§25. EMC3-EIRENE Simulations of Linear Divertor Plasmas

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Linear divertor plasma simulators (LDS) have been playing an important role for understanding the edge plasma physics and the plasma surface interactions, because their system has inherent features such as high stability, flexibility, and accessibility. In order to make the knowledge and output obtained in the LDS universal, it is effective way to compare the experimental results with the numerical simulation calculated by using the widely used code in large confinement devices. In this study, we have applied the EMC3-EIRENE code[1)], which can deal three-dimensional (3D) effects, to linear plasmas. Ultimately we would like to simulate the plasma detachment and clarify its dependence on 3D structures like the V-shaped target in GAMMA 10/PDX[2)].

Firstly, we have tried to calculate the linear plasma of the linear divertor plasma simulator NAGDIS-II. Figure 1 shows the schematic of the current simulation model. Because the EMC3-EIRENE code is described in the cylindrical coordinates, we employed the high aspect ratio approximation to generate the quasi-linear computational grid. Two regions were set up in this model: ZONE 1 was the source region and ZONE 0 was the divertor plasma test region. The mesh spacing along the magnetic field line was modulated from 0.05 mm in front of the target to 20 mm near ZONE 1.

In torus devices, the energy source is normally defined as the surface source distributed on the vicinity of the last closed flux surface. In contrast, in the linear device, plasma source is laying in the parallel direction from the calculation region. To simulate such a particular situation in the linear device, we introduced the volume energy source with arbitrary radial distribution in ZONE 1 in fiscal year 2014.

Figure 2 shows the calculated distributions of the electron temperature and the electron density of a hydrogen discharge as examples. By changing shape of the volume energy source, we can control the electron temperature distribution.

In the next step, we are planning to simulate the particle balance in the vacuum vessel with a more realistic geometry. We will add gas-puff and pump effects as shown in Fig. 3. Additionally, a baffle plate will be included at between ZONE 0 and 1 as appropriate. Moreover, we plan to simulate deuterium plasma discharges.

1) Feng, Y. et al. : Contrib. Plasma Phys. 44 (2004) 57.
2) Sakamoto, M. et al. : Fusion Sci. Technol. 63 (2013) 188.

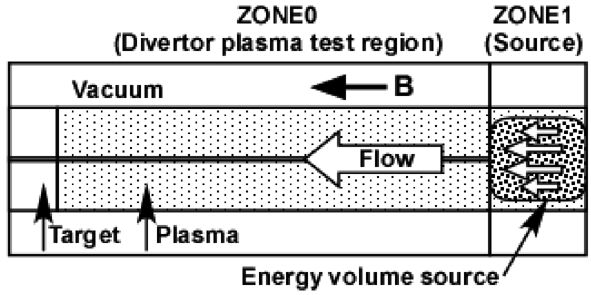

Fig. 1. Schematic of the NAGDIS-II plasma simulation.

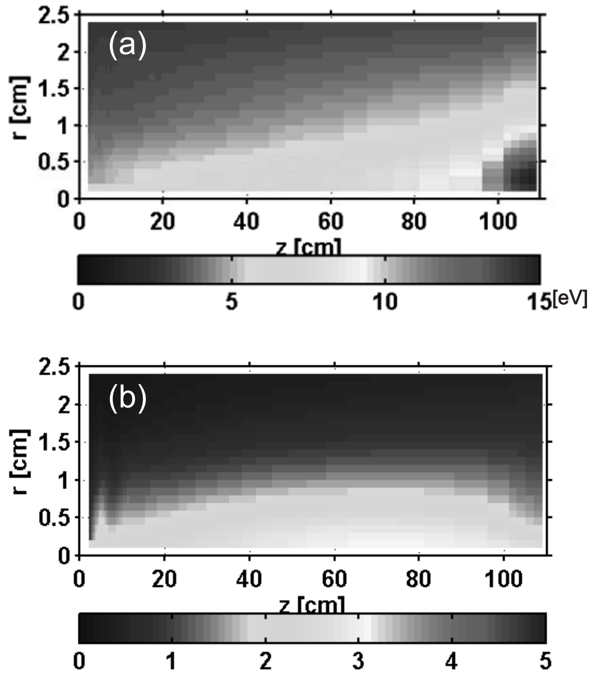

Fig. 2. Calculated distributions of (a) electron temperature and (b) electron density.

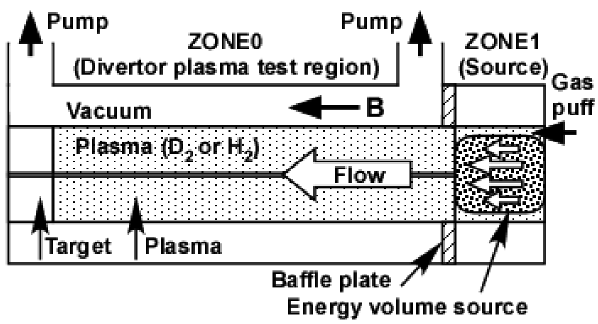

Fig. 3. New simulation model that we are planning.