Fast imaging of intrinsic dust events in experimental advanced superconducting tokamak

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Understanding the production mechanisms and transport of dust particles present in the magnetic fusion devices are necessary for minimising the radiative power losses and also important from the safety and operational point of view [1]. In this study, dust events recorded by fast framing camera in between 2000 fps to 5000 fps during 2018 experimental campaign of EAST tokamak have been analyzed by the TRACE code [2, 3]. Fast Cameras combined with wide-angle endoscope system for visible light observation make it possible to use different fields of view (FOV) and observe a wide area in EAST including the upper and lower divertor and the inner and outer walls [4]. The micron size dust particles with sufficient temperature can be detected as bright spots in fast camera movies. Different patterns and trajectories of dust events, e.g. dust collision with walls, dust spinning, dust ablation etc. have been observed in discharges with different configurations. Statistical analysis of long term temporal evolution of dust production rate reveal that average dust rate is high at the beginning of the discharge campaign because of the unconditioned wall and disruption. It has been found that irrespective of discharge configuration, higher number of dust events has been detected during flattop phase compared to ramp-up and ramp-down phase. The temporal correlation of dust events with the core radiation power and vertical displacement events (VDEs) has been presented for the disruptive discharges. Intense core radiation spike has been observed in disruptive discharges which resulted from the ablation of dust particles. Significant dust events have been detected before the disruption preceded by the upward and downward VDEs. It has been observed that dust rates were first increased and then decreased for higher values of VDE amplitude and plasma stored energy in both upward and downward VDE cases. Also, it has been found that a significant number of dust particles were produced at the time of minor disruption in discharges preceded by the last major disruption. Large dust explosion events caused by strong edge localized modes (ELM) are often observed. Metal and light impurity signals as measured by fast EUV spectrometer are found to increase with increasing dust rates. Moreover, it has been found that there exists an important trade-off in choosing the proper inner and outer gap between the separatrix and the main wall surfaces in order to minimize the dust production.

Acknowledgement:
This work was supported by the National Key R&D Program of China under Contract No. 2017YFA0402500, 2018YFE0311100 and the National Nature Science Foundation of China under Contract No. 11675218, 11575244, 11775269.

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