§5. Confirmation of Beam Orbit of the Heavy Ion Beam Probe on LHD

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The installation of 6 MeV heavy ion beam probe (HIBP) system to LHD was completed in previous year, and the secondary beam was tried to be detected for checking beam orbit and calibrating energy analyzer in this year. The secondary beam was successively detected by using micro channel plates (MCP) that are high gain current detector and that provide us with the capability to measure a very small amount of current. In this report, an experimental result to check the beam orbit by using the signal from MCP is shown.

The beam orbit of HIBP in LHD is deflected by sweepers, which are 8-pole type electric deflector. Sweepers are installed at the beam injection point to plasma and at the front of the energy analyzer. In the experiment shown in this report, only the first sweeper was used. The electric field produced by this sweeper is characterized by two parameters, V1 and V2, which are the voltage supplied to plates in two perpendicular directions. Both V1 and V2 were swept as sine wave, and the signal from MCP located at the front of the entrance slit of analyzer was investigated.

In Fig.1, the time traces of sweeper voltage, V1, V2, and the detected signal with MCP are shown. The condition of magnetic field was, Bt=2.75T, Rax=3.6m. The secondary beam arose from collision with neutral gas in this experiment. Since the MCP detects electron, the signal appears as minus value. The detected signal is The gain of this MCP is about 10^3, therefore the total current of secondary beam was about 0.1 nA. In Fig.2, the shading map of signal intensity in V1-V2 space is shown. Shading level of map means the intensity of detected signal. In V1-V2 space, the region where signal intensity is large is localized. The secondary beam is the sheet beam, because the secondary beam ions arise from the primary beam path anywhere. This secondary sheet beam orbit was numerically calculated, and the minimum distance between this sheet beam and the position of MCP detector was estimated. In this calculation, V1, V2 were swept and the map of the minimum distance in V1-V2 space was produced. The contour lines shown in Fig.2 are drawn by using this calculation result. As shown in Fig.2, the detected current intensity by MCP coincides with these counter lines, therefore the beam was controlled well by sweeper as we intend to do.

The calibration of energy analyzer is not complete yet, since the ratio of signal to noise is small at the detector in the energy analyzer. By optimizing beam line and improving ion source, the current intensity will be increased in the next experiments and the calibration will be done.

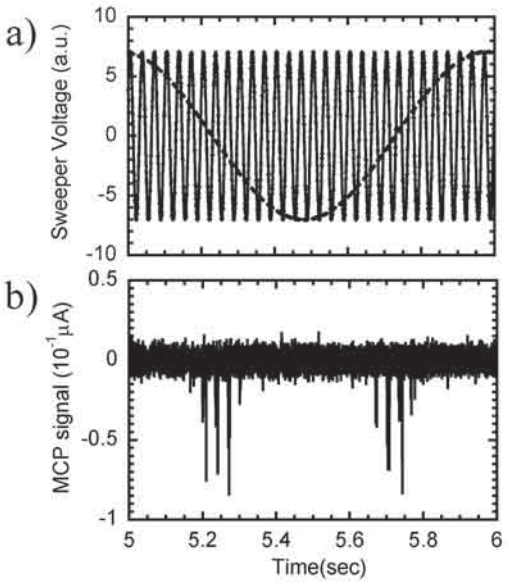

Fig.1 a) Voltages supplied to plates of sweeper. Solid line and dotted line correspond to V1 and V2 respectively. b) Detected signal with MCP located at the front of energy analyzer.

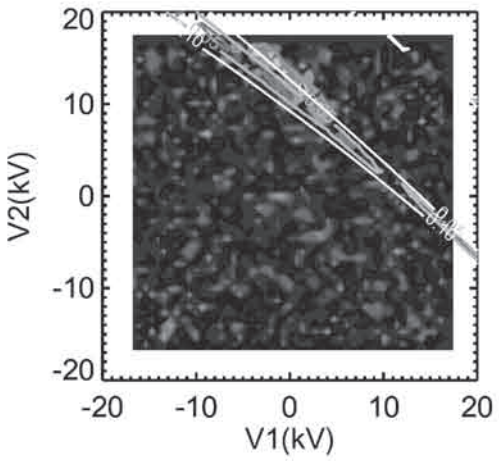

Fig.2 Shading map of detected signal intensity in V1-V2 space. Counter lines are made from calculation result, and which mean the minimum distance between secondary beam and MCP detector.