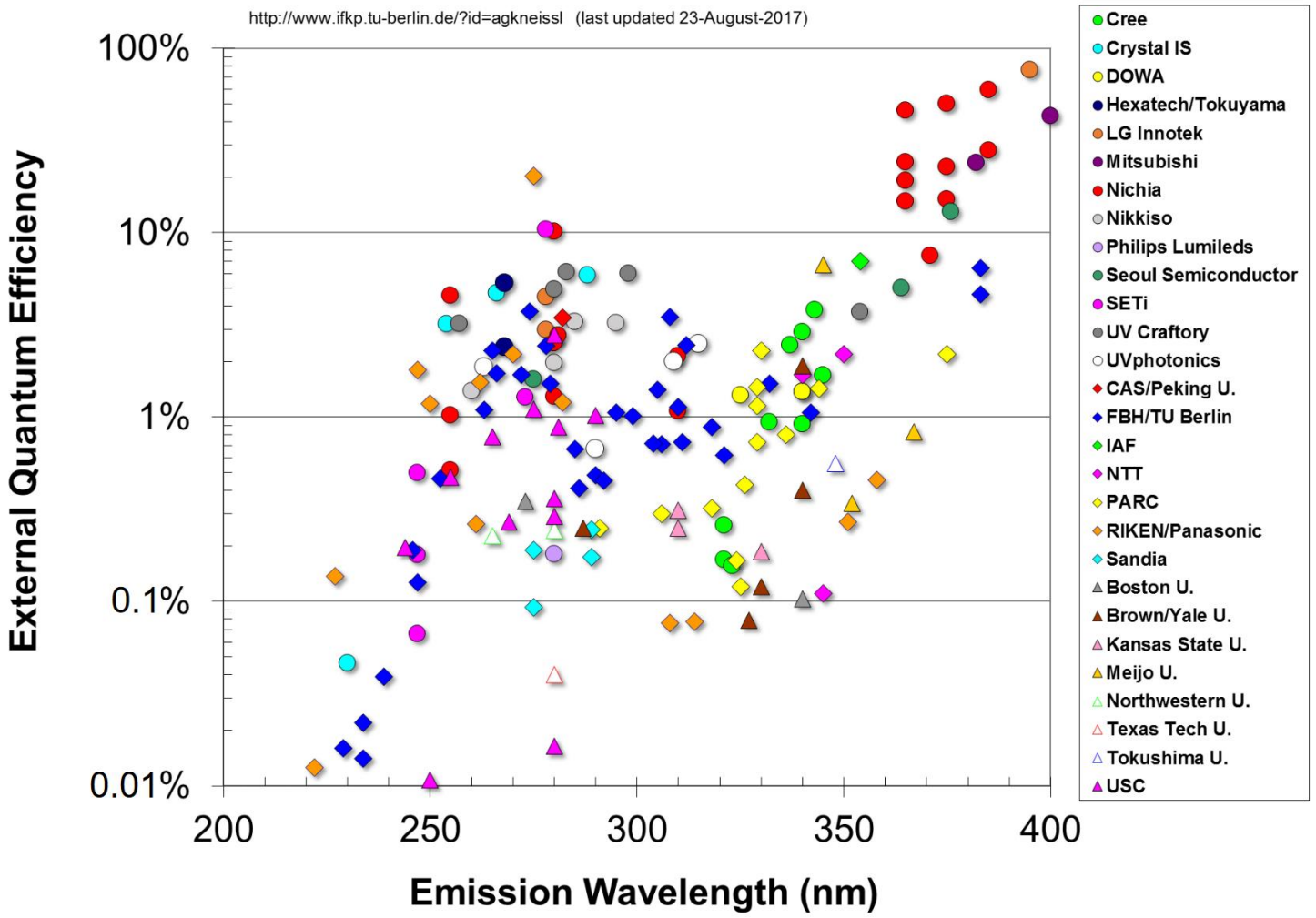
Opsytec Dr. Gröbel

We apply **photonics.**

UV Calibrations – a state of the art review

Dr. Mark Paravia, 18.10.2017

UV-LED efficiency



Source: Kneissl, University of Berlin

Opsytec Dr. Gröbel

- Manufacturer of UV equipment
- First accredited calibration laboratory for UV sensors according 17025
- Accredited testing laboratory for spectrometers and lamps (17025)

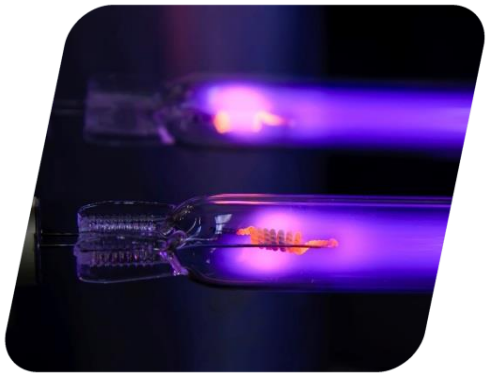
ilac-MRA

DAkkS Deutsche Akkreditierungsstelle
D-K-20284-01-00
D-PL-20284-01-00

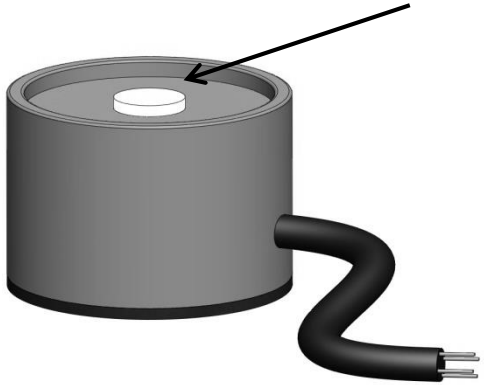
DKD

cie

UV measurement



Irradiance at sensor surface

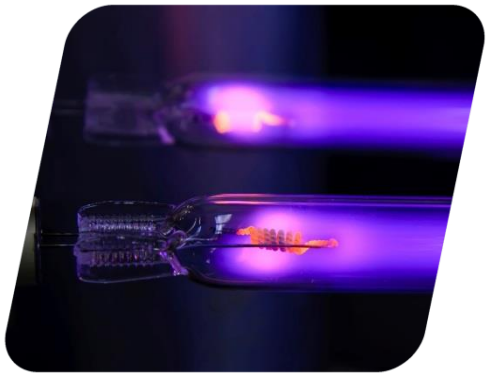


UV Calibrations

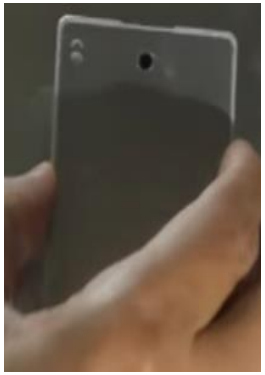
Calibration = operation that, under specified conditions … establishes a relation between the quantity values with measurement uncertainties provided by measurement standards … and … uses this information to establish a relation for obtaining a measurement result

(Calibration ≠ Adjustment) [VIM]

UV Calibrations



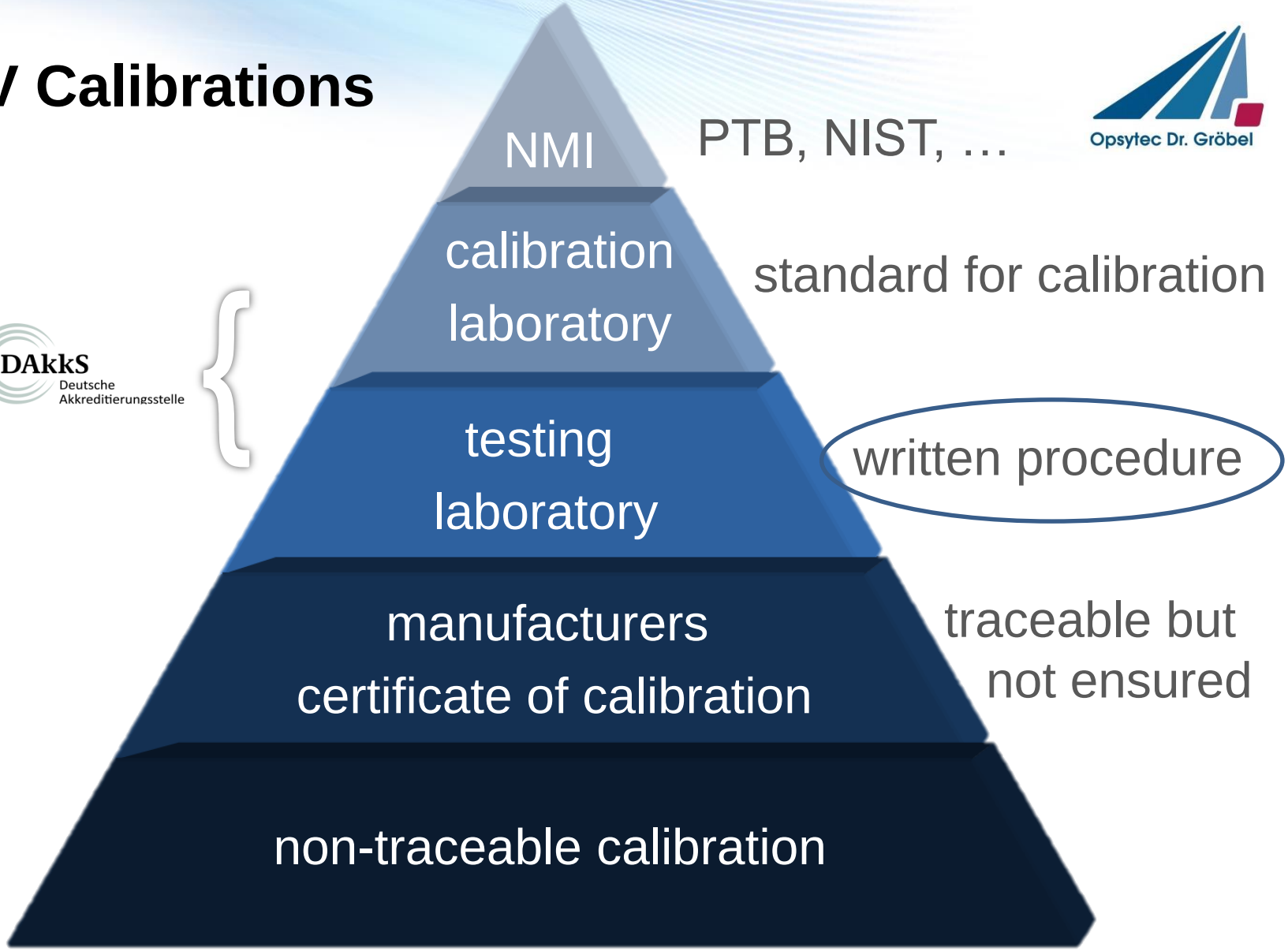
Calibration = a relation under specified conditions …



Outline

- Laboratory standards
- Measurement and calibration methods
- Flux measurements for a 275 nm LED

UV Calibrations



UV Calibration methods

- CIE 220:2016

Characterization and calibration methods of UV radiometers

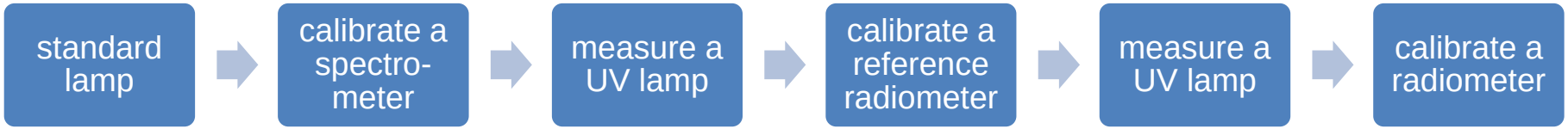
… novel standard, comparable quality indices

… calibration of sensor spectral sensitivity [nA/W/nm]

… lamp spectra must be known to cal. Irradiance relative or absolute

UV Calibration methods

ASTM G138-12



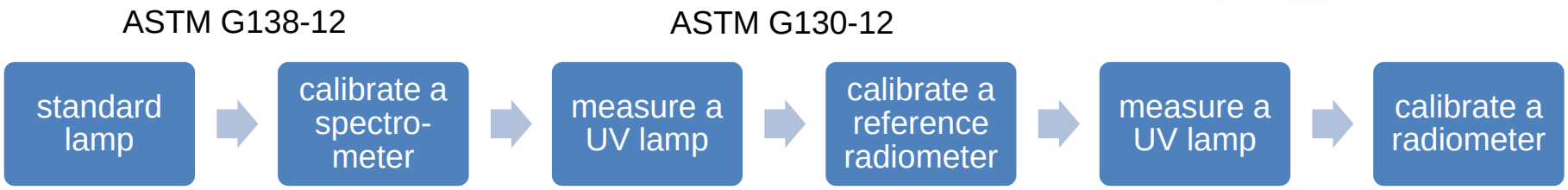
- ASTM G138-12

Calibration of a spectroradiometer using a standard source of Irradiance

… Typical lab procedure for a traceable calibration

… Ensure entrance optics match application / sensor

UV Calibration methods



- ASTM G130-12

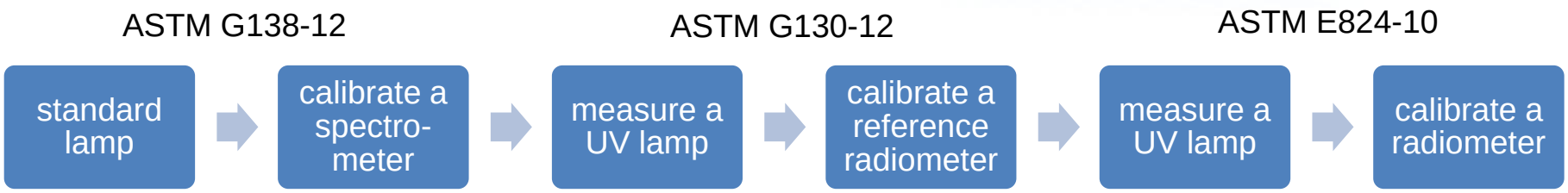
Calibration of narrow- and broad-band ultraviolet radiometers using a spectroradiometer

… Usable for all UV sensors

… Sensors spectral sensitivity is not needed

… Reference measurement of standard lamp must be done before UV lamp measurement

UV Calibration methods



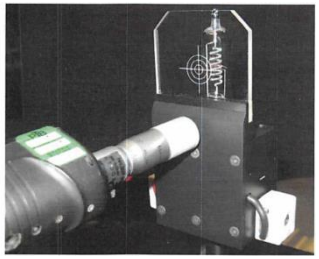
- ASTM E824-10

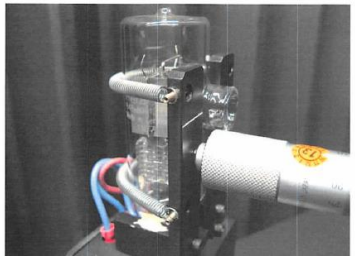
Transfer of Calibration From Reference to Field Radiometers

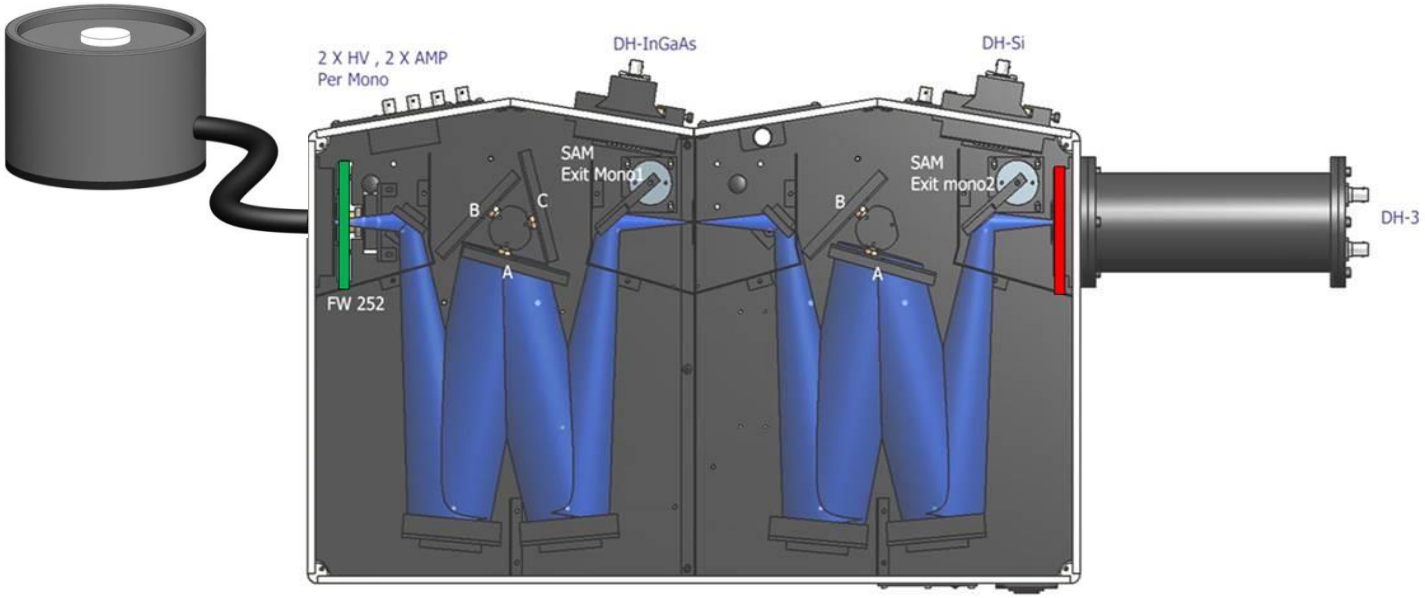
… Fast and reliable method to calibrate with a known UV lamp and a calibrated sensor

… 2-3 reference sensors per application

UV Calibration – verification & validation

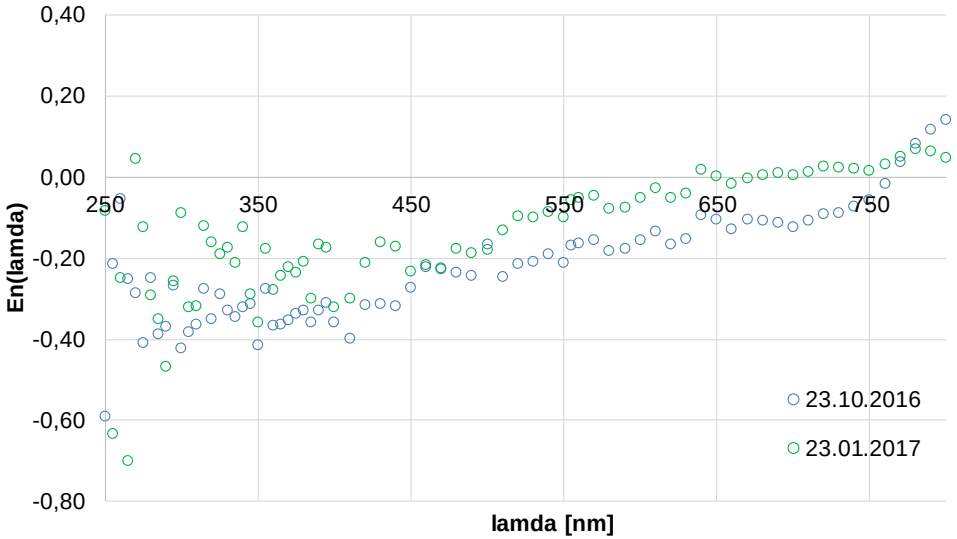




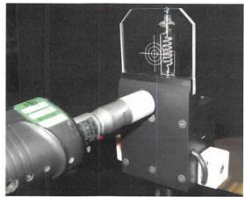


- While a verification of an instrument is necessary for all methods, a validation of a standard method isn't

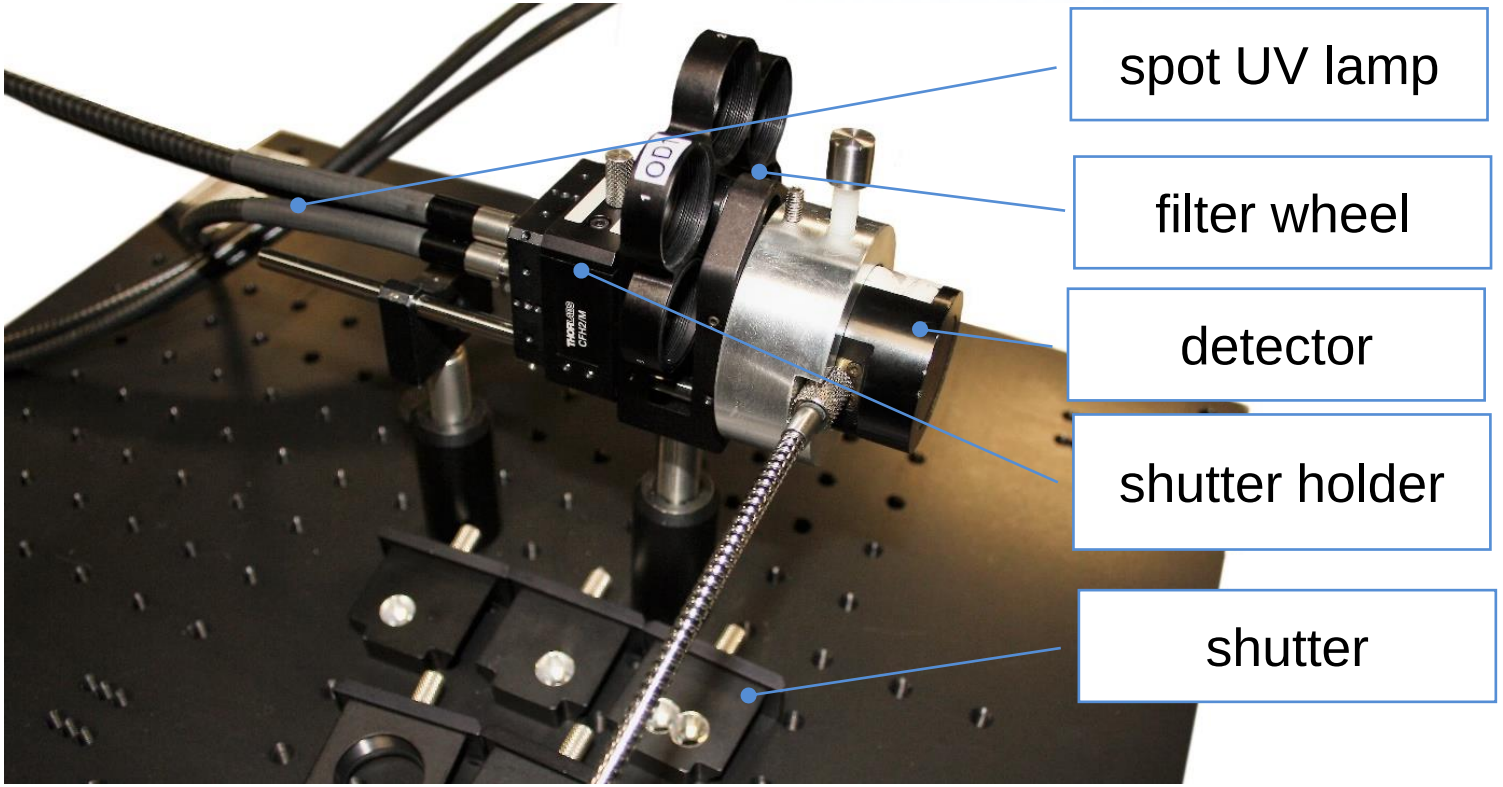
UV Calibration – verification & validation



- Bidirectional measurement of a standard lamp with PTB
- E_n value:
  - “Deviation / Combined uncertainty – 1”
  - En < ±1 to pass comparison
  - En < ± 0,5 to verify both lab results



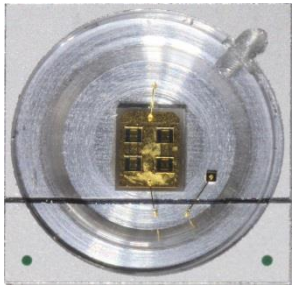
UV Calibration – verification & validation



- Linearity measurement using optical density filter
- Lamp A + lamp B = Lamp (A+B) at each OD filter

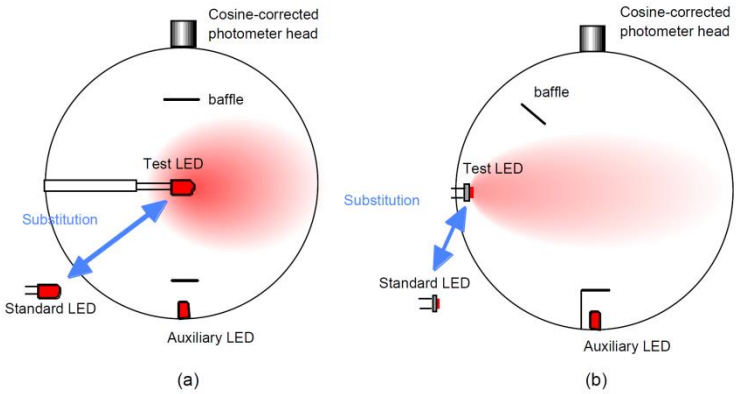
How to measure the flux of a UVC LED?

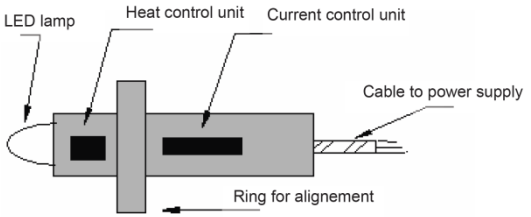
- SMD LED:
  - 275 nm
  - Nominal voltage 6.5 V
  - Max. current 700 mA
  - Output power ?
  - EQE ?



How to measure the flux of a UVC LED?

- 1. Use a integrating sphere

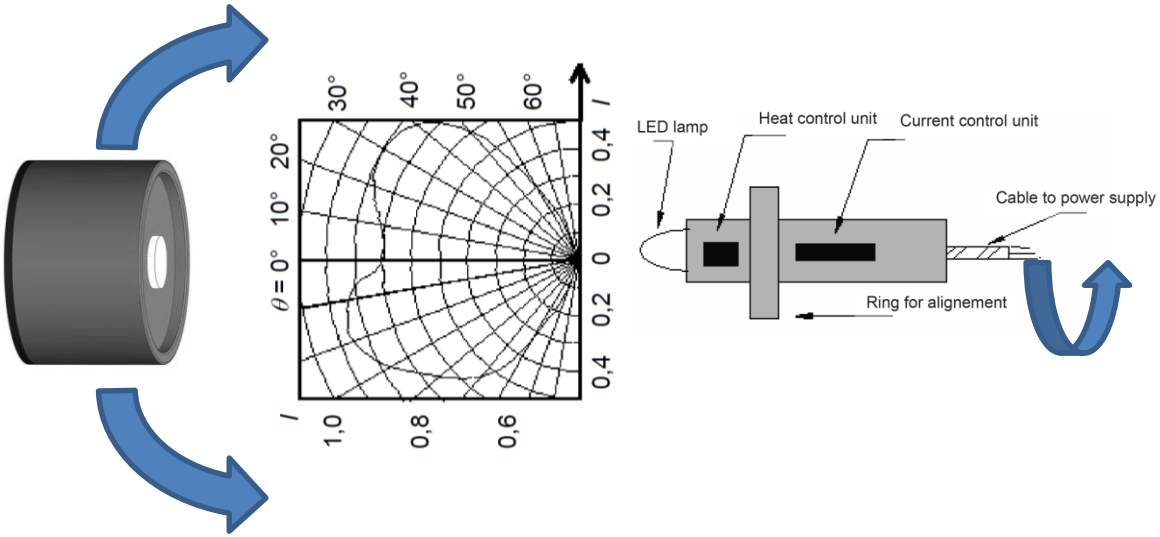




- … integrating sphere must be of PTFE
- … self absorbance and corrections unknown
- … no calibration lamp or LED is available
- … typical flux standard is still an incandescent lamp

How to measure the flux of a UVC LED?

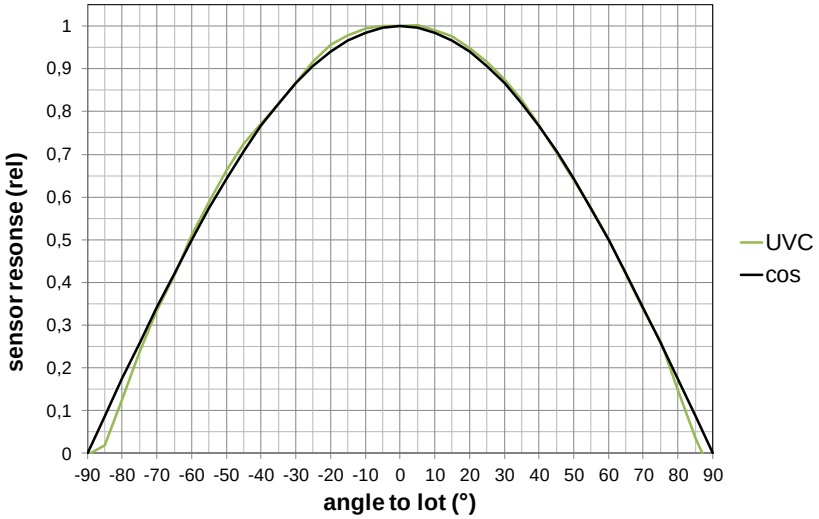
- 2. Use a goniometer

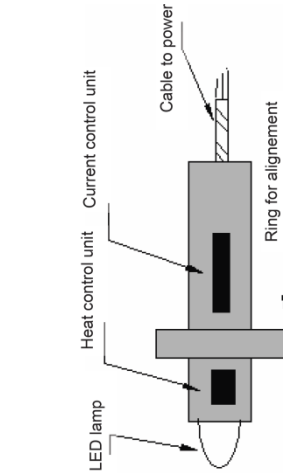


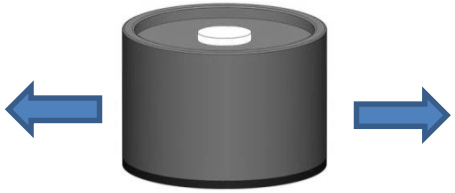
- … distance at least 10 x LED dimensions
- … Strong distance dependence and a compromise between no signal or no mechanical space

How to measure the flux of a UVC LED?

- 3. We use a near-field goniometer

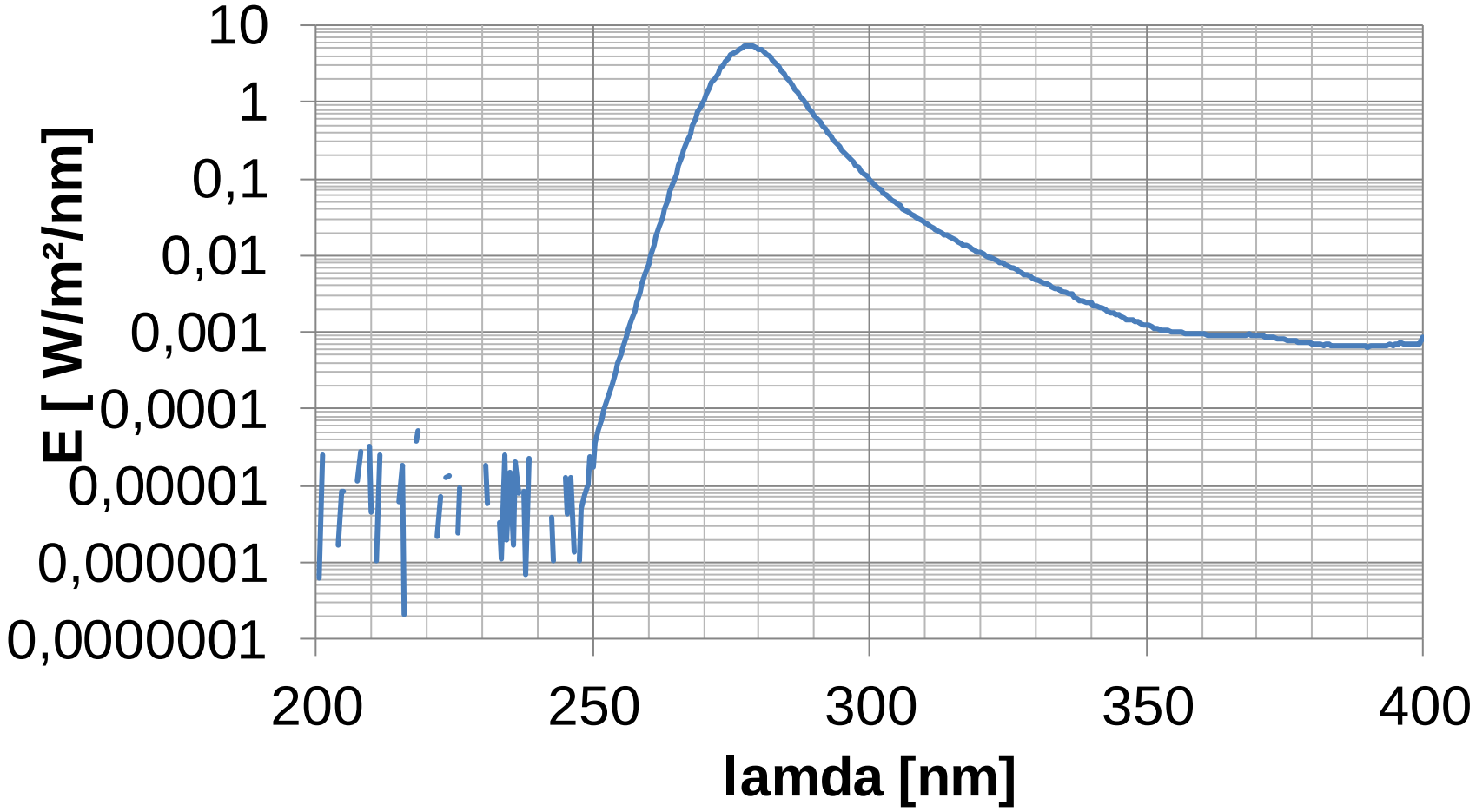






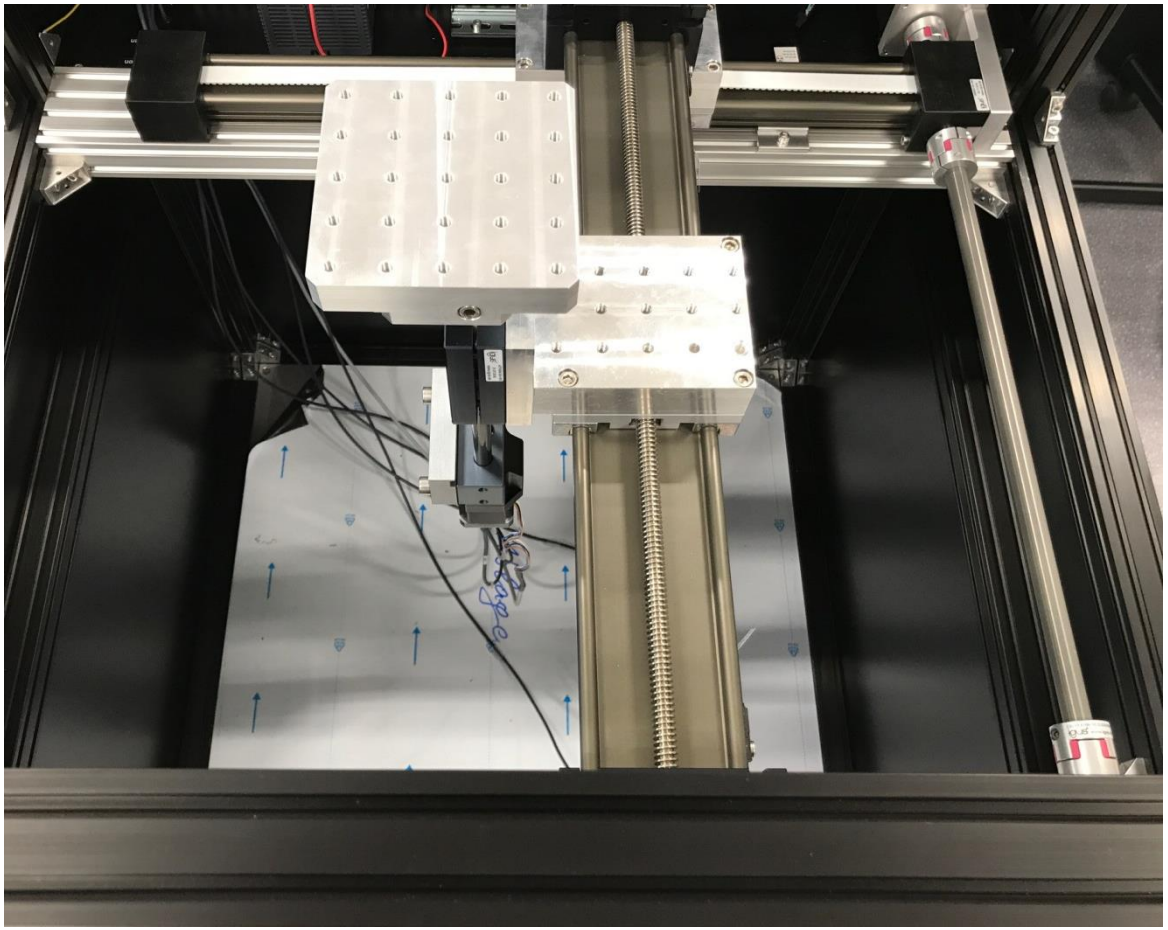
- … cosine correction is necessary
- … irradiance calibration is necessary
- … ensure that measurement area is large enough

How to measure the flux of a UVC LED?

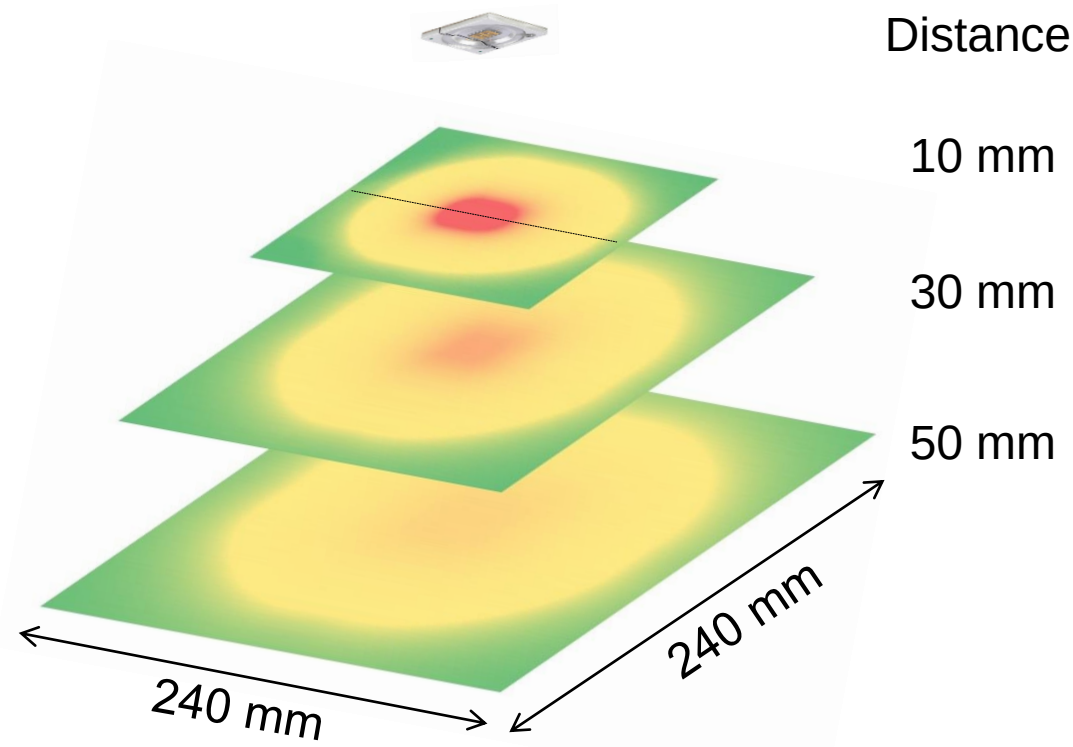


- Peak emission 278 nm at 350 mA

How to measure the flux of a UVC LED?

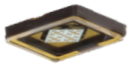


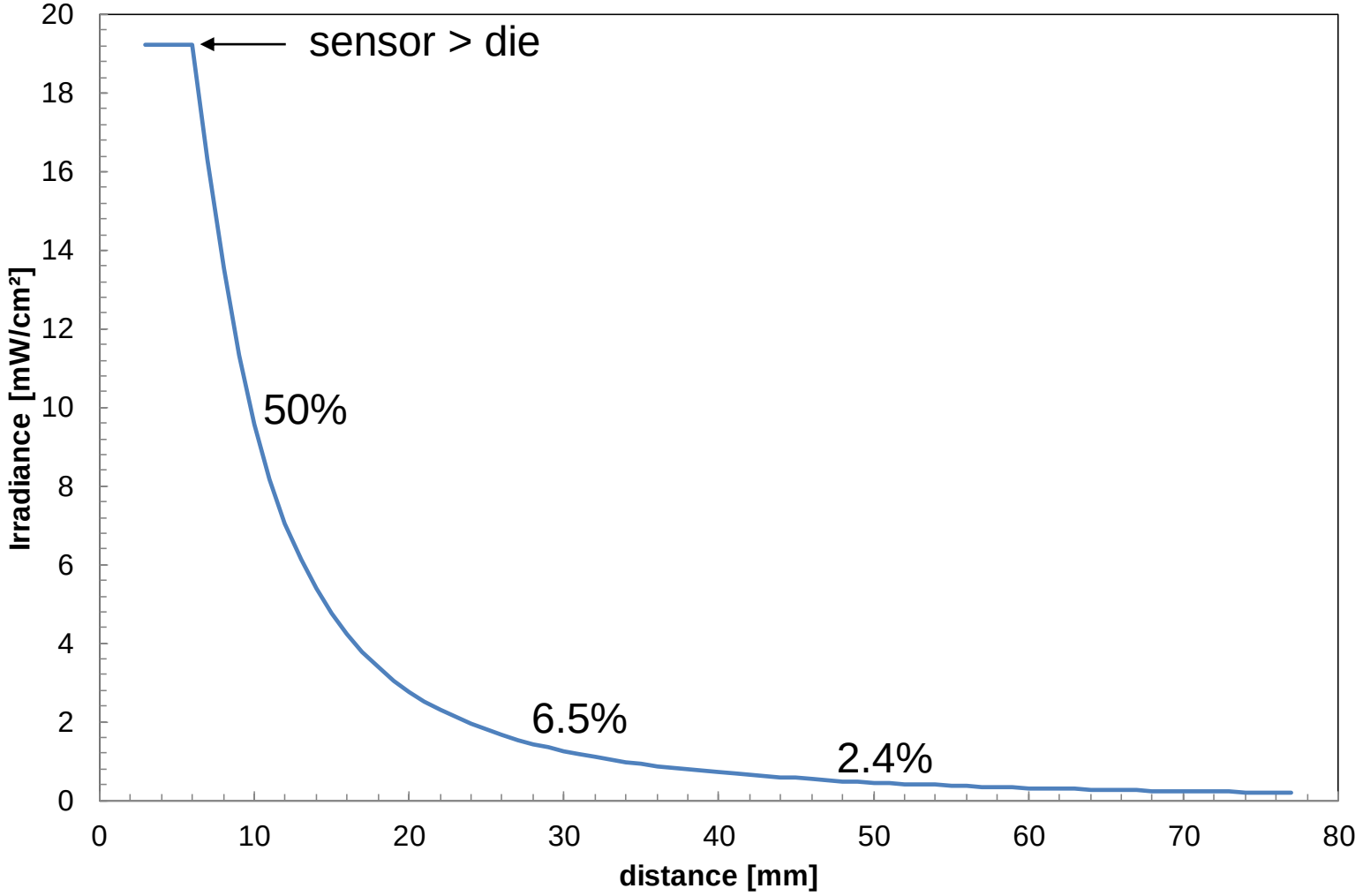
How to measure the flux of a UVC LED?



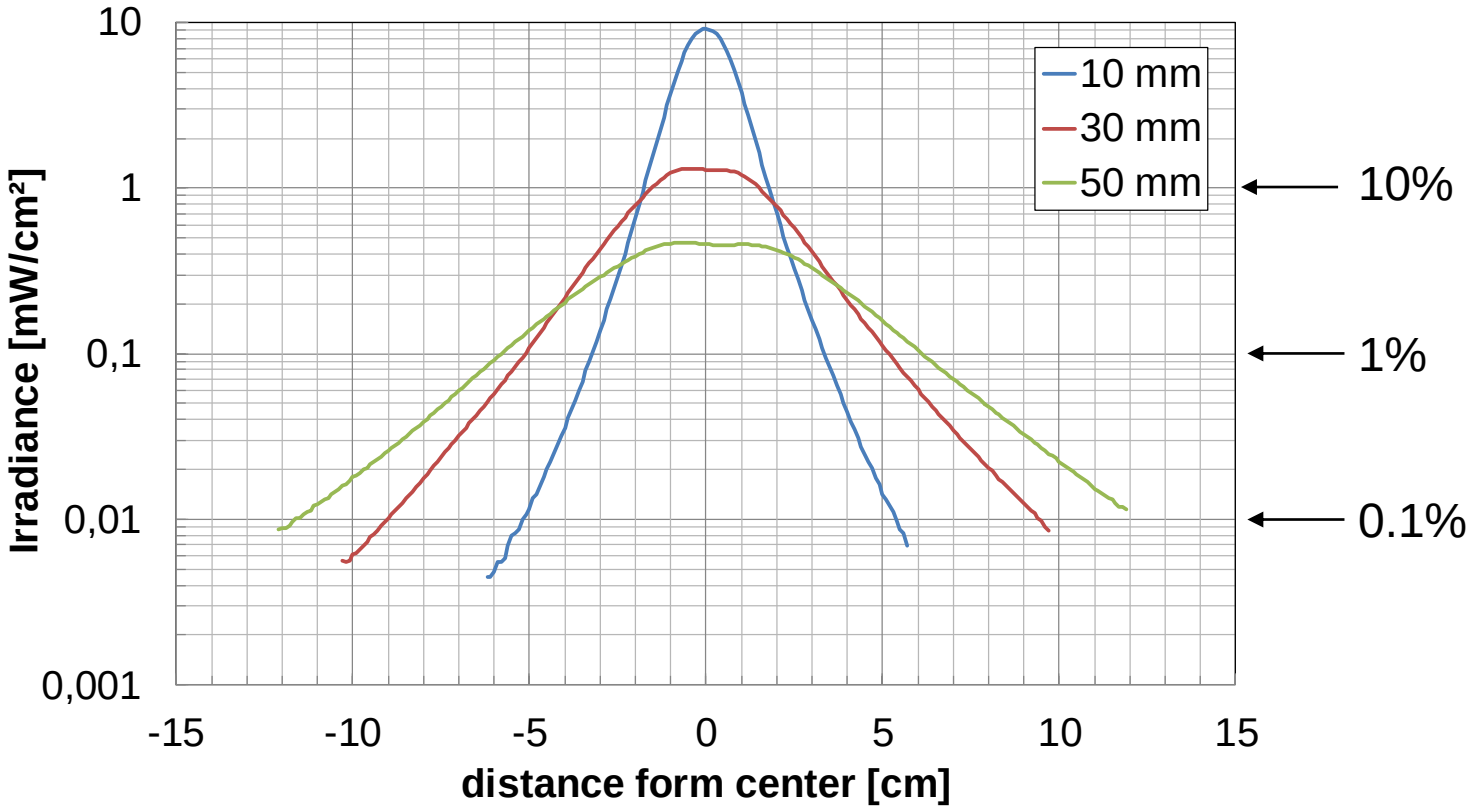
- Measurement of an single LED in 10, 30, and 50 mm

How to measure the flux of a UVC LED?





How to measure the flux of a UVC LED?



- A measurement area of 20 x 20 cm is already necessary for a distance of 30 mm

How to measure the flux of a UVC LED?

	10 mm	30 mm	50 mm
total flux	**44.9 mW**	**44,5 mW**	(42 mW)

distance	10 mm	Failure
Area >10%	35 mW	22%
Area >1%	43 mW	4,2%
Area >0.1%	44.8 mW	0,2%

- Total flux is 44.9 mW. Measurement area should be large enough to measure at least down to 0.1% of peak value.

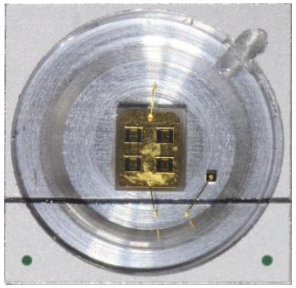
Uncertainty calculation

	uncertainty
Sensor calibration	5.1%
Movement	0.1%
Drift / Stability	1%
Temperature	1%
total uncertainty	**5.3%**

- Flux measurements in UVC with low uncertainty possible.

How to measure the flux of a UVC LED?

- SMD LED:
  - 275 nm
  - Nominal voltage 6.5 V
  - Operated at 350 mA
  - Output power : 44.9 mW ± 2.4 mW (k = 2)
  - EQE : 2.1 %



Opsytec Dr. Gröbel

Thank you for your attention.

Visit us at the exhibition for more information

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We apply **photonics.**

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