

## §10. Study of Radial Transport of Bounce Ions by Use of a Lithium Beam Probe Method

Ishii, K., Saito, T., Katanuma, I., Yoshikawa, M., Kojima, A., Miyata, Y., Yamaguchi, T., Fujimoto, S. (Tsukuba Univ.),  
Iguchi, H., Nakamura, K.

Existence of the plug potential (PP) bounce ion which is bounced by the plug potential hill is essential to improve the axial confinement time in the tandem mirror GAMMA 10. The PP bounce ion and the inner mirror throat (IMT) bounce ion bounced by the IMT magnetic hill of the plug/barrier cell have been measured as neutral particles charge-exchanged from the bounce ions using a charge exchange bounce ion analyzer (CX-BIA) located near the IMT.<sup>1,2</sup> Radial profile measurements with high accuracy of the plasma and neutral particle density are required in order to estimate more quantitatively the bounce ions. We designed a diagnostic system composed of both radial profile measurements of electron density and neutral particle density. A neutral lithium beam probe (LiBP) method has already been used.<sup>3</sup> It is useful for the profile measurement of the electron density over a wide range. Figure 1 shows the locations of the LiBP, the CX-BIA and H $\alpha$  detectors.

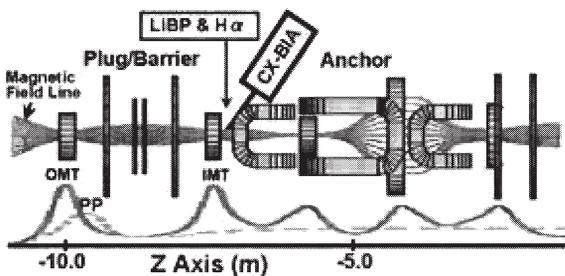


Fig.1 Locations of the diagnostic devices are shown with magnetic coils. Axial profiles of magnetic field strength and electrostatic potential are illustrated by a solid line and a dashed line, respectively.

We designed the LiBP system as shown in Fig.2.

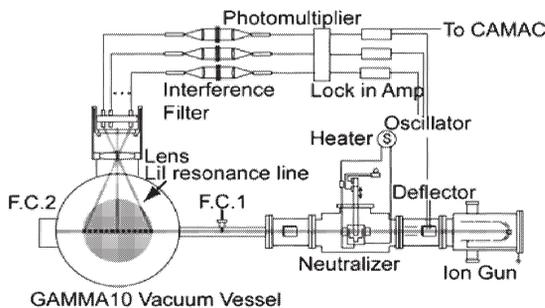


Fig.2 A LiBP system at the inner mirror throat.

In order to check the validity of the measurement by the LiBP method, we reconstructed the density profiles on the condition that the peak density was variable and the width was constant ( $r_{1/2}=2.5$  cm). The peak density was changed from  $1 \times 10^{12}$  cm $^{-3}$  up to  $1 \times 10^{14}$  cm $^{-3}$ . A Gaussian type of density profile was assumed as a good approximation. The calculated results are shown in Fig.3.

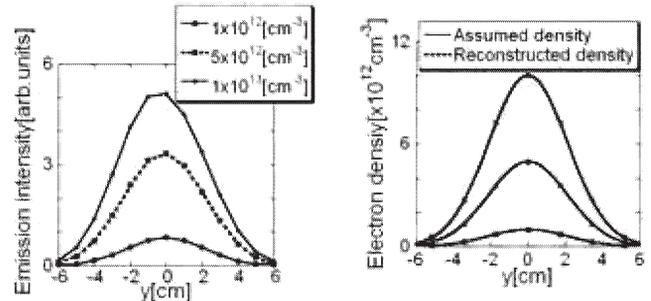


Fig.3 Intensity of light emitted from the lithium beam. Reconstruction of the electron density profiles. Solid lines are the initial density profiles. Dashed lines are the reconstructed profiles which coincide well with the initial profiles.

In the present experiment of the tandem mirror GAMMA10, the peak density is seemed to be usually several times  $10^{12}$  cm $^{-3}$  at the IMT. Therefore the attenuation of the neutral beam is not effective and the reconstruction of the density profiles is carried out quite well. In the range of more than  $6 \times 10^{13}$  cm $^{-3}$ , the reconstructed curves began to shift from the initial density profiles.

The outer mirror throat (OMT) bounce ion, together with the PP bounce ion, was also measured by the CX-BIA and the existence was confirmed as shown in Fig.4.

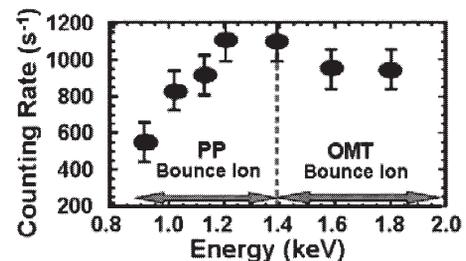


Fig.4 Detected counts of the PP and OMT bounce ions. Two kinds of bounce ions are separated at the energy of 1.4 keV.

Gold neutral beam probes were applied to measure the radial profiles of the plasma potential and the fluctuations excited in the plasma. We found the relation between the bounce ions and the potential profile.

### Reference

- 1) Ishii, K., et al., Rev. Sci. Instrum, **75**, (2004) 3619.
- 2) Miyata, Y., Master's Thesis, Graduate School of Pure and Applied Science, University of Tsukuba (2005).
- 3) Iguchi, H., et al., Rev. Sci. Instrum, **56**, (1985) 1050.