

G13.08.01

Highlights from TC-PR

Stefan Kück



EMPIR PhotoLED

Future Photometry Based on Solid-State Lighting Products



[HOME](#)

[PROJECT](#)

[PARTNERS](#)

[EVENTS](#)

[RESULTS](#)

[MEMBERS AREA](#)

[CONTACT](#)



<http://photoled.aalto.fi/>

EMPIR PhotoLED - Future Photometry Based on Solid-State Lighting Products

EMPIR PhotoLED - Partners



1 September 2016 – 31 August 2019



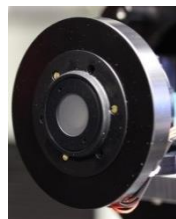
EMPIR PhotoLED – Introduction

Urgent need for LED standard lamps in photometry



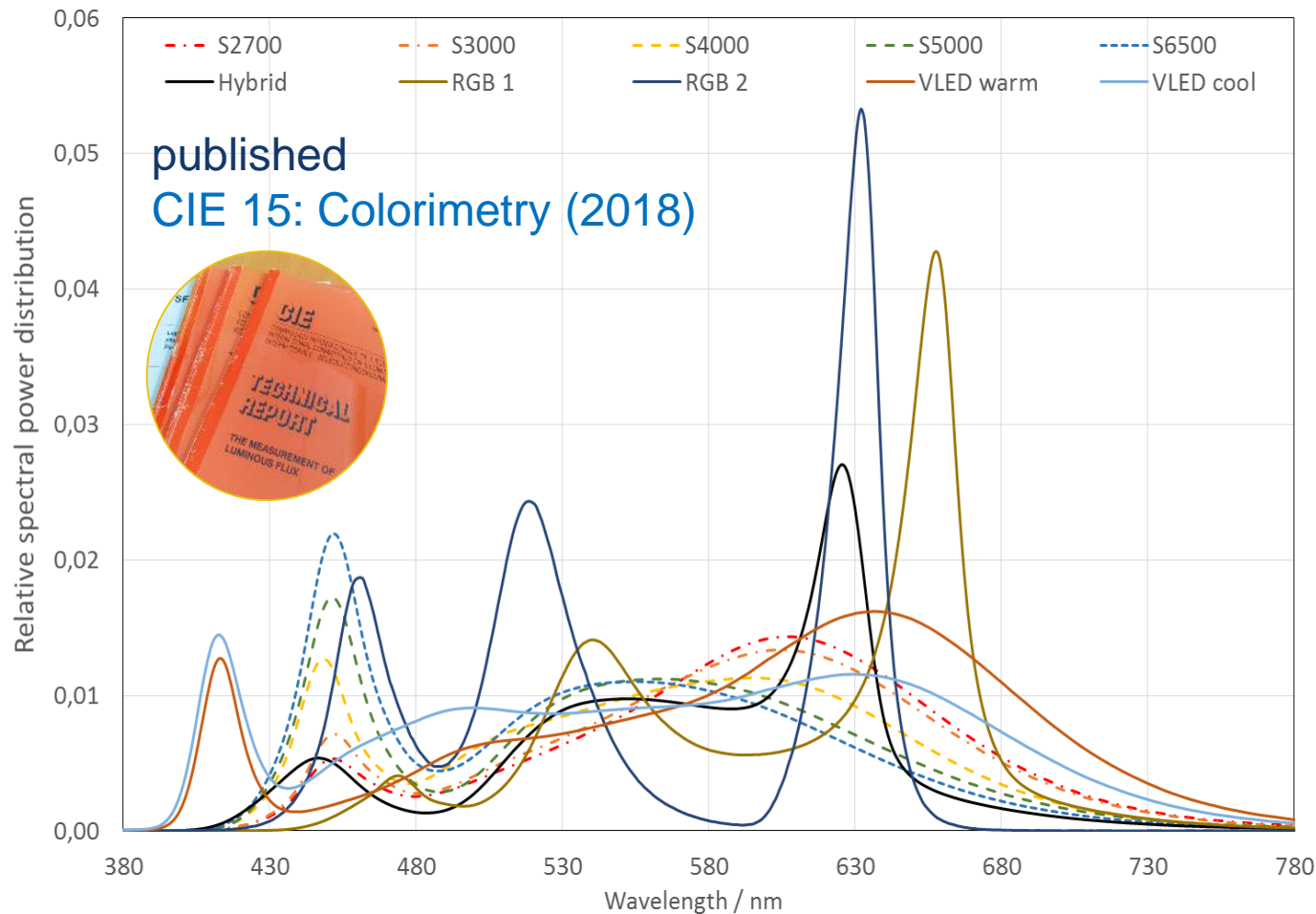
- Photometers are calibrated using incandescent standard lamps with spectra close to CIE Standard Illuminant A (CCT 2856 K)
 - Calibration works well for measurements of incandescent light
 - Spectral errors in measurements of other types of light
- Availability of incandescent standard lamps
 - Some standard lamp types no longer available for purchase
 - Issue notified in arranging CCPR key comparison of luminous flux
 - Some existing laboratories have acquired hundreds of lamps to 'last for lifetime' -> Some sell or rent lamps for comparisons.
 - How to ensure measurement capabilities of other (new) laboratories?

- Develop new photometry based on white LED sources
 - LED illuminants and LED reference spectra for calibration use
 - LED standard lamps for luminous intensity and luminous flux
 - Philips, OSRAM and OSRAM OS involved in the development
 - Cooperate with CIE -> New CIE Technical Reports and Standards
- New measurement methods
 - Measure illuminance of LED sources without optical $V(\lambda)$ -filters using Predictable Quantum Efficient Detectors (PQED)
 - Replace large goniophotometer facilities by a fisheye camera in angular distribution measurements of LED products.



EMPIR PhotoLED –Achievements

10 new LED illuminants for colorimetry

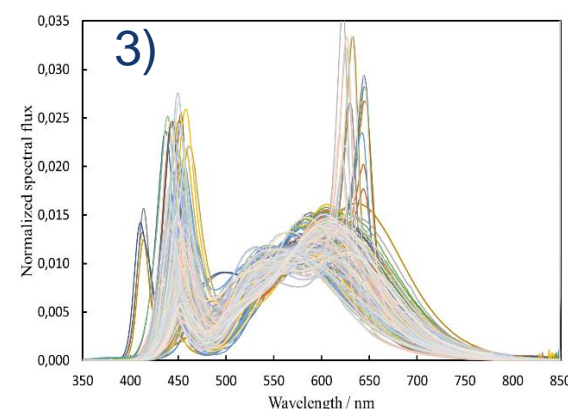
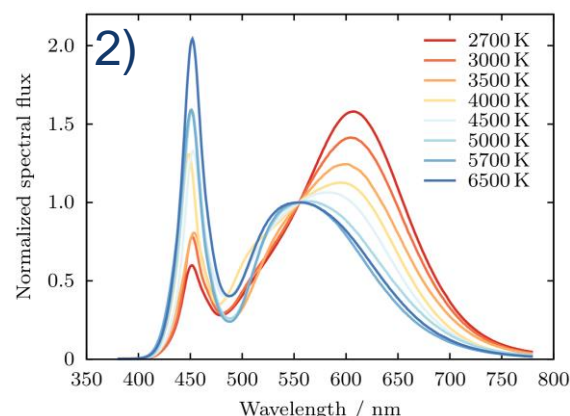
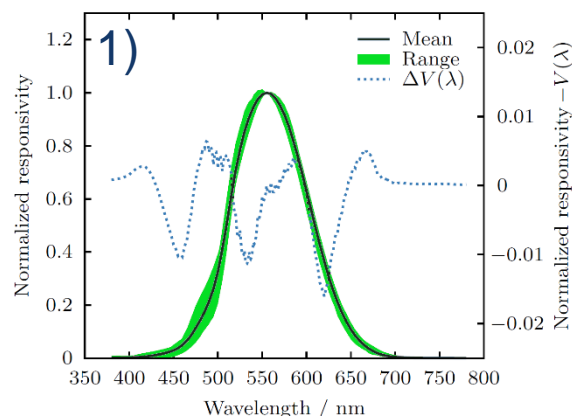


New LED Illuminants analysed in project PhotoLED from 1500 LED product spectra.

Analysis of LED calibration spectra

Finding the optimal LED spectrum for photometer calibration

- Find LED calibration spectrum that leads to the smallest spectral errors on average, when measuring SSL / LED light with $V(\lambda)$ -filtered photometers
 - Relative spectral responsivities of over 100 photometers, $s_{\text{rel}}(\lambda)$
 - Relative spectra of 8 potential white LED calibration sources, $\Phi_{\text{cal}}(\lambda)$
 - Relative spectra of about 1500 LED products, $\Phi_{\text{DUT}}(\lambda)$

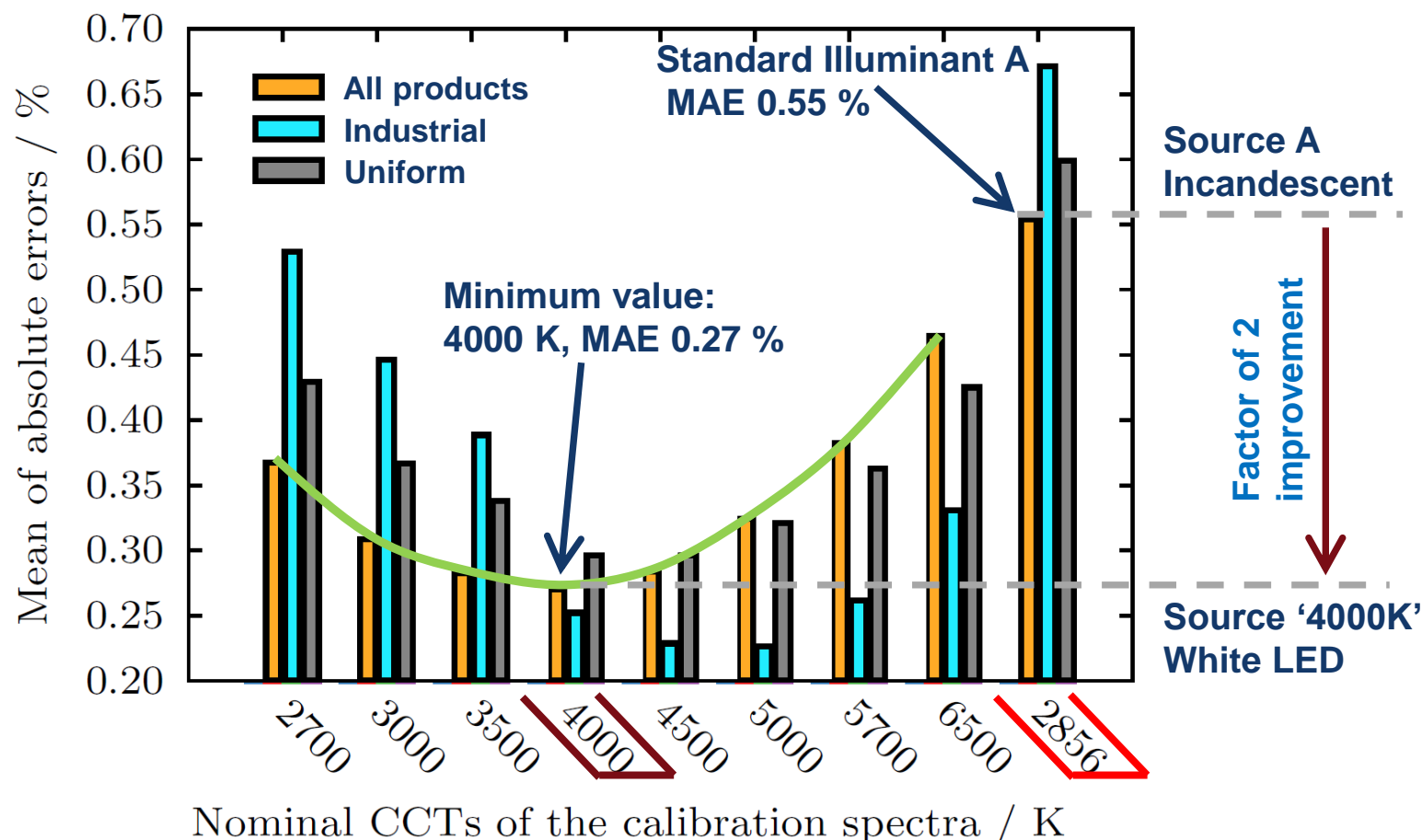


$$\text{MAE} = \frac{\sum_{i=1}^N |F_i - 1|}{N} \cdot 100\%$$

$$F = \frac{\int \Phi_{\text{DUT}}(\lambda) V(\lambda) d\lambda}{\int \Phi_{\text{cal}}(\lambda) V(\lambda) d\lambda} \cdot \frac{\int \Phi_{\text{cal}}(\lambda) s_{\text{rel}}(\lambda) d\lambda}{\int \Phi_{\text{DUT}}(\lambda) s_{\text{rel}}(\lambda) d\lambda}$$

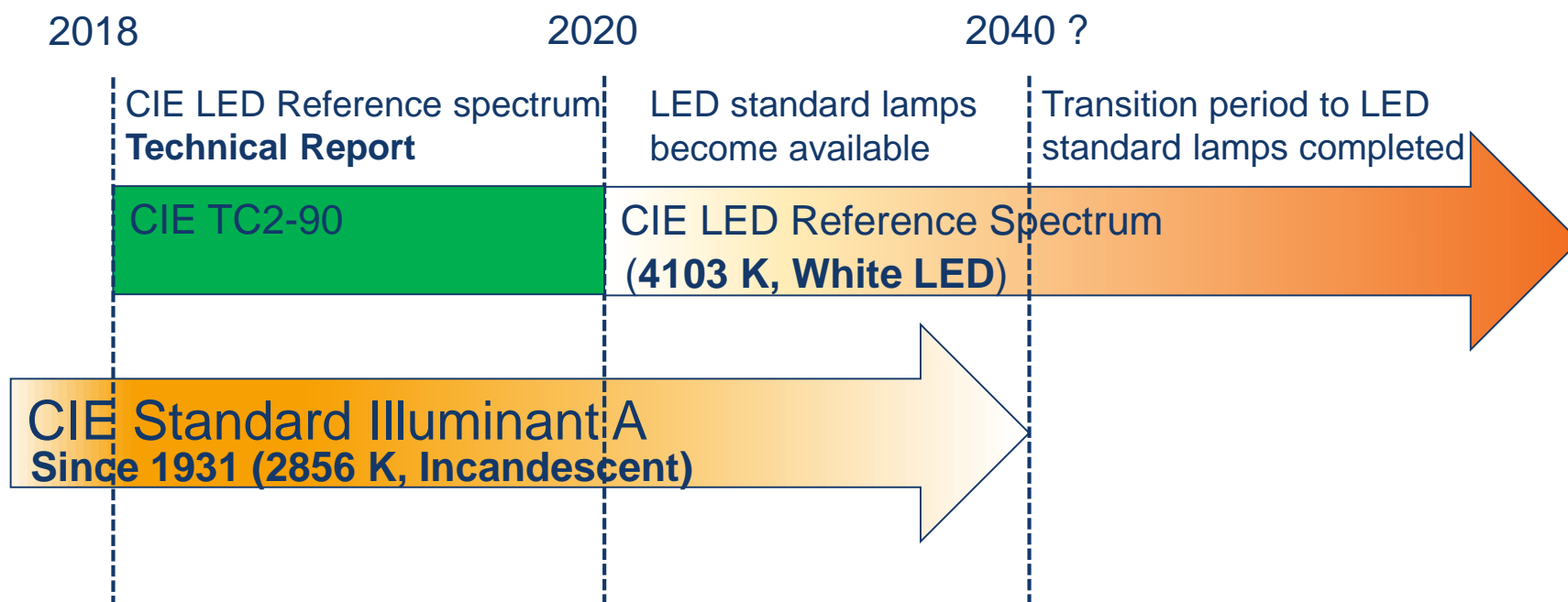
Analysis of LED calibration spectra

Finding the optimal LED spectrum for photometer calibration



Calibration of photometric instruments

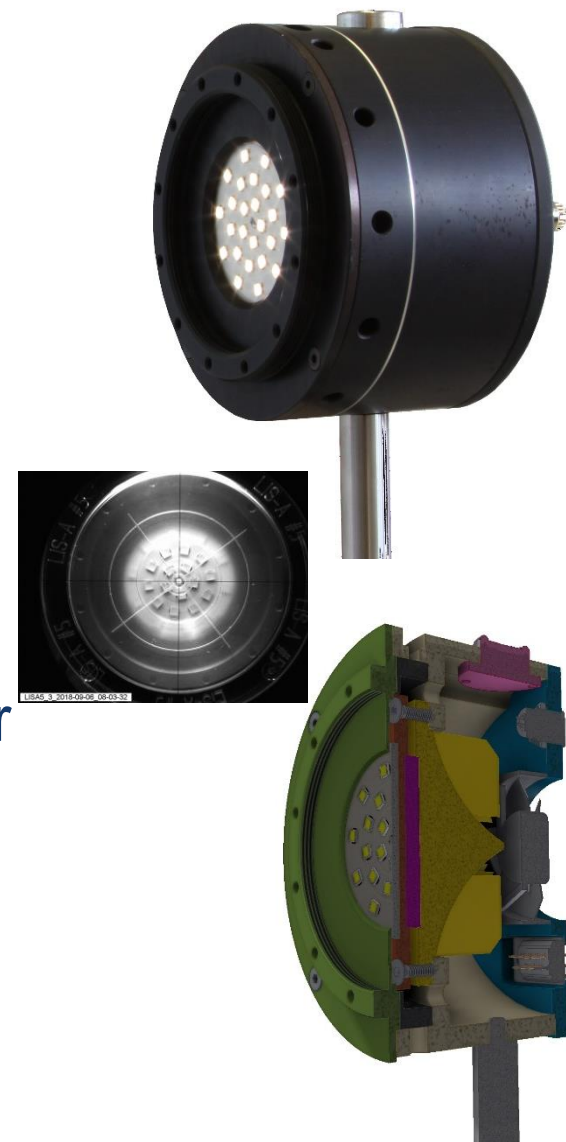
Complementing Source A with LED standard lamps



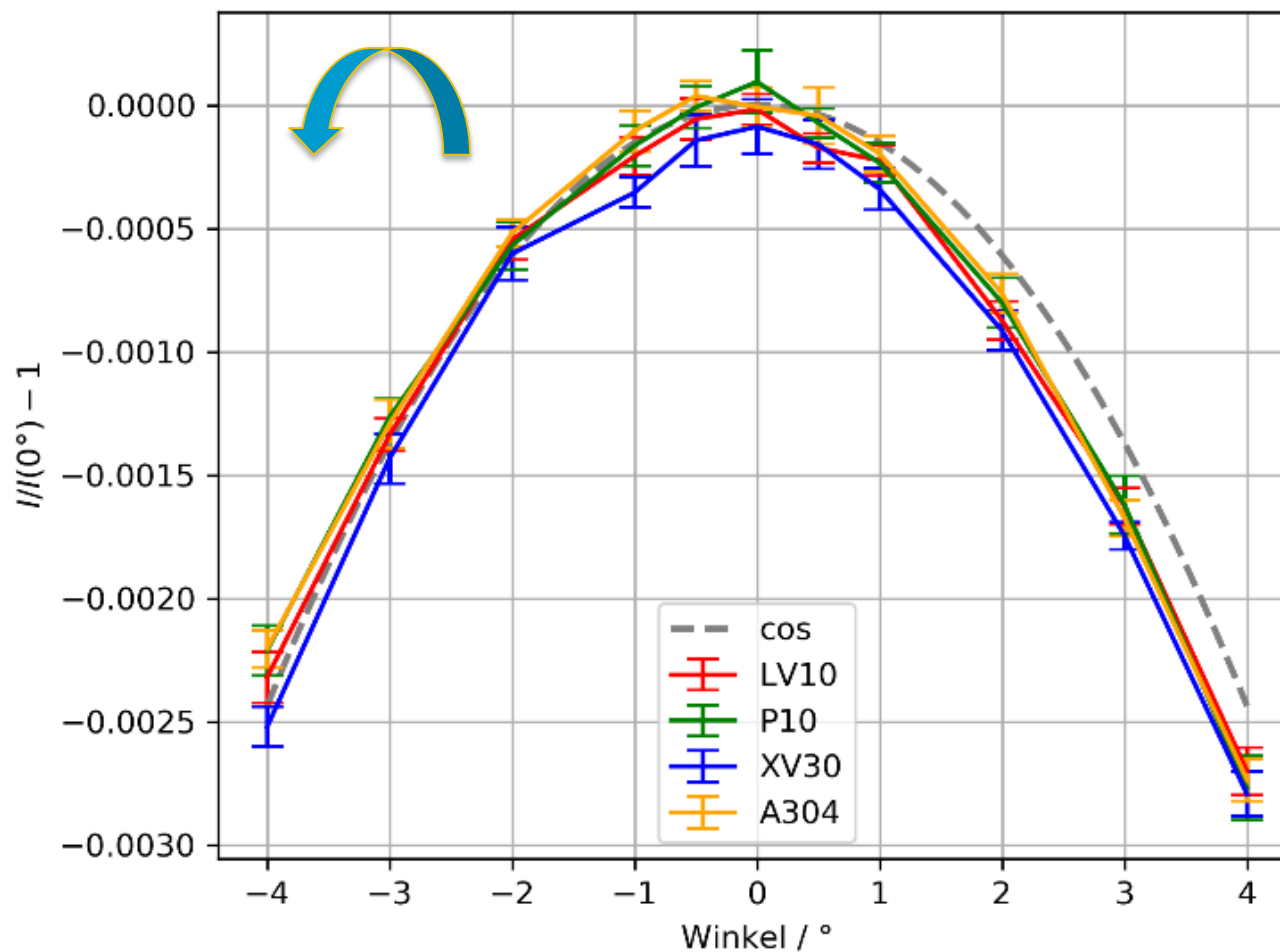
Introduction of LED Reference spectrum and LED standard lamps in photometry.

Reference standard (LIS - A)

- aluminum case, \varnothing 100 mm x 70 mm
- internal heat sink with fan
- variable air outlet
- LED circuit board on peltier element
- internal temperature controller
- ability to add on protection cap, baffles, diffusers, autocollimation mirror
- lamp current 65 mA, voltage 71 V
- 10 specimens were build

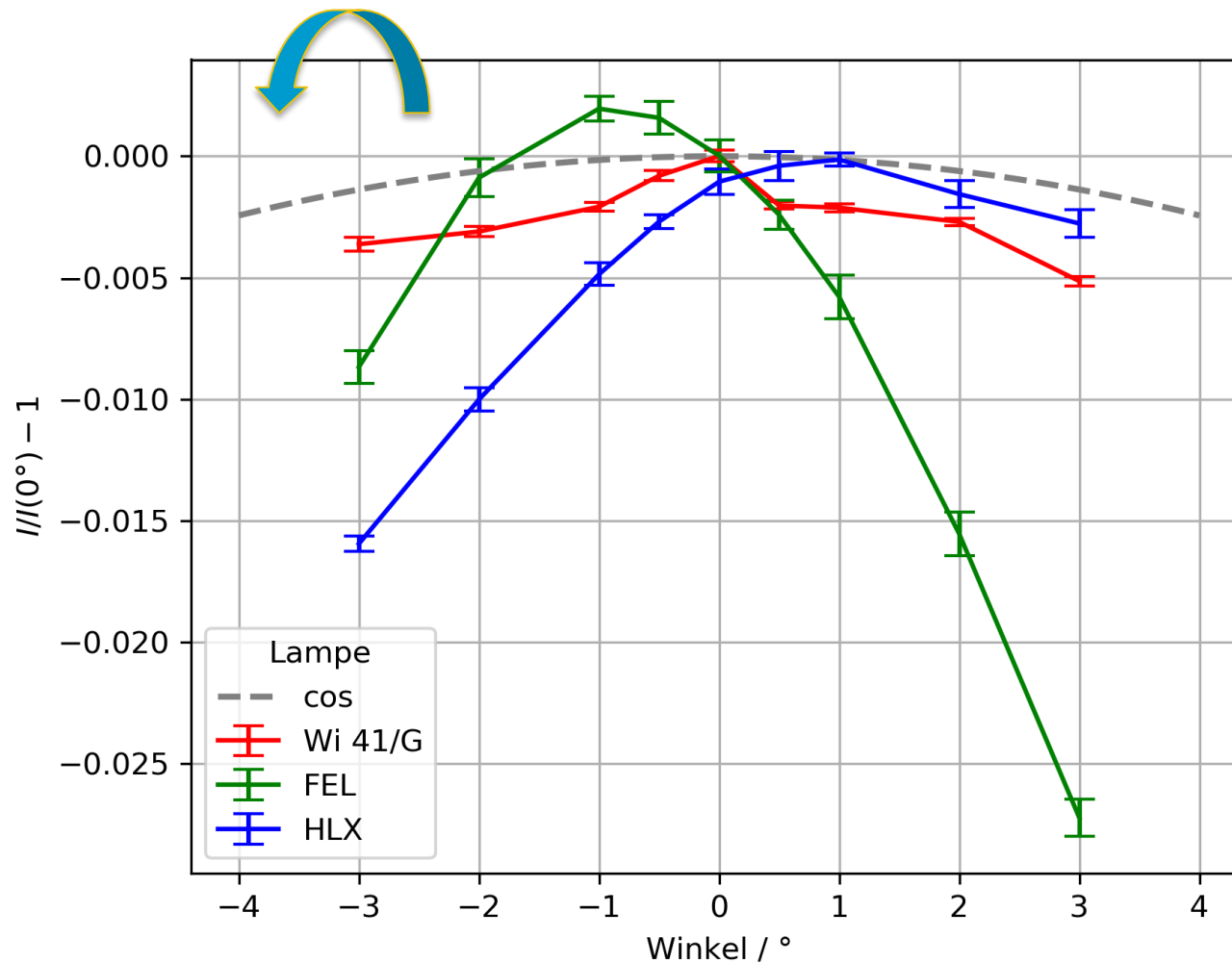


Characterisation: Orientation



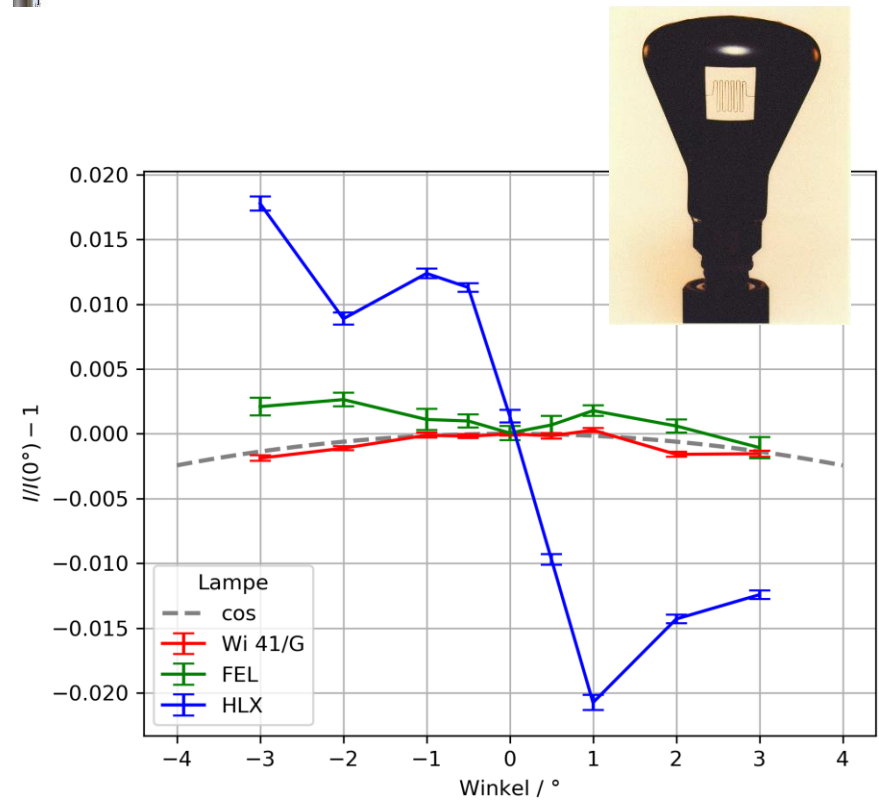
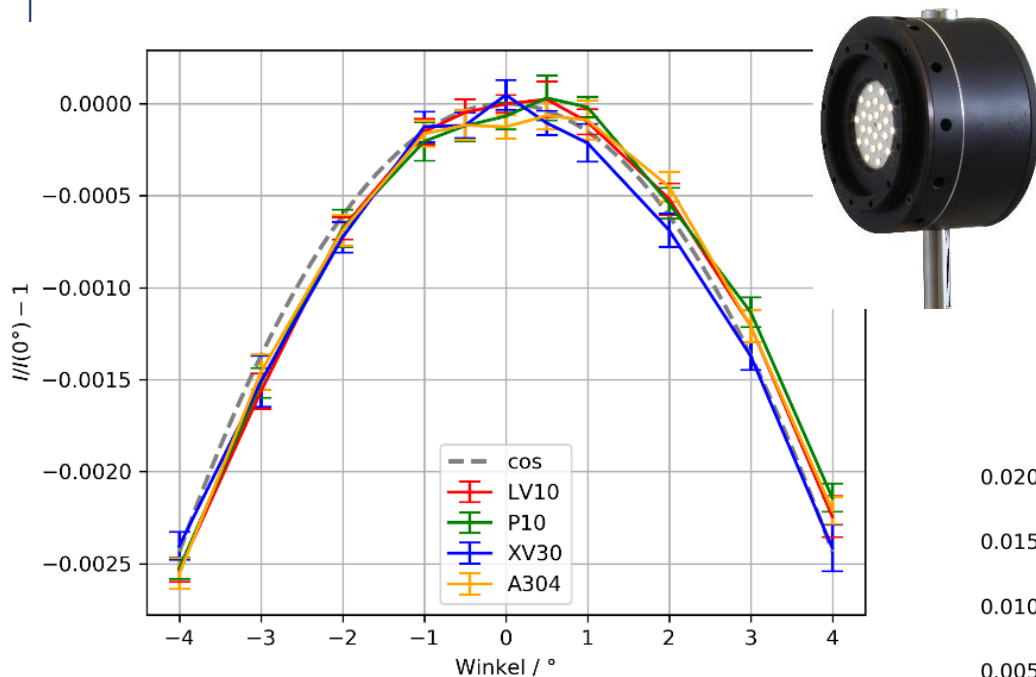
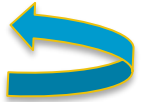
LED standard, rotation around horizontal axis

Characterisation: Orientation



incandescent lamps, rotation around horizontal axis

Characterisation: Orientation



EURAMET TC-PR WORKSHOP on EMPIR Call 2019 on Energy, Environment, Normative, Networks

- **Energy:**
1 PRT suggested, 1 submitted \Rightarrow 1 SRT
- **Environment:**
3 PRTs suggested, 3 submitted \Rightarrow 2 SRTs, 1 pending
- **Normative:**
5 PRTs suggested, 4 submitted \Rightarrow 4 SRTs
- **Networks:**
1 PNT suggested, 1 submitted \Rightarrow 1 SNT

Outcome of Workshop on Support, Collaboration and Coordination

- Summary of results: sorted all strategic goals and needs
- Discussion on how to proceed further:
- Original TC work:
 - Discussions needed between members
 - # 1101: Strategic planning in Photometry and Radiometry
 - Create new consultation projects?
- ⇒ Needs and activities fit into existing and planned EMNs
- ⇒ Create new research project within TC-PR

Some statistics



- Meetings:
 - 29.01. – 31.01.2019: IPQ, Portugal
 - 28.01. – 30.01.2020: IMN-MD, Moldova
- 26 members: 24 NMIs, 2 Dis
- 2 observers: 2 DIs
- CMCs: 45 submitted, 45 approved, 4 withdrawn (EURAMET.PR.14, EURAMET.PR.15, EURAMET.PR. 16)
EURAMET.PR.17 under intra-RMO review
- Comparisons: 7 in progress, 2 completed, 1 concluded