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Statistical analysis of temporal and spatial evolution of in-vessel dust particles in fusion devices by using CCD images

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Study of dust particles in tokamaks will be an important issue for future large tokamaks like International Thermonuclear Experimental Reactor (ITER) because of their physical and chemical behaviors in vacuum vessel: 1) damage to first wall & diagnostics due to high velocity impact, 2) flaking of radioactive tritiated co-deposits of nano- to micrometer size, 3) a strong chemical reactivity with air (hot dusts, ITER accidental scenario). In order to control the amount of dusts inside the vacuum vessel, it is important to monitor the dust creation events and the spatial location of the origins of dust creation.
Images of wide-angle visible standard CCD cameras contain information on Dust Creation Events (DCEs) that occur during plasma operations. Analyzing the straight line-like dust traces in shallow cylindrical shell-structured scrape-off layer along the vacuum vessel, caused by plasma-dust interaction, database on the DCEs are built. The database provides short/long term temporal evolution and spatial distribution of origins of DCEs in fusion devices. We have studied DCEs of CIMES (2006) and DITS (2007) Tore Supra (TS) campaigns, 2007 ASDEX Upgrade (AUG) campaign, 2010 and 2011 KSTAR campaign. The results from the TS CIMES campaign show different patterns of DCEs meaning different plasma-wall interaction depending on power coupling. TS DITS campaign indicates that dusts may be an operational limit if a fixed plasma operation scenario is used repeatedly. Different behaviours of DCEs between carbon limiter machine and full tungsten divertor machine are found. Huge amount of dust creation events were observed in KSTAR due to severe damage of PFCs. An analysis software, with which the location of dust trajectories in 3D position in the KSTAR vacuum vessel is identified, is developed and the dust velocity distributions in 2010, 1011 campaigns are measured.

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