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Magnetic measurements of a full-scale prototype of the HL-LHC beam separation dipole

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A beam separation dipole of the High-Luminosity LHC, known as MBXF, is a 7-m NbTi magnet, which is designed to generate 35 Tm at the operating condition of 1.9 K. The magnet has a collared yoke structure with a 150-mm-aperture single-layer coil. The dipole field is 5.6 T at nominal operating current while a b3 integral is required to be within 2.9 units. The target pre-load is set to 115 MPa to increase mechanical reinforcement against the high Lorentz force. The High Energy Accelerator Research Organization, KEK, has developed three 2-m model magnets in collaboration with CERN and has evaluated those field qualities. The last two model magnets have shown anomalous b3 which was higher than expectations by 16-18 units and this is mainly due to incorrect cable thickness assumed during the magnetic design stage. In addition, the coil is known to be deformed ovally because of large pre-loads, giving an additional offset to b3. The complexity of design problem is overcome by starting optimization of two dimensional coil cross section from the lower current where we can eliminate effects from magnetization of other components such as an iron yoke. After then necessary corrections are considered to estimate a three dimensional b3 distributions at the nominal operating current. The magnetic design of the first MBXF prototype (MBXFP1) was considered by following the above methodology. Even though the two dimensional coil cross section of MBXFP1 is not fully optimized due to a limited span of time, it is quite important to evaluate our methodology and to check if further iterations are possible for series production of MBXF magnets. In this presentation we first review field qualities of the model magnets and then report results from magnetic measurement of MBXFP1. Finally, final magnetic design of series production magnets is presented.

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