§18. Experimental Estimation of Particle Transport in Stochastic Region in LHD Using MHD Event

Morisaki, T., Ohdachi, S., Tanaka, K., Tanaka, H.

In heliotron configuration, there exists thick edge stochastic region surrounding the core plasma, where magnetic field shows complicated three-dimensional structure. In the region, heat and particle transport is predicted to have different properties from those in the closed flux surface region, since perpendicular (radial) excursion occurs during the parallel procession. In addition, if the remnants of islands exist on rational surfaces, radial deviation becomes larger. Recently, even in tokamaks, there is growing interest in such a three dimensional effect of magnetic field structure on heat and particle transport in the RMP (resonant magnetic perturbation) experiment to mitigate ELM (edge localized mode) heat loads to the divertor components. Thus it is crucially important to clarify the transport properties in the region.

In order to estimate the particle transport, gas puff modulation[1)] and pellet injection[2)] experiments have been performed in LHD. These conventional methods utilize the density perturbations propagating through the region to be measured. However the perturbation is not so small that the plasma performance is changed by the diagnostics. Recently we have developed the new technique to measure the particle transport using MHD events. In LHD, the super dense core plasma ($n_{e\_core} > 10^{20}m^{-3}$) can easily be obtained. In such a high density regime, the ballooning like MHD event called CDC (core plasma collapse) is often seen, which evacuates certain amount of particles from confinement region to divertor through edge stochastic region. With this method, particle source for diagnostics is originally at the core region, thus it is possible to diagnose the core region without any disturbance in the edge region. Another interesting feature of this experiment is that the large Shafranov shift occurs in such a high density discharge, which makes magnetic structure more stochastic.

Experiments were carried out at the outward shifted configuration at R_{ax} = 3.85 m with B_T = 2 T. Just after the maximum density achieved with repetitive pellet injection, CDC takes place (t=4.368s in Fig.1 and 4.367s in Fig. 2). After the CDC, temporal evolutions of line averaged density at three different radial positions and divertor flux were compared between different edge stochasticities i.e., with and without RMP. It can be seen that the evacuated density pulse originated from the central region propagates to the divertor through the edge stochastic region. Different delay time from CDC event to the density peak at R = 4.228 m is observed between two discharges with different edge stochasticities. Decay time of density and divertor flux is also different between two discharges. These results suggest the different transport characters in each discharge.

Further investigation with higher sampling frequencies is necessary to clarify the underlying physics.

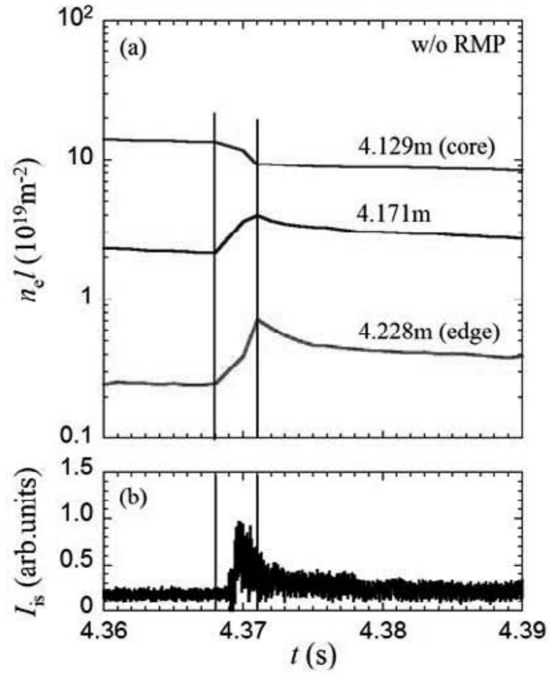

Fig. 1. Temporal evolutions of (a) line integrated densities at three different positions measured with CO2 laser interferometer, and (b) ion saturation current measured with Langmuir probe embedded in divertor plates, in the discharge without RMP.

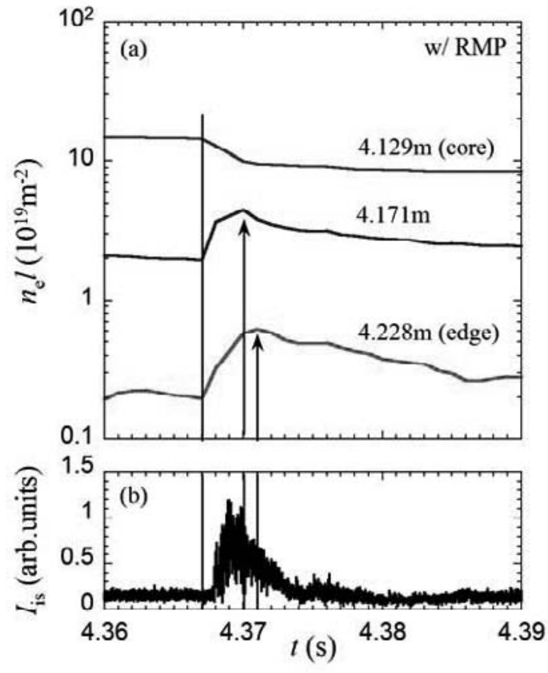

Fig. 2. Temporal evolutions of (a) line integrated densities and (b) ion saturation current, in the discharge with RMP.

1) Tanaka, K. et al.: Nucl. Fusion **46** (2006) 110.
2) Morisaki, T., et al.: IAEA FEC (2010) EX/C1-5.