Contribution ID: **34** Type: **Poster Presentation of 1h45m**

Thermomechanical behavior of the HL-LHC 11 tesla Nb3Sn magnet coil constituents during reaction heat treatment

Wednesday, 30 August 2017 13:15 (1h 45m)

The superconducting magnets for the LHC High Luminosity upgrade (HL-LHC) are built using Nb3Sn technology, which implies a reaction heat treatment when the conductor is at final shape. During the reaction heat treatment the Nb3Sn coil is surrounded by a fixture that restricts the coil volume changes. The knowledge of the evolution of the thermo-mechanical properties of the coil materials and of the reaction fixture during the heat treatment is required in order to predict the coil geometry and stress state by Finite Element simulations. We have measured the Young's and shear moduli of the HL-LHC 11 T Nb3Sn magnet coil and reaction tool constituents with the non-destructive dynamic methods resonance and impulse excitation during in situ heat cycles in the temperature range -60℃ to 700℃. The 4.2 K elastic properties are obtained by fitting and extrapolating these results. The thermal expansion of the coil components was measured by dilation experiments.

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Session Classification: Wed-Af-Po3.10

Track Classification: F8 - Structural Materials for Magnets