



THE FUTURE OF MEASURING LIGHT

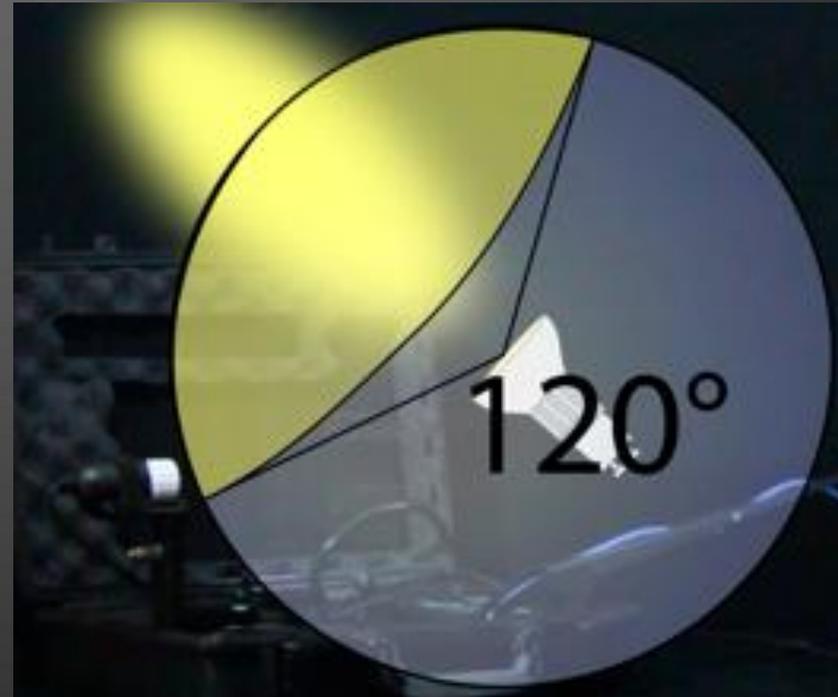
JANA BALTSER
VISO SYSTEMS APS
COPENHAGEN

ENVIRONMENTAL CONCERNS: NEW REGULATIONS

The core objective of these regulations is to reduce CO₂ emissions in the EU by 20% in 2020 (compared to 2012).

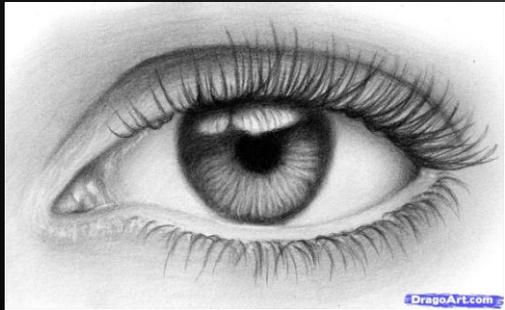
To phase out existing incandescent light sources and implement energy efficient directional light sources.

Definition of a directional lamp: 80% of light is radiated into a fixed beam angle (90° or 120° cones).

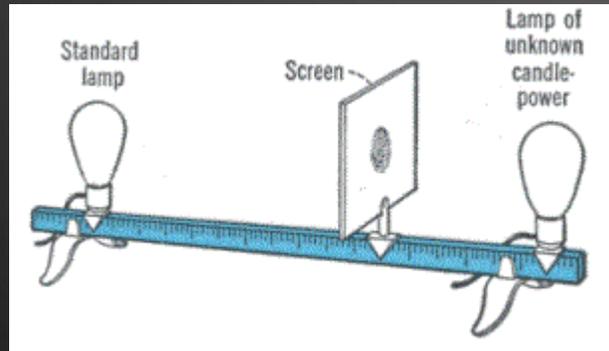


HISTORICAL PERSPECTIVE

Photometry measures light radiation in terms of perceived brightness to the human eye. Main characteristic of light is luminous flux.



Early days,
eye
estimation



Mid 1850's,
Bunsen's
photometer



Mid 1960's,
photometers and lux
meters



Nowdays, integrating
spheres and
goniophotometers

INTEGRATING SPHERES

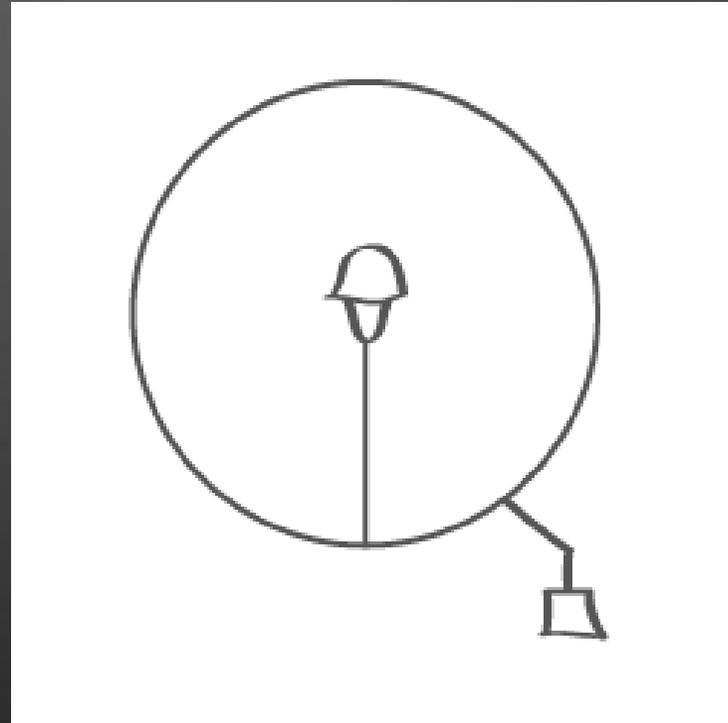
Luminous flux (lumen) coming from all directions of a light source - spherical shape integrates the light inside.

Technique originated at the turn of the 20th century to compare the lumen output of different lamp types.

Inside of the sphere is covered with a diffuse reflective surface.

Lamp is mounted in the centre of the sphere and baffled from the viewing port.

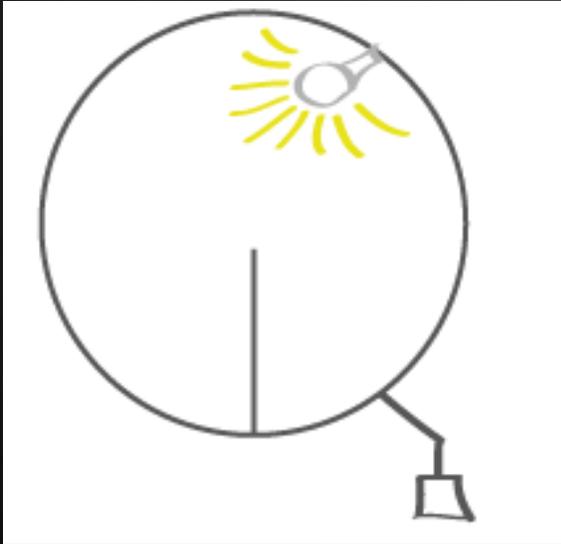
Spectrometer calibration with an auxiliary lamp followed by the lumen measurement.



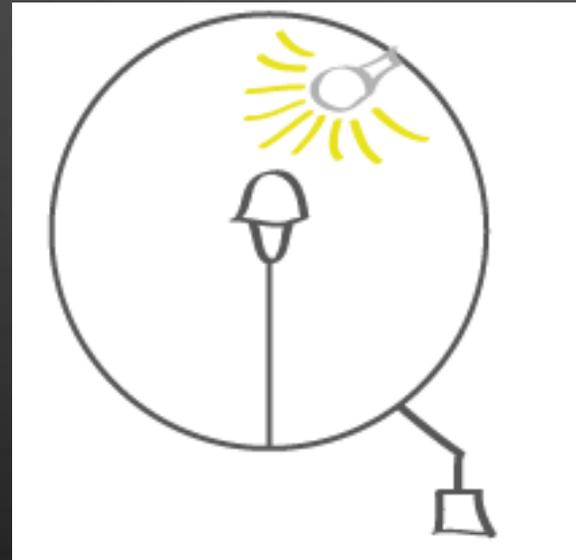
INTEGRATING SPHERES

Measuring principle of integrating spheres

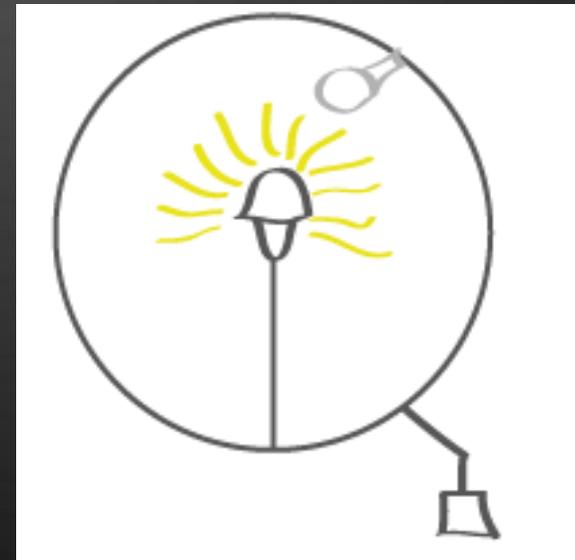
"Empty" calibration



"Form" calibration



Measurement itself



Calibration requires longer time and additional elements (the inside calibration lamp).

INTEGRATING SPHERES

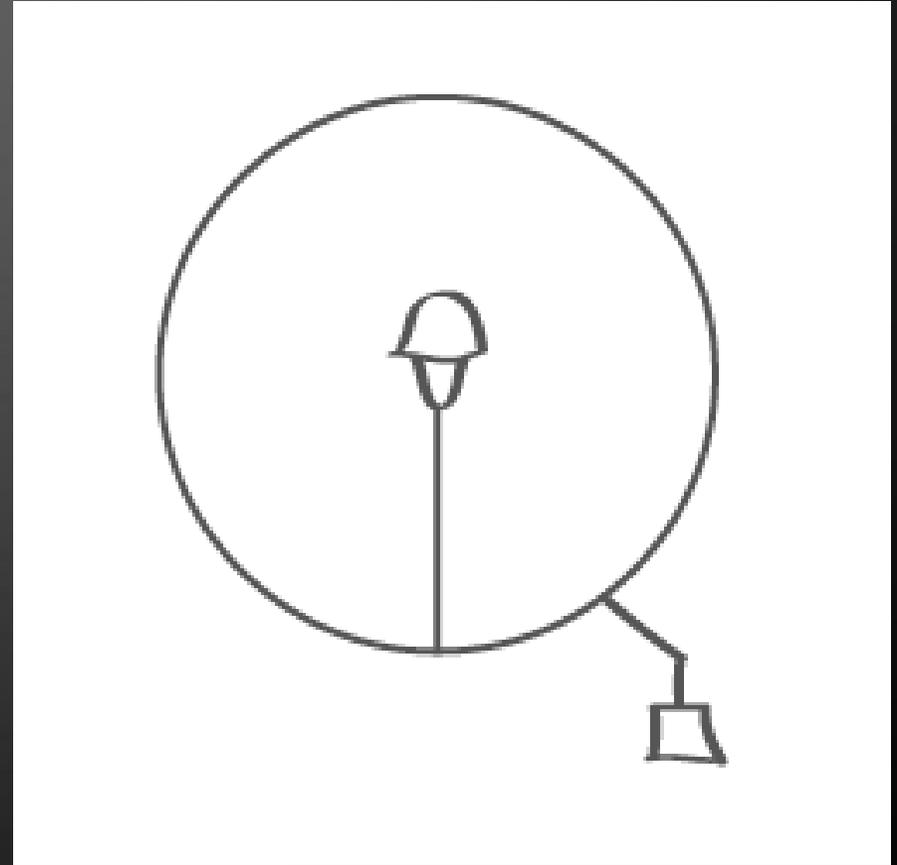
Results and further considerations

Measuring data:

- Luminous flux
- CRI
- CCT

Contemporary drawbacks:

- Takes a long time for a single measurement and prior knowledge
- Directional lights give large errors (7-10%)
- Linear lights (tubes) lamp dimensions yield huge spherical dimensions to accommodate for them
- No 3D information (no IES/LDT files)



GONIOPHOTOMETERS

One step further and a technological advancement – luminous flux information in 3D brings IES and LDT files. Appearance of goniophotometers of various types.



Integration sphere: lumen values



Goniometer: spatial distribution

Spatial distribution is of high importance for the lighting industry: manufacturers, designers and engineers need this information for 3D modelling.

GONIOPHOTOMETERS

Directional LED lighting impose an increased need for goniophotometers. For example, measurements with high accuracy are highly demanded by automotive lighting industry.



Type A: fixed horizontal axis, moving axis perpendicular to this axis. Measurement: rotating the fixture about the horizontal axis keeping the other axis fixed (rotation vs evaluation).

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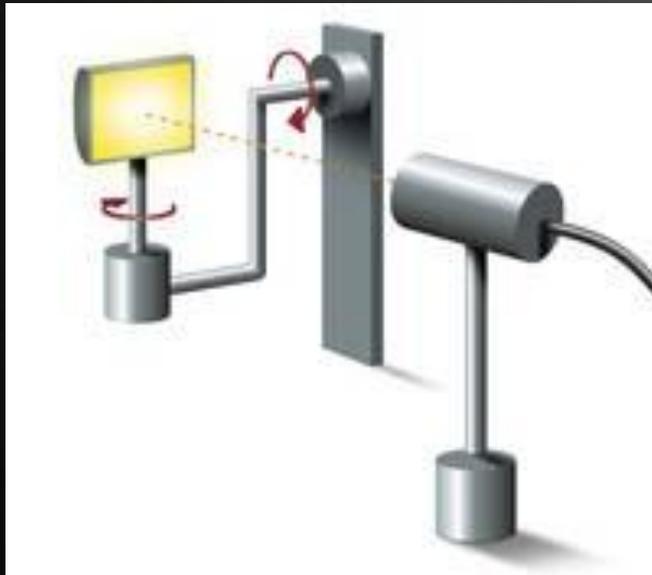
Type A: fixed horizontal axis, moving axis perpendicular to this axis. Measurement: rotating the fixture about the horizontal axis keeping the other axis fixed (rotation vs evaluation).



Type B: fixed vertical axis, moving horizontal axis. Measurement: rotating the fixture about the vertical axis keeping the horizontal axis fixed (evaluation vs rotation).

GONIOPHOTOMETERS

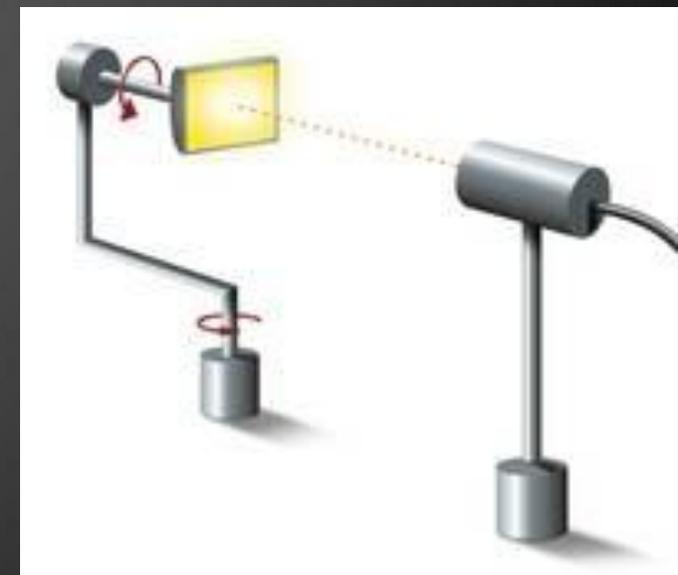
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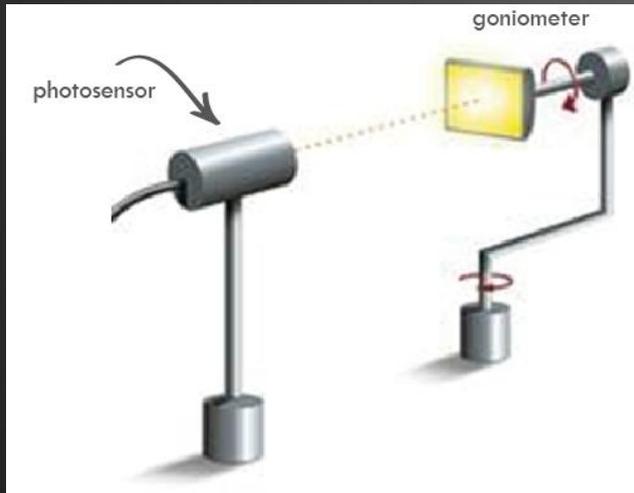
Type B: fixed vertical axis, moving horizontal axis. Measurement: rotating the fixture about the vertical axis keeping the horizontal axis fixed (evaluation vs rotation).



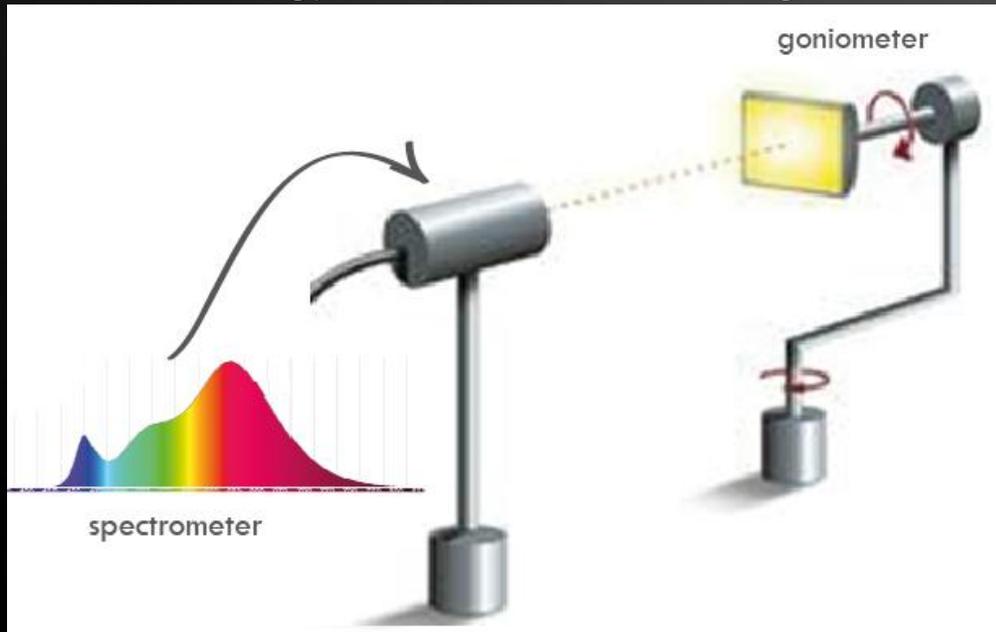
Type C: fixed vertical axis and moving horizontal axis. Measurement: C-plane measurement, similar to type B if the fixture is rotated by 90°.

GONIOPHOTOMETERS

Typical systems include a photo-sensor, goniometer and a spectrometer



New technology: All-in-one measuring solution includes spectrometer and a goniophotometer



GONIOPHOTOMETERS

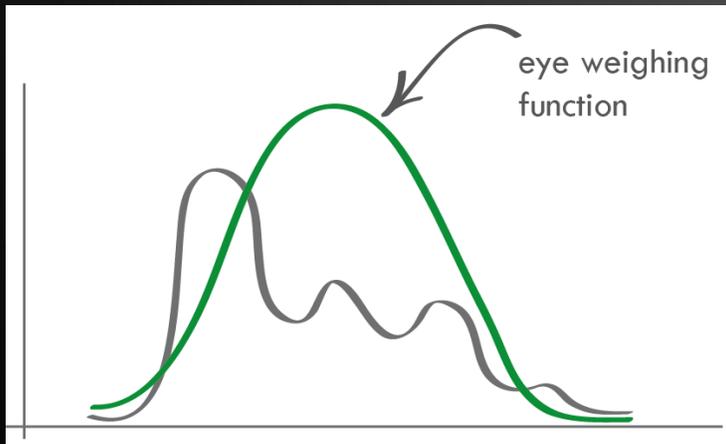
Measuring principle of goniophotometers

Spectrometer: spectrum (watt/nm/cm^2)

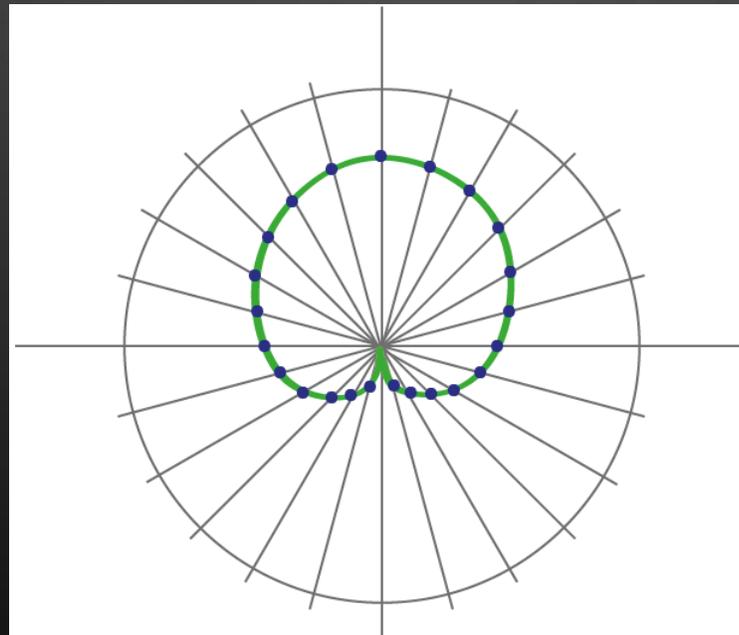


Goniometer: angular positions (watt/nm/sr)

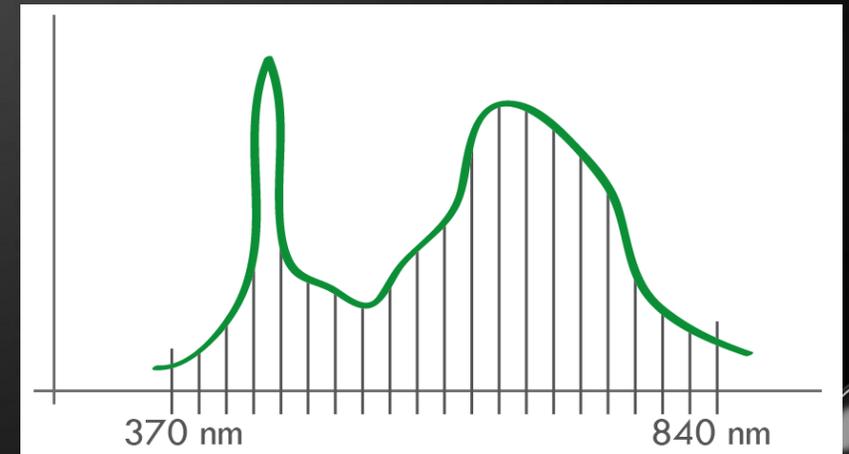
Light intensity in candela



Luminous flux in lumen



Integrated spectrum

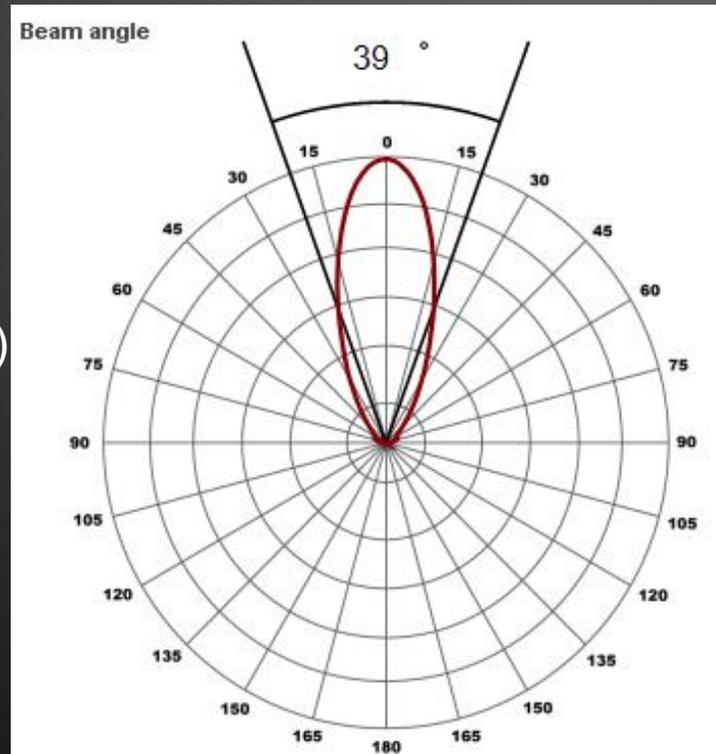


GONIOPHOTOMETERS

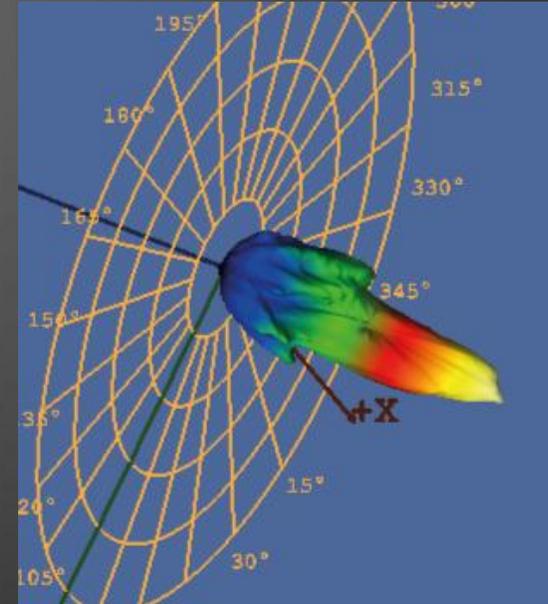
Measures the following parameters in one setting

- Light distribution curve
- Beam angle
- Efficiency (lm/watt)
- Luminous flux (lumen)
- Light intensity (candela)
- CRI (CSQ)
- CCT
- Spectrum
- Power
- Power factor
- IES and LDT files

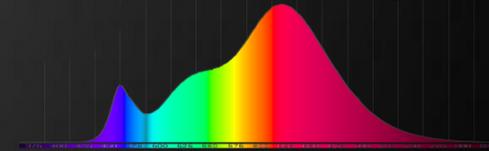
Beam



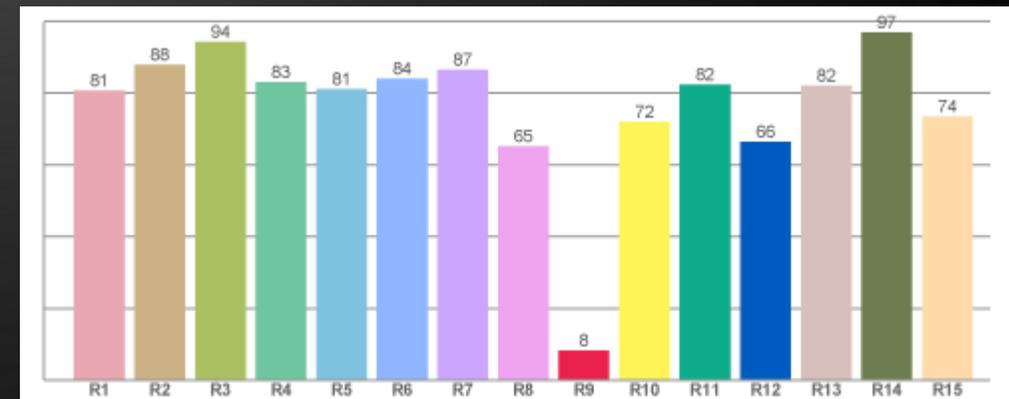
3D visualisation



Integrated spectrum

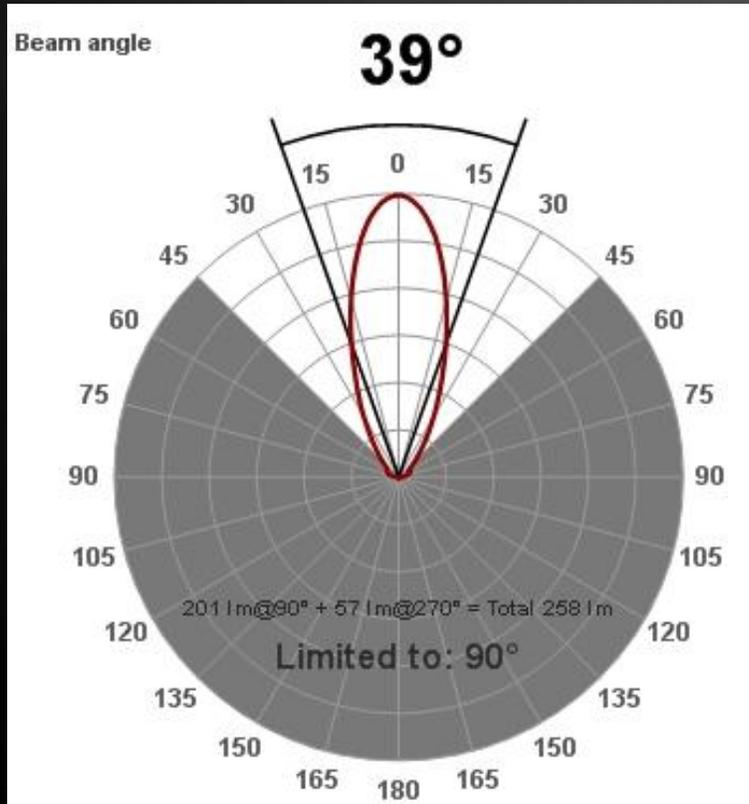


Colour rendering indices



GONIOPHOTOMETERS

For example:



Lumen is only calculated in a 90° cone (white part) grey part is considered waste light, according to the new EU regulation.

Total: 258 lm
90° cone: 201 lm
Waste light: 57 lm

Environmental energy efficiency 1194/2012

directional lamps with a beam angle $\geq 90^\circ$ other than filament lamps and carrying a warning on their packaging in accordance with point 3.1.2(j) of this Annex: rated luminous flux in a 120° cone ($\Phi 120^\circ$).

- other directional lamps: rated luminous flux in a 90° cone ($\Phi 90^\circ$).

GONIOPHOTOMETERS

Application:

DIAL
light. building. software.

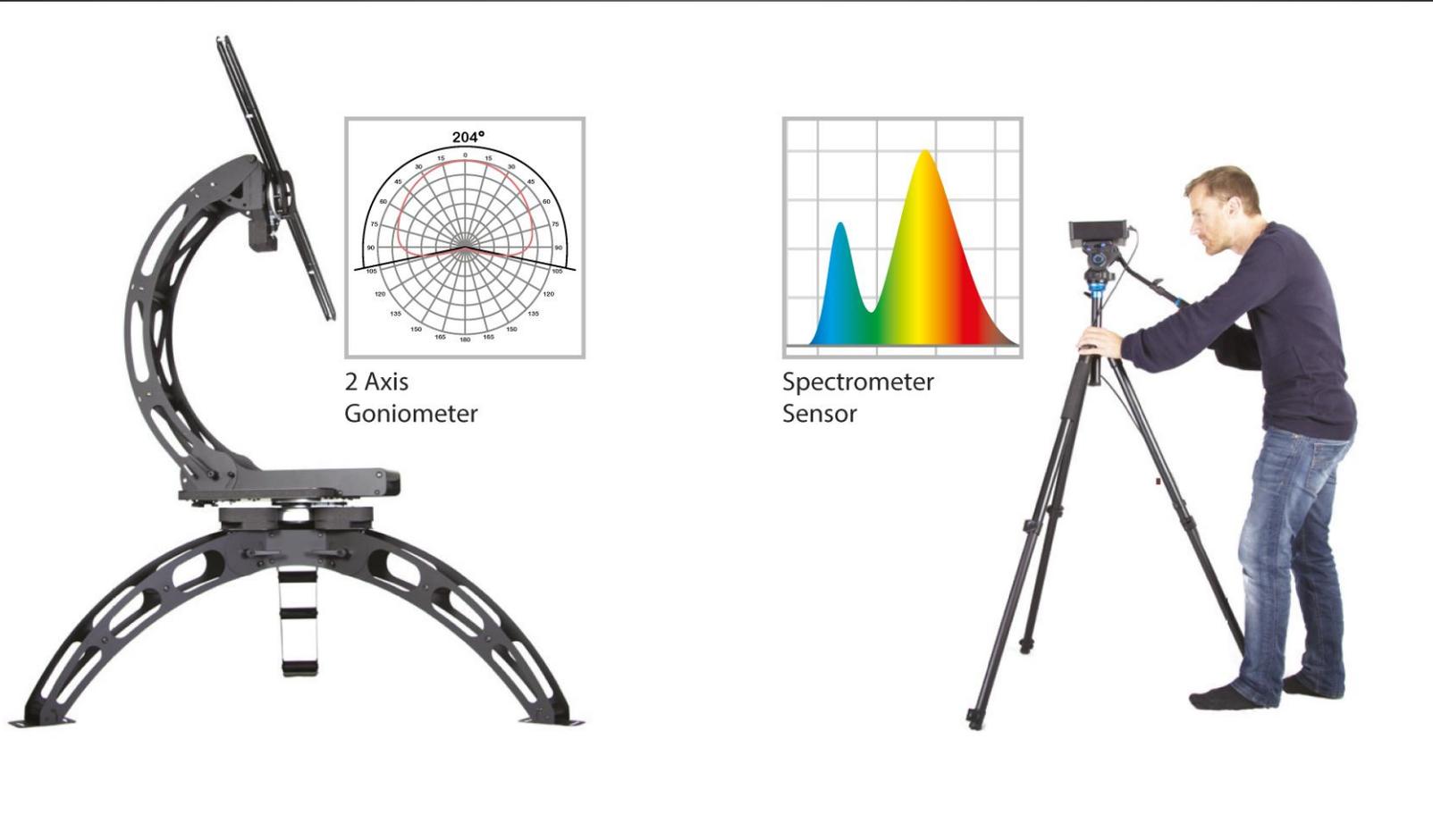
IES and LDT files.



DIALux



THE FUTURE OF MEASURING LIGHT IS... NOW



Your questions and suggestions are very welcome!

Visit us at Acal Bfi booth nr. 9 😊