

Air Fields Measured while Commissioning the SM1 Magnet at Soudan

Andrew Godley, Walter Jaskierny, Jim Kilmer, Jerry Meier, Jeff Nelson

ABSTRACT

SM1 coil was first energized on July 26th 2002. This note summarized the air-field measurements taken during this first 6-hour run of the magnet and their implications. The fields are above 5 gauss in on the decks near SM1 and people with cardiac pacemakers should not enter these areas when the coil is energized. The fields at the MUX boxes are at anticipated levels and should not affect the PMTs. This will be verified by LI studies in the near future. There are no significant fields either above the detector or north of the detector and there are not rigging restrictions except in the inter-SM gap and near the coil's turns.

Introduction

We worry about the fringe fields from the MINOS toroids on a few fronts including: personal safety, mechanical rigging limitations due to magnetic forces on steel loads or cranes, and their potential effects on the M16 PMTs.

Personnel Safety Issues and Findings

OSHA defines 3 levels of regulatory exposures for static magnetic fields. The lowest is 5 gauss for exposure to people with cardiac pacemakers. We took data to define the 5 gauss line. We found that all detector decks south of the 2nd pillar of SM2 (i.e. 4m north of the end of SM1) were near or above 5 gauss. The highest field readings on the decks were found on the lower deck between the SMs near the top of the fiber strain reliefs (35 gauss) and at the south end of the detector near the coil's standpipe (22 gauss) near the floor.

When SM2 is completed the entire detector area and a few meters north of the detector will be within the 5 gauss perimeter. Since that it less that 10 months away, signage and warning lights for power to the coil power supply are being mounted beyond the expected SM2 perimeter. A crash button will be mounted at in the workstation area outside of this field perimeter.

The highest field we found was in contact with the turns as they exited the bore and bent down to vertical. At the side of the turns we measured 500 gauss. This is below either of the other two OSHA regulatory thresholds (600 gauss for continuous whole body exposure and 6k gauss for extremities).

Fields in Areas Used for Rigging and Construction

Ten SM2's steel planes were installed when these measurements were collected. We were particularly concerned about two areas: the north face of the detector where new planes would be installed and fields where the access bridge or 25t crane hook would travel. Of secondary importance are the forklift isle (the lower east deck) and the south storage area.

At the north face of SM2 we measured the field in a number of locations. Near the lower axial bolts the field was 25 gauss. Near the lower "bat ear" the field was 22 gauss. In both locations the field fell off to below the Earth's field within 10 cm. At the lower flat of the plane the field was 3 gauss. Anywhere on the face of the plate more than 1 cm from the edge had fields consistent with the Earth's magnetic field. These fields were low enough to not require any restrictions on rigging at the north of the detector face.

The fields were measured on the access bridge. At the surface of the bridge the fields were 4 gauss. The fields were also measured at the top axial bolts. This location was expected to have the largest fringe fields on the top of the detector. They should be largest at the ends of the supermodules. Plane 0 had a field of 10 gauss, plane 248 had a field of 30 gauss and plane 259 had a field of 10 gauss.

The fields in the south storage area (<8 gauss) and the forklift isle (<5 gauss) are low enough that there are no rigging restrictions in these areas.

The field in the inter-SM gap and near the coil turns are high enough that the coil should be powered down before any large steel object (e.g. the crane hook) are moved in the area (electrical LOTO procedures apply). For electrical safety we require supervisor approval for work near the trench under the detector with the coil energized. These are the only restrictions related to the coil's operation other than standard electrical safety practices.

Fields Near the MUX Boxes

The M16s suffer charge collection and gain effects in magnetic fields that are orientation dependant and onset at roughly 5 gauss. The PMTs are encased in steel boxes to help exclude flux. Test at IU showed that these boxes were able to shield the PMTs in fields up to about 30 gauss. The measured fields appear to be OK for the PMTs. Data for careful LI studies of the PMT response with the no field and with the coil powered were collected but not available for this document.

To try to mask the effect of field concentrations at the corners of the MUX boxes themselves, the field data was collected roughly 10cm north or south the rack locations. For example in contact with the upper outboard corner of MUX box 6 on the west side, the field was 3.6 gauss at 10 cm south of the rack (presumably the true air field) but was 14 gauss in contact with the corner of the MUX box. This is a clear indication that the MUX boxes were doing their job. The points listed refer to location relative to the MUX box stacks.

Location		Inboard	Outboard
West Upper Rack 6	Upper	5.9	3.6
	Lower	4.0	3.8
West Upper Rack 8 (South side of rack)	Upper	3.2	3.3
	Lower		5.1
West Upper Rack 8 (North side of rack)	Upper	8.1	7.9
	Lower	6.1	6.3
East Lower Rack 1	Upper	14.1	6.0
	Lower	9.8	5.9

Other Measurements

A few additional measurements were taken that have some curiosity value. Some of these points and a few from the previous sections are plotted in Figure 1.

The inter SM Gap

- The field on the back of the ear of plane 249 was 37 gauss.
- The field on the north bookend (SM2) near the top deck was 37 gauss.
- The field the railing on the middle deck railing at the gap was 29 gauss.

Under the detector

- The field in the coil trench was 120 gauss in contact with the turns.
- The field halfway between the detector and the trench was about 50 gauss.
- The field in contact the bottom flat of the detector above the trench was 22 gauss.
- The field in contact with a lower axial bolt was 40 gauss.

Gaps in a random plane in the middle of the SM

- In a slot between adjacent sheets of a plane (at 4m radius) the field was 28 gauss.
- The same location but at 4.06m radius was 15 gauss.
- The field in the air between planes was seen to vary from 7 to 14 gauss depending on the position.

Figure 1: Some fringe field measurements are indicated in the following drawing. The fields are indicated in gauss and all measurements should be considered left-right symmetric.

