

How to Measure and Characterize LED Lighting Fixtures.

Explanation of Photometric Quantities and Measurement Instruments Requirements According to CIE Standards and Other International Norms

by

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About GL Optic :

GL Optic is the brand name of JUST Normlicht GmbH Germany the world's leading supplier of the standardized light solutions for printing and graphic arts industries. For more than 30 years Just has been developing the innovative solutions which are of the highest quality in standard-light viewing conditions.



GL OPTIC

Light measurement solutions by JUST Normlicht

About GL Optic :

The spectral light measurement project was created at the end of 2009 by Michael Gall the owner and CEO of Just Normlicht in cooperation with Jan Lalek, a Polish physicist who had been involved in the creation of the innovative LED tunable standard lighting systems. They also developed together the light quality assurance instruments installed at Just spectral measurements laboratory.



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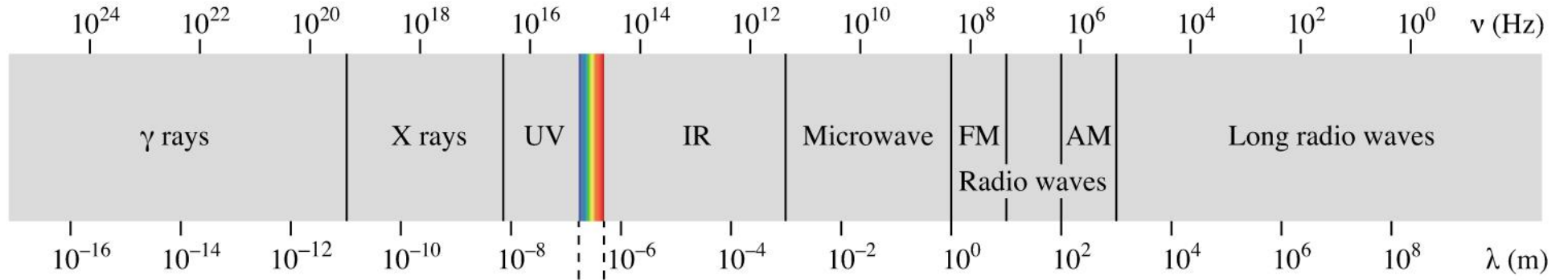
How to measure LEDs

When designing an LED lighting fixtures, we instantly had to deal with parameters and issues such as Flux and Colour shift with temperature and current, accurate current control and heat management are just a few of them. Therefore the accurate light measurement system is crucial for the development of these LED products.

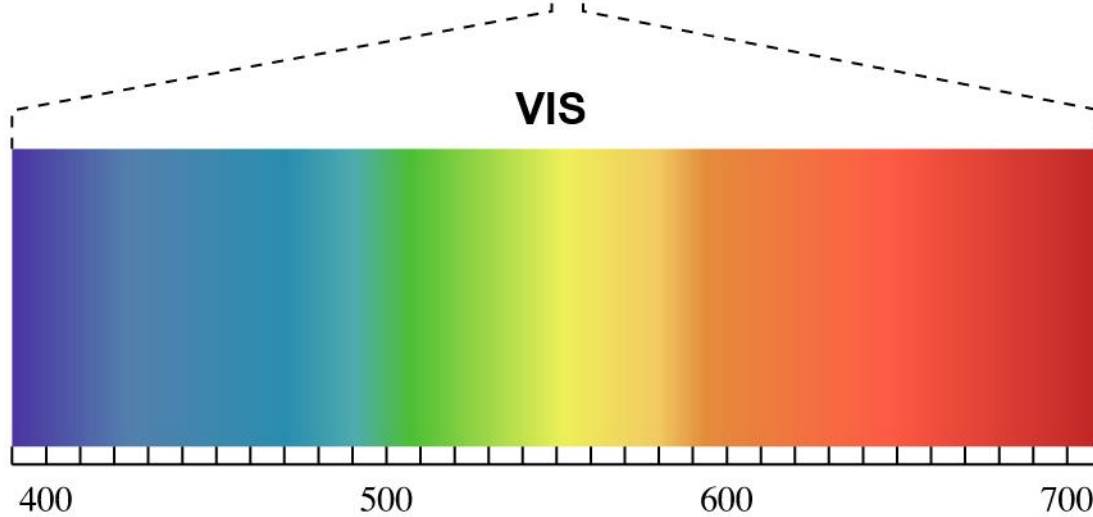
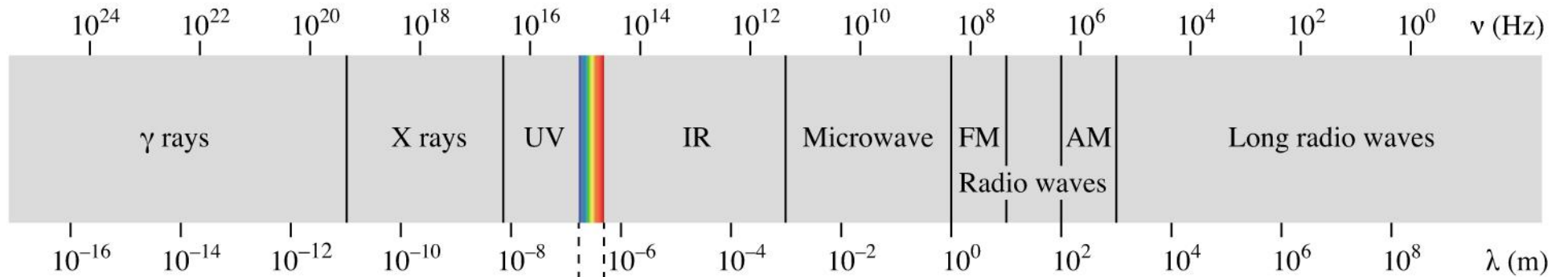
This presentation will cover basic information on light measurement procedures, international standards as well as the presentation of available instrumentation for very different measurement tasks from luminous flux measurement with integrating spheres to luminance measurement and, with the cosine corrected measurement head for illumination.

Lux | Lumen | Candela | CCT | CRI
cd/m² | lm/Watt ...

The Light



The Light



How to measure the Light ?

- What are the standards ?
- What are the quantities ?
- What instruments are used ?
 - How it is done ?

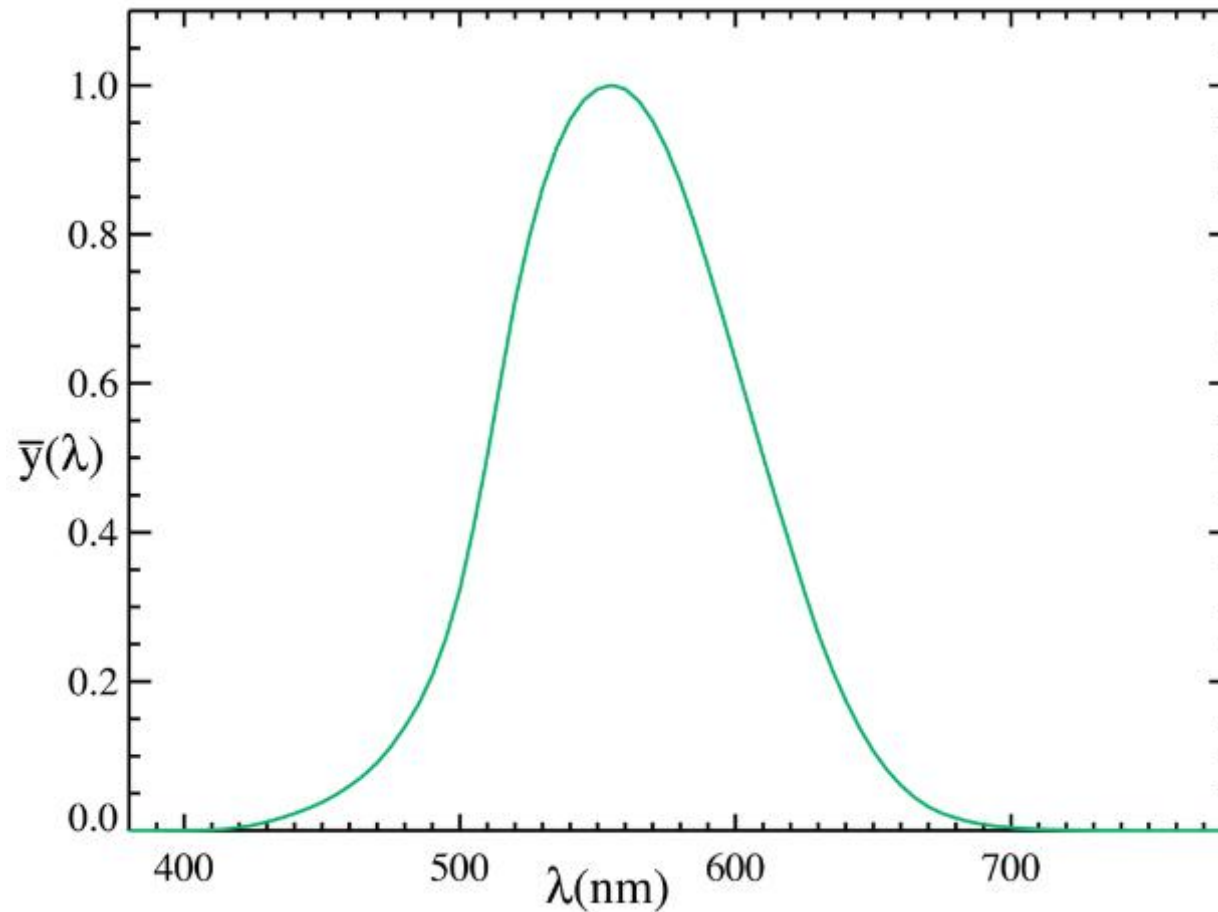
PHOTOMETRY
Human eye perception

?

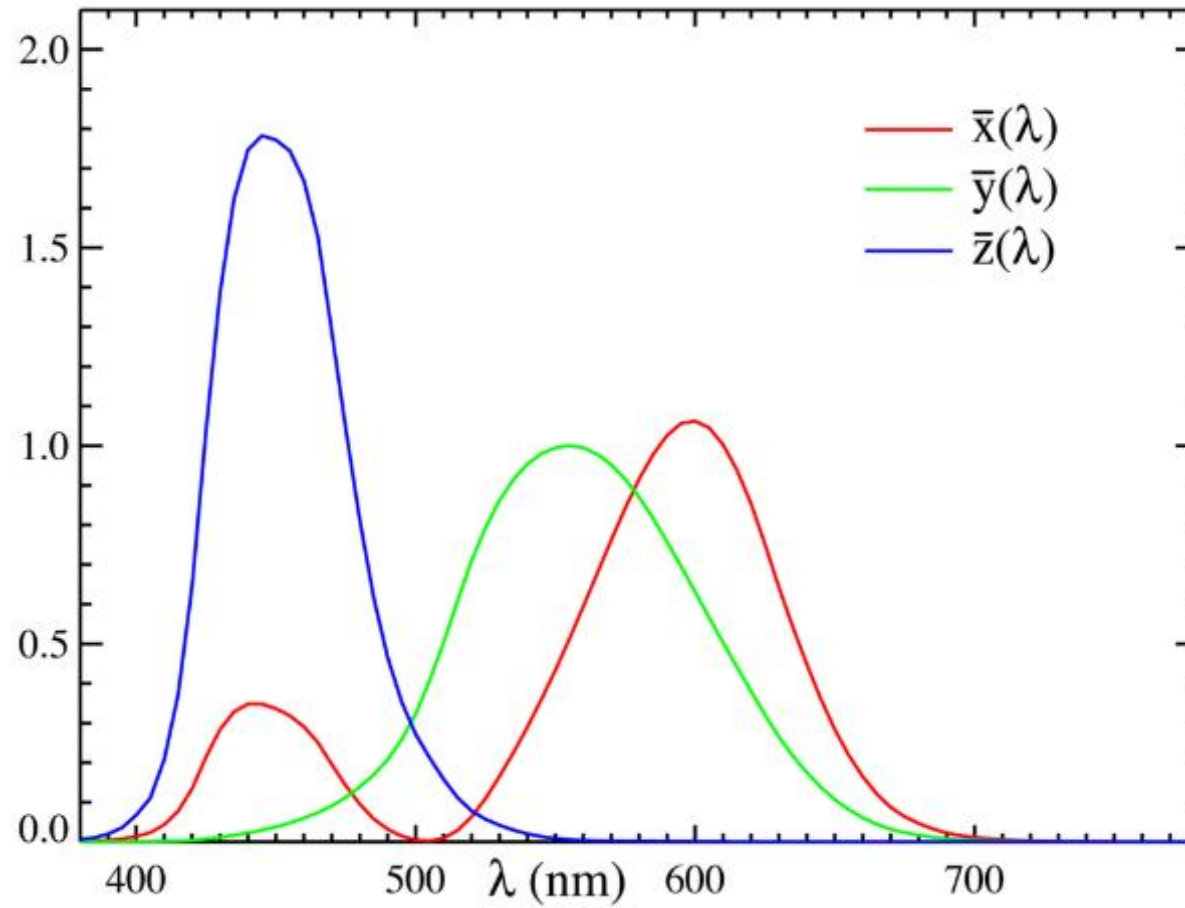
RADIOMETRY
Energy quantities

CIE 1931

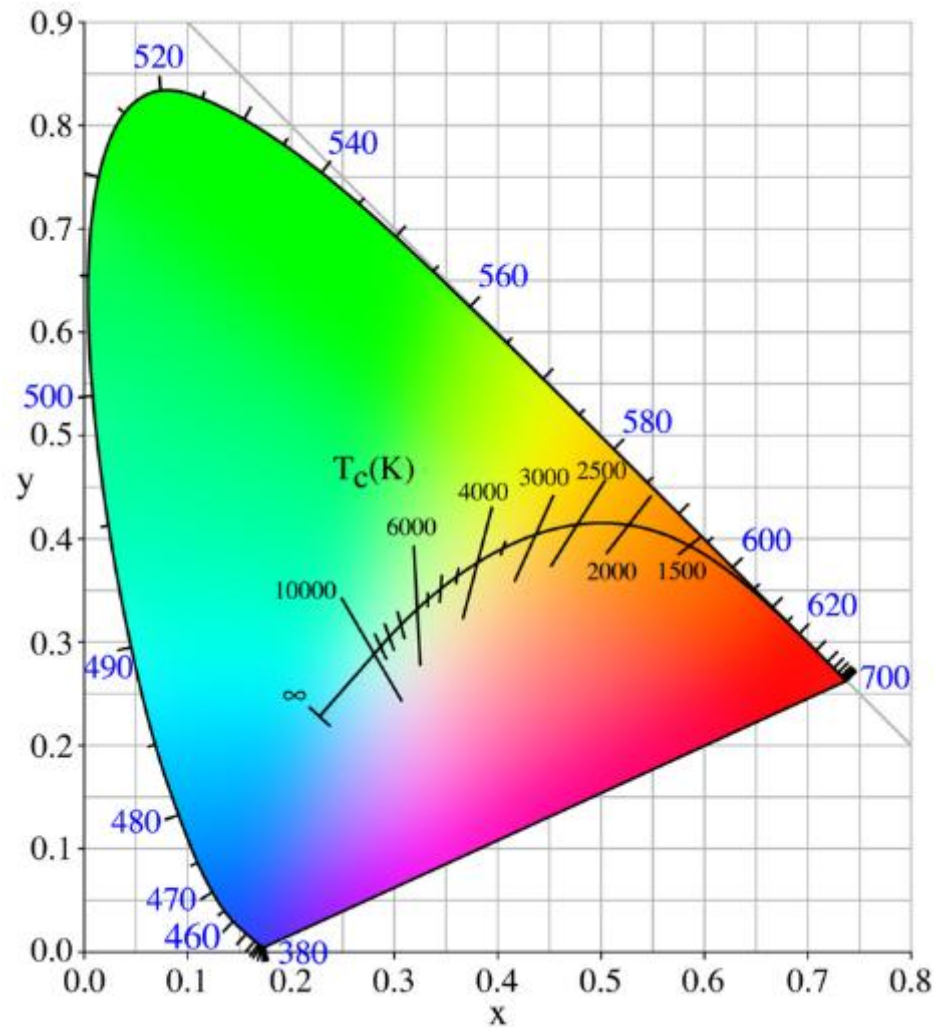
Commission Internationale de l'Eclairage



CIE XYZ 1931

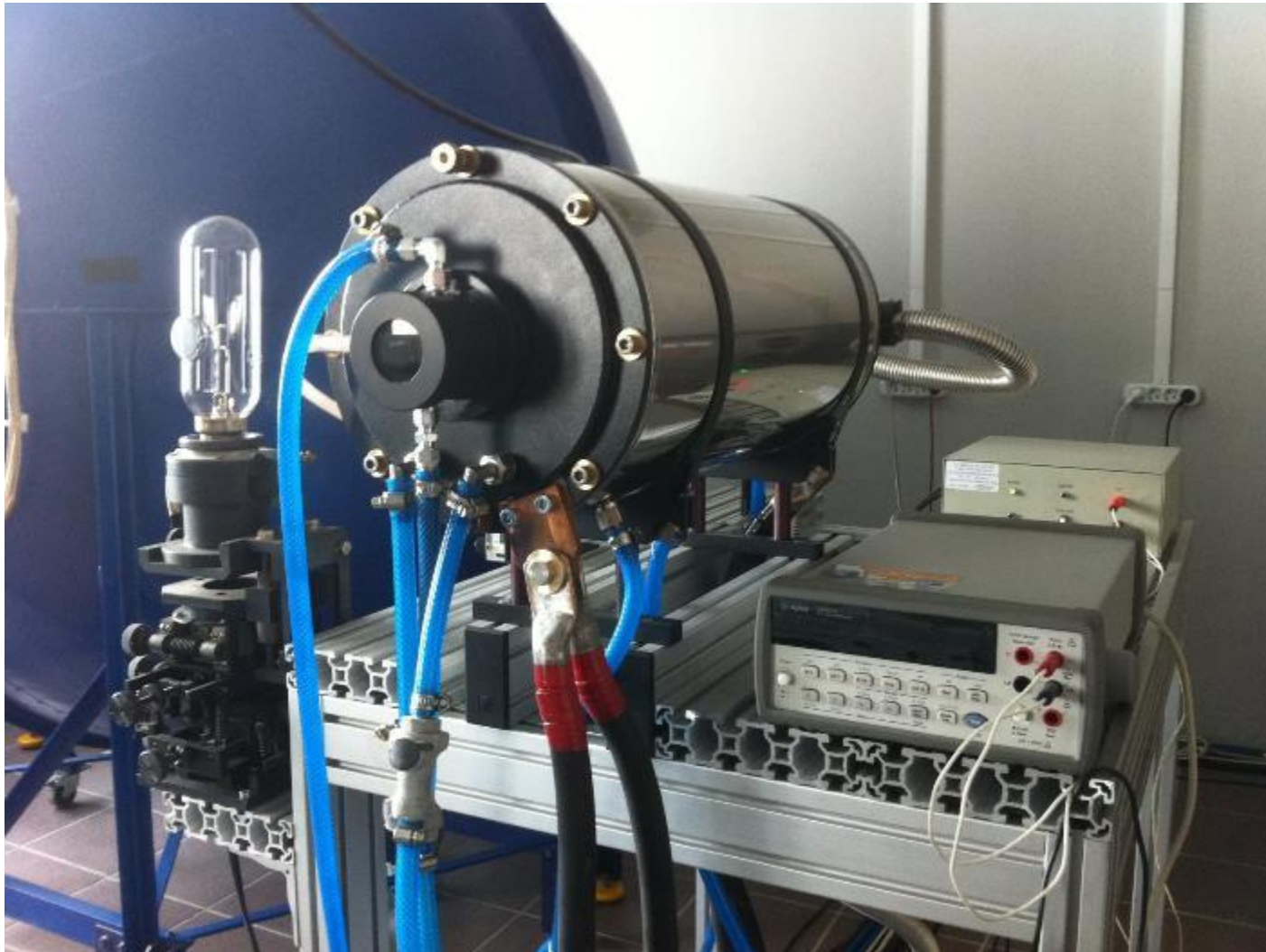


CIE 2 degree observer 1931



Ideal Black Body Radiator

VNIIOFI Institute Moscow



EN	DE	
Luminous intensity	Lichtstärke	(cd)
Luminous flux	Lichtstrom	(lm)
Illuminance	Beleuchtungsstärke	(lx)
Luminance	Leuchtdichte	(cd/m ²)

How to measure LED light

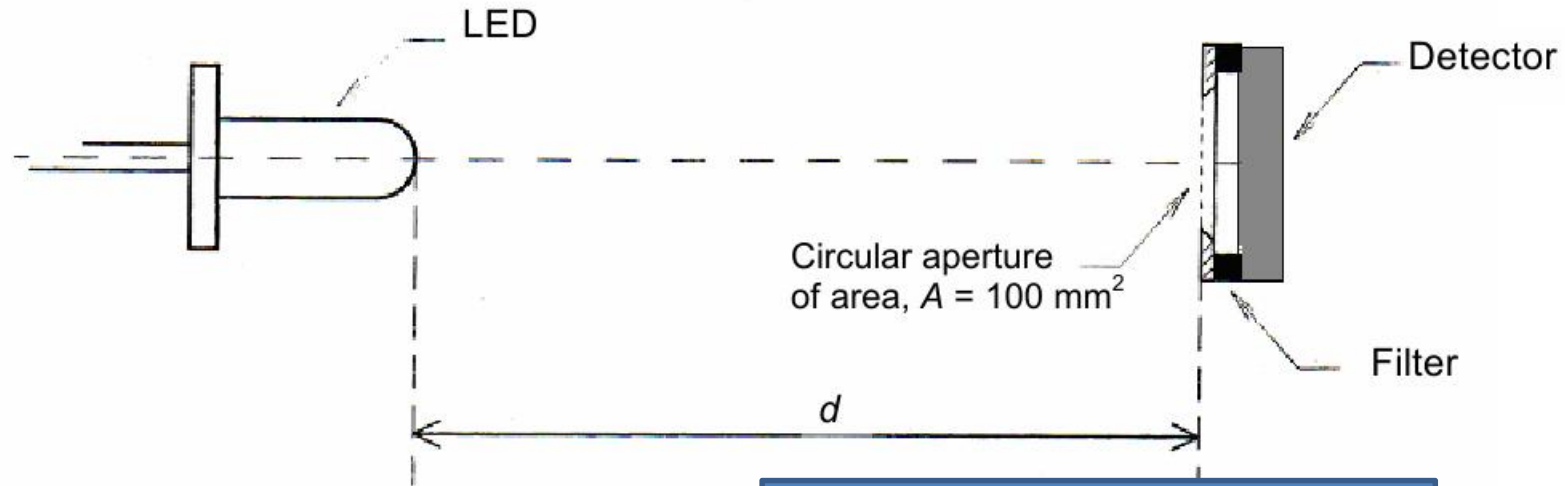
CIE Technical Report

CIE 127:2007



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Luminous intensity - Lichtstärke [cd] (candela)



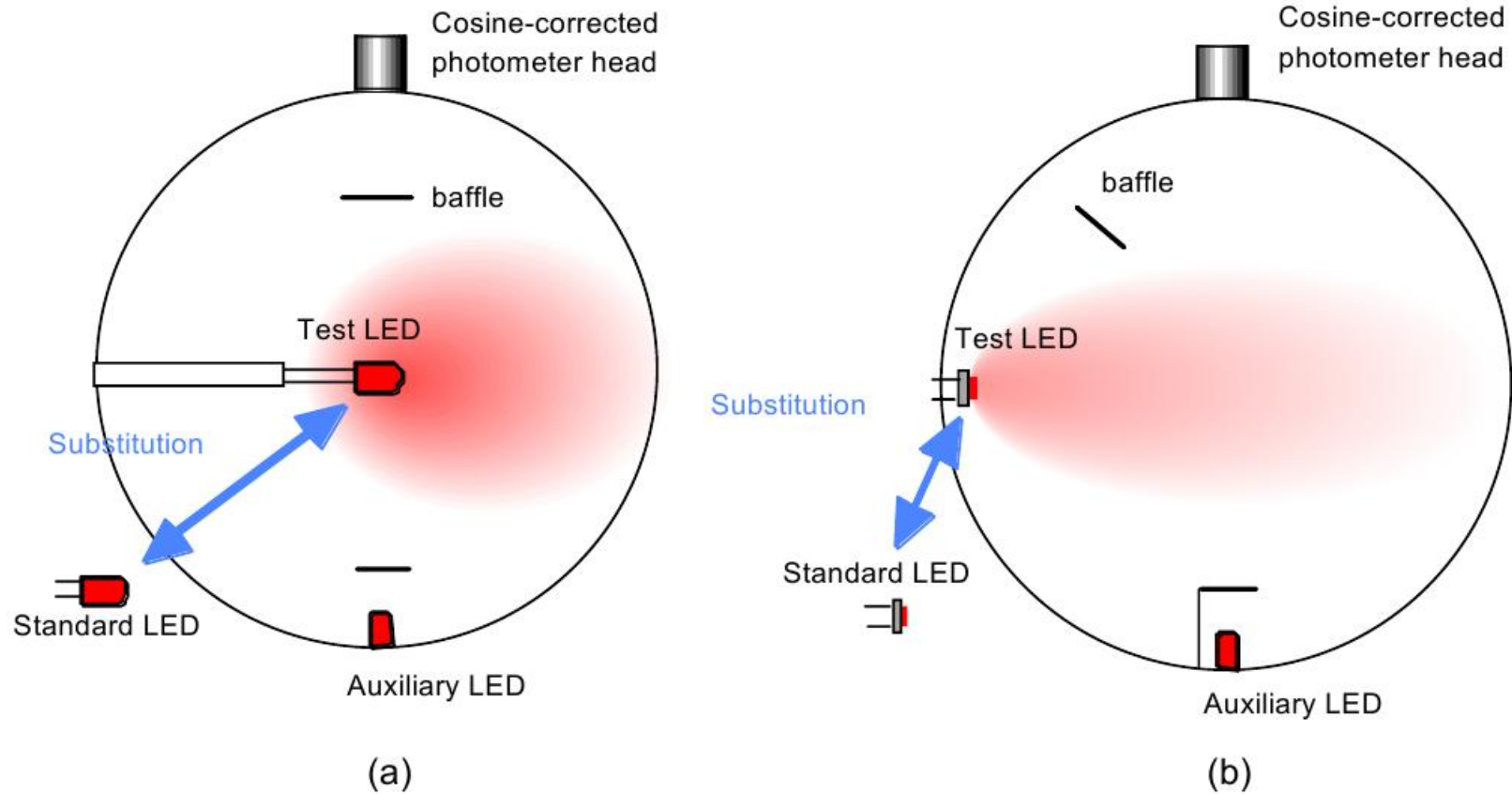
CIE Standard condition A: $d=316 \text{ mm}$
CIE Standard condition B: $d=100 \text{ mm}$

$$I_{LEDV} = E_v \cdot d^2$$

E_v – lux value measured

d - distance measured in meters

Luminous flux Lichtstrom- (lumen)



Illuminance measurement [lux]

Irradiance [mW/m²/nm]

What is illuminance?

It is the total luminous flux incident on a surface, correlated with human brightness perception.

How is it measured and which unit is used?

It is measured with a spectrometer with a cosine-corrected measurement probe called a diffuser. It is placed on an examined surface and measures the luminous emittance in lux [lx].

What does it give us?

It is a very practical method of determining the level of light on surfaces such as those of working tables, pavements, roads or shelves. Illuminance is inversely proportional to the square of the distance from the source.

Illuminance measurement

It is measured with a spectrometer with a cosine-corrected measurement probe called a diffuser. It is placed on an examined surface and measures the luminous emittance [lx].

Lux [lx]



Luminous Flux [lm]

Radiant power [W]

What is a luminous flux?

It is the total measure of the perceived power of light in relation to the spectral sensitivity of the human eye.

How do we measure it?

Luminous flux is measured with a spectrometer connected to an integrating sphere. This method allows to determine the total amount of energy emitted by an examined source in all directions. The SI unit of luminous flux is lumen [lm].

What does it give us?

It allows to determine the total amount of light emitted by a source in every direction, taking into account the sensitivity of the human eye. Such measurement provides a basis for calculating other parameters and can be used for comparing different light sources.

Luminous Flux [lm]

Luminous flux is measured with a spectrometer connected to an integrating sphere.

Lumen [lm]



Luminance measurement [cd/m²]

What is luminance?

Luminance is a photometric measure of luminous intensity of light that is emitted or diffused by a particular area.

How is it measured and which unit is used?

It is measured with a measuring adapter with a lens directed towards the examined surface. The SI unit is candela per square metre [cd/ m²].

What does it give us?

It allows to assess the brightness of a particular surface and is especially useful when measuring the brightness of screens and displays, airport aprons and runways, roads lighted with street lamps etc.

Luminance measurement [cd/m²]

It is measured with a with a lens directed towards the examined surface.

[cd/m²]



Performance requirements for lamps and
luminaires

IESNA Standards on LED/SSL

International Electrotechnical Commission



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IESNA Standards on LED/SSL

Published standards on SSL

- [LM-79-08](#) Approved Method for Electrical and Photometric Measurement of Solid State Lighting Products
- [LM-80-08](#) Approved Method for Measuring Lumen Maintenance of LED Light Sources
- [LM-82-12](#) Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature
- [RP-16-10](#) a new section on light emitting diodes

Under development

- [TC-21](#) Lumen Depreciation Lifetime Estimation Method for LED Light Sources
- [LM-xx](#) Electrical and Photometric Measurements of High Power LEDs
- [LM-xx](#) Characterization of LED Light Engines and Integrated LED Lamps for Electrical and Photometric Properties as a Function of Temperature
- Starting
 - Photometric Measurement of AC-driven LEDs
 - Test methods for lumen maintenance of LED light engines, LED lamps, LED luminaires.

IESNA = Illuminating Engineering Society of North America



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International Electrotechnical Commission

IEC TC34 Lamp and Related Equipment

SC34A Lamps and glow starters (MT PRESCO)

SC34B Lamp caps and holders

SC34C Lamp control gear

SC34D Luminaires (MT LUMEX)

IEC PAS 62612 **Self-ballasted LED-lamps - Performance requirements**

IEC 62663-2 **Non-ballasted LED lamps - Performance requirements**

IEC 62722-2-1 **LED luminaire - Performance requirements**

IEC 62727 **LED modules for general lighting– Performance requirements**

IEC TS 62504 **Terms and Definitions for LED and LED modules**

IEC 62031 Safety standard for LED modules

IEC 62560 Safety standard for self-ballasted LED lamps

IEC 62471-2 Photobiological safety; Guide

IEC xx LED binning



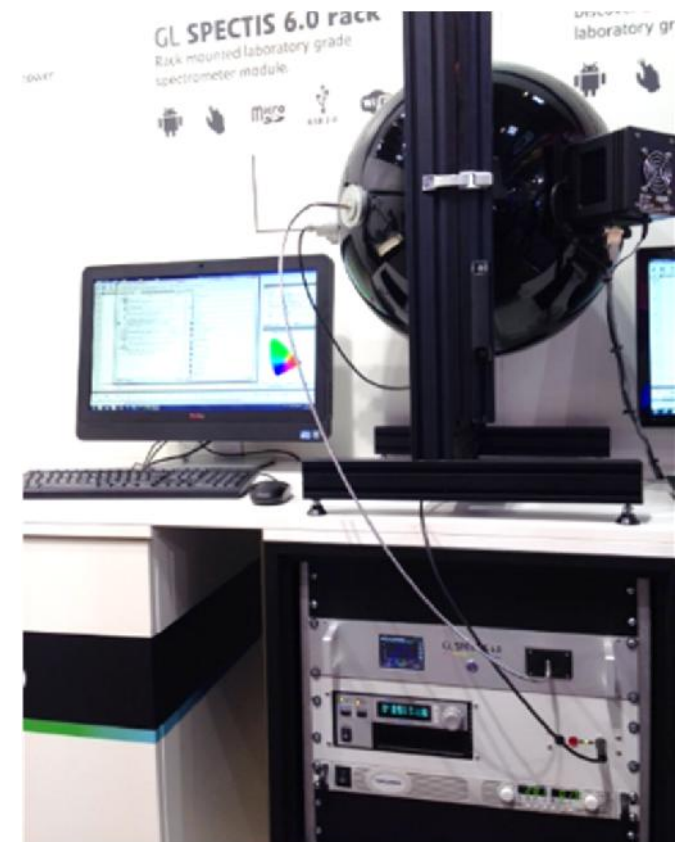
-- Efforts in progress to
resolve differences
between CIE and IEC
definitions.



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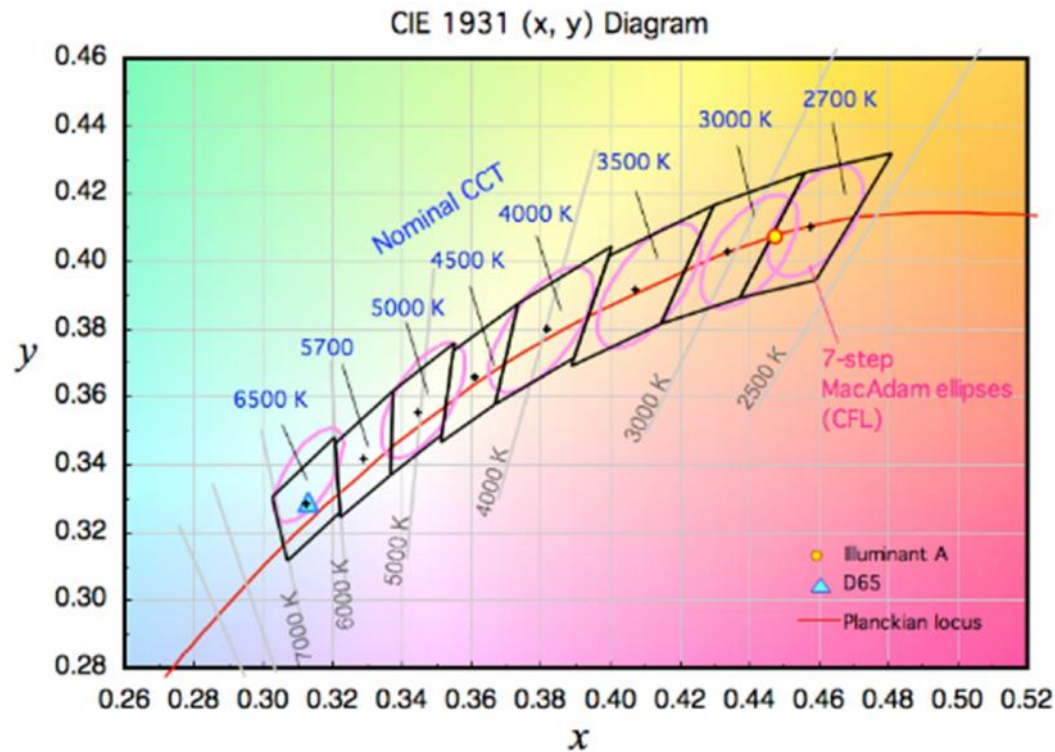
Performance tests of lamps and luminaires

- Optical measurements
Lumen, color, CCT, CRI
- Thermal consideration
Flux drops with higher temp.
- Electrical consideration
Stabilized power supply with measurements function

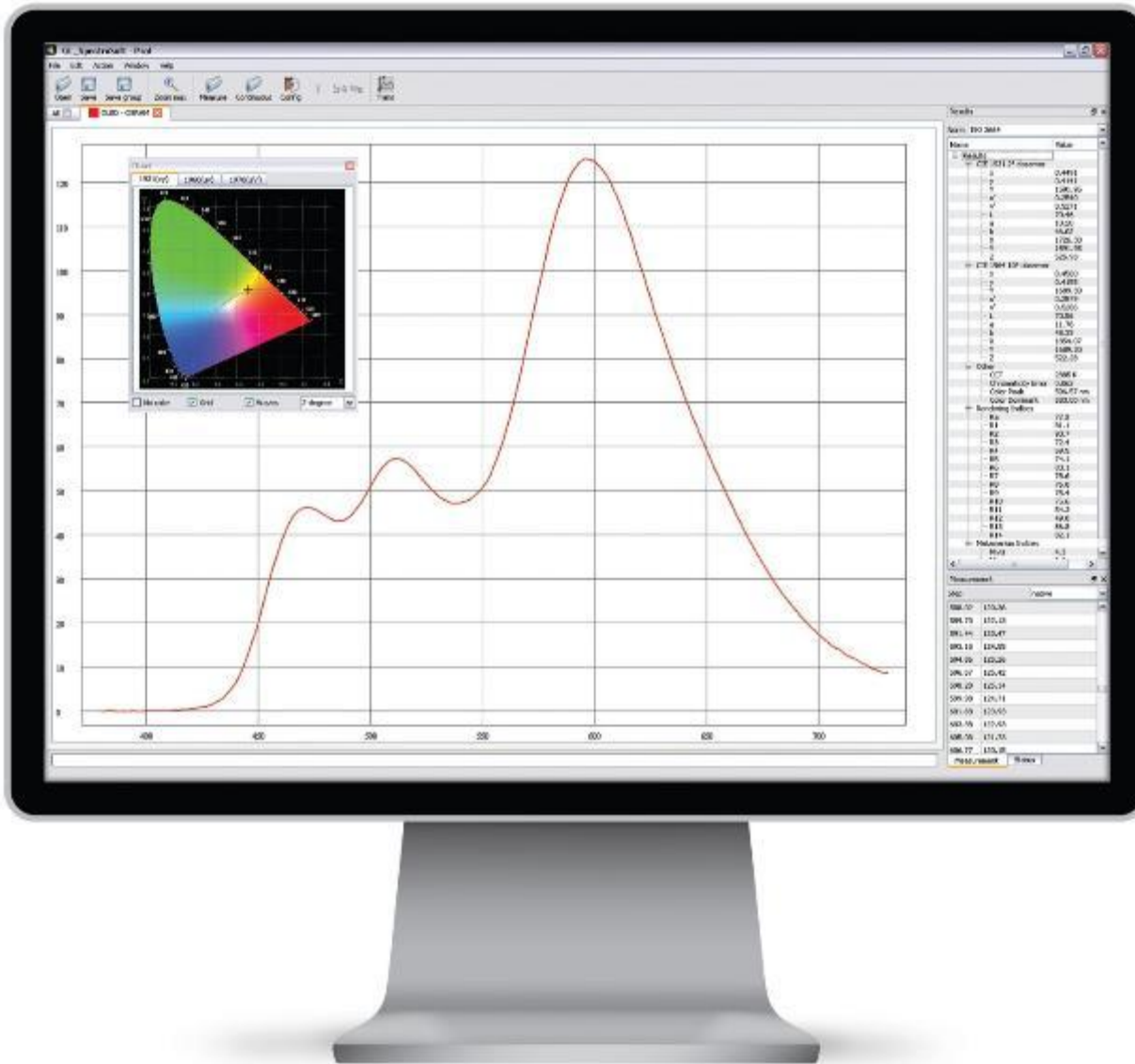


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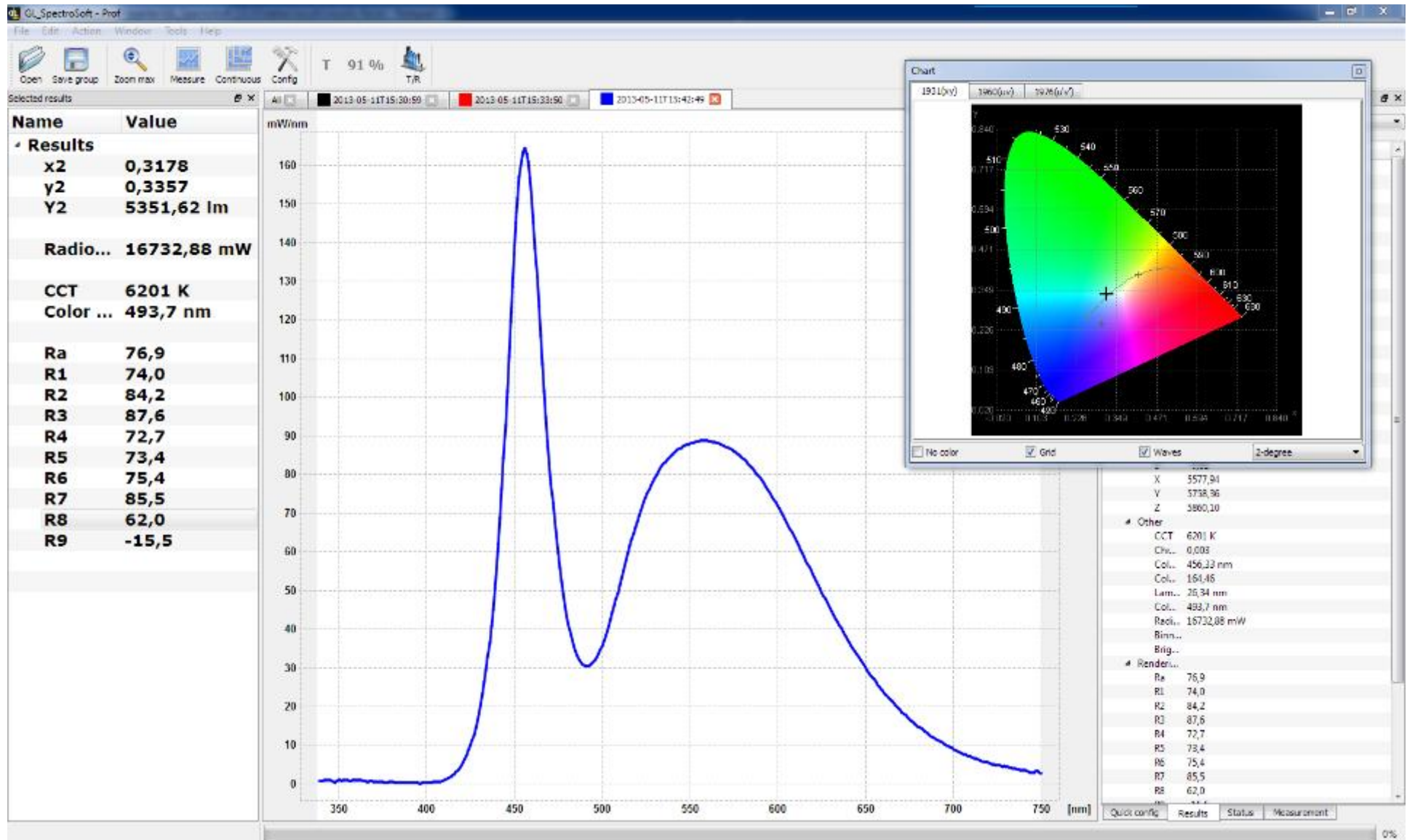
ANSI C78.377 Specifications for the Chromaticity of SSL products



- Key standard for white light chromaticity of SSL products (indoor applications).
- Used by Energy Star. Accepted worldwide.
- Major contribution by NIST.
- Revision being discussed
 - Binning scheme (IEC)
 - True visual preference



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Thank you for your attention!

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