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Proof-of-Principle Demonstration of a Novel Overpass/Underpass High Field Dipole

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This paper presents the basic engineering design, analysis, and plan to build and test a "Proof-of-Principle" overpass/underpass (also called cloverleaf) high field block coil dipole. Block coil configurations are appealing for their simplicity in the body of a magnet, but less so in the ends of the blocks that must be lifted to clear the beam tube. This lifting —which typically is in the hard direction of the broad cable —must be very gradual, to avoid conductor degradation (especially Nb3Sn or HTS) from excessive strain, making for ends that are undesirably long. The overpass/underpass or cloverleaf end geometry is designed to overcome the above-mentioned shortcomings. The conductor clears the bore tube at the ends by replacing the hard-way bends by a gentle twist in a 270° turn. The design produces ends that are shorter in length as compared to those with lifted end designs. Moreover, the strain on the cable in the ends also remains low, although the geometry of the ends becomes more complex.
This work has been carried out under a Phase I Small Business Technology Transfer (STTR) program between the Particle Beam Lasers, Inc. (PBL) and the Brookhaven National Laboratory (BNL). A specific proof-of-principle demonstration will be carried out in Phase II for the pole coils in a 2-in-1 common coil dipole reaching ˜11 T. The dipole DCC017 has a large, easily accessible open space in which the new coils can be inserted and tested as an integral part of the magnet without any need to disassemble and reassemble the original magnet. Once the design is successfully demonstrated, the overpass/underpass end geometry is likely to be used in other block coil designs besides the common coil. In fact, the present 20 T HTS dipole program at CERN is based on the overpass/underpass or cloverleaf design.

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