SOXS Instrument Overview

P. Schipani

SOXS Consortium Science Meeting
Napoli, 25-27 June 2024

Son Of X-Shooter

- Single-object wide band spectrograph from U to H band @ESO-NTT 350-2000 nm
- *'Similar'* to X-Shooter @VLT
- Two arms (VIS + NIR) with partial overlap around 800 nm to cross-calibrate spectra
- R~4,500 (3,500-6,000)
- Acquisition camera to perform photometry ugrizY-V (3.5' FoV)

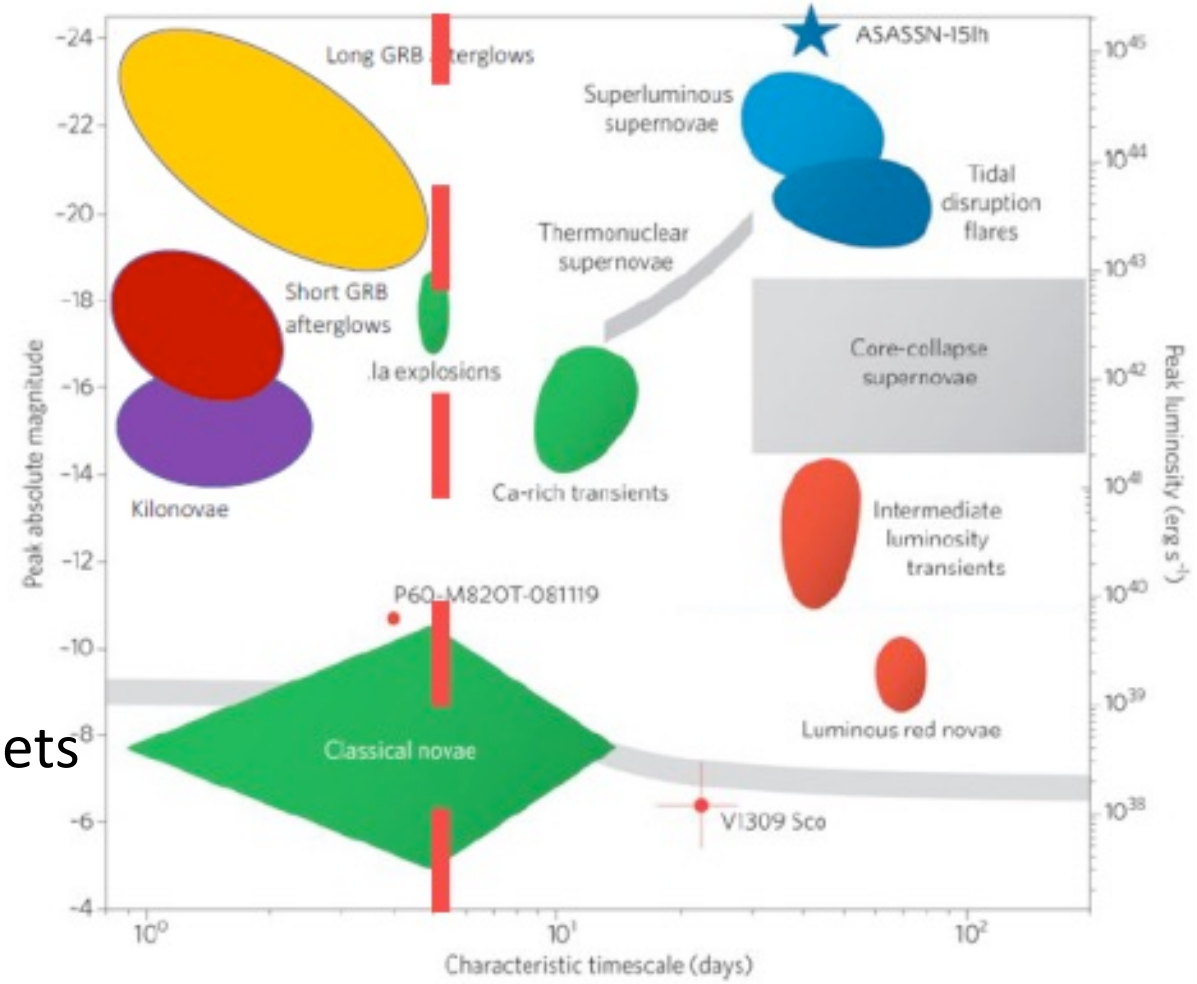
Consortium

Institutes from 6 Countries

- Istituto Nazionale di AstroFisica (INAF), Italy
- Department of Particle Physics and Astrophysics, Weizmann Institute of Science, Rehovot, Israel
- Instituto de Alta Investigación, Universidad de Tarapacá, Chile
- FINCA - Finnish Centre for Astronomy with ESO & Turku University, Turku, Finland
- Queen's University Belfast, Oxford University, UK
- Tel Aviv University, Israel
- Niels Bohr and Aarhus University, Copenhagen, Denmark

Spectroscopic follow up of transients

- ❑ Classification of transients
- ❑ Supernovae (all flavours)
- ❑ Gravitational Wave events
- ❑ Neutrino events
- ❑ Blazars and AGN
- ❑ Nuclear transients and Tidal Disruption Events
- ❑ GRB and FRB
- ❑ Transient X-ray binaries, magnetars, ultra - luminous X-ray sources (NS & BH)
- ❑ Young Stellar Objects, stellar variability, exoplanets
- ❑ Asteroids and Comets
- ❑ The Unknown

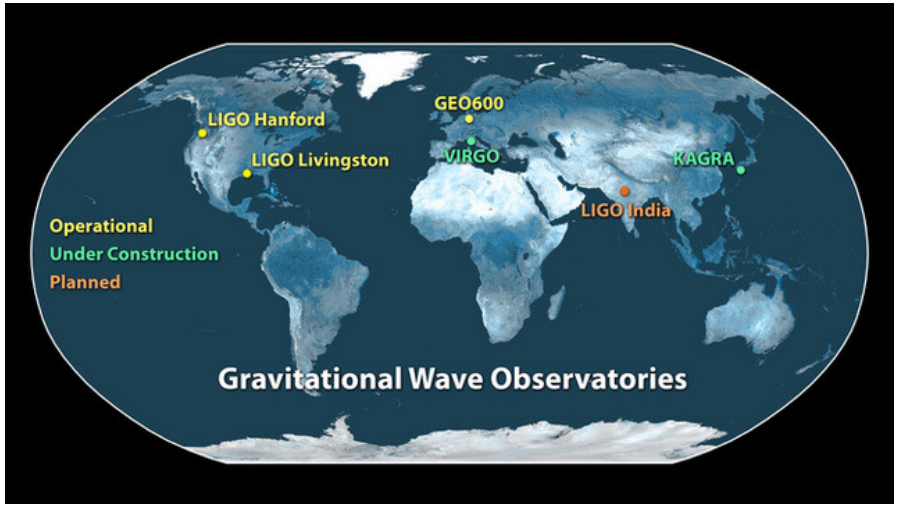


Synergies

SOXS will have 180 n/yr (for ≥5 yr)
~3,000-4,000 spectra/yr

A spectroscopic machine for the transient sky

- ❑ New deeper survey: Vera Rubin, PanSTARSS, DES, ZTF, …
- ❑ Space optical missions: Gaia, EUCLID, …
- ❑ Space high-energy missions: Swift, Fermi, SVOM, …
- ❑ Radio new facilities: MeerKAT, SKA, …
- ❑ VHE: CTA
- ❑ Messengers: aLIGO-Virgo, KM3Net, ANTARES, …



VERA C. RUBIN OBSERVATORY

SKAO

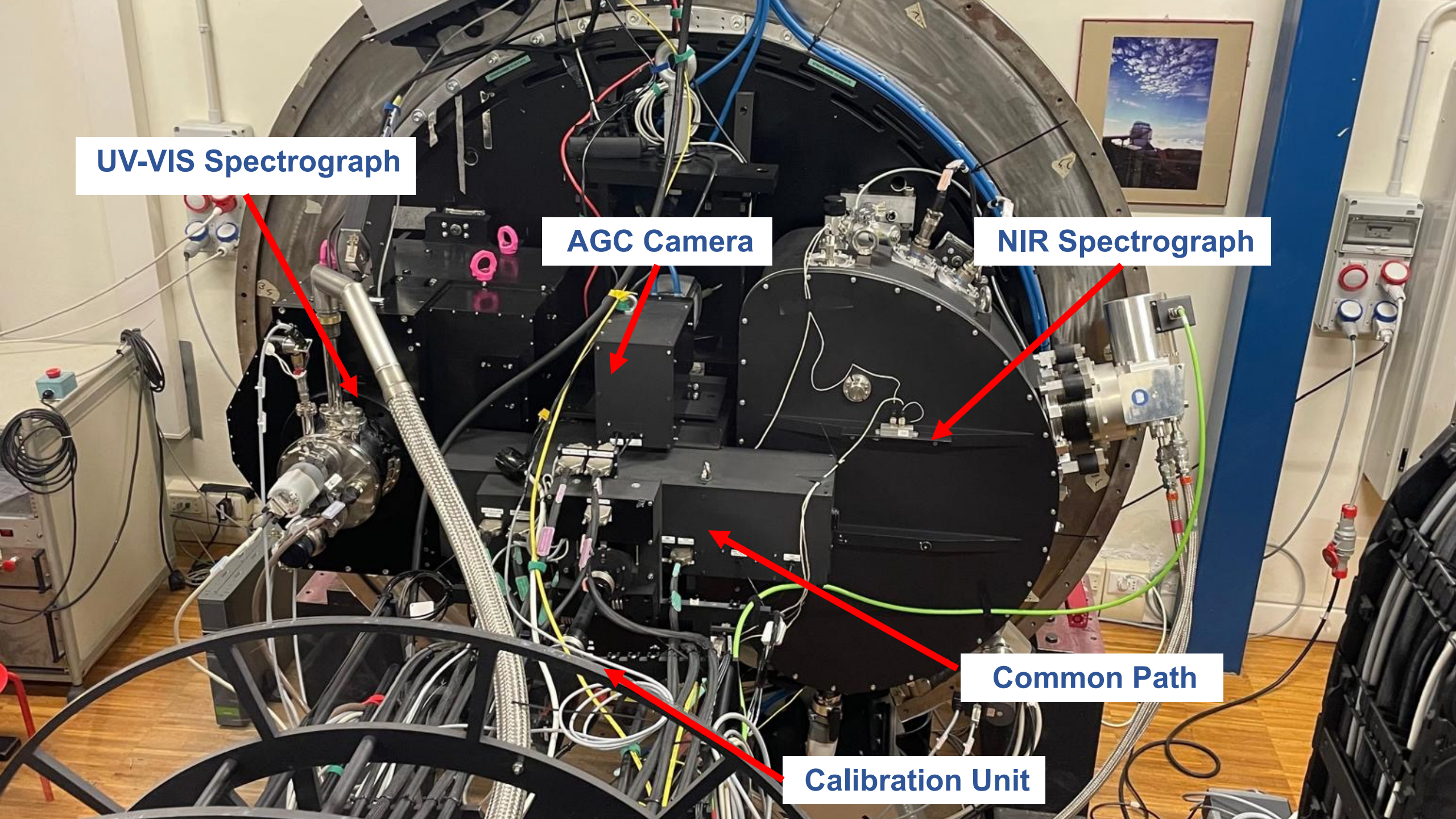
cta cherenkov telescope array

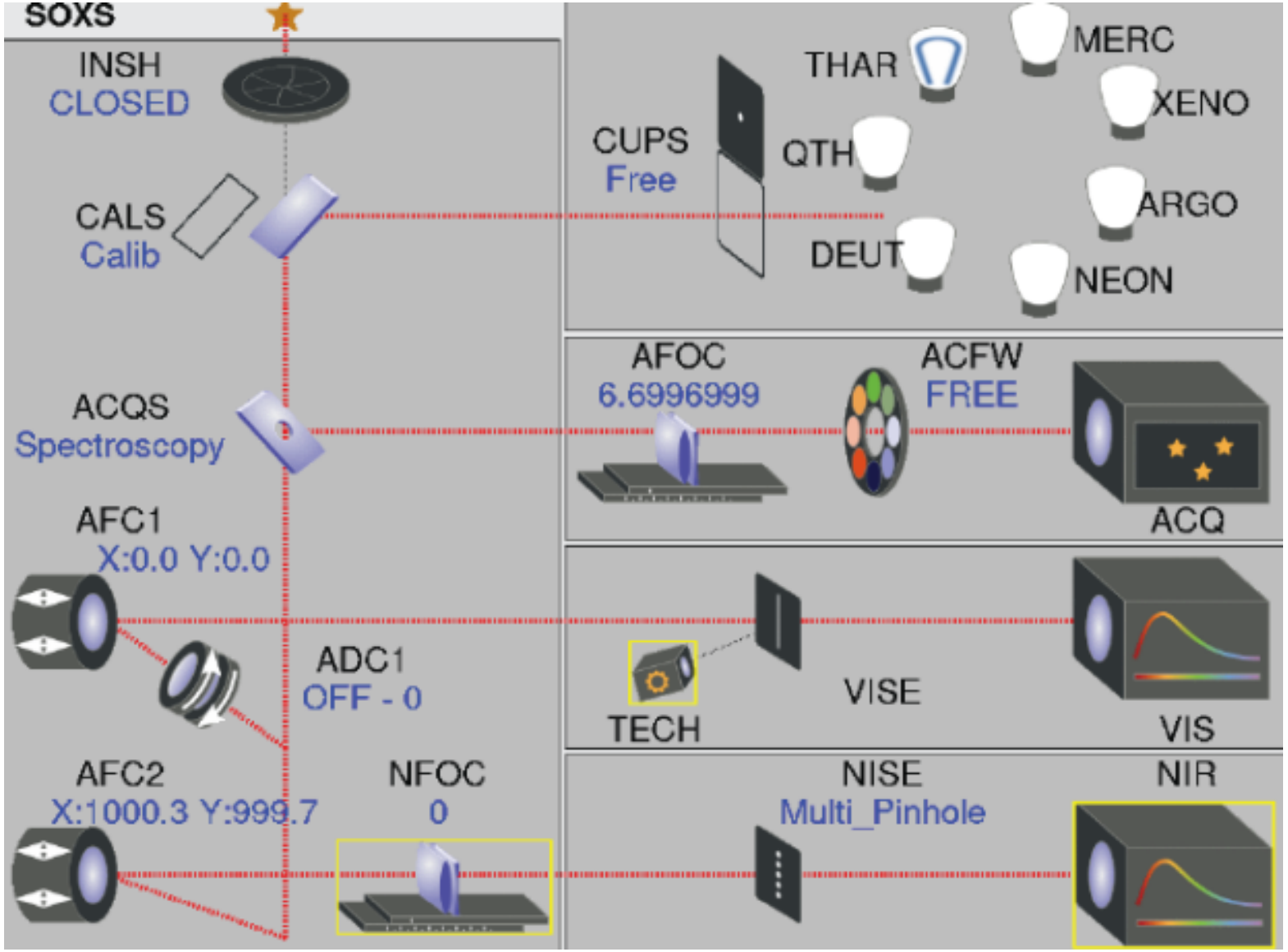
ANTARES

SVOM

	UV-VIS	NIR
Spectral range	350-850 nm	800-2000 nm
Resolution (1" slit)	>3600 (≈4500 avg)	5000
Slit widths	0.5 - 1 - 1.5 - 5 arcsec	0.5 - 1 - 1.5 - 5 arcsec
Slit height	12 arcsec	12 arcsec
Detector	e2V CCD44-82 2Kx4K	Teledyne H2RG 2Kx2K
Pixel Size	15 µm	18 µm
Detector Scale	0.28"/pixel	0.25"/pixel

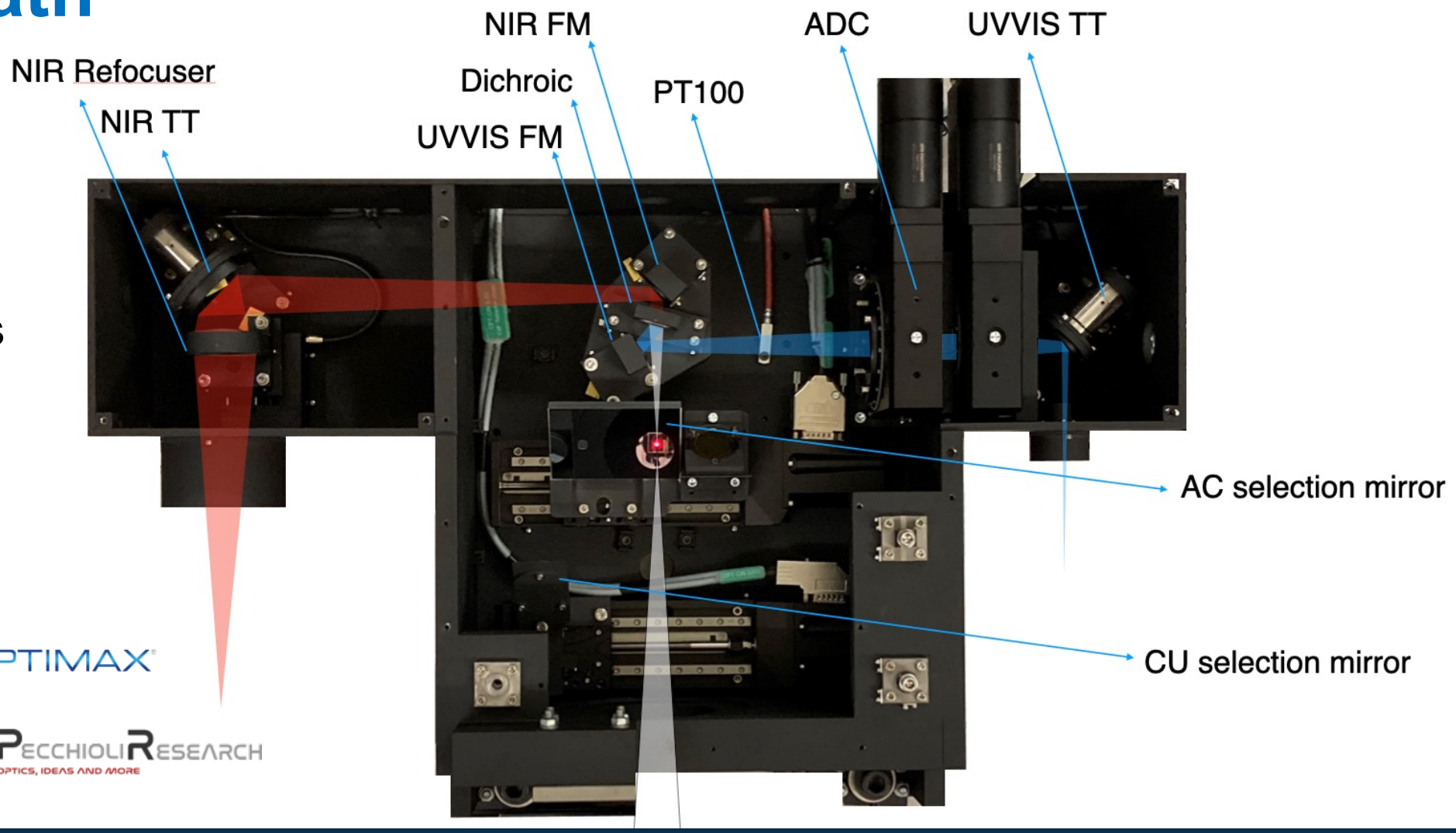
	Camera
Spectral range	360-970 nm
Detector	Andor iKon M-934 1Kx1K
Field of View	3.5'
Pixel Size	13 µm
Detector Scale	0.205"/pixel


UV-VIS Spectrograph
AGC Camera
NIR Spectrograph
Common Path
Calibration Unit


SOXS
INSH
CLOSED
CALS
Calib
ACQS
Spectroscopy
AFC1
X:0.0 Y:0.0
ADC1
OFF - 0
AFC2
X:1000.3 Y:999.7
NFOC
0
CUPS
Free
THAR
MERC
XENO
QTH
ARGO
DEUT
NEON
AFOC
6.6996999
ACFW
FREE
ACQ
TECH
VISE
VIS
NISE
Multi_Pinhole
NIR

Common Path

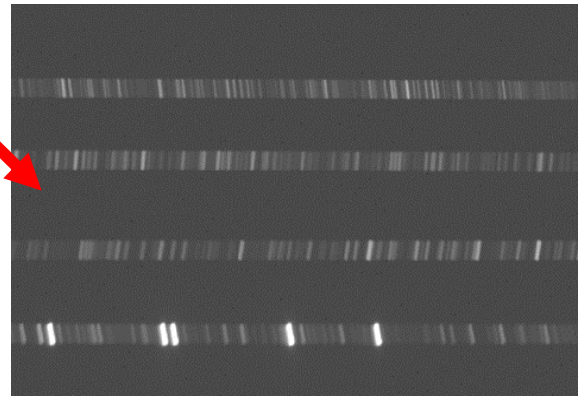
Receives F/11 beam from the telescope and feeds the spectrographs with F/6.5 beam

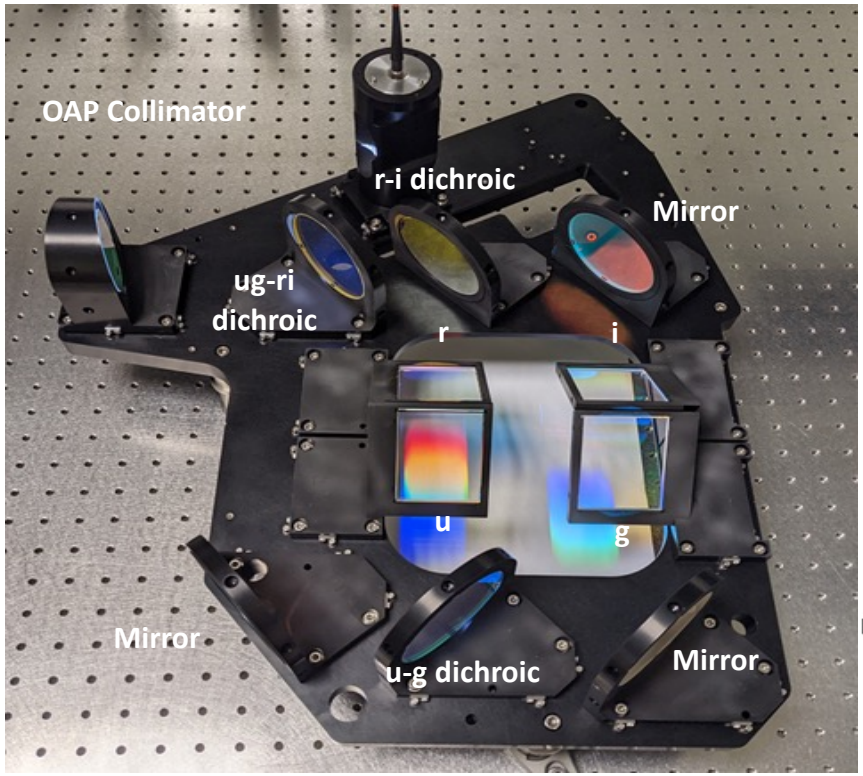


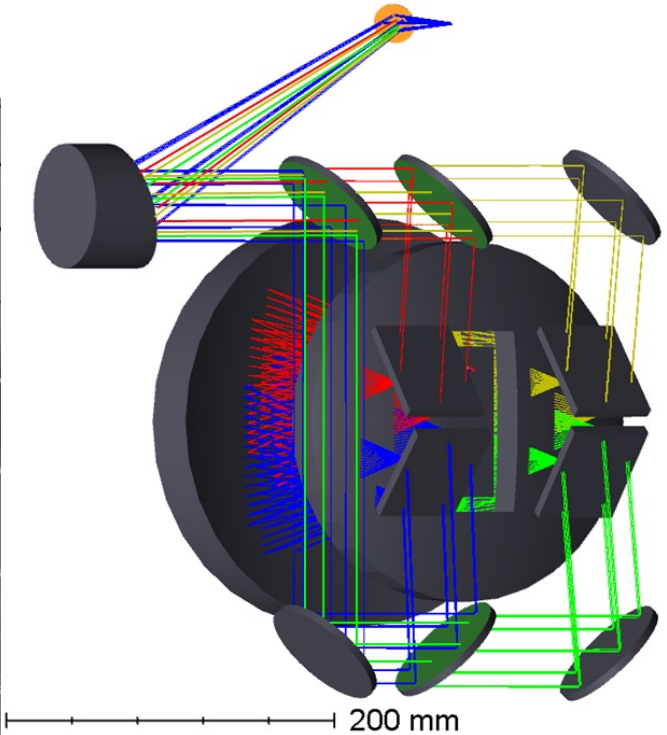
Archer OpTx
Optical Precision. Optimal Outcome.
OPTIMAX
ASAHI SPECTRA USA
PECCHIOLI RESEARCH
OPTICS, IDEAS AND MORE

UV-VIS Spectrograph

- Collimated beam is divided to 4 bands using 3 dichroics.
- Each band has its own optimized disperser
- Single camera
- 1st order dispersion, $\mathcal{R}\sim4500$ at α_{Lit}.
- 4 bands quasi-orders are imaged onto a single 4k×2k CCD.





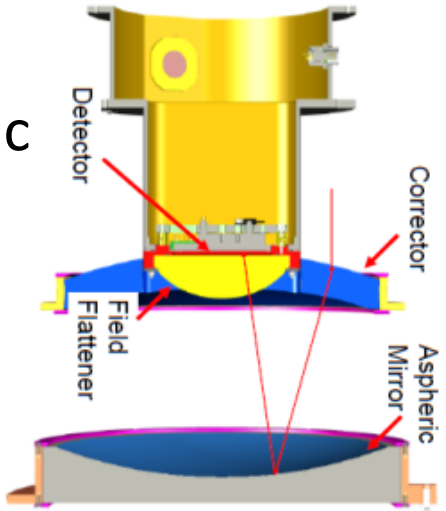


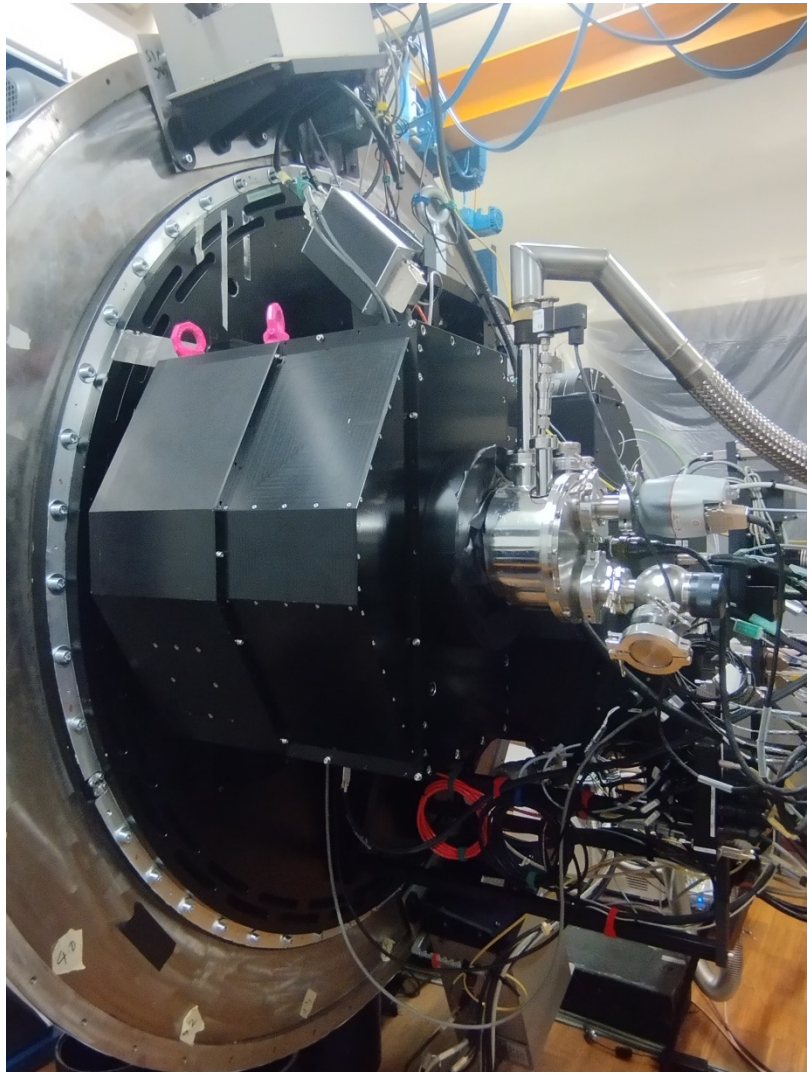
Quasi-Order	Wavelength Range [nm]
u	350 – 439.5
g	427 - 547
r	527 - 680
i	664 – 850

Winlight System
ASAHI SPECTRA USA
Fraunhofer IOF

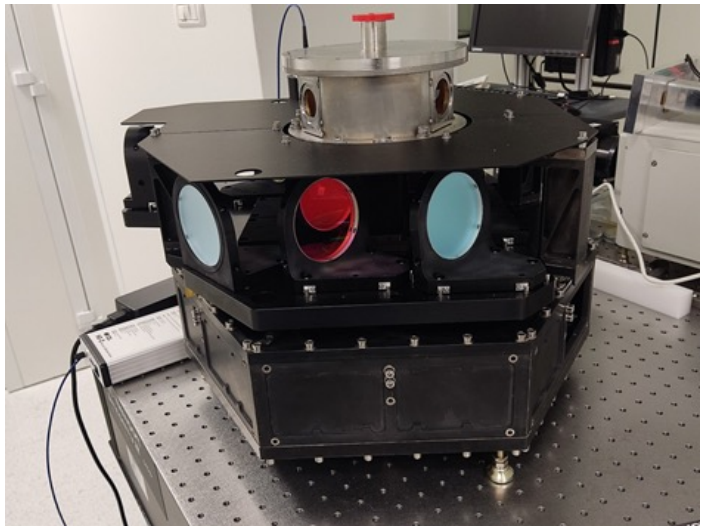
UV-VIS Camera

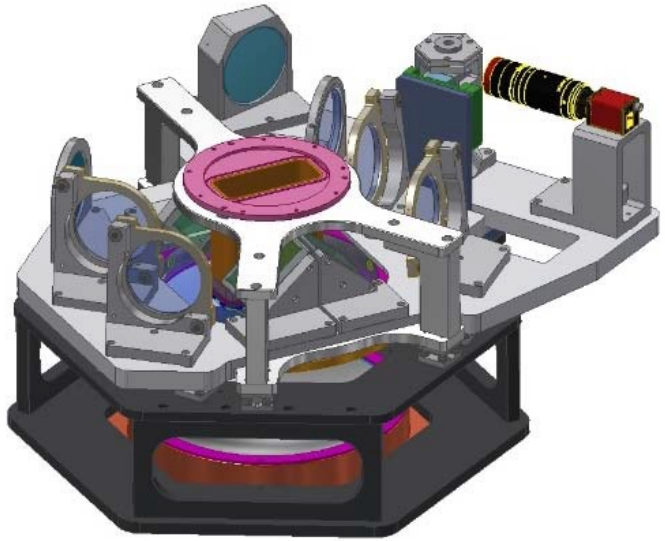
- Three element catadioptric camera - all aspheric
- Used as 4 off axis F/3.1 cameras.
- CaF2 corrector + Fused Silica Field Flattener
- Low CTE=>Athermal camera



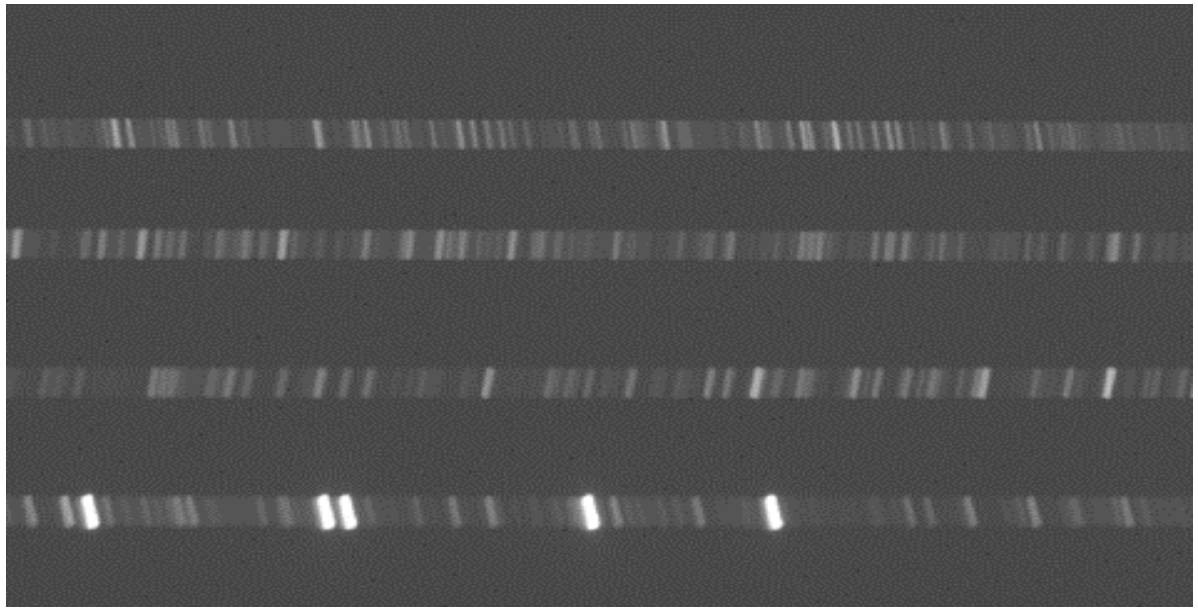


Feed + Camera

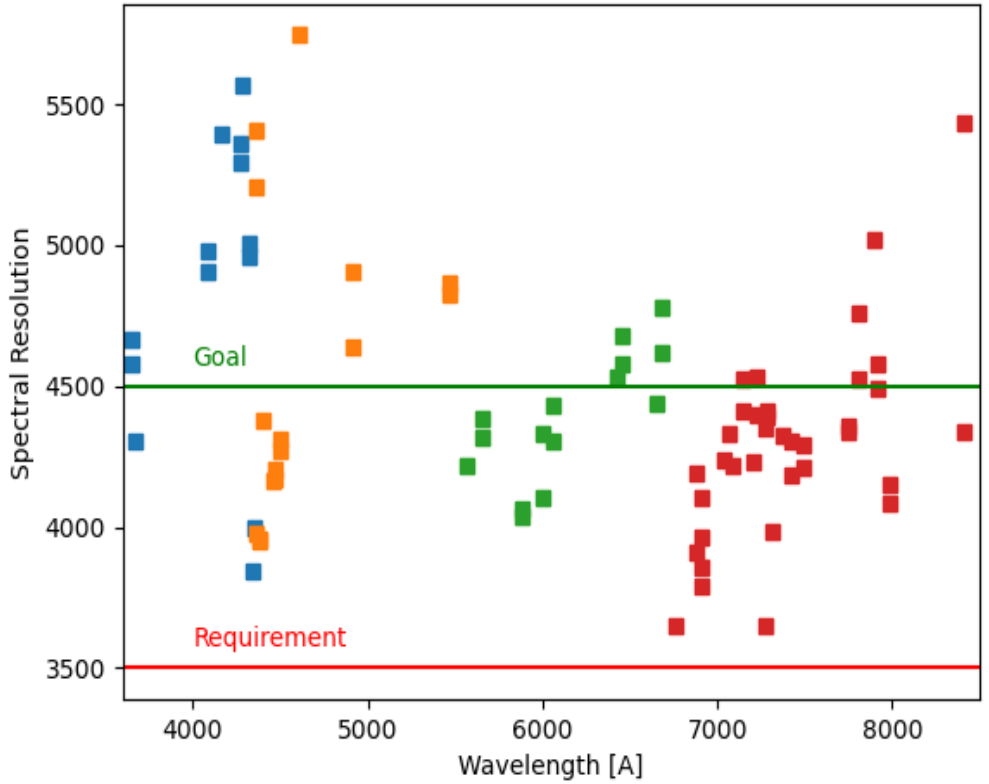




UV-VIS Spectrograph



UVVIS four traces when fed through the CP using SOXS CBX arclamps.



Measured spectral resolution, shown average resolution of $\mathcal{R}\sim4500$

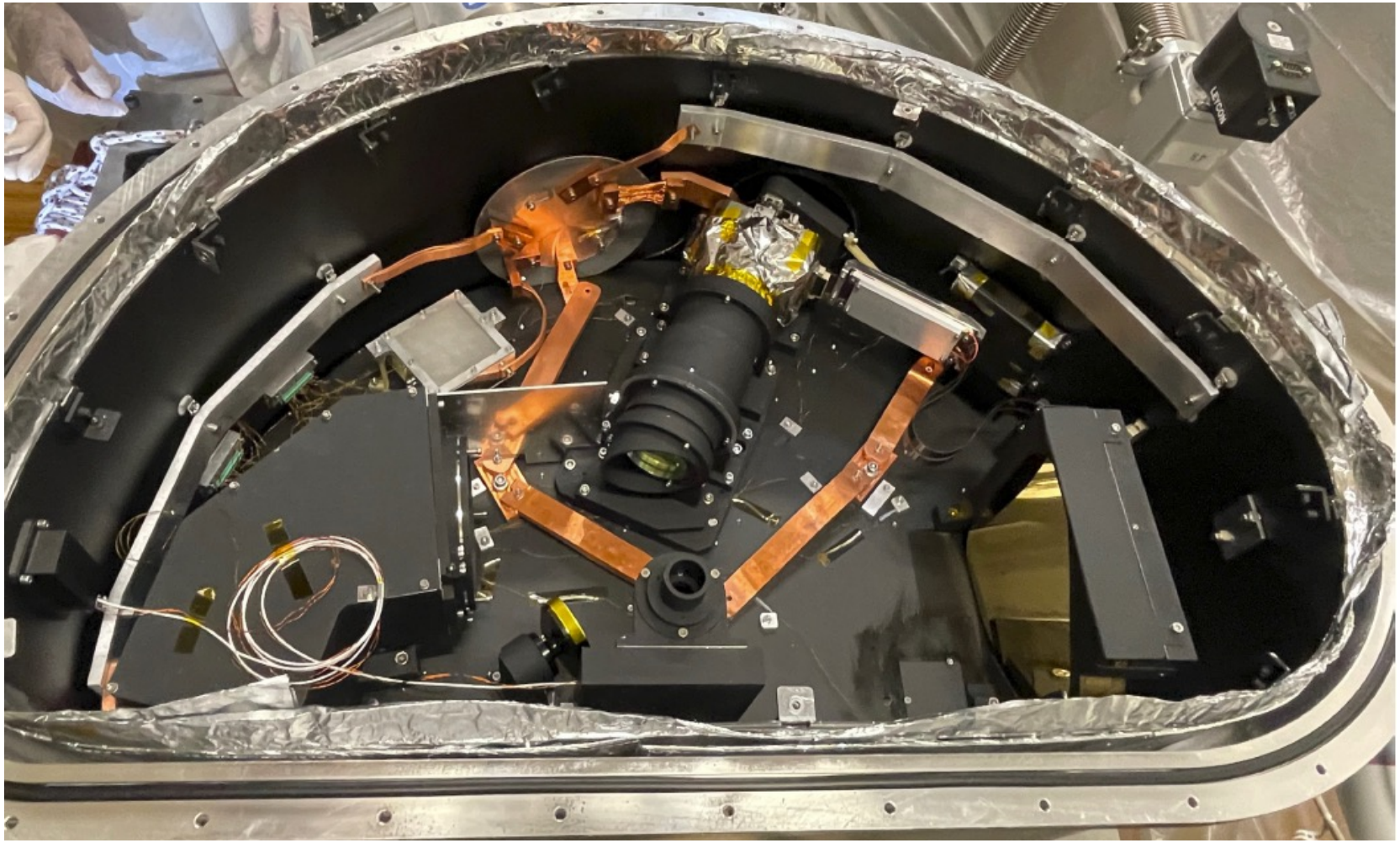
NIR Spectrograph

4C Design

Spectrograph with **C**ollimator **C**ompensation of **C**amera **C**hromatism Echelle Cross-Dispersed

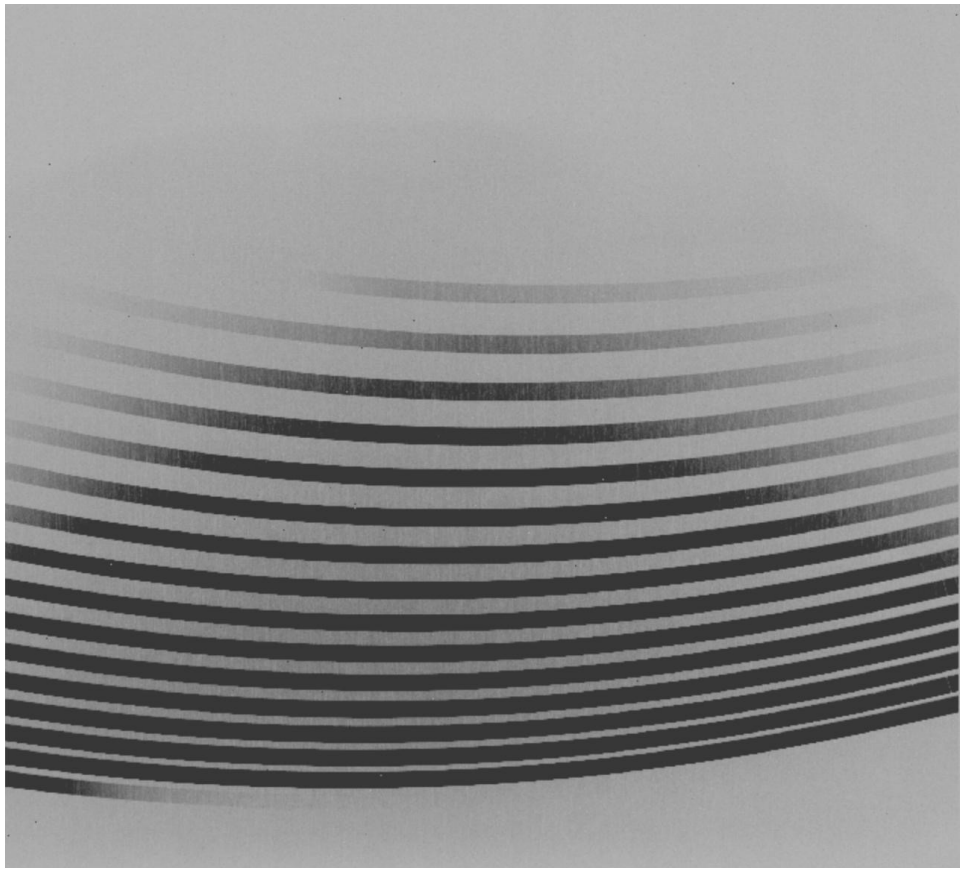
R ~ 5000, 0.25’’/px

F/3.7 camera, H2RG + NGC

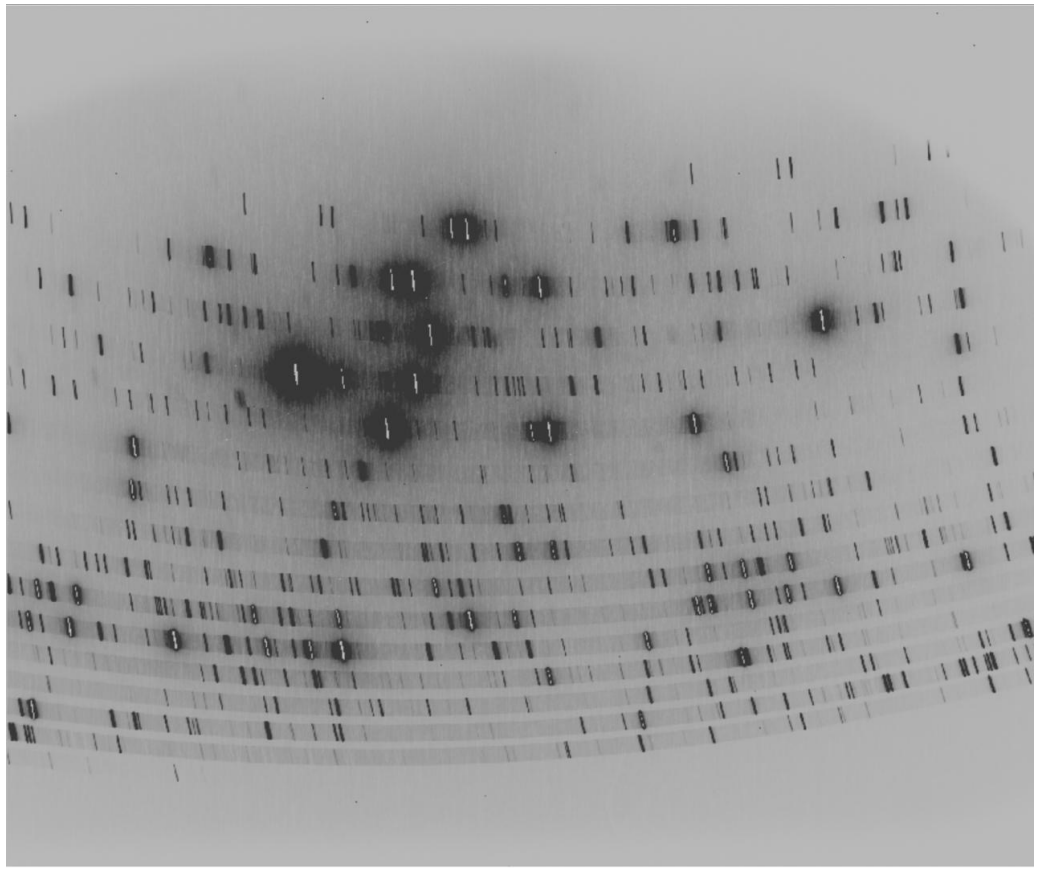


NIR Spectrograph

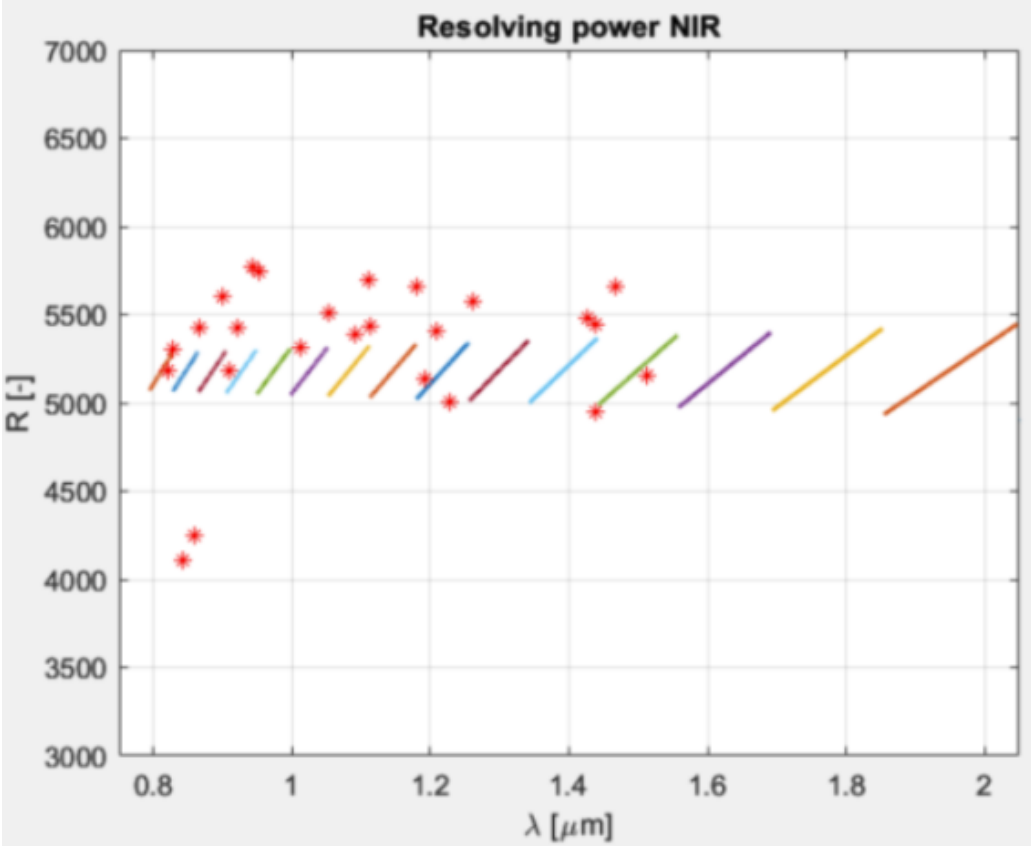
QTH 5s exp. raw frame

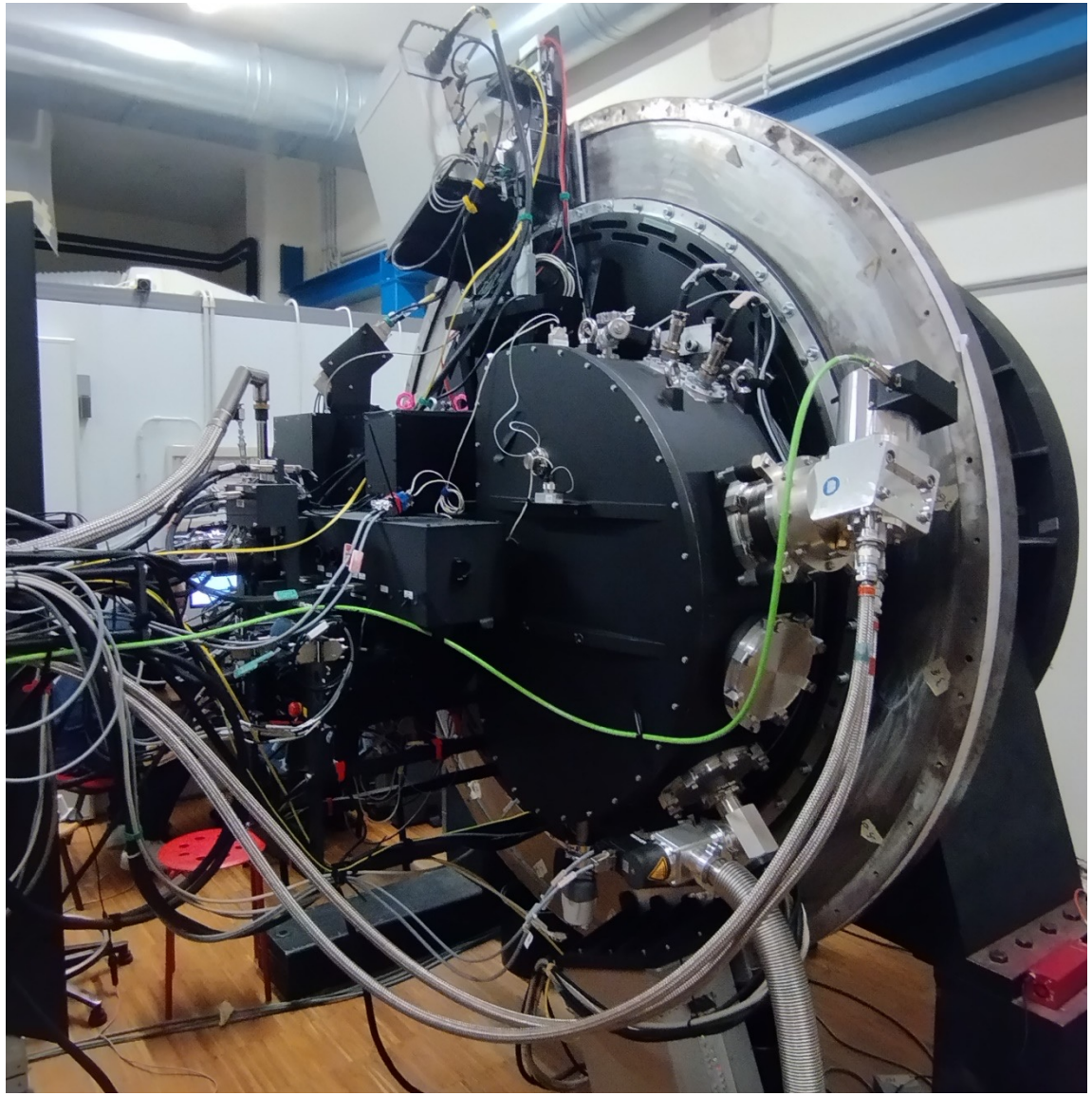


Arc lamps 15s exp. raw frame 0.5” slit



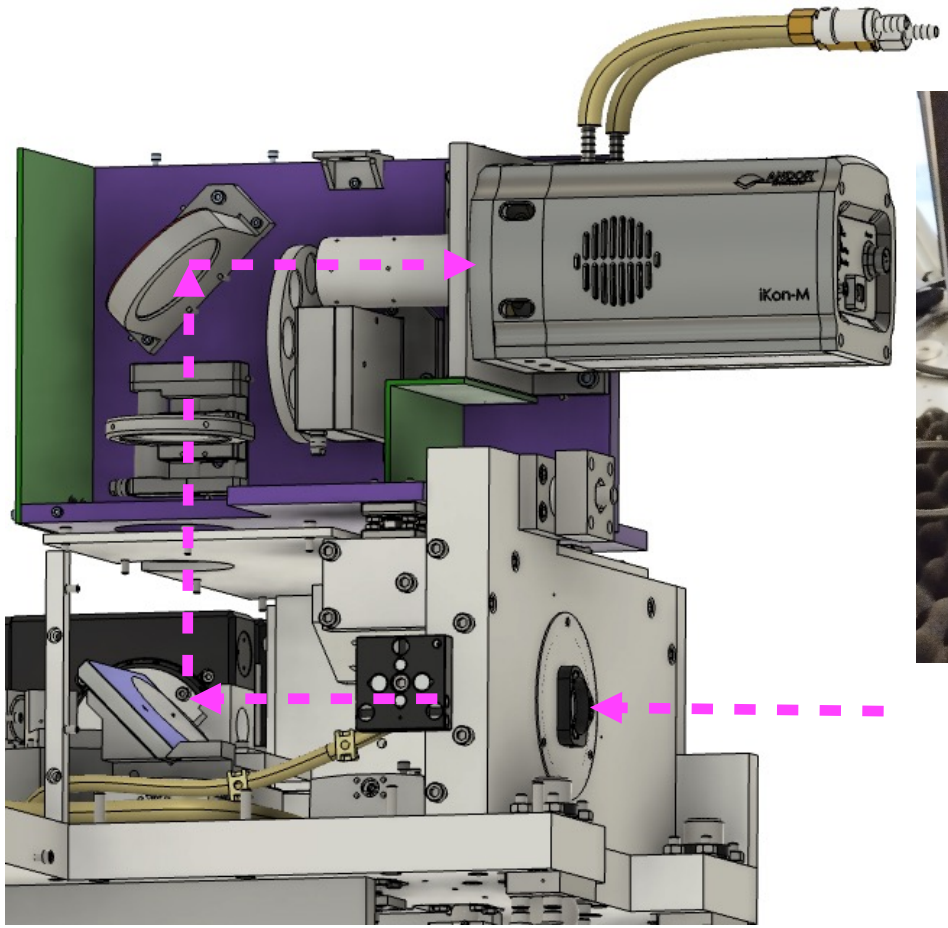
NIR Spectrograph

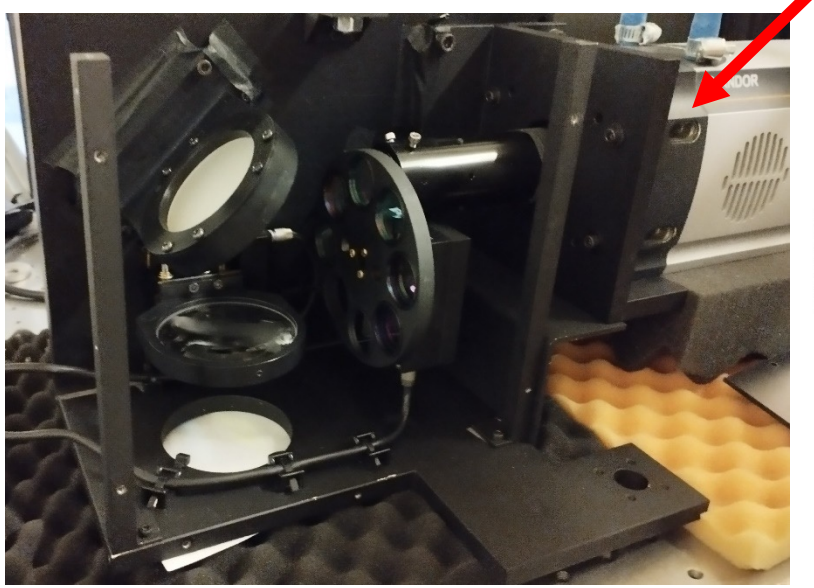


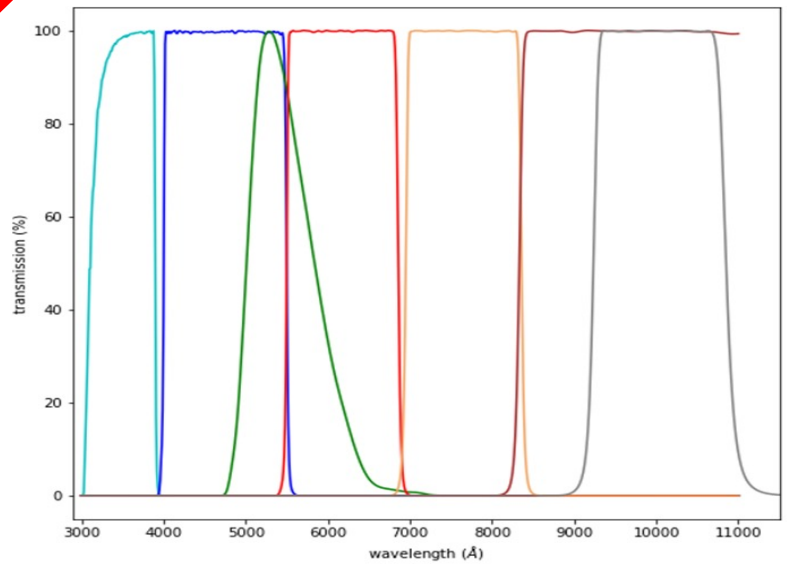


A&G Camera

Andor iKon M934 1024x1024
13µm/px 0.205 "/px





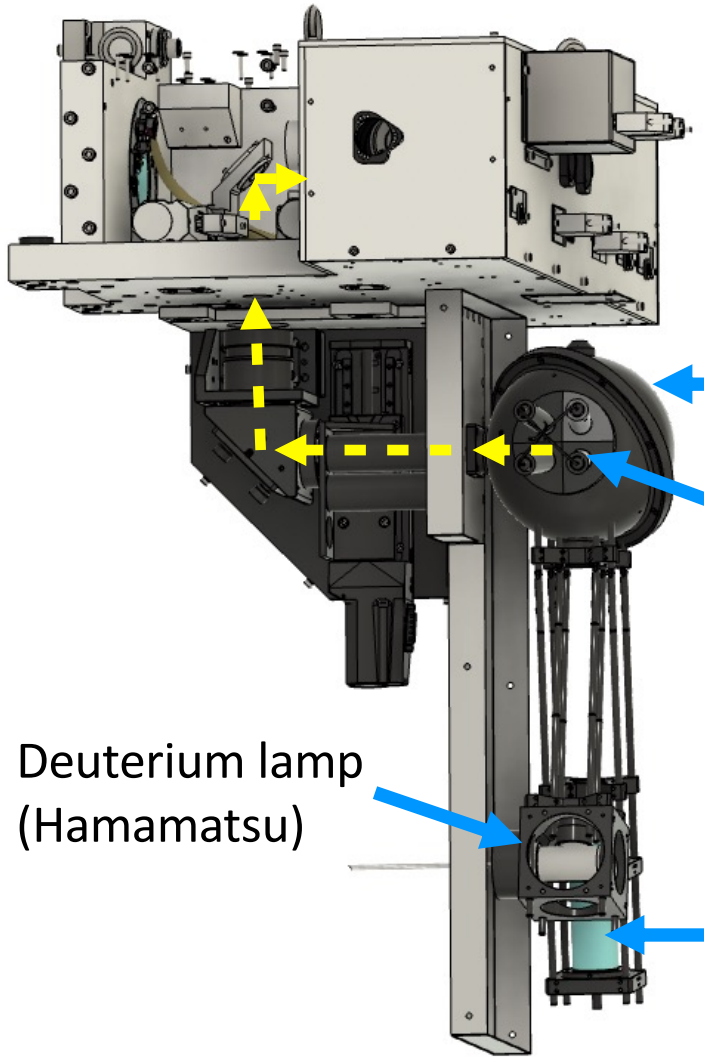


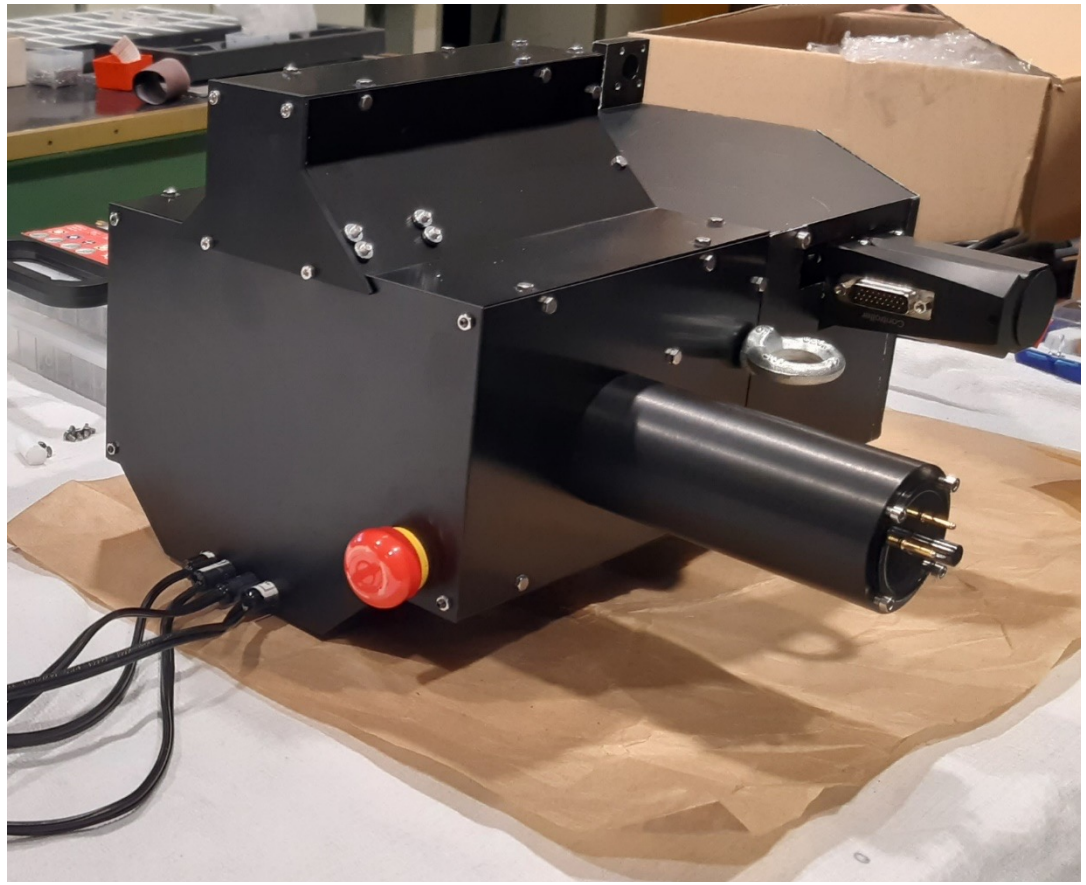
- ❑ Target Acquisition
- ❑ Secondary guiding
- ❑ Photometry

Filters: ugrizY + V

FoV: 3.5'

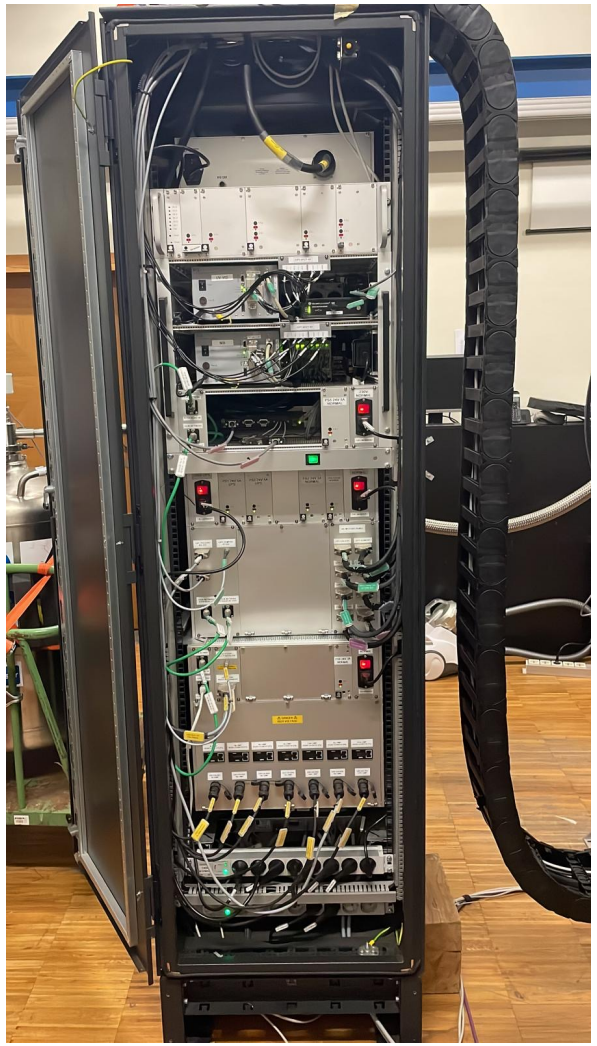
Calibration Unit





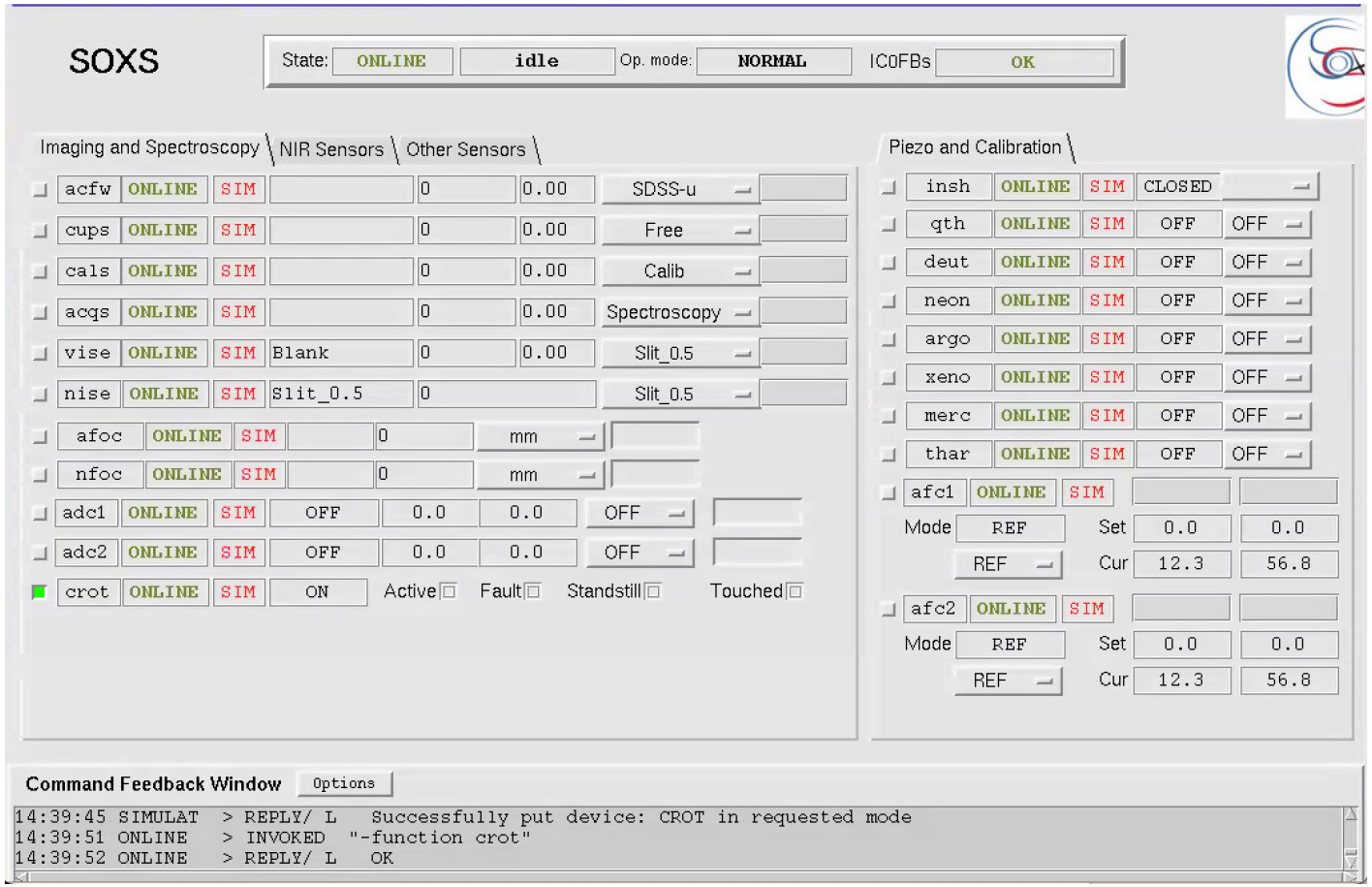

Ctrl Electronics
• Motors
• Lamps
Ctrl Electronics
• Cryovacuum
• Detectors
• Co-rotator

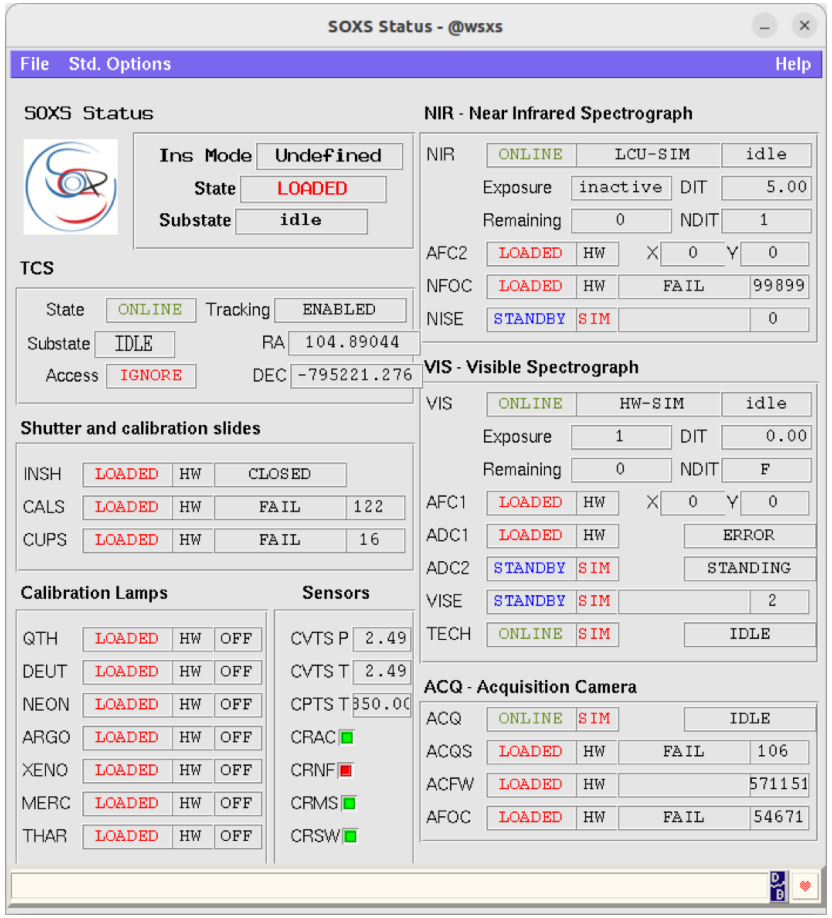
Electronic cabinets



Instrument Software

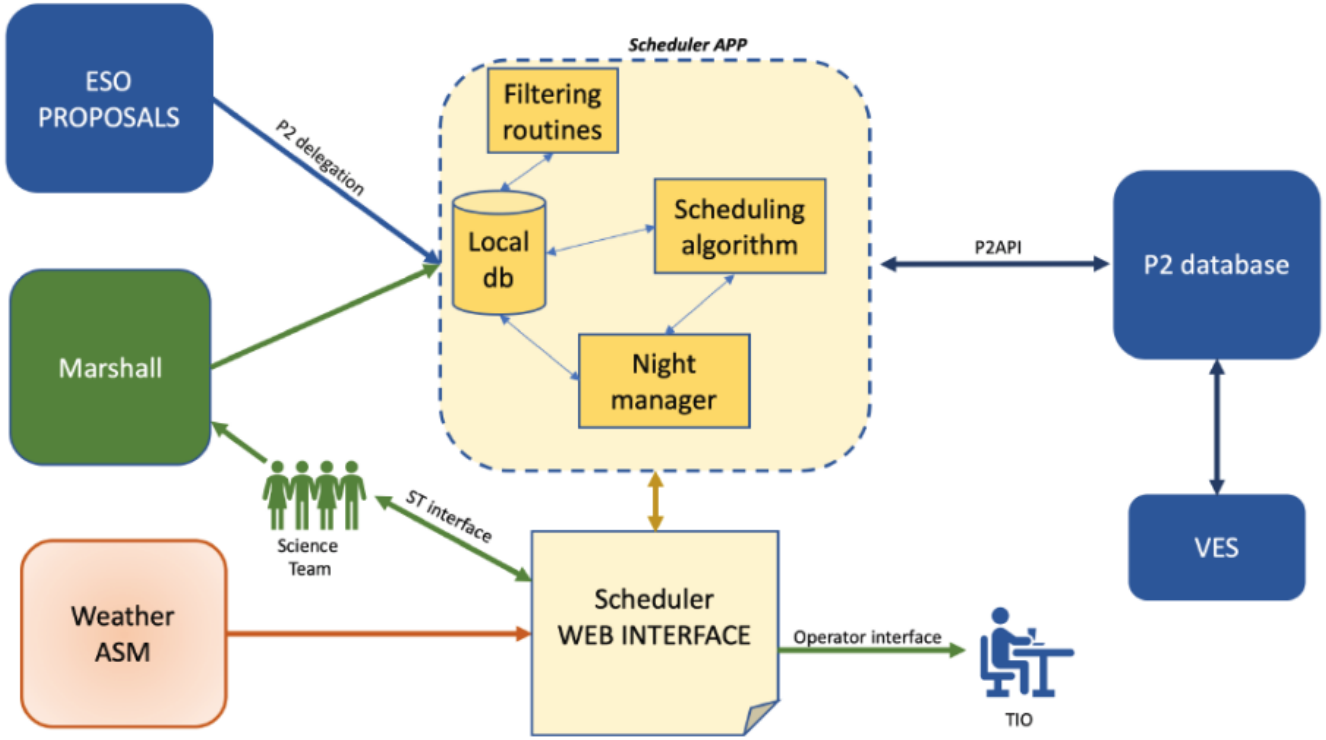
Based on VLT Common SW

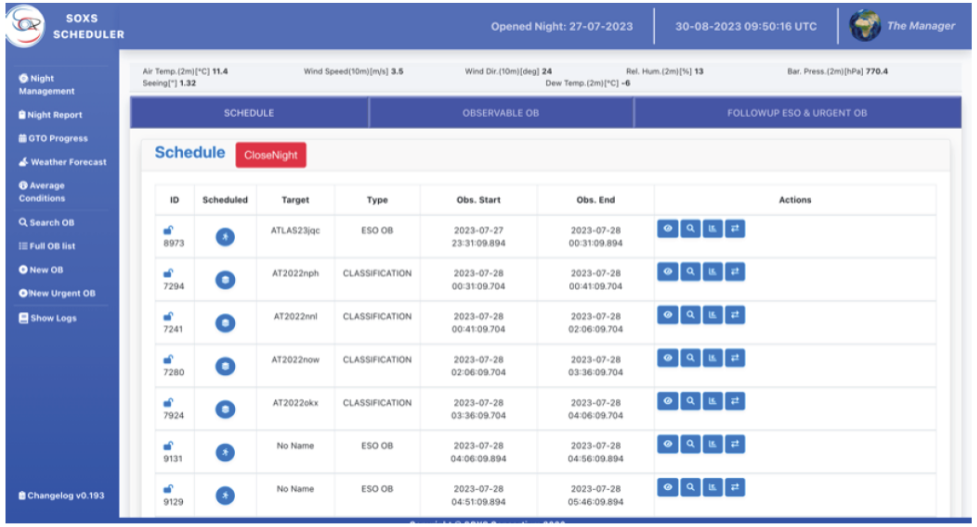




Scheduler

- ❑Schedule is updated daily
- ❑Telescope operator on site
- ❑P2 system, vOT interface with ESO
- ❑Web based app





Marshall

Feeders:

- ❑ ZTF, ATLAS, PanStarrs, LSST-Lasair, etc.
- ❑ TNS, Atel, GCN, etc.

Pipeline

Several rounds with ESO counterpart (A. Modigliani) done

Pre-pre-PAE Interactions started well before

SOXS ETC

Avalaible: http://192.167.38.34/


FIRE

First steps into the PAE

June 2024: pre-delivery of documentation on ESO PDM

June 2024: visit of ESO SW counterpart (G. Zins)

July 2024: visit of ESO EMC counterpart (A. van Kesteren)

End of July 2024: internal deadline for ALL documents delivery

September 2024: visit of ESO Safety counterpart (S. Alvarez Diaz)

End of September 2024: deadline for ALL documents delivery

Timeline

Other ESO visits – RIXs – discussions (September – October)

All SOXS people shall interact with ESO through JIRA

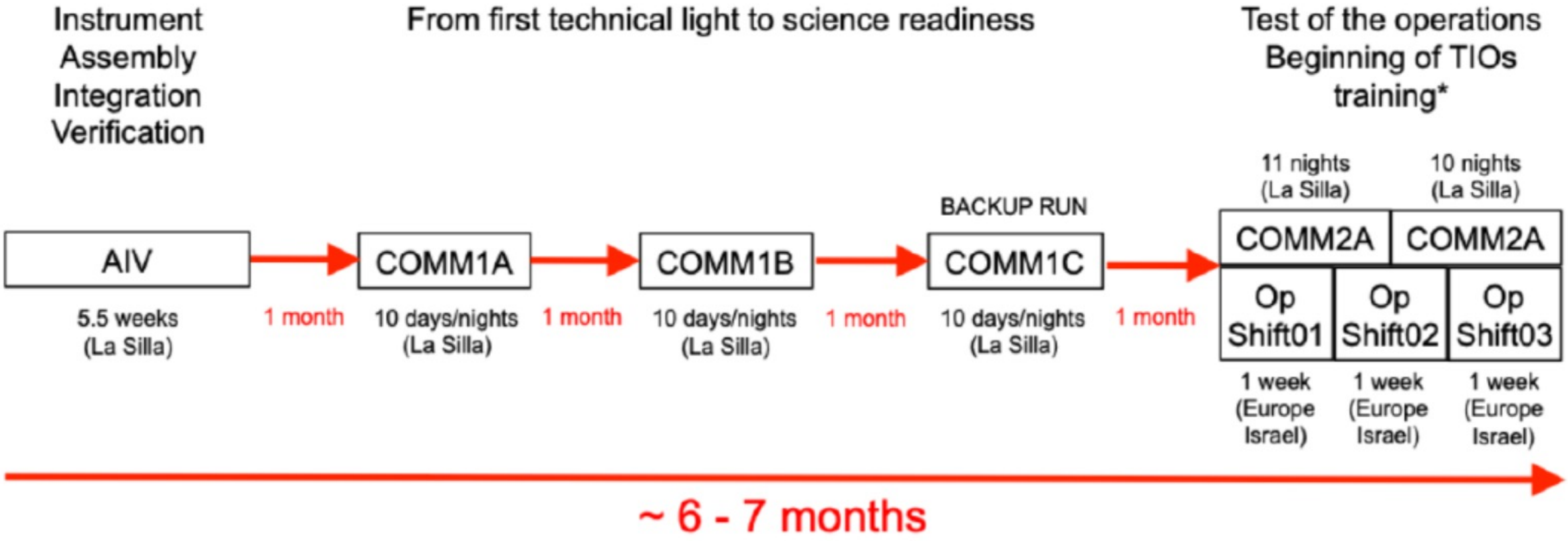
First week of November 2024: PAE closure

November 2024: Packing

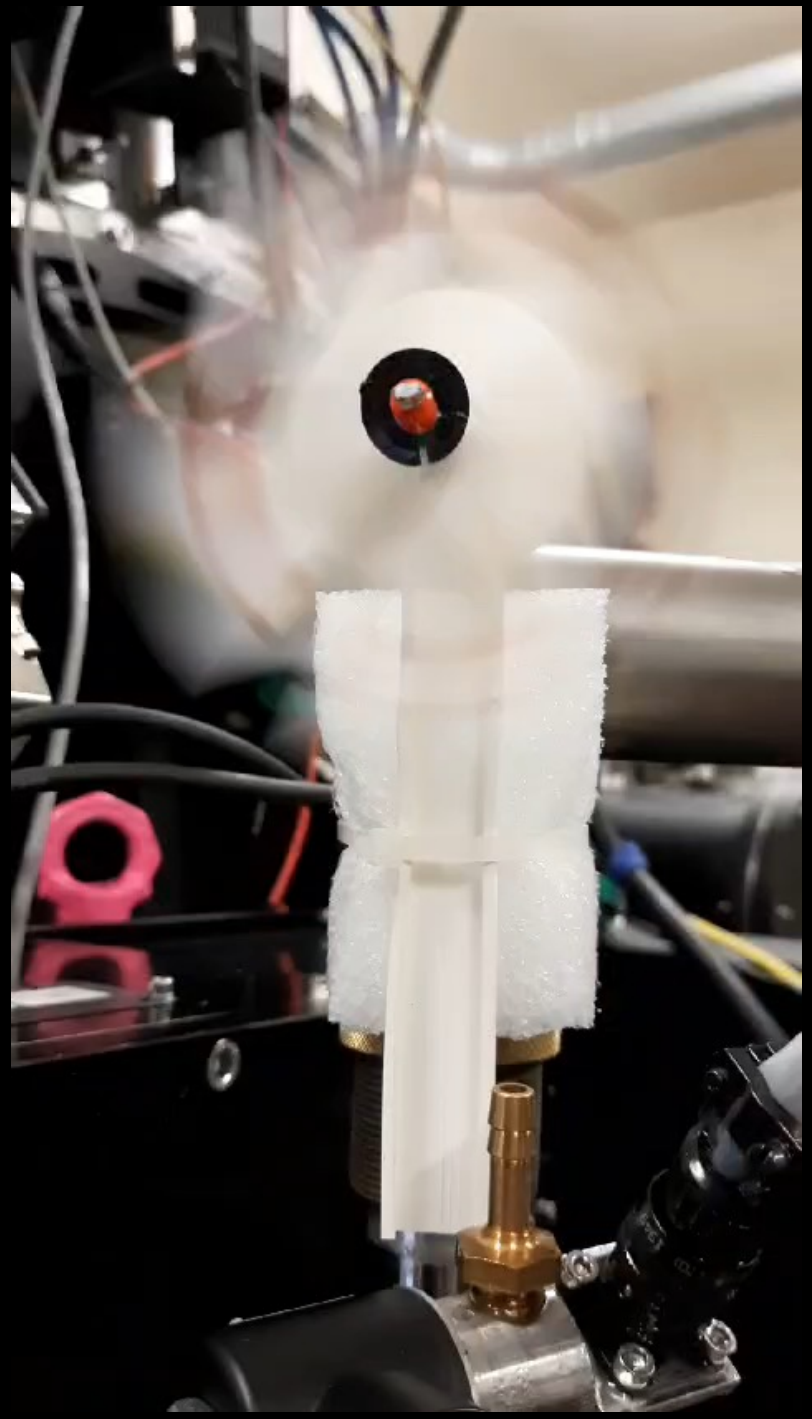
December 2024: Shipping

January 2025: Start of AIV in Chile…

Timeline (Chile)



*also SOXS GTO time can be used to test operations and to train TIOs




See you soon

SPIE. ASTRONOMICAL TELESCOPES + INSTRUMENTATION

Ground-based and Airborne Instrumentation for Astronomy X

- ❑ P. Schipani, et al., “Walking with SOXS towards the transient sky"
- ❑ F. Vitali, et al., "The Status of the NIR arm of the SOXS Instrument toward the PAE", AS24-AS105-42
- ❑ K. Radhakrishnan, et al., "Integration and Verification of the SOXS Instrument", AS24-AS105-187
- ❑ J.A. Araiza-Durán, "Final Alignment and Image Quality Test for the Acquisition and Guiding System of SOXS", AS24-AS105-209
- ❑ R. Cosentino, et al., "Characterisation and Assessment of the SOXS Spectrograph UV-VIS Detector System", AS24-AS105-302
- ❑ M. Genoni, et al., "SOXS NIR: Optomechanical integration and alignment, optical performance verification before full instrument assembly.", Paper n. AS 13096-104

Modeling, Systems Engineering, and Project Management for Astronomy XI

- ❑ A. Scaudo, et al., "End-to-End simulation framework for astronomical spectrographs: SOXS, CUBES and ANDES", AS24-AS108-71
- ❑ R. Claudi, et al., "SOXS System engineering from design to installation. Challenges and results.", AS24-AS108-76

Software and Cyberinfrastructure for Astronomy VIII

- ❑ L. Asquini, et al., "Automated scheduler for the SOXS instrument: design and performance", AS24-AS110-31
- ❑ D. Ricci. et al., "The SOXS Instrument Control Software challenges approaching the PAE", AS24-AS110-32
- ❑ M. Colapietro, et al., "The integration of the SOXS control electronics towards the PAE", AS24-AS110-55