Progress on the SOXS transients chaser for the ESO-NTT

P. Schipani, S. Campana, R. Claudi, M. Aliverti, A. Baruffolo, S. Ben-Ami, G. Capasso, R. Cosentino, F. D'Alessio, P. D'Avanzo, O. Hershko, H. Kuncarayakti, M. Landoni,M. Munari, G. Pignata, K. Radhakrishnan, A. Rubin, S. Scuderi, F. Vitali,D. Young, J. Achrén, J. A. Araiza-Duran, I. Arcavi, F. Battaini, A. Brucalassi, R. Bruch, E. Cappellaro, M. Colapietro, M. Della Valle, R. Di Benedetto, S. D'Orsi, A. Gal-Yam, M. Genoni, M. Hernandez, J. Kotilainen, G. Li Causi, L. Lessio, L. Marty, S. Mattila, M. Rappaport, D. Ricci, M. Riva, B. Salasnich, S. Savarese, S. Smartt, R. Zanmar Sanchez, M. Stritzinger, G. Umbriaco, H. Ventura, L. Pasquini, M. Schöller, H.-U. Käufl, M. Accardo, L. Mehrgan, E. Pompei, and I. Saviane

SPIE. ASTRONOMICAL TELESCOPES + INSTRUMENTATION

Montreal

17-22 July 2022

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'x3.5')

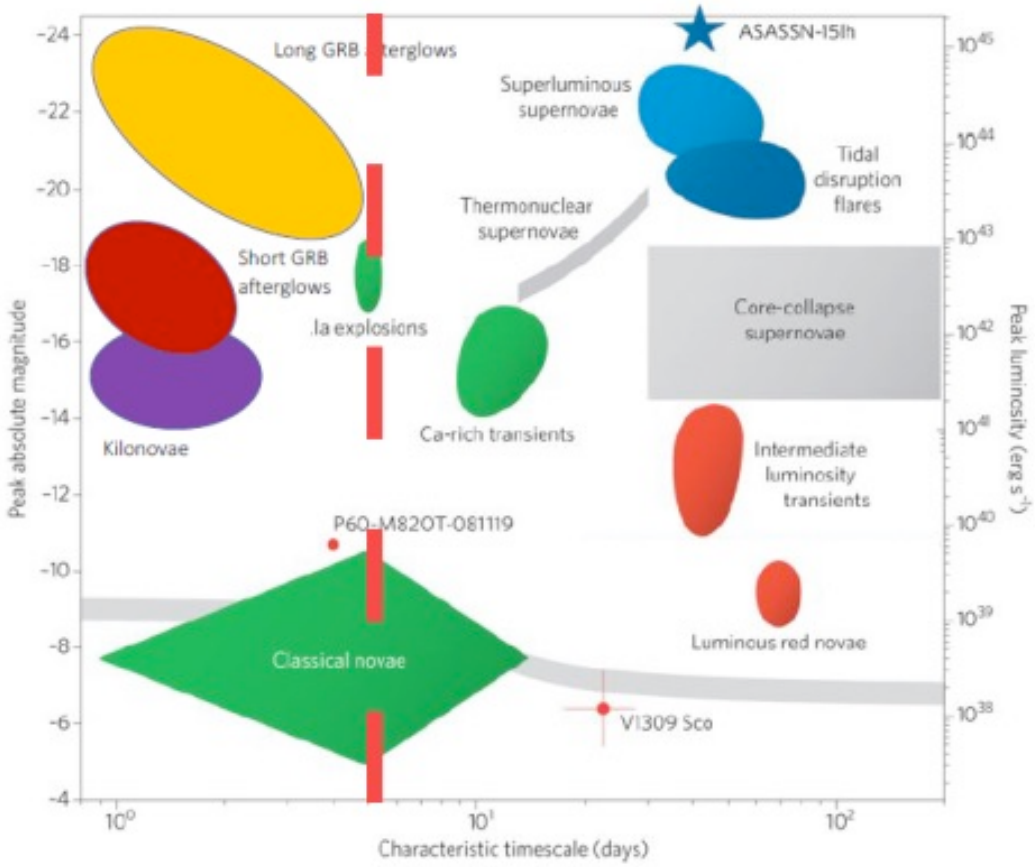
Consortium

Institutes from 6 Countries

- ❑ Istituto Nazionale di AstroFisica (INAF), Italy
- ❑ Department of Particle Physics and Astrophysics, Weizmann Institute of Science, Rehovot, Israel
- ❑ Universidad Andres Bello & Instituto Milenio de Astrofisica (MAS), Santiago, Chile
- ❑ FINCA - Finnish Centre for Astronomy with ESO & Turku University, Turku, Finland
- ❑ Queen's University Belfast, 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)
- ❑ Asteroids and Comets
- ❑ Young Stellar Objects, stellar variability, exoplanets
- ❑ The Unknown

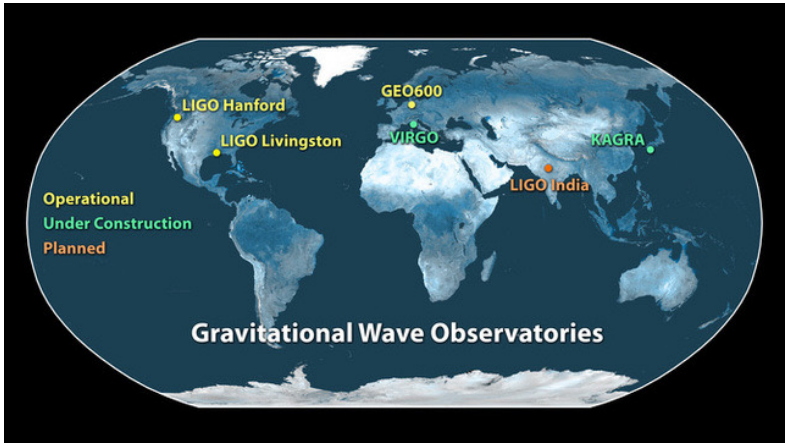


Sinergies

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

A spectroscopic machine for the transient sky

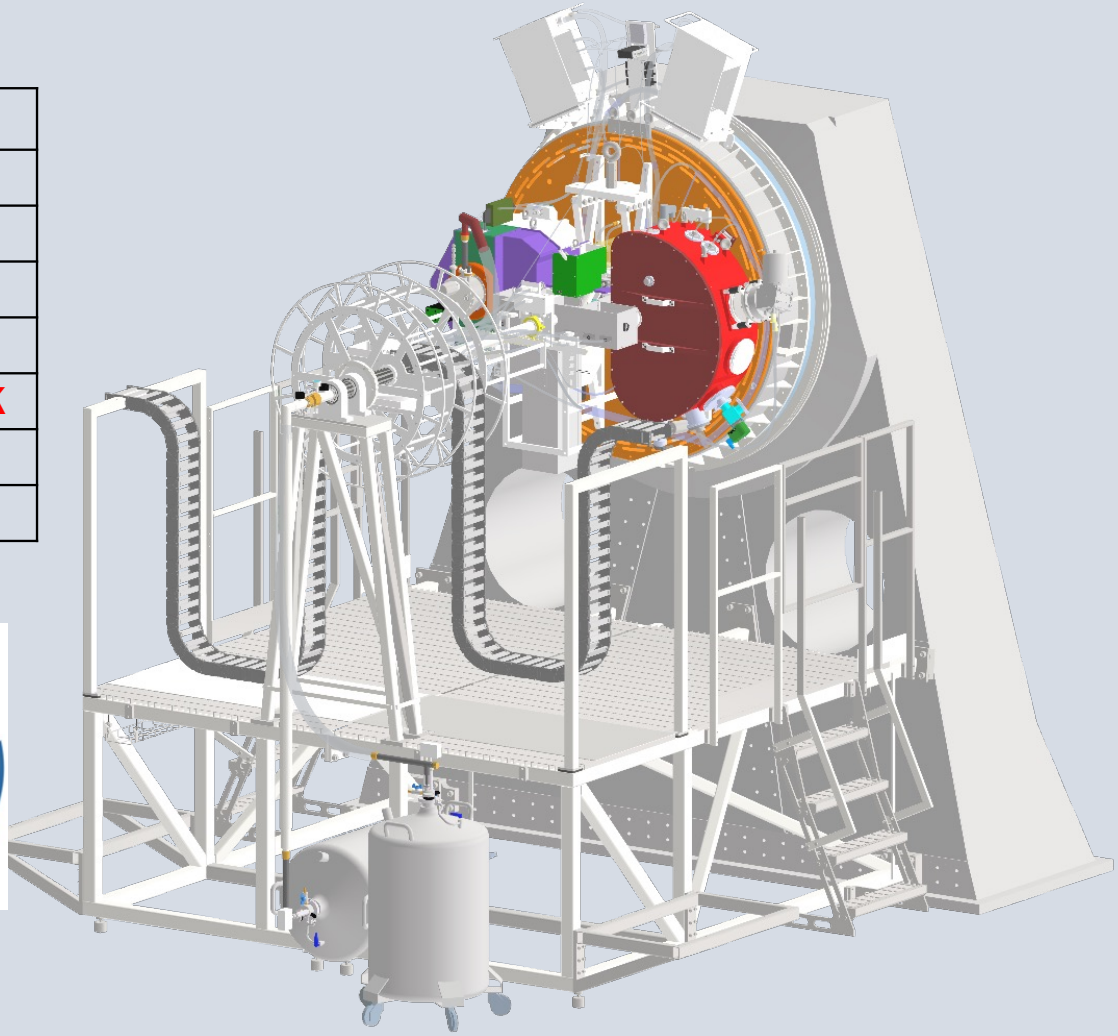
- ❑ New deeper survey: Vera Rubin, PanSTARSS, DES, ZTF, …
- ❑ Space optical missions: Gaia, EUCLID, …
- ❑ Space high-energy missions: Swift, Fermi, SVOM, …
- ❑ Radio new facilities: MeerKAT, SKA, …
- ❑ VHE: CTA
- ❑ Messengers: aLIGO-Virgo, KM3Net, ANTARES, …



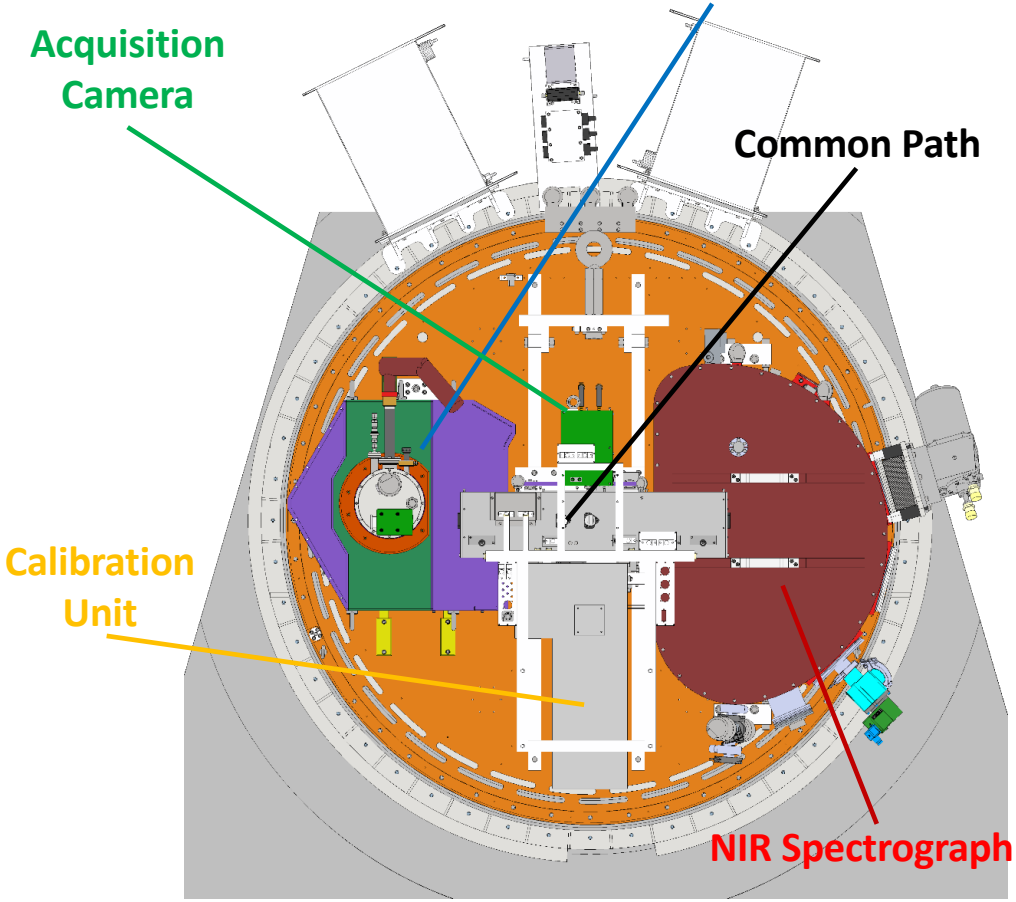
VERA C. RUBIN OBSERVATORY · SKAO · cta cherenkov telescope array · ANTARES · SVOM

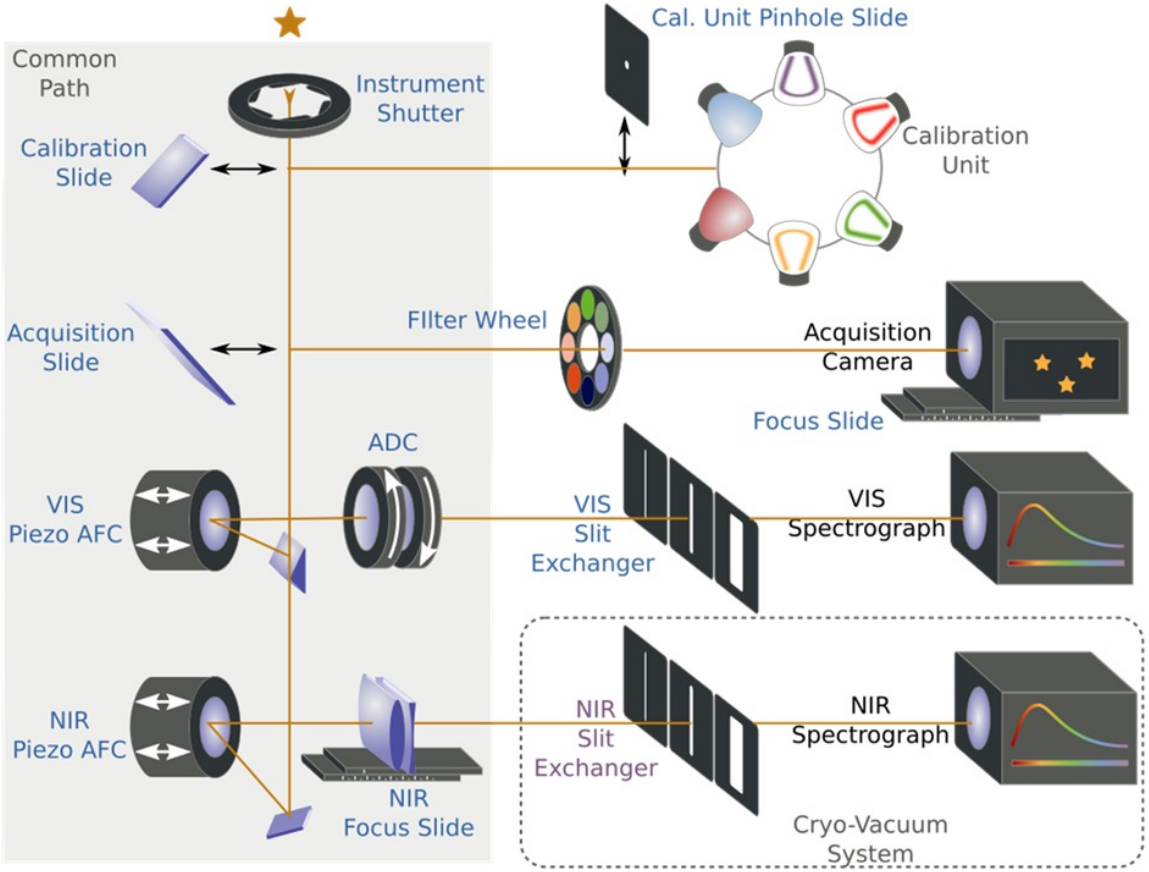
	UV-VIS	NIR
Spectral range	350-850 nm	800-2000 nm
Resolution (1" slit)	>3600 (≈4500 avg)	5000
Slit widths	0.5 - 1 - 1.5 - 5 arcsec	0.5 - 1 - 1.5 - 5 arcsec
Slit height	12 arcsec	12 arcsec
Detector	e2V CCD44-82 2Kx4K	Teledyne H2RG 2Kx2K
Pixel Size	15 µm	18 µm
Detector Scale	0.28"/pixel	0.25"/pixel

	Camera
Spectral range	360-970 nm
Detector	Andor iKon M-934 1Kx1K
Field of View	3.5'x3.5'
Pixel Size	13 µm
Detector Scale	0.205"/pixel

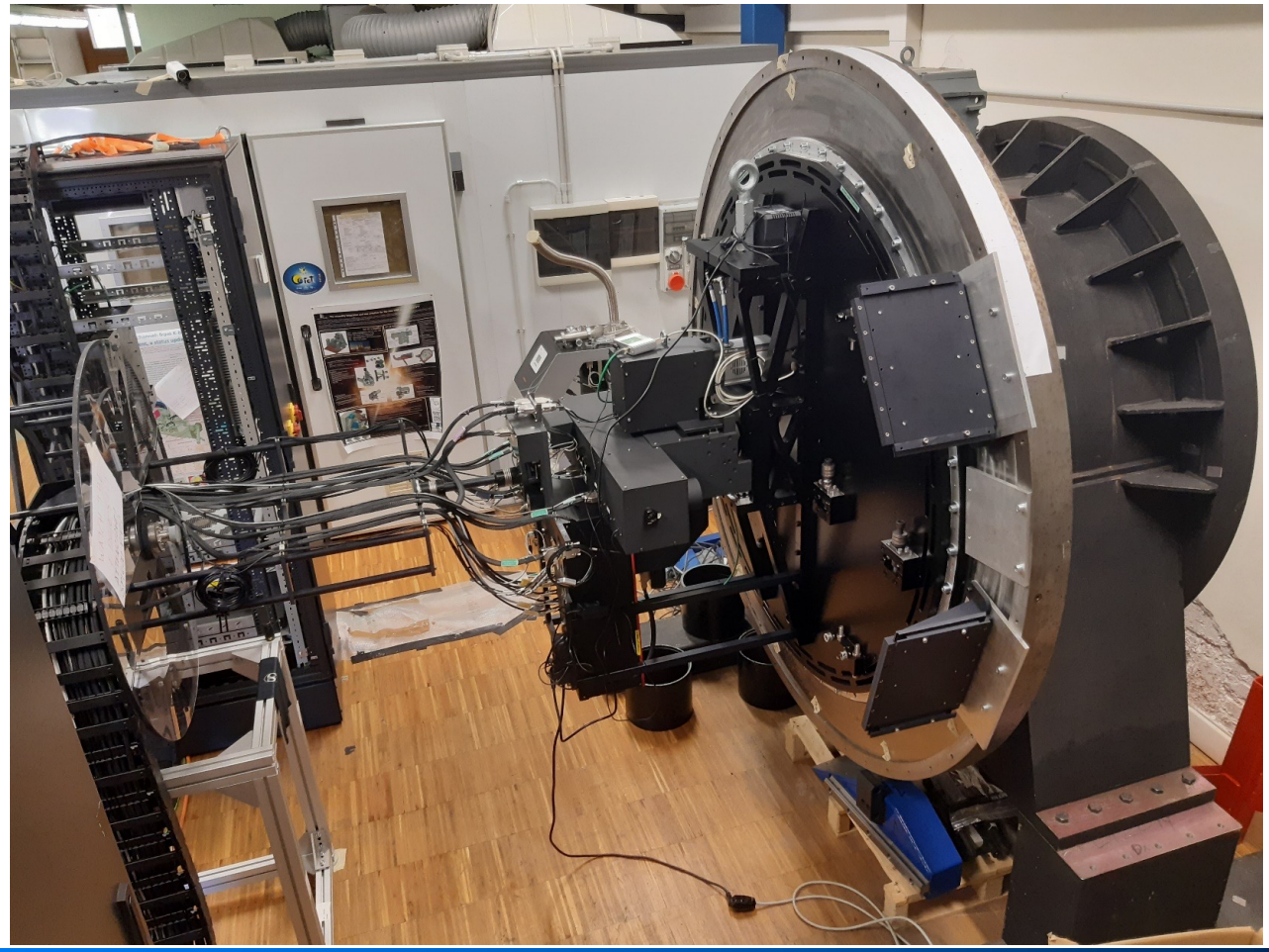


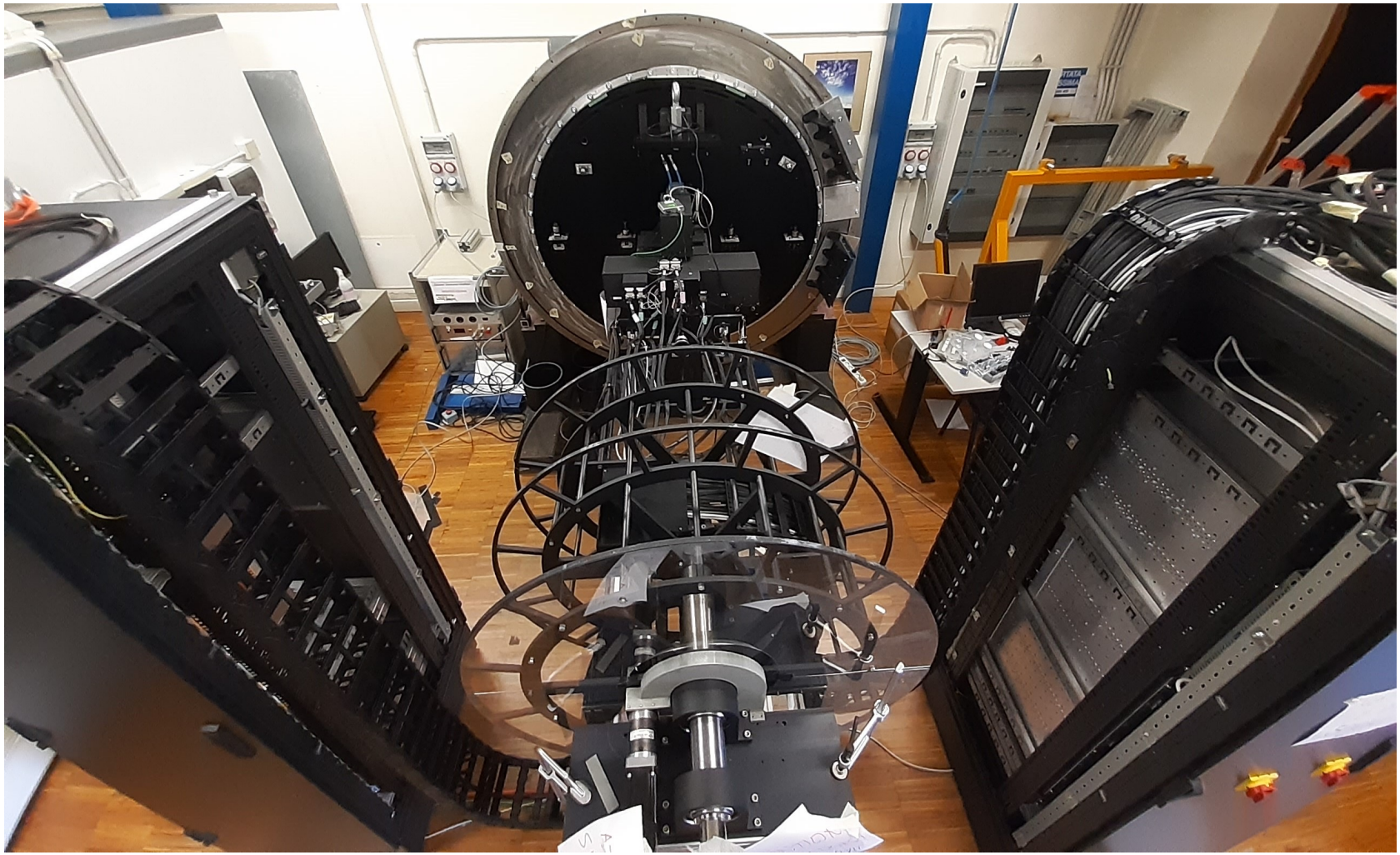
UV-VIS Spectrograph



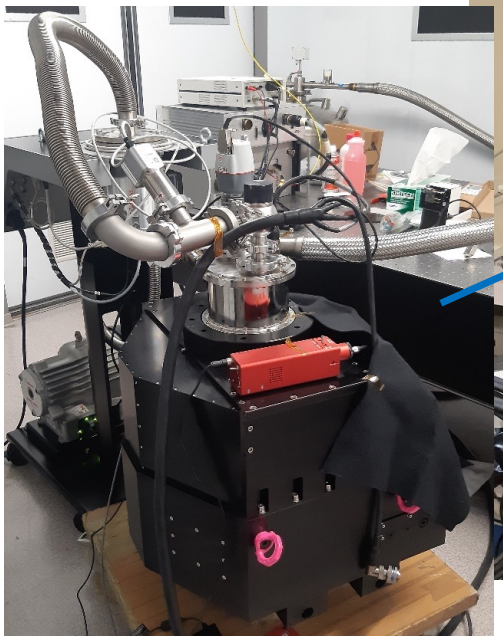


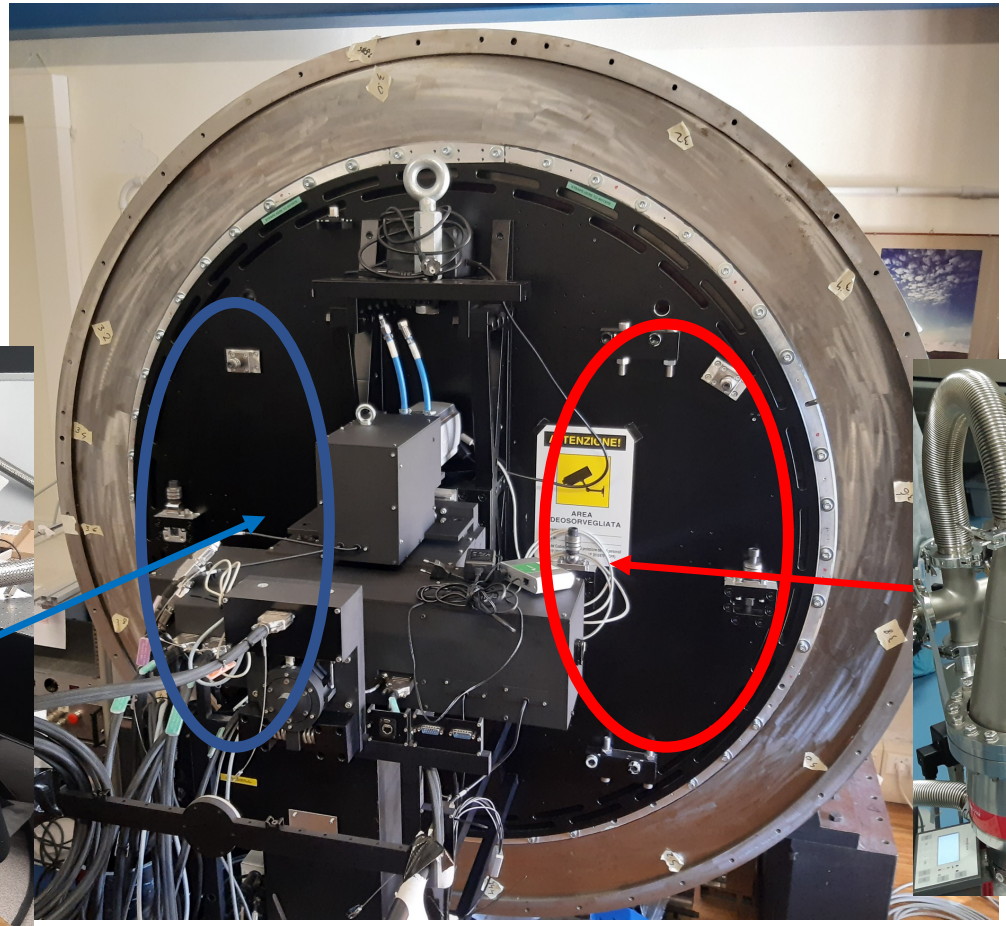
AIT @INAF Padova



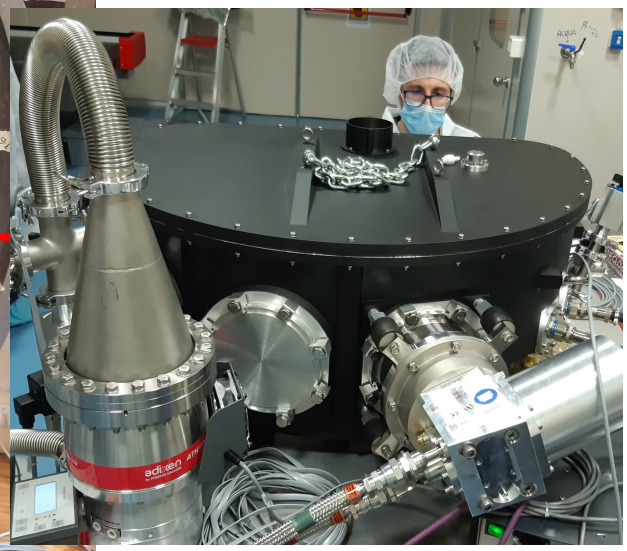


UV-VIS Spectrograph @INAF Padova

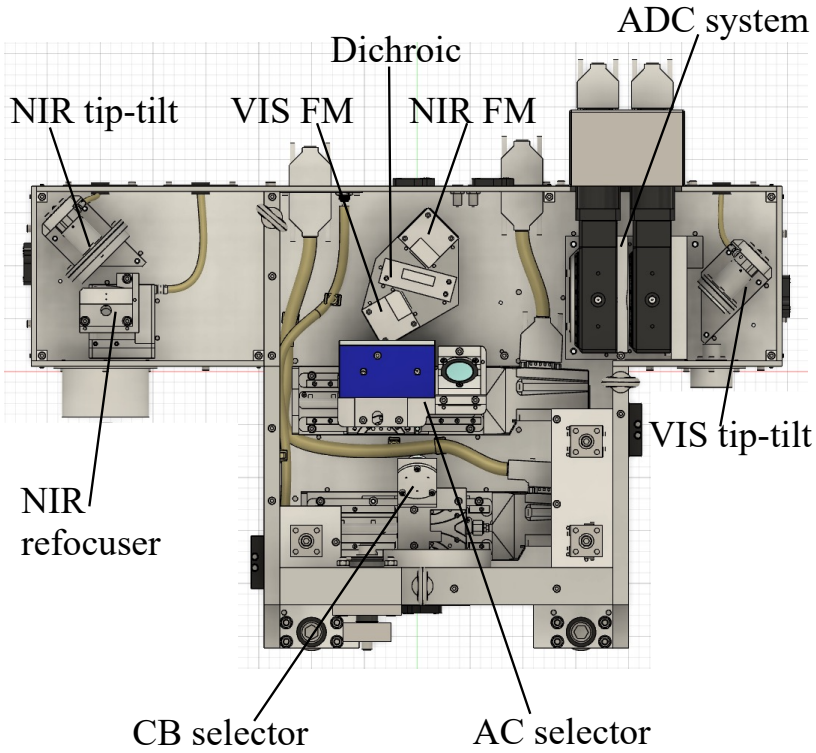


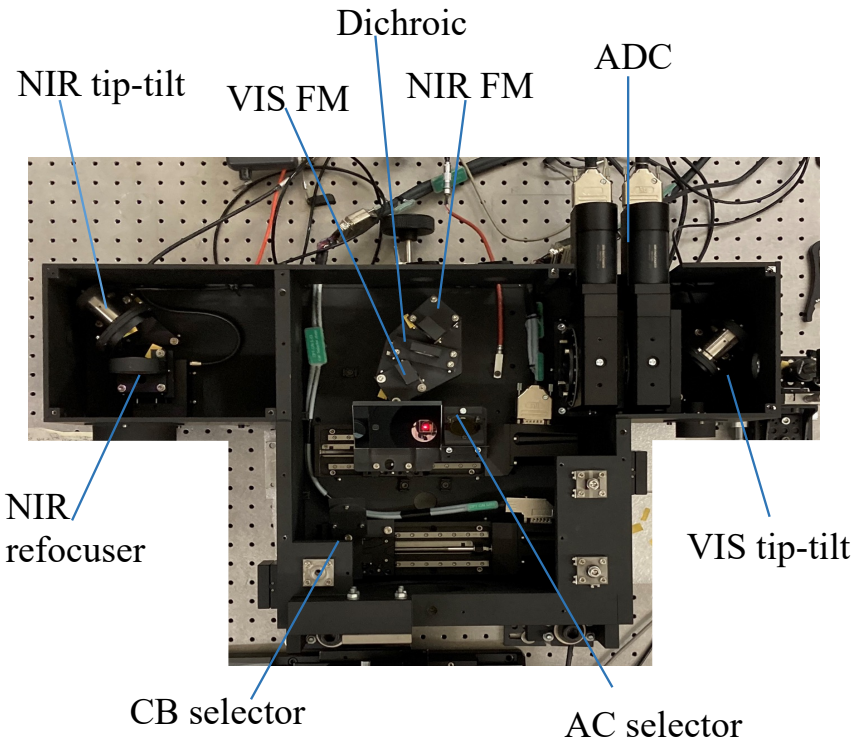


NIR Spectrograph AIT Phase @INAF Merate



Common Path

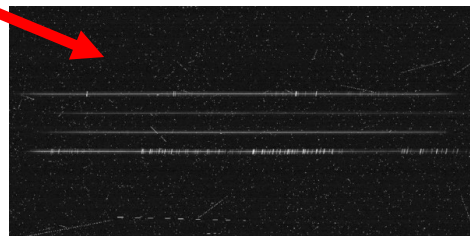


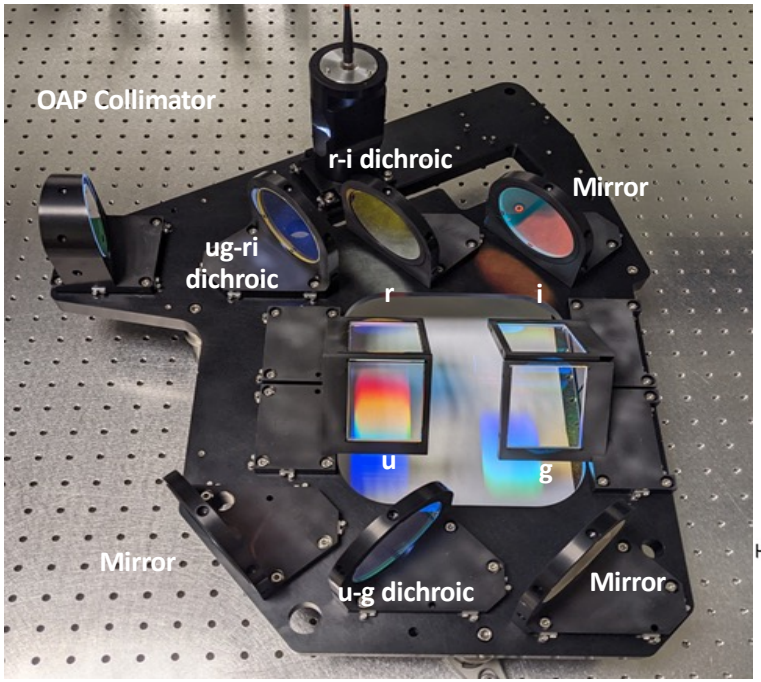


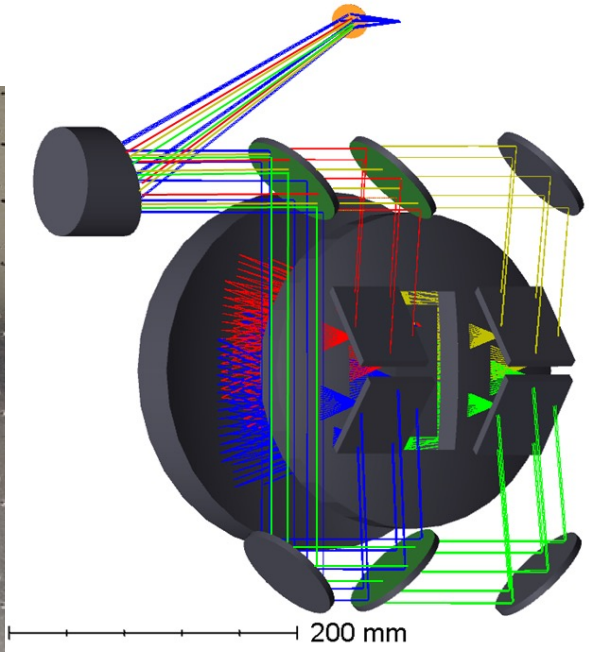
Archer OpTx Optical Precision. Optimal Outcome.
OPTIMAX
ASAHI SPECTRA USA
PECCHIOLI RESEARCH OPTICS, IDEAS AND MORE

UV-VIS: Multi-Imaging Transient 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.





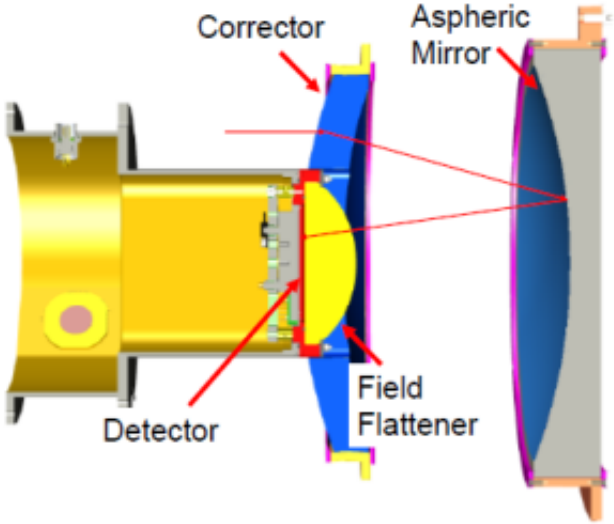


Quasi-Order	Wavelength Range [nm]
u	350 – 439.5
g	427 - 547
r	527 - 680
i	664 – 850

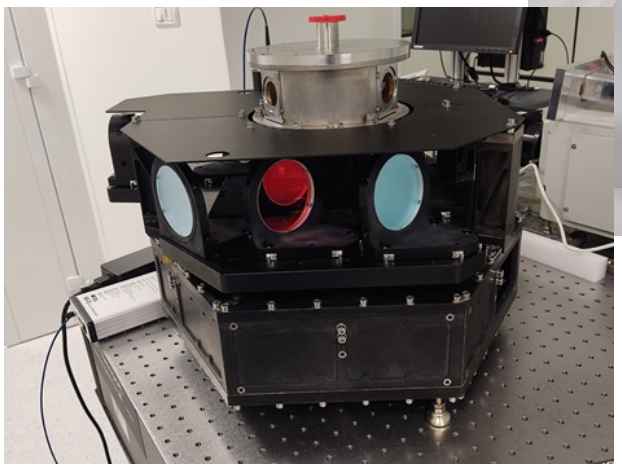
Winlight System · ASAHI SPECTRA USA · Fraunhofer IOF

UV-VIS Camera

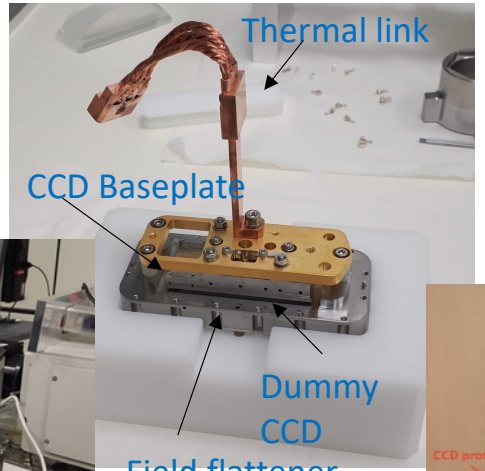
- Three element catadioptric camera: all aspheric
- Used as 4 off axis F/3.1 cameras.
- CaF2 corrector + Fused Silica Field Flattener
- Low CTE=>Athermal camera



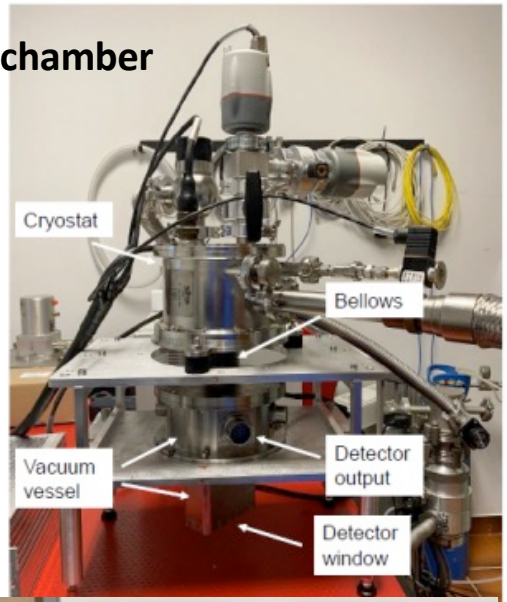
Feed + Camera

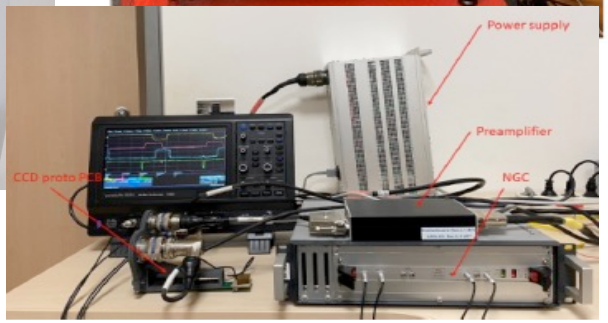


CCD Invar Baseplate gold plated

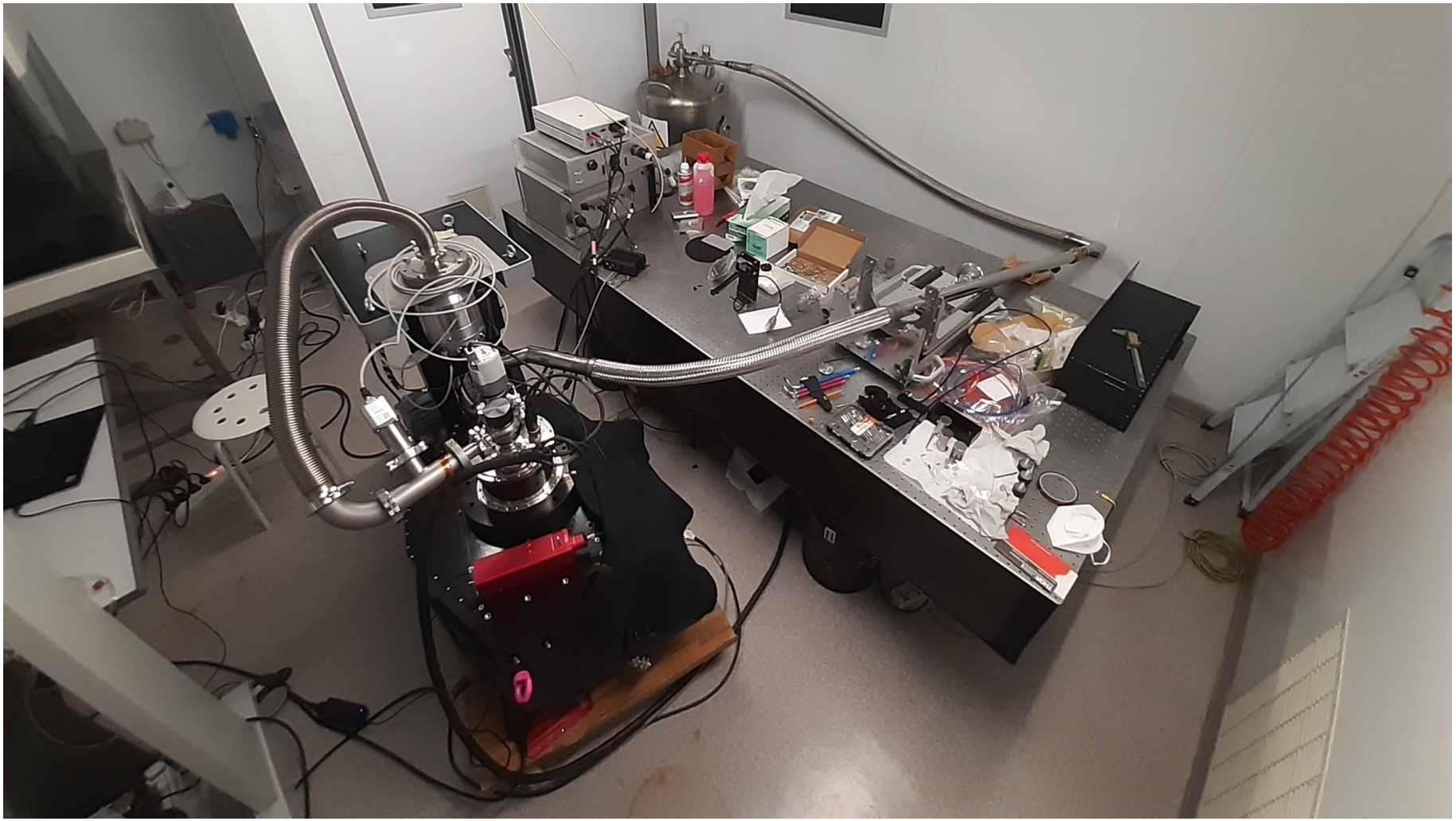


CCD vacuum chamber





ESO NGC Controller

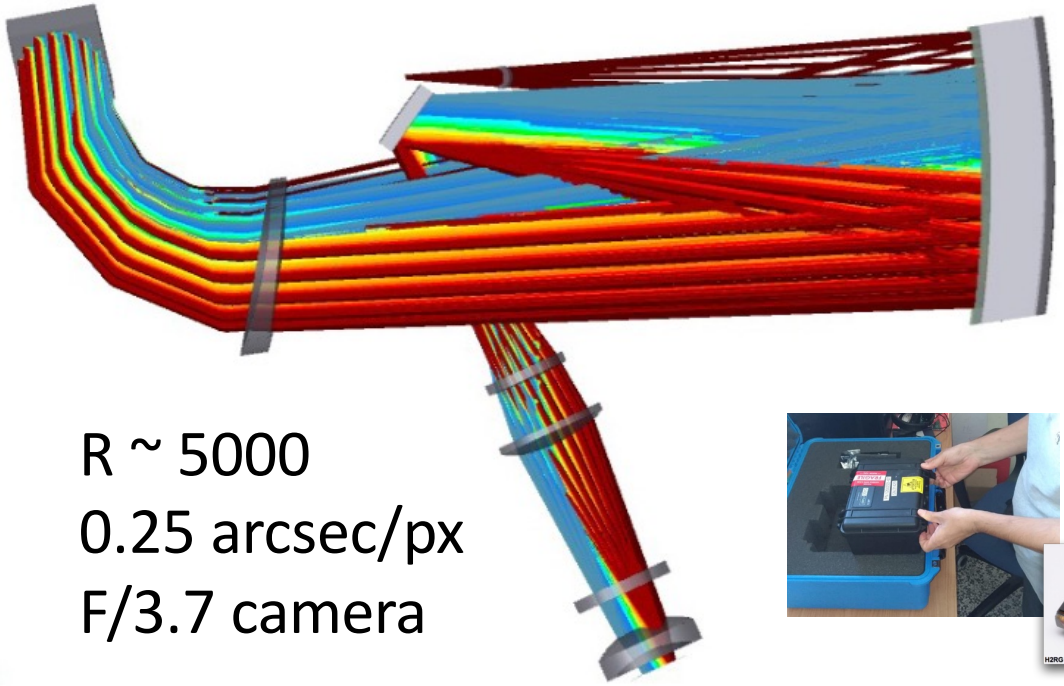


NIR Spectrograph

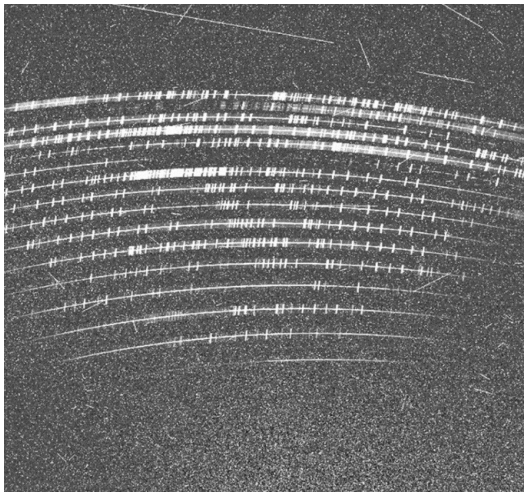
4C Design

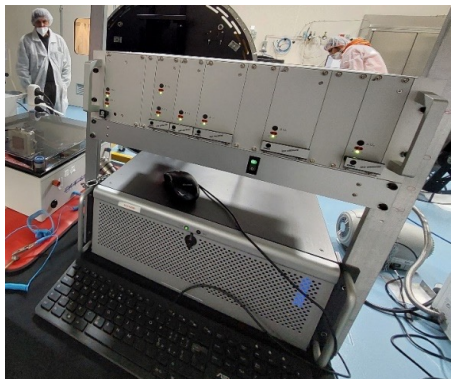
Spectrograph with
Collimator
Compensation of
Camera
Chromatism

Echelle
Cross-Dispersed



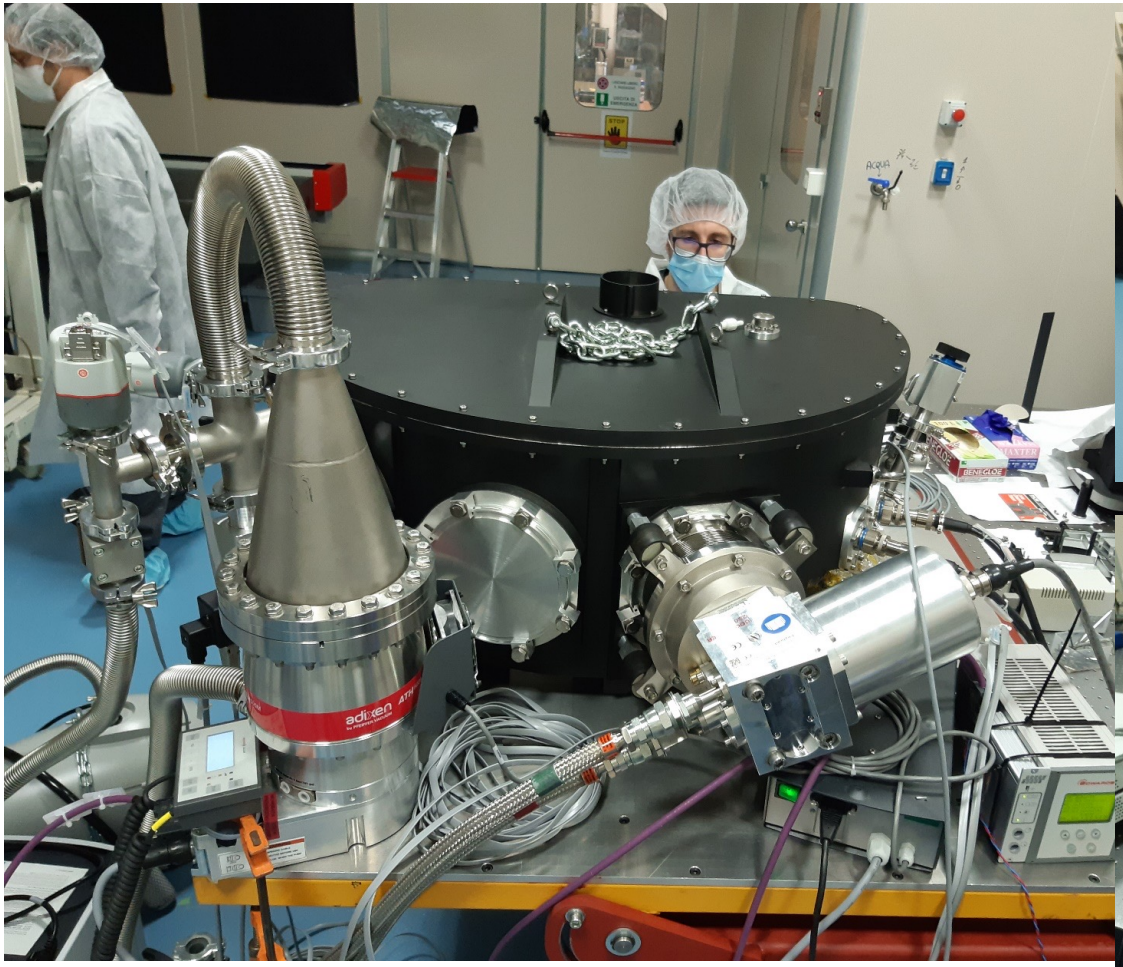
R ~ 5000
0.25 arcsec/px
F/3.7 camera

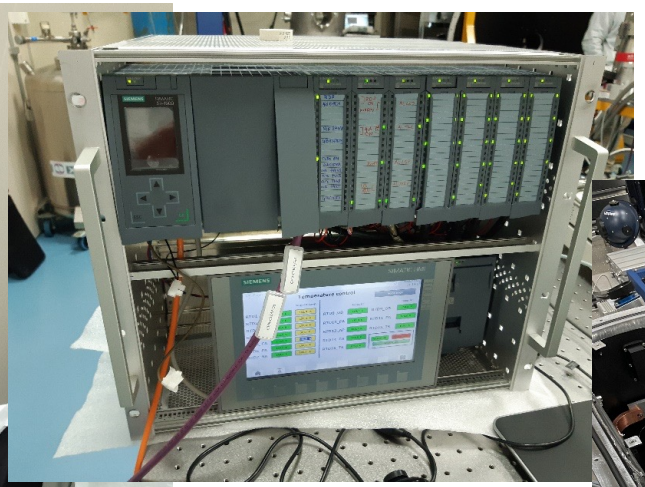


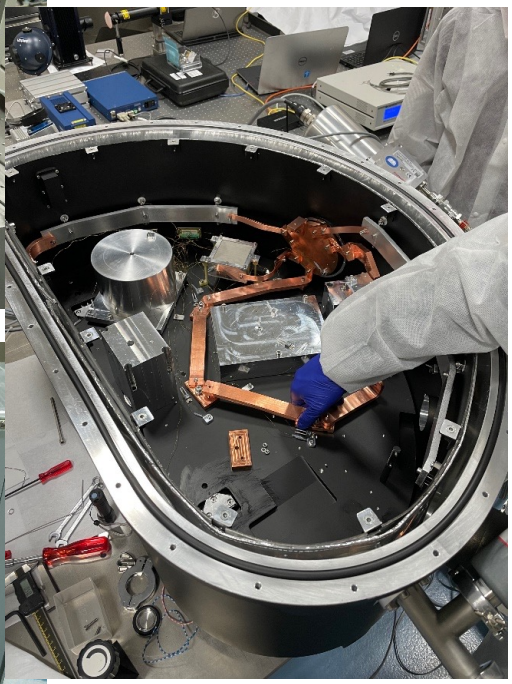


ESO NGC Controller

Richardson Gratings™ A Newport Corporation Brand
CRYSTRAN UV · VISIBLE · IR SPECIALIST OPTICS
OPTIMAX ASAHI SPECTRA USA
OFFICINASTELLARE OUR WORLD, YOUR SPACE
NOVA

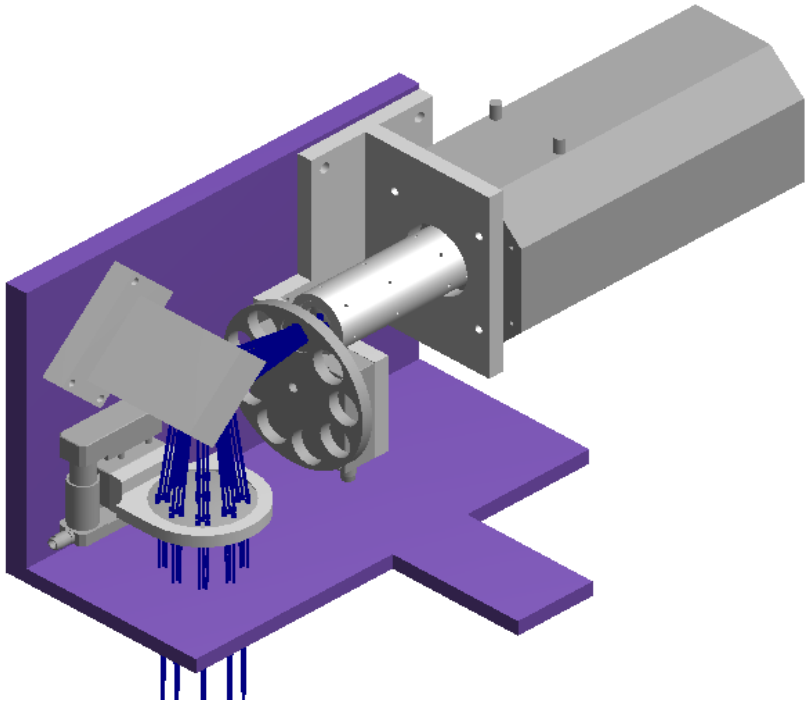


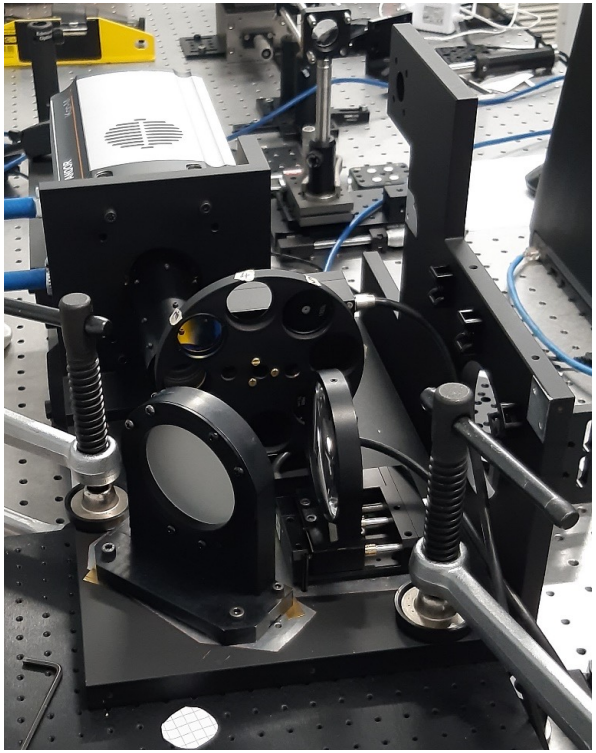


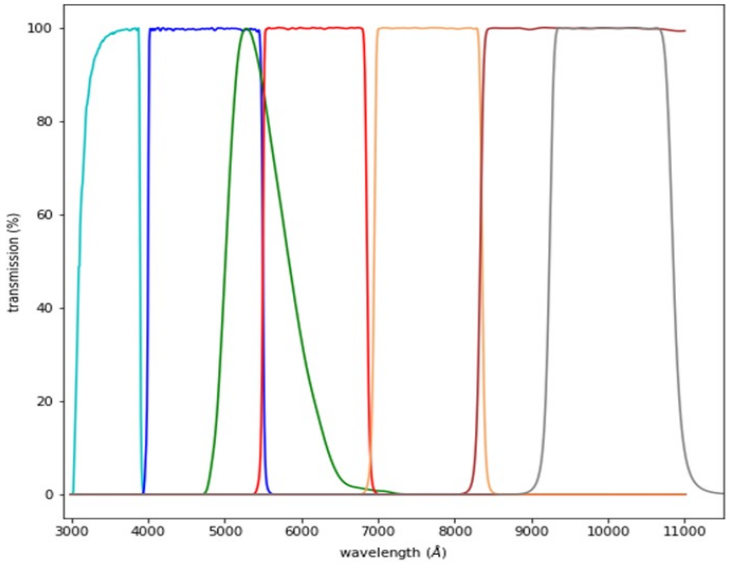


A&G Camera

- ❑ Target Acquisition
- ❑ Secondary guiding
- ❑ Photometry







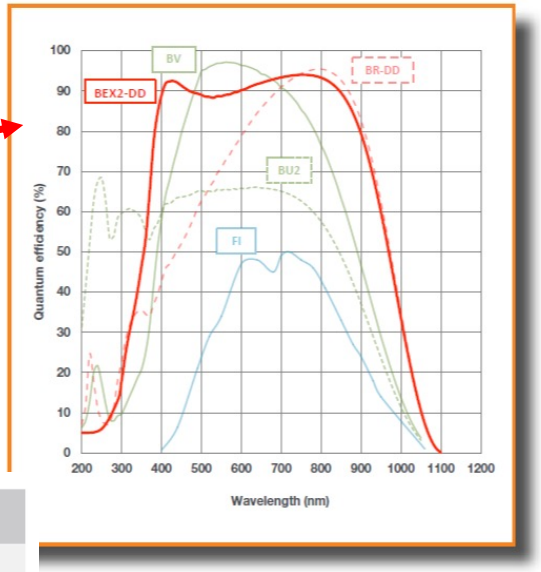
FoV: 3.5'x3.5'

Filters: ugrizY + V

INAOE
ASAHI SPECTRA USA
PECCHIOLI RESEARCH
OPTICS, IDEAS AND MORE

A&G Camera

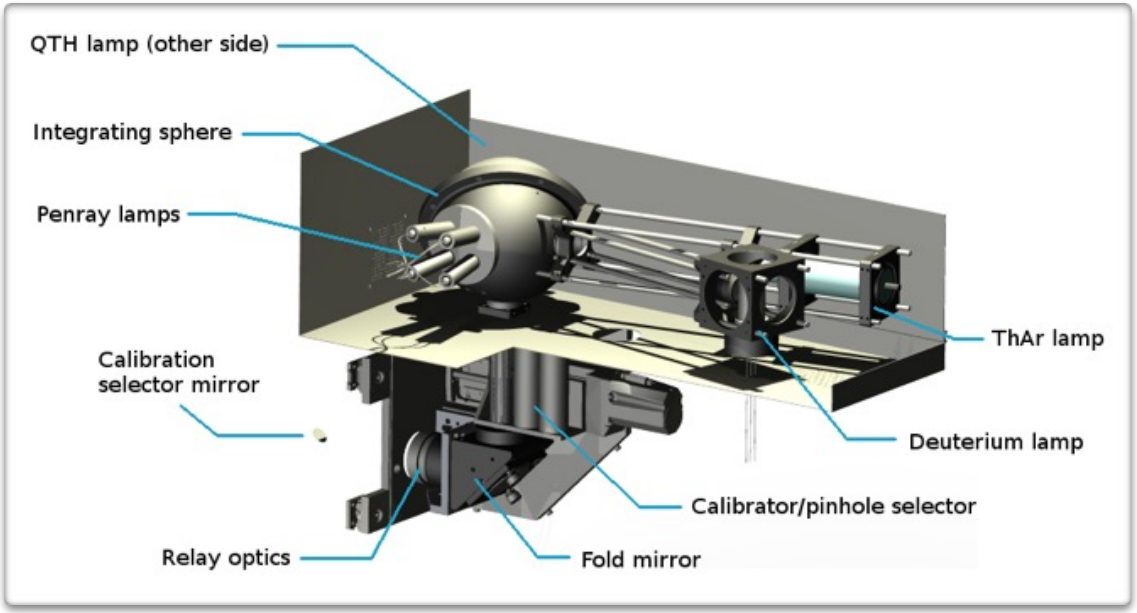
BEX2-DD => High QE in a broad wavelength range

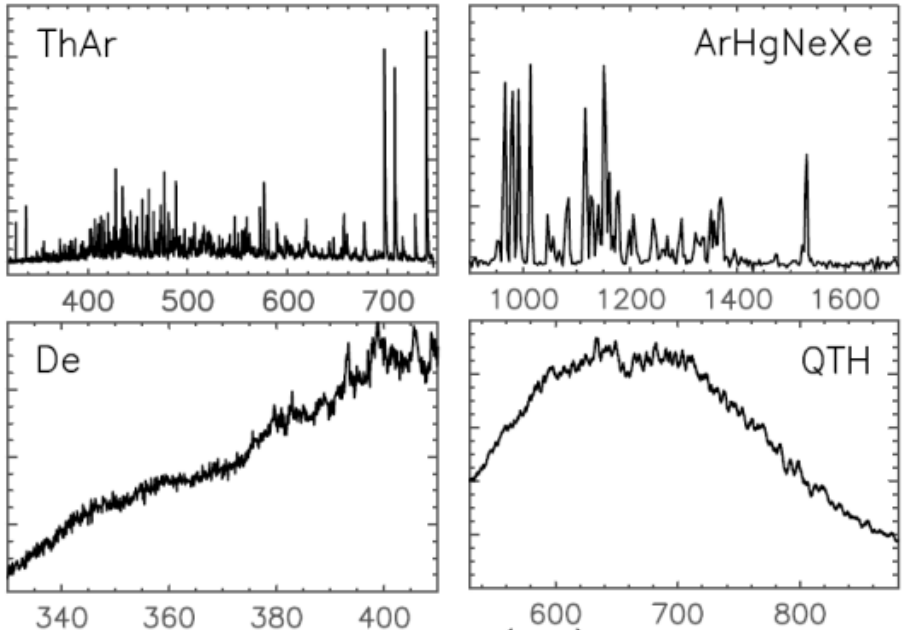


Active pixels	1024 x 1024
Sensor size	13.3 x 13.3 mm
Pixel size (W x H)	13 µm x 13 µm
Active area pixel well depth	100,000 e^- (130,000 e^- for BR-DD and BEX2-DD models)
Pixel readout rates (MHz)	5, 3, 1, 0.05
Read noise	2.9 e^-
Maximum cooling	-100°C
Frame rate	4.4 fps (full frame)

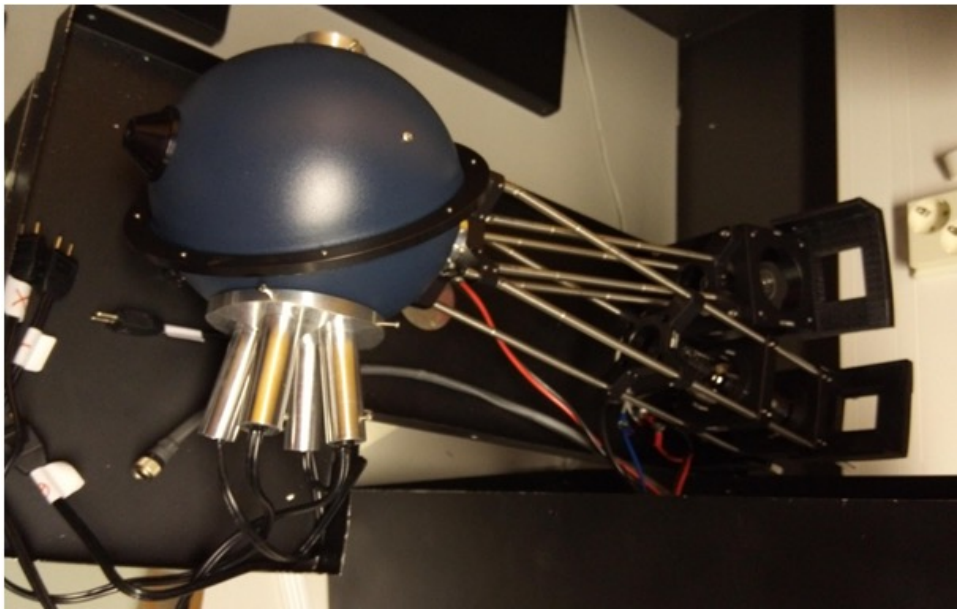
Andor iKon M934
1024x1024
13µm/px 0.205 "/px

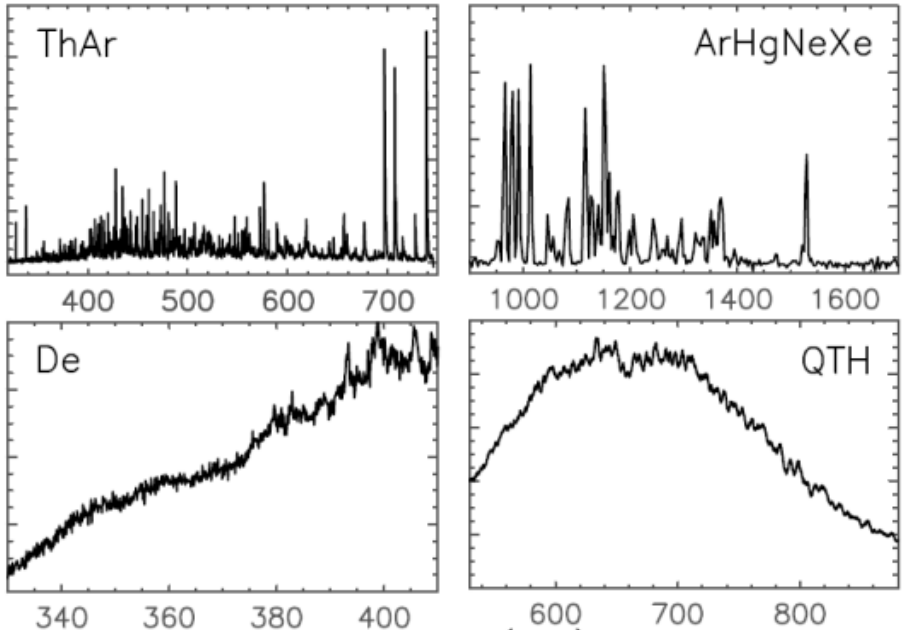
Calibration Unit



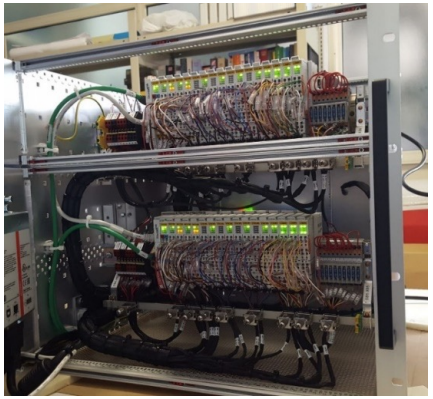


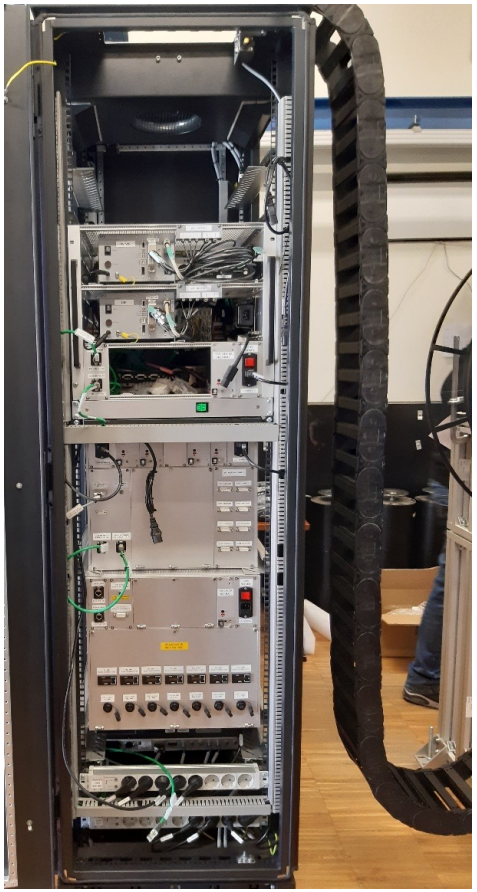
Calibration Unit



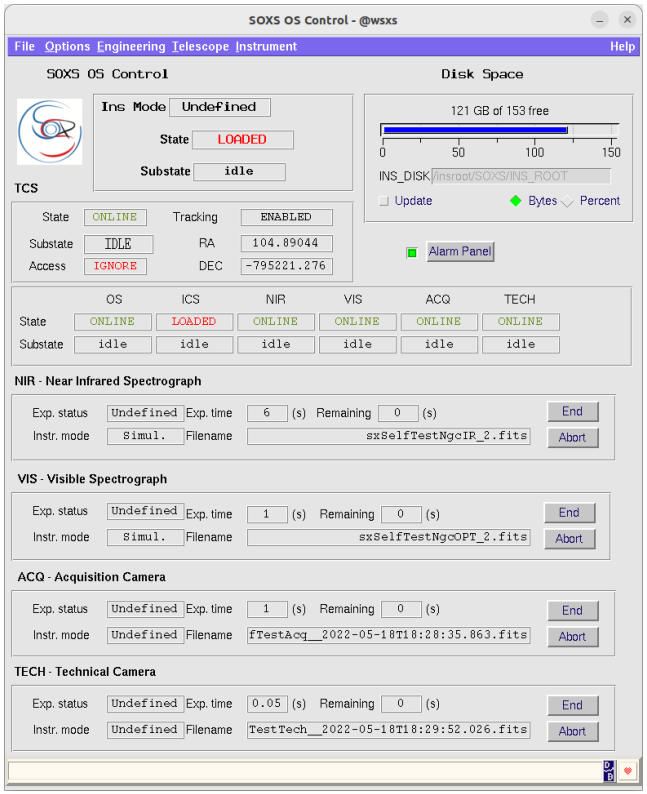


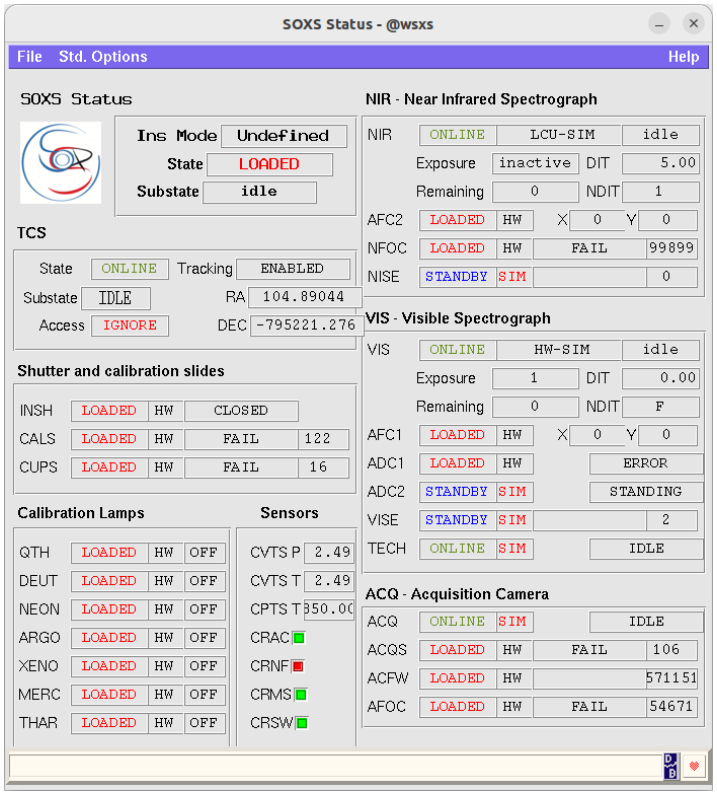
Electronics

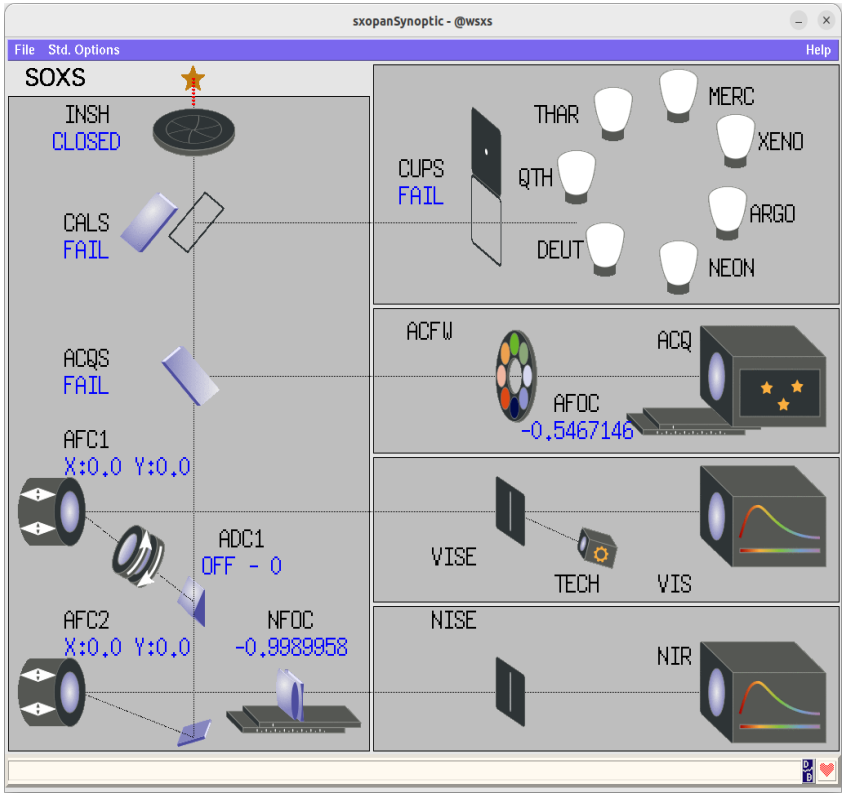




Instrument Software



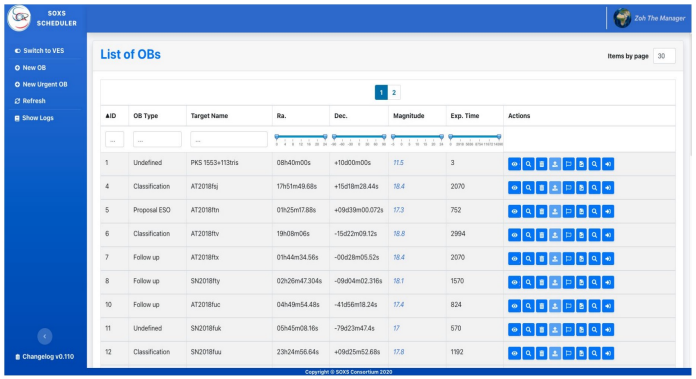


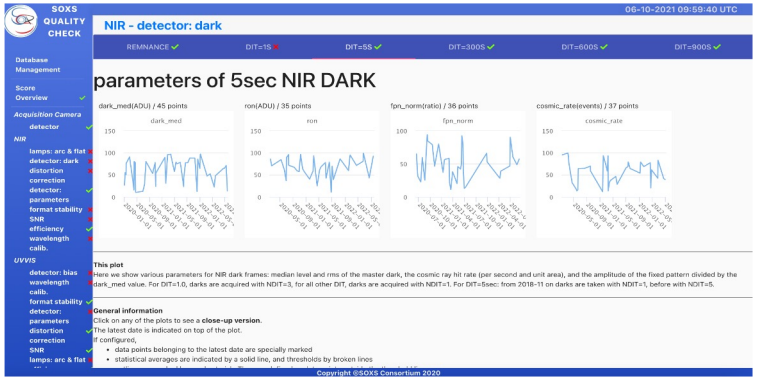


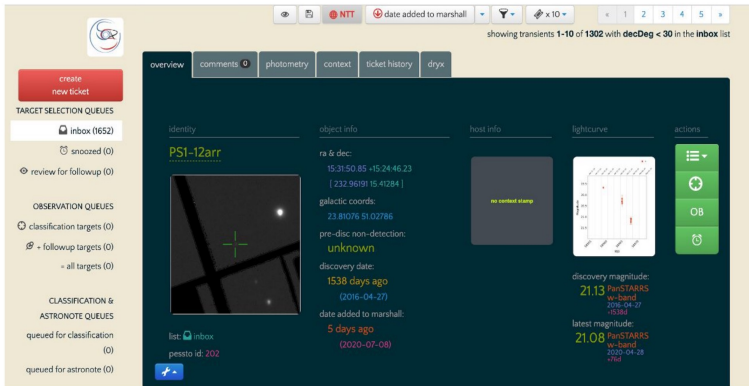
Operations

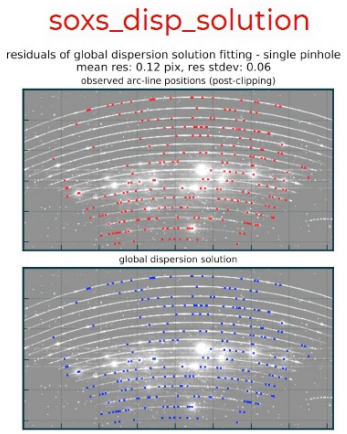
- ETC
- Pipeline
- Scheduler
- Quality Control
- Remote Monitoring
- Help desk

5 years





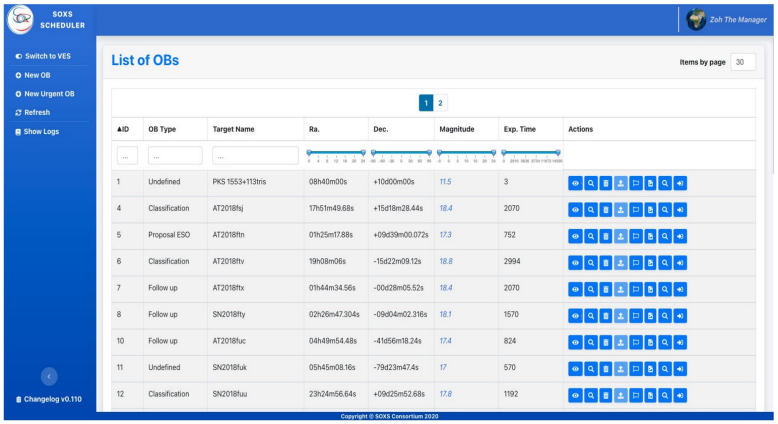


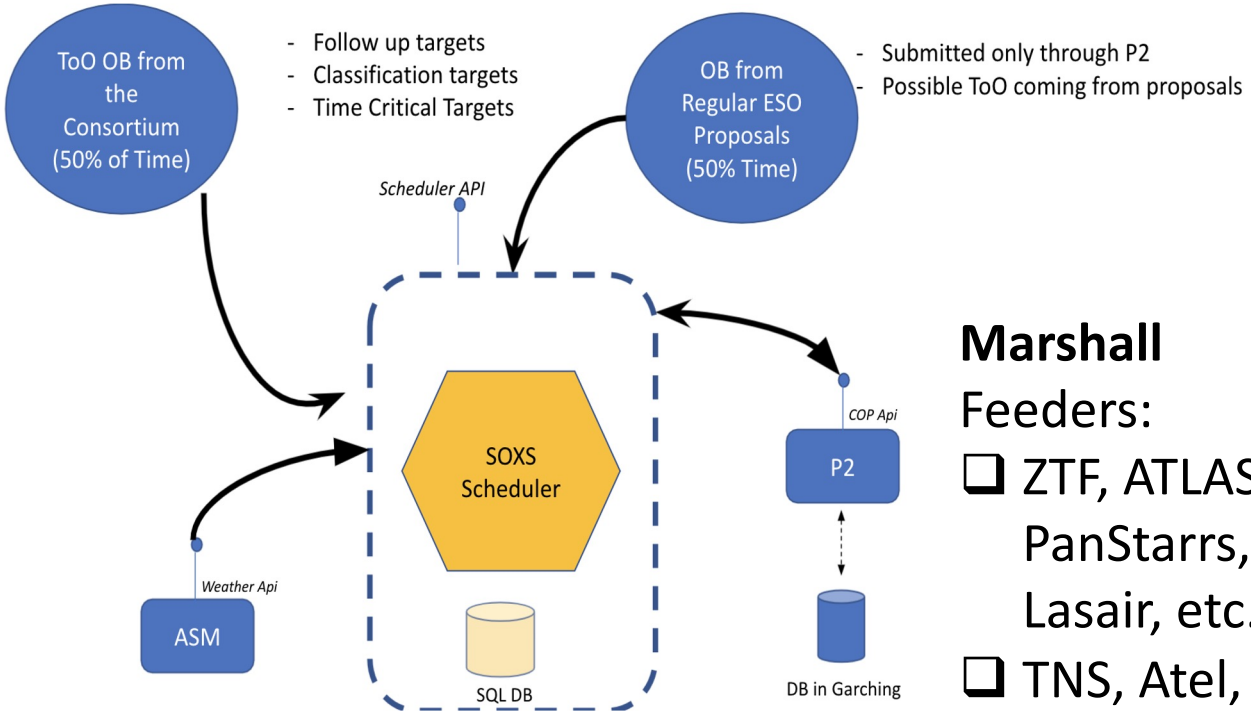


Scheduler

- Schedule is updated daily
- Telescope operator on site

- P2 system, vOT interface with ESO
- Web based app

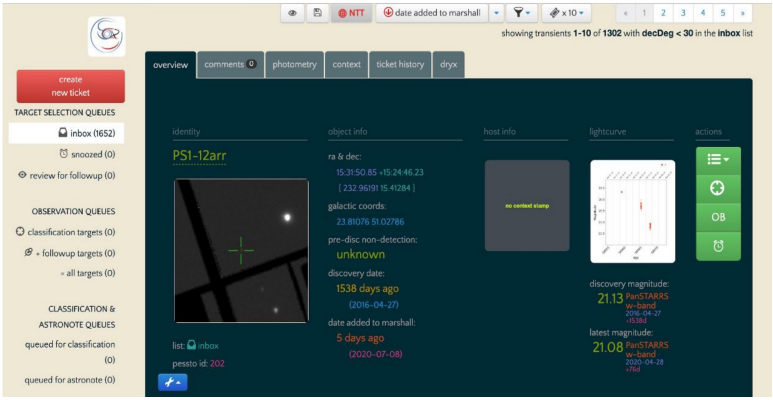




Marshall

Feeders:

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



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