The use of a single-monochromator diode array spectroradiometer for UV-radiation measurements

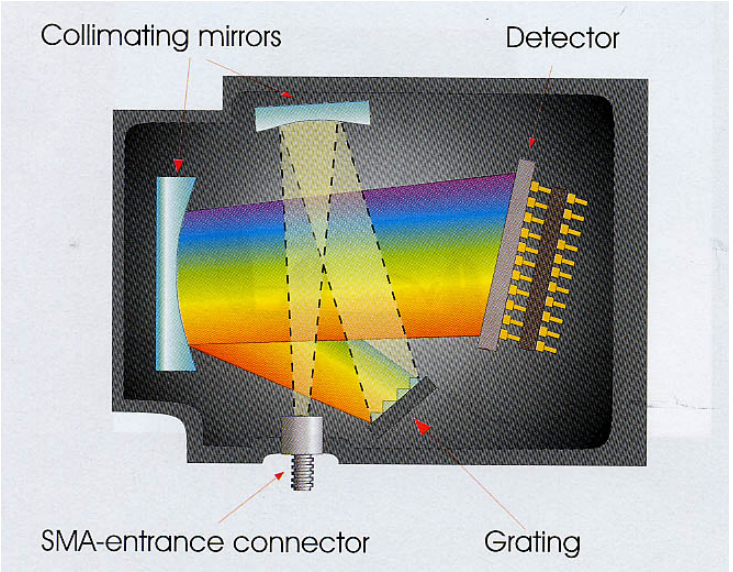
Lasse Ylianttila, STUK, Finland

UVNet 6
Davos

Ocean Optics S2000 spectroradiometer

Technical data

- Cherny - Turner design
- CCD detector
- wavelength range 200 -800 nm
- FWHM 1.6 nm, pixel distance 0.4 nm
- USB connection (previously PCMCIA)
- 4 m long optical fibre
- Oriel 51122 visible absorbing filter for UV measurements (STUK)
- temperature stabilised (previously temperature monitored)

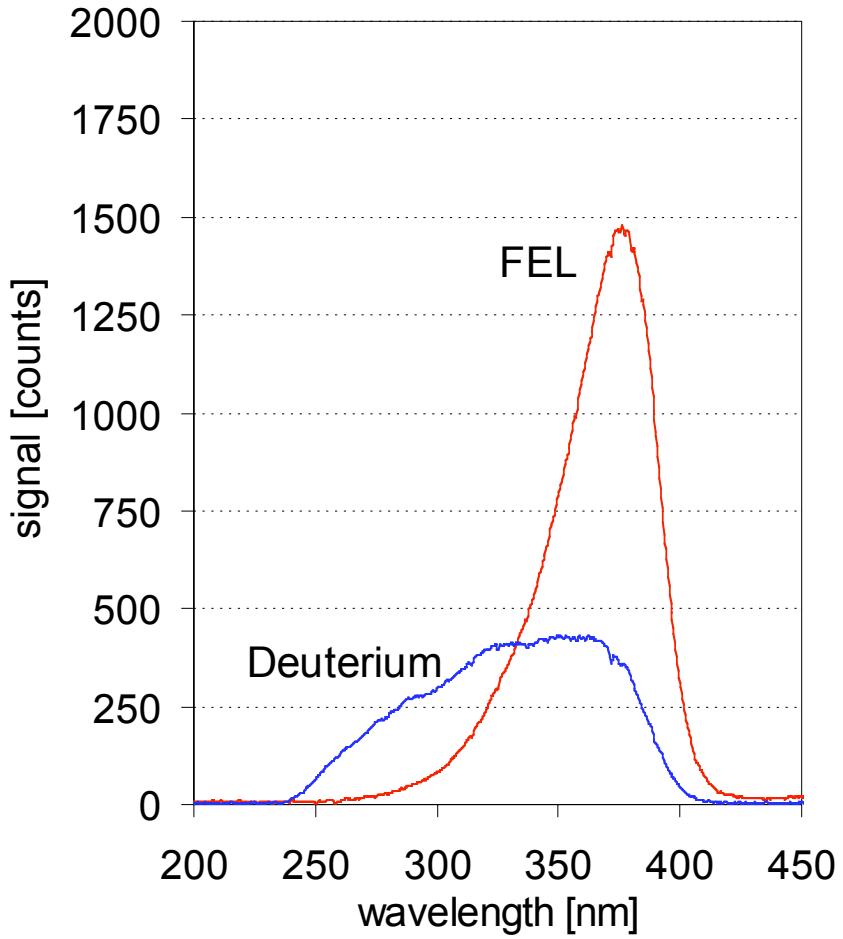


Special attention to:

- calibration
- temperature response
- cosine response
- wavelength accuracy
- stray-light

Calibration

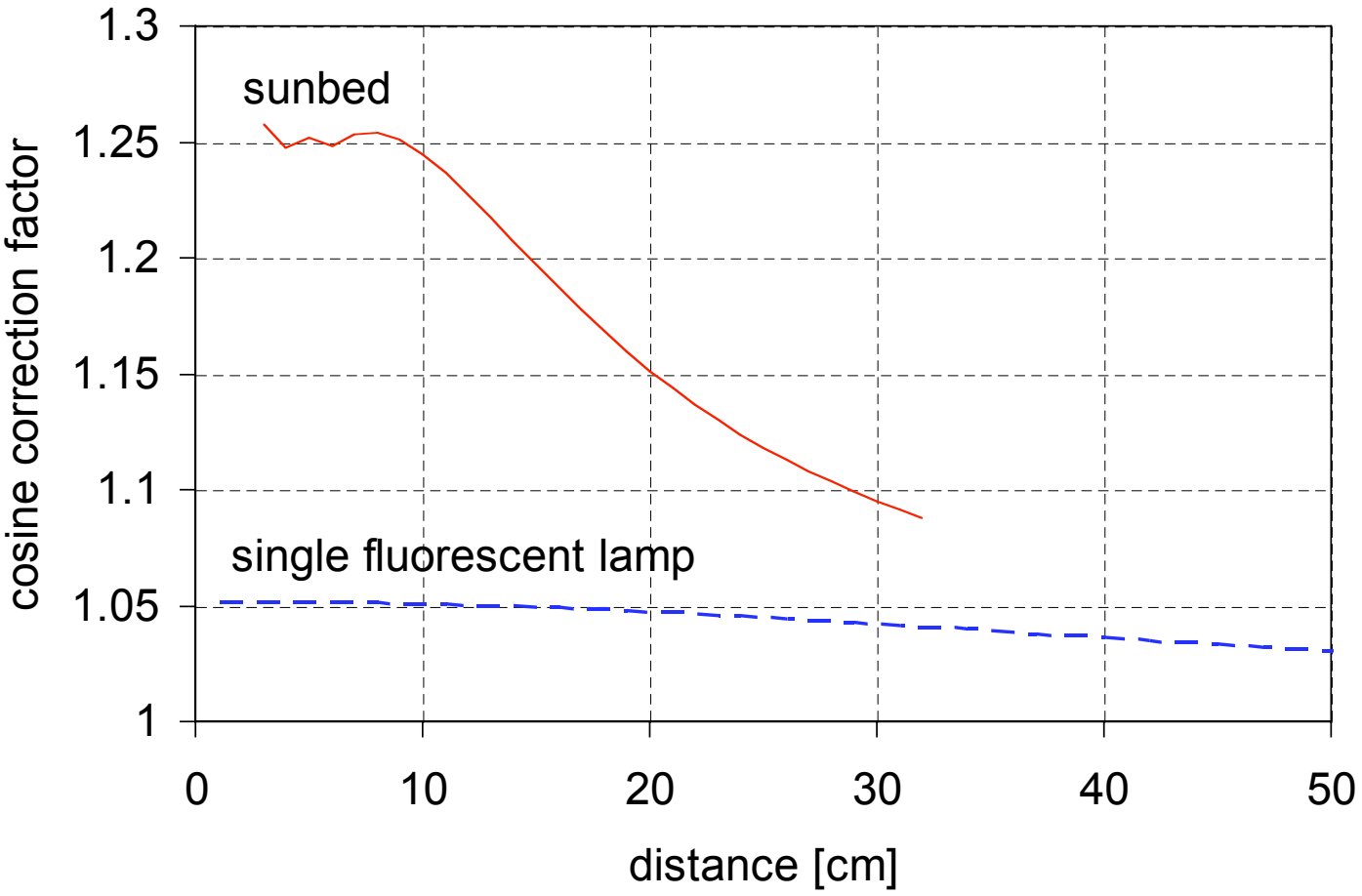
- 1 kW FEL
- Deuterium as close as possible
- combined
- integration time 20000 ms



Temperature

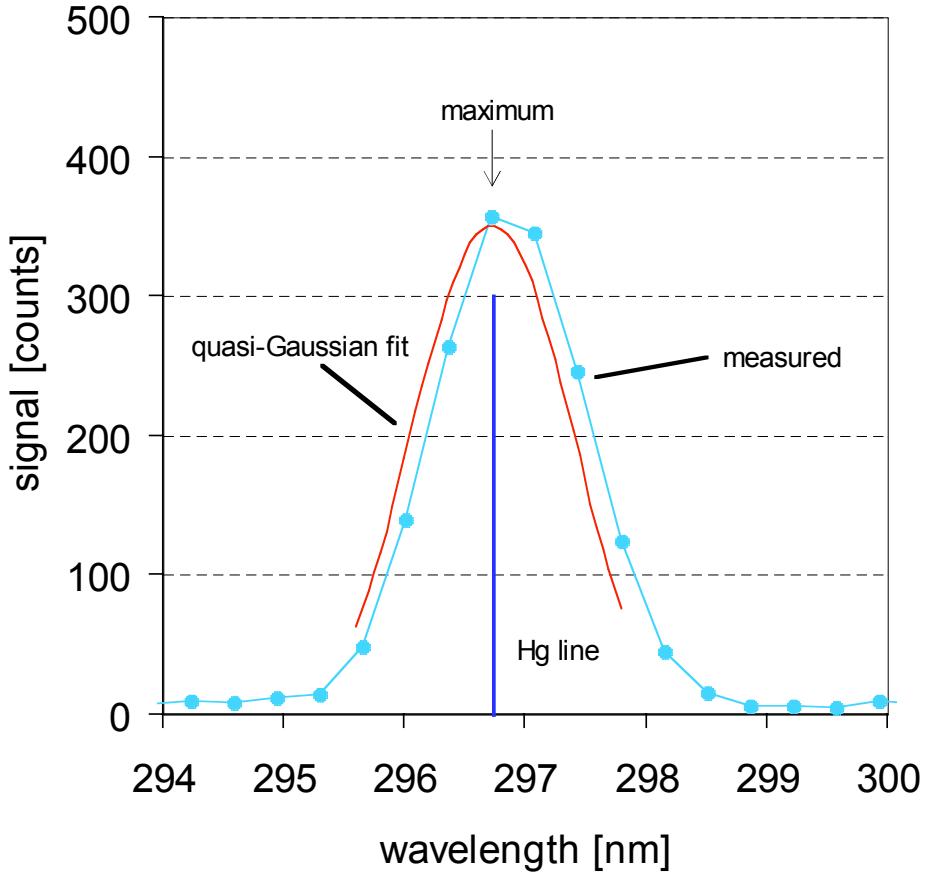
- Usable T-range 20 - 35 °C; sensitivity change below 5%
- Dark count depends strongly on temperature:
  - **high T**: low absolute level, high noise
  - **low T:** high absolute level, low noise
- wavelength shift 0.03 nm /°C

Cosine corrections



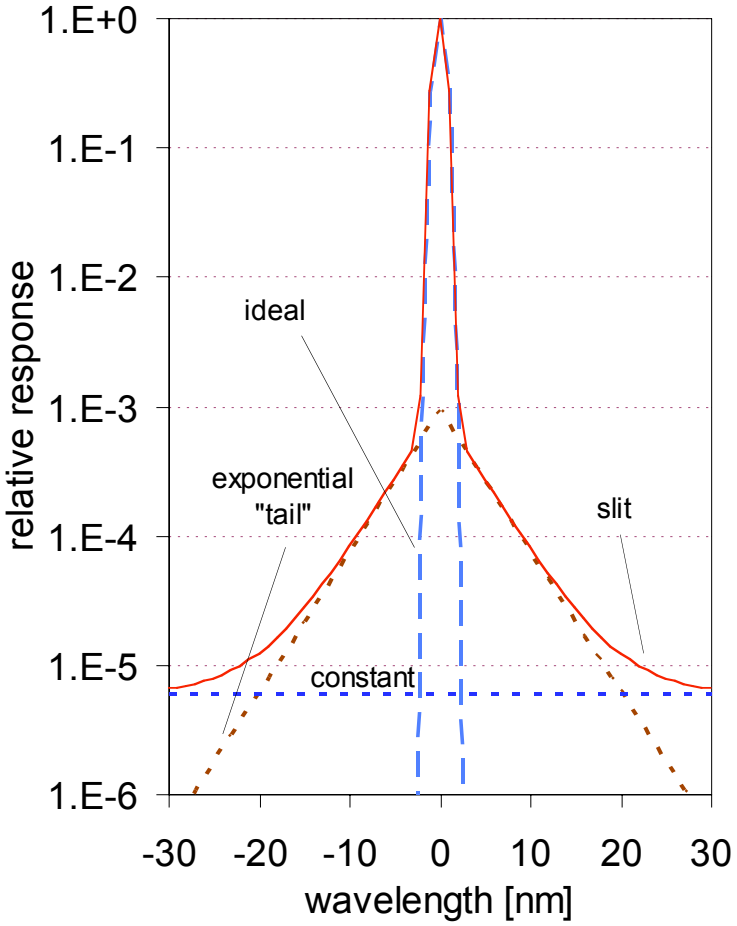
Wavelength accuracy

- Pixel - wavelength function; polynomial fit
- Pixel distance 0.4 nm
- Method for wavelength determination; maximum / fitted
- Wavelength accuracy better than 0.05 nm can be achieved

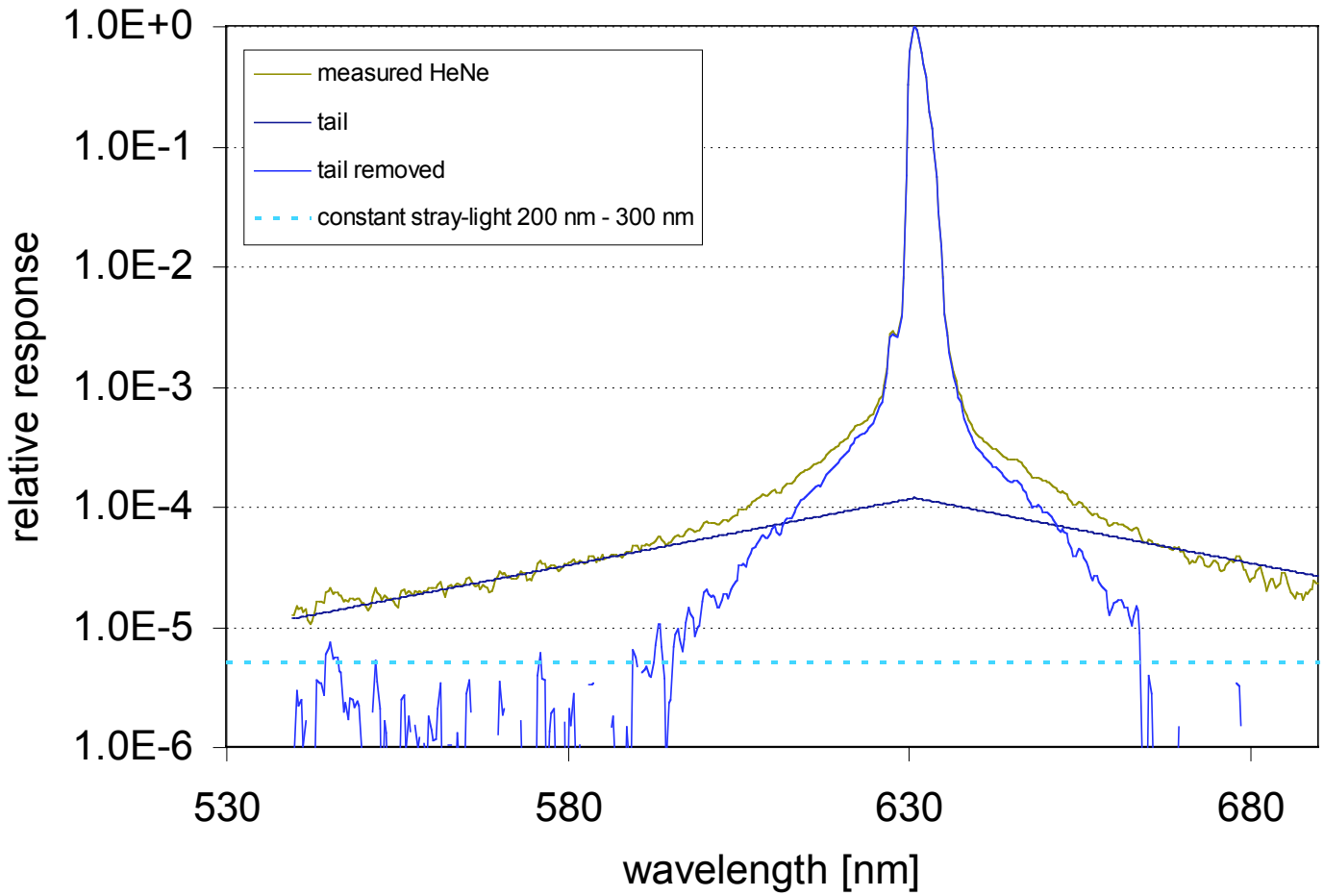


Stray-light correction

- Slit function is divided to three parts:
  - ideal slit
  - exponential “tail” stray-light ~ $e^{a+b\Delta\lambda}$
  - constant stray-light

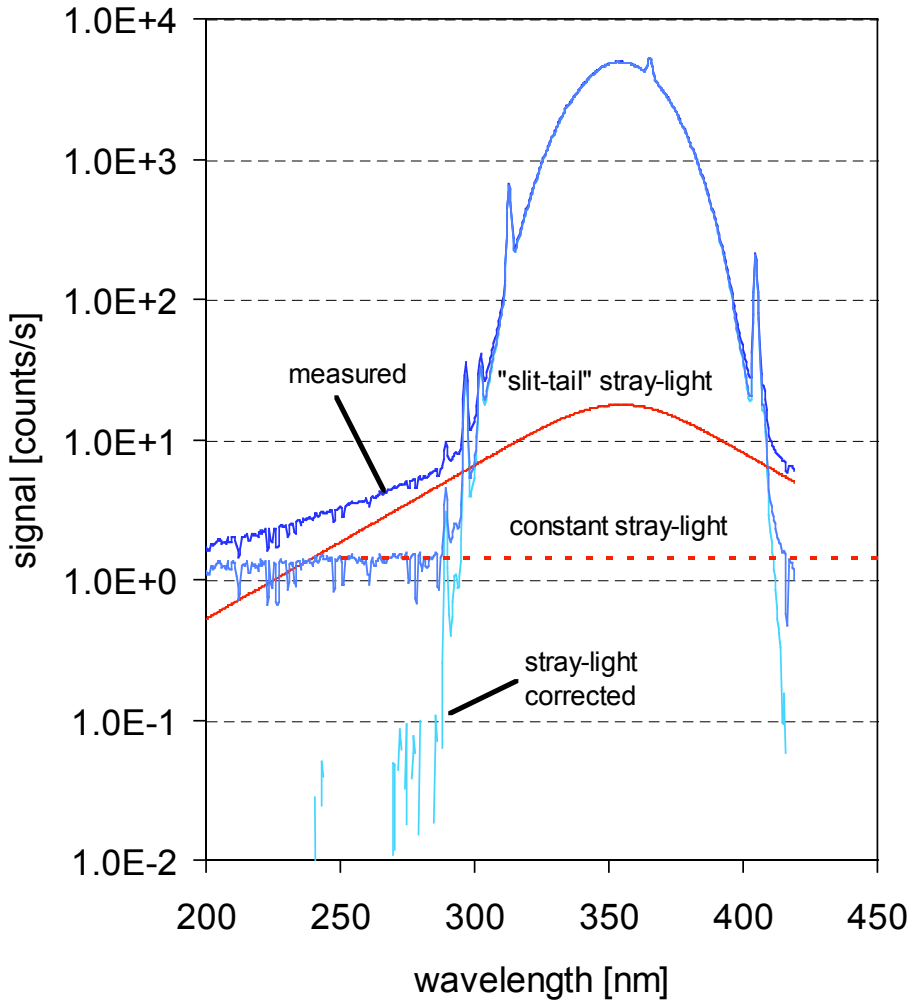


Measured slit function



Stray-light correction

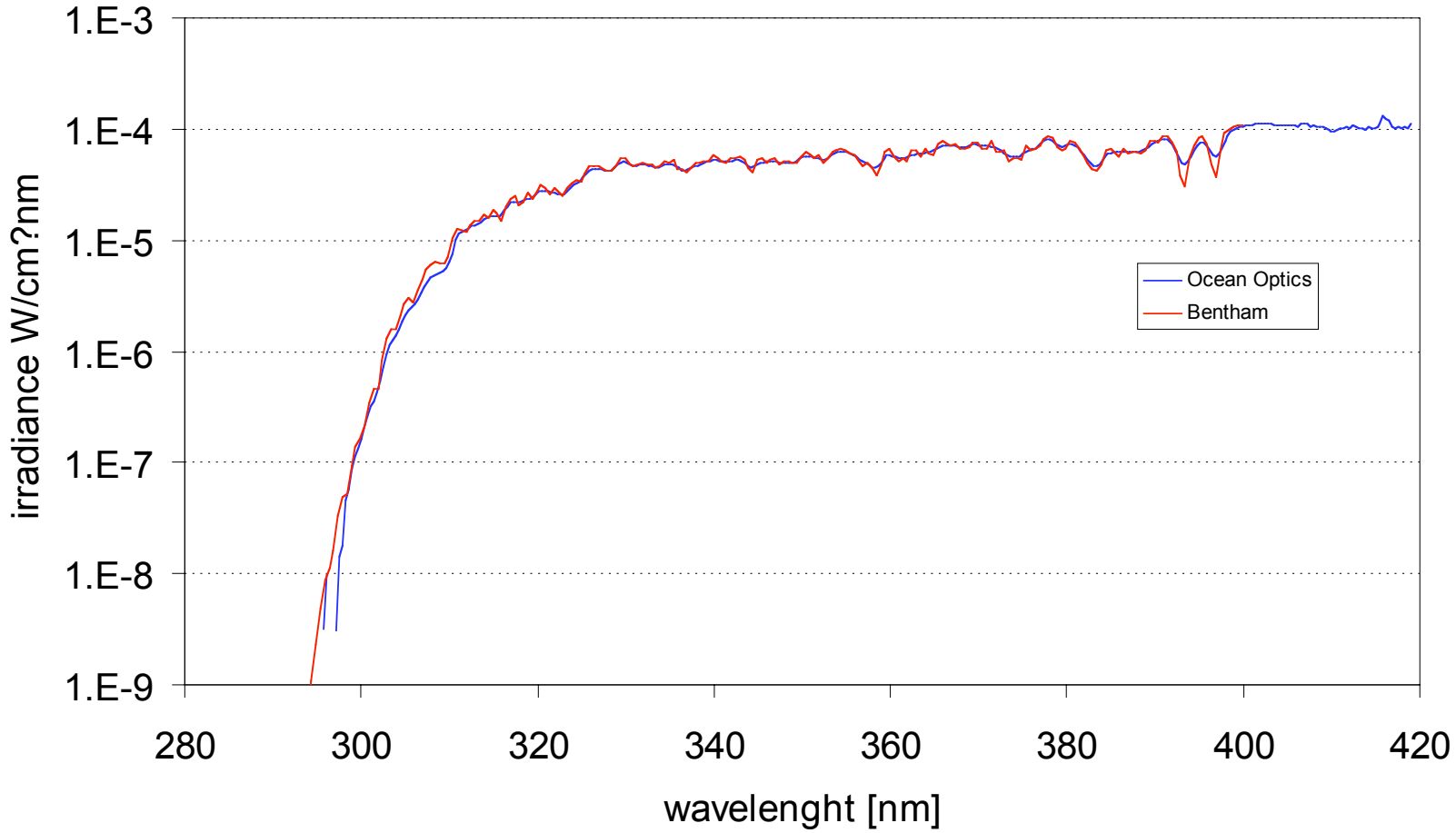
- measured spectrum convoluted with “slit-tail” and subtracted
- constant stray-light removed
- no further iterations necessary



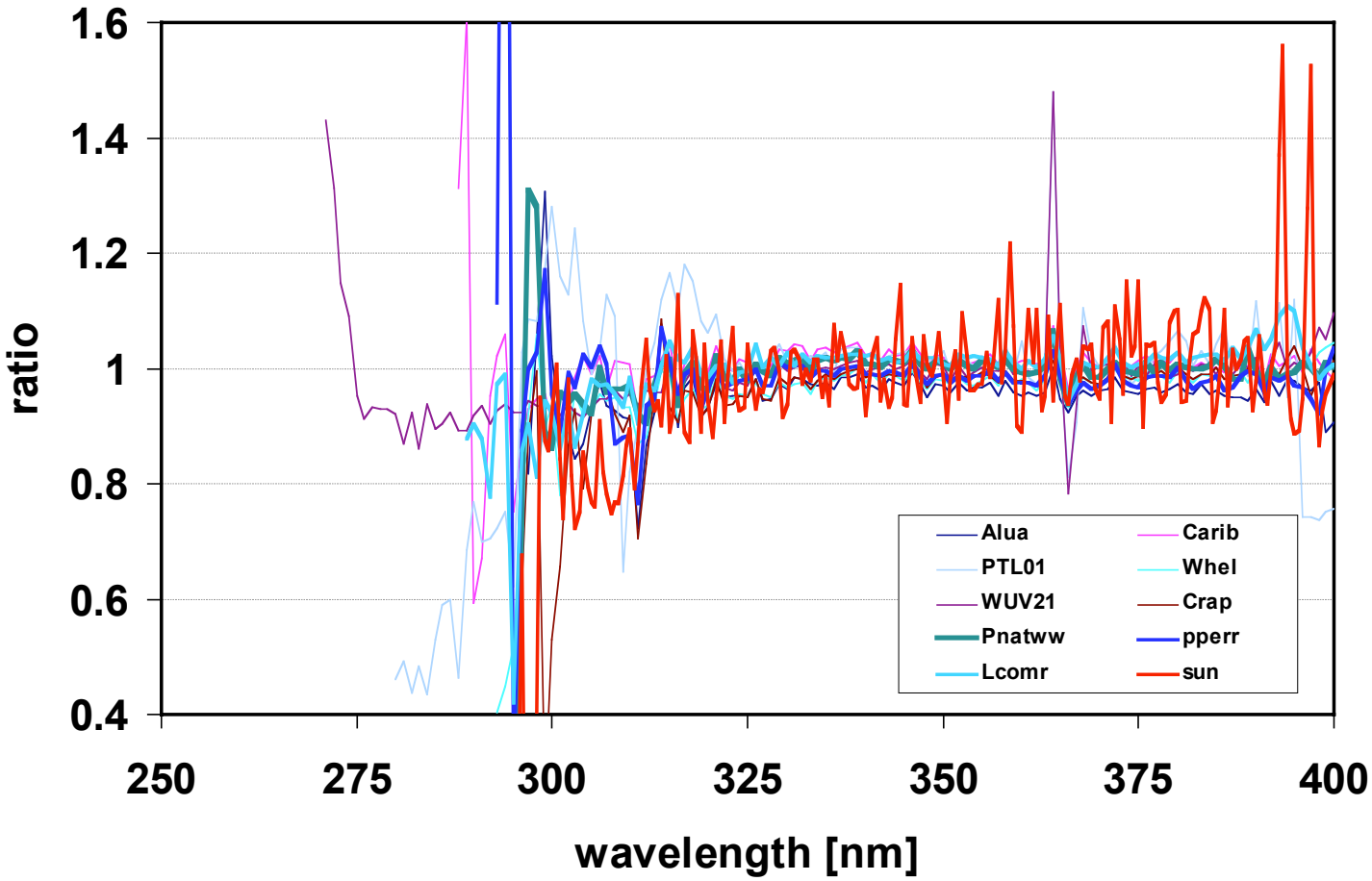
Comparison measurements

- Compared to double-monochromator spectroradiometers; Optronic 742 and Bentham DM 150
- Single fluorescent lamps (sun-bed and medical), sun-bed and sun as radiation sources
- integrated ratios:
  - UV (250 nm - 400 nm) 0.96 - 1.10
  - CIE erythema UV 0.91 - 1.10
  - CIE erythema UV-B 0.87 - 1.10

Example spectrum, sun



Spectral ratios, Ocean Optics / ref



Uncertainty estimation

uncertainty component	*relative standard uncertainty [%]*
calibration	3
stray-light	4
cosine response	3
temperature	3
wavelength	1
other sources	2
combined uncertainty	6.9
expanded uncertainty (k = 2)	13.9

Conclusions

- ~10% measurement uncertainty can be achieved (current estimation 14%)
- only for experienced users
- easy to transport
- Ylianttila L., R. Visuri, L. Huurto, and K. Jokela Evaluation of a single-monochromator diode array spectroradiometer for sunbed UV-radiation measurements, Photochemistry and Photobiology, **81**, 333-341, 2005