§47. Fueling Pellet Injector for LHD

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A fueling pellet injector has been installed for LHD in the second campaign of LHD experiment [1]. The pellet injection in the NBI heated plasma was carried out 33 times during second campaign. The density-clamping and/or pumping-out is pronounced in hydrogen discharge at standard magnetic configuration under the 1.5 T operation. It is difficult to carry out effective fueling by using only gas puffing. The pellet fueling could extend the experimental region to the high density. Fig. 1 shows the maximum line-average density of NBI heated plasma. The maximum line-average density with pellet injection was about 1.5 times higher than that was without pellet injection.

Fig. 2 shows the temporal evolution of plasma stored energy (W_p), electron temperature (T_e) and line-average electron density ($\bar{n}_e$) with hydrogen pellet. The target plasma was heated by NBI with power of about 3 MW and has the properties of typical hydrogen discharge with density-clamping. The pellets (8×10^{20} atoms) were injected at 460 ms (just before the density-clamping and maximum density) for #6115 and at 800 ms (steady state) for #6126 with velocity of 1000 m/s. The central electron temperature of the target plasma was 0.8 keV at 460 ms and 1.4 keV at 800 ms. Electron density increased discontinuously, while electron temperature dropped discontinuously. The plasma stored energy started to increase clearly after pellet injection.

The deposition profiles of the pellet ablation were determined by the FIR Laser interferometer measurement at 0.5 ms before and after the ablation of pellet (see Fig. 3). In the case of $T_e(0)$=0.8 keV (#6115), the pellet is ablated near the plasma center, but the pellet is ablated in the periphery (ρ=0.8) in the case of $T_e(0)$=1.4 keV (#6126). Theoretical prediction of pellet ablation by a neutral gas shielding model (NGS) expressed as follows,

$$\frac{dr_p}{dt} \propto T_e^{1.64} n_e^{0.33} r_p^{-0.67}.$$

The ablation rate strongly correlates with electron temperature. Experimental result is qualitatively consistent with the NGS model.

The fueling efficiency determined by volume integration of deposition profile is about 90 % in the case of #6115 and about 70 % in the case of #6126.

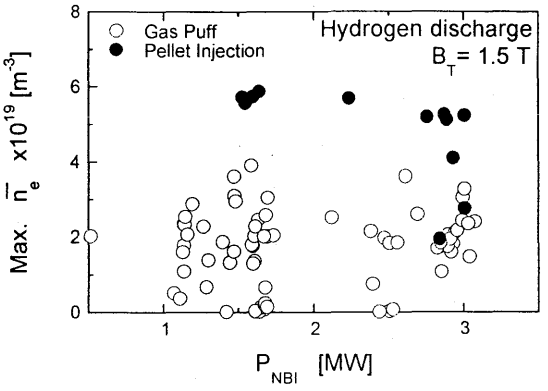

Fig. 1. The maximum line-average density of NBI heated plasma.

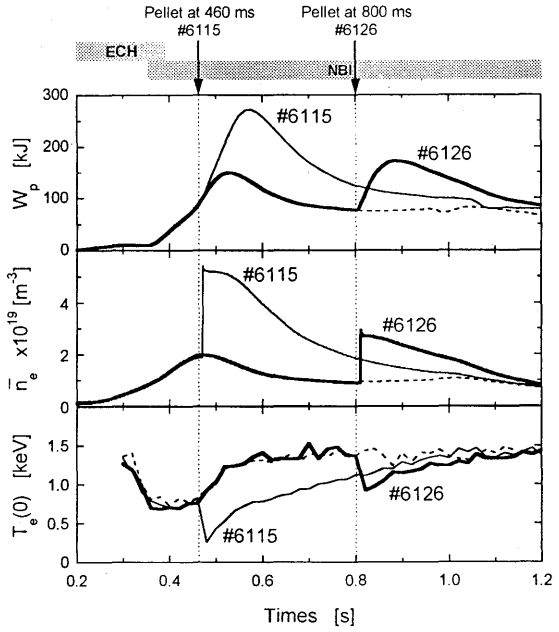

Fig.2. The temporal evolutions of plasma parameter with 8×10^{20} hydrogen pellet. The broken lines show the target plasma (#6065). Pellets were injected at 460 ms for #6115 and 800 ms for #6126.

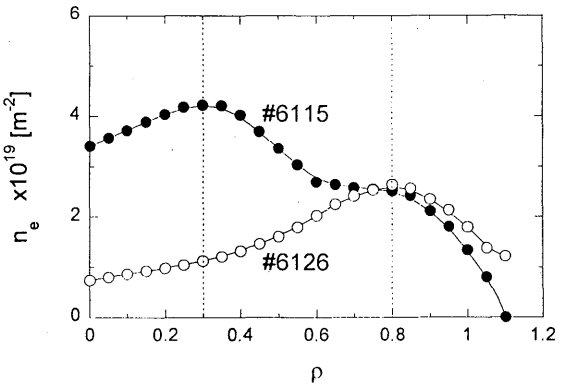

Fig. 3 The deposition profiles from FIR Laser interferometer data.

Reference

[1] Sakamoto, R. *et al.*, Annual Report of NIFS, April 1998 - March 1999, (1999).