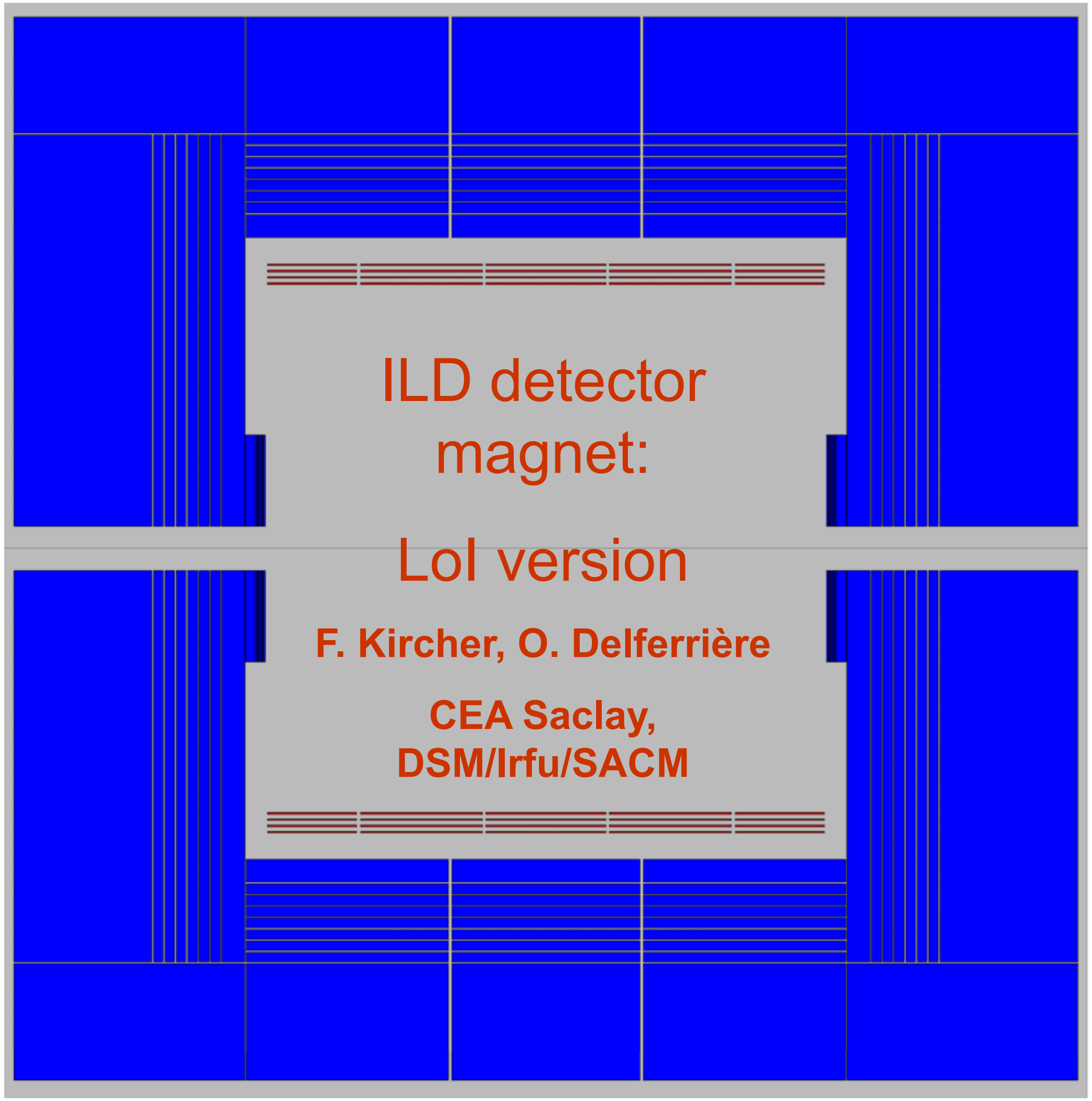

ILD detector magnet:

LoI version

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Summary

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Introduction

Introduction

. The magnet main parameters have been fixed during the Cambridge meeting last September

. Since that time, the design of both the coil and the yoke has been refined to cope with these parameters, and with the integration of the magnet within the detector

. As ILD magnet parameters are roughly the same as for CMS magnet, the ILD magnet concept is based on CMS magnet one, with two extra requests:

- High integral field homogeneity in the TPC volume
- Lower fringing field (push-pull operation)

. The ILD-V5 version presented today is also that one for the LoI

Summary

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Cambridge meeting decisions

- The main parameters for the ILD detector magnet have been fixed at the ILD Cambridge meeting of last September:

. Central field = 3.5 T for operation
4.0 T for design

. R_{int} cryostat = 3.44 m

. L coil = 7.35 m

. $B_{ext} \leq$ 50 G @ R=15 m in the radial direction (push-pull operation)

. Integral of field homogeneity within the TPC volume ≤ 10 mm

. Addition of a anti-DiD (Dipole in Detector) within the magnet structure

Version ILD-V5 : generalities

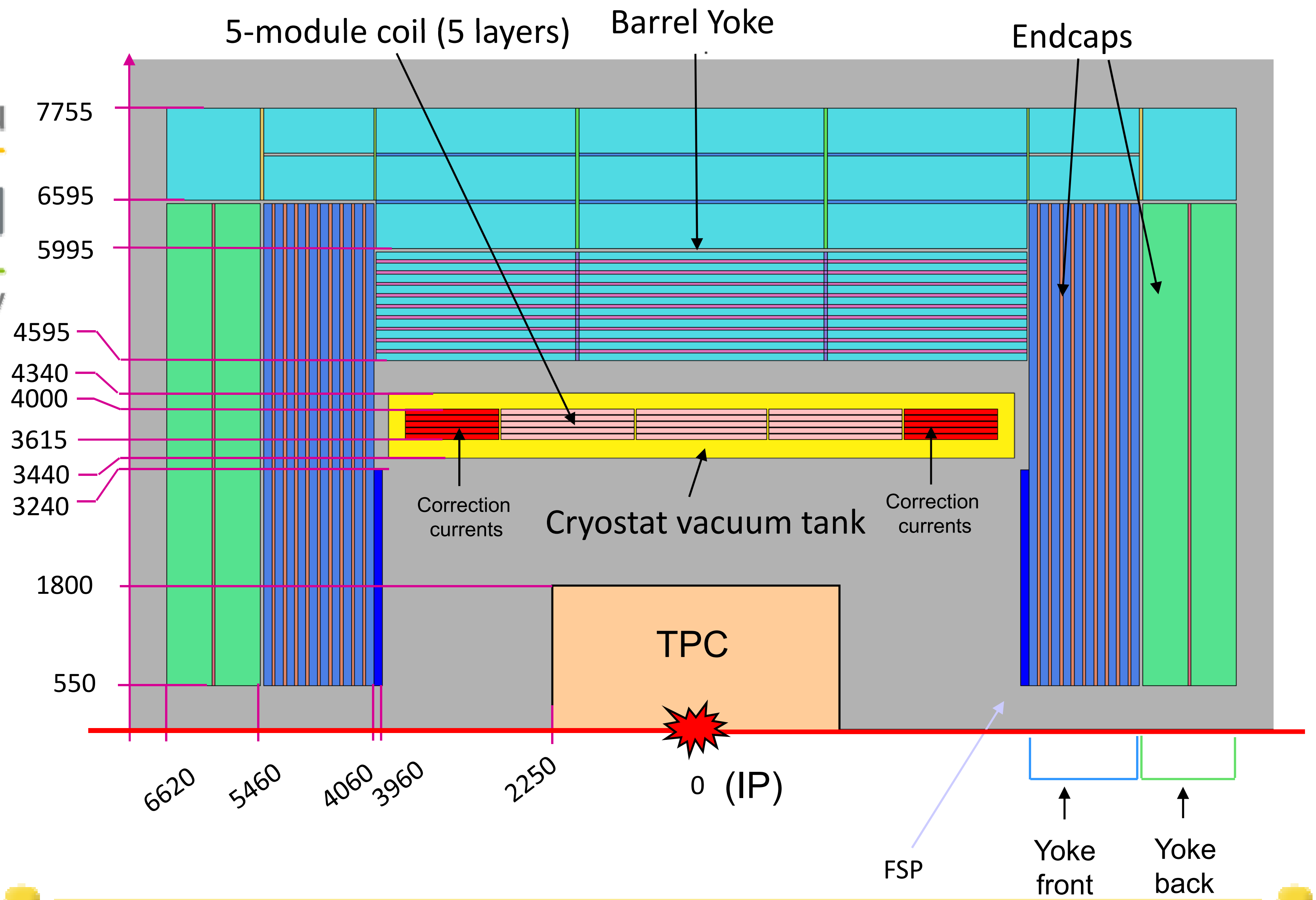
- Magnet = Coil + iron yoke (barrel + end-caps)

- Coil
  - 5 modules (2 different lengths)
  - 5 layers in each module (one layer added from the previous versions)
  - correction current in some parts of the coil to adjust the field homogeneity

- Yoke configuration:
  - as described by Uwe in his previous talk

- For all cases: 2D calculations (cylindrical symetry)

Version ILD-V5 : magnet design



Version ILD-V5: field homogeneity

- Request

- homogeneous field in the volume of the TPC:

$$\Delta l\,(R) = \int_{0}^{z_{max}} (B_r\,(R) / B_z\,(R)\,dz \leq 10\text{ mm}$$

within the TPC volume:

z_{max} = 2.25 m

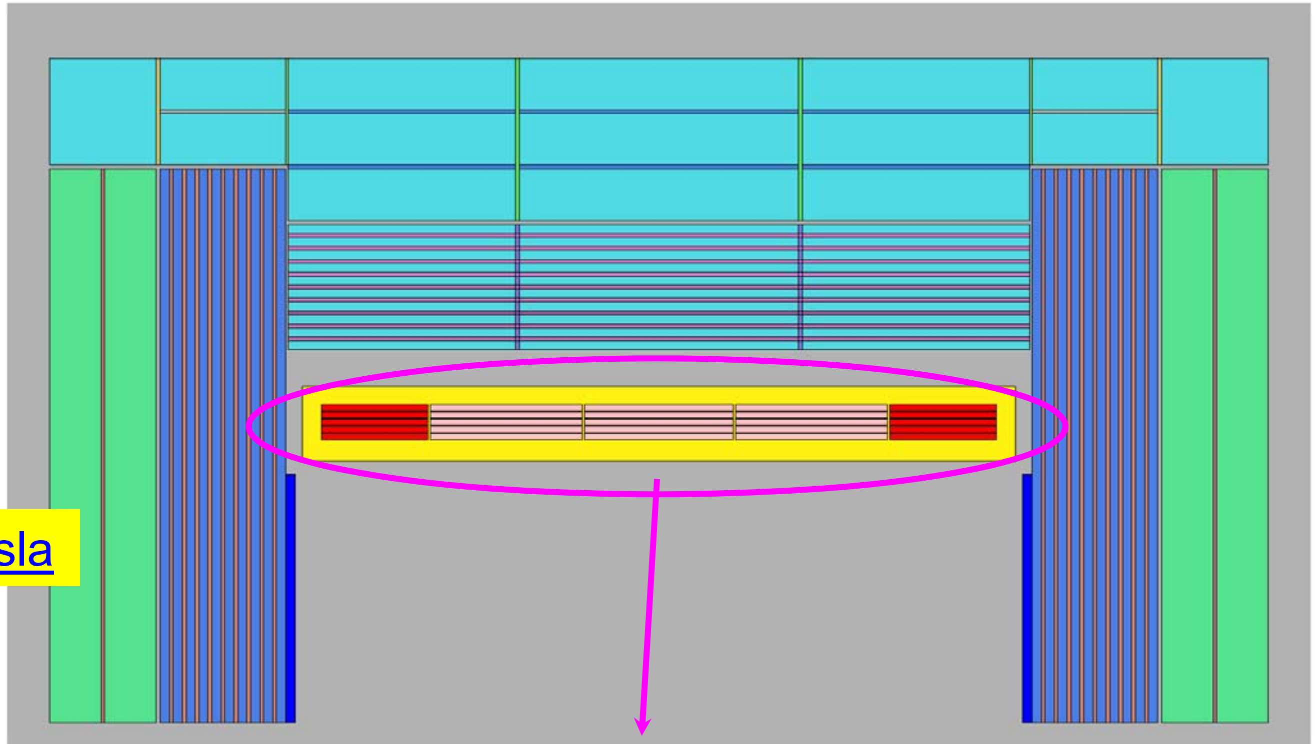
and R = 0 to R_{max} = 1.8 m

- the field homogeneity is ajusted with a FSP (Field Shaping Plate), located ahead of the end-cap yoke, and correction currents in some places of the coil.

Version ILD-V5: main outputs

Parameter	Operation	Design
Central field (T)	3.5	4
Maximum field on conductor (T)	4.82	5.50
Inom (kA)	15.8	18.4
ΔI cor (kA)	16.2	18.4
Stored energy (GJ)	2.07	2.73
Density of stored energy in the cold mass(kJ/kg)	9.0	11.9
Integral homogeneity in TPC volume (mm) (without anti-DiD)	≤ 5	≤ 10
Stay field @ R = 15 m (G)	35	38

Version ILD-V5: magnet configuration



ILD-V5 @ 4 Tesla

Current distribution : (KA)		5 layer corrections		
36.80	18.40	18.40	18.40	36.80
36.80	18.40	18.40	18.40	36.80
36.80	18.40	18.40	18.40	36.80
36.80	18.40	18.40	18.40	36.80
36.80	18.40	18.40	18.40	36.80

Version ILD-V5: coil configuration

C2	C1	C1	C1	C2
C2	C1	C1	C1	C2
C2	C1	C1	C1	C2
C2	C1	C1	C1	C2
C2	C1	C1	C1	C2

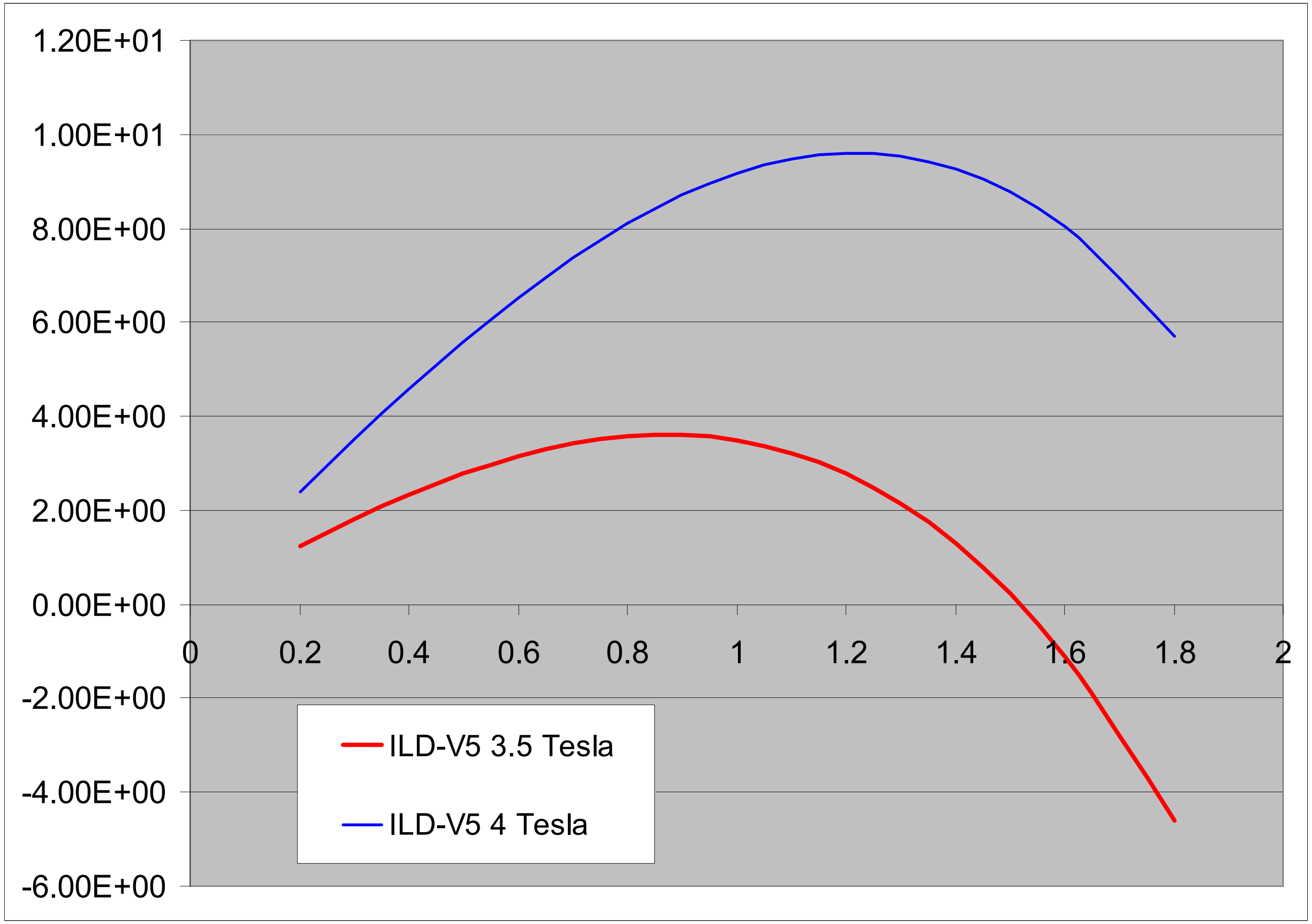
3.5 T

	NI (MA)	J (A/mm²)	N (turns/layer)	I per turn (kA)	I correction (kA)	Length (m)
C1	0.87	7	55	15.8	0	1.65
C2	1.28	14.8	40	32	16.2	1.2

4. T	NI (MA)	J (A/mm²)	N (turns/layer)	I per turn (kA)	I correction (kA)	Length (m)
C1	1.02	8.2	55	18.4	0	1.65
C2	1.47	17	40	36.8	18.4	1.2

Version ILD-V5: field homogeneity

$\int(Br/Bz)dz$ *vs* r (z=0 to 2.25 m)



Comparison of ILD-V5 and CMS designs

Parameter	CMS	ILD-V5
Useful aperture (m)	6	6.9
Length (m)	12.5	7.35
Design field (T)	4	4
Max. field (T)	4.6	5.50
Nominal current (kA)	19.1	18.4
Extra correction current (kA)	0	18.4
Coil configuration	5 modules * 4 layers, same length	5 modules * 5 layers, 2 ≠ lengths
Stored energy (GJ)	2.6	2.73
Density of stored energy (kJ/kg)	11.6	11.9

Summary

2. Some technical points
   2.1 Points similar to CMS
   2.2 Modules with correction current
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Technical points similar to CMS

A lot of technical points will be similar to CMS:

. Reinforced conductor, based on a superconducting cable
. Inner winding of the five layers of each module
. Mandrel also acting as mechanical support and quench-back tube
. Indirect cooling by saturated liquid helium at 4.5 K, with thermo-siphon
. Cold mass supported in the vacuum tank by several sets of tie-rods
. Vacuum tank supported in a cantilever way by the central barrel yoke
. Inner sub-detectors supported on rails inside the vacuum tank

The experience gained by CMS will be (and already has been) of a great interest for ILD.

Modules with correction current

This is one of the main novelty from CMS.

Basic concepts:

- the conductor with the extra correction current has:

. the same overall dimension as the conductor with the main current, typically 73*22 mm^2 without insulation

. but a higher current transport capacity to work with about the same safety margin with respect to the critical current

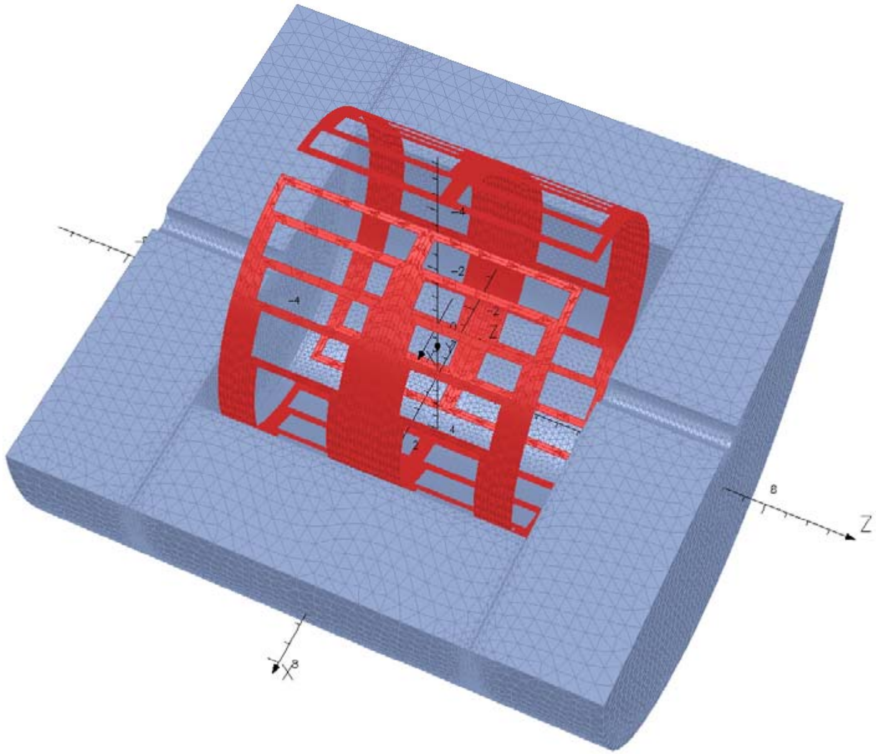
. a stronger mechanical support: at least for the conductor with the extra correction current, the ratio of structural material is close to 1 (cf conductor for the ATLAS Central Solenoid developed by Akira Yamamoto et al.), vs 0.6 for CMS

- in case of quench, the extra local Joule heating is absorbed by the quench-back phenomenon, much quicker than the increase of temperature of the coil, and which diffuses the uniformly the heat

Anti-DID coil design

The anti-DiD allows to zero the crossing angle for the outgoing beam (and pairs) behind the I.P.

Brett Parker has started some conceptual design study



. Two dipole coils, anti-symetric with respect to the I.P.

. Proposal to wind the anti-DID coil outside the main solenoid coil (reduced field region)

. Field maps (3D) do not yet include the ILD solenoid

. $B_{anti\text{-}DID}$ ~ 0.065 T

Summary

Conclusions

Conclusions

- Magnetic calculations have been done with the LoI parameters. Solutions which meet the specifications have been found

- Most of the CMS concepts can still be used for ILD. Some R&D on a conductor with a ratio of structural material close to 1 would strenghten the mechanical design of the most mechanically solicited modules

- Conceptual design of the anti-DID has started, and must continue with the present detector magnet configuration

- Even if some points can still evolved and/or need some more studies, the present design is at an acceptable level of study for the LoI