

WBS 16 Coil Services System

Cost Estimates

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Coil Services System Description

The coil services consist of the cryogenic feeds and electrical leads inside the cryostat, serving all of the coils, including conventional. It includes the specification of requirements for the coil protection system.

Lower-level elements include:

LN2 Distribution System (WBS 161);
Coil Electrical Leads (WBS 162); and
Coil Protection Requirements (WBS 163)

WBS 161 LN2 Distribution System

Description

This element covers the distribution of liquid nitrogen (LN2) coolant within the cryostat. The system serves all the coils: the TF (WBS 131), PF (WBS 132), External Trim (WBS 133), and Modular (WBS 14) Coils.

Scope

Work includes engineering design, procurement, and fabrication of manifolds, cooling hoses, jumper hosing, valving, and associated supports. I&C is procured in 1408. WBS161 responsibility ends at the LN2 supply/return header interfaces within the Cryostat. Work in this WBS ends with delivery of components to machine assembly operations.

WBS 162 Coil Electrical Leads

Description

This element covers the electrical leads within the cryostat, serving all the coils: the TF (WBS 131), PF (WBS 132), External Trim (WBS 133), and Modular (WBS 14) Coils.

Scope

Work includes engineering design, procurement, and fabrication of cables, mounting brackets, thermal transition boxes, and associated supports. The WBS161 interface ends at the cryostat thermal transition/terminal box. It does not include I&C, bus work, or routing in the test area. Work in this WBS ends with delivery of components to machine assembly operations.

WBS 163 Coil Protection System

Description

This element covers the specification of coil protection requirements for the coil protection system.

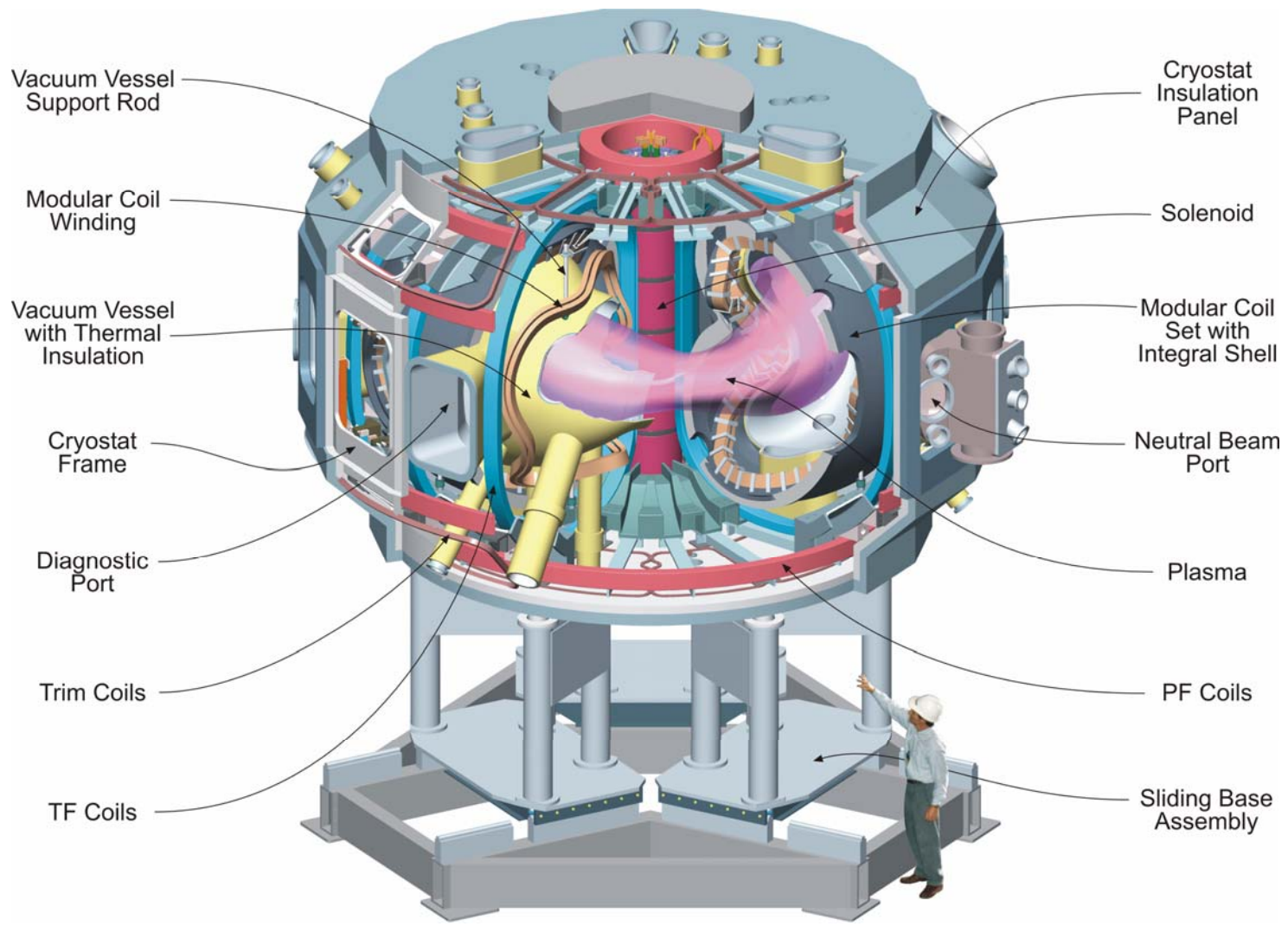
Scope

Work covers Title I, II, and III Engineering support for development of the system, including drawings, Electrical and I&C schematics, analyses, and procurement specifications.

Design Overview

- View graphs deal primarily with MC design
- To date, most of design effort has concentrated in this area
- Conventional coils will be handled in a similar manner and use identical components.(same cable, hoses, brackets, terminations, manifold connectors, etc.)

NCSX Device Showing Coils

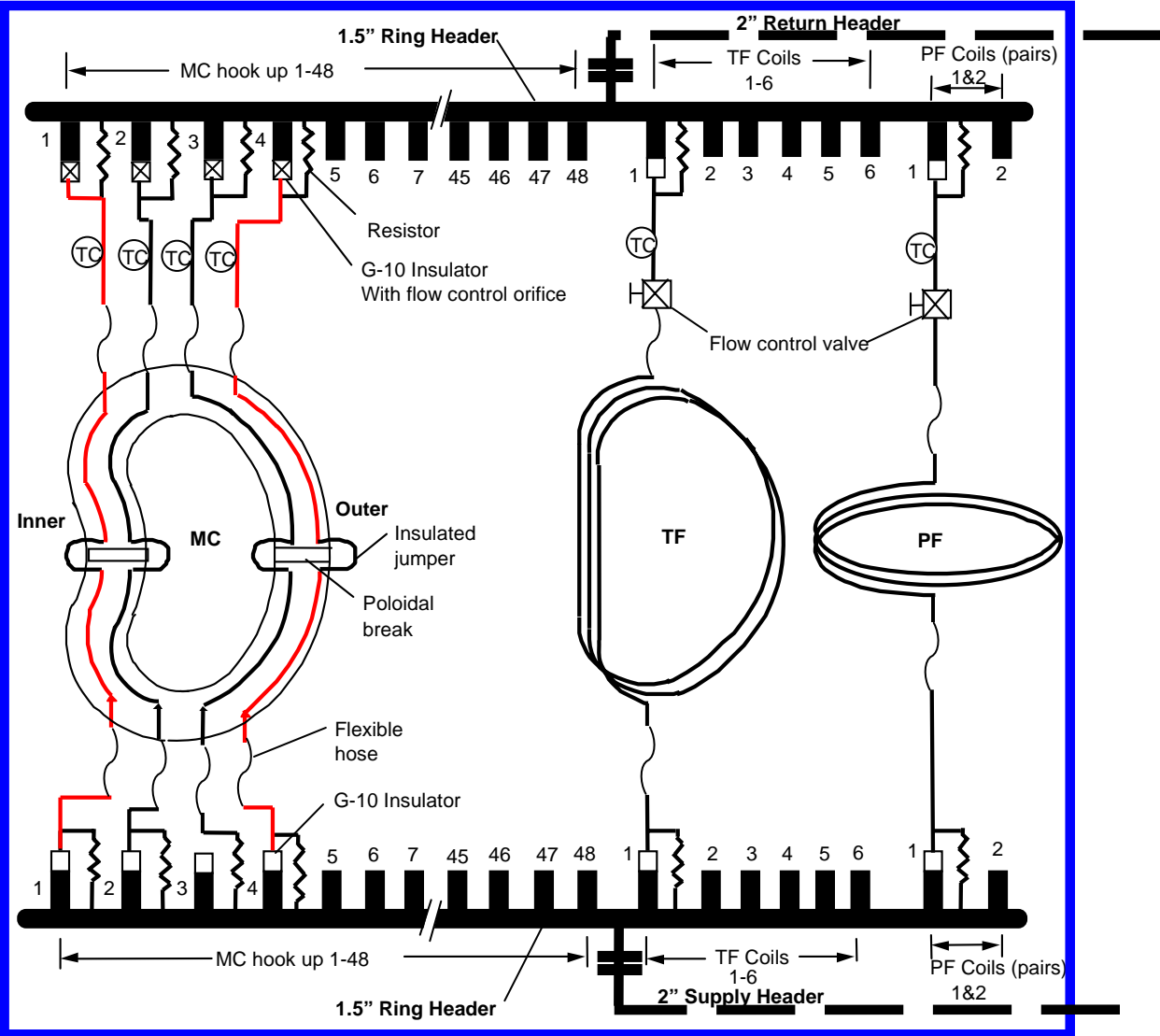


Modular Coil and Conventional Coil Cooling

Requirements

- Operate at 77 K with LN₂.
- Operating pressure 5 atmospheres absolute.
- Routing and distribution of coolant between coil input and output terminations and supply/return headers.
 - WBS16 provides distribution manifolds, tubing, hose, etc.
 - WBS17 provides supply/return to headers and hook up interfaces in the Cryostat
- Electrical isolation of MC coil coolant lines poloidally.
- Electrical current limitation between cooling components. (bypass resistors isolate hoses to ground)
- Flow balance between systems is required.

Conventional Coil Cooling System Diagram

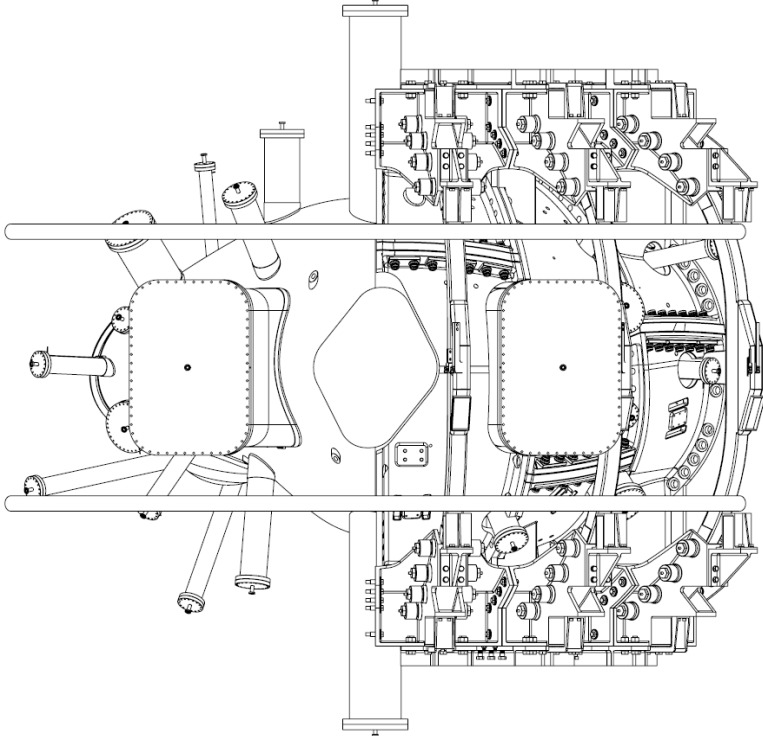
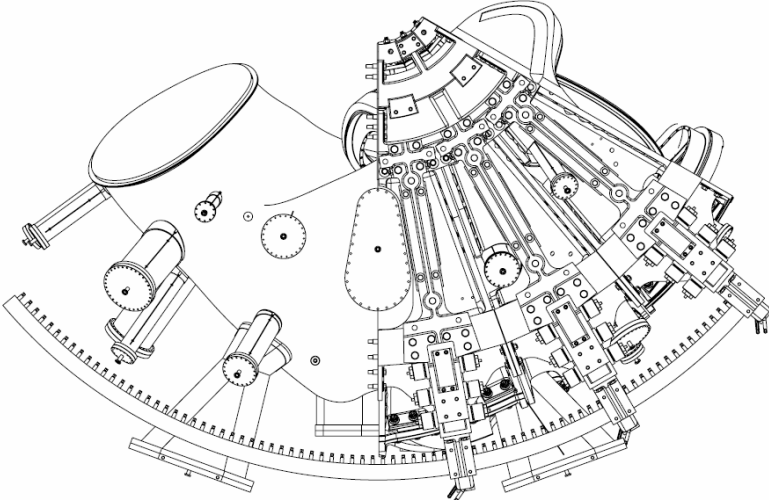
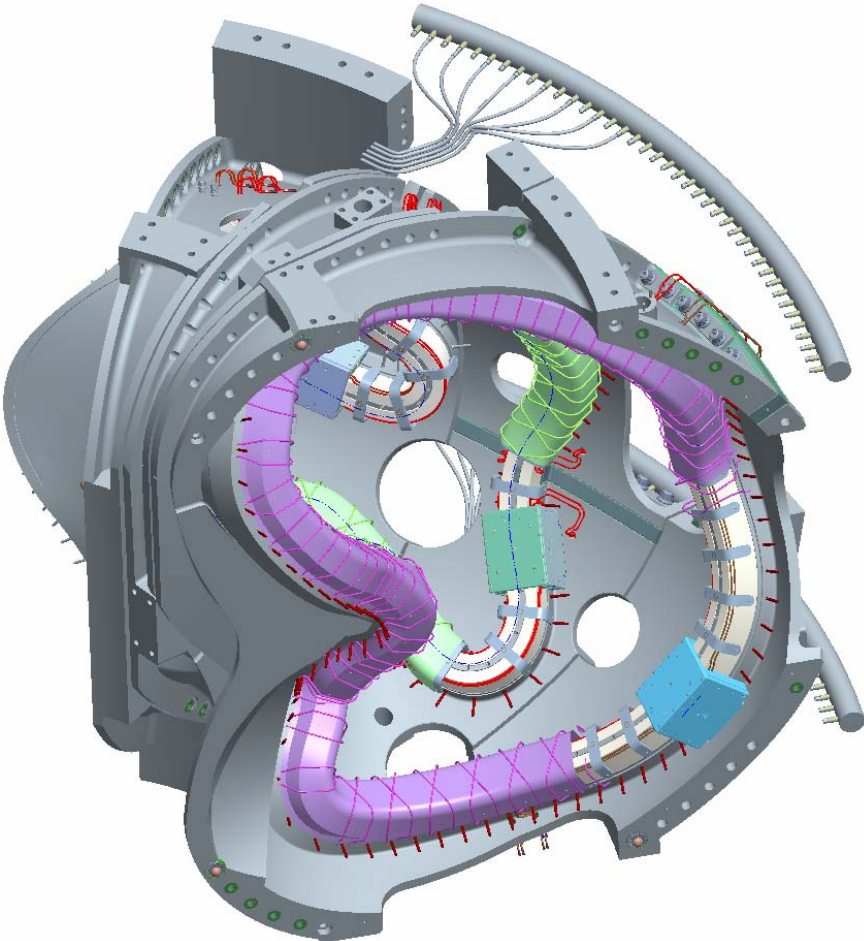


Typical Field Period Cooling Circuit - One side of a Modular Coil shown

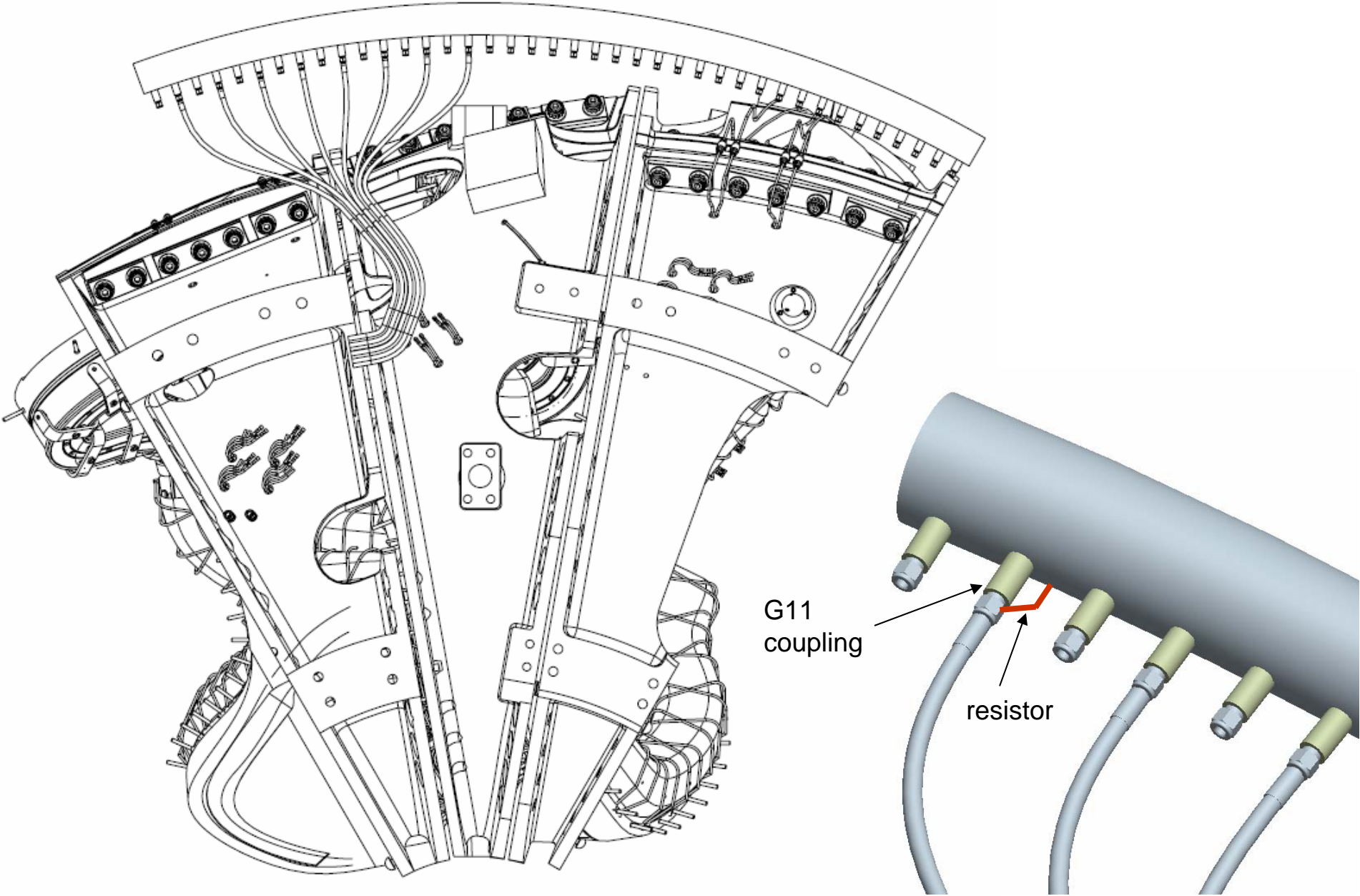
Cryostat Boundary

External manifolds

Transition to flex hosing at the winding form

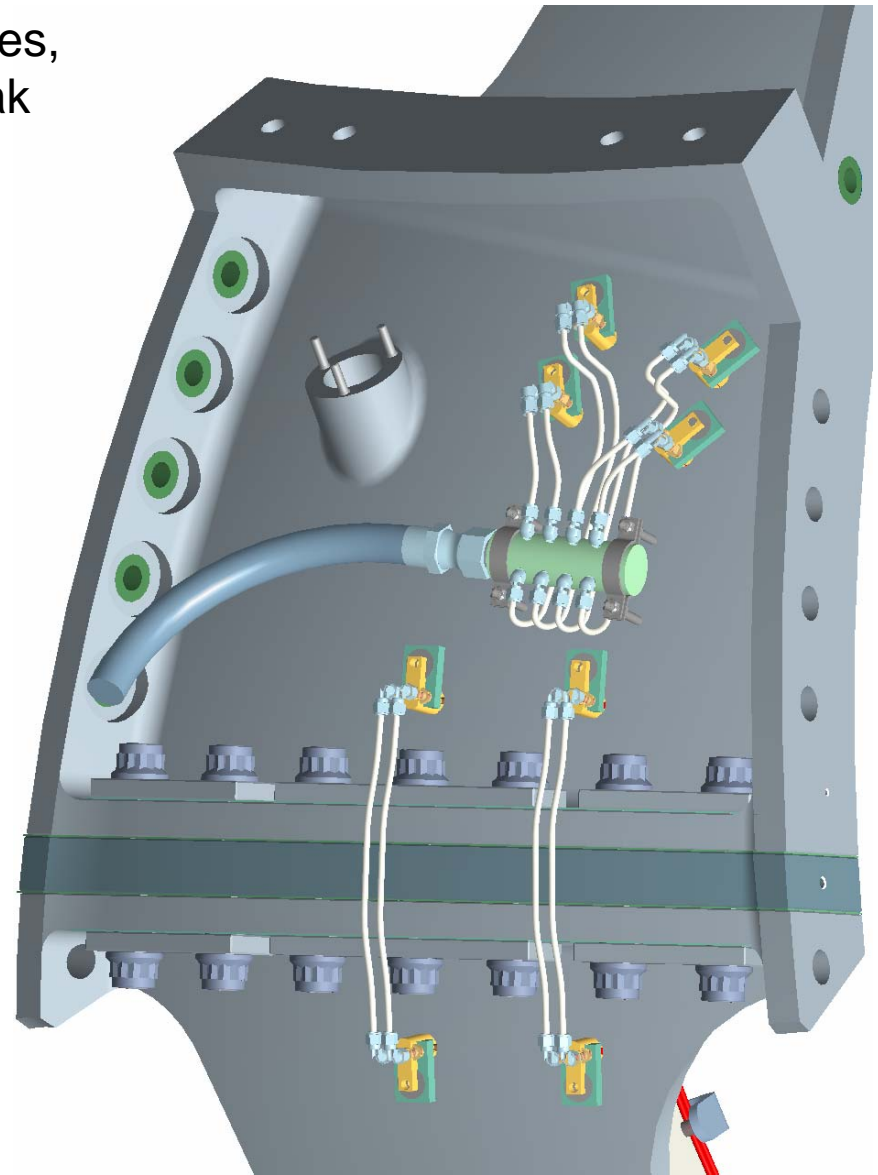
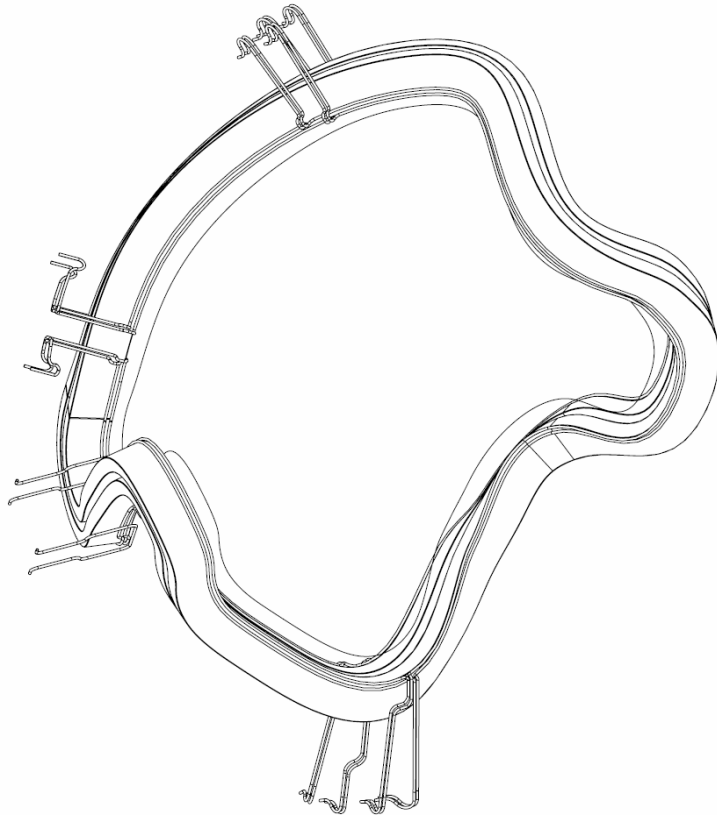


MC Flex hose routing

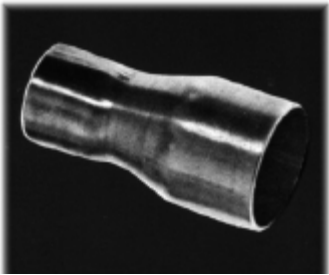


MC Coolant loops and termination

- Each winding pack has four inlet/outlet lines, with two lines interrupted by poloidal break
- One leads area chill plate per side
- Concept includes a manifold mounted to winding form



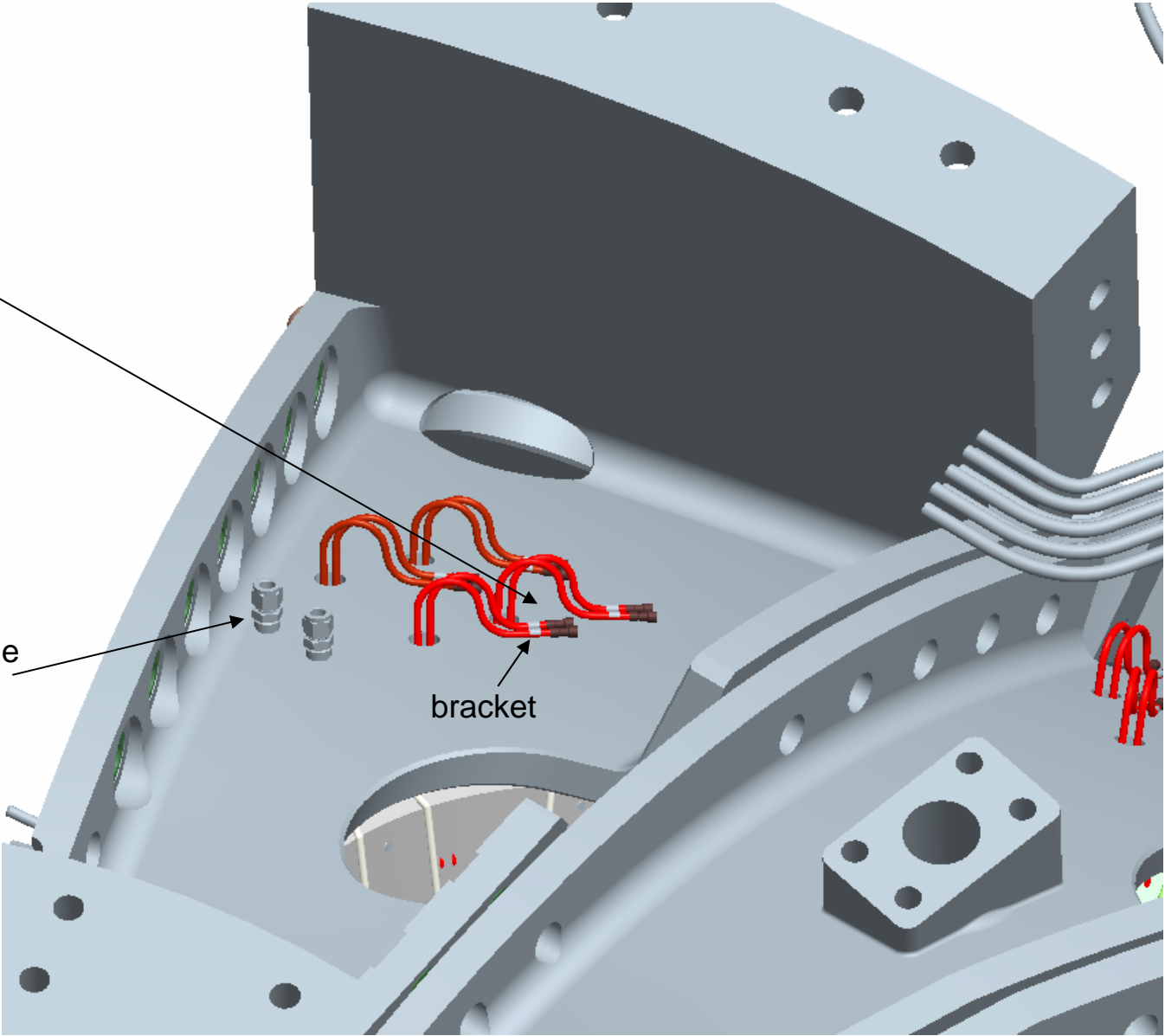
MC Tube termination



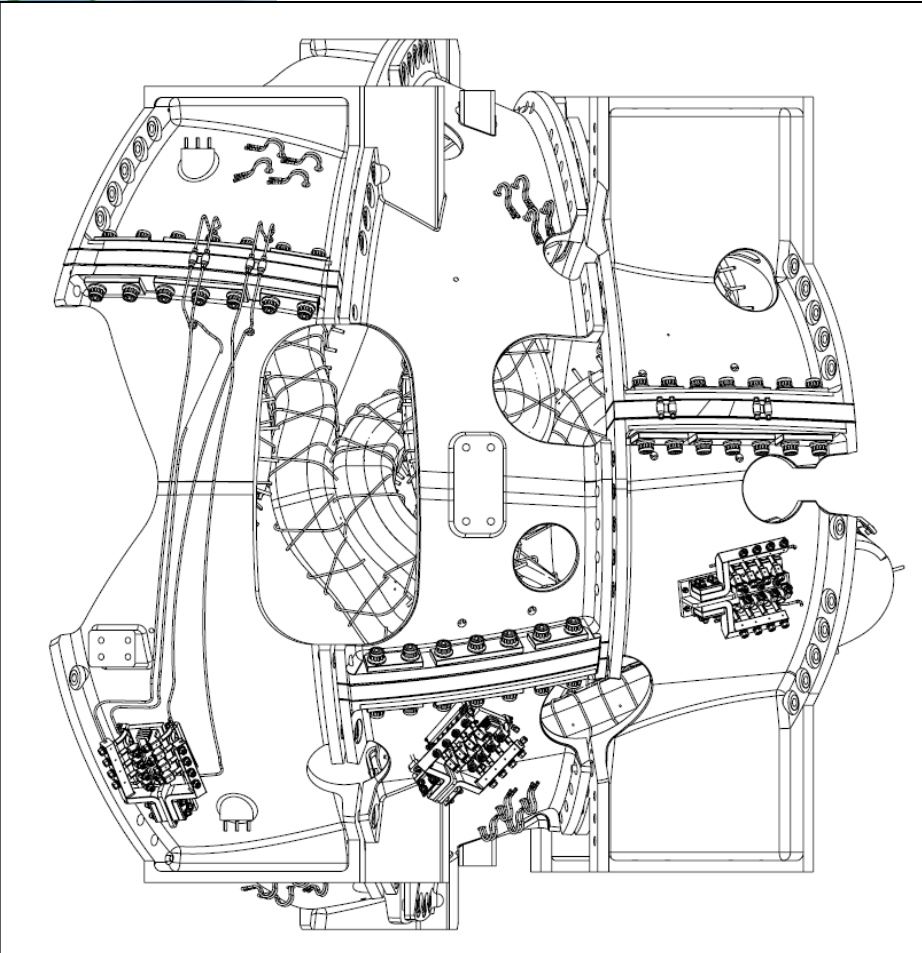
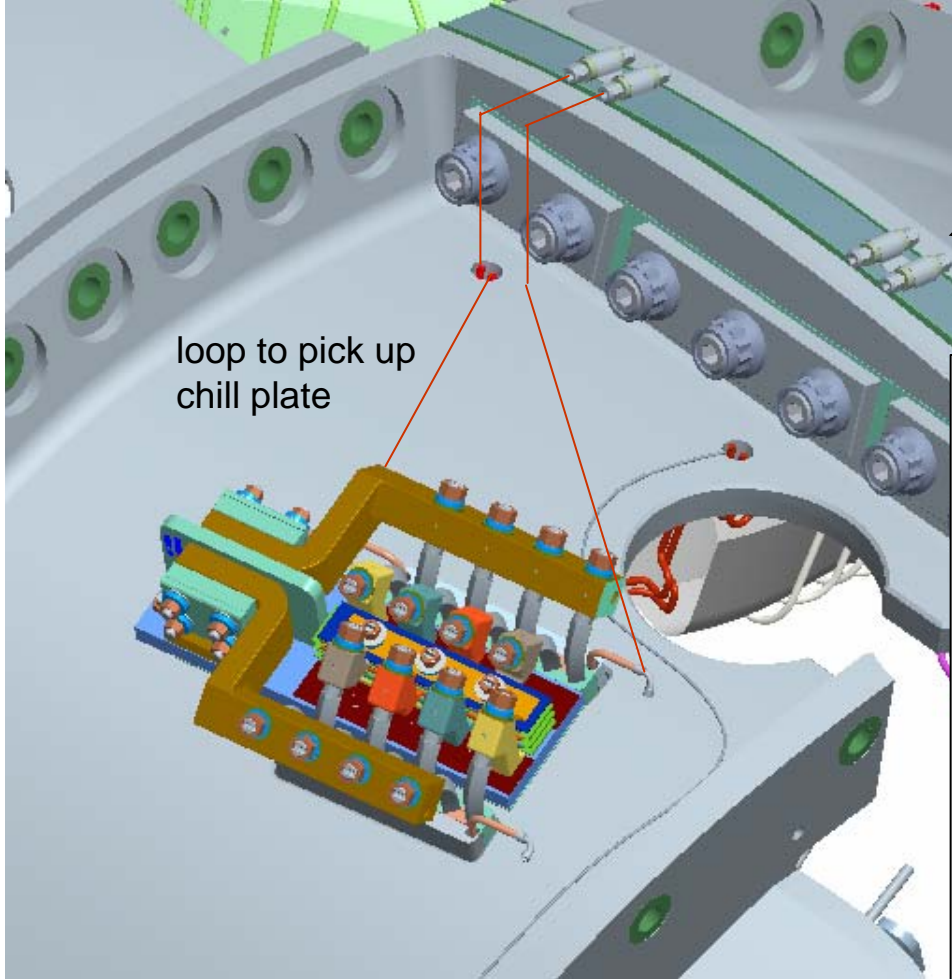
Truly Tubular
Brazetyte 5FF-5-4

bleed hole
fittings

bracket



MC Lead area chill plates



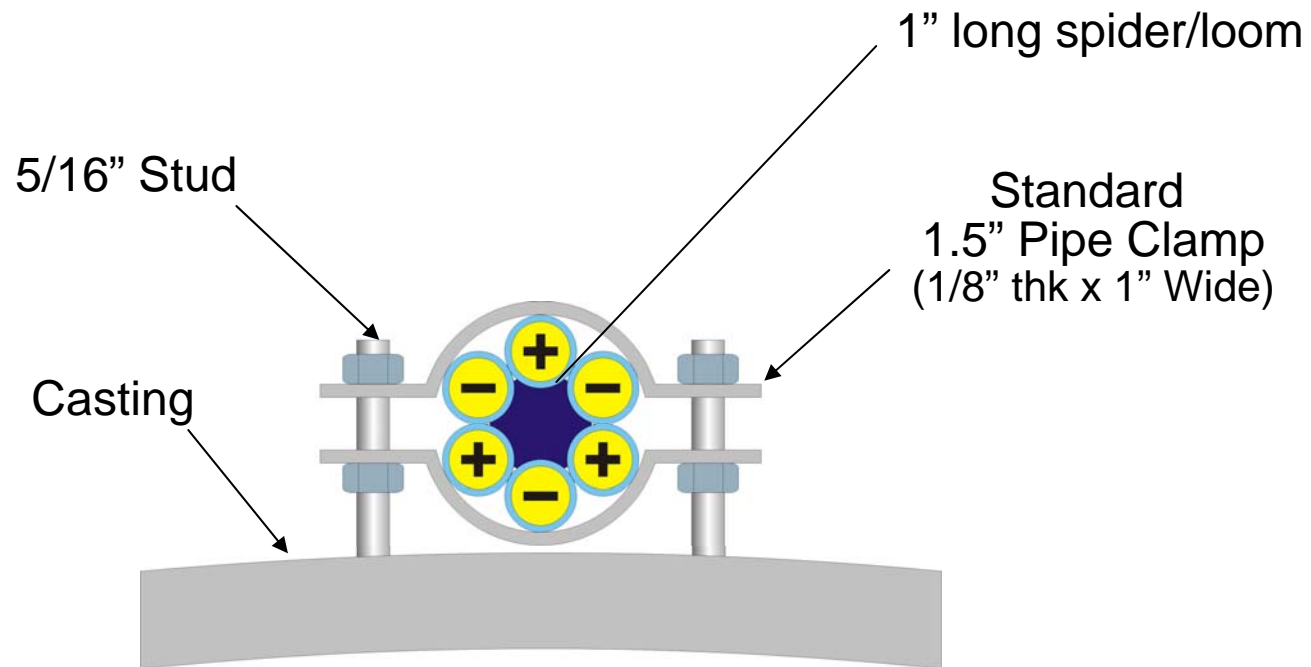
Leads

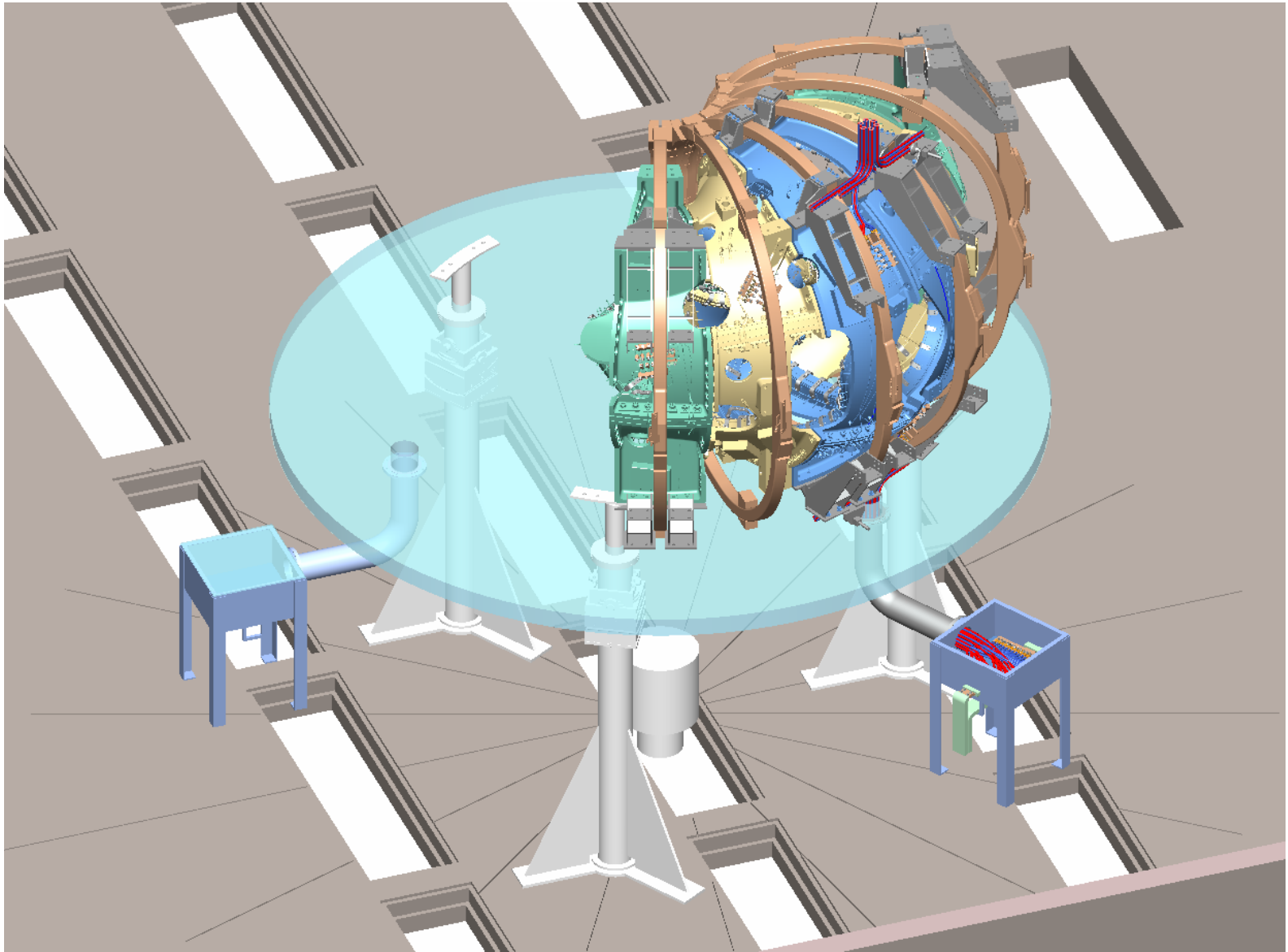
Requirements:

- Connect between bus bars in test cell and coil terminals inside cryostat.
- Operate nominally at 77-80 K but no active cooling is required, Cryo environment is sufficient to return temperature to operating level between shots.
- Grounding protection cover over leads.
- Provide Cryostat seal interface.
 - Minimize icing
 - Maintain positive pressure in Cryostat
- React magnetic loads.
- Cancel (minimize) field errors.

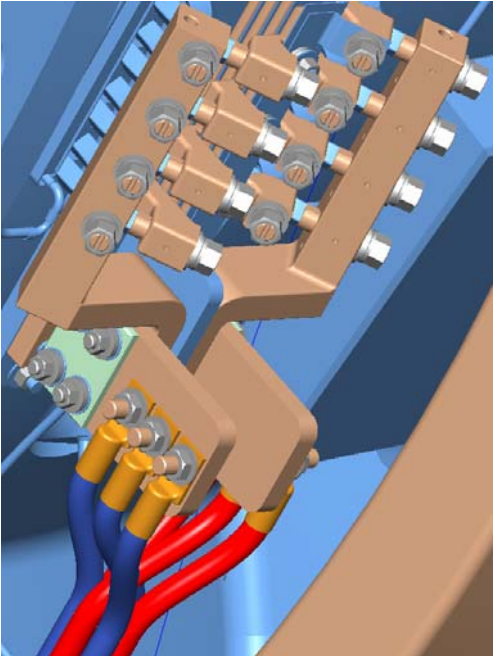
Lead Configuration

Cable is 250 MCM

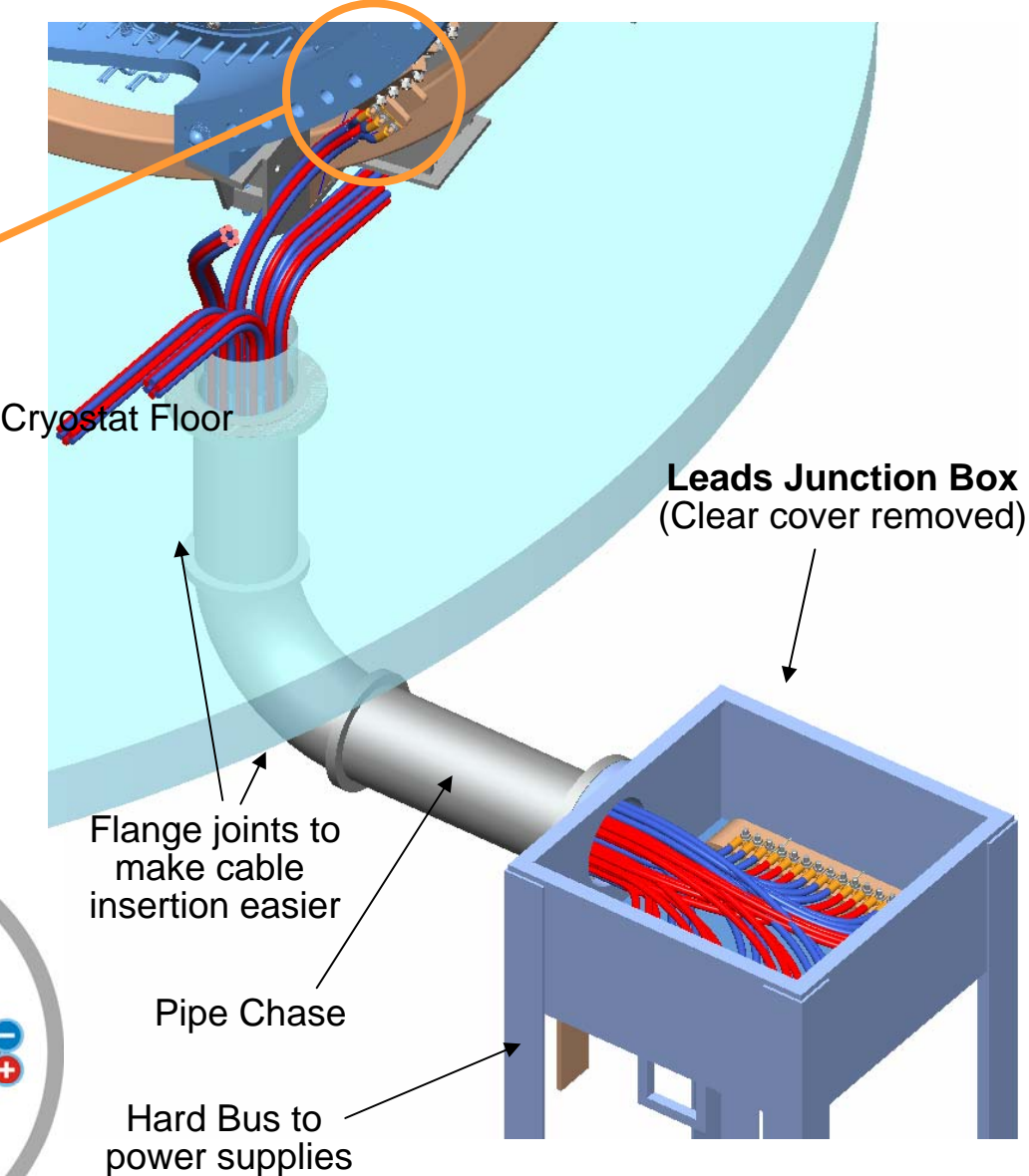




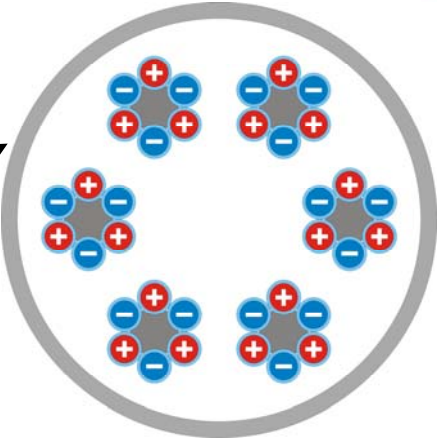
Typical interface of a modular coil's leads as they transition from coil attachment, thru the cryostat, to room temp.

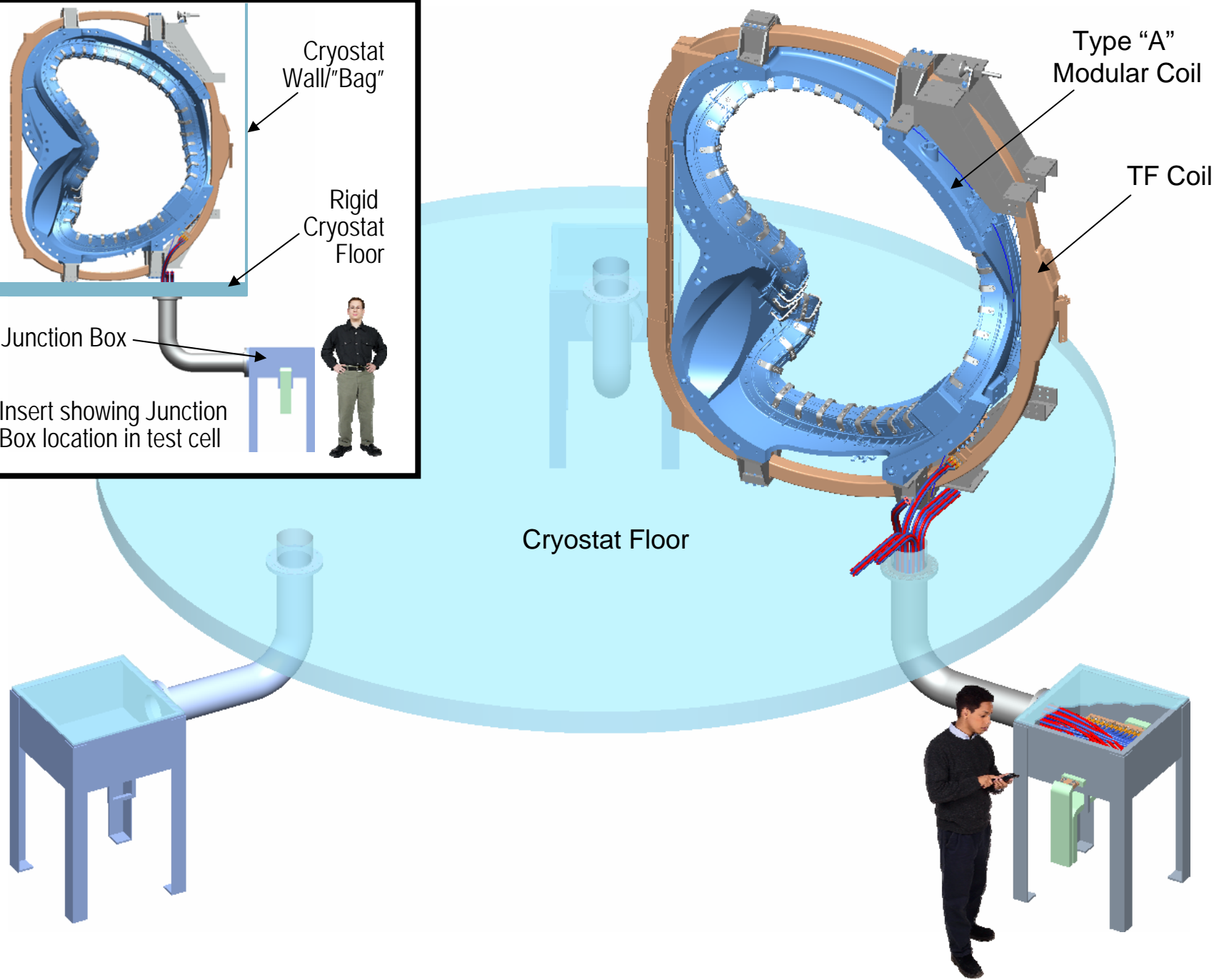
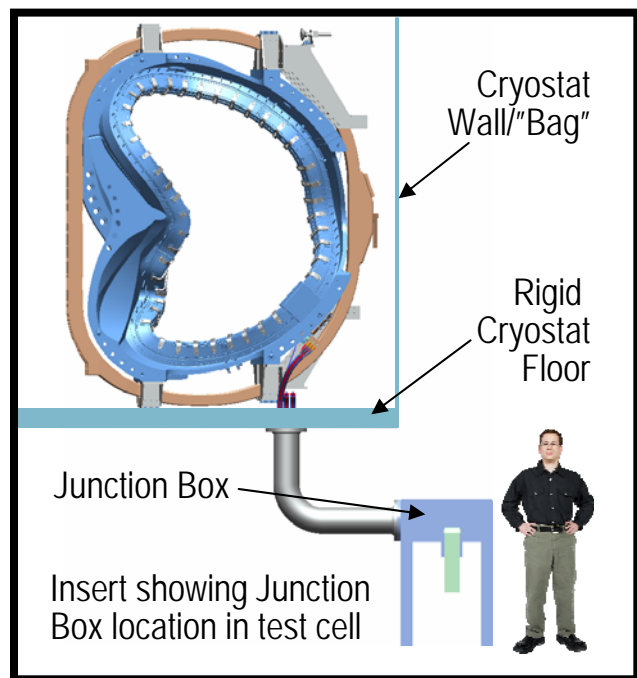


Typical modular coil leads attachment. The configuration of this joint will be optimized to reduce the resulting electrical loop



Top View of an 8" diameter pipe chase showing the (6) modular coil leads cables from a field period





Cost Estimates

Cost Basis

- **Cable and spacers are catalog items.**
 - **Lengths are based on sketches in work sheet.**
- **LN2 hoses are catalog items.**
 - **Lengths are based on ProE models.**
- **Manifold designs and prices are based on a similar design used on the VV.**
 - **Sizing is based on thermo hydraulics performed by Engineering.**
- **Material cost is estimated on a \$ per lb at current market.**
- **Supports are based on a \$/length of cable.**
- **Engineering time is based on number and type of drawings for each element, specifications, and the analyses anticipated.**

Cost Estimates

Risk

- LN2 Distribution System (WBS 161)
Low, design is straight forward and procured items are by and large commercially stocked. Manifolding is similar to gas system on VV, which is complete and costs are well documented.
- Coil Electrical Leads (WBS 162)
Low, design is straight forward and large ticket procured items (cable and mounts) are commercially stocked. No complications such as active cooling are required.
- Coil Protection Requirements (WBS 163)
Low, specifications may be replaced with data sheets, in that procured items are available as stock items.