§43. 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 study the interaction between fast-ions and GAE, a Si-diode based Fast Neutral Analyzer are installed at the neutral particle dump port of the conventional Charge eXchange Neutral Particle Analyzer (CX-NPA). To study the fast time response phenomena on fast-ions, the SiFNA is operated with current mode not with a conventional pulse height analysis mode[3]. Since the Si-diode is sensitive to Soft X-rays (SX) as well as fast neutrals from plasma and the discrimination of fast-neutral signals from SX signals are usually done based on the pulse height analysis, the contamination of fast neutral signals by SX are concerned when SiFNA is operated with current-mode. Figure 1 shows typical example of a discharge where the SiFNA observes the fast-ion signal affected by instabilities. As shown in the figure, significant coherent signals are observed between Mirnov-coil and SiFNA above 100kHz between t=200ms and 240ms while no significant coherent signals are observed between Mirnov and SX. This indicates SiFNA has a potential to measure the fast-ion behavior with instabilities.

To study the fast-ion behavior with instability more clearly, a new fast-ion detector based on artificial diamond is under development by a collaboration with Hokkaido Univ. Since the atomic number of carbon (Z=6) is about a half of the atomic number of silicon(Z=14), the diamond is less sensitive to SX. This feature provides us more robust application of semiconductor detector based FNA to fast-ions. Figure 2 shows the prototype of the detector and its initial results. The energy spectra of alpha particles from ^{241}Am measured by the prototype detector is shown in Fig.2(b). As shown in this figure, the alpha particles of 5.486MeV emitted from ^{241}Am were clearly observed. From the analysis of the spectra, it was found that the thickness of insensitive layer at the entrance window of the detector is equivalent to the range of 100keV protons, which has much higher energy of fast-ion energy (~20keV) produced by a neutral beam injector on H-J. We have found that the reduction of insensitive layer thickness is the ongoing task in applying artificial diamond detectors to fast neutral measurement on H-J.

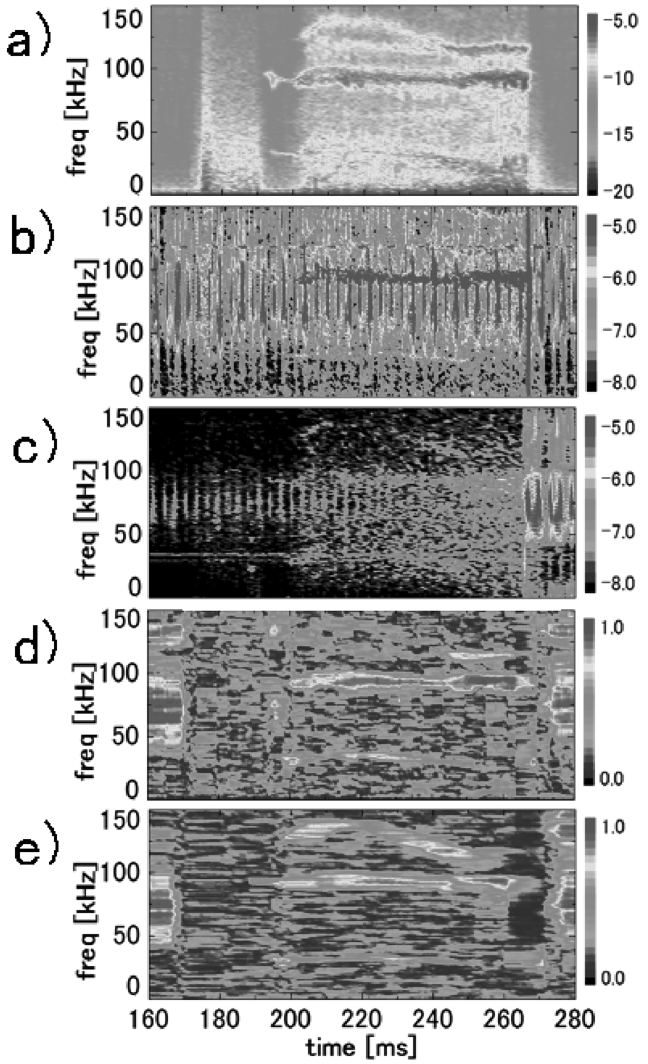

Fig.1 Typical Spectrograms of (a)Mirnov coil, (b) Soft X-ray (SX), and (c)SiFNA signals are shown. The coherence (d) between Mirnov and SX, and (e) between Mirnov and SiFNA are also shown.

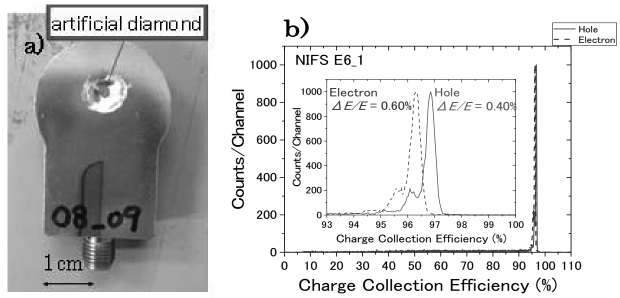

Fig.2 (a) A prototype of artificial diamond based fast ion detector and (b) the energy spectra of alpha particles from ^{241}Am measured by the artificial diamond detector...

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)