§4. Study of High-temperature Plasmas in LHD

Takahashi, H., Nagaoka, K., Osakabe, M., Nakano, H., Yamada, I., Tanaka, K., LHD Experiment Group, Murakami, S., Nagasaki, K. (Kyoto Univ.)

The collaboration research has been carried out to deepen the understanding of the isotope effect on the confinement characteristics of the troidal plasmas. The effect of the ion mass on the thermal transport has been investigated with various H/He ratio prior to the upcoming deuterium experiments in the LHD.

Figure 1 shows the dependence of (a) the central temperatures and (b) the energy confinement time for ion and for electron with four different conditions of H/He ratio. The plasmas were sustained using NBI. The line-average electron density was ~1.3x10^{19} m^{-3} and the electron density profile was almost same for these discharges. There was no clear dependence of T_{e0} and the electron energy confinement time on H/He ratio. On the other hand, T_{i0} and the ion energy confinement time clearly increased with increase in the contents of He. We also confirmed that the ion thermal diffusivity normalized by the Gyro Bohm factor significantly decreased in the plasma edge region for He rich condition.

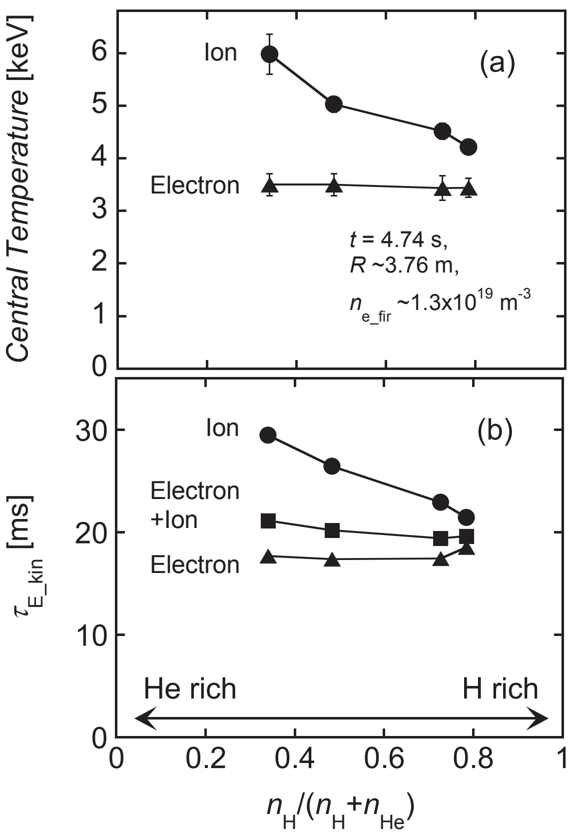

Figure 1. The dependence of (a) the central temperatures and (b) the energy confinement time for ion and for electron with four different conditions of H/He ratio.

These results suggested that ion thermal confinement improved due to the reduction of the turbulent transport by the mass effect. Thus we have performed a heat transport simulation using TASK3D taking account of the mass effect, where the heat deposition was evaluated by the multi-ion version of GNET. In the transport simulation, we assumed a turbulent transport model with an improvement factor depending on the effective mass number to the ion thermal diffusivity. This simulation could reproduce the experimental results of T_i profiles of four different H/He contents. Then we applied this model to the deuterium discharges in order to predict the achievable ion temperature. The result showed that ~20% higher ion temperature will be obtained in the deuterium dominant discharges ($n_D/(n_H+n_D)$ = 0.8) compared with the pure hydrogen plasma.

Figure 2 shows the comparison of T_{i0} between the previous achievement and the expected values in the deuterium experiments with regard to the ion heating power normalized by the electron density. In the deuterium experiment phase in the LHD, the deuterium beam will be also operated as NBI. Then the beam energy and the power of each perpendicular NBI increased up to 60-80 keV and 9 MW, respectively, from the present value of 40 keV and 6 MW. Higher T_{i0} in the deuterium plasma compared with previous results is expected due to the upgrade of the NBI heating capability in addition to the isotope effect.

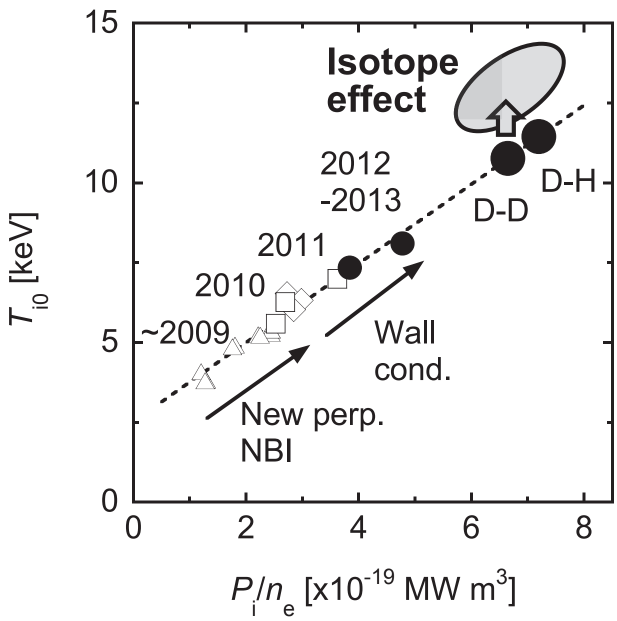

Figure 2. The comparison of T_{i0} between the previous achievement and the expected value in the deuterium experiments with regard to the ion heating power normalized by the electron density.