§10. 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.

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). Although T_i was higher than T_e in low-density plasma, both temperatures became almost same with increasing the density. The tendency that $T_i \sim T_e$ at high density might be explained by taking into account energy relaxation between ions and electrons[1].

In this campaign, we have discussed the possibility of probe measurements along the same magnetic field line in order to clarify the difference of plasma parameters during plasma detachment using the movable multiple functions probe. The candidate positions for the measurement are in the ergodic layer / divertor leg and on the divertor plate. However, the measurement in these regions has some difficulties especially the limited accessibility. In the next experimental campaign, we focus on the ion and electron temperature measurements in detached plasma using probe measurement on a divertor plate.

While discussing the diagnostics on the divertor plate, we have also prepared a laser induced fluorescence (LIF) measurement with a tunable diode laser for calibration of ISP for reliable T_i measurement. Because of the importance of T_i in energy balance and transport in detached plasmas, diagnostics and monitoring for ion energy in the plasma are necessary. Radial profile measurements of T_i in linear plasma devices have shown the tendency that T_i becomes higher than the balk plasma with increasing radial position[2]. Simple analytical model based on the ion Larmor motion is qualitatively consistent with the experimental T_i profile. These results indicate ISP measurements have great influence of perpendicular component. Though the anisotropy makes strong impact on the transport process, the effect of the ion temperature anisotropy on ISP measurements is not clarified. Hence, we attempt to perform detail comparison of ion temperatures between ISP and LIF measurements in a linear boundary plasma simulator CTP-HC in magnetized Ar plasma using the setup as shown in Fig. 1 and 2. Since the LIF measurement distinguishes parallel and perpendicular components of ion velocity distribution functions by the directions of the injected laser and of fluorescence observation, the influence of ion temperature anisotropy on ion sensitive probes can be evaluated. The detail comparisons are expected to reveal the influence of ion temperature anisotropy on ion sensitive probes. These results contribute to precise measurements of the ISP in the LHD boundary plasmas as well as characterization of detached plasmas.

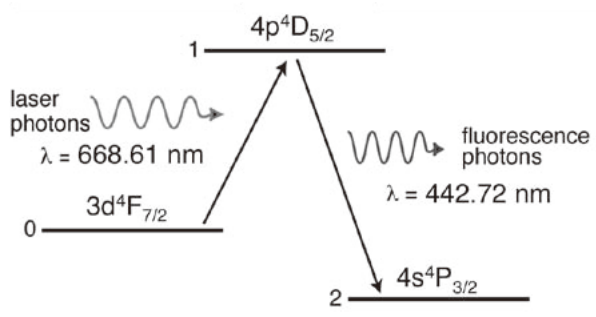

Fig. 1. LIF transition used in this study (ArII).

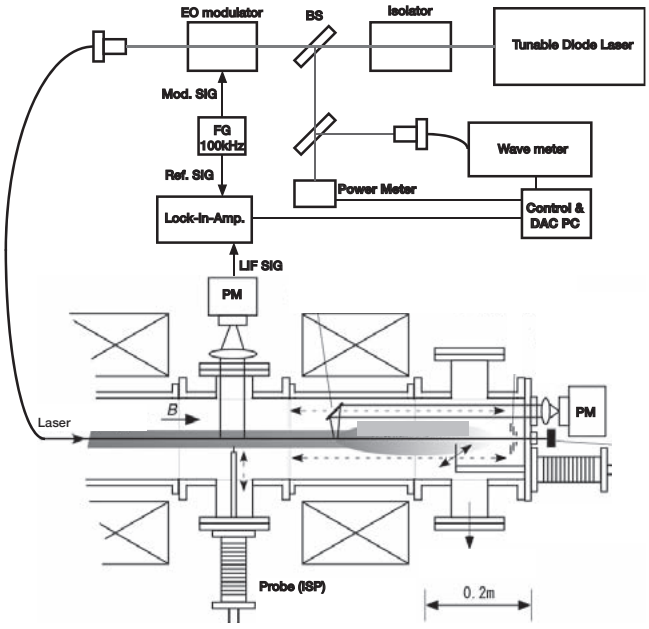

Fig. 2. Setup of simultaneous measurement T_i by ISP and LIF in a linear boundary plasma simulator CTP-HC under different neutral gas pressure. The laser direction is variable.

1) Hayashi, Y., Ezumi, N. *et al.*: J. Nucl. Mater. **438** (2013) S1228.
2) Ezumi, N., Hayashi, Y. *et al.*: J. Nucl. Mater. **438** (2013) S472.