# §19. Plasma Flow Measurement at Peripheral Region of the Central Cell during ICRH in GAMMA10

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Plasma flow is known to be associated with formations of a radial electric field and a transport barrier, which are important research topics for improving the fusion plasma confinement. As a high power ion cyclotron resonance heating (ICRH) is progressed in GAMMA 10 device, investigating the correlation between the plasma flow and the electric field will contribute to performance improvement of the large mirror fusion device. Basic study on the plasma flow at the peripheral region of the central cell has been performed in our collaborative works during the ICRH and/or the electron cyclotron resonance heating (ECRH) at the plug/barrier region, which arise the radial electric field.

In our previous work, a 4-tip Mach probes shown at the top of Fig. 1 were installed in GAMMA10 and tuned so as to measure the axial and rotational plasma flows. This work is aimed to observe the temporal evolutions of the direction change of the axial plasma flow, which is discovered in the last year, and to estimate the Mach number of the plasma flow.

In GAMMA10, the high ion temperature mode and the resultant increase in the ion temperature have been detected during the ICRH (RF1: 10 MHz, RF2: 6.4 MHz) at the central cell. The 4-tip Mach probe is inserted from the bottom vacuum port at both the east and west sides of the central cell (128cm from the axial center of the GAMMA10). The data are taken at the peripheral region ($r$ = 18 cm) of the plasma core. The signals of the probe tips proportional to the ion saturation current are plotted as a function of the rotation angle of the probe shaft. As the probe has four tips, the axial and azimuthal components of the plasma Mach number can be estimated as reported previously [1-3]. Here the ICRH (RF3: 10.3 MHz) power is supplied to the central cell at $t \sim 150$ msec.

Figure 2 shows the temporal evolution of the Mach number $M_z$ of the axial plasma flow. The simultaneous measurements using the two different probes located to the East and West sides can give the important information on the plasma flow at the peripheral region. Before applying the ICRH ($t < 150$ msec), the Mach numbers at the East and West sides show the positive and negative values, respectively, which indicates that the plasma diffuse from the center of the central cell to both the sides. When applying the ICRH, it is found that the flow velocities are enhanced to the same direction as that before the ICRH. Furthermore, the results on the azimuthal flow velocity shows that the same rotational direction of the plasma flow is detected both the sides and corresponds to the ion diamagnetic direction.

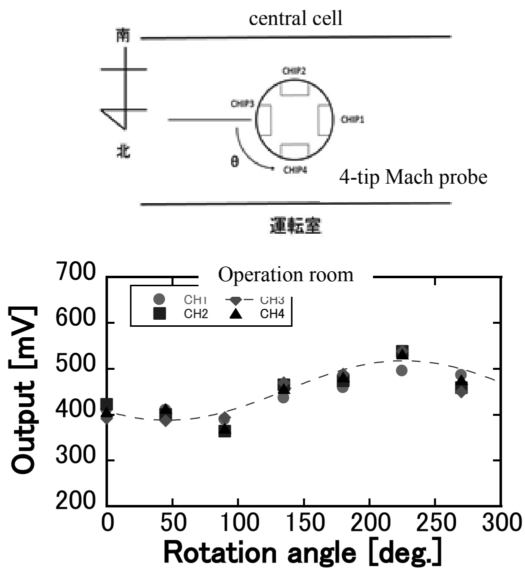


Fig.1 Schematic diagram of the 4-tip Mach probe and the signal of the tips as a function of the probe angle.

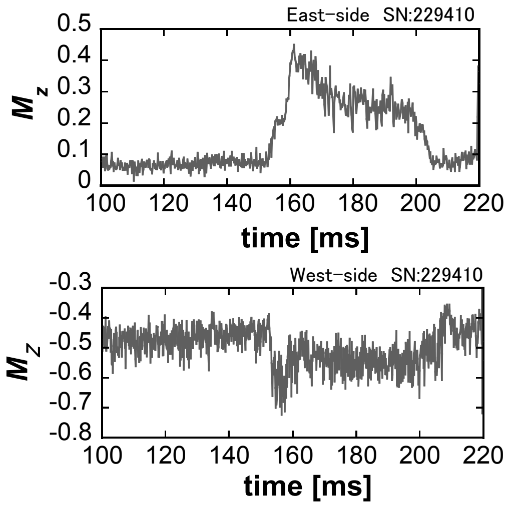


Fig.2 Temporal evolution of the Mach number of the axial plasma flow during the ICRH, where the data are taken at (top) East and (bottom) West sides.

Regarding the direction change of the flow velocity, the results suggest the correlation between the direction change and the diamagnetic signal and the decreasing plasma density. The details are under investigation and the discussion on the direction change phenomenon will be progressed by analyzing the data.

We would like to thank GAMMA 10 Group for their great collaboration on the plasma flow dynamics experiments in GAMMA 10 device.

1) A.Ando *et al.,* J. Plasma and Fusion Research, 81, 451 (2005),
2) A. Ando et al., Contributions to Plasma Phys., **46**, 335 (2006).
3) H.Muro *et al.*, Fusion Science and Technology **55**,172 (2009).