§11. Effect of Magnetic Islands on Plasma Performance

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In helical systems, the existence of well-nested vacuum magnetic surfaces plays an essential role on plasma performance. However, the flux mapping, carried out at B_t = 2.75 T and R_{ax} = 3.6 m in the second campaign, showed that there were an m/n = 1/1 island with a maximum width of about 8 cm and 2/1 islands with a maximum width of about 5 cm. The cause of such large islands is not clear, but there are a variety of possibilities, for example, the existence of ferromagnetic material located around the LHD, the large misalignment of the coils and so on. An error field due to the 2-mm misalignment of the coils, which was the maximum tolerance permitted in the coil specification, forms the m/n = 1/1 island with a maximum width of about 4 cm. However, the size of the islands could be minimized by a local island divertor (LID) coil system. Both 1/1 and 2/1 islands were almost simultaneously eliminated by the LID coil system, and the more accurate magnetic surfaces were realized, than those formed with the 2-mm misalignment of the coils.

In the third campaign, the plasma performance was examined in the magnetic configuration with the minimized islands. A comparison between NBI plasma discharges with and without the correction by the LID coil system was performed with the NBI power of 3 MW at B_t = 2.75 T and R_{ax} = 3.6 m. Figure 1 shows the temporal evolution of plasma parameters. Solid and broken lines represent the parameters with and without the correction by the LID coil system, respectively. No large difference between these two discharges is observed, but plasma parameters are found to be a little different from each other especially at t ~ 0.6 – 1.0 s. The electron temperature T_e profile, measured along a major radius by a Thomson scattering diagnostic and averaged for the period of 0.7 – 0.9 s, shows clearly that the magnetic configuration without the islands is favorable for plasma confinement, as shown in Fig. 2. In the uncorrected magnetic configuration, the islands are recognized as the flat T_e profiles in the island positions of $\iota/2\pi$ = 1, while such a flat T_e profile is not observed in the corrected magnetic configuration. As approaching the plasma center, T_e in the latter becomes higher than T_e in the former from the outer edge of the island especially located in the outboard side, and reaches a higher maximum value at the plasma center than in the former. Taking account of this favorable result, we will use the magnetic configuration corrected by the LID coil system in the fourth campaign to obtain better plasma parameters.

The experiment was also performed, where the width of the m/n = 1/1 island was expanded. In this case, the stored energy was found to decrease with the island width, and this was attributed to the change of the plasma volume that became small with an increase in the island volume.

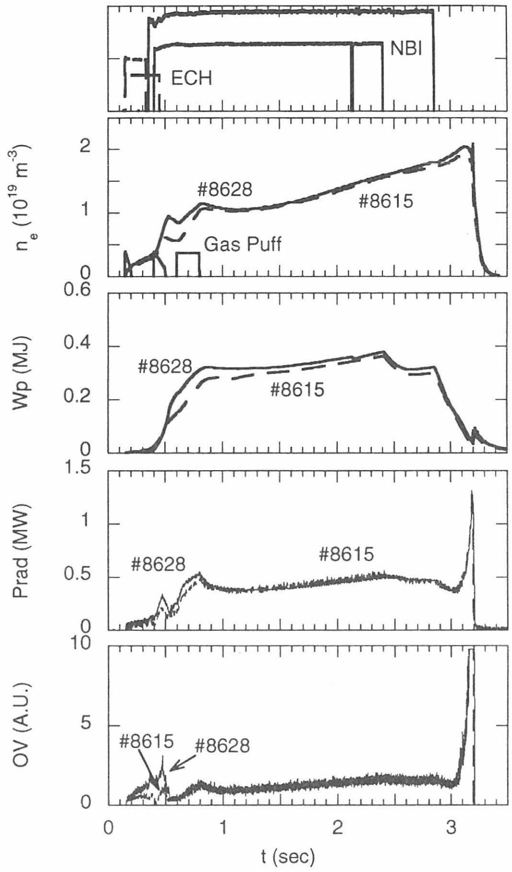

Fig. 1. Time evolution of plasma parameters obtained the magnetic configuration with the minimized islands.

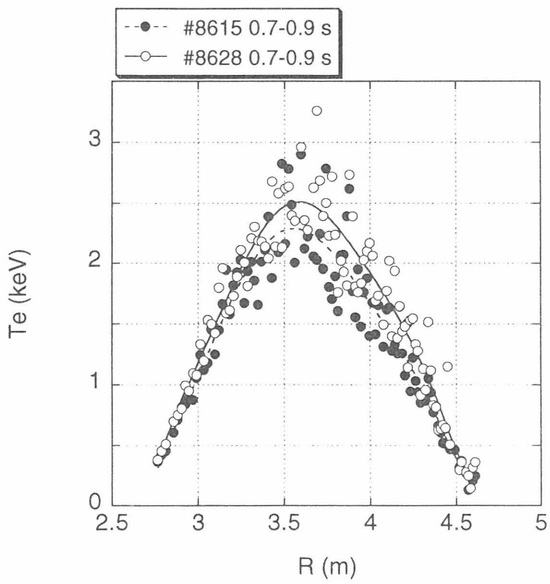

Fig. 2. Radial Te profiles obtained with and without the correction by the LID coil system.