Dimensionless analysis of high temperature plasma in Large Helical Device


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Temperature of plasma is one of the most important parameter for the fulfillment of fusion reactor. In the last experimental campaign (16th) of Large Helical Device (LHD), which is the world largest helical-fusion-experiment device [1], the central ion temperature ($T_{i0}$) has been achieved 7.3 keV, which is the highest $T_{i0}$ in helical devices. We have succeeded in frequent productions of high $T_{i0}$ plasmas of more than 7 keV by carbon pellet injection and by the wall conditioning due to main plasma discharge with ion cyclotron heating. We have also maintained the high $T_{i0}$ plasma of more than 5.5 keV for about 1 second by helium gas puffing. The high electron-temperature ($T_e$) plasma regime has extended to 13.5 keV of the central $T_e$ with $1.0 \times 10^{19}$ m$^{-3}$ of line-averaged density [2], with newly installed electron cyclotron heating system with 154 GHz gyrotron whose nominal injection power is 1 MW. For realization of fusion reactor, the plasma performance has to reach to 10 keV of $T_i$ with $1 \times 10^{20}$ m$^{-3}$ of density. A dimensionless analysis is useful to extrapolate the reactor plasma regime. In this paper, we review the achievement of the high temperature plasma experiments in the LHD 16th campaign and show the dimensionless analysis of these high temperature plasmas.