§25. Directional Probe Measurements in the Heliotron J Plasma with Confinement Transition

Nagaoka, K., Takeiri, Y., Osakabe, M.,
Kobayashi, S., Mizuuchi, T., Sano, F. (Kyoto Univ.)

The mechanisms underlying the generation of plasma flows play a crucial role to understand transport in magnetically confined plasmas. Plasma flows are an important ingredient to access improved confinement regimes, both in edge and core plasma transport barriers, and have been strongly studied theoretically and experimentally [1].

In Heliotron J, an improved confinement was observed in both electron cyclotron heated (ECH) plasmas and neural beam injection (NBI) heated plasmas. In order to investigate the edge plasma behaviors associated with confinement improvement, a directional probe was installed in Heliotron J (moved from CHS [2]). The directional probe has four pairs of directional probe channels on the probe surface, and can simultaneously measure plasma flows in different minor radial positions. The detailed structure of this probe is presented in Ref [2]. The probe can be rotated along the probe axis by the rotary stage, which corresponds to change the angle of collector surface to the magnetic field, and also driven two-dimensionally in the poloidal cross section (R-z plane). Figure 1 shows the probe position and the plasma shape, and the probe is inserted across near the X point.

The directional probe measurement was performed and three results were obtained in the experimental campaign in JFY2007; one is the dependence of ion saturation current on the angle between collector surface and the magnetic field. The different dependence was observed in an out of the LCFS, which means that the plasma flow changes between in and out of the LCFS, and the directional probe can measure the plasma flow in the edge of Heliotron J plasma. Second is the observation of transition of density gradient associated with confinement transition. The density gradient near the LCFS significantly changes and a steep gradient is formed in high-confinement phase, which implies the possibility of edge transport barrier formation associated with improved confinement. Third is the toroidal flow observation. The ctr-directed toroidal flow is generated spontaneously inside the LCFS in high-confinement phase, while flow direction outside of LCFS is in the co-direction. This observation is very interesting from view point of coupling between turbulent transport and parallel flow, which was observed in tokamaks for example in JET [3].

We successfully started the directional probe experiment on this topic. The systematic measurement of characteristics of edge plasma associated with the confinement transition is necessary to understand the mechanism of confinement transition in Heliotron J. The fluctuation measurement near the transport barrier or LCFS is considered as a next target at this moment.

[1] Terry, P.W. Rev. Mod. Phys. **72**, 109 (2000).
[2] Nagaoka, K. et al., Nucl. Fusion to be published.
[3] Hidalgo, C. et al., Phys. Rev. Lett. **91**, 065001 (2003).

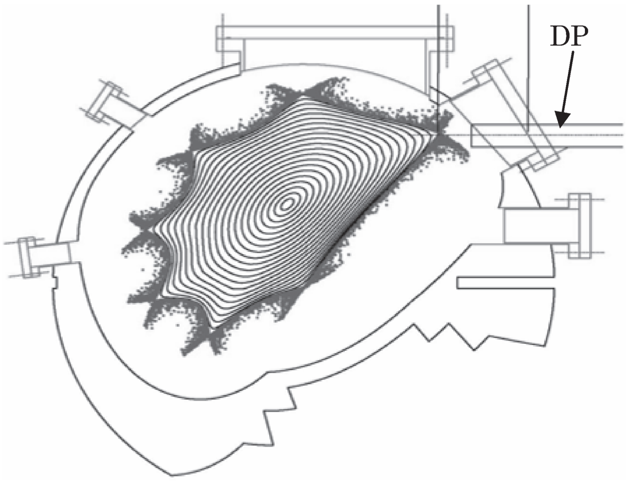

Fig.1 The schematic of the directional probe (DP) position and the plasma shape.

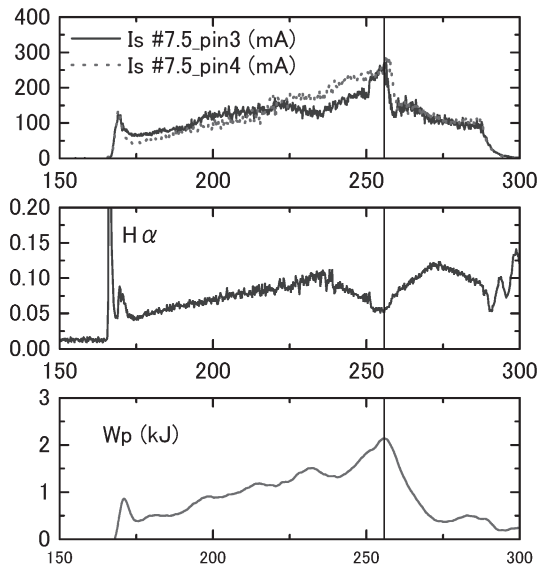

Fig. 2 (upper) The directional probe signals measured at 30mm inside of the LCFS. The co- and ctr-directed fluxes are solid (pin3) and dotted lines (pin4), respectively. (middle) The intensity of H_α emission. (bottom) The stored energy.