DELPHI-1 TECHNICAL DESCRIPTION

The overall goal of the DELPHI-1 mission is to demonstrate Lux Aeterna's end-to-end reusable satellite concept: launch to low Earth orbit (LEO), on-orbit operations, controlled deorbit, atmospheric reentry, parachute descent, and recovery for refurbishment and reflight.

The satellite will be launched as a secondary payload aboard SpaceX Transporter-20, a Falcon 9 rideshare mission launching from Vandenberg Space Force Base (VSFB), California, no earlier than April 1, 2027. The vehicle will be inserted into a sun-synchronous LEO at or below 600 km altitude. Following launch, commissioning, and a roughly three-month cruise phase during which operational testing is conducted, the spacecraft executes a phased reentry sequence with parachute descent and landing at the Koonibba Test Range in South Australia.

The vehicle is a sphere-cone reentry body 1.2 meters in diameter. The launch mass is about 231 kilograms (kg) and the reentry mass about 186 kg. See Figure 1.

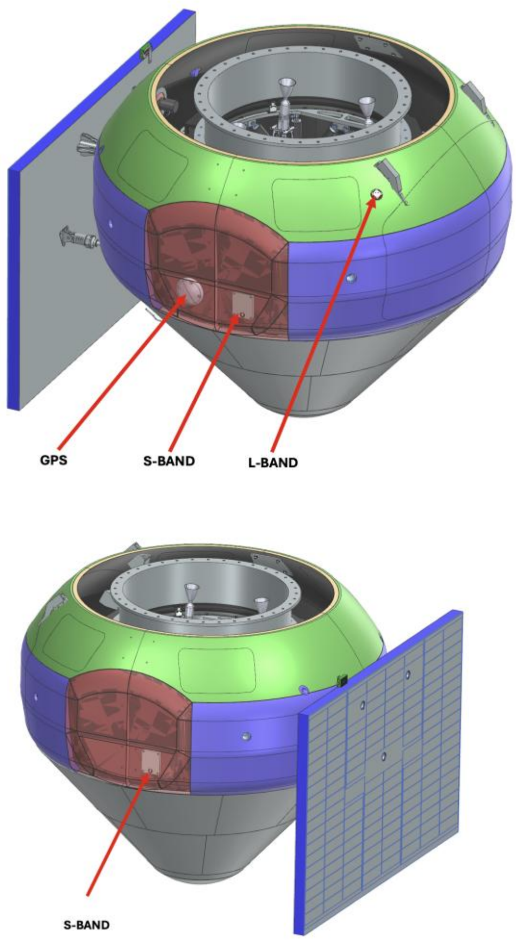

Figure 1 DELPHI-1 Overview Showing Antennas

Major subsystems are described below.

Guidance, Navigation and Control (GNC) Subsystem: GNC is a three-axis stabilized architecture using reaction-wheel control during cruise, thruster control during burns, and magnetorquer-based momentum management.

Attitude determination uses two star trackers, two sun sensors, and a magnetometer. Position and time references come from a GPS receiver, and the NearSpace Launch Black Box provides a second GPS.

Command and Data Handling (CDH) Subsystem: C&DH is centralized on a radiation-tolerant flight computer with a Lux Aeterna custom I/O carrier.

Communications Subsystem (COMMS): The communications subsystem is a full-duplex S-band transceiver for primary command and telemetry, plus an L-band Iridium transceiver. The primary radio is a Satlab SRS-4 software-defined radio with AES-256-GCM link encryption, using two Haigh-Farr 57200 hemispherical patch antennas mounted on opposite faces of the vehicle.

S-Band ground station locations will be:

Punta Arenas Chile
Svalbard Norway
Troll Antarctica
Maspalomas Spain

The NearSpace Launch Black Box incorporates an Iridium EyeStar-S4 transmitter and integrated GPS. It provides on-orbit backup telemetry, and functions as the primary post-reentry beacon, running on power isolated from the primary EPS bus.

Per FCC §5.107 transmitter control requirements, all transmissions can be terminated by ground command via either radio system.

Electrical Power Subsystem (EPS): The EPS is built around a PCDU that captures solar input. Solar generation is provided by silicon flexible cells fixed to the vehicle exterior. The beginning-of-life array output is 135 W.

Propulsion Subsystem: Propulsion is a bipropellant module. Components include four biprop impulse thrusters for orbital maneuvers, phasing burns, and the deorbit burn.

Structure Subsystem: The spacecraft is a single integrated reentry vehicle composed of three primary structural modules: forward heat shield, propulsion deck, and a fixed, one-piece backshell, joined by composite struts with metallic end fittings. The backshell protects the interior from aft heating, provides transonic aerodynamic stability, hosts the L-band, S-band, and GPS antennas and the solar array, and carries a removable parachute door that releases during chute deployment. The solar array is mounted to the vehicle exterior and is jettisoned prior to the deorbit burn.

Thermal Protection Subsystem (TPS): The TPS protects the spacecraft during reentry, using a combination of ablative material, heat resistant material, and insulation.

Thermal Control Subsystem (TCS): Thermal control combines passive isolation, multi-layer insulation, oscillating heat pipes, and zone heaters managed by flight software (FSW). Internal components are thermally decoupled from the high-temperature forward shell, and propellant tanks are enclosed within a multi-layer insulation lined cavity. Dissipating components are coupled to discrete radiator panels through oscillating heat pipes. Heaters are zone-controlled by mode-aware FSW logic.

Experimental Subsystems:

- On-orbit manufacturing demonstrator producing semiconductor crystals.
- A spectrometer will take plasma wake spectroscopy during reentry to better understand the reentry environments.
- Virtual RSO-detection software will process images from the star trackers and a camera.
- Material exposure coupon test. (~0.5 kg).
- Visible and LWIR camera will be used to validate radiometric models by imaging stars and other astronomical objects.

Mission Assurance

A GoPro camera captures video of the atmosphere out the rear of the spacecraft during reentry. It will be turned on to record the reentry environment and for marketing purposes.

A machine-vision unit feeds the on-board RSO-detection payload. Our focus will be on RSO's that may pose a conjunction threat to Delphi-1 or to other satellites, but we expect to see a variety of objects within the field of view. Under nominal conditions, we expect to observe RSOs that include both active and non-operable satellites, along with debris.

Both cameras are pointed out through the opening in the backshell.