§35. Imaging Analysis of Injected Dust Particle Movement in Fusion Plasma

Asakura, N. (JAEA),
Ashikawa, N., Iwama, N.,
Hayashi, T., Fukumoto, M. (JAEA),
Ohtaki, Y., Ohnishi, A. (Nagoya Univ.),
Takeuchi, Y. (Daido Univ.)

Dust ejection experiments were performed in order to investigate transport of dust particles, which would be formed on the divertor target due to material deposition. Important parameters of the dust analysis such an initial position, a material composition and a diameter of dust particles are determined, and the background plasma parameters such as temperature and density are measured. Thus, lifetime and dynamics of dust particle in the edge plasma can be evaluated from trajectory and duration of the dust movement. Dust ejection experiment was started using DiMOS (material test probe) in DIII-D and this result showed a useful method to understand dust dynamics.

A movable material probe is locates at the lower port in LHD, and dust sample holders are set at the position of divertor leg plasma just before the plasma discharge. We prepared for spherical glassy carbon dust with the different size of 8, 60 and 120 microns, which are the commercial size made by Tokai Carbon Co., LTD. On the other hand, a typical diameter of 'natural' carbon dust collected in LHD was under 1 micron of carbon. In this experiment, larger dust particles with 8 and 120 micron were used in order to measure longer and brighter images in the plasma. The two sizes of carbon dust particles were set in the separate stainless steel holders on the head of the material probe, and the plasma exposed area to the dust was controlled by rotation of the material probe. Initial amount of the carbon dust particles were about 2.0 g per each sample, which was measured by microbalance.

High-speed TV camera (Photoron Co., FASTCAM MC2.1) measured the dust movement though line-of-site from the upper port to lower direction in LHD, and the TV camera image was shown in Fig.1 (a). A frequency of TV frame speed is 2000FPS. For the case of 120-micron particles, separated dust particles can be identified in the image. On the other hand, automatic identification of the multi dust particles in such general images was important process to handle TV camera images in the dust dynamic analysis. Duotone filter processing with setting a threshold of intensities could not applied since maximum intensities of these dust particles by high-speed camera are different. New algorithm for dust image identification was investigated in this study.

Major brightness spots from dust particles could be separated from background signals such as plasma radiation, using duotone filter processing after 3 x 3 Laplacian filter. Here, bright regions on structural materials of LHD vacuum vessel (upper area in Fig.1) and the sample holder were not included in this analysis. Dust image on the surface of the sample holder was not used for the dynamics analysis since some were saturated and small velocity. Figure 1 (b) shows an analytical result of major brightness points and short lines, which correspond to dust particles and the trajectories of dust particles without background signals. In this report, only 2-dimentional images are shown. Using the automatic filtering, an original raw movie data can be directly converted to a movie of dust trajectories with short time. In future work, 3-dimentional position analysis in LHD vacuum vessel will be developed using synchronized two TV camera system.

This work is supported by NIFS budget KEMF021 and the Imaging Science Program of National Institutes of Natural Sciences (NINS).

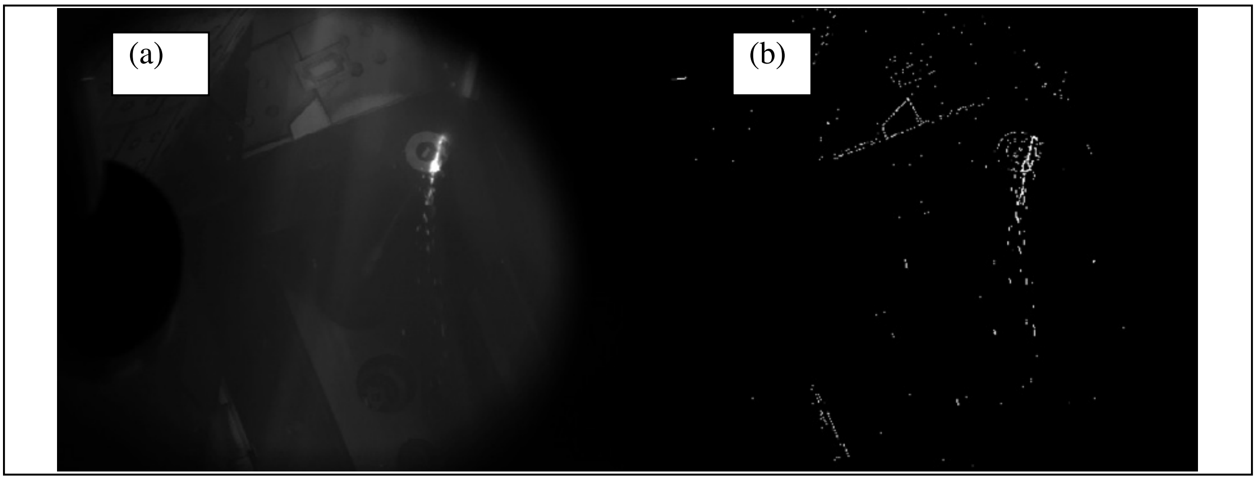

Fig.1 comparison of imaging data (a) raw image data of high-speed TV camera in LHD and (b) analytical result using duotone filter processing after 3 x 3 Laplacian filter.