Leak Testing of Hall D Solenoid coils 3 and 4.

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The leak testing of the Hall D Solenoid Supeconducting coils three and four was completed last week. There were no detectable Helium space leaks and both LN2 shields

were found to have significant leaks requiring either repair or replacement.

The leak testing was performed at IUCF as part of the initial work to evaluate the coils present condition in a definitive manner to guide further work.The final leak tests were performed using two test fixtures , one made by JLAB and one which came with the coil that was in storage from SLAC. Both coils three and four had conflat flanges welded on to the N2 and He plumbing and to the two test fixtures to reduce the background from imperfect connections. These conflats will be used from now on to join the four coils to the new cryo box(replacement for Puffing Billy) in lieu of the cut and reweld technique used by SLAC and LANL. The leak Detector was a Varian with a maximum sensitivity of 0.2 x 10^-9 atm-cc/sec. The backgound from the coils due to outgassing was quite high so the leak testing was performed with a turbo pump in parallel with the leak detector. This necessitated a system overall calibration to correct for the loss of signal into the turbopump. The system calibration was done using a standard leak and the calibration factor was determined to be 138. That is any leak signal is to be multiplied by 130 to get the true leak rate. This also determines the minimum detectable leak. The leak detector background fluctuation was +/- 0.2 x 10 ^-9 atm-cc/sec. The minimum detectable signal above background is thus 0.4 x 10^-9 atm-cc/sec which gives a minimum detectable leak rate of 5.2 x 10^-8 atm-cc/sec. This minimum detectable leak rate can be reduced by pumping on the coils longer so that a parallel turbo pump is not necessary. This would take about two weeks per coil to reduce the background.

The leak test resulted in no detectable Helium leaks at 1 atm internal Helium pressure.

The Helium spaces were then pressure tested to ~ 6 atmospheres and there was no evidence of a leak. The Helium system is thus pressure tight to 6 atmospheres and He. Mass Spec. leak tight to 5.5 x 10^-8 atm-cc/sec. Both coils had leaks in the LN2 shields. This was not unexpected based on the oral history gathered from LANL and SLAC. Coil three had an indicated leak rate of 3 x 10^-7 which yields a true leak rate of 4 x 10^-5 atm-cc/sec. Coil 4 had an indicated leak of 3 x 10^-8 with a true leak rate of 4 x 10 ^-6 atm-cc/sec.The coil 3 & 4 shields were not pressure tested. An acceptable leak rate for a Liquid Nitrogen cooled shield is mid 10^-8 and an acceptable leak rate for a Liquid Helium cooled system is mid 10 ^-9.Acceptability is based on operating the solenoid for at least a year without active pumping. Clearly the N2 shields must be repaired or replaced. It would be desirable to repeat the Helium leak tests with better sensitivity to verify that the coils Helium vessels are still leak tight. There is no history of leaks in the Helium system after the initial birth defects were corrected. It is my intention to order new shields for the coils as soon as coils one and two are tested.

Electrical tests

All four coils have had extensive electrical tests performed. All systems including the voltage taps, PT 100 thermometers, silicon diode thermometers and thermocouples are OK and are as found by LANL or SLAC. Some of the strain gauges have been found to have failed and at least one coil (# 3) is down to two (out of five) working strain gauges.

There is a possibility of recovery as there is some chance that the failures are due to bad wiring and not bad sensors. This will be investigated further during shield replacement.

The magnetic forces will also be recalculated with the final iron geometry to verify that the strain gauges are still a requirement for operation at maximum field and current. The strain gauges were not used at LANL because they operated the solenoid at 1200 amps, two thirds of maximum and thus the forces were only 44 % of maximum. The strain gauges are mounted on the coil supports and are accessible during shield replacement.

Summary

Coils three and four have been completely tested and coils one and two have only had electrical tests. The leak tests of coils one and two will be complete by first week of November. The conclusion based on the test results for coils three and four are that the N2 shields should be replaced and that the strain gauges need some further investigation and possible repair or replacement.