Concept of Operations (ConOps) – DeSCENT Mission

1 1. Mission Overview

The Demonstration of Suborbital ChipSats Ejected from New Shepard Test Flight (DeSCENT) is a Cornell SSDS mission in collaboration with Johns Hopkins APL.

The mission will deploy 100 ChipSats from a Blue Origin New Shepard suborbital launch vehicle at ~100 km altitude.

1.1 Primary objectives:

Goal 1 The mission shall collect in-situ sensor data from a distributed fleet of chipsats.

Goal 1.1 The mission shall collect data that demonstrates the potential of chipsats for atmospheric science. **[Goal 1]**

Goal 2 The mission shall characterize the free-fall dispersion dynamics and the landing ellipse of a chipsat fleet.

2 Mission Phases

2.1 Pre-Launch Integration

The DeSCENT payload consists of a spring-loaded deployer containing 100 ChipSats, integrated alongside other experiments within the APL JANUS platform for the New Shepard propulsion Module (PM).

ChipSats remain powered off inside the deployer until ejection, per safety requirements.

Payload is mounted within an AxBxC mm envelope, inverted relative to vehicle axes.

2.2 Launch & Ascent

New Shepard PM launches vertically from Blue Origin's West Texas Launch Site.

The BE-3 engine burns for ~2.5 minutes, propelling the vehicle and payload stack above 100 km altitude.

ChipSats remain stowed; environmental loads are verified against payload specifications.

2.3 Apogee & Deployment

At apogee (~100 km, ~T+3 min), a burn-wire mechanism triggers deployer springs, releasing ChipSats at ~0.2–0.4 m/s relative velocity.

Doors hinge open, ejecting ChipSats into free space.

Deployment is vertical relative to launch orientation, ensuring controlled dispersion.

2.4 Free-Fall Descent

Each ChipSat (~20 g, <50×50×4 mm) enters a ballistic free-fall trajectory, reaching terminal velocities between ~110–220 m/s.

Onboard sensors (BME280, BNO085 IMU, GNSS) continuously log data.

Communications strategy:

- Low-density, real-time telemetry sent to ground station.
- High-density data stored in onboard flash retrievable upon recovery.

2.5 Impact & Recovery

ChipSats are designed to survive terminal impact due to their low mass and high structural frequencies.

GNSS beacons and LoRa transmissions support localization.

Ground recovery teams search the landing ellipse to collect ChipSats.

2.6 Post-Mission Analysis

Recovered ChipSats provide stored high-fidelity datasets.

Combined telemetry and flash data validate free-fall models, atmospheric measurements, and swarm dispersion behavior.

Results inform future ChipSat swarms for atmospheric entry on Earth or other planetary bodies.

3 Key Systems

Deployer: Aluminum structure with spring-loaded ejection bars and burn-wire trigger.

ChipSat Command and Data Handling: MCU/LoRa IC, Environmental sensors (BME280), IMU (BNO085), GNSS, Flash storage.

ChipSat Communications: LoRa at 915 MHz ISM band, asynchronous chirp spread spectrum modulation.

ChipSat Power: Solar and 350 mAh LiPo, low-duty cycle operation.

Integration Platform: APL's JANUS system, providing power control, data monitoring, and environmental characterization.

4 Operational Constraints

Must meet Blue Origin payload integration requirements: mechanical envelope, EMI/EMC, vibration, and thermal testing.

Deployer must pose no risk to launch vehicle, other payloads, or personnel.

RF transmissions must not interfere with New Shepard telemetry.

Recovery probability and data survival are mission-critical success metrics.

5 Success Criteria (MIS Requirements)

MIS 1 One hundred chipsats shall be deployed from the New Shepard suborbital launch vehicle at approximately 100 km apogee.

MIS 2 The chipsat sensor data shall be collected from chipsat descent trajectories and landing positions.

MIS 2.1 The collected chipsat data shall contain in-situ atmospheric sensor data and measurements of chipsat free-fall kinematics. **[MIS 2]**

MIS 3 Two percent of chipsats shall survive terminal velocity impact with the ground.

MIS 4 X percent of chipsats shall be recovered after landing.