§4. Investigation of Spatial Profile of the LHD Detached Plasma

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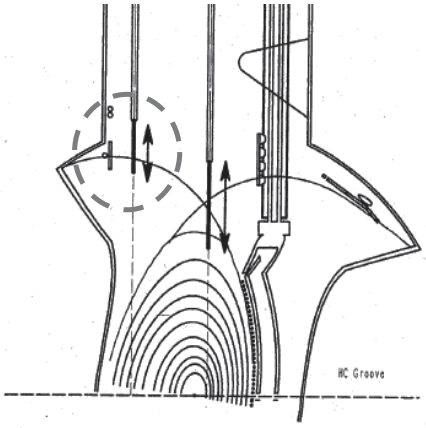
Detached plasmas have attracted great interest from the point of view of handling of plasma heat flow in the divertor of magnetic confinement fusion experimental reactors such as LHD. It makes a strong temperature and density gradient along the magnetic field. Spatial profile of the temperature and density along magnetic field lines is an essential general issue and of particular importance for the proper functioning of the divertor region plasma.

a)



b)

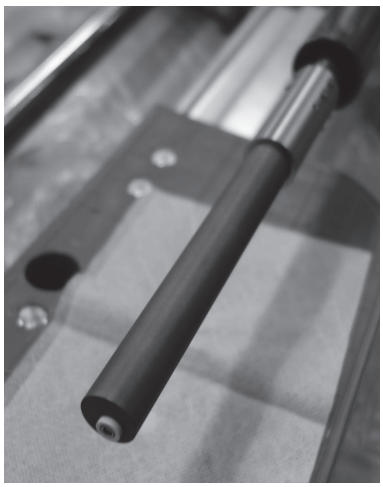


Fig. 1: a) Position of the ISP measurement using one of the fast reciprocated probe systems in the 4.5U port. Pointed out by a dotted red circle.
b) The newly designed ISP head installed in the 4.5U port.

So far, we observed the density dependence of electron temperature (T_e) and ion temperature (T_i) in the LHD divertor leg plasma using a movable multiple functions probe, which consists of Mach probes and an ion sensitive probe (ISP) [1].

In this campaign, we prepared to a newly designed ISP head and installed it on one of the fast reciprocate probe systems in the 4.5U port as shown in Figure 1. The ISP has optimized structure for measuring a divertor leg near the observed port. The angle of magnetic field line along the orbit of the probe movement is almost parallel to the probe head as shown in Fig.1 (a). TZM has been used for the ISP electrodes, which consist of an ion collector and a guard electrode. The height of the ion collector inside the guard electrode was decided as small as possible by taking a angle of magnetic field line at the position of the probe head and typical electron gyro radius into account. The structure is expected to reduce uncertainty caused by space charge in the inner space of the ISP [2].

Figure 2 shows that probe current profiles obtained by the outer electrode (electron guard electrode; G) of the ISP with voltage sweep at the divertor leg during attached and detached plasmas discharges. The horizontal time axis corresponds to the probe position. In the case of the attached plasma, the probe current pattern reflects the spatial structure of the divertor leg along the probe movement. In the case of the detached plasma, however, the current is decreased and the profile becomes almost flat. These results indicate particle flux to the divertor leg region is drastically reduced by the detached plasma discharge.

Energy balance in the LHD diverter leg plasma will be investigated by using the ISP system in the next experimental campaign.

1) Hayashi, Y. *et al.*: J. Nucl. Mater. **438** (2013) S1228.
2) Brunner, D. *et al.*: Plasma Phys. Control. Fusion **55** (2013) 095010.

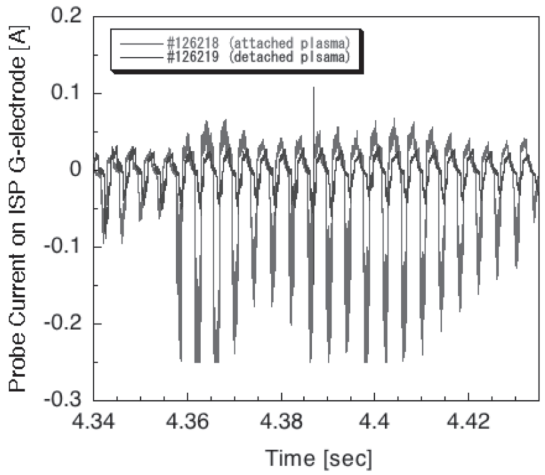


Fig. 2: Probe currents of the ISP guard electrode measured by using the fast reciprocating probe system at 4.5U port during an attached and a detached plasma discharges.