§10. Modification of Electron Temperature Profile by Synergy Effect of ECCD and NBCD

Yoshimura, Y., Nagasaki, K. (Kyoto Univ.), Ogawa, K., Du, X.D., Osakabe, M., Igami, H., Seki, T., Kubo, S., Shimozuma, T., Takahashi, H., Nishiura, M., Ogasawara, S., Makino, R., Kobayashi, S., Ito, S., Mizuno, Y., Okada, K., Yamada, I., Sakakibara, S., Motojima, G., Ida, K., Tanaka, K., Mutoh, T., Yamada, H.

In LHD, conditions for the formation of internal transport barrier for electrons (e-ITB) have been investigated from the aspects of such as NB direction, profile of rotational transform ι, deposition region of electron cyclotron heating (ECH).[1] Recently the effect of electron cyclotron current drive (ECCD) on the e-ITB formation was reported.[2] In LHD 16th experimental campaign, it was found that a synergy effect of ECCD and NBCD also affect the profiles of electron temperature T_e.

The magnetic configuration of the experiment was, R_{ax} = 3.6 m with B = −1.375 T for second harmonic ECH and ECCD. 77 GHz EC-waves injected from 9.5-U port (1 MW) and NBI#2 (counter (ctr), 3.7 MW) generated and sustained plasmas from the timing t = 3.3 s. Then co- or ctr-ECCD by use of 77 GHz EC-waves injected from 2-O port (0.76 MW) was additionally applied from t = 3.8 s. Direction of NB injection was switched from ctr (#2) to co (#1, 5.6 MW) at t = 4.8 s. ECH from 9.5-U and ECCD were terminated at t = 5.8 s. An example, ctr-ECCD case here, of the ECCD discharges is seen in Fig. 1.

The variation of the electron temperature profile obtained in the experiment is summarized in Fig. 2. When both the CDs are in the same direction (ctr-NBCD + ctr-ECCD or co-NBCD + co-ECCD), center-peaked T_e profiles

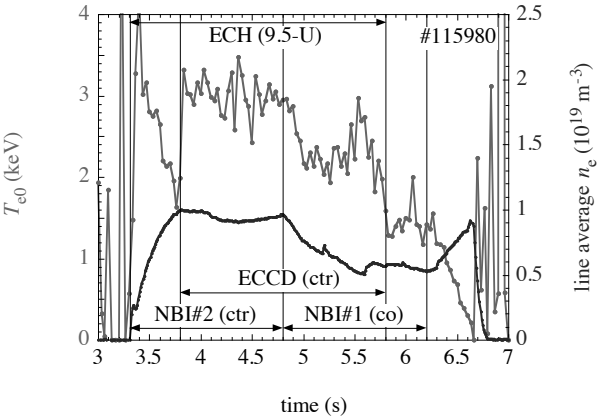

Fig. 1. Waveforms of T_{e0} (red) measured with Thomson scattering diagnostics at R = 3.615 m and line average electron density (blue) in the ctr-ECCD discharge #115980.

are formed, while when the CDs are opposite (ctr-NBCD + co-ECCD or co-NBCD + ctr-ECCD), the profiles are center-rounded. As the cause of the T_e profile change, ι profile and/or existence of the rational surface of m/n = 2/1 may be excluded, because co + co and ctr + ctr cases work oppositely for the modification of ι profile. Also, the time constant of ~100 ms for changing the T_e profile (see Fig. 1) is much faster than that of a few hundreds ms for changing ι profile. In the next experimental campaign in 2013, obtaining the data set such as time evolutions of ι and potential profiles will be tried to investigate the cause and mechanism of the change in T_e profile. This investigation will also contribute to the study on the e-ITB formation.

1) Shimozuma, T. *et al.*: Nucl. Fusion **45** (2005) 1396.
2) Igami, H. *et al.*: EPJ Web of Conf. **32** (2012) 02006.

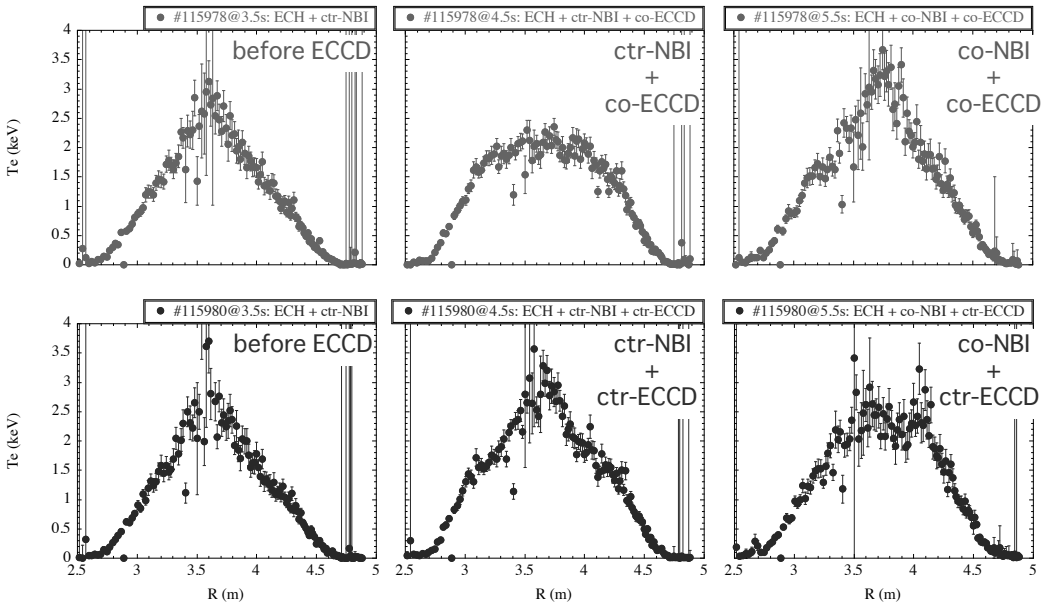

Fig. 2. Variation in the electron temperature profile in the co-ECCD (upper figures, #115978) and counter-ECCD (lower figures, #115980) discharges at the timings of 3.5 s (left, no ECCD), 4.5 s (center, ctr-NBCD + ECCD) and 5.5 s (right, co-NBCD + ECCD).