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Small Bodies Missions and Technologies (Part 2) (4B)

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THE D-MEN SAMPLING DEVICE – EXTRACTING AND COLLECTING ASTEROID MATERIAL FOR SAMPLE RETURN

Abstract

Sample return missions for small bodies are increasingly attracting attention during the last years. Acquiring samples of unaffected asteroid or comet material allows for studying the nature and composition of early remnants from planetary formation processes. The return of the acquired material enables ground based post-flight analysis with higher accuracy than achievable through in-situ analysis with spaceborne instruments. We report about the development and the characteristics of a Device for Material Extraction from Near earth objects (D-MEN).

The D-MEN sampling tool is being developed as part of the NEOShield-2 project, which has received funding from the European Union's Horizon 2020 Programme. NEOShield-2 addresses technologies required to characterize or deflect Near Earth Objects (NEO). In the context of sample return missions, this includes the development of autonomous spacecraft control systems for landing on and the D-MEN system for collecting of NEO material. The design drivers for the material sampling are a short static landing scenario and the required capability to not only collect loose particles, but also to extract material from solid surfaces having compressive strengths up to 50 MPa.

The D-MEN combines the functionality of 1) pyrotechnically driven bolt actuators for the extraction of material from solid surfaces and 2) a collecting device based on the fluidization of regolith and loosed material. In the concept of operation, the D-MEN is first positioned on the NEO surface by a robotic arm. Sampling starts with fluidizing the loose regolith material and smaller centimeter-sized particles from the surface it stands on. The material is blown into a first collection compartment by a nitrogen gas flow through lateral nozzles. Then bolt actuators are ignited to break up material from the now exposed solid surface. The loosened fragments are then fluidized and collected in a second compartment. By this two-step procedure, upper regolith layers are collected in the first compartment while the second

compartment contains material extracted from lower lying solid surfaces. Two sampling attempts can be performed to collect at least 100 gram NEO material.

The D-MEN is a highly integrated system including two bolt actuators with recoil compensation, two self-closing material compartments and a pressure pipe system. 3D metal printing technologies have been applied to implement the system in a cylindrical volume of 150 mm diameter by 130 mm long. Comprehensive tests on different materials have been conducted to bring the D-MEN to Technology Readiness Level 5.