§7. Current Control of Superconducting Coils for LHD – Interaction between Control System and Plasma Current –

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Outline

In the 6th campaign of LHD, two coil current control system using H∞ theory are designed and tested. One system controls the coil currents in constant while plasma operation and the other system controls interconnecting magnetic flux constant. These systems work as well as designed.

In the LHD operation, we made some plasma experiments in which the plasma current is driven by NBI injection using these control system and traditional P control. In the results, some difference in coil terminal voltage, coil current deviation, plasma current waveforms and induced voltage at plasma center are observed. In this campaign, we but new control system that keeps interconnecting flux in constant.

Current control system

The control system designed in last year, observed plasma current by Rogovsky-coil is used in control system but drifts of coil currents caused by offset control system. It made difficulty for a long pulse plasma operation with this control system. To resolve this problem, a new control scheme didn't use a plasma current signal.

The simplest way to realize it is stopping the current feedback while plasma operation and uses a characteristic that the superconducting coils keep the interconnecting flux constant. In this scheme, the voltage drops in the current feeder and offset voltage of power supplies may cause some current drift. In the helical coils, the current drift is estimated with recent experiment result. The terminal offset voltage is around 0.2V and leakage inductance is around 0.1 H , so the current drift is estimated as 2A/s.

Preliminary experiments

Before the plasma experiment, we made preliminary experiments to confirm the coil current drift. We blocked the feedback control in 90 seconds at B=0.2T and B=0.5T. Figure 1 and 2 shows the current waveforms of helical and poloidal coils. For the poloidal coils that have larger leakage inductances, the drift currents are less than 20 A and they are enough small for plasma operation. For the HM coil that had largest drift, the drift is 50A / 90A and it can be permitted. With these preliminary experiments, it is confirmed that a plasma operation within 30 seconds is possible without coil current feedback control and the coil current drift can be compressed in one tenth with system tuning.

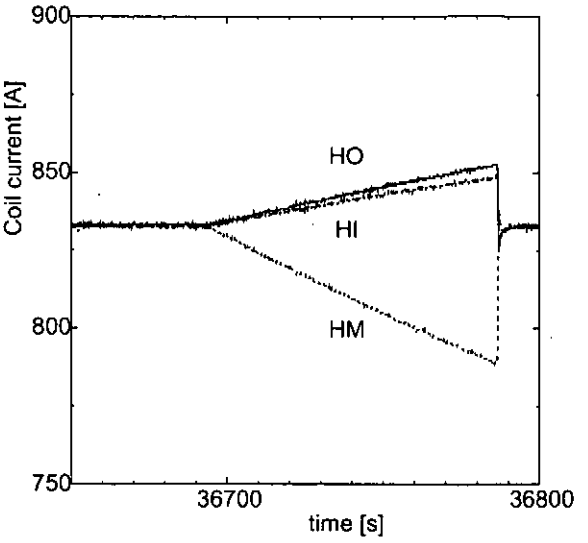

Figure 1: Coil current drift for helical coils

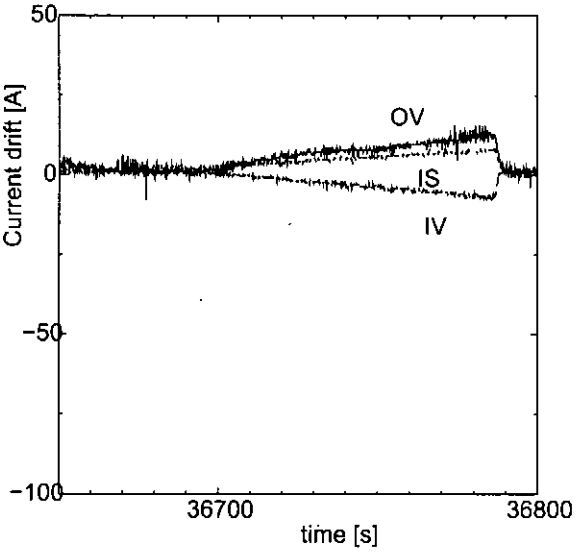

Figure 2: Coil current drift for poloidal coils

Plasma Experiments

The experiments with plasma operations were planed but it was not executed because of the limitation of LHD machine time.