Configuration effect on energetic particle and energy confinement in NBI plasmas of Heliotron J

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For the optimization of helical/stellarator magnetic configurations toward the reactor design, it is important to reduce the ripple loss of energetic particle and control the neoclassical transport since the magnetic field has three-dimensional structure. The Heliotron J device [1,2] is medium sized heliotron device with an L/M=1/4 helical coil to expl
ore the concept of optimization of helical-axis heliotron configuration [3,4]. The control of bumpiness (toroidal mirror ratio; B_{04}/B_{00}) has an important role in the energetic particle confinement and neoclassical transport in the helical-axis heliotron configuration [3,4]. In this paper, we discuss the effect of the bumpiness on the energetic particle transport and the global energy confinement in the NBI plasmas of Heliotron J.
The bumpiness scan experiment has been carried out using three configurations with different bumpiness of 0.01 (low), 0.06 (medium) and 0.15 (high) at $\rho = 2/3$. It has been found that the 1/e decay time of the high energy CX flux after the NBI turn-off increases with increasing bumpiness. The experimental result was consistent with that of the numerical calculation, that is, the collisionless orbit calculation predicted that the life time of the trapped particle became longer as bumpiness increased.
In the counter-NBI plasmas at the averaged electron density of $2\text{x}10^{19}$ m^{-3}, the energy confinement time of bulk plasma has been compared among the three configurations. In the high and medium bumpiness configurations, a clear high stored energy has been obtained than that in the low bumpiness case. The enhancement factor of the experimental energy confinement time to the international stellarator scaling law ISS95 was 1.8 and 1.7 in the high and medium bumpiness configurations, respectively, which was higher than that for the low bumpiness case. In the case of the high and medium bumpiness conditions, the ion temperature deduced by charge-exchange (CX) neutral particle analysis was relatively higher than that in the low bumpiness case. The electron cyclotron emission measurement at the core region indicates increase in the electron temperature both in high and medium bumpiness case. The difference in the ion temperature should be attributed to the difference in the energetic ion confinement due to the control of bumpiness. Since the discharges were done in electron-heating regime of NBI, the electron temperature should have a dependence on the energetic ion confinement. The increase in the ion and electron temperature contributes to the increase in the stored energy toward bumpiness.

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