




NASA Flight Opportunities
**25 Years of Microgravity Research –
A Conversation with Dr. Steven Collicott**
Community of Practice Webinar Series – January 6, 2021

Session will start at 10am PT – Please mute your microphone and turn off your camera

www.nasa.gov

1

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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

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Welcome to the Community of Practice Webinar Series!

Flight Opportunities hopes these webinars will enable researchers, program staff, and flight providers to connect informally and share information


- Designed to distill and share the most important lessons learned to:
 - Increase the impact of suborbital flight tests
 - Transfer best practices
 - Optimize the experience of current and prospective program participants
- Part of an effort to capture, organize, and communicate lessons learned by suborbital researchers
- An opportunity to hear from subject matter experts on best practices for preparing for suborbital flight tests

3


3

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Today's Speakers



John Kelly
Program Manager
NASA Flight Opportunities




Dr. Steven Collicott
Professor of Aerospace Engineering
Purdue University

4

4

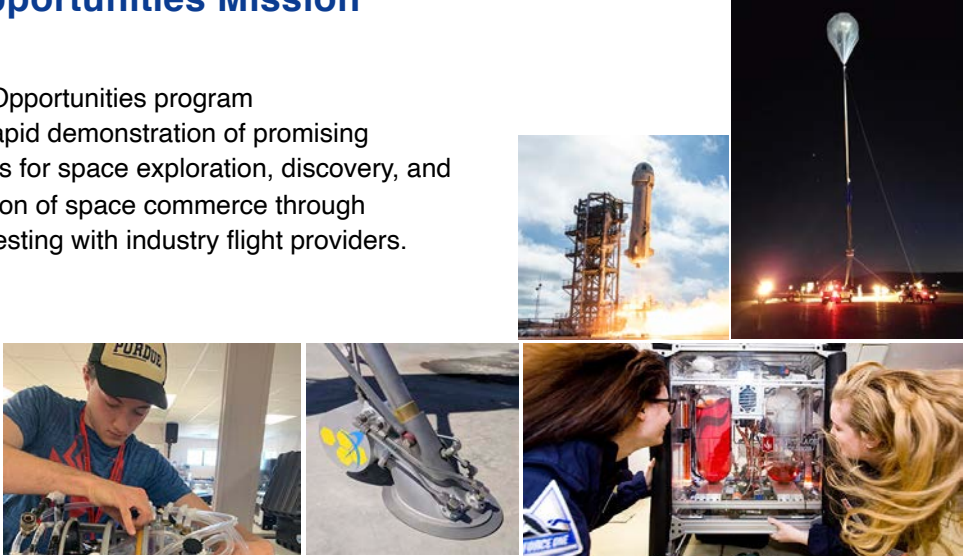
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Flight Opportunities Mission

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.




5

5

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A Decade of Flight Opportunities

BETWEEN 2011 AND TODAY...

- Supported **211** successful flights
- Enabled **735** tests of payloads
- 274** technologies in the portfolio
- 12** active commercial providers



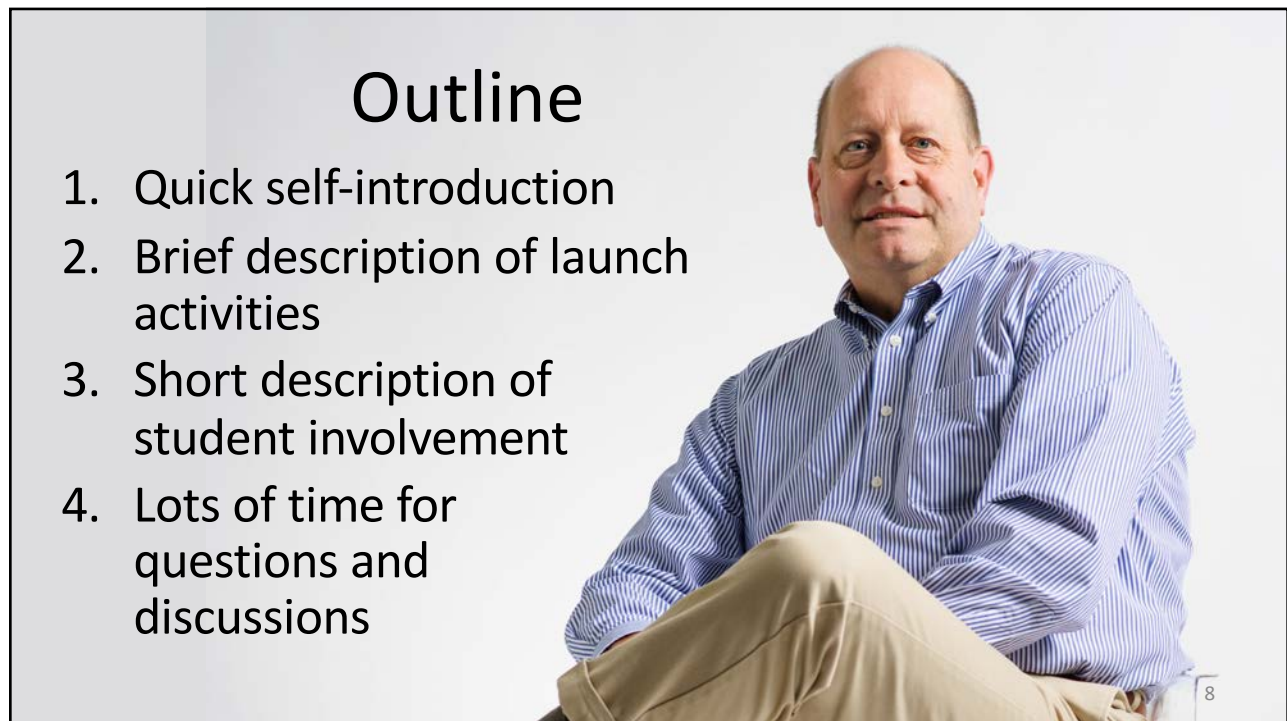
As of December 31, 2020

6

6



7

A slide titled "Outline" featuring a list of four items on the left and a photograph of Dr. Steven Collicott on the right. He is a middle-aged man with short hair, wearing a blue and white striped button-down shirt and khaki pants, sitting and looking towards the camera. The background is a plain, light color. A small number "8" is in the bottom right corner of the slide.

Outline

1. Quick self-introduction
2. Brief description of launch activities
3. Short description of student involvement
4. Lots of time for questions and discussions

8

1. Zero-g Experimentation Experiences, 1997 to date

- 7 fluids payloads on 5 Blue Origin New Shepard commercial sub-orbital flights
- 2 fluids test vessel geometries designed for the successful Vane Gap fluids payloads in ISS.
- 28 payloads on NASA parabolic aircraft flights, mostly fluids experiments
- 12 fluids payloads on ZeroG Corporation parabolic aircraft flights
- Advised Dr. Mo Kassemi, on important changes to NASA's ZBOT tank geometry, thus enabling highly successful ZBOT operations in orbit in 2018.
- Advised industry on 1 commercial ISS payload launched recently to the ISS.
- 1 fluids payload on UpAerospace Spaceloft launch, second payload delivered November, 2020
- Fluids payloads launched on 7 Armadillo Aerospace sub-orbital mission attempts
- Sensor payload launched on 3 Exos Aerospace sub-orbital mission attempts, #4 soon.
- 2 payloads designed, 1 built, for XCor Aerospace sub-orbital missions
- 1 fluids payload completed, 1 sensor payload begun for Masten Space Systems flights.
- 1 fluids payload begun for Virgin Galactic flights.
- Advised on 2-phase fluids separator design for the successful CCF experiment in space station.
- Drop tower experiments to solve fluids issues and reduce required astronaut time, for an ISS animal habitat.
- Built and operated 2 drop towers at Purdue for zero-g fluids experiments.

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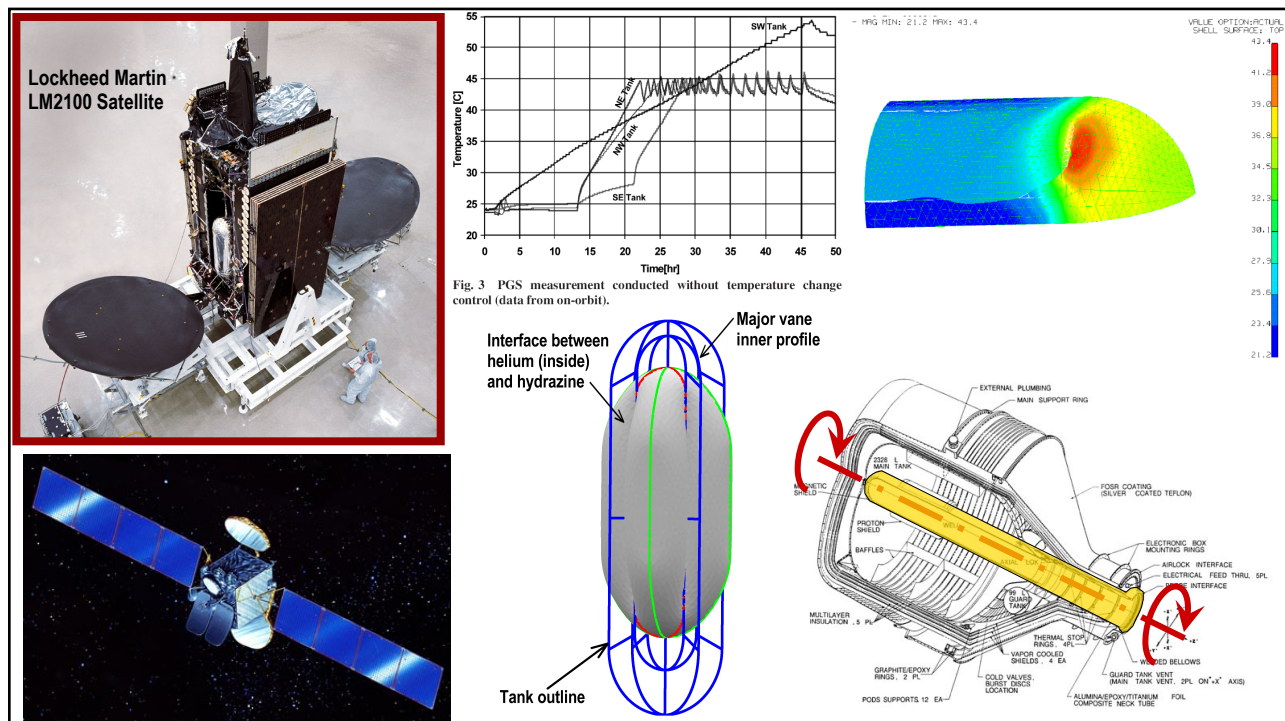
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Zero-g Industrial Experiences

- Gravity Probe-B main helium dewar bubble positioning tests and modeling, 1994. Validated by performance on orbit.
- Computed the first accurate propellant mass center position history throughout the mission for profitable Lockheed Martin A-2100 commercial communications satellites. 1998.
- First computation of propellant mass center shifts during stationkeeping burns in Lockheed-Martin communications satellites, c. 2000.
- Developed thermal propellant gauging system with Lockheed Martin Commercial Space Systems, 1998. Validated on orbit numerous times
- Delivered thermal propellant gauging for GEO satellites with LM, Comsat Technical Services, and YSPM. 1998 to date.
- Developed thermal re-balancing of fuel in multi-tank satellites with Lockheed-Martin. Validated by profitable lifetime extensions of actual commercial satellites in orbit.
- Created and deliver, to industry and NASA, a 2-day short course on using the *Surface Evolver* computer code for practical tank and PMD modeling and analysis.
- Consulting for numerous industrial clients and NASA on propellant management problems. Disclosure of commercial client names is generally prohibited. 1998 to date.

11

11



12

1-g Two-Phase Fluids Experiences

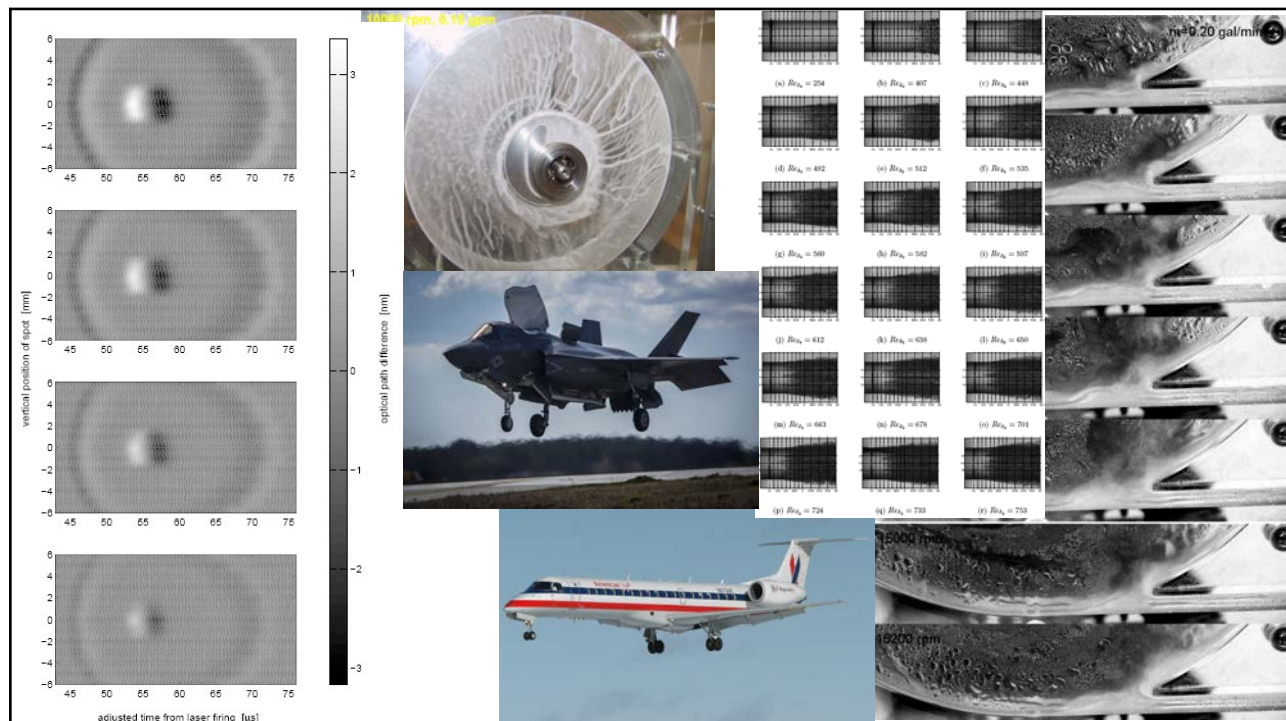
- World's first true-scale (200 micron), true pressure (206 MPa) visualization of unsteady cavitation inside diesel fuel injector orifices, 1997. NSF CAREER award research with Cummins collaboration.
- Oil sump research and design, 1999 to 2006. Teamed with industry sponsor to solve a major oil flow problem in what has since become a ubiquitous and highly dependable turbofan engine in the global regional jet market. This work also generated the knowledge for the sponsor to design the successful oil system in the F-35B Joint Strike Fighter lift fan used for every vertical take-off and landing.

Plus, aerodynamics impact:

- Developed the laser-perturber for hypersonic boundary layer receptivity and stability experiments in Purdue's world-leading hypersonic quiet-flow tunnels.
- Developed the ultra-high sensitivity laser differential interferometer for measuring wave growth non-intrusively in hypersonic boundary layers on realistic flight geometries in Purdue's world-leading hypersonic quiet-flow wind tunnels.

13

13



14

Professional Service

- **Chair of SARG:** Sub-orbital Applications Researchers Group of the Commercial Spaceflight Federation (CSF), June 2013 to date.
 - Advocate in legislative and executive branches of US government, plus NASA and the FAA, for increasing science and education uses of the new generation of low-cost readily-available commercial re-usable sub-orbital rockets.
 - Advertise in the science community to expand awareness of these new opportunities.
 - Partner to manage technical program for Next-gen Sub-orbital Researchers Conferences, March 2020 is the 7th.
- **President-elect, American Society for Gravitational and Space Research, Nov. 2020 to Oct. 2021**
 - To be followed by a year as ASGSR president, then a year as ASGSR conference organizer
- **Invited Testimony, U.S. Senate Sub-committee on Science and Space, May, 2013.**
 - Senators Bill Nelson (FL) and Ted Cruz (TX) presiding.
- **Committee on Biological and Physical Sciences in Space, National Academies.**
 - Advise NASA BPS (was: SLPSRA) on research priorities and paths
 - Helped oversee the pending decadal plan for BPS in SMD
 - Aid in planning for NASA research in the new lunar exploration era
- **Science and Technology Advisory Panel, ISS-National Labs/CASIS. April 2013 to October 2020.**
 - Advise on the use of national labs in space station for impacting life on Earth.
 - Aided in creation of joint ISS-NL & NSF fluids and combustion funding for ISS experiments. 2016 to date.
- **Chair, AIAA Microgravity and Space Processes Technical Committee, 2015 to 2019.**
 - Increase participation in TC, increase awareness of new opportunities
 - Oversee biennial Space Processing technical award process.

15

15



16

Launch Activities

- Launched with FOP to date:
 - Blue Origin, 5 payloads on 4 flights
 - UpAerospace, 1 launched, 1 more delivered
 - Zero-G Corp airplane, many to date
- Building with FOP for:
 - Virgin Galactic, 1 so far
 - Masten Space Systems, 1 so far
- Also, outside of FOP:
 - active with Exos (was Armadillo) since 2009, many launches
 - My first Blue Origin payload was launched courtesy of Blue Origin, built with NSF support
 - My K-12 payload on Blue Origin was funded by local fund-raising

17

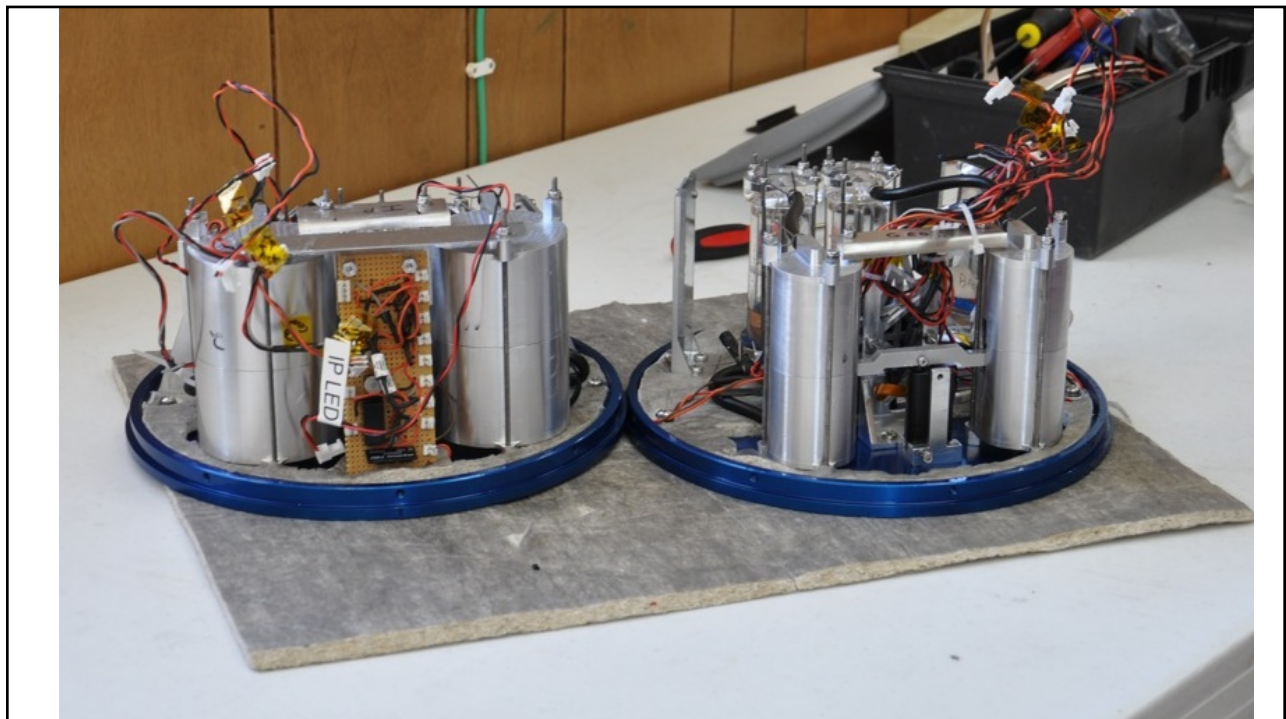
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18



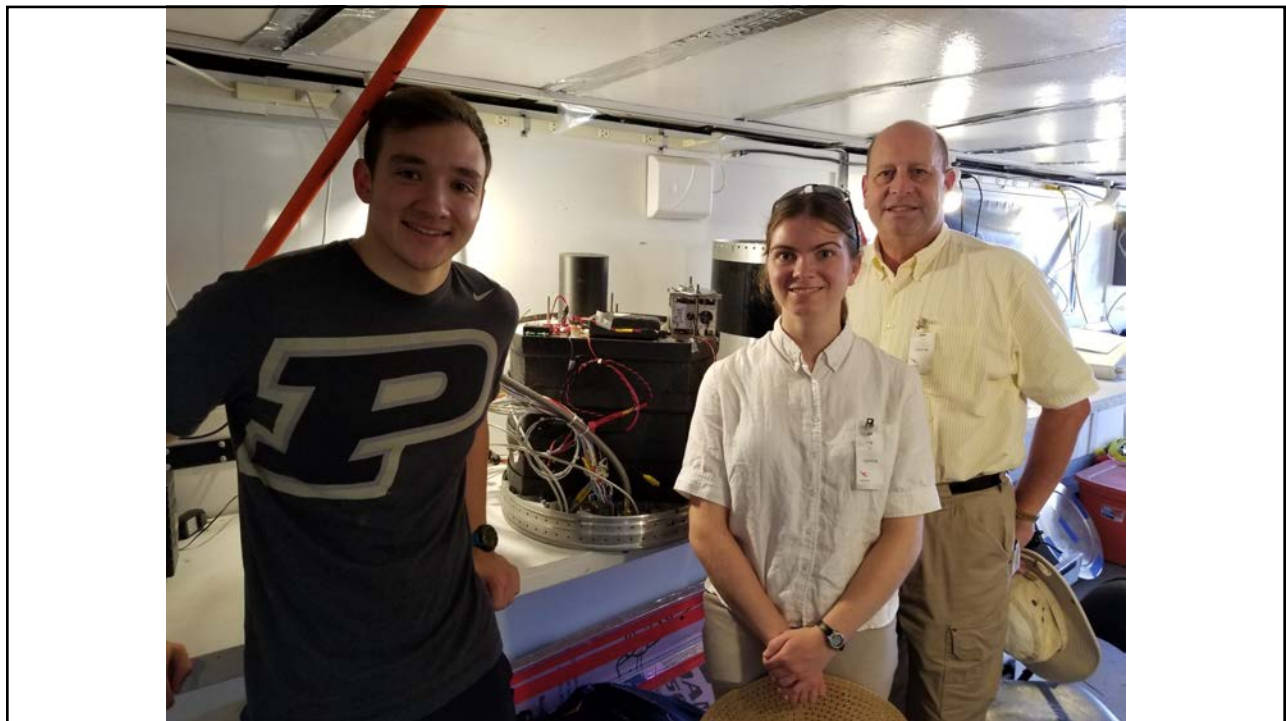
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20



21



22



23

Unique Teaching

- Started what became “AAE418 Zero-gravity Flight Experiment” in 1996 from student interest in NASA’s then-new “Reduced Gravity Student Flight Opportunity Program” or RGSFOP.
 - This design-build-test class grew to 4 experiments winning per year in the competitive proposal program and then flying in parabolic aircraft flights for zero-g experimentation.
 - In 2009 I added commercial sub-orbital payloads.
 - 2014 was the last NASA RGSFOP flight when NASA closed their Reduced Gravity Office.
 - First Blue Origin launch in summer 2016, thanks to Blue Origin and NSF.
 - I have secured over \$7M of aircraft and rocket flights for AAE students. Plus 5 days in NASA’s NBL.
- Now 60 juniors and seniors per semester, plus 30 in the summers. Over 1,100 students since 1996.
 - Now working with grad students, professor, and technicians on FOP payloads
 - Payloads take more than one semester to design, build, test, fly, and analyze, so each semester sees a different team.
 - One or more students generally travel to launch

24

24



25


Question time

- What's on your mind?
- Also, for detailed questions regarding your own payload, specific design choices, consulting, *Surface Evolver* modeling, etc., drop me an email. collicott@purdue.edu

26

26

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Join us for the future Community of Practice webinars!

Successfully Proposing to the Flight Opportunities Program

- February 3, 2021 at 10 a.m. PST
- Stephan Ord, Flight Opportunities Chief Technologist, along with veteran suborbital researchers


Future webinars

- Webinar series will be held 1st Wednesday of each month at 10 a.m. PT
- Topics will be announced in the Flight Opportunities newsletter and website
- Sessions recordings will be posted on the Flight Opportunities website
- Let us know session topics you would like to see covered

27

27


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Thank you!

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

Contact us:
NASA-FlightOpportunities@mail.nasa.gov



28 www.nasa.gov

28