Survey Support to Magnetic Measurement

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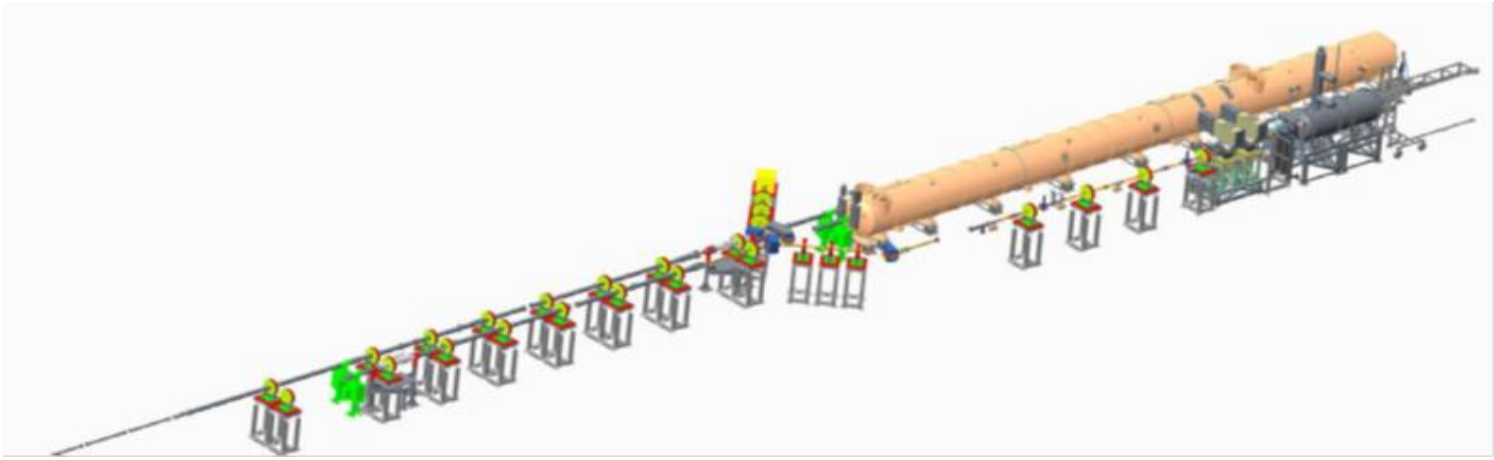
Outline

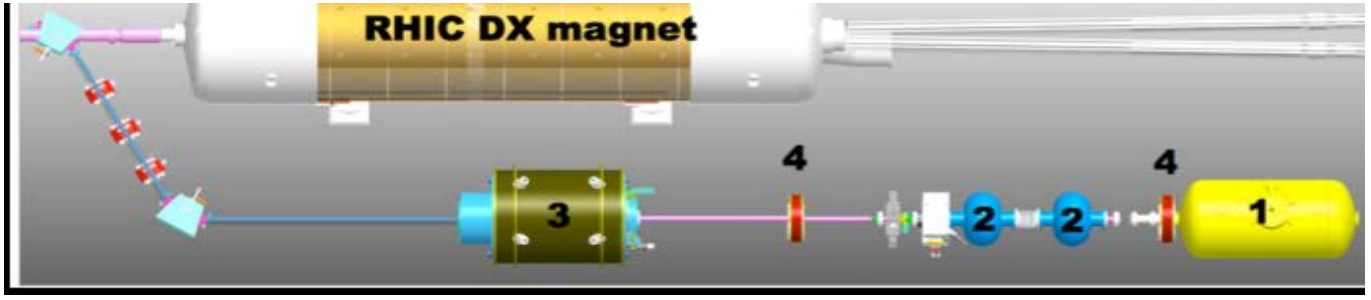
- Magnets introduction
- Hall Probe Bench Survey
- Align magnets relative to Hall Probe
- Align magnets for vibrating wire measurement
- Summary

CEC and LEReC



Low Energy RHIC electron Cooling (LEReC) project

The Relativistic Heavy Ion Collider (RHIC) Update

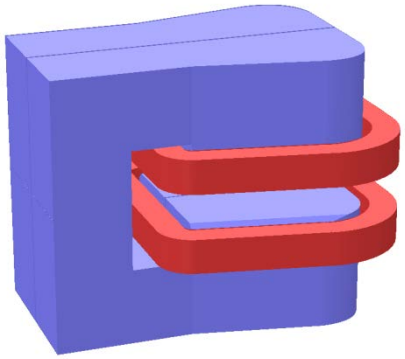


Coherent electron cooling (CEC)

Magnets in CEC and LEReC

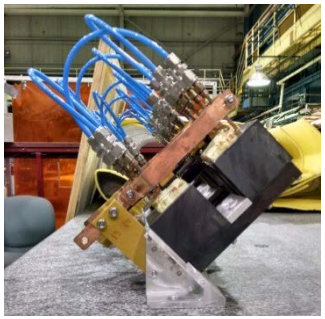
Solenoid

CEC C-Frame Dipole
45° bend, round corners

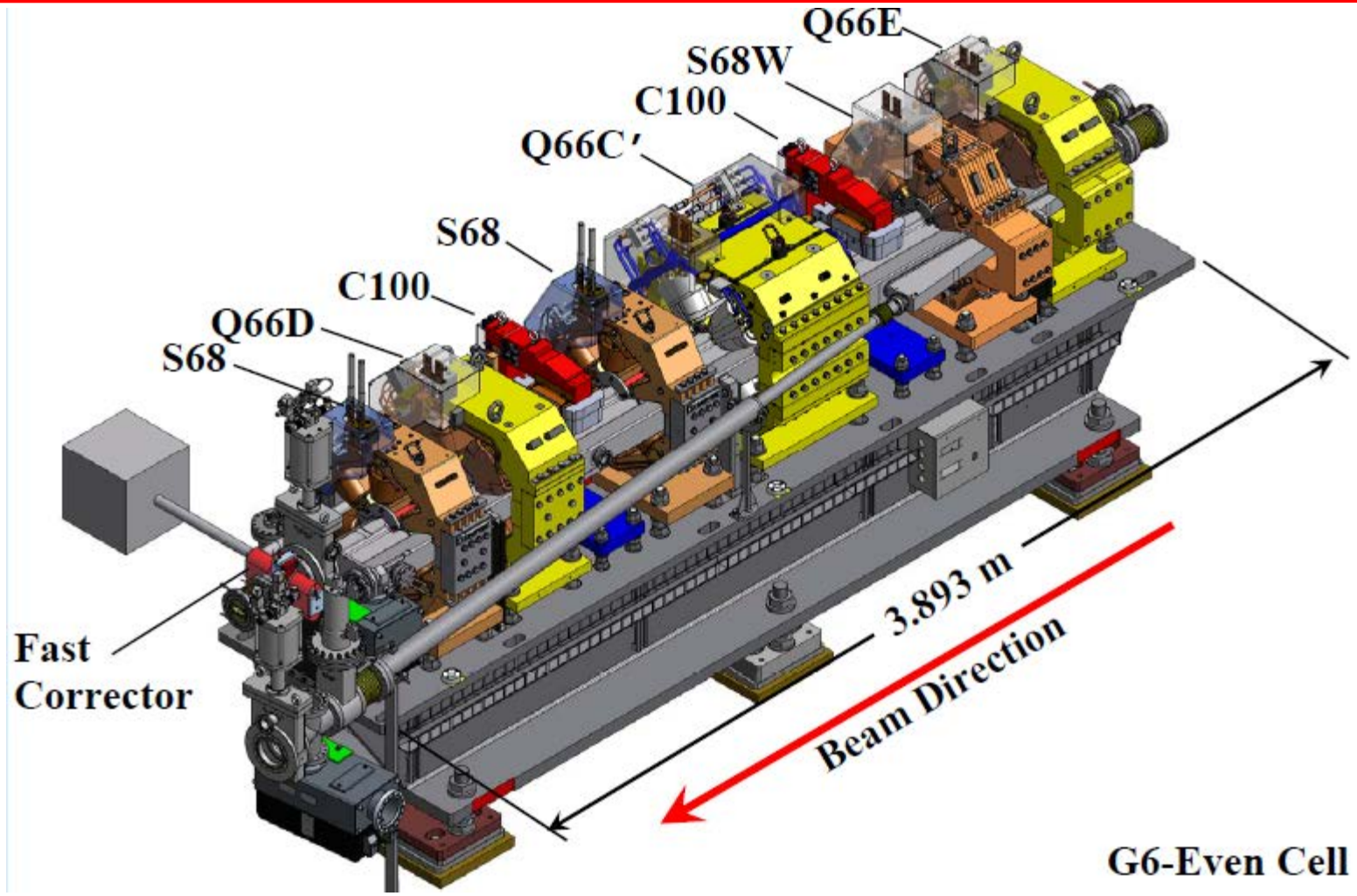


20 °Dipole

Phase Shifter Magnet



Vibrating Wire Measurement for NSLS-II



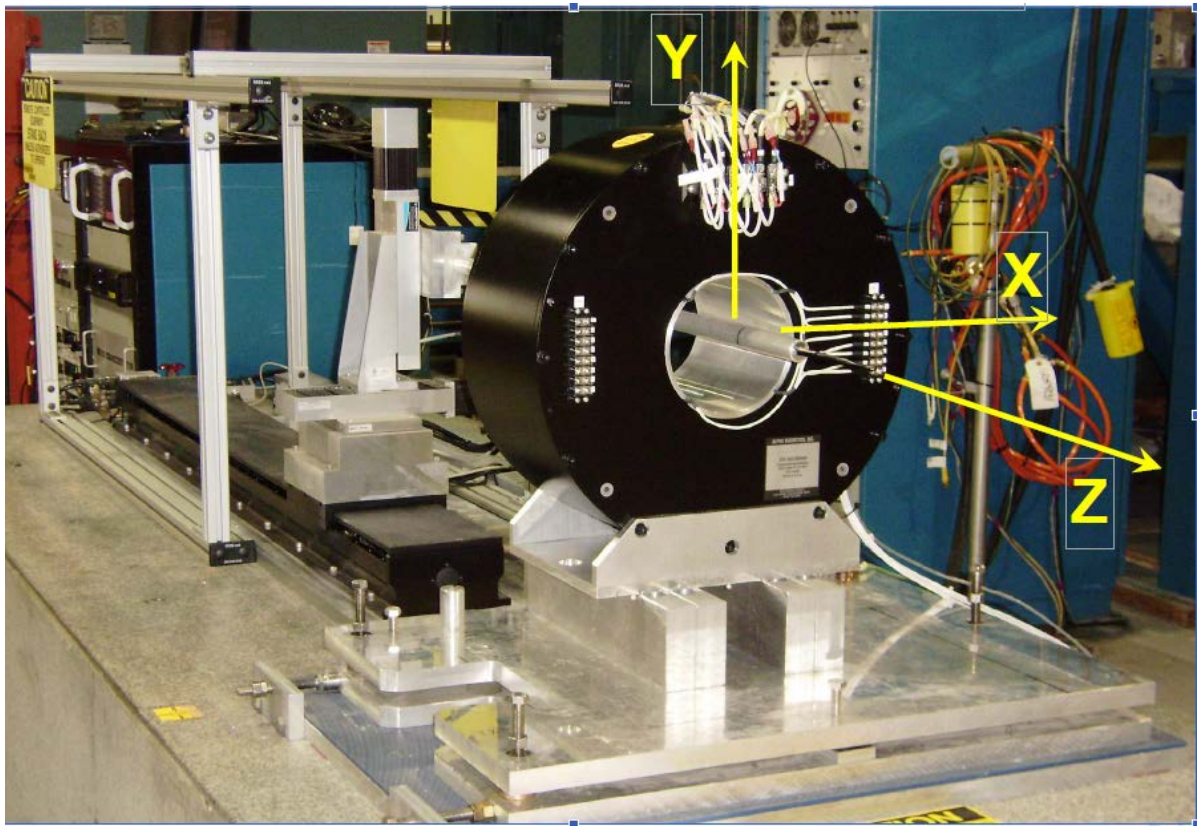
Hall Probe Bench Survey

Frame Definition:

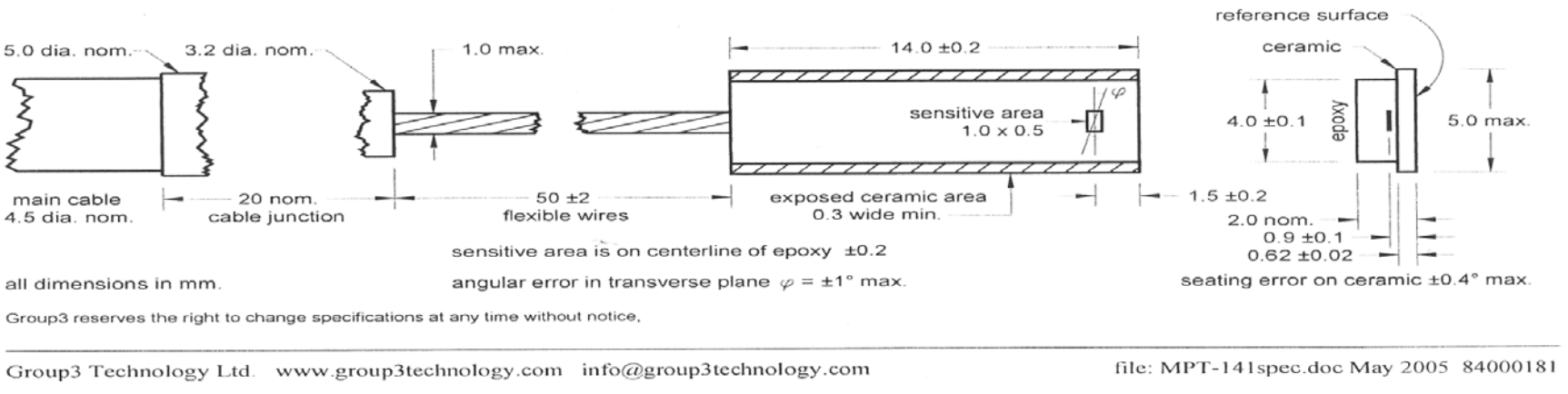
- +X: Radially outward
- +Y: Vertically UP
- + Z: Axial downstream

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



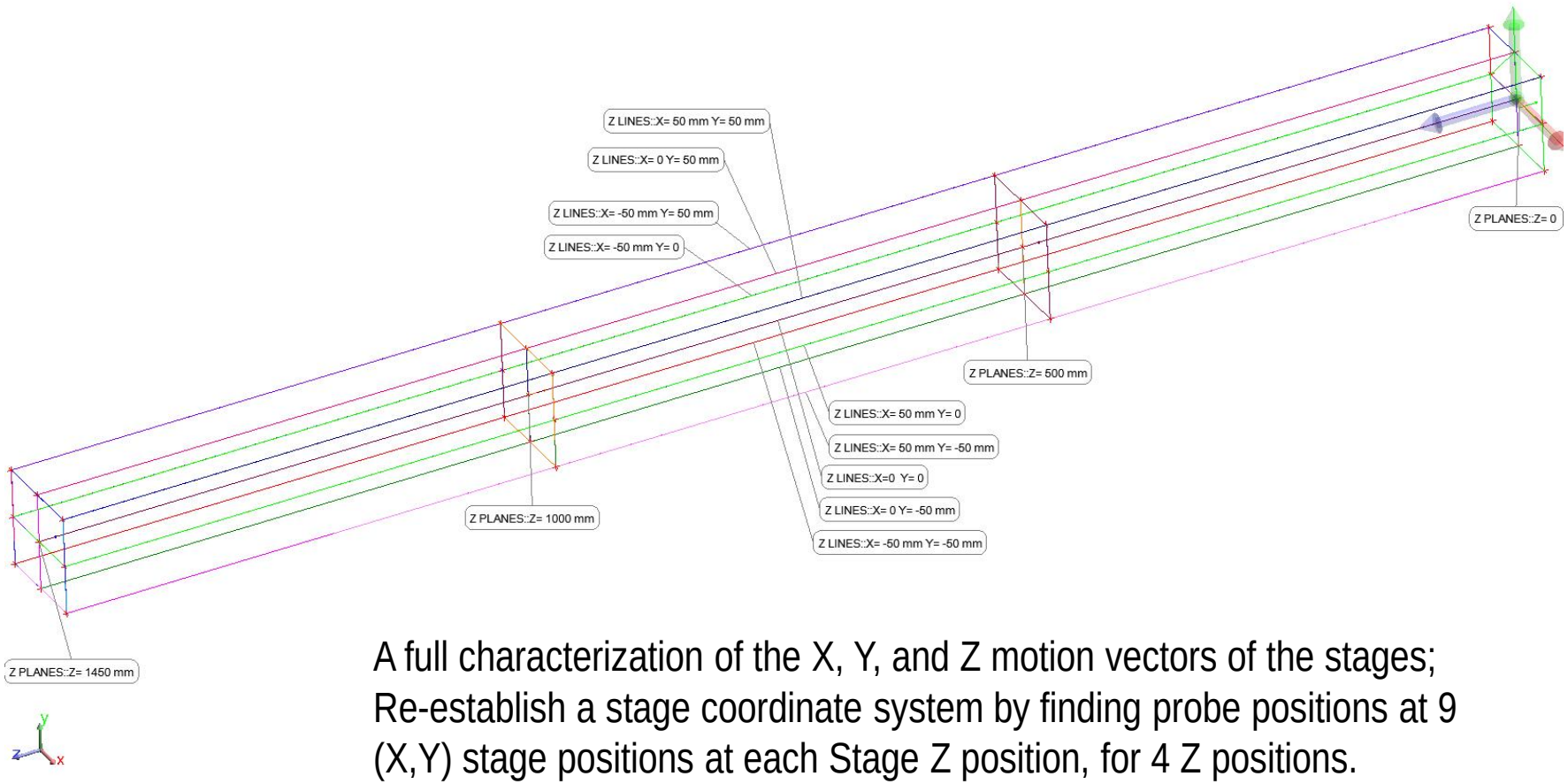
Hall Probe Bench Survey



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

Hall Probe Bench Survey

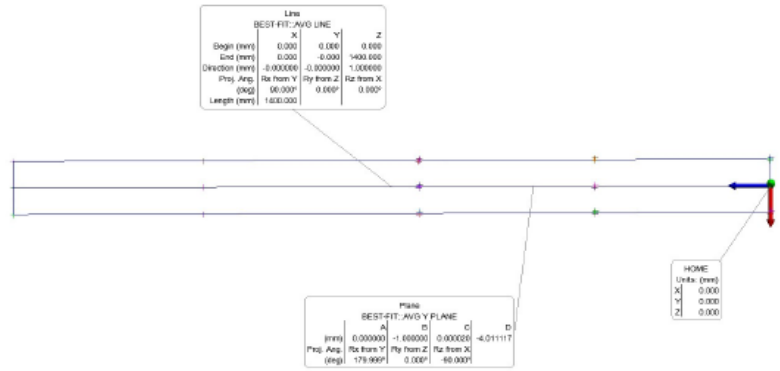


A full characterization of the X, Y, and Z motion vectors of the stages; Re-establish a stage coordinate system by finding probe positions at 9 (X,Y) stage positions at each Stage Z position, for 4 Z positions.

Hall Probe Bench Survey

The Hall Probe Bench Survey

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



Frame is created in the following manner:
Origin is the HP home position;
The primary axis Z is averaged from the 12 Z lines;
The secondary axis Y is the normal vector of the average horizontal plane from the 4 planes;
The X axis is determined according to right hand rule.
+X is outboard;
+Y is up;
+Z points downstream.

100.0 mm

AT401 and Romer Arm were used to survey the Hall probe.

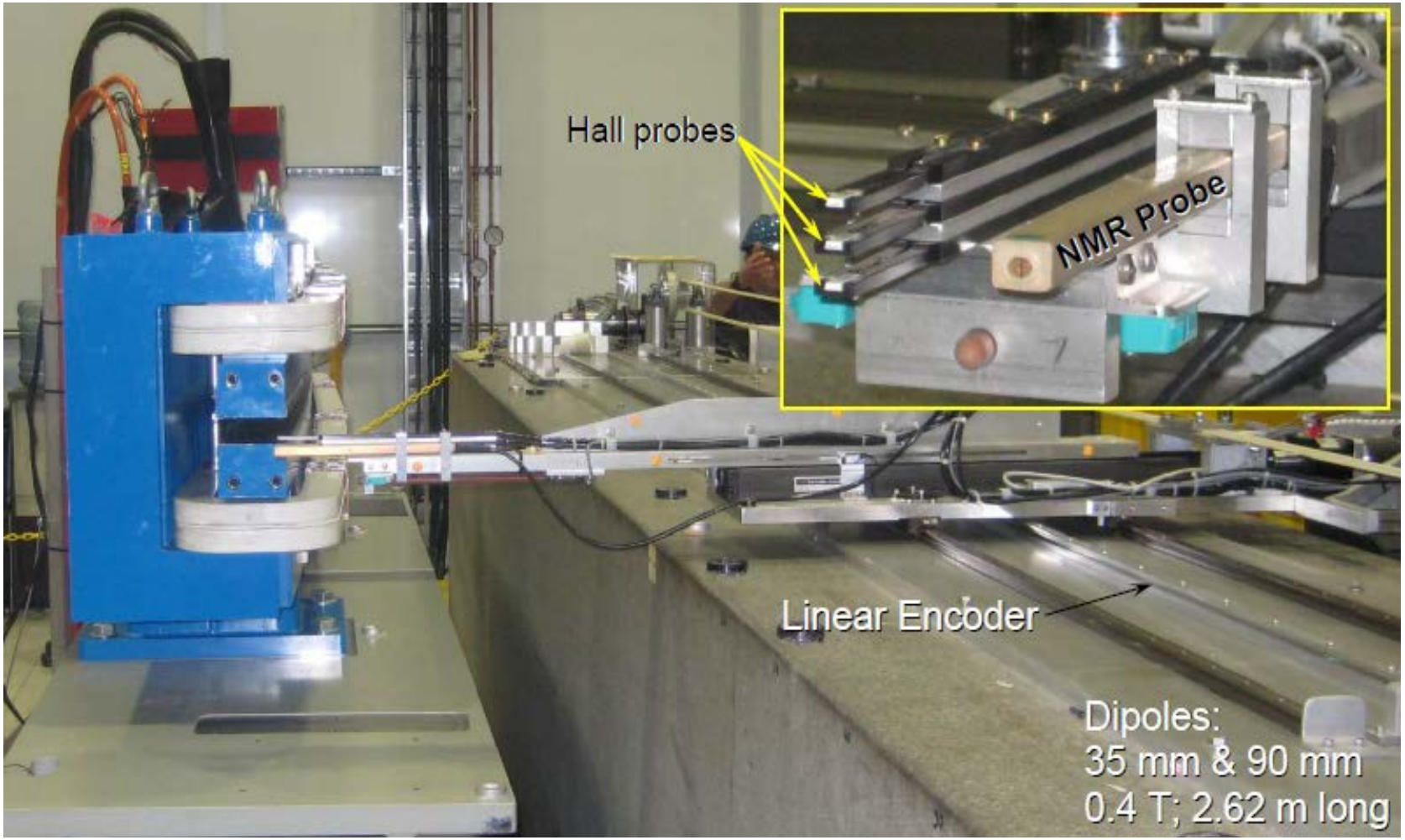
Line BEST-FIT::AVG LINE	X	Y	Z
Begin (mm)	0.000	0.000	0.000
End (mm)	0.000	-0.000	1400.000
Direction (mm)	-0.000000	-0.000000	1.000000
Proj. Ang. (deg)	Rx from Y 90.000°	Ry from Z 0.000°	Rz from X 0.000°
Length (mm)	1400.000		

Average Z axis

Plane BEST-FIT::AVG Y PLANE	A	B	C	D
(mm)	0.000000	-1.000000	0.000020	-4.011117
Proj. Ang. (deg)	Rx from Y 179.999°	Ry from Z 0.000°	Rz from X -90.000°	

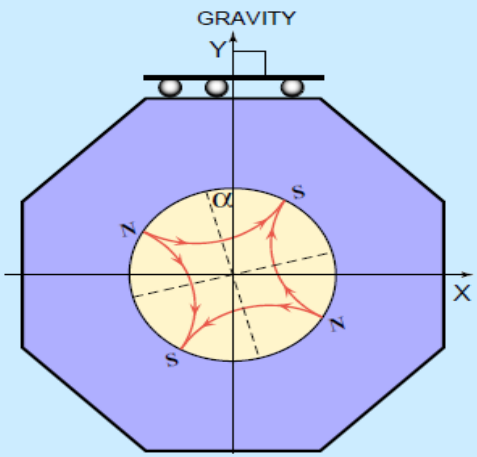
Average horizontal plane

Align magnet to Hall Probe



Vibration Wire Measurement

Roll Angle Measurement Error Correction

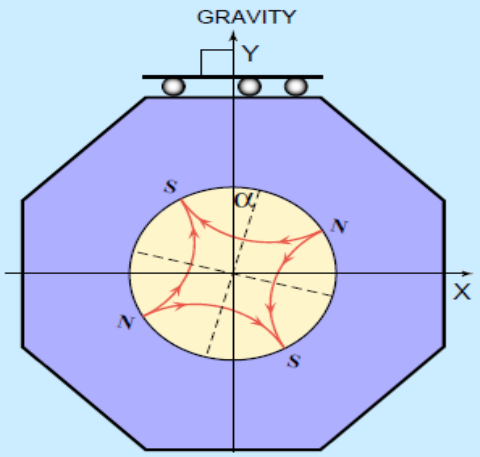


View from one end:

True Roll Angle = α

Meas. Roll Angle = $\alpha + \varepsilon = \alpha_1$

True Roll Angle = $\alpha = (\alpha_1 - \alpha_2)/2$



View from opposite end:

True Roll Angle = $-\alpha$

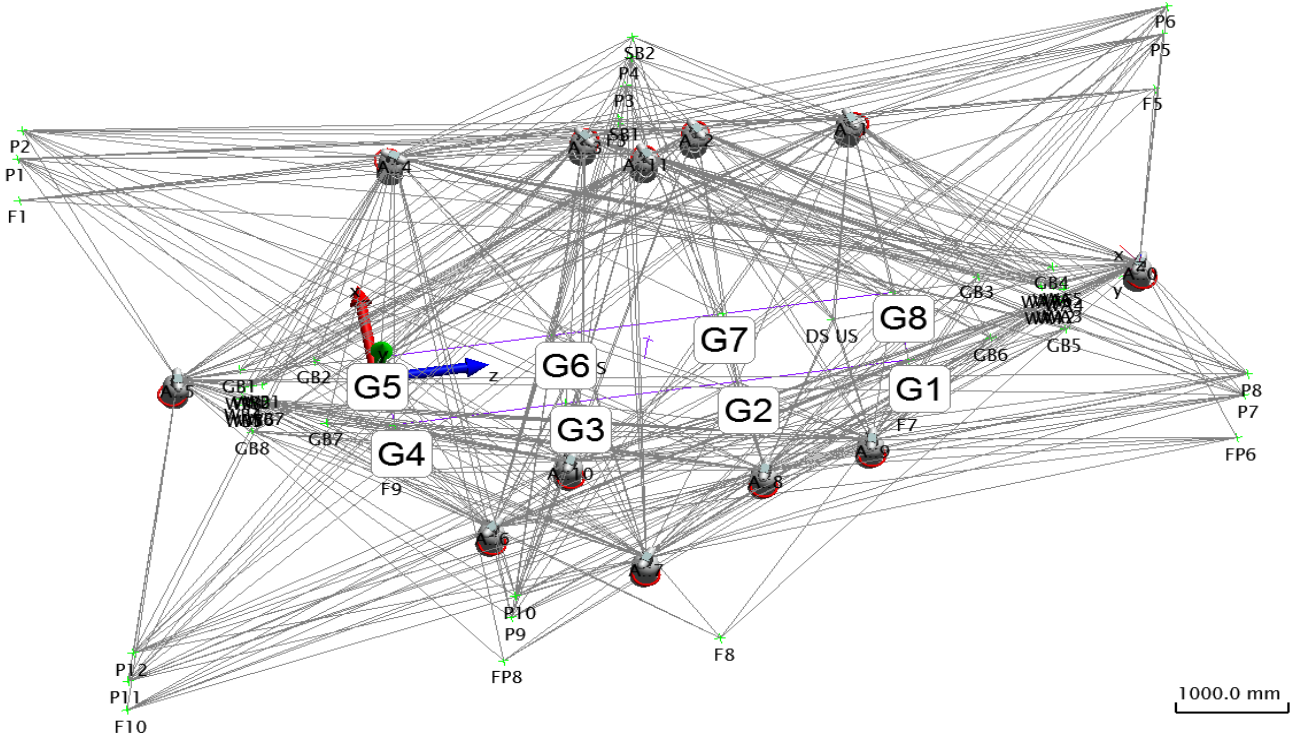
Meas. Roll Angle = $-\alpha + \varepsilon = \alpha_2$

Meas. Error = $\varepsilon = (\alpha_1 + \alpha_2)/2$

+/-100 micron initial alignment precision of magnets by laser tracker

0.5 mrad roll alignment accuracy

10 Tracker Setup



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 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!