§21. Recent Progress on High Ion Temperature Experiment with High-Z Discharge in LHD

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High ion temperature experiment with high-Z discharge progressed year by year. We have achieved the ion temperature 10 keV in the 7th experimental campaign [1). Three negative-ion-based neutral beam injectors are arranged tangentially in LHD. The neutral beam power is mainly deposited on electrons due to the high-energy hydrogen neutral beam of 180 keV. It is important to increase the ion-heating power in order to increasing the ion temperature. High-Z discharges used Ar or Ne are effective to increasing of ion heating power in the low electron density plasma below $0.5x10^{19}m^{-3}$. It is also important to reduce contamination of the neutral particle from the wall in order to maintain high beam absorption in the low-density plasma. The Ar- and Ne-glow discharge cleaning have been carried out 41 hours and 22 hours in front of the experiment day, respectively.

Figure 1 shows the time evolution of the density and the temperature of the shot number 54878th on the Ar-puffed plasma with the magnetic field axis of 3.7m. The electron density measured by a far-infrared interferometer, is build up by the short Ar gas puffing. The beam power of 8.7MW of the injected power of 10.5MW is absorbed in the plasma. The central ion temperature rapidly increases as the density decreases, and reaches the new record of 13.5 keV where the ion temperature is measured with the Doppler broadening of ArXVII. The electron temperature measured by the Thomson scattering, is 4.5 keV, it is lower than the ion temperature due to the dominant ion heating. The neutral beam heating at the 8^{th} experimental campaign

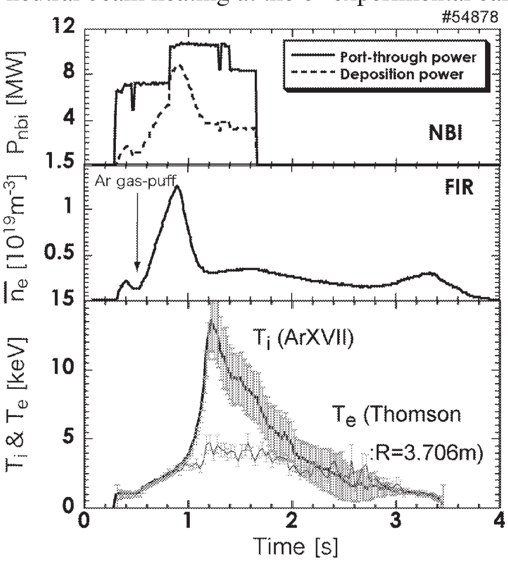

Fig. 1 Time evolution of the density and the temperature in an Ar gas-puffed plasma. The neutral beam power of 10.5 MW is injected totally

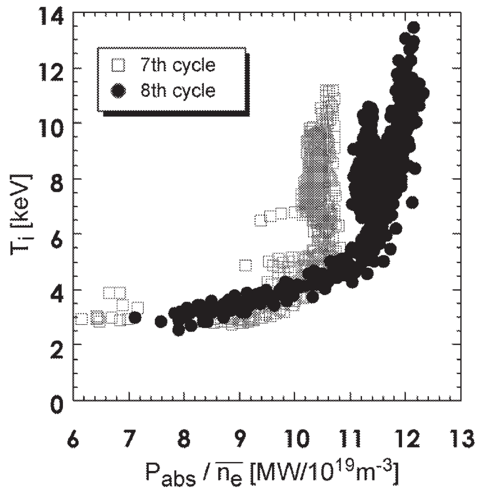

Fig. 2 Ti against absorbed NBI power normalized electron density on the Ar-puffed plasma in the 7^{th} and 8^{th} experimental campaign.

is more effective to the heating at 7^{th} experimental campaign as shown in Fig.2. As the result, the ion temperature increase as the ion heating power per unit density increases. It is indicate that the intensive Ar- or Ne-glow discharge wall conditioning is effective to keep the low density.

Characteristic of the ion temperature with high-Z discharge is researched well in the case of the magnetic field axis below 3.7m. The ion temperature well rises due to the density peaking in case of the magnetic field axis of 3.7m. Figure 3 shows the effect of the neutral beam heating on the Ne-puffed plasma with various magnetic field axes outside of 3.7m. In the case of 4 m, the ion temperature dose not increases as the heating power increases because of the bad confinement. The ion temperature with the case of 3.85m well rises as the case of 3.7m. If it can maintain density low, we expect to produce higher ion temperature by using the Ar-puffed discharge.

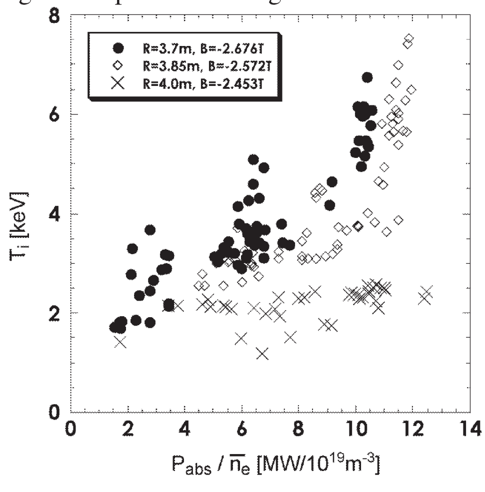

Fig. 3 Ti against absorbed NBI power normalized electron density in various magnetic field axes on Ne-puffed discharge plasma.

1) Y. Takeiri, et al., 20^{th} IAEA Vilamoura, 2004, EX/P4-11