## § 26. LID Experiments

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One of the key research issues in the Large Helical Device (LHD) program is to enhance helical plasma performance through the edge plasma control, carried out with a local island divertor (LID) that uses an $m/n$=1/1 island. A head system of the LID was installed on LHD, and initial results of LID experiments were obtained in the sixth experimental campaign in 2002 - 2003, suggesting its potential of particle control and subsequent confinement improvement. The head system is a main part of the LID, and consists of a divertor head, its driving system, a pumping duct, and an LID chamber. The length of the head system is so long that the driving system requires the long LID chamber to take out the head from the LHD vacuum vessel and to seal up it with a gate valve whose inner diameter is 1,400 mm. These driving system and gate valve are necessary for maintaining the head system and performing experiments without the LID.

In the LID configuration, the outward heat and particle fluxes crossing the island separatrix are expected to flow along the field lines to the backside of the island, where divertor plates are placed on the divertor head to receive heat and particle loads. The particles recycled on the divertor plates are pumped out by a pumping system. The geometrical shapes of the divertor head and pumping duct were designed to form a closed divertor configuration with high pumping efficiency of over 30%. This highly efficient pumping, combined with core fueling by pellet injection, is the key to realizing the high temperature divertor operation, which leads to the improved plasma confinement.

In the sixth experimental campaign, the divertor head was located a little different from the expected position, in addition to the fact that the core plasma went much deeper into the island than as expected, so that the core plasma was in contact with a part of the divertor head, as shown in Fig. 1. Thus, the radiation collapse occurred frequently at the end of discharges, due to outgas from the divertor head. The plasma parameters were, however, found to change in the LID discharges before the collapse. The particle flux to the helical divertor decreased, and almost no particle flux was observed, while the flux to the divertor head increased remarkably. The neutral particle pressure, measured with a fast-ion gauge on the wall, was lower than that without the LID, and was found to be independent of the amount of gas puffing, i.e., plasma density. These results suggest that the particle flow is indeed guided to the backside of the divertor head by the island magnetic field structure, and that the particle recycle from the wall is reduced.

The electron temperature $T_e$ was found to be almost the same in the plasma center as that in the discharges without the LID, when the NBI power was 4 - 6 MW, and to rise from the inner island separatrix, as shown in Fig. 2. The electron density was also peaked at the plasma center, and bounded by the same separatrix, as expected. This density profile is different from the usual one that is flat inside the last closed flux surface and decreases in the area outside it.

The above experimental results demonstrated fundamental LID functions, and also suggest the feasibility of improved plasma confinement after the optimization of position and shape of the divertor head.

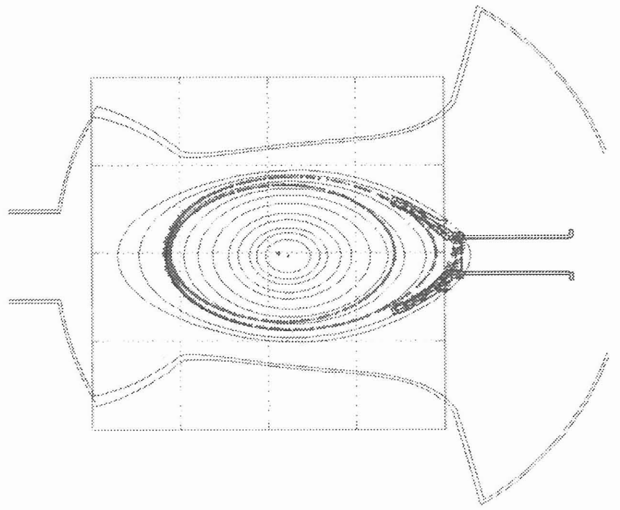

Fig. 1. The head was located just outside the $m/n$ = 1/1 island in the 6th experimental campaign.

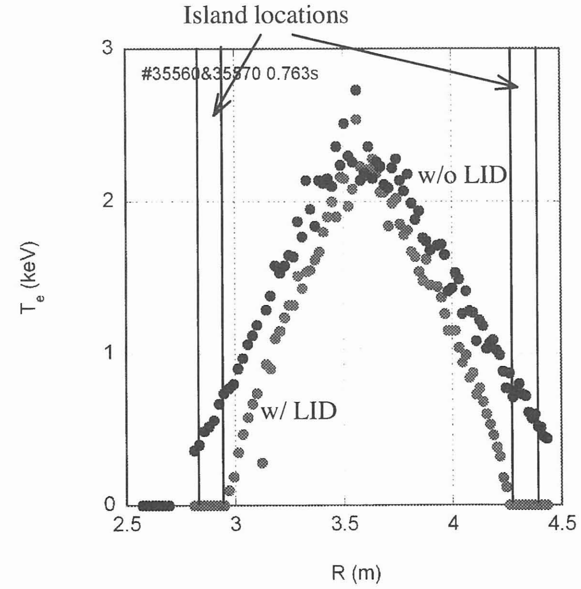


Fig. 2. Radial electron-temparature profiles obtained with and without the LID, when the NBI power was 4 - 6 MW.