§19. Formation of the Radial Electric Field Shear at the Boundary of Magnetic Island with Repetitive Pellet Injection in LHD

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Since the radial electric field E_r and its shear are expected to reduce neoclassical and anomalous transport, respectively, the control of the radial profile of the radial electric field is considered to be one of the important tools to improve confinement in helical plasmas. In general, the radial electric field can be controlled by changing the collisionality, and positive or negative electric field has been obtained by decreasing or increasing the electron density, respectively. Farther, the radial electric field has been observed to be zero inside the magnetic island in the large helical device (LHD) [1]. When the plasma achieves the ion root (negative E_r) outside the magnetic island by increasing the collisionality, the large radial electric field shear will be formed at the boundary of the magnetic island as shown in Fig.1. We demonstrated that the formation of the radial electric field shear at the boundary of a n/m = 1/1 magnetic island induced by external perturbation coils (LID coils) with repetitive pellet injection in the plasma with a magnetic axis of 3.6m and magnetic field strength of 2.75T. The pellet was injected into the NBI sustained plasma with the electron density of $1.0x10^{19}m^{-3}$ to fuel the particles inner side of the magnetic island to archive the negative E_r of ion root regime.

Figure 2 shows the radial profiles of the radial electric field with the repetitive pellet injection. The radial electric field is close to zero in the discharge with the LID coil current of 1200A. The radial electric field profile shows that the plasma is in the ion root outside of the magnetic island in the discharge with the LID coil current of 1920A and the radial electric field shear was formed near the boundary of the magnetic island (shaded region in Fig.2). The electron density after the pellet injection is $1.5x10^{19}$ m^{-3} and $2.5x10^{19}$ m^{-3} in the discharge with the LID coil current of 1200A and 1920A, respectively. Larger increase of the electron density is observed in the plasma with larger magnetic island.

Figure 3 shows the time evolution of the radial electric field at the R=4.04m measured with the charge exchange spectroscopy with better time-resolution. With the single pellet injection, the formation of the negative electric field and strong E_r shear was transient, and then the E_r shear disappears in the time scale of few 100msec. By injecting a repetitive pellet, the negative electric field and electric field shear can be sustained. Faster change of E_r is observed in the discharge with large pellet injection.

Reference

1) Ida, K., et.al., Phys.Rev.Lett **88**, (2002) 15002.

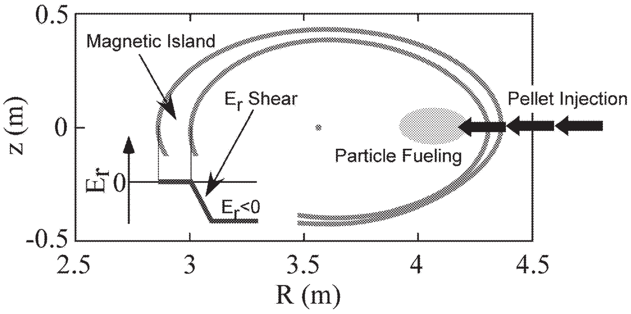

Fig. 1. Schematic view of the E_r shear formation by pellet injection with external induced magnetic island. The red line shows the poloidal cross section of magnetic flux surface near the magnetic island induced by external perturbation coil.

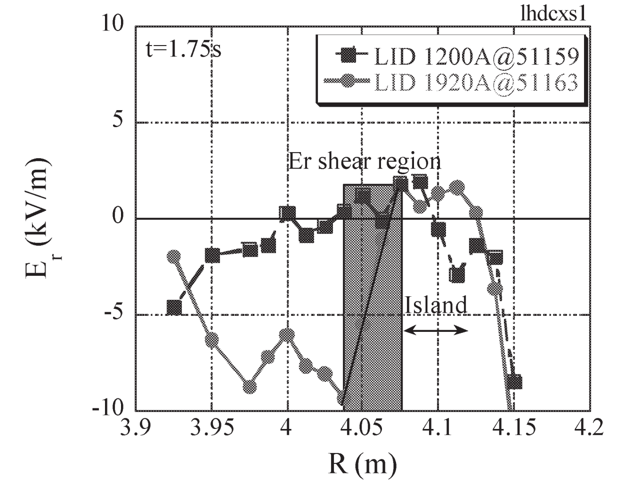

Fig. 2. Radial profiles of radial electric field with the repetitive pellet injection in the case of 1200A (square) and 1920A (circle) of LID coil current.

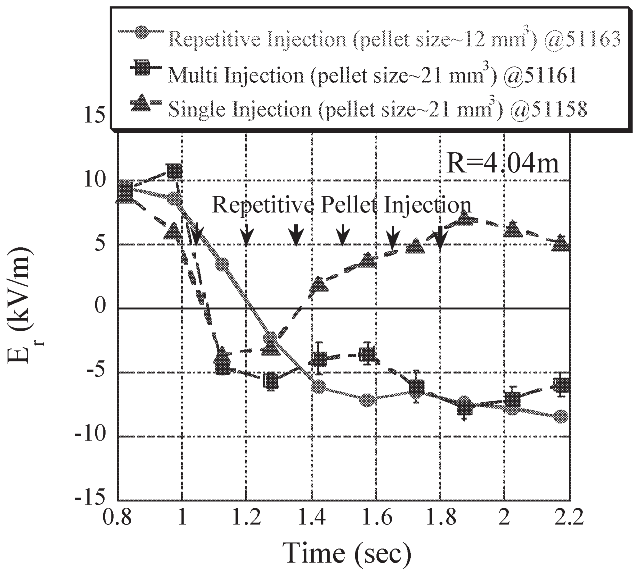

Fig. 3. Time evolution of the radial electric field E_r at the R=4.04m. Pellet which has the size of $12mm^3$ is injected repetitively (circle). Pellet which has the size of $21mm^3$ is injected three times (square) and singly (triangle).