§31. Control of Magnetic Shear by Neutral Beam Injection in LHD

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Control of magnetic shear has been recognized to be important issue in helical plasma as well as tokamak plasma, because it has significant impact to the transport and MHD stability at the rational surface. For example, the interchange mode appears, when the magnetic shear at the rational surface decreases. Further decrease of magnetic shear causes growing of 2/1 magnetic island at a rational surface of 0.5. Appearance of interchange mode and growing of 2/1 magnetic island have been observed in the plasma with counter-NBI, where the toroidal current in the counter direction is increasing[1,2].

Radial profile of rotational transform (ι) is measured with Motional Stark Effect (MSE) spectroscopy [3] during the transient phase where the direction of NBI is switched during the discharge in LHD. Figure 1 shows the time evolution of toroidal current driven by NBI and radial profile of rotational transform (ι) and shift of polarization angle due to toroidal current and Pfirsch-Schluter current. (The absolute value of polarization angle is a order of 10 degree at the plasma edge.) As seen in the time evolution of toroidal current, the toroidal current keep increasing or decreasing during the co- and ctr-NBI phase and does not reach to the steady state. This is because the diffusion time scale is much longer than the duration of discharge.

In order to study the effect of the current ramp rate on ι profile and magnetic shear, the two ι profiles are compared with similar magnitude of toroidal current (Ip = 56 – 59kA in counter direction) and different ramp rate: one is in the discharge where the counter current is decreasing with dIp/dt = 42kA and the other is in the discharge where the counter current is increasing with dIp/dt = -34kA. When the current is decreasing the polarization angles have negative values that indicate the decrease of ι. This is contrast to the radial profile of polarization angle where the current is increasing, where the polarization angle changes its sign in radius. (positive values near the plasma center and negative values near the plasma edge). These polarization angle profiles clearly show the existence of d reversal of toroidal current near the plasma center. Please note the contribution of Pfirsch-Schluter current, which is typically causes the negative offset in polarization angle, is small in this experiment where the plasma density is low ($0.67x10^{19}m^{-3}$) and magnetic field is high (2.75T).

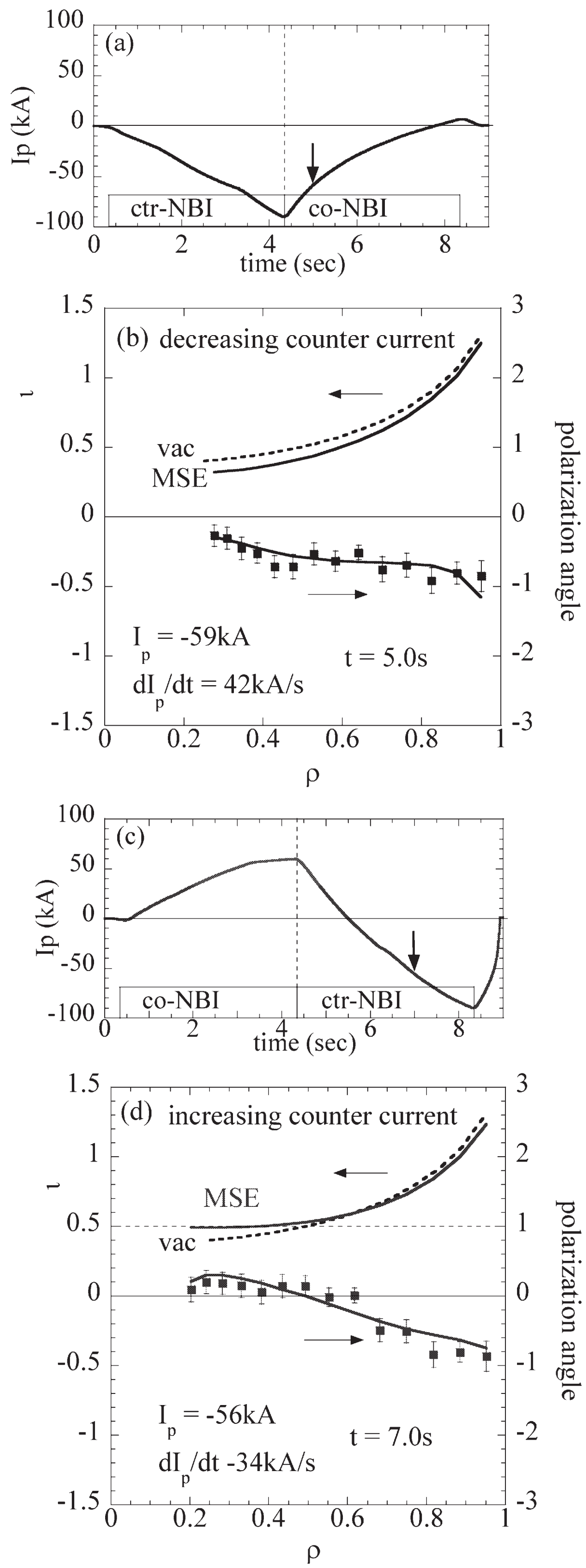

Fig.1. Time evolution of plasma current and radial profile of rotational transform and change in polarization angle for the discharge with (a),(b) decreasing counter plasma current and (c),(d) increasing counter plasma current.

Reference
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[3] K.Ida et al., Rev. Sci. Instrum. **76**, 053505 (2005)