Astro-Tech-Talk

The METIS-cryostat

centra
center for astrophysics and gravitation

Science and Technology Facilities Council
UK Astronomy Technology Centre

Astro-Tech-Talk

The METIS-cryostat

centra
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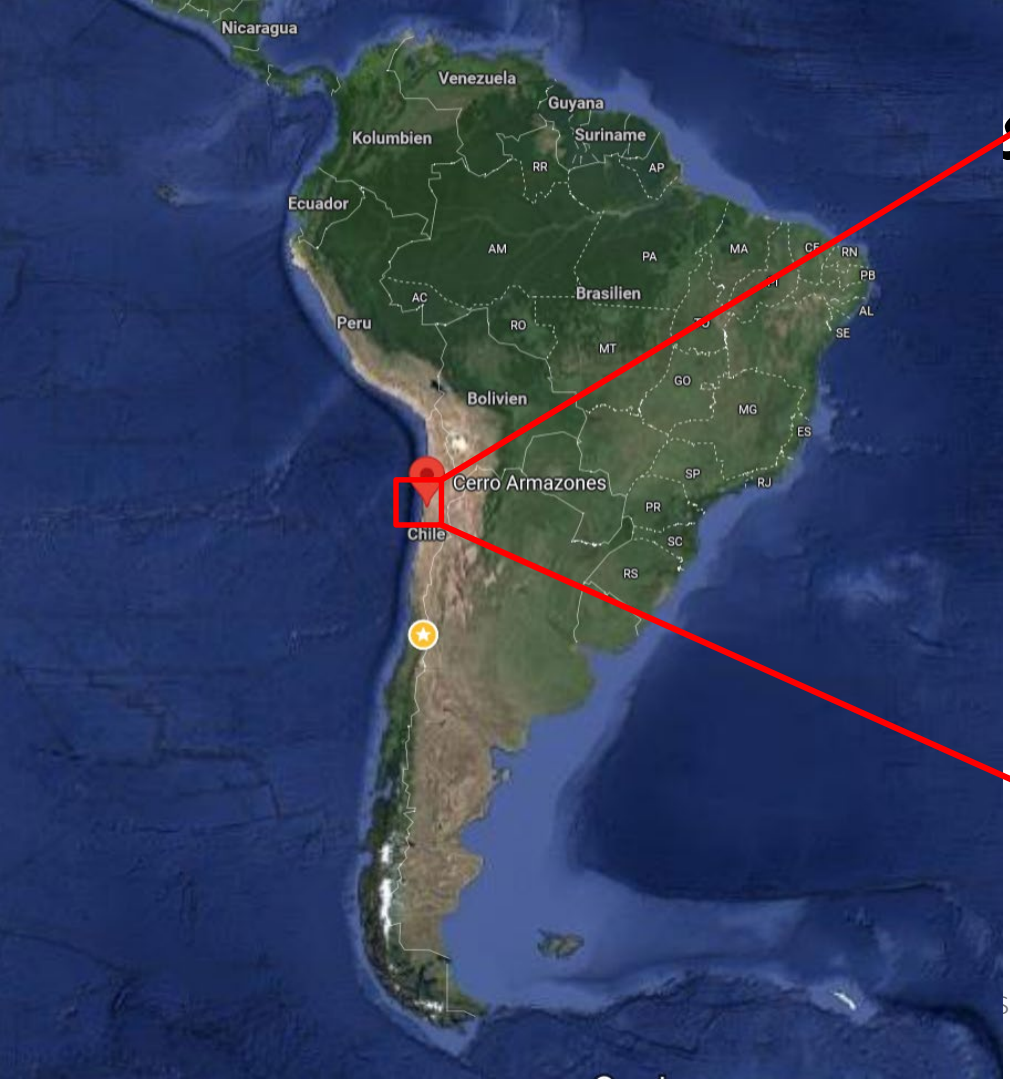
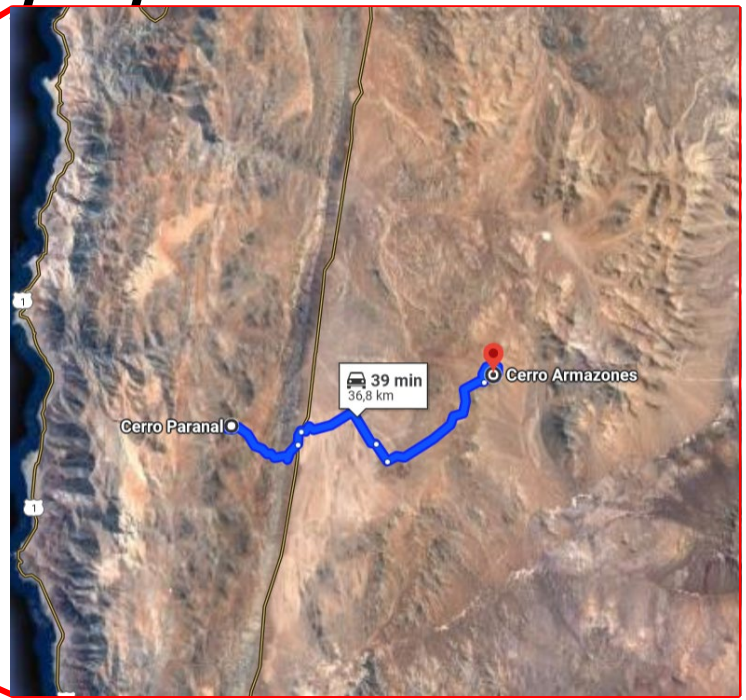
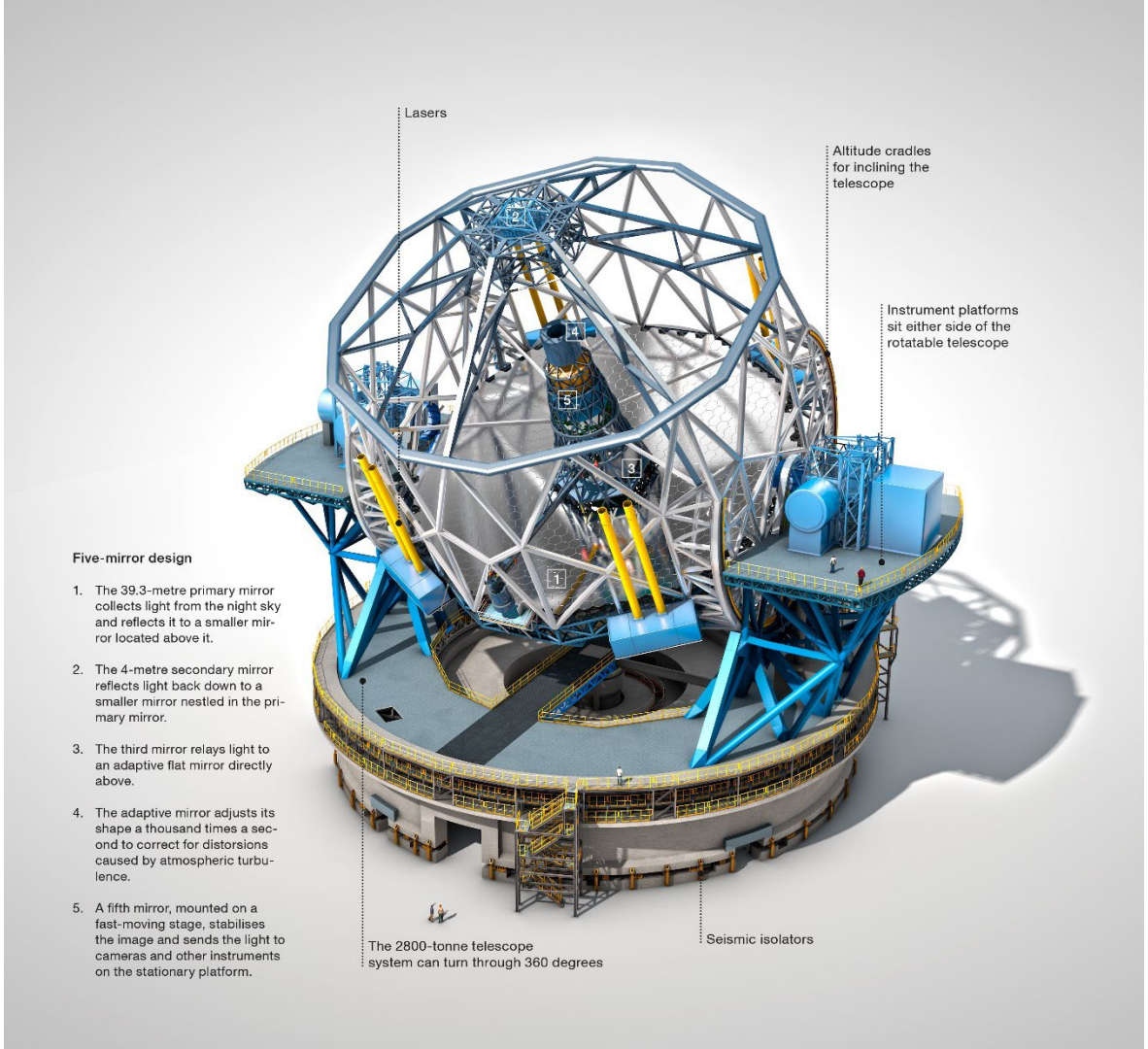




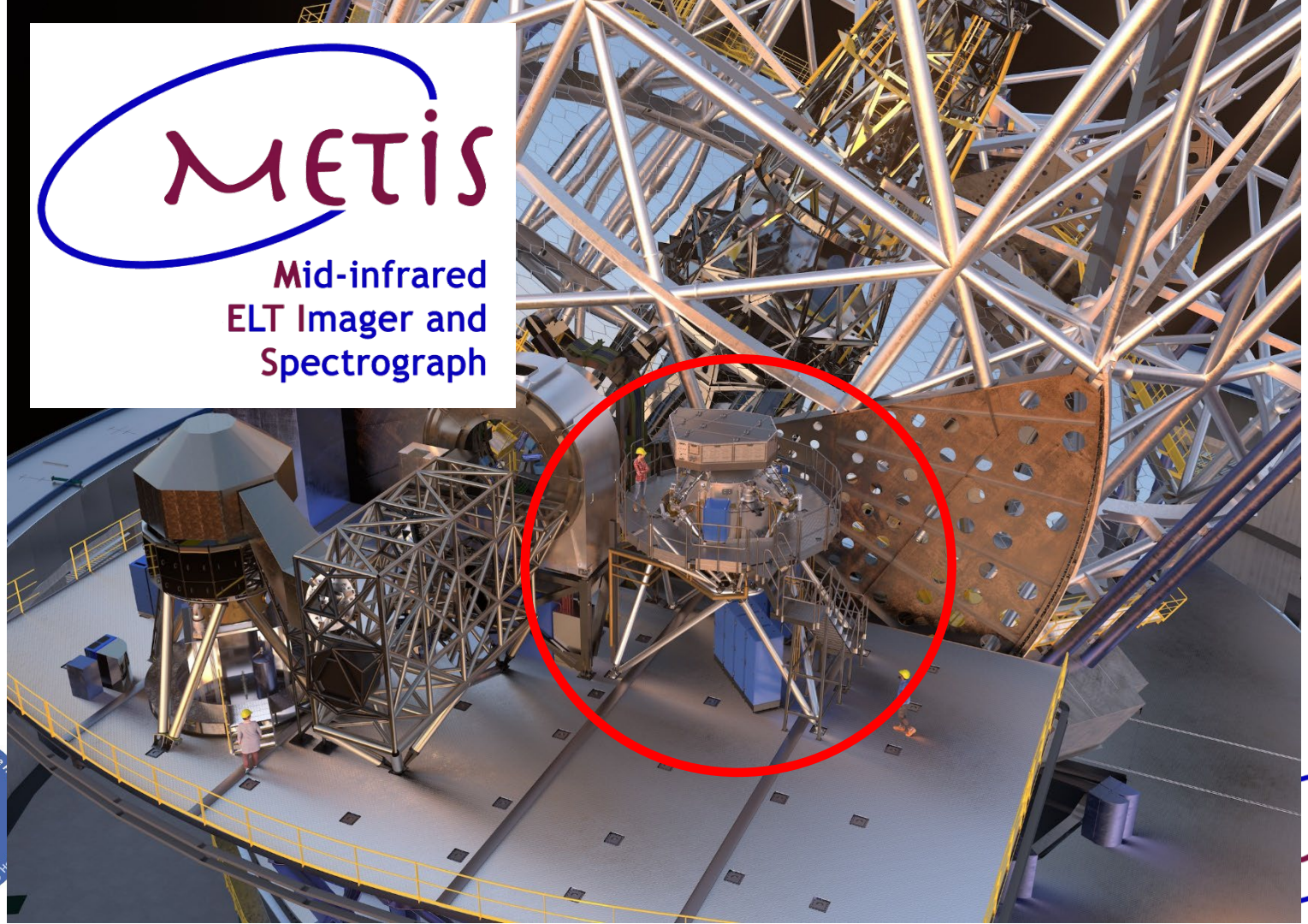
Mid Infrared ELT Imager and Spectrograph

METIS-Cryostat



Mid Infrared ELT Imager and Spectrograph

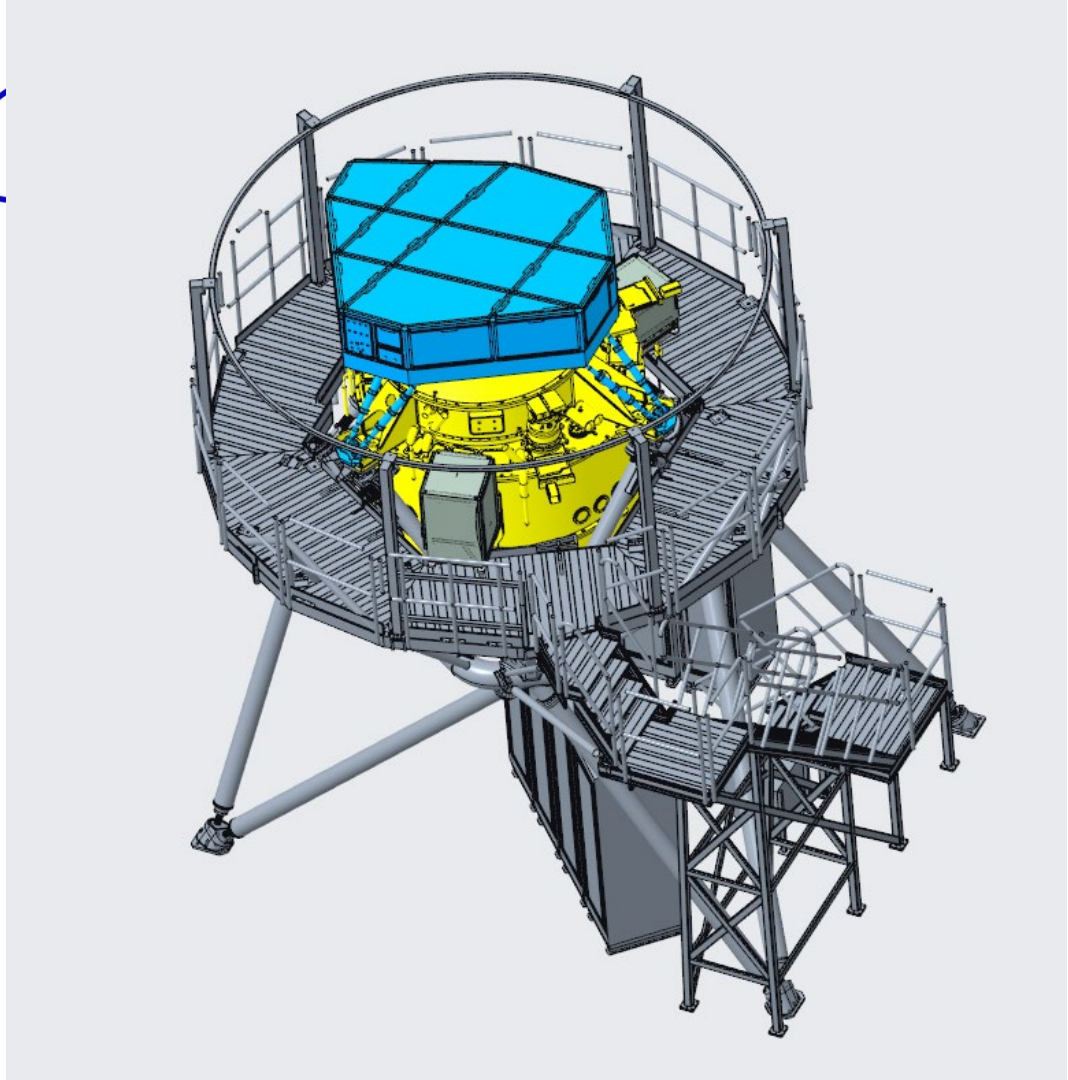
METIS



Mid Infrared ELT Imager and Spectrograph

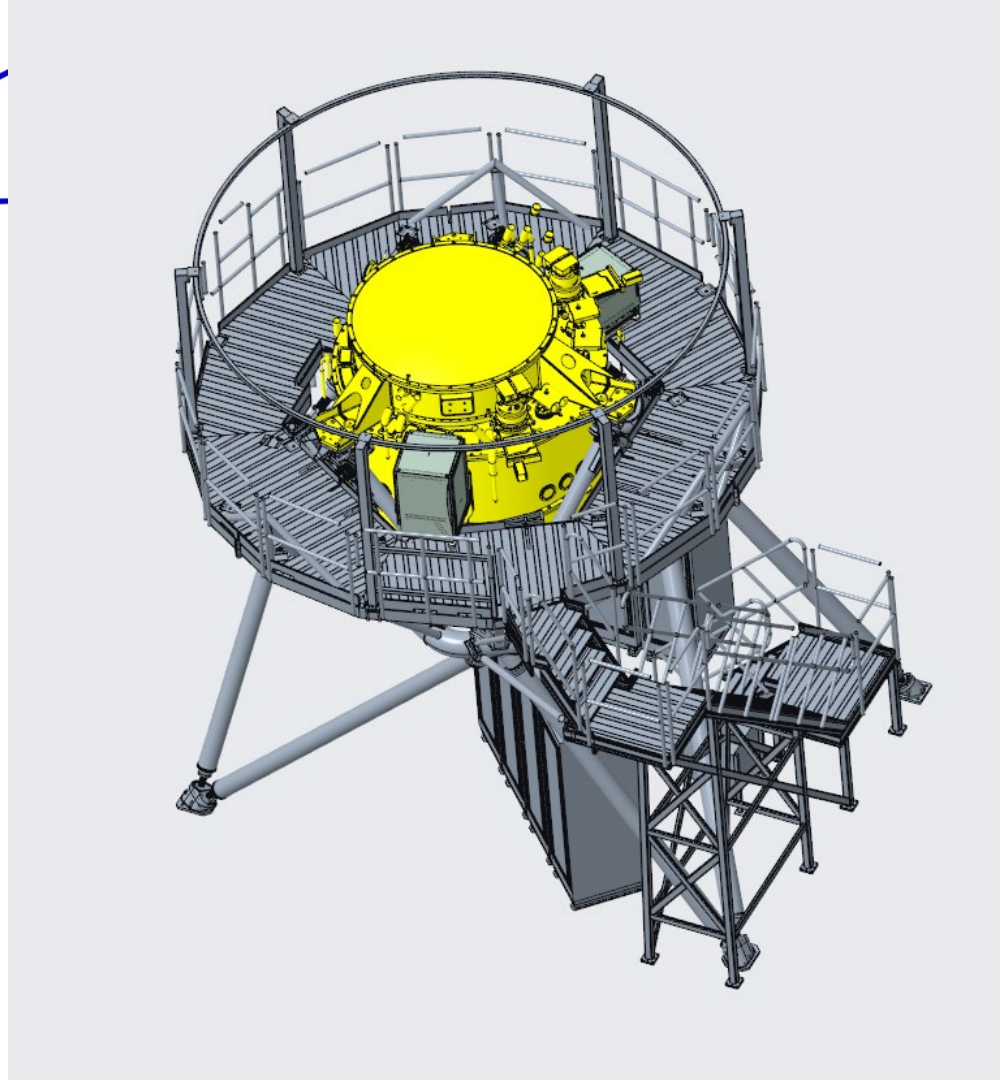
Mid Infrared ELT Imager and Spectrograph

Mid Infrared ELT Imager and Spectrograph



Mid Infrared ELT Imager and Spectrograph

METIS



Mid Infrared ELT Imager and Spectrograph

METIS

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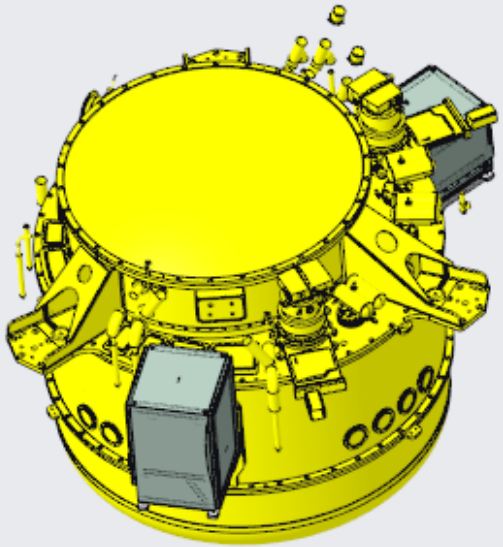
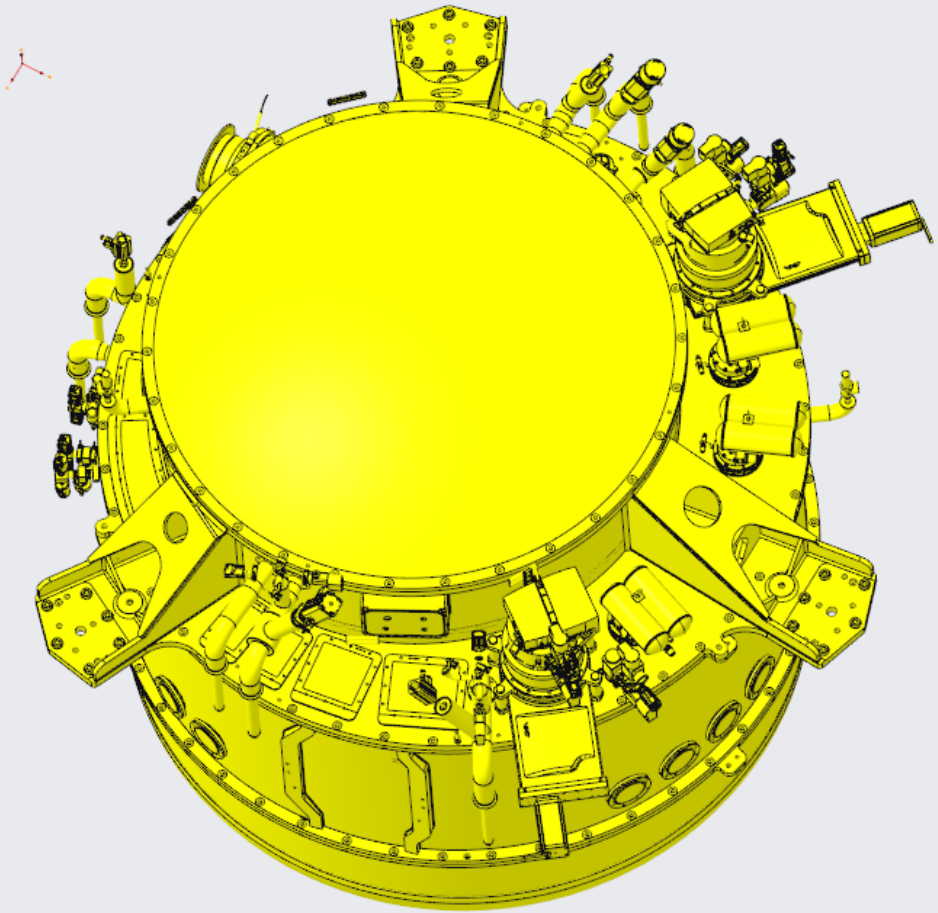
Max Planck Institute for Astronomy Heidelberg



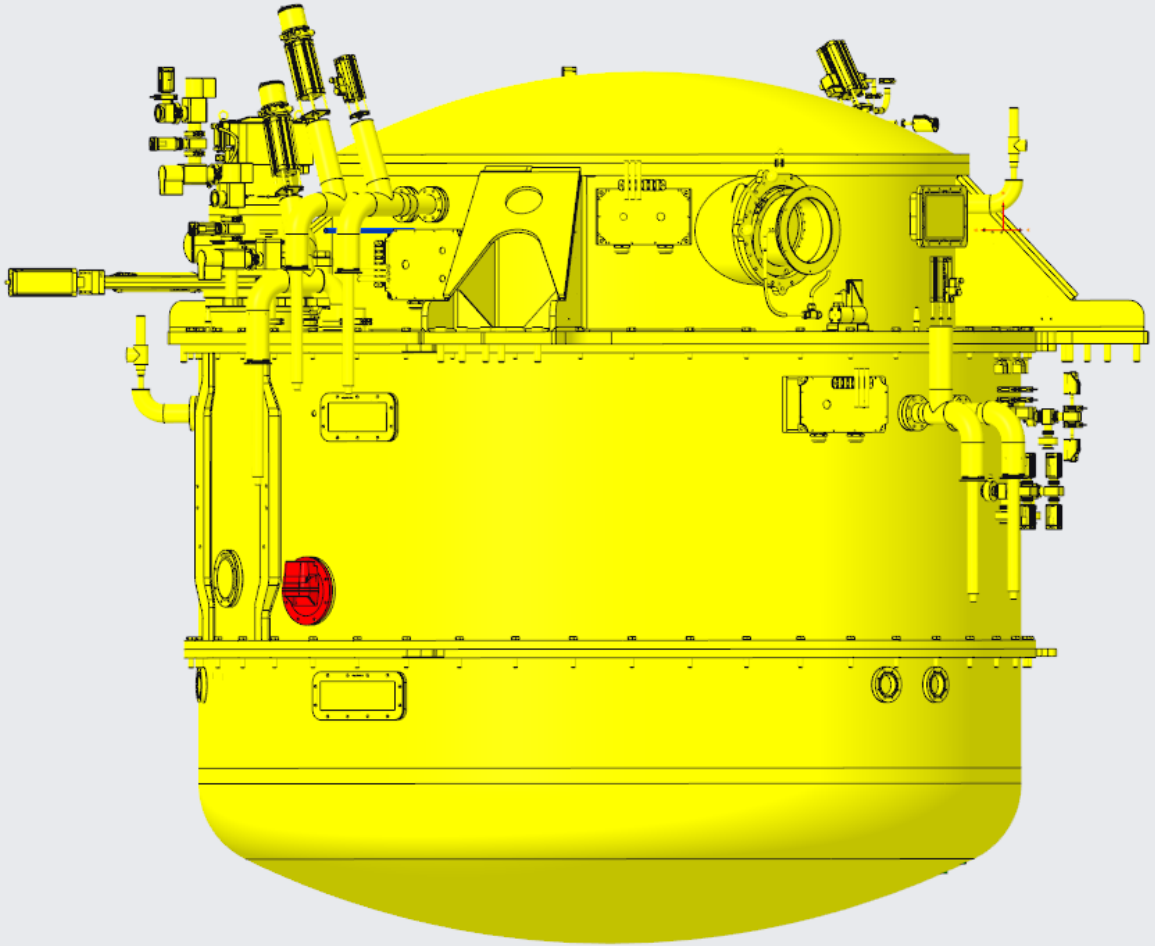
Mid Infrared ELT Imager and Spectrograph



Max-Planck-Institut für Astronomie Heidelberg
Max Planck Institute for Astronomy Heidelberg

METIS

Mid Infrared ELT Imager and Spectrograph



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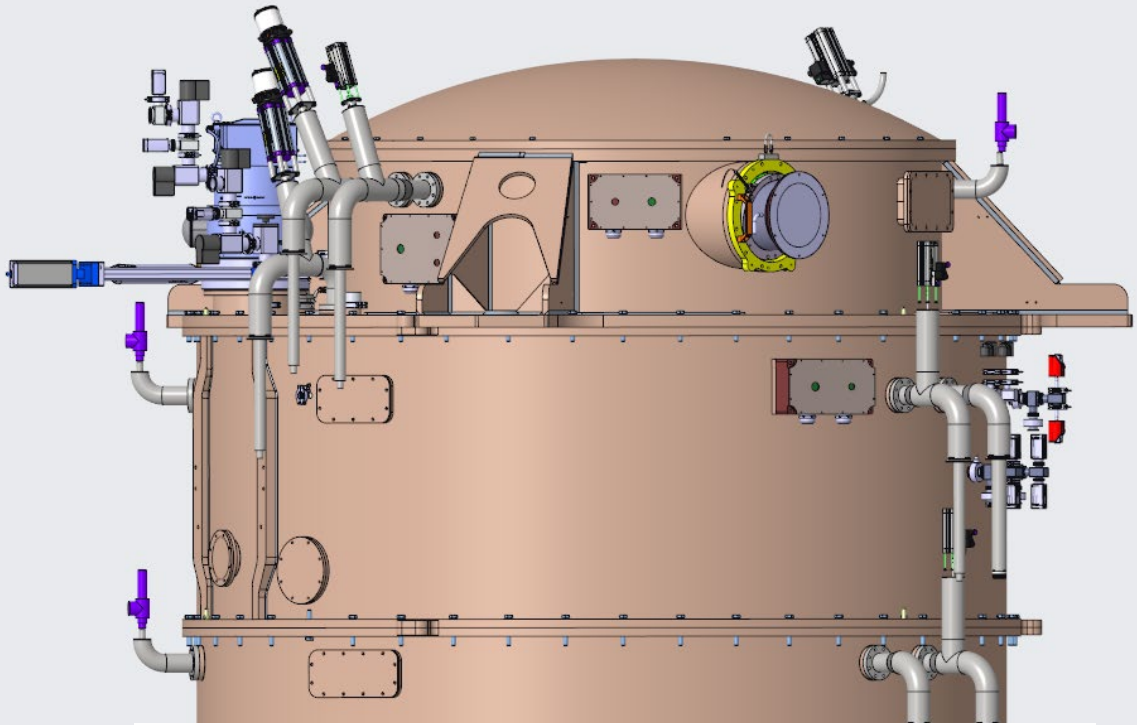
METIS

Mid Infrared ELT Imager and Spectrograph

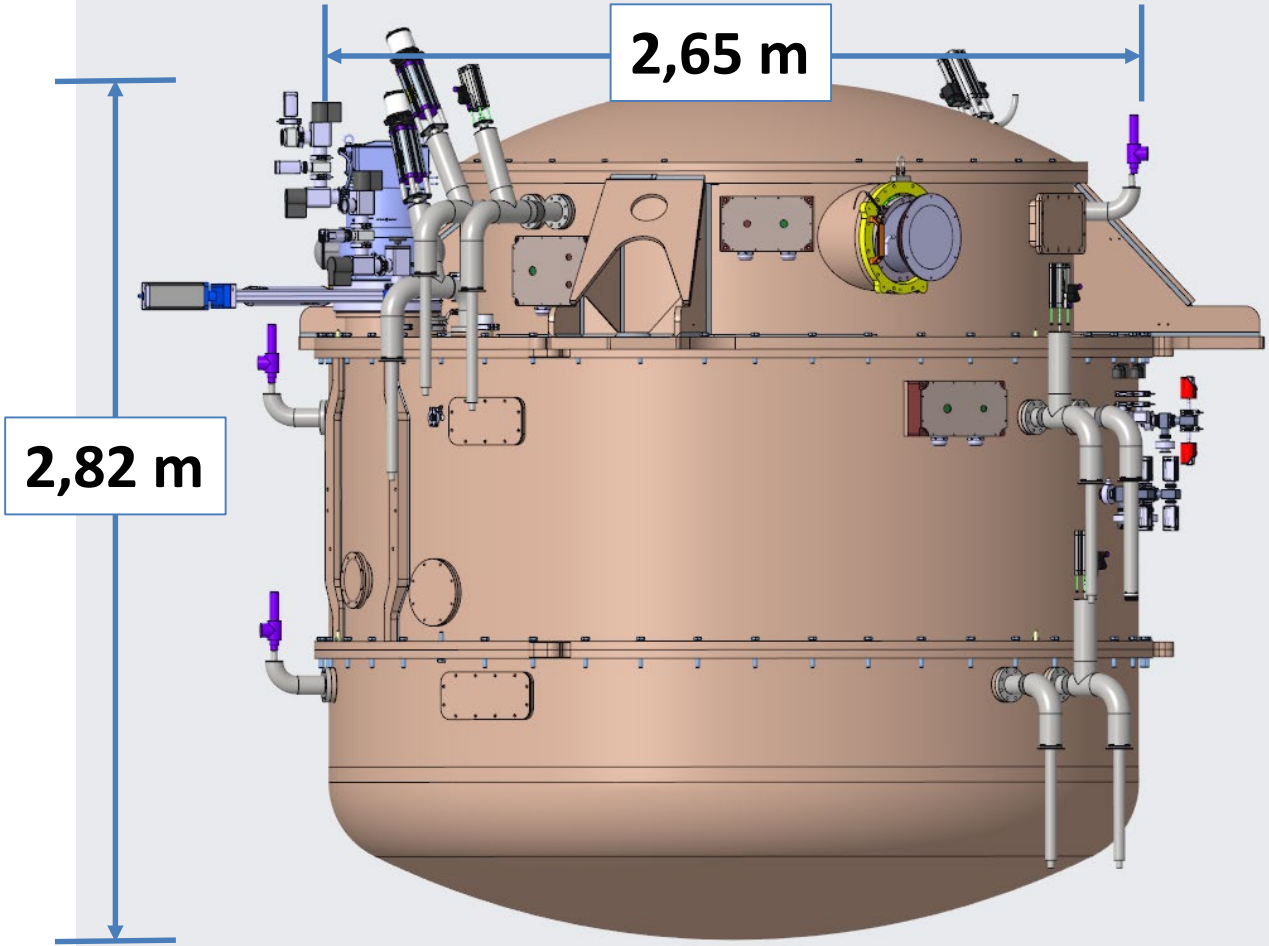


The METIS-cryostat

Mid Infrared ELT Imager and Spectrograph

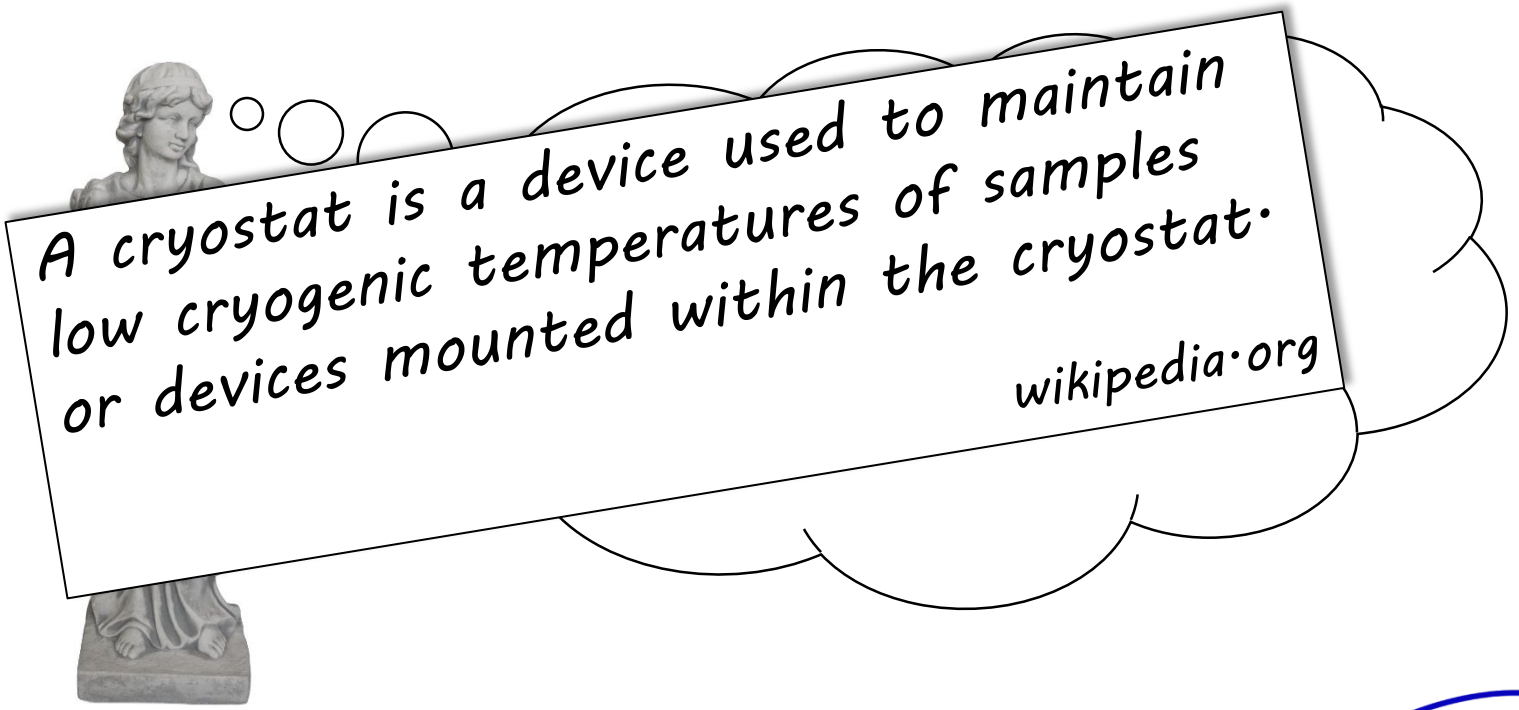
Max-Planck-Institut für Astronomie Heidelberg
Max Planck Institute for Astronomy Heidelberg

METIS



Mid Infrared ELT Imager and Spectrograph

METIS-Cryostat



Mid Infrared ELT Imager and Spectrograph

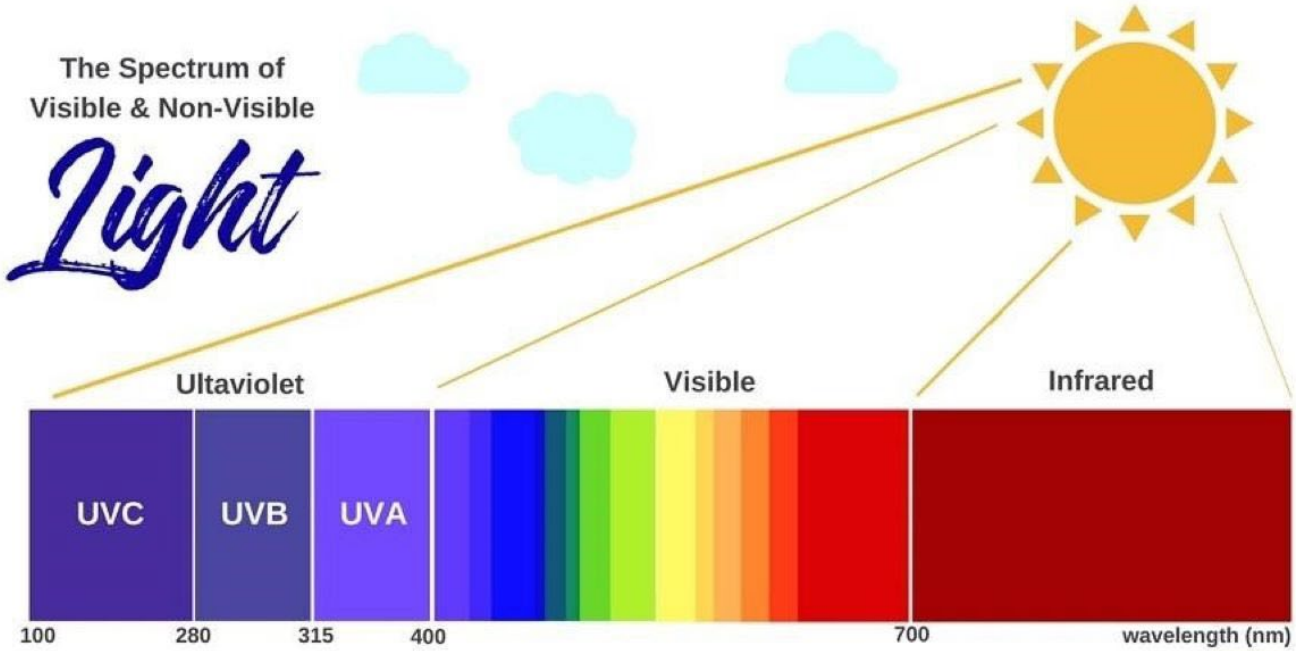
METIS-Cryostat

Why do we need a cryostat?

Mid Infrared ELT Imager and Spectrograph

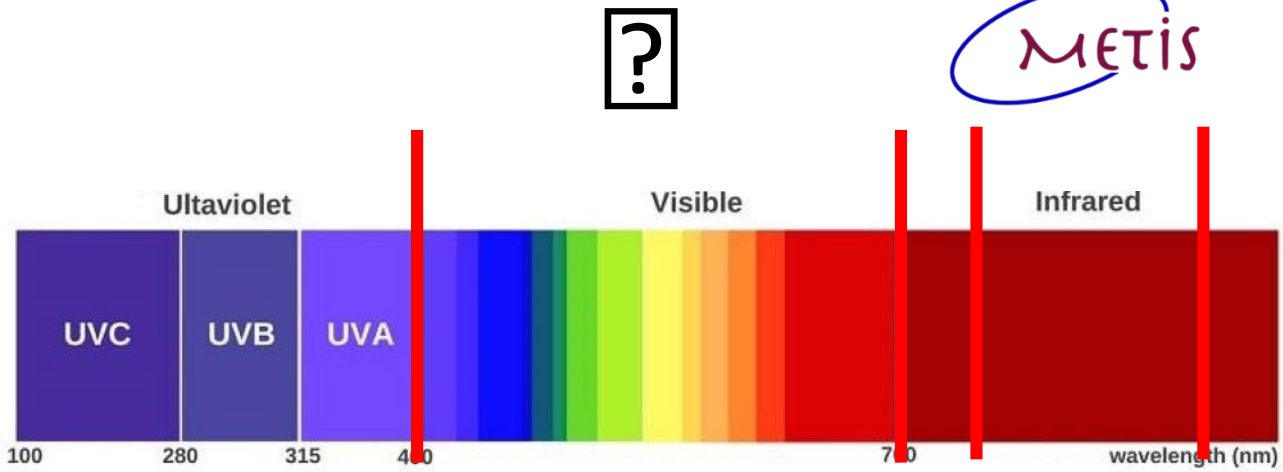
METIS-Cryostat

- Why do we need a cryostat?



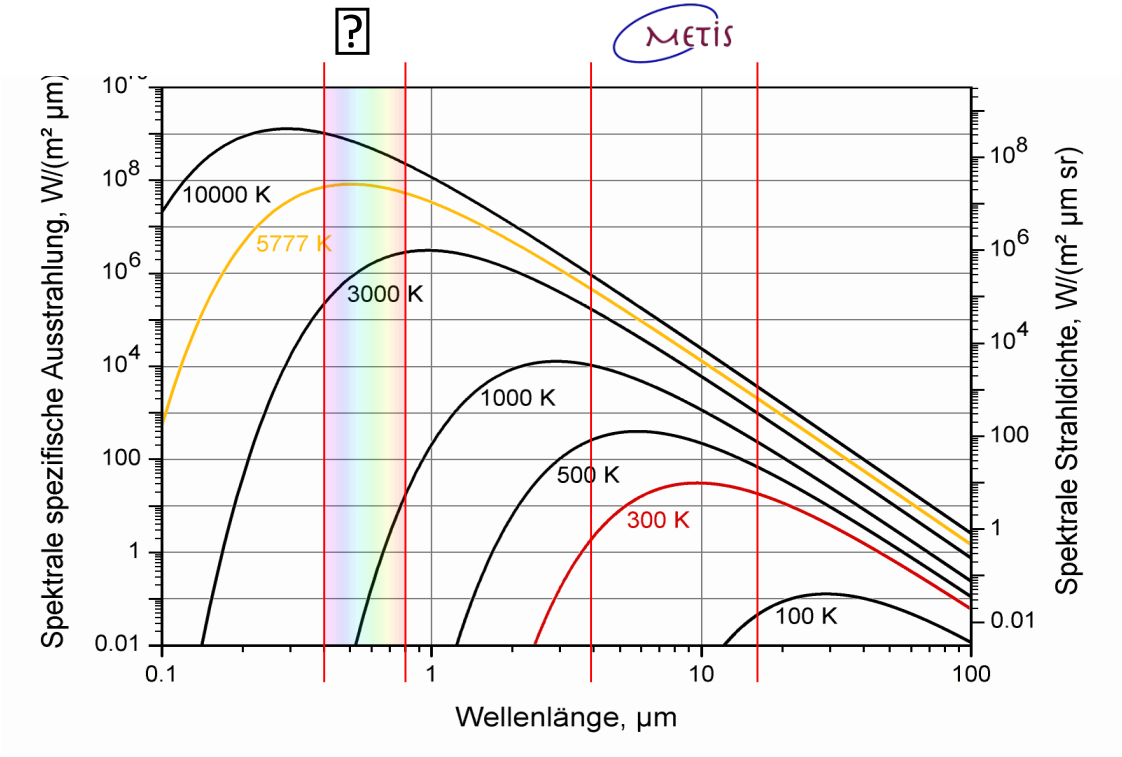
METIS-Cryostat

- *Why do we need a cryostat?*



METIS-Cryostat

- Why do we need a cryostat?



METIS-Cryostat

- *Why do we need a cryostat?*
  - To see IR light the instrument has to be cold to reduce it‘s own IR radiation
  - The longer the wavelength the colder the cryostat needs to be
  - The more sensitive the instrument is the colder the cryostat needs to be
  - IR detectors can not see objects with a lower temperature than their own

METIS-Cryostat

Which light does METIS want to see?

Mid Infrared ELT Imager and Spectrograph

METIS-Cryostat

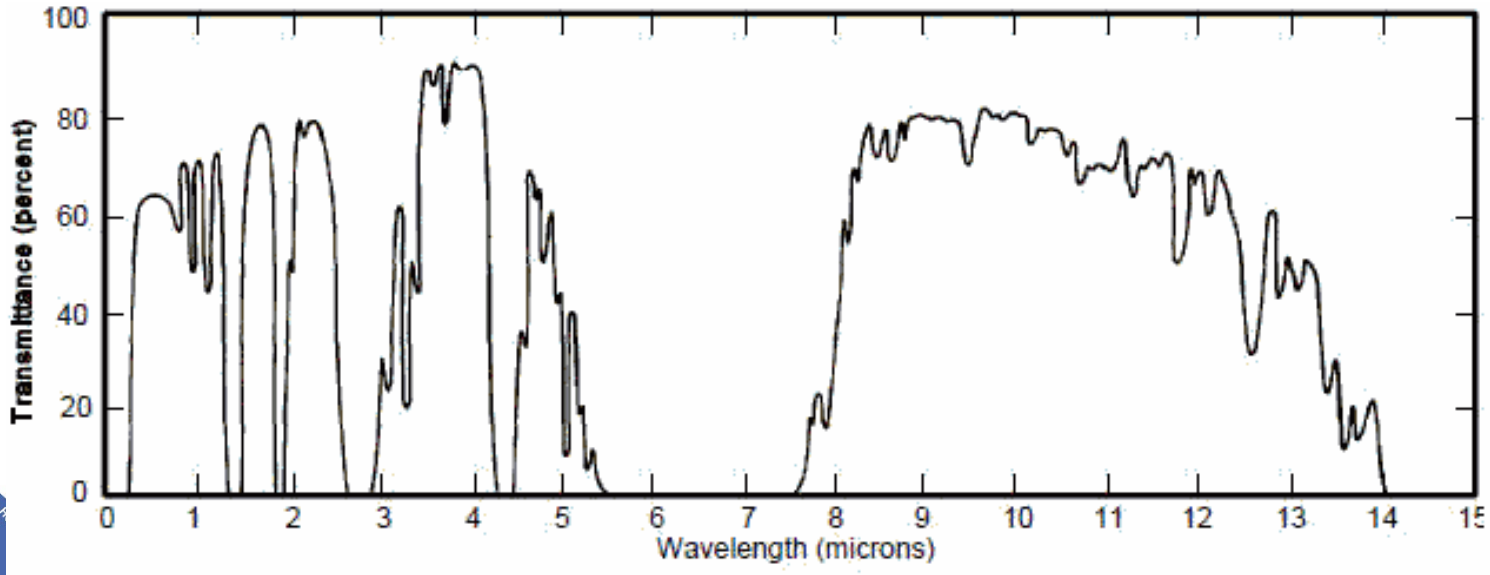
- Which wavelength does METIS want to see?

  - Wavelength range LM band (2,9 – 5,5 µm) with HAWAII 2 RG detector
  - Wavelength range N band (7,5 – 13,5 µm) with Geosnap detector

METIS-Cryostat

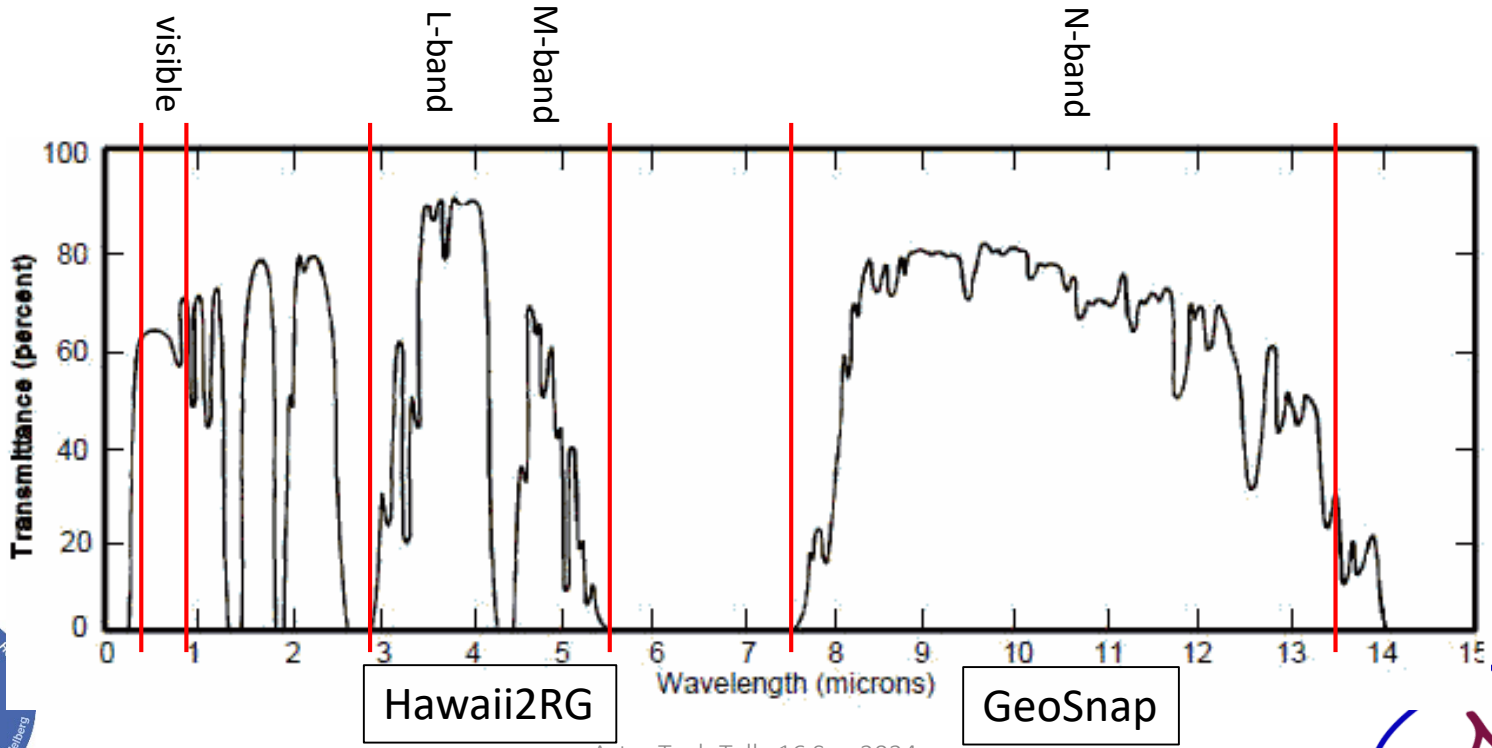
- Which wavelength does METIS want to see?

Atmospheric transmission



METIS-Cryostat

- Which wavelength does METIS want to see?



Mid Infrared ELT Imager and Spectrograph

METIS-Cryostat

Which temperature does METIS need?

Mid Infrared ELT Imager and Spectrograph

METIS-Cryostat

Components of the cold optics

CFO
Common fore optics, NOVA, Netherlands

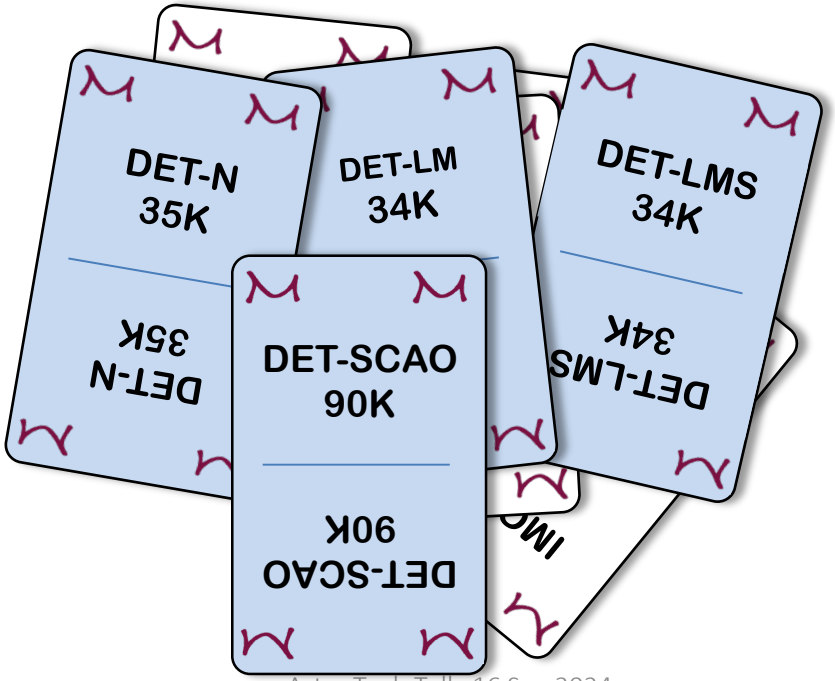
LMS
LM band spectrograph, UK-ATC, Scotland
4 Hawaii2RG detectors

SCAO
Single conjugated adaptive optics, MPIA, Germany
1 Saphira detector

IMG
LM band and N band imager, MPIA, Germany
1 Hawaii2RG detector (LM band)
1 GeoSnap detector (N band)

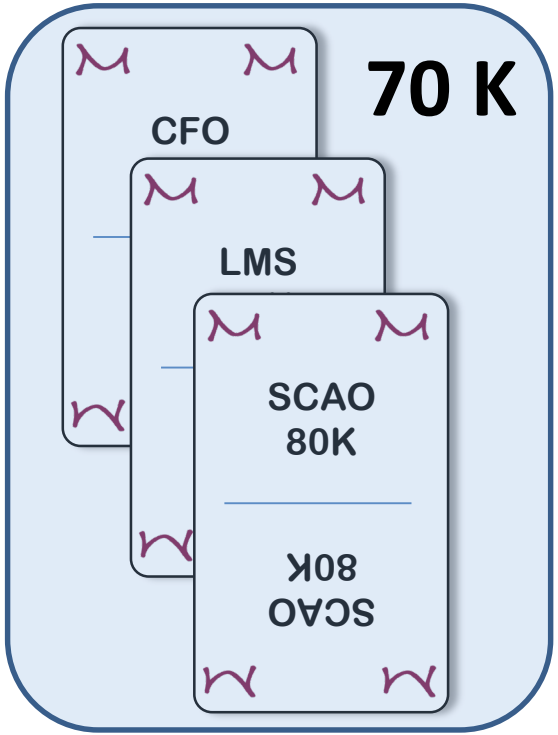
METIS-Cryostat

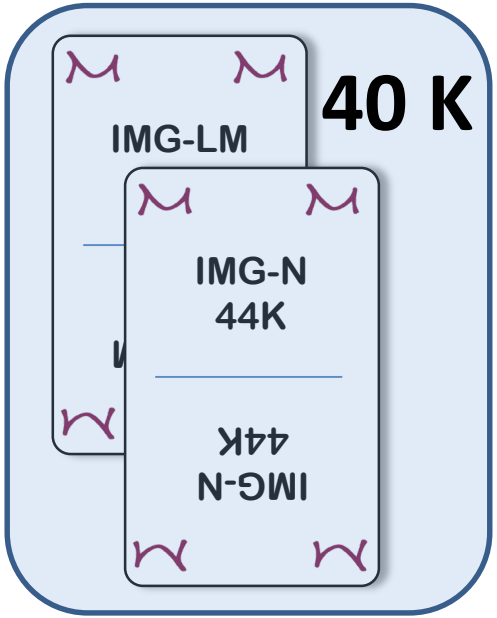
- Which temperature does METIS need?



METIS-Cryostat

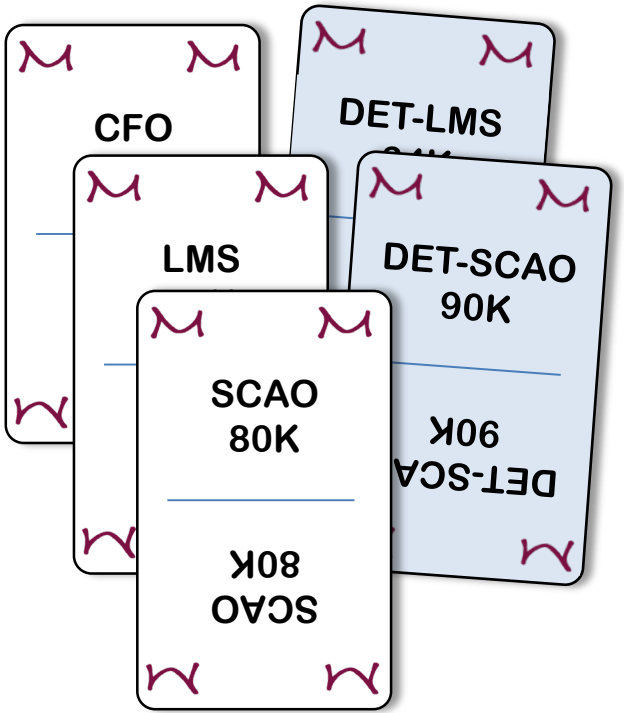
- Cleaning up the temperature regions

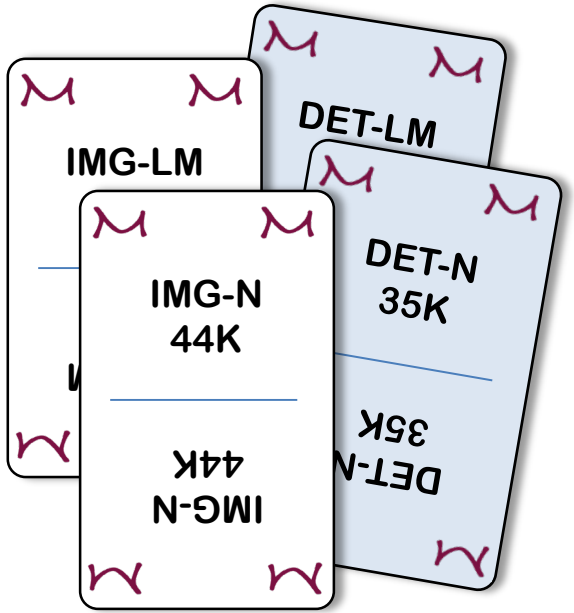




METIS-Cryostat

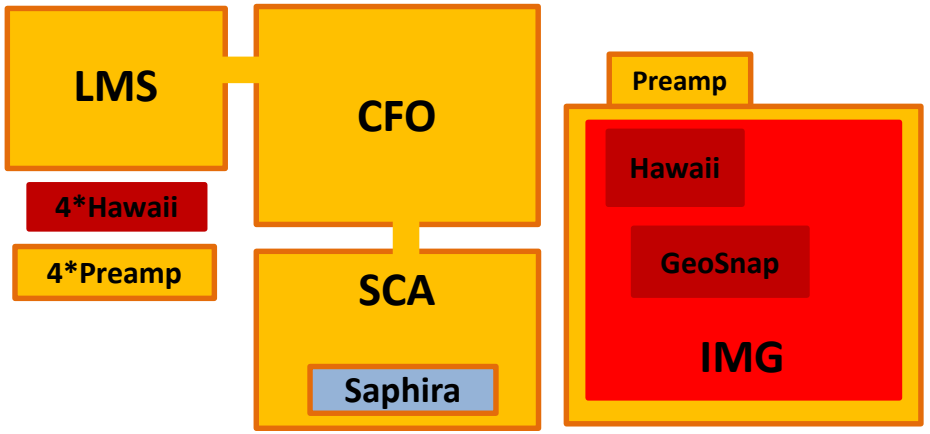
- Cleaning up the temperature regions





METIS-Cryostat

- Simplified thermal set up



70K
40K
35-40K
90-110K

METIS-Cryostat

How do we cool to this low temperature?

METIS-Cryostat

- How to cool to this low temperature?

Liquid Nitrogen

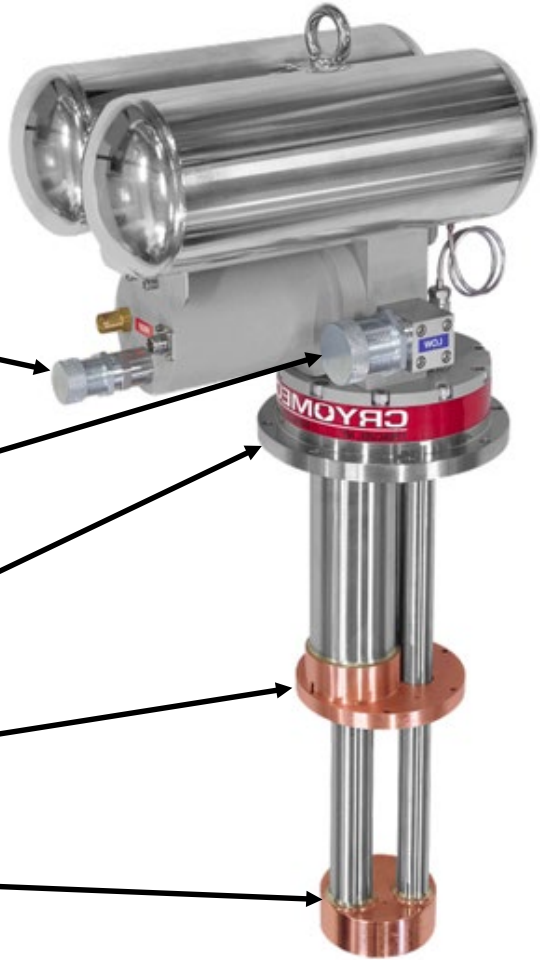
Not cold enough

77 K boiling temperature

METIS-Cryostat

- How to cool to this low temperature?

CRYOMECH PT810

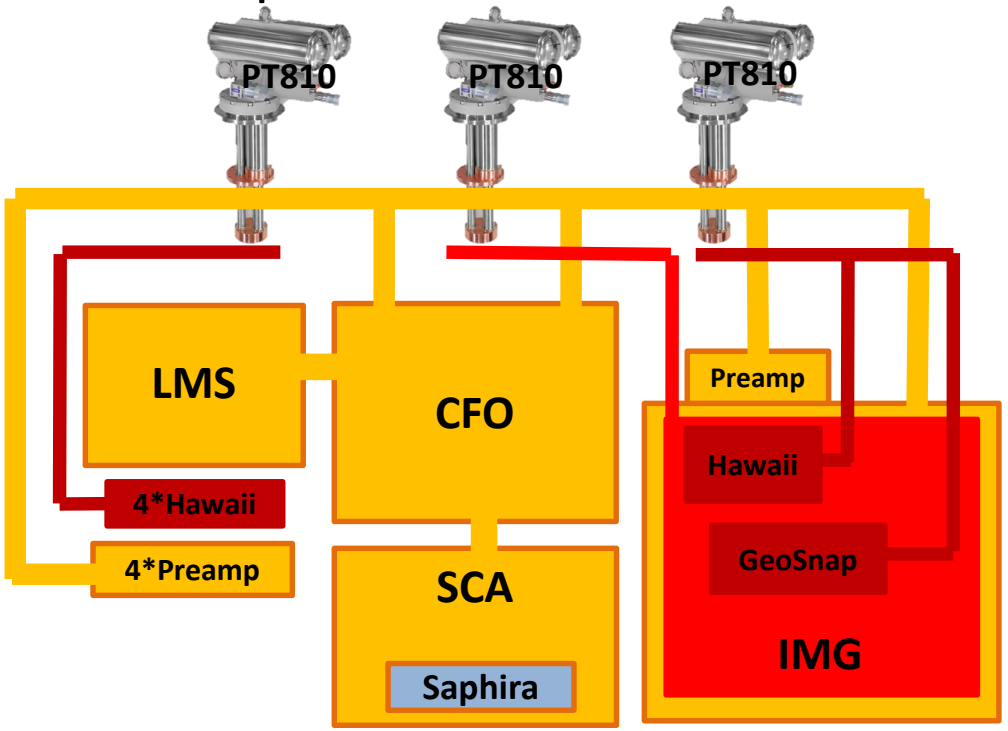


METIS-Cryostat

- Cooler CRYOMECH PT810
  - ESO standard cooler
    - Performance known and tested at ESO
    - Spare parts available
    - Service can be done at the telescope
  - Low vibration
    - Pulse tube coolers have only small moving parts inside
    - Vibration damping of cooler and lines tested at ESO

METIS-Cryostat

- Simplified thermal set up



70K
40K
35-40K
90-110K

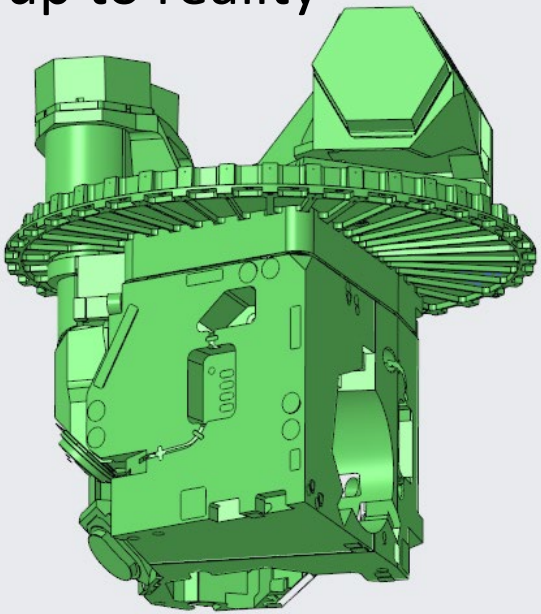
METIS-Cryostat

- From schematic set up to reality

70K
40K
35-40K
90-110K

METIS-Cryostat

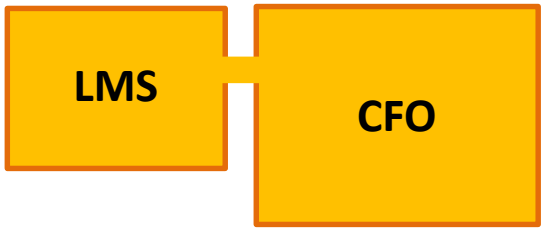
- From schematic set up to reality



CFO

METIS-Cryostat

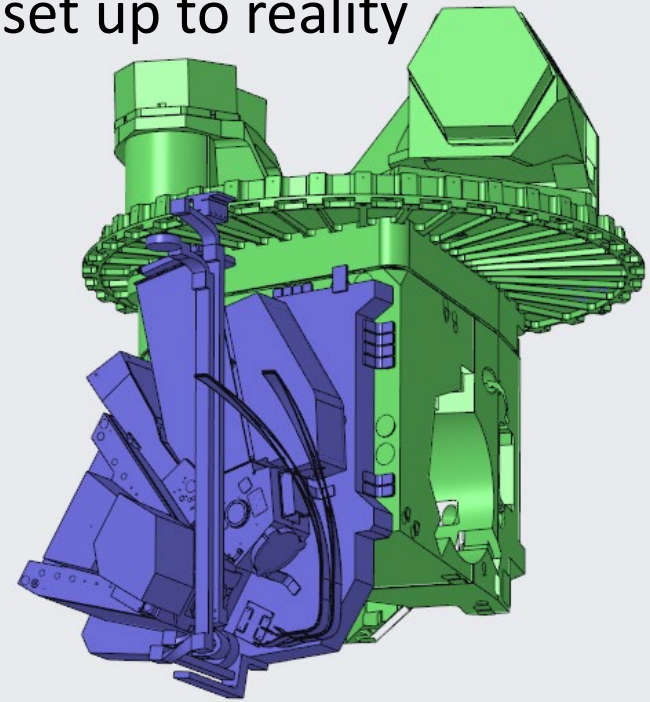
- From schematic set up to reality



70K
40K
35-40K
90-110K

METIS-Cr

- From schematic set up to reality



CFO

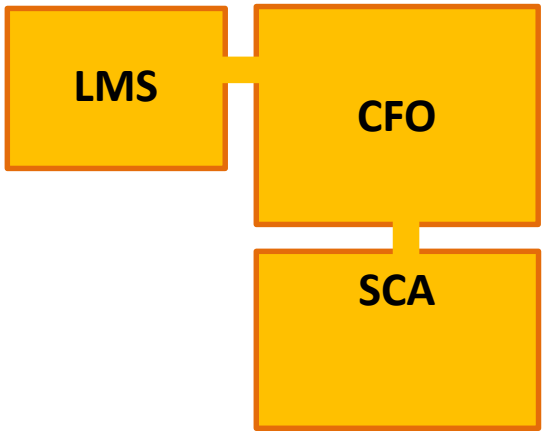
LMS

Mid Infrared ELT Imager and Spectrograph

METIS

METIS-Cryostat

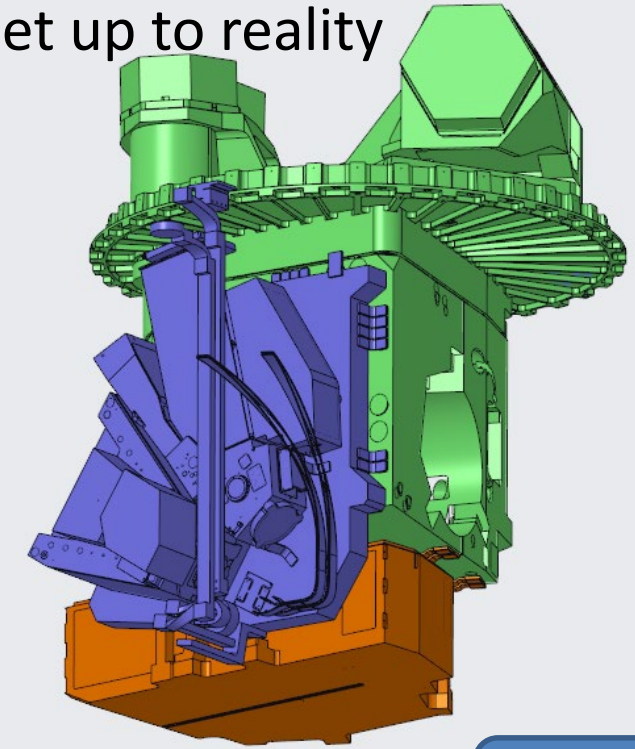
- From schematic set up to reality



70K
40K
35-40K
90-110K

METIS-Cryostat

- From schematic set up to reality



CFO

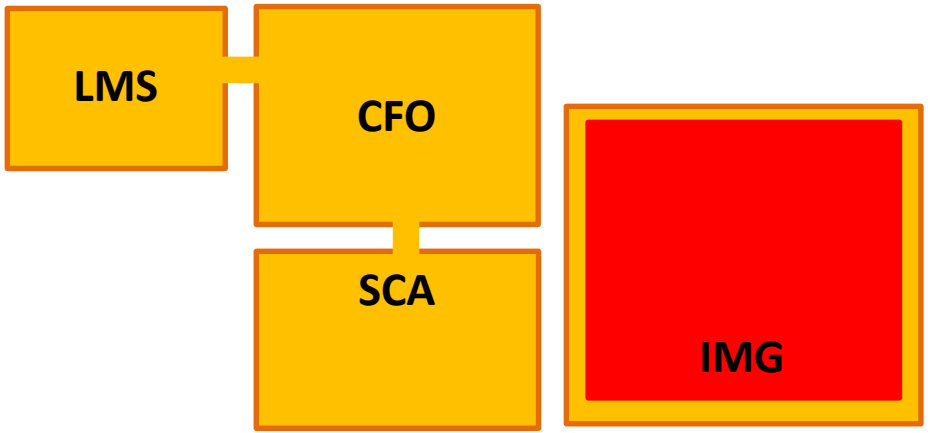
LMS

SCA

Mid Infrared ELT Imager and Spectrograph

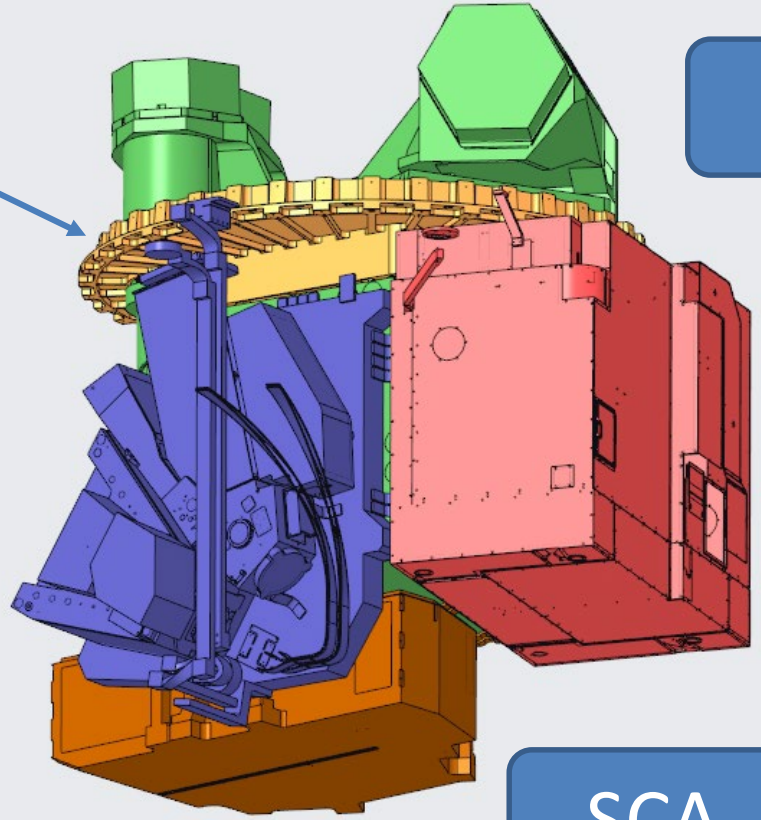
METIS-Cryostat

- From schematic set up to reality



70K
40K
35-40K
90-110K

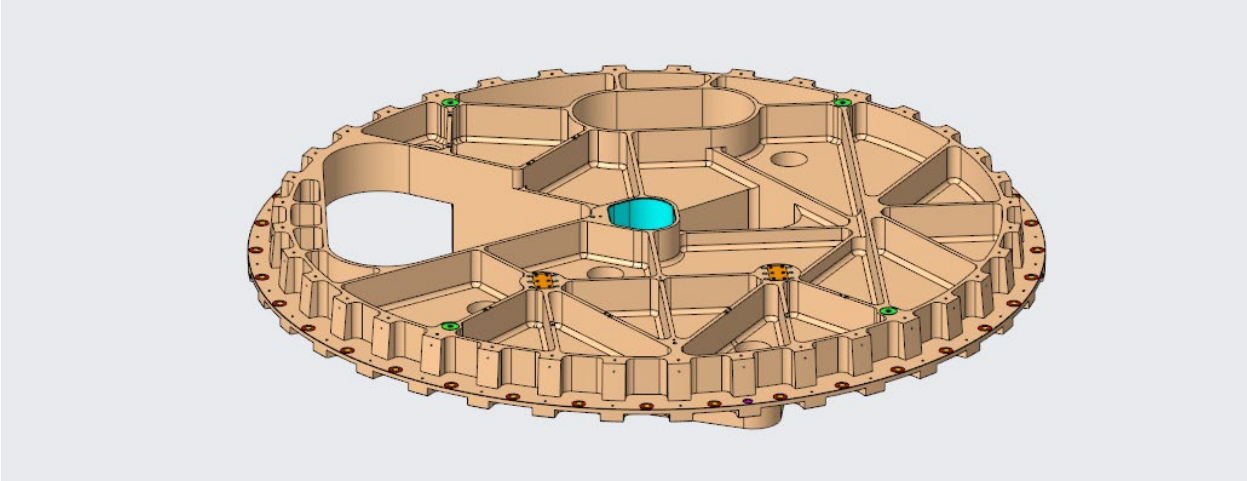
METIS-Cryostat



Mid Infrared ELT Imager and Spectrograph

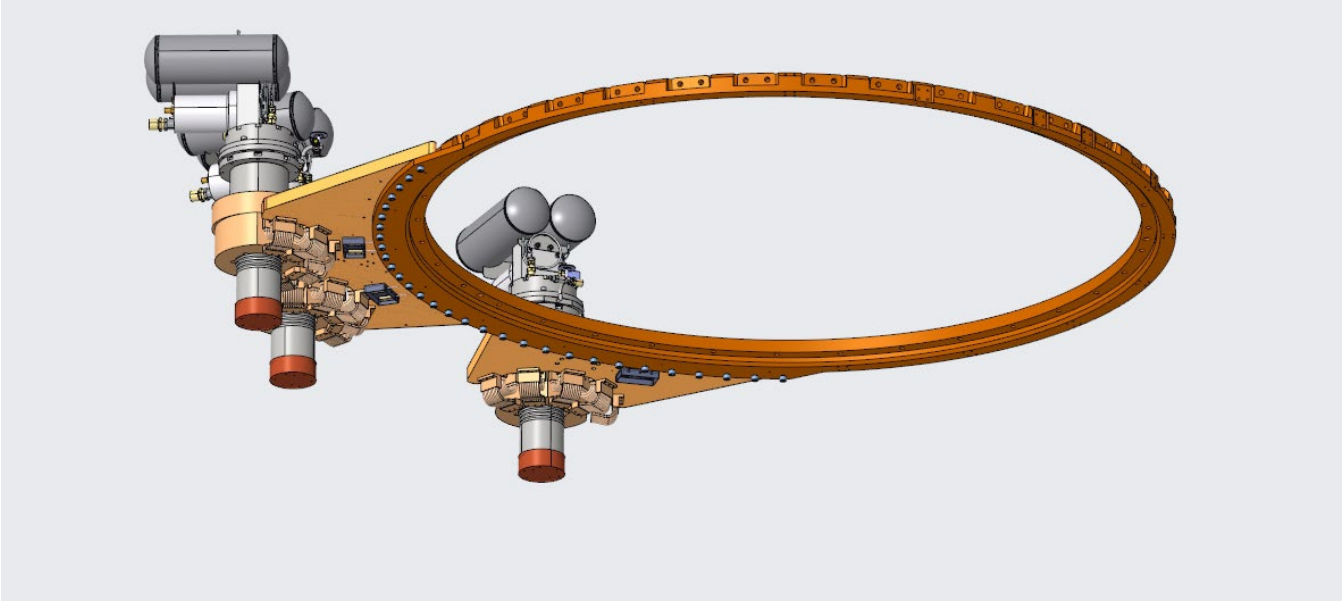
METIS-Cryostat

Interface flange on the CFO

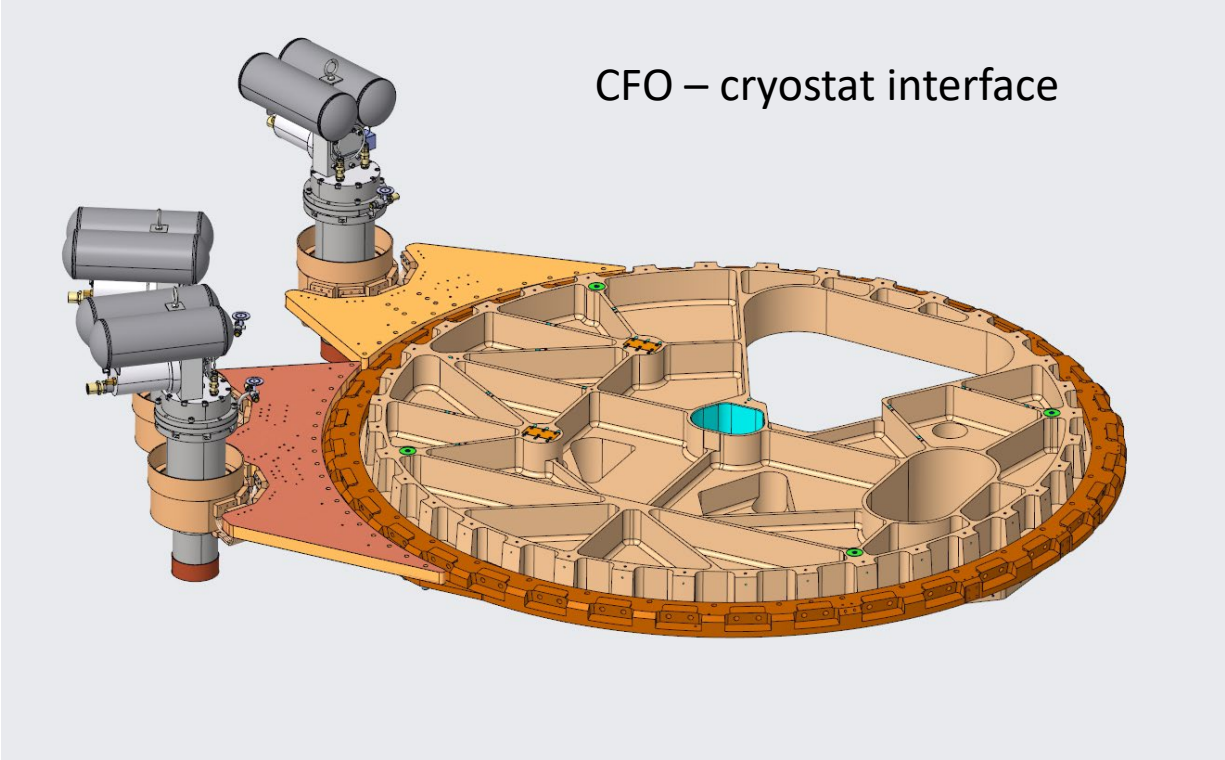


METIS-Cryostat

Interface flange on the cryostat

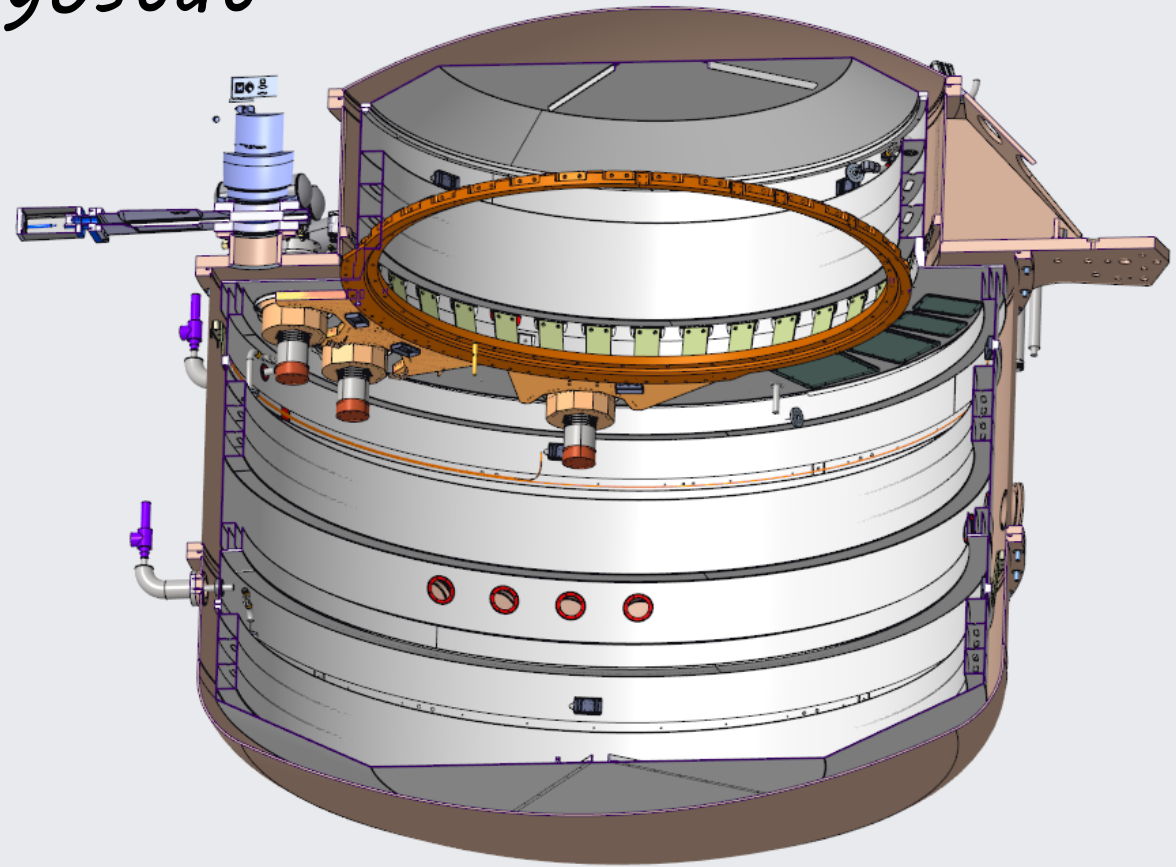


METIS-Cryostat



METIS-Cryostat

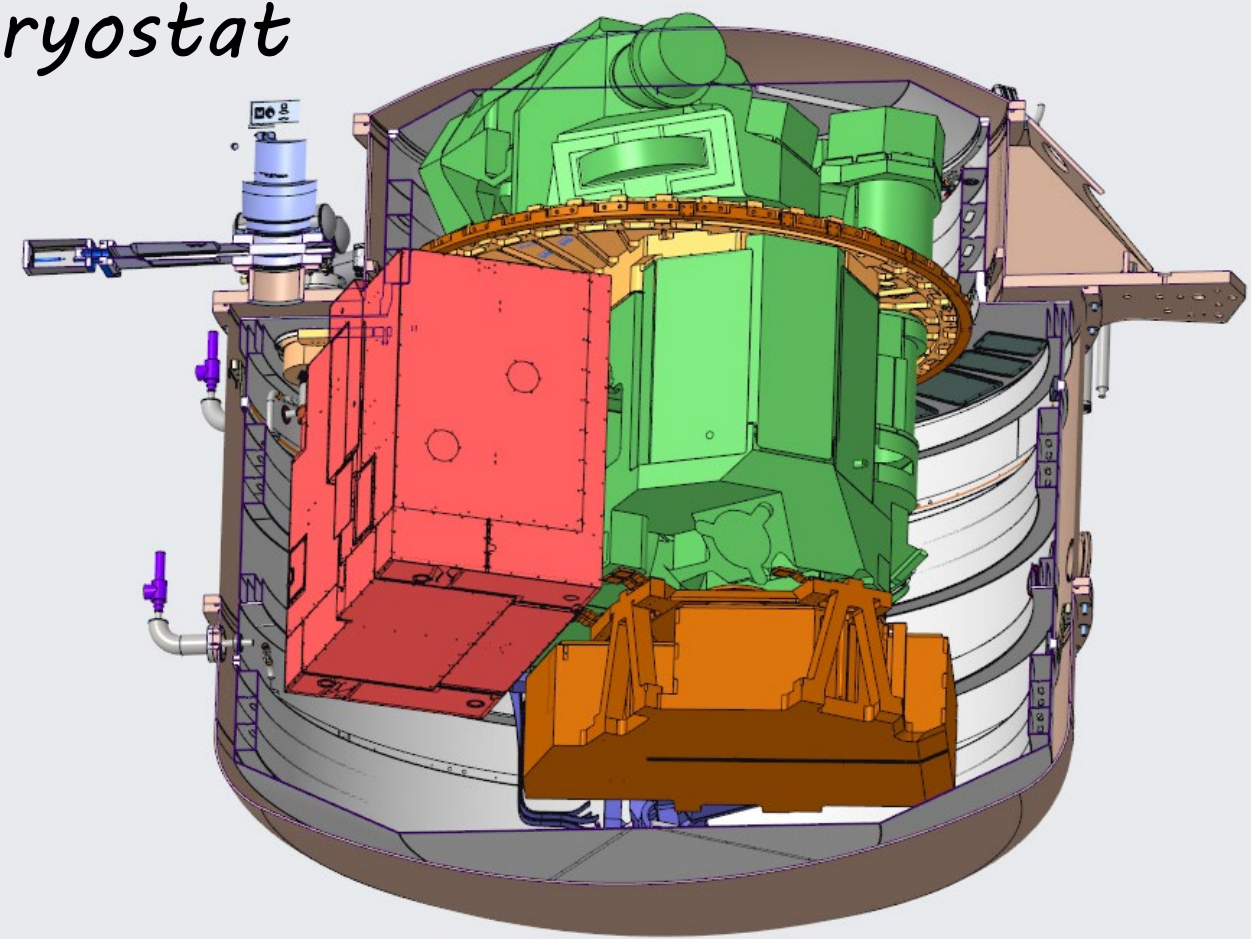
Cross section of the cryostat with interface flange



Mid Infrared ELT Imager and Spectrograph

METIS-Cryostat

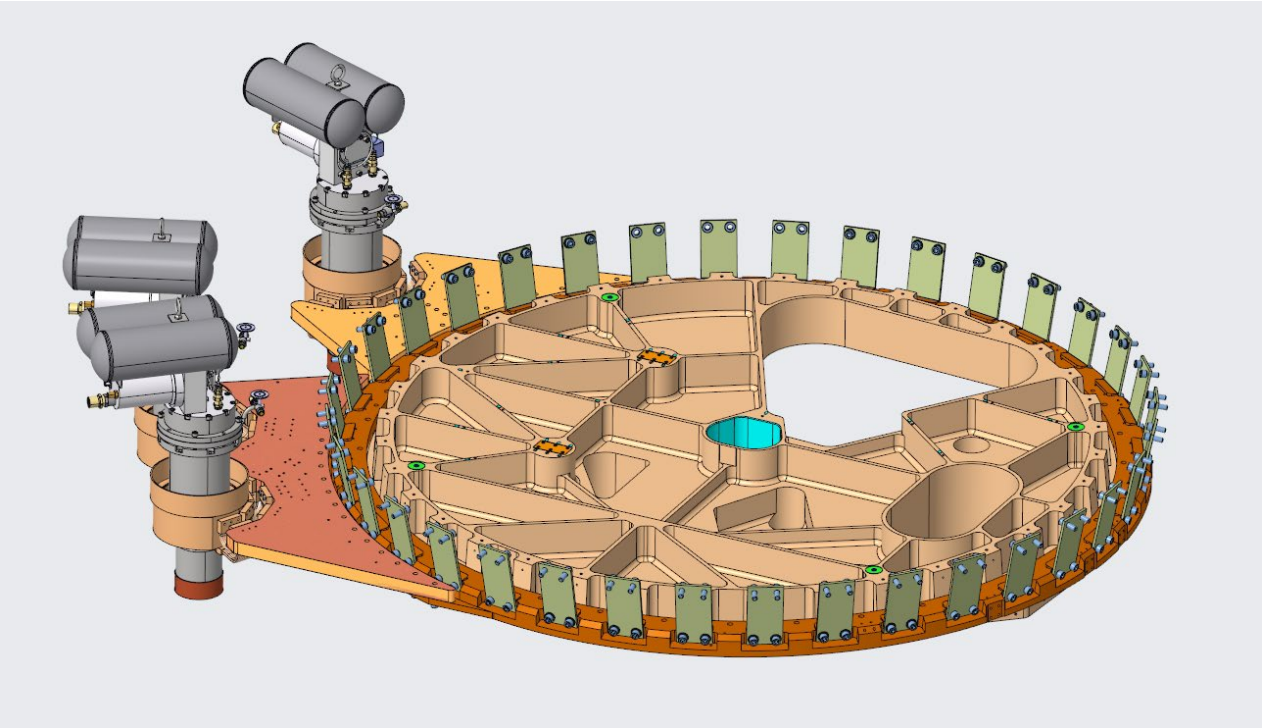
Cross section of the cryostat with cold optics



Mid Infrared ELT Imager and Spectrograph

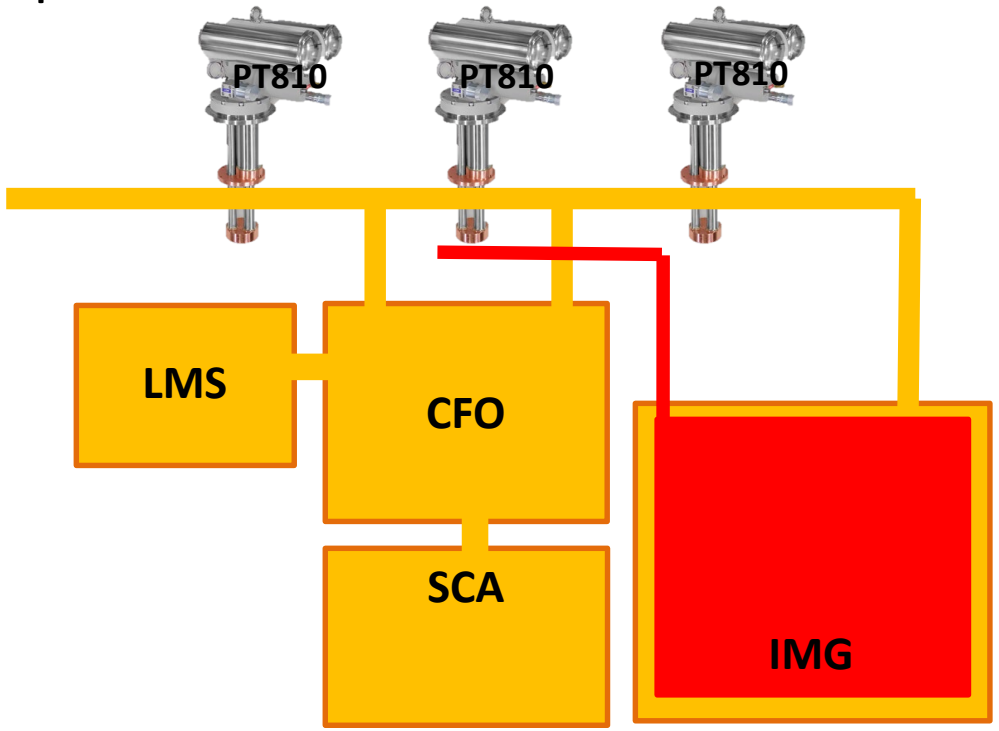
METIS-Cryostat

CFO – cryostat interface with mounting plates from glass-fibre reinforced plastic



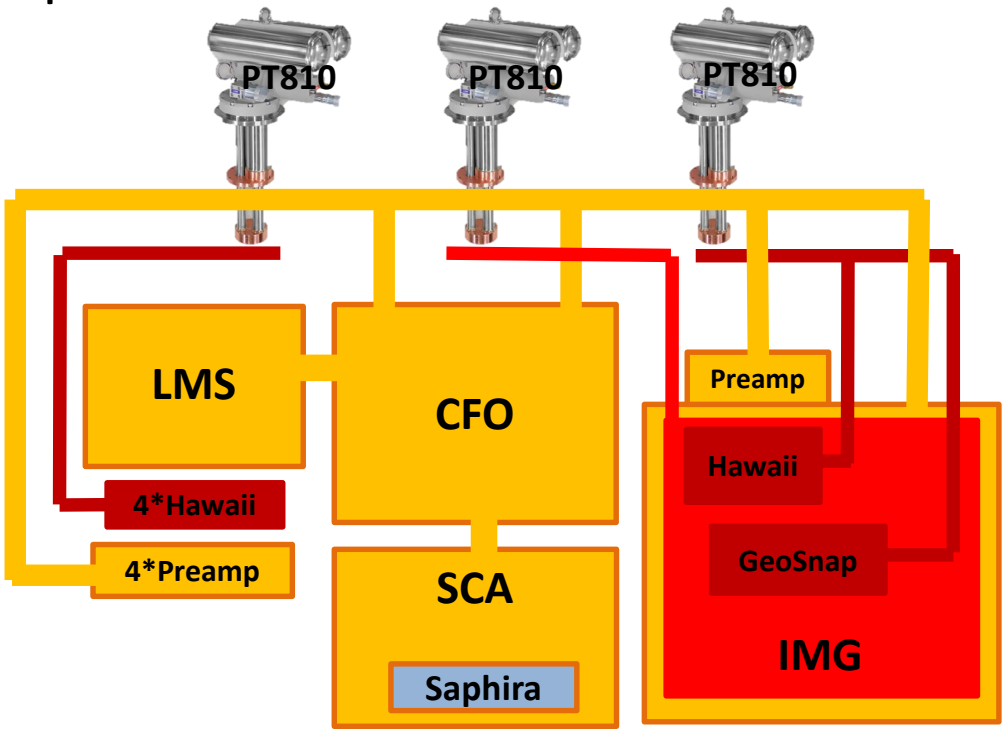
METIS-Cryostat

- Schematic set up



METIS-Cryostat

- Schematic set up



70K
40K
35-40K
90-110K

Mid Infrared ELT Imager and Spectrograph

METIS-Cryostat

How much cooling power do we need?

METIS-Cryostat

- Heat input

heat condu

>300 W

cold optics / detectors

heat radiation

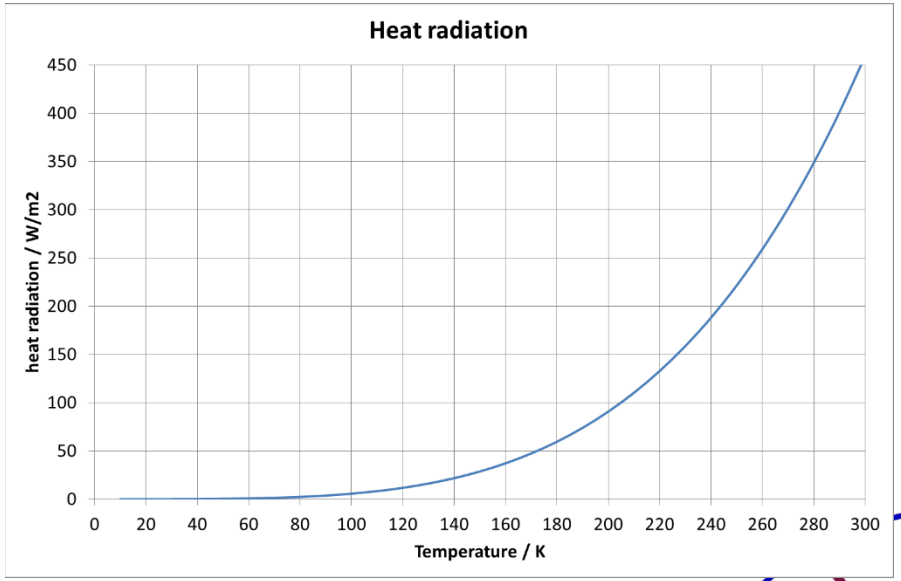
convection

power dissipation

METIS-Cryostat

- Heat radiation
  - Radiation from 290 K about 400 W/m^2
  - With 90% reflectivity still 40 W/m^2
  - Changing with T^4

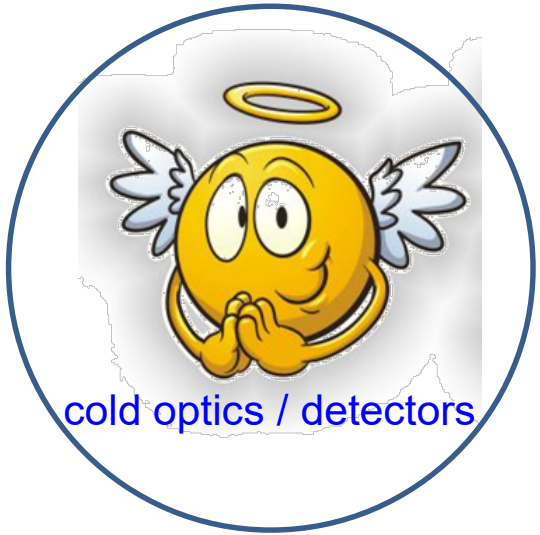
heat radiation



METIS-Cryostat

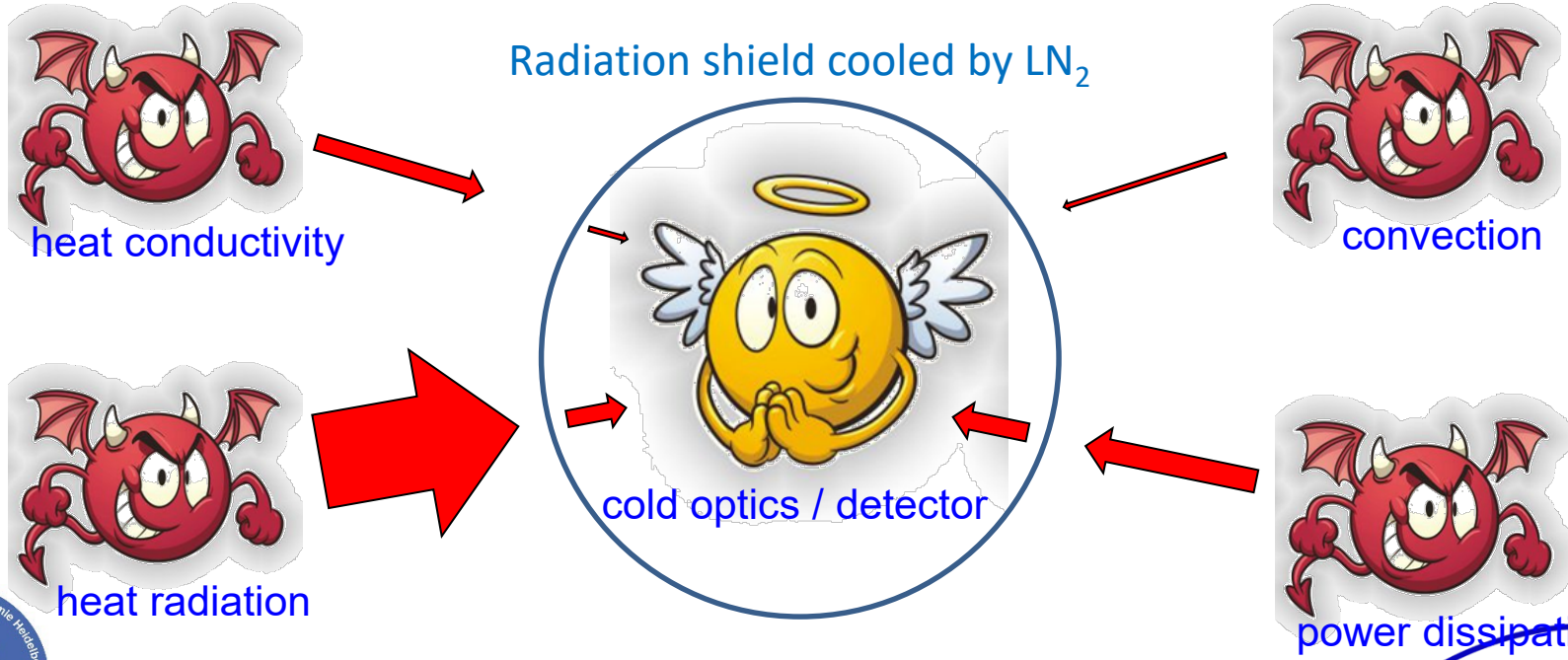
- Heat input

Radiation shield cooled by LN_2



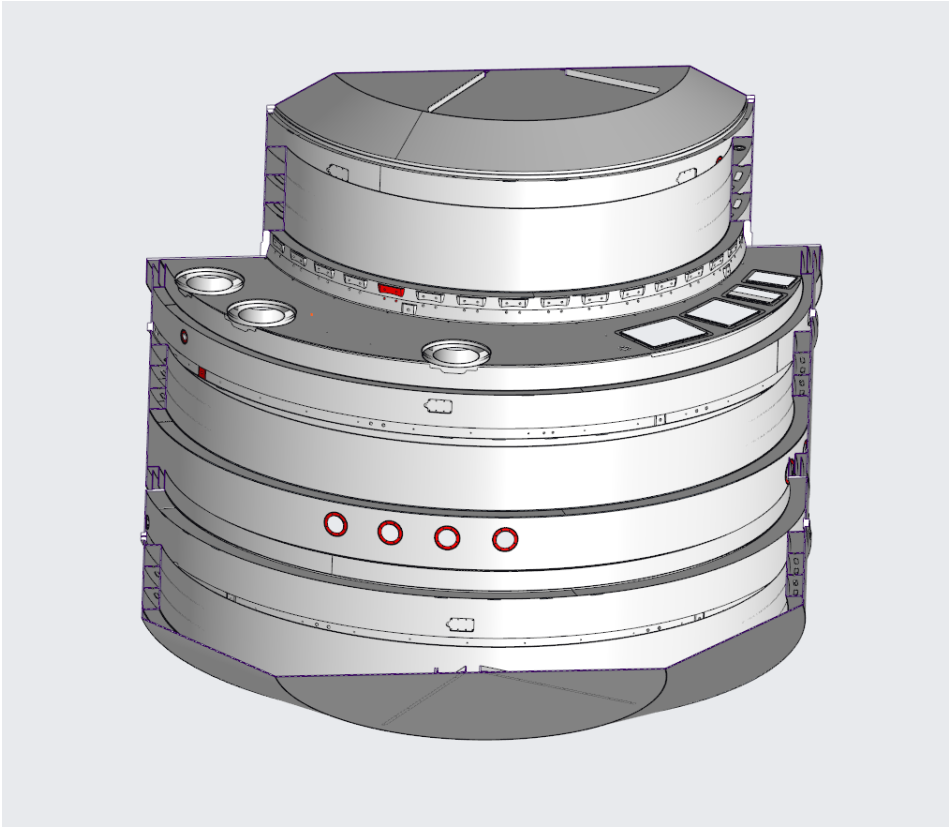
METIS-Cryostat

- Heat input



METIS-Cryostat

- LN_2 cooled radiation shield



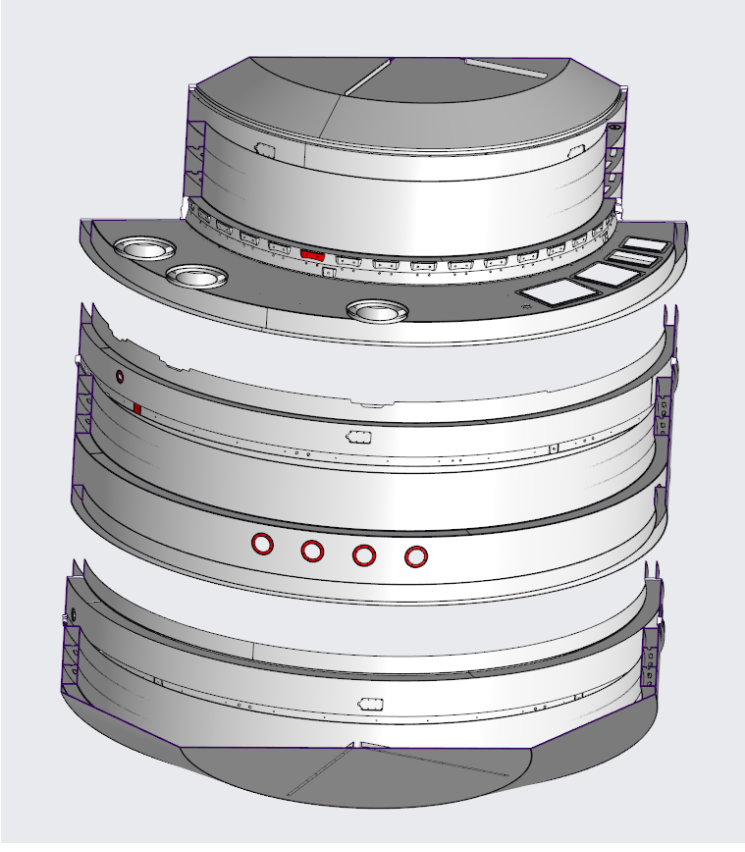
METIS-Cryostat

- LN_2 cooled radiation shield

Top segment

Middle segment

Bottom segment

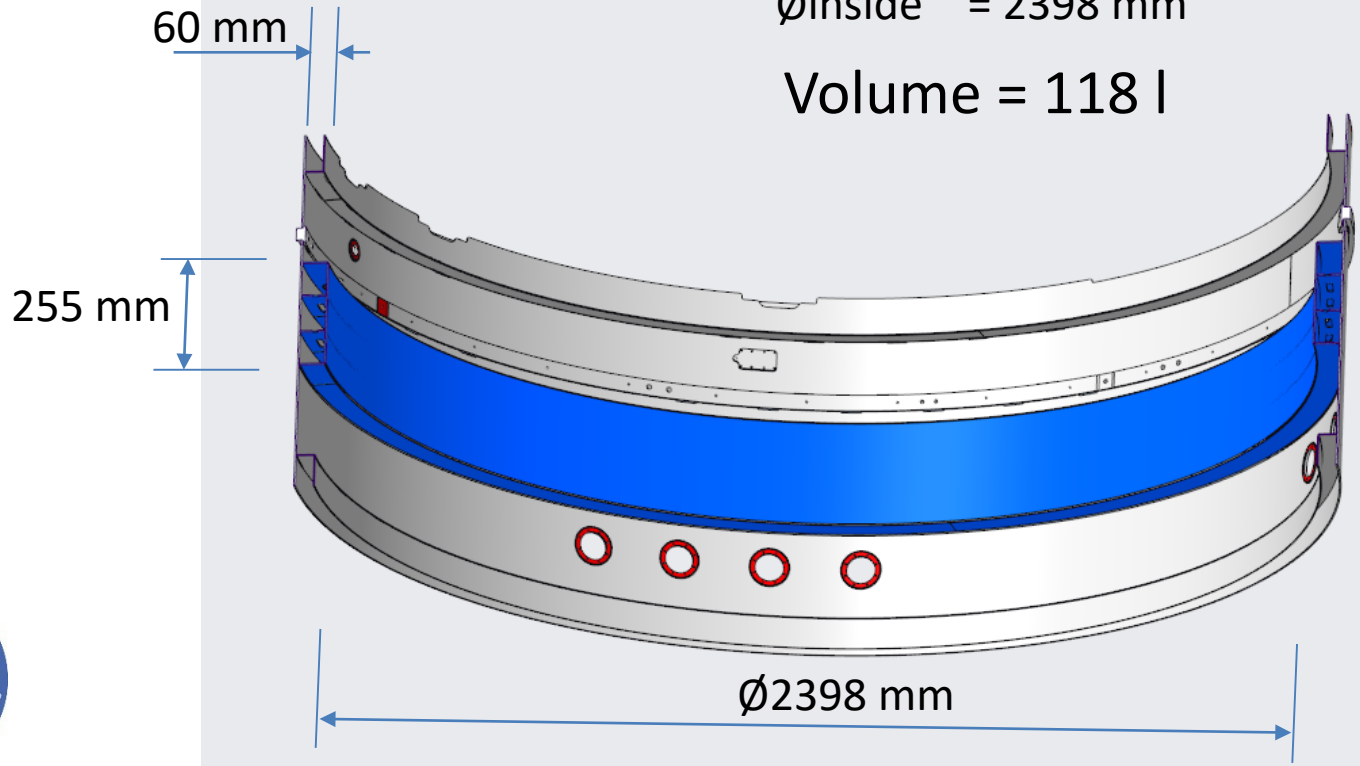


METIS - Cryostat

- LN_2 cooled radiation shield

LN2 vessel
height = 255 mm
width = 60 mm
Øinside = 2398 mm

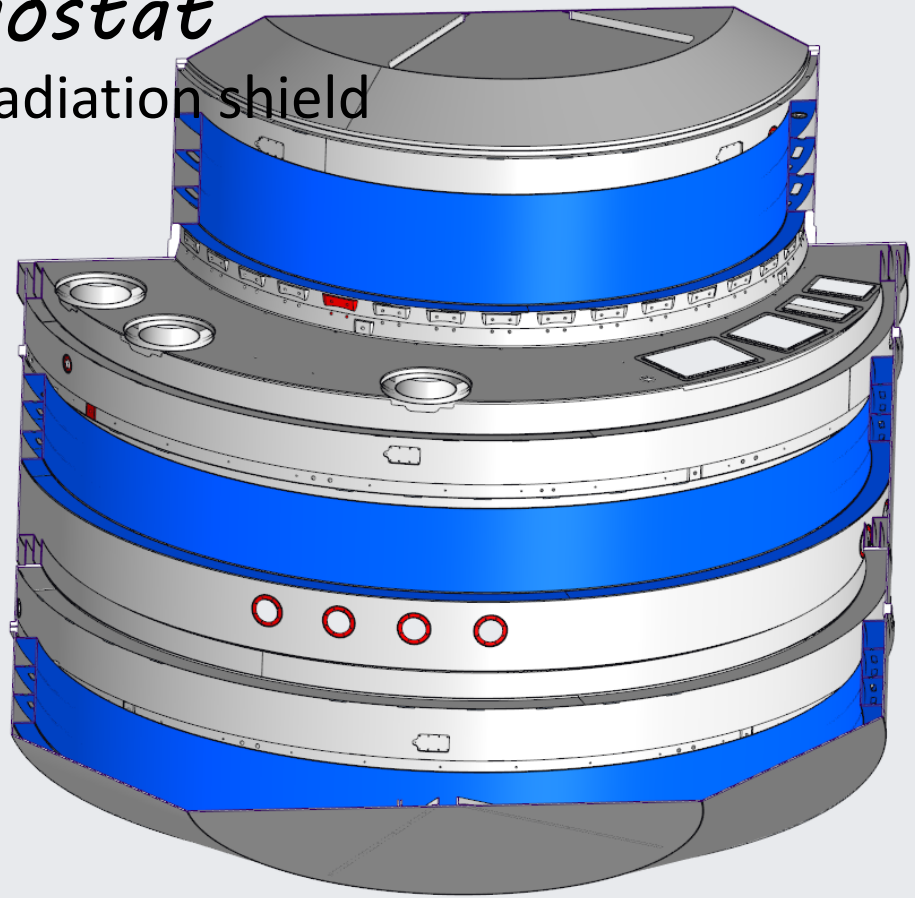
Volume = 118 l



Mid Infrared ELT Imager and Spectrograph

METIS-Cryostat

- LN_2 cooled radiation shield



136 l

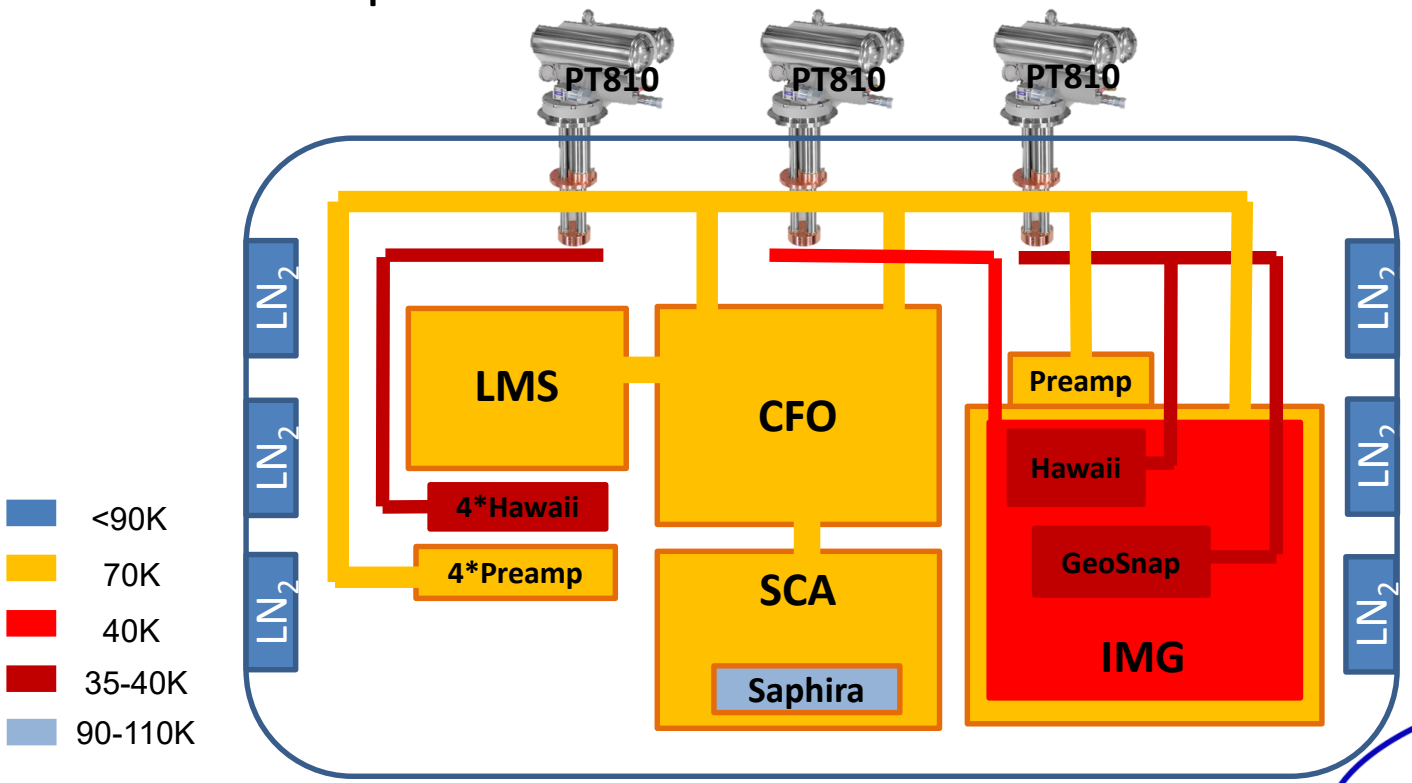
118 l

118 l

Mid Infrared ELT Imager and Spectrograph

METIS-Cryostat

- Schematic set up

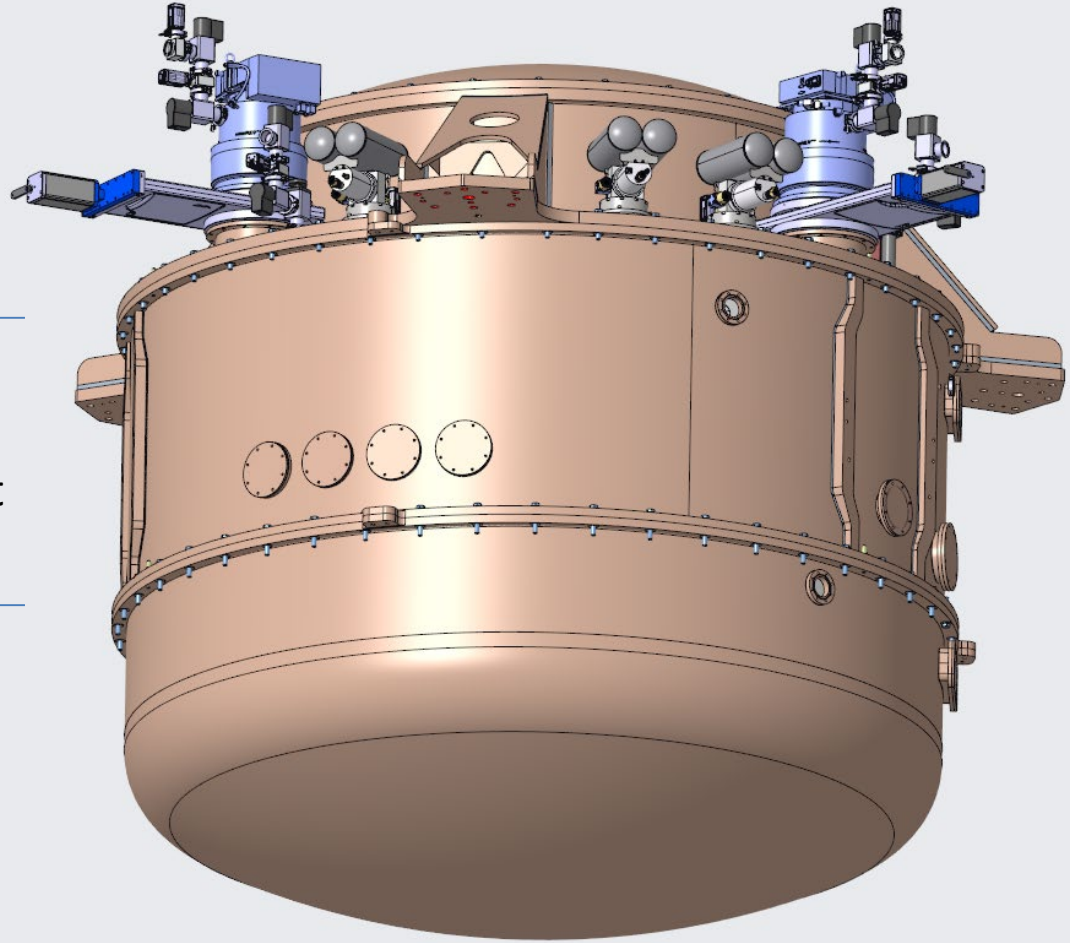


METIS-Cryostat

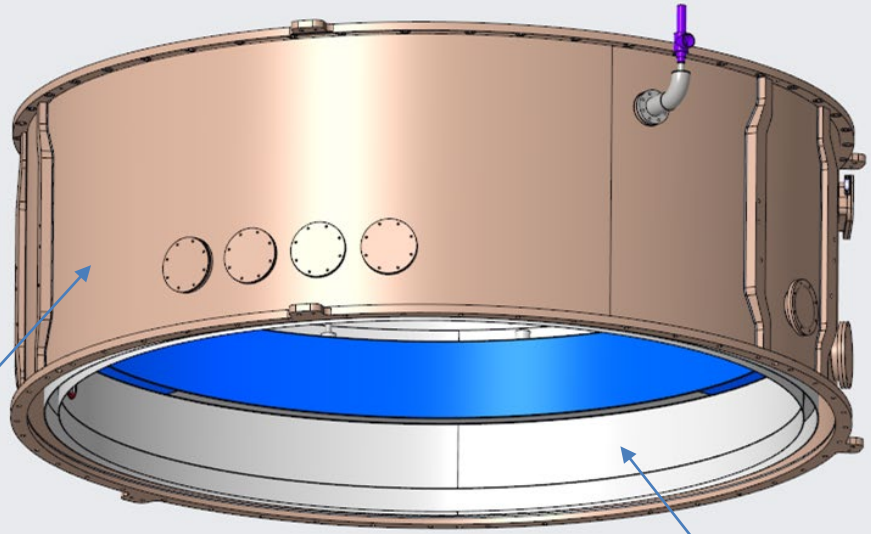
How do we mount and dismount the cryostat?

Mid Infrared ELT Imager and Spectrograph

Middle Segment



Vacuum vessel and radiation shield build one unit

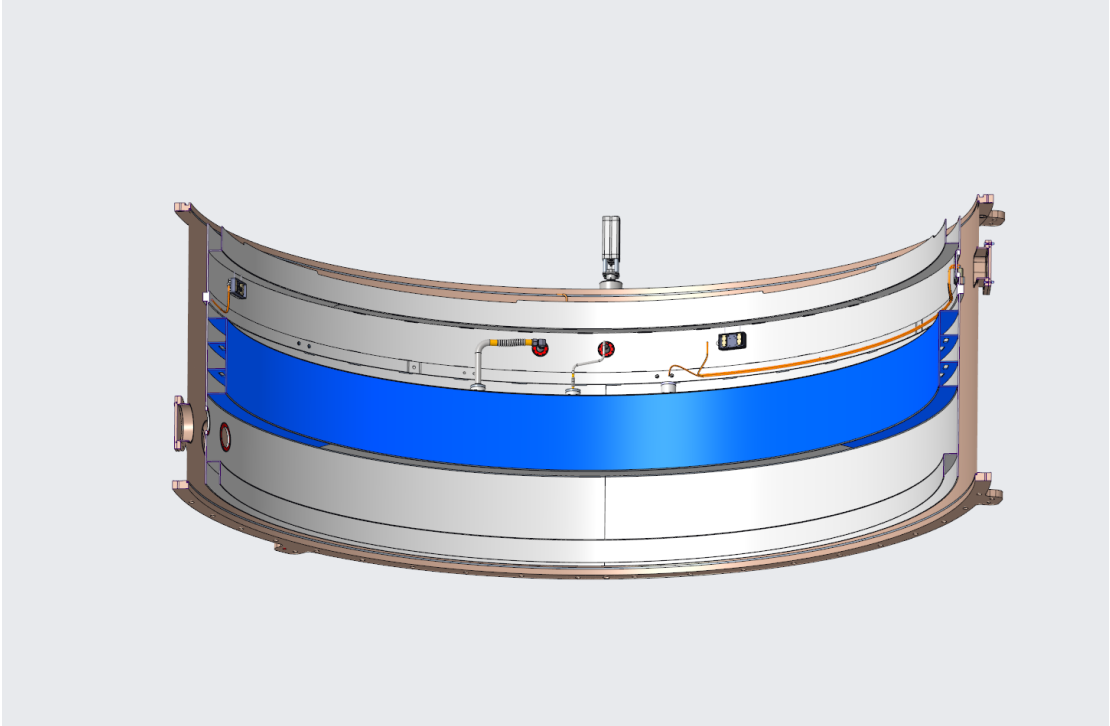


Vacuum vessel

Radiation shield

METIS-Cryostat

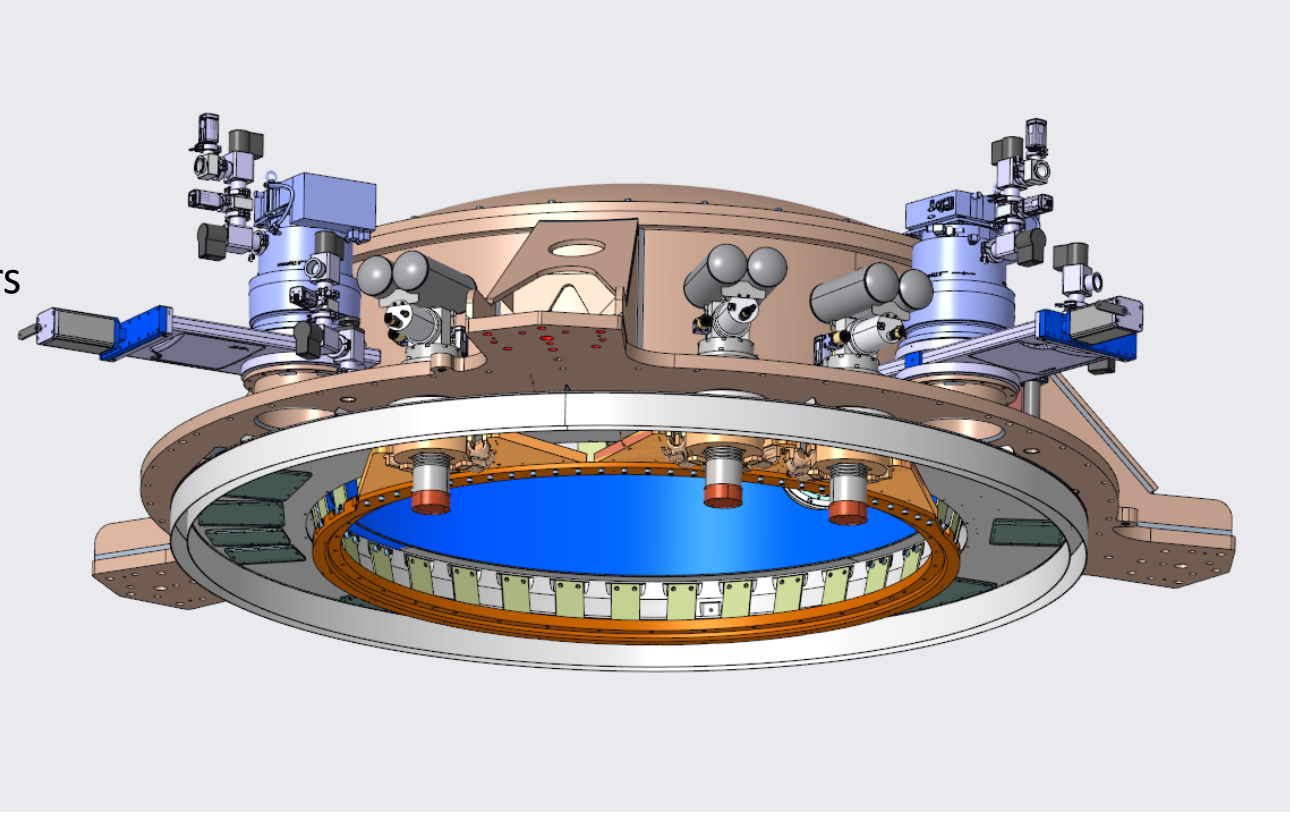
- LN2 filling
- GN2 exhaust
- LN2 level sensor
- Temperature sensor
- Warm up heater



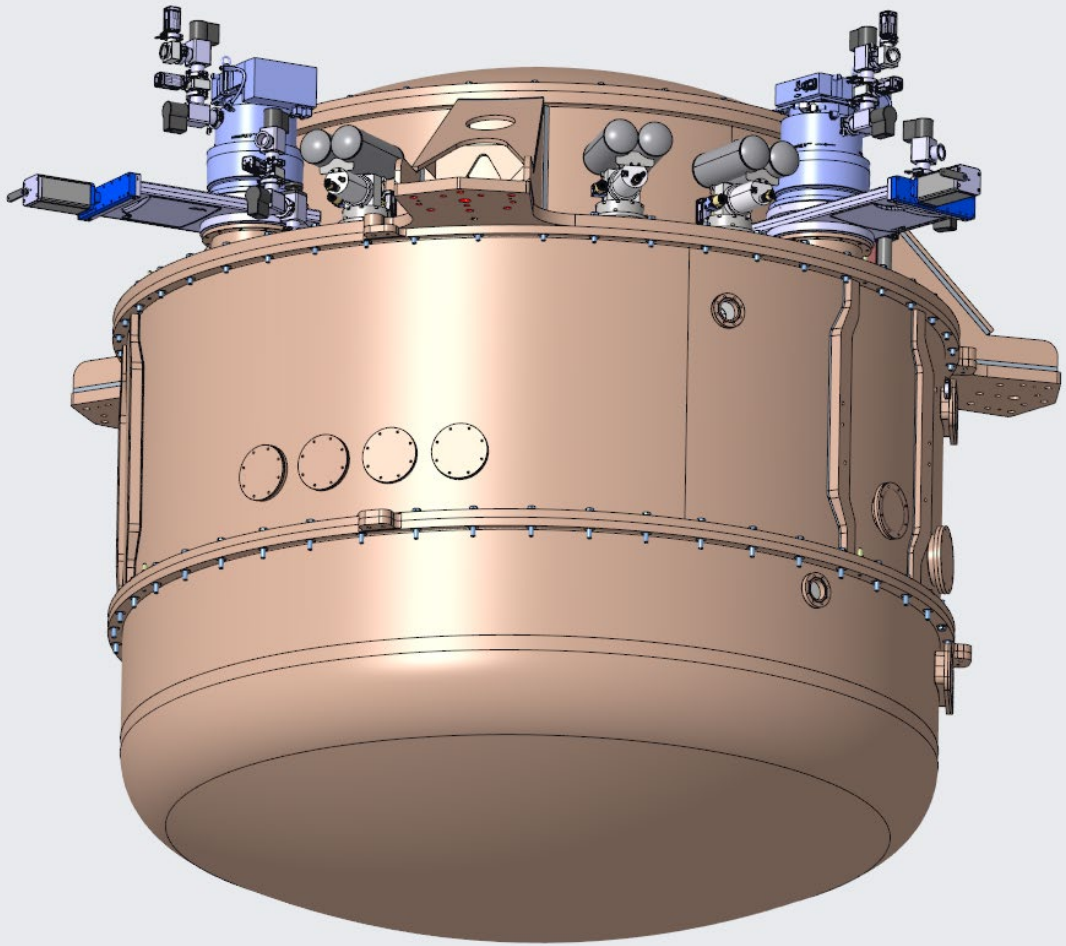
METIS-Cryostat

Top segment

- Coolers
- Vacuum pump
- Connectors for
  - Motors
  - Temperature sensors
  - Heaters
- Entrance window



METIS



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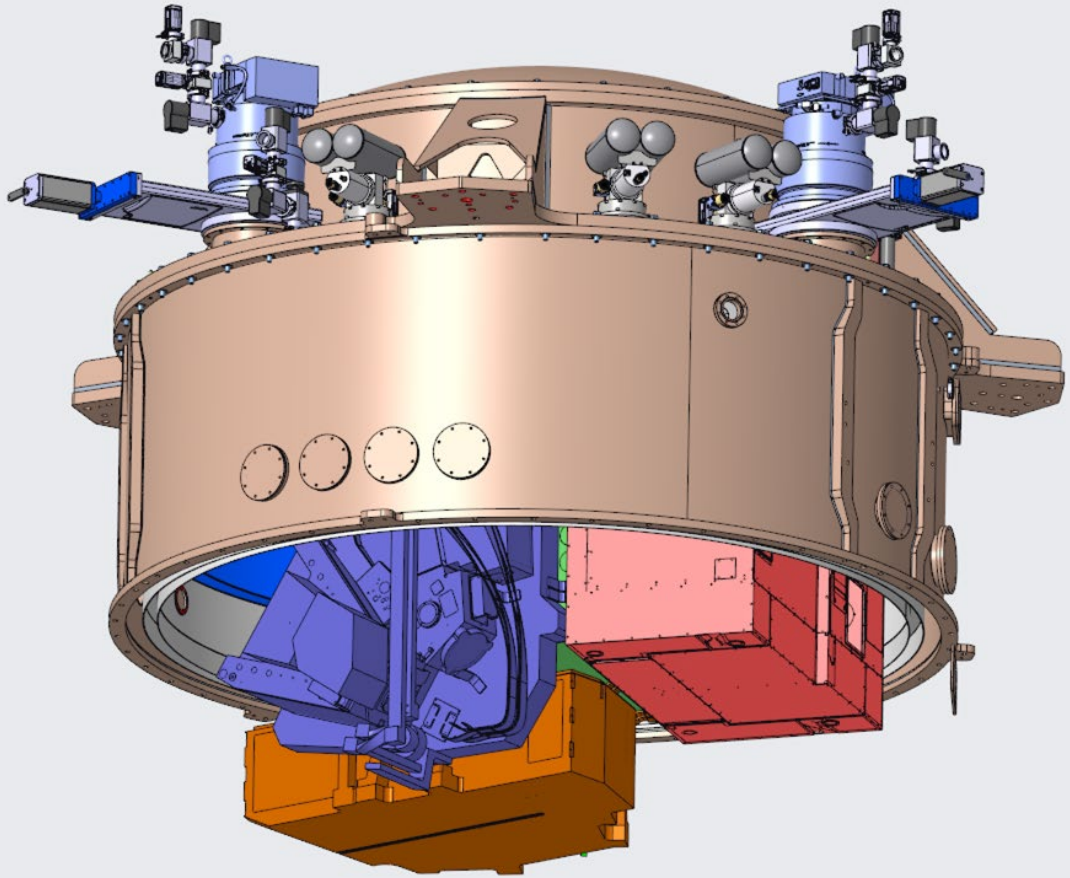
Mid Infrared ELT Imager and Spectrograph

METIS

METIS



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Mid Infrared ELT Imager and Spectrograph

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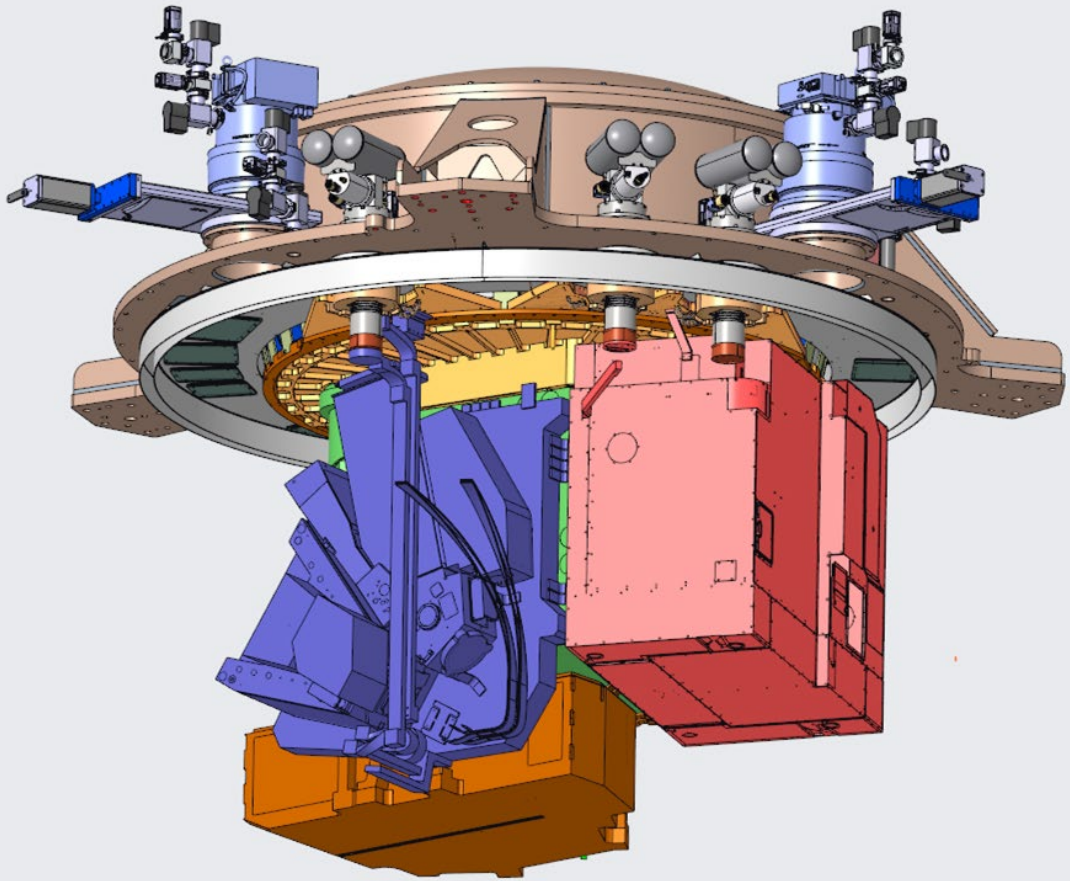

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Mid Infrared ELT Imager and Spectrograph

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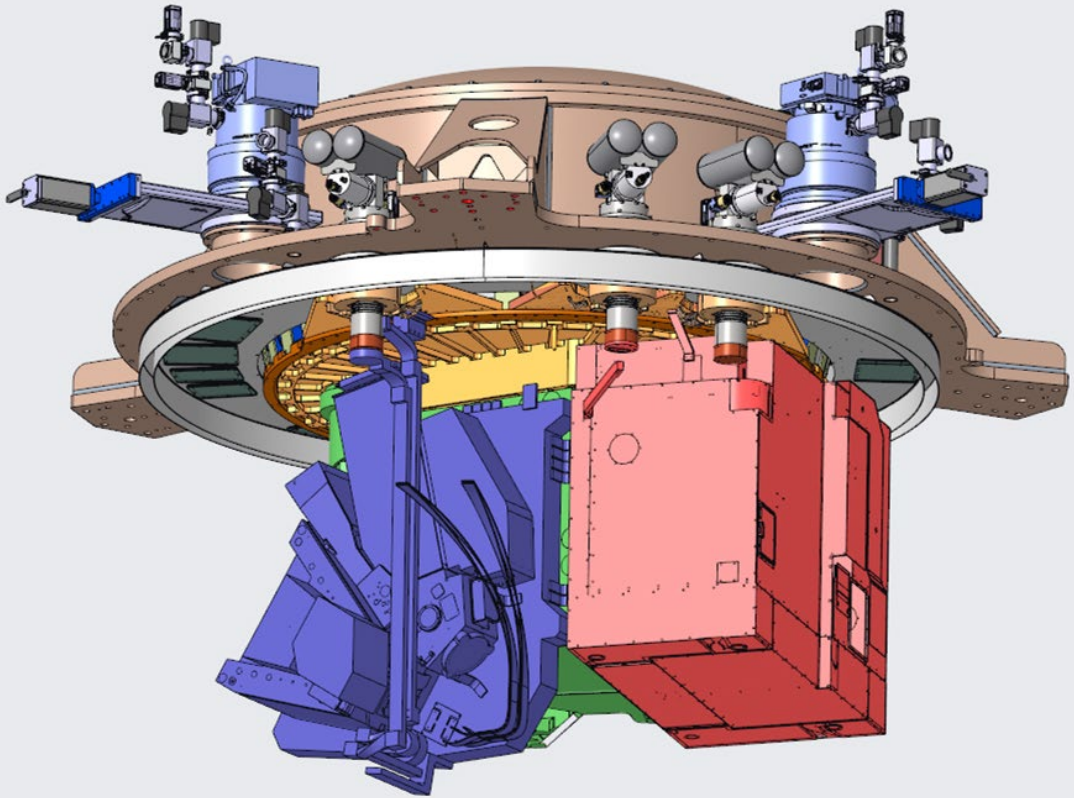
METIS



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Mid Infrared ELT Imager and Spectrograph

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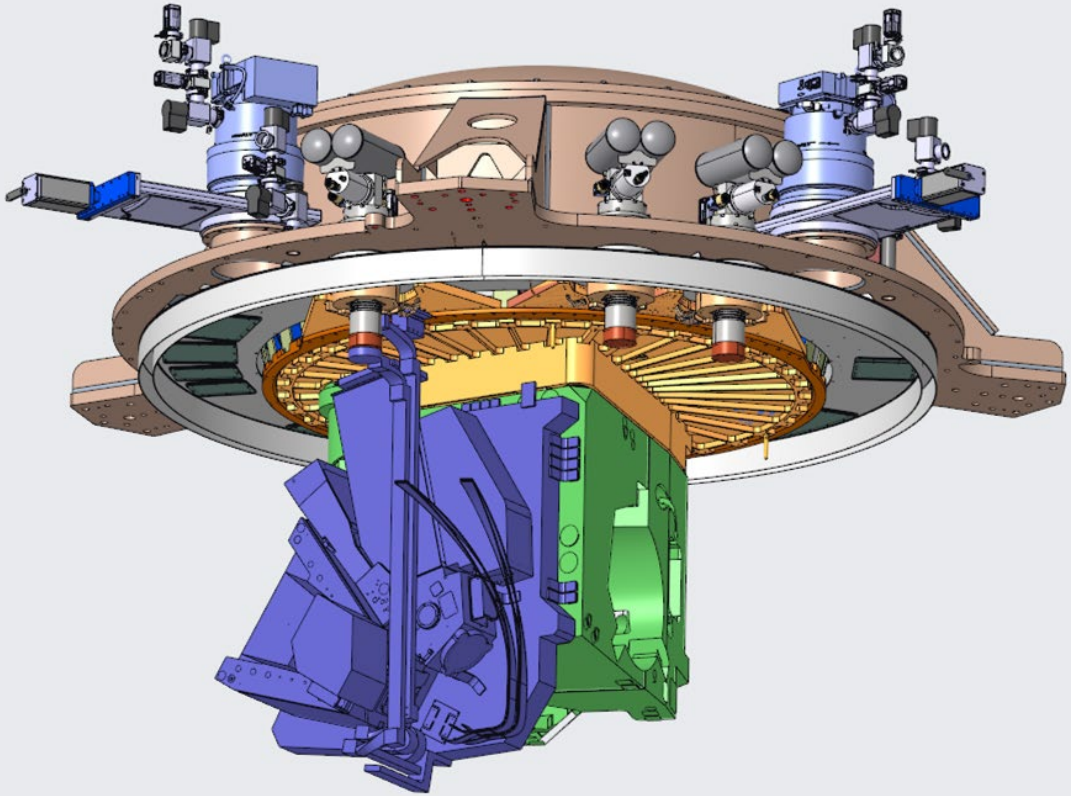

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Mid Infrared ELT Imager and Spectrograph

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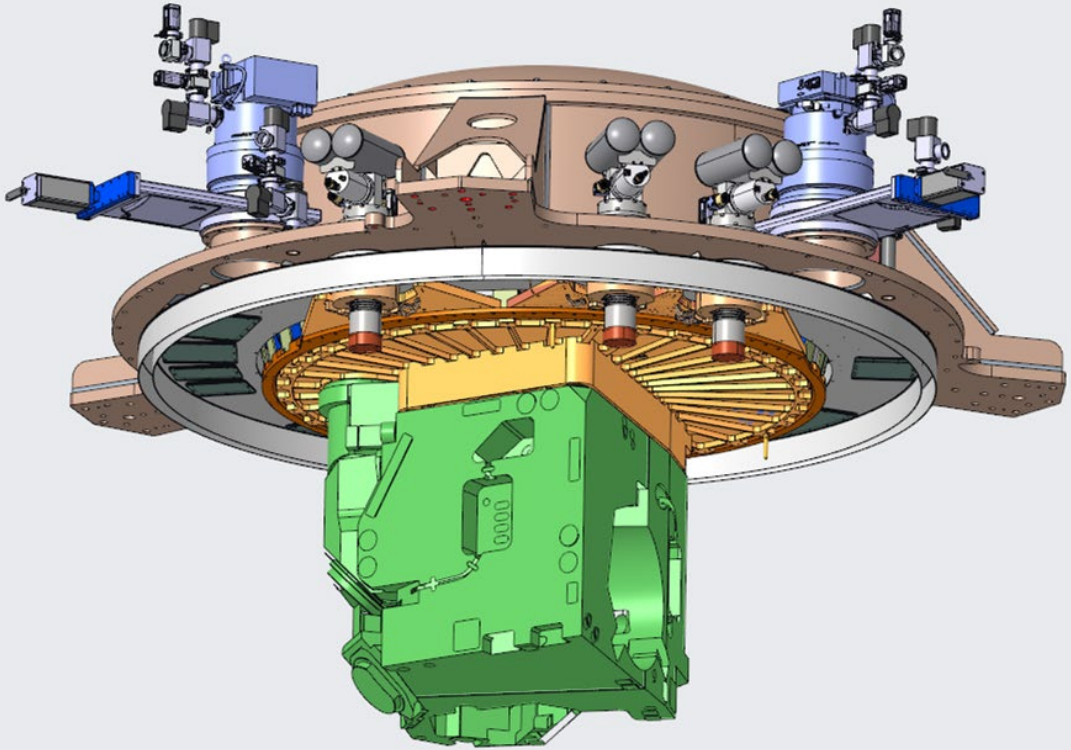

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Mid Infrared ELT Imager and Spectrograph

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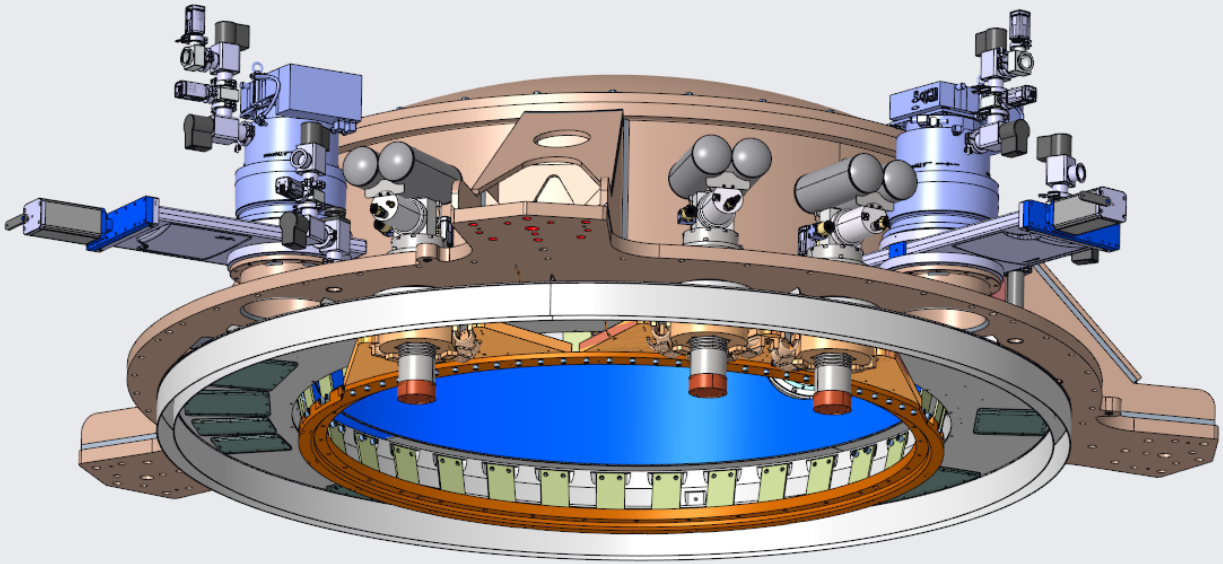


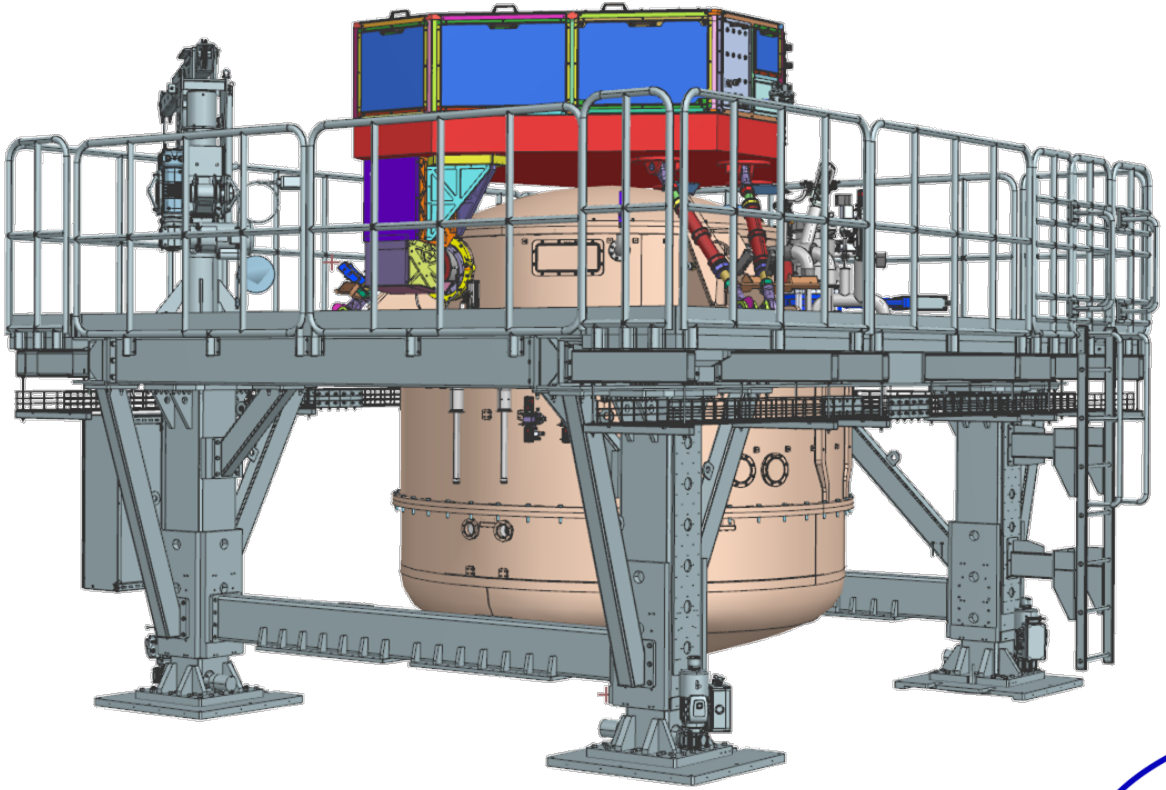
Mid Infrared ELT Imager and Spectrograph

METIS-Cryostat

ASF
Assembly and
Support
Frame

METIS-Cryostat

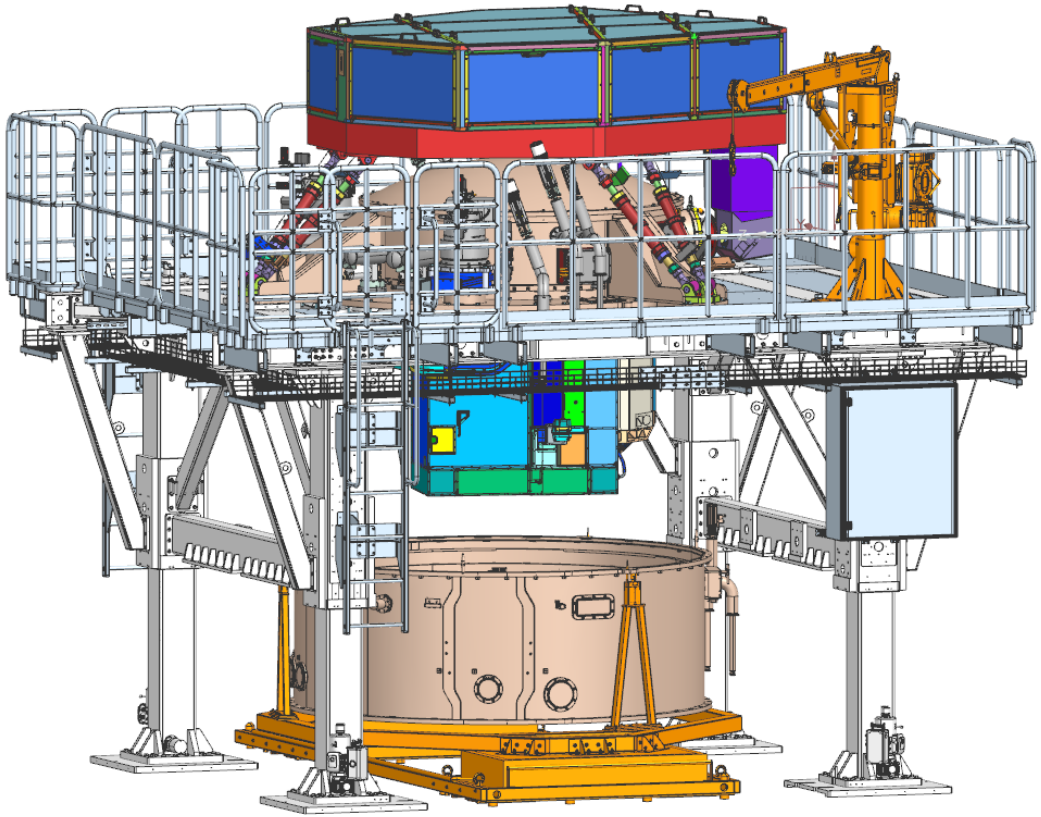
ASF
Assembly and
Support Frame



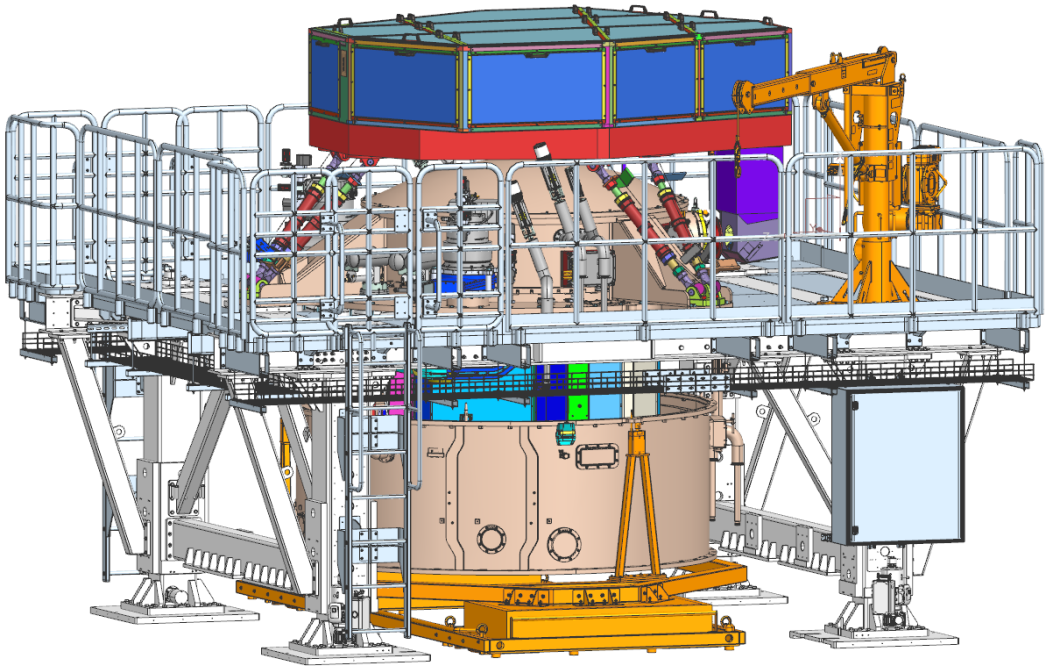
METIS-Cryostat

ALP
Assembly and
lifting platform

METIS-Cryostat

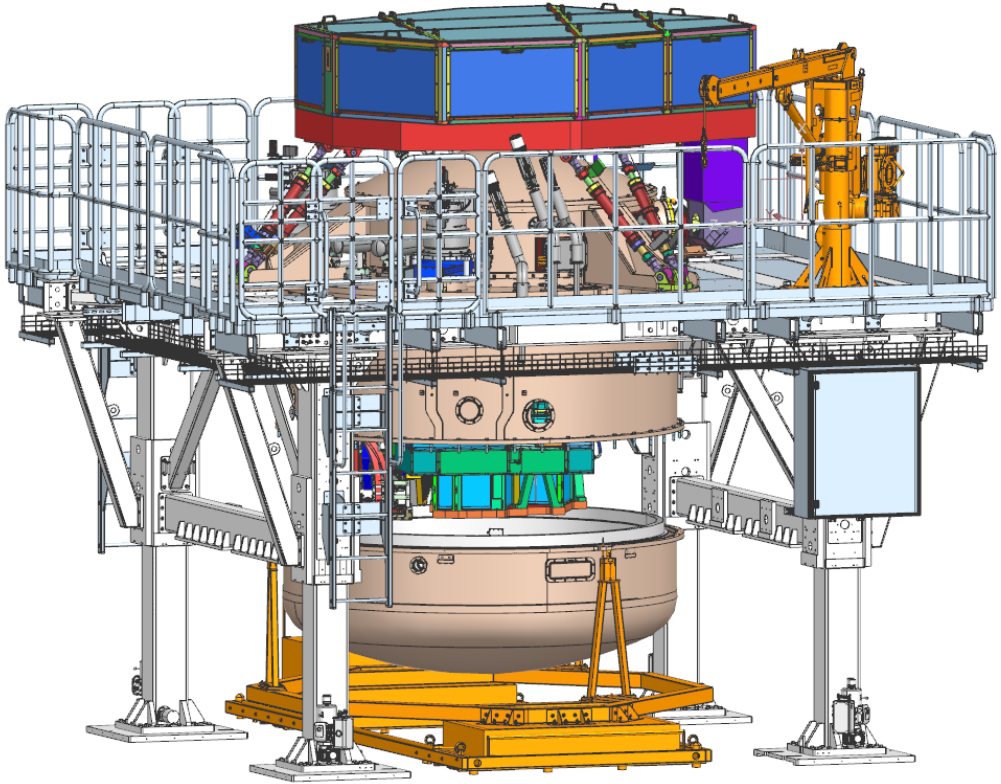


METIS-Cryostat

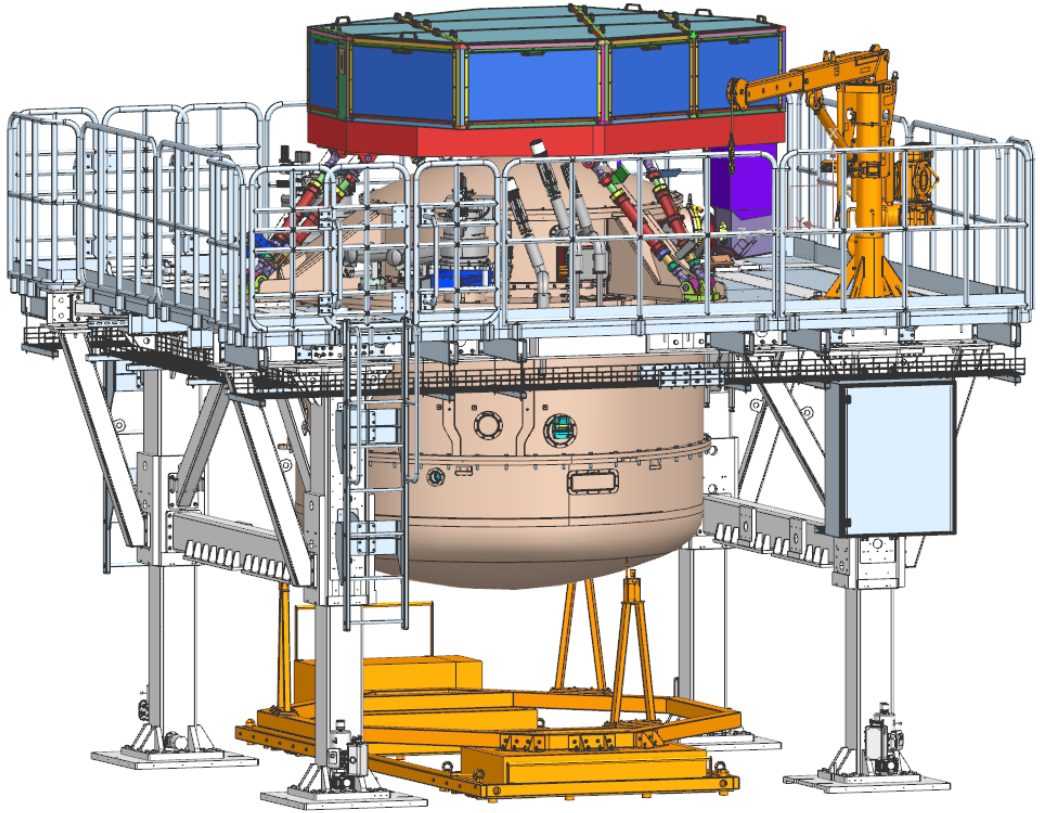


Mid Infrared ELT Imager and Spectrograph

METIS-Cryostat



METIS-Cryostat



METIS-Cryostat

How long does the cryostat need to cool down?

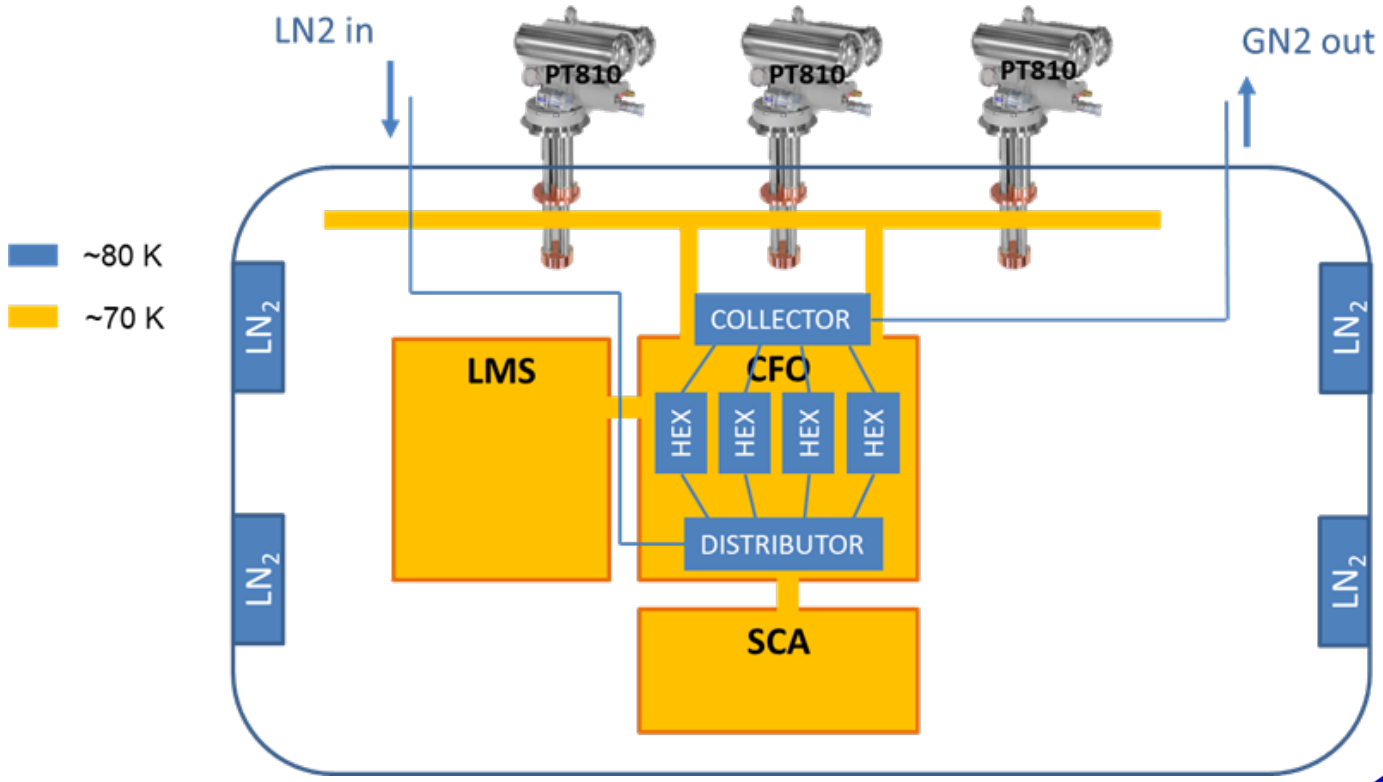
Mid Infrared ELT Imager and Spectrograph

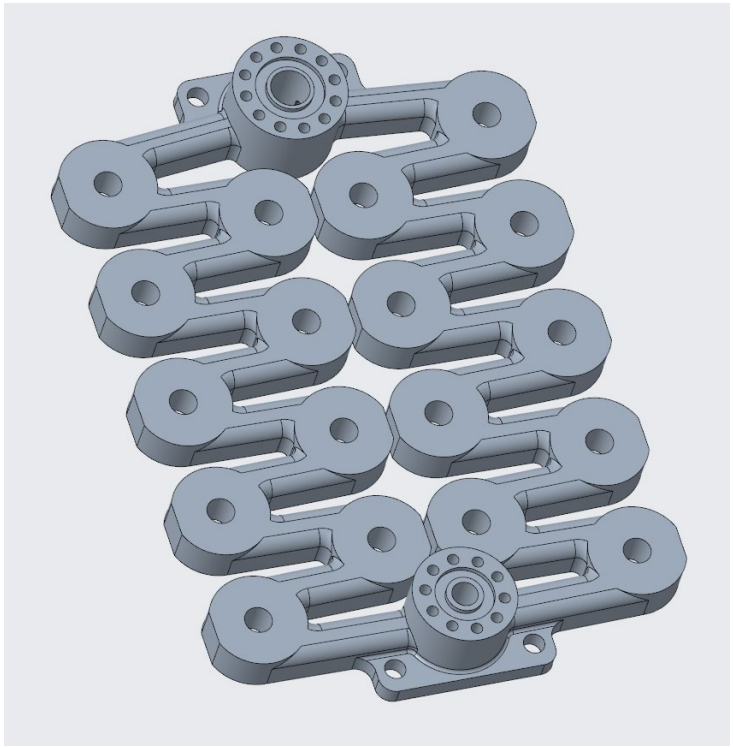
METIS-Cry

Mid Infrared ELT Imager and Spectrograph

METIS

METIS-Cryostat



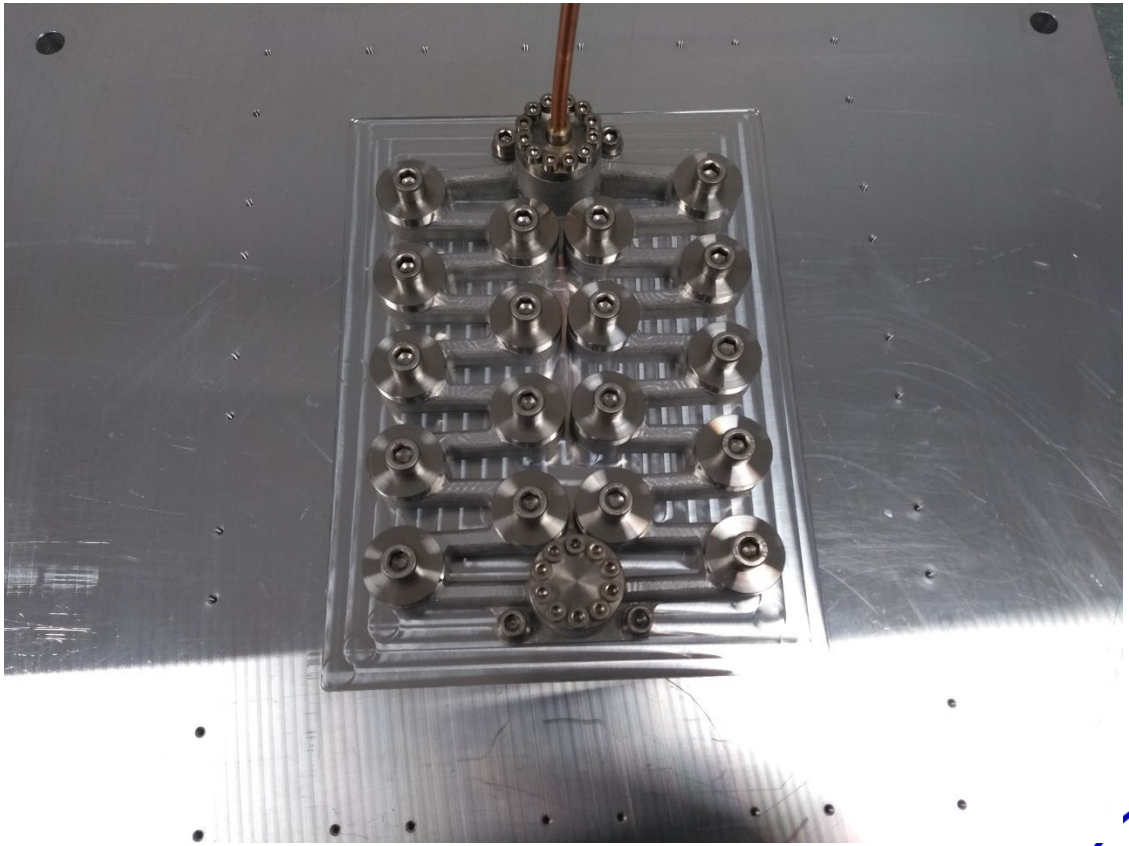


3D printed heat exchanger

Astro Tech Talk 16 Sep 2024

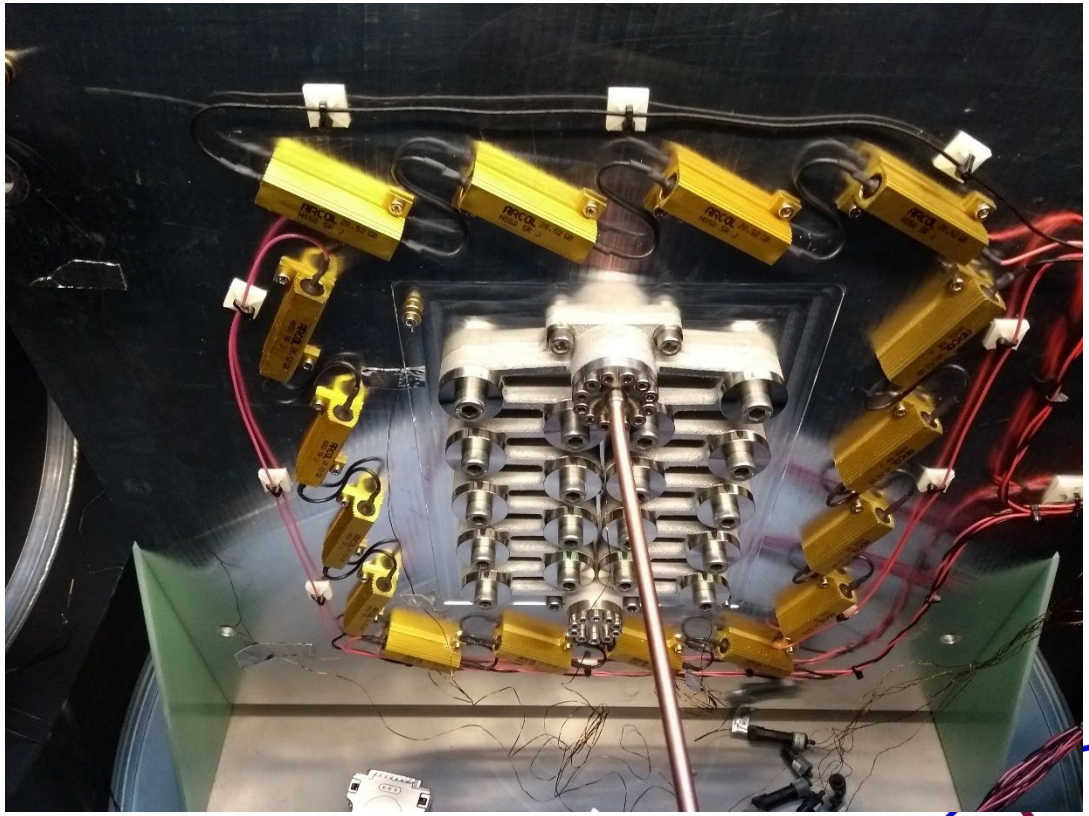
METIS-Cryostat

Heat exchanger mounted on a test plate

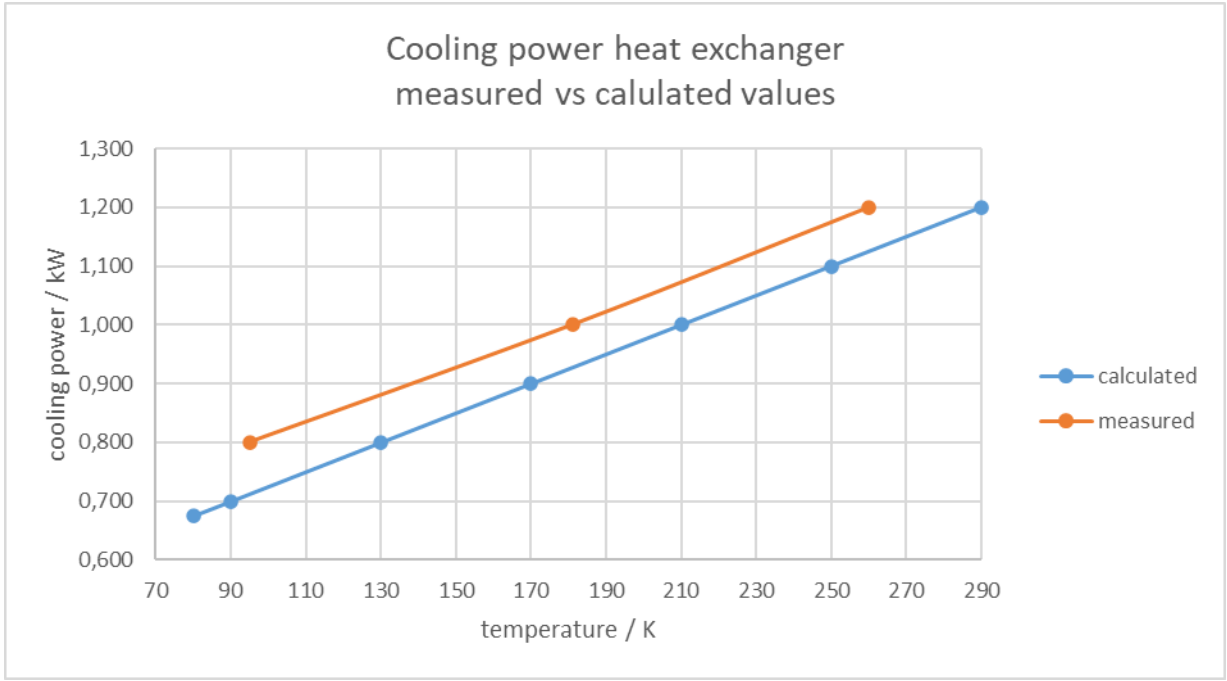


METIS - Cryostat

Heat exchanger with heaters and temperature sensors to measure the cooling power



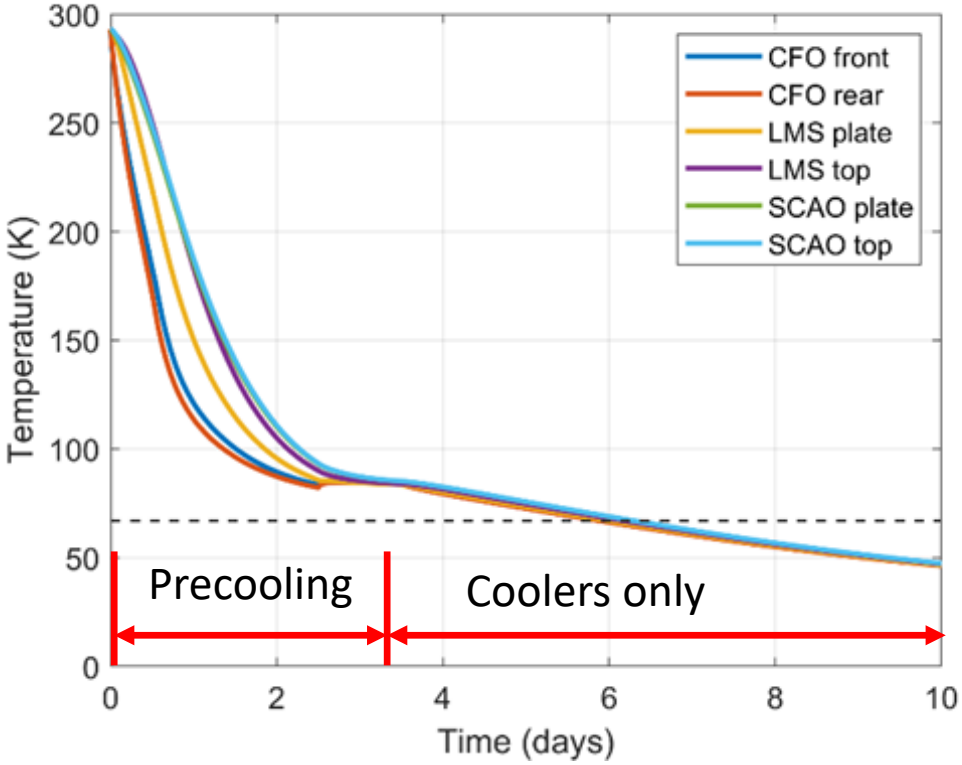
METIS-Cryostat



Mid Infrared ELT Imager and Spectrograph

METIS-Cryostat

Cool down with LN_2 precooling system



End-temperature

Mid Infrared ELT Imager and Spectrograph

METIS

LN_2 consumption

In steady state for cooling the radiation shield

180 liter / day

For cool down

About 4.000 to 5.000 liters in 3 days

METIS-Cryostat

Current status

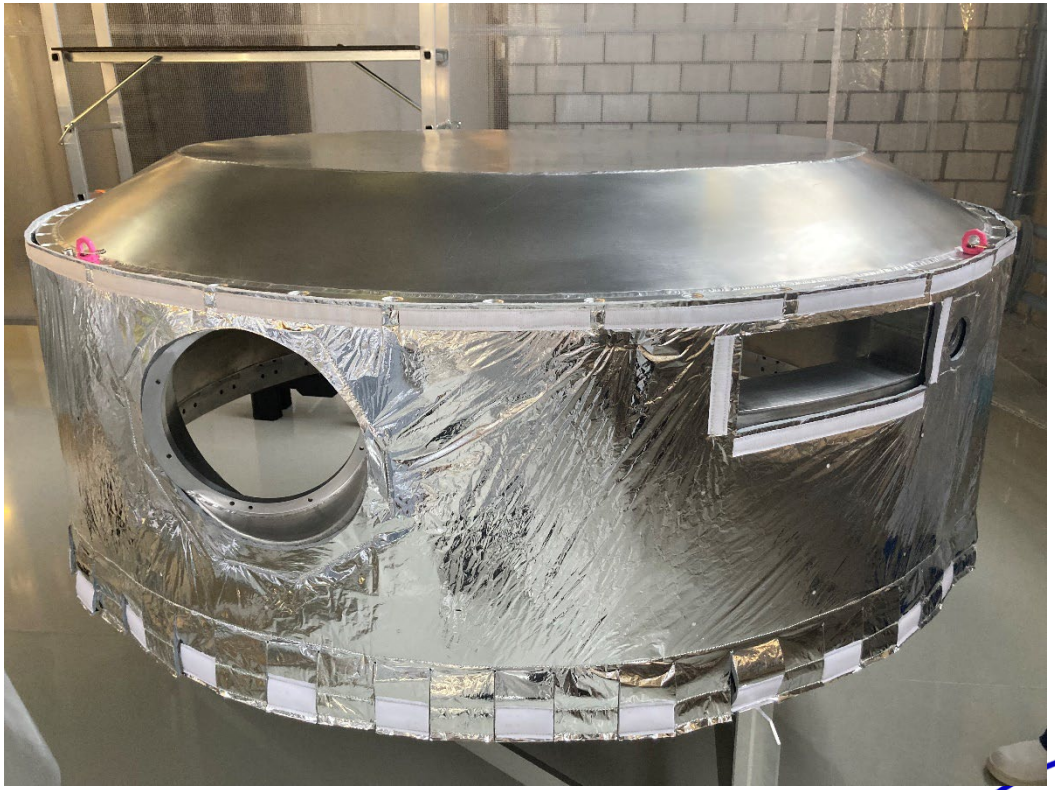
- ETH Zurich has set up a large integration hall
- Vacuum vessel is delivered
- Radiation shield is delivered
- Integration has started

METIS - Cryostat

Empty vacuum vessel inside the integration facility in Zurich

METIS-Cryostat

Top part of the radiation shield, covered with high reflective foil



METIS-Cryostat

Schedule

- ETH Zurich is integrating and testing the cryostat in their facility
- When all functional tests are made the cryostat will be delivered to Leiden (5/2025)
- NOVA is currently setting up an integration hall

METIS-Cryostat

Mid Infrared ELT Imager and Spectrograph

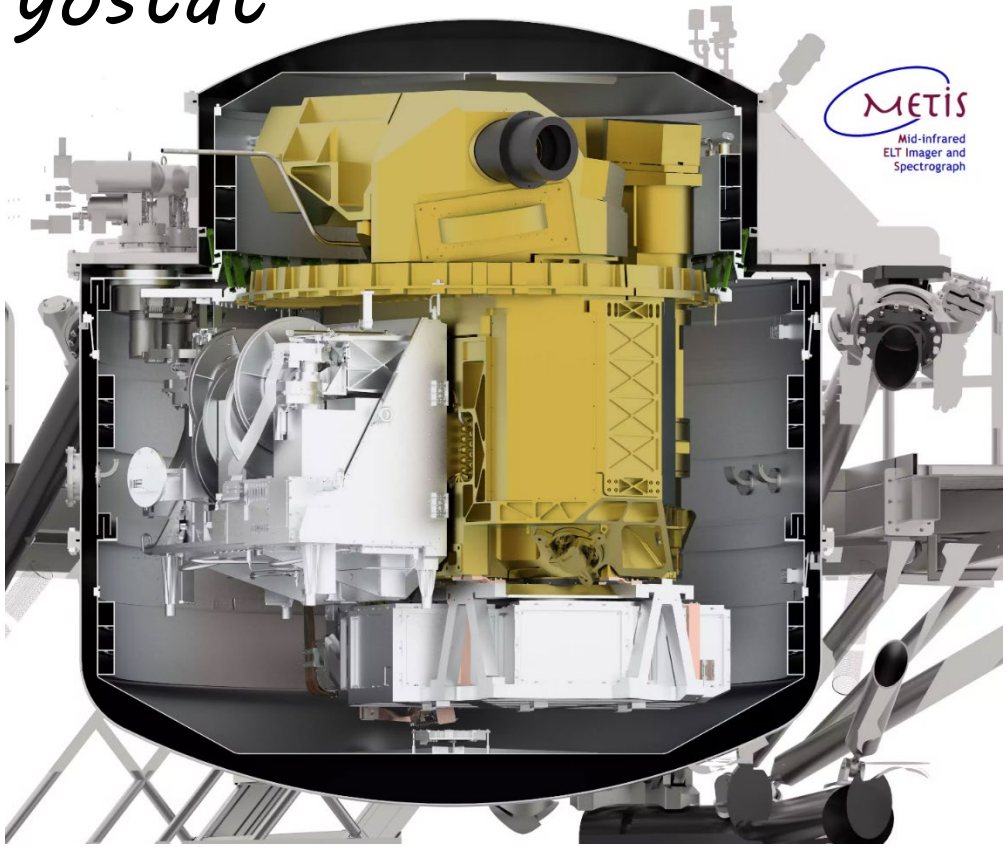
METIS-Cryostat

Schedule

- ETH Zurich is integrating and testing the cryostat in their facility
- When all functional tests are made the cryostat will be delivered to Leiden (5/2025)
- NOVA is currently setting up an integration hall
- This hall should be ready when the cryostat arrives
- The whole instrument will be integrated and tested in Leiden
- When tests are successfully finished the instrument will be packed and shipped to Chile (end of the decade)

Questions?

METIS-Cryostat



Mid Infrared ELT Imager and Spectrograph