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Quench Behaviour of Prototype HL-LHC Dipole Canted Cos-Theta Orbit Corrector Nb-Ti Magnet

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The HL-LHC upgrade requires installation of eight, 105 mm diameter, double aperture dipole correctors (MCBRD) on both sides of ATLAS and CMS, each side with a horizontal and a vertical dipole. A Canted Cos-Theta (CCT) design was selected by CERN in 2015 and a development of the MCBRD magnet followed. Since then, a prototype (P01) has been built and measured at CERN, and quench results agree with simulations. In 2017, the programme has been joined with in-kind contribution of one prototype (P02) and twelve (four spare) series magnets with efforts by WST, IMP, IHEP, BAMA, all in China.

The MCBRD comprises two tilted Nb-Ti solenoids wound on aluminium formers, with opposite inclination and operating at nominal 394 A and 1.9 K with a peak field of 2.94 T. Due to winding proximity to the metal formers and selected impregnation method, the allowed voltage to ground and hot-spot temperature were limited to 500 V and 200 K, respectively.

Based on simulations using the code STEAM-ProteCCT, developed at CERN, energy extraction was selected as the most promising method to protect the magnet against overheating in case of a quench. Simulations showed that high magnetic-field change rate during the magnet discharge causes substantial quench-back due to the heat generated by the eddy currents in the formers, hence increasing the discharge rate and reducing the hot-spot temperature.

The P01 and P02 prototypes use strands with different Cu:SC ratio and aluminium formers with different electrical and thermal conductivity. This altered the quench behaviour of P02 which was recently measured at CERN. A quench simulation study was launched, and additional material properties were measured. This contribution presents the results and elaborates on to what degree the quench behaviour change can be accounted for by wire and formers properties.

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