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Calibration of a Heavy Ion Beam Probe on the PLATO tokamak.

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A Heavy Ion Beam Probe (HIBP) is a powerful plasma diagnostic instrument in transport research because it can measure the electric potential, its fluctuation, and density fluctuation, simultaneously[1]. The PLATO tokamak[2], which aims to elucidate plasma turbulence transport phenomena, is equipped with a HIBP as one of main diagnostic tools[3]. Currently, the installation of the HIBP has been completed. Calibration experiments are in progress to evaluate the installation accuracy of the injection and detection beamlines.

The accuracy of the injection beamline installation is evaluated by detecting the injected beam by a detector installed at the bottom of the detection port. The injected beam trajectory is determined by the ion species, toroidal magnetic field, beam energy, and injection angle. The injection angle is determined by the voltage applied in the electrostatic deflector (PS1 in Fig. 1). Since the injected beam is a singly charged positive ion, it is bent by the toroidal magnetic field. The PS1 voltage required to be detected by the injected beam detector was determined by the beam trajectory calculation as shown in Fig. 2. This PS1 voltage is compared with the PS1 voltage at which the injected beam can be detected by the injected beam detector in the calibration experiment. The installation accuracy of the injection beamline can be estimated by the differences in the PS1 voltages between the trajectory calculation and the experiment.

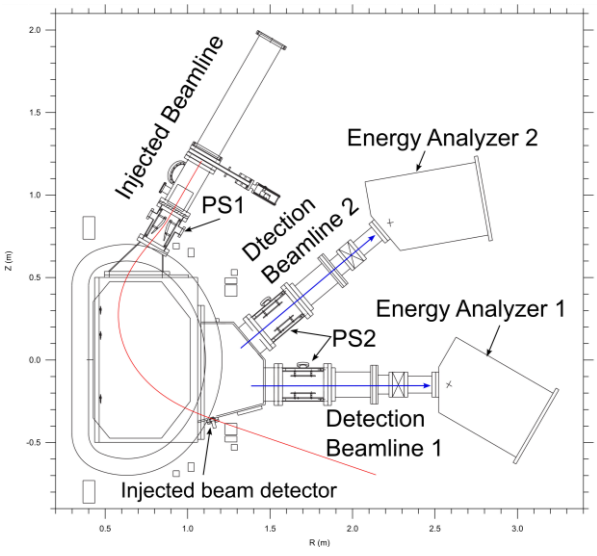

Figure 1. Poloidal cross section of a HIBP on the PLATO tokamak. The red line is an injected beam. The blue lines are detection beams.

The installation accuracy of the detection beamline can be estimated by utilizing the fact that the energy analyzer with parallel electrodes has a quadratic convergence characteristic with respect to the incident angle of the detected beam to the energy analyzer when the incident angle is near 30°[4]. In the calibration experiment using the detected beam, the detected beam is generated by collisional ionization with neutral gas so that no electric potential distribution is generated in the vacuum vessel. The installation accuracy of the detection beam line is evaluated by checking whether the detected beam enters the energy analyzer at the angle predicted by the trajectory calculation. In addition, it is also important to demonstrate that two energy analyzers work simultaneously. The results of these ongoing calibration experiments will be reported.

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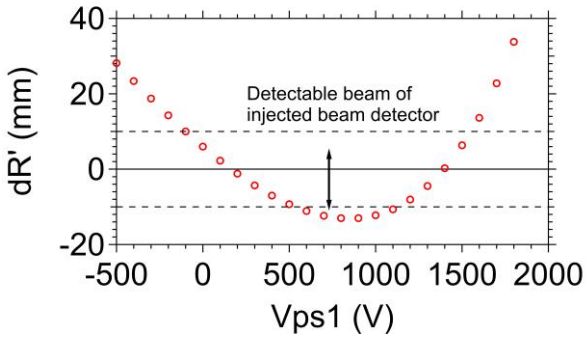

Figure 2. Beam arrival position on the surface of the injected beam detector and dR' is distance between the arrival position and center of the detector. The ion specie is Cs, the toroidal magnetic field strength is 0.3T, and the beam energy is 20keV. The Vps1 is voltage in the PS1.