§23. General Characterisics of a Heavy Ion Beam Probe on JIPP T-IIU

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The neutal gas puffed into a tokamak vacuum vessel is a very useful substitute of a plasma in a heavy ion beam probe (HIBP) through the collisional ionization of high energy particles. Since the gas is uniform across the cross section of the vacuum vessel, the collisional ionization of the injected primary beam by the gas provide useful information of the HIBP. 1) the boundary of the poloidal and toroida sweep for the existence of the sample volume, 2) the size of the sample voume is proportional to the intensity of the secondary beam due to the collisonal ionization. Accordingly, the filling of the vessel with gas helps us to have a much wider understanding of the behaviour of the sample volume especially near and outside the plasma boundary.

Here we report that we are able to observe interesting phenomena such as multiple sample volumes and multiple sample volume divergence by gas ionization .

Figure 1 shows the summary of 9 gas ionization experiments with different toroidal fields. The beam energy is fixed (E_b = 150 keV). Helium gas is puffed to the pressure of about 0.1 Pa. The horizontal axis is the poloidal sweep angle and the vertical axis is $150(3.0/B_t)^2 + 18.0 \times I_s$, where the first term is the equivalent (converted) beam energy $E_b = 150(3.0/B_t)^2$ in keV for 3 Tesla at different toroidal field (B_t in Tesla).

I_s is the sum of the upper and lower detector currents in nA. Since the toroidal field is constant during one gas ionization experiment, the vertical position of each curve is shifted upwards by E_b to avoid the confusion induced by many curves. The region of non-zero beam current in Fig. 1 is limited by 4 dashed curves, A to D. The dashed line A is the limit of sweep angle at the injection port i.e., hitting of the injected swept beam on the injection port. The dashed curve B is the boundary of the non-existence of the solution i.e., non-existence of the secondary beam to the input slit of the analyzer . At B there occur the merging of double sample volumes as shown in Fig. 1 and the sample volume divergence i.e., a sharp increase of the sum signal[1,2].

The dashed curve C is the sweep angle versus beam energy at which hitting of the secondary beam to the lower part of the horizontal port occurs. The dashed line D is also the sweep angle at which hitting of the primary beam on the wall of the injection port occurs. Near the line C, there occur again a sharp increase of the sum signal (the divergence of the sample volume). This sample volume divergence found to be due to the fact that the sample volume is positioned nearly outside the toroidal coil. In this case the primary beam trajectory is almost linear and the sample volume can extends freely along the trajectory of the primary beam. From these observation, we guess that we may have divergence of the sample volume in three different positions, the first may be at the injection into the tokamak vessel, the second is at the boundary of the non-existent and existence of the solution, and the third is again outside the toroidal coil and at the horizontal port.

Reference

1) Y. Hamada et al., Plasma Phy. Contol. Fusion, **36** (1994) 1743.

2) Y. Hamada et al., Journal of Plasma Phy. and Fusion Research, **69** (1993) 1050.

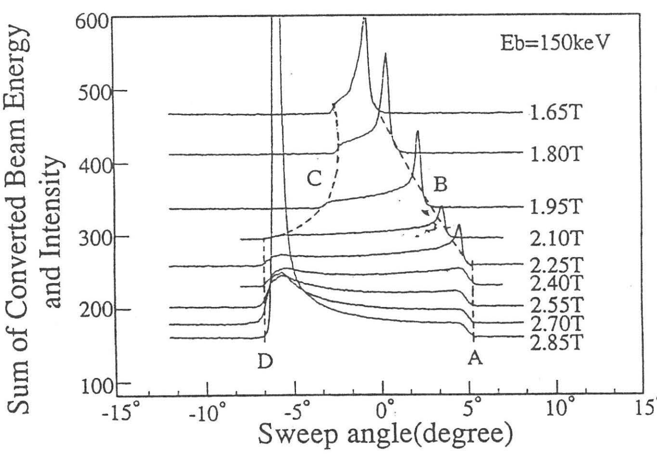

Figure 1. Behaviours of the intensity of gas ionized secondary beam at the analyzer detector under the poloidal sweep at different experiments with various toroidal field. The beam energy is 150 keV. Each curve is shifted upwards by the converted beam energy, $E_b = 150(3.0/B_t)^2$ to avoid confusion induced by several shot with different toroidal field strength.