§9. Turbulence and Transport Characteristics of High β H Mode in LHD

Tanaka, K., Michael, C.A., Vyacheslavov, L.N.
(Budker Institute of Nuclear Physics)

H mode is achieve in LHD at high b regime (β>2%) [1]. The relation between transport and fluctuation characteristics were studied. Fluctuation, of which wave number region is ITG/TEM reigon ($k_{perp}\rho_i$=0.1~1, here k_{perp} is perpendicular wavenumber and ρ_i is ion Larmor radius) were measured by the two dimensional phase contrast imaging [3]. Figure 1 shows time trace of H mode. Under constant external fueling, Hα signal suddenly dropped at t=2.51 sec and line density started to increase. This is clear indication of the improvement of particle confinement. Energy confinement time (τ_E) was improved transiently at transition timing, however, after transition it became almost same values before transition as shown in Fig.1 (c). Since international stellarator scaling predict positive n_e dependence, same energy conferment time after transition at higher n_e indicate degradation of energy confinement.

Figure 2 shows change of n_e, T_e and fluctuation profiles before (t=2.3sec) and after (t=2.7sec) H mode transition. As shown in Fig.2 (a) and (d), T_e did not change before and after transition, while n_e increased suggesting particle diffusion reduced. Fluctuation shows different behavior depending on its location and propagation direction. As shown in Fig.2 (c) and (f), three different braches are seen. The first one is core (ρ<0.7) ion diamagnetic (i-dia.) component, the second one is edge (ρ~1.0) electron diamagnetic (e-dia.) component, the third one is edge (ρ~1.2) i-dia. component. The edge i-dia fluctuation power, where fluctuation power is proportional to the square of fluctuation amplitude, did not change after transition although density increased. This indicates that fluctuation level, which was fluctuation amplitude normalized by density, reduced. Previous results showed that the edge i-dia. fluctuation level increased with increase of edge diffusion coefficient [4]. This is consistent that edge i-dia, fluctuation level decreased after transition when edge particle confinement was improved. On the other hands, edge e-dia fluctuation power increased around 10 times (amplitude increased around three times) after transition. Since density increased around factor two, fluctuation level increased factor 1.5. The degradation of energy confinement at high β regime (volume averaged β>1%) and associated increase of low k (k<0.1mm^{-1}) fluctuation level was observed [5]. The β increased from 2% at t=2.3sec to 2.5% at t=2.7sec. As described above, energy confinement depredated after transition. The increased e-dia. components might be related to the degradation of the energy confinement.

1) Toi, K., et al., Phys. of Plasmas **12**,020702,(2005)
2) Michael, C., et al., Rev. Sci. Instrum. **77**, 10E923,(2006)
3) Yamada, H. et al, Nucl. Fusion **45**,1684 (2005)
4) Tanaka, K., et al., Fsuion Sci, Tech. **51,** 97 (2007)
5) Tanaka, K., et al., NIFS Anuual report 2007

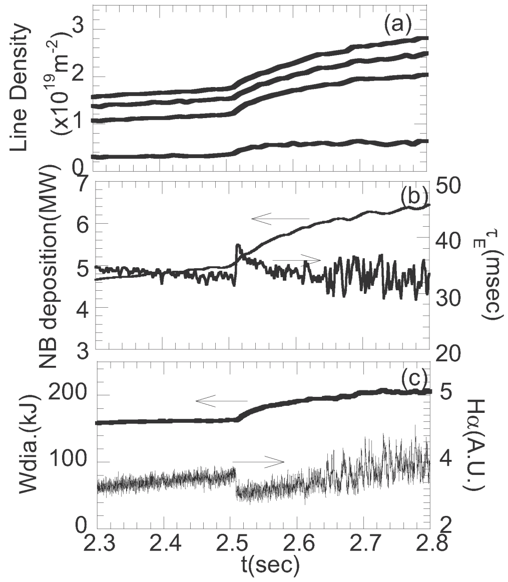

Fig.1 Time trace of (a) line density (from upper, chord position at the equatorial plane is ρ = 0.34, 0.58, 0.81, 1.05) (b) Deposition power and τ_E and (c) Stored energy and Hα

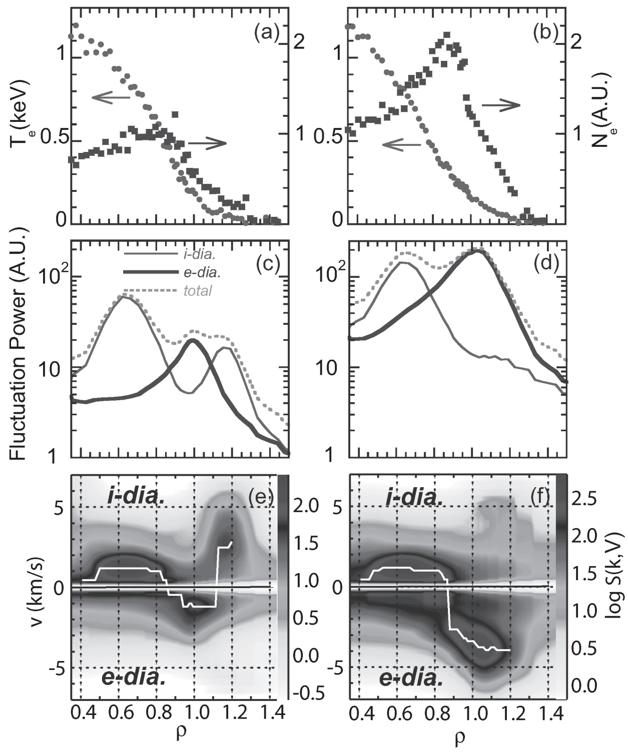

Fig.2 Comparison of profiles before and after transition. (a), (b) T_e and n_e profiles (c), (d) spatial profile of fluctuation power spectrum and (e), (f) spatial profile of poloidal phase velocity. (a) is at t=2.3 sec, (c) and (e) are at t=2.3~2.35sec. (b), (b) is at t=2.7 sec, (d) and (f) are at t=2.7~2.75sec.