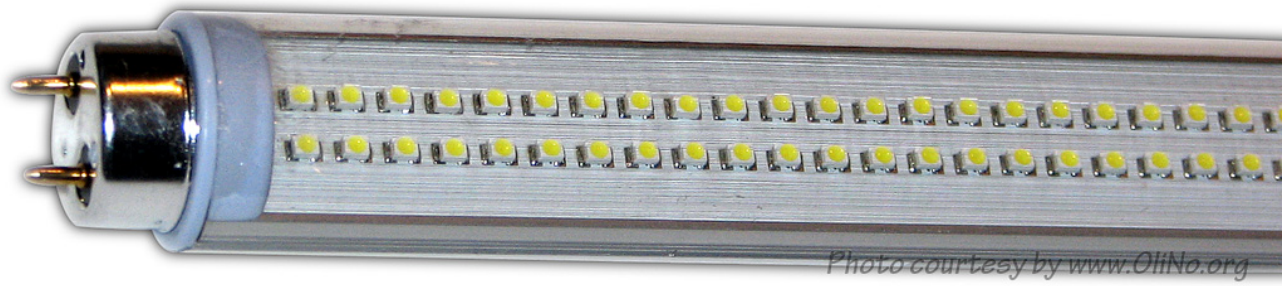
Lamp measurement report – 31 Oct 2009

Tube T24120CWClear

by

Lioris



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Summary measurement data

parameter	meas. result	remark
Color temperature	7603 K	Cold white
Luminous intensity I_v	647 Cd	Measured straight underneath the lamp
Beam angle	121 deg	118° for the C0-C180 plane (length direction of tube), and 121° for C90-C270 plane (perpendicular). These values are virtually the same.
Power P	25.8 W	
Power Factor	0.99	For every 1 kWh net power consumed, there has been 0.1 kVAhr for reactive power.
Luminous flux	2009 Lm	
Luminous efficacy	78 Lm/W	
CRI_Ra	80	Color Rendering Index.
Coordinates chromaticity diagram	x=0.3011 and y=0.3018	
Fitting	FL-tube	It is connected directly to the grid.
PAR-value	6.4 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.
S/P ratio	2.2	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 L external dimensions	30 x 1197 mm	External dimensions of the lamp. Excluding the pins.
L x W luminous area	1150 x 17 mm	Dimensions of the luminous area (used in Eulumdat file). This is equal to the surface on which the leds are mounted.

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General remarks		The ambient temperature during the whole set of measurements was 23-25 deg C. The tube ends are measured on surface temperature (37° C en 52° C where the power supply houses). Warm up effect: during the warm up time the illuminance and the consumed power decrease with 11 % and 12 % respectively. Voltage dependency: the power consumption and illuminance depend linearly on the voltage when it is varied from 200 - 250 V. This article contains the test results of dimming the tube at the end.

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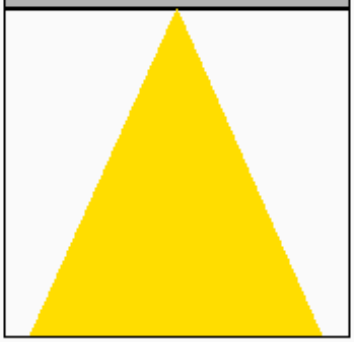
Overview table

m.	Ø 50% C0-180	Ø 50% C90-270
0.25	0.83	0.88
0.5	1.66	1.75
1	3.31	3.5
1.5	4.97	5.25
3	9.94	10.51
4	13.26	14.01
5	16.57	17.52

C0-180: 118°
C90-270: 121°



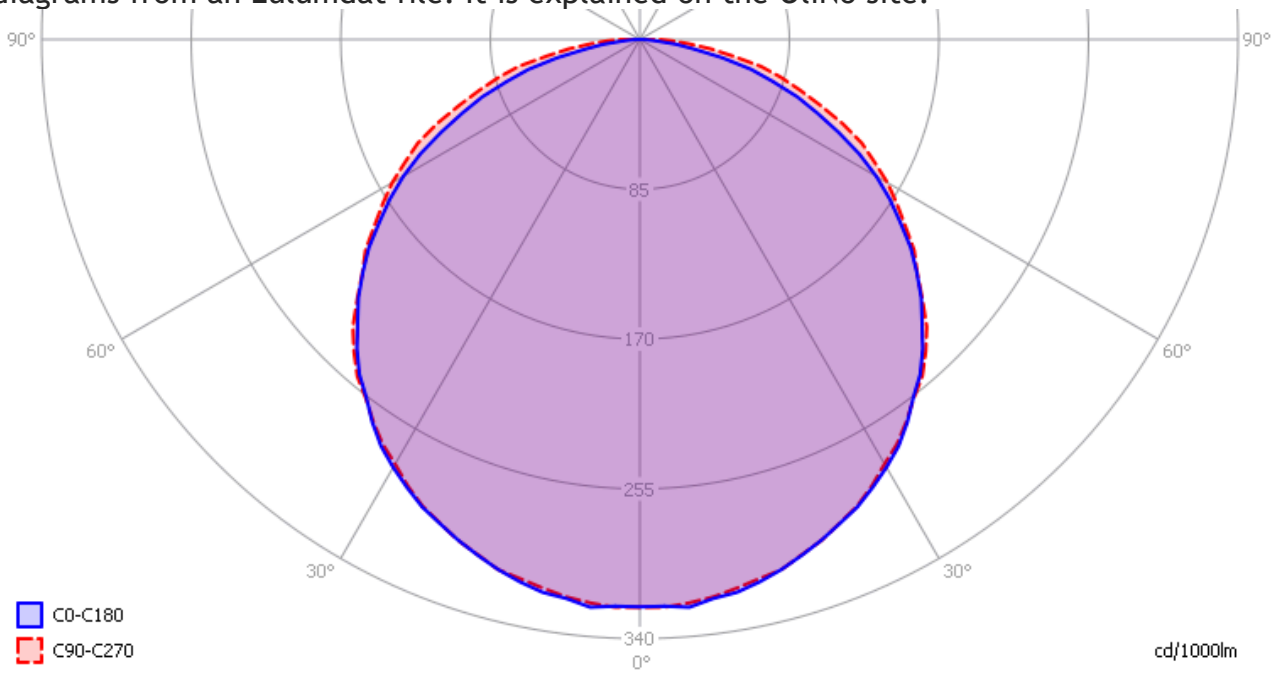
E (lux)
10353
2588
647
288
72
40
26

Luminaire Efficacy	
78	(lumens per Watt)
Half-peak diam C_{0-180}	
3.31	x diameter(m)
Half-peak diam C_{90-270}	
3.5	x diameter(m)
Illuminance	
647	/ distance² (lux)
Total Output	
2009	(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.

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.



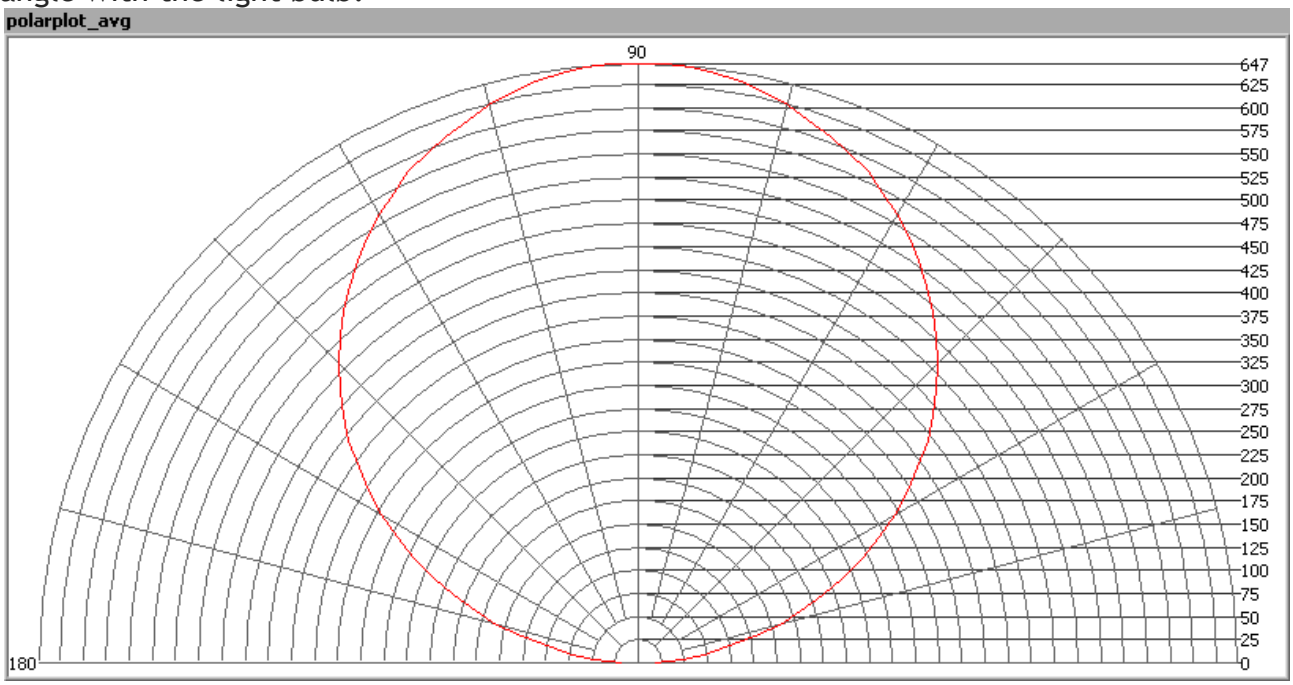
The light diagram giving the radiation pattern.

It indicates the luminous intensity around the light bulb. This light bulb has the same

light diagram for the C0-C180 as for the C90-C270 plane.

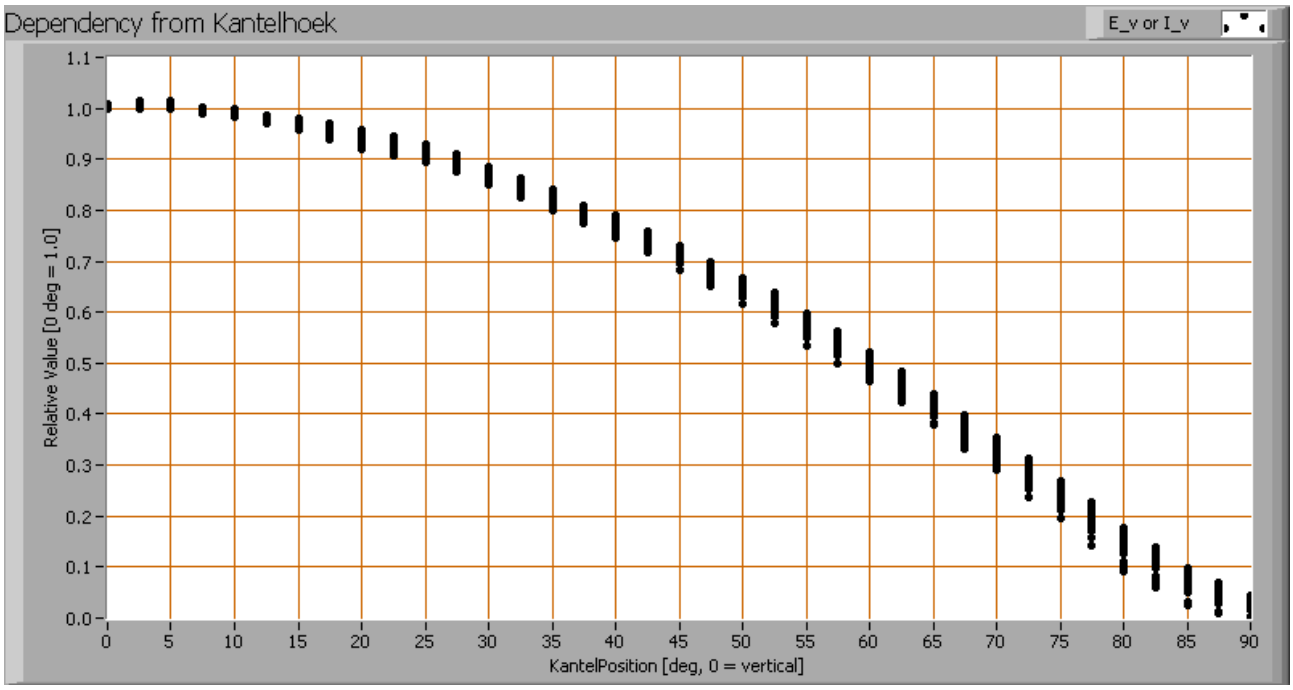
Illuminance Ev at 1 m distance, or luminous intensity Iv

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



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 118-121 degrees.

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 2009 Lm.

Luminous efficacy

The luminous flux being 2009 Lm, and the power of the light bulb being 25.8 W, yields a luminous efficacy of 78/W.
A power factor of 0.99 means that for every 1 kWh net power consumed, a reactive component of 0.1 kVAr was needed.

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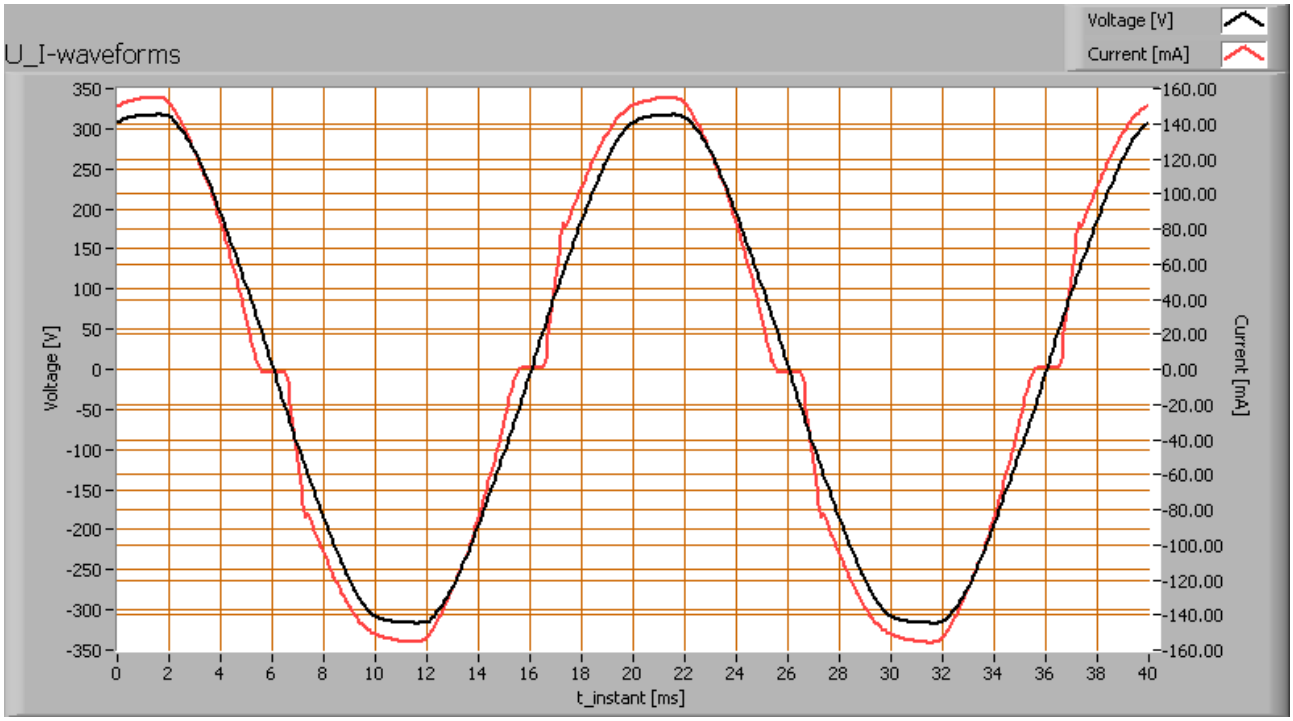
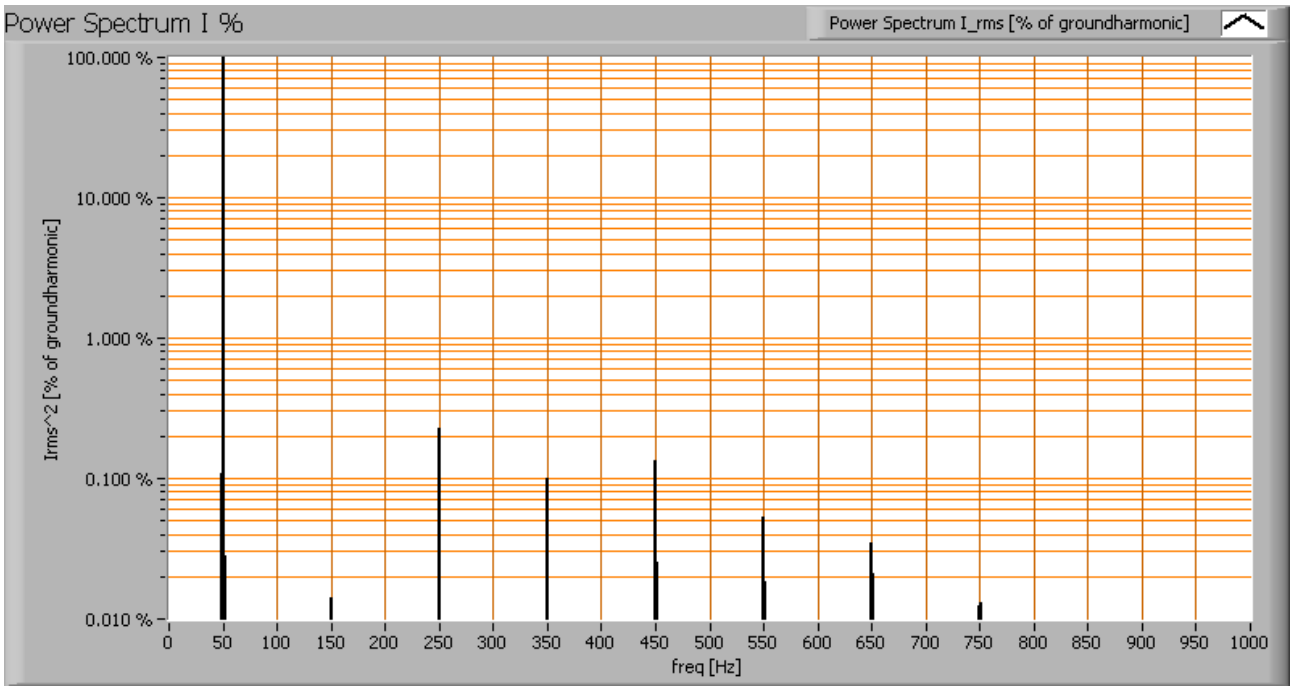
Light bulb voltage (used on power supply!)	230 VAC
Light bulb current	113 mA
Power P	25.8 W
Apparent power S	26.0 VA
Power factor	0.99

Of this light bulb the voltage across ad the resulting current through it+its constant current driver power supply are measured and graphed. See the OliNo site how this is obtained.



Voltage across and current through the lightbulb

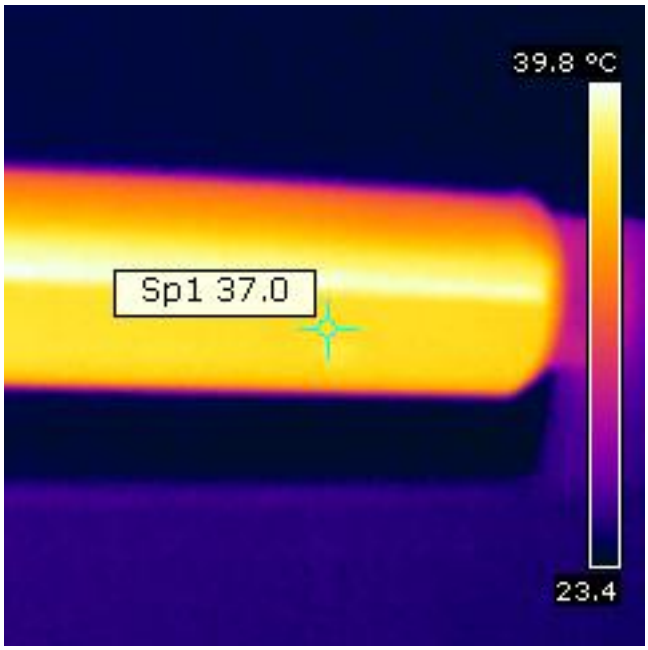
The current does look like a nice sine and it has the same phase as the voltage, hence the power factor is about 1, perfect!
Also the power spectrum of the current is determined.



Current power spectrum in % of the first harmonic (50 Hz).

No relevant higher harmonics.

Temperature measurements lamp



Temperature image of cold side of the tube, after warming up

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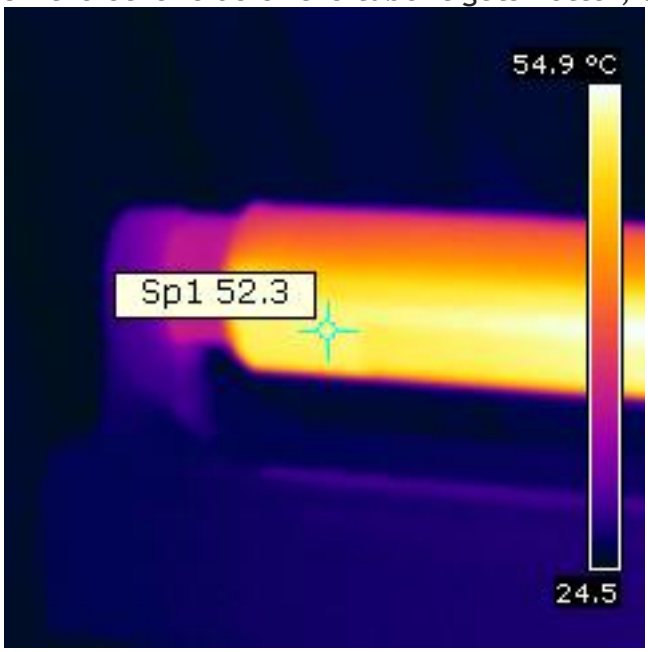
status lamp	> 1 uur warm up
ambient temperature	23.5° C
camera	Flir B-CAM SD
emissivity	1.00[1]
measurement distance	0.25 m
$IFOV_{geometric}$	0.8 mm
NETD (thermal sensitivity)	100 mK

[1] The emissivity has been set such that the measuremed temperatures were corresponding as much as possible to those measured directly with a contact measurement probe. The contact measurement probe measured 3 degrees lower, but had a lowering effect when it touched the surface for measurement. As a compromise the reported temperature here is the average temperaure of both these calibrated temperature sensors was taken.
On the other side of the tube it gets hotter, as the power supply is housed in there.

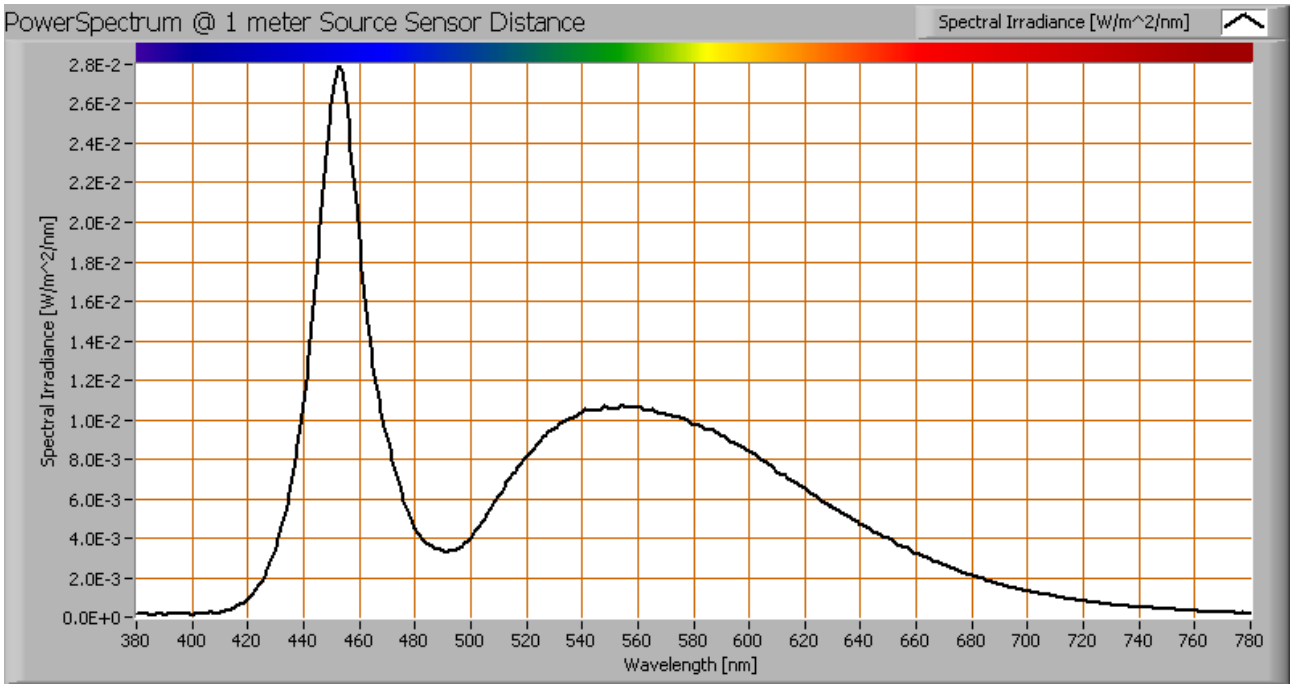


Temperature of the heat sink

emissivity	1.0[1]
measurement distance	0.25 m
$IFOV_{geometric}$	0.8 mm

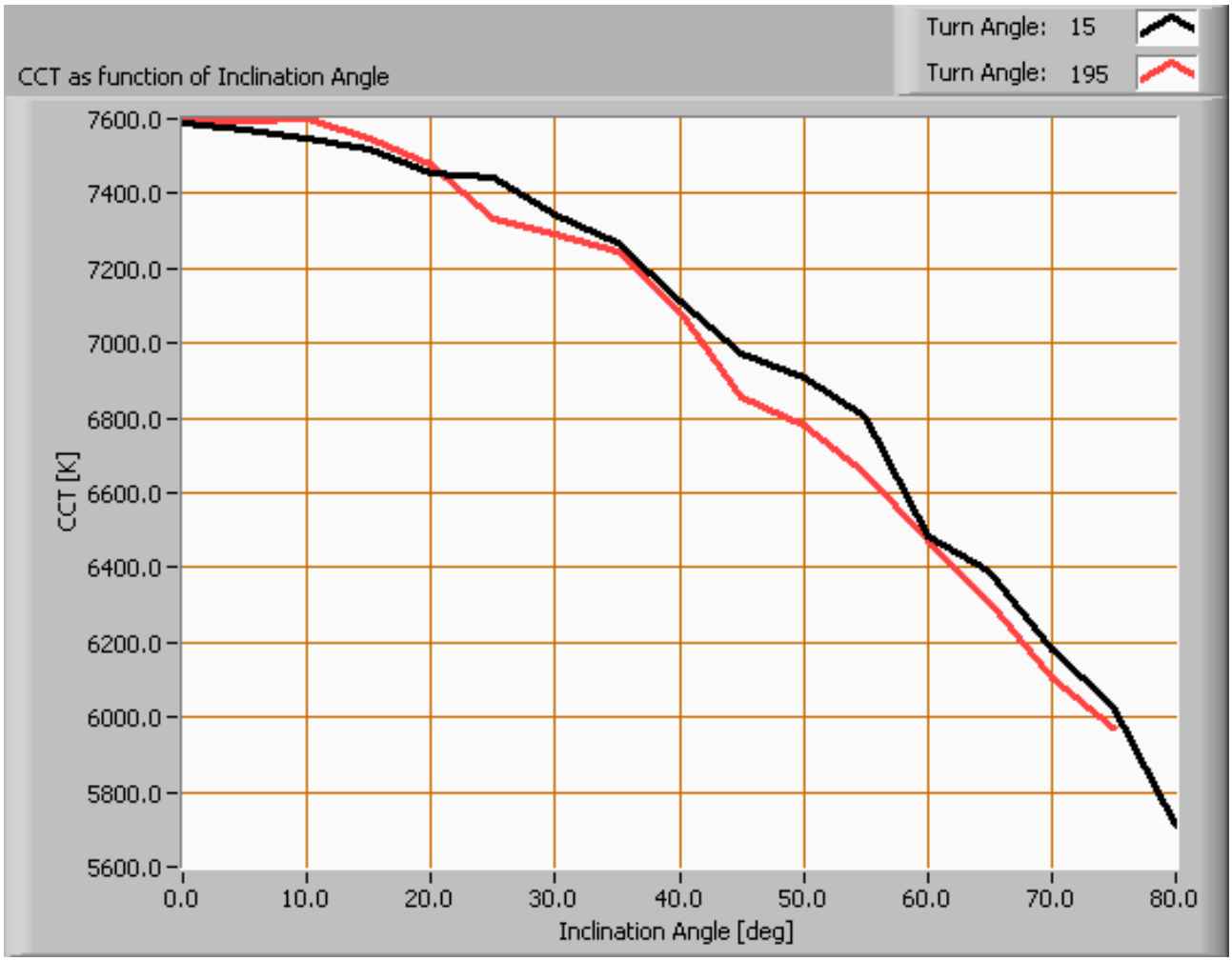
This side gets above 52° C as it houses the power supply unit.

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 7600 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.



Color temperature as a function of inclination angle.

The measurement of CCT has been stopped when the inclination angle was 75 as the illuminance value was decreased to very low values there (< 5 lux).
The beam agle is 121°, meaning an inclination angle of max 60.5°. Almost all light fall within this angle. The variation of the color temperature within this angle is about 14 %.

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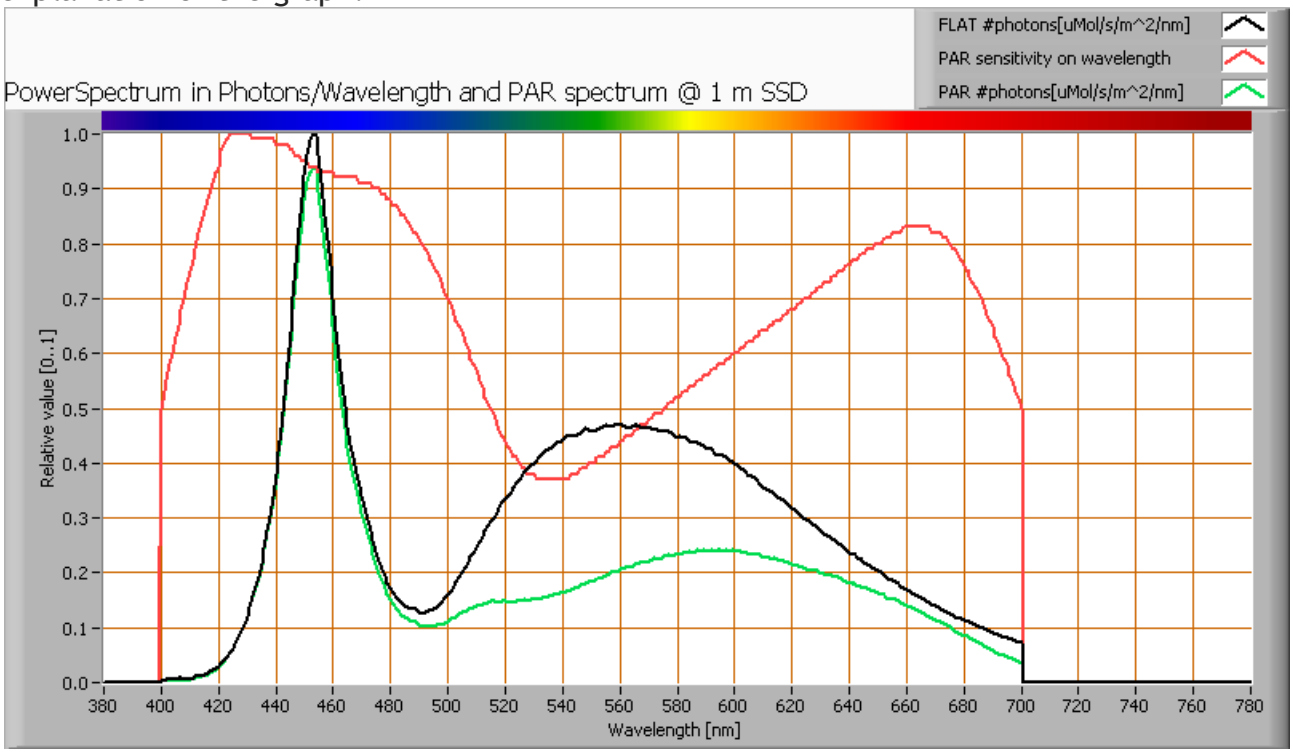
PAR value and PAR spectrum

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 6.4 µMol/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 67 % (valid for the PAR wave length range of 400 - 725 nm). So maximally 67 % 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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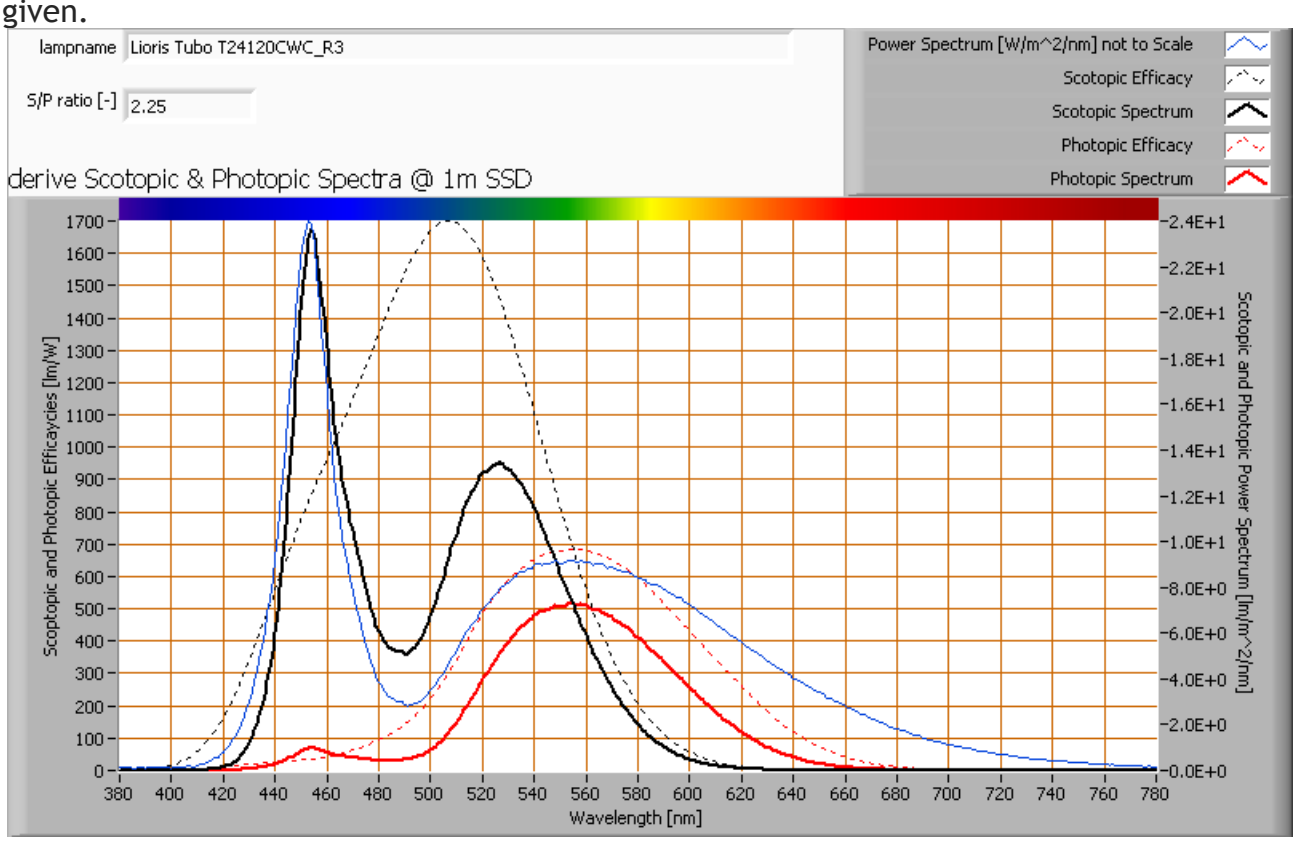
S/P ratio

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 2.2.
More info will come in a separate article.

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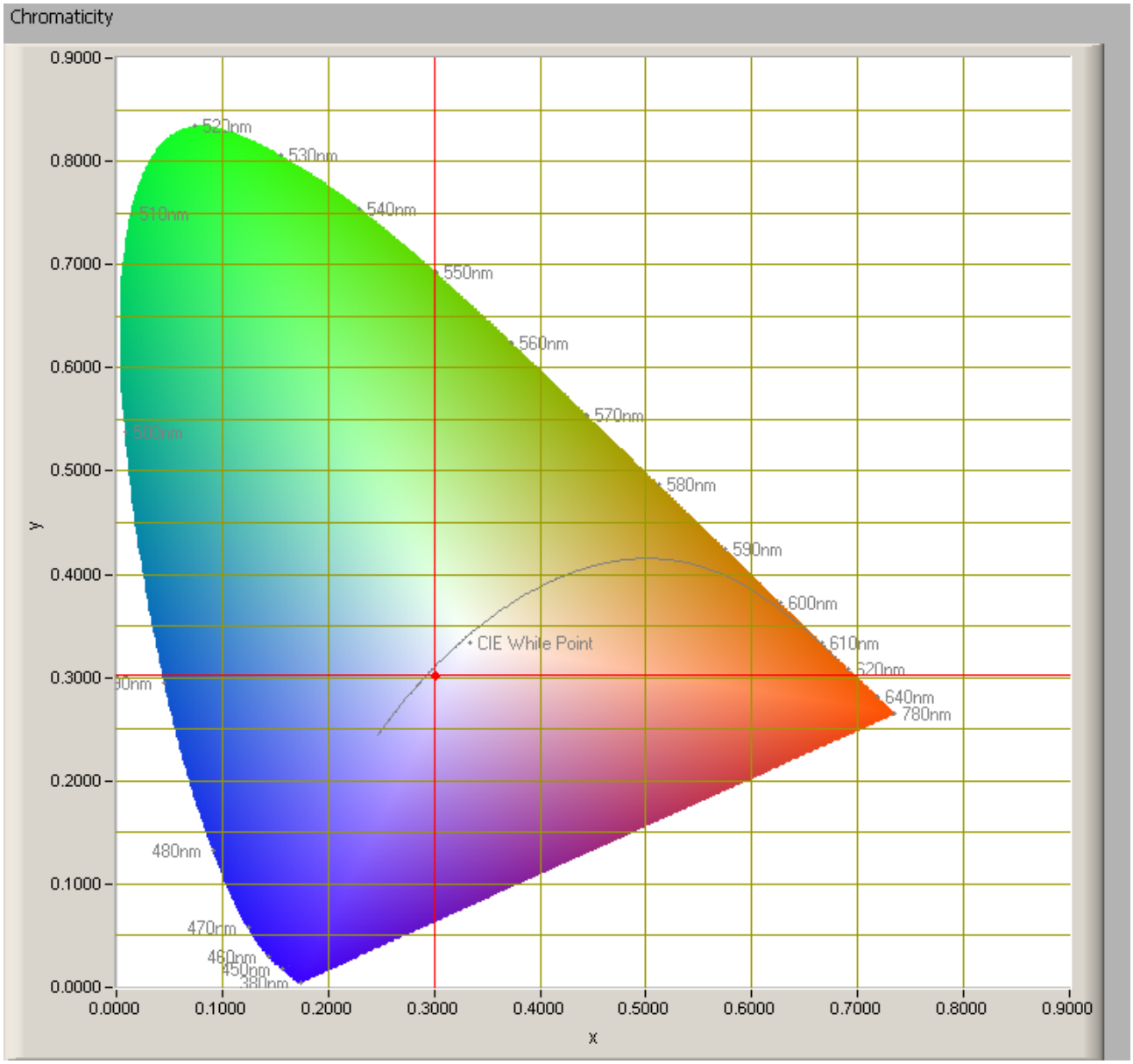
Chromaticity diagram

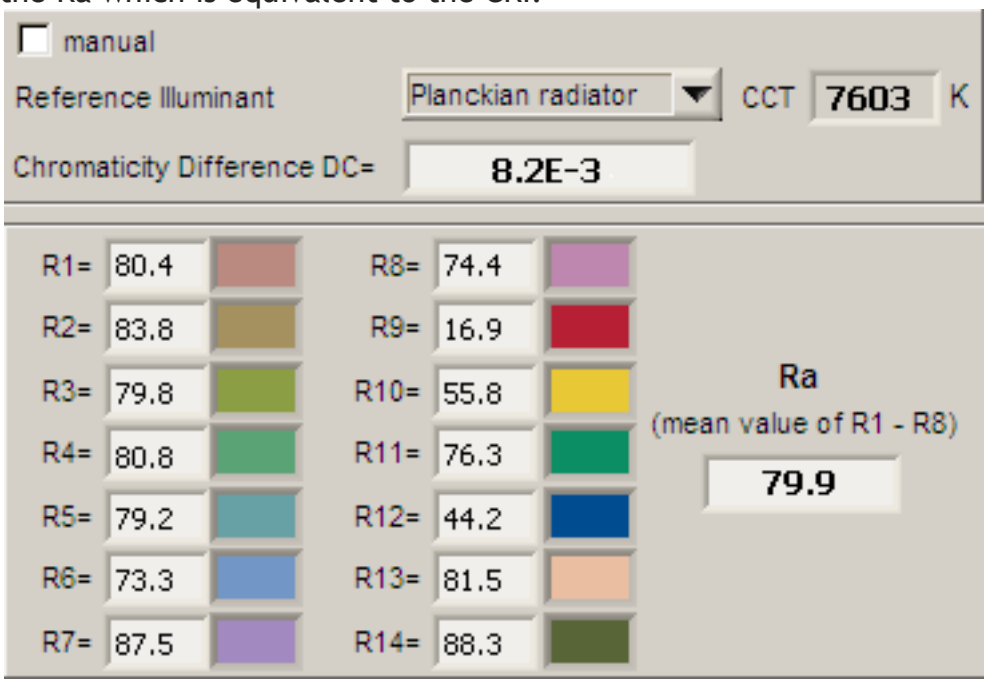


The chromaticity space and the position of the lamp's color coordinates in it.

The light coming from this lamp is close to the Planckian Locus (the black path in the graph).
Its coordinates are x=0.3011 and y=0.3018.

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).
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.

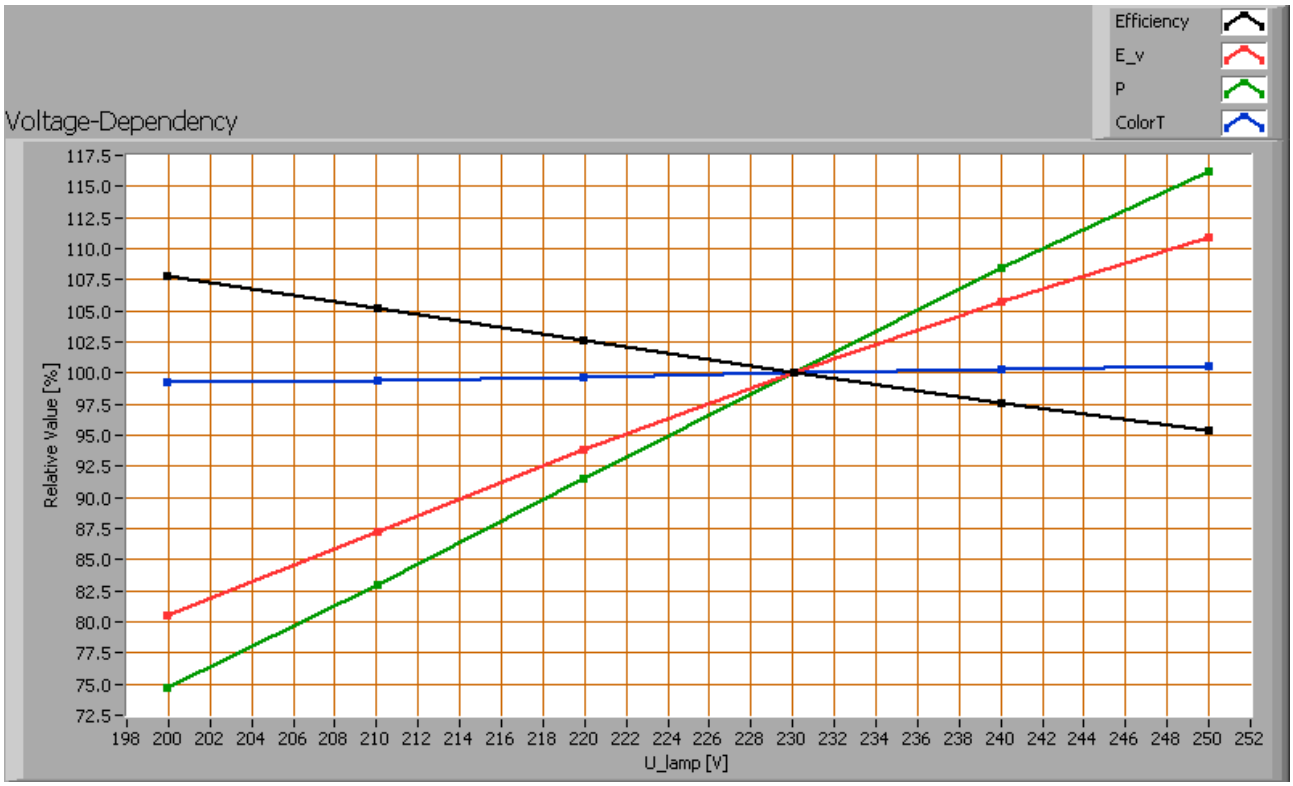


CRI of the light of this lightbulb.

The value of 80 is equal to 80 which is considered a minimum value for indoor usage.
Note: the chromaticity difference is 0.0082 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 lamppower P [W], the (Correlated) Color Temperature [K] 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 consumed power varies and the illuminance vary linearly when the voltage is varied. When the voltage at 230 V varies with + and - 5 V, then the illuminance varies within 3 %, 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 lamppower P [W] and the luminous efficacy [lm/W].

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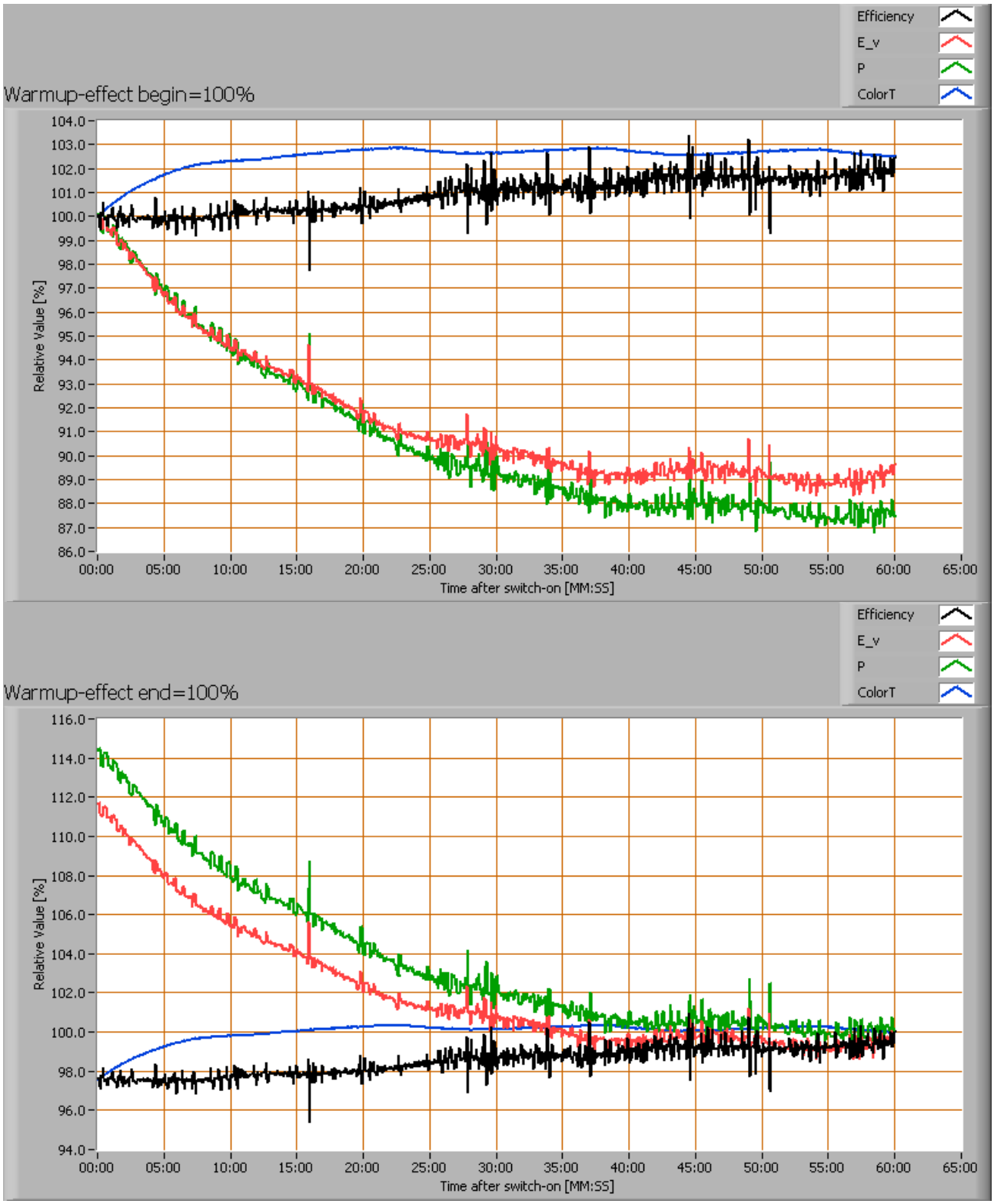


Effect of warming up on different light bulb parameters. At top the 100 % level is put at begin, and at bottom at the end.

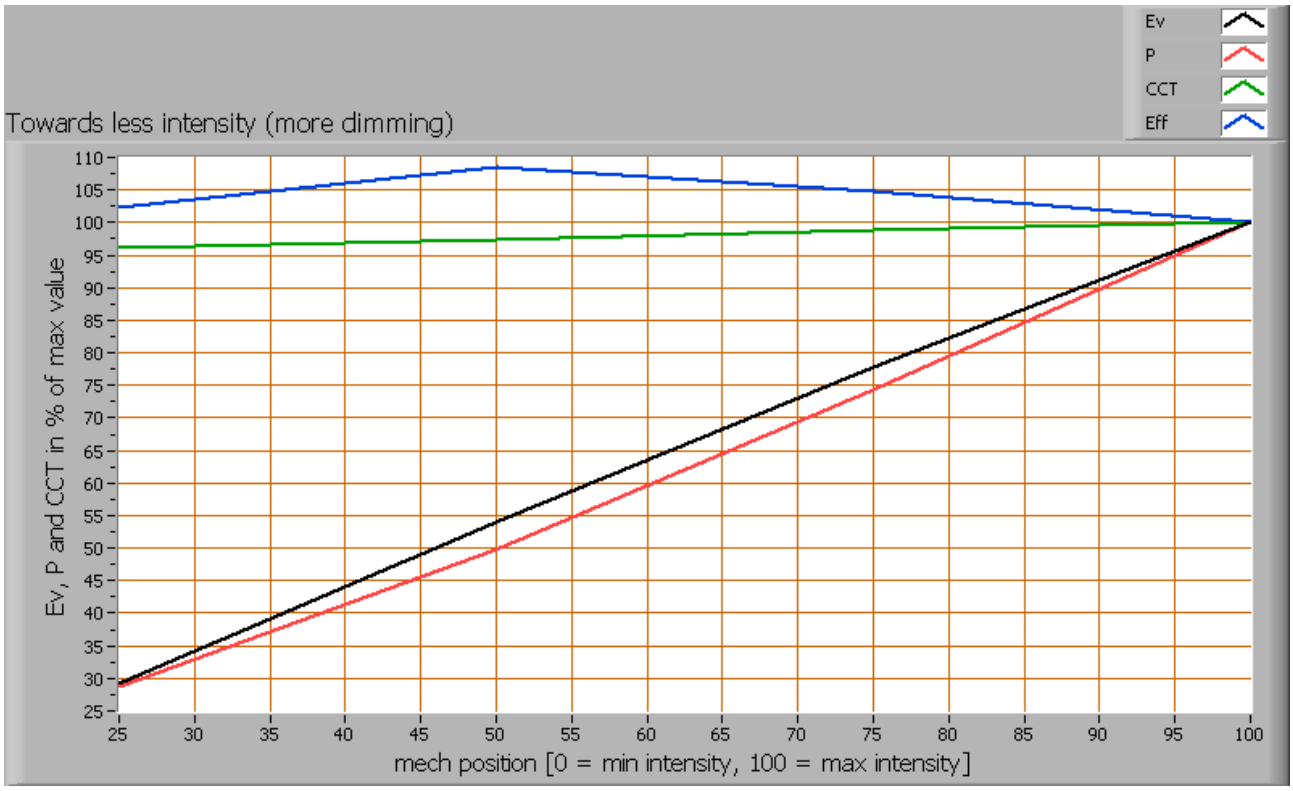
The warm up time is about 35 minutes. During that time the illuminance decreases with 11 % and the consumed power with 12 %.

Dim function

The tube has its own dim function, which is operated as follows (explanation Lioris):
Step 1. Switch on the Tubo. It will switch into it's previous choosen setting (memory).
Step 2. Within 10 seconds switch the Tubo off and on again.
Step 3. The dimming program will start. 3 blinks to indicate program mode
Within 6 seconds the Tubo will go to 100% light output and will blink 2 times
User has 4 seconds to select 100% or can select within the previous 6 seconds.
Within 6 seconds the Tubo will go to 75% light output and will blink 2 times
User has 4 seconds to select 75% or can select within the previous 6 seconds.
Within 6 seconds the Tubo will go to 50% light output and will blink 2 times
User has 4 seconds to select 50% or can select within the previous 6 seconds.
Within 6 seconds the Tubo will go to 25% light output and will blink 2 time
User has 4 seconds to select 25% or can select within the previous 6 seconds.
Tubo switches to 100% instantly
Step 4. If within step 3, the tube is switched off: then that dim setting will be selected when it is switched on again.

This is easy to dim, and this way all tubes connected to the same on/off switch can be dimmed to the same position.

The following graph gives the result of the dimming function. The general interpretation of the parameters and the graph is explained on the OliNo website.



Dim result on the lamp parameters

The tube is well dim-able. The illuminance decreases linearly with the dim-preset values being 100 %, 75 %, 50 % and 25 %.
The consumed power decreases at even a little higher speed, resulting in an even better efficacy.
The color temperature decreases a bit when dimming is done.

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