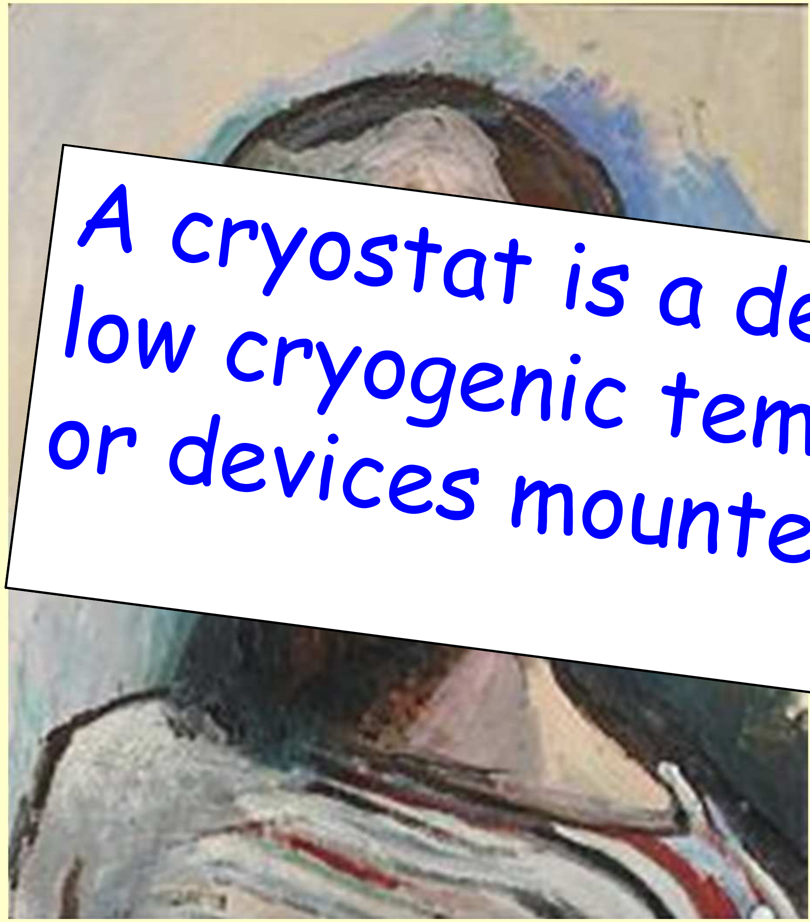
MATISSE cryostats

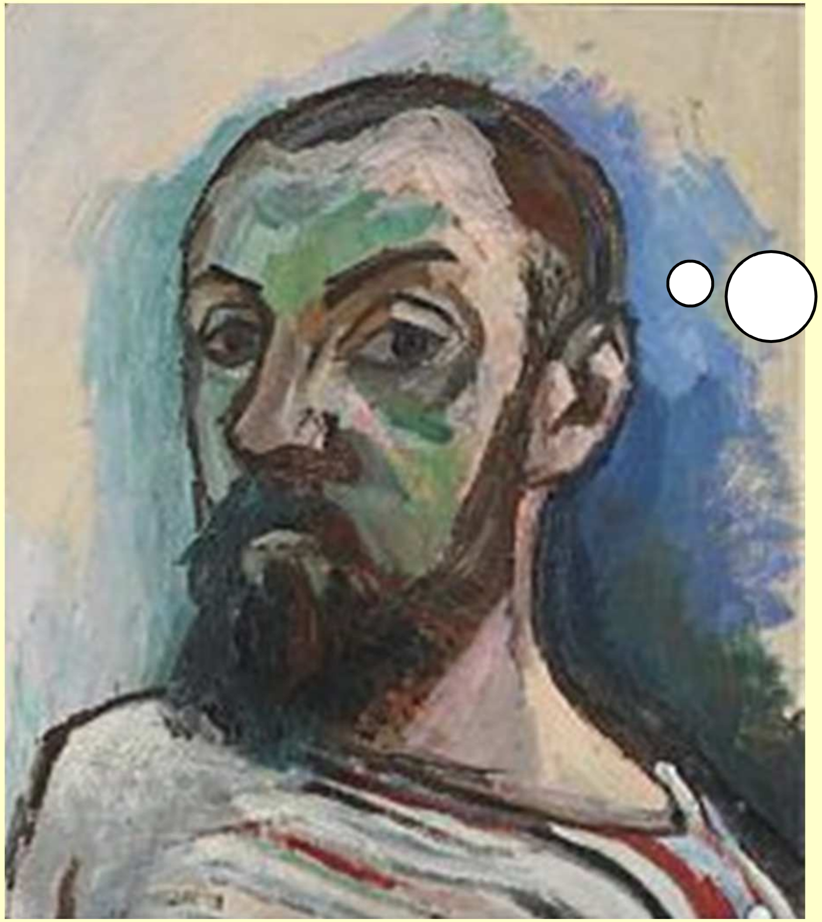
Cryostats?



A cryostat is a device used to maintain low cryogenic temperatures of samples or devices mounted within the cryostat.

wikipedia.org

Cryostat?

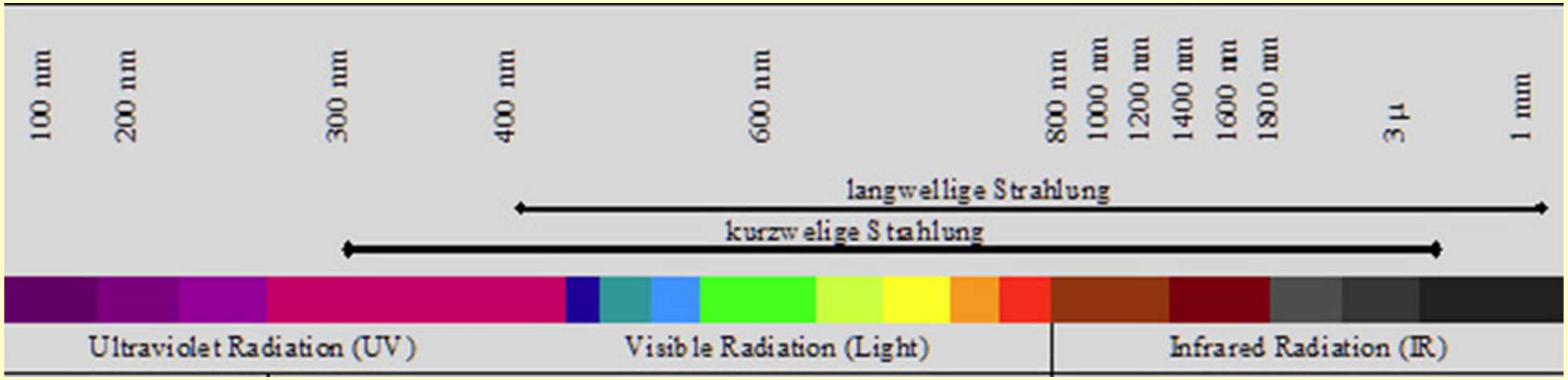


Why do we need a cryostat?

Cryostat?

- Why do we need a cryostat?

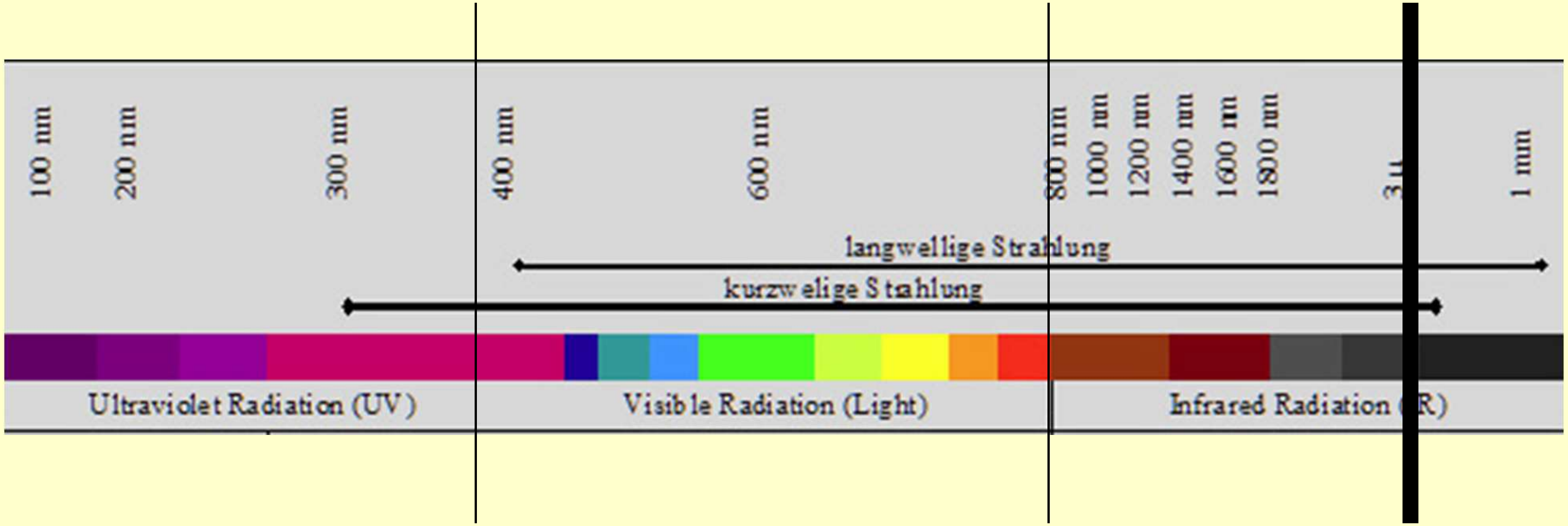
Spectrum from UV to IR



Cryostat?

- Why do we need a cryostat?

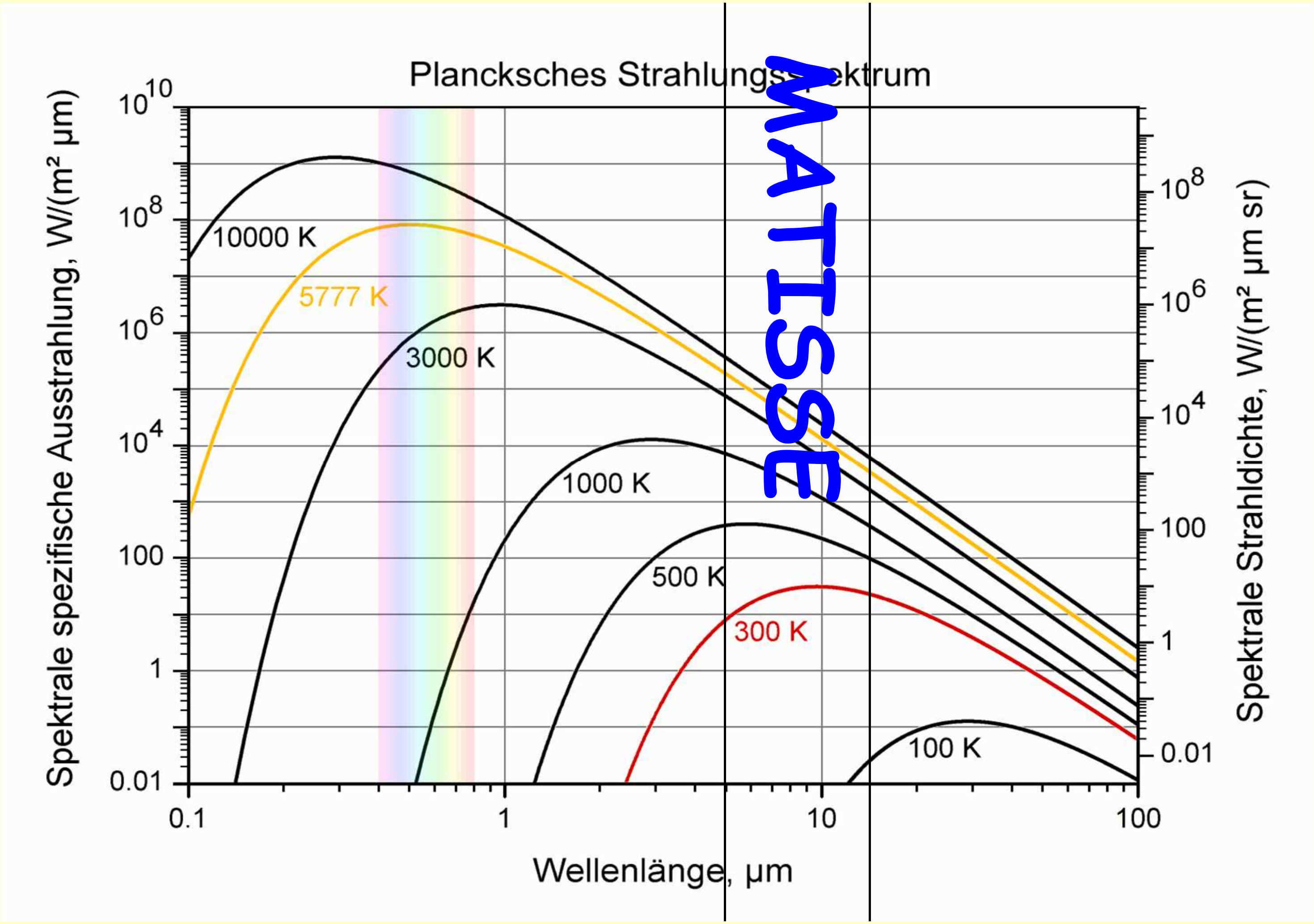
Spectrum from UV to NIR



MATISSE

Cryostat?

- Why do we need a cryostat?



Cryostat?

- Why do we need a cryostat?
  - IR detectors need cold environment
  - The longer the wavelength the colder the cryostat needs to be

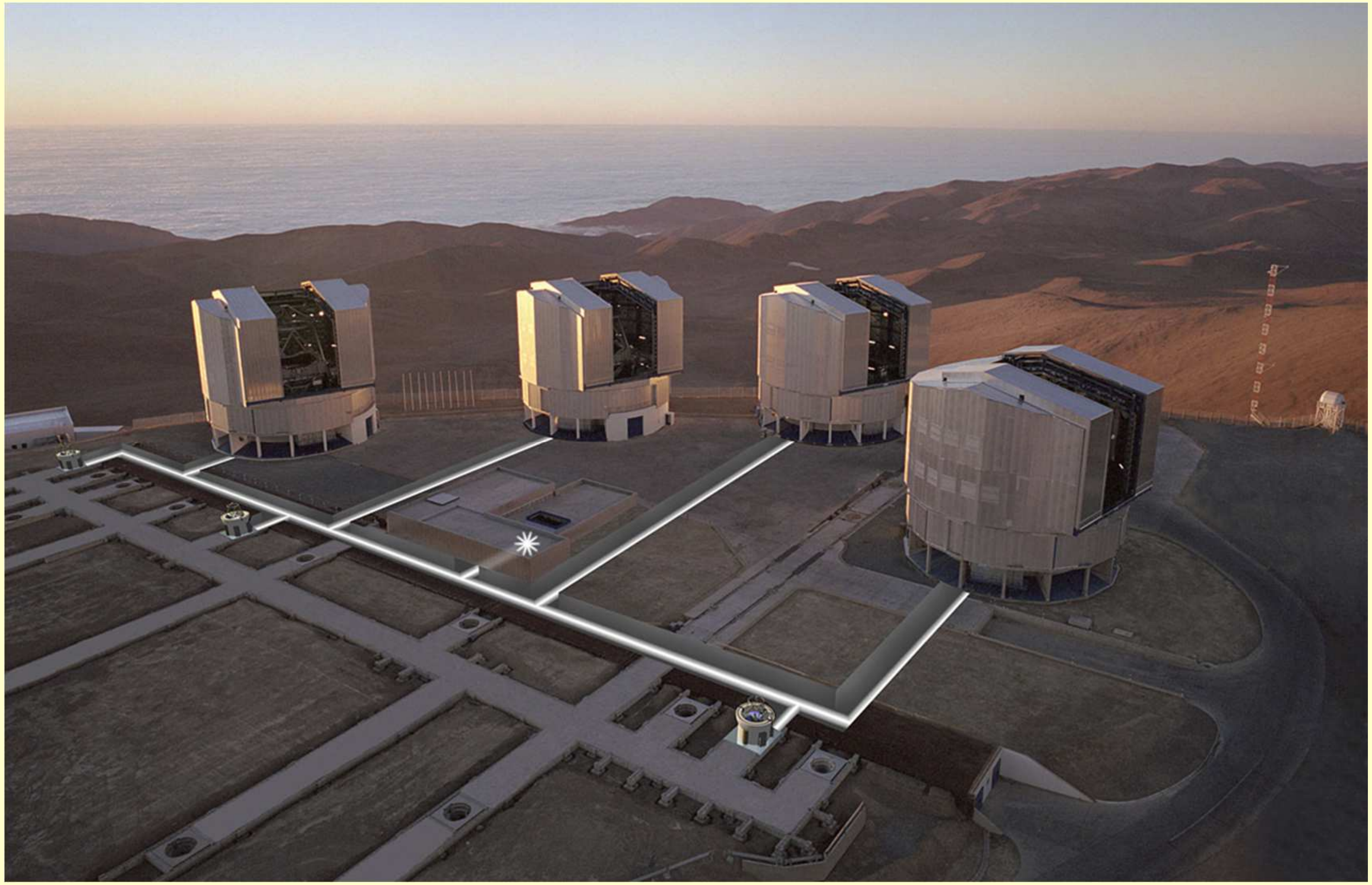
MATISSE?

- What does MATISSE do?
  - Interferometric observation with up to 4 telescopes

MATISSE is designed to be a mid-infrared interferometric instrument combining the beams of up to four telescopes (UTs or ATs) of the European Southern Observatory Very Large Telescope Interferometer (VLTI).

MATISSE?

- What does MATISSE do?
  - Interferometric observation with up to 4 telescopes

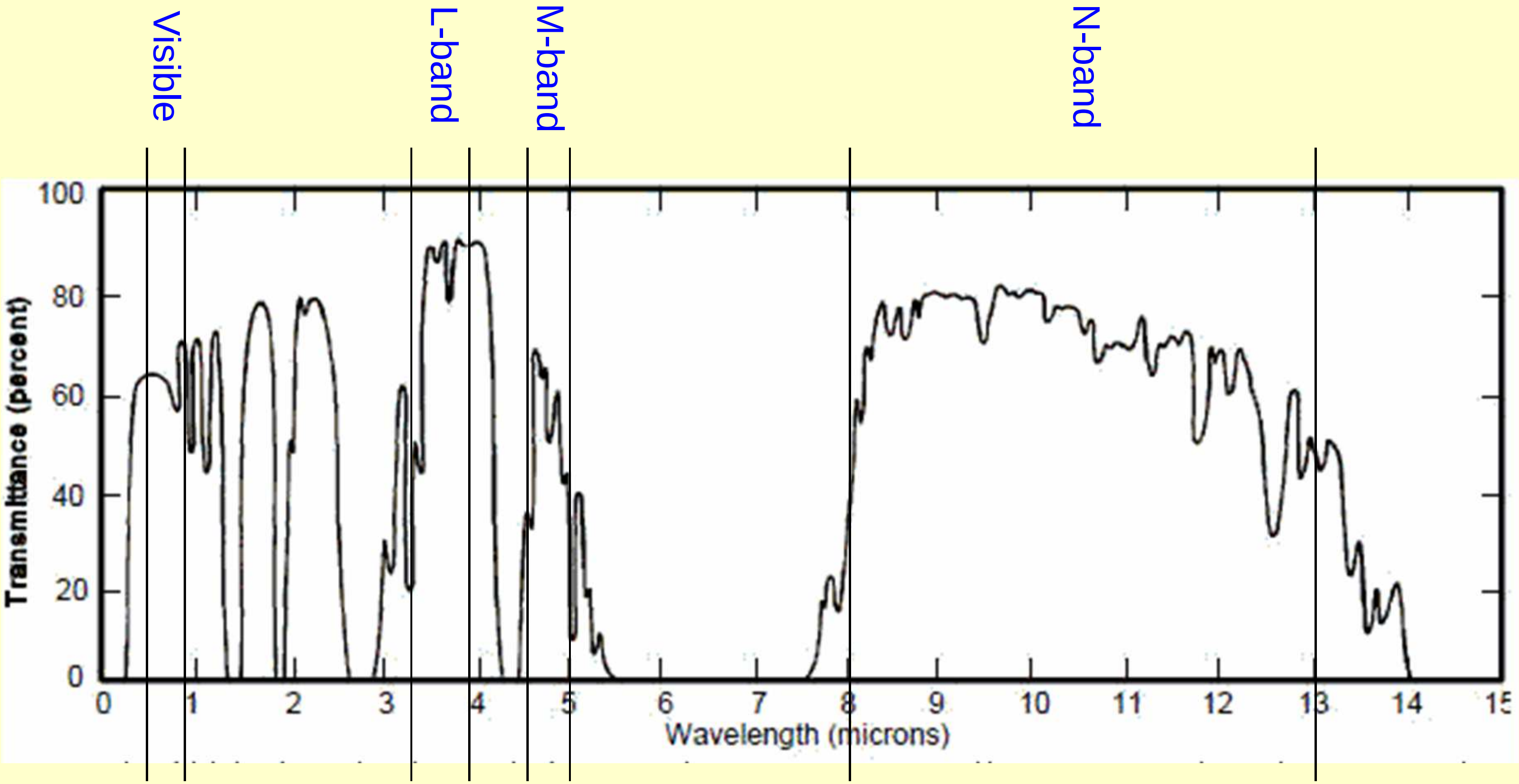


MATISSE?

- What does MATISSE do?
  - Interferometric observation with up to 4 telescopes
  - Wavelength range LM band
  - Wavelength range N band

MATISSE?

Atmospheric transmission



Human eye Hawaii2RG Aquarius

MATISSE?

- What does MATISSE do?
  - Interferometric observation with up to 4 telescopes
  - Wavelength range LM band with Hawaii 2 RG detector
  - Wavelength range N band with Aquarius detector

MATISSE team

- Team (hardware parts only)
  - OCA, Nice, France
    - PI institute
    - Warm optics
  - Astron, Dwingeloo, Netherlands
    - Cold optics
  - ESO, Garching (MPIfR, Bonn)
    - Detectors
  - MPIA
    - Instrument control electronics
    - **Cryostats**

MATISSE history

o Successor of MIDI	
o Installation	2002
o Decommissioning	2015
o Phase A kick-off	Nov 2006
o Phase A final review	July 2007
o PDR	Dec 2010
o FDR optics and cryogenics	Sep 2011
o Transport to Nice	
o LM-band cryostat	July 2014
o N-band cryostat	Nov 2014
o **Transport to Paranal**	**June 2017**

MATISSE cryostats

- Design driver
  - Temperature requirements
  - Space requirements
  - Vibration stability

MATISSE cryostats

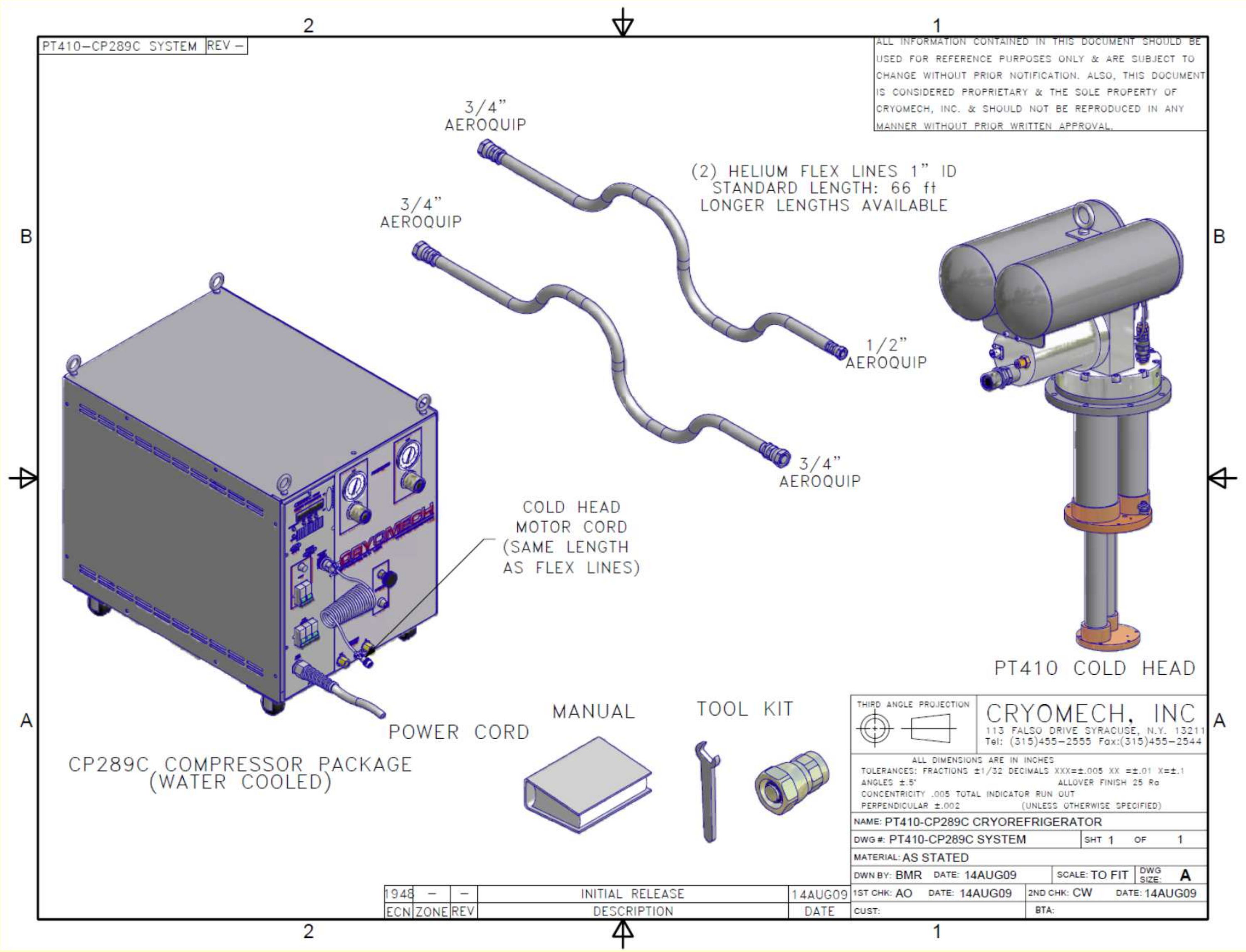
- <u>Temperature requirements</u>
  - LM-band optics 80 K → liquid nitrogen 77 K
  - N-band optics 40 K → cooling machine
  - Hawaii2RG 40 K → cooling machine
  - Aquarius 8 K → cooling machine

vibration

PT cooler

- <u>Cooling with a pulse tube cooler</u>
  - Low vibration
  - T_{min}< 40 K (1st stage)
  - T_{min}< 6 K (2nd stage)

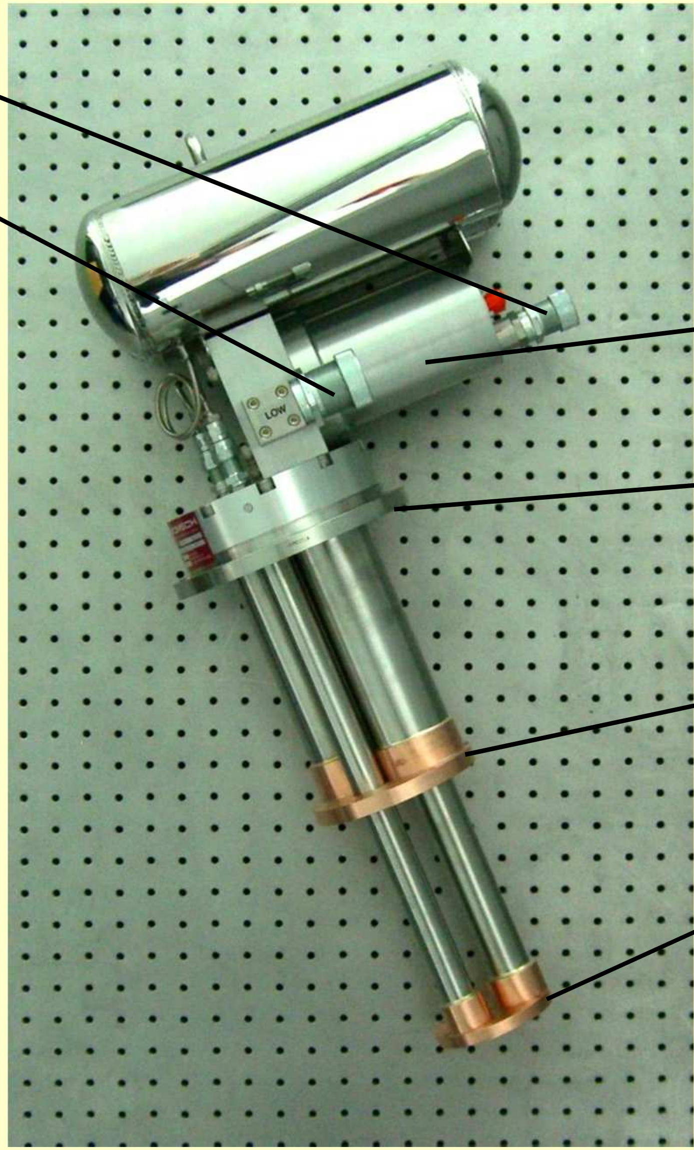
PT cooler


PT410-CP289C SYSTEM REV –
ALL INFORMATION CONTAINED IN THIS DOCUMENT SHOULD BE USED FOR REFERENCE PURPOSES ONLY & ARE SUBJECT TO CHANGE WITHOUT PRIOR NOTIFICATION. ALSO, THIS DOCUMENT IS CONSIDERED PROPRIETARY & THE SOLE PROPERTY OF CRYOMECH, INC. & SHOULD NOT BE REPRODUCED IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL.
3/4" AEROQUIP
(2) HELIUM FLEX LINES 1" ID
STANDARD LENGTH: 66 ft
LONGER LENGTHS AVAILABLE
3/4" AEROQUIP
1/2" AEROQUIP
3/4" AEROQUIP
COLD HEAD MOTOR CORD (SAME LENGTH AS FLEX LINES)
PT410 COLD HEAD
POWER CORD
MANUAL
TOOL KIT
CP289C COMPRESSOR PACKAGE (WATER COOLED)
THIRD ANGLE PROJECTION
CRYOMECH, INC
113 FALSO DRIVE SYRACUSE, N.Y. 13211
Tel: (315)455-2555 Fax:(315)455-2544
ALL DIMENSIONS ARE IN INCHES
TOLERANCES: FRACTIONS ±1/32 DECIMALS XXX=±.005 XX =±.01 X=±.1
ANGLES ±.5° ALLOVER FINISH 25 Ra
CONCENTRICITY .005 TOTAL INDICATOR RUN OUT
PERPENDICULAR ±.002 (UNLESS OTHERWISE SPECIFIED)
NAME: PT410-CP289C CRYOREFRIGERATOR
DWG #: PT410-CP289C SYSTEM SHT 1 OF 1
MATERIAL: AS STATED
DWN BY: BMR DATE: 14AUG09 SCALE: TO FIT DWG SIZE: A
1ST CHK: AO DATE: 14AUG09 2ND CHK: CW DATE: 14AUG09
CUST: BTA:
1948 – – INITIAL RELEASE 14AUG09
ECN ZONE REV DESCRIPTION DATE

PT cooler

helium high pressure

helium low pressure



motor

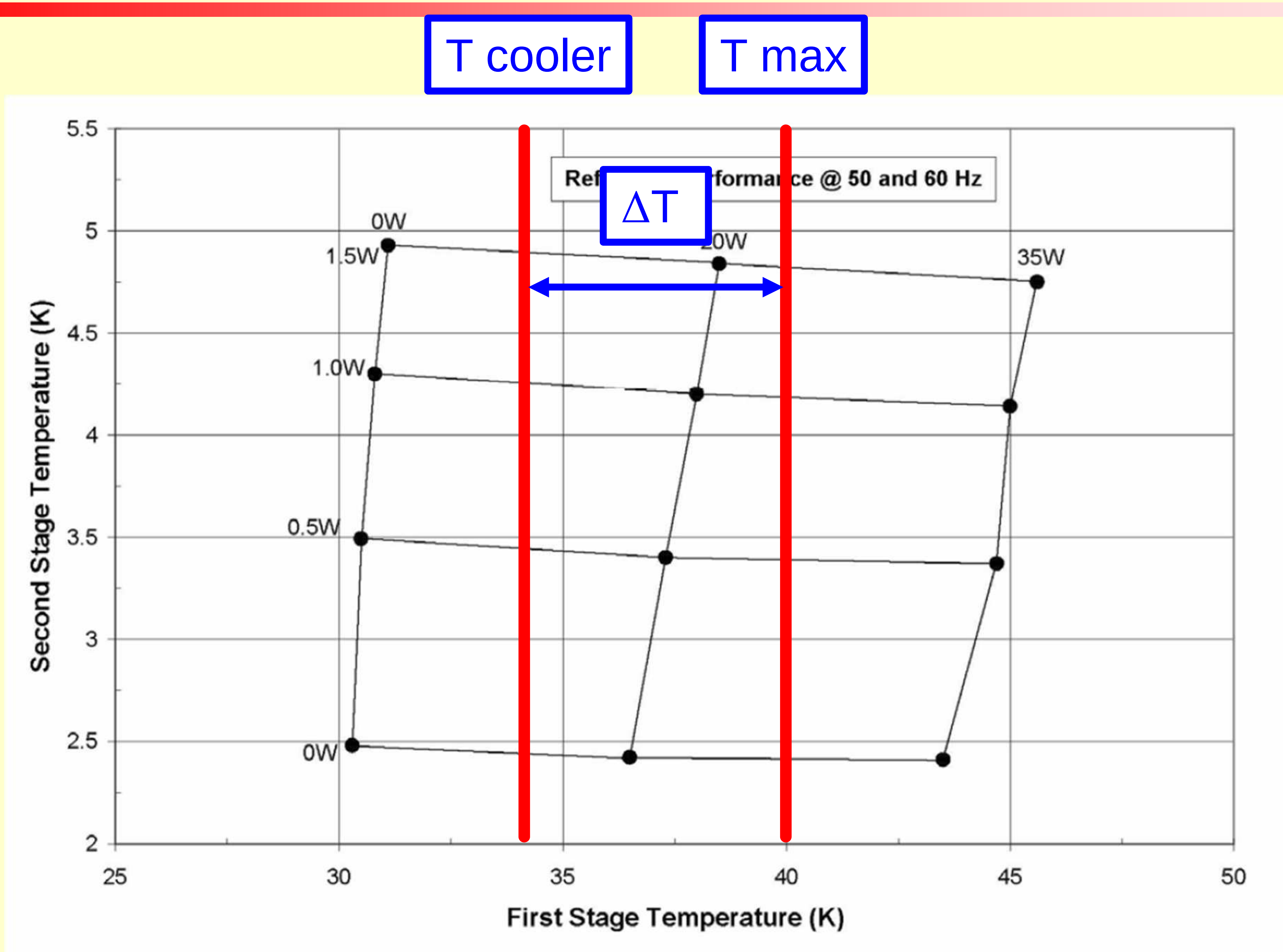
vacuum flange
300 K

first stage
< 40 K

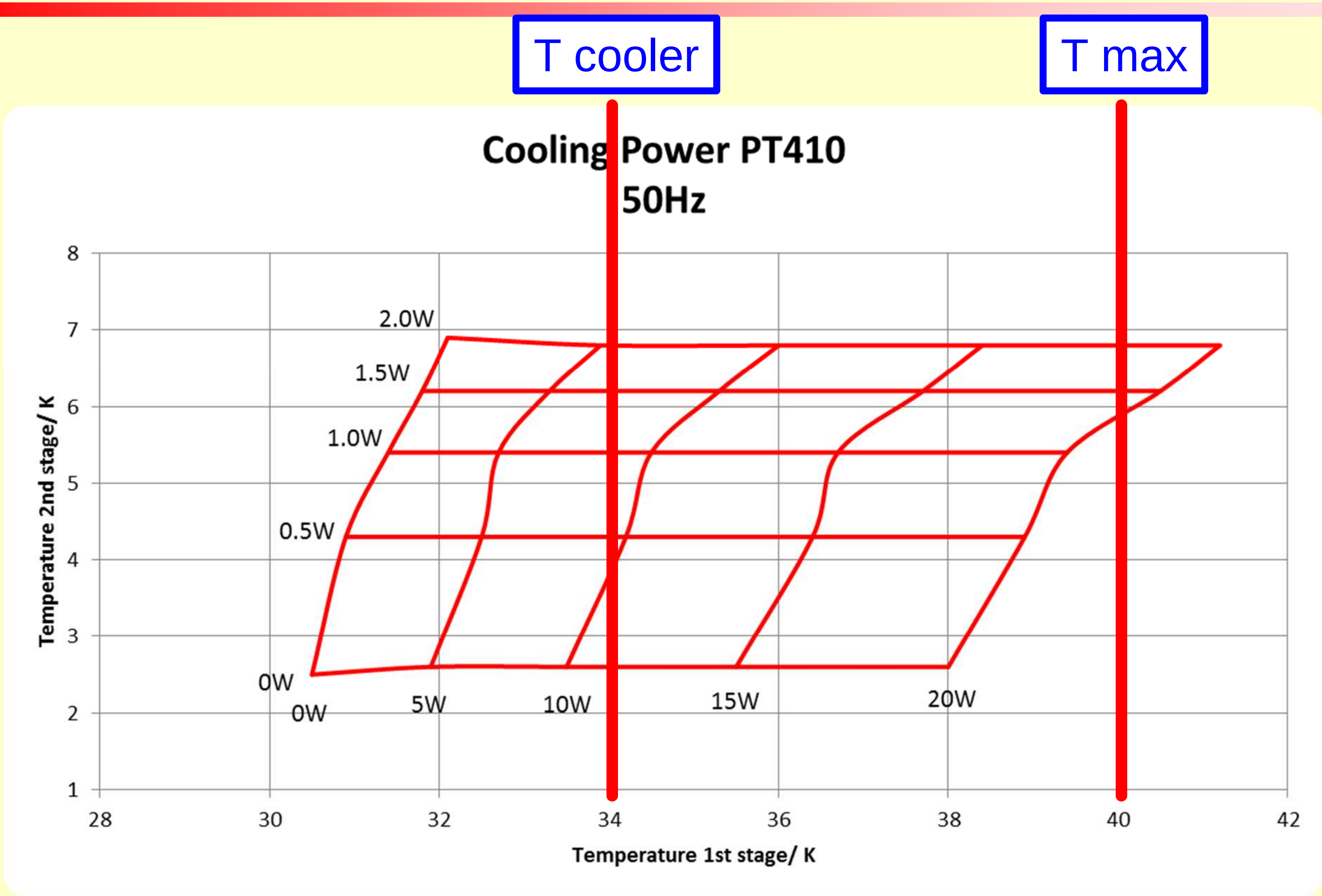
second stage
< 6 K

PT410
Cryomech

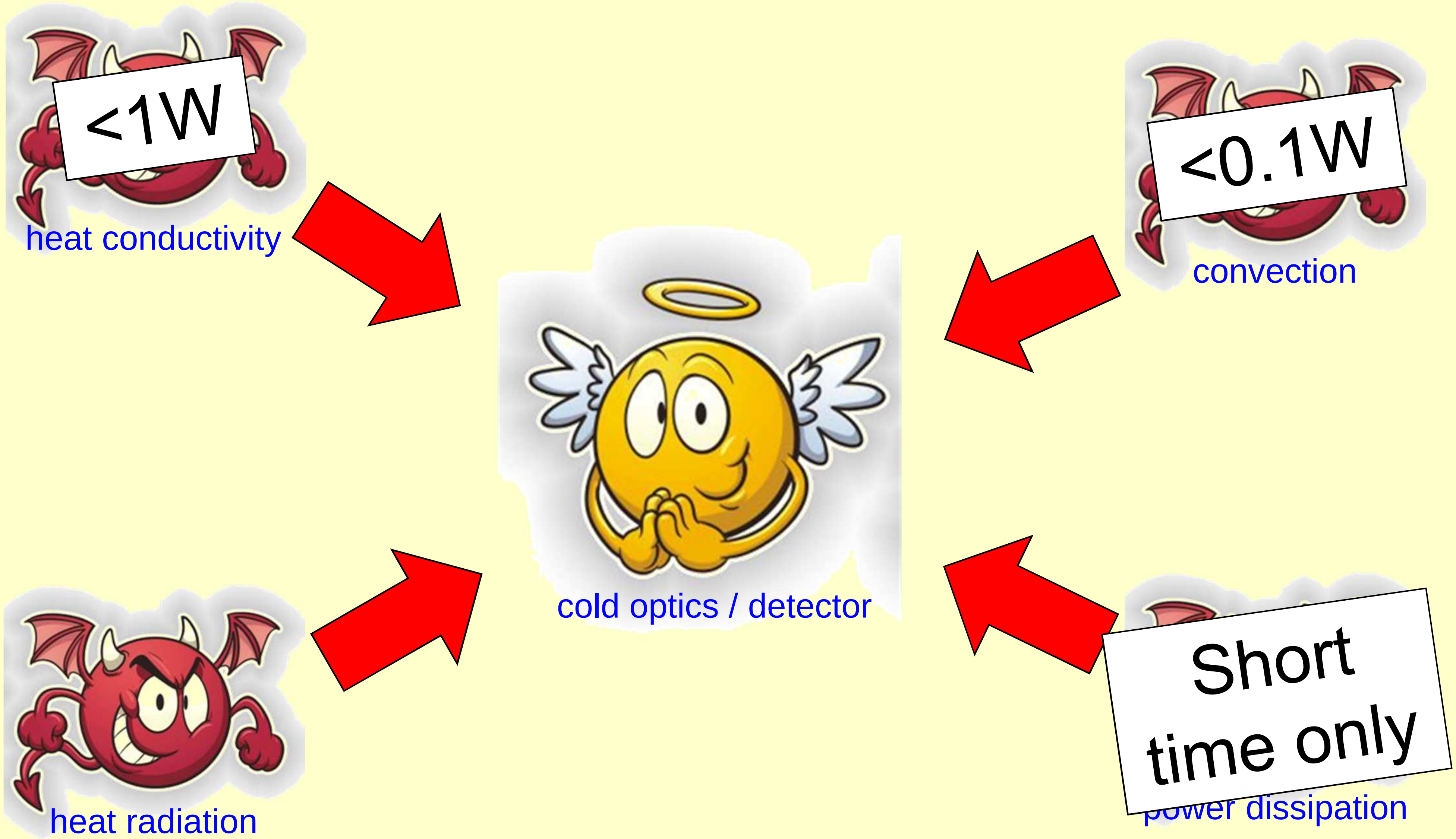
PT cooler


T cooler
T max
ΔT
Ref formance @ 50 and 60 Hz
0W
1.5W
1.0W
0.5W
0W
20W
35W
Second Stage Temperature (K)
First Stage Temperature (K)
5.5
5
4.5
4
3.5
3
2.5
2
25
30
35
40
45
50

PT cooler

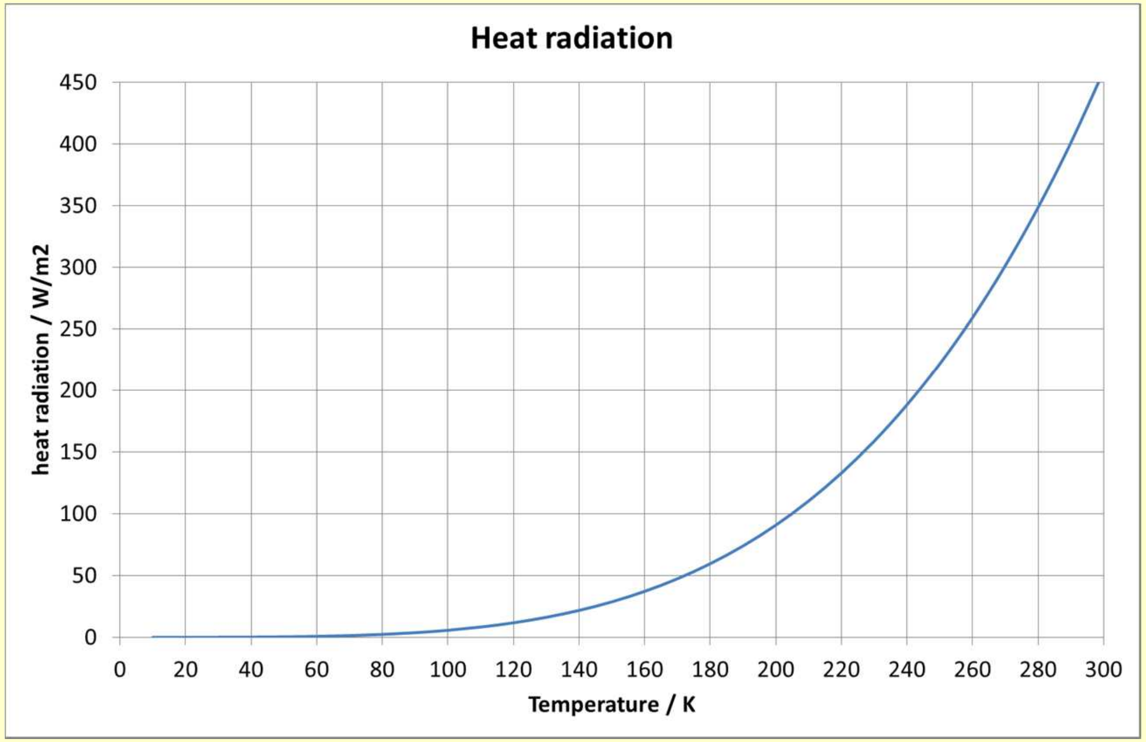

T cooler
T max
Cooling Power PT410
50Hz
2.0W
1.5W
1.0W
0.5W
0W
0W
5W
10W
15W
20W
Temperature 2nd stage/ K
Temperature 1st stage/ K
8
7
6
5
4
3
2
1
28
30
32
34
36
38
40
42

Cryostats heat input



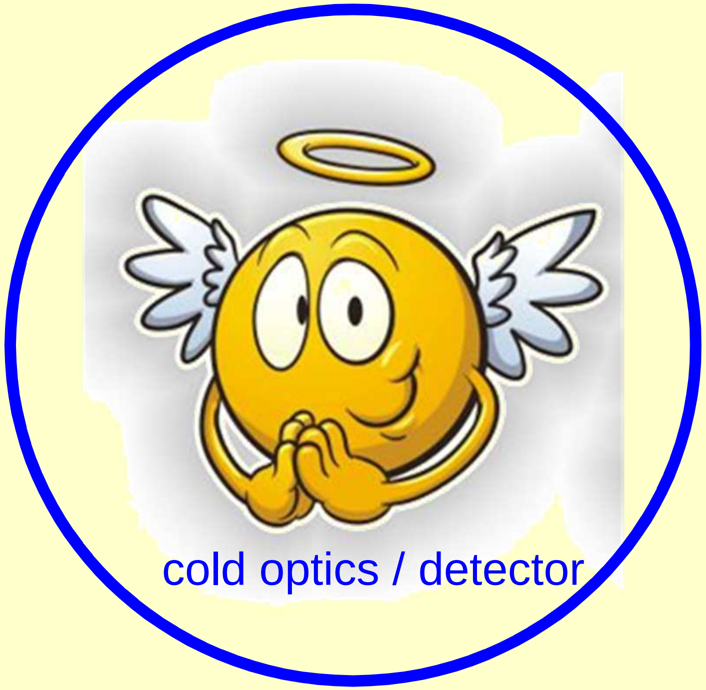
Cryostats heat input

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

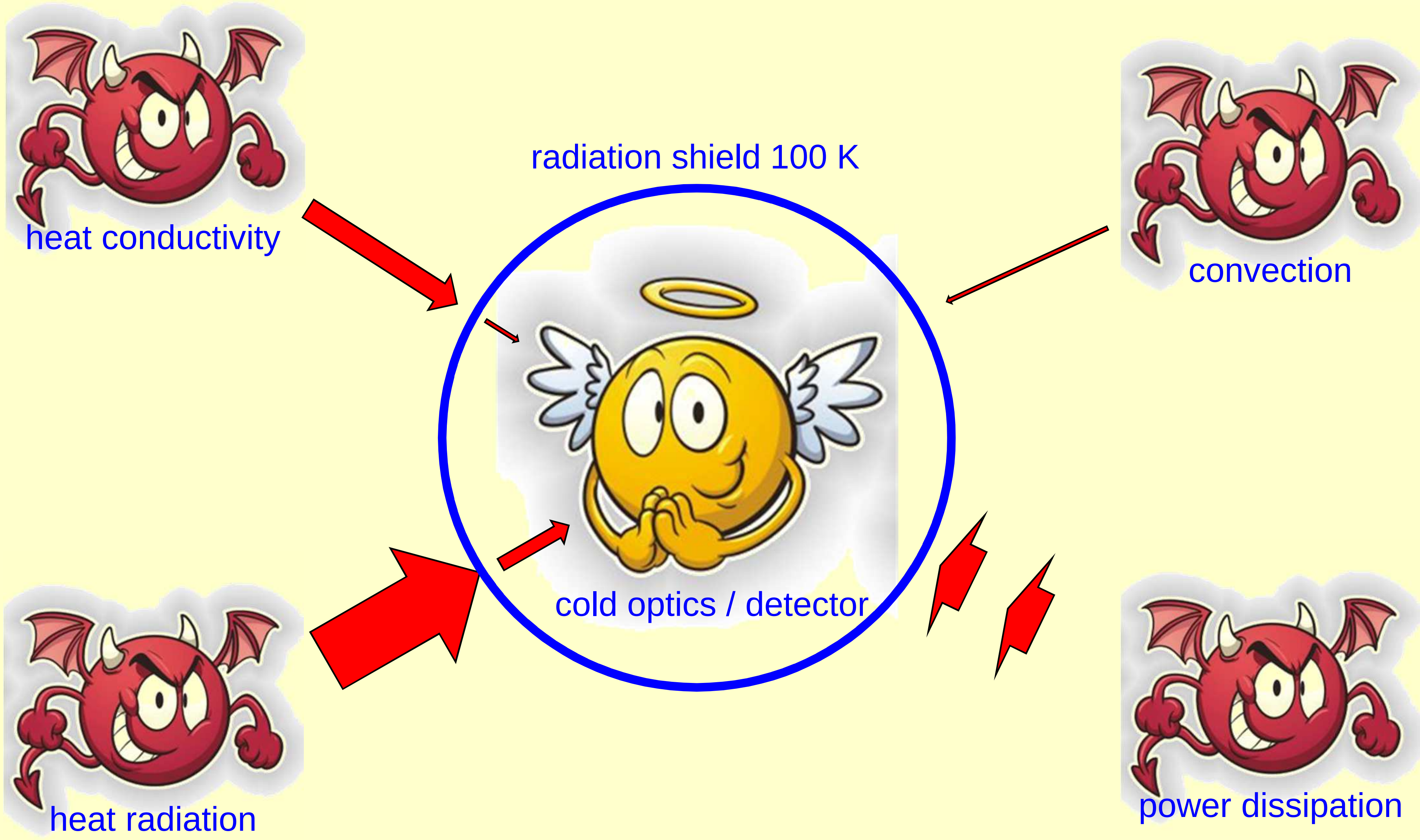


Cryostats heat input

Radiation shield cooled by LN_2



Cryostats heat input



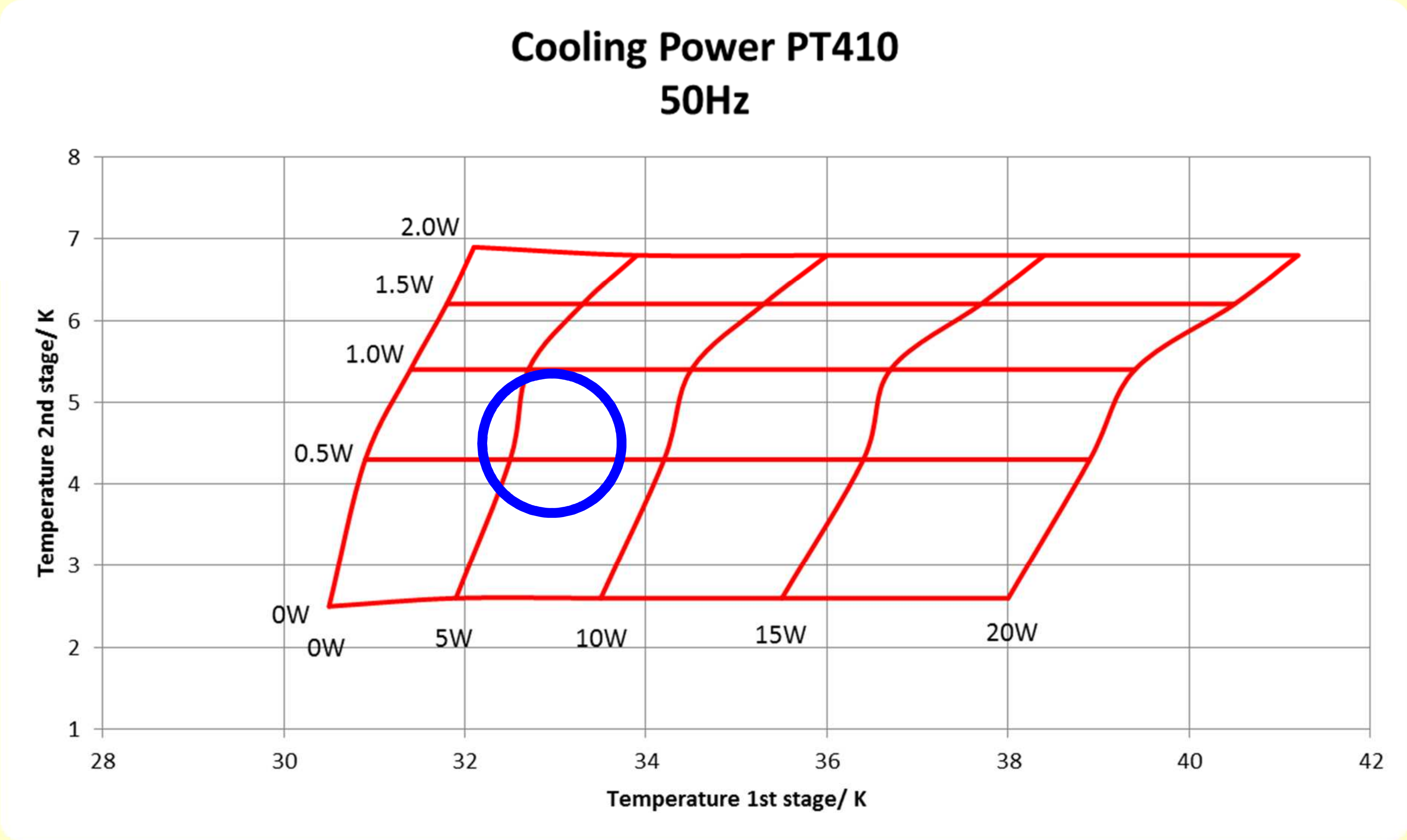
Cryostats heat input

- <u>Heat input</u>
  - Radiation
    - On surface — 3 W
    - Through windows — 1.2 W
  - Conductivity
    - Spacer — <1 W
    - Cables — <1W
  - Dissipation
  - Convection

=====

- 6.2 W

Cryostats heat input

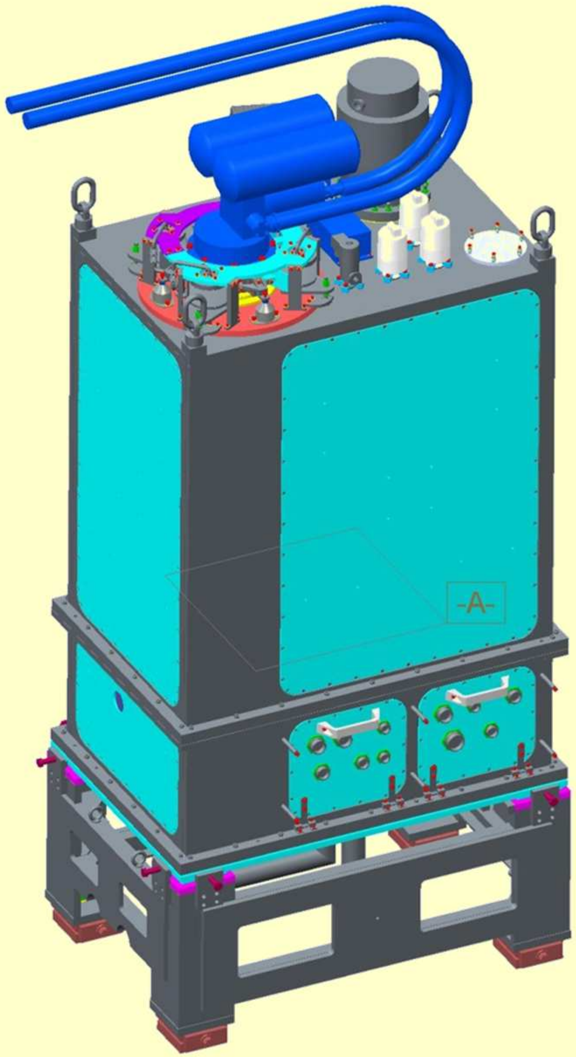


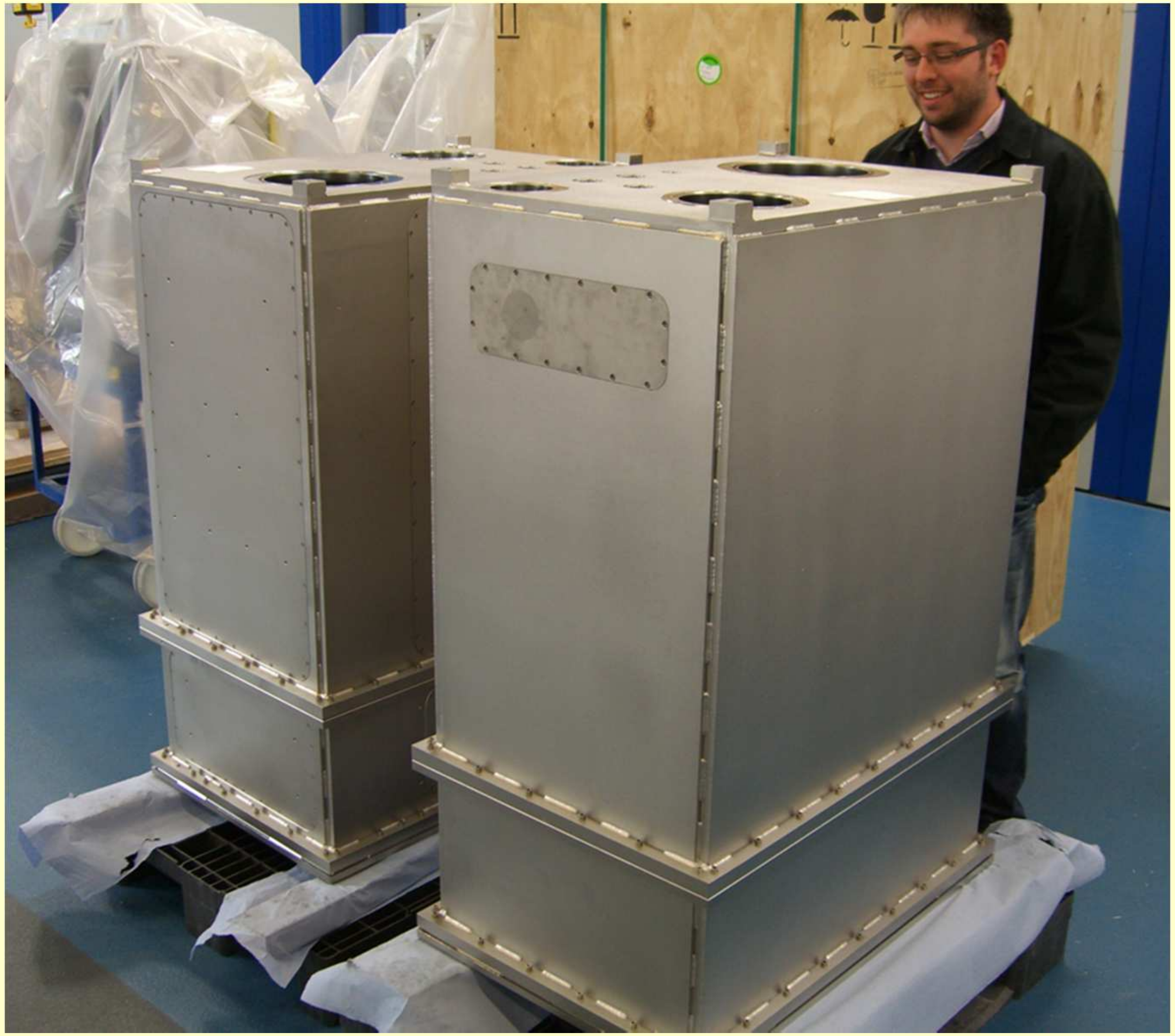
MATISSE cryostats

MATISSE cryostats

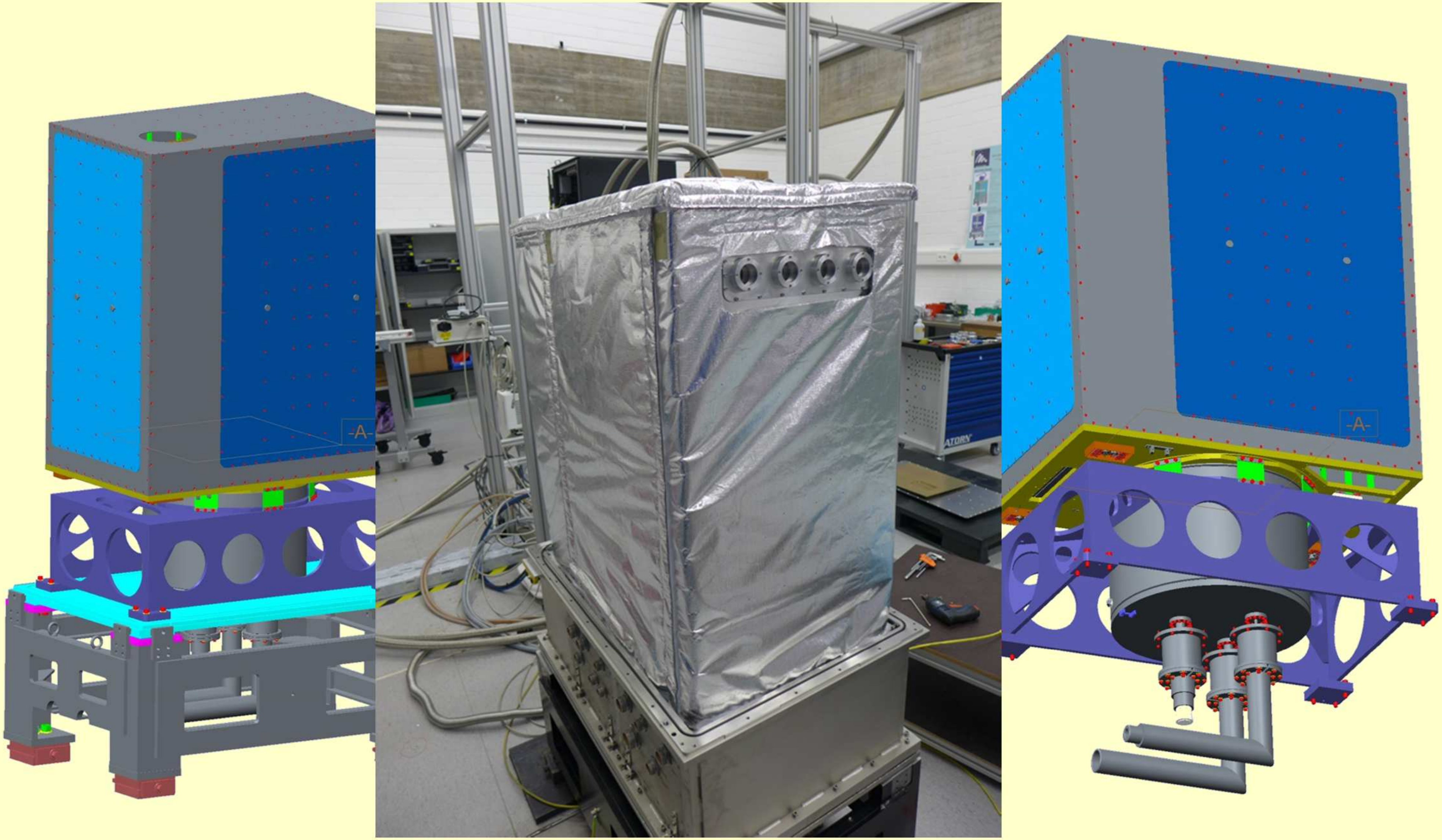
vacuum vessel	**290 K**
radiation shield	**100 K**
cold optics	**40 K**
detector	**8 K**

MATISSE vacuum vessel (290 K)

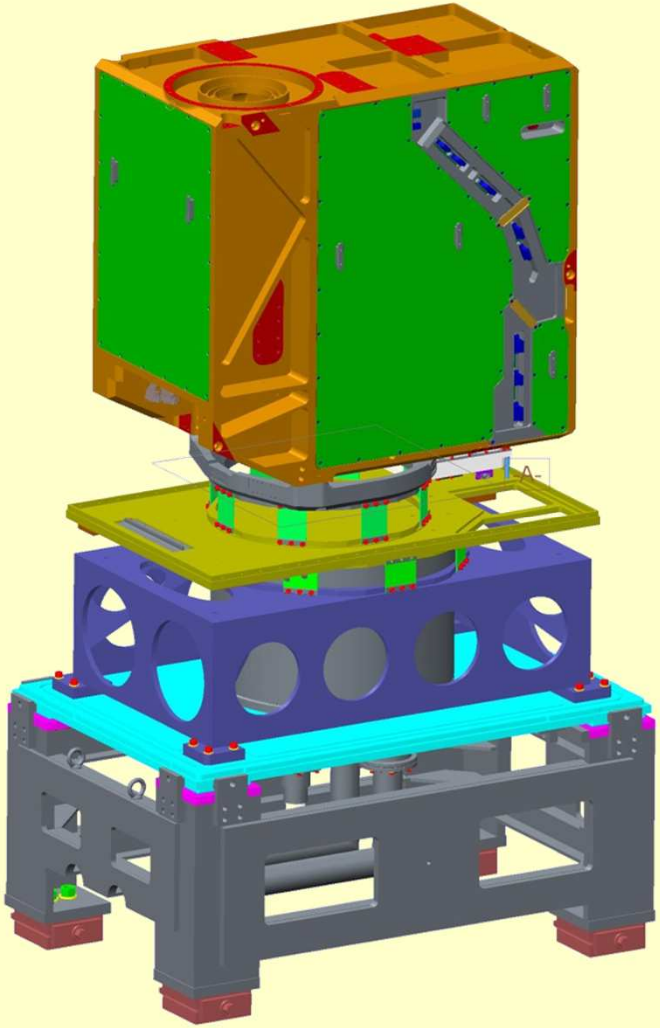




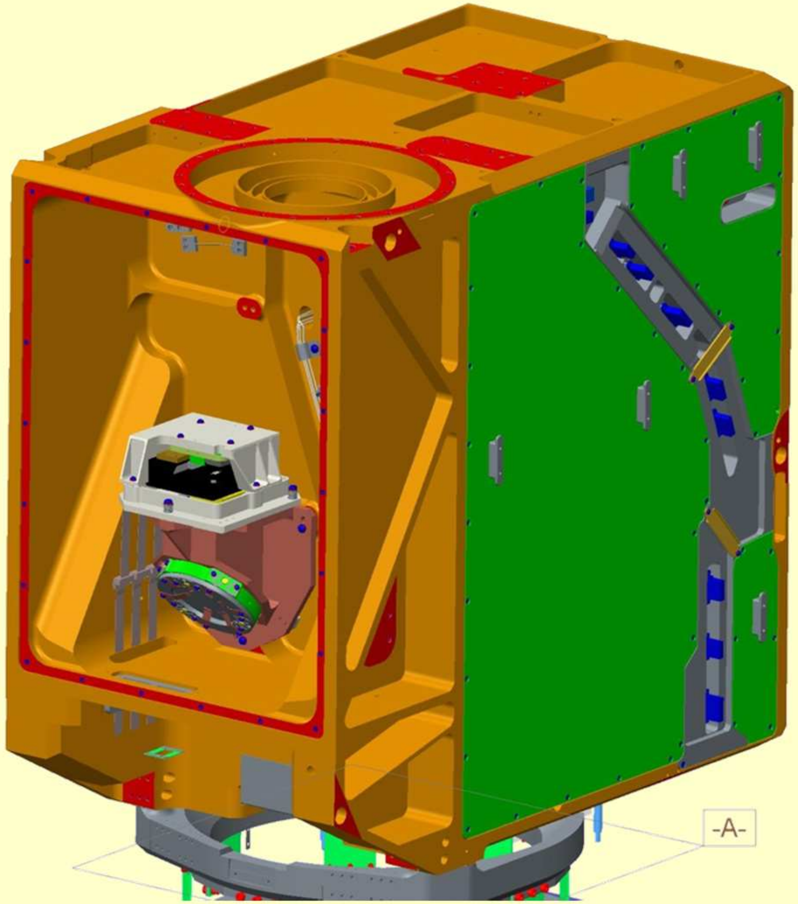
MATISSE radiation shield (100 K)

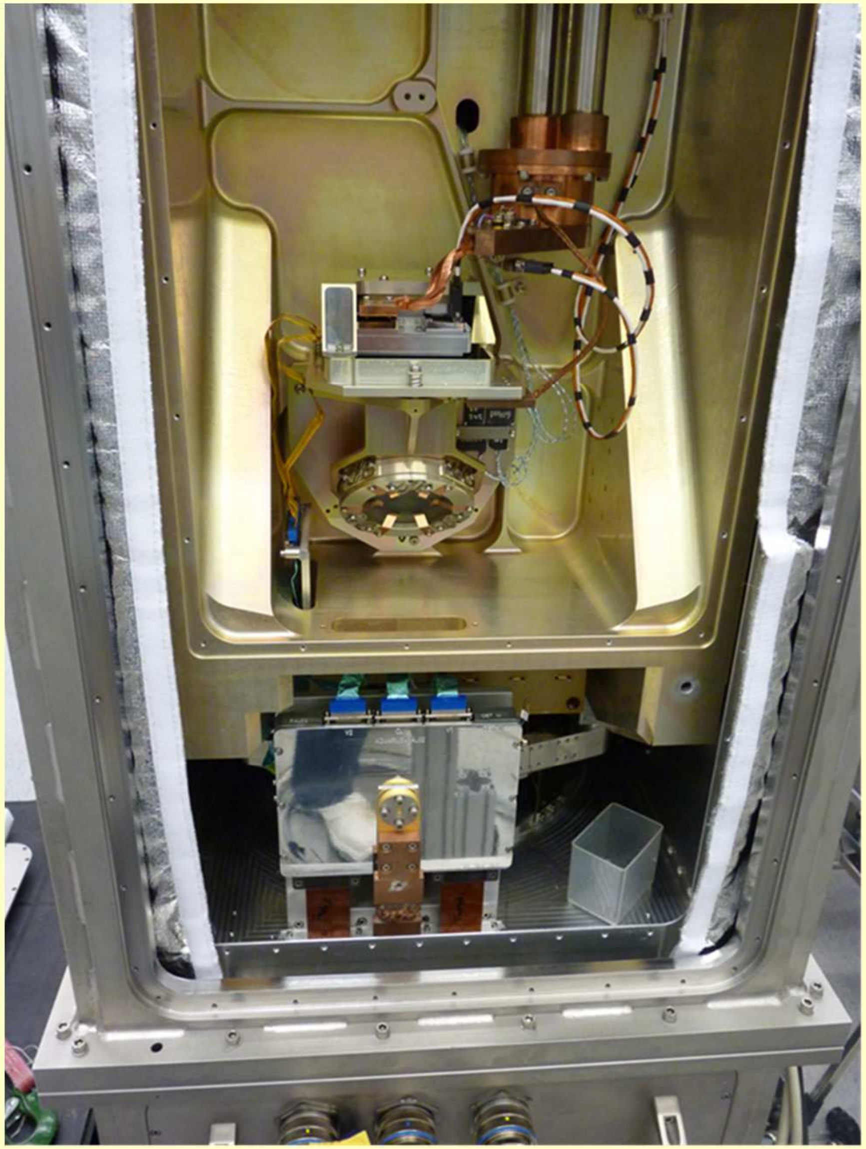


MATISSE cold optical bench (40 K)

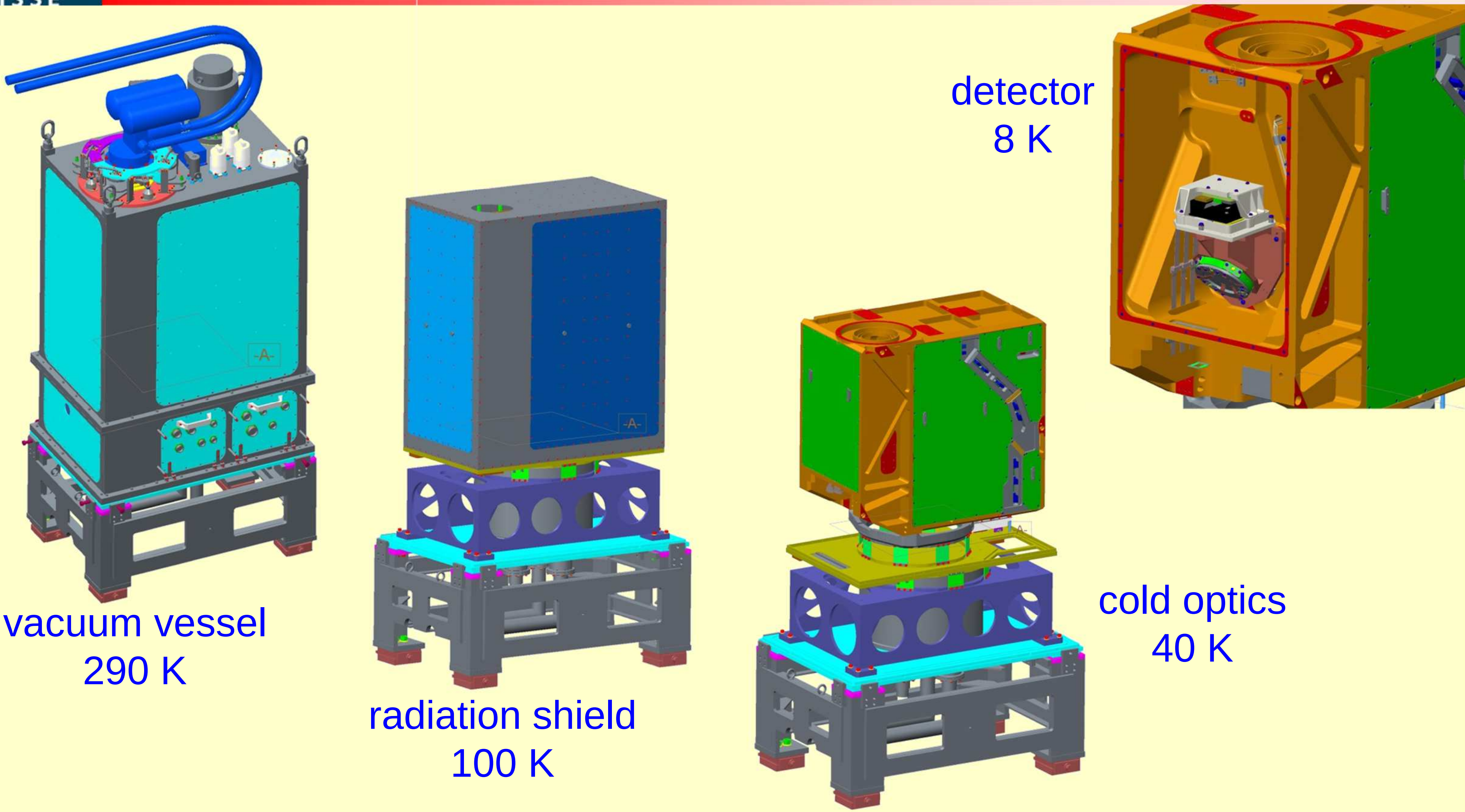


MATISSE detectors (Aquarius 8 K)





MATISSE cryostats



PT cooler

- o <u>Mounting and coupling of the PT cooler</u>
  - o Very soft mechanical connection due to vibrations
    - o Damping system

Cryomech standard damping

Modified ESO damping system

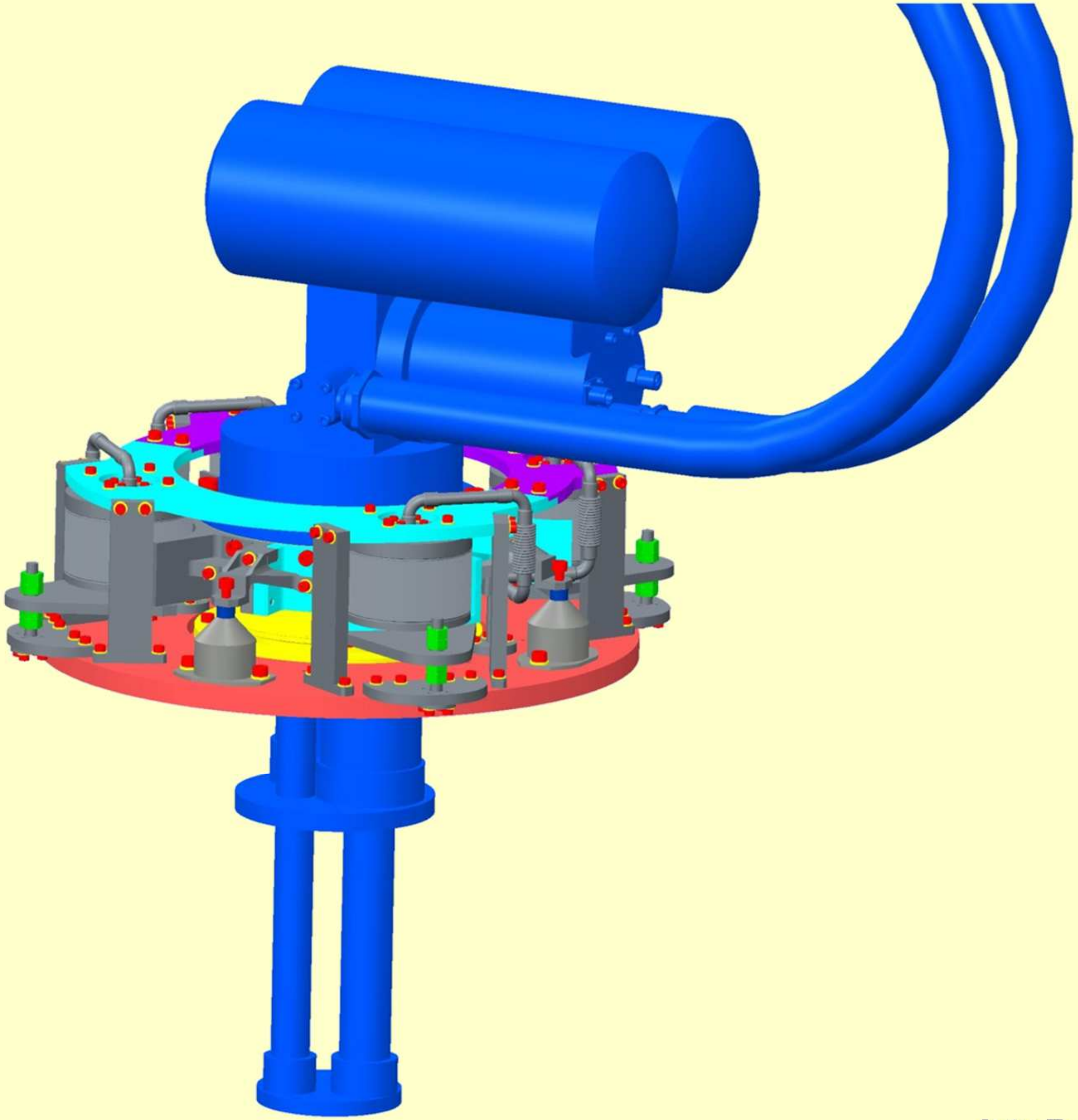
Vibration damping system

- Damping system
  - Standard damping system from cryomech
    - Bellow with spring damping

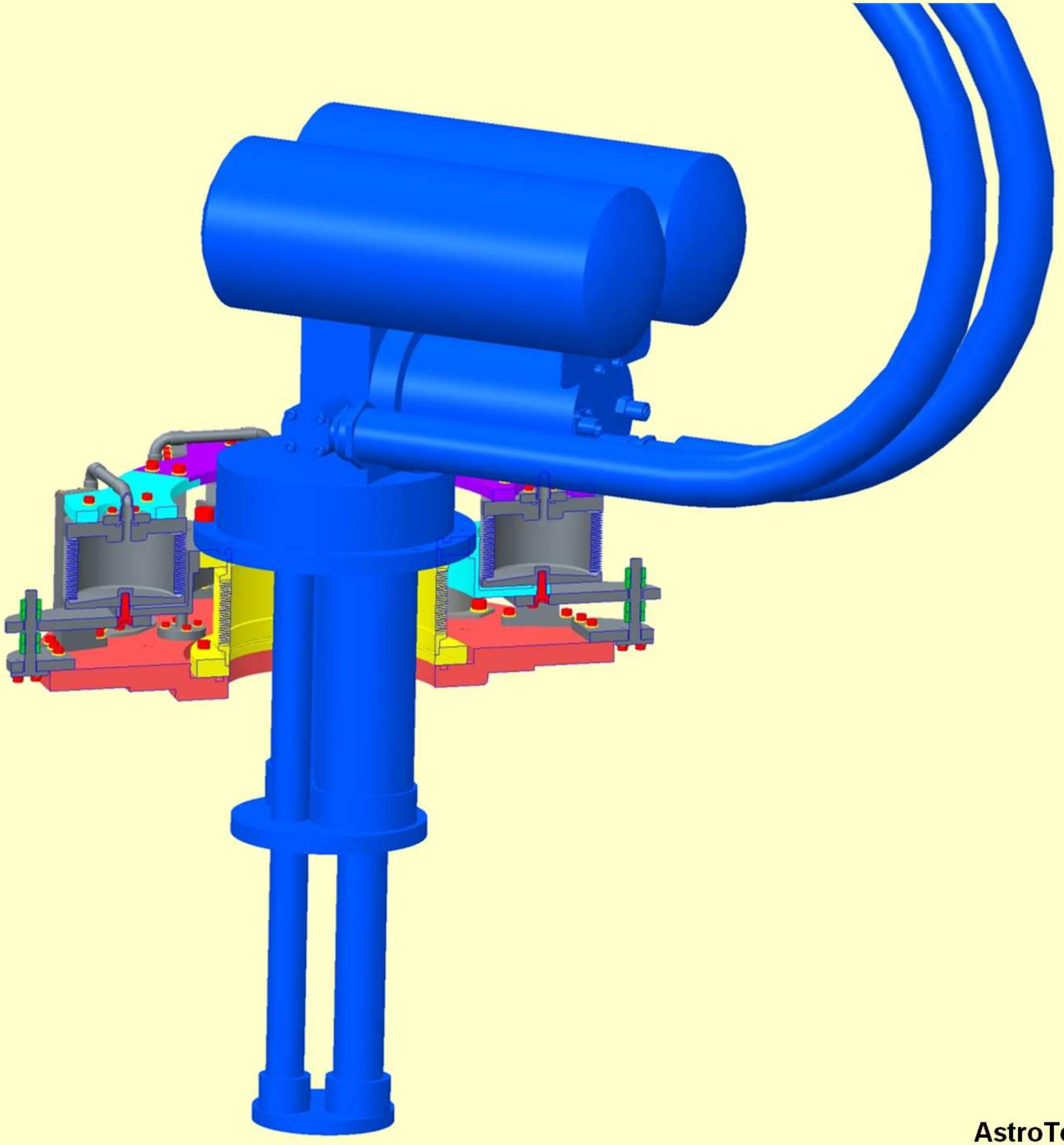
Vibration damping system

- <u>Damping system</u>
  - Modified ESO damping system
    - Balance between 1 central bellow pulling down and 4 small bellows pulling up

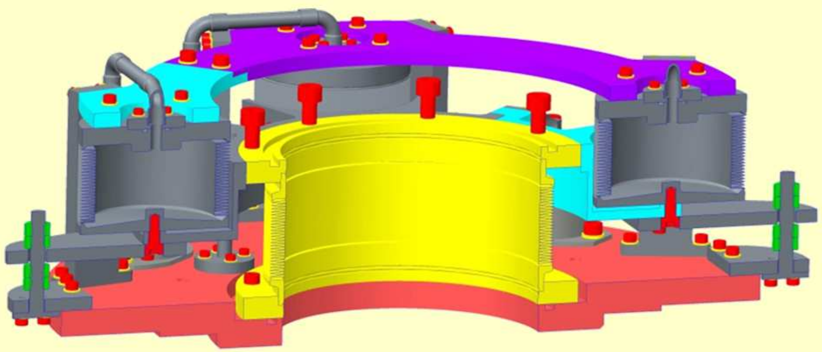
Vibration damping system



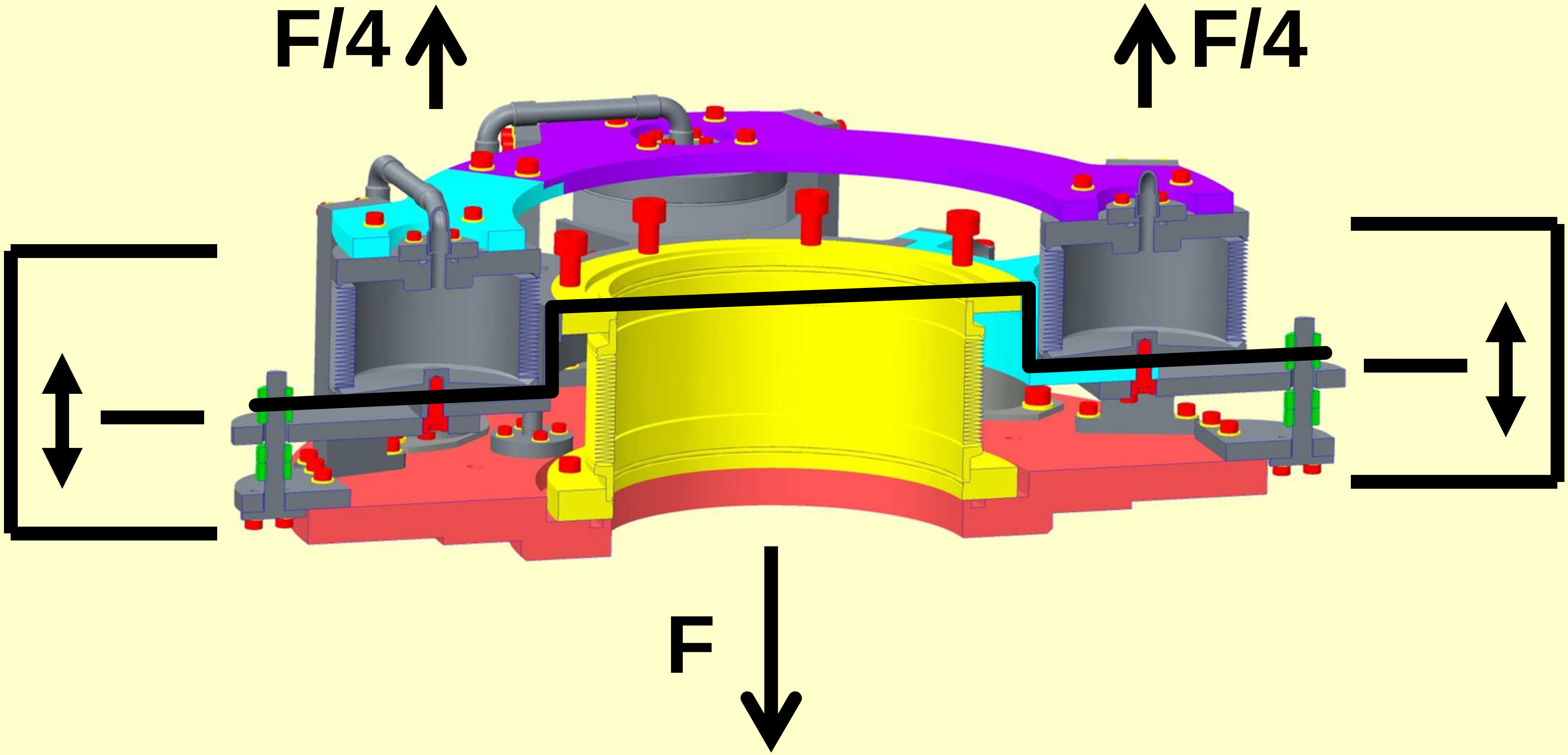
Vibration damping system



Vibration damping system



Vibration damping system

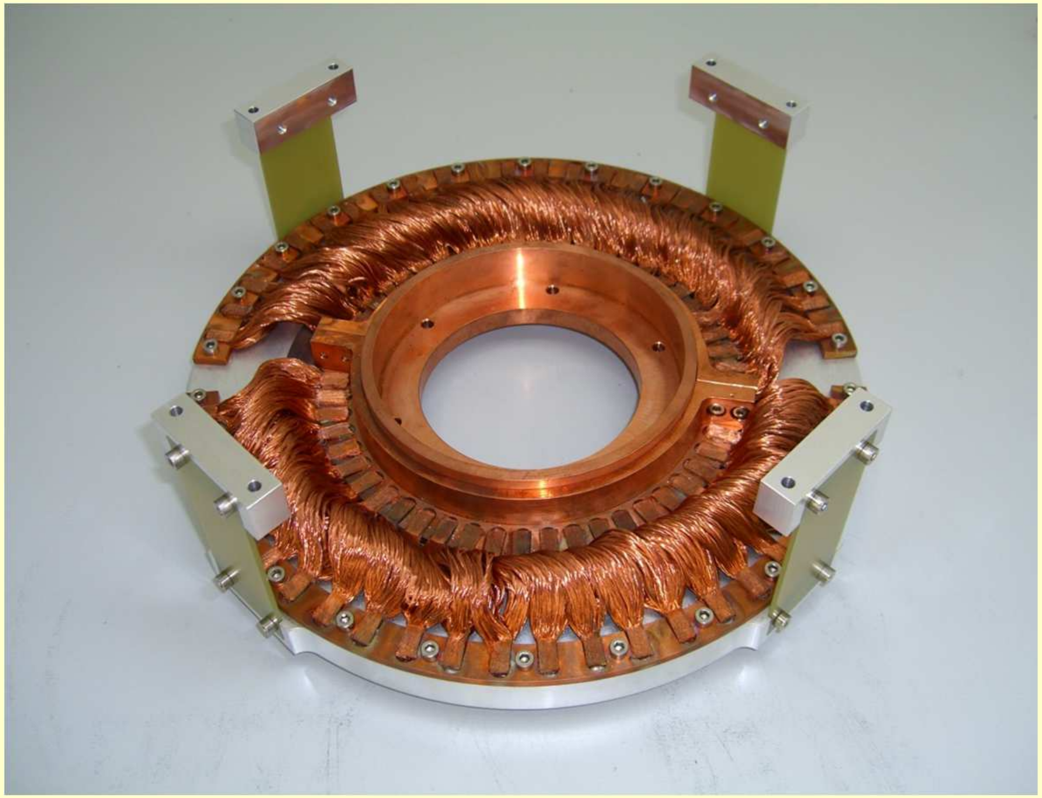


PT cooler

- Mounting and coupling of the PT cooler
  - Very soft mechanical connection
    - Damping system
  - Very soft but efficient thermal connection

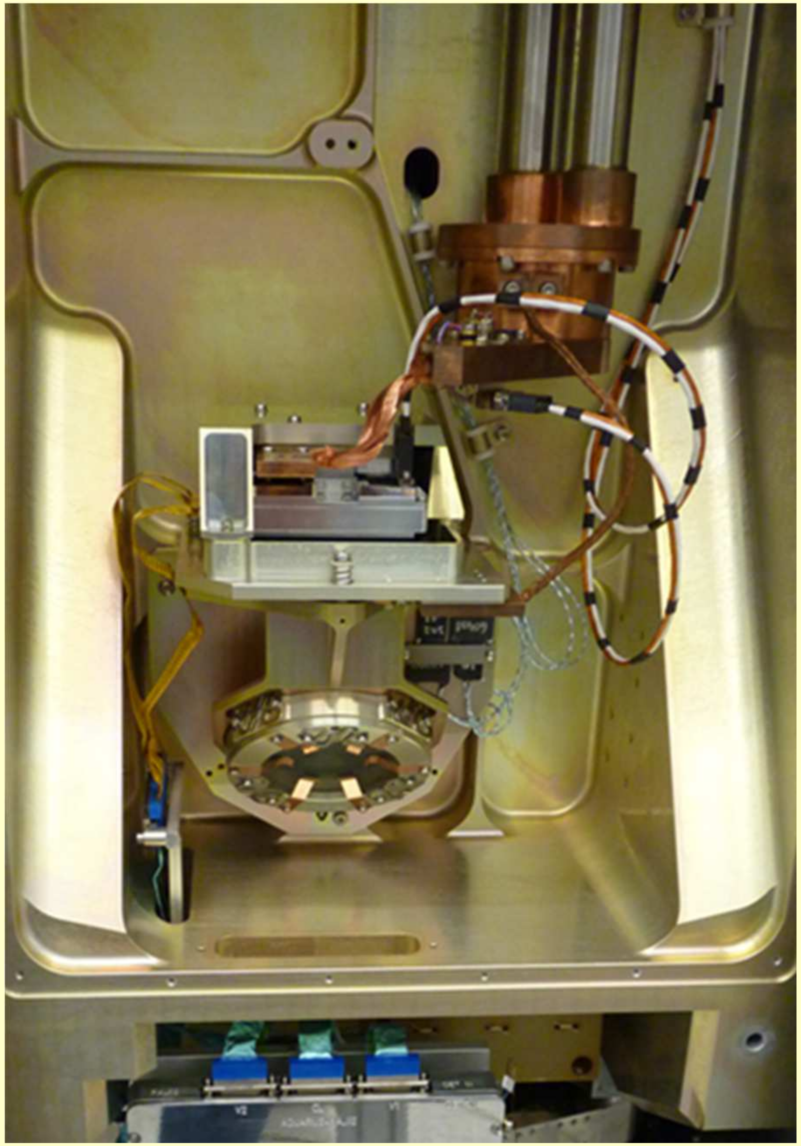
Thermal connection COB

- Very soft thermal connection
  - With copper braids A/l ≈ 20 mm²/mm for small ΔT
  - Solved by using 48 braids each A= 20 mm², l= 50 mm
  - 48 braids placed in a circle around the 1st stage of the cooler



Thermal connection Aquarius

- 2^{nd} stage to 8 K
  - $\Delta T \approx 4$ K
  - Copper braid
    $A = 16$ mm^2 , $l = 65$ mm

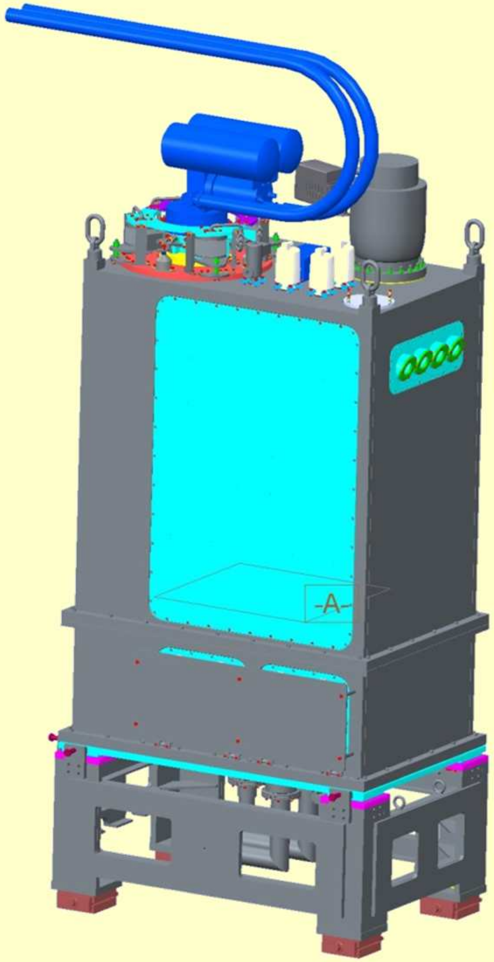


Thermal connection Hawaii

- 2^{nd} stage to 40 K
  - $\Delta T \approx 36$ K
  - Copper braid (detector)
    $A = 0.5\ mm^2$, $l = 85$ mm
  - Copper braid (preamp)
    $A = 2.5\ mm^2$, $l = 50$ mm

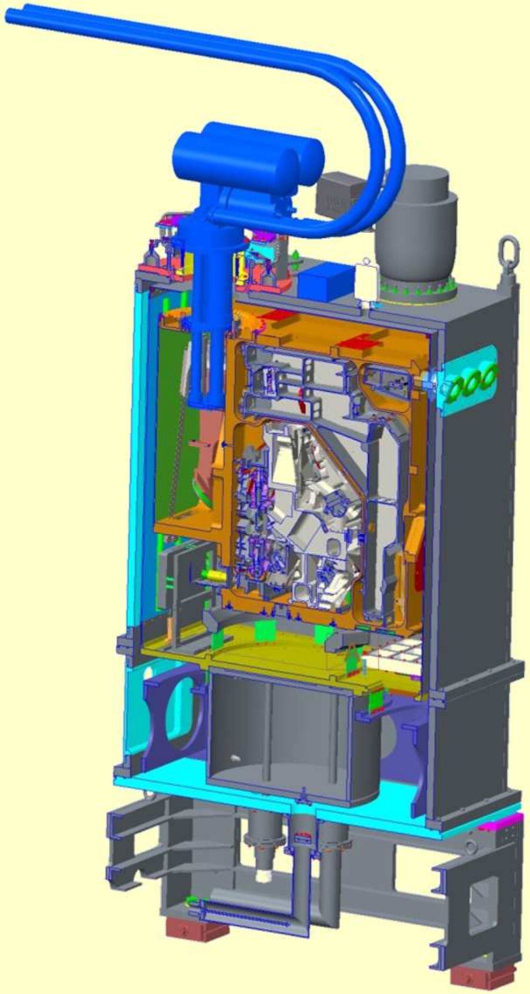
MATISSE cryostats

- Mounting and coupling of the PT cooler



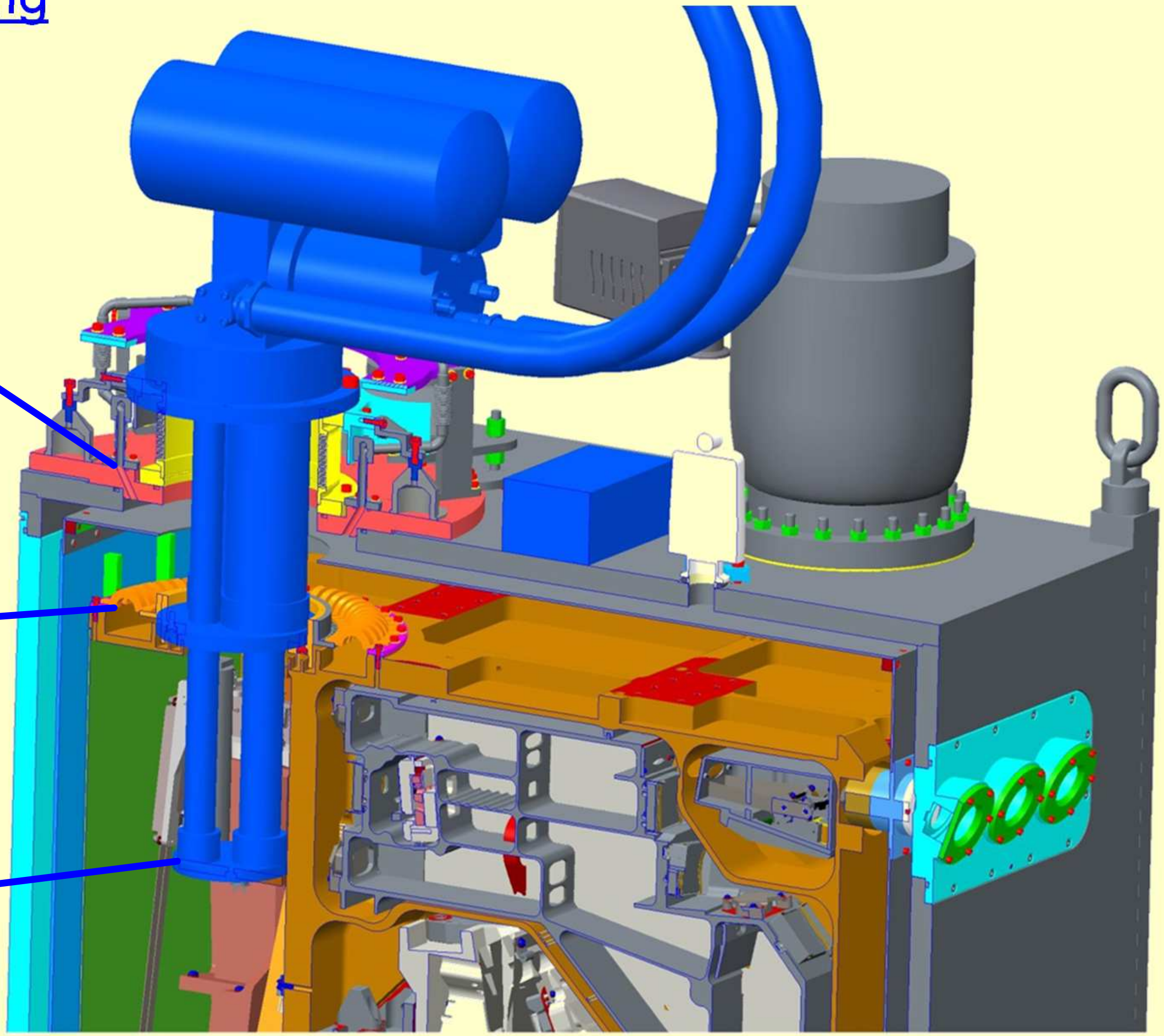
MATISSE cryostats

- Mounting and coupling of the PT cooler



MATISSE cryostats

- Mounting and coupling of the PT cooler



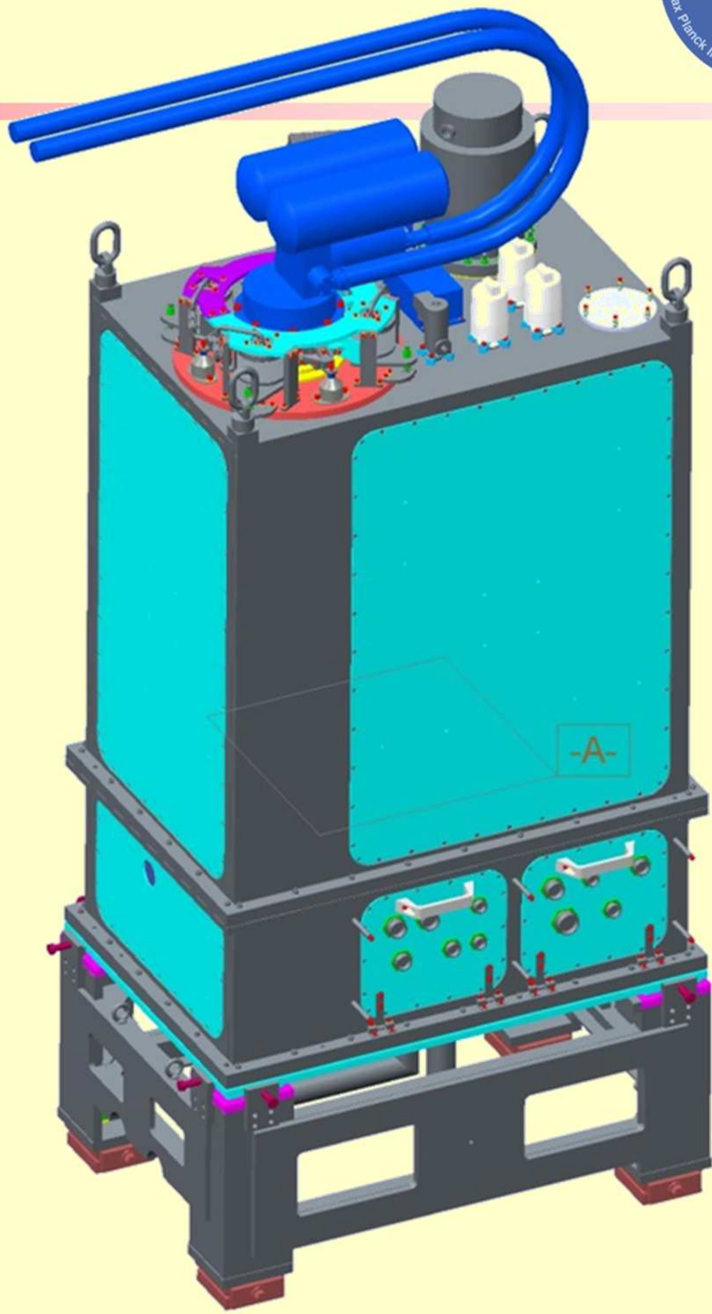
mechanical interface to vacuum vessel

thermal interface to COB

thermal interface to detector

MATISSE cryostats

- Accessibility to optics and detector
  - Side window for access to cold optics
  - Backside window for access to detector

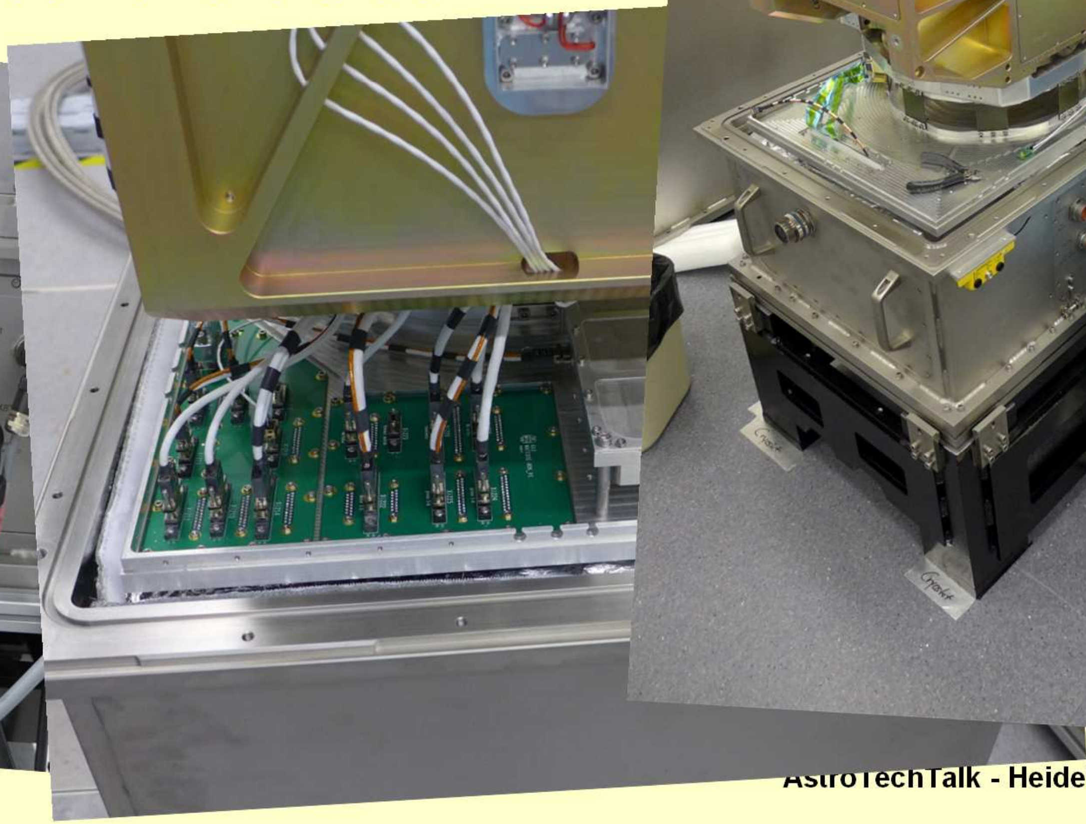


MATISSE cryostats

- [Accessi
  - Side
  - Bac

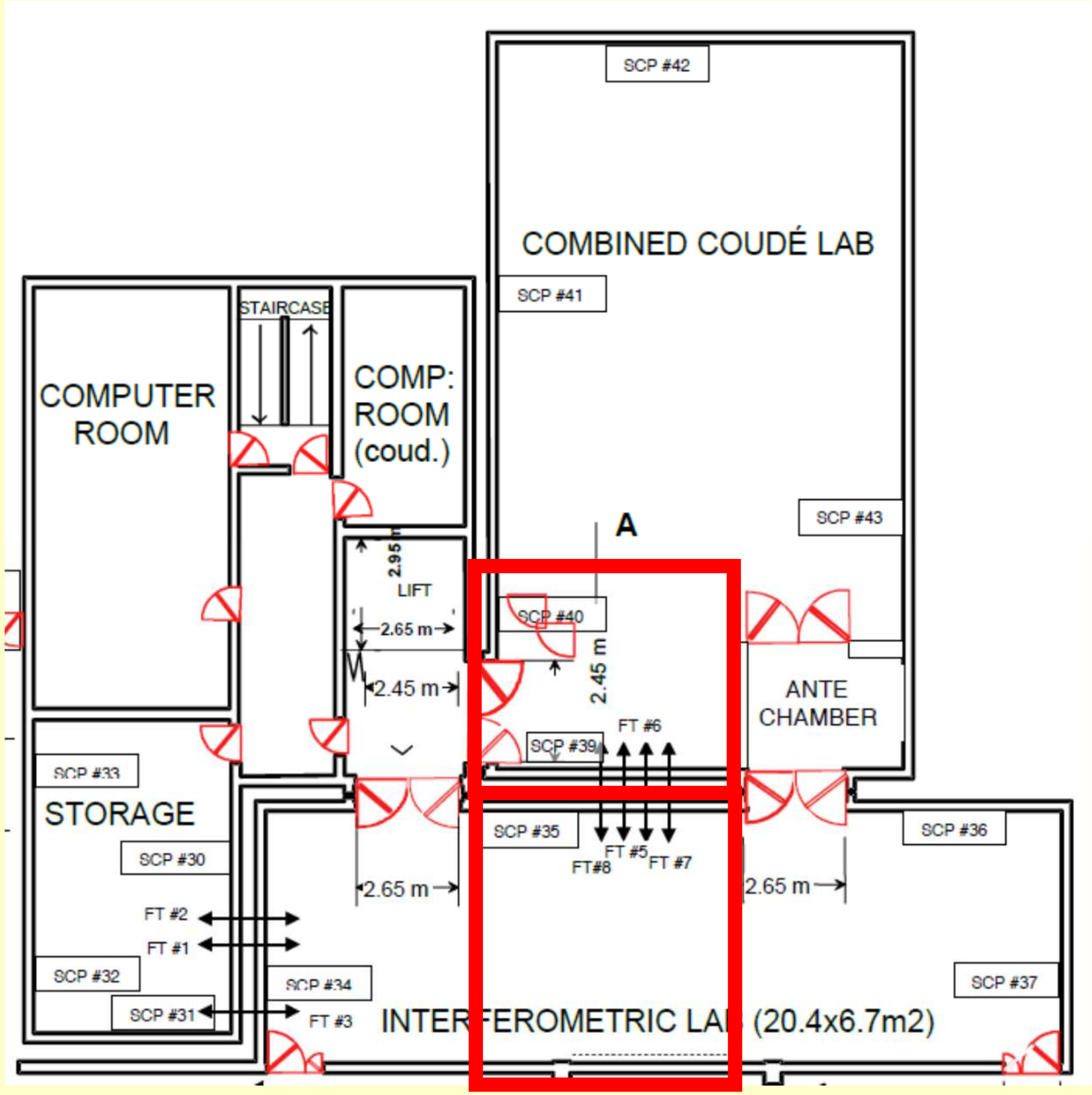
Cabling

- Cabling for the ICE
  - All feedthroughs on the lower part of the vacuur
  - Thermal coupling on the radiation shield
  - Distribution panel mounted to the base plate of
  - Connectors on the side wall of the COB



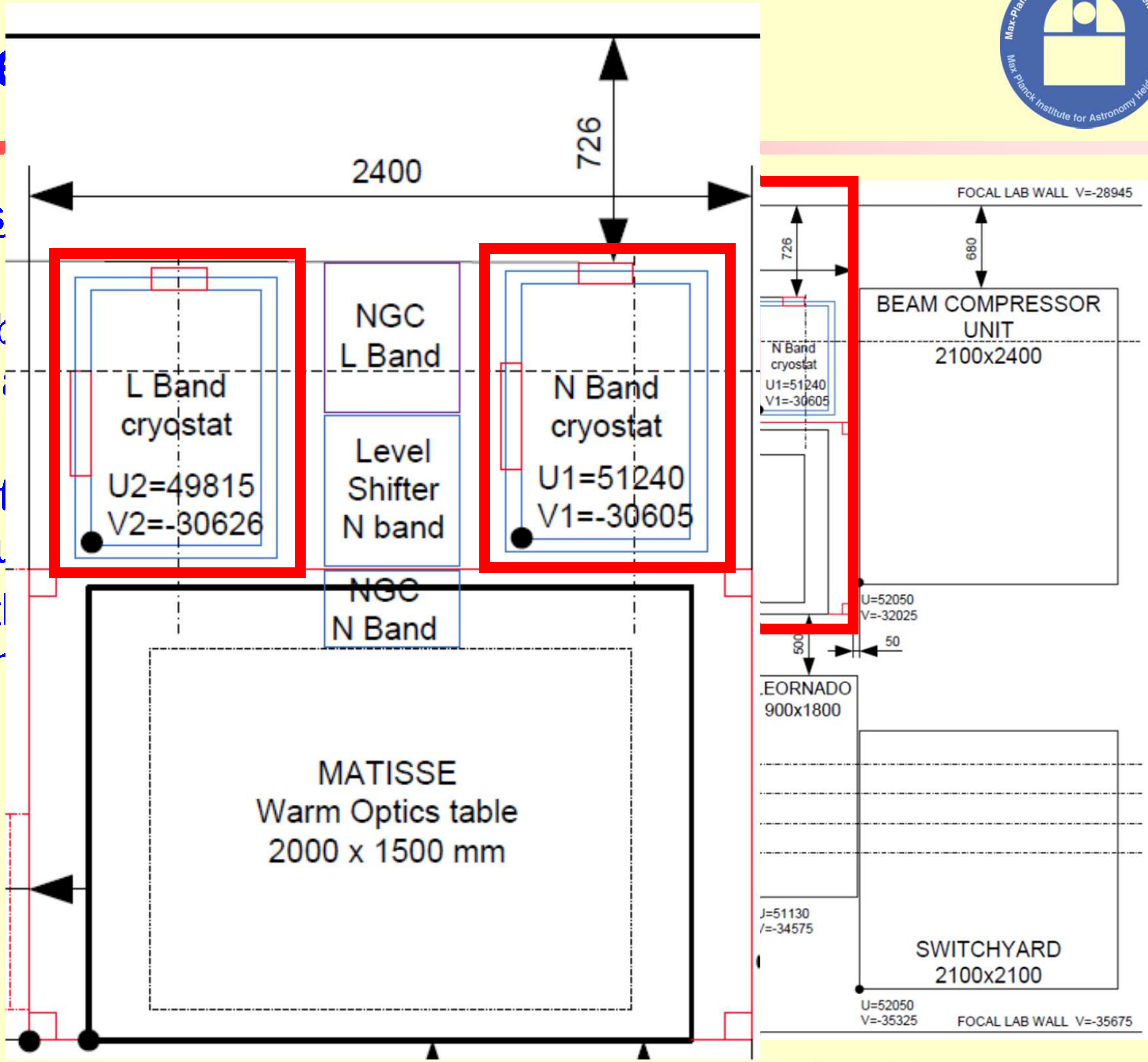
Space requirements

- Space requirements
  - Warm optical bench and cryostats inside interferometric lab
  - Electronic cabinets and helium-compressors inside combined coudé lab



Space r

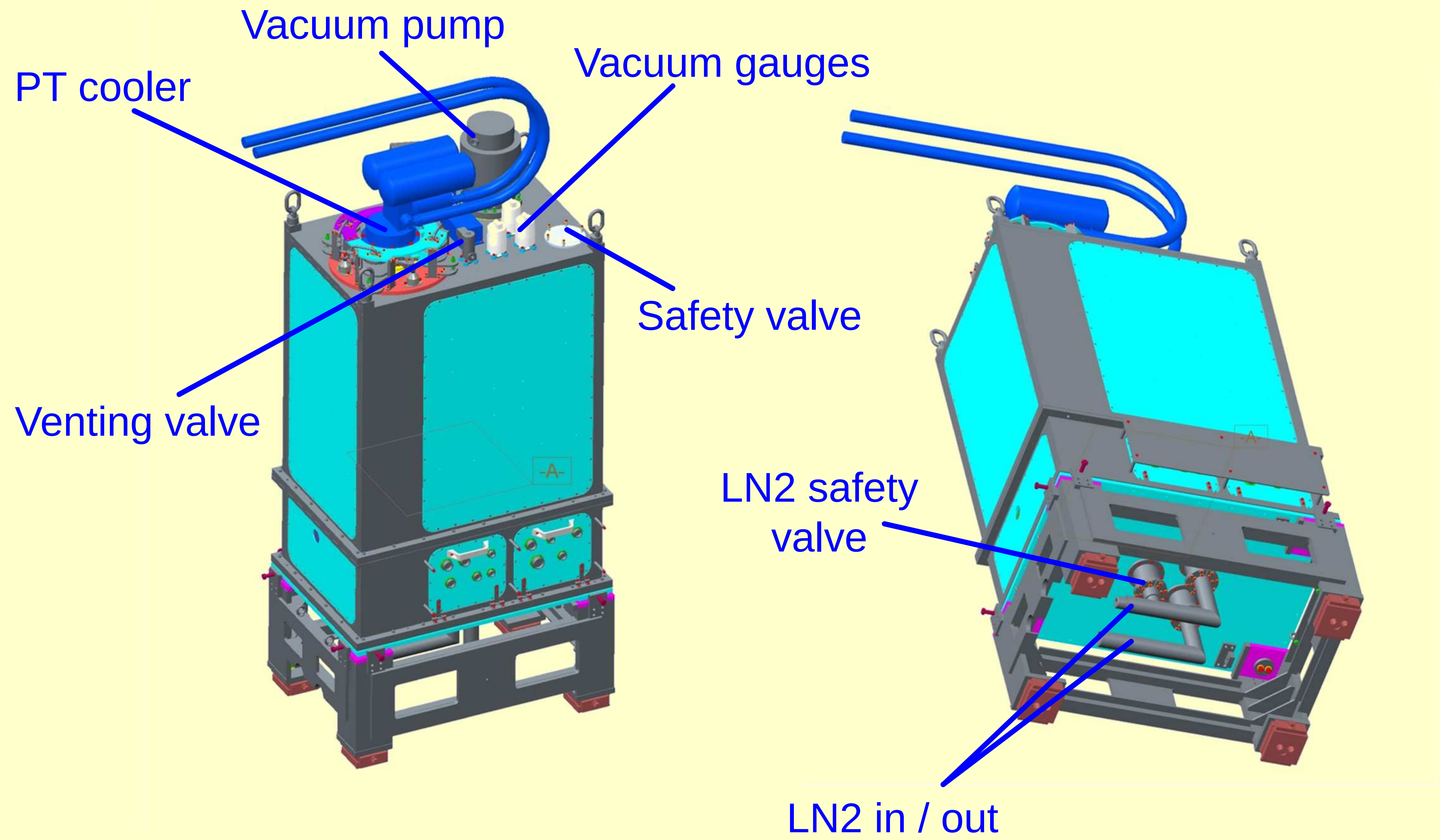
- Space requirements interferometric lab
  - Warm optical tab cryostats within 2.65 m x 2.40 m
  - Space required around the instru
  - Accessibility of t from one side ar back necessary



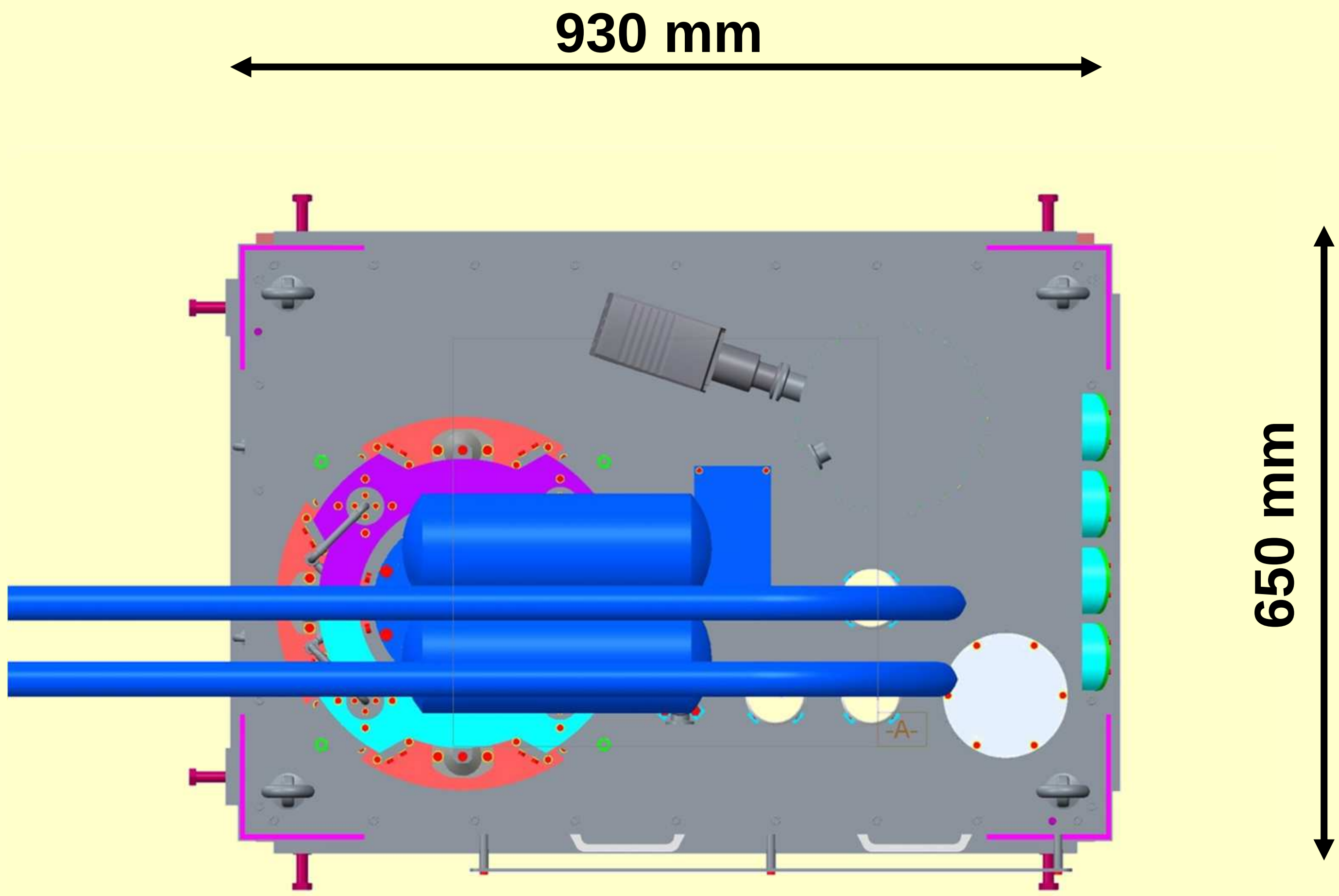
Space requirements

- Methods to reduce size
  - Extremely compact optics with multiple folding in 3 dimensions
  - Vacuum vessel with flat side walls
  - All protruding installation on top or below the cryostat
  - Helium lines bend in a high bow above the pass way on the back

Space requirements

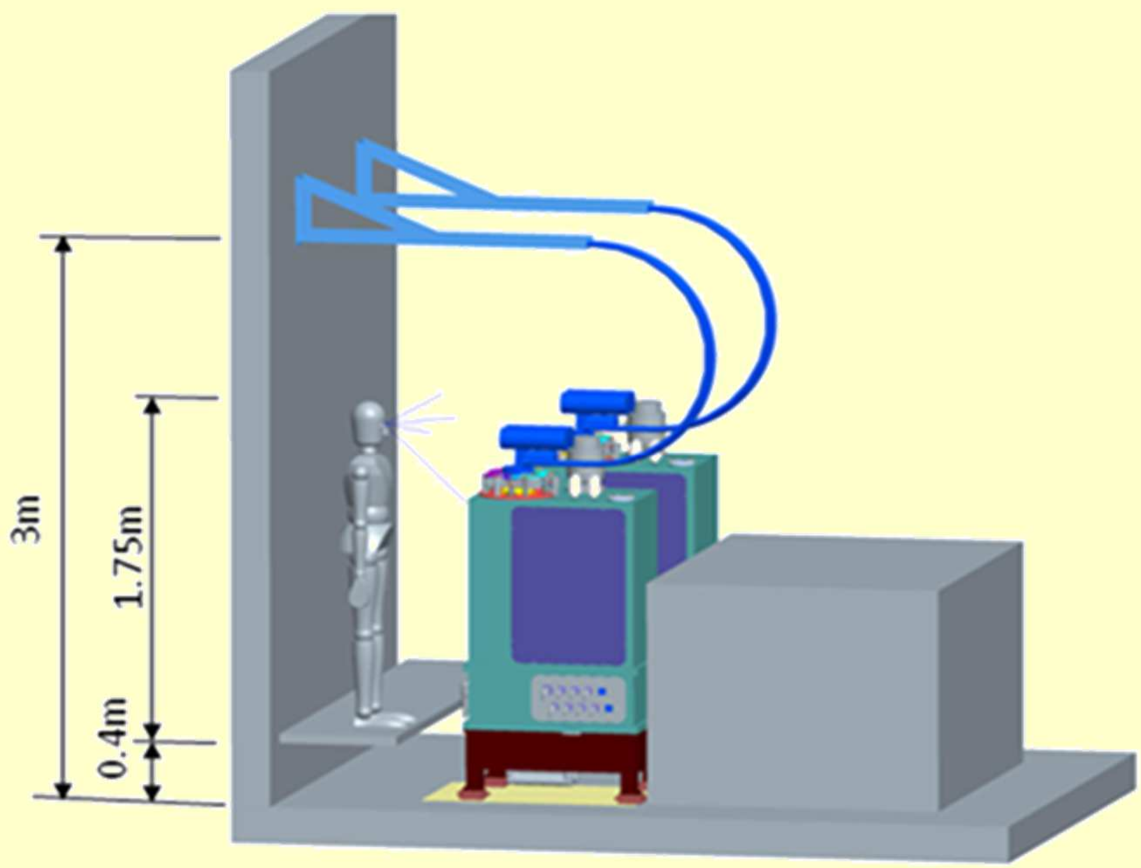


Space requirements



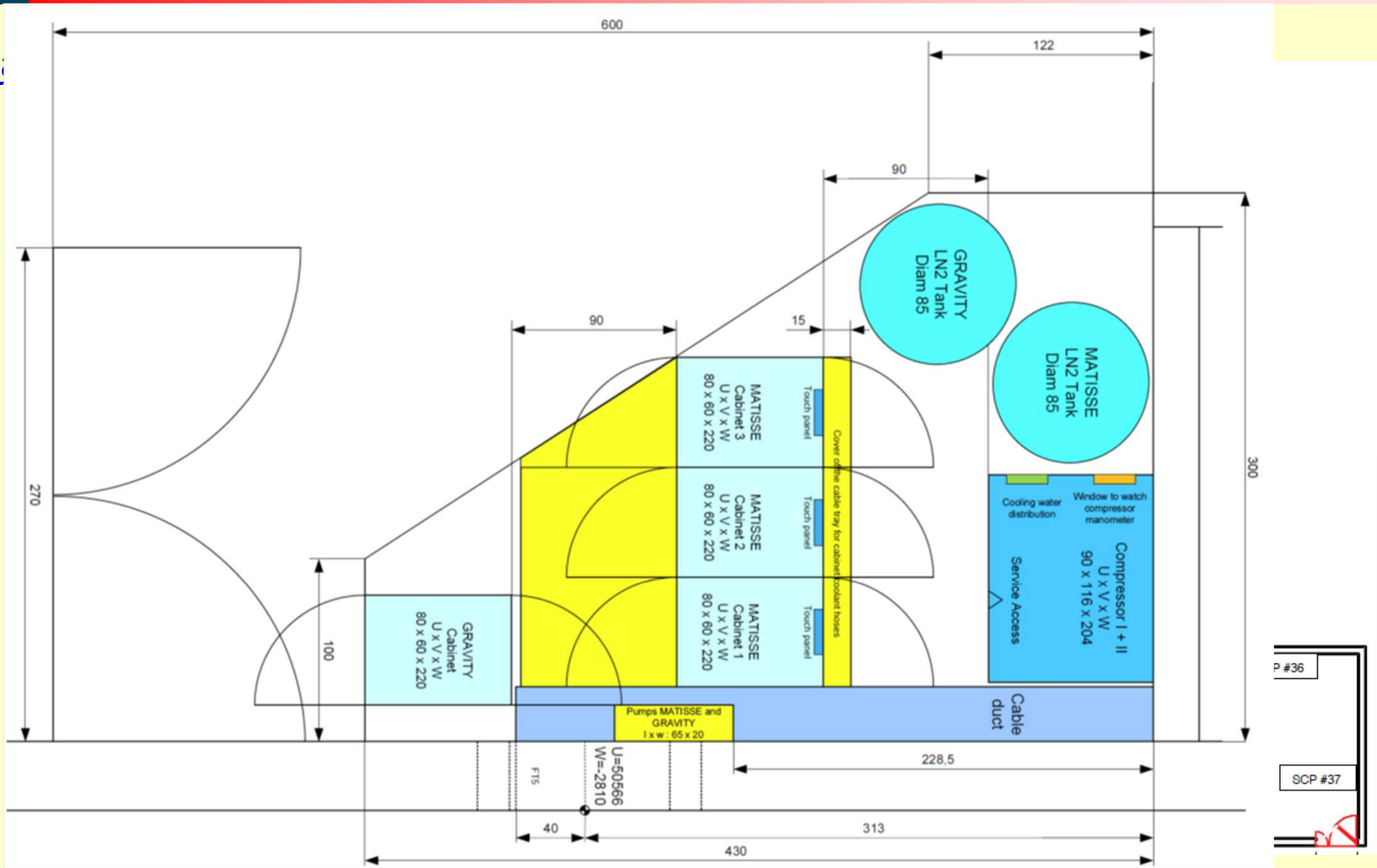
Space requirements

- Pass way behind the cryostat
  - Helium lines bend up



Space requirements

- Sp



Space requirements

- Space inside combined coudé lab
  - Two compressors mounted in vibration and noise damping housing
  - Mounted on top of each other

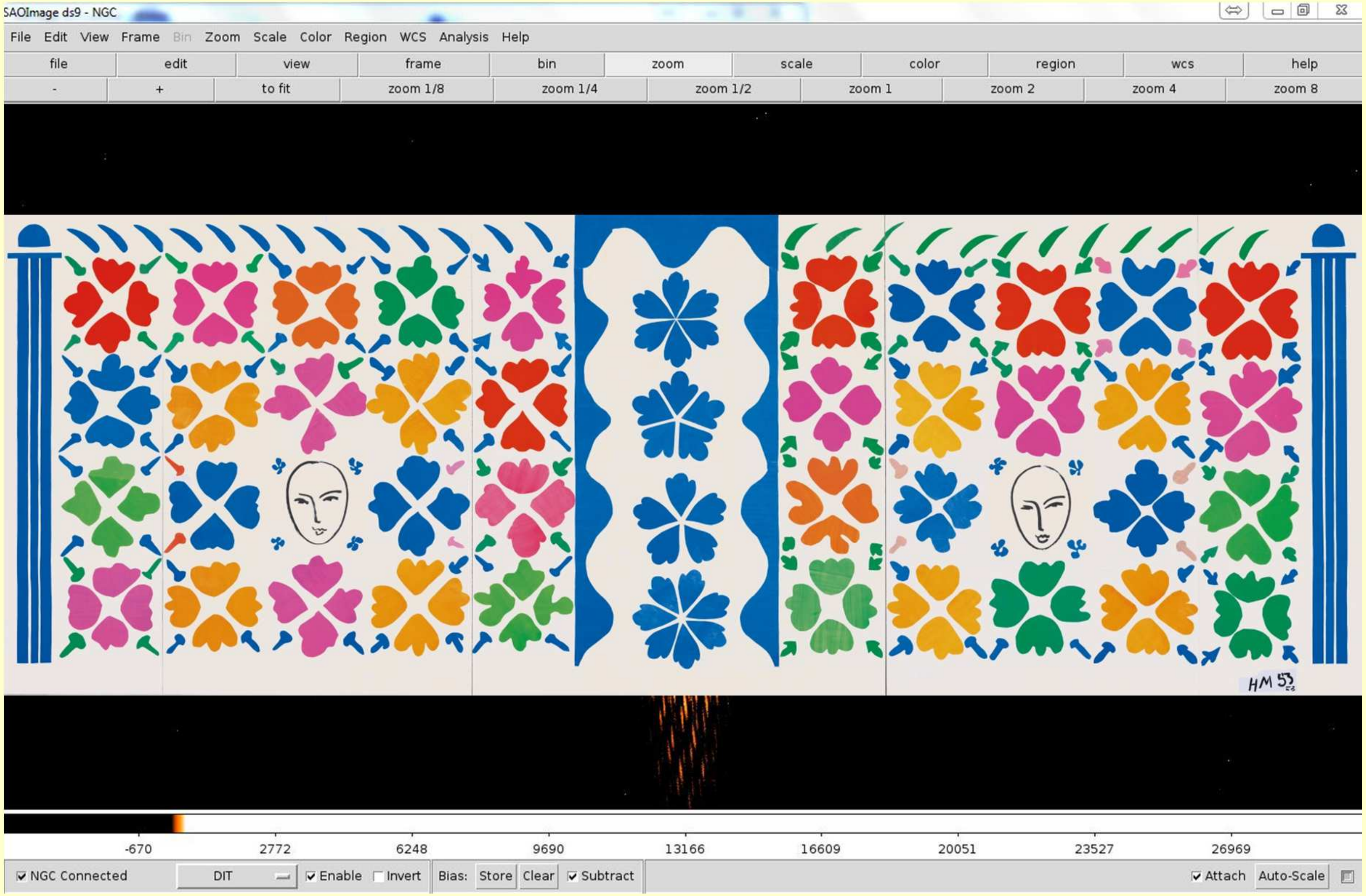
Compressor housing

MATISSE in Nice

- Current status and set up
  - Both cryostats in Nice
  - Integration and alignment of warm optics almost finished
  - Soon start of tests with the complete setup

MATISSE in Nice

- First fringes in July 2015



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Lessons learned

- Good planning is important
- Don‘t start manufacturing before the design is finished
  or it will result in technical compromise or remanufacturing of parts
- Don’t work only on the solution of your own problems, think also about what your partners need
- “higher authority” is needed to keep discipline in
  - planning, testing, documentation
- Make realistic planning for resources like personnel, lab space, money…
  - Fight for getting those resources

Future

- Future planning
  - PAE, May 11, 2017
  - Start packing: May 12, 2017
  - Start transport: June 16, 2017
  - Start integration, June 30, 2017

MATISSE on Paranal 2017

Questions?

?

Good bye Uwe