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Happy Spring, Flight Opportunities Community!

Ronald Young, Program Manager

We hope the season is off to a good start for you! We want to thank you once again for being part of this growing community. As always, we're bringing you news from recent program activities and information relevant to upcoming opportunities. We hope you'll check out what's on offer in this month's newsletter:

- Announcement of the **SpaceTech-REDDI-2016 F1(B) payload selections**
- A **recap of flights** in late 2016 that helped to mature several notable technologies for future NASA missions
- A technology spotlight highlighting a new **Lunar Plant Habitat** designed to grow plants on the surface of the moon
- Insights from Paul De León about **how to minimize flight campaign risks**
- News about **recent opportunities and upcoming solicitations**
- **Upcoming events**

Thank you for reading!

Ron

Ronald Young, *Program Manager*
NASA's Flight Opportunities Program

Payload Selections

SpaceTech-REDDI Payloads Selected

Through its SpaceTech-REDDI-2016 F1(B) solicitation, NASA has selected five space technologies to test on low-gravity-simulating aircraft, high-altitude balloons, or suborbital rockets. The opportunity to fly on these vehicles helps advance technologies closer to practical use by taking them from a laboratory environment to the real world.

Two topics were included in this call for research. Under the first topic, which requested demonstration of space technology payloads, NASA selected four proposals:

- **Protein-Drop Pinning in Microgravity,** Amir Hirsa, Rensselaer Polytechnic Institute (Troy, NY)
  Demonstration of a system for maintaining protein solutions in liquid samples involved in the study of diseases such as Parkinson's and Alzheimer's without using a container, which often influences scientific measurements

- **Rapid Calibration of Space Solar Cells in Suborbital Environments**, Justin Lee, The Aerospace Corporation (El Segundo, CA)
  Demonstration of an automated solar cell calibration platform, using a device attached to a high-altitude balloon to capture the solar spectrum and characterize the performance of the solar cells at high altitude up to 22 miles

- **Guided Parafoil High-Altitude Research II**, Garrett "Storm" Dunker, Airborne Systems (Pennsauken, NJ)
  Demonstration of a new parafoil design that can be used for precision delivery or mid-air retrieval of scientific payloads, tested from a high-altitude balloon

- **Strata-S1 - Refining a Testbed to Evaluate the Behavior of Regolith Under Microgravity Conditions**, Adrienne Dove, University of Central Florida (Orlando, FL)
  Demonstration of a regolith compression mechanism with transparent tubes containing beads and pebbles that simulate regolith, to evaluate behavior at various gravity levels during suborbital flights

Under the second topic, demonstration of vehicle capability enhancements and onboard research facilities for payload accommodation, NASA selected one proposal:

- **BioChip SubOrbitalLab: An Automated Microfluidic and Imaging Platform for Live-Cell Investigations in Microgravity**, Daniel O'Connell, HNu Phototonics (Kahului, HI)
  Demonstration of an automated platform to visualize in real time how live cells will react to the different phases of a rocket launch

Flight Tests in Late 2016 Helped Mature Technologies for Future NASA Missions

In December 2016, Vector Space Systems successfully launched a test flight of its first-stage 5K-lb engine for the Vector-R launch vehicle.

In late 2015, NASA selected Vector Space Systems as a corporate partner through its **Announcement of Collaborative Opportunity (ACO) solicitation**, "Utilizing Public-Private Partnerships to Advance Emerging Space Technology System Capabilities." Through these partnerships, NASA provides technical expertise and test facilities to aid industry partners in maturing key space technologies. Via a non-reimbursable Space Act Agreement, Vector has worked with NASA's Marshall Space Flight Center to use additive manufacturing to fabricate an integrated injector for a LOX/Propylene-fueled engine and test the design. The December 8 engine test in Mojave, California, featured a single-piece, 3D-printed injector developed in partnership with Flight Opportunities. To learn more about the technology and the successful test flight, **read the full Vector Space Systems press release**.

In November 2016, Zero Gravity Corporation's G-FORCE ONE aircraft helped to advance several technologies that were awarded SpaceTech-REDDI grants, including:

- **Orbital Medicine, Inc.'s Evolved Medical Microgravity Suction Device** (**T0162**): A medical device currently in prototype form that can be used to extract blood and air when treating a collapsed lung of an injured astronaut
- **Carthage College's Modal Propellant Gauging in Microgravity** (**T0147**): A novel, real-time non-invasive technology that aims to achieve unprecedented accuracy in sloshing tanks, providing high-resolution gauging in zero gravity and thereby addressing a problem that has hindered propellant engineering since the Apollo days
- **Purdue University's Advanced Diaphragm Modeling Technology for Propellant Management** (**T0150**): Testing to advance modeling capabilities for propellant diaphragm technology by analyzing dynamic responses of elastomeric diaphragms in typical propellant tank geometries
- **MIT's MOJO-Micro: Multi-Orthogonal Jaunting rObot in Microgravity** (**T0163**): MOJO is a robotic system specifically designed to traverse and inspect a 3D reversibly assembled discrete lattice structure, with research focused on enabling simplification over current state-of-the-art structure-traversing robots
- **Orbital Technologies Corporation's Water Capture Device (WCD)** (**T0167**): A novel device that uses unique microgravity-specific phenomena to create an efficient means of capturing, transporting, and collecting sparse airborne liquid droplets for a variety of human spaceflight subsystem applications

From left to right, Masten employees Luke Farrell and Richard Garcia, along with intern Alex Drozda, prepare the Xodiac rocket to flight test JHU APL technology.

Also in November 2016, Masten Space Systems conducted a flight test on its Xodiac rocket, launching from Mojave Air and Spaceport, California, and carrying a Johns Hopkins University Applied Physics Laboratory (JHU APL) electromagnetic field measurement experiment onboard.

Named JANUS, after a Roman god of transitions and new beginnings, the experiment gauged the spacecraft's internal environmental conditions. This was the first flight of APL's JANUS system, which will ultimately facilitate routine integration and flight testing of multiple future experiments and technology demonstrations.

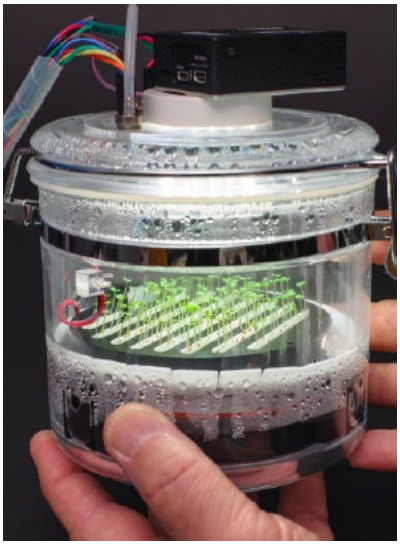
Masten's vertical take off, vertical landing rocket flight tested the measurement experiment, reaching an altitude of approximately 1,476 feet. A follow-on flight test of the JANUS platform will include a global positioning system and an accelerometer with an inertial measurement unit to gauge resistance or disinclination to motion, action, or change. This second flight is aimed to fly an experiment to a higher altitude of up to 60 miles.

Tech Spotlight

Test Flights Help Validate First Technology to Grow Plants on the Moon

Researchers at NASA's Ames Research Center have developed a process for growing plants on the moon (**T0140**)—a method tested successfully in the lab and matured, in part, through the Flight Opportunities program. Prior to flight tests of Ames's Lunar Plant Habitat, no plant-based biological spaceflight experiment had ever hydrated seeds in lunar gravity. Scientists had only performed hydration of seeds at *1 g* because they anticipated that the presence of bubbles or of uneven dispersion would result in inferior water distribution in lunar gravity. Ames's Lunar Plant Habitat addresses this challenge using a direct pressure pump that works even with air bubbles present, passing water to osmosis paper to distribute it evenly to plant seeds. The technology promises to be the first method of growing plants on the moon and is a direct response to the Decadal Survey calling for investigations into the role of plants in long-term lunar life support.

With the Lunar Plant Habitat tested successfully in ground-based experiments, Ames researchers turned to Flight Opportunities for flight tests to see if the technology would indeed work as anticipated in lunar gravity—and if not, to determine if the system's sensors would detect the failure. The payload first underwent parabolic flight testing in 2014. In November 2015 another round of parabolic flight tests was performed to evaluate the flight performance of its microfluidics systems under lunar gravity as well as a camera image capture and system performance evaluation. The test flights increased the habitat's technology readiness level (TRL) to 6, and it is now flight qualified for microgravity, low gravity, and *1 g* ground and spaceflight applications.



Ames's Lunar Plant Habitat promises to be the first method of growing plants on the moon.

Risk Reduction: Ensuring Flight Campaign Success

"A ship in harbor is safe, but that is not what ships are built for."
- John A. Shedd, Salt from My Attic, 1928

Preparations prior to flight campaigns help to reduce risk.

One of the purposes of the Flight Opportunities program is to reduce the risk associated with new innovations prior to their use in NASA missions or other space-related applications. These risks are related both to the performance of the technology as well as the safety of the air- or spacecraft where the technology is used, such as the International Space Station (ISS).

To aid the risk-reduction efforts for a technology, Flight Opportunities provides access to a variety of space-like environments—microgravity, vibration, low temperatures, radiation, etc.—where its performance can be tested. Preparing for these relatively low-cost flights entails a risk-reduction process all its own. In this interview, Campaign Manager Paul De León highlights key elements that principal investigators preparing for participation in the Flight Opportunities program should keep in mind.

Technical Reviews
Several rounds of technical reviews take place prior to a flight campaign, with the payload provider receiving input from the flight provider and Flight Opportunities teams.

"Every campaign is different, but we know about things that can go wrong. So, we share our 'lessons learned' from prior flight campaigns with the payload provider," explains De León.

Installation and Integration
As the technology is installed and integrated with the flight platform—be it a sounding rocket, a high-altitude balloon, a parabolic aircraft, or a vertical takeoff, vertical landing rocket—inspections confirm that the payload has good workmanship.

"We want to be sure it won't fall apart or have some other negative effect during the flight," notes De León.

Combined System Testing
In most cases, the flight provider and researchers perform a combined system test with the payload. De León points out that such testing mimics everything about the flight except the actual flying.

"For example, you activate the technology and the flight platform's electronics to ensure there won't be any EMI [electromagnetic interference] issues."

Timing
Exactly when the integration and testing occurs depends on the flight platform. For sounding rockets, the installation and combined system test usually happens about one month before the flight. For high-altitude balloons, De León explains, "things tend to happen on a faster schedule. Integration takes place in the week before, and the combined test is later that week."

The Weather Factor
Weather is also a risk to be mitigated. For example, excessive winds could make a suborbital vehicle go off the predicted trajectory and come down outside the specified landing area. Restrictions from the Federal Aviation Administration (FAA) and the flight provider's own rules are designed to reduce such risks.

Then, if the weather's right and everything is ready, it's time to fly.

Opportunities

NASA Internal Call for Payloads

The next **NASA Internal Call for Payloads** is open with proposals due May 19, 2017. Interested researchers can read up on valuable resources for putting together a successful proposal by **perusing our prior presentations online** or **email us** for more information.

SpaceTech REDDI-2017 F1(A) Solicitations

The SpaceTech-REDDI program seeks proposals to demonstrate cross-cutting space technologies in relevant space-like environments using currently available U.S. commercial reduced-gravity, high-altitude balloon, and suborbital reusable flight opportunities. The SpaceTech-REDDI 2017 F1(A) solicitation is now open, and applications are due June 2, 2017. More information can be found on **NSPIRES**.

Tipping Point Proposals in Review

Proposals submitted in response to the NASA Draft Appendix entitled, "Utilizing Public-Private Partnerships to Advance Tipping Point Technologies," are currently being reviewed. Watch future issues of this newsletter for updates.

Upcoming Conferences & Events

Don't forget to check out these upcoming events...

- April 25-27: **Space 2.0**
- May 1-2: **Interplanetary Small Satellite Conference**
- May 9-11: **The Humans to Mars Summit 2017**
- May 23-25: **Space Tech Expo USA**

Have ideas or feedback for the Flight Opportunitiesnewsletter?
Drop us a line at: NASA-FlightOpportunities@mail.nasa.gov

STAY CONNECTED:

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