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Overview of Transport and MHD Stability Study and Impact of Magnetic Field Topology in the Large Helical Device

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The progress of physics understanding and concurrent parameter extension since the last IAEA-FEC 2012 [1] in the Large Helical Device is overviewed. Recently the plasma with high ion and electron temperature (Ti(0) ~ Te(0) ~ 6keV) is obtained by the combination of 1) a reduction of wall recycling and neutrals by Helium ICRF discharges and 2) optimization of carbon pellet injection and on-axis ECH. The temperature regime obtained is significantly extended. The stochastic magnetic field in the plasma core which causes flattening of the temperature and the plasma flow can be eliminated by the control of the magnetic shear by NBCD and ECCD and a high central ion temperature (Ti(0) ~ 8keV) discharge is achieved by overcoming the core temperature flattening frequently observed in the plasma with an ion- ITB. After the formation of the ion-ITB, the residual stress switches the sign from the counter- to the co-direction and results in a large toroidal flow in the co-direction [2]. On the other hand, the radial convective velocity of the carbon impurity (Vc) also changes sign from inward to outward and this reversal of convection causes the extremely hollow impurity profile (called impurity hole). A stochastization of the magnetic field affects the MHD instability driven by a pressure gradient. This is an interesting topic because the stochastization of the magnetic field is also a key issue in the resonant magnetic perturbation (RMP) experiment for edge localized mode (ELM) suppression. When the stochastization of the magnetic field is enhanced by a RMP, the pressure driven mode is suppressed even without a change in the pressure gradient itself. In LHD, a low mode (n/m=1/1) magnetic island exists near the plasma periphery and the width of the magnetic island can be controlled by the RMP. By injecting hydrogen pellets into the O-point of the magnetic island, a significant peaked pressure profile inside the magnetic island is produced for a relatively long time, which is similar to the phenomena of a "snake"in a tokamak. Inside the LCFS, the stochastization causes the damping of flows, while it enhances the E×B flow due to the electron loss to the wall along the magnetic field.

[1] O.Kaneko, et. al., Nucl. Fusion 53 (2013) 104015.
[2] K.Ida, et. al., Phys. Rev. Lett. 111 (2013) 055001.

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