§9. Achievement of High Ion Temperature Plasmas on LHD

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An achievement of high temperature plasmas is one of the most important missions on the Large Helical Device(LHD) project to demonstrate the ability of realizing reactor relevant plasmas by helical devices. On LHD, the radial Neutral Beam Injection (NBI) system based on low energy positive ion sources was upgraded from 6MW to 12MW in order to extend the operational range in ion temperatures.

Figure 1 shows typical waveforms for a discharge of high ion temperature scenario. Plasmas are initiated by Electron Cyclotron Heating and were maintained by subsequent NBI heating. The ion temperature starts to increases after a carbon pellet injection and additional NB-injection. As shown in the figure the central ion-temperature over 6.4keV was achieved with this scenario at Bt=-2.85T.

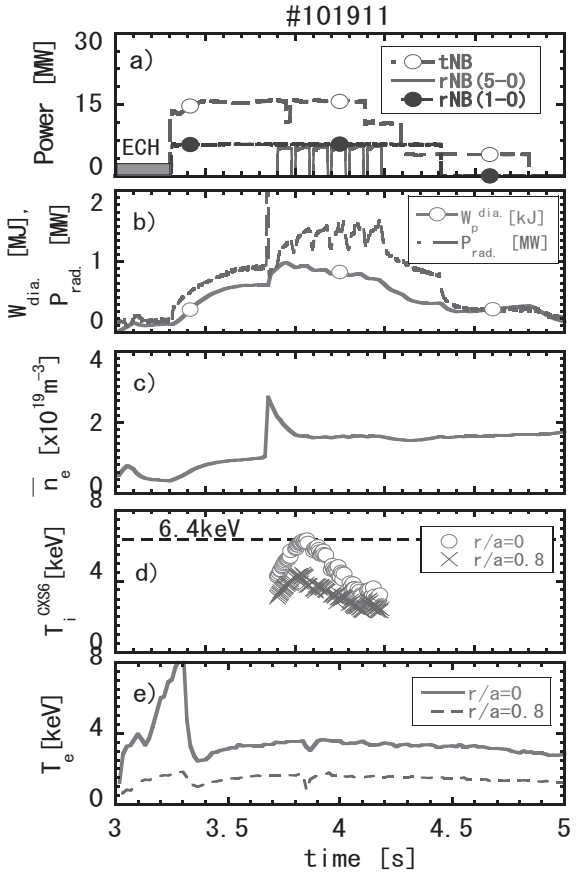

Fig.1 Wave forms for (a)input power by ECH and NBI, (b)stored energy and radiation power, (c)line averaged electron density, (d)ion temperature and (e)electron temperature.

The achievable ion-temperature depends on the magnetic field strength of the configurations as shown in Fig.2 (a). The maximum ion-temperature is scaled almost linearly at higher magnetic field strength around 3T. On the other hand, no clear improvement on ion-temperature is observed at low magnetic field strength around 2T. The ion temperature is far below the scaled line in Fig.2 (a) and is similar to electron temperature at the field strength. This indicates that there is a threshold value on the strength to achieve high ion-temperature regime. The ion temperature profile is shown for high magnetic field operation in Fig.2(b). At the central region of these plasmas, the ion tempera profile show flattening and saturate at certain level depending on the field strength, while the ion-temperature at peripheral region (r_{eff}>0.4m) is almost similar and is independent to the field strength. Further investigation on the mechanism of the ion temperature flattening is necessary to achieve higher ion temperature on LHD.

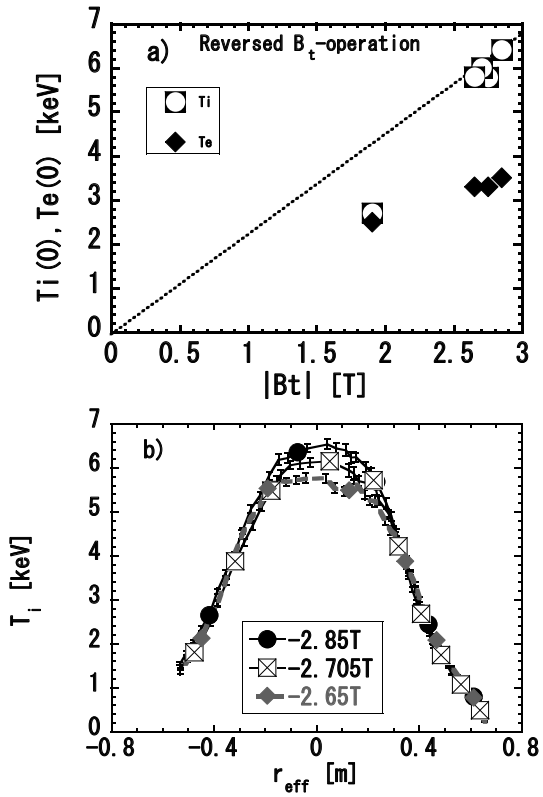

Fig.2 (a)Magnetic field dependence of central ion temperatures and (b) their profile