§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, 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]. In TU-Heliac the ion viscosity for the plasma with islands was roughly estimated from the $\boldsymbol{J} \times \boldsymbol{B}$ driving force using the electrode biasing. It suggested that the ion viscosity increased according to the increase in the magnetic island width[2]. Therefore it is expected that plasma poloidal rotation will be driven by the poloidal rotation of the island. The purposes of this experiment are, to propose the new method for rotating islands by the external perturbation fields, to survey the ability of the plasma poloidal rotation driven by rotating islands[3] and, to study the rotating island effects on confinement modes in TU-Heliac.

In TU-Heliac the profile of a rotational transform can be changeable by selecting current ratios of toroidal, center conductor, and vertical coils, we selected the current ratio to locate a rational flux surface ($n/m = 5/3$) in the plasma periphery. The efficient configuration of perturbation coils for generating islands ($m = 3$) has been searched. We decided four pairs of upper and lower coils shown in Fig.1, which generate cusp field at each toroidal angle. To check experimentally the effect of the external perturbation field, we measured the floating potential by a Langmuir probe (high speed triple probe). We surveyed the radial profile of FFT power spectrum at the frequency of the perturbation coil current (f=8.895kHz) of floating potential and the radial position of the magnetic island (Fig. 2). Power spectrum have the maximum around the $m = 3$ magnetic island. We also measured phase differences in floating potential signal of two probes which set on a same meridian plane. The expected phase difference was calculated from the probe positions. In the case of c/cw direction (i-diamag direction) the phase difference was $\sim \pi$ and in the case of cw direction (e-diamag direction) $-\pi$. The measured phase difference in the floating potential signals by two Langmuir probes agreed well with the expected value π in the c/cw rotation (i-diamag). However the phase difference in the cw rotation (e-diamag) had large error (Fig. 3).

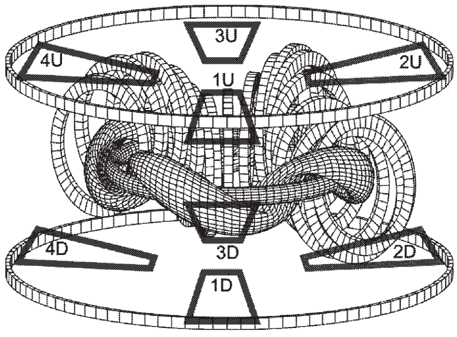

Fig.1. External perturbation coils set-up. Coils are located at toroidal angle φ = 0°, 90°, 180°, 270°, upper and lower location of toroidal coils.

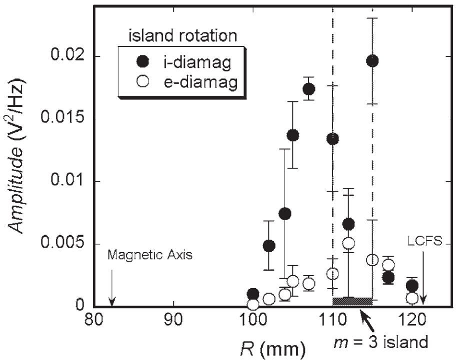

Fig.2. Radial profile of FFT power spectrum of floating potential and the radial position of the magnetic island

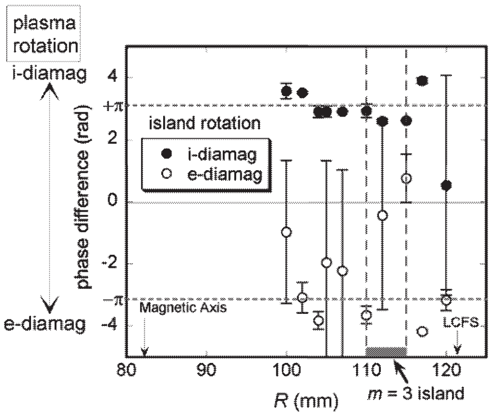

Fig.3. Phase differences in the floating potential signals of two Langmuir probes

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