MEBT Beam Current Transformers:
Status Update

3-4 October 2016

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2nd BI Forum, Bilbao

Outlines

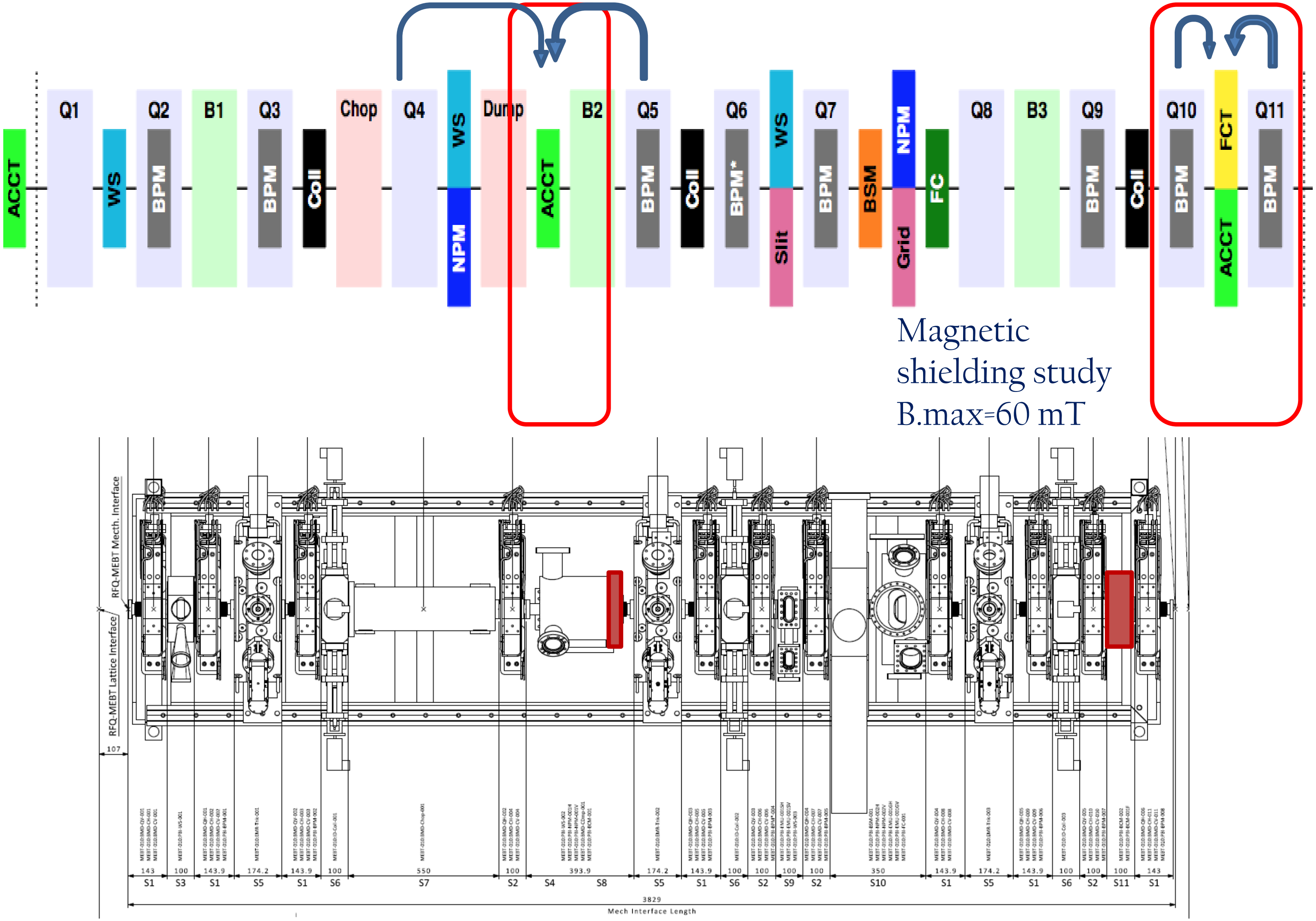
- Requirements
- Interfaces
- Design concept
    - ACCT2+FCT
    - ACCT1
- Planning
- Preliminary safety assessment
- Risk assessment

Bilbao Responsibilities

Bilbao			ESS ERIC		
Category	**Issue**	**Quantity**	**Category**	**Issue**	**Quantity**
Mechanical	Mechanical design, manufacturing and assembly	3	**Electrical**	Digital electronics and acquisition	3
	Magnetic shielding	2		Cables from Analogue electronics to digital electronics (ACCTs)	2
	Bypass wall current and insulator gap	2		Cables from Toroid (FCT)	1
	Mechanical Support on *raft*	1	**ICS**	Control and EPICS integration	3
Electrical	Analogue Electronics (ACCTs)	2			
	Sensor calibrated cable to EX (ACCTs)	2			

General layout

Magnetic shielding study (B.max ‹ 0.5 mT)
Radiation shielding study (‹1000 Gy)

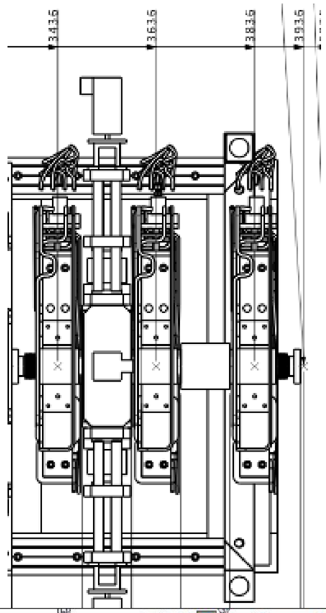


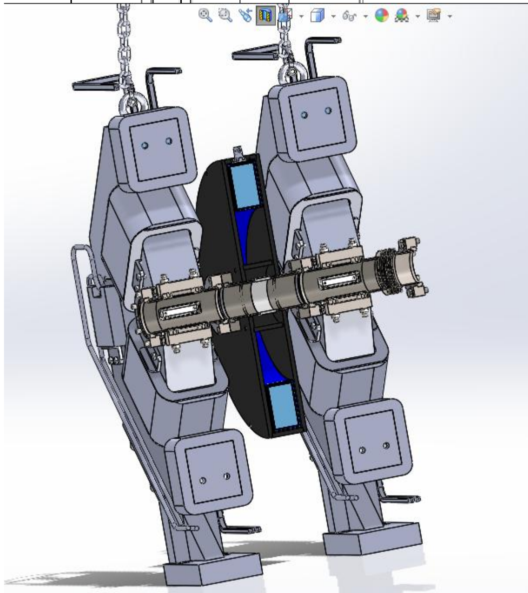
Magnetic shielding study B.max=60 mT

Design Concept

Location and related field data for ACCT2, FCT box

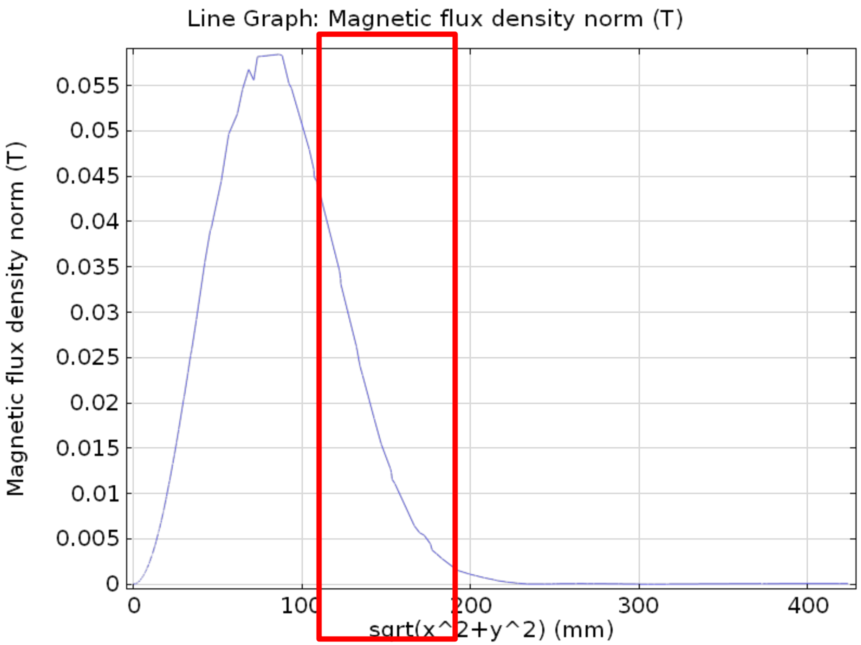
Quadrupoles field data for Combined BCMs (2015.v0c)			
Q10 current (negative or *Vertical*)	-31.5 T/m	220 A (nominal	300 A
Q11 current (positive or *Horizontal*)	24.02 T/m	168 A (nominal)	300 A
BCM distance from Q10	100 mm		
BCM distance from Q11	100mm		



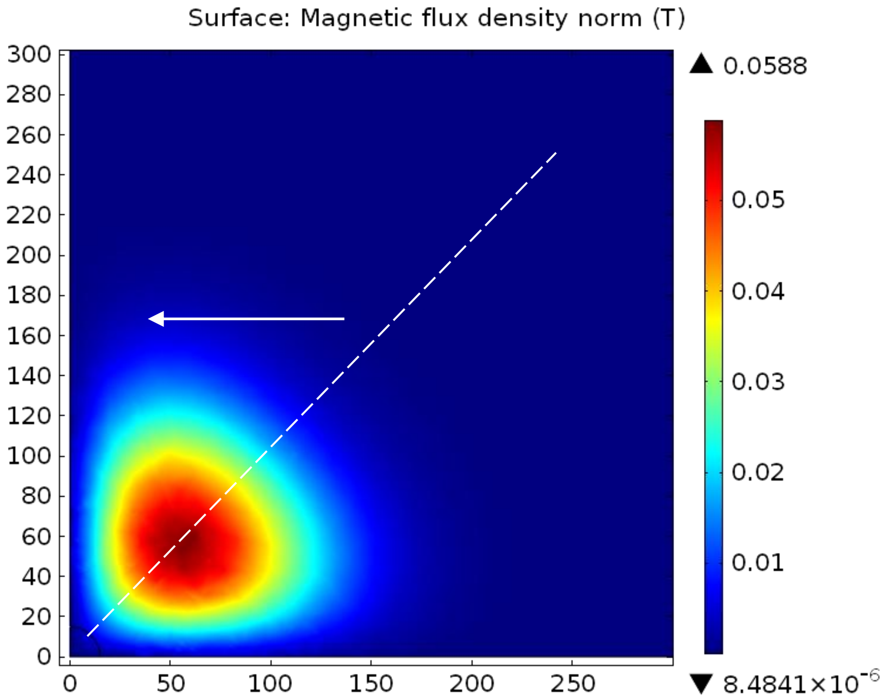


Magnetic field maps

Magnetic flux density versus distance from center (Q10, Q11 with opposite polarity at maximum current of 300 A.

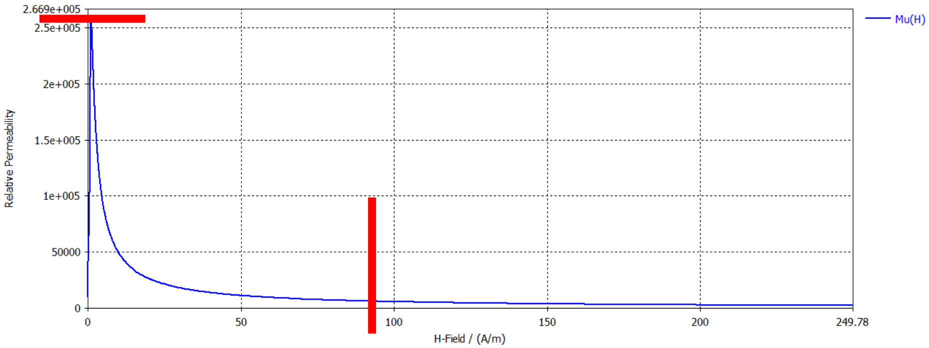


Magnetic flux density at toroid transverse location produced by Q10,Q11.

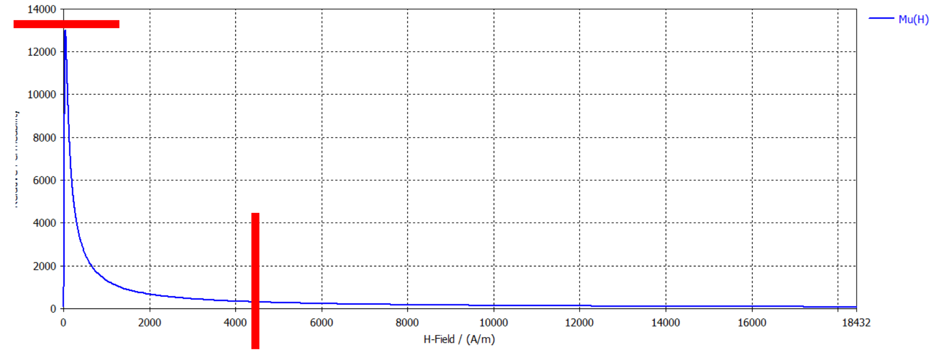


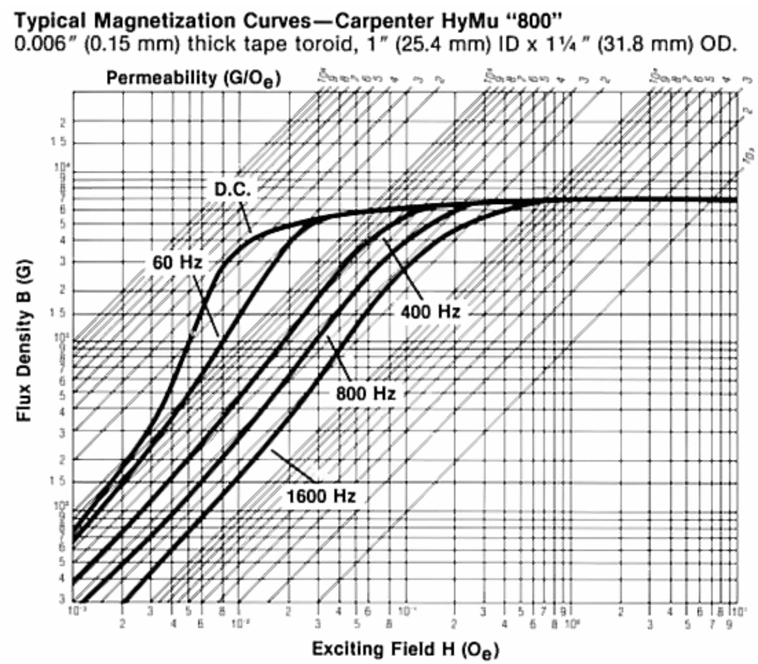
Material magnetic properties

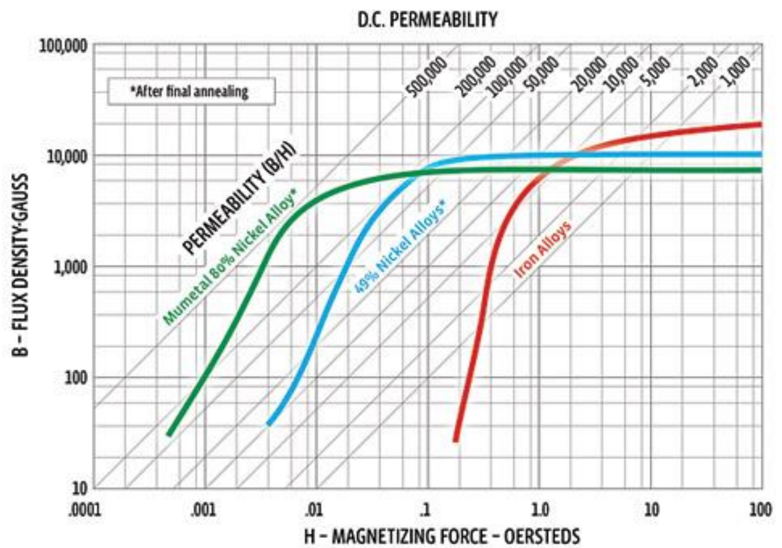
Mu-metal Relative permeability



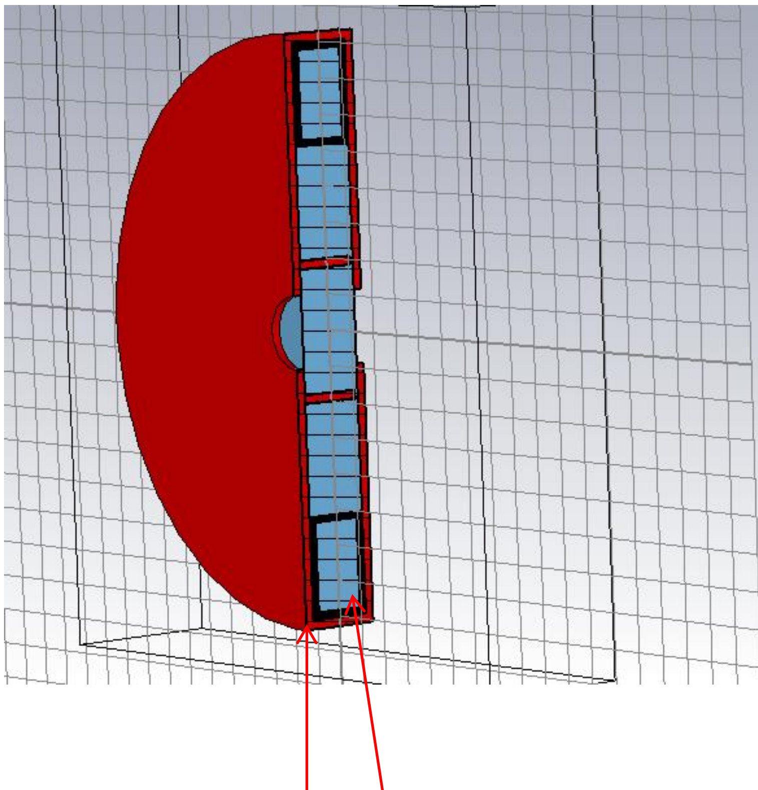
Soft iron Relative permeability

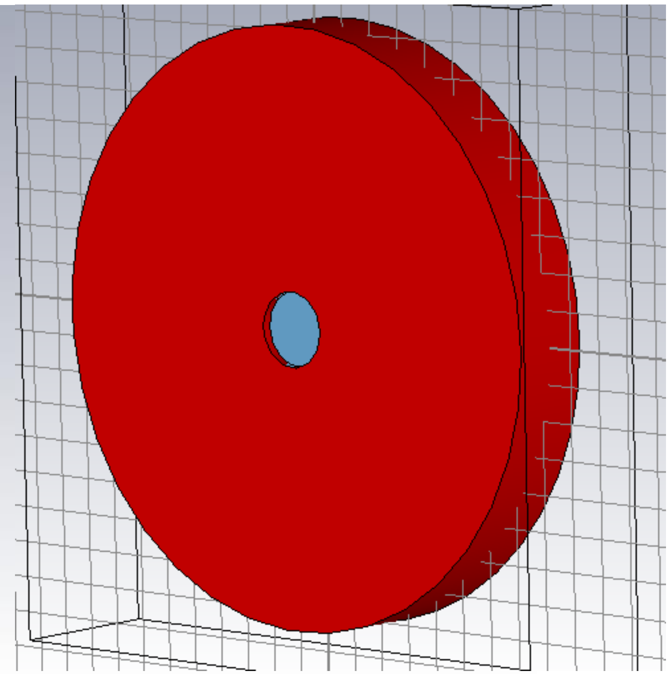






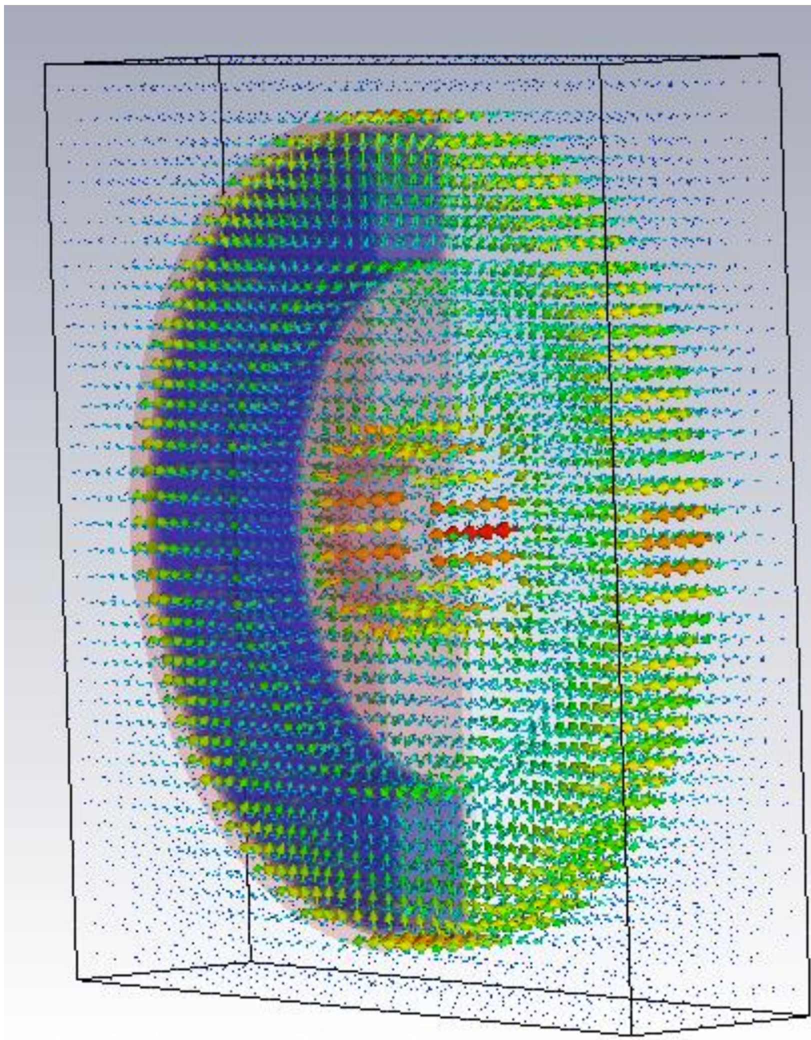
The simulation has been done, in order to reduce the external magnetic field to the safe values for toroids.

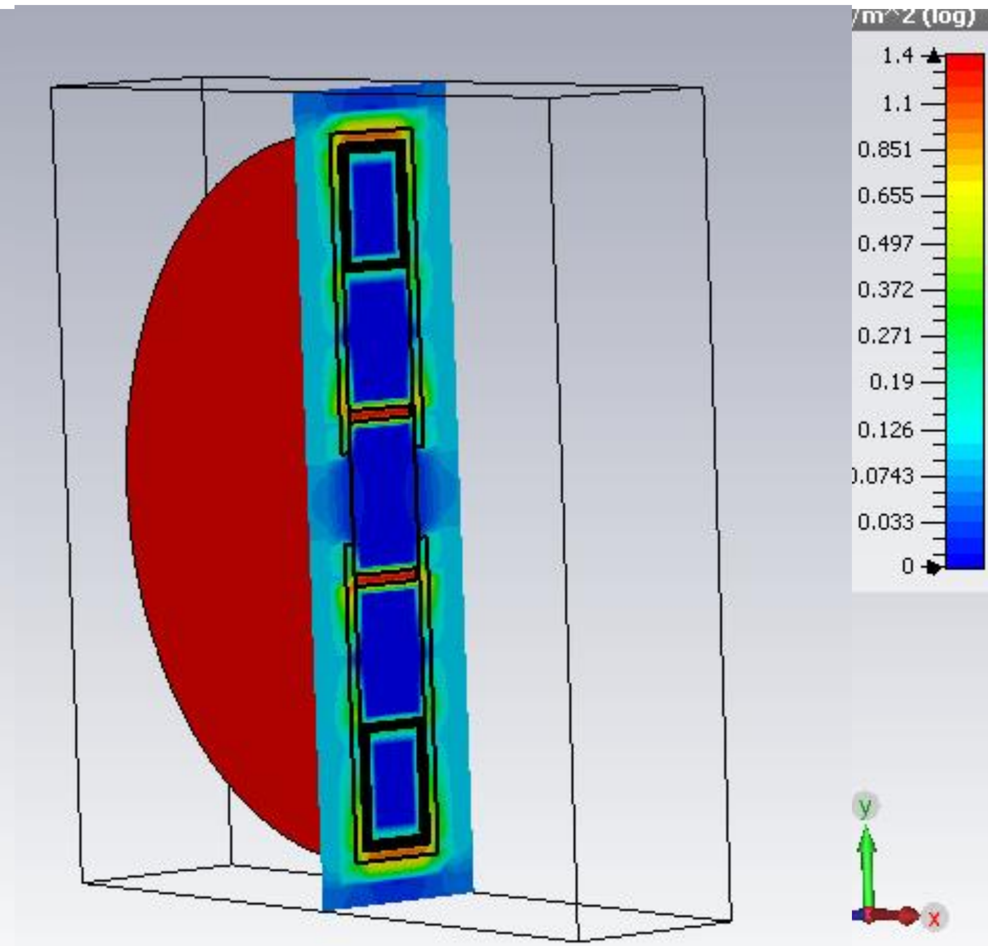




Two layers of Mumetal
One layer of soft iron

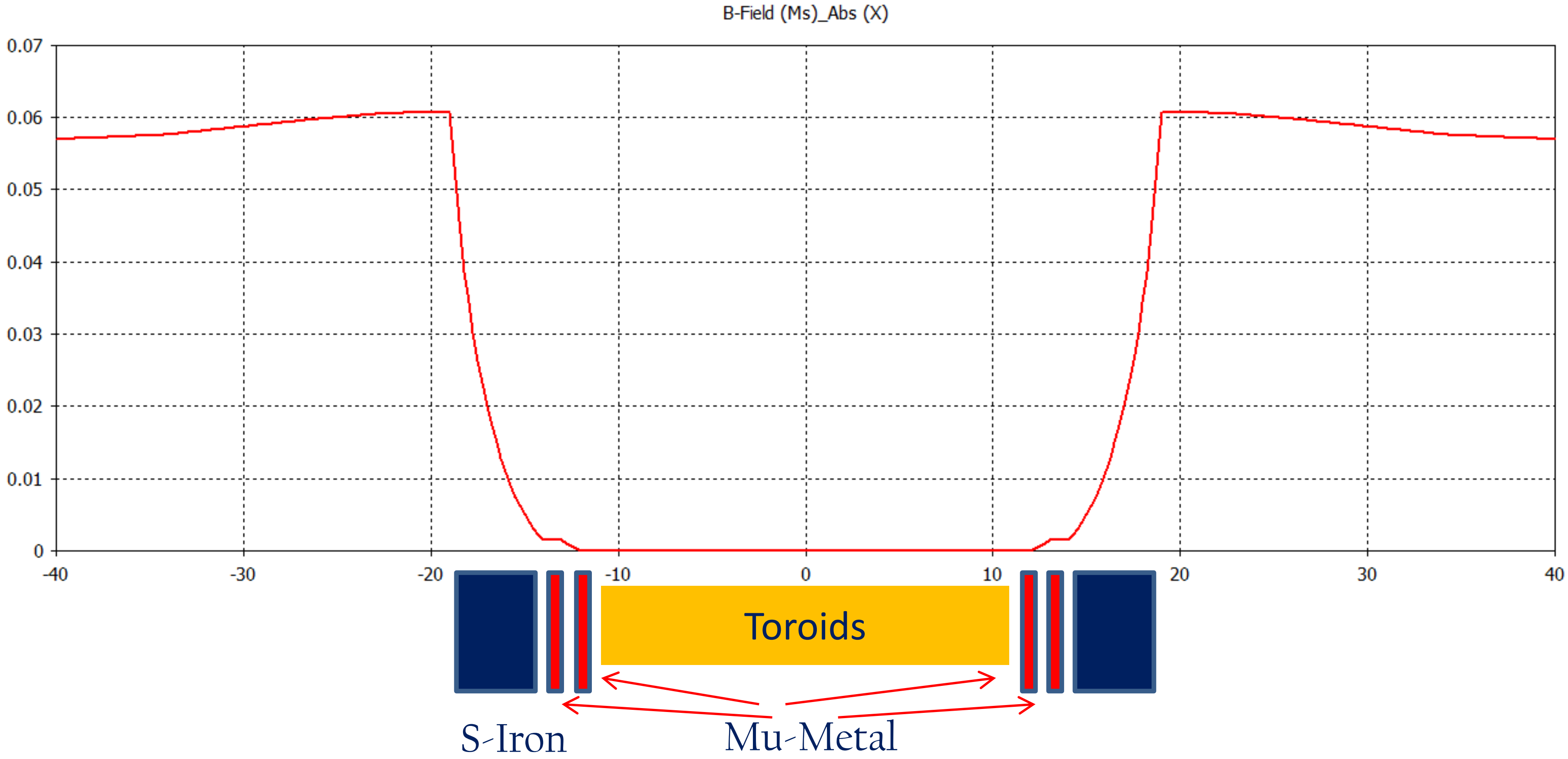
The simulation has been done, in order to reduce the external magnetic field to the safe values for toroids(2). The thick soft-iron reduce the magnetic field from 60 mT to 5 mT and mu-metals reduces from 5 mT to a few Gauss .





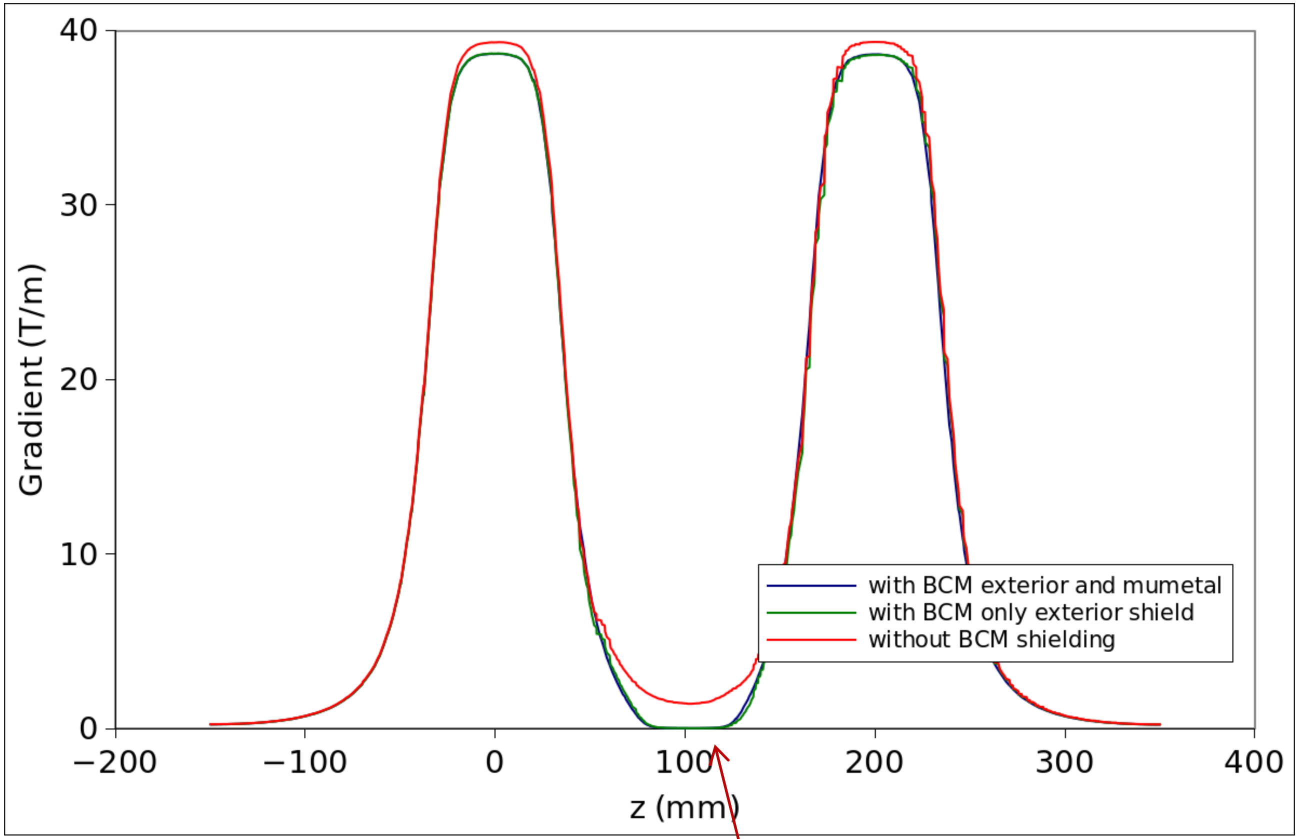
External magnetic field reduction

External magnetic field in the Toroids location



Reverse effects of magnetic shielding on adjacent quadrupole gradient

The effect on the gradient is not very big. A small reduction in peak gradient is observed, and integrated gradient is also reduced due to the field absorbed by the shielding (J. Muñoz on Quadrupole internal report).



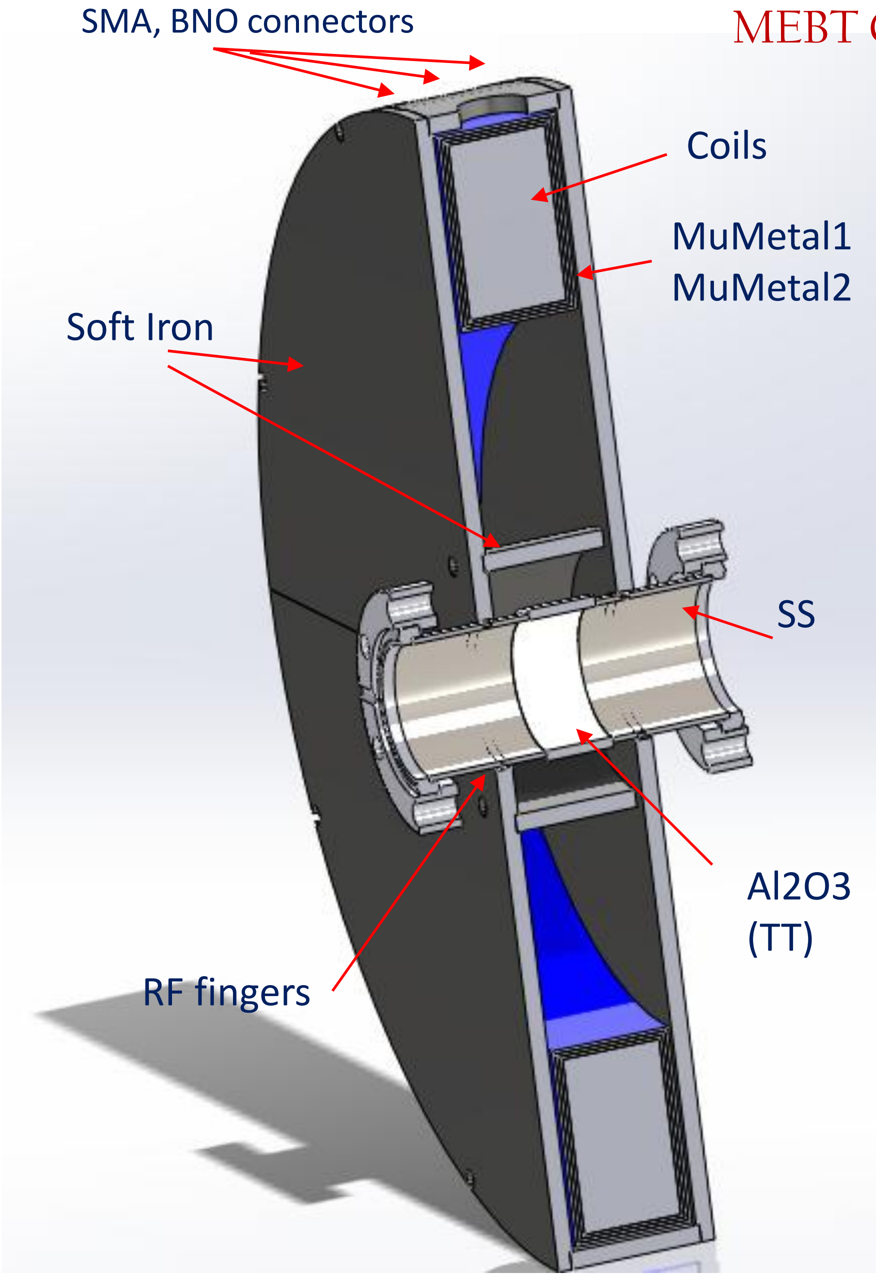
BCM effects (Green)

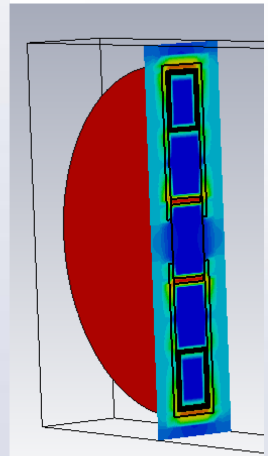
Insulation gap

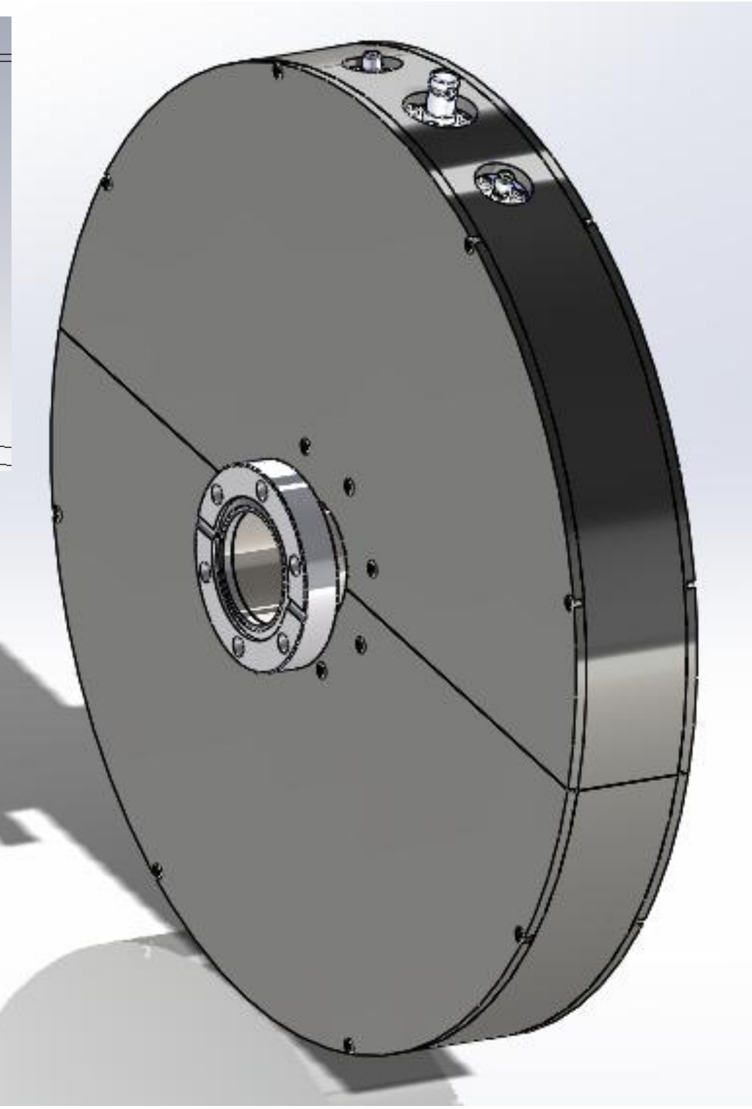
Several options under study for box of ACCT2+FCT:

- ✓ Mechanical barrier plus normal ceramic
- ✓ Ceramic thin without coating (ceramic brazed on Kovar)
- ✓ Ceramic with titanium coating
- ✓ Anti-static ceramic
- ✓ Larger aperture ceramic

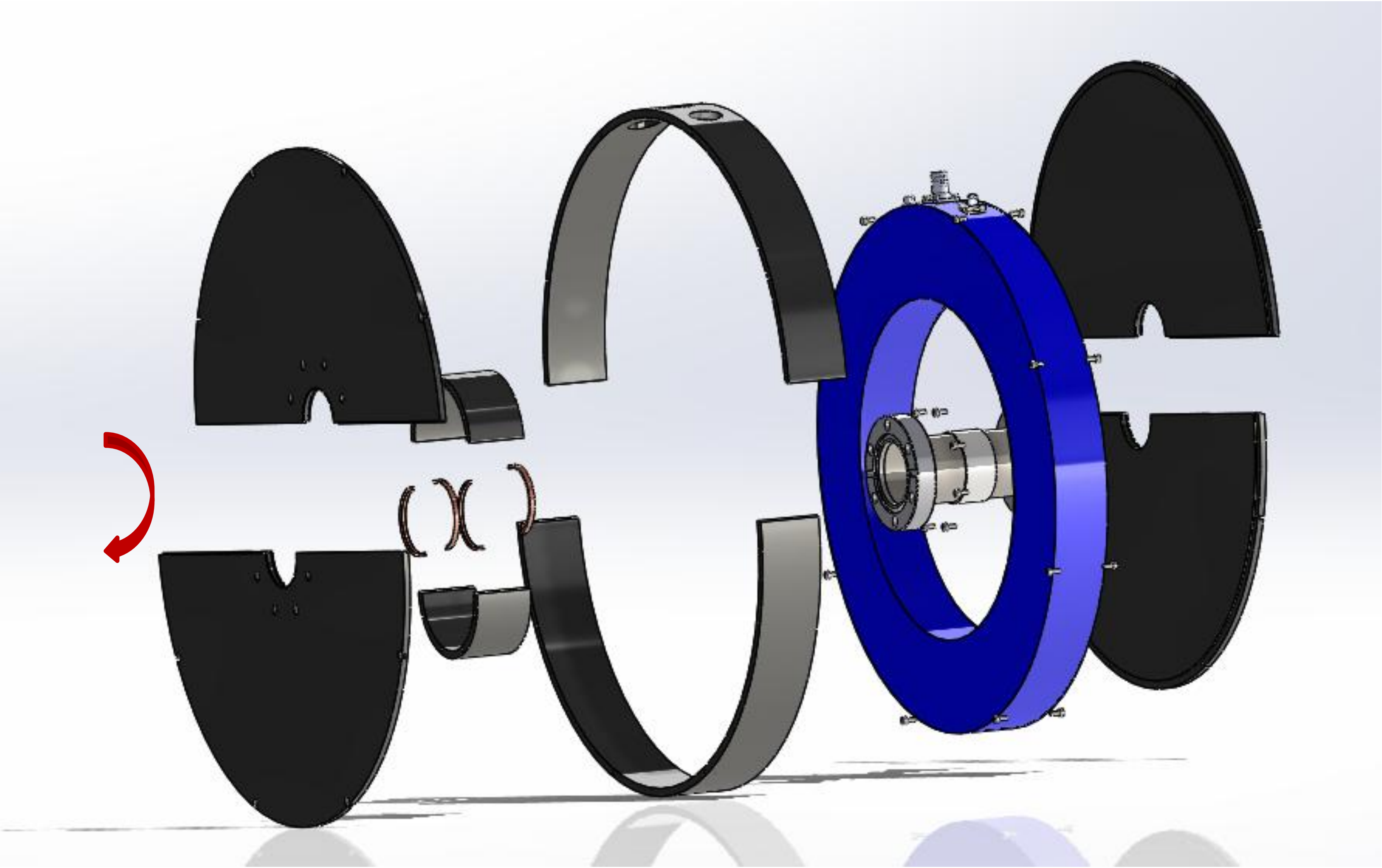
MEBT Combined BCM's







Outer Iron shield assembly steps



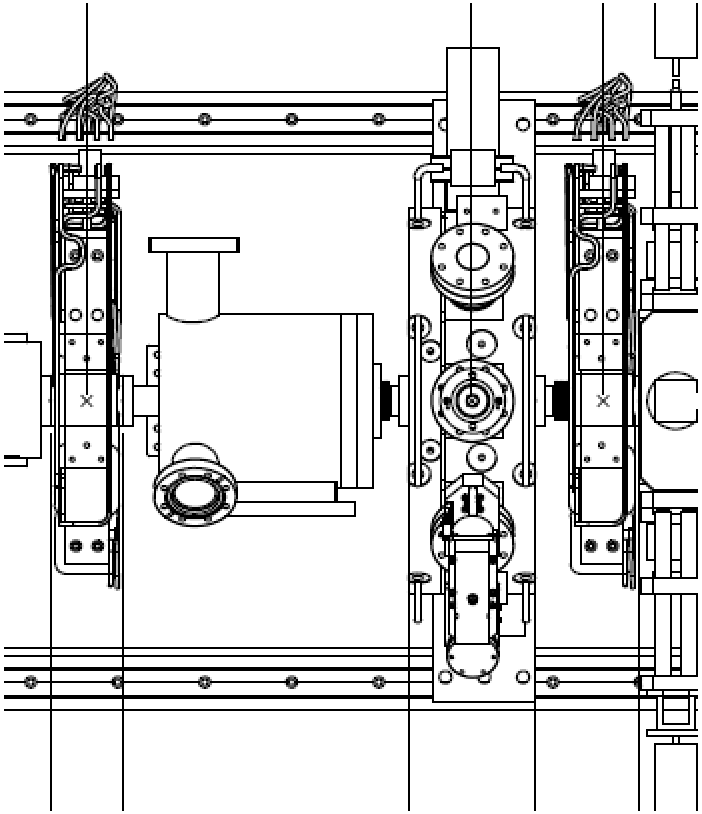
ACCT 1

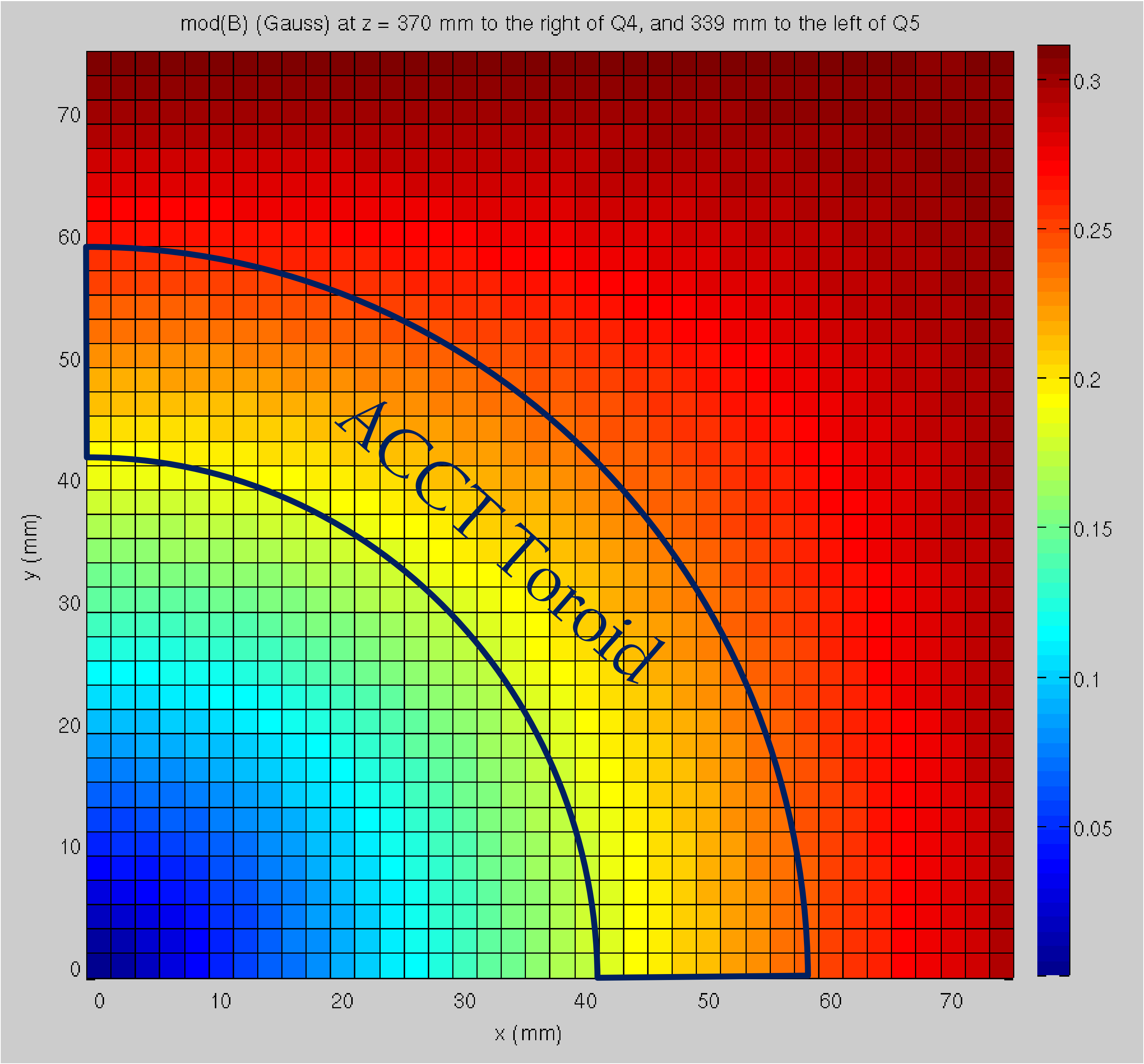
Studies

Magnetic field data

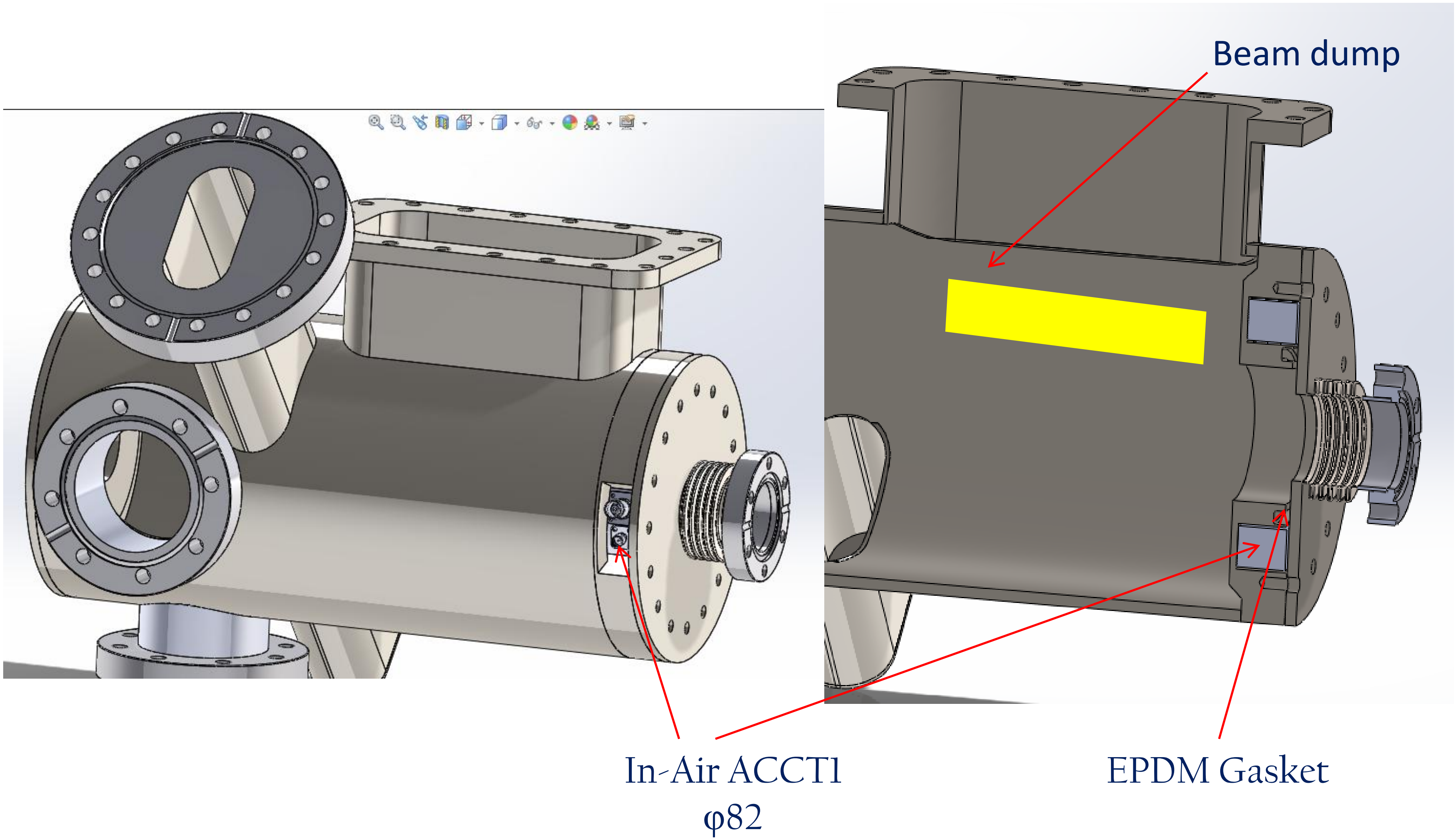
External magnetic field in the location of ACCT1 Toroid is less than 0. 5 G

Quadrupoles field data		
Q4 Gradient	5 T/m	+20%
Q5 Gradient	6.5 T/m	+20%
ACCT1 distance from Q4	373 mm	
ACCT1 distance from Q5	339 mm	




mod(B) (Gauss) at z = 370 mm to the right of Q4, and 339 mm to the left of Q5
ACCT Toroid
y (mm)
x (mm)
0
10
20
30
40
50
60
70
0.05
0.1
0.15
0.2
0.25
0.3

Primary analysis show no requirement for magnetic or radiation shielding

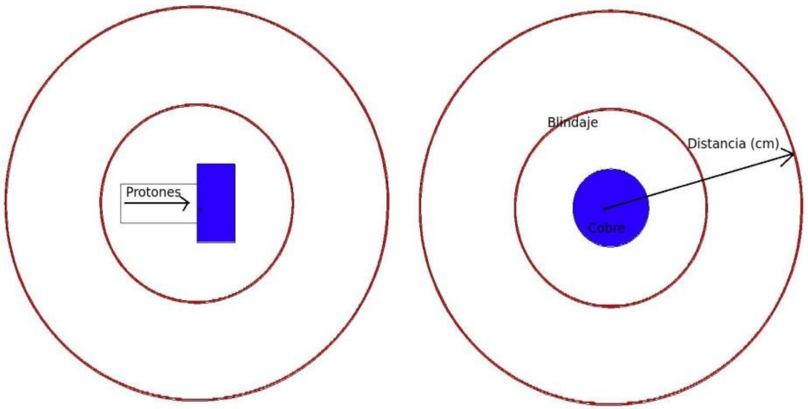


Organic and Radiation-sensitive materials used in the Standard Bergoz sensors
Source: Bergoz®

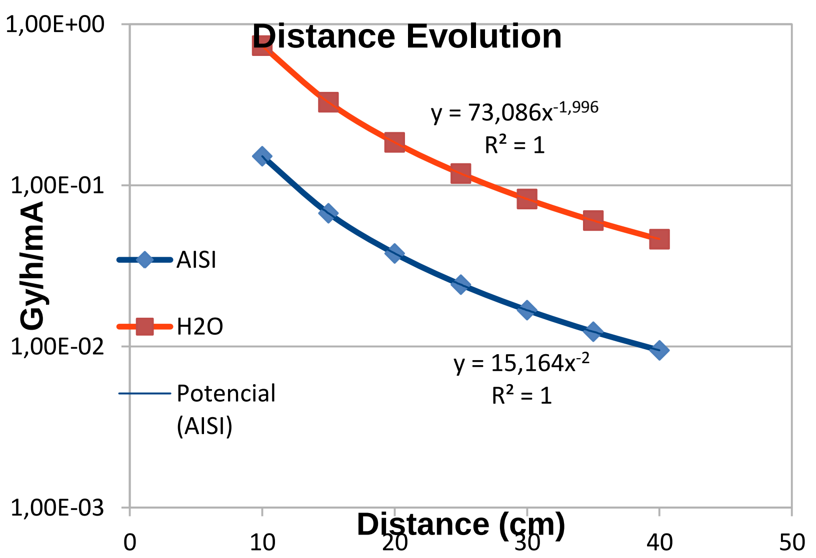
ACCT Component	Material	Radiation Resistance (Gy)
Wiring Insulation	PVC	$2x10^5$
	Fiber Glass	$>10^8$
	+Rubber Adhesive	$>10^6$
Stress Absorbent	Silicon Rubber Tape SIR	$5x10^5$
	Silicon Rubber SIR	$2x10^5$
Connector Isolation	PTFE (BNC)	$<10^3$
	PE (BNO)	10^6

Radiation analysis for ACCT1

Model: Assuming Cu target and incident 3.6 MeV H+ beam is considered.
Shielding: the stainless steel wall are considered as shielding, also H2O has been considered for comparison purposes.
A parametric curve for different distances is presented.
(Ref: MEBT-BI-MC55-01: T. Mora, I. Bustinduy, F. Sordo)

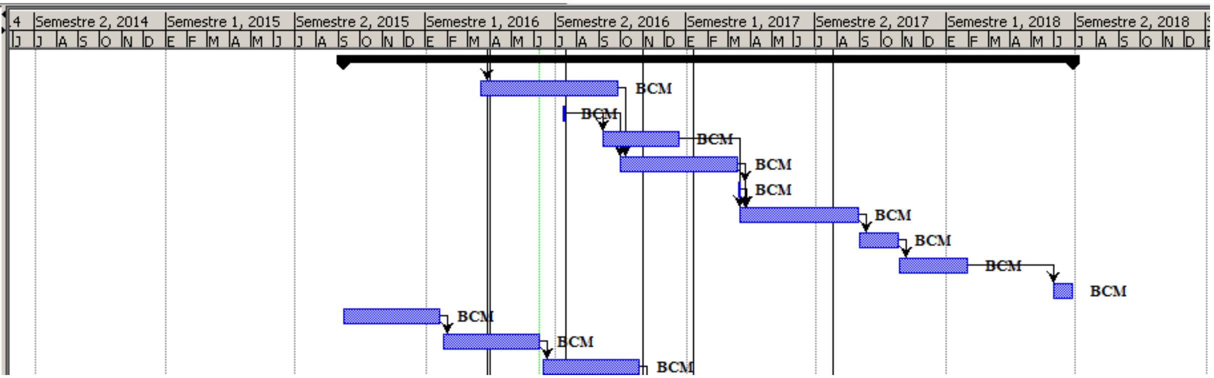


Distance (cm)	I average (mA)	Time (h)	AISI (Gy)	H2O (Gy)
50	2,50	100	1,50	7,30
100	2,50	1000	3,75	18,25
150	0,02	100	0,00	0,01
5	**0,02**	**1000**	**10,50**	**51,10**



Planning

	Nombre	Duracion	Inicio	Terminado
107	⊟BCM	734 days?	7/09/15 ...	28/06/18 17:00
108	BCM: Shielding Design	140 days	17/03/16 ...	28/09/16 17:00
109	BCM: PDR	1 day?	13/07/16 ...	13/07/16 17:00
110	BCM:Toroids ordering (3 pieces)	80 days?	5/09/16 8:00	23/12/16 17:00
111	BCM: Mechanical Design	120 days?	29/09/16 ...	15/03/17 17:00
112	BCM: CDR	1 day?	16/03/17 ...	16/03/17 17:00
113	BCM: Fabrications	120 days	17/03/17 ...	31/08/17 17:00
114	BCM: Electrical and vacuum tests	40 days?	1/09/17 8:00	26/10/17 17:00
115	BCM: Contingencies and integration	70 days?	27/10/17 ...	1/02/18 17:00
116	BCM: Delivery	20 days	31/05/18 ...	28/06/18 17:00
117	BCM: uTCA Environment	100 days?	7/09/15 8:00	22/01/16 17:00
118	BCM: uTCA SETUP	100 days?	25/01/16 ...	10/06/16 17:00
119	BCM: EEE Integration	100 days?	13/06/16 ...	28/10/16 17:00



Future Milestones:

Finish the complete detailed design: March 2017

Fabrication process: April 2017