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Wed-Af-Po.08-06: deBOX: effect of transverse stress on the training of Nb3Sn Rutherford cable

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Within the framework of the study of future high-energy particle colliders, high-field (15-16 T) Nb3Sn magnets are being developed. These magnets are usually impregnated using epoxy resin with glass fiber to provide electrical insulation and mechanical support to the conductor.
However, several phenomena are often observed: first, the high-stress conditions applied during pre-load, cool-down, and powering of magnets lead to cracks in the resin. Then, during powering, high Lorentz forces may break the epoxy bond at the interface between cables and metallic components, and provoke a detachment of the coils and conductor motions. Later, friction phenomena may appear. This irreversible behaviors are likely to release enough energy to trigger quenches of the conductor. Understanding and reducing the causes of these phenomena can help to significantly reduce the number of quenches and increase the maximum quench current during the training phase of magnets and therefore improve the performances of future high field magnets.
A campaign has been carried out at the University of Twente. The goal is to characterize the training behavior of Nb3Sn Rutherford cables in representative conditions, and to reproduce the detachment phenomena under low contact pressures. To do so, an existing experimental setup has been redesigned to allow an accurate measurement of the compressive force up to 10 MPa of compressive stress. This experiment was named the deBonding eXperiment (deBOX).
Four deBOX samples were tested, changing the interface between metallic sample holder and epoxy CTD-101K impregnation resin. Training at 10 MPa of compression were made for each sample. Then, the Nb3Sn Rutherford cables have been subjected to a gradual release of the transverse compressive force at cryogenic temperature with at constant current in the sample. It was observed for the first time that the release of the compression force triggered quenches of the cable. Finally, after the full training of the samples, another training at lower compression force was made. In this case, a detraining was observed, with difficulties to reach the critical current. The behavior of the different samples is analyzed and the effect of the various contact conditions are compared.

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