Contribution ID: **976** Contribution code: **THU-OR5-301-03** Type: **Oral**

Design considerations for practical very high field cryogen-free superconducting magnets: 33 T and beyond

Thursday, November 18, 2021 7:00 PM (15 minutes)

In the quest for all-superconducting very high field magnets, the first successes where obtained with High Temperature Superconducting inserts wound using BiSrCaCuO conductors. It is the case for the 25T CSM (Cryogen-free Superconducting Magnet) installed in 2015 at the HFLSM (High Field Lab. for Superconducting Materials). It remains to date the only magnet above 24T that is fully open to users, with a convenient 52 mm room-temperature bore. Even though BSCCO conductors are still improving, REBaCuO Coated Conductors are more attractive for magnets exceeding 30T, due to their higher mechanical-strength/critical-current ratio. One of the difficulties for the practical implementation of REBCO inserts is the protection in case of thermal runaway due to local defects. This problem is rendered particularly difficult by the extreme energy densities that these inserts can reach.

Different approaches are being studied to solve this problem. We recently proposed to use a conductor made of two REBCO tapes co-wound, reducing significantly the likeliness and potential impact of local defects. In addition, we propose to use a sensitive voltage-based detection system to obtain advance warning of thermal runaways, allowing a safe protection discharge at moderate speed. This solution was chosen for the ongoing project to upgrade the 25T CSM to 30T by replacing the existing BSCCO insert, while keeping the outsert and the cryogen-free cooling system. The R&D effort conducted in the course of this project aims beyond 30T. We will present practical design solutions for a 33T conduction-cooled magnet, in terms of electromagnetic and mechanical margins, cooling, and protection. These solutions are validated by recent R&D coil results. We then discuss the options to improve the present conduction-cooled technology for 40T+ designs, in particular in terms of HTS/LTS combination and HTS winding mechanical reinforcement.

Author: Prof. BADEL, Arnaud (Tohoku University)

Co-authors: TAKAHASHI, Kohki (Tohoku University); OKADA, Tatsunori (Tohoku University); Prof. MIYAZAKI, Hiroshi (Kyushu University); Dr HANAI, Satoshi (Toshiba Energy System & Solutions Corporation); Dr IOKA, Shigeru (Toshiba Energy System & Solutions Corporation); AWAJI, Satoshi (Tohoku University)

Presenter: Prof. BADEL, Arnaud (Tohoku University)

Session Classification: THU-OR5-301 High Field Magnet