Paper ID: 10775
oral
student

SPACE DEBRIS SYMPOSIUM (A6)
Hypervelocity Impacts and Protection (3)

Author: Mr. Ashish Goel
Stanford University, United States, ashish09@stanford.edu

Mrs. Sigrid Close
Stanford University, United States, sigridc@stanford.edu
Mr. Nicolas Lee
Stanford University, United States, nnlee@alumni.stanford.edu
Mr. Dave Lauben
Stanford University, United States, dsl@stanford.edu
Mr. Ivan Linscott
Stanford University, United States, linscott@stanford.edu
Ms. Theresa Johnson
Stanford University, United States, theresaj@stanford.edu

ELECTRICAL EFFECTS OF HYPERVELOCITY IMPACTS

Abstract

While a large fraction of the space community is cognizant of the mechanical damage that can be caused by hypervelocity impacts, very few take into consideration the electrical pathway that can lead to satellite anomalies and failures. In this paper, we briefly describe the characteristics of the plasma that is generated when a satellite is struck by a meteoroid or a piece of orbital debris. We discuss the design of sensors for measuring the properties of the plasma and the accompanying electromagnetic pulse. Unlike the mechanical effects which are localized, the expanding plasma and the electromagnetic radiation associated with it allow for the detection and characterization of hypervelocity impacts over larger distances.

We present a brief summary of recent results from the ground based hyper-velocity impact tests carried out by our research group at the Van de Graaff accelerator facility in the Max Planck Institute for Nuclear Physics, Heidelberg, Germany. Retarding Potential Analyzers, wide-band log periodic arrays, VLF loops and E-field sensors were deployed and data was collected for projectile velocities ranging from 1-60 km/s. Tungsten, thick aluminum, thin aluminum foil and the brass knob on the E-field sensor were used as targets. Clear signatures of an expanding plasma and electric field oscillations were observed.

We discuss how the information gained from these experiments helps us in the design of a compact sensor module which when flown aboard a satellite, can detect and characterize the hypervelocity impacts that it experiences. Coupled with radiation dosimeters, such a module can serve as a black-box for satellites. The data from these experiments also enables us to design appropriate shielding mechanisms to mitigate the effects of hypervelocity impacts.