



APOSSUM – Asteroid Payload for Obtaining, Storing, and Sample return with Utility Module for the PRIAMOS mission

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The proposed PRIAMOS (PRImordial Asteroid Mission to understand the Origin of the Solar system) mission aims to revolutionize our understanding of the solar system's formation by returning a pristine sample from a D-type asteroid. PRIAMOS would be the first European-led sample return mission. The scientific analyses of the returned sample will allow the determination of the nature of primordial materials of the solar system, test the modern view of the solar system evolution including an early giant planet instability, and constrain the importance of outer solar system materials as a potential source of water and other volatiles to Earth. The total sample mass needed to address the scientific objectives, for public display, and for long term curation and future analysis is 22 g. The detailed mission concept is presented at this meeting by Marschall et al. [1].

Here, we introduce the APOSSUM system – the Asteroid Payload for Obtaining, Storing, and Sample Return with Utility Module. APOSSUM is an instrument suite designed to collect, safely store, and return the sample to Earth. The APOSSUM comprises four key subsystems: the Brush Wheel System (BWS) for sample acquisition, the Sample Capture and Storage (SCS) system of containment and sealing of the sample, the Earth Reentry Capsule (REC) for safe return to Earth's surface, and the Data Processing and Electronics (DPE) unit for integrated command, control, and data handling. The BWS employs counter-rotating brushes driven by motors to lift and transport particles from micrometers to centimeters during the touch-and-go (TAG) sampling into the sample catcher of the SCS. The BWS and results from the ongoing development and test campaign are presented at this meeting by Bannemann et al. [2]. The sample catcher is designed with a capacity to safely retain a minimum of 170 cm³ of material. Successful sampling will be monitored by a camera on the BWS as well as in-situ measurement of the electric permittivity in the sample catcher to quantify the sample amount during TAG. Here, we will present the preliminary design of the sample catcher and test measurements of the sample quantification by electric permittivity measurements of analog materials.

Sample contamination control in the APOSSUM is a critical design driver, following the requirement of the return of pristine material. All surfaces in contact with the sample will be manufactured from PEEK (polyether ether ketone). PEEK is chemically robust, resistant to abrasion, exhibits very low outgassing, and is widely used in ultra-clean laboratory environments. After sample collection the sample catcher will be transferred by the SCS system into the REC and hermetically sealed for the duration of the return flight and Earth atmosphere re-entry. The container is designed to retain any

evolved volatiles from the sample. The temperature in the container will be monitored to document the sample environment. The REC is tasked with the safe return of the sample to the Earth's surface. The envisioned design consists of a sphere-conical heatshield with a diameter of 700 mm built from a titanium-aluminium substructure to which the thermal protection shield is mounted. The REC is designed for a return to Earth at up to 12.8 km/s with a passive entry trajectory, and preliminary tests are currently ongoing. Finally, the APOSSUM system is also tasked with the command, control, and data handling of the asteroid remote-sensing instruments [1]. Key data products will be stored with the sample container and returned to Earth for redundancy.

In this presentation, we will describe the current state of the APOSSUM design and first test results of the sample storage process in the system. We will discuss the suitability for asteroid surface material sampling of D-types, and regolith materials more broadly. APOSSUM exemplifies a new era of sample return: a contamination-controlled, robust, and scientifically transformative payload that will deliver the most pristine extraterrestrial material ever returned to Earth.

[1] Marschall et al. (2026) EPSC2026

[2] Bannemann et al. (2026) EPSC2026-542

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