§14. 500 keV HIBP on JFT-2M Tokamak

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The heavy ion beam probe(HIBP) is a unique technique to measure the electric potential and density fluctuation directly, simultaneously and with the time resolution up to about 1 microsecond. Accordingly, we installed an HIBP at the JFT-2M tokamak, which has a few of clear improved confinement modes such as H-mode, using many components of JIPP T-2U HIBP such as a 500 kV accelerator and the energy analyzer, the lens system and the cylindrical deflector.

The measurement of space potential by a high-voltage HIBP should be carried out very carefully because the change of the beam energy due to the space potential is much smaller than the beam energy. The beam energy is measured with the parallel plate electrostatic analyzer, so the change of the injection angle to the analyzer induces the error in the measurement of the total energy of the beam. Therefor, we installed for JFT-2M HIBP, two poloidal and two toroidal sweepers to suppress the changes of the in-plane (poloidal) and out-of-plane (toroidal) entrance angles to the analyzer, as sample volumes are swept from the edge to the core region of the plasma. This method was originally employed at the HIBP on CHS torsatron stellarator.

Figure 1 shows the schematic view of an HIBP on the JFT-2M tokamak. The HIBP injects singly ionized thallium or cesium ions up to the current of a few tens of microamperes. The 500 kV electrostatic accelerator, which was originally used in the HIBP at JIPP T-IIU tokamak, is placed on the ion core of the tokamak in order not to interfere with various kind of heating and diagnostics apparatus. The beam is transported with two electrostatic cylindrical deflectors and two pairs of double electrostatic quadrupole lenses (doublet) to the upper port, as shown in Fig. 1.
The main task of the first doublet is to compensate the strong focusing power of the cylindrical deflectors. The second doublet may be able to change the shape of the sample volume. The primary beam current is a few tens of microamperes. The radius of the beam is adjusted to a few millimeter at the observation point in a plasma. energy analyzer, and seven sets of detectors. Therefore, we can measure simultaneously at seven points which extend over a few cm.

Two sets of poloidal and toroidal sweepers are placed at the entrance and exit ports. The first poloidal sweeper scans the beams across the poloidal cross section. Figure 2 show the trajectories of the primary and secondary beams as the primary beam is swept by the entrance poloidal sweepers. As is clearly shown in Fig. 2, the entrance angle to the analyzer changes considerably as the sample volume is swept across the plasma. The second poloidal sweeper is aimed to adjust the injection angle to the energy analyzer to 30 degree while the sample volume moves inside the plasma. We will apply the preprogrammed waveforms to the sweeper electrode to fix the poloidal entrance angle. We are going to express our gratitude to Dr. Y. Miura of Japanese Atomic Research Institute for his devotion to this collaboration between NIFS and JAERI.

Reference

1) A. Fujisawa et al., Rev. Sci. Instrum. , **63** (1992) 3694.

Figure 1. Schematic vies of JFT-2M HIBP