§6. Effects of Neon Injection on Plasma Confinement in LHD

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When neon gas was injected into the LHD plasmas locally from the strong field side at the plasma start-up phase, it was observed that the increase in the stored energy, W_p, became steep. Figure 1 shows time evolution of some plasma parameters, (a) W_p, (b) averaged electron density, $\bar{n}_e$, and (c) radiation power, P_{rad}, for neon-puffed discharges. Two discharges are plotted here. The full curves (#15389) represent a discharge with the early neon injection and the broken curves (#15371) represent the case of the later neon injection. The magnetic axis strength was 2.75 T and its position was $R = 3.60$ m. The ECH, ICRF and NBI pulses are also plotted. The n_e signal began to increase from about 0.25 s after the injection time. It is considered that neon gas may be puffed for 1 $\sim$ 2 seconds. The increment in n_e after the neon puff was $1 \times 10^{19}\,\mathrm{m}^{-3}$. In the P_{rad} signal of the #15389 shot, a steep peak was observed at $t \simeq 0.5$ s. After this peak of P_{rad}, $\bar{n}_e$ also showed a peak at $t \simeq 0.56$ s. Then W_p became maximum at $t \simeq 0.70$ s. The stored energy of #15389 was larger than that of #15371 by about 1.2, which is similar to the ratio of $\bar{n}_e$ at that time.

Figure 2 shows the electron temperature, T_e, profiles of similar discharges to those of Fig.1 at the timing of the radiation peak ($t = 0.48$ s (•)) and after P_{rad} became almost steady ($t = 0.58$ s (○)). At $t = 0.48$ s, in the region of the major radius, $R \geq 4.3$ m, T_e was lower than 100 eV. But the T_e profile recovered to the extent of $R \simeq 4.63$ m at $t = 0.58$ s. The electron density, n_e, profiles of the two discharges in Fig. 1 are shown in Fig. 3. The closed circles represent the earlier puff case and open circles represent the later case. In the earlier-puff case, n_e was high at the central region. Moreover, a gradient existed in the region of $\rho \geq 0.7$. At $t = 0.70$ s, when W_p became maximum, the profile in outer region ($\rho \geq 0.85$) were almost same. But the n_e profile of the earlier-puff case was peaked in the central region. As T_e in the peripheral region decreased, the neutral particles easily penetrate into the main plasma, then n_e increased and high W_p was observed. Therefore the discharges which showed the high radiation peak at plasma start-up phase had steep increment in W_p.

Here, we discussed mainly about at the start-up phase of the discharges. The amount of puffed neon gas of the two discharges in Fig. 1 were almost same. The amount of neon is estimated by the comparing the radiated power with the results of impurity transport calculations. An example showed that the ratio of neon to the central n_e may be about 6%. This value is maximum because impurities other than neon were not included. The plasma confinement seemed to be improved transiently. But the n_e and W_p signals in the latter half of these discharges were close to each other. So the effect of neon on the global plasma confinement is considered to be small. The local transport analysis of neon-injected plasmas is now studied.

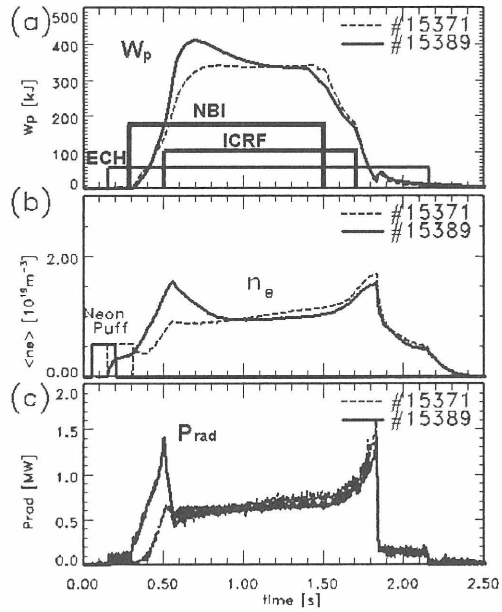

Fig. 1. Time evolution of some plasma parameters for neon-puffed discharges. (a) stored energy (b) averaged electron density (c) radiation power

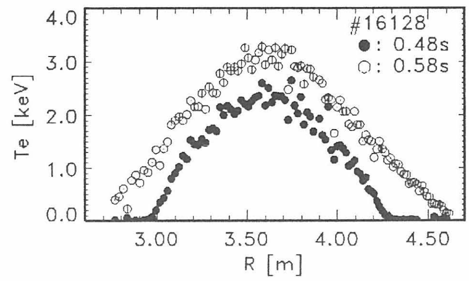

Fig. 2. The electron temperature spatial profiles at two different times after the neon injection.

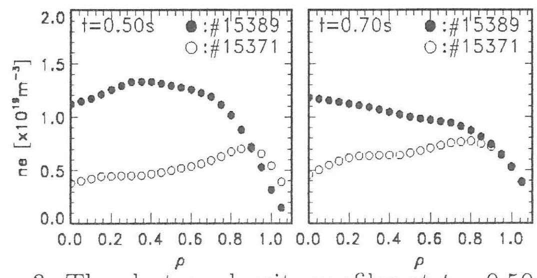

Fig. 3. The electron density profiles at $t = 0.50$ s and 0.70 s. Two discharges are compared. (• : the earlier puff case, ○ : the later puff case)