§3. First Observation of High Density Edge Transport Barrier Formation during Reheat Mode of Helical Plasma on CHS

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A reheat mode and an edge transport barrier (ETB) are improved confinement modes that have been observed on CHS. The reheat mode is initiated by shutting off fueling with stopping gas-puff[1, 2]. The electron temperature in the peripheral region is raised up resulting from suppression of neutral particle density causing the charge exchange loss. However, the reheat mode has a problem: the peripheral density continues to decrease after the gas-puff stopping. Meanwhile, the ETB mode on CHS has a problem that the edge temperature decrease by large density increase in the peripheral region, then the confinement improvement is degraded. This paper is the first report for the observation of the confinement improvement in high density range by the simultaneous achievements of both the reheat mode and the ETB. This mode provides the good confinement improvement, because the temperature and density in the peripheral region increase simultaneously.

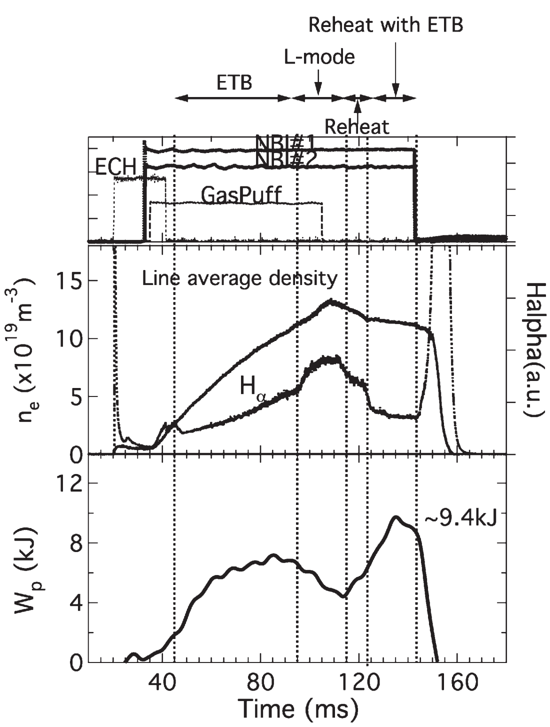

Fig. 1: Global behavior of ETB plasma during reheat mode: line average density, H_α signal , and the stored energy W_p are plotted with the injection timings of NBI and ECH heatings.

Figure 1 shows a global behavior of the reheat mode discharge with the ETB. Although the high field strength (B_T = $1.86T$) is favorable for the reheat mode, the formation of the ETB under high magnetic field condition is difficult, because NBI power threshold of the ETB formation depends on the magnetic field strength[3]. When the field strength increases, the NBI power threshold becomes larger. When the vacuum magnetic axis location (R_{ax}) shifts outwards, the threshold NBI power decreases. Accordingly, the experiment is carried out for the magnetic configuration of R_{ax}=94.9 cm, which is larger than that of the standard configuration (R_{ax}=92.1 cm).

As shown in Fig. 1 , the two co-NBIs (total power is 1.6 MW) are injected to the target plasma that is produced by the 54.5 GHz gyrotron. The ETB is formed below an upper density limit that is related to the NBI power threshold: the power threshold is determined by the heating power normalized with the electron density (P/n_e) [3]. On the other hand, because the higher plasma density is required for a good reheat mode, the plasma density is increased by a gas-puffing until the ETB formation disappears once.

As shown in Fig. 1, the initial ETB mode is formed at 45 ms, then the ETB disappeared and the plasma returns to the L-mode again at 95 ms resulting from the electron density exceeding the upper limit. The plasma density, as shown in the middle of the Fig. 1, decreased after the gas-puff stopping at 105ms. The onset of the reheat mode is denoted by the plasma stored energy increase from 115 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 (123 ms) during the reheat mode. As a result, the stored energy increased up to ~ 9.4kJ.

In conclusion, improved confinement mode with reheat and edge transport barrier is observed on CHS. This mode provides good improved confinement in high density region ($\bar{n}_e \sim 1.2\times10^{20}m^{-3}$) due to the temperature rising with keeping high density in peripheral region.

References

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