§18. Radial Electric Field Control by Electrode Biasing in Heliotron J

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The radial electric field control experiments were carried out by an electrode biasing in Heliotron J. In L–H transition theories, the local maximum in ion viscosity versus poloidal Mach number M_p around $-M_p \sim 1$–3 is considered to play a key role[1)]. This maximum is considered to be related to Fourier components of a magnetic configuration. In the Tohoku University Heliac (TU-Heliac), the effects of the viscosity maxima on the L-H transition have been experimentally investigated. The poloidal viscosity was estimated from the $\boldsymbol{J} \times \boldsymbol{B}$ driving force for a plasma poloidal rotation, where $\boldsymbol{J}$ was a radial current controlled externally by the LaB_6 hot cathode biasing. It was experimentally confirmed that the local maxima in the viscosity play the important role in the L-H transition[2-3)]. Therefore it is important to perform this biasing experiments mentioned above in the confinement system that has changeability of the Fourier components of the magnetic configurations. The purposes of our electrode biasing experiments in Heliotron J were, (1) to estimate the ion viscous damping force from the driving force for the poloidal rotation, and (2) to study the dependence of the ion viscosity on helical ripples and bumpiness.

In the biasing experiments in Heliotron J, the plasmas were produced by the ECH of 2.45 GHz ($P_{max} \sim$ 4kW). We used the hot cathode made of LaB_6 to bias the target plasmas. In this campaign we improved the probe scanning system and we can successfully accumulated the plasma profile databases. Figure 1 shows the radial profiles (before/after biasing) of electron temperature T_e and electron density n_e measured by the triple probe. The electrode located at $\rho = 0.5$ and 0.75. We can see that the electron density increased by a factor of 2, in spite of the temperature decrease around the magnetic axis and the density (or pressure) formed the steep gradient at the plasma periphery after biasing.

In this campaign we also surveyed the various magnetic configurations to study the dependency of transition condition on the Fourier components of the configurations. Figure 2 shows the feasible magnetic configurations and the relation between coil currents, rotational transform and magnetic flux surfaces in a low magnetic field operation. These databases were expected to develop the understanding the dependency of a transition condition on the ripple structure by the biasing experiment in Heliotron J.

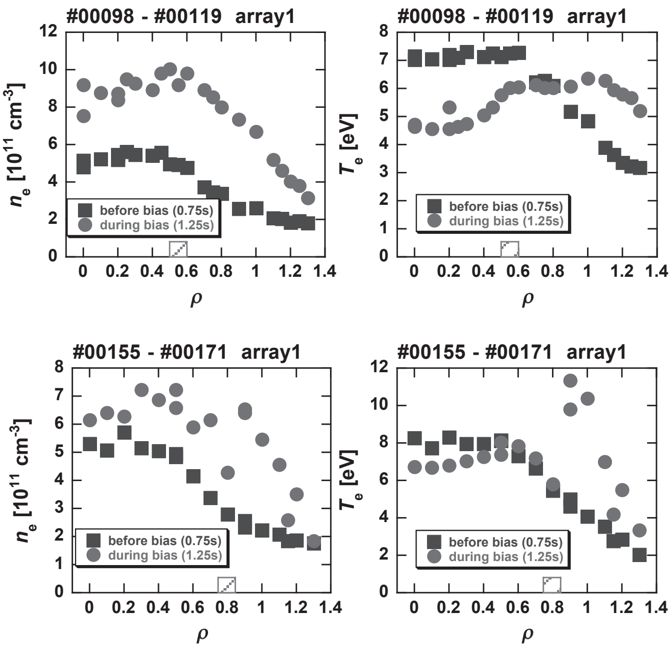

Fig. 1. Radial profiles (before/after biasing) of electron temperature T_e and electron density n_e measured by the triple probe. The electrode positions were r = 0.5 and 0.75.

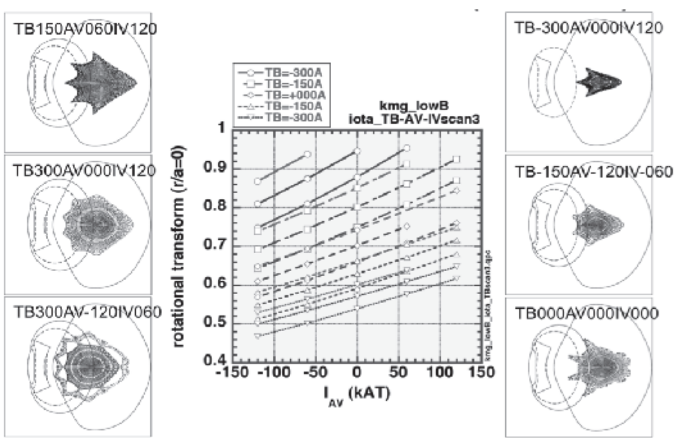

Fig. 2. Feasible magnetic configurations and the relation between coil currents, rotational transform and magnetic flux surfaces in a low magnetic field operation

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2) Kitajima, S., *et al.*: Nucl. Fusion, **46**, 200-206 (2006).
3) Kitajima, S., Takahashi, H. *et al.*: Nuclear Fusion, **48** (2008) 035002.