MAGNET MEASUREMENT SYSTEMS FOR THE ADVANCED PHOTON SOURCE UPGRADE*

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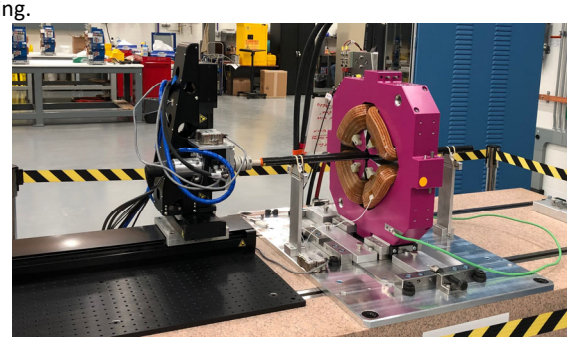
OVERVIEW:

The present storage ring at the Advanced Photon Source will be replaced with a new ring based on a Multi-Bend Achromat design as part of an upgrade currently in construction. The new ring will require about 1320 new magnets which need to be measured and fiducialized to ensure field quality and alignment requirements are met. Seven test benches were designed and built to meet these measurement requirements. Field quality in the multipole magnets is measured using four rotating coil benches, whereas the longitudinal gradient dipoles are mapped using a Hall probe system. Two rotating wire benches are used to find the magnetic centers of multipoles and relate them to magnet fiducials using laser trackers. Mechanical designs of the measurement benches are presented.

ROTATING COIL BENCHES (RC1 to RC4):

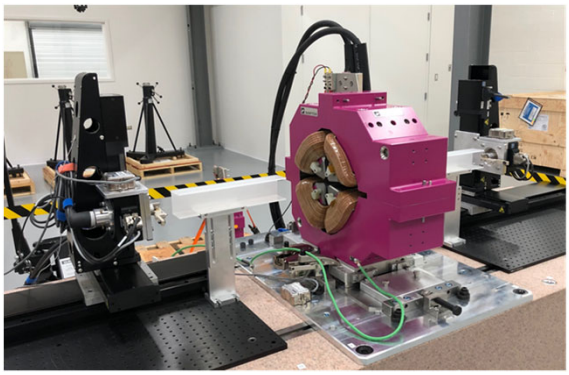
A total of four rotating coil measurement benches (RC1-RC4) were designed and built to accommodate the large variety and quantity of magnets needed for the APS-U project. Printed Circuit (PCB) coils, designed and built by Fermilab, offer unbucked and suitably bucked signals for accurate measurement of field harmonics in dipoles, quadrupoles and sextupoles. The PCB coil is mounted on a 3-D printed coil support and rotates inside a carbon fiber cylindrical housing.



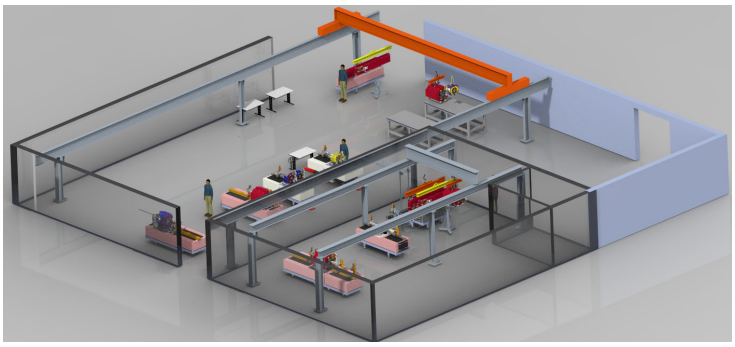
One of the rotating coil benches showing the granite block, XYZ-θ stages, magnet support plate, stop blocks and customized shim plates for alignment in X, Z.

ROTATING WIRE BENCHES (RW1 and RW2):

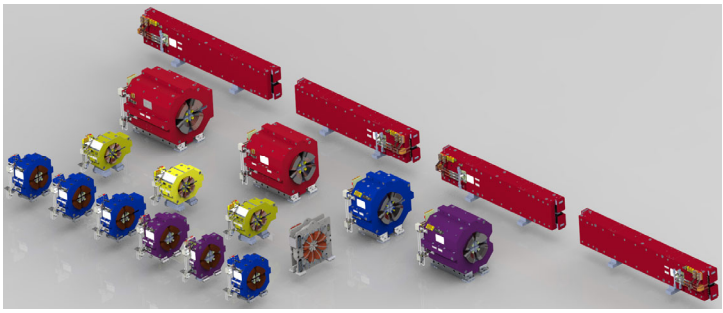
The two rotating-wire systems were designed to locate the magnetic center of multipole magnets and relate it to fiducials which are accessible on the magnet exterior. The uncertainty in determining the magnet center with this method has been shown to be better than 10 microns. These stages allow programmable X and Y linear motion of a one-turn loop of 0.100 mm diameter Cu-Be wire which is stretched between the two sets of θ-stages. During magnetic measurements the wire-loop is rotated at 1 Hz.



One of the two rotating wire benches showing motion stages and wire holders on both ends. Most of other mechanical features are similar to the rotating coil benches.



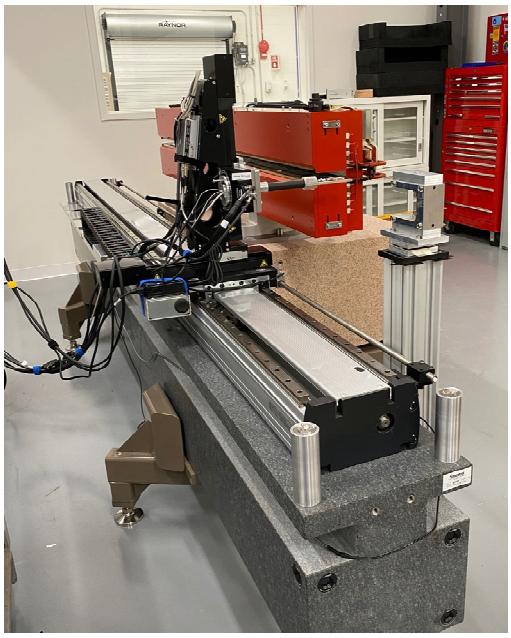
Iso-view of new 550 m^2 Magnet Measurement Lab, built for APS-U



APS-U Family of Magnets, at a relative size scale

HALL PROBE MAPPING BENCH (HP1):

The M1 and M2 longitudinal gradient dipole magnets are magnetically measured with a Hall probe-based system (HP1). This system includes a Hall probe sensor translation bench (HP1-A), and a magnet support bench HP1-B.



Hall probe field mapping system showing the HP1-A bench with a custom profiled granite block supporting the Hall probe assembly and motion stages, the HP-1B bench used to support the magnet under test (MUT) and the reference magnet (RM).

ACKNOWLEDGEMENTS:

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