RF Emissions from Meteoroid Hypervelocity Impacts

A. Nuttall, A. Goel, M. Hew, P. Tarantino, I. Linscott, S. Close
Stanford University

The space environment poses a number of unique hazards to spacecraft, including hypervelocity meteoroid impacts. While impacts from large meteoroids can cause mechanical damage, impacts from dust sized particles can create unwanted, potentially damaging electrical effects. While the high energy mass/velocity meteoroid impact configurations that can be seen in orbit cannot be experimentally recreated on the ground, the lower energy configurations were tested. Ground-based tests were conducted at dust accelerator and light gas gun facilities to investigate into the creation of RF pulses from hypervelocity impact events. Impact cases were run with varying bias voltages on the target to recreate the natural spacecraft charging conditions that can occur in orbit. RF emissions were observed under a number of different test conditions with different potential causes. Low power emissions were observed directly after time of impact at the dust accelerator facilities for negatively biased targets. These low power signals were isolated using novel noise filtering techniques and exhibited highly transient and broad spectrum content. The strength of this emissions correlate with impact plasma production and target bias, suggesting a bulk electron acceleration as the source of the emission. In the presence of a larger plasma plume produced from a light gas gun impact, RF emissions were observed on a grounded target. A pulse was present directly at time of impact, and a series of additional pulses were observed in the following microseconds due to secondary collisions. While the RF signals observed in these ground-based tests are low power, they have the ability to scale by orders of magnitude in high mass/velocity impact events that naturally occur in orbit.