Fast ion confinement study by NB blips in the LHD deuterium plasma

Taleo Nishitani[1], Kunihiro Ogawa[1,2], Sadayoshi Murakami[3], Neng Pu[2], Hiroki Kawase[2], Mitsutaka Isobe[1,2], Masaki Osakabe[1,2], and the LHD Experiment Group

[1] *National Institute for Fusion Science, National Institutes of Natural Sciences, Toki, Japan*

[2] *The Graduate University for Advanced Studies, Toki- 509-5292, Japan*

[3] *Kyoto University, Kyoto 615-8520, Japan*

The confinement of neutral beam (NB)-injected fast ions has been investigated by neutron emission rate response to the short pulse NB injection called "NB-blip" at the Large Helical Device (LHD). This method is widely used in tokamaks with deuterium plasma operation, however, this is the first time application to the large size helical systems. Generally, neutron intensity decay time after the NB blip is analysed by a 0-dimensional fast ion slowing down model, where differences of the beam deposition profile for each shot is not taken into account. We have developed a neutron emission rate calculation code FBURN based on the classical slowing down model, which is taking into account of not only the beam deposition profile but also other plasma parameter profiles such as the electron density and the electron temperature, and time evolutions of those parameters. The confinement of NB-injected fast ions is investigated by the discrepancies between measured and calculated neutron emission decay time τ_n after the NB blip and between measured and calculated maximum neutron emission rate S_n during the NB blip. The former is reflected by the collisional diffusion mainly and the later is reflected by the collision-less diffusion and prompt loss mainly. The Large Helical Device (LHD) has five NB injectors. NBI#1, #2, and #3 are tangential direction injectors with typical energy is 180 keV. NBI#4 and #5 are perpendicular direction injectors with typical energies are 60 keV and 80 keV, respectively. In this experiment, NBI#1, #2, #3, and #4 each with the pulse width of 40 ms are injected into different configuration plasmas with various electron densities. It is found that the diffusion coefficient of NB-injected fast ion evaluated from τ_n is 1-3 m^2/s for perpendicular injections and 0.3 m^2/s or smaller for tangential injections, and the diffusion coefficient evaluated from S_n is 2-5 m^2/s for perpendicular injections and 1.5 m^2/s or smaller for tangential injections. Also, the diffusion coefficient increases as the plasma axis is shifted outward.