Present status of beam transport line from SRC to BigRIPS

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A beam transport line delivering the primary beam extracted from the SRC to the BigRIPS target has been operated since 2007, and it is called the "T-course" beam line. The T-course beam line consists of 3 bending magnets and 17 quadrupoles.[1] Two identical 50° bending magnets DMT2 and DMT3 in the T-course are "2-Tesla" room-temperature dipoles, with a maximum current of 650 A. They are designed as resistive-type magnets with saddle-shaped correction coils in addition to main coils. The correction coils are installed in the gap of the magnet, and were originally excited with the main coils in series. Each main coil has 72 turns and consists of 6 double pancakes, in which a 13.5×13.5 mm hollow conductor is wound 6 times in each layer. In contrast, each correction coil is a 12-turn double pancake in which a 14×10 mm rectangular hollow conductor is wound 6 times in each layer.[1]

The layer isolation of the lower correction coil of the DMT3 magnet was damaged in an October 2017 incident,[2] and the upper correction coil was found to be short-circuited in November 2019.[3] Furthermore, the lower main coil of the DMT3 was damaged in a test excitation performed in March 2020.[4] When we energized only the main coils with a total current of 800 A by adding an auxiliary power supply to the original one, unstable behaviors were observed at the excitation voltages of the second and fourth pancakes of the lower main coil.[4] Although we considered that the upper main coil was not critically damaged, we decided to replace the main coils with new ones.

We designed the new main coils for the DMT3 magnet such that they are excited with the original DMT3 power supply using neither correction coils nor additional auxiliary DC power supply in its circuit. We increased the number of turns of each main coil from 72 to 84. Furthermore, the shape of each main coil was designed to fit in the original DMT3 iron pole and yoke without any modifications. As shown in Fig. 1, the 12-layer new main coil in the upper-half has a pentagonal-shaped cross-section. We choose the same 13.5×13.5 mm hollow conductor as in the original DMT3 main coils. Each new coil consists of three types of double pancake coils in which a hollow conductor is wound 4, 6, and 8 times in each layer, respectively. Each new pentagonal-shaped coil is formed by combining one 4-turn, one 6-turn, and four 8-turn pancakes with epoxy resin. Because the lengths of cooling water channels are different, we introduce valves and flow meters in each cooling channel at the cooling water header. The new coils were fabricated and tested by HANMI TECHWIN in Korea under the supervision of Toshiba and shipped to RIKEN in July 2021. The new coils were successfully installed in the DMT3 magnet on site, as shown in Fig. 2. Associated plumbing and wiring works were finished in August 2021. After a series of test excitations, the DMT3 magnet with the new main coils was excited, and a ^{238}U beam was successfully transported from the SRC to the BigRIPS target in the beam time from November to December 2021.

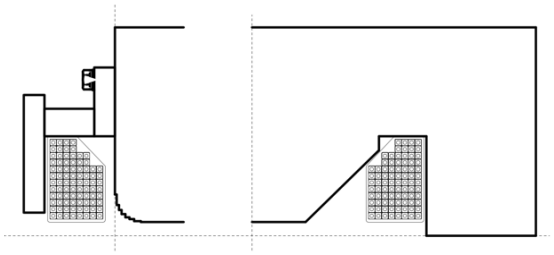

Fig. 1. Schematic of the upper-half cross section of DMT3 magnet with new main coil.

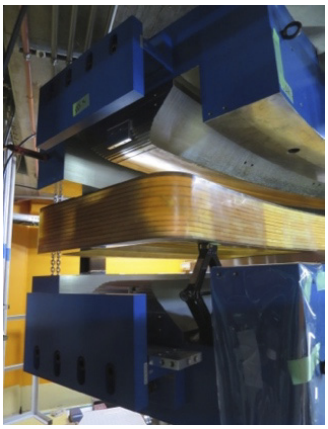

Fig. 2. Installation of new coil in DMT3 iron yokes.

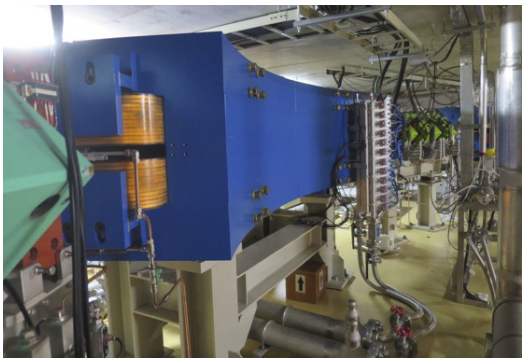

Fig. 3. DMT3 magnet with new coils in T-course beam line.

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References
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2) K. Kusaka *et al.*, RIKEN Accel. Prog. Rep. **51**, 173 (2018).
3) K. Kusaka *et al.*, RIKEN Accel. Prog. Rep. **53**, 104 (2019).
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