§7. EHO-like Density Fluctuations Measured Using Beam Emission Spectroscopy in ETB Discharge on CHS (NIFS02KZPD003)

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The behaviors of the density fluctuations and the density gradients accompanied by the edge particle transport barrier (ETB) formation in compact helical system (CHS)1,2) have been investigated by using the beam emission spectroscopy (BES).3,4) The BES system in the present study detects Doppler-shifted H_α emissions from the collisionally excited neutral beam atoms injected for the additional heating. 16 sightlines are located so that the radial correlation along the minor radius of CHS is obtained.5) BES can also provide the density gradient ∇n from the difference between the intensity of signals measured in adjacent sightlines.

A typical heating condition for the ETB discharge is shown in Fig. 1(a). Plasma was initiated by electron cyclotron heating (ECH) and further heated by two neutral beam injection (NBI) systems. In the case that the heating power exceeds a certain threshold, a transition phenomenon characterized by sudden drop in the temporal evolution of the H_α intensity signal as shown in Fig. 1(b) can be observed. Figure 1(c) and (d) show the BES signals for $\rho = 0.95$ and $\rho = 1.03$, respectively, which indicates that the density inside the last closed flux surface (LCFS) increases while that outside the LCFS decreases at the transition. We categorize the waveform into three phases as indicated in Fig. 1: (1) L-phase representing that before transition, (2) density building-up phase, in which the density continues to increase, and (3) the ETB-formation phase, which is after a saturation of density building up.

Figure 2 shows the fluctuation power spectra in the BES signals at $\rho = 0.95$ averaged over L-phase (52-62 msec), density building-up phase (64-74 msec), and the ETB-formation phase (110-120 msec). Coherent fluctuations having the fundamental frequency of around 4 kHz and the 2nd harmonic frequency of around 8 kHz appear at only this location in the ETB formation phase. The mode which is similar to the edge harmonic oscillations (EHO) in Tokamaks6) is observed only in the case that the heating power is much higher than the threshold of the ETB transition. The threshold port-through heating power of the ETB transition in the standard magnetic configuration is about 1.0 MW for the density range of the discharge shown in Fig. 1, while the EHO-like mode was observed for that higher than 1.2 MW.

Figure 3 shows the amplitude of the fundamental mode as a function of ∇n. The EHO-like mode is enhanced when ∇n achieves a certain threshold. ∇n keeps almost constant after the enhancement of the mode.6) For the discharges with EHO-like mode, ∇n in the ETB-formation phase did not vary significantly even if the heating power was increased. There is a possibility that the onset of the EHO-like mode saturates the density gradient. It seems analogous to the fact that the EHO enhances the particle transport in Tokamaks.7) This should be investigated more detailed in the future.

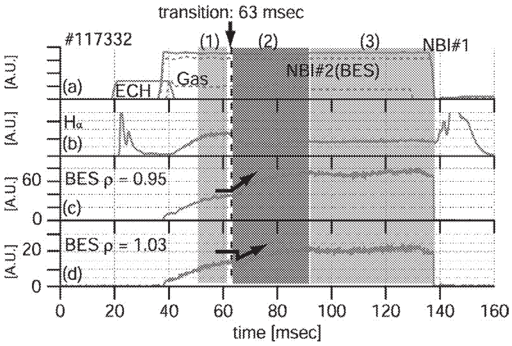

Fig. 1. Typical waveforms of the discharge with the ETB transition. (a) heating and fueling, (b) H_α intensity, (c) and (d) BES signals for $\rho = 0.95$ and $\rho = 1.03$, respectively.

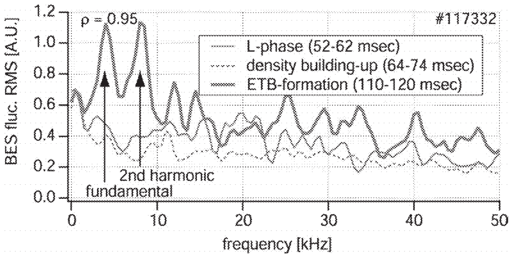

Fig. 2. The density fluctuation power spectra at $\rho = 0.95$ averaged over L-phase, density building-up phase, and the ETB-formation phase.

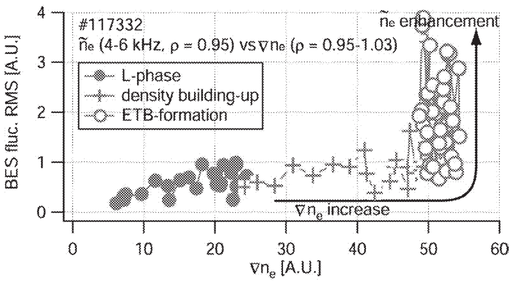

Fig. 3. The amplitude of the fundamental frequency of the EHO-like mode as a function of the density gradient measured using BES.

Reference

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