

(2) Mission Research Themes

§1. Extension of Operational Regime in High-*T*₁ Plasmas in the LHD

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Realization of high- T_i plasmas is one of the most important issues in helical plasmas, which have an advantage for steady-state operation comparison with plasmas. newly tokamak Since 2010, installed perpendicular-NBI with the beam energy of 40 keV has been operational in the LHD and the total-heating power of perpendicular-NBIs increased from 6 MW to 12 MW. Such low-energy NBIs are effective for ion heating and enabled us to achieve a higher T_i than that obtained previously [1]. In the last experimental campaign, ICRH-discharge cleaning was adopted to reduce particle recycling from the wall. As a result, NBI-heating-power profile became peaked and the density-normalized ion heating power in the core region increased by 18%.

In the LHD, high- T_i plasmas have been realized in combination with a carbon pellet [1-3]. The kinetic-energy confinement was improved by a factor of 1.5 after the pellet injection. Figure 1 shows the typical time evolution of (a) the port-through NB power, (b) line-averaged-electron density, (c) the radiation power, (d) the plasma stored

 $T_{
m e0}$ [keV] $W_{
m p}$ [MJ] $P_{
m rad}$ [MW] $~n_{
m e_{
m fir}}~~P_{
m NB}$ [MW] (a) #110599 Tang. x3 10 ب-0 E 2 (b) pellet 0 0.5 (d) 0 4 2 8 T_{_Cxs} [keV] 4.6 4.7 4.8 4.9 5 5.1 5.2

Time [s]

energy, (e) T_{e0} , (f) T_{i} , (g) the radial profiles of T_{i} , T_{e} and n_{e} in the high- T_i discharges, which recorded the highest T_{i0} and (h) the progress of the achieved T_{i0} in the LHD as the dependence of T_{i0} on the density-normalized ion heating power $P_i/\langle n_i \rangle$. The plasma was sustained by three tangentially injected NBs and two perpendicularly injected NBs with the total-port-through power of 27 MW and the column-shaped C pellet ($\phi = 1.0$ mm, l = 1.0 mm) was injected at t = 4.57 s. One line of the perpendicular NBIs was modulated for T_i measurement by CXRS. After the pellet injection, the central T_i , dT_i/dr_{eff} at the core region clearly increased indicating the formation of the ion-ITB. On the other hand, there was little change in $T_{\rm e0}$. The radiation power increased just after the pellet injection but went back to the previous level due to the formation of the impurity hole. Ion temperature of 7 keV at the plasma center was successfully obtained and the achieved T_{i0} has been increasing approximately linearly with $P_i < n_i >$.

ICRH-discharge conditioning exerted a preferable effect also on quasi-steady-state operation of high- $T_{\rm i}$ discharges without C-pellet injection. The sustain time of the plasma with $T_{\rm i0} > 4.5$ keV has been successfully extended to 1 s from 0.5 s, which is the previous record, even the $P_{\rm NB}$ was 4 MW lower than that of the previous one.

- 1) O. Kaneko et al.: Plasma Fusion Research 4 (2009) 027.
- 2) K. Ida et al.: Nucl. Fusion, 49 (2009) 095024.
- 3) K. Nagaoka et al.: Nucl. Fusion, 51 (2011) 083022.

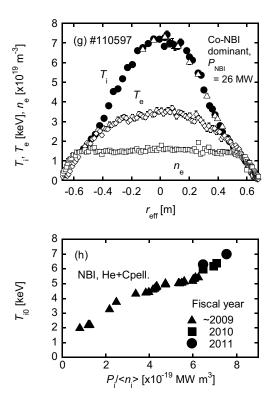


Fig. 1. The typical time evolution of (a) the port-through NB power, (b) line-averaged-electron density, (c) the radiation power, (d) the plasma stored energy, (e) T_{e0} , (f) T_{i} , (g) the radial profiles of T_{i} , T_{e} and n_{e} in the high- T_{i} discharges, which recorded the highest T_{i0} and (h) the progress of the achieved T_{i0} .