§32. Calibration of the CHS HIBP Ion Beam Trajectory with a Gas Ionization Method

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The CHS HIBP system is equipped with a pair of octupole deflectors which can completely control the ion beam orbit. By using this system, a rather wide region of the plasma can be observed (including almost all plasma radii) . In addition, noise caused by UV radiation and leakage magnetic field effects is reduced because the energy analyzer could be placed further point from the plasma. However, the application of octupole systems to a heliotron/torsatron type device which has a 3-dimensional magnetic configuration presents uniqueness and difficulties.

Each octupole deflector sweeps the beam in 2 -dimensions, so that we need to control a total of 4 sweep voltages to control the observation point. These combinations of sweep voltages have already been numerically calculated [1]. However, it is important to confirm these sweep voltages sets experimentally. In the experimental analysis, the entrance slit and split plate detector signals are examined to find cases where the secondary beam coming from each observation point passes through the center of both plates simultaneously (figure.1 shows the location of these slits). This insures that the beam enters the energy analyzer at the correct angle. The sweep voltage sets which satisfy this criteria are shown in figure. 2.

Figure 2 shows that the sweep voltage sets are spread over a wide range of voltages. This property could be caused by a low spatial resolution and large sample volume size which are undesirable for the CHS HIBP measurement. In addition, there are voltage differences between the numerical and experimental results, particularly in the radial injector direction, resulting in an uncertainty in the observation points location. The followings are candidates causes of these two essential problems. Firstly, a large primary beam width caused by poor beam focus or by neutralization of the beam by the gas that slide the Larmor orbit of a fraction of primary beam in magnetic field may spread the sweep voltage region. Secondly, mis-alignment of the beam line may cause the discrepancy between experimental and numerical values.

In future experiments, we will study these issues.

[1] Fujisawa, A. et al., Rev. Sci. Instrum. Vol. 63, No7, (1992) 3694-3700

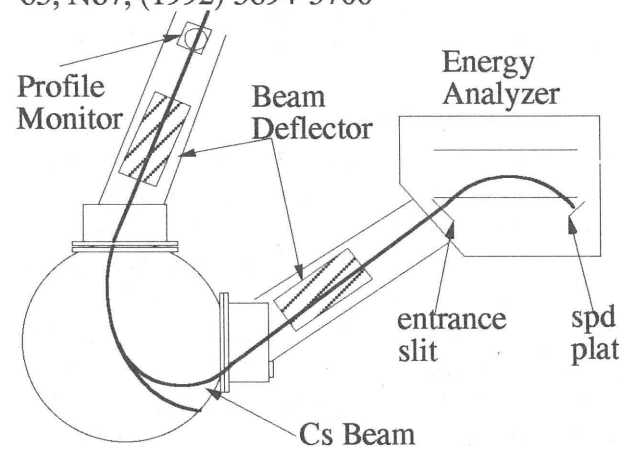

Fig. 1. Schematic of beam line of CHS HIBP system.

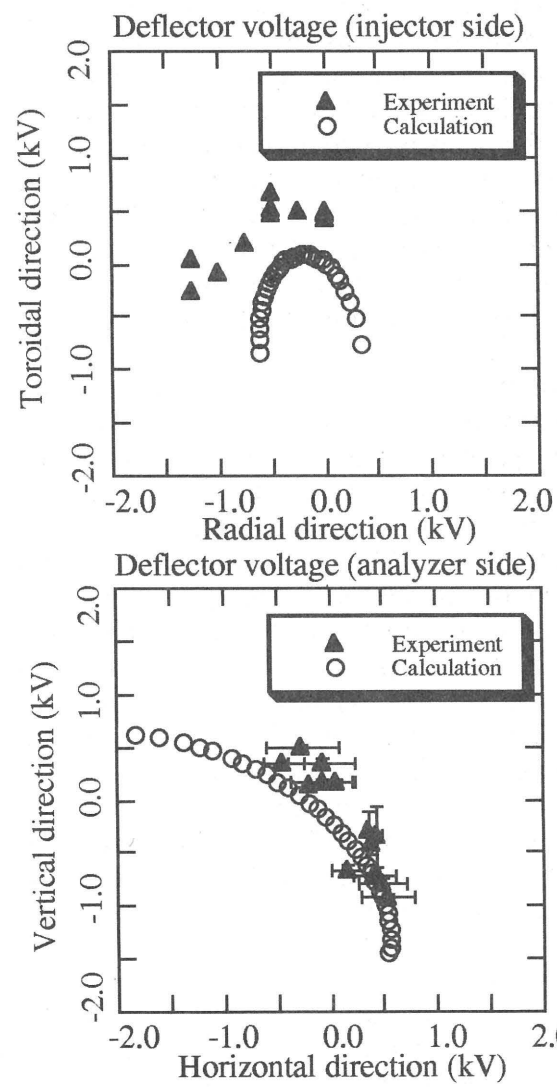

Fig. 2. Results of calibration experiment.