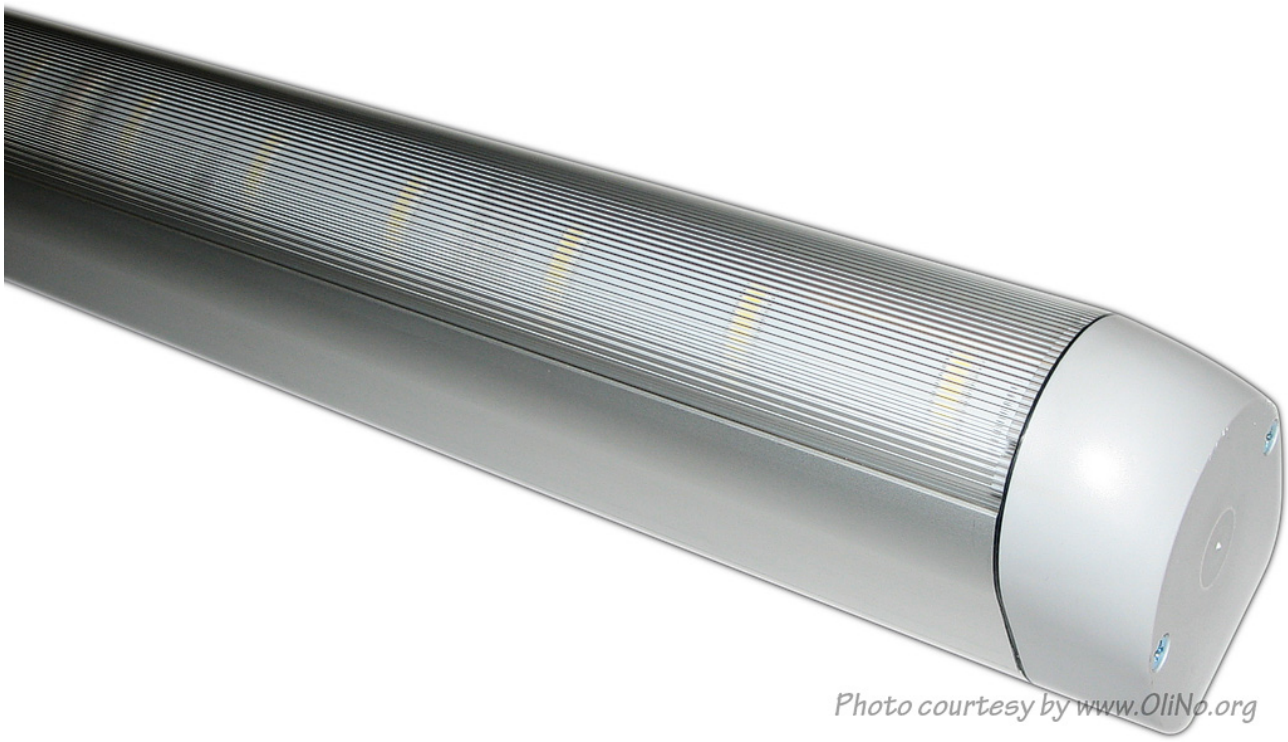
# Lamp measurement report – 22 May 2010

## Led Tube 24V
## by
## Ledlighting



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## Summary measurement data

| parameter | meas. result | remark |
|---|---|---|
| Color temperature | 5112 K | Cold white |
| Luminous intensity $I_v$ | 778 Cd | Measured straight underneath the lamp |
| Illuminance modulation index | 0 % | Measured straight underneath the lamp. Is a measure for the amount of flickering. |
| Beam angle | 122 deg | 122° for the C0-C180 plane (crossing length direction of the tube) and 111° for the C90-C270 plane (length direction). |
| Power P | 25.9 W | |
| Power Factor | n.a. | The lamp has been connected to 24 V DC, and with DC power there are no blind currents between the power supply and the lamp. |
| THD | n.a. | The current drawn is a DC current hence no THD. |
| Luminous flux | 2530 Lm | |
| Luminous efficacy | 98 Lm/W | |
| CRI_Ra | 75 | Color Rendering Index. |
| Coordinates chromaticity diagram | x=0.3430 and y=0.3549 | |
| Fitting | FL-tube | This Tube Light is connected a 24 V DC power supply. |
| PAR-value | 6.9 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 | 0.9 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. |
| | | |

| | | |
|---|---|---|
| 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). |
| L x W x H external dimensions | 1560 x 64 x 80 mm | External dimensions of the lamp. |
| L x W x H luminous area | 1500 x 50 x 13 mm | Dimensions of the luminous area (used in Eulumdat file). This is equal to the dimensions of the transparent cover around the leds. |
| General remarks | | The ambient temperature during the whole set of measurements was 23.5-25 deg C. The warmest temperature of the tube get about 5 degrees hotter than ambient.<br><br>Warm up effect: during the warm up time there is no significant dependency of the illuminance nor consumed power.<br>Voltage dependency: the power consumption and illuminance do not vary significantly when the voltage is varied from 200 - 250 V. |
| | | |

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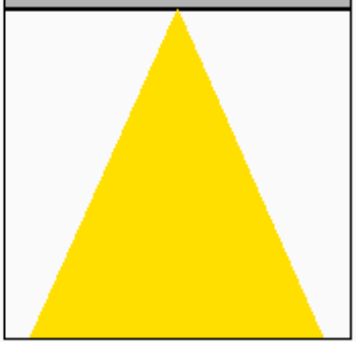
## Overview table

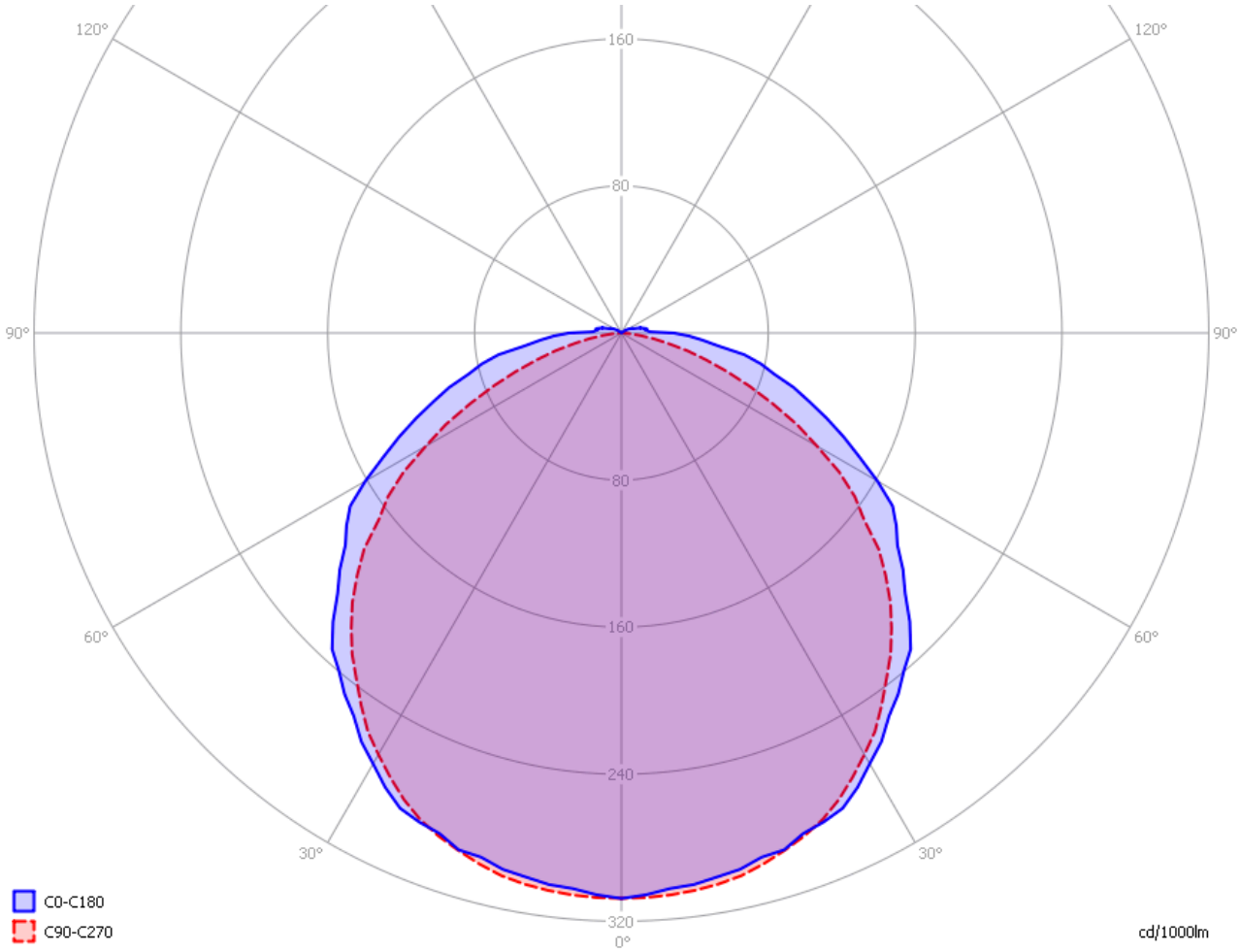
| m. | Ø 50% C0-180 | Ø 50% C90-270 | C0-180: 122° C90-270: 111° | E (lux) |
|---|---|---|---|---|
| 0.25 | 0.91 | 0.72 |  | 12453 |
| 0.5 | 1.82 | 1.44 | | 3113 |
| 1 | 3.64 | 2.88 | | 778 |
| 1.5 | 5.46 | 4.32 | | 346 |
| 3 | 10.93 | 8.65 | | 86 |
| 4 | 14.57 | 11.53 | | 49 |
| 5 | 18.21 | 14.42 | | 31 |

| | |
|---|---|
| Luminaire Efficacy | |
| 98 | (lumens per Watt) |
| Half-peak diam $C_{0-180}$ | |
| 3.64 | x diameter(m) |
| Half-peak diam $C_{90-270}$ | |
| 2.88 | x diameter(m) |
| Illuminance | |
| 778 | / distance² (lux) |
| Total Output | |
| 2530 | (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 1500 mm ≈ 7500 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 direction or plane C0-C180 cuts the lamp in the direction crossing the length direction of the tube, and the C90-C270 plane cuts the lamp in the length direction.

## 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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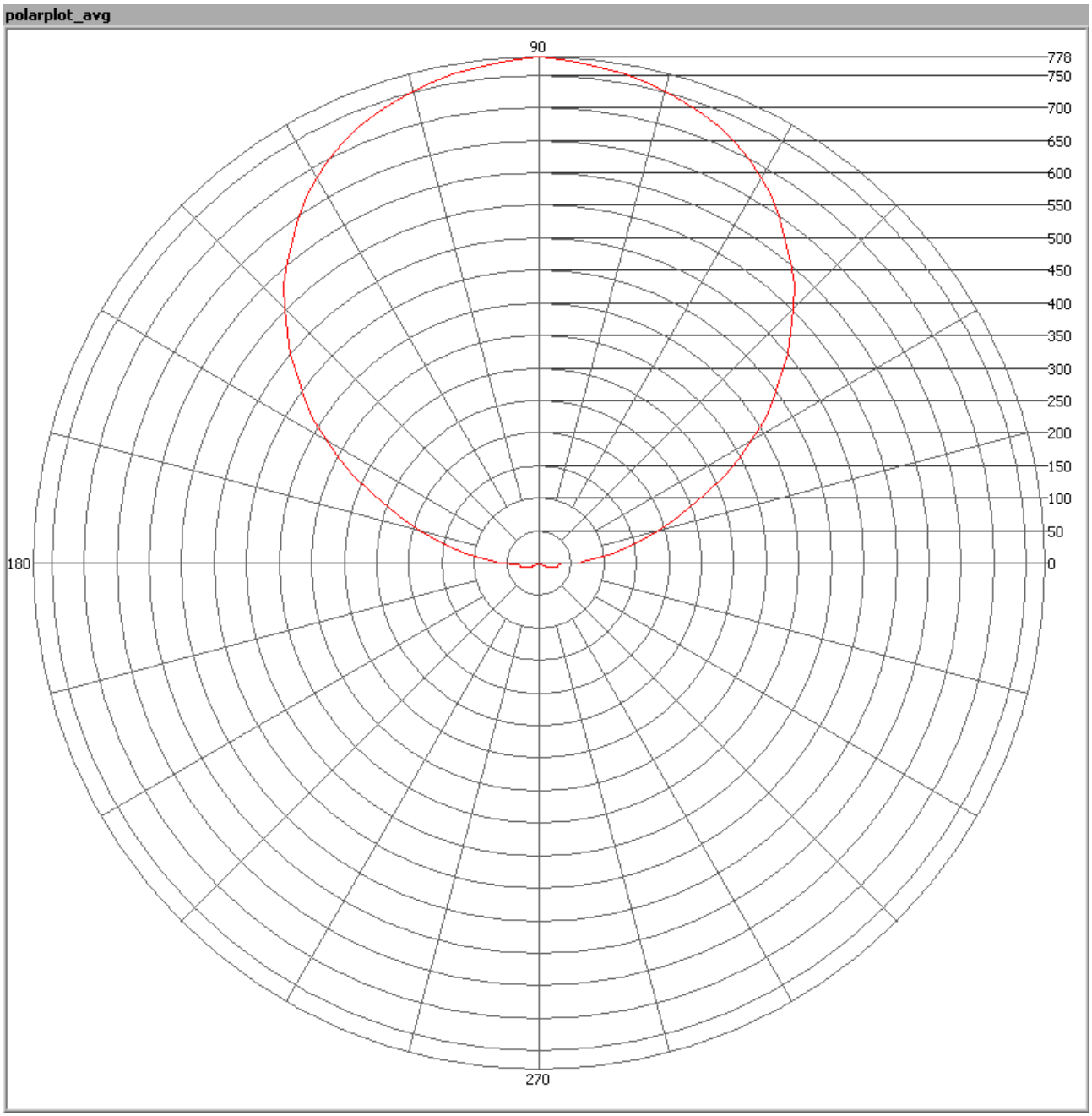
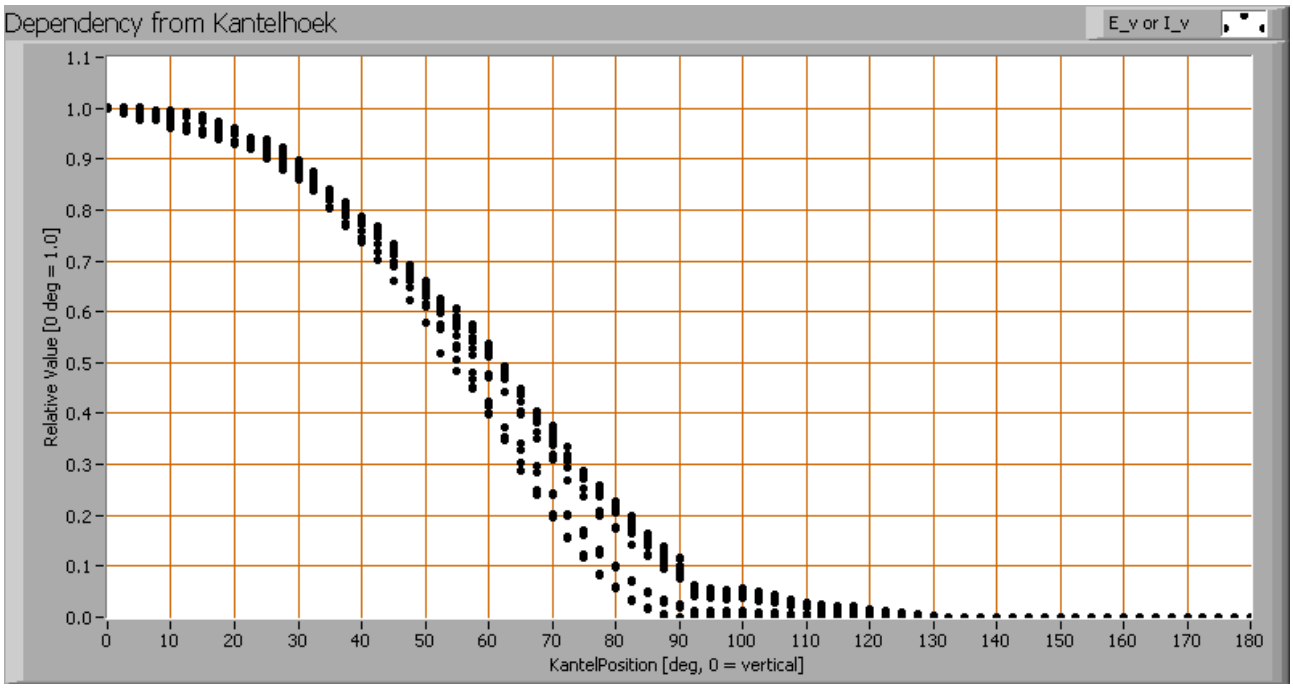



*The radiation pattern of the light bulb.*

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 122° in the C0-C180 plane and 111° in 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 2530 Lm.

## Luminous efficacy

The luminous flux being 2530 Lm, and the power of the light bulb being 25.9 W, yields a luminous efficacy of 98 Lm/W.

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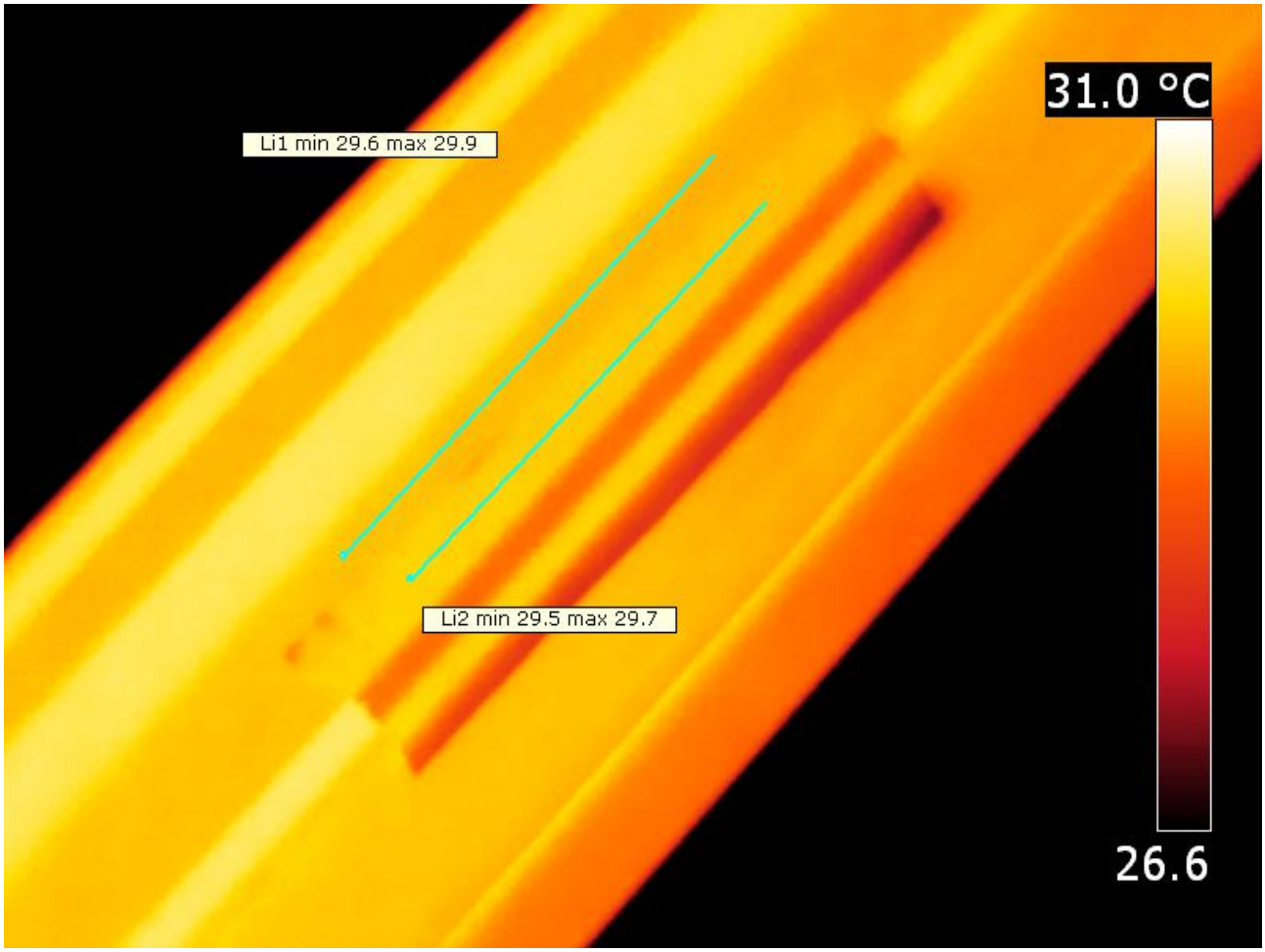
## Electrical properties

Since it was powered with a (24 V) DC power supply, there were no blind currents and hence the power factor definition is always 1 and makes no sense.

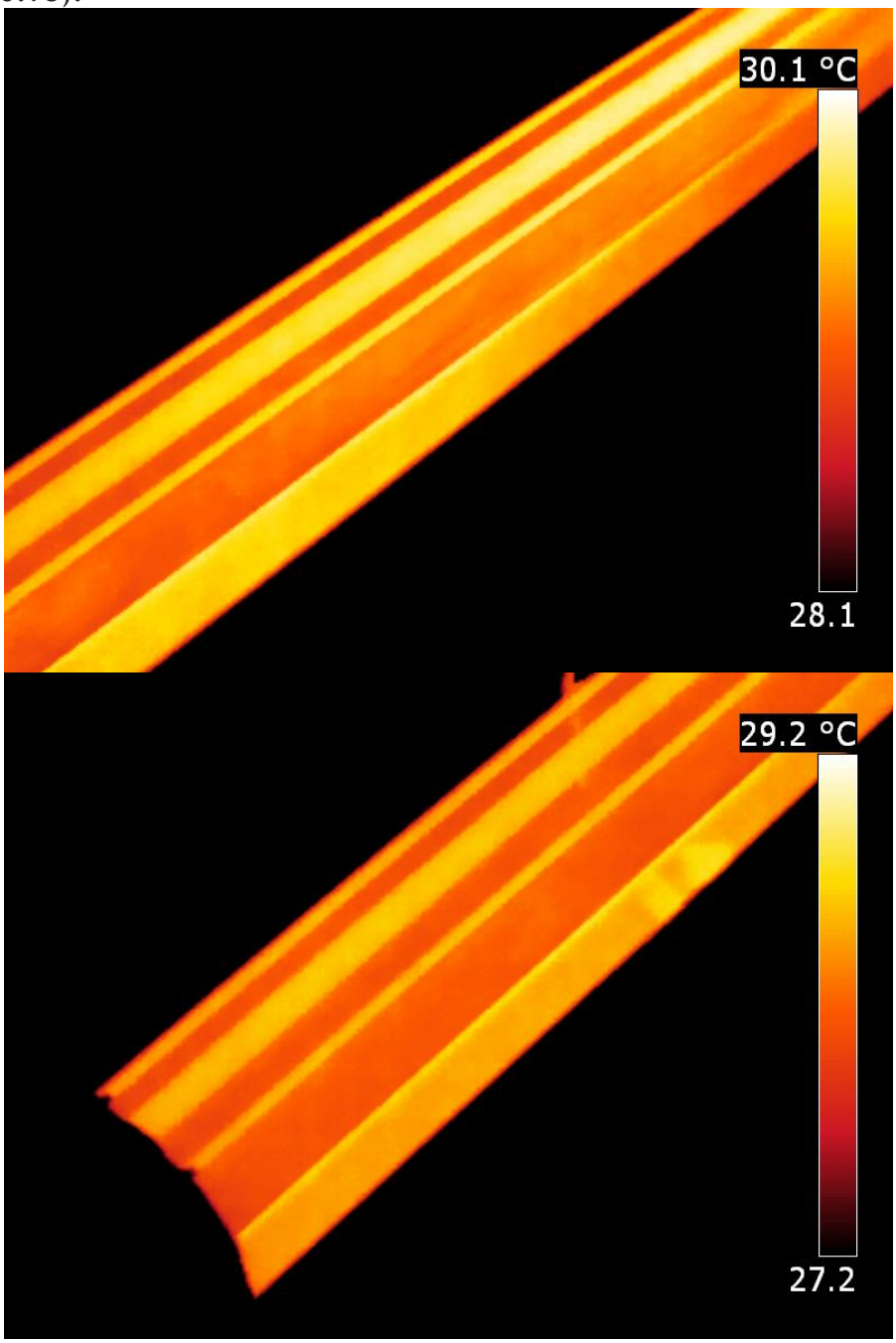
| | |
|---|---|
| Lamp voltage | 24 V DC |
| Lamp current | 1.08 A |
| Power P | 25.9 W |
| Apparent power S | not relevant |
| Power factor | not relevant |

## Temperature measurements lamp




*Temperatures measured on the tape are equal to measurement results directly on the body.*

The temperatures on tape and body directly are the same, meaning equal emissivity (of 0.95).




*Temperatures up to 30 deg C.*

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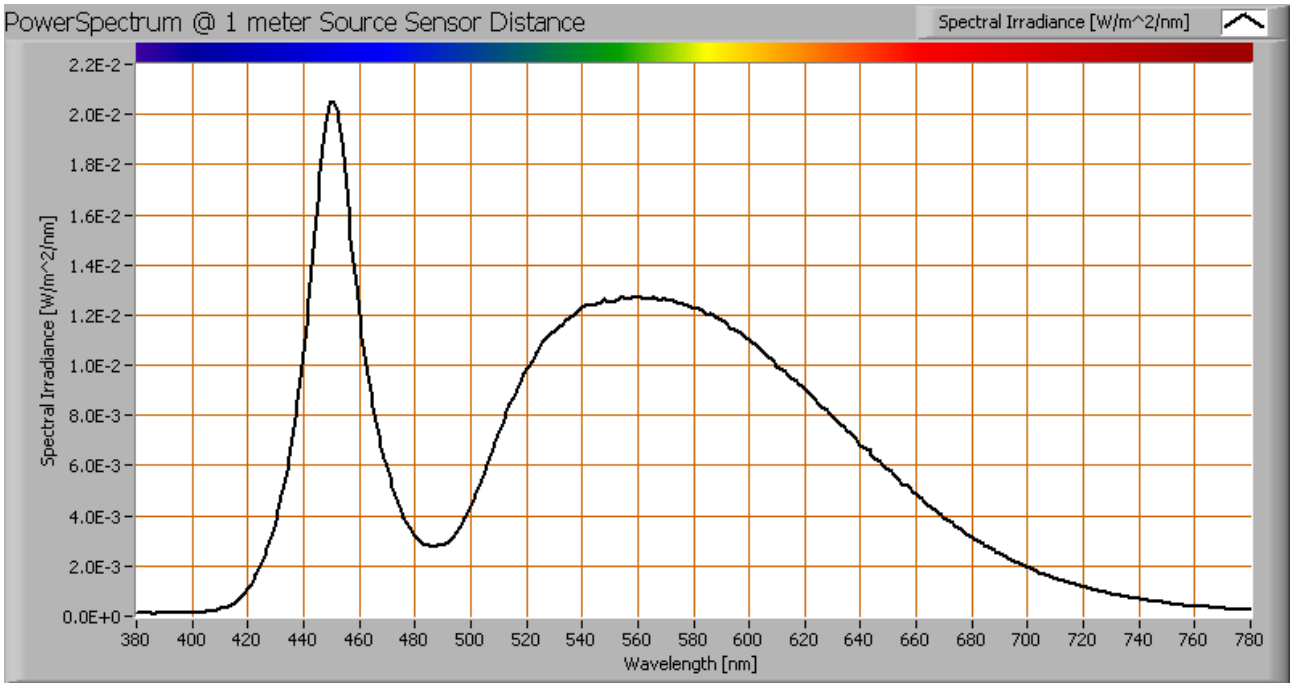
| | |
|---|---|
| status lamp | > 2 hours on |
| ambient temperature | 24 deg C |
| reflected background temperature | 24 deg C |
| camera | Flir T335 |
| emissivity | 0.95[1] |
| measurement distance | 0.3 m |
| $IFOV_{geometric}$ | 0.4 mm |
| NETD (thermal sensitivity) | 50 mK |

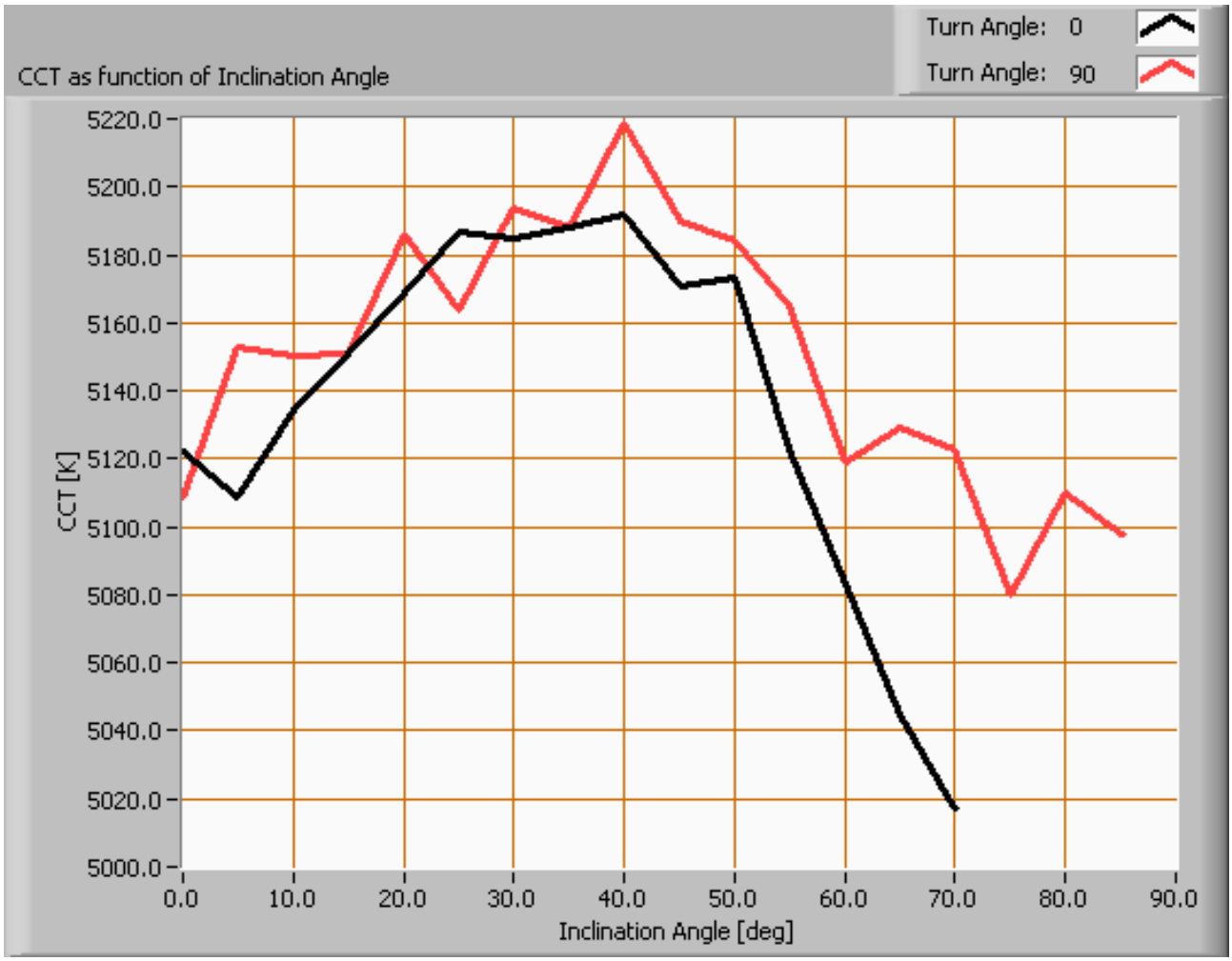
[1] The emissivity is set at 0.95 which is close to the value of the masking tape used.

## 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 5100 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.

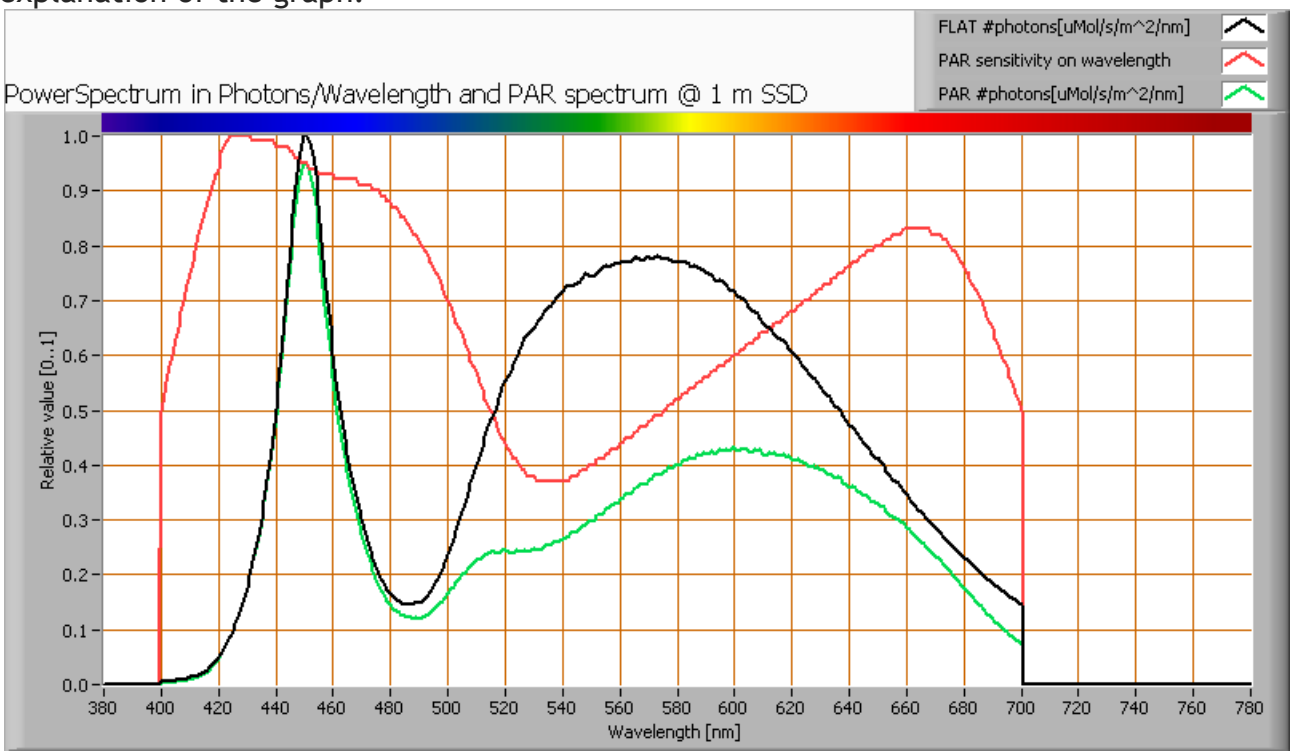



*Color temperature as a function of inclination angle.*

The measurement of CCT is measured for inclination angles up to 70° as beyond that angle the illuminance values are very low (< 5 lux).
The beam angle is maximally 122°, meaning a 61° inclination angle. In this area most of the light is present. The variation in correlated color temperature in this area is ≈ 2 %.

## 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 | 6.9 | µMol/s/m² |
| PAR-photon current | 22.5 | µMol/s |
| PAR-photon efficacy | 0.9 | µMol/s/W |

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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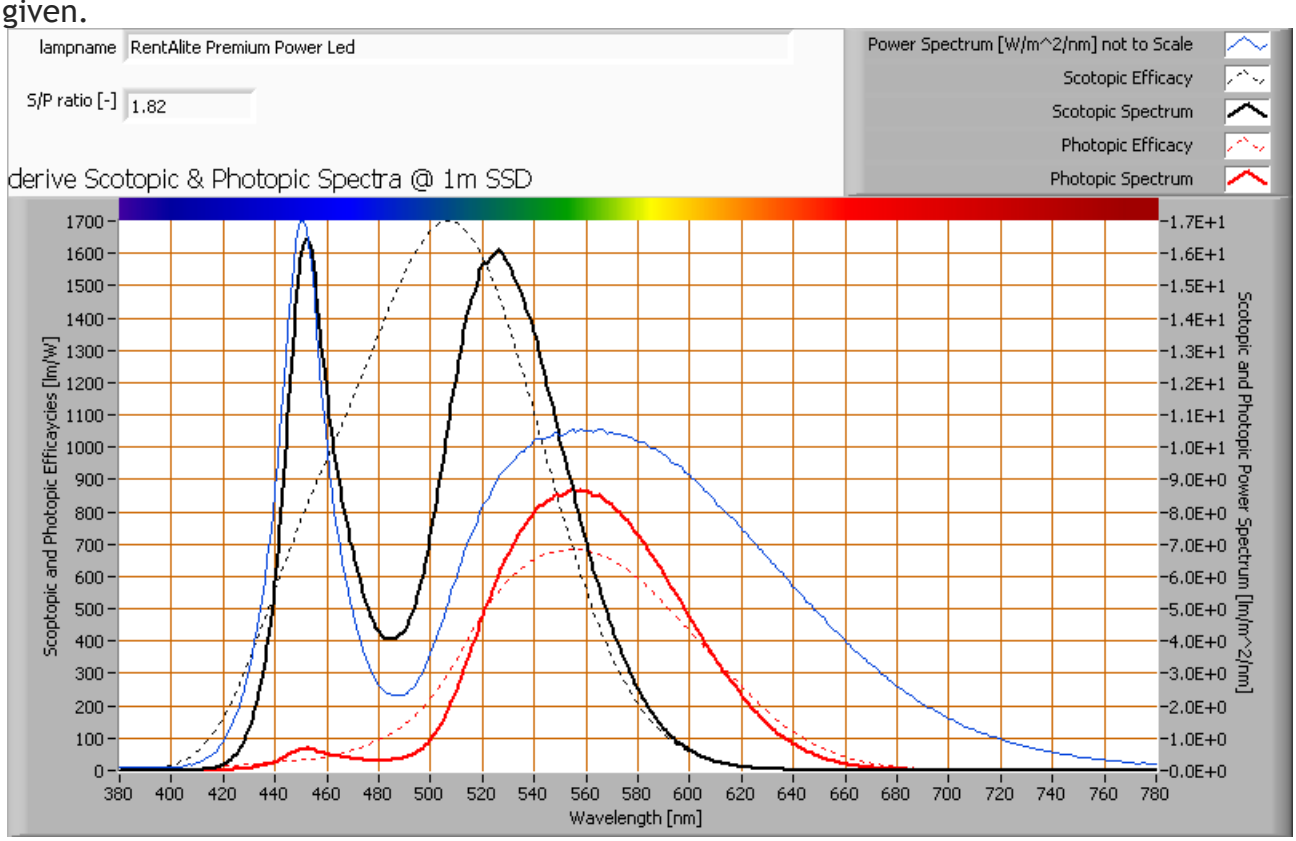
## S/P ratio

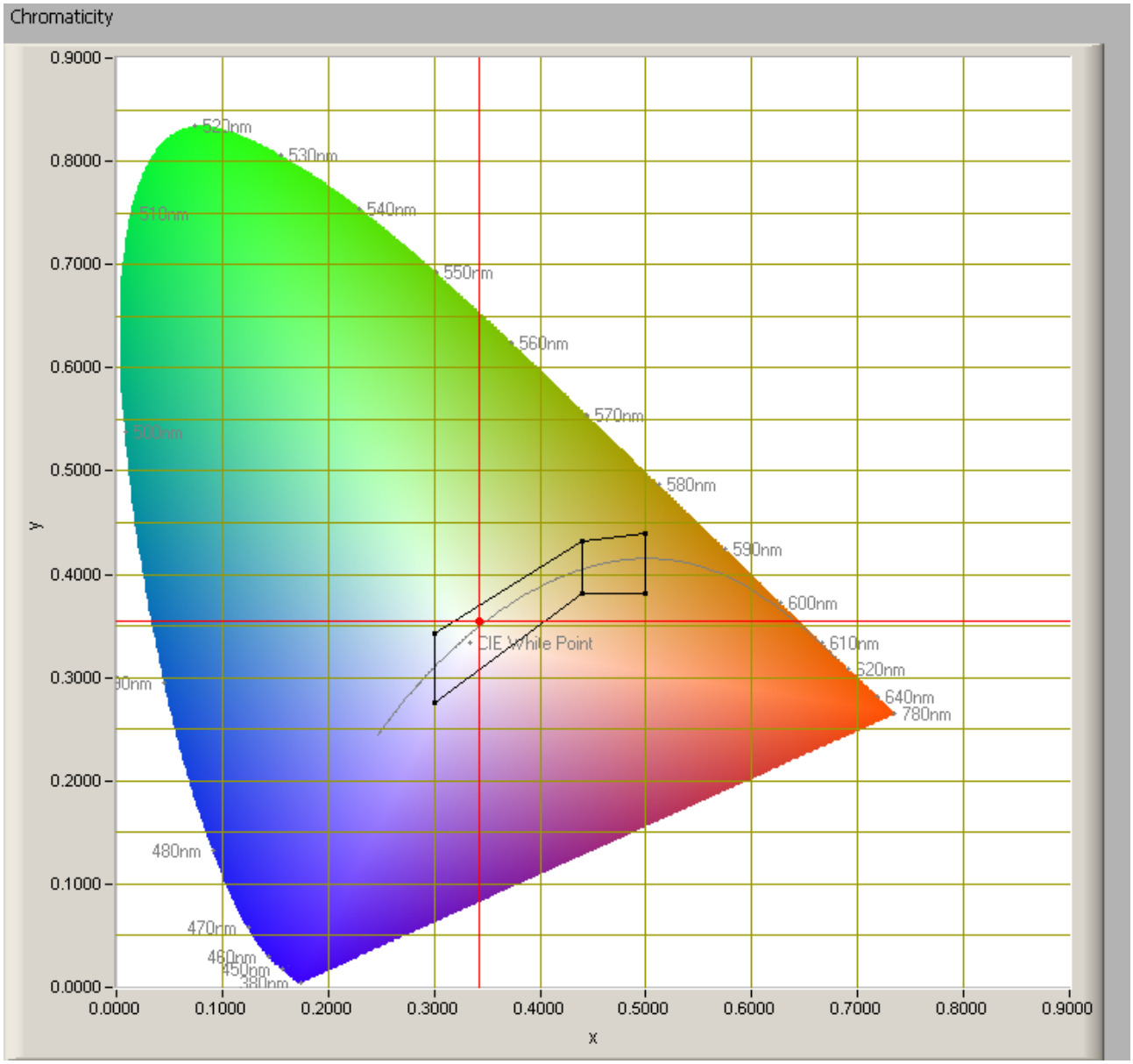
The S/P ratio and measurement is explained on the OliNo website. Here the results are given.




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

The S/P ratio is 1.8.
More info on S/P ratio can be found on the OliNo website.

## Chromaticity diagram

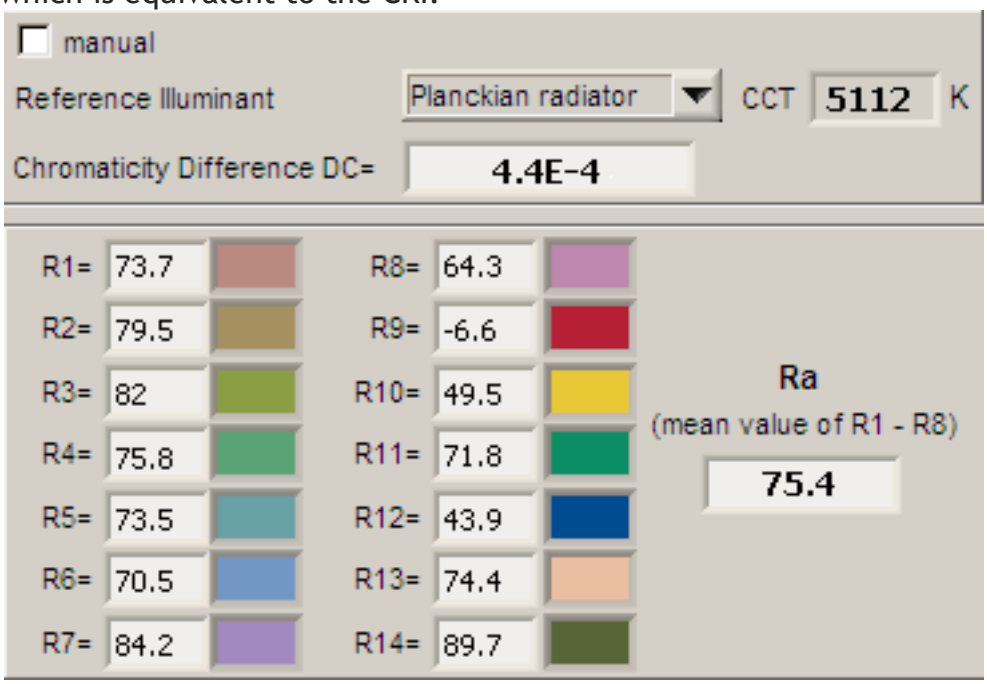



*The chromaticity space and the position of the lamp's color coordinates in it.*

The light coming from this lamp is inside 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=0.3430 and y=0.3549.

## 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.



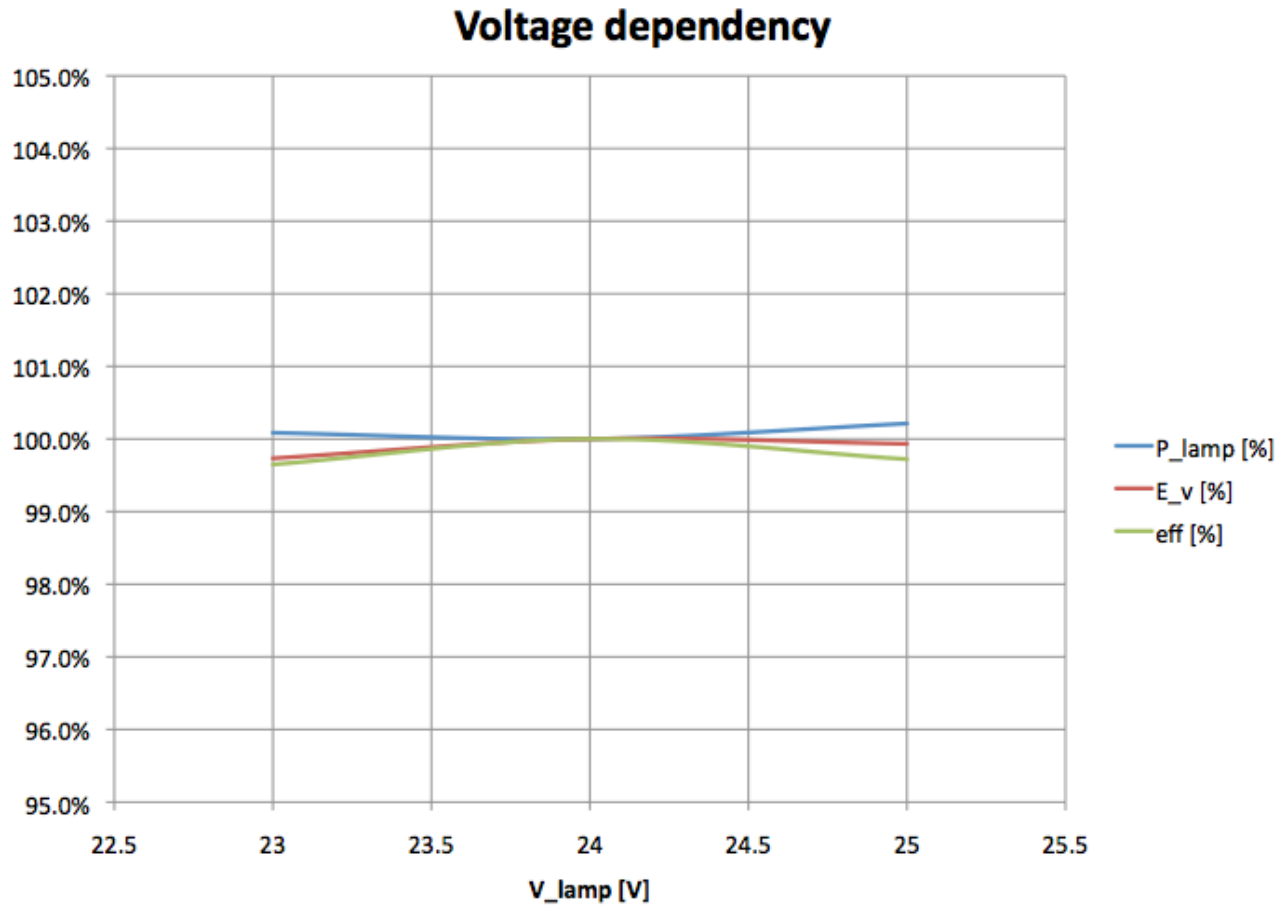

*CRI of the light of this lightbulb.*

The value of 75 is (a bit) lower than 80 which is considered a minimum value for indoor usage.
Note: the chromaticity difference is 0.0004 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].

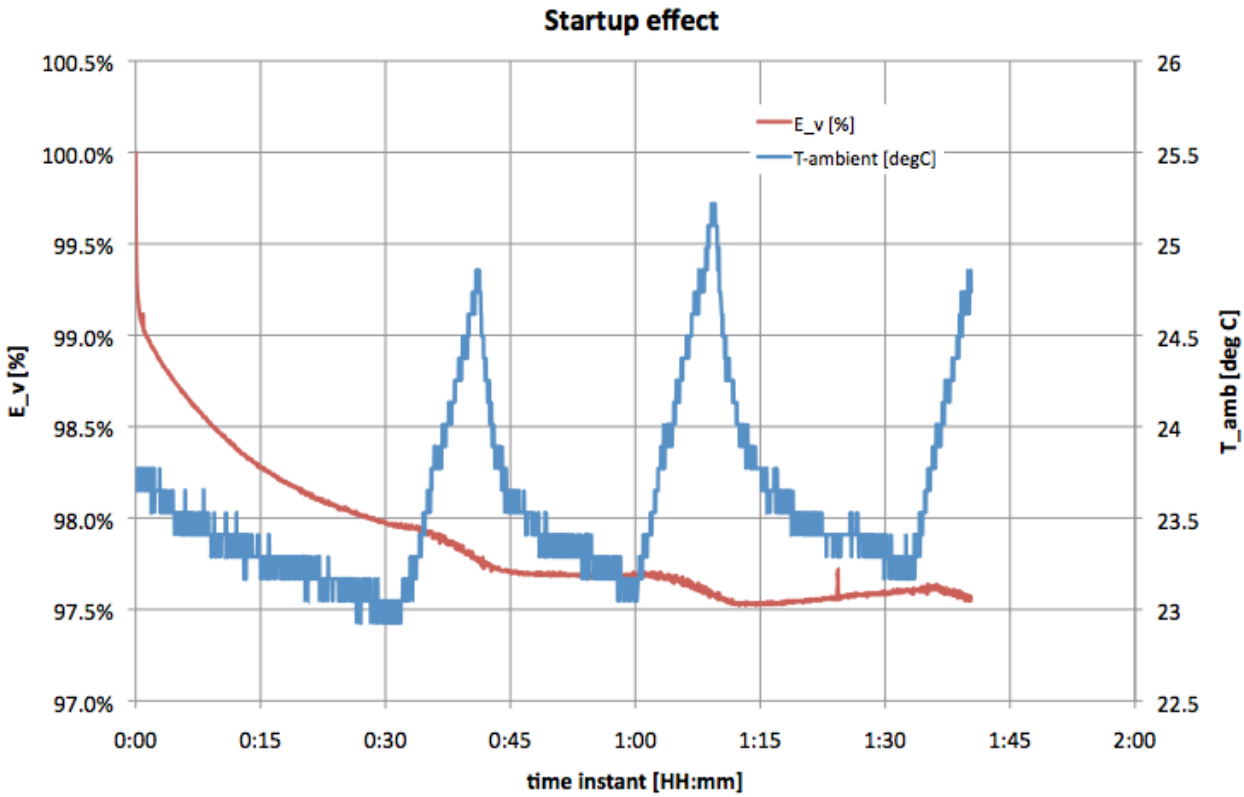



*Lamp voltage dependencies of certain light bulb parameters, where the value at 24 V is taken as 100 %.*

The illuminance and consumed power do not vary significantly when the voltage is varied.
When the voltage at 24 V varies with + and - 1 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], the lamppower P [W] and the luminous efficacy [lm/W].




*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 not relevant as the illuminance does vary less than 5 %. The consumed power is measured separately and did not change at all in value.

## Measure of flickering

An analysis is done on the measure of flickering of the light output by this light bulb. See the OliNo site for more information.

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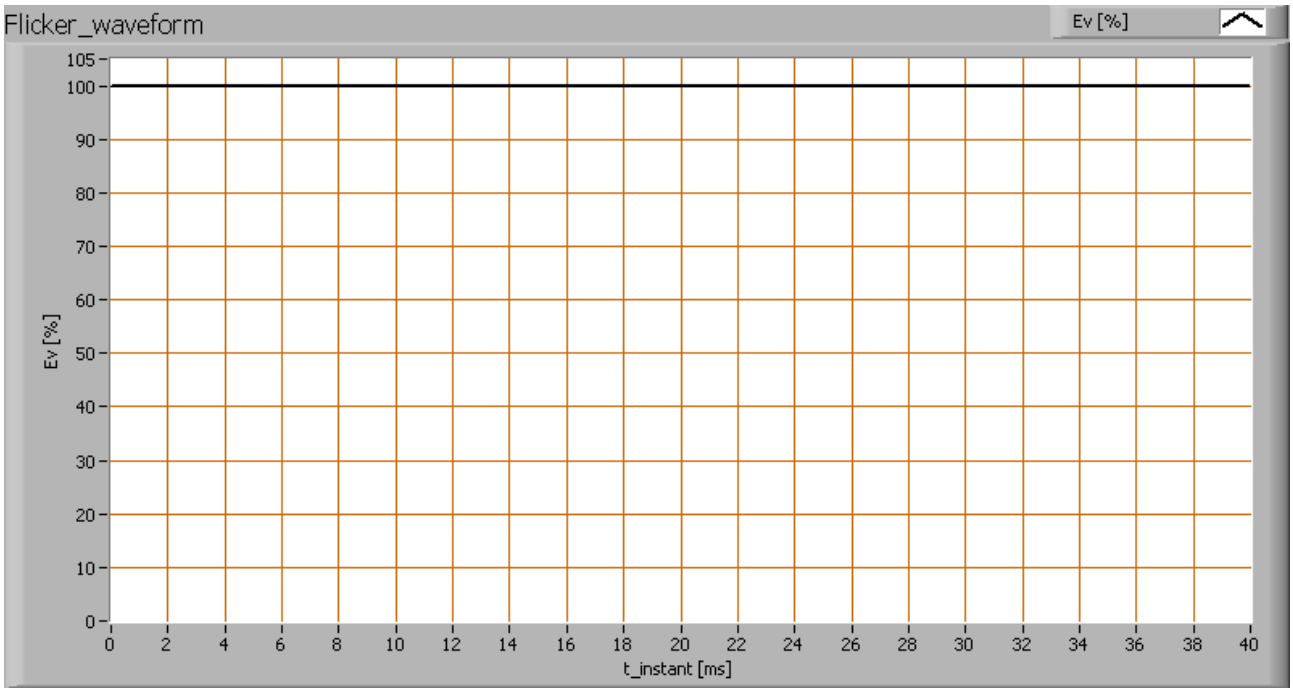


*The measure of fast illuminance variartion of the light of the light bulb*

| parameter | waarde | eenheid |
|---|---|---|
| Flicker frequency | n.a. | Hz |
| Illuminance modulation index | 0 | % |

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

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