§41. Study of Interaction between Fast-ion and Fast-ion Driven MHD Instabilities on Heliotron-J

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On the Heliotron-J device (H-J), the excitation of Global Alfvén Eigen-mode (GAE) by the fast-ions produced by the tangentially injected Neutral Beam (NB) was observed [1]. Moreover, the density fluctuation by the instabilities were also observed by a Beam Emission Spectroscopy(BES) diagnostic on H-J[2]. Thus, it was considered that the H-J is a good platform to explore the fast-ion studies on the interaction with plasma instabilities if we can achieve the fluctuation information of fast-ions by the instabilities.

To achieve the fast-ion information circulating in the tourus with high time resolution (~100kHz), a Si-diode based fast neutral analyzer (SiFNA) was newly installed on H-J. The SiFNA has an advantage of its high sensitivity to neutrals and its simple structure. It can measure the fast neutral with only single Si-diode and the energy of the detected neutrals are resolved by the pulse height analysis (PHA) of the detector signals. Thus, the influx of the neutral onto the detector must be suppressed so that the detected single pulse corresponds to the single event caused by a single neutral particle. The detector also requires a cooling system based on a Peltier module or liquid nitrogen in order to suppress the contamination by thermal noises on the detector signals [3]. In the application of a SiFNA to the high time resolution measurement on H-J, we gave up the energy measurement by the PHA. We have tried a rough energy measurement by inserting a thin aluminum foil in front of the SiFNA. All of the particle will be stopped at the foil if their corresponding range is shorter than the thickness of the foil. Since the range is a monotonic function of the energy, the foil acts as a high pass filter of the particle energy measurement.

Figure 1 shows schematic drawing of the SiFNA installation geometry. The SiFNA is installed at the Neutral particle dump of the conventional Charge eXchange Neutral Particle Analyzer (CX-NPA). The NPA is aligned to measure the pitch-angle scattered components of fast-ions produced by NBI BL-2. Figure 2 shows typical waveforms of a discharge with fast-ion drive instabilities. As shown in the figure, signals of SiFNA increases only when the NBI BL-2 is injected as we planned. Thus, we believe the fast neutral measurement by SiFNA is successfully performed. Unfortunately, a big increase of the SiFNA signal were observed when the BL-2 was turned on. We are speculating this is due to the serge noise of NBI power supply. As shown in Fig.3, nice correlations between SiFNA and Mirnov-coil were observed at the frequency of 20kHz an 80kHz. The detailed analysis between the two signals will be carried out in FY2015.

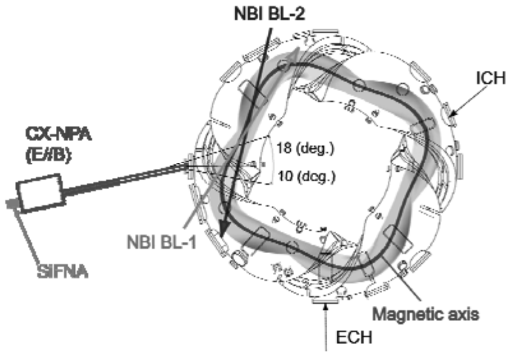

Fig.1 Schematic drawing of SiFNA installation geometry on H-J.

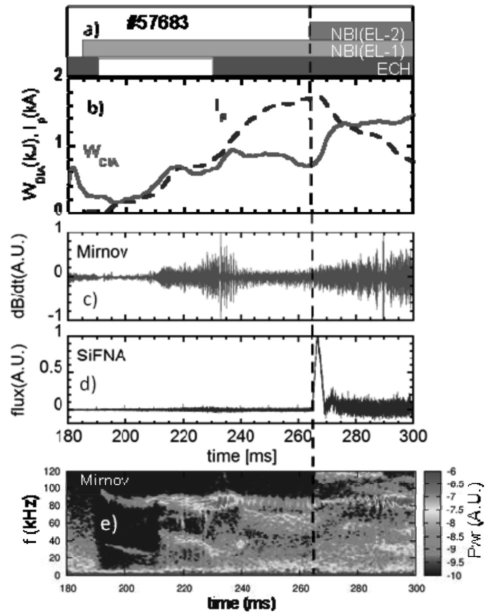

Fig.2 Typical waveforms of a discharge with fast-ion driven instabilities. (a)Heating power injection pattern, (b) plasma current and diamagnetic stored energy, (c)Mirnov-coil signal and (d) SiFNA waveforms are shown. The spectrogram of Mirnov-coil signal is also shown in (e).

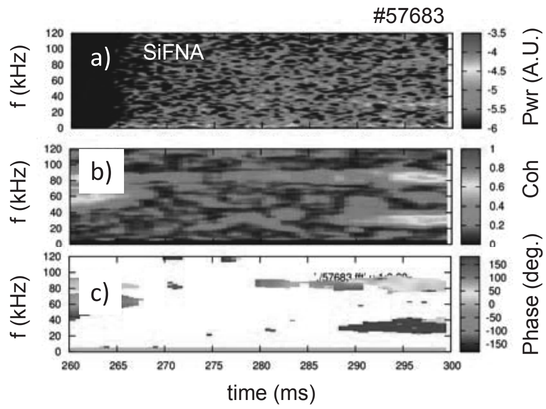

Fig.3 Spectrogram of (a) SiFNA, (b) Mirnov-coil and (c) The phase difference between these two signals are shown.

1) Yamamoto, S., et.al.: **Fusion Sci. and Tech. 51**(2007) 92
2) Kobayashi, S., et al.: Rev. Sci. Instrum. **83**(2012) 10D535
3) Osakabe, M., et.al.: Rev. Sci Instrum **72**(2001)