

# LTS magnets electro-mechanical modelling taking into account magnetic iron forces

Keywords: High field Nb3Sn magnet ; electro-mechanical modelling ; magnetic forces ; reluctance forces ; coupling phenomena ; strongly coupled ; weakly coupled

In this paper, we aim to show mechanical analysis using models of numerous High field Nb3Sn, both Cosine-Theta and block types magnets, namely FRESCA2, Block type demonstrator for FCC, HEPDipo [1], 11 T and MQXF [2].

On these high field magnets, iron is employed for several reasons. Magnetically, the bore field can be increase and it helps in the purpose of shielding. Mechanically, iron helps on the coils pre-load, transferring the mechanical pre-load provided by the aluminium shell, for example.

For considerable Nb3Sn magnets, cable and iron pole are impregnated together. As consequence, the magnetic force applied on the iron can play an important role on the coil stress. The contributions from Lorentz and magnetic forces on coils are investigated.

The influence of the magnetic iron forces on the mechanical structure can be taking into account by using to types of coupling : strong or weak coupling. Weak coupling means that the magnetic and Lorentz forces are applied to the mechanical model but the mechanical strain and displacement doesn't affect these forces. A strong coupling happens when the mutual influence is taken into account. The difference on these methods are investigated.

References:

[1] P. Bruzzone et al., "Conceptual Design of a Large Aperture Dipole for Testing of Cables and Insert Coils at High Field,"IEEE Transactions on Applied Superconductivity, vol. 28, no. 3, pp. 1–5, Apr. 2018.

[2] P. Ferracin et al., "Development of MQXF: The Nb3Sn Low-  $\beta$  Quadrupole for the HiLumi LHC,"IEEE Transactions on Applied Superconductivity, vol. 26, no. 4, pp. 1–7, Jun. 2016.

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