§2. Conductor Motions in the Helical Coils of the Large Helical Device

Imagawa, S., Yanagi, N., Satow, T.

In order to detect the coil quench, the imbalance voltage between each pair of the coil blocks is monitored. 1) It is usually the voltage of *H1* minus *H2*. Typical imbalance voltages in charging and discharging processes are shown in Fig. 1. The spike voltages appear frequently from about 8 kA in a charging process, and these disappear while holding the current or discharging to about 9 kA. These should be due to the conductor motions which have hysteresis. Since the conductor should move to enlarge the coil inductance, positive and negative voltages are due to the motions in *H1* and *H2* coils, respectively. The amplitude of the spike voltage should be proportional to the current and not the velocity but the amount of the motion, because the signal was cut by a low-pass filter of 10 Hz. Besides, the imbalance voltages with a long time constant of 20 ms appear when changing the ramp rate of the current. These are considered to be induced by the secondary circuits such as the helical coil cases and the supporting structures.

The spike voltages are coincidentally observed in the three blocks, and the clear spike voltages of *I* block are always higher than the other blocks. Therefore, apparent conductor motions are induced in only the *I* block. From the comparison of charging and discharging processes, the spike voltages in discharging are obviously lower and more frequent than those in charging. Consequently, the conductors move back smoothly in a discharging process. It is not clear why and where large motions are induced in only the *I* block in charging, but it should be related to the structure of the coils. Since total displacements of the *M* and *O* blocks by electromagnetic forces are less than the *I* block, these blocks might be within an elastic region, or the motions might be smooth by being pressed by the *I* block.

Before plasma experiments, the coils are charged once up to the slightly higher current to prevent the conductor motions against the increase of the coil current due to the plasma current. Disappear of co-directional plasma current of 100 kA increases the current of only the I block by 100 A around. Then, the current of I block is usually charged once up to 200 A higher than the current for the plasma experiment. In the fourth campaign, we compared the conductor motions by charging all three block by 100 A to that by charging only I block, as shown in Fig. 2. It shows 100 A of the three blocks is equivalent to about 200 A of only the I block for the conductor motions. After this experiment, the highest current for plasma experiments can be increased by 100 A, which corresponds 0.025 T.

When the major radius or shape of plasma, currents of only the poloidal coils are changed. Figure 3 shows the imbalance voltage of the helical coils during the shift of the major radius. In spite of current margin of 100 A, the conductor motions started in the half way of the shift. The reason is considered to be the change of the distribution of electromagnetic forces on the helical coils. It is a future work to solve the relation between them.

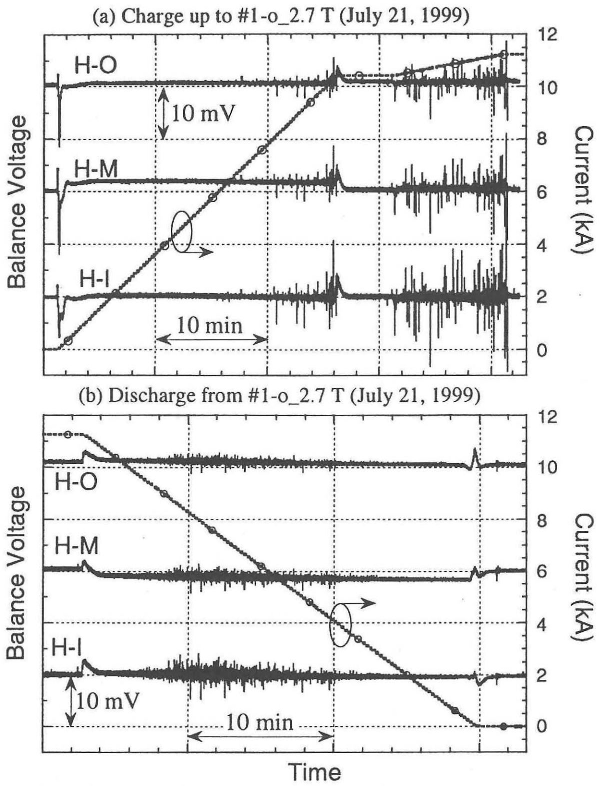

Fig. 1. Balance voltage of the helical coils during a charge and a discharge.

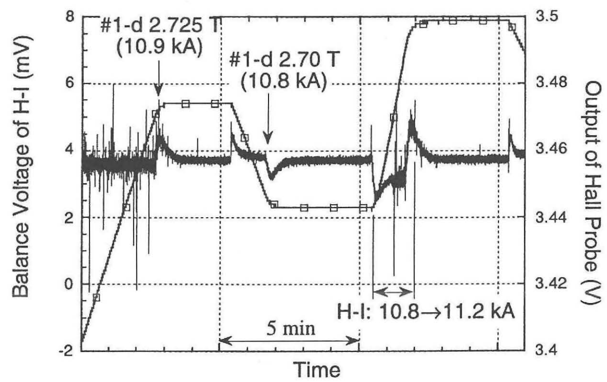

Fig. 2. Balance voltage during charging up only *I* block.

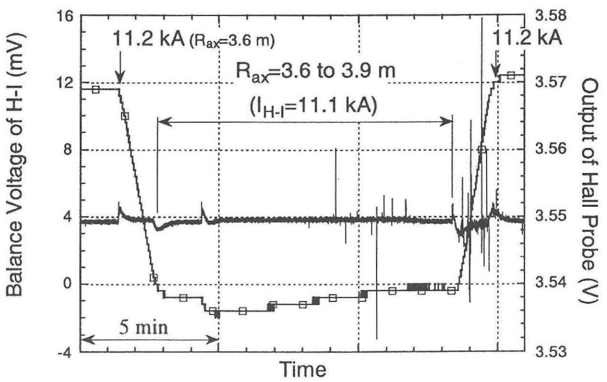

Fig. 3. Balance voltage during R_{ax} shift from 3.6 to 3.9m.

Reference

1) S. Imagawa, et al., IEEE Trans. Appl. Supercond., Vol. 11 (2001) 1889-1892.