§8. Study of Interaction between Magnetic Island and Poloidal Flow 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 island formation can be controlled by external perturbation field coils, (2) 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)]. The fixed $m = 3$ magnetic island were produced by the two pairs of external cusp field coil shown in Fig. 1. In order to study the effects of magnetic islands on plasma poloidal flow we externally controlled the flow velocity by changing the electrode current with the current control power supply. When the electrode current exceeded a critical value, we observed the sudden increase in a Mach probe current ratio (poloidal flow velocity). Then we can survey the relation between the threshold of the external driving force required for a plasma flow jumping and the island width[3)].

In this campaign we prepared the measurement systems for the plasma poloidal flow in order to survey more precisely about the effects of magnetic islands on plasma poloidal flow. We developed (1) multi-points Mach probes for increase in space and time resolution and (2) multi-channel spectroscopy for simultaneous multi-point measurement of plasma flow and ion temperature. Figure 2 shows the time evolution of the radial profile of the poloidal flow measured by the multi-points Mach probe. By this Mach probe we clarified that the poloidal flow increased gradually from the inside of plasma to outside of plasma ($31 < t < 33$ ms) in the biasing case in which the electrode current was increased linearly.

Figure 3 shows the radial profiles of the poloidal plasma flow in three biasing cases (electrode current I_E =0, 1 and 5 A) measured by the multi-channel spectrometer. It is clear that the poloidal plasma flow was almost zero in the case I_E =0. According to the increase in the electrode current the poloidal flow increased the velocity and had the zero velocity region around the magnetic axis (MA), which means a poloidal rotaion. From these measurement systems we can measure the radial profile of flow velocity and evaluate the absolute value in low velocity case. We expect that these results enable us to estimate the ion viscosity in a configuration with islands.

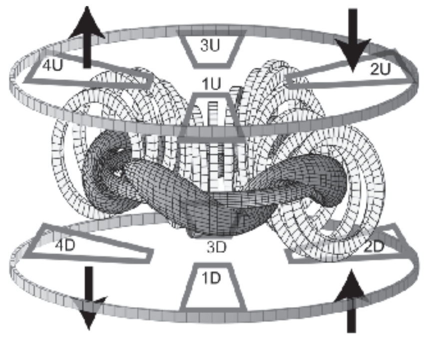

Fig. 1 External perturbation coils set-up. Coils are located at toroidal angle φ = 0°, 90°, 180°, 270°, upper and lower location of toroidal coils.

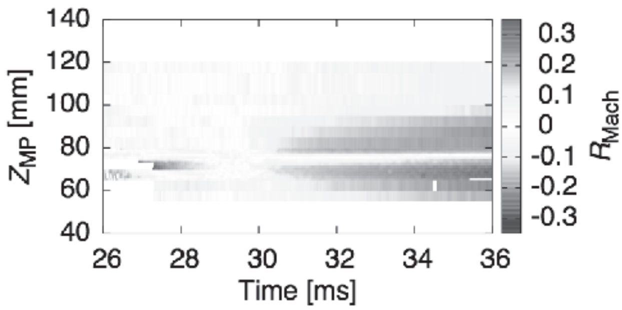

Fig. 2 Time evolution of the radial profile of the poloidal flow measured by the multi-points Mach probe

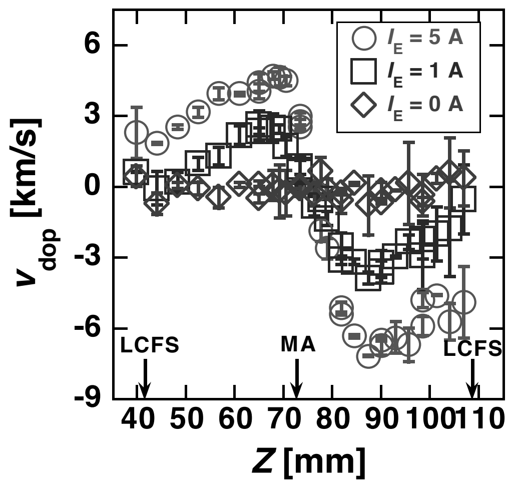

Fig. 3 Radial profiles of the poloidal plasma flow in three biasing cases (electrode current I_E =0, 1 and 5 A) measured by the multi-channel spectrometer

1) Kitajima, S. *et al.*: Nucl. Fusion, **46**, (2006) 200.
2) Kitajima, S. *et al.*: Fusion Sci. Technol. **50**, (2006) 201.
3) Sato, Y. *et al.*: Plasma and Fusion Res. **6** (2011) 2402144.