Proposal for a field mapping measurements of the MICE beamline dipoles

v 0.1

September 2016

1 Introduction

The momentum selection in the MICE beam line is determined by the fields in the dipoles D1 and D2. If the field is not as expected the performance of the muon/pion beamline can be poor and a mismatch between D1 and D2 can lead to a lower transmission than calculated.

The bending magnets used in the MICE beam line are Type 1 6" tapered-poles NIMROD dipoles [1]. The formula with the relation between magnetic field B and the dipoles current I, used in the spreadsheet to decide the currents appears to be a fit of the original magnet datasheet from 1968

$$I = 39.59B^3 - 55.998B^2 + 253.91B \tag{1}$$

A measurement done in 2013 with an uncalibrated gaussmeter shown significantly higher fields at high current (6% at 360A) [2].

Further more reliable measurements are necessary to understand if the discrepancy is real. Moreover the measurement of a field map along the z axis would help to understand if the models used in MAUS and for the Monte Carlo are reliable.

2 Requirements

The D1 dipole is located in the synchrotron and mainly filled with a vacuum chest that prevents to measure the field in its center (Fig. 1) with only the two corners accessible, while D2 is located in the DSA, is fully accessible but Q4 is nearly against it (Fig. 1); the dipole, mounted on wheels, can be moved in an offline position. Since both the dipoles are in zones under control of ISIS, the measurements require a formal approval by ISIS and need to be down between two user run cycles, tentatively between 2016/03 and 2016/04, that means around the first two weeks of November.

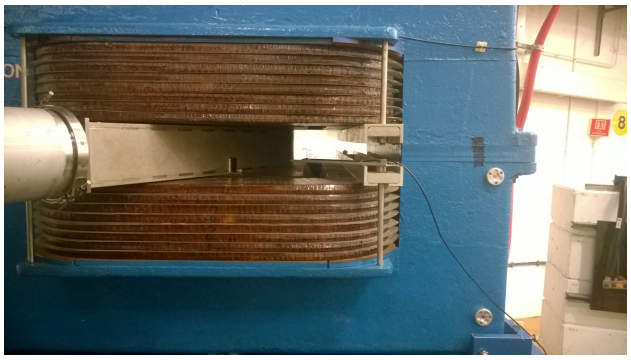

Figure 1: Bending dipole D1

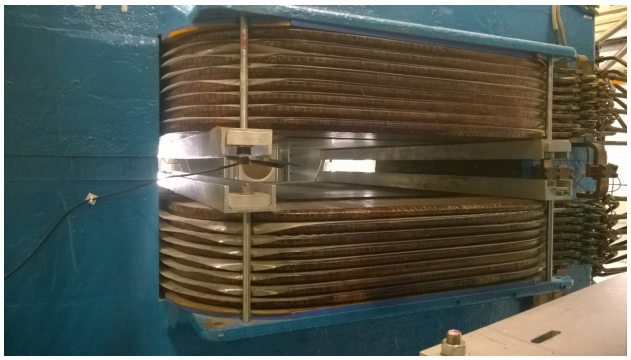

Figure 2: Bending dipole D2

The aperture of the dipoles is around 508(H)x152(V) mm so a jig needs to be build to hold a gaussmeter owned by MICE (the recently calibrated Hirst

GM08 [3]) inside the pole that could be capable of performing the measurements on both the magnets. The jig has to extend its arm up to 1.2 meter inside the pole allowing 3 degrees of freedom for an off-axis measurements even of the fringe field just outside form the magnets. A step motor can be taken into consideration in order to automatize the progression of the probe. The position of the probe could be measured with respect to the survey nests across the magnets.

3 Measurements

Different measurements can be proposed:

- field measurement in D1 and D2 in several points inside the pole to be compared with the OPERA model in order to understand the non-uniformity of the beam;
- since only D2 is completely accessible can be used to make a field map along the z axis, with a resolution of 0.5 cm keeping the magnet current constant; map that can be used to fit the fringe fields formulas;
- field-current relationship measurement inside D2 in order to compare the past survey and the nominal formula.

All the measurements can be probably be done in a two or three days by a team of two people. The measurements in D2 have the highest priority.

References

[1] T. Roberts, MICE Beamline Magnet Drawings (2003), http://mice.iit.edu/micenotes/public/pdf/MICE0065/MICE0065.pdf

[2] H. Nebrensky, MICE Dipole Current-Field Relationship (2013), https://micewww.pp.rl.ac.uk/attachments/1636/DipoleField.PDF

[3] https://www.gaussmeter.co.uk/gaussmeters/GM08-Gaussmeter