§16. Bursty Behavior during the Detachment in the LHD Plasma with a Perturbation Field Applied

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Considering future fusion reactors, the heat load to a divertor have to be mitigated. One of the ideas to do this is a dissipation of the heat flux to the divertor as a radiation at an edge plasma. One of the important issues in this idea is a stabilization of the radiation region. Otherwise the radiation region (with a low temperature) moves to the core region and it causes a radiation collapse of the plasma. Applying the perturbation field is found to enhance the radiation at the edge region and successfully stabilize the region of interest in LHD [1]. Hence it is a potential operation of future helical reactors.

As shown in Fig. 1, bursty behaviors are found after the detachment took place. While the edge channel (ch1) of the FIR laser interferometer, which passes through the stochastic region at the edge region of the LHD plasma, indicates a decrease in the electron density, the centeral channel (ch5) of that indicates an increase in the electron density (① in Fig. 1). And then, the magnetic fluctuations suddenly decrease and the electron density begins to change. In the phase ①, the radiation from the edge region decreases. Thus, in order to maintain the high radiation level at the edge region, the bursty behavior should be suppressed as small as possible. In the phase ②, the magnetic fluctuations increase and the electron density in the stochastic region turns to increase. The radiation from the edge region goes back to the level before the phase ①. The bursty behavior becomes significant with the lower heating power: larger amplitude of the burst and lower frequency. Dependences of the burst behavior on the heating power and edge pressure gradient will be surveyed in the 17th experiment campaign.

Figure 2 shows the variation of the electron density profile with the burst. The electron density in the stochastic region decreases while that in the core region does not change. Not shown significantly in the Fig. 2 the density seems to increase around the last closed flux surface as shown by arrows. Local increase of the electron density in the outboard stochastic region (R~4700 mm) may be related to the region where the magnetic island with n/m=1/1 structure is formed.

The ion saturation current measured with the toroidal Langmuir probe array in the divertor plates also shows the bursty behaviors. The profile of the height of density flushing to the divertor region has three dimensional distribution due to the m/n=1/1 structure of the perturbed field.

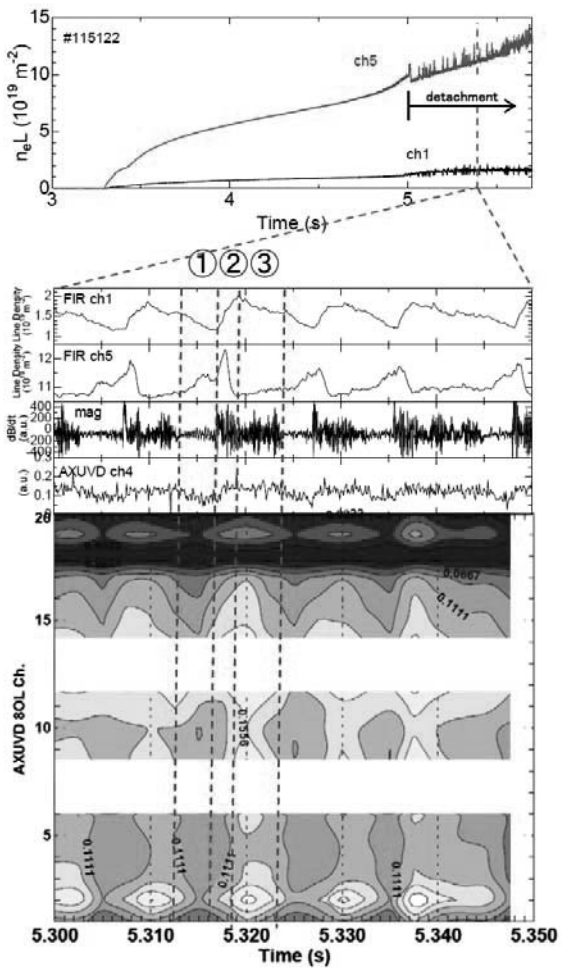

Fig. 1: Bursty behaviours of the electron density, the magnetic fluctuations and the radiation during a detachment phase in the discharge with a puturbation field.

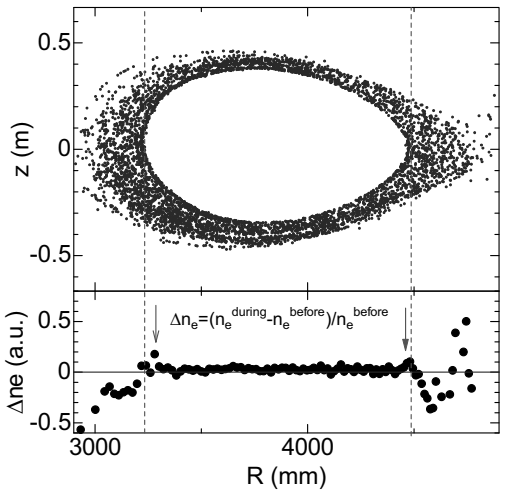

Fig.2 : Poincaré plot of the magnetic field line in the stochastic field region and the variation of the electron density profile with the burst.

1) Kobayashi, M et. al.: Phys. Plasmas **17**, 056111 (2010).