§11. Fluctuation during the High Density Edge Transport Barrier on CHS

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When both a reheat mode and an edge transport barrier (ETB) are simultaneously realized, the thermal transport and particle transports are improved, because the temperature and density in the peripheral region increase simultaneously.

There are two outstanding characteristics for ETB plasma with the reheat improvement. First, in the ETB during the reheat mode, the density reduction is suppressed and is increased slightly by the ETB formation in the peripheral region, and the temperature continues to increase due to the improvement by the reheat mode. Consequently, the peripheral plasma pressure and the pressure gradient becomes larger than that of the ETB alone. Secondly, in typical L-mode plasma or ETB plasma, the improved confinement is degraded by the increase in density. However, in the reheat mode with the ETB, enhanced confinement is realized even in the high density range ($\bar{n_e} \sim 1 \times 10^{20} m^{-3}$).

In order to investigate the physical mechanism of the improvement, we measure the plasma density fluctuation with a YAG laser phase contrast interferometer. The experiments are performed as follows. The two co-NBIs (total power = 1.6 MW) are injected into the target plasma which is produced by the 54.5 GHz gyrotron. As shown in figure 1, the initial ETB mode was formed at 45 ms. When the plasma density increases, the ETB disappeared and the plasma returned to the L-mode again resulting from the density exceeding the upper threshold of the ETB formation. The plasma density, as shown in the figure 1 (b), decreased after the gas-puff was stopped at 115 ms. The onset of the reheat mode is denoted by increase of stored plasma energy from 125 ms due to the temperature increase in the peripheral region. When the density decreased below the upper limit, the density reduction was suppressed due to the reformation of the ETB (135 ms) during the reheat mode, and the H_α signal is sharply dropped.

Figure 1(c) shows the result of the fluctuation measurement (k_θ component). The fluctuation is integrated along the YAG laser path passing through the plasma center. In the initial ETB phase without the reheat mode, the fluctuation is reduced after a few micro seconds from the transition. However, the fluctuation increase again as the density increase, then the plasma confinement return to the L-mode due to the disappearance of the ETB. In this phase, the H-factor compared to the ISS04 ATF/Heliotoron/CHS scaling was reduced. From the timing of the gas-puff stop, the fluctuation level gradually decrease. When the plasma enter the reheat mode, the reduction of the fluctuation is enhanced, and the H-factor also increases. When the ETB is formed during the reheat mode, the fluctuation sharply drop to the level of the onset of the initial ETB phase, though the plasma density during the reheat mode is considerably larger than the initial ETB phase. The reduction of the fluctuation is maintained during the ETB phase. When the ETB mode and reheat mode are simultaneously realized, the H-factor increases up to the maximum value of the whole discharge, though the plasma density is maintained in the higher range.

These observation denotes the ETB and the reheat mode are closely related to the plasma density fluctuation. Therefore, the observation of the high plasma pressure in the edge region and the preferable plasma confinement of the ETB plasma during the reheat mode are related to the reduction of the plasma fluctuation and the suppression of the anomalous transport.

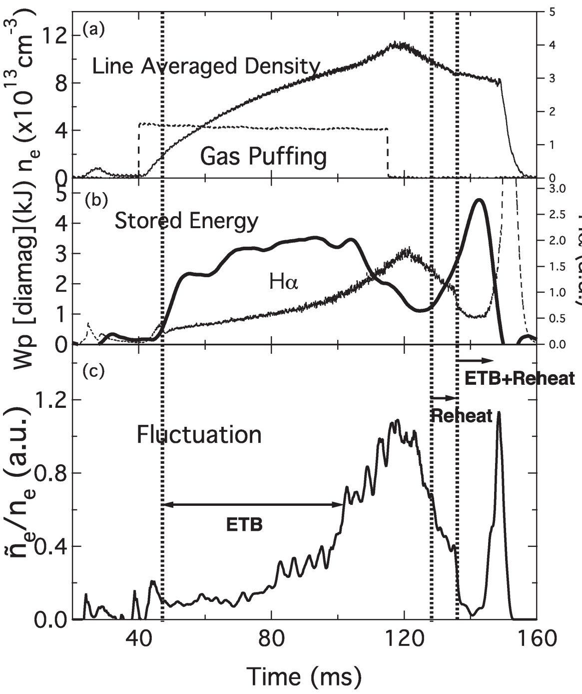

Fig. 1: (a) Line averaged density and gas-puffing period. (b) Plasma stored energy and H_α signal. (c) Plasma density fluctuation measured with YAG laser phase contrast interferometer.

Reference

[1] T.minami, et.al., Plasma and Fusion Research Vol.1, **047** (2006)