§2. Response of Magnetic Island to Localized ECH to Magnetic Island Region

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In tokamaks such as JT-60U, neoclassical tearing mode (NTM), which appears in a high-beta plasma, degrades the confinement of the plasma through magnetic island formation. Thus, stabilization of the NTM by electron cyclotron current drive (ECCD) is important to sustain the high-beta plasma. In 2008 in JT-60U, it became possible to modulate the electron cyclotron (EC) wave power at about 5 kHz and drive localized current at the O-point or X-point of the magnetic island. It is also observed in LHD that magnetic island affects the confinement, and the characteristics have been extensively investigated. The aim of this research is to clarify the effect of localized electron cyclotron current (ECH) in the magnetic island region on the behavior of the island and ultimately to clarify similarities and differences of the behavior of magnetic islands in tokamaks and helical systems.

This experiment requires (a) formation of stationary magnetic island, (b) ECH at the magnetic island region (O-point and X-point), (c) electron temperature measurement with high temporal and spatial resolutions. Magnetic configuration satisfying the requirements was obtained (B=2.750 T, R_{ax}=3.600 m, γ=1.254, B_q=100%) in the previous experimental campaign, and data for O-point ECCD were obtained. Experiments in this campaign were performed to obtain data for X-point ECCD under similar discharge scenario. In the experiment, direction of neutral beam (NB) was switched from the co-direction to the counter direction to make large magnetic islands. After the switch-over, central ECH with the modulation frequency of 29 Hz (frequency of EC wave is 77 GHz) and X-point ECH were applied.

Typical discharge is shown in Fig. 1(a). Duration of counter NB was set longer than that in the previous campaign. Modulated ECH was applied at t=6.5-7.7 s, and X-point ECH was applied at t=6.9-7.5 s. Perturbation of electron temperature can be seen during the modulated ECH as shown in Fig. 1(b). Analysis using fast Fourier transform also shows that perturbation amplitude at the frequency of the modulated ECH is much larger than the other frequency components. Phase profile during this phase is shown in Fig. 1(c). In general, an inversed V-shape profile is obtained when there is a magnetic island with nested magnetic surfaces because heat wave by modulated ECH first propagates to the peripheral region through the island X-point and then propagates to the inside of the island O-point. However, in this campaign, such inverse V-shape profile was not observed before the X-point ECH while it was observed during X-point ECH in some discharge as shown in Fig. 1(d). According to the motional Stark effect (MSE) diagnostic, the rotational transform was higher than 0.5 in the whole regime. Thus, the structure in Fig. 1(c) is unlikely to be associated with an m/n=2/1 magnetic island (m and n are the poloidal and toroidal mode numbers, respectively). It is probable that some kind of unknown structure is formed transiently.

1) Isayama, A., Inagaki, S., Ida, K. and the LHD experimental group: MHD workshop 2009 (January 2009, NIFS)

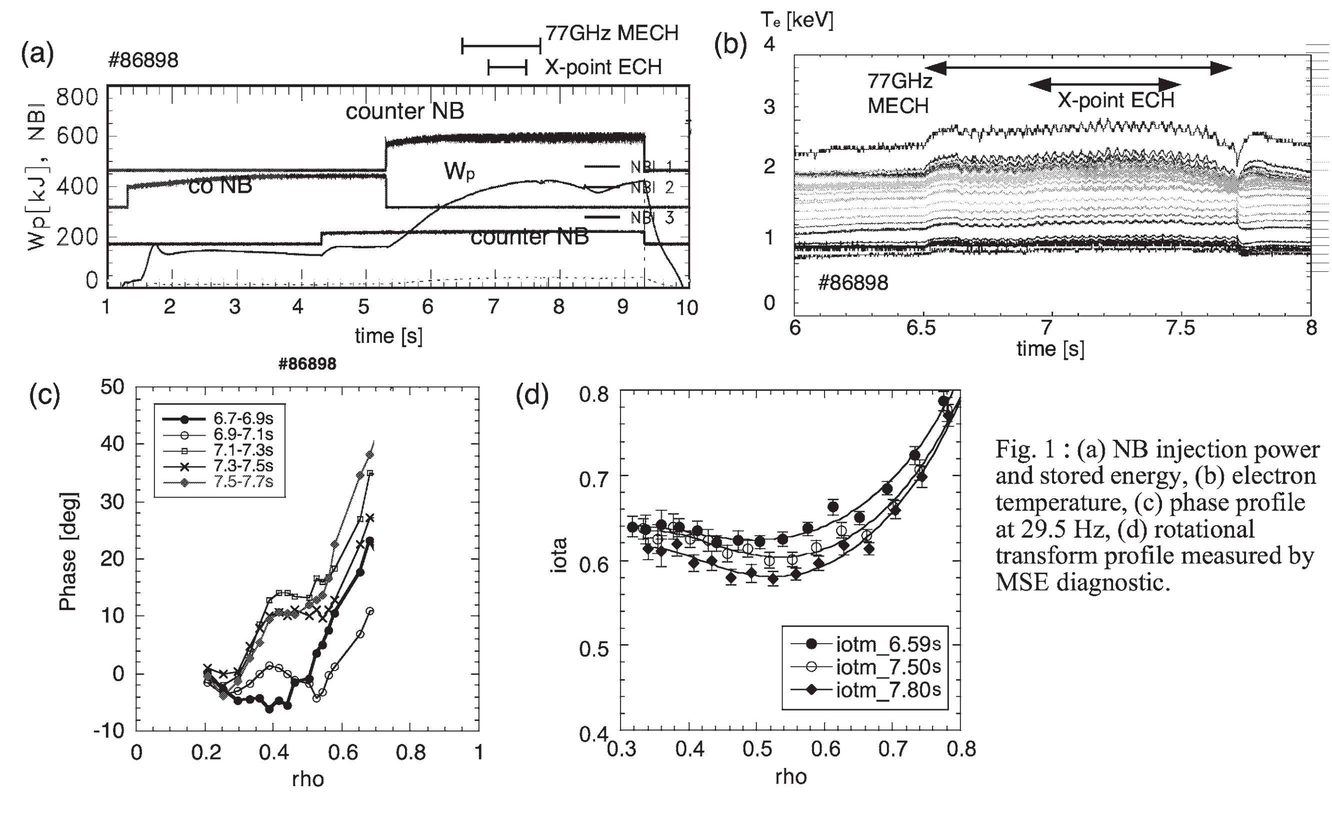

Fig. 1 : (a) NB injection power and stored energy, (b) electron temperature, (c) phase profile at 29.5 Hz, (d) rotational transform profile measured by MSE diagnostic.