§3. Remarks on Transient Confinement Improvement after Pellet Injection

Yamada, H., Sakamoto, R., Sakakibara, S.

An element of confinement characteristics can be seen dynamically in the transient phase after pellet injection. Figure 1 shows waveforms of the high-beta attempt shot at low magnetic field of 1.3 T. 5 pellets are injected within 80 ms and density is raised rapidly. Then diamagnetic stored energy starts to increase, which is accelerated with additional NBI in this discharge. Dots show the stored energy estimated from profile measurement of T_e and n_e and assumption of the same ion temperatures. The kinetic estimate usually agrees quite well with diamagnetic measurement. However, a systematic discrepancy has been often observed in transient phase after the pellet injection. This suggests that ion temperature is significantly higher than electron temperature. An increase in the stored energy stops at 1.05s and the density decay rate also changes at the same time, which suggests deterioration of particle confinement as well. This event is correlated with the start of bursts in Hα and magnetic fluctuation. A mode analysis of magnetic fluctuations suggests that the large coherent modes with m $\geqq$ 3, which presumably have a resonance surface in the peripheral region, are excited. An Mercier criterion indicates that the pedestal part is still stable against the ideal interchange mode in the burst phase. Correlating bursts are also observed in the particle flux onto the divertor plate and the CIII impurity line emission. The bottom frame in Fig.1 shows that energy confinement time including time derivative indicates significant enhancement of a factor of up to 4. This tremendous improvement, which cannot be explained by the density increase, lasts during the quiescent phase of Hα and magnetic fluctuation. After this event, confinement settles down to usual level characterized by the factor of 2 improvement.

The temperature drops instantaneously by pellet injection. This process looks adiabatic. Then plasma is heated up again. The ratio of increase is larger in the peripheral region than in the core. In other words, a pedestal which is destroyed by pellet injection, recovers quickly. However, it is clearly found that the pedestal temperature is limited at a certain level while the central temperature continues to increase. Figure 2 shows the evolution of pressure gradient profile. Pressure gradient has a negative sign. A pedestal pressure is significantly reduced by pellet injection and recovers in 0.1s. However, it is stuck after 1.02s which coincides with the start of bursts of fluctuation in a various plasma parameters.

There is every possibility that the bursts in Hα and magnetic fluctuation is a sort of ELM limiting pressure gradient at the edge. As long as there is room for pedestal pressure, confinement looks much improved since a pedestal pressure recovers so fast. However once the edge pressure reaches a certain level, it cannot increase further. Then global confinement is determined by transport in the core. since the pedestal is limited. These observations can be also seen in the operation with higher magnetic field, which suggests that limitation of pedestal pressure cannot be explained by β or ∇β alone.

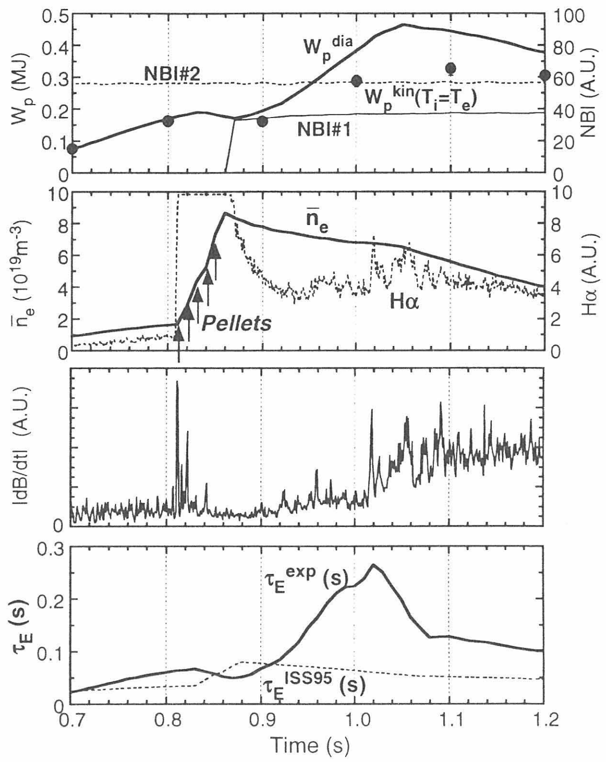

Fig.1 Expanded waveforms before and after the pellet injection.

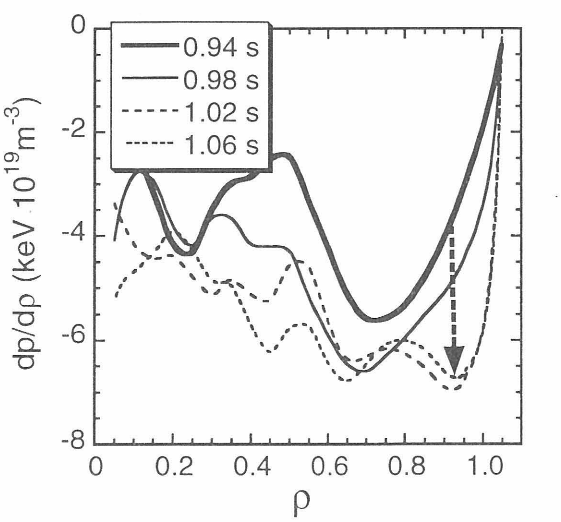

Fig.2 Evolution of the profile of electron pressure gradient after the pellet injection.