

# SPEX: Spectropolarimeter for Planetary EXploration

Gerard van Harten<sup>a</sup>, Frans Snik<sup>a</sup>, Jos de Boer<sup>a</sup>, Christoph Keller<sup>a</sup>  
& SPEX team<sup>b</sup>

<sup>a</sup>Leiden Observatory, Leiden University

<sup>b</sup>SRON, TNO, NOVA-ASTRON, Mecon, cosine, Dutch Space

The 1<sup>st</sup> WG meeting of the MP1104 COST Action

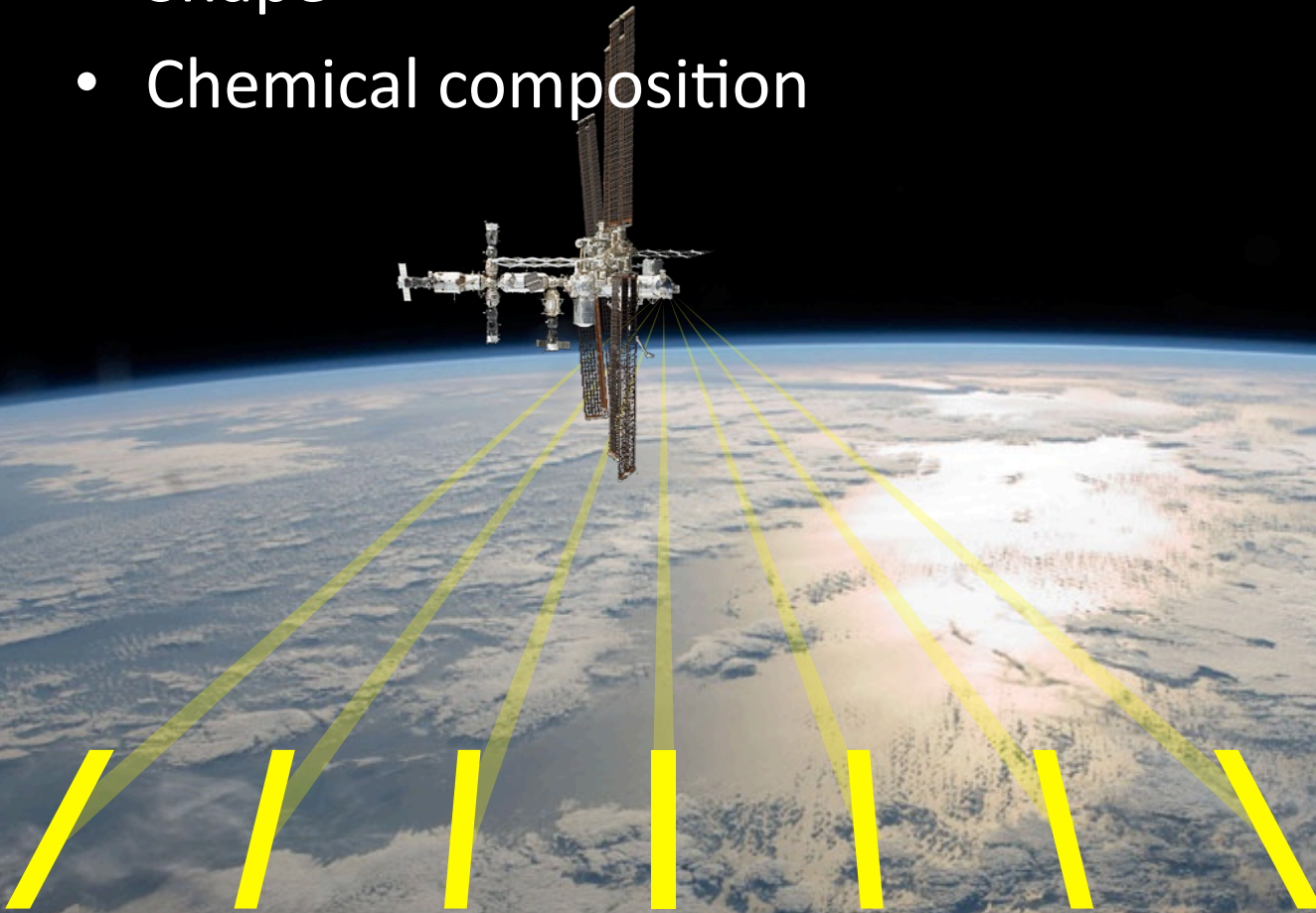
May 2012

Warsaw, Poland



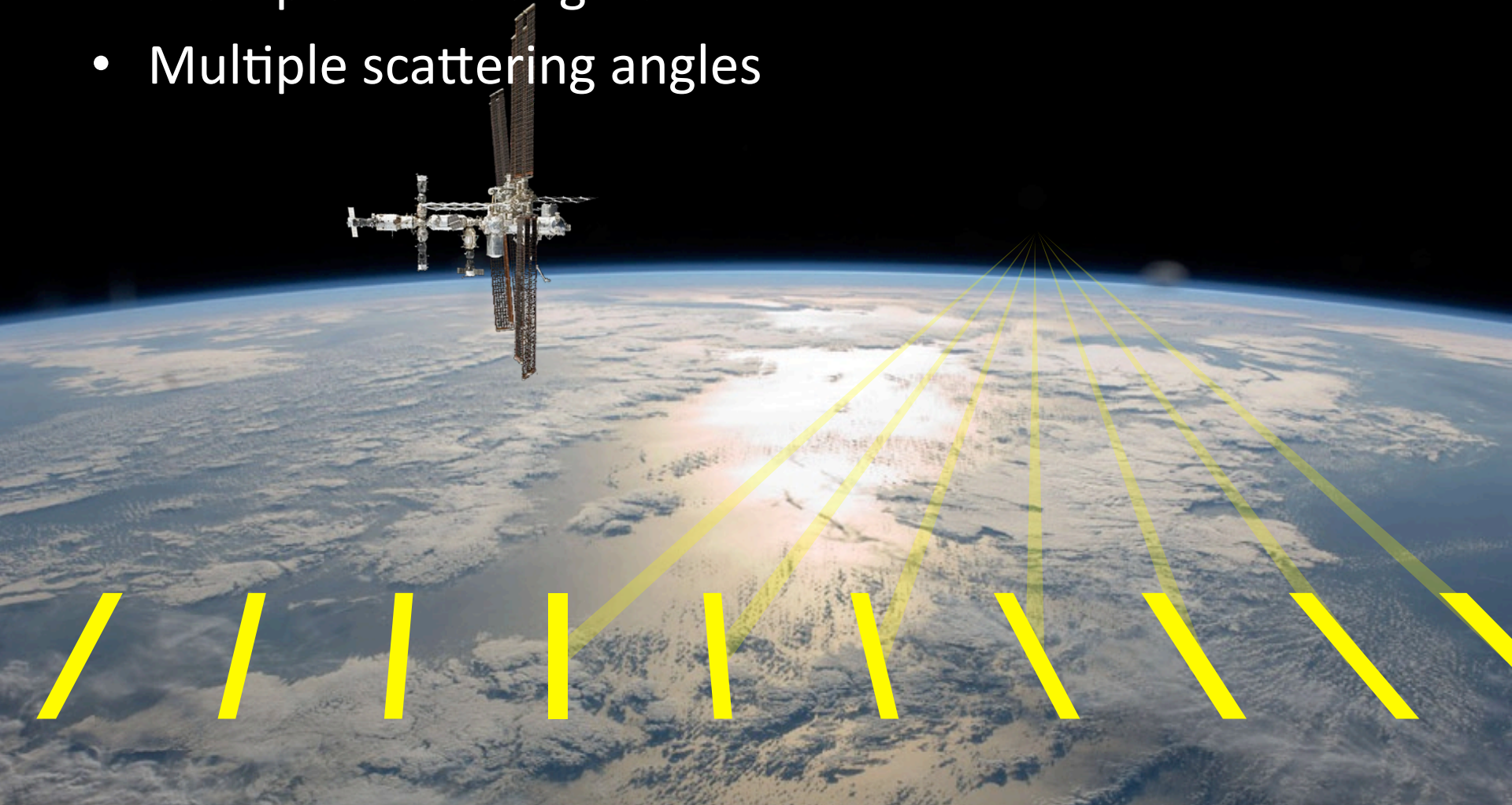
# Atmospheric aerosols

- Size
- Shape
- Chemical composition



# Measurements

- Stokes I, Q, U
- Multiple wavelengths
- Multiple scattering angles



## Aerosol forcing on climate:

- 400-1600 nm
- 30 viewing angles
- $0.001 + 0.005 \times \text{DoLP}$  accuracy

1. *Temporal modulation*: rotating waveplate or liquid crystal.

Risk of failure; large power consumption; timing issues.

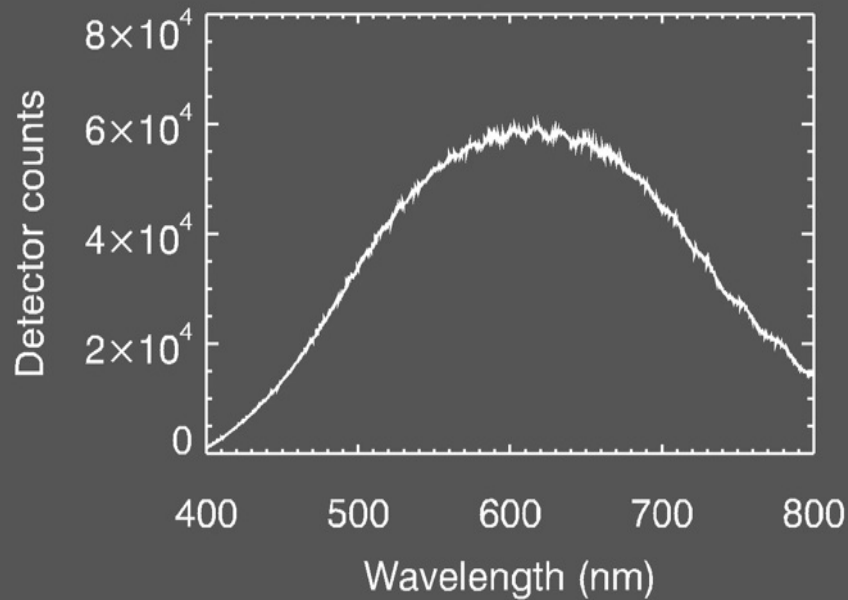
2. *Spatial modulation*: split up beam according to four (three) linear polarization directions.

Not precise enough; too large.

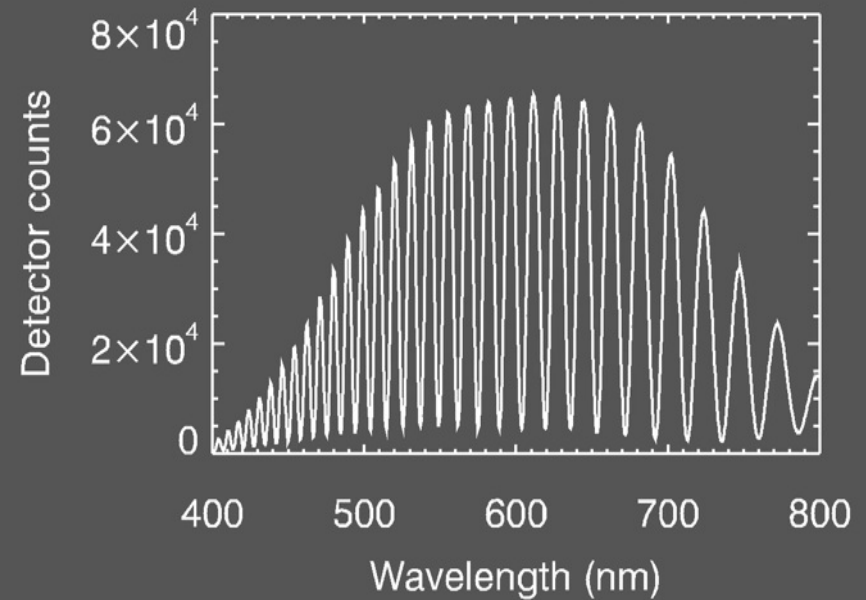
3. *Spectral modulation*: a sinusoidal modulation on the measured intensity spectrum.

Degree of Linear Polarization (DoLP) → Amplitude

Angle of Linear Polarization (AoLP) → Phase

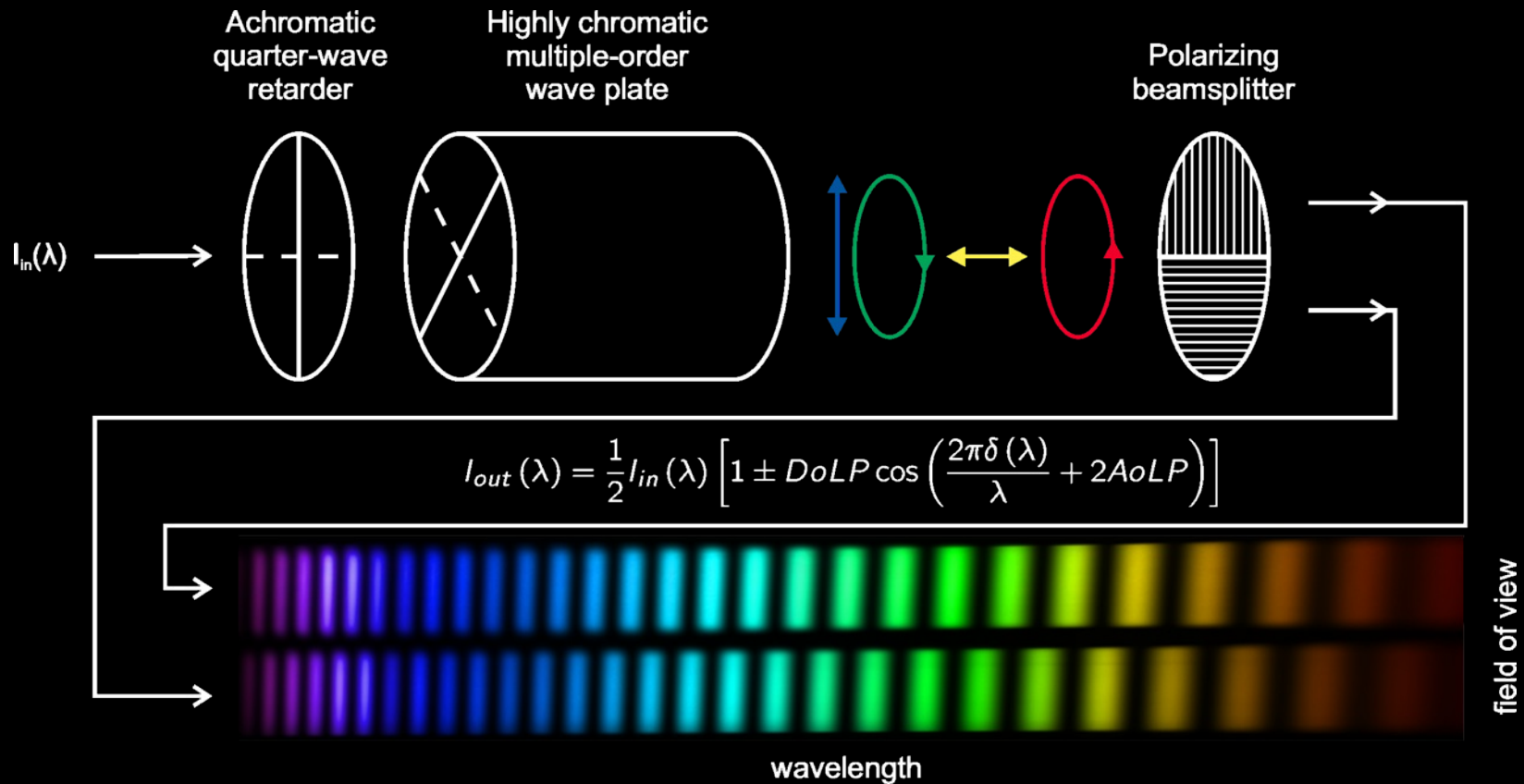


DoLP variation

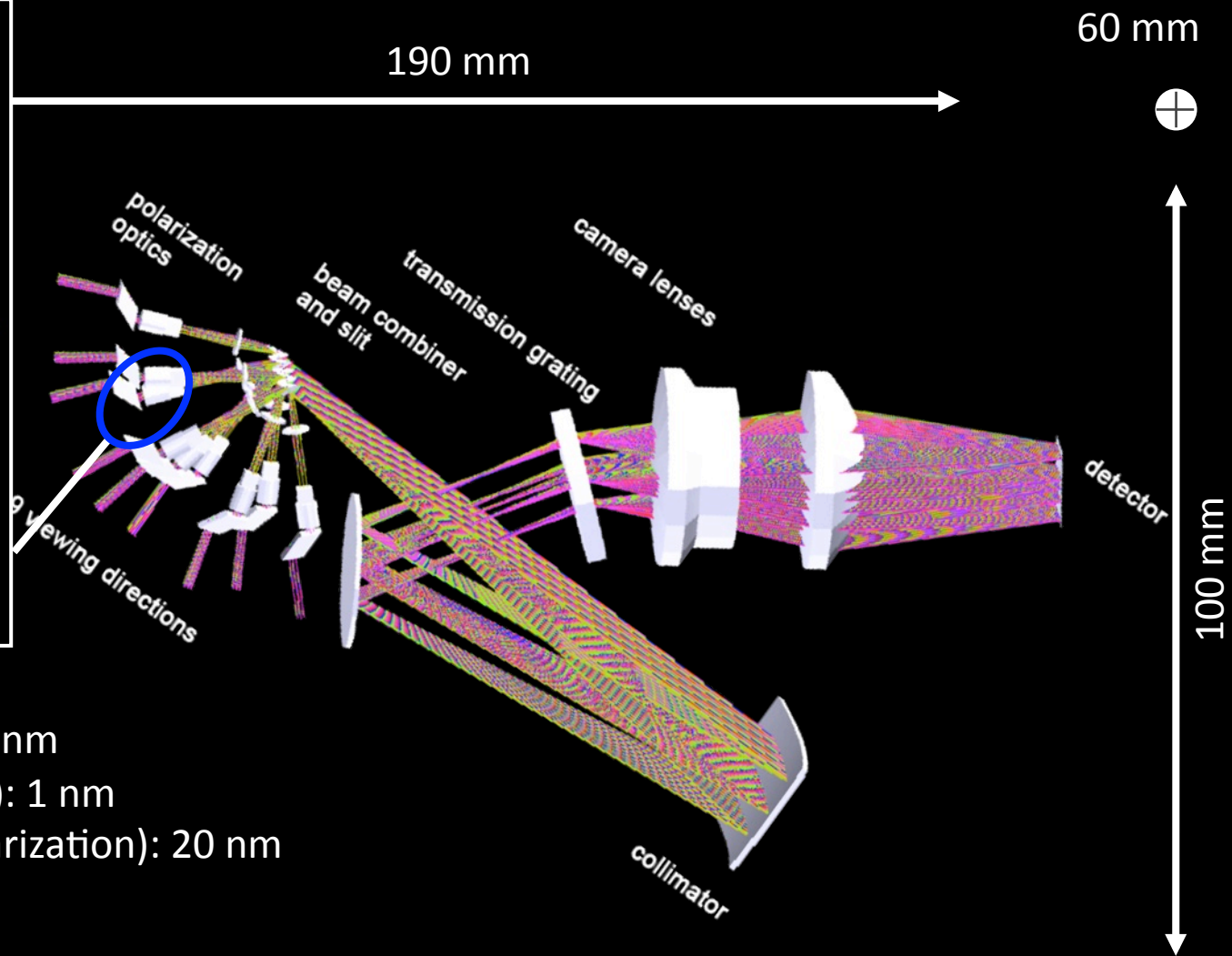
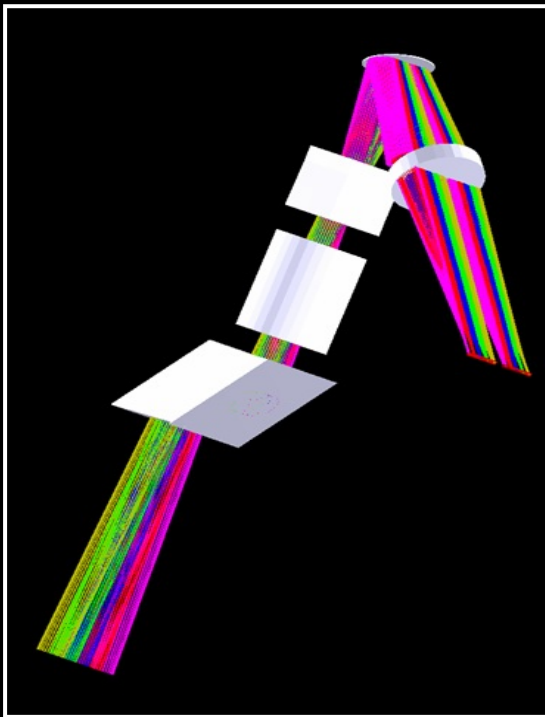


AoLP variation





# SPEX prototype

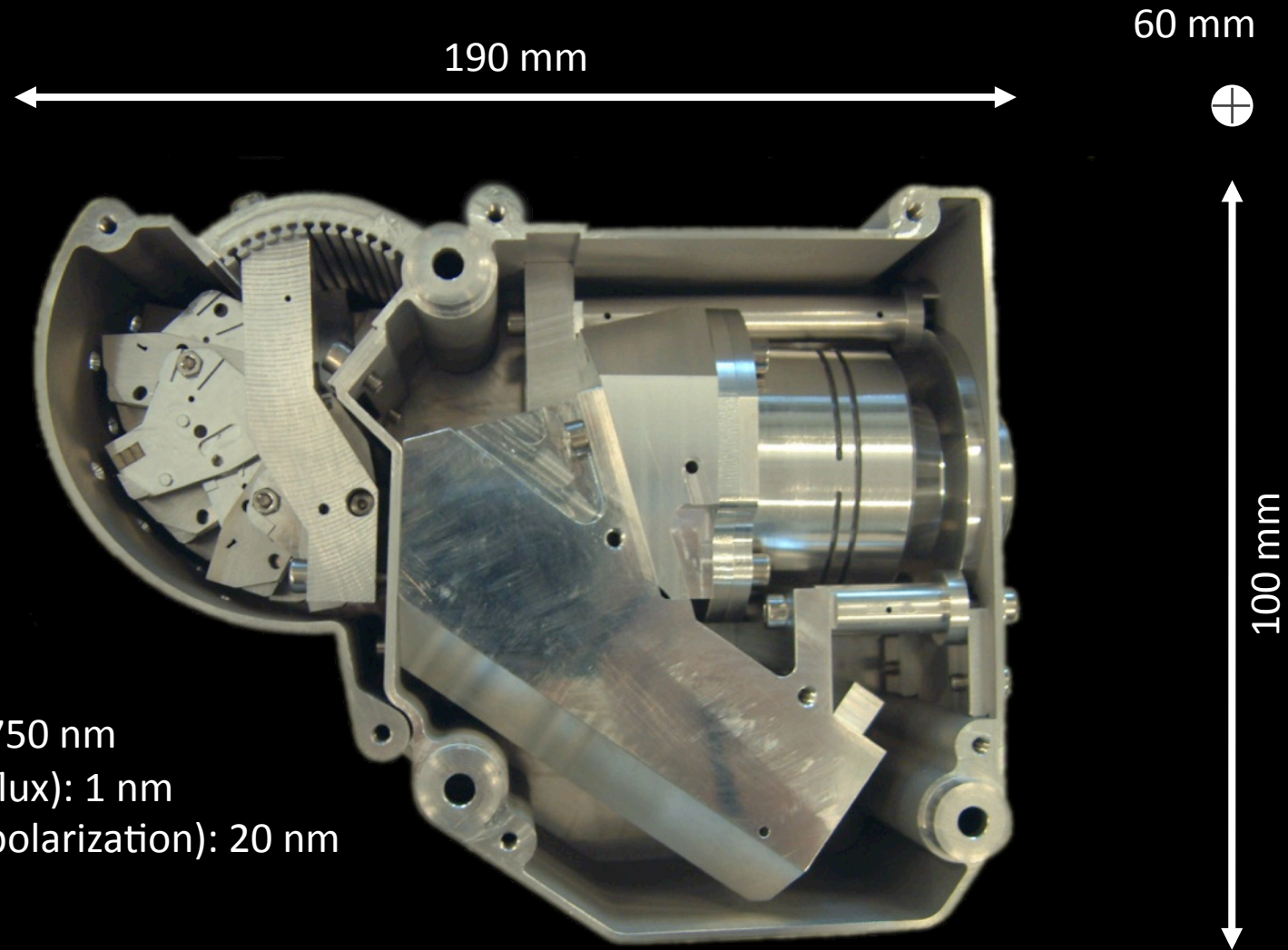


spectral range: 400-750 nm  
spectral resolution (flux): 1 nm  
spectral resolution (polarization): 20 nm

volume: 1.1 dm<sup>3</sup>  
mass: 1.0 kg



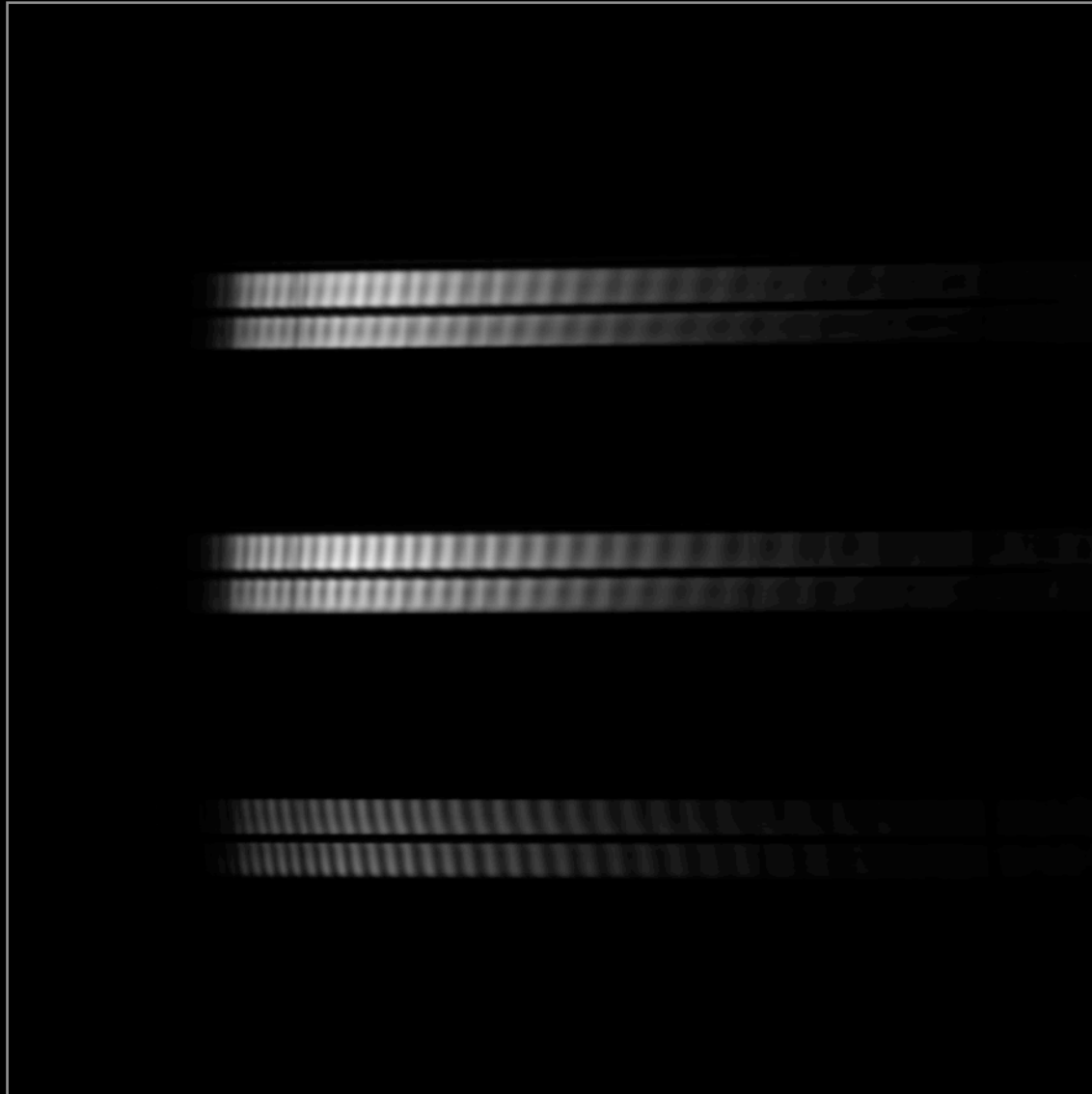
# SPEX prototype



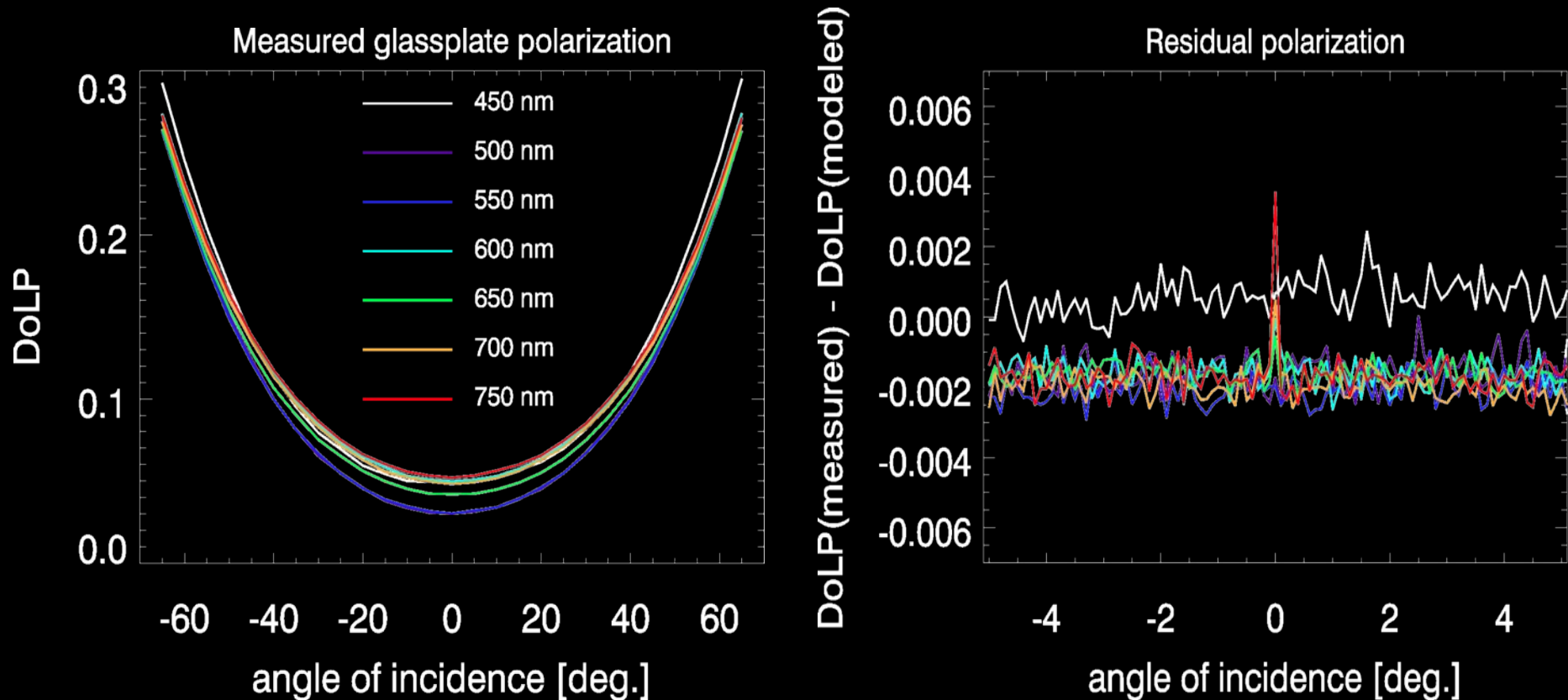
spectral range: 400-750 nm  
spectral resolution (flux): 1 nm  
spectral resolution (polarization): 20 nm

volume: 1.1 dm<sup>3</sup>  
mass: 1.0 kg

# Blue sky measurement



- Tilted glass plate behind weakly polarized source
- $2 \times 10^{-4}$  DoLP sensitivity at minimum resolution



## Advantages of spectral modulation:

- Fully passive
- Scalable
- One-shot measurement
- No differential effects
- Low susceptibility to noise

- $10^{-3}$  polarimetric accuracy
- Global coverage → widefield optics

- Fresnel refraction
  - 0.7% total instrumental polarization



- Fresnel refraction
  - 0.7% total instrumental polarization
- Fresnel rhomb
  - Retardance changes with angle of incidence
  - Swath along insensitive direction
  - 0.008% U → V

- Fresnel refraction
  - 0.7% total instrumental polarization
- Fresnel rhomb
  - Retardance changes with angle of incidence
  - Swath along insensitive direction
  - 0.008% U → V
- Multiple order retarder
  - Longer pathlength + different birefringence
  - Spectral averaging: modulation decreases
  - MgF<sub>2</sub> + SiO<sub>2</sub> optimized: efficiency > 90%

- Fresnel refraction
  - 0.7% total instrumental polarization
- Fresnel rhomb
  - Retardance changes with angle of incidence
  - Swath along insensitive direction
  - 0.008% U → V
- Multiple order retarder
  - Longer pathlength + different birefringence
  - Spectral averaging: modulation decreases
  - MgF<sub>2</sub> + SiO<sub>2</sub> optimized: efficiency > 90%
- Double Wollaston prism

**CONFIDENTIAL**

Thanks!

SPEX

