The Role of Azimuthal Prestress in Longitudinal Strain Induced Degradation in Nb3Sn Superconducting Accelerator Magnets

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***Abstract*— Superconducting magnet coils are subject to enormous electro-magnetic forces which push the cables away from the winding pole, and against the surrounding structure. This structure is usually optimized trying to limit the overall motion and the strains experienced by the superconducting elements. To achieve this, preload forces are applied both in the coil cross-section and along its length. If the e.m. forces overcome these preloads, separation between the coil and the pole occurs, resulting in an overall loss of rigidity. During the magnet design process, it is often tempting to treat the optimization of the azimuthal and longitudinal preload systems separately. However, the two are inextricably related: as the cross-section preload increases, friction can prevent any motion in the longitudinal plane, and decreasing it can instead allow dangerous motions in the conductor ends. The latter can result in very high strains and, in Nb3Sn conductors, damage that can prevent the magnet to reach the desired performances. In an attempt to define design guidelines, in this paper we use simplified analytical and numerical models to compute, as a function of the azimuthal prestress, the variation of the peak strains in the end region of cos(θ) magnets. Different supporting structure designs are considered. Finally, we investigate the optimal azimuthal/longitudinal prestress space for a real magnet case, using as an example the High-Luminosity Nb3Sn Quadrupole MQXF.**

***This work was supported in part by the U.S. Department of Energy, Office of Science, Office of High Energy Physics, through the US HL-LHC Accelerator Upgrade Project.***

***Keywords—Mechanical Aspects, Accelerator Magnets, Preload***