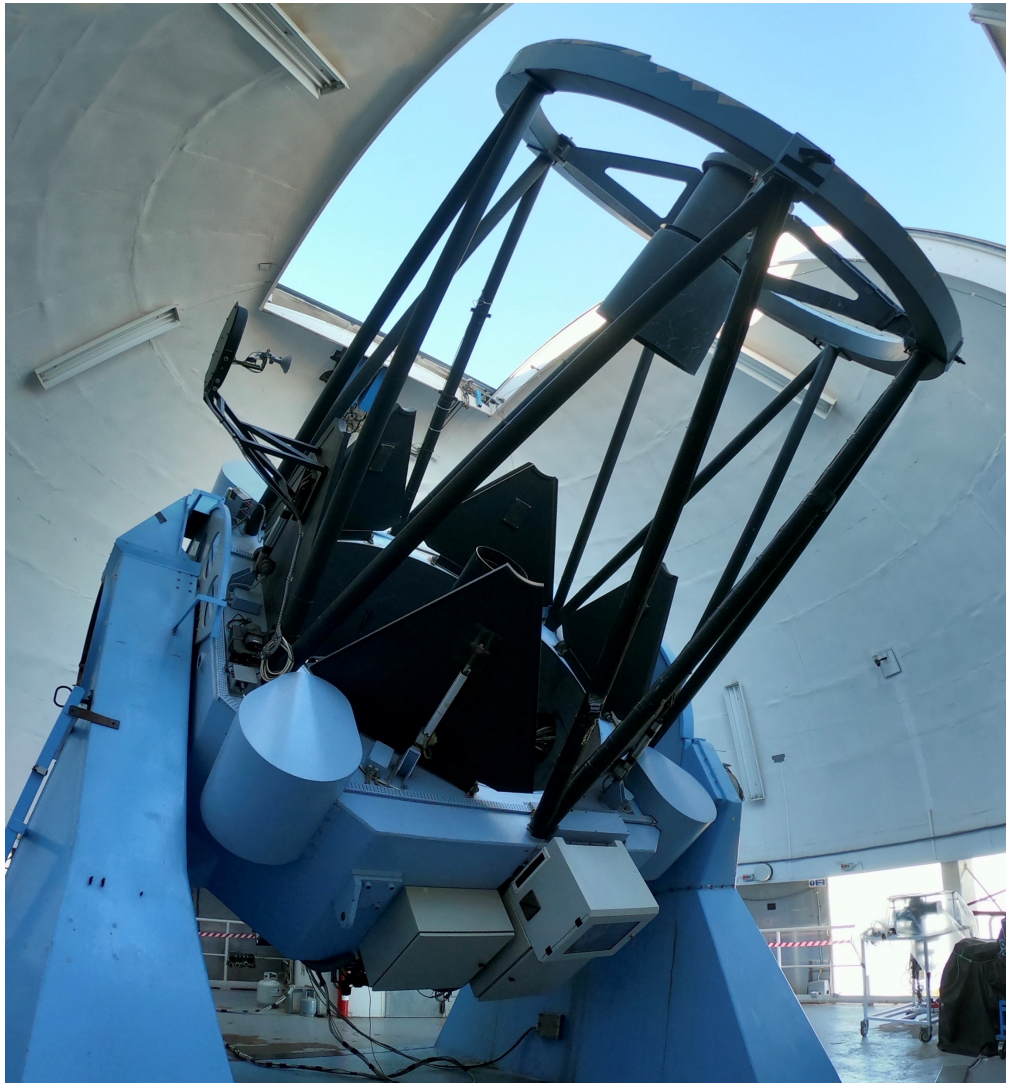


NOT Transient Explorer (NTE)

A new instrument for the
Nordic Optical Telescope

https://nte.nbi.ku.dk/

NTE Team

Niels Bohr Institute

Michael I. Andersen – Systems engineer

Lise Christensen – Pipeline responsible

(Niels Michaelsen – Mechanics)

Bo Milvang-Jensen – Pipeline development

Anton N. Sørensen – Calibration and AIT

Joonas K. M. Viuho – Motors and control

Dennis Wistisen - Mechanics

Nordic Optical Telescope

Sergio Armas – Software systems

Peter Brandt – Mechanics

Jacob W. Clasen – Project Manager

Graham C. Cox – Detector systems

Anlaug Djupvik – Astronomer, IR applications

Carlos Perez – Mechanics

Tapio Pursimo – Astronomer, imaging

John Telting – Astronomer, spectroscopy

Partner institutes

John E. V. Andersen – VIS Imager mechanics
University of Aarhus, Denmark

Stéphane Basa – Origonally Infra-red imager
LAM, France, now Svom

Stefano Covino – Head of science team
INAF Brera, Italy

Anders S. Damgaard - VIS Imager mechanics
University of Aarhus, Denmark

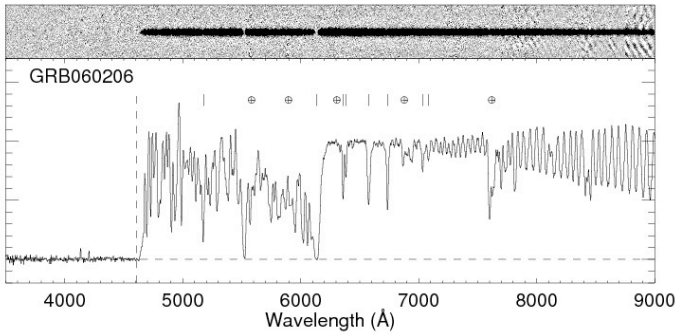
Kasper E. Heinz – Instrument scientist, pipeline
University of Iceland, Iceland

Vitaly Neustreov – Imaging pipeline
FINCA/University of Oulu, Finland

Marco Riva – Spectrograph camera optics
INAF Brera, Italy

Science cases for the NTE (examples)

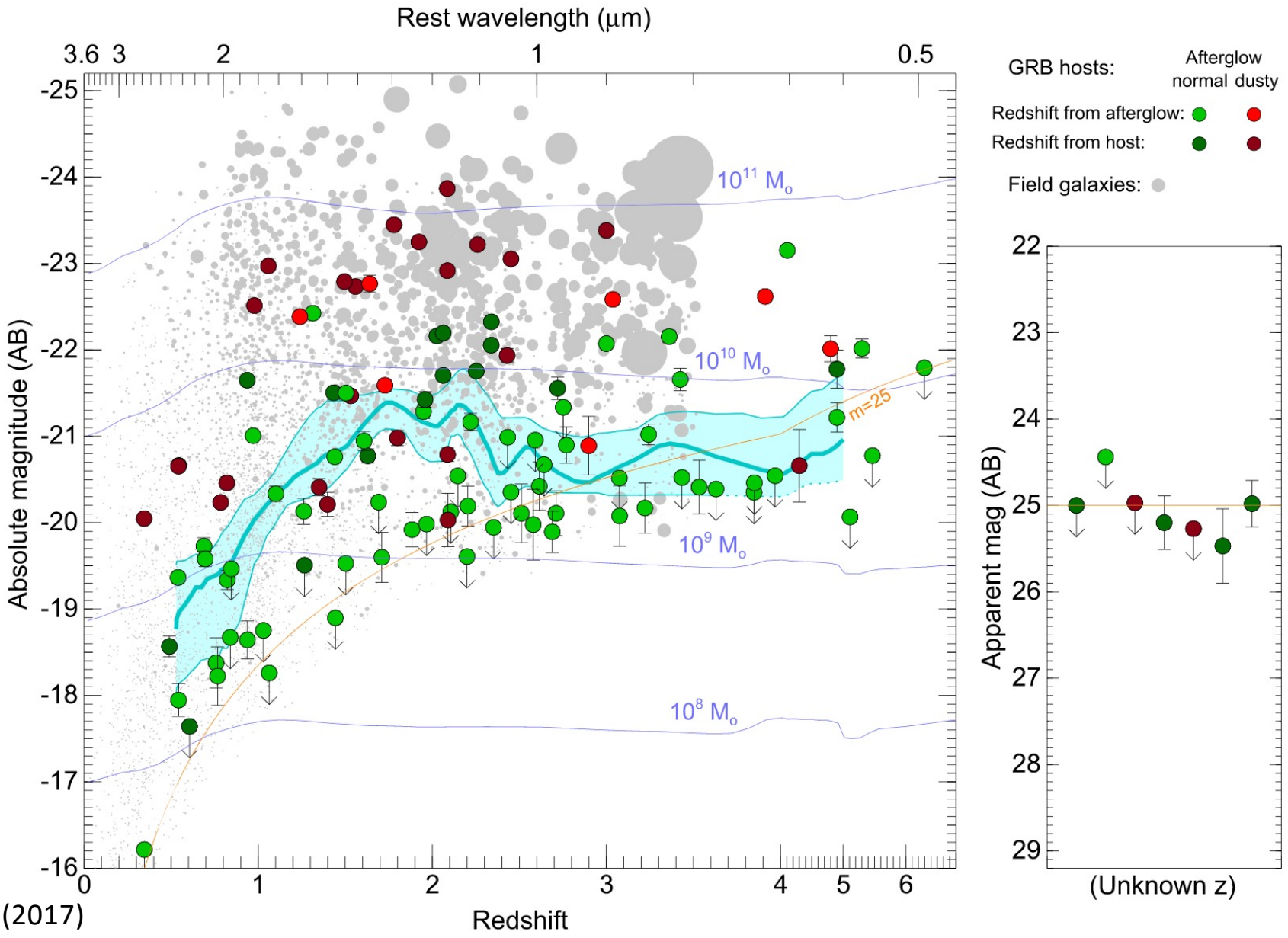
- Transient phenomena
  - GRBs, kilonovae and other EM counterparts of GW sources
  - supernovae Ia,
  - core-collapse supernovae,
  - new transients: FRB , Changing look AGN, TDE, ...
- Other programs where the time domain is important
  - reverberation mapping
  - exoplanet atmospheres
- Non-transient programs
  - AGN hosts
  - spectroscopic follow-up of sources from wide-field surveys
  - QSOs from Gaia
  - Solar System objects



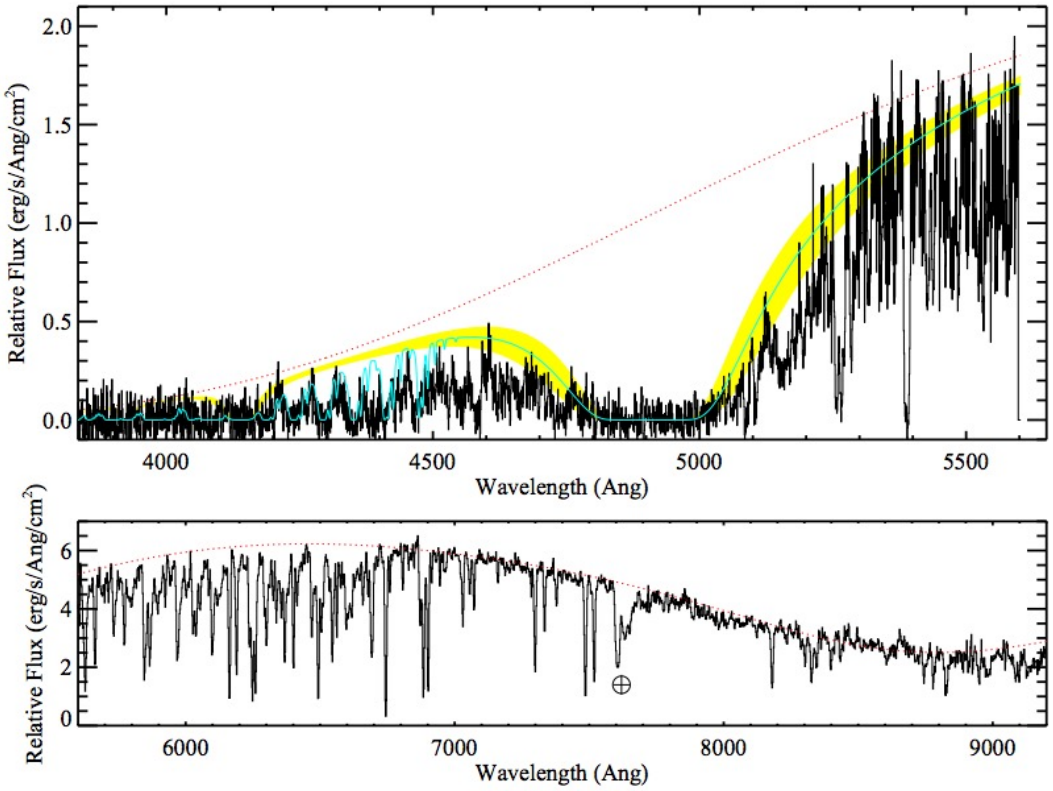
Gamma ray burst at redshift z=4.05
Started 48 min after burst trigger using ALFOSC

Important drivers: wide wavelength coverage, resolution, simultaneous optical and near-IR imaging, rapid follow-up, versatility

My personal main interests for GRB follow-up



Perley et al. (2017)



Prochaska et al. (2009)

GRB080607

Very bright afterglow observed 12 minutes after the burst

$z = 3.04$

$\log N_{HI} = 22.7$

H_2 and CO

Forest of metal lines!

Solar metallicity

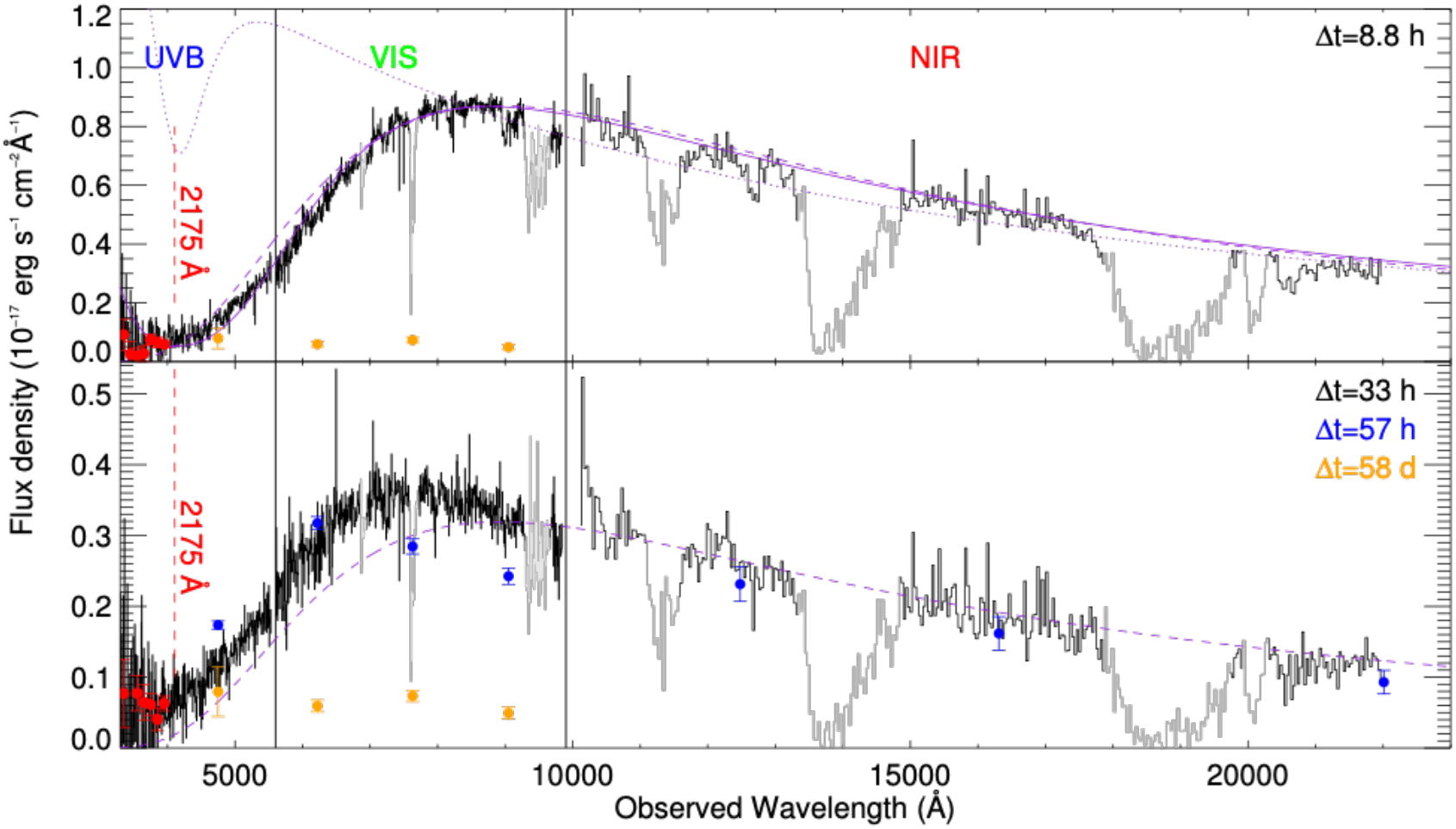
$A_V = 3.3$ mag

2175Å extinction bump.

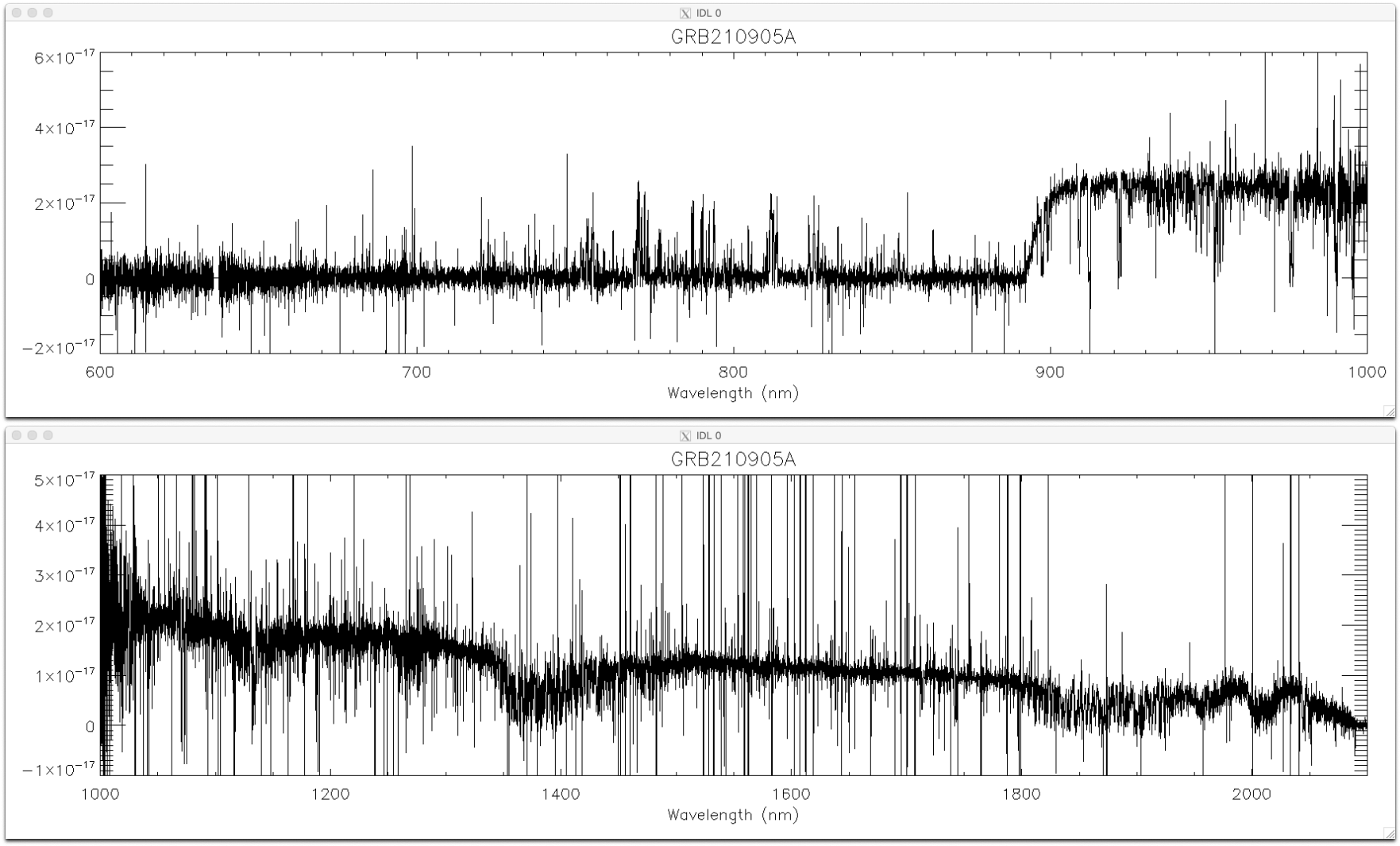
Bright/massive and dusty host

SFR = 10 $M_\odot$/yr

GRB140506A


UVB
VIS
NIR
Δt=8.8 h
2175 Å
Δt=33 h
Δt=57 h
Δt=58 d
2175 Å
Flux density (10^-17 erg s^-1 cm^-2 Å^-1)
Observed Wavelength (Å)
5000
10000
15000
20000

Very distant GRBs

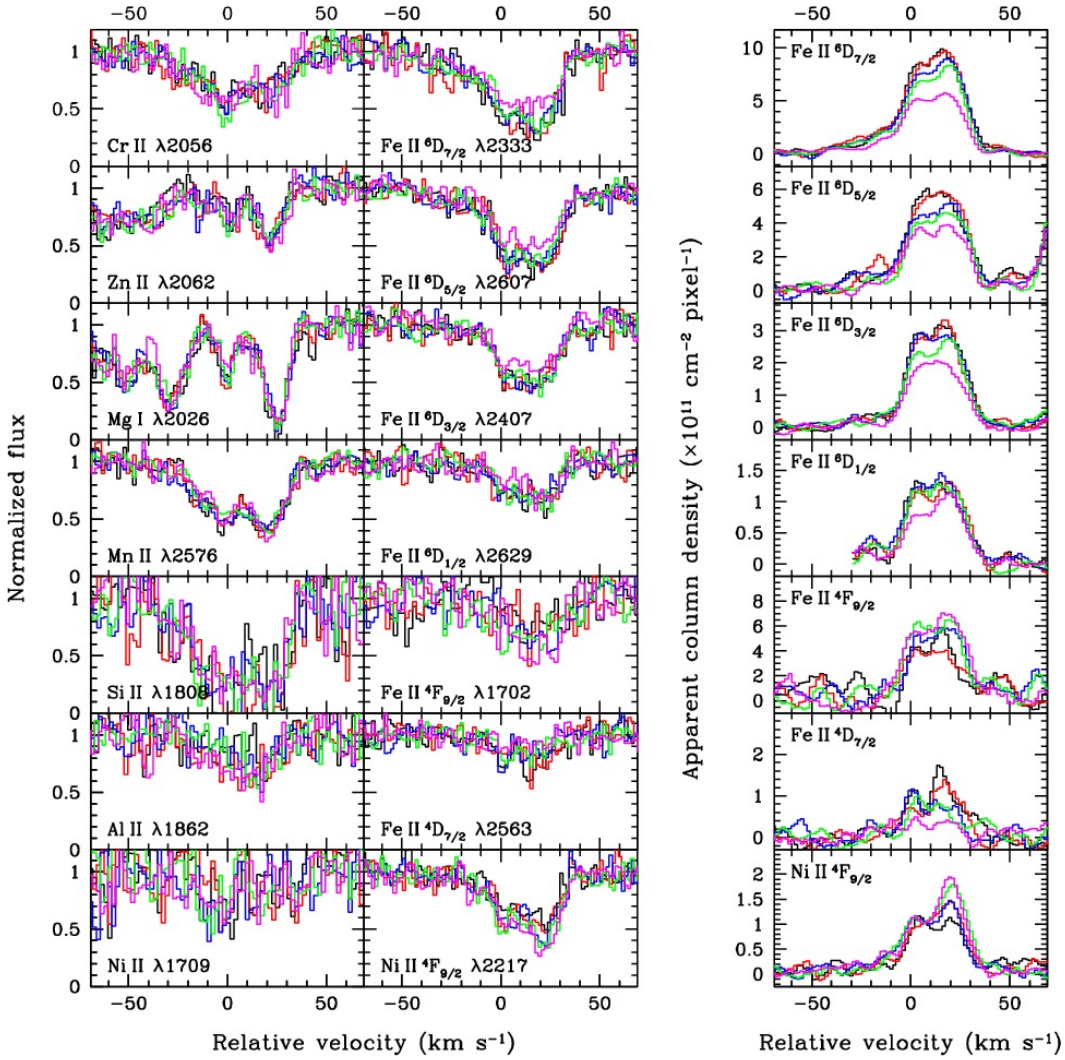


VERY FAST RESPONSE

Very rapid response (here Vreeswijk et al. 2007)

Variable absorption lines

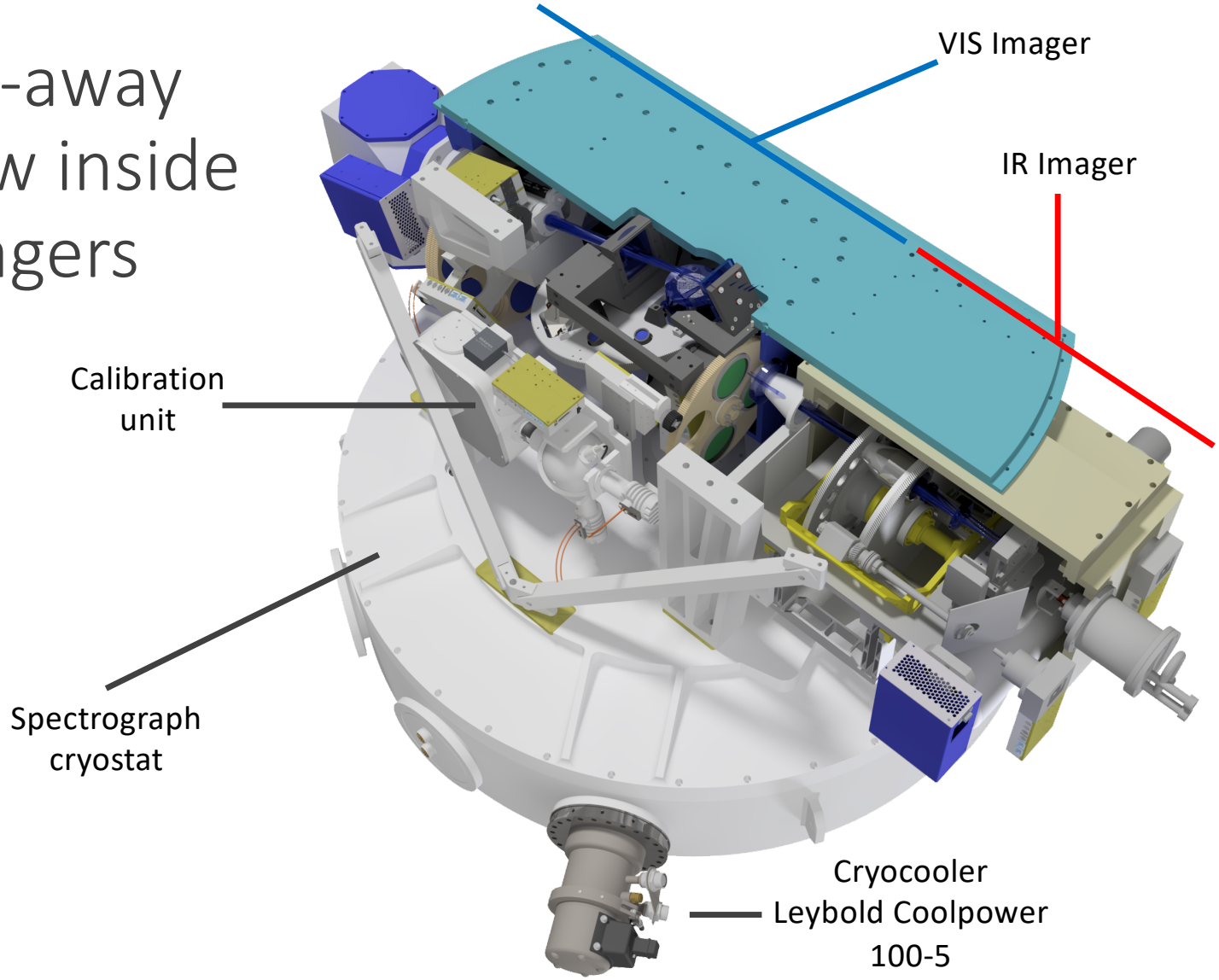
Getting an optical spectrum during the prompt phase would be very interesting



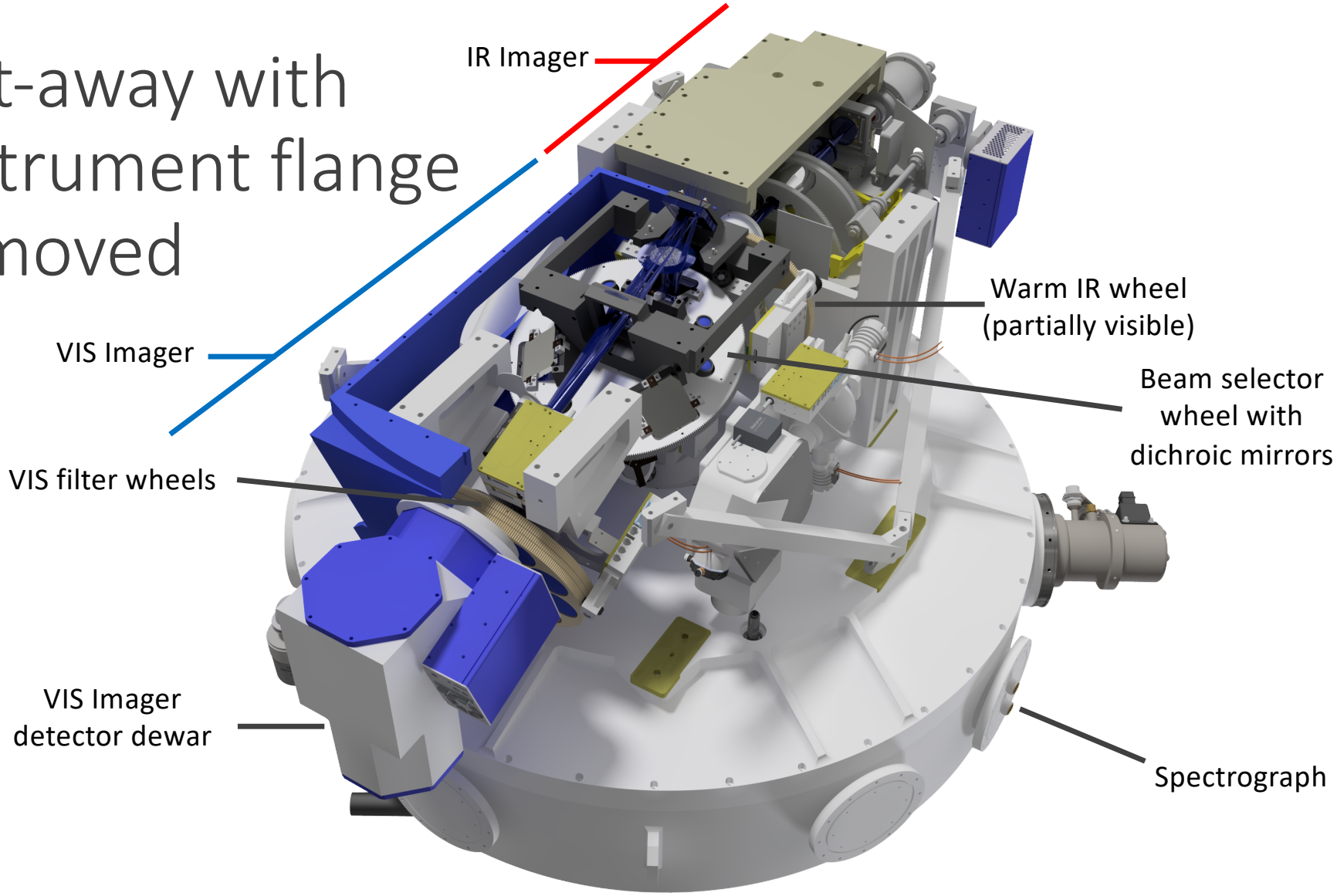
The NTE concept

- Dual imager
- Single slit spectrograph
- Imagers and spectrograph covering from U to K band
- Short re-configuration time
- Independent operation of VIS and NIR arms in both imaging and spectroscopy

Cut-away view inside imagers



Cut-away with instrument flange removed

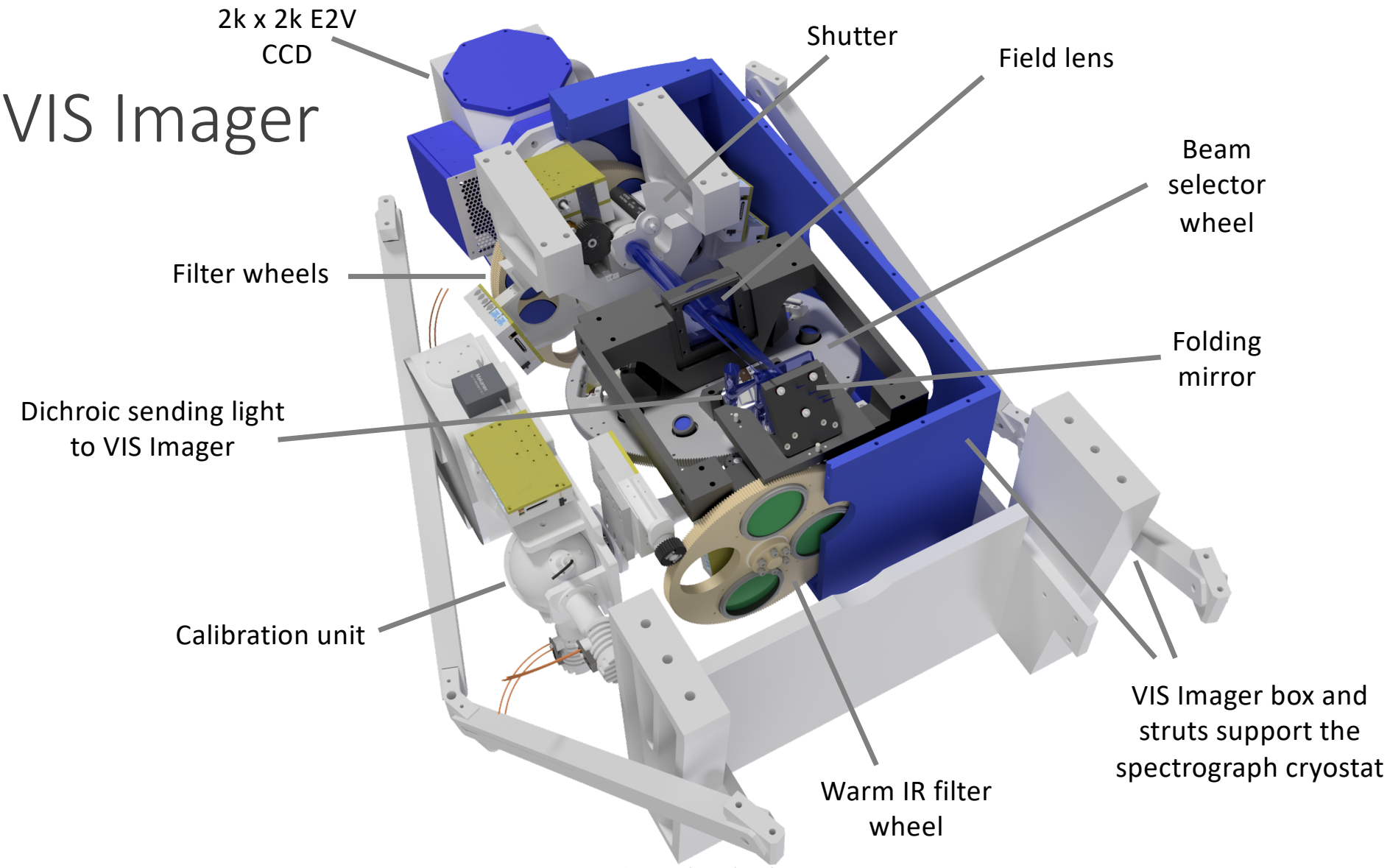


VIS Imager - specifications

- 6x6 arcmin^2 FOV
- Permanently mounted filters
  - Bessel UBVRi
  - SDSS ugri
- space for 15 extra filters
- 2k E2V CCD with very low RON securing background limited performance
  (possibly QHY600 CMOS in the beginning)
- Simultaneous VIS and NIR imaging (one filter each)
- Incorporates beam selector wheel and warm infrared filter wheel

Limiting magnitudes (1h, S/N=5)
U=25.0
B=26.2
V=26.8
R=25.2
I=24.4

VIS Imager

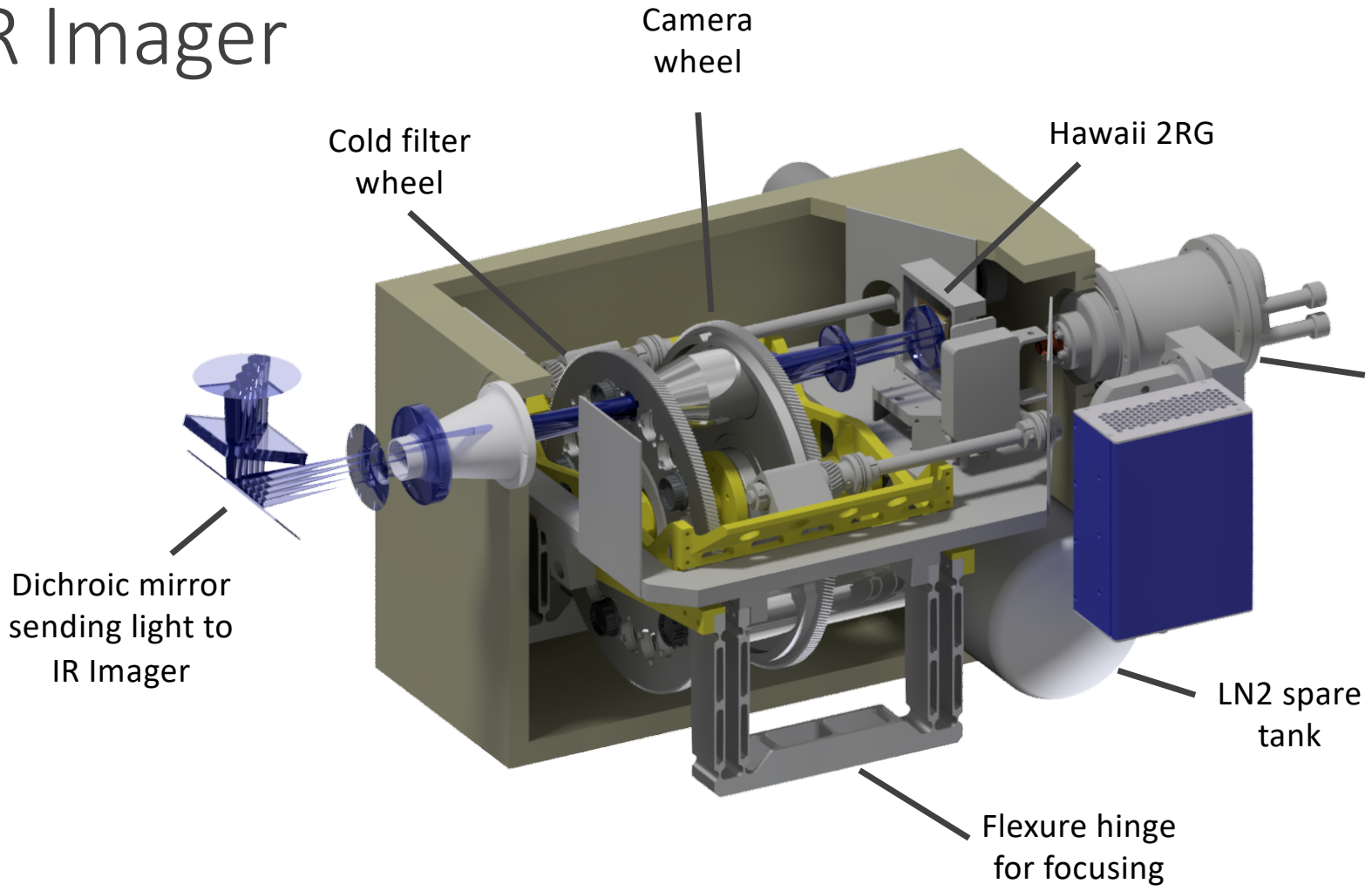

2k x 2k E2V CCD
Shutter
Field lens
Beam selector wheel
Filter wheels
Folding mirror
Dichroic sending light to VIS Imager
Calibration unit
Warm IR filter wheel
VIS Imager box and struts support the spectrograph cryostat

IR Imager - specifications

- 6x6 arcmin FoV
- Cold filter wheel with Bessel I, SDSS iz, LSST y, VISTA-like ZYJHKs and K+
- Warm filter wheel with four slots for narrow band filters with thermal emission blocking dipotassium KDP
- Hawaii 2RG detector

Limiting magnitudes (1h, S/N=5, AB)
Y=23.4
J=22.9
H=22.6
K=22.4

IR Imager


Camera wheel
Cold filter wheel
Hawaii 2RG
Dichroic mirror sending light to IR Imager
LN2 spare tank
Flexure hinge for focusing

Spectrograph - specifications

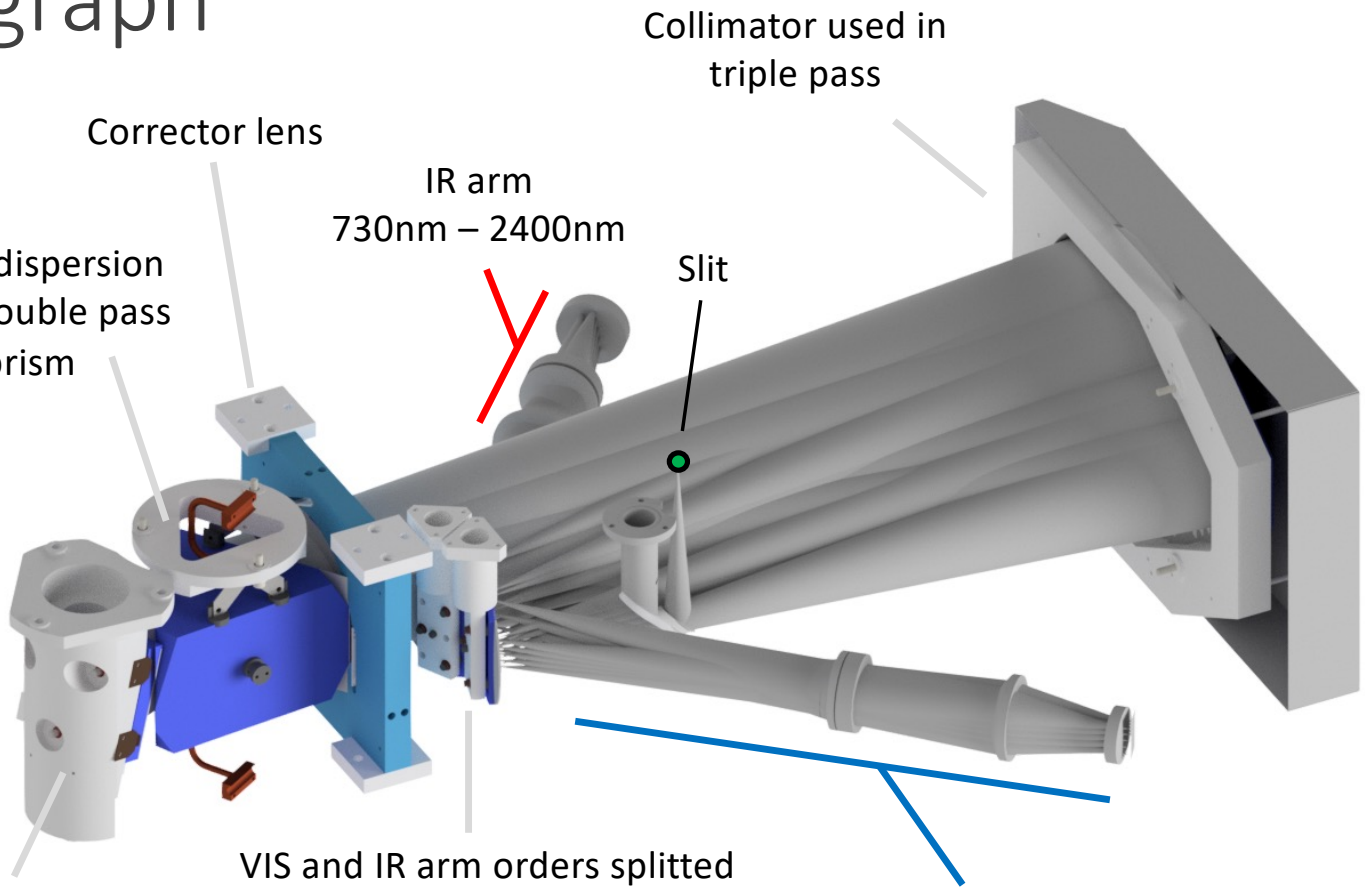
	VIS arm	**NIR arm**
Grating groove frequency	0.75l/m, Resolution 4000	
Grating blaze angle	17.5°	
Beam diameter	75mm	
Minimum order separation	27”	
Wavelength coverage	0.34-0.80µm	0.73-2.25µm
Spectral orders	11 – 25	5 – 10
Camera F-ratio	f/3.0	f/3.6
Pixel scale	0.38”-0.42”	0.42”-0.50”

Spectrograph

SR2: Limiting magnitudes, spectroscopy
Specification: For a point source observed for 1 hour split in 3 exposures, using a 1.0'' slit in 0.8'' seeing and under dark sky conditions, a S/N of 5 per spectral resolution element (FWHM) shall be reached in regions of the spectrum almost free of skylines (skyline flux <10% of the continuum) and where the atmospheric transmission is better than 70% for airmass=1.2 (this then excludes λ<400 nm and most of the gap between the J and H bands) for the following AB magnitudes: 20.90 at 400 nm, 20.70 at 650 nm, 20.25 at 1200 nm, and 20.15 at 1600 nm.

We will also have one 1.0" wide and 10" long slit for spectropolarimitry.

Spectrograph

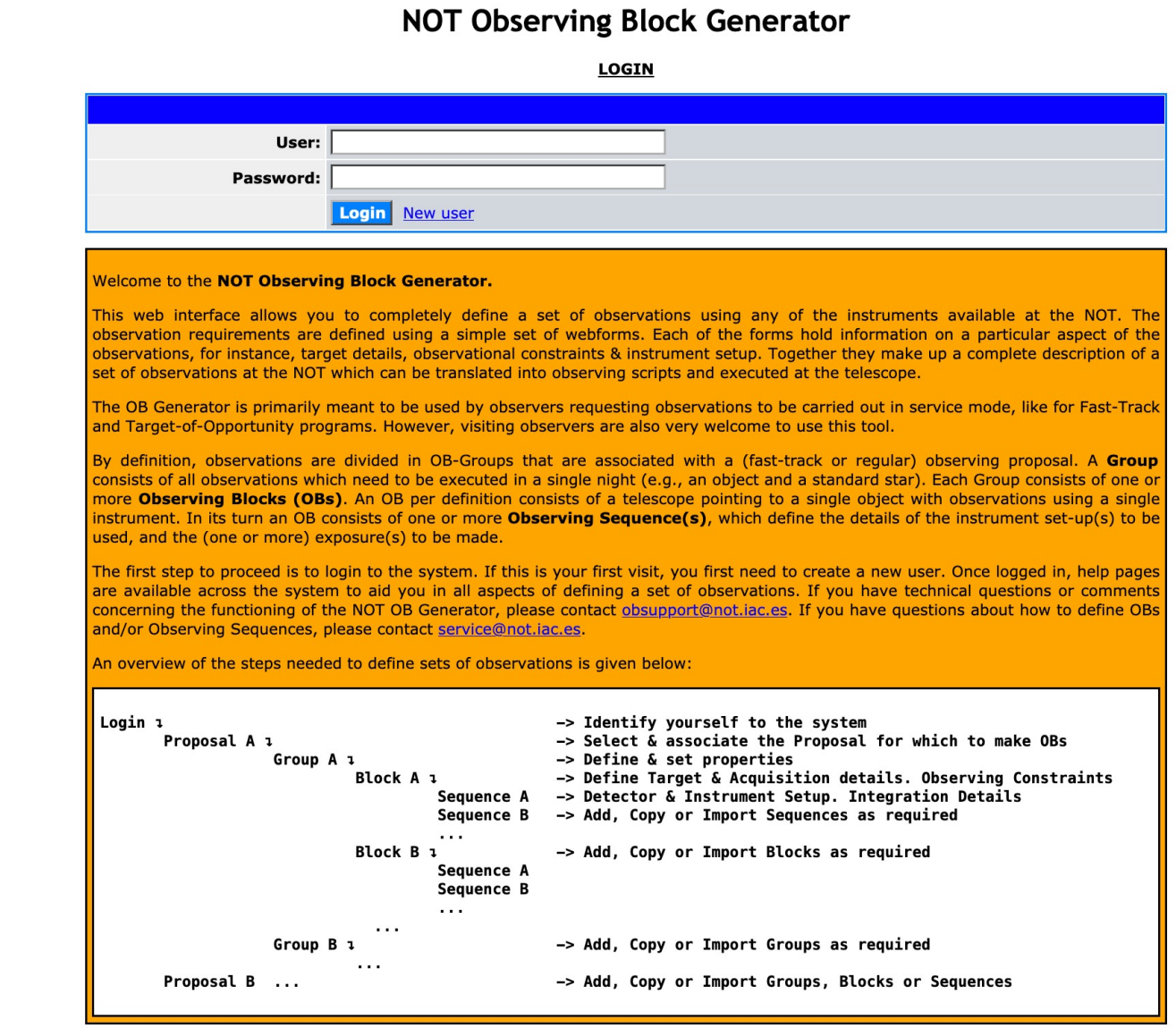


Observing modes

Spectroscopy - acquisition

- Acquisition with acquisition camera
  - Direct
  - Blind offset
- Acquisition with optical imager
  - Direct
  - Blind offset
- Acquisition with NIR imager
  - Direct
  - Blind offset

How we trigger



NOT Observing Block Generator

LOGIN

User:

Password:

Login New user

Welcome to the **NOT Observing Block Generator.**

This web interface allows you to completely define a set of observations using any of the instruments available at the NOT. The observation requirements are defined using a simple set of webforms. Each of the forms hold information on a particular aspect of the observations, for instance, target details, observational constraints & instrument setup. Together they make up a complete description of a set of observations at the NOT which can be translated into observing scripts and executed at the telescope.

The OB Generator is primarily meant to be used by observers requesting observations to be carried out in service mode, like for Fast-Track and Target-of-Opportunity programs. However, visiting observers are also very welcome to use this tool.

By definition, observations are divided in OB-Groups that are associated with a (fast-track or regular) observing proposal. A **Group** consists of all observations which need to be executed in a single night (e.g., an object and a standard star). Each Group consists of one or more **Observing Blocks (OBs)**. An OB per definition consists of a telescope pointing to a single object with observations using a single instrument. In its turn an OB consists of one or more **Observing Sequence(s)**, which define the details of the instrument set-up(s) to be used, and the (one or more) exposure(s) to be made.

The first step to proceed is to login to the system. If this is your first visit, you first need to create a new user. Once logged in, help pages are available across the system to aid you in all aspects of defining a set of observations. If you have technical questions or comments concerning the functioning of the NOT OB Generator, please contact obsupport@not.iac.es. If you have questions about how to define OBs and/or Observing Sequences, please contact service@not.iac.es.

An overview of the steps needed to define sets of observations is given below:

```
Login ↴                                  -> Identify yourself to the system
      Proposal A ↴                       -> Select & associate the Proposal for which to make OBs
                  Group A ↴              -> Define & set properties
                           Block A ↴     -> Define Target & Acquisition details. Observing Constraints
                                    Sequence A   -> Detector & Instrument Setup. Integration Details
                                    Sequence B   -> Add, Copy or Import Sequences as required
                                    ...
                           Block B ↴     -> Add, Copy or Import Blocks as required
                                    Sequence A
                                    Sequence B
                                    ...
                              ...
                  Group B ↴              -> Add, Copy or Import Groups as required
                           ...
      Proposal B  ...                    -> Add, Copy or Import Groups, Blocks or Sequences
```

The NOT OB Generator uses session cookies to ensure that you are recognised as you move from page to page. For the correct functioning of the OB generator, it is essential that you allow your browser to accept cookies from our site.

Proposal: 64-502 -> Groups notgrb

List Targets | List Proposals | Help | Logout

SUMMARY OF PROPOSAL: 64-502

Proposal	P.I.	Title	Email	
64-502	Daniele B. Malesani, Johan P. U. Fynbo	Building the Sample of Swift Gamma-Ray Bursts	d.malesani@astro.ru.nl,jfynbo@nbi.ku.dk,grb@dark-cosmology.dk	View

OBSERVING TIME BREAKDOWN

Type	InPrep	Submitted	Active	Closed	Expired	Total
ToO	16864	0	1887	4396	1887	25034
SoftToO	1887	0	0	0	4628	6515

LIST OF OBSERVING GROUPS

Show Closed/Expired

Group Name	Instrument(s)	Mode(s)	Type	Seeing	Weather	Moon	Obs. Time	Comments	Time Critical	Priority	Linked	Blocks	Status	Group Actions
alfosc_ima_g	ALFOSC	IMA	ToO	9.9	Thin Clouds	Any	0	Yes	20211001	1	No	List	InPrep	Copy Edit Delete Submit
alfosc_ima_griz	ALFOSC	IMA	ToO	9.9	Thin Clouds	Any	4489	Yes	20211001	1	No	List	InPrep	Copy Edit Delete Submit
alfosc_ima_i	ALFOSC	IMA	ToO	9.9	Thin Clouds	Any	0	Yes	20211001	1	No	List	InPrep	Copy Edit Delete Submit
alfosc_ima_r	ALFOSC	IMA	ToO	9.9	Thin Clouds	Any	674	Yes	20211001	1	No	List	InPrep	Copy Edit Delete Submit
alfosc_ima_rz	ALFOSC	IMA	ToO	9.9	Thin Clouds	Any	0	Yes	20211001	1	No	List	InPrep	Copy Edit Delete Submit
alfosc_ima_r_grb211024b_4	ALFOSC	IMA	ToO	1.3	Thin Clouds	Any	1887	Yes	20211105	1	No	List	Active	Copy
alfosc_ima_r_grb211024b_bak	ALFOSC	IMA	SoftToO	1.3	Thin Clouds	Any	1887	Yes	20211103-20211105	1	No	List	InPrep	Copy Edit Delete Submit
alfosc_ima_z	ALFOSC	IMA	ToO	9.9	Thin Clouds	Any	1387	Yes	20211001	1	No	List	InPrep	Copy Edit Delete Submit
alfosc_spec_g4	ALFOSC	SPEC	ToO	1.3	Thin Clouds	Any	5246	Yes	20211001	1	No	List	InPrep	Copy Edit Delete Submit
notcam_ima_jhk	NOTCAM	IMA	ToO	9.9	Thin Clouds	Any	2480	Yes	20211001	1	No	List	InPrep	Copy Edit Delete Submit
stancam_ima_rz	STANCAM	IMA	ToO	9.9	Thin Clouds	Any	2588	Yes	20211001	1	No	List	InPrep	Copy Edit Delete Submit

Add New Group | Import Group | Link Groups | Show All Blocks

Proposal: 63-503 -> **Group:** grb210610b_alfosc_spec_g4 -> View Block notgrb

List Proposals | List Groups | List Blocks | Help | Logout

OBSERVING BLOCK DEFINITION FORM

Instrument	
Instrument	ALFOSC
Mode	SPEC
OB Identifier	
Observing Group	grb210610b_alfosc_spec_g4
Observing Block	g4
Generated Script Name	grb210610b_alfosc_spec_g4_g4
Image Type	(x)Science ( )Standard ( )Calibration
Comments	For calibration, please run alfosc_calibs in the morning, which will obtain bias frames, wavelength calibration lamps, and halogen flats.
Target Details	
Finding Charts	63_503_FC_GRB10B2.jpg View
Target name	GRB210610B
RA	16:15:40.4 Proper motion 0.00 arcsec/year
DEC	+14:23:56.7 Proper motion 0.00 arcsec/year
Equinox	2000.00
Magnitude	17
Non-sidereal Tracking	[ ] Read the Help page for important information on moving targets
Target Acquisition	
Guide Field	ALFOSC Default
ADC	No
Slit	Slit_1.3" Horizontal Long slit 1.3"
Order Blocking	#94: WG345 356_LP cut-on
Slit Position Angle	Parallactic Angle If Custom Angle chosen, please specify:
Observing Constraints	
Max Seeing	1.3
Weather	Thin Clouds
Moon Phase	Any
Moon Distance	Any
Visibility	Airmass < 2.50 --or-- LST Range: 11.5 - 21.0 Leave airmass field empty or set to '0.00' for custom LST range setting to take effect. Make sure target is visible on any time critical dates defined in the observing group and set an appropriate LST to limit observations to a given UT interval if applicable

How we get the data and what we do with it

- The data is automatically transferred to a folder in ftp.not.iac.es. Each accepted program has its own folder.

- When on duty we manually download the raw data and reduce with home made scripts.

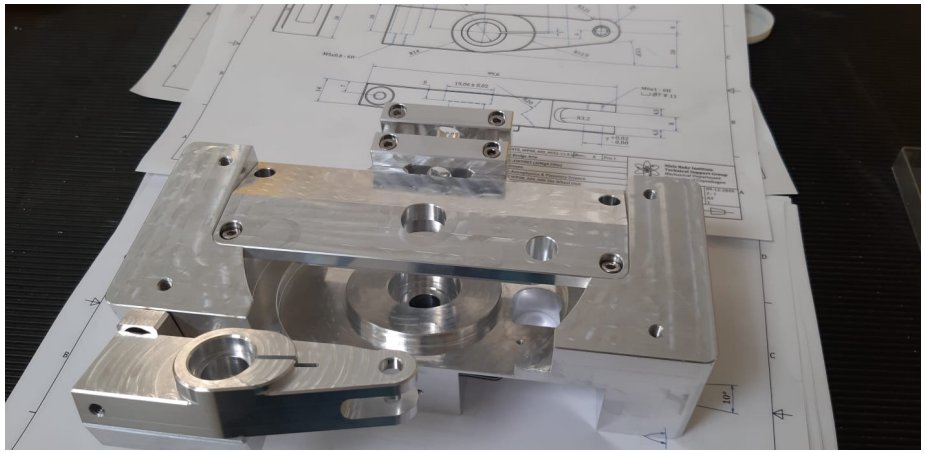
- With NTE we will have a pipeline that produces reduced and wcs-calibrated images (not as sofisticated as what I saw yesterday) and reduced spectra (1- and 2d files, wavelength and flux calibration – similar to the X-shooter pipeline).

When?

- The calibration unit is build.
- The slit-viewer is being build.
- The prism and collimator lens are under production.
- The spectro pipeline will be delivered by Uppsala (Piskunov). For imaging we hope to use a pipeline developed by Vitaly Neustrov from Oulo in Finland.

- Lots and lots and lots of work in front of us. In particular, the AIT will be a challenge, but lots of thoughts and planning are going in to it.

- We are working towards commissioning in late 2022 or early 2023.



Extra slides from here

User interface

VIS wheel	NIR cold wheel	NIR warm wheel	Slit-viewer wheel	Slit-wheel	Main mode-selector wheel
B	J	KDP	R	1.2 arcsec	Spec

Selector window GUI (filters, slits, …)

ToO and RRM alert window

Calibration unit (status, operate lambs, folding mirror)

Detector statuses

NTE Status Display

Graphical illustration of the current setup and light path

Saoimage VIS Imager

Saoimage NIR Imager

Sequencer window 1

Saoimage VISARM spectrograph

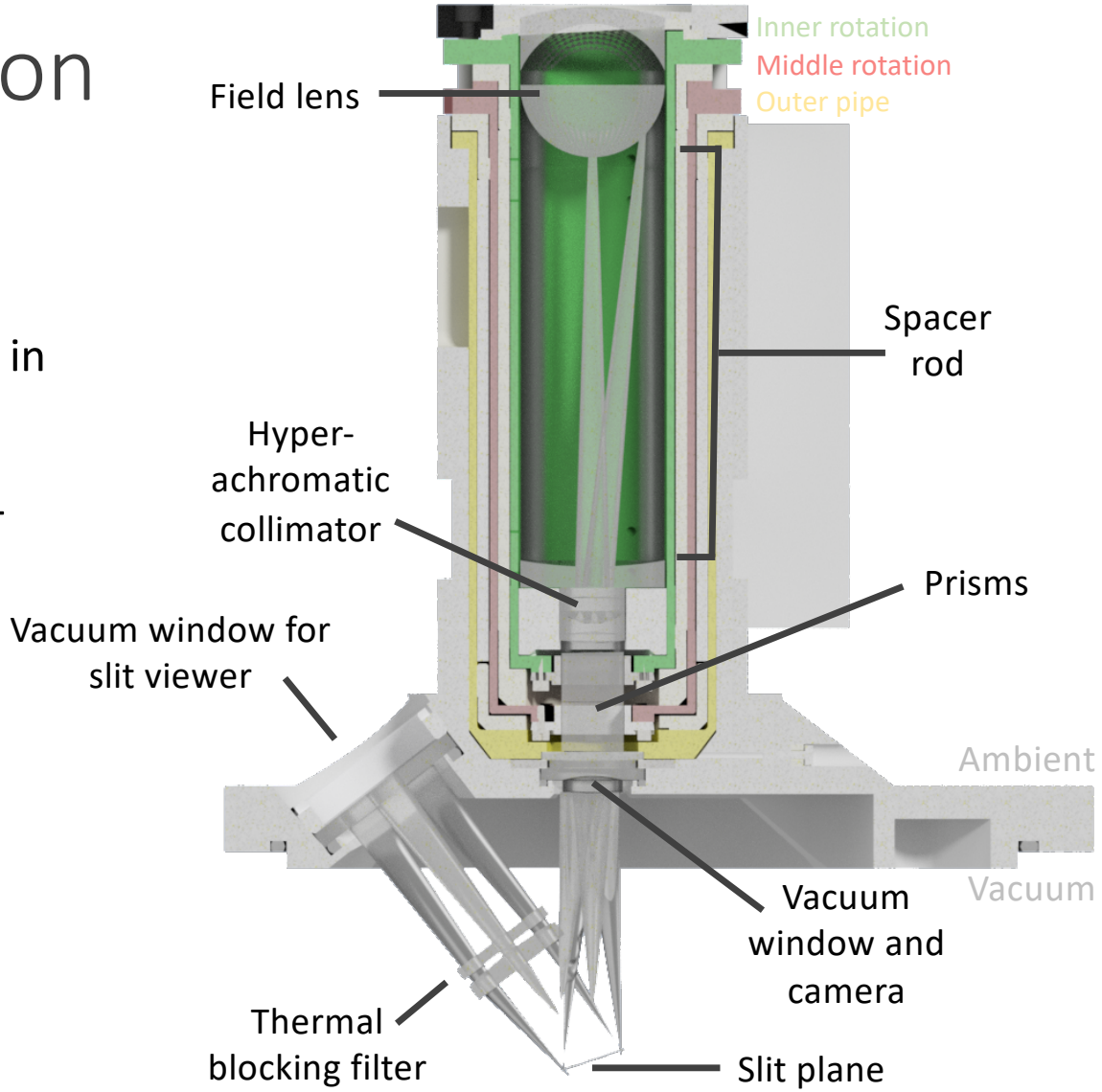
Saoimage NIRARM spectrograph

Saoimage Slitviewer with guidestar marked

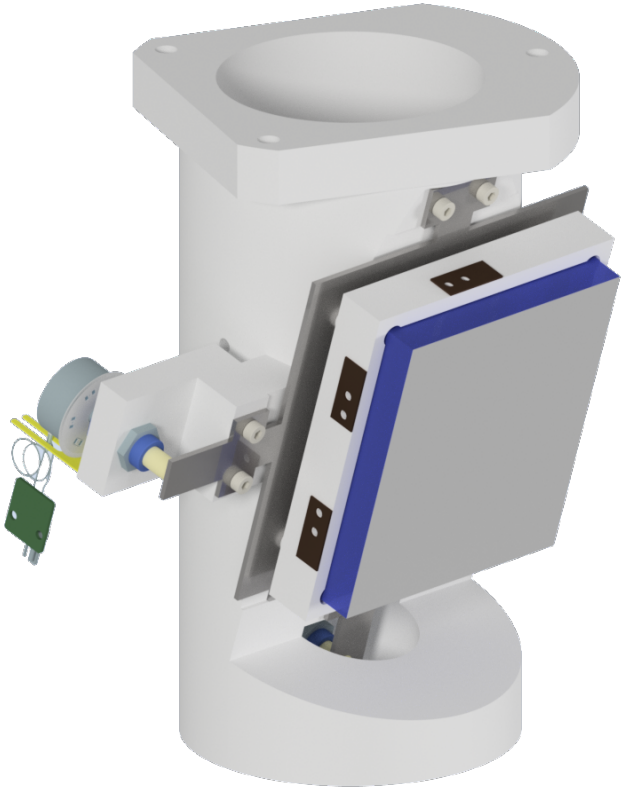
Sequencer window 2

Atmospheric dispersion corrector (ADC)

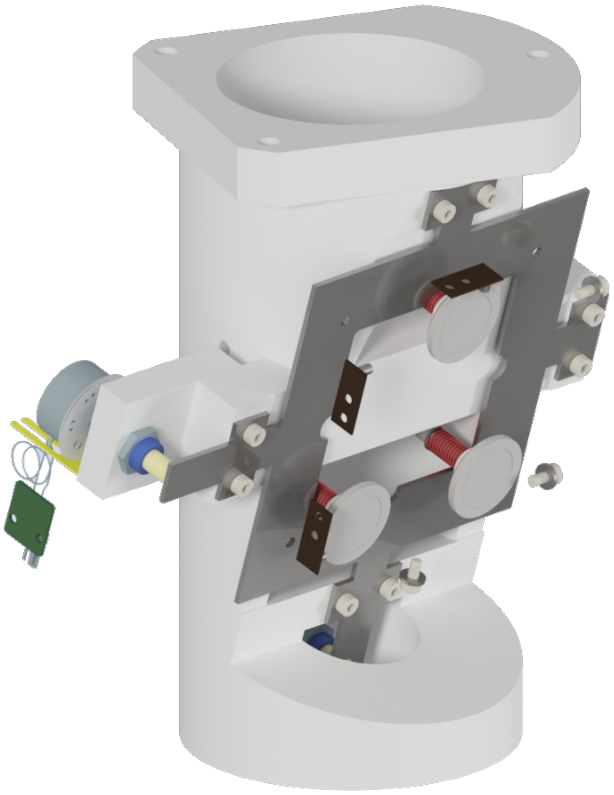
- Key optical system for NTE
  - In the common optical path, always in the beam → extreme wavelength coverage 320nm – 2.2µm
  - Dispersion correction to airmass = 4
- Multifunction
  - Dispersion correction
  - Focal reduction
  - Pupil for thermal blocking
  - 2'x 2' FoV for slit viewer
- Crystal and liquid materials to optimize throughput



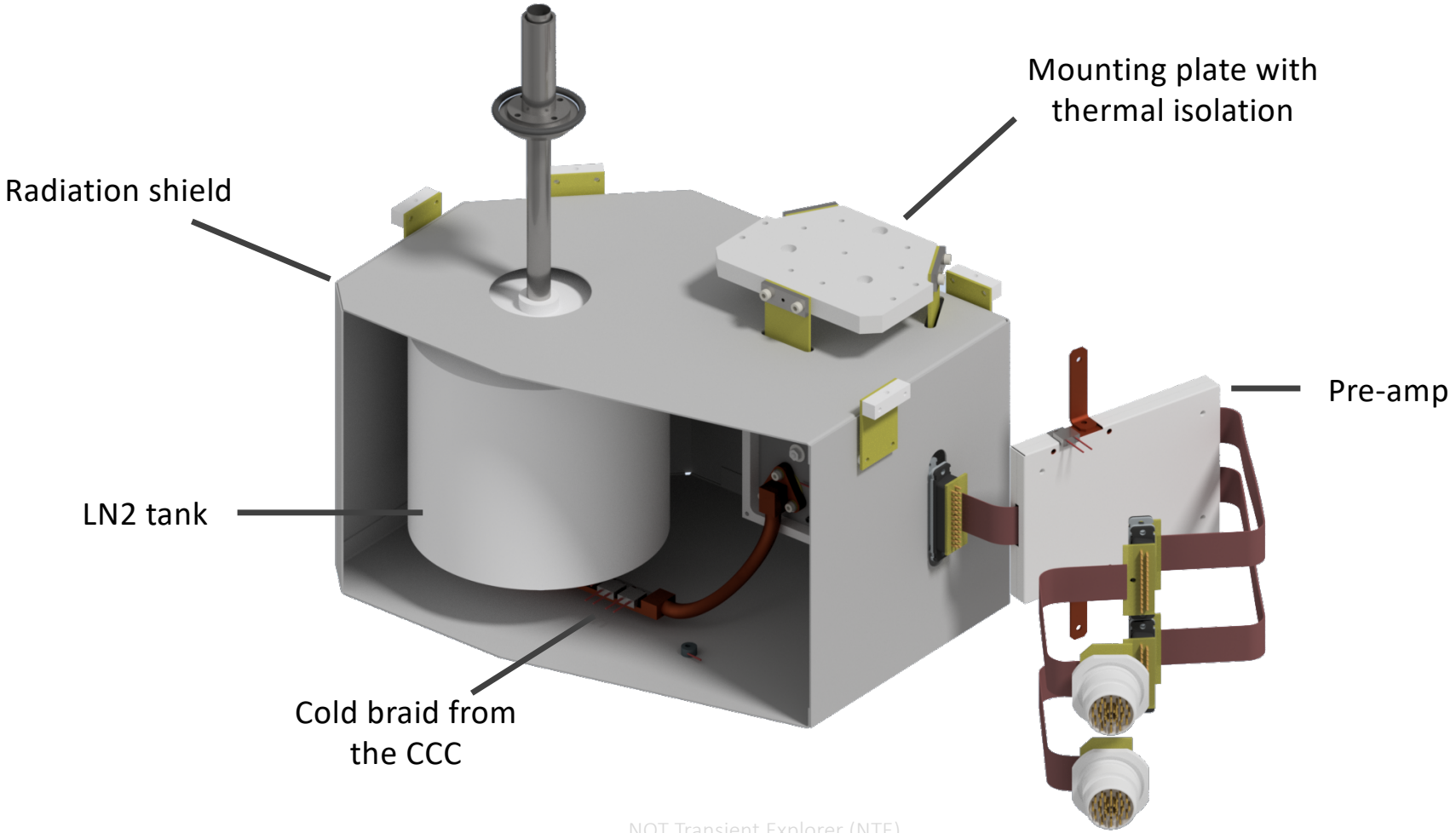
Grating mount



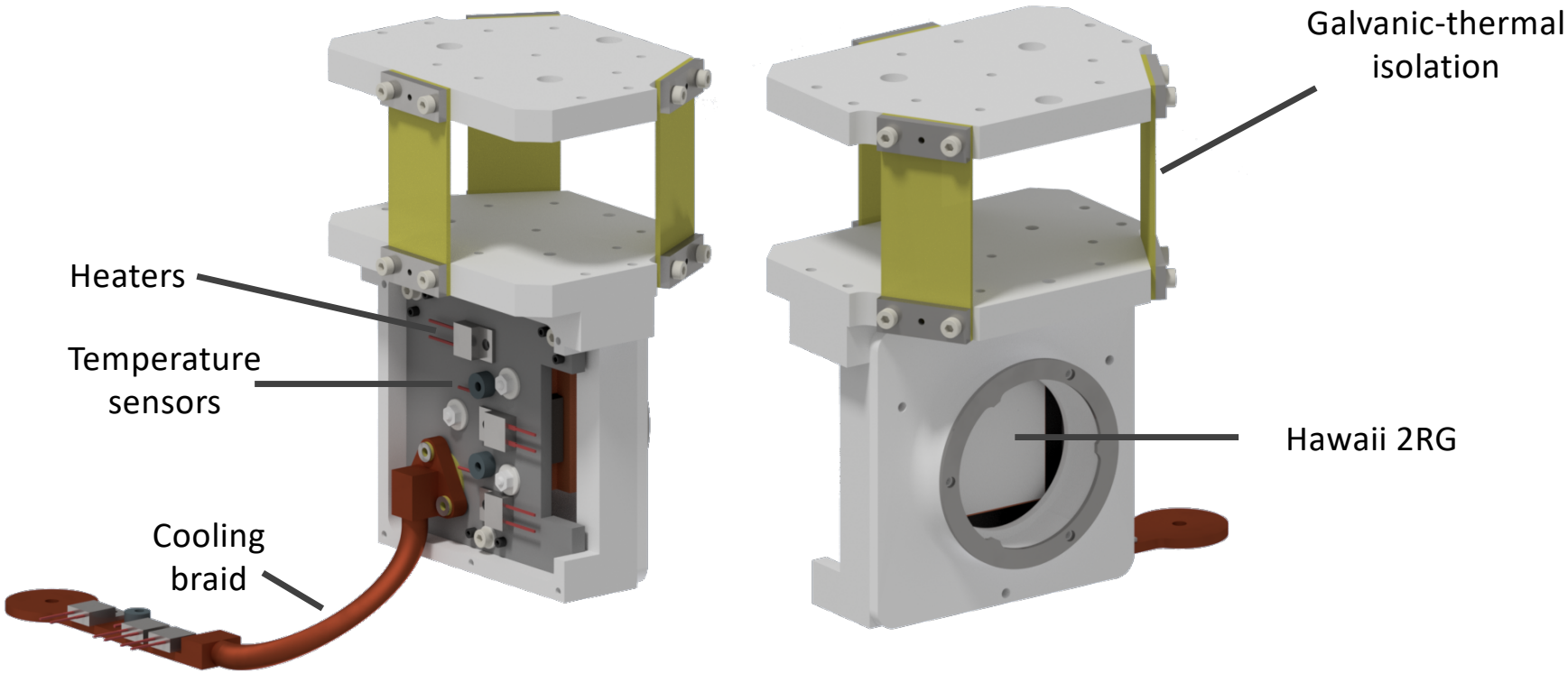
- Option to retrofit high precision piezo knobs for tip-tilt correction
- Allows flexure compensation if that is deemed necessary during commissioning
- At the first light, fixed setup with the cradle bolted on the base



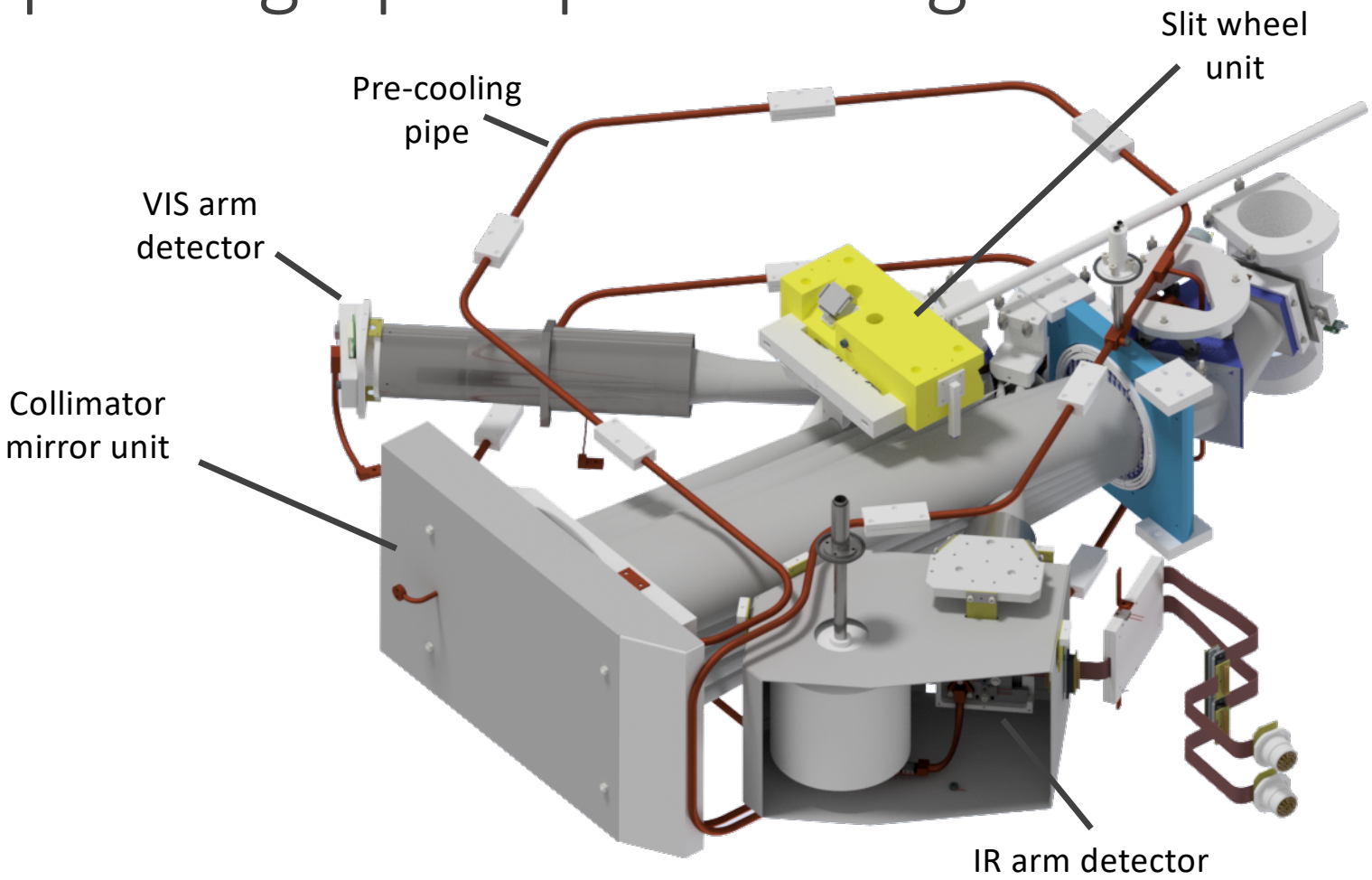
Infrared arm detector housing



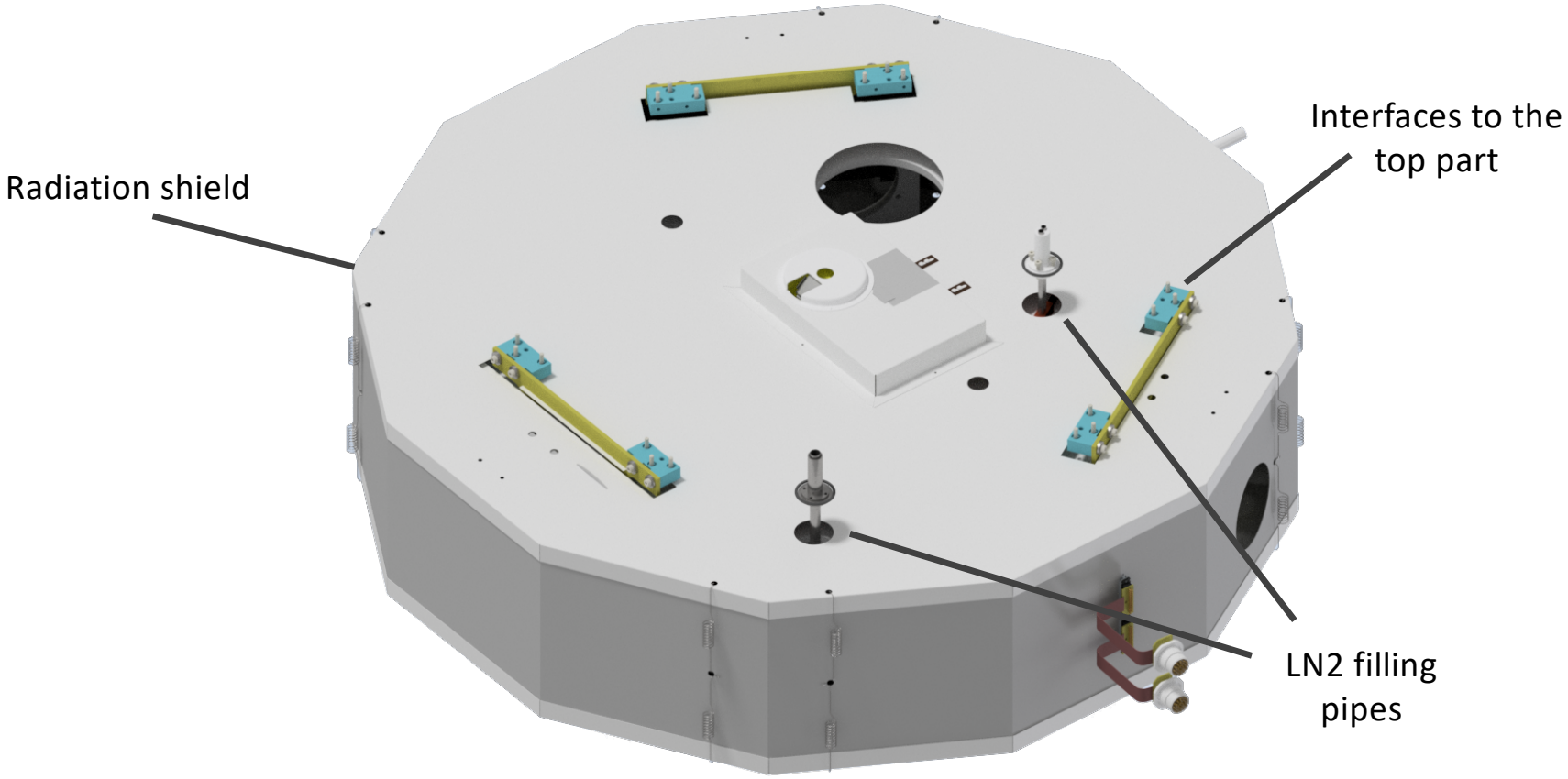
Infrared arm detector mount



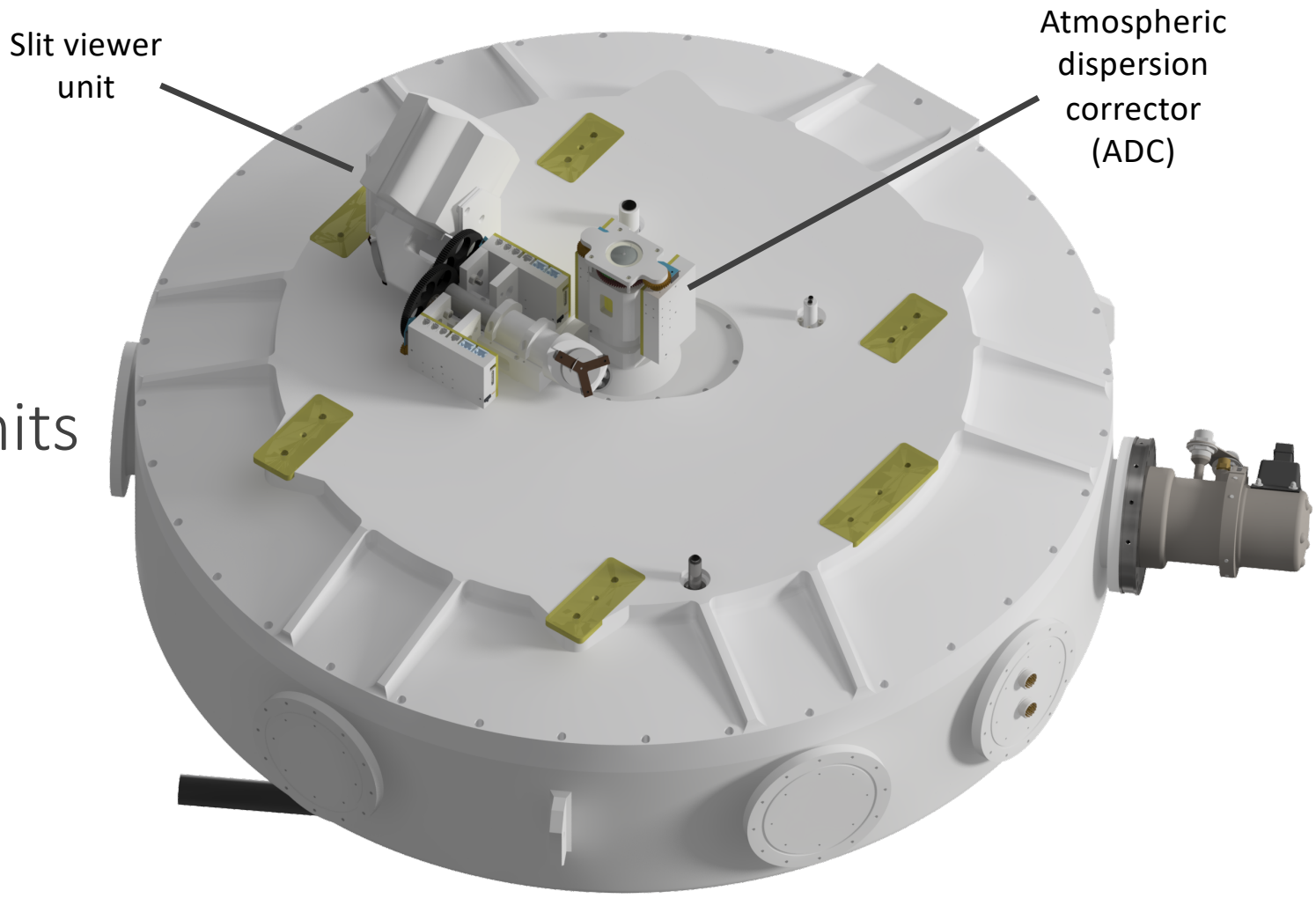
Spectrograph – pre-cooling



Spectrograph - radiation shields



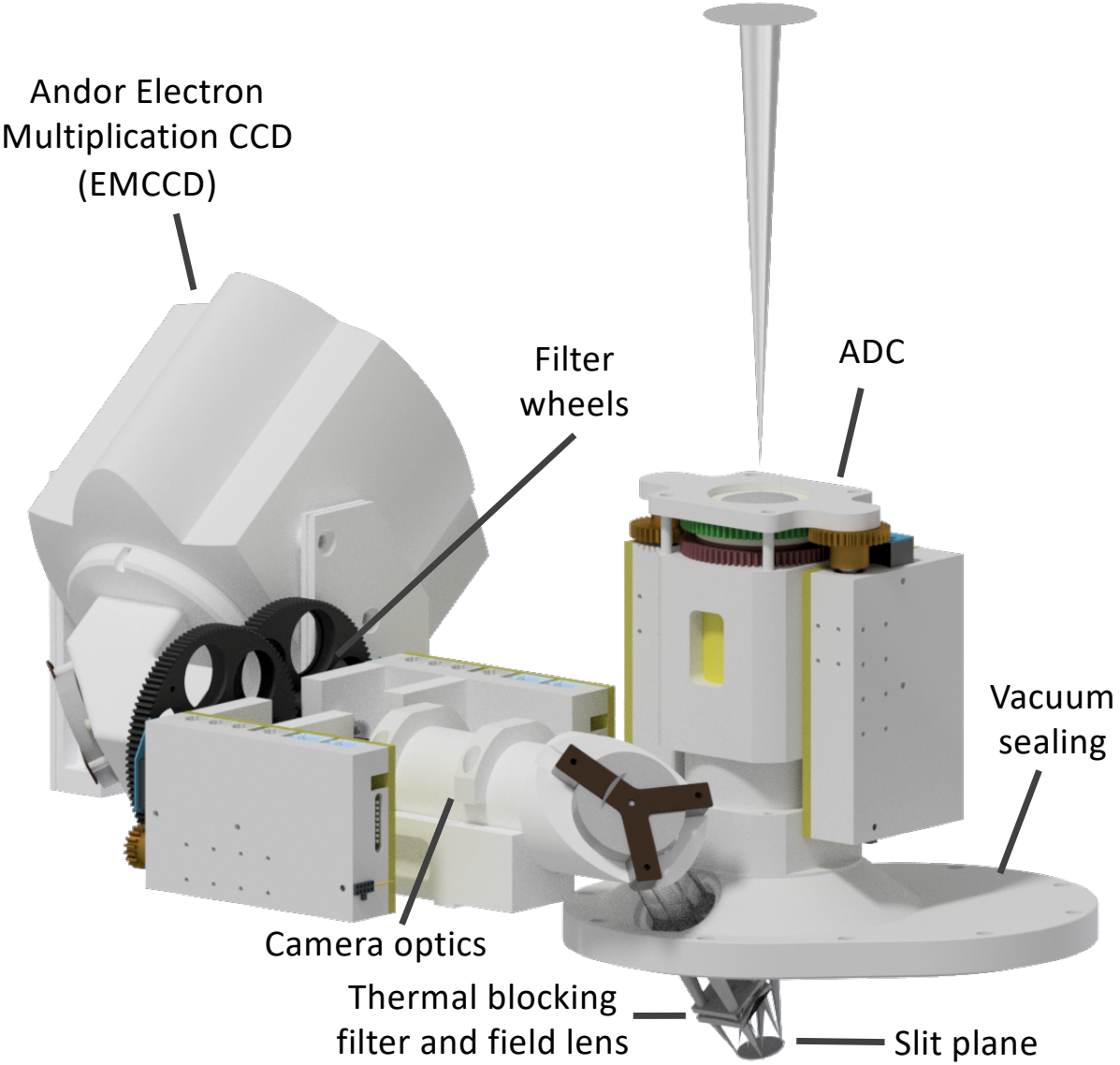
The ADC and Slit-viewing units mounted on spectrograph



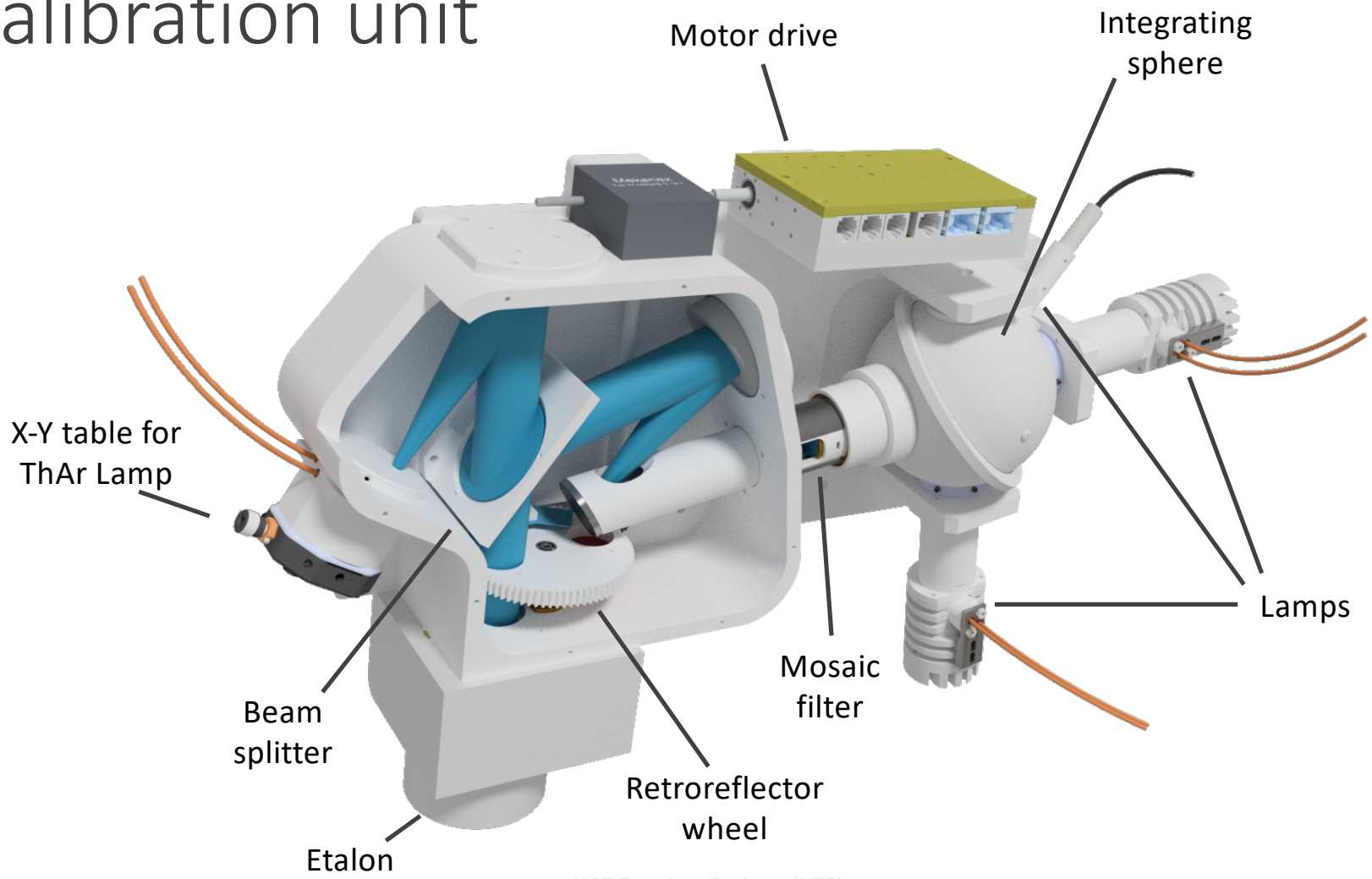
Slit viewing unit

- Slit viewer with two filters wheels
  - Bessel V, R and SDSS i', z' filters
  - Neutral density filters
  - Focus pyramid
  - Wave front sensor
- Pupil imager
- Andor DU-888 EMCCD camera
  - S/N=5 limiting magnitudes in 60s photon counting exposures

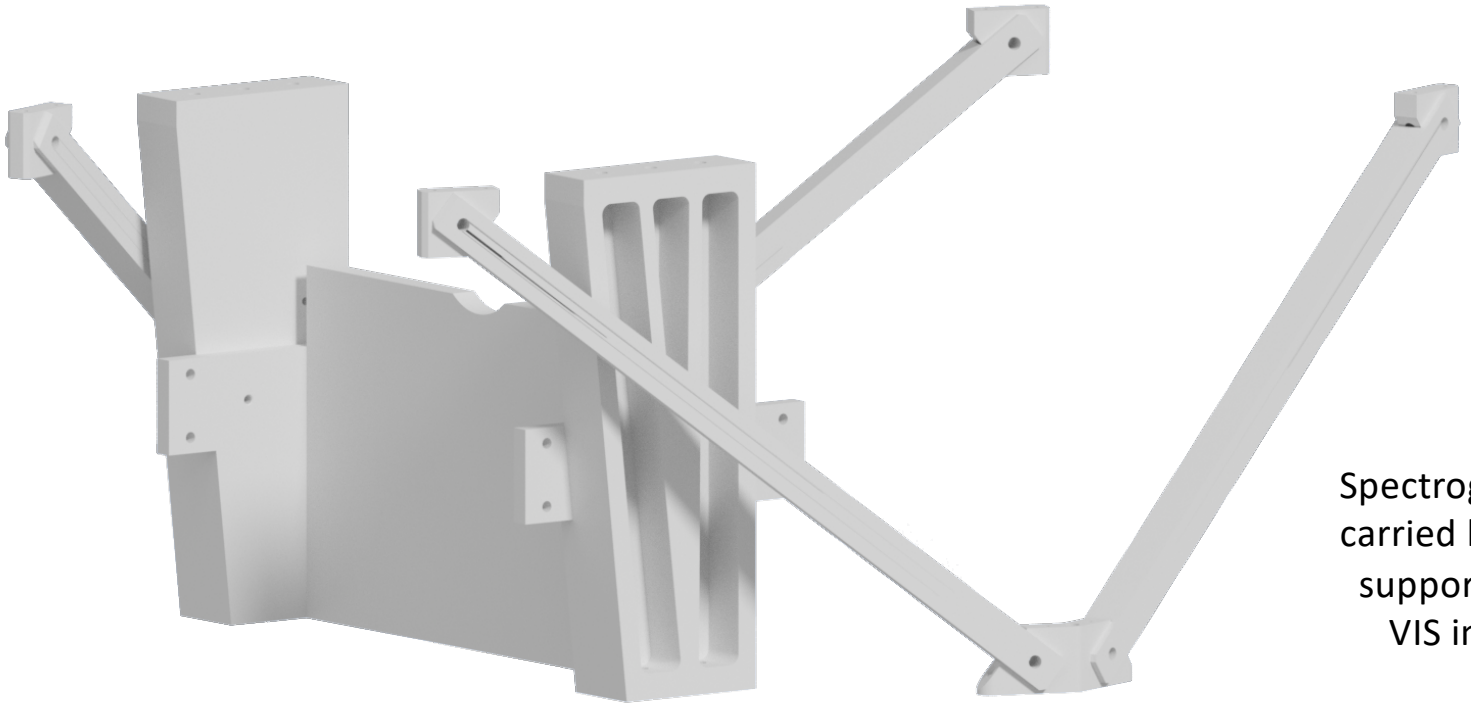
  V = 23.05, R = 22.82, i' = 22.25, z' = 21.24
- Thermal emission blocking



Calibration unit

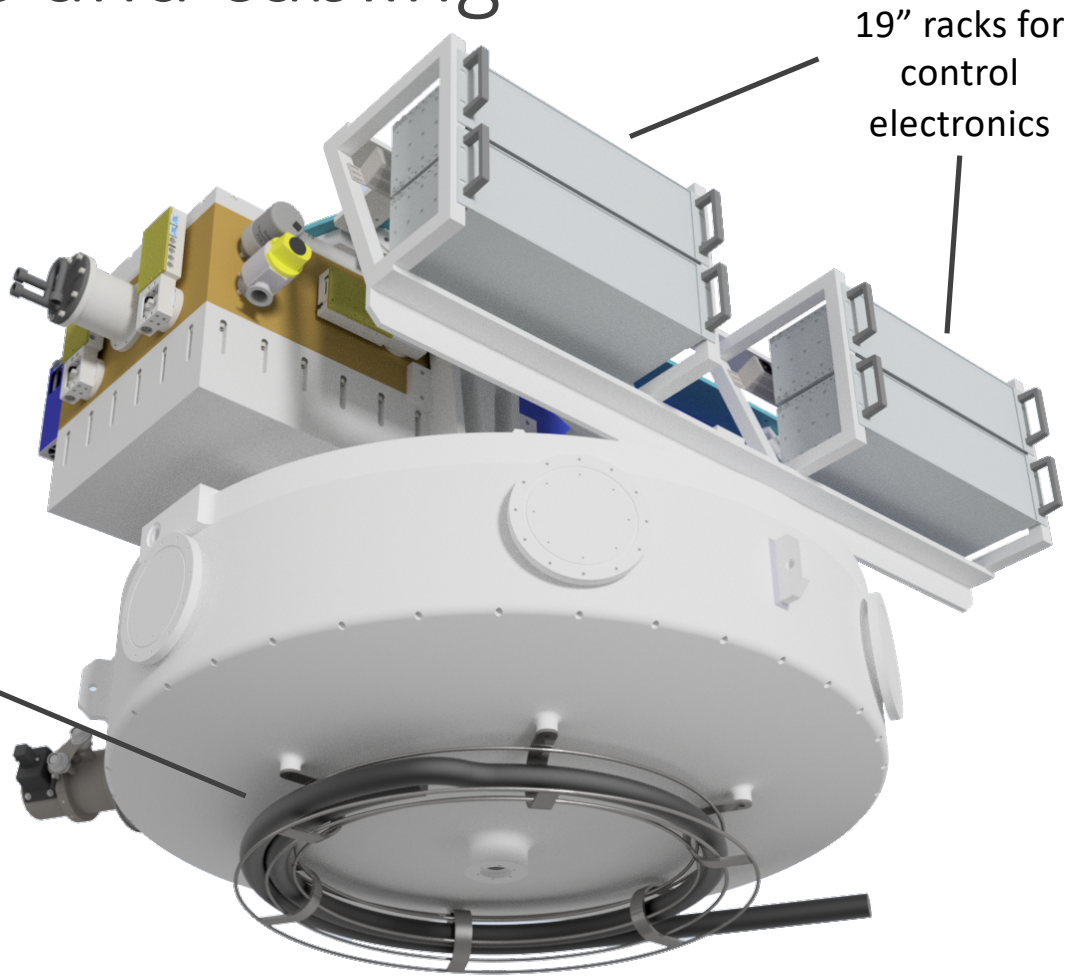


Spectrograph mounting



Spectrograph weight carried by aluminum support struts and VIS imager box

Controllers and cabling



Support arm