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

Seki, R., Seki, T., Yokoyama, M., Saito, K., Kamio, S., Mutoh, T.

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 transferred power efficiency evaluated by change the effective fast ion temperature, which calculated from the ICRF fast ion velocity distribution in case of plasma temperature 1 keV. It is found from Fig. 2 that heating efficiency decrease with increase in the effective fast ion temperature. In the plasma with T_{bg} = 1 keV, the transferred power to ion is almost the same as that to electron when effective fast ion temperature = 20 keV. In the high effective temperature case (~ 60 keV), the transferred power to ion is much smaller. Figure 3 shows the ICRF electric field in terms of absorbed power. From this figure, the absorbed power is almost proportional to ICRF electric field in the two resonance layer case. On the other hand, the ICRF electric field in the one resonance layer case is higher than that in the two resonance layer case when the absorbed power is higher.

In the ICRF experiments, the ICRF fast ions velocity distribution is measured by SiFNA. And, the effective fast ion temperature is evaluated. I will compare the results with experiments using the Fig.2 and Fig. 3.

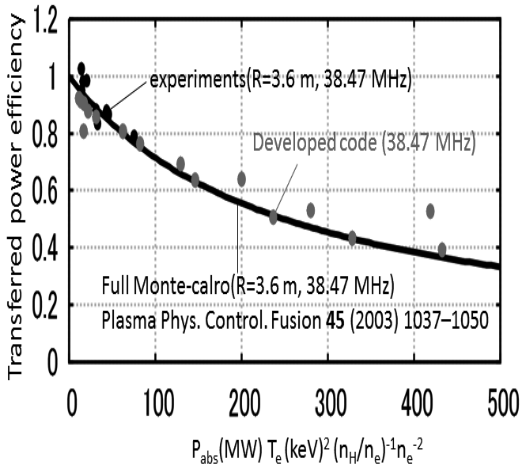

Fig. 1 Comparison of transferred power efficiency between the developed code and the full Monte Carlo code.

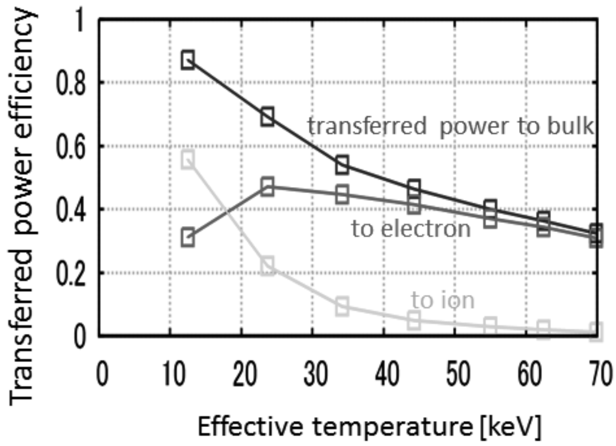

Fig. 2 transferred power efficiency vs effective temperature.

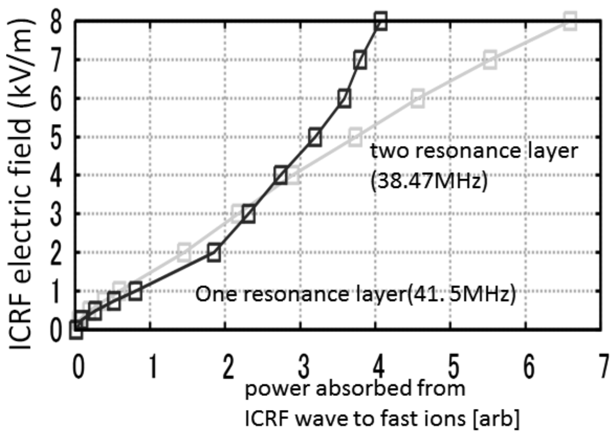

Fig. 3. absorbed power to fast ions vs ICRF electric field on the resonance layer

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