§24. Helically Trapped Particle Analyzer

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In the helical device such as CHS, charged particles with large pitch angle are trapped in the helical ripple mirror. Figure 1 shows a typical projection of the helically trapped ion orbit on the equatorial plane. The trapped ion gradually escapes from the confining region along local minimum magnetic well with a bouncing motion in the helical mirror without sharing its energy to bulk plasma. This direct loss of the ion with high energy not only deteriorates a plasma energy confinement characteristic but also may cause an impurity release from the vacuum wall. These trapped particles are produced in ICRF heating due to an acceleration of perpendicular velocity via. an ion cyclotron damping. It is a key issue to measure the trapped particle behavior during ICRF heating. For this purpose, we have designed a particle detector to measure the loss trapped ions.

This detector was designed to collect the ions with large pitch angle and with the high perpendicular energy. Figure 2 shows a schematic drawing of the detector. The detector consists of two cylindrical orifices with coaxial arrangement so that they make a cylindrical narrow channel. An ion collector of a thin ring shape is placed behind cylinders. When an axis of the detector is aligned to a direction of the magnetic field line, the ions with the Larmor radius that fits to the narrow channel can pass through. Thus, the ion with the unique perpendicular kinetic energy to the magnetic field line can be collected by the detector. However, the ions with low energy, whose Larmor radius is much smaller than the width of the narrow channel, would have easily penetrated to the collector, if the detector has no baffle to protect them in the channel. Then three baffles of a semicircle are equipped; first one and the third one are in the same azimuthal position, and the second one is opposite side to the first one. Therefore, the collector cannot be seen from the detector inlet. Furthermore, these baffles make a spiral path in the narrow channel. The ion can reach to the collector with a spiral trajectory. Since the gyro frequency and the pitch angle determine the trajectory of the ion, the parallel energy to the magnetic field line can be fixed. The parallel energy distribution can be obtained by changing applied electrical potential of cylinders and baffles. Measuring the orbit loss of ions with high energy will be helpful to improve ICRF heating characteristics in helical systems.

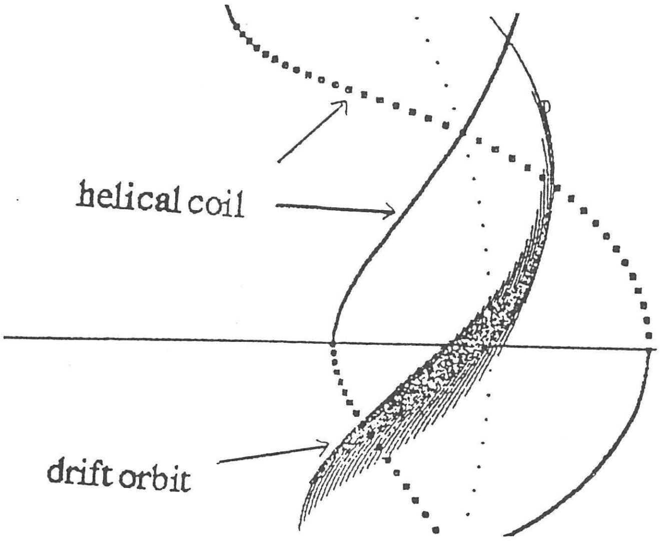

Fig.1 Drift orbit of helically trapped particle calculated by MAGFRP and ORBITRP codes.

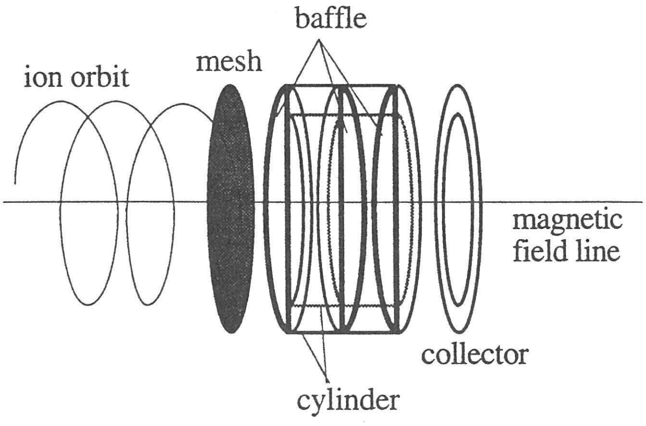

Fig. 2 Schematic drawing of detector and trajectry of ion.