

§34. Plasma Collapse Phenomenon in Ctr-NBI Heating Plasma with the Magnetic Configuration of Bq=200%

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Recently, the magnetic axis split was observed in LHD with strongly elongated configuration in horizontal direction (Bq=300%) [1] and it was also investigated by analysis of MHD equilibrium [2]. A new type of plasma collapse phenomenon has been observed with the magnetic configuration of $R_{ax}=3.6\text{m}$, $B_t=1.5\text{T}$, $\Gamma=1.254$, $B_q=200\%$, which is also horizontally elongated configuration.

The collapse was observed in the plasma heated by counter neutral beam injection (NBI), of which typical discharge is shown in below figure. The NBI is switched at $t=5.3\text{sec}$ from dominated by co-beam with total port-through power of 3MW to ctr-beam with port-through power of 2.6MW. The electron density significantly increases from $0.9\times 10^{19}\text{m}^{-3}$ to $2.5\times 10^{19}\text{m}^{-3}$ after the switch of NBI direction, and plasma current can not be in the counter direction. The electron temperature profile becomes flat soon from peaky profile after the switch of NBI. In this discharge, two collapses occur, first one is minor

collapse at $t=6.6\text{sec}$ and the stored energy of about 15% is lost. Second is complete collapse at $t=9.3\text{sec}$. The characteristics of the plasma going to the collapse are spontaneous density increase, increase of radiation, flattening of electron temperature profile. The collapse starts from center region of the plasma, and the electron temperature profile becomes hollow, which is most impressive feature of this phenomenon.

The necessity condition for the collapse is the magnetic configuration of Bq=200% and ctr-NBI heating. This collapse has a critical density, the low density plasma lower than $\sim 0.7\times 10^{19}\text{m}^{-3}$ can be sustained and plasma current can be driven in the counter direction. However the plasma density gradually increases and exceeds the critical density, and finally goes to collapse.

The electron temperature profile is clearly different from magnetic axis split for the point that two maximum electron temperatures appeared in hollow profile are always same. This indicates that magnetic equilibrium is completely different from magnetic axis split. This collapse is interesting phenomenon at the point of view of equilibrium limit.

