ASTROFORGE'S DEEPSPACE-2 MISSION: THE FIRST COMMERCIAL MISSION TO LAND ON A METALLIC NEAR-EARTH ASTEROID.

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Introduction: AstroForge, Inc. is a commercial space startup founded in 2022 and headquartered in Seal Beach, California, with the goal of extracting platinum group metals (PGMs) from metallic near-Earth asteroids (NEAs). PGMs, including platinum, palladium, rhodium, and iridium, are rare, high-value materials essential for catalytic converters, fuel cells, electronics, and medical devices. Terrestrial extraction of these metals is environmentally destructive and increasingly constrained by geopolitical supply chain risks. AstroForge's approach is to develop low-cost, vertically integrated spacecraft capable of identifying, reaching, and ultimately mining metallic asteroids.

Mission Overview: DeepSpace-2 will be the first private spacecraft to rendezvous with a celestial body outside the Earth - Moon system. The mission is currently scheduled for launch in late 2026 as a secondary payload aboard Intuitive Machines' IM-3 mission on a SpaceX Falcon 9. After separation from the launch vehicle, the spacecraft will use electric propulsion to conduct a multi-month transit to rendezvous with a target metallic NEA. The specific target asteroid will be selected closer to launch from a database of candidate M-type asteroids approximately 100 meters in diameter located ~0.1 AU from Earth (0.9 - 1.1 AU heliocentric distance). Upon arrival, DeepSpace-2 will obtain high resolution images to assess metallicity and ultimately touch down on the asteroid surface.

Spacecraft Bus: DeepSpace-2 represents a major evolution from AstroForge's previous Odin bus architecture, incorporating extensive lessons learned. The spacecraft has a wet mass of approximately 200 kg. The primary structure is built around a baseplate mounting to a 24-inch bolt circle via an Exolaunch CarboNIX ST separation ring. The Xenon propellant tank (11 kg dry) carries 60 kg of Xe, representing ~35% of total vehicle mass. The bus is designed to withstand quasi-static launch loads of 8.0g axial and 12.5g lateral per SpaceX Falcon 9 rideshare requirements, with all structural modes above 40 Hz.

Propulsion: Unlike Odin, which used chemical propulsion for its flyby trajectory, DeepSpace-2 employs two Safran EPS X00 Hall effect thruster systems (each comprising a PPS X00 thruster, Power Processing Unit, and Fluid Management System). The Hall thrusters consume up to 1,240 W at maximum thrust and require thousands of hours of continuous burn to achieve asteroid rendezvous. Only one thruster fires at a time, providing single-fault tolerance.

Power: Two deployable solar array wings, each consisting of three hinged panels of carbon composite honeycomb construction, generate ~1 kW per wing (~2 kW total). The arrays are deliberately oversized to sustain continuous electric propulsion burns while remaining power-positive - a critical improvement over Odin, which operated power-negative during thruster firings and was limited to ~1-hour burn durations. The radiating surfaces are coated to prevent plasma arcing from the electric propulsion plume.

Avionics and Flight Software: The avionics are designed to be single-fault tolerant with dual-string (A/B) redundancy. Each string comprises a radiation-hardened SAMRH71 microcontroller (handling power management, radio control, and thermal safety) and a flight computer. The system uses a mix of radiation-hardened and radiation-tolerant processors. Flight software runs on Linux with a microservices architecture managed by systemd, using NixOS for reproducible builds. Each subsystem (propulsion, attitude control, communications) runs as an isolated process, enabling graceful degradation in the event of partial hardware or software failures.

Significance: No M-type asteroid has been visited at close range by any spacecraft to date (NASA's Psyche mission, launched October 2023, will not arrive at (16) Psyche until August 2029). DeepSpace-2 will provide the first ground-truth surface measurements of a sub-kilometer metallic NEA, offering constraints on metal content and surface structure that are inaccessible from remote sensing alone. Furthermore, the mission serves as a critical pathfinder for AstroForge's long-term commercial extraction operations, demonstrating autonomous deep-space navigation, electric propulsion transit, and soft landing on a low-gravity metallic body - capabilities foundational to any future asteroid mining architecture.

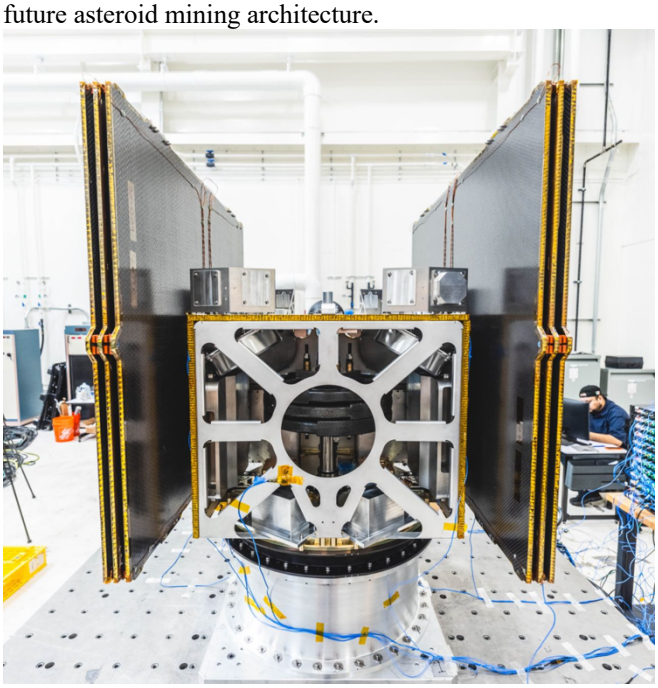

Figure 1. DeepSpace-2 vibration test in January 2026.