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for the SCORPIO Team.

SCORPIO: Gen4/3 facility instrument for Gemini South

Time-domain astronomy

- LSST Transients
- Gravitational Wave Sources
- Gamma-Ray Bursts
- Supernovae
- Black Hole Sources
 - X-Ray Binaries
 - Active Galactic Nuclei
 - Tidal Disruption Events
- Neutron Stars & White Dwarfs
 - Isolated Neutron Stars
 - Magnetars
 - Binary Millisecond Pulsars
 - Interacting Binaries
- Extrasolar Planets
- Small Solar System Bodies
- Transiting Exoplanets
- Pulsating Variable Stars
- Low-Mass Binaries
- Brown Dwarfs
- Massive Stars
- Supernova Remnants
- Microlensing

General facility instrument

- High-redshift galaxies
- Galaxy Evolution
- Young stars in clusters
- Circumstellar disks and accretion

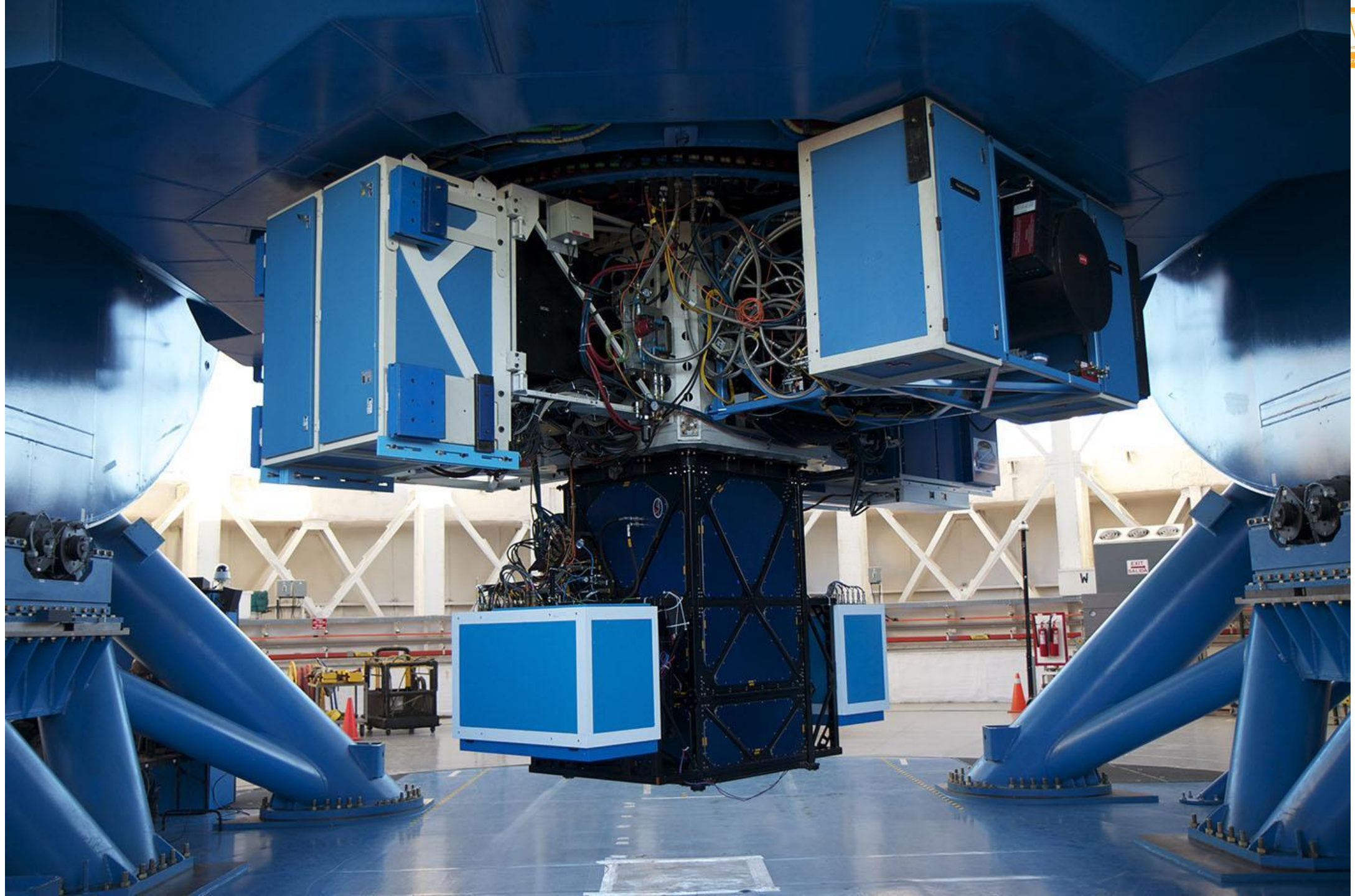
Main instrument capabilities

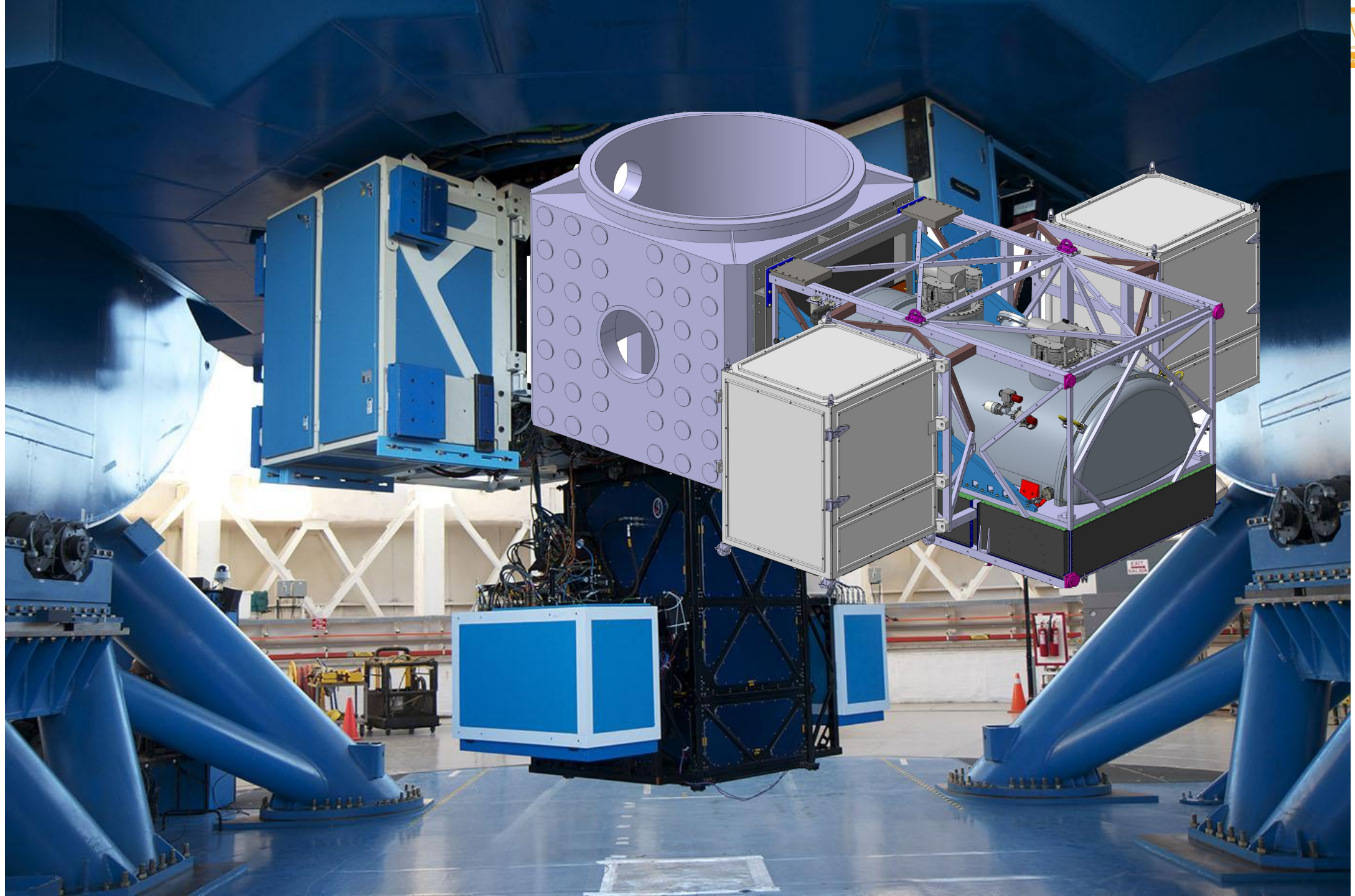
Imaging mode

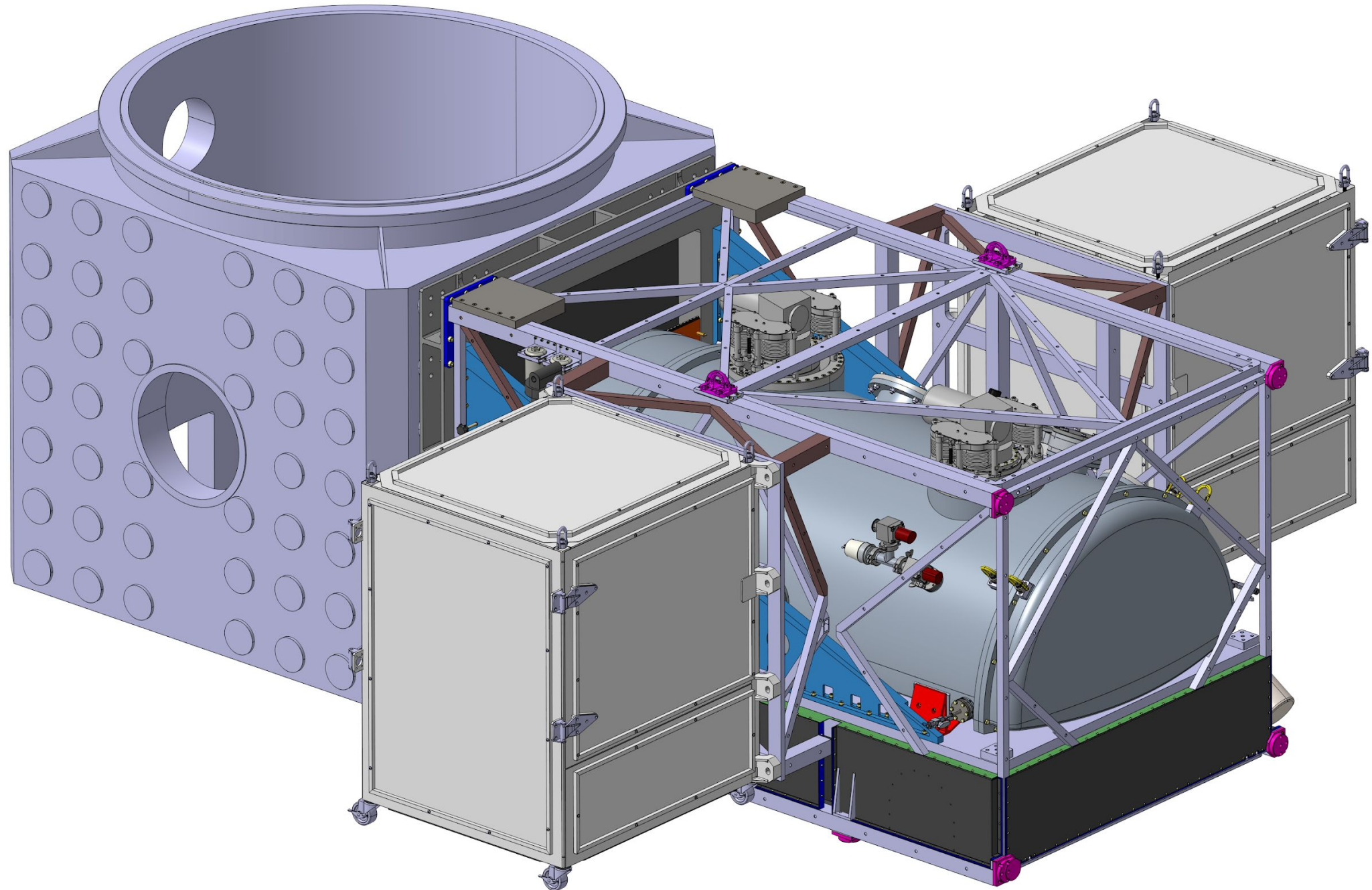
- 8-channel imager
- g, r, i, z, Y, J, H, and K_s bands
- 3'x3' field of view
- 0.18" pixel same for all cameras

Spectroscopic mode

- 8-channel spectrograph
 - simultaneous 0.385-2.35 microns
 - $R \sim 4,000$ @ 3 pixel sampling
 - 3' long slits
-
- Rapid reconfiguration imager-spectrograph
 - Rapid target acquisition through slit viewing camera
 - Shutter-less mode for ultra-high speed imaging



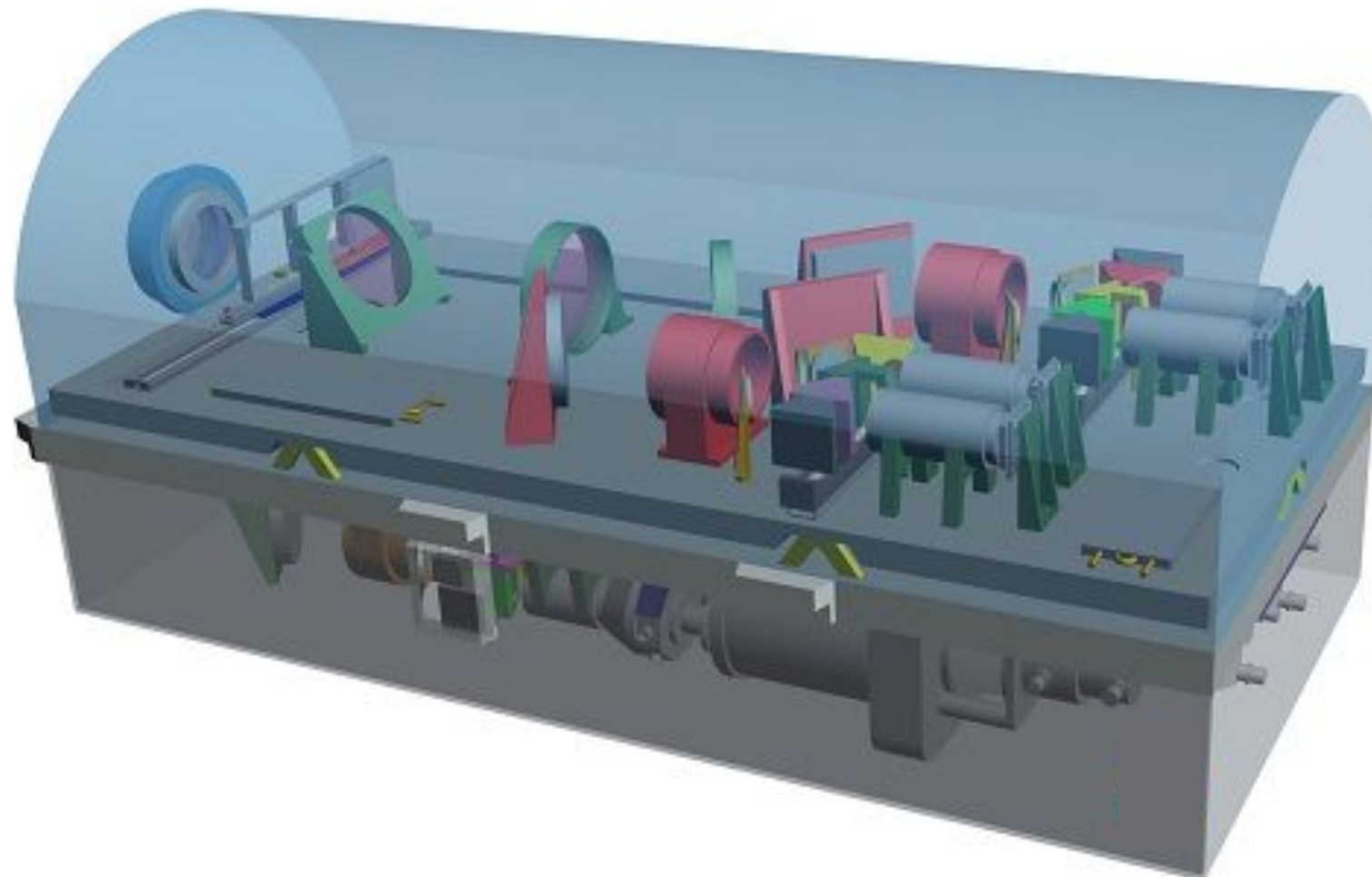




Instrument layout

Infrared

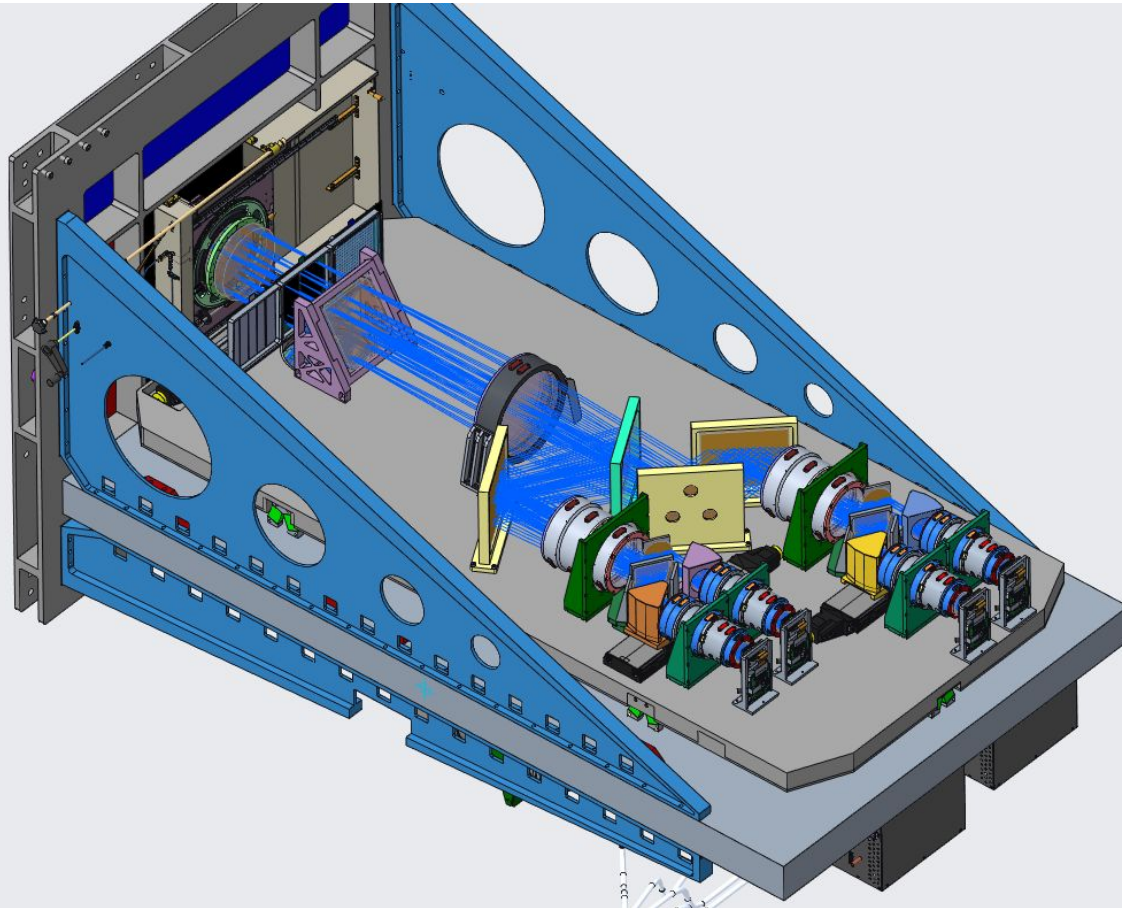
Visible



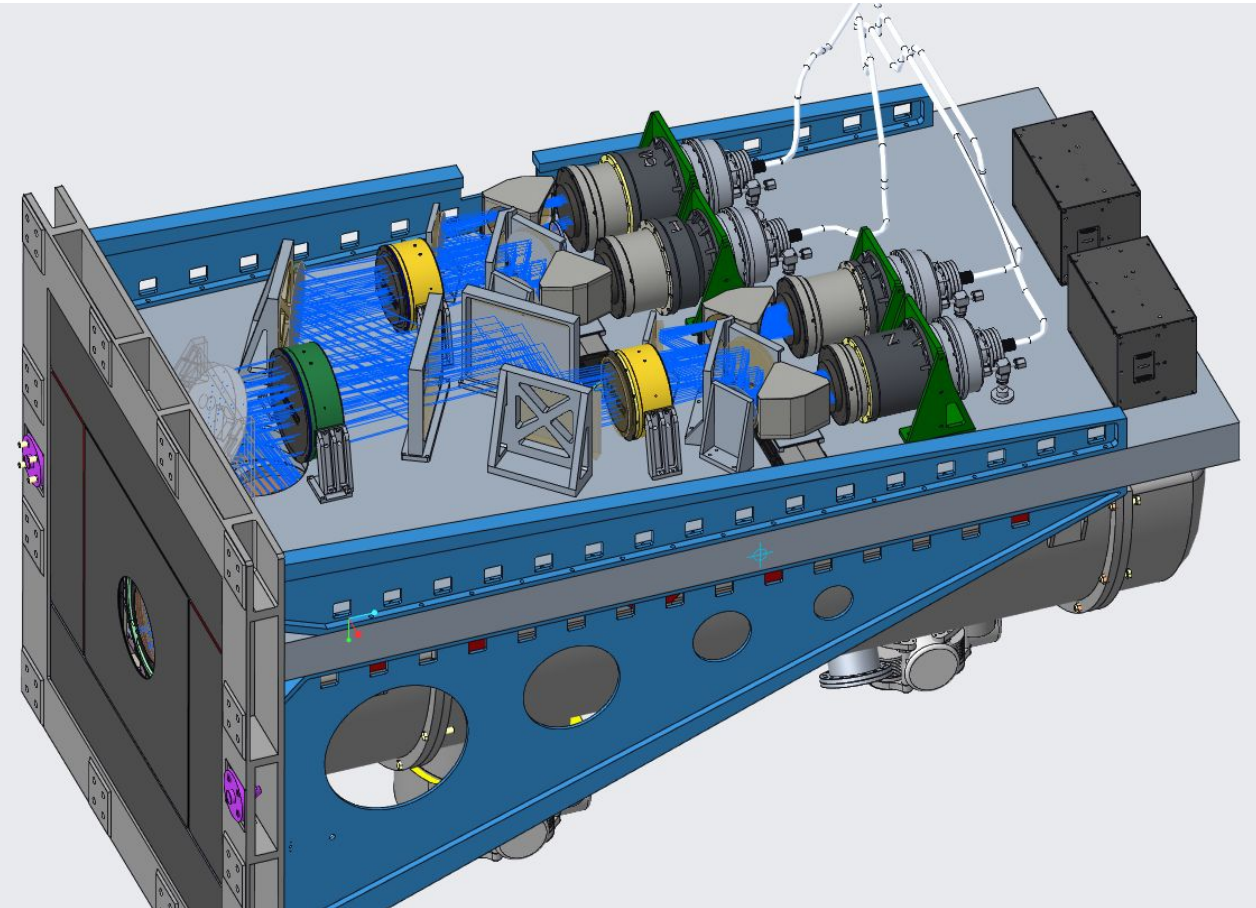
Y, J, H, K

g, r, i, z

NIR Channel



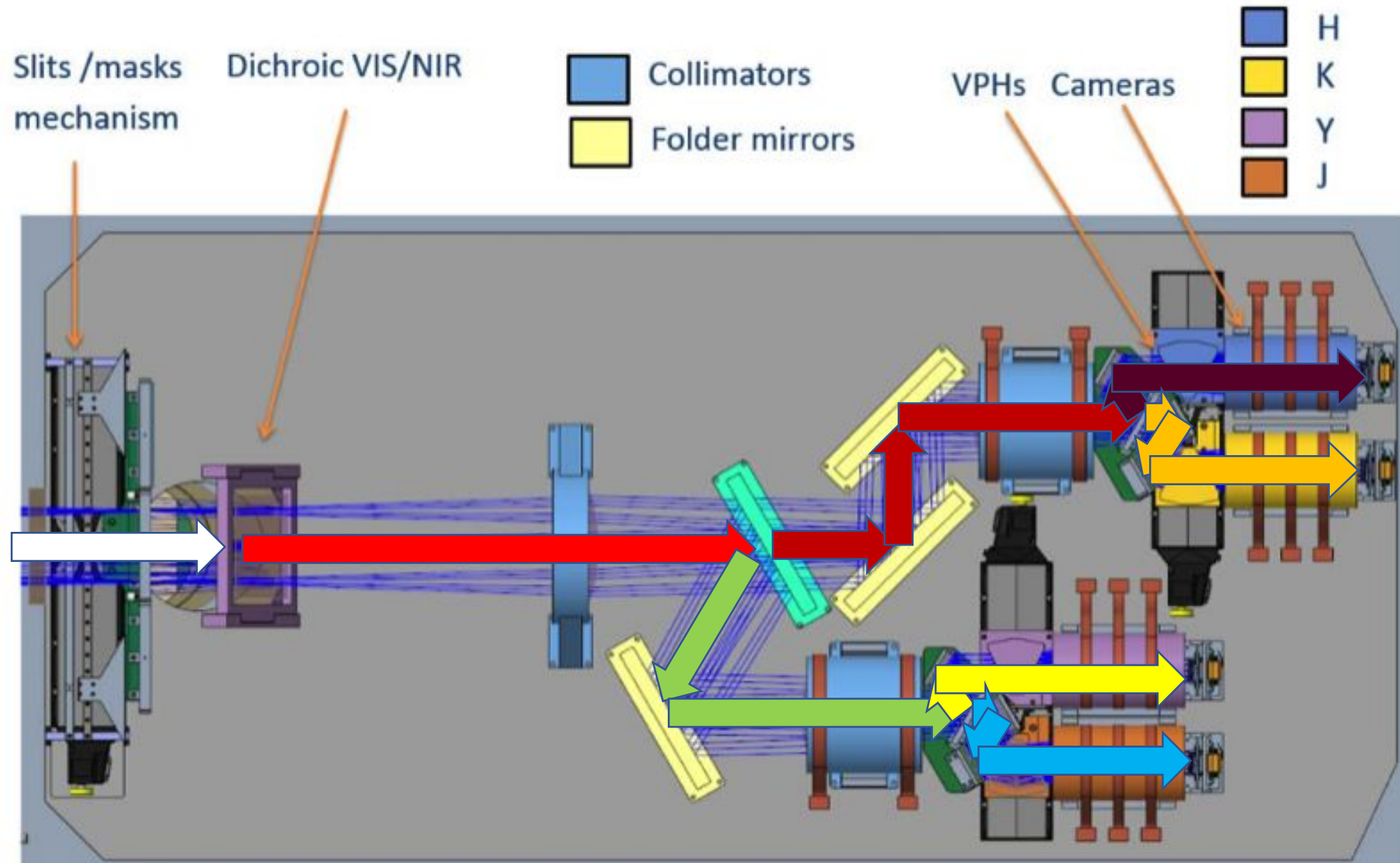
VIS Channel



Infrared side

$f/16 \rightarrow f/2.56$

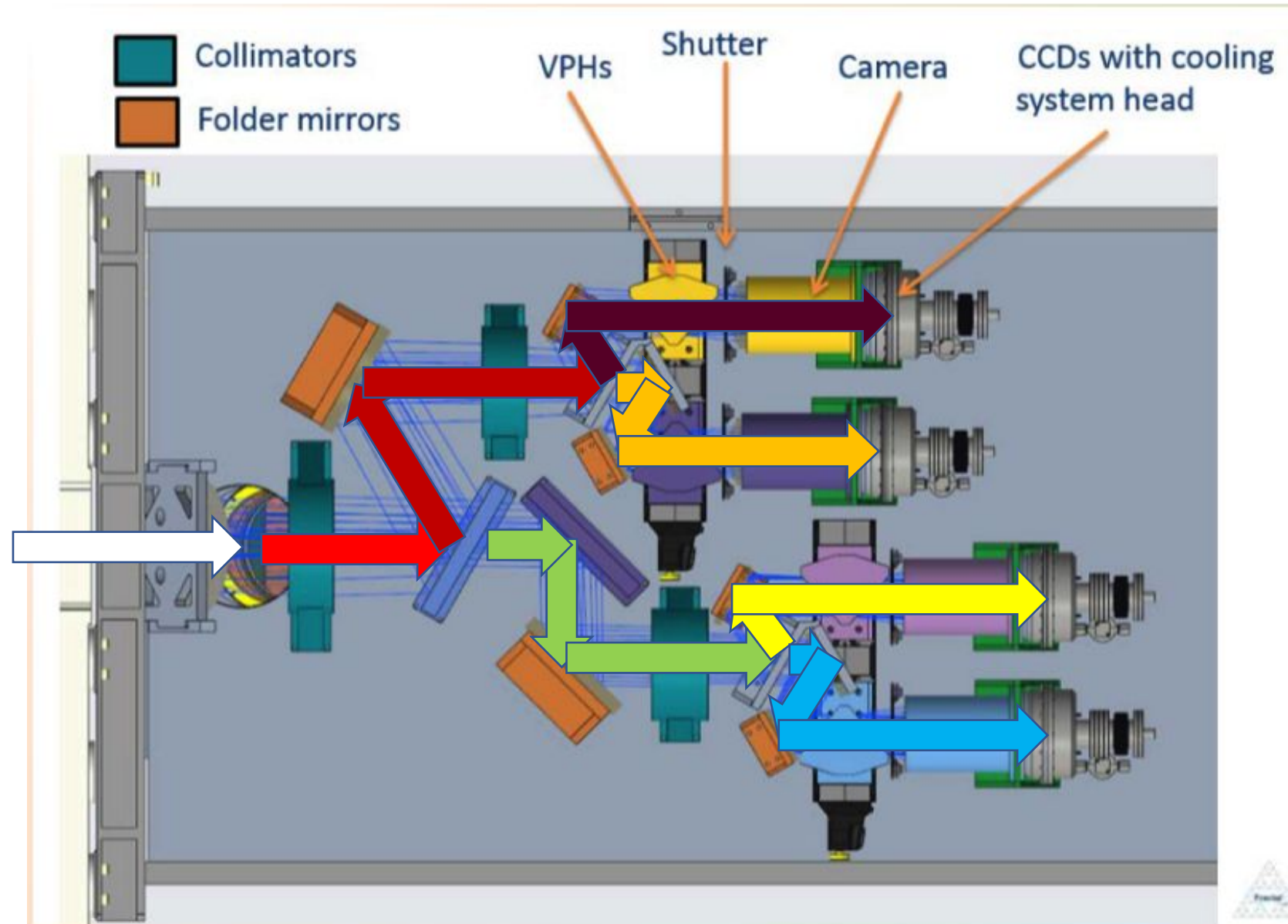
not shown :
Atmospheric Dispersion
Corrector



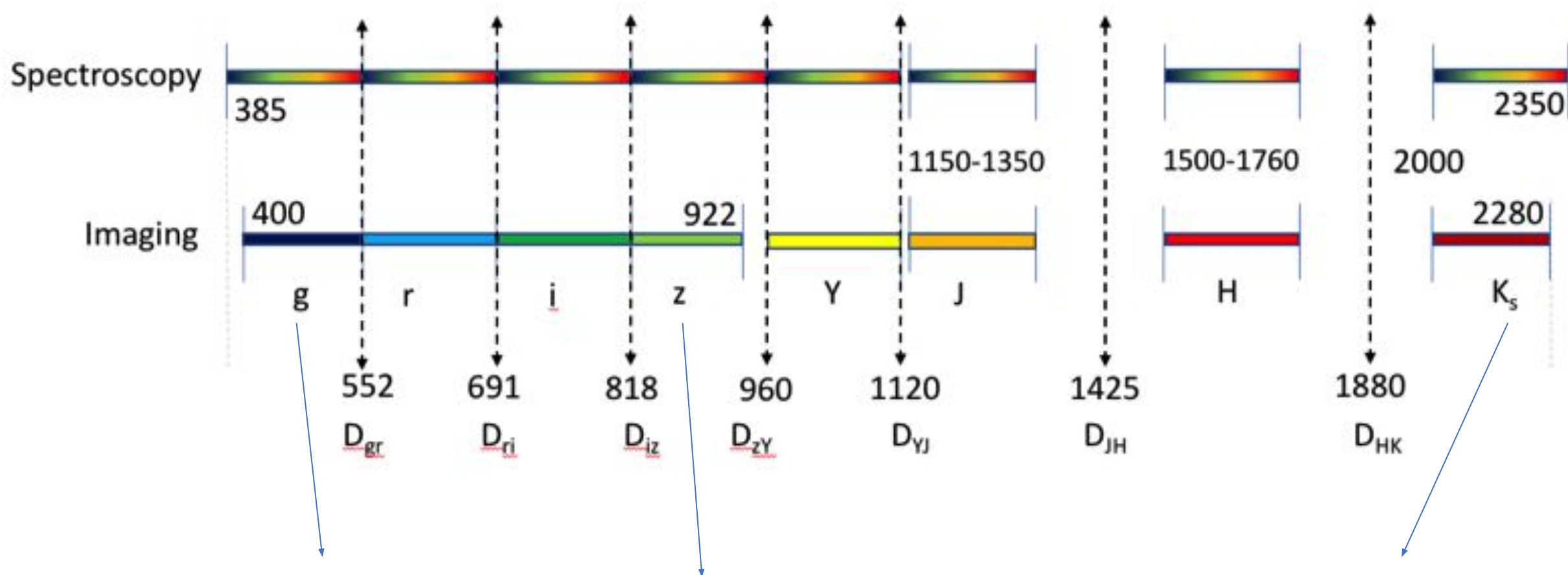
Visible side

$f/16 \rightarrow f/2.15$

not shown :
Atmospheric Dispersion
Corrector



Bandpasses

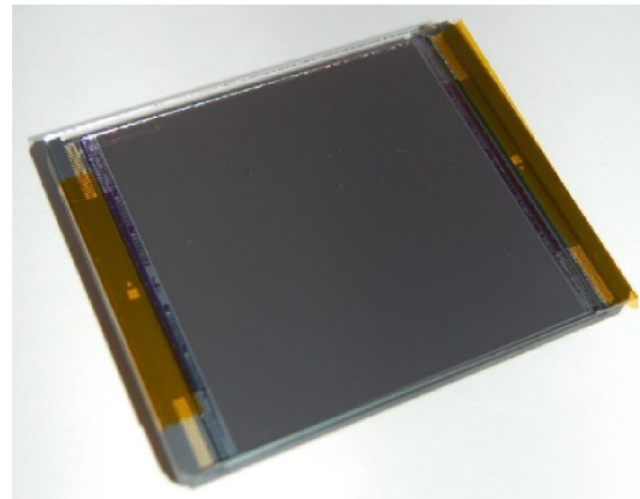


3 retractable filters to delimit bandpass in imaging mode



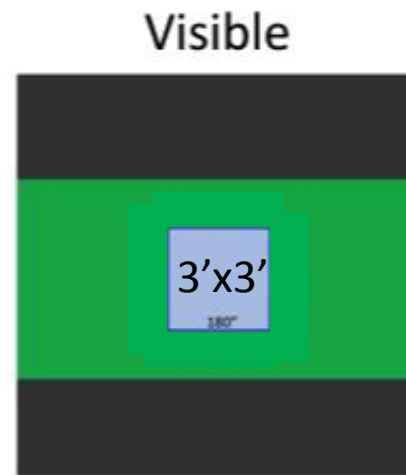
Observing modes

E2V CCD 231-84

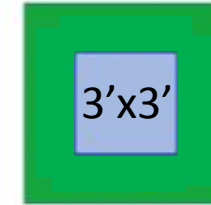


Number of pixels	4096(H) x 4112(V)
Pixel size	15 μm square
Image area	61.4 mm x 61.7 mm
Outputs	4
Amplifier sensitivity	7 $\mu\text{V}/\text{e}^-$
Readout noise (rms)	5 e^- at 1 MHz 2 e^- at 50 kHz
Maximum pixel data rate	3 MHz
Charge storage (pixel full well)	350,000 e^-
Flatness (both packages)	<20 μm (peak to valley)

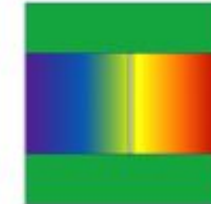
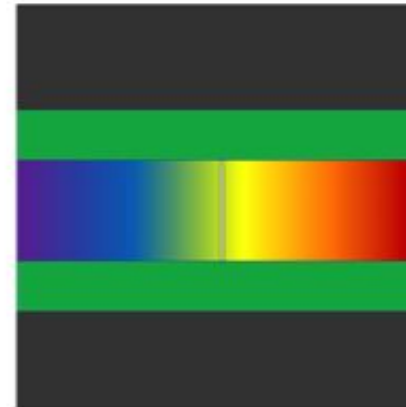
Imaging



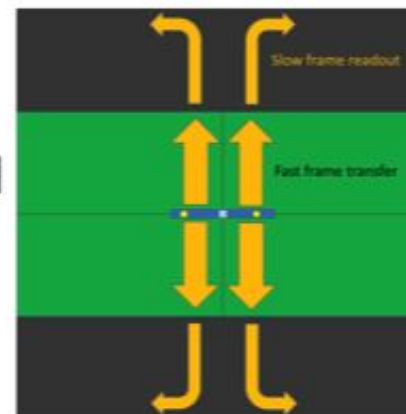
Infrared



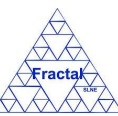
Spectroscopy



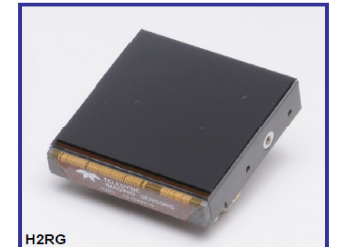
High-speed Imaging



4kx4k e2v CCD231-84



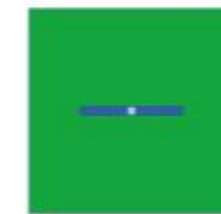
Hi2RG



Format	2048x2048
Pixel size	18 x 18 micron
Readout Speed	200 KHz
Output lines	32

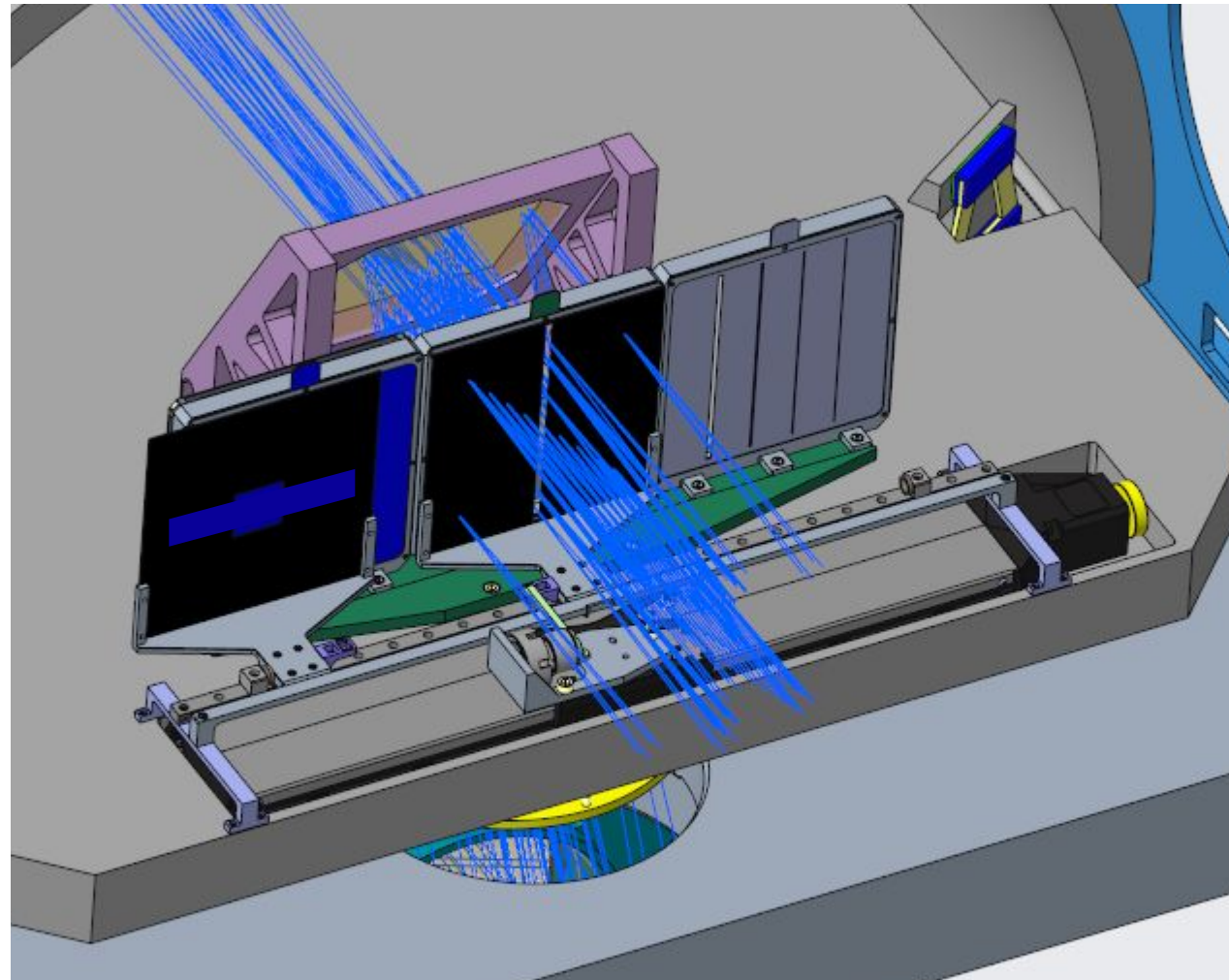
3' x R~4000 spectra

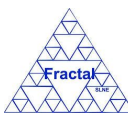
18'' x 3' at 50ms/frame



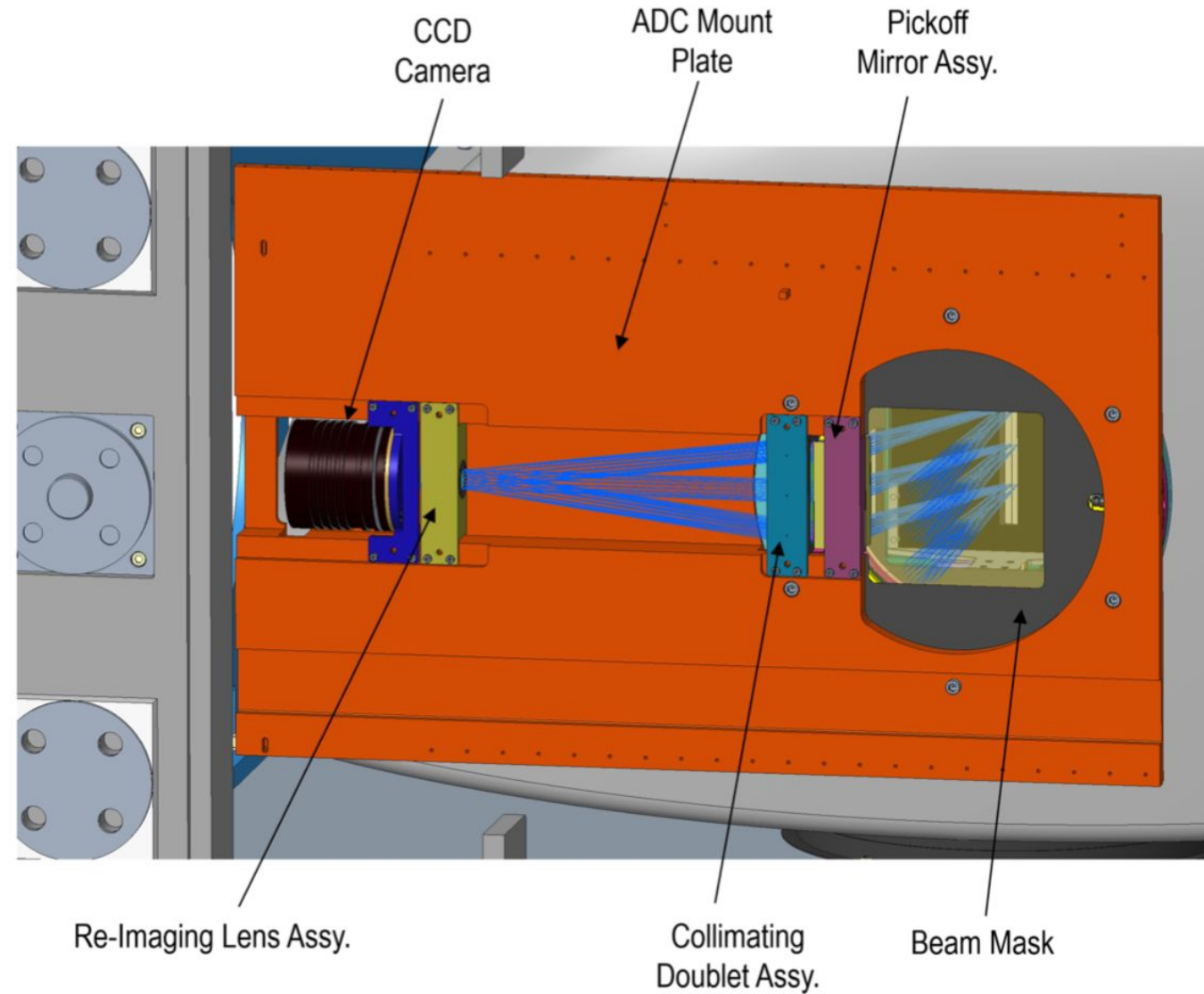
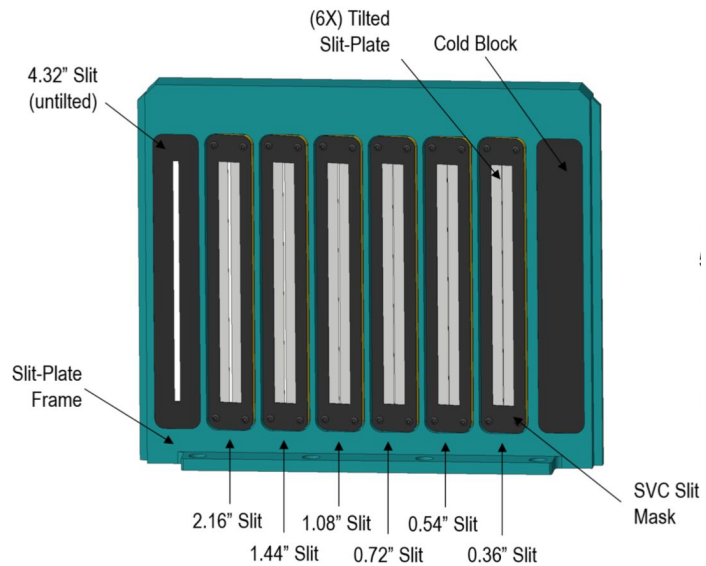
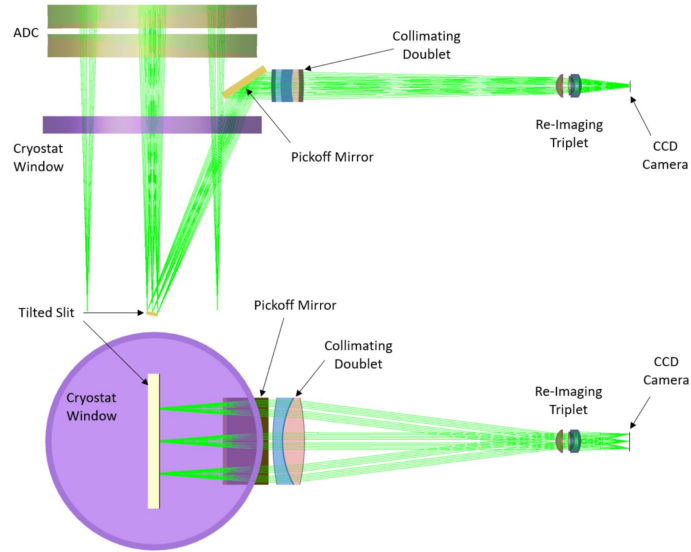
2kx2k Hi2RG

Focal Plane Mechanism

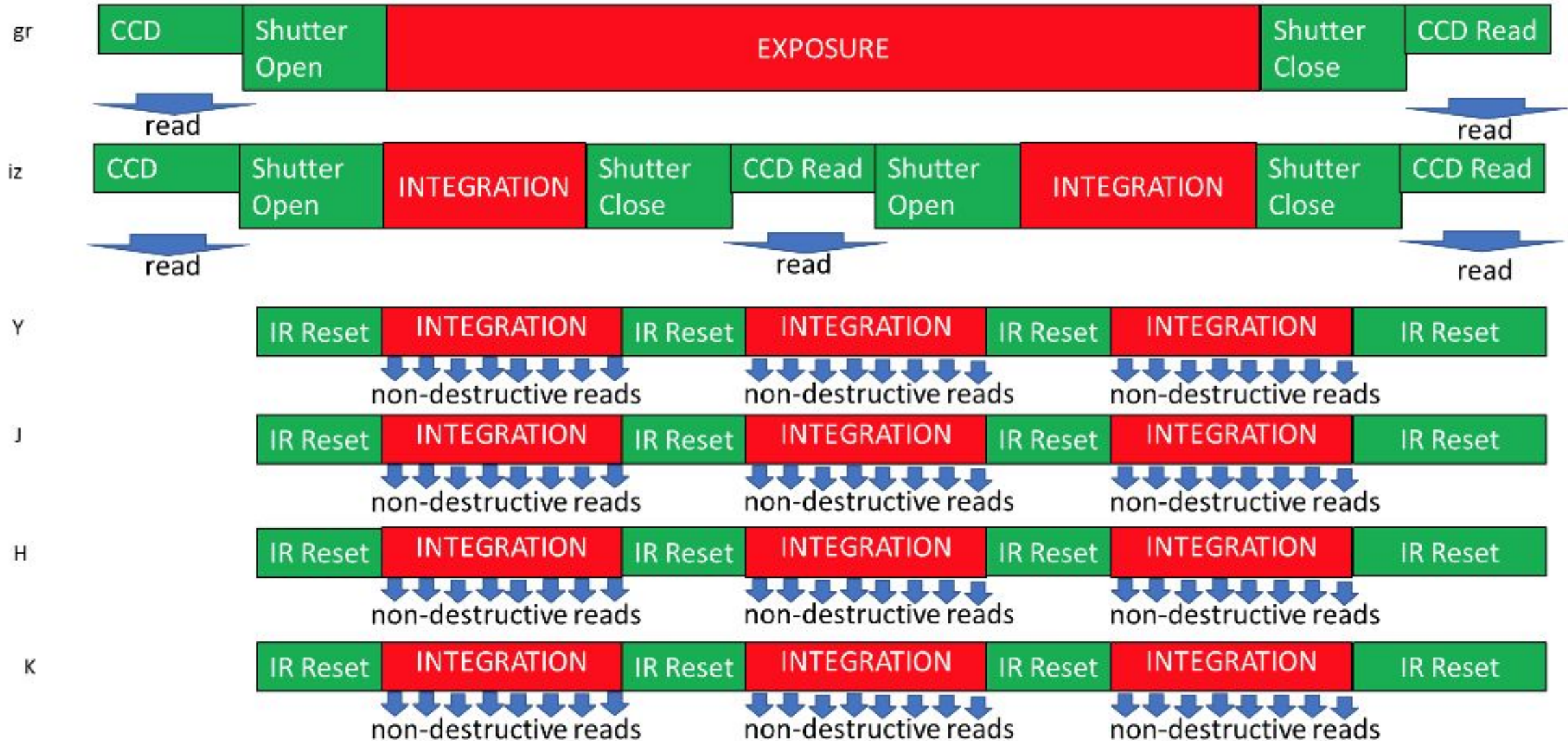




Slit Viewing Camera



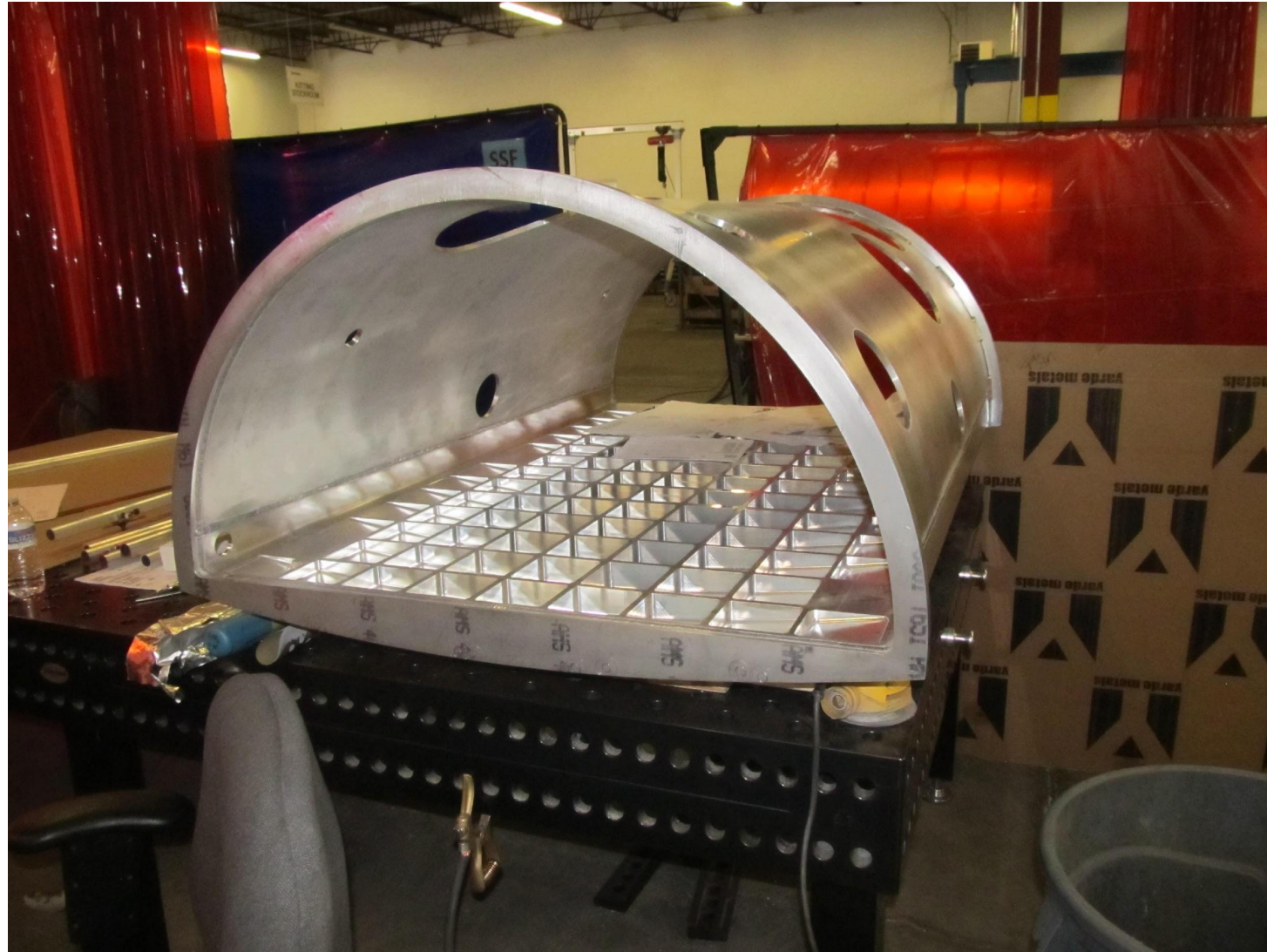
A sample exposure



Project Status

- ✓ Concept Design Kickoff (Mar 2017)
- ✓ Systems Requirements Review (May 2017)
- ✓ Concept Design Review (Aug 2017)
- ✓ Preliminary Design Review (Apr 2018)
- ✓ Optical Design Review (Sep 2018)
- ✓ Critical Design Review (Apr 2019)
- ✓ Manufacturing & Sub-system level AIV (Oct 2019- Oct 2021)
 - System level AIV (Oct 2021- Oct 2023)
 - Final integration and Performance Testing (Oct 2023-July 2024)
 - Delivery to Gemini (July 2024)

Cryostat construction at Dynavac



End caps completed

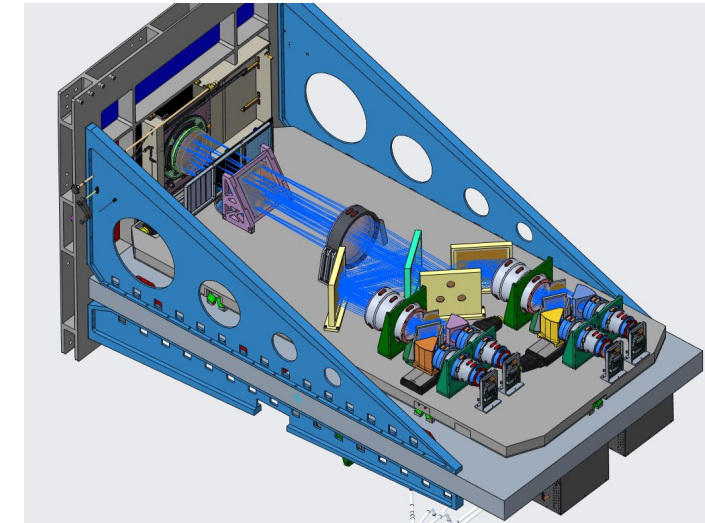


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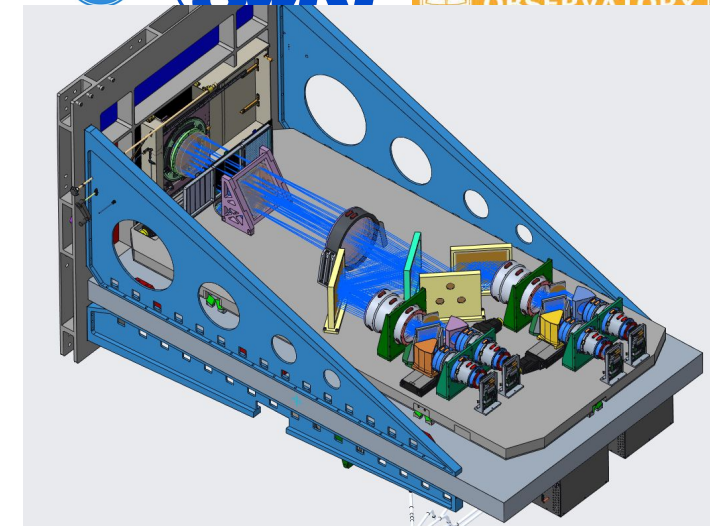


Cryostat delivery date: early October 2022

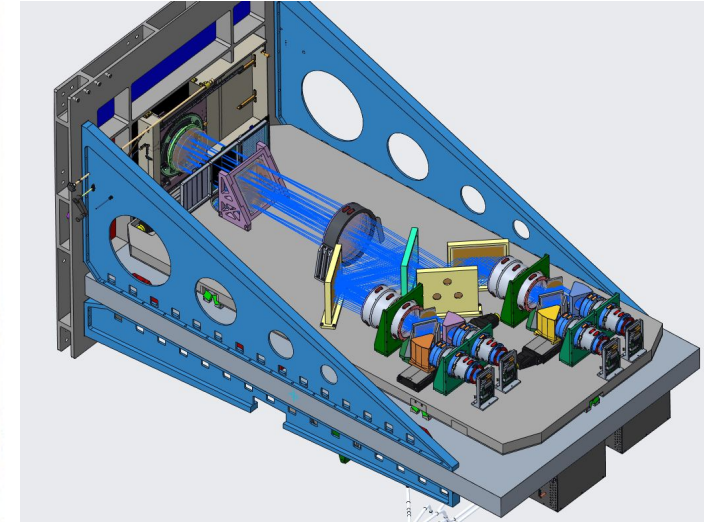
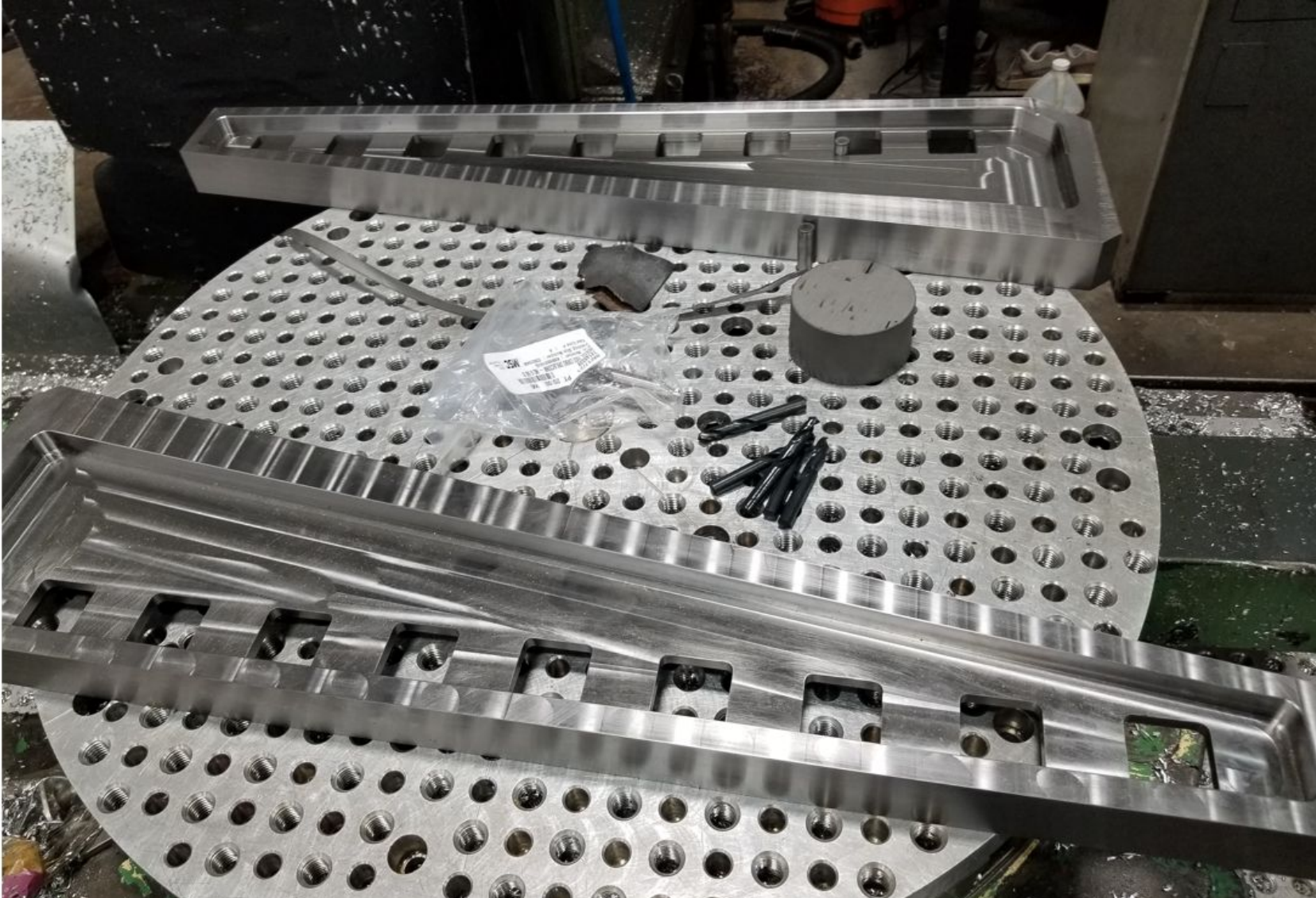
Big Ti frame: completed April 2022



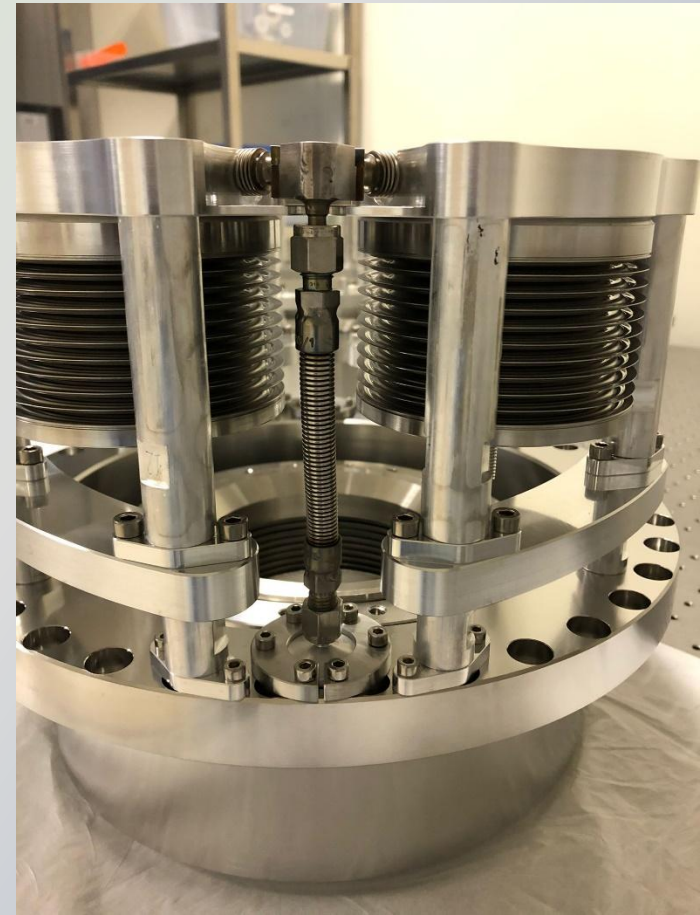
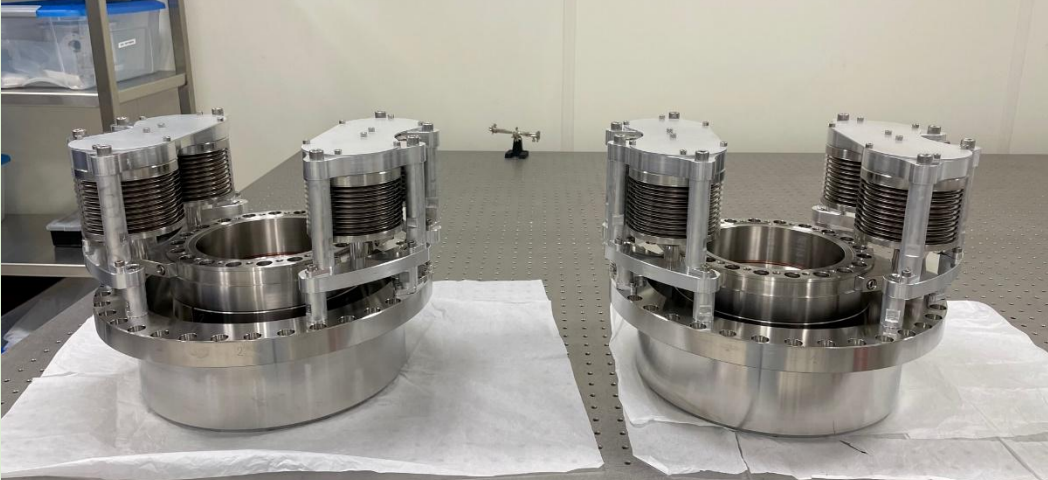
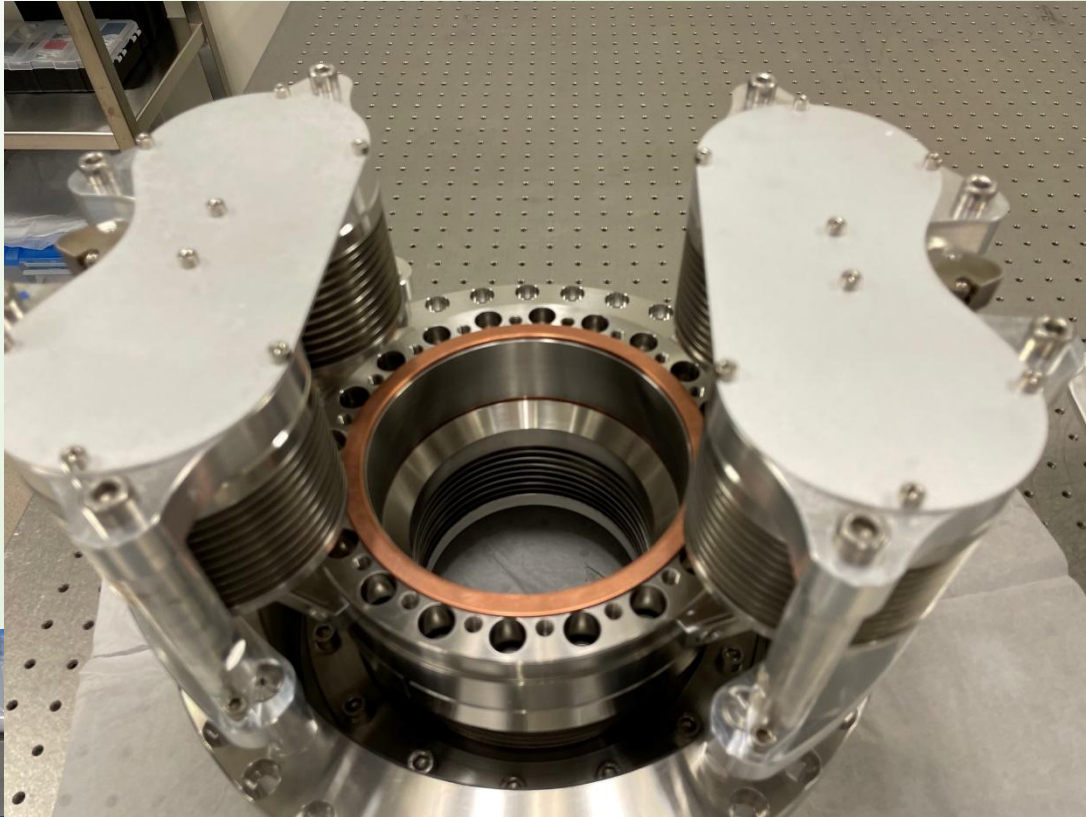
Large Ti gussets



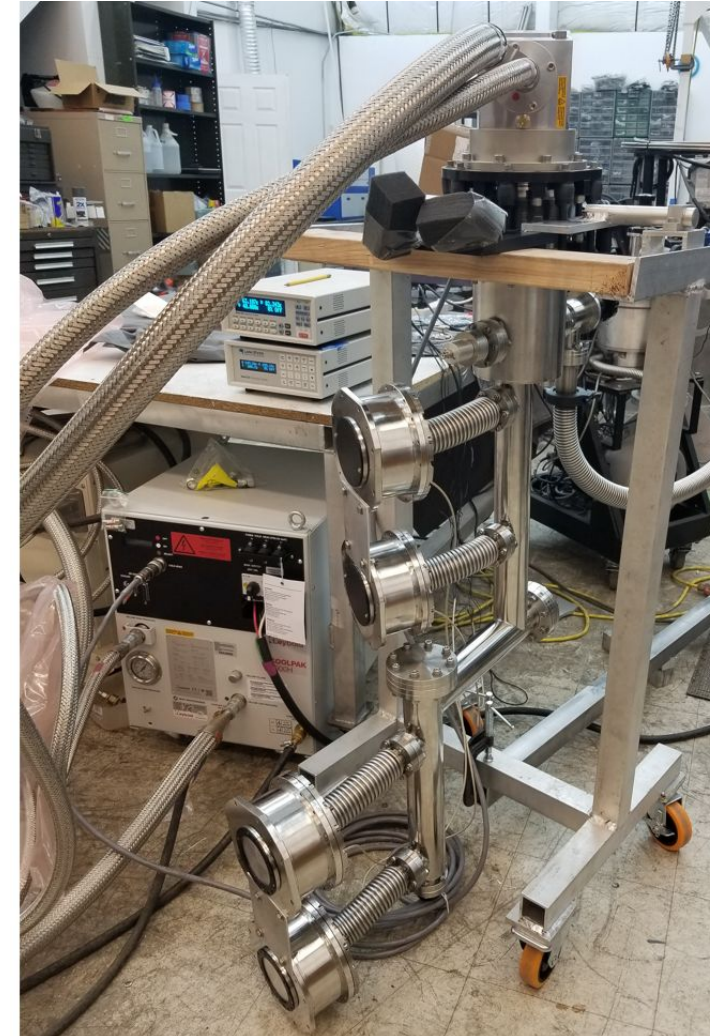
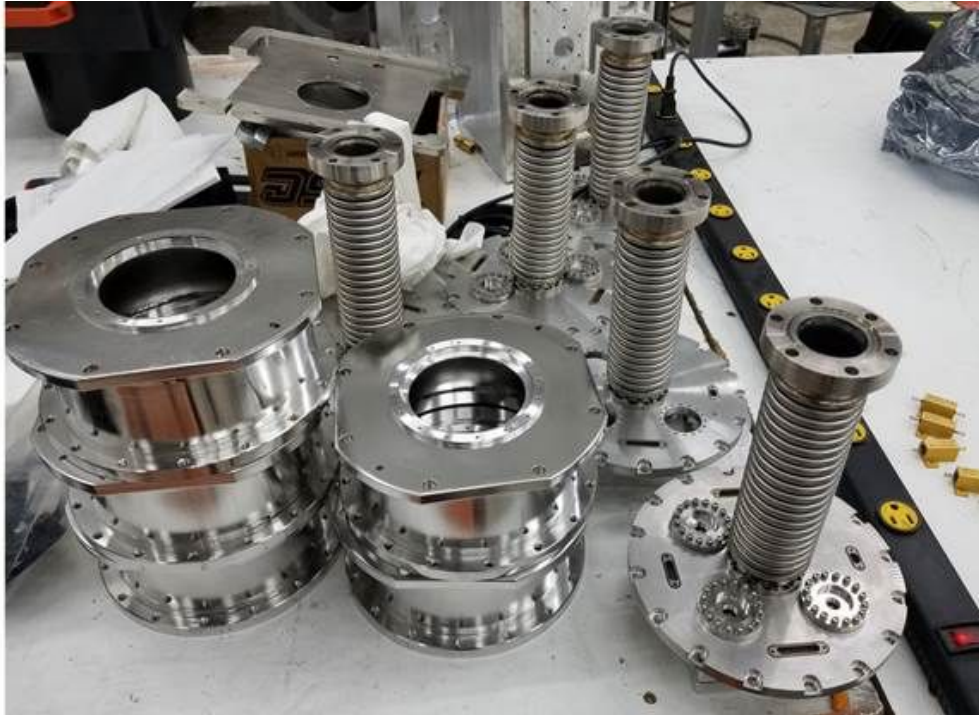
Small Ti gussets

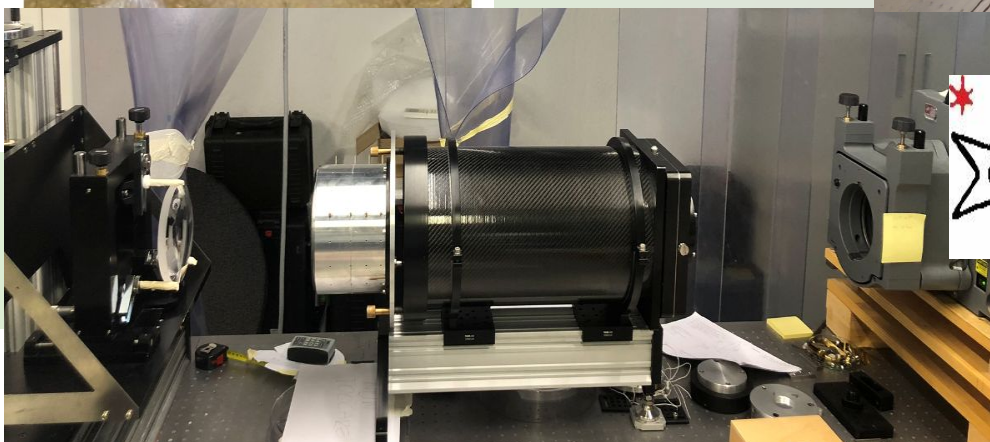
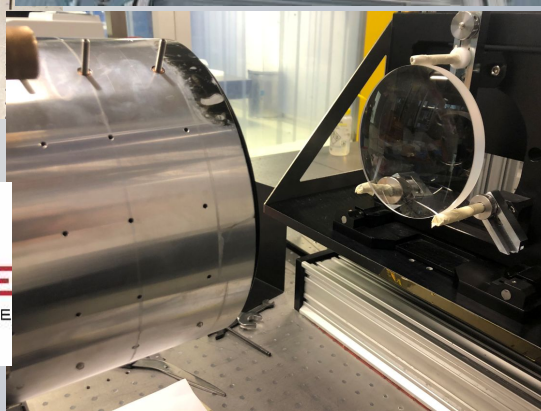
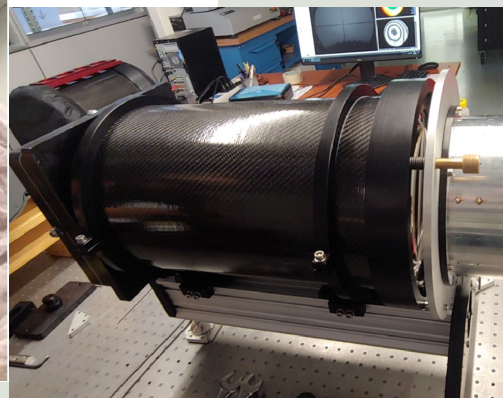


Anti-Vibration Mounts

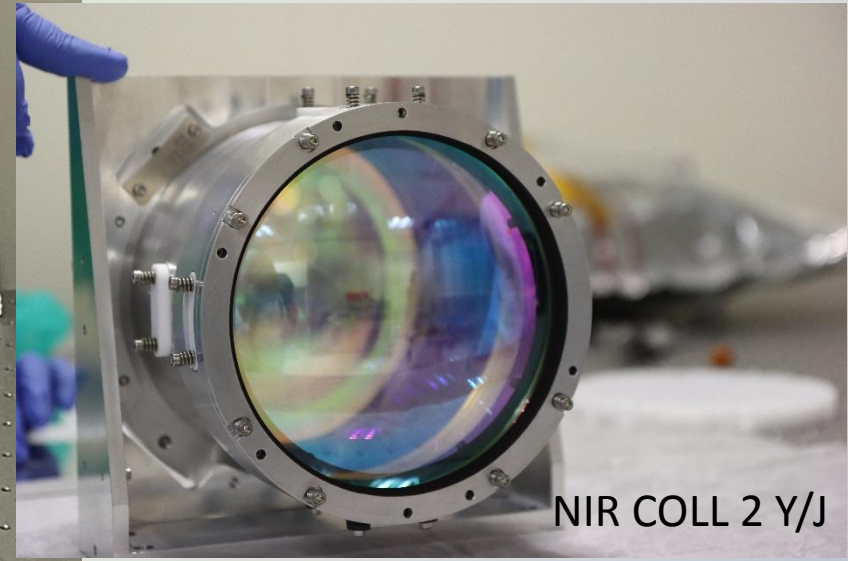
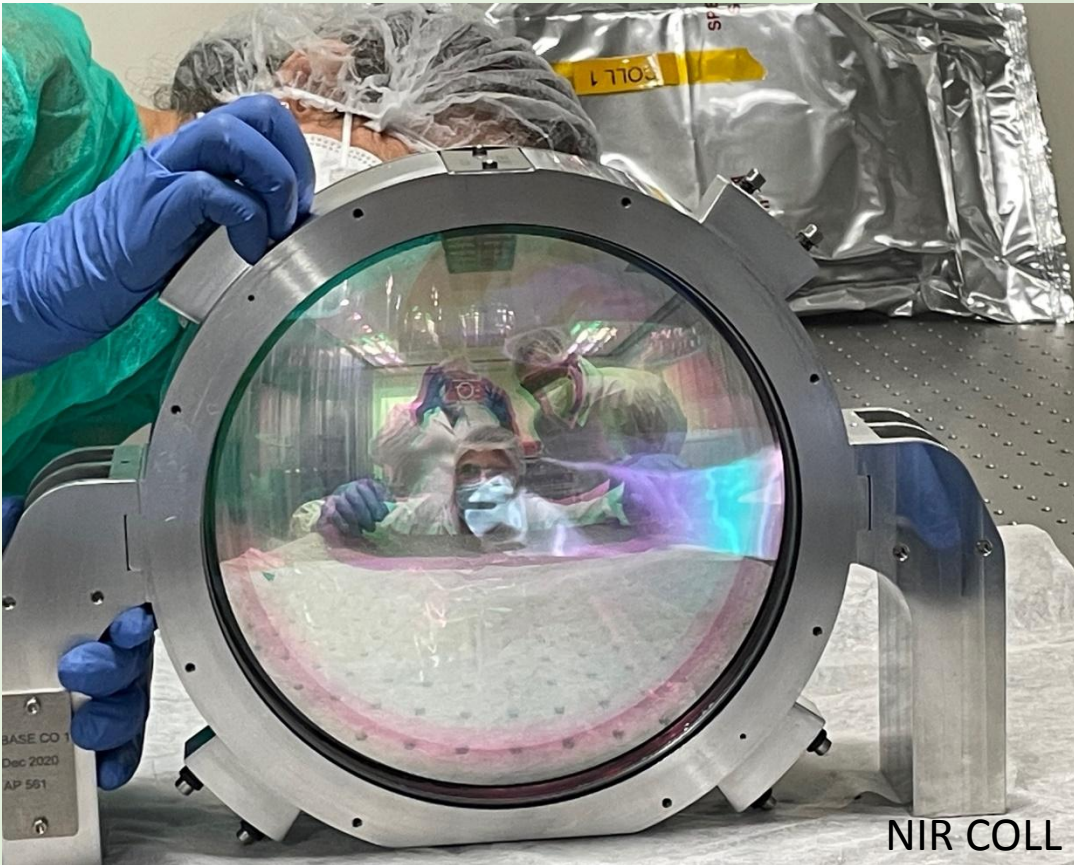


CCD Camera heads at Unicryo





NIR Collimator and camera inspection



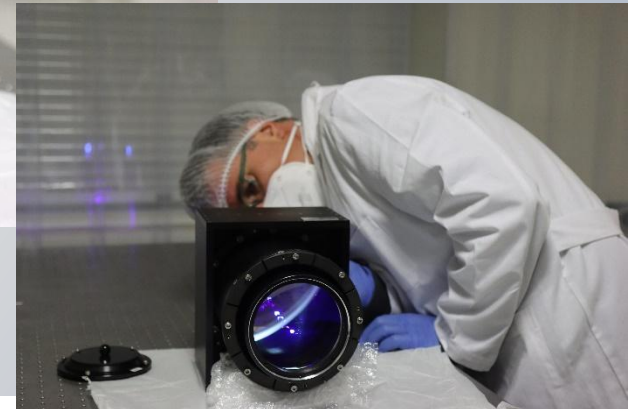
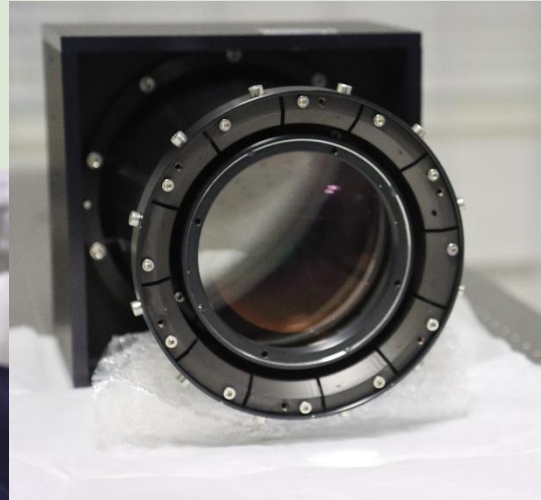
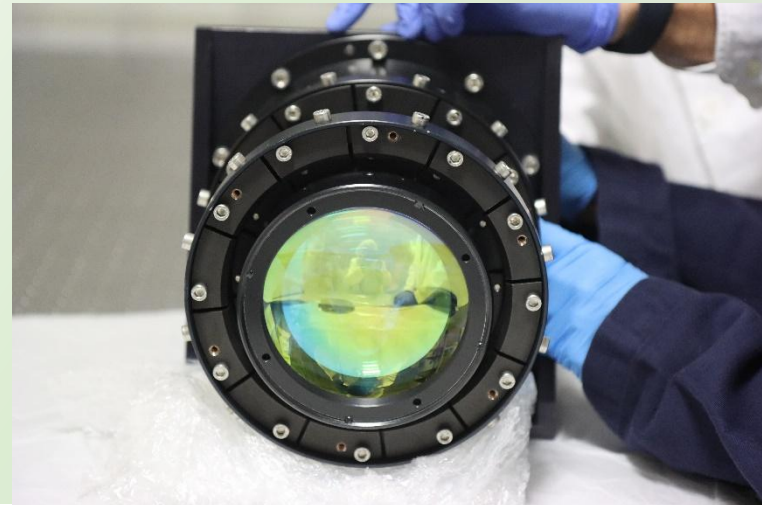
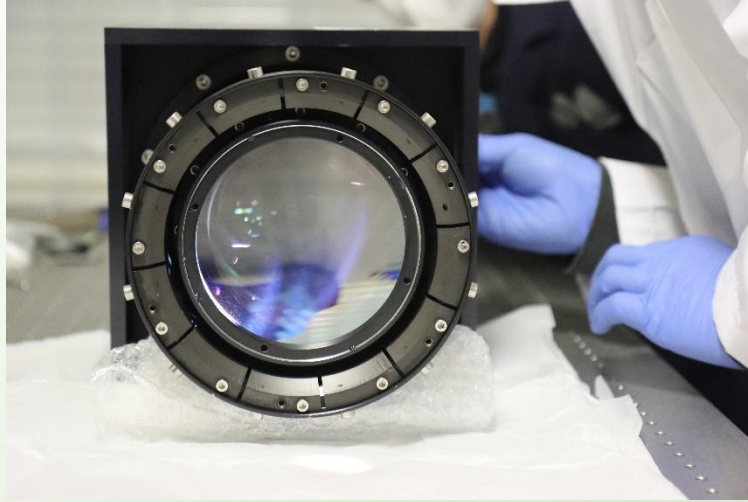
VIS Collimators and Cameras: ACCEPTED



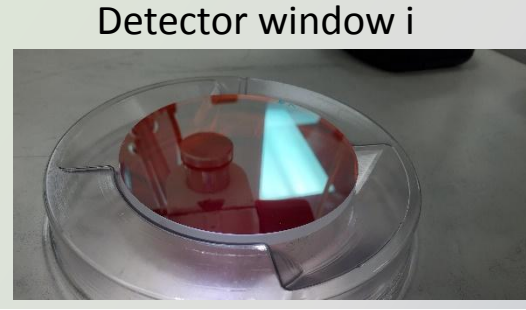
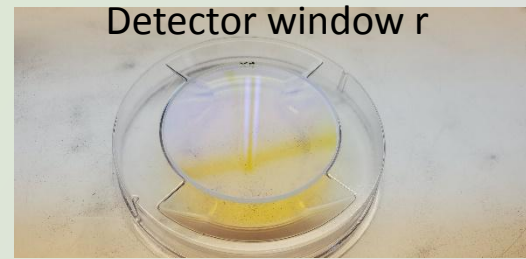
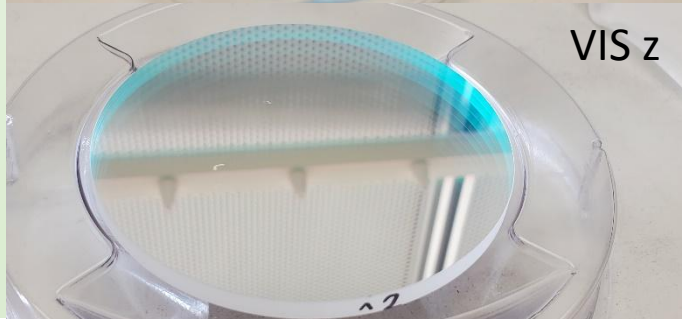
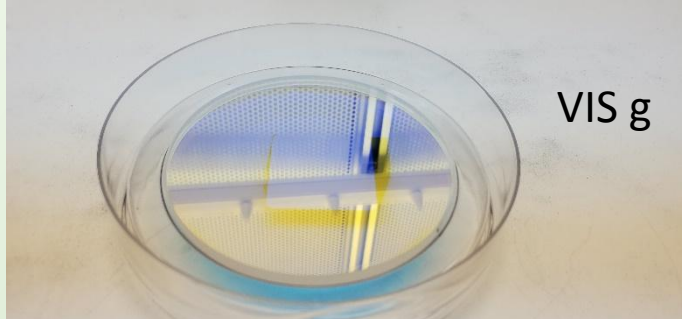
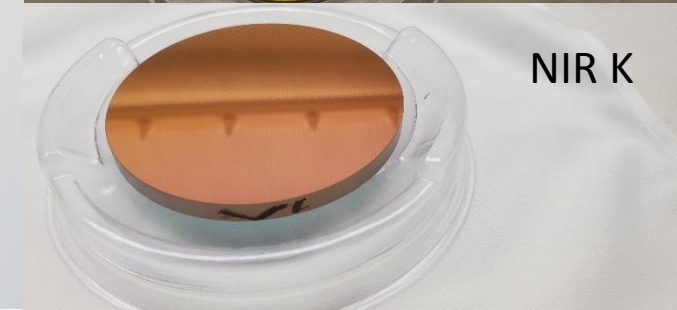
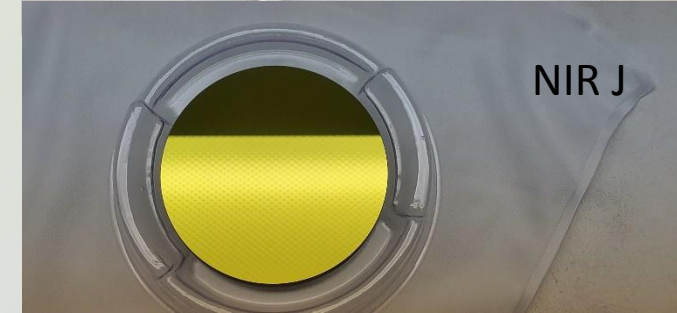
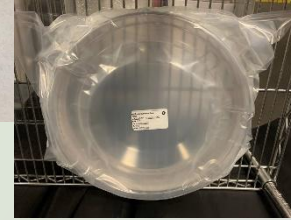
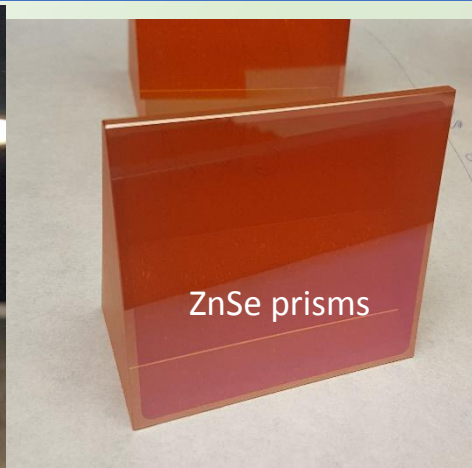
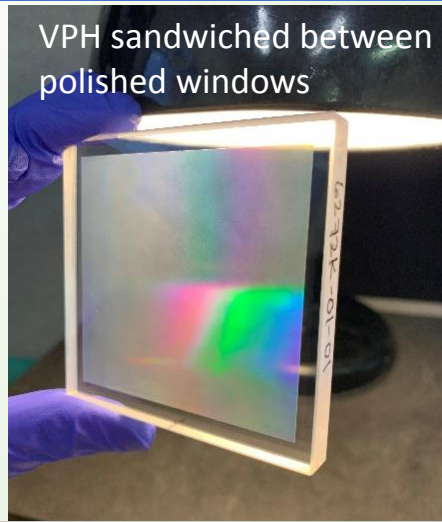
Winlight System



VIS Collimator and camera inspection

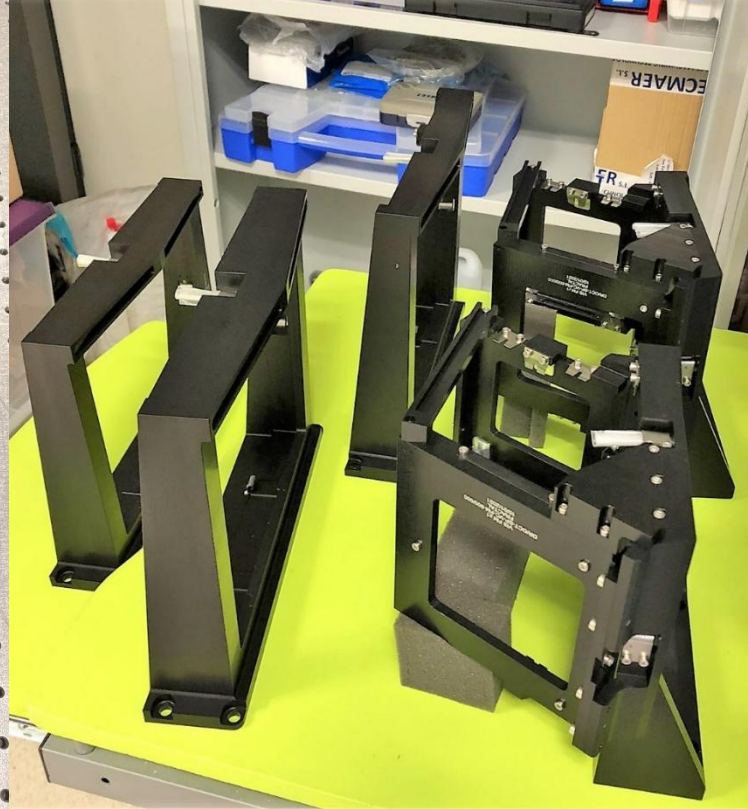


Optical elements

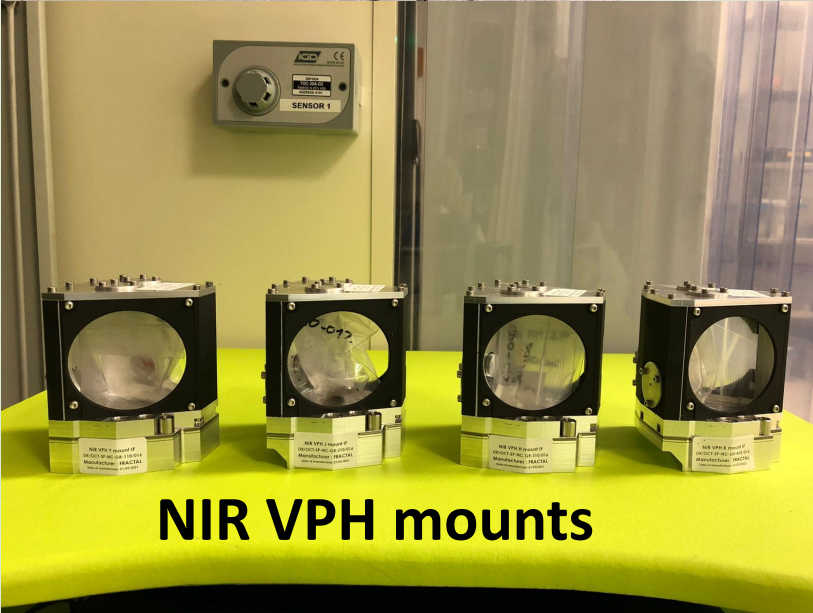




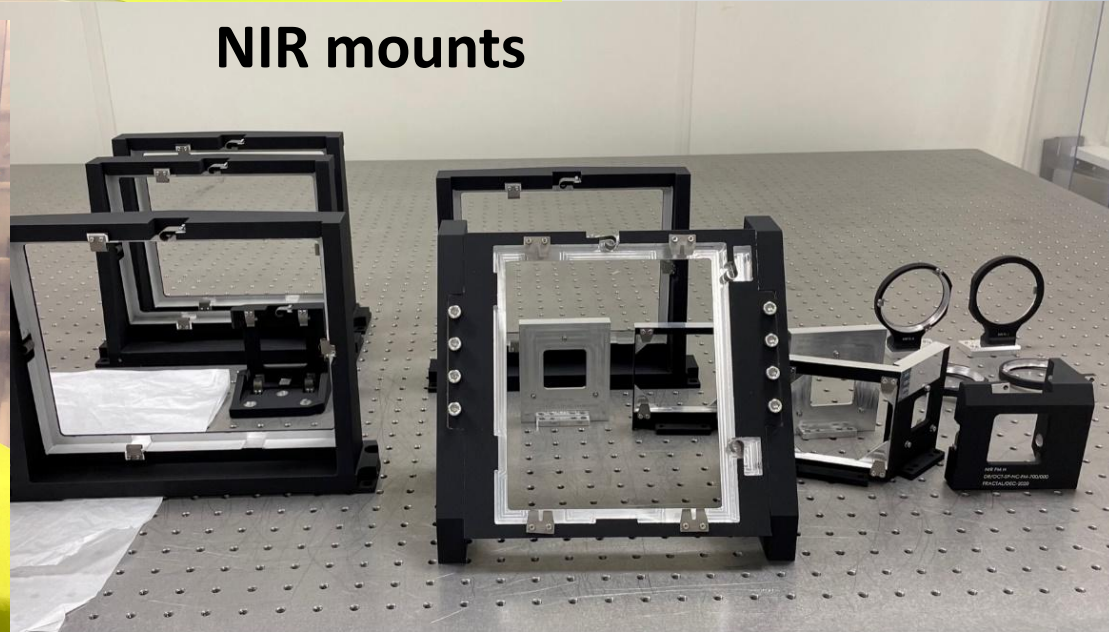
VIS VPH mounts



VIS mounts

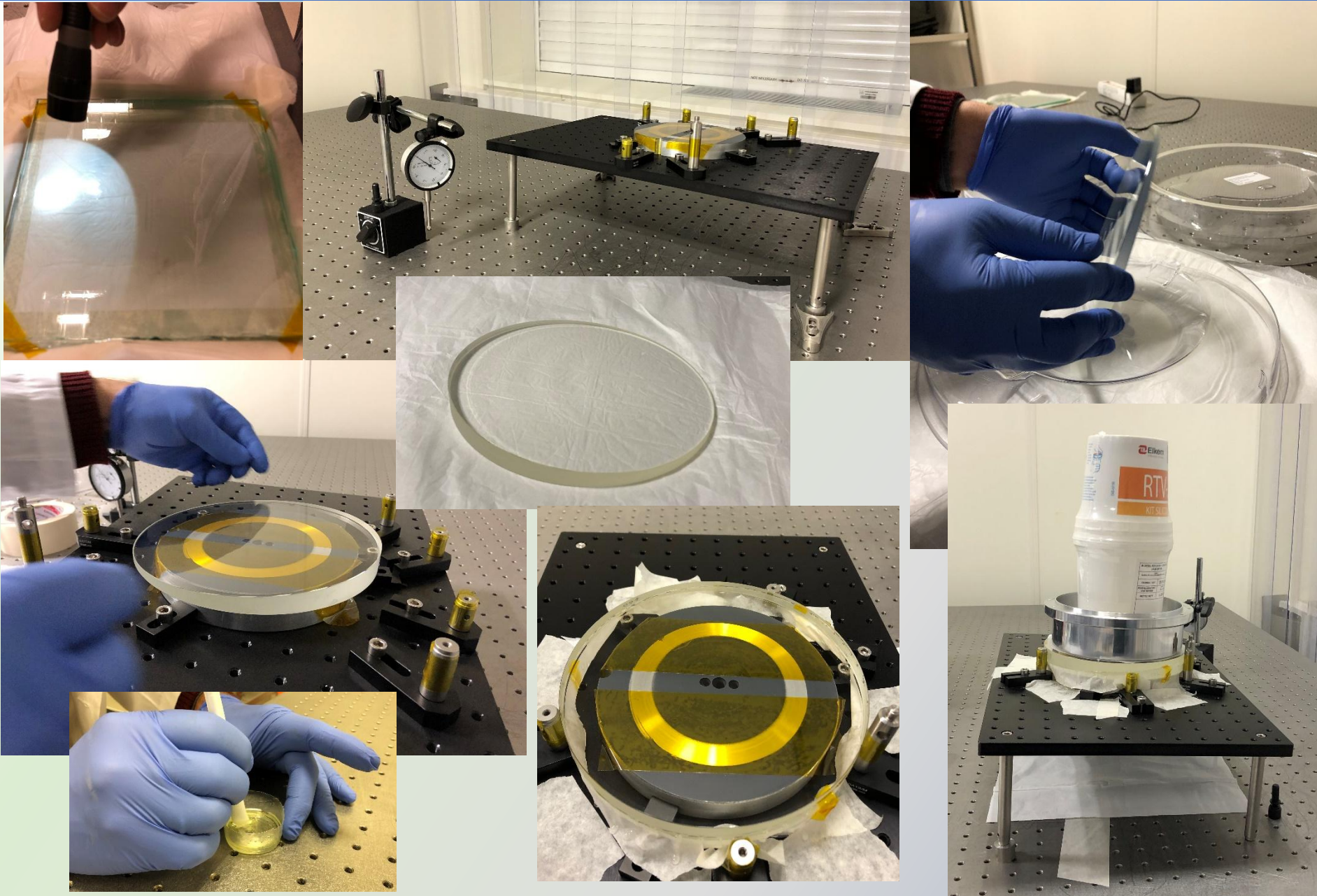


NIR VPH mounts



NIR mounts

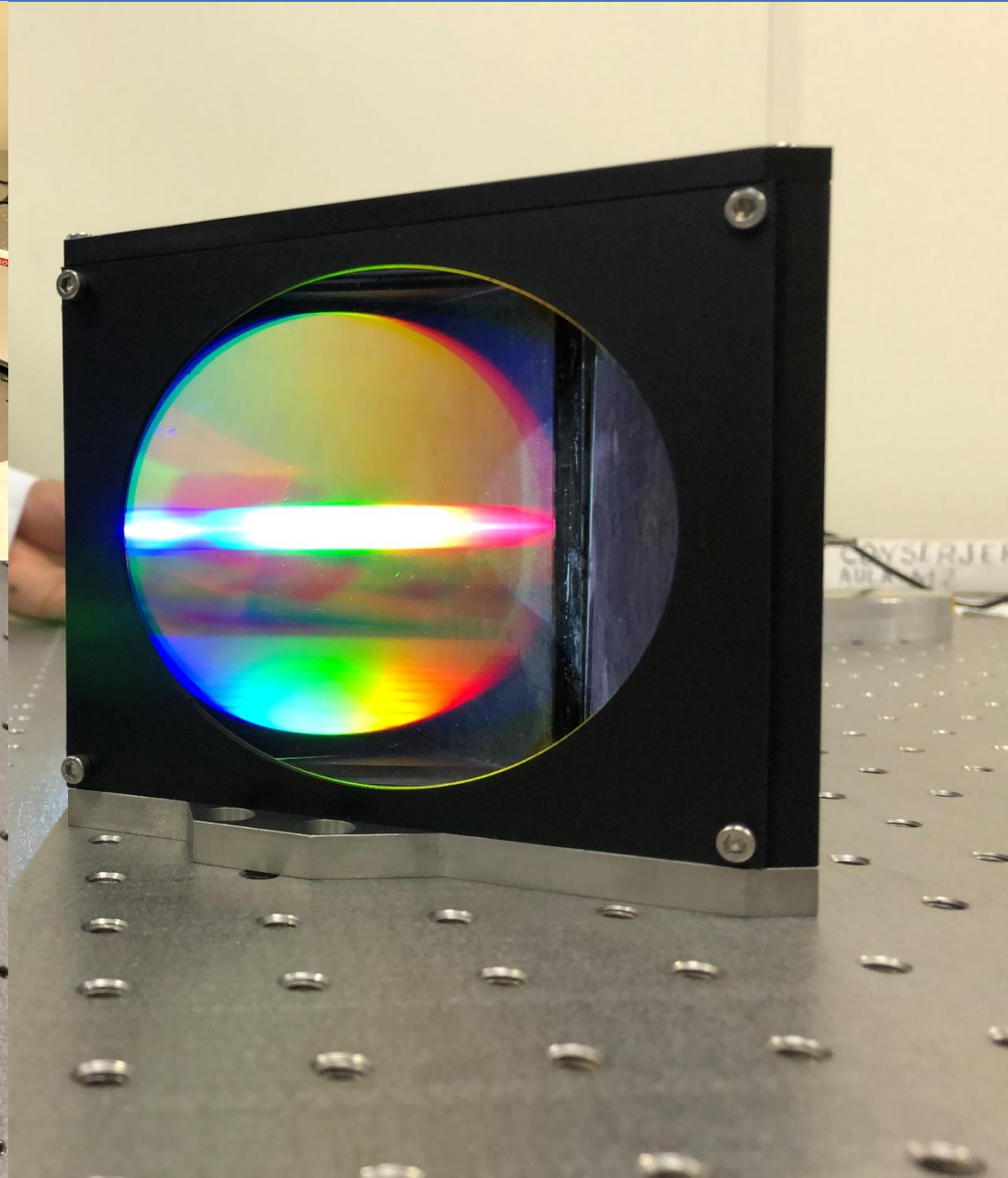
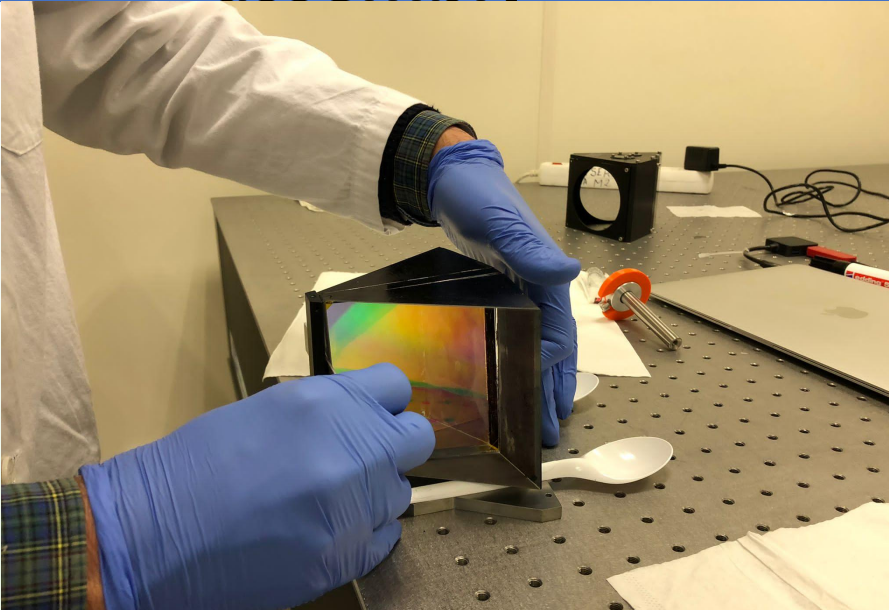
ADC prims gluing



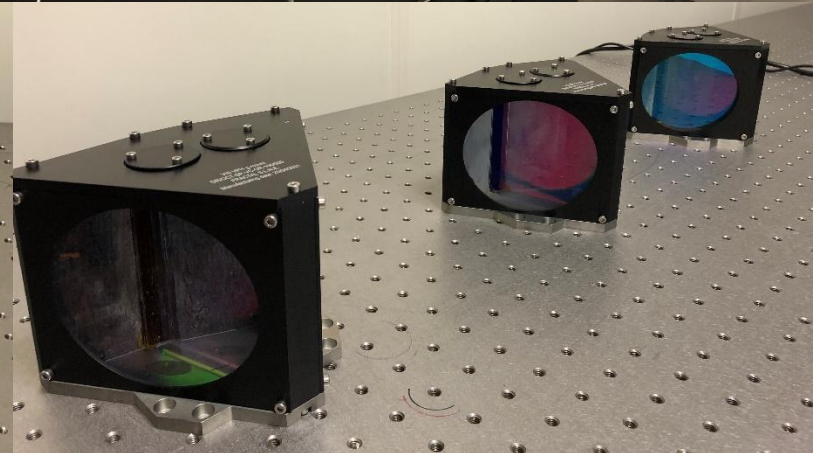
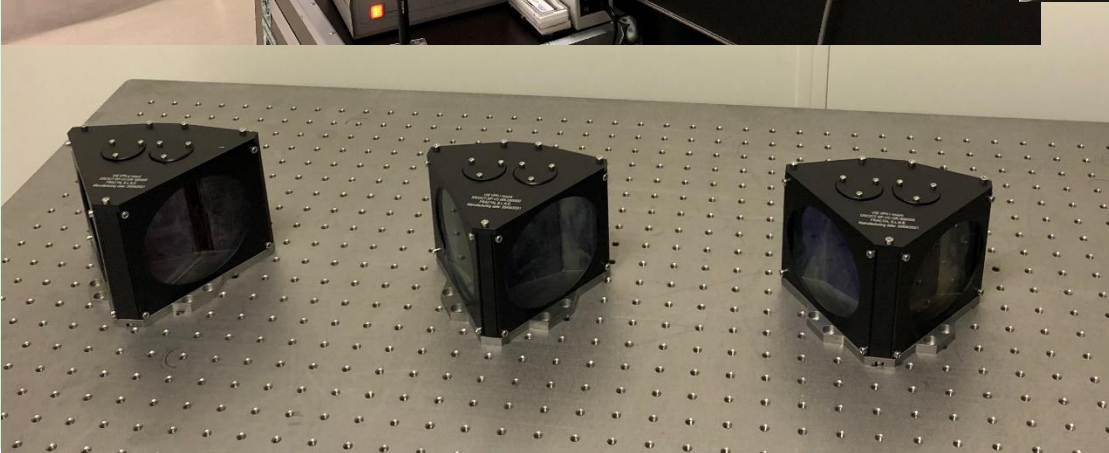
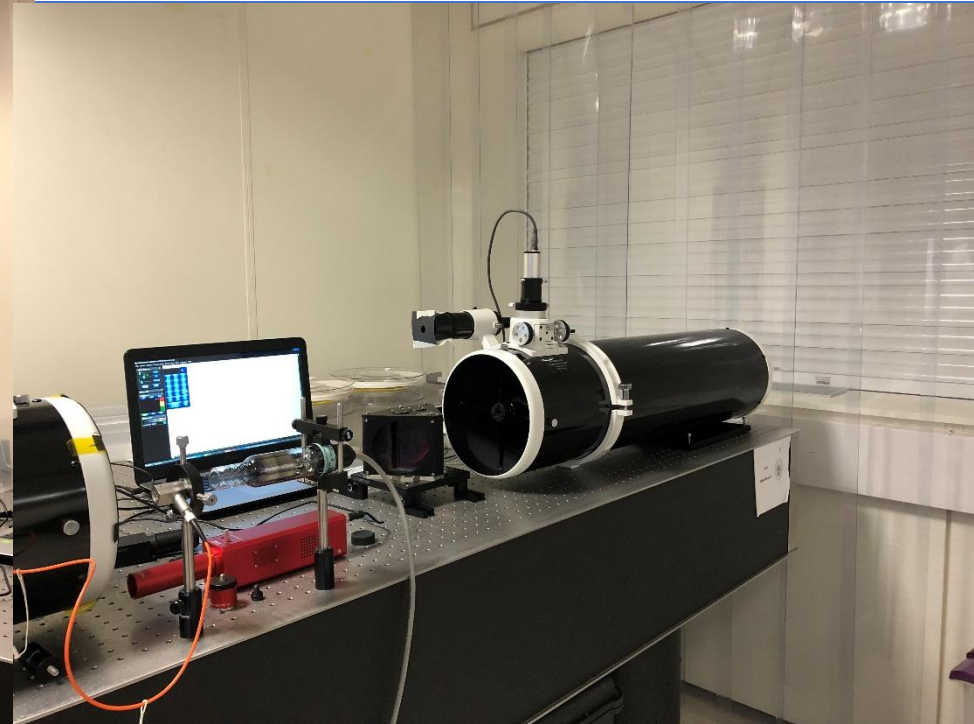
VPH-g bonding



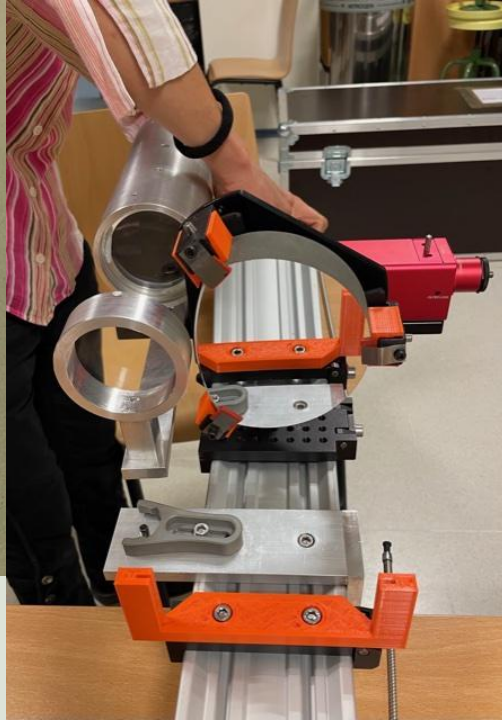
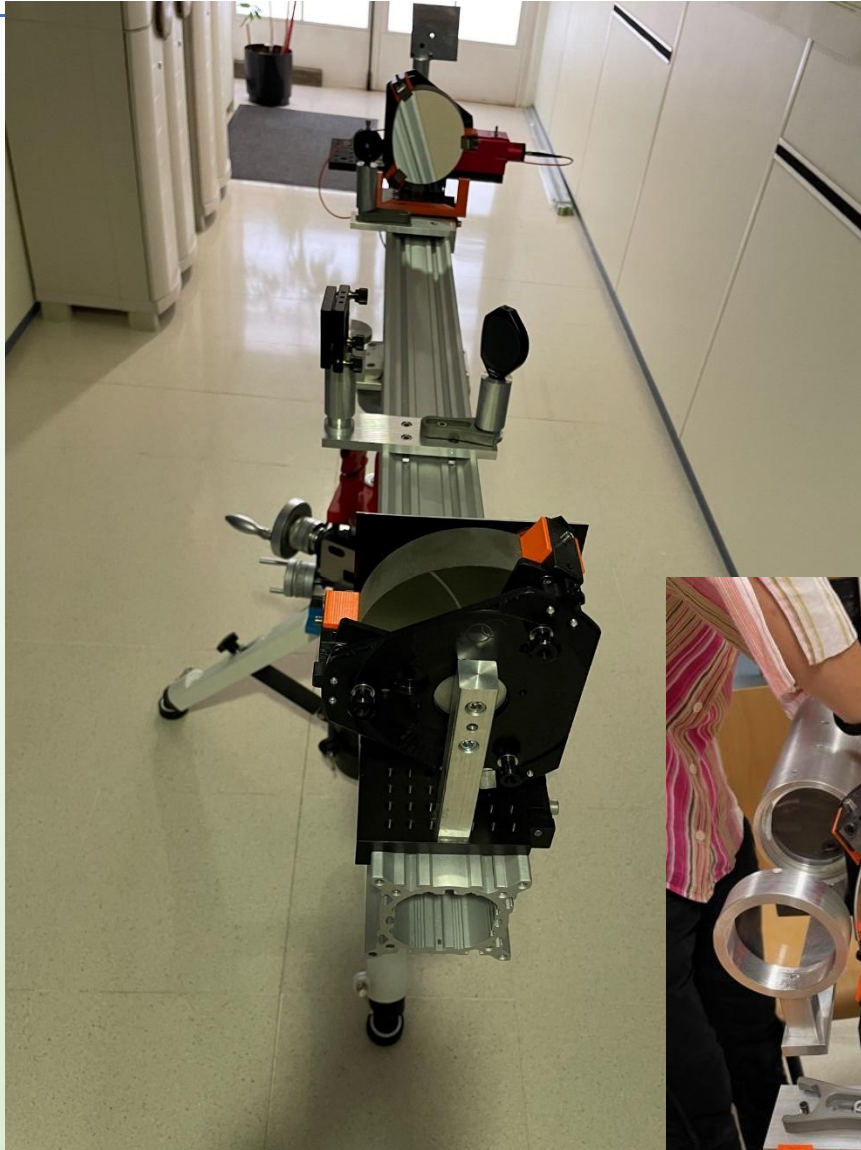
VPH-g Optics/Opto-mechanics assembly



VPH-g, r, i Tests (set-up)



Telescope Simulator



Conclusion

- SCORPIO is approaching the end of the Manufacturing and Sub-System Assembly, Integration and Verification Phase, and entering the System AIV.
- COVID had a major impact on manufacturing schedule, but the extra time has provided an opportunity for refining various details related e.g. to operations, SW, etc.
- A very strong collaboration has been established between the SCORPIO instrument team and the Gemini staff. Critical for such an operationally complex instrument.
- SCORPIO is expected to be delivered to Gemini-S in mid 2024, offering from day 1 a rich set of new and unique science capabilities