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Fast-ion D alpha diagnostic with enhanced FIDASIM in the Large Helical Device

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A magnetic confinement fusion reactor requires the sustainment of plasma by energetic alpha particles from fusion reaction. Therefore, it is important to understand the behavior of energetic particles in the magnetic confinement device. To investigate the behavior of energetic particles, a Fast-Ion D Alpha (FIDA) diagnostic system was installed on the Large Helical Device (LHD) [1,2]. In LHD, we have conducted hydrogen experimental campaigns since March, 1998. To understanding physics of energetic particles and obtain isotope effects, the deuterium experimental campaigns has been started in LHD since March, 2017. In the FIDA diagnostic, the Doppler-shifted D alpha lights from fast neutrals are utilized as signals of energetic particles, where these fast neutrals are produced by the charge exchange process between fast ions in plasmas and actively induced neutrals by injected Neutral Beam (NB) [3,4]. The advantages of the FIDA diagnostic are the local measurement at the crossing point between its line of sight (LOS) and incident line of NB. An enhanced FIDASIM, which is improved to simulate in a three dimensional magnetic configuration device such as stellarator and helical types, was applied on LHD to analyze the FIDA diagnostic. The FIDASIM was originally developed in an axisymmetric configuration for a two-dimensional magnetic configuration device such as a tokamak type [5]. The FIDASIM requires the distribution function, plasma profiles, magnetic equilibrium and diagnostic geometry. For LHD, a code is developed to produce the inputs files needed to run the enhanced FIDASIM in a three-dimensional magnetic configuration device. We inputted the distribution functions which were calculated by GNET, MORH and MEGA which were the code to simulate the energetic particle behavior. In order to validate the enhanced FIDASIM, measurement of radial profile of fast ions using the FIDA diagnostic was performed in MHD-quiescent plasmas. As a result of the comparison, the FIDA diagnostic results and the enhanced FIDASIM calculation results obtained good agreement on LHD. In the presentation, we will describe current status of the FIDA diagnostic and the enhanced FIDASIM on LHD and representative results.

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