CICC Performance Tests for the Series-Connected Hybrid Magnet


Introduction
The series-connected hybrid (SCH) magnets for Helmholtz Centre Berlin and the NHMFL use superconducting Nb$_3$Sn cable-in-conduit conductor (CICC). The performance of the CICC is critical to magnet design, especially in the light of the unexpected performance degradation in ITER CICCs due to the transverse Lorentz forces. Therefore a comprehensive CICC test program is carried out. Three types of CICCs respectively for high field (HF), medium field (MF) and low field (LF) are tested. This report presents the results from MF and LF CICC tests performed at the NHMFL.

Experimental
The test sample as shown in Fig. 1 is fabricated and heat treated at the NHMFL. The test facility at cell 16 of the NHMFL provides 20 kA current, 14 T maximum field, and 4.5-10 K sample temperature control, and up to 250 kN tension.

Results and Discussion
The current sharing temperature ($T_{cs}$) measurements were carried out at transport current and magnetic field similar to SCH operating conditions. Performance degradation was not significant after a few hundreds load cycles. Fig. 1 and 2 show $T_{cs}$ as a function of applied tensile strain for MF and LF conductor respectively. The solid lines are fittings based on the strand $I_c$ vs. strain data with different assumed degradations. The self-field is corrected.

Conclusions
Full size SCH MF and LF CICC samples are tested successfully at the NHMFL. No significant degradation was observed after a few hundreds load cycles for each sample. The $T_{cs}$ vs. applied strain curves indicate that the thermal pre-compression on Nb$_3$Sn is 0.65% and 0.75% for MF and LF samples respectively. The $T_{cs}$ vs. applied strain curves are in reasonable agreement with the prediction from the scaling law.

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