Beam ion confinement and heat deposition of perpendicularly injected NBI heating in LHD

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Because of the three dimensional magnetic configuration behaviors of trapped particles in a helical ripple are complicated. A good confinement of energetic particles is one of key issues in the development of a reactor based on a helical system. In LHD the neoclassical transport optimized configuration has been proposed by inwardly shifting the magnetic axis position, R_{ax}, from 3.75m to 3.53m[1], in which a good confinement of energetic ion confinement is expected[3]. Thus LHD is the first large size helical device in which the energetic ion confinement can be investigated in the both of the classical (R_{ax}>3.75m) and advanced stellarator (R_{ax}=3.53m) configurations.

The several energetic ion measurement systems based on the neutral particle analyzer (NPA) have been installed and the energetic ion distributions are investigated in the NBI and/or ICRF heating plasmas[2]. However, the measured information by the NPA systems is obtained as an integrated value along a line of sight and the radial profile information is dropped, which is very important for the detail confinement analysis. Thus, a radial profile measurement system is necessary for the energetic ion confinement analysis.

In this paper we study the energetic ion distribution and confinements of perpendicularly injected NBI beam ions in LHD applying a newly developed radial profile measurement system, FICXS (Fast Ion Charge Exchange Spectroscopy) based on the Doppler shifted Balmer-alpha (H_α) emission from the energetic ions charge-exchanged with injected neutral beams. A clear difference is found in the H_α emission spectrum changing the magnetic configurations from the neoclassical optimized (R_{ax}=3.53m)[1] to the classical heliotron (R_{ax}>3.75m) configuration. The results are compared with the GNET simulations[2], in which the drift kinetic equation is solved in 5-D phase space, and show relatively good agreements. Also we show the heat deposition profiles comparing with that of the FIT-3D code, in which the prompt orbits of test particles are followed and the finite orbit effects during the energy slow-down are not included.

References

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