§21. 3 D Asymmetry of Density Behaviors during Detachment with Resonant Perturbation Field

Akiyama, T., Kobayashi, M., Masuzaki, S.,
Ohno, N. (Nagoya Univ.)

Considering future fusion reactors, the heat load to a divertor have to be mitigated. One of ideas is dissipation as a radiation from a plasma. The resonant perturbation field is found to enhance and stabilize the radiation in the peripheral region [1]. Since the perturbation field used for the above purpose has toroidal asymmetry of m/n=1/1, the detachment plasma is expected to have toroidal and poloidal asymmetry. In order to understand the three-dimensional structure of the detachment plasma, multichannel and multiposition measuerments are preferable. However, all diagnostics do not have lots of channels. Hence, we changed the position of the O-point of the magnetic island induced by the perturbation field and studied responses of plasmas.

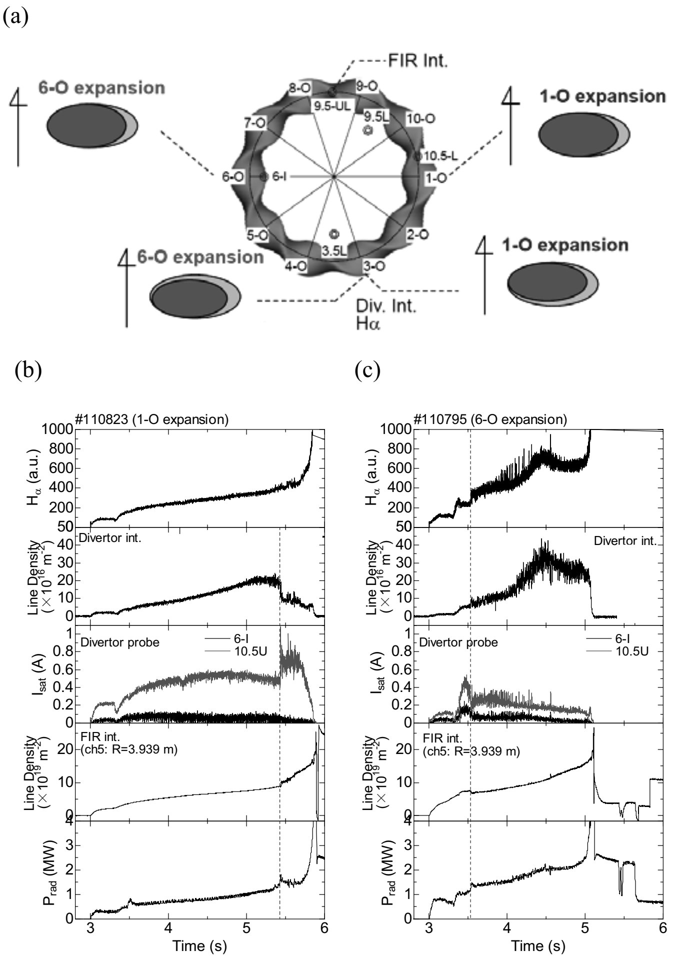

Fig. 1: (a) Positions of diagnostics and island structures. (b) and (c) Temporal evolutions of detached plasmas with the resonant perturbation field. The position of the O-point of an island is (b) 1-O and (c) 6-O position, respectively. Broken lines indicate timings of onset of detachment

Figure 1 (b) and (c) show temporal evolutions of detached plasmas with different positions of O-points of islands: 1-O and 6-O. The positions of diagnostics and island structure of each perturbation field are illustrated in Fig. 1(a). In the case of the 1-O island expansion configuration, the line electron density measured with a divertor interferometer (3-O, outer leg) decreases while the ion saturation current measured on the divertor plate at 10.5-U increases after the detachment at t = 5.45 s. On the other hand, the density of the outer leg at 3-O shows gradual increase and the ion saturation current at 10.5-U decreases when the island O-point is at 6-O. As summarized in Table 1, the divertor plasma behavior is not uniform and it depends on the structure of island (the phase of perturbation field).

Bursty signals, which are expected to be ejection of particles, have also dependence on the island structure. While significant bursty signals are observed with a Hα emission intensity measurement (3-O), the divertor interferometer and the divertor probe for 6-O expansion configuration, less bursty for the 1-O expansion one. This indicates that some sort of instability localizes at a position which is determined by the island structure.

In order to evaluate an energy balance during the detachment, the three dimensional structure have to be known. Although the heat load is totally mitigated, we have to examine whether heat or particle loads are focused at a certain position or not. Since additional divertor probes will be installed on closed divertors before the 16th experiment campaign, the toroidal structure of divertor plasma behaviors will be shown.

Another issue to be addressed is differences of detachment conditions and stability between two island phase configurations. It seems that higher density is necessary for 1-O expansion configuration for the detachment and there is only small margin to a radiation collapse. The relationships to the vacuum island or geometrical relation between NB injections and the island will be examined in the next campaign.

Table 1: Behaviors of a divertor plasma after detachment

	Island expansion	
	1-O	6-O
Div. int. (3-O)	Rapid **decrease** in the line density	Gradual **increase** in the line density
Div. probe (10.5-L)	Rapid **increase** in the ion saturation current	Rapid **decrease** in the ion saturation current
Hα (3-O)	**Less bursty**	**Bursty**

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