§22. Anomalous Transport of Fast Ions Observed by Directional Probe on Heliotron J

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Anomalous transport of fast ions induced by fast-ion-driven MHD activities is a crucial issues in burning plasma experiments such as ITER, and is intensively studied in tokamak and helical devices. Recently interactions between fast ions and energetic particle modes (EPM) were investigated using a hybrid directional Langmuir probe (HDLP) in CHS, and strong resonant interaction between EPM and fast ions was identified[1]. After the shutdown of CHS experiment, the HDLP was installed in Heliotron J, and utilized for the studies of fast ion transport.

The HDLP can measure co-directed and ctr-directed ion fluxes separately. When the co-directed neutral beam is injected, the fast ion flux can be estimated by $I_{\mathrm{Fast-Ion}} = I_{\mathrm{Co}} - I_{\mathrm{Ctr}}$. The fast ion measurement was performed for co-directed fast ions because the HDLP was installed at the outboard side of Heliotron J plasma, which is shown in Fig.1.

The response of co-directed fast ions to the repetitive burst mode was observed just inside of the last closed flux surface (LCFS). The fast frequency chirping down during each burst was observed. The ion saturation currents measured by the HDLP oscillated with the burst fequency. The coherence and phase difference between co-/ctr-directed ion flux and the bursting mode were shown in Fig.2 (a)-(d). The response in co-directed flux is predominated by the fast ion response and that in ctr-directed one is by bulk ion response to the bursting mode. The coherence in both cases are significant and the most important result in this analysis is the difference of phase relation. The phase relation between particle flux and wave indicates the information of interaction between the particles and the wave. The obtained phase relation in this experiment indicates that the interaction of fast ions with the bursting mode is quite different from that of bulk ions. In order to identify the resonance between fast ions and the bursting mode, it is necessary to observe fast ions and the bursting mode at the same position, which is planned in the next experimental campaign on Heliotron J.

1) K. Nagaoka, M. Isobe, et al., Phys. Rev. Lett., 100, 065005 (2008).

2) S. Kobayashi, K. Nagaoka, S. Yamamoto, T. Mizuuchi et al., Proceedings of 17th International Steralator/Heliotron Workshop, Oct.12-16, 2009. PPPL.

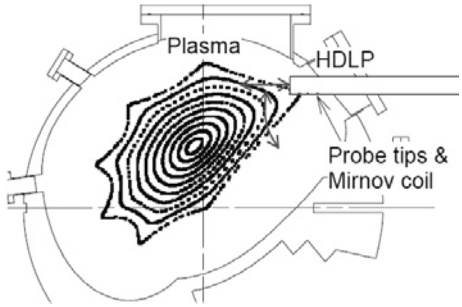

Fig. 1: Poloidal cross section of Heliotron J at the HDLP position.

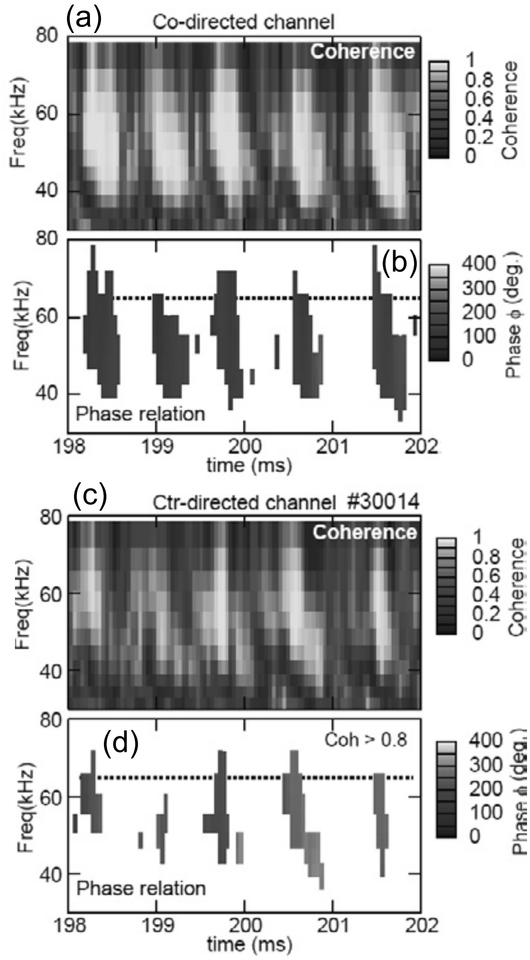

Fig. 2: (a) Coherence between Mirnov coil signal and ion saturation current measured by co-directed channel(ch.3 of DLP). The Mirnov coil used in this analysis is mounted on the vacuum vessel. (b) Phase difference between them with large coherence. (c) Coherence between Mirnov coil signal and ion saturation current measured by ctr-directed channel(ch.4 of DLP). (d) Phase difference between them with large coherence.