MVTX Mechanical Design

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MIT
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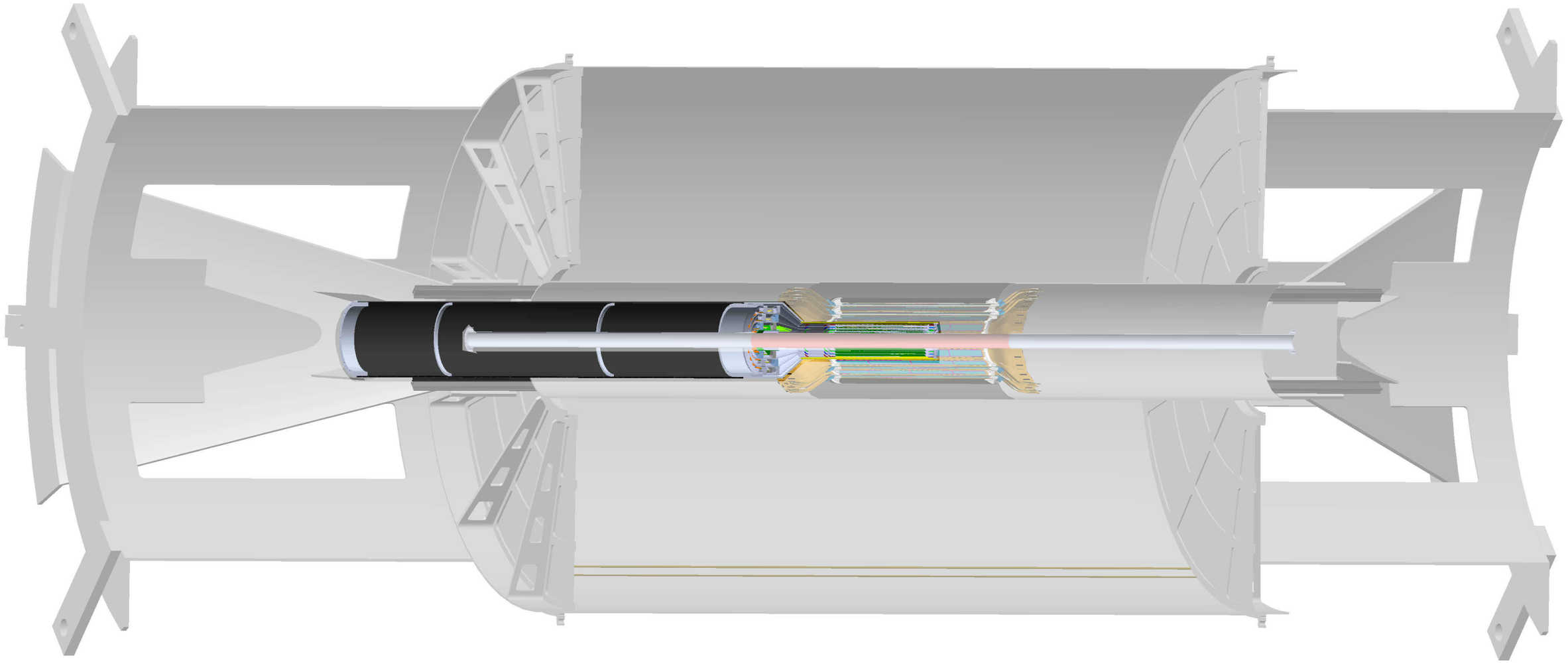
L3 Components

- Mechanical Support Structures
- Installation
- Cooling System and Cabling

Mechanical Support Overview

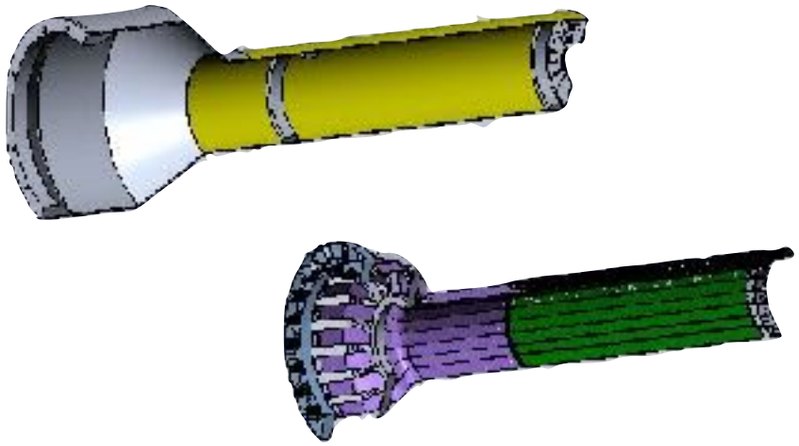


- Carbon fiber cantilevers detector (~few kg)
- Adapt from ITS for sPHENIX envelope

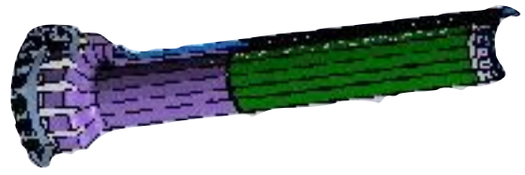
Support Structure Elements

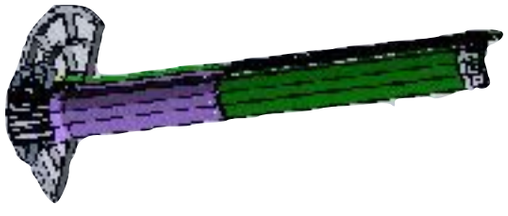
Service Barrel
- cylinder past first flange
- intermediate patch panels
- ribs and flanges

Cylindrical Structural Shell (CYSS)
- outermost cone and cylinders



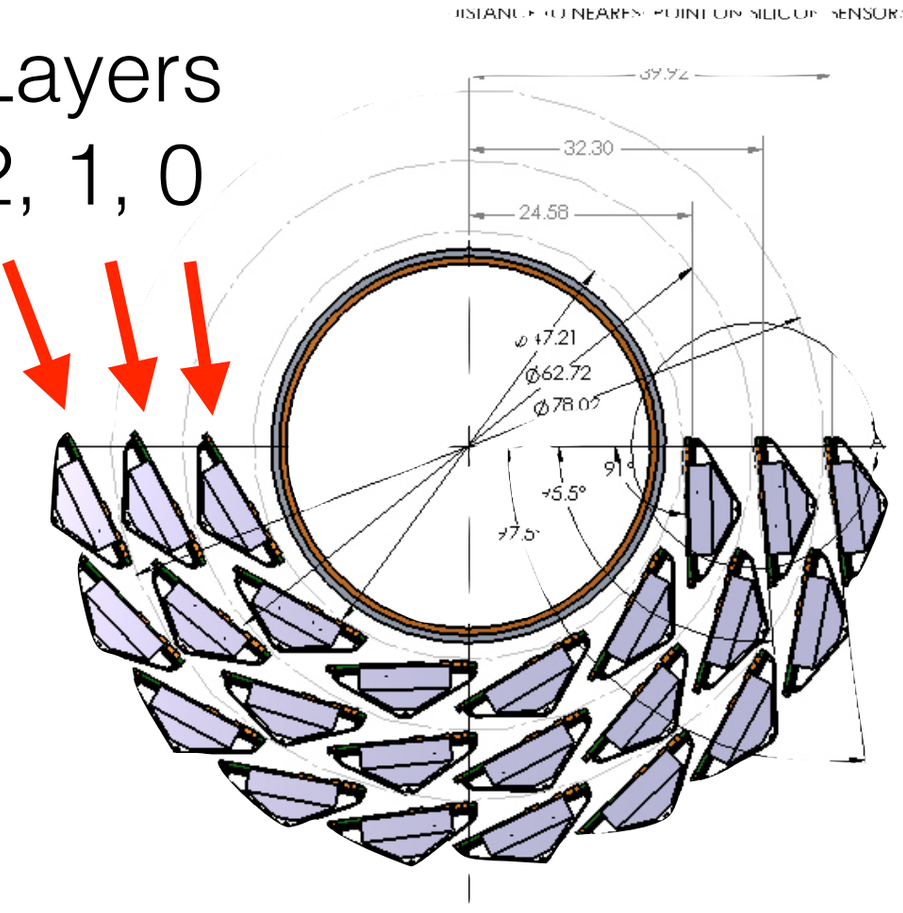
Endwheels
- thin rings
- layer supports
- cylinders
- pass-throughs
- patch panels
- aluminum

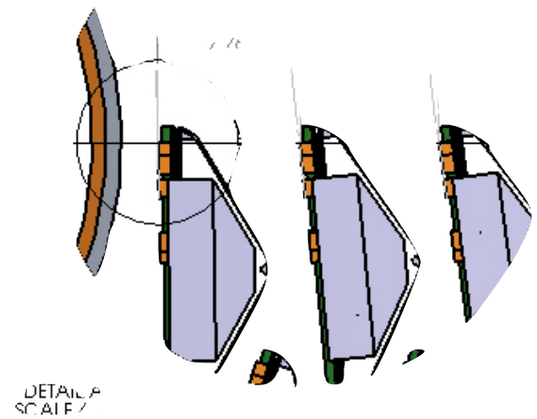


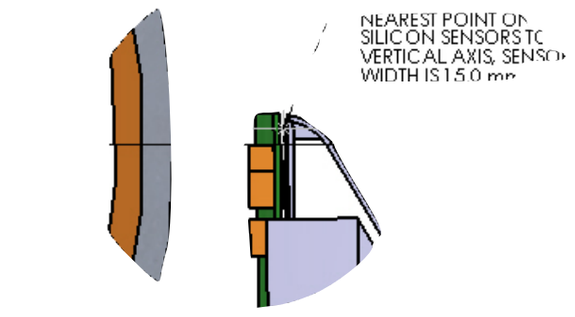


Comparison to ITS

Layers
2, 1, 0



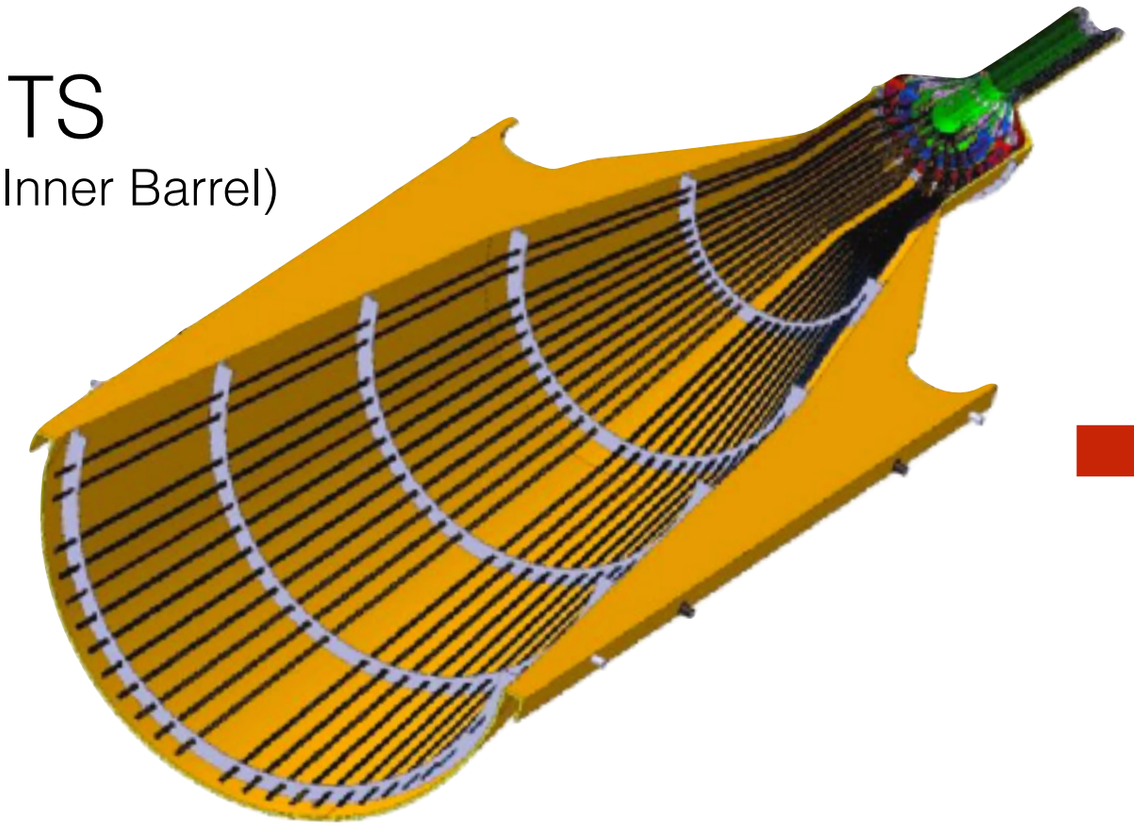


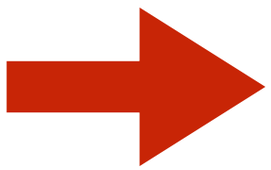


- Modify ITS design for sPHENIX beampipe Al and Be

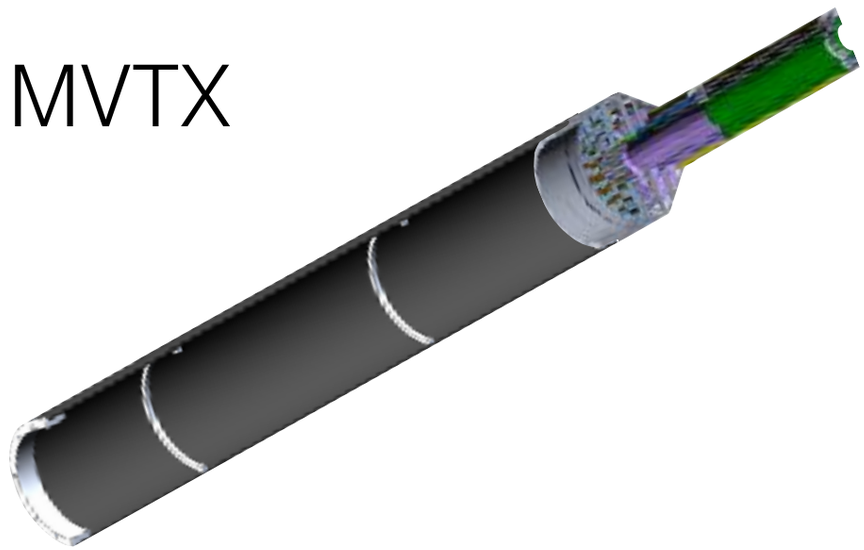
Comparison to ITS

ITS
(Inner Barrel)



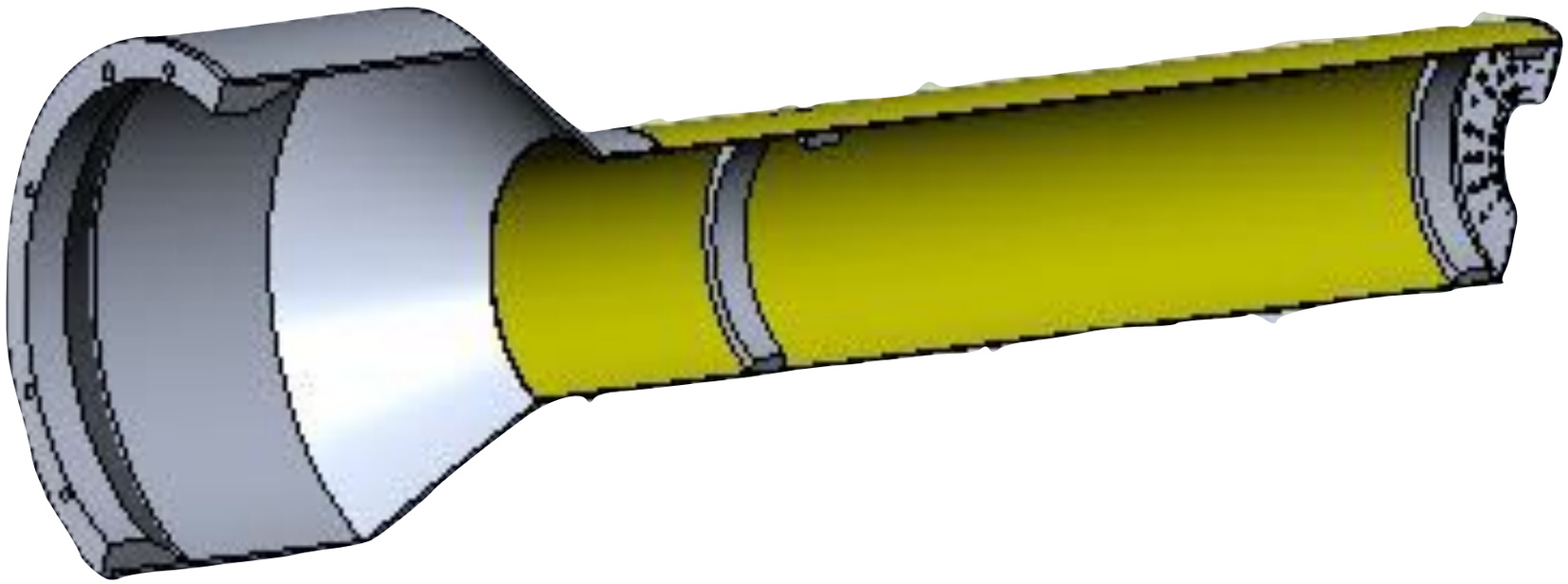


MVTX



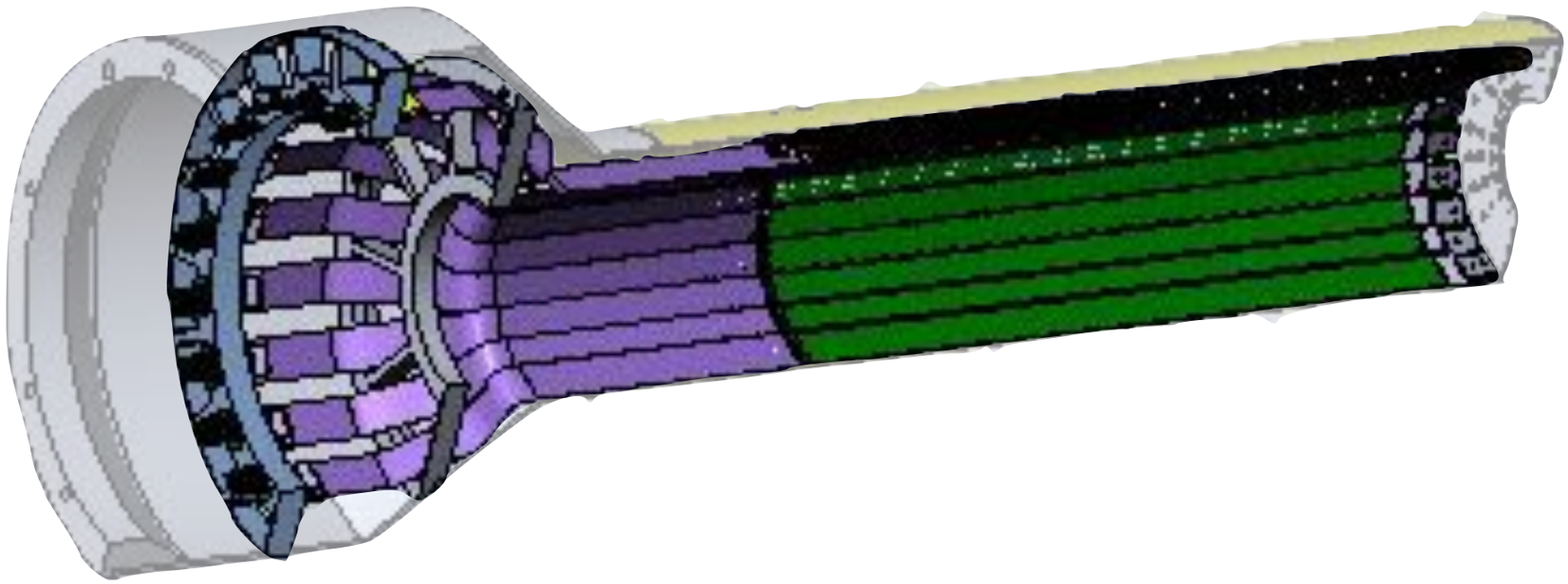
- Few differences from ITS:
  - beampipe slightly wider than ALICE
  - INTT/TPC envelope narrower/shorter than ALICE

CYSS



- Rohacell sandwiched between carbon fiber layers
- Upstream flange mounts to Service Barrel
- Downstream plate to secure staves

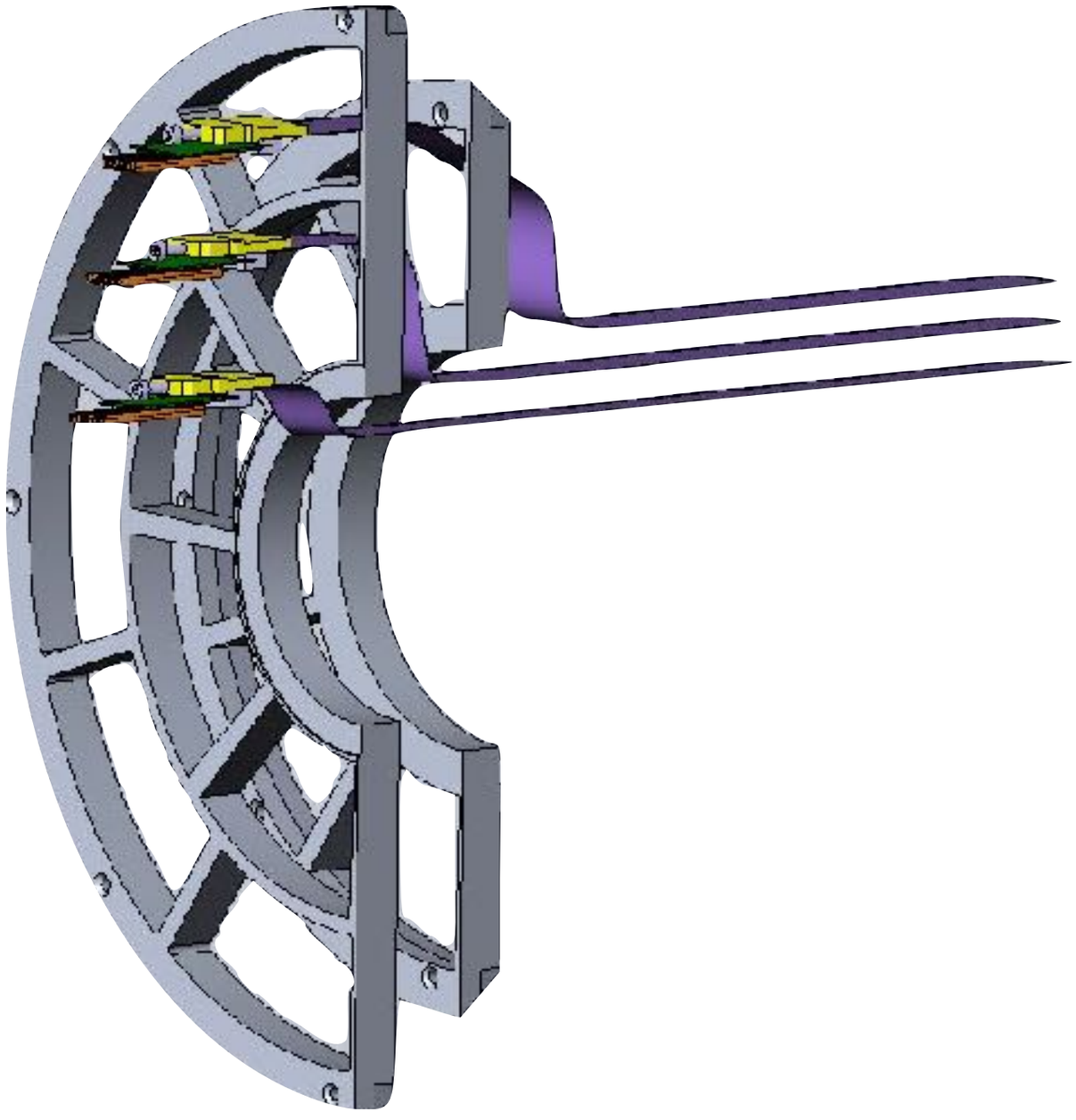
Endwheels



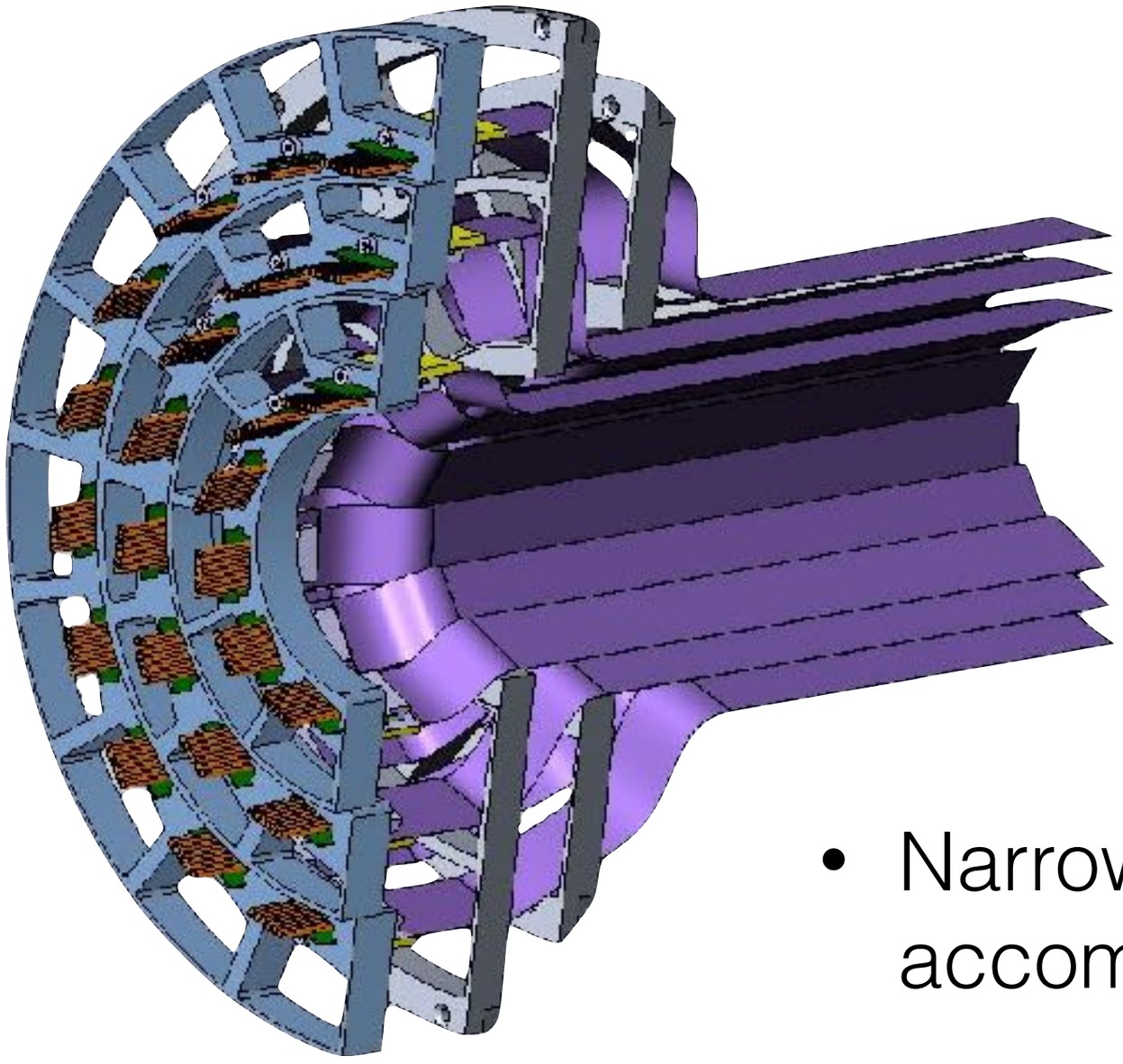
- Upstream cylinder mounts to Spider Wheel or CYSS
- Downstream ring mounts to endplate
- Staves mount to cylinder and ring

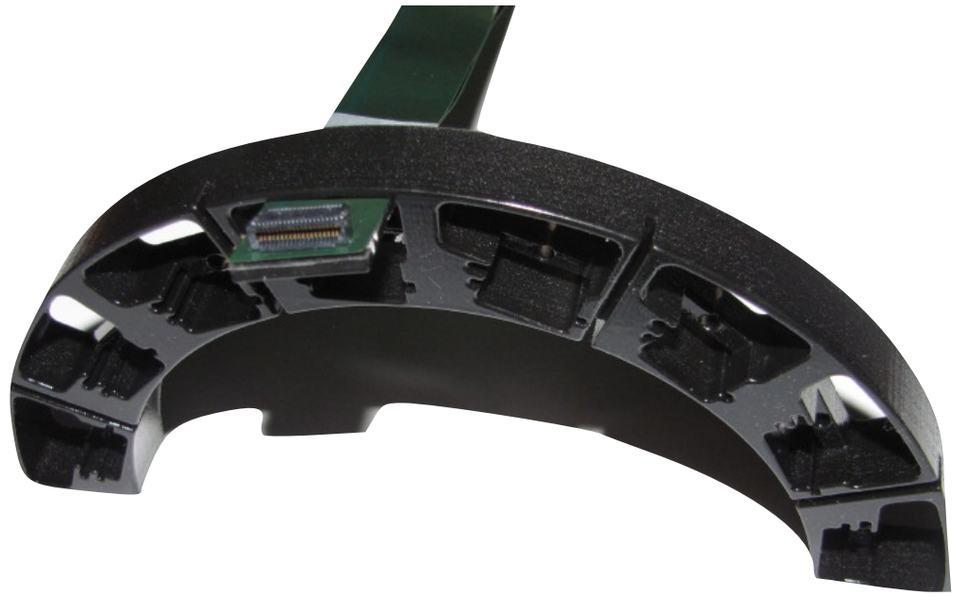
Spiderwheel Detail

- Replace nested conic segments in ITS design (easier to fabricate)
- Mount to conic section of CYSS
- Cables and hoses fan out between consecutive wheels



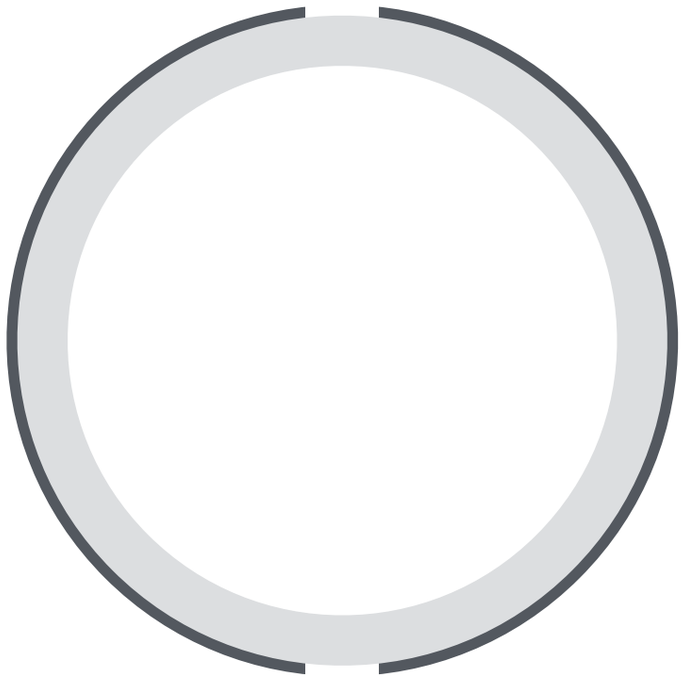
Patch Panel

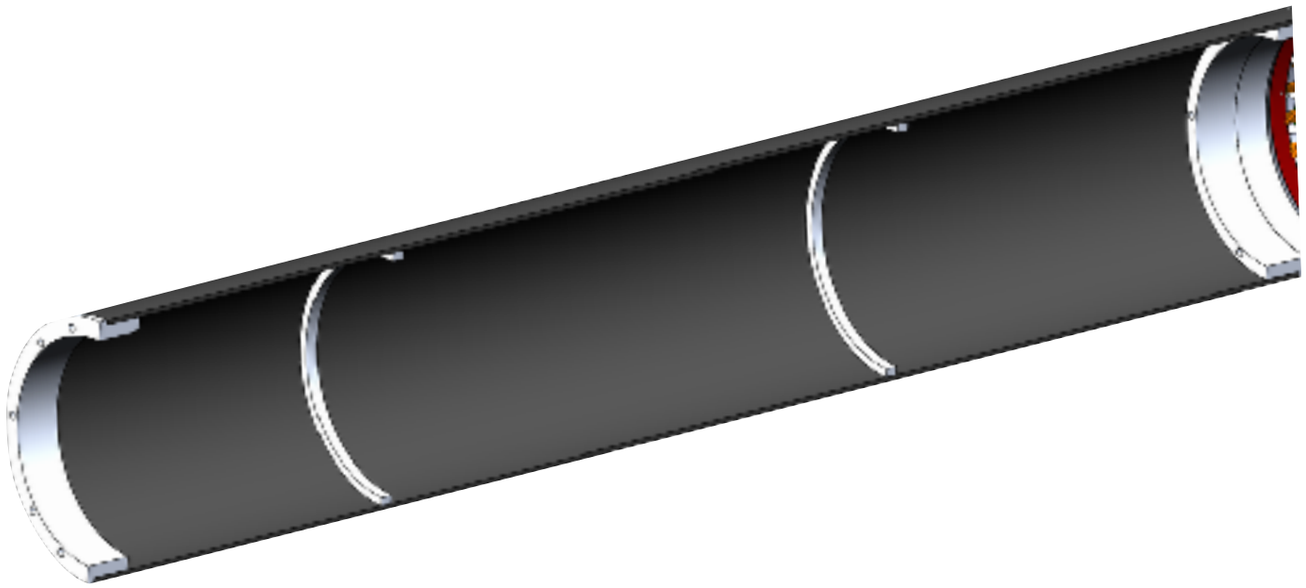




- Narrower than ITS to accommodate INTT
- Signal cables terminate, others pass through to Service Barrel

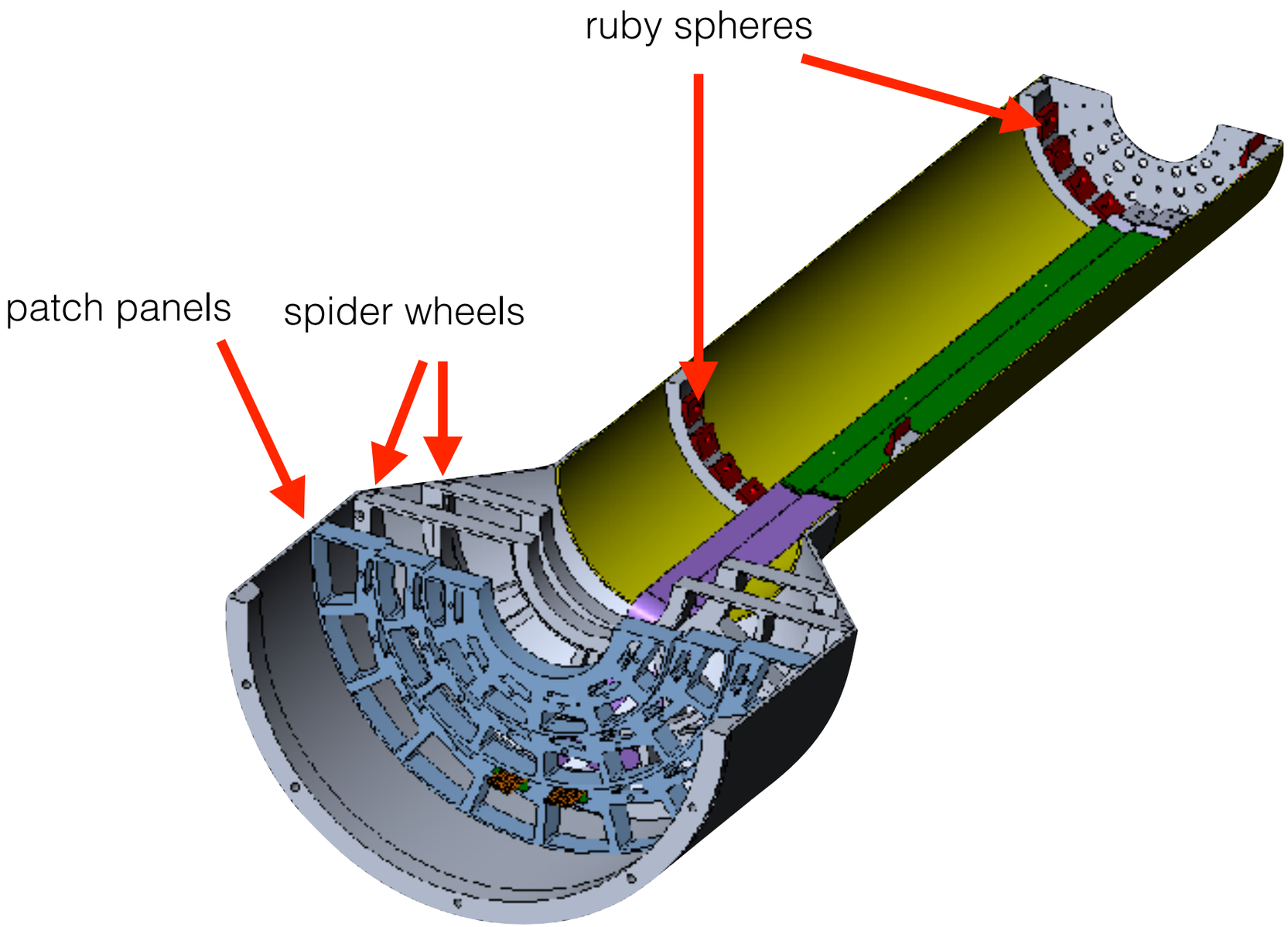
Service Barrel





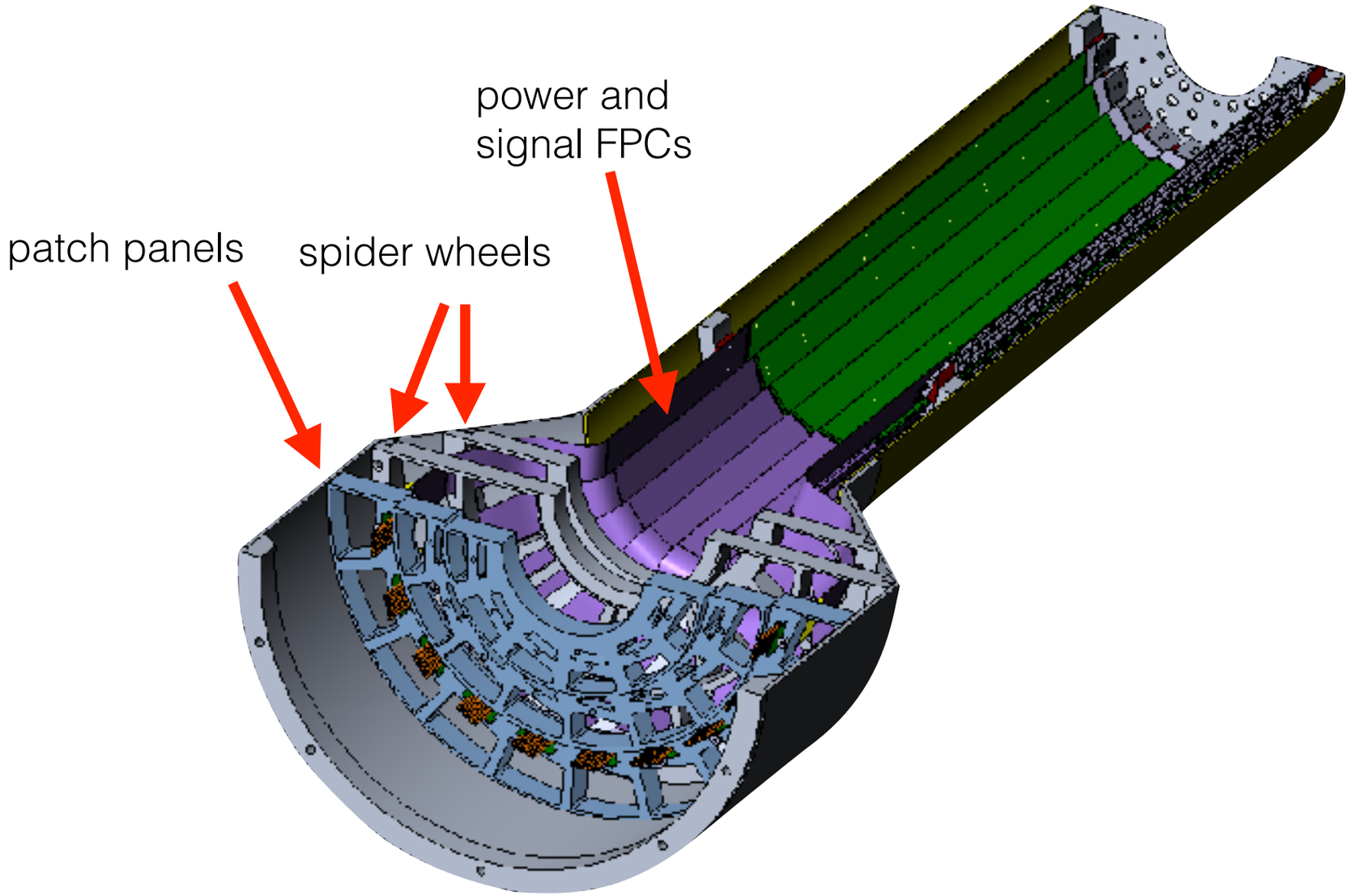
- Stiffening ribs cover full phi
- Gap in CF allows vertical beampipe supports to coexist with the SB

Assembly Steps



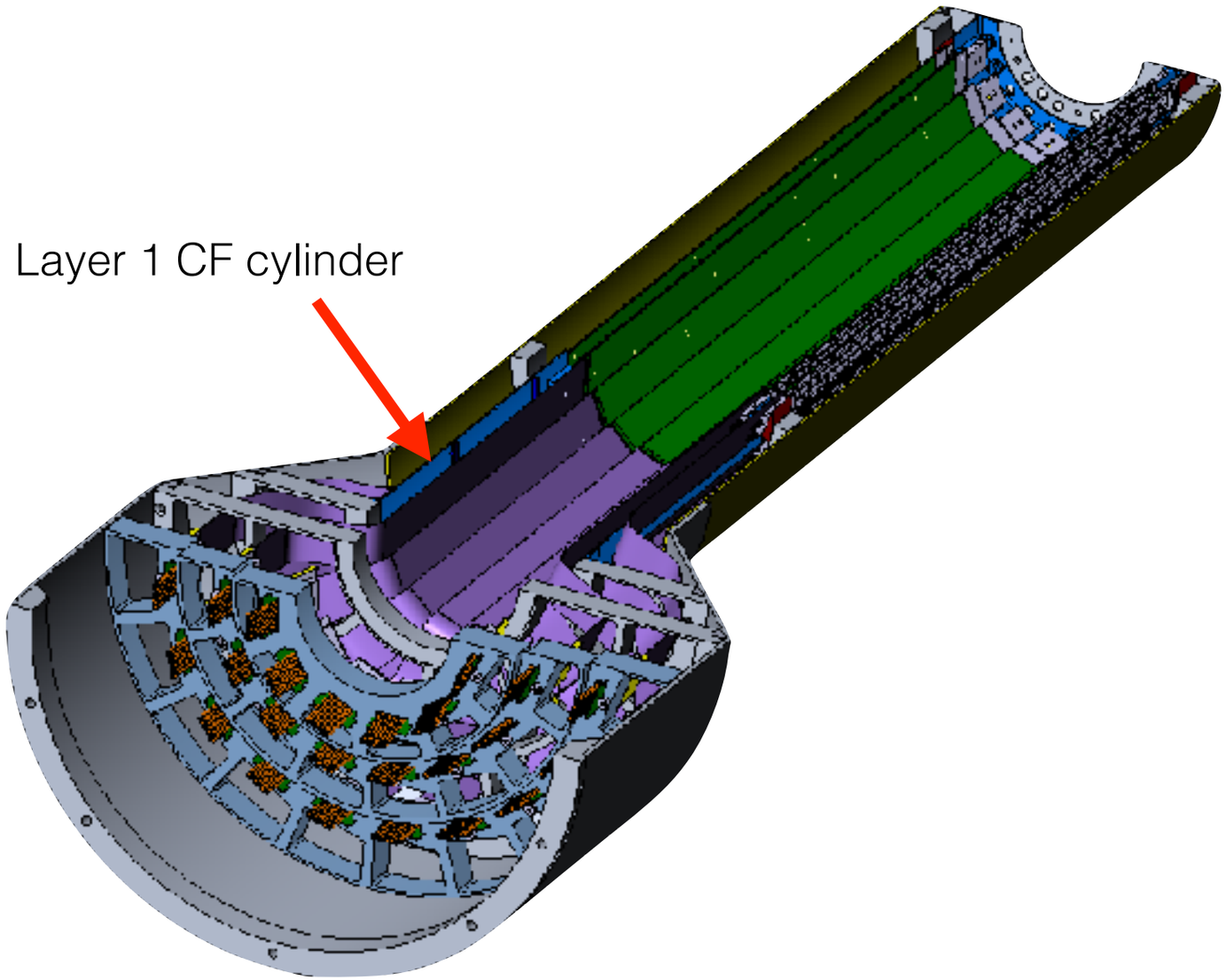
- Center staves are mounted on blocks, indexed by ruby spheres
- Layers 1,0 are self-supporting between north and south blocks

Assembly Steps



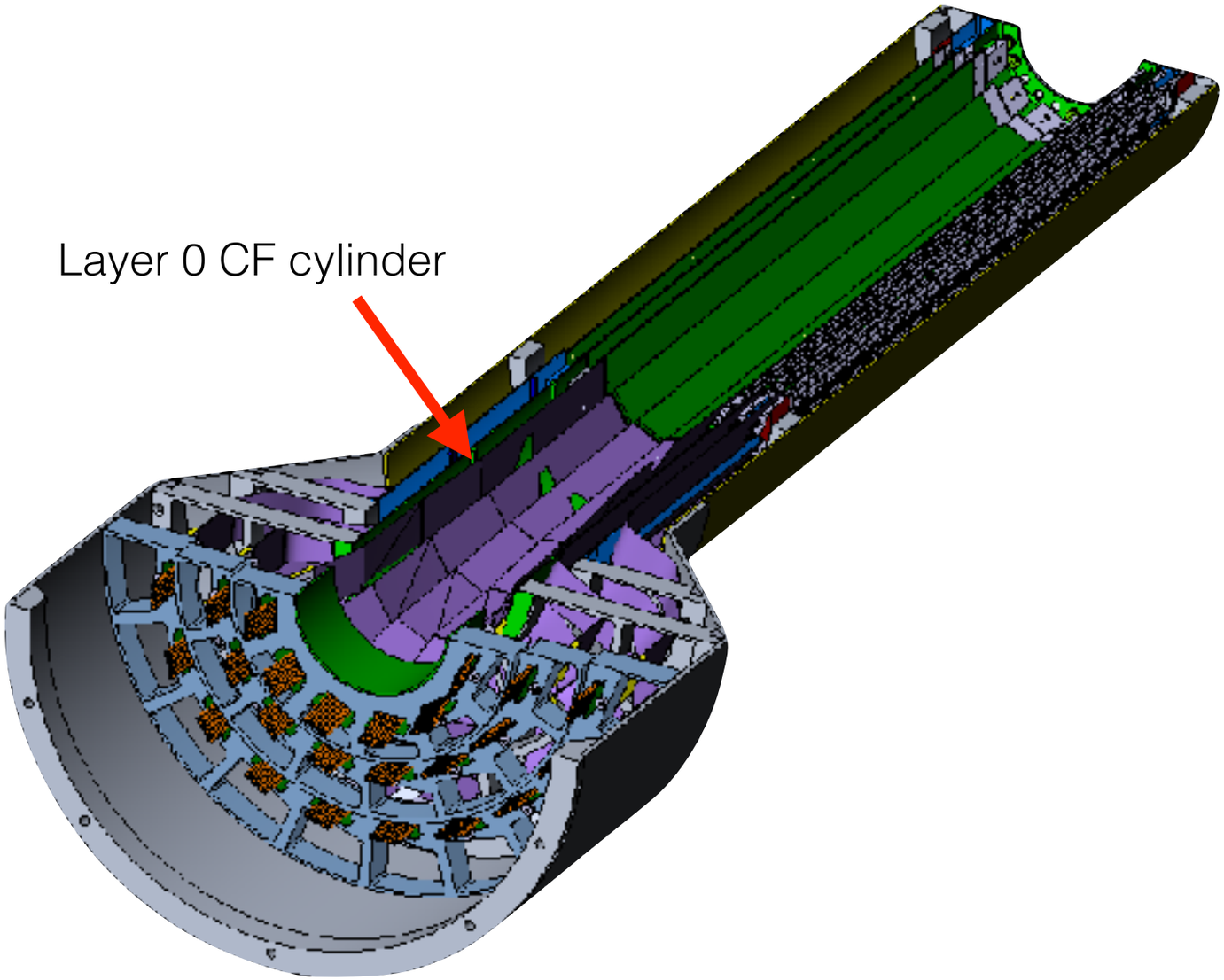
- Working out from there, remaining staves are mounted.
- Signal cables are guided through spider wheels to patch panels. (Power cables and cooling lines pass through)

Assembly Steps



- Completed layer 1 is assembled separately, then set in position.
- Nose wheel is bolted to end plate, CF cylinder is connected to spider wheel.

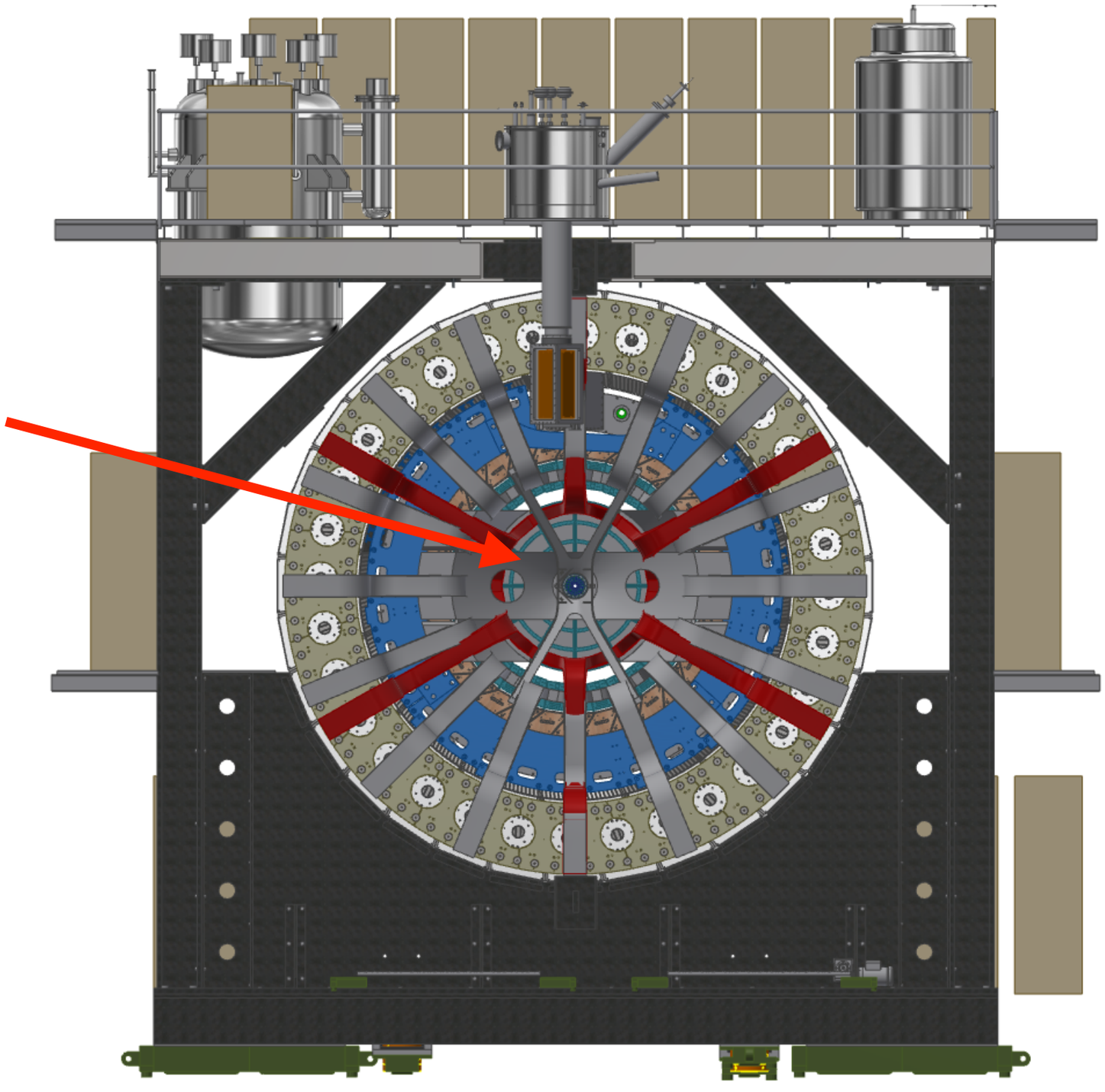
Assembly Steps



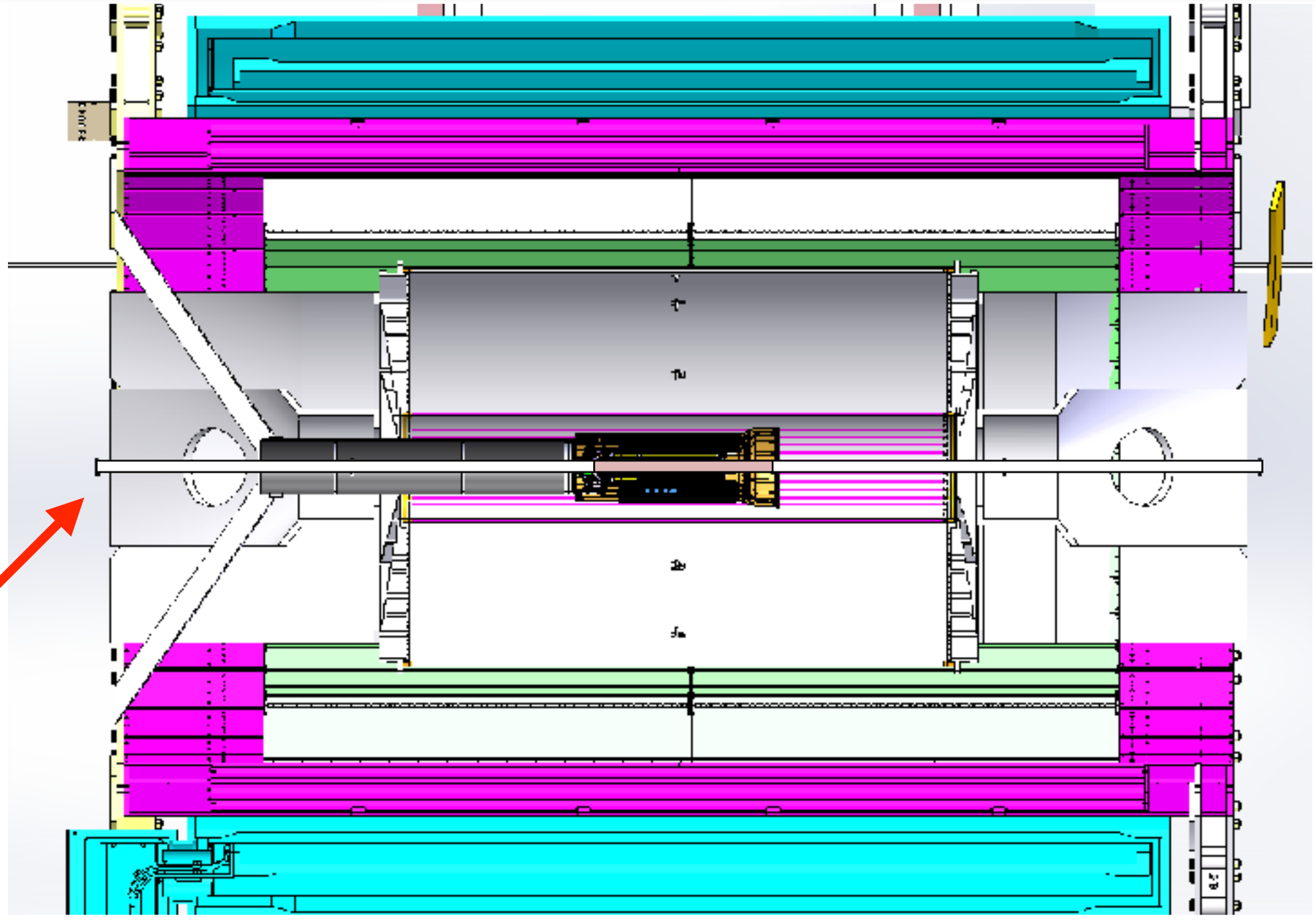
- Repeat for layer 0. Repeat for the other half-barrel.
- Note: Still working on beamline clearance for layer 0 cables.

Outer Support Structure

- 'X wing' provides rigid structure to install and support Service Barrel
- Still in development

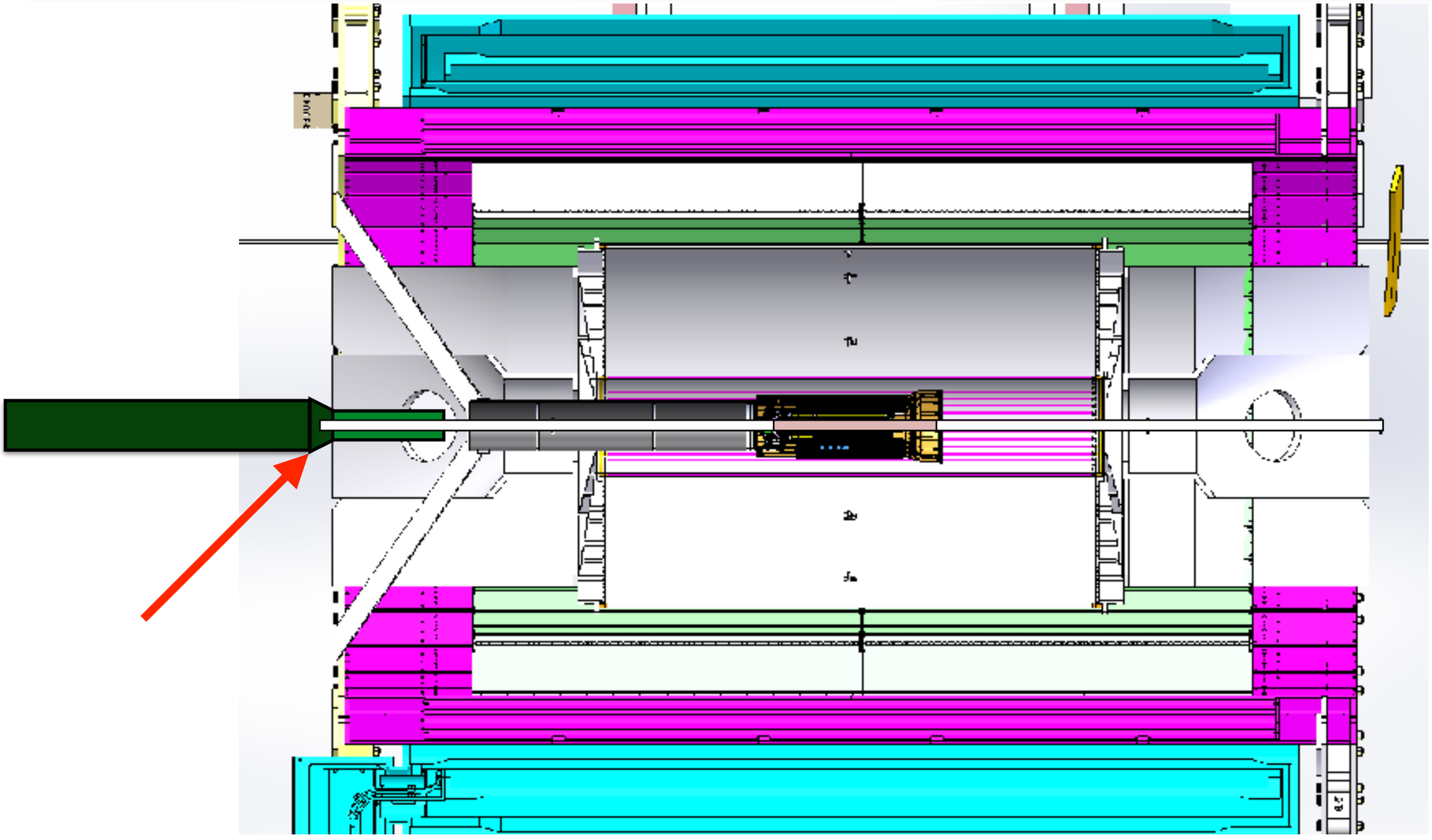


Beampipe



- Want flange moved back so MVTX can clamshell outside of TPC bore before insertion.

Beampipe



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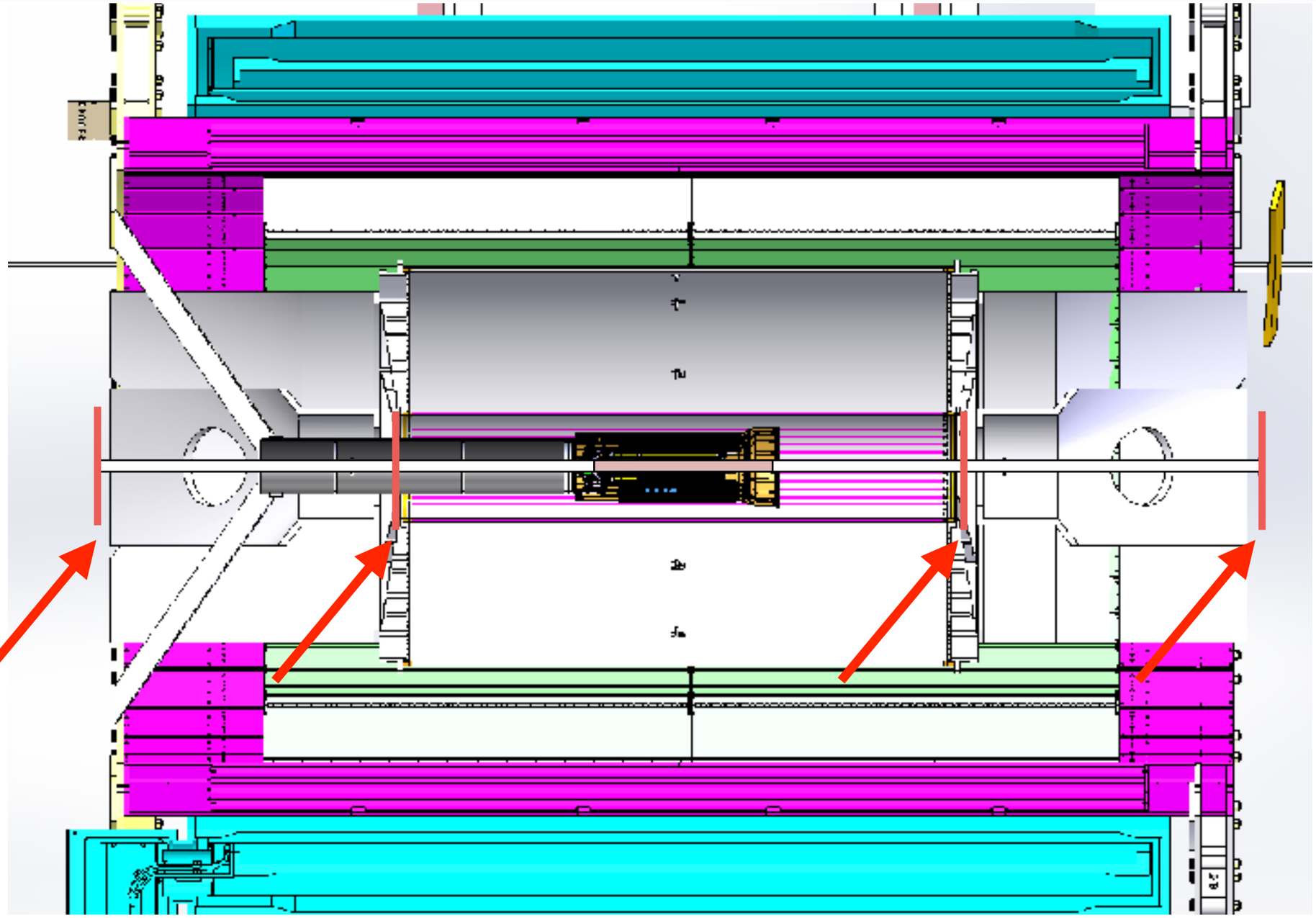
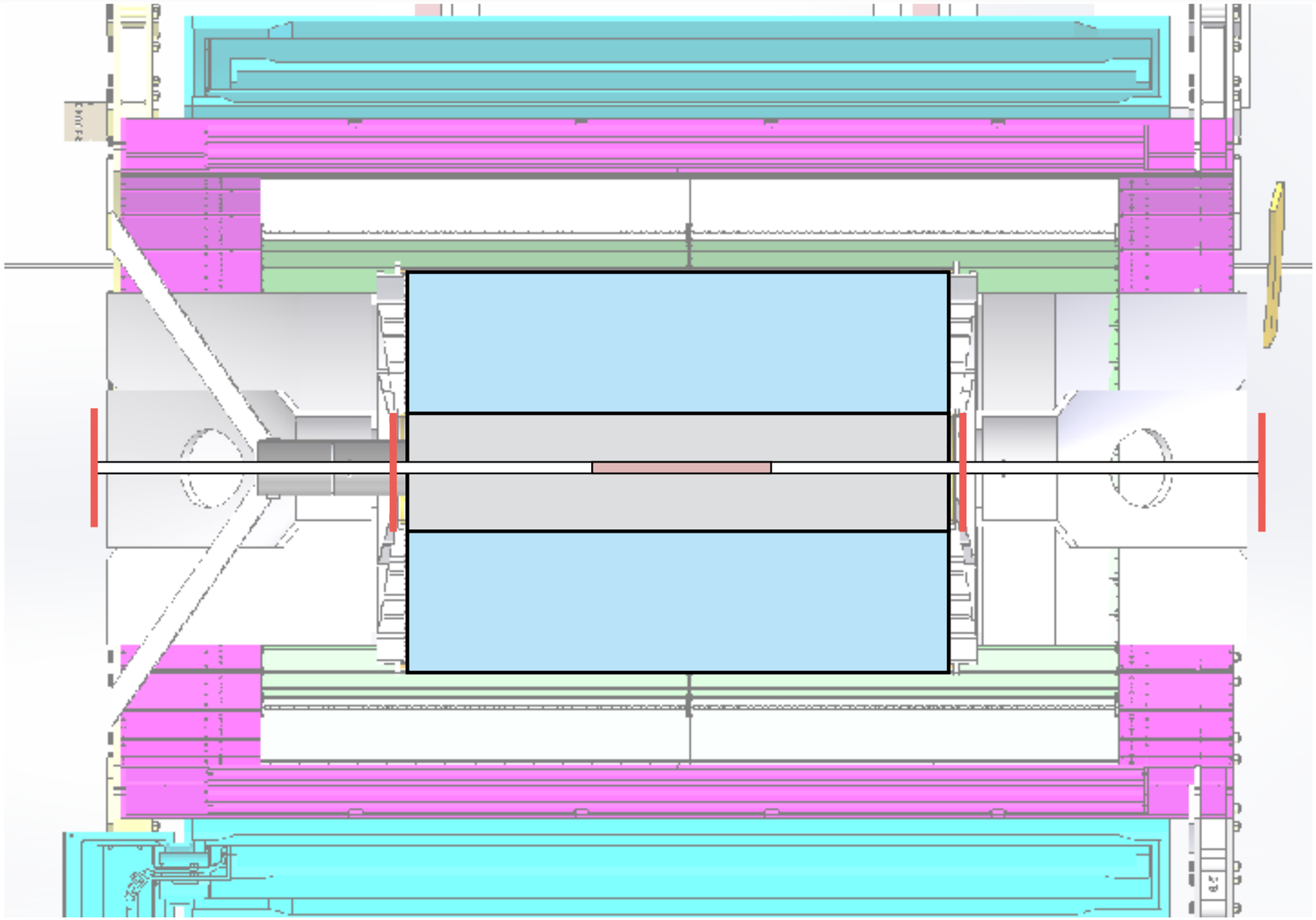
Beampipe



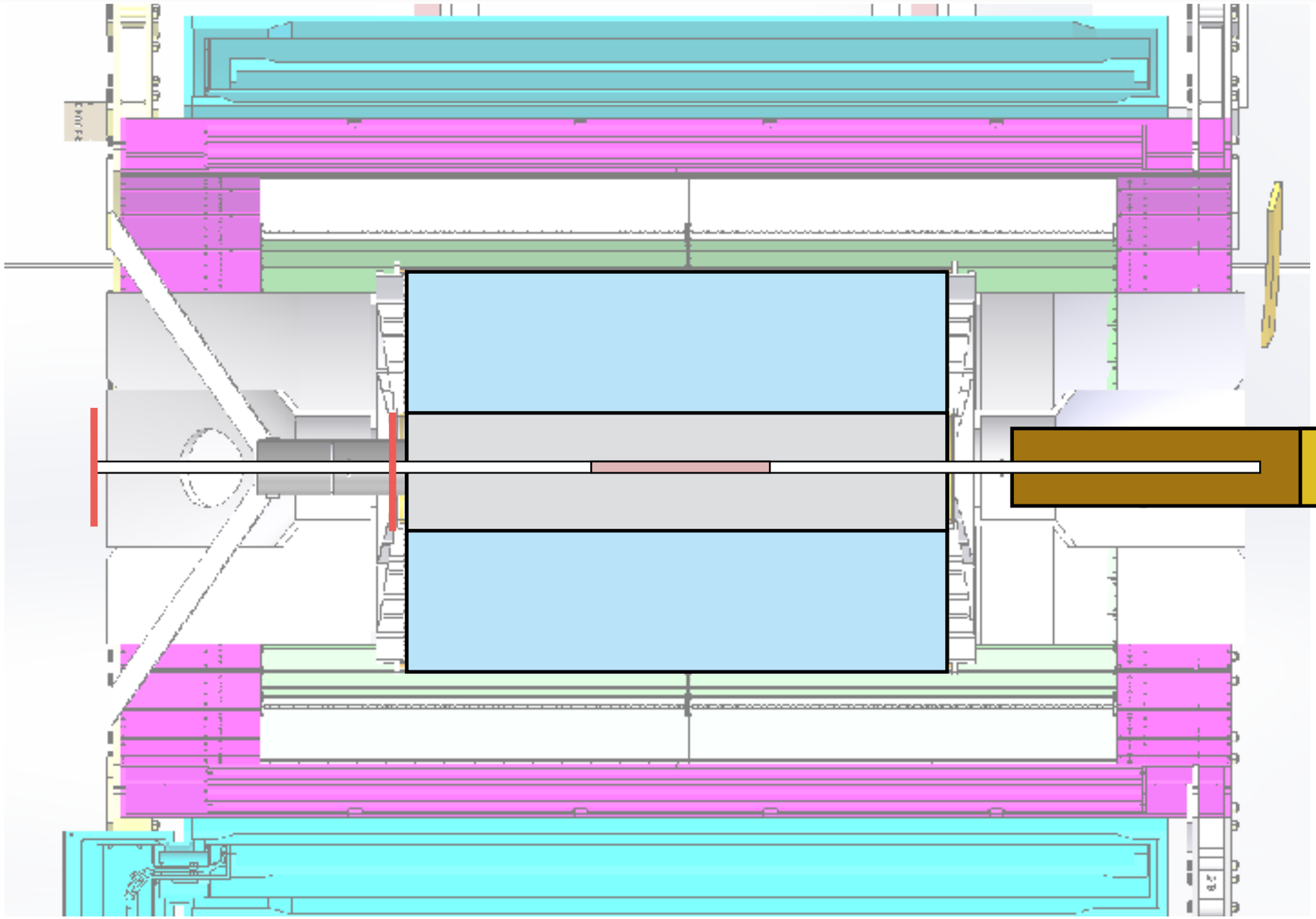
- Symmetric extension causes sag >2mm if pipe unsupported, so use supports at flanges and TPC wagon wheels

Installation Scheme



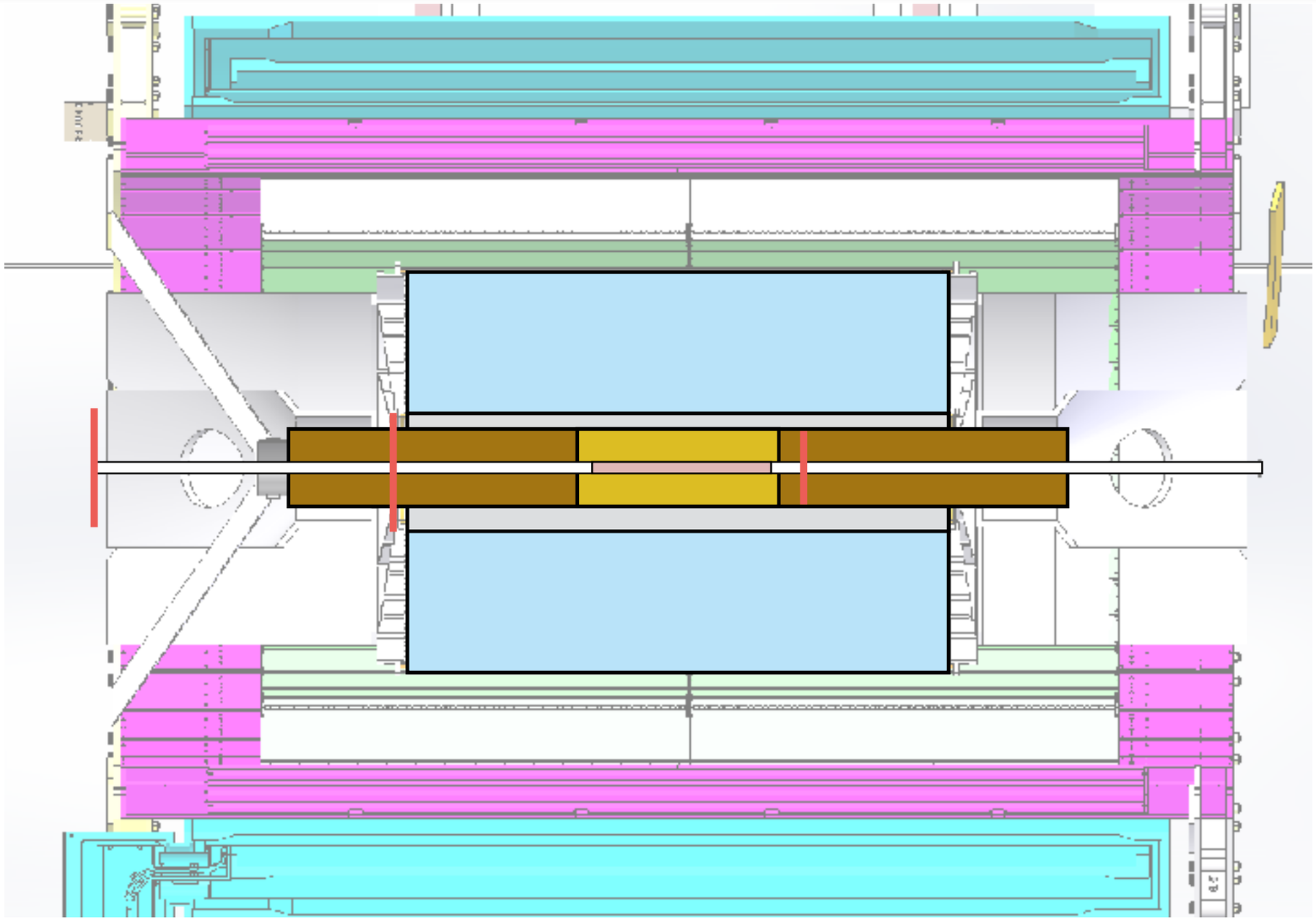
- TPC, INTT rails, beampipe, and temporary supports installed

Installation Scheme



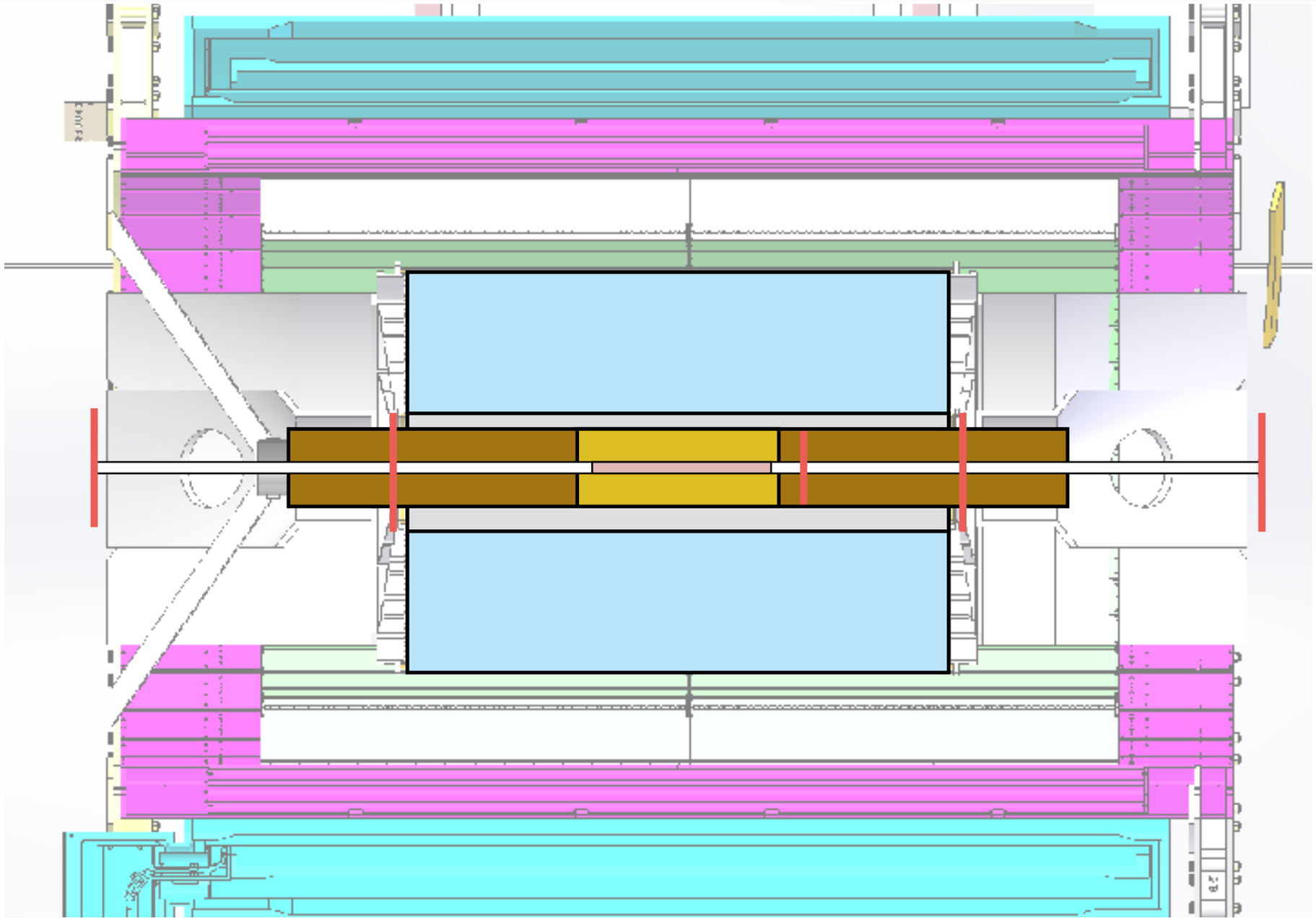
- North supports removed, INTT with Service Barrel assembled

Installation Scheme



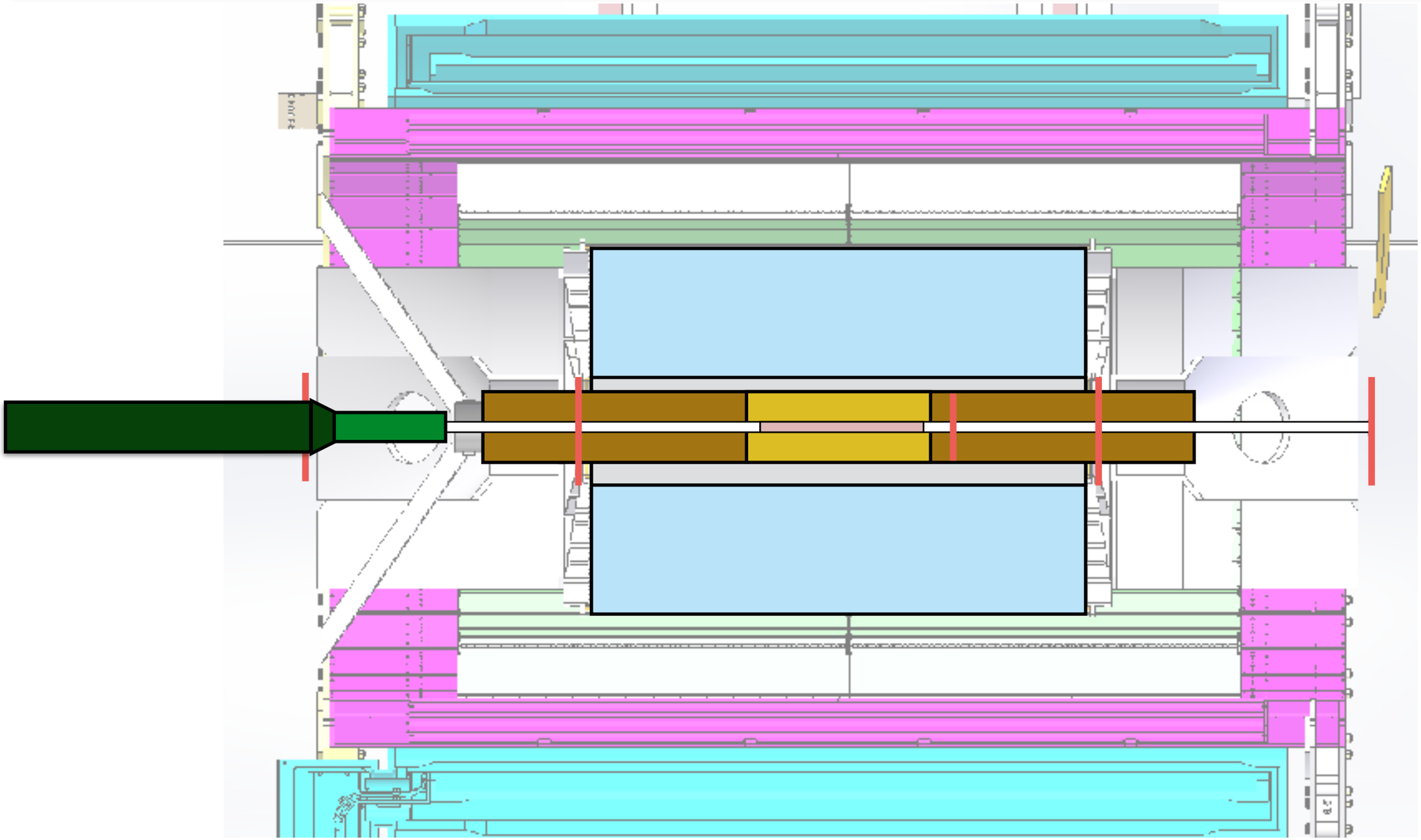
- INTT slides in on rails. ROCs do not interfere with support. Internal beampipe guide limits sag.

Installation Scheme



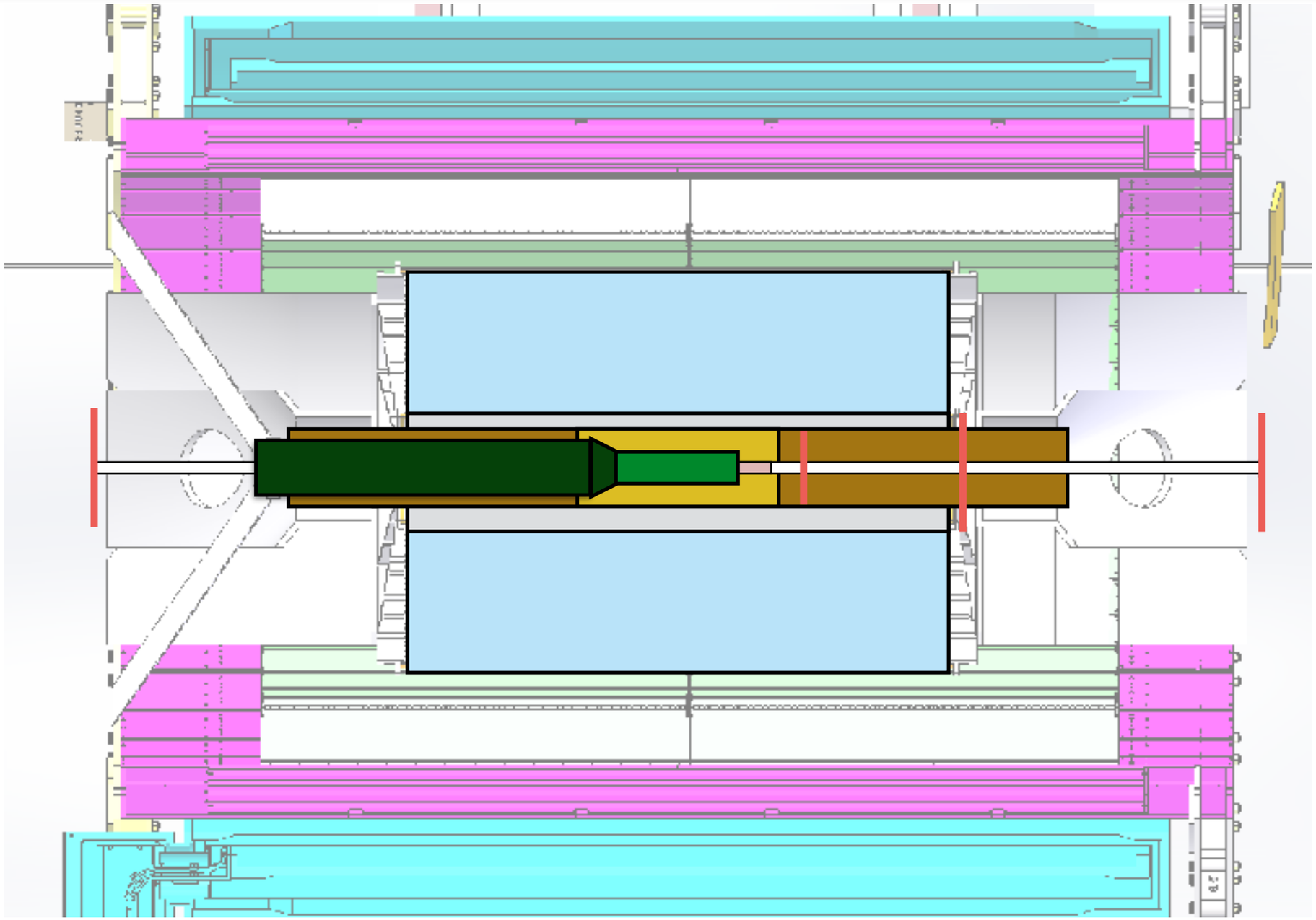
- North TPC support reinstalled. Permanent north flange support installed

Installation Scheme



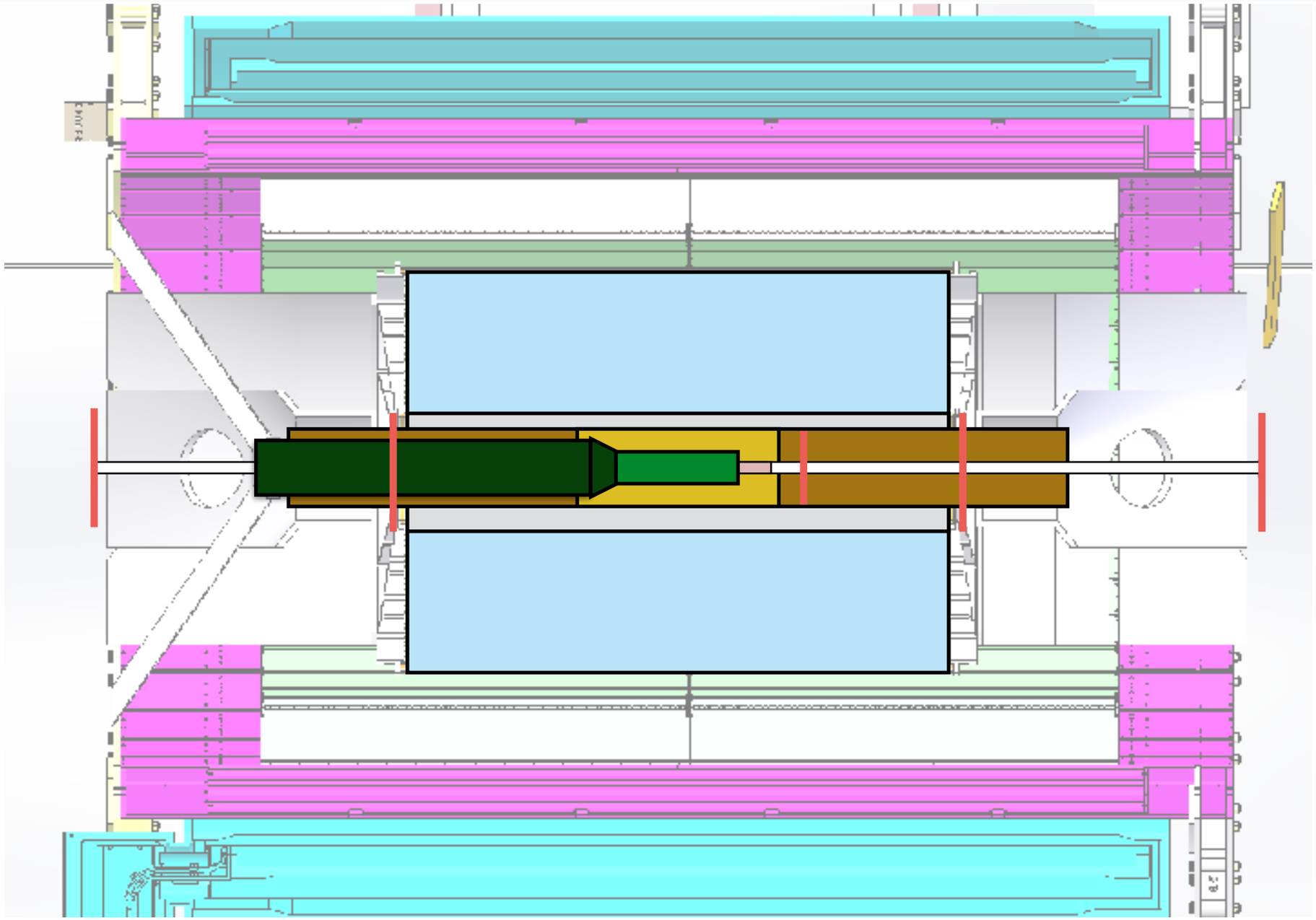
- MVTX support installed, MVTX installed north of flange. Barrel has gap for flange support.

Installation Scheme



- South TPC support removed, MVTX slides in, buttons up past flange support.

Installation Scheme



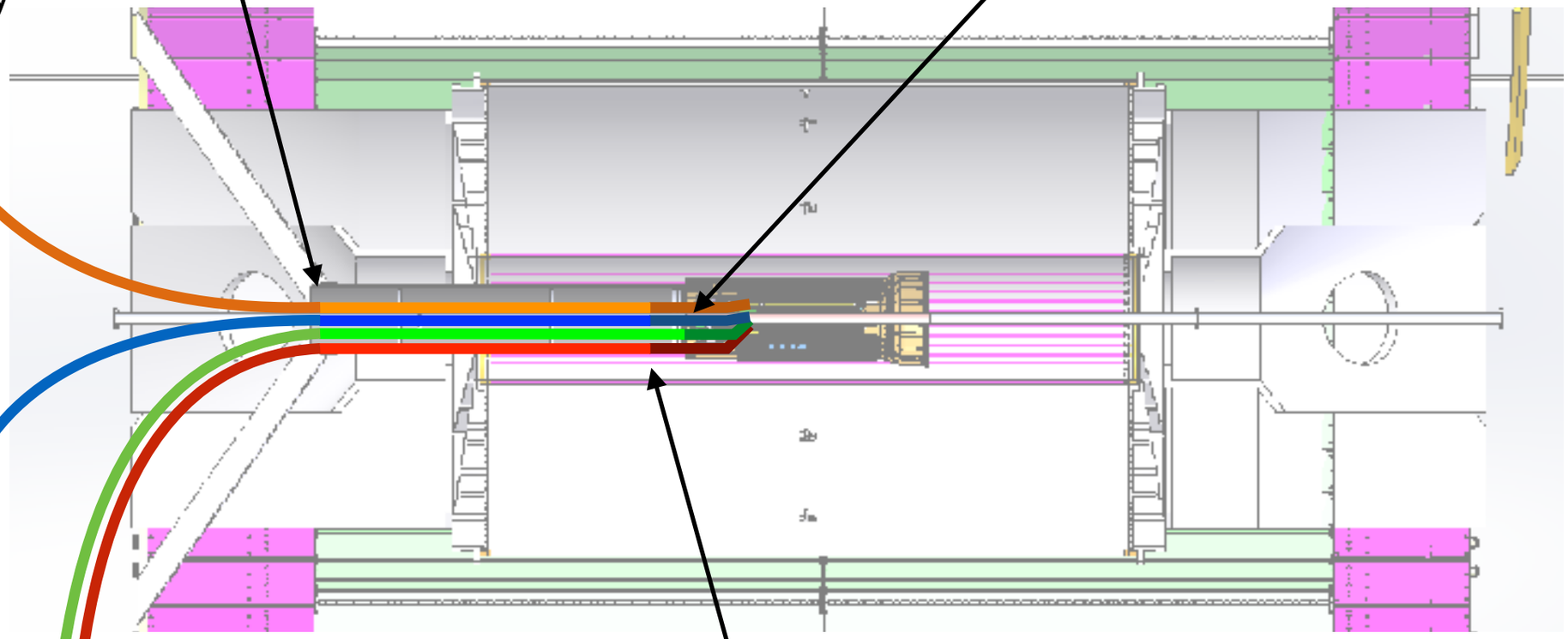
- TPC support carried by MVTX is installed. Permanent south flange support installed.

Cabling

Outer patch panel
• All lines terminate

Endwheel patch panel
• Signal FPC <--> Firefly

Dry air to
air supply

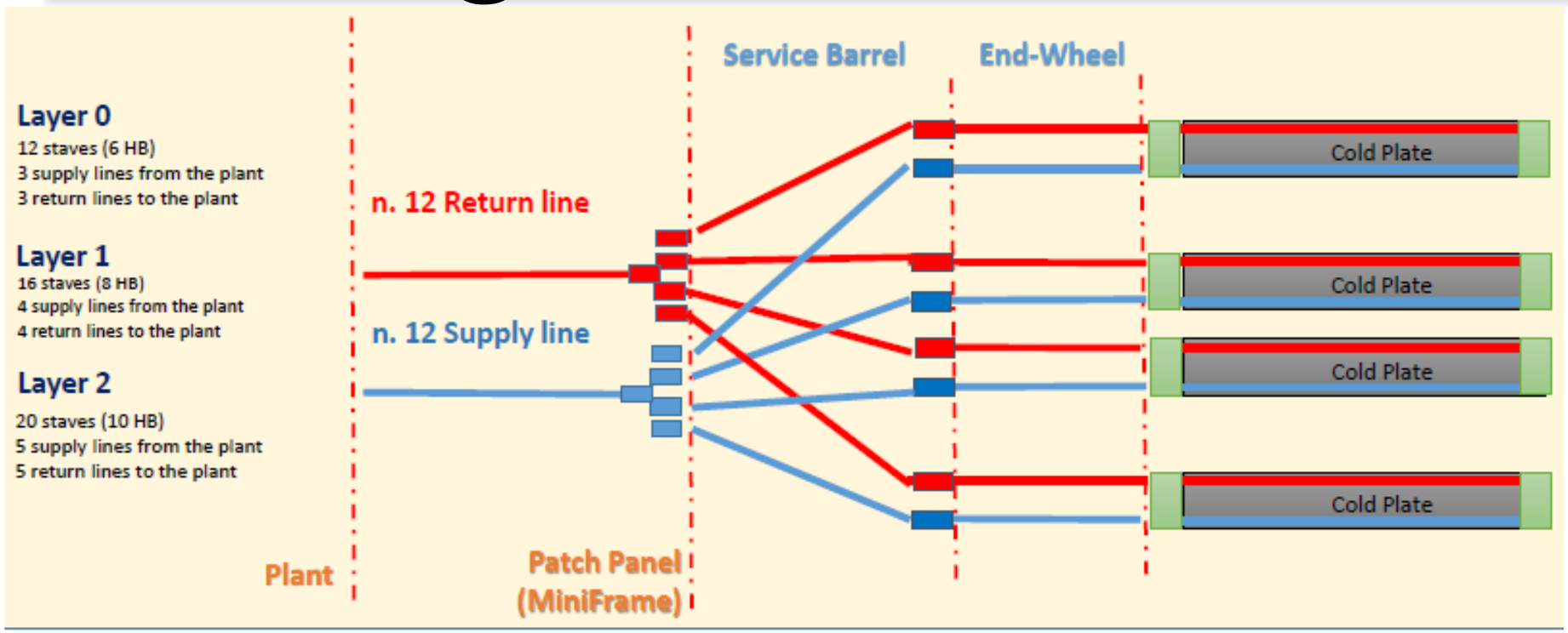


Water lines
to cooling
plant

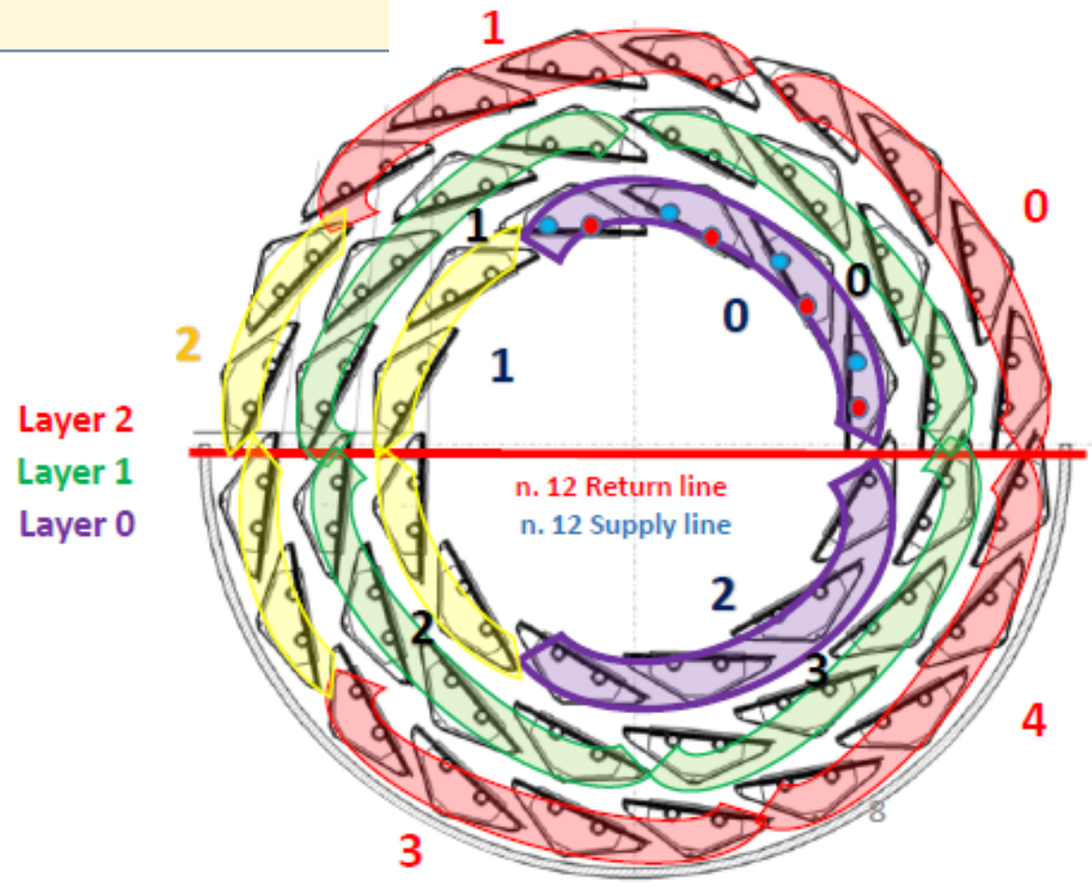
Endwheel patch panel
• Power FPC <--> cables
• Water small diam. <--> large diam.

Power and data
lines to racks

Cooling

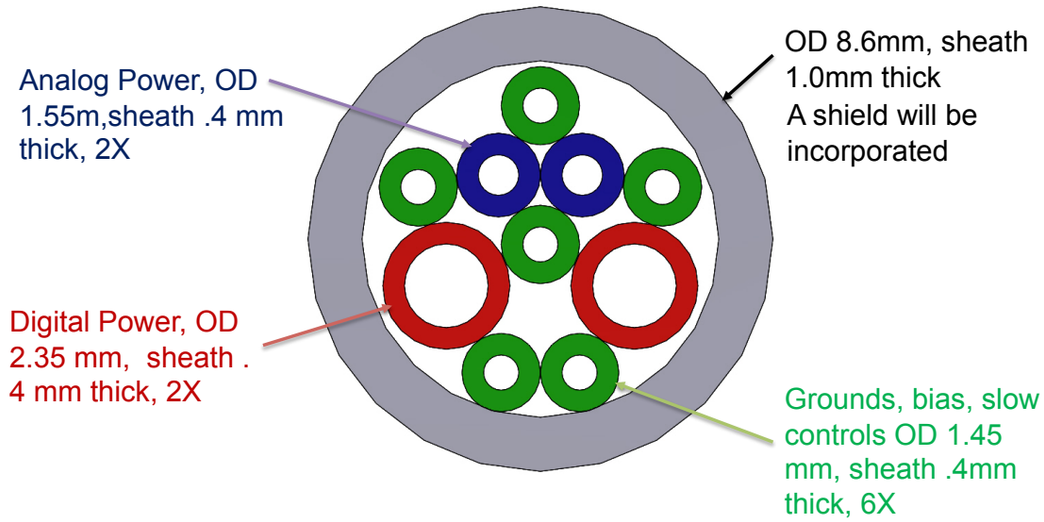


- Adapted (heavily) from ITS. Cooling plant size reduced.
- Leakless, subatmospheric water cooling
- >1 gal/hr through each stave, < 5W
- Low flow dry air used for humidity control



Cabling

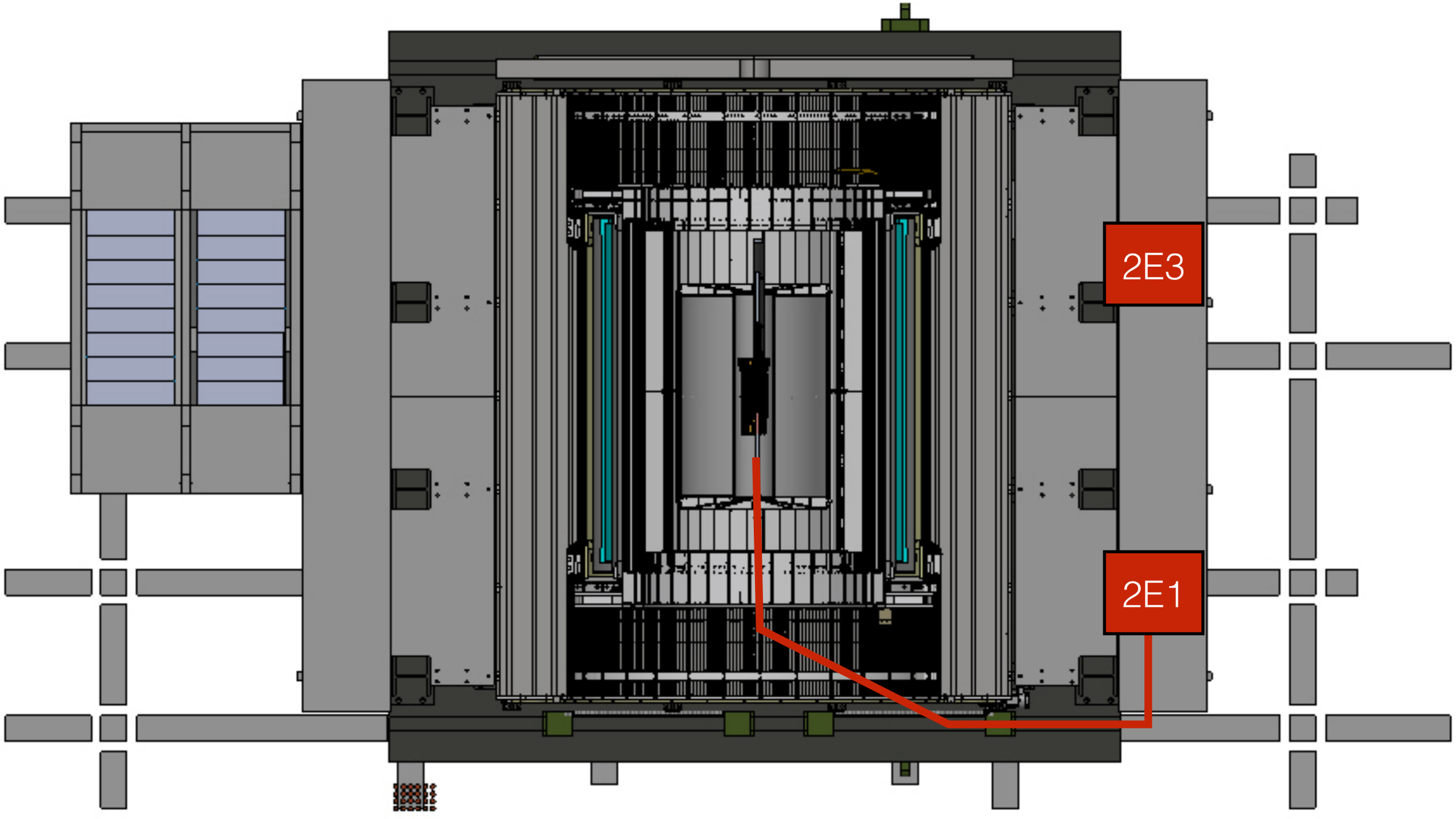
- ITS custom power and controls cable



- Firefly TwinAx data cable

- Including air+water, total cross section ~7 sq.in.

Racks



Ongoing Work

- Finalize/Optimize stave positions
- Detail cable routing through inner structures
- Revise and detail intermediate patch panels
- FEA analysis of structural supports
- Continue mounting and installation design

Status and Highlights

- Mechanical Support Structures
  - INTT interferences resolved and confirmed with physical model
  - Design updated with feedback from ALICE, LBNL
  - Pursuing other production options with industry
- Installation
  - First-pass plan developed with INTT
  - Detailed design pending support structure design
- Cooling System and Cabling
  - ITS cooling plant design in-hand
  - Redesigning for MVTX cooling load

Issues and Concerns

- Mechanical Support Structures
  - Cable routing still needs to be checked with full cable model
- Installation
  - Availability of beam pipe extension needs to be confirmed
  - Details of beam pipe support need to be established
- Cooling System
  - Pump specs may vary depending on pipe lengths / cooling plant location

Summary

- Inner mechanical support structures have significantly matured
- Outer support structures have preliminary designs -- no major obstacles encountered
- Cooling plant derived from ITS design, revision still in early stages
- Continuing to work with OSI on installation and integration issues

Backup

MIT Scope

- Mechanical Structures
  - Stave Assembly Tooling (1.5.3.1.2)
  - Metrology Tooling (1.5.3.1.3)
  - Mechanical Detector Design (1.5.3.2.1)
  - Stave Support Frame & MVTX Integration (1.5.4.4)
- Cooling System (1.5.4.2)
- Safety System (1.5.4.3)

L3 Collaborators (dependencies)

- Stave Assembly Tooling (1.5.3.1.2)
  - Depend on stave layout from simulation and engineering (LANL, BNL, etc)
- Metrology Tooling (1.5.3.1.3)
  - Depend on specifications from assembly (LBNL)
- Mechanical Detector Design (1.5.3.2.1)
  - Depend on feedback on constructability (LBNL)
  - Working with LANL engineers
- Stave Support Frame & MVTX Integration (1.5.4.4)
  - Iterate with OSI/INTT engineers for compatibility
  - Working with LANL engineers
- Cooling System (1.5.4.2)
  - Depend on OSI feedback for location details
- Safety System (1.5.4.3)
  - Depend on specifications from staves, details of cooling system

Schedule Drivers

- Stave Assembly Tooling (1.5.3.1.2)
  - Inner mechanical design must be final before procuring
  - Must be available for stave assembly
- Stave Support Frame & MVTX Integration (1.5.4.4)
  - Iterate with OSI/INTT engineers for compatibility
- Cooling System (1.5.4.2)
  - Lead time for vacuum vessel/pumps
- Generally: Manpower

Cost Drivers

- Stave Assembly Tooling (1.5.3.1.2)
  - Engineer/Designer time
- Metrology Tooling (1.5.3.1.3)
  - Engineer/Designer time
- Mechanical Detector Design (1.5.3.2.1)
  - Engineer/Designer time
- Stave Support Frame & MVTX Integration (1.5.4.4)
  - Engineer/Designer time
  - Procurement
- Cooling System (1.5.4.2)
  - Engineer/Technician time
  - Procurement
- Safety System (1.5.4.3)
  - Engineer/Technician time
  - Procurement

Status and Highlights

- Mechanical Detector Design (1.5.3.2.1)
  - Interferences with INTT resolved and checked with physical mock-up
  - Incorporating ALICE and LBNL feedback
- Stave Support Frame & MVTX Integration (1.5.4.4)
  - First-pass installation scheme developed
- Cooling System (1.5.4.2)
  - Depend on OSI feedback for location details
- Safety System (1.5.4.3)
  - Depend on specifications from staves, details of cooling system

Issues and Concerns

- Mechanical Detector Design (1.5.3.2.1)
  - Cable routing still needs to be checked with full cable model
- Stave Support Frame & MVTX Integration (1.5.4.4)
  - Availability of beam pipe extension needs to be confirmed
  - Details of beam pipe support need to be established
- Cooling System (1.5.4.2)
  - Location of cooling system still uncertain. Pumping needs may vary depending on pipe lengths.