Abstract for an Invited Paper
for the DPP07 Meeting of
The American Physical Society

Extension of High-Ion-Temperature Regime in the Large Helical Device (LHD)[1]

MASAYUKI YOKOYAMA[2], National Institute for Fusion Science

The production of high-ion-temperature hydrogen plasmas was successfully demonstrated in the LHD. The ion temperature (Ti) exceeded 5 keV (the record value in helical plasmas) at an average plasma density (n_e) of $1.2\text{x}10^{19}\text{m}^{-3}$ and also achieved 3 keV at $n_e \sim 4\text{x}10^{19}\text{m}^{-3}$. This achievement demonstrated the capability of high-ion-temperature plasma confinement in helical devices. The total injection power of neutral beams of 20 MW (3 parallel and 1 perpendicular injections) and ion cyclotron heating power of about 2 MW was applied in reduced helical-ripple magnetic configurations with Rax in the range of 3.575-3.65 m and B of 2.7-2.85 T. Here Rax is the vacuum magnetic axis position. High-Ti plasmas typically have large toroidal velocity, Vt, of order 50 km/s in the core region, accompanied by an increase of the Ti-gradient.
The measured core density of carbon-impurity ions strongly drops as the core-Ti increases. This implies that carbon-impurity ions are expelled from the core region. This unique feature may provide an efficient knob to avoid the impurity accumulation in reactor-relevant helical plasmas. Transport analysis has been performed, including comparison with relevant theories. In these high-Ti plasmas, the ions are in $1/\nu$ regime and the neoclassical ambipolar Er is expected to be negative (ion-root). This prediction indicates that the hollow impurity profile (usually anticipated from the positive Er (electron-root)) must be due to effects beyond neoclassical transport theory. The role of the large Vt in the improved ion heat confinement, with the viewpoint of plasma viscosity structure in three-dimensional magnetic configurations, will be discussed.

[1]This work is supported by the collaboration program of NIFS (NIFS07KLDD011) and by the Grants-in-aid from the Japanese Ministry of Education, Culture, Sports, Science, and Technology (18760638) for M.Y.
[2]for the LHD Experimental Group