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

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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 this campaign the target plasma for the biasing in Heliotron J was produced by the ECH (f = 2.45 GHz $P_{\max} \sim 19$ kW) in magnetic configurations (inward, outward and DCC) shown in Fig. 1. We used the hot cathode made of LaB_6 to bias the target plasmas. Figure 2 shows the typical time evolutions of (a) the electrode voltage V_E, (b) the electrode current I_E (c) line density and (d) the radial electric field E_r in the outward configuration. The biasing was applied from t = 0.3 s to 0.7 s. The electrode was negatively biased through the power supply ($P_{out} \sim 3$ kW) by the triangle input waveform as shown Fig. 2(a). Figure 2(b) shows the sudden current rise ($t \sim 0.47$ s) and drop ($t \sim 0.61$ s) in the electrode current. In accordance with this current change the line density increased and the negative radial electric field was clearly formed at $\rho \sim 0.9$ as shown in Fig. 2(d). These suggested the transition to another confinement mode.

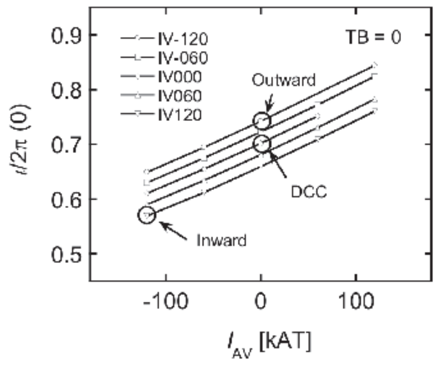

Fig. 1. Feasible magnetic configurations and the relation between coil currents, rotational transform in a low magnetic field operation

Figure 3 shows the relation between the magnetic axis position and the driving force required for the transition normalized by the plasma pressure. In the outward configuration the transition was performed by the external driving force which was 60 % of that in DCC configuration.

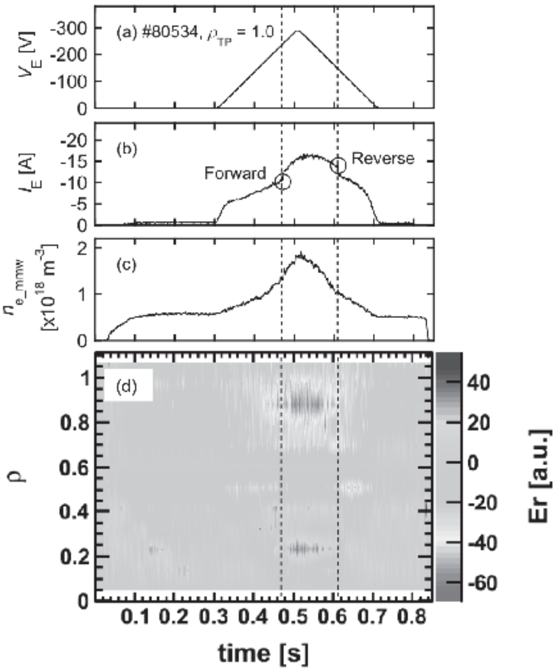

Fig. 2 The typical time evolutions of (a) the electrode voltage V_E, (b) the electrode current I_E, (c) line density and (d) the radial electric field estimated from plasma potential

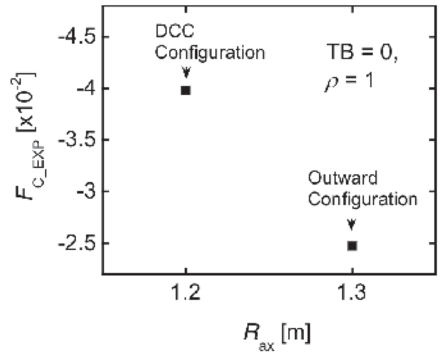

Fig.3 Relation between the normarized driving force and the magnetic axis position

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3) Kitajima, S., Takahashi, H. *et al.*: Nuclear Fusion, **48** (2008) 035002.