

# Sensor Design and Manufacturing Services



***Color (White) -  
control  
of Power LEDs  
MAZeT 2006***



## LEDs for luminary and illumination

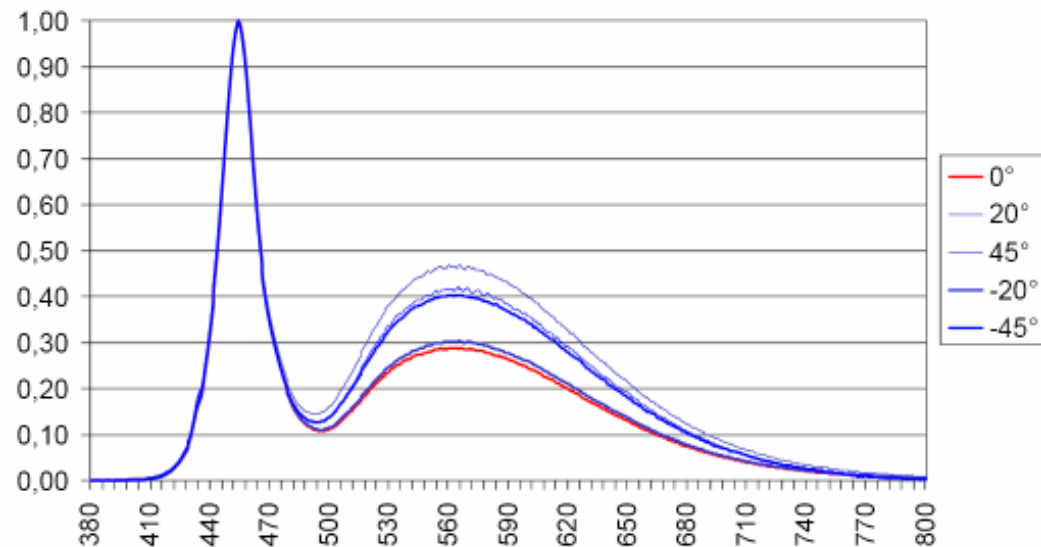
- ▶ **„ ... The LEDs are the third great revolution after the incandescent and fluorescent lamp in illumination.”**
- ▶ **„... The efficiency of the LED duplicates itself on the average all 2-3 years. This is double light efficiency in the case of identical electric power.”**
- ▶ **„ ... The LEDs revolutionize the technologies for displays and beamers (projection).”**



## but LEDs also have technical disadvantages

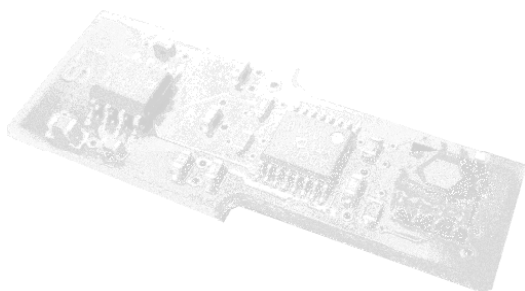
### e.g. problems with temperature and ageing

- ... its efficiency and light color is more or less dependent of temperatures
- ... LEDs transit time effects over the lifetime





## Examples of applications

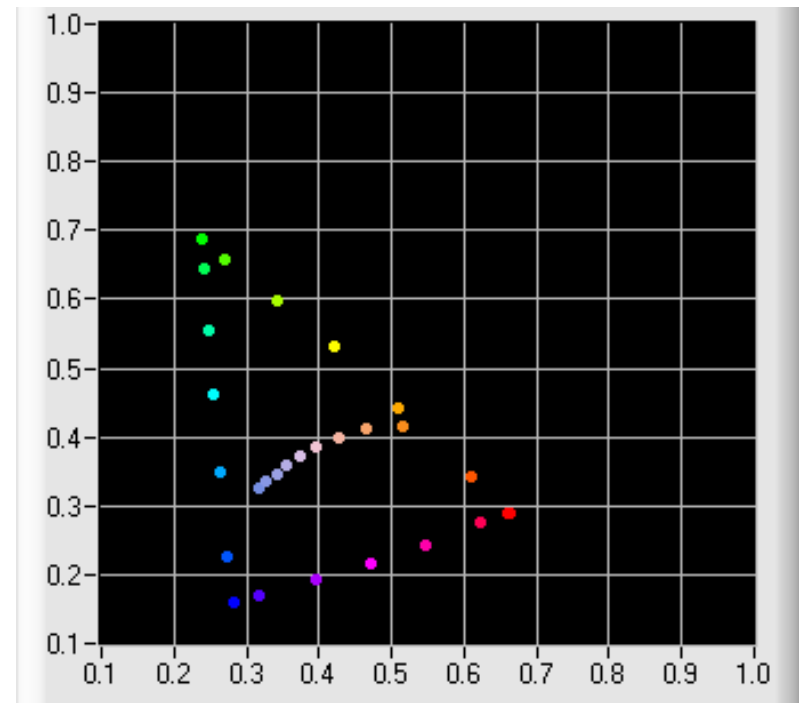


**Check and Control Color  
(~temperature) for  
illumination, displays,  
beamer, etc.**

# JENCOLOR – ReguLED



- ▶ **Adjust any reference color to any color place in color space xy**
- ▶ **Tuning or regulation according to Planck'scher radiation curve**
- ▶ **Readjust second lamp according to an example lamp**

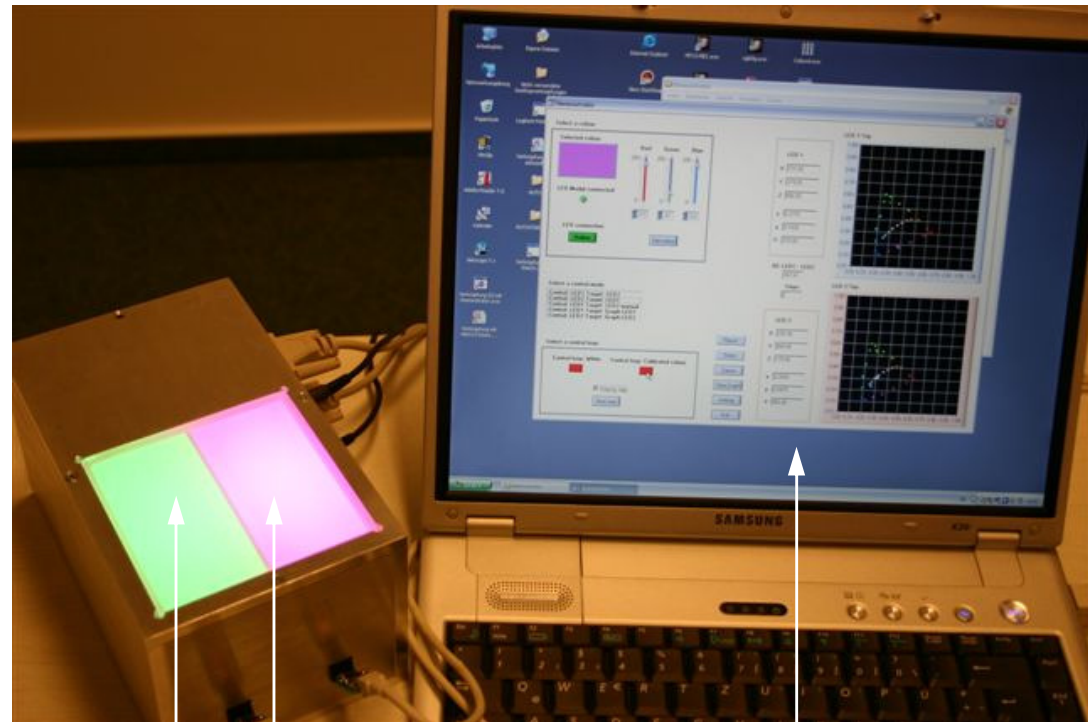


Planck'sche Radiation curve

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Lamp 1 and 2

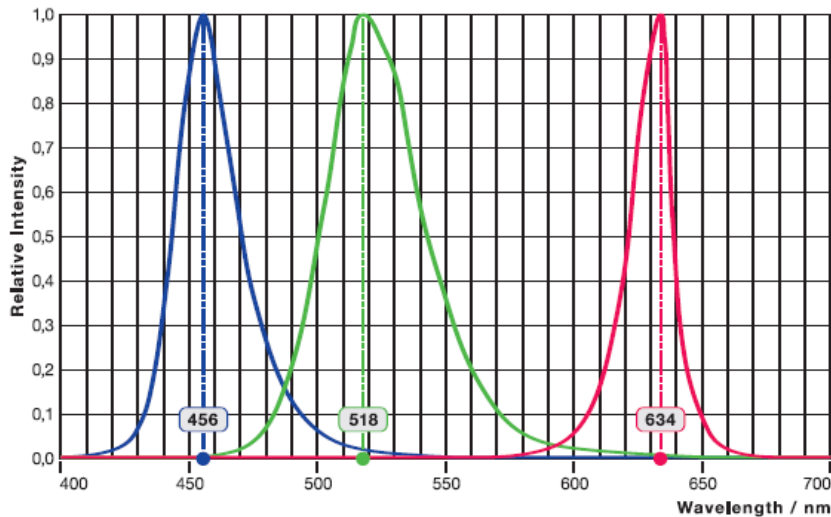
Application software



# Aufbau ReguLED

## RGB Power LED - ACULED™

- ▶ **Producer: PerkinElmer® Elcos GmbH**
- ▶ **Module based on 4 single LEDs**
- ▶ **max current 350mA**



- ▶ **Power consumption R-G-B**  
**1,05 W - 3,2 W - 1,8 W**
- ▶ **Optical Efficiency R-G-B**  
**18 lm/W - 11 lm/W - 2 lm/W**

Quelle: ACULED™-Datenblatt 5.11.2005



# Construction of ReguLED

## RGB Power LED - ACULED™

- ▶ power Supply 9V
- ▶ RGB separate controllable
- ▶ 24-Bit color space
- ▶ basic frequency PWM 168Hz
- ▶ interface RS232
- ▶ Passive cooling element



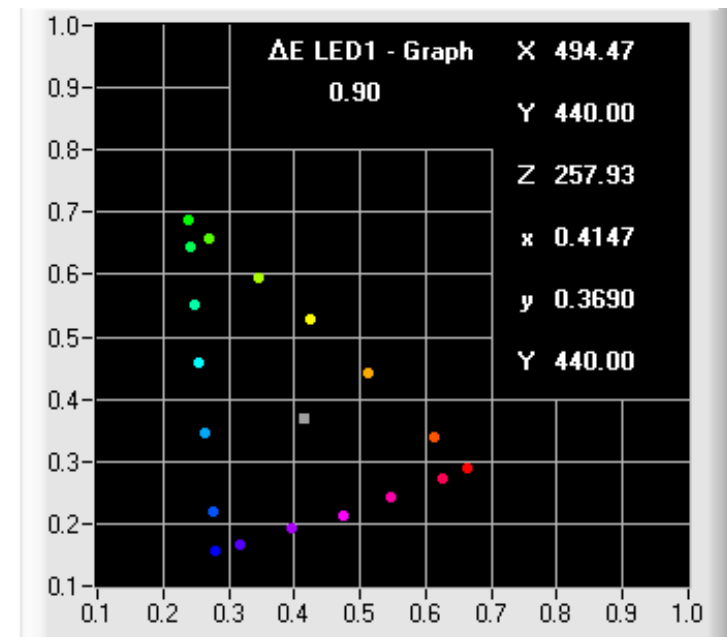
Source: RGB Evaluation Kit Elcos 25.4.2005





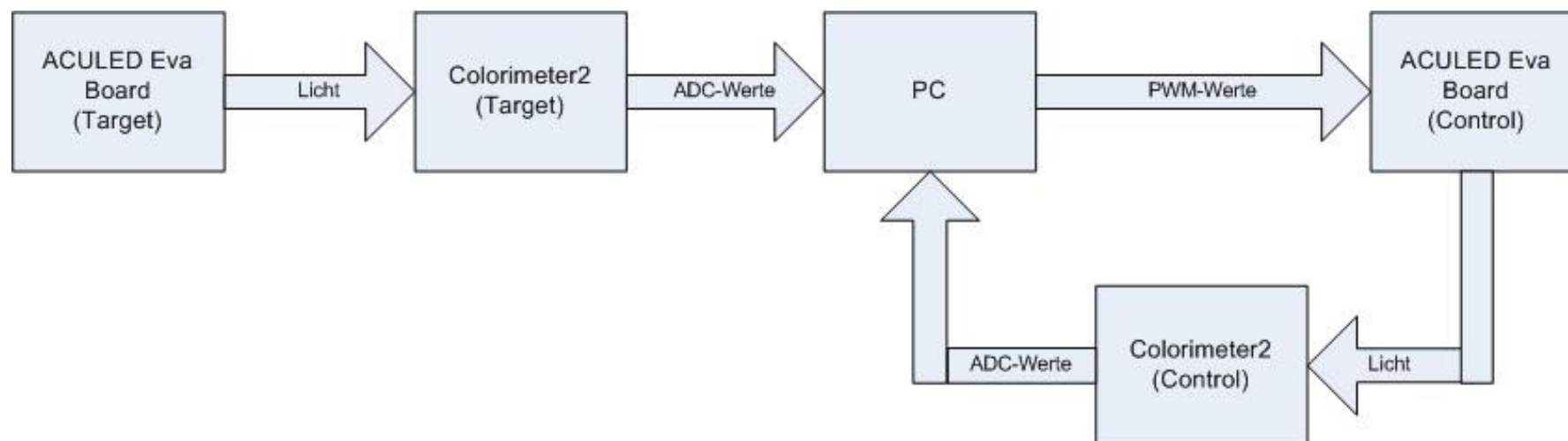
# Functions of ReguLED

- ▶ **Control RGB Power LEDs**
- ▶ **Control Color Sensor Colorimeter2**
  - Calculation of the coefficient matrix for the linear measured value adjustment
  - Offset correction of the measured values
  - Color space calculations
- ▶ **Menu, applications**
  - Regulation of the Planck'schen radiation function
  - Color setting of lamp defined by inputs xyY of color space
  - Color setting of lamp defined by fortuities
  - Demonstration mode in continuous operation
- ▶ **Performing the closed-loop control system**
- ▶ **graphic edition of the results**



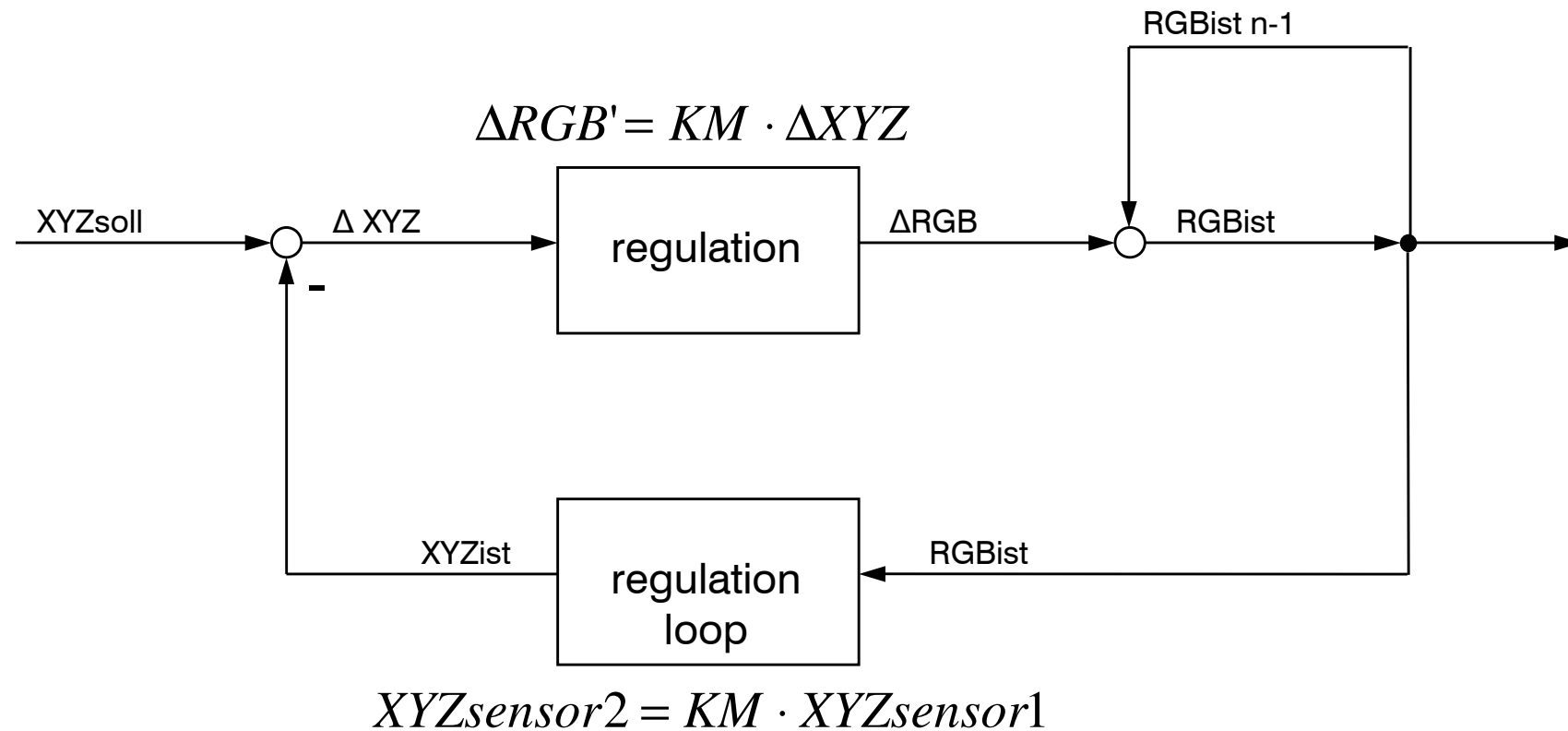


# LED-regulation by ReguLED





# Control-Loop with coefficient matrix

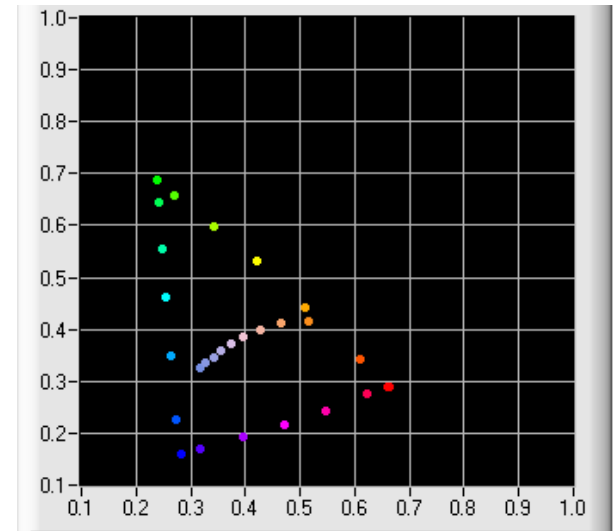
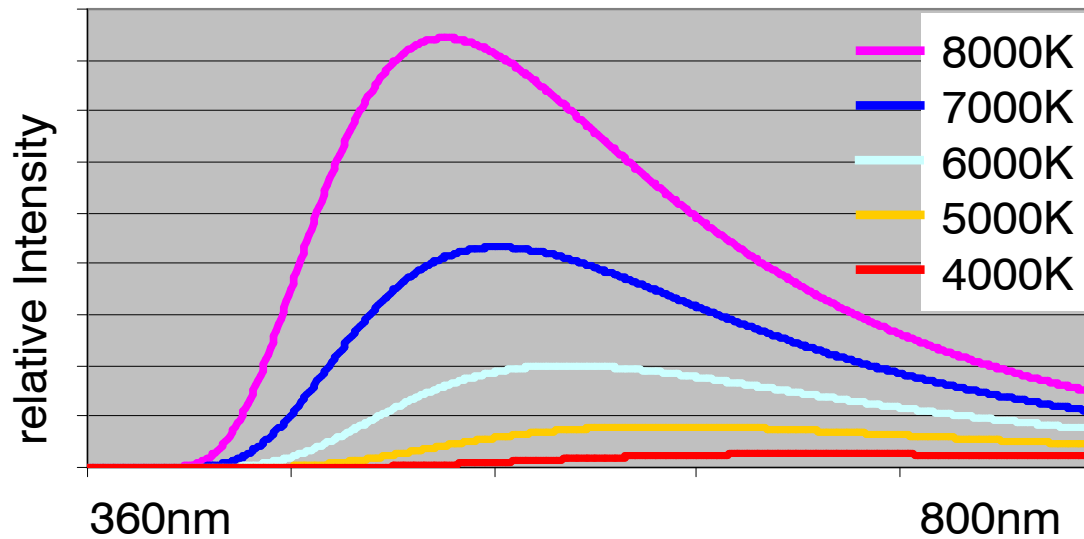


# Example - Planck'sche Radiation curve

$$M(\lambda, T) = \frac{k_1}{\lambda^5 \cdot \left( e^{\left( \frac{k_2}{T \cdot \lambda} \right)} - 1 \right)} \quad \left[ \frac{W}{m^3} \right]$$

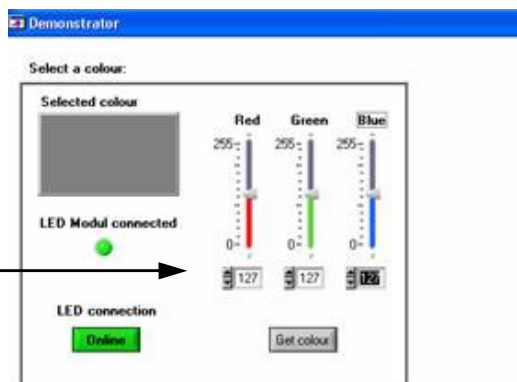
$$k_1 = 2 \cdot \pi \cdot h \cdot c^2$$

$$k_2 = \frac{h \cdot c}{k}$$

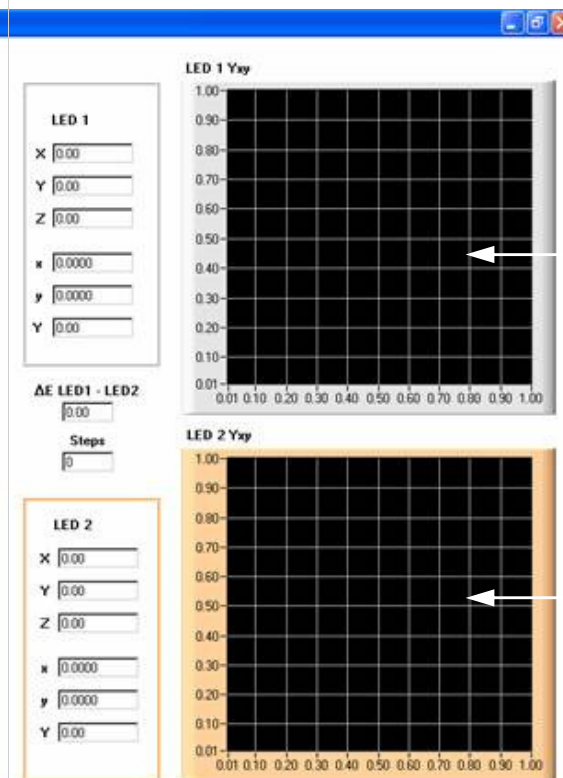


# Software (menu) ReguLED

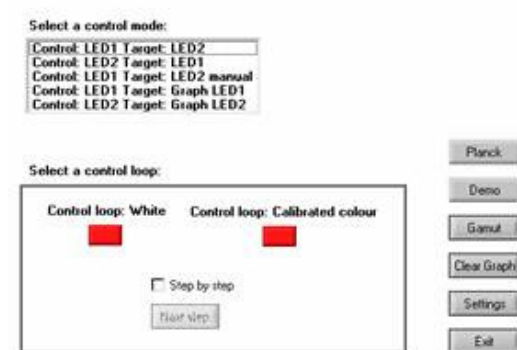
Definition User



Results of sensor



Select function





# ReguLED 10001

## 10001 randomized Colors:

- ▶ **10001 successfully regulations**
- ▶ **∅ 7,01 steps per regulation**
- ▶ **∅  $\Delta x = 0,0003$**
- ▶ **∅  $\Delta y = 0,0003$**
- ▶ **∅  $\Delta Y = 0,13$**

