Integration of vertex detector services and cooling

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FCC-ee vertex detector R&D workshop
Pisa
30-31 October 2025

Current vertex layout

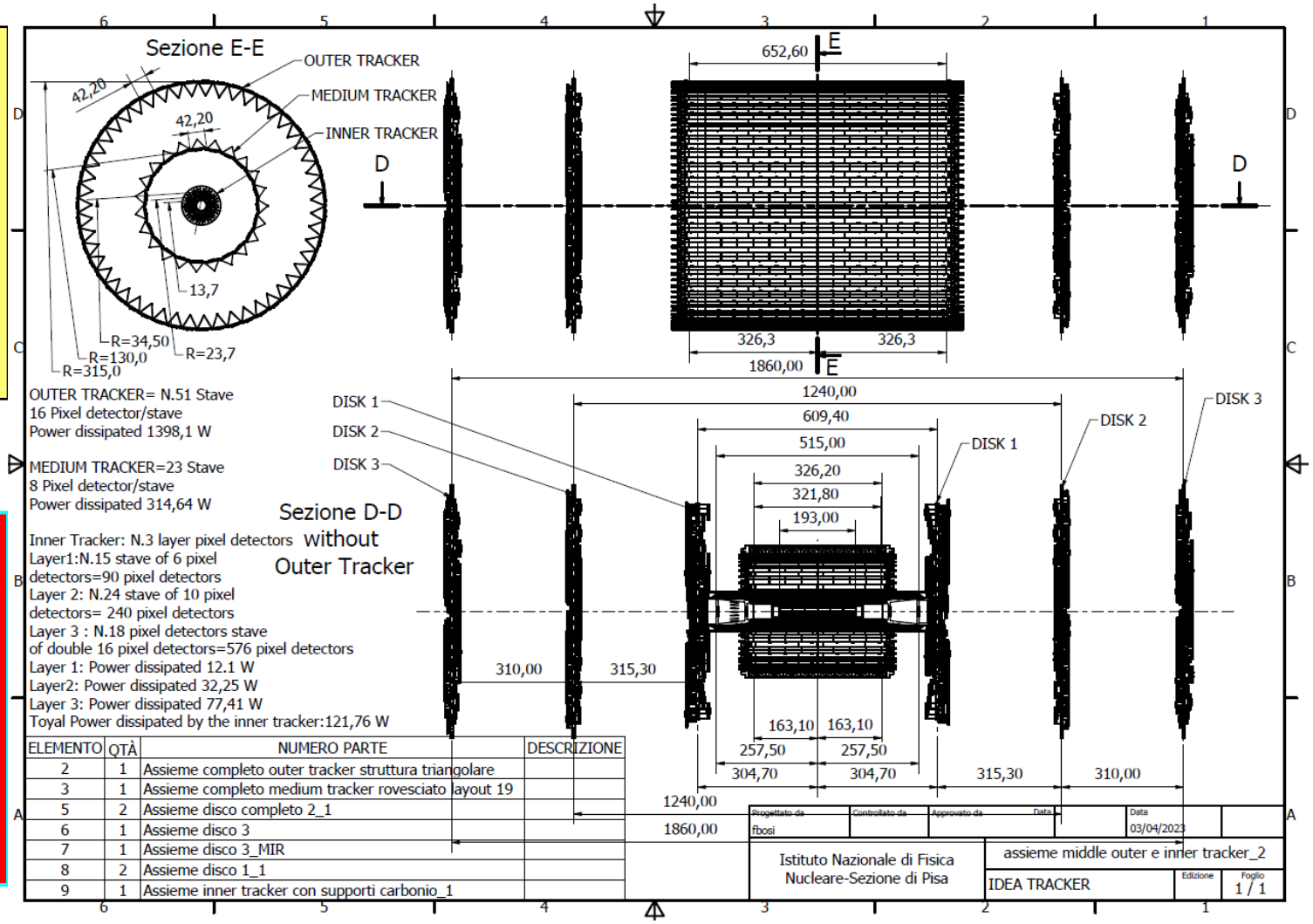
Outer vertex tracker:
ATLASPix3 based

Modules of $50 \times 150\ \mu m^2$ pixel size
- Intermediate barrel at 13 cm radius
- Outer barrel at 31.5 cm radius
- 3 discs per side

Inner Vertex detector:
ARCADIA based

Modules of $25 \times 25\ \mu m^2$ pixel size

3 barrel layers at
- 13.7, 23.7 and 34/35.6 mm radius

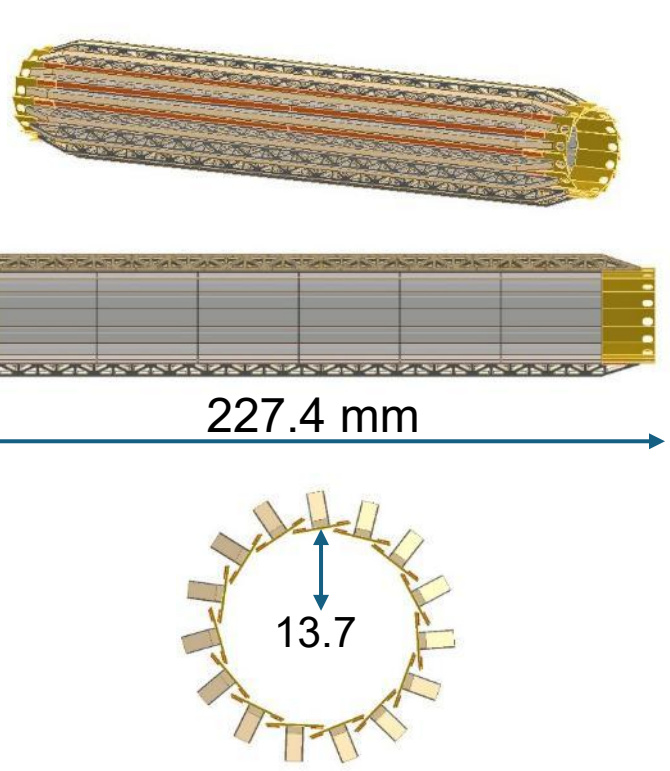


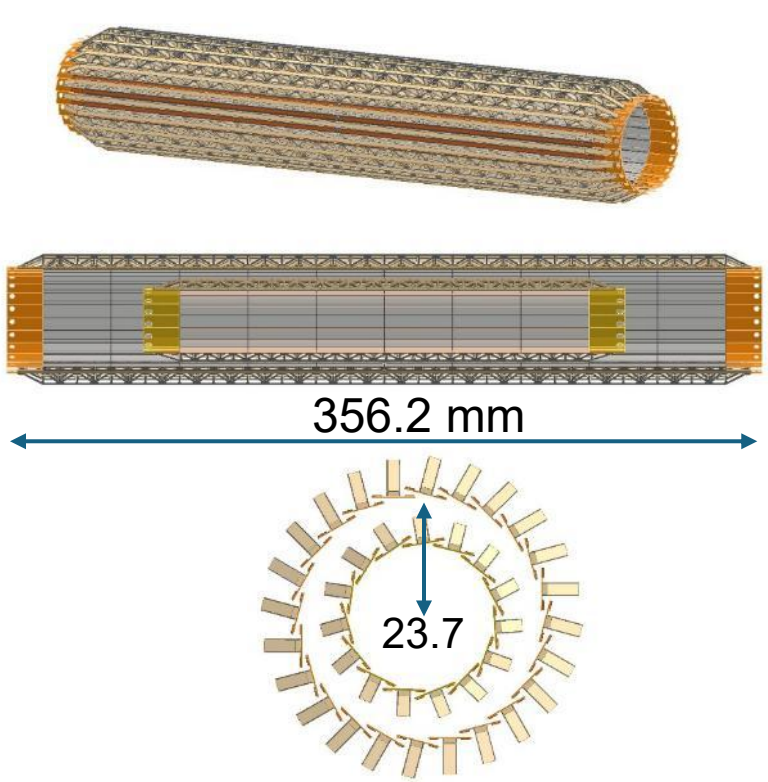
Inner vertex

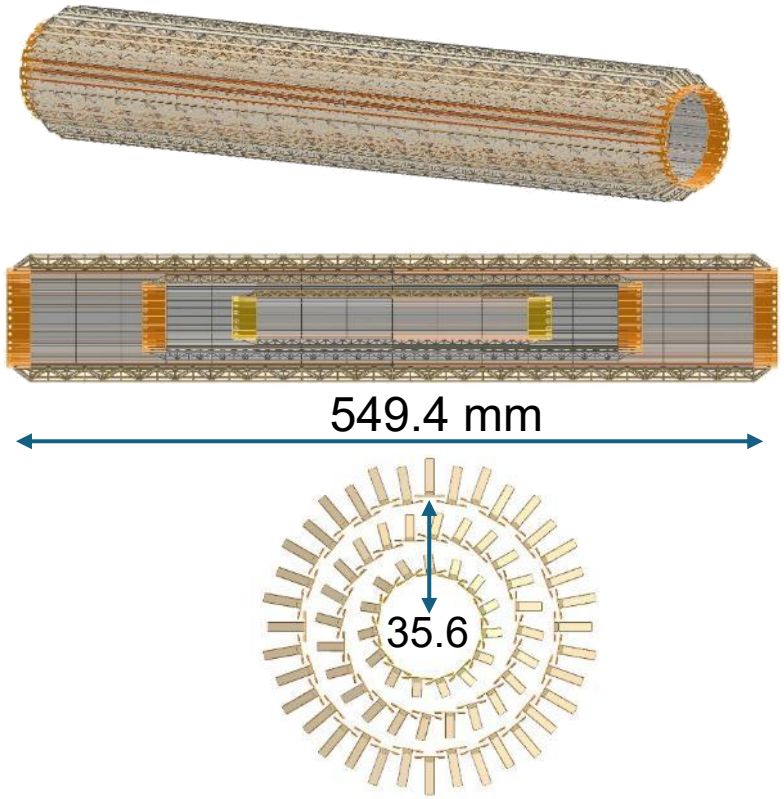
Layer 1:
15 staves of 6 modules each
Power budget ≈ 12 W

Layer 2:
24 staves of 10 modules each
Power budget ≈ 32 W

Layer 3:
36 staves of 16 modules each
Power budget ≈ 77 W



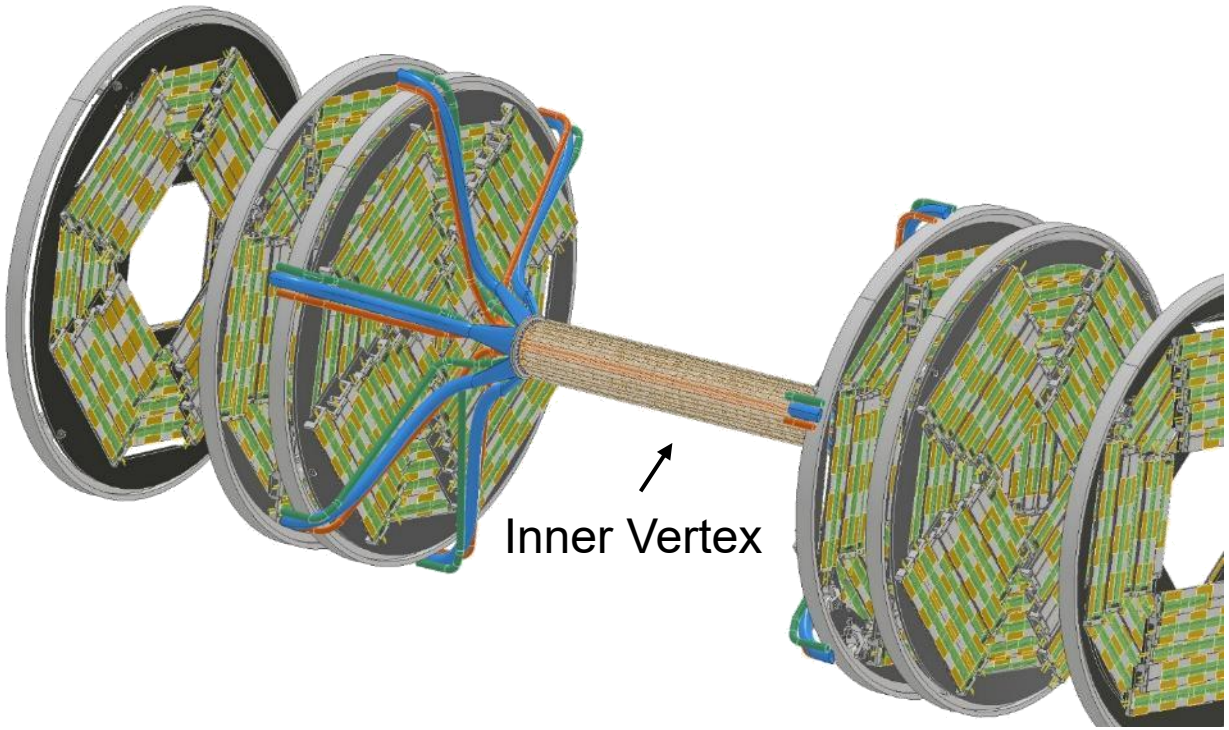


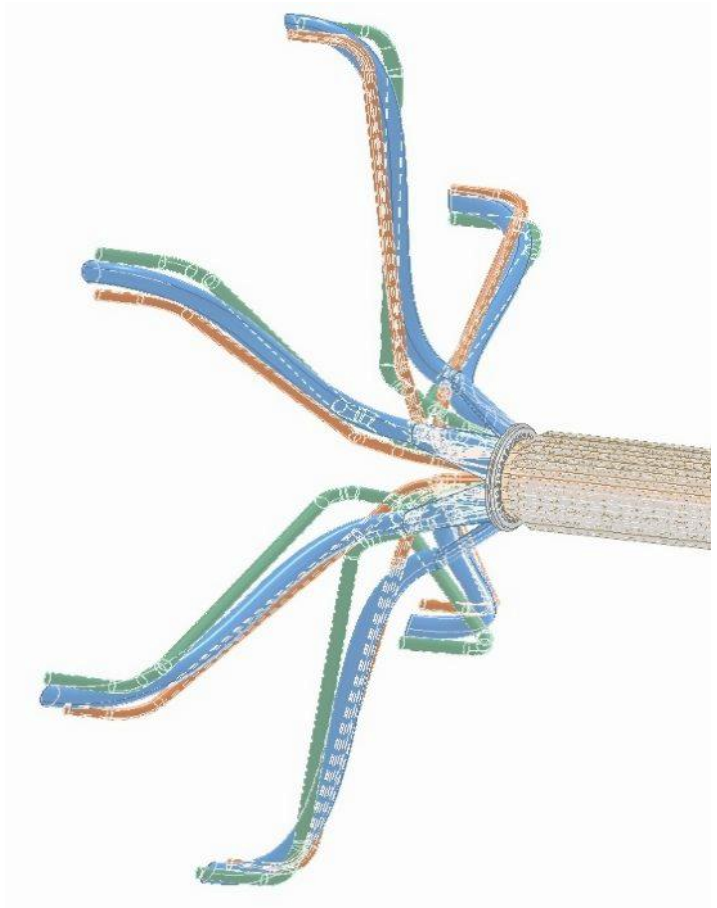


Reticular lightweight support to provide stiffness:

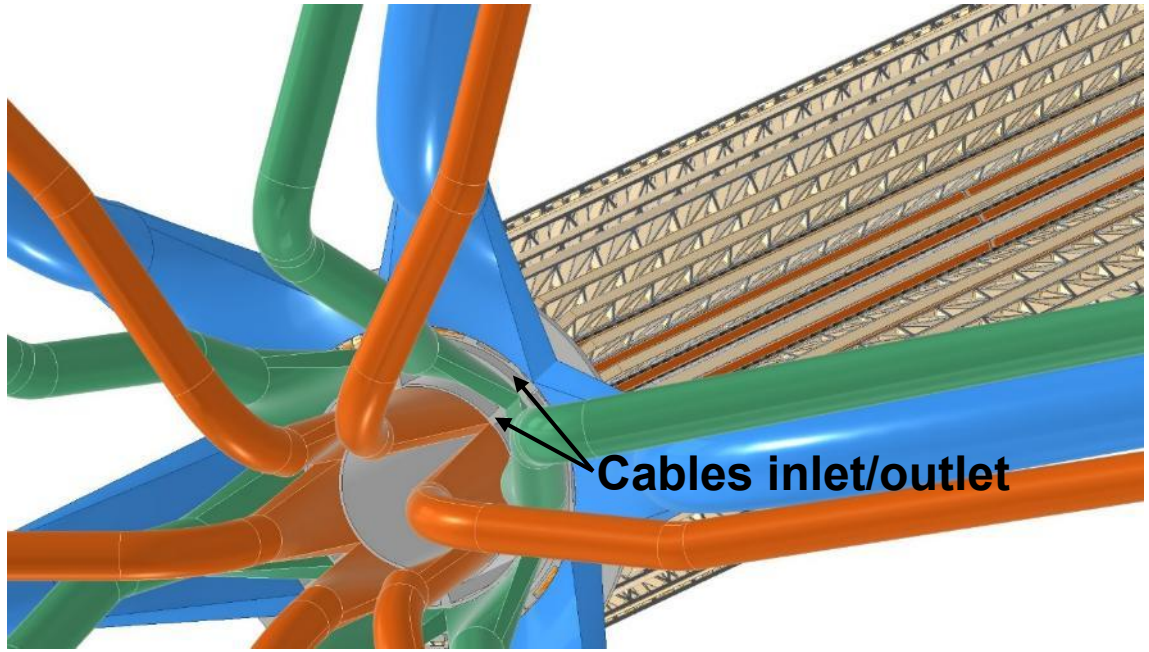
- **Thin carbon fiber walls interleaved with Rohacell**
- **2 buses (data and power) 1.8 mm wide and 250 μm thick**

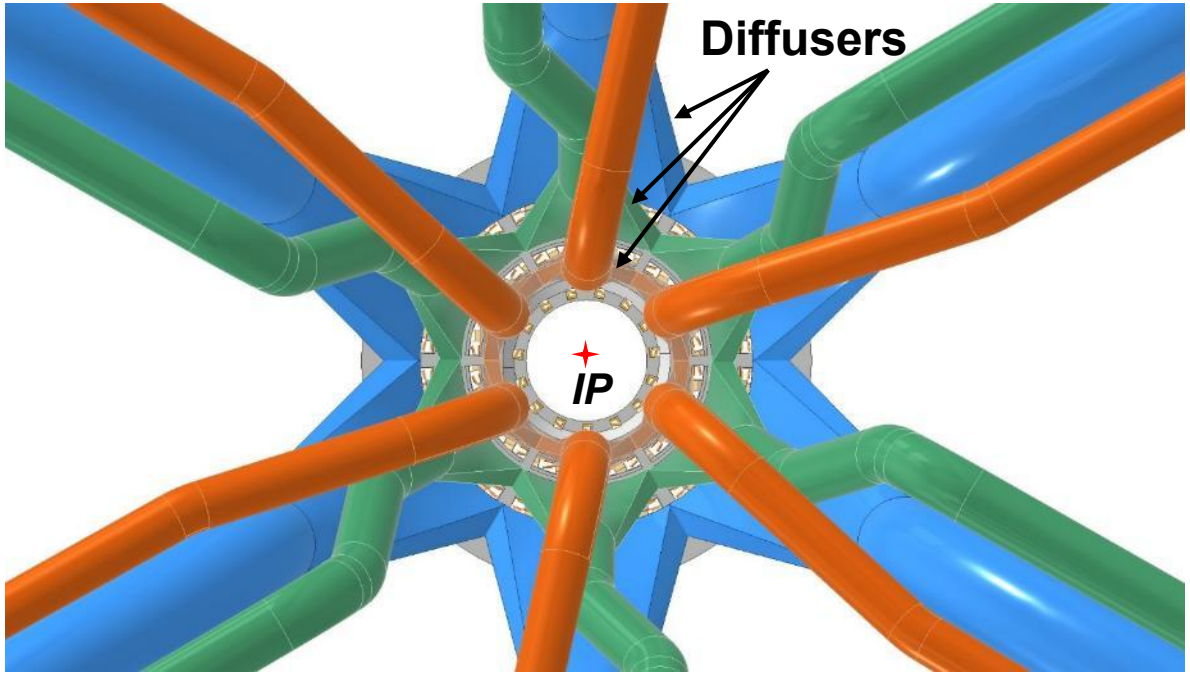
The current approach for supply power and air flow involves reaching the inner vertex radially, descending from the support tube In z position located ahead of the disks, as outlined by Gherardo Ammirabile in Vienna.





Radial inlet/outlet detail



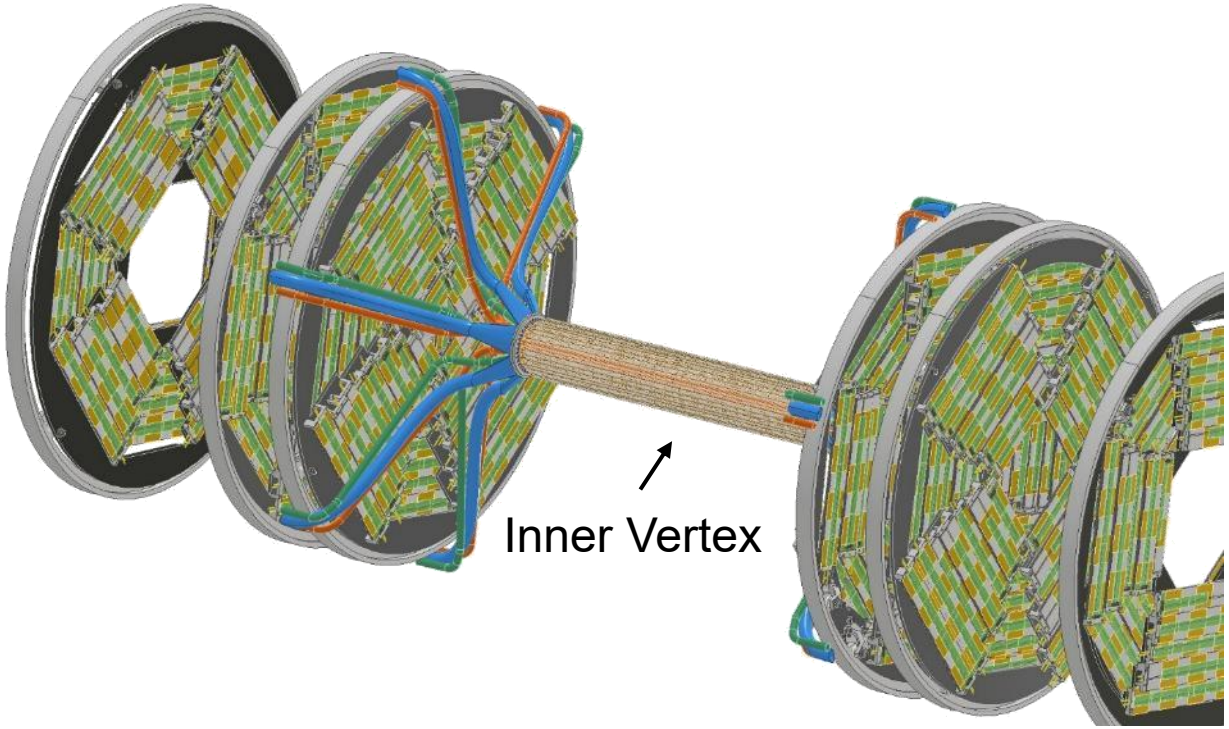


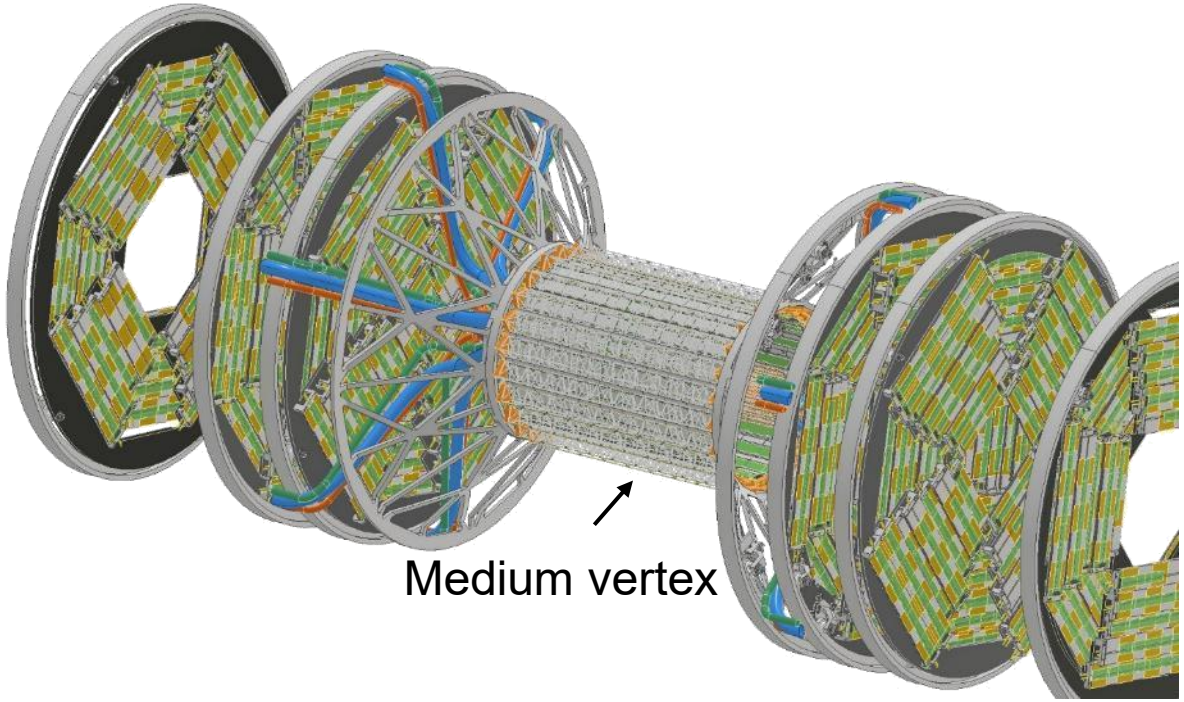
Rear view

- Layer 3 ducts
- Layer 2 ducts
- Layer 1 ducts

6 sectors of 60° for each of the three indipendently powered layers → Actually, diffusers are included with hose connection in the same component → Need to be optimized for all aspect: length, shape, material, roughness and space for power and readout .

Radial inlet/outlet



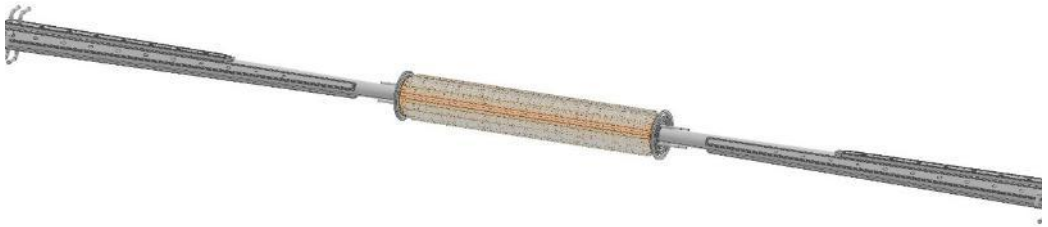


In this solution the Pipe system and cables wraps around the innermost disk.
This:

- Minimize the effect on the other disks
- But need an adequate assembly procedure.

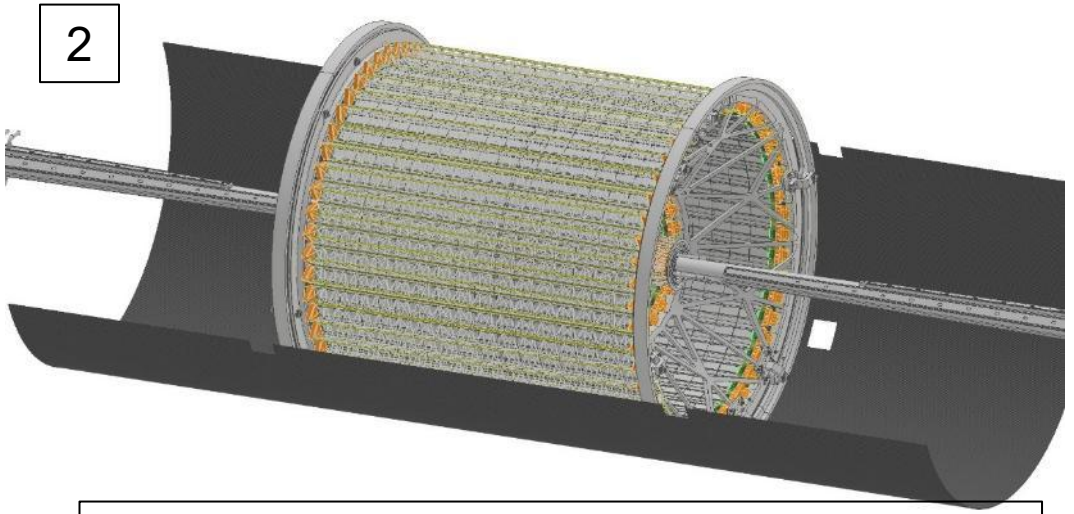
Possible assembly procedure

1



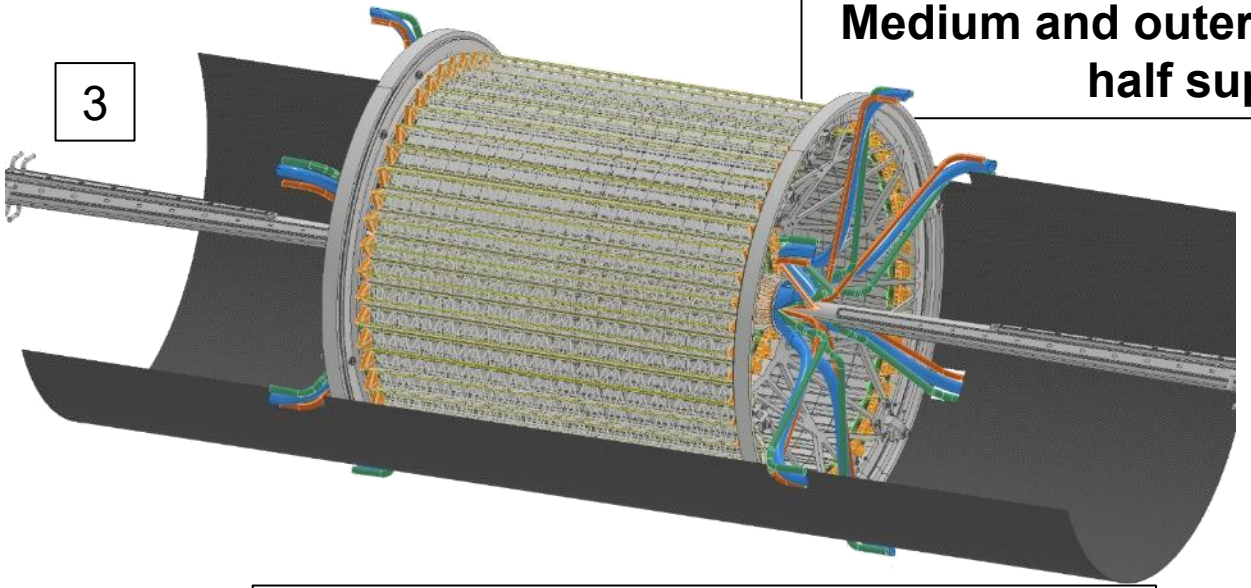
Beam pipe with inner vertex

2



Medium and outer vertex assembled in half support tube

3

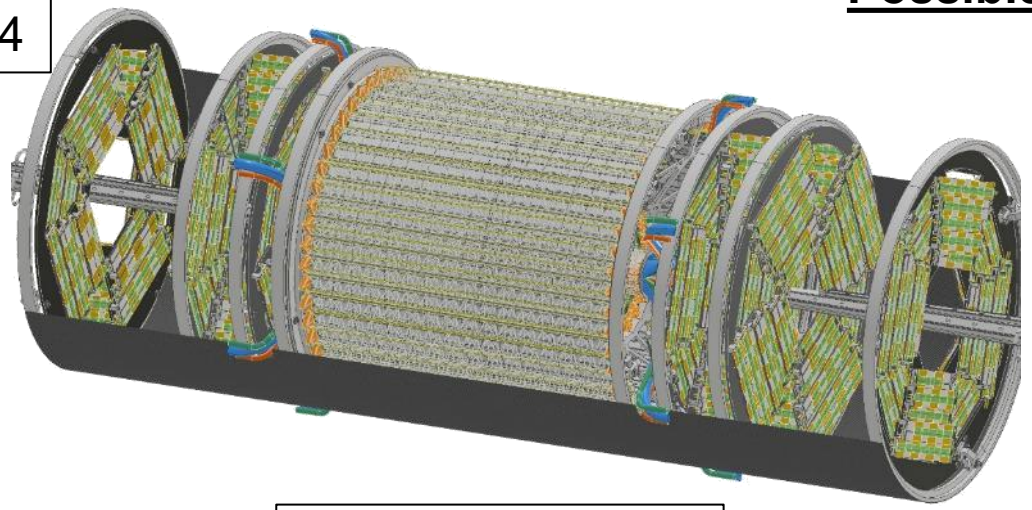


Inner vertex services assembly installation

Layer 3 ducts
Layer 2 ducts
Layer 1 ducts

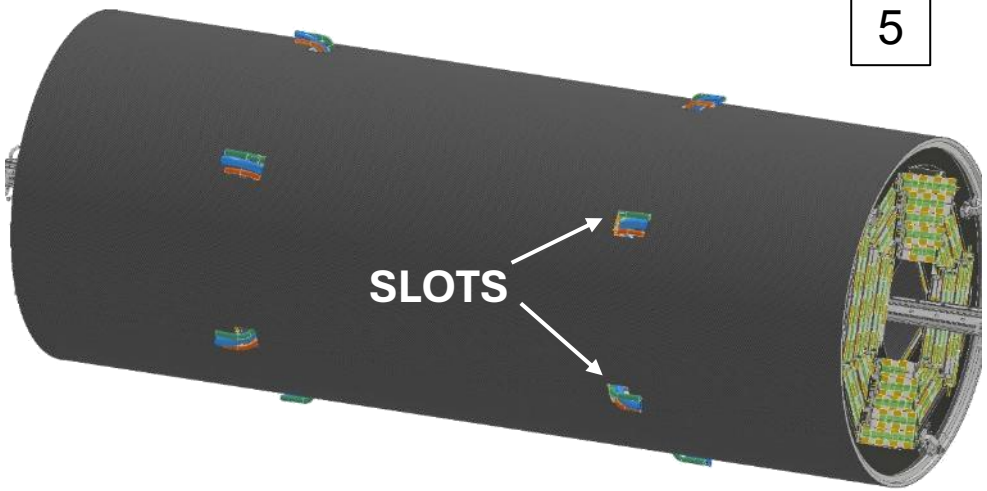
Possible assembly procedure

4



Discs assembly

5



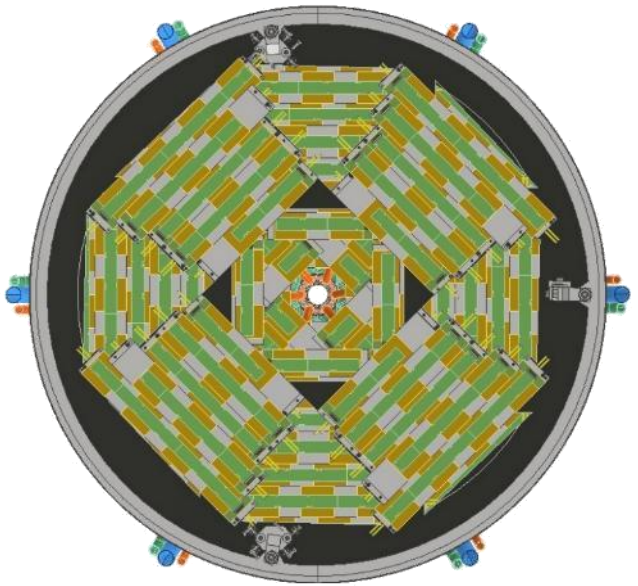
Support tube closed

Slots are required on the support tube to allow services entry and exit

The arrangement and shape of the slots must be studied to accomodate:

- Air ducts of the three layers
- Cooling water channels of discs, middle and outer barrels
- Cables from the inner region

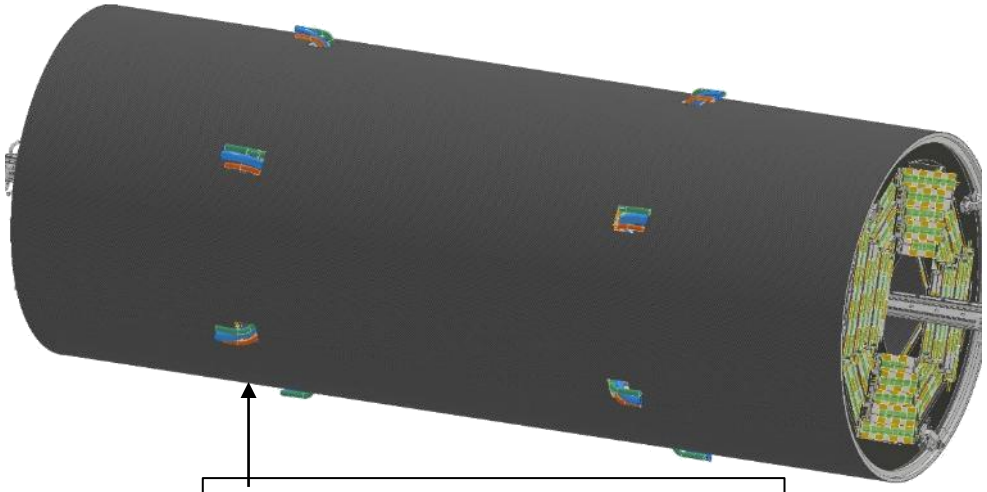
- Layer 3 ducts
- Layer 2 ducts
- Layer 1 ducts



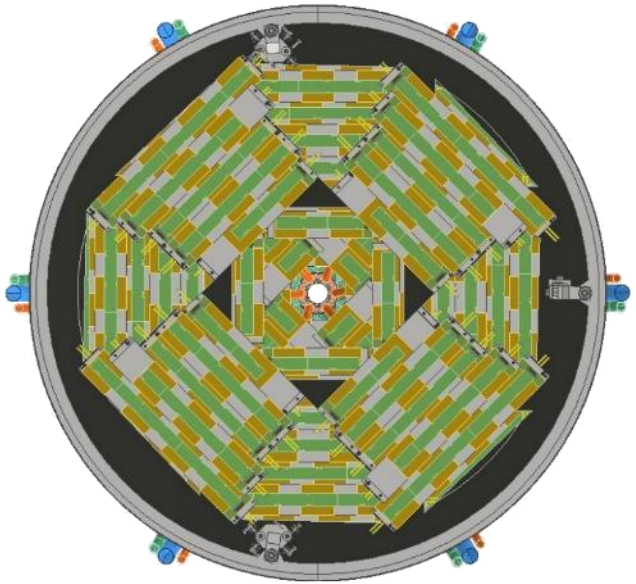
ADVANTAGES:

- Easier routing of services
- Full Discs assemly

Possible assembly procedure



Support tube

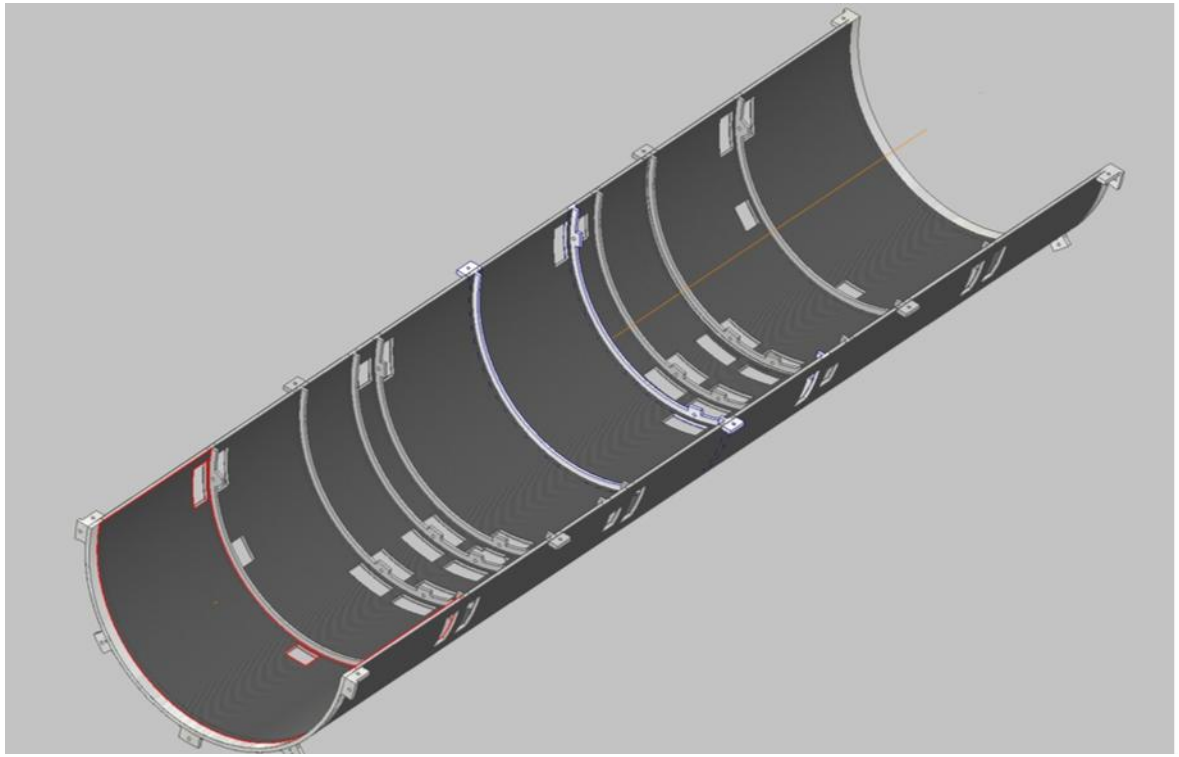


In order to validate and check this procedure is important to have a support tube prototype .

The **main news** on this topic is that the tender to purchase the support tube prototype is started in this last days.

The prototype should be ready in the beginning of the next summer 2026.

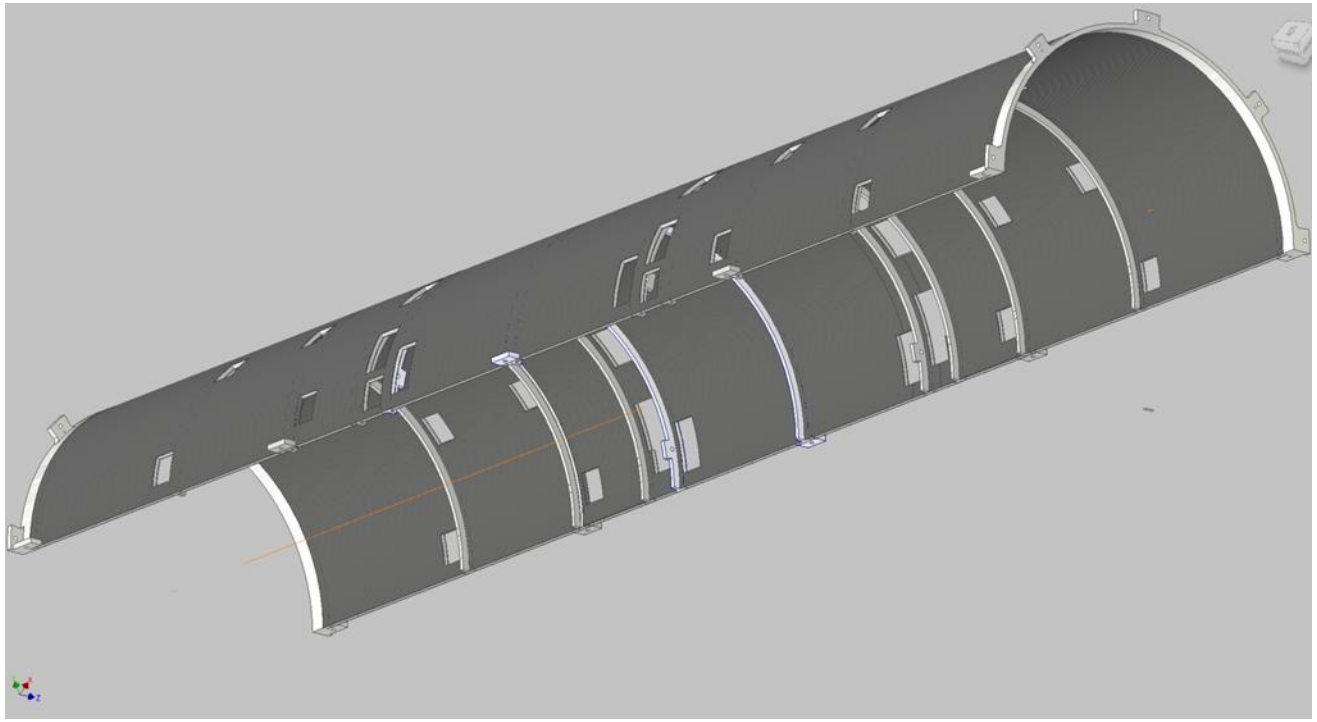
Support Tube details



Lower side Tube Assembly

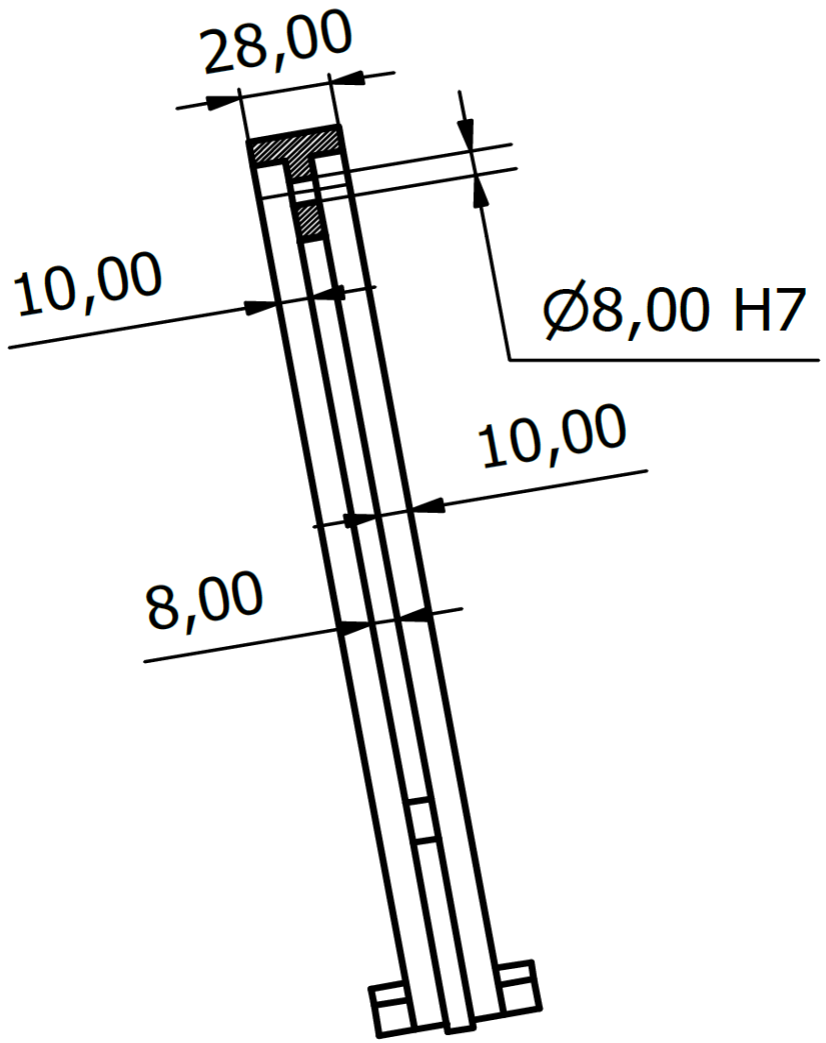
It consist in two half shell made by carbon fiber sandwich panels and several ribs.

Upper side Tube Assembly



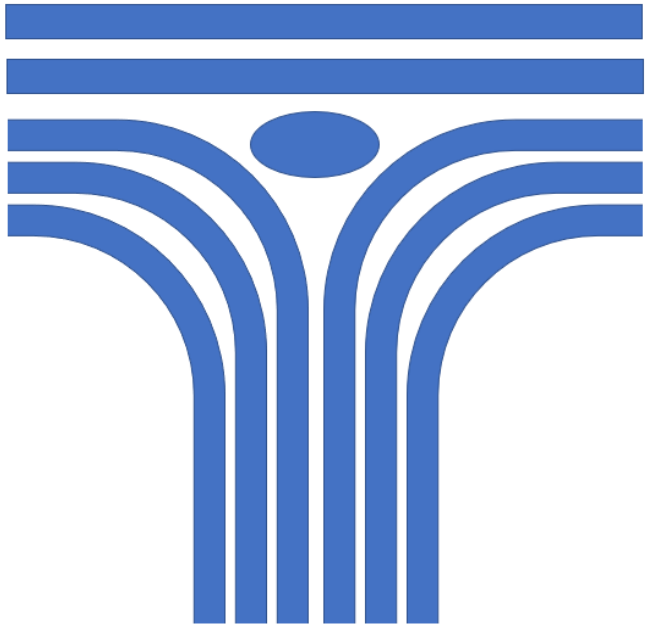
Overall length 2800mm
Outer diameter 710mm
Sandwich panel thickness 8mm

Support Tube details

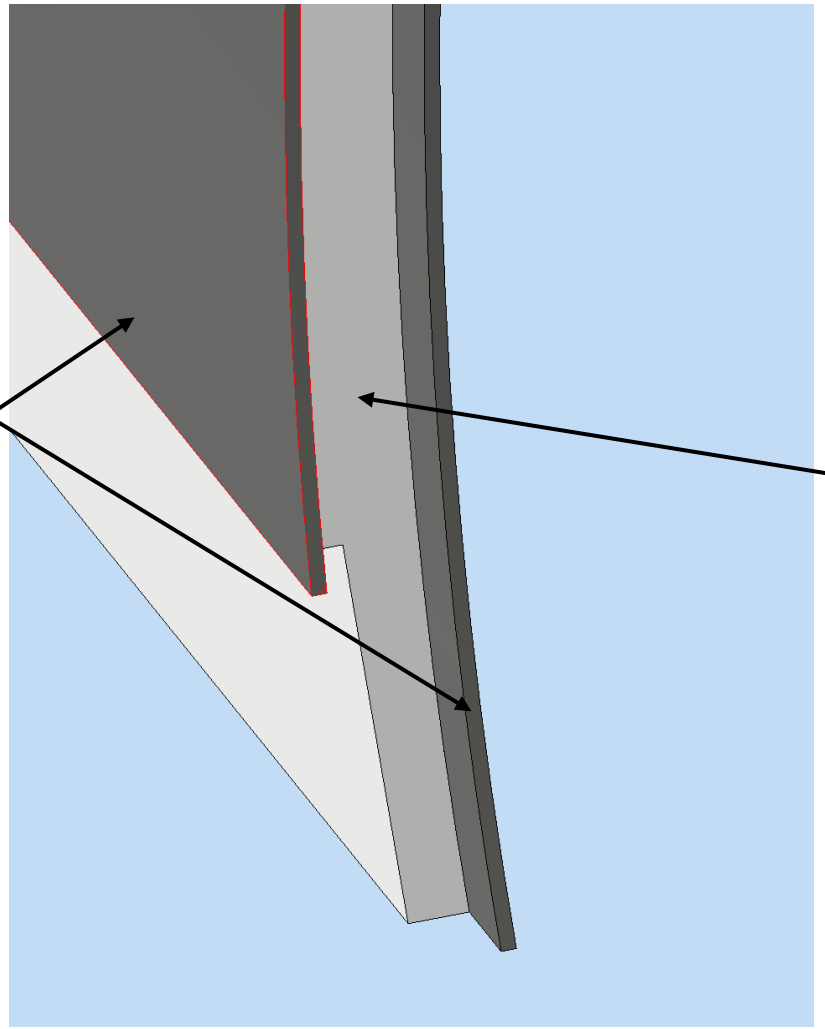


Typical shape and dimension of a Rib

Ribs are completely made in carbon fiber plate using Molds to be laminated following this rule:



Support Tube details



T700 sheet

52 rohacell core

External sandwich panel are made by two Carbon T700 fiber tissue sheet and a rohacell core type 52 with 12 kg/m3 density.

The overall thickness is 8mm and the two T700 sheet have a thickness of 1 mm each.

Cylinder external radius 710mm
Overall length 2800mm

Thank you for your attention!