§10. New Cloud Data of the Ablating TESPEL on LHD

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Measurements of pellet cloud parameters are important for many applications of pellet-injection diagnostic (e.g. PCX diagnostics). It could help to clarify relative role of shielding mechanisms (neutral, plasma) and therefore to improve existing pellet ablation models. This work is devoted to the study of polystyrene pellet clouds in the Large Helical Device. The observation of the pellet cloud radiation was performed using a 9-channel filter-lens imaging polychromator (NIOS)[1,2]. It was observed in previous experimental LHD cycles that plateau on a cloud density distribution appears at high enough density of bulk plasma (> 4×10^{19} m^{-3}) while the cloud density gradually decreases from the pellet vicinity at lower bulk densities(< 2×10^{19} m^{-3}) see[2,3] and Fig.1. This phenomenon was extensively investigated during 16th LHD campaign with aim to elucidate the threshold values of bulk plasmas. Bulk density and temperature parameters are summarized in Table I. NIOS system allows obtaining only single snapshot per injection. For each $n_e(0)$ $T_e(0)$ set several injection were performed. A pellet position at major radius was varied from one injection to another in order to obtain scan along pellet trajectory, see Fig. 2. On Fig. 3 one can see measured electron density distributions (longitudinal profiles) in three discharges corresponding to three positions along pellet trajectory as denote by vertical dashed lines in Fig.2. All profiles are flat; absolute values of the electron density are similar because of close values of ablation rate. Similar results were obtained for other $n_e(0)$, $T_e(0)$ sets. Flat profiles with absolute values $(4\text{-}8)\times10^{22}$ m^{-3} were observed in all discharges from Tab. 1. Pellet cloud structure was studied in a wide range of bulk plasma parameters during 16th LHD cycle. Specifically, the bulk plasma densities were more than 3×10^{19} m^{-3}. All cloud density distributions are almost flat. One can conclude that threshold value of the bulk plasma electron density is in the range $(2\text{-}3)\times10^{19}$ m^{-3} which separate between flat and narrow cloud density distributions in the pellet vicinity. Maximal cloud density values are in the range $(4\text{-}8)\times10^{22}$ m^{-3} and are smaller than those measured in 13th cycle (up to 18×10^{22} m^{-3}). Ablation rate values in 16th cycle are smaller than in 13th cycle by factor of ~2, hence, these results in agreement with Ref. 4), where proportionality of "averaged" electron density in the pellet cloud to the ablation rate was measured.

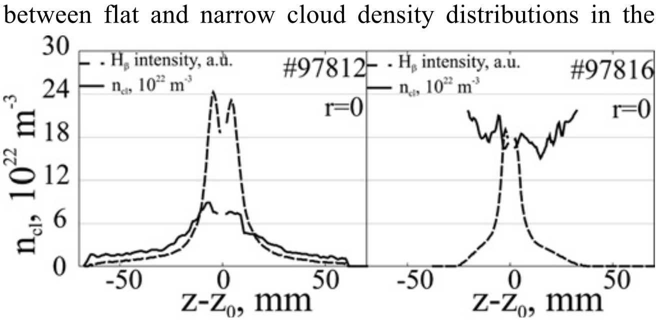

Fig.1. Longitudinal profiles of the electron density inside pellet cloud (solid line) and H_β intensity (dashed line). $n_e(0)\sim1.6\times10^{19}$ m^{-3} in #97812, $n_e(0)\sim4.6\times10^{19}$ m^{-3} in #97816

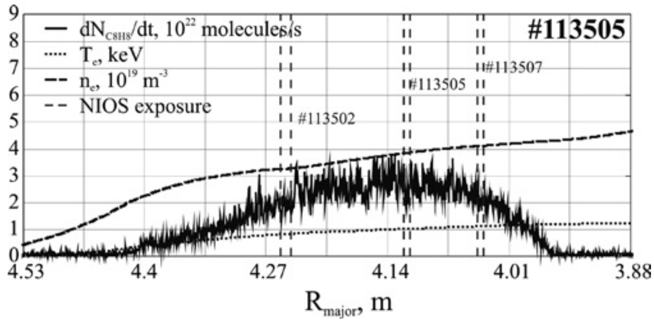

Fig.2. Pellet ablation rate curve (solid line), radial profiles of the background plasma electron temperature (dotted line) and density (dashed line). LHD shots #113502, #113505 and #113507 are similar, moments of the polychromator triggering were adjusted to take images at different pellet positions along major (as shown by vertical dashed lines) radius corresponding to different ablation rate values.

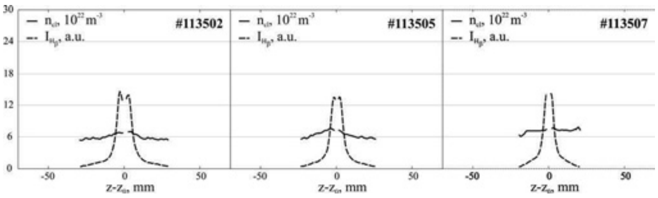

Fig. 3. Longitudinal profiles of the electron density inside pellet cloud (solid line) and H_β intensity (dashed line).

$n_e(0)$ \ $T_e(0)$	1.5 keV	2.5 keV
$3\cdot10^{19}$ m^{-3}	113502, 113505, 113506, 113507, 113508, 113517, 113518	113514, 113515, 113516,
$5\cdot10^{19}$ m^{-3}	113529, 113532	113522, 113524, 113525, 113526

Table 1. Characteristic parameters of LHD shots used for NIOS measurements during 16th cycle.

1) Tamura, N. et.al.: Rev.Sci.Instrum. **79** (2008) 10F541.
2) Sharov, I. A. et al.: IEEE Transactions on Plasma Science **39** (2011) 2476.
3) Sharov, I.A. et.al.: Proc. 37th EPS Conference on Plasma Phys., Dublin, Ireland, 2010, P5.131
4) Tamura, N. et. al. : Proc. 30th EPS Conf. Plasma Phys., St. Petersburg, Russia, 2003, pp. 1–59.