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Magnetic Measurements of HL-LHC AUP Cryo-Assemblies at Fermilab

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LQXFA/B production series cryogenic assemblies are being built for the LHC upgrade by the HL-LHC Accelerator Upgrade Project (AUP). These contain a pair of MQXFA quadrupole magnets combined as a cold mass installed within a vacuum vessel, and are to be installed in the IR regions of the LHC. The LQXFA/B are being tested at 1.9 K to assess alignment and magnetic performance at Fermilab's horizontal test facility. The ˜10 m - long assembly must meet stringent specifications for quadrupole strength and harmonic field integrals determination, magnetic axis location, and for variations in axis position and local field profile. A multi-probe, PCB-based rotating coil and Single Stretched Wire system are employed for these measurements. Magnetic measurements are confined to be within the 100 mm diameter of the anti-cryostat used for cold testing, but the aperture is reduced to 46 mm at the cryogenic feed box of the test stand –further complicating both the alignment and rotating coil measurements. To accurately determine rotating coil location and angles within the cold mass, a laser tracker is employed to record multiple targets at one end of the probe, deep within the anti-cryostat.

This paper describes the measurements, probes/equipment, and techniques used to perform the necessary characterization of the cold mass.

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