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EX/2-5: Extension of Operational Regime in High-Temperature Plasmas and the Dynamic-Transport Characteristics in the LHD

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Realization of high-T_i plasmas is one of the most important issues in helical plasmas, which have an advantage for steady-state operation comparison with tokamak plasmas. Since 2010, newly installed perpendicular-NBI with the beam energy of 40 keV has been operational in the Large Helical Device (LHD) and the total-heating power of perpendicular-NBIs increased from 6 MW to 12 MW. Such low-energy NBIs are effective for ion heating and enabled us to achieve a higher T_i than that obtained previously. In the last experimental campaign, ICRF-discharge cleaning was adopted to reduce particle recycling from the wall. As a result, NBI-heating-power profile became peaked and the density-normalized ion heating power in the core region increased by 18% and the central T_i of 7 keV, which is the world's highest value for helical devices, was successfully achieved as the new record in the LHD.
In the LHD, high-T_i plasmas have been realized in combination with a carbon pellet. The kinetic-energy confinement was improved by a factor of 1.5 after the pellet injection. In the high-T_i phase, a flat or hollow profile in the electron density has been observed. This is the different characteristics from PEP mode investigated in Tokamaks. After the pellet injection, the central T_i, the gradient of T_i and that of the toroidal-flow velocity at the core region clearly increased indicating the formation of the ion-internal-transport barrier. In the high-T_i phase, reduction of the thermal diffusivity over the wide region was observed. In the core region, the time constant of the improvement of the ion-heat transport was found to be larger than that in the peripheral region. The toroidal-momentum transport was also improved accompanied with the reduction of the thermal diffusivity and the Prandtl number ignoring the intrinsic torque was close to unity. However, the confinement improvement was temporal and the gradient of T_i gradually decreased. Similarly, the toroidal-momentum transport went back to the low-confinement state in the latter phase of the discharge. Decrease of the negative radial electric field and increase of the density fluctuation were also observed in the phase.

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