TO BRING ABOUT BREAKTHROUGHS IN INTERNATIONAL SPACE RESEARCH

SPEXone instrument characterization & calibration

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AIRBUS

IOCS-2025
Ocean Colour Satellite Sensor Calibration

Content

SPEXone instrument

On-ground calibration

In-orbit monitoring & cross-calibration

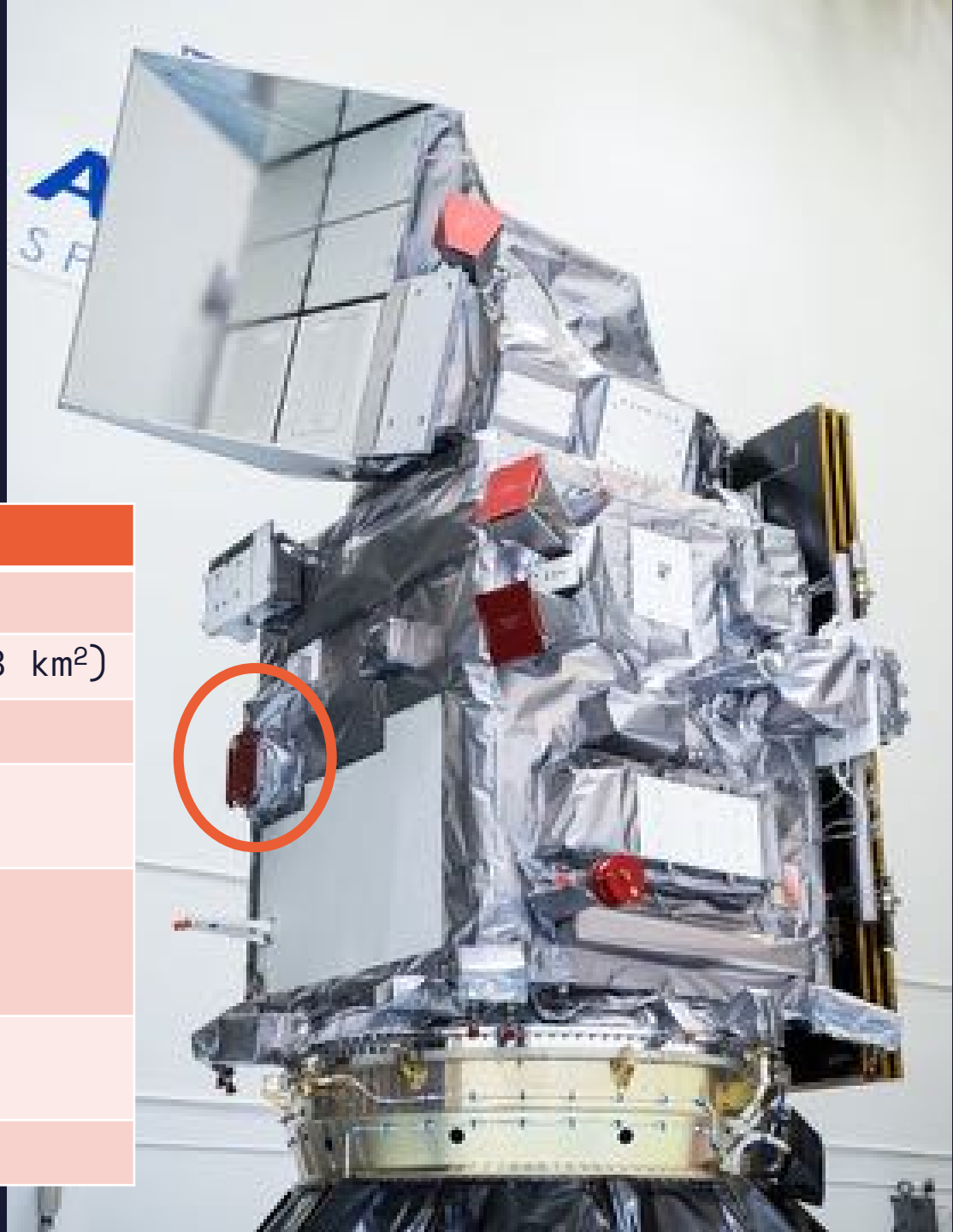
Scientific results

SPEXone

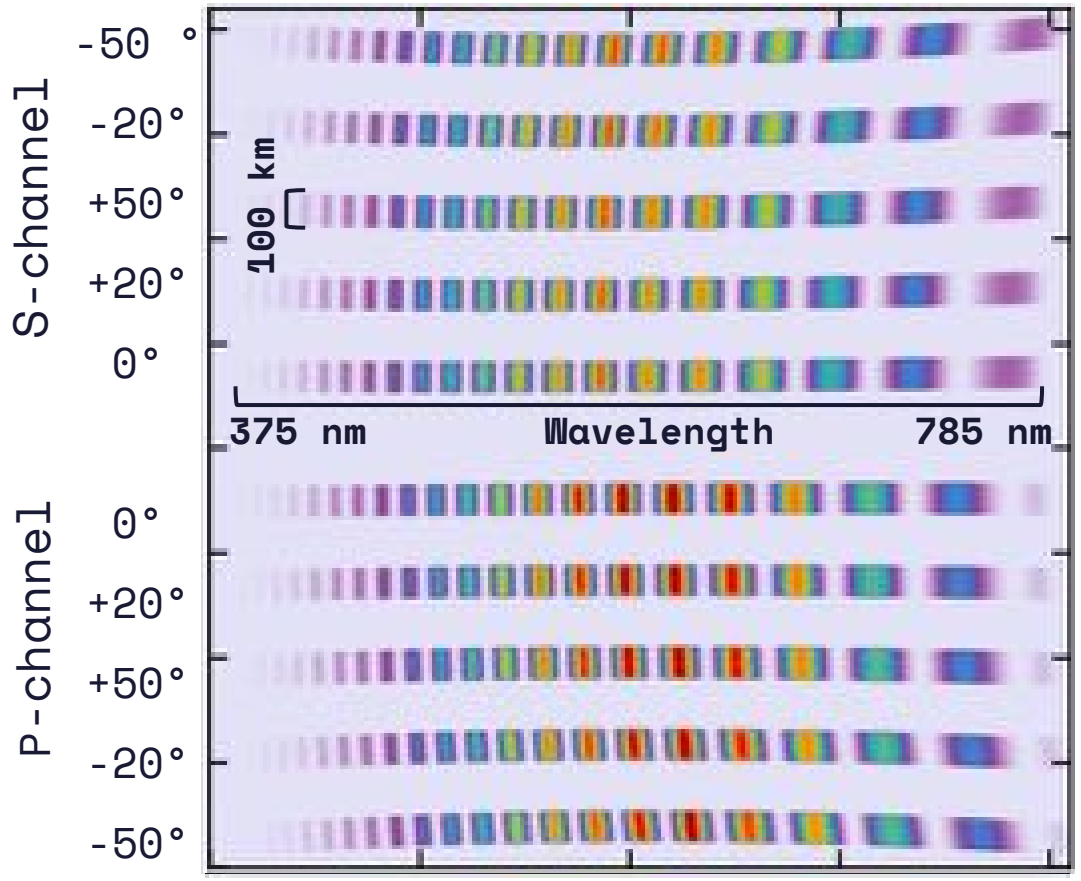
Multi-angle spectropolarimetry using dual beam spectral polarization modulation

5 instantaneous footprints yielding snapshot pushbroom measurements of radiance and polarization

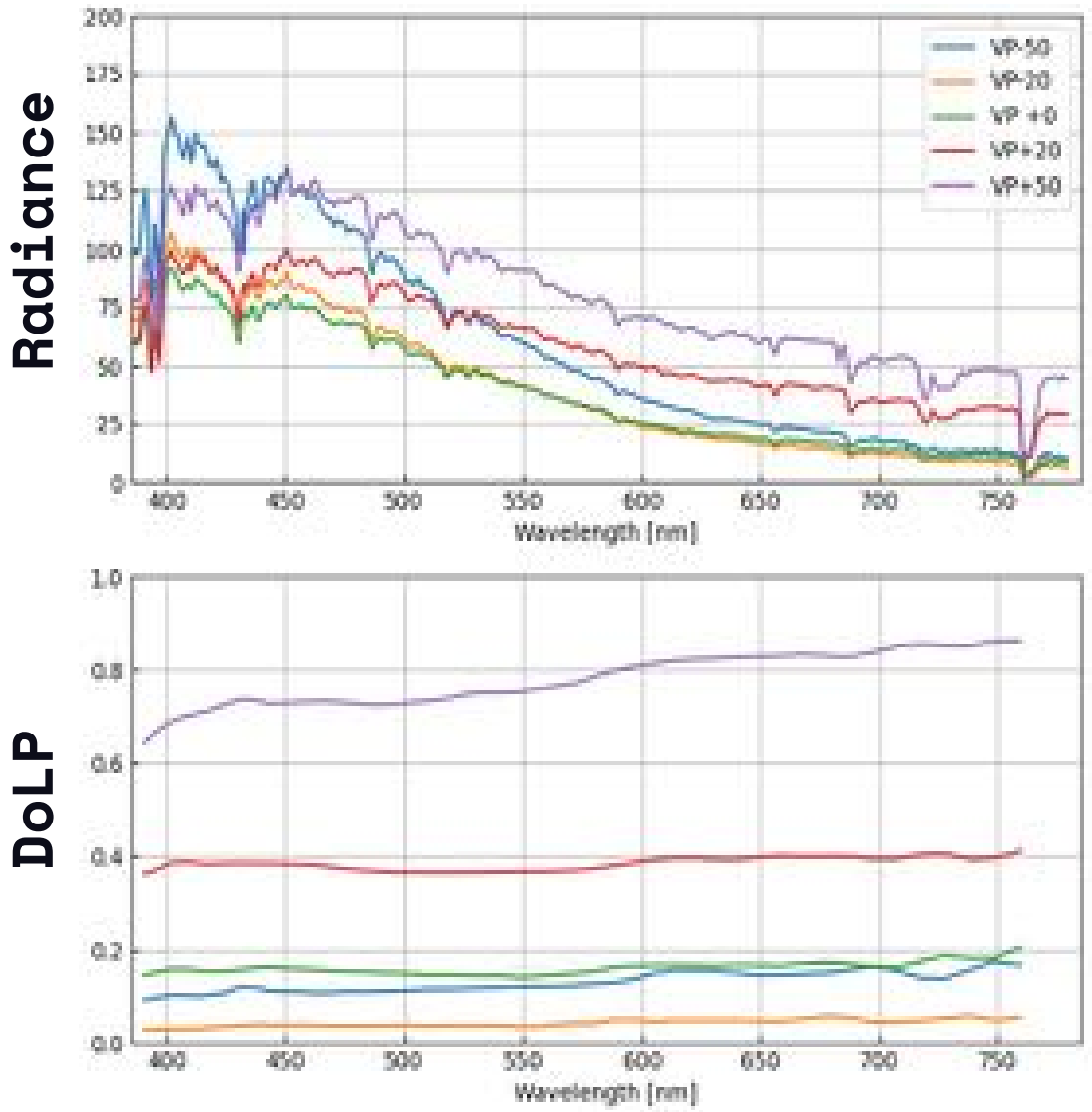
Parameter	Specification
Swath width	100 km
Spatial resolution (sampling)	5x5 km^2 (~2.3x2.8 km^2)
Spectral range	385 - 770 nm
Spectral resolution radiance	2 nm 400 bands
Spectral resolution polarization	10 nm @ 385 nm 45 nm @ 770 nm 50 bands
Radiometric accuracy SNR	< 2% (goal) > 300
Polarimetric accuracy	< 0.003 (goal)



SPEXone observations



Ocean



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Content

SPEXone calibration & characterization

- Detector characterization on Detector Module (DEM) level
  - Full homogeneous illumination only, focus on pixel characterization
- Full instrument level ambient calibration @ SRON
- Radiometric, polarimetic & spectral/ISRF calibration @ GSFC
- Spectral and polarimetric trending during PACE level TB/TV
- Detector testing on other DEMs to characterize signal dependent effects

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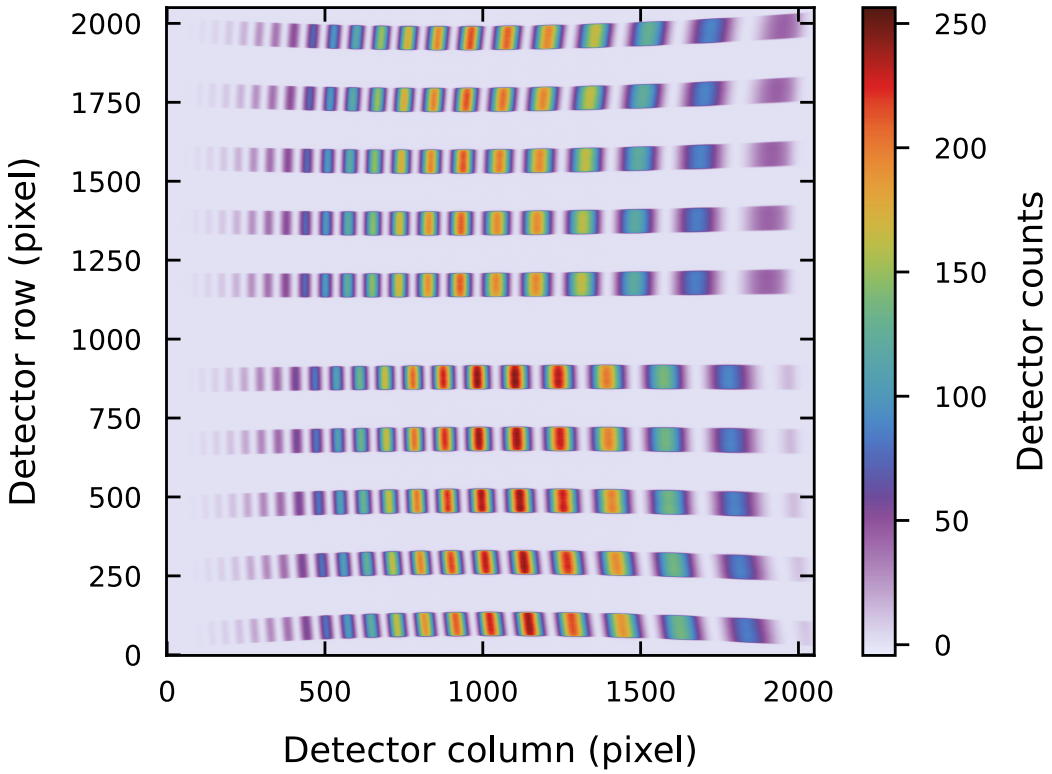
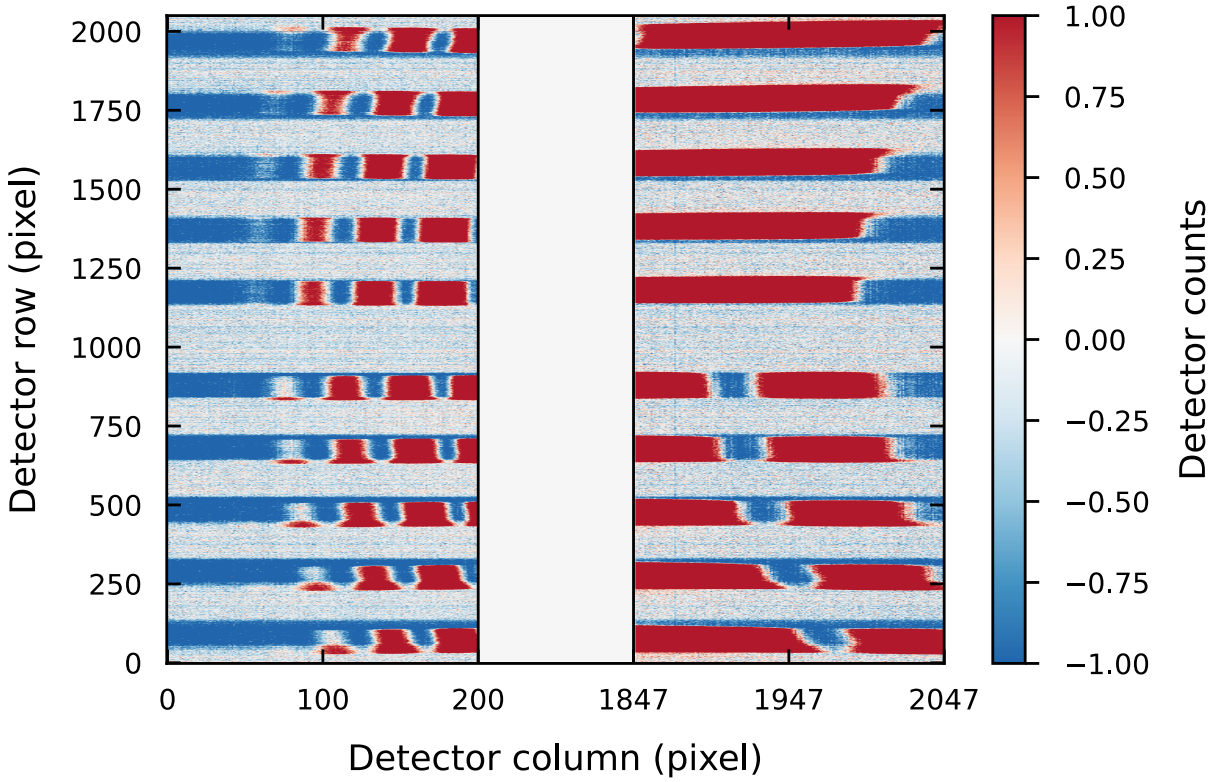
Signal dependent (offset) effects in the CMV4000





Signal dependent offset depends on:

- Total signal in row
- Total signal in full frame
- Signal distribution over row

Problem:

any (systematic) offset will result in a polarimetric error, especially at low signals

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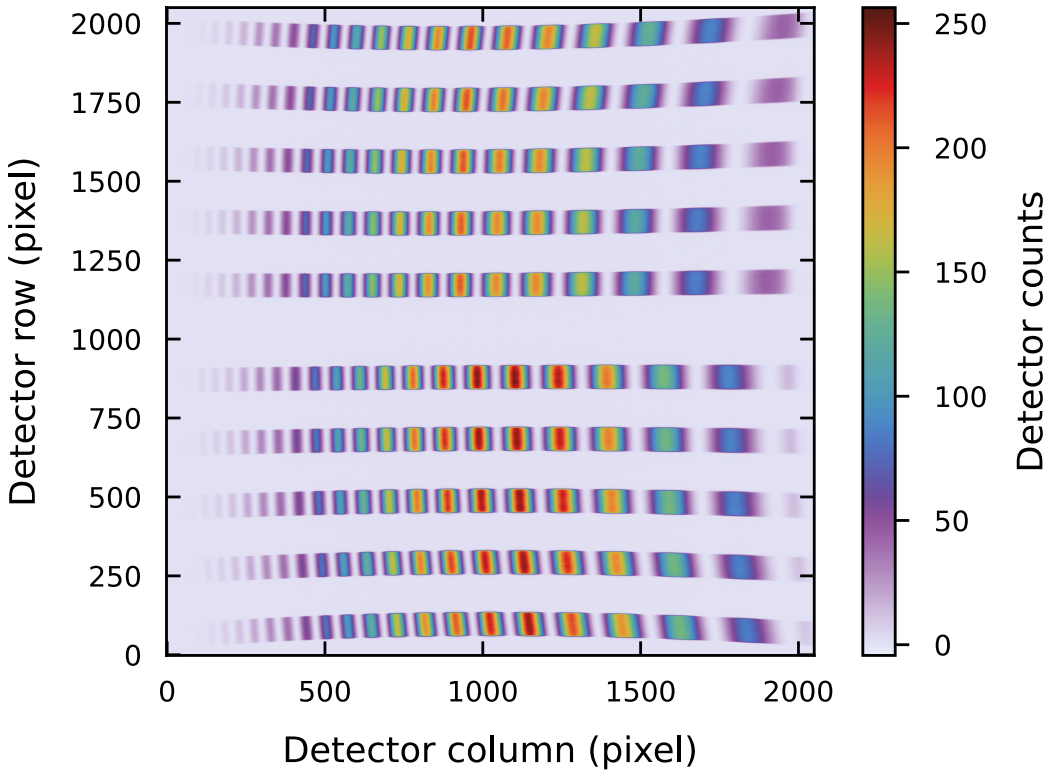
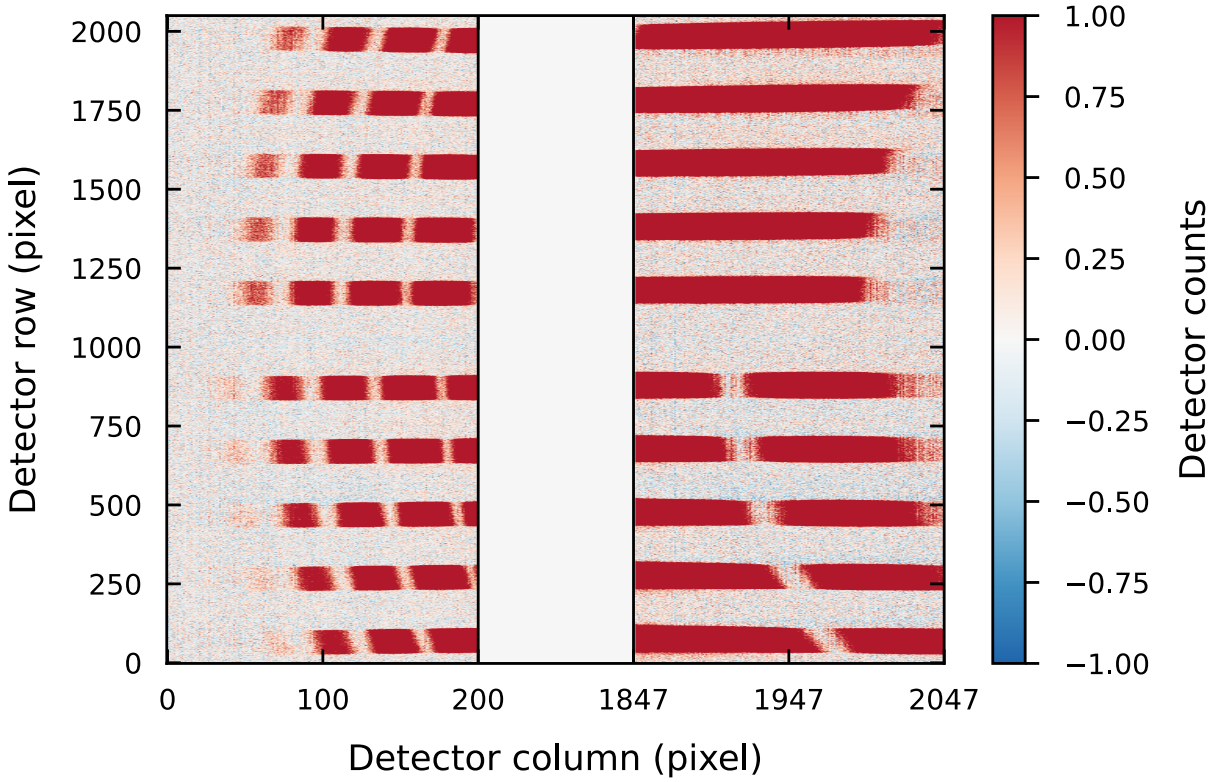
Signal dependent (offset) effects in the CMV4000





Signal dependent offset depends on:

- Total signal in row
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Solutions:

- perform per-row correction based on first few pixels
- use different detector setting in-flight

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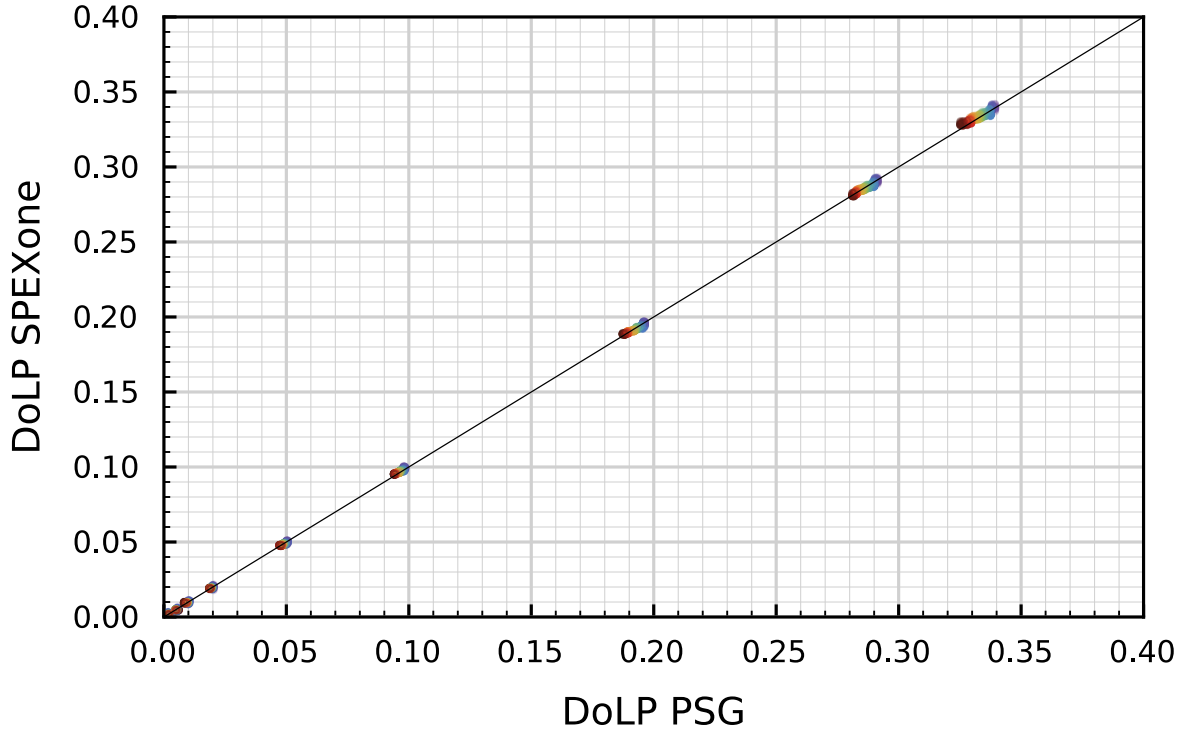
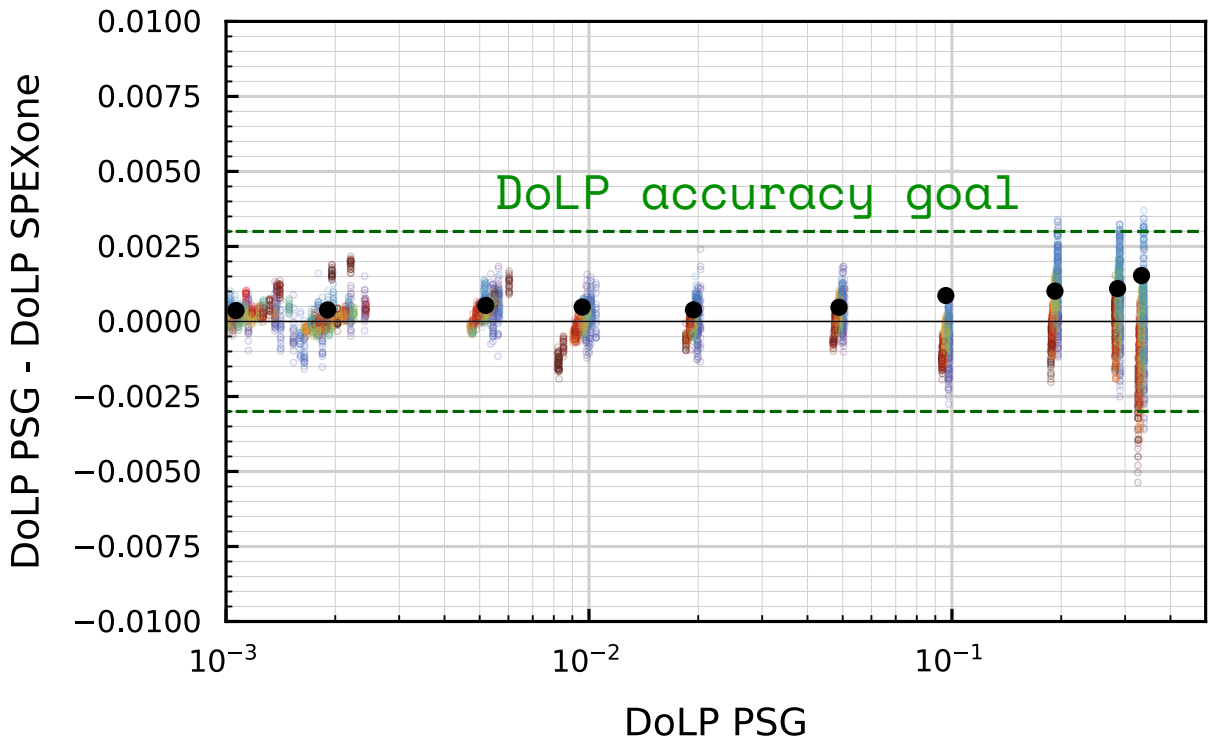
Polarimetric verification

+50 viewing angle (lowest impact of signal dependent effects)





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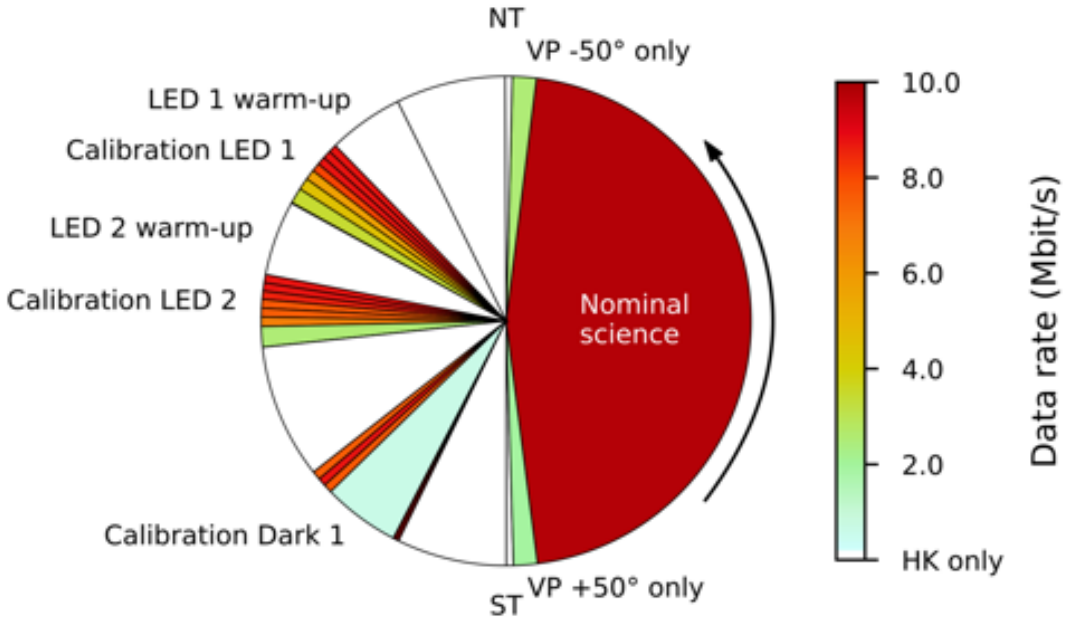
Content

In-flight monitoring approach – radiometric

- Instrument: no shutter, no on-board calibration source
- Absolute radiometry: instrument intercomparison ±20° views with OCI
- Relative radiometry: interangle comparison over bright clouds
- Polarimetric zero point (low DoLP):
  - Bright clouds under certain large scattering angle are (almost) unpolarized
- Polarimetric scaling (high DoLP):
  - Sun glint near Brewster's angle
- Spectral and spatial stability:
  - L1B & L1C science data
- Detector monitoring
  - Darks, LED's, deep space



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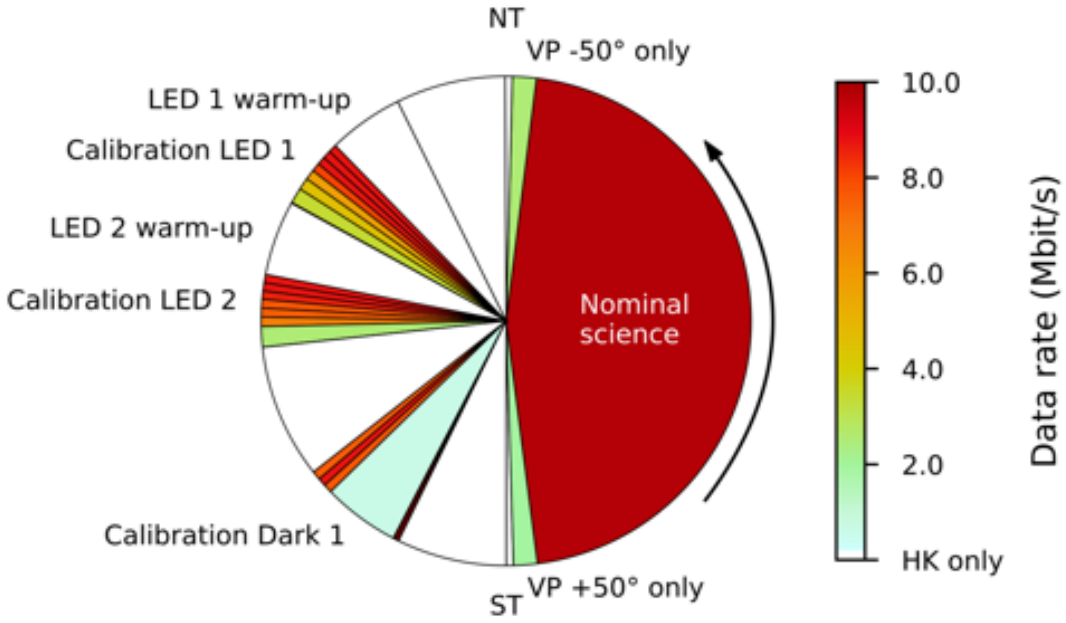
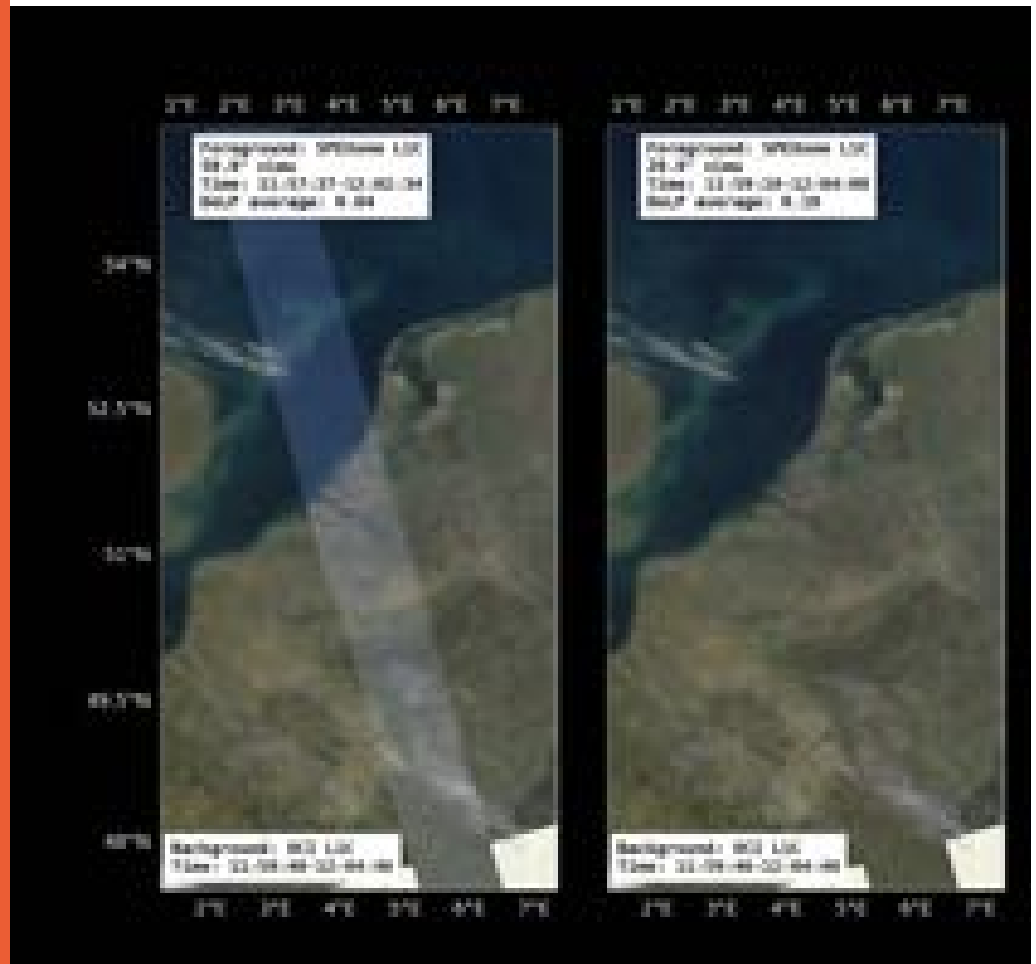
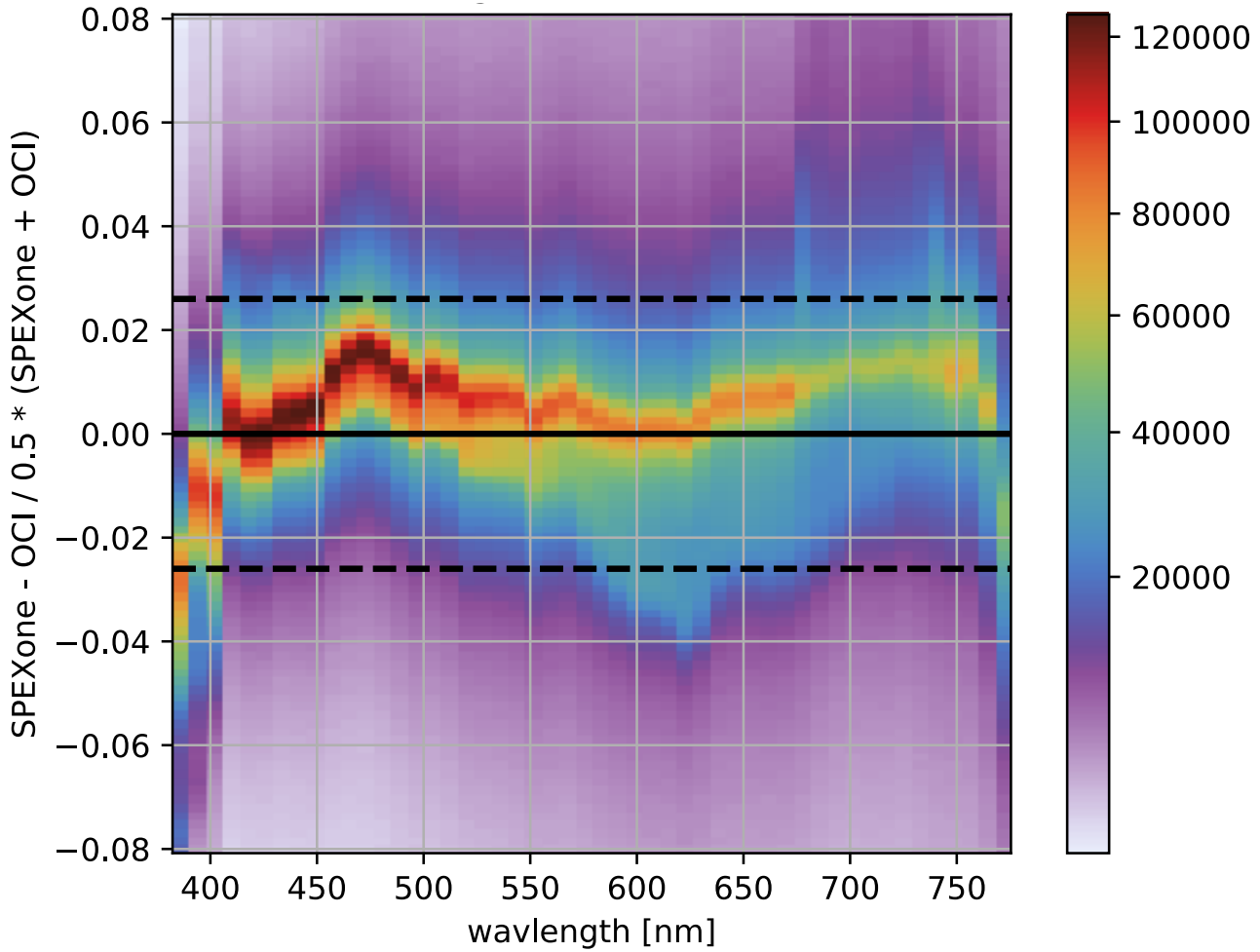


Radiometric monitoring

- Instrument intercomparison between ±20° OCI tilt angles, and ±20° SPEXone viewing angles.



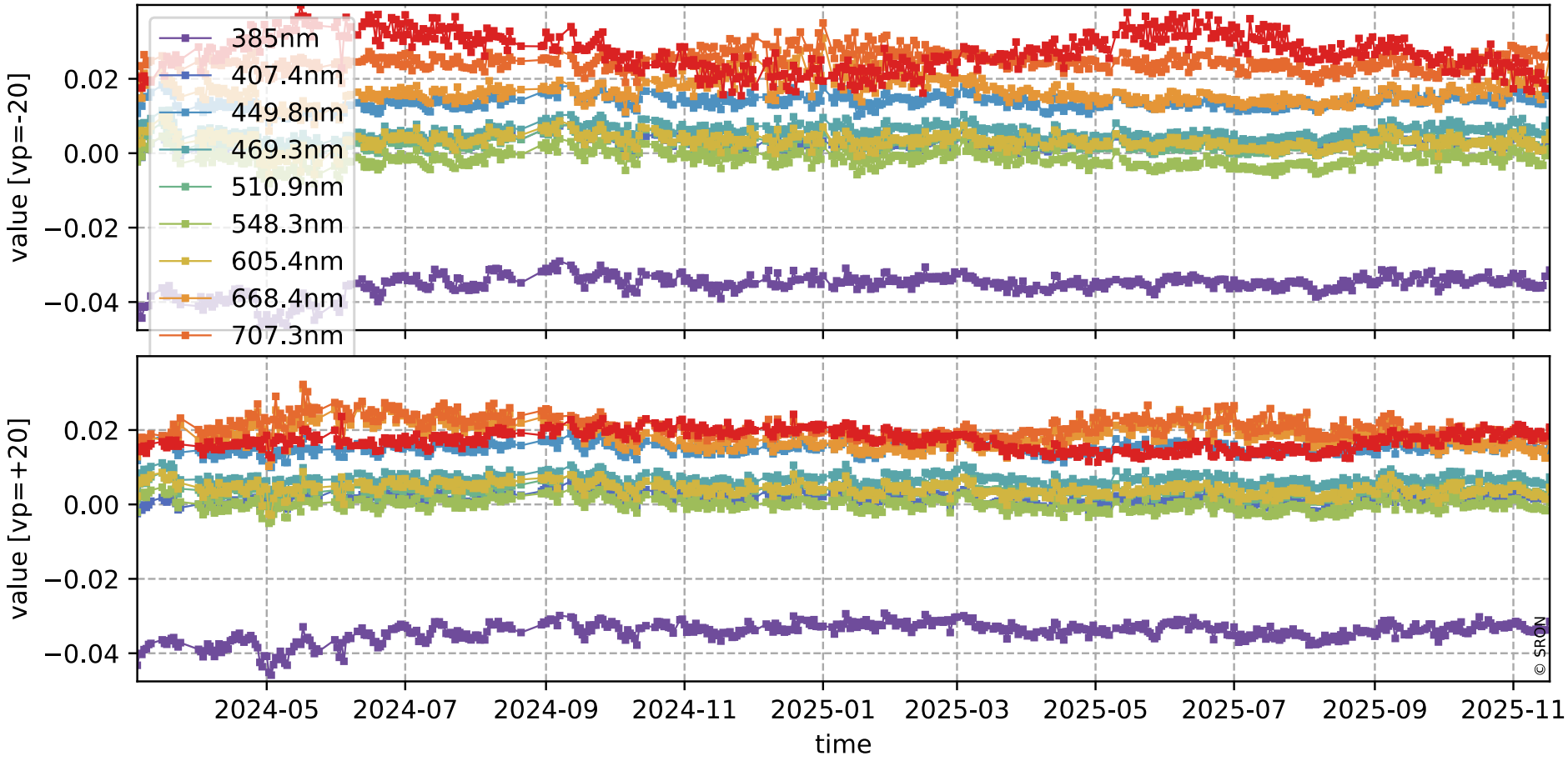


Radiometry trending

PACE SPEXone: radiometric inter-comparison

trend of radiance (SPEXone - OCI) / SPEXone

coverage: 2024-03-05 / 2025-11-18
all: [-180, -60, 180, 60]
I_{SPEX}: ×0.975
created: 2025-11-20T08:37:39Z



https://www.sron.nl/en/pillars/science/earth/spexone-monitoring/

Main conclusions and lessons learned

- Calibrate radiometry using at least 2 independenly absolutely calibrated NIST-traceable sources
- Spectral shape (& intensity) of sources is important:
  - Using different broadband spectral sources allows testing of data processing chain without potential error-compensation when test-scene is identical/similar to calibration scene
- Use combination of measurement settings
  - Flight-settings not always suitable for deriving CKD or instrument characterization
  - Flight-settings are essential for performance verification and L0–L1B processing
- Utilize TB/TV tests to gather additional (optical) instrument characterization data
- Ensure detector can be monitored and (partly) calibrated in-flight

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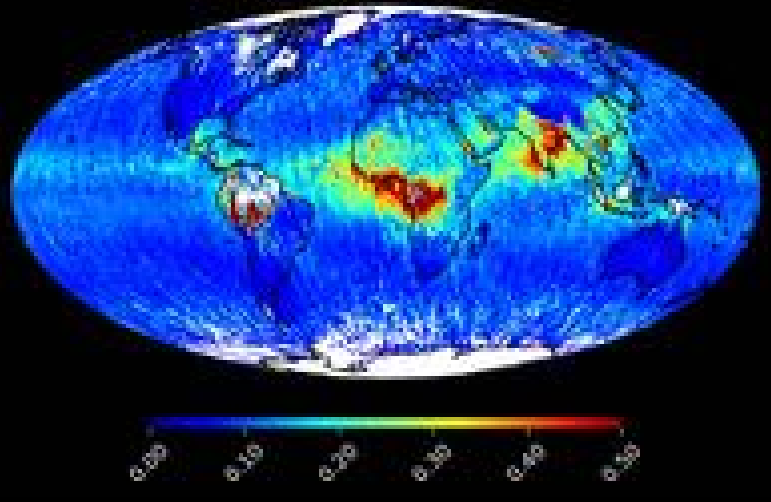
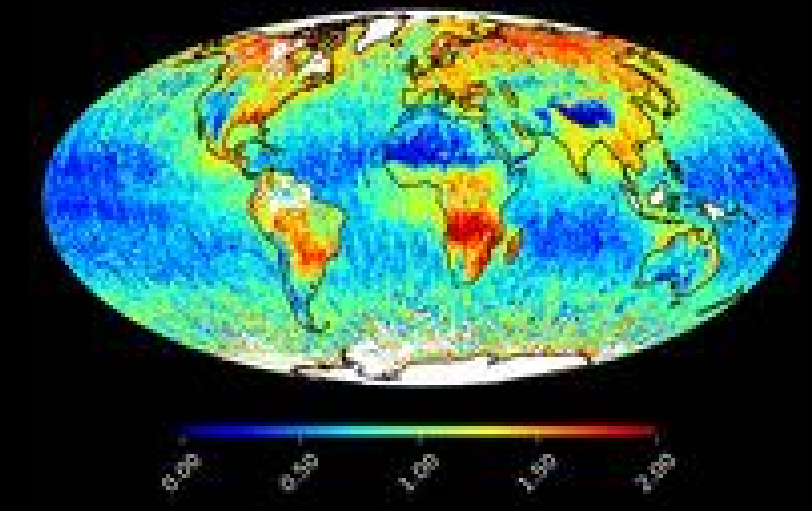
Annual Mean SPEXone aerosol data

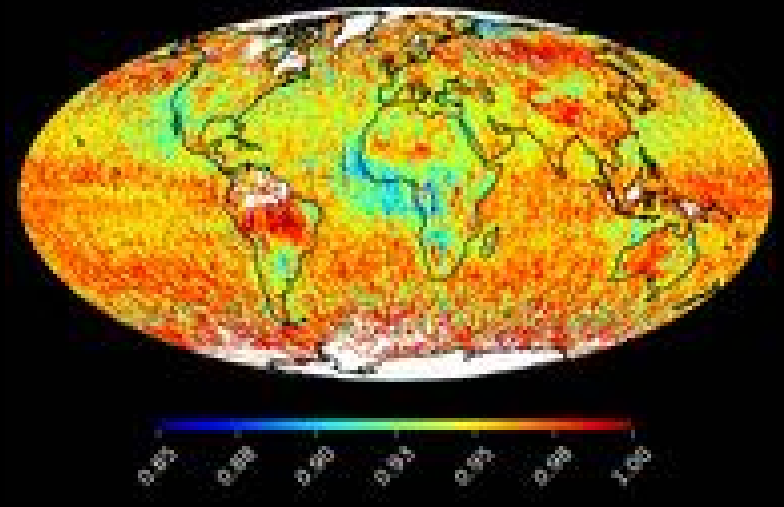
AOD



Angstrom Exponent



SSA



Acknowledgements

We would like to acknowledge project funding from the Netherlands Organization for Scientific Research (NWO) and the Netherlands Space Office (NSO) and the Ministry of Education Culture and Science (OCW).

We thank the NASA PACE team for advice and guidance. We thank all suppliers for their contribution to the project.

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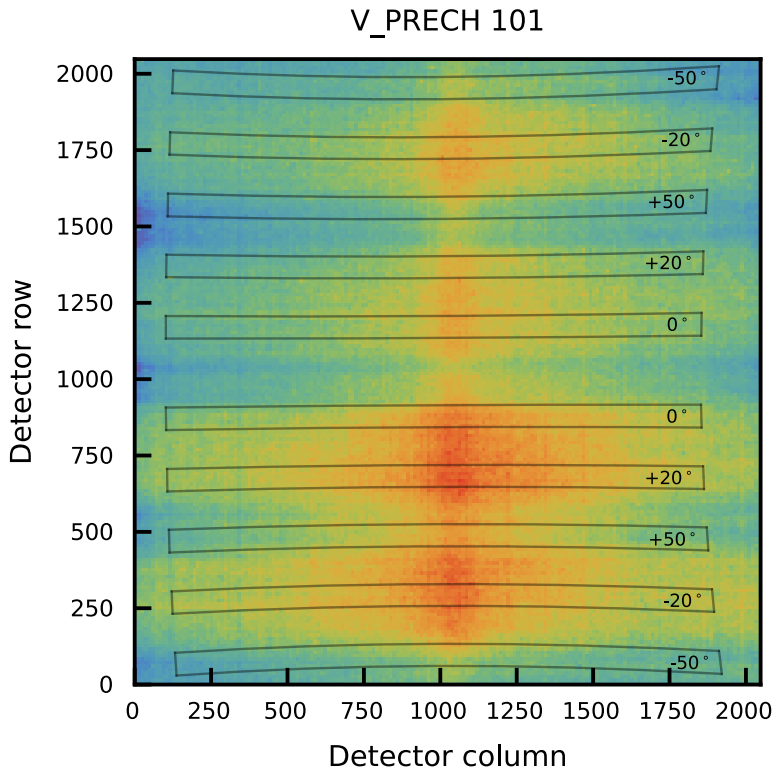
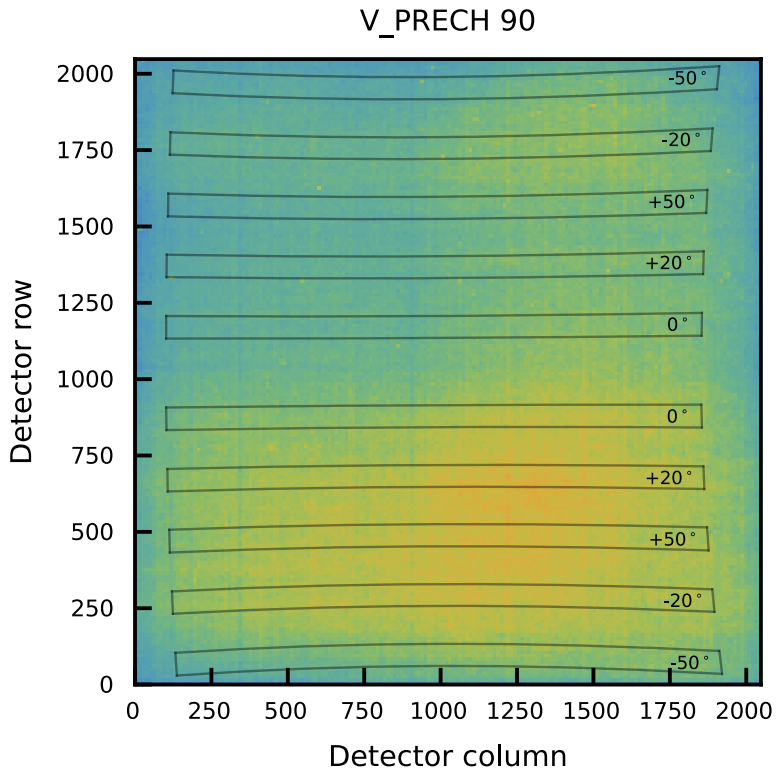
Additional slides

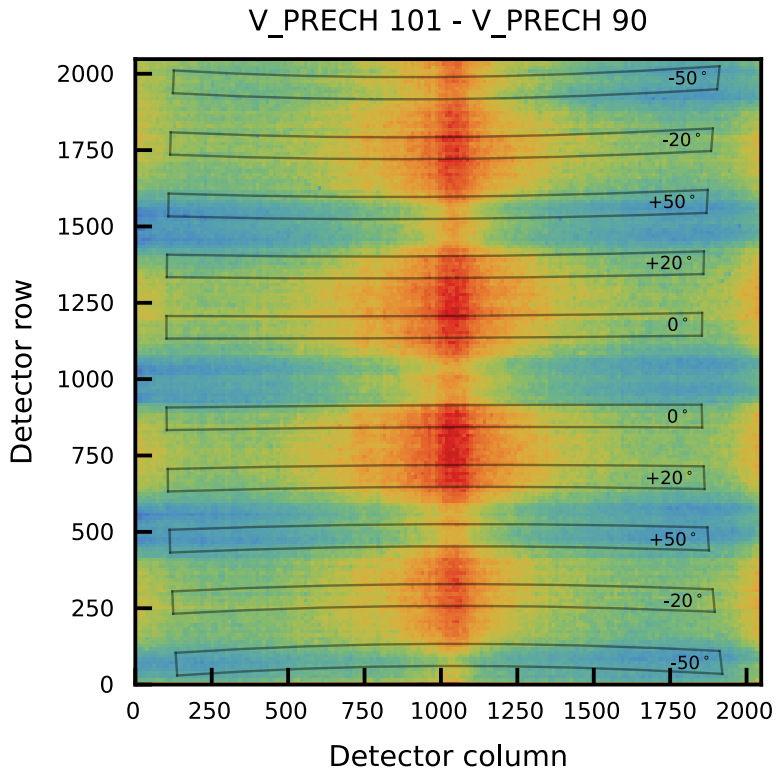
Detector non-linearity

Stray light

Signal dependent (offset) effects in the CMV4000







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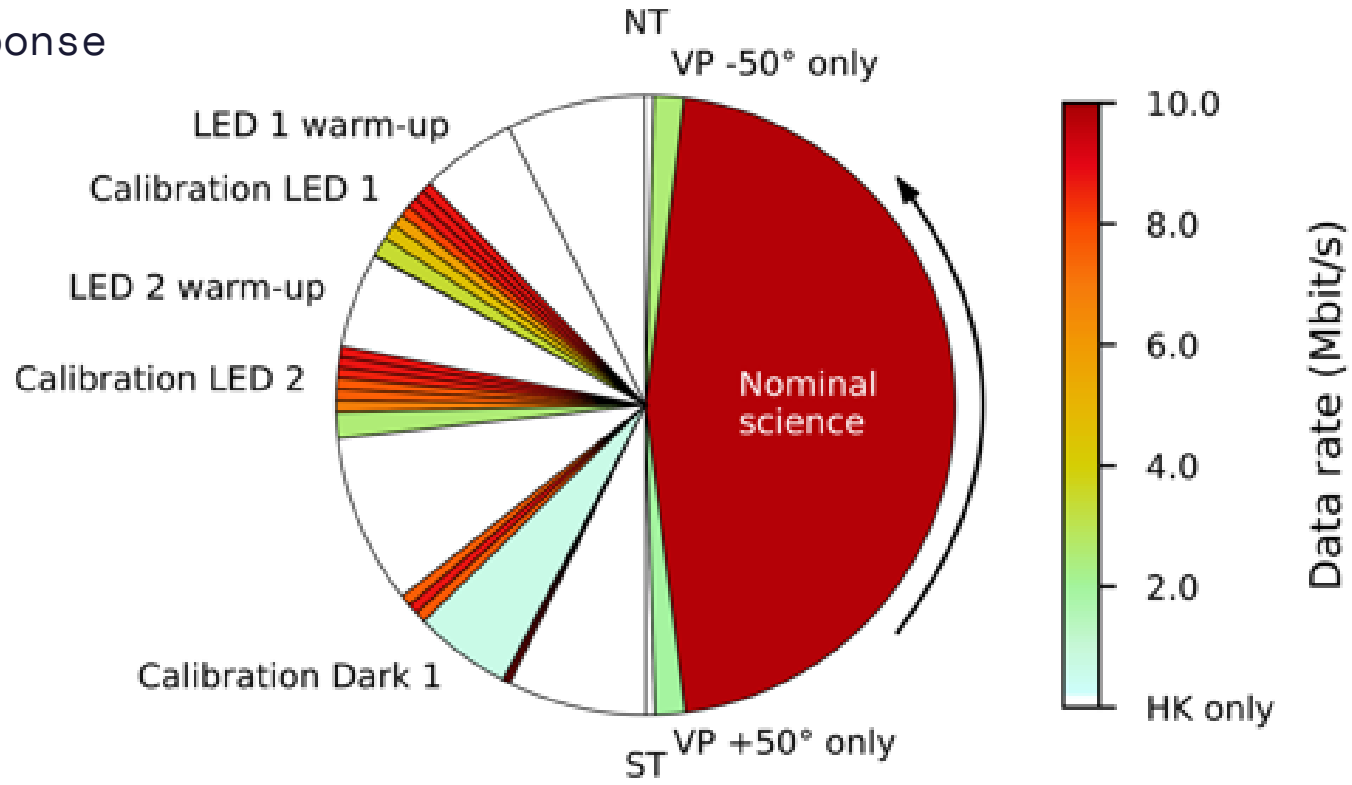
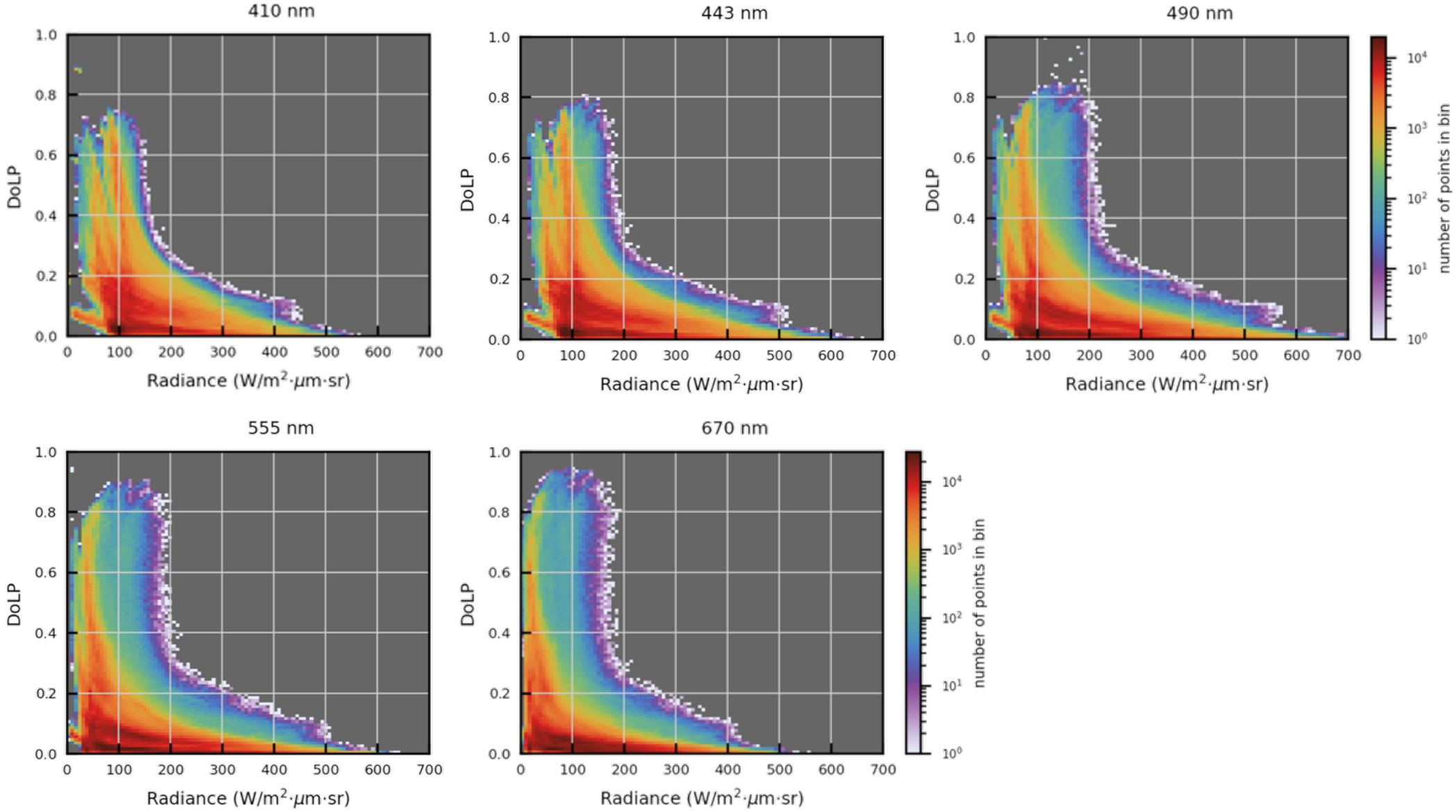
In-flight monitoring approach - detector

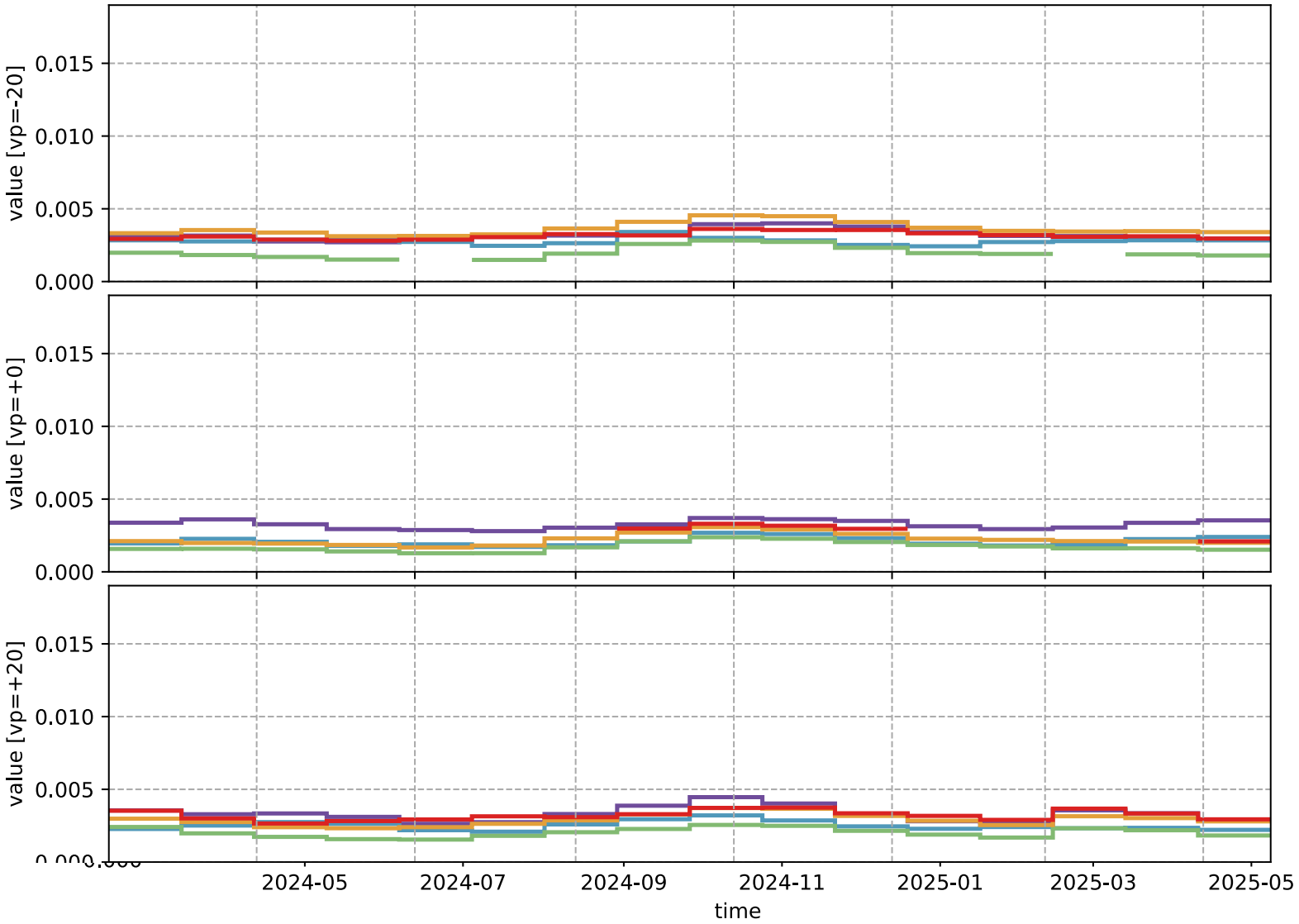
- Instrument: no shutter, no on-board calibration source
- Standard detector monitoring during eclipse
  - ‘Dark’ measurements
  - On-board LED’s for light response
  - Multiple integration times and LED light levels
- Deep space observations
  - During lunar cal maneuvre
  - Reference darks
  - Only 2-3 times per month



SPEXone observations



Polarimetric zero point monitoring using DCC



Algorithm

- Identify deep convective clouds (using OCI-data)
- Filter for scattering angle range
- Filter for 1% lowest DoLPs
- No trend visible → instrument is stable

- (does not currently work well for ±50deg viewing angle)

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