§15. Imaging Analysis of Dust Particles in LHD

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An investigation of dust movement by ejected dust experiments has been done for an understanding the material transport in vacuum vessel and an estimation of dust movements. Dust ejection experiment was started using DiMOS in DIII-D [1] and this result shows a useful method to understand dust dynamics. In this method, the initial parameters of dust particles, such as elements, diameters, shapes, total amounts, are known. These dust particles interact with similar histories of plasma conditions, such as electron temperatures, on the way of their moving process. A typical diameter of 'natural' carbon dust in LHD is under 1 micron of carbon [2]. In this experiment, different diameters of spherical glassy carbon dust, 8 micron and 120 micron are used in LHD. These dust particles are the commercial size made by Tokai Carbon Co., LTD.

Carbon dust particles of two kinds of diameters was set in the separated stainless steel holders on the head of the material probe, which locates at the lower port in LHD. The area with dust particles exposed to plasmas was controlled by rotation of the material probe. An initial amount of carbon dust particles is about 2.0 g per each type, which was measured by a microbalance. The dust holder with dust particles was installed the position of divertor leg plasma before plasma discharges. And then carbon dust particles were ejected to plasma discharges.

Dust movements were measured by high-speed visible camera (Photoron Co., FASTCAM MC2.1). A frequency of this camera is 2000FPS. The same types of cameras were set at the 4.5U port in LHD. One was located at the inner side and the other was located at the outer side of the 4.5 poloidal cross-section in LHD. The Development of analytical tool by direct conversion for motion videos is required. In previous methods for an analysis of dust movements [3], 3 x 3 Laplacian filter was used and background signals by plasma radiation were removal. But it was not sufficient yet.

Standardizations of stereo images and parallax components using new processing for two images by MC2.1 cameras are calculated as shown in Fig.1(c). An advantage of a new method is that the positioning calibration and the automatic processing of two cameras are possible at the same time. X and Y axes show numerical spatial positions and Z axis shows the parallax component related Z-direction of the LHD vacuum vessel. Each point indicates positions of a dust particle at different time frames. Because it is smooth, the movement of a dust particle thinks that new processing acts well as shown in Fig.1(c). A conversion from relative dimensions to absolute dimensions is planned in the future work.

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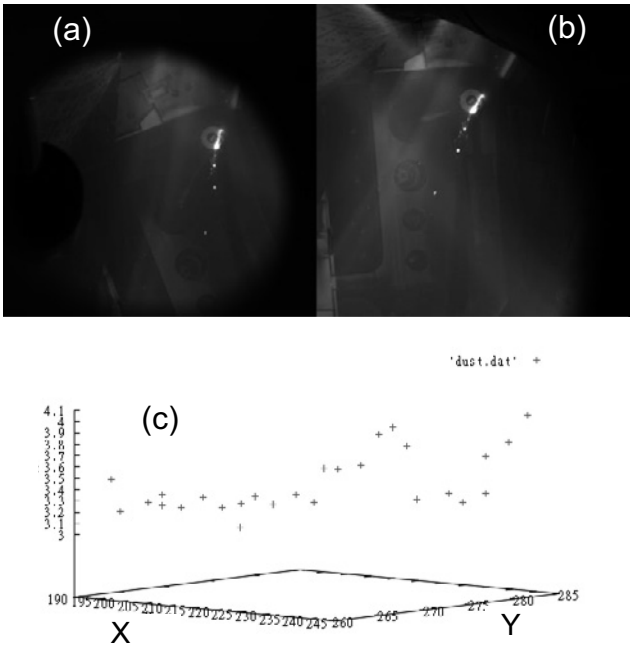
[1] D.Rudakov, J. Nucl. Mater. 363-365 (2007) 227.
[2] K. Koga, Plasma Fusion Res. 4 (2008) 034.
[3] N.Asakura, et al., in this NIFS annual reports.



Figs.1 (a),(b) Dust images of dust particles around the sample holder by two high-speed cameras. (c) An analytical result of dust movements using new processing.