§42. Initial Results of Edge Plasma Control Experiment Using Superimposed Magnetic Island

Morisaki, T.

One of the major research goal for LHD is to improve the core energy confinement through the edge plasma control. Three divertor configurations, i.e., helical divertor (HD), local island divertor (LID) and SHC boundary configuration, have been proposed to attain the objective.

The SHC experiment which is an option of LID configuration was performed in LHD from the 1st experimental campaign in addition to HD experiments. For SHC the m/n=1/1 island externally applied by LID perturbation coils was utilized, although no limiter head was inserted in the island.

First of all, calculations of magnetic configurations and profile measurements were performed. Figure 1 shows the electron temperature T_e profile measured by Thomson scattering method together with the puncture plot of magnetic field lines and "local" rotational transform $\iota/2\pi$ profile at the poloidal cross section where the diagnostic system is located. The T_e profile presents flat near the rational surface of $\iota/2\pi = 1$, showing the existence of m/n = 1/1 island. At the position where $\iota/2\pi = 0.5$, it seems that there exists another deformation in T_e profile. It may be caused by the m/n = 2/1 island which is generated by the toroidal coupling of 1/1 perturbation. In the T_e profile, there is another interesting feature. Just outside of the inner separatrix of the 1/1 island where R~4.4m, the gradient of the T_e profile is very steep. It is too early to explain the experimental result at this stage, although, there may be possibility to be explained as follows. Flattening of the T_e profile inside the island and steepening outside the island lead to the formation of strong shear of the electric field which is supposed to suppress fluctuations and improve the confinement.

With the increase of the perturbation field, the width of 1/1 island becomes large as expected in theory. The T_e profile measurements in various magnetic axis positions were also performed and consistency between experiment and calculation was confirmed.

To study the effect of the 1/1 island on the particle transport, the divertor flux Γ_{div} was measured by Langmuir probes installed on divertor tiles, by which Γ_{div}'s at two different striking points of divertor legs can be compared at the same time. It was found that the total flux to divertor tiles is not so changed in the case with and without the 1/1 island, although the flux to each striking point present asymmetric when the 1/1 island is externally superimposed, as shown in Fig.2. Toroidal asymmetry in H_α emission intensity profile was also observed in discharges with 1/1 island. There is a tendency that the H_α emission profile has a peak at the toroidal position where the o-point of the 1/1 island locates at the outboard side of the torus. Effect of 1/1 island on global plasma parameters was studied. Fig.3 shows the dependence of roughly estimated particle and energy confinement time on the strength of the perturbation field, i.e., island width. It is found that the energy confinement time decreases as the island width becomes large, although the particle confinement time does not change so much.

Further experiments especially with more heating power are needed to study the effect of the island on plasma properties in detail.

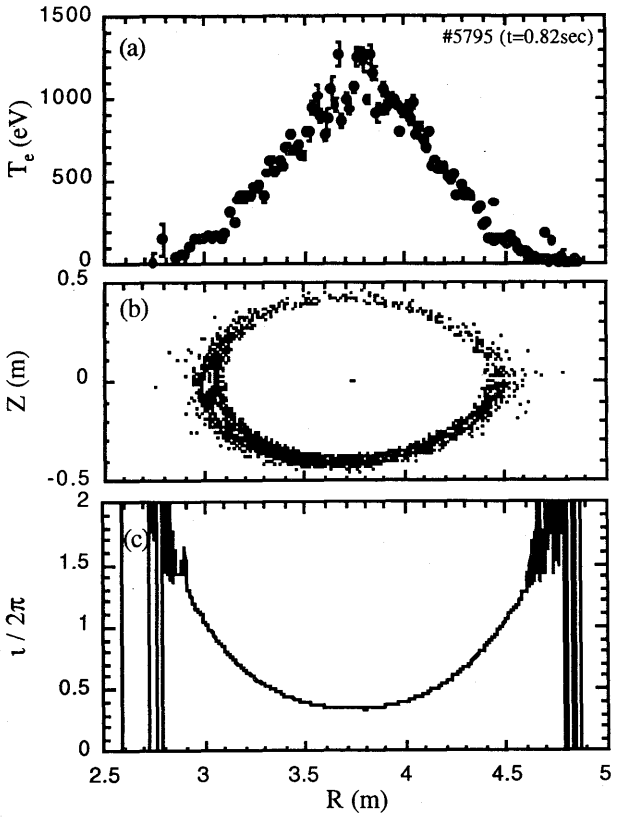

Fig.1. Radial profiles of (a) electorn tempetature and (c) rotational transform. Island structure is also depicted in (b) as a pucture plot of magnetic field lines.

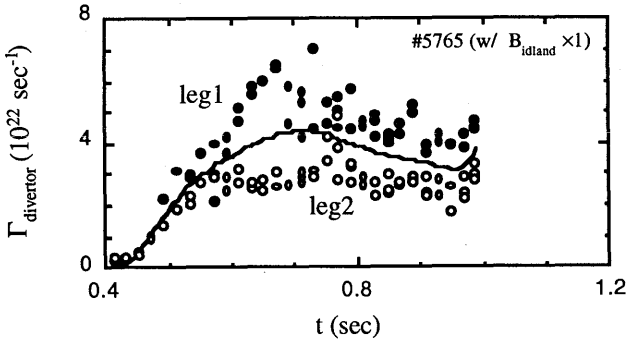

Fig.2. Particle flux to divertor tiles with 1/1 island.

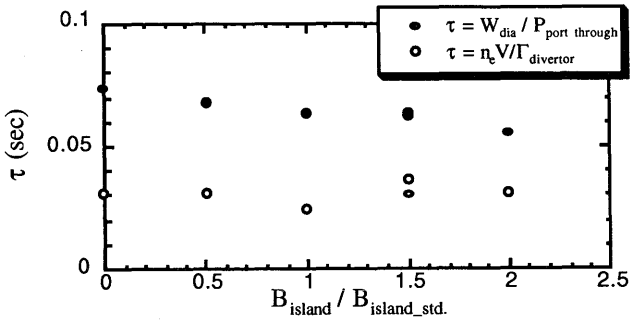

Fig.3. Rough estimates of confinement time.