

Update on Advanced Development Initiatives for Europa Lander and Other In-Situ Ocean Worlds Mission Concepts

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De-Orbit, Descent, and Landing (DDL) Initiatives

• DDL Sensors

- **Objective:** Build and test two lidar breadboards (<5 cm at <500m altimetry, 5 cm GSD hazard detection)
- **Status:** Sigma Space and MIT/LL Brass-boards in assembly for delivery in Oct 2021 and July 2022, Helicopter field tests in 2022

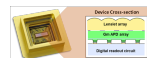


LVS Field Test

- **Objective:** : Conduct high-performance (0.1 m/s, 3σ) **optical velocimetry** field test.
- **Status:** Drone testing at China Lake facility in Sept 2021



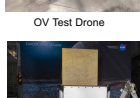
OV Test Drone



Lidar detector

• Landing System Advanced Mechanical Development

- **Objective:** : Prototype and test landing system concepts (legs, feet, bellypan) for very rugged terrain
- **Status:** Second generation legs, feet, belly pan complete.
 - Landing leg testbed complete this fall.



Leg Test Bed

• TRN

- **Objective:** : Develop and test **Terrain Relative Navigation** (collaboration with Mars 2020)
 - Field test Lander Vision System (LVS)
 - Integrated (hardware and software) testing of the Vision Compute Element
 - Develop and validate Lander Vision System Core high fidelity simulation
- **Status:** Spectacular landing of Perseverance. TRN products delivered to Lander team.



2nd Gen Lander/Printed Foot



Perseverance Landing

• Landing Engines

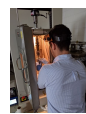
- **Objective:** Prototype and test **low-thrust (800N) throttleable engine**
- **Status:** Based on M2020 3,300N landing engines. Prototype valve assembly built. Testing at Aerojet in Sept 2021



Low Thrust TVA

• Deorbit Stage

- **Objective:** Mature the De-Orbit Stage design through advancement of high-risk areas on a Star 48 class solid rocket motor. (NASA/MSFC)
- **Status:** Major contracts with NGIS and Aerojet/Rocketdyne (currently in phase 4). Vendor propellant and NSI radiation testing.



Tensile testing



SRM propellant coupons

Surface Mission Initiatives

• Sampling

- **Objective:** Prototype and environmentally test **cryogenic excavation, acquisition, and sample transfer** techniques
- **Status:** Successful cryo/vacuum -170 C pneumatic sample transfer. Multiple tool designs/studies. Advanced simulant development.



Cryo/vacuum Sampling test chamber



Sampling tools

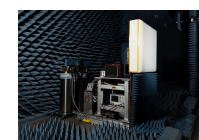
• Surface Resources (size/weight/power/life)

- **Objective:** Develop and test lightweight, low-power **motor controllers** (3A and 10A)
- **Status:** Two prototype controllers developed.
- Controller has been adopted by Mars Sample Return



LiCFx D and DD cells

- **Objective:** Conduct radiation, temperature, and life testing of high specific energy (Li-CFx) primary batteries
- **Status:** Improved cell specific energy by 10%. Performed radiation and abuse testing. Now doing long-life testing on final build. Analysis has extended surface lifetime to 41-50 days..



HGA in Cryo Radome for Env Test

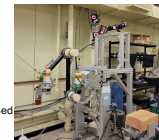
- **Objective:** Develop and test full-scale high-efficiency (80%) x-band **High-Gain Antenna**
- **Status:** Complete. Excellent performance in cryo testing at -170C.

• Surface Autonomy

- **Objective:** Develop hardware testbed and software simulation for **autonomy** development. Prototype flight system that is both autonomous and capable of ground control.
- **Status:** Field testing planned for 2022.



RING Sampling Arm



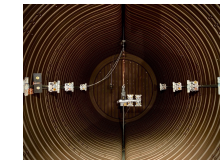
Luigi Test Bed

• Planetary Protection/Contamination Control

- Conducted **bioburden** analyses to mature payload and flight system requirements
- Mature **Terminal Sterilization System (TSS)** in-situ, high-heat microbial reduction system to TRL-6 (Sandia National Labs). Energetic material identified. Small and large box testing underway.
- Evaluating **outgassing properties** of radiation-exposed materials
- Assess **plume product interaction** and alteration with cryogenic ices
- Cryo/vacuum plume interaction testing with samples in DLR facility in Gottingen.



Terminal Sterilization System (TSS) test



Cryo/vac thruster test chamber in Gottingen

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