§3. Realization of High T_i Plasmas Using RF Wall Conditioning in the Established Confined Magnetic Field in the LHD

Takahashi, H., Osakabe, M., Nagaoka, K., Nakano, H., Tokitani, M., Takeiri, Y., Seki, T., Saito, K., Kasahara, H., Seki, R., Kamio, S., Masuzaki, S., Mutoh, T., Murakami, S., Fujii, K. (Kyoto Univ.)

It has been recognized that a wall condition substantially affects the plasma performance in the toroidal system. In the LHD, high performance plasmas e.g. super dense core plasmas and high ion temperature plasmas have been realized due to the peripheral particle control technique such as local island diverter, glow discharges, titanium gettering and wall conditioning using NBIs[1)-3)]. Recently, higher ion temperature (T_i) plasmas, which were produced using high power NBIs, were found to be obtained using a series of RF wall conditioning discharges on ahead[4), 5)].

The RF wall conditioning was carried out using Ion Cyclotron Range of Frequency (ICRF) heating and/or Electron Cyclotron Resonance Heating (ECRH) with the working gas of helium under the confinement magnetic field of ~2.75 T. The RF power of ICRF heating and ECRH to produce and sustain the conditioning plasma was ~1 MW each and the pulse duration was at most 10 s. The presence of the established main magnetic field, the higher power input and the shorter pulse duration were the different points from the conventional glow discharge conditioning. After enough numbers of repetitive wall conditioning discharges, the decrease of line-averaged electron density (n_e), the formation of the peaked n_e profile, the reduction of the H_α emission, the decrease of neutral hydrogen density in the whole plasma region and the increase of the central T_i were observed. These results represent that the stored hydrogen inside the vacuum vessel structures such as the first wall, the diverter and the other components was sputtered out by the helium plasmas of the RF wall conditioning discharges then the hydrogen recycling was decreased. As a consequence, the ion heating power of NBI increased in the plasma core region due to the n_e peaking and to the decrease of the charge exchange loss of the NBI-high-energy particles, leading to the realization of the higher central T_i.

The preferable effect described above were confirmed both in the ICRF and ECRH conditioning discharges and there was no clear difference in the attained central T_i of the NBI discharge just after the conditioning using almost same input energy regardless of the applied RF source as shown in Fig.1. Thus it is concluded that both the ICRF heating and the ECRH are effective for the higher T_i plasma production under the established magnetic field in the LHD.

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2) Masuzaki, S. et al.: Fusion Sci. Technol. **58** (2010) 297.
3) Nagaoka, K. et al.: Nucl. Fusion, **51** (2011) 083022.
4) Takahashi, H. et al.: Nucl. Fusion **53** (2013) 073034.
5) Nagaoka, K. et al.: submitted to Journal of the Korean Physical Society.

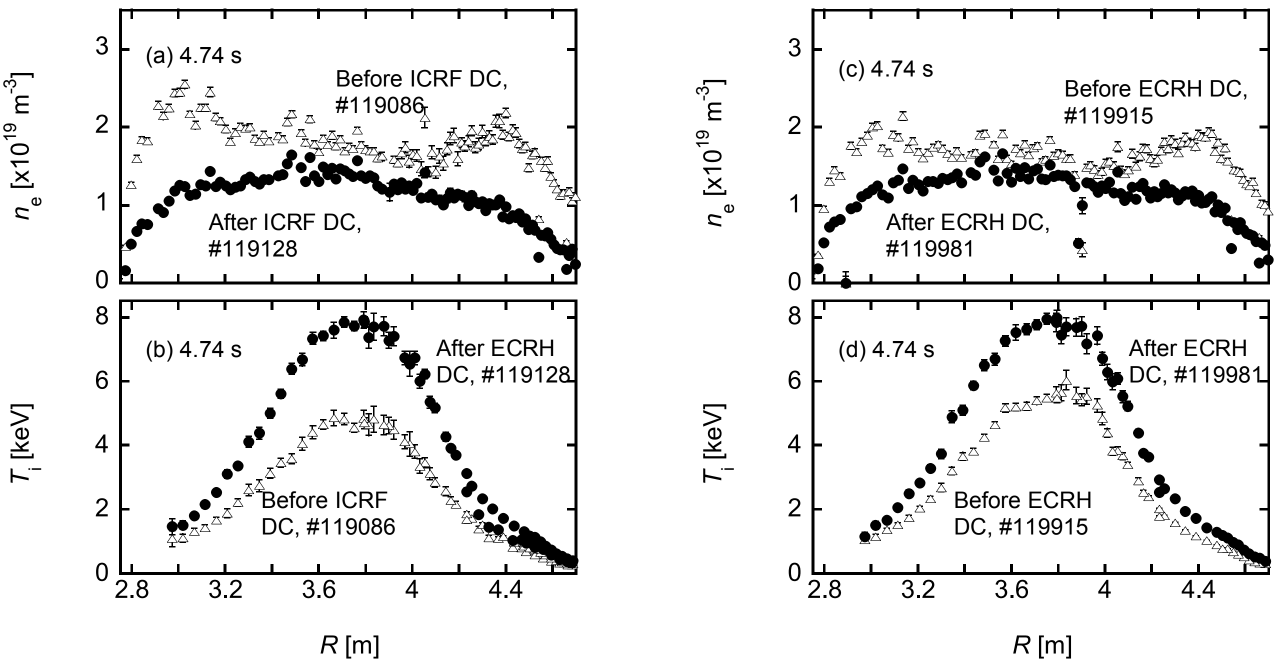

Figure 1. The comparison of the redial profiles of n_e and T_i produced by NBI just before and after the wall conditioning using (a), (b) ICRF and (c), (d) ECRH. The triangle and the circle symbols represent the data before and after the wall conditioning, respectively.