§19. Response of Magnetic Island to Localized Electron Cyclotron Heating

Isayama, A. (Japan Atomic Energy Agency),
Inagaki, S. (Kyushu Univ.), Kubo, S., Sakakibara, S.

Control of magnetic island is important since the magnetic island can affect the confinement and achievable beta. The aim of this study is to investigate the response of magnetic island to external perturbations and compare with magnetic island observed in JT-60U. In this experimental campaign, the effect of localized island heating by electron cyclotron heating (ECH) was investigated.

Figure 1 shows a typical plasma configuration, where the toroidal field is 2.75 T, and the location of magnetic axis is 3.6 m. By injecting 82.7 GHz electron cyclotron (EC) wave from the 9.5U port, the EC wave is deposited at the O-point of an m/n=2/1 island, which is formed at ρ=0.4-0.5. Here, m and n are the poloidal and toroidal mode numbers, respectively, and ρ is normalized minor radius. By injecting 82.7 GHz EC wave from the 5.5U port, the EC wave is deposited at the island X-point. In experiments, modulated ECH (MECH) with the frequency of ~30 Hz was also done to evaluate the island width by observing heat wave propagation using the electron cyclotron emission (ECE) diagnostic at the 1-I port.

Since magnetic island formed by the LID coil does not rotate toroidally nor poloidally, the island structure is usually estimated only by evaluating a flat region in a temperature profile. To double-check the island structure measurement, island width was also estimated by utilizing the property of heat wave propagation. Figures 1(b) and 1(c) show the profiles of amplitude and phase of electron temperature at 29.3 Hz, respectively. It can be seen that the location where the amplitude reaches a maximum and the phase reaches a minimum is ρ=0.33, showing that modulated EC wave was deposited at this location. At ρ=0.4-0.5, a flat region was observed in the amplitude profile, and at the same time, inverted V-shape structure was observed in the phase profile. This behavior can be understood by the following picture: heat wave from the core region propagates to the peripheral region by passing the island X-point; the heat wave propagates inside the island O-point both from $\rho<\rho_s$ and $\rho>\rho_s$. Here ρ_s is the minor radius at the rational surface. Reduced heat transport inside a magnetic island was previously observed during TESPEL injection [1)], and the above profiles suggest similar characteristics. This result is expected to be an alternative method to evaluate the island structure.

Figures 2(a)-(c) show the increment profiles of electron temperature for no island heating (i.e. MECH alone), O-point heating, and O-point and X-point heating, respectively. For no island heating, increase in the electron temperature by MECH was small, which is suitable for the investigation of localized island heating. For O-point heating, localized increase at the island region, ρ=0.4-0.5, was observed. Such localization was also observed for O+X-point heating, but the profile is much broader. Comparing between Fig. 2(b) and Fig. 2(c), it is probable that the increment of electron temperature is highly localized at the island O-point due to low heat diffusivity. ECH at X-point alone, which was done but failed in this campaign, will clarify the difference in the increment profile and thus heating property. As for the change in the magnetic island width, no clear change in the amplitude and phase profiles was observed.

Reference

1) Inagaki, S. et al.: Phys. Rev. Lett. **92** (2004) 055002.

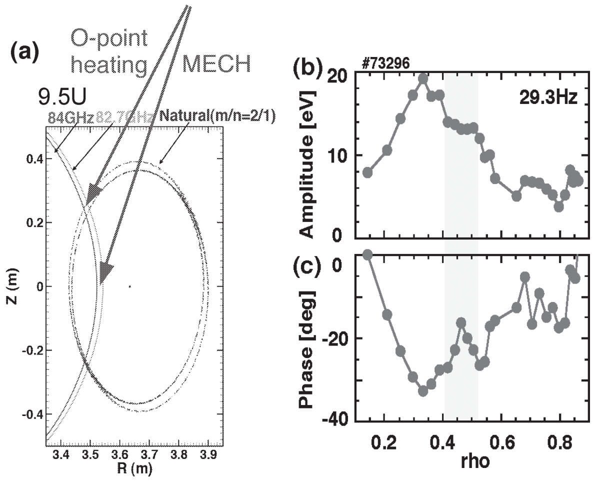

Fig. 1. (a) Typical configuration in experiments. Modulated EC wave was injected in the core region, and at the same time unmodulated EC wave was injected in the island region. (b) Amplitude profile and (c) phase profile at the modulation frequency.

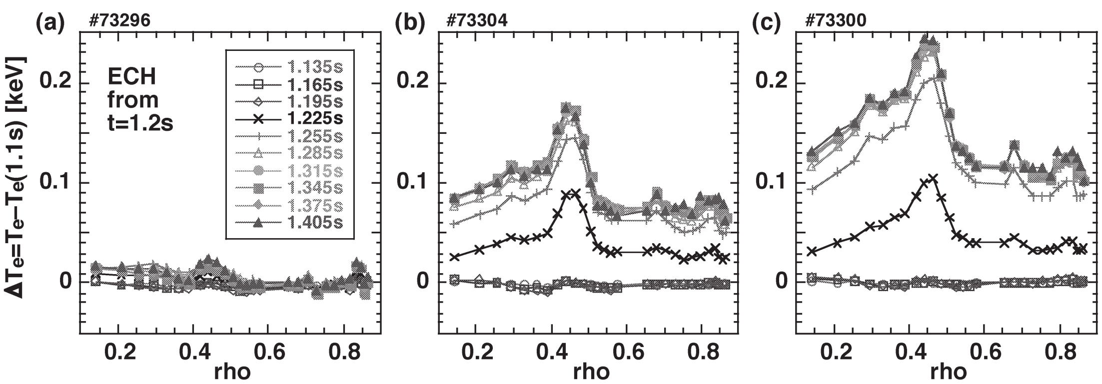

Fig. 2. Profiles of increment of electron temperature for (a) no ECH (b) O-point ECH, (c) O-point and X-point heating. The vertical axis corresponds to electron temperature subtracted by that at t=1.1 s.