Cryostat Seed Scheme

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Rome, 28/7/2025

Cryostat Design Meeting

Cryostat main components

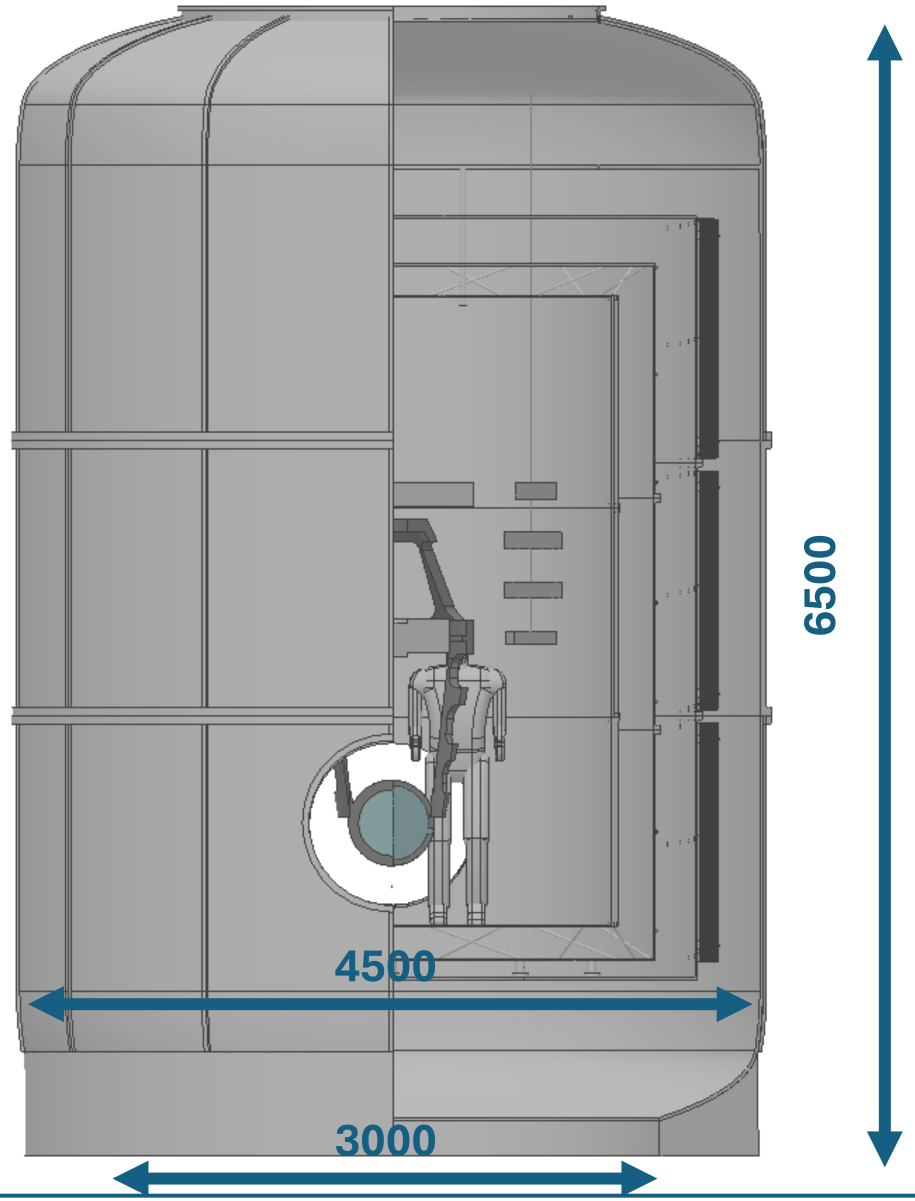
Vacuum Chamber

Material
Stainless Steel

Dimensions
External Diameter ≈ 4.5 m
Height ≈ 6.5 m
3 or more horizontal divisions

Bottom Access
To clean room Diameter ≈ 3 m
Interface flange to be defined (ca. 1.6 m)

Vacuum Separation from upper warm tower, but vacuum is shared between all shields



Cryostat main components

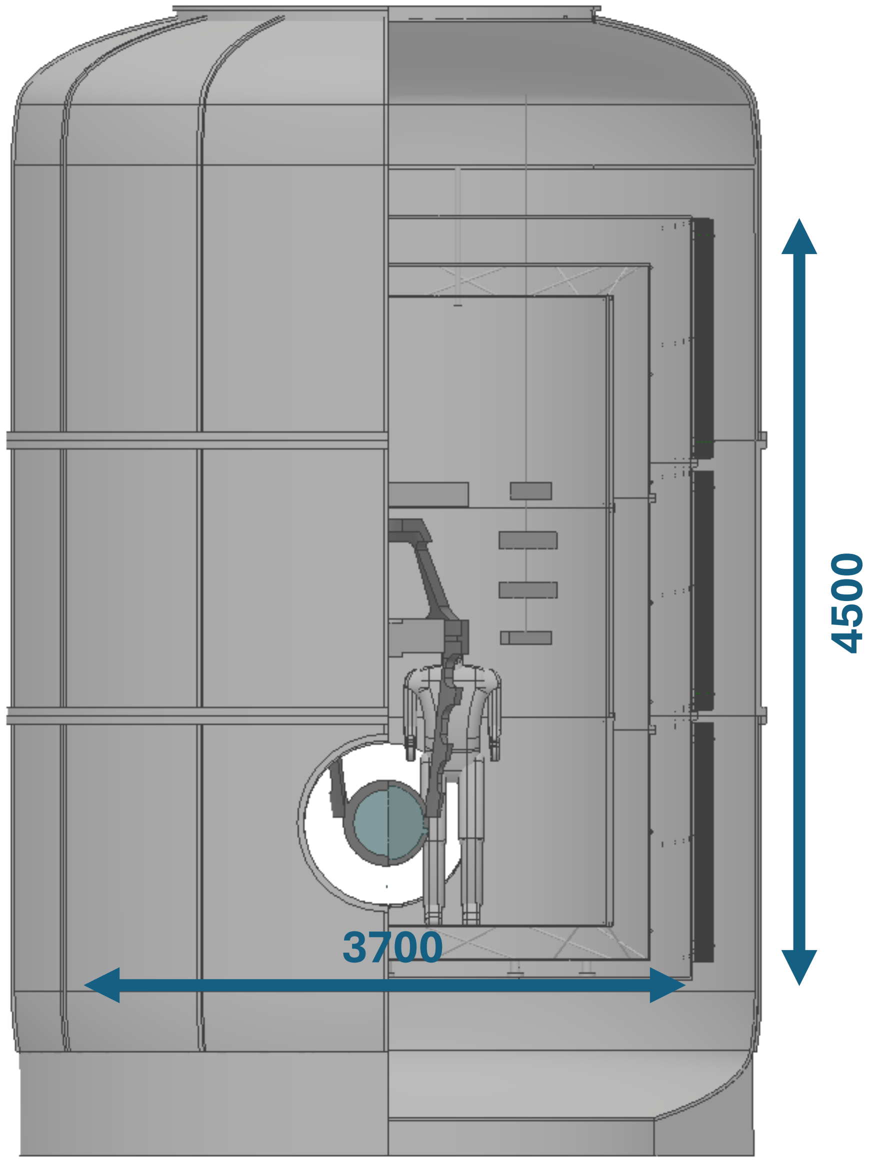
Outer Thermal Shield - OTS

Material
High thermal conductive Aluminum (e.g. Al6063, 1000 series)

Dimensions
External Diameter ≈ 3.7 m
Height ≈ 4.5 m

Physical properties
3 or more horizontal divisions
Stiffeners
Arm Pipe
Bottom Access

Target Temperature 80 K
Compulsory Radiation shielding
Helium Gas Exchange



Cryostat main components

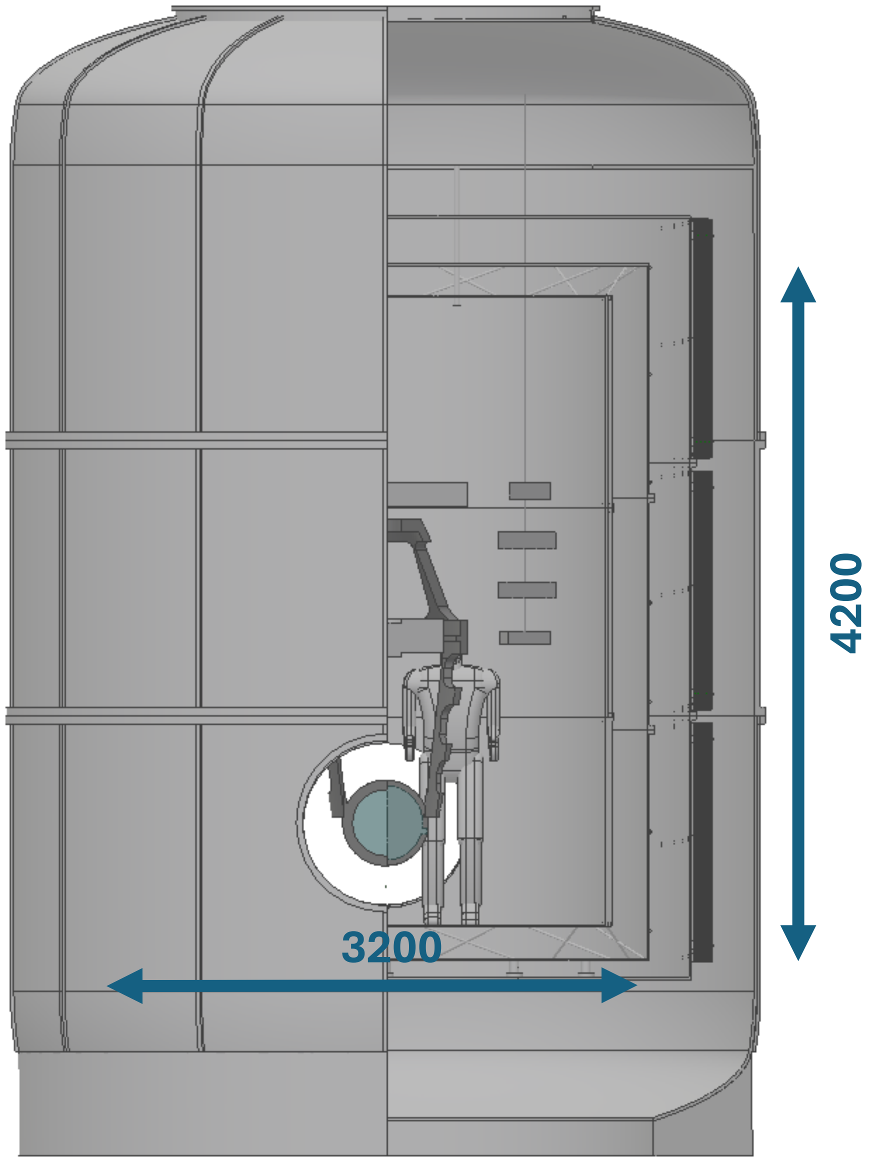
Inner Thermal Shield - ITS

Material
High thermal conductive Aluminum (i.e. Al6063, 1000 series)

Dimensions
External Diameter ≈ 3.2 m
Height ≈ 4.2 m

Physical properties
3 or more horizontal divisions
Stiffeners
Arm Pipe
Bottom access

Target Temperature 8 K
Helium Gas Exchange



Cryostat main components

Internal Inner Thermal Shield - IITS

Material

High thermal conductive Aluminum (i.e. Al6063, 1000 series)

Dimensions

External Diameter ≈ 2.7 m

Height ≈ 3.8 m

Physical properties

3 or more horizontal divisions

Stiffeners

Arm Pipe

Bottom access

Target Temperature 2 K

Helium II

Payload and Beam Axis

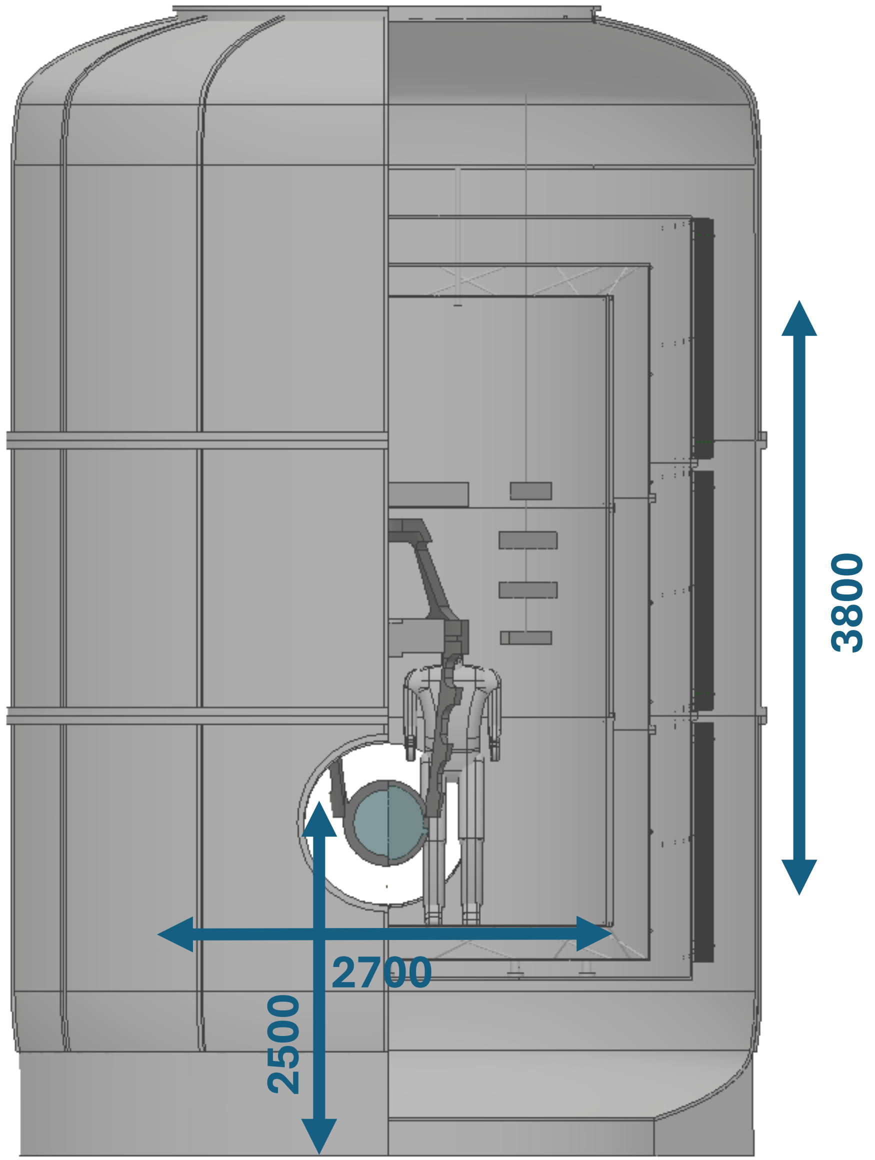
Height from ground

2.5 m (Locally)

1.3 m in general

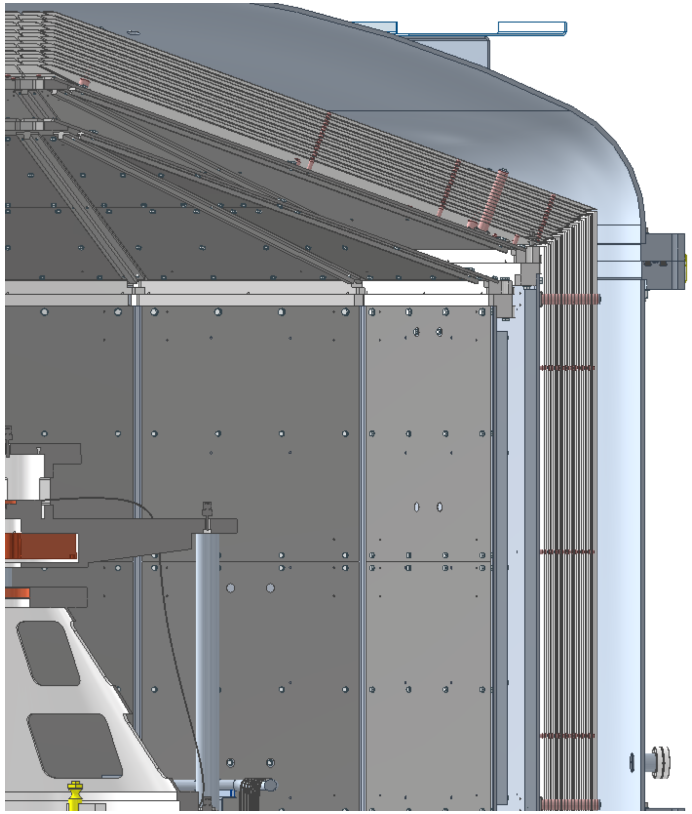
Height from IITS base ?

Last iteration from2nd ET-ISB Workshop on ET-LF TM Tower Integration ET-0094A-25



Thermal Shields – Radiation Shield of OTS

OTS faces VC at room temperature, so a radiation shield must be considered
MLI (Multi Layer Insulation) blankets proved to release particles, resulting in frosting on optical windows.
New proposed radiation shielding by ARC-ETCRYO in Rome is RML (Rigid Multi Layer)


C75 in ARC-ETCRYO Rome

RML - Rigid Multi Layer

Thin (up to 0.3 mm of Aluminum) layers kept in place by a non-conductive system

Easier to be applied on Polygonal surface
Takes into account tie-rods
To consider thermal input thorough various holes

In case of layed thermal shields (this proposal will be explained in next slides), RML on bottom surface must be designed

Other proposals?

Thermal Shields

Shape

Circular or Polygonal

Number of horizontal Divisions

3 or more

Stiffeners

On VC-OTS-ITS-IITS

Material

Al6063 (ARC-ETCRYO)

Cabling Management

Electrical wires

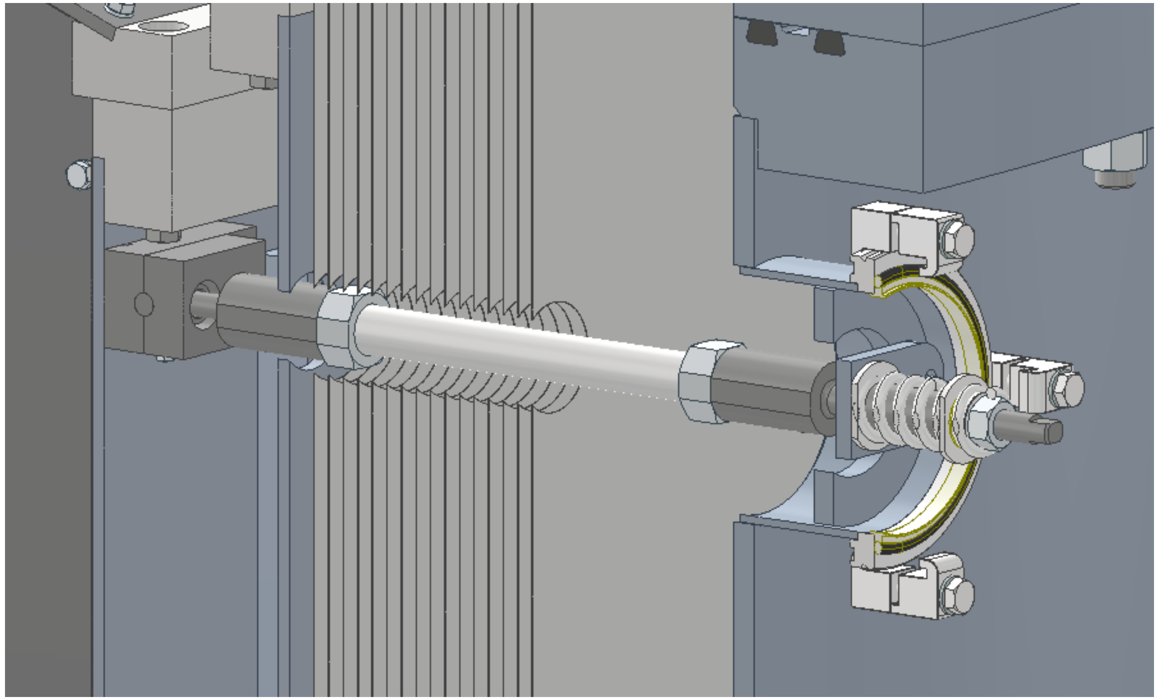
Hole Management

Cables – suspension wires

Tie Rods

Anchor thermal shields to VC, for stabilization and modes control

Material: G10 + stainless steel



Thermal Shields - Supports

Thermal shields supports must be chosen taking into account: operability inside IITS, thermal inputs, modal analysis.

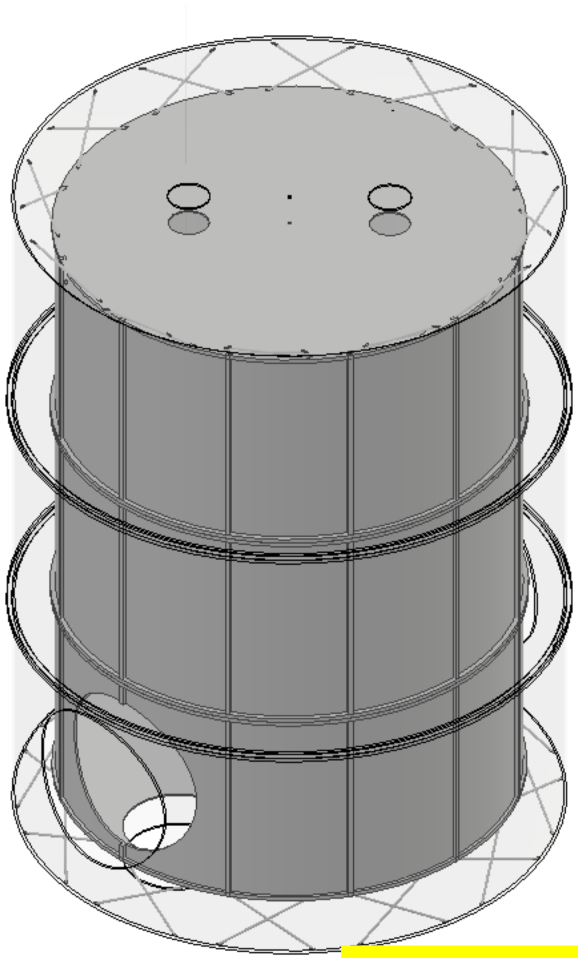
Beam Supported

Presented by Iaquaniello
ET-0055B-24

Top and bottom rods for all thermal shields

Easy implementation for RML

Material and sizing to be defined



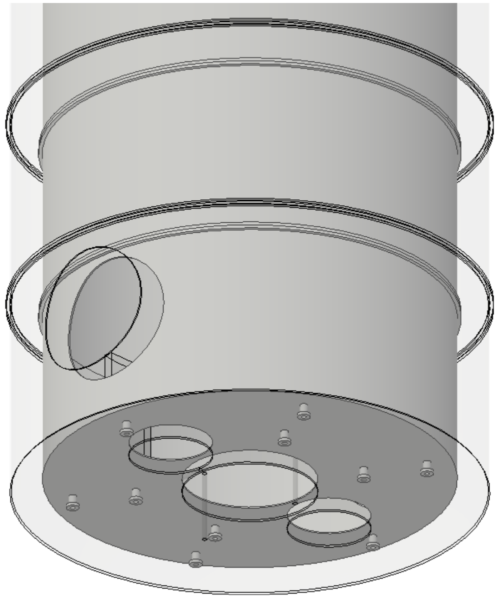
Layed

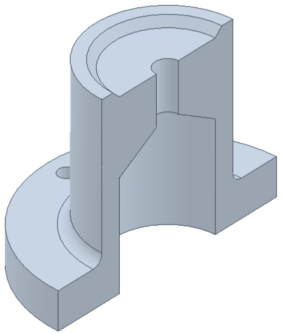
Will be used in C75

Must be take into account:

- Themal input
  →insulating material
- Weight loads
- Bottom radiation shielding
- Hard implementation of RML

- Material and sizing to be defined





Other proposals?

Helium Channels

To consider different phases of helium between OTS, ITS and IITS due to
different target temperatures→different cooling architectures.

Since thermal shields are divided in horizontal sections, continuity between helium channels must be guaranteed (i.e. indium flanges)

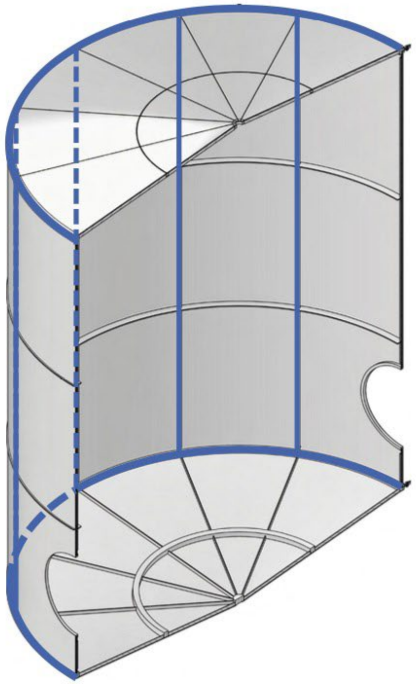
Proposal: Intrinsic in structure

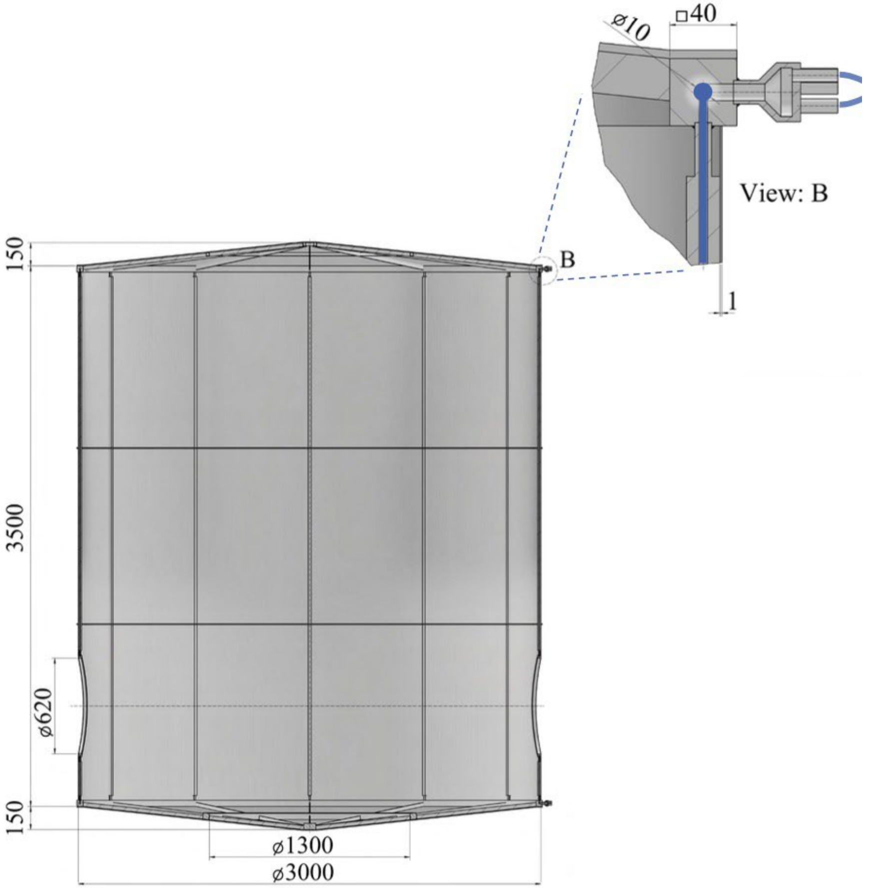
Aluminum structure with hollow profile, already simulated

To be defined:

- Number of vertical paths
  - Vertical paths is good for Newtonian noise
  - Multiple vertical path means multiple passages on horizontal sections

EXAMPLE
On the right as presented by L Busch, G Iaquaniello, P Rosier, M Stamm and S Grohmann ET 0297A -23





Helium Channels

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Proposal: Soldered Tubes

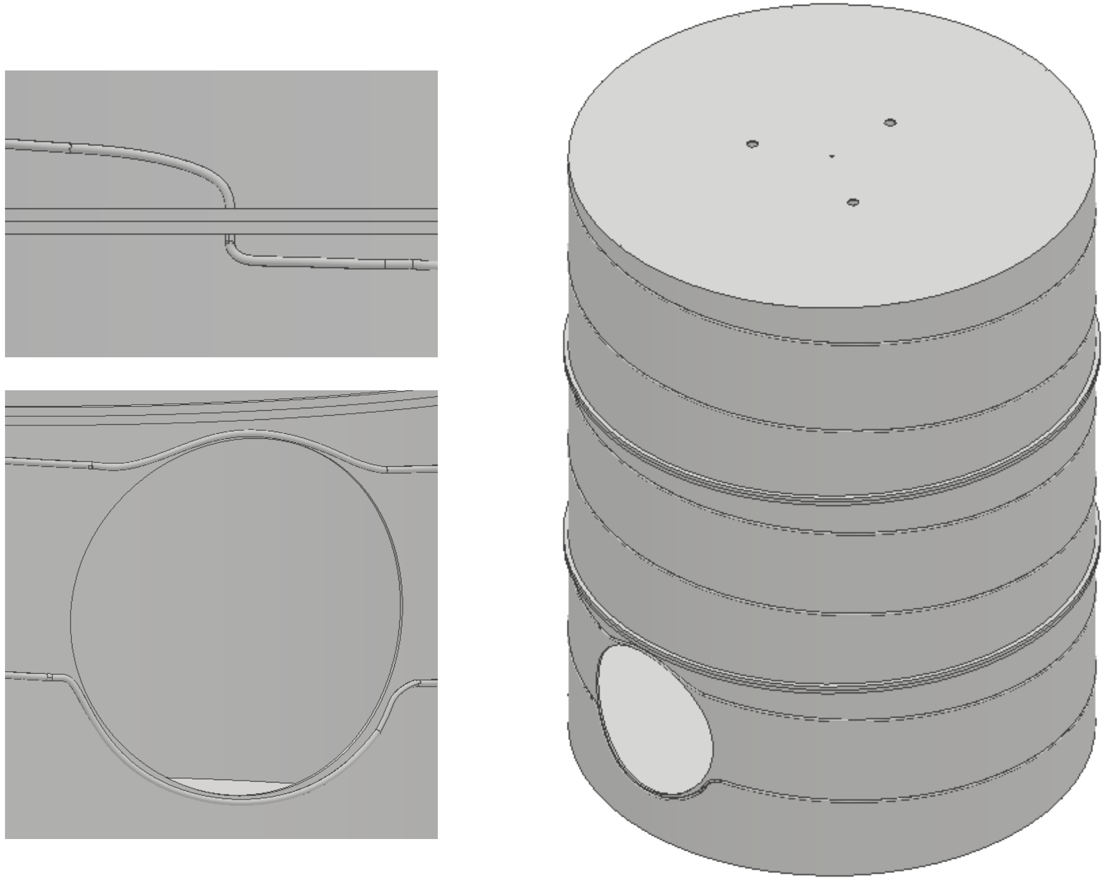
Path and geometry, to be defined, must ensure:

- Low thermal gradient on all the surface
- Low number of passages through horizontal sections
- No passage on arm pipe

EXAMPLE:
Helicoidal path with semicircular cross section
To be defined:

- Number of total spirals

Other proposals?



Clean air vents

Clean air flow must be operative inside IITS prevent dirt/particles to deposit on the mirror. Direction and flow must be defined. During opening of VC, there must be slight overpressure.

Flow of clean air from above, in a vertical or angular manner (to be analyzed)

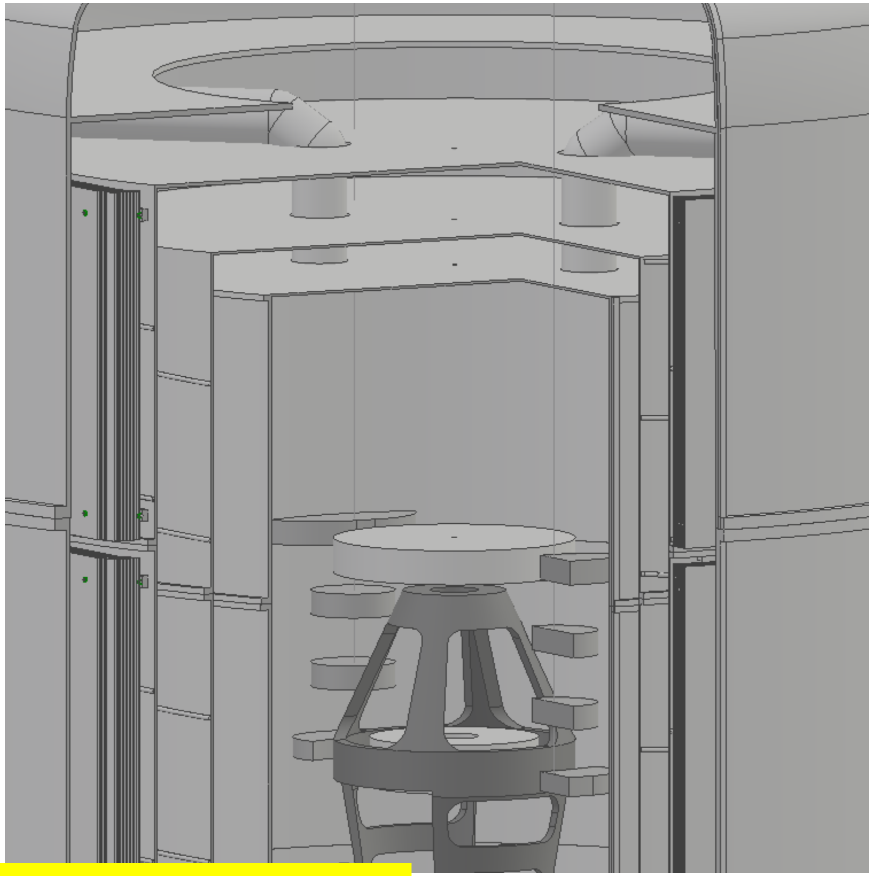
Whole payload is impinged by the clean air

Clean air exits from the payload hole on the bottom or from other air vents.

Air must not be trapped between main thermal shields, so exhaust holes might be necessary.

To consider variety and abundance of metal parts encountered by the flow

To consider wise design of pipe in between the shields



Other proposals?

Clean air vents

Clean air flow must be operative inside IITS prevent dirt/particles to deposit on the mirror. Direction and flow must be defined. During opening of VC, there must be slight overpressure.

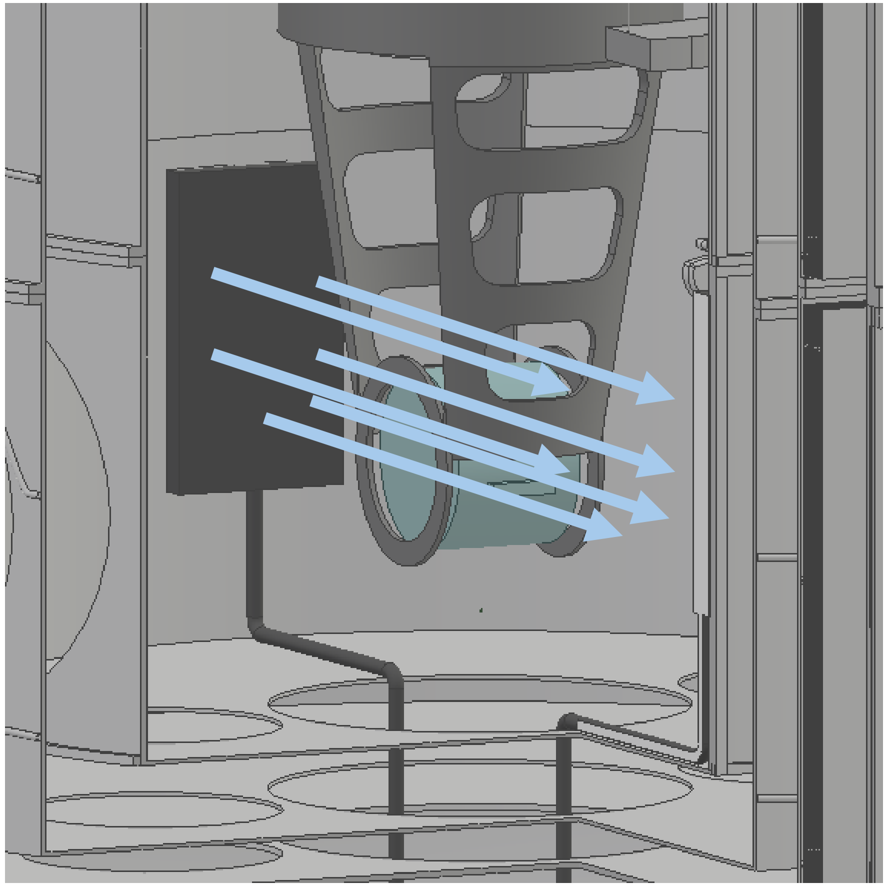
Lateral flow

Perpendicular to the optical axis, but not on all the payload.

One inlet and one symmetrical outlet.

Operator must connect clean air tube inlet and outlet when entering the cryostat, that is why overpressure is needed

Other proposals?



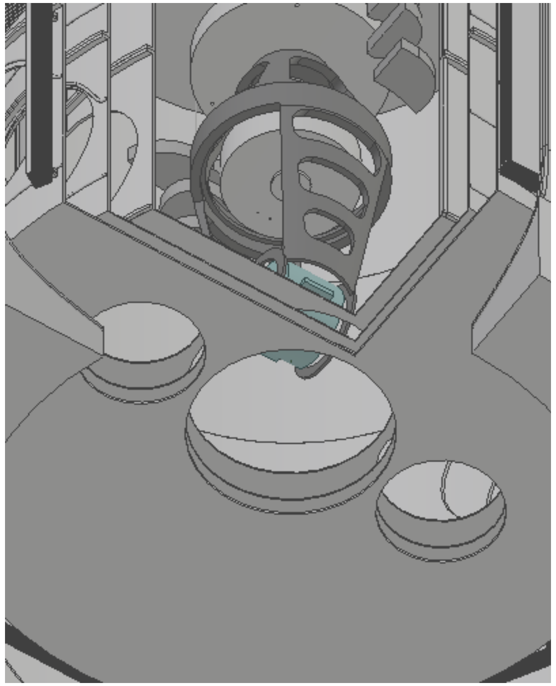
Safety

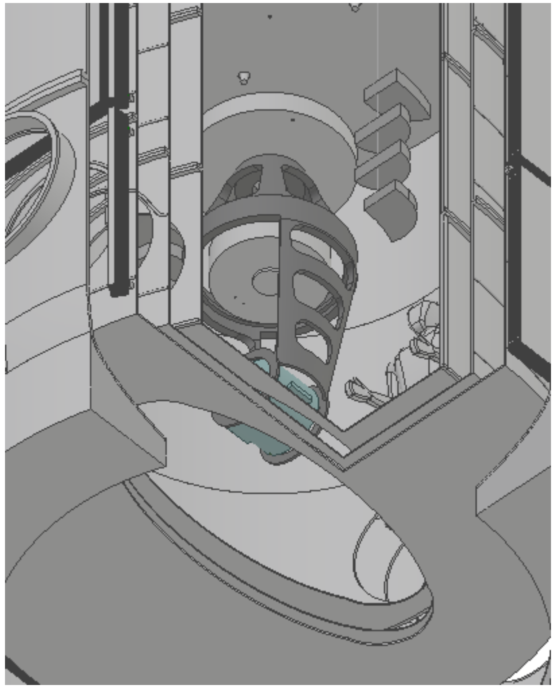
In case of emergency, one must be able to pull the body out (lost of consciousness) from the IITS. Usual man footprint is 60 cm. What about unconscious man?

Proposals

- Manholes (collateral to Payload entrance hole)
- Only one elliptical payload hole (with auxiliary walkable floor sections)

During interferometer operation, holes must be closed. During maintenance/assembly safety must be ensured (no falling), but one's unconscious body has to be able to pass through.
Can you add a platform on top of the holes?



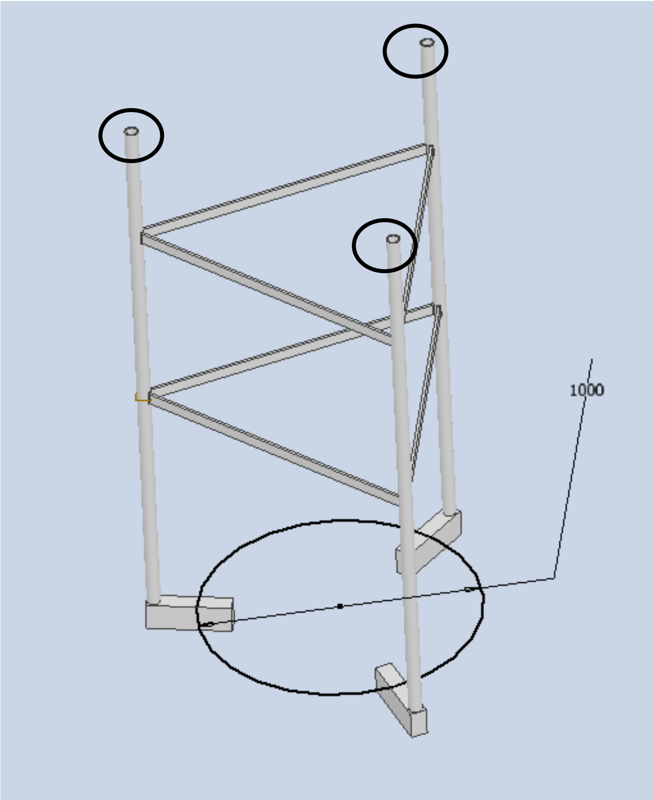


What will be the procedures of rescue?
Use of ropes? Gurney?
Any other safety procedures?

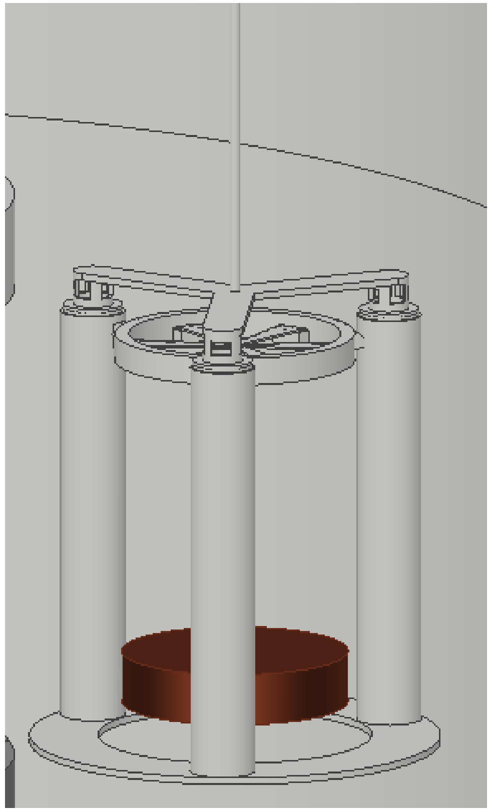
Other proposals?

Room Temperature Roof

Solid plane, at room temperature and fixed to the VC, on which various elements, thatmust reach the payload, are fixed to



Just a first concept
Structural TBD



CuBe blades can be used here TBD

- An antifailure system for payload suspension is needed

It can be integrated in the mounting system, but this choice impacts on the structural stiffness required to all the thermal shields and finally also constraining the thermal behaviour.

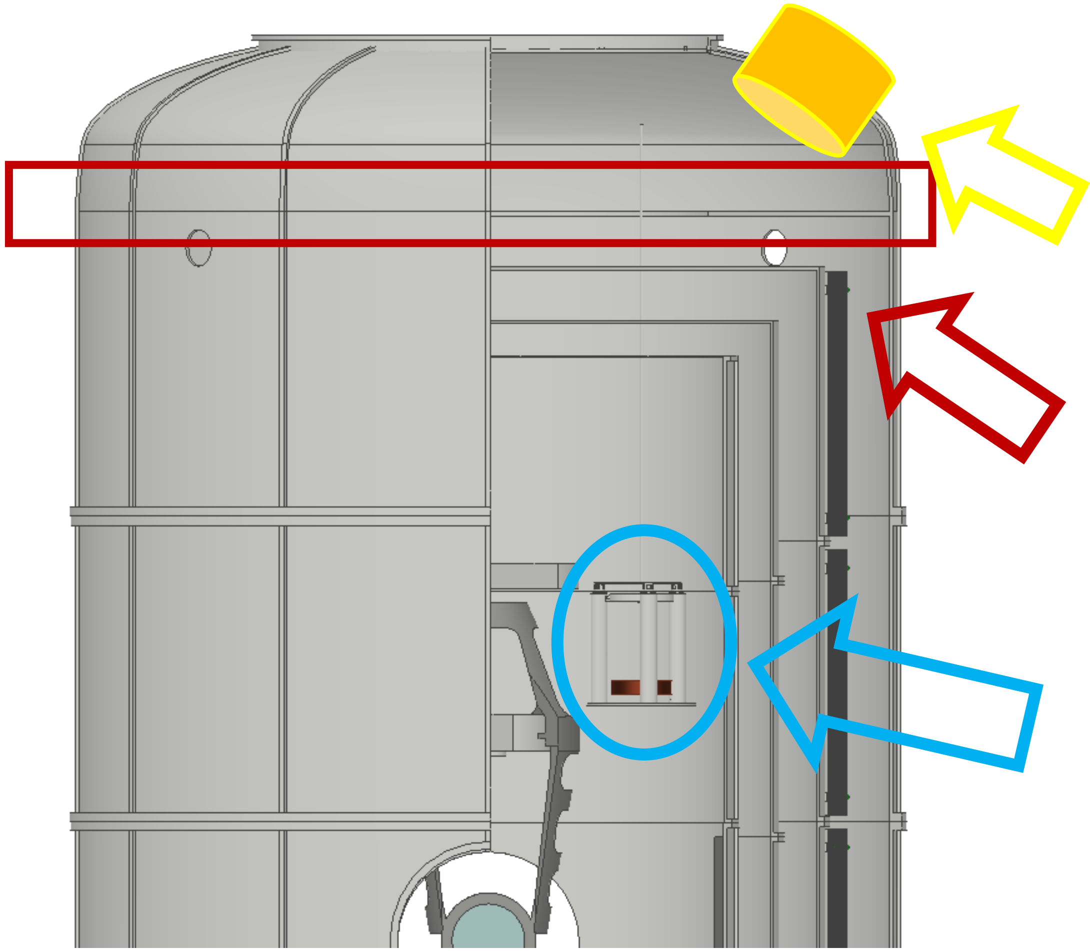
--> We are delevoping the concept of a structure hanging from the RTR

- KAGRA developed a HLVIS (Heat Link Vibration Isolation System) to reduce the impact of thermal shields modes (ca. 12-16 Hz). In our case we need to also cut the LF seismic background.

--> We are developing a compact LF attenuation system (already mentioned in the PBS)

Room Temperature Roof

Solid plane, at room temperature and fixed to the VC, on which various elements, that must reach the payload, are fixed to



Dimensions and position to be defined

Handling aperture flanges on the dome

Anti-failure system and mounting system for the payload can be mounted on the separating roof

HLVIS Heat links Vibration Isolation System can also be mounted here