



TROPOMI

Pre-launch Activities TROPOMI

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DEFENCE & SPACE

TNO innovation
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SRON
Netherlands Institute for Space Research



Koninkrijk Nederlands
Meteorologisch Instituut
Ministerie van Infrastructuur en Milieu



Sentinel 5 precursor

COPERNICUS ATMOSPHERE MISSION IN POLAR ORBIT

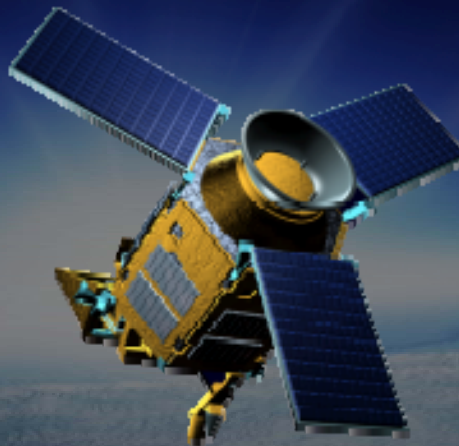


- The ESA Sentinel-5 Precursor (S-5P) is a pre-operational mission focussing on global observations of the atmospheric composition for air quality and climate.
- The TROPospheric Monitoring Instrument (**TROPOMI**) is the payload of the S-5P mission and is jointly developed by The Netherlands and ESA.
- The planned launch date for S-5P is 2016 with a 7 year design lifetime.



TROPOMI

- ▶ UV-VIS-NIR-SWIR nadir view grating spectrometer.
- ▶ Spectral range: 270-500, 675-775, 2305-2385 nm
- ▶ Spectral Resolution: 0.25-1.1 nm
- ▶ Spatial Resolution: 7x7km²
- ▶ Global daily coverage at 13:30 local solar time.



Contribution to Copernicus

- ▶ Total column
O₃, NO₂, CO, SO₂, CH₄, CH₂O, H₂O, BrO
- ▶ Tropospheric column
O₃, NO₂
- ▶ O₃ profile
- ▶ Aerosol absorbing index & layer height

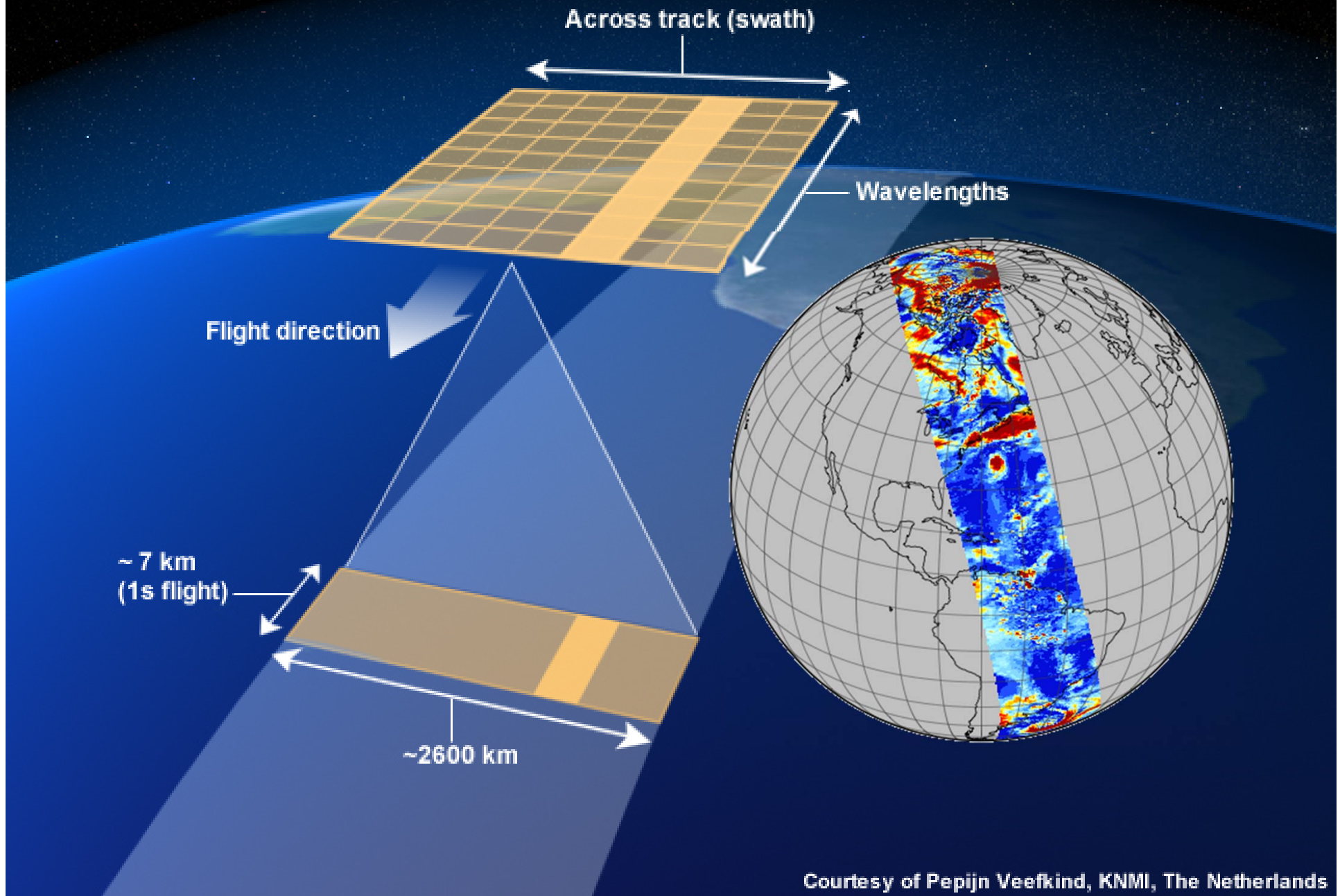
TROPOMI in the CEOS AQ Constellation



- Covering the spatial regions that are not covered by the GEO's
- Add products, e.g. CO, CH₄, Aerosol layer height, aerosol profile.
- Act as a “travelling standard” between the GEOs

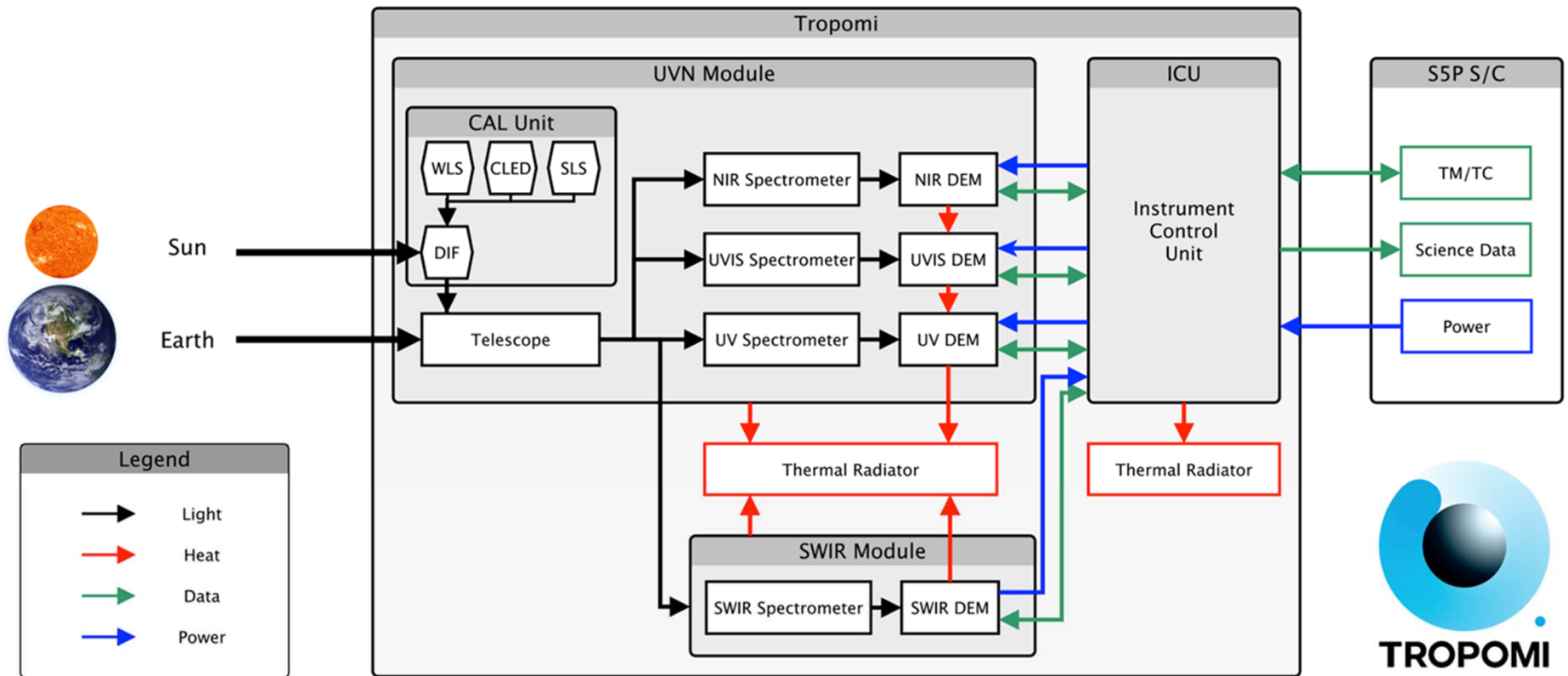
- Instrument
- Level 0-1B Development
- On-ground Calibration

The TROPOMI Measurement Principle



Courtesy of Pepijn Veeffkind, KNMI, The Netherlands

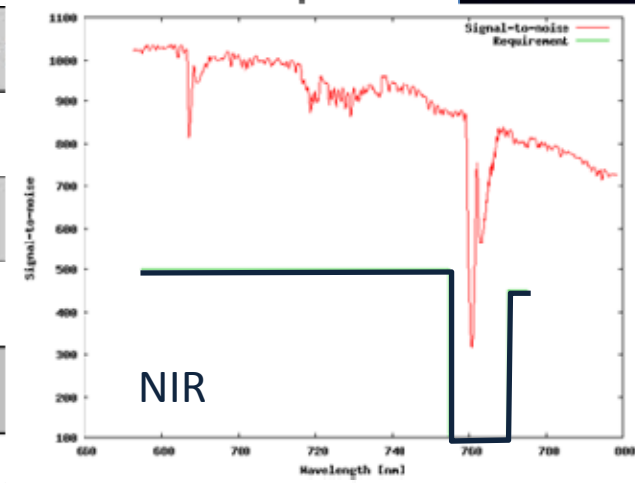
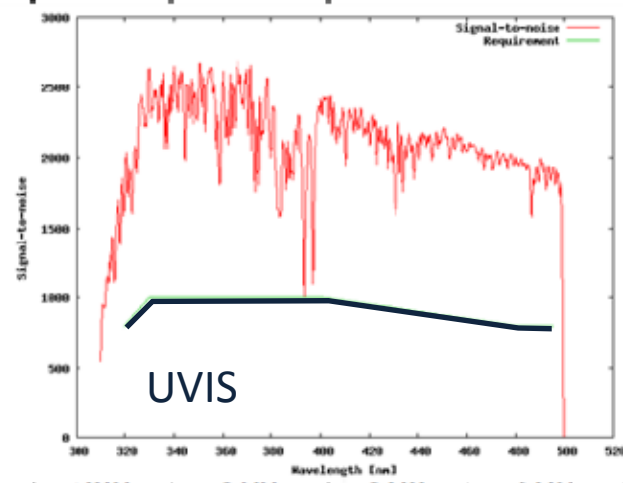
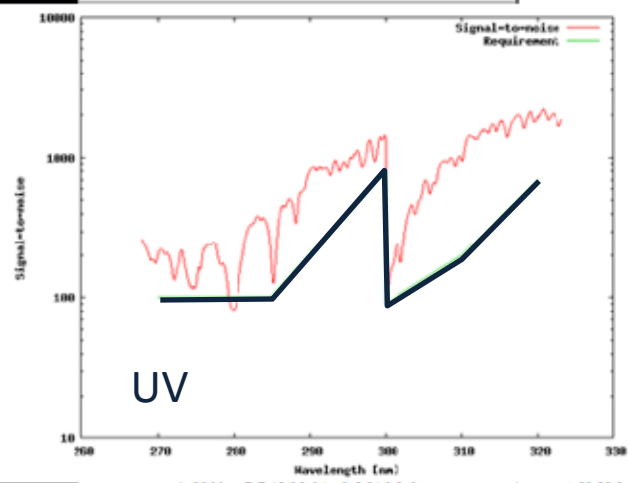
Functional Diagram



Performance Overview

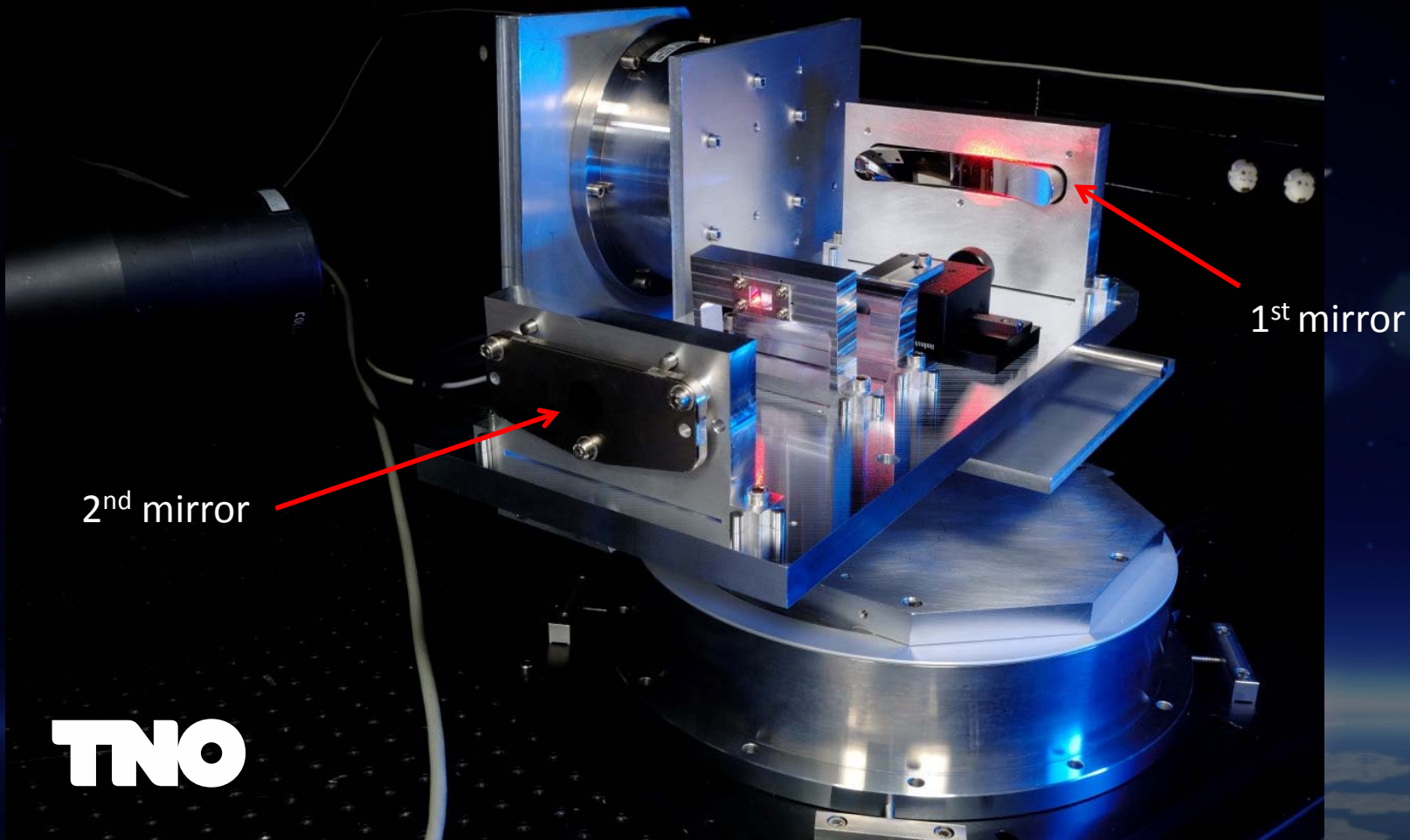


Spectrometer	UV		UVIS		NIR	SWIR		
Band ID	1	2	3	4	5	6	7	8



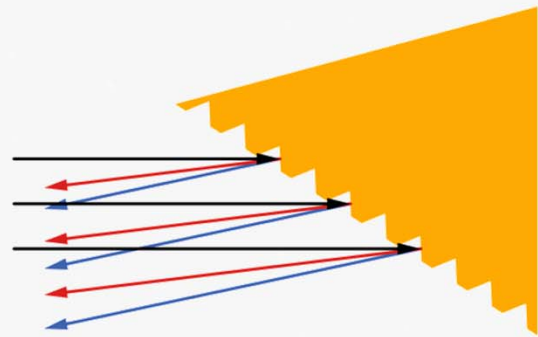
Spectral magnification	0.327	0.319	0.231	0.231	0.263	0.263	TBD	TBD
Spatial Sampling at nadir [km ²]	28x7	7x7	7x7		7x7	3.5x7	7x7	
Required Signal-to-noise	100-800 ^{2,3}	90-700 ²	800-1000 ²		100-500 ^{2,4}		100-120 ⁵	

Telescope

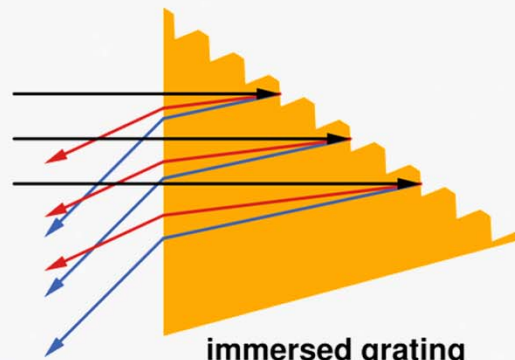


TNO

SWIR Immersed Grating

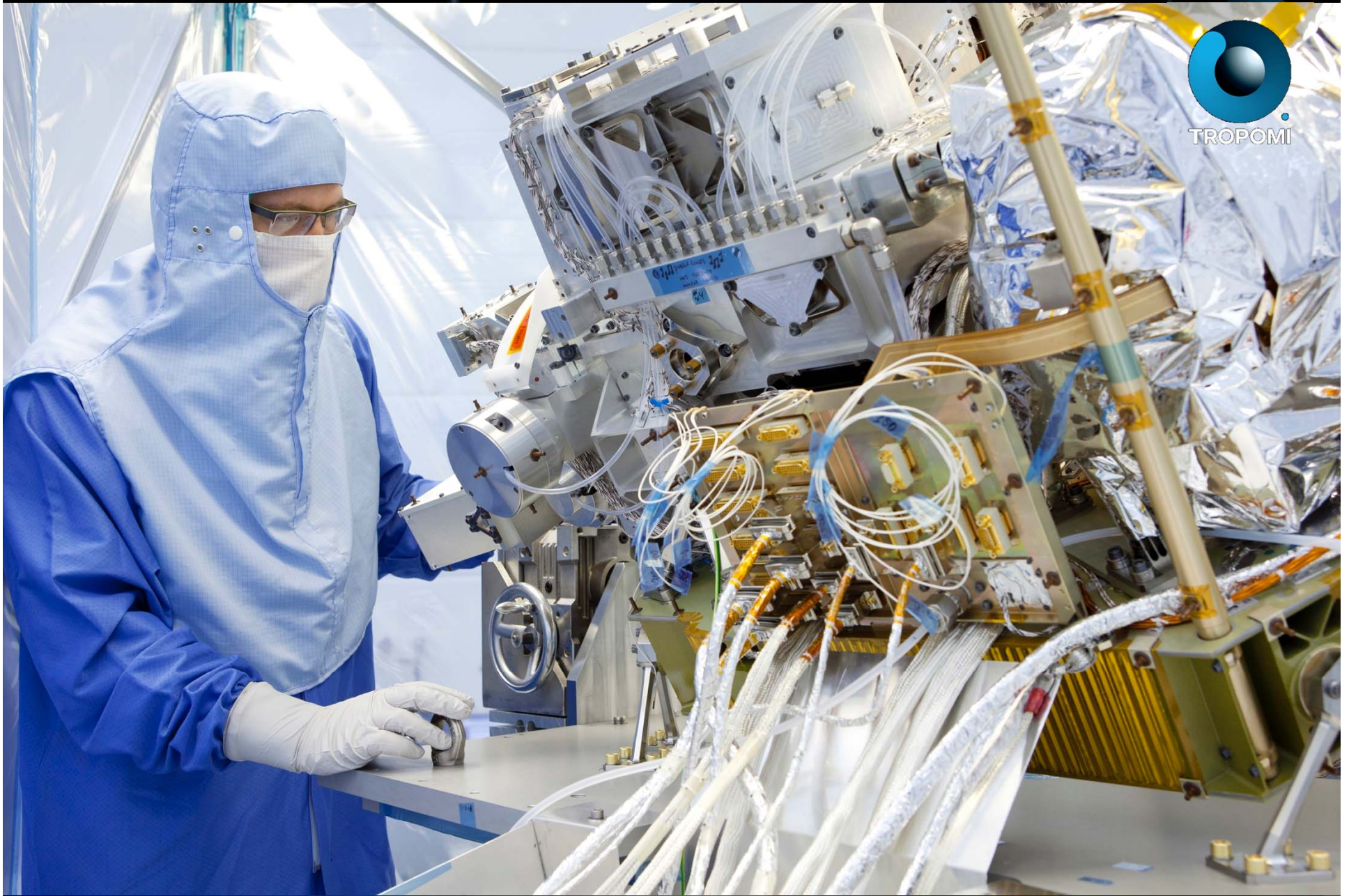


normal grating



immersed grating

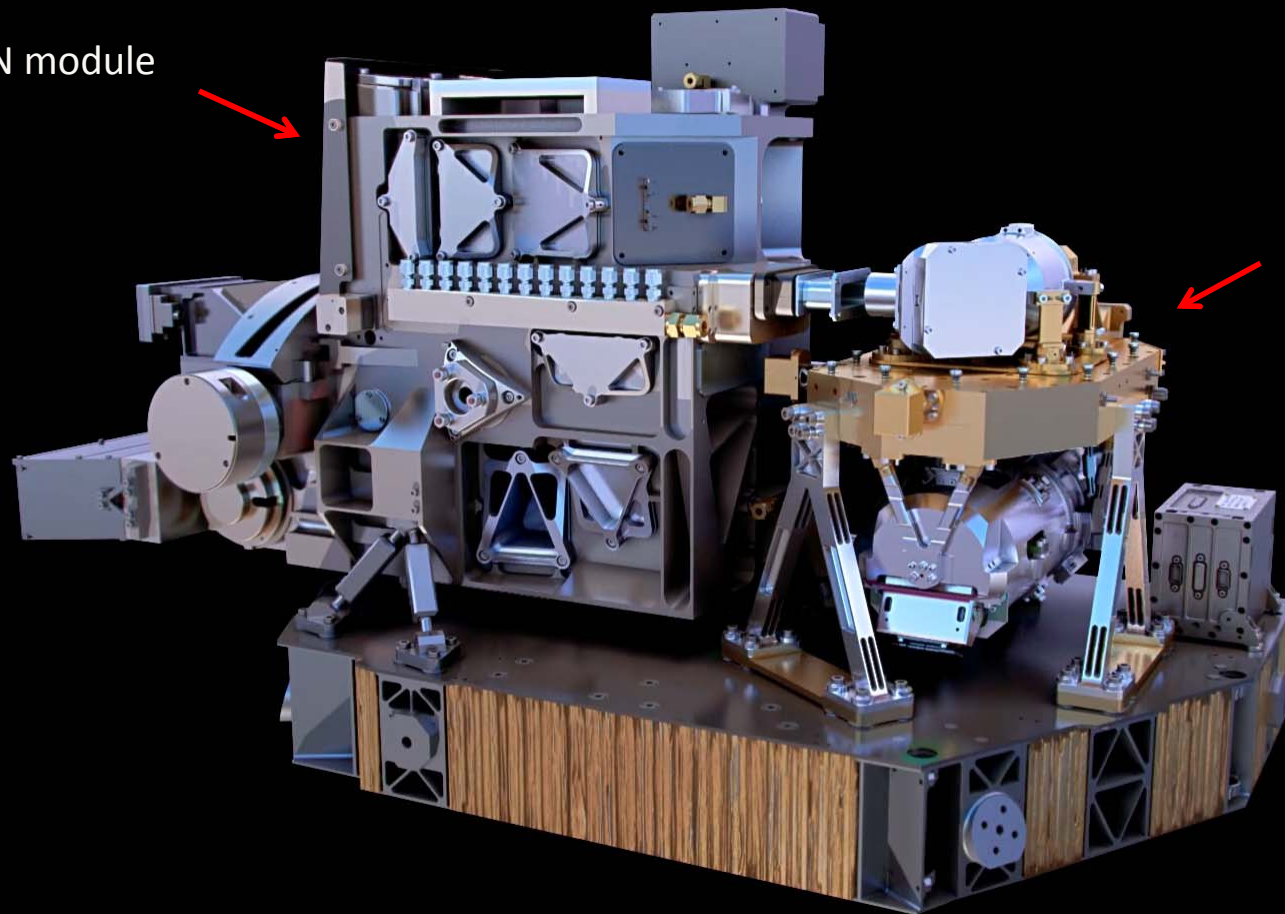




UVN module

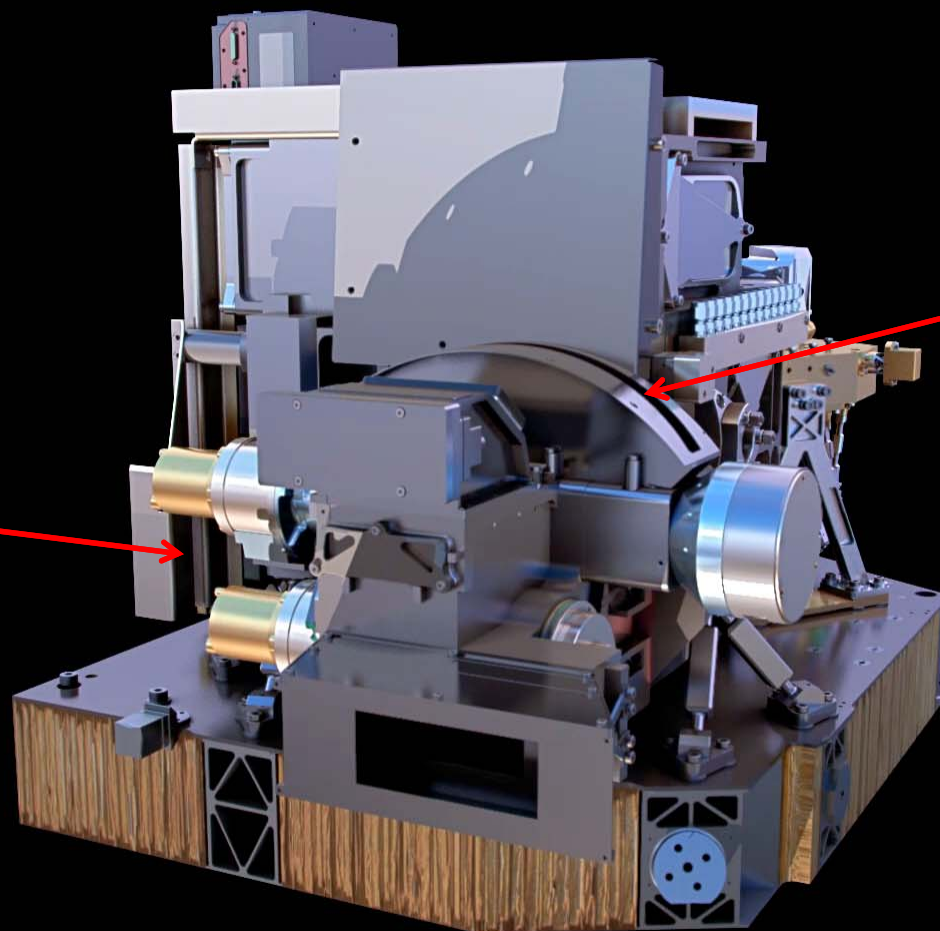


SWIR module

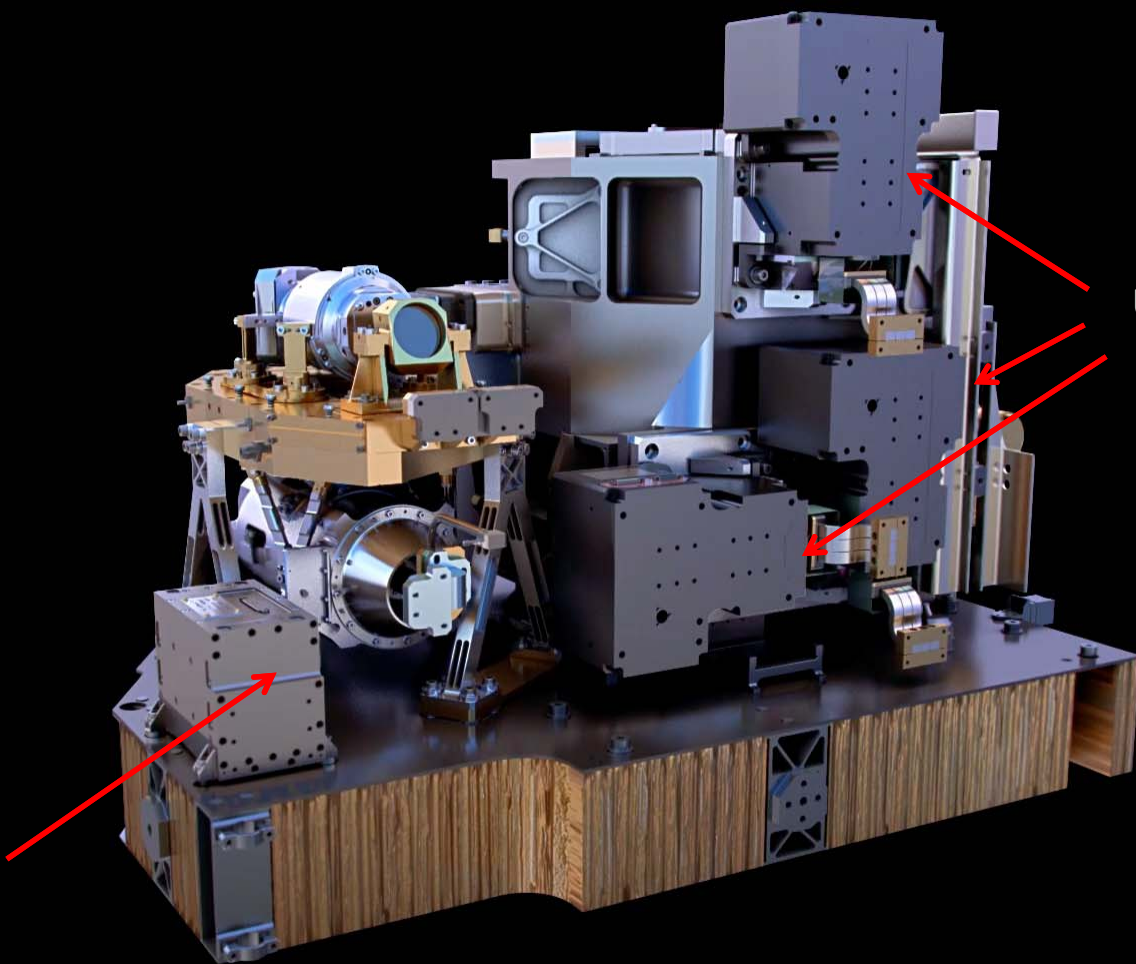


CAL unit

Telescope



SWIR DEM

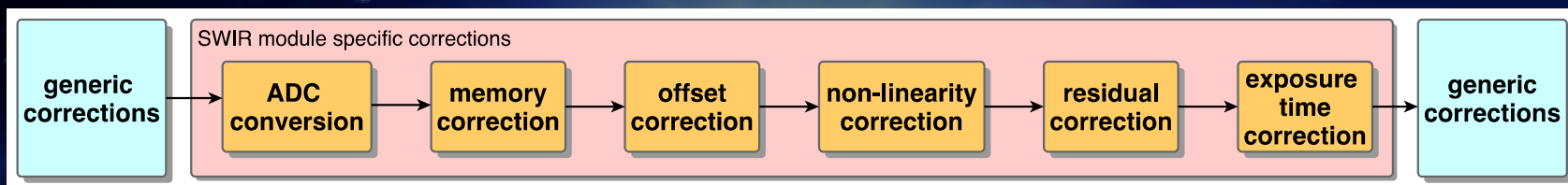
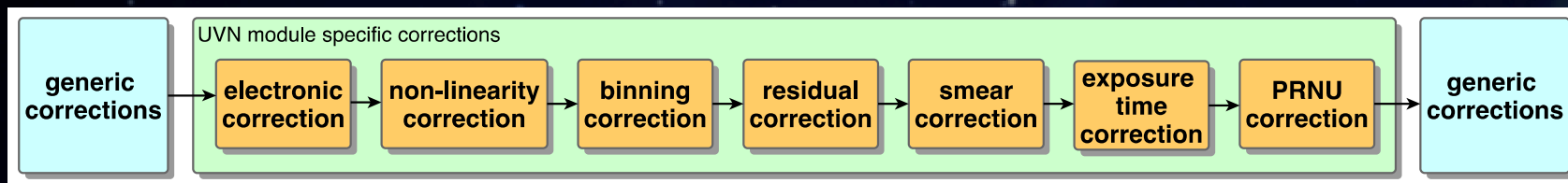
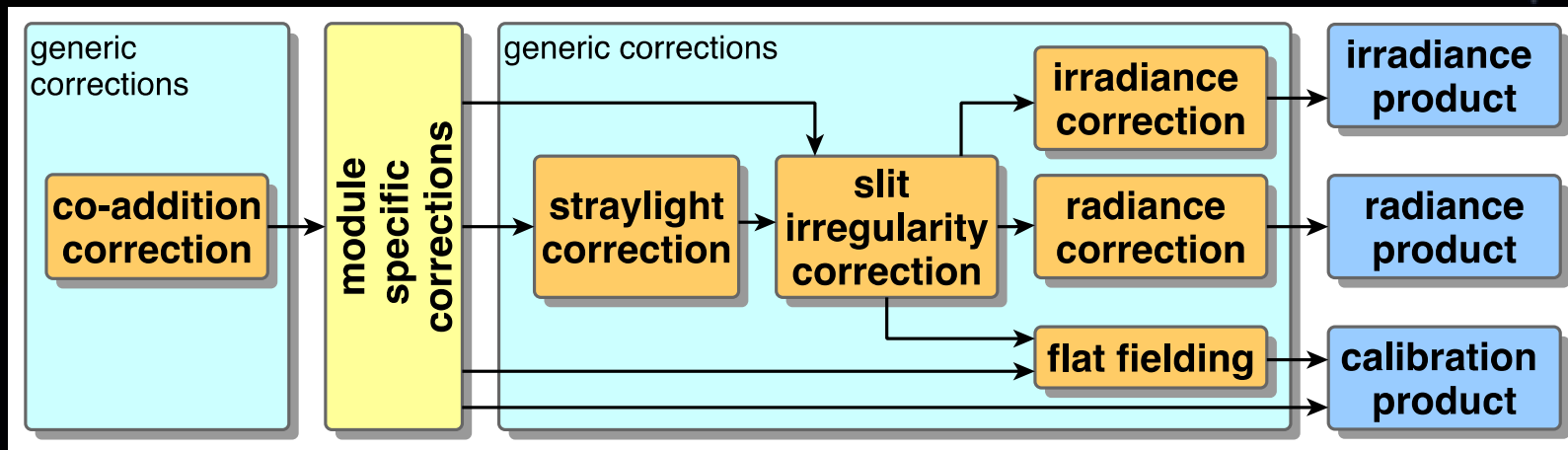


UVN DEMs

Level 0-1B Processor



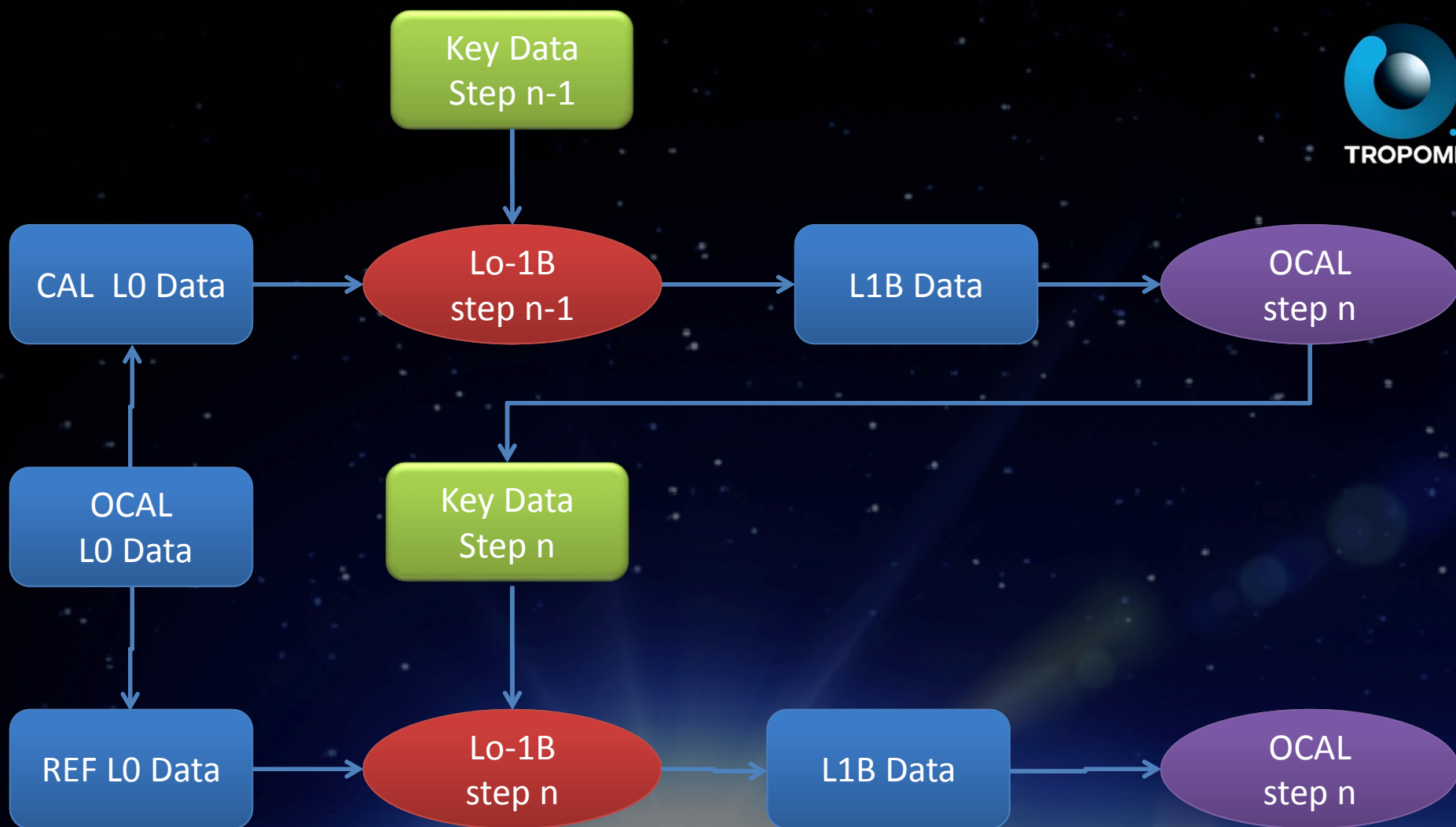
- Multi-threading
- Multi-pass
- Algorithms are pluggable at run-time
- Full error propagation (noise + systematic errors)
- L1B product ~25 Gbyte / 100 min
- S/W design can be re-used



On-ground Calibration



- All measurements done in vacuum.
- Automated processing system for quick-look and key data analysis, using L0-1B processor.
- Calibration period of 125 days of continuous measurements.
- Strong involvement of KNMI/SRON:
 - On-site science support team
 - Data analysis team

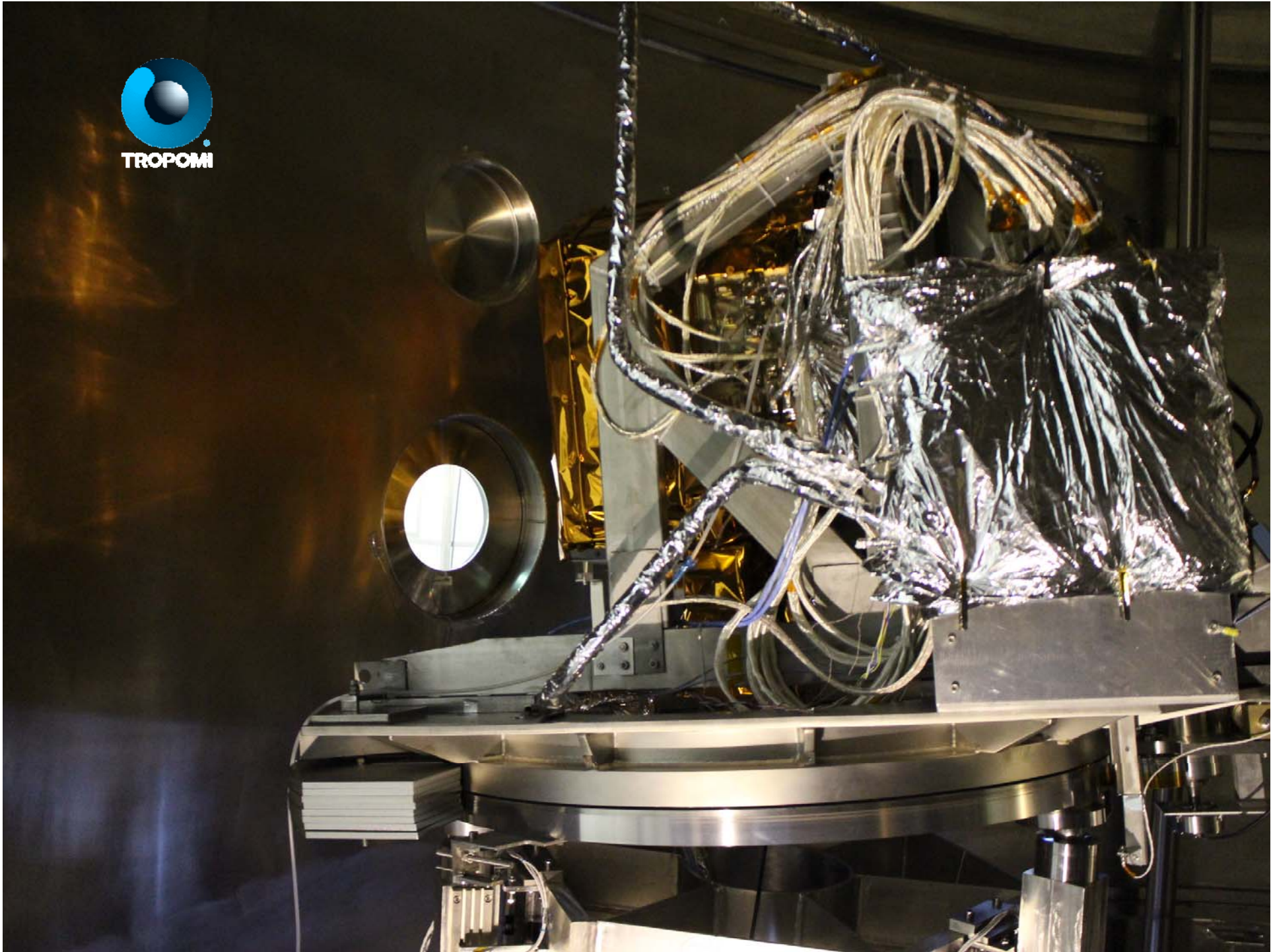


Optical Stimulus	Calibration Key Data
Star stimulus	Geolocation
Lasers (UVN/SWIR)	ISRF, Stray light
Echelle grating stimulus	UVN ISRF
Spectral filters	Stray light
Spectral Line Lamps	Spectral calibration
FEL lamp + diffuser	Absolute radiometric calibration
Black bodies	Absolute radiometric calibration
Integrating Sphere	Relative radiometry, BSDF
Sun simulator	Relative radiometry, BSDF
Internal LEDs	Detector parameters
Internal WLS	Relative radiometry
Internal laser diodes	ISRF

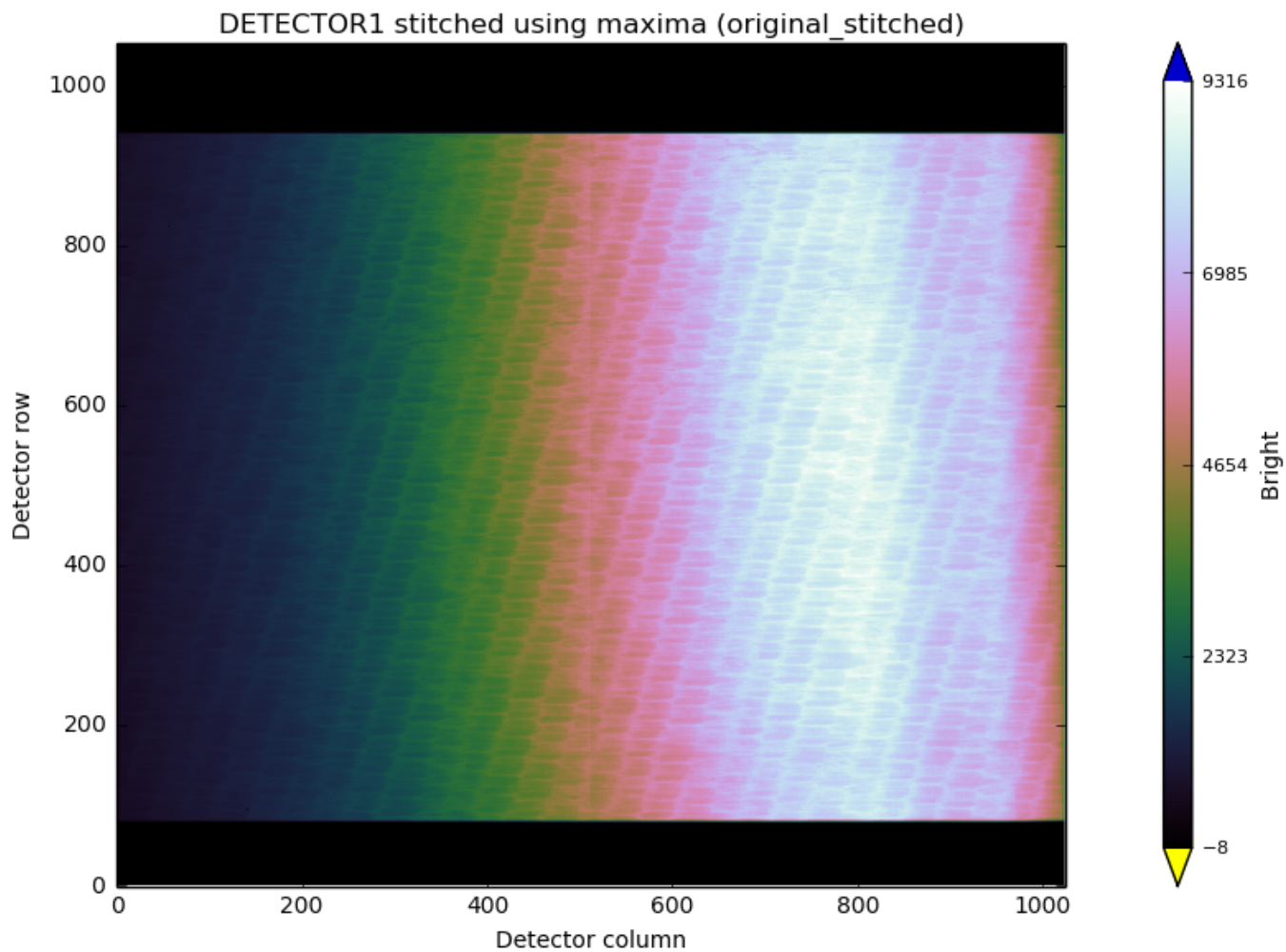






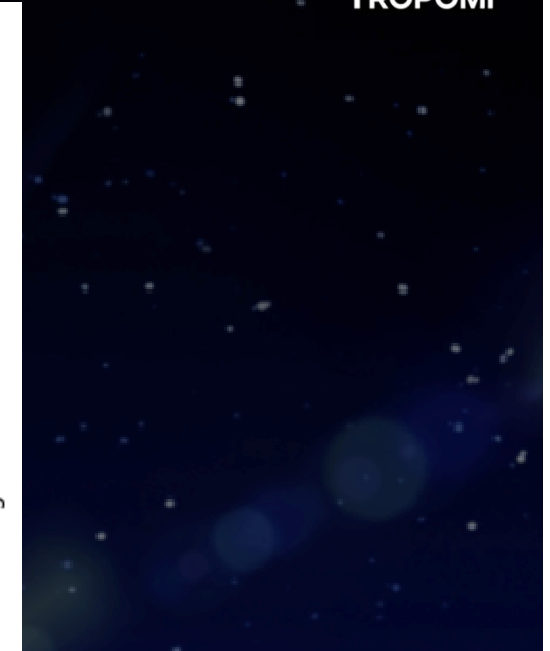
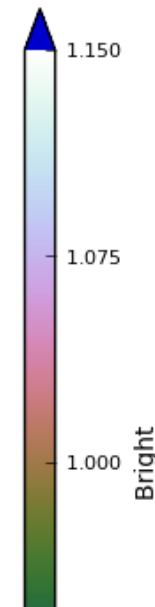
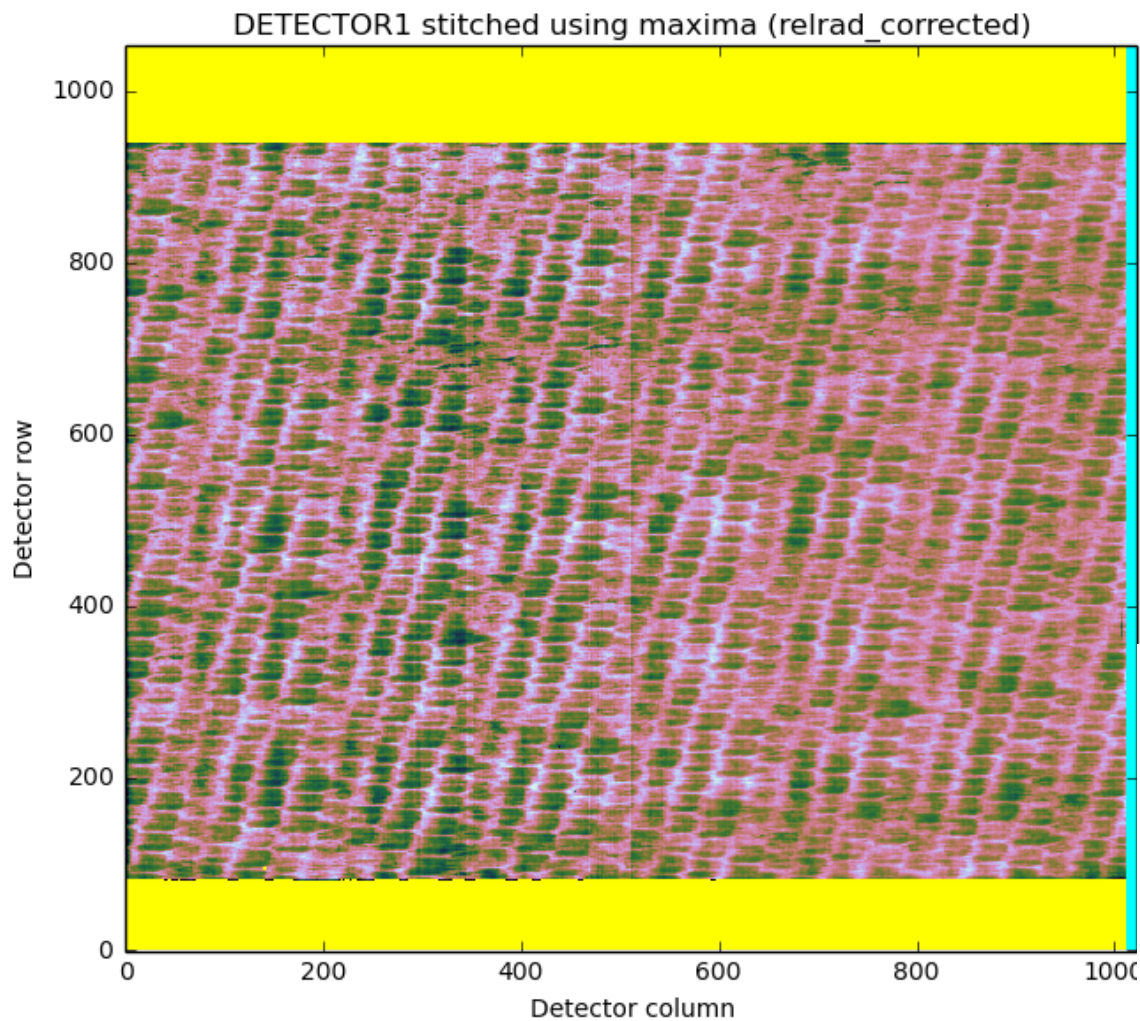


Pixel Response Non-Uniformity

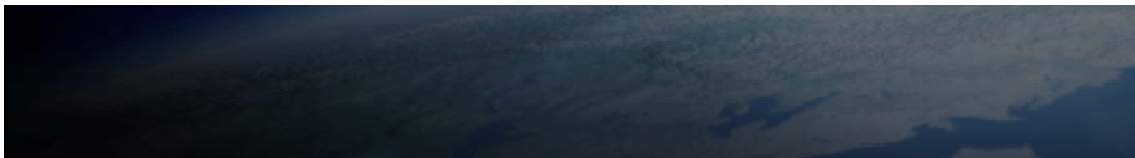
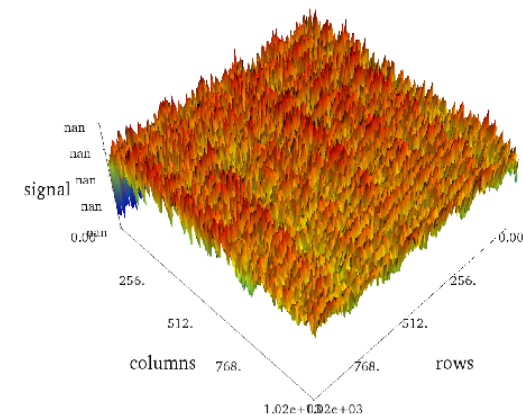


- The integrating sphere is used in a series of measurements scanning the swath angle is steps of 1 degree with a field of 4 degrees.

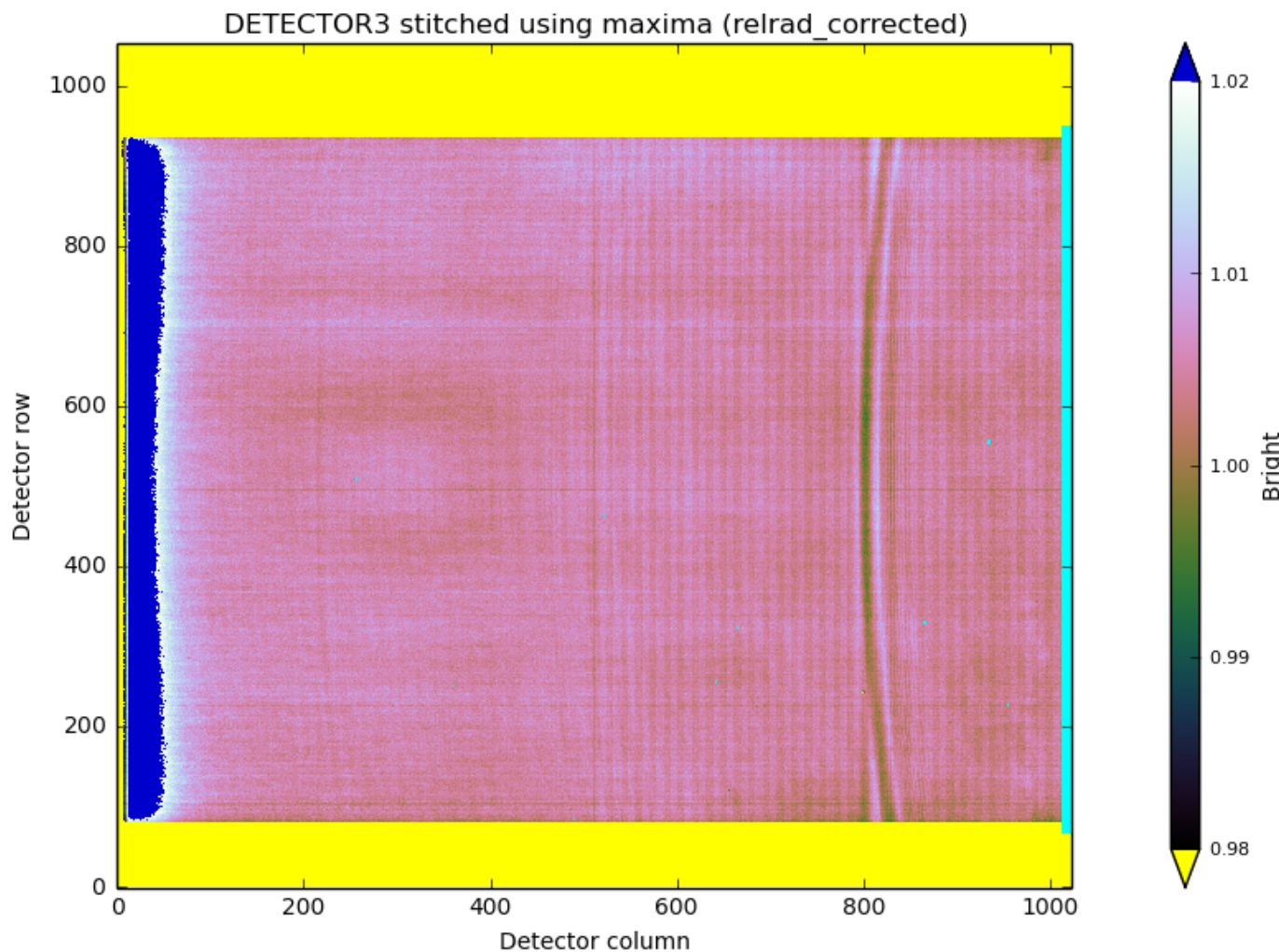
Pixel Response Non-Uniformity UV



relrad_corrected (detector 1)

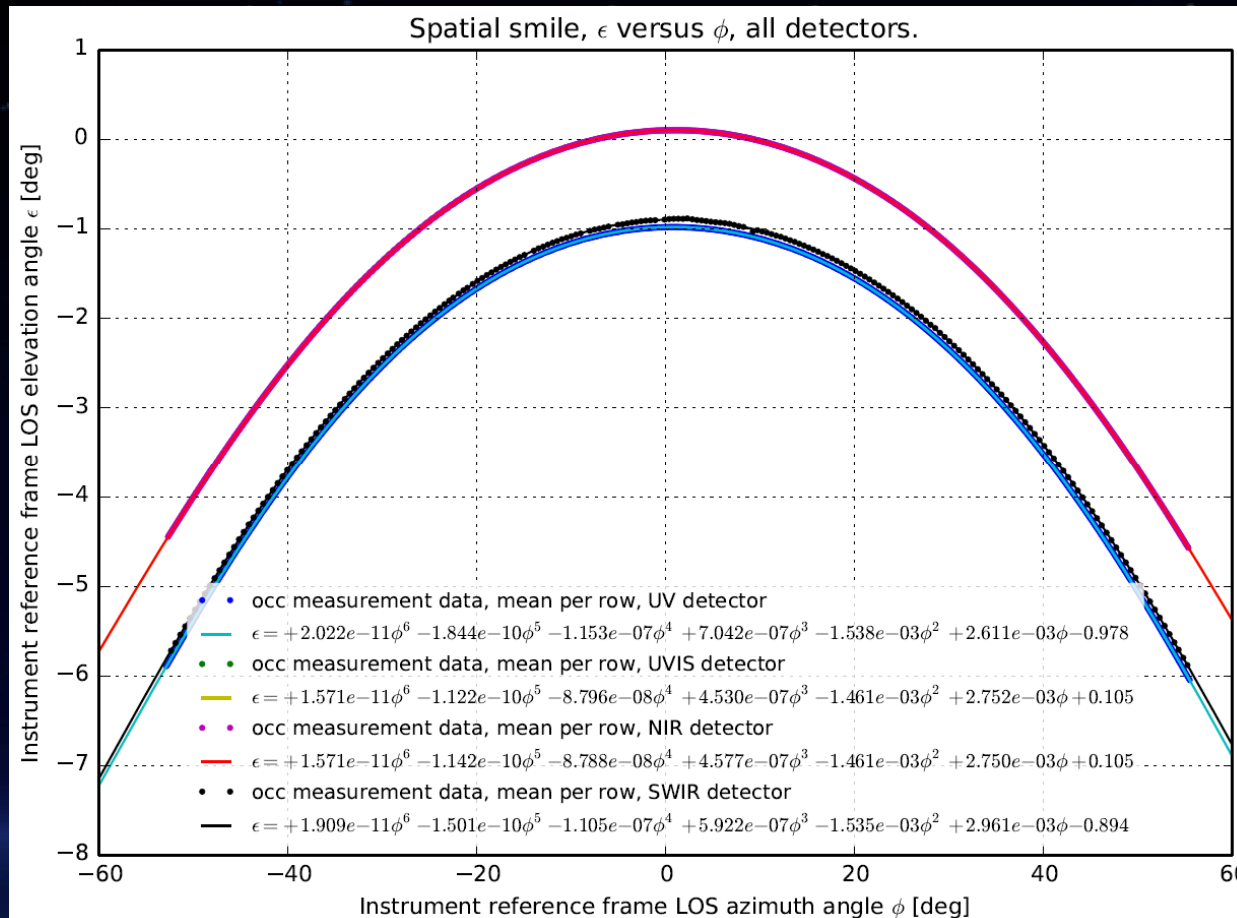


Pixel Response Non-Uniformity NIR



- At detector 3 the vertical line around column 800 (~760 nm) is caused by the absorption by oxygen in between the lightsource and the detector (~1m)

Geolocation LOS Analysis

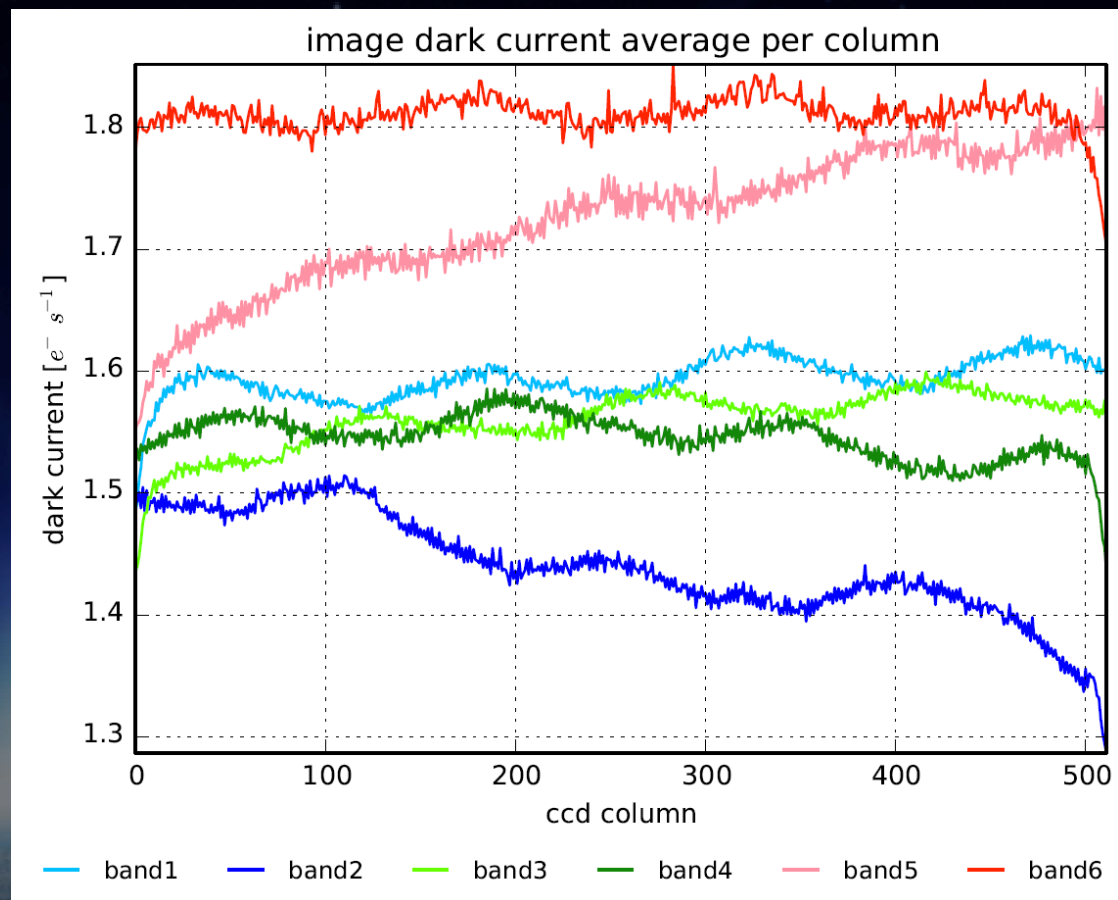


Dark Current Results



Dark currents in Bands 1-6 lower than 2 e/s

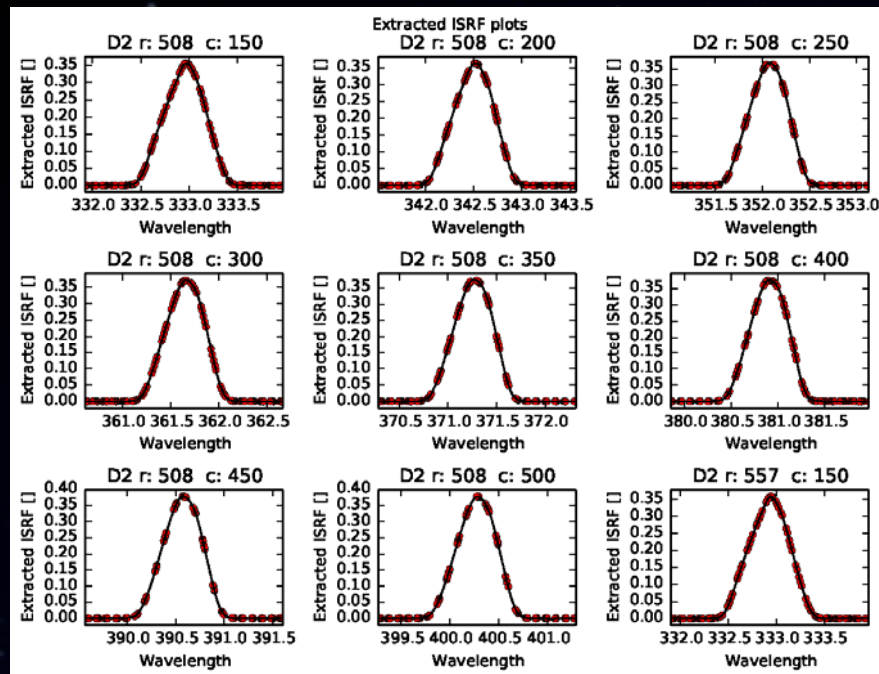
band	dc e/s
1	1.622
2	1.477
3	1.593
4	1.579
5	1.759
6	1.849



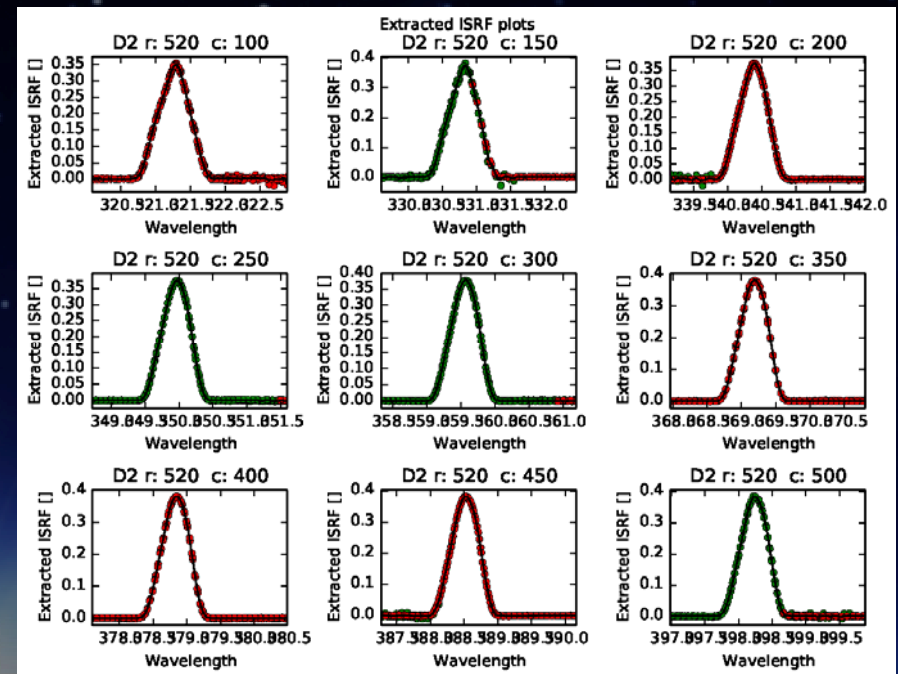
Instrument Spectral Response Function



Laser



SFS



Note: laser and ISRF plots can have different x-scale

Summary & Outlook



- TROPOMI will be a major step forward for atmospheric composition observations due to improved spatial resolution & sensitivity.
- TROPOMI will address important societal challenges: air quality, climate change, ozone layer.
- The on-ground calibration is in its final stage.
- We are counting down for a launch in 2016!

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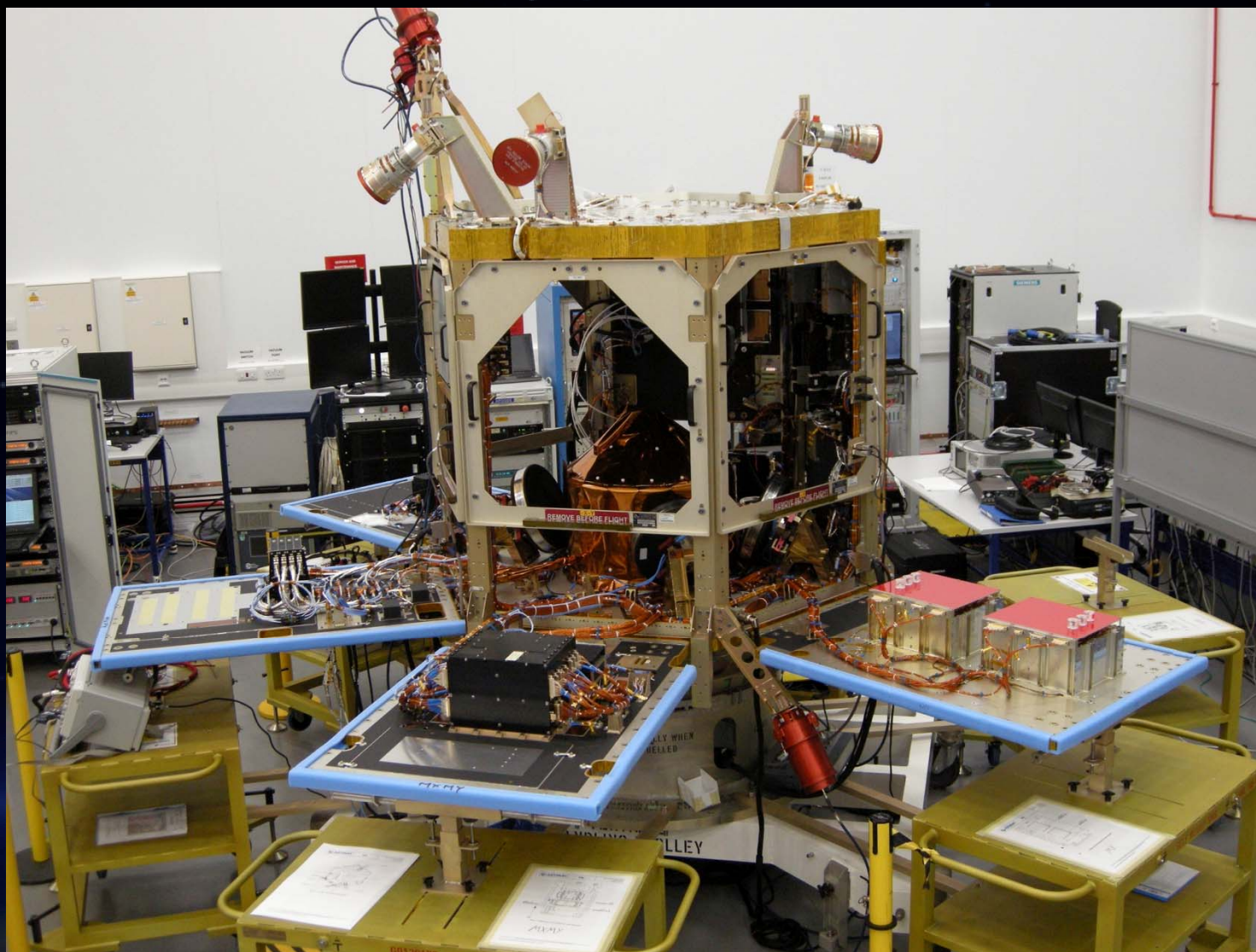
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What's next:



Spectral Coverage

