Electrostatic Dust Detector with Improved Sensitivity

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Measurement of dust inventories in next-step fusion devices will be necessary to ensure compliance with safety regulations. An electrostatic device for detection of dust on remote surfaces, consisting of an ultrafine grid of interlocking copper traces biased to 30-50V, has been developed and tested in the laboratory[1]. Impinging dust particles produce temporary short circuits and the resulting current pulses are recorded using nuclear counting electronics. Up to 90% of the particles are ejected from the grid or vaporized suggesting the device may be useful for controlling dust inventories. While large quantities of dust are expected in long pulse tokamaks such as ITER, dust detectors with high sensitivity are necessary to measure the low dust levels in contemporary tokamaks on a shot-by-shot basis. The mass of dust collected over 2 months by a passive dust collector in the National Spherical Torus Experiment, NSTX, indicated an average mass per discharge that was below the previous detection threshold of the electrostatic dust detector. Some improvements in sensitivity were later achieved with larger area detectors[2].

In the present work a digital oscilloscope was used to analyze the current pulse waveform under various experimental conditions in order to enhance the sensitivity of the detection electronics. Test particles were scraped from an unused CFC tile and detectors of both 13 mm and 51 mm size were used. Ultra-low (microgram) quantities of test particles were used and the response of the single channel analyser (SCA) to the input current pulse was monitored. It was found that many pulses were at a level of 50-100 mV, below the previous setting of the SCA threshold. Also, an in-line low pass RC filter, installed to prevent pulse pile-up, lowered the number of counts recorded. Depending on the experimental conditions the detection threshold could be reduced by up to 9x by lowering the SCA threshold and the overall detection threshold reduced by up to 120x when the RC filter was bypassed (Fig. 1). We will present results from applying the detector to NSTX during the 2008 campaign.

[1] C. V. Parker et al., J. Nucl. Mater., 363-365 (2007) 1461.
[2] C. H. Skinner, R. Hensley, A. L. Roquemore, submitted to Plasma Physics Reports 2007.

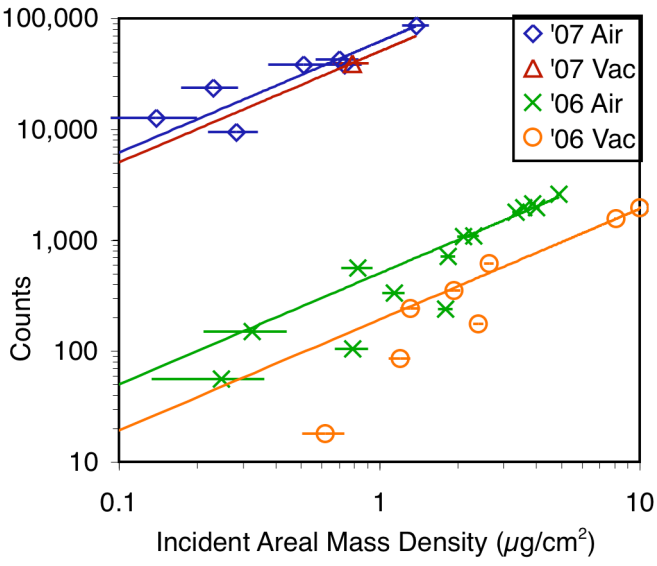

Fig. 1 Improvement in overall detection threshold compared to the 2006 results[2]. Conditions are 51mm grid, 30V bias, 50mV SCA; the lines are a linear fit to the data.