
TROPOMI

TROPOMI SWIR on ground calibration

All results by Paul Tol, Richard van Hees, Matthijs Krijger, support Ralph Snel & OCAL Science Support team (KNMI) & Industrial Team (aDSnl, CSL, VSL)

Presented by Matthijs Krijger

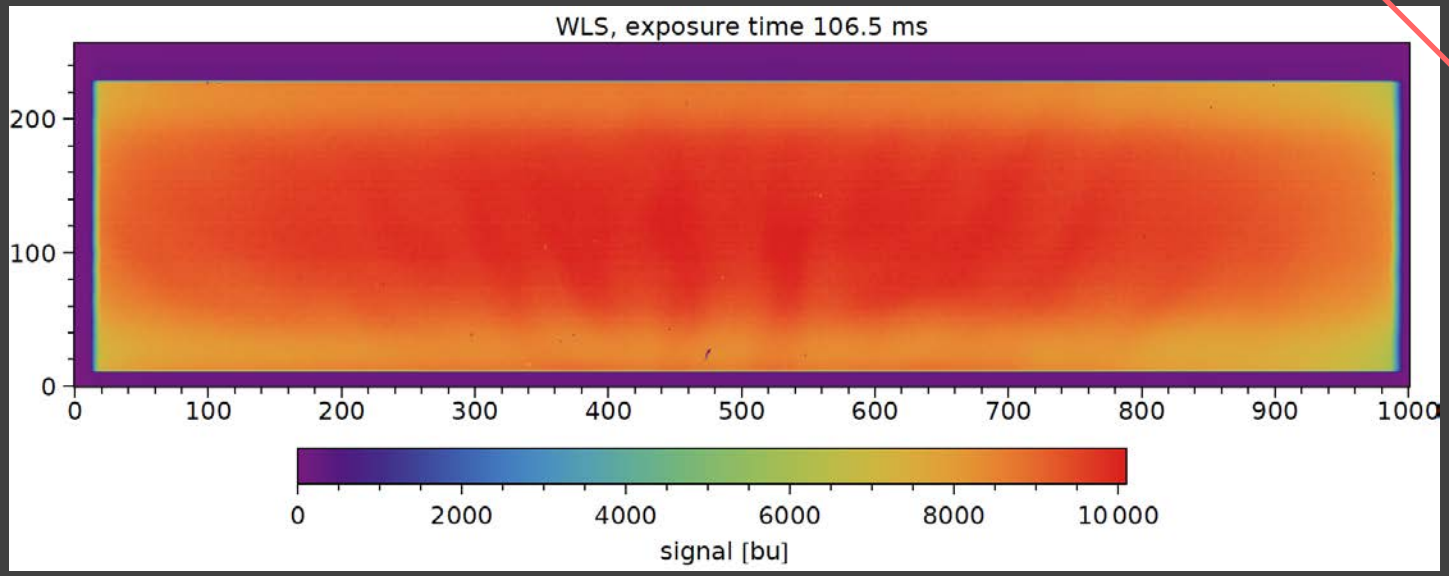
SRON

TROPOMI SWIR requirements

For Lv2 SWIR retrievals (CO and CH4) the

- Instrument Spectral Response Function (ISRF) is required at high subpixel (0.02px) resolution
- Radiometric offset (straylight) must be reduced to less than 0.1% signal

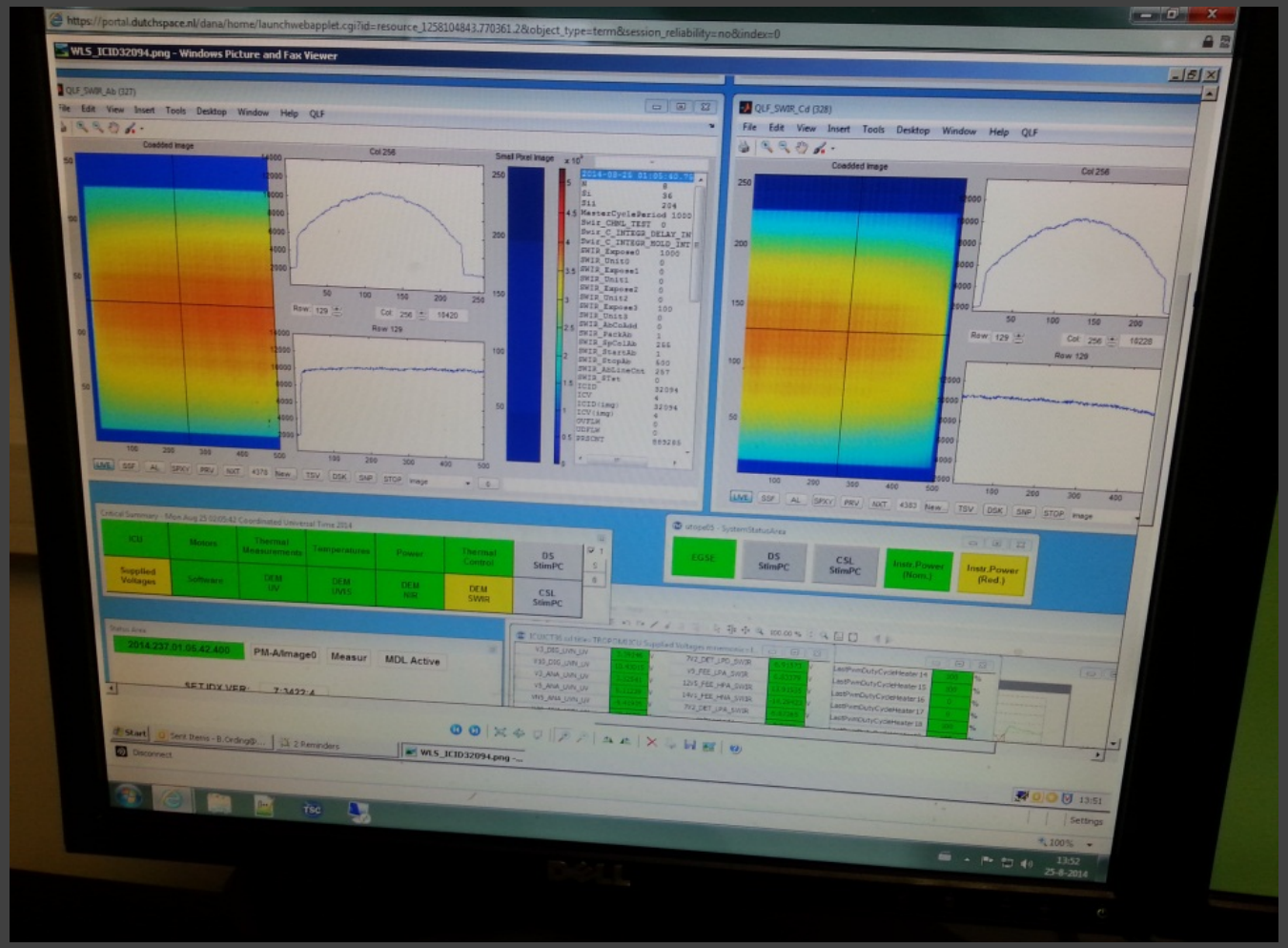
109 degrees [0.5 degree/px] viewing angles



Wavelength (2300-2390nm) [0.1nm/px]

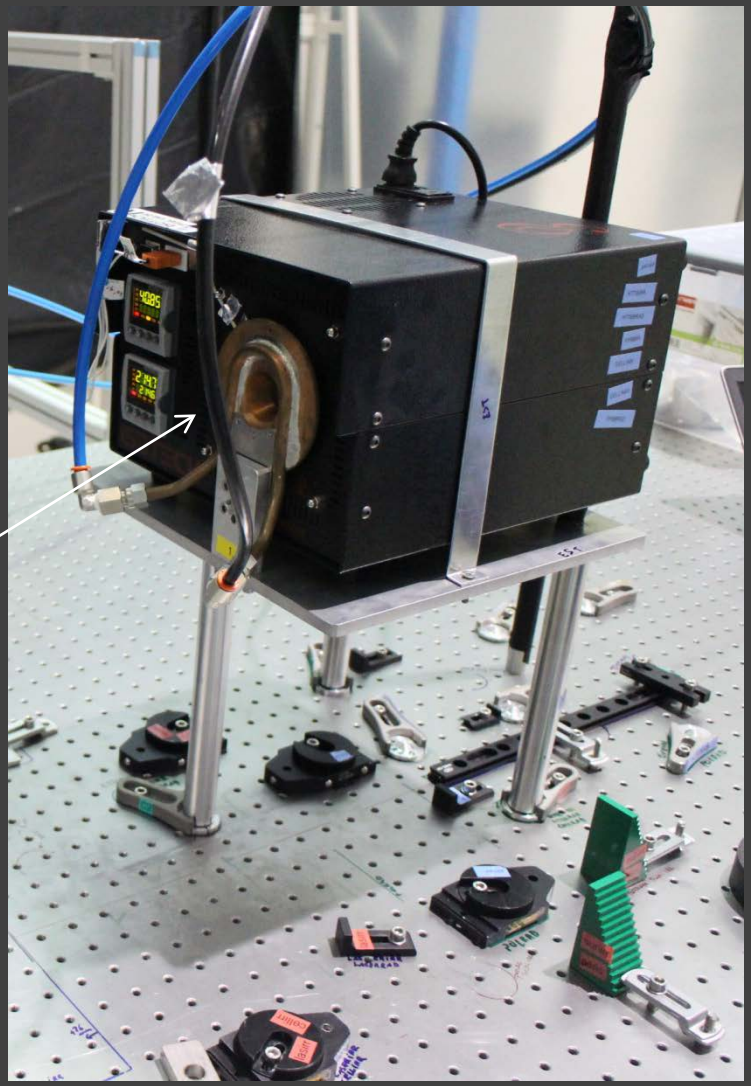
TROPOMI in 6.5m vacuum tank Centre Spatial Liege

First SWIR light

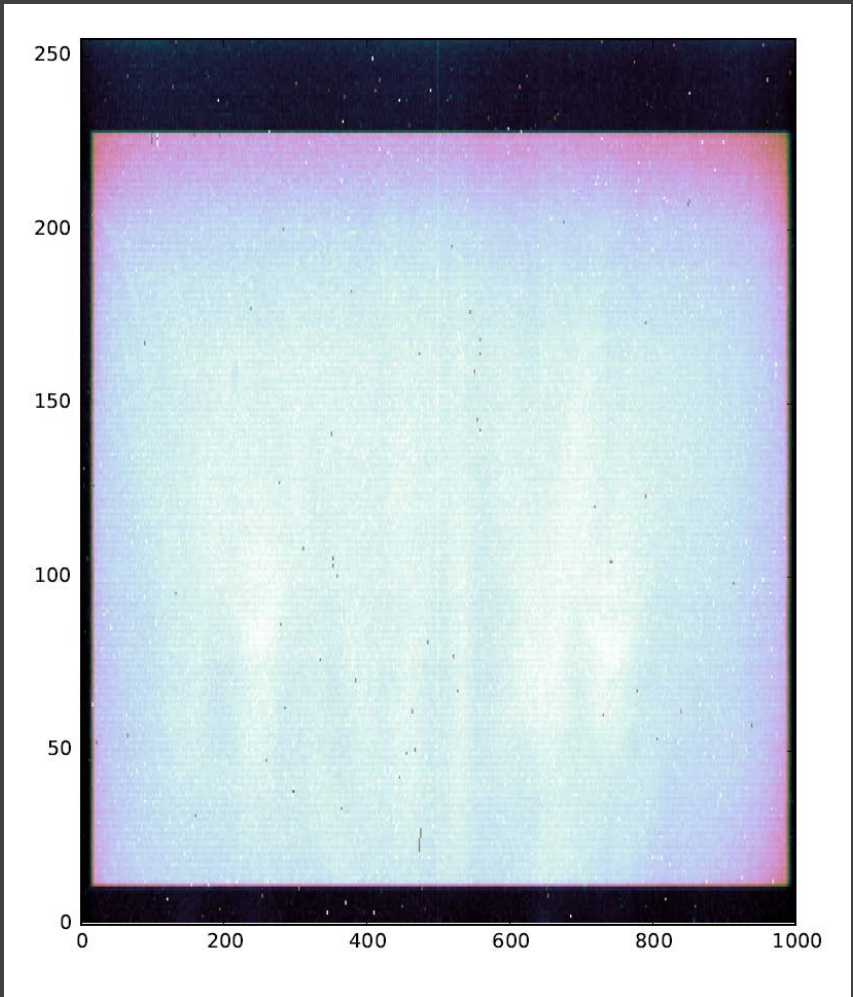


First SWIR light as seen in CSL

New OGSE - Black body (solidifying silver cell)

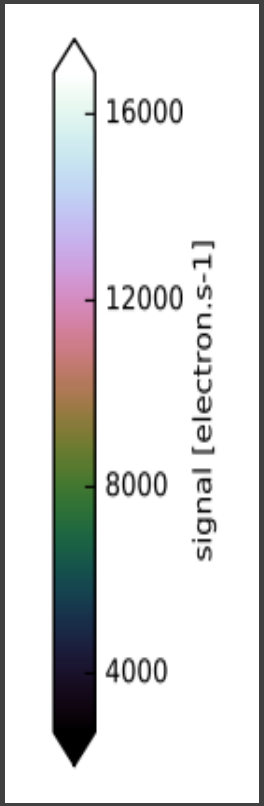


Silver Cell Black Body – Absolute (Ir)Radiance



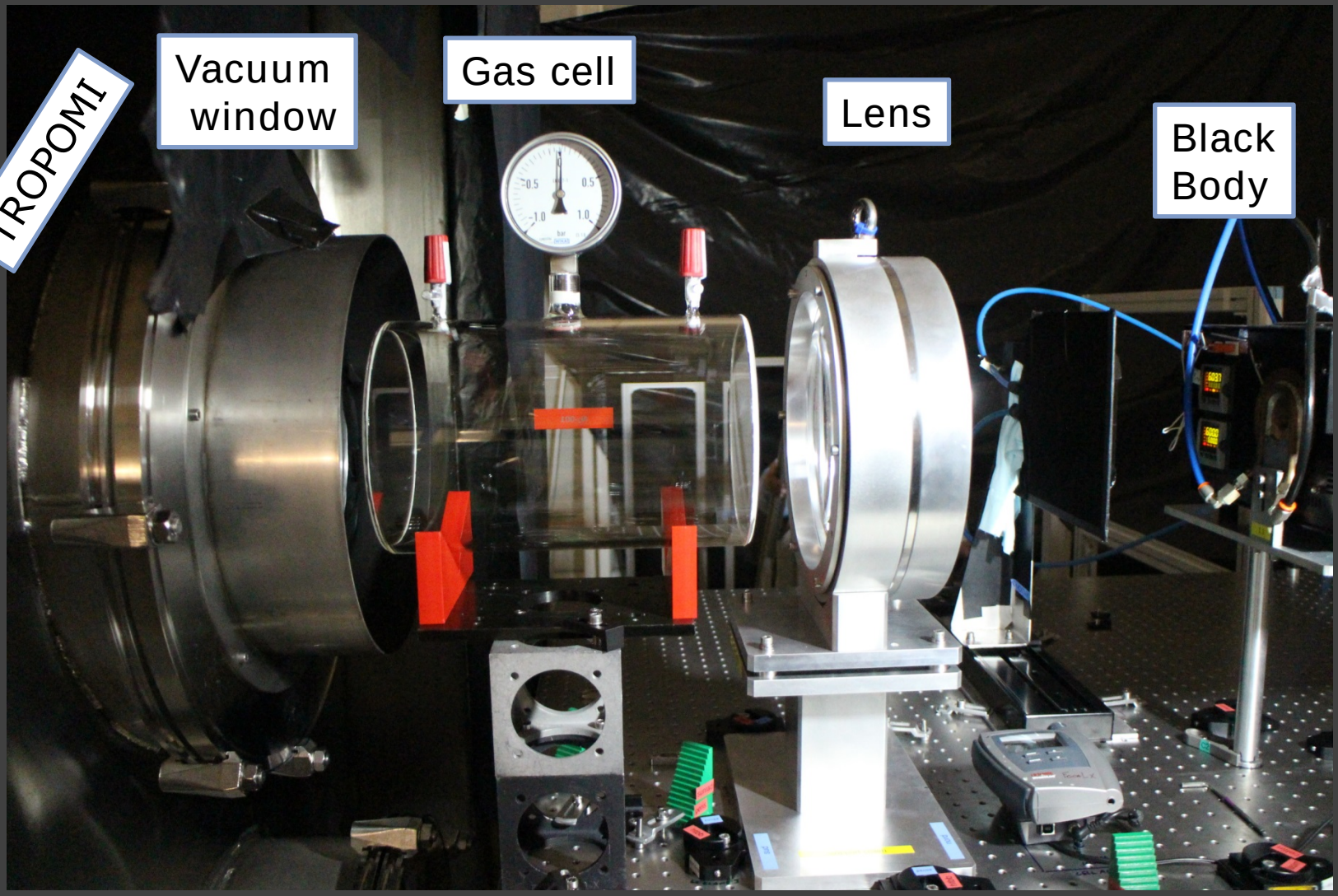
Wavelength (2300-2390nm)

109 degrees viewing angles



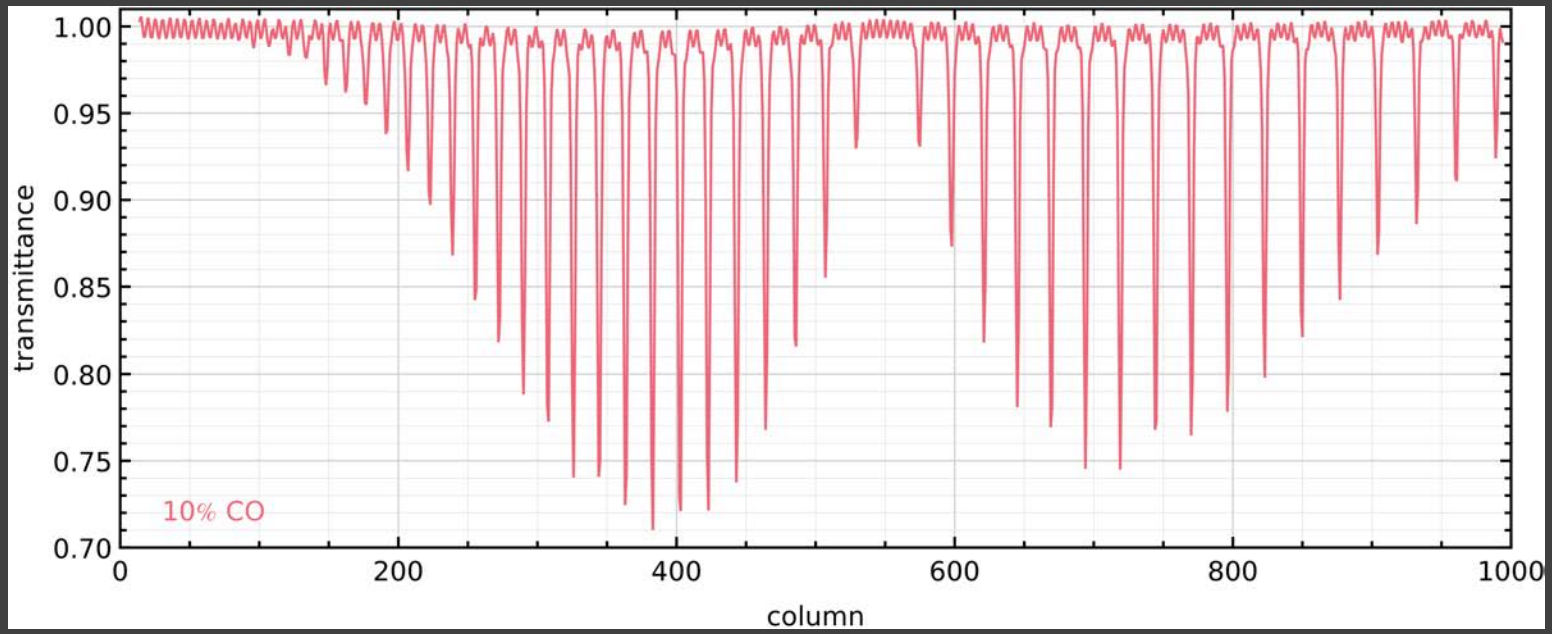
Preliminary analysis:
0.1% stability

Wavelength calibration



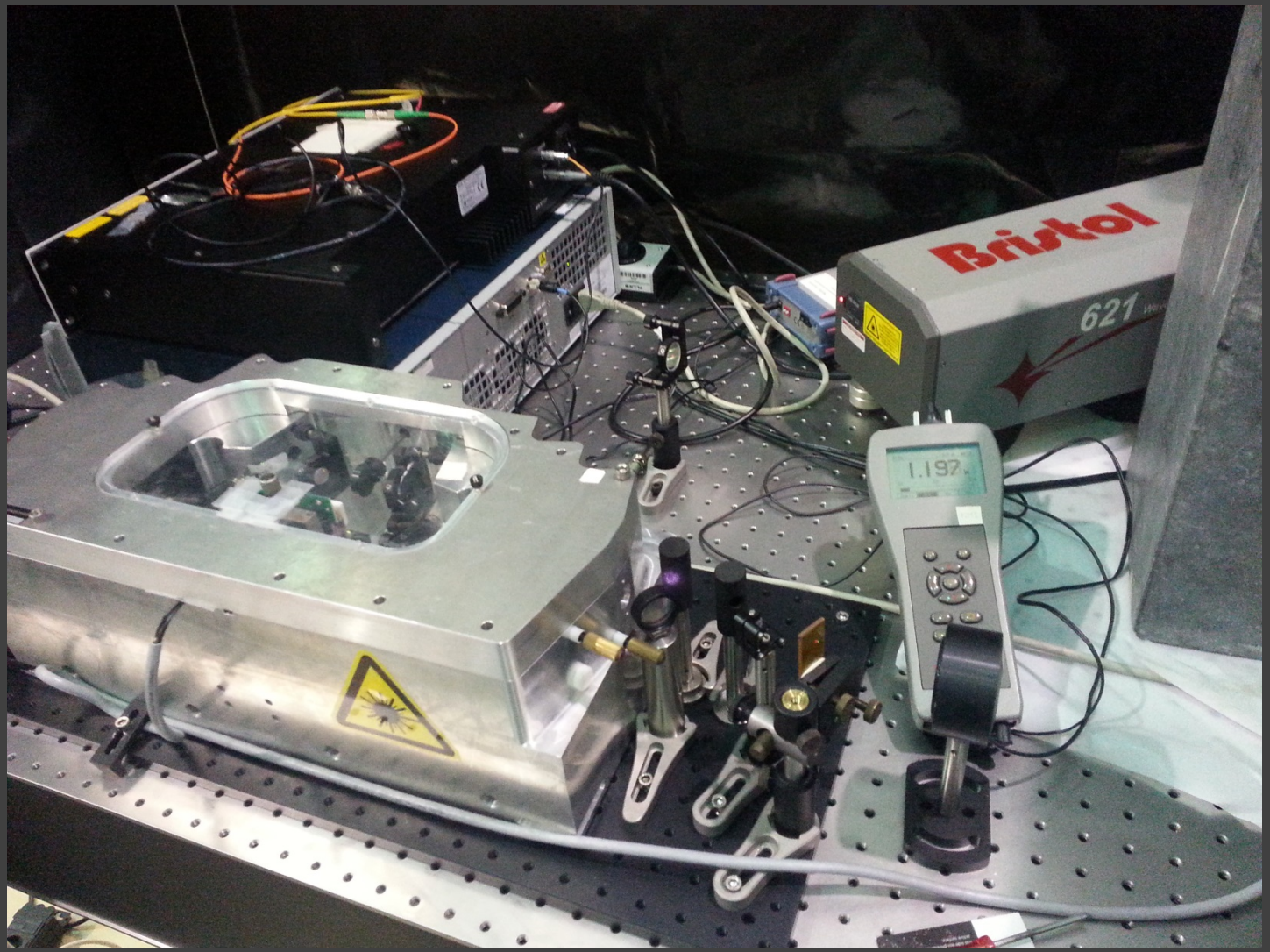
Wavelength calibration

CO 10% Gas cell



Uncertainty after validation 0.003 nm (0.03px)

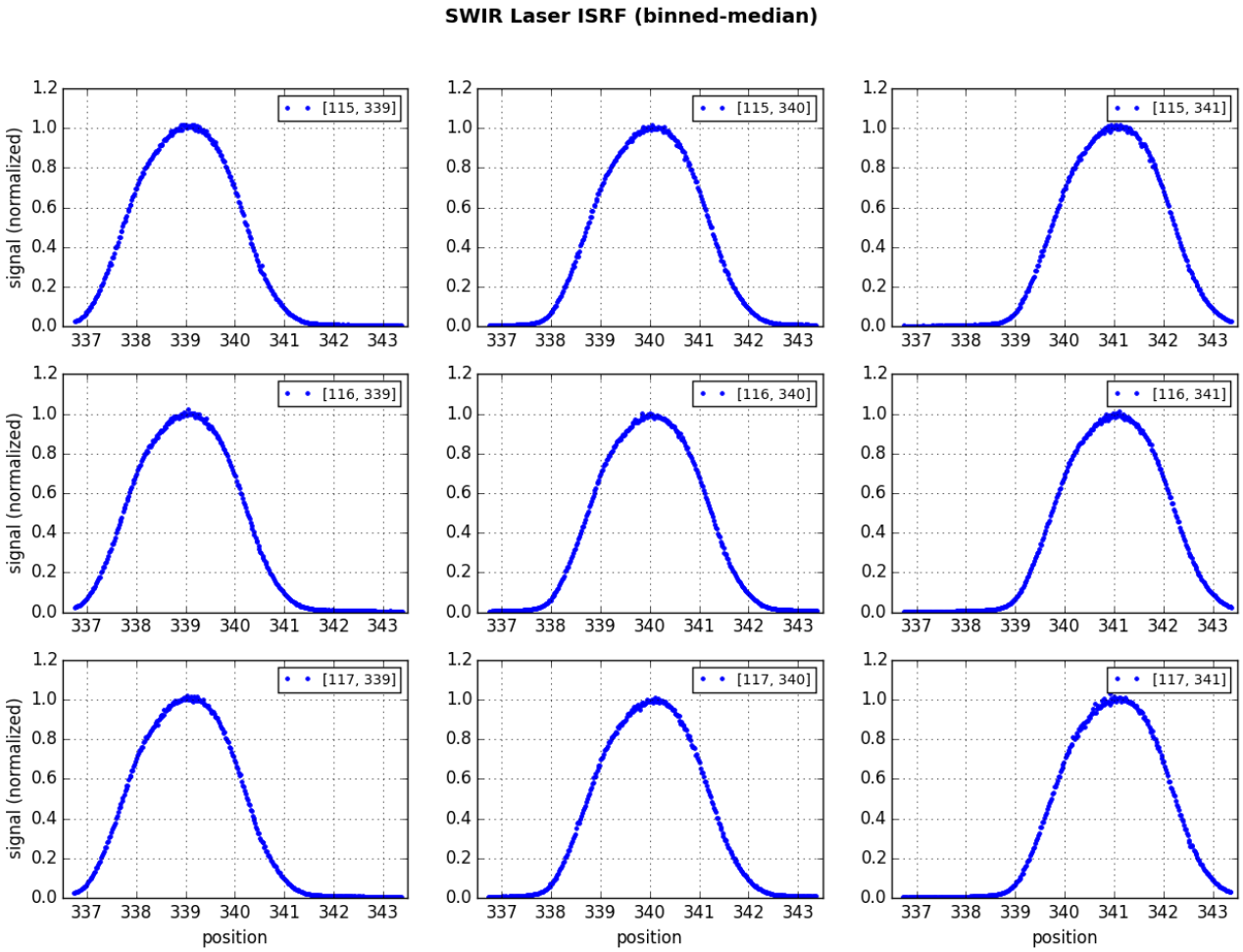
SWIR custom-made tunable laser (VSL)



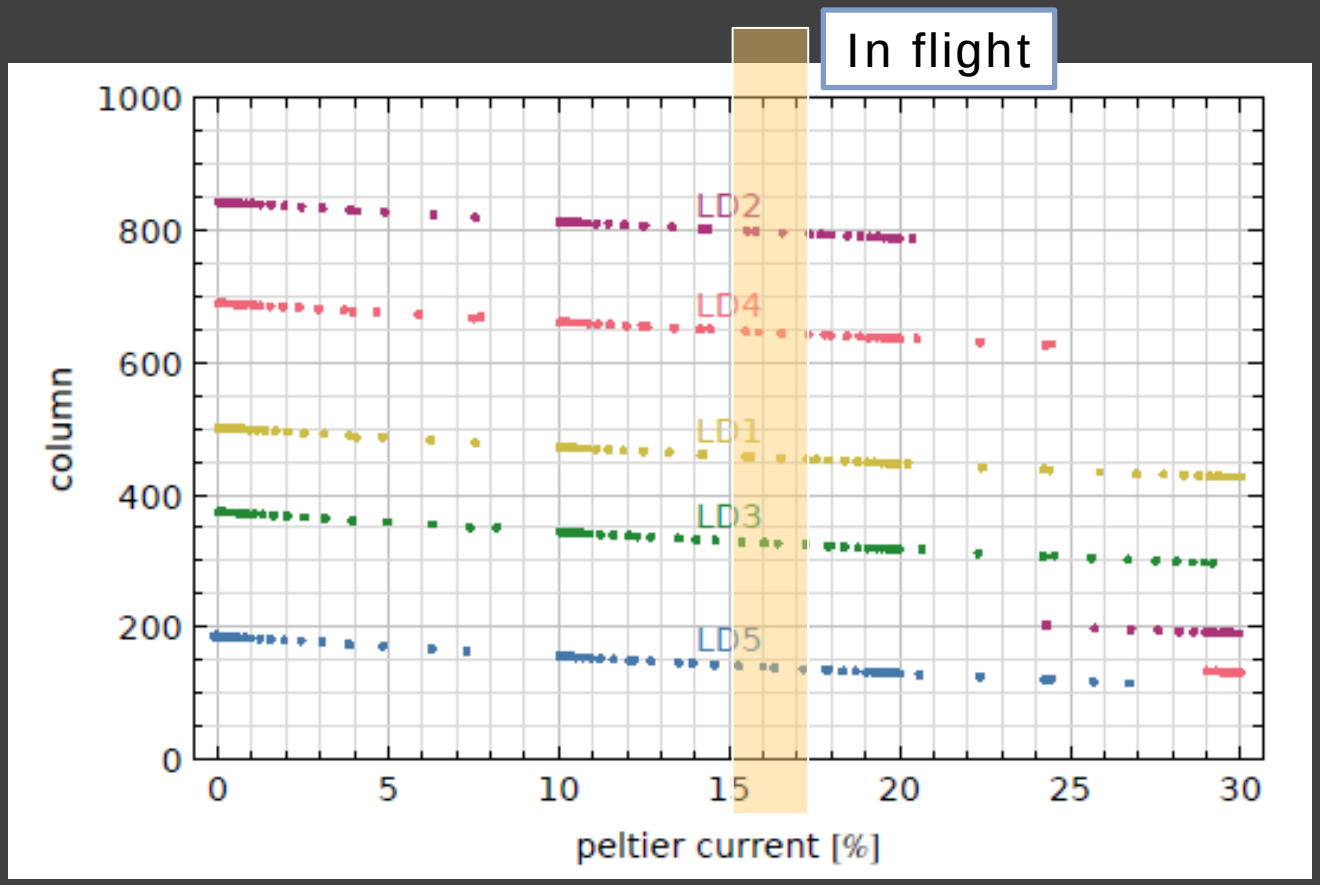
High Power Needed: 2Watt

Instrument Spectral Response Function

Scan laser over both wavelength and angle 0.002nm steps

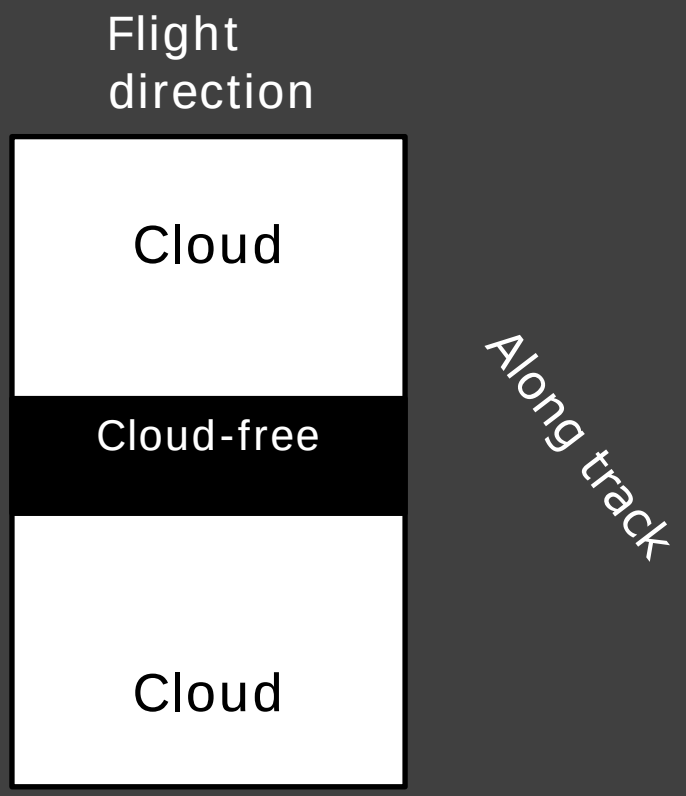


ISRF: On-board laser diodes characterization



5 Internal Laser Diodes with variable Peltier-cooler power, and hence variable wavelength
This will allow in-flight ISRF monitoring at 0.002nm resolution

Straylight: Why should you care

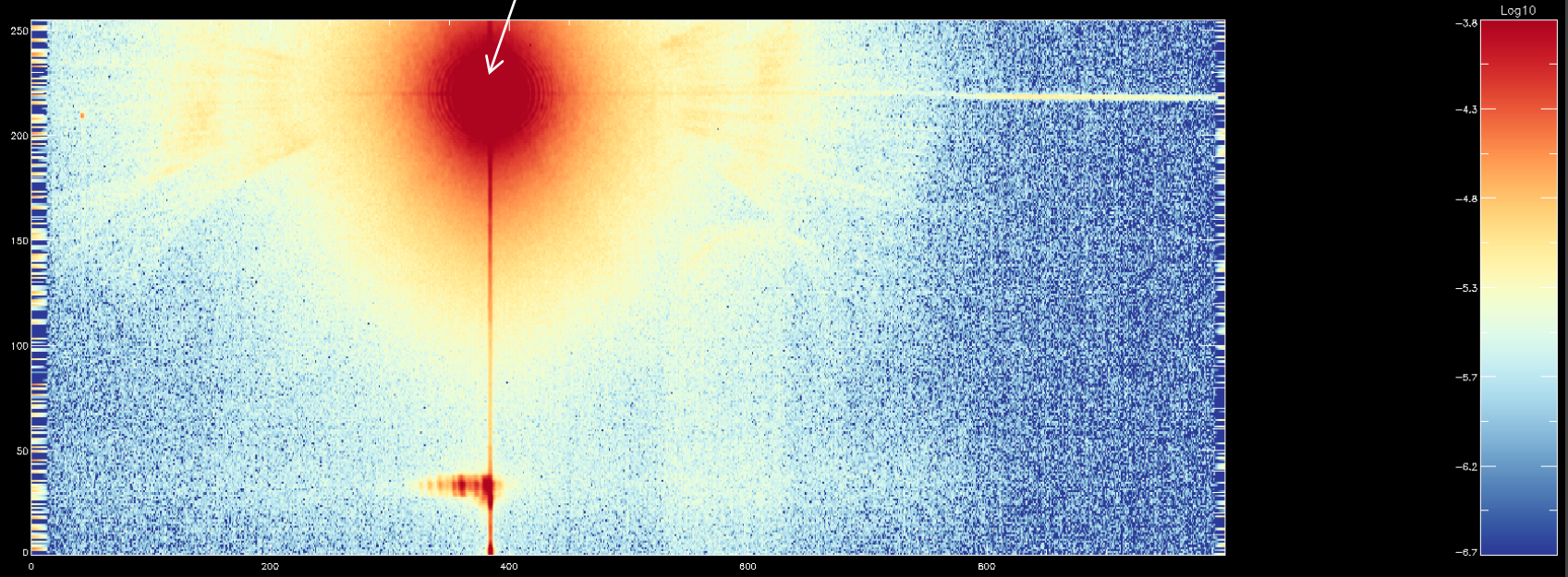


Straylight

Cloud

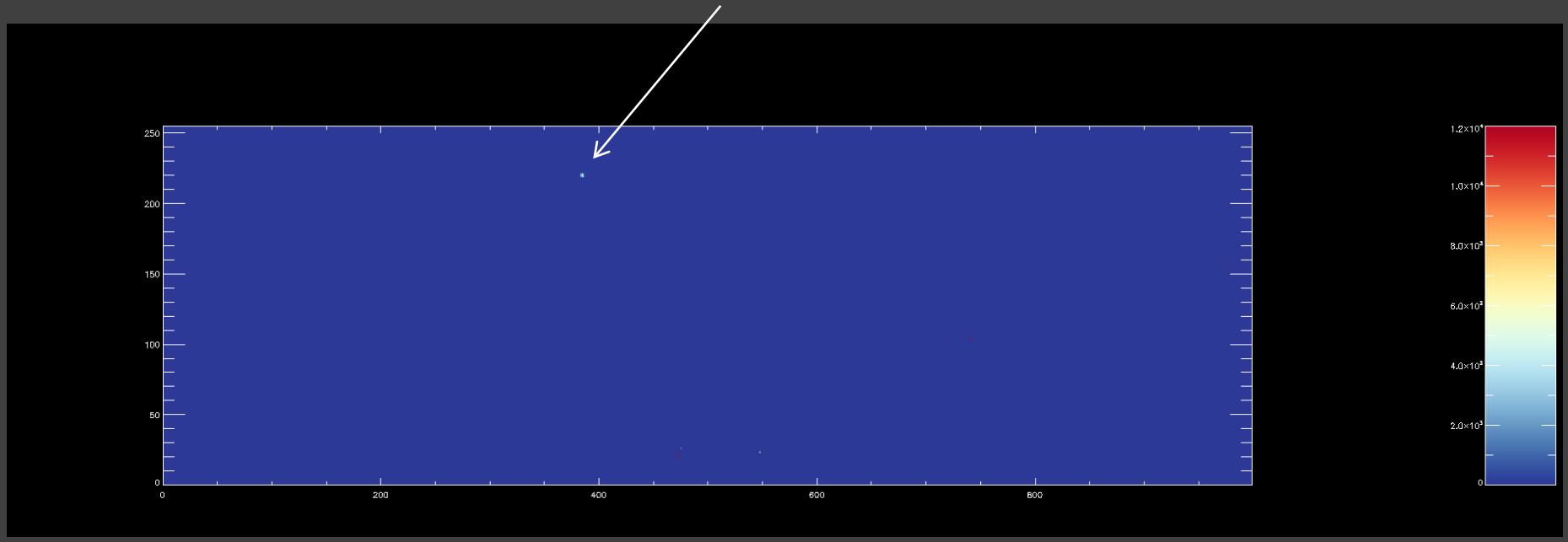
Area of interest

Laser under specific angle with specific wavelength, repeat for all

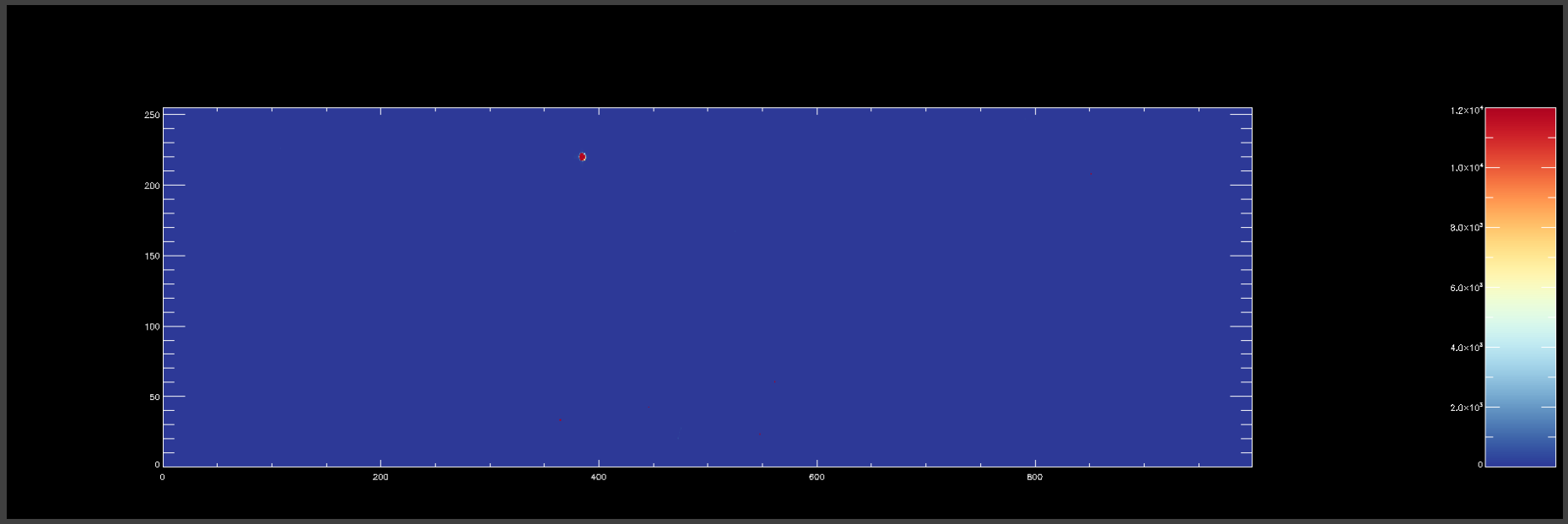


New method: varying integration times

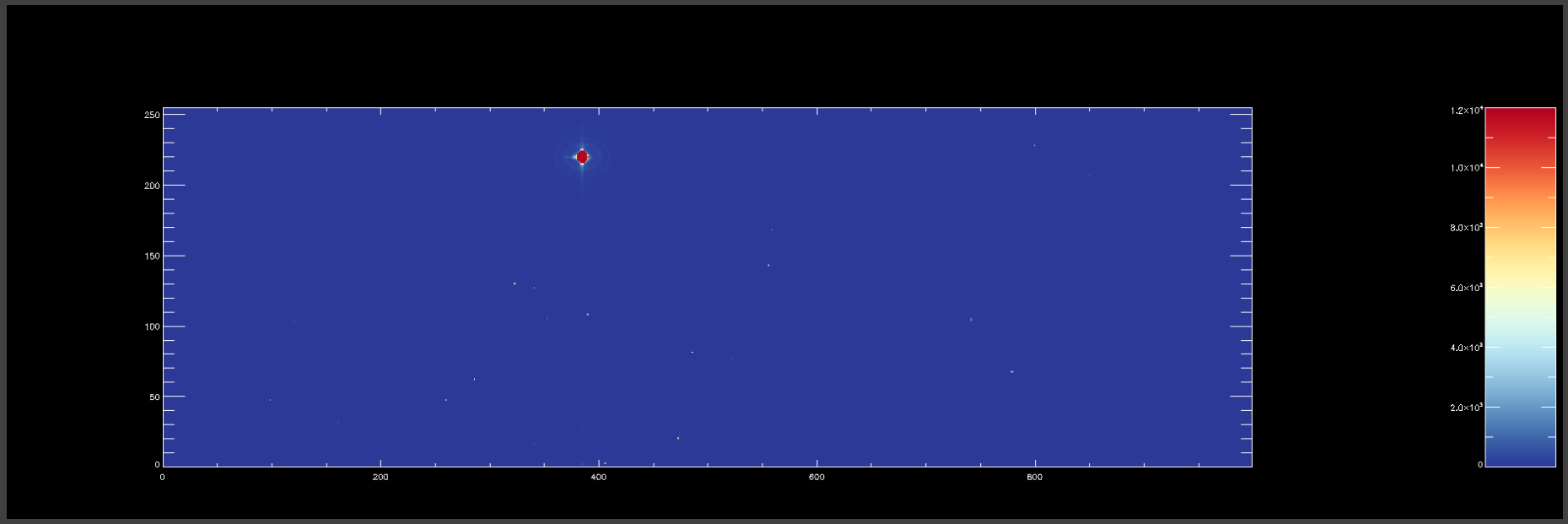
Laser 0.2ms (remember that high power)



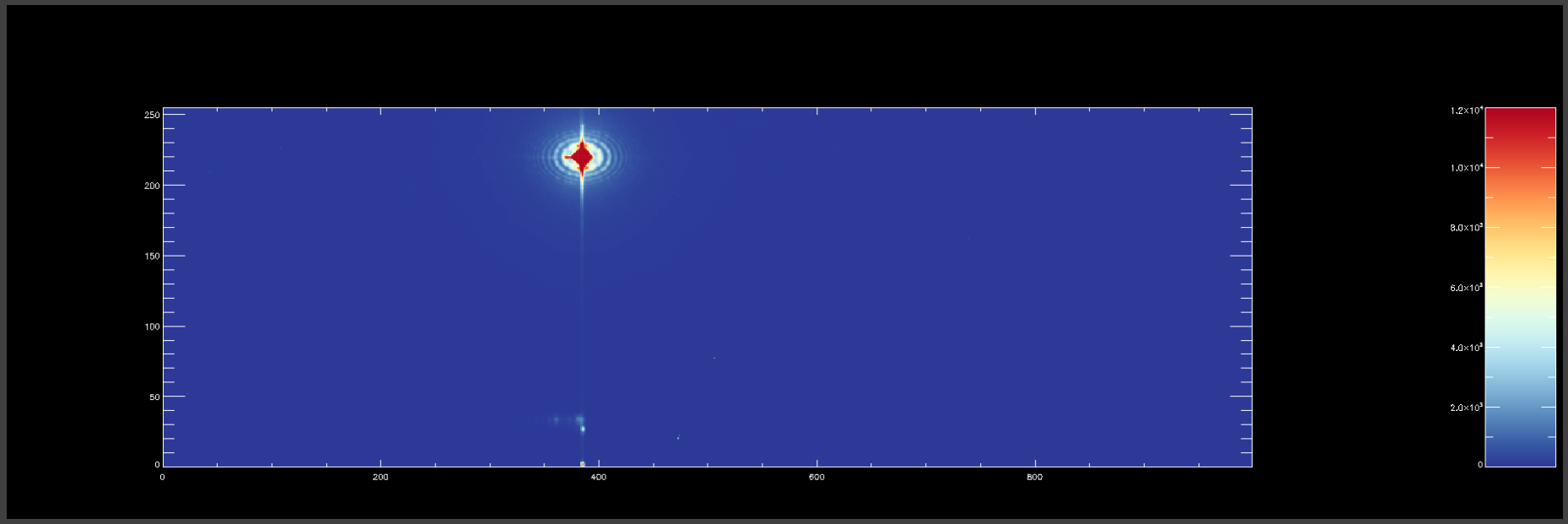
Laser 4ms


250
200
150
100
50
0
0
200
400
600
800
1.2×10⁴
1.0×10⁴
8.0×10³
6.0×10³
4.0×10³
2.0×10³
0

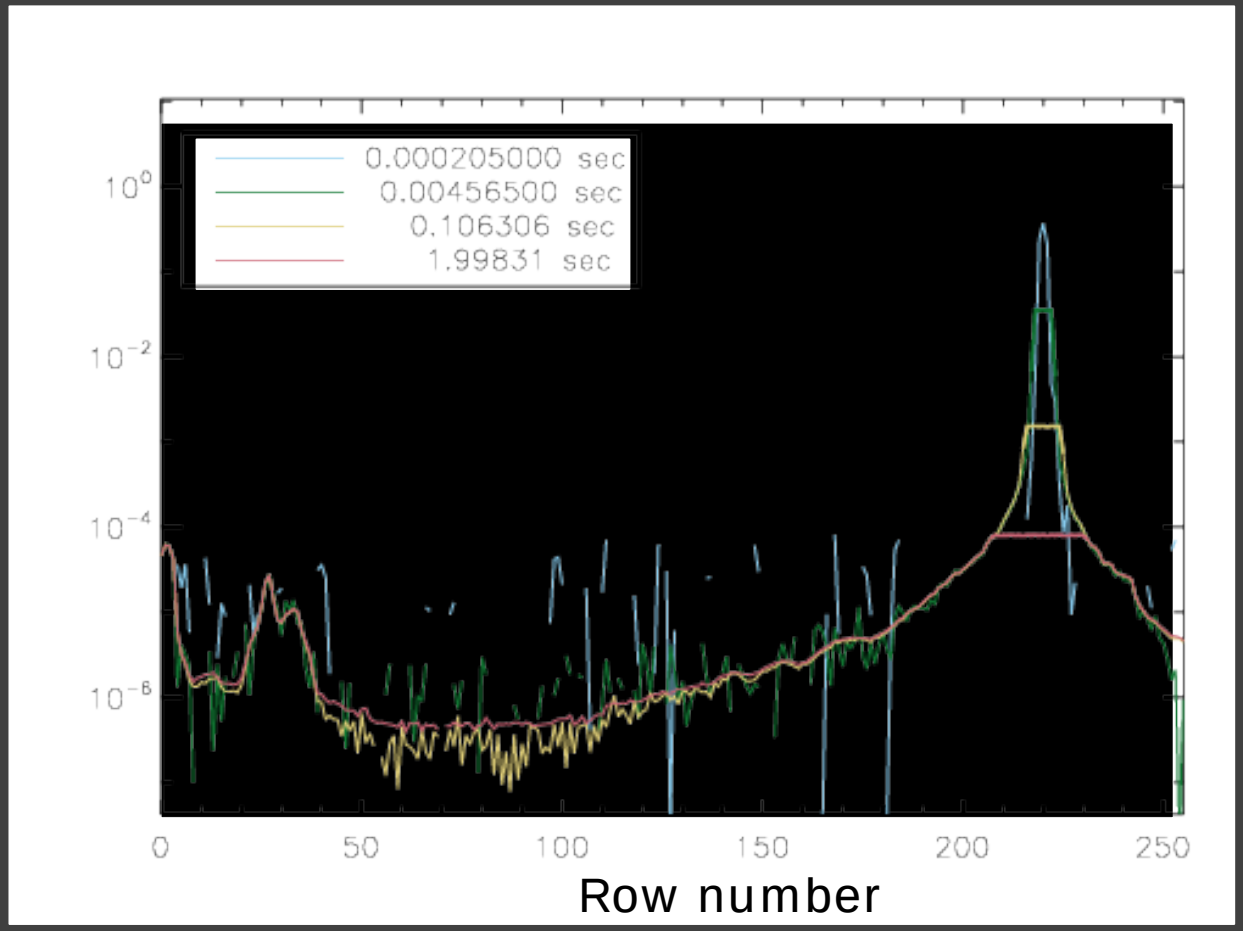
Laser 100ms


250
200
150
100
50
0
0
200
400
600
800
1.2×10⁴
1.0×10⁴
8.0×10³
6.0×10³
4.0×10³
2.0×10³
0

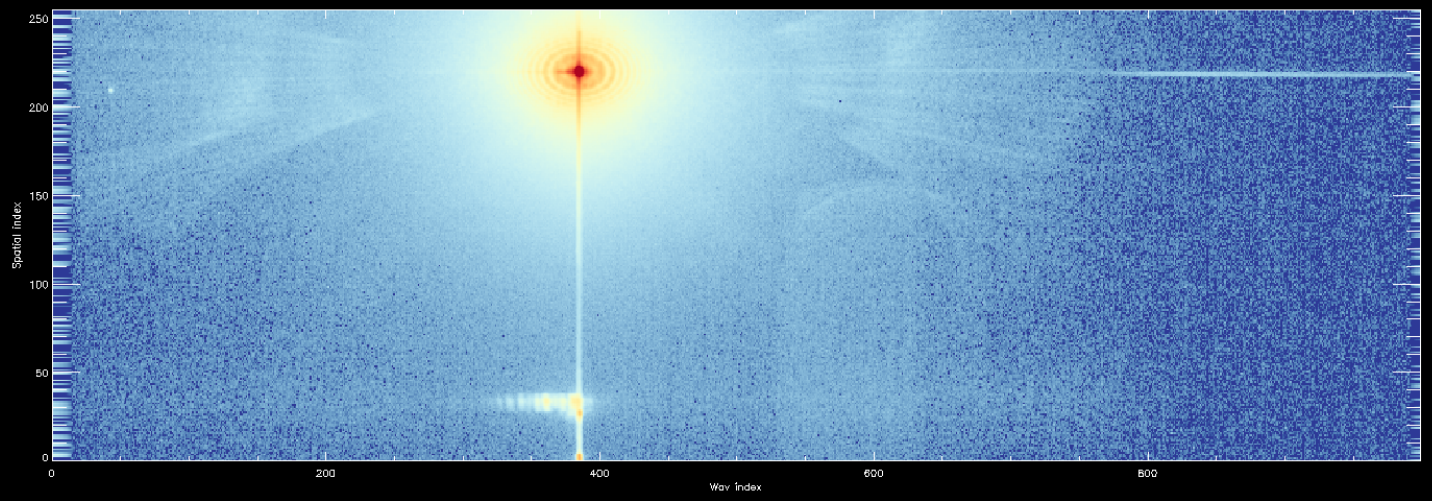
Laser 2sec

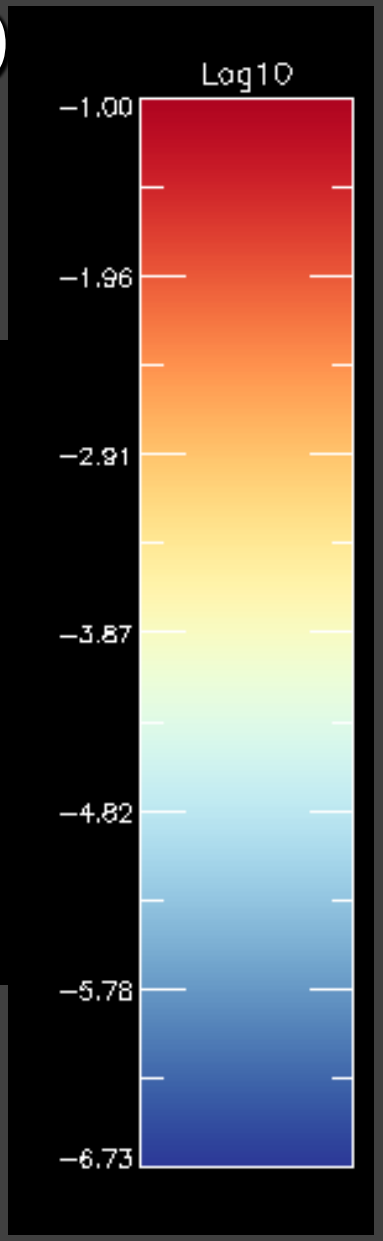

250
200
150
100
50
0
0
200
400
600
800
1.2×10⁴
1.0×10⁴
8.0×10³
6.0×10³
4.0×10³
2.0×10³
0

Add it all together and stir

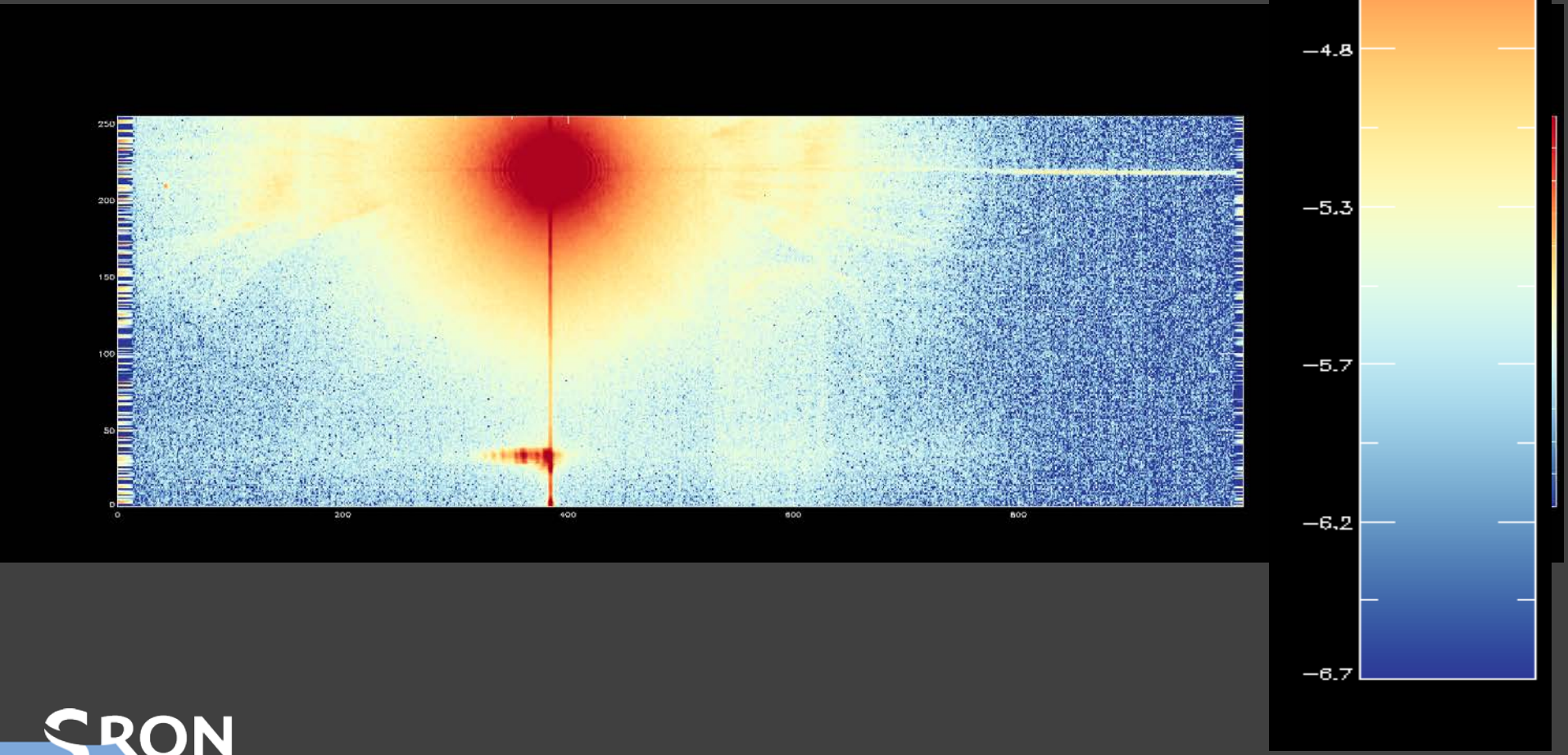


Stray Light Laser combined (logarithmic)





Straylight measured to 10e-6~10e-7 or .001%
Now to implement correction algorithm…

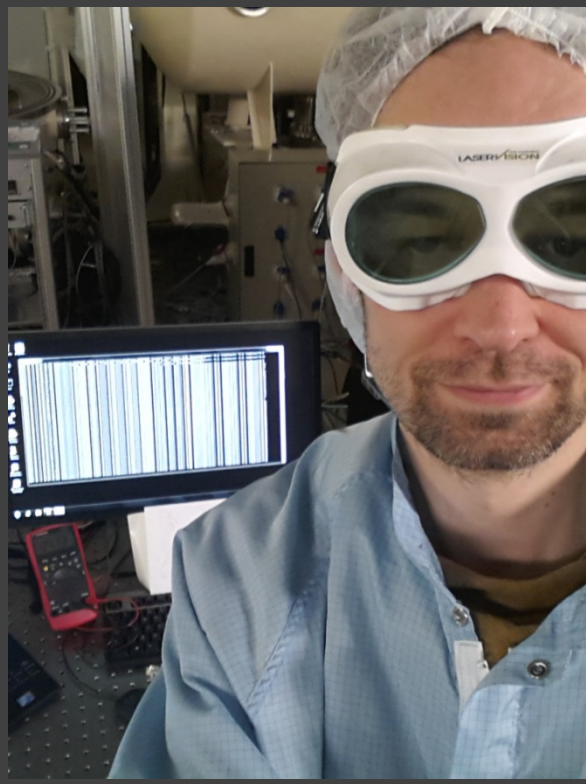

Log10
−3.8
−4.3
−4.8
−5.3
−5.7
−6.2
−6.7
250
200
150
100
50
0
0
200
400
600
800

Summary

- Straylight
  - at 0.001% measured
  - (allows 2 orders of magnitude reduction)
- Wavelength
  - 0.003 nm uncertainty
- Instrument Spectral Response function
  - for every pixel
  - at 0.002nm
- Laser Diodes in-flight monitoring
  - at 0.002nm
  - (for select few pixels)

Measurements meet requirements!

Analyses on-going

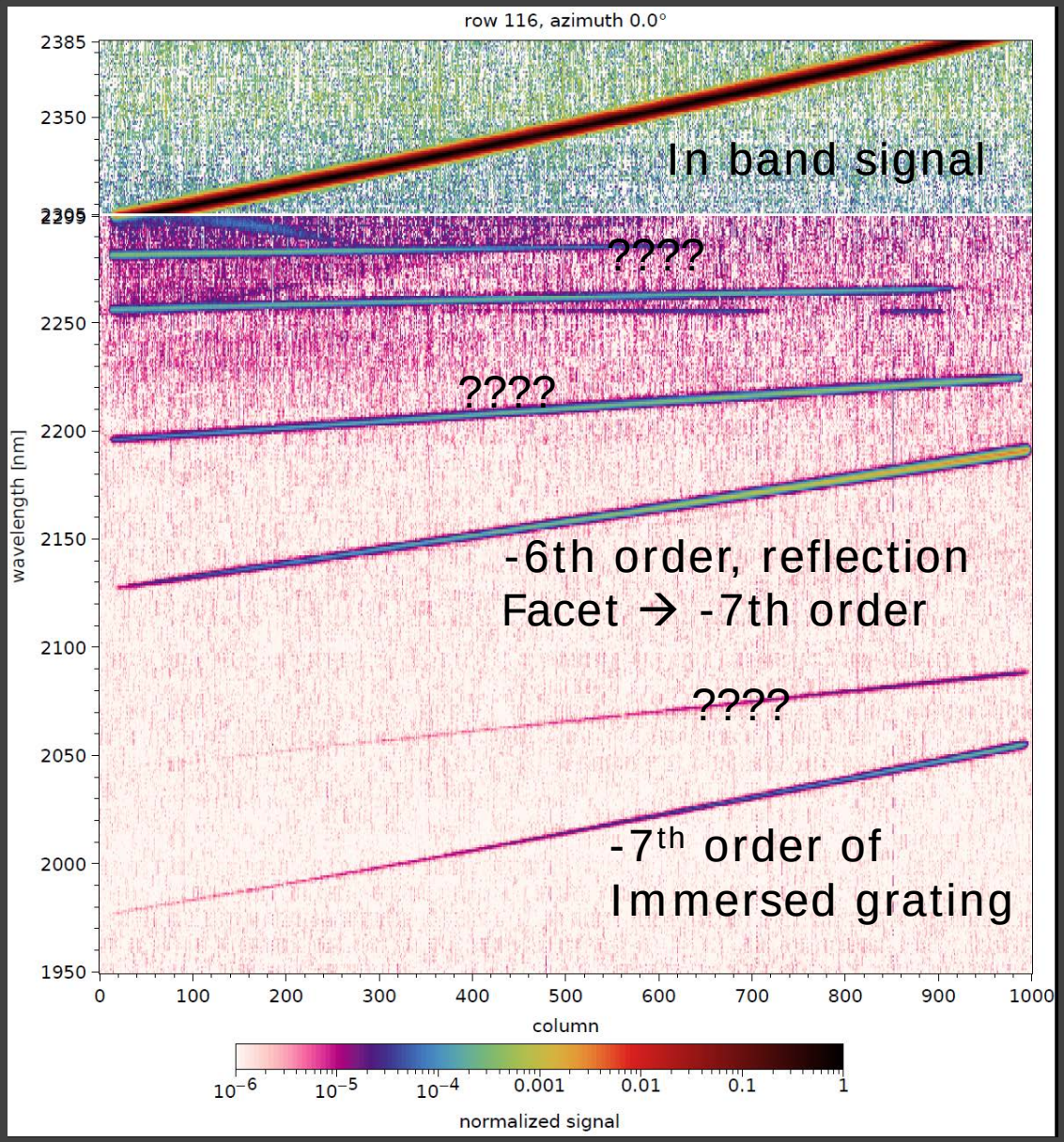


Your author Matthijs Krijger in action

Thank you

Backup Slides

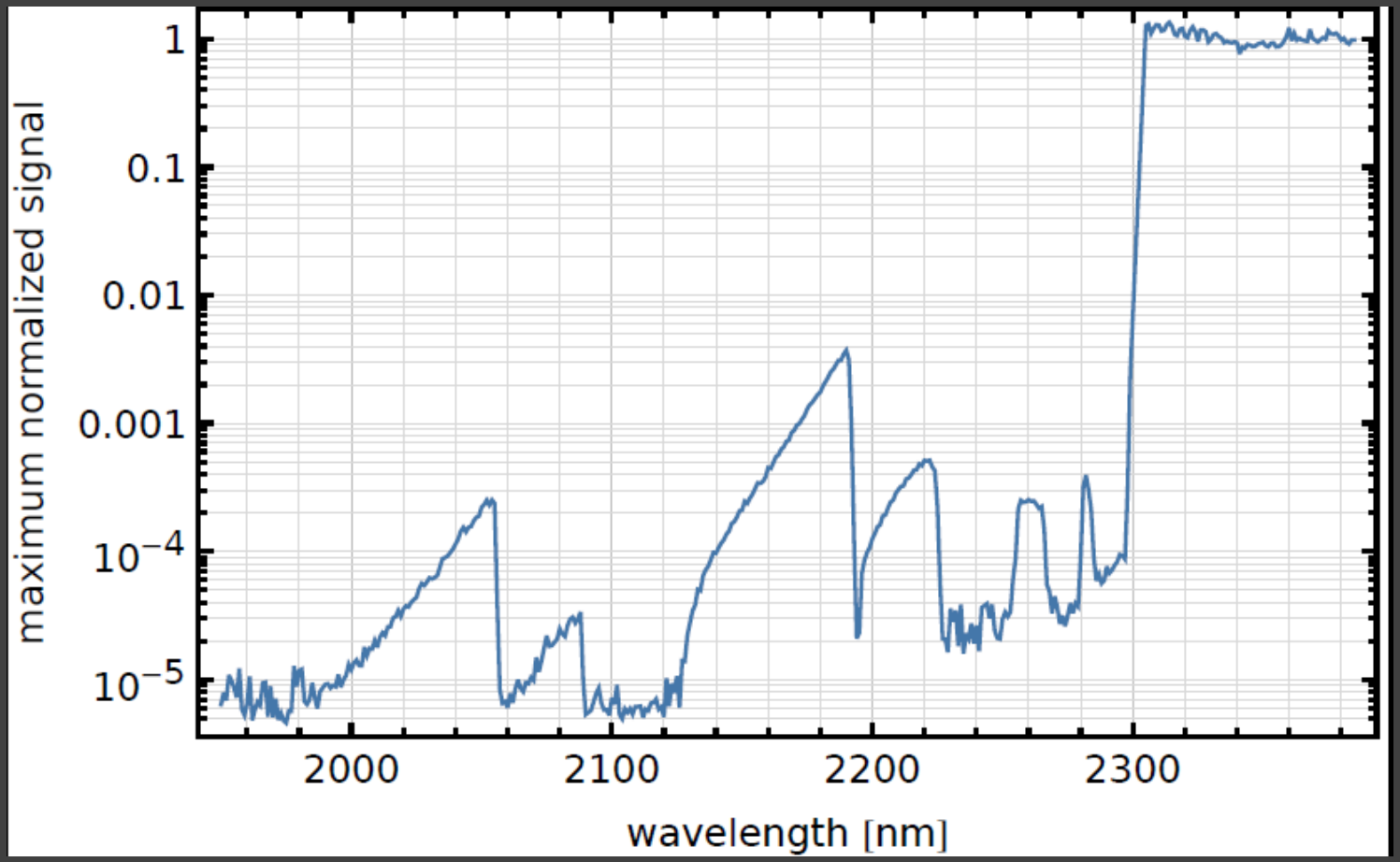
Straylight Out of Band



Commercial
Expla laser

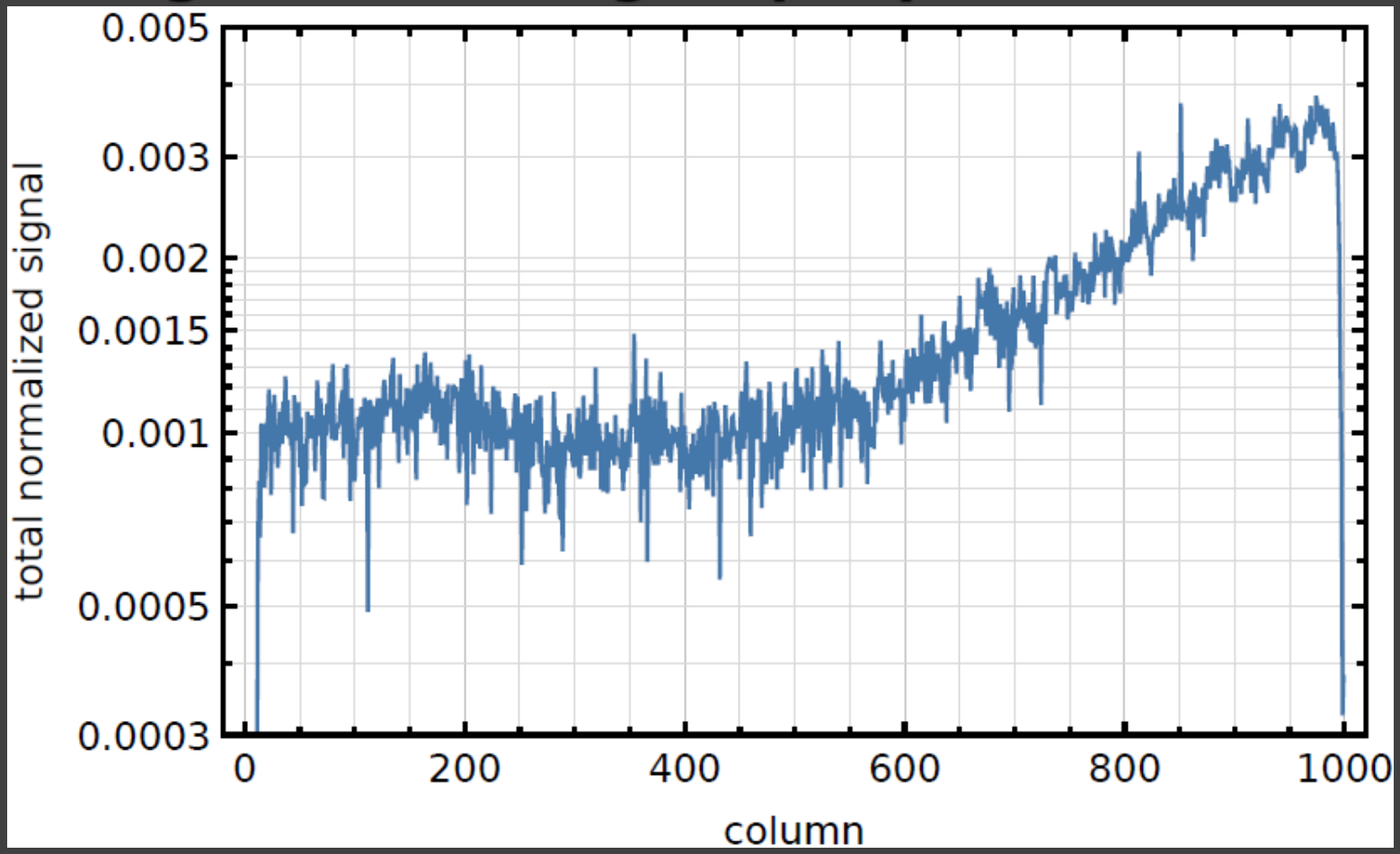
Several
unexplained
ghosts

Maximum signal per wavelength



Maximum OOB straylight at 2190 nm: 0.35%.

Integrated OOB signal per pixel

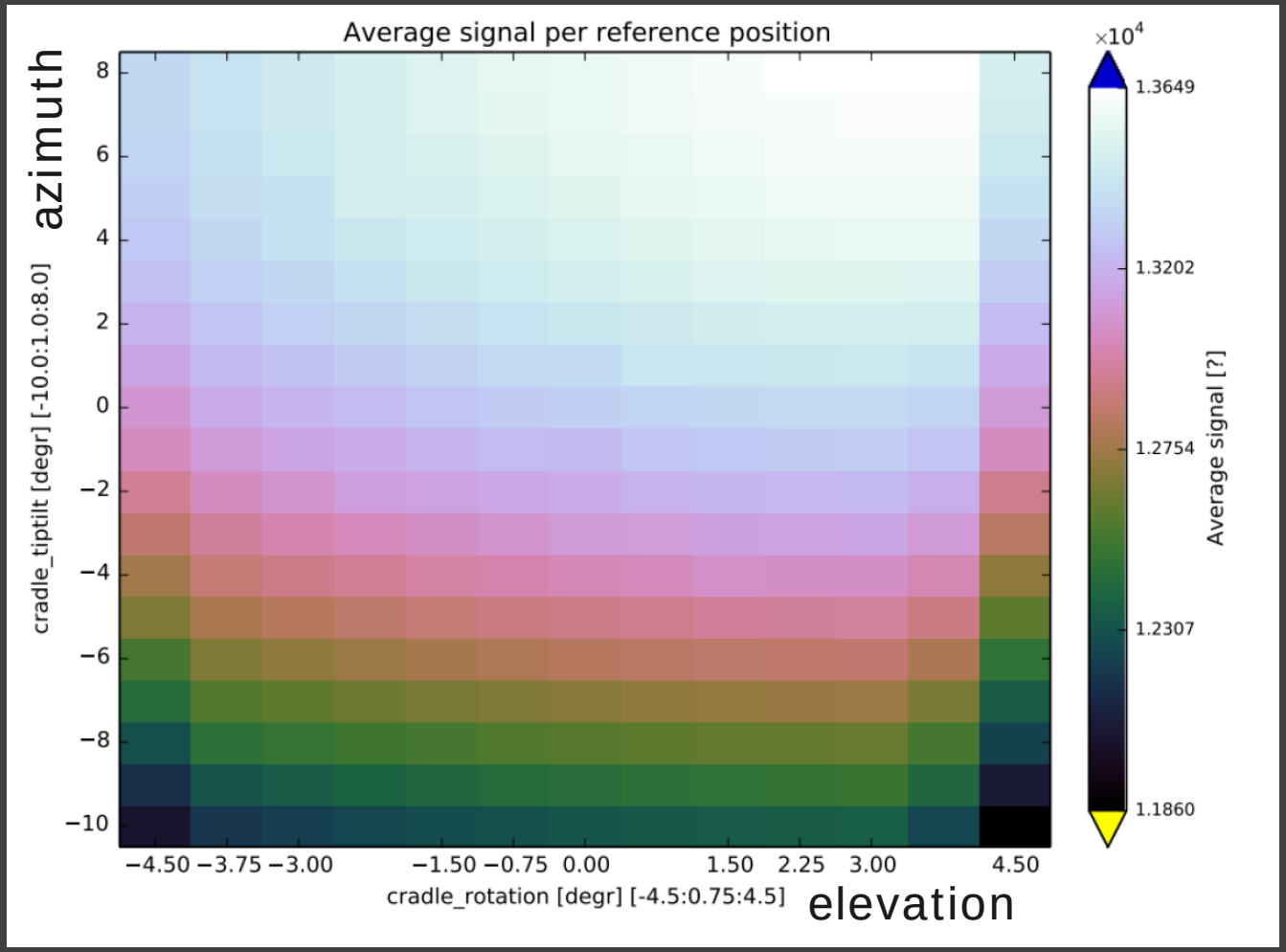


OOB straylight around 0.1%, up to 0.35% at the end of the band
Measured up to 10e-3 or .001

On ground calibration plan

category	session type	source	port	cradle	pattern
SWIR only	SWIRLS_EARTH_STRAY	N			
	SWIRLS_EARTH_ISRF	N			
	SWIRLS_EARTH_ISRF_INHOMO	N			
	FPBB_EARTH				
	CELL_EARTH				
	CELL_EARTH_INHOMO				
	SWIRLS_SUN_STRAY	N			
	SWIRLS_SUN_ISRF	N			
	FPBB_SUN				
	FPBB_SUN_BSDF				
	CELL_SUN				
	LASER_DIODES	[ ]			
	LD_STRAY	[ ]			
	DLEDLIN_SW	[ ]			
	WLSLIN_GO	[ ]			

Relative Irradiation sensitivity



Rotating TROPOMI

Seasonal angle

Sunrise angle