§23. Calibration of HIBP Ion Beam Trajectory

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The CHS HIBP has two sets of beam deflectors to control the primary and secondary ion beams independently so that the injection angle of the secondary beam into the energy analyzer may be kept constant during entire radial scanning. This method makes the observation area wider and improves accuracy in the determination of plasma potential. Experimental calibration for the beam line alignment and the observation points in the plasma has been carried out using a movable detector and a gas ionization method[1].

The detector was at first used for primary beam detection. The center of the detector head was set at the magnetic axis Rax = 94.9 cm, which is a typical magnetic configuration in the CHS operations. The beam was swept two dimensionally with different frequencies in radial and toroidal direction to find two corresponding deflector voltages to hit the detector, and those voltages of - 420 $\pm$ 180 V and 220 $\pm$ 160 V were obtained respectively. The detector then was used as a biasing electrode to determine the set of deflector voltages for the secondary beam observing plasma center. Uniform background helium gas was supplied by gas puffing for about 100 ms. The secondary beam created with gas ionization process at the center of the biased detector has an additional energy same as the electrode potential, and the energy analyzer can identify these secondaries. In the experiment, a bias voltage up to 900 V was applied to the detector and the beam energy was analyzed by sweeping the secondary beam, while the primary beam was fixed to pass through the center of the detector. Secondary beams are created everywhere along the primary beam trajectory, but their energies are different depending on the ionization position. Figure 1 shows the energy change of the secondary beam as a function of the deflector voltages in the analyzer side. The maximum energy change was observed at the deflector voltages of 300 $\pm$ 150 V and 70 $\pm$ 150 V for horizontal and vertical deflectors, respectively. The obtained sets of deflector voltages for center and different radial positions [1] are shown in Fig 2. Open square in the figure corresponds to the magnetic axis determined by the movable detector. Experimental data generally agree with the calculation. However, further improvement is necessary to be completed as a calibration method.

References

[1] Lee, S. et al., to be published in Fusion Engineering and Design.

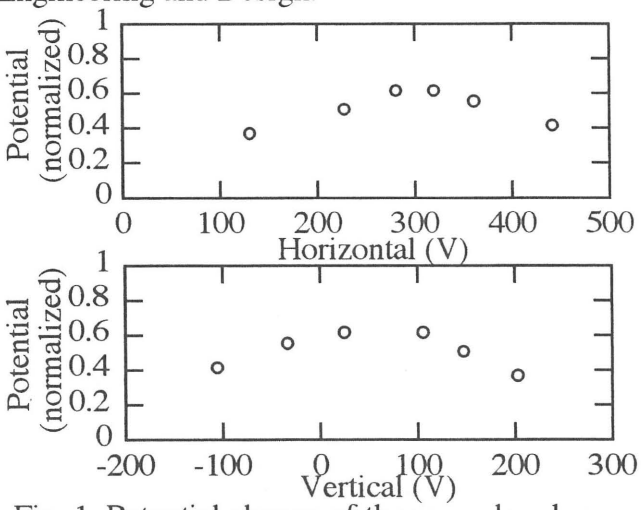

Fig. 1. Potential change of the secondary beam.

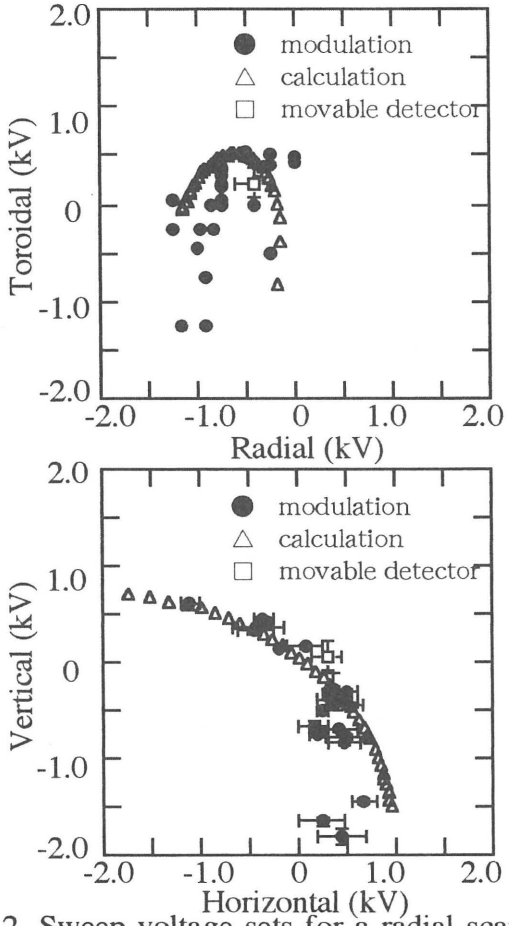

Fig. 2. Sweep voltage sets for a radial scan (a) primary beam. (b) secondary beam.