The Linear Energy Transfer Spectrometer (LETS) Payload on NASA's Commercial Lunar Payload Services (CLPS) TO2 Peregrine-1.

WRMISS

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Purpose/Team

Overview of the LETS radiation sensor manifested on the upcoming Peregrine-1 mission

Team Members

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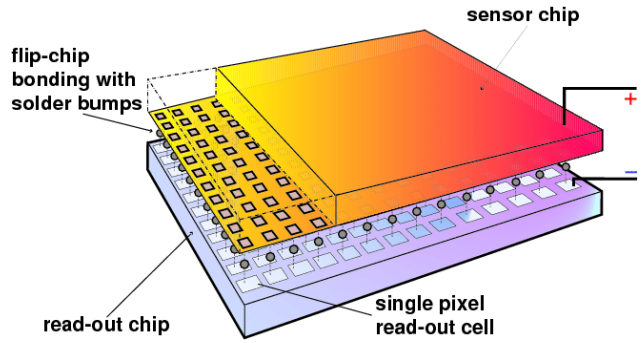
Definition / Background

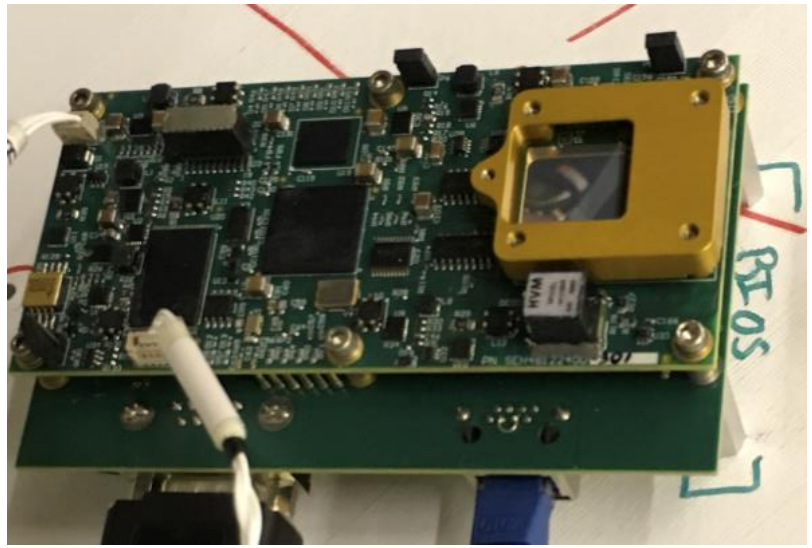
- LETS is one of original 13 science and technology payloads selected as part of the NASA Provided Lunar Payloads (**NPLP**) program in 2019
  - Fast tracked science payloads to support short delivery schedules for commercial landers
- One of ten NPLPs selected for NASA's Commercial Lunar Payload Services (CLPS) TO2 –AB, Astrobotic Peregrine-1 Mission
  - One of only five installed on the lander
- LETS mission is to collect lunar radiation data to advance science knowledge for human exploration.
- LETS is capable of meeting the needs of the 2018 NASA Strategic Plan and 2016 HEOMD Strategic Knowledge Gaps.
  - Measure energetic electrons as a SEP precursor during (pending SEP occurrence).
  - Provide LET measurements at the lunar surface that can be combined with past LRO/CRaTER measurements.
  - Directly measure primary GCR and secondary radiation via Linear Energy Transfer (LET).
- The primary mission objective is to obtain radiation data on the lunar surface.
- Secondary mission objectives are to obtain radiation data in lunar orbit and during transit (through the Van Allen Belts and beyond) when lander resources are available.

Timpix Sensor

- The LETS science element is a Timepix pixel detector
- The solid-state silicon sensor delivers the capability to provide compact high fidelity radiation measurements.
- The sensor consists of a matrix of 256x256 silicon pixels, each can measure the energy imparted by a crossing charged particle result: image of particle track.
- Each silicon pixel has a pitch of 55 µm and a thickness of 500 µm, for a total surface area of 2 cm2
- Each silicon sensor is individually solder bump-bonded to a complete electronics processing chain, including preamplifier, threshold discriminator, and counter, which, with appropriate calibration, allows measurement of the deposited energy in each pixel with a minimum threshold of 5 keV.
- measure over a huge dynamic range -> single 5 keV photons to heavy ions depositing > 2 GeV (400000x)



Schematic of Timepix hybrid pixel detector

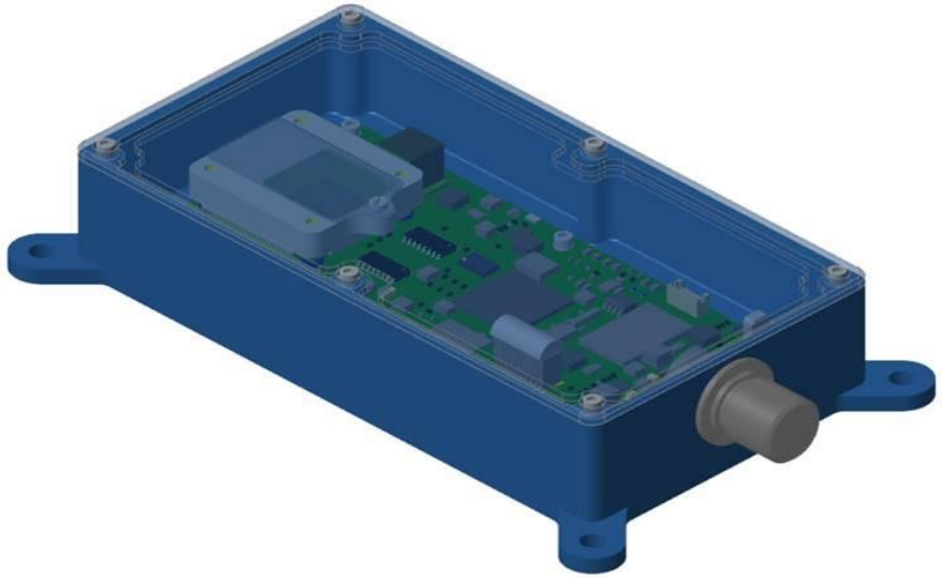


“Open” LETS Board during calibration

Proposed LETS Hardware

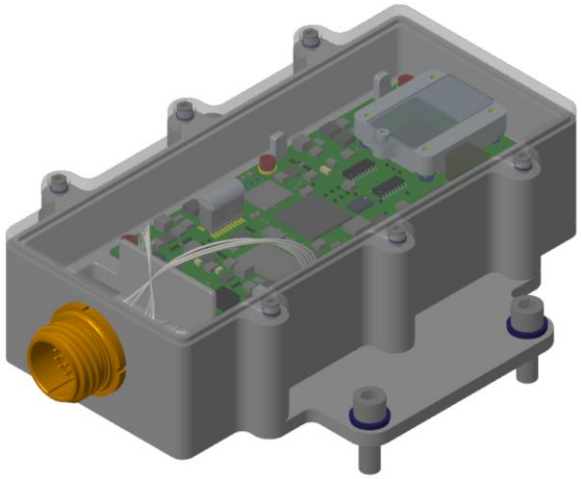
NPLP LETS payload proposal required minimal design

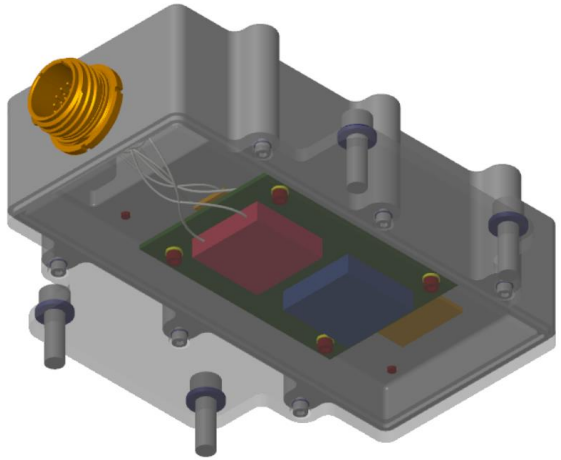
- LETS integrates a Biosentinel board design
  - RadWorks donated resources
- Design and fabricate housing with vehicle power and data interface
- Software modifications for vehicle RS-422 interface

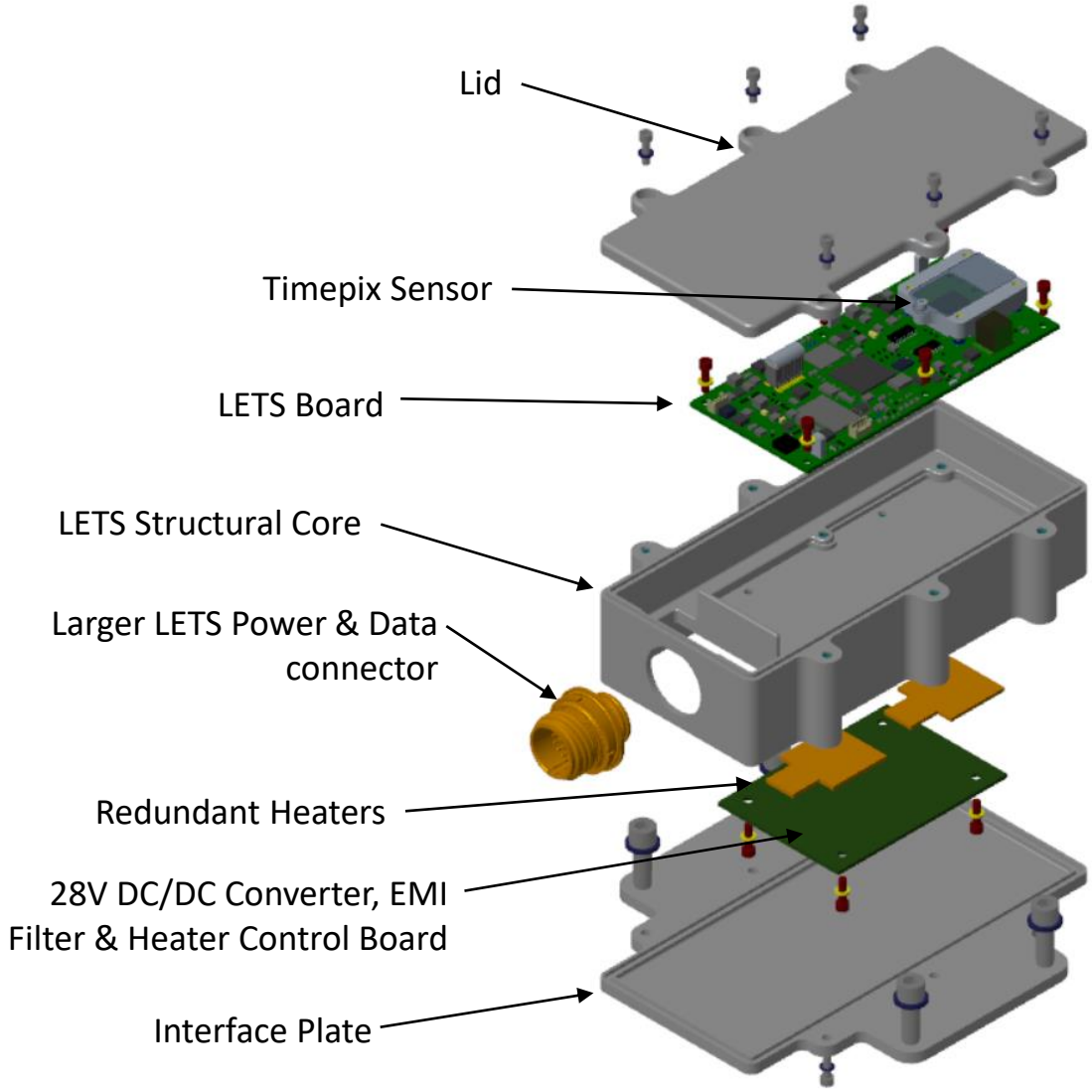


Peregrine Lander Design Updates

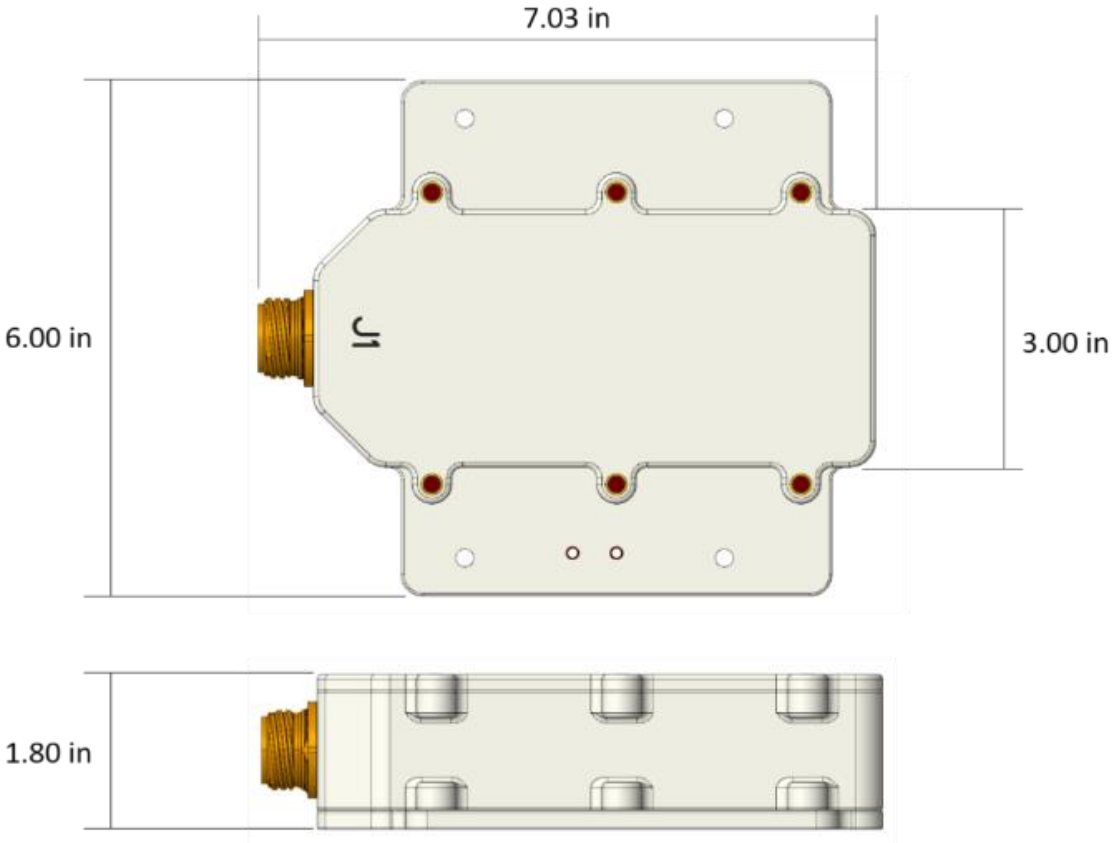
- 28V DC interface
- Thermal isolation
- Increased thermal environment required active heating and better passive thermal management (Lunar Orbit temperatures -120°C and +100°C)



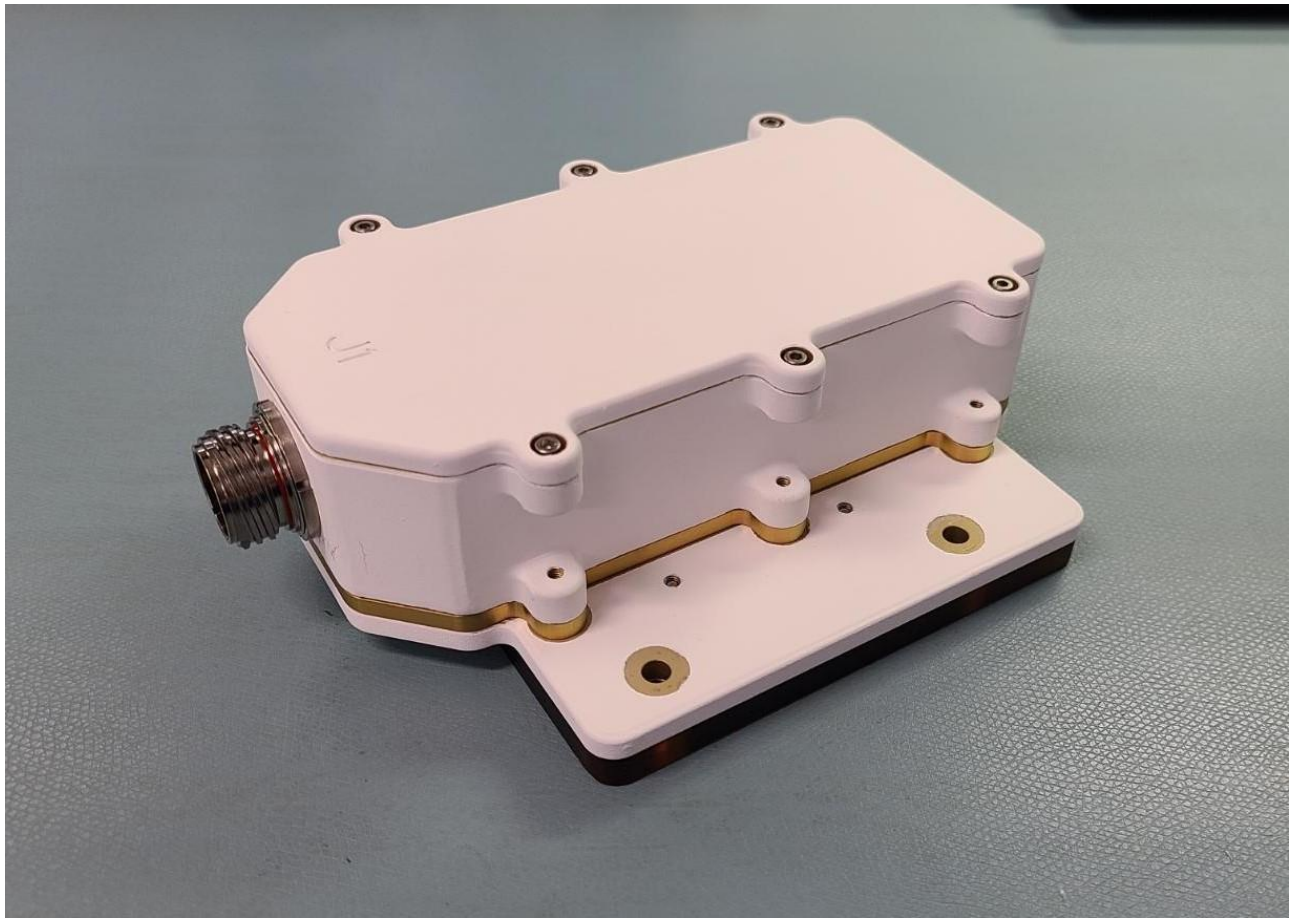




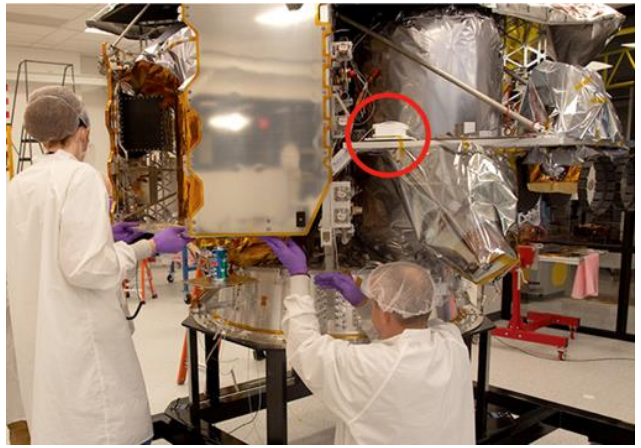
LETS

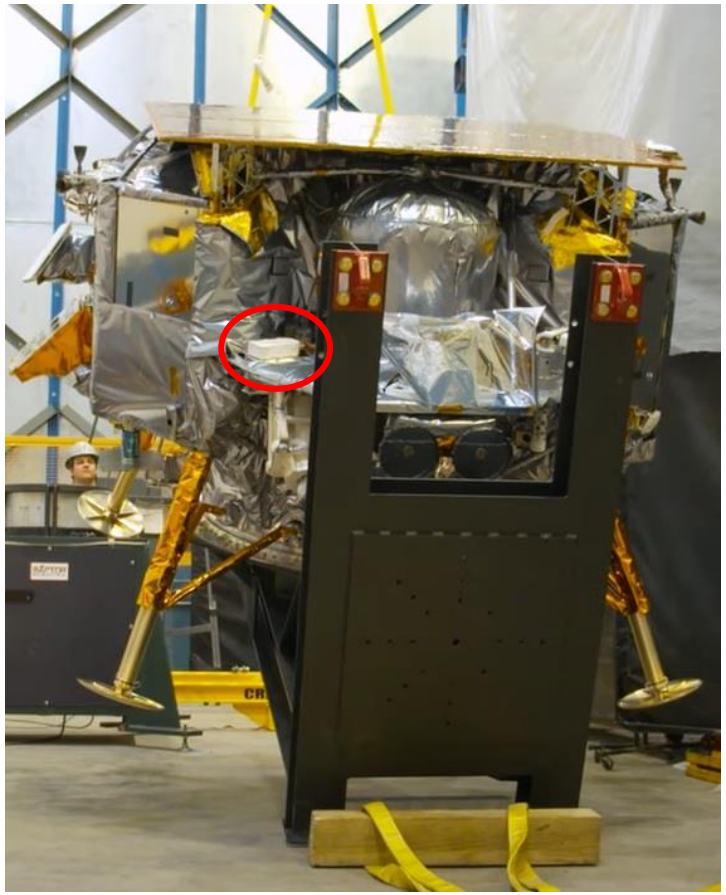


17.9 cm X 15.2 cm X 4.6 cm



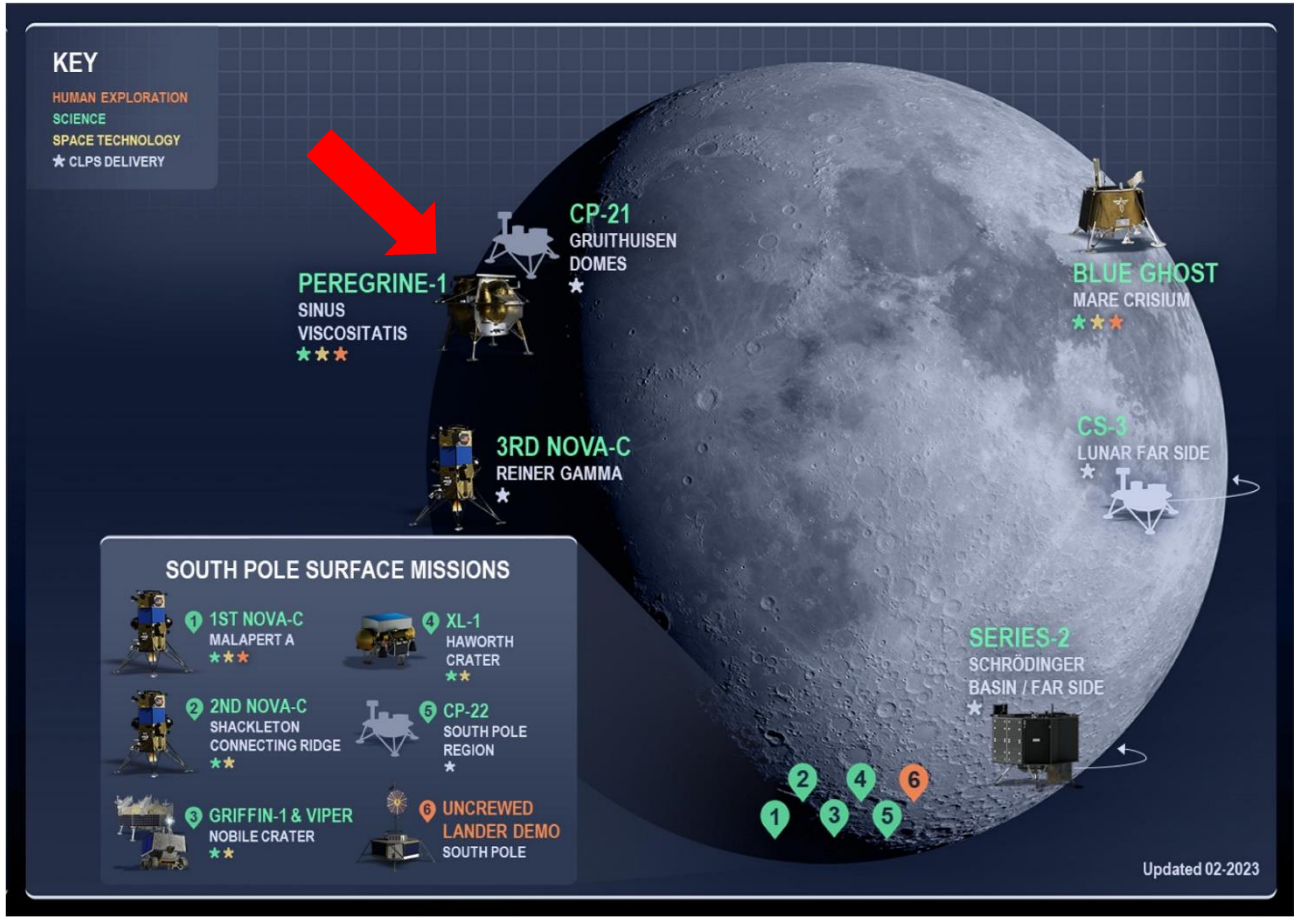
Peregrine Vehicle Integration





Peregrine Mission Overview

- Peregrine launch: 2023 -pending flight approval of the launch vehicle
- Destination: Sinus Viscositatis (Bay of Stickiness) located near the Gruithuisen Domes
- Transit: < 30 days
- Lunar Orbit: 2-3 starting with high elliptical and final circular orbit
- Surface Ops: ~1 Lunar day



https://science.nasa.gov/lunar-discovery/deliveries

LETS Peregrine Mission Concept of Operations

LETS….

- will be powered on after launch vehicle separation and checkout
- when powered, starts autonomously and commences science activities within a couple minutes.
- collects and process radiation data during transit and lunar orbit
- broadcast data to the vehicle on a per minute cadence for downlink to the ground
- will be power down for lunar descent
- will be powered back on after vehicle post landing checkout
- Will resume broadcasting data to the vehicle on a per minute cadence for downlink to the ground
- raw frame data will be stored on-board LETS for in-mission downlink if available.
- telemetry includes science and engineering data along with command capability.

Flight Data

- Data will be received through out mission
- Frames will be downloaded end of mission based on resource availability
- SRAG will spend 3-6 months processing data
- LETS Peregrine Mission data will be available in NASA PDS (Planetary Data Services)
    - ~6 months post mission

Additionally, a 2nd LETS is ready for delivery to NPLP

– discussions are in work for an upcoming non-CLPS lunar mission.

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