§43. Ion Heating Experiments Using a Perpendicular Neutral Beam Injection in LHD

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In 9th experimental campaign of LHD, a perpendicular neutral beam injector (P-NBI) with the port through power of 3MW was installed in 5-O port of LHD. Two ion sources produce positive ions and accelerate them up to 40keV. The P-NBI has a higher ion heating efficiency than the negative-ion-based NBI (N-NBI) and the clear ion temperature increase due to the P-NBI was observed in 9th experimental campaign.

In 10th experimental campaign, two ion sources were installed additionally and the port through power was increased up to 6MW. This increment of beam power made significant progress of production of high-ion-temperature hydrogen plasmas and measurement of ion temperature profile using charge exchange spectroscopy. The beam power modulation was used for the charge exchange spectroscopy and improved the data quality.

Ion heating experiment using only P-NBI was performed and the ion temperature increase with heating power was observed, which is shown in Fig. 1. The ion heating experiments using P-NBI, N-NBI, and ICRF were performed and the high ion temperature of 5.2keV with the plasma density of $1x10^{19}m^{-3}$ was achieved, which is a new record in helical devices. The relatively high ion temperatures were also obtained with higher plasma density. The density dependence of ion temperature and electron temperature are shown in Fig. 2. The ion temperature slowly decreases with the plasma density, and is almost 3keV with the density of $4x10^{19}m^{-3}$. The electron temperature is lower than ion temperature in the low density under $2x10^{19}m^{-3}$ and is almost same to the ion temperature in the higher density. It is understood by decrease of equipartition time in high density plasmas.

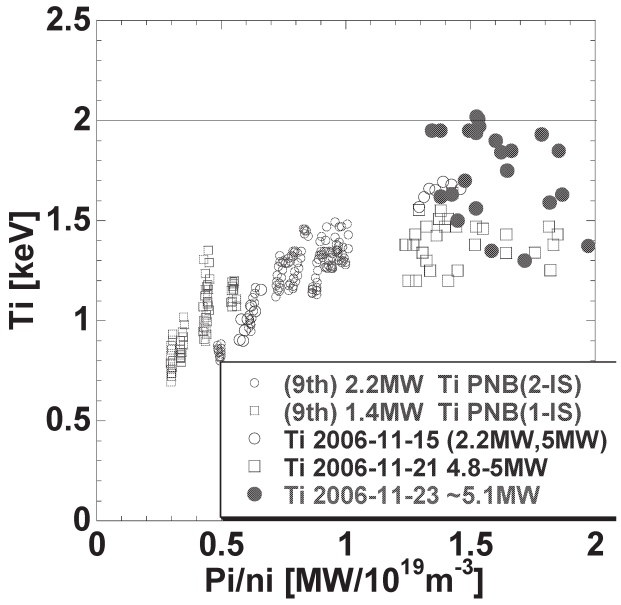

Fig. 1 The ion temperature at the center of the P-NBI heating plasmas as a function of ion heating power normalized by the density.

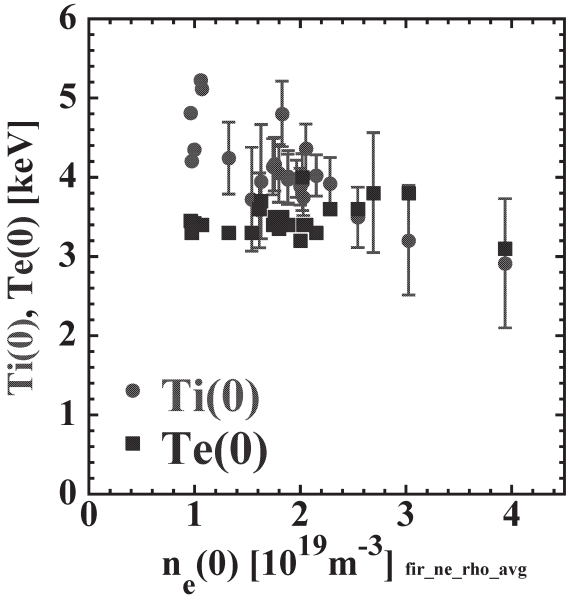

Fig. 2 The ion and electron temperatures at the center of the plasma as a function of electron density at the center.