§49. The Highest Density Achieved in LHD

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The highest central density in helical plasmas of 5 × 10^{20} m^{-3} has been demonstrated on LHD. The volume-averaged electron density, $\langle n_e \rangle$, reaches 3 × 10^{20} m^{-3}, in spite of the small absorbed power density in LHD (< 0.5 MW/m^3) compared to W7-AS (≤ 4 MW/m^3), where $\langle n_e \rangle$ ~ 4 × 10^{20} m^{-3} was attained with divertor detachment.

Waveforms in the highest $\langle n_e \rangle$ discharge are depicted in Fig. 1. This is obtained at an "inward-shifted" configuration, where the magnetic axis (R_{ax}) of 3.65 m and the magnetic field strength on the magnetic axis (B_0) of 2.71 T. Eight hydrogen ice pellets are injected from t = 0.7 sec to 1 sec. Both the line-averaged electron density measured by CO_2 laser interferometer and $\langle n_e \rangle$ measured by Thomson scattering reach 3 × 10^{20} m^{-3}. The density signals of Thomson scattering are calibrated to match the $\langle n_e \rangle$ with that estimated from Abel inversion data of FIR interferometer signals at the density regime of less than 1 × 10^{20} m^{-3}. Note that the absolute sensitivity of each channel is not yet calibrated.

The highest value of the central electron density (n_{e0}) of 5 × 10^{20} m^{-3} is obtained at an outward-shifted configuration of R_{ax} = 3.75 m and B_0 = 2.64 T, as is shown in Figs. 3 and 4 (a). Hydrogen ice pellet injection is also used in this case. After the pellet injection, the electron density decreases and the electron temperature increases vice versa (Fig. 4 (b)). The total stored energy increases in this phase, as is known as the "reheat" (Fig. 4 (c)). In this case, the Super-Dense-Core (SDC) is formed after t ~ 1.2 sec. The central plasma pressure reaches 100 kPa ($T_i = T_e$ and $n_i = n_e$ are assumed). A large Shafranov shift from 3.75 m to 4 m is observed at the SDC phase. Although the SDC has been studied in the Local Island Divertor configuration, where n_{e0} ~ 5 × 10^{20} m^{-3} is also attained, it is possible to form the SDC in the usual helical divertor configuration.

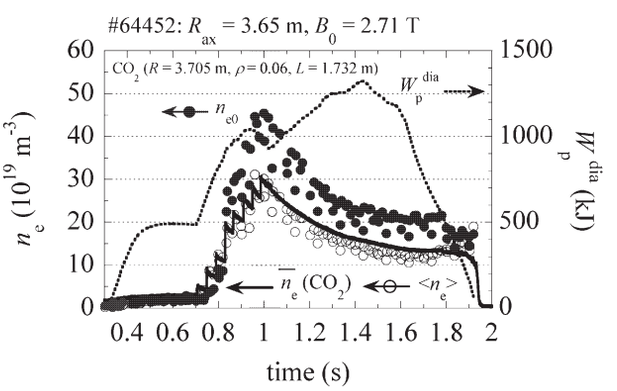

Fig. 1. Waveforms in the highest $\langle n_e \rangle$ discharge.

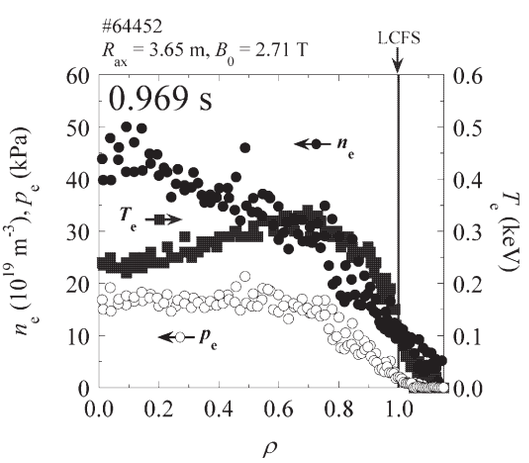

Fig. 2. Radial profiles in the highest $\langle n_e \rangle$ discharge.

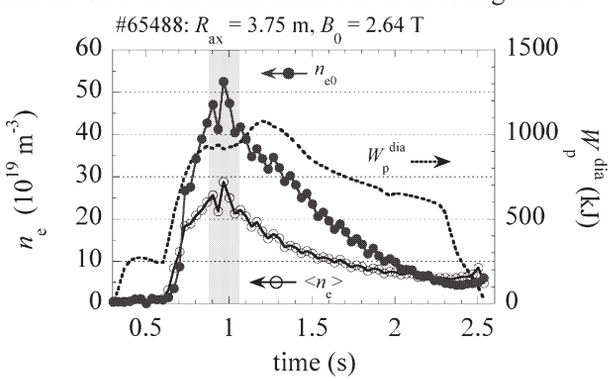

Fig. 3. Waveforms in the highest n_{e0} discharge.

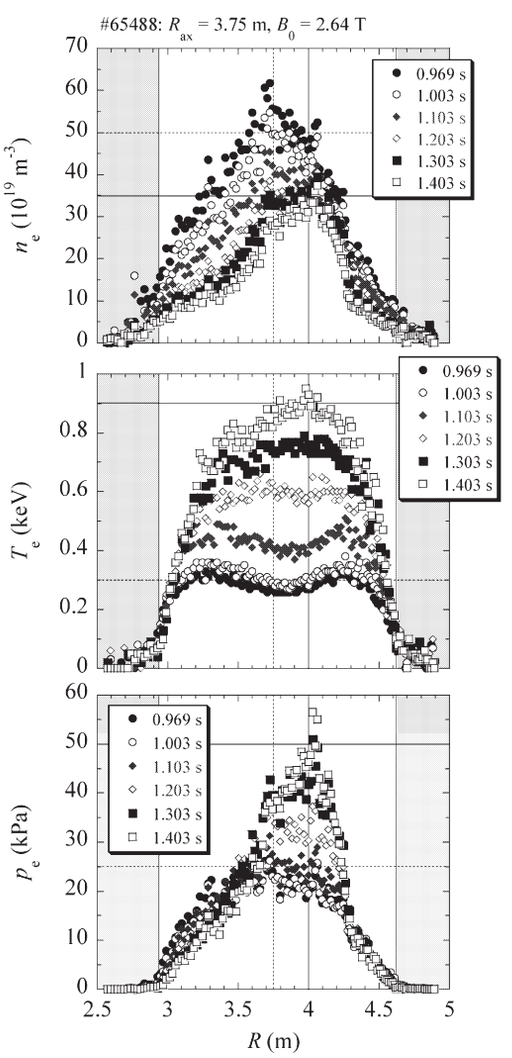

Fig. 4. Radial profiles in the highest n_{e0} discharge.