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Particle Transport Characteristics around Expanding Static Magnetic Island in the Large Helical Device

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In the magnetic island, the particle transport characteristic is supposed to be different from the outside bulk plasma. The study of electron heat transport has been carried out and the characteristic in the island is clear in Large Helical Device (LHD) [1]. Also, the particle transport study of the bulk plasma has been done [2]. However, the particle transport in the island is still open question, because it needs high spatial and temporal resolution diagnostics. Recently we install the ultrashort pulsed radar reflectometer for density profile measurement [3]. In the experiment, an m/n=1/1 island is superimposed by the local island divertor magnetic field coil system [4] and the particle source is modulated. Two types of modulation experiment are carried out. One is a gas puffing modulation. In this case, the bulk density is sinusoidal modulated and the density profile is gradually changed. In the island fine structure can be measured. Comparison with some model simulations is carried out and it is used for the estimation of diffusion coefficient and convection velocity. Also, another modulation

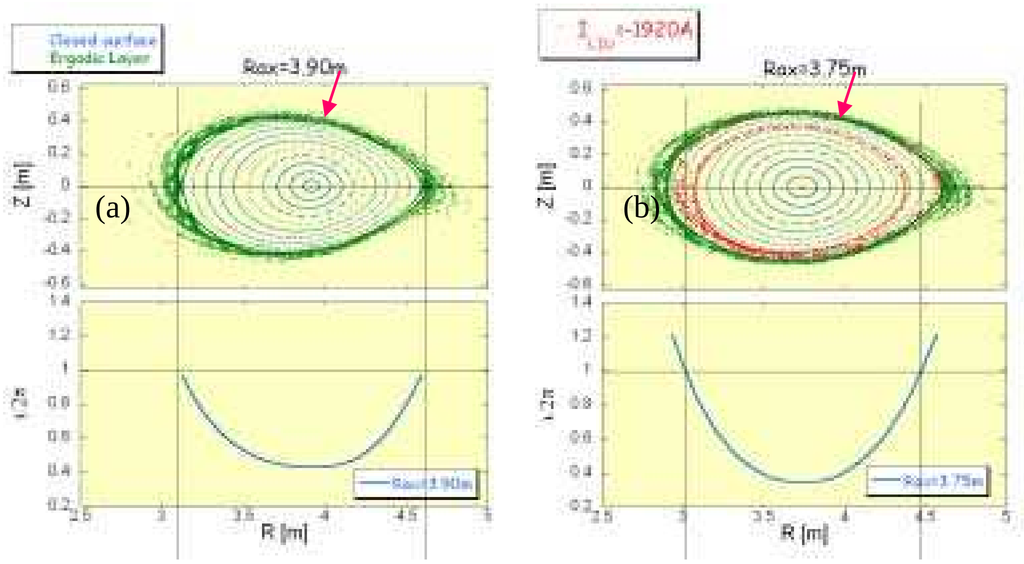

Fig. 1 Cross section of closed magnetic surface and ergodic layer at the toroidal section locating the diagnostics (upper) and radial profile of rotational transform (bottom). The magnetic configuration of magnetic axis position (Rax) is (a) 3.90m and (b) 3.75m. In the case of Rax=3.75m, expanded m/n=1/1 magnetic island is also plotted (red dots).

experiment is done using a pellet injection and it is treated as like as an impulse response. we explain as follows.

In LHD, we utilize the local island divertor (LID) system to enlarge the m/n =1/1 static magnetic island in the plasma. Fig. 1(b) shows the cross section of closed magnetic surface (blue), ergodic layer (green) and expanded m/n=1/1 magnetic island (red dots) sustained by current of LID coil is -1920 A. Such a nested island is located in the close magnetic surface in the case of the magnetic configuration with the magnetic axis (Rax) is 3.75m. In this paper we investigate the temporal behaviour of the electron density profile around expanding island.

Two case of perturbation are tested. One is the gas puffing modulation technique [5]. In this case, gas puff is modulated shown in Fig. 2(d) and electron density is also modulated periodically. Figure 2(c) shows the reflectometer signal which the delay time means the time of flight (ToF) of microwave reflected from corresponding cut-off layer. Cut-off layer, which is located outside of the island, moves also periodically and smoothly (shown by the purple line). However, in the case of the cut-off layer, which is located just boundary between the island and outside region, we observe with the positive and negative spikes in time trace of ToF signal. It is likely that the flat density profile is located at the boundary region and the flight time of

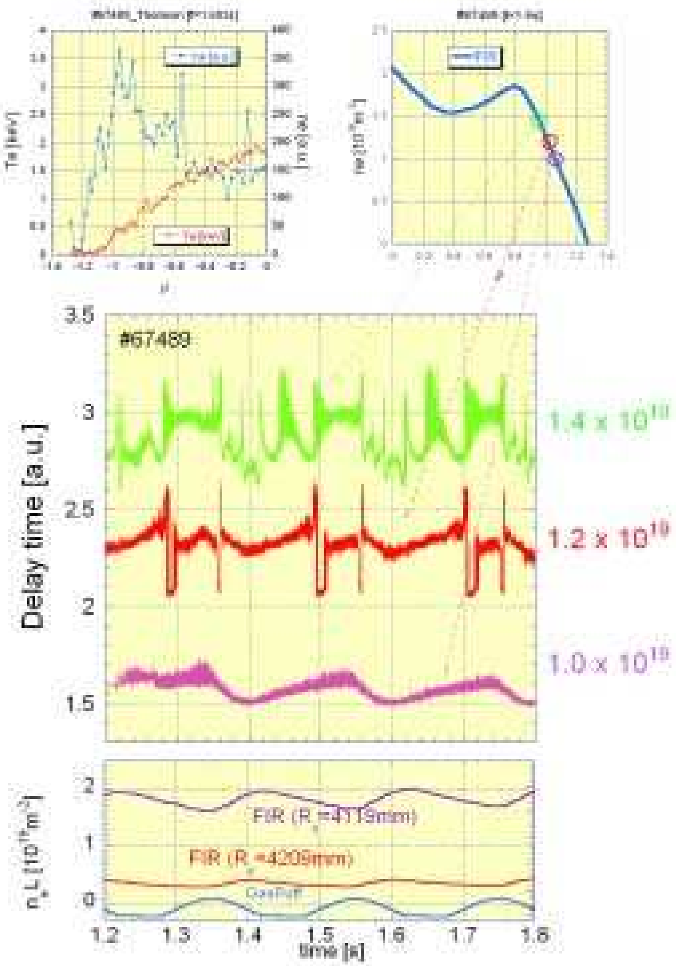

Fig. 2 (a) Radial profile of electron temperature and density measured by Thomson scattering. (b) Radial profile of electron density measured by FIR interferometer. (c) Temporal behaviour of ToF of reflected pulses from corresponding cut-off layer. (d) Temporal behaviour of line integrated electron density and modulated gas puff signal.

the launching microwave becomes large. Also, in the island we can see the fine structure. Now we try to calculate the island model simulation for explaining this structure.

The other perturbation test is pellet injection [6] experiment. When the ice pellet is injected to the plasma, the electron density is abruptly increased. Also, the density profile expands to the edge direction and then it comes to shrink. It makes as follows: Just after pellet injection, each cutoff layer moves to the plasma edge. Then, during shrinking time stage, cutoff layer moves to the core direction and go away from the antenna. Figure 3 and 4 show the ToF value of each cut-off frequency component in the case of magnetic configuration of Rax=3.90m and 3.75m. During the plasma shrink, it is observed two spikes. However, in the case of Rax=3.90m experiment, one spike can be observed. It is likely that the difference of the island structure between two magnetic configurations is essential effect. The boundary between the island and outside / inside plasma region is clear in the case of Rax=3.75m. In the case of Rax=3.90m, the static island is not in the closed magnetic island and located in the ergodic region and the boundary between the island and outside plasma is not clear. Therefore,

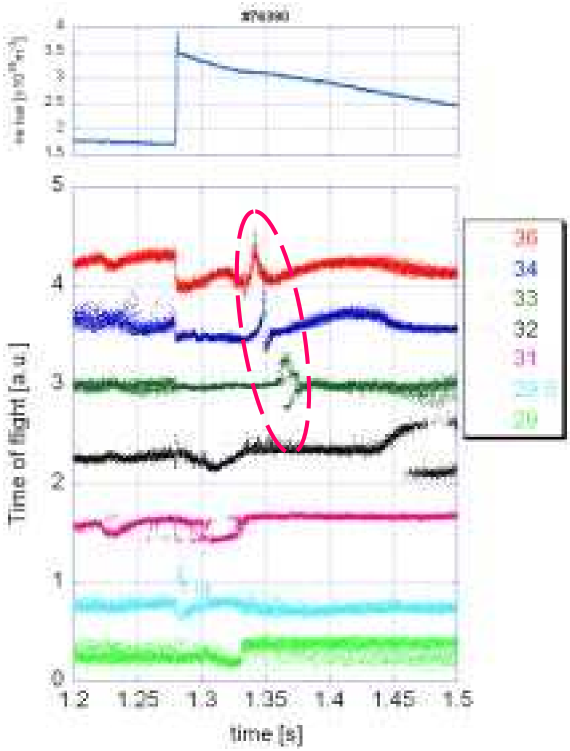

Fig. 3 Temporal evolution of each ToF signal in the case of Rax=3.90m.

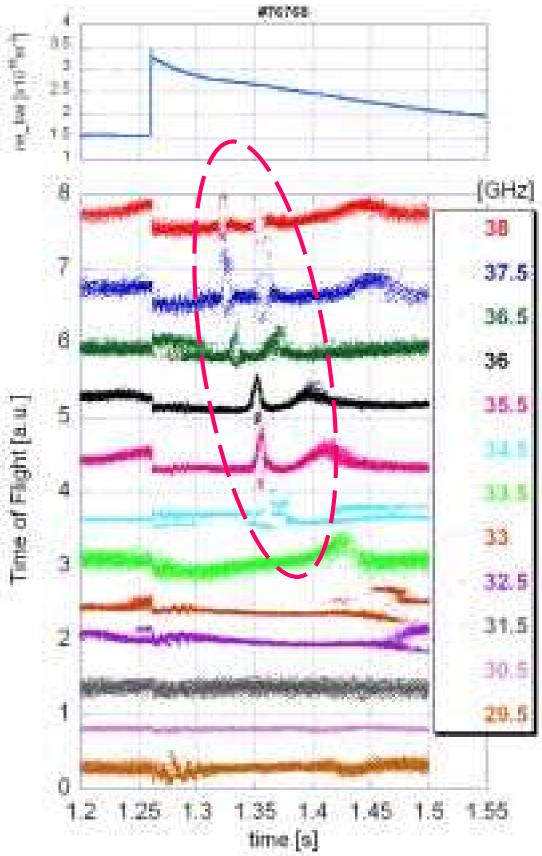

Fig. 4 Temporal evolution of each ToF signal in the case of Rax=3.75m.

we can see each island characteristics and its location. Next study is plan to know the structure in the island and precise model calculation will be carried out.

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