Measurement of Phase Space Structure of Fast Ions Interacting with Alfven Eigenmodes

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Experimentally observed Alfven eigenmodes (AEs) show nonlinear behaviors such as intermittency, fast sweep in frequency and so on. In order to understand such nonlinear behaviors of AEs, it is widely recognized that the phase space dynamics have to be taken into account. However, there are few direct measurements of phase space structure in experiments so far. Here, we propose to apply the wave-particle interaction analyzer (WPIA) technique being developed for magnetosphere plasma physics (ERG project) to magnetically confinement fusion experiments.

The concept of WPIA is a phase detection between particle flux and the wave for the quantitative evaluation of energy transfer between them. We have developed a high speed pulse analyzer system for WPIA using the field programmable gate array (FPGA) module, and installed the system to the large helical device (LHD). One channel of Mirnov signal and eight channels of semi-conductor fast neutral analyzer (Si-FNA) signals are digitized with sampling rate of 50MS/s (maximum), which is significantly higher (factor of $10^4$) than that of conventional pulse height analyzer technique and enable us to evaluate the phase with respect to the wave. The particle detection time and particle energy are recorded for all particles detected by the Si-FNAs. The detail of the system and some phase space structures observed in LHD experiments will be discussed in the meeting.

Fig. 1 Conceptual drawing of wave-particle interaction analyzer (WPIA).