§1. Observation of Magnetic Field with Very-Long Time Constants in LHD Poloidal Coils

Takahata, K., Imagawa, S.
Hamajima, T. (Tohoku University)
Tsuda, M. (Yamaguchi University)

Previous studies have reported evidence of magnetic field trapping/shielding with very-long time constants in large-scale superconducting coils which consist of cable-in-conduit conductors.[1] The magnetic field trapping/shielding is probably caused by coupling current loops in the conductors. The coupling current will result in an increase in AC losses[1), 2)] and instability due to non-uniform current distribution. However, it is difficult to estimate the path and amount of the coupling current. In this study, Hall sensors were mounted in the LHD poloidal coils and the magnetic field with long time constants was observed.

Fig. 1 shows the locations of the Hall sensors. The sensors (model BHT921, Bell) are located on the equatorial plane and 90 mm away from the inside surface of the Inner Shaping (IS) coils. Two sensors were mounted for each coil (IS-U and IS-L) at toroidal angles of 23 and 203 degrees clockwise from the north. The vertical component of the field was then measured. The observations were carried out during the 7th plasma experimental campaign. In the device engineering experiments, extended operations in which only IS and OV (Outer Vertical) coils were energized were performed.

Fig. 2 shows typical observations of residual magnetic field. The figures indicate the time variation of the residual magnetic field just after discharging the IS coils from 14 kA. Although the coils were fully separated from power supplies, the decay of magnetic field was observed. Fitting curves with an exponential function are also plotted in Fig. 2. The results show that the decay has a time constant of about 2000 s. This provides evidence of magnetic field trapping with very-long time constants more than half an hour. On the other hand, the magnetic field shielding with long time constants was also confirmed just after energizing the coil. Then, these observations suggest the occurrence of large coupling current loops in the conductors.

Four additional Hall sensors were mounted in the Outer Vertical (OV) coils after the 7th experimental campaign in order to investigate the effect of the coil size. More accurate observations will be carried out in the 8th campaign.

Reference
1) Hamajima, T. at al.:IEEE Trans. on Appl. Supercond. 10 (2000) 812.
2) Takahata, K. et al.: Fusion Eng. Des. 65 (2003) 39.

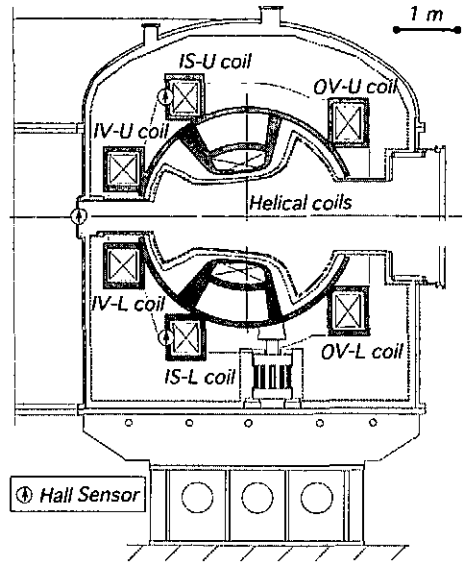
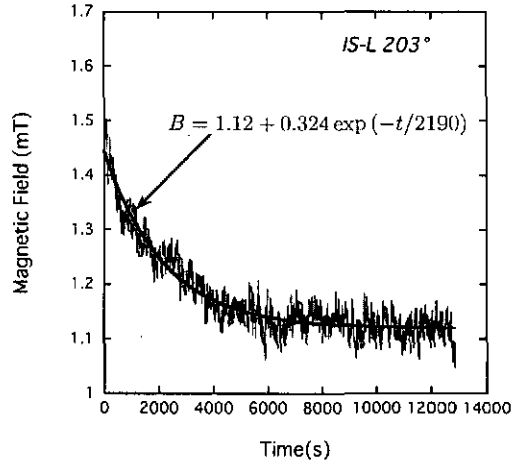


Fig. 1. Cross-sectional drawing of LHD and locations of Hall sensors.

(a)



(b)

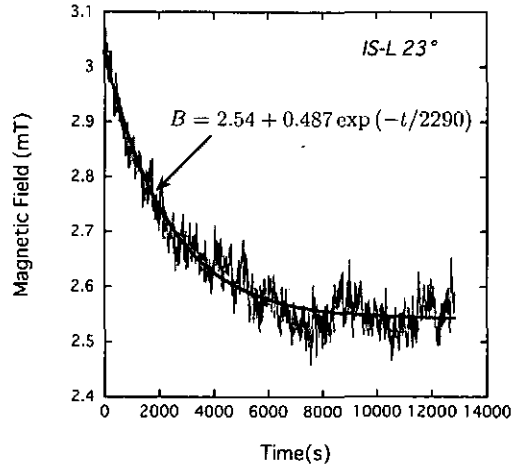


Fig. 2. Observed residual magnetic field after discharging the IS coils from 14 kA. The sensors are located at two toroidal angles: (a) 23 and (b) 203 degrees.