



EXPLORE SPACE TECH

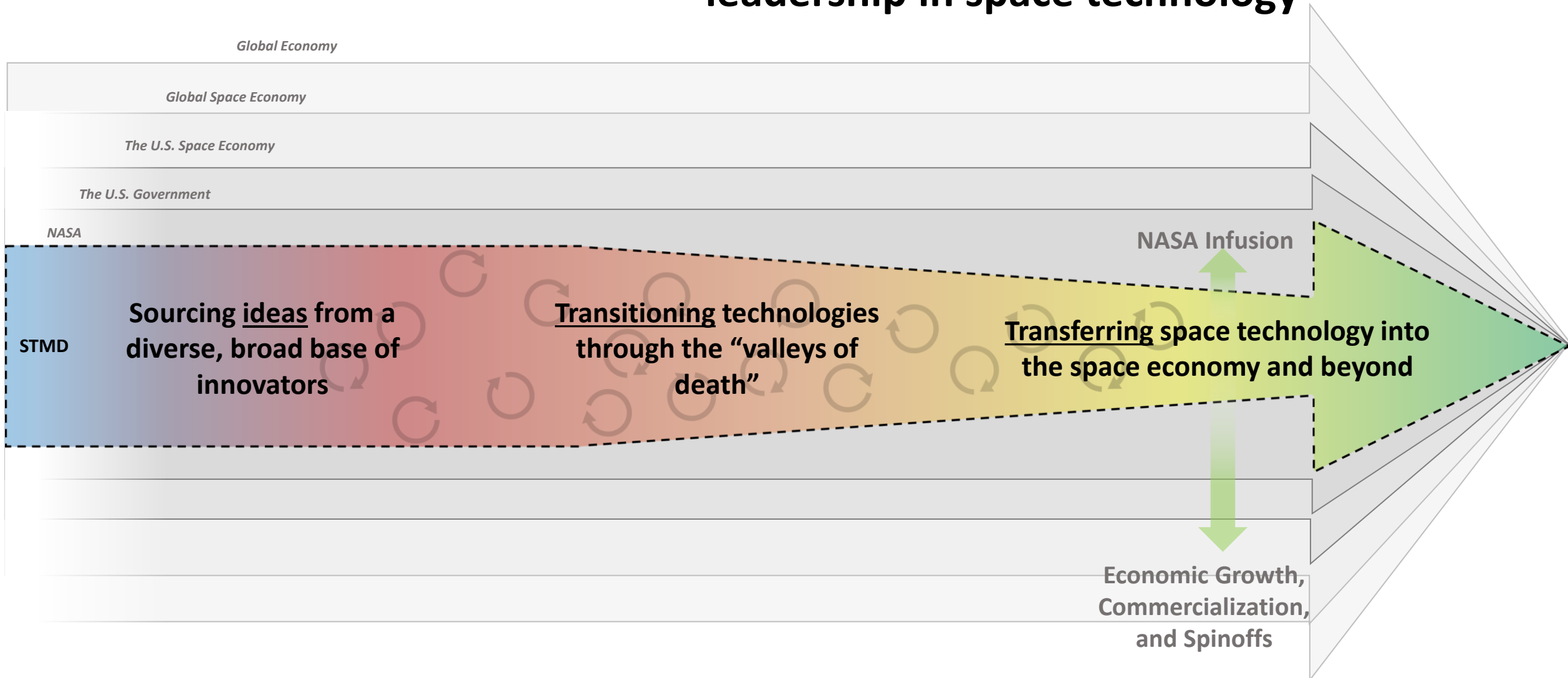
Opportunities to develop and fly payloads on their path towards commercialization

Jenn Gustetic

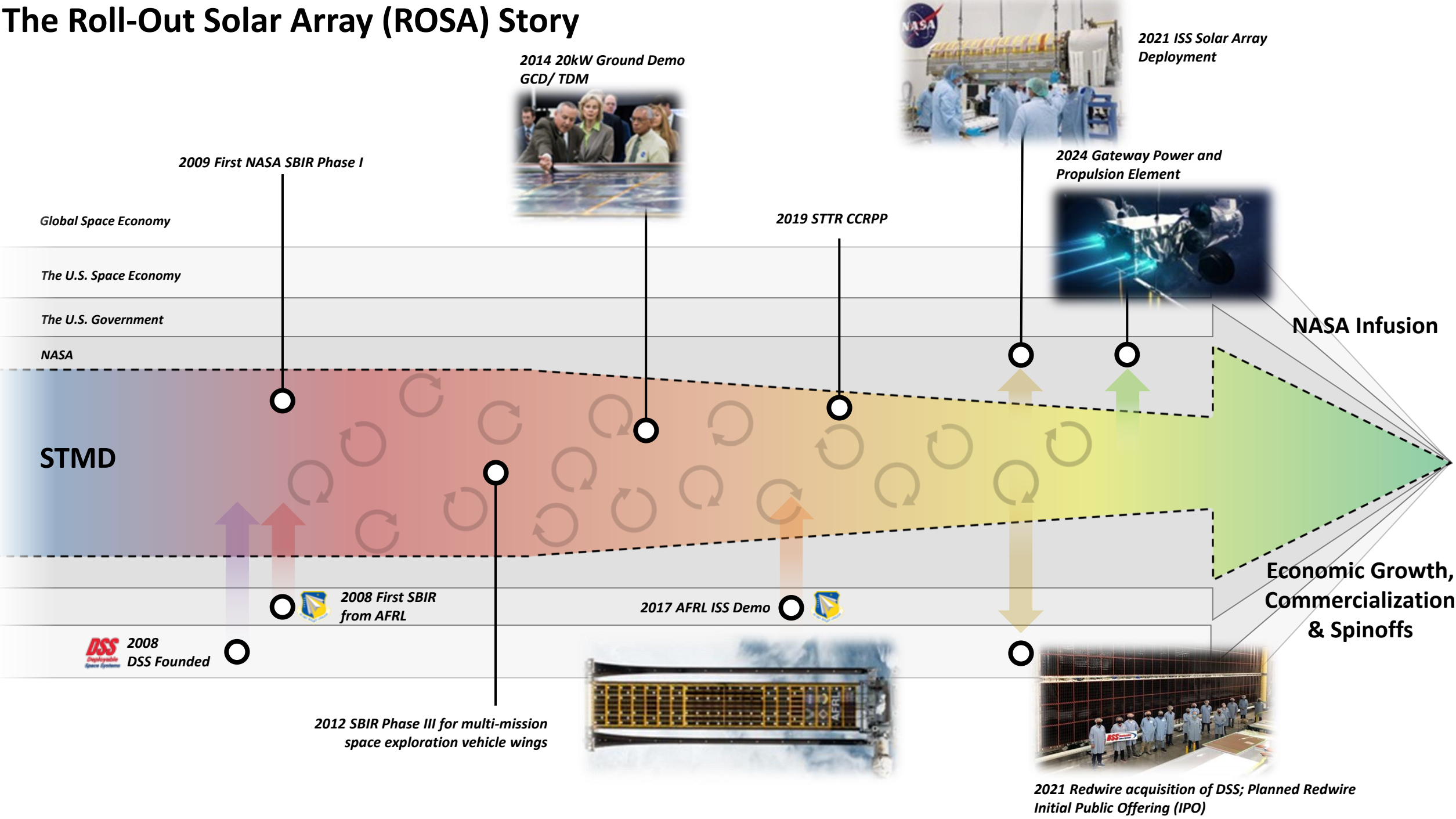
NASA Space Technology Mission Directorate

Director, Early Stage Innovations and Partnerships

NASA STMD ensures American global leadership in space technology

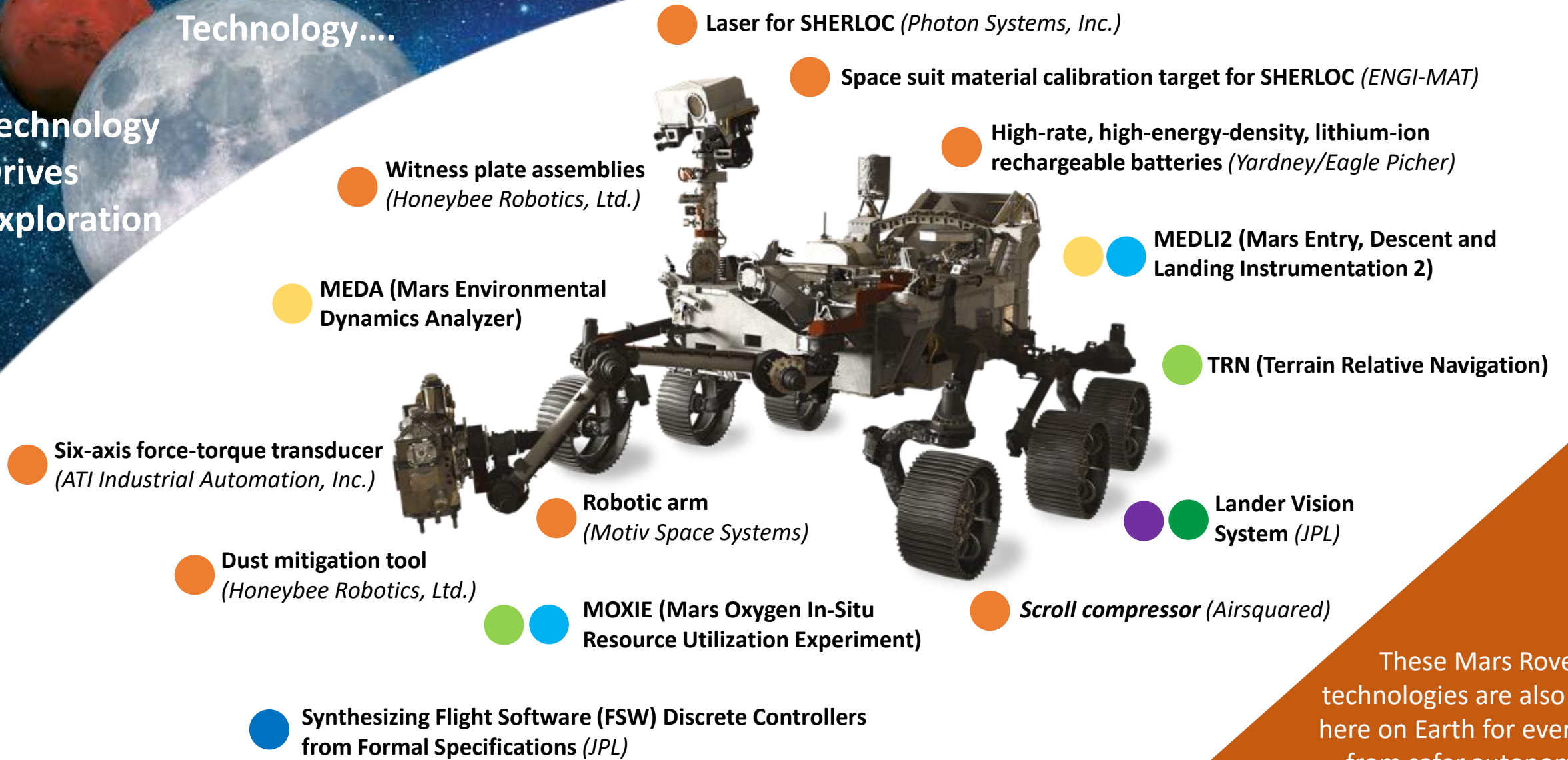


The Roll-Out Solar Array (ROSA) Story



Innovation Drives Technology....

Technology Drives Exploration



These Mars Rover technologies are also useful here on Earth for everything from safer autonomous vehicles to helper robots in hospitals. To learn more, visit spinoff.nasa.gov.

SPACE TECHNOLOGY PORTFOLIO

EARLY STAGE INNOVATION

- NASA Innovative Advanced Concepts
- Space Tech Research Grants
- Center Innovation Fund/ Early Career Initiative

PARTNERSHIPS AND TECHNOLOGY TRANSFER

- Technology Transfer
- Prizes and Challenges
- iTech

SBIR/STTR PROGRAMS

- Small Business Innovation Research
- Small Business Technology Transfer

TECHNOLOGY MATURATION

- Game Changing Development
- Lunar Surface Innovation Initiative

TECHNOLOGY DEMONSTRATIONS

- Technology Demonstration Missions
- Small Spacecraft Technology
- Flight Opportunities

Technology Drives Exploration

LOW

MID

Technology Readiness Level

HIGH

Space Technology Research Grants Program

Engage Academia: *tap into spectrum of academic researchers, from graduate students to senior faculty members, to examine the theoretical feasibility of ideas and approaches that are critical to making science, space travel, and exploration more effective, affordable, and sustainable.*

**NASA Space Technology
Graduate Research
Opportunities
(NSTGRO)**

**Early Career Faculty
(ECF)**

**Early Stage Innovations
(ESI)**

**Lunar Surface
Technology Research
(LuSTR) Opportunities**

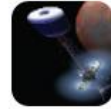
**Space Technology
Research Institutes
(STRI)**



TA01
Launch Propulsion
24 Awards



TA02
In-Space Propulsion
74 Awards



TA03
Space Power &
Energy Storage
39 Awards



TA04
Robotics &
Autonomous Systems
115 Awards



TA05
Communications, Navigation &
Orbital Debris Tracking
82 Awards



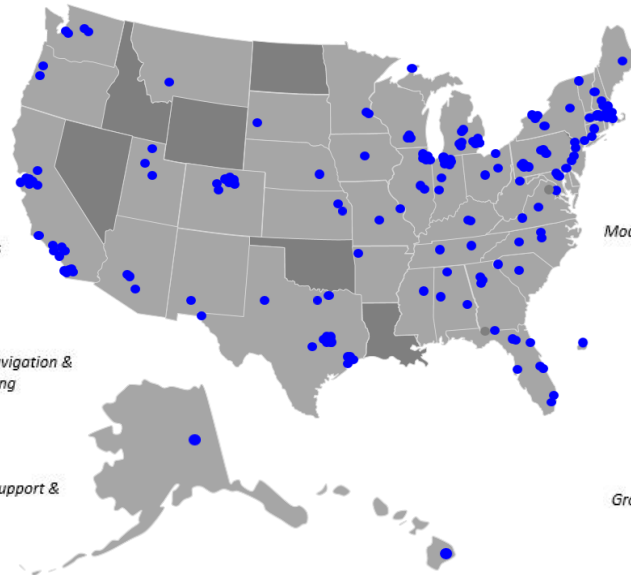
TA06
Human Health, Life Support &
Habitation
55 Awards



TA07
Human Exploration
Destination Systems
32 Awards

796 Awards 116 Universities

44 States 1 Territory (PR)



300+ Active Awards

TA08

Science Instruments,
Observatories and
Sensor Systems
90 Awards



TA09

Entry, Descent & Landing
82 Awards



TA10

Nanotechnology
40 Awards



TA11

Modeling, Simulation, IT &
Processing
33 Awards



TA12

Materials, Structures,
Mechanical Systems
& Manufacturing
98 Awards



TA13

Ground & Launch Systems
1 Award



TA14

Thermal Management
31 Awards

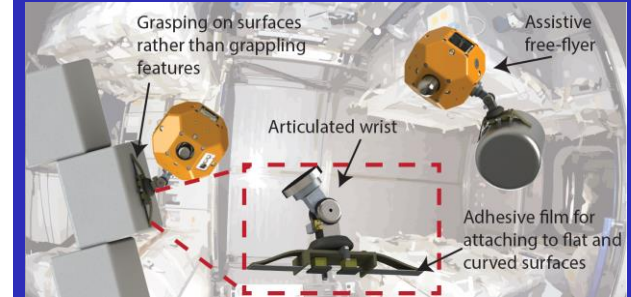
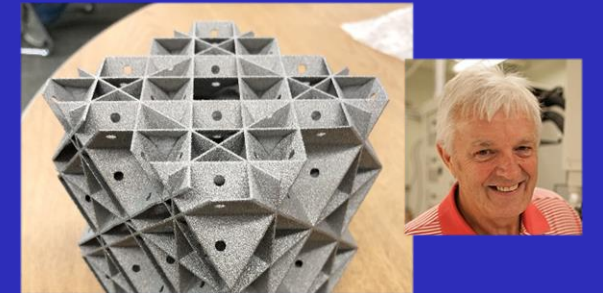


Photo Credit: <http://bdml.stanford.edu/Main/AdhesionNASA>



Biomimetics & Dexterous Manipulation Laboratory



ESI17 - Haydn Wadley/University of Virginia
Created new structural lattice materials with double the strength of currently used honeycomb sandwich structures.

STRG accelerates the development of groundbreaking high-risk/high-payoff low TRL space technologies

NASA SBIR/STTR Program

As a program under STMD, the NASA SBIR/STTR program funds the research, development, and demonstration of innovative technologies that fulfill NASA needs.



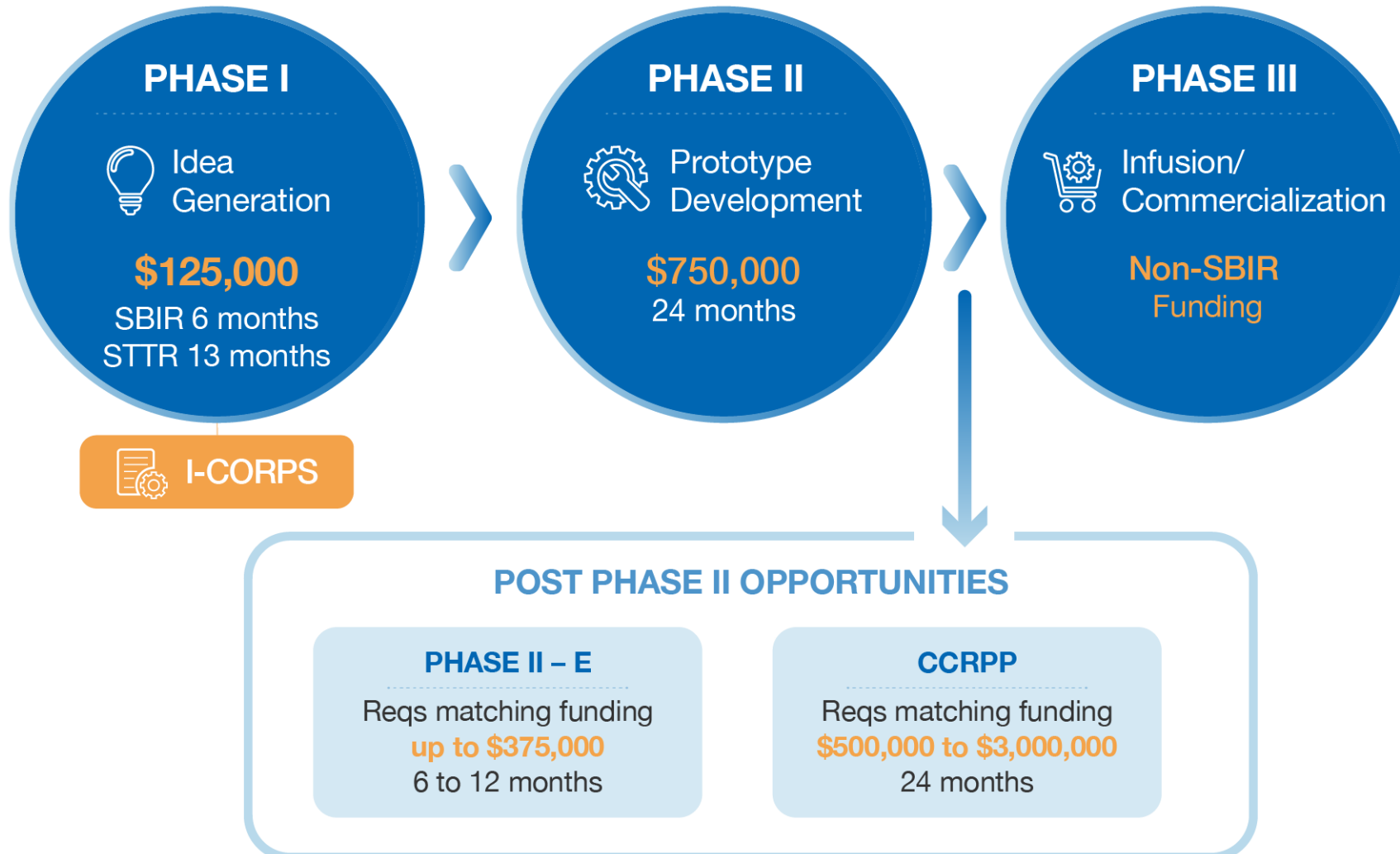
NASA's SBIR/STTR Program has **awarded more than \$3.3 billion** to research-intensive American small businesses



Engineers and scientists from **more than 12,000** small businesses in all 50 States, DC and Puerto Rico have participated

NASA SBIR/STTR Funding

NASA SBIR/STTR PHASES



Success Story | Techshot



[Read more about Techshot's success on
sbir.nasa.gov](https://sbir.nasa.gov)

3-D Bioprinter Overcomes Gravity by Printing Living Tissues in Space

POST-AWARD SUCCESS:

More than \$5 million external investment attributed to BFF, including \$2.5 million from ISS Program

SNAPSHOT:

Techshot, Inc., based in Greenville, IN, is the first U.S. company to 3-D print organic products on the International Space Station (ISS). The company's BioFabrication Facility (BFF), developed in collaboration with nScript, Inc., prints in space to overcome the effects of gravity on Earth, which cause 3-D printed tissues to disform under their own weight.

Techshot's BFF was launched to the ISS supported by the NASA SBIR/STTR program in 2019. The company has since worked with NASA and other customers, valuing BFF's external investments at more than \$5 million, including \$2.5 million from the ISS Program.

Success Story | TechShot

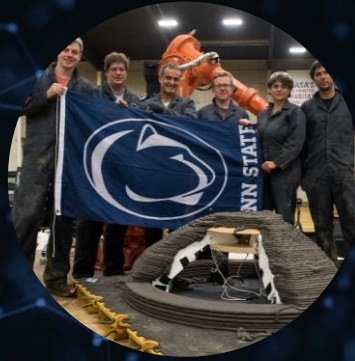


Our company has been able to provide jobs in a rural area in a non-space state, and we really tie that back to the SBIR program.

– Richard Boling VP of Corporate Advancement, Techshot



Astronaut Jessica Meir is using the BFF at the International Space Station.
Photo courtesy of Techshot



Prizes and challenges: approaching innovation differently

Complements other NASA approaches to solve technological problems, with a unique set of strengths:

- Targets solutions, not proposals; awards performance
- Increases number and diversity of participants addressing a problem



These opportunities can be accessed by the public on the NASA Solve website: **www.nasa.gov/solve**



Lunar Surface Innovation Initiative and Prizes



NASA Tournament Lab

49,776

Share

Follow (1.7K)

Honey, I Shrunk the NASA Payload

Give a tiny bot a new set of tools to explore the moon. Share your ideas for a mini payload to make lunar exploration more effective.

Government

Science

Space

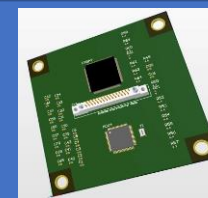
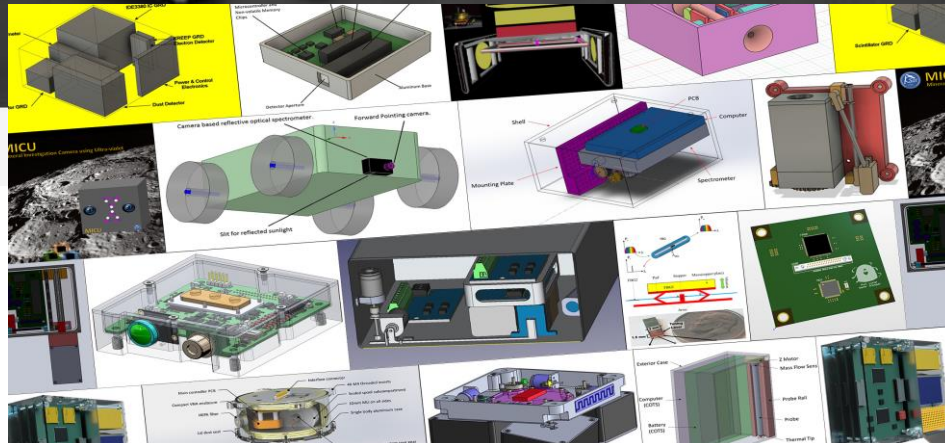
**Stage:
Judging Closed**

**Prize:
\$160,000**



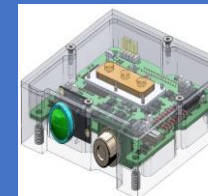
NASA Tournament Lab

14 Winners Awarded: July 14, 2020



1st Place Resources Potential

**The Puli Lunar Water
Snooper**



1st Place Lunar Environment

**Sun Slicer – Miniaturized
XRAY Spectrometer**

SUBORBITAL FLIGHT TESTING – A STEPPING STONE...

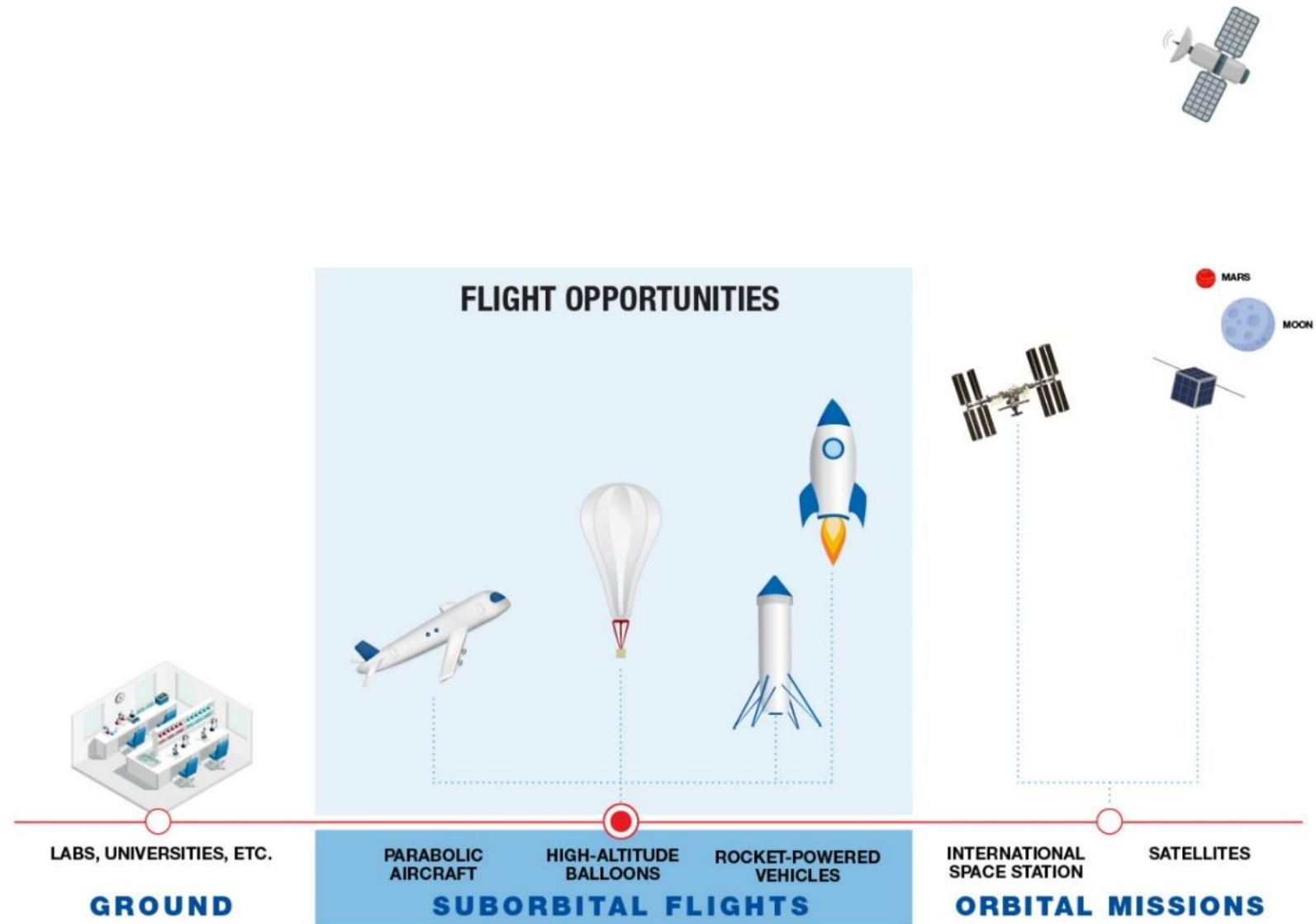
Evaluate performance in harsh conditions of space that are difficult to replicate in ground-based testing

Obtain data to increase technology readiness level (TRL) and gain more assurance of success for future missions

Refine experiments to reduce risk for orbital missions (CubeSat, International Space Station, lunar mission, etc.)

Tech Flights solicitation provides grants for suborbital testing with commercial providers.

SBIR companies with a Phase I can request suborbital testing via a Phase III or partner with Flight Opportunities on a Phase II-E/X



FLIGHT OPPORTUNITIES SUBORBITAL TECHNOLOGY FLIGHT TESTING

BETWEEN 2011 AND THE END OF FY2020, FLIGHT OPPORTUNITIES...

- Supported **196** successful flights
- Enabled **692** tests of payloads
- **268** technologies in the portfolio
- **12** active commercial providers

FLIGHT PARTNERS:



BLUE ORIGIN

Masten



R A V E N

NSC



STRATODYNAMICS

BlackSky
Aerospace



Photo Credit: Virgin Galactic

PlanetVac

Honeybee Robotics

What It Is

This pneumatic device attaches to the leg of a lander vehicle and enables fast, simple, and reliable collection of regolith for analysis.

Why It Matters

The technology addresses one of the most difficult and important tasks for planetary exploration: collection of surface samples on the Moon, planets, asteroids, and other celestial bodies.

Transition Outcomes

Selected in 2019 as a payload that will be used on a lander being developed under NASA's Commercial Lunar Payload Services contracts and infused into a JAXA MMX mission, where it will capture regolith from the surface of Phobos.

FLIGHT TEST MILESTONES

- Tested in the Mojave Desert in a simulated landing, performing exactly as planned
- Successfully collected more than 300 grams of simulated regolith
- Established device's ability to quickly and efficiently collect samples

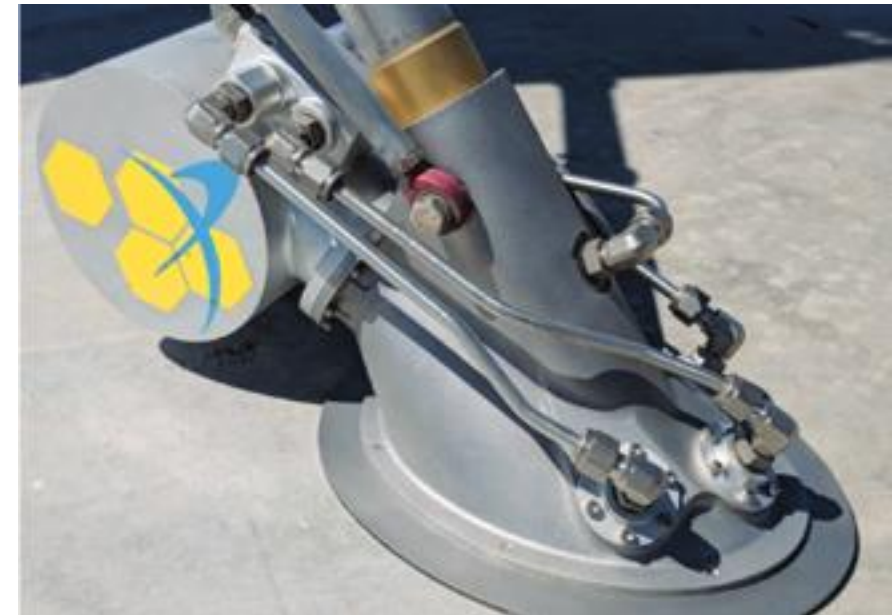


Photo credit: Honeybee Robotics

FLIGHT PROVIDER

- Masten Space Systems

Vibration Isolation Platform

Controlled Dynamics

What It Is

The vibration isolation platform is a payload mounting interface that includes active stabilization and 6-degree-of-freedom, non-contact isolation for suborbital and orbital flights. It allows a payload to be undisturbed and float freely in the sway space of the platform.

Why It Matters

By isolating experiments from disturbances of the crew, host vehicle, or other experiments—reducing the ambient flight environment by more than two orders of magnitude—the vibration isolation platform provides greater and more economical access to high-quality microgravity.

Transition Outcomes

Controlled Dynamics was awarded several SBIR awards, which led to selection of the vibration isolation platform for NASA's Deep Space Optical Communications (DSOC) platform. DSOC is scheduled to launch in 2022 aboard NASA's Psyche asteroid mission.

FLIGHT TEST MILESTONES

- Demonstrated robustness with sensitivity studies
- Demonstrated performance through simulation
- Demonstrated high-performance vibration isolation capabilities in freefall



Photo credit: Controlled Dynamics

FLIGHT PROVIDERS

- UP Aerospace
- Blue Origin
- Virgin Galactic

STMD Enabling Technology Innovation on ISS

The International Space Station enables critical technology development necessary for testing in a realistic space & operational environment

- ❖ ISS serves as a key interface to space and operational environment testing of specific technology development experiments
 - Reduces the risk associated with requiring fully operational system to test a single experiment
 - Provides critical capability for human and robotic space exploration beyond Low Earth Orbit (LEO)
- ❖ Key technologies requiring these environments include fluid transfer, autonomy, in-space manufacturing and assembly, biologicals, materials, food production, and ECLSS
- ❖ Flight Opportunities funds sub-orbital testing in order to validate testing and/or hardware prior to ISS flight.

Space Environment Testing

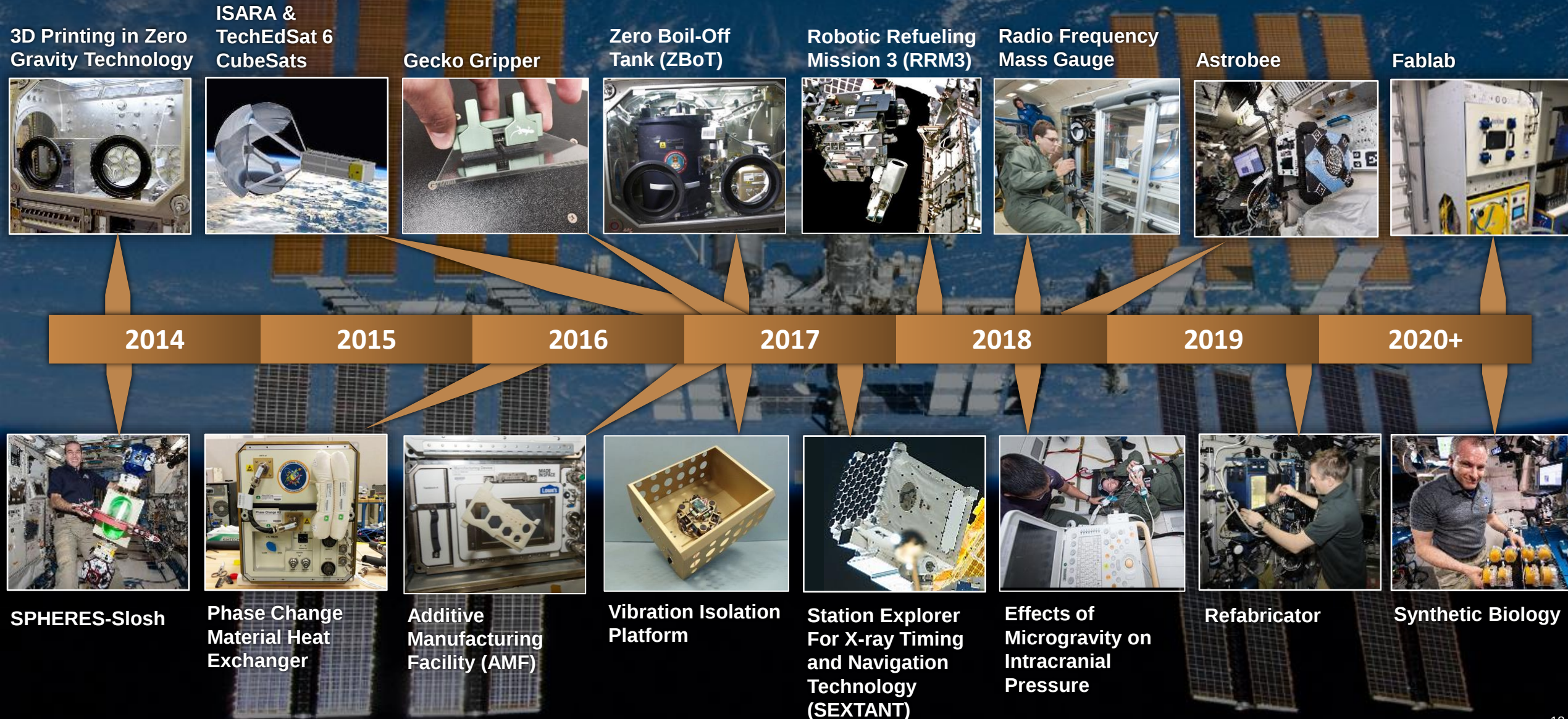
- Microgravity
- Thermal
- Vacuum
- LEO radiation
- Solar Heating



Operational Environment Testing:

- EVA
- Robotics
- Shirt Sleeve
- ISS Operational Systems
- Biological

STMD Technologies on ISS



- Utilize commercial end-to-end delivery services to enable access to the lunar surface.
- CLPS Providers are required to “accommodate” the needs of the payloads.
- Sponsored (programmatic and funding) by the Science Mission Directorate in support of NASA’s science, human exploration and technology goals.
- NASA wants to be a marginal customer, one of many payload providers. NASA does not intend to manage or direct these commercial missions.
- Master contract awarded to vendors to safely integrate, accommodate, transport, and deliver NASA payloads using contractor-provided assets, including launch vehicles, lunar lander spacecraft, lunar surface systems, and associated resources.



Deliveries to the Lunar Surface



- Payloads and Research Investigations from the Surface of the Moon (PRISM)
 - PRISM is SMD's primary method of soliciting payloads for delivery to the Moon via CLPS
 - Solicitations will typically state the location for each delivery, allowing PIs to propose scientific investigations optimized for those locations
 - High-value 'location agnostic' and campaign investigations will be the focus of a future PRISM call
 - PRISM instruments will feed the manifests for Task Orders for deliveries from late 2023 onwards
 - Can be expanded to include orbital payloads
 - Payloads from international partners and other NASA mission directorates may also be identified in a PRISM call to reduce redundancies in proposed science
 - International contributions to PRISM investigations may be included at up to 30% the total cost of the investigation
- Other Mission Directorates may use PRISM, or their own solicitations (e.g. such as STMD's Tipping Points, LuSTR, SBIR sequentials, Challenges, NIAC Ph. III's, etc.) / directed work to identify payloads to fly on CLPS.
- Each CLPS delivery will be a mixture of Science, Technology, and exploration related payloads
- International contributions are accepted on an Agency to Agency basis, or int'l partners can go directly to a CLPS vendor to fly their payloads without partnering with NASA.

LEARN MORE: [WWW.NASA.GOV/TECHNOLOGY](https://www.nasa.gov/technology)

