§5. Development of Wave Propagation-absorption Code and Plasma Heating Power Profile Evaluation Code

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In the LHD, a long time discharge is maintained for roughly one hour by the ICRF minority ion heating [1]. In order to optimize the ICRF heating condition, it is important to develop the wave propagation and absorption power calculation code using the three-dimensional equilibrium field as well as heating evaluation code of transferred power from fast ions produced by ICRF to bulk plasma. Therefore, first, we developed the transferred power evaluation code using the simple model where the ICRF fast ions is accelerated on the resonance layer by ICRF wave. In this code, ICRF wave profile is assumed to be uniform. In order to save the calculation time, only the ICRF fast ions are traced. In addition, in this code, since the particle loss boundary is set on the vacuum vessel wall, the re-entering fast ions which is important for analyses of fast ions in LHD is included and the ICRF fast ions may be accelerated near the ICRF antenna.

In the LHD typical ICRF discharge (magnetic configuration:R=3.6 m, Bt=2.75, frequency of ICRF wave: 38.47 MHz,), transferred power efficiency (ratio of transferred power to absorption power from ICRF wave) is evaluated by using the developed code with change in the density, temperature, and strength of ICRF wave. Figure 1 show the difference between the full Monte Calro simulation (bulk line) and the developed code (red points). From Fig.1, the dependence of transferred power efficiency evaluated by the developed code is almost same as the results of full Monte Carlo code. Figure 2 shows the density dependence of the the transferred power efficiency evaluated by the developed code in case of plasma temperature 1 keV. It is found from Fig. 2 that the maximum energy averaged over all test particles decrease with increase in the density and the transferred power efficiency is 0.9 in the region of maximum energy ~ 10 keV. On the other hand, the maximum energy is large in the low density regime and the transferred power efficiency decrease with decrease in density. In this developed code, the profile of transferred power is also evaluated. The normalized peaked value which denotes how much flat is it is shown in Fig. 3. From Fig. 3, a normalized peak value of the transferred power is less than that of absorption power. The profile of transferred power tends to be flatter. In addition, the normalized peak value of transferred power increases with increase in the density. In the high density regime, the profile of transferred power is close to that of absorption power.

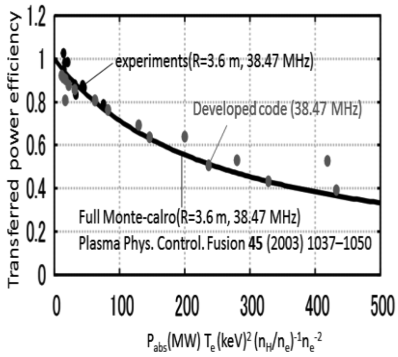

Fig. 1 Comparison of transferred power efficiency between the developed code and the full Monte Carlo code.

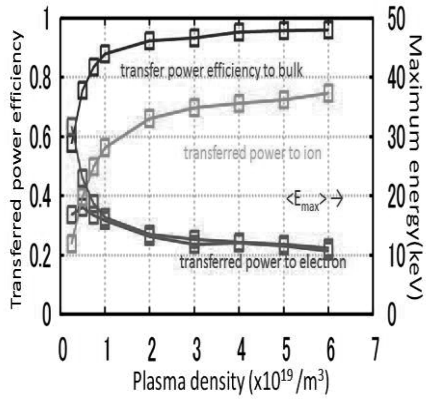

Fig. 2 Density dependence of transferred power efficiency.

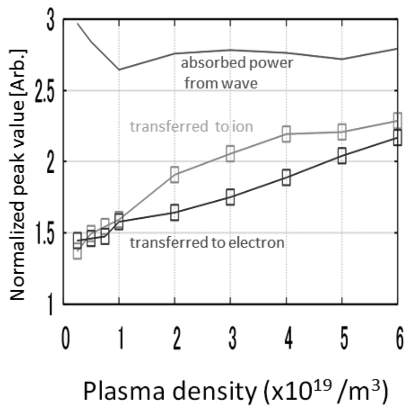

Fig. 3 Normalized peak value.

[1]T. Mutoh, et al., Nucl. Fusion. **53** (2013) 063017.