



NASA Flight Opportunities

**Effectively Preparing for Flight**

Paul De León, *Flight Opportunities*  
Annie Meier, Ph.D., *NASA's Kennedy Space Center*  
Brett Streetman, Ph.D., *Draper*


**Community of Practice Webinar Series – May 5, 2021**

Session will start at 10 a.m. PT – Please mute your microphone and turn off your camera

[www.nasa.gov](http://www.nasa.gov)

1

NASA FLIGHT OPPORTUNITIES



**Welcome to the Community of Practice Webinar Series!**

***First, a bit of housekeeping...***

- Please mute your microphone and turn off your camera
- Today's session will be recorded
- Recordings for this and all future session will be posted on the Flight Opportunities website
- Please engage!
  - Use the chat throughout the session to ask questions

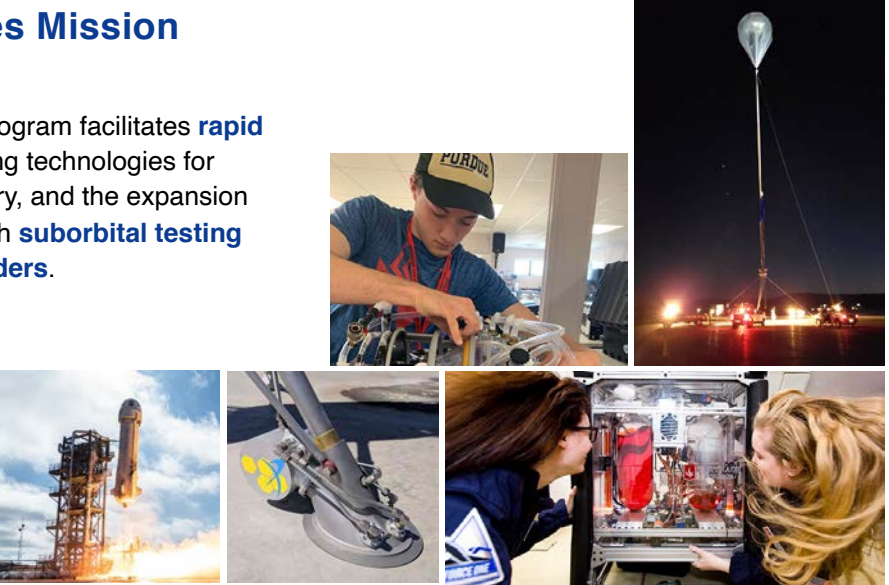
2

NASA FLIGHT OPPORTUNITIES

NASA  
National Aeronautics and Space Administration

## Flight Opportunities Mission

The Flight Opportunities program facilitates **rapid demonstration** of promising technologies for space exploration, discovery, and the expansion of space commerce through **suborbital testing with industry flight providers**.



3

3

NASA FLIGHT OPPORTUNITIES

NASA  
National Aeronautics and Space Administration

## Join us for future Community of Practice webinars!

### From the Mojave Desert to the Jezero Crater: Lander Vision for Mars Perseverance

Andrew Johnson, Ph.D.  
NASA's Jet Propulsion Laboratory  
Christopher Baker  
NASA Flight Opportunities and Small Spacecraft Technology

 June 2<sup>nd</sup> at 10 a.m. PST

### Future webinars


- Webinars are held 1<sup>st</sup> Wednesday of each month at 10 a.m. PT
- Topics will be announced in the Flight Opportunities newsletter and website
- Session recordings will be posted on the Flight Opportunities website
- Let us know session topics you would like to see covered

4




4

NASA FLIGHT OPPORTUNITIES

National Aeronautics and Space Administration



## Today's Speakers



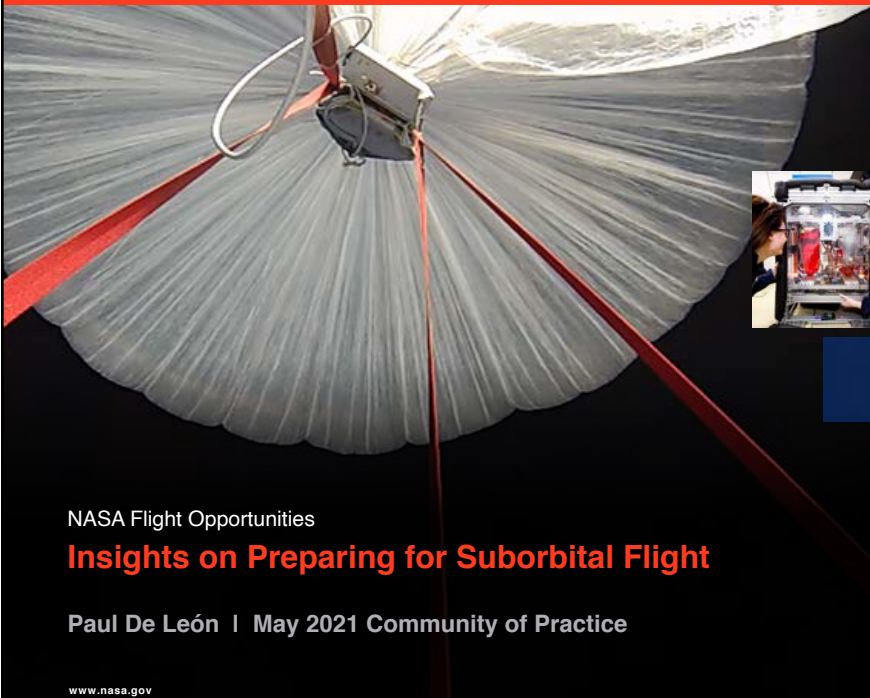
**Paul De León**  
Campaign Manager  
Flight Opportunities

**Annie Meier, Ph.D.**  
Chief, Exploration Systems and  
Development Office  
NASA's Kennedy Space Center



**Brett Streetman, Ph.D.**  
Principal Member, Technical Staff  
Draper

5

5



National Aeronautics and Space Administration



NASA Flight Opportunities  
**Insights on Preparing for Suborbital Flight**  
Paul De León | May 2021 Community of Practice


www.nasa.gov

6

6


NASA FLIGHT OPPORTUNITIES

National Aeronautics and Space Administration



## Understand the expected flight environment and test your payload accordingly.

- **Study up:** Review your flight provider's Payload User's Guide (PUG), which describes the flight environment (e.g., temperature, pressure, acceleration, shock, vibration) as well as flight profiles, interfaces, and other good information to help prepare your payload and concept of operations (CONOPS) for flight.
- **Ask questions:** Reach out to the flight provider or Flight Opportunities campaign manager in case the information in their PUG is not clear, or if you need any additional information.
- **Test:** Fully test your payload to qualify for the expected environment prior to delivery for integration and flight.
  - *'Test like you fly and fly like you test'*
  - Flight profiles and environments vary with each flight provider




Flight Provider: Zero Gravity Corporation  
Photo credit: North Carolina State University

7

7


NASA FLIGHT OPPORTUNITIES


National Aeronautics and Space Administration



## Give yourself enough time to develop and test your payload.

- **Be realistic** about your date for payload readiness and schedule your flight with the flight provider accordingly.




 **Avoid** showing up to the Integration and Testing (I&T) still working on your payloads. Usually, these are the payloads that do not achieve their flight objectives.

- **Engage** with your flight provider and Flight Opportunities campaign manager to address any schedule or technical issues.
- **Speak up** if you are running behind and need more time to get your payload ready for flight.

8


8


NASA FLIGHT OPPORTUNITIES

National Aeronautics and Space Administration 

## Avoid making changes to your payload after I&T with the flight provider.

- Once the payload successfully completes CST/electromagnetic interference testing (EMI) with the other payloads and the flight systems, all payload configuration is considered **locked**. Any changes after that must be negotiated with and approved by the flight provider.



 **Be aware:** Sometimes small changes can have a negative impact not only to your payload, but to other payloads or the flight systems.


Examples include:

- Changing the location of an antenna
- Adding or changing components
- Software changes

9


9

NASA FLIGHT OPPORTUNITIES

National Aeronautics and Space Administration 

## Have a thorough understanding of what happens during the flight week and prepare for any contingencies.

- Ask the flight provider and/or campaign manager** to go over the schedule, payload integration facility, available payload support equipment, etc.
- Make any special requirements clear** to the flight provider like cold storage, power, tools, test equipment, vacuum pumps, etc.
- Be mindful of consumables or materials** that will require inspection, servicing, and/or replacement between flights or due to launch delays or scrubs.


 **Prepare for surprises!** Have procedures in place to deal with these contingencies.

10


10

NASA FLIGHT OPPORTUNITIES

National Aeronautics and Space Administration



## We recommend that the PI is present during payload integration and flight.



- We always encourage PIs to be present at the flight campaigns.
- If the PI is not available, be sure to send someone with thorough knowledge of the payload and who is qualified to make last-minute decisions.
- Whenever possible, ensure all team members are familiar with all aspects of the payload (e.g., testing, operation, hardware, systems).

Location: West Texas Suborbital Launch Site  
Photographer: Blue Origin

11

11


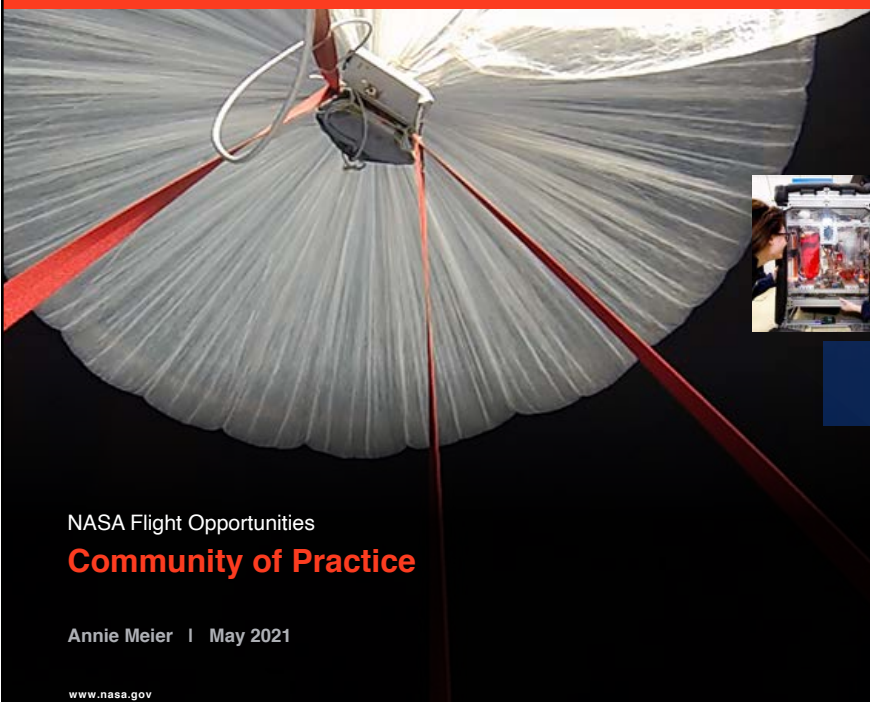

NASA Flight Opportunities

**Community of Practice**

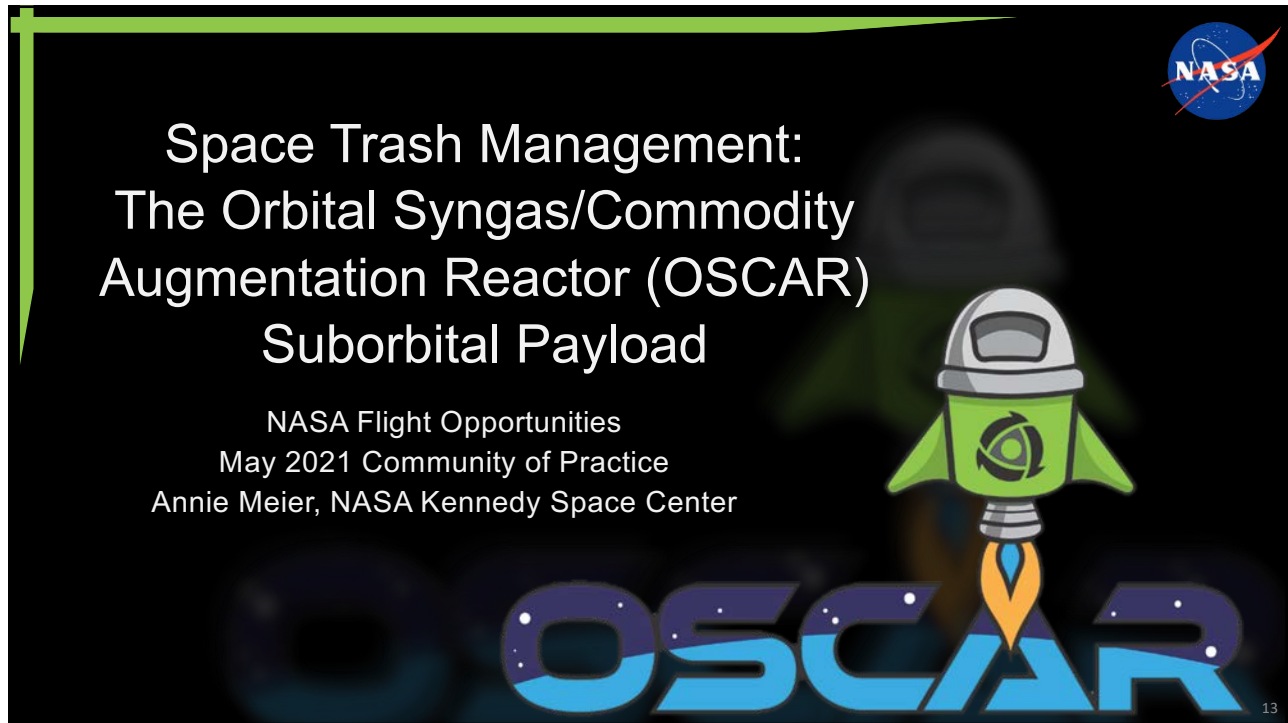
Annie Meier | May 2021

www.nasa.gov

National Aeronautics and Space Administration





12




**Space Trash Management:  
The Orbital Syngas/Commodity  
Augmentation Reactor (OSCAR)  
Suborbital Payload**

NASA Flight Opportunities  
May 2021 Community of Practice  
Annie Meier, NASA Kennedy Space Center



13

13



**OSCAR** • A **microgravity** demonstration of mission waste conversion to reduce mass, vent gas, and recover raw materials.



The diagram illustrates the OSCAR waste conversion process. It starts with an astronaut on the left, pointing towards the OSCAR reactor. The reactor is shown as a box with a plus sign. Waste is input into the reactor, which produces three outputs: Recovered H<sub>2</sub>O (in a cylinder), Recycled Solids (in a stack), and Propellant Storage (in a tank). Arrows indicate the flow of these products towards a rocket on the right, which is shown launching. An inset image shows the OSCAR reactor in operation, with a bright flame and a control panel displaying 'BLUE ORIGIN' and 'F2 0:03'.

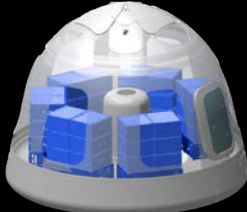
Image/Video Credit: Blue Origin / Blueorigin.com

14


14

# OSCAR

• A **microgravity** demonstration of mission waste conversion to reduce mass, vent gas, and recover raw materials.






Image/Video Credit: Blue Origin / Blueorigin.com



OSCAR Full Stack, Image: NASA

## STANDARD INTERFACES




Single Locker      Double Locker      Full Stack

Reference: Blue Origin LUNAR-G QUICKSTART GUIDE

15

15

# OSCAR Development



2s $\mu$ g	5s $\mu$ g	3min $\mu$ g
<b>2.2s Drop Tower</b> System level proof Waste injection Structural validation	<b>Zero Gravity Research Facility</b> Microgravity ignition Gas motion	<b>Blue Origin New Shepard</b> Microgravity ignition Sustained reaction

Concepts to final suborbital flight report in ~ 2.5 years!

Image/Video Credit: Blue Origin / Blueorigin.com

16

16



# OSCAR Development



17

17

# More Lessons Learned


- Site visit as soon as you can fund it
- Align internal and external technical processes from day 1
- Environmental tests
  - Vibration, Shock, Acceleration, EMI, Thermal
  - Have campaign manager and Commercial Flight Provider team reps at CERS!
- Documentation
  - Understand response to 'scrubs' & off-nominal procedures
- Frequent communication
  - FTP server crucial
  - Have one team POC during flight integration
- Software integration
  - Unexpected last-minute changes
- Pack Everything
  - Expect the unexpected!
    - Backup for parts that break
    - PPE, Fittings
- Things go wrong!
  - Flight providers have proven to be so flexible
  - Plan power margin
- Getting the flight ready
  - Packing lists, full automated rehearsal, transportation



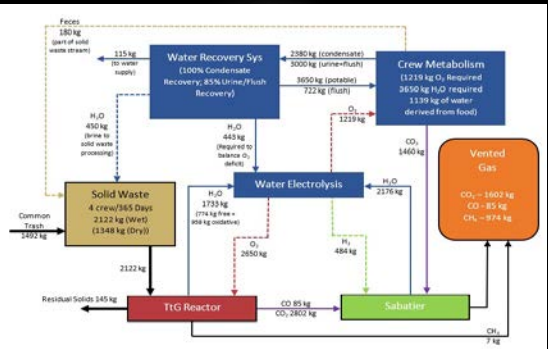
18

18


# After OSCAR Flight 1




- OSCAR awarded second suborbital flight opportunity via STMD Flight Opportunities program for 2021 Flight.
- NASA HEOMD AES Logistics Reduction Project
  - Comparing 3 core trash management strategies
    - **Trash-to-Gas** (volume reduction, mass reduction, resource recovery)
    - **Trash Compacting and Processing System** (volume reduction, radiation protection)
    - **Mass Jettison** (volume reduction, mass reduction)
  - System infusion dependent on mission architecture, duration, and phase
  - OSCAR is first flight tested prototype included in the LR project
- OSCAR Performance
  - 91% solid-to-gas conversion
  - 99% volume reduction

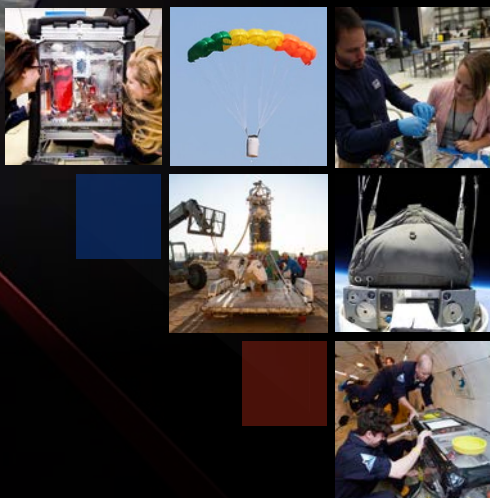


Olson, J., et. al., "A Comparison of Potential Trash-to-Gas Waste Processing Systems for Long-Term Crewed Spaceflight", "50th International Conference on Environmental Systems, Virtual, July 2021.





National Aeronautics and Space Administration



NASA Flight Opportunities

**Community of Practice**

Brett Streetman | May 2021

www.nasa.gov

**DRAPER**

# Flight Opportunities Community of Practice Panel: DMEN Overview

Authors: Brett Streetman  
May 5, 2021

**Approved for Public Release**

This material is based upon work supported by NASA under award 80NSSC20K0104. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Aeronautics and Space Administration.


The Charles Stark Draper Laboratory, Inc.  
555 Technology Square, Cambridge Mass. 02139-3563  
CAGE Code: 51993

21


## Flight Test Experience

- Completed a large number of test campaigns for GN&C software and hardware on a variety of vehicles (guided parafoils, VTOL rockets, balloons, experimental air vehicles)
- Worked the GENIE program with Masten early in the Flight Opportunities program
- Currently the PI for DMEN
  - Completed 2 balloon flights, in progress for a suborbital campaign, and awarded for a VTOL test


**GENIE**



**Precision Guided Airdrop**



**DMEN**



**DRAPER**

Subject to Restrictions on Title Page

22

22

## Draper Multi-Environment Navigator (DMEN)

- DMEN is a flight testing program funded by NASA Flight Opportunities designed to test Draper's vision-based navigation (VBN) algorithms in a new relevant environment
- Two successful high altitude balloon flights were completed in 2019, both taking DMEN to altitudes of over 100,000ft
  - Two cameras and an IMU were used to collect sensor data through the duration of the flight
  - All data recorded for later use algorithm testing and validation
- Funded for 2 additional campaigns
- Development focused on maturing Draper's lunar optical navigation technologies



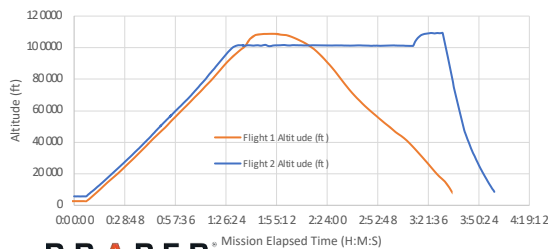
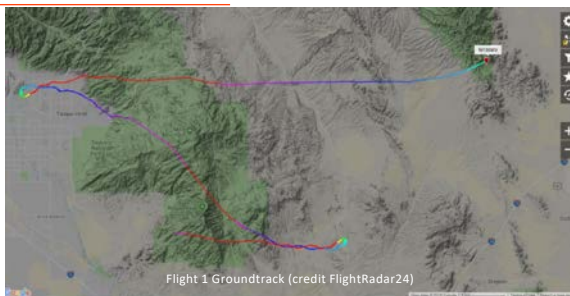
**DRAPER**

Subject to Restrictions on Title Page

23

23

## DMEN Flight Testing



**DRAPER**

Mission Elapsed Time (H:M:S)



DMEN Integrated With World View Vehicle



Sample Inflight Imagery

Subject to Restrictions on Title Page

24

24


NASA FLIGHT OPPORTUNITIES

NASA  
National Aeronautics and  
Space Administration

# Thank you!

Flight Opportunities website:  
<http://nasa.gov/flightopportunities>

Contact us:  
[NASA-FlightOpportunities@mail.nasa.gov](mailto:NASA-FlightOpportunities@mail.nasa.gov)



The logo is circular with a gold border. The text 'FLIGHT OPPORTUNITIES PROGRAM' is written in white along the top inner edge. The bottom inner edge contains 'NASA AFRC' on the left and 'ARC' on the right. The central graphic depicts a blue and green Earth with a white satellite in orbit, a white rocket launching, and a white cube-shaped satellite in space. A purple arc and several white stars are also visible against a dark blue background.

25 [www.nasa.gov](http://www.nasa.gov)