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

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Investigation of edge plasma behavior and neutral particle transport is important subject for open magnetic field configuration plasmas as well as toroidal configuration plasmas. Particularly in tandem mirror plasmas, penetration of neutrals into the core plasma region plays an important role in formation of the neutral density profile, since the plasma density is lower than that of tokamaks. Neutral particle transport simulations based on the Monte-Carlo methods have been widely used as a standard way to approach neutral behavior in the complicated systems of fusion devices. In this study, we develop three-dimensional neutral transport analyses in open magnetic field region such as in GAMMA 10 plasmas using the Monte-Carlo neutral particle code DEGAS. In order to investigate precise behavior of edge plasmas, a high-speed camera is applied to the GAMMA 10 central-cell for the first time.

In the last academic year, three-dimensional mesh model was structured. In this model, an up-down symmetry is introduced and the simulation space is divided into 11 segments radially and 8 segments azimuthally. In the axial direction, 69 segments are defined, which extend from the central midplane to the outer-transition of the anchor-cell. In order to apply the geometrical structure precisely into the simulation space, additional structures, "second wall", were successfully implemented. Figure 1 shows the comparison between the simulation result and the measured one in the central-cell. The open circles represent the results determined from the simulation in which only the central-cell is modeled and the simple exit is located at the outside of the mirror throat. In this case, it should be noted that the discrepancy is observed at the location of the gasbox (z = -240cm). However, the triangles obtained from the present simulation, in which both central-cell and anchor-cell are combined into one structure, well reproduces the experimental results shown as filled circles. On the other hand, the data represented by cross are obtained from another simulation in which the size of the gasbox is artificially reduced. In this case, a noticeably higher intensity of calculated Hα emission is recognized. From these results, it is clarified that the neutral transport is much affected by a geometrical configuration.

In the GAMMA 10 central-cell, visible imaging measurement was carried out by using a fast camera

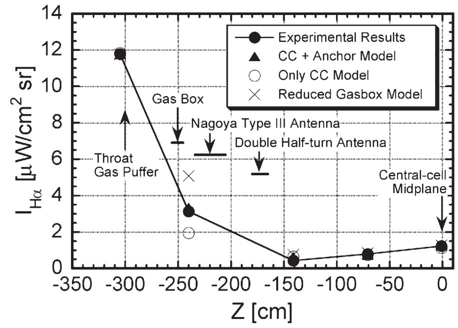

Fig. 1. Axial intensity profile of Hα line-emission. The solid circles are the experimental results. Triangles are the results of the present simulation. Open circles are determined from the simulation without the anchor-cell. Another simulation with reduced size of the gasbox model is shown in cross.

(Ultima-SE, Photron Inc.). Gas puff in the central region was used to visualize mainly plasma periphery and it is expected that plasma turbulence will be visualized. Figure 2 shows one of the digital video output images of gas puff imaging with 40500 FPS and 64x64 pixels (a), two-dimensional phase image distribution based on FFT analysis (b), a vertical profile obtained from the phase image analysis (d). As shown in Fig.2(a), the localization of plasma light and the vibration of plasma periphery were observed clearly by the fast camera. From FFT analysis, observed vibration with m = 1 was speculated to be a fluctuation due to electron diamagnetic drift.

Reference

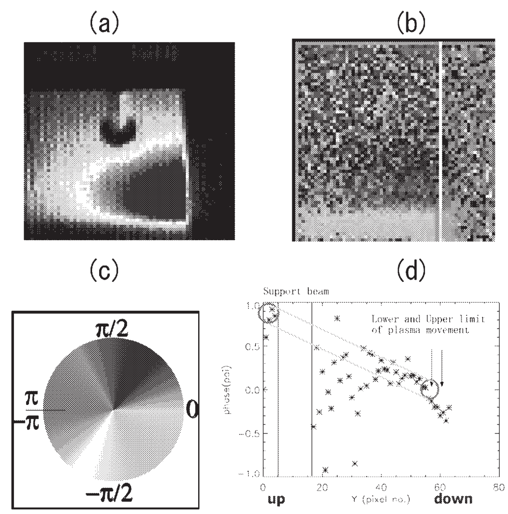

Fig. 2. Result of 2-dimensional image analysis

1) Nakashima, Y. *et al.*: J. Nucl. Mater. **337-339** (2005) 461.
2) Nakashima, Y. *et al.*: Proc.19th ICNSP and 7th APPTC (July 12-15, 2005, Nara, Japan)
3) Nishino, N., Nakashima, Y. *et al.*: to be published to J. Plasma and Fusion Research.