Royal Netherlands
Meteorological Institute
Ministry of Infrastructure and the Environment

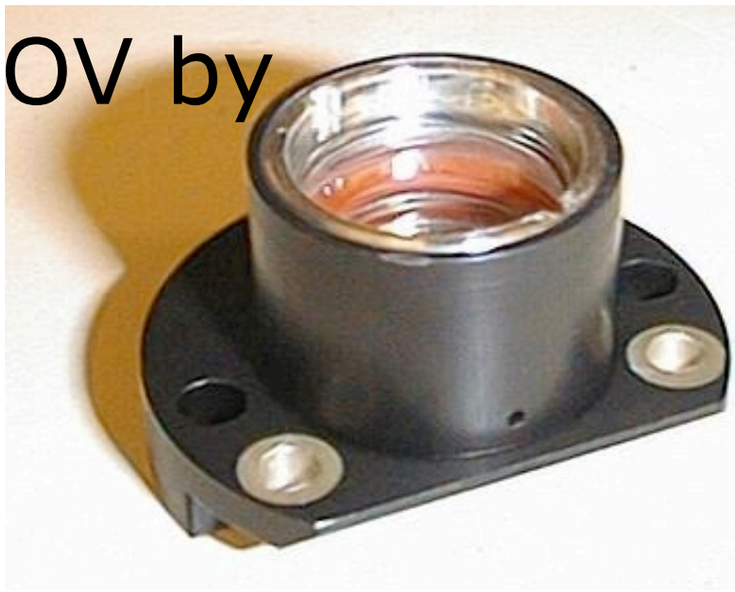
OMI Polarization Scrambler

Pepijn Veefkind
Pieternel Levelt

veefkind@knmi.nl

Conclusions

- OMI uses a Dual-Babinet Compensator Pseudo-depolarizer scrambler.
- The OMI scrambler is a robust optical element, without moving parts.
- Measured polarization sensitivity is 0.4-1%.
- Spectral features are less than 4 10^{-4}.
- The scrambler increases the IFOV by approximately 20%.



Variation over the Orbit (LEO)

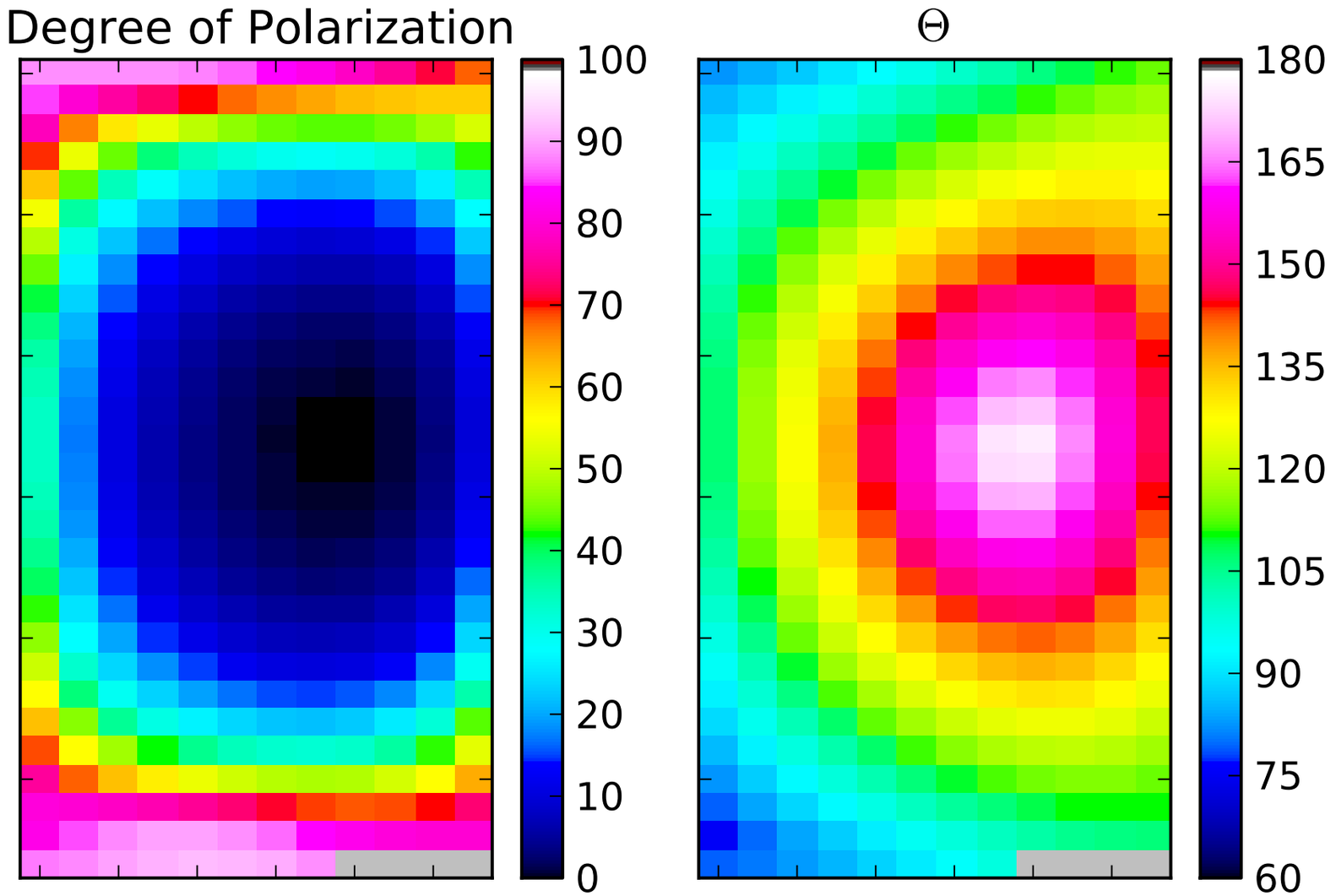


Figure 3: The maximum degree of linear polarization in the simulated spectrum (left) and the single scattering angles Θ (right) for the simulations. The orbit runs from south to north, from the bottom to the top of this figures. The horizontal dimension is the across track direction, with the west-side of the swath on the left. The same orientation as is used in figures 5 – 9. The grey pixels at the start of the orbit are geometries with a solar zenith angle larger than 88°.

Polarization

- Measure the polarization and correct (GOME / SCIAMACHY)
- Make the instrument insensitive to polarization (OMI/TROPOMI)

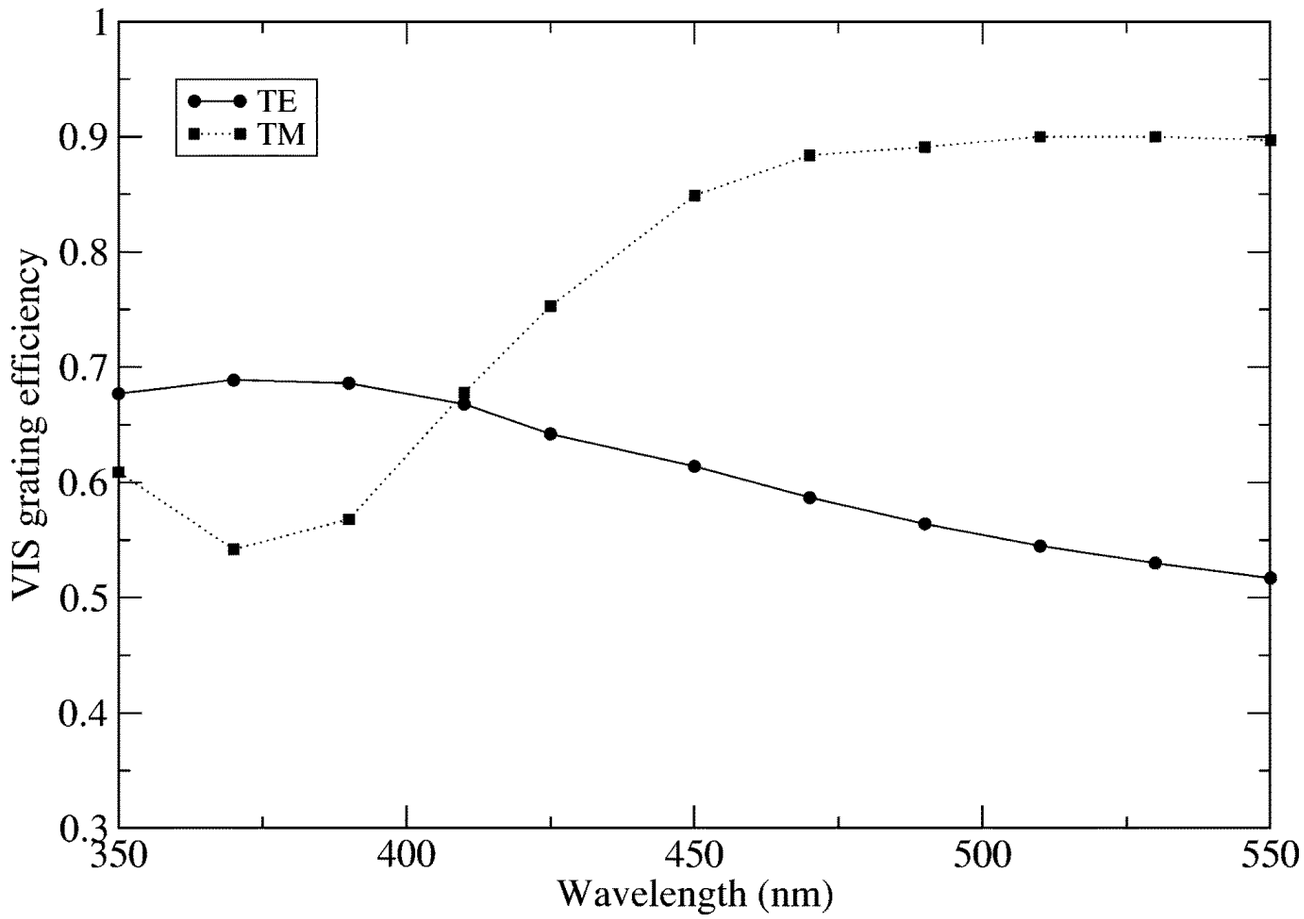


Fig. 4. Polarization-dependent grating efficiencies for the VIS channel grating.

Dual Babinet Compensator Pseudo-Depolarizer

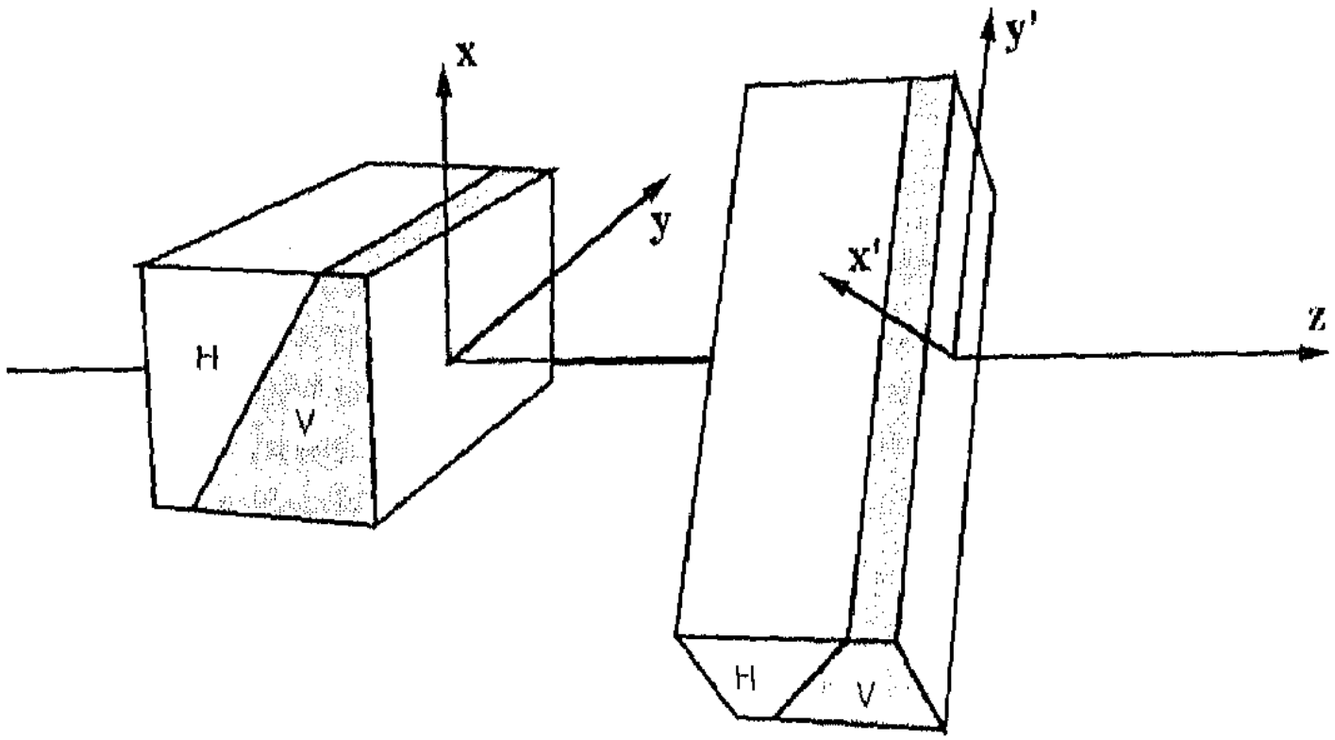
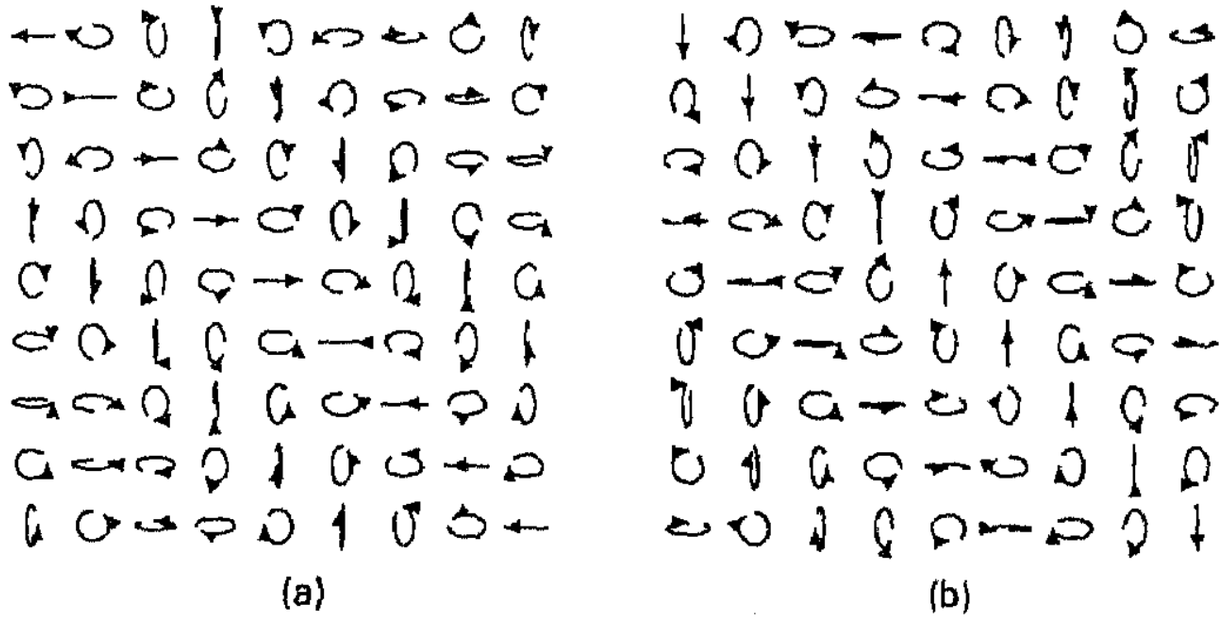
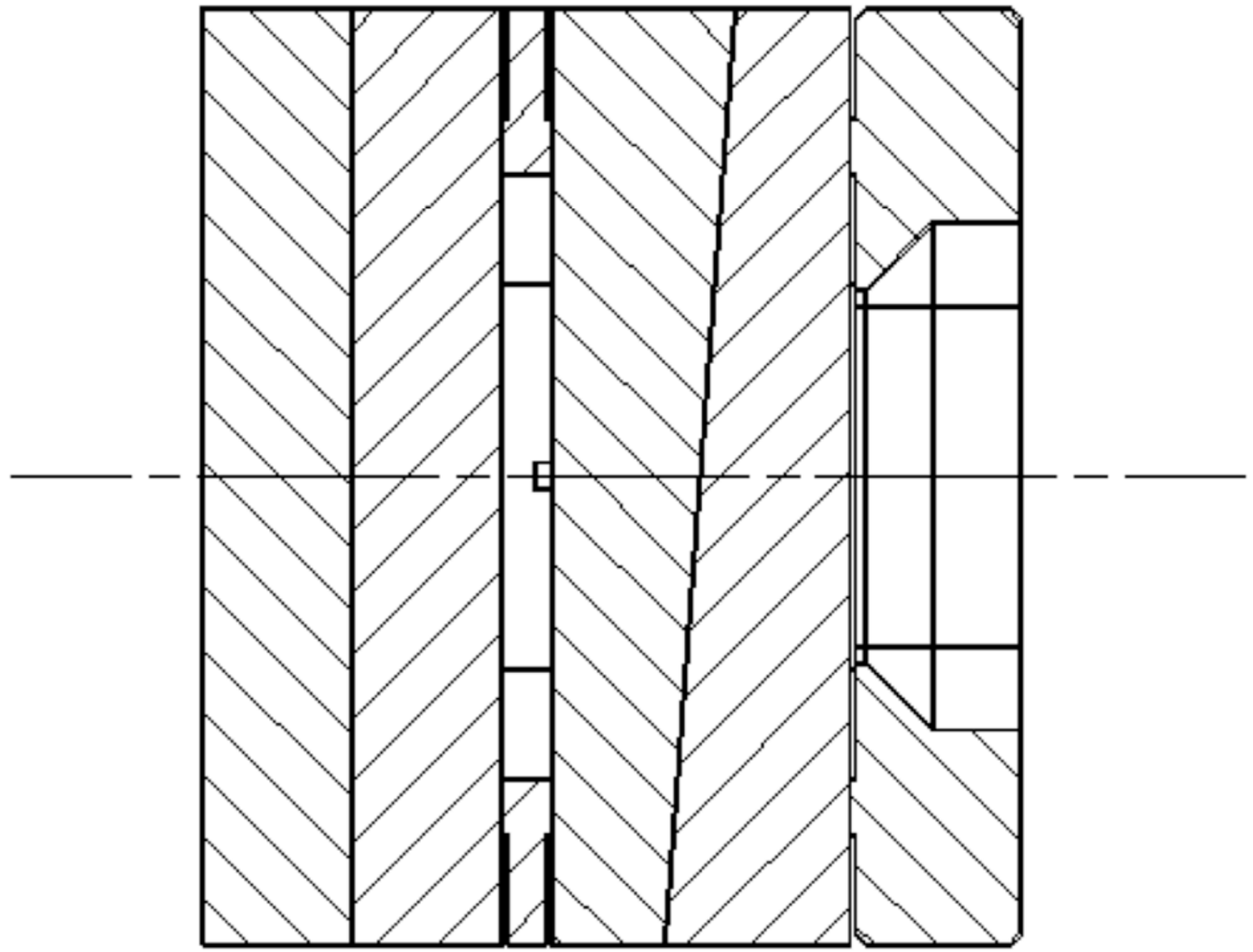


Fig. 5. Construction of the dual Babinet compensator pseudodepolarizer. H and V denote birefringent material with the fast axis horizontal and vertical.



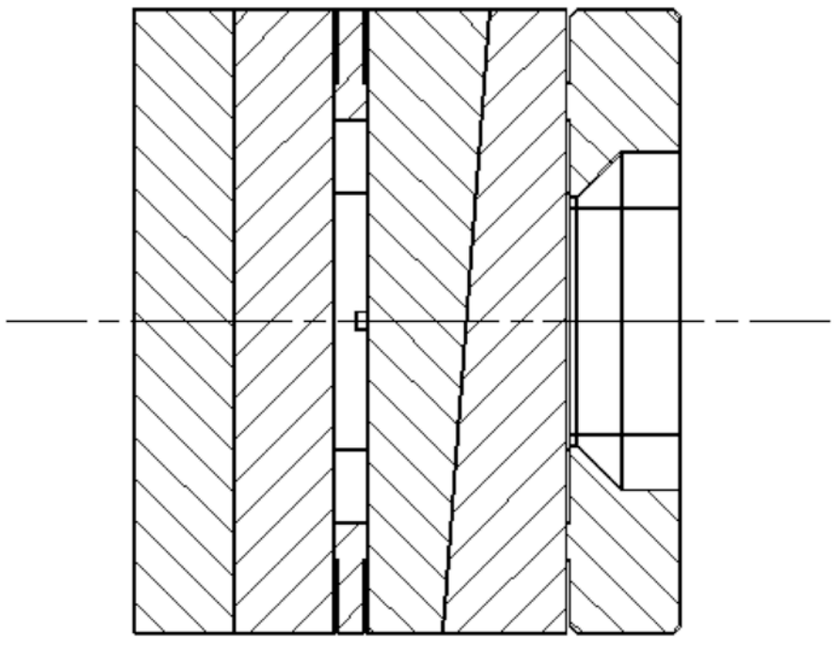
McGuire and Chipman, "Analysis of Spatial pseudo depolarizers in imaging systems", Optical Engineering, December 1990, volume 29, nr. 12, page 1478 - 1484

OMI Scrambler

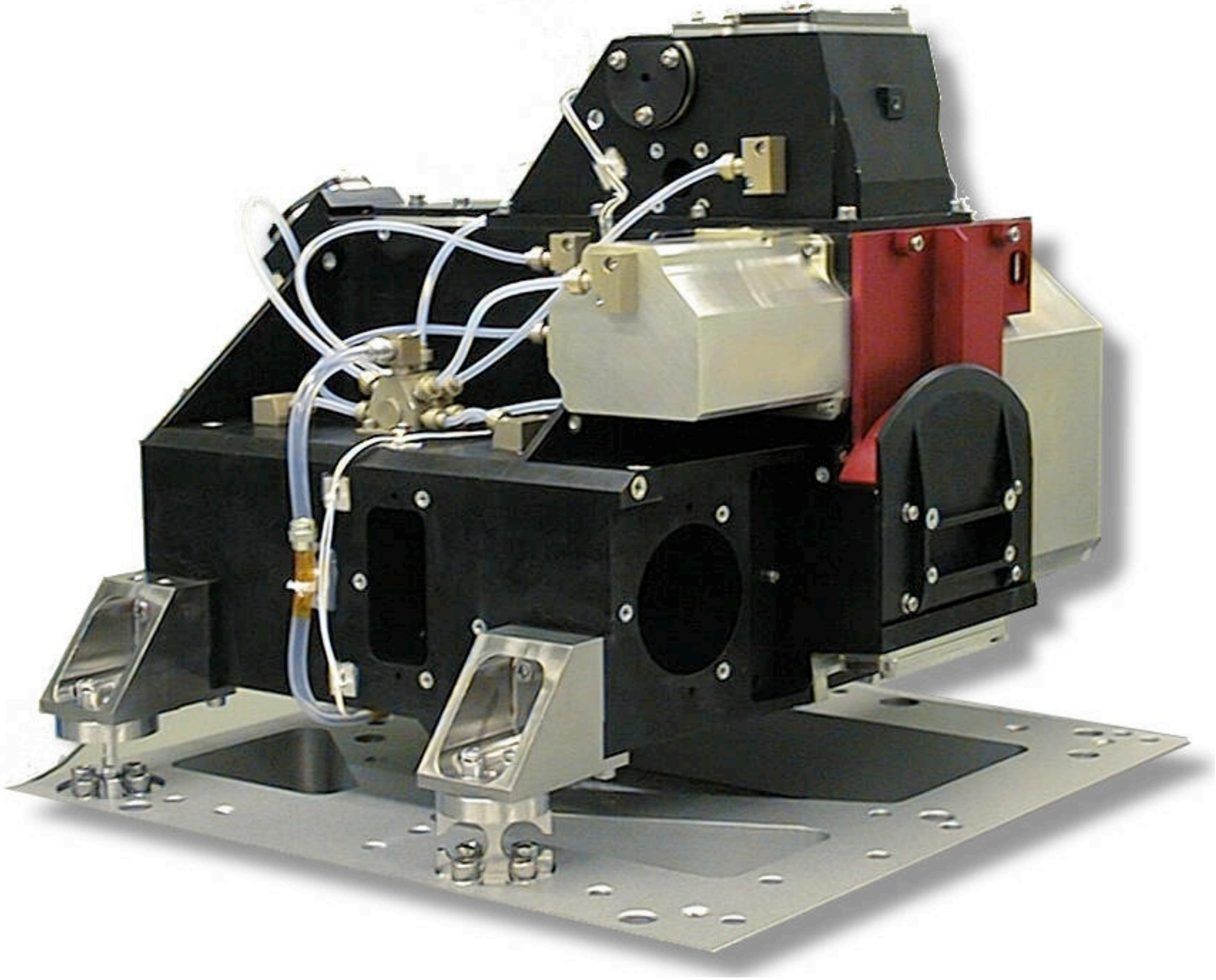


Trades in OMI

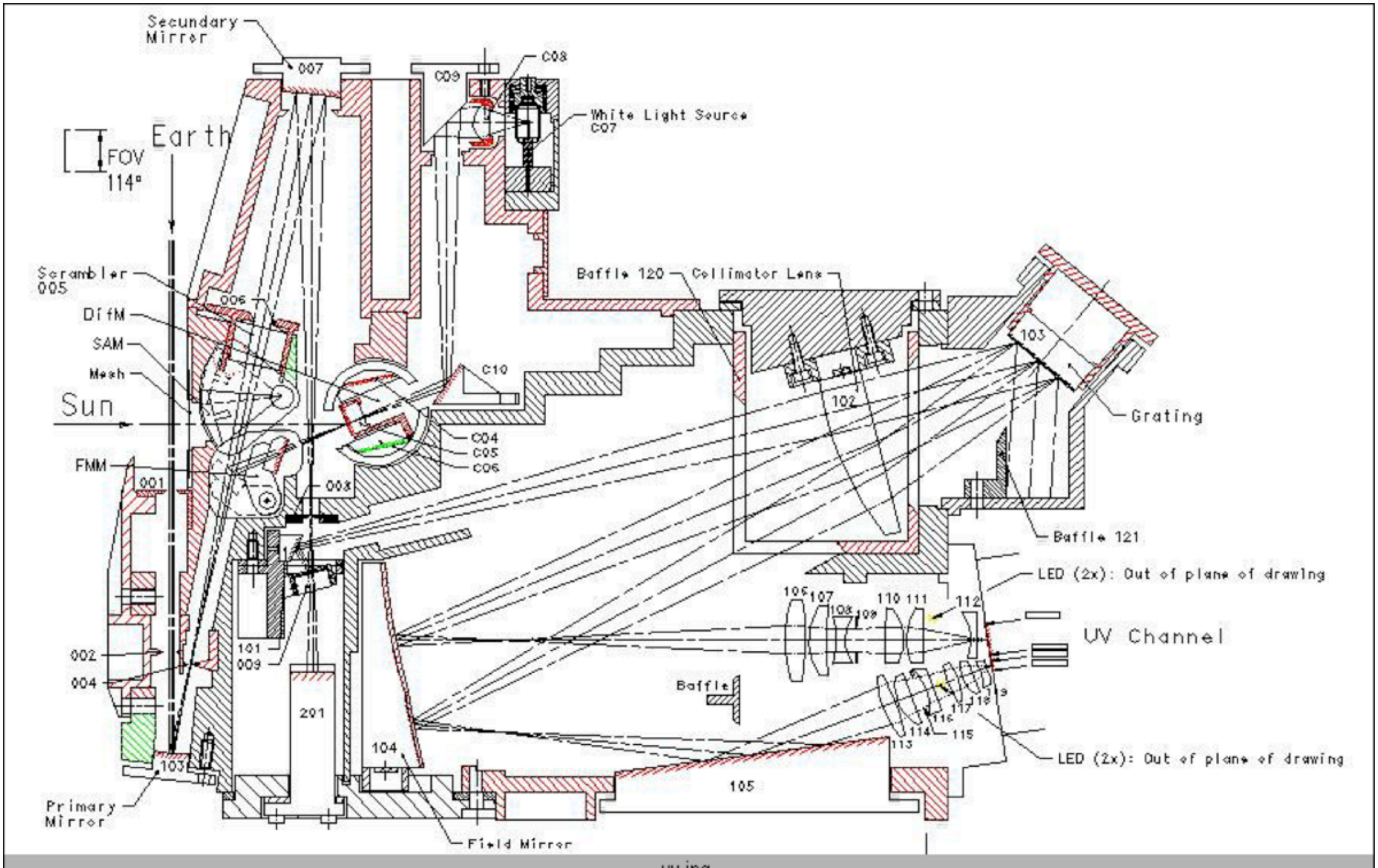
- Wedge angle: increases improves the depolarization and reduces spectral features, but increases spatial effects.
- Effects of the first mirror and the first optical surface of the scrambler.
- Larger spectral coverage makes it harder to optimize the scrambler performance.



OMI DM Optical Bench



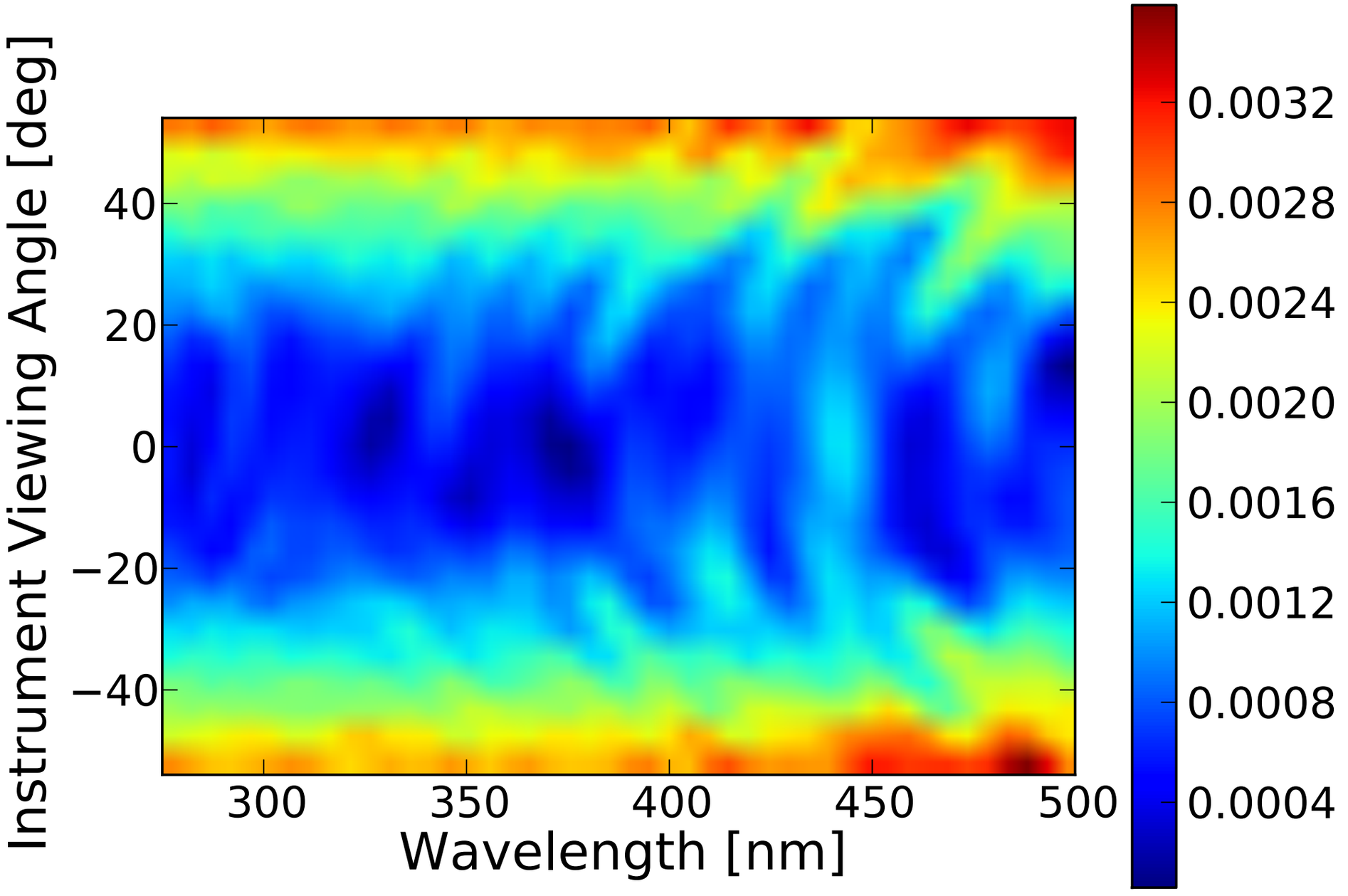
OMI Telescope and UV Channel



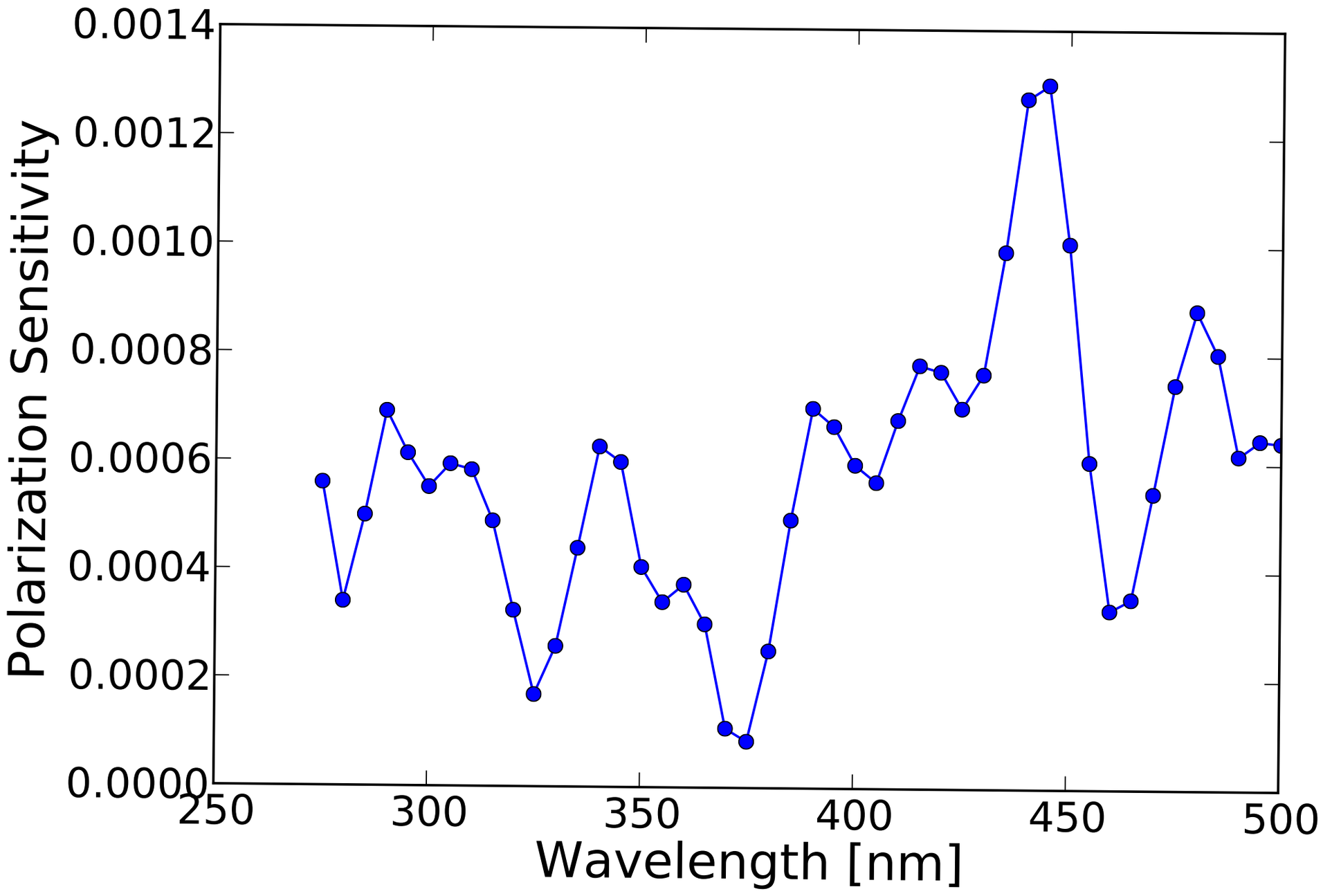
uv.jpg

OMI Scrambler

Simulated Polarization Sensitivity

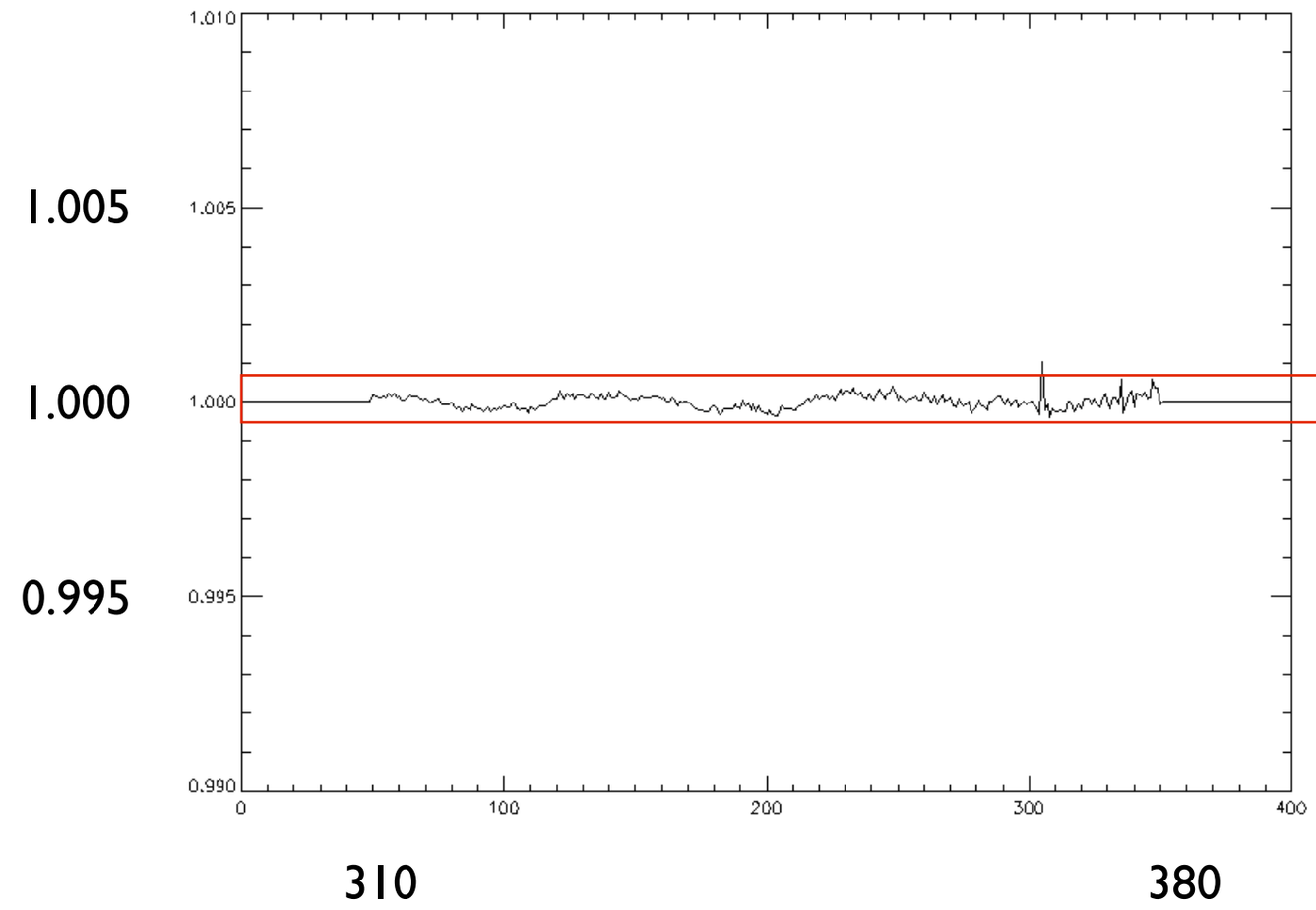


Simulated Polarization Sensitivity



OMI Spectral Features

UV

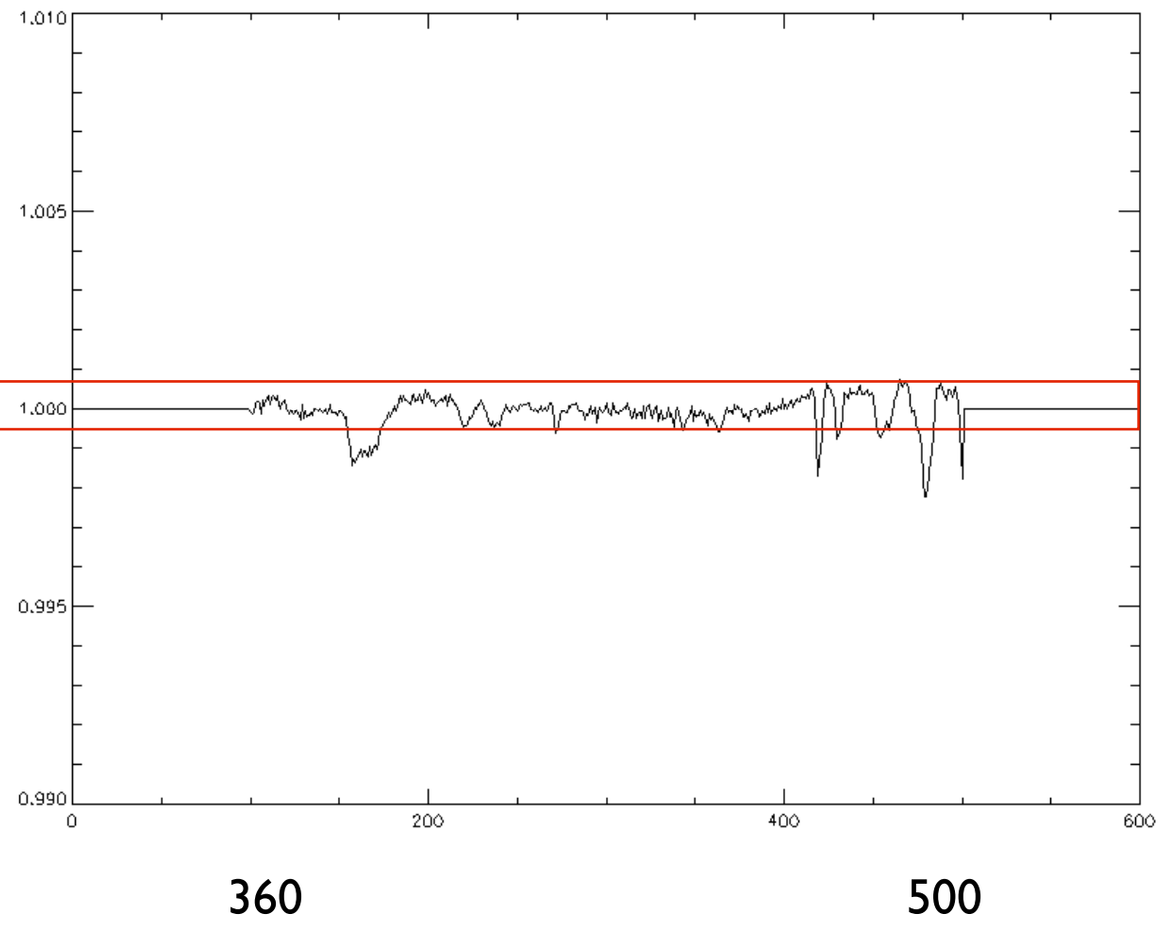


1.005
1.000
0.995

310 380

approximate wavelength [nm]

VIS



360 500

approximate wavelength [nm]

“Diamond” Effect

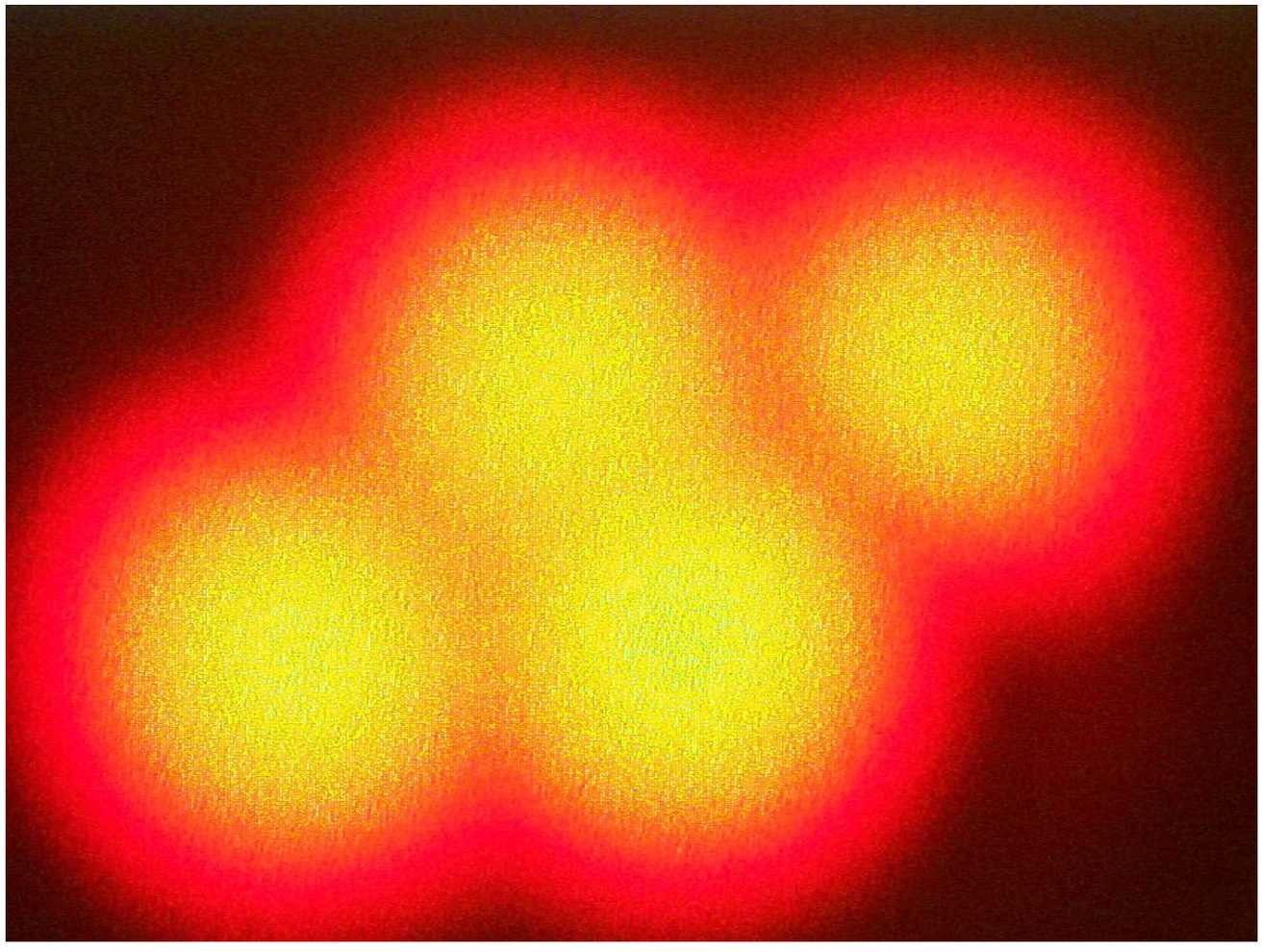


Figure 6.2. Characteristic beam pattern exiting from a DBCP

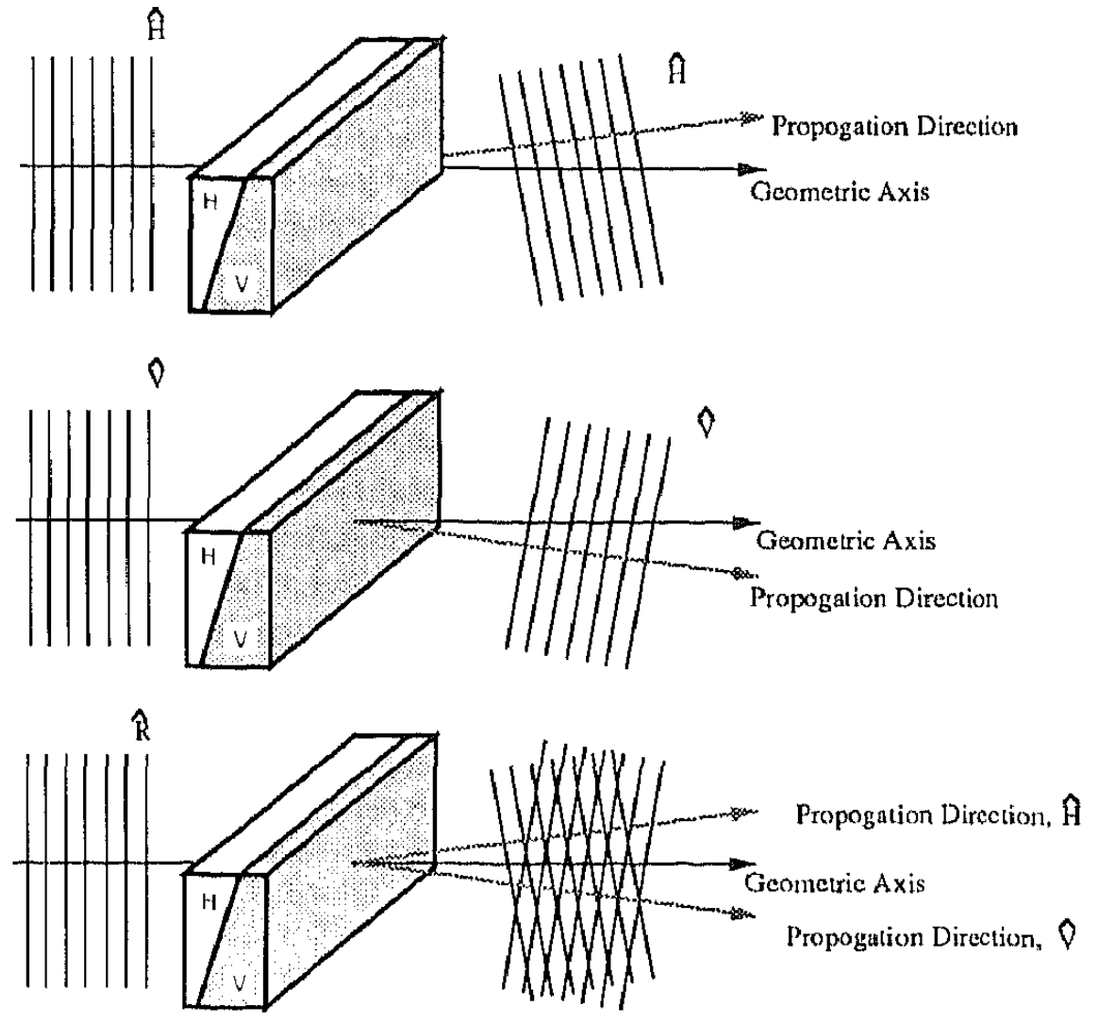


Fig. 6. The propagation of horizontally, vertically and, circularly polarized light through a Babinet compensator. $\hat{R}$ = right circular polarized light, $\hat{V}$ = vertically polarized light, $\hat{H}$ = horizontally polarized light, H = birefringent material, fast axis horizontal, V = birefringent material, fast axis vertical, $\hat{R} = \hat{H} + j\hat{V}$.

Effect on the FOV in Swath Direction

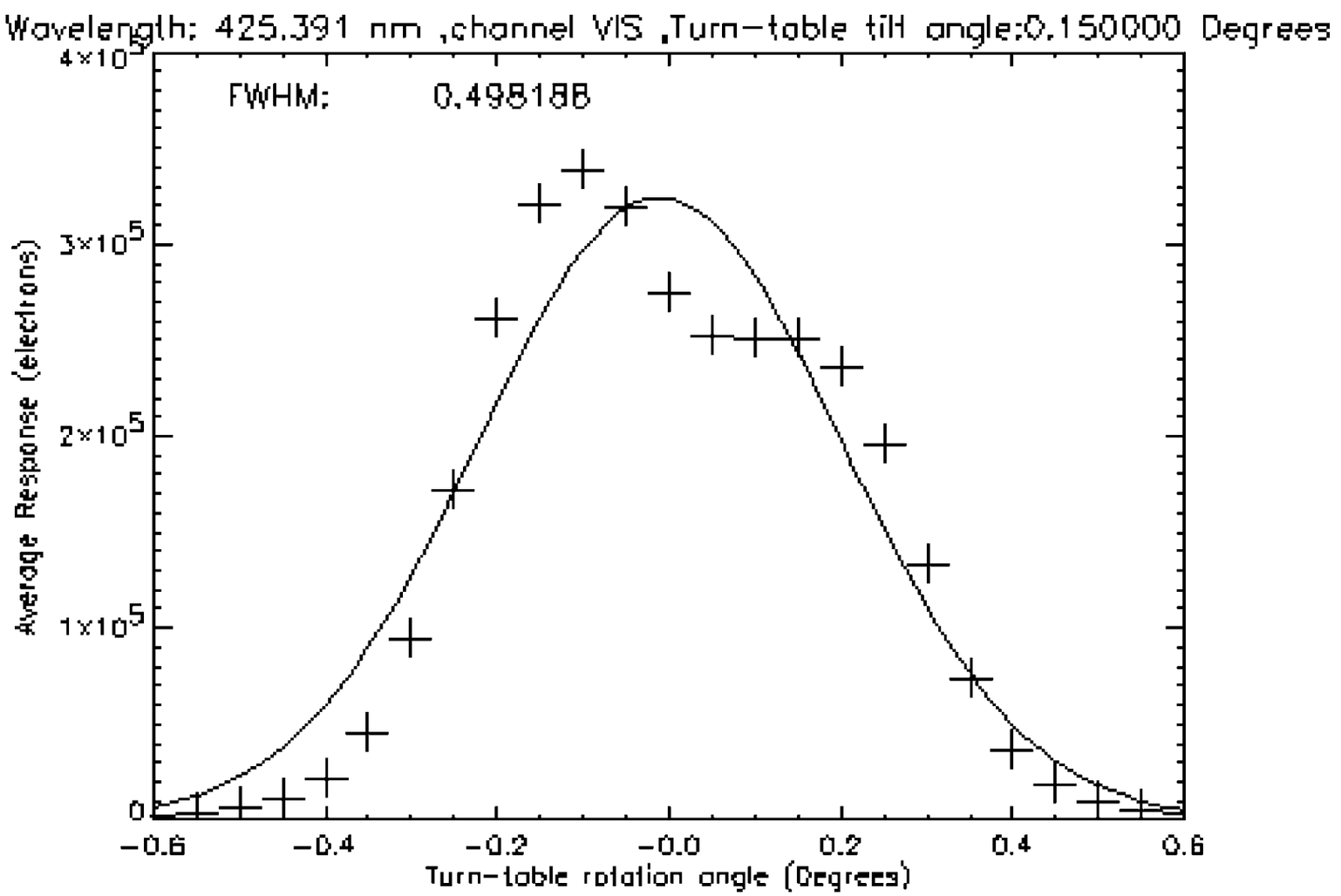


Fig. 31. Measured spatial resolution in the swath dimension for a pixel close to nadir in the VIS channel at about 425 nm along with the fitted Gaussian result. The double peak is originating from the polarization scrambler.

Recommendation

- Implement polarization scrambling in GEMS.
- Include a polarization sensitivity of better than 1%.
- Include a spectral feature requirement of 0.05%.