§24. Measurements of Self Magnetic Field on NbTi Cable-in-conduit Conductors near the Shake-hands Lap Joint

Obana, T., Takahata, K., Hamaguchi, S., Mito, T., Imagawa, S.,
Kizu, K., Murakami, H., Yoshida, K. (JAEA)

In superconducting fusion magnets consisting of cable-in-conduit (CIC) conductors, the joint is an important component which influences the performance of the magnet. To minimize electrical resistance and AC loss at the joint between the conductors, various joint types for the magnet have been developed. In the case of JT-60SA Equilibrium Field (EF) coils, a shake-hands lap joint was chosen as the joint type [1]. In this study, in order to understand the electromagnetic behavior of the CIC conductor, the joint sample was used to measure the self magnetic field near the CIC conductor's shake-hands lap joint.

Fig. 1 shows the joint sample, the configuration of which is a racket shape of 300 mm in diameter at the circular part. In the joint, a saddle spacer of oxygen-free copper is located between the conductors removing Ni plating. The superconducting test facility at NIFS was used as an experimental setup. The test facility can deal with testing of superconductors cooled by LHe, under an external magnetic field generated by a superconducting split coil. The joint sample was installed into the gap of the split coil so as to fit the center of the joint sample with that of the split coil, and immersed in LHe. As illustrated in Fig. 1, the joint sample is equipped with Hall sensors. Fig.2 shows the layout of the Hall sensors arranged around the CIC conductors near the joint. In this study, magnetic fields in the y direction were measured with the calibrated Hall sensors (HS-1, HS-2,･･･, HS-8), the models of which are LakeShore HGCT-3020 and F.W. BELL BHT-921.

Self magnetic field measurements of the joint sample were carried out with and without the external magnetic field generated by the split coil. The joint sample was energized up to 20 kA, held for 500 sec, and then degaussed. When the joint sample was subjected to the external magnetic field, the self magnetic fields were obtained by removing the external magnetic field from raw data. Fig. 3 shows the result of the self magnetic field without the external magnetic field. In Fig. 3, the symbols B1, B2, ・・・, B8 indicate the self magnetic fields at each hall sensor HS-1, HS-2, ・・・, HS-8. The currents in each of the CIC conductors surrounded by the Hall sensors flow in opposite directions, so that the y-directional self magnetic field at the Hall sensors HS-2, HS-4, HS-5, HS-7, which are located between CIC conductors, are larger than those at the Hall sensors HS-1, HS-3, HS-6, HS-7. Fig.4 shows the results of the self magnetic field in the joint which was subjected to the external magnetic field of 3 T. When the external magnetic field is 3 T, the distribution of the self magnetic field is different from that of the self magnetic field without the external magnetic field. Under the external magnetic field of 3 T, the y-directional self magnetic field is enhanced in the space between the CIC conductors and is weakened outside the space.

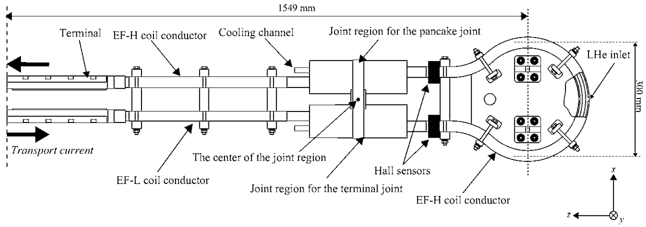

Fig. 1. Schematic view of the joint sample.

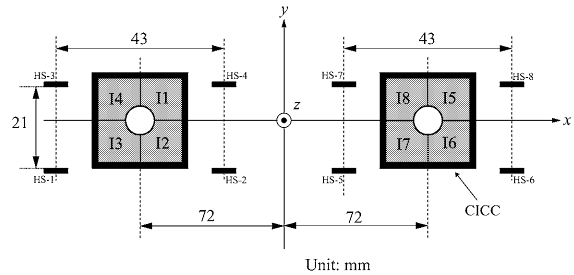

Fig. 2. Cross-section of the conductors near the joint.

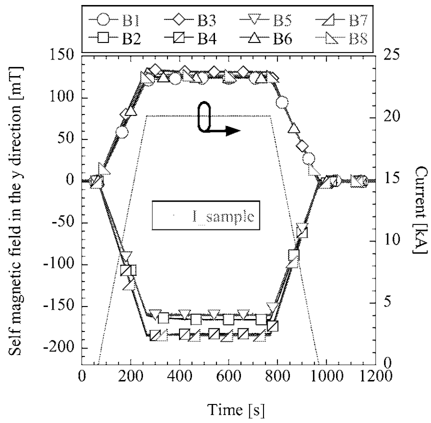

Fig. 3. Measurement results of the self magnetic field without the external magnetic field.

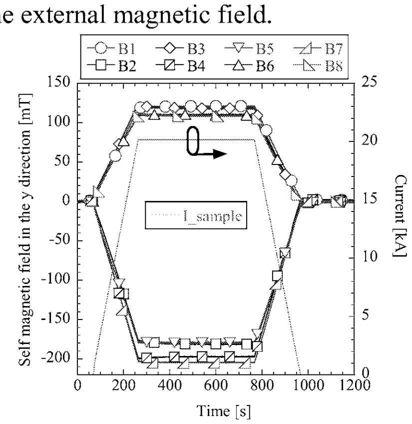

Fig. 4. Measurement results of the self magnetic field under the external magnetic field of 3T.

1) Yoshida, K.,: Physica C **470** (2010) 1727.