§44. Plasma Response of Helical Plasma during Current Quench Phase

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The precise prediction of current decay time during tokamak disruptions is one of the most critical issues in next generation tokamaks such as ITER because the current decay time τ determines electromagnetic forces acting on in-vessel components. The database of current quench decay times during disruptions has also been set up among the different tokamaks based on so called *L/R* model [1]. In this model, τ normalized by the plasma cross-section area S is proportional to $T_e^{3/2}$, where T_e is electron temperature. Some problems, however, have been found that data of the normalized τ's have large scatters among different tokamaks, as well as different shots. The validity of the *L/R* model has not been confirmed yet, moreover the understanding of the determination mechanism of τ is rather poor at this moment. The difficulty may come from the co-existence of different mechanisms to determine τ during the current quench, such as atomic/molecular processes associated with electron cooling and rapid change of magnetic surface in tokamaks. On the other hand, in helical devices, we can distinguish the influences of atomic/molecular processes and the magnetic surface change on the current quench because the helical devices always keep magnetic surfaces externally. Therefore, the systematic study of the current quench in the helical system can give better understanding of the mechanism of the current quench in tokamaks.

In order to generate plasma current, we used unbalanced neutral beam injection (NBI). The current decay was observed by turning off the NBIs. Figure 1 (a) and (b) show the waveforms of plasma current and NB Injection power during the current decay. After turning off the NBI at t = 3.3s,the plasma current began to decrease. The time evolution of the plasma current shows slow decay phase (t = 3.3s~) and fast decay phase (t = 3.95s~) as shown in (a). Figure 1 (c) and (d) show the time evolution of plasma resistance R_p and plasma inductance L_p calculated from Te profiles. It is found that R_p changes drastically in the slow decay phase whereas L_p is almost constant.

Figure 2 shows comparison between τ_{cal} and τ_{exp}. τ_{exp} is the plasma current decay time obtained from the plasma current waveform. It is found that τ_{exp} and τ_{cal} has correlation. However both $\tau_{L/R}$ and $\tau_{L/R+NBI}$ are larger than τ_{exp}.

In future works, we need to evaluate directly the plasma inductance and effective charge in the current decay phase.

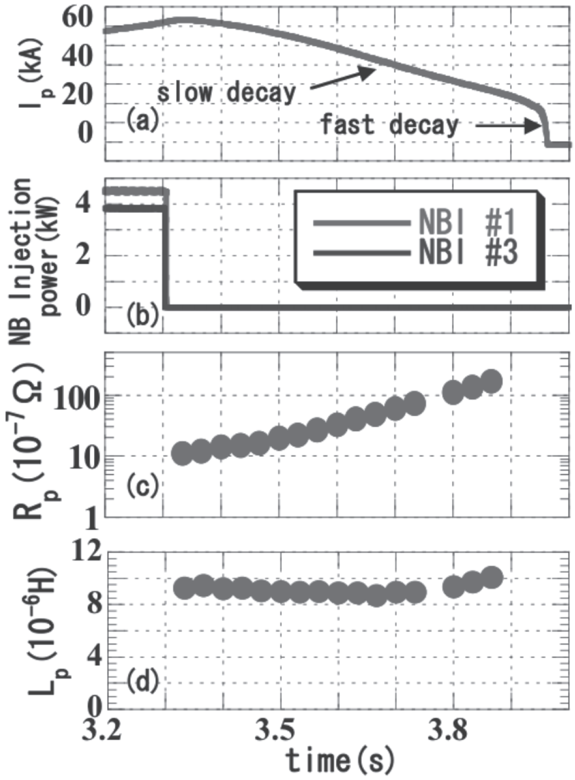

Fig. 1 Temporal evolution of (a) plasma current I_p, (b) NB Injection power, (c) plasma resistivity, (d) plasma inductance in slow decay phase.

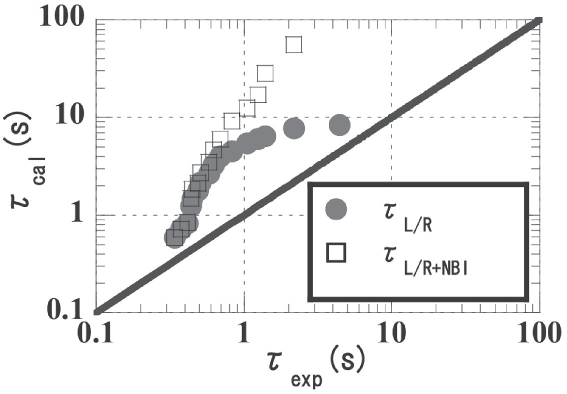

Fig. 2 Evaluation of plasma current decay time. $\tau_{L/R}$ is the plasma current decay time calculated by L/R model and $\tau_{L/R+NBI}$ is the plasma current decay time by taking into account the slowing down of the NBIs. τ_{exp} is the plasma current decay time calculated by the experimental plasma current waveform. The solid line has shows $\tau_{cal} = \tau_{exp}$.