§ 5. Edge Transport Barrier for NBI Plasmas

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A new type of the edge transport barrier (ETB) was observed in the neutral beam heated plasma in CHS. This ETB is characterized by the clear drop of H-alpha emission and the appearance of the back transition when the heating power decreases below the power threshold. No ohmic current drive is necessary. It is different from the previous H-mode discharge in CHS (about 20 kA was the current level threshold). New arrangement of two neutral beams in both co-direction and the good wall conditioning are necessary for the ETB formation.

Figure 1 shows the time traces of a discharge which show the transition of the edge particle transport. Two (co-direction) neutral beams are injected to the ECH heated plasma followed by the hydrogen gas puffing. The magnetic configuration is R_{ax}=92.1 cm where the boundary of the plasma is limited by the inboard side of the vacuum chamber wall. The H alpha detector monitors the line-integrated emission from the plasma. The plasma contacting point is not within the detector's viewing area on the wall. The plasma size parameters are: major radius R = 92 cm and minor radius a = 19 cm, and the magnetic field strength is 0.95 T on the magnetic axis. The port-through heating power of two neutral beams are 0.8 MW and 0.6 MW. Beam driven current is roughly 5 kA. About 30 msec after the injection of neutral beam, the H alpha emission drops showing the formation of ETB. The back transition occurs about 3 msec after the NBI#2 termination which is comparable to the energy decay time of the beam particles. When two NBIs are applied to the end of discharge, the transition phase continues for more than 100 msec without the large increase of the radiation. The average electron density at the transition is in the range of 2-3 x $10^{19}m^{-3}$.

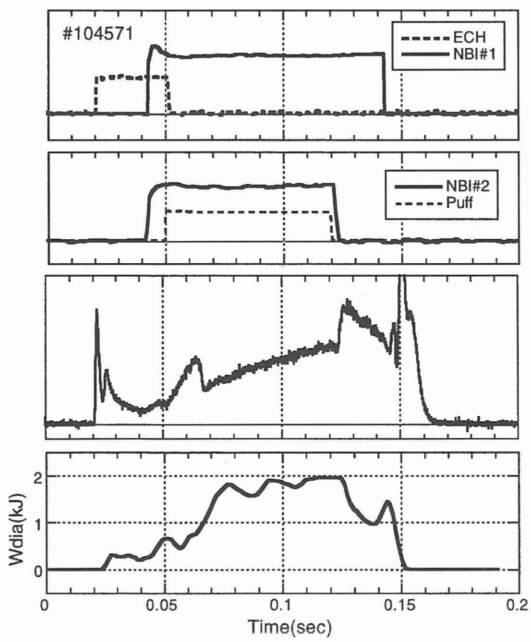

Fig. 1. Time traces of NBI heated discharge with a transition of edge particle transport

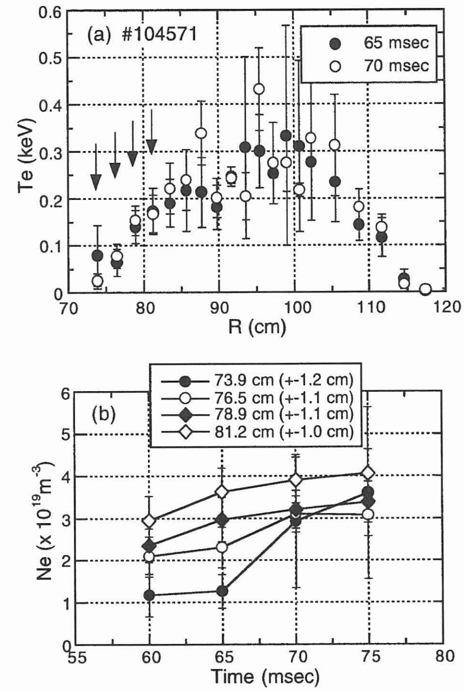

Fig. 2. Electron temperature profiles and the variation of local density at the ETB formation

Figure 2(a) shows the electron temperature profiles at two different timings before and after the transition. There is no noticeable increase of edge electron temperature with the ETB formation. On the other hand, the increase of the edge electron density is very clear as shown in Fig. 2(b). The time variation of the local densities measured by YAG Thomson scattering are plotted for four measuring points at the plasma edge region (shown in Fig. 2(a) by arrows). Normalized minor radii for outer two measuring points are: r/a = 0.87 for R = 73.9 cm and r/a = 0.79 for R = 76.5 cm. The quick increase of the edge local density is also confirmed by the beam emission spectroscopy (BES).

The heating power threshold is examined by controlling the second NBI power for different plasma density. The power threshold for the transition is roughly proportional to the density. For 2 x $10^{19}m^{-3}$ density, the power threshold is about 1 MW in the port-through power. The estimation of the heating efficiency for this density is 60 to 70 %. For lower heating power, the time delay of the transition after the increase of the heating power becomes longer and the H alpha emission drops slower.