§9. Spatial Dynamics of L-H Transition Observed with Two-dimensional Phase Contrast Imaging

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Two dimensional phase contrast imaging (2d PCI) [1] was applied to observation of discharges with L-H transition during 11[th] cycle. The probe beam crosses plasma vertically slightly off the plasma center so the plasma core (ρ<0.4) is not accessible. This fact is not critical for measurements of LH transition which occurs at the plasma edge near ρ=1. Figure 1 represents time traces of phase velocity (e) and plasma density fluctuation amplitude (d) at ρ=1.1 obtained with 2d PCI. Open diamonds mark fluctuations characteristics at plasma top while solid circles denote the plasma bottom. Additional plots are produced with the use of other diagnostics: line density at edge chord of FIR interferometer (a), diamagnetic beta (b), and Hα emission (c).

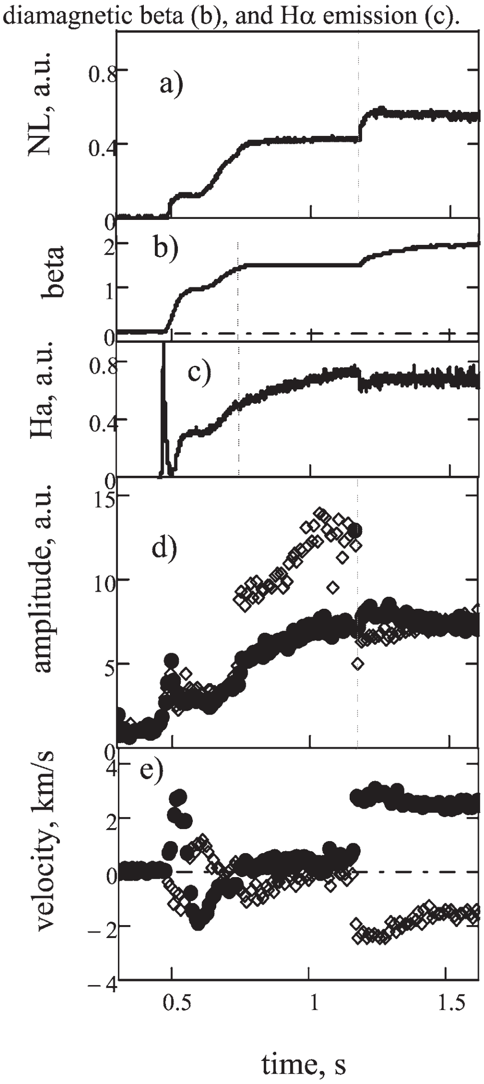

Fig. 1. Time traces for discharge #82395. Phase velocity (e) and amplitude of density fluctuation (d) correspond to location at ρ=1.1

It is seen that simultaneously with the growth saturation of NL and β strong asymmetry in fluctuation amplitude starts quickly. This moment is marked by the left vertical dashed line. Then at 1.17s L-H transition occurs when the phase velocity of fluctuations abruptly increases at ρ=1.1 by a factor of 3-4 and simultaneously asymmetry in fluctuation amplitude greatly reduces. The spatial profiles of density fluctuations (a) and phase velocity (b) are shown in figure 2 at the instants before transition (1.16s) and after it (1.17s). One can see the peak in density fluctuations amplitude (ρ=1) at the plasma top that

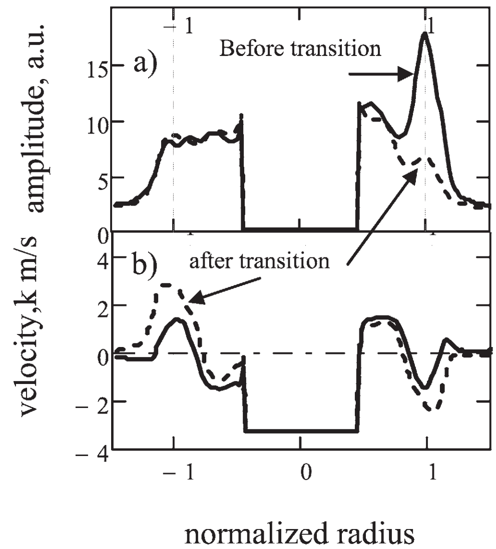

Fig 2. Profiles of amplitude (a) and phase velocity of fluctuations at time points 1.16s (solid line) and 1.17s (dashed line)

disappears during L-H transition. The fast plasma rotation might be the cause for decrease of fluctuation peak which might be responsible, in its turn, for increased radial particle transport. However the plasma rotation is not measured independently in these experiments with CXS so it is difficult to separate plasma rotation and phase velocity fluctuation in the plasma frame. The characteristic wavenumber of measured fluctuation k=2-4 cm^{-1} within frequency bandwidth 5-200 kHz. It should be noted also that there is some contribution from radial correlation length l_c of density fluctuation in the amplitude shown in figures 1d and 2 as was discussed elsewhere [1, 2]. It means that peak in figure 2a can be caused not by enhanced local fluctuation amplitude but by increase of l_c which should be related to radial transport as well. Finally we like to emphasize that the unique capability of 2d PCI technique permits us to observe fine global structure of density fluctuations.

1) K.Tanaka et al., Rev. Sci. Instrum. 79, 10E702 (2008)

2) L.N.Vyacheslavov et al., Plasma and Fusion Research, 2, S1035 (2007)