§11. 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. Recently gas puff imaging (GPI) experiments have been performed in the central-cell and the detailed investigation of edge plasma behavior has been started.

The upper drawing of Fig. 1 shows the mesh geometry of fully 3-dimensional Monte-Carlo simulation using DEGAS code. In this model, the simulation space is divided into 11 segments radially and 32 segments azimuthally. In the axial direction, 55 segments are defined from the east mirror throat (z = -300 cm) to the middle of the west side (z = +200 cm). In order to apply the geometrical structure precisely into the simulation space, additional structures, "second wall", were implemented and the precise mesh structure is designed in front of the central mid-plane (viewing area of the high-speed camera). The left side of the lower pictures is 2-dimensional image obtained with high-speed camera during GPI and the simulation result (right side) shows a good agreement with the experiment. From the above results, analysis method of neutral behavior in GPI and NBI experiments has been established.

In the GAMMA 10 central-cell, hydrogen ice pellet was injected to build up the central-cell plasma density and the visible imaging measurement was carried out by using a high-speed camera (MEMORECAM fx-K4, NAC Inc.). In this experiment detailed images of ablation light was captured for the first time in GAMMA 10. Figure 2 shows the 2-D images of the ablation light of the pellet with 40,000 FPS and 192x144 pixels. As shown in the figure the ablation light is expanded along the magnetic field line (horizontal direction) and a significant structure along the field line is also observed. In this pellet injection experiment, penetration length of the pellet and the effect of the central ECH on pellet ablation.is also clarified.

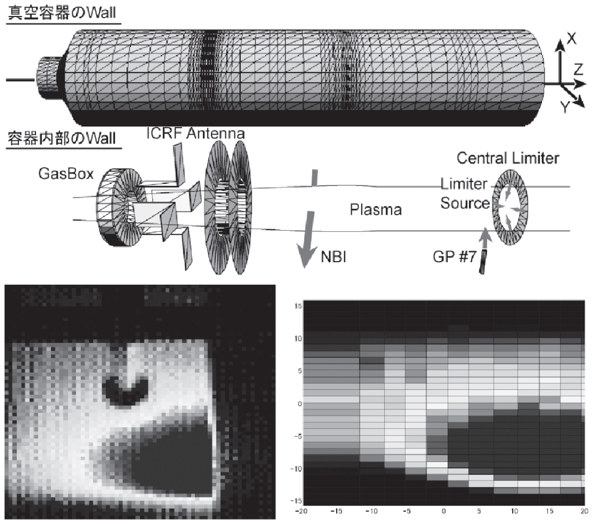

Fig. 1. Upper: Fully 3-dimensional mesh model of the GAMMA 10 central-cell, Lower left: 2-dimensional image in GPI experiment in the central-cell. Lower right: Simulation result of the GPI experiment.

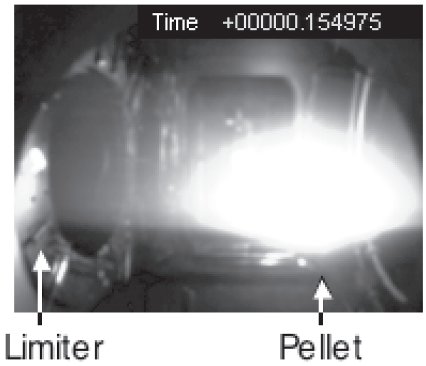

Fig. 2. Ablation light of hydrogen pellet in the central-cell measured with a high-speed camera.

Reference

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