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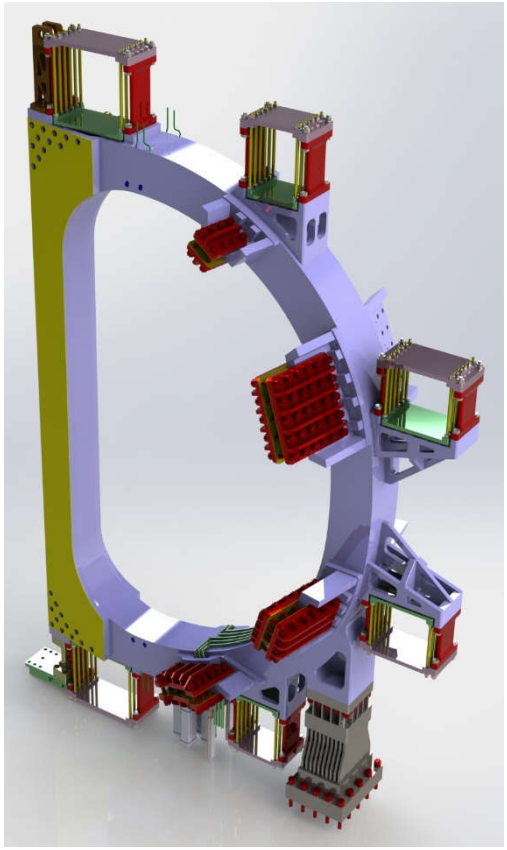
Italian National Agency for New Technologies,
Energy and Sustainable Economic Development

TF Casing and miscellanea stuctures

Aula B. Brunelli, C.R. ENEA Frascati (Rome), Italy – 08/10/2019

Alessandro Anemona on behalf of the DTT team

DTT Magnet System – TF coils structures



DTT Magnet System – TF coils structures

Maintain the connection of the upper and lower part of the TF coil during energization reducing its radial outward movement and minimizing the cyclic loads

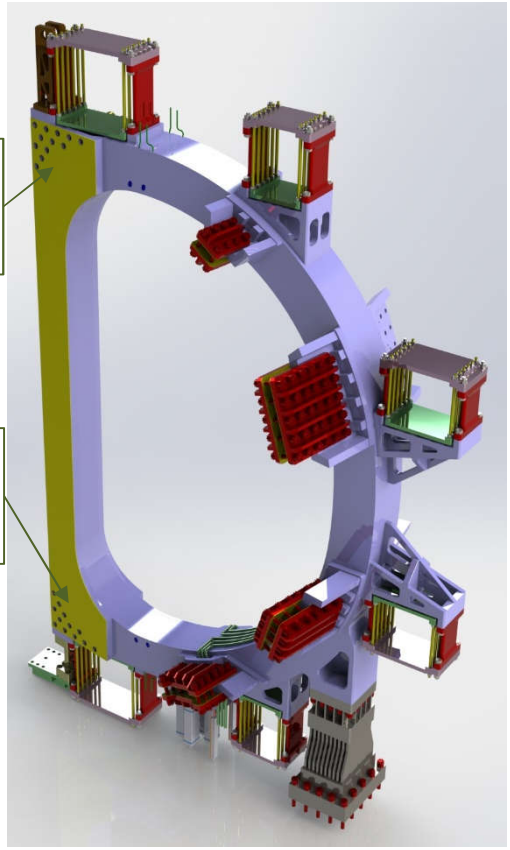
The system consists in 9 M33 superbolts (460 KN) each side and 3 Superbolt EzFit M33 used as shear pins.

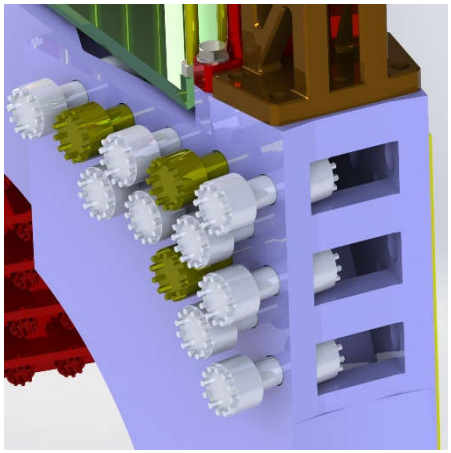
A 2.5 mm sheet of G10 is used to insulate the TF coils

A 2.5 mm gap, filled with sheets of steel, is considered to optimize the coupling between TF coils during the installation.

Inner Upper Intercoil structures

Inner Lower intercoil structures

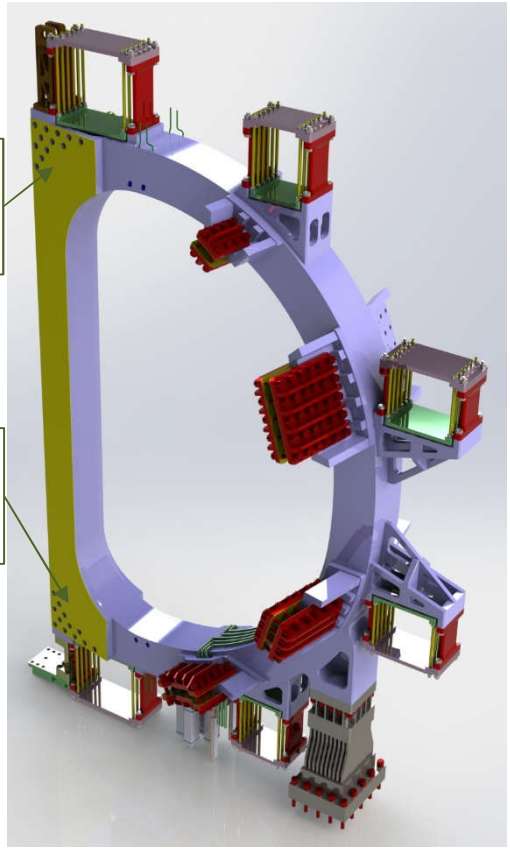




DTT Magnet System – TF coils structures

Inner Upper Intercoil structures

Inner Lower intercoil structures



Maintain the connection of the upper and lower part of the TF coil during energization reducing its radial outward movement and minimizing the cyclic loads

The system consists in 9 M33 superbolts (460 KN) each side and 3 Superbolt EzFit M33 used as shear pins.

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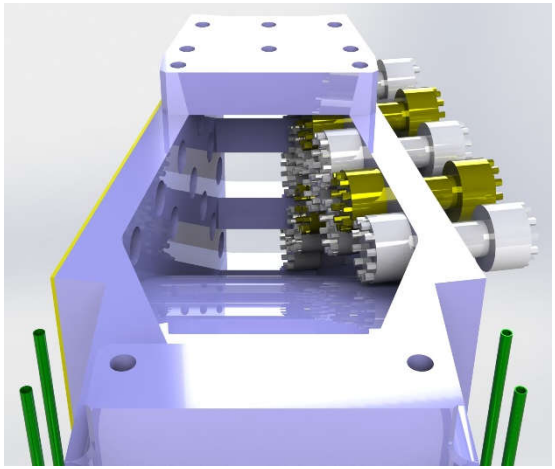
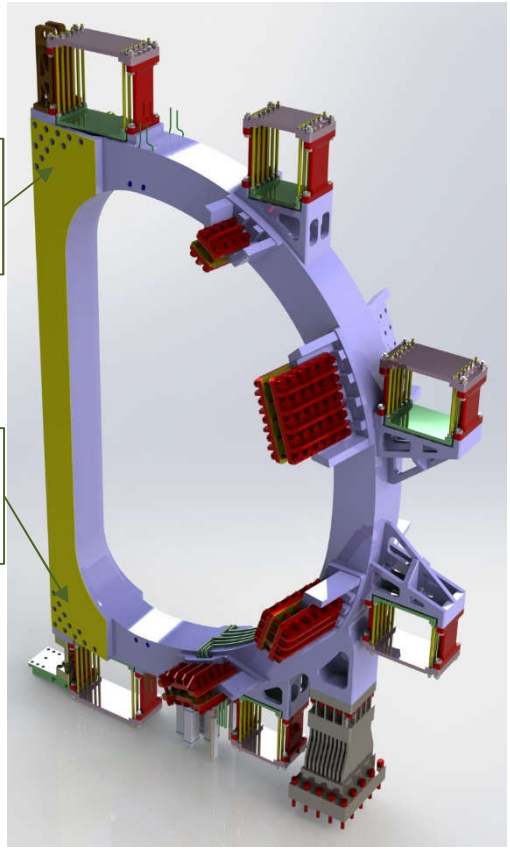


DTT Magnet System – TF coils structures

Inner Upper Intercoil structures

Inner Lower intercoil structures



Maintain the connection of the upper and lower part of the TF coil during energization reducing its radial outward movement and minimizing the cyclic loads

The system consists in 9 M33 superbolts (460 KN) each side and 3 Superbolt EzFit M33 used as shear pins.

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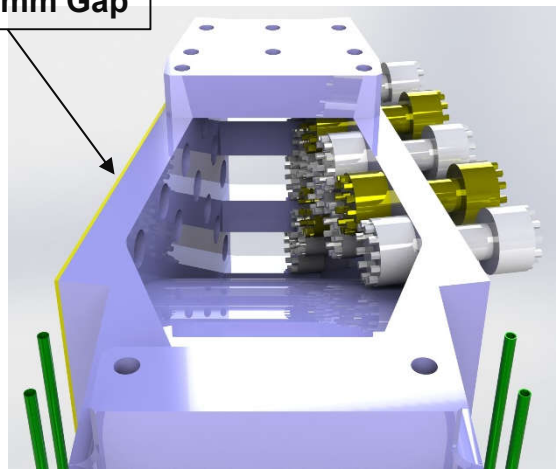
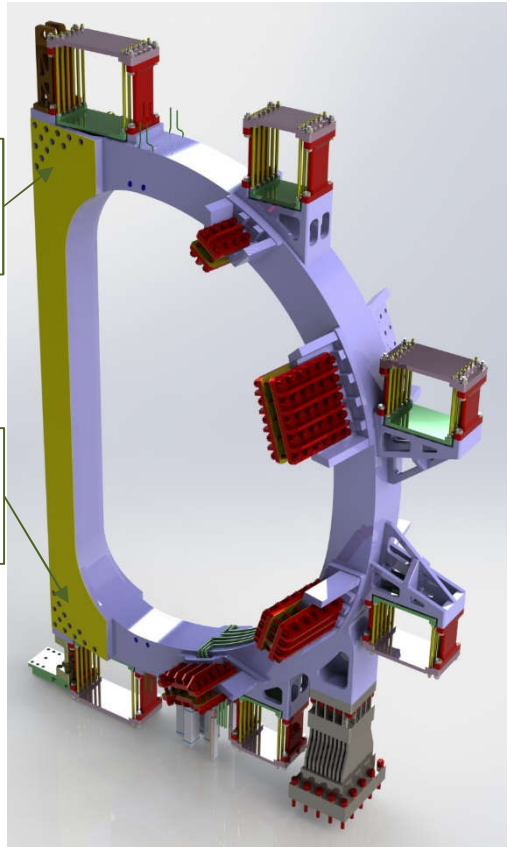
2,5+2,5 mm Gap



DTT Magnet System – TF coils structures

Inner Upper Intercoil structures

Inner Lower intercoil structures



Maintain the connection of the upper and lower part of the TF coil during energization reducing its radial outward movement and minimizing the cyclic loads

The system consists in 9 M33 superbolts (460 KN) each side and 3 Superbolt EzFit M33 used as shear pins.

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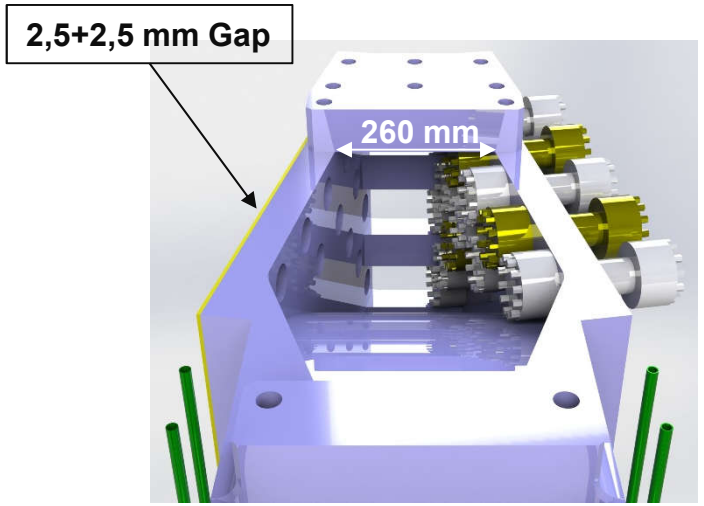

DTT Magnet System – TF coils structures

Maintains the connection on the internal straight leg between the TF coils
A 2.5 mm sheet of G10 is used to insulate the TF coils
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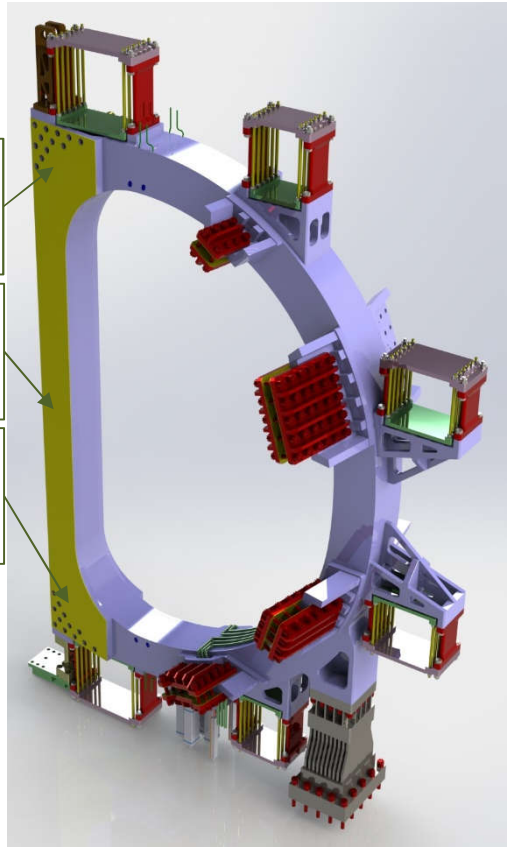
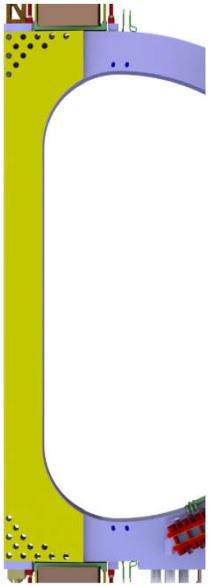
Inner Upper Intercoil structures

Inner leg intercoil structure

Inner Lower intercoil structures





DTT Magnet System – TF coils structures

Maintains the connection on the internal straight leg between the TF coils
A 2.5 mm sheet of G10 is used to insulate the TF coils
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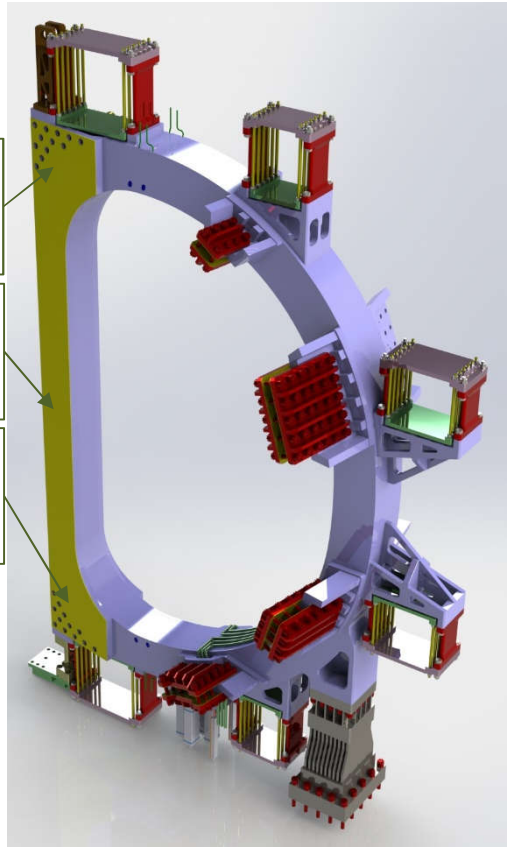
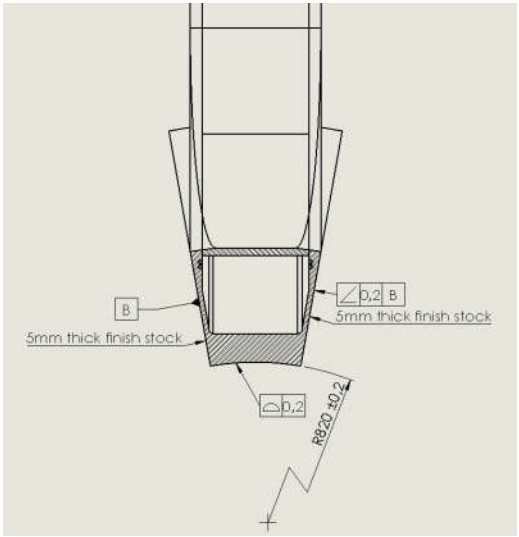
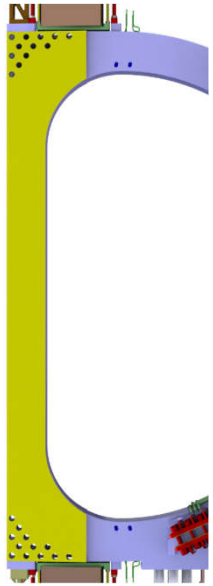
Inner Upper Intercoil structures

Inner leg intercoil structure

Inner Lower intercoil structures







DTT Magnet System – TF coils structures

Mantains the PF coils in position supporting their weight (PF1/6 17,8 Ton, PF2/5 18,5, PF3/4 30,9 Ton) and magnetic loads (Max 40MN).

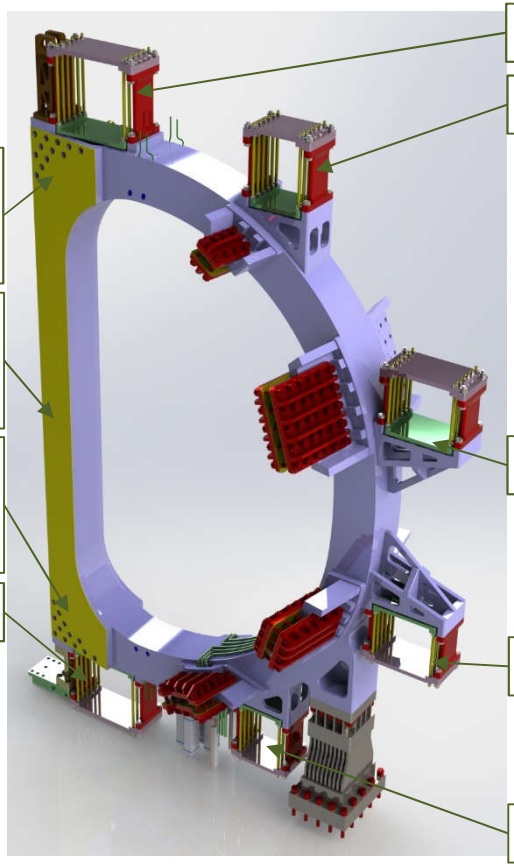
The system consists in a cage of 12 rods (diam 24mm) that compress the PF on a sector of about 20° between two steel plates; two G10 sheets (3mm) are placed between the steel and the PF; the cage is supported by two flexible columns that are designed to support the vertical loads and leave the radial deformation free.

Inner Upper Intercoil structures

Inner leg intercoil structure

Inner Lower intercoil structures

PF6 support



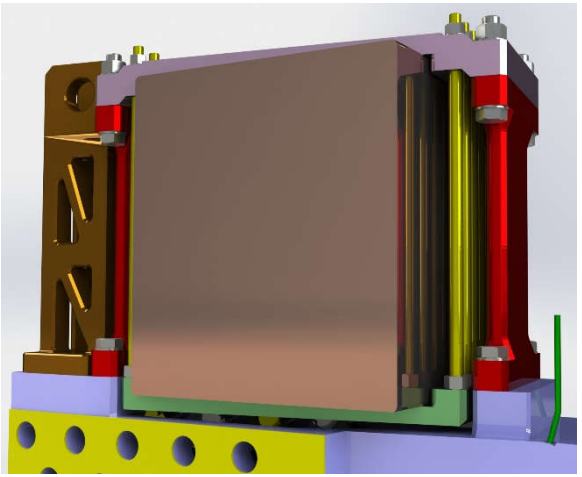
PF1 support

PF2 support

PF3 support

PF4 support

PF5 support



DTT Magnet System – TF coils structures

AISI 316LN

- **σn=1000 Mpa (T=4,2 K)**
- **Lower range of N content**

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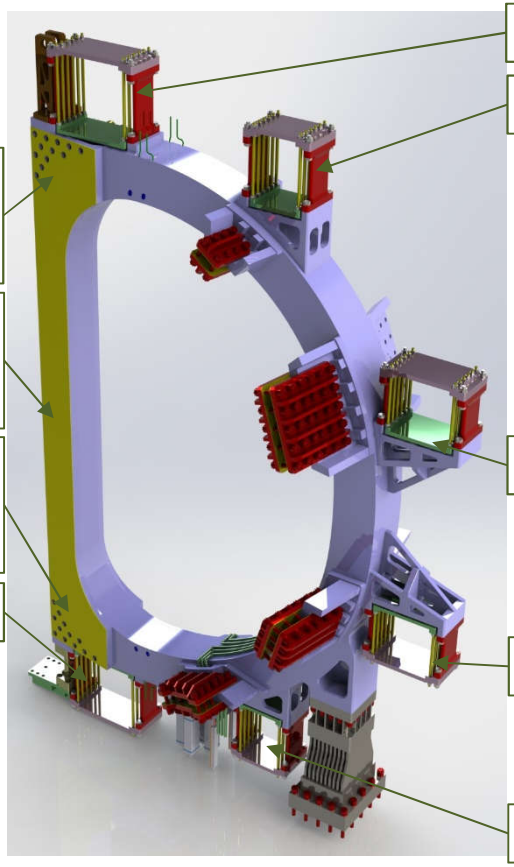

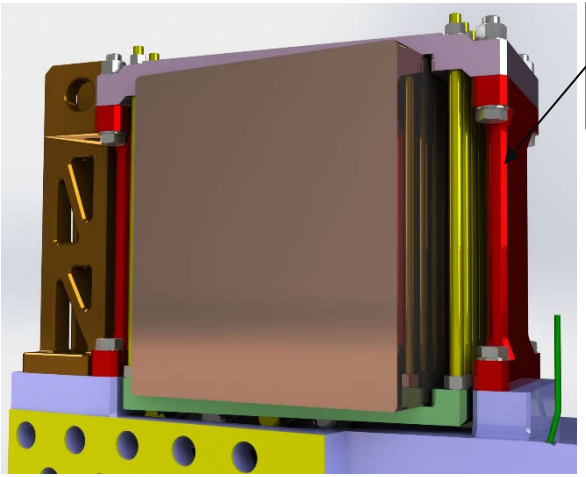

- **AISI 316 LN**
- **35 mm thikness**
- **40Kg**

DTT Magnet System – TF coils structures

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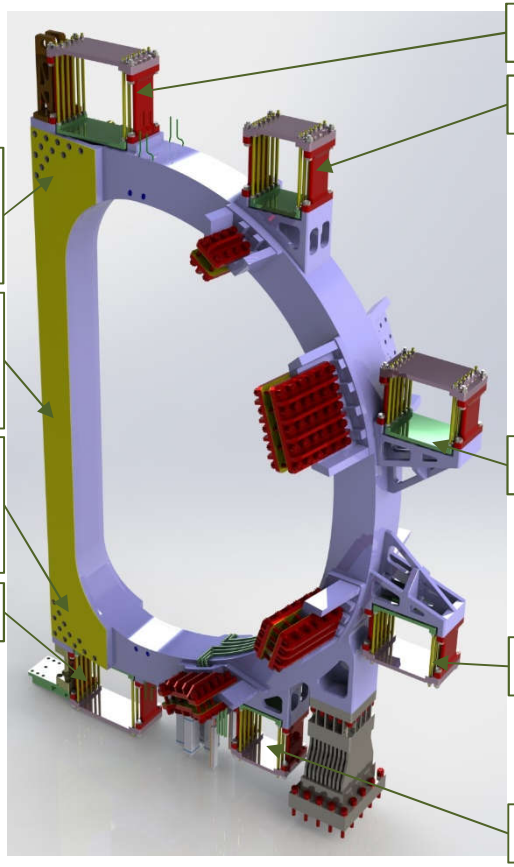

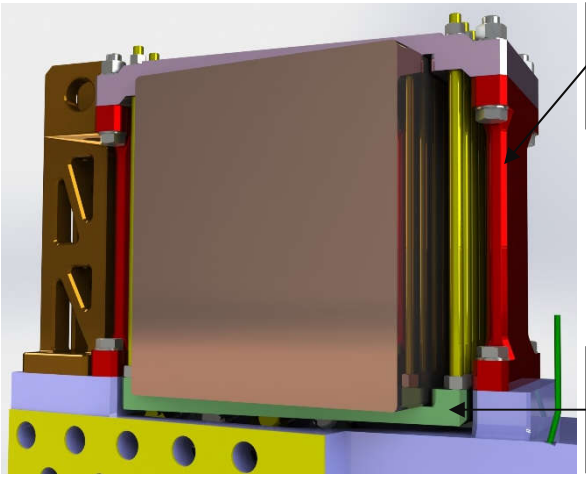

- AISI 316 LN
- 35 mm thikness
- 40Kg

- AISI 316 LN
- 60 mm thikness
- 55Kg

DTT Magnet System – TF coils structures

AISI 316LN

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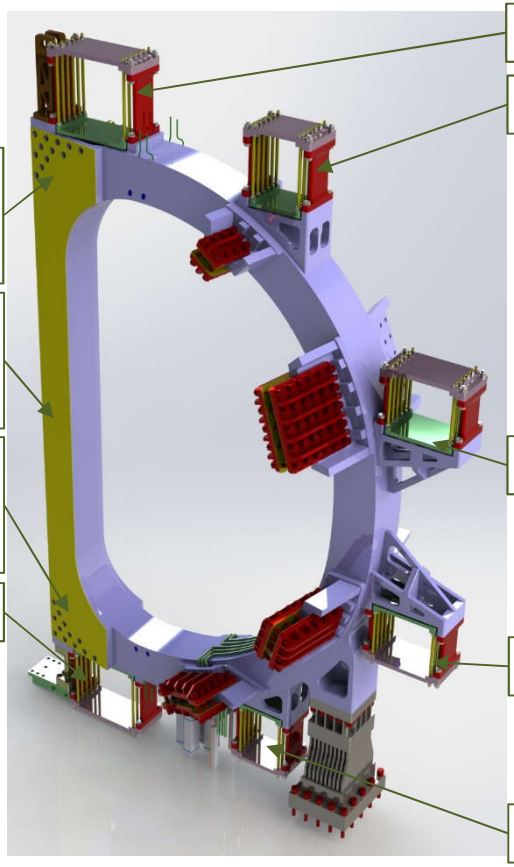


Inner Upper Intercoil structures

Inner leg intercoil structure

Inner Lower intercoil structures

PF6 support

PF1 support

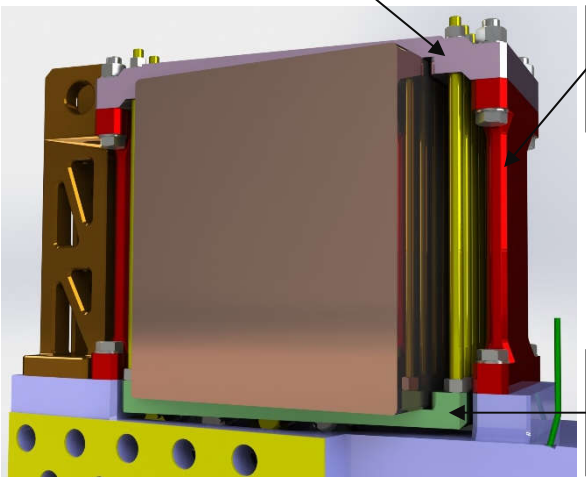
PF2 support

PF3 support

PF4 support

PF5 support

- **AISI 316 LN**
- **60 mm thikness**
- **85Kg**



- **AISI 316 LN**
- **35 mm thikness**
- **40Kg**

- **AISI 316 LN**
- **60 mm thikness**
- **55Kg**

DTT Magnet System – TF coils structures

AISI 316LN

- σn=1000 Mpa (T=4,2 K)
- Lower range of N content

Mantains the PF coils in position supporting their weight (PF1/6 17,8 Ton, PF2/5 18,5, PF3/4 30,9 Ton) and magnetic loads (Max 40MN).

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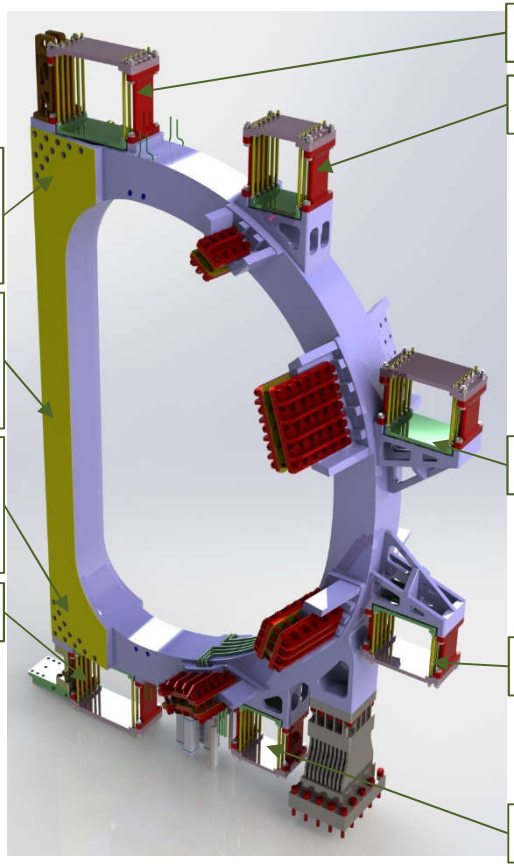
Inner Upper Intercoil structures

Inner leg intercoil structure

Inner Lower intercoil structures

PF6 support



PF1 support

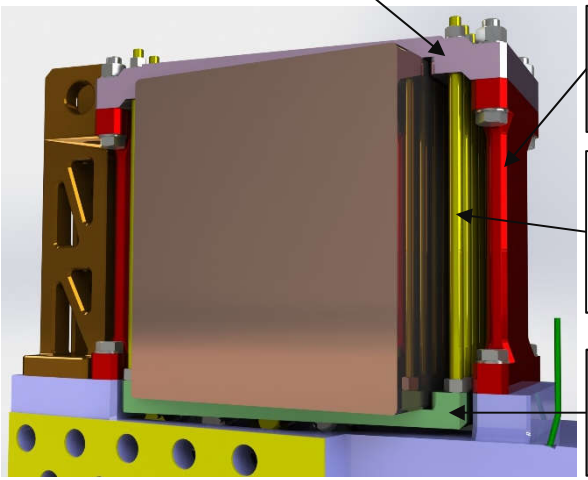
PF2 support

PF3 support

PF4 support

PF5 support

- AISI 316 LN
- 60 mm thikness
- 85Kg



- AISI 316 LN
- 35 mm thikness
- 40Kg

- AISI 316 LN
- 12 tie-rods
- Diam 24 mm
- Length 550 mm

- AISI 316 LN
- 60 mm thikness
- 55Kg

DTT Magnet System – TF coils structures

AISI 316LN

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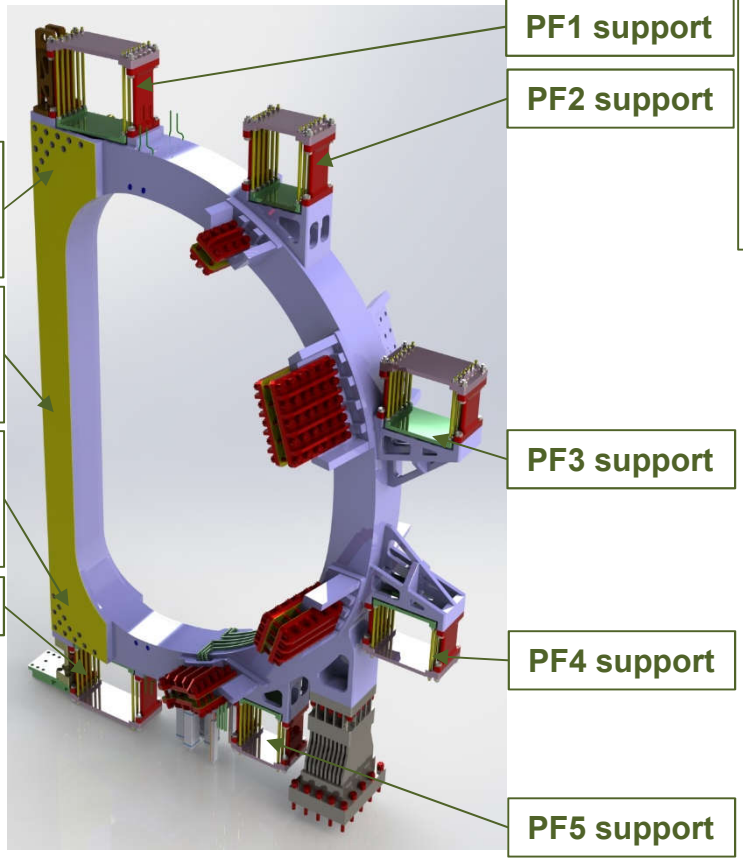
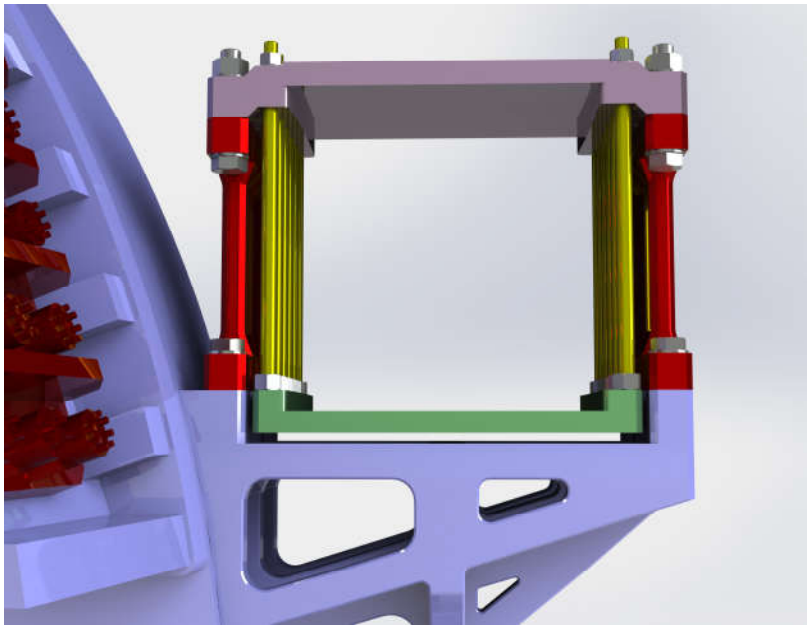




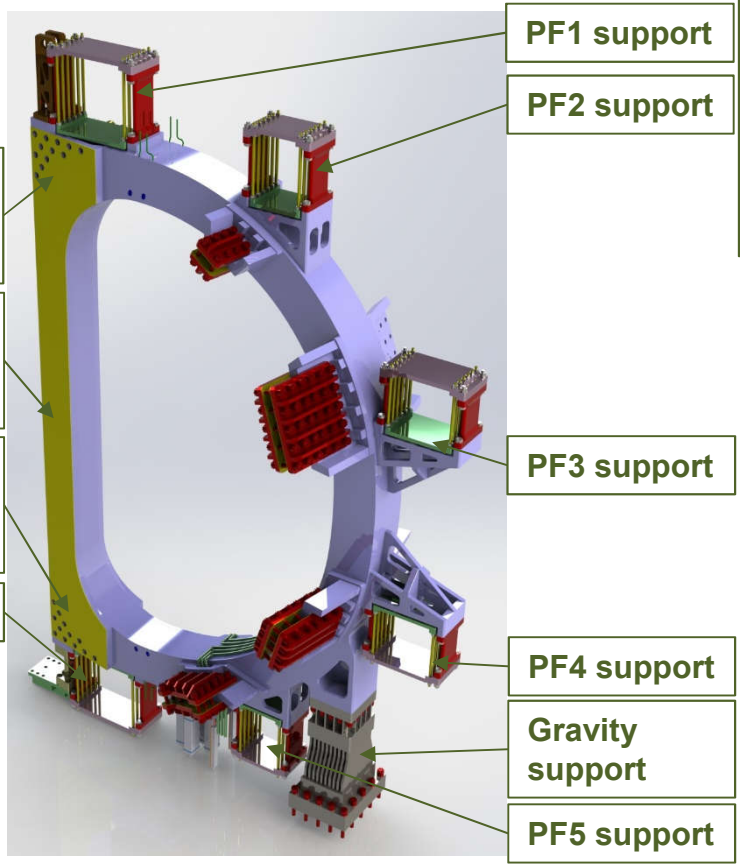
DTT Magnet System – TF coils structures

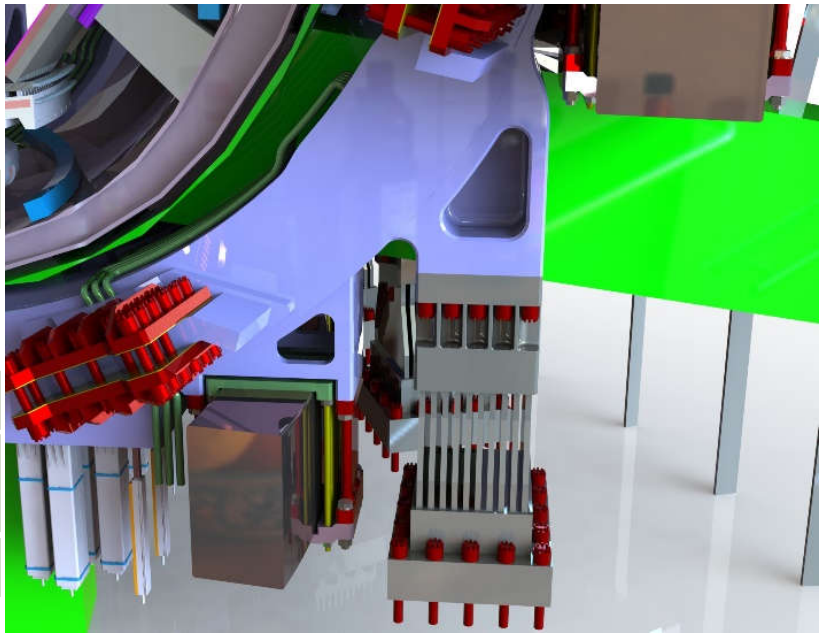
- Supports all the magnet system (blocks the vertical and toroidal displacements leaving the radial displacements free)
- Breaks the thermal input from the ground

The system is based on the ITER gravity support design.

Ten sheets 20mm thick that can resist to al the vertical loads

Analisys are in progress in order to optimize the design.





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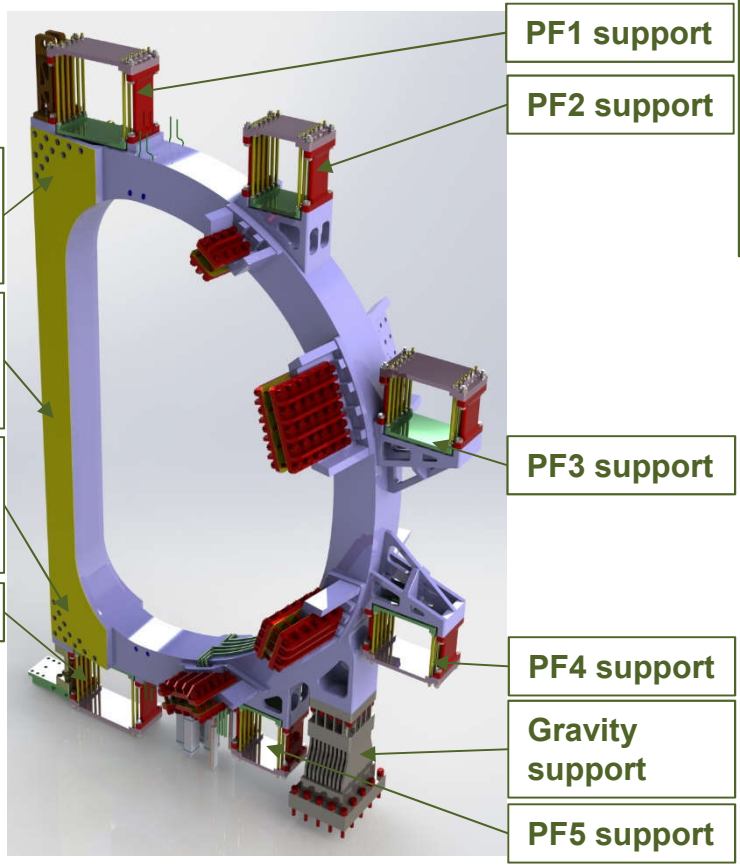

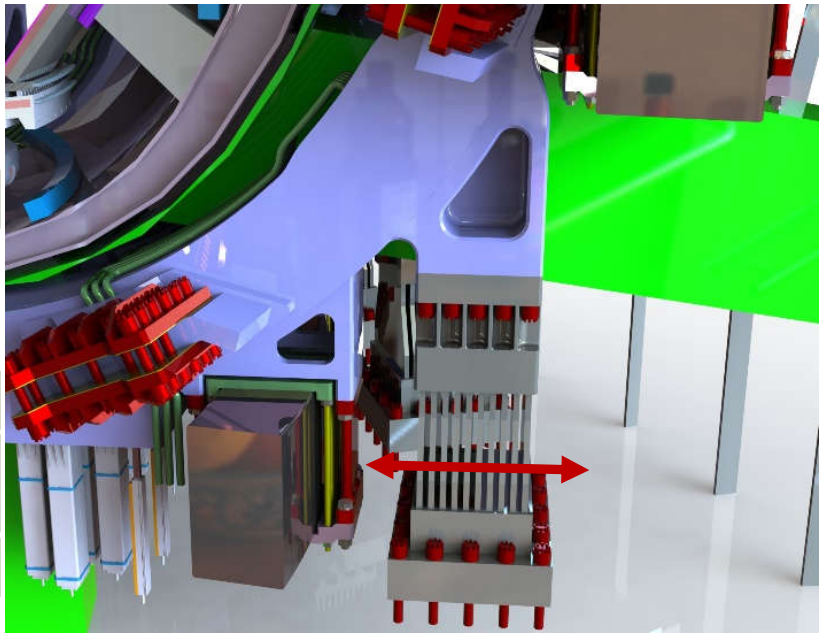

DTT Magnet System – TF coils structures

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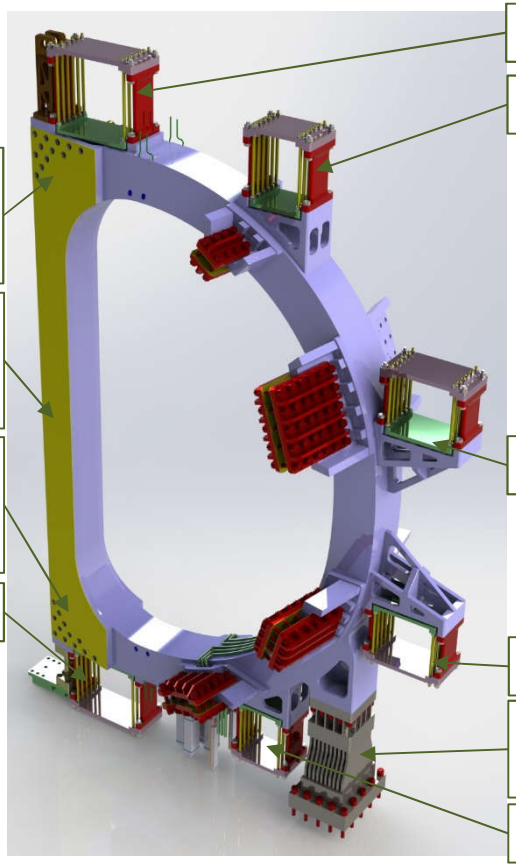
Inner Upper Intercoil structures

Inner leg intercoil structure

Inner Lower intercoil structures

PF6 support



PF1 support

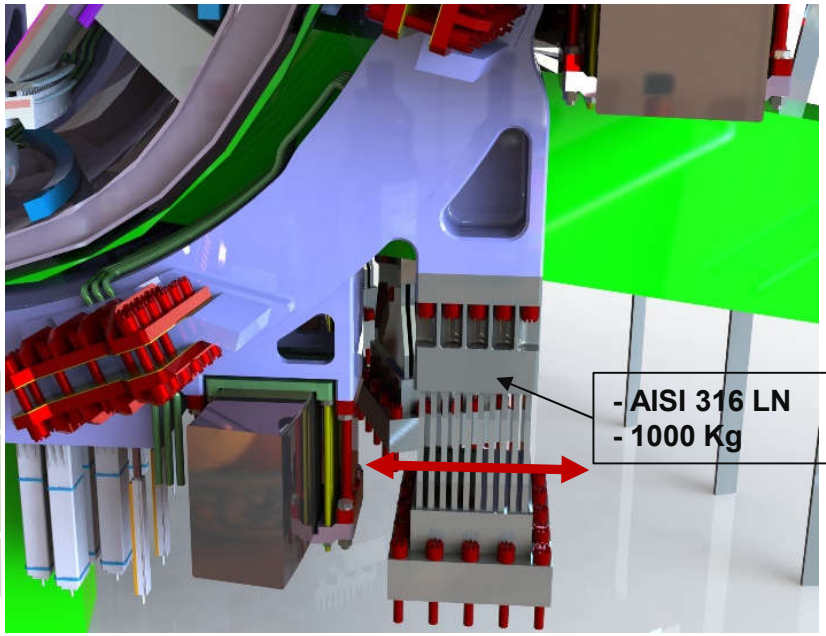
PF2 support

PF3 support

PF4 support

Gravity support

PF5 support



- AISI 316 LN
- 1000 Kg

DTT Magnet System – TF coils structures

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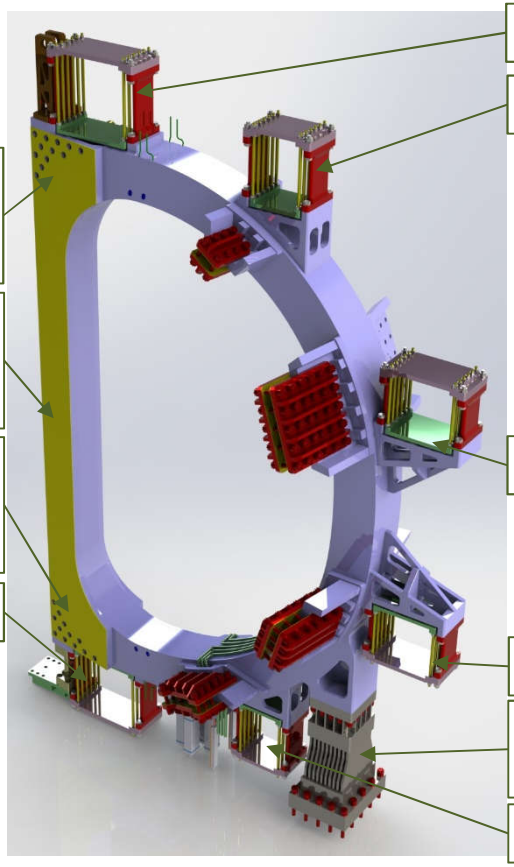
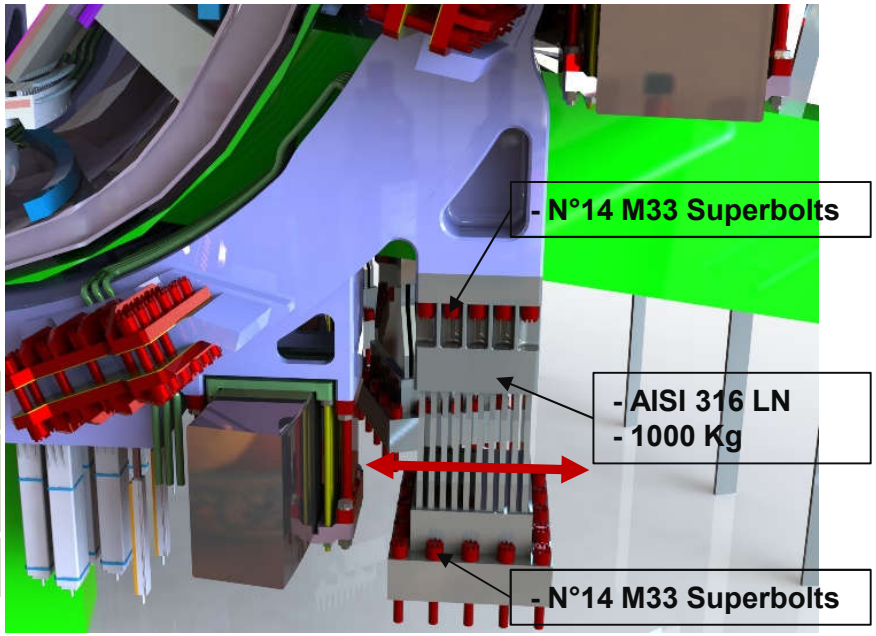


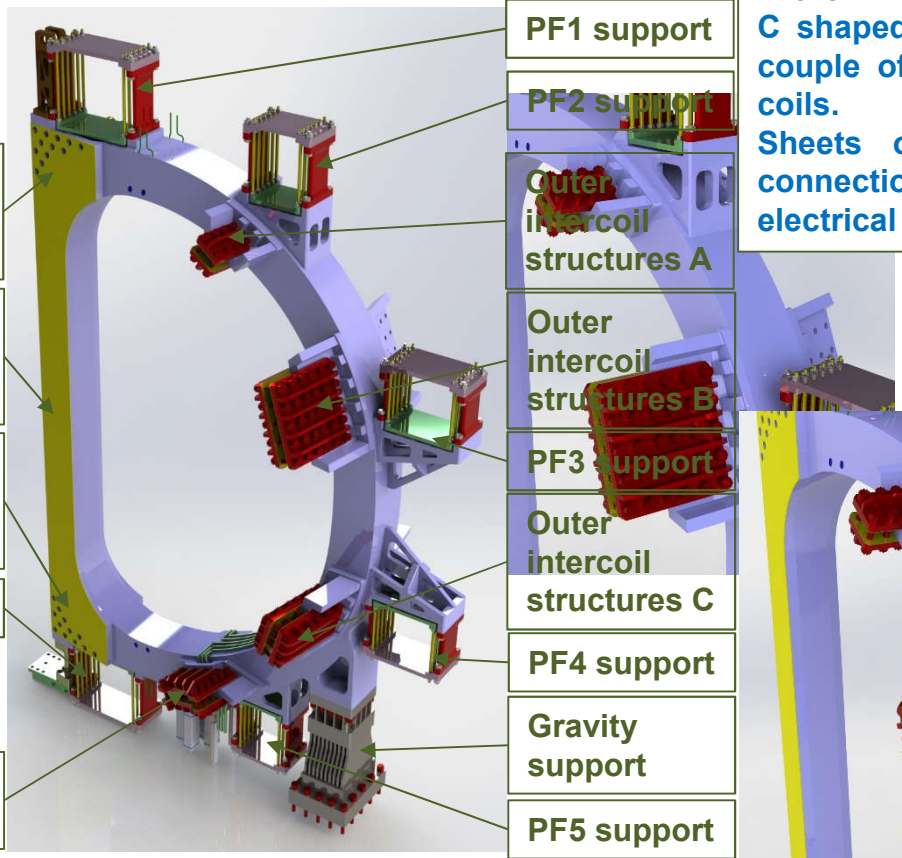


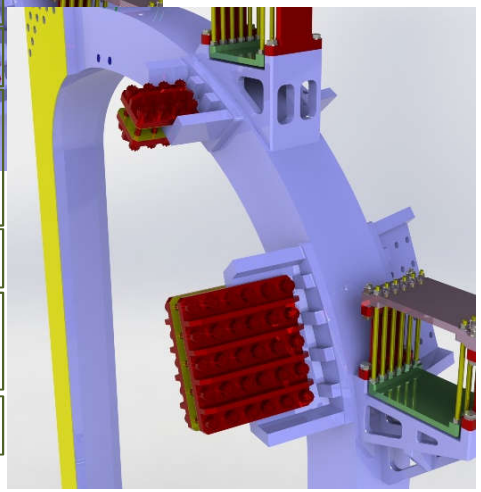
DTT Magnet System – TF coils structures

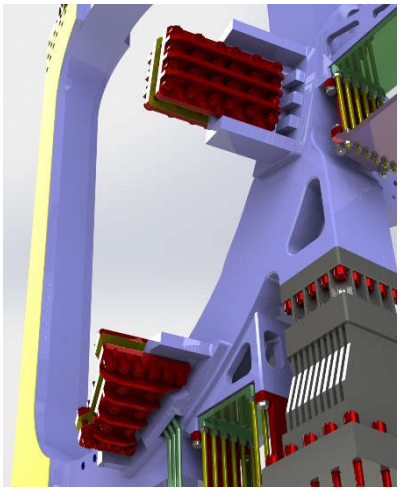
- Increase the toroidal and torsional stiffness of the TF coils
- Reduce the in-plane and out of plane deflection of the TF coils

C shaped structure is welded on the TF coil and a couple of plates with ribs connect two adiacent TF coils.

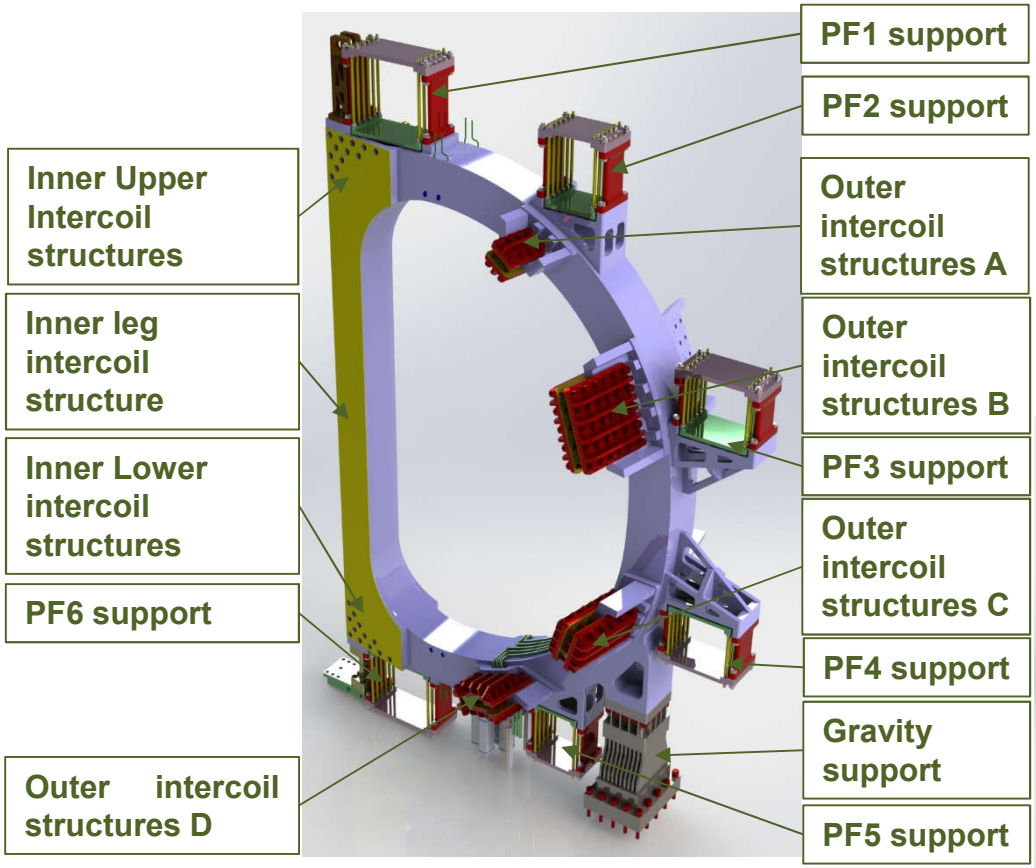
Sheets of G10 (3mm) are placed between the connection plates and the TF in order to maintain the electrical insulation.

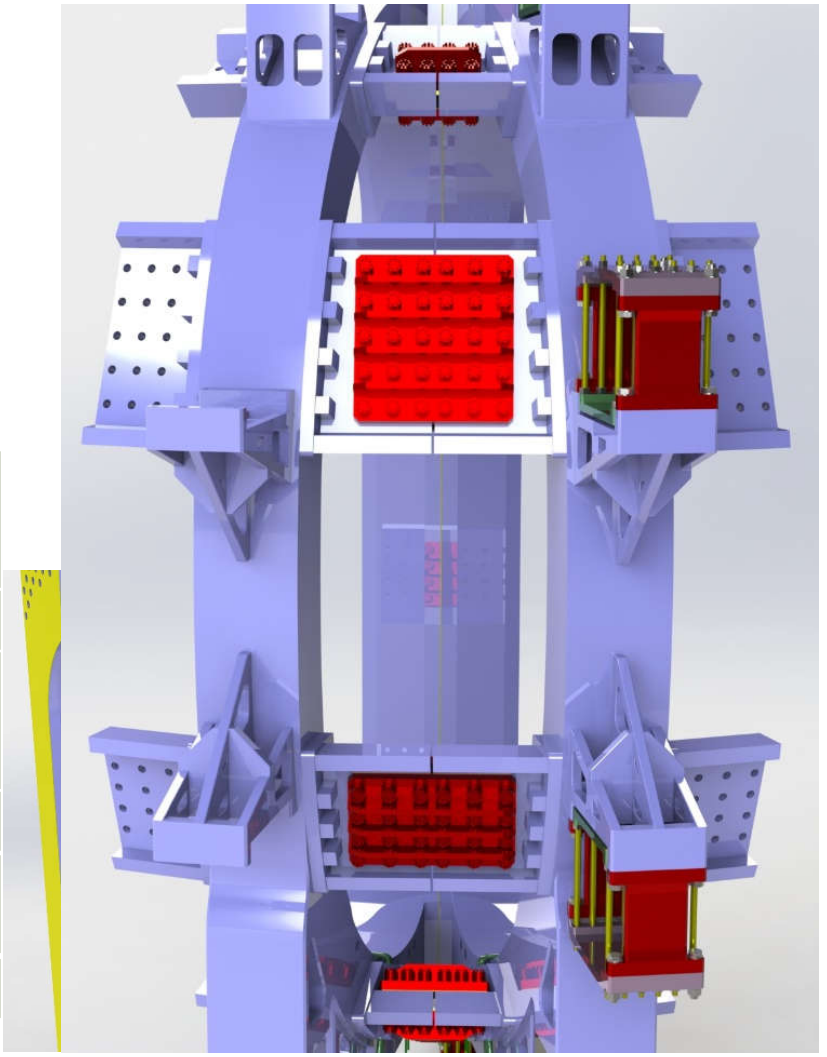






DTT Magnet System – TF coils structures





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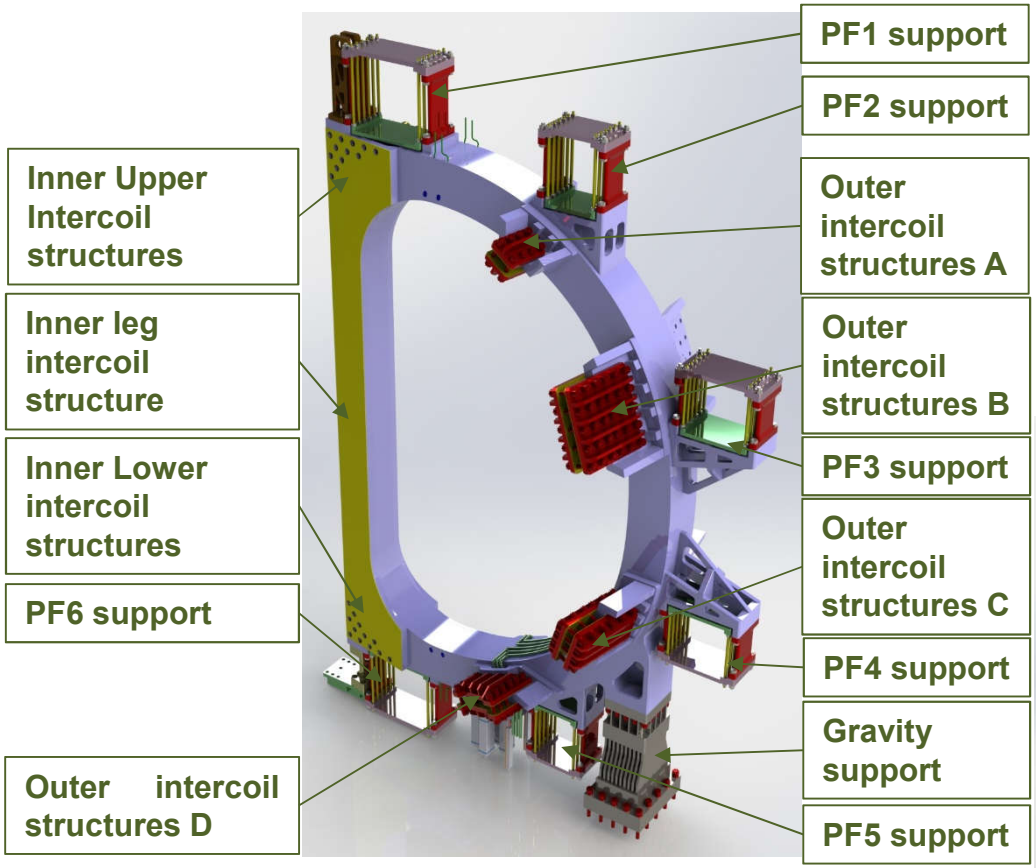
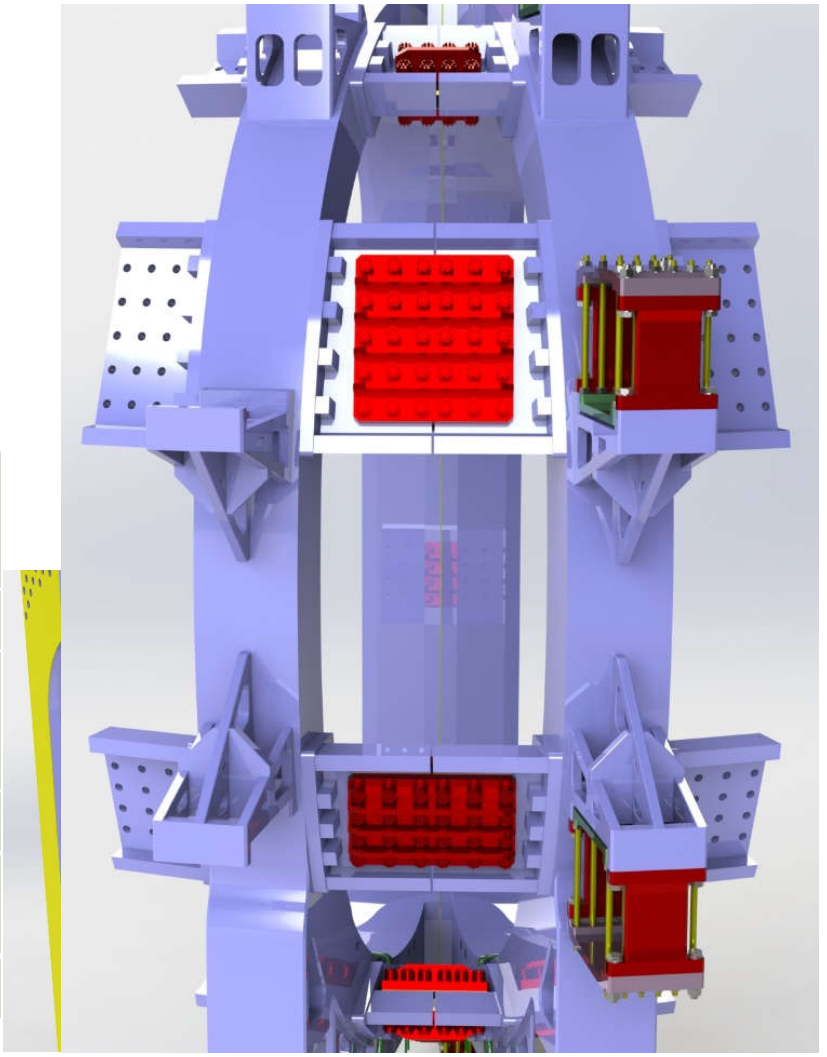
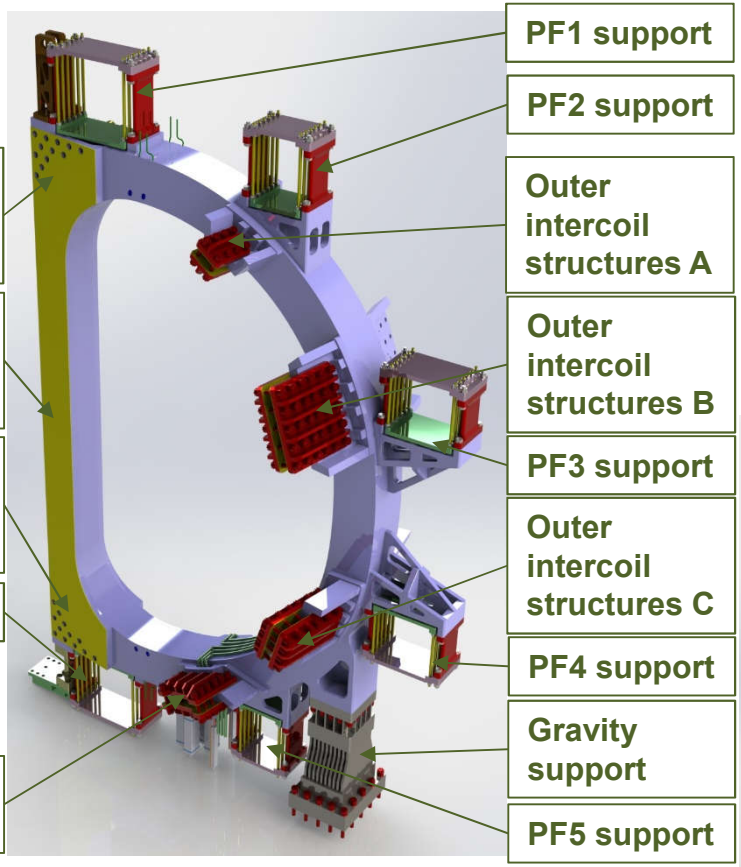
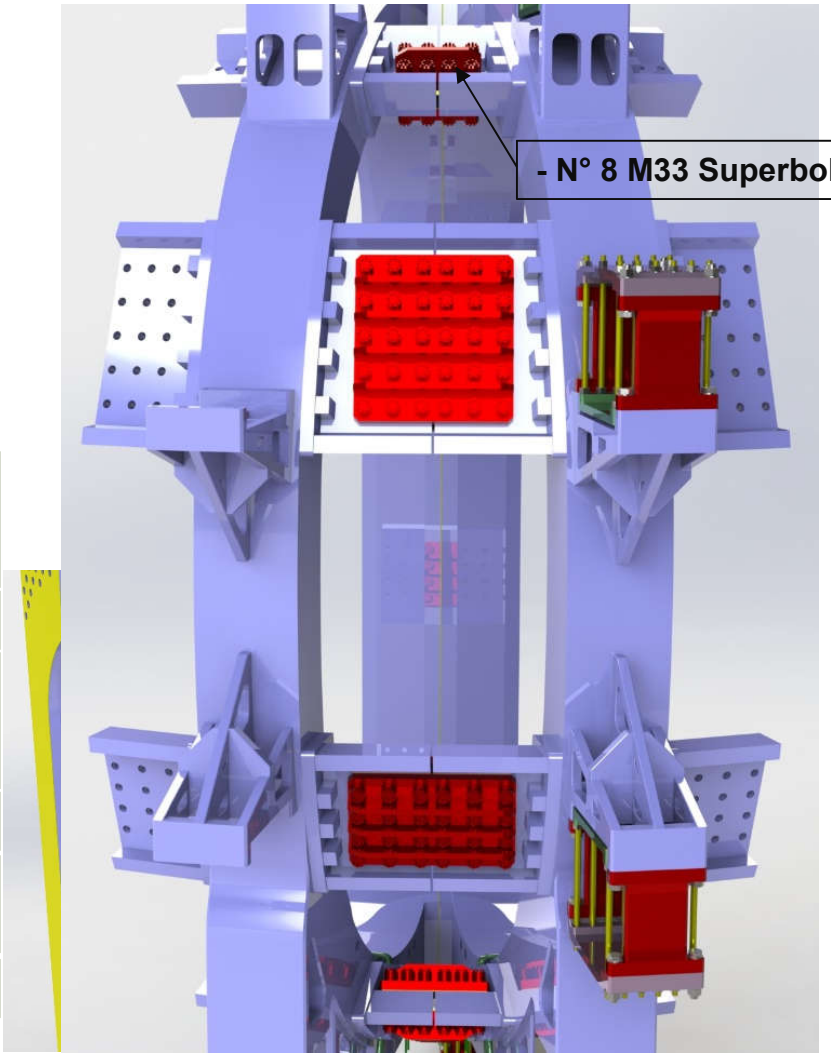




DTT Magnet System – TF coils structures





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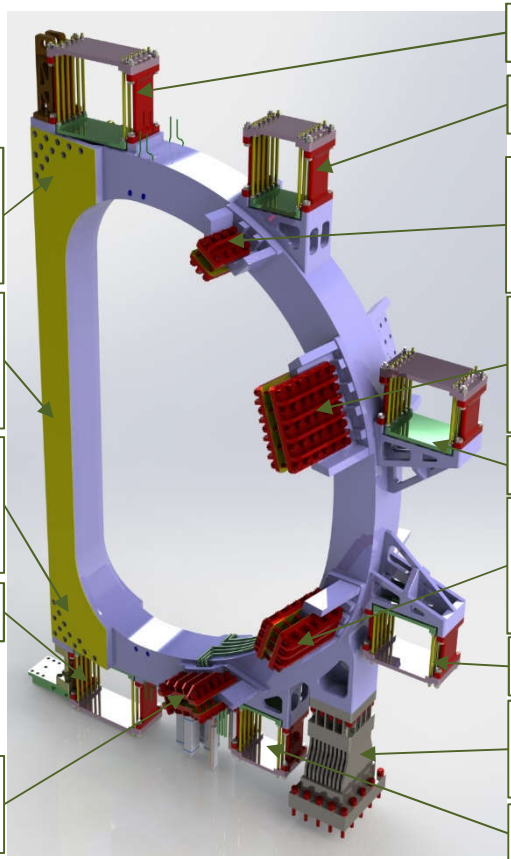


Inner Upper Intercoil structures

Inner leg intercoil structure

Inner Lower intercoil structures

PF6 support

Outer intercoil structures D

PF1 support

PF2 support

Outer intercoil structures A

Outer intercoil structures B

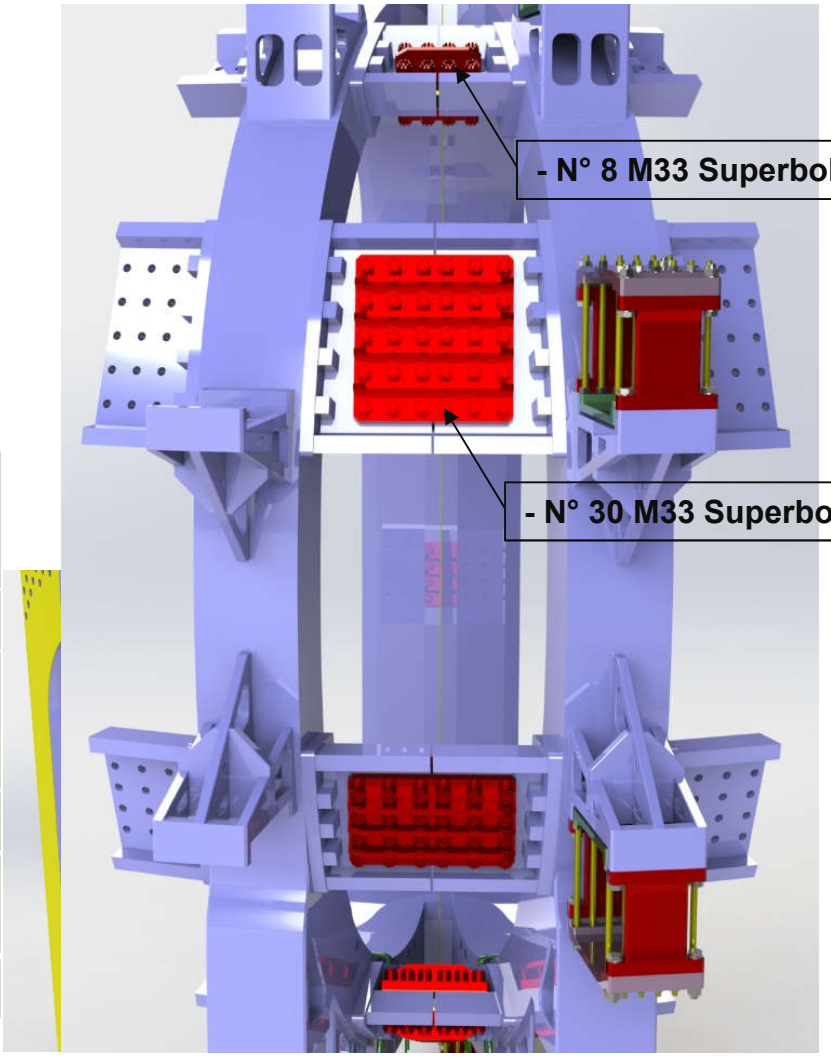
PF3 support

Outer intercoil structures C

PF4 support

Gravity support

PF5 support



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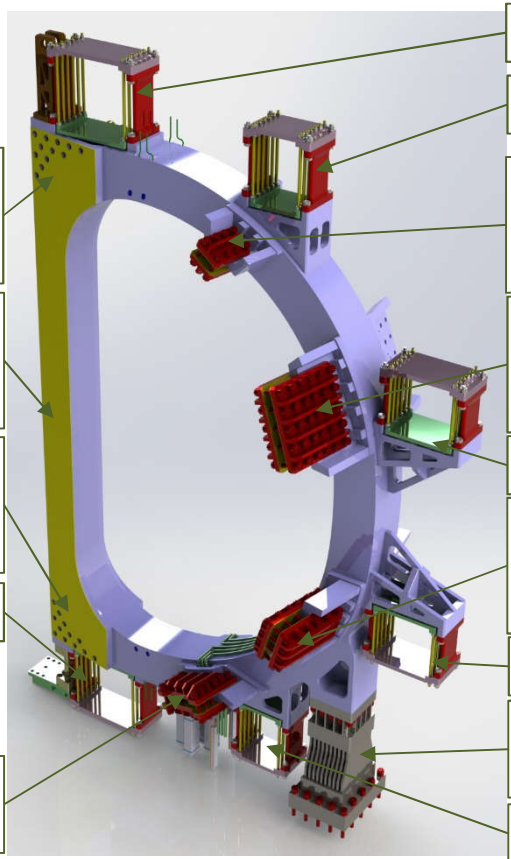

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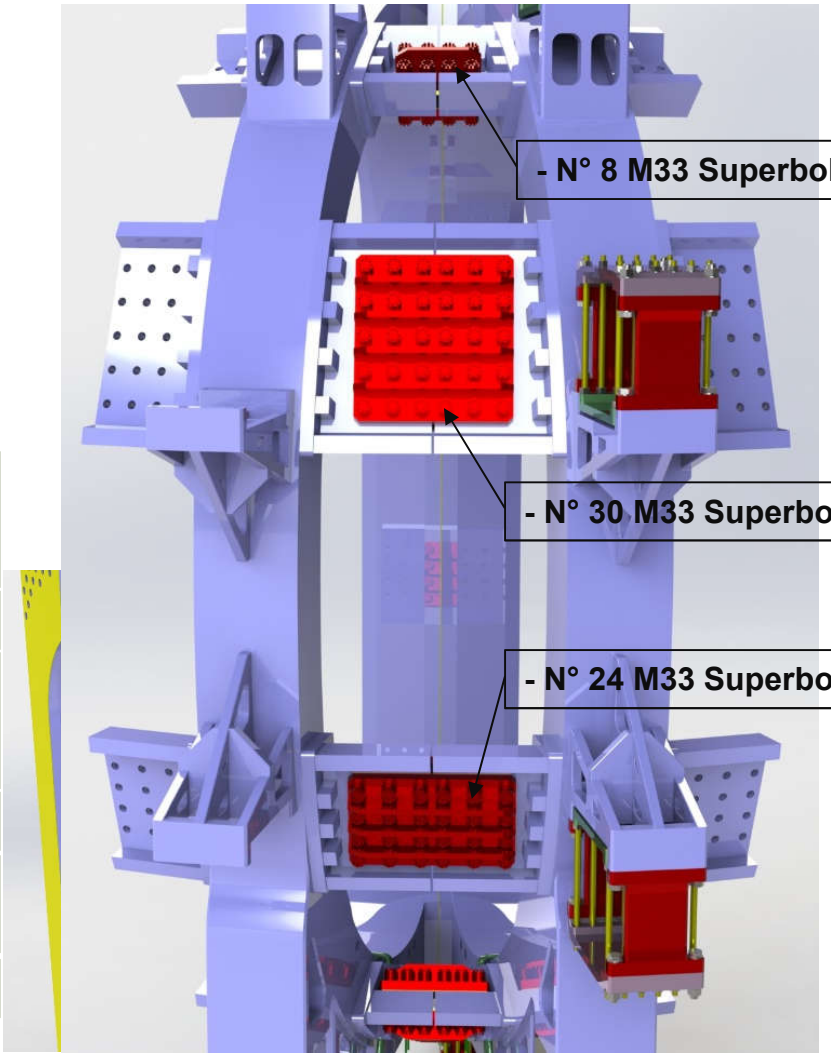

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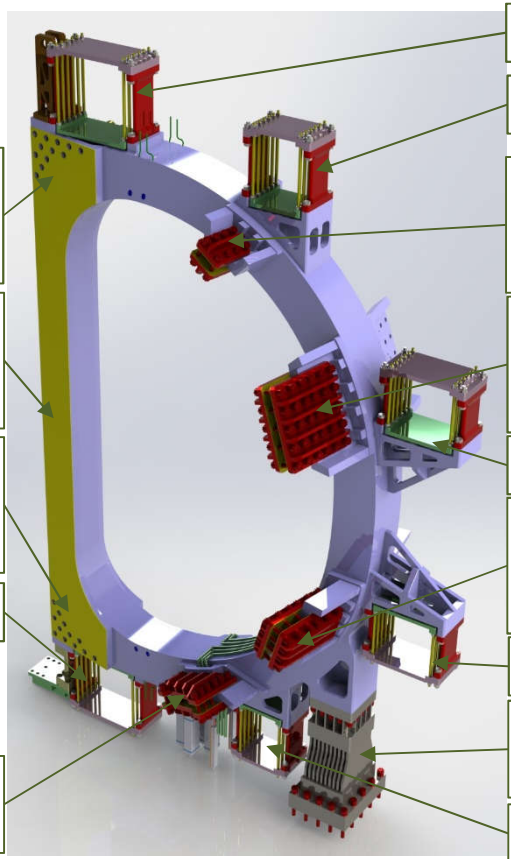

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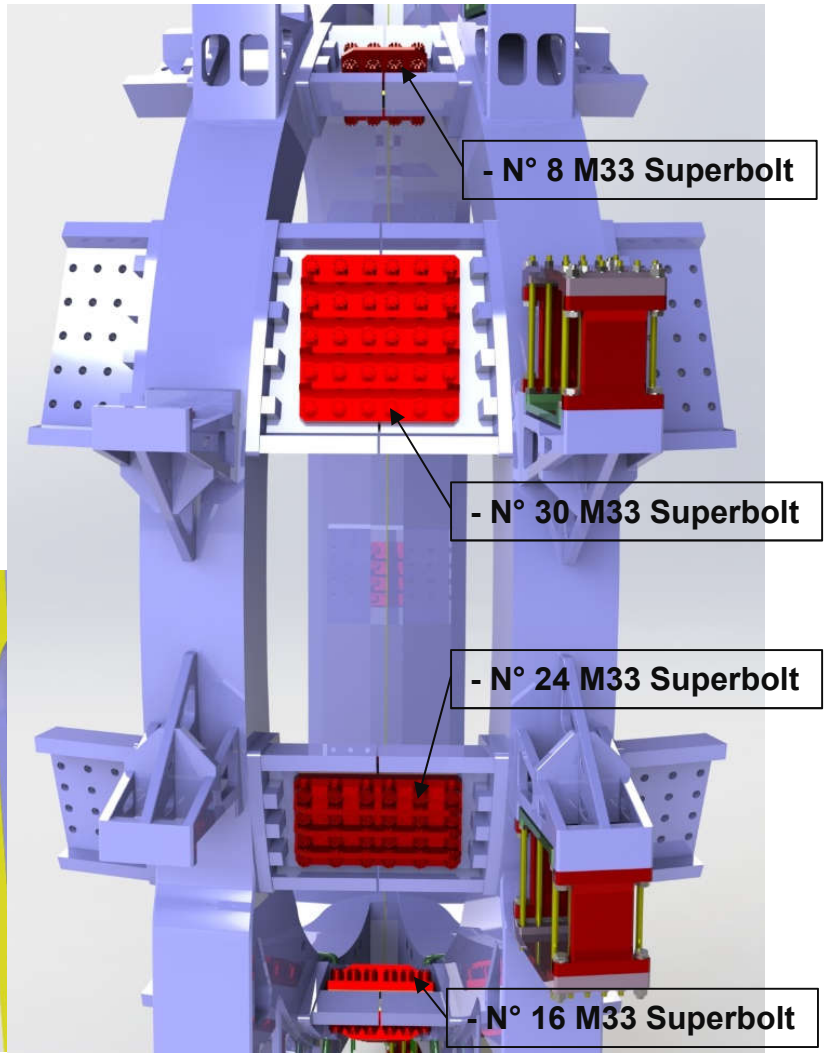

- N° 8 M33 Superbolt

- N° 30 M33 Superbolt

- N° 24 M33 Superbolt

- N° 16 M33 Superbolt

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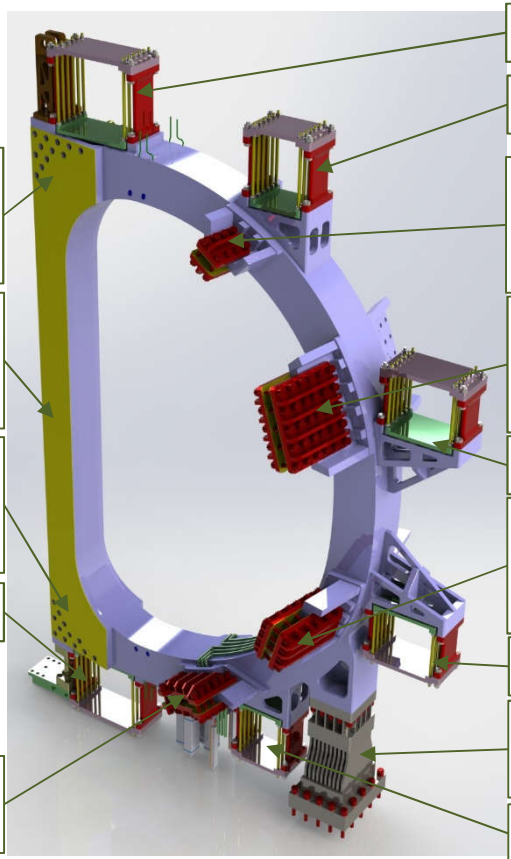

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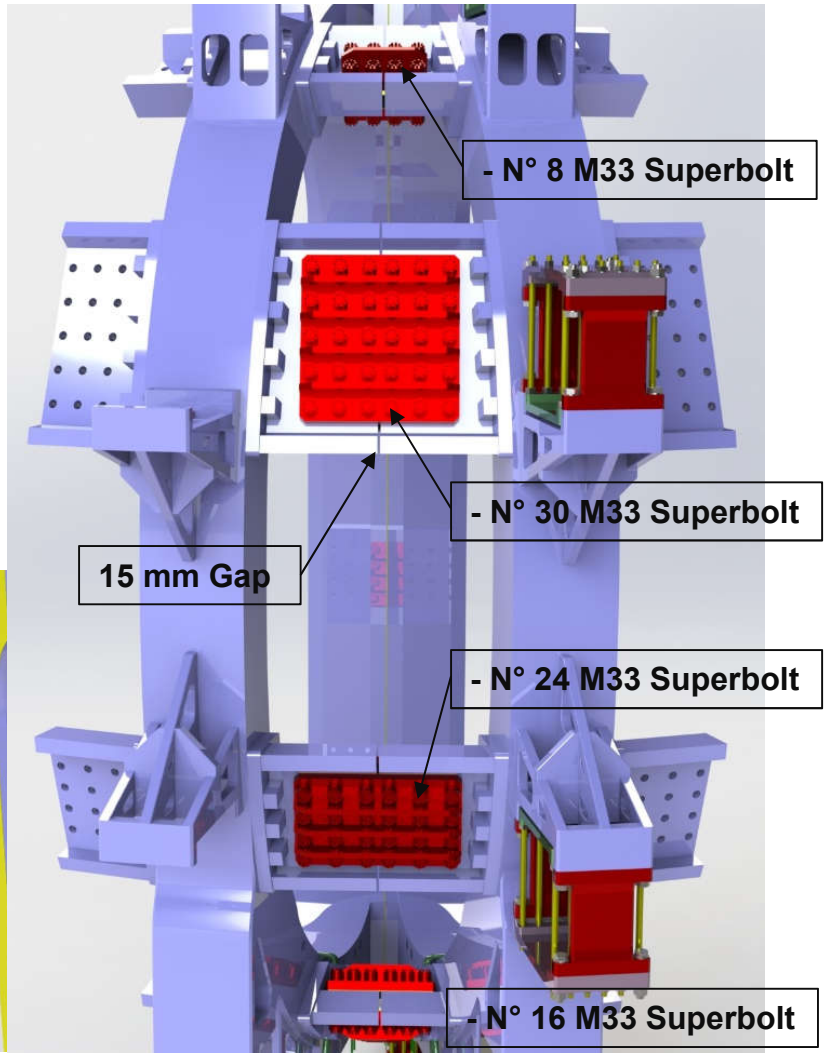

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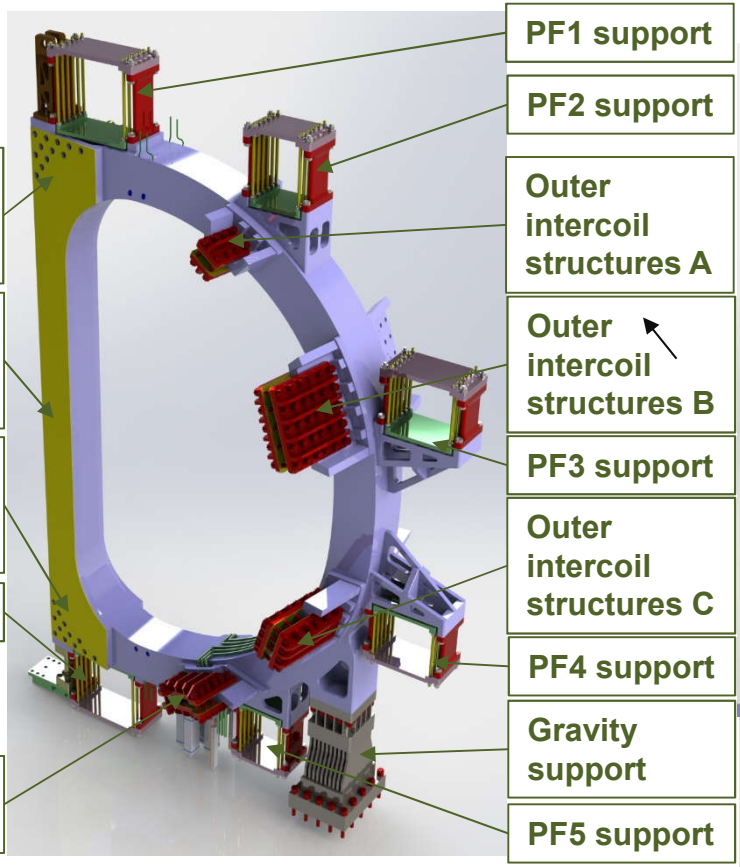

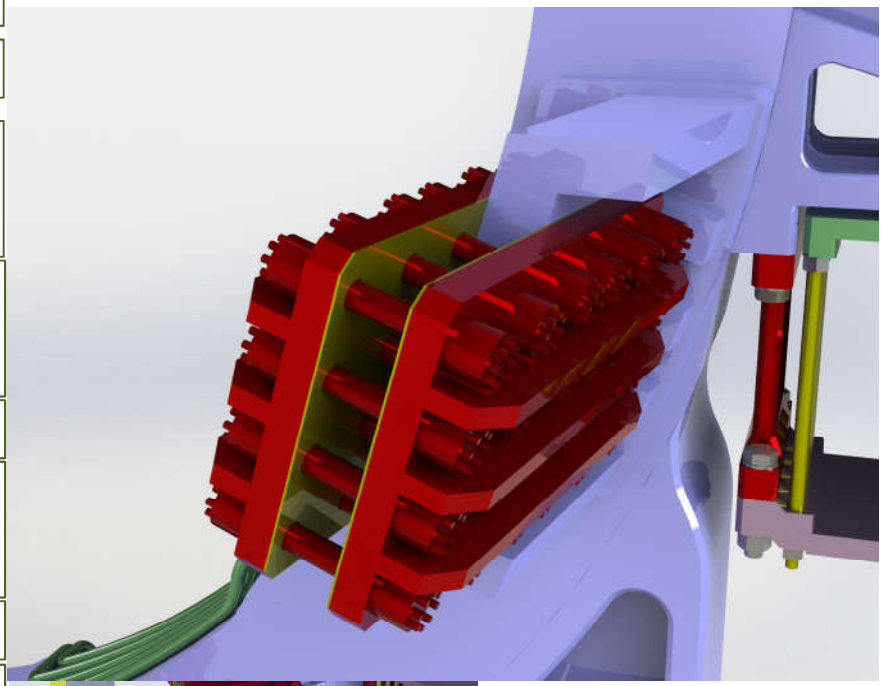

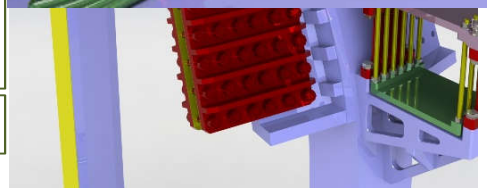

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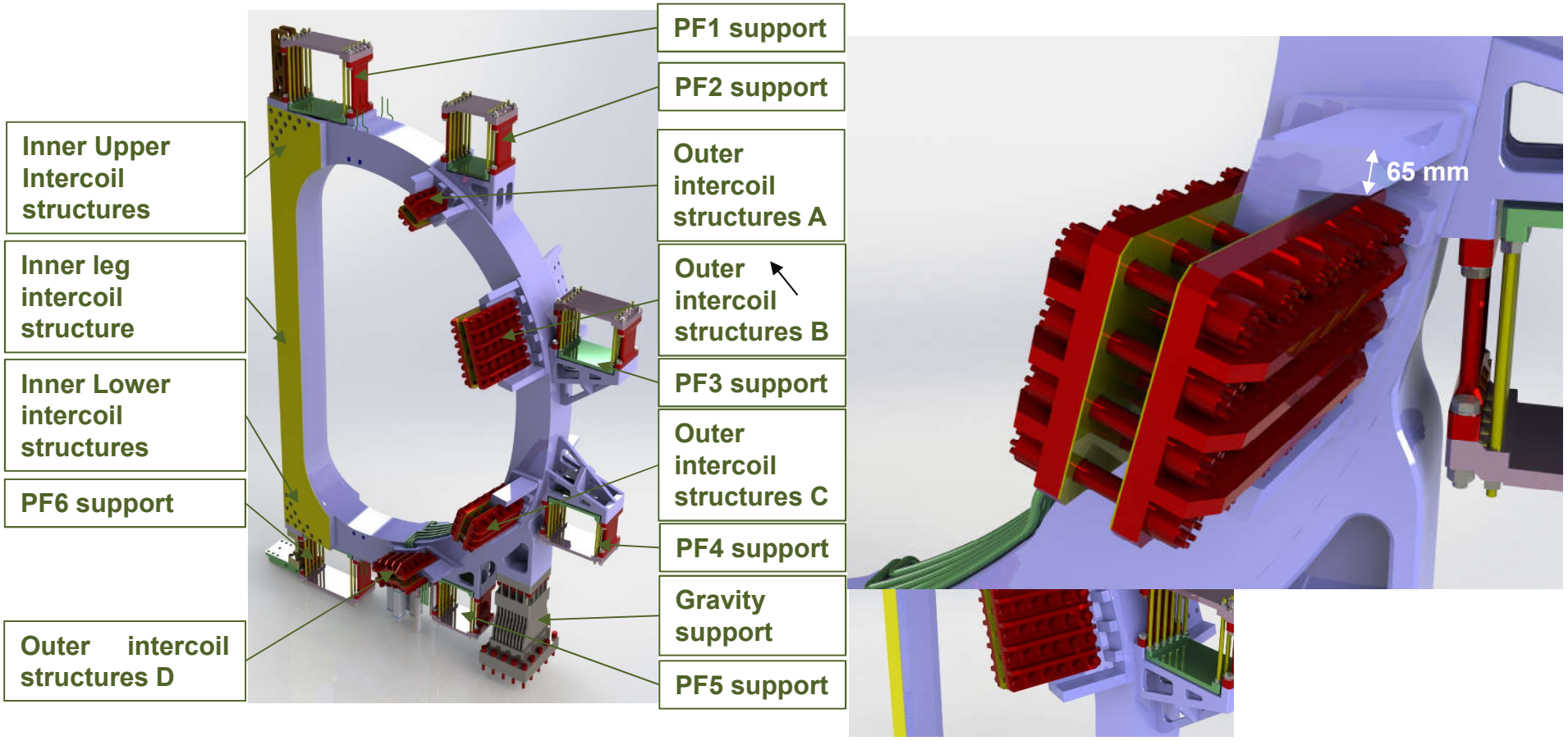

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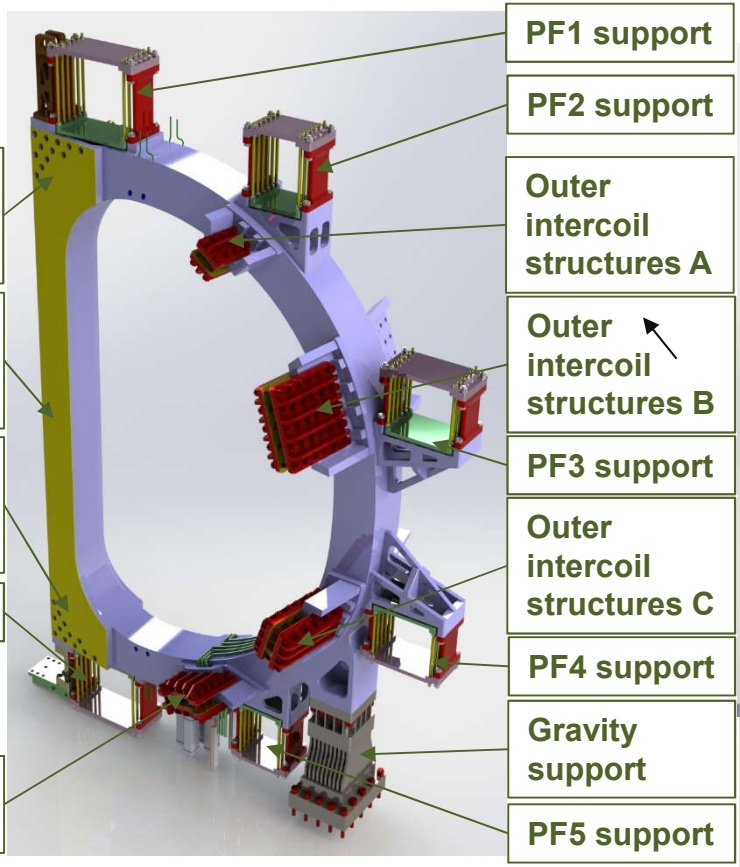

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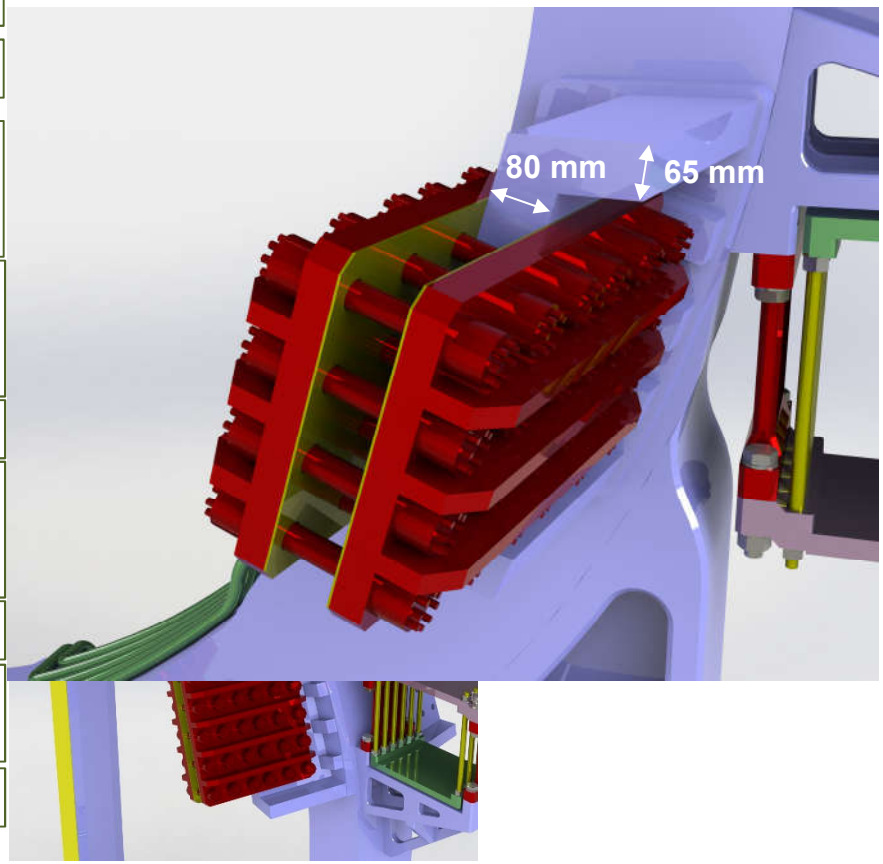

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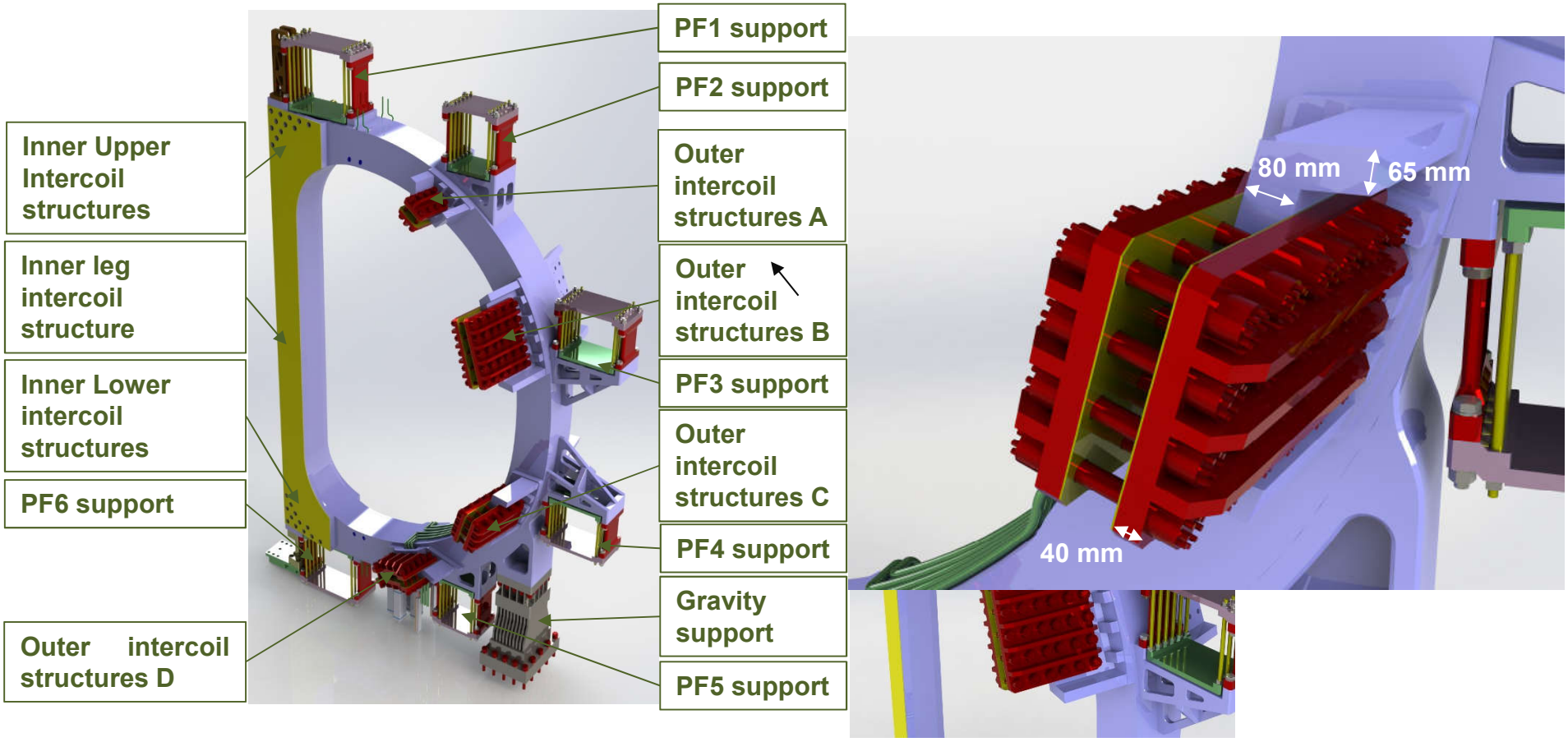

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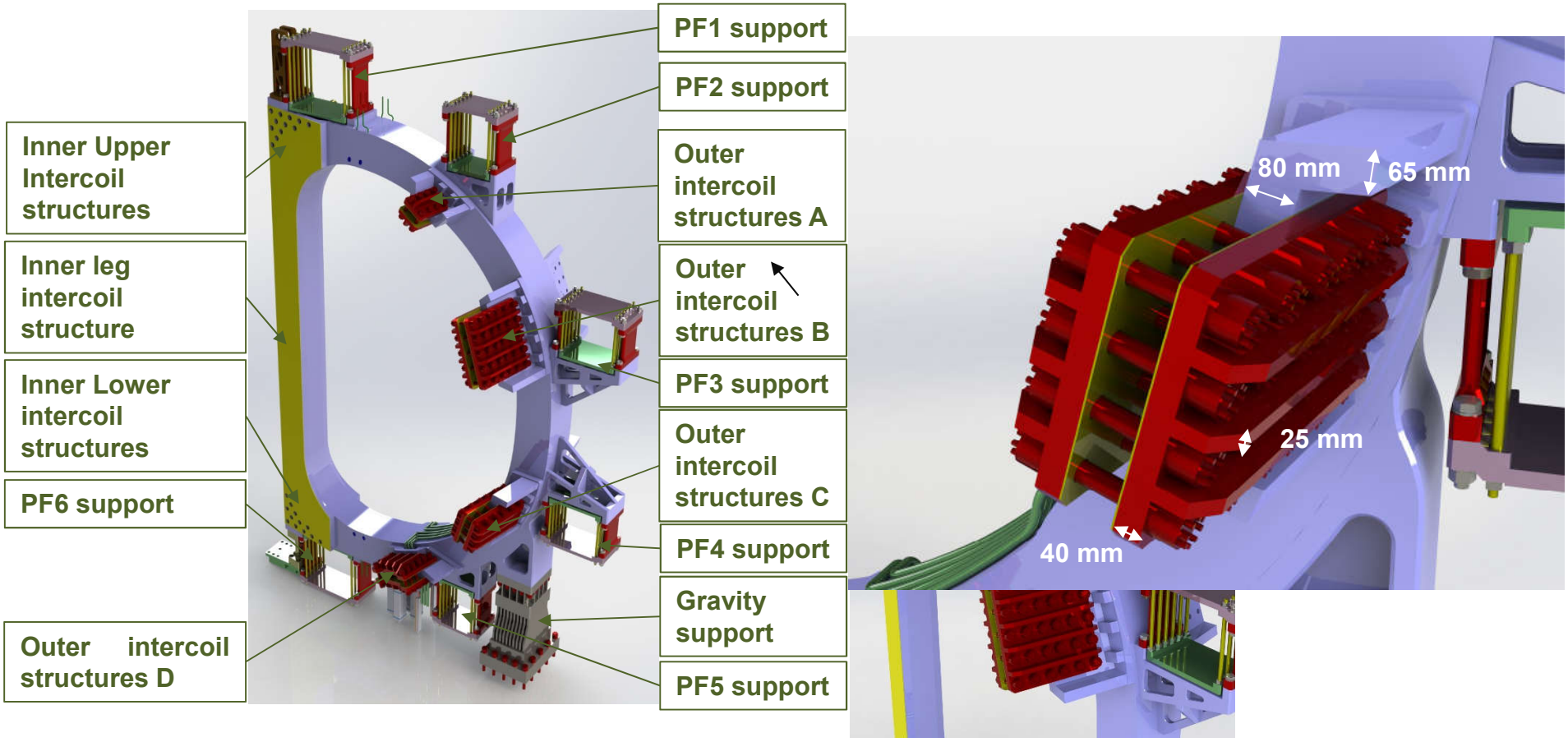

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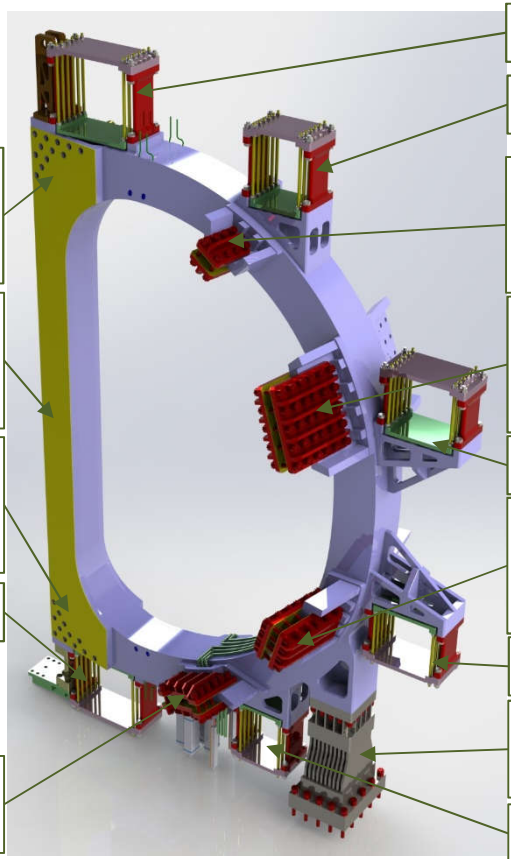

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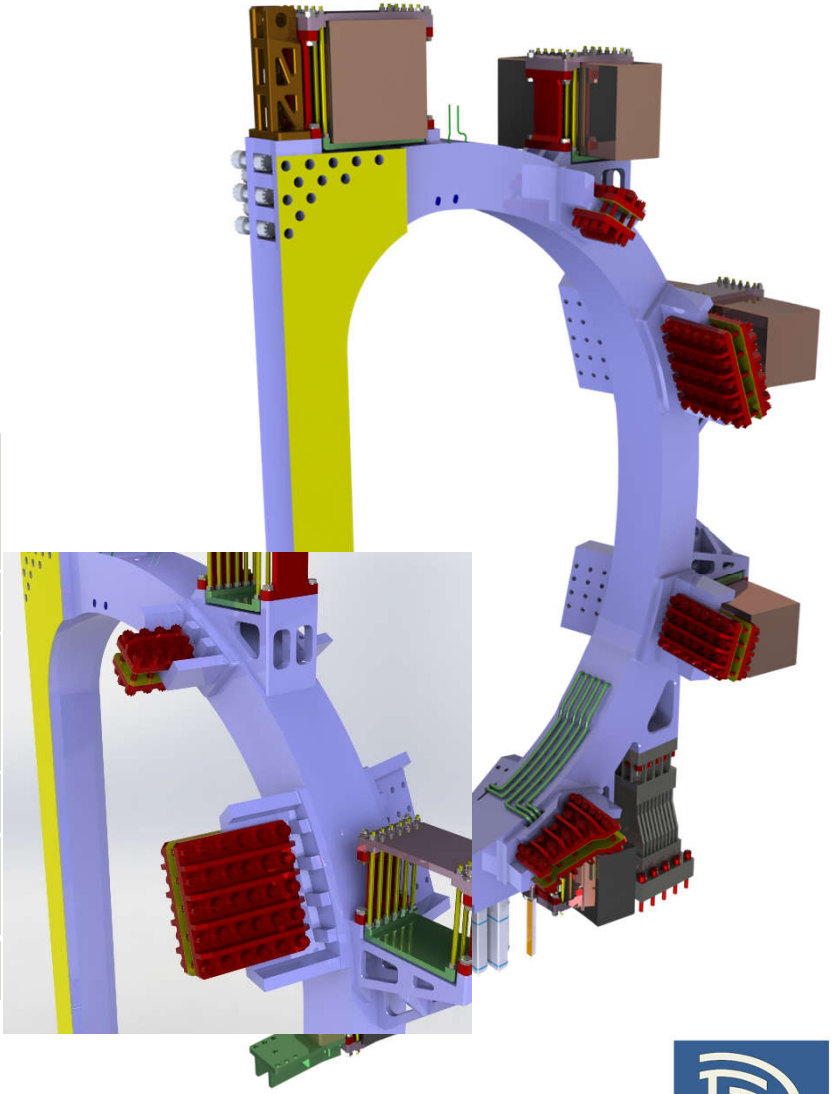

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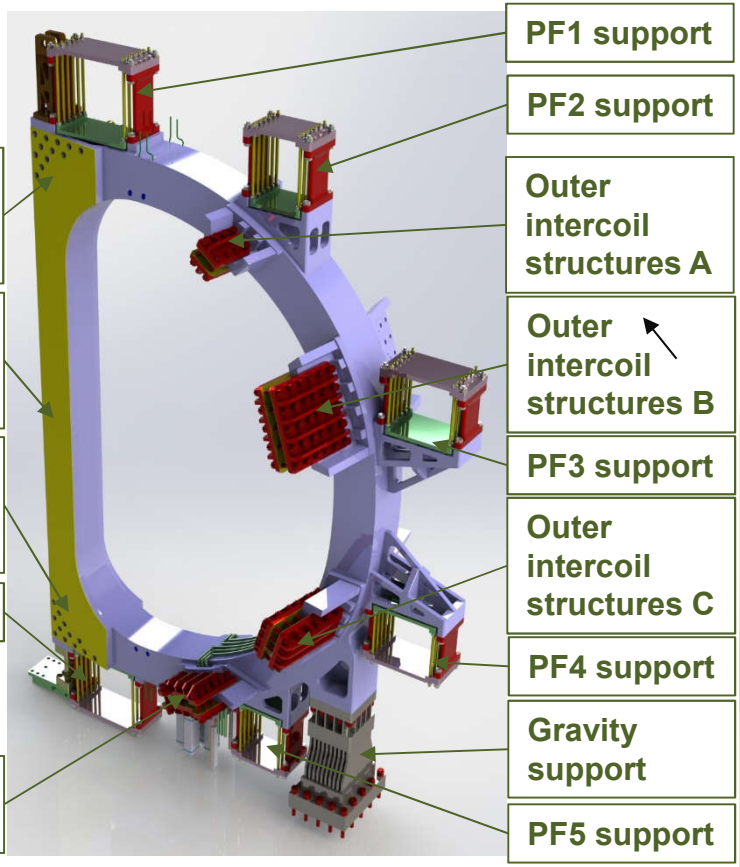

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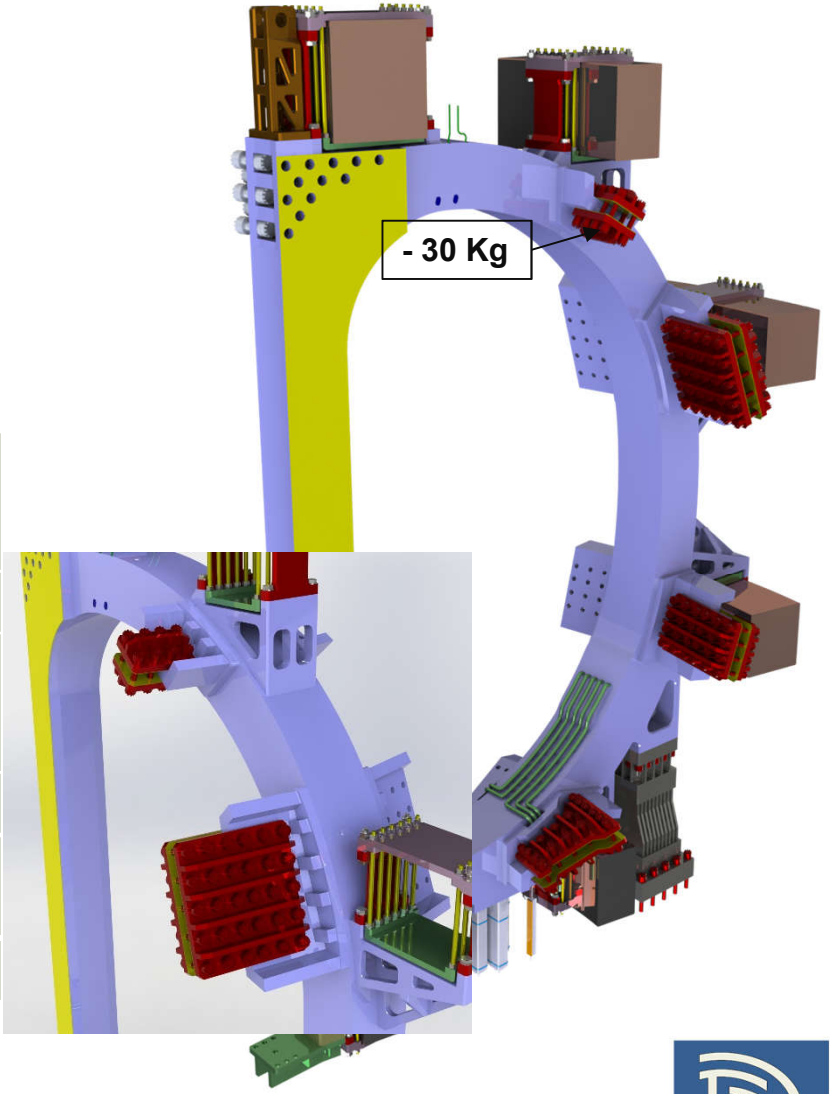

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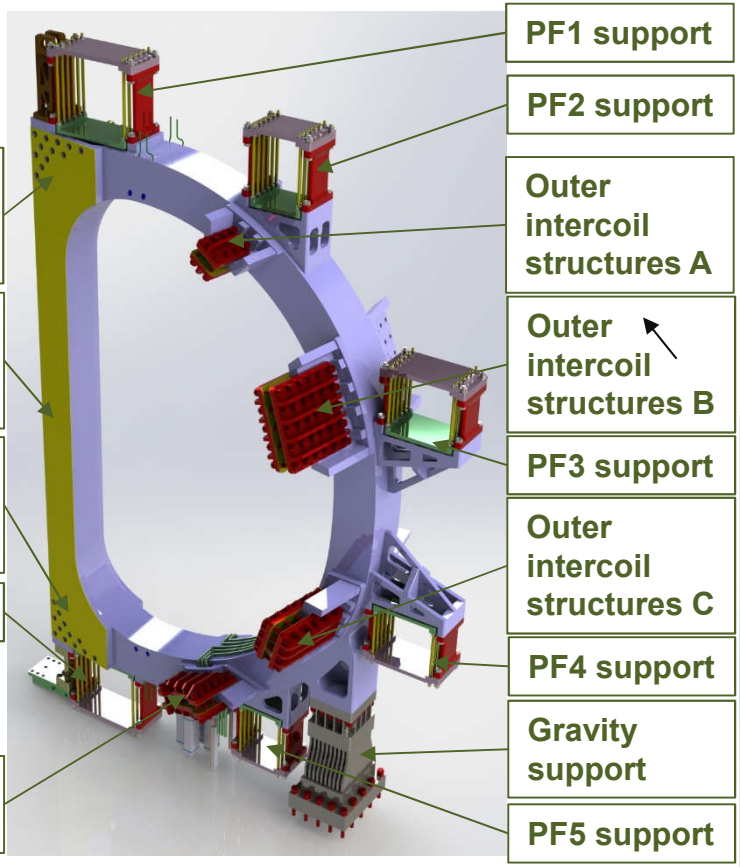

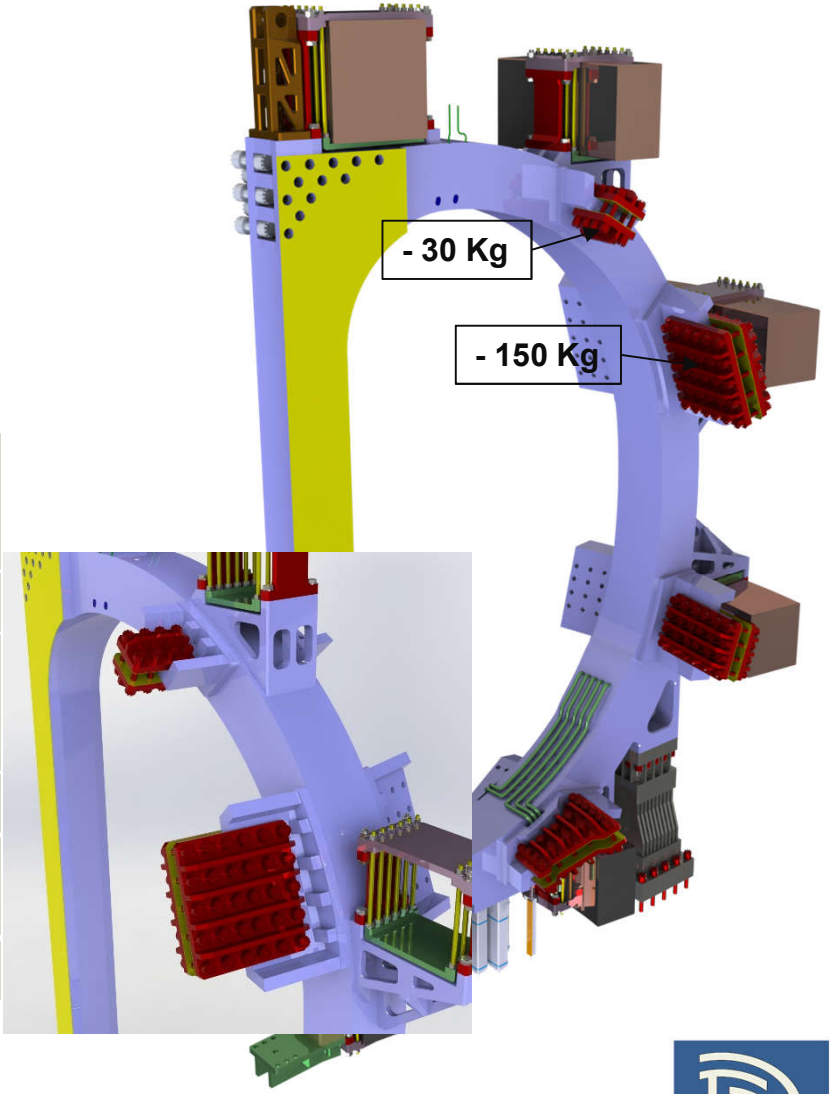

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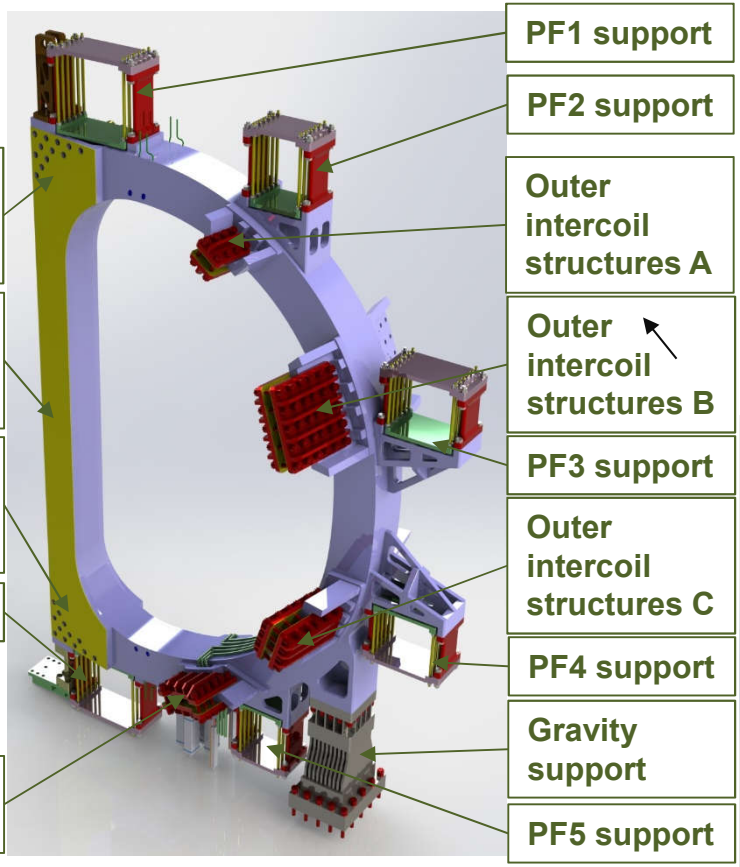

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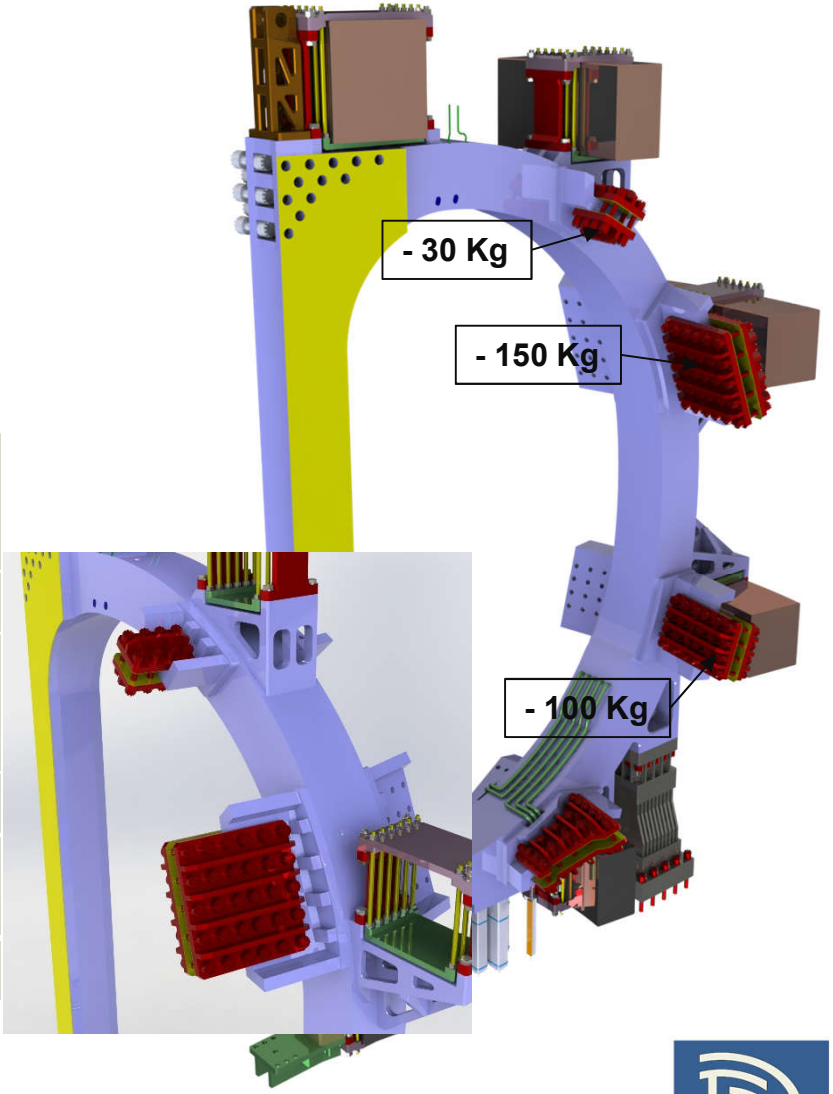

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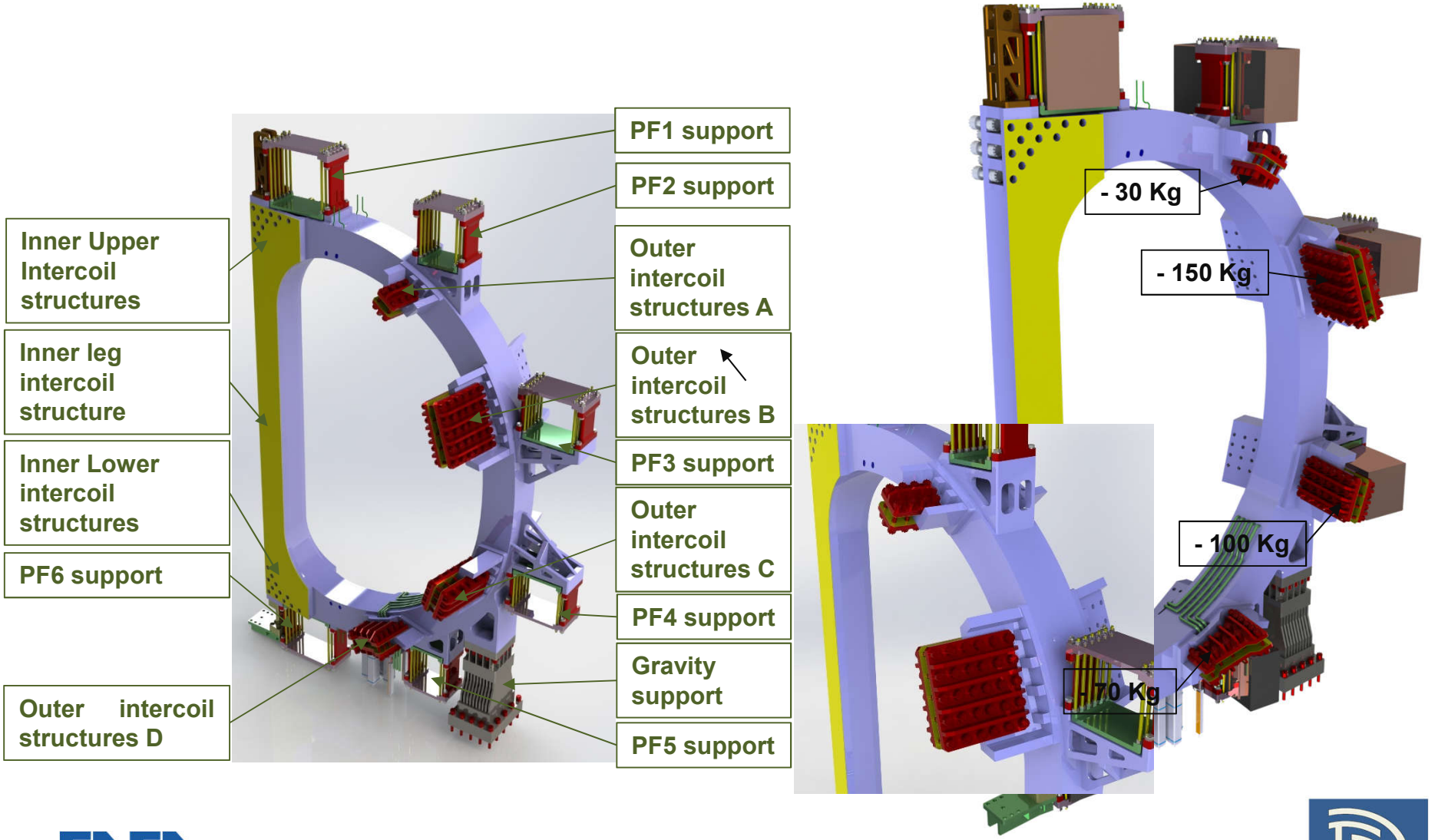

DTT Magnet System – TF coil fabrication

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Laminated or forged blocks of Aisi 316 LN

- **σn=1000 Mpa (T=4,2 K)**
- **Lower range of N content**

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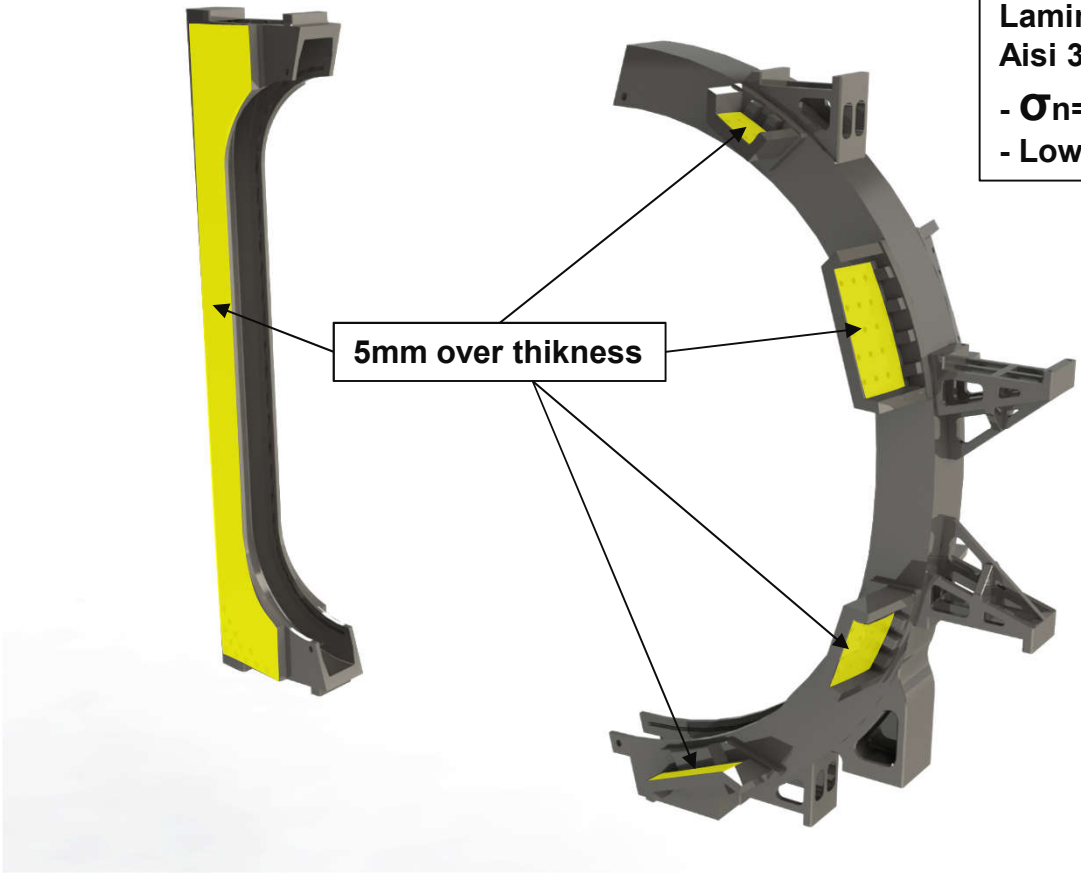

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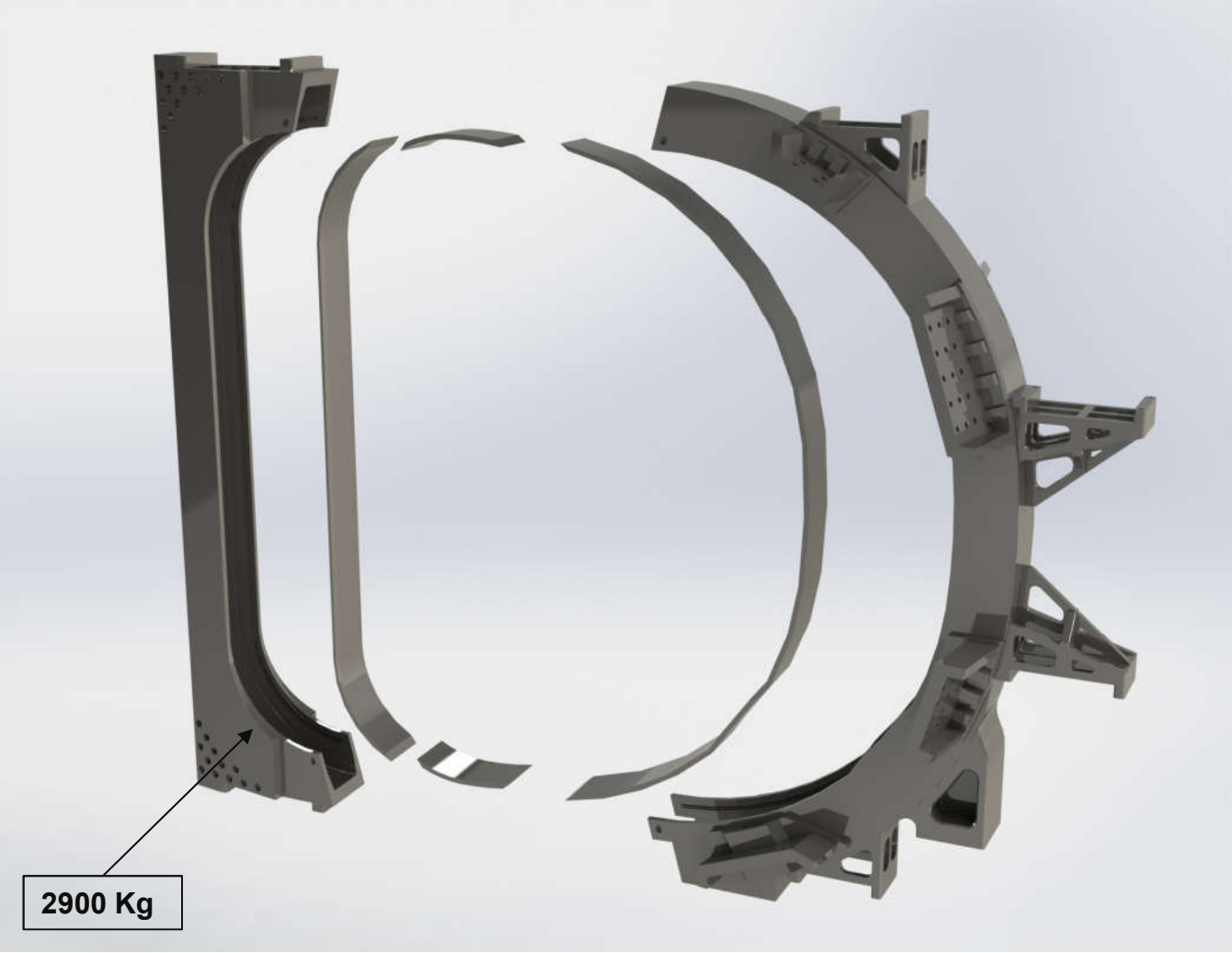

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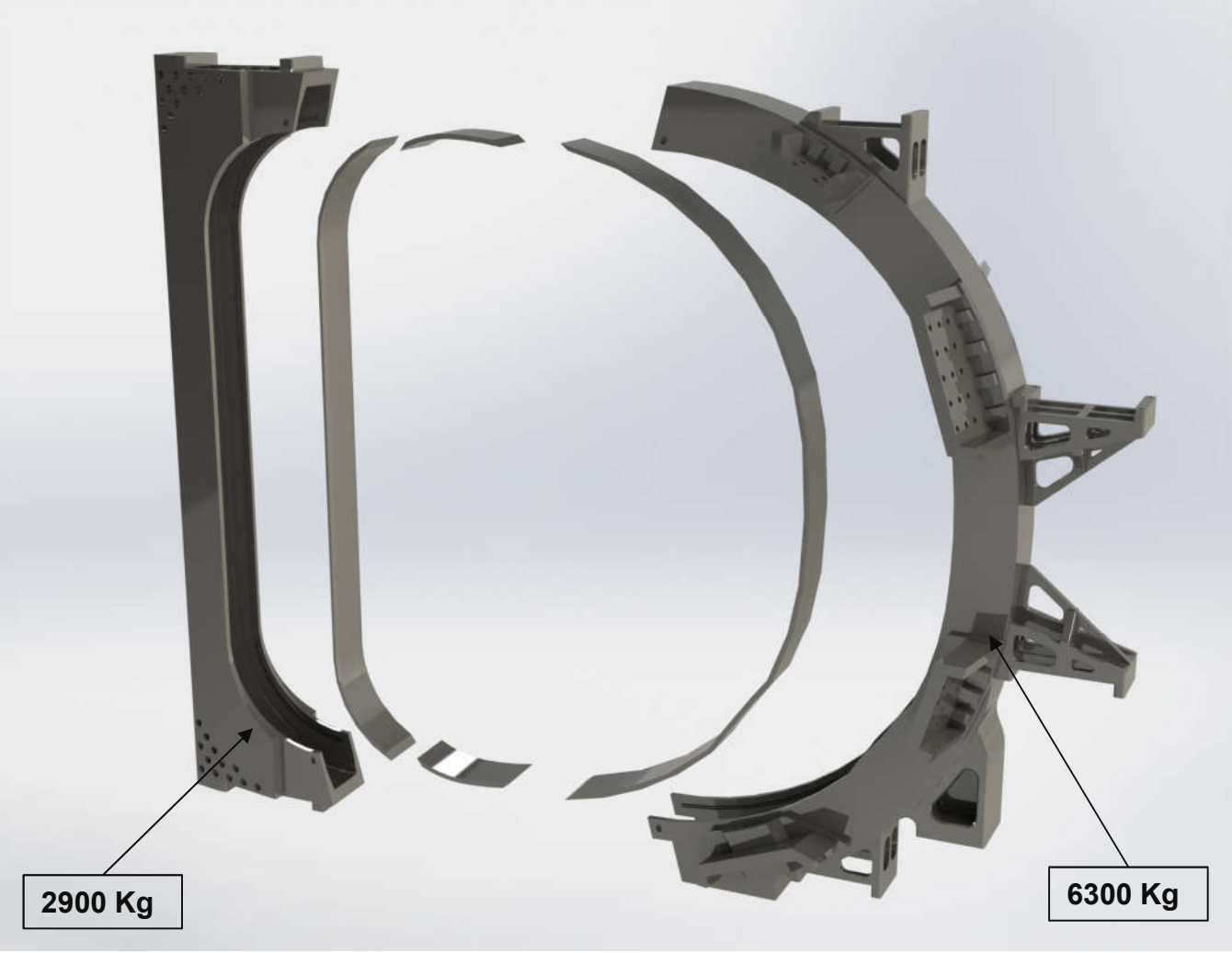

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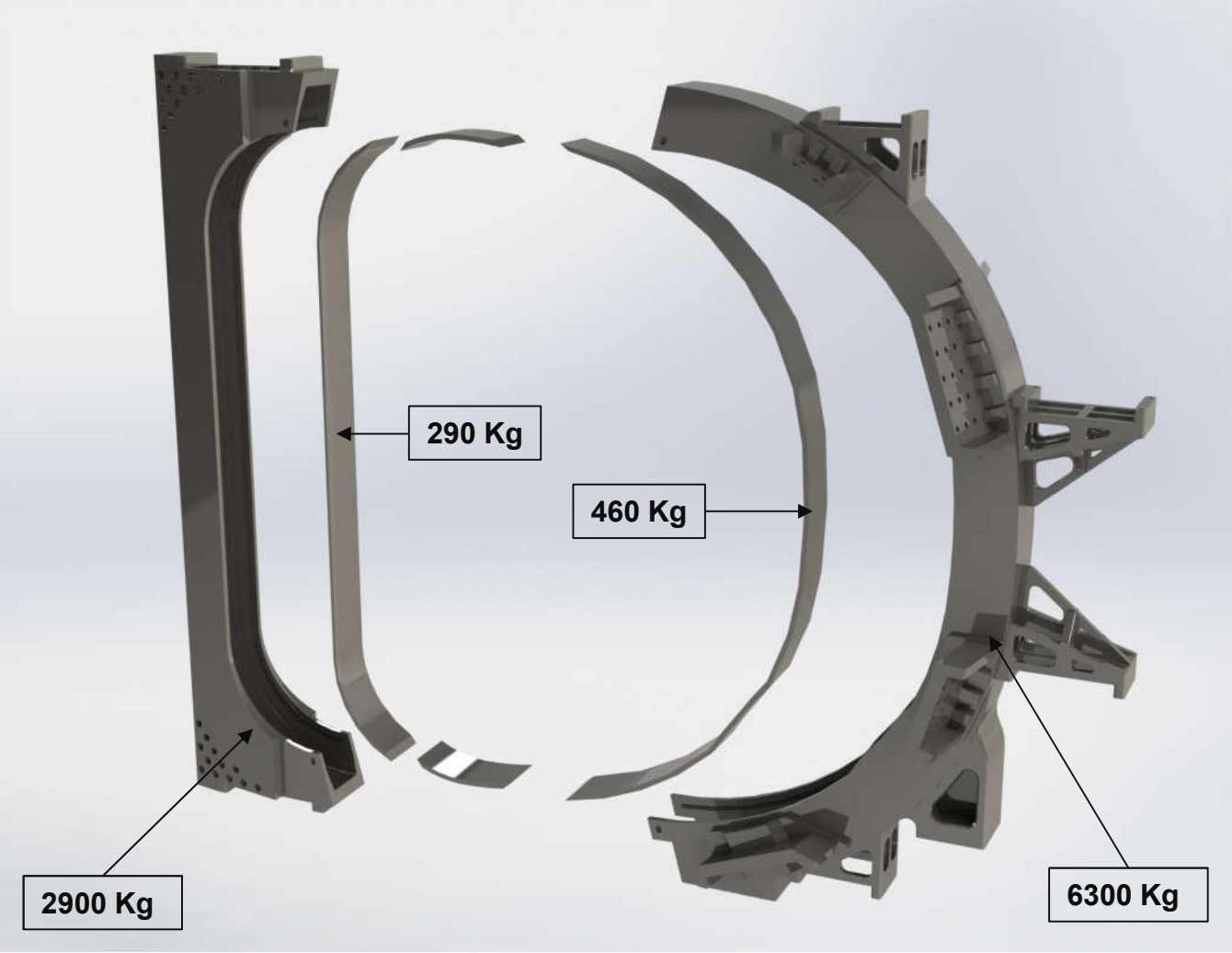

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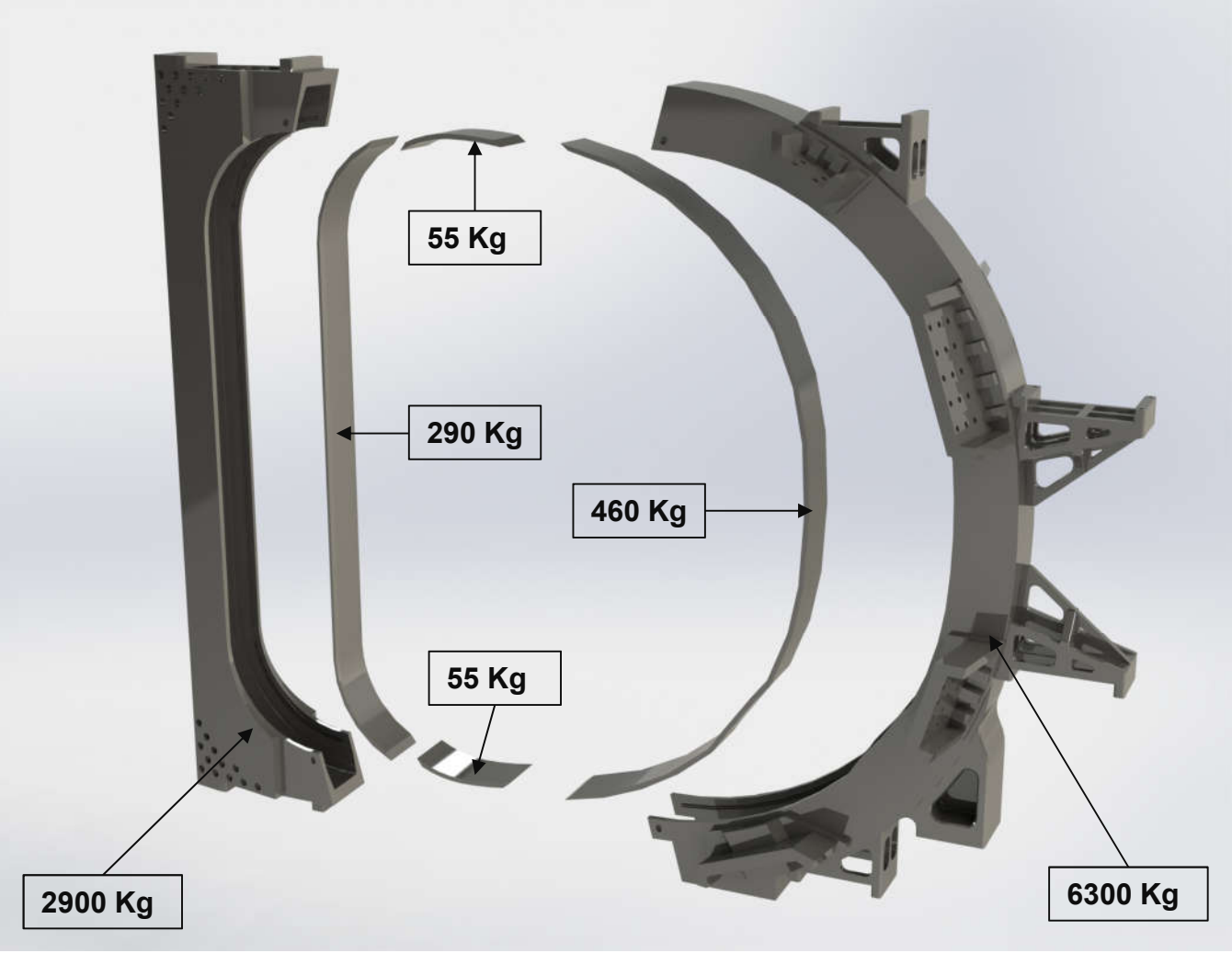

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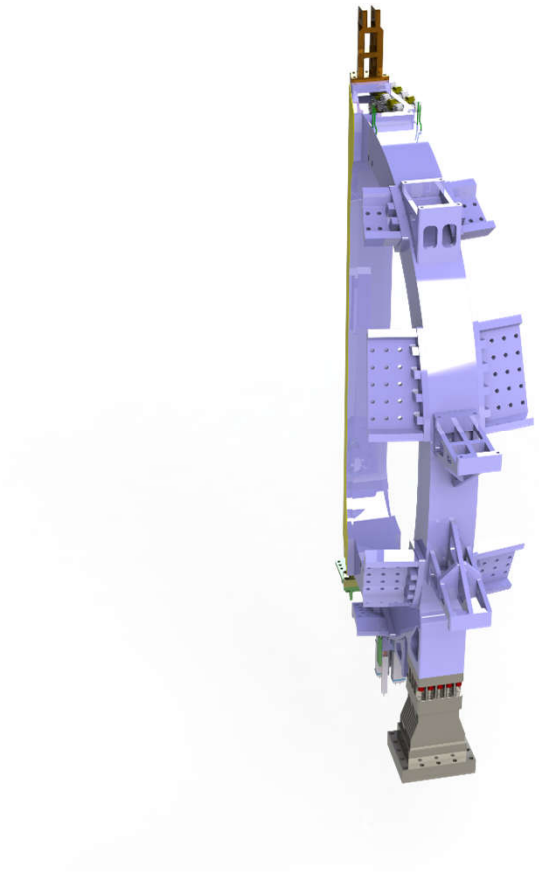

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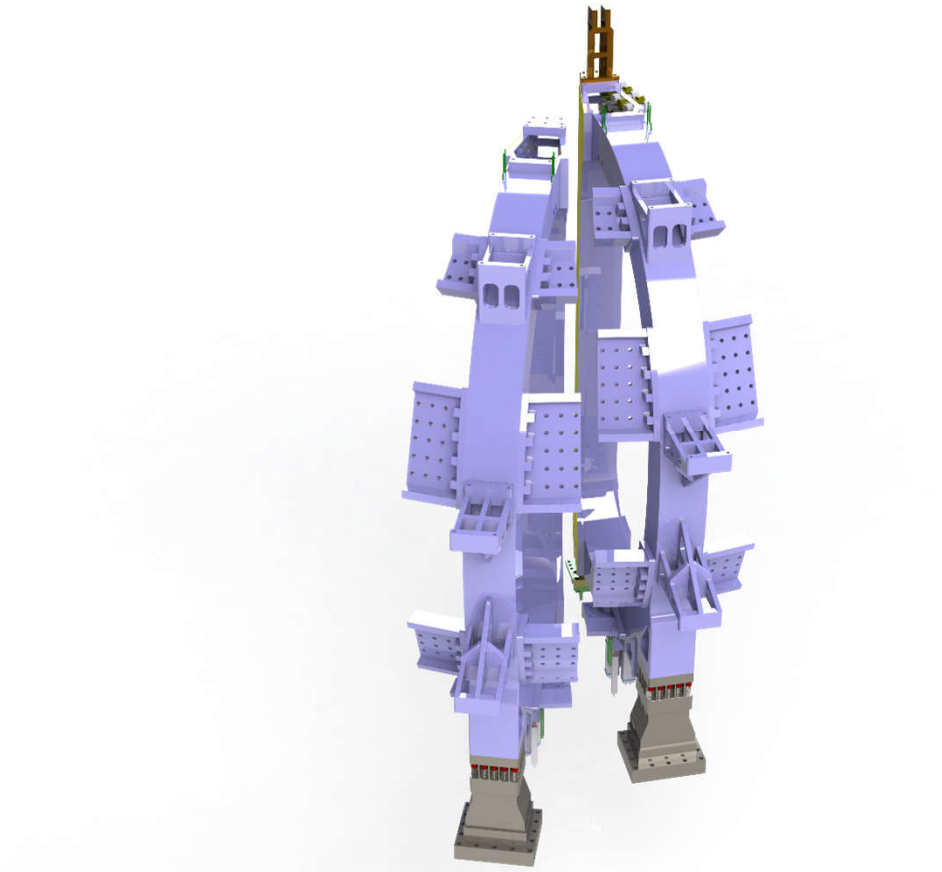

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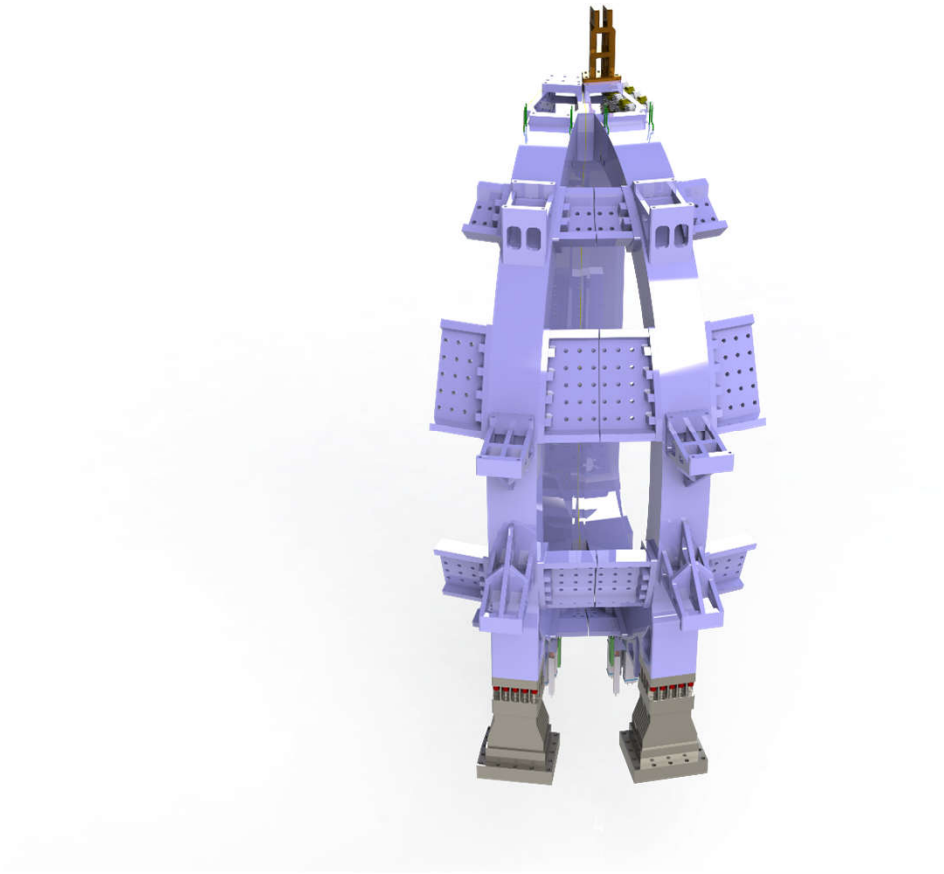

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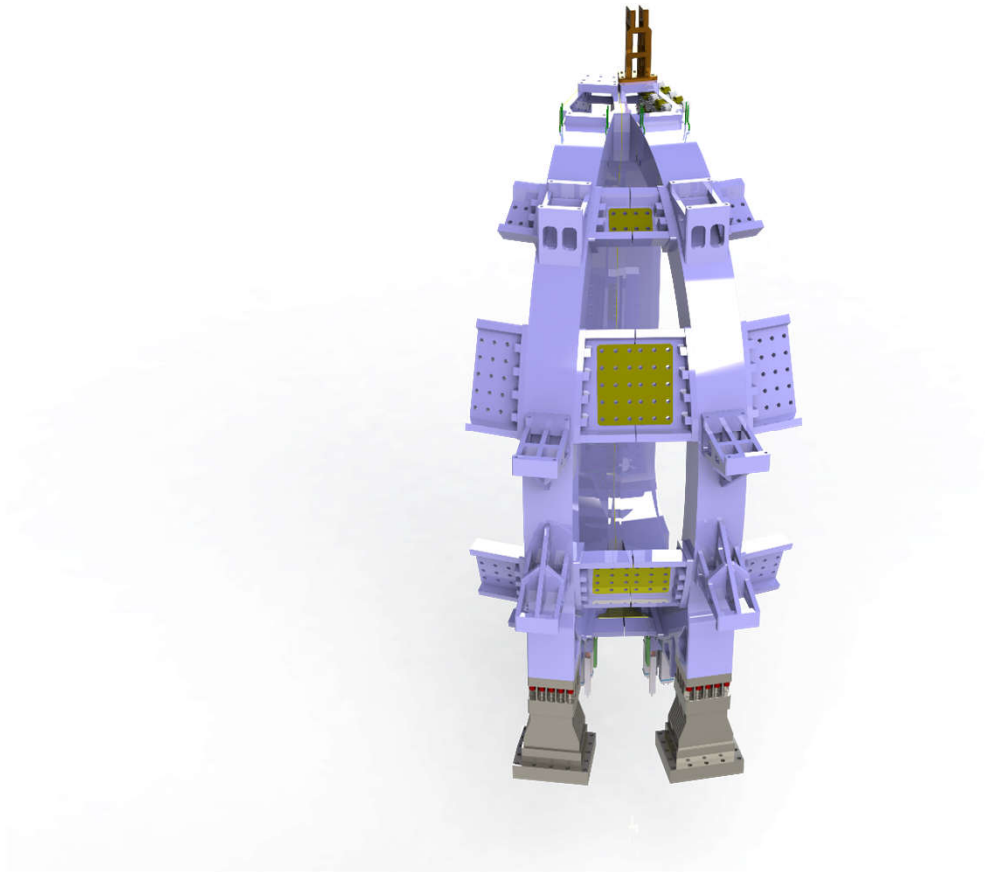

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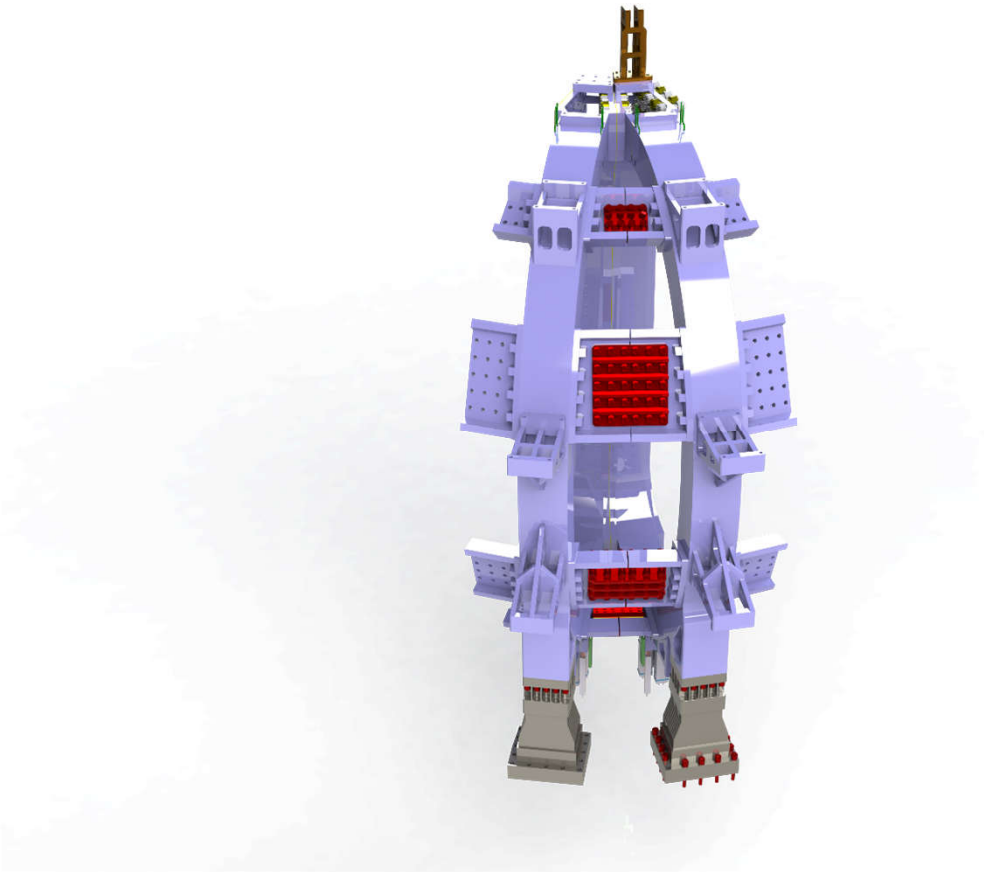

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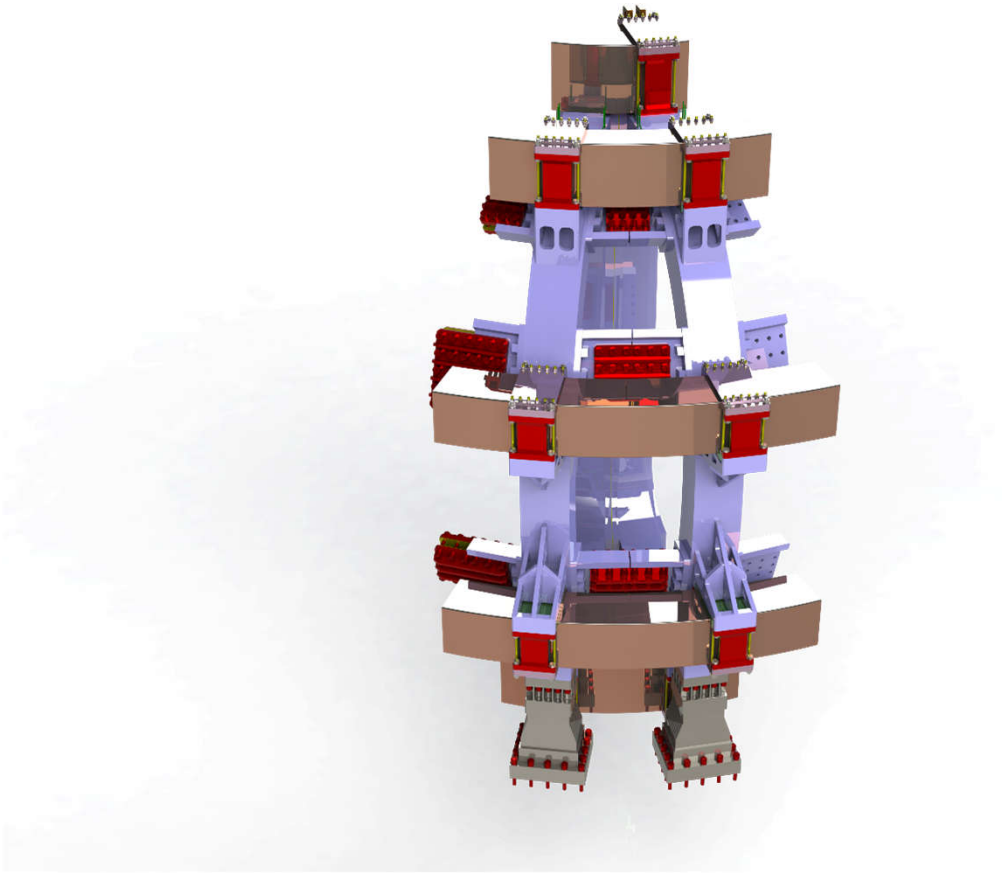
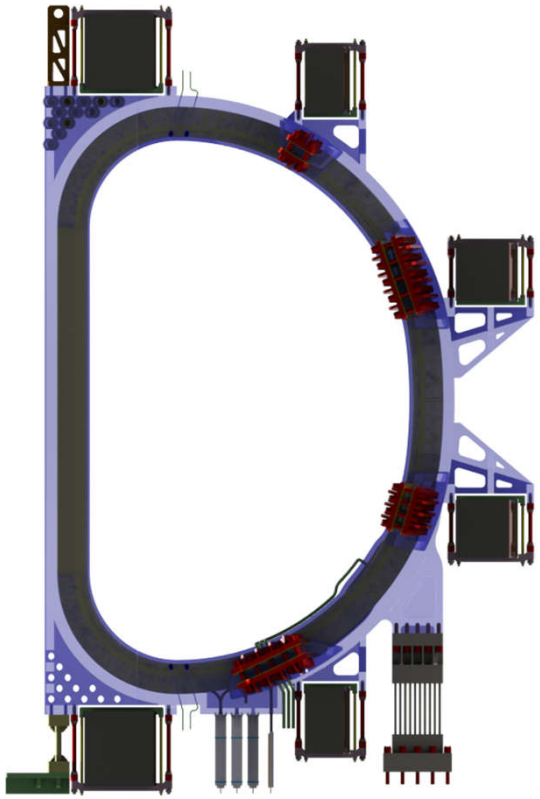


DTT Magnet System – TF coil cooling



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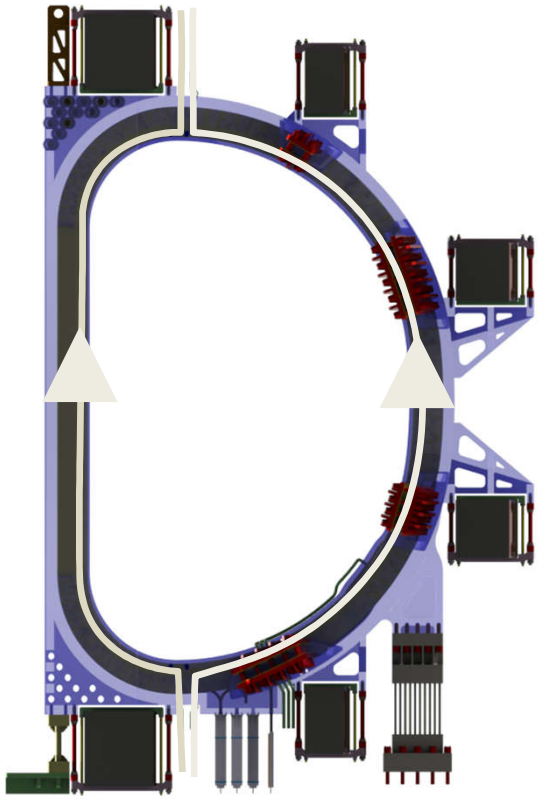

In order to reduce the heat load from the plasma to the WP active cooling system is added to the TF case
4 Channels diam 10mm

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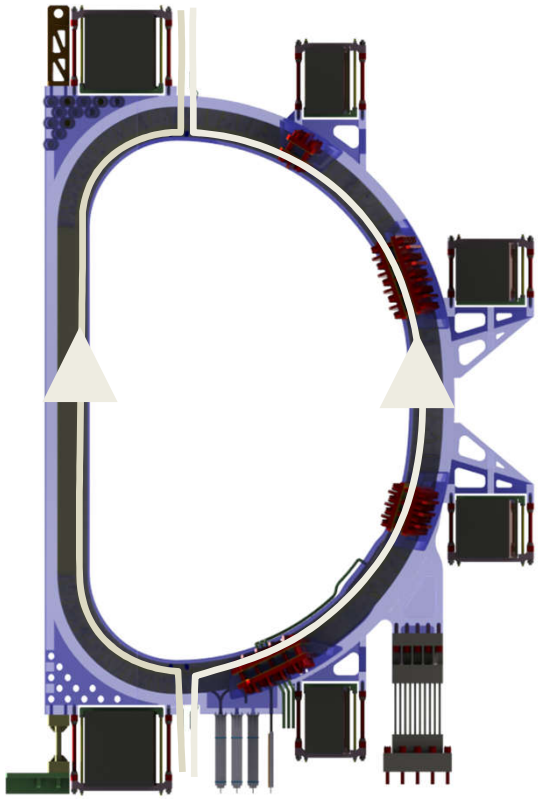

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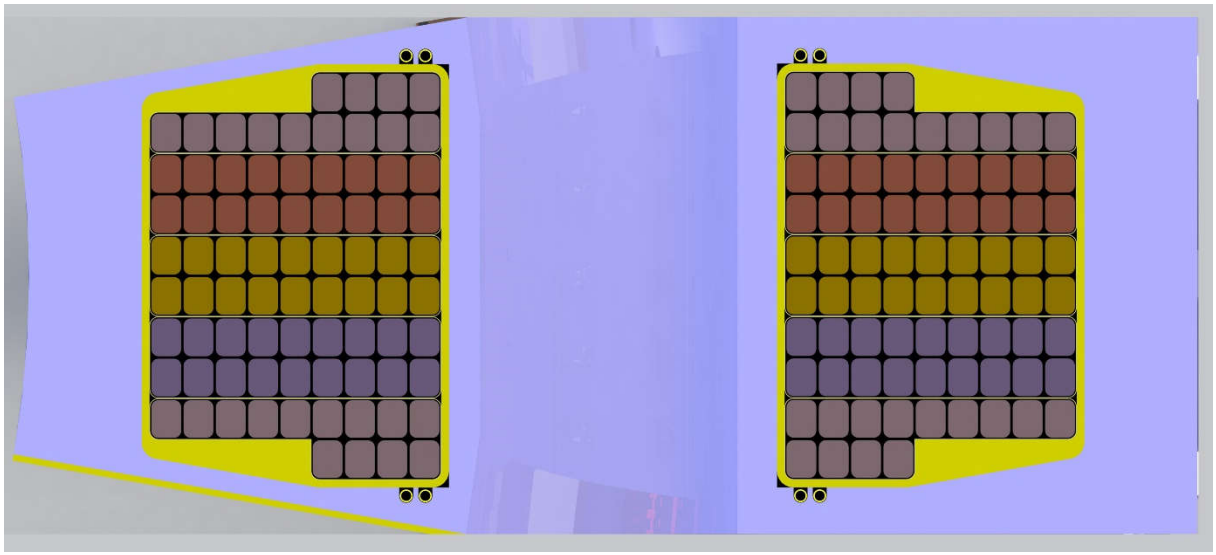

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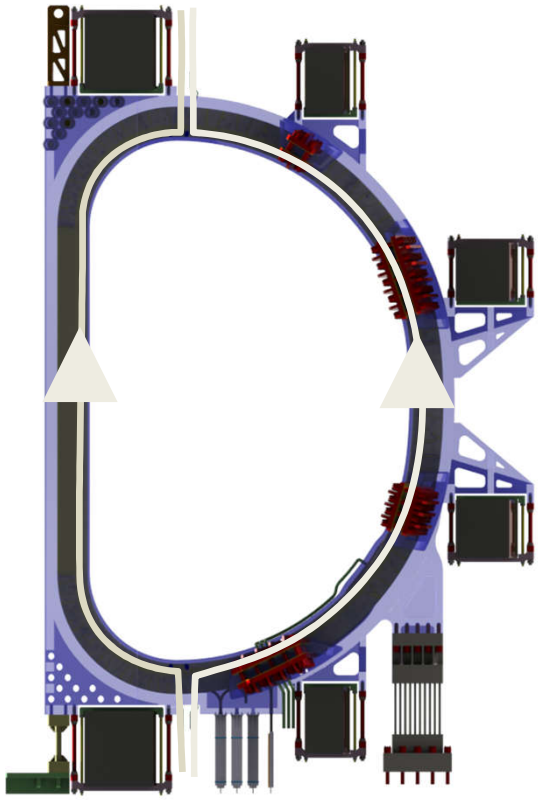

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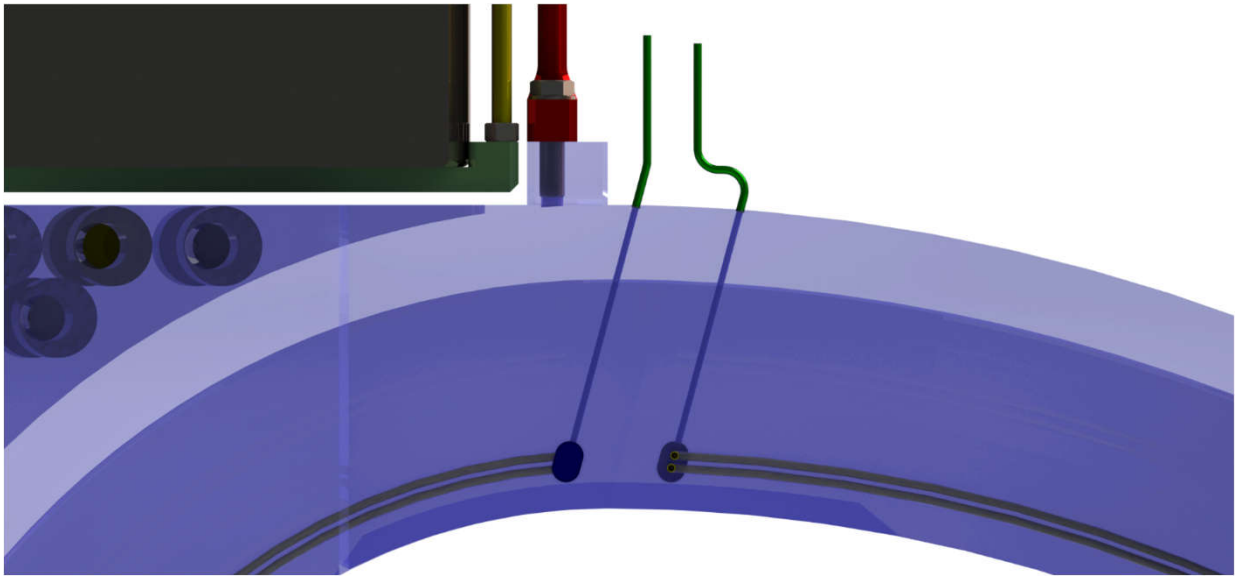

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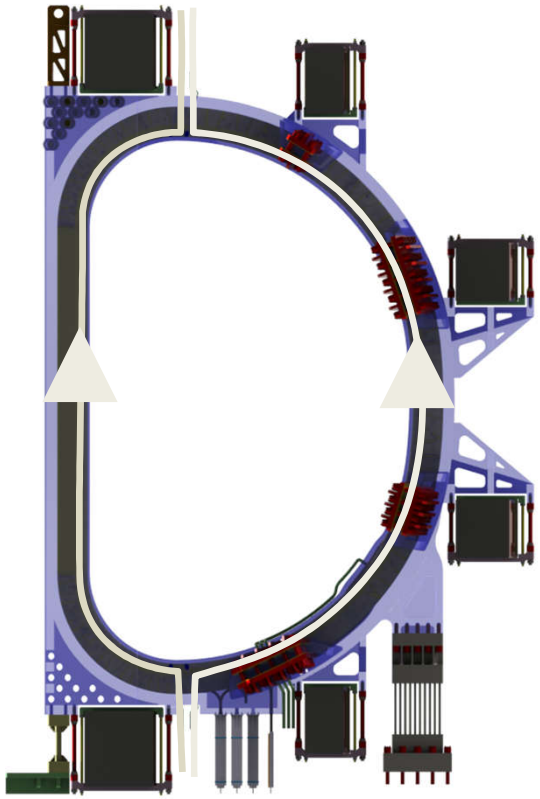

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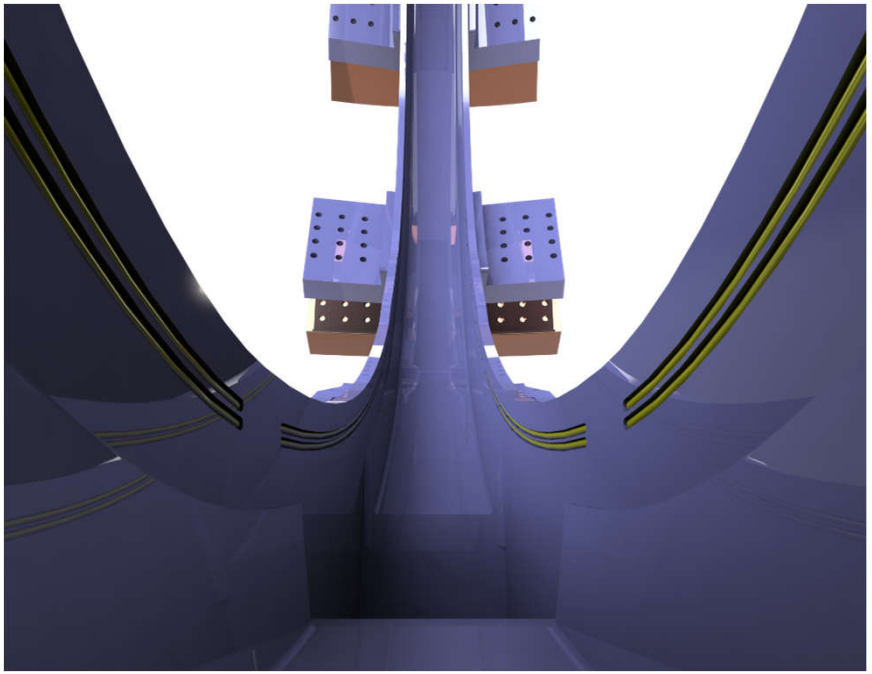
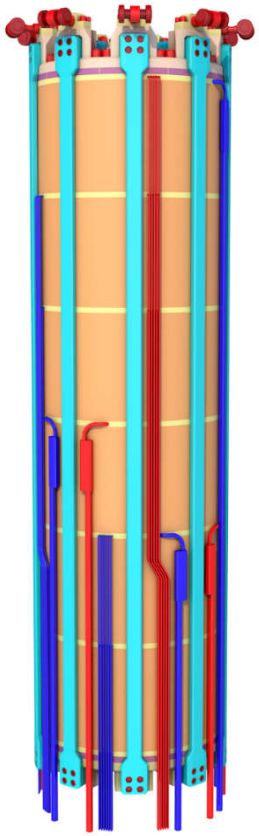


DTT Magnet System – CS structures



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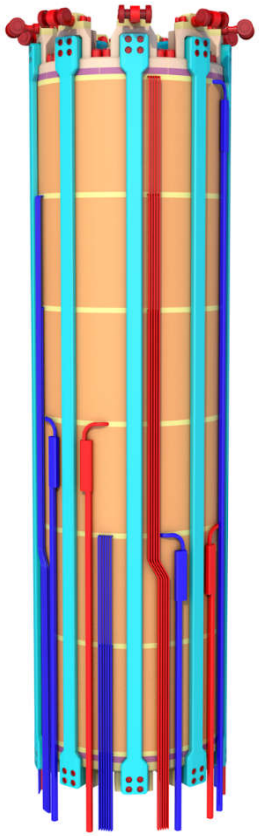
Not part of this procurement



DTT Magnet System – CS structures

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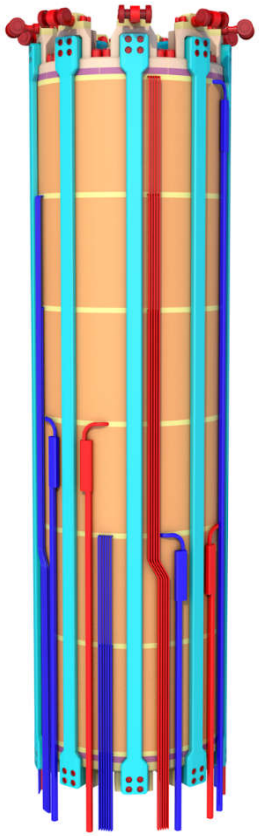
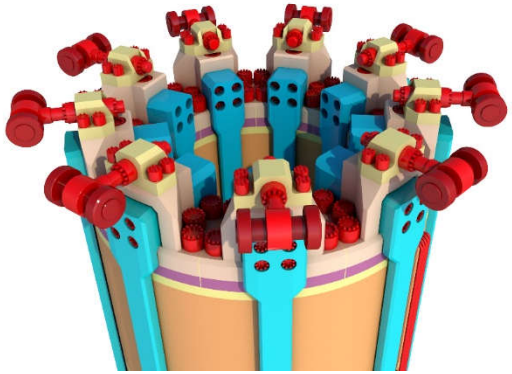
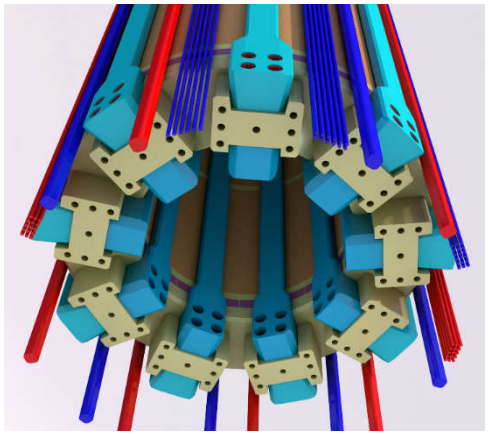


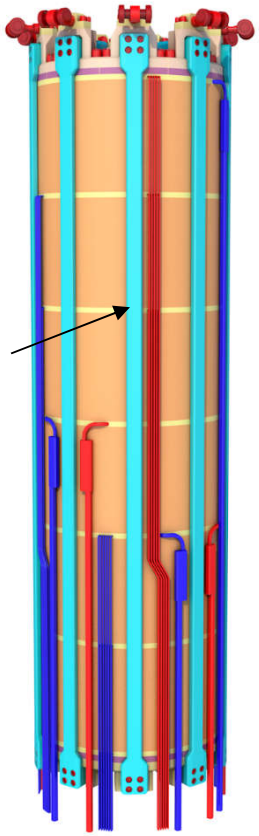


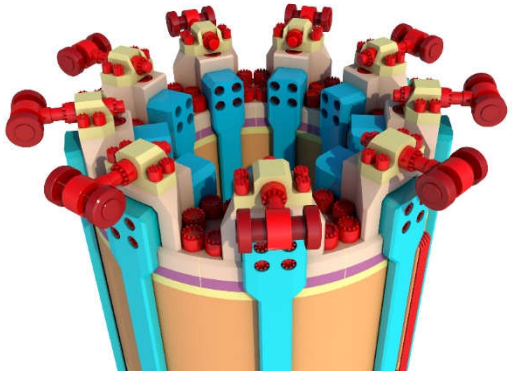


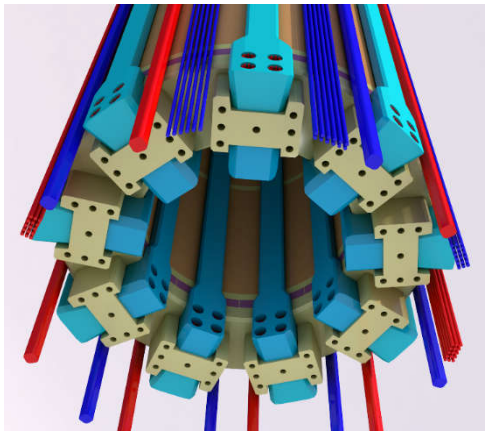
DTT Magnet System – CS structures

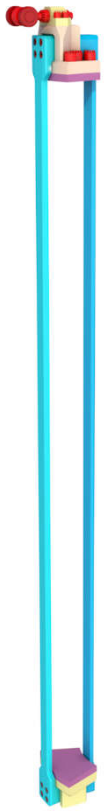
Not part of this procurement

Tie rods
-Free radial space 62mm
-Gap TF 10mm









DTT Magnet System – CS structures

Not part of this procurement

Precompression system
Max value 29 MN

Tie rods
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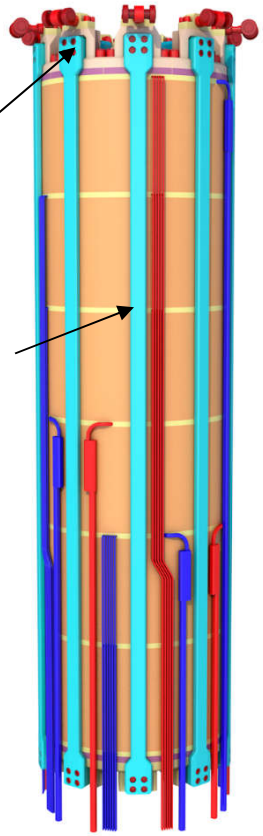
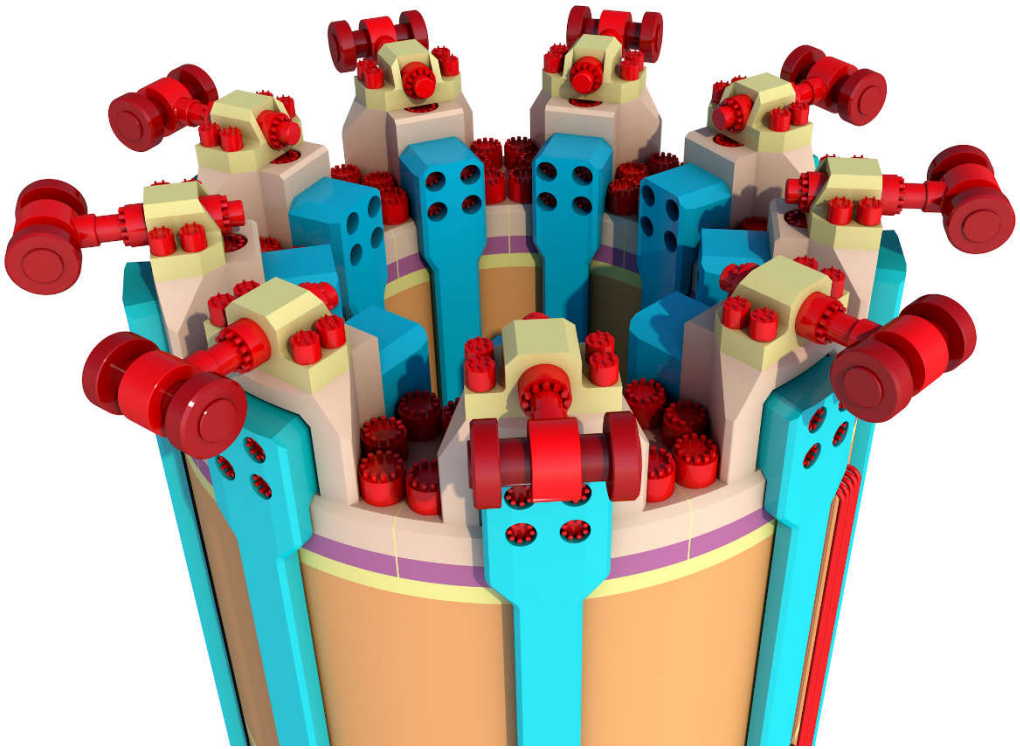
-Gap TF 10mm





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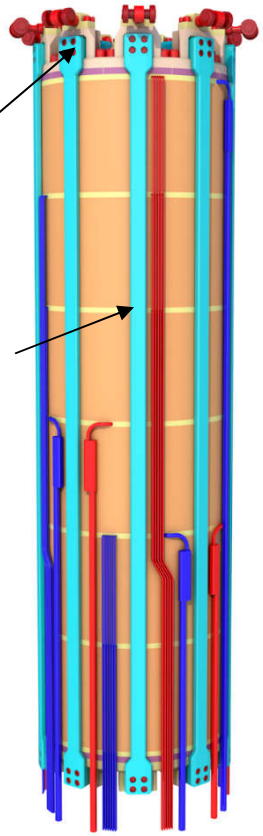

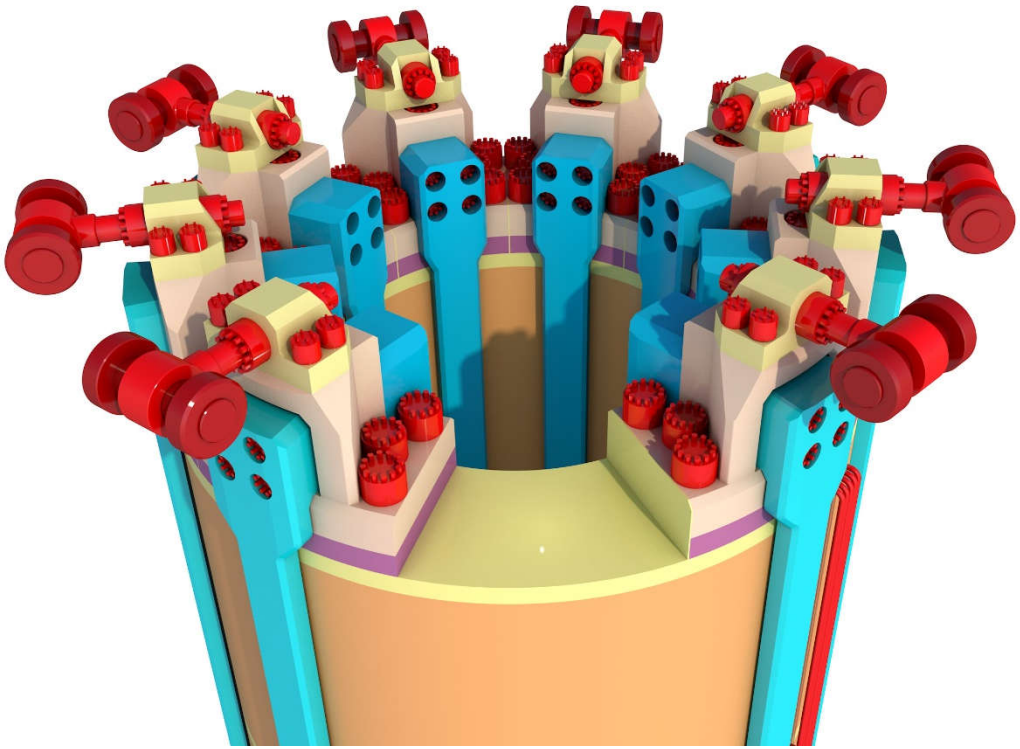

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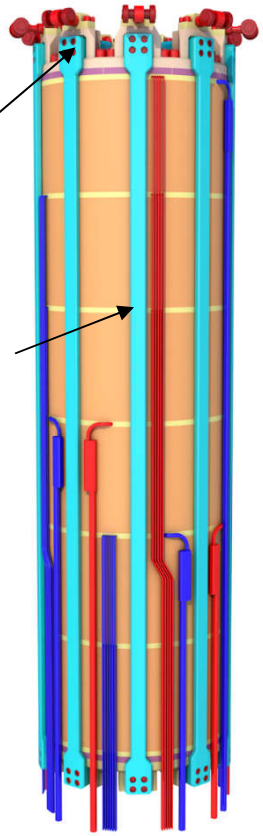

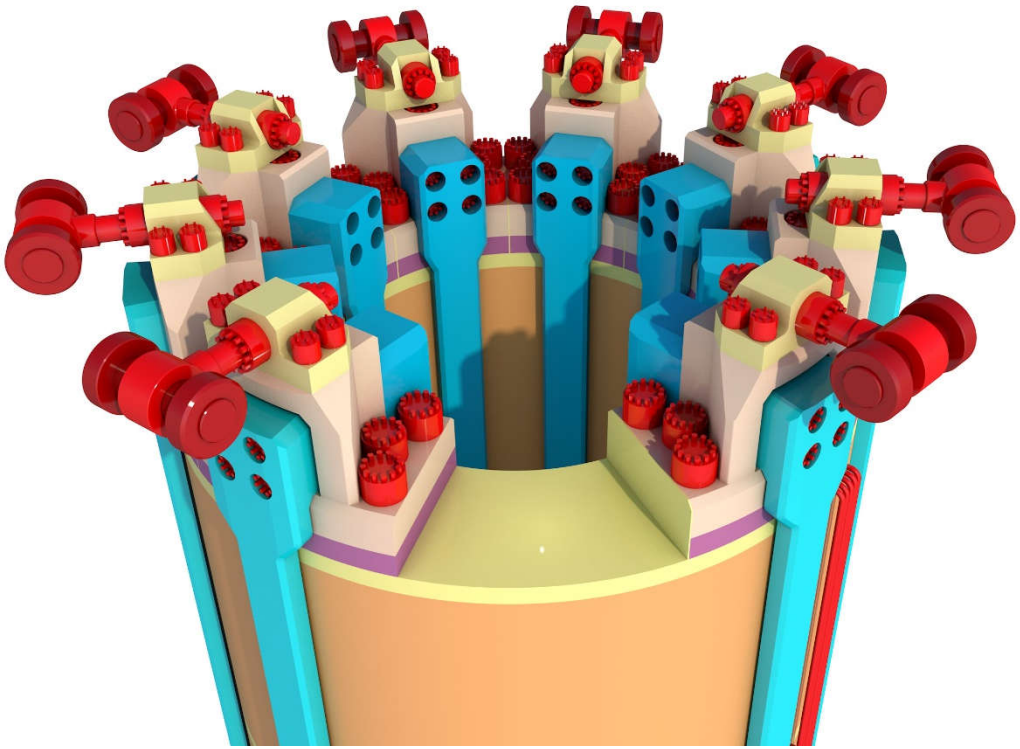

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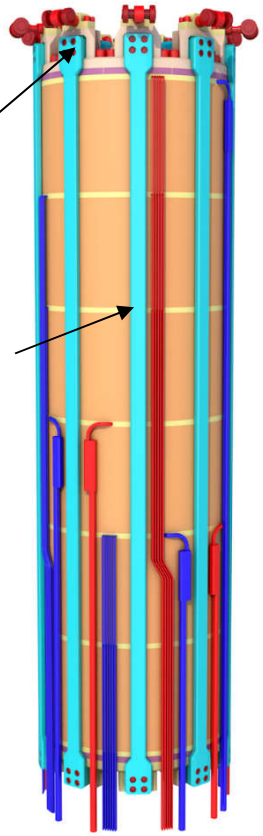

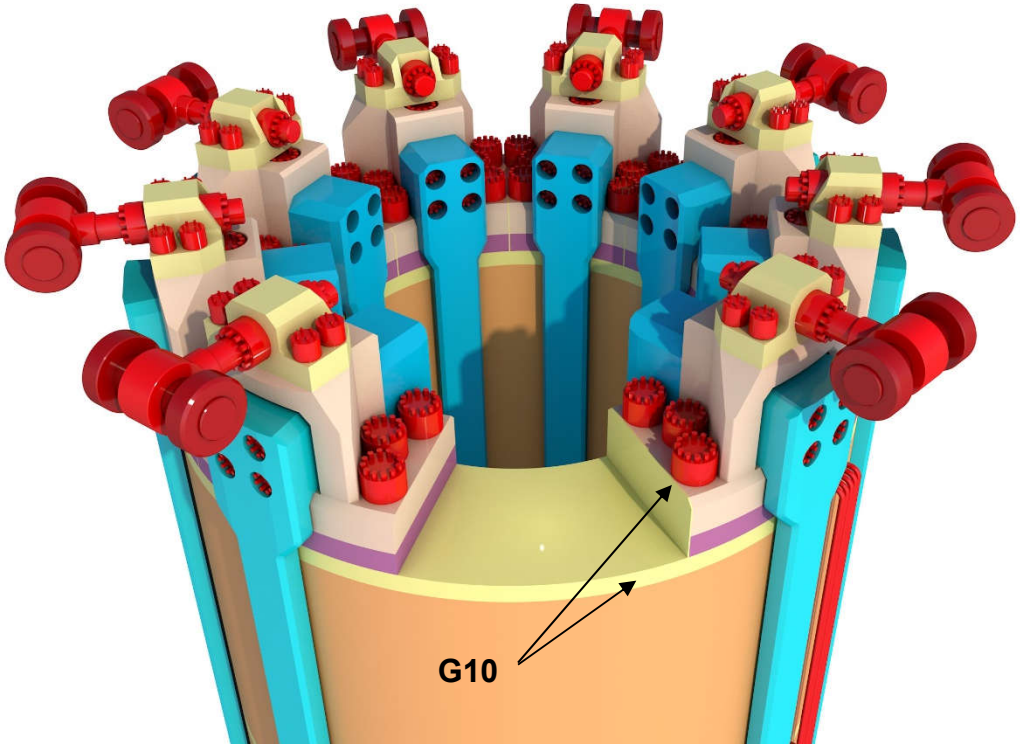

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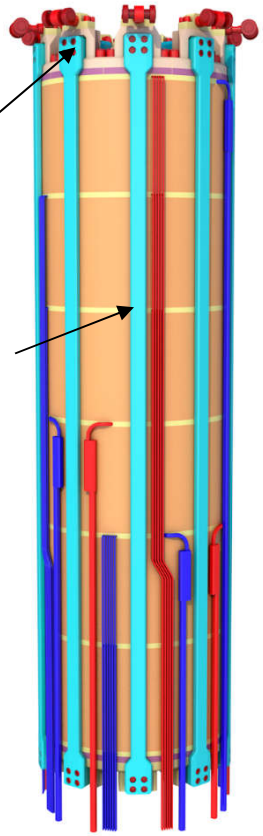

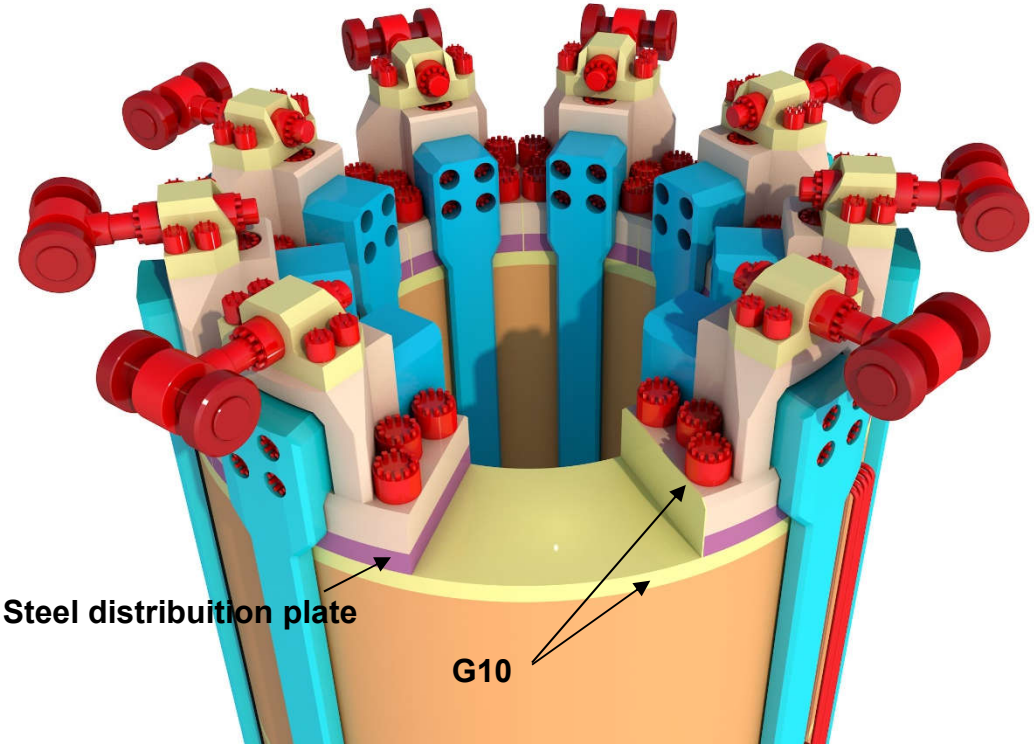

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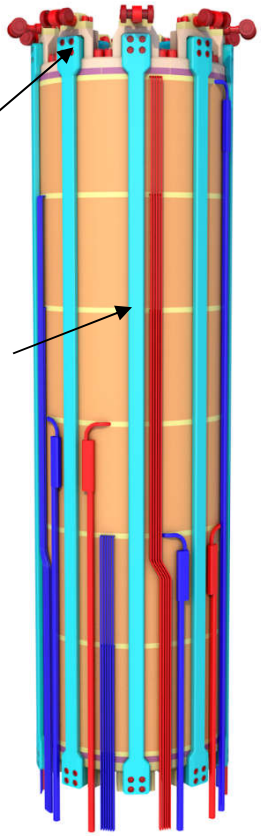

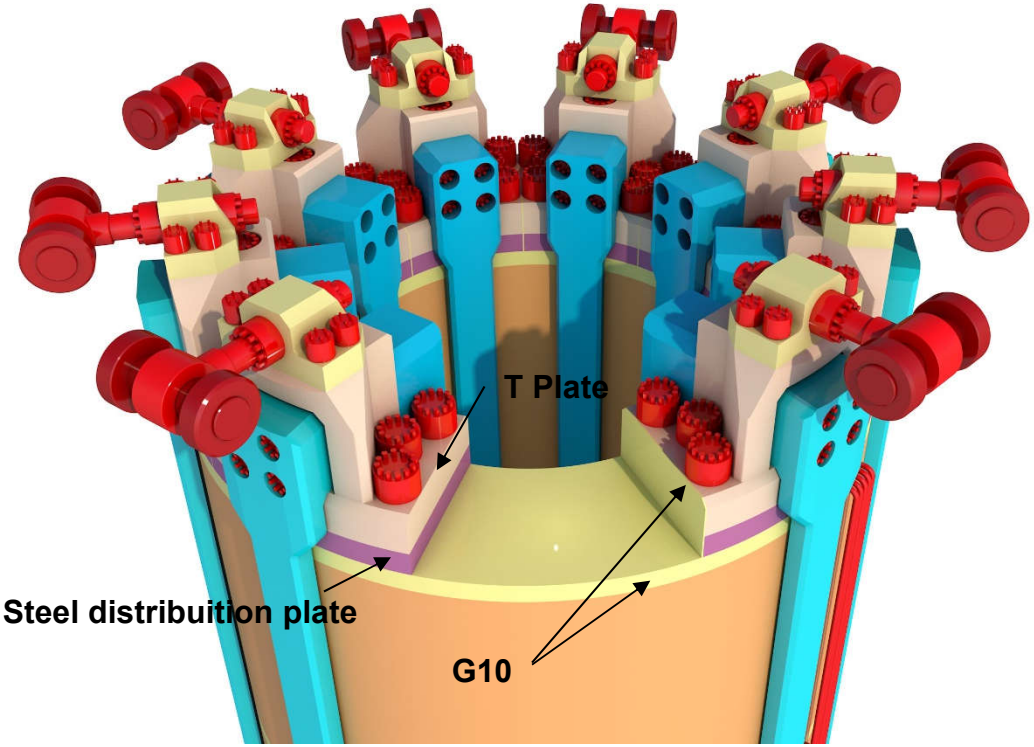

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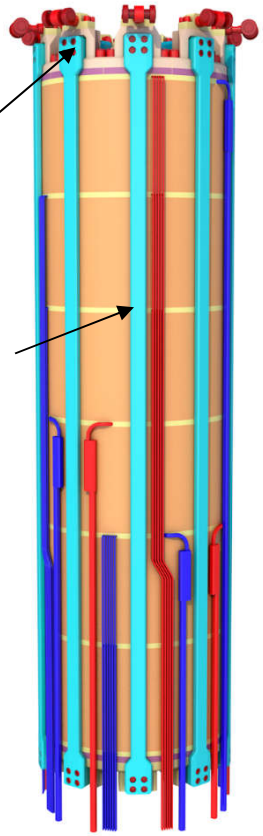

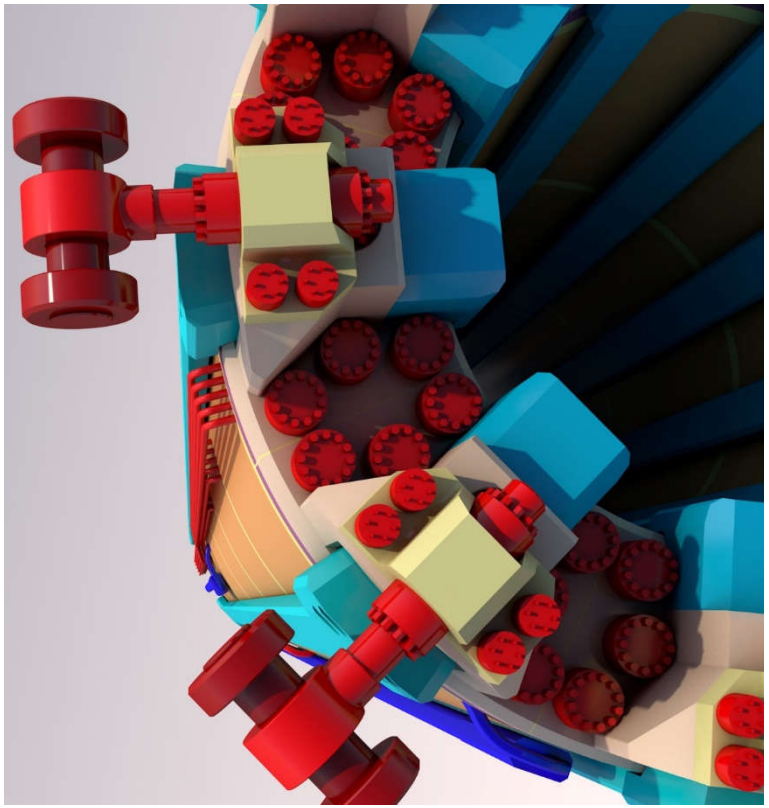

DTT Magnet System – CS structures

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Precompression system
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Tie rods
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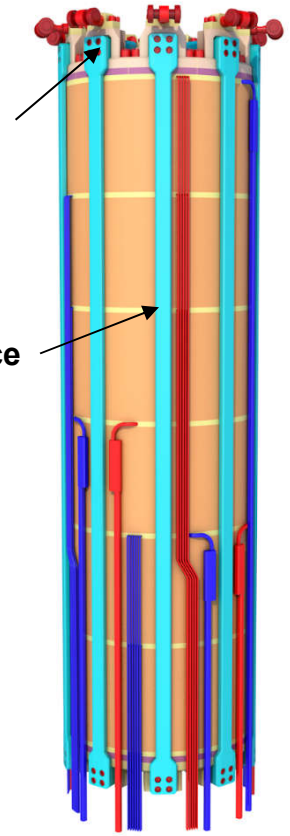
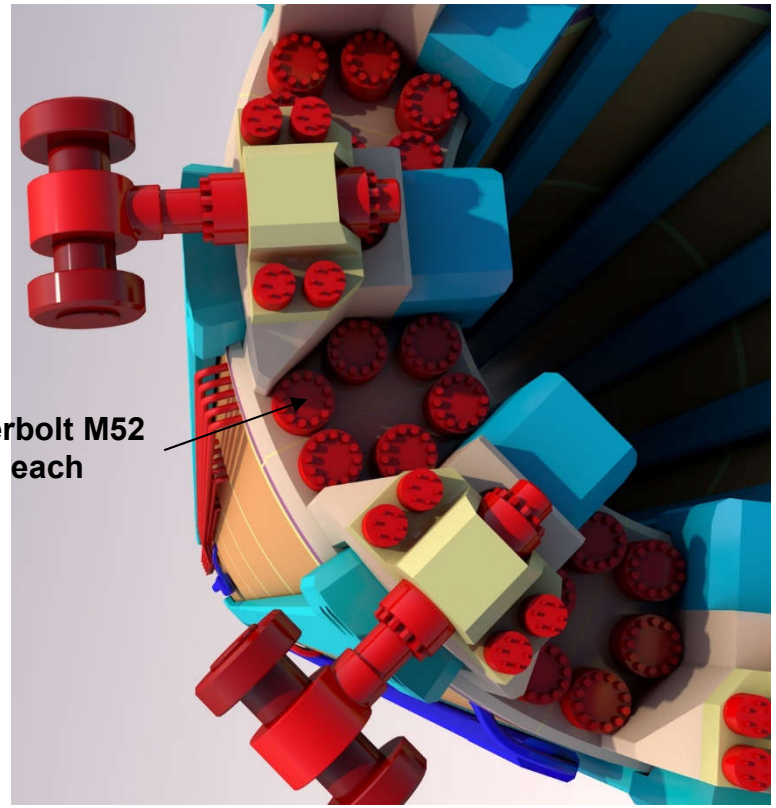


N°7 Superbolt M52
- 1400 kN each

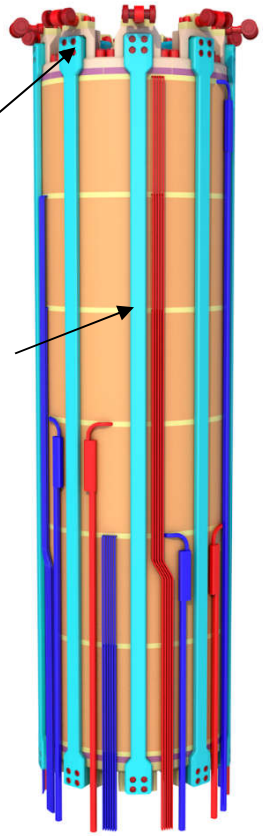


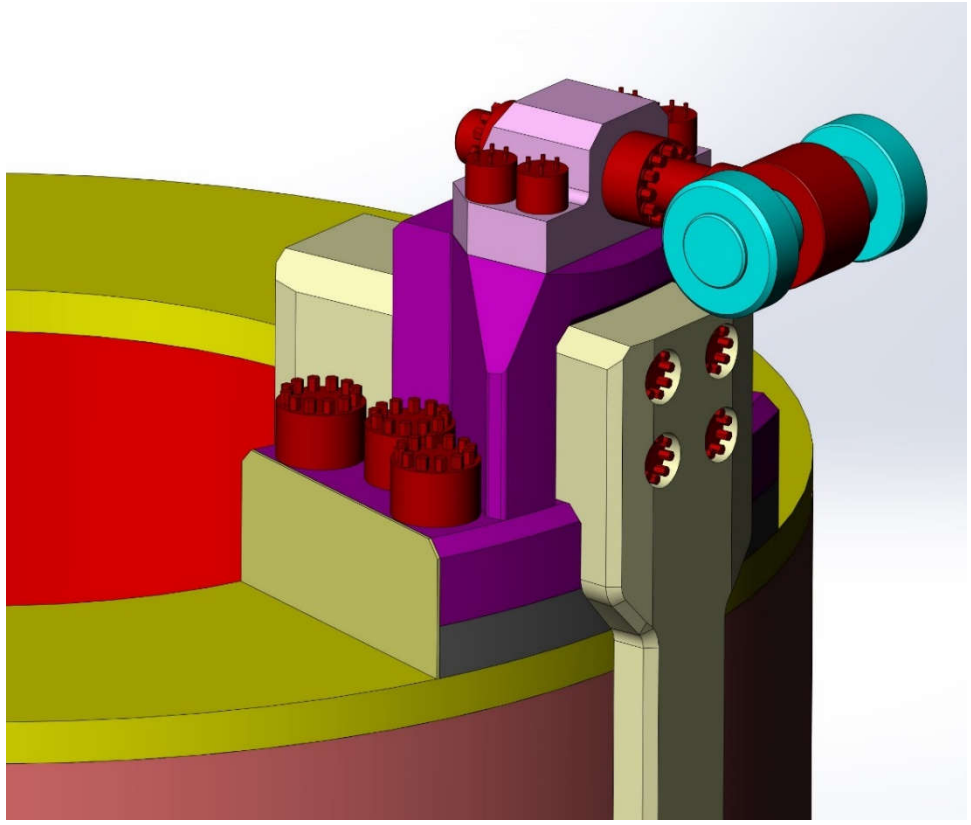
DTT Magnet System – CS structures

Not part of this procurement

Precompression system
Max value 29 MN

Tie rods
-Free radial space 62mm
-Gap TF 10mm





DTT Magnet System – CS structures

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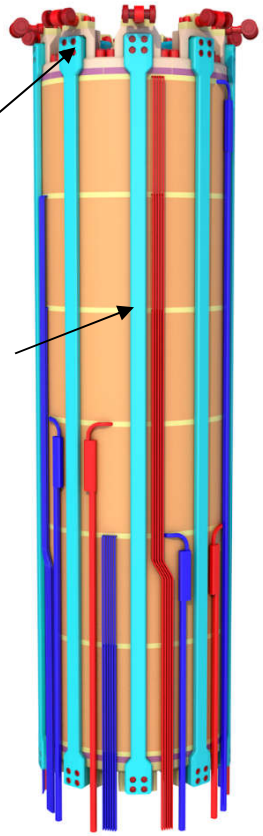
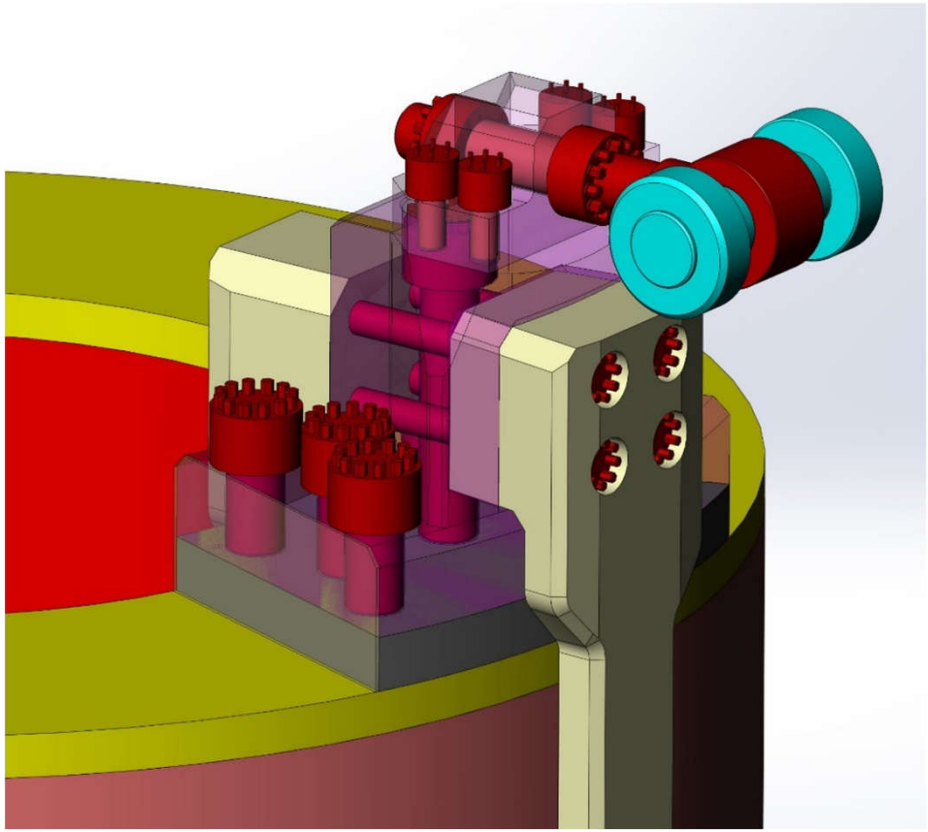
Precompression system
Max value 29 MN

Tie rods
-Free radial space 62mm
-Gap TF 10mm



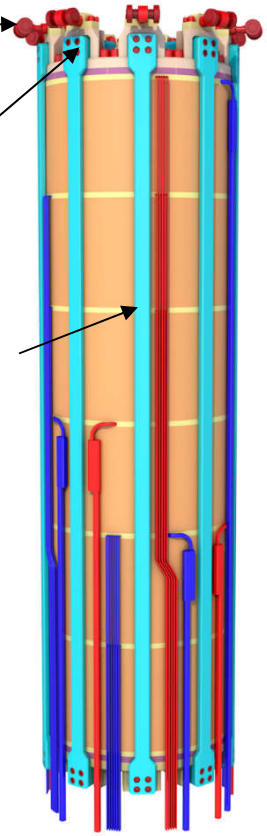


DTT Magnet System – CS structures

Not part of this procurement

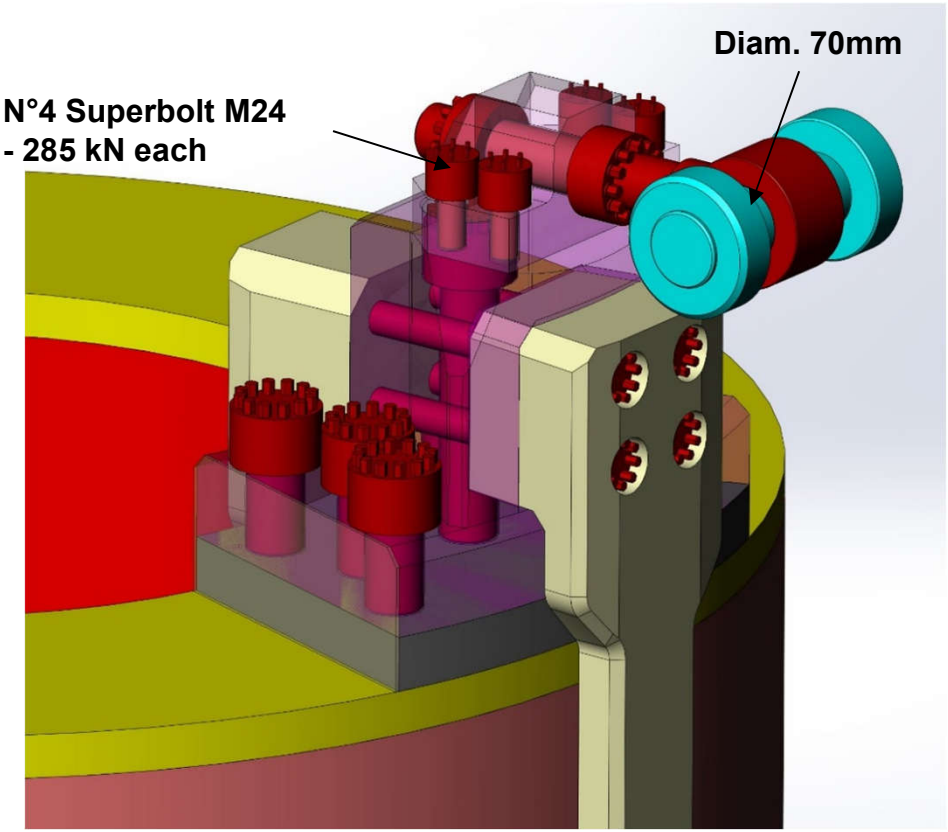
Centering system
Precompression system
Max value 29 MN

Tie rods
-Free radial space 62mm
-Gap TF 10mm



N°4 Superbolt M24
- 285 kN each

Diam. 70mm



DTT Magnet System – CS structures

Not part of this procurement

Centering system
Precompression system
Max value 29 MN

Tie rods
-Free radial space 62mm
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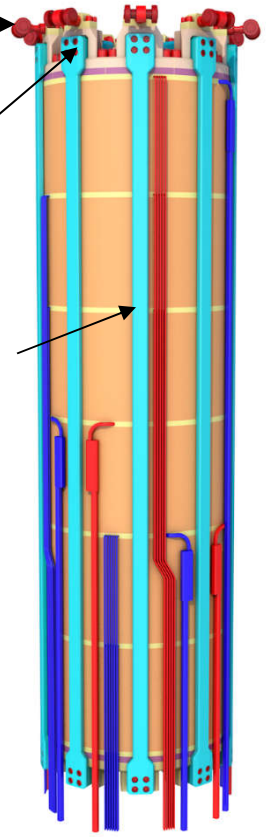

DTT Magnet System – CS structures

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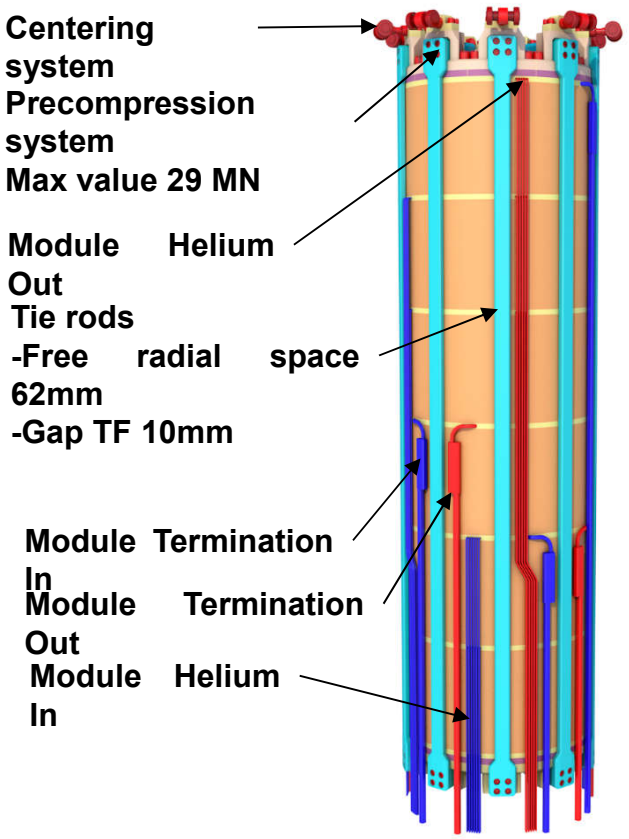

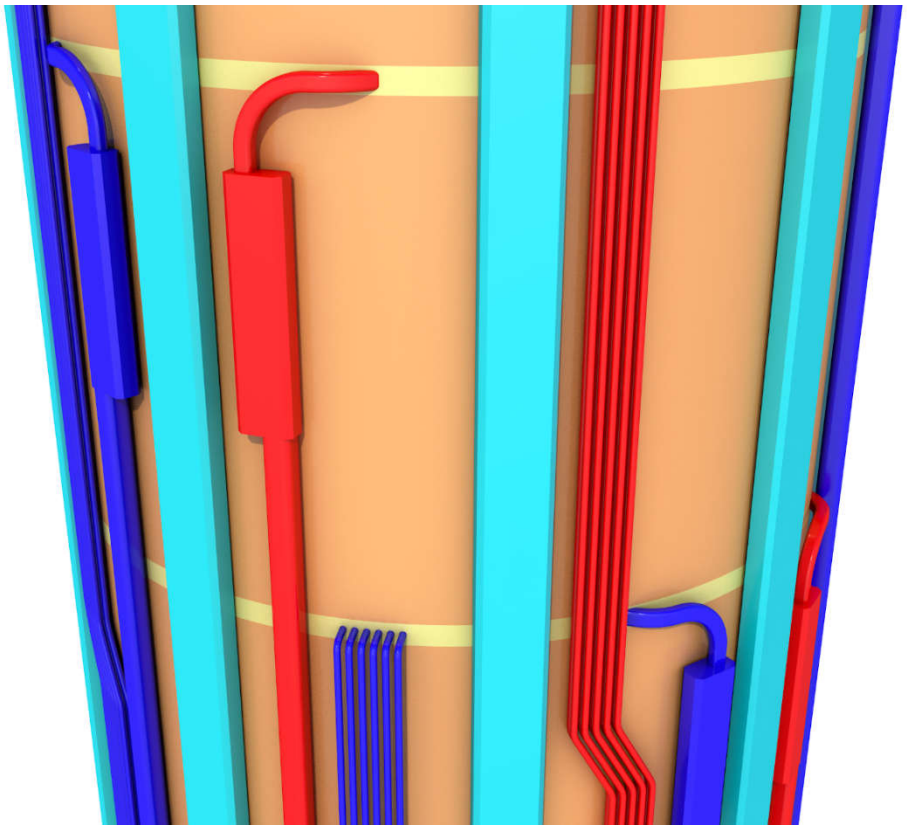

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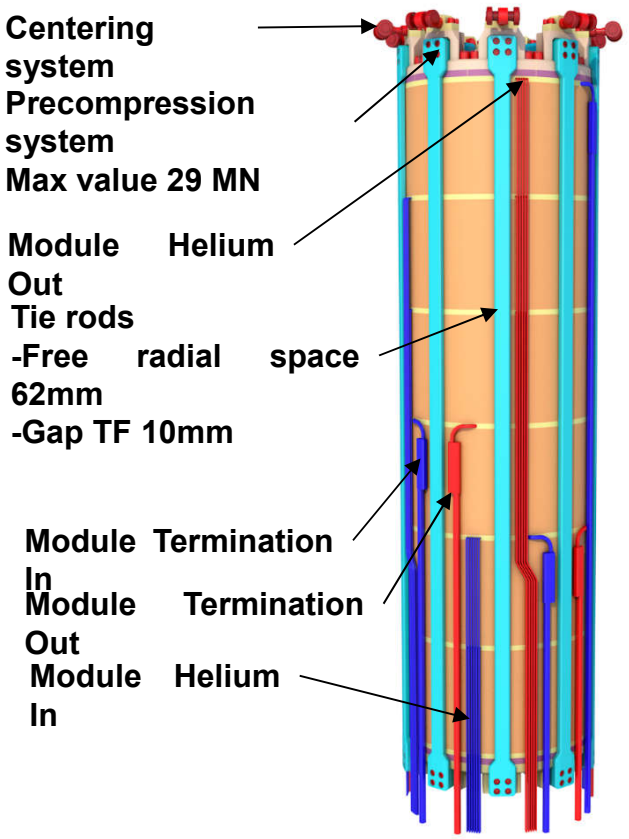

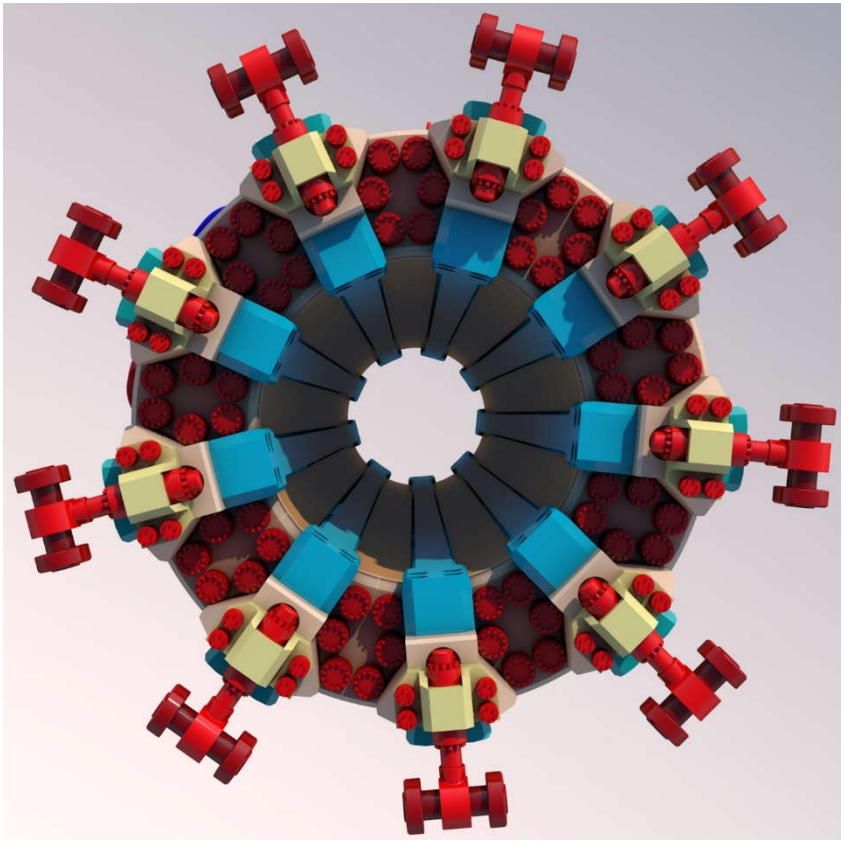

DTT Magnet System – CS structures

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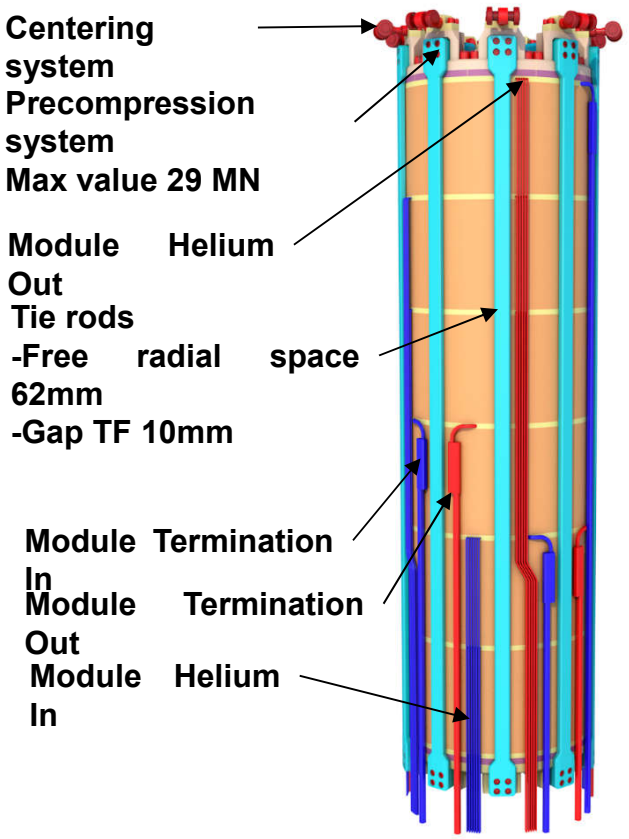

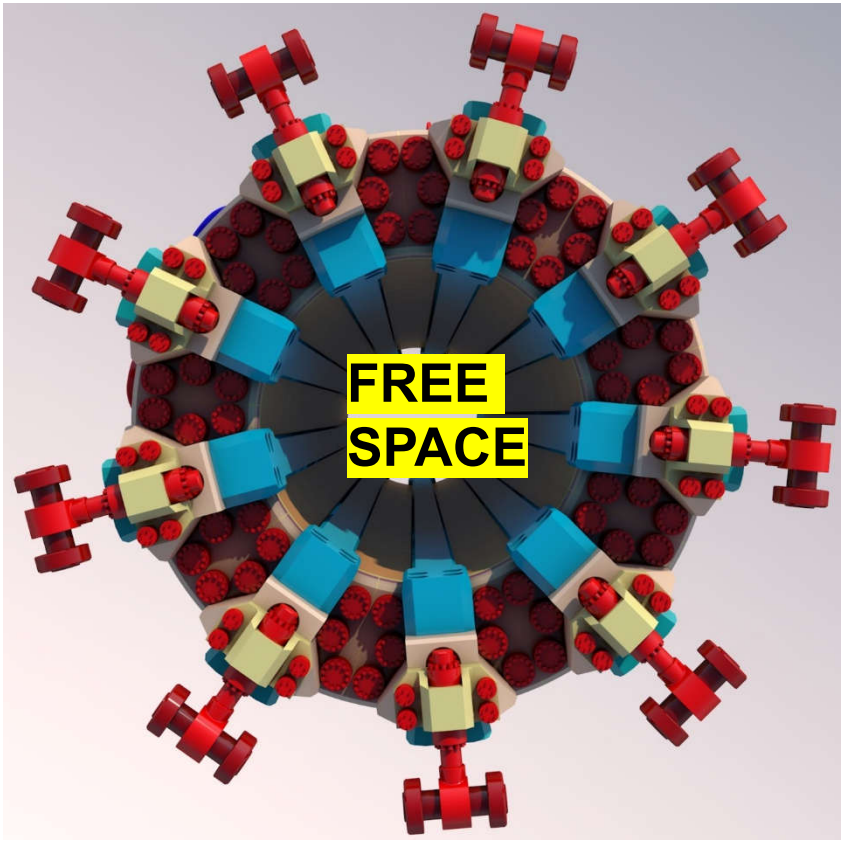

QUESTIONS?

alessandro.anemona@enea.it