Recent progress of fast-ion loss detector project in magnetic confinement fusion devices in Japan, Korea and China

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Good confinement of fast ions in fusion plasmas is crucial to the success of the fusion reactor since fusion-born α particles play an essential role in steady state sustainment of future burning plasma as a primary heating source. Although unfavorable effect on fast-ion orbit caused by axisymmetry breaking of the system is one of the oldest issues in fusion, attention is now being focused on it again because the non-axisymmetric three-dimensional (3D) perturbed field produced by resonant magnetic perturbation (RMP) is often superposed to mitigate ELMs in recent experiments. Fast-ion-driven MHD instabilities such as toroidal Alfvén eigenmodes (TAE) and energetic-particle modes (EPM) are also of great concern since those can potentially lead to fast-ion loss. For reasons above mentioned, tight collaborative activities on fast-ion physics in fusion were initiated in 2012 in Asian three countries in the support of the A3 foresight program on critical physics issues specific to steady state sustainment of high-performance plasmas. Primary purpose of our activity is to obtain comprehensive understanding of fast-ion transport and/or loss caused by 3D field and fast-ion-driven MHD instabilities in toroidal fusion plasmas. Our immediate goal in the early stage of this program is to set up scintillator-based fast-ion loss detectors (FILDs) onto four major fusion devices in East Asia, i.e., LHD heliotron [1], KSTAR [2], HL-2A [3], and EAST tokamaks. In LHD, TAE/EPM-induced fast-ion losses have been intensively studied by using the FILD [4]. The KSTAR FILD is also successfully working. A study on behavior of fast ions due to RMP field is in the center of attention in KSTAR [5]. A recent big step in our work is that the operation of the FILD on HL-2A has begun lately. The localized bright spot appears on the screen while neutral beam (NB) is injected and disappears after NB is turned off as expected. Also, the measured energy of escaping beam ions matches the beam injection energy. Because EAST will be equipped with an NB injector soon, the design of FILD on EAST is steadily ongoing. The FILD will be installed onto EAST in 2014. In the latter stage of the A3 program, joint experiments will be conducted to reveal common physics issues related to fast ions in tokamak and heliotron/stellarator. In this paper, current status on fast-ion loss detector projects in Japan, Korea and China, and representative results from ongoing activities will be presented.

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