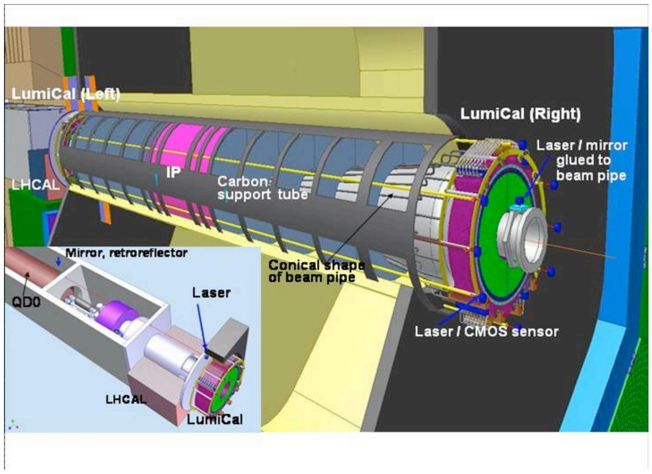

FIGURE 4.12-17. The detectors of the very forward region. A conical carbon fiber structure will support the vertex and forward tracking detectors and be fixed at both sides on the front face of LimiCal. LumiCal and BeamCal are supported by the support tube of the final focus quadrupole QD0.

- Prototyping of a laser position monitoring system for LumiCal. In particular the control of the inner acceptance radius with μm accuracy is a challenge and must be demonstrated.
- Development and prototyping of FE Asics for BeamCal and the pair monitor. There are challenging requirements on the readout speed, the dynamic range, the buffering depth and the power dissipation.
- Design of GamCal and estimate of its potential for a fast feedback beam-tuning system.

4.13 COIL AND RETURN YOKE

Francois Kircher etal.

4.13.1 Generalities

The basic layout of the ILD detector has always followed the strategy of tracking in a magnetic field. So, the ILD detector design asks for a 4 T field in a large volume, with a high field homogeneity within the TPC volume and with a reduced fringing field in the radial direction because of the operation in push-pull mode.

The parameters of the ILD magnet being very similar to the CMS ones, basic designs of both magnets are similar. An anti DiD (Dipole in Detector) is also added in the design, which allows to zero the crossing angle for the outgoing beam (and pairs) behind the I.P.

4.13.2 Physics requirements

The main requests from the physics for the ILD magnet are a solenoidal central field of 4T, in a volume of 6.9 m in diameter and 7.35 m long, with the following requests: - a high integral field homogeneity:

$$| \int_0^{2.25m} (B_r/B_z)\, dz \,| \leq 10mm \quad \text{(ii)}$$

with

$$B_r = B_x(x/r) + B_y(y/r) \quad \text{(iii)}$$

within the TPC volume, which is a cylinder 3.6 m in diameter and 4.5 m long - fringing field in the radial direction less than 50 G at R = 15 m for not magnetically perturbing the second detector when in operation on the beam line - yoke instrumented for the muon detection.

4.13.3 Magnet design

The magnet consists of the superconducting solenoid, including the correction coils, and of the iron yoke, one barrel yoke in three pieces and two end-cap yokes, also in three pieces each. The anti DiD is located outside the solenoid.

Concerning the correction coils, it seemed practically simpler and less space requesting to incorporate them in the main winding, by adding extra currents in appropriate locations of the winding.

The cross section of the ILD detector magnet is shown on Fig 1.2-1. Its main geometrical and electrical parameters are given in Tab 1.2-1 and Tab 1.2-2 respectively.

4.13.4 Coil main characteristics

The coil is divided into five modules, electrically and mechanically connected: there are three central modules, 1.65 m long each, and two external modules, 1.2 m long each. All modules consist of a four layer winding.

The nominal main current, 18.2 kA for a central field of 4.0 T, runs through all the turns of the solenoid. An extra correction current of about 15.8 kA is added in the turns of the four layers of the two external modules to get the integral field homogeneity.

4.13.5 Yoke (to be updated with the final version)

The barrel yoke has an octagonal shape (TBC). It is longitudinally split into three parts. In the radial direction, the inner part of the yoke is made of 9 iron plates, with a space of 30 mm between each to house the muon detectors. 5 external thick plates, each 345 mm thick 30 mm space in between, make up the total iron thickness. The weight of the barrel yoke is around 9 680 t TBC.

The end cap yokes, also of octagonal shape, have a similar split structure, with 10 iron plates in the inner part, with a space of 30 mm between each to house the muon detectors, and 4 external thick plates, each 450 mm thick, to make up the total iron thickness. A 100 mm thick field shaping plate (FSP) will be added inside each end-cap to improve the field

Cryostat inner radius (mm)	3440
Coil inner radius (mm)	3615
Coil outer radius (mm)	3915
Cryostat outer radius (mm)	4240
Barrel yoke inner radius (mm)	4340 TBC
Barrel yoke outer radius (mm)	7485 TBC
Coil length (mm)	7350
Cryostat length (mm)	7810
Yoke overall length (mm)	7190*2 TBC

TABLE 4.13-6
Main geometrical parameters

Central field (T)	4.0
Maximum field on conductor (T)	5.35
Stored energy (GJ)	2.0
Stored energy per unit of cold mass (kJ/kg)	12.2
Nominal main current (kA)	18.2
Nominal correction current (kA)	15.8
Ampere-turns main coil (MAt)	1.52 TBC
Ampere-turns correction coils (MAt)	1.36 TBC

TABLE 4.13-7
Main Magnetic and electrical parameters

homogeneity. The weight of each end cap yoke is around 770 t for the endcaps with muon chambers, and 1 370 t for the last part, giving a total yoke weight of about 4 300 t with FSP. The total weight of the yoke is around 18 300 t. (All values TBC)

4.13.6 Magnetic field

The calculated integral field homogeneity, with the nominal values of the main and correction currents given in Tab.1.2.2 meets the requirement (maximum value of 7 mm at 4 T. Note that the effect of the anti DiD in not taken into account in this calculation.

With the yoke structure described, the calculated fringing field is of 50 Gauss at 15 m in the radial direction for a gap filling of 50% and fulfil the requirements. TBC

4.13.7 Some technical aspects

As previously mentioned, several technical aspects are quite similar for the ILD and CMS magnets. So the experience gained during the construction of the CMS magnet will be of great help for ILD.

The conductor will consist of a superconducting cable coextruded in a very pure aluminium and mechanically reinforced by aluminium alloy. Two different conductors will be necessary, using different superconducting cables and different ratio of mechanical reinforcement, but with the same overall dimensions.

The winding will be done using a inner winding technique. The magnetic forces will be contained both by the local reinforcement of the conductor, and by an external cylinder. The coil will be indirectly cooled by saturated liquid helium at 4.5 K, circulating in a thermosiphon mode.

The central barrel yoke ring will support the vacuum tank. Internal sub-detectors will be supported on rails inside the vacuum tank.

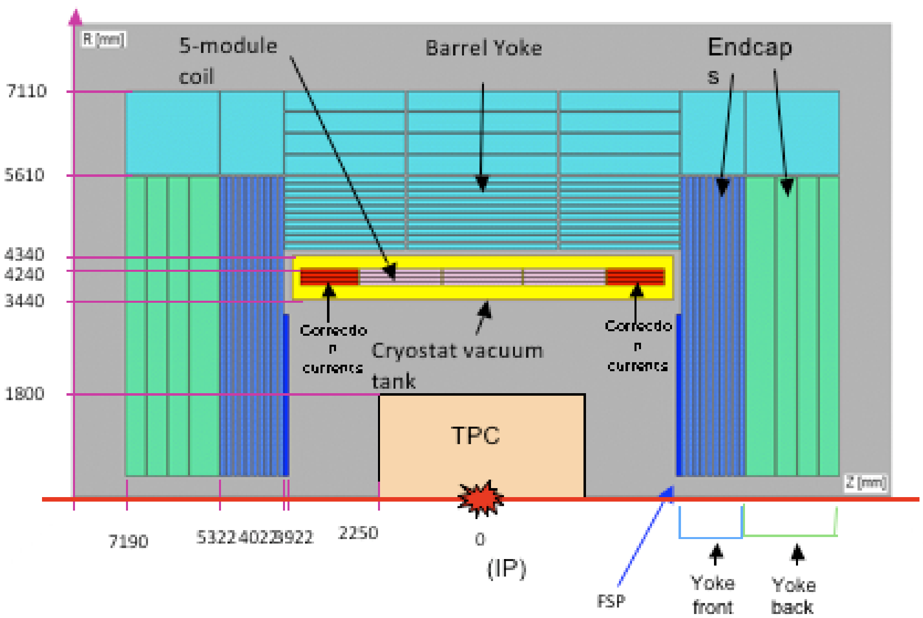

FIGURE 4.13-18. Cross section of the ILD magnet (to be updated and improved).

4.14 MUON DETECTOR

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