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SUPERCONDUCTING MAGNET DIVISION
CAPABILITIES AND FACILITY

CAPABILITIES

Staff members of the Superconducting Magnet Division (SMD) have designed, built, and tested superconducting magnets for the RHIC[1] collider at BNL and for colliders at CERN (Geneva, Switzerland), IHEP (Beijing), KEK, JPARC, and SuperKEKB (Japan). For the RHIC project, the group managed industrial procurements of several hundred 3.5 T, 10 m NbTi dipoles, quadrupoles, and corrector magnets. The group also built few-of-a-kind magnets for RHIC at BNL. In 2016, RHIC completed its sixteenth year of operation with downtime due to magnet failures at the level of a few percent. In the last few years, the group has been working with staff at Fermilab and Lawrence Berkeley lab to build magnets wound with Nb_3Sn (higher-performance material than NbTi) for an upgrade of the CERN Large Hadron Collider. Details on these programs are available at https://www.bnl.gov/magnets/

The group has designed, built, and tested one-of-a-kind superconducting magnets for special purposes, such as a magnetic trap for antimatter at CERN. One-of-a-kind magnets have been built using several types of High Temperature Superconductor (HTS).

The group has expertise in magnetic, mechanical, electrical, and cryogenic design of magnets made with NbTi, Nb_3Sn, and HTS. The group has expertise in the precise measurement of magnetic fields with a variety of sensing devices.

FACILITY

The magnet construction and test facility occupies the large high-bay originally occupied by BNL's first accelerator, the Cosmotron. Each of the three bays has crane coverage (up to 25 tons) as well as power, water, and network utilities. Power supplies can provide up to 22 kA. The cryogenic magnet test facility can supply helium at superfluid temperatures and is equipped with state-of-the-art DAQ system. The facility has a machine shop and access to the lab's machine shop.

The semi-automatic coil manufacturing equipment wind and cure cosθ coils (wound with high current superconducting cable, both NbTi and Nb_3Sn) as long as 10 m. In addition, there are two specialized semi-automatic coil winding facilities: the Direct Wind and the Universal Winder. The Direct Wind facility makes coils with cylindrical conductor configurations. The conductor is precisely located via a CAD-CAM process that starts with the coil design code. The Universal Winder makes two-dimensional windings (e.g., circular or oval) and can wind two materials (e.g., conductor and insulator) simultaneously up to a length of 4 m and width of 2.5 m.

There are two ovens capable of reacting Nb_3Sn conductor (~ 650° C). One can react coils as long as 4.2 m in an inert atmosphere. The other is a vacuum oven, which can react coils up to ~ 1m in length. There is a vacuum impregnation facility which can impregnate coils up to 4.2 m in length.

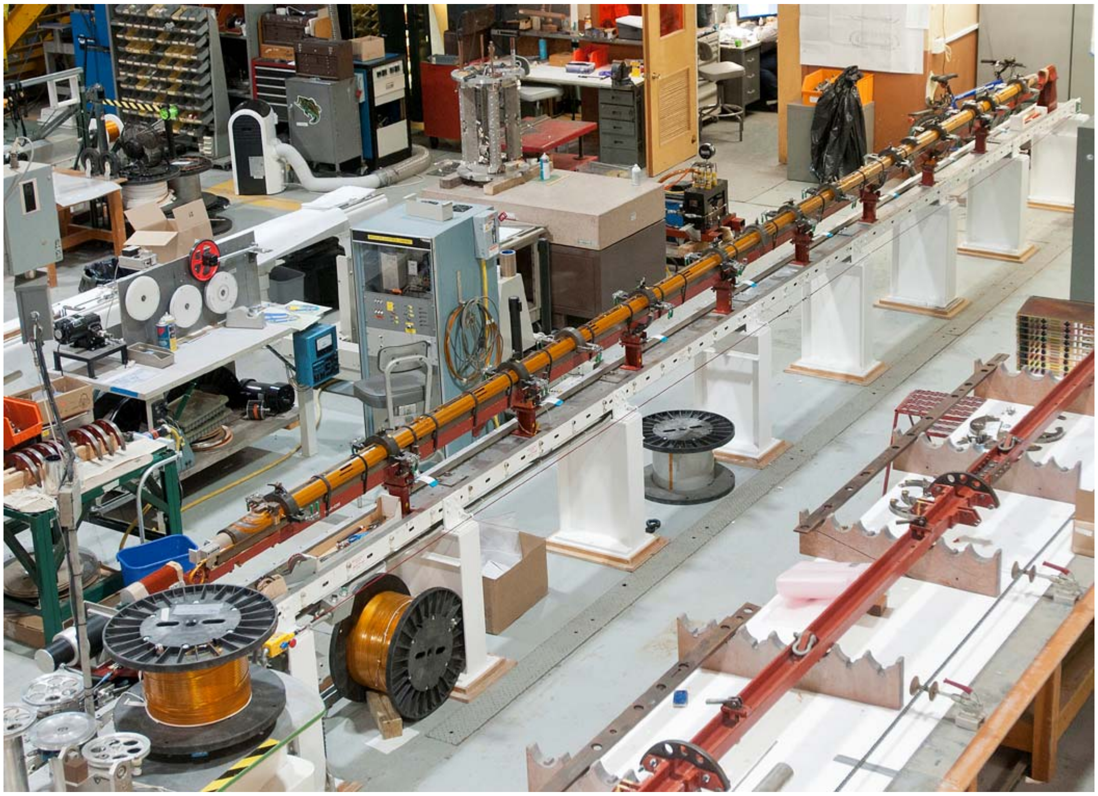
The cryogenic test facility has the capability of testing bogth magnet cold masses and cryostatted magnets. Magnet cold masses with length and diameter up to those of the LHC HiLumi quadrupoles (e.g., L < 4.2 m, diameter < 630mm) are tested in a vertical dewar where they can be ramped to 22 kA at 1.9 K. Quench detection, protection, and test data acquisition are state of the art (largely National Instruments Labview). Quench protection includes fast shut-off by high power IGBTs. Cryostatted magnets as long as 10 m would be tested in a horizontal test station at currents up to 5 kA under forced-flow conditions at 4.5 K.

Magnetic field measurement capability includes rotating coils, Hall probes, and NMR.

References

1. M. Anerella et al., The RHIC Magnet System, Nuclear Instruments and Methods A 499 (2003) 280-315.

North HiBay (14,700 sq. ft / 1365 m^2)



10 m coil winding machine and coil in the South Bay