भाभा परमाणु अनुसंधान केंद्र
BHABHA ATOMIC RESEARCH CENTRE

Design of DUNE ND Magnet

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Outline

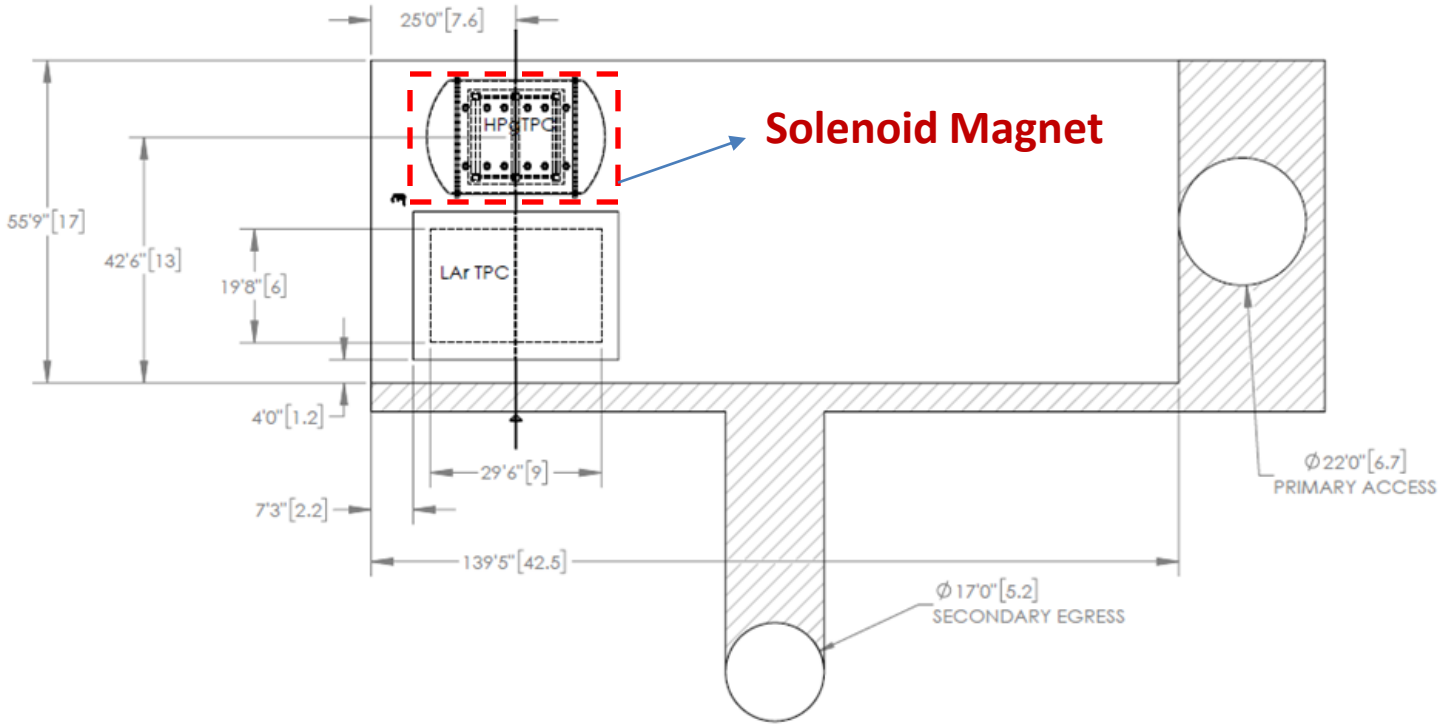
In last meeting (30 November, 2018), main concerns were as follows

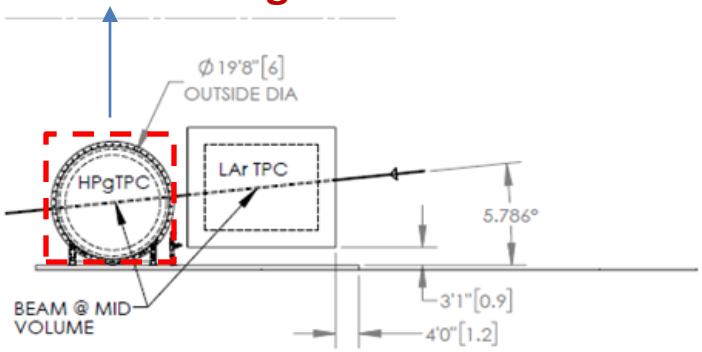
a. **Thickness of copper coils in view of physics requirements**
b. **Stray fields generated by the magnet**

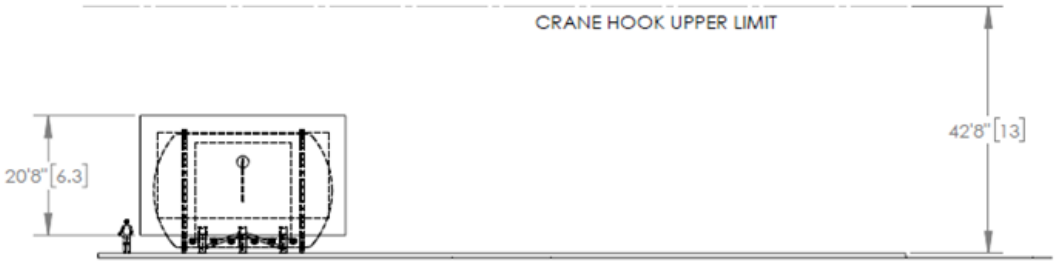
New layout of magnet similar to the 2015 BARC design is used as the basis for the new design.

The dimensions are modified to house HPgTPC

Introduction

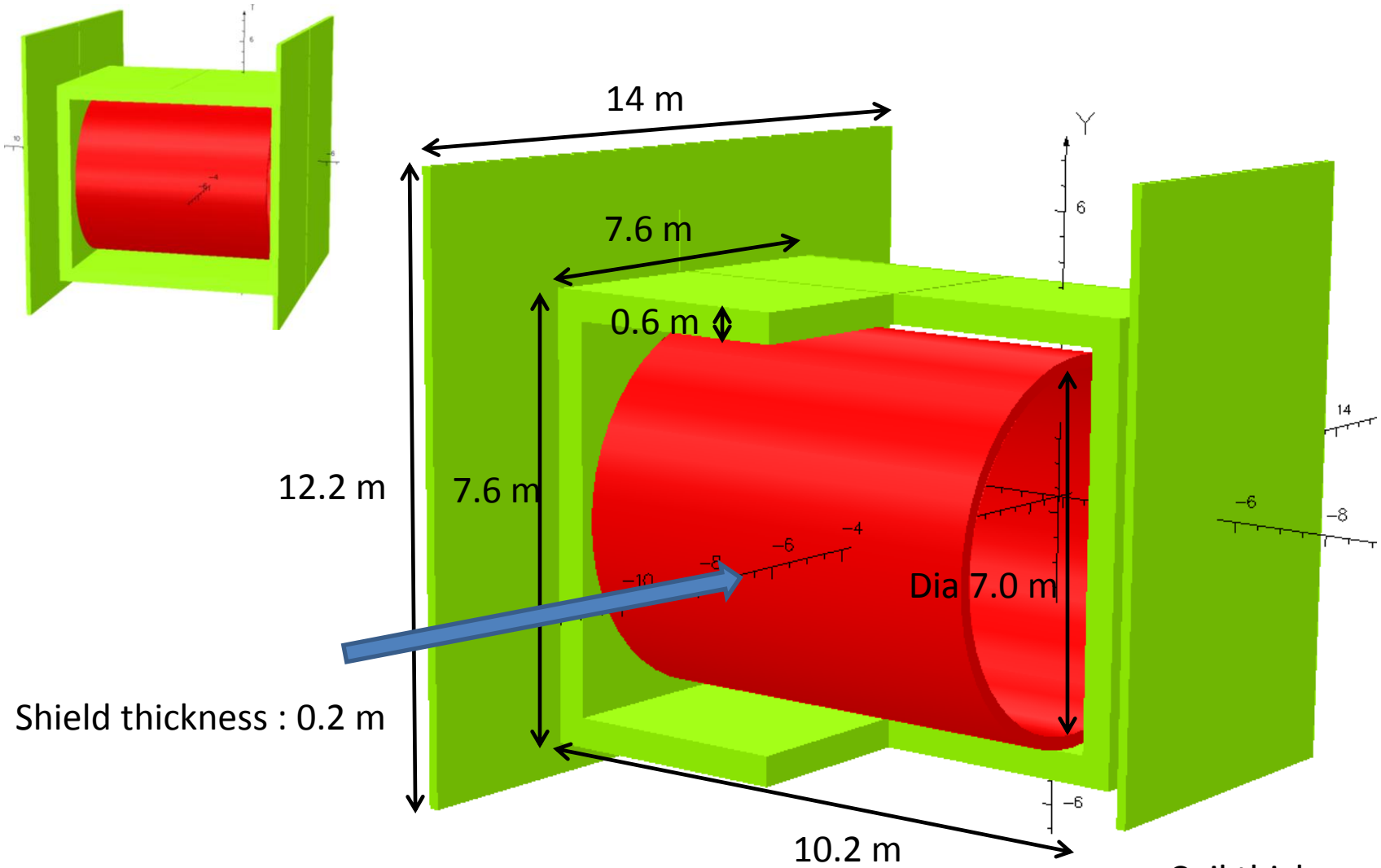




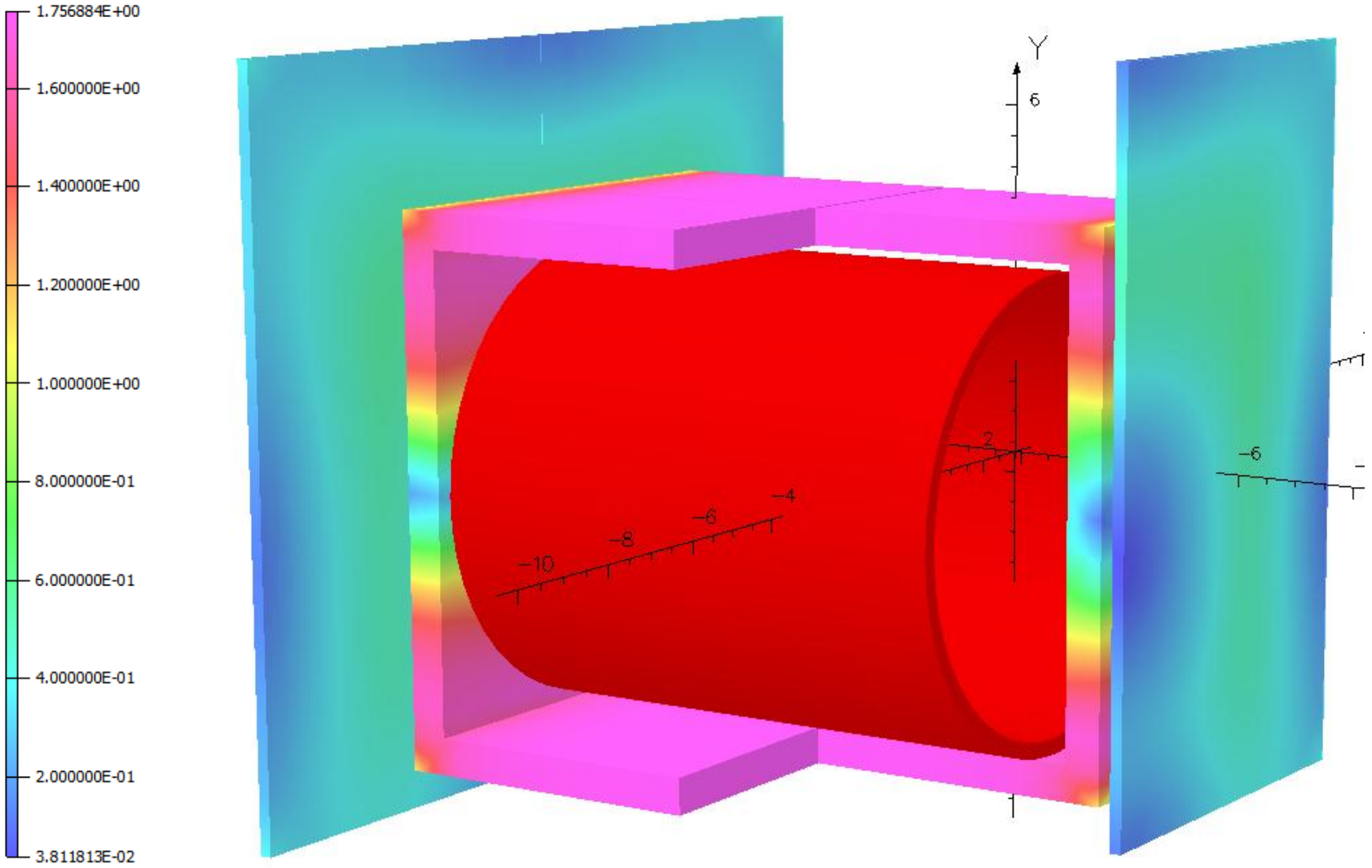


Layout Courtesy :R. Flight & F. Feyzi

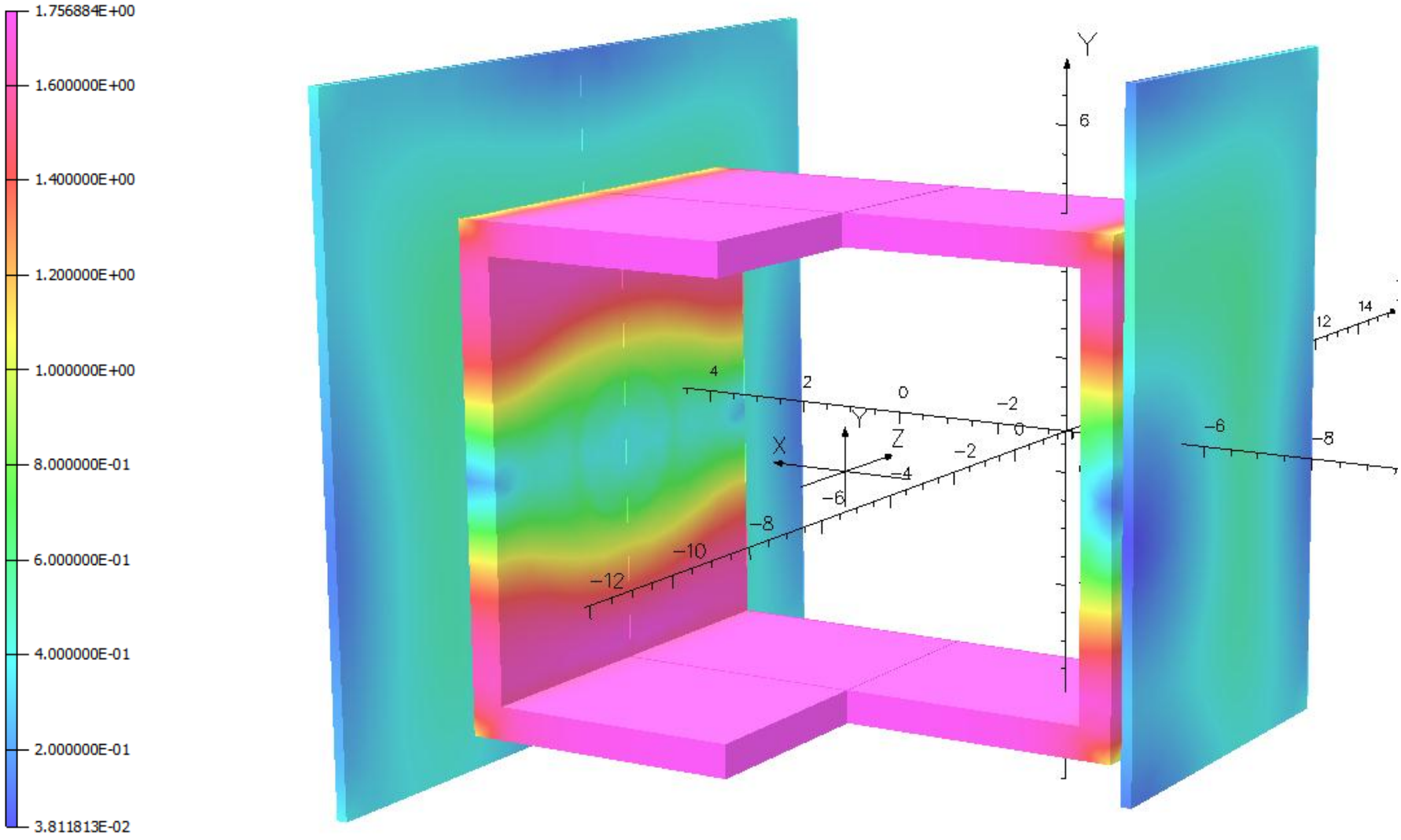
Magnet Geometry (3/4 view)



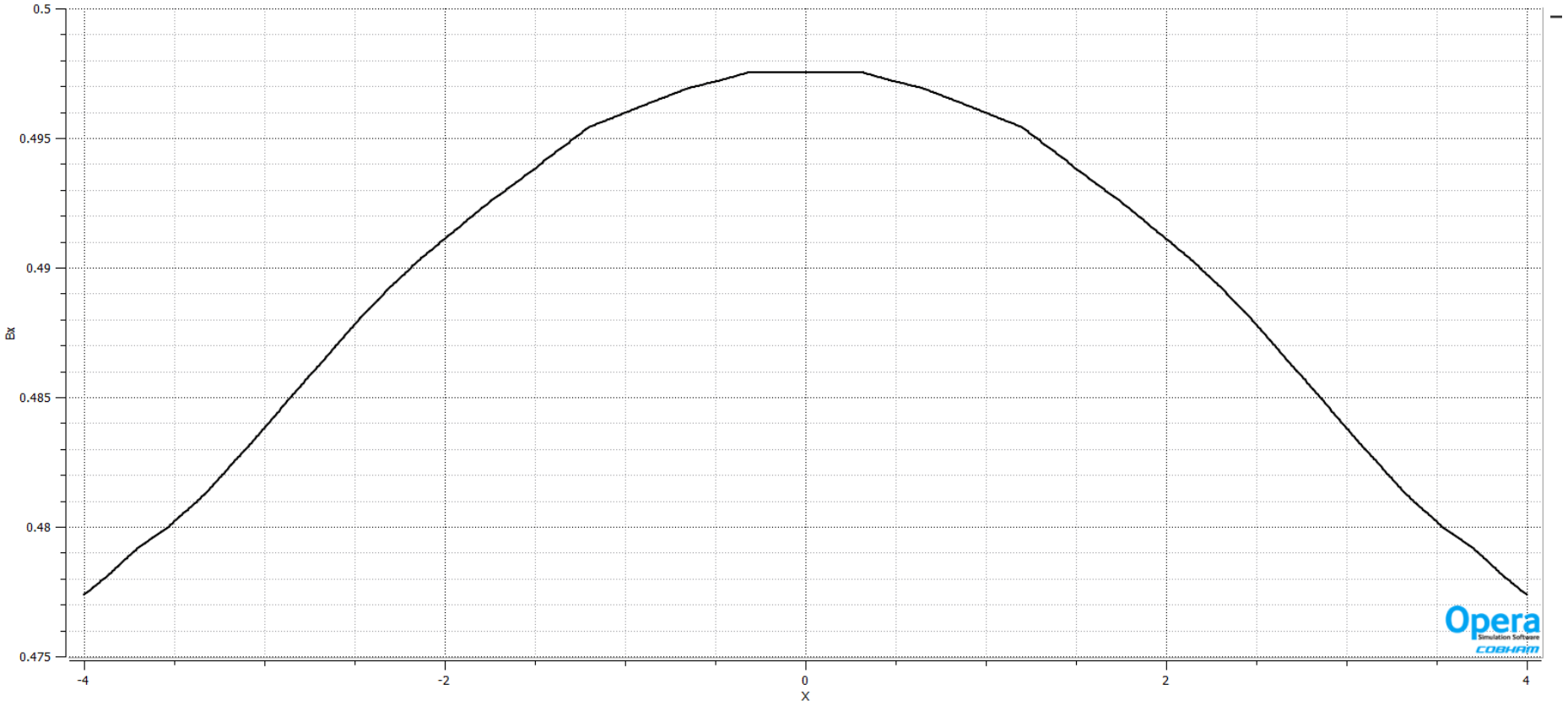
Electromagnetic simulation



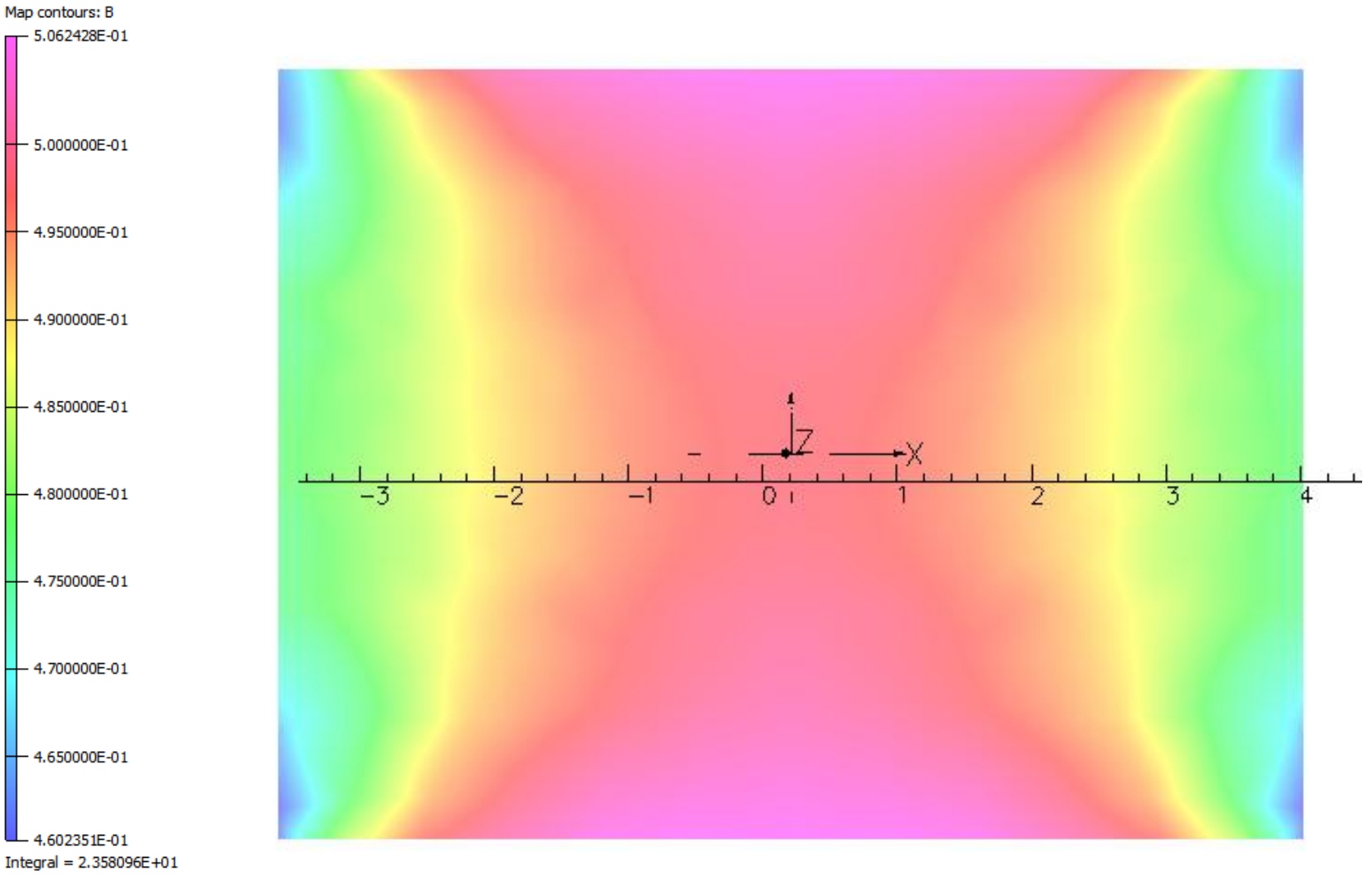
Electromagnetic simulation



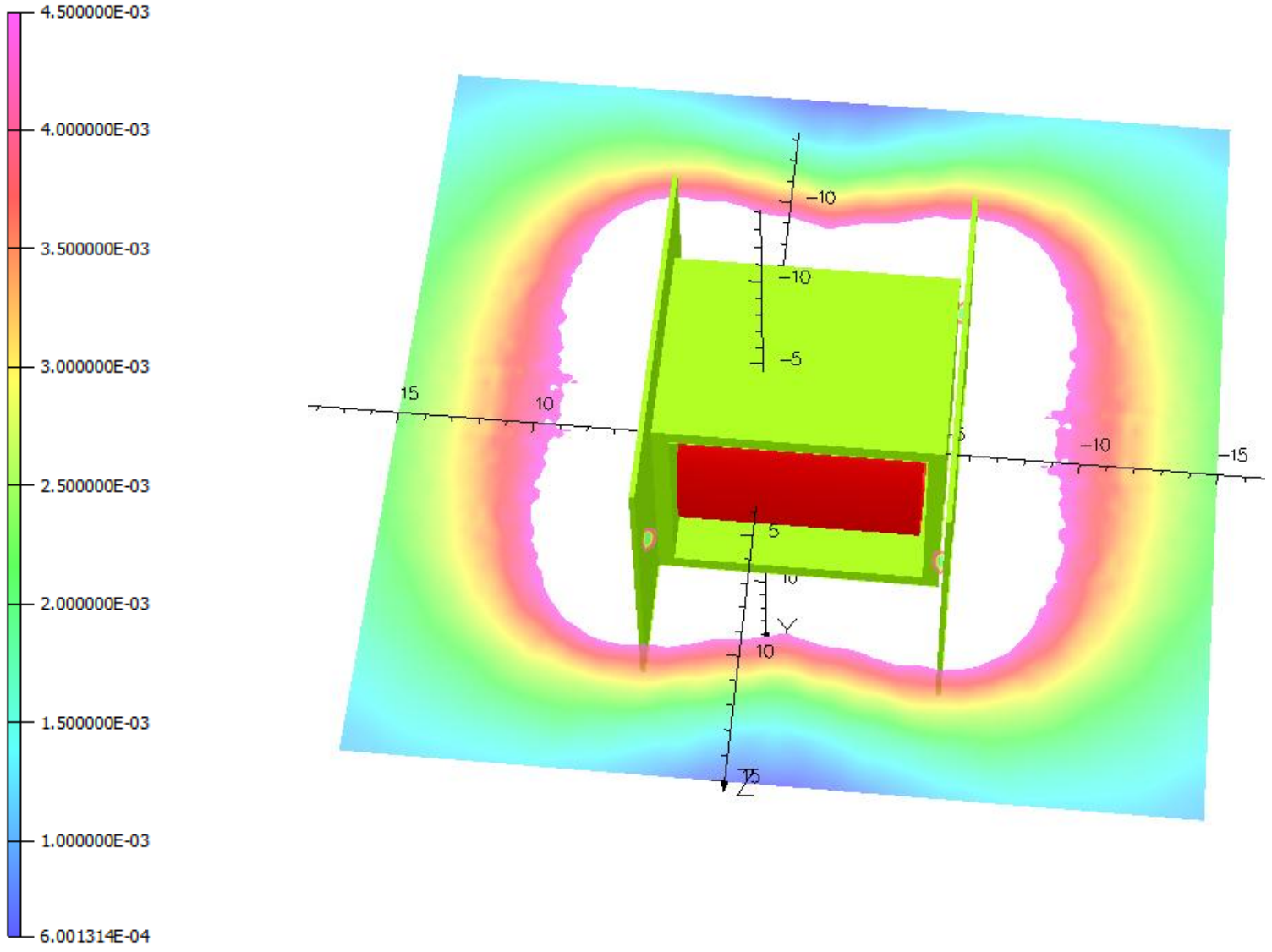
Magnetic Field profile (along axis)



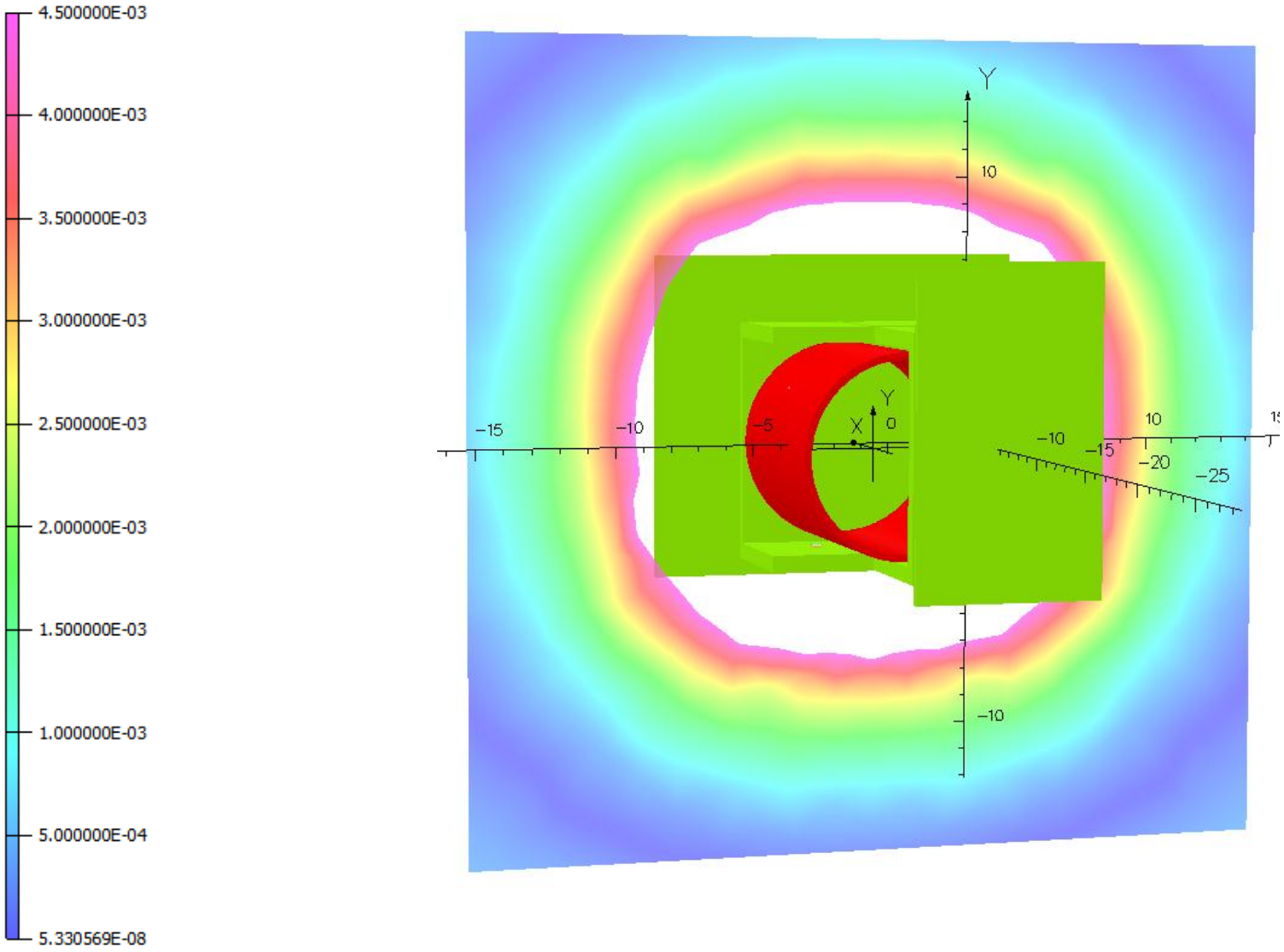
Magnetic Field profile (Longitudinal plane)



Fringe Fields in Horizontal Plane



Fringe Fields in Vertical Plane



Summary of Electrical Design

SN	Parameter	Value (Copper)	Value (Copper Modified)	Unit
1.	Coils Type	Double Pancake	Double Pancake	-
2.	Number of Double pancakes	52 10 turns per pan cake	52 6 turns per pan cake	-
3.	Copper Coil Thickness	**0.500**	**0.260**	-
4.	Conductor Dimensions	80 X 80 Hole dia : 36	80 X 80 Hole dia : 36	mm
5.	MMF	**4,600,000**	**3,660,000**	At
6.	Current density	1.65	2.18	A/mm sq
7.	Power dissipation per pancake	57.5	63	kW
8.	Total Power dissipation	3	3.28	MW
9.	Chilling power consumption	1	1.10	MW
10.	Pumping motor power consumption (gross estimate)	0.25	0.20	MW
11.	Water velocity	2.5	2.5	m/s
12.	Total pressure drop	5	4	bar
13.	Water temperature rise	5.38	5.71	C
14	Weight per pancake coil	11	6.7	MT
15	Magnet Coil OD	8	7.52	Meter
16	Total power dissipation	~4.25	~4.5	MW

Summary

1. A Modified magnet design with iron yoke and shield is used.
2. The MMF required in modified design reduced from 4,600,000 to about 3,600,000.
3. The thickness of copper coil is reduced from 500 mm to 260 mm.
4. The shields on either side have reduced to fringe fields.

Collaboration may consider freezing the functional requirement specifications (FRS) for speeding the magnet design.

Thanks!

Outline

Dear Sanjay,

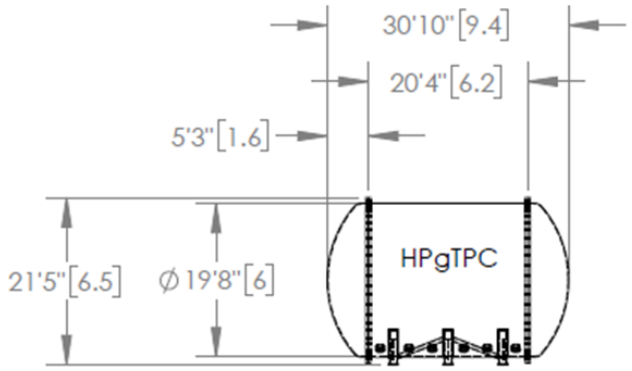
I was at CERN last week and spoke with Tom Taylor regarding the UA1 magnet. Although Tom did not have the engineering details, he believed that in UA1 (running with 0.7T), they used a thermal shield in order to control the temperature of the active detectors. The shield was thermally isolated from the coils, metal with water cooling. He thought that there was also forced air between the coils and the shield.

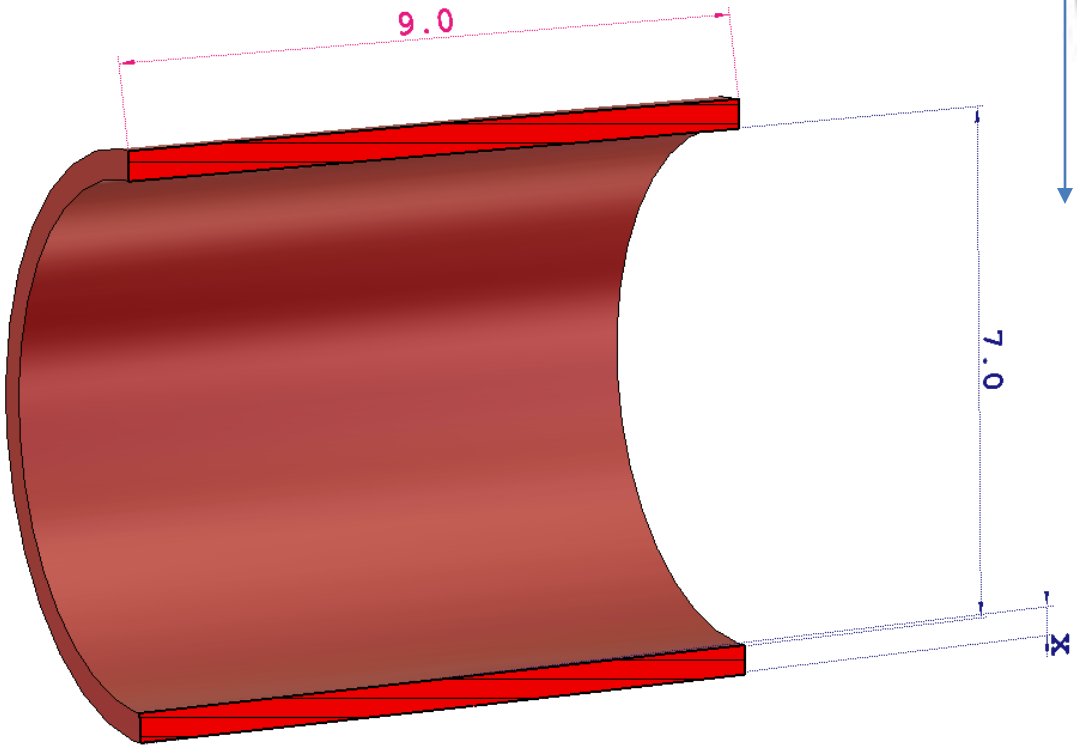
I would think that this approach would work with the original BARC design for the DUNE near detector magnet. This might be something your group could look into.

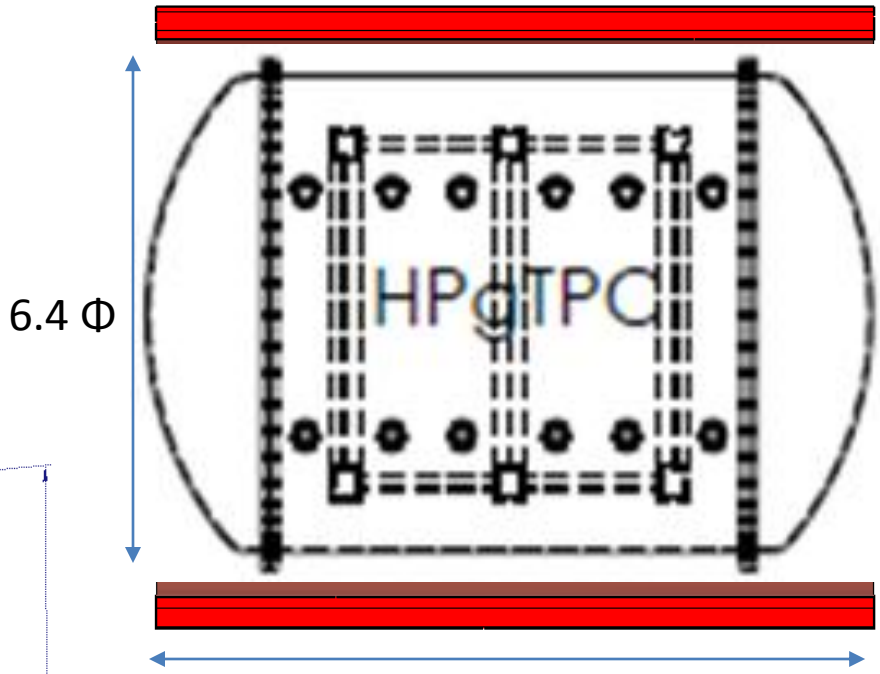
Best regards,

Alan

EM Coil layout and HPgTPC







HPgTPC dimensions taken from presentation done by F. Feyzi on November 14, 2018