# FUSION IGNITION RESEARCH EXPERIMENT (FIRE)

# Machine Configuration

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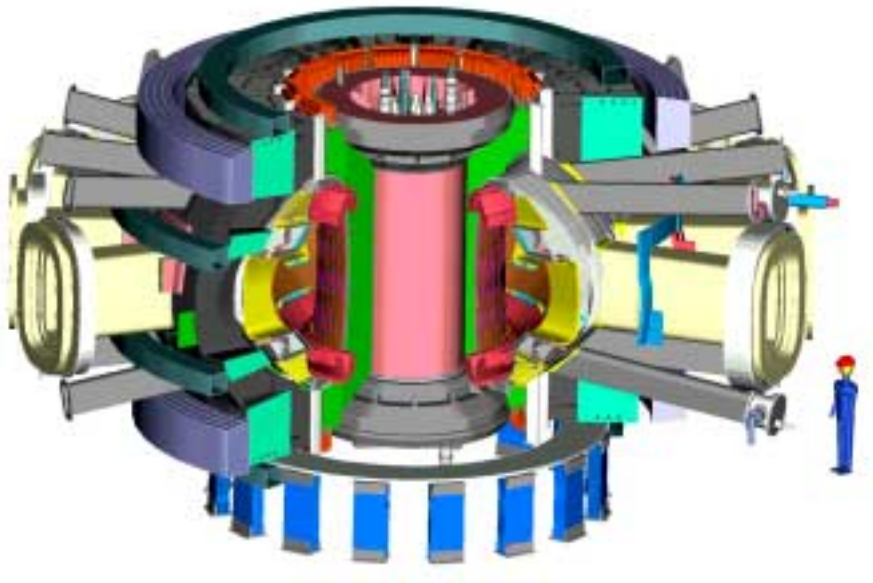
**June 5 – 7 , 2001**

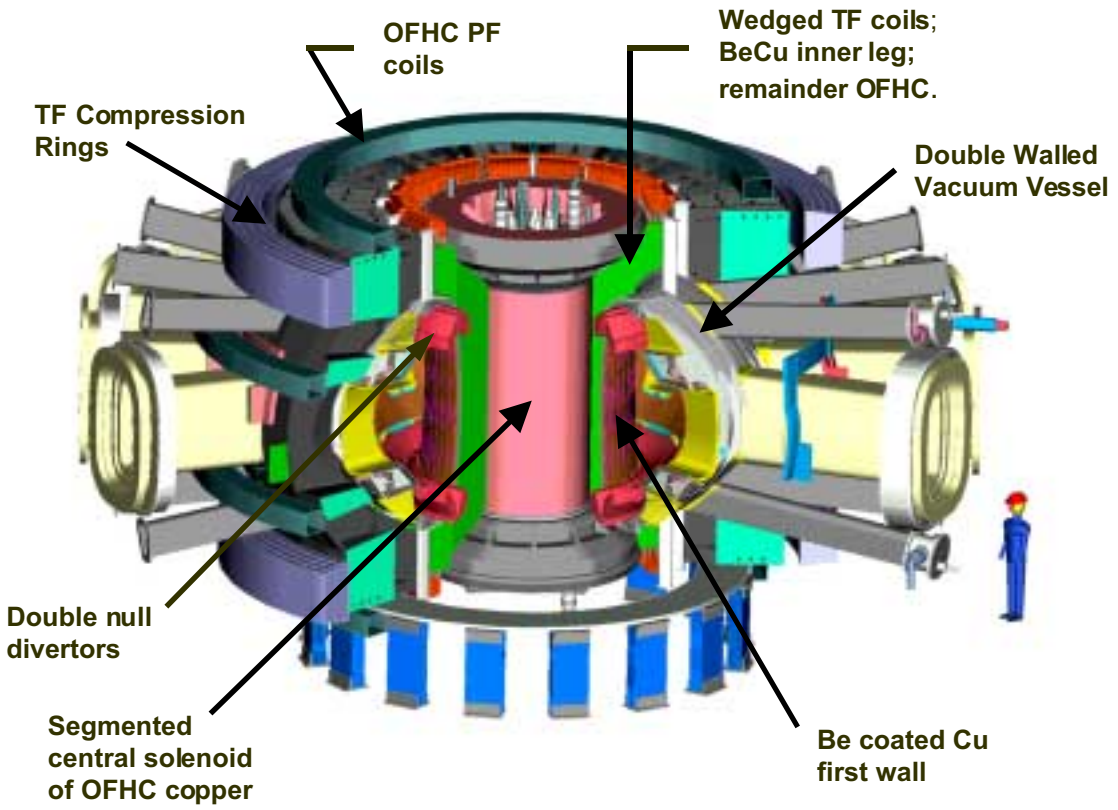
# FIRE Configuration Presentation Outline

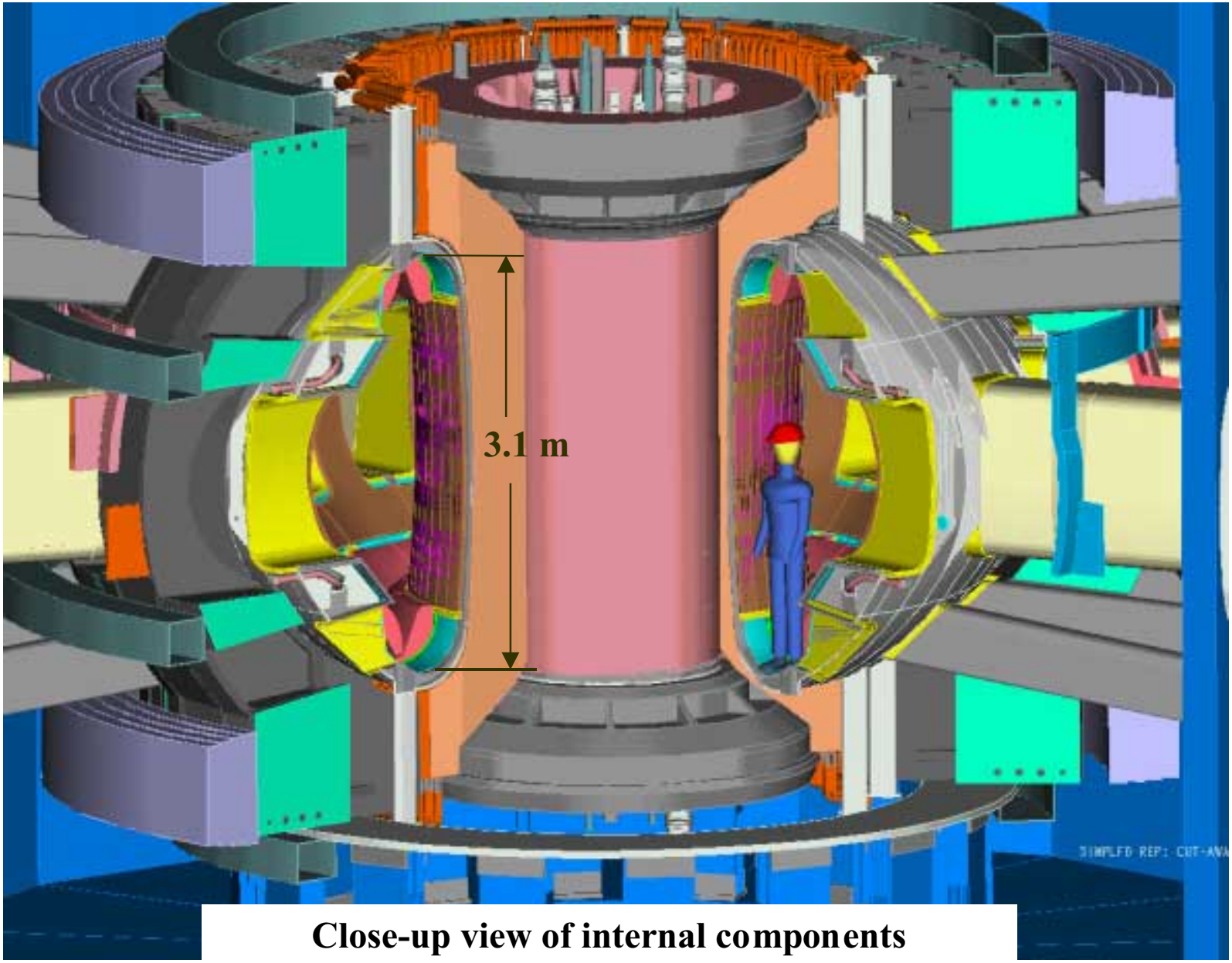
- **Review the basic configuration concept.**
- **Define key component design features and assembly approach.**
- **Summary.**



# FIRE Configuration Features

- **Double null divertors**
- **Double wall VV integrating cooling and shielding**
- **Wedged, inertially cooled ($LN_2$) TF coils**
- **Compression rings help support in plane loads**
- **RM of divertors through midplane port**



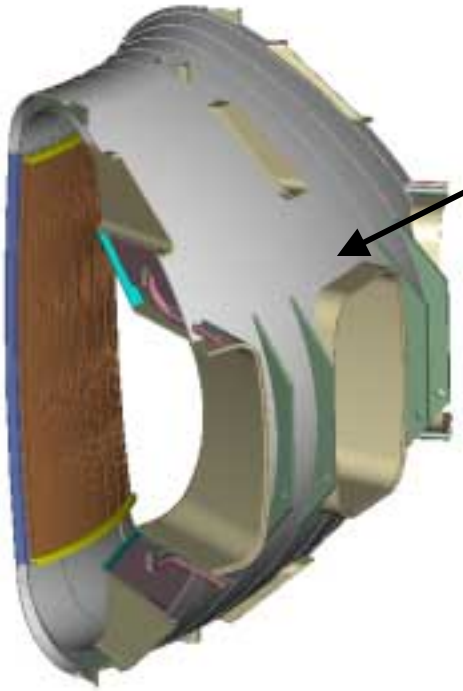


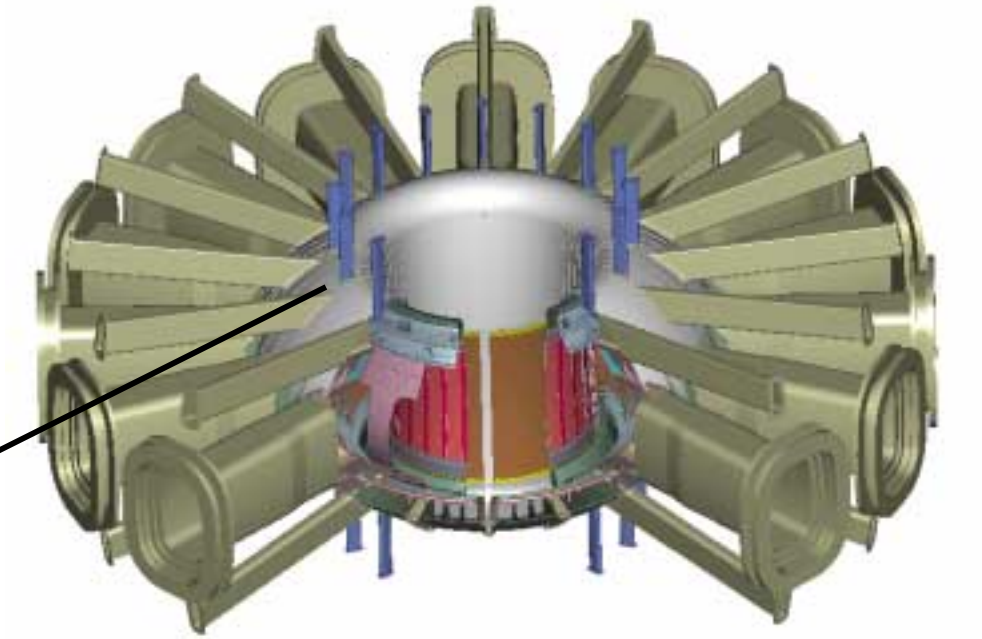

**Close-up view of internal components**

# VACUUM VESSEL

**Weight of structure, shield and ports is ~130 tonnes**

**VV Octant**



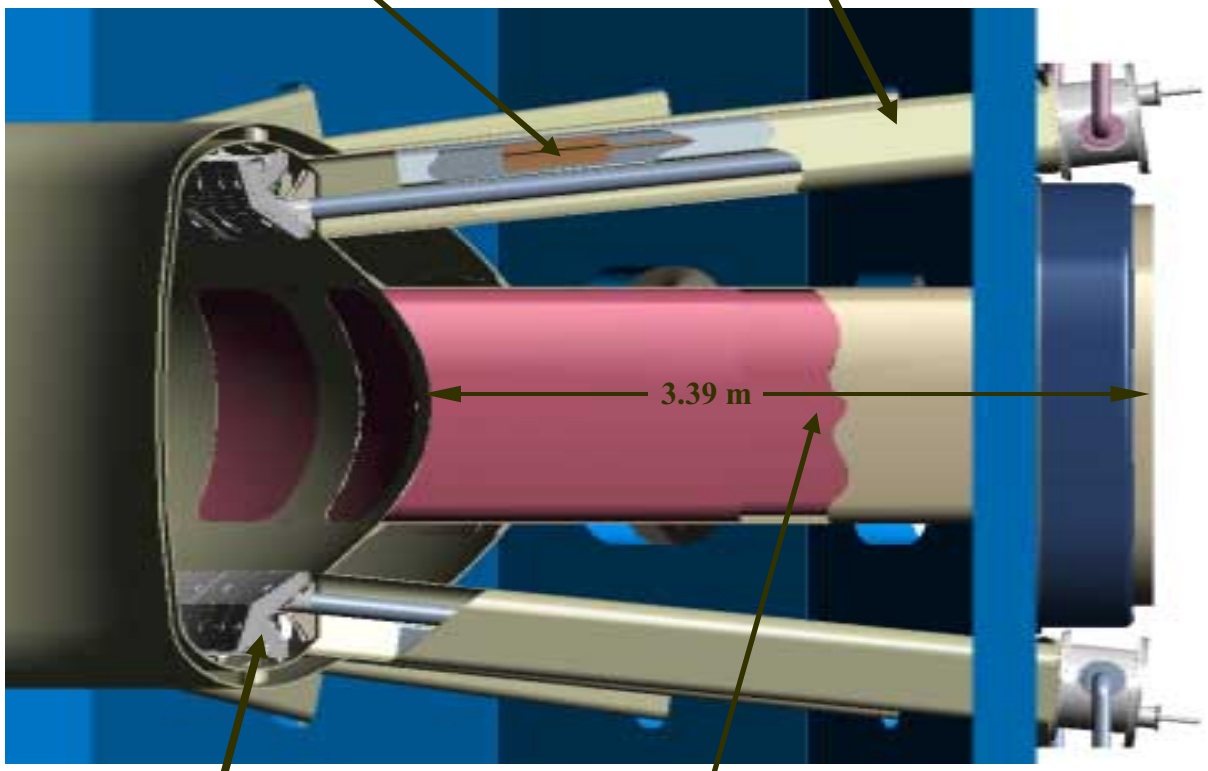


- **Double wall construction integrates cooling and shielding**
- **supports active and passive stability systems**
- **Divided into 45° Octants**
- **16 horizontal ports**
- **16 upper/lower angled ports**
- **16 small circular ports, top/bottom**

# Vacuum Vessel Port Details

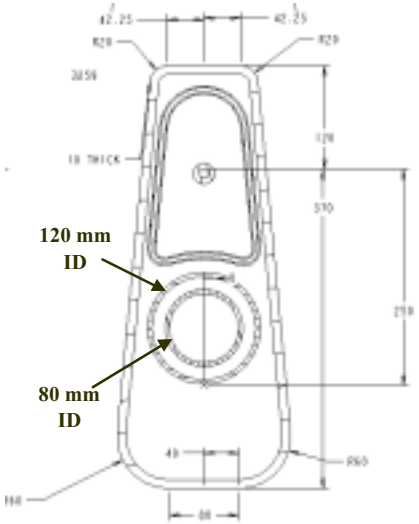
Cryopump (in half the ports)

Divertor duct




Divertor (coolant in all ports)

Midplane port



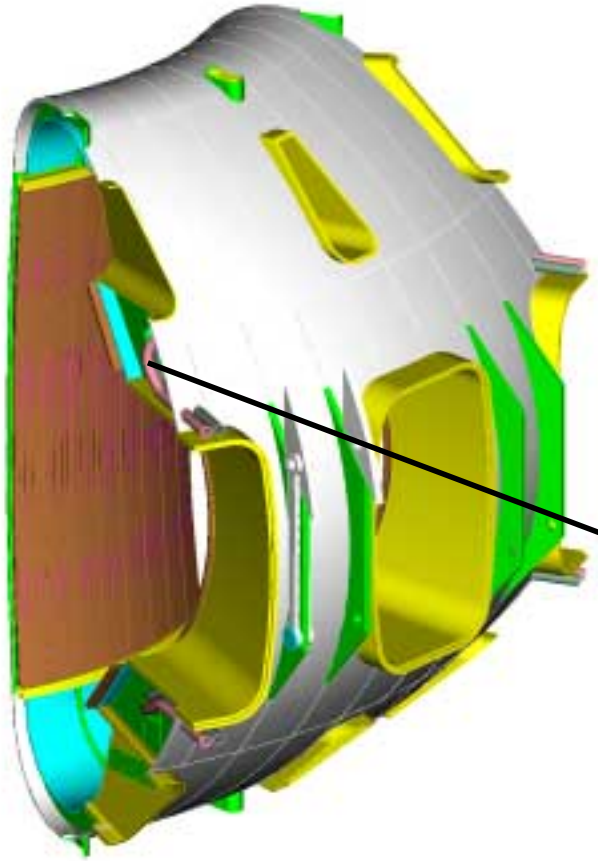

**Auxiliary Port Geometry**

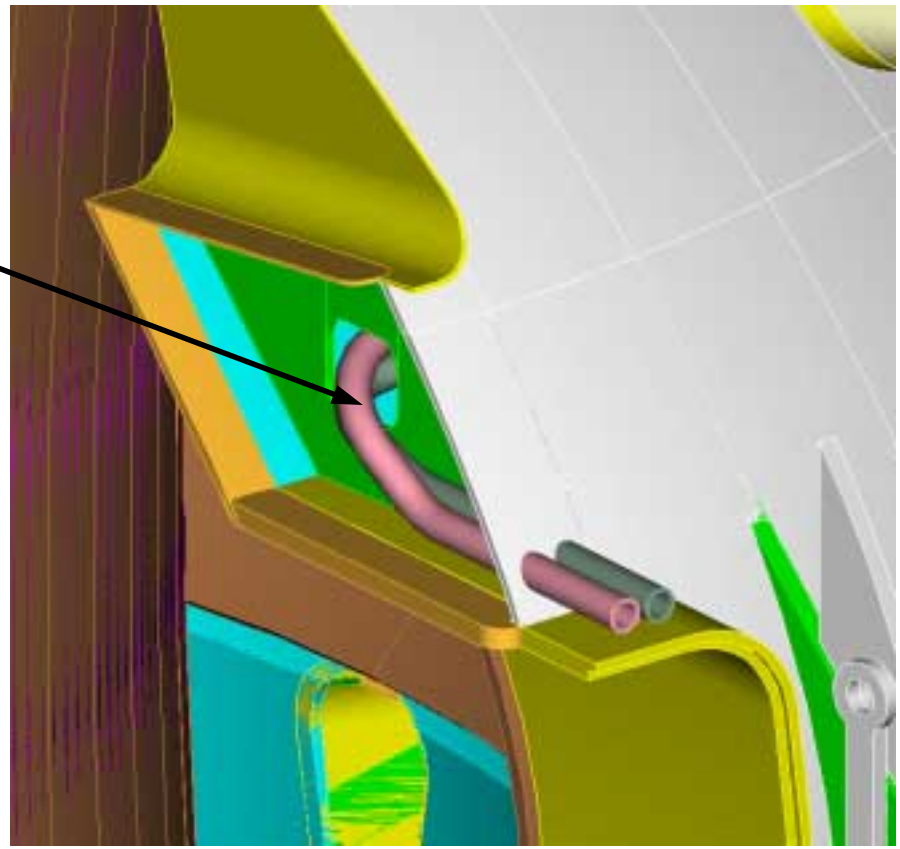
**Midplane Port**

**1.25 m H by**

**0.71 m W**

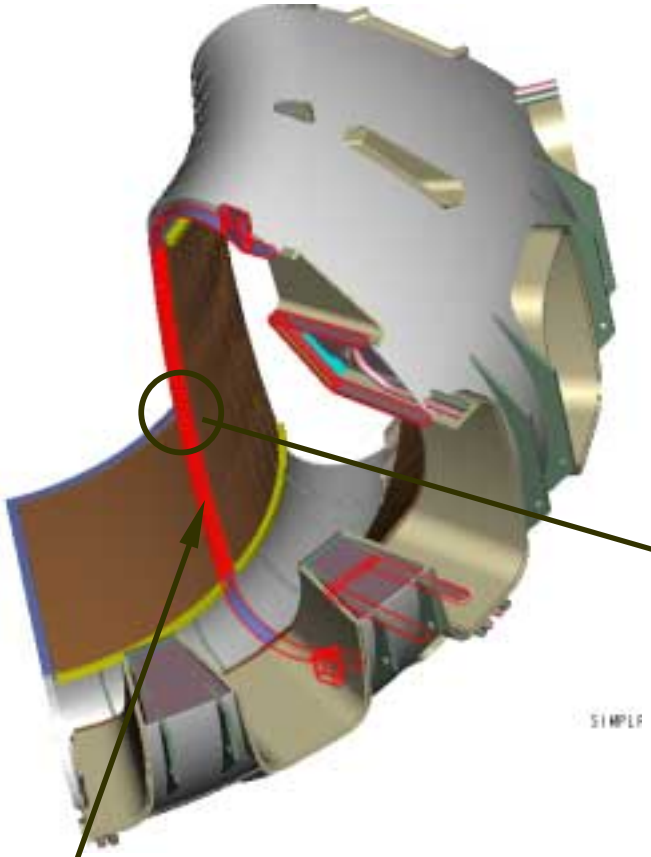
# INTERNAL CONTROL COLL INTERFACE DETAIL

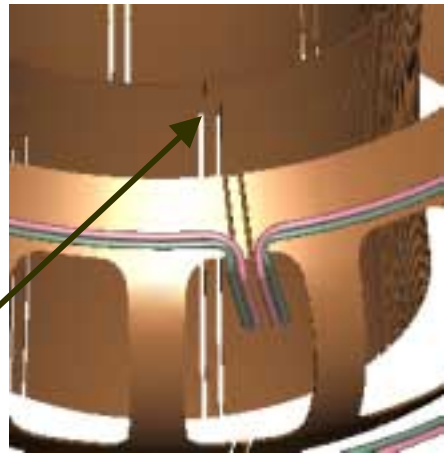




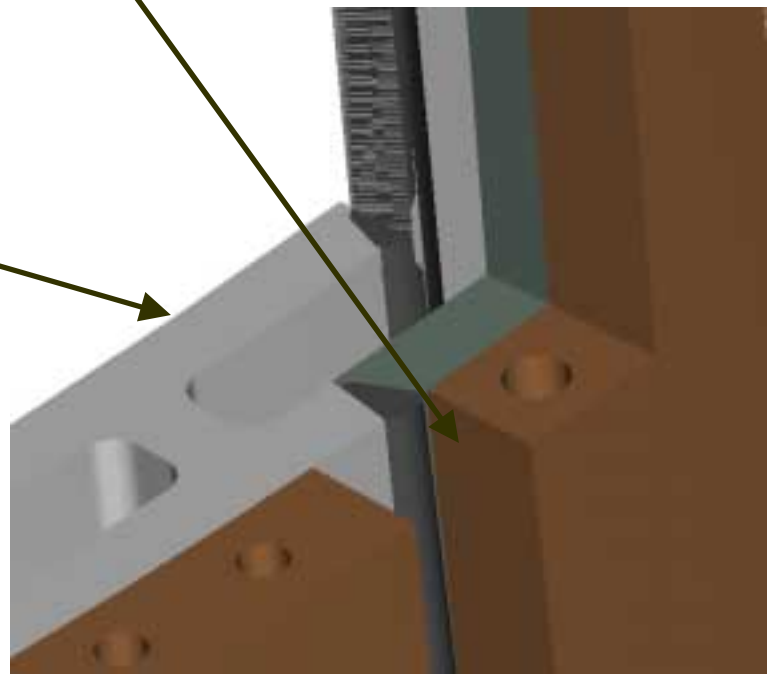
**2 sets of MgO insulated cables are located between the VV walls**

# Octant –to-octant joining concept



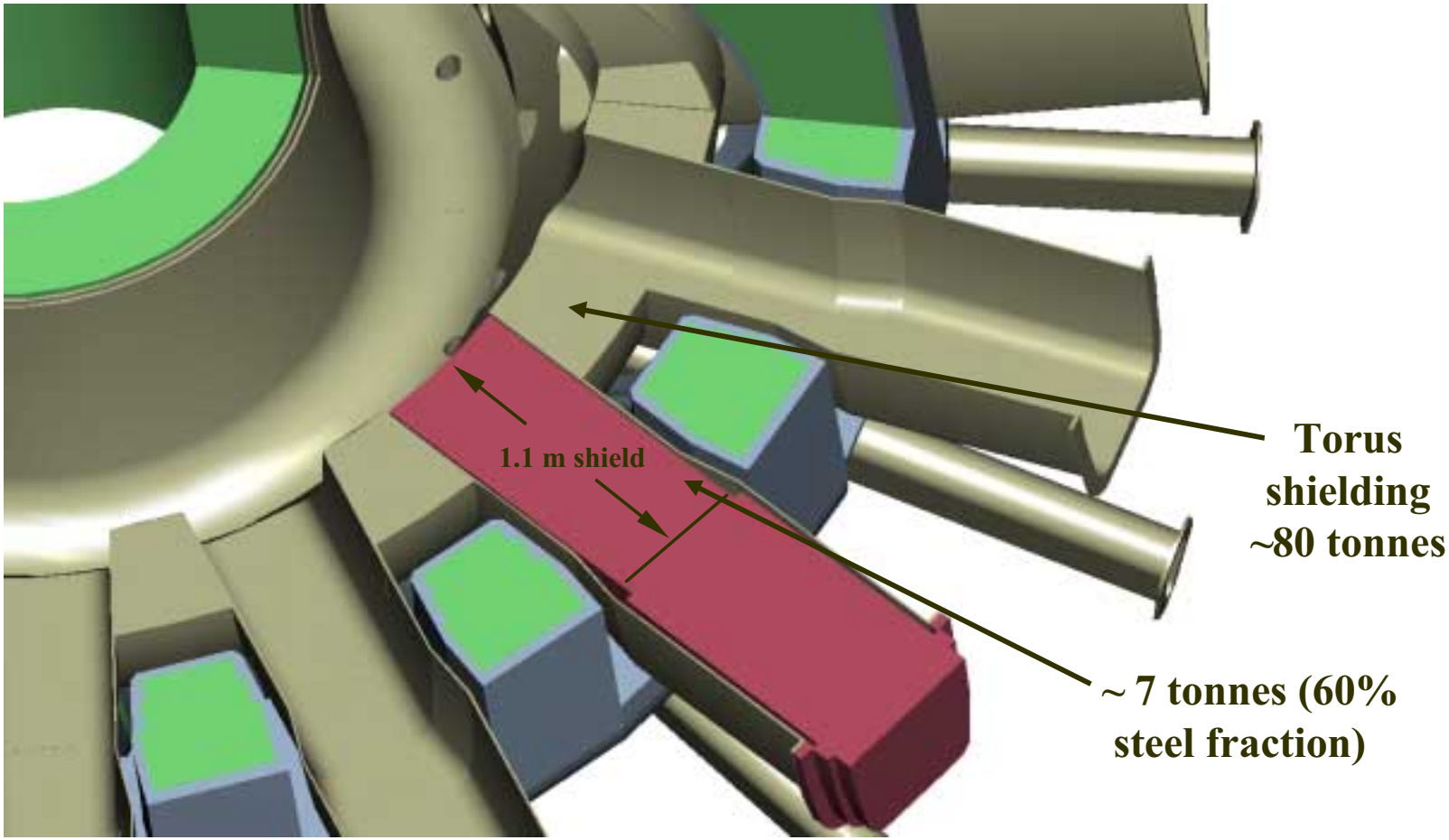


Local connection required for electrical continuity

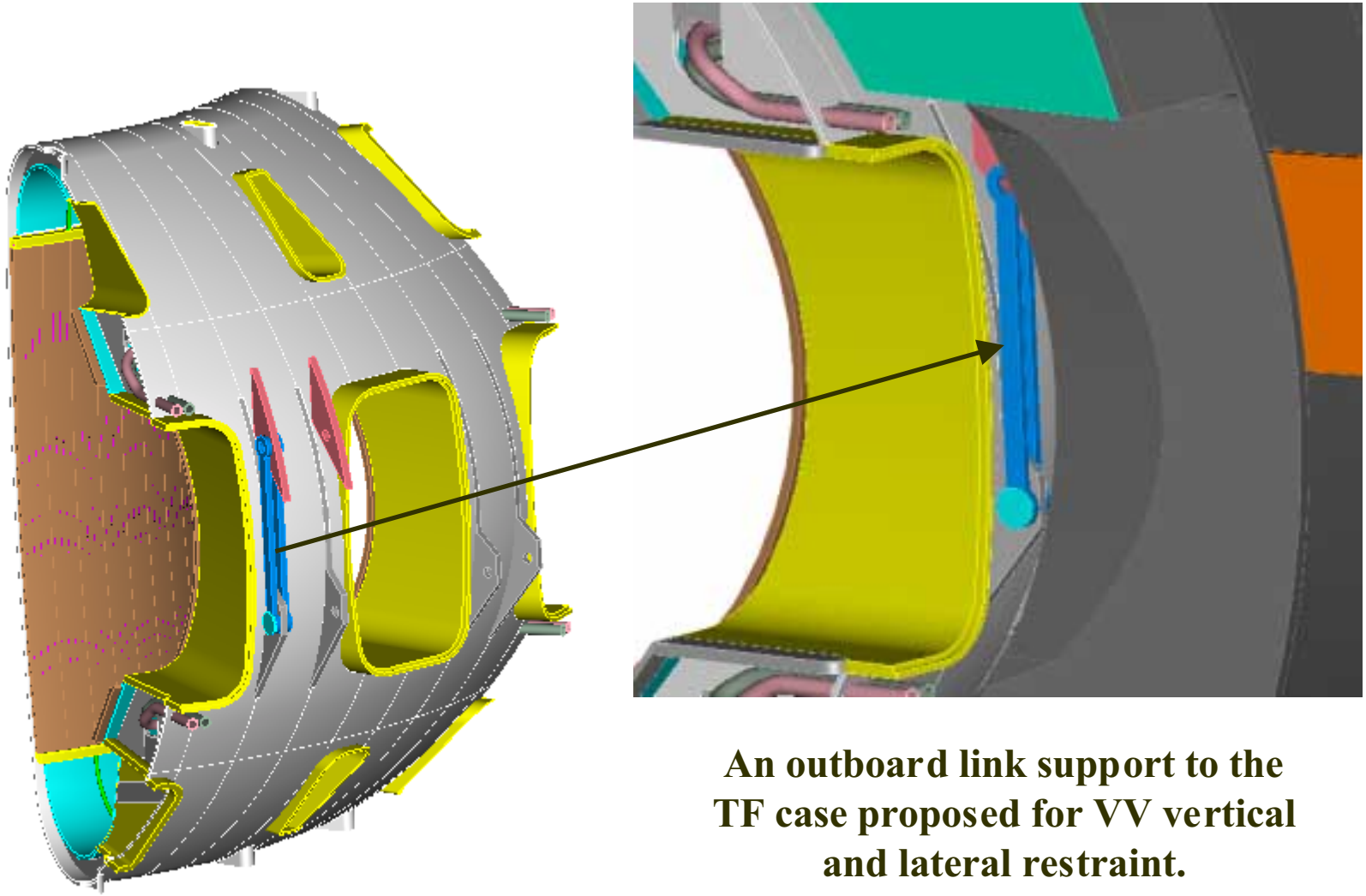


Splice plates join octants similar to ITER design

# Vessel shielding, port plugs and TF provides hands-on access to port flanges



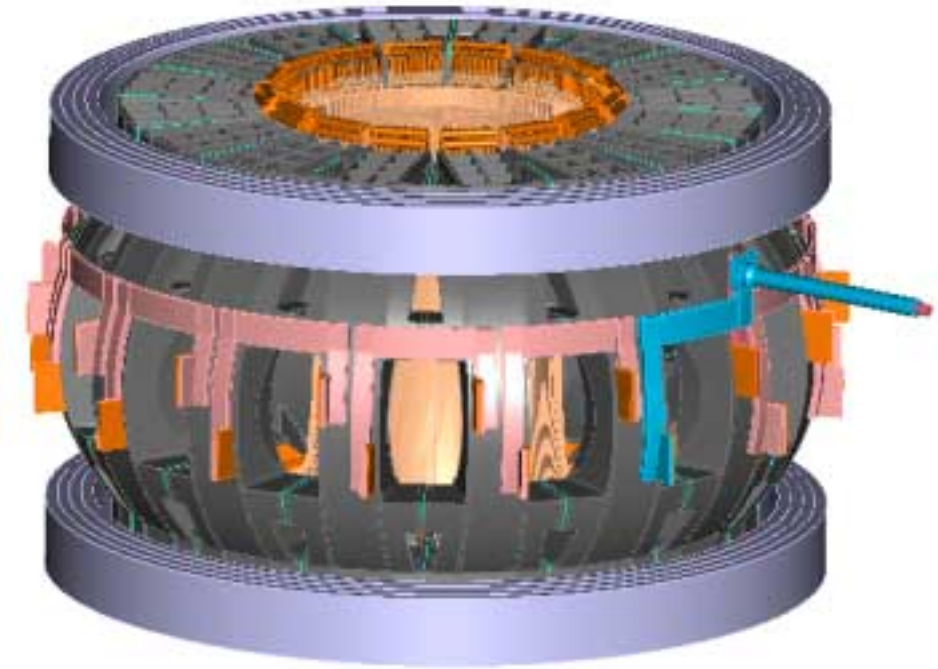
# Vacuum Vessel Support Concept



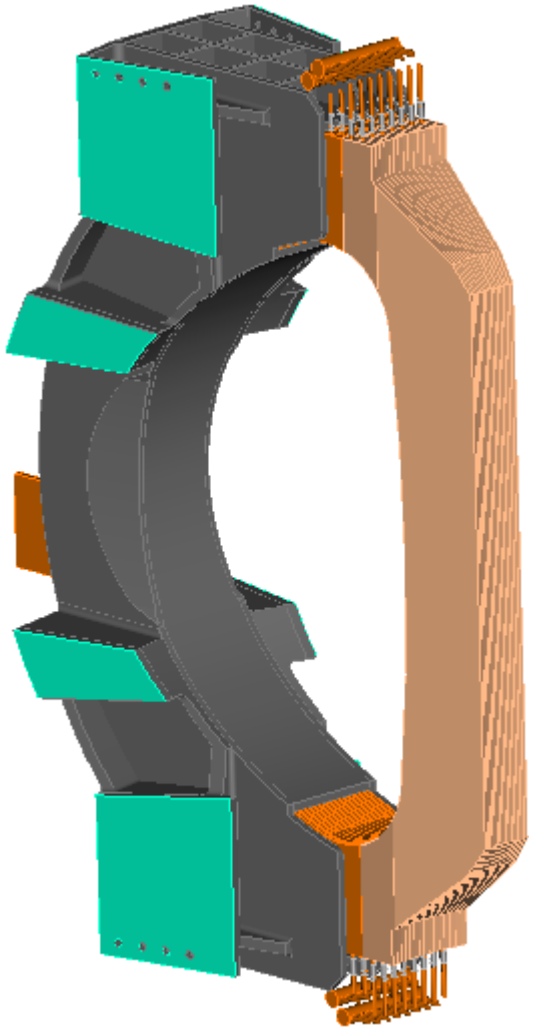
**An outboard link support to the TF case proposed for VV vertical and lateral restraint.**

# TF System

- 16 coils with partial cases
- Inertially $LN_2$ cooled
- High strength BeCu C17510 inner legs, OFHC copper used in remainder of coil
- Wedged support
- Compression rings help in supporting in plane loads

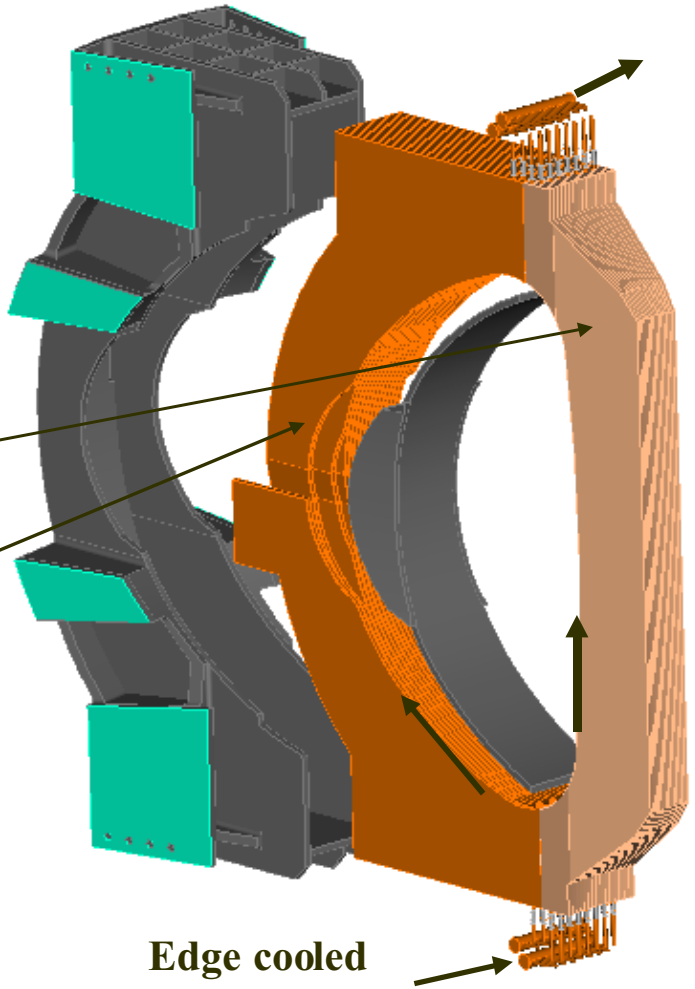


**Cast intercoil structure with rolled side plates.**

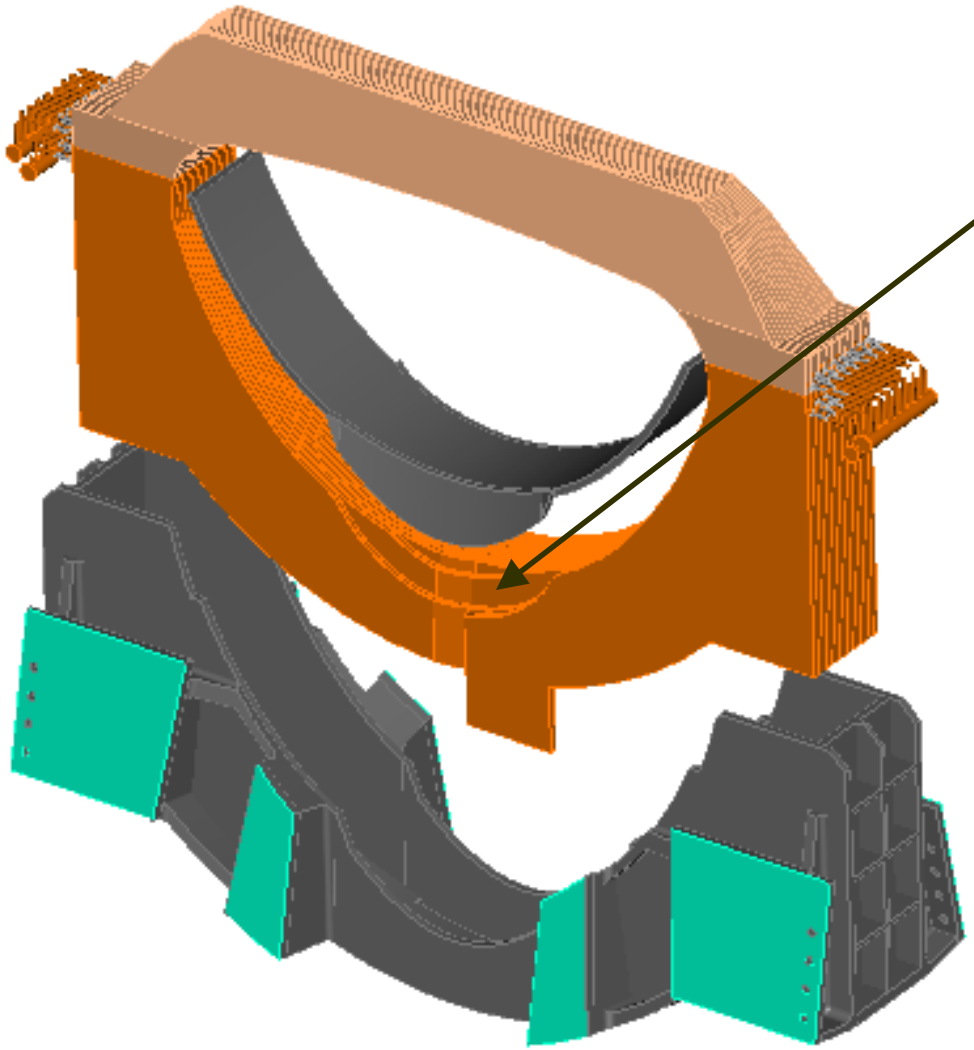


**31.7 tonnes conductor**

**11.6 tonnes case**



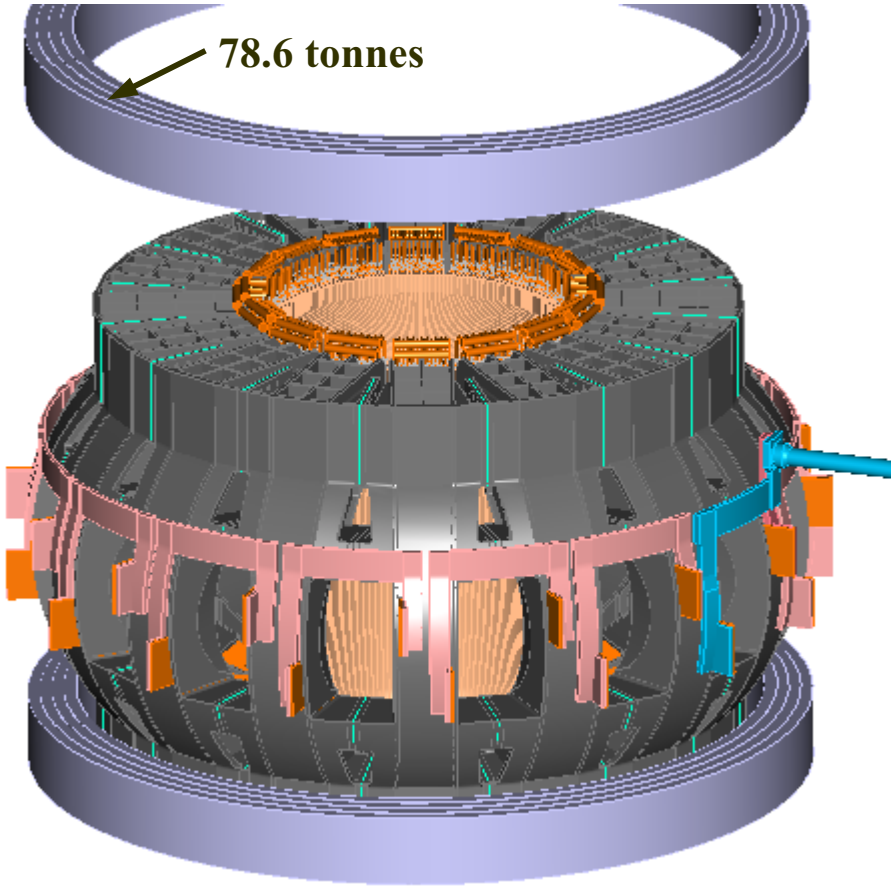
# TF Assembly Scheme

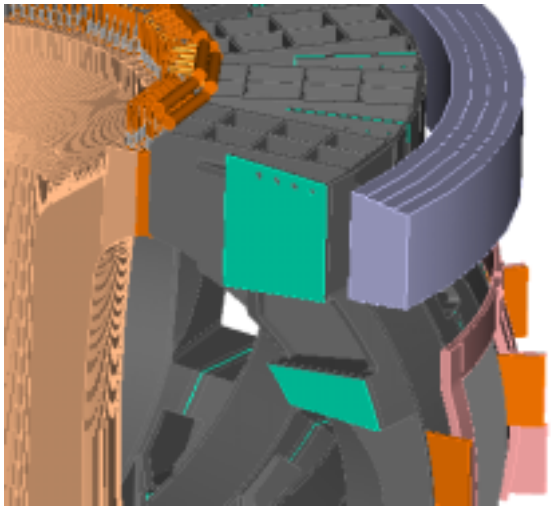


**Local sculpture of the TF winding and case is needed to accommodate the VV port**

**Prior to an epoxy fill, the winding pack is optically aligned. Adjustment pads and lift sling are used to move the case.**

# Compression rings suppress “de-wedging” in the corners of the TF coils



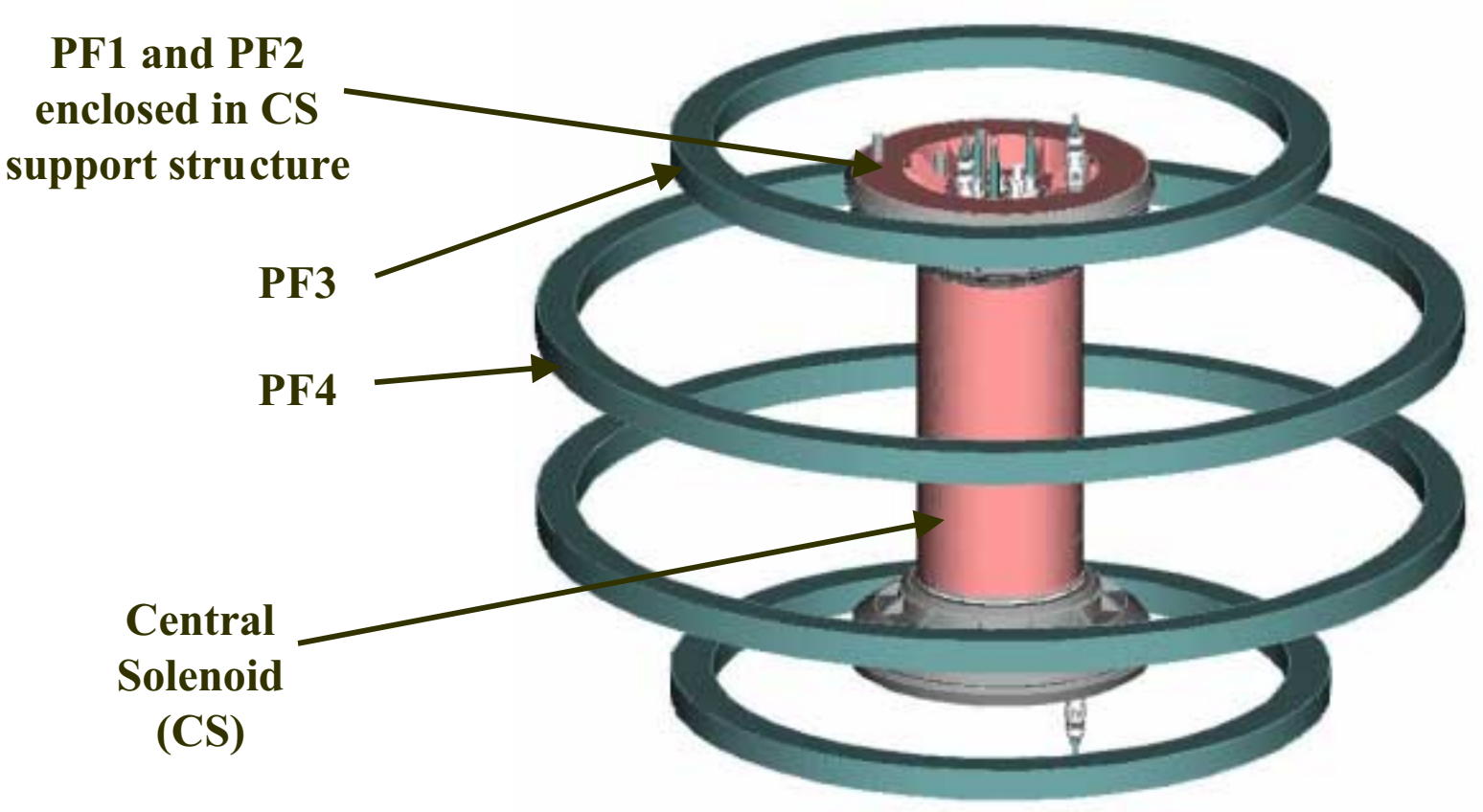



**.51m W x .83m H ring**

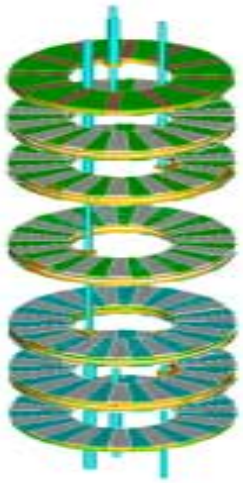
**10 ksi jack pressure (64 Mpa)**

**500 Mpa ring hoop stress**

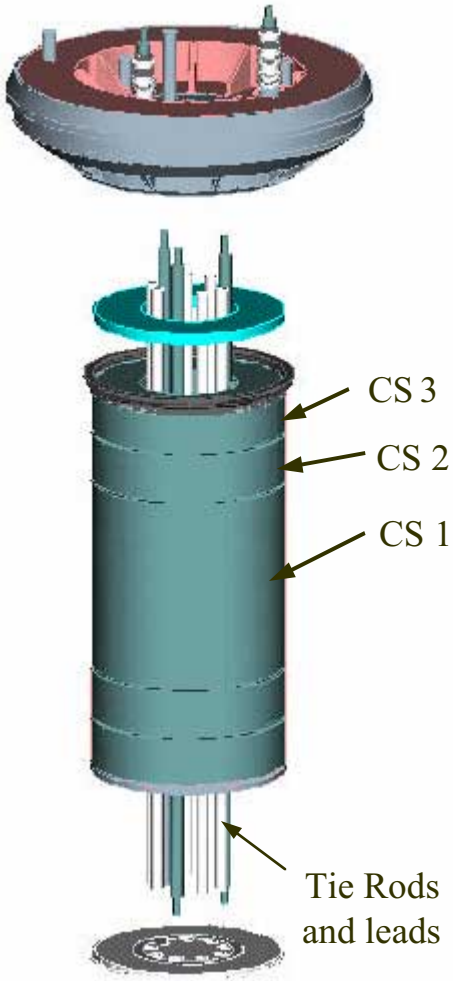
# PF System Arrangement

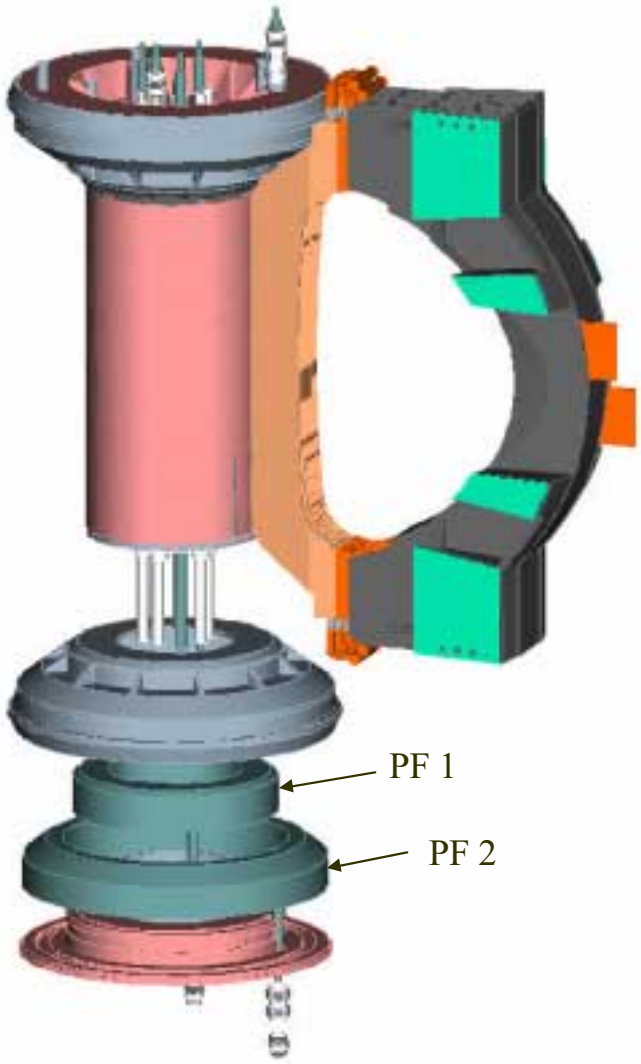


# CS and PF1,2 Details



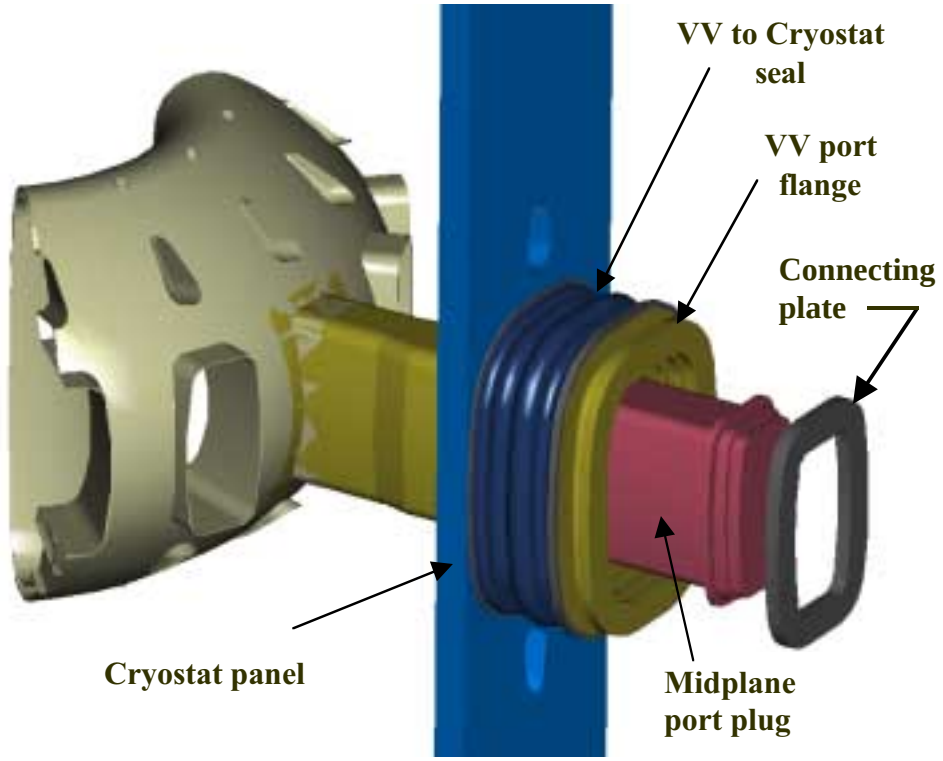
**CS Windings**

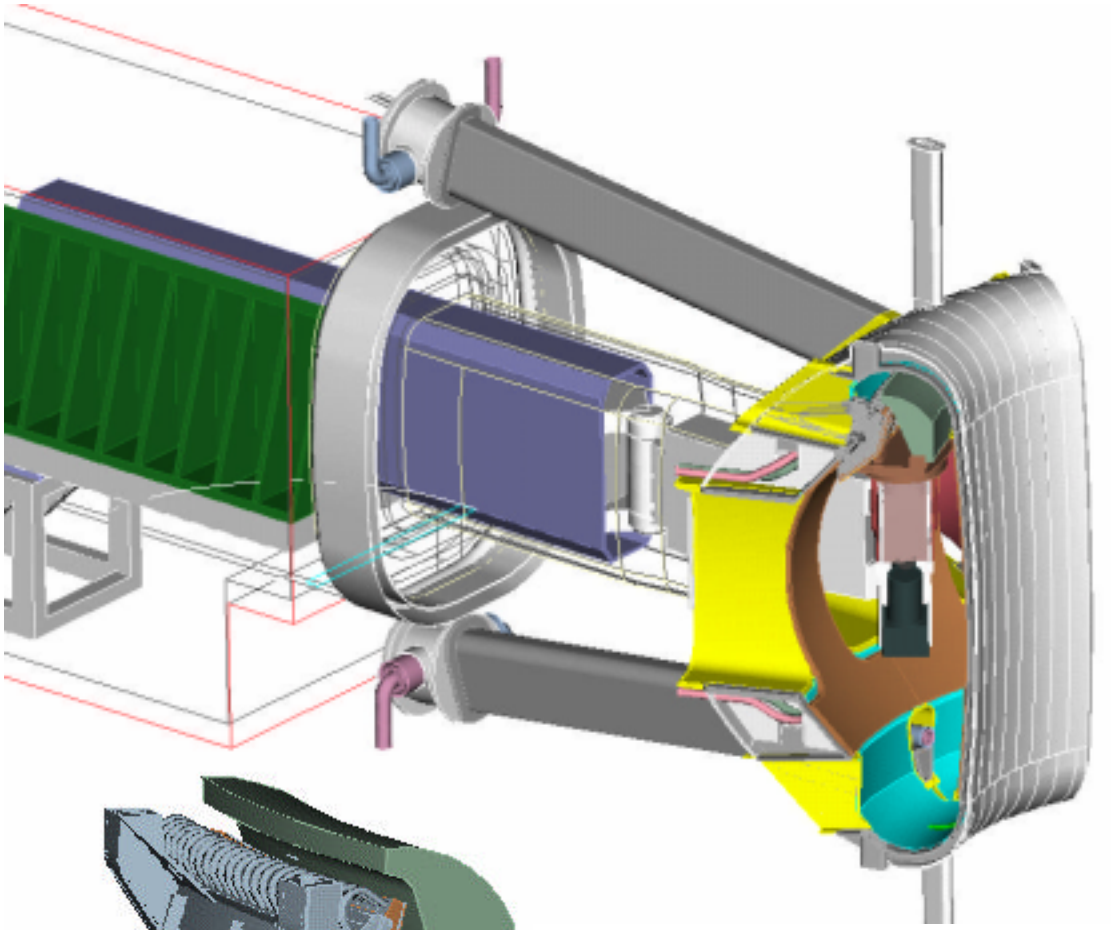


# FIRE device thermal enclosure and interface detail

**Polyurethane foam insulation with fiberglass inner and outer skins**

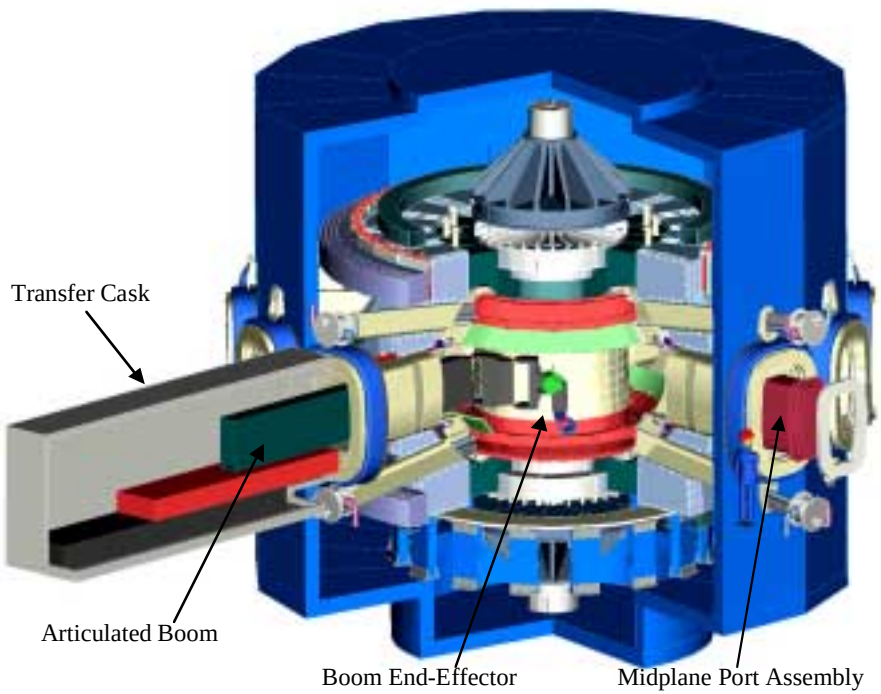


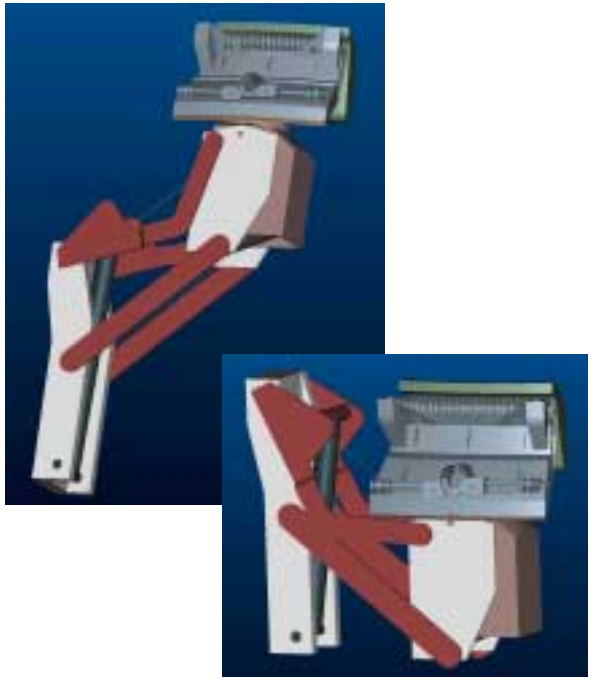


- Divertors installed through midplane ports
- Cantilevered articulated boom provides in-vessel coverage through 4 ports
- End-effector sized for 800 kg divertor/baffle module
- A smaller power arm end-effector would be used for FW maintenance

# Divertor / RM Interface

# FIRE In-Vessel Remote Handling System



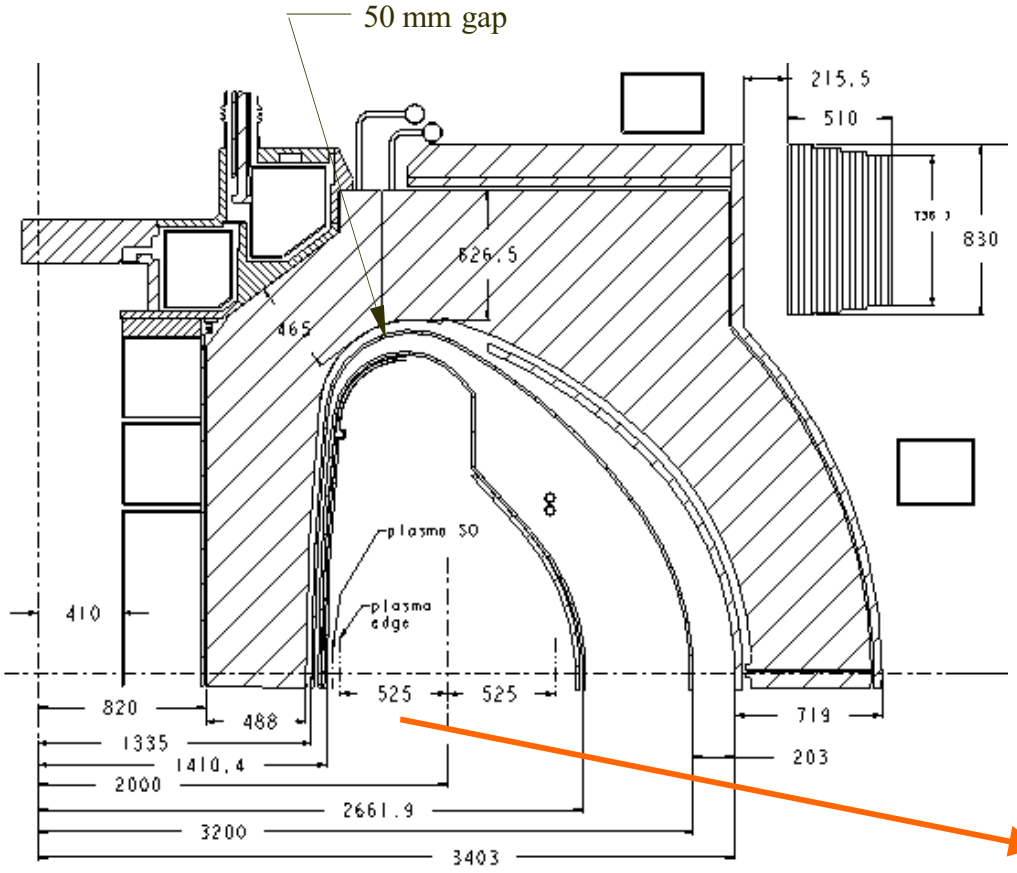
## In-vessel transporter

- Articulated boom deployed from sealed cask
- Complete in-vessel coverage from 4 midplane ports
- Fitted with different end-effector depending on component to be handled
- First wall module end-effector shown

## Divertor end-effector

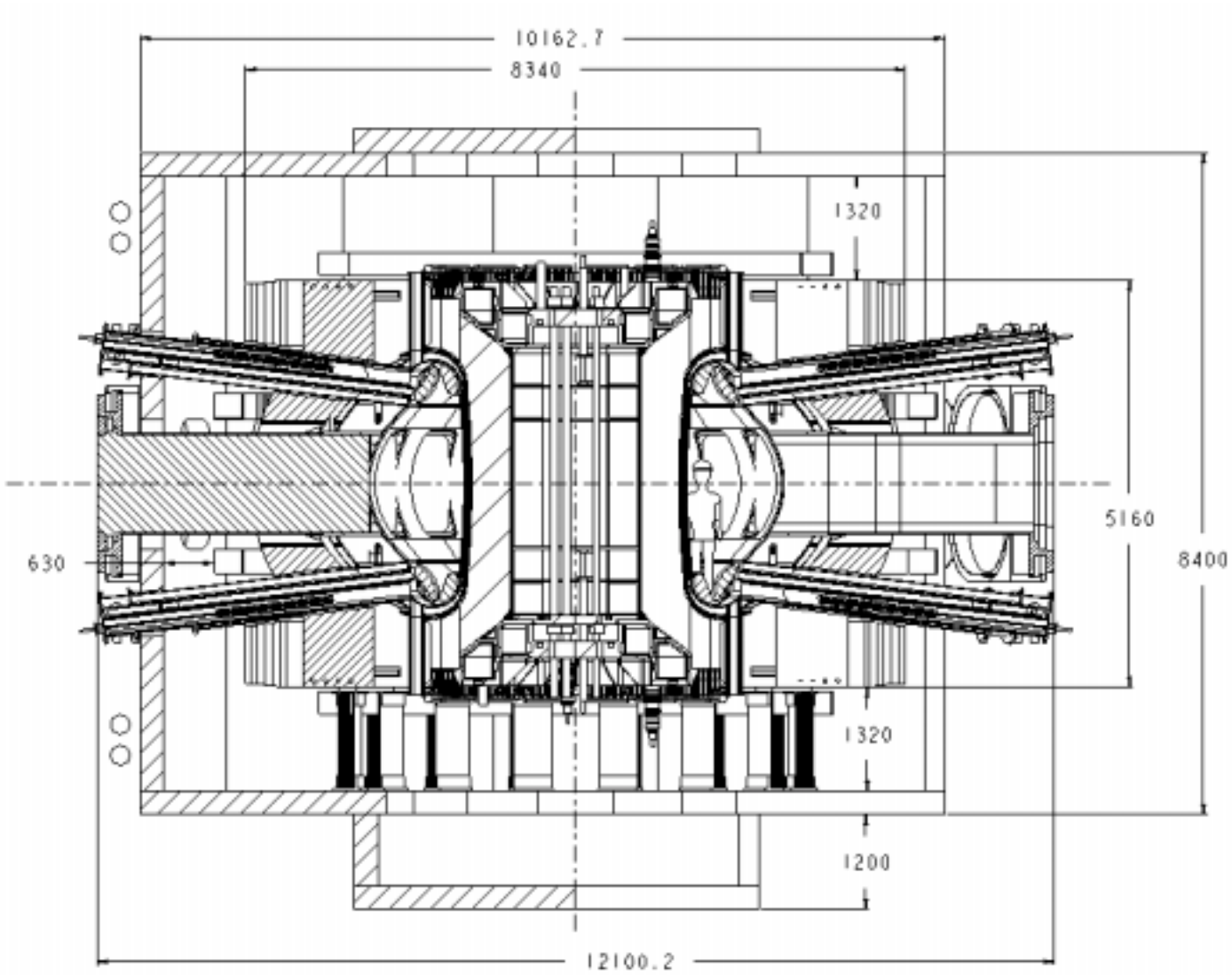
- High capacity (module wt. ~ 800 kg)
- Four positioning degrees of freedom
- Positioning accuracy of millimeters required

# COMPONENT BUILD DIMENSIONS

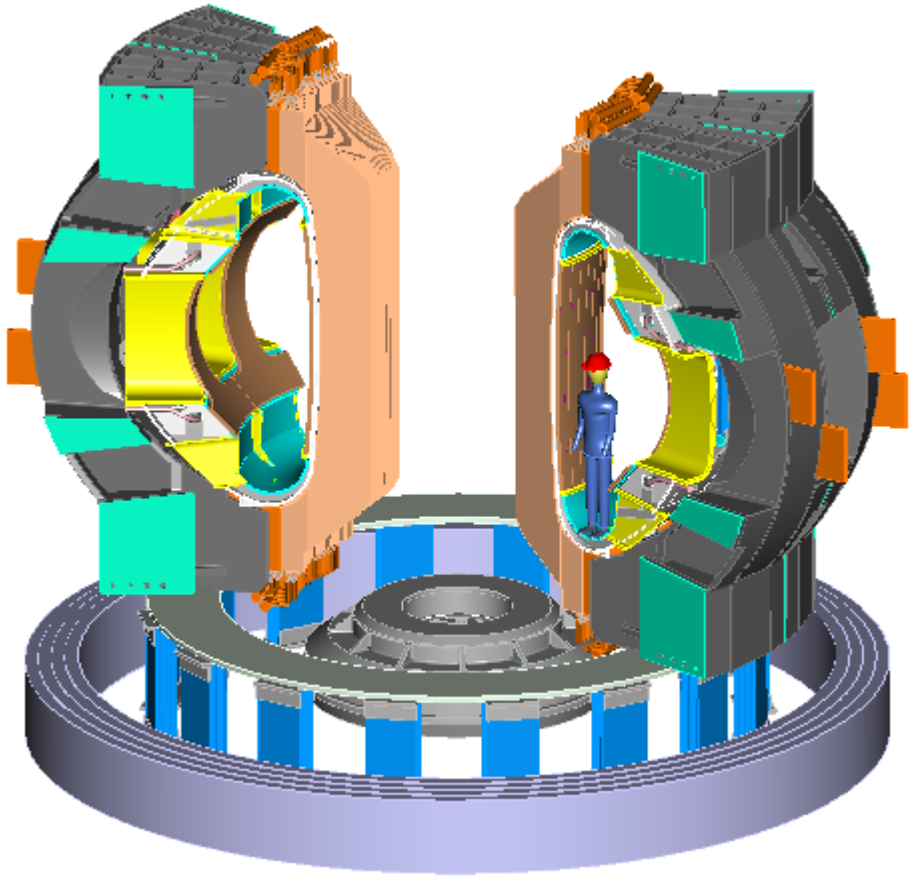



| | COMP BUILD mm | | COMP Dim | TOTAL Dim |
|---|---|---|---|---|
| | Machine Center | | | 0.0 |
| | gap | 410 | | 410.0 |
| **CS** | Insulation inside | 10.0 | | |
| | Nom winding thk | 370 | | 605 |
| | Insulation outside | 10.0 | 390.0 | 800.0 |
| | CS shell | 10 | | |
| | gap | 10 | | 820.0 |
| **inbd TF** | CS side case thk | 0.0 | | |
| | ground insul / filler | 12.0 | | |
| | winding pack | 464.0 | | |
| | ground insul / filler | 12.0 | | |
| | plasma side case thk | 0.0 | 488.0 | 1308.0 |
| | Trapezoidal Effect | 0.0 | | 1308.0 |
| | TF TPT | 5.0 | | |
| | Minimum TF/VV gap | 10.0 | | |
| | VV TPT | 0.0 | | |
| | Thermal Shield | 12.0 | 27.0 | 1335.0 |
| **inbd VV** | VV shell thk | 15.0 | | |
| | water | 20.0 | | |
| | VV shell thk | 15.0 | 50.0 | 1385.0 |
| **PFC Module** | Cu Heat Sink | 25.0 | | |
| | FW | 30.0 | 55.0 | 1440.0 |
| | Plasma SO | 35.0 | | |
| | Plasma minor radii | 525.0 | | |

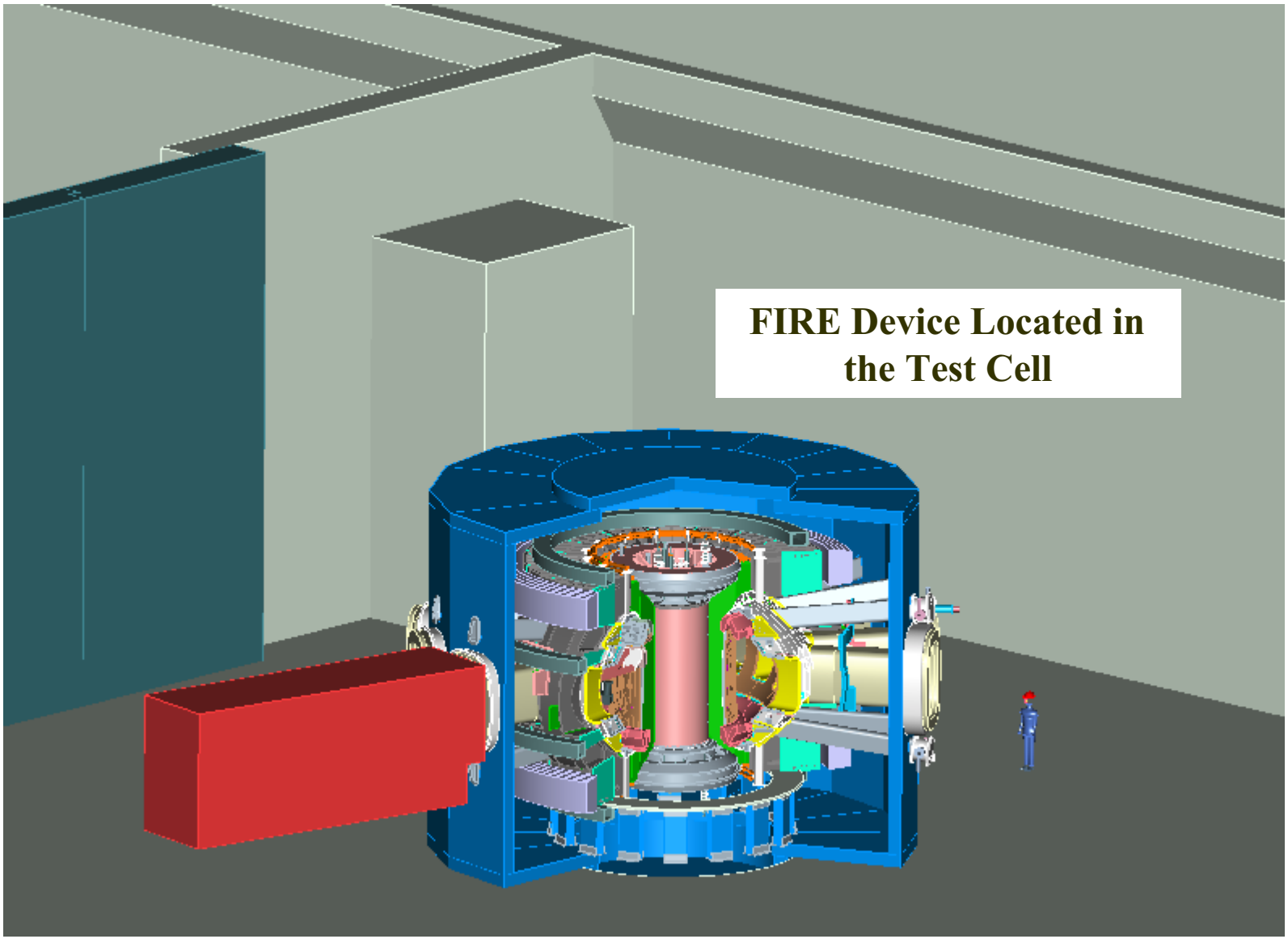
# FIRE – Elevation Section View



# Machine Assembly of TF / VV Octant in the Test Cell Building



~ 93 tonnes
TF/VV
Octant


FIRE Device Located in
the Test Cell

# Configuration Summary

A baseline configuration has been developed for FIRE in sufficient detail to address major design issues.

- No technical "show stoppers" have been uncovered,
- Component support requirements can be met,
- In-vessel access for RM, heating, auxiliary systems appear feasible.

Design issues still need to be addressed in the next design phase.

- The full array of diagnostic equipment needs to be integrated into the design,
- Assessment of RM of in-vessel components should continue,
- Service details needs to be integrated and their maintenance approach reviewed.