§23. Directional Probe Experiments in the Heliotron J

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In the Heliotron J, a directional probe was installed (which had been utilized in CHS experiment) for mainly two subjects; one is edge plasma studies related to transition phenomena to the improved confinement mode (H-mode), and the other is fast-ion transport studies when fast-ion-driven MHD activities occur in NBI heated plasmas.

On the former subject, the long range correlation of turbulence between two different toroidal position was tried to measure when the transition from L- to H-mode occurs. In order to obtain an experimental evidence of reduction of turbulent transport due to large scale coherent structure formation such as zonal flow, further experiments is necessary at this moment.

On the latter subject, the fast ion measurement due to directional probe method was applied to a NBI heated plasma with fast-ion-driven MHD burst. Figure 1 shows the time evolution of frequency spectrum of magnetic fluctuation, Mirnov signals, ion saturation currents measured by the co- and ctr-channels on the directional probe inside of the last closed flux surface (LCFS). The frequency of bursting mode shifts quickly during each burst, and the most likely candidate of this mode is considered to be global Alfven eigenmode (GAE) driven by fast ions injected by NBI [1]. A response of co-directed ion current to the bursting activitiy of magnetic fluctuation was observed, while clear response was not observed in the ctr-directed ion current. The response of co-directed ion current is considered as a fast ion response to the bursting MHD mode, and has a same frequency as the MHD mode. The amplitude of the fast ion response to the each MHD burst increases with the mode amplitude and the interval of bursts as shown in Fig. 1. This property can be understood by the predator-prey model between fast ions and MHD mode[2]. The amplitude of fast ion oscillation synchronized with the MHD mode is proportional to the amplitude of magnetic fluctuation, which is shown in Fig. 2. The similar response of fast ions to MHD activities was observed in the CHS plasma with energetic particle mode (EPM) burst and it was recognized as a resonant convective oscillation of fast ions[3, 4]. The observed response of fast ions in Heliotron J experiment is also considered as the resonant convective oscillation, which is just oscillation and not net transport of fast ions. The detailed observation of interaction between fast ions and MHD activity and the transport mechanism of fast ions due to the interaction are left for future studies.

1) S. Yamamoto, et al., Fusion Sci. Tech., **51** (2007) 93.

2) K. Nagaoka, et al., Plasma Fusion Res., **1** (2006) 005.

3) K. Nagaoka, et al., Phys. Rev. Lett., **100** (2008) 065005.

4) K. Nagaoka, et al., Nuclear Fusion, **48** (2008) 084005.

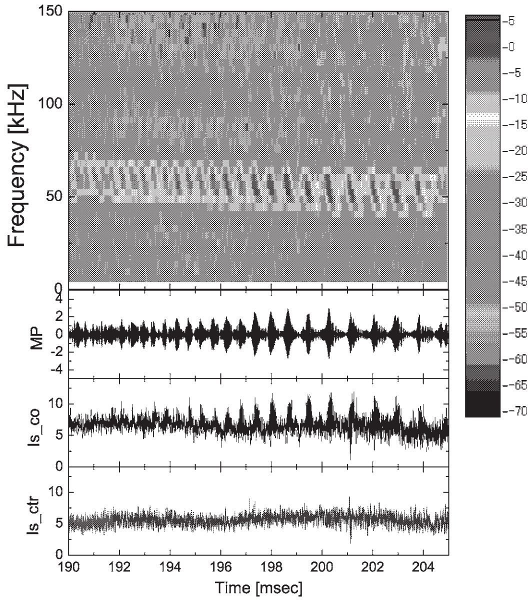

Fig. 1: The contour of frequency spectrum as a function of time, the time evolution of Mirnov coil signal, co- and ctr-directed ion currents measured by the directional probe [Ref.2].

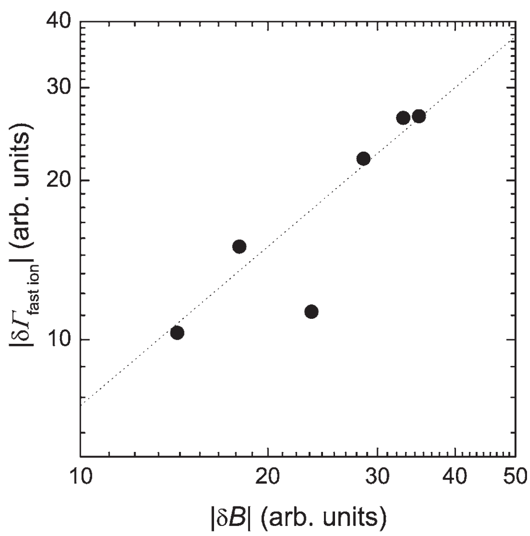

Fig. 2: The amplitude of fast ion response synchronized with the MHD mode as a function of amplitude of magnetic fluctuation [Ref.2].