## §10. Development of Quasi-steady State High Ion Temperature Scinarios on LHD

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On the Large Helical Device(LHD), the high ion-temperature plasmas are often realized with a scenario using a carbon pellet injection. Although this scenario provides the highest ion-temperature (Ti) plasmas on LHD, the time durations of sustaining Ti-plasmas are relatively short. Thus, this regime is not suitable for steady state operation of high-Ti plasmas. Alternatively, high-Ti discharge with He-gas puffing scenario has been developed for quasi-steady state operation.

Figure 1 show typical waveforms for a quasi-steady state high-Ti scenario. Plasmas are initiated by Electron Cyclotron Heating (ECH) and was subsequently sustained by a low energy (~40keV) radial Neutral Beam(NB) injected from 1-O port of LHD. Helium gas was supplied simultaneously with the NB injection and the electron density is raised to ~$1.5\times10^{19}$ [$m^{-3}$]. Then, tangential-NBs and radial-NB are additionally injected to increase the ion temperature. As shown in Fig.1(a), the central ion-temperature of around 5keV was sustained for 400ms with this regime. The time duration of high-Ti phase are currently limited by the pulse duration of radial-NB at 5-O port with this injection power level. Further optimization of the scenario is necessary to extend the time duration of high-Ti phase with reduced heating power of radial-NB at 5-O port.

In Fig.2, the magnetic axis dependence of central ion temperature is shown. The improvement of central ion-temperature was significantly observed for inwardly shifted magnetic configurations. This is because fast-ions produced by radial-NB injection system, which was upgraded the 15th experimental cycle, has no preference on the magnetic axis in terms of particle deposition and because fast-ions are better confined at inwardly shifted configurations on LHD [1]. The extension of time duration of high-Ti phase would be possible with the combination of Ion Cyclotron Heating at the inwardly shifted configurations.

[1] Murakami, S., *et.al.,* Fusion Sci. Tech. **46** (2004)241

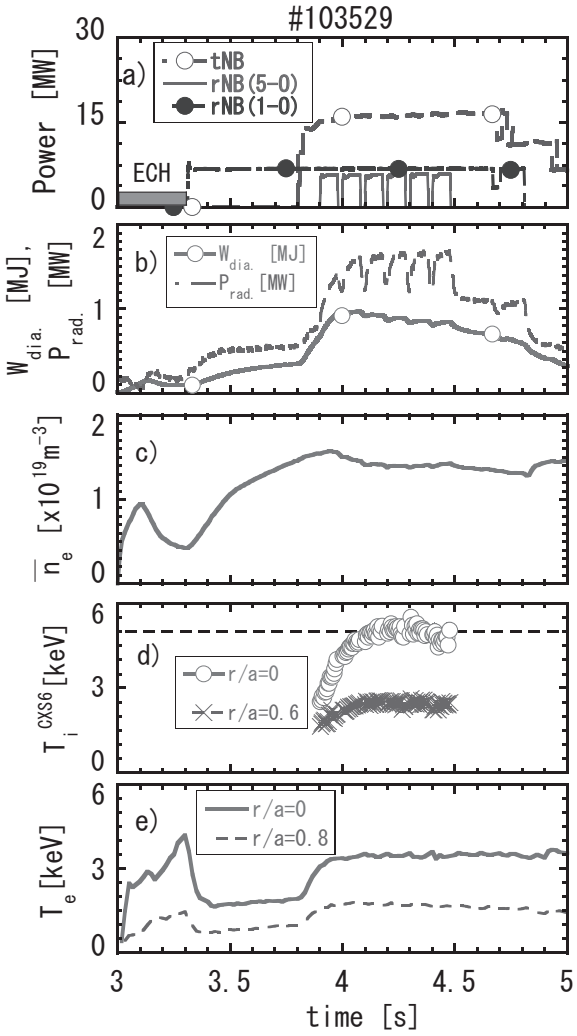


**Fig.1 Wave forms of (a)input power by ECH and NBI, (b)stored energy and radiation power, (c)line averaged electron density, (d)ion temperature and (e)electron temperature.**

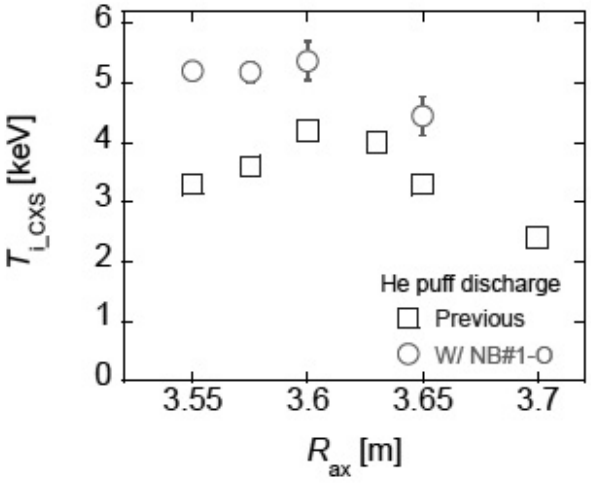


**Fig.2 Dependence of central ion-temperature on magnetic axis positions. Data for 15th experimental cycle(○) and for 14th cycle (□) are shown.**