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## **The cryogenic system for a REBCO insert coil of a cryogen-free 25 T superconducting magnet**

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A cryogen-free 25 T superconducting magnet is under development by using a REBCO insert coil which generates 11 T in a 14 T background field of outer low temperature superconducting (LTS) coils. The ac-loss of the insert coil during a field ramping is approximately 10 W, which is difficult to be cooled at the operating temperature of the LTS coils, 4 K. However, a REBCO coil can operate at a temperature above 4 K. Thus the REBCO insert coil is cooled to about 10 K by two GM cryocoolers while the LTS coils are independently cooled by two GM/JT cryocoolers. Two GM cryocoolers cool a circulating helium gas through heat exchangers, and the gas is transported at a long distance to another heat exchanger located on the REBCO insert coil, in order to protect the cryocoolers from the leakage field of high magnetic fields. The temperature difference of the 2nd cold stage of the GM cryocoolers and the insert coil can be reduced with an increase of the gas flow rate. However, at the same time, the heat loss of the heat exchangers increases, and the temperature of the 2nd cold stage is raised. Therefore, the gas flow rate is optimized to minimize the operating temperature of the REBCO insert coil by using a flow controller and a bypass circuit connected to a buffer-tank.

**Primary author:** Mr IWAI, Sadanori (Toshiba Corporation)

**Co-authors:** Dr OGURO, Hidetoshi (High Field Laboratory for Superconducting Materials, Institute for Materials Research, Tohoku University); Dr MIYAZAKI, Hiroshi (Toshiba Corporation); Prof. WATANABE, Kazuo (High Field Laboratory for Superconducting Materials, Institute for Materials Research, Tohoku University); Dr TASAKI, Kenji (Toshiba Corporation); Mr TAKAHASHI, Masahiko (Toshiba Corporation); Dr AWAJI, Satoshi (High Field Laboratory for Superconducting Materials, Institute for Materials Research, Tohoku University); Mr HANAI, Satoshi (Toshiba Corporation); Mr IOKA, Shigeru (Toshiba Corporation); Dr TOSAKA, Taizo (Toshiba Corporation)

**Presenter:** Mr IWAI, Sadanori (Toshiba Corporation)

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