§2. Study of Potential Confinement Mechanism via Plasma Visualization Technology

Mase, A., Kogi, Y. (KASTEC, Kyushu Univ.),
Yoshikawa, M., Nakahara, A., Itakura, A., Hojo, H., Cho, T. (PRC, Univ. Tsukuba),
Nagayama, Y.

In tandem mirrors, an electrostatic potential is created in order to improve axial confinement. The radial electric field due to this potential often causes an $\boldsymbol{E}\times\boldsymbol{B}$ rotation shear. The verification of this effect is one of the most critical issues to understand the physics basis for recent confinement improvement. Understanding the mechanism of this effect requires the use of sophisticated diagnostic tools for measurement of plasma profiles and their fluctuations. Significant advances in microwave and millimeter wave technology have enabled the development of a new generation of imaging diagnostics as visualization tool of plasma parameters.[1] This report describes the development of millimeter wave imaging diagnostics (a phase imaging interferometer) applied to the GAMMA 10 tandem mirror.

The phase imaging interferometer is installed in the west plug region (z=970 cm, where z is the axial position from the central-cell midplane).[2, 3] The imaging array consists of beam-lead GaAs Schottky barrier diodes bonded to 4×4 (2D) bow-tie antennas fabricated using photolithographic techniques on a fused-quartz substrate. The quadrature detection system provides the phase difference between two intermediate frequency (IF) signals obtained by mixing the transmitted signal (RF) and the local oscillator signal (LO). The phase difference is proportional to the line density of plasmas. In FY2006, we have prepared 16 quadrature phase detectors in order to apply to all of the imaging array channels. The 2D detector observes the axial (z) and vertical (x) directions of the plasma. The detector can be moved in the x and z axes.

As an initial test of the quadrature phase detector, the ICRF produced plasmas without the ECRH application for potential formation was utilized. Figure 1 shows the radial profiles of the line density for various axial positions, and 2D view of the profile. The dots and crosses are obtained in one plasma shot, while the imaging array is shifted 1.5 cm. The values of the line density seem to be in good agreement with each other. This means that the detailed 2D profiles can be obtained by a few plasma shots. The 2D view of the Abel-inverted density profile in Fig. 1 is thus obtained. The arrows are the magnetic field lines. It is seen that the density is localized at the center of the plug/barrier cell. In Fig. 2 is shown the 2D density profile during the ECRH application. When the ECRH is applied, the plug potential is created near the position where the magnetic field strength equals to 1 T (z=961-062 cm). Present phase imaging interferometer is located at the position just outside of the plug potential. It is noted that the plasma density in the core region decreases during the injection of the ECRH power. At the outside of the plug potential, the plasma flow decreases due to the formation of the confining potential.

In summary, the quadrature phase detection system was completed in FY2006. The 16 imaging array channels can be utilized for the measurement. The 2D density profiles are now obtained in a few plasma shots.

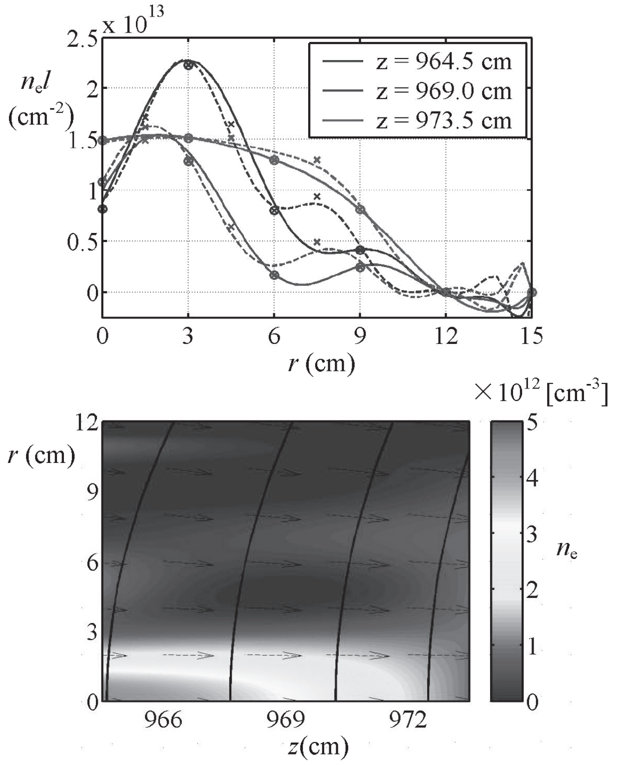

Fig.1. Radial profiles of the line density for various axial positions (top), and 2D view of the Abel-inverted density profile (bottom).

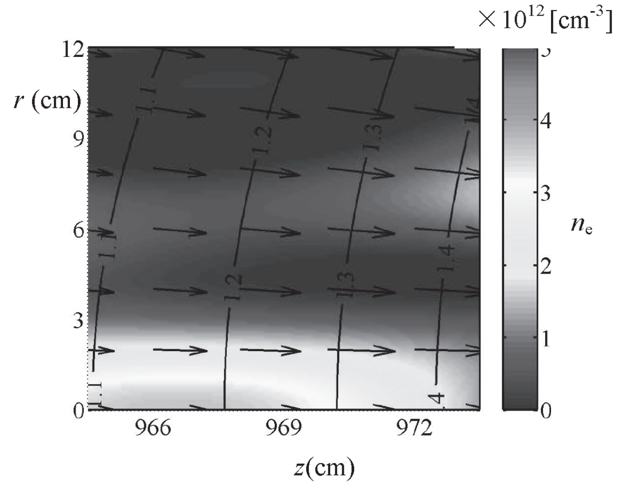

Fig.2. 2D view of the density profile during the ECRH for potential formation is applied.

References

1) Mase, A. et al, Trans. Fusion Sci. Tech, **51**, 277 (2007).
2) Watabe, K., Oyama, N., Mase, A., and Mizuno, K., Rev. Sci. Instrum. **73**, 2282 (2002).
3) Nakahara, A., Yoshikawa, M., Shima, Y., Matsumoto, T., Yanagi, N., Itakura, A., Cho, T., Mase, A., and Kogi, Y., Trans. Fusion Sci. Tech, **51**, 277 (2007).