SHIMADZU
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HR41-7026A

Color Measurement of LED

SHIMADZU Corporation

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1. Abstract

Spectral profiles of a LED were acquired by the Spectro Sensor OSS-0081.

After the data processing, subtle color difference under the varied condition was detected.

2. Introduction

As assembled, the LEDs in the same product line have variation in the chromaticity of their emission. In case for some precise applications, they are screened or sorted one by one after the color measurement.

In this report, the LEDs' color variation is emulated by the slight change of a blue LED's color corresponding to its operating current. The chromaticity was calculated according to the CIE Standard from the spectral profiles acquired by the OSS-0081.

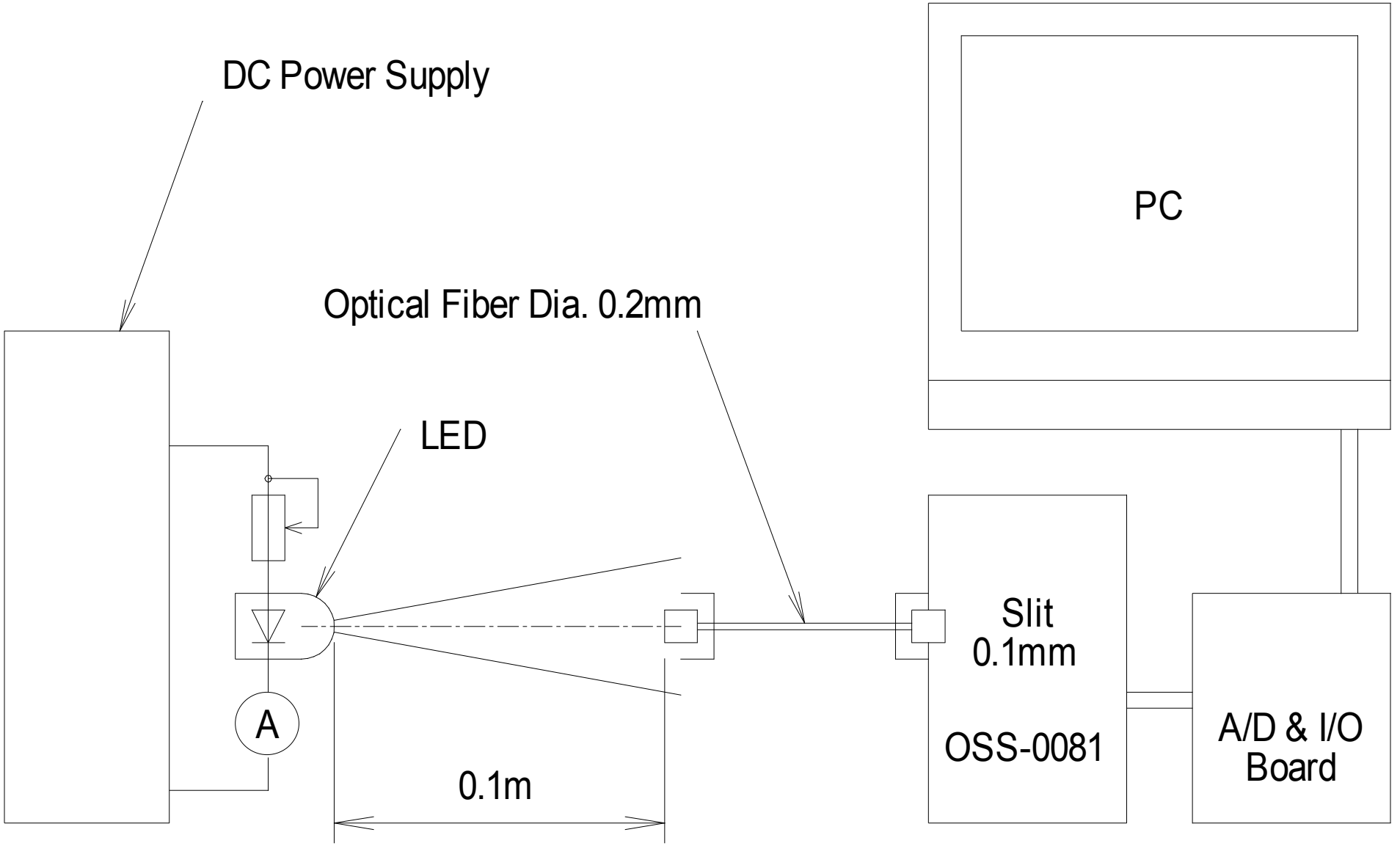
3. Method -Measured LED

Model: STANLEY UB5306X
Peak wavelength: 465nm(@20mA)
Luminous Intensity: Typ. 2800mcd(@20mA)
Maximum Forward Current: If=25mA
Forward Voltage: Typ. Vf=3.7V(@20mA)
Half Intensity Angle: 2θ=10deg(@20mA)

Our operated condition:

If= 18mA, 17mA, 16mA, 15mA, 14mA

3. Method -Measurement Apparatus



Schematic of Measurement

3. Method -Data Processing

1. Emission of the LED is entered into the Spectro Sensor OSS- 0081 via optical fiber and the LED's spectral profiles are acquired and stored in the PC.
2. After the dark noise is subtracted, the spectral profile is calibrated to the spectral irradiance(⊿nm=1) by the prepared photometric tables (see appendices).
3. With the C.I.E. coefficient, the spectral irradiance(SpIrr) is converted to the tristimulus values and the illuminance.

$$X = \sum_{\lambda=380,381\ldots}^{780} CIE\_cmf\_X(\lambda)SpIrr(\lambda) \qquad Illuminance = \sum_{\lambda=360,31\ldots}^{830} CIE\_cmf\_Y(\lambda)SpIrr(\lambda)$$

$$Y = \sum_{\lambda=380,381\ldots}^{780} CIE\_cmf\_Y(\lambda)SpIrr(\lambda)$$

$$Z = \sum_{\lambda=380,381\ldots}^{780} CIE\_cmf\_Z(\lambda)SpIrr(\lambda)$$

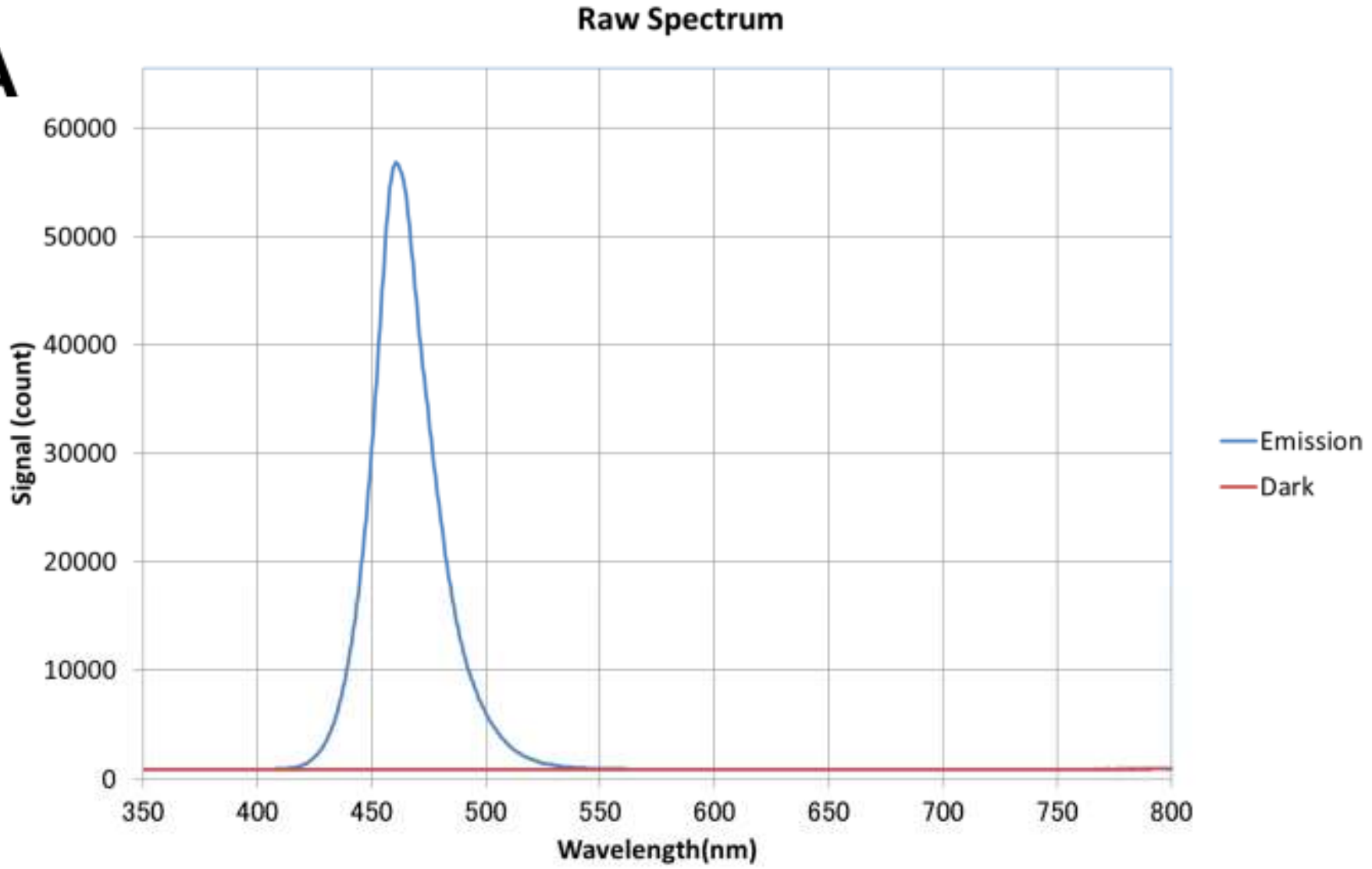
Chromaticity Coordinates

$x=X/(X+Y+Z),\ y=Y/(X+Y+Z)$

$u'=4X/(X+15Y+3Z),\ v'=9Y/(X+15Y+3Z)$

4. Results –Acquired Data by OSS-0081

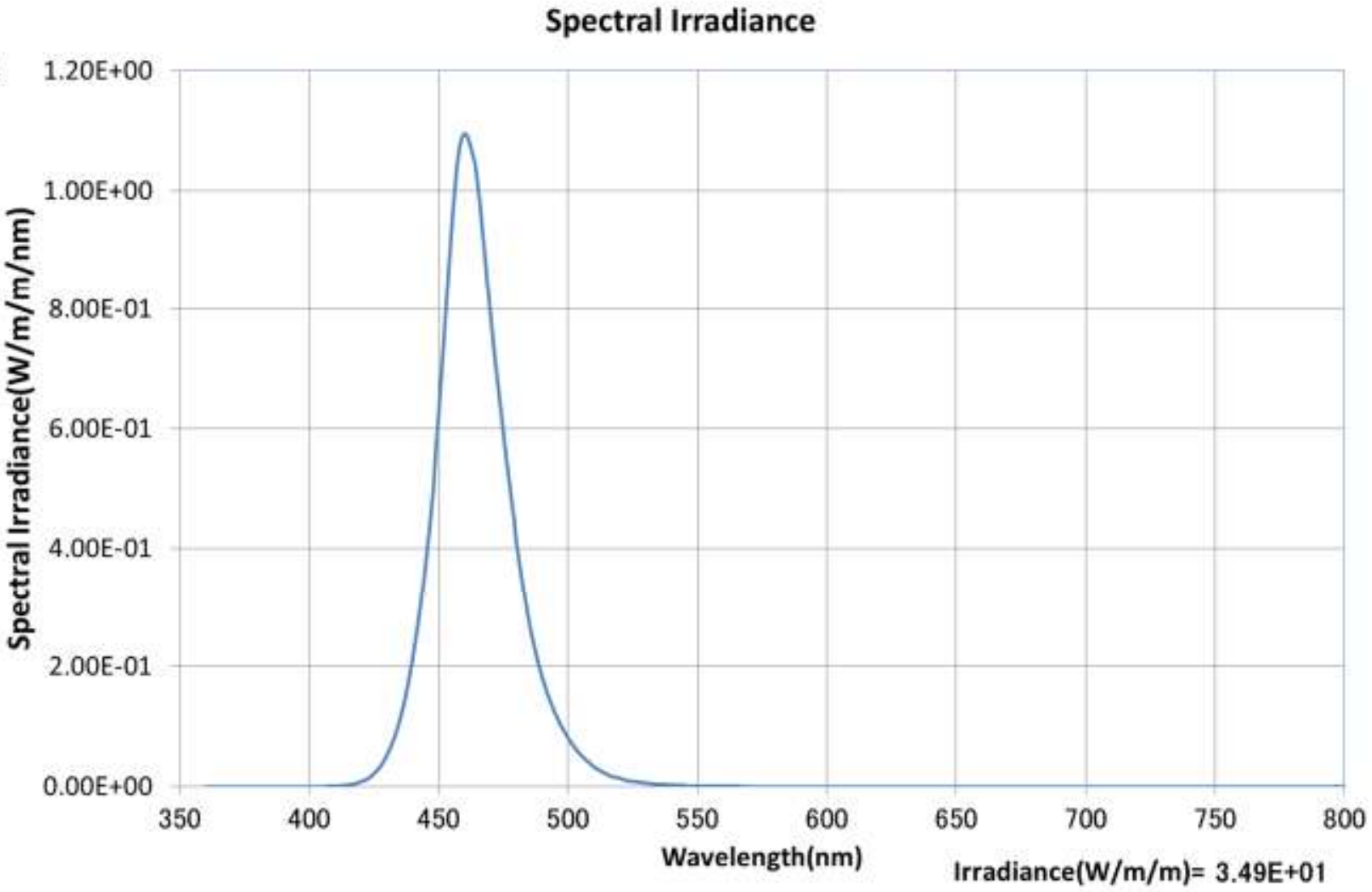
If=18mA



Integration=100ms Gain=Low Av.=10scan

4. Results –Calibrated Data

If=18mA

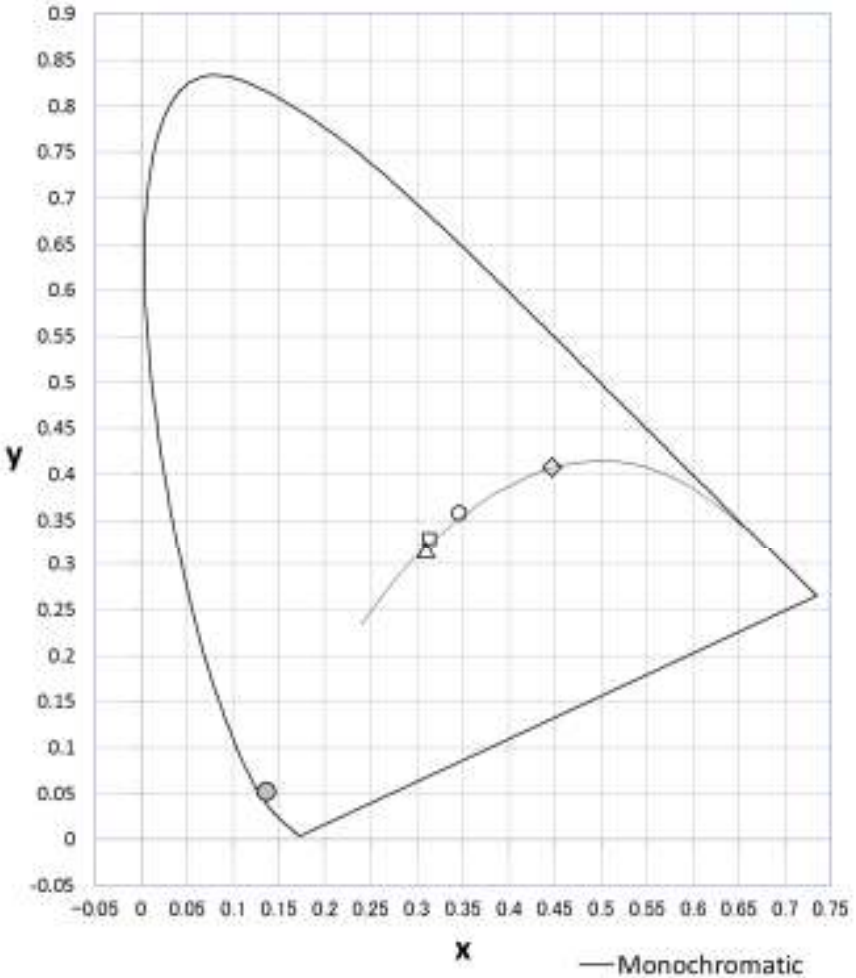


Integration=100ms Gain=Low Av.=10scan

4. Results –CHROMATICITY DIAGRAM

If=18mA

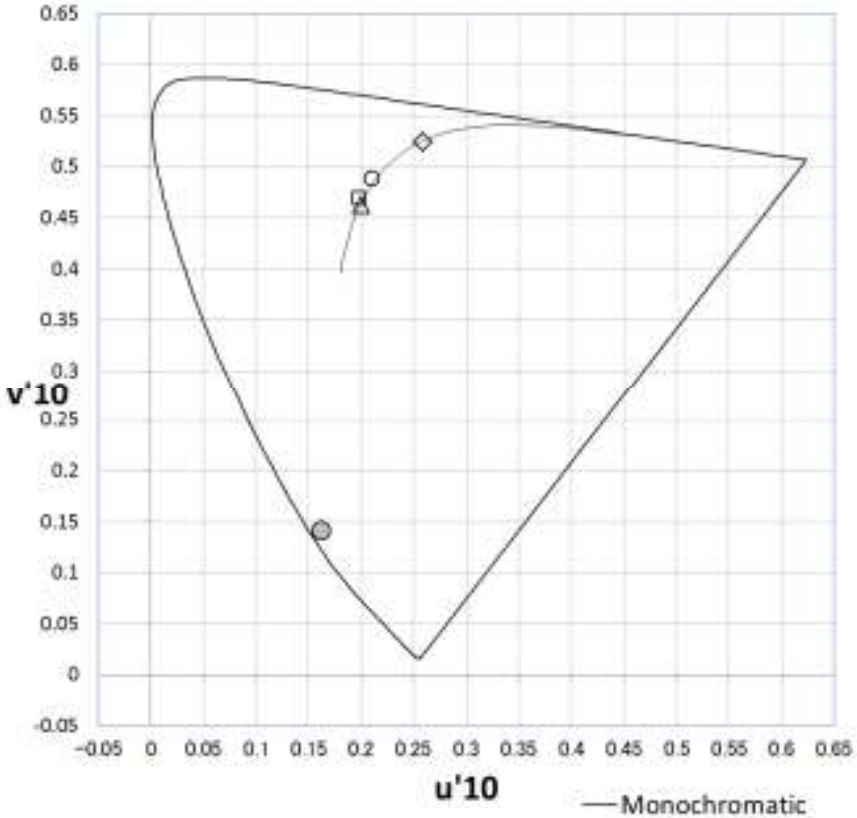
C.I.E. 1931 CHROMATICITY DIAGRAM



2.170E+03 lx
x= 0.136287
y= 0.052994

—Monochromatic
—Blackbody Locus
◇ CIE Illuminant A
△ JIS Illuminant C
○ Illuminant D50
□ CIE Illuminant D65
● Measured Data

C.I.E. 1976 U.C.S. CHROMATICITY DIAGRAM

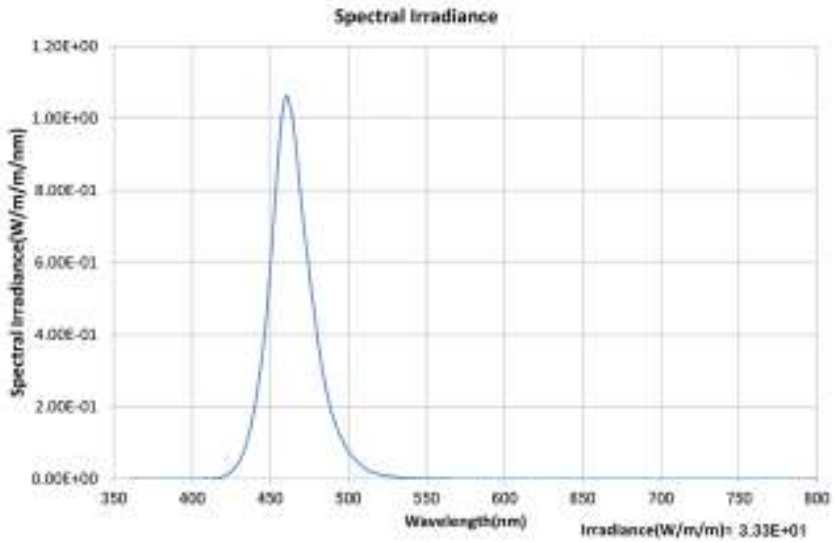


2.170E+03 lx
u'10= 0.162085
v'10= 0.141806

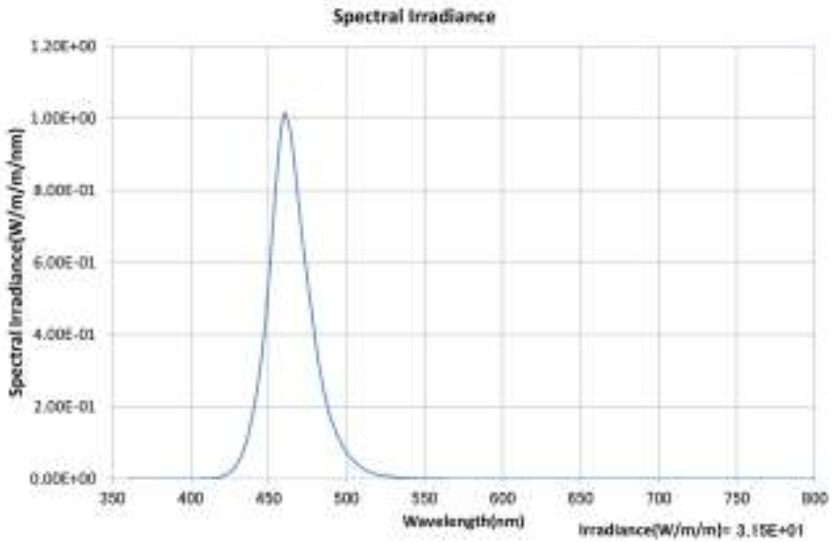
—Monochromatic
—Blackbody Locus
◇ CIE Illuminant A
△ JIS Illuminant C
○ Illuminant D50
□ CIE Illuminant D65
● Measured Data

4. Results –Calibrated Data (Each If's)

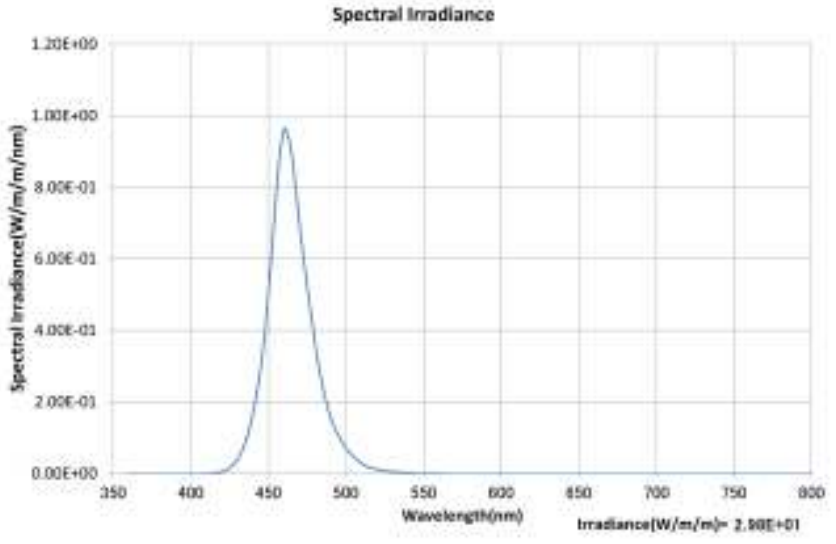
If=17mA



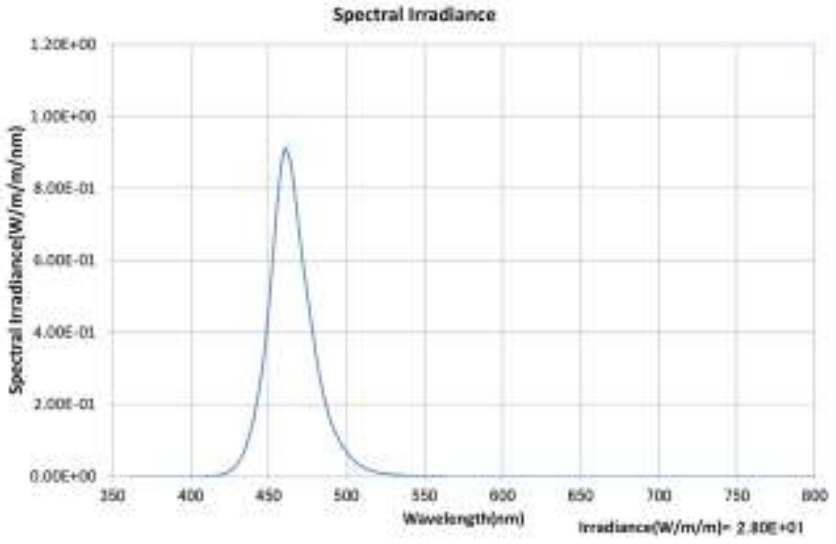
If=16mA



If=15mA

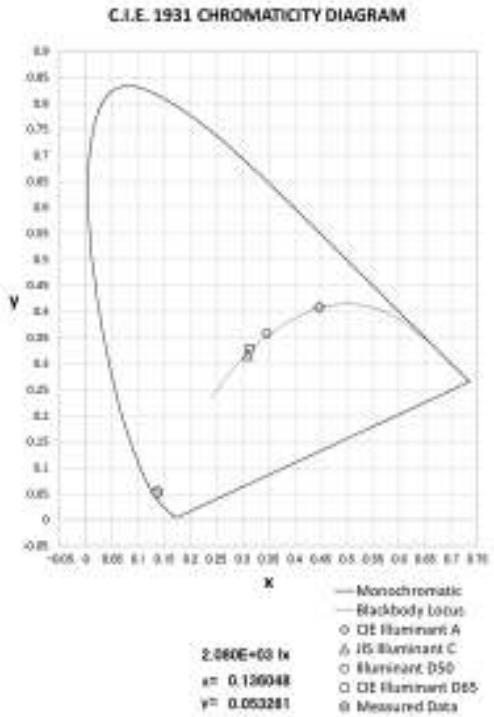


If=14mA

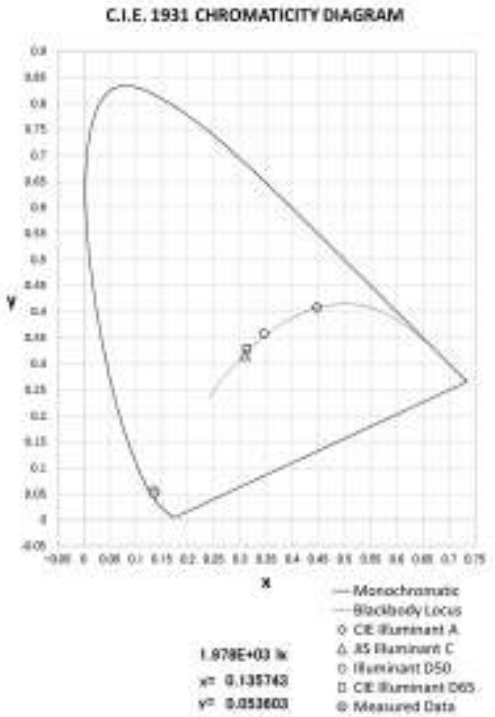


4. Results –CHROMATICITY (Each If's)

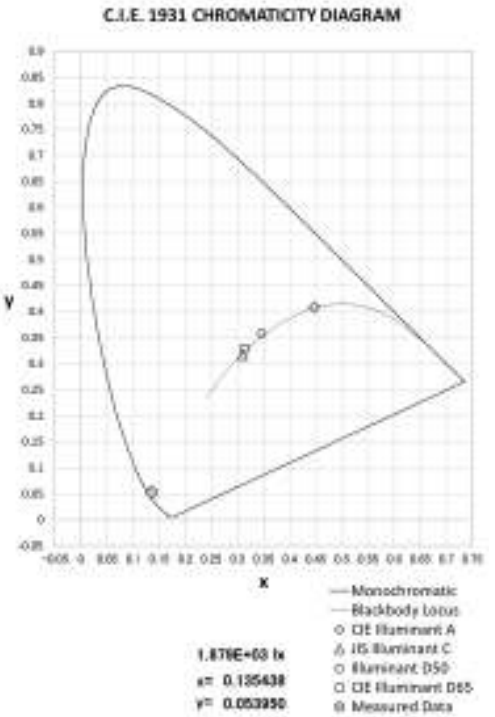
If=17mA



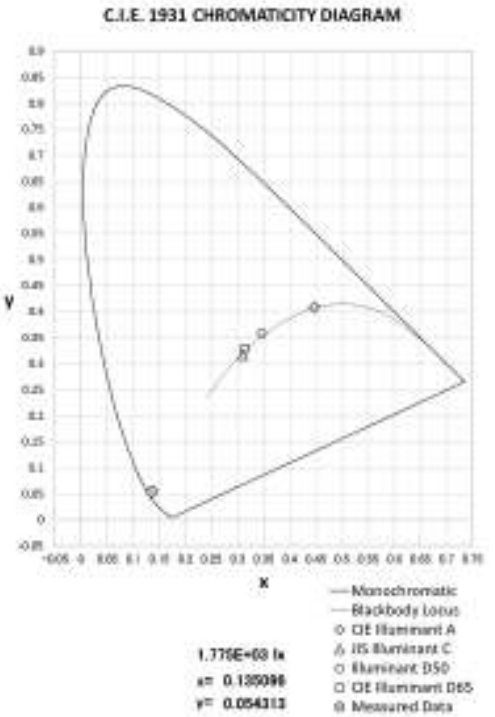
If=16mA



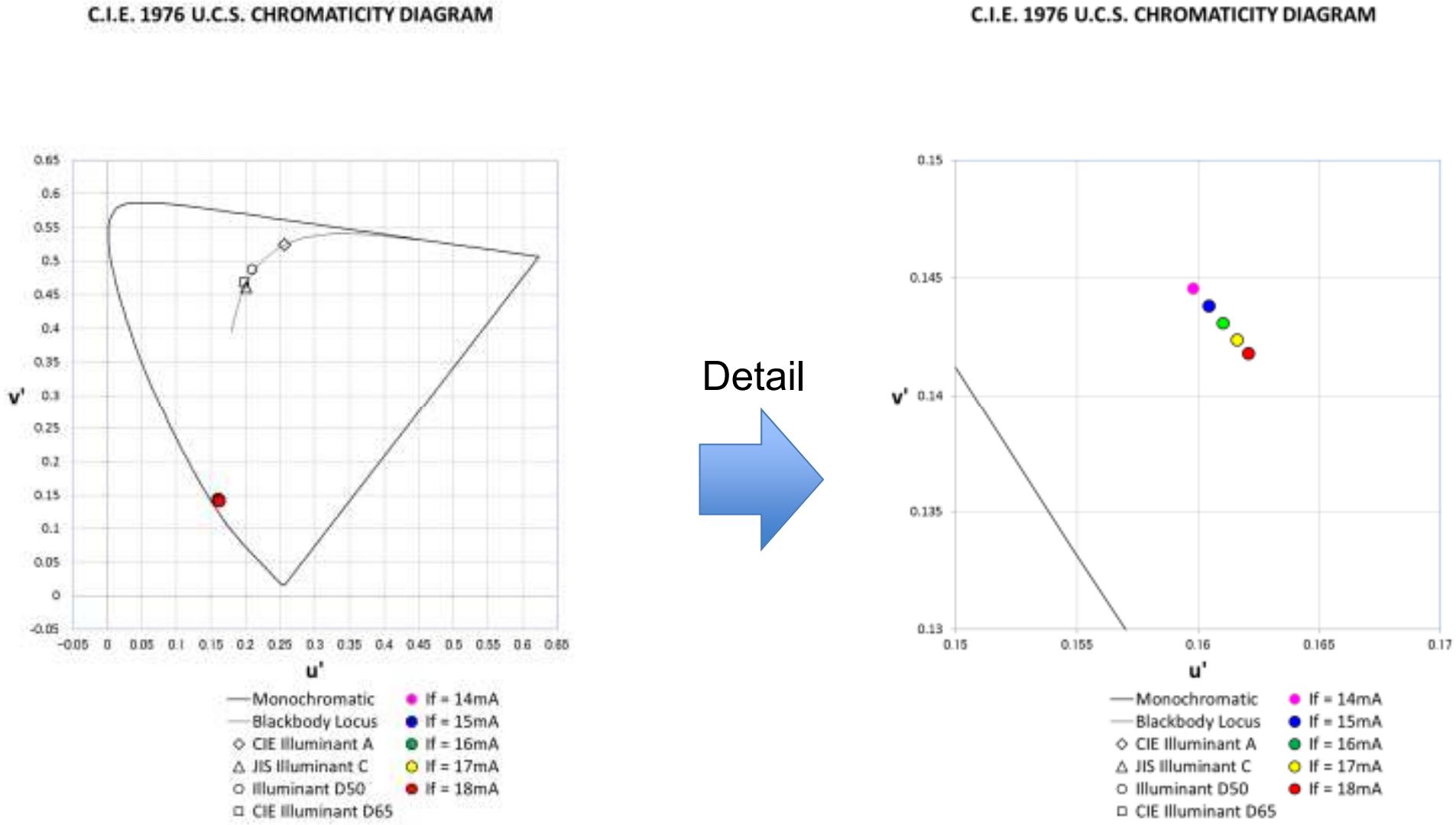
If=15mA



If=14mA



5. Analysis



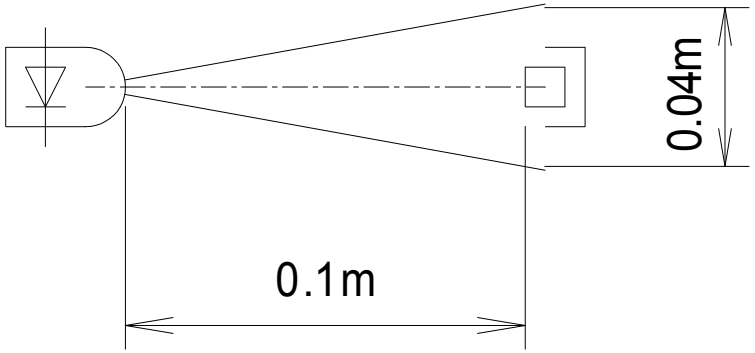
Over plot on the C.I.E. 1976 U.C.S CHROMATICITY CHART shows this system easily detect the color difference of o.oo1

5. Analysis

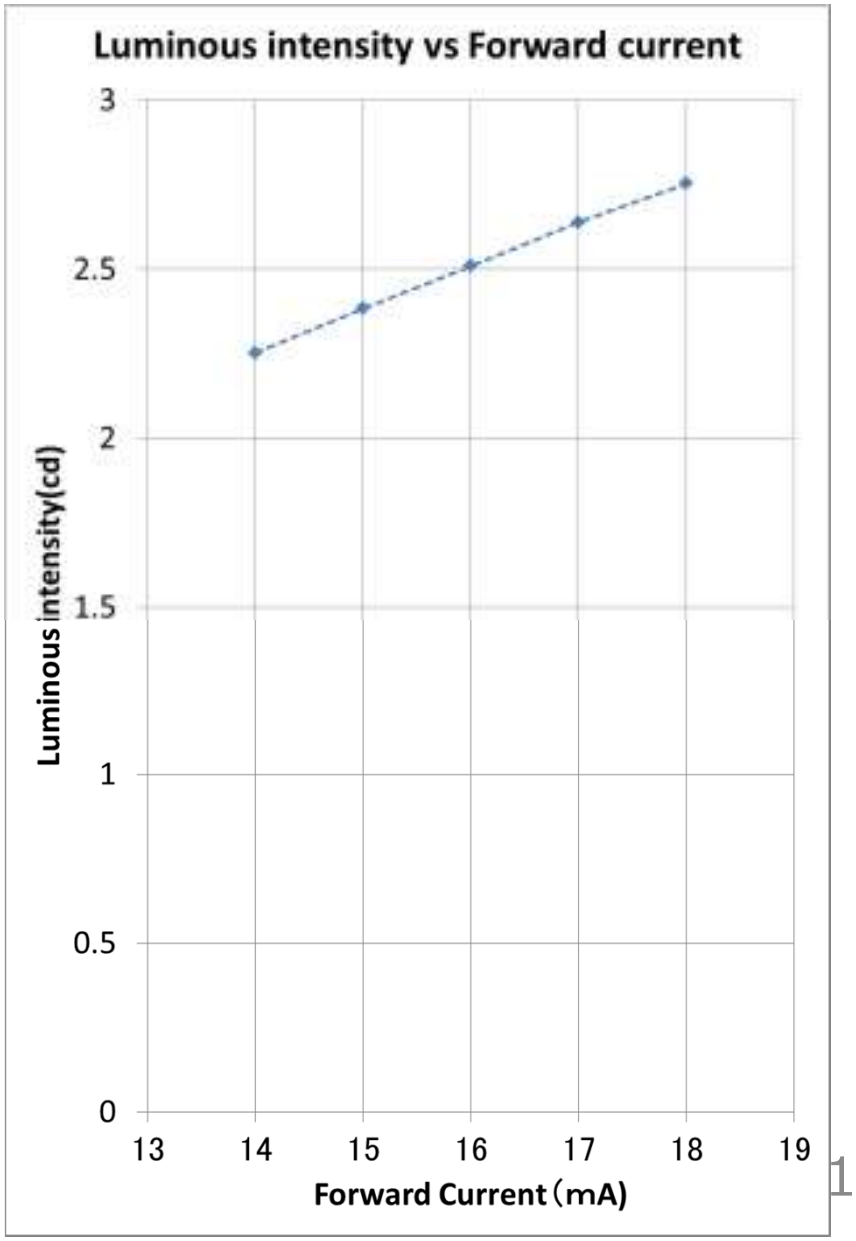
Approximate the diameter of the light flux D=0.04m at the distance from the top of the LED L=0.1m, the luminous intensity(cd) is calculated from the illuminance(lx).

$$cd = 2\pi\sqrt{L^2 + \frac{D^2}{4}}\left(\sqrt{L^2 + \frac{D^2}{4}} - L\right)lx$$

The right chart shows that the value is comparable with the LED's specification.



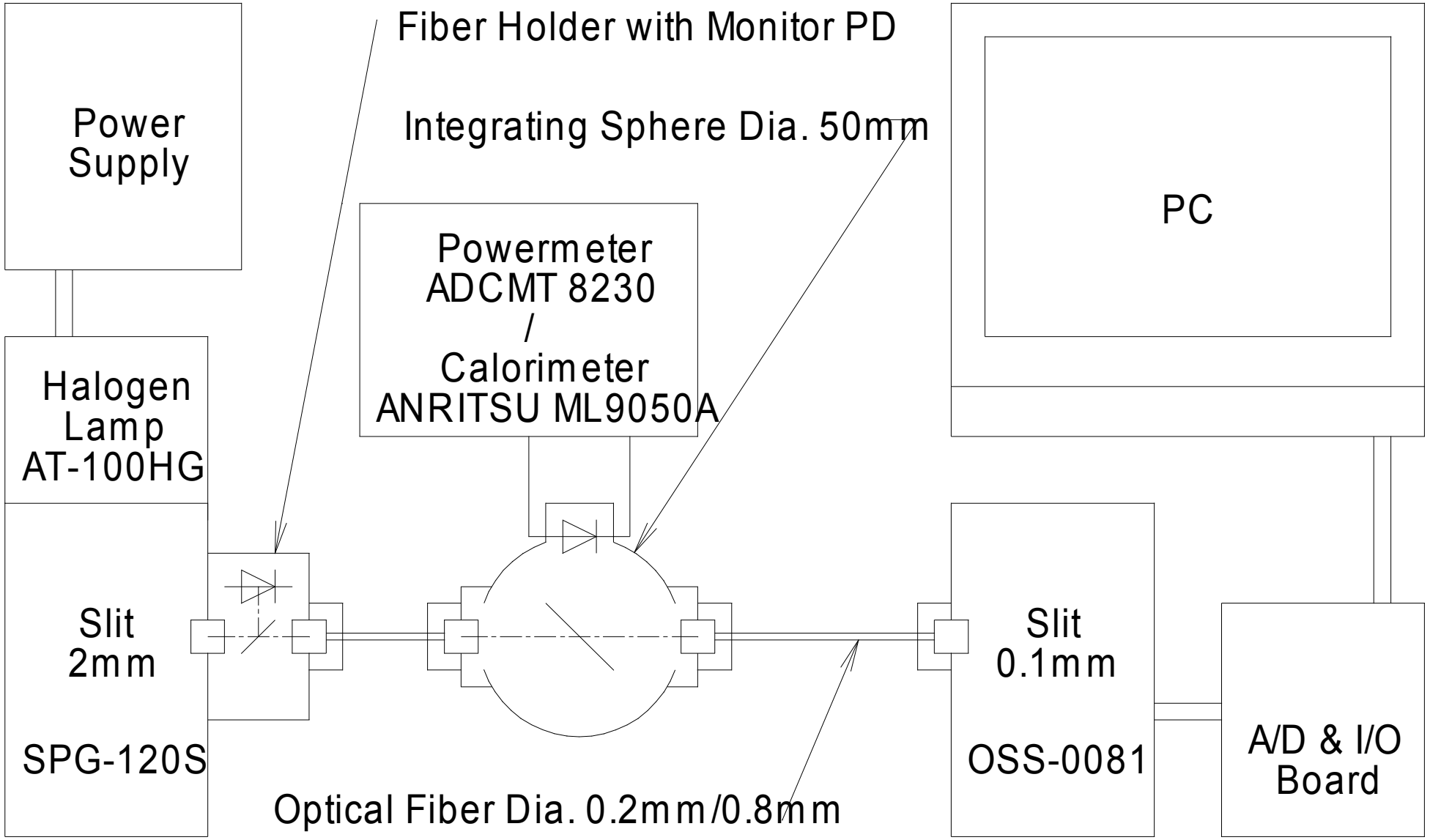
Schematic of Measurement



6. Conclusions

Precision measurement by OSS-0081 made it possible to detect the slight color difference of the LEDs.

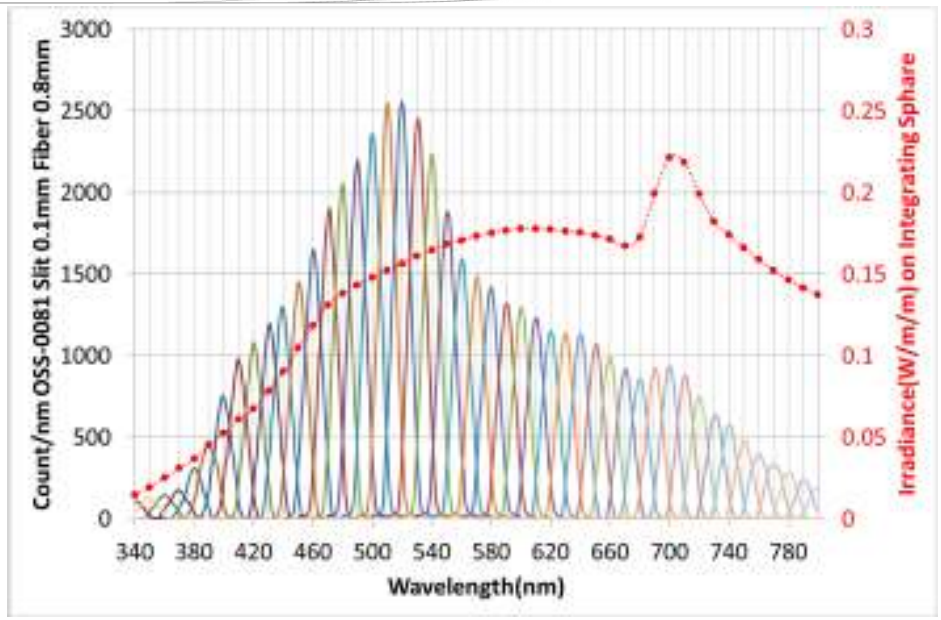
7. Appendices(Photometry)



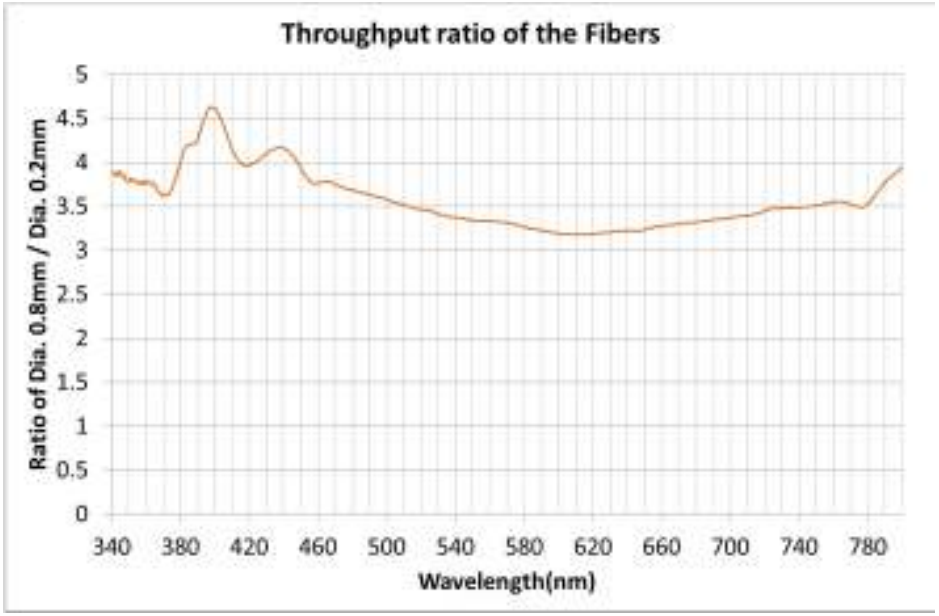
Schematic of Irradiance Calibration

7. Appendices(Photometry)

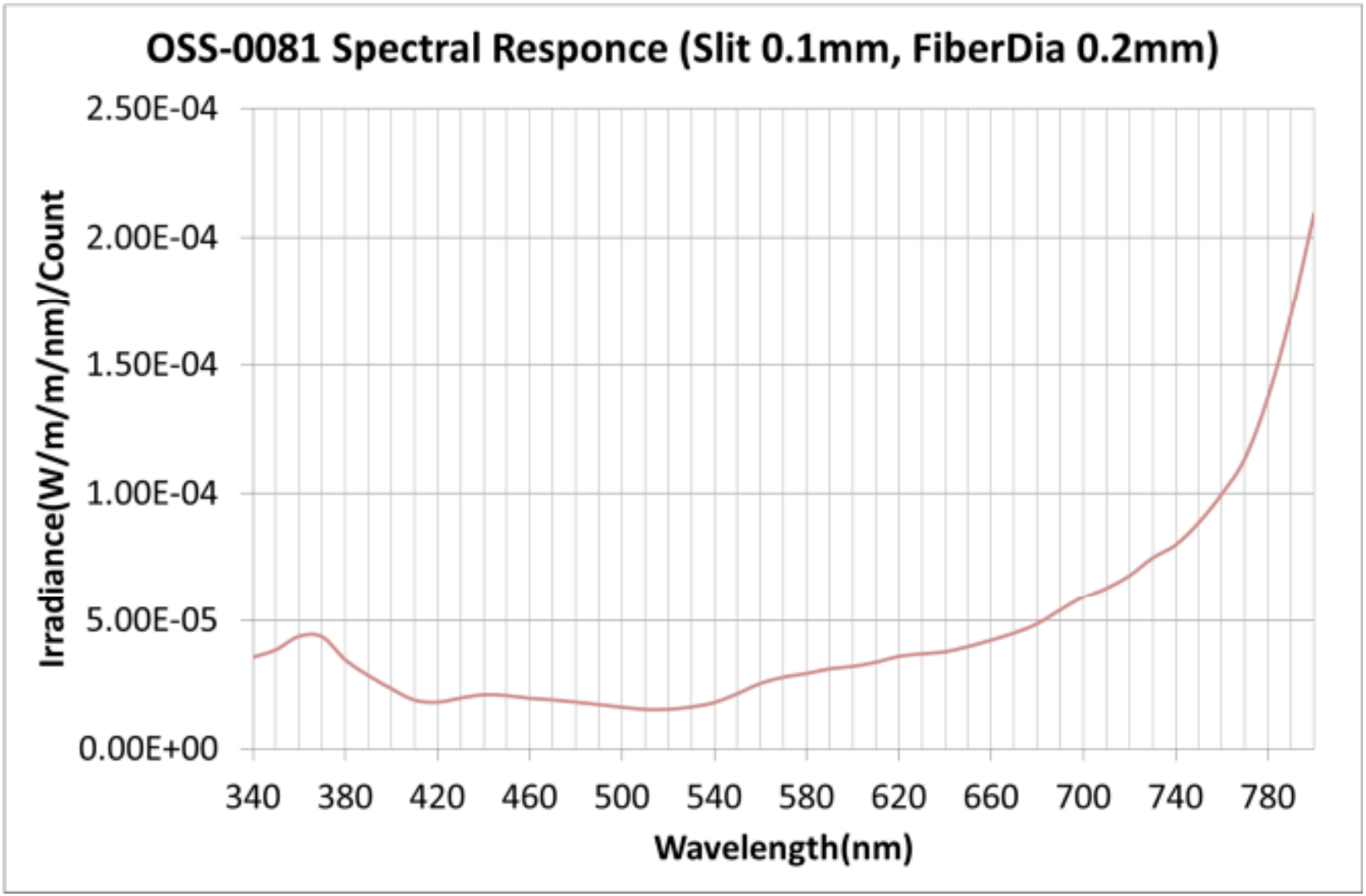
Monochromatic light generated by the SPG-120 is entered in the integrating sphere and measured by the OSS-0081 (each curve). The irradiance is measured by the power meter / colorimeter concurrently.



The inside wall irradiance of the integrating sphere is so weak that the calibration is mainly examined by the 0.8mm fiber. To use 0.2mm fiber, the throughput ratio of the fibers is also evaluated.



7. Appendices (Photometry)



Data used for this Color Measurement