

## Lamp measurement report – 18 Feb 2010

### SMD Led Tube Light 1200 mm pure white by RR Led Solutions



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### Summary measurement data

parameter	meas. result	remark
Color temperature	5376	Cold white
Luminous intensity $I_v$	433 Cd	
Beam angle	111 deg	111° for the C0-C180 plane (crossing length direction of the tube) and 108° for the C90-C270 plane (length direction). This is virtually the same value.
Power P	20.3 W	
Power Factor	0.99	For every 1 kWh net power consumed, there has been 0.2 kVAh for reactive power.
Luminous flux	1225 Lm	
Luminous efficacy	60 Lm/W	
CRI_Ra	69	Color Rendering Index.
Coordinates chromaticity diagram	x=0.3371 and y=0.3761	
Fitting	FL-tube	
PAR-value	3.5 $\mu\text{Mol/s/m}^2$	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	0.5 $\mu\text{Mol/s/W}_e$	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	1.8	This factor indicates the amount of times more efficient the light of this light bulb is perceived under scotopic circumstances (low environmental light level).




## Lamp measurement report – 18 Feb 2010

L x D external dimensions	1200 x 26 mm	External dimensions of the lamp (L = length, without the pins).
L x W luminous area	1125 x 16 mm	Dimensions of the luminous area (used in Eulumdat file). This is equal to the surface on which leds are mounted.
General remarks		<p>The ambient temperature during the whole set of measurements was 23-25 deg C. The temperature of the lamp gets about 25 degrees hotter than ambient.</p> <p>Warm up effect: during the warm up time the illuminance decreases with 3 % and the consumed power with 7 %.</p> <p>Voltage dependency: the power consumption and illuminance do not vary significantly when the voltage is varied from 200 - 250 V.</p>

## Lamp measurement report – 18 Feb 2010

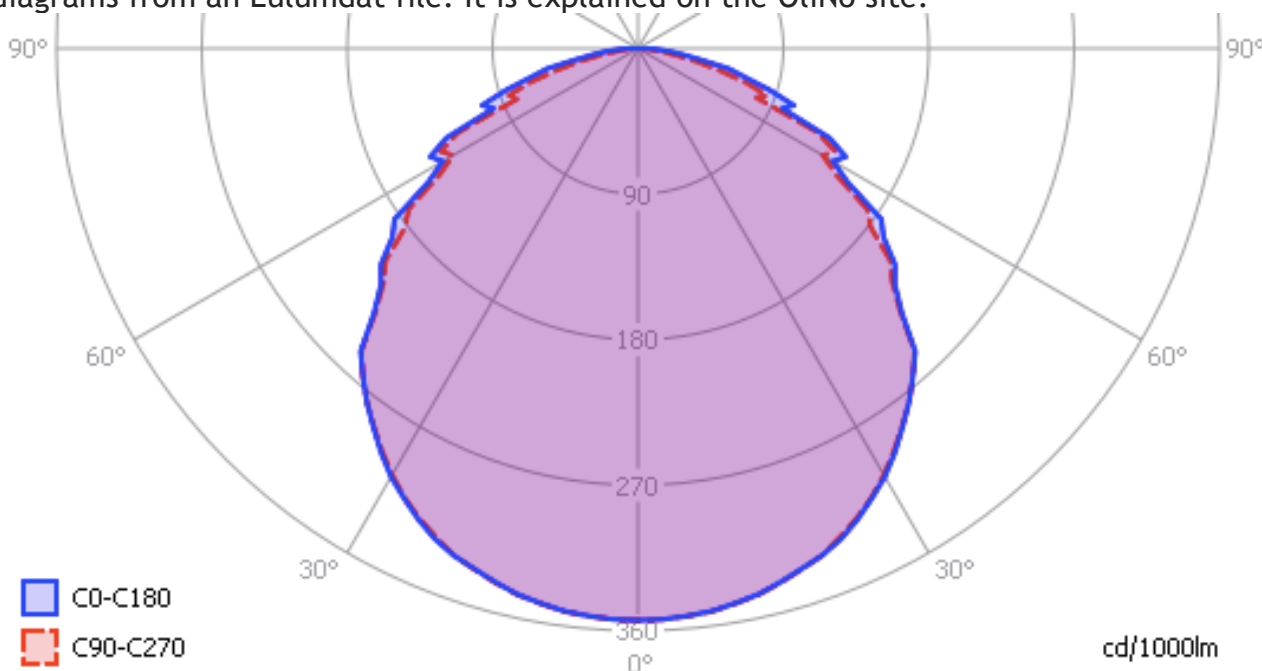
### Overview table

m.	Ø 50%		CO-180: 111° C90-270: 108°	E (lux)	Luminaire Efficacy
	CO-180	C90-270			60 (lumens per Watt)
0.25	0.73	0.69		6932	Half-peak diam CO-180
0.5	1.46	1.38		1733	2.92 x diameter(m)
1	2.92	2.75		433	Half-peak diam C90-270
1.5	4.38	4.13		193	2.75 x diameter(m)
3	8.76	8.26		48	Illuminance
4	11.68	11.01		27	433 / distance <sup>2</sup> (lux)
5	14.6	13.76		17	Total Output
					1225 (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 1125 mm ≈ 5600 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.



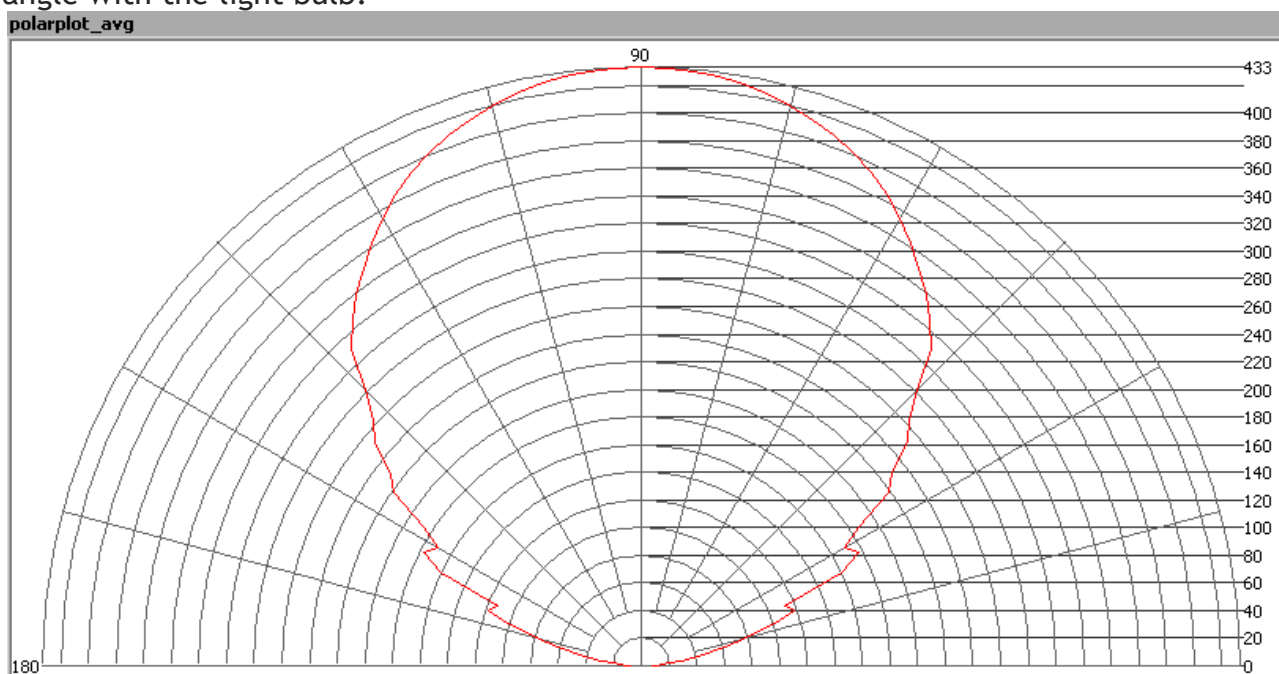
## Lamp measurement report – 18 Feb 2010

*The light diagram giving the radiation pattern.*

It indicates the luminous intensity around the light bulb. The directions or planes C90-C270 and C0-C180 give the same result.

### 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.

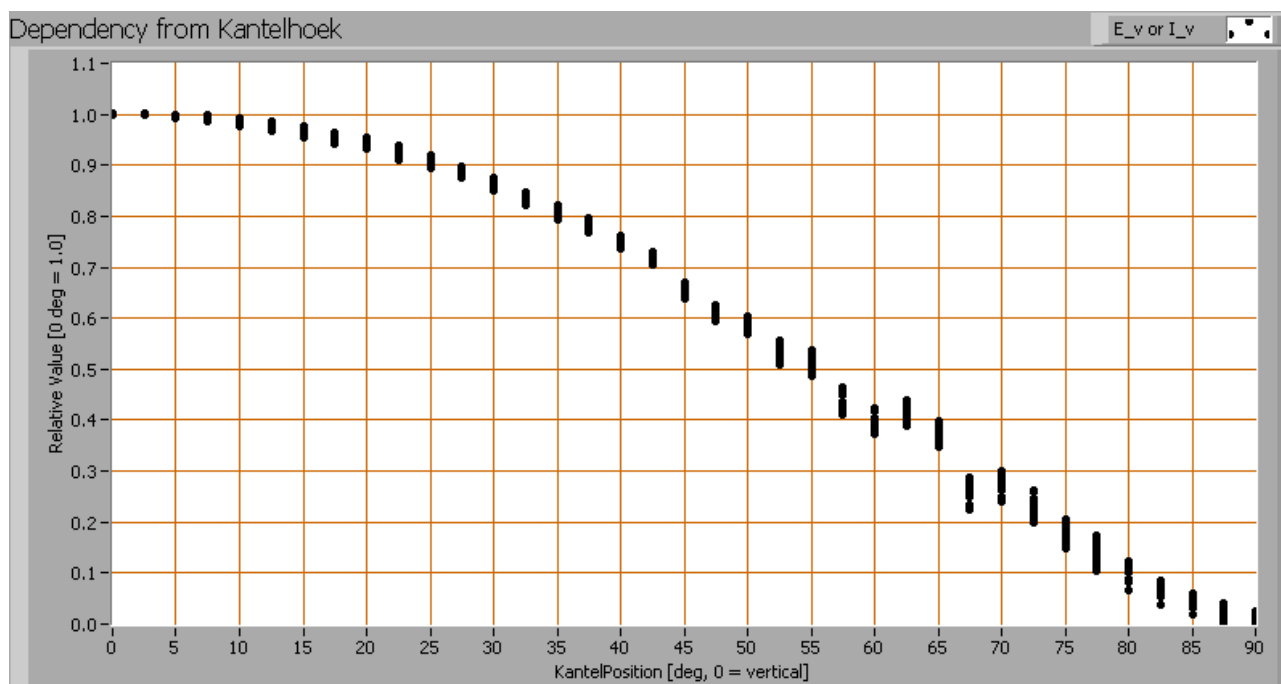


*The radiation pattern of the light bulb.*

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.

## Lamp measurement report – 18 Feb 2010



*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 108-111° depending on the plane looked at (virtually the same values).

### 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 1225 Lm.

### Luminous efficacy

The luminous flux being 1225 Lm, and the power of the light bulb being 20.3 W, yields a luminous efficacy of 60 Lm/W.

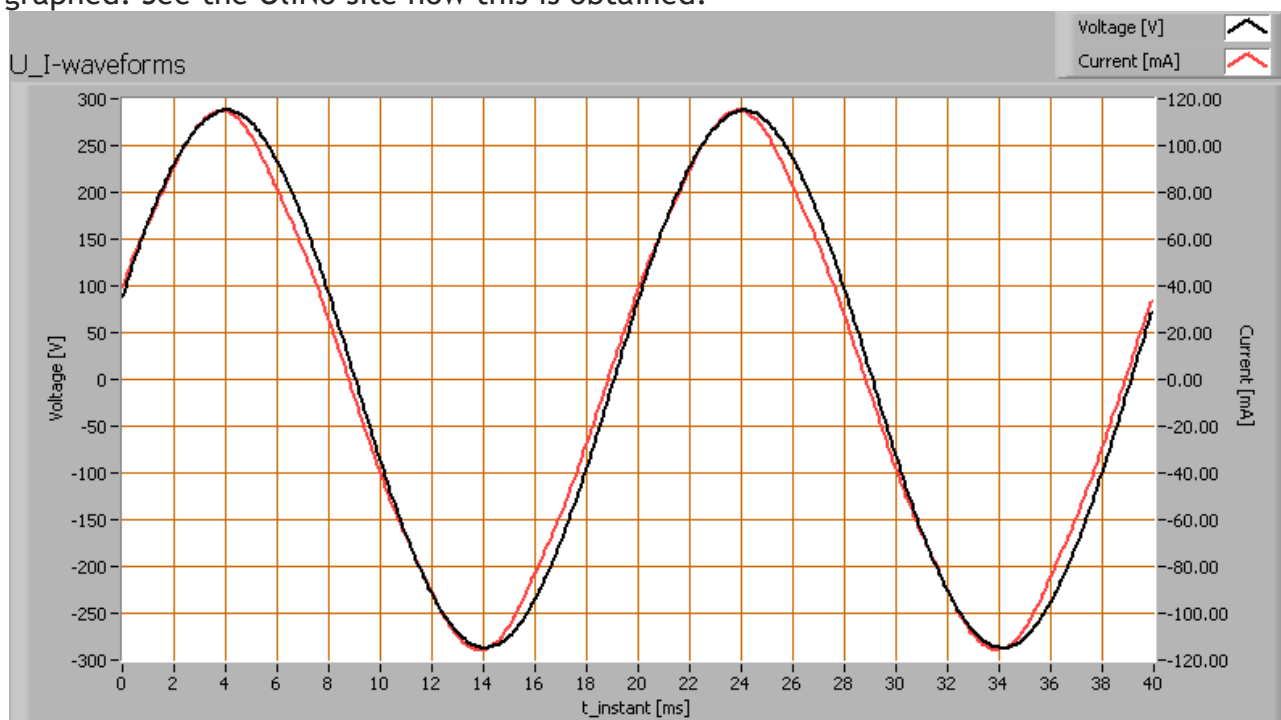
## Lamp measurement report – 18 Feb 2010

### Electrical properties

A power factor of 0.99 means that for every 1 kWh net power consumed, a reactive component of 0.2 kVAr was needed.

Lamp voltage	230 VAC
Lamp current	90 mA
Power P	20.3 W
Apparent power S	20.6 VA
Power factor	0.99

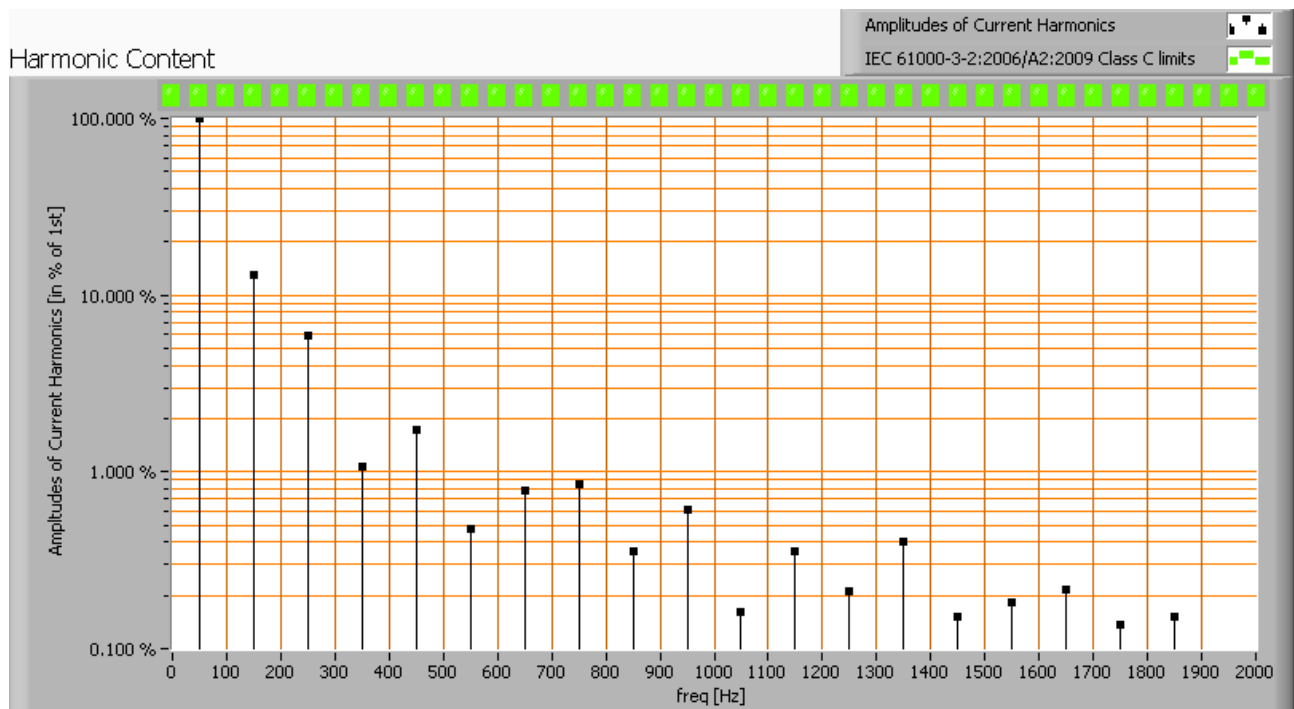
Of this light bulb the voltage across and the resulting current through it are measured and graphed. See the OLiNo site how this is obtained.



*Voltage across and current through the lightbulb*

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.

## Lamp measurement report – 18 Feb 2010

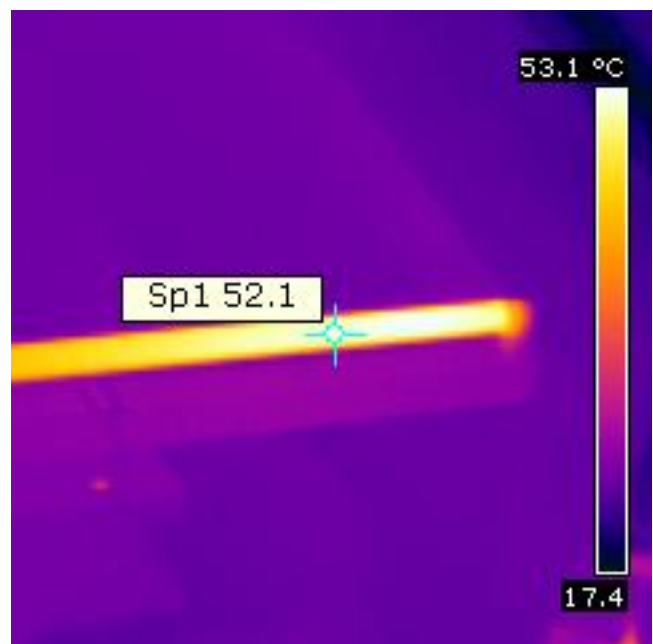
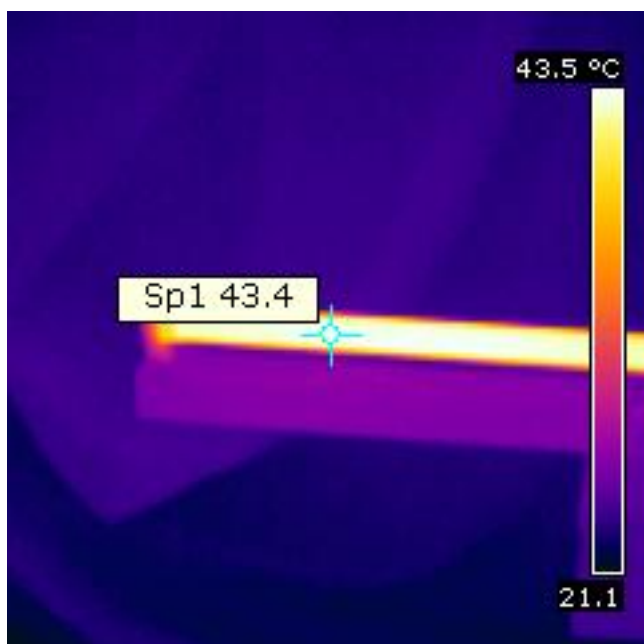


Harmonics in the current waveform and checked against IEC61000-3-2:2006

There are no limits for the harmonics for led lighting equipment  $\leq 25$  W.

The Total Harmonic Distortion of the current is computed as 17 %.

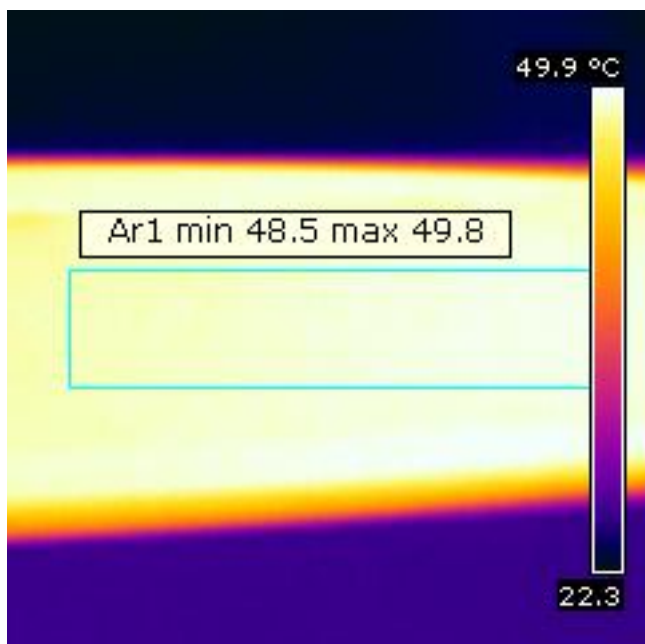
## Temperature measurements lamp





## Lamp measurement report – 18 Feb 2010

*Temperature image (overview) of the light bulb. One end is hotter*



*Hottest spot on the heat sink, measured on masking tape*

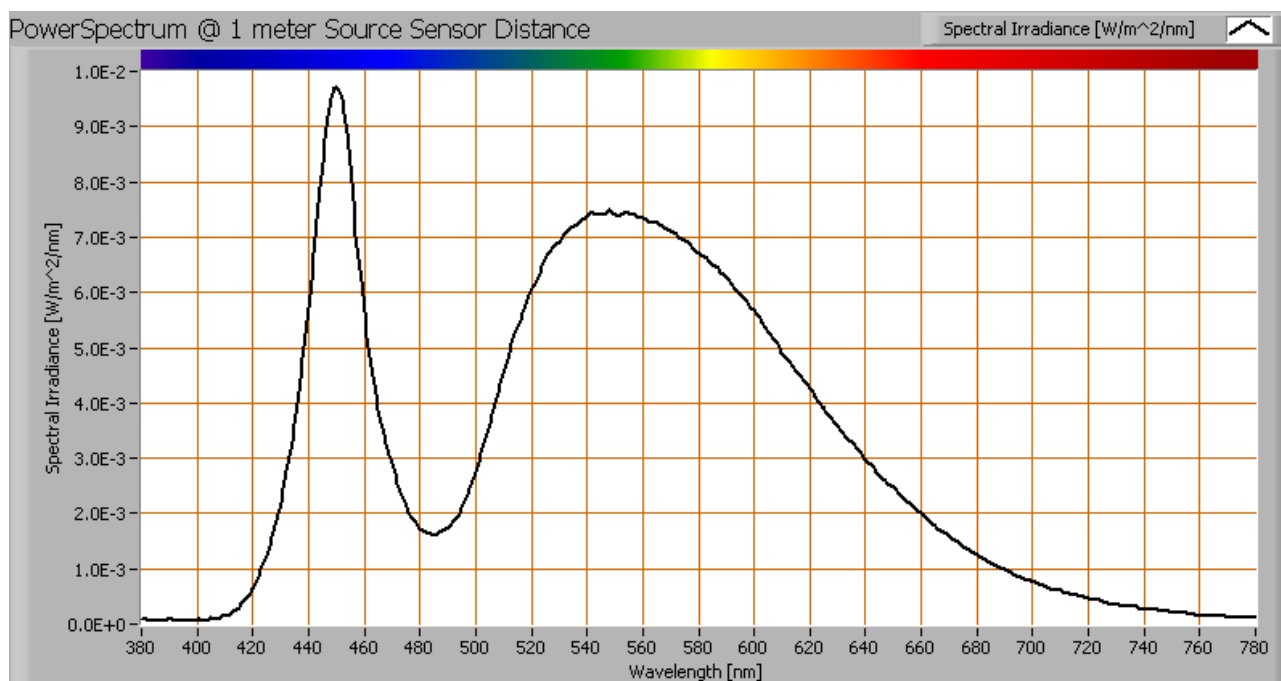
status lamp	> 2 hours on
ambient temperature	24 deg C
reflected background temperature	24 deg C
camera	Flir BCAM
emissivity	0.95 <sup>(1)</sup>
measurement distance	0.10 m (zoomed image)
IFOV <sub>geometric</sub>	0.4 mm
NETD (thermal sensitivity)	100 mK

<sup>(1)</sup> The emissivity is set at 0.95 which is close to the value of the masking tape that was used when measuring the metallic heatsink.

The hottest temperature on the heatsink part of the tube is hotter than warm-to-the-touch, here 49 deg C.

## Lamp measurement report – 18 Feb 2010

### Color temperature and Spectral power distribution

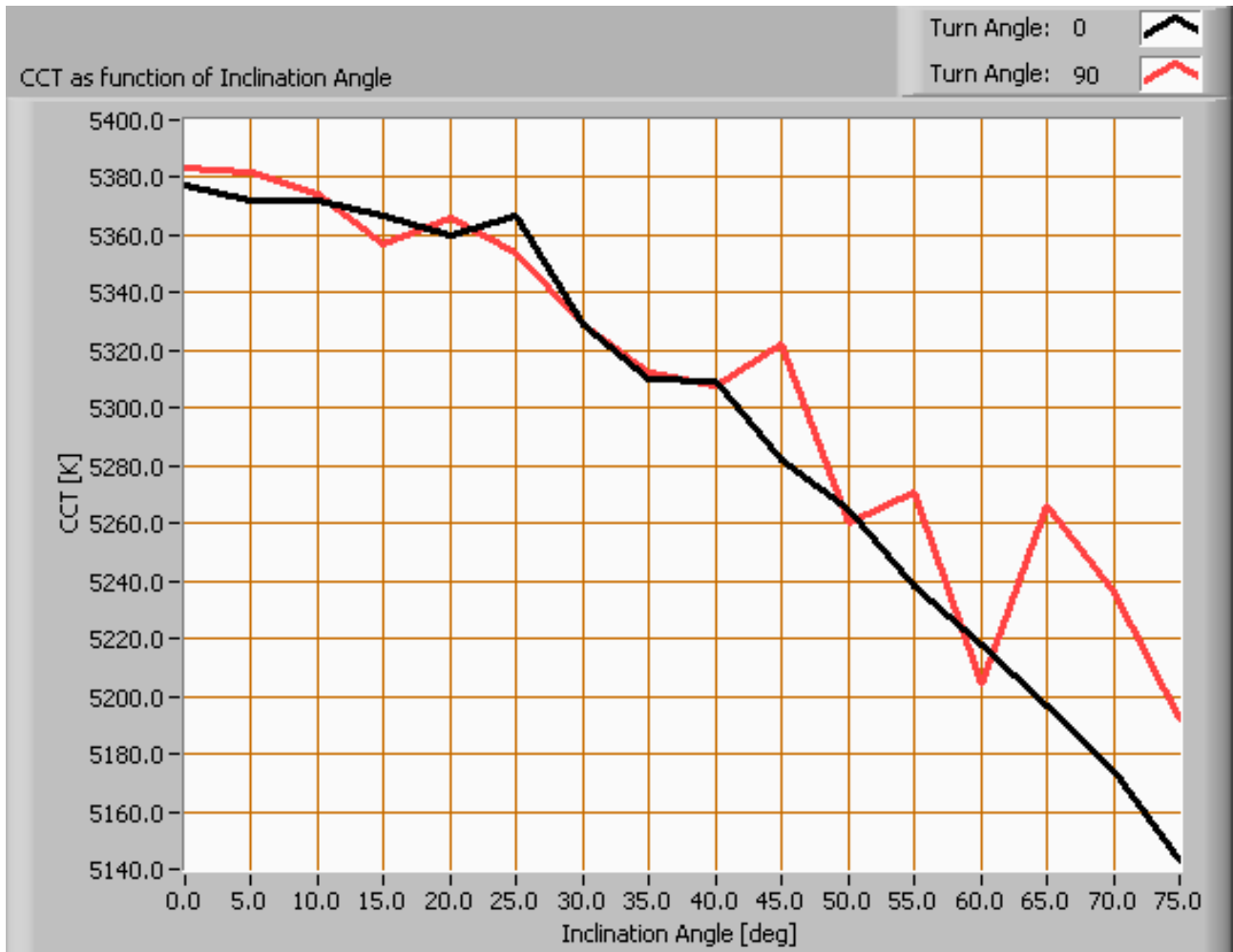


*The spectral power distribution of this light bulb, energies on y-axis valid at 1 m distance.*

The measured color temperature is about 5375 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.

## Lamp measurement report – 18 Feb 2010



*Color temperature as a function of inclination angle.*

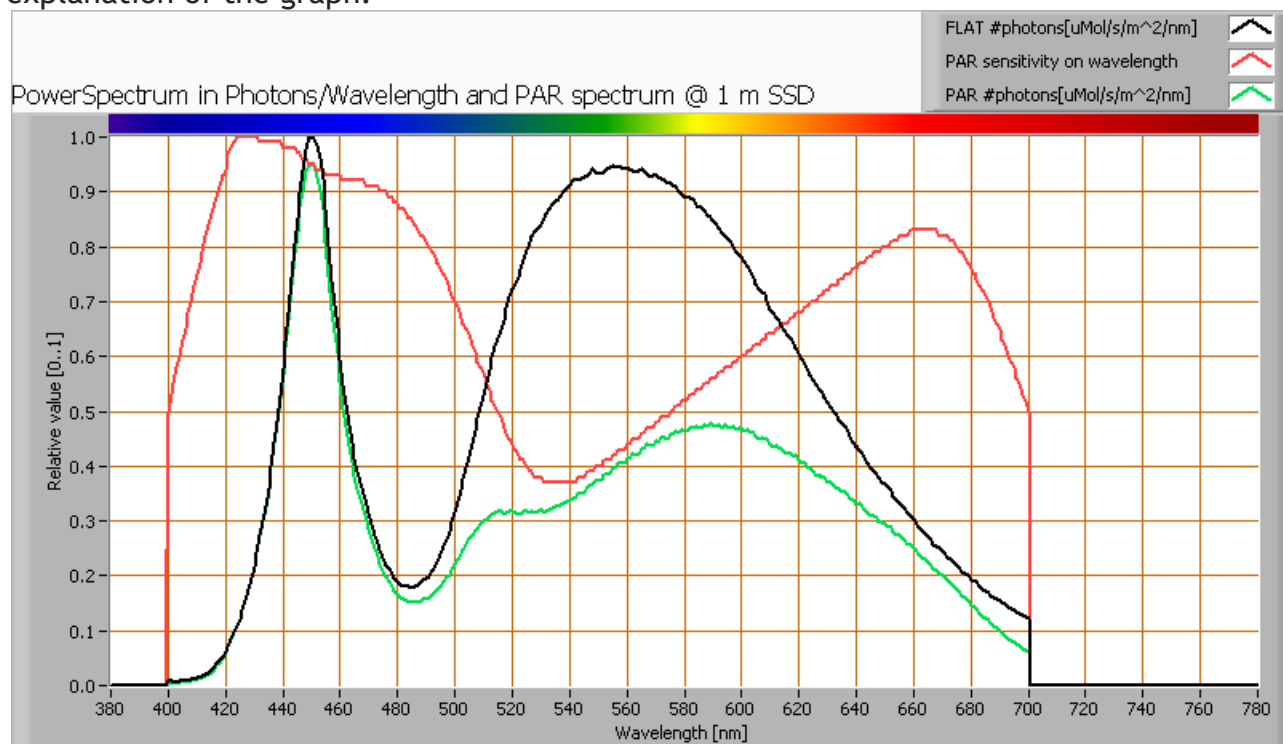
The measurement of CCT is measured for inclination angles up to 75° as beyond that angle the illuminance values are very low (< 5 lux).

The beam angle is maximally 111°, meaning a 55.5° inclination angle. In this area most of the light is present. The variation in correlated color temperature in this area is about 3 %.

## Lamp measurement report – 18 Feb 2010

### 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*

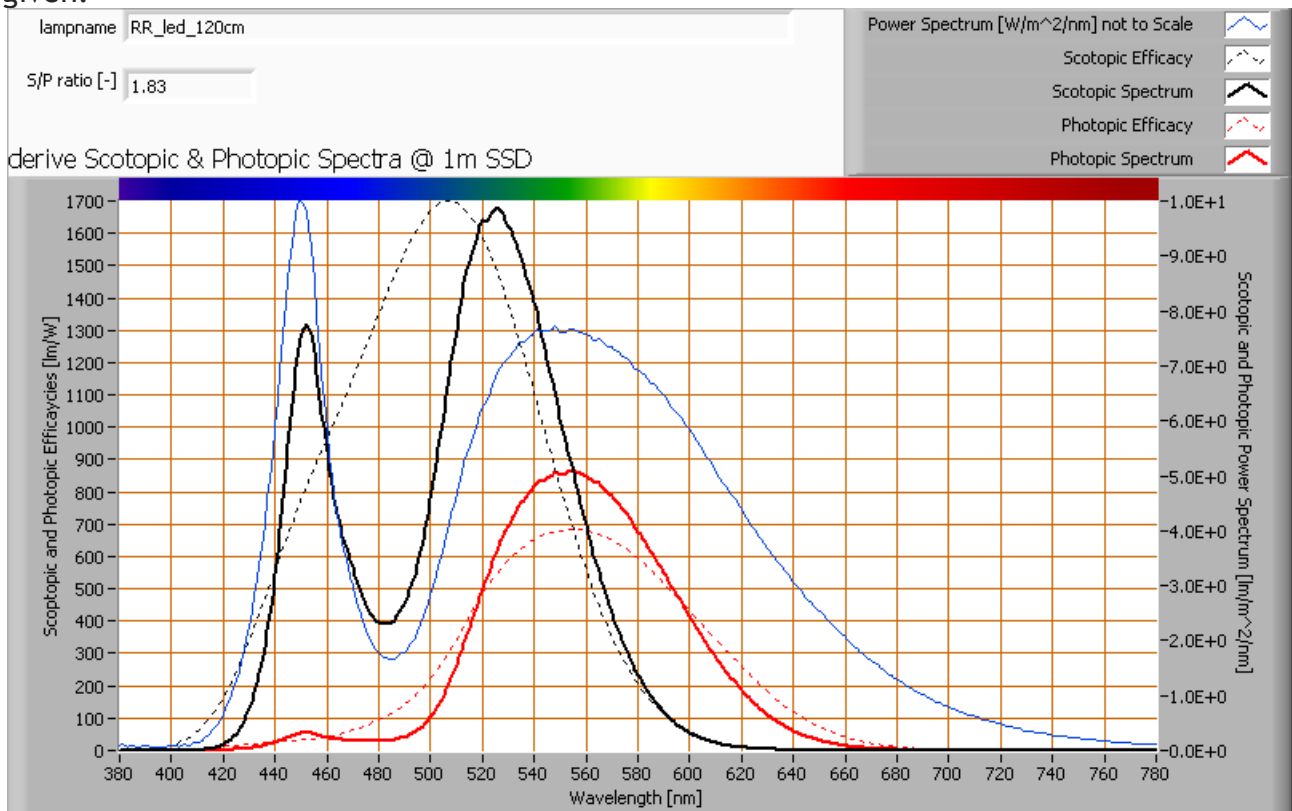
parameter	value	unit
PAR-number	3.5	$\mu\text{Mol/s/m}^2$
PAR-photon current	10.0	$\mu\text{Mol/s}$
PAR-photon efficacy	0.5	$\mu\text{Mol/s/W}$

The PAR efficiency is 63 % (valid for the PAR wave length range of 400 - 700 nm). So maximally 63 % 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 %).

## Lamp measurement report – 18 Feb 2010

### S/P ratio

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



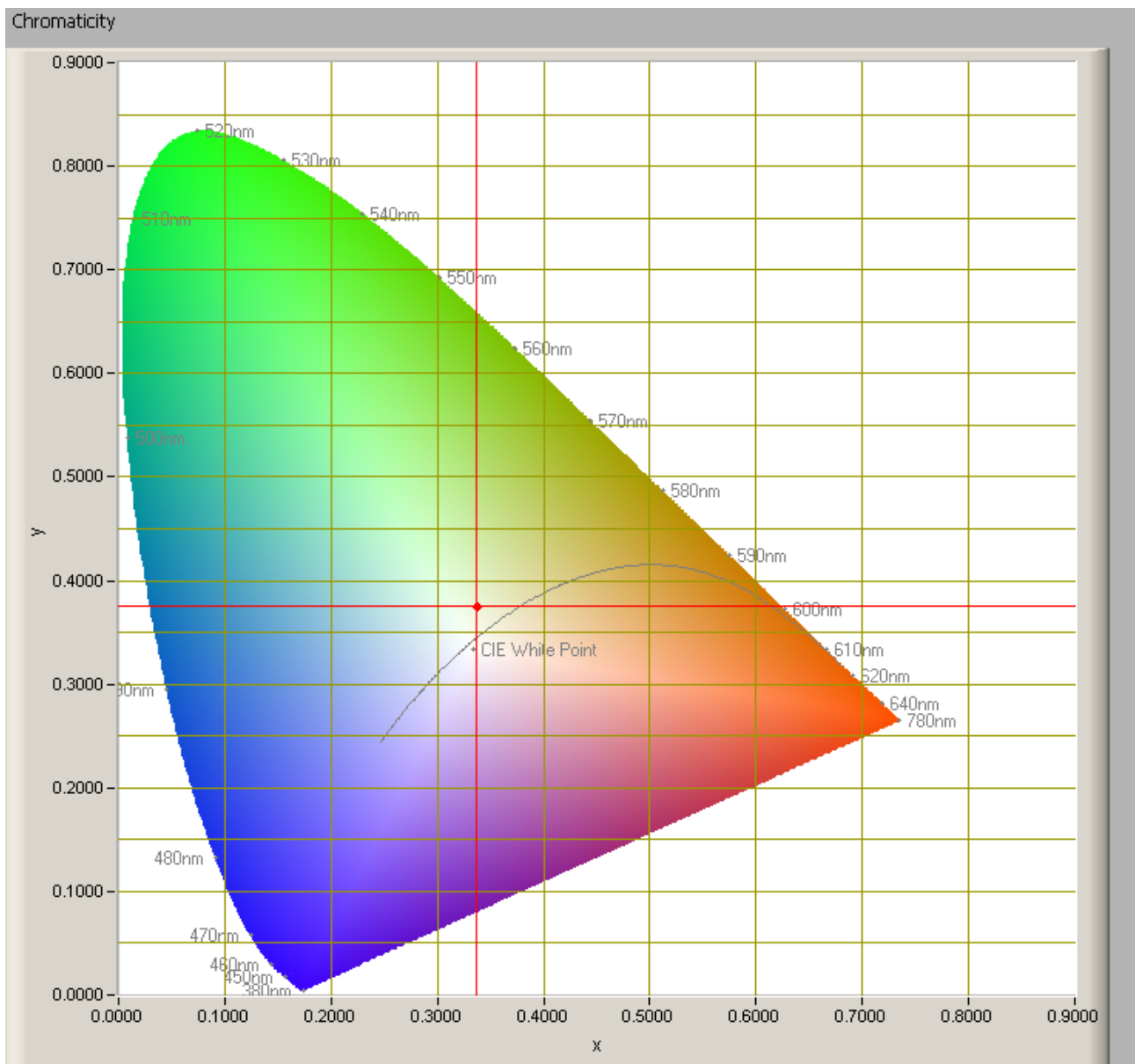
*The power spectrum, sensitivity curves and resulting scotopic and photopic spectra (spectra energy content defined at 1 m distance).*

The S/P ratio is 1.8.

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

## Lamp measurement report – 18 Feb 2010

### Chromaticity diagram



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

The light coming from this lamp is at a distance from the Planckian Locus (the black path in the graph).

Its coordinates are  $x=0.3371$  and  $y=0.3761$ .

## Lamp measurement report – 18 Feb 2010

### 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: 5376 K

Chromaticity Difference DC= 1.2E-2

R1= 63.4	R8= 53.3	<b>Ra</b> (mean value of R1 - R8) <b>69.1</b>
R2= 73.4	R9= -47.6	
R3= 82.2	R10= 38.2	
R4= 68.8	R11= 63.9	
R5= 64.9	R12= 35.9	
R6= 64.6	R13= 64.8	
R7= 82.5	R14= 90.1	

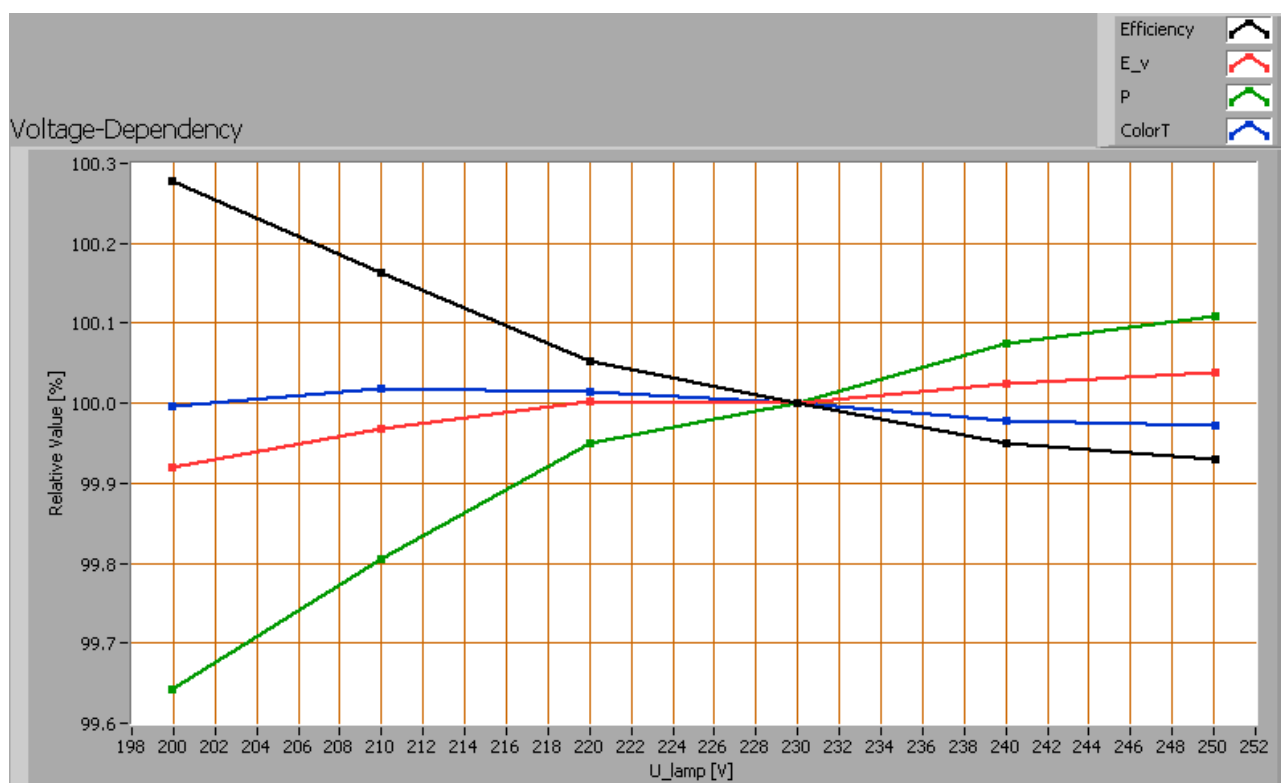
*CRI of the light of this lightbulb.*

The value of 69 is lower than 80 which is considered a minimum value for indoor usage. Note: the chromaticity difference is 0.012 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].

## Lamp measurement report – 18 Feb 2010



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.

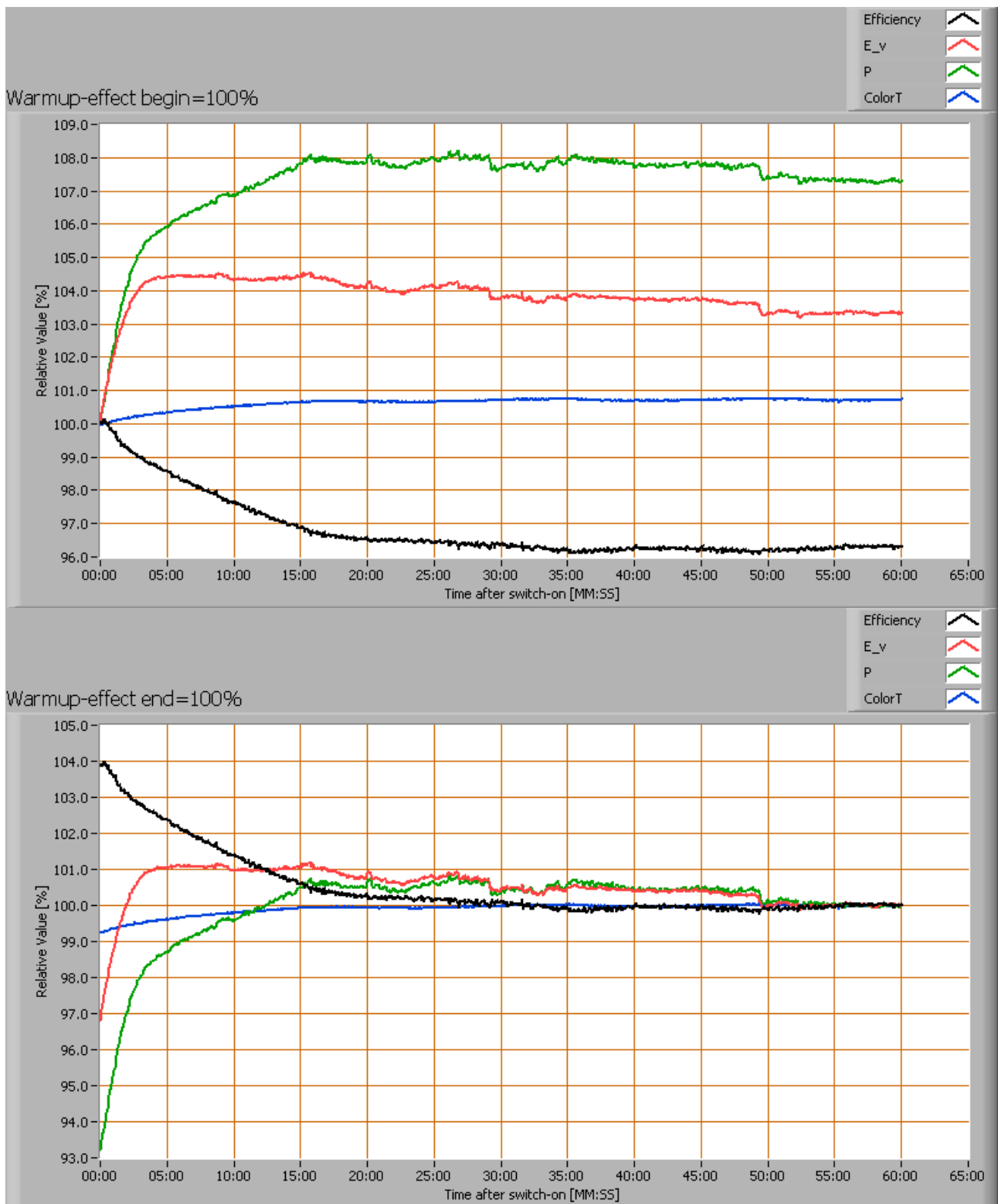
When the voltage at 230 V varies with + and - 5 V, then the illuminance varies < 0.1 %, so when abrupt voltage changes occur this effect is not visible in the illuminance output.

### Warm up effects

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



## Lamp measurement report – 18 Feb 2010



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



## **Lamp measurement report – 18 Feb 2010**

The warm up time is about 15 minutes. During that time the illuminance decreases with  $\approx 3 \%$  and the consumed power with  $7 \%$ .

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