Core turbulence and comparison with gyro kinetic simulation in high Ti discharge of LHD

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Large Helical Device (LHD) is the largest super conducting helical device showing an equivalent performance to tokamak. An extensive study of turbulence driven transport is underway. The spatial and spectrum structure of core turbulence was measured by the two dimensional phase contrast imaging (2D-PCI) in the entire region of plasma cross section. A 2D-PCI covers k range of $k=1-10cm^{-1}$, frequency range of 20~500kHz with spatial resolution of $\delta\rho=0.1-0.3$. The turbulence measurements were performed in the ITB like high $T_i$ discharge. The ion temperature and its normalized gradient increased by the auxiliary heating of neutral beam injection. The ion thermal conductivity which is normalized by the gyro Bohm factor ($T_i^{1.5}$), reduced at auxiliary heating phase, although the normalized electron thermal conductivity stayed almost constant. This indicates the confinements were improved in the ion energy but not in the electron energy. A clear peak of the turbulence appeared at around foot point of ITB (at $\rho \sim 0.7$), when the normalized Ti gradients exceeded the critical values at this position. The critical gradients and growth rate of ion temperature gradient (ITG) turbulence were calculated by the gyro kinetic Vlasov simulation code (GKV-X) developed at NIFS[1]. The peak position of the fluctuation corresponds to the peak position of linear growth rate of ITG. This fluctuation component likely propagates to the ion diamagnetic direction in plasma frame and its peak wave number is around $k\rho_i=0.3$. These are consistent with ITG simulation of GKV-X. The improvements of ion thermal confinement were more significant toward the plasma center, although no clear peak of turbulence was observed at $\rho < \sim 0.7$. The improvement of ion energy confinement in central region can be interpreted as stable ITG. Recent non linear calculation by GKV-X showed that simulated $\chi_i$ at $\rho=0.6–0.8$ was close to the experimental values.

[1] M. Nunami et al., Plasma and Fusion Research Volume 6, 1403001 (2011)