Magnet WS -- MPD Magnet

A. Bross

ND general meeting

9/18/19

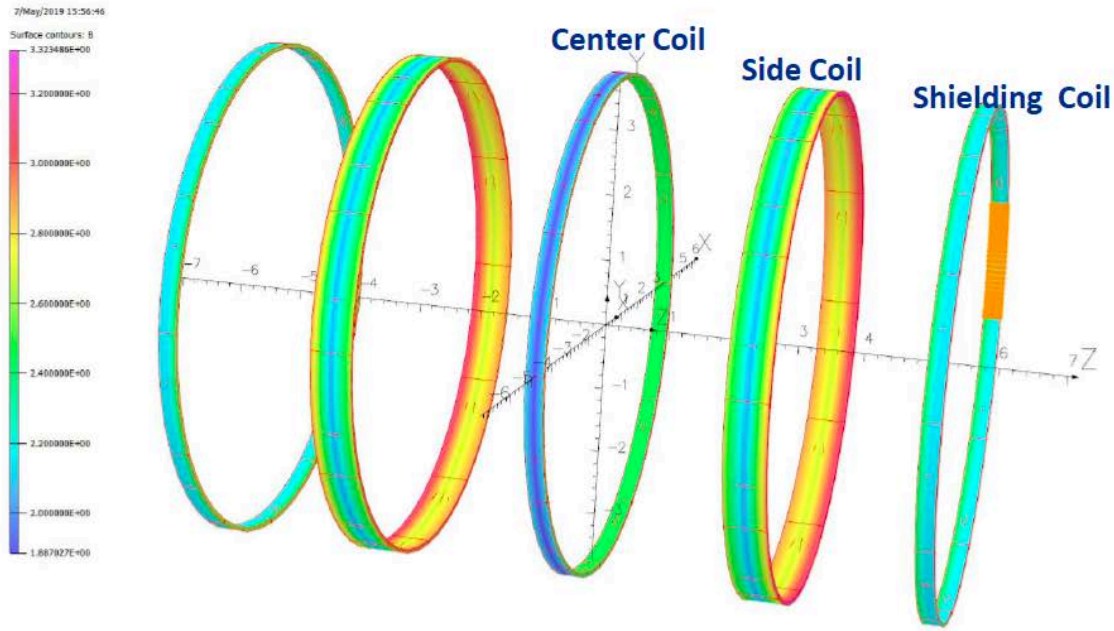
Superconducting 3-coil Helmholtz with 2 superconducting bucking coils

- Overarching requirements
  - Large acceptance for particles leaving LAr
  - Present minimal mass
- Central field = 0.5T

5 Coil system

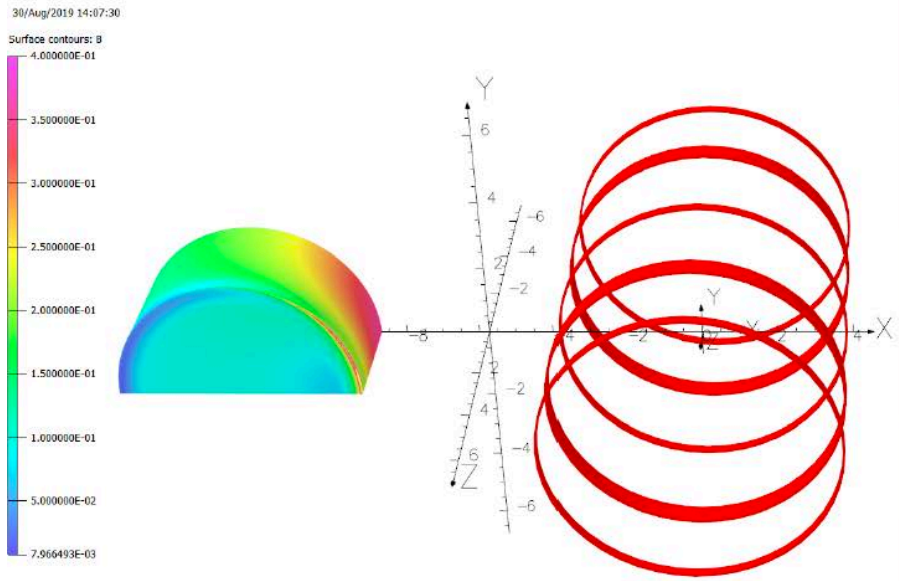
- Side coils at 2.5 m, shielding coils placed at 5 m from the magnet center in Z.
  - All coils have the same inner radius (3.5m)
  - Center and shielding coils are identical.
- Basic magnetic, cryostat and structural designs complete
- Design Team
  - Vladimir Kashikhin, Colin Narug, Thomas Strauss (TD) [Sandor Feher]
  - Don Mitchell (PPD)
  - Terry Tope (AD) [Jay Theilacker]

Coils



- Peak coil fields: 2.53 T (center), 3.32 T (side) 2.72 T (shield).
- Total stored energy 109 MJ
- Forces Fz : 0.0 (center), - 8.2 MN (side), 4.5 MN (shield).
- Side coils at 3.0 m, shielding coils placed at 5.5 m from the magnet center in Z.
- All coils have the same inner radius 3.8 m and outer radius 3.862 m.
- Center and shielding coils are identical and have the same number of ampere-turns.

Stray field analysis



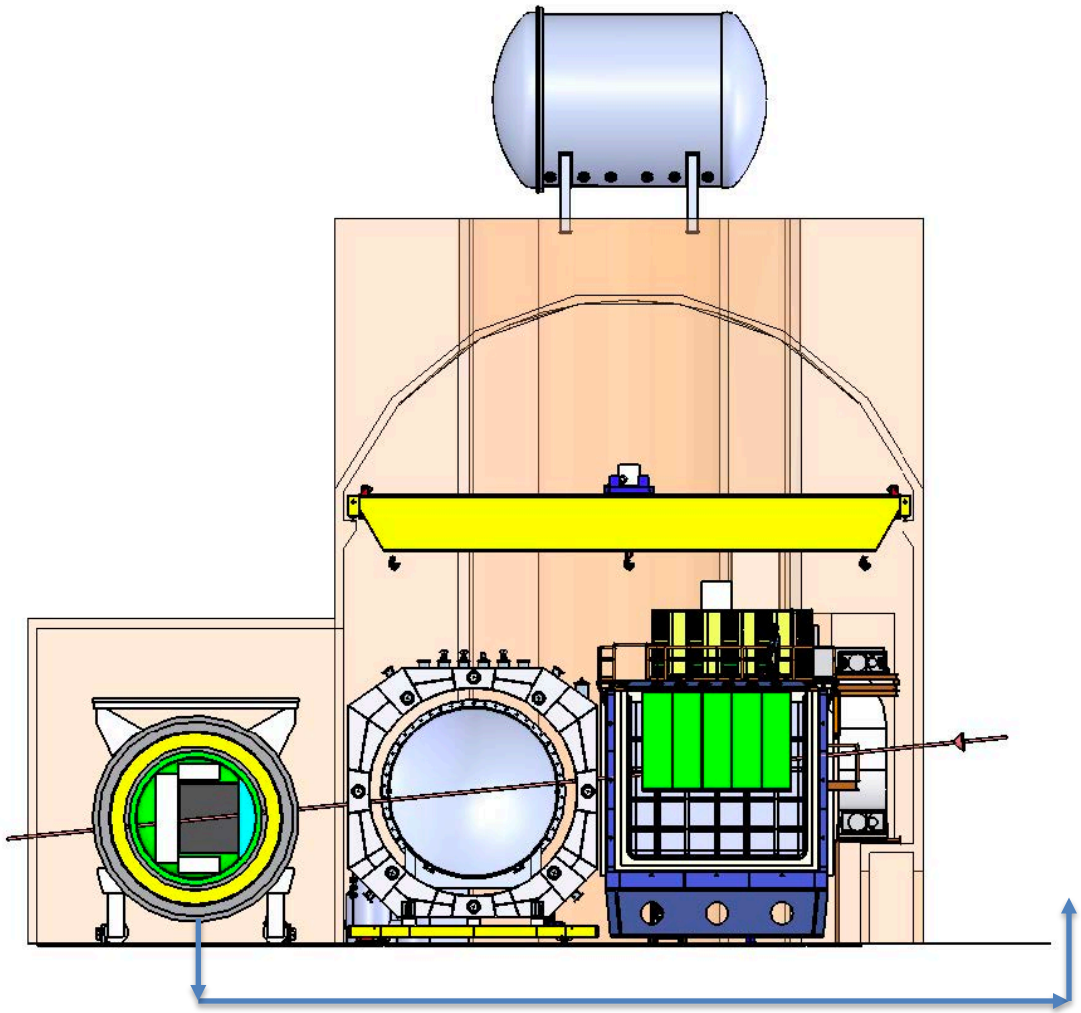
N	Coil	Iw MA	Fz MN	Fx kN
1	Shield	1.08	-4.38	-164
2	Side	-2.46	8.28	23
3	Center	-1.08	0	485
4	Side	-2.46	-8.28	23
5	Shield	1.08	4.38	-164
KLOE	Solenoid	0	0	0

KLOE iron max field from ND is 0.4 T at zero current in KLOE solenoid.

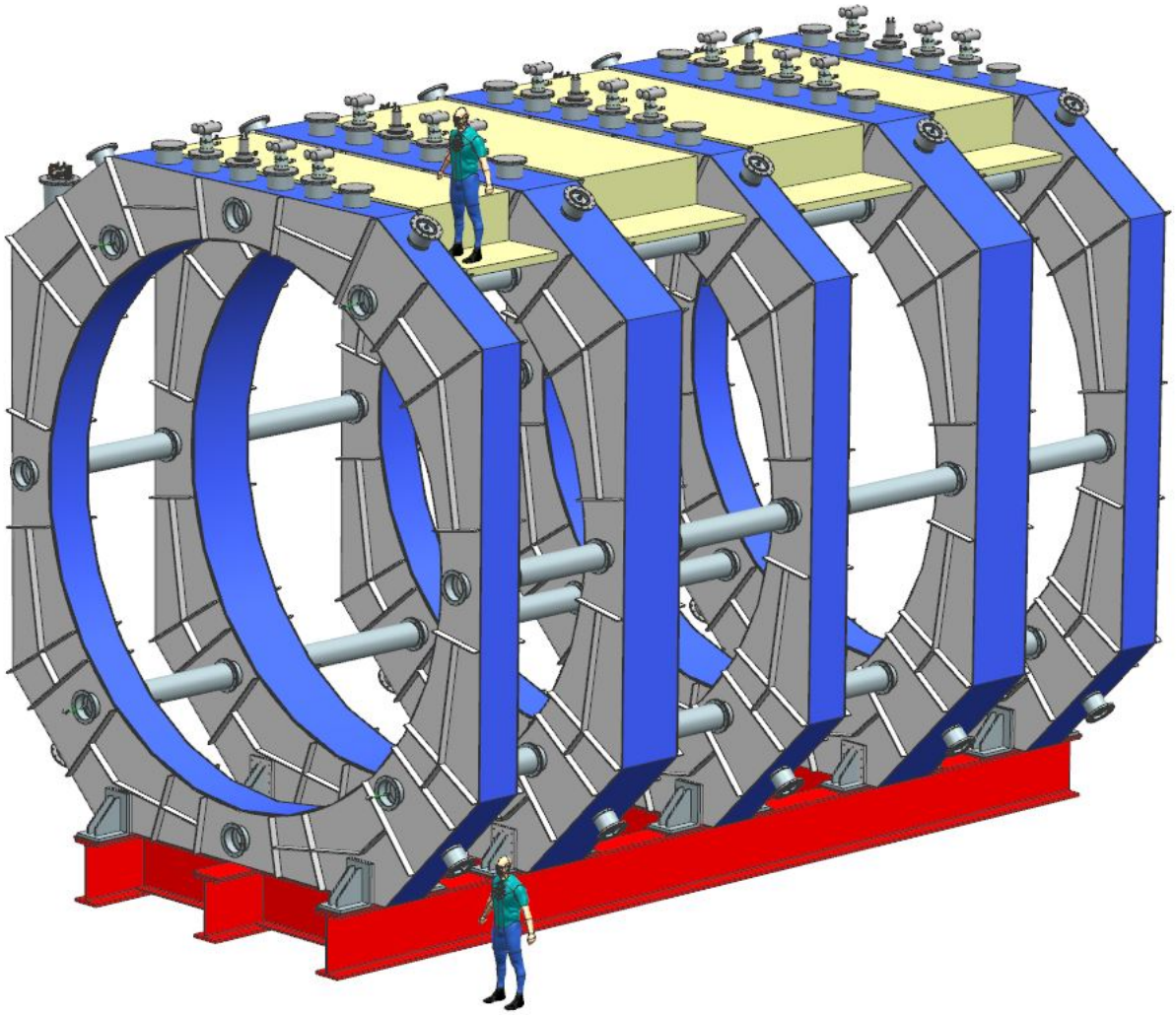
Horizontal force between magnets (on ND coils) is 202 kN.

Horizontal force on KLOE solenoid is zero.

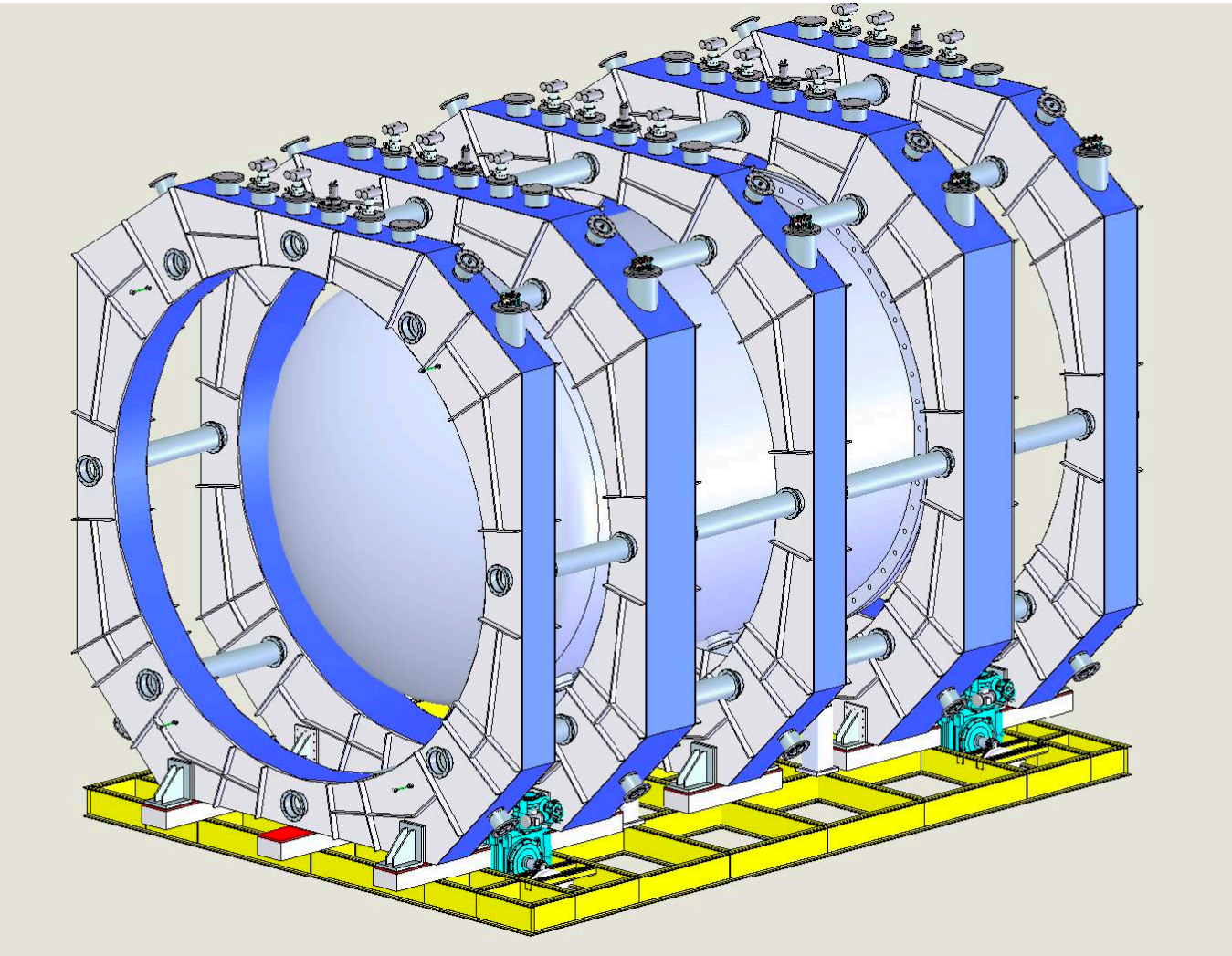
Alternate alcove position



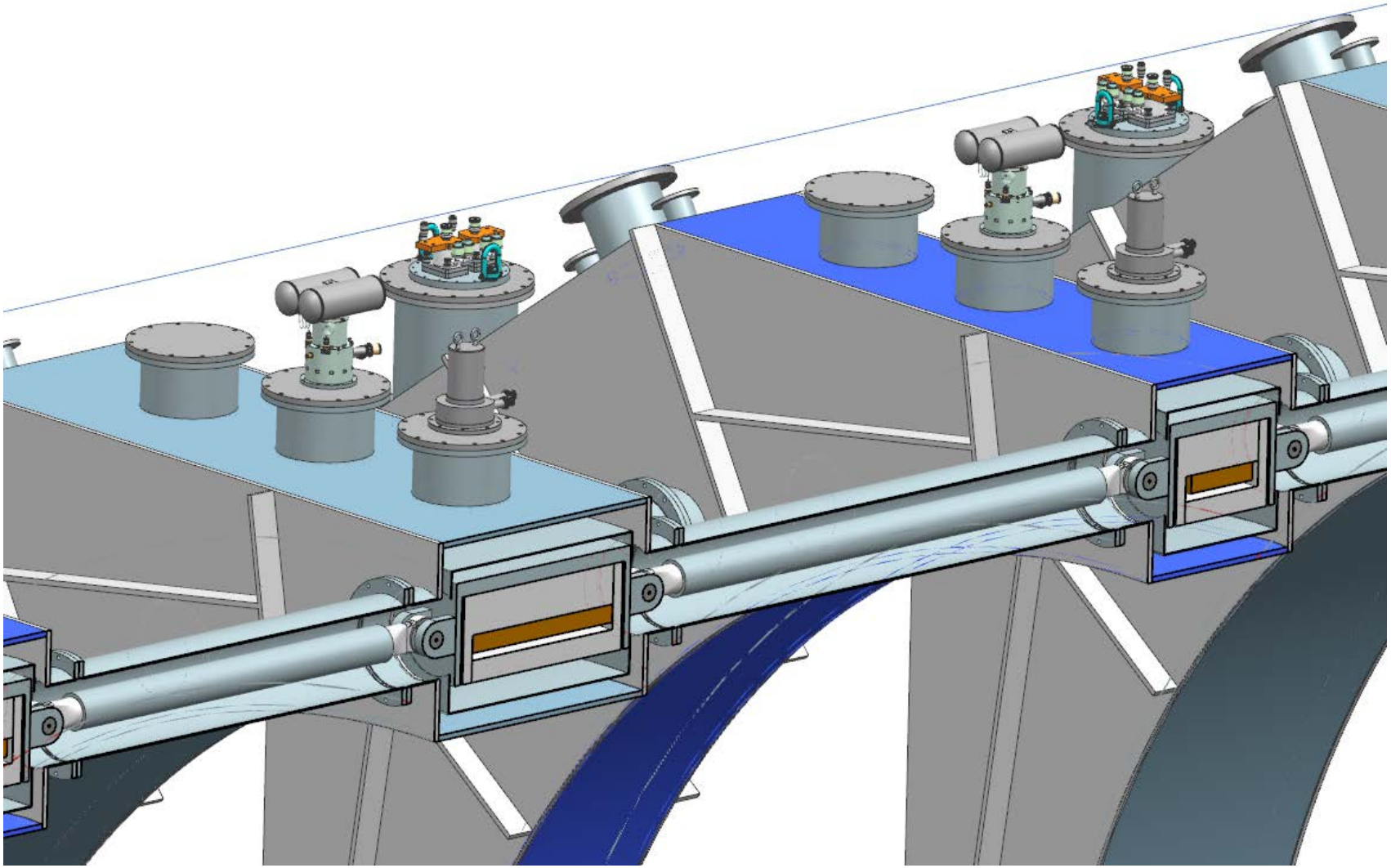
Mechanical/cyro design



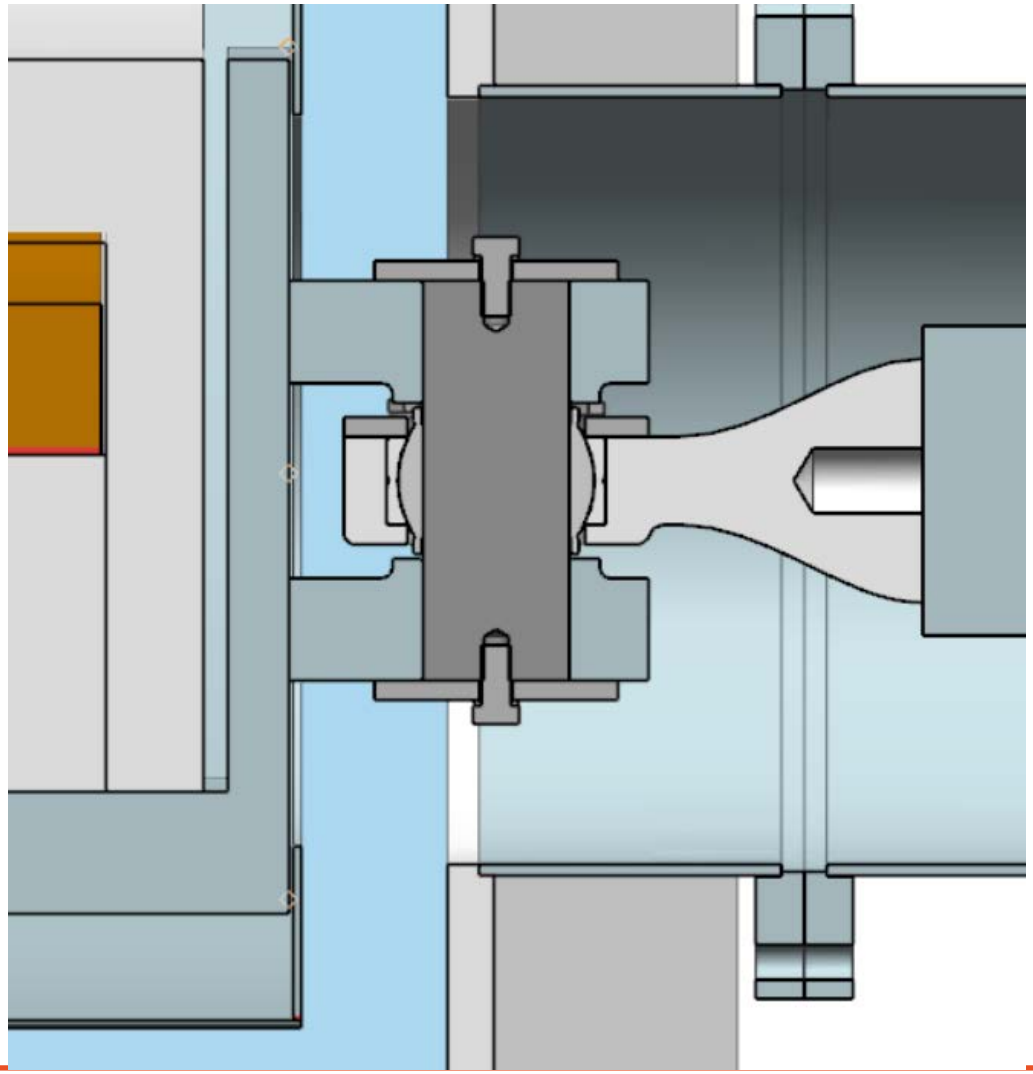
With HPgTPC

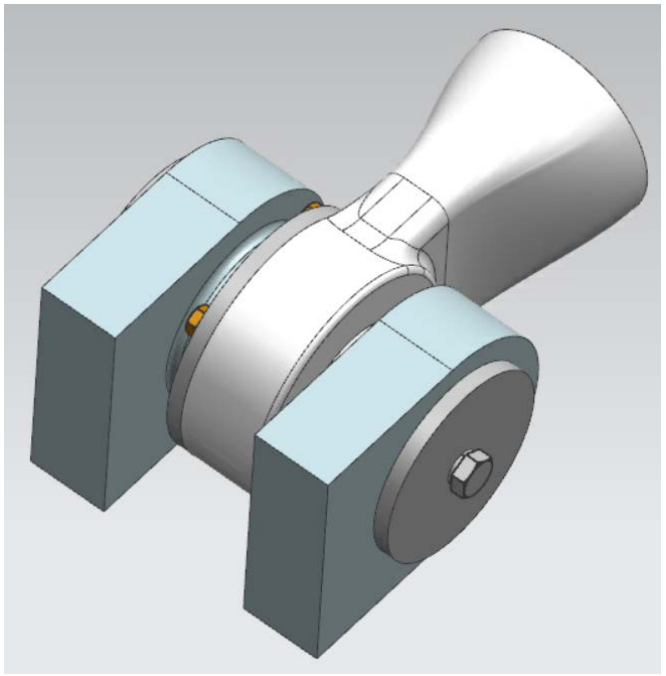


Mechanical details

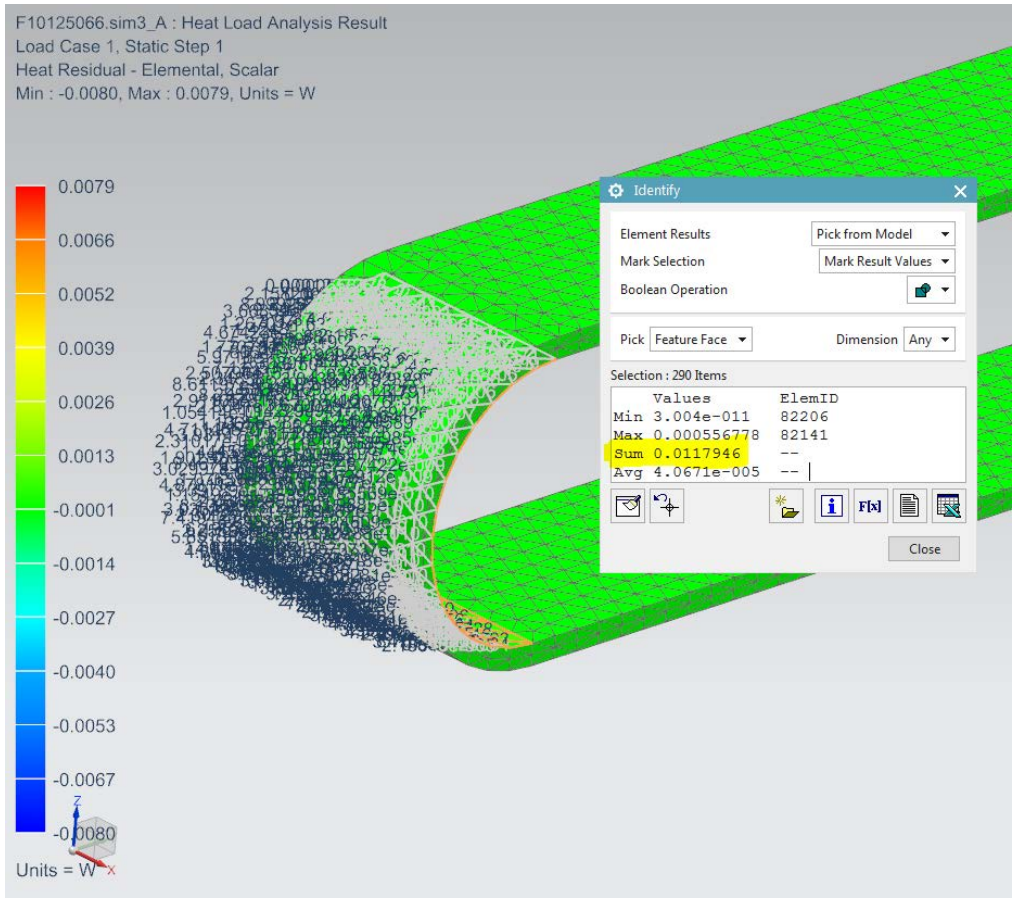


Mechanical details II



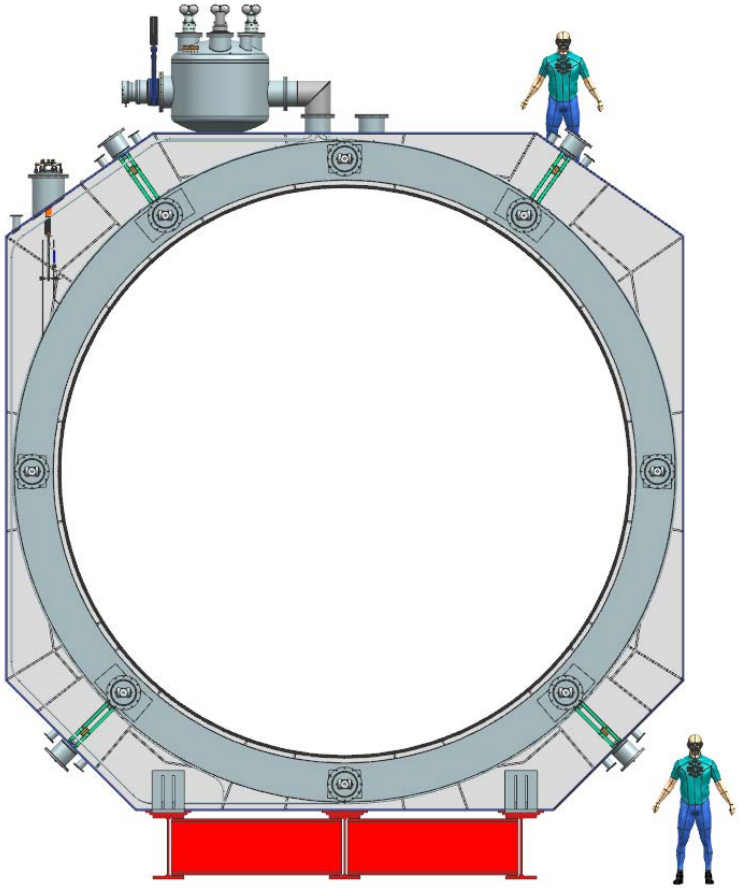


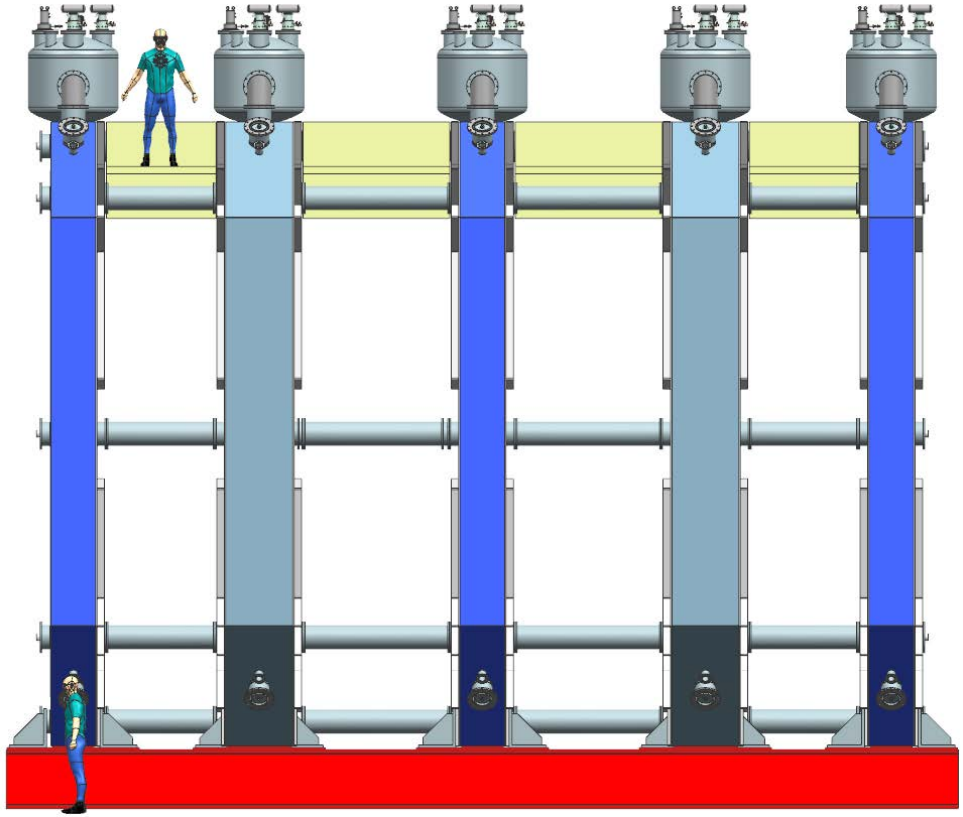
Cold mass supports



- 4 Supports = .192W total load into coil (4K).
- Radiative load to 4K <1W/coil
- Cyro-cooler option still viable, if coils powered in series
  - Only 2 leads then @ 3W/lead

Cyro-cooler option

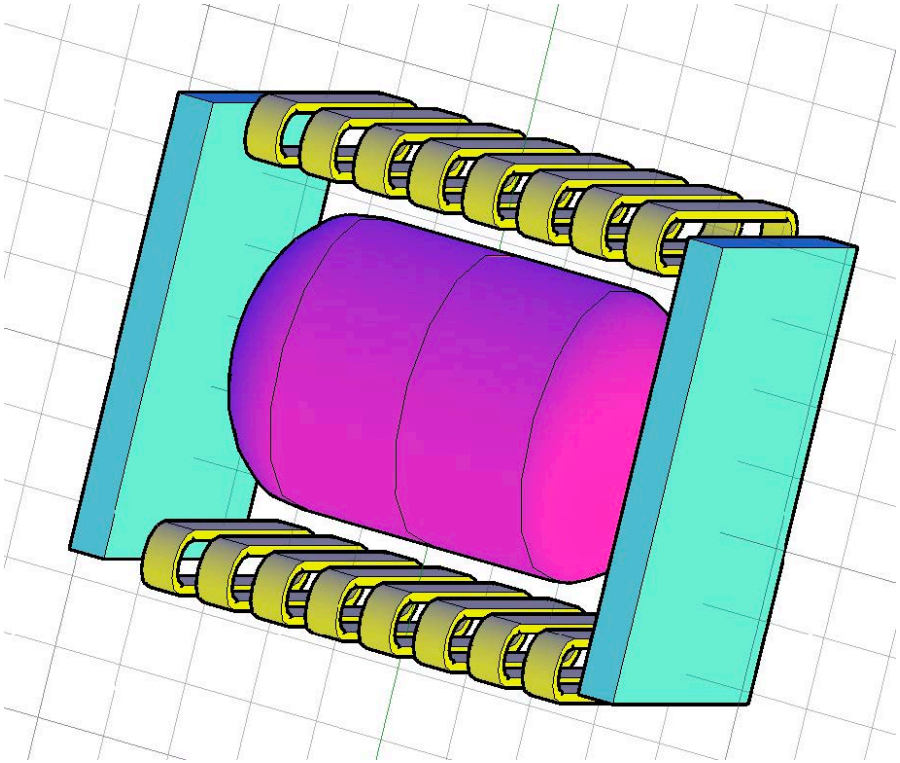




Excellent progress, but much to do

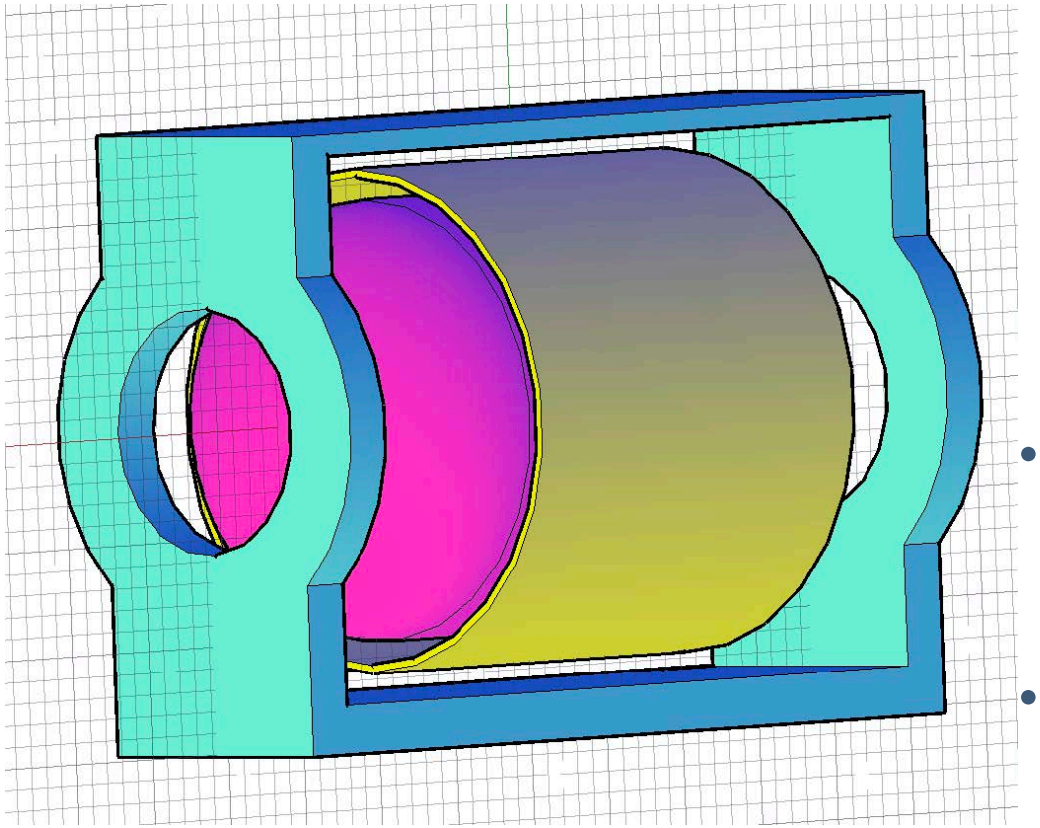
- Analyze magnet loads induced by proximity of KLOE magnet
- Side loads will need supports that will induce more heat loads – impact on cooling system
- Design side load supports
- Support cryo-team with any required mechanical design work to help determine the cooling path
- Reduce footprint of magnet system to fit, lengthwise, in ND hall
- Analyze cryostat shell under various loading schemes and design to code allowed deflections and stresses
- Work with Rockwood Composites to properly size the straps
- Develop the installation and transportation mounts within the 16 ports
- Work with Analysis group to perform a complete coil analysis under gravity, cool-down, and energizing phases of operation
- And more…

Alternate design I: Double-dipole



- Andrea Bersani (Genoa)
  - Developed during WS!
- Ups and downs of the iron slabs
  - they are an order of 500 t problem
  - they can provide independent path load for pressure vessel, calorimeter and coils
- W.r.t. Helmholtz coil design:
  - shorter in beam direction
  - taller
  - no material along beam line

Alternate design II: Solenoid w/ PRY



- Calorimeter is integrated "around" or inside solenoid cryostat
  - Fit in access shaft as currently configured?
    - Depends on cryostat thickness
- TPC is inserted via rails integrated in the calo-cryo system
- possibly calo "end-caps" can be assembled at this stage
- Detector is inserted laterally in the beams

Conclusions

- 5C Helmholtz design reaching maturity
  - No show-stoppers
    - Stray-field analysis continues
- Alternate designs will be investigated by Genoa group
  - Discussion at ND WS at DESY in October