§18. Behaviors of Sample Volumes of the Heavy Ion Beam Probe on JFT-2M

Ido, T. (Dept. Energy Engineering and Science, Nagoya Univ.),
Kamiya, K. (Grad. Univ. Advanced Studies),
Hamada, Y., Nishizawa, A., Kawasumi, Y.
Miura, Y. (JAERI)

The position of the sample volume of HIBP is calculated by the complex trajectory calculations of the beam. Since the primary and secondary beam goes through the region of 100 % toroidal ripple, the careful 3D analysis of magnetic field of a tokamak is required. Accordingly, the calibration of the position of sample volumes throughout the plasma cross-section is required to check the accuracy of the magnetic field and the beam trajectory calculation.

The calibration experiments are performed by the detection of the secondary beam ionized by puffing the neutral helium gas into the tokamak chamber. Figure 1 shows the secondary beam current in the gas ionization experiments with various strength of Bt by sweeping the primary beam poloidally. The horizontal axis is the poloidal sweep voltage and the vertical axis is the measured secondary beam current. In the case of 0.90T, a large peak of the beam current signal is found at a sweeper voltage of 9.4kV. This phenomenon is the sample volume divergence1) (SVD) that are predicted with the trajectory calculation. And there is a small peak at a sweeper voltage of 4.7kV, which is just a half of the sweeper voltage of the large peak, in the case of 0.90T. It indicates that small part of the primary beam ions is ionized before they pass through the sweeper and the ionized beam can reach to the detector. In other words, the secondary beam of the large peak traces the same trajectory of the secondary beam ionized in front of the sweeper. There is a divergence without corresponding small peak at the half the sweep voltage in the case of 0.94T as is found in Fig. 1. In the region 1.13T<Bt<1.73T, the intensity is almost constant. It indicates that the sample volumes are normal sample volumes and the volumes are almost constant. The huge peak in the case of 1.83T indicates the SVD out of the toroidal coil in the exit port side. In the case Bt>1.88T, no divergence appears since the Larmor radius is too small for the secondary beam to arrive at the detector. These behaviors of the secondary beam are in good agreement with the result of the trajectory calculation qualitatively. It confirms validity of the magnetic field and trajectory calculation. As a result, the absolute position is determined with the ambiguity of about 15mm, which is caused by the ambiguity of the relation between a sweeper voltage and an injection angle and by the accuracy of the setting of the vacuum vessel.

Fig.1. The intensity of the secondary beam in the gas ionization experiments with various toroidal fields by sweeping the primary beam poloidally. The horizontal axis is the poloidal sweep voltage and the vertical axis is the intensity of secondary beam. The numbers in the right of the figure indicate the toroidal magnetic fields.

Reference

1) Y. Hamada, et al. : Plasma Phys. Control. Fusion, 36, 1743 (1994).