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Thu-Af-Or22-01: Improvement in training performance by enhancing coil end support of the Beam Separation Dipole for the High-Luminosity LHC

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The high-luminosity LHC upgrade (HL-LHC) aims to increase integrated luminosity by a factor of ten compared to the present LHC. To focus the beam more strongly towards the interaction point, superconducting magnets in the insertion regions must be upgraded. In the framework of CERN-KEK collaboration, KEK is in charge of developing a large150-mm-aperture beam separation dipole (MBXF). The field integral of 35 T· m with the nominal dipole field of 5.6 T is produced at the operating conditions of 12 kA and 1.9 K by a 7-m-long Nb-Ti based magnet. The design option of a single layer cos coil wound with 15-mm-wide Nb-Ti/Cu Rutherford cable was selected for maximizing iron volume and higher cooling capability. In such a thin and large-aperture coil, mechanical support against Lorentz force is one of the most important design considerations.
Three 2-m-long model magnets (MBXFS1–3) have been fabricated and tested at KEK. The test results of MBXFS1showed that the azimuthal coil pre-stress in straight section plays a major role in training performance. At coil end in this magnet, cable deformation towards the bore was observed after magnet test. To enhance cable support, wet-winding with radiation resistant resin was applied to coil end in MBXFS2. However, this could not perfectly prevent cable displacement. Quench start location concentrated on coil end in the early stage of training, suggesting that pre-stress at coil end was insufficient.
In this paper, we report training performance of MBXFS3, in which mechanical support of the cable at coil end is further enhanced. The influence of azimuthal pre-stress at coil end and axial pre-load on training curve will be discussed. A unique mechanical behavior found in the model magnets, hysteresis in the azimuthal coil pre-stress as a function of the current square during training quench, will also be presented.

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