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Extension of Operational Regime of LHD towards Deuterium Experiment

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The final goal of the LHD project is to obtain the high performance helical plasma relevant to the fusion reactor, i.e., ion and electron temperature T_i > 10 keV, volume averaged beta > 5 %, fusion triple product n_e tau_E Ti > 1020 keV mˆ-3 s, and long pulse length of more than 3600 s with heating power of 3 MW. In order to achieve this objective, the deuterium plasma is expected to have better energy and particle confinement than the hydrogen plasma, which is clearly seen in tokamaks, but is not always obvious in helical devices.
As the finalization of the hydrogen experiment towards the deuterium phase, the exploration of the best performance of the hydrogen plasma was intensively performed in the Large Helical Device (LHD). High T_i, T_e, of more than 6 keV were simultaneously achieved by superimposing the high power electron cyclotron resonance heating (ECH) on the neutral beam injection (NBI) heated plasma. It was also demonstrated in hydrogen/helium discharges that experimental and numerical results imply the existence of the confinement improvement for heavier ions than proton. Another key parameter to present plasma performance is an averaged beta value. The high beta regime around 4 % was extended to an order of magnitude lower collisional regime than before. The pulse length has also become longer. In the last experimental campaign, the high performance plasma with e-ITB could successfully be maintained for more than 5 minutes. In such a long pulse discharge, it was found that the mixed-material deposition layer plays a key role in the wall retention and the particle recycling. These three results assured the start of the deuterium experiment from March 2017.

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