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View Abstract

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ABSTRACT TITLE: Design, construction, and test of R&D dipole B0ApF for the EIC

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ABSTRACT: B0ApF is a modest field (~3.9 T) Interaction Region (IR) dipole magnet for the Electron Ion Collider (EIC), now under construction at Brookhaven National Laboratory. This is one of several large-bore superconducting magnets for the EIC IR, where the coil length to coil aperture ratio is relatively small compared to those in most accelerators. Conventional cosine n-theta cable magnet designs are not efficient for such short magnets as the ends dominate and dilute the integral field. Moreover, since only one such magnet is required in the machine, the cost of tooling and engineering dominates the cost in a conventional cosine theta cable magnet program. Direct Wind (DW) technology keeps the cost of building one each of such magnets low since it requires little engineering and no new tooling. The Optimum Integral Design (OID) offers a novel solution to keep the maximum field in short length magnets low for the required integral field. In the OID, the midplane turns extend essentially the full length of the coil, and the fields in the body and ends are combined for optimizing the integral field harmonics. This extends the magnetic length by minimizing the loss due to the ends, the impact of which are large in short magnets requiring maximum integral fields. The Department of Energy awarded Phase I and Phase II Small Business Technology Transfer grants to Particle Beam Lasers, Inc. with Brookhaven National Laboratory serving as a partner to demonstrate a proof-of-principle design of this magnet and technology in a full-length (0.6 meter) B0ApF and to study it for other applications. Primarily because of this initiative, the optimum integral design is now being used in several other EIC IR magnets as well. We present the design, construction, and results of a series of tests of this magnet with a central field of ~3.8 T and a coil aperture of 114 mm for an integral field of 1.98 T.m. This is a significant field in a significant aperture dipole (for reference, RHIC arc

	dipoles had a design field of 3.45 T and a coil aperture of 80 mm). This magnet is constructed with twelve layers of direct wind coils, based on the OID principle with a series of tension roving and two stainless steel tubes for mechanical support. In a previous test, this magnet was energized, without any quench, to 331 A (yielding 74 % of the design field integral) at 4.2 K. The magnet performance in the test was limited by superconducting leads from the top-hat to the magnet. This limitation, which occurred outside of the magnet, will soon be addressed in an upcoming magnet test, to be supported by the EIC magnet program. This will be a key test of the direct wind technology for such a high-field large-aperture magnet and of the OID principle in a full-length prototype of the EIC IR magnet B0ApF.
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