# Flight Opportunities

ISSUE: 26 | October 2019

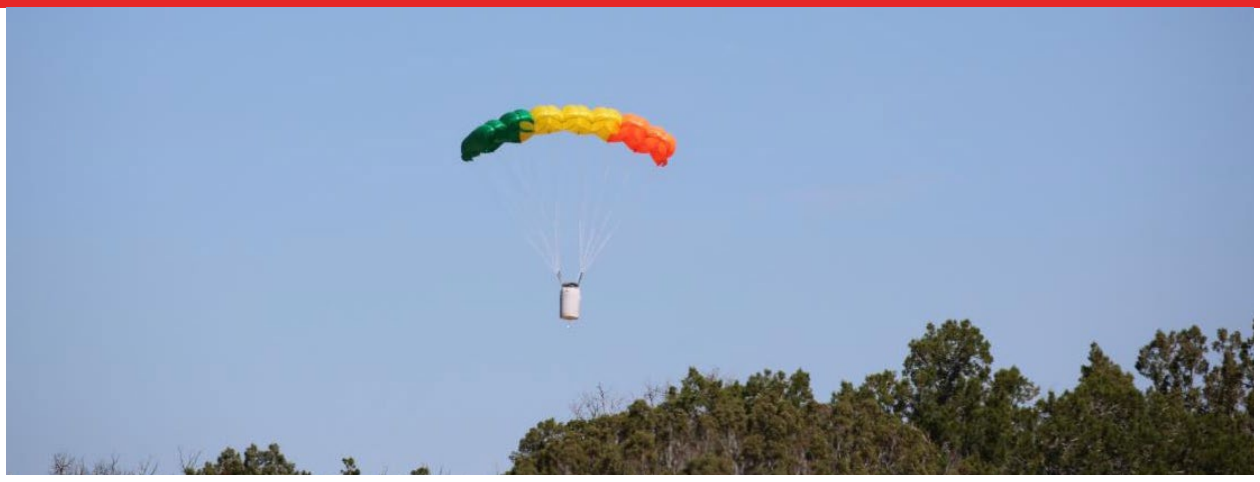
**Greetings from Flight Opportunities**

In this month's newsletter, we are pleased to share:

- Recent flight tests for payloads from Airborne Systems North America, Draper, and Montana State University
- A conversation with SPLICE PI John Carson with advice on planning for mission infusion
- Congratulations to Flight Opportunities-supported researchers who have won prestigious NASA Honor Awards
- Upcoming conferences and events

Enjoy!
The Flight Opportunities team

## Recent Tech Flights



*A guided parafoil payload recovery system from Airborne Systems North America carries a test payload to a safe landing as part of a recent high-altitude flight test. Credit: Airborne Systems North America*

### High Altitudes Enable Technology Testing for Three NASA-Supported Payloads

Three Flight Opportunities-supported payloads recently leveraged high-altitude balloon flight tests to evaluate a variety of technology capabilities that have the potential to help NASA achieve its exploration goals.

**Guided Parafoil High-Altitude Research II from Airborne Systems North America**
The guided parafoil payload recovery system from Airborne Systems successfully delivered a 214 lb test payload within 1200 feet of a pre-selected landing location as part of the flight test. Deployment occurred at 101,000 feet and was followed by fully autonomous and controlled flight. The time from payload launch until return to launch site was efficient at just five hours and 20 minutes. This technology is being developed to enable recovery of scientific balloon payloads as well as re-use of rocket components; satellite recovery; and sample return from the International Space Station, Mars, or other terrestrial body descent and landing systems. The data gathered will be added to that from **an April 2019 balloon flight**.

**Draper Multi-Environment Navigator from Draper**
Draper gathered valuable data for its vision navigation system—part of a portfolio of entry, descent, and landing technologies. The information gathered adds to data collected on a previous balloon flight in April 2019. Draper has leveraged NASA-sponsored flights on several vehicles through Flight Opportunities, enabling them to test their EDL technologies at a variety of altitudes and conditions to ensure that the systems can successfully execute a landing on the Moon or Mars.

**Using Space Radiation for Secure, Wireless Communication from Montana State University**
Montana State University's experiment leverages space radiation to create truly random encryption keys for secure, wireless space-based communication. The 106,000 foot altitude for the balloon flight enabled the payload to be tested above the protective layer of atmosphere that shields ground-based computers from radiation. This facilitated exposing the technology to representative space radiation, which is helping researchers evaluate its ability to create random numbers.

These technologies were selected through **NASA's Tech Flights solicitation**, which awards grants and cost-share agreements that enable researchers to purchase test flights from commercial providers. The payloads were tested on Sept. 22, 2019 on a balloon flight from World View Enterprises, and all were recovered successfully.

## Targeting Infusion: A Conversation With SPLICE PI John Carson

*John M. Carson III, Ph.D., is the principal investigator for NASA's SPLICE project.*

John M. Carson III, Ph.D., is principal investigator (PI) for the **SPLICE** project at NASA's Johnson Space Center in Houston. SPLICE (short for Safe and Precise Landing – Integrated Capabilities Evolution) serves as a hub to bring together the agency's work to develop a full suite of advanced navigation sensors and related hazard avoidance technologies for future missions to the Moon and beyond.

We spoke with Carson recently about how the Flight Opportunities program is helping to mature the sensors and capabilities under the SPLICE umbrella. He also had some advice to offer other PIs interested in getting the most out of commercial flight testing—and eventually infusing their technologies in future NASA missions.

**Tell us a bit about your work on the SPLICE project and how you began testing SPLICE capabilities with Flight Opportunities.**
In 2005, I was at NASA's Jet Propulsion Laboratory, and a few of us were working on some novel guidance algorithms. We realized a few things pretty early on: First, that this was just the tip of the iceberg. We knew we needed a full suite of guidance, navigation, and control capabilities—we call this GNC for short—for future missions. Second, that an even bigger challenge would be getting these technologies infused into an actual mission. There's always risk, and we needed to minimize that risk.

So, when Masten Space Systems participated in NASA's Lunar Lander Challenge in 2009, it got us thinking how we might be able to use these rockets and other suborbital vehicles to test new GNC technologies and use that to learn what works, fix what doesn't work, and ultimately reduce the risk for infusion into missions.

**Now that you are able to test these technologies through Flight Opportunities, how do you go about deciding which SPLICE capability to test on any given flight?**
Each time we fly, we say, okay, what within the technology development have we achieved and what haven't we? We have to mature each capability, but we also have to look at the full picture, or what we call the Concept of Operations—CONOPS for short. That means we have to test each piece to move it up the technology readiness level (TRL) ladder and then eventually do integrated tests of the full suite of capabilities to show the full CONOPS works together as it's meant to. So, we have to balance these priorities.

**Do the missions you are targeting also factor into these decisions?**
Yes, definitely. We're targeting infusion for robotic lunar missions first. The challenge is that NASA has nine **Commercial Lunar Payload Services** vendors—and they're all developing

their own vehicles. So, we build our sensors to our best educated guess of the performance requirements for a generic set of landers. And we set those requirements to make them of interest to as many missions as possible to increase the odds of infusion.

**This guesswork sounds tricky and also quite necessary. How do you approach it?**
A good example is the **Navigation Doppler Lidar** (NDL) capability. Five years ago, we were looking to develop a new generation of that sensor, but we needed to evolve it to gain legitimate mission interest. So, in setting the performance requirements, we looked at a variety of data: potential robotic lunar lander trajectories, potential usage scenarios, and even some of the Mars landing radar velocimeters. That paid off: We'll be flying that sensor on two CLPS missions in the 2021 timeframe, and the performance is more than meeting the robotic vendors' requirements. We're now using this approach for other SPLICE capabilities as well, and for the current work to define requirements for the full CONOPS.

**In advance of these CLPS missions, how do you go about choosing the right suborbital platform to test your technologies?**
In our case, it's been relatively straightforward. Rockets are very relevant to us, because that's what we'll be landing on the Moon and planets. Masten's Xombie has provided a very relevant environment to show how precision landing is done with the integrated suite of sensors and computing. In a few months, we'll be flying on Blue Origin's New Shepard, where we'll be able to blend **terrain relative navigation** with NDL and a path-to-flight computer for a flight test at a higher altitude and for a longer duration. That will give us more data, and the payload will also experience vacuum conditions, hopefully leading to technology readiness level 7. So, for this phase of the work, New Shepard makes sense.

**What advice would you offer PIs who are interested in Flight Opportunities or who are perhaps in the process of preparing a payload for flight?**
First, consider how you're going to demonstrate value to a mission. In looking at NASA missions, are there also commercial infusion targets? Once you know that, you need to keep the right people aware of what you're doing and your testing progress. Smoke and fire from a rocket launch is a lot more convincing than a PowerPoint. You can do that by filming and photographing your progress and leveraging social media. This gives people context for what your technology does, and that's extremely valuable.

Second, make sure the data you're getting is mission relevant. It should not only validate performance but also show that the technology could work on spacecraft. So again, look at the usage scenarios for likely missions and design your performance parameters around that.

Finally, work closely with the flight provider early on. Open communication is critical. Also key is physical hardware integration and testing long before the flight. And the payload doesn't have to be fully baked to start. We've found it incredibly valuable to send early versions of some of the avionics to the flight provider for interface testing. When you work early and often as one integrated team with your flight provider, you discover issues when you still have time to fix them, and you vastly increase your chances of success.

## Flight Opportunities-Supported Researchers Receive Prestigious NASA Honor Awards

In last month's issue we congratulated Franklin Robinson, principal investigator for the **Flight Opportunities-supported Flow Boiling in Microgap Coolers experiment** from NASA's Goddard Space Flight Center, for receiving the agency's Exceptional Technology Achievement Medal. We have since learned that other Flight Opportunities-supported researchers received NASA Honor Awards as well:

**Exceptional Scientific Achievement Award**
**Anna-Lisa Paul, Ph.D., University of Florida**
*For results suggesting that genetic manipulation can produce plant varieties better adapted to growth in microgravity by eliminating unnecessary environmental responses.*

**Silver Achievement Medal**
**Andrew Boone, KBRwyle/NASA's Johnson Space Center**
*For extraordinary technical contributions in the development and certification of a new acoustic monitor for use on the ISS, Orion, and NASA's Commercial Crew Program vehicles.*

Congratulations to these notable researchers for their meritorious work and commitment to utilizing commercial suborbital flight testing to help mature technologies that have the potential to help NASA achieve it's goals of returning to the Moon, and venturing beyond.

## News From the Spaceflight Community

John Carmack, whose former company Armadillo Aerospace was an early flight provider for Flight Opportunities, talks about his days building a rocket company on the Joe Rogan podcast. **Link**

Niki Werkheiser of NASA's Space Technology Mission Directorate gives an overview of NASA's Lunar Surface Innovation Initiative on the Commercial Space Teleconference. **Link**

World View Enterprises achieves a new record with a 32-day high-altitude balloon mission. **Link**

NASA has released a new Request For Information for a new lunar spacesuit. **Link**

***We are always interested in learning more about where Flight Opportunities-supported technologies are today. Please send us news of your technology advancements, infusions, and other recognition so that we can track your progress.***


*Flight Opportunities Program Manager John Kelly spoke on a panel at last month's International Symposium for Personal and Commercial Spaceflight and was pleased with the engagement level of the audience and the many thoughtful questions across a broad range of spaceflight topics.*

## Mark Your Calendar

We'll be attending several events next month, and welcome the opportunity to meet any of you who plan to be there. **Get in touch** if you plan to attend:

**Space Health Innovation Conference**
**November 2**
San Francisco, CA

**Innovation and Opportunity Conference**
**November 14-15**
Aurora, CO

**Space Commerce Conference and Exhibition (SpaceCom)**
**November 20-21**
Houston, TX

**2019 meeting of the American Society for Gravitational and Space Research (ASGSR)**
**November 20-23**
Denver, CO

Also be sure to plan ahead for:
**Next-Gen Suborbital Researchers Conference**
**March 2-4, 2020**
Broomfield, CO

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