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Performance of a MQXF Nb3Sn Quadrupole Under Different Stress Level

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In a dipole or quadrupole accelerator magnet the electromagnetic forces in the coil are azimuthally directed towards the mid plane and radially outwards. Displacement of the turns at powering could compromise field quality and cause releases of frictional energy, which could trigger a quench. To avoid movements of the conductors, preload is applied to the coil in the azimuthal direction. The design criteria used in accelerator magnets aim in the design phase at a preload providing contact between pole and coil at nominal current. This requirement was set at the beginning of the accelerator magnet era. On the other hand, accelerator magnets had shown that good magnet performance can be reached with only a partial preload, i.e. that coil unloading during the ramp does not prevent reaching higher currents. This issue is particularly relevant for Nb3Sn magnets, where the loads applied to the Nb3Sn filaments can reduce and/or permanently degrade their critical current. In order to investigate the impact of mechanical stress on the quench performance, the MQXFS6 short model quadrupole for the High Luminosity Upgrade was tested under an azimuthal pre-load ranging from 50 % to 100 % of the electromagnetic forces at nominal current. This paper presents the assembly details, quench performance, and describes the mechanical behavior of the magnet under the different stress conditions. The magnetic measurements of the first allowed multipole are also analyzed and compared to simulation results, to see if any evidence of coil unloading can be seen from the harmonics.

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