§12. Effect of Magnetic Islands on Plasma Performance

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Recently, the plasma performance has been examined by controlling the widths of intrinsic magnetic islands, which seem to be generated by an error field. A remarkable improvement was observed in plasma parameters in the high-density plasmas produced by pellet injection. When the intrinsic islands were minimized, the increment of W_p amounted to about 25% and the maximum W_p of 1.03 MJ was achieved in the last experimental campaign.

Figure 1 shows temporal evolutions of typical LHD discharges. Five pellets were injected from 0.5 s to 0.7 s, which increased $\bar{n}_e$ beyond the 1×10^{20} m^{-3} in this short time. While W_p behaves in an adiabatic condition at the pellet injection, it rises slowly due to confinement improvement by a density increase. A large difference was observed between $\bar{n}_e$ in the two discharges in Fig. 1, and this causes the difference in W_p, as predicted by the scaling law. The relation of $\bar{n}_e$ versus W_p shows that the limitation of W_p is not caused by the deterioration of confinement, but by the density limit arising from the existence of the intrinsic islands. The confinement enhancement factor from the ISS95 is about 1.4 for these discharges. The effect of minimization of the intrinsic islands should be recognized as the extension of preferable confinement in the higher density regime. In the lowest figure of Fig. 1, the radiation power, measured by a bolometer, shows little difference between the two discharges before $t \sim 1.2$ sec. At this time, the five pellets are already injected and W_p's begin to be saturated. The emissivity profile evolutions also indicate that the intense-radiation areas are located observed at $\rho \sim \pm 1$ in both cases, and the radial radiation profiles are almost the same in this period. Thus, the reason for the density increase is not attributed to impurity behavior.

A large difference was observed between the H_α radiation in the discharges with and without the minimization of the islands. After the pellet injection, the H_α radiation in the discharge with the minimized islands was found to be smaller than that with the intrinsic islands, indicating that the former particle flux towards the wall is smaller than the latter particle flux. This was also demonstrated by the divertor fluxes, which were measured with Langmuir probes located on the divertor plates. The radial n_e profiles, measured before and after the first and second pellet injections and those during the second pellet injections, show that n_e in the configuration with the intrinsic islands is higher in the edge region of 4.2 m $< R <$ 4.5 m than that with the minimized islands. Especially, the high n_e value near the last closed flux surface of $R \sim 4.5$ m coincides well with the high particle flux towards the wall when the intrinsic islands exist. In this case, the ablation of the second pellet occurs mainly in the edge region, and an increase in n_e near the plasma center becomes small. The high density in the edge region is considered to promote the ablation of the pellet, although the dependence of the ablation on n_e is weaker than that on T_e. In the case of the magnetic configuration with the minimized islands, the ablation of the second pellet occurs mainly near the plasma center, and a large increase in n_e is observed there. This is proved by the fact that n_e around R = 4 m during the ablation with the minimized islands is much higher than that with the intrinsic islands, indicating that the size of the pellet passing there is larger in the former case than that in the latter case. It should be noted that n_e around the m/n = 1/1 island is high, although the reason is not clear at this stage. The reason why the ablation is quickened in the presence of the islands is not clear either.

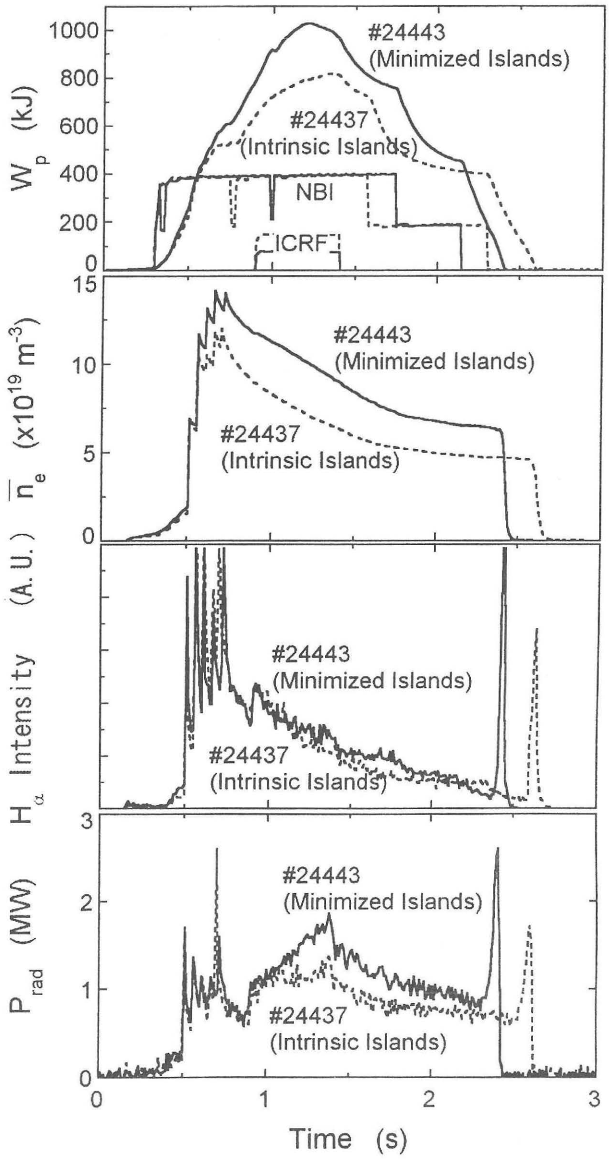

Fig. 1. Temporal behaviors of W_p, n_e, H_α intensity and radiation power in the configurations with and without correction by a perturbation coil system.