Survey Support to Magnetic Measurement

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Outline

• Magnets introduction
• Hall Probe Bench Survey
• Align magnets relative to Hall Probe
• Align magnets for vibrating wire measurement
• Summary
CEC and LEReC

Low Energy RHIC electron Cooling (LEReC) project

The Relativistic Heavy Ion Collider (RHIC) Update

Coherent electron cooling (CEC)
Magnets in CEC and LEReC

Solenoid

CEC C-Frame Dipole
45° bend, round corners

Phase Shifter Magnet

20° Dipole
Vibrating Wire Measurement for NSLS-II
Hall Probe Bench Survey

Frame Definition:
- +X: Radially outward
- +Y: Vertically UP
- +Z: Axial downstream

It defines all the motion vectors (X_Move, Y_Move and Z_Move)

A truly orthogonal measurement coordinate system
Whichever axis has a longer travel would be the preferred choice
A sketch shows the location of active probe area relative to outside surfaces of the probe. The active volume is centered in Y, 0.9 mm above the bottom face of the probe, and 1.5 mm inwards in Z.

Arm is used to measure the probe surfaces and the fiducials on the Hall probe holder when the stages are homed.
A full characterization of the X, Y, and Z motion vectors of the stages; Re-establish a stage coordinate system by finding probe positions at 9 (X,Y) stage positions at each Stage Z position, for 4 Z positions.
The Hall Probe Bench Survey

Measurement Date: 5/7/2015
Measured By: R. Hubbard, M. Ke
Analysis Date: 6/7/2015
Analyzed By: M. Ke

Frame is created in the following manner:
Origin is the HP home position.
The primary axes X, Y, Z is averaged from the 12 Z times.
The secondary axis Y is the normal vector of the average horizontal plane from the 4 planes.
+X is outboard;
+Y is up;
+Z points downstream.
AT401 and RomarArm were used to survey the Hall probe.

<table>
<thead>
<tr>
<th>BEST-FIT AVG LINE</th>
<th>BEST-FIT AVG Y PLANE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Begin (mm) 3.000</td>
<td>Proj. Ang. (deg) 0.000</td>
</tr>
<tr>
<td>End (mm) 3.000</td>
<td>X from Y -1.00000</td>
</tr>
<tr>
<td>Direction (mm) -0.00000</td>
<td>Y from X 0.00000</td>
</tr>
<tr>
<td>Proj. Ang. (deg) 20.000</td>
<td>Z from X 0.00000</td>
</tr>
<tr>
<td>Length (mm) 140.000</td>
<td>Length 0.000</td>
</tr>
</tbody>
</table>

Average Z axis

Average horizontal plane
Align magnet to Hall Probe
Vibration Wire Measurement

Roll Angle Measurement Error Correction

View from one end:
True Roll Angle = \( \alpha \)
Meas. Roll Angle = \( \alpha + \varepsilon = \alpha_1 \)

View from opposite end:
True Roll Angle = \( -\alpha \)
Meas. Roll Angle = \( -\alpha + \varepsilon = \alpha_2 \)

True Roll Angle = \( \alpha = (\alpha_1 - \alpha_2)/2 \)
Meas. Error = \( \varepsilon = (\alpha_1 + \alpha_2)/2 \)

+/-100 micron initial alignment precision of magnets by laser tracker
0.5 mrad roll alignment accuracy
Comprehensive survey to record the girder shape and as built magnet location
Summary

- Precise magnetic alignment can't be independent of survey support.
- Survey provides frame information for Hall probe.
- Survey provides coarse alignment so that precise magnetic measurement can work on.
- After magnetic measurement, survey record the as built location so that it can be referred in the future.
Reference

1. J. Animesh, Production Measurements of magnets for the NSLS-II Storage Ring, 17th International Magnetic Measurement Workshop.

2. J. Animesh, Results of Magnetic Measurements in LEReC Solenoids, Internal report.

THANKS FOR YOUR ATTENTION!