Detection of dust impacts on spacecraft by antenna instruments

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Antenna-based detection of dust grains by spacecraft is a valuable mechanism to enhance the science return from existing missions, and conduct serendipitous observations of interplanetary dust by spacecraft not equipped with dedicated dust instruments. In principle, the detection mechanism is simple: dust grains encountering the spacecraft at high relative speeds undergo ionization upon impact and some fraction of the resulting charged particles is recollected on the spacecraft body or antenna resulting in a measurable signal. However, there is a large uncertainty in calculating the mass of the dust particle from the impact signal. In order to enhance our understanding of the dust impact signals, a series of supporting laboratory measurements have been conducted using the dust accelerator facility at the University of Colorado. These included the measurements of the impact charge yield for common spacecraft materials and reproducing the basic signal-generating mechanisms. We identified three mechanisms (spacecraft charting, antenna charging, antenna pickup) that also depend on the geometric arrangement, the impact location, as well as the bias potentials of the elements. We have also determined that the effective temperature of the impact plasma is lower than previously reported in the literature, and is increasing with impact speed. Our current focus is the study of impact signal generation by the Cassini spacecraft. For this a 20:1 reduced size model of Cassini has been constructed. The three Radio Plasma Wave Science (RPWS) antennas are configured either in a dipole or a monopole mode. The laboratory measurements support the recent suggestion that most dust detection events recorded in the dipole mode are due to antenna hits, as opposed to impacts on the spacecraft body.