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Space Debris Detection, Tracking and Characterization - SST (1)

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LARID: CONCEPT OF A LARGE AREA LOW RESOURCE INTEGRATED IMPACT DETECTOR

Abstract

In-situ impact detectors were among the first sensors flown on early satellites at the beginning of the space age. Acoustic sensors and penetration detectors, including resistive grids, pressurized cells and capacitive discharges detectors, helped showing that the micrometeoroid impact threat was not as strong as initially feared. Since the 1970ies, scientific detectors, based on impact charge detection and PVDF depolarization, are used to sample micron-sized interplanetary dust. Derived detector concepts were developed with the growing space debris problem. Until now, the results of these developments are limited. Thus, a gap of observational space debris data exists between the outcomes from post-flight analyses of penetration damages on retrieved hardware on the smaller size end and the sensitivity limit of ground-based tracking with radar and telescopes on the larger size end.

A systematic approach for data collection of >0.1 mm space debris, i.e. particles that may have significant effects on spacecraft when impacting, requires an in-situ detector that is resource-effective and adaptable for various space missions. A large detection area is needed to obtain statistically meaningful samples for supporting the modeling of the orbital environment. In this paper, we present the concept of LArID, a large area low resource integrated impact detector that is currently being developed by Fraunhofer EMI for ESA. The focus here is on the trade-off between detection techniques for measuring impact effects and the derived instrument baseline design for the ongoing breadboard development phase.

The combination of different sensing principles is considered a key for both noise immunity and discrimination of impact parameters like particle size, velocity and angle. Three sensor techniques are combined for LArID: piezoelectric sensors, resistive grids and impact flash photodetectors. PVDF vibration sensors are attached to a thin trigger membrane, the outermost layer of the detector. Triangulation of signal arrival times allows to trace back the impact location of perforating impactors. The second layer uses

resistive grids for determining impactor size and location. Impact velocity and trajectory are derived from time-of-flight measurement, backed by photodiodes that are integrated between the two detection layers.

LArID is a modular system with the overall detection area built from base units. Each unit consists of a complete set of sensors and integrated read-out electronics. While the LArID detector is a stand-alone system, its data output can be combined with attitude knowledge data from the spacecraft to study impactor mass for larger particles.