§20. Density Clamping by ECRH Applied at the Magnetic Ripple Top or Bottom on LHD

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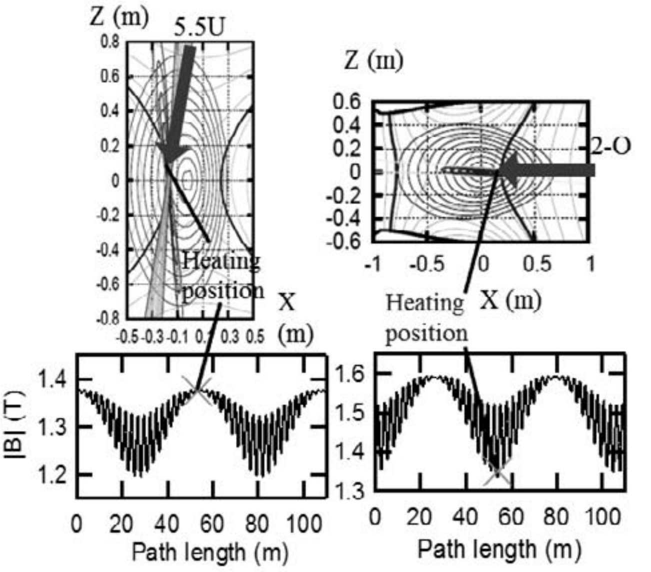
Density clamping by electron cyclotron resonance heating (ECRH) is generally observed on magnetic confinement fusion devices. This phenomenon is caused by the increase in the neoclassical and anomalaous transport and transport by the production of trapped particles by ECRH.

To clarify the particle transport caused by the production of trapped particles by ECRH, ECRH was applied at the top or bottom of the ripple of the magnetic field strength along a magnetic field line on the Large Helical Device (LHD). Trapped particles are readily produced from passing particles by ECRH applied at the bottom of the magnetic ripple, while trapped particles are rarely produced by ECRH applied at the top of the magnetic ripple. Figure 1 shows ECRH position on the cross section of the torus and magnetic field strength on a magnetic field line at the miner radius ρ ~ 0.3. 1 MW 77 GHz X2-mode ECRH was injected to the top or bottom of the magnetic ripple. The EC heating position was accurately set on the top or bottom of the magnetic ripple by ECRH antenna scan experiments and calculation of heat pulse propagation from the electron temperature data measured by electron cyclotron emission (ECE) systems. The magnetic field strength at the heating position is 1.375 T for X2-mode ECRH. X2-mode is selected because X2-mode ECRH accelerates electrons in a direction perpendicular to the magnetic field line more directly than O-mode ECRH. Plasmas were sustained by NBI heating. The experimental conditions are as follows: The magnetic axis position R_{ax} is 3.9m. The miner radius is 0.55 m. The line averaged electron density is about 0.5 × 10^{19} m^{-3} . The central electron temperature is about 1.0 ~1.5 keV.

Figure 2 shows profiles of the decreases in the electron density measured by Thomson scattering measurements for 500 ms during EC heating applied at the top or bottom of the magnetic ripple. The density degreases by the top ECRH and the bottom ECRH were approximately equivalent. 7.6 Hz modulated ECRH experiments were also performed on LHD. The line integral electron density was measured by multi-channel FIR laser interferometer. The electron density changed with the same period as ECRH modulation. Figure 3 shows the amplitudes of density fluctuation at the frequency of the ECRH modulation of the line integral electron density. There were no differences between responses of the electron density to the top ECRH and the bottom ECRH. These indicate that the particle transport caused by the production of trapped electrons by ECRH is negligible on LHD.



(a)Top ECRH (b)Bottom ECRH

Fig. 1. EC heating position on cross section of torus and the magnetic field strength along a magnetic field line on ρ ~ 0.3.

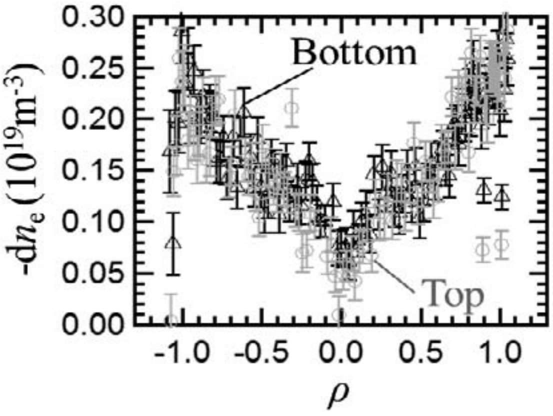


Fig. 2. Profiles of the decreases in the electron density for 500 ms during EC heating applied on the top or bottom of the magnetic ripple.

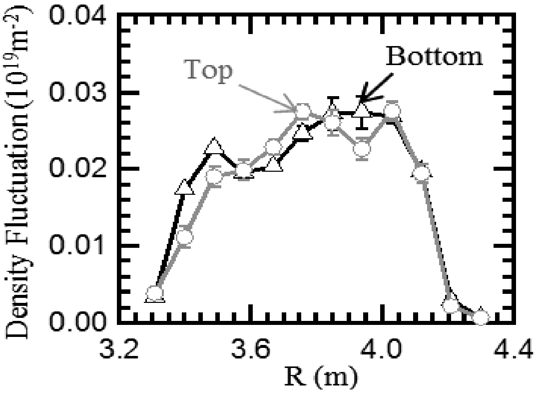


Fig. 3. Profiles of the amplitudes of density fluctuation at the frequency of the ECRH modulation of the line integral electron density. ECRH was applied at the magnetic ripple top or bottom.