TS-SSC 92-027

Wayne Koska
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DCA315 Production Summary

DCA315 is the fifth SSC 50 mm aperture collider dipole magnet to be built and tested at Fermilab. Its assembly followed the baseline as stated in the 50 mm Collider Dipole Magnet Requirements and Specifications Book[1] (the Yellow Book). This report will summarize the production history of DCA315 and note any major discrepancies from the baseline design, however it is not a complete discussion of all "Discrepancy Reports". A number of references will be made to DCA315's Specific Data Summary Traveler (SDST) and to the Fermilab Advanced Magnet R&D group's technical note series.

Winding of the coils for DCA315 began on July 13, 1991. Several metal chips, believed to have come from the clamping jigs, were found on coil 15M-50-1013. These were removed prior to curing. There was some excess varnish and torn B-stage and kapton insulation discovered on this coil after curing which was repaired. Coil 15M-50-1012 had torn insulation, discovered during measuring, at position 172 at the pole, which was repaired by taping with 1/2 mil adhesive backed kapton tape. A glued on return end shelf on the saddle of outer coil 15M-50-2012 separated from its spacer during winding. It could not be repaired without backwinding and it is believe that the separation should cause no problems in the magnet performance, since it would be held in place once the coil was cured. Future coils are to be built with one piece spacers so this problem should not recur. Several steps were not signed off in the traveler during the construction of coil 15M-50-2013, however it is believed that the steps were performed and an inspection of the coil showed no discrepancies in its assembly. Some koldwelds were missing from the winding map, due, it is believed, to miscounting. More care will be taken to properly mark cold welds during the cable insulating stage in the future. The lead end G-10 key of coil 15M-50-2012 cracked and the ramp splice shim fell out. The crack should not be a problem and the shim was reglued into position. The averages of the azimuthal measurements, taken in three inch sections along the length of the inner coils, were 9.0 and 9.5 mils relative to the steel master block, with standard deviations of 1.0 and 1.1 mils. Azimuthal measurements of the outer coils resulted in averages of -1.8 and -2.1 mils with standard deviations of 1.1 mils. The longitudinal distribution of the azimuthal size variations is reproducible from coil to coil, as can be seen in the plots in the SDST. These azimuthal sizes provided adequate final (pre-cold test) prestresses in the desired ranges (8-12 kpsi for the inner coils and 6-10 kpsi for the outer coils) at the lead end gauge packs, however the return end packs registered stresses somewhat below the minimum desired values (the outer coils averaged about 4 kpsi). The SDST should be consulted for details. (Note that some of the data shown in the SDST has been contaminated by a bad compensator gauge during some of the measurements. For those with access to the raw data who are interested in doing further analysis, this data can be recovered by swapping in the compensator from a different gauge .)

Prior to keying it was discovered that one of the brass shoes had a sharp edge 82.5" from the lead end. The shoe was removed and the sharp edge blunted. The collaring of magnet DCA315 on 8/29/91 went smoothly. A prestress history plot can be found in the SDST, along with a memo indicating the position of the 2 collar gauge packs relative to the maximum and minimum of the summed azimuthal size of the inner coils. The collar gauges indicate that the maximum inner (outer) coil stresses were about 16 kpsi (12 kpsi) and the final stresses after collaring were in the range of 9-12 kpsi (4.7-7.8 kpsi). The usual inner coil prestress loss of 2-3 kpsi after collaring can be seen. This may be due to creep of the kapton insulation. Measurements of the collared coil diameter show little variation along the length of the magnet[2], implying that there is not a large axial position dependence of the prestress.

The lead end aluminum end can could not be installed because the ramp splice groove in the G-10 collet insulator did not line up with the ramp splice. The groove was modified to fit the as built condition. Both the lead end and return end cans were installed with a single extra layer of 5 mil kapton[3]. Prior to welding the shell in place it was discovered that the return end strain gauge upper pack was installed in a reversed configuration. This caused a somewhat larger gap than usual between the gauge pack and its neighboring pack on one side. It was the opinion of John Carson that this should not have an effect on the performance of the magnet. This inadvertent positioning of the gauge pack put gauges A245, A141, and C107 into quadrant 2 and A246, A244 and C191 into quadrant 1.

The stainless steel magnet shell was welded between October 24 and October 28, 1991. The yoke packs on DCA315 were configured with 4 approximately 12 foot long packs, with 99% packing factor, sandwiched between monolithic packs.

The lead end of the beam tube was too short and was recessed inside the flange by 0.375 inch. The bus length was also slightly out of tolerance, but an engineering study indicated that the tolerance could be relaxed for this and future magnets. An electrical check during final assembly discovered a shorted condition between the magnet leads and ground[4]. The short was caused when the G-10 supports, which are inserted around the leads where they pass through the end plate, pushed and buckled one of the leads which forced it against the end can cap cutting its insulation. The cable was straightened and reinsulated. The supports were modified so they could slide around the cable more easily.

A plot of the measured end forces can be found in the SDST. The final force was 2300 pounds.

Several problems were encountered during the cryostating of DCA315. The beam tube length was 0.048 inches too short. This was compensated for when the cryosystem was installed. The single phase helium leak check was probably done at 30 psig instead of 60 psig which, was the new specification being promulgated at about this time. The Remay extension was originally missing from the 20 MLI blanket but was later attached. The 20K and 80K shields were distorted due to the component parts being out of shape. This could have resulted in a thermal short. Aluminum tabs were welded onto the shields to maintain the proper alignment. The usual out of tolerance conditions of various tube positions were found. The discrepancy reports or the traveler should be consulted for details. This problem is being addressed by the engineering group. The radius at the end dome to single phase tube transition is less than the requested radius of 8 mm, however this specification was not received before the parts had arrived. This is not considered to be of consequence to the performance of the magnet. There was a modification (to be standard from now on) to the wiring of the pressure sensor on the ASST board and the drawing is being revised to match the as-built condition.

Assembly of the magnet was completed and DCA315 was shipped to the Fermilab Magnet Test Facility on January 29, 1992. It exceeded its operating field on the first attempt on February 8, 1992.

In summary, DCA315 had no major assembly anomalies which would affect its mechanical performance.

1 50 mm Collider Dipole Magnet Requirements and Specifications, E.G. Pewitt ed., 8-16-91.

2 Strait, J. Collar Diameter Measurements of Long Magnets DCA310-315, TS-SSC 91-178, 9-13-91

3 Delchamps, S. DCA315 Return End Extra Kapton, TS-SSC 91-171, 9-5-91, Lead End Extra Kapton, TS-SSC 91-172, 9-5-91

4 Tassotto, G. Location of Upper Inner Lead to Ground Short in Magnet DCA315, TS-SSC 91-245, 12-30-91.