§56. A Study of Edge Plasma Transport in LHD

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Electron density and temperature profiles in the edge plasma region in the Large Helical Device (LHD) are investigated experimentally by use of the movable Langmuir probe [1] and numerically by means of the three-dimensional edge transport modeling with EMC3-EIRENE [2] in the magnetic axis position of R_{ax}=3.75m configuration. Comparison of the profiles between experimental data and simulated data has been conducted to estimate the cross-field transport coefficients in the edge plasma in LHD. As the result, the simulation well reproduces some features in the measured n_e and T_e profiles.

In the relatively low input power cases, the movable Langmuir probe is applied to measure n_e and T_e profiles. The probe is vertically inserted from top port (4.5U), and its length of stroke is 500mm. In Fig.1(a) and (b), simulated and measured n_e and T_e profiles for two discharge conditions are shown, respectively. The connection length of the field lines, L_c, profile along the axis of the probe measurement is depicted in Fig.1(c). In the R_{ax}=3.75m configuration, the position of the last closed flux surface (LCFS) is Z~0.85m on this axis for the vacuum condition. Simulation results well reproduce the characteristics of the measured profiles as described below: In Fig. 1(b) T_e peak appears at the L_c peak position around Z~1.13m in the lower input power and density case while the T_e peak disappears in the higher input power and density case. It is caused by the decrease of parallel heat conductivity due to the decrease of T_e in the higher density case. In Fig. 1(a), such peak structure that appears in the T_e profile in the lower density case is not clear in the n_e profiles. There are steep n_e and T_e slopes around Z~1.05m where magnetic field lines with long L_c densely appear, and the slope of n_e profile is steeper in higher density case than that in lower density case. It suggests that the particle source is deeper inside for the higher density case due to the lower T_e.

Comparing T_e profiles between simulation and measurement, simulation results with D=0.25-0.75m^2/s (χ=0.75-2.25m^2/s) reproduces measured values. In both discharge conditions, measured n_e is larger than simulated one. One of the causes of this discrepancy seems to be a diagnostics error in the Langmuir probe measurement. In this study, the cross-field transport coefficients are assumed to be constant in the edge region. The preliminary edge transport analysis shows that the magnetic field structure could affect the plasma transport [3]. Therefore it could be necessary to take into account the cross-field transport coefficients profiles to more precise analysis. In this study, impurities are not taken into account in the simulation. Low Z impurities, such as carbon, radiate in the relatively low T_e plasma (below 50eV). Thus impurities could affect the n_e and T_e profiles especially in the edge region of the profiles in Fig.1.

Reference
[1] Masuzaki S., Annual report of NIFS 2004-2005, p.62.
[2] Y. Feng et al., Nucl. Fusion **46** (2006) 807.
[3] T. Morisaki et al., J. Nucl. Mater. **313-316** (2003) 548.

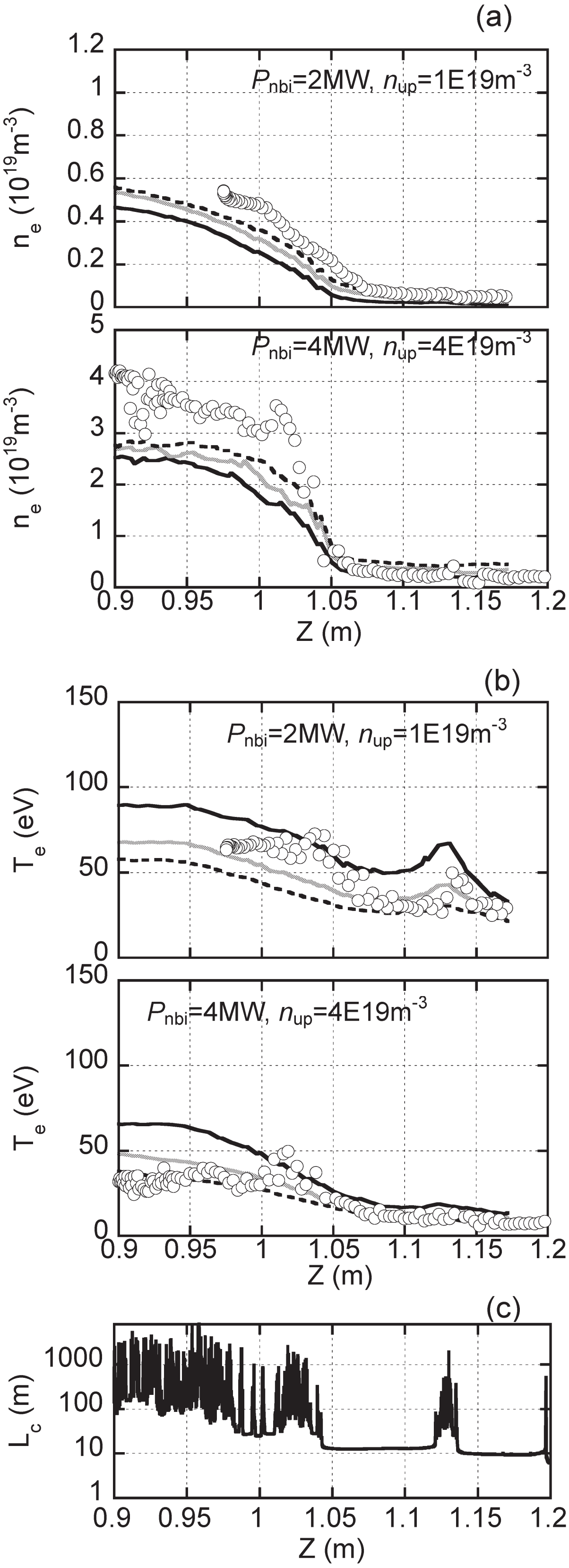

Fig.1 (a) n_e and (b) T_e profiles measured by use of the fast scanning probe (open-circles) and calculated by means of EMC3-EIRENE code (lines). (c) L_c profile along the axis of fast scanning probe measurement. In (a) and (b), black solid line, gray solid line and black broken line are the cases of D=0.25, 0.5, 0.75m^2/s (χ_i=χ_e=3D is assumed), respectively.