§15. Study of Influence of Magnetic Field Structure on Detached Plasma Formation

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Plasma detachment is expected to one of the most promising method to reduce huge plasma heat loads to the divertor plate in next generation fusion devices. Now, new innovative divertor concept, such as super-X and snowflake divertor, is proposed. The magnetic field structure in the innovative divertor geometry is expected to establish plasma detachment more stable.

Linear divertor plasma simulators (LDS) have been widely used to investigate fundamental property of the detached plasma. The most important point in LDS study is how to make the scientific output obtained in LDS universal, being able to adapt them to ITER and DEMO design. From this point of view, the numerical simulation to evaluate plasma characteristics in the LDS is essential.

The EMC3-Eirene code, widely used in toroidal devices, is adapted to the linear device, NAGDIS-II in Nagoya University. The computational grid is shown in Fig. 1. The size of the computational area is 110 cm in the magnetic field direction, and 2.5 cm in the radial direction. In order to simulate a linear plasma, the large aspect ratio assumption is used and the cylindrical symmetry is assumed. Particle and power source is assumed to be located in the plasma source region.

First, we have tried to reproduce the attached plasma generated in the NAGDIS-II. Fig. 2 show the 2D distribution of electron density n_e and electron temperature T_e calculated with the EMC3-Eirene code. The radial profiles of n_e and T_e at $z = 24$, 53, 75 cm are also shown. The radial profiles of n_e and T_e are controlled by adjusting a the additional volumetric energy source in the plasma source region to reproduce the NAGDIS-II plasma. It is found that along the magnetic field, n_e once goes up and gradually decreases toward the target plate. This tendency matches the experimental result in NAGDIS well.

Understanding of the energy balance in attached and detached plasma conditions is quite important. Fig. 3 shows the energy dissipation rate of the total input power in the plasma. In the attached plasma condition, 59 % of the total input power is dissipated through neutral gas due to charge exchange process, and 39 % becomes heat load to the target plate. In the future, the energy balance in the detached plasma condition will be investigated systemically.

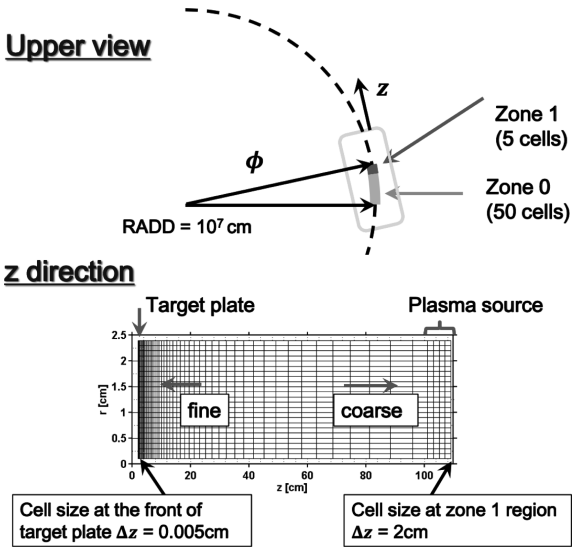

Fig. 1: Schematic of computational grids for EMC3-Eirene calculation.

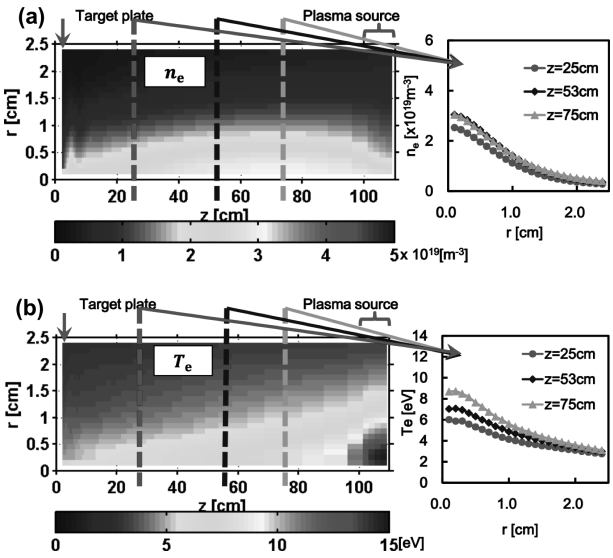

Fig. 2: Calculated distribution of (a) electron density and electron temperature.

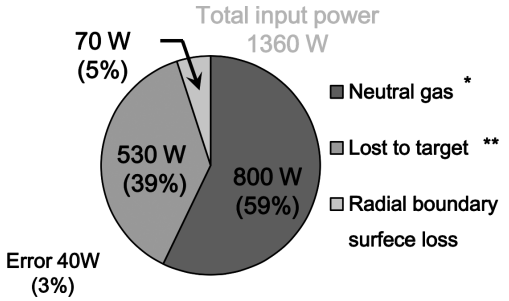

Fig. 3: Energy dissipation rate of total input power.