BROOKHAVEN NATIONAL LABORATORY

Superconducting Magnet Division
Magnet Note

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Title: Integral Field Measurement of SNS Prototype Dipole

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INEGRAL FIELD MEASUREMENT OF SNS PROTOTYPE DIPOLE

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This note reports a measurement of the integral magnetic field of the SNS prototype dipole. The magnet was measured as initially built, with no 2D S. edge bumps and no z-bumps. For this measurement, a search coil of length 244 cm (96") and turns area of approximately 3100 cm^2 was constructed. The coil had 10 turns and a width of 1.28 cm (0.505").

The vertical and horizontal centers of the magnet aperture (X=0, Y=0) were established by mechanical measurements of the pole gap and width. The search coil was positioned at the vertical center of the aperture, using the lower pole surface as a "table" and micarta blocks to establish the correct height. The coil was placed at the desired positions on the horizontal midplane (HMP) of the magnet by using marble blocks of the appropriate length to position the coil a known distance from stops at the horizontal edge of the lower magnet poles. The length of each ground marble block is known to an accuracy of 0.001". At each X position on the HMP, the search coil was "flipped" 180° and then "flipped back" to its original (0°) position. The signal induced by the search coil "flip" in the DC magnetic field was measured by an electronic integrator and was directly proportional to the magnetic field integral (Bdl) at the X, Y location of the search coil. The relative repeatability of the measurement was at least as good as 0.5 x 10^{-4}. The largest factor in the absolute uncertainty was the width of the search coil. It is estimated to be 0.0005", which is 1 x 10^{-3} fractionally.

The measurements were made at a current of 4500A since this current is calculated to give the required 1.11 T•m field integral for 1.0 GeV operation of the SNS ring. The measurements on the HMP were normalized to 1.0 at X=0 and are plotted in Fig. 1. Prior to taking measurements, the magnet current was cycled to 4750A three times and then set to 4500 A on a down current cycle. The geometry of the ring dipole was computed using POISSON (2D) and TOSCA (3D). The 3D results on the HMP were also normalized to 1.0 at X=0 and plotted in Fig. 1.

There was also good agreement between calculated and measured values of the magnetic field in the 2D portion of the magnet.

For 1.3 GeV operation, the field integral must increase 20% to 1.33 T•m. Fig. 2 shows a quadrant of the 2D cross section of the magnet with the proposed changes to the iron yoke to carry the extra flux necessary for 1.3 GeV operation. Based on a Tosca calculation, the current needed for 1.33 T•m operation is approximately 5430A, assuming the original 12 turns/pole coil and the modified iron yoke,.

We thank E. Hoey for his careful work in the construction and use of the search coil.

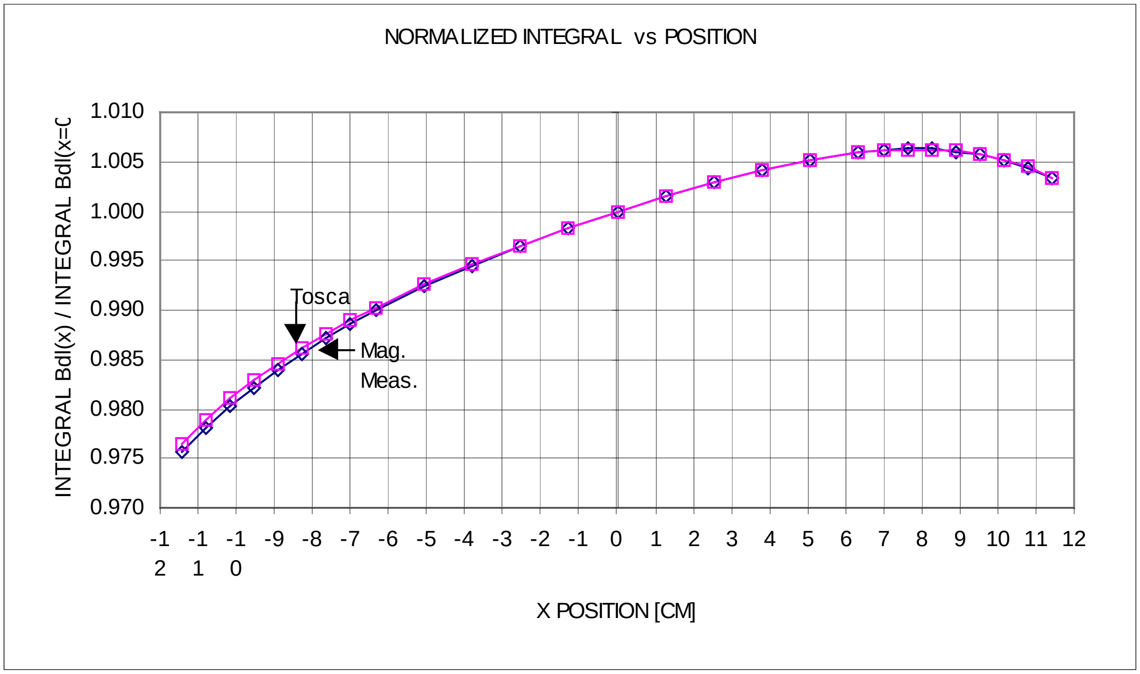

Figure 1. Calculated and measured values of the integral field, normalized to 1.0 at X=0.

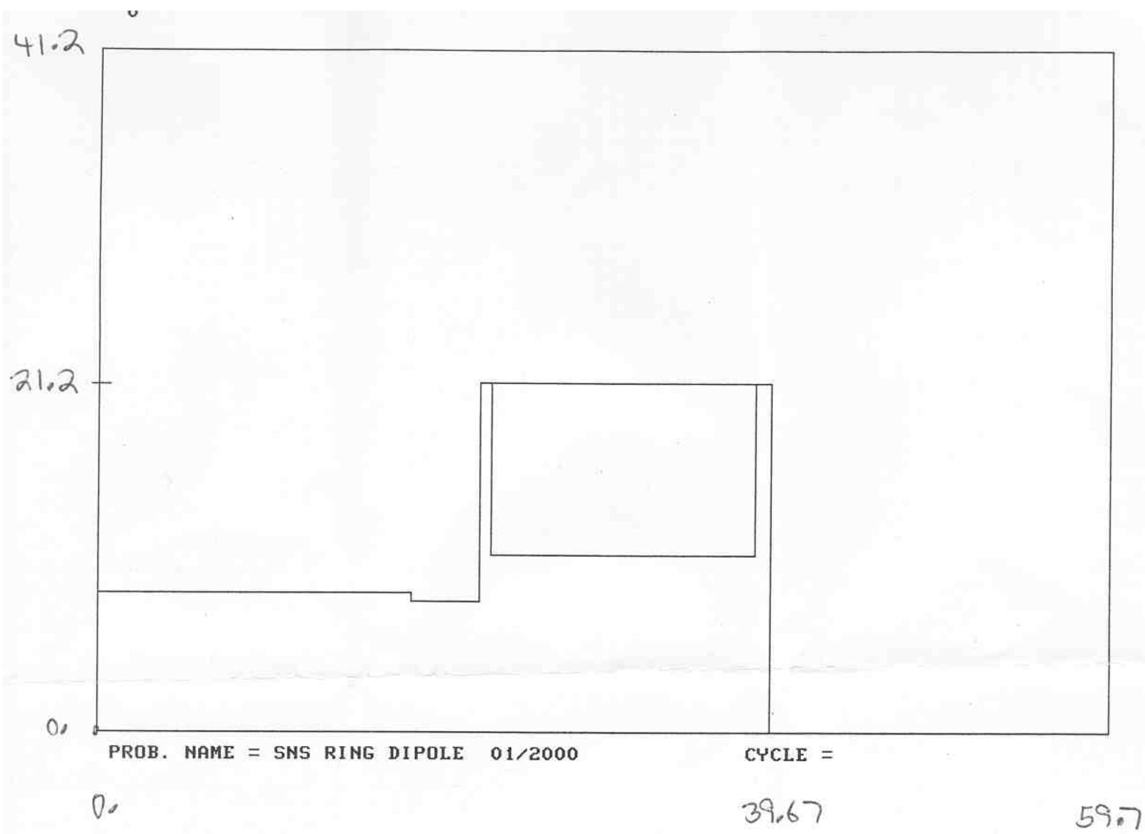

Figure 2. Quadrant of the iron and coil cross sections for 1.3 GeV operation. Dimensions are in cm. The overall width of the magnet is 119.4 cm. The overall height is 82.4 cm.