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In-situ Space Debris detection with the MOVE-III CubeSat in LEO

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The past few decades, numerous artificial objects have accumulated in orbits around the Earth. While a portion of the defunct objects are large enough to be tracked by surveillance networks, the vast majority is non-trackable debris. With the increase of space debris in orbit, several models have been developed, aiming at modelling the dynamic space debris and meteoroid environment. The modelling of the environment is not an easy task, especially when we consider the non-trackable population. On-orbit remote sensors have the potential of detecting non-catalogued objects, but up to now, the sub-millimetre realm has only been studied with in-situ impact techniques.

Various space agencies have worked to build models to characterize the space environment. Prominent space debris models include ESA's MASTER and NASA's ORDEM. Such models typically depend on in-situ measurement data to validate their small object population estimates. For ESA's MASTER model, the main validation source is impact features from spacecraft or components exposed to the space environment for a period of time and brought back to Earth. In the same way, NASA's software ORDEM has used impact analysis measurements from STS windows and radiators to validate particles smaller than 3.16 mm in LEO. Returned surfaces can provide invaluable information but they depend on missions to return them and are characterized by limited orbital coverage and time of exposure. A potential validation source for models like MASTER and ORDEM is data from active in-situ detectors.

MOVE-III is a CubeSat project of the Department of Aerospace and Geodesy at the Technical University of Munich. To goal of the mission is to provide in-situ measurements of sub-millimetre space debris and meteoroid impactors in order to support the validation of space debris models and the characterization of the space debris and meteoroid environment in LEO. The main payload of MOVE-III consists of an assembly of impact ionization DEDRA (DEbris Density Retrieval and Analysis) sensors, carried on a 6U Platform. The design of the sensor is based on the legacy of the MDC (Munich Dust Counter). The basic information provided by the sensor is the number of impacts encountered at a specific location and time. Additional processing may determine the mass and speed of each single impactor, which could allow the classification of the impactor's origin. Directional information provided by the advanced DEDRA sensor design could be used to recovers the full velocity vector, allowing a first order approximation of the impactor's orbit.

Space is a harsh environment, and in the new era of satellite technology CubeSats can provide a robust and, at the same time, low-cost platform, which can be employed to collect in-situ space debris and meteoroid impact data using dedicated impact detectors. Well-established sensor technologies and data processing chains may open a new path to continuous in-situ data collection that can support the efforts of modelling the small space debris and meteoroid environment and contribute the validation of space debris models like MASTER or ORDEM. Better knowledge of the space debris environment may benefit future missions and play a crucial role in optimal spacecraft design and traffic management in the next decades.

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