§40. Core and Edge Plasma Parameter Dependence of Divertor Plasmas in LHD

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For understanding of the divertor plasma properties, it is necessary to make clear the relationships between core and edge plasma parameters and the divertor plasma parameters. In the third campaign, the line averaged densities and NBI port through power reached 8×10^{19} m^{-3} with the gas-puffing and 4.2 MW, respectively. Therefore, the relationships can be analyzed in the wide density range. The line averaged and the edge densities were measured by FIR interferometer, and the core and the edge electron temperatures were measured by Thomson scattering. The density and the electron temperature in front of the divertor plates were measured by the Langmuir probe array embedded in the divertor plates.

Figure 1 shows electron density and temperature at the edge (LCFS), $n_{e,edge}$, $T_{e,edge}$, and the outboard-side divertor (1-O probe array), $n_{e,div}$, $T_{e,div}$, as the functions of the line averaged density for the case of $R_{ax} = 3.6$m. All data points were obtained at the time when the stored energy has a maximum in the helium discharges, and $n_{e,div}$ is estimated with assuming all ions to be He^+. The NBI port through power was 1 - 4.2 MW.

Both $n_{e,edge}$ and $n_{e,div}$ increase linearly with the line averaged density, and the former is about a half and the later is about one several tenth of the line averaged density. The behavior of $n_{e,div}$ indicates that the divertor plasma condition do not reach so called 'high recycling regime' [1], where $n_{e,div}$ increases with the upstream density nonlinearly even at the line averaged density of about 8×10^{19} m^{-3}.

Electron temperatures at the edge and the divertor gradually decrease with the line averaged density, and although the wide range of NBI input power, all data points are on universal curves. The $T_{e,edge}$ behavior is considered to reflect the pedestal temperature, $T_{e,ped}$ behavior [2]. Although $T_{e,ped}$ increases with the input power, the power dependence is not so large, and saturates at the input power of about 3 MW. $T_{e,ped}$ decreases with increasing the line averaged density gradually, and this tendency is also reflected in the $T_{e,edge}$ behavior. $T_{e,div}$ is almost proportional to $T_{e,edge}$, and the ratio is about one fifth at this probe array.

It is difficult to relate the edge plasma parameter profiles to those in the divertor plasma in LHD. Figure 2 shows T_e and L_c profiles in the open field line region measured by the fast scanning probe [3]. The peak $T_{e,div}$'s measured with the 1-O probe array and the 10.5-L probe array are 20-25 eV and 8-9 eV, respectively. Therefore, $T_{e,div}$ at the former probe array corresponds to T_e at $Z < -0.86$ m. On the other hand, $T_{e,div}$ at the latter probe array corresponds to T_e at $Z > -0.89$ m. The difference seems to be caused by the origins of the magnetic field lines forming divertor legs. To make it clear, the calculation of magnetic field line tracing will be performed in detail, and T_e and n_e profiles in the open field line region will be measured by the fast scanning probe, Li beam probe and Thomson scattering with a fine spatial resolution.

REFERENCES

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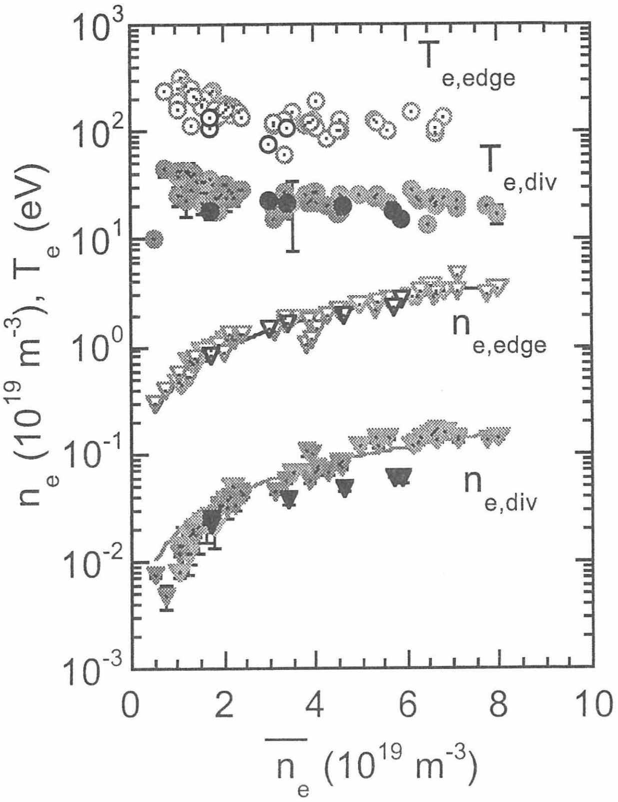

Fig.1. The line averaged density dependences of the electron temperature and density in the edge (near the LCFS) and the divertor plasmas. ($R_{ax} = 3.6$ m, Helium-puff) The differences of marks are correspond to the different input power.

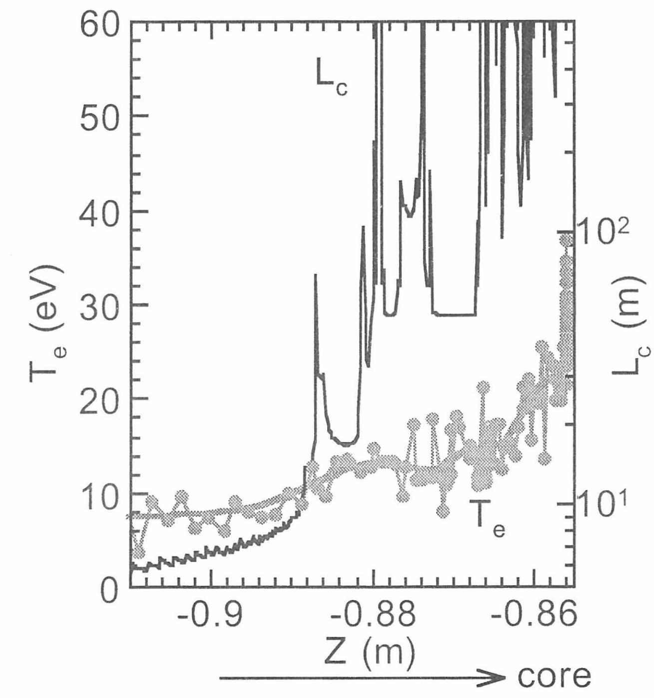

Fig.2. T_e and L_c profiles measured by the fast scanning probe. Z=0 (X-Y plane) is the equatorial plane. (#13831, t = 0.91-1.07 sec)