

CLAS12 - TORUS Magnet

The *CLAS12 Toroid* is based on six superconducting coils around the beam line to produce a field primary in the azimuthal (ϕ) direction. The choice of this configuration leads to an approximate toroidal field distribution around the beam axis. The Torus design was driven by the following physics requirements:

- Large acceptance for forward going particles (50% particle acceptance in detectors at 5 degrees from beam axis)
- Good momentum resolution
- 6 fold symmetry around the beam axis
- Large bore to allow passage of scattered primary beam



TECHNICAL PARAMETERS

PARAMETER	DESIGN VALUE
Magnet Type	Toroidal Field Geometry
Number of Coils	6
Coil structure	Double pancake potted in Aluminum Case
Warm bore \varnothing (mm)	124
Total weight (Kg)	25,500
Number of turns per pancake	117
Number of turns per coil	234
Conductor	SSC outer dipole cable soldered in 20 mm x 2.5 mm Cu channel
Turn to Turn Insulation	0.003" E-Glass Tape $\frac{1}{2}$ Lap
Nominal current (A)	3770
Ampere turns (-)	882,000
Peak Field (T)	3.58
Peak Field Location	Inner turn near warm bore adjacent to cooling tube
B-Symmetry	Yes
$\int Bdl$ @ nominal current (Tm)	2.78 @ 5 degree , 0.54 @ 40 degree
Inductance (H)	2.00
Stored Energy (MJ)	14.2
Quench Protection/Dump Resistor	Hard wired quench detector / 0.124 Ω dump resistor
Coil Cooling	Conduction Cooled by Supercritical Helium
Supply temperature (K)	4.6
Temperature margin (K)	Min 1.52 (@5.3 K) to Generation temperature 6.82
Heat Shield Cooling	LN2 Thermo-Siphon

- **Construction Strategy:**

- JLab lead the design effort
- JLab procured the soldered conductor
- FNAL manufactured 8 coils and potted them in the coil cases (CCMs)
- JLab assembled each coil into cryostats in an on-site factory
- All 8 coils tested at 80K
- The six coil torus assembled and tested as a magnet in Hall B

- **Significant Dates:**

- August 1, 2013 - 7 conductor spools soldered
- December 1, 2013 - Practice coil delivery to JLab
- January 2, 2014 - Prototype coil fabrication start
- Oct 17, 2014 - Begin erection of the Torus assembly tooling in Hall B
- Nov 1, 2014 - Complete coil fabrication process (Practice CCM001)
- Nov, 2014 - First CCM delivered to JLab for Cryostating
- February 6, 2015 - First coil delivered to Hall B
- May 11, 2015 - 4th Coil installed on Installation Spit
- June, 2015 - Last CCM delivery to JLab
- June, 2015 - 6th Coil installed on Torus
- January, 2016 - Magnet Assembled and off the Assembly Spit
- August 2016 - Cooldown Starts
- September 2016 - Torus at 4 Kelvin
- November 2016 - Torus commissioned and field mapped in Hall B

- **Project Status 3/15/2017**

- Magnet achieved full field
- Small internal helium leak is not effecting performance
- Lower vacuum pump system will have Turbo Pump moved to low field region

Last Updated: March 22, 2017



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