§13. Fast Neutral Particle Analyzer for LHD

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Neutral particle measurement is one of the important diagnostics for an ion temperature, a high energy particle confinement analysis at a neutral beam injection and an ion cyclotron range frequency heatings on LHD. We have been improving the time-of-flight (TOF) neutral particle analyzer which was developed in ENEA Frascati, for LHD under the collaboration with ENEA Frascati group. We have also been developing the fast neutral particle measurement system which consists of the movable stage, the vacuum and data acquisition equipments. We have completed the calibration of the time-of-flight analyzer. The fast neutral particle measurement system have been constructed.

The neutral particles from plasma are ionized in the stripping cell. The energies of the particles are separated at the cylindrical electrode not by their species but only their energies. The species can be separated by their different flight times in the time-of-flight tube. The radiation noise can be instrictively reduced by using the coincidence technique. Some incident particles in the tube hit its inner walls and produce secondary electrons due to the particle divergence and the scattering in the foil. The electron is delayed to enter the stop channeltron detector (ChB) because the electron speed is lower than the particle one. Therefore the hydrogen signal is delayed and overlapped with the deuterium signal, and the mass rejection factor becomes worse. To reduce the effect, we set an aperture at the center of the flight path. The diaphragm in front of ChB is biased to suppress such virtual signals. Figure 1 shows the mass rejection for varying the bias of the diaphragm. We have obtained the optimum diaphragm bias of 40 V. The foil in front of the start channeltron detector (ChA) is also biased to accelerate the secondary electron. The secondary electron energy is very low and wide. Then the start trigger timing has jitter by the flight time from the foil to ChA. The bias applied in the foil is equal to the difference of the biases between ChA and ChB in our TOF configuration. Figure 2 shows the dependency between the foil bias and the count rate. When the foil bias increases, the count rate of ChA also increases. We can obtained the optimum bias of 150 V. Final calibration has been done using these bias values.

The fast neutral particle diagnostic system have been also developing. The system consists of the movable stage, the vacuum and data acquisition equipments. The movable stage with a 4 m rotational radius, can be rotated up to 40 degree horizontally and 33 degree vertically. The vacuum equipment has two pump systems in order to keep the high vacuum under the gas injection into the stripping gas cell. The movable stage and vacuum equipment are controlled by the VME computer automatically. The data acquisition consists of the particle species selection circuits and latching scalars and their control unit. We can control all the system from the computer network.

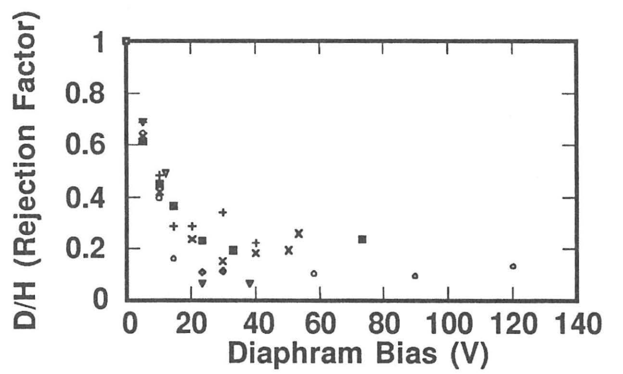

Fig. 1. The mass rejection v.s. the bias of the aperture in front of ChB.

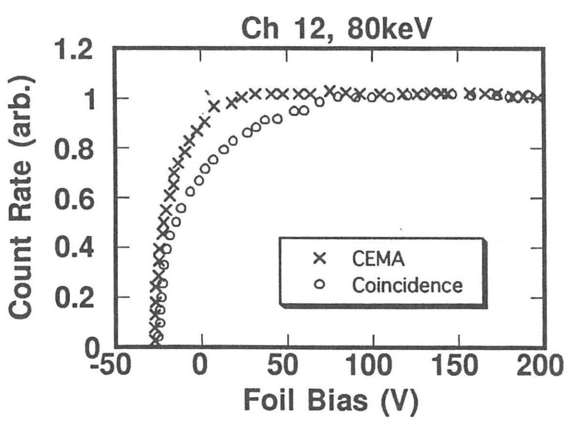

Fig. 2. The count rate v.s. the bias difference between ChA and B.