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

Nakashima, Y., Yoshikawa, M., Islam, Md. K. (Univ. Tsukuba, P.R.C.)
Nishino, N. (Hiroshima Univ., Eng.)
Kobayashi, S. (Kyoto Univ., I.A.E.)
Shoji, M.,
Sawada, K. (Shinshu Univ., Eng.)
Ishimoto, Y. (JAERI, Naka)
Kubota, Y., Higashizono, Y. (Univ. Tsukuba, Graduate School of Pure and Appl. Sci.)
Tomita, Y., Sagara, A., Masuzaki, T., Morisaki, T.

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.

Figure 1 shows the mesh model of the wall surface of the vacuum chamber in the central and anchor cells, together with the grid structure of the plasma surface and the components installed in the vacuum chamber used in the present calculation. In this model, as shown in the figure, 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", are defined. In the present simulation, a gasbox and two ICRF antennas are treated as isolated walls in addition to the 3-dimensional mesh structure of the central-cell vacuum vessel wall. The components defined as the second wall are shown in Fig.1 (c). After introducing this boundary condition, a modification of the algorithm has been made in the code, which preserves the consistency in particle tracking with interactions between test particles and the "second wall". Thus the use of a "second wall" was successfully applied in addition to the usual vacuum chamber wall. It enabled us to realize a detailed three-dimensional particle simulation including complicated structures in the simulation space.

In the GAMMA 10 central-cell, visible imaging measurement was tried by a fast camera (Ultima-SE, Photron Inc.) for the very first time. 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. The right side in Fig.2 is limited by port duct. During gas puff, localization of plasma light and the vibration of plasma periphery were observed clearly by the fast camera.

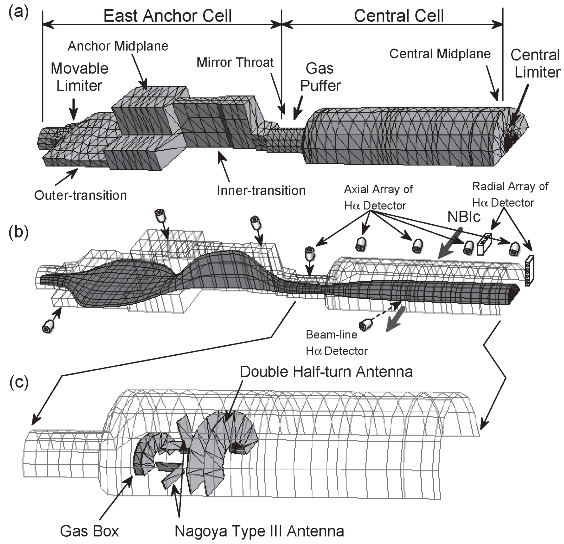

Fig. 1. Mesh model used for the 3D-DEGAS simulation. (a) surface structure of the vessel wall, (b) grid shape of the plasma surface, (c) structure of the "second wall" introduced into the code.

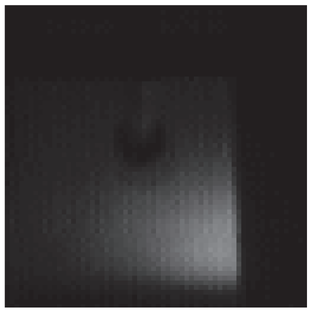

Fig. 2. Video output image during gas-puff imaging Gas puffing is carried out at the right side of the picture from the bottom.

Reference

1) Nakashima, Y. *et al.*: Proc.16th PSI meeting (May 24-28, 2004, Portland Maine, USA)
2) Nakashima, Y. *et al.*: Trans. Fusion Technol. **47** No.1T (2005) 155.
3) Nakashima, Y. *et al.*: J. Nucl. Mater. **337-339** (2005) 461.
4) Nishino, N., Nakashima, Y. *et al.*: submitted to J. Plasma and Fusion Research.