



Introduction to the instrument

*P. Schipani
&
SOXS Dream Team*

*SOXS Consortium Science Meeting
24-26 November 2020*



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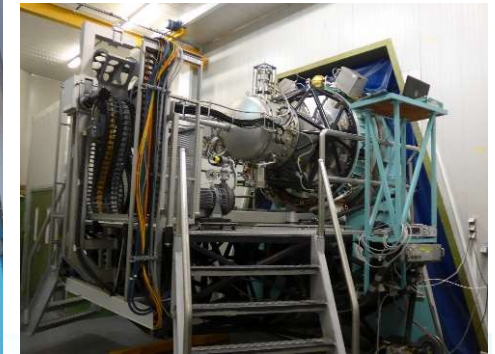
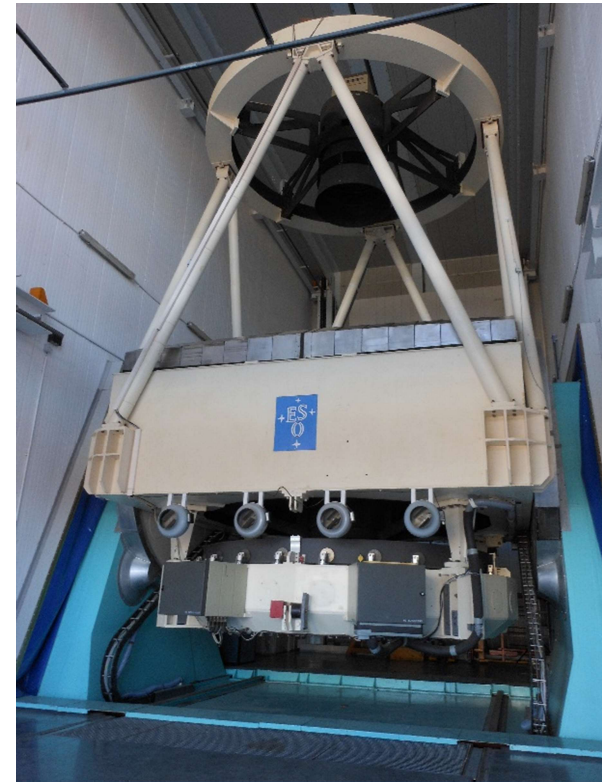
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- ❑ Single-object wide band spectrograph from U to H band @ESO-NTT 350-2000 nm
- ❑ 'Similar' to X-Shooter @VLT
- ❑ Two arms (VIS + NIR) with partial overlap around 800 nm to cross-calibrate spectra
- ❑ $R \sim 4,500$ (3,500-6,000)
- ❑ Acquisition camera to perform photometry ugrizY-V (3.5'x3.5')



ESO La Silla (LPO)



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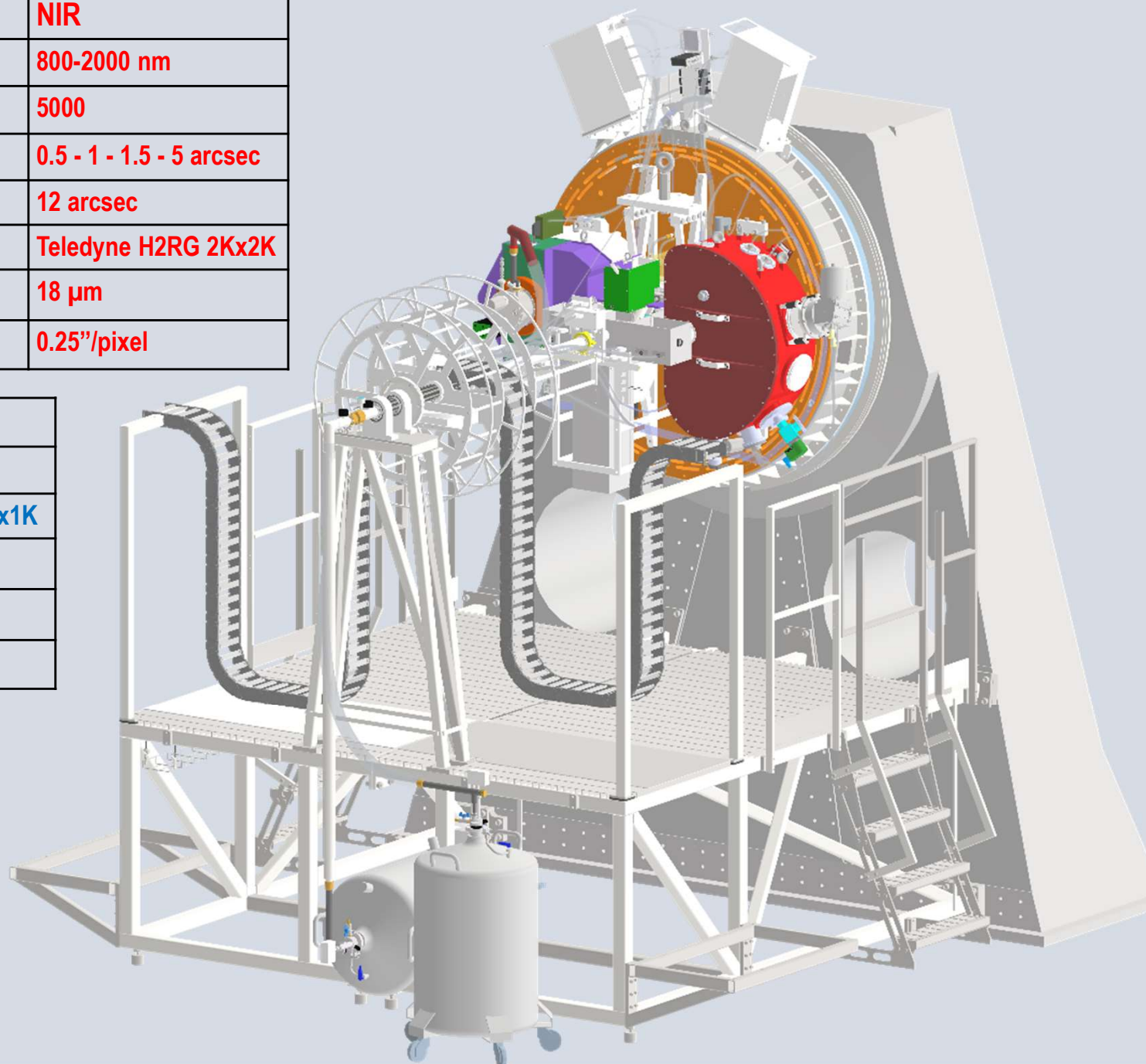


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	UV-VIS	NIR
Spectral range	350-850 nm	800-2000 nm
Resolution (1" slit)	>3600 (\approx 4500 avg)	5000
Slit widths	0.5 - 1 - 1.5 - 5 arcsec	0.5 - 1 - 1.5 - 5 arcsec
Slit height	12 arcsec	12 arcsec
Detector	e2V CCD44-82 2Kx4K	Teledyne H2RG 2Kx2K
Pixel Size	15 μ m	18 μ m
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 μ m
Detector Scale	0.205"/pixel





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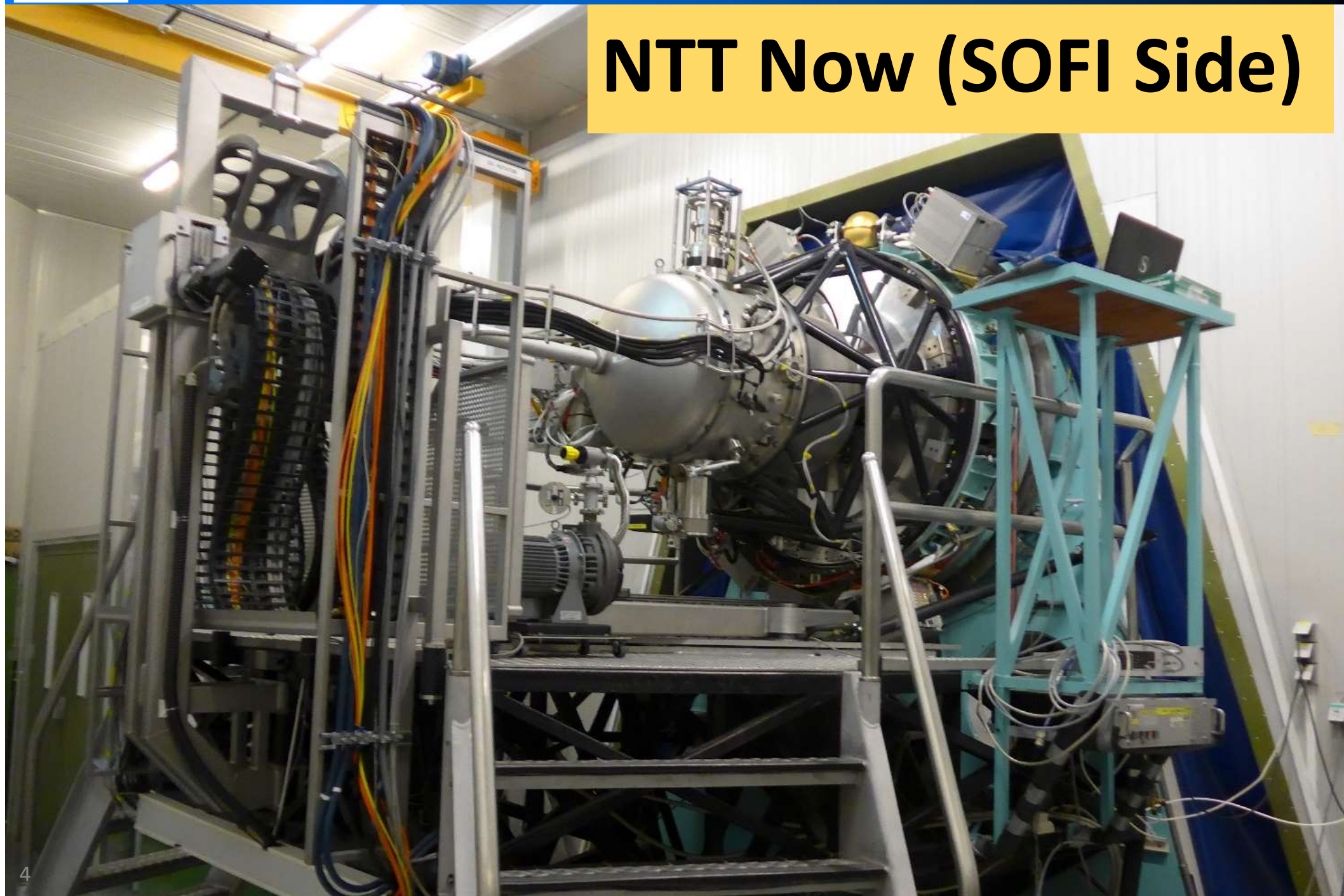
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NTT Now (SOFI Side)





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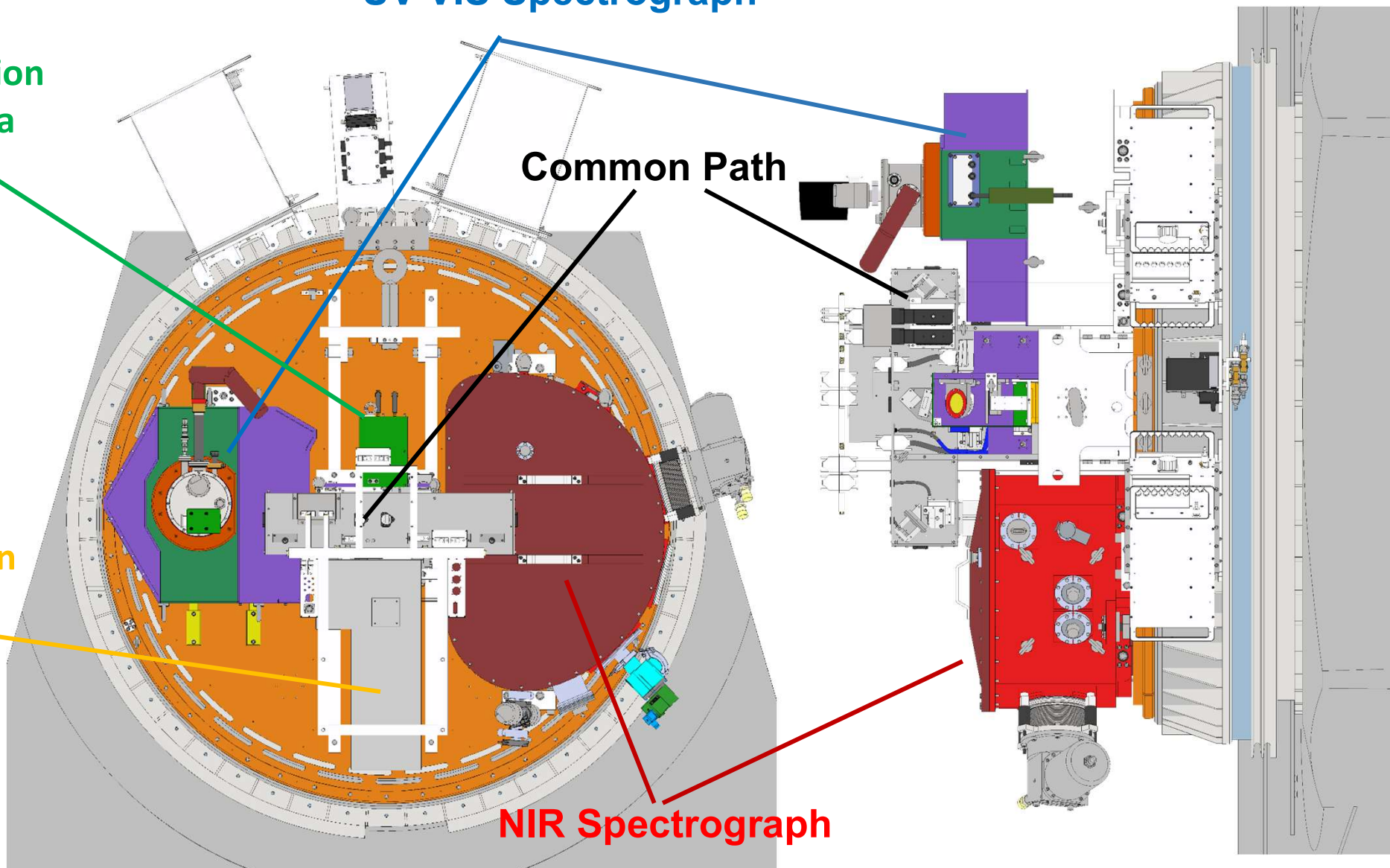
UV-VIS Spectrograph

Acquisition
Camera

Calibration
Unit

Common Path

NIR Spectrograph





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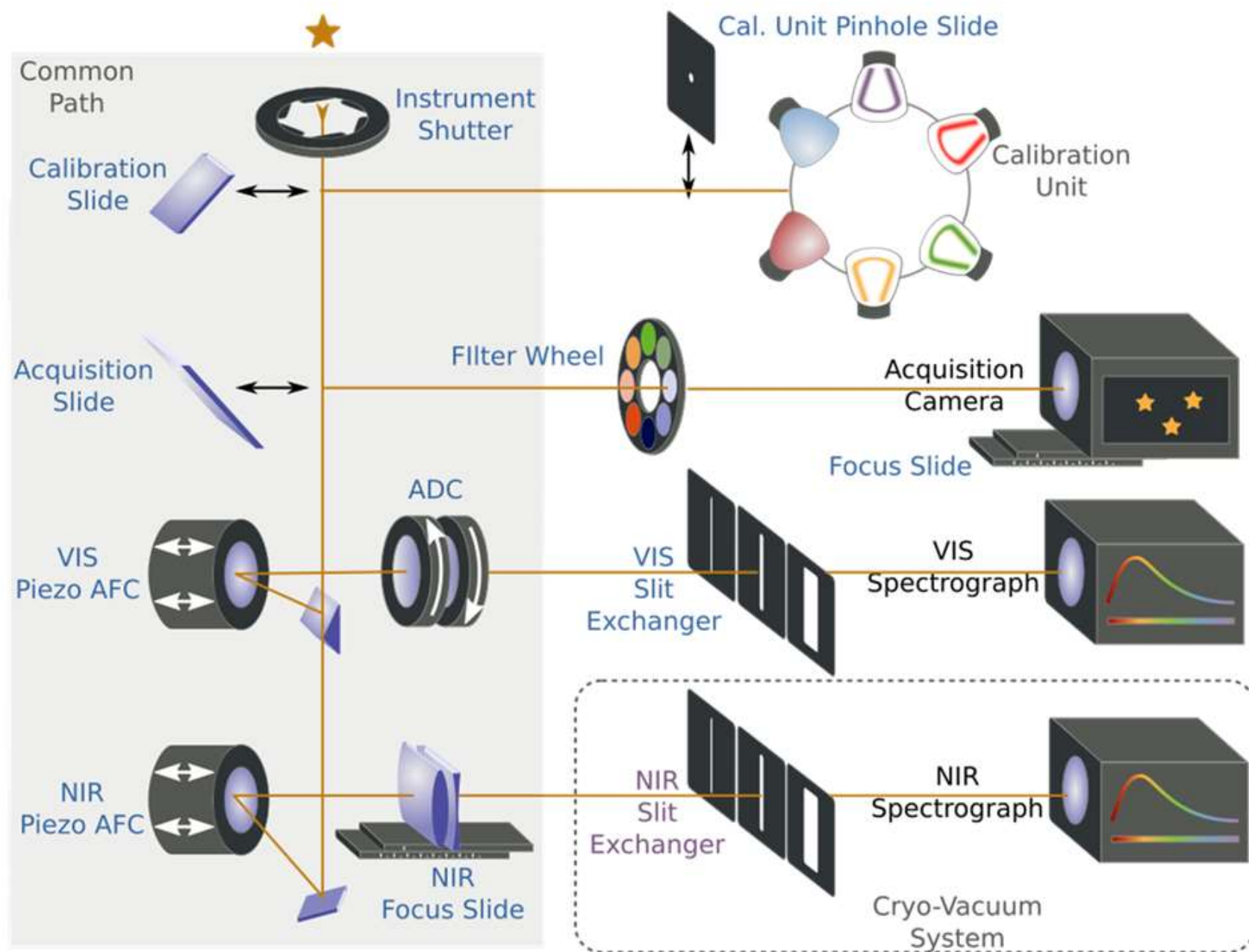
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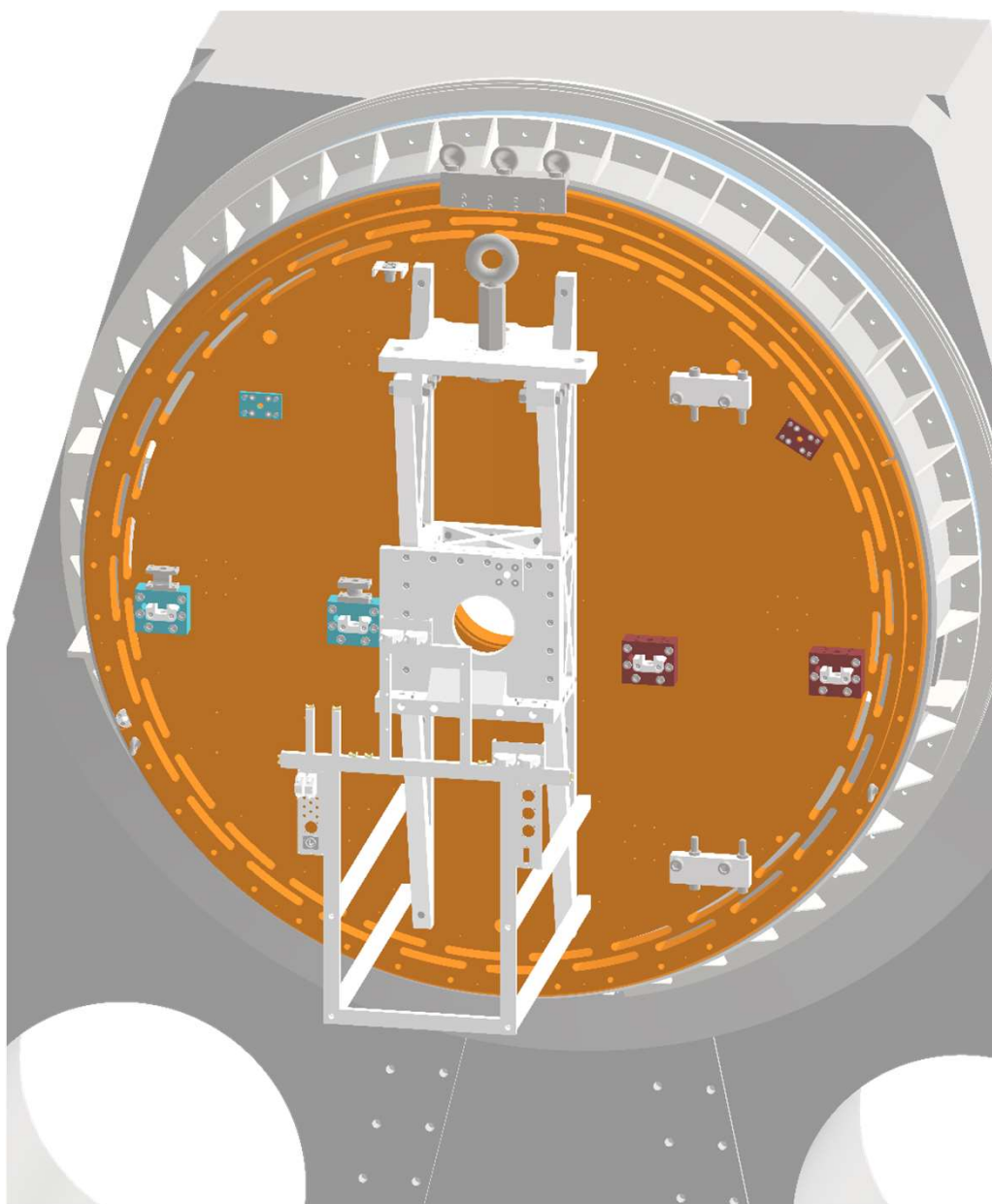
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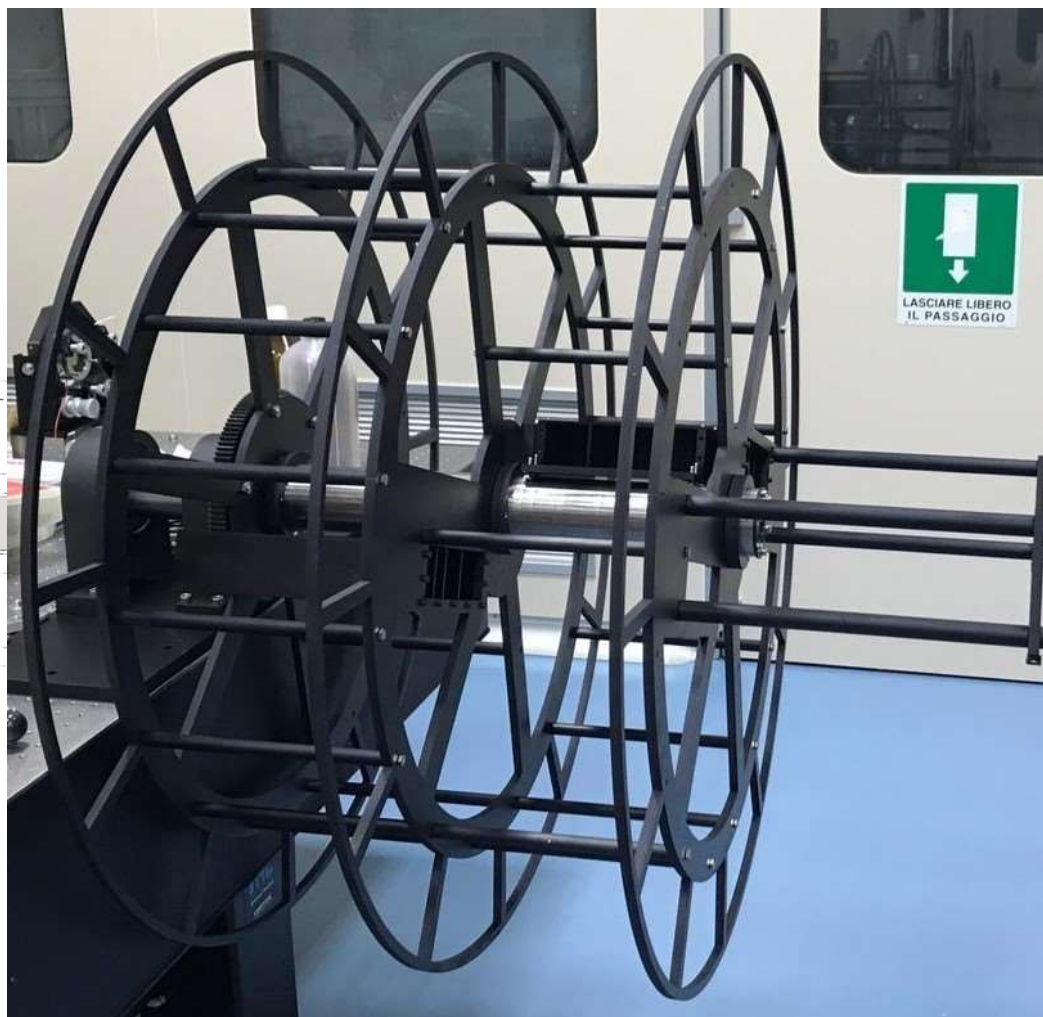
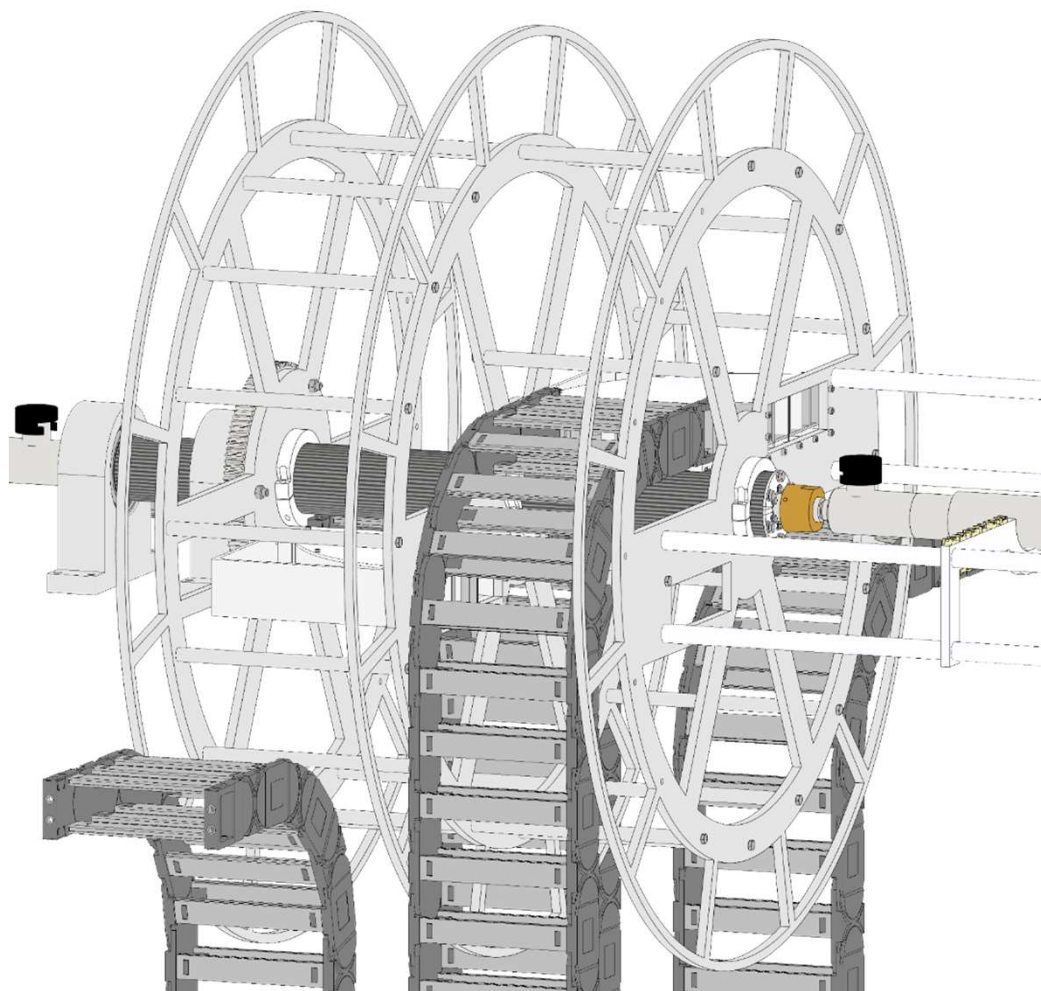
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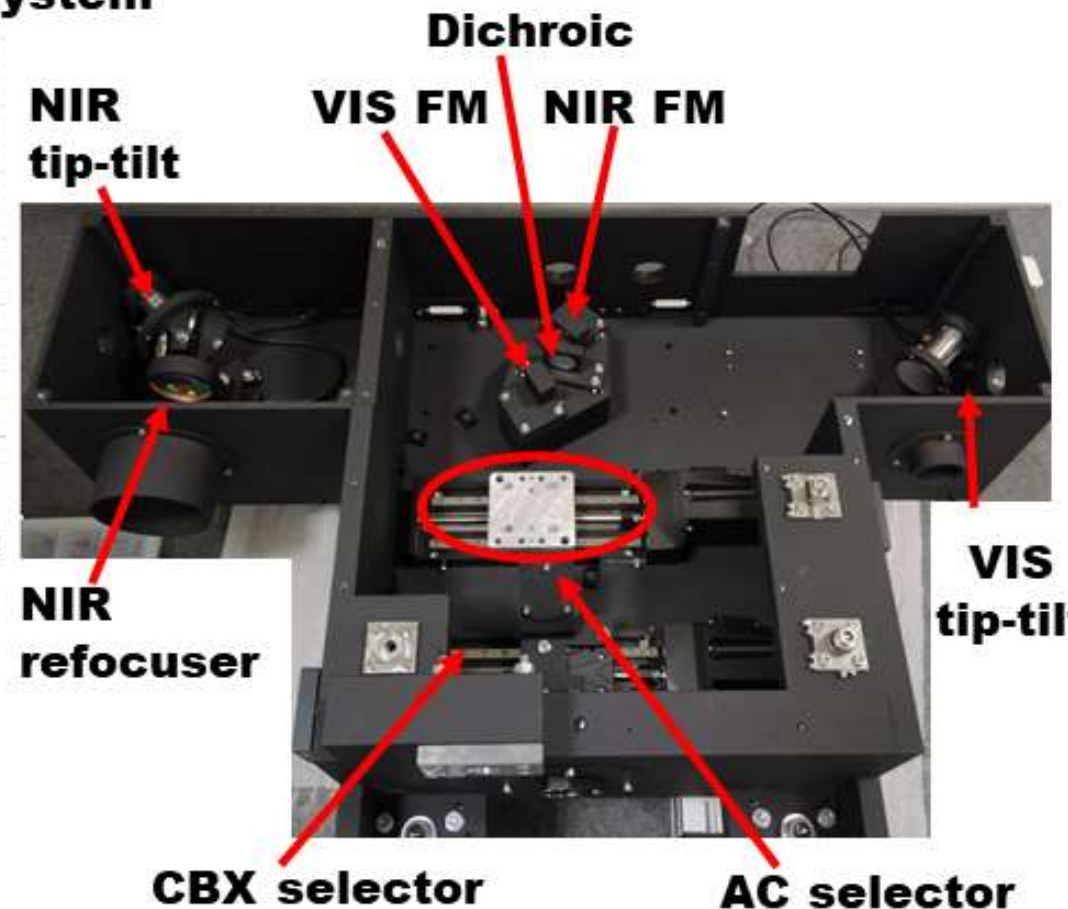
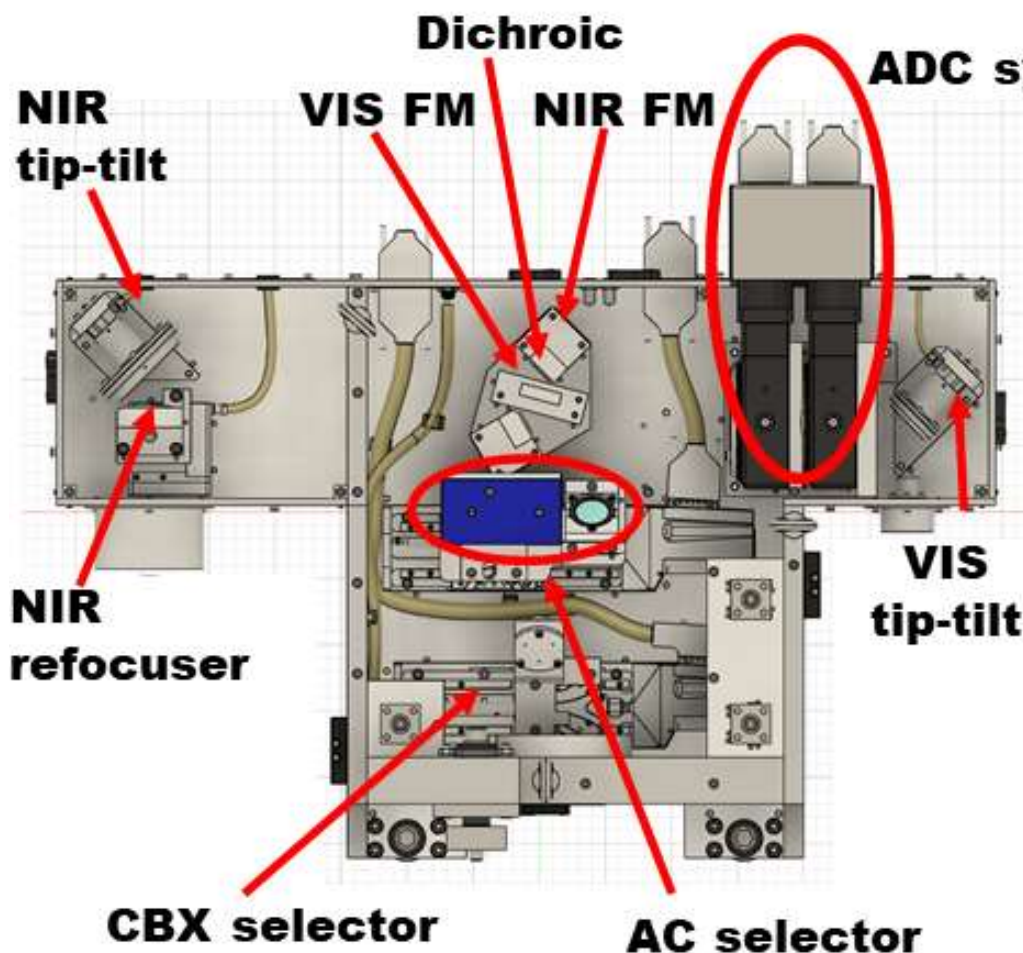
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Common Path



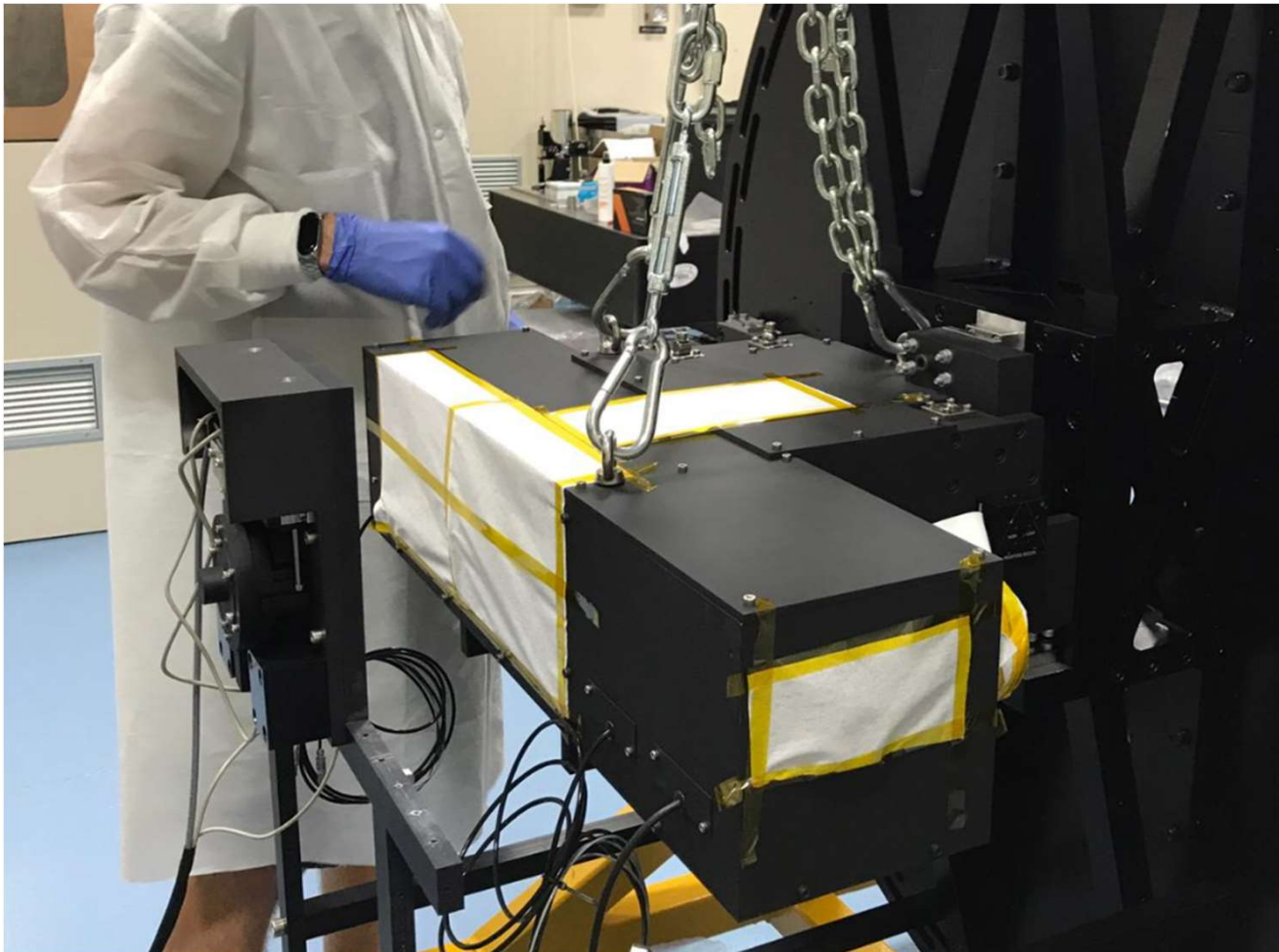
Archer OpTx
Optical Precision. Optimal Outcome.

OPTIMAX

ASAHI SPECTRA USA

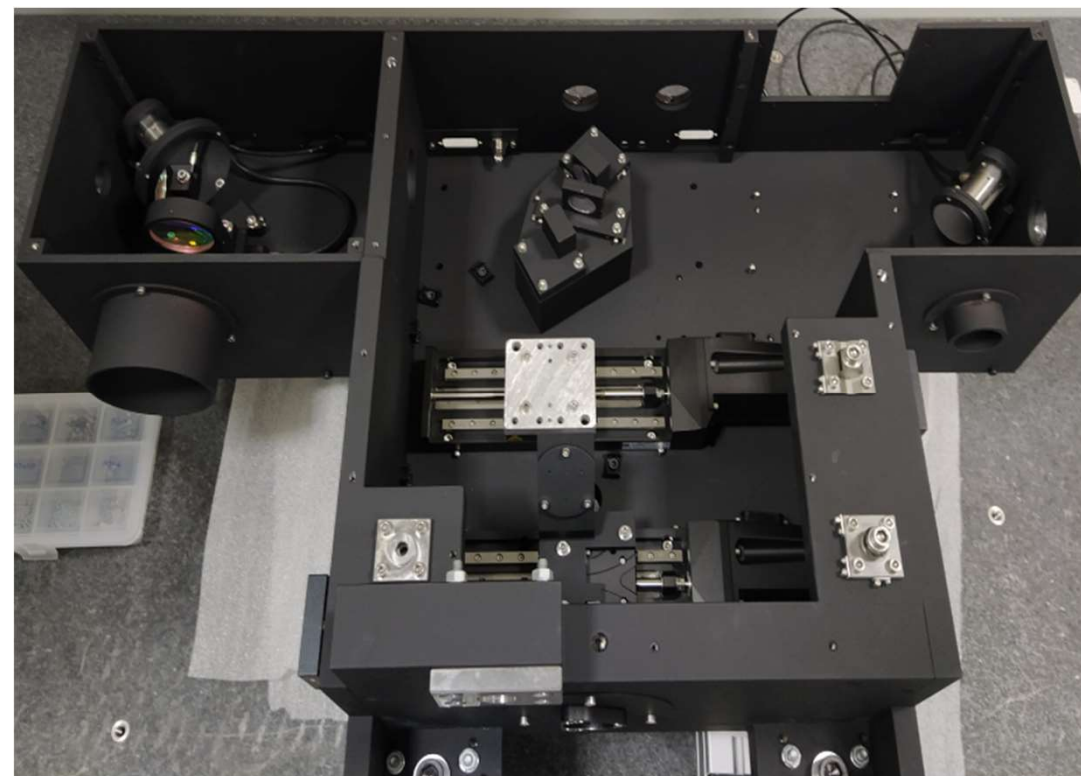
PECCHIOLI RESEARCH
OPTICS, IDEAS AND MORE

Common Path



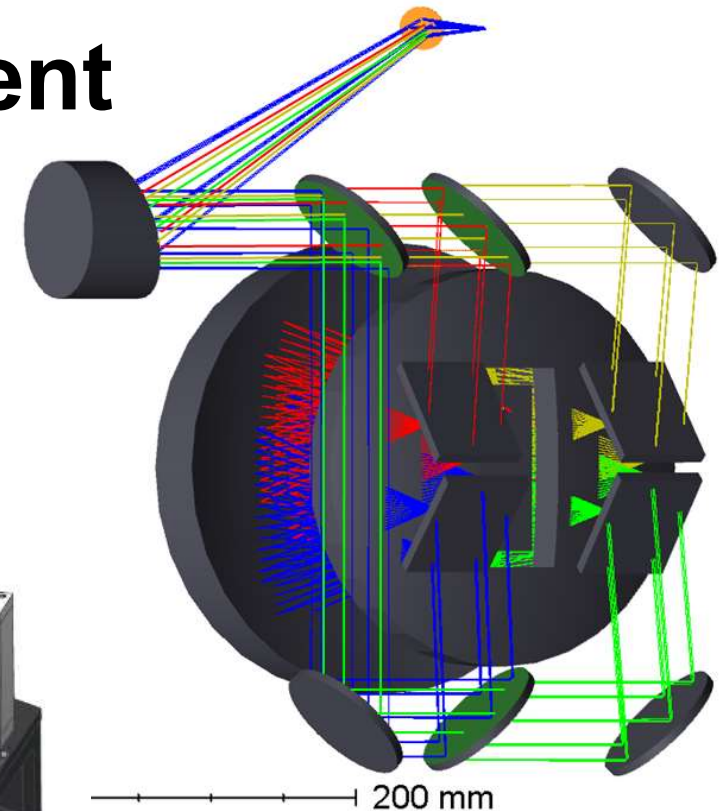
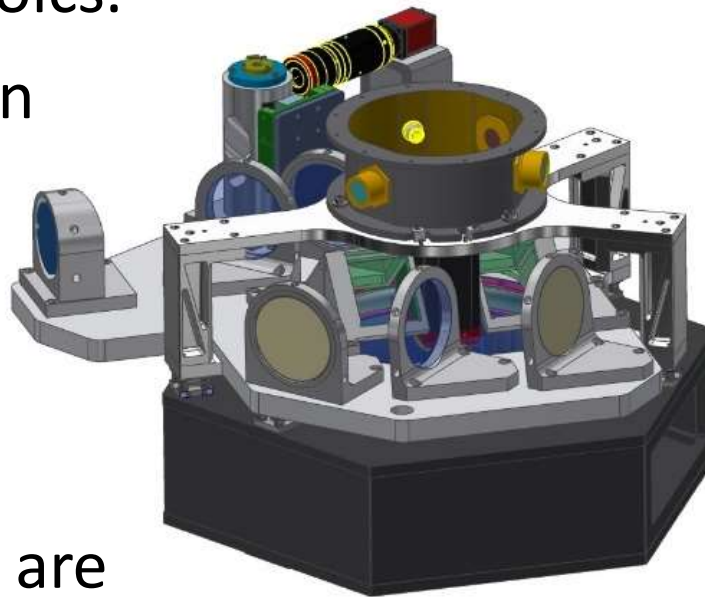
Common Path

- ❑ All optics available but ADC (Archer OpTx)
- ❑ Available optics glued on supports
- ❑ System moved from INAF-Merate to INAF-Padova
- ❑ Pre-alignment completed
- ❑ Control system (HW @INAF-Capodimonte + INS @INAF-Padova) ready, to be integrated & tested
- ❑ *Pending activities are in Italy and US (Archer OpTx)*



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, $\mathcal{R} \sim 4500$ at α_{Lit} .
- ❑ 4 bands quasi-orders are imaged onto a single 4k×2k CCD.



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



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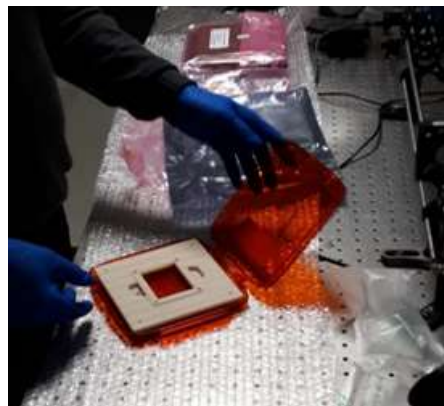


Winlight System

OAP

Gratings

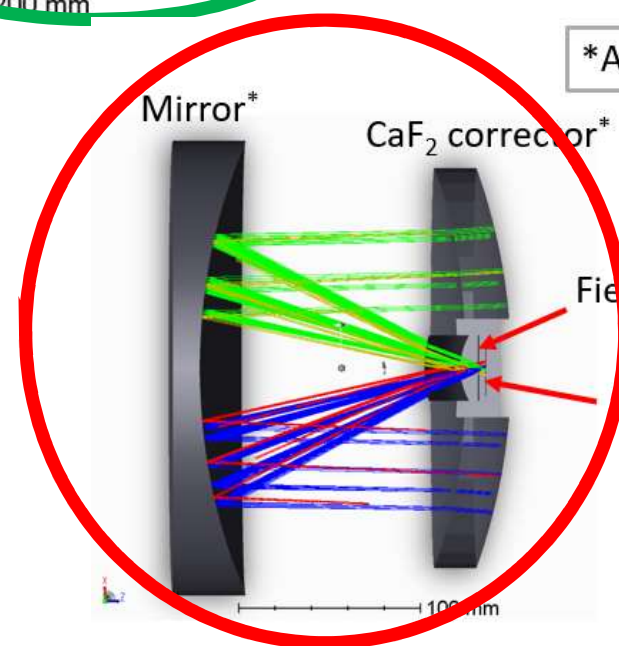
Fraunhofer
IOF



Feed

ASAHI SPECTRA USA

Dichroics & Folding Mirrors



*Aspheric

Mirror*

CaF₂ corrector*

Field flattener*

Detector

Winlight System

Camera



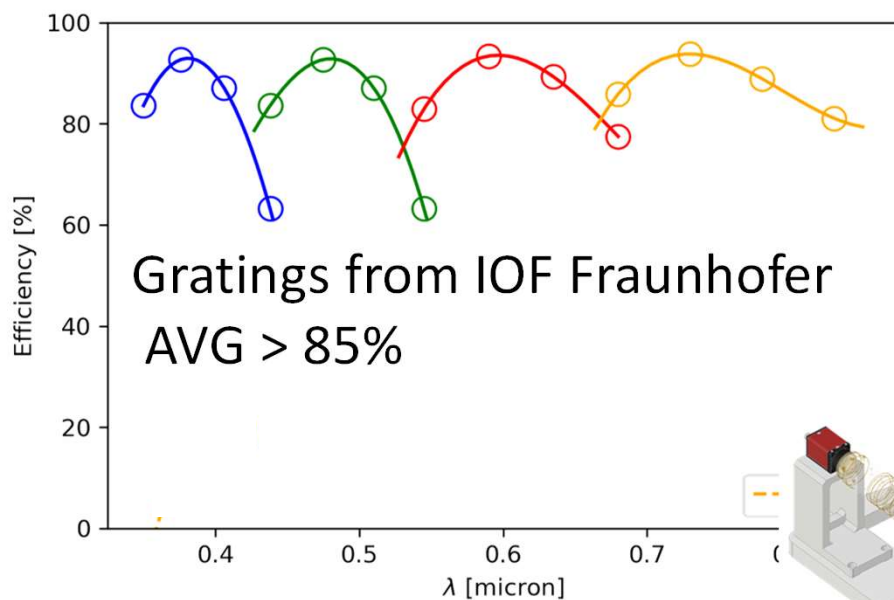
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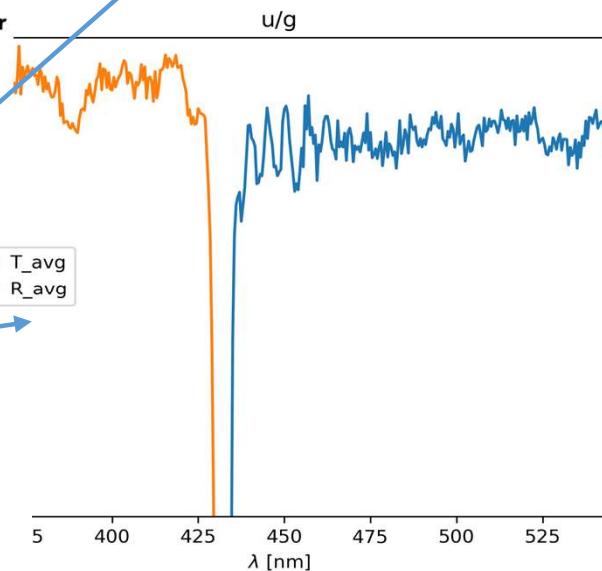
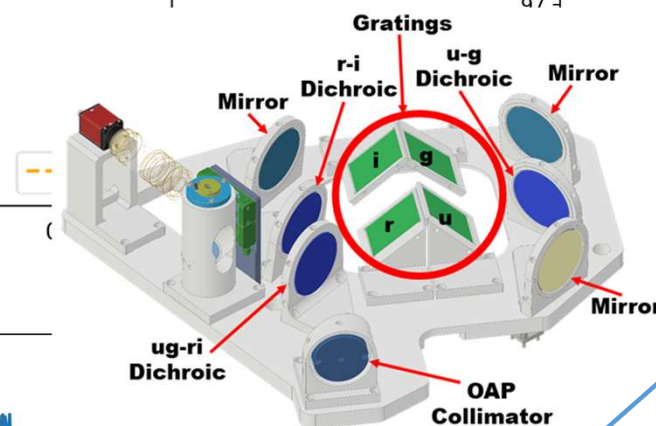
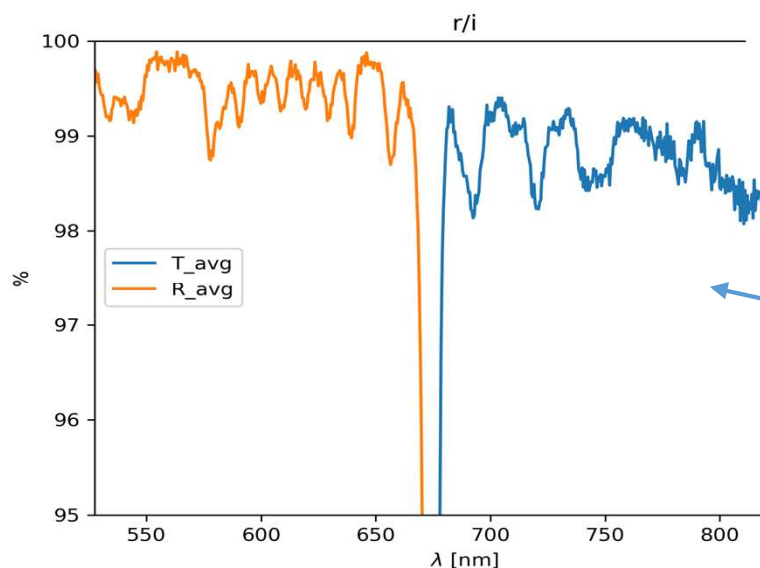
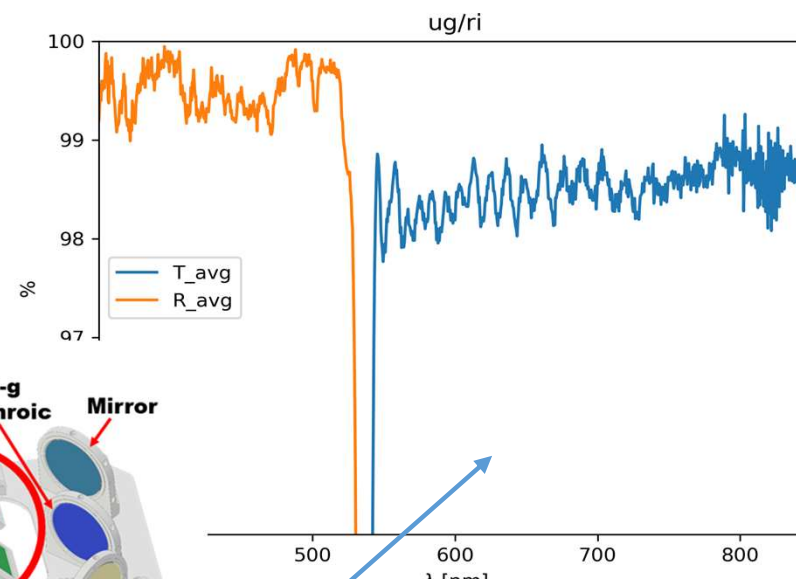
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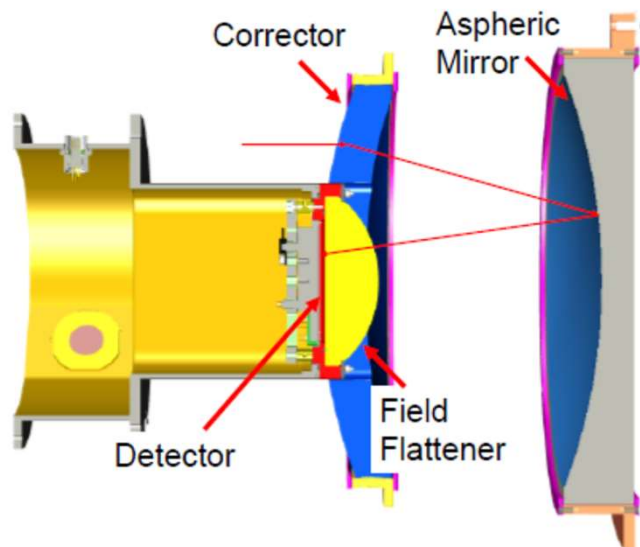
Feed



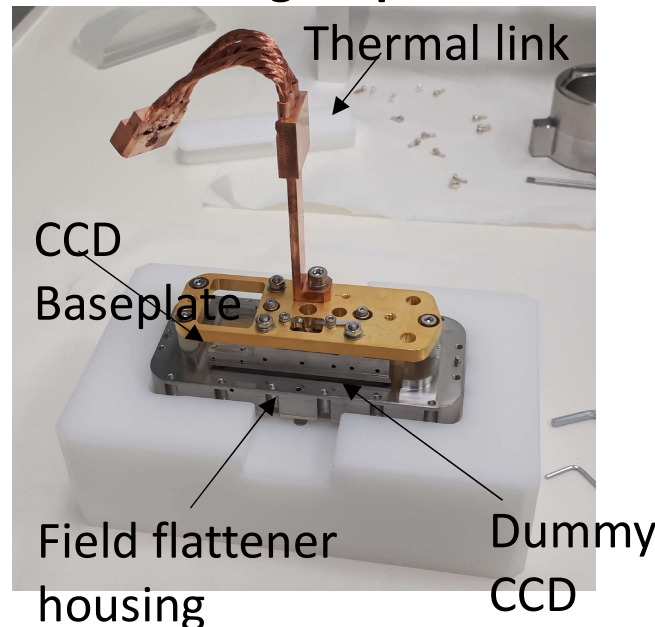
Dichroic Throughput > spec

UV-VIS Camera

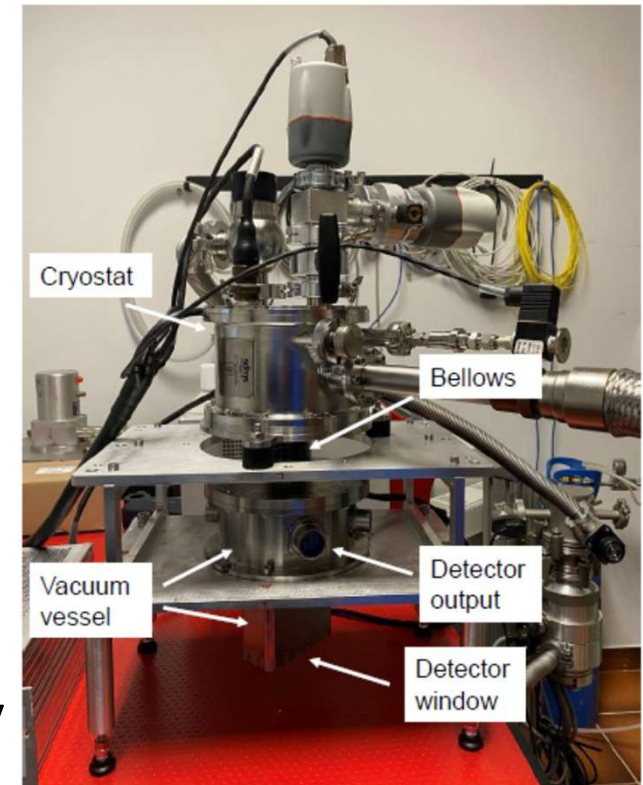
- ❑ Three element catadioptric camera: all aspheric
- ❑ Used as 4 off axis F/3.1 cameras.
- ❑ CaF₂ corrector + Fused Silica Field Flatteners
- ❑ Low CTE=>Athermal camera



CCD Invar Baseplate gold plated

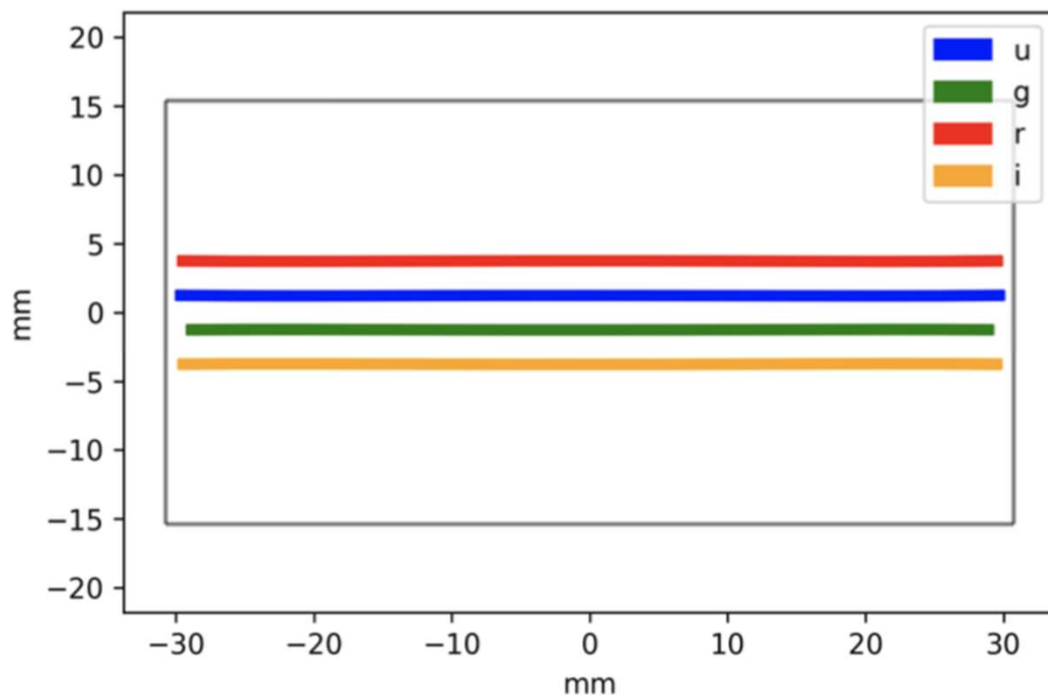


CCD vacuum chamber



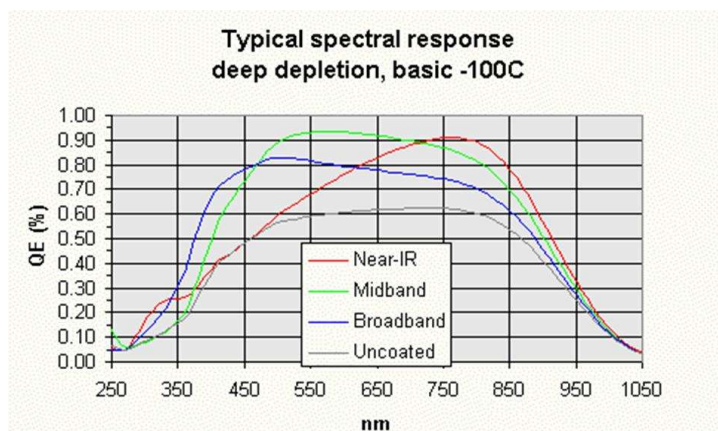
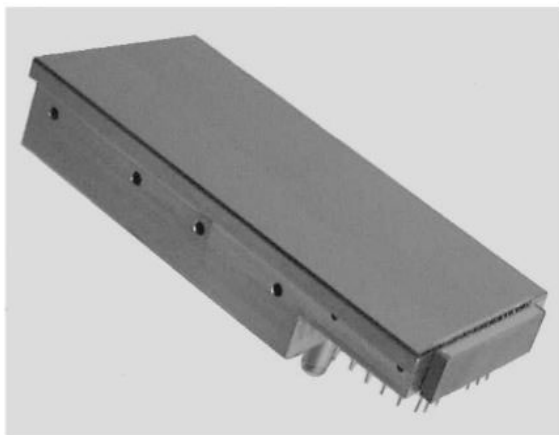
VIS Spectral Format

4 quasi orders images along the long axis of the detector



- ☐ Efficient use of detector
- ☐ Large separation between quasi orders: no overlap/leak between orders.
- ☐ No inherent curvature – linear trace, easy data reduction.

VIS Detector E2V CCD44-82



Detector	CCD44-82
Chip type	Thinned back illuminated
Pixel size	15 μm
Area (pixels)	2048 x 4096
Area (mm)	30.7 x 61.4
QE at 500 nm	90%
Coating	yes
Flatness	Better than 20 μm peak to valley
Peak signal	200 K e^-/pixel
CTE	99.9995%

ESO NGC Controller



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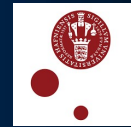
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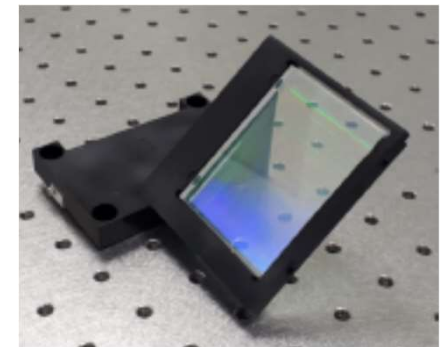
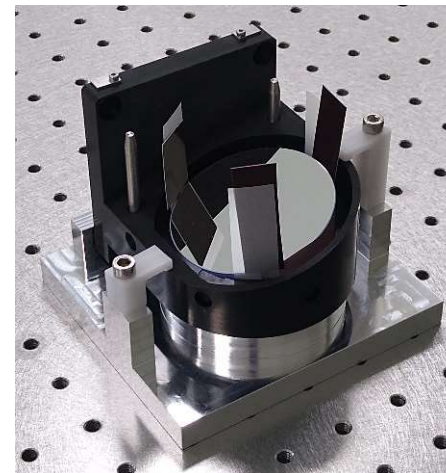
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UV-VIS Spectrograph

- ❑ Optics of the feed available @Weizmann Institute
- ❑ Optics of the camera under production (Winlight, France)
- ❑ Control system (HW @INAF-Capodimonte + INS @INAF-Padova) ready, to be integrated & tested
- ❑ Vacuum & Cryogenics under development @INAF-Catania (waiting for few ESO items)
- ❑ Detector available @INAF-La Palma (TNG)
- ❑ NGC to be shipped to INAF-La Palma (TNG) - so far working with NGC loaned system
- ❑ *Pending activities in Israel, Italy, Spain, France (Winlight), Germany (ESO)*





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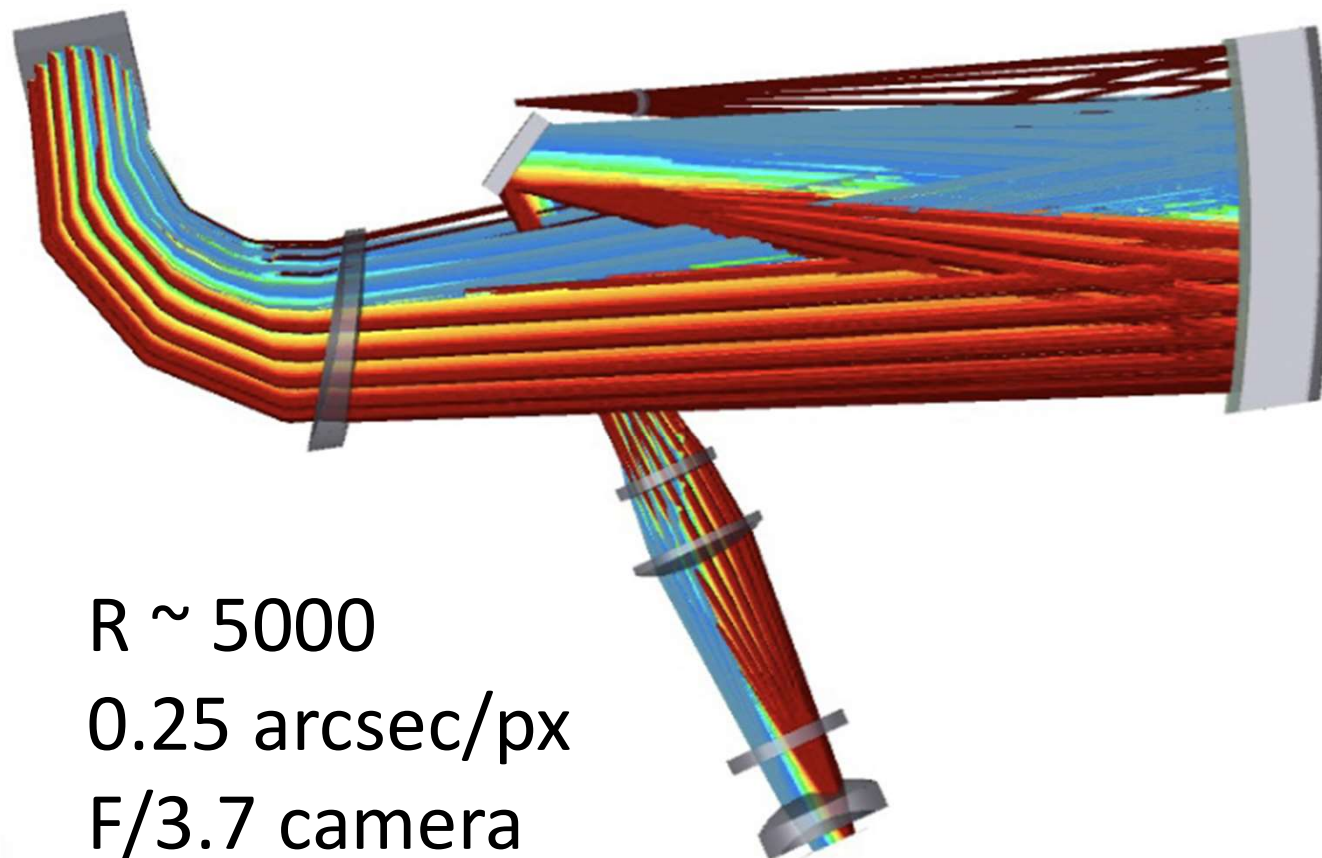
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NIR 4C Design

Spectrograph with
Collimator
Compensation of
Camera
Chromatism

Echelle
Cross-Dispersed



$R \sim 5000$

0.25 arcsec/px

F/3.7 camera

Richardson Gratings™
A Newport Corporation Brand

CRYSTRAN
UV • VISIBLE • IR SPECIALIST OPTICS

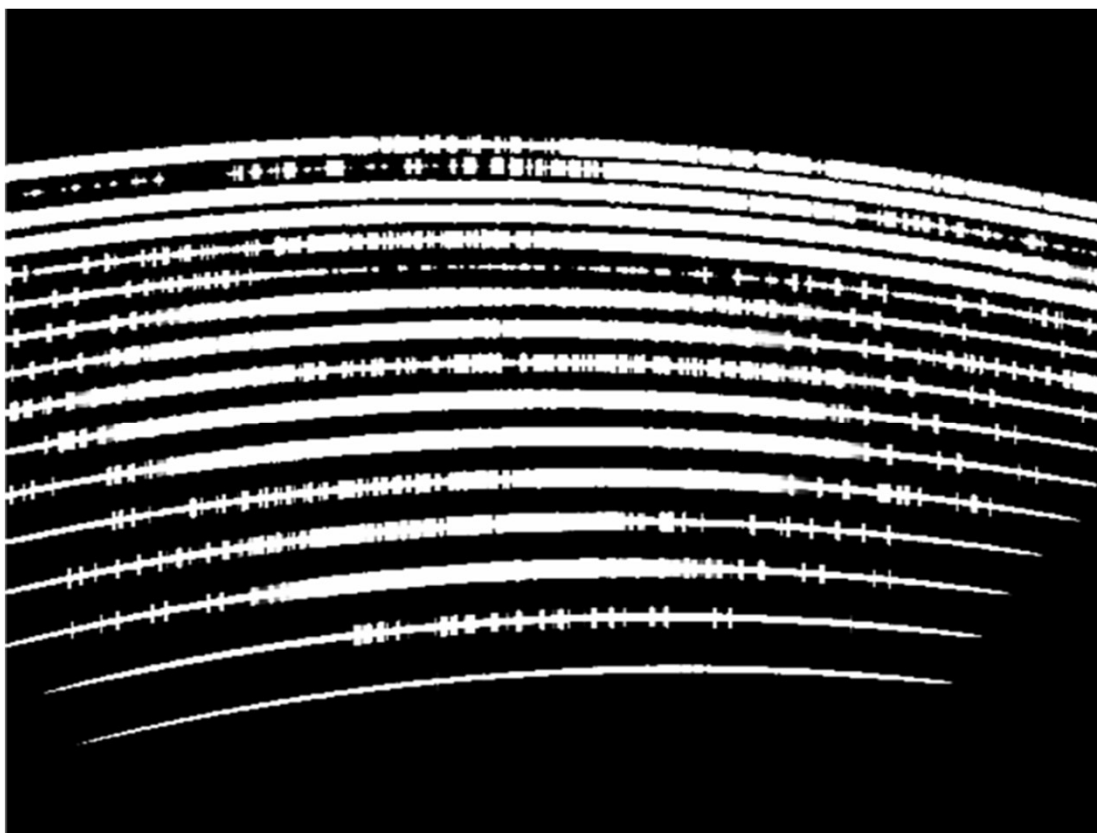


OPTIMAX=ASAHI SPECTRA^{USA}

OFFICINA STELLARE
OUR WORLD, YOUR SPACE



NIR Spectral Format



ORDER	FSR	MIN WL	BLAZE WL	MAX WL
11	0.159	1.674	1.754	1.834
12	0.134	1.541	1.608	1.675
13	0.114	1.427	1.484	1.541
14	0.098	1.329	1.378	1.428
15	0.086	1.244	1.286	1.329
16	0.075	1.168	1.206	1.244
17	0.067	1.102	1.135	1.168
18	0.06	1.042	1.072	1.102
19	0.053	0.989	1.016	1.042
20	0.048	0.941	0.965	0.989
21	0.044	0.897	0.919	0.941
22	0.04	0.857	0.877	0.897
23	0.036	0.821	0.839	0.857
24	0.034	0.787	0.804	0.821

- 15 Orders
- 0.787-2.009 μm



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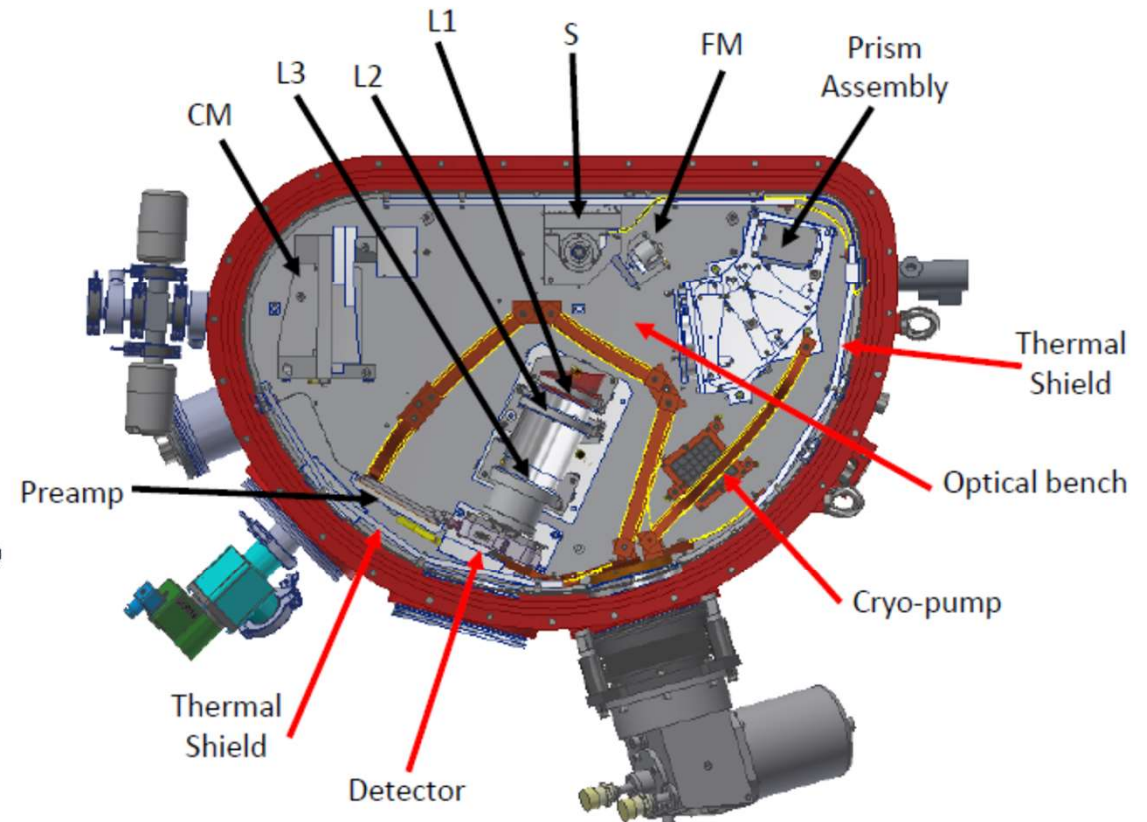
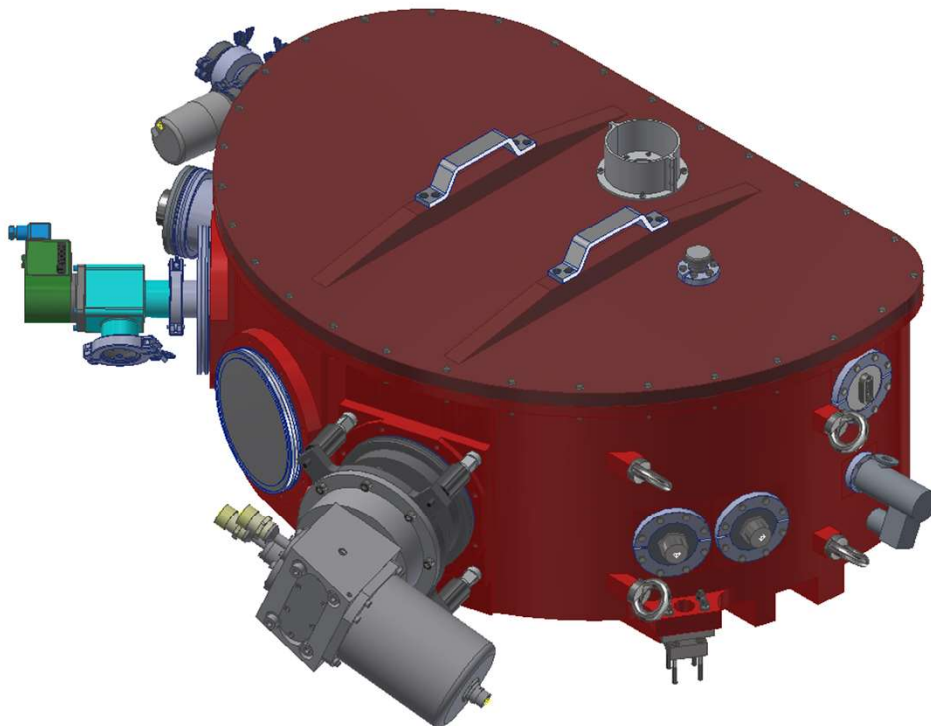


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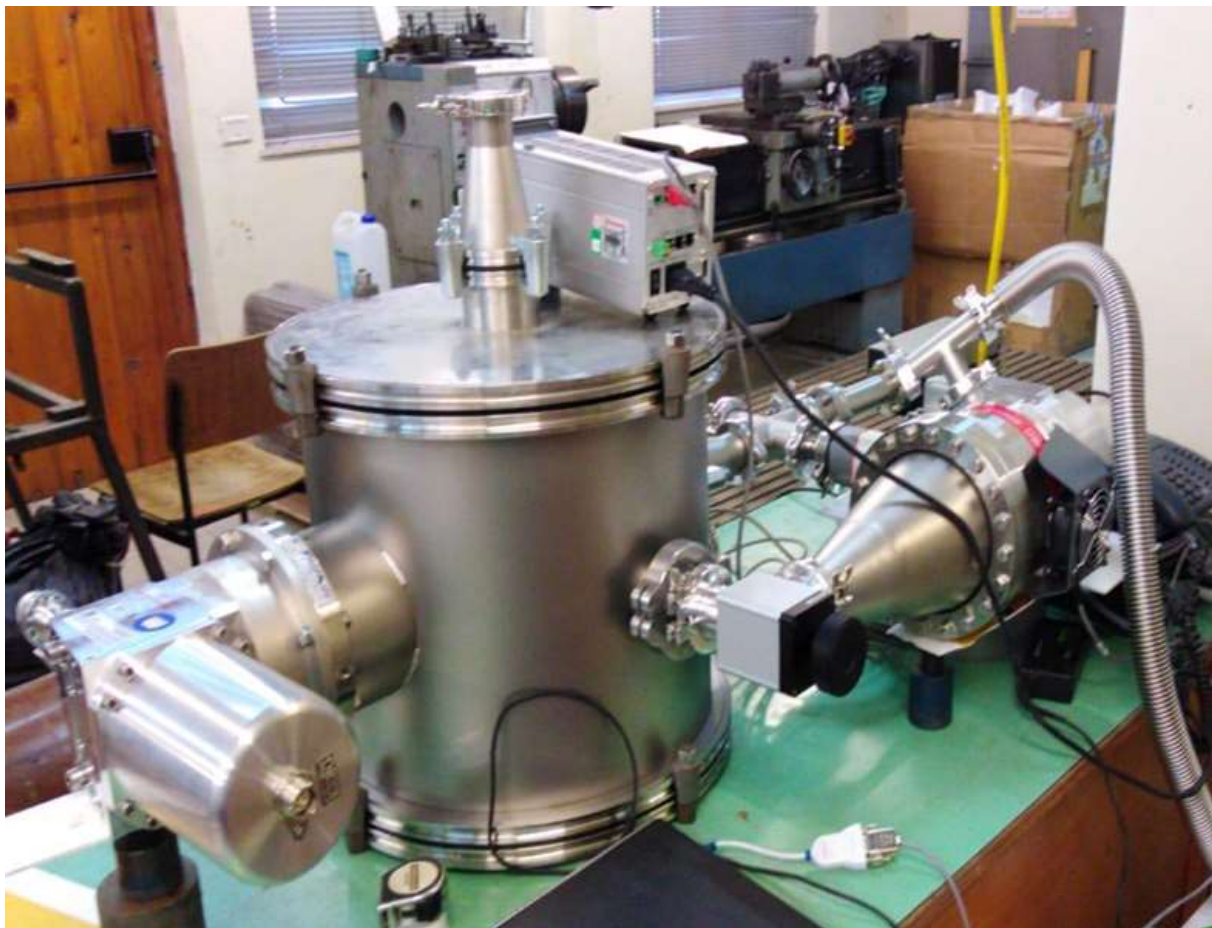


NIR Cryogenics

Nr	Component	Reference	Supplier
1	Compressor COOLPAK 6000 HMD	842015V0001	Leybold
2	Cold Head COOLPOWER 250 MD	840000V6002	Leybold
3	Connecting cable compressor to COOLPOWER 20m	842112	Leybold
4	Temperature sensor PT100	PT-103-AM	Lake Shore
5	Detector temperature sensor	DT670	Lake Shore
6	Heaters (detector & optical bench)	MP820 (50 Ω)	Caddock



Vacuum & Cryogenics





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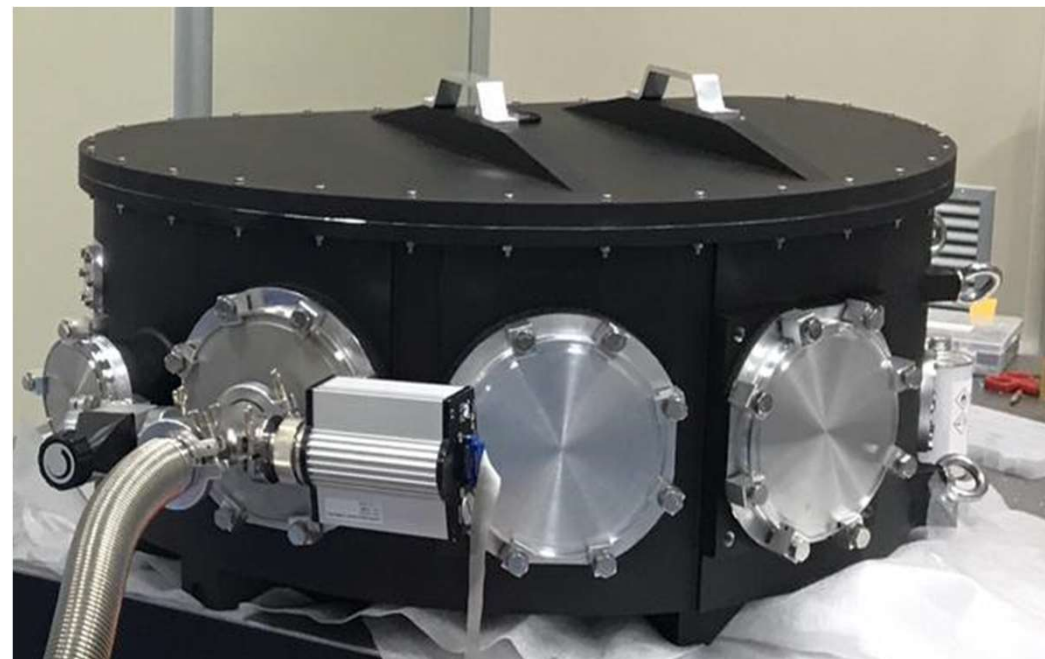


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NIR Spectrograph

- ❑ Vacuum Vessel ready @INAF-Merate, under preliminary tests
- ❑ All optical elements available but Al mirrors and collimator lens. Forced to change vendor - about 7 months delay.
- ❑ Control system (HW @INAF-Capodimonte + INS @INAF-Padova) ready, to be integrated & tested
- ❑ Vacuum & Cryogenics under development @INAF-Catania (waiting for few ESO items)
- ❑ Detector delivered
- ❑ NGC to be shipped to INAF-Rome
- ❑ *Pending activities in Italy, Netherlands (Astron - NOVA)*





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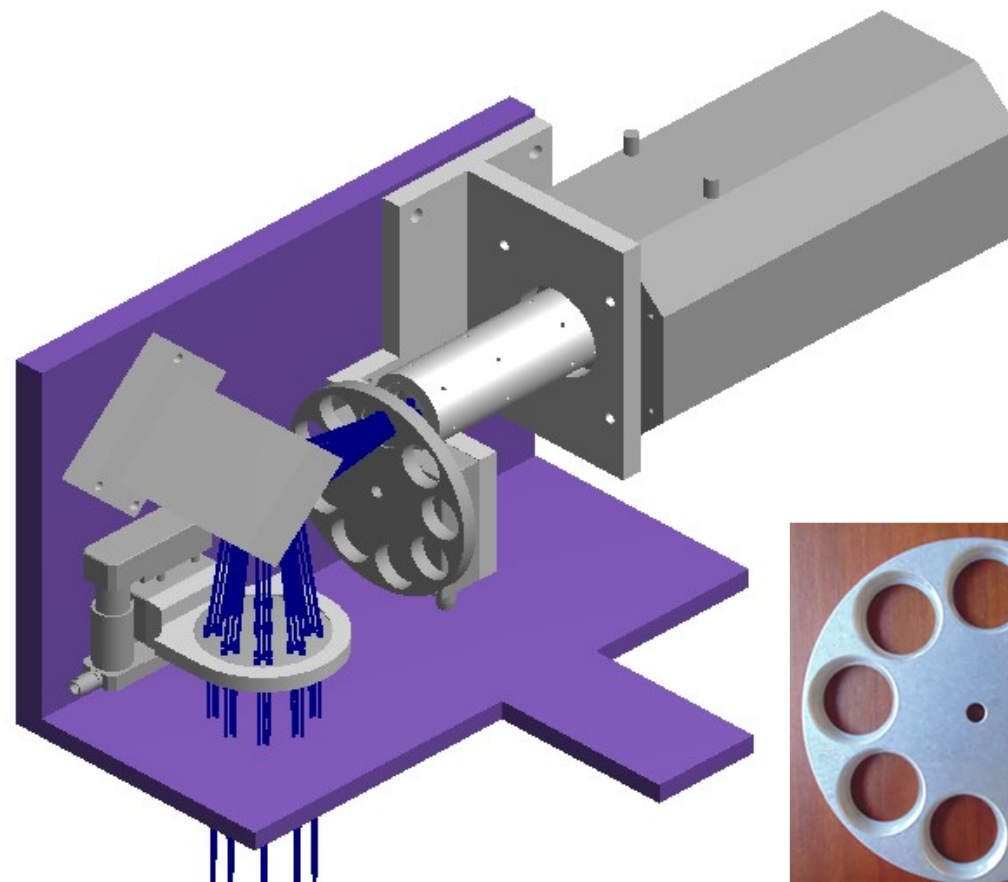
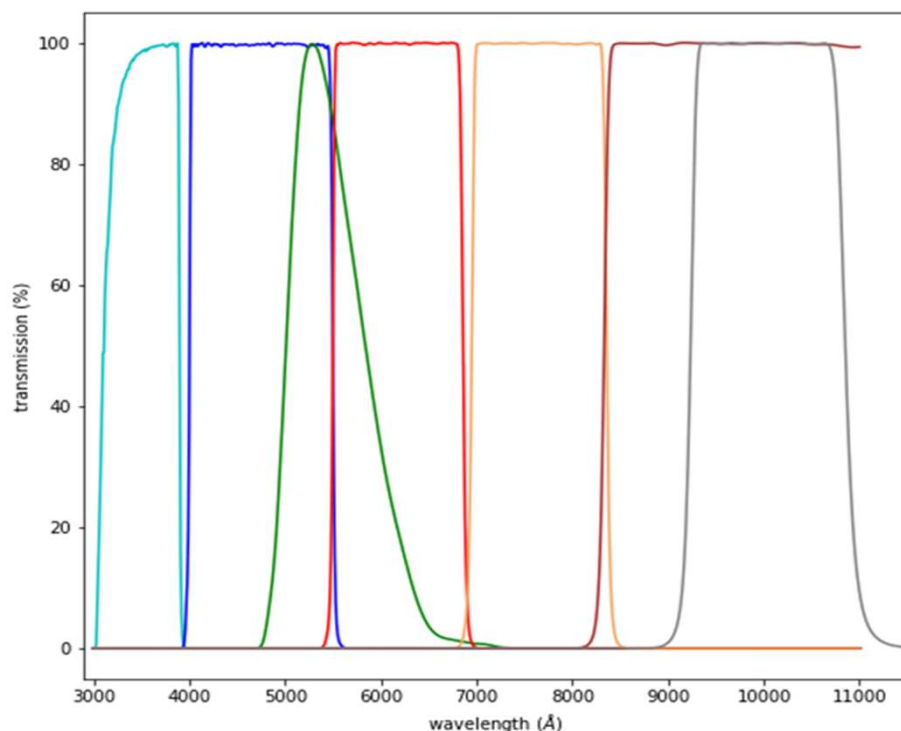


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A&G Camera

- Target Acquisition
- Secondary guiding
- Photometry

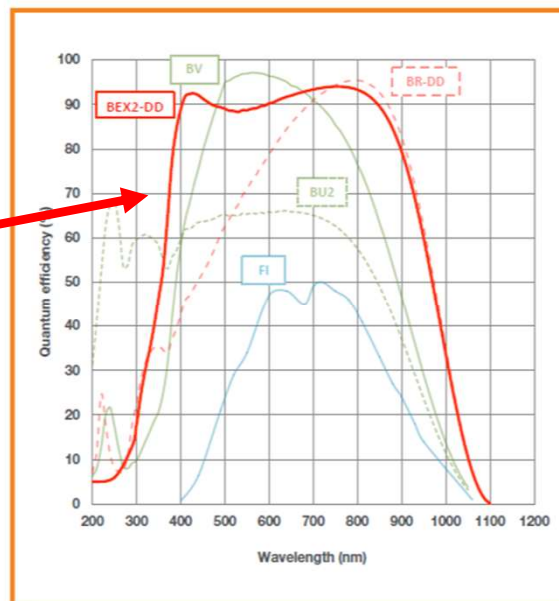


FoW: 3.5'x3.5'

Filters: ugrizY + V



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



Andor iKon M934
1024x1024
13 μ m/px 0.205 "/px

High frame rate
Low RON

Active pixels	1024 x 1024
Sensor size	13.3 x 13.3 mm
Pixel size (W x H)	13 μ m x 13 μ m
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)



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Acquisition & Guiding Camera

- ☐ MAS responsibility (Chile)
- ☐ Many parts delivered (detector, filters, motors, mirror)
- ☐ Missing Optics still under manufacturing (INAOE, Mexico – stopped working for months; now open again)
- ☐ Control system (HW @INAF-Capodimonte + INS @INAF-Padova) ready, to be integrated & tested
- ☐ Final integration planned @INAF - Padova
- ☐ *Pending activities in Mexico, Chile, Italy*



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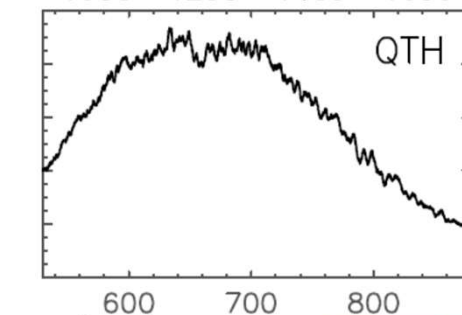
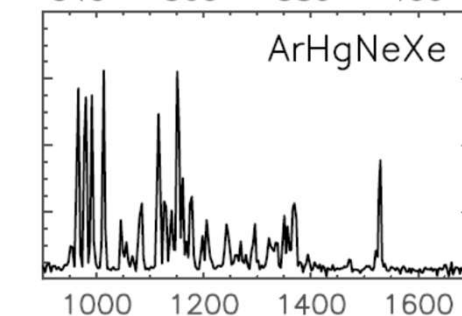
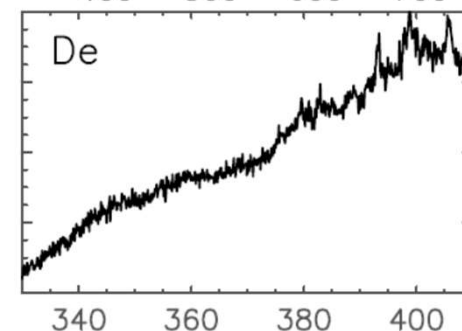
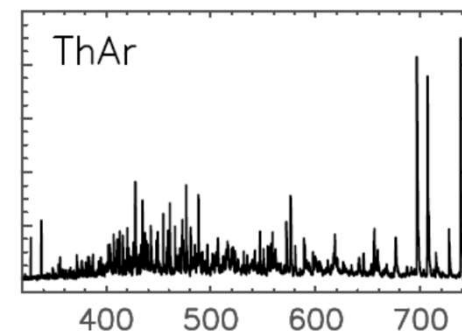
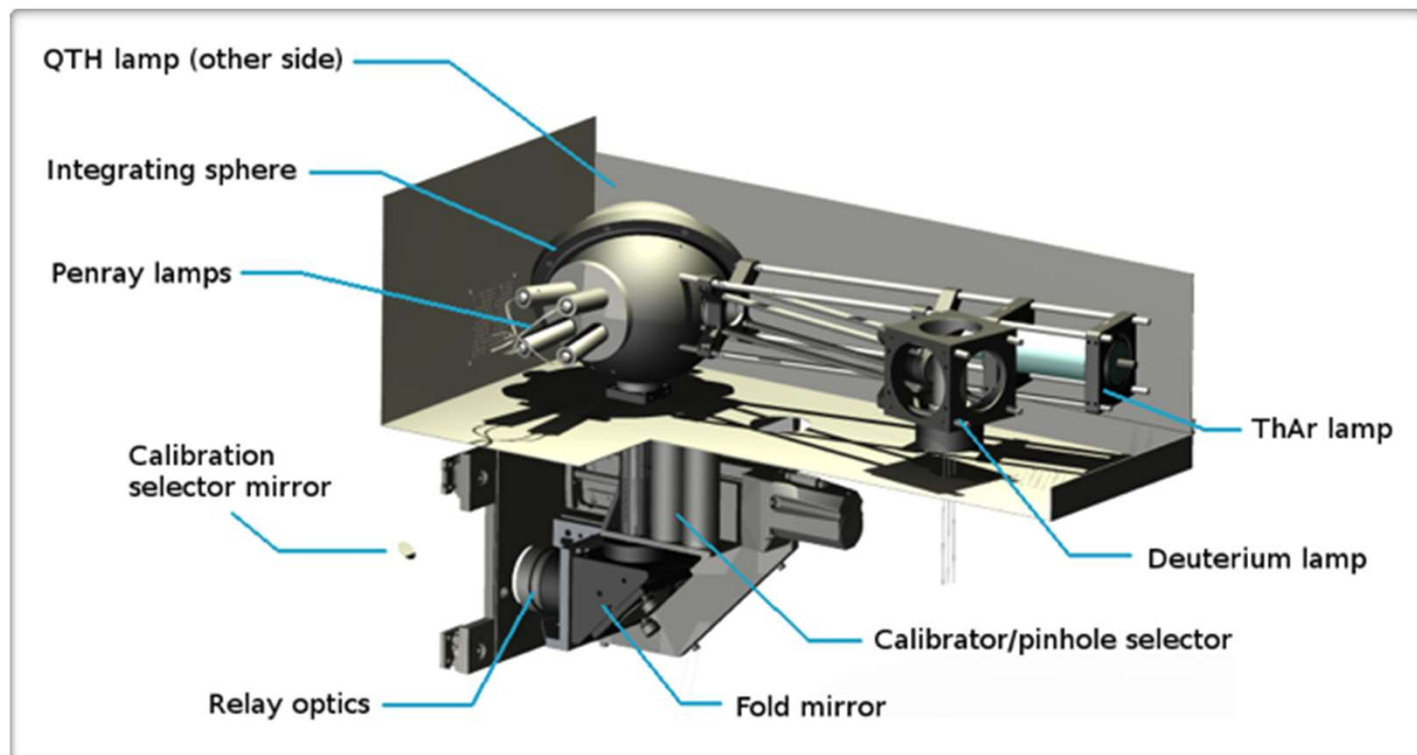


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Calibration unit





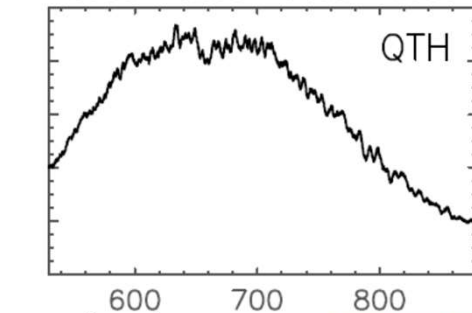
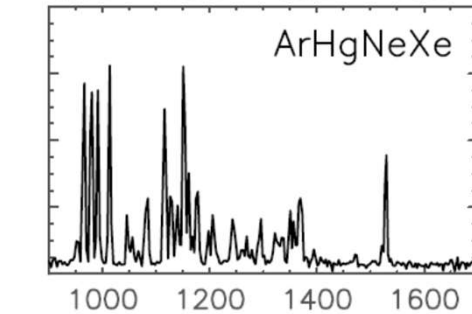
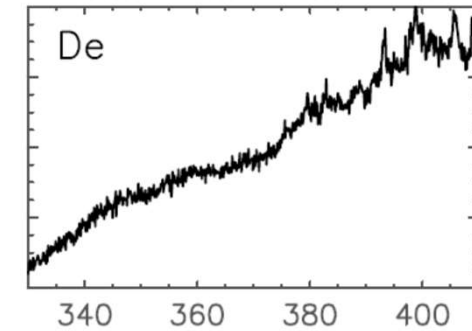
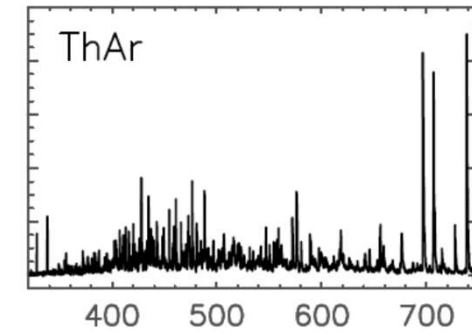
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Calibration unit





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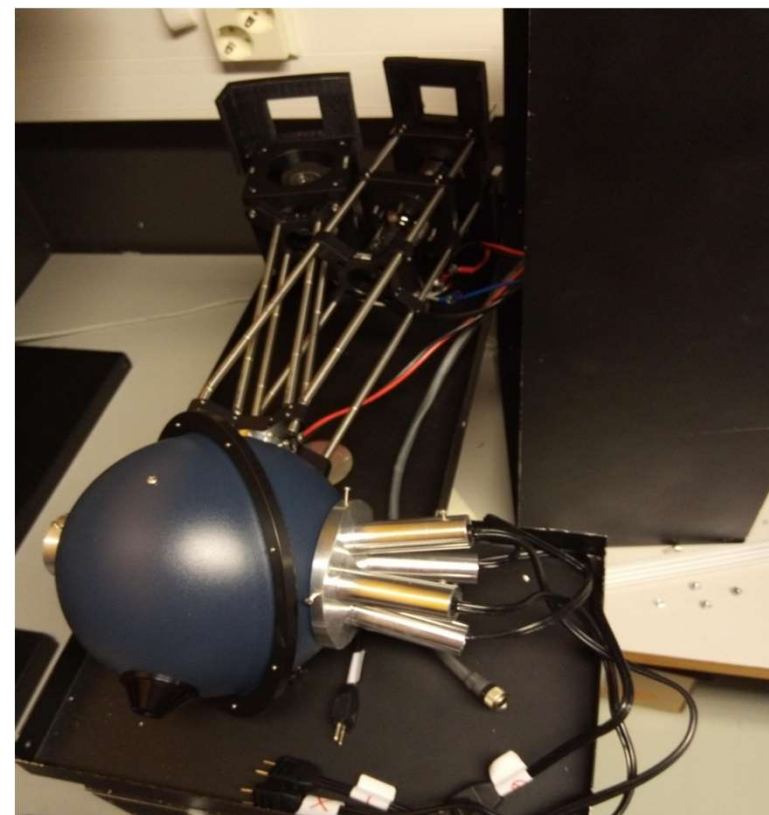


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Calibration Unit

- ❑ Assembled @Turku University
- ❑ INS @INAF-Padova ready, to be integrated & tested
- ❑ Electronics ready, in test phase
- ❑ Soon fully ready (plan: November) then shipped to INAF-Padova
- ❑ *Pending activities in Finland*





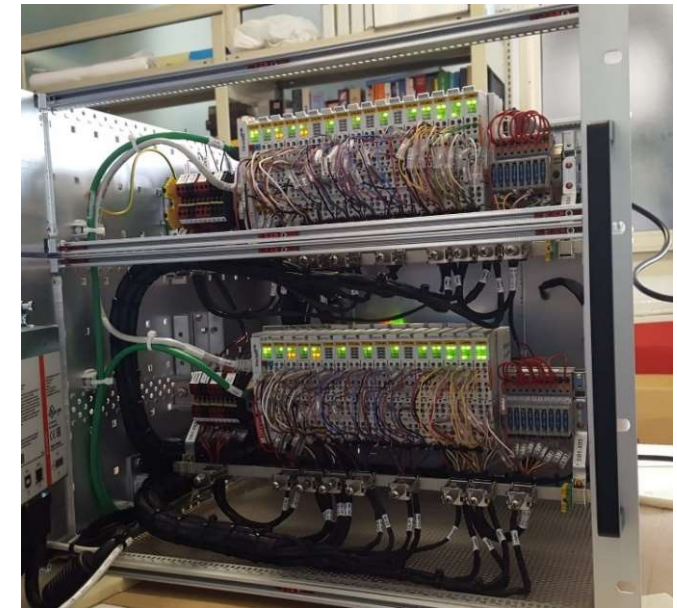
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Electronics





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Instrument Software

BOB: Broker for Observation Blocks (bob_19396@wsxs)

File Configure Errors Help

Obs: (file) -> bob -> SOXS OS

- SOXS_slit_cal_SpecphotStdStare -- Async Point-and-shoot expo
- SOXS_slit_cal_TelluricStdNod -- Synchronous exposures and Au
- SOXS_slit_cal_TelluricStdStare -- Async Point-and-shoot expo
- SOXS_slit_cal_VISLampFlatAtt -- Attached Calibration Templat
- SOXS_slit_cal_VISLampFlat -- VIS Lamp Flat calibration expos
- DET2
- INS
 - MODE = SLT
 - OPTI3.NAME = Slit_0.5
- SEQ
- SOXS_slit_cal_VISLampFlatSinglePinhole -- VIS Single Pinhole
- SOXS_slit_obs_AutoNodOnSlit -- Observations with AutoNodOnSlit
- SOXS_slit_obs_FixedSkyOffset -- Alternating between Object a

Template log-messages

Started at 2017-07-13T14:47:19

Greetings from SOXS_slit_cal_VISLampFlatAtt!

Finished in 0 seconds at 2017-07-13T14:47:19

SOXS_slit_cal_VISLampFlat -- VIS Lamp Flat calibration exposures

Started at 2017-07-13T14:47:19

Greetings from SOXS_slit_cal_VISLampFlat!

SOXS OS Engineering - @wsxs

File Graphical Interfaces Device Simulation Help

ICS	ACQ	VIS	NIR	TCS
ONLINE	OFF	ONLINE	ONLINE	ONLINE
IDLE				IDLE
Normal	Normal	HW-SIM	LCU-SIM	Tracking
STARTUP	STARTUP	STARTUP	STARTUP	STARTUP
OFF	OFF	OFF	OFF	STANDBY
STANDBY	STANDBY	STANDBY	STANDBY	ONLINE
ONLINE	ONLINE	ONLINE	ONLINE	SHUTDOWN
SHUTDOWN	SHUTDOWN	SHUTDOWN	SHUTDOWN	GUI
GUI ...	GUI ...	GUI ...	GUI ...	

SOXS OS Control - @wsxs

File Std. Options Help

SOXS State: ONLINE Instrument mode: Undefined

OS	ICS	ACQ	VIS	NIR
State: ONLINE	State: ONLINE	State: OFF	State: ONLINE	State: ONLINE
Substate: idle	Substate: idle	Substate: unknown	Substate: idle	Substate: idle

TCS: wsxtcs

State: ONLINE

Substate: idle

Access: unknown

Coordinates: RA 13720.5510 DEC 53740.1920

Alarms: Alarm Panel

Disk space: 158 GB of 164 free

INS_DISK /insroot/SOXS/INS_ROOT

Update Bytes Percent

ACQ

Exp. status: Undefined Exp. time: 0 (s) Abort End

Instr. mode: Undefined Remaining: 0 (s) Filename: default.fits

VIS

Exp. status: Undefined Exp. time: (s) Abort End

Instr. mode: Undefined Remaining: (s) Filename:

NIR

Exp. status: Undefined Exp. time: 6 (s) Abort End

Instr. mode: Simul. Remaining: 0 (s) Filename:

SOXS

File Std. Options Help

INSH OPEN

CALS Science

ACQS Spectroscopy

PZT1 X:1 Y:2

PZT2 X:3 Y:4

ADC1 AUTO - 0

NFOC 12.3

THAR QTH DEUT

MERC XENO

ARGO NEON

CUPS Free

ACFW SDSS-u

AFOC 45.6

ACQ

WISE Slit_0.5

VIS

NISE Slit_1.5

NIR

SOXS ICS Control - @wsxs

File ICS Devices Maintenance Std. Options Help

SOXS State: ONLINE idle mode: NORMAL IGNORED

Calib. Unit \Imaging\ Spectroscopy\ Sensors and Piezo\

Calib.	Unit	Imaging	Spectroscopy	Sensors and Piezo
visc	ONLINE	SIM	Slit_0.1	Slit_0.5
nisc	ONLINE	SIM	Slit_1.1	Slit_1.0
vfo1	ONLINE	SIM	0	Slit_0.5
vfo2	ONLINE	SIM	0	Slit_1.0
vfo3	ONLINE	SIM	0	Slit_1.5
vfo4	ONLINE	SIM	0	Slit_5.0
adc1	ONLINE	SIM	STANDIN	Pinhole
adc2	ONLINE	SIM	STANDIN	Blank
				enc
				enc1

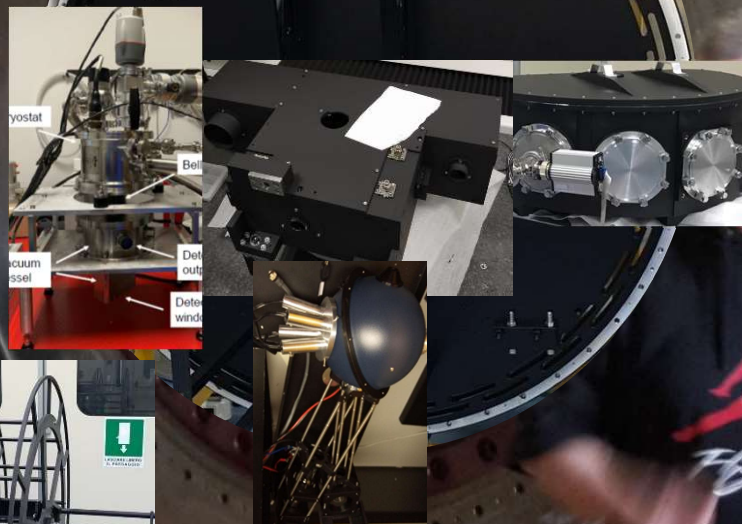
Command Feedback Window Options

15:58:17 SETUP > REPLY/ L OK

15:58:23 SETUP > INVOKED *-function INS.VISE.NAME Slit_0.5 INS.NISE.NAME Slit_1.0

15:58:23 SETUP > REPLY/ L OK/OK

SETUP STOP





SOXS



מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE



Queen's University
Belfast



Turun yliopisto
University of Turku



TEL AVIV UNIVERSITY



Thanks

