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

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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

![Graph showing cosine corrections for sunbed and single fluorescent lamp.](image)
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 $\sim e^{a+b\Delta\lambda}$
  - constant stray-light

![Graph showing stray-light correction with ideal, exponential, and constant components.]
Measured slit function

**Graph Description:**
- The graph shows the measured slit function for a device, with data points plotted for wavelengths ranging from 530 nm to 680 nm.
- The y-axis represents the relative response, with values ranging from $1.0 \times 10^{-6}$ to $1.0 \times 10^0$.
- The x-axis represents the wavelength in nanometers (nm), with intervals at 530, 580, 630, and 680.

**Key Lines and Legends:**
- **Measured HeNe**: A yellow line representing the measured HeNe signal.
- **Tail**: A blue line indicating the tail effect.
- **Tail Removed**: A blue line showing the response after removing the tail.
- **Constant Stray-Light 200 nm - 300 nm**: A dotted cyan line indicating the constant stray-light range.
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

![Example spectrum, sun](image-url)
Spectral ratios, Ocean Optics / ref

- Alua
- Carib
- PTL01
- Whel
- WUV21
- Crap
- Pnatww
- pperr
- Lcomr
- sun
### Uncertainty estimation

<table>
<thead>
<tr>
<th>uncertainty component</th>
<th>relative standard uncertainty [%]</th>
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<tbody>
<tr>
<td>calibration</td>
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<td>stray-light</td>
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<td>cosine response</td>
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<td>expanded uncertainty (k = 2)</td>
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Conclusions

• ~10% measurement uncertainty can be achieved (current estimation 14%)
• only for experienced users
• easy to transport