EMRP
European Metrology Research Programme
Programme of EURAMET

The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union

Novel micro-mirror-based diode array UV solar spectrometer

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pmod wrc

NIST National Institute of Standards and Technology U.S. Department of Commerce

MSL Measurement Standards Laboratory of New Zealand

PRINCIPAL OPTICS

EMRP

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This work is done within the EMRP Joint Research Project ENV03 Solar UV.

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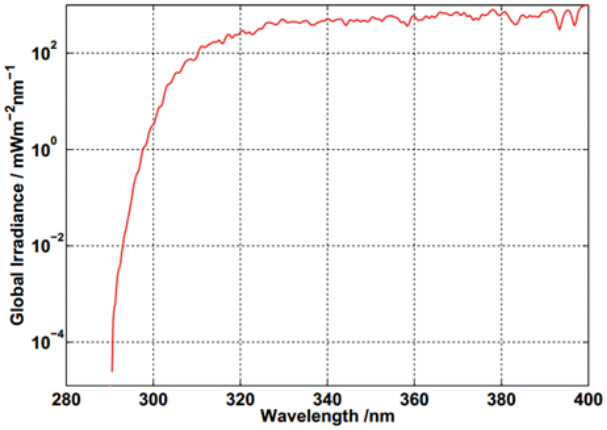
Motivation 1

Solar spectrum

- 5 decades dynamic range in UV 280-400 nm
- >3 decades change over a 20 nm range
- low irradiance below 300 nm



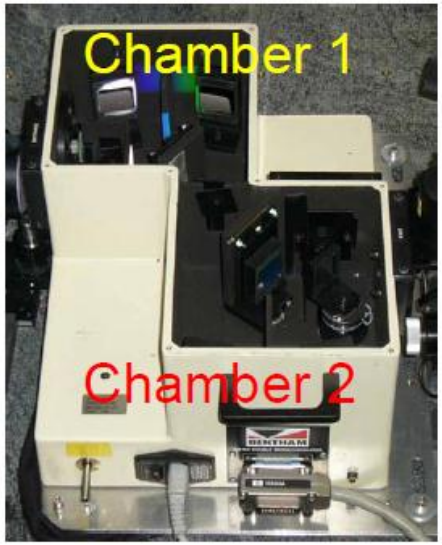
Measuring Solar UV (290 – 400nm):

- Scanning Double Monochromator
- Advantage:

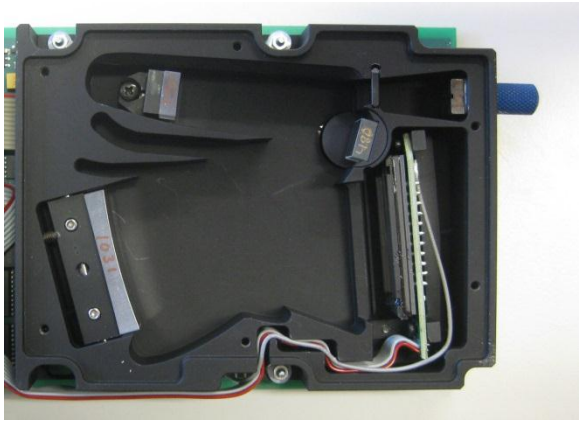
  Straylight reduction > 6 orders of magnitude
- Disadvantage:

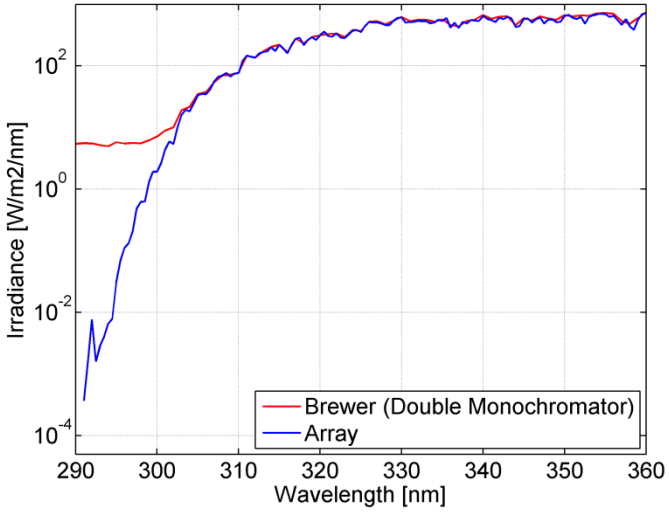
  Scanning time for spectrum ~10 – 20 min.

  cost and maintenance expensive



DA Spectrometers





Pros:

- Instant acquisition of UV spectrum
- Cost effective for expanding global UV monitoring network

Cons:

- Straylight from other wavelengths with higher intensities
- Low dynamic range of diode array and inherent noise

Motivation 3

Conclusion:

To develop some form of a

„Double-grating array spectrometer“

Where:

- The role of second grating scanning monochormator is taken by some form of Digital Light Processing Device, responsible for:
  - Suppressing stray-light
  - Extending dynamic range

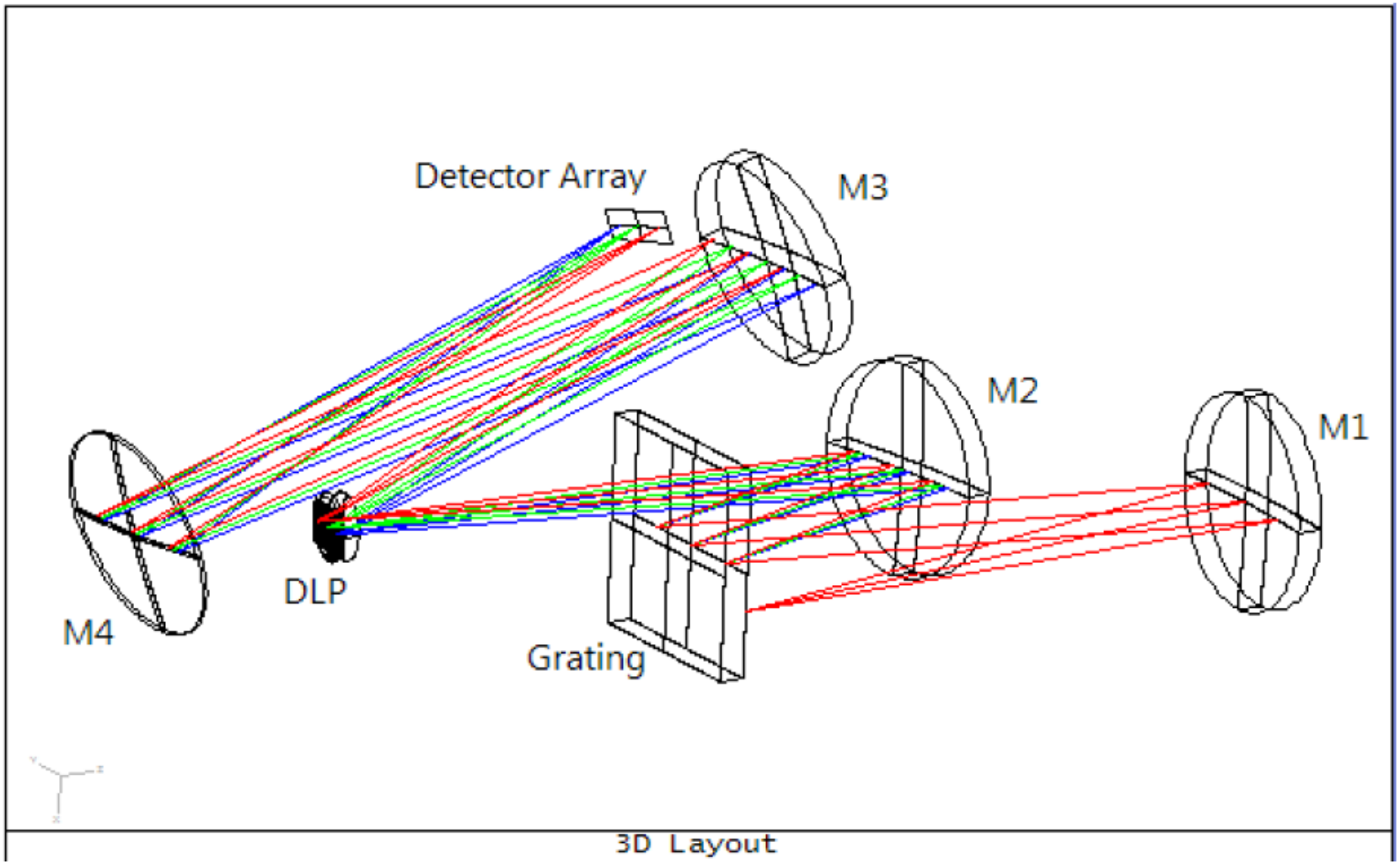
Micro-mirror-based diode array UV spectrometer

(µ-MUV)

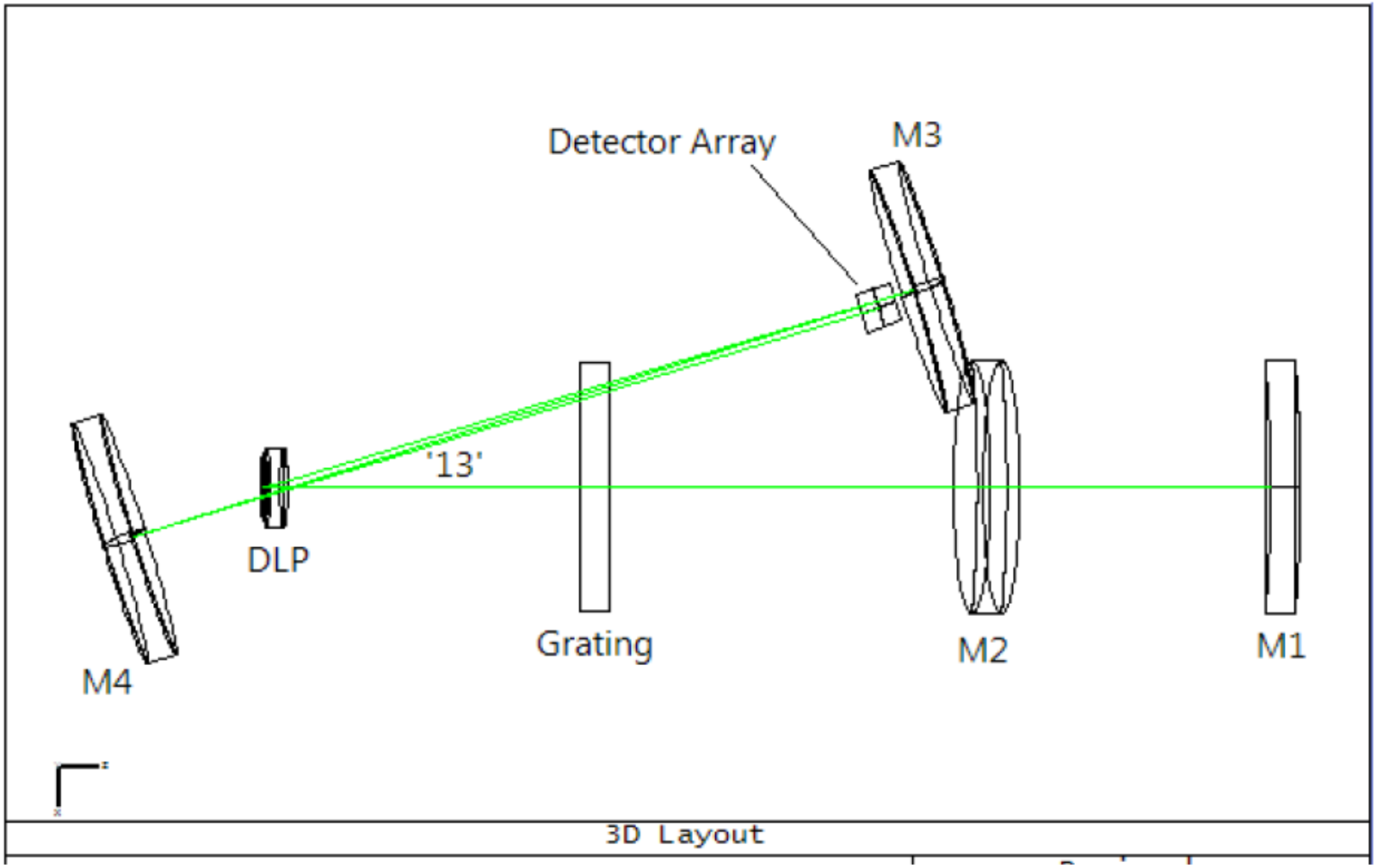
Criteria set for optical design:

- Compact optical set-up matching Optical grating, Digital Light Processor (DLP) and detector array to optimize fill-factor
- To maximize the optical throughput
- Utilizing off-the-shelf commercially available optical and mechanical elements to:
  - Simplify the prototyping
  - Keep the process cost efficient

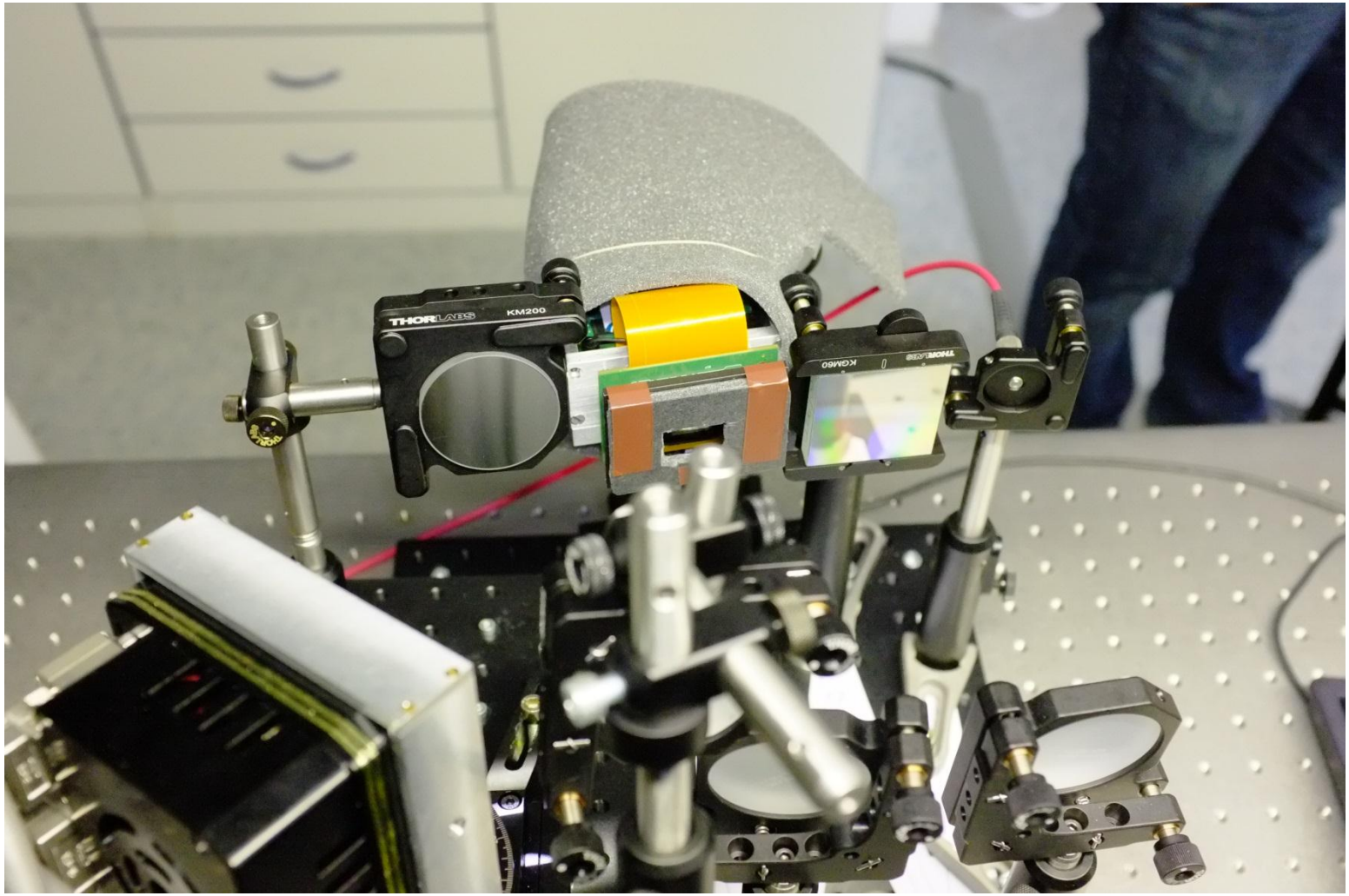
μ-MUV 1st prototype design



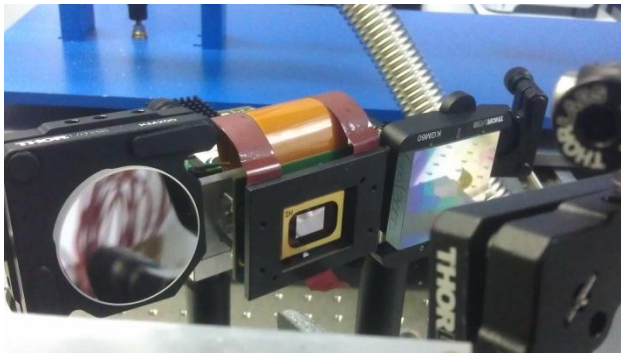
μ-MUV 1st prototype design - side view

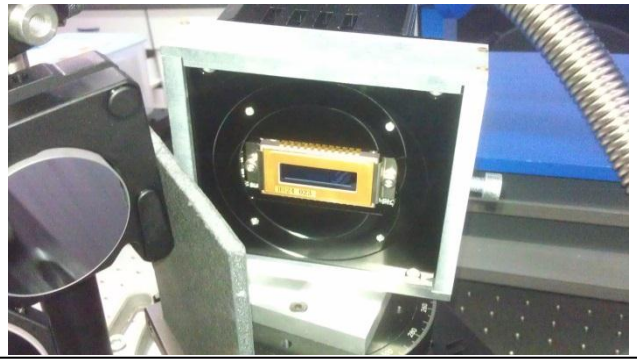


μ-MUV 1st prototype design



μ-MUV 1st main optical elements





DLP Chip:
Texas Instrument 0.7” XGA , 1024 x 768 micro-mirrors, about 13.92 x 10.44 mm DLP area, VIALUX DLP development kit V4100 with controller suite

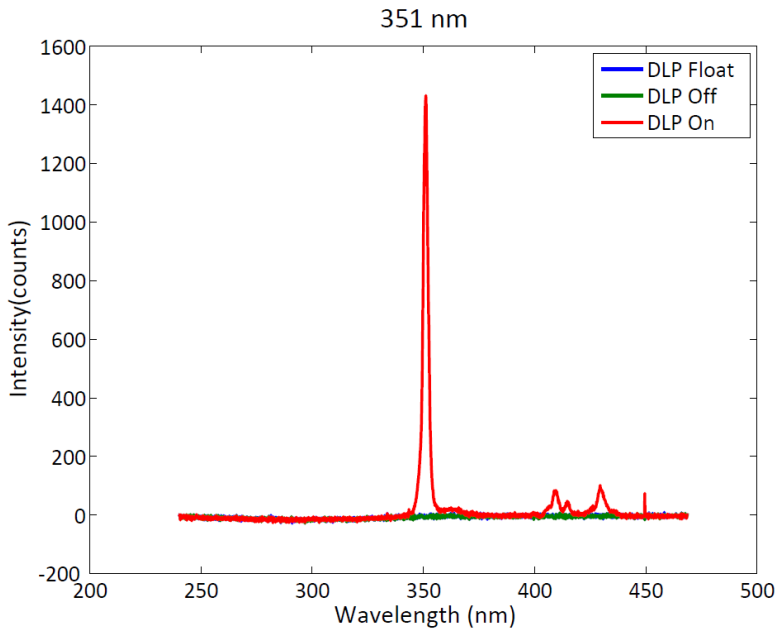
Array detector:
Hamamatsu S10141-1108S cooled back-lit detector, pixel size 12 um x12 um 2048 (x 250) pixels, about 24 mm x 3 mm sensitive area

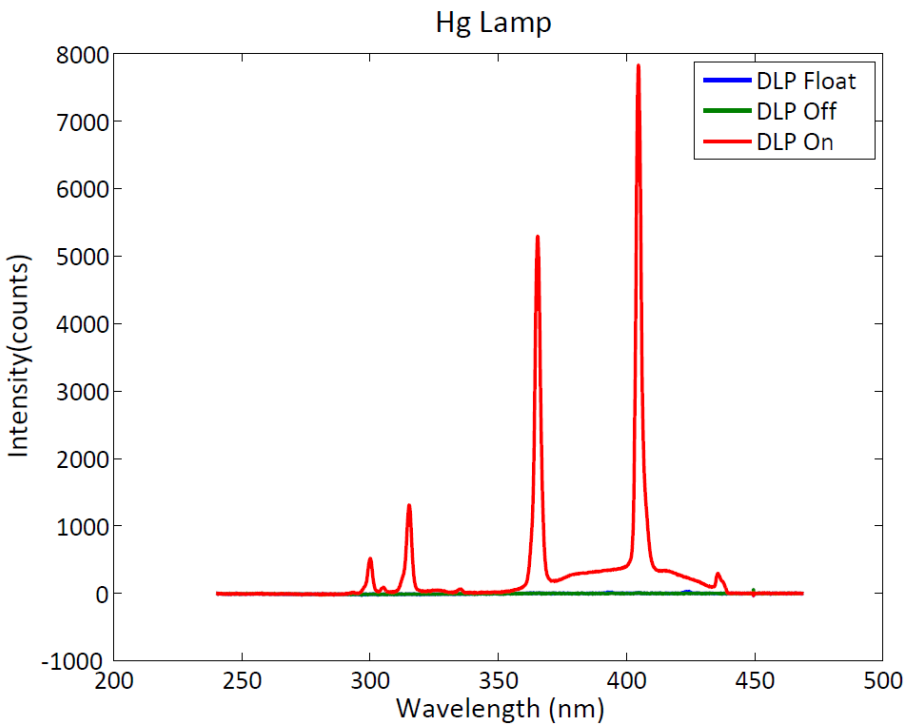
Grating:
Plain ruled 600 G/mm, blazed @ 300 nm, 50 mm x 50 mm x 9.5 mm

All mirrors off-shelf spherical, (*f=150 mm, 50 mm diam*)
All passive optical and mechanical componants from Thorlabs

µ-MUV First results

Wavelength scale and Bandwidth:

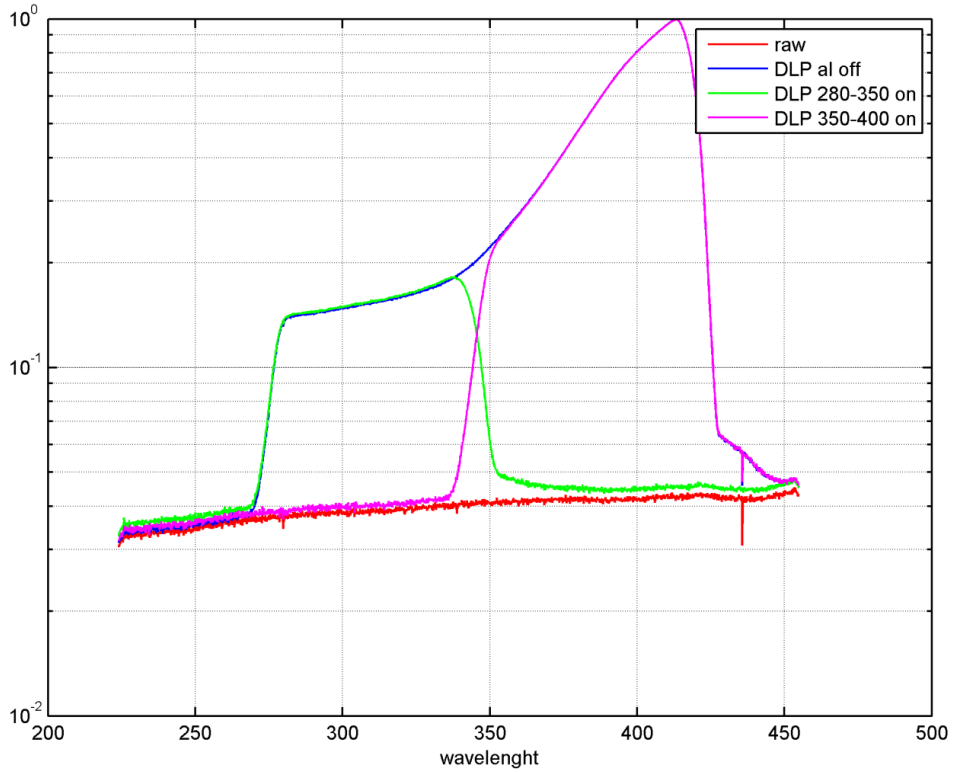




- Correction function had to be applied - non-flat focal plain at detector
- Achieved resolution 0.2 nm, uncertainty within resolution after correction
- Achieved bandwidth approx. 5 nm, so far wider than expected 2 nm

µ-MUV First results

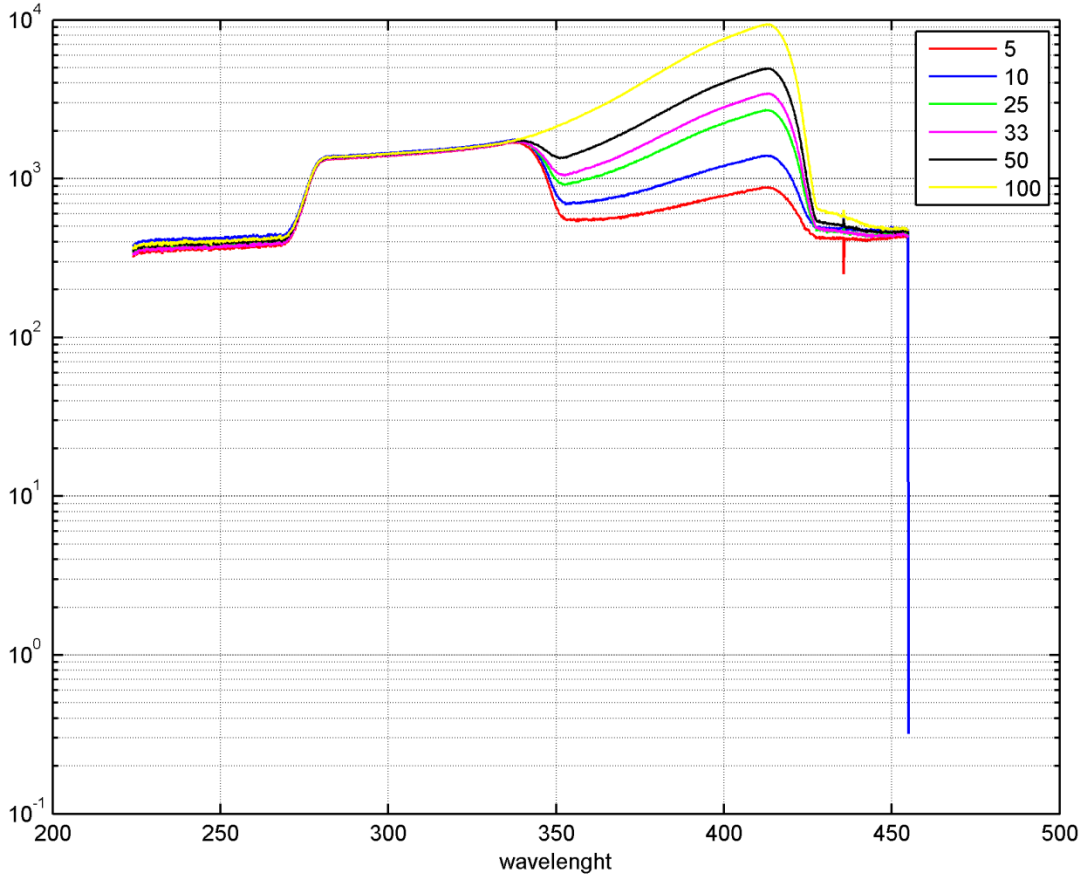
Spectral selecion of dispersed light:



- QTH Radiation source
- Removing“ parts of spectra, here 280-350 nm and 350-400 nm

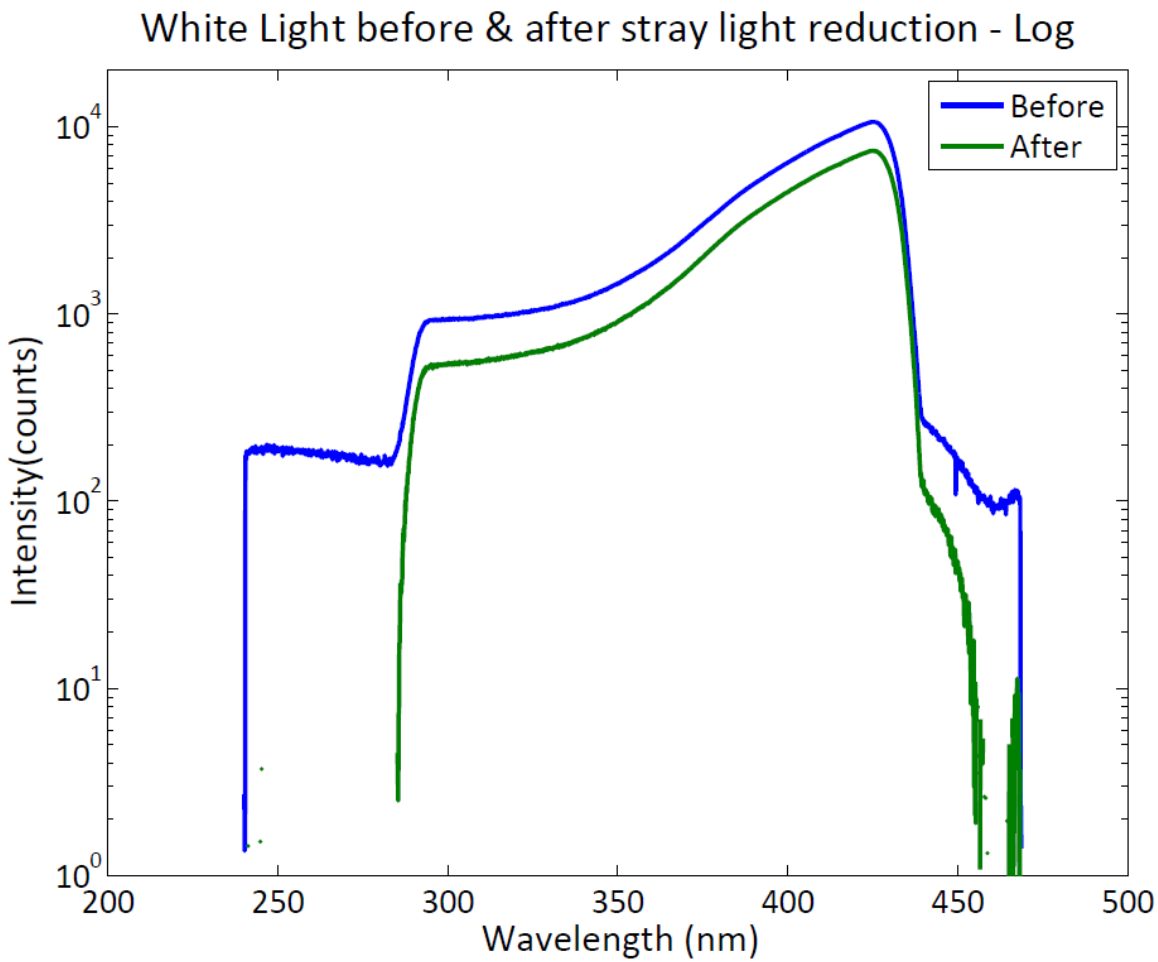
µ-MUV First results

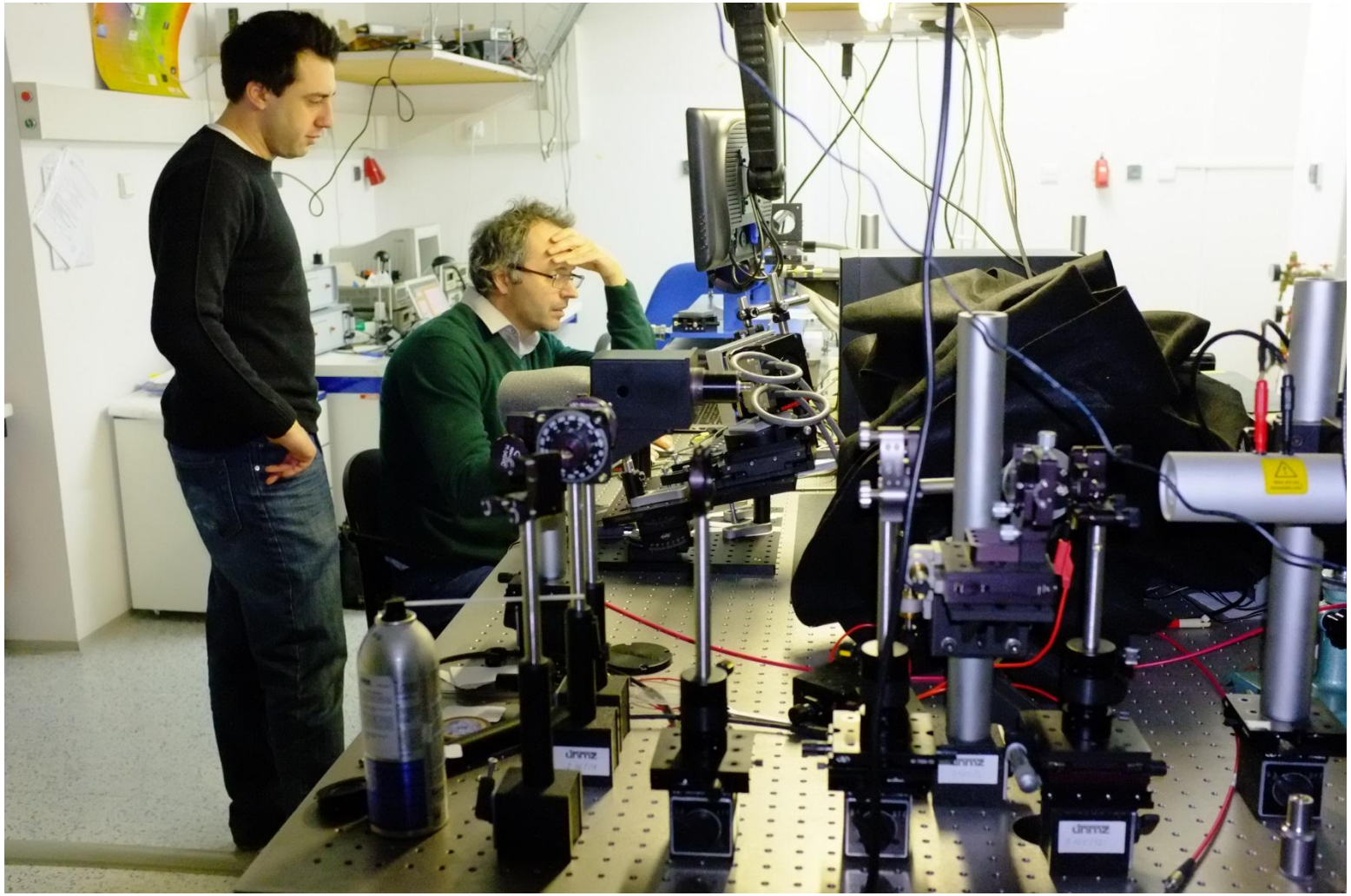
High-speed switching for spectral resolved optical attenuation:



µ-MUV First results

Issues with parasite beams and baffling :





µ-MUV Current activities and future steps

Optimising the mechanical set-up:

- Dedicated customised optical bench
- More robust light-tight housing
- **Thorough baffling for instrumental stray light**

Further optimisation of reflective optics:

- Introducing non-spherical mirrors
- Decreasing entrance slit width from 200 um to 100 um

Extending dynamic range via the tradeoff between spectrally selective filtering (by DLP high-speed switching) and detector's integration time.