§21. Role of Poloidal Ion Viscosity on a Transition to Improved Confinement Mode Using a Biasing Electrode in LHD

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We have continued electrode biasing experiments in LHD and achieved the improved mode transition accompanied with the nonlinear plasma resistance[1]. Purposes of the biasing experiments are (1) to estimate experimentally the dependence of the neoclassical poloidal ion viscosity on the ripple component in magnetic configurations and compare the viscosity estimated experimentally with the theoretical models and (2) to clarify the role of the neoclassical poloidal ion viscosity in the transition phenomena to the improved confinement mode. If the neoclassical theory dominates the transition, transition conditions will depend on the ripple structure and normalized collisionarity etc and will be independent of the size of device and the difference of confinement systems. Therefore the consistency of experimental results with theoretical predictions in various confinement systems enabele us to reveal the importance of the neoclassical poloidal ion viscosity and to estimate transition conditions for another device from the extrapolation of the database. Furthermore the achievement of the improved mode transition by electrode biasing in LHD and the clarification of the mechanism contribute to the spread of understanding the H mode physics in helical system.

The target plasma for the biasing in LHD was produced by ECH (P_{ECH} = 0.8 MW) in magnetic configurations (R_{ax} = 3.53, 3.60, 3.65 and 3.75 m, B_t = 1.375 T). Working gas was helium. In previous biasing experiments we observed the transition in the configurations (R_{ax} = 3.53 and 3.60). By the increase of power source for the biasing and the reduction of the electrode size, we can succeed in the observation of the transition in the configurations (R_{ax} = 3.65 and 3.75). Figure 1 shows relations between the electrode voltage and electrode current in the biasing case in which the electrode voltage was linearly increased. We can confirm the transition in four configurations by the observation of the negative resistance region where an electrode current decreases in spite of an increase in an electrode voltage. Figure 2 shows the dependence of the external driving force ***J*** x ***B*** required for the improved mode transition (critical driving force) on configuration. It clearly show that The critical driving forces increases with the major radius of the magnetic axis R_{ax} going outward, which reveals the same dependency in the Shaing model[2].

We successfully measured space potential profiles by HIBP under the electrode biasing in the configuration (R_{ax} = 3.6, 3.53 and 3.65 m) and the radial profiles of space potential were shown in Fig. 3, and we cannot observe the significant difference between three configurations. These results are available to estimate the ion viscosity from theoretical models.

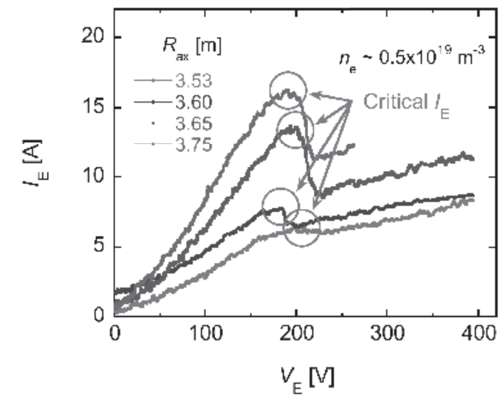

Fig. 1 Relations between the electrode voltage and electrode current

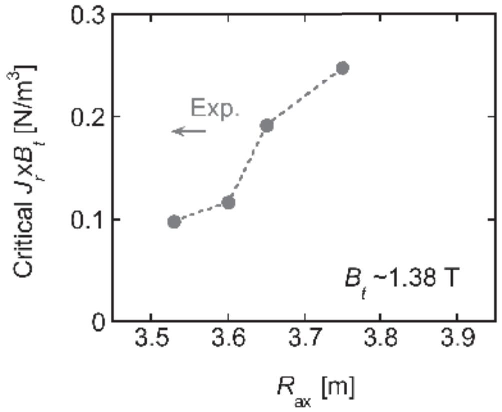

Fig. 2 Dependence of the external driving force ***J*** x ***B*** required for the improved mode transition (critical driving force) on configuration

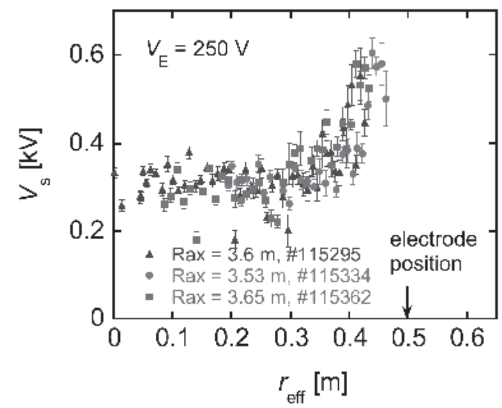

Fig. 3 Space potential profiles measure by HIBP

1) S. Kitajima et al., Nucl. Fusion, **51** (2011) 083029.
2) K. C. Shaing: Phys Rev. Lett. **76**, (1996) 4364.