Contribution ID: **42** Type: **Oral**

Magnetic Measurement activities at Magnet Division, Brookhaven National Laboratory

1. Introduction Magnet Division, Brookhaven National Laboratory is one of the world's earliest magnet research and development laboratories. Having played a significant role in early collider projects including the Relativistic Heavy Ion Collider, Large Hardon Collider, and recent Accelerator Upgrade Project, it will play a major role in BNL's Electron-Ion Collider. Contributions to other scientific and industry projects is worth mentioning. For the characterization of magnets, magnetic measurement facilities kept flourishing under the aegis of several projects. Magnet Division has over the last decades maintained high standards of discipline in magnetic measurements and standardization of magnetic measurement procedures. For magnetic field mapping several instruments and facilities are developed. This paper is a report on magnetic measurement operations at Magnet Division along with work underway on hardware and support upgrades of existing systems and development of new technologies for future magnetic measurement systems.
2. Magnetic measurement facilities at Magnet Division, Brookhaven National Laboratory Several magnetic field mapping and measurement systems, developed in due course of time are operational at the Magnet Division. The majority of these include rotating coils, hall probe-based mappers, vibrating wire systems, and stationary coils for ramping magnets. The two variants of rotating coils namely "the moles"which have internal drive and are used for low field measurement in long magnets and "rotating coil"which are externally driven. These systems are built for several reference diameters and lengths. The "moles"and "rotating coils"are multi-loop with a standard design having 5-loop coils and 9-loop coils with digital bucking. Magnetic field mappers using hall probes are in use for field mapping and vibrating wire systems for magnetic axis determination. Magnet Division also has a Stationary multi-coil system for harmonic measurements during magnet ramping. BNL has having facility for the calibration of Rotating Coil and Hall Probes. The facility consists of a large aperture dipole magnet, quadrupole, and sextupole magnet, high rating stable power supply, and NMR sensor. The facility is also supported by various mechanical alignment and transportation systems.
3. Recent Magnet Measurement activities Several magnets are recently measured at the Magnet Division. These are largely from transfer function and harmonic measurement considerations. These include measurement of Dipole Magnet (DX) from RHIC, Rapid Cycling Synchrotron low field dipole test magnet, Refurbished Quadrupole and Sextupole Magnets from Advanced Photon Source, warm measurements of direct wind magnets for Electron-Ion Collider and magnetic measurements on Nb3Sn Quadrupole magnets for Accelerator Upgrade project (AUP). These measurements are being carried out using a combination of "moles", external drive rotating coils, and PCB-based rotating coils.
4. Magnetic Measurement System upgrades Many of the existing magnetic measurement systems at Magnet Division are running on outdated hardware and software causing significant loss of person-hours for repairs and diagnostics. The existing rotating coil systems including both the "mole"and "external drive rotating coil"are proposed to be upgraded. The coil rotating mechanism is proposed to be upgraded using standard rotary stages from reputed suppliers. Rotary stages with rotating speeds as high as 1000° /sec are easily available which is sufficient for present requirements. The data acquisition and processing systems are being planned to be upgraded with modern visual programming platforms. The upgraded system is proposed to have options for both voltage and flux measurement and acquisition and will have the option of both analog and digital bucking. The synchronization between data acquisition systems and rotary stages will be carried out using FPGA-based embedded electronics. The magnetic measurement moles consist of an in-built main motor that rotates the coil and a gravity sensor motor that aligns the mole to gravity. It is the presence of these motors built into the mole which limits the magnetic field strength when the mole is placed in this field. Piezo motors are proposed to

replace both of these motors. Analysis programs are also being replaced with one using languages like MATLAB or Python.

5. New Magnetic Measurement Systems New magnetic measurement systems are being planned at the Magnet Division to meet the requirements of upcoming projects. PCB-based analog-bucked rotating coils for dipole and quadrupole magnets are being designed. An integrated dual-rotating coil system is being planned for the z-scanning of a magnetic field inside compensation magnets having longitudinally varying harmonic contents. An integrated facility consisting of vibrating wire, stretched wire and rotating wire is also being planned. Options of liquid helium-compatible rotating coils are being explored for Electron Ion Collider. This paper will discuss them in detail.
6. Summary This paper/talk is a comprehensive coverage of Magnetic measurement capabilities and activities at the Magnet Division at Brookhaven National Laboratory which extends over more than 5 decades. This talk will cover them as described above.
7. Acknowledgement The magnetic field measurement system at Brookhaven National Laboratory is the outcome of tremendous efforts by our former colleagues including Animesh Jain, James Herrera, Richard Thomas, Peter Wanderer, George Ganetis, and John Skaritka. Contribution of Christopher Tamargo and John Cintorino is highly appreciated.

Primary author: TEOTIA, Vikas (Brookhaven National Laboratory)

Co-authors: MARONE„ Andrew (Brookhaven National Laboratory); ANERELLA„ Michael (Brookhaven National Laboratory); Mr JOSHI, Piyush (Brookhaven National Laboratory)

Presenter: TEOTIA, Vikas (Brookhaven National Laboratory)