§76. Effects of the Local Modification of the Rotational Transform by ECCD on the Formation and Sustainment of the e-ITB and Characteristics of the Heat Pulse Propagation

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Effects of the local modification by electron cyclotron current drive (ECCD) on the formation and sustainment of the electron internal transport barrier (e-ITB) was investigated for the first time. Characteristics of the heat pulse propagation were also investigated with use of the modulated electron cyclotron heating (MECH). In the experiment, the target plasma was sustained by balanced tangential neutral beam injection (NBI) and co / counter(cntr.) ECCD and 25Hz MECH from 3.3s to 4.8s. The launched power was about 1MW for ECCD and 0.5MW for MECH. The line averaged electron density was 0.7~0.75 x10^{19}m^{-3}. The magnetic configuration was (R_{ax},B_t) =(3.6m, 2.75T) where R_{ax} is the position of the magnetic axis and B_t is the magnetic field strength at the magnetic axis.

For the case of co ECCD, in the early phase of the discharge, the e-ITB was formed. However, the electron temperature T_e near the magnetic axis suddenly dropped and a flat T_e profile was observed in the core region as shown in Fig. 1 (MECH+Co ECCD, 4.1s). In Fig. 1 the power absorption profile of ECCD estimated by ray-tracing calculation with use of the dispersion equation in the hot plasma is shown. It indicates that the current is driven near the magnetic axis. The rotational transform $\iota/2\pi$ profile obtained by motional Stark effect (MSE) measurement was raised by co-ECCD in the core region to be close to 0.5. The phase delay of 25Hz modulated heat pulse obtained by the FFT analysis does not change in the region where the T_e profile is flat. These results suggest that the stochastic region appears in the core region with formation of a large magnetic island. During the balanced NBI and co-ECCD for two seconds, the e-ITB was not formed unless the additional 1MW electron cyclotron heating (ECH) was applied from 4.3s. (MECH+Co ECCD+ECH, 4.7s) From 4.3s to the end of the discharge at 4.8s, the e-ITB was sustained.

For the case of cntr. ECCD, the e-ITB was formed in the early phase of discharge and was sustained through the discharge for two seconds. No additional ECH is required to sustain the e-ITB. As shown in Fig. 1 (MECH+Cntr. ECCD, 4.7s) In the core region, $\iota/2\pi$ is separated from 0.5 by cntr. ECCD. Flattening of the T_e profile was not observed in this case.

The change of the phase delay of the 25Hz modulated heat pulse is large inside $\iota/2\pi$ = 0.5 rational surface for the case of cntr. ECCD. The region of good confinement spreads to the $\iota/2\pi$ = 0.5 rational surface. On the contrary, the change of the phase delay is not large in inside $\iota/2\pi$ = 0.5 rational surface when the e-ITB is formed by additional ECH for the case of co ECCD. The local flattening of the T_e profile is shown $0.3 < \rho < 0.5$ inside $\iota/2\pi$ = 0.5 rational surface. The magnetic island might remain after the e-ITB was formed.

Since in the region of $\rho < 0.25$ fluctuations appear in ECE signals, the FFT analysis is not appropriate to analyze the heat pulse propagation. Analysis of these fluctuations is required to investigate the characteristics of thermal transport inside the region of steep T_e gradient near the magnetic axis.

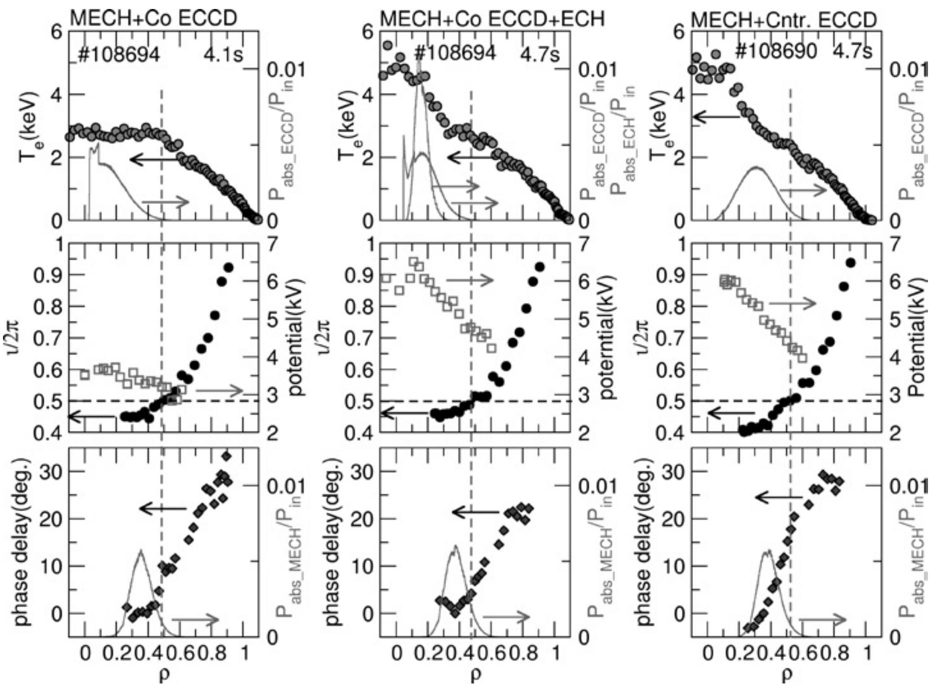

Fig. 1. (From the top) Profiles of the electron temperature (T_e) and power absorption of ECCD. additional ECH. Profiles of the rotational transform ($\iota/2\pi$) and plasma potential. Profiles of the phase delay of 25Hz modulated heat pulse and power absorption of MECH.