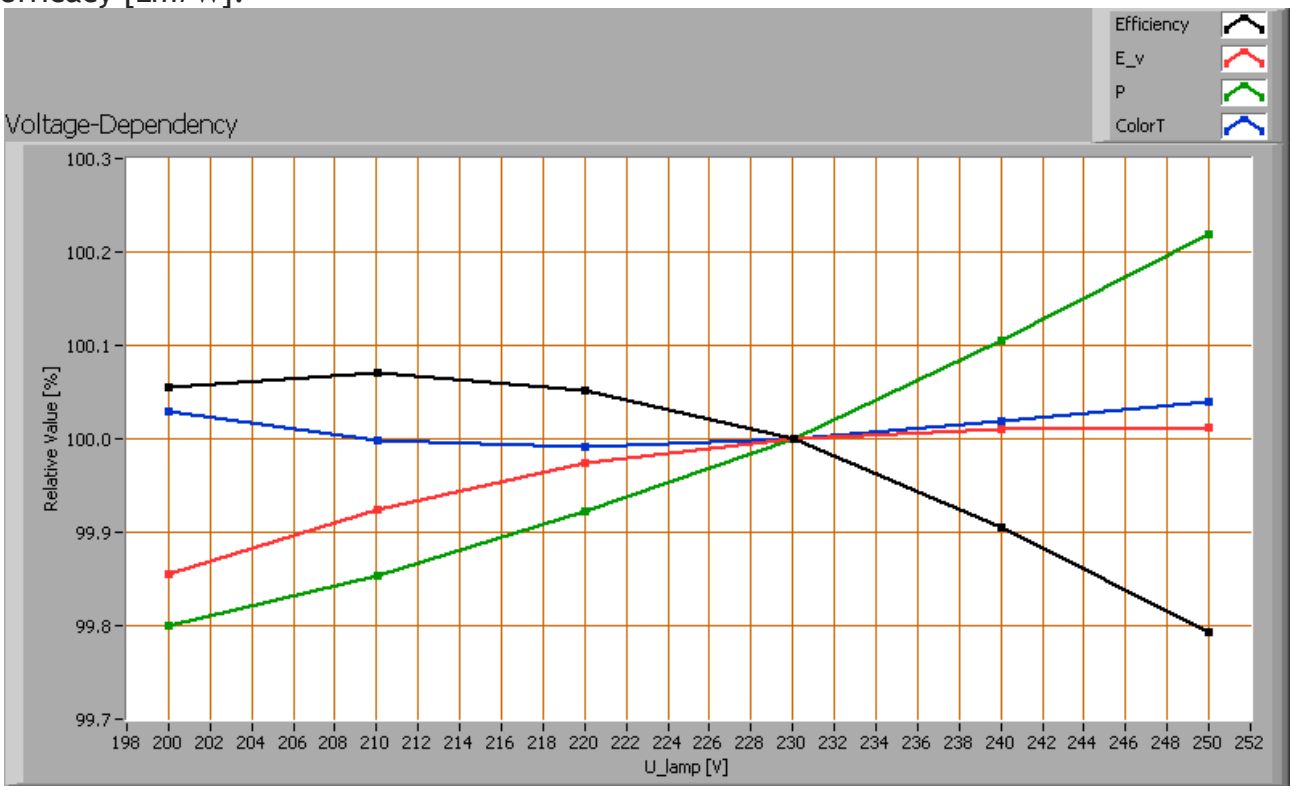
CRI of the light of this lightbulb.

The value of 83 is higher than 80 which is considered a minimum value for indoor usage. Note: the chromaticity difference is 0.0028 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. A reference with signal lights as a reference is given in the chromaticity diagram.

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 lamppower P [W] and the luminous

efficacy [Lm/W].



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

The illuminance and consumed power vary linearly when the voltage is varied.
When the voltage at 230 V varies with + and - 5 V, then the illuminance varies ≈ 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], the lamppower P [W] and the luminous efficacy [lm/W].

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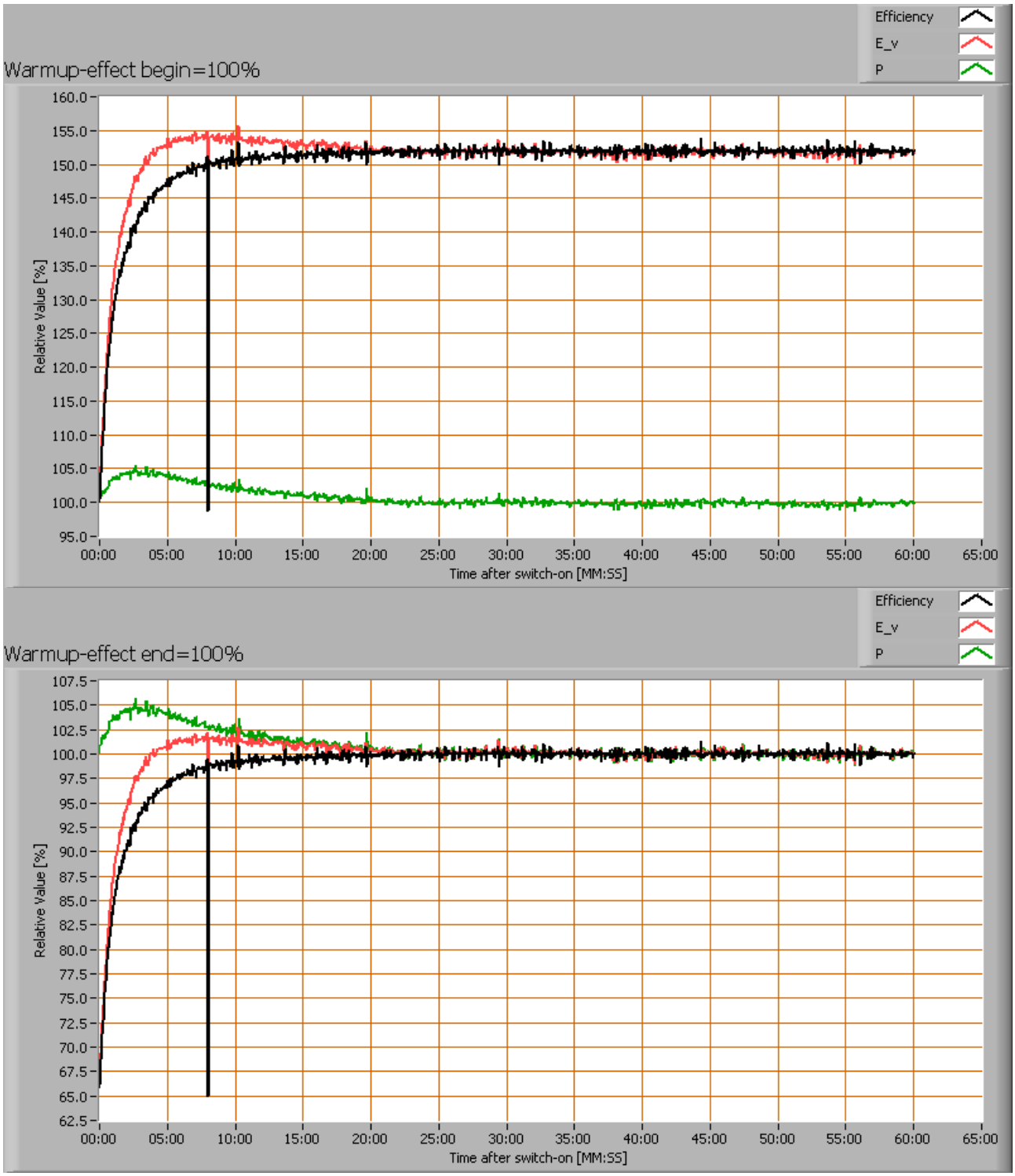
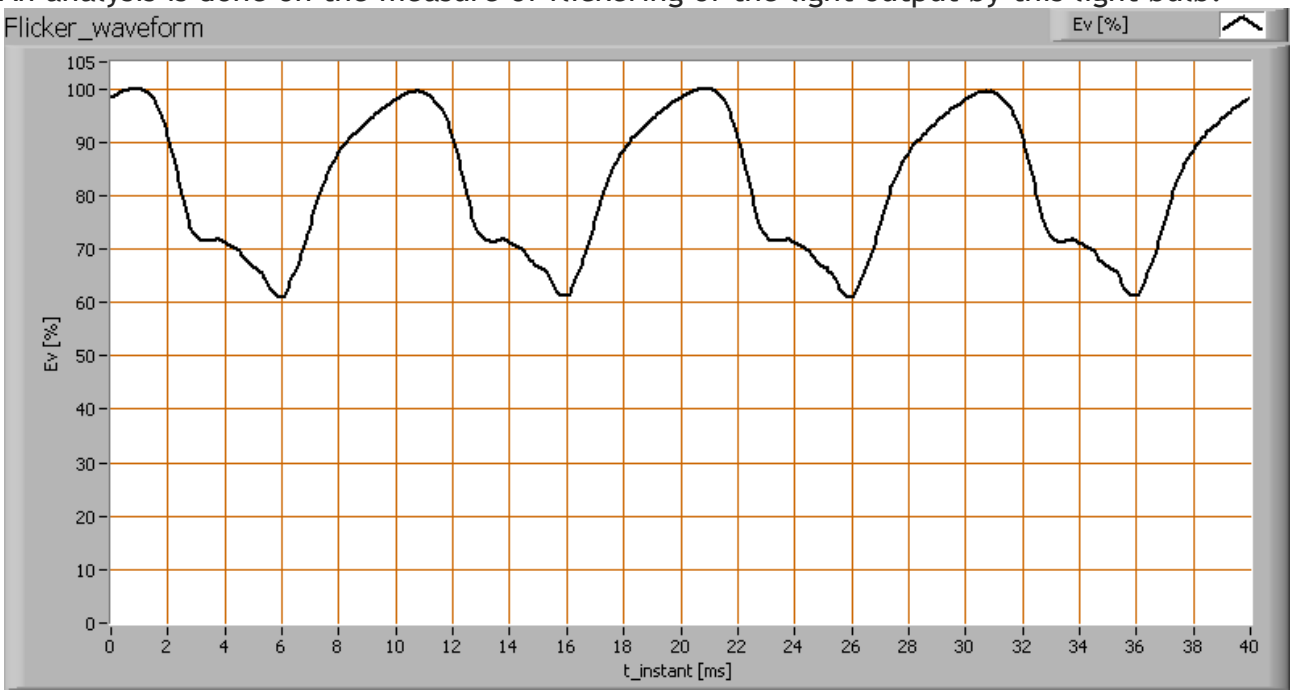


Effect of warming up on different light bulb parameters. At top the 100 % level is put at begin, and at bottom at the end.

The warm up time is about 5 minutes. During that time the illuminance increases to 150 % of its initial value.

Measure of flickering

An analysis is done on the measure of flickering of the light output by this light bulb.



The measure of fast illuminance variartion of the light of the light bulb

parameter	waarde	eenheid
Flicker frequency	100.0	Hz
Illumination modulation index	24	%

The illumination modulation index is computed as: (max_Ev - min_Ev) / (max_Ev + min_Ev).

Disclaimer