§12. Analysis of Recycling and Neutral Particle Behavior in Open Magnetic Field Configuration

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In magnetic fusion devices, particle balance is important issues for stable sustainment of the potential confined plasma. Control of the plasma diameter by the limiter causes the hydrogen recycling around the limiters. Recycling phenomena on the limiters have a more significant influence on the plasma performance compared with those on the other vessel wall, since the limiters are located near the plasma boundary.

In order to measure neutral particles, Hα emission detectors and medium-speed camera have been installed. Hα emission detectors are located near each limiter for observing the recycling source around the three limiters install in the central-cell. The central limiter is located at z = +30 cm, the west and east limiters are located at z = 100 cm and z = -155 cm, respectively. The central limiter is the fixed type of limiter and 400 mm in diameters, while the iris limiter is radially variable type of limiter. In the cases of usual limiter position, the diameter of the iris limiters is 360 mm (d = $^{\phi}$360 cm). The purpose of this experiment is to comprehend the mechanism of the degradation of the plasma performance, and to find the optimal limiter condition for effective operation of ECH.

Figure 1 shows the temporal behavior of the plasma parameters and Hα emission intensity in the two different cases of the diameter of the iris limiters. In the case of d = $^{\phi}$350 mm, as shown in figure 1 (a), the diamagnetic signal (DMcc) is degraded with both P-ECH and C-ECH. The Hα emission intensity increases near the limiters in each ECH period. The electron line integrated density (NLcc) measured at the central-cell increases in P-ECH period however, in the case of C-ECH, NLcc decreases just after the start of the ECH pulse. In another shot, in extremely bad condition, the plasma collapses with P-ECH on the same sequence of the plasma production/heating systems. The Hα emission intensity also remarkably increases near the limiters at the same time.

In order to understand the above phenomena, Monte-Carlo simulation code was applied to the GAMMA 10 central-cell. In this simulation model, as shown in Fig. 2, the limiters, antenna of ion cyclotron radio frequency (ICRF) and gas puffer are precisely implemented in realistic configuration. Figure 3 shows the axial distribution of the Hα emission intensity from the east mirror throat (z = -310 cm) toward the central-midplane (z = 100 cm) obtained from the DEGAS simulation. The Hα line intensity calculated by DEGAS simulation is normalized at the measured points (z = -310, -240 and -141 cm). The amount of the hydrogen recycling on the east iris limiter is calculated in the two different cases of the diameter of the iris limiters. It is found that the neutral particle from GP#3 is dominant in the mirror throat region (z = -300 ~ -250 cm) and that the neutral particle from the east iris limiter becomes dominant near the iris limiter, since the influence of the particle of GP#3 becomes weak.

In future, we will conduct the experiment to aim to prevent the exhaust of plasma particle during the C-ECH period by using an active particle supply. We will continue to improve the mesh model of the central-cell west side that more faithfully reproduces the experimental condition.

1) K. Hosoi et al., Proc. 26th Annual Meeting of JSPF (December 1-4, 2009 Kyoto) (2009) 4pE25P.
2) K. Hosoi et al., 19th Int. Toki Conf. on Advanced Phys. in plasma and Fusion Res. (December 8-11, 2009 Toki, Japan) P1-6.

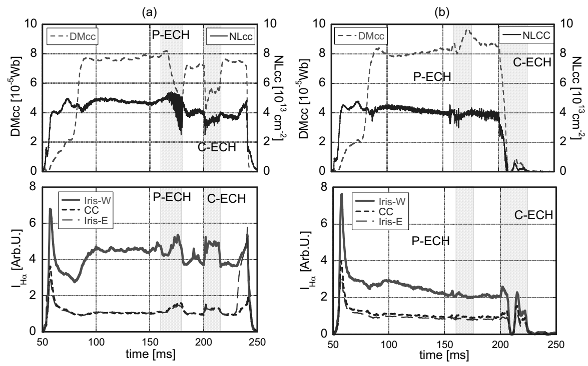

Fig. 1. The temporal behavior of plasma parameters and Hα emission intensity in the central-cell in the case of d = $^{\phi}$350 mm (a) and d = $^{\phi}$380 mm (b)

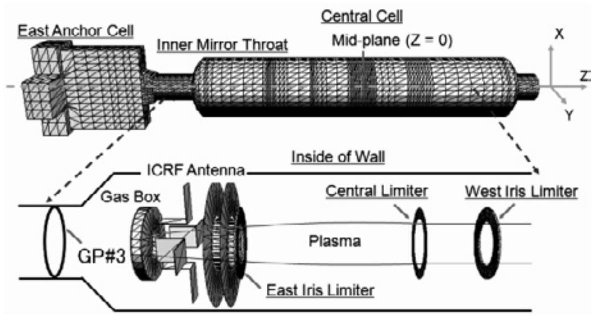

Fig.2 The fully 3-dimensional DEGAS mesh-model.

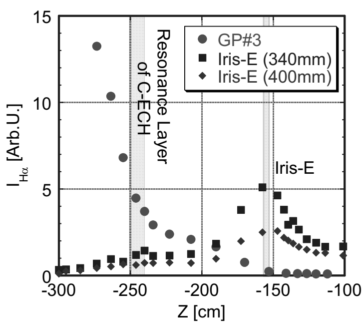

Fig.3 Axial distribution of th Hα emission intensity obtained from the DEGAS simulation