BARC First Prototype PXIE Magnets Measurements at Fermilab
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- Shipment Received in TD 7/9/14
  - Unpacked, Assembled per travelers
  - Electrical Inspection (L,R,Hipot)
    - Some discrepancy with BARC inductance data
  - MTF Stand B for BARC Director Tour 7/15
- Magnetic Measurements and Survey
  - Quad F alone; with prototype BPM and beam tube
  - Corrector Dipole alone
BARC Prototype Quad F Measurements at Fermilab
BARC Prototype Quad F Measurements at Fermilab

• Quad F Magnetic Requirements:
  - Center Stable to 0.1 mm (dis/re-assembly)
  - $\int GdI_{\text{max}=10\text{A}} = 1.5 \text{ T} \quad (TF=150 \text{ T/kA})$
  - 1\% Field Homogeneity for $R<11.5 \text{ mm}$

• Quad F Magnetic Measurements:
  - Single Stretched Wire Technique
  - Center Stability vs $I$, survey center reproducibility
  - Rotating Wire, Integral Strength and Harmonics
    • At good field radius $R=11.5 \text{ mm}$
Change in magnet center due to dis/re-assembly of half cores:

Laser tracker survey with wire placed at magnet center

<table>
<thead>
<tr>
<th>Component Fudicals</th>
<th>Differences dx [mm]</th>
<th>dz [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>PXQF001_UP</td>
<td>0.045</td>
<td>-0.030</td>
</tr>
<tr>
<td>PXQF001_CENTER</td>
<td>0.040</td>
<td>-0.030</td>
</tr>
<tr>
<td>PXQF001_DN</td>
<td>0.030</td>
<td>-0.040</td>
</tr>
</tbody>
</table>

Meets Requirement

This is essentially at the level of reproducibility in the survey results.
Change in magnet center vs Current:

**Meets Requirement**

X/Y offsets are stable vs current at the level of ~20 microns

BPM does not introduce a shift vs current (not surveyed)
Integral Gradient TF vs Current:  slightly low (4%) at 10 A

Meets Requirement?

Strength TF at various DC currents is fairly stable at the 0.5% level (variations are appx. within meas. resolution)
Field Homogeneity at R=11.5 mm:

Harmonics data were taken at:
• 10A, DC before disassembly
• 10A, AC after reassembly
• 10A, AC with BPM (the AC measurement with BPM inserted was necessary because of the small usable aperture)

The AC data should have better resolution, but do not include remnant/iron effects

All normal harmonics are < ~ 30 units
Skew terms are also small \(< ~ 10 \text{ units}\)

Sum of Harmonics Errors: (100 units = 1%)
- 10A, DC before disassembly: 35 +/- 10 units
- 10A, AC after reassembly: 25 +/- 7 units
- 10A, AC with BPM: 30 +/- 15 units
BARC Prototype Dipole Corrector Measurements at Fermilab
BARC Prototype Dipole Corrector Measurements at Fermilab

• Dipole Corrector Magnetic Requirements:
  – $\int Bdl (I_{\text{max}}=4\text{A}) = 2.1 \text{ mT-m}$
  – 5% Field Uniformity for $R<11.5 \text{ mm}$
  – HD, VD Field Angles Perpendicular to $<3^\circ$

• Dipole Magnetic Measurements:
  – 3-axis Hall Probe Technique
  – Center Strength vs I
  – Point Scan X-Y Circle vs Z
    • At radius $R=25.4 \text{ mm}$
BARC Prototype Dipole Corrector Measurements at Fermilab

- Center Strength vs I

Y is UP
X is West
Z is North
Dipole Integral, Uniformity

- HD Scan X-Y Circle vs Z [inches]

HD Integral (4A) = 2.39 mT-m
Uniformity at 1” = 0.74%
(24 points, 15 degree angle on r=1” circle)

HD, VD perpendicular to better than ~1°

100 G at 4A
Dipole Integral, Uniformity

- VD Scan X-Y Circle vs Z \(\text{[inches]}\)

VD Integral(4A) = 2.39 mT-m
Uniformity at 1” = 1.57%

100 G at 4A
BARC Scan (Sept 2013)

Dipole Corrector Magnet Magnetic measurement results

9/20/2013
Electromagnetics Application Section

9/16/2014
Michael Tartaglia, TD/T&I Dept
Conclusions

• Quad F: **Meets Requirements**
• Dipole Corrector: **Meets Requirements**
• Prototype Status and Schedule: (9/5/14)
  – Quad Triplet Assembly
    • Nearing Completion
      – (S. Mishra will be shown during his upcoming visit)
  – 1 Quad Triplet and 1 Quad Doublet
    • Mag. Meas. ~end October, 5MeV Beam Test ~December
    • **Both will ship to Fermilab in ~December 2014**