DESIGN AND SIMULATION RESULTS OF MASS SPECTROSCOPY DIPOLE MAGNET FOR BARC

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Abstract

A dipole magnet is designed for the compact mass spectroscopy setup at BARC. The specifications of magnet are 0.6 T field, bending radius/angle 100mm/120^o, with entry/exit edge angle of 40.75^o±0.1^o in a pole gap of 11mm. In this paper, we will discuss the design aspect (which include the coil design, pole design etc.) and present the simulation results of POISSON 2D code [1] and TOSCA [2] for 3D.

INTRODUCTION

C-type dipole magnet having a pole gap of 11mm, bending radius of 100mm with centre opposite to back yoke is designed. Fixed entry/exit edge angle of 40.75^o±0.1^o is required for the double focusing condition for a table top/compact spectroscopy setup. Pole width of 60mm is chosen to achieve good field region of 2E-04 for ±10mm at maximum operating magnetic field of 0.6T.

2D DESIGN RESULTS

2D Design is carried out using POISSON Code. Using this code pole width (with upper pole cut) is optimised along with coil cross section. Pole width is increased by 7.5mm from inner side and 2.5mm from outer side. This is done to achieve a good field region and also to reduce the magnet weight (For detail see Fig.1). Top and back yoke width is optimised during 3D modelling.

NI Calculation

The Ampere turns (NI) required to generate a magnetic (Bo) in gap (g) is given as:

$$\mathrm{NI}_{\mathrm{TOTAL}} = \frac{Bo(T) * g(m)}{\mu o} = 5252\, A - turn \quad (1)$$

So, require Ampere-turns per pole is 2626.

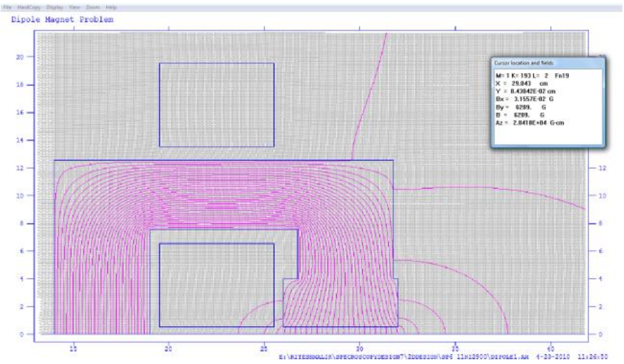

Figure 1: Cross Section of magnet.

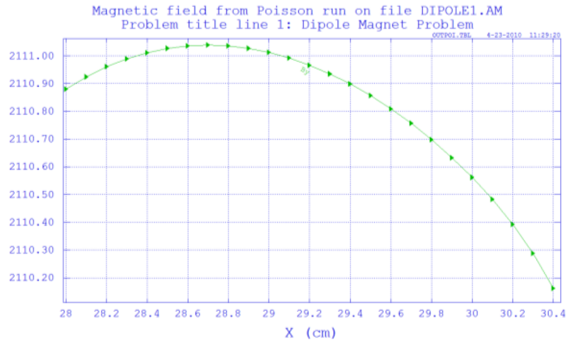

Figure 2: Radial Field Distribution at 0.2T.

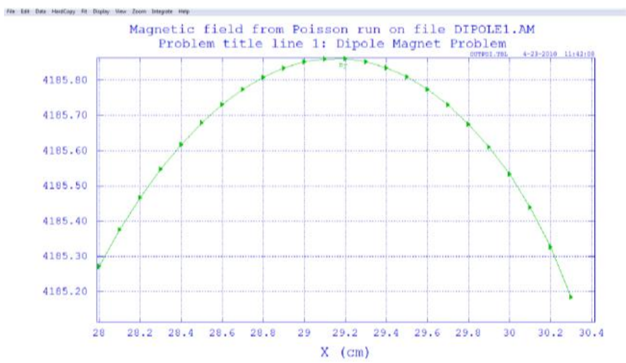

Figure 3: Radial Field Distribution at 0.4T.

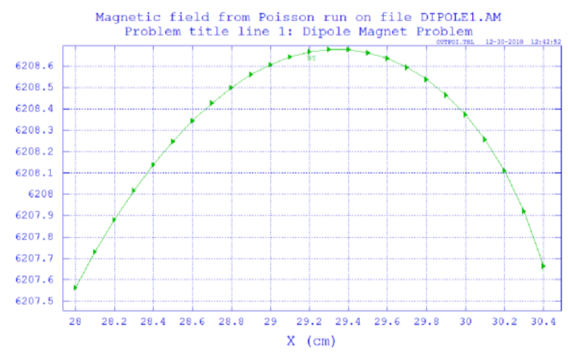

Figure 4: Radial Field Distribution at 0.6T.

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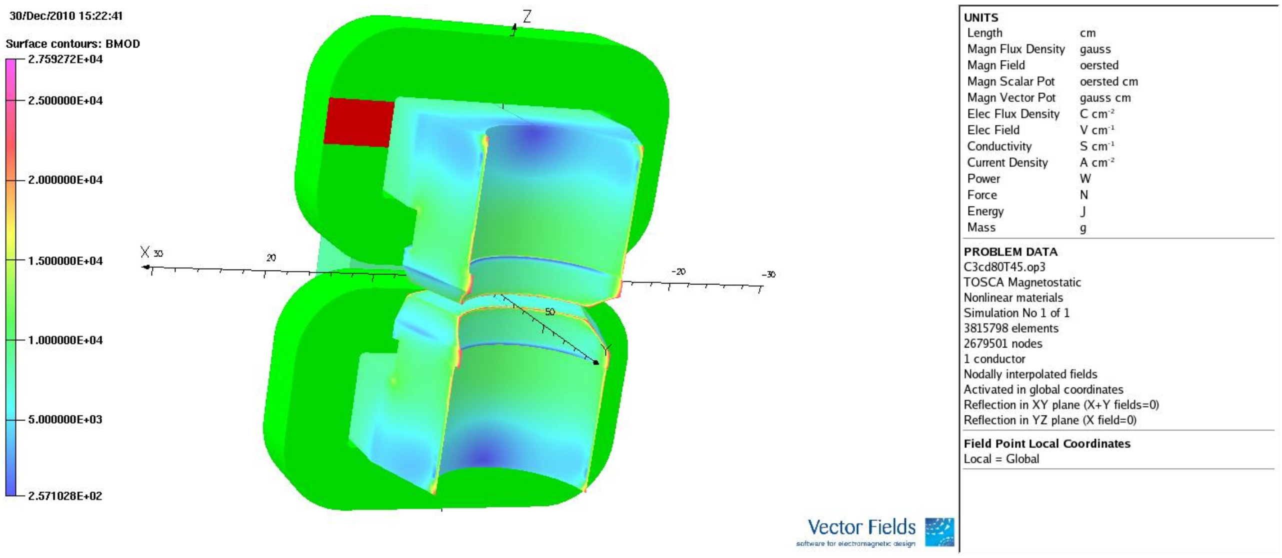

Figure 5: Colour field contour at 0.65T gap field. Magnet is showing saturation at the sharp corner of the magnet. Magnetic field in top/back lag is around ~1T.

From figure 2 to 4, it is clear that shift in position of peak magnetic field is with in 8mm with field change (from 0.2 to 0.6T).

The Radial field distribution is with in 3E-04 for ±10mm at magnetic field of 0.2, 0.4 and 0.6T.

3D DESIGN RESULTS

Optimised 2D modelling cross section of magnet (from POISSON) is taken input to MODELLER (VECTOR FIELDS). TOSCA solver is used for solution.

In figure 6, field quality is with in 2E-04 for ±10mm. Required half effective length is 104.720mm (π/3*100mm as per design) and we are getting 101.925mm for 45^{o} taper angle (see Table1) and edge angle 38.39^{o} in spite of 40.75^{o}.

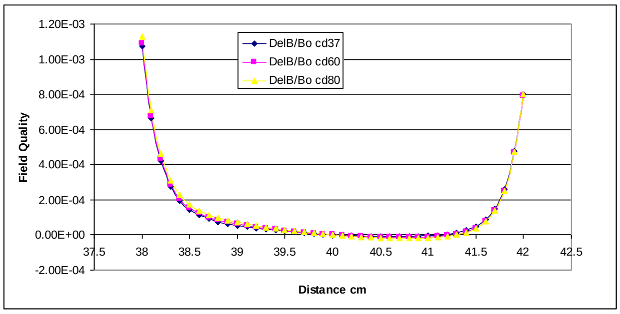

Figure 6: Radial field distribution for taper angle 40 ^{o} at 0.3, 0.48, and 0.65T

Table 1: Variation in Effective Length with Taper Angle.

Taper Angle (Degree)	Bo (Tesla)	Half Effective Length (cm)
90	0.65	11.9996
55	0.65	10.6747
45	0.65	10.1925
35	0.65	9.5613

CONCLUSION

We are getting extra effective length (for a taper angle of 90/55). Also, there is a mismatching in the design and simulated edge angle. So, it is decided that effective length/edge angle will be corrected by modification (cutting/adding) at the pole end side (after scanning the magnet with hall probe). and rescan the magnet (with hall probe) to verify the modification.

REFERENCES

[1] POISSON.
[2] Vector Fields.