§2. Achievements of High-ion-temperature Mission Experiment in 16th Campaign of LHD

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High temperature plasma production is one of the most important mission experiments in LHD project. In 16th experiment campaign, high-temperature group has three targets of mission experiments; quasi-steady state operation of high-ion-temperature plasma (T_{i0} = 5.0keV, 1 sec), realization of T_{i0} = 7.3keV of central ion-temperature and T_{e0} = 10keV of central electron-temperature in the density range of $1 \times 10^{19}\mathrm{m}^{-3}$, and all missions were successfully completed. In this report, the mission experiment of high-ion-temperature plasma is reviewed.

In the end of 15th campaign, it was found that ion cyclotron range of frequency heating (ICH) plasma is effective to reduce the wall recycling and increase of central ion temperature. Therefore, the main plasma discharges heated by ICH with duration time of 10 sec were used as a wall conditioning procedure. After ICH plasma dischrges repetitive from 20-40 shots and with well-supressed recycling condition, high-ion-temperature plasma productions were tried. Figure 1 shows the time evolution of ion temperature measured by charge exchange spectroscopy (CXS), and over 5.5keV of central ion-temperature was sustained for 1.0 sec. The duration was limited by the pulse length of perpendicular (radial) neutral beam injection (NBI), which is also utilized as a probe beam of CXS measurement. The profiles of ion-temperature, electron temperature and density are shown in Fig. 2. The triangle shape of ion-temperature was observed at the center, while electron-temperature is parabolic profile and density profile is flat there.

Figure 3 shows the profiles of ion-temperature, electron-temperature and density, and the new record of central ion-temperature of $T_{i0} = 7.3 \pm 0.1$keV was achieved with carbon pellet injection. This high-ion-temperature was sustained for 0.040 sec. The profile of ion-temperature is parabolic at the plasma center, and transport barrier foot is observed around half of minor radius. The detailed transport analysis to understand the improvement of ion heat transport is in progress.

The ICH discharge cleaning technique enables us to extend the opportunities to investigate high-ion-temperature plasma properties as well as to extend high-ion-temperature regime of helical plasma. In the 16th campaign, 47 discharges realized high-ion-temperature plasma with $T_{i0} > 6$keV during high-ion-temperature mission experiment with 642 discharges including ICH cleaning discharges. The ratio of realization of ion-temperature with $T_{i0} > 6$keV is 7.3%, which is 3.5 times higher than that in 15th campaign.

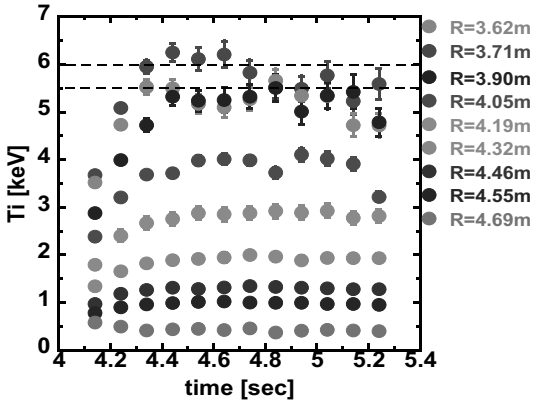

Fig. 1: Time evolution of ion temperature in quasi-steady state operation of high-ion-temperature plasma.

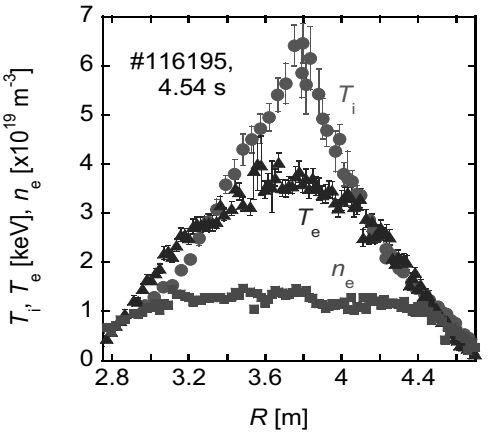

Fig. 2: Profiles of ion-temperature, electron temperature and density of quasi-steady state high-ion-temperature plasma.

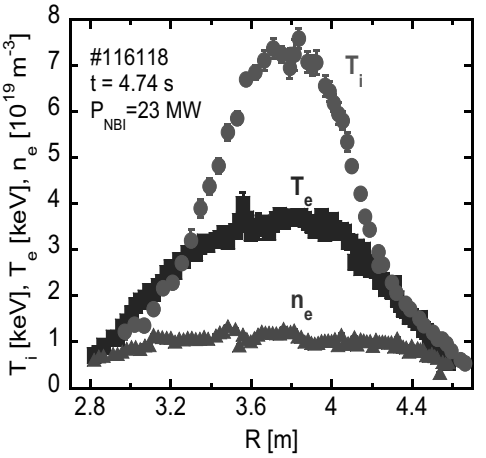

Fig. 3: Profiles of ion-temperature, electron temperature and density of highest-ion-temperature discharge with carbon pellet injection.