FCC Week 2018

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Mechanical Behaviour of Epoxy Impregnated Nb_3Sn Cables

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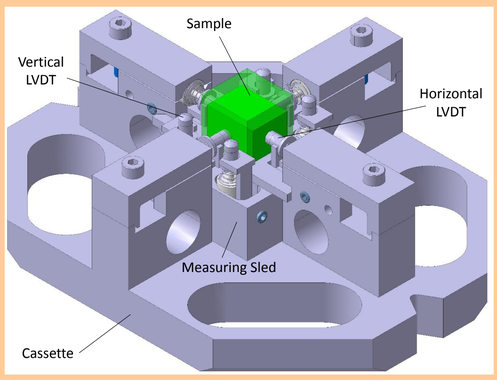
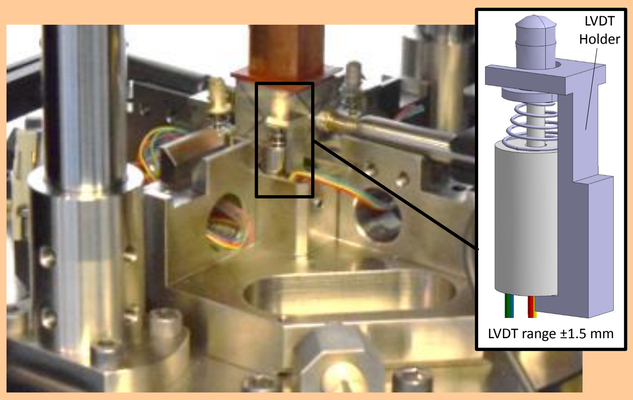
Description

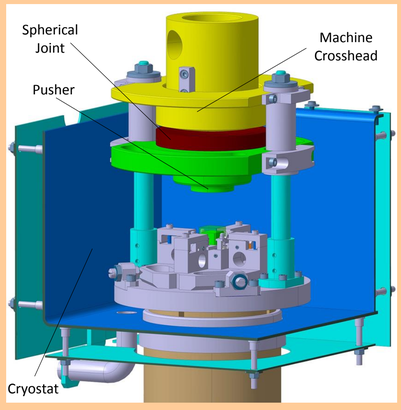
In the framework of the FCC study, the Nb_3Sn technology plays a crucial role for high-field superconducting magnets. The new generation Nb_3Sn cable greatly contributes to bring the magnetic field produced by the superconducting dipole magnets to the 16 T level; nevertheless, its mechanical properties are unknown making it difficult to predict the mechanical behaviour of the magnet structure. For this reason, an extended experimental campaign on specimens made from a stack of 10 Nb_3Sn cables was launched at CERN. The 10-stack can be considered a representative sample of the magnet coil because it is produced following the same construction process: curing, reaction and impregnation. The experimental campaign consists of compression tests along the three sample directions at room temperature. Multiple loading and unloading cycles were performed as occurs for real magnet coils. A dedicated test bench was designed to measure the vertical and lateral deformations of the sample. This work presents the stress-strain relationships highlighting the not linear behaviour of the cable stack and its stiffness is strongly depended by the stress level in all loading directions. Moreover, the transverse-longitudinal strain relationships give further information about the complex behaviour of the Nb_3Sn cable stack because cables slipping phenomena can be observed.

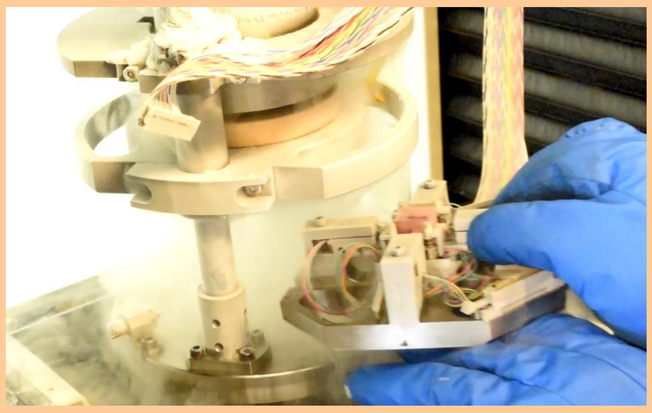
Experimental Set-up

A dedicated test bench to carry out compression tests at room and cryogenic (77 K) temperature was designed and validated in the EN-MME Mechanical Laboratory.





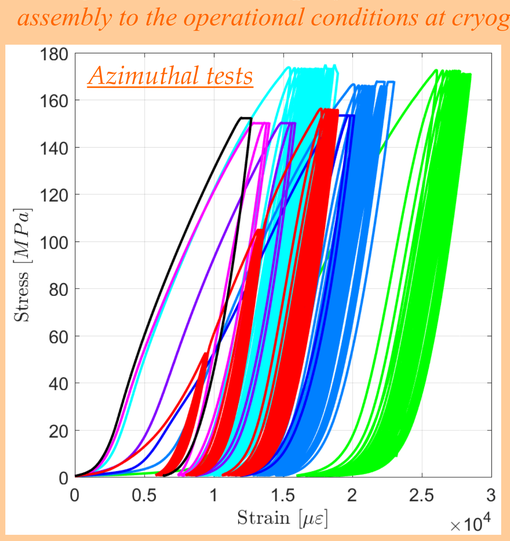


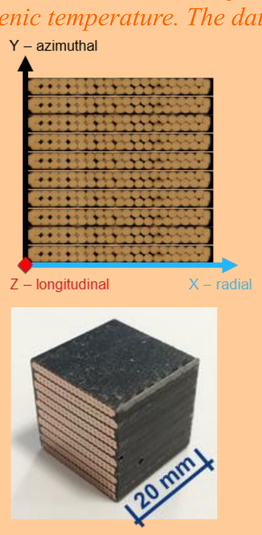


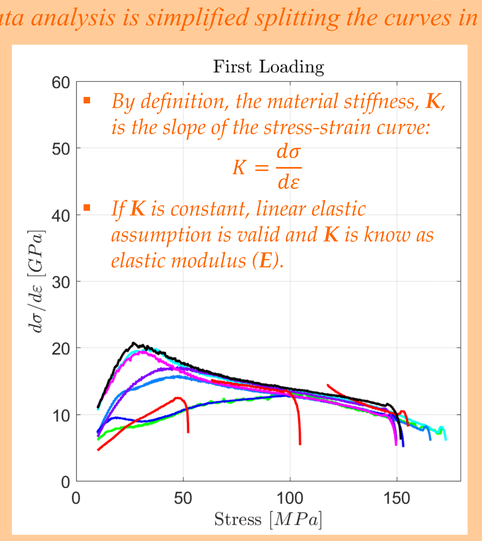
Experimental Results

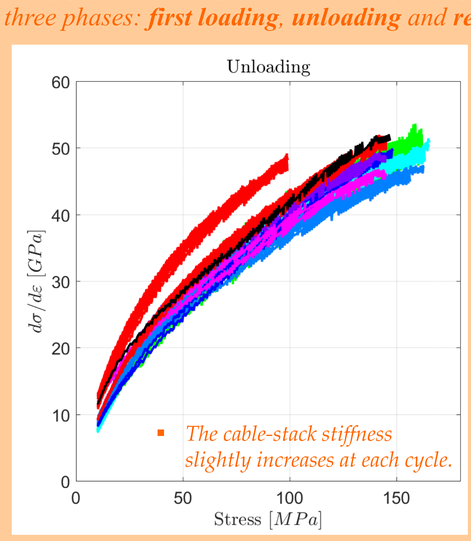
Stress-Strain relationship

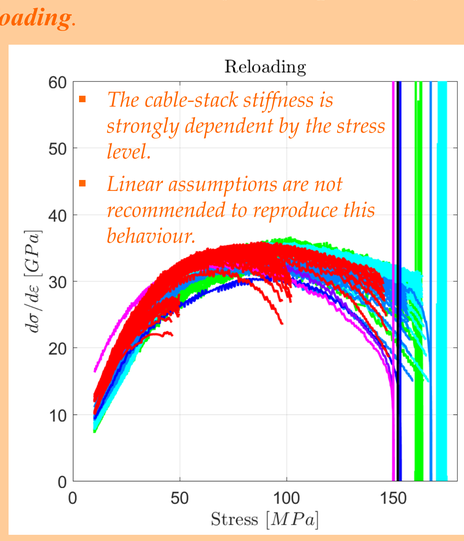
*A comprehensive knowledge of the mechanical properties of the Nb_3Sn superconductive cable in high-field magnets is of paramount importance to study and predict the behaviour of the magnet coil from assembly to the operational conditions at cryogenic temperature. The data analysis is simplified splitting the curves in three phases: **first loading**, **unloading** and **reloading**.*





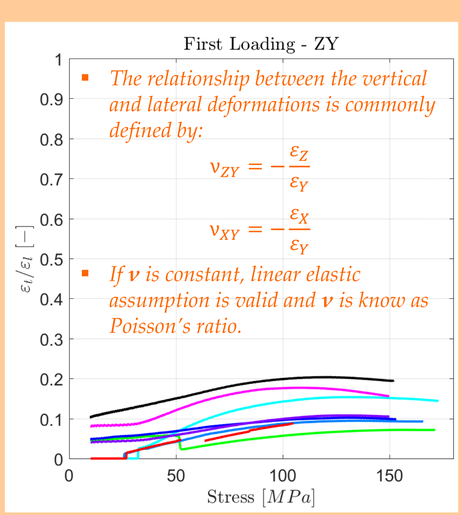


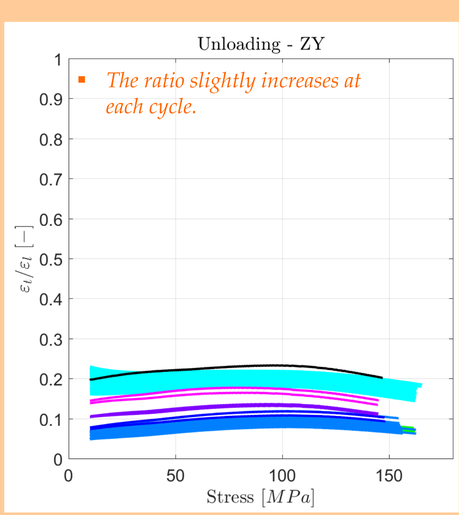


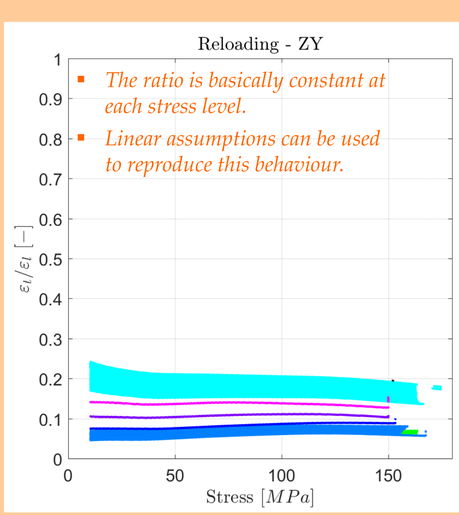


Transverse-Vertical strain relationship

The cable sliding phenomena is not negligible and instability occurs at high stress levels.

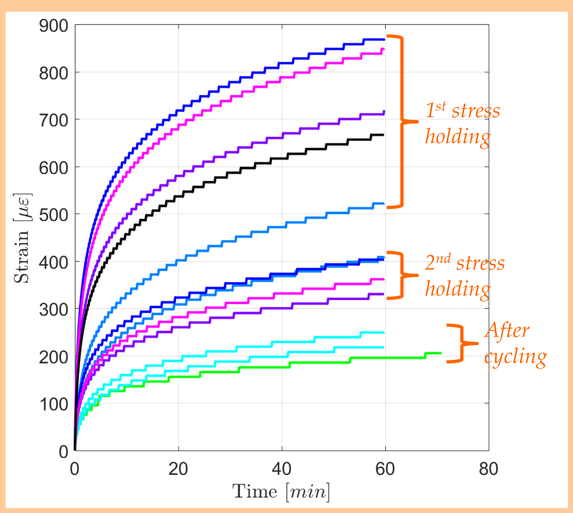


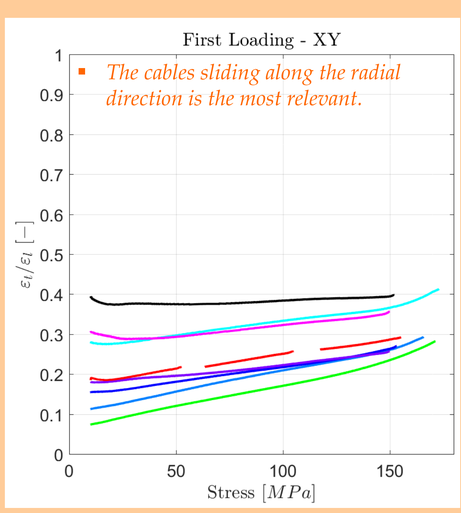


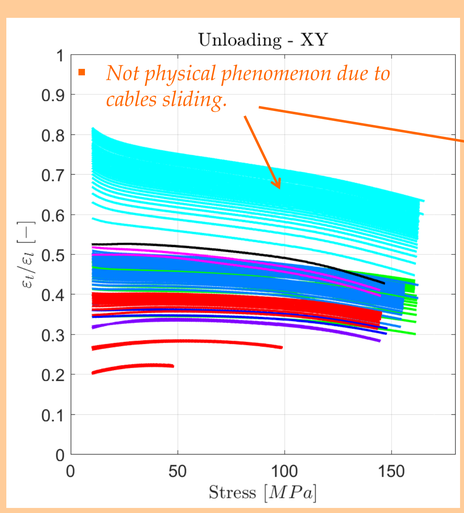


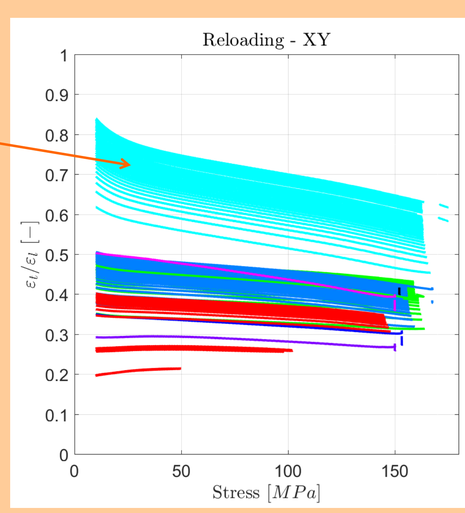
Creep

Relevant strain increasing at constant stress (~150 MPa).









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