

§7. Effect of Externally Applied Oscillating Magnetic Field Perturbations on Plasma Transport

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A small amplitude of helical magnetic field resonates with the confinement magnetic field line near the edge is applied to a tokamak plasma for the control of plasma-surface interaction by the ergodic divertor action as well as for suppression of the current disruption[1-3]. In all of these experiments the helical fields are applied quasi-stationary. It is interesting to study the effects of oscillating helical fields on plasma transport. In JIPP-IIU oscillating perturbation fields in the range of 30-50 kHz comparable to electron diamagnetic frequency are applied to the plasma using a m=4 coil assembly installed inside the vacuum vessel.

When the perturbation fields with 37.5 kHz are applied to the ohmic plasma, the line averaged electron density is increased with reduced $H\alpha/D\alpha$ and He II line intensities as shown in Fig.1. In the discharge shown in Fig.1, the plasma is produced using the mixture of deuterium and helium gas. After about 20 ms from the turn-on of the perturbation fields the plasma is terminated by the disruption. Just before the disruption, that is, from 210 ms to 220ms the loop voltage is appreciably increased. This is thought to be due to shrinkage of the electron temperature profile. Figure 2 clearly suggests the possibility. That is, in this phase electron temperature near the edge is decreased but that near the plasma center is increased with enhanced sawtooth activity. Radial profiles of electron temperature and density are obtained by YAG laser Thomson scattering (Fig.3). For about 10 ms after the turn-on of the perturbation field these profiles remain unchanged, but then they are changed dramatically as seen from Fig.3. In the edge region of $r/a > 0.6$ the electron temperature is decreased, while the core region of $r/a < 0.4$ is heated up. Thus, the electron temperature profile has a steep gradient around $r/a = 0.5-0.7$. The electron density profile becomes flat having a steep gradient around $r/a = 0.6-0.8$.

The oscillating helical fields effectively modify the edge plasma, that is, the decrease in edge electron temperature. The effect on local plasma transport is under investigation.

[1] T.E. Evance et al., Proc. IAEA Conf. Plasma Physics and Controlled Nuclear Fusion, Nice, 1988, Vol. 1, IAEA, Vienna (1989) 347.

[2] K. Yamazaki et al., Proc. IAEA Conf. Plasma Physics and Controlled Nuclear Fusion, Kyoto, 1986, Vol. 1, IAEA, Vienna (1987) 309.

[3] S. McCool et al., Nucl. Fusion 29(1989)547.

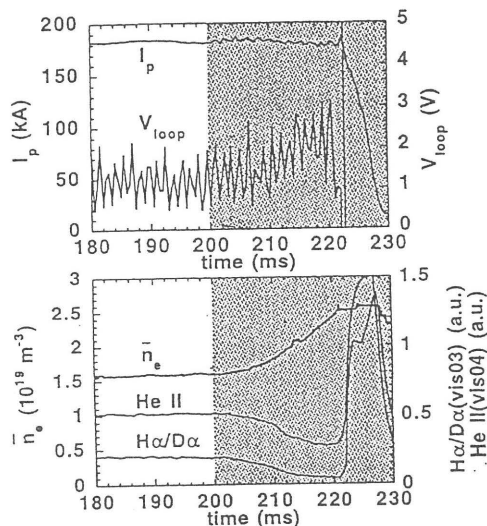


Fig.1 Time behaviors of the ohmic discharge where the oscillating helical fields of 37.5 kHz are applied from t=200 ms.

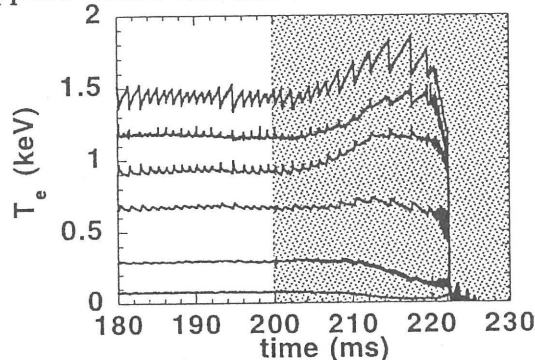


Fig.2 Time evolution of electron temperatures obtained by ECE data at various radial positions.

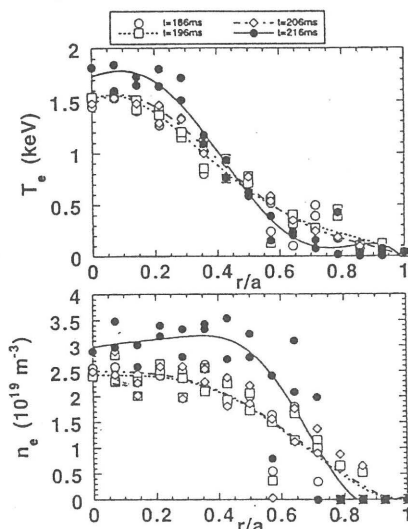


Fig.3 Radial profiles of electron temperature and electron density just before (186ms and 196 ms) and during the phase the perturbation fields are applied(206 ms and 216 ms).