§46. Energy Balance in the LHD Detached Diverter Leg Plasma

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Understanding of formation mechanism for detached plasma in divertor region with plasma-gas interactions has been strongly required in order to avoid seriously high heat flux to the divertor plate in magnetic fusion experimental devices such as LHD. The divertor Plasma is expected to lose the energy through collisions between ions, electrons and neutral particles as shown in Figure 1. To evaluate the energy loss channel, it is important to know electron temperature (Te), electron density (ne) and ion temperature (Ti). In this study, we focus on measurements of these parameter in the LHD divertor leg plasma during detached and attached plasma operations.

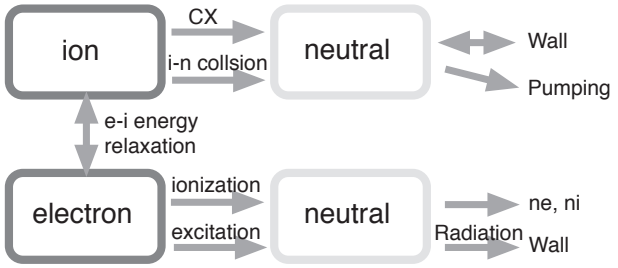

Fig. 1: Schema of energy flow between ion, electron and neutral particles in the edge and divertor region.

We have done the measurement of T_e, n_e and T_i in the LHD divertor leg plasma using an ion sensitive probe (ISP) installed on one of the fast reciprocate probe systems in the 4.5U port as shown in Figure 2. The ISP is a kind of electrostatic probe and it has the capability to measure the T_e, n_e and T_i simultaneously. The structure of ISP has been optimized for measuring the divertor leg plasma at the observed port.

Figure 3 shows that n_e, T_e spatial profiles of the divertor leg along the reciprocating orbit of the probe head. for the cases of attached (#126218) and detached (#126219) plasma operations. In the case of attached plasma, the spatial profiles show corresponding structure of connection length of magnetic field lines. On the other hands, the n_e and T_e are decrease and the profiles become almost flat during detached plasma discharge. However, at the outer part of the leg (especially Z > 1.37 m), little density drop has been observed. This result is considered as the influence of density dependence of electron-ion energy relaxation process (see in Fig. 1), because the density is relatively low in this region, even in the case of attached plasma. The probe current data for evaluating ion temperature have some difficulties such as unexpected negative current on an ion collector of the ISP. To resolve the problem, particle simulation for the correcting current is planned. As for the future plan, isotope effect on plasma properties in the diverter leg will be discussed in the next experimental campaign.

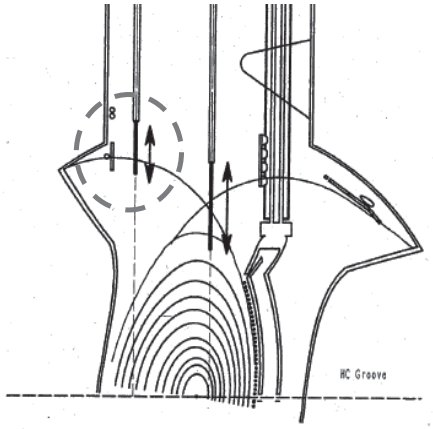

Fig. 2: Position of the ISP measurement using one of the fast reciprocate probe systems in the 4.5U port.

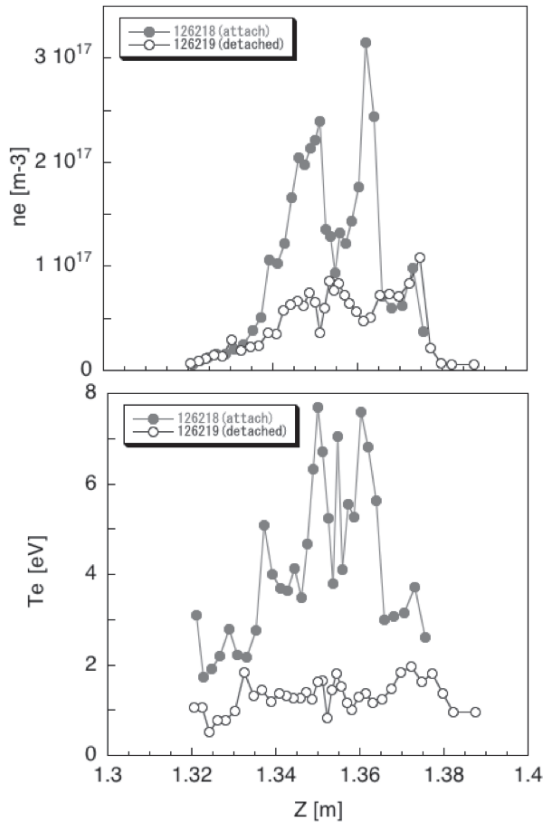

Fig. 3: n_e, T_e spatial profiles of the divertor leg along the reciprocating orbit of the ISP at 4.5U port. Closed and open circles correspond to attached (#126218) and detached (#126219) plasmas, respectively. Note: calibration of collection area is necessary for discussing the absolute value of n_e.