01aP41

Study of ion heat transport with TR-snap code in high-density NBI plasma in Heliotron J

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In magnetically confined fusion plasmas, reduction of ion heat transport is one of the key issues to improve plasma confinement. A high density NBI plasma experiment has been carried out in Heliotron J. It is observed that high-density NBI plasma, obtained by using a High Intensity Gas Puffing (HIGP) scenario [1], has a good property from the viewpoint of ion heating.

The plasma was sustained by Neutral Beam Injection (NBI) from 180ms. After the HIGP (210-220ms), both line averaged electron density ($\bar{n}_e$) and plasma stored energy (W_p) increased significantly, which may be concerned with the improvement of plasma confinement. Figure 1 shows the profile variation of electron density (n_e), electron temperature (T_e) and ion temperature (T_i). After HIGP, n_e increased more than 200%, T_i also slightly increased, T_e decreased about 80eV in core region.

To study the transport characteristic of HIGP discharge, a one-dimensional diffusive transport module (TR-snap code) [2], which based on the power balance analysis is being used. The effective ion heat transport coefficient, which ignored the particle flux, energy loss, energy equilibrium is show as follow equation:

$$\chi_i^{eff} = -\frac{\int P_i^{NBI}(\rho)V'd\rho}{\langle|\nabla\rho|^2\rangle V' n_i(\rho)\frac{\partial T_i(\rho)}{\partial\rho}}$$

where ρ, $n_i(\rho)$, $P_i^{NBI}(\rho)$ is the normalized minor radius, profile of ion density and NBI heating power absorbed by ion.

The variation of effective ion heat transport coefficient after HIGP are shown in figure 2. The χ_i^{eff} (252ms) decreases more than 40% after HIGP injection, which implies a significant improvement of energy confinement.

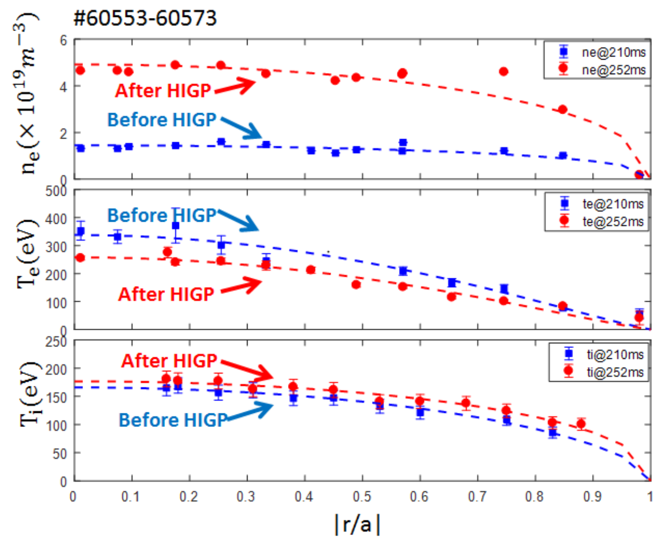

Fig.1. The profile variation of n_e, T_e and T_i after HIGP

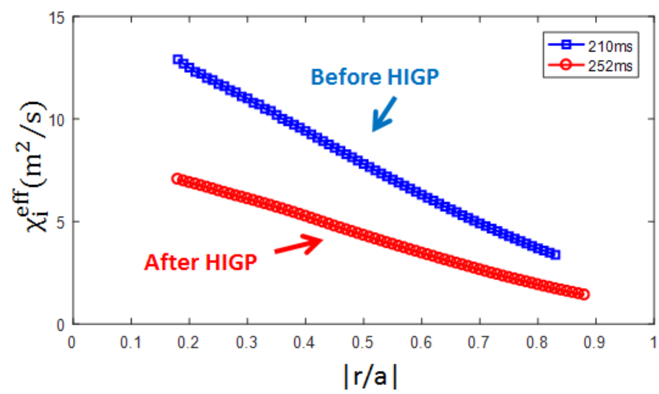

Fig.2. The profile variation of effective ion heat transport coefficient

[1] T. Mizuuchi, et al., IAEA-CN-221/EX/P4-29 (2014).
[2] S. Ryosuke, et al., *Plasma Fusion Res.* **6**, 2402081 (2011).