§ 5. Transition Phenomena of Plasma Confinement by External Perturbation in Electron Cyclotron Heated Plasmas

Shimozuma, T., Idei, H., Kubo, S., Inagaki, S.,
Yoshimura, Y., Notake, T.
Ohyama, N., Fujita, T., Fukuda, T. (JAERI)

Transition phenomena of plasma confinement have been observed in the EC heated plasmas with an internal transport barrier. The external perturbation methods, such as ECH power ramp down/up , additional ECH, density modulation, pellet injection and so on, are powerful methods to investigate the ITB characteristics. In these experiments several interesting transition phenomena were observed. In this report ECH power ramp down/up and additional ECH experiments are described.

The target plasma was NBI-sustained low density plasma with $\overline{n_e} = 0.6 - 0.8 \times 10^{19}\mathrm{m}^{-3}$ and $T_{e0} \sim 2$ keV. The magnetic axis was placed on R=3.5 m, and the field strength was 2.854 T on the axis.

The 82.7 GHz/280 kW ECH power was injected from 1.16 to 1.66 s as shown in Fig. 1. The time evolution of the electron temperature measured by multi-channel ECE radiometers is plotted in the figure. During the pulse the 82.7 GHz power was gradually ramped down from 1.36 to 1.41 and ramped up to the previous power level for 50 ms. The variation of the power ΔP_{ECH} was approximately 140 kW. The temperature at the center fell and rose along with the power ramp down/up. Around the bottom of the power level a small crash was noticed in the plasma core. No obvious transition was observed on this power change and down/up time rate. The back transition phenomenon, however, appeared at $t = 1.82$ s. It was about 160 ms after all ECH powers were switched off. The peaked profile of the electron temperature decreased continuously and abruptly crashed at this time point. The heat flux looks to flow from the core to the periphery. The inversion radius of the ECE signals locates on $\rho \approx 0.5$, which roughly corresponds to $\iota/2\pi = 2/3$ surface.

Another example of the external perturbation to ITB plasmas is an additional heating of 168 GHz power. The 84 GHz range/800 kW ECH was switched on during 1.16-1.66 s, then the 168 GHz/400 kW/0.2 s power was superposed from 1.3 s as shown in Fig. 2. During these experiments distinctly different shots were observed. Figure 2 indicates the time traces of ECE radiometer signals for such shots. The upper figure shows the formation of the ITB, while the lower case is the one without ITB. There is no difference in these shots except the fact that the upper case had a higher electron density than the lower case. The high T_e state started from the first 84 GHz range ECH injection in the upper case. Some initial MHD activities could affect whether the transition to high T_e state occurs after ECH on. More detailed investigation is needed for deeper understanding.

At the end of 84 GHz pulse of the lower case, the central ECE signal jumped up to high level. The spontaneous transition to the high T_e state triggered by a little density decrease.

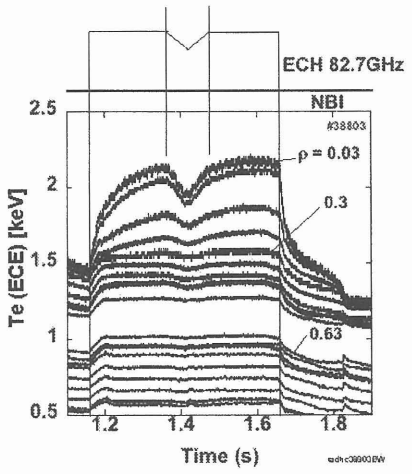

Fig. 1: ECH power ramp down/up experiment. Time evolution of ECE radiometer signals are plotted for several radial positions.

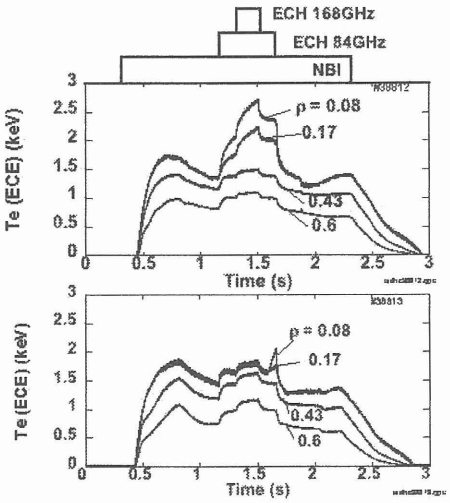

Fig. 2: Additional heating of 168 GHz to the ITB plasma. Two different kinds of shot were observed. One was realization of central high T_e, another was worse confinement.