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

Author: Mr. Martin Rudolph
Fraunhofer EMI, Germany, martin.rudolph@emi.fraunhofer.de

Mr. Nathan Welty
Fraunhofer EMI, Germany, nathan.welty@emi.fraunhofer.de
Mr. Christoph Maier
Fraunhofer EMI, Germany, christoph.maier@emi.fraunhofer.de
Mr. Robin Putzar
Fraunhofer EMI, Germany, robin.putzar@emi.fraunhofer.de
Dr. Frank Schäfer
Fraunhofer EMI, Germany, frank.schaefer@emi.fraunhofer.de
Mr. Michel Lambert
European Space Agency (ESA), The Netherlands, Michel.Lambert@esa.int

# ELECTRICAL RESPONSE OF CURRENT-CARRYING SPACE-GRADE HARNESSES TO HYPERVELOCITY IMPACT

**Abstract**

The micrometeoroid and space debris (MM/SD) environment poses a threat to satellites and manned spacecraft. This threat lies in the risk of individual components being affected by an impact of a particle from the MM/SD population. Among spacecraft components, the harness is especially exposed to that risk due to its ubiquity inside a spacecraft and its importance for fundamental spacecraft functioning as a power supply, communications channel or radio frequency relay. The degradation or breakdown of such a mission-critical component can shorten the lifetime of a satellite or, in the worst case, lead to abortion of a mission.

Past impact tests have shown that mechanical damage to the harness like cratering and removal of insulation can result in permanent functional degradation after impact. However, during the impact event, transient processes develop which until now have not yet been characterized quantitatively. These processes include voltage spikes and oscillations that propagate freely through a harness up to its termination where they may damage connected equipment like on-board computers, sensors and other electronics.

This paper presents work performed as part of a European Space Agency contract. A hypervelocity impact test campaign is performed on space-grade unshielded single conductor, screened twisted pair and radio frequency cables with a representative experimental setup. This comprises both realistic operational parameters and a realistic physical setup behind an aluminum sandwich panel similar to an actual spacecraft structure wall. Impactors were aluminum spheres with diameters ranging from 2 mm to 5 mm with impact velocities between 3 km/s and 7 km/s. Impact-induced transient responses are recorded. Observed voltage spikes go up to twice the nominal voltage level. Oscillation frequencies are observed up to 2GHz.