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Iron Toroidal Magnets
Front absorber and back calorimeter

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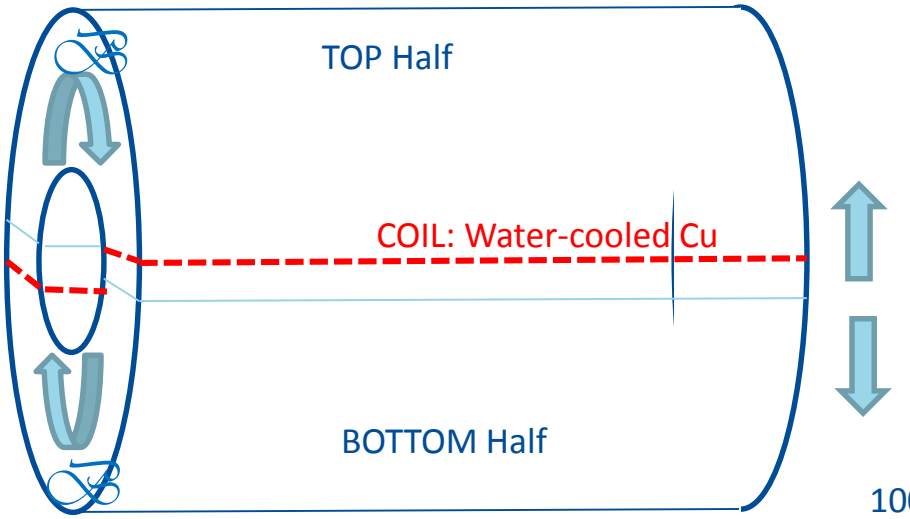
OUTLINE

- Magnet specification
- Magnetic field simulations and analysis
- Coils parameters
- Fringe field analysis
- Magnet conceptual design
- Summary

Magnetised Fe Toroids around "small" beam pipe

At front as absorber, at back as calorimeter

Fe cylinder (E.g. AISI 1010 ~0.1%C)



COIL: Water-cooled Cu
Field in Fe B ~ 2T at inner radius
~ 1T at outer radius

Field on beams small (5 Gauss?)
Thanks to Vladimir Kashikhin

100 GeV Muons bend in 3m @ 2T = 18 mrad

& Mult. Scatt. θ_{RMS} ~ 2 mrad

R_{inner} ~ 10cm. R_{outer} ~ 30 cm → Area 0.25 m^2

Length ~ 3m = ~ 18 λ_{INT}

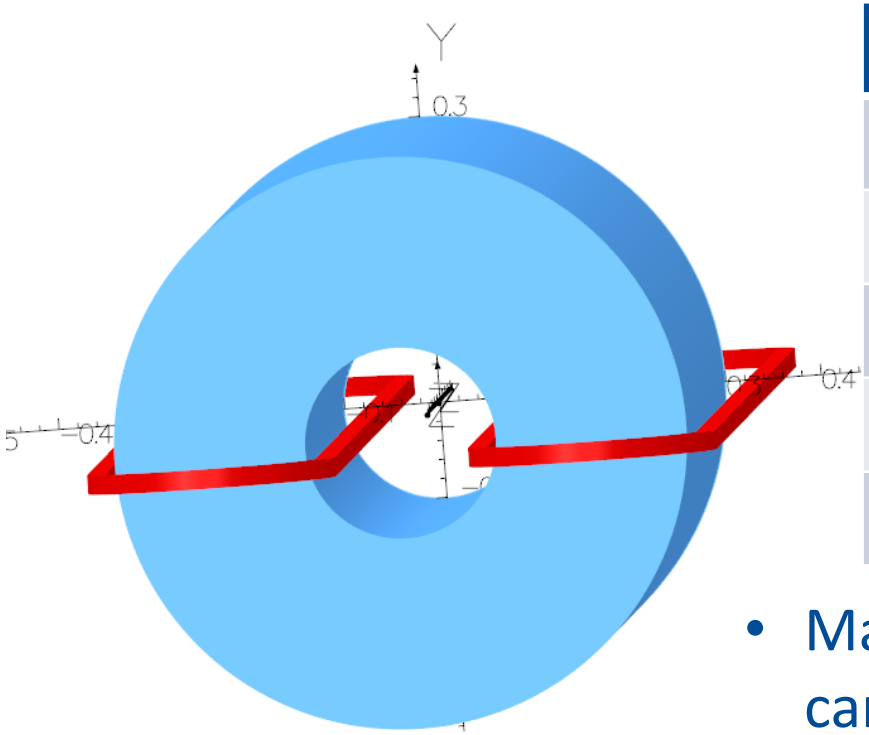
Stacked half-disks ~ 1" = 2.5cm thick

Top and bottom halves separate.

(Each half weighs ~ 3T if L = 3m)

FRONT CYLINDER @ z ~ 82m
Behind separation dipole D1 and Diode
BACK CYLINDER @ z ~ 120m = Calorimeter
Plates separated with detector layers

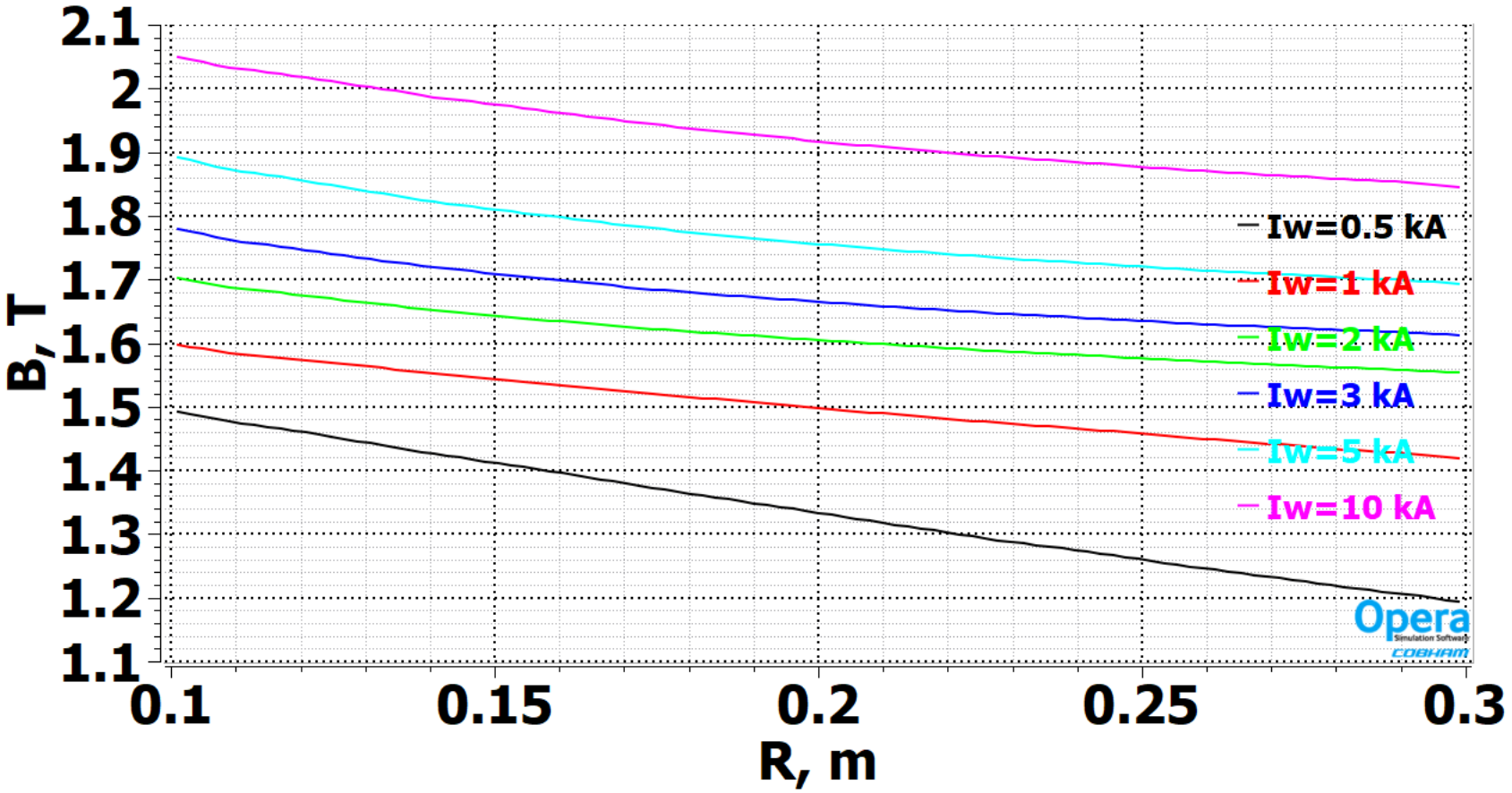
Magnet Model and Input Parameters



Parameter	Unit	Value
Inner radius	m	0.1
Outer radius	m	0.3
Length	m	3.0
Number of coils		2
Range of total currents	kA	0.5 - 10

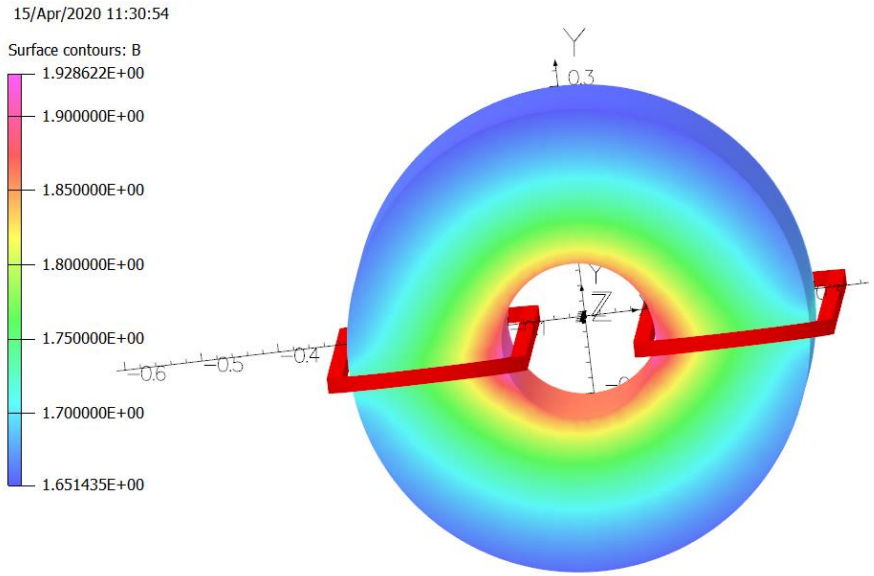
- Magnet core made from AISI 1010 low carbon steel.
- Coils wound from the copper hollow water cooled conductor.
- Magnet assembled from two halves split in the horizontal plane.

Magnet Iron Field

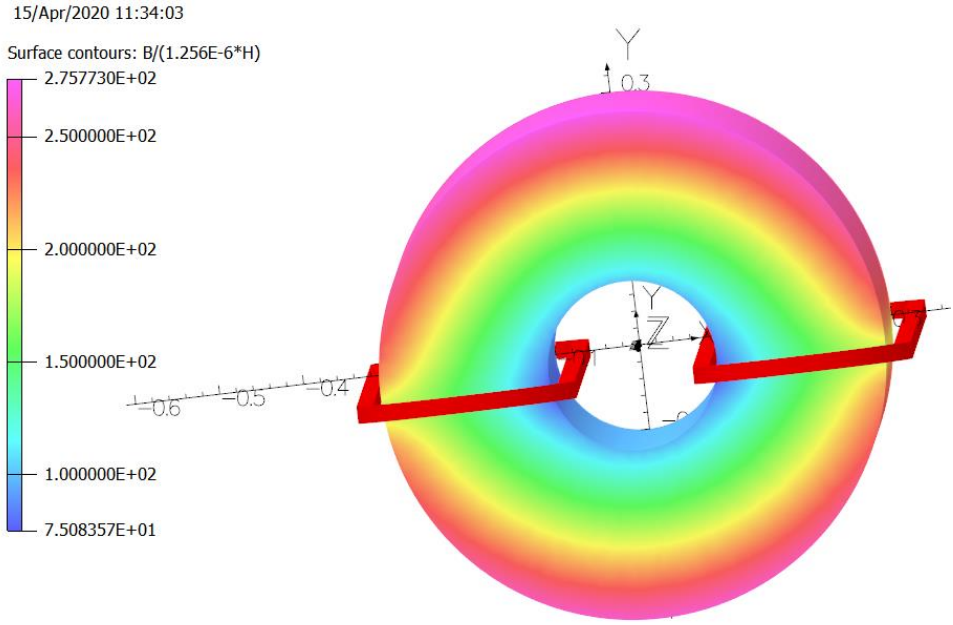


1.9 T at inner radius and 1.7 on the outer obtained at 5 kA in each coil.

Magnet Iron Field at 5 kA



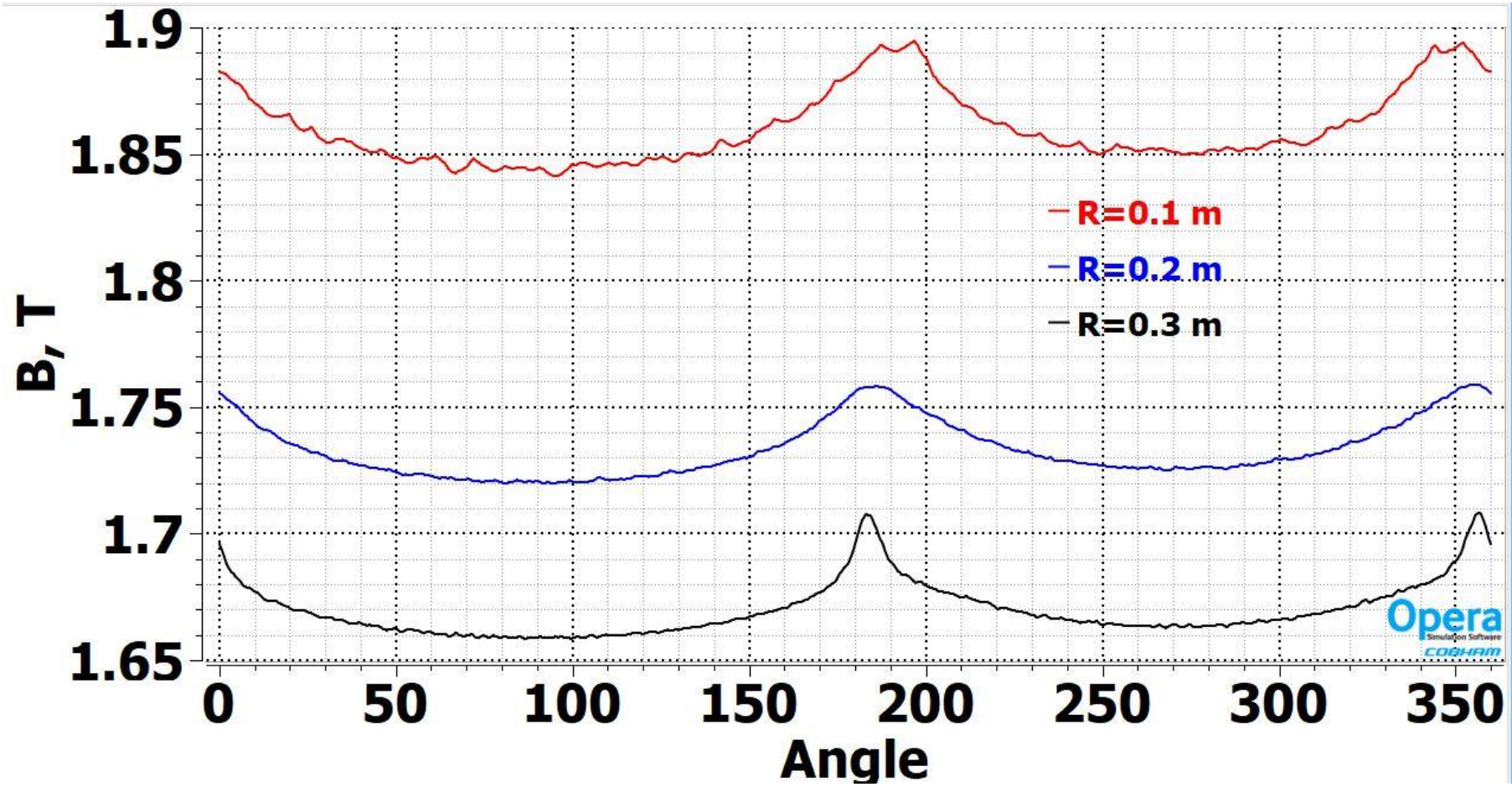
Flux density



Magnetic permeability

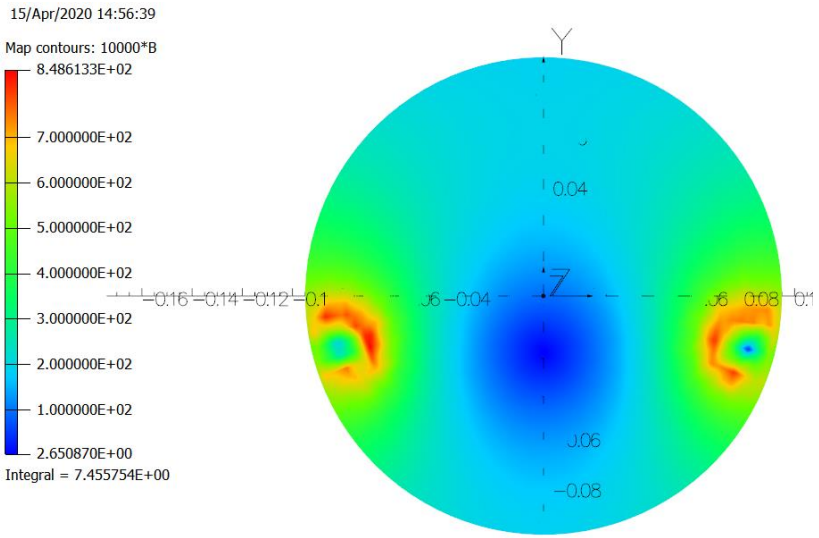
Iron field in the range of 1.65T – 1.93T, magnetic permeability 75-276.

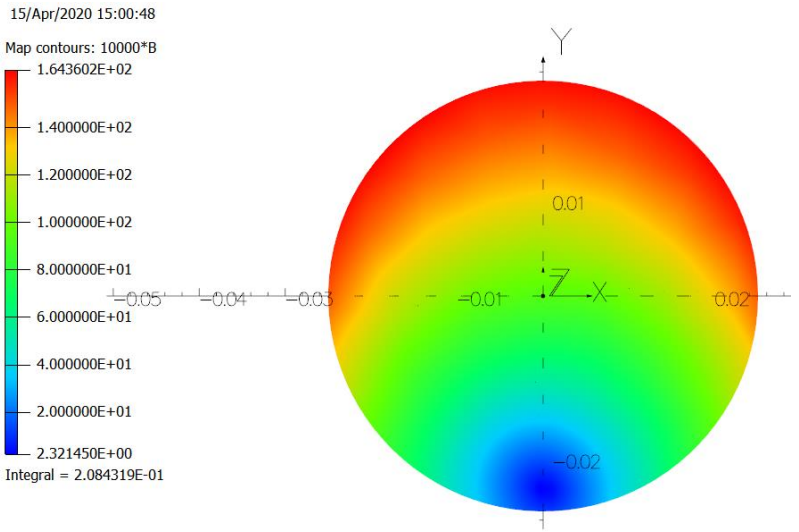
Magnet Iron Field at 5 kA as B(Ang)



Two field peaks ~3 % caused by coils fringe fields.

Fringe Field in Hole at 5 kA

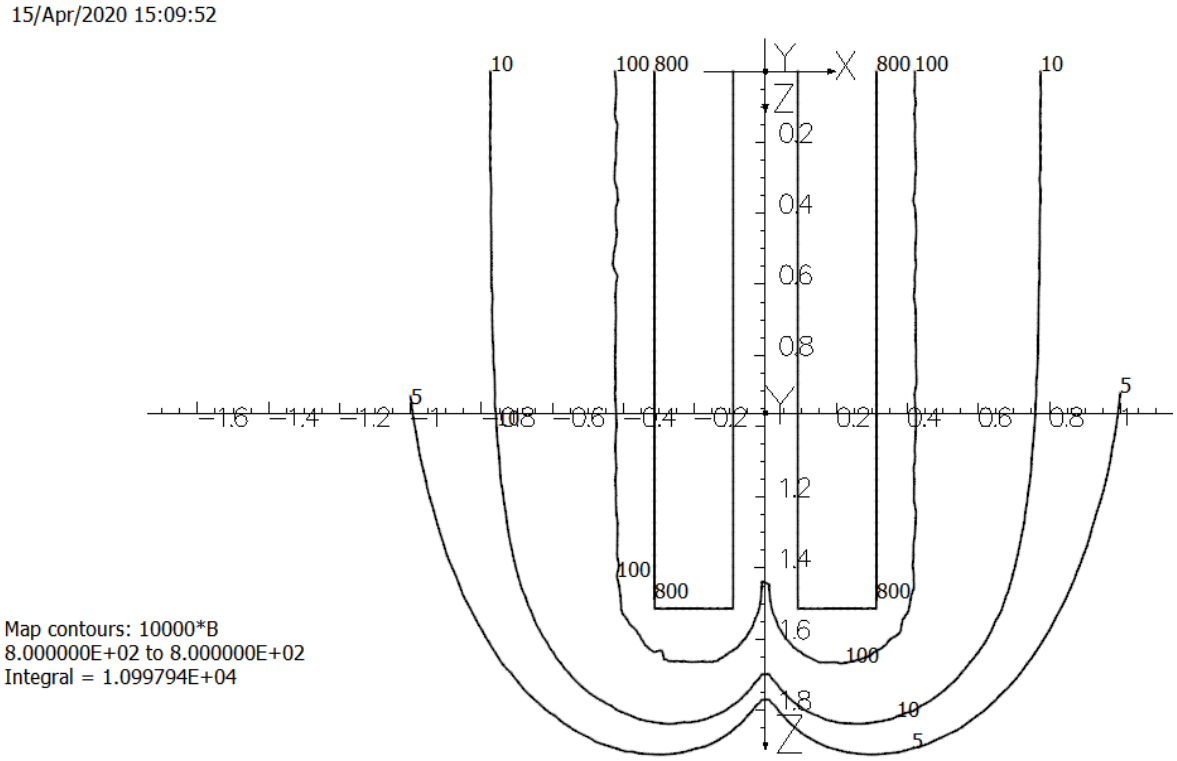




Fringe field inside the 200 mm (including coils) hole diameter at z=0 is from 2.6 Gauss to 849 Gauss.

Fringe field inside the 50 mm hole diameter at z=0 is from 2.3 Gauss to 164 Gauss.

Fringe Field in X-Z Plane at 5 kA

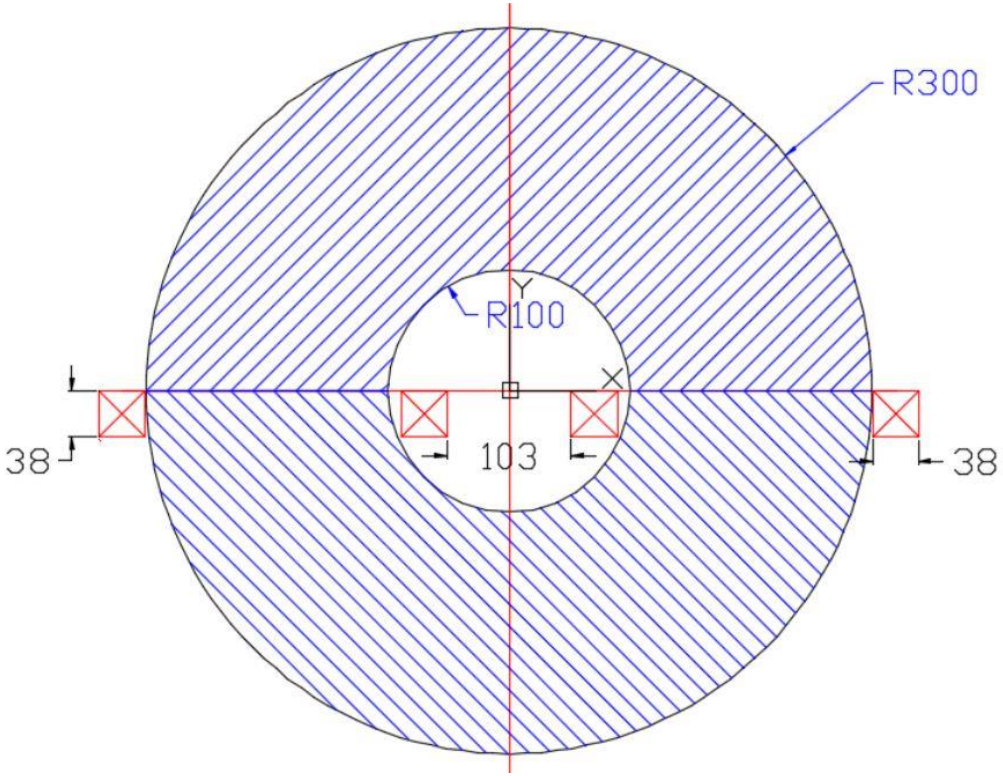


Fringe field outside of magnet in Gauss for 5, 10, 100, 100, 800 lines.

Coil Parameters

Parameter	Unit	Value
Number of coils		2
Number of turns/coil		4
Peak current	A	1250
Copper conductor dimensions	mm	18x18
Conductor cooling hole diameter	mm	8.0
Coil width	mm	38
Coil height	mm	38
Coil resistance	mΩ	2.2
Magnet voltage	V	5.5
Total power	kW	6.9
Number of water cooling circuits		2
Water temperature rise	C˚	6.4

Magnet Cross-Section



- Assembled from two halves.
- Both coils attached to low half cylinder for easy assembly/disassembly.

SUMMARY

- This is the first look at the pre-conceptual magnet design.
- Magnet FRD and specification should be designed.
- Possible variations:

- Coils inner straight parts could be placed in the iron core slots to reduce inner fringe field in the beam area;
- Add thin Fe shield around beam pipe to reduce the fringe field;
- If critical add outer thin Fe shield;
- Voltage, current, power should meet the power supply parameters, cabling, etc.
- Magnet cooling should be in an agreement with LCW supply.