

1.2.1 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.

1.2.2 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 :

$$\left| \int_0^{2.25 \text{ m}} (B_r / B_z) dz \right| \leq 10 \text{ mm}$$

with

$$B_r = B_x (x/r) + B_y (y/r)$$

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.

1.2.3 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.

1.2.4 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 19.0 kA is added in the turns of the four layers of the two external modules to get the integral field homogeneity.

Table 1.2-1. Main geometrical parameters

Cryostat inner radius (mm)	3440
Coil inner radius (mm)	3615
Coil outer radius, with support (mm)	3965
Cryostat outer radius (mm)	4240
Barrel yoke inner radius (mm)	4495
Barrel yoke outer radius (mm)	7655
Coil length (mm)	7350
Cryostat length (mm)	7810
Yoke overall length (mm)	13210

Table 1.2-2. Main Magnetic and electrical parameters

Central field (T)	4.0
Maximum field on conductor (T)	5.54
Stored energy (GJ)	2.72
Stored energy per unit of cold mass (kJ/kg)	15.3
Nominal main current (kA)	18.2
Extra nominal correction current (kA)	19.0
Ampere-turns main coil (MA _t)	22.4
Ampere-turns correction coils (MA _t)	7.5

1.2.5 Yoke

The barrel yoke has an 12-fold shape. It is longitudinally split into three parts. In the radial direction, the inner part of the yoke is made of 10 iron plates, with a space of 40 mm between each to house the muon detectors. 3 external thick plates, each 560 mm thick with 40 mm space in between, make up the total iron thickness. The weight of the barrel yoke is around 9 200 t. TBC

The end cap yokes, also of 12-fold shape, have a similar split structure, with 10 iron plates in the inner part, with a space of 40 mm between each to house the muon detectors, and 2 external thick plates, each 560 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 homogeneity. The weight of each end cap yoke is around 840 t TBC for the endcaps with muon chambers, and 940 t TBC for the last part, giving a total yoke weight of about 3600 t with FSP TBC. The total weight of the yoke is around 12800 t. TBC

1.2.6 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 8 mm at 4 T. Note that the effect of the anti DiD is 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 with some gap filling and fulfil the requirements. **TBC**

1.2.7 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 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.

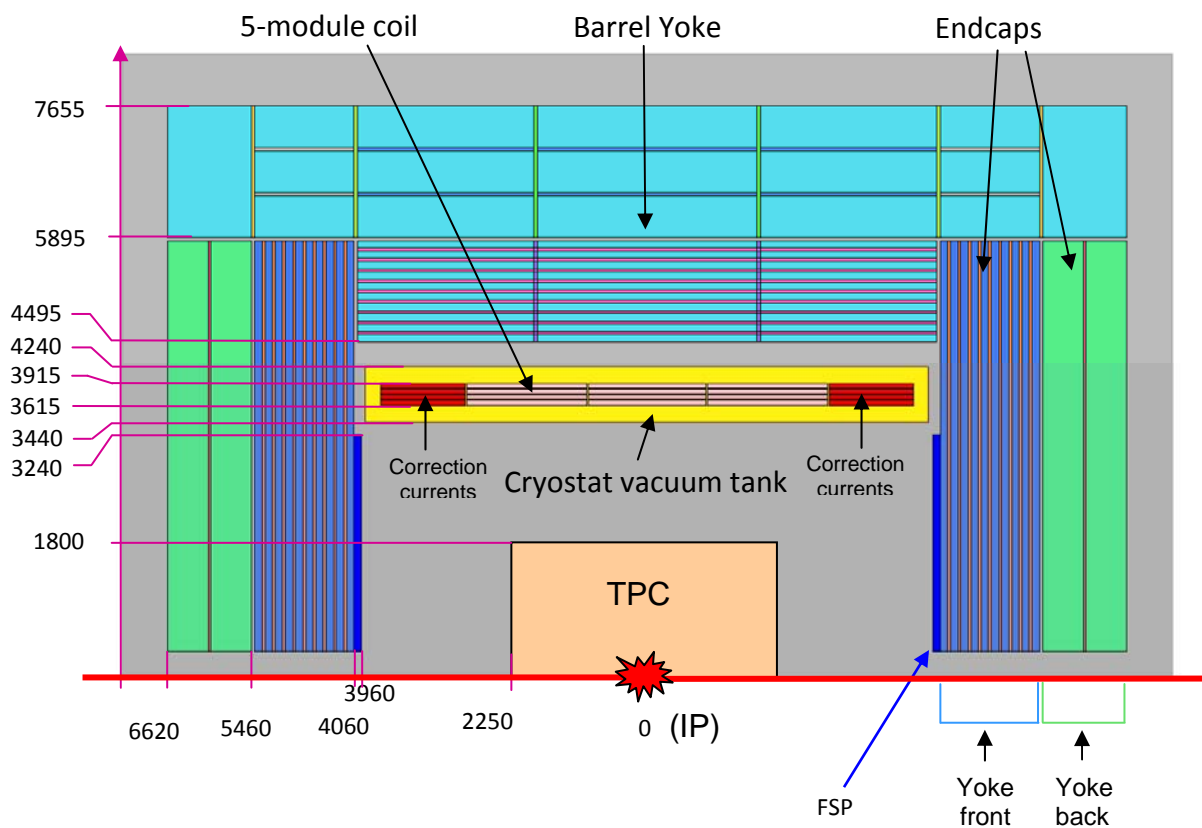


Fig 1.2-1. Cross section of the ILD magnet