1 The Hadron Calorimeter (HCAL)

Description: The iron serves as yoke for the magnetic flux return and for the hadronic calorimetry and as muon filter. There are:

2 x 6	end-cap modules	75 tons each
2 x 12	barrel modules	70 tons each
		$\sum$ = 2580 tons

The iron barrel around the coil and the two end-caps are subdivided into 23 layers. The active part of the detector consists of 23 layers of streamer tubes inserted into the gaps of the iron yoke. The basic element is a wire counter made of a graphite coated plastic tube operated in limited streamer mode. Each tube layer is equipped with pad readout for integrated energy flux measurement and with strips, parallel to each tube for digital reconstruction of the track pattern. The pads of each layer are connected together so as to form towers pointing to the vertex.
Gas: $ArCO_2$ + Isobutane. (12.5% : 56.5% : 30%)

Dimensions:

Iron Yoke:

Barrel radius:	R_{inner} = 300 cm, R_{outer} = 468 cm
Endcap radius:	R_{inner} = 45 cm,R_{outer} = 435 cm
Distance from I.P.	z = 315 cm
Endcap length	Δz_{pole} = 168 cm, $\Delta z(R > 2.1m)$ = 121 cm
Slab thickness	5 cm (except last layer = 10 cm)
Gap width	2.2 cm
Interaction length	7.16 λ_{int} at $\theta = 90^0$
Total iron thickness	120 cm at $\theta = 90^0$
	199 cm at $\theta = 53^0$

Plastic tubes:

Length:	700 cm (barrel), 40 cm to 450 cm (end-cap)
Cross section	$1 \times 1cm^2$
Wire diameter	100μ
Strip width	0.4 cm
Strip pitch	1 cm

Tower size:
$\Delta\phi = 3.7^0$, $\Delta\theta \sim 3.0^0$ ($34^0 < \theta < 90^0$)
$\Delta\phi = 7.5^0$, $\Delta\theta \sim 2.7^0$ ($18^0 < \theta < 34^0$)
$\Delta\phi = 15^0$, $\Delta\theta \sim 2.5^0$ ($6^0 < \theta < 18^0$)

Readout:

Channels	Barrel ($41^0 < \theta < 139^0$)	End-caps ($6^0 < \theta < 41^0$) ($139^0 < \theta < 174^0$)	Total ($6^0 < \theta < 174^0$)
♯ Tubes (=♯ Wires)	48,384	71,040	119,424
♯ Towers	3,456	1,344	4,800
♯ Layers	23	23	

Performance: Energy resolution $\sigma/E = 84\%/\sqrt{E}$

2 The Superconducting Coil

Description: Superconducting solenoid with Helium cooled pipes surrounding the Al conductor.

Conductor	aluminium around NbTi/Cu
Weight Coil+Cryostat	55 tons
Field at 5000A	1.5T
Stored energy	136 MJoule
Refrigeration power	100 W at 4.2 K
	2400 W at 80 K
	30 l/h of liquid He

Dimensions:

Cryostat radius:	$R_{inner} = 248$ cm
	$R_{outer} = 292$ cm
Cryostat length	7 m
Absorption length (coil+cryostat)	0.4 λ_{abs}
Radiation length (coil+cryostat)	1.6 X_0

Performance:

Field homogeneity $\Delta B_z/B_z$	$< 0.2\%$
Radial field component B_r/B_z	$< 0.4\%$
Azimuthal field component B_ϕ/B_z	$< 0.04\%$
Elongation of coil for $\Delta Temp. = 300^0$	2.5cm
Time to cool down	10 days
Time of forced cool down	8h
Time to charge to 5000A	1h