§7. Dynamics of L-H Transition Observed with Phase Contrast Imaging

Vyacheslavov, L.N. (Budker Institute of Nuclear Physics),
Tanaka, K., Michael, C.A.

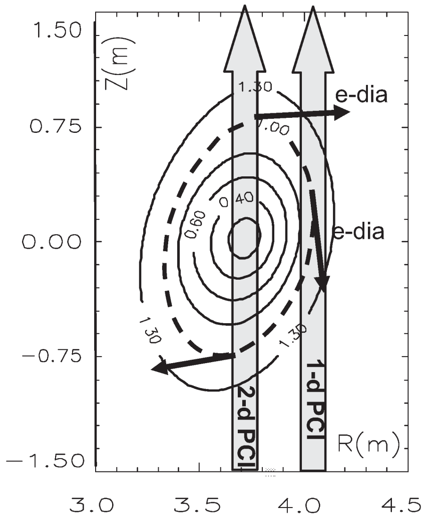

Fig.1. Geometry of plasma density fluctuations observation with PCI. Last closed flux surface at ρ=1 is marked by thick dashed line. The black arrows show the directions of electron diamagnetic drift

The temporal behavior of plasma density fluctuations in k-range 1-5 cm^{-1} during L-H transition is studied with the use of phase contrast imaging (PCI). The geometry of measurement is shown in figure 1. Two laser beams depicted by arrows intersect plasma vertically near the plasma center (two-dimensional PCI, [1]) and at the plasma edge (one-dimensional PCI, [2]). The PCI technique is sensitive to spatial components of density fluctuations oriented normally to the laser beam direction. For the geometry shown in figure 1 it means that 2-d PCI is more sensitive to poloidal structure while 1-d PCI records better radial fluctuation pattern. The 2-d PCI can resolve fluctuations along the view line whereas 1-d PCI records line integral along view chords. Due to edge geometry however each channel views distinct spatial regions limited by different minimal normalized radiuses ρ_{min}. The LCFS at ρ=1 is marked in the figure by thick dashed line and corresponds to ρ_{min}=1 for the middle channel of 1-d PCI.

The time history of spatial distribution of fluctuation velocities in the laboratory frame measured with the use of 2-d PCI is shown in figure 2. The maximal velocity amplitude is located at r=0.9 and the velocity is pointed to the electron diamagnetic drift direction. At the time of L-H transition near 2.51s amplitude of this velocity increases steeply to 3km/s. Simultaneously fluctuations outside LCFS swaps velocity direction from ion diamagnetic to electron diamagnetic.

Figure 3 shows velocity of line integrated density fluctuations measured with 1-d PCI and averaged over 0.3ms. A comparison between data obtained using 1-d PCI with results produced with the use of other diagnostics shows that fluctuations velocity V rise time history almost coincides with that of Ha-radiation intensity. Whereas plasma line density and fluctuation intensity increase at least ten times slower and reach only 10% of maxima at

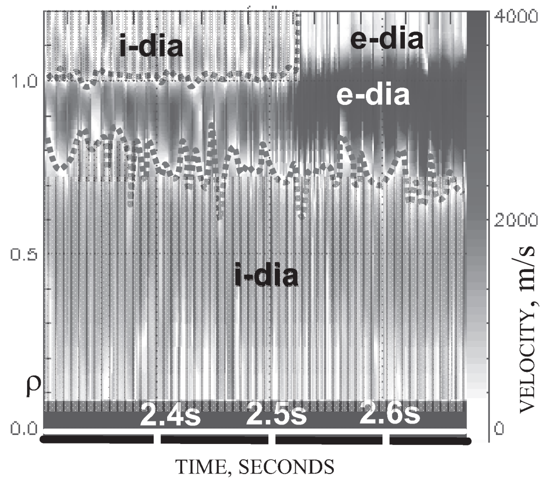

Fig.2. Dynamics of spatial velocity distribution of density fluctuations obtained with 2-d PCI. Vertical scale is normalized plasma radius and gray scale shows velocity magnitude. The L-H transition occurs at 2.08s

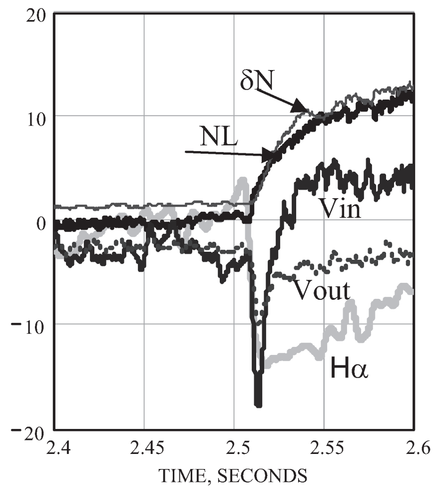

Fig.3. Time plot of density fluctuations velocity measured with 1-d PCI where Vout is for ρ_{min}>1 Vin for ρ_{min}<1 . Other plots are Hα signal, plasma line density NL, and fluctuations amplitude δN, all are in arbitrary units.

2.51s when Hα and V are at their peak amplitudes. The amplitude of velocity obtained with the edge measurement by 1-d PCI at sharp peak directed inward is also order of km/s. In a few milliseconds the direction of velocity in channels corresponding to ρ_{min}<1 swaps from inward to outward. It can explain an increase of a peak in plasma density near ρ=1 after the transition in the case when contribution of radial motion to V is dominant. Additional analysis of 1-d and 2-d PCI data is necessary to clarify this point.

1) A.L.Sanin et al., Rev. Sci. Instrum. 75, 3439 (2004)
2) K.Tanaka et al., Rev. Sci. Instrum. 74, 1633 (2003)