§17. Analysis of the Three-dimensional Trajectories of Incandescent Dusts Observed with a Fast Framing Camera with a Stereo-optics

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Small incandescent dusts during plasma discharges were observed with cameras in the initial phase of experimental campaigns, low γ magnetic configurations, high-T_i experiments and fueling pellet injections, etc. Recently, it has been recognized that ICRH heated long pulse discharges are terminated by dusts released from ICRF antennas, divertor plates, etc., indicating that investigation of transport of dusts is an extremely important issue for extending the duration time of plasma discharges.

A fast framing camera (Photron SA-X) with a stereo-optics has been installed in an outer port (3-O) for measuring the three-dimensional trajectory and ablation process of tracer-encapsulated solid pellets (TESPEL). This fast camera was applied to measurements of the transport of dusts. Two lenses were mounted in the left and the right side positions of the outer port for stereoscopic measurement of the trajectories of dusts. Images from the two lenses are transferred to the stereo-optics via quartz image fibers. Images of an incandescent dust observed from the two different positions are simultaneously captured in the fast framing camera. The sequential images of the dust provide information for the three-dimensional trajectories of the dust using a pin-hole camera model.

Figure 1 is four snap shots of a dust observed in a typical NBI heated plasma for R_{ax}=3.75m. The left and right images are views from the lenses installed in the left and the right side in the outer port, respectively. This figure shows that the dust is moved from the right to the left in the beginning, and its trajectory suddenly turns to the down side just before disappearance of the dust.

For investigating the physical mechanism of change of movement of the dust, the three-dimensional trajectory of the dust is essential information. Analysis of the stereoscopic images captured with the fast camera provides this information. Figure 2 is a bird's eye view showing the three-dimensional trajectory of the dust (green line). Some dust trajectories observed in other NBI heated discharges are also indicated. It clearly proves that all observed dusts locate on the outer edge of the ergodic layer (small white dots), suggesting that the ergodic layer has a function preventing dusts from penetrating into the main plasma confinement region inside of the last closed flux surface.

In the near future, a dust transport simulation code (DUSTT) will be applied to investigation of the trajectories of the dusts in the LHD plasma periphery. It can clarify the physical mechanism of the sudden change of the movement of the dust, and the effect of the ergodic layer on the transport of dusts in more detail.

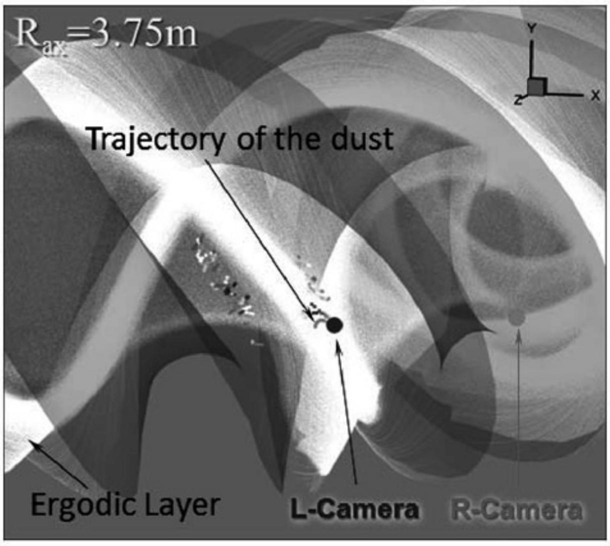

Fig. 2 A bird's eye view showing three-dimensional trajectories of dusts observed with a fast framing camera for R_{ax}=3.75m.

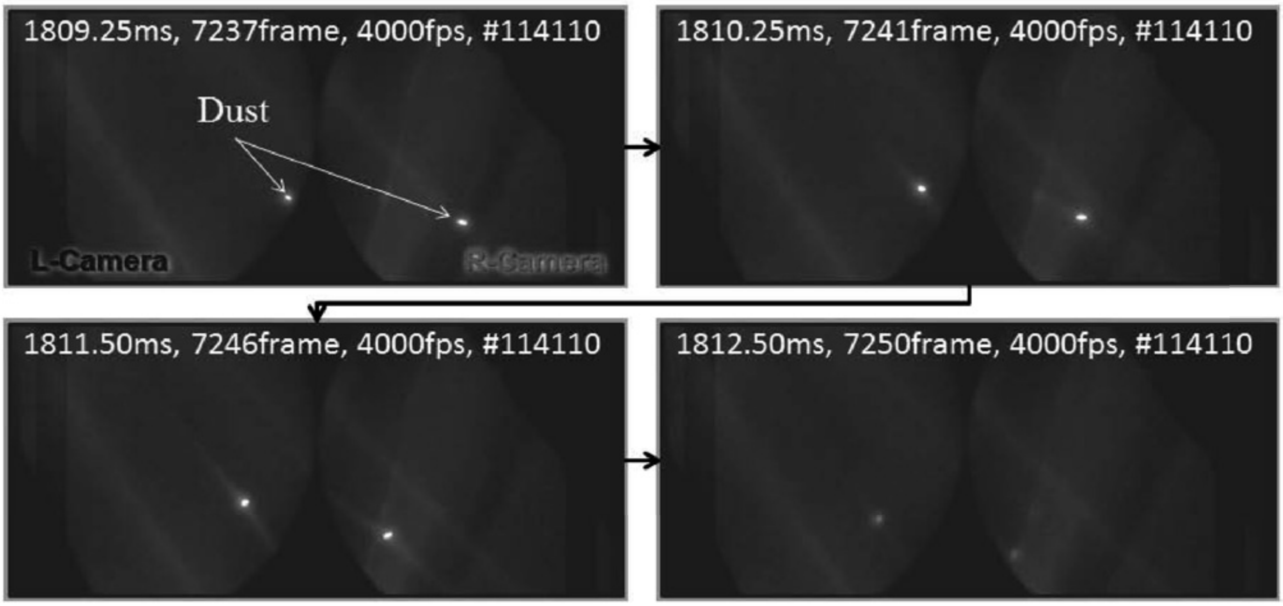

Fig. 1 Four snap shots of movement of a dust observed with a fast framing camera with a stereo-optics for R_{ax}=3.75m.