§4. Integrated Simulation of C-pellet Injected High Ion Temperature Plasma of LHD

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High ion temperature plasma is obtained after the rapid change of the plasma density due to a C pellet injection in the LHD plasma. The rapid increase of the plasma density by the pellet injection enhances the ionization of neutral beams, and following rapid density decay increases the heating power per particle. In order to analyze the transport property in these time development plasmas, we have to use beam deposition code including the effect of plasma time development.

In this study we perform time-dependent NBI heating simulation of the time development plasma in LHD using GNET-TD[1] code, which is a modified version of GNET code [2]. We take into account the time development of the plasma density and temperature during the slowing-down of beam ions. The experimentally measured plasma density and temperature are used in the GNET-TD simulation. Furthermore, we perform a time-dependent heat transport simulation using the integrated transport code, TASK3D [3], in a combination with GNET-TD.

The experimental time development data (shot #110597, Rax=3.6m, Bax=-2.85T) of the temperature and density is loaded to GNET-TD code and beam ion source profiles are evaluated by HFREYA using the same time development data. We analyze the time development of the beam ion distribution and the heat deposition profile.

Figure 1 shows the time development of the ion and electron heat deposition power in the region r/a<0.5 (left) and r/a>0.5 (right). After the carbon pellet injection at t=4.57s the line averaged density increases rapidly and decay slowly about 0.1s. The heat deposition power for ion and electron increase about 0.05sec and, then, gradually go down. The modulation (NBI-4) effect on the heat deposition can be seen in the ion heating, where the heating power is modulated to measure the ion temperature; 80ms on and 20ms off.

We, next, performed heat transport simulation of high-Ti experiment plasma using integrated transport code TASK3D. We assumed a pure H plasma for simplicity at present. The gyro-Bohm model is assumed as the turbulence transport model with a fixed constant factor. In this simulation we use the density profiles form the experimental data and only the heat transport is solved.

Figure 2 shows the time development of the electron (top) and ion (bottom) temperatures. After the pellet injection we can see a negative spike of the electron temperature in the outer region and, then, the electron temperature goes back to the previous temperatures. These are similar behavior with the experimental observation. On the other hand ion temperature once decreases and, then, goes up about 1keV. These behaviors are qualitatively similar with the experimental observation but the reached ion temperature is lower than the experimental one. This would be due to the lack of the transport improvement effect in the turbulence transport model.

[1] H. Yamaguchi, et al., Plasma Fusion Res. 8 (2013) in press.
[2] S. Murakami, et al., Fusion Sci. Technol. 46 (2004) 241.
[3] S. Sato, et al., Plasma Fusion Res. 3 (2008) S1063.

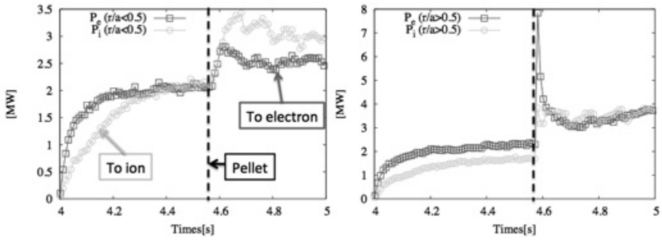

Fig. 1. Time development of the ion and electron heat deposition power in the region r/a<0.5 (left) and r/a>0.5 (right) evaluated by GNET-TD.

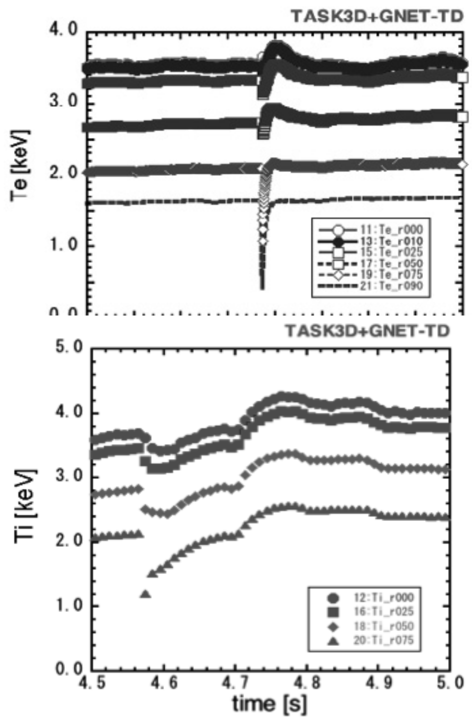

Fig. 2. Time development of the electron (top) and ion (bottom) temperatures of C-pellet injection plasma using TASK3D assuming gyro-Bohm transport model.