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Fri-Mo-Po.05-04: Optimum Integral Design for EIC Dipole B1ApF

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The Optimum Integral Design (OID) with Direct Wind (DW) technology offers a unique value engineering opportunity for the Interaction Region (IR) dipole B1ApF of the Electron Ion Collider (EIC). The current design of the B1ApF magnet is based on the conventional cosine theta configuration using Rutherford cable. As compared to most accelerator magnets, B1ApF has a small coil length (1500 mm) to coil aperture (370 mm) ratio. The relative benefit of the Optimum Integral Design is significant in such short magnets since it minimizes the loss in effective magnetic length due to ends. In the Optimum Integral Design, the midplane turns extend over the full length of the coil, making the effective magnetic length closer to the full coil length. Further benefits of the design come from the elimination of end plates, which in the current cable magnet design, take a significant portion of the slot length available in the lattice. Calculations show that for the required integral field of 4.05 Tesla-meters, the increase in magnetic length in the Optimum Integral Design is so much that the field at the center of the magnet can be relaxed from 3.92 T to 2.55 T. As a result, the Lorentz forces/stresses, and hence the technical challenges and risk to the program, get significantly reduced. Since the Direct Wind Technology doesn't need coil winding, coil curing and coil collaring tooling, the cost and time required to build such a magnet gets significantly reduced as well. Hence, the proposed OID option provides significant savings, making it a value engineering alternate to the baseline design of B1ApF. The required field integral can be achieved with only two layers of windings with the 6-around-1 cable that is being purchased for the EIC program. As a part of the complete study, we will also present several other design options. The paper will also provide a summary and benefits of the Optimum Integral Design.

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