

Summary

Introduction

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1. Version ILD-V2 Saclay for the magnet configuration
 - 1.1 Main parameters
 - 1.2 Main outputs
2. Some other points
 - 2.1 Anti-DID coil design

Present conclusions

Summary

Introduction



Introduction

- New parameters used for ILD V2 detector magnet:

- . after Cambridge, Chicago and Catherine parameter list

- . homogeneous field in the TPC volume:

$$\Delta I (R) = \int_0^{z_{\max}} (B_r (R) / B_z (R)) dz \leq 10 \text{ mm}$$

within the TPC volume:

$$z_{\max} = 2.25 \text{ m}$$

$$R_{\max} = 1.8 \text{ m}$$

- Same design for the coil as before
 - . 5 modules (correction current in each module at extremity)
 - . 4 layers per module (correction current in the 3 inner layers of the modules at extremity)

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1. Version ILD-V2 Saclay for the magnet configuration
 - 1.1 Main parameters

Version ILD-V2 Saclay



New parameters used for ILD-V2 detector magnet

- . $B_0 = 4$ T nominal, 3.5 T operation
- . R_{int} coil = 3 590 mm
- . R_{ext} coil = 3 940 mm
- . L coil = 3 672 * 2 mm

Stray field (@ 3.5 T)

- . $B_{\text{ext}} \leq 200$ G @ $z=10$ m from I.P.
- . $B_{\text{ext}} \leq 200$ G @ at ($R_{\text{out}} + 1.5 - 2$ m) in the radial direction

Yoke (barrel + end-caps)

- . dimensions and constitution as in Catherine's table
- . no endcap gap filling factor

Version ILD-V2 Saclay: field homogeneity



As previously described, the field homogeneity is adjusted with:

- a FSP (Field Shaping Plate)
- and correction currents in some places of the coil (3 inner layers of the two modules at extremities).

Summary



1.2 Main outputs

ILD-V2: main outputs



Electrical parameters (4 T)

I_{nom} (kA)	15.9	
Eng. J (A/mm ²)	9.6	(for I_{nom})
ΔI_{cor} (kA)	18.1	(3 layers * 2 modules)
Stored energy (GJ)	2.0	
W_s density (kJ/kg)	12.2	

Integral homogeneity in TPC volume (mm)

≤ 9

Yoke dimensions

R_{out} barrel yoke (mm)	7 110
Z_{out} endcap yoke (mm)	7 190

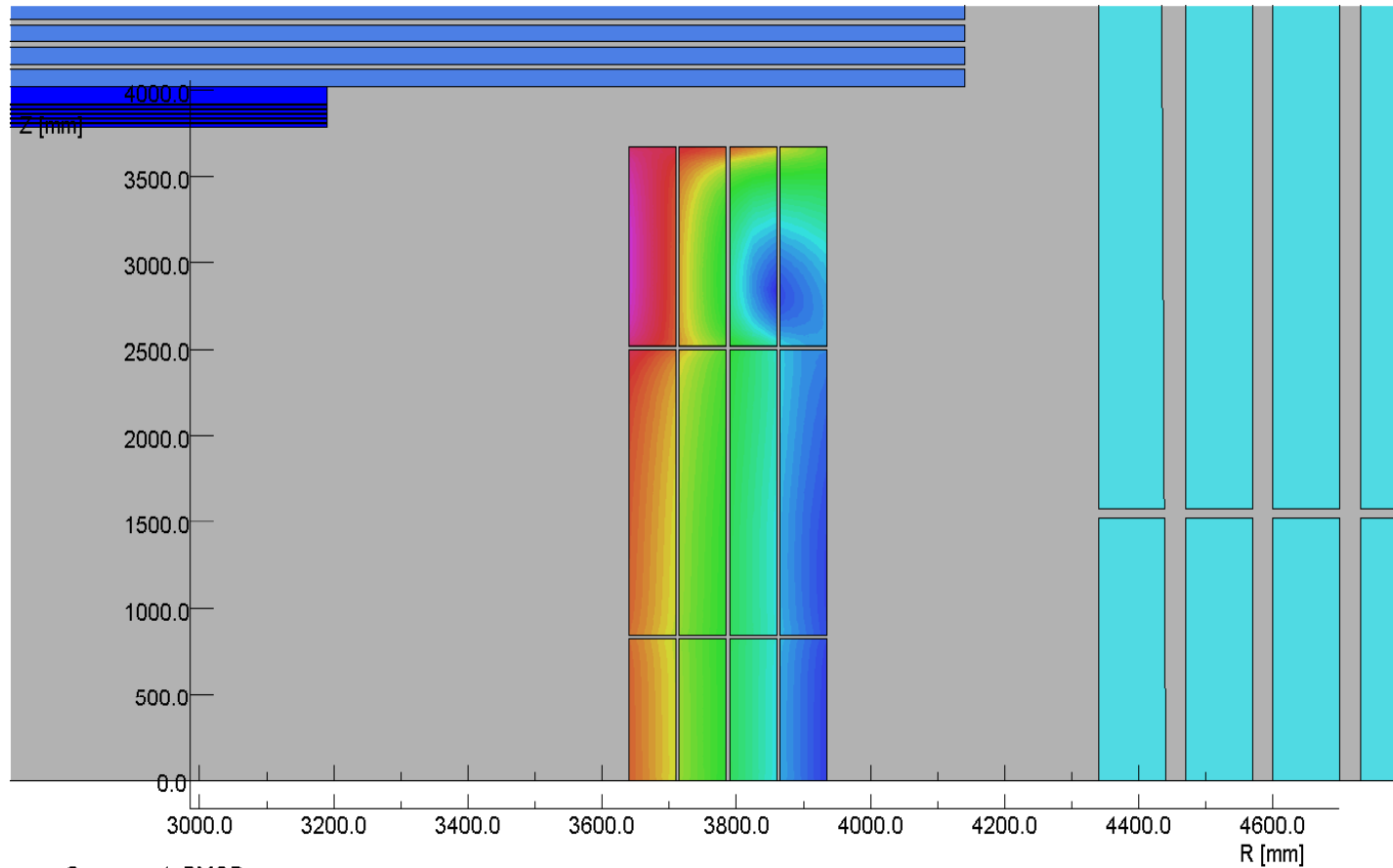
Stray field (@ 3.5 T)

$B_{\text{ext}} = 110 \text{ G @ } z=10 \text{ m from I.P.}$

$B_{\text{ext}} = 220 \text{ G @ at } R_{\text{out}} + 2 \text{ m in the radial direction}$

Field on conductors @ 4 T

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Component: BMOD
 0.039983735

2.647685556

5.255387376

UNITS	
Length	: mm
Flux density	: T
Field strength	: A m ⁻¹
Potential	: Wb m ⁻¹
Conductivity	: S m ⁻¹
Source density	: A mm ⁻²
Power	: W
Force	: N
Energy	: J
Mass	: kg

PROBLEM DATA	
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Linear elements	
Axi-symmetry	
Modified R*vec pot.	
Magnetic fields	
Static solution	
Scale factor: 1.0	
125334 elements	
63106 nodes	
281 regions	

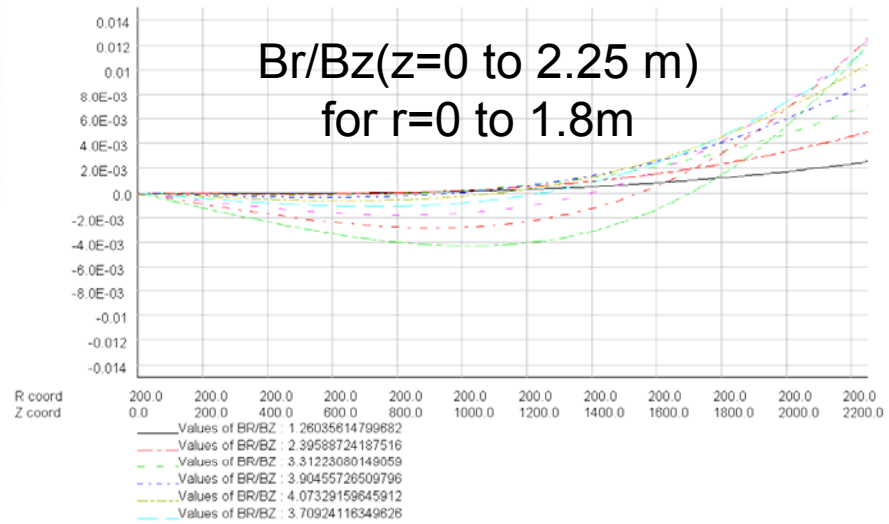
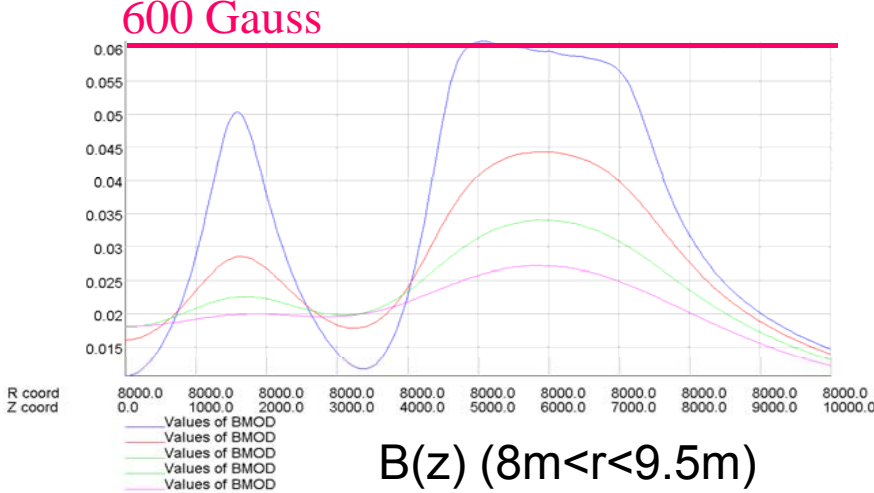
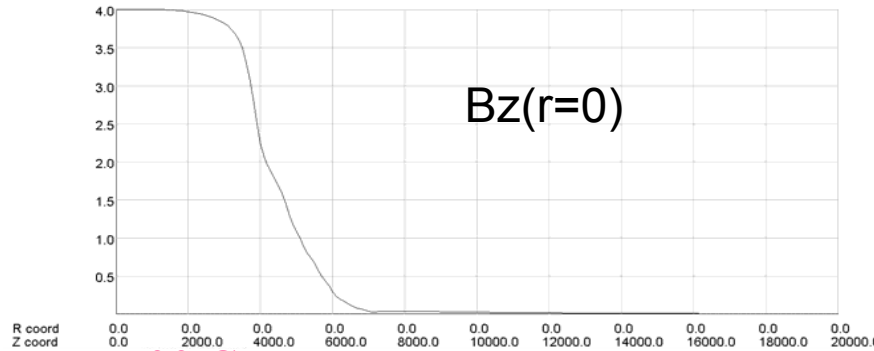
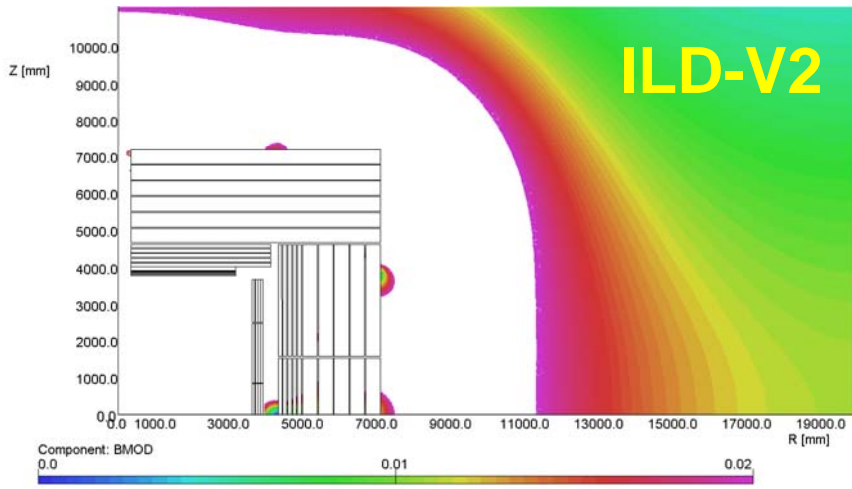
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Vector Fields
 software for electromagnetic design

ILD-V2 SACLAY configuration @ 4 Tesla

Iron : up to R=7.110m (2.76m thick), up to Z=+/-7.190m (3.27m thick)
 + 100 mm FSP (Field Shaping Plate)

Coil : 4 layers ,7.35 m length subdivided in 5 parts



UNITS

Length	: mm
Flux density	: T
Field strength	: A m ⁻¹
Potential	: Wb m ⁻¹
Conductivity	: S m ⁻¹
Source density	: A mm ⁻²
Power	: W
Force	: N
Energy	: J
Mass	: kg

PROBLEM DATA

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ERA-V12\ILD\2\2-Sacl
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Linear elements
Axi-symmetry
Modified R ² vec pot
Magnetic fields
Static solution
Scale factor: 1.0
123245 elements
65064 nodes
305 regions

Magnetic fields

Static solution

Scale factor: 1.0

123334 elements

63106 nodes

281 regions

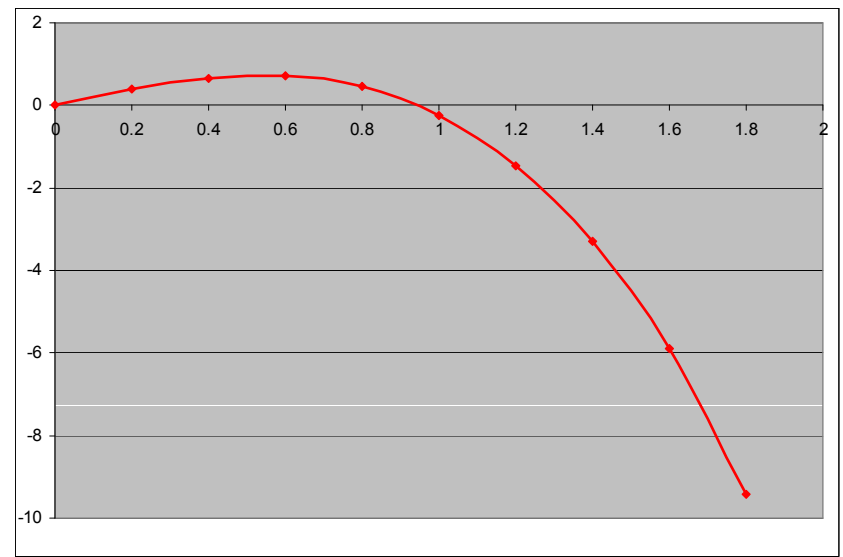
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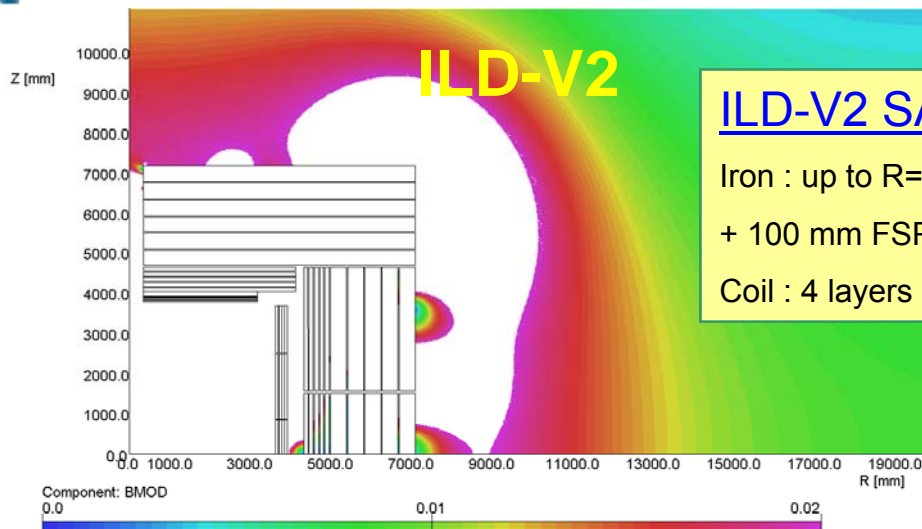
Length	: mm
Flux density	: T
Field strength	: A m ⁻¹
Potential	: Wb m ⁻¹
Conductivity	: S m ⁻¹
Source density	: A mm ⁻²
Power	: W
Force	: N
Energy	: J
Mass	: kg

PROBLEM DATA

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ERA-V12\ILD\2\2-Sacl
ylD-V2-S ST
Linear elements
Axi-symmetry
Modified R ² vec pot
Magnetic fields
Static solution
Scale factor: 1.0
123245 elements
65064 nodes
305 regions

∫(Br/Bz) vs r (z=0 to 2.25 m)





ILD-V2 SACLAY configuration @ 3.5 Tesla

Iron : up to R=7.540m, up to Z=+/-7.192m (~3m thickness)
 + 100 mm FSP (Field Shaping Plate)
 Coil : 4 layers ,7.35 m length subdivided in 5 parts

UNITS
Length mm

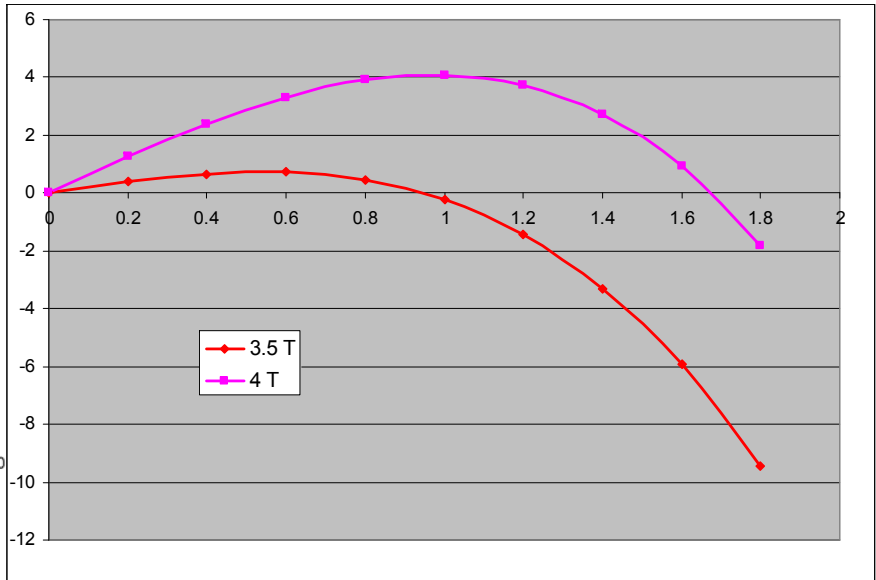
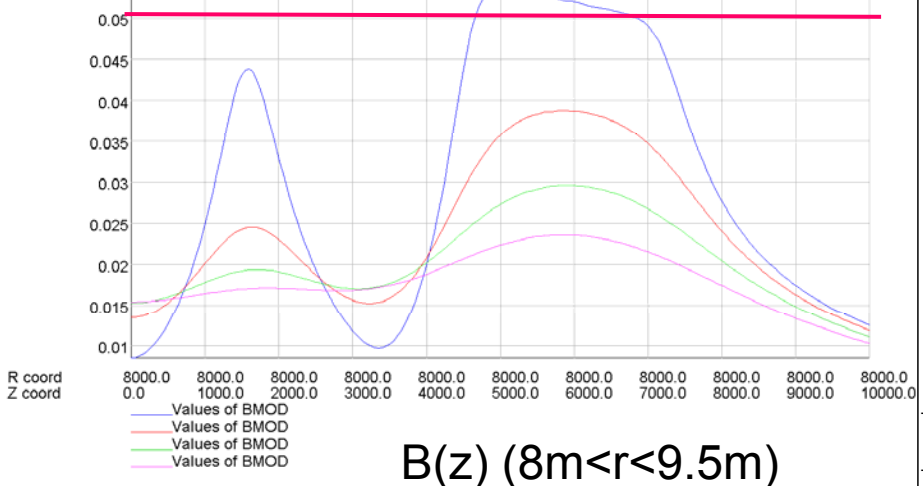
Static solution
Scale factor: 1.0
125334 elements
63106 nodes
281 regions

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$\int(B_r/B_z)$ vs r
(z=0 to 2.25 m)

500 Gauss



Stray field for ILD-V2 (3.5 T)

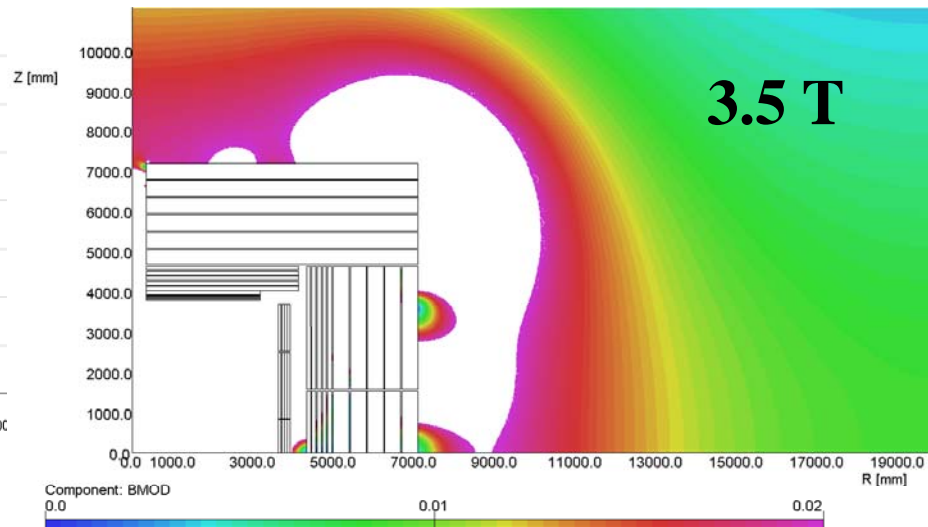
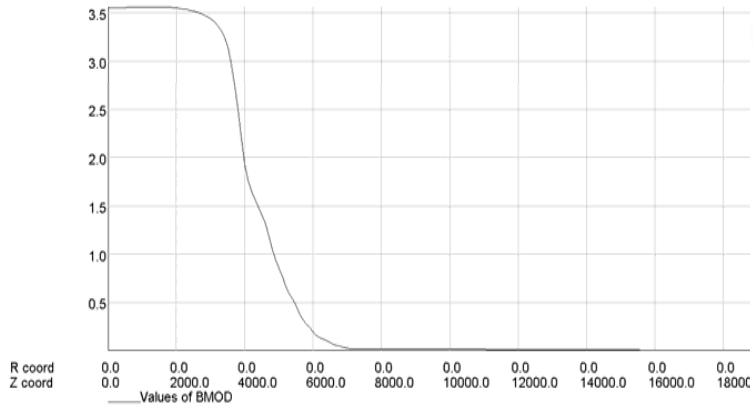
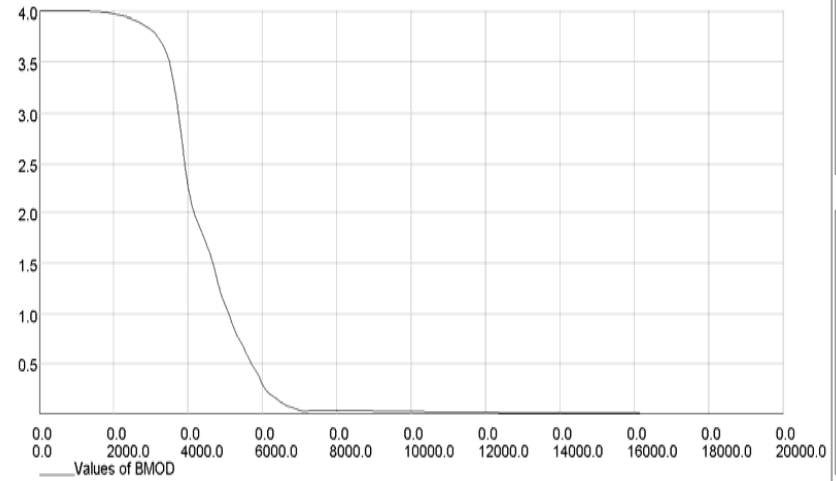
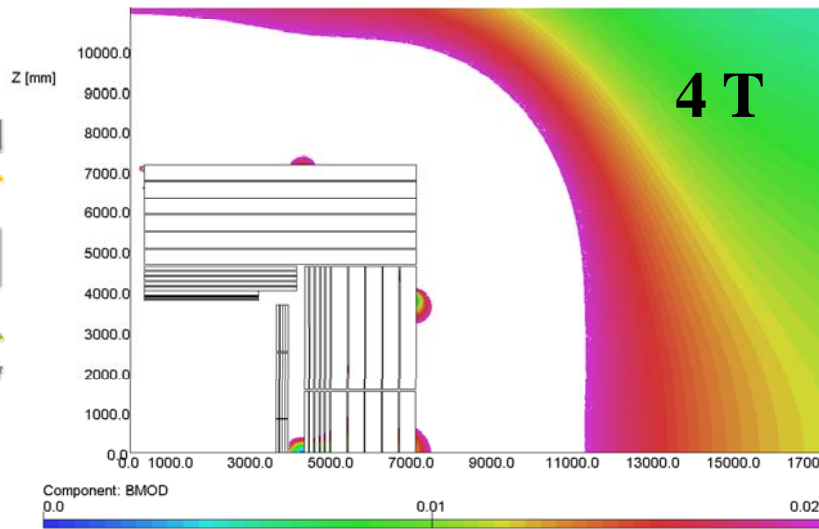
R (m)	Z (m)	B _{stray} (G)
0	10	150
9.5	5	230
9.5	0	150

. Even if stray field has been calculated for 4T, results are given for the operation field of 3.5 T

. Strong influence of the radial gaps in the barrel yoke: increasing the yoke thickness in the R direction does not help too much because of these gaps

Stray Field at 4 T and 3.5 T: 200 Gauss limit

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UNITS	
Length	: mm
Flux density	: T
Field strength	: A m ⁻¹
Potential	: Wb m ⁻¹
Conductivity	: S m ⁻¹
Source density	: A mm ⁻²
Power	: W
Force	: N
Energy	: J
Mass	: kg

PROBLEM DATA
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 Linear elements
 Axis-symmetry
 Modified R*vec pot.
 Magnetic fields
 Static solution
 Scale factor: 1.0
 125354 elements
 63106 nodes
 281 regions

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Vector Fields
 software for electromagnetic design

Stray Field vs Barrel Yoke thickness @ 3.5 T

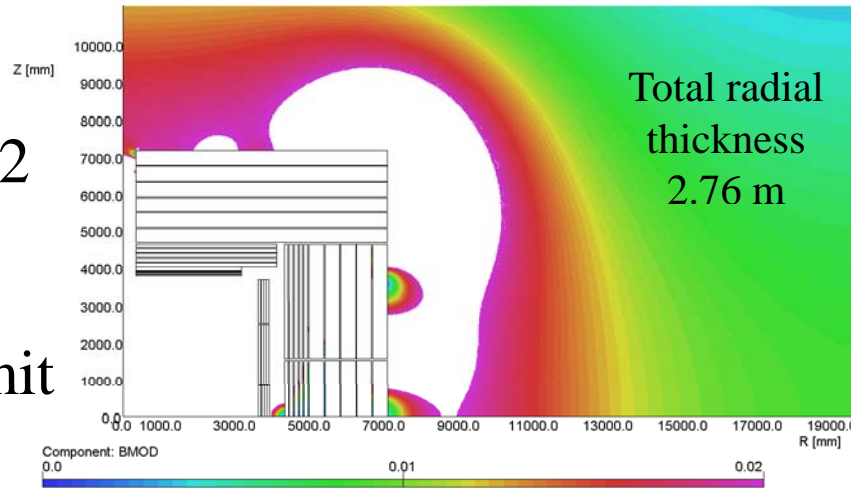
Irfu

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ILD V2

200 Gauss limit

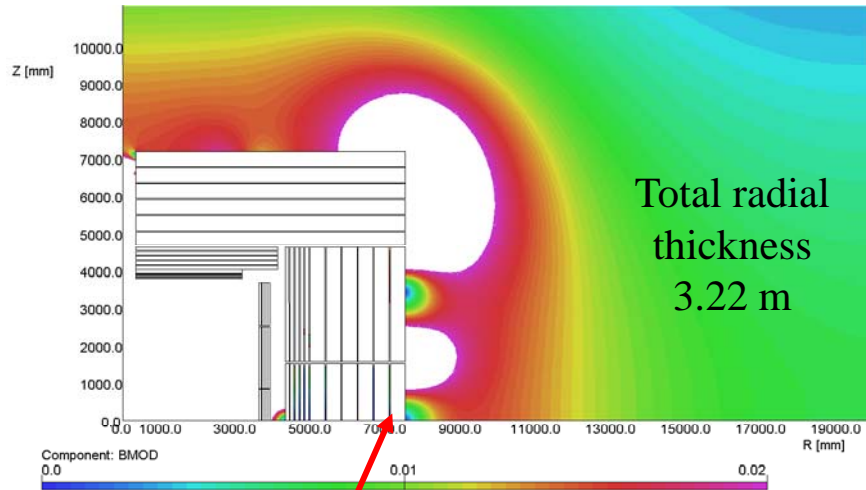


UNITS	
Length	mm
Flux density	T
Field strength	A m ⁻¹
Potential	Wb m ⁻¹
Conductivity	S m ⁻¹
Source density	A mm ⁻²
Power	W
Force	N
Energy	J
Mass	kg

PROBLEM DATA	
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Modified R ² vec pot.	
Magnetic fields	
Static solution	
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281 regions	

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Vector Fields



UNITS	
Length	mm
Flux density	T
Field strength	A m ⁻¹
Potential	Wb m ⁻¹
Conductivity	S m ⁻¹
Source density	A mm ⁻²

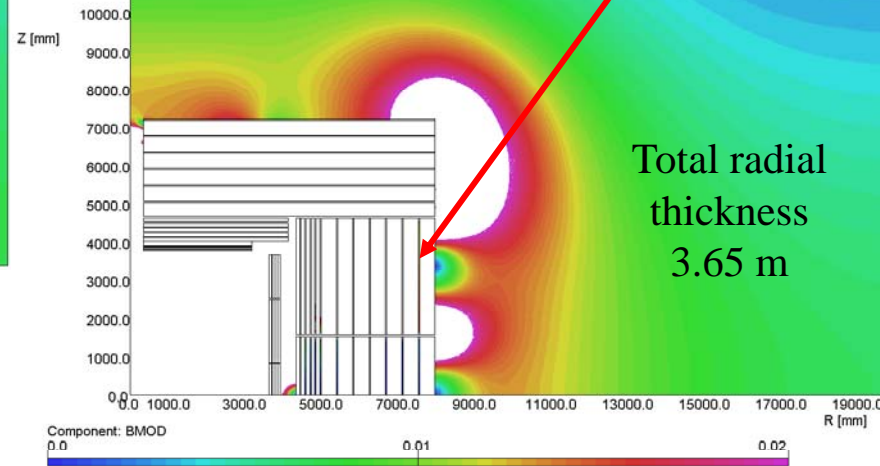
Z [mm]

Component: BMOD

0.0

0.01

+2 x 400mm iron layer



UNITS	
Length	mm
Flux density	T
Field strength	A m ⁻¹
Potential	Wb m ⁻¹
Conductivity	S m ⁻¹
Source density	A mm ⁻²
Power	W
Force	N
Energy	J
Mass	kg

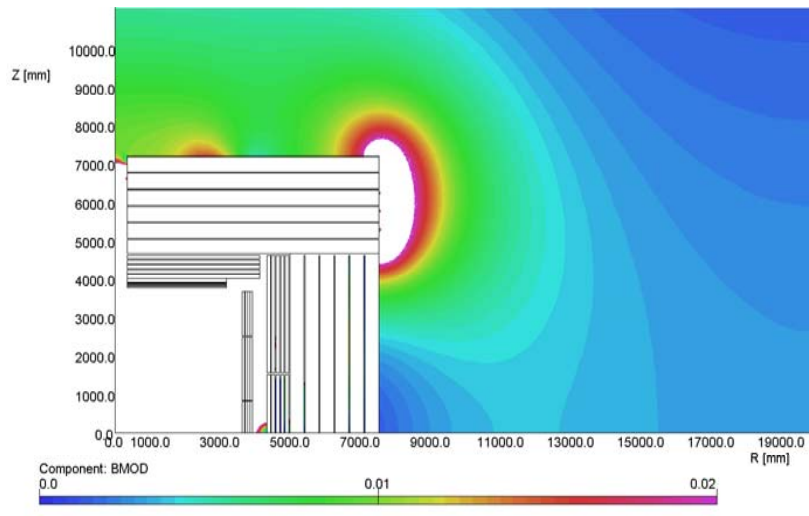
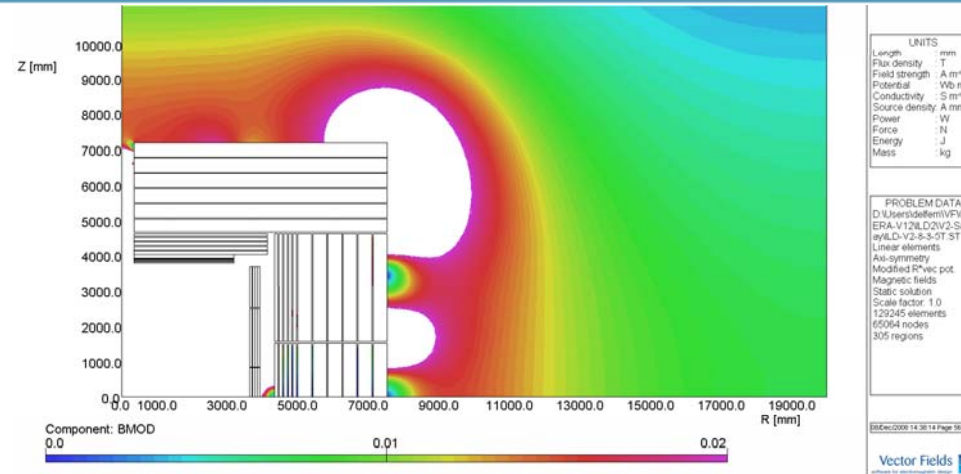
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Modified R ² vec pot.	
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Static solution	
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557 regions	

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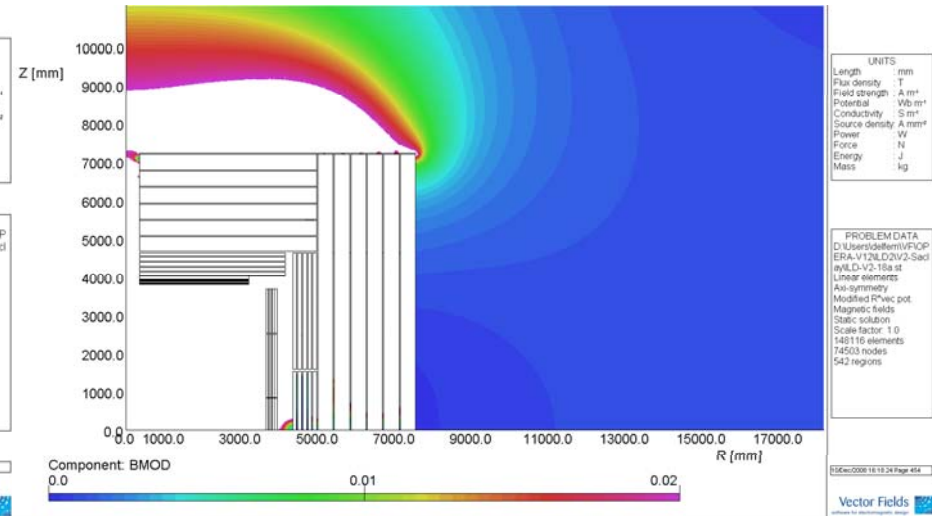
Vector Fields

+1 x 400mm iron layer

Influence of gaps on the stray field (ILD V2 iron up to R=7.54 m)



No gaps in the barrel



Barrel up to $Z=7.2$ m

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2. Some other points
 - 2.1 Anti-DID coil design

Anti-DID coil design

Brett Parker has agreed to contribute to the anti-DID coil design:



. in a first step, he will provide a coil pattern compatible with the new solenoid coil geometry to first order

. next step will be the conceptual coil design (forces, peak field, stored energy...)

. then, semi-realistic engineering (conductor, winding technique, support and cooling of the coil...).

We are in touch together, and he told me that he will start this work this week

Summary



Present conclusions

Present conclusions

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- New magnetic calculations have been done with the Lol parameters. Solutions which meet the specifications have be found
- Point which still needs some study is the yoke design, in relation with the acceptable stray field: minimum dimension of gaps in the yoke, partial filling of the gaps...?
- Conceptual design of the anti-DID is going to restart, with the new detectotr magnet configuration.