

HISTORY OF OPERATIONAL EXPERIENCE WITH LARGE  
SUPERCONDUCTING MAGNETS\*

There are 3 large diameter contact cooled coils in existence, compared to dozens of pool boiling magnets. The history of contact cooled coils is shorter and has had limited success. A large number of pool boiling magnets have been built with relatively minor problems and have functioned successfully for many years.

The three contact cooled coils are CELLO, CLEO and the TPC. Data on each of these magnets is given below.

CELLO - Contact Cooled

The CELLO magnet was constructed by Saclay for PETRA. The stored energy is 7 MJ at 1.5 T. The magnet is 1.7 m in diameter and 3.5 m long. Initially the current was limited to 1900 A (corresponding to a field of 0.85 T) because of a conductor defect in the last 7 turns. The magnet was reworked by removing the last seven turns and now operates at 1.3 tesla field. Additional defects in the conductor are presumed to prevent the attainment of full field.

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R. Kephart, et al.

CLEO - Contact Cooled

The CLEO magnet was built for the Cornell Electron Storage Ring to study electron-positron collisions. The stored energy at its design field of 1.5 tesla is 9.4 MJ. The magnet is 2 m in diameter and 3.1 m long. The operating current to obtain 1.5 tesla is 2260 A. The magnet has been tested to only 1.0 tesla because the designers expect the conductor to separate from the bore tube at 1.2 tesla. Separation from the bore tube would most likely create a training problem. This problem can be directly traced to the unexpected creeping of their soft 1100 aluminum bore tube during winding. At 1.0 tesla the magnet quenched 5 times during a one month test run. Sources of the quenching were varied, from someone adjusting the refrigerator system to an electrical storm in the vicinity affecting the electronics.

TPC - Contact Cooled

The TPC magnet was built at the Lawrence Berkely Lab for the time projection chamber experiment PEP-4 at SLAC. The design operating current is 2270 A, which produces a field of 1.5 tesla. The coil is 2.17 m in diameter and 3.3 m long. The magnet has a stored energy of 11 MJ. During a test run a disastrous short to ground destroyed the magnet. Iron filings which penetrated the insulation are the suspected cause. The magnet is currently being rebuilt.

Large pool boiling magnets have enjoyed a rather successful history which extends back nearly 20 years. The number of magnets in operation is overwhelming. To our knowledge no cryostable pool boiling magnet using stabilized conductor has failed catastrophically. Therefore, listed below are several representative examples of pool boiling successes.

#### Morpurgo I1 Solenoid - Pool Boiling

The Morpurgo Solenoid was built for the Intersecting Storage Ring at CERN. The magnet operates at 1.5 tesla with a current of 2200 A. It is 1.8 m long by 1.5 m in diameter, and has a stored energy of 3 MJ. The magnet operated successfully for 5 years before a recent failure of an epoxy-fiberglass support. The failure is thought to be the result of thermally cycling the magnet. Failure occurred during operation, however, the magnet did not quench. It is currently under repair.

#### 15' Fermilab Bubble Chamber Magnet - Pool Boiling

With a stored energy of 396 MJ the 15' magnet is large by anyone's standards. The inside diameter of the coil pair is 14'. During operation the 5000 A operating current provides a 3 tesla field. The magnet was built at Argonne National Lab and was completed in 1972. It has operated successfully since its installation. Once during operation the LHe level dropped below a safe level and a normal region developed. The magnet was discharged and no serious damage occurred to the magnet.

12' Bubble Chamber/HRS Magnet - Pool Boiling

Completed in 1968 the 12' magnet has a stored energy of 80 MJ. The average coil diameter is 200". It operates at 2200 A. After working in the 12-Foot BC until 1978, it has since been converted to horizontal operation for a spectrometer at PEP.

BEBC (Big European Bubble Chamber) - Pool Boiling

The BEBC magnet has been operating at CERN since 1972. A central field of 3.5 T is produced by the 5700 A operating current. The inside diameter of the magnet is 4.7 m and the length is 1.5 m. During operation the magnet has a stored energy of 800 MJ.

Omega - Pool Boiling

The Omega Magnet was built by the Oerlikon Company in Switzerland, CERN. It has a stored energy of 50 MJ. It operates at 5000 A and produces a field of 1.8 T. The magnet has operated successfully since its installation in 1973.

Some additional large pool boiling coils which have been built and operated are listed below.

1. 7' Bubble Chamber, Brookhaven National Lab, 72 MJ stored energy
2. Chicago Cyclotron Magnet, Fermilab, 30 MJ stored energy
3. 2' Analysis Dipole, Fermilab, 2.3 MJ stored energy
4. 4' Multiparticle Spectrometer Magnet, Fermilab, 2.9 MJ stored energy
5. LASS, SLAC, 36 MJ stored energy

6. AVIS, Fermilab, 600 KJ stored energy
7. HERTZ, Fermilab, 600 KJ stored energy
8. U-25 MHD magnet, Argonne Lab, 20 MJ stored energy
9. MFTF Baseball Magnet, Lawrence Livermore, 420 MJ stored energy
10. CDIF MHD Magnet Development, Argonne National Lab, 168 MJ stored energy