

§1. Control of q-Profile by Current Ramp-Up during NBI Heating

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Radial profile of the toroidal current density or the safety factor strongly affects the stability and confinement of a tokamak plasma. Recently magnetic shear reversal is paid much attention from a point of view of confinement improvement[1]. In order to study the correlation between the safety factor(q-) profile and confinement we have carried out the rapid ramp-up of the plasma current during NBI heating.

Figure 1 shows the time evolution of the current ramp-up discharge. The q=1 surface is removed from the plasma for a while after the ramp-up at t=205 ms, because the soft X-ray(SX) signal at the center chord is modulated by m=1 oscillations from t~240 ms. The ice pellet injection at t=250 ms enhances the sawtooth activity as seen from SX and ECE signals.

The q-profile in the interior region (r/a < 0.6) is obtained with a multi-channel motional stark effect (MSE) polarimeter[2] and that in the peripheral region (r/a > 0.5) with the fast-response Zeeman(ZM) polarimeter[3]. Figure 2 shows the time evolution of q-profiles obtained by the MSE polarimeter, where the MSE data are averaged over 20 ms time-window. The q-value in the interior region is decreased keeping almost the similar profile shape. In Fig.3 we show the time evolution of q-value at various minor radii. The q₀ from MSE agrees well with that calculated by the magnetic diffusion equation based on the neoclassical resistivity. The time evolution of q-values at ρ (=r/a)=0.55 and 0.82 is obtained by the ZM polarimeter. The q-profile tends to flat during the current ramp-up but does not exhibit the negative shear region. This is caused by fairly fast penetration of the toroidal current due to relatively low electron temperature of T_{e0} < 2 keV and small minor radius of ~23 cm.

During the ramp-up the Hα/Dα emission is reduced as shown in Fig.1, and the electron density profile becomes peaky. The density fluctuations in the low field side obtained by FIR laser scattering are also reduced during the phase. This suggests the reduction of particle transport, but there is no obvious reduction of heat transport.

[1] F. M. Levinton et al., Phys. Rev. Lett.75(1995)4417
 [2] Xu, J. et al., NIFS-419 (1996).
 [3] Kuramoto, H. et al., NIFS-397(1996).

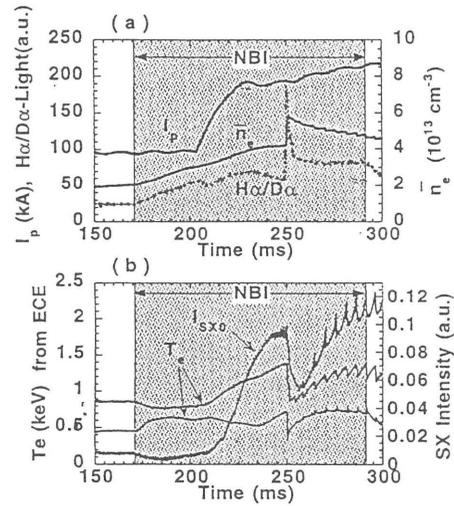


Fig.1 Time evolution of the NBI heated current ramp-up discharge: (a) plasma current, line averaged density and Hα/Dα light, (b) ECE signals at the plasma center and the plasma periphery, and soft X-ray emission at the center.

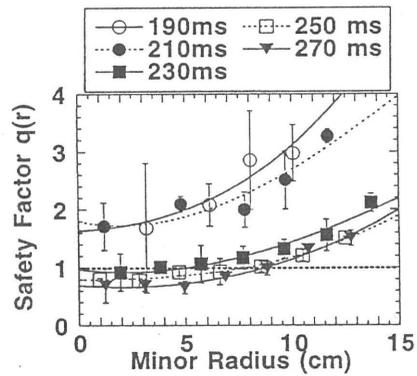


Fig.2 Time evolution of q-profiles obtained by the MSE polarimeter, where the profile is obtained for 20 ms for the marked mean time.

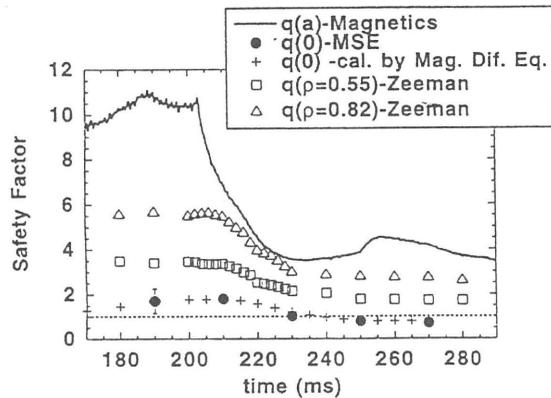


Fig.3 Time evolution of q-values at each minor radius obtained by various methods.