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Energetic-ion Confinement Studies by using Comprehensive Neutron Diagnostics in the Large Helical Device

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Study on neoclassical and anomalous transport of energetic particle (EP) in the Large Helical Device (LHD) has been performed by means of escaping EP diagnostics. By starting deuterium operation of the LHD, confinement study of EPs has remarkably progressed by using newly developed comprehensive neutron diagnostics providing the information of EPs confined in the core region. Time evolution of total neutron emission rate (S_n) following the short pulse neutral beam (NB) injection is reproduced by drift kinetic simulation, indicating that beam ion transport can be described with neoclassical models. The vertical neutron camera (VNC) works successfully, demonstrating that neutron emission profile shifts according to magnetic axis position (R_{ax}). Correlated with helically-trapped EP driven resistive interchange mode (EIC) burst, substantial drop of (S_n) and change of neutron emission profile are observed, indicating the significant loss of helically-trapped beam ion due to the EIC mode. Time-resolved triton burnup study is performed for the first time in stellarator/heliotron so as to understand the alpha particle confinement. It is found that the triton burnup ratio which largely increases at inward shifted configurations is similar to that measured in tokamak having a similar minor radius with the LHD. We demonstrate the confinement capability of EPs toward a helical reactor and expansion of the energetic-ion physics study in toroidal fusion plasmas.

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