§43. Study of Plasma Boundary in LHD Experiment

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It is important to construct the consistent MHD configuration with measured data when we study something in balk plasma. To determine the MHD equilibrium configuration, the plasma boundary, plasma pressure and its profile, toroidal current and its profile are necessary when well-defined magnetic surfaces exist. In this paper, we study the plasma boundary in LHD experiment. Here, we focus 1.5T H_2 Rax=3.75m operations.

Fig.1 (1) shows the normalized electron pressure profiles in torus outside at toroidal angle with horizontally elongated cross-section. T_e and n_e are estimated by Thomson and FIR measurements. There are data with 3 different beta value, 0.3%, 0.5% and 0.9%, thus central beta values are different by 3 times in data. Fig.1 (2) shows the connection length of magnetic field line to wall in vacuum at same toroidal angle in (1). Arrow 'a' corresponds to the outermost magnetic surface estimated from the existence of well defined nested magnetic surface, where the non-trivial electron pressure exists. However, the value is less than 1/10 of central value and the electron pressure in outer region is small and it affects the MHD equilibrium configuration little. There are some theoretical predictions for behavior in finite beta. LHD experiment suggests that the radial locations, where electron pressure is almost zero, don't change independently of beta.

Next we show the limiter experiment using ICRF antenna. ICRF antenna touches plasma in torus outside at toroidal angle with vertically elongated cross-section. Fig.2 (1) shows the connection length of magnetic field line at toroidal angle with vertically elongated cross-section. In Fig.2 (1), magnetic surfaces indicated by arrow '4190', '4180' and '4160' correspond to '4190', '4180' and '4160' in Fig.1 (2). The outer region than '4180' corresponds to stochastic layers. Fig.2 (2) shows the measured electron pressure, p_e, profiles with various limiter locations. The p_e~0 location in '4160' limiter location experiment is quite different from that in '4180' limiter location. It shows that the electron pressure remains when the limiter isn't inserted deeply enough to the well-defined closed magnetic surfaces. And when the limiter is inserted deeply, the p_e~0 locations estimated by FIR and Thomson measurements in torus inside and outside are consistent with MHD equilibrium calculations.

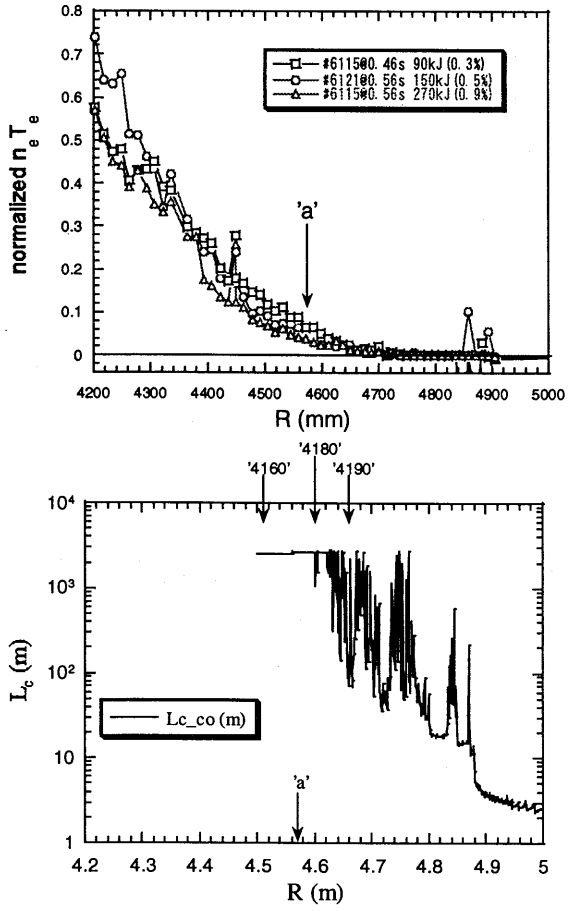

Fig.1 (1) Electron pressure profile in various beta discharges. (2) Connection length of magnetic field line at horizontally elongated cross-section.

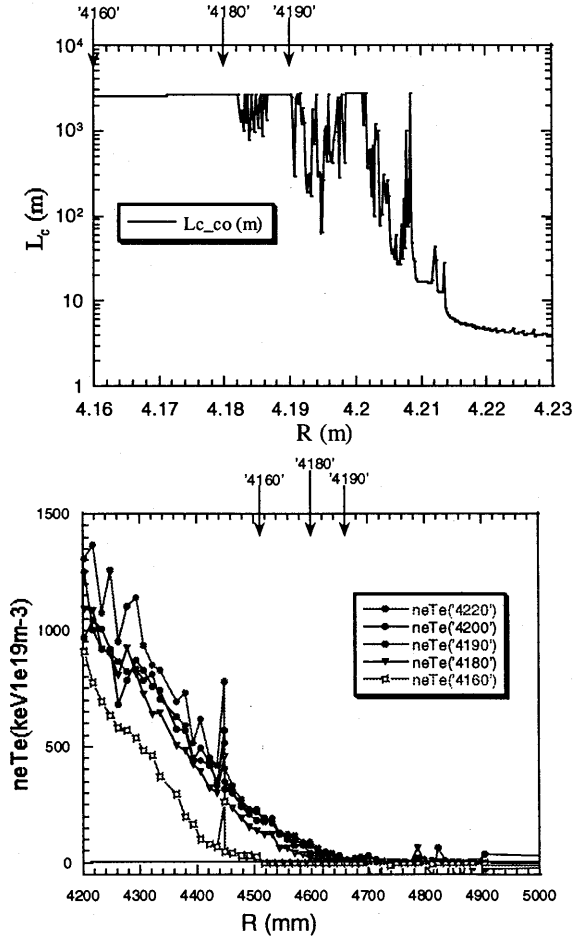

Fig.2 (1) Connection length of magnetic field line at vertically elongated cross-section. (2) Electron pressure profile in various limiter locations.