§4. Confinement of High Density Edge Transport Barrier during Reheat Mode on CHS

Minami, T., Akiyama, T., Okamura, S., Isobe, M.

This paper describes a characteristic of a plasma profile during the reheat mode with the ETB and a confinement characteristic of this mode. Figure 1 shows time behaviors of the electron temperature, the density and the pressure of the reheat plasma with the high density edge transport barrier at the peripheral region (ρ=0.7) and the plasma center (ρ=0). These results are obtained with a YAG Thomson scattering measurements. During the initial ETB phase, the temperature from the plasma center to the edge decreased due to the density rising. In the subsequent L-mode phase, the peripheral pressure decreases due to the temperature decrease in the peripheral region resulting from the disappearance of ETB. On the contrary, in the ETB during the reheat mode, the density reduction is suppressed and slightly increases 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. These results show that the anomalous transport in the peripheral region might be suppressed by the simultaneous achievement of the reheat mode and the ETB.

In typical L-mode plasma or ETB plasma, the improved confinement is degraded with the density increase. However, in the reheat mode with the ETB, good confinement is achieved in high density range. Figure 2 shows H-factor plot derived from ISS04 CHS/Heliotron/ATF[1] scaling as a function of the plasma density. The H-factor decreases with the density increases during the L-mode or the initial ETB phases. However, the ETB phase during the reheat mode, the good improved confinement is realized on the high density range ($\bar{n_e} \sim 1 \times 10^{20} m^{-3}$), because the H-factor increases up to two times just before L-mode value. Although the H-factor ($\sim$ 1.2) of the ETB plasma during the reheat mode is same as the value of the typical ETB plasma in the R_{ax}=92.1 cm configuration, this value at R_{ax}=94.9 cm might be underestimated, because the scaling is derived from the data of the R_{ax}=92.1 cm configuration. The CHS L-mode confinement is degraded by the outward shift[2]. For the realization of the helical fusion reactor, it is a key issue that the product of the density and energy confinement time ($n\tau_E$) should increase as the ion temperature increases. In the reheat mode with the ETB, the triple product of $n\tau_E$ and the temperature increases by two times compared to the value of the ETB alone and five times compared to the L-mode value. Although the improvement of the reheat mode with the ETB is transient at this time, it is one of the candidates for the confinement improvement method of the helical plasma.

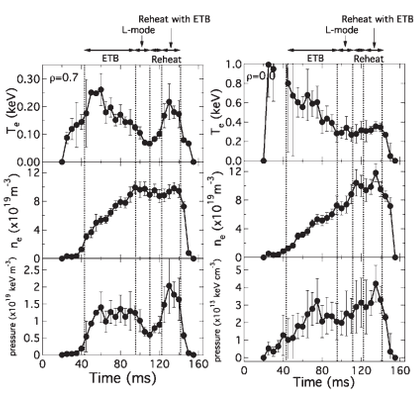

Fig. 1: Time evolutions of electron temperature, density and pressure in the peripheral region (ρ=0.7) and the plasma center (ρ=0)measured with YAG thomson scattering.

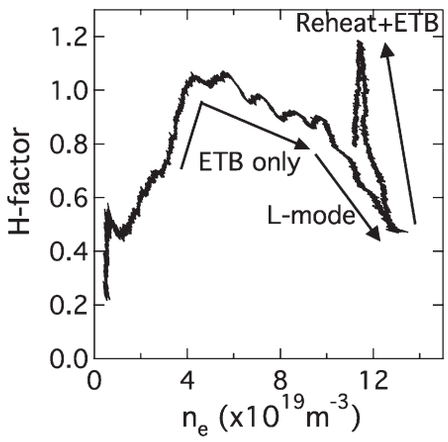

Fig. 2: H-factor plot for the same discharge as a function of the plasma density.

In conclusion, this mode provides good improved confinement in high density region ($\bar{n_e} \sim 1.2 \times 10^{20} m^{-3}$) due to the temperature rising with keeping high density in peripheral region.

References

[1] H.Yamada, et.al., Proc. of 31th EPS Conf. on Contr. on Fusion and Plasma Phys. ECA Vol. **28G**, P-5 099 (2004)

[2] S. Okamura, et.al., Nucl. Fusion **39** (1999), 1337