

Leveraging Suborbital Flight Testing to Advance Science and Technology for Planetary Exploration

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Introduction: Suborbital flight testing is an invaluable but often overlooked tool that can be used to advance space research and technology development more quickly. NASA's Flight Opportunities program leverages commercial flight providers to accelerate the maturation of space technologies using suborbital rocket-powered vehicles, aircraft flying parabolic trajectories, high-altitude balloons, and hosted orbital payload platforms. Exposure to relevant space environments can validate a technology's functionality in a cost-efficient and timely manner, reducing risk ahead of longer, more expensive missions, including missions to the Moon and Mars.

Since 2011, Flight Opportunities has facilitated over 260 flights with more than 870 tests of payloads. Presenters from the Flight Opportunities team will highlight how these flight tests have supported the maturation of technologies and research with applications for lunar and planetary exploration.

This poster will illustrate the following key points as a resource for researchers interested in maturing their space technologies and engaging with NASA:

- Ways for U.S. researchers from industry, academia, and non-profit research institutes—as well as those from NASA and other government agencies—to engage with the Flight Opportunities program, including information on the program's solicitations and challenges
- How principal investigators (PIs) can make the most of their flight tests and design them with a future planetary or other application in mind
- Why suborbital flight testing has become a best practice for NASA-supported technologies across disciplines
- Resources available for prospective and seasoned investigators, including a monthly Community of Practice webinar series, the Flight Opportunities newsletter, and one-one-ones with Flight Opportunities team members

Technologies and Research Appropriate for Suborbital Testing: Under the umbrella of NASA's Space Technology Mission Directorate (STMD), Flight Opportunities advances STMD's mission to rapidly develop, demonstrate, and transfer revolutionary, high-

pay off space technologies. STMD organizes the agency's technology investments into a strategic framework with focus areas to drive technology development.

Technologies and experiments that fit the four "thrusters" of NASA's Strategic Technology Framework and will enable NASA's future exploration missions are well-suited for flight testing through Flight Opportunities. Examples include, but are not limited to:

- GO: Cryogenic fluid management
- LAND: Entry, descent, landing; precision landing, thermal protection systems
- LIVE: In situ resource utilization; advanced thermal management; advanced materials, structures, and construction; advanced habitation systems
- EXPLORE: Advanced manufacturing; small spacecraft systems

Relevant Test Environments and Available Flight Vehicles: Flight Opportunities facilitates access to a variety of test environments that replicate conditions encountered on lunar and planetary missions. Relevant environment test conditions include, but are not limited to:

- Microgravity and weightlessness
- Atmospheric re-entry
- Challenging landing navigation
- High-altitude solar exposure
- Radiation
- Extreme temperatures and vacuum
- Intense spacecraft vibrations

Commercial flight providers utilize a variety of different vehicles to provide these test profiles. Presenters will offer insights into how these platforms can support the advancement of investigators' research or technology development plans.

Rocket-Powered Vehicles: This category includes both suborbital reusable launch vehicles (sRLVs) that reach high altitudes and may include periods of microgravity, as well as lander vehicles that specialize in entry, descent, and landing (EDL) technologies. Both of these classes of vehicles are typically recoverable and reusable after launch. They can be used for testing EDL and navigation systems, atmospheric and surface

sampling, biological experiments, robotic systems, in-space manufacturing methods, and electronics and information technology systems.

High-Altitude Balloons: Large balloon systems reach a nominal altitude of 30 kilometers and can also typically sustain the longest duration of the suborbital vehicles – hours, days, or even weeks at a time. This makes them ideal for payloads that benefit from extended periods of data collection. These systems are ideal for testing sun-sensitive and solar instruments, Earth observation instruments, and other instruments and technologies that may benefit from high-altitude observations (both to ground and into space) and drop tests.

Parabolic Flights: Aircraft flying this profile achieve brief periods of reduced gravity through a series of maneuvers called parabolas. They can be used for testing technologies that need to operate in the absence of gravity, such as space-based medical experiments, biological experiments, robotic systems, in-space manufacturing methods, cryogenic fluid management techniques, and electronics and information technology systems.

Getting Started with Flight Opportunities:

Interested researchers are encouraged to reach out to Flight Opportunities at any time outside of an open solicitation and stay up-to-date with current opportunities via the Flight Opportunities newsletter. While NASA and NASA-supported researchers should contact the Flight Opportunities team directly about internal funding opportunities, eligible non-NASA investigators can apply to the program's annual TechFlights solicitation or compete for payload development funding and access to flights through NASA's TechLeap Prize.

The Space Technology Mission Directorate is strongly committed to ensuring that proposal review is performed in an equitable and fair manner that reduces the impacts of any unconscious biases. In addition to other techniques, Flight Opportunities uses a dual-anonymous peer review (DAPR) process where the identities of both reviewers and proposers are not shared until after the technical merit has been evaluated for all anonymized proposals.

About the Flight Opportunities program:

Flight Opportunities rapidly demonstrates promising technologies for space exploration, discovery, and the expansion of space commerce through suborbital testing with industry flight providers. The program matures capabilities needed for NASA missions and commercial applications while strategically investing in the growth of the U.S. commercial spaceflight industry.