

# Thin Solenoid, Compensating Solenoid, FMUON Toroids for ZEUS Experiment



MAGNETS FOR FUSION



MAGNETS FOR HIGH ENERGY PHYSICS



MAGNETS FOR MEDICAL APPLICATIONS



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## Thin Solenoid

A large thin wall superconducting solenoid was designed, manufactured and installed for the detector ZEUS at the HERA electron-proton collider of the DESY facility (Hamburg) in 1989.

The thin solenoid, 1.88 m in diameter and 2.5 m in length, is characterized by a high magnetic field level ( $B = 1.8 \text{ T}$ ), by a two-layer winding and by a variable linear current density.

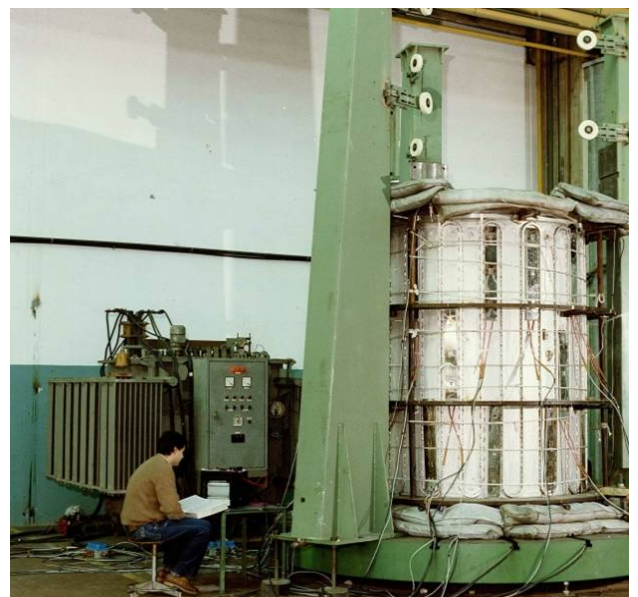
The solenoid with a thickness lower than 0.9 radiation lengths, has been successfully in operation from 1990 to 2007, with an operating current of approximately 5000 A. Electrical insulation was provided using a VPI process.

Indirect cooling through the external restraining cylinder assured an operating temperature lower than 4.5 K. The magnet showed no training behaviour.



*Assembly of thin solenoid*

Plant	HERA (Hamburg)
Delivery	1989
Max. field value	1.8 T
Type of winding	solenoid, 2500 mm length, 5000 total turns
Nominal current	4987 A
Conductor	NbTi, copper, aluminium stabilized
Cooling	LHe, two phases indirect
Weight of coil	2500 Kg



*Shrink fitting of aluminum restraining cylinder around thin solenoid coil*



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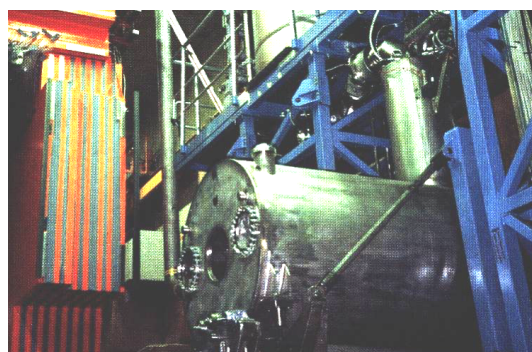
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## Compensating Solenoid

INFN ordered this system in the framework of the ZEUS project, for the design and manufacture of a superconducting compensating magnet, delivered in 1989, for the detector inside the HERA accelerator at DESY, Hamburg. The compensating magnet is bath cooled in LHe; the winding is 1200 mm long, with 370 mm inner diameter, 474 mm outer diameter, 5 T peak field at centre. The nominal current is 1000 A and the stored energy is 1.53 MJ. The coils were impregnated with epoxy resin using a VPI process.

The suspension system of the cryostat sustains, in addition to the weight of the ferromagnetic shield, also rather intense magnetic field strengths with very tight positional tolerances.

The power supply, the quench detection system, the vacuum vessel and both hardware and software of the control system were part of the scope of supply.



*Compensating solenoid mounted on the beam axis*

Center max. range	5 T
Stored energy	1.53 MJ
Type of winding	solenoid winding, 1200 mm long, 5000 total turns
Nominal current	1000 A
Conductor	4 x 2.6 mm <sup>2</sup> s.c. cable
Cooling	liquid helium bath
Weight of coil	650 Kg
Yoke weight	4500 Kg
Insulation	electroglass

## FMUON Toroids



*FMUON Toroids for ZEUS Experiment*

Type	Bulk Yoke - Toroids
Yoke	Low carbon steel / Fe GM 01 UNI 3595
Conductor	OFHC copper
Yoke Magnetic Field	1.75
Magnetic Field Strength	7800 Amp/m
Current	509 Amp
Current Density	1.8 Amp/mm <sup>2</sup>
Conductor Size	19 x 19 mm <sup>2</sup>
Conductor Cooling Duct dia.	10 mm
Power	16 KW
Total Flow Rate	1360 l/h
Water Temperature Rise	10°C
Pressure Drop	1 atm
Dimensions	6 x 9 m
Weight	100 t