§3. Measurement of Plasma Potential by HIBP with a Single Poloidal Sweep

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Continuous efforts are also devoted in this year for the development of the accurate measurement of the potential profile of the tokamak plasmas. Basic requirements for the accurate mesurement of the potential profile may be summarized as 1) measurement must be performed in a single poloidal sweep to remove the assumption of the identical successive plasma discharges, 2) the suppression of the optical interference on the analyzer. A few improvements are performed on these points.

One of the main error in the potential measurement may be due to the large off-axis entrance angle of the secondary beam to the energy analyzer. Last year we succeeded in the removal of the error due to the change of the out-of-plane entrance angle of the secondary beam to the analyzer when the primary beam is scanned across the plasma cross-section. The energy analyzer appropriate to this method should have a very wide slit (1 mm high and 80 mm wide used in the experiment) and the very homogeneous characteristics along this wide input slit. We changed the shape of the upper electrode in Fig.1 in order to increase the region of uniform electric field and also tried to reduce the effect of radiation by installing the optical trap on t;he lower surface on the upper electrode. We reduced the distance between upper and lower electrode and increaed the width of the upper electode in spite of the large applied voltage of about 85 kV. The uniformity up to $\Delta\phi/\phi_0 = 5.0\text{x}10^{-4}$ is obtained numerically after the optimization of the corona plates, in the entire section of the input slit ±4 cm (width of the input slit). ϕ is a calculated electric potential in the analyzer and ϕ_0 is the electric potential in the ideal energy analyzer. In addition the region of the uniformity of $5.0\text{x}10^{-4}$ is fairly small in the zone covered by the detector. In the following the calibration of the system with a new electrode in the energy analyzer in the case of large off-axis entrance angle is described

Figure 2a, b show time behaviours of ND of the gas-ionization currents and a monitor signal of the toroidal sweep voltage under toroidal sweep when the analyzer axis is shifted by -3.0° for (a) and by 3.0° for (b). The maxima of ND for both cases are approximately the same at the approximately opposite sweep voltage in spite of the large difference in the toroidal deflection angle. It experimentally supports our method of the measurement indicating we can get true total energy even if the beam is under the large toroidal deflections and our energy analyzer has very homogeneous characteristics along the horizontal displacement of the beam at the input slit.

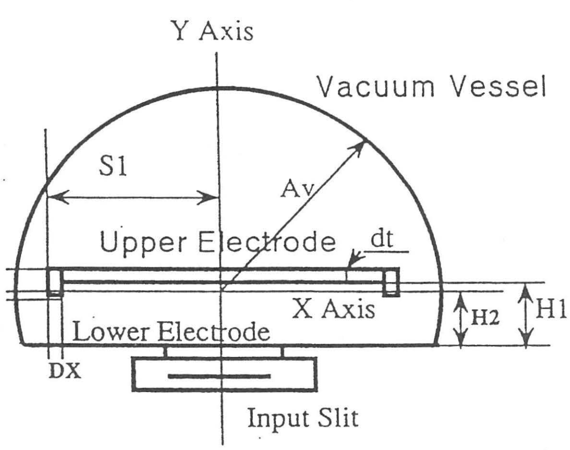

Figure 1. Cross-sectional view of the analyzer. The width of the upper plate is expanded and the distance between the upper and lower electrodes are shortened to get the uniform electric field. The height and thickness of the side bars are optimized numerically for optimum unifromity.

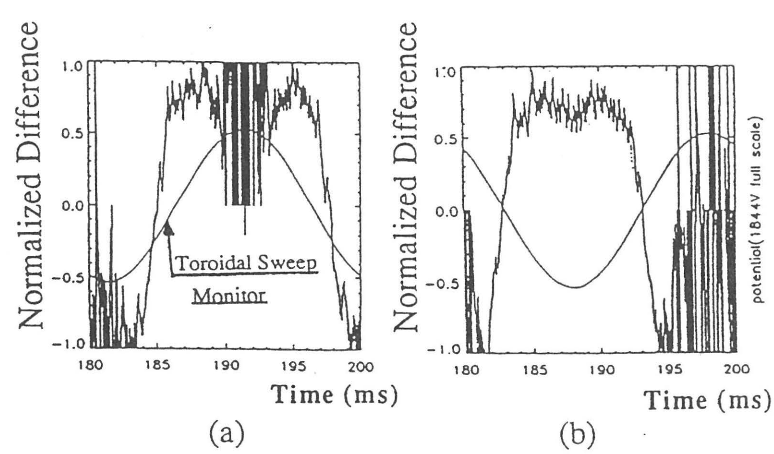

Figure 2. Time behaviours of ND of the detector currents by gas ionization under 60 Hz sinusoidal toroidal sweep. The analyzer plane (plane of symmetry of the analyzer) is rotated into toroidal direction by the angle of -3.0° in the case of (a) and 3.0° in the case of (b). Also shown is the toroidal sweep voltage monitor.