§ 53. Study on Production and Control of High-Performance Steady-State Plasmas

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Experimental study on production and control of high-performance steady-state plasmas in LHD has been performed for comparison with the results on the JT-60U tokamak. The comparison may help the deeper understanding of the common physics mechanism for high-performance steady-state plasmas in toroidal systems. The study was done in a research theme "comparison between tokamak and helical", which was established in 2002 to perform experiments comparing physics in the tokamak plasma and that in the helical plasma and to contribute one of the objectives of LHD project, "comprehensive understanding of toroidal plasmas." Fifteen experimental proposals were submitted from JAERI researchers and 8 proposals were performed while 7 proposals were canceled due to the change of LHD operation schedule. The proposals from JEARI researchers were basically related to the research that they had done or were doing in the JT-60U tokamak and were intended to compare the results on LHD and JT-60U. The proposed research was done in close collaboration with NIFS researchers, "counter persons," through the whole process including planning, experiments and analysis. As for the circumstances for collaborative research, software for data display and analysis has been improved significantly for easy use including the connection from the outside of NIFS. The video conference system was also useful for discussion on the plan of the experiments and the analysis of the results. Results of individual proposals are shown below.

In "internal transport barrier (ITB) formation study", electron ITBs were compared for the co-injected NB and the counter-injected NB expecting the difference in rotational transform and magnetic shear due to the beam driven current. It was found that the electron temperature gradient along the major radius, measured with YAG Thomson scattering system, was larger for the counter-injected NB, where smaller rotational transform and deeper magnetic well were expected than the co-injected NB.

In "perturbation to ITB", impurity pellets (TESPELs) were injected into electron ITB plasmas. The propagation speed of cold pulse by pellets became slower when it entered the ITB region. Increase of central electron temperature with the pellet injection was found, which had been observed in JT-60U reversed shear plasmas, but the central electron temperature decreased again when the cold pulse reached the center.

In "relation of rotational transform and confinement", density profiles were compared for the co-injected NB and the counter-injected NB with enhanced beam driven current, I_p/B~95kA/T, by neon puff. Broader density profiles were observed in the counter-injected NB.

In "MHD oscillations in high stored energy plasmas", electron temperature oscillations with frequency of ~ 1 kHz were observed around the $\iota/2\pi = 0.5$ radius, which was consistent with the magnetic perturbation measurements where oscillations with poloidal and toroidal mode numbers of 2 and 1 were observed. The phase of electron temperature oscillations were inverted at the $\iota/2\pi = 0.5$ radius, suggesting the existence of magnetic islands, as shown in JT-60U high-β_p H-mode plasmas[1]. The region of this kind of oscillations is closely related to the plasma current, mainly driven by neutral beams, than the plasma stored energy or plasma beta as shown in Fig. 1. This suggests that these oscillations are related to the change of rotational transform by beam-driven currents.

In "impurity transport study", argon was puffed into helium discharges and the evolution of soft X-ray emission was measured to study the transport of argon ions. In "SOL plasma at high density", oscillations with ~100 kHz frequency were observed in radiation power, recycling flux (H_α) and electron density near the density limit, which was similar to those observed near MARFE in the JT-60U tokamak. In "boronization effect", the change in recycling was compared in similar discharges,

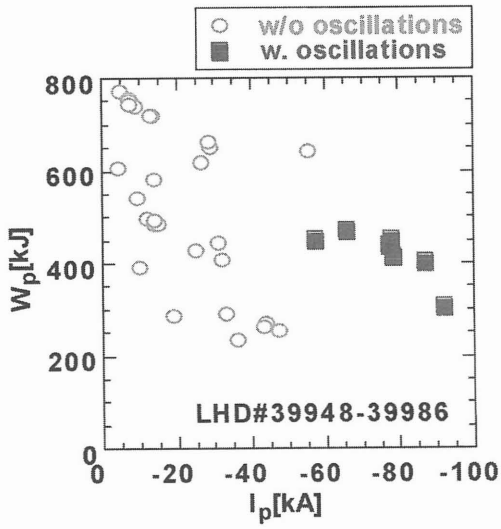

Fig. 1. Region of appearance of electron temperature oscillations in counter-injected NB discharges.

without gas puffing, before and after the boronization.

References

1) Isayama, A., et al. : Plasma Phys. Control. Fusion 41 (1999) 35.