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Quench Protection Heater Study with the 2-m Model Magnet of Beam Separation Dipole for the HL-LHC Upgrade

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Construction of the High Luminosity Large Hadron Collider (HL-LHC) is being planned for an increase of luminosity in order for the further exploration of the physics beyond the Standard Model. Under this program, a series of final focusing magnets, including a beam separation dipole (D1), has to be upgraded, and we, KEK, are responsible for development of the new D1 magnet. This magnet is designed to have an aperture size of 150 mm and to generate a field integral of 35 Tm. Fabrication of the first 2 m model magnet of D1, called MBXFS01, was completed in 2016, and the subsequent cold test was conducted to ensure its performance. After the test, we re-assembled MBXFS01 to enhance the coil pre-stress, and the second cold test was conducted with the re-assembled one (MBXFS01b) in 2017.

During the first and second cold tests, study on the quench protection was made using spot heaters (SHs) and quench protection heaters (QPHs). SHs are bonded to the inner surface of a single turn of the coil with the highest and the lowest fields, and the detection time of the balanced voltage are experimentally evaluated at given operating currents. The model magnet (MBXFS01 and MBXFS01b) also equips QPHs which cover the outer surface of the coils. These heaters are used to estimate the total heat input required to trigger a quench. In addition, we study how the maximum temperature of the coils varies with given operating currents when we rely only on these QPHs for an extraction of the coil energy. In this paper, we report a series of the quench protection studies and results from the measurements.

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