MVTX Mechanical Design

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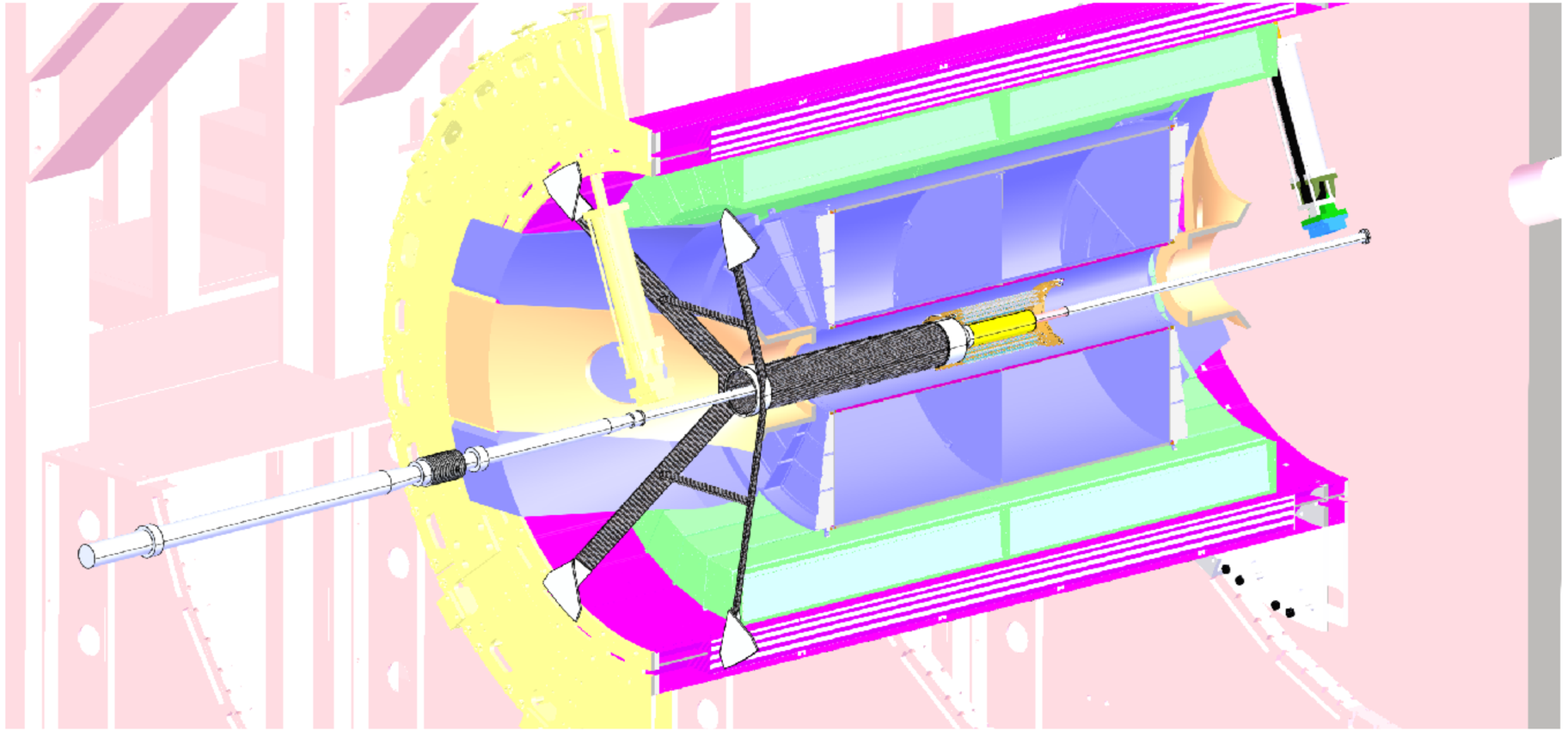
L3 Components

- Mechanical Support Structures
- Installation
- Cooling System and Infrastructure

L3 Collaborators (dependencies)

- Mechanical Support Structures (MIT, LANL)
- Installation (MIT, LANL, with RIKEN, BNL)
- Cooling System and Infrastructure (MIT, LANL, with RIKEN, BNL)

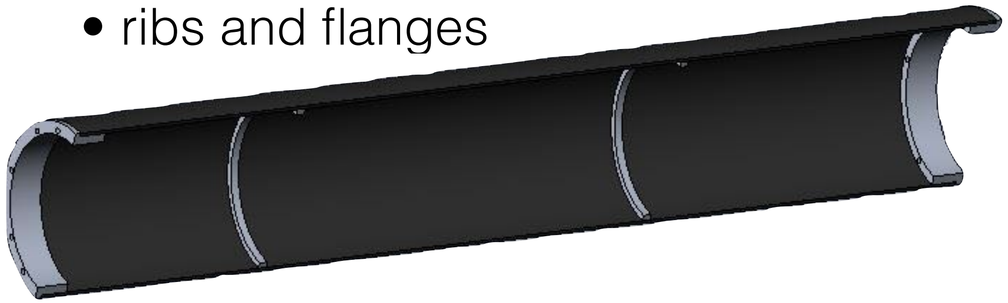
Mechanical Support Overview



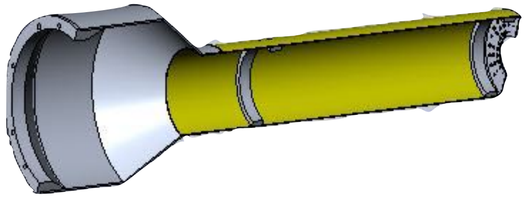
- Carbon fiber cantilevers detector (~few kg)
- Adapt from ITS for sPHENIX envelope

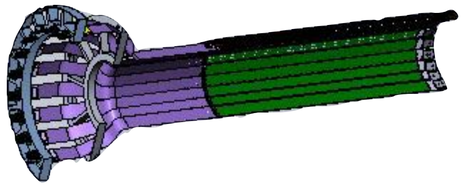
Inner Support Elements

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

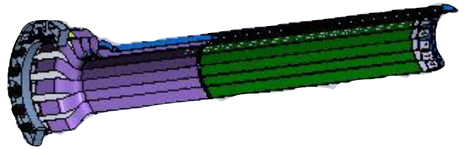


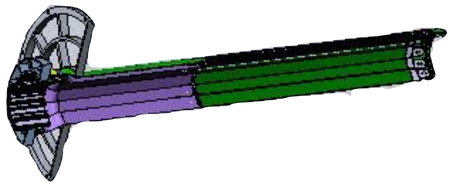
Cylindrical Structural Shell (CYSS)
- outermost cone and cylinders



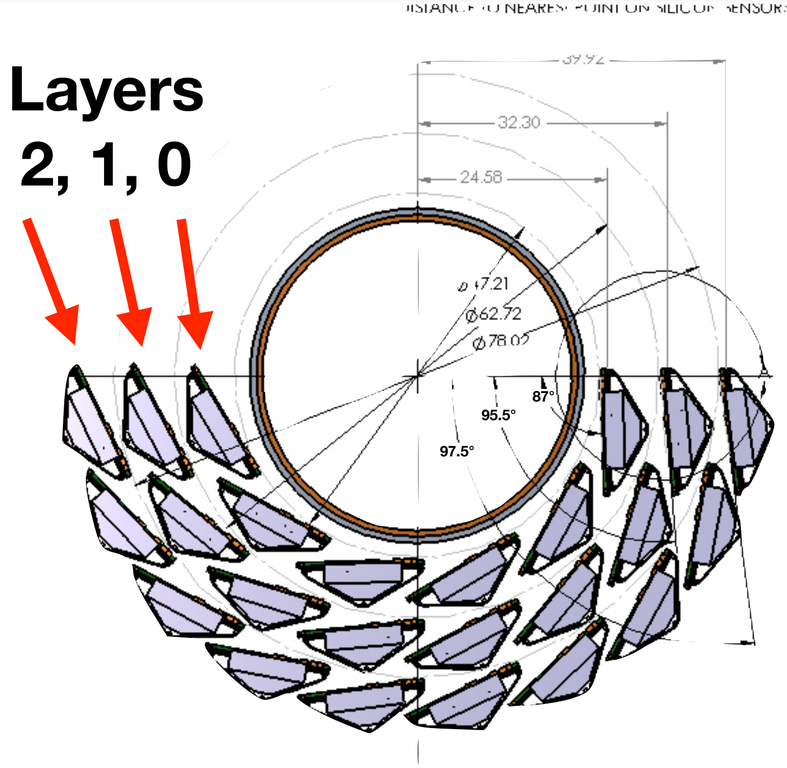


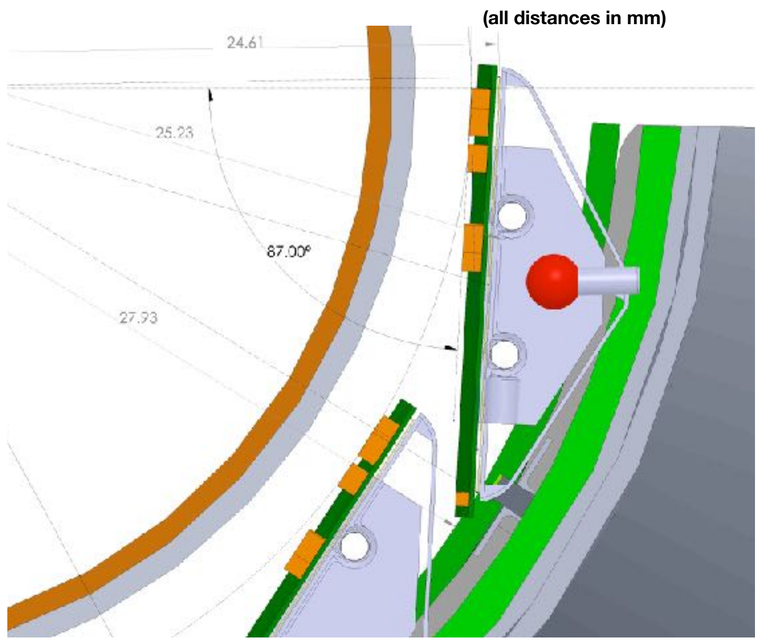
Endwheels
- thin rings
- layer supports
- cylinders
- pass-throughs
- patch panels





Adapting from ITS

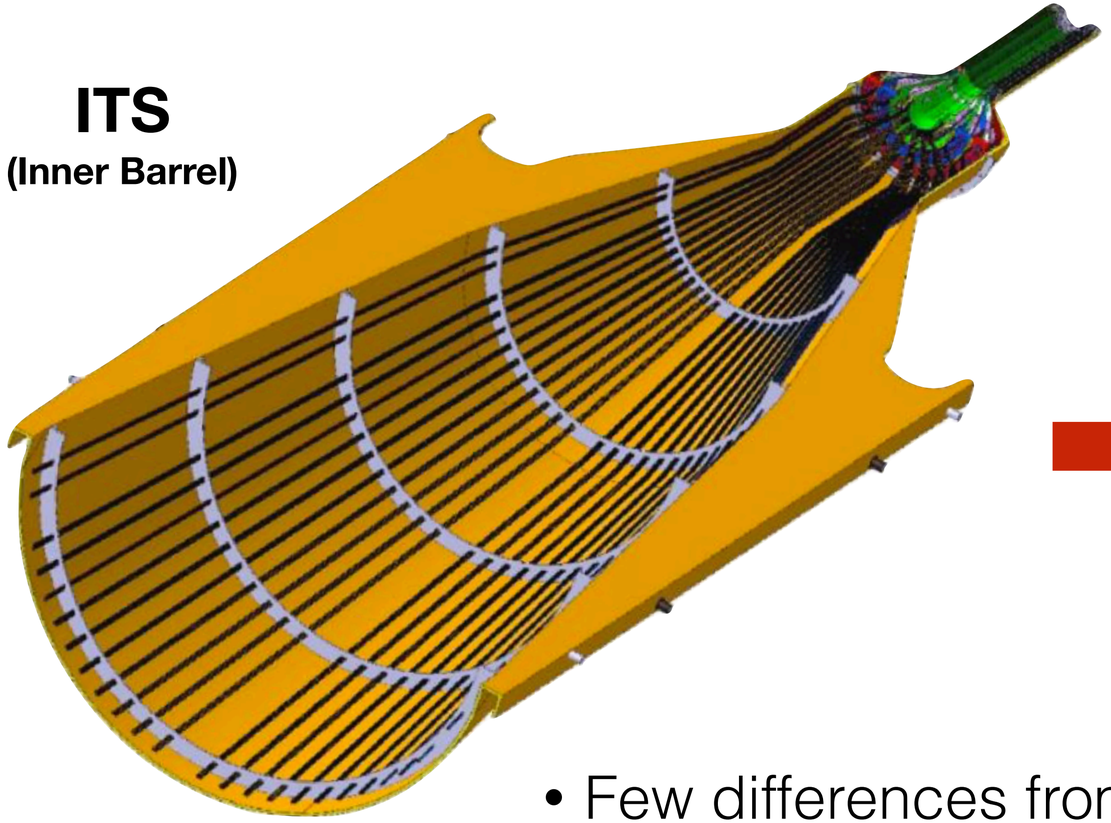




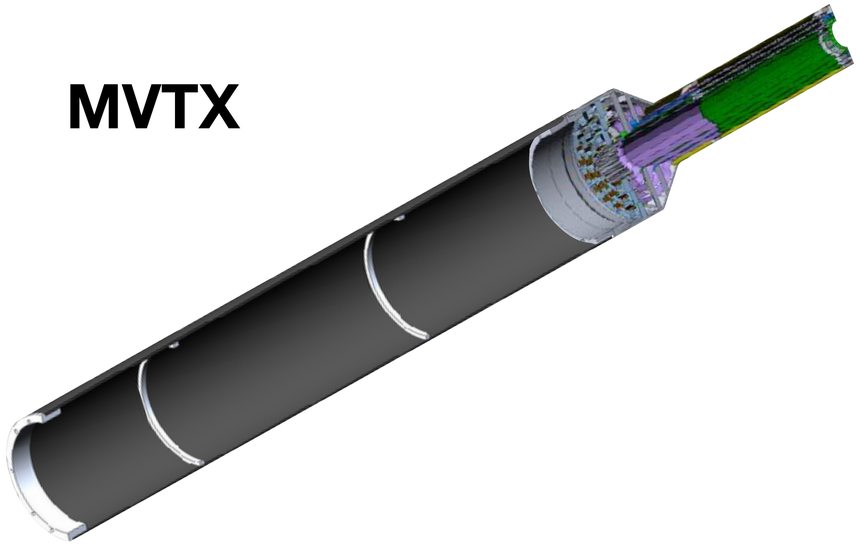
- ITS stave layout modified for sPHENIX beampipe Al and Be
- ALICE Be beampipe radius 19.0mm compared to sPHENIX 20.76mm
- Layer 0 Rmin 22.38mm -> 24.58mm
- Maintains hermetic coverage with same staves per layer

Adapting from ITS

ITS
(Inner Barrel)

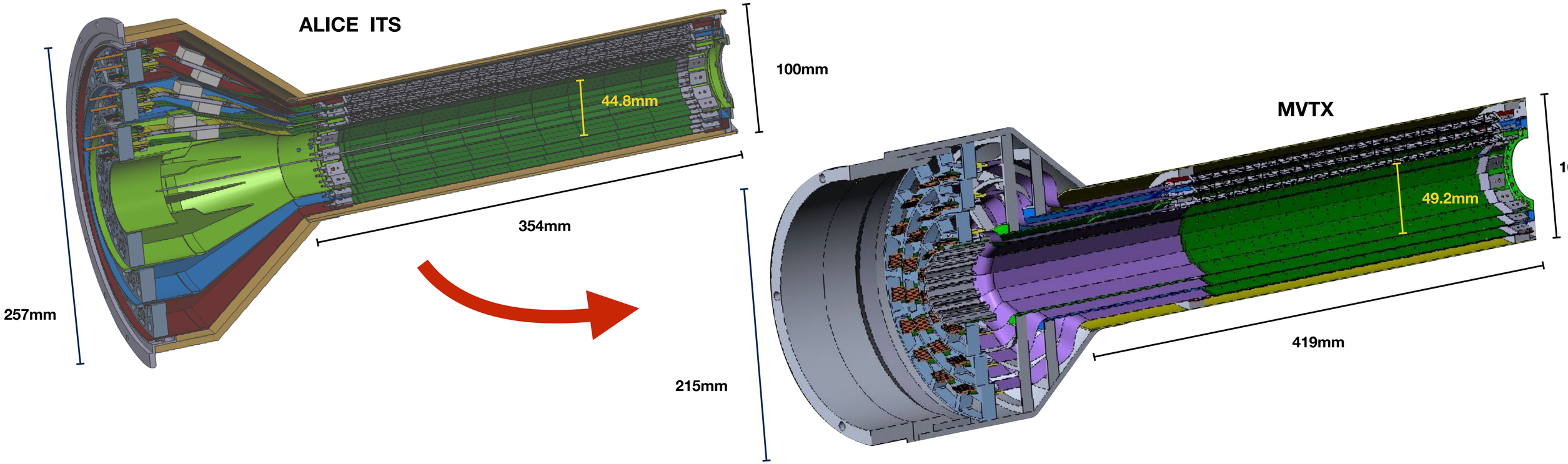


MVTX



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

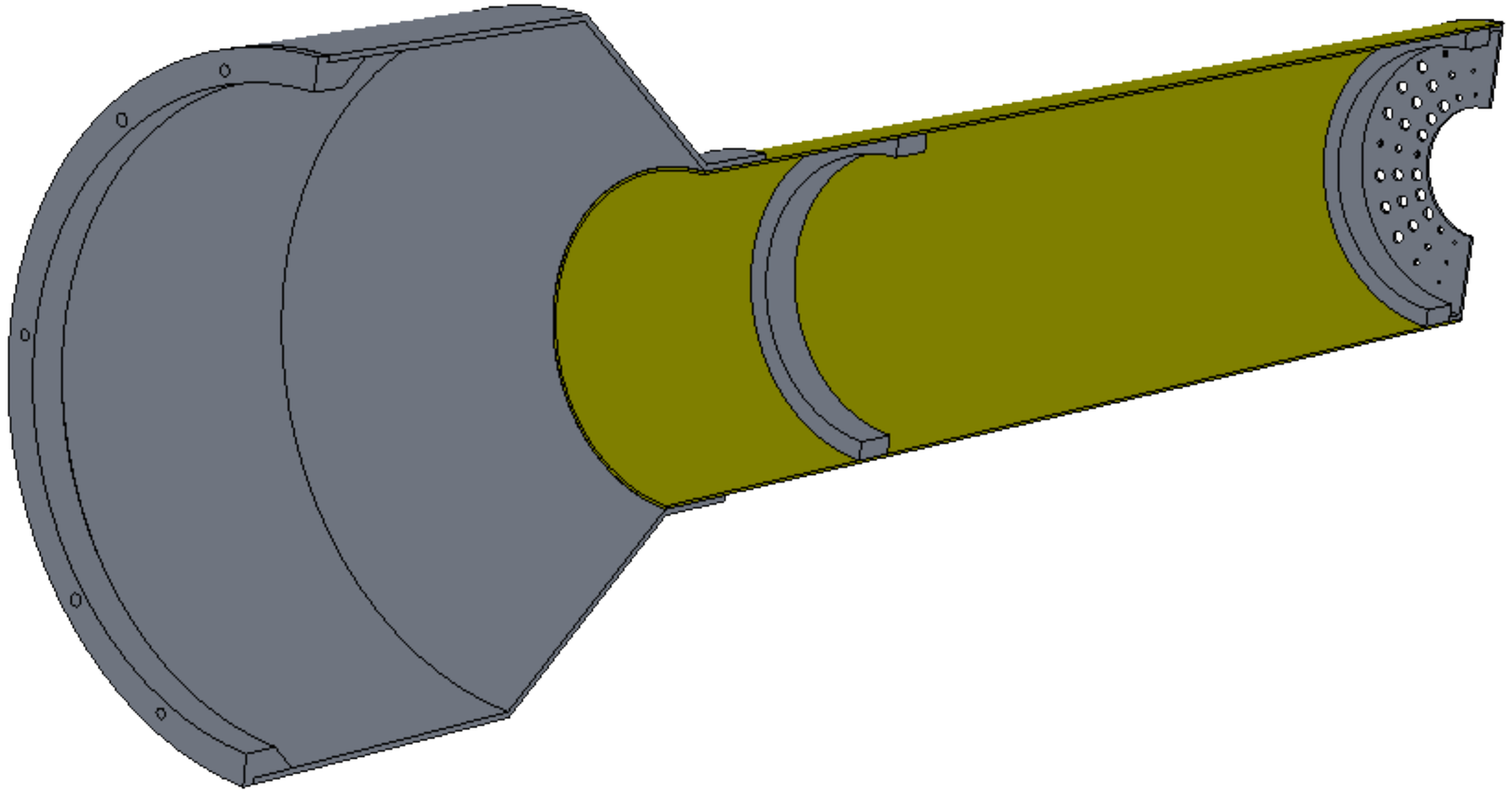
Adapting from ITS



- Conical section and OD modified for compatibility with INTT
- Intermediate conical sections removed to simplify construction

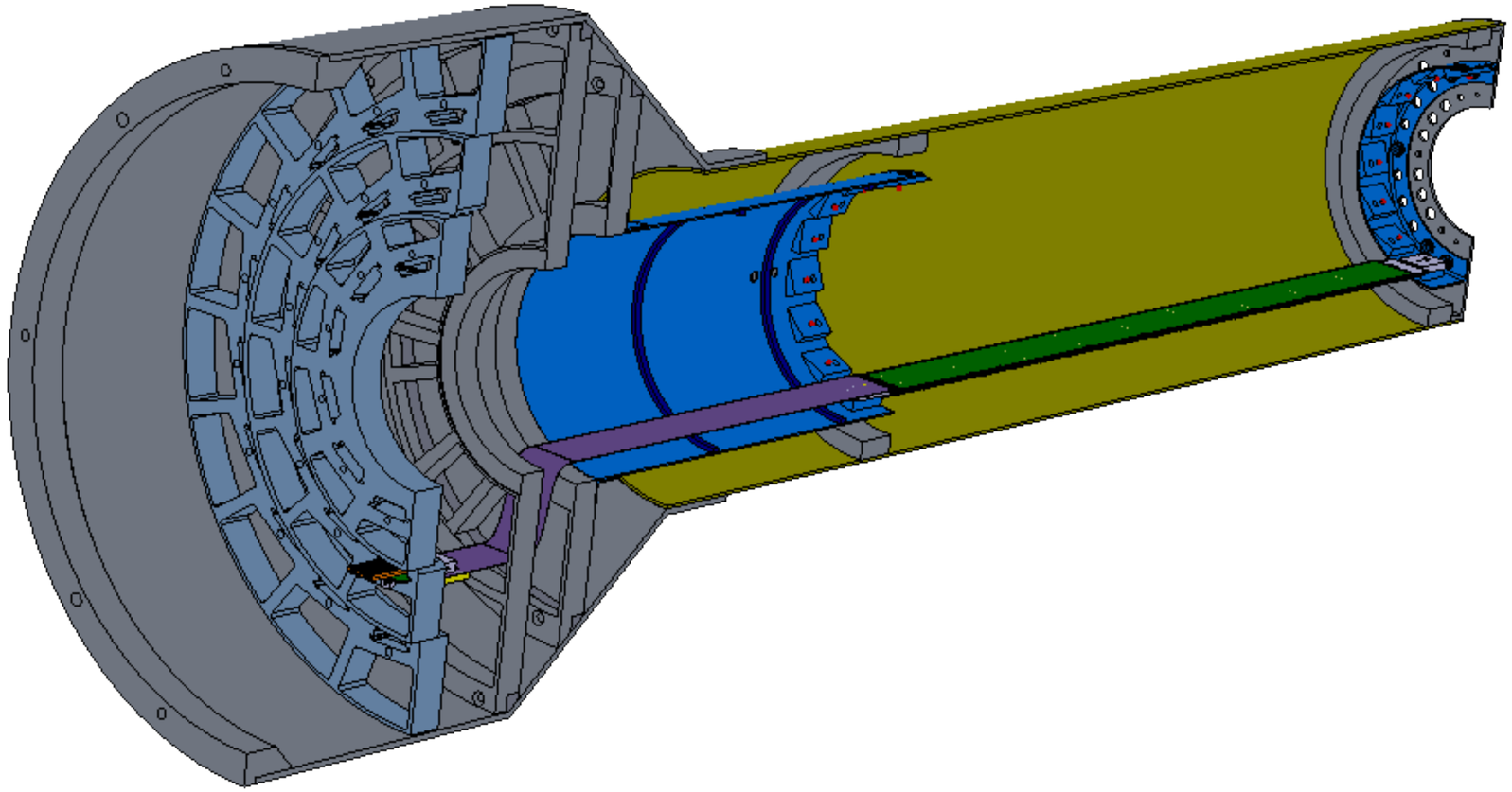
CYSS

- Large and small diameter CF half-cylinders connected by conical section
- Upstream flange mounts to Service Barrel
- Downstream plate to secure staves



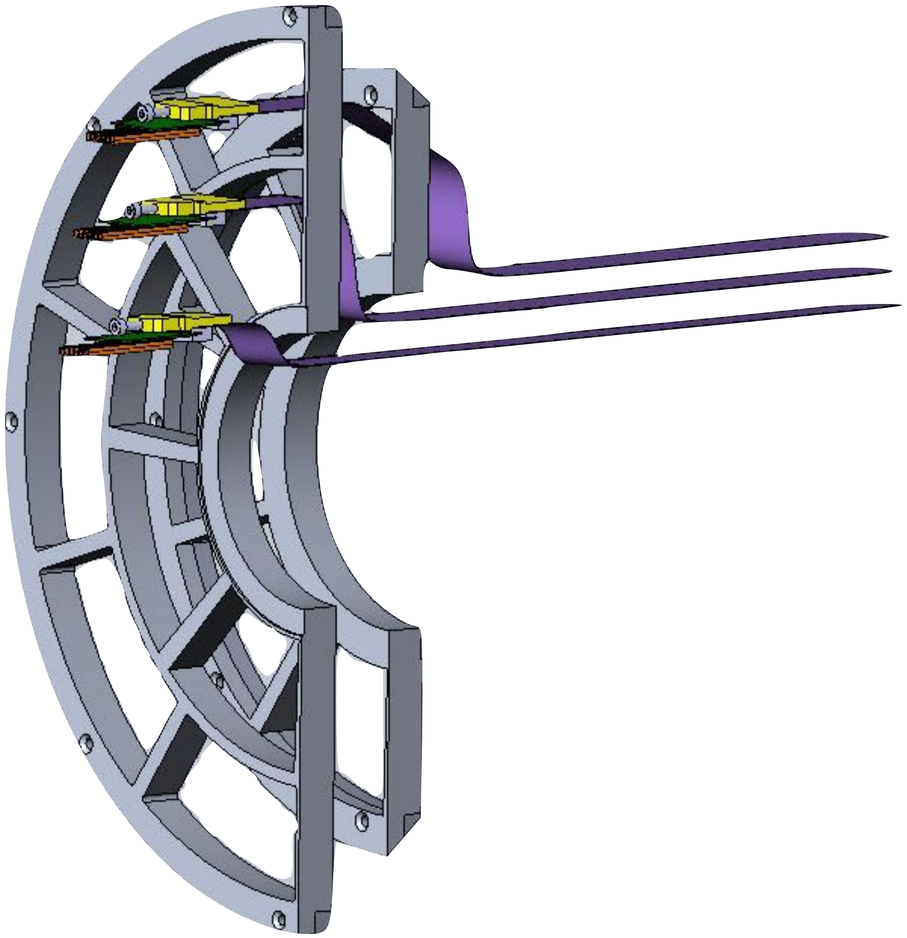
Endwheels

- Upstream CF half-cylinder mounts to Spider Wheel
- Downstream CF ring mounts to endplate
- Blocks with 1mm ruby spheres precisely position staves
- Outer layer staves mount to CYSS directly

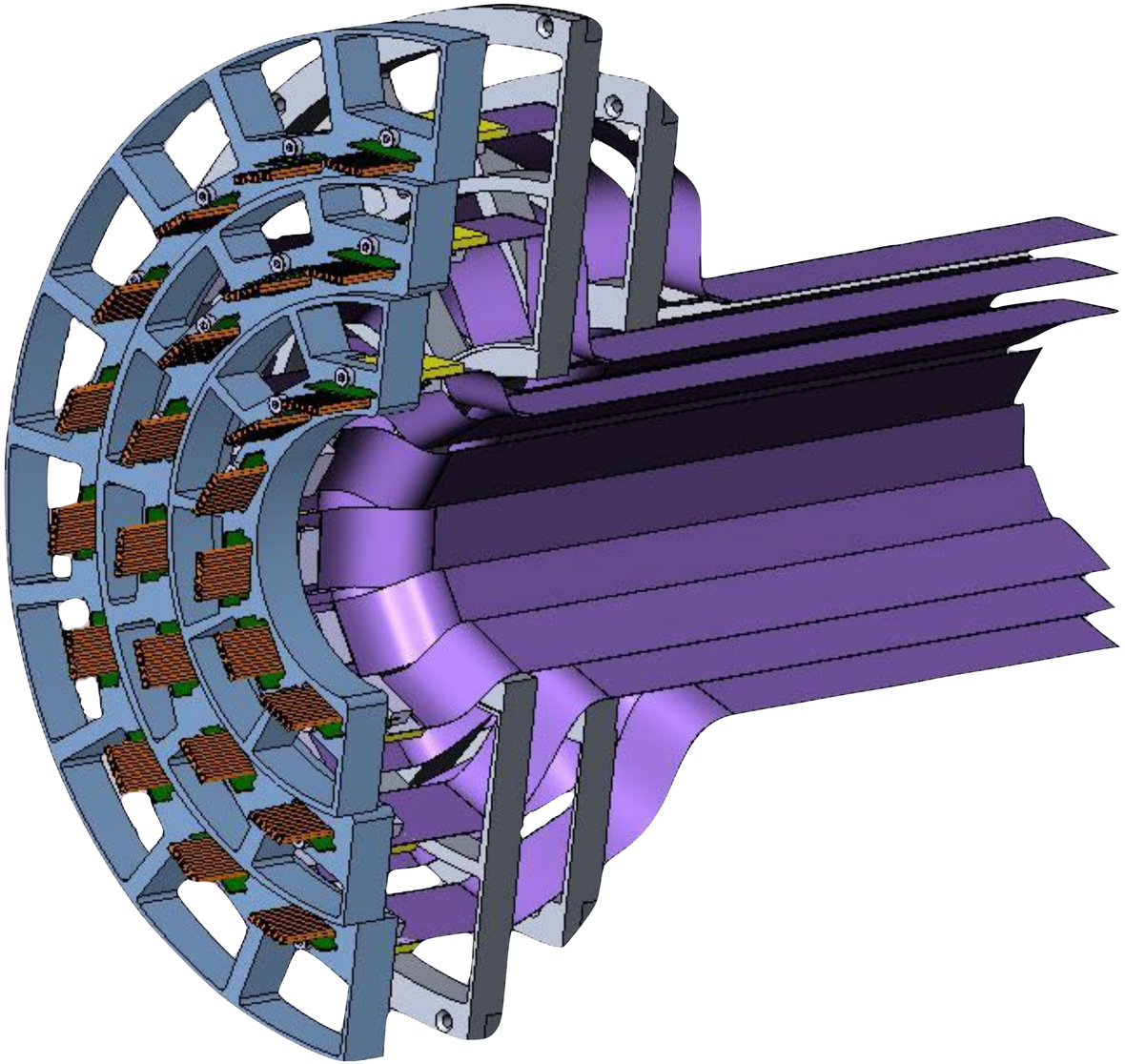


Spiderwheel Detail

- Aluminum frames support endwheels
- Replace nested conic segments in ITS design (easier to fabricate)
- Mount to conical section of CYSS
- Radial elements give room for cables and hoses to fan out between wheels

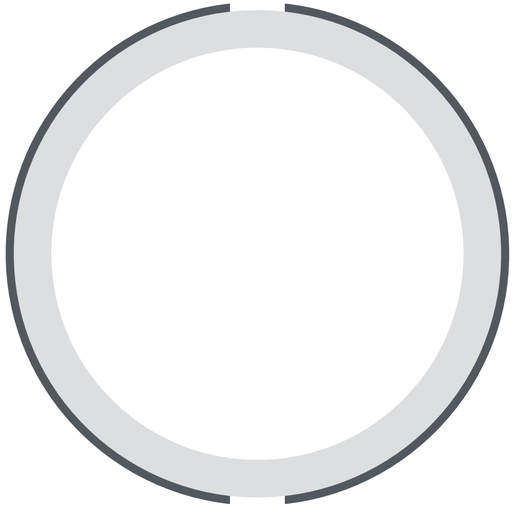


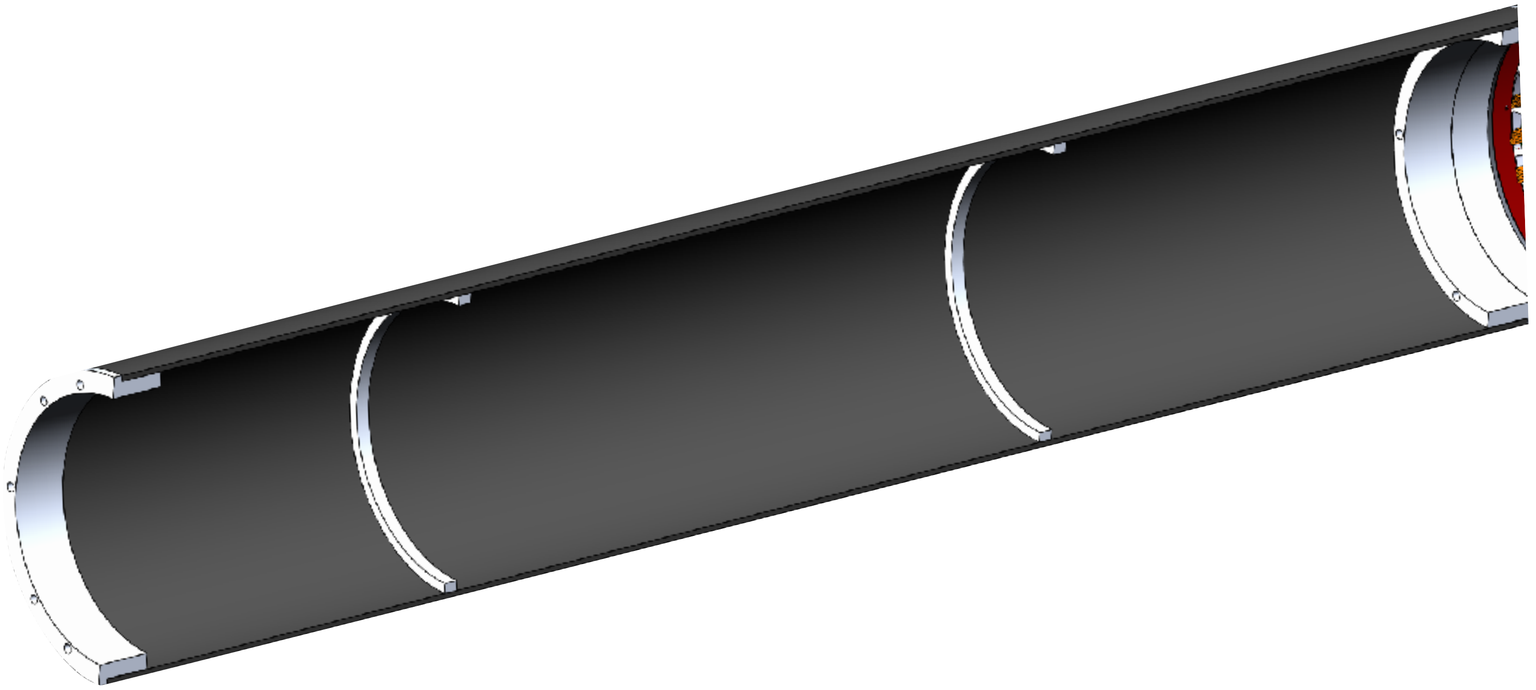
Patch Panels



- 3D-printed structure to transition signal FPC to Firefly cable
- Narrower than ITS to accommodate INTT
- Power FPCs and cooling lines pass through to Service Barrel

Service Barrel

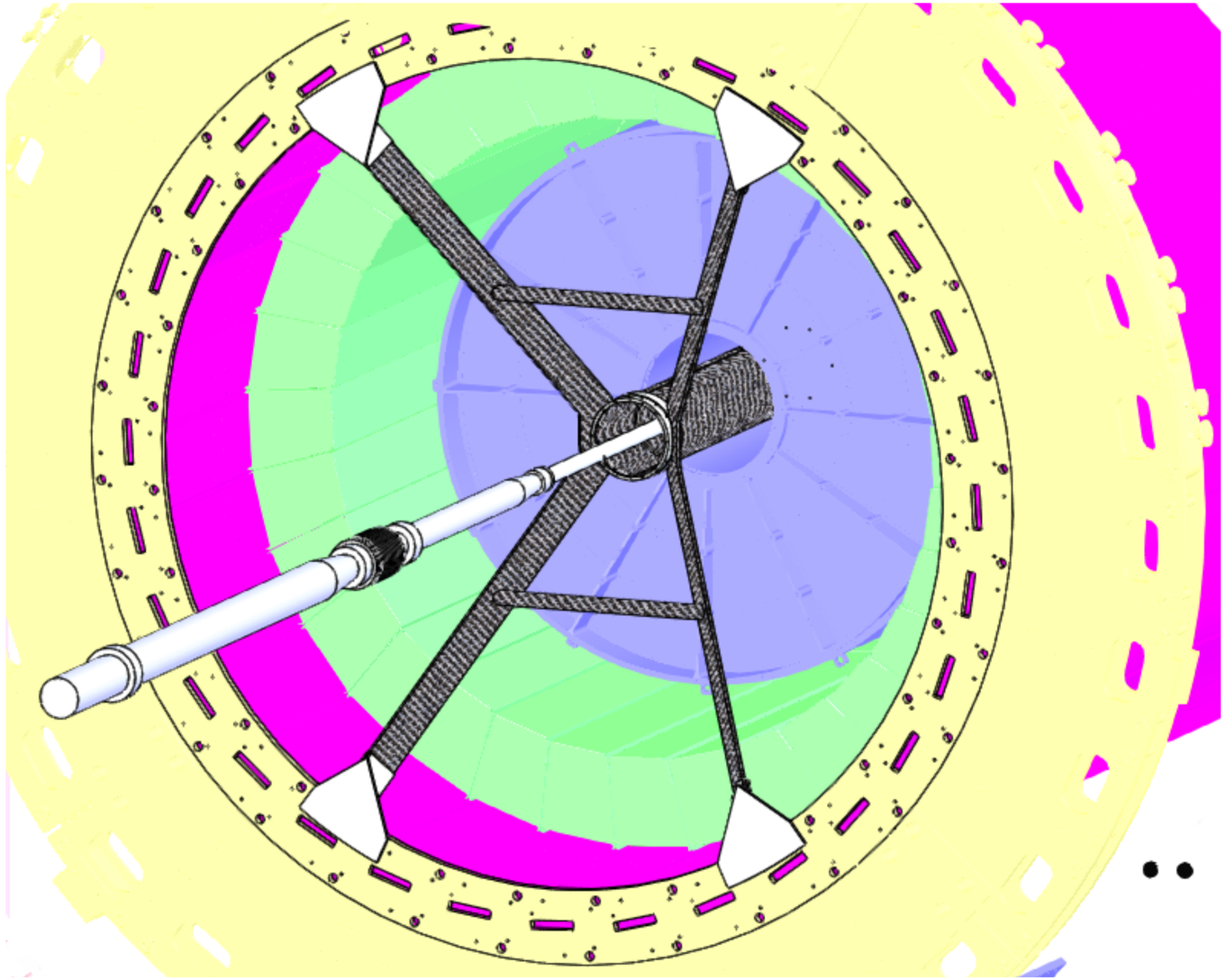




- Aluminum stiffening ribs cover full phi (with insulating spacers)
- Gap in CF half-cylinders allows vertical beampipe supports to coexist with the SB

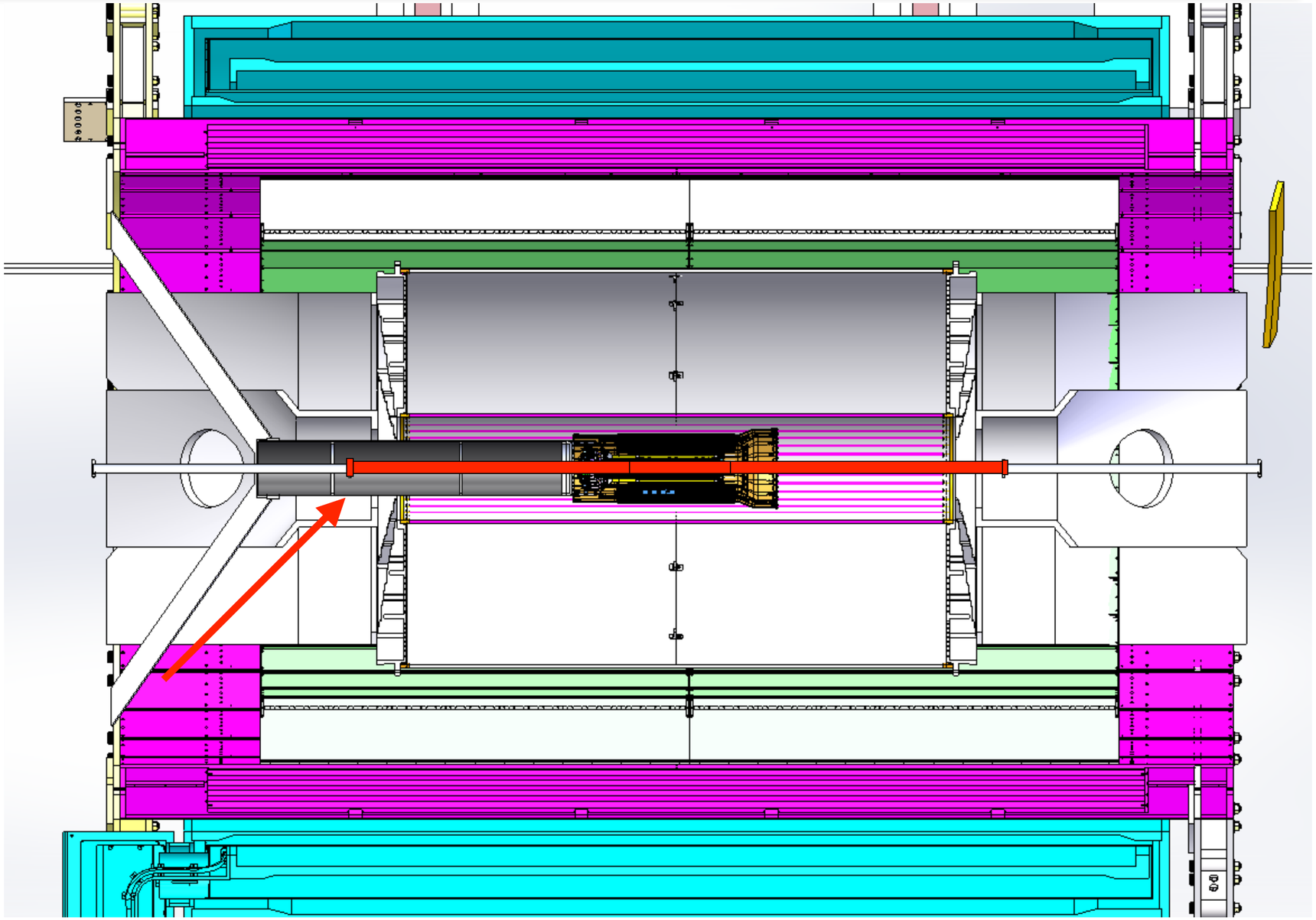
Outer Support Structure

- 'X wing' provides rigid structure to install and support Service Barrel
- Mounts to HCal support
- Iteration with OSI, structural analysis ongoing



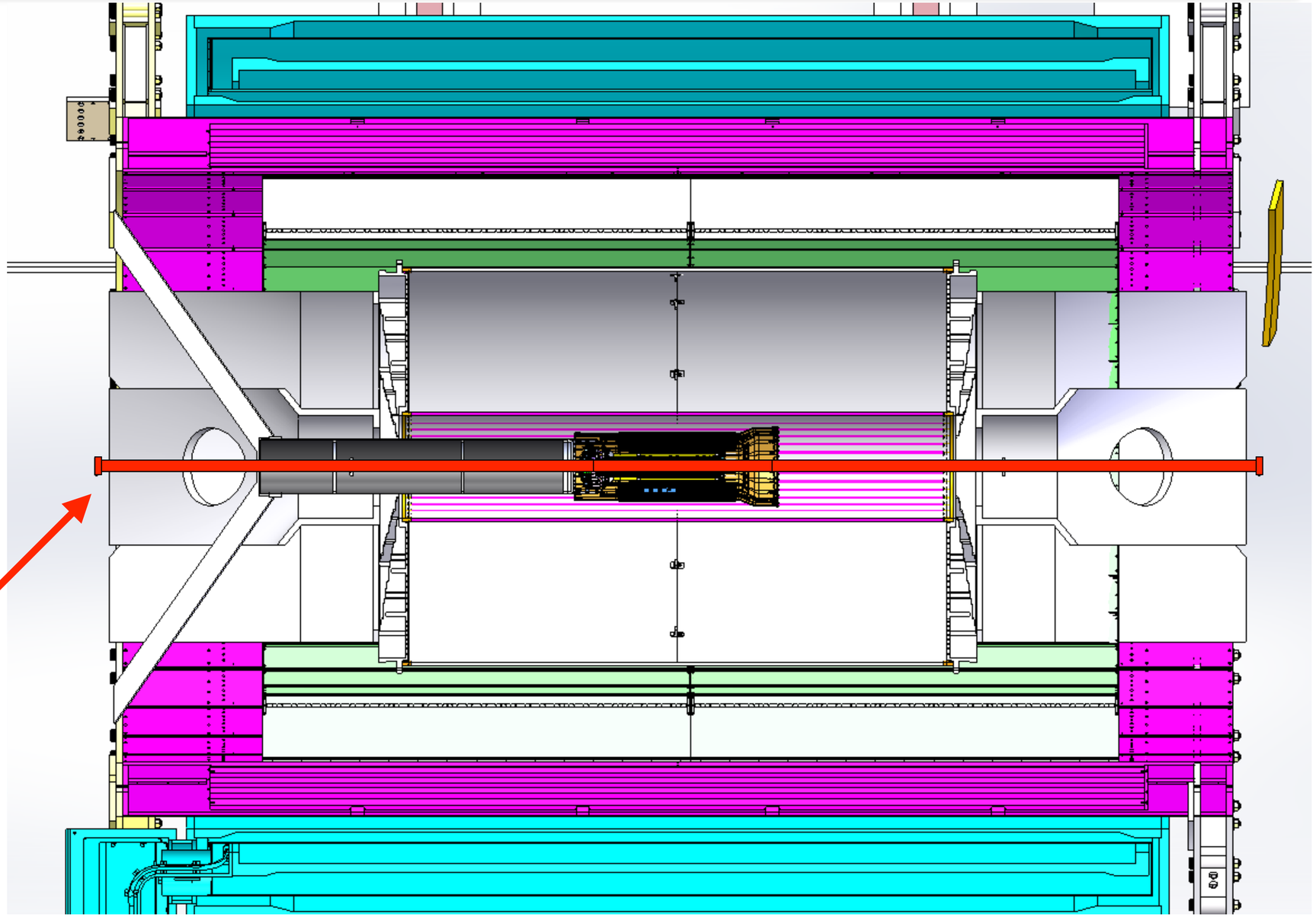
Beampipe

- Current beampipe flange requires assembly/clamshell within the TPC bore

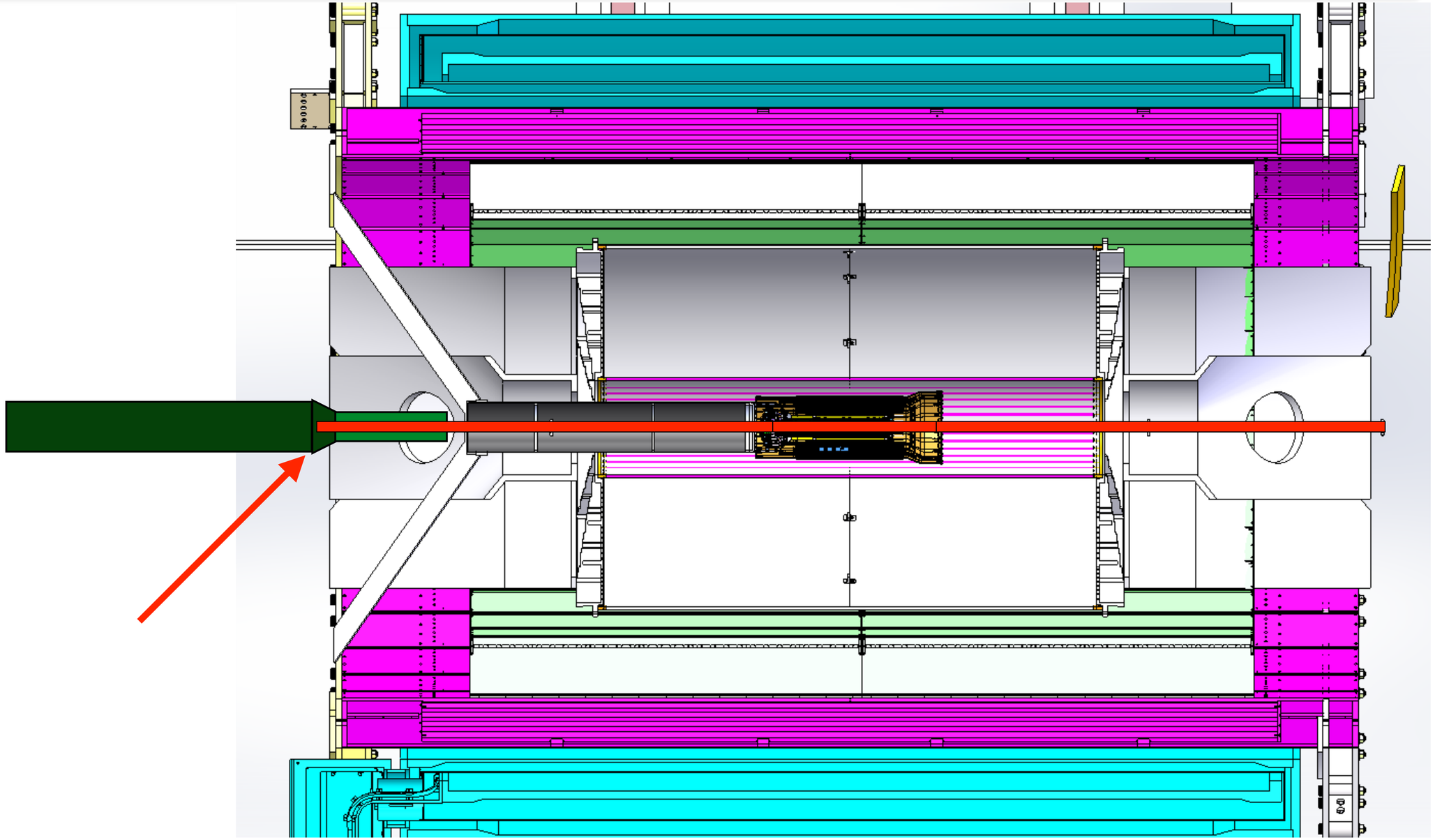


Beampipe

- Symmetric extension of flange by 1m allows MVTX to clamshell outside of TPC bore before insertion

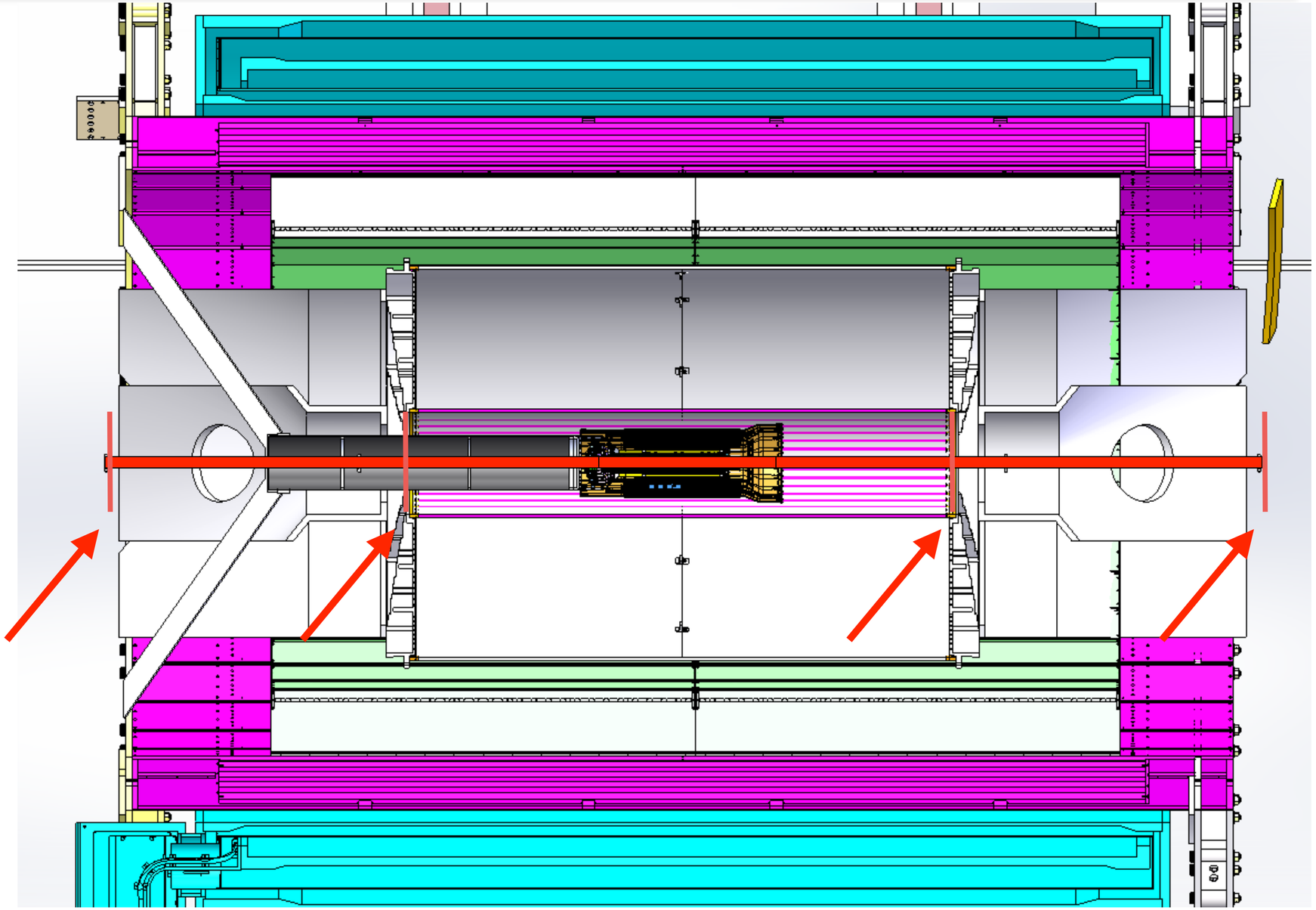


Beampipe

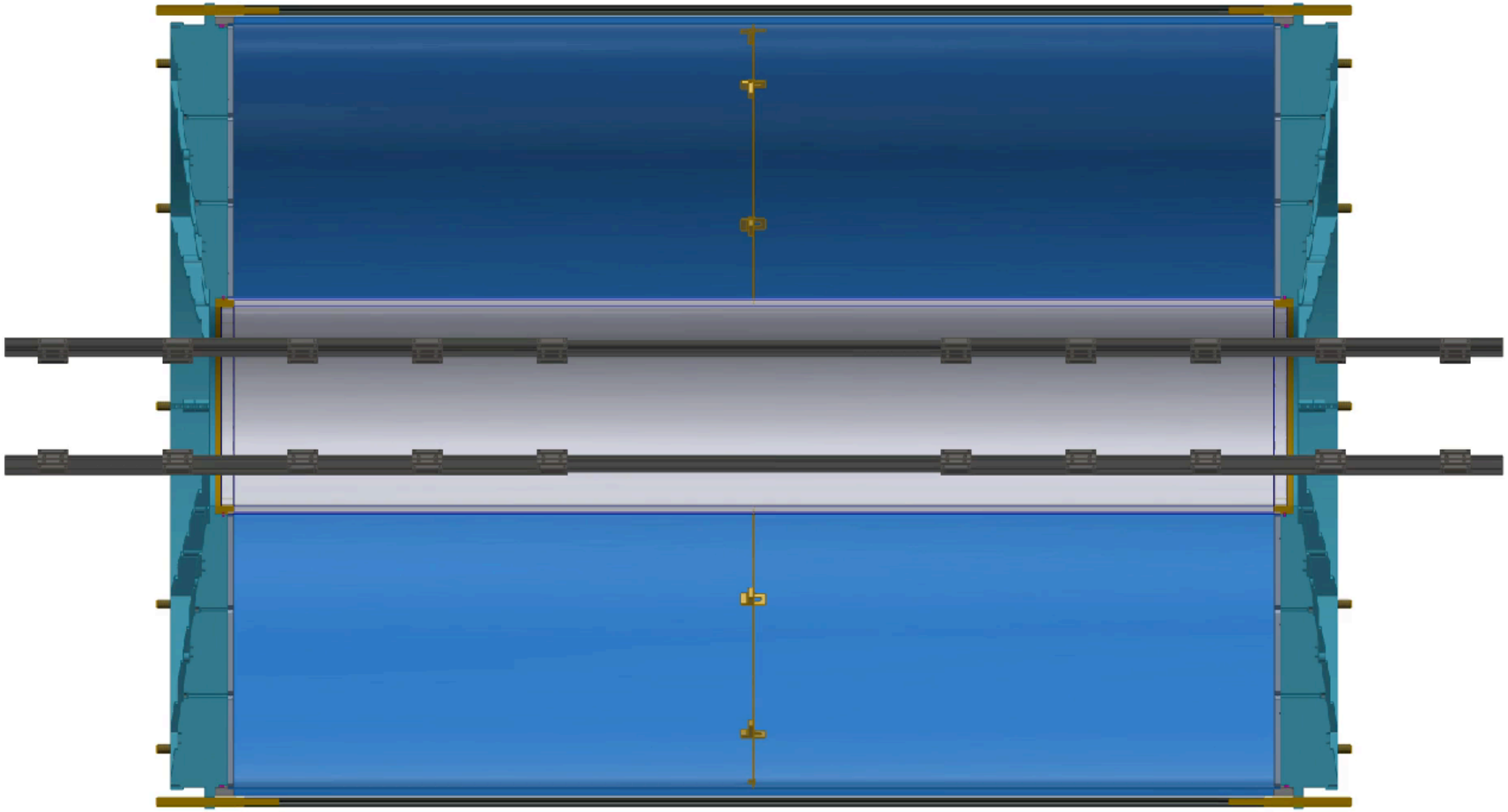


Beampipe

- Supports at new flange and at TPC wagonwheel control sag in the extended pipe

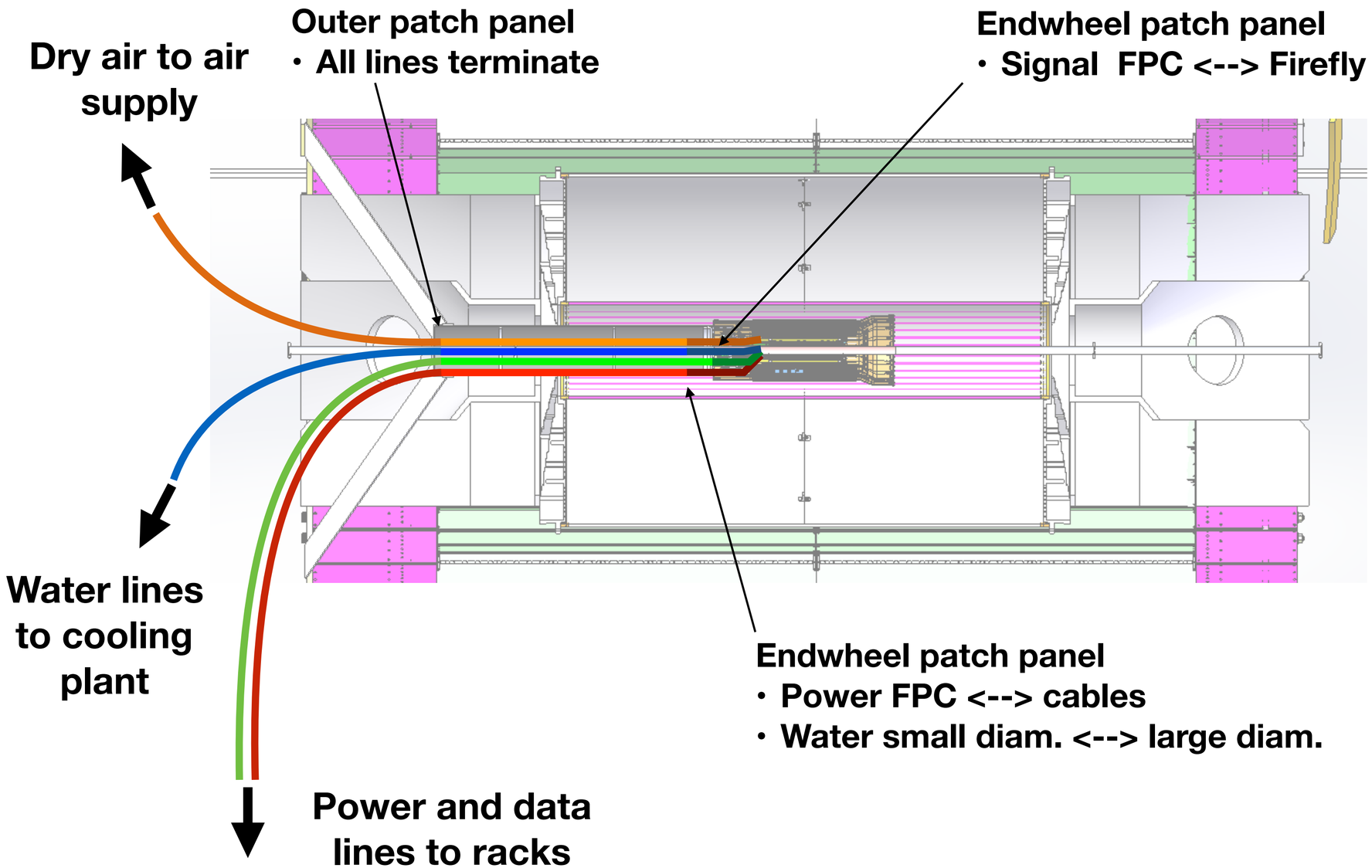


Installation Scheme

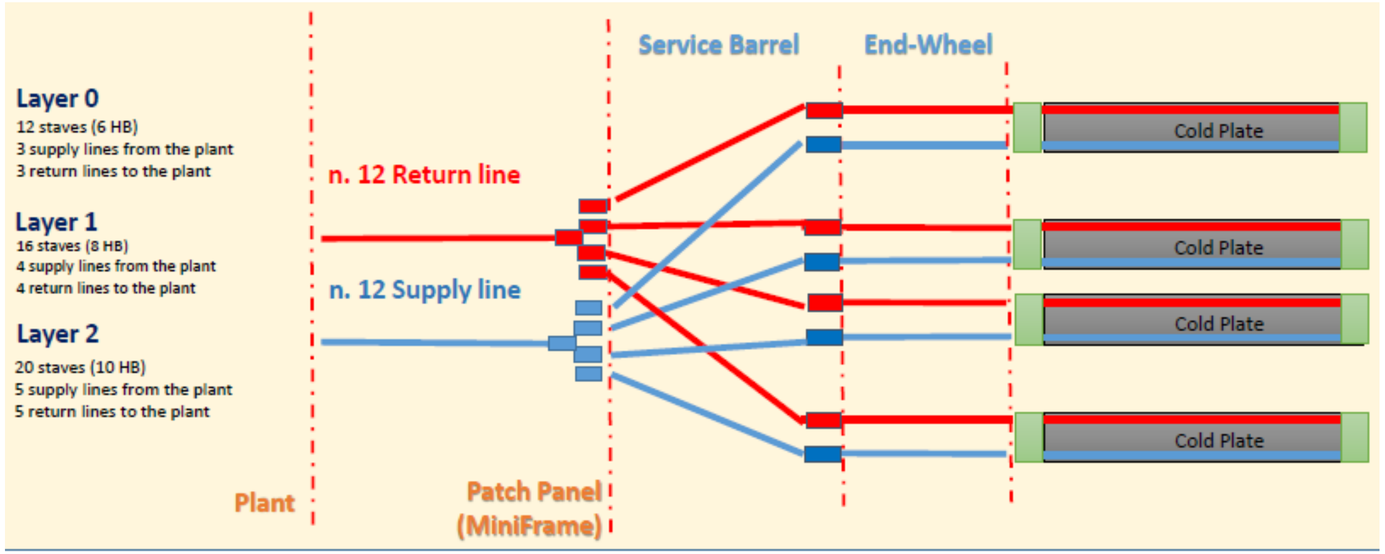


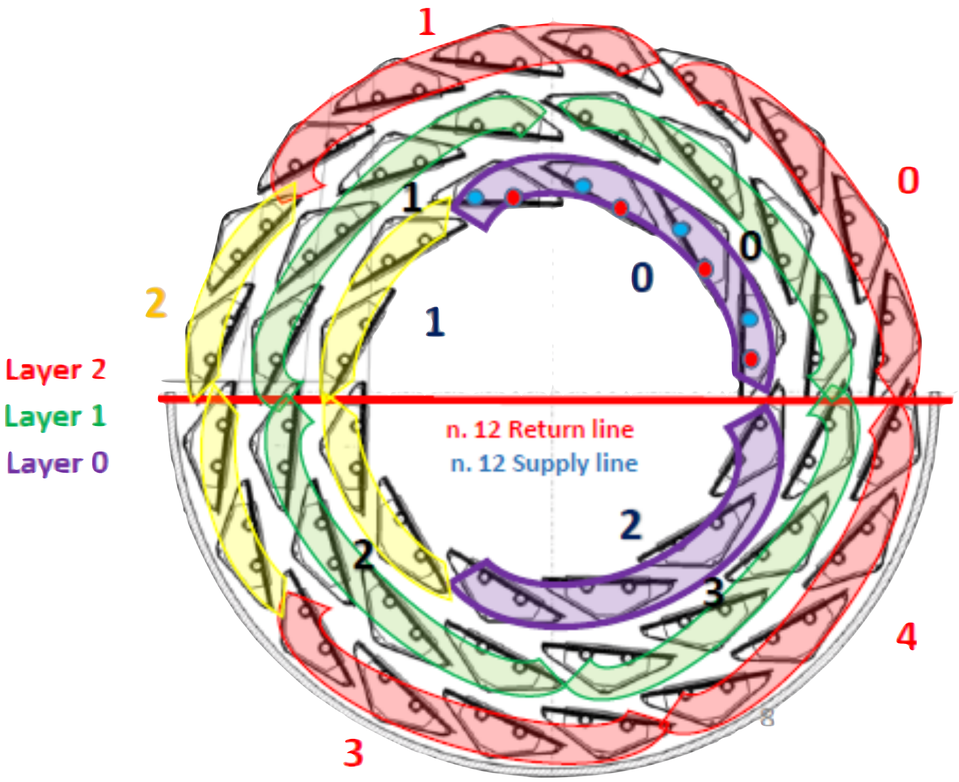
- Preliminary insertion scheme with modified beampipe developed with INTT

Cabling


Dry air to air supply
Outer patch panel
• All lines terminate
Endwheel patch panel
• Signal FPC <--> Firefly
Water lines to cooling plant
Endwheel patch panel
• Power FPC <--> cables
• Water small diam. <--> large diam.
Power and data lines to racks

Cooling

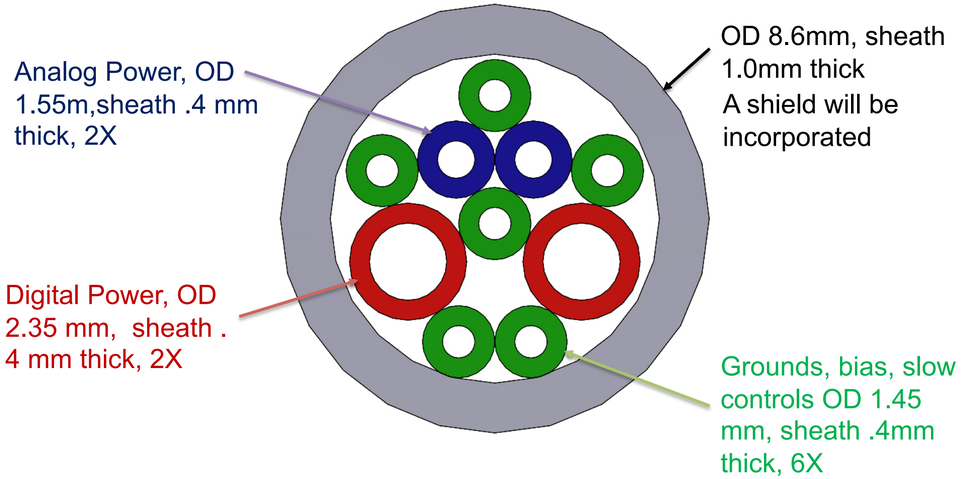




- Leakless, subatmospheric water cooling
- Adapted (heavily) from ITS. Cooling plant size reduced.
- >1 gal/hr through each stave, < 5W
- Lines grouped together by half-barrel
- Low flow dry air used for humidity control

Cables

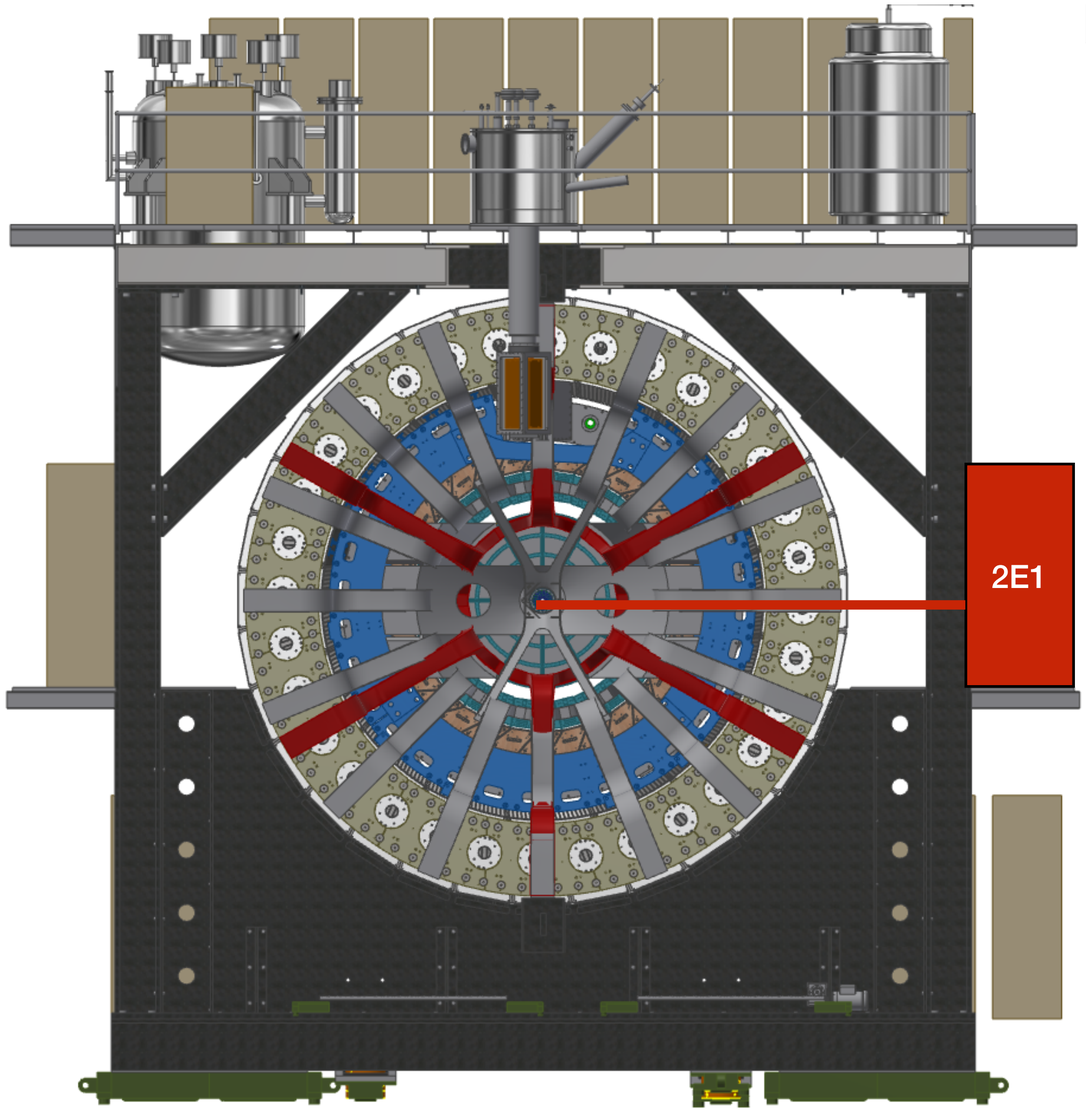
- ITS custom power and controls cable

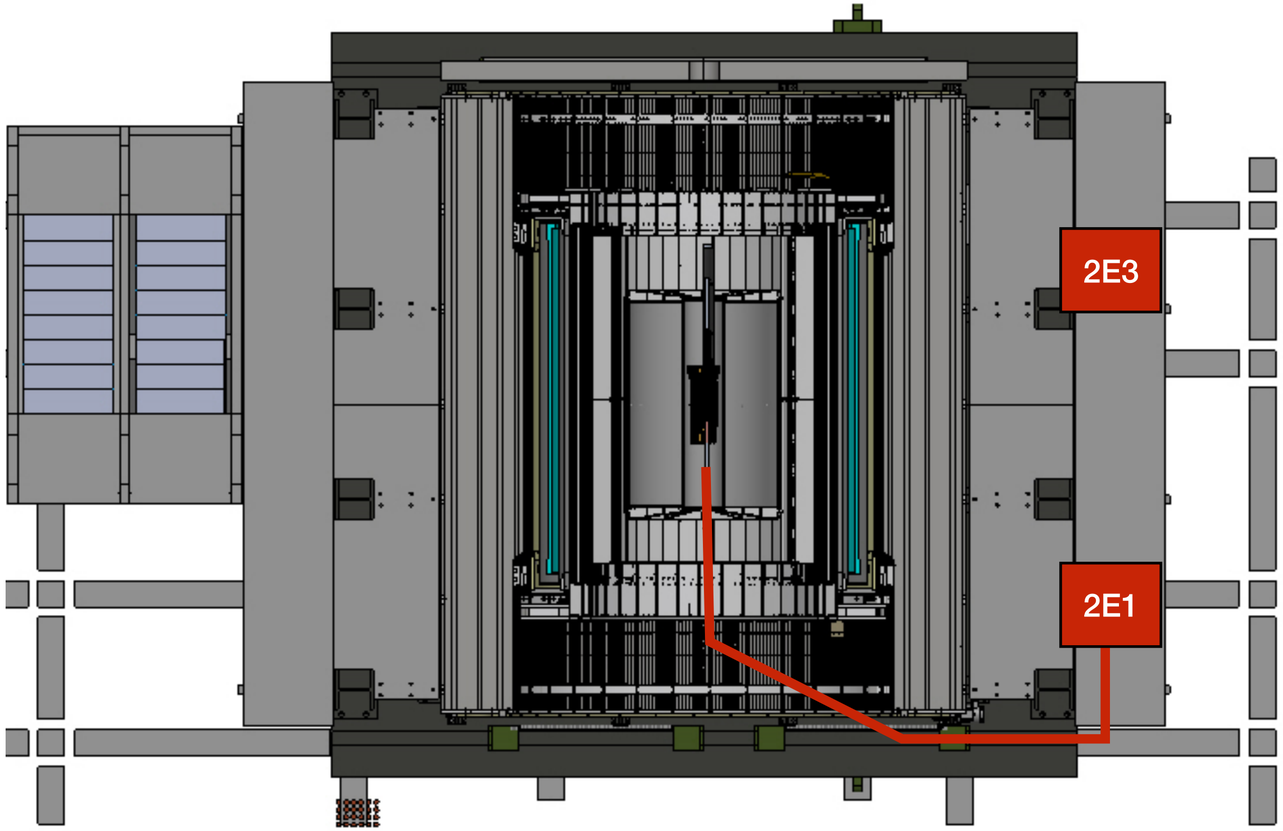


- Firefly TwinAx data cable

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

Racks





- Estimated cable run from MVTX to 2E1 (testing 10m cables)

Status and Highlights

- Mechanical Support Structures
  - INTT interferences resolved and confirmed with physical model
  - Design updated with feedback from ALICE, LBNL, continuing to revise and detail
  - FEA structural analysis
  - Pursuing other CF production options with industry
- Installation
  - First-pass plan developed with INTT
  - Continuing to develop in parallel with mechanical supports
- Cooling System and Cabling
  - ITS cooling plant design in-hand, redesigning for MVTX cooling load
  - prototype developed at LANL

Schedule Drivers

- Stave Assembly Tooling (3.02.3.02.03.01.02)
  -Inner mechanical design must be final before procuring
  -Must be available for stave assembly
- Stave Support Frame & MVTX Integration (3.02.3.02.04.03)
  -Iterate with OSI/INTT engineers for compatibility
- Cooling System (3.02.3.02.04.01)
  -Lead time for vacuum vessel/pumps
- Generally: Manpower

Cost Drivers

- Mechanical Detector Design (3.02.3.02.03.02.01)
  - -Engineer/Designer time $168k
- Stave Support Frame & MVTX Integration (3.02.3.02.04.03)
  - -Engineer/Designer time $178k
  - -Procurement $96k
- Cooling System (3.02.3.02.04.01)
  - -Engineer/Technician time $58k
  - -Procurement $77k

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/Cabling
  - Pump specs may vary depending on pipe lengths / cooling plant location
  - Not clear if we can procure same ALICE cables

Summary

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