LUNAR SURFACE CHARACTERIZATION WITH THE LUNASAT SENSOR NETWORK

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Abstract

Understanding the properties of the lunar surface will be paramount for future mission planning, and surface characterization can be accomplished through a deployed sensor network. The Great Lunar Expedition for Everyone (GLEE) is a catalyst for a new generation of space missions and explorers from around the world. GLEE, initially funded through the Artemis Student Challenge, is a unique mission to demonstrate a new data collection strategy using a large network of inexpensive, student designed, sensing packages on the lunar surface. The GLEE mission will deploy hundreds of solar-powered, 5 cm x 5 cm sensing boards, called LunaSats, over approximately 300 square meters on the lunar sur-face. Each LunaSat will autonomously record and transmit thermal, magnetic, acceleration, and regolith characterization data using a radio mesh network. The LunaSat network will allow for the investigation of magnetic anomalies, lunar seismicity, micromete-orite impact rates, thermal properties and characteri-zation of the lunar regolith in the deployment area. Student teams will help design the mission parame-ters and science cases addressed. The data collected will then be made available on a community science platform.

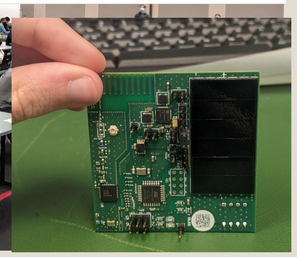
GLEE Student Team Engagement

GLEE is not only a technology demonstration and science mission, but also an outreach mission engaging thousands of students from around the world in the process of scientific discovery. In October 2021, GLEE hosted an in-person workshop in Boulder, Colorado with over 100 students from around the country taking part in a multi-day educational program about GLEE, the LunaSats, planetary science, electronics, and coding. Each team received a LunaSat kit and worked through the training modules. Photos of the LunaSat and workshop shown. After the successful in-person workshop, the asynchronous virtual workshop was launched. It is currently in progress engaging over 1200 more students with the GLEE mission from 30 countries, including the Artemis Accords countries.

GLEE Kit

19 Team In-person Workshop in Colorado (Oct 2021)

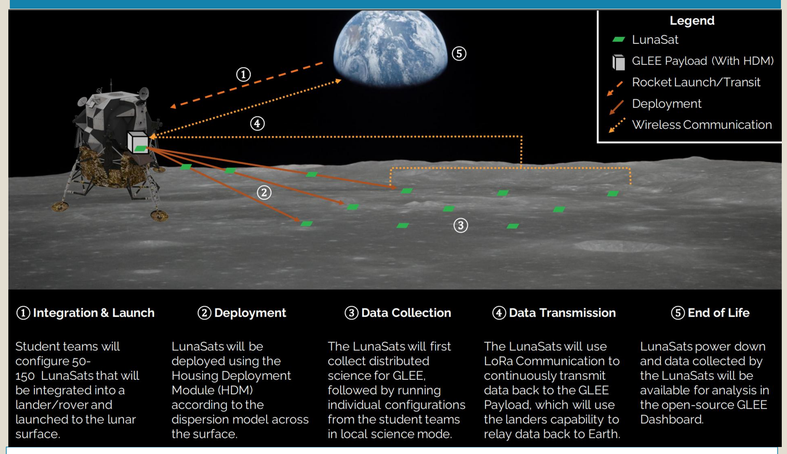
Global Remote Workshop (Shipped Oct 2022)



GLEE: Great Lunar Expedition for Everyone

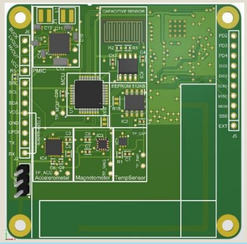
GLEE is engaging thousands of high school and higher education students and faculty around the world in authentic lunar science, meeting the goal of the NASA Global Road Map to "Inspire and Edu-cate" and "Create opportunities for participation in space exploration" that will stimulate international engagement in space exploration and development. Phase one of GLEE engaged international student teams through an online workshop where students learned to program and test the LunaSats, and devel-op their science case for the Lunar phase.
In addition to the large network data collection once on the moon, individual teams code will be activated to collect their desired data. The data will be made available on a public dashboard for future science and analysis, allowing for even greater community science access and opportunity. GLEE is also a Space Grant student run and student designed mission. Students are gaining experience in project management, systems engineering, hardware and software development, and community relations.

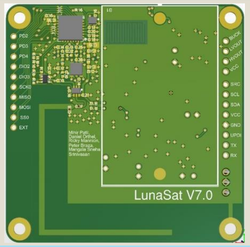
GLEE Mission ConOps



Geology and geophysics has long utilized distributed network measurements, recording physical variables in multiple locations at the same time, but historically they have not been deployed in an extraterrestrial planetary science context. GLEE aims to fill that gap by collecting distributed data on the moon during an upcoming lunar mission. The LunaSat network, will allow for the investigation of magnetic anomalies, lunar microseismicity and characterization of the lunar regolith in the landing area.

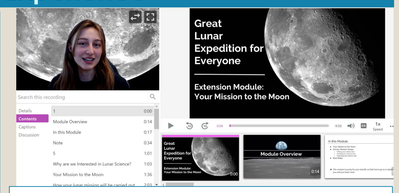
Dispersing hundreds of LunaSats on the surface presents some unique challenges in sensor location and orientation. The recommended dispersion pattern is shown to the right. Depending on the lander support available, localization may be possible with external imaging of the landing area and a test data pulse. Testing the sensor network in lunar analog environments allows for test datasets to be acquired and analyzed, bench test shown below. The software team is currently working on the flight code and how to partition the memory on the LunaSat and optimize power for data packet handling.





Student Experience

The online Workshop platform includes the training modules, video, quizzes, help resources and live chat. In the workshops, students envision their own unique applications for the GLEE dataset and go through the process of designing a sensing system for a science investigation using the LunaSat's suite of sensors. Further, the GLEE data will be made publicly available for students to conduct true lunar science after the mission, giving students hands-on experience that may lead them to careers in planetary and space sciences.

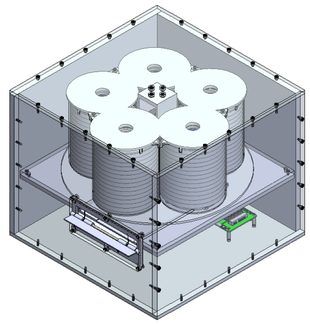


Workshop modules are designed, tested, recorded and moderated by CU GLEE students. Our communications team manages the workshop and outreach activities. The software team will be working with comms on designing a data dashboard interface for community science access for our global teams after landing.

Next Steps: Lunar Landing

The next phase of development for the GLEE project includes finalizing the lunar version of the LunaSat and the deployment module and testing it in a variety of environments, including near space on a HASP flight and in simulated lunar regolith testbeds. Data handling and storage are being tested for the final Lunar Power and Data module. This will be added to the workshop in a module that utilizes the LPDM serving as a way for student teams to generate bitstrings that affect LunaSat operations by changing which sensors are powered on; the sampling rate of the sensors; and the sampling modes of the sensor. This is how the global teams will program their individual science case for flight. A collaborative effort with the Global STEM Engagement subteam and SSERVI will develop modules to utilize Moon Trek to prepare for lunar landing.

The GLEE project is working on securing space on a lander mission by 2026. During this final project phase, the global teams are encouraged to design and test applications of the LunaSats and share their results. These test datsets can accessed by the data dashboard so teams can practice interacting with GLEE data even before we collect lunar data.



CAD design of the updated Lunar Deployment module. The LunaSats will be loaded into the vertical column stacks. Each will drop down and be launched by a sweeper arm. This device will allow for controlled deployment of the LunaSats from either a stationary lander, or a rover. This design minimizes mass and space requirements, while increasing deployment accuracy.

To test the LunaSats in an extreme environment, the team designed an experimental payload that flew on the High Altitude Student Platform (HASP). The sensor capability and data communication protocols were tested during the 12 hour flight.

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