HQS
Mechanical Design and Analysis

Helene Felice

Collaboration Meeting 13

Port Jefferson, NY

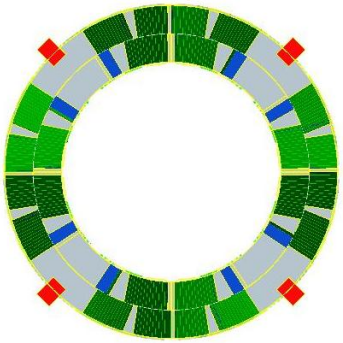
November 4-6 2009

HQ objectives

- Provide support up to 219 T/m
- Provide alignment
    - From LQS to HQ => alignment between the coils and the structure

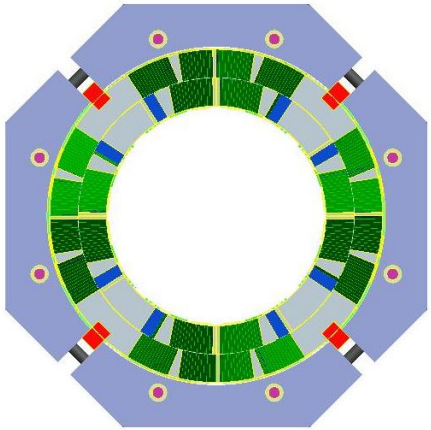
HQS – Coils and alignment keys

- Provide support up to 219 T/m
- Provide alignment
    - From LQS to HQ => alignment between the coils and the structure



- Aluminum alignment key inserted in Titanium pole

HQS – Aluminum Collars

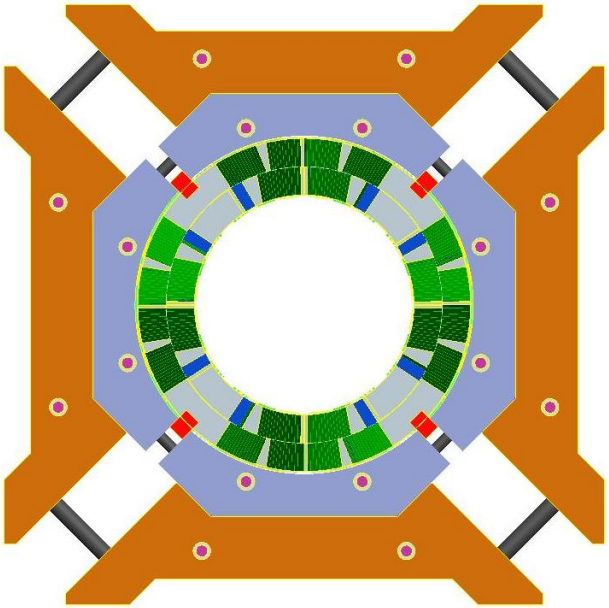


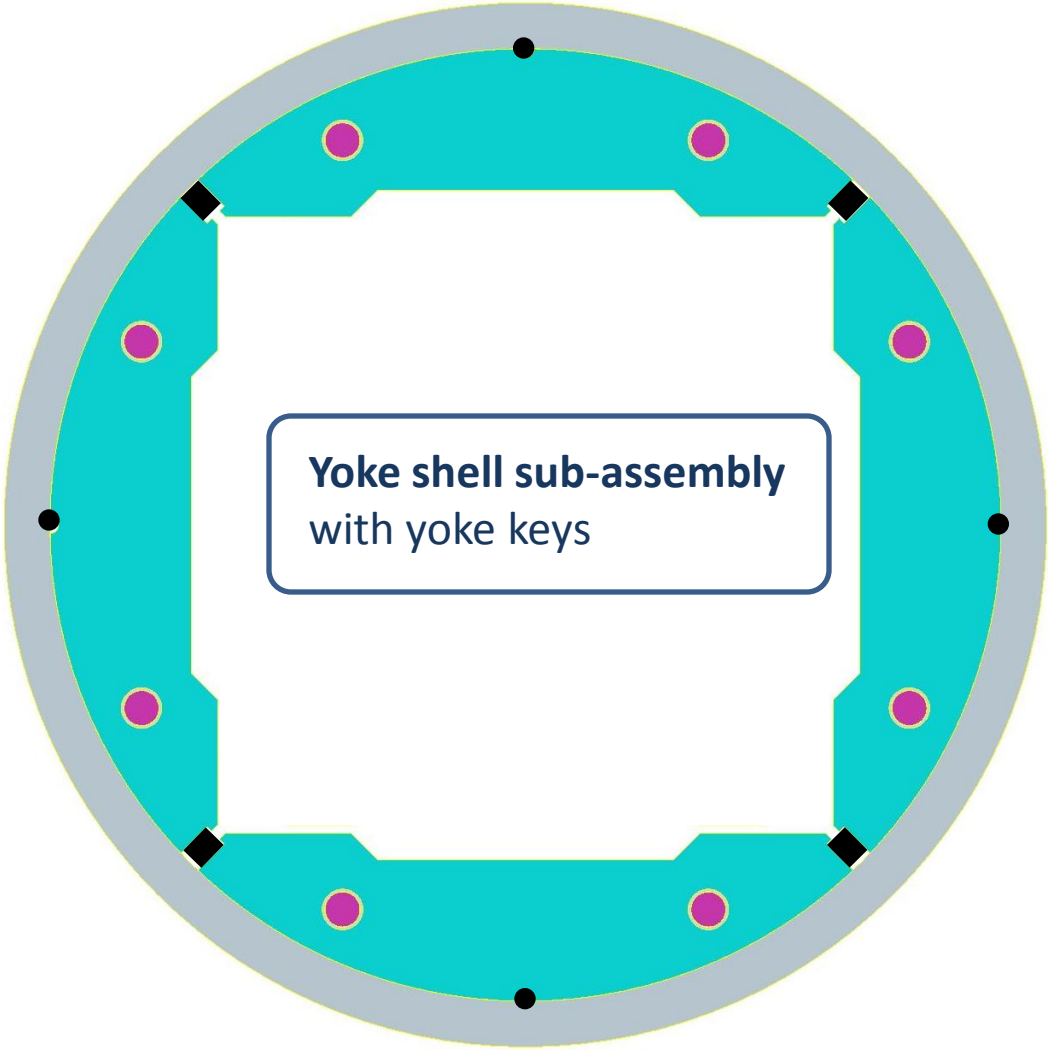
- Aluminum alignment key inserted in Titanium pole
- Aluminum collar bolted around the coil coming in contact with the key
    - Collars are an assembly component
    - Collars not used to pre-stress the coils
    - Collars and keys anodized
    - G10 insulation between coil and collars

HQS – 2 Sub-assemblies

Coil- Pads sub-assembly

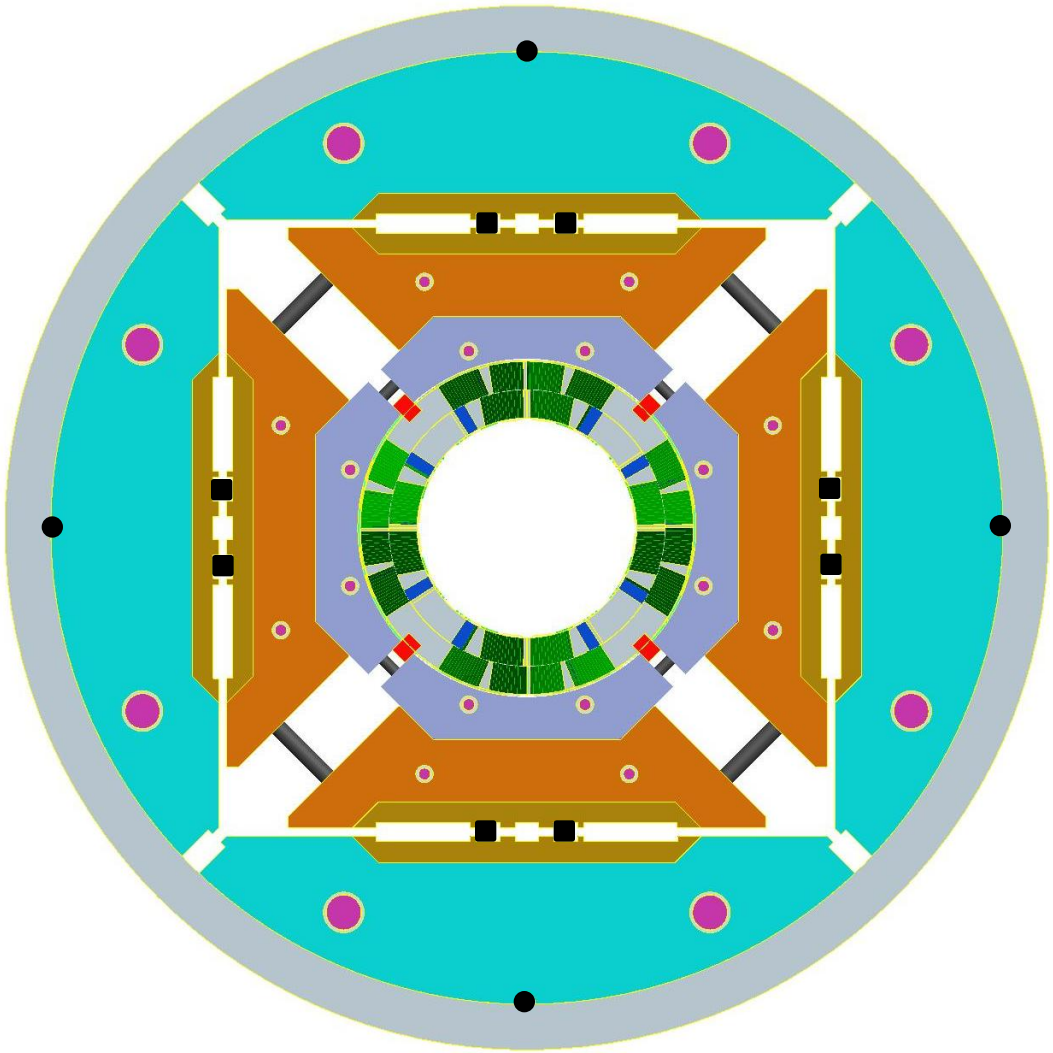
with iron pads bolted around the coil/collar assembly





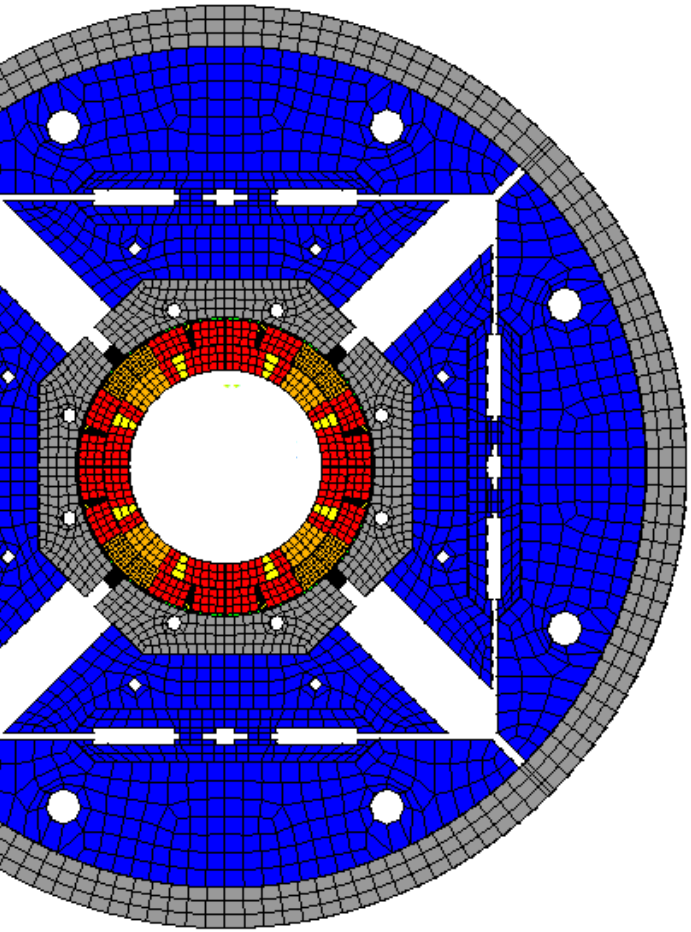
Yoke shell sub-assembly
with yoke keys

Final assembly

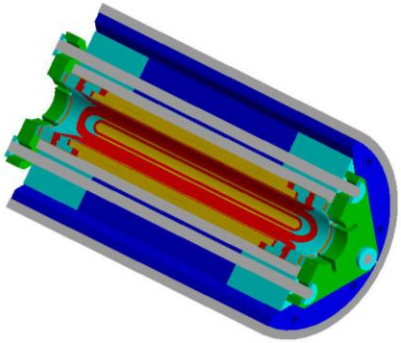


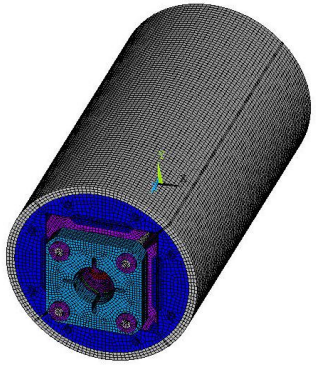
- Coil pack sub-assembly inserted in yoke/shell sub-assembly using bottom master
- Removal of the yoke keys
- Shimming of the load keys
- Alignment
  - pin
  - masters and collar shape
  - key at the pole
- 570 mm outer diameter

Model

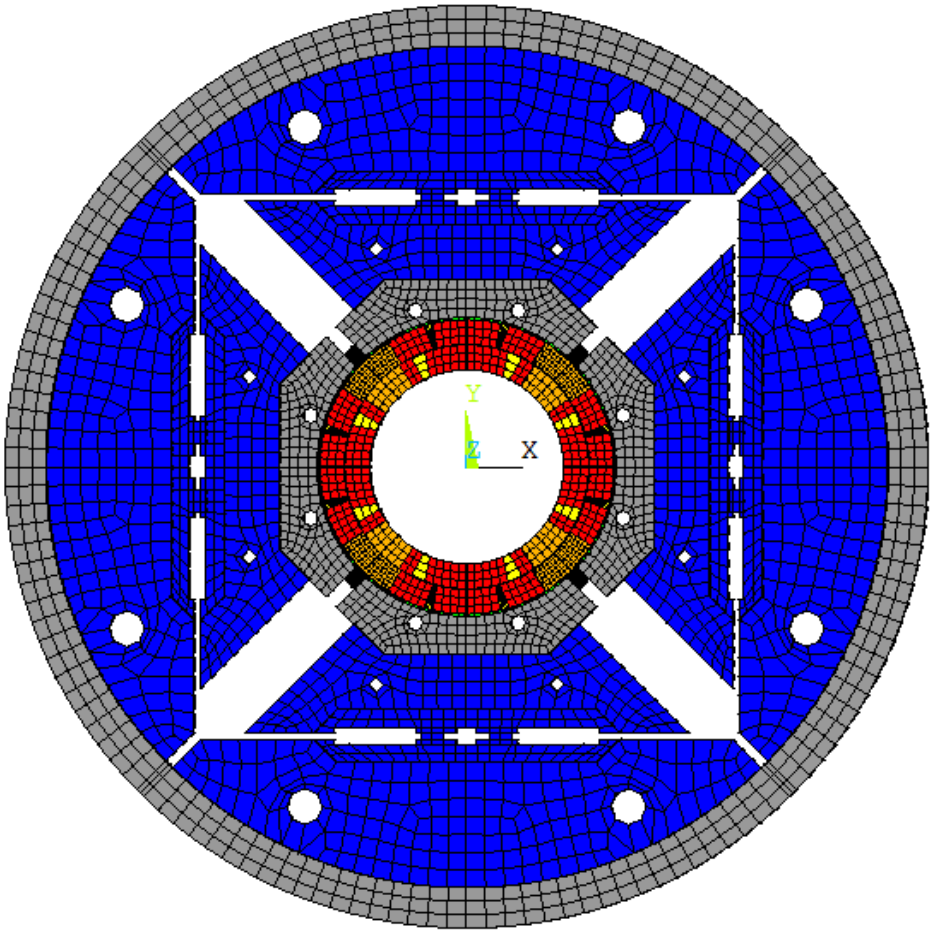


- **2D and 3D ANSYS mechanical model**
- **Friction 0.2**
- **coil, pole, end-shoe, spacers glued**
- **Pre-stress for G_{ss} at 219 T/m**
- **Steps of computation**
  - Bladder operation
  - key insertion
  - cool-down
  - Lorentz forces at 120, 180 and 219 T/m



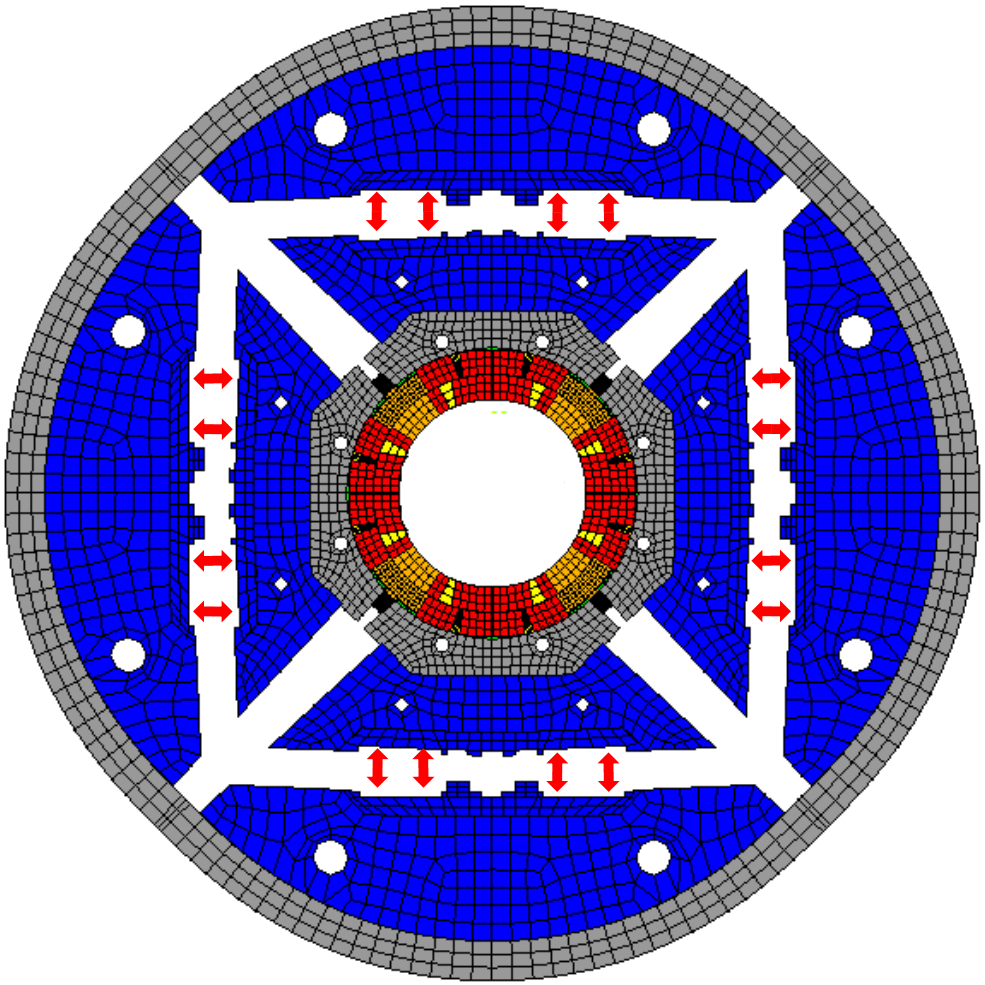


Starting point



Displacement scaling 30

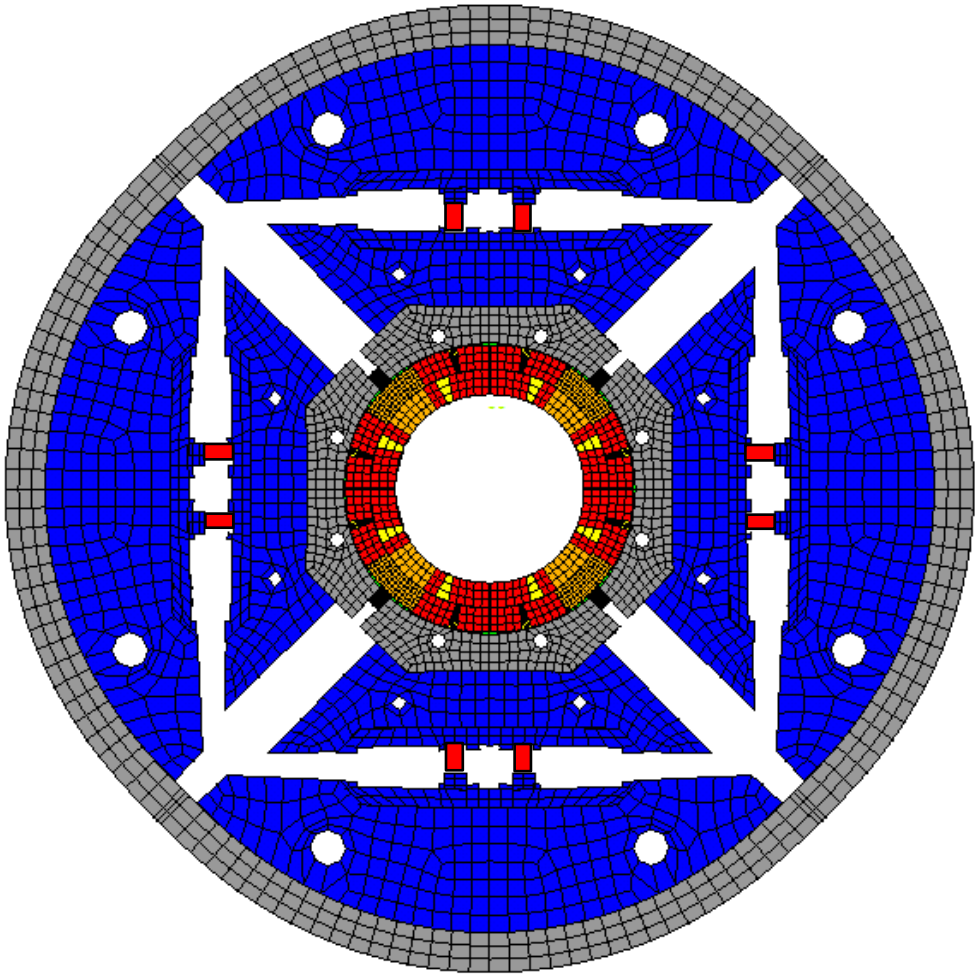
Bladder operation



Displacement scaling 30

- 8 bladders
  - pressurized at 45 MPa
  - opening an interference of 650 microns
  - allowing the shimming of the load keys

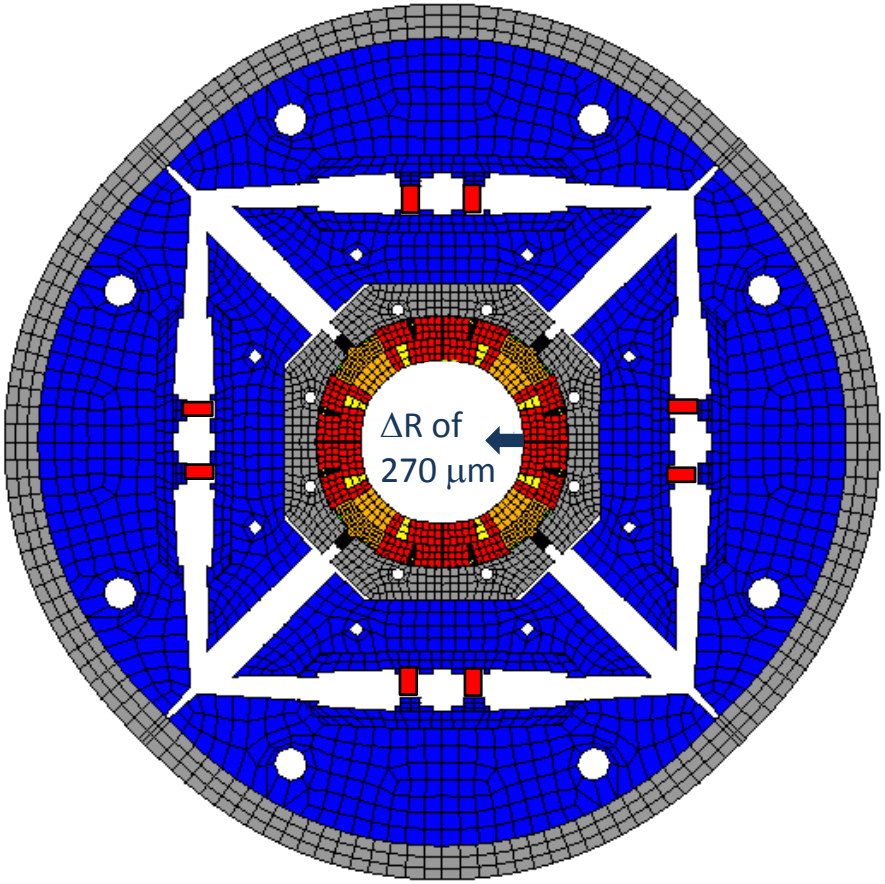
Load key insertion



Displacement scaling 30

- Shimming of the load keys
- Bladder pressure released
- Bladders removed

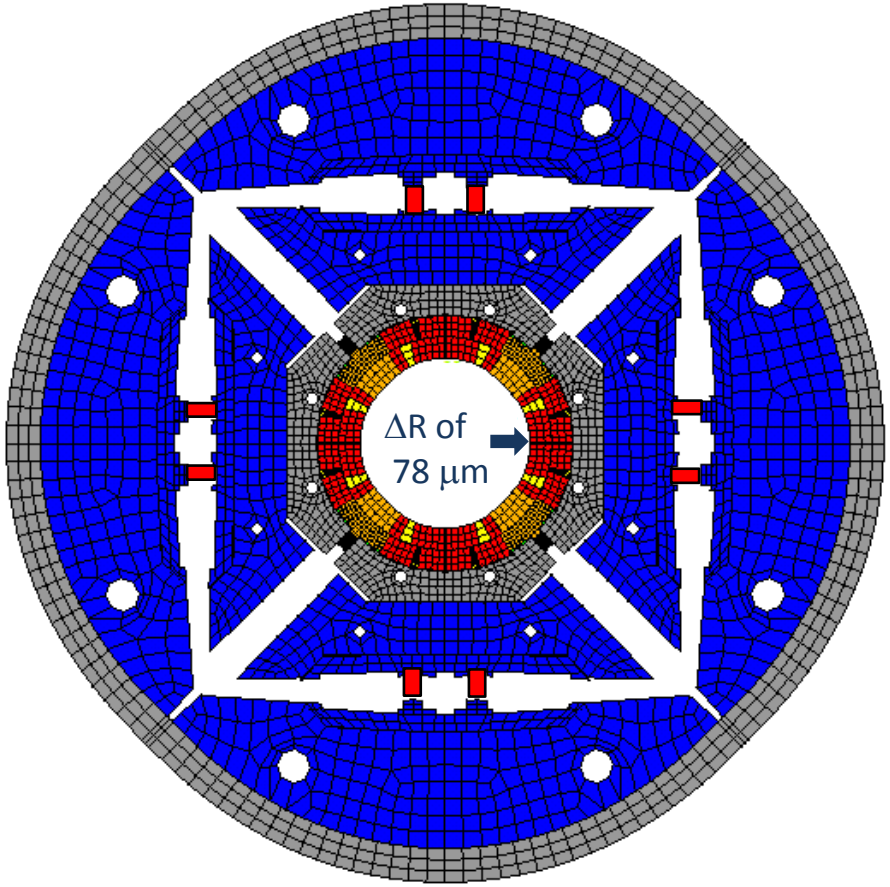
Cool-down



- Shrinkage of the 25 mm thick aluminum shell around the iron yoke
- Pre-stress transmitted to the coil by load keys, pads and collars

Displacement scaling 30

219 T/m

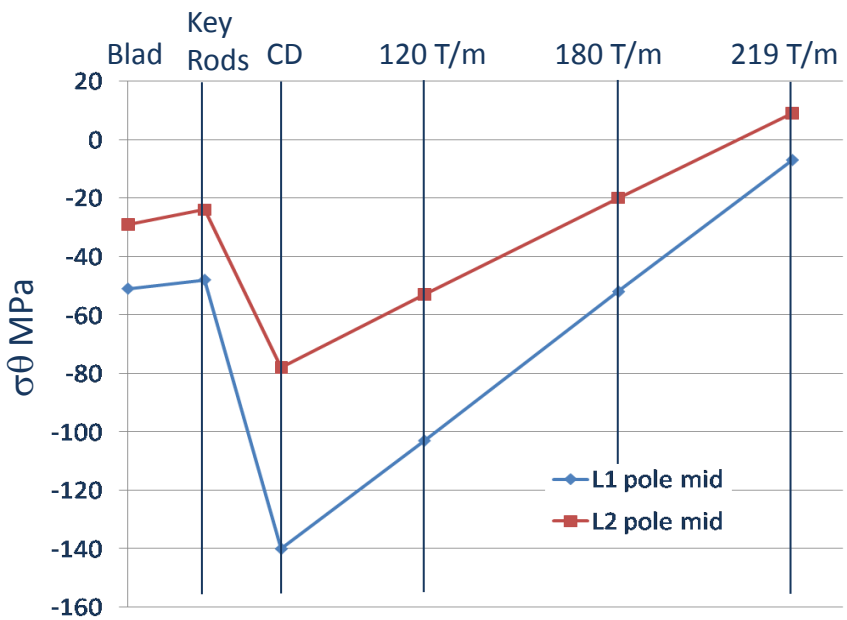


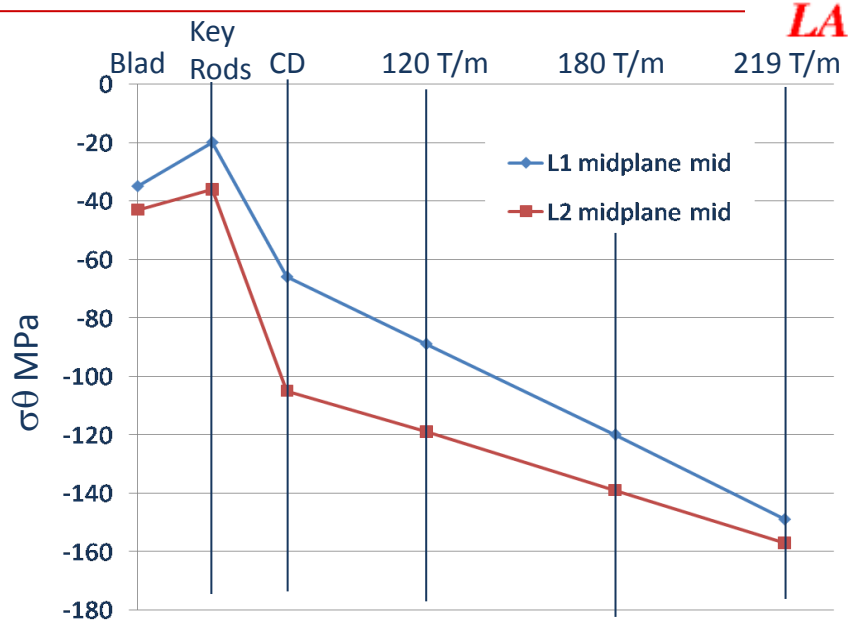
Displacement of the mid-plane of

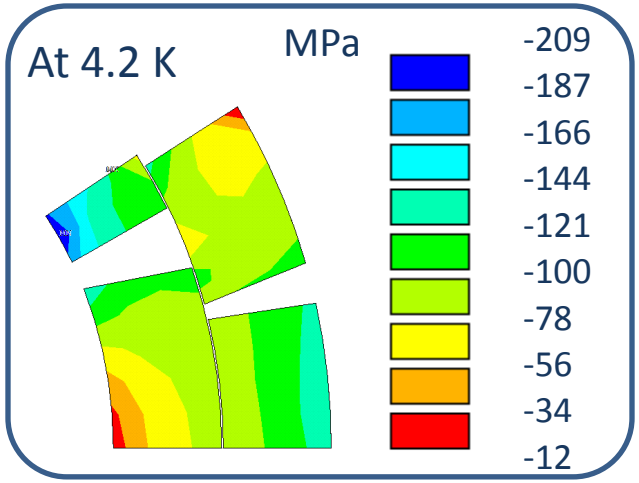
- 78 microns at 219 T/m
- 53 microns at 180 T/m
- 22 microns at 120 T/m

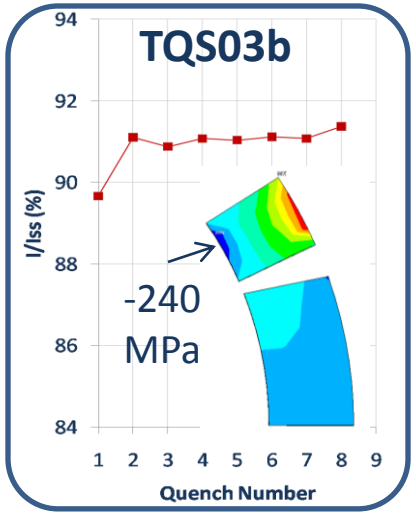
Displacement scaling 30

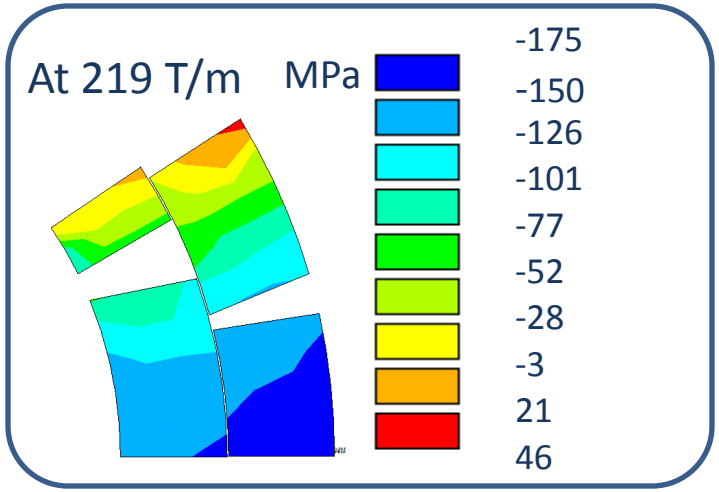
Coil azimuthal stress distribution





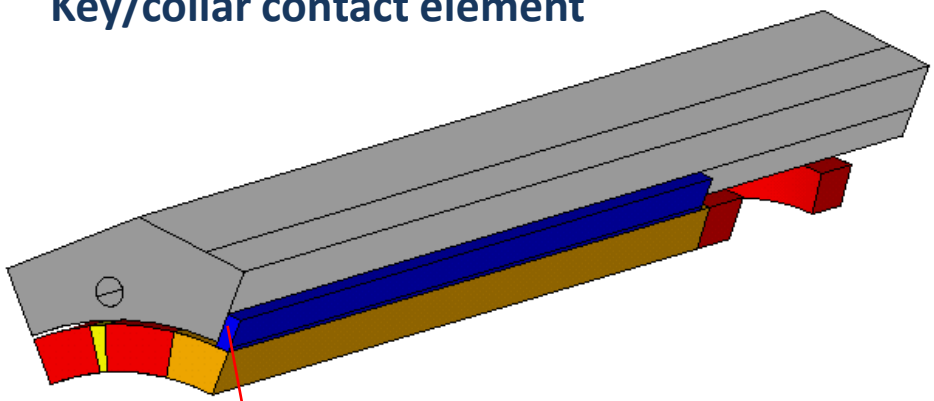


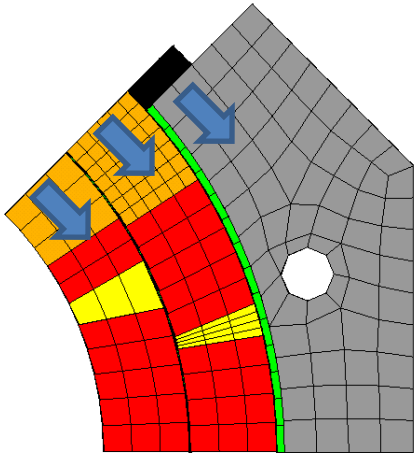




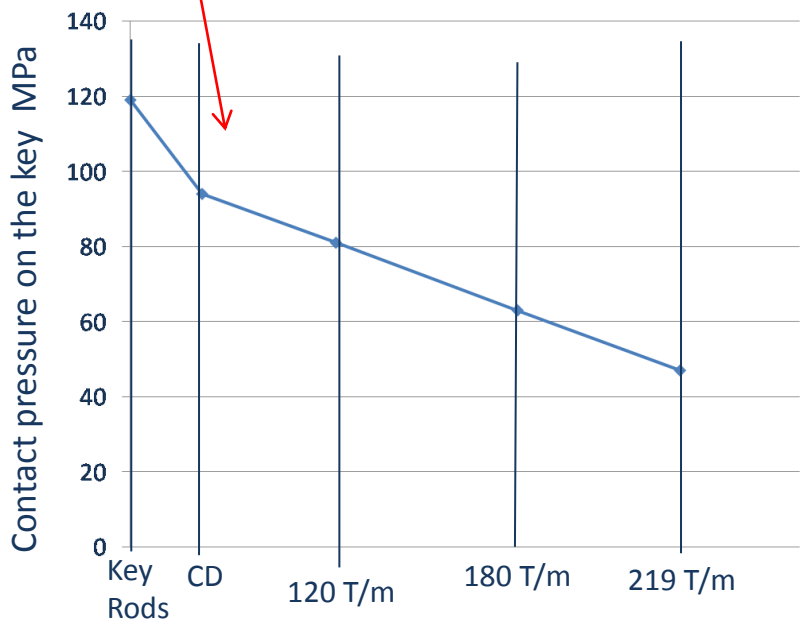
Alignment conservation

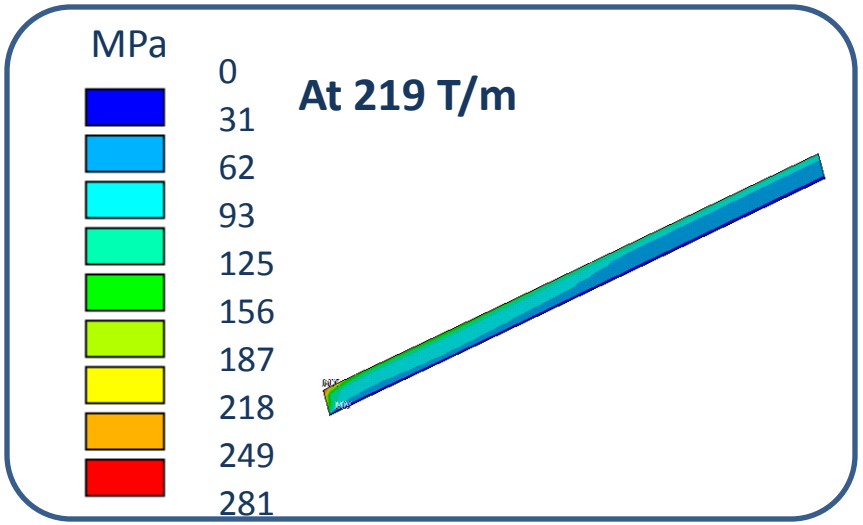
Key/collar contact element



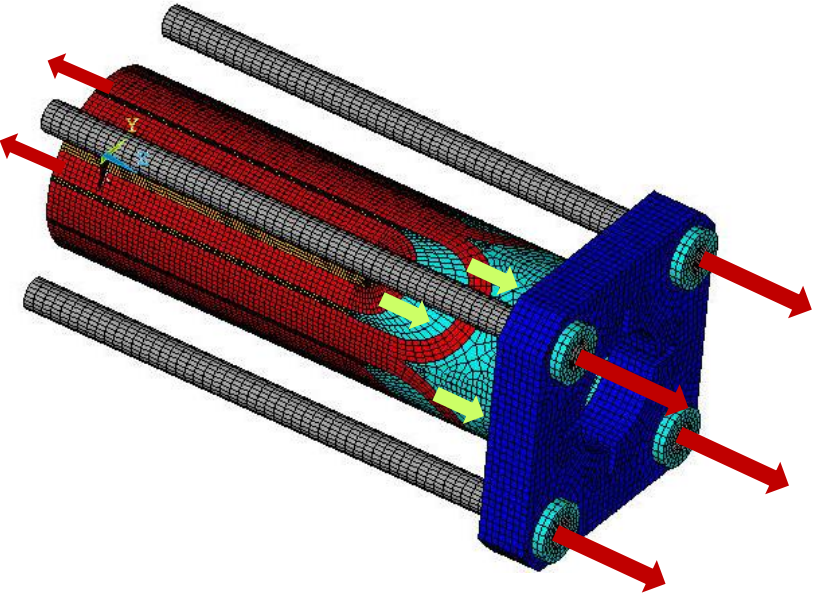


Aluminum collar intercepting ~25 % of the preload



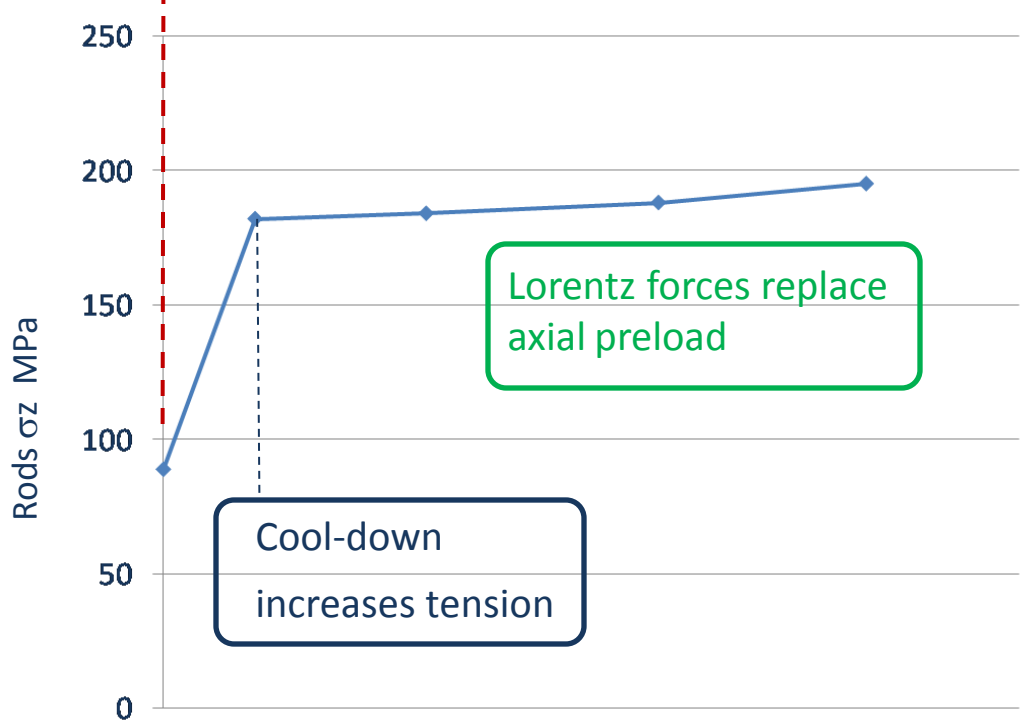


Axial preload

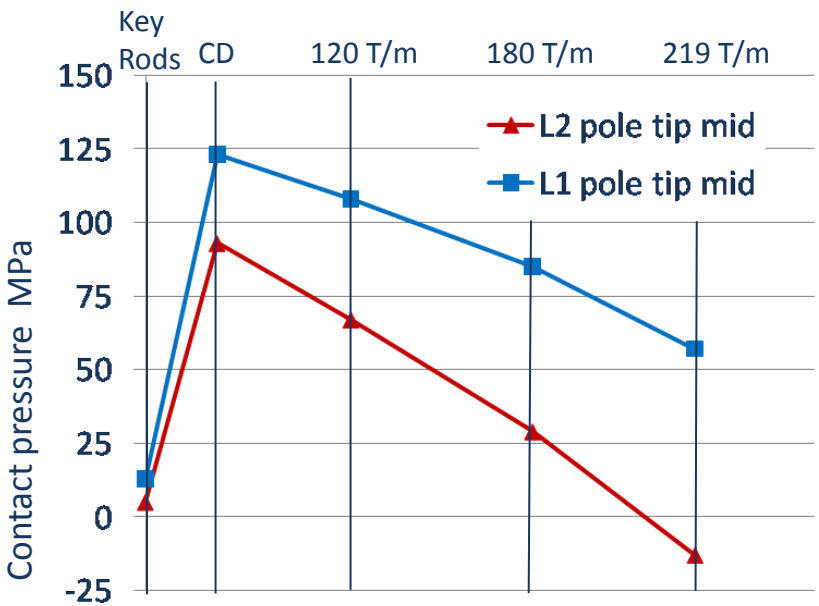


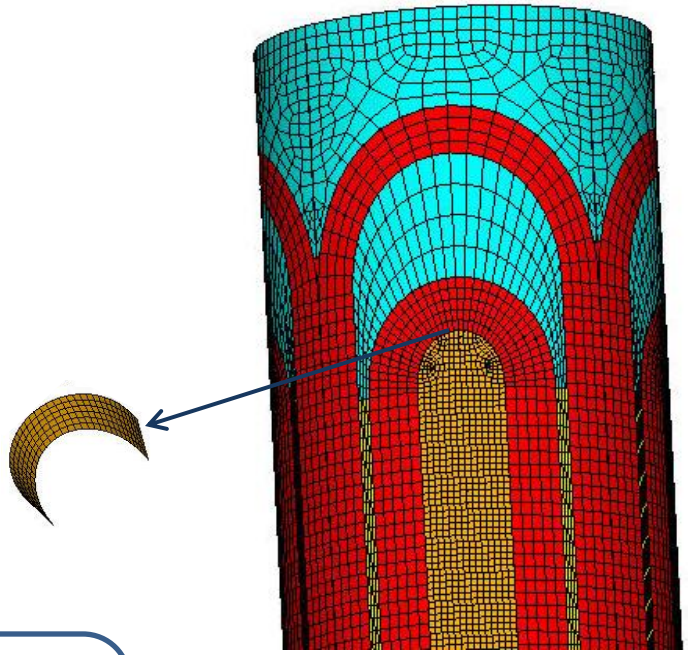
Four 31.75 mm diameter aluminum axial rods

Rod pre-tensioning at room temperature preloading coil axially



Axial Loading





Total axial pre-stress applied

Fz tot ~ 600 kN

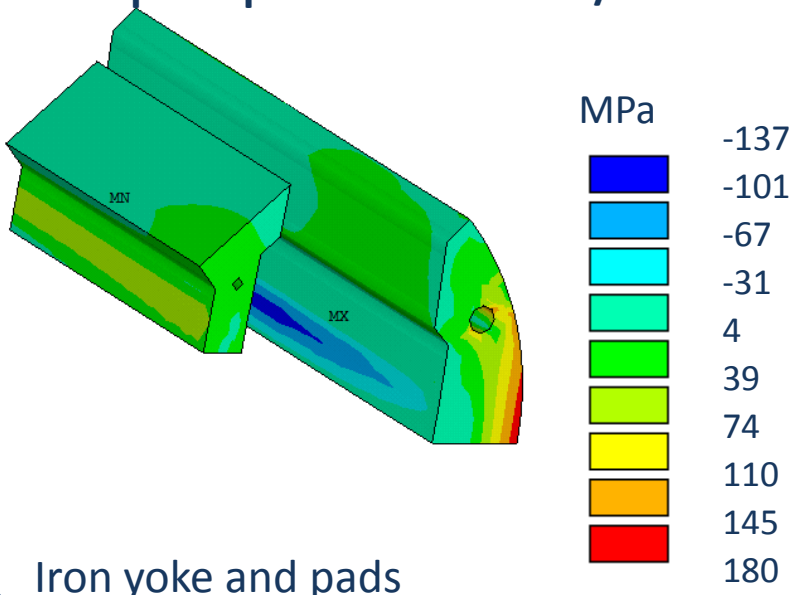
Total axial Lorentz force

Fz Layer 1 = 0.48 MN

Fz Layer 2 = 0.92 MN

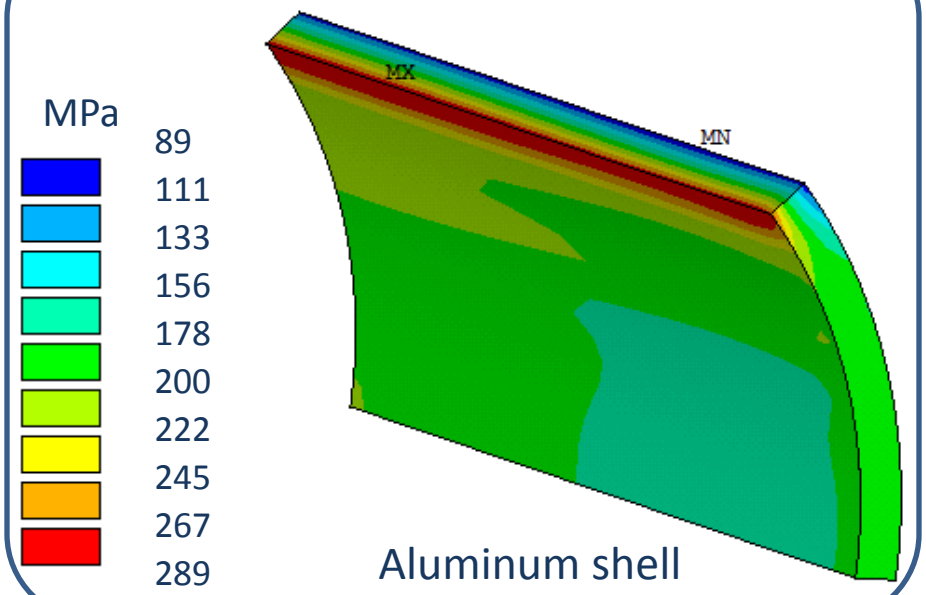
Structure components

First principal stress at 219 T/m



Iron yoke and pads

Azim stress at 219 T/m



Aluminum shell

Conclusion

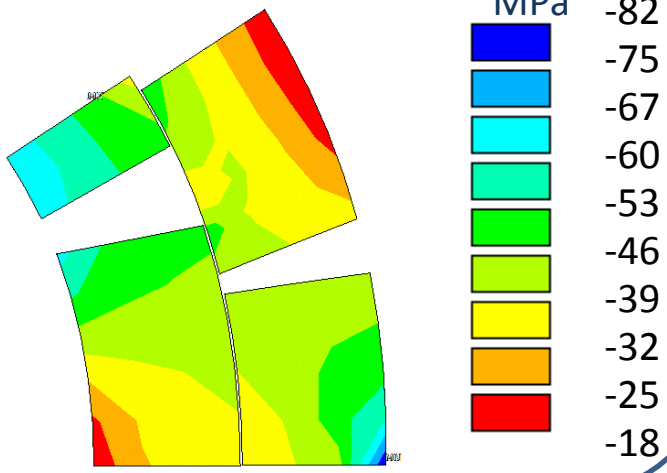
- Mechanical structure providing support up to 219 T/m
- Mechanical structure providing alignment from coil to shell

Next Steps

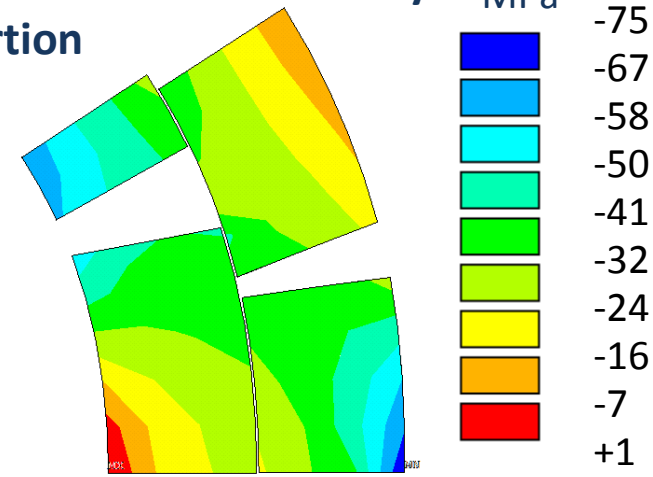
- Mechanical model with aluminum dummy coils

Appendix

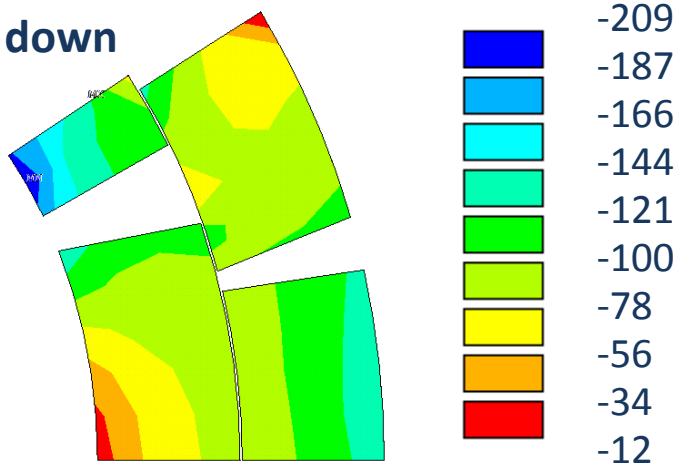
Coil azim stress – Bladder op



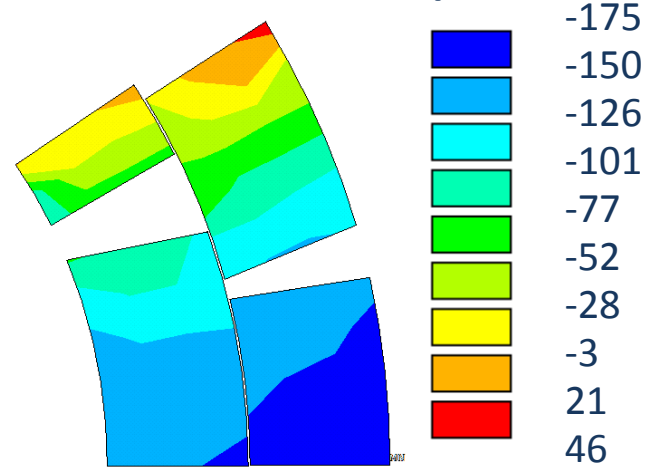
Coil azimuthal stress – Key insertion



Coil azim stress cool down



Coil aziml stress 219 T/m



Appendix II