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# Investigation of the effective confinement time of energetic ions in LHD by using neutron measurement and simulation

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Enhancement of the plasma heating efficiency is one of the most important issue for magnetically confined fusion devices. In general, the plasma heating in fusion devices is achieved by the kinetic energy transfer from fast ions, which are generated by the neutral beam (NB) injection, the radio frequency waves, and the fusion reactions, to bulk plasmas through Coulomb collision. To obtain the high efficiency of the plasma heating, fast ions should be confined in plasmas until its kinetic energy is transferred sufficiently. Unfortunately, however, the fast ion confinement often degrades due to several transport mechanisms. For this reason, there are numerous researches, which have performed to clarify the fast ion transport mechanisms.

This paper aims to investigate the fast ion confinement in the Large Helical Device (LHD). Generally, the accurate description of the fast ion transport is very difficult because the fast ion transport mechanism includes several phenomena, which have wide range of time and spatial scale. Therefore, in this paper, we have estimated the effective fast ion confinement time by using neutron measurement and simulation codes.

In LHD deuterium plasmas, fast neutrons are yielded owing to the deuterium-deuterium (D-D) fusion reaction. In present magnetically confined fusion devices including LHD, the fusion reaction between fast ion and thermal ion is dominant. For this reason, we can evaluate the fast ion confinement from the neutron emission rate measurement. We have performed the series of the short pulse NB injection experiment to investigate the effective fast ion confinement time $\tau_n$. The neutron emission rate decays exponentially after NB is turned off. This decay can be explained by two reductions. One is the reduction of the fusion cross-section due to the fast ion slowing down. The other is the reduction of the fast ion density due to the fast ion transport. For this reason, we obtain the following relation: $\tau_n^{-1} = \tau_s^{-1} + \tau_c^{-1}$, where $\tau_s$ and $\tau_c$ denote the time constant of the neutron decay due to the slowing down and transport. The time constant $\tau_n$ can be obtained by the neutron measurement and $\tau_s$ can be obtained by the Fokker-Planck simulation. Analysis result with several magnetic configurations and plasma parameters will be presented.

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