§17. Effects of Resonant Perturbation Magnetic Field on Detachment Plasmas

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

Stabilization of a radiation region in the peripheral region with the resonant perturbation magnetic field is one of great advantages of detachment plasmas in LHD. 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.

Figure 1 shows the two detachment plasmas with positions of the O-point of the magnetic island at 6-O and 7-O positions, respectively. In the former case, the ion saturation current I_{sat} of Langmuir probes embedded in the divertor plates spontaneously decreased at t=4.4 s and kept the small I_{sat}. This indicates that the divertor plasma detached. During the detachment phase, the electron density still increases and the bursty signals are observed with a divertor interferometer, which measures the density at outer and upper divertor leg (intermediate position between the outer X-point and a divertor plate) in the horizontally elongated cross section. This density behavior is quite different from that measured with the Langmuir probes. On the other hand, the detachment plasma with the O-point at 7-O position, the less bursty signals were observed with the divertor interferometer. Although the divertor interferometer suffered from significant fringe jump errors, the circled area in the Fig.2 shows almost no bursty behaviors. This indicates that the particle ejections toroidally or poloidally localizes, depending on the perturbation field. The relationship between the particle ejections and the island structure could be deduced by the calculation of the magnetic field lines connected to the measurement position of the divertor interferometer. For design of the divertor, the maximum heat and particle loads have to be known. In addition, the phase of the perturbation field have to be scanned to disperse the load. Understanding of characteristics of the localized particle ejection is one of ongoing studies.

When the O-point locates at the opposite side, 1-O or 2-O positions, the detachment plasma could not be obtained. Even though the line averaged density of the core plasma and the heating power were the same, the detachment was not achieved. Figure 2 shows the edge electron temperature profiles of detached (just before detachment) and atached plasmas with the same line density. In case of the atached plasma, density flatting is less clear than that of the detached one although the island phase is different at the position of the Thomson scattering measurement. One of the speculated reason is that the electron temperature was slightly high for any reason and the island might be healed in the case that the O-point was at 2-O section. Hence the plasma could not transit to the detachment state. Due to the current scan of the local island coils before plasma, the magnetic analyses of the island healing could not be done. In the next 15th experimental campaign, operational region of the detachment and the relationship between the detachment onset and the island dinamics will be studied.

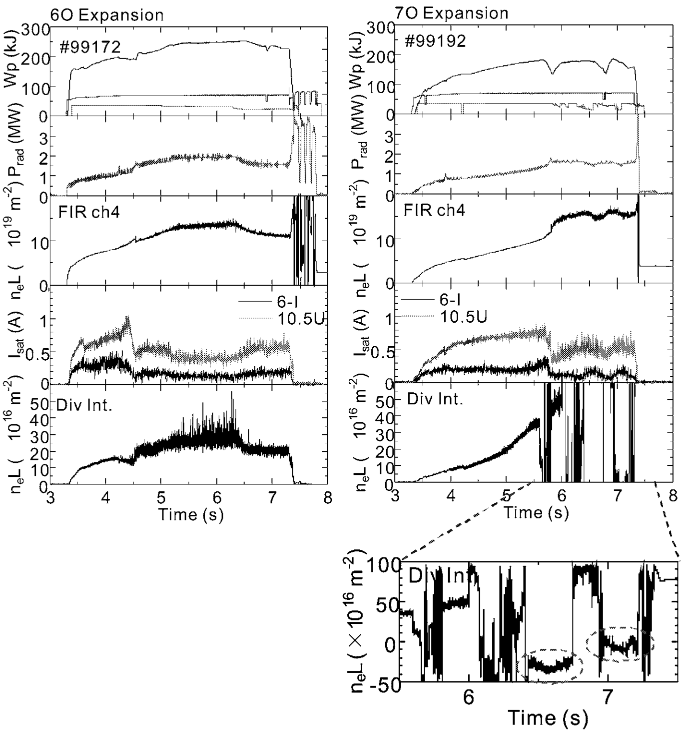

Fig. 1: Detachment plasmas with positions of the O-point of 6-O (left) and 7-O (right) positions

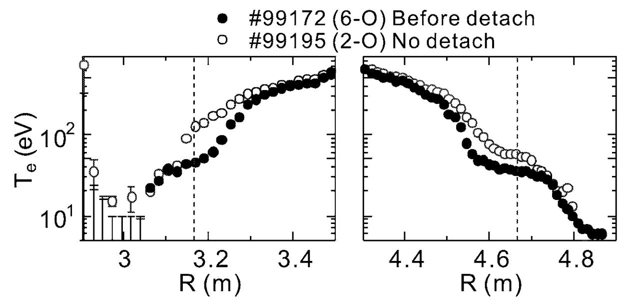

Fig. 2: The edge electron temperature profiles of detached (closed marks, just before detachment) and attached (open marks, with the same density as the detached plasma) plasmas. Broken lines indicates the positin of $\iota/2\pi=1$