§ 64. Real-Time Plasma Current Control Experiments

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The real-time plasma current control (RCC) system that consisted of a personal computer (DOS/V machine), VME controller and Reflective Memories was constructed and applied to the plasma current control experiments in the 4th campaign of LHD. 1,2) This system worked well in the control cycle of 20 msec. This system is linked to the LHD power-supply (PS) control computer. The measured plasma current I_p is inputted to the VME controller through an analog digital converter (A/DC). The Coil currents for the plasma current control are calculated using the standard proportional-integral control algorithm in the VME controller and sent to the RFM with 20 msec cycle. In the 5th experimental campaign, this RCC system was used for the real-time feedback control of the plasma current. System worked well but the thermal drift and offset in a long time integrator were remained as a serious problems. In the 6th experimental campaign, we compared the multi-analog integrator system which was developed in NIFS and the digital integrator using Voltage-Frequency (VF) converter which was developed in JAERI.

The real-time plasma current control experiments using the RCC system have been carried out at 1.5T in the 6th cycle experimental campaign. Plasma was produced and sustained by the No. 3 Neutral Beam Injector (NBI#3) for 10 seconds and switched to the NBI#2. The NBI#2 sustained the plasma for more 10 seconds. Plasma current induced by the NBI#3 flowed counter direction about 3 kA and plasma current induced by the NBI#2 flowed co-direction about 50 kA. The multi-analog integrator system has been used in these experiments, because this integrator system has very wide dynamic range and has drift linearity. Output signal from Rogowski coil was divided and sent to the multi-analog integrator system and the digital integrator system using VF converter. Figure 1 shows the time evolutions of a line electron density n_{el}, monitor signals of NBIs, a plasma current I_p measured with the multi-analog integrator system, target plasma current I_p(set), a coil current of the IV coil I_{IV} and out put signal from VF converter. Figure 1 a) shows data without plasma current control and Fig. 1 b) shows data with plasma current control. Control of a plasma current was started at T = 3 sec till a discharge terminated. During the NBI#3 injection, plasma current was kept almost zero from 5 sec. to 10 sec. After switched to the NBI#2, this current control system could not cancel a large beam driven plasma current. The IV coil current was increasing with the maximum swing rate (40A/sec).

The output signal from VF converter shows good characteristic with a small offset voltage and a thermal drift. On the other hand the multi-analog integrator system has a problem on the time response. Large miss integration occurred at the end of discharges when plasma current decreased rapidly.

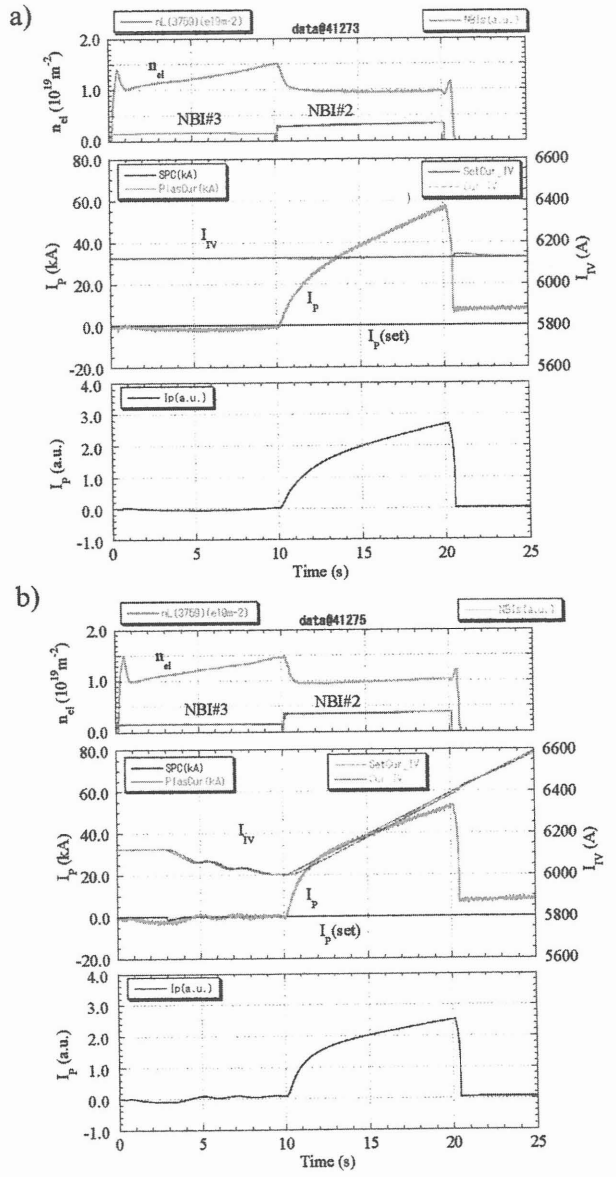

Fig. 1. Time evolutions of plasma parameters in real-time plasma current control shot.
(a) Data without plasma current control (reference shot),
(b) data with plasma current control.

References

1) Takami, S., Nishimura, K., Chikaraishi, H. et. al., J. Plasma Fusion Res. SERIES, Vol. 3 (2000) 513.
2) Nishimura, K., Takami, S., Chikaraishi, H. et. al., to be published in J. Plasma Fusion Res. SERIES, Vol. 5 (2002).