§9. Development of External Control Knob for Improved Confinement Mode in TU-Heliac

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Study of magnetic island effects on the transport is important, because it leads to the advanced control method for a plasma periphery in a fusion reactor. The perturbation field effects on the transport have been surveyed widely in LHD and DIIID *etc*. For the research on island effects on confinement modes, Tohoku University Heliac (TU-Heliac) has advantages that (1) the position of a rational surface is changeable by selecting the ratio of coil currents, (2) the island formation can be controlled by external perturbation field coils, (3) a radial electric field and particle transport can be controlled by the electrode biasing[1)]. The island effects on the plasma periphery by the external perturbation fields in TU-Heliac were surveyed[2, 3)]. The fixed m = 3 magnetic island were produced by the two pairs of external cusp field coil shown in Fig. 1. The electron density decayed from the outer edge of the island after perturbation field applying. The radial profiles of electron temperature and plasma space potential in the island region revealed the magnetic island structure. The radial electric field at the inner edge of the island increased after perturbation filed applying. The positions of local maxima in the plasma space potential profile agree well with the position of the n/m = 5/3 rational surface. The potential profile in the island grew according to the perturbation field strength. The full width at half maximum of the potential profile depends on the square root of the perturbation field coil current.

Figure 2 shows the radial profile of the plasma space potential. The plasma space potential had the local maxima in the island region (109 < R < 114.5 mm) after perturbation filed applying. The radial electric field at the inner edge of the island (109 < R < 112 mm) increased after perturbation filed applying. In contrast to the density profile the potential profile had the tendency to have the same value at the inner and outer edge of the island because of the short-circuit in the magnetic line of force. The details about the time evolution of the radial profile of plasma space potential are shown in Fig. 3. The radial profile of plasma space potential was spreading according to the increase in the perturbation field. The perturbation coil current increased depending on time. The positions of peak in the profiles agree well with the position of the n/m = 5/3 rational surface.

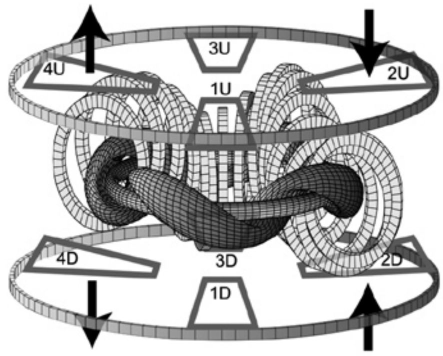

Fig.1. External perturbation coils set-up. Coils are located at toroidal angle φ = 0°, 90°, 180°, 270°, upper and lower location of toroidal coils.

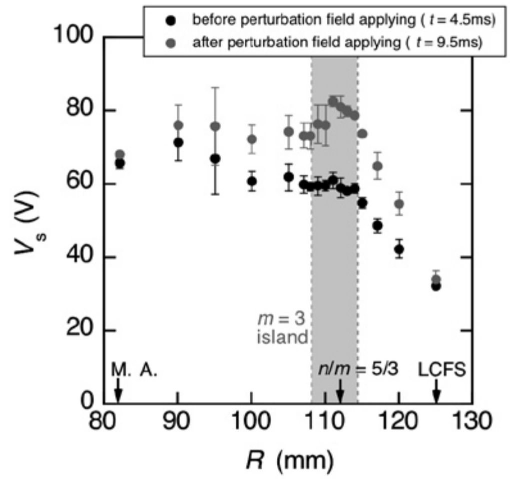

Fig.2. The radial profiles of plasma space potential

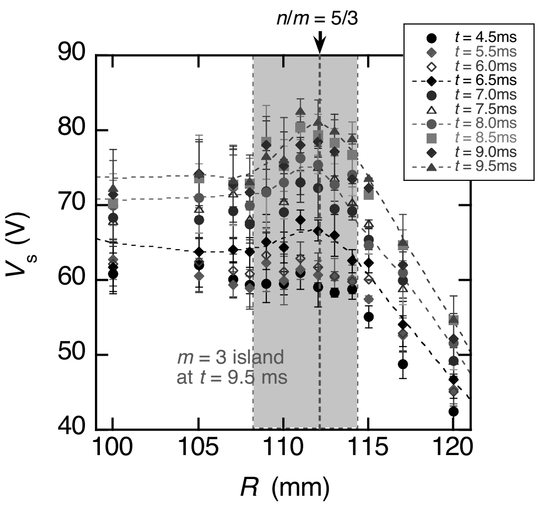

Fig.3. The radial profiles of the plasma space potential. The perturbation field was applied at t = 5 ms

1) Kitajima, S. *et al*.: Nucl. Fusion, **46**, 200-206 (2006)
2) Kitajima, S. *et al*.: Fusion Sci. Technol. **50**, 201 (2006)
3) Kitajima, S. *et al*.: Plasma Fusion Res. **3** (2008) S1027