Technology, Innovation & Engineering Committee Meeting

Mr. James Reuter | Associate Administrator, Space Technology Mission Directorate | December 14, 2021

SPACE TECHNOLOGY PORTFOLIO

EARLY STAGE INNOVATION AND PARTNERSHIPS

- Early Stage Innovation
  - Space Tech Research Grants
  - Center Innovation Fund
  - Early Career Initiative
  - Prizes, Challenges & Crowdsourcing
  - NASA Innovation Advanced Concepts
- Technology Transfer

SBIR/STTR PROGRAMS

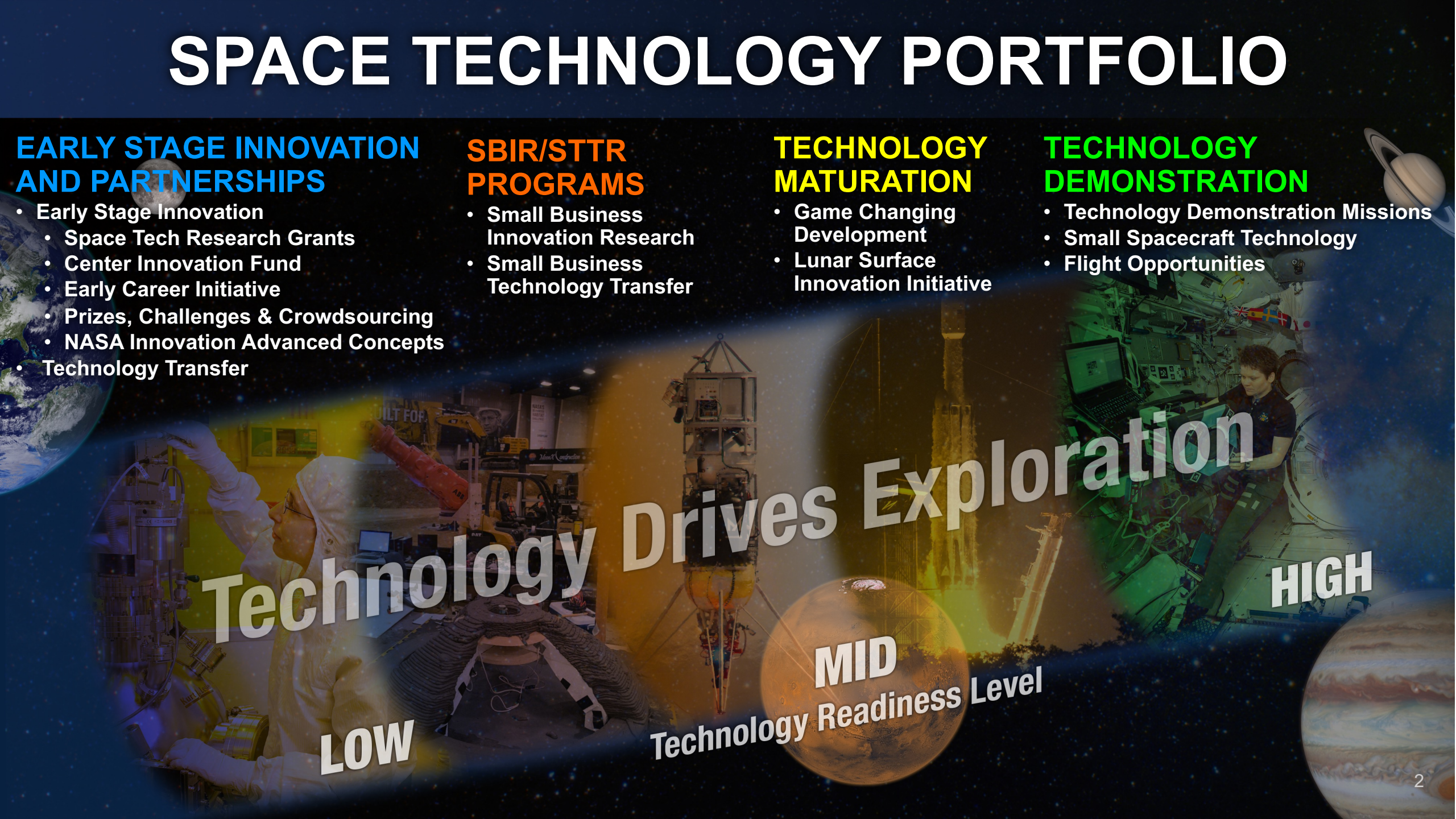
- Small Business Innovation Research
- Small Business Technology Transfer

TECHNOLOGY MATURATION

- Game Changing Development
- Lunar Surface Innovation Initiative

TECHNOLOGY DEMONSTRATION

- Technology Demonstration Missions
- Small Spacecraft Technology
- Flight Opportunities



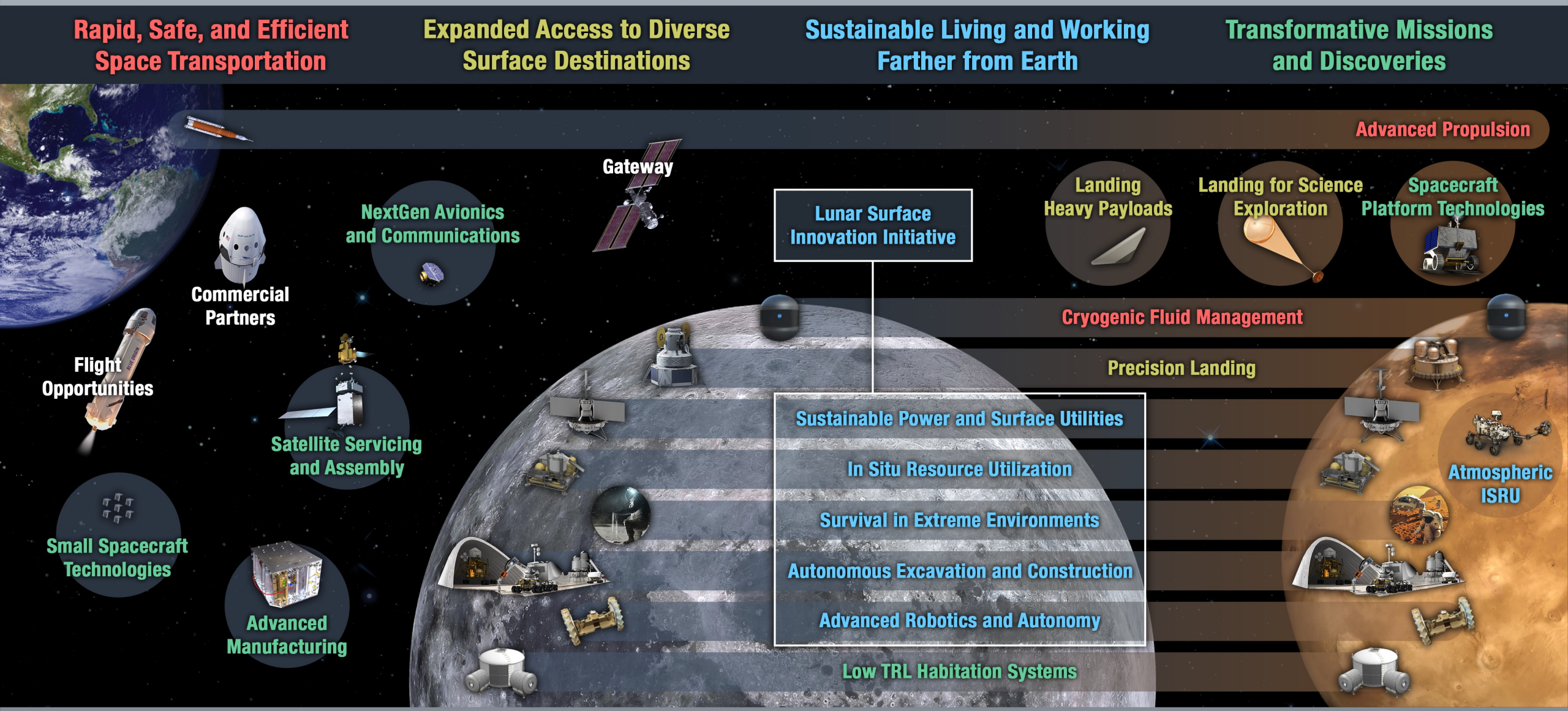
Strategic Technology Framework

Lead	Thrusts	Outcomes	Primary Capabilities
Ensuring American global leadership in Space Technology • Advance US space technology innovation and competitiveness in a global context • Encourage technology driven economic growth with an emphasis on the expanding space economy • Inspire and develop a diverse and powerful US aerospace technology community	 **Go** Rapid, Safe, and Efficient Space Transportation	• Develop nuclear technologies enabling fast in-space transits. • Develop cryogenic storage, transport, and fluid management technologies for surface and in-space applications. • Develop advanced propulsion technologies that enable future science/exploration missions.	• Nuclear Systems • Cryogenic Fluid Management • Advanced Propulsion
	 **Land** Expanded Access to Diverse Surface Destinations	• Enable Lunar/Mars global access with ~20t payloads to support human missions. • Enable science missions entering/transiting planetary atmospheres and landing on planetary bodies. • Develop technologies to land payloads within 50 meters accuracy and avoid landing hazards.	• Entry, Descent, Landing, & Precision Landing

	
	Live
	Sustainable Living and Working Farther from Earth
		• Develop exploration technologies and enable a vibrant space economy with supporting utilities and commodities
		  • Sustainable power sources and other surface utilities to enable continuous lunar and Mars surface operations.
		  • Scalable ISRU production/utilization capabilities including sustainable commodities on the lunar & Mars surface.
		  • Technologies that enable surviving the extreme lunar and Mars environments.
		  • Autonomous excavation, construction & outfitting capabilities targeting landing pads/structures/habitable buildings utilizing in situ resources.
		• Enable long duration human exploration missions with Advanced Habitation System technologies. [Low TRL STMD; Mid-High TRL SOMD/ESDMD]
			• Advanced Power
			• In-Situ Resource Utilization
			• Advanced Thermal
			• Advanced Materials, Structures, & Construction
			• Advanced Habitation Systems

	 **Explore** Transformative Missions and Discoveries	• Develop next generation high performance computing, communications, and navigation. • Develop advanced robotics and spacecraft autonomy technologies to enable and augment science/exploration missions. • Develop technologies supporting emerging space industries including: Satellite Servicing & Assembly, In Space/Surface Manufacturing, and Small Spacecraft technologies. • Develop vehicle platform technologies supporting new discoveries. • Develop technologies for science instrumentation supporting new discoveries. [Low TRL STMD/Mid-High TRL SMD. SMD funds mission specific instrumentation (TRL 1-9)] • Develop transformative technologies that enable future NASA or commercial missions and discoveries	• Advanced Avionics Systems • Advanced Communications & Navigation • Advanced Robotics • Autonomous Systems • Satellite Servicing & Assembly • Advanced Manufacturing • Small Spacecraft • Rendezvous, Proximity Operations & Capture • Sensor & Instrumentation

Ensuring American Global Leadership in Space Technology



Technology Drives Exploration

STMD FY 2022 Budget Summary ($M)	FY 2021	FY 2022 PBR	House $1,280.0	FY 2023	FY 2024	FY 2025	FY 2026
	1,100.0	1,425.0	Senate $1,250.0	1,454.5	1,486.4	1,519.2	1,552.9
SBIR and STTR	**227.0**	**287.0**		**292.7**	**298.6**	**304.6**	**310.7**
Early Stage Innovation and Partnerships	**117.5**	**145.0**		**147.9**	**150.8**	**153.9**	**157.0**
Agency Technology and Innovation	**8.4**	**9.4**		**9.6**	**9.8**	**10.0**	**10.2**
Technology Transfer	**19.9**	**20.0**		**20.4**	**20.8**	**21.2**	**21.6**
Early Stage Innovation	**89.2**	**115.6**		**117.9**	**120.2**	**122.7**	**125.2**
Center Innovations Fund (CIF) / Early Career Initiative (ECI)	24.4	28.0		28.6	29.0	29.7	30.3
NASA Innovative Advanced Concepts (NIAC)	8.4	9.5		9.7	9.9	10.1	10.3
Space Technology Research Grants (STRG)	47.9	61.1		62.3	63.5	64.8	66.1
Prizes & Challenges (P&C)	8.6	17.0		17.3	17.7	18.0	18.4
Technology Maturation / Game Changing Development (GCD)	**227.1**	**491.2**		**501.0**	**511.1**	**521.3**	**531.7**
Rapid, Safe, & Efficient Space Transportation	11.0	44.0		33.8	26.6	12.0	12.0
Expanded Access to Diverse Surface Destinations	43.9	43.8		43.2	45.8	26.0	25.7
Sustainable Living and Working Farther from Earth	110.3	199.5		187.8	188.3	237.1	250.0
Transformative Missions and Discoveries	36.7	85.3		60.2	67.9	49.0	28.0
Industry and Commerce Innovation Opportunity	-	85.6		142.4	148.4	162.7	180.9
Tech Management & Integration	25.1	33.1		33.6	34.1	34.6	35.1
Technology Demonstration	**528.4**	**501.8**		**512.9**	**525.9**	**539.4**	**553.5**
Technology Demonstration Mission (TDM)	**461.2**	**430.6**		**440.3**	**451.9**	**463.9**	**476.5**
Cryogenic Fluid Management (CFM)	60.1	82.0		122.1	103.5	125.7	136.4
Space Nuclear Technologies (SNT)	57.9	34.0		34.1	87.2	186.7	258.3
Nuclear Fission Surface Power	*8.0*	*34.0*		*34.1*	*87.2*	*186.7*	*258.3*
Nuclear Thermal Propulsion	*49.9*		*110.0*				
OSAM-1 (Restore & SPIDER)	227.0	227.0	227.0	227.0	227.0	103.6	25.4
OSAM-2 (Archinaut)	17.7	16.1		16.5	-	-	-
Solar Electric Propulsion (SEP)	26.2	24.2		18.5	15.9	17.8	5.8
Low-Earth Orbit Flight Test of an Inflatable Dec (LOFTID)	20.4	13.0		2.4	-	-	-
Deep Space Optical Comm (DSOC)	16.4	6.2		2.0	0.1	-	-
LCRD, MOXIE, DSAC, TDM Management & Integration	35.6	28.1		17.8	18.2	30.1	50.6
Small Spacecraft Technology (SST)	**40.2**	**46.2**		**47.6**	**49.0**	**50.5**	**52.0**
Flight Opportunities (FO)	**27.0**	**25.0**		**25.0**	**25.0**	**25.0**	**25.0**

Lunar Surface Innovation Initiative (LSII)

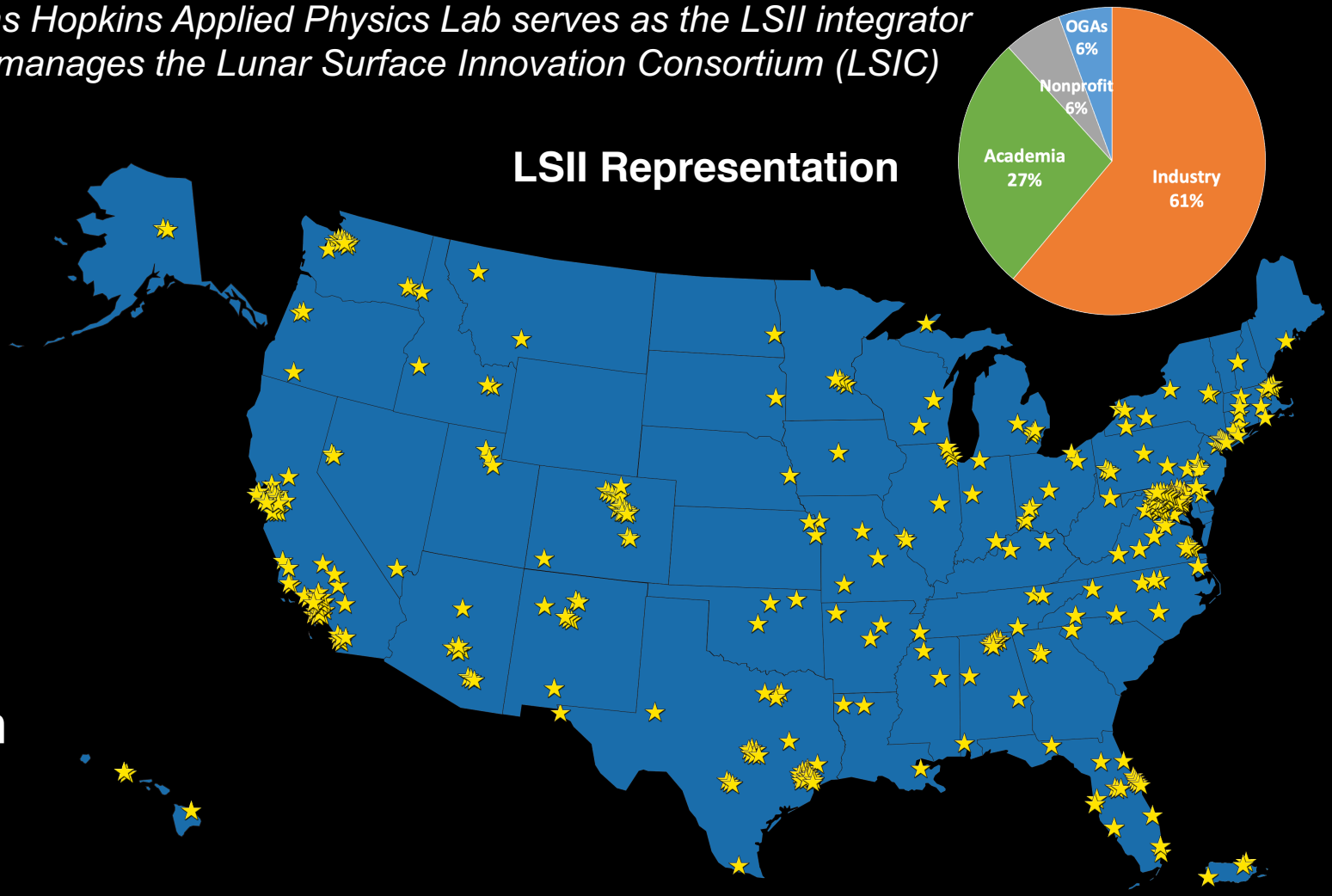
LSII engages ~500 organizations across 4**9** states and Puerto Rico to advance technologies needed to explore the lunar surface and stimulate economic development.

Johns Hopkins Applied Physics Lab serves as the LSII integrator and manages the Lunar Surface Innovation Consortium (LSIC)

Technology Focus Areas

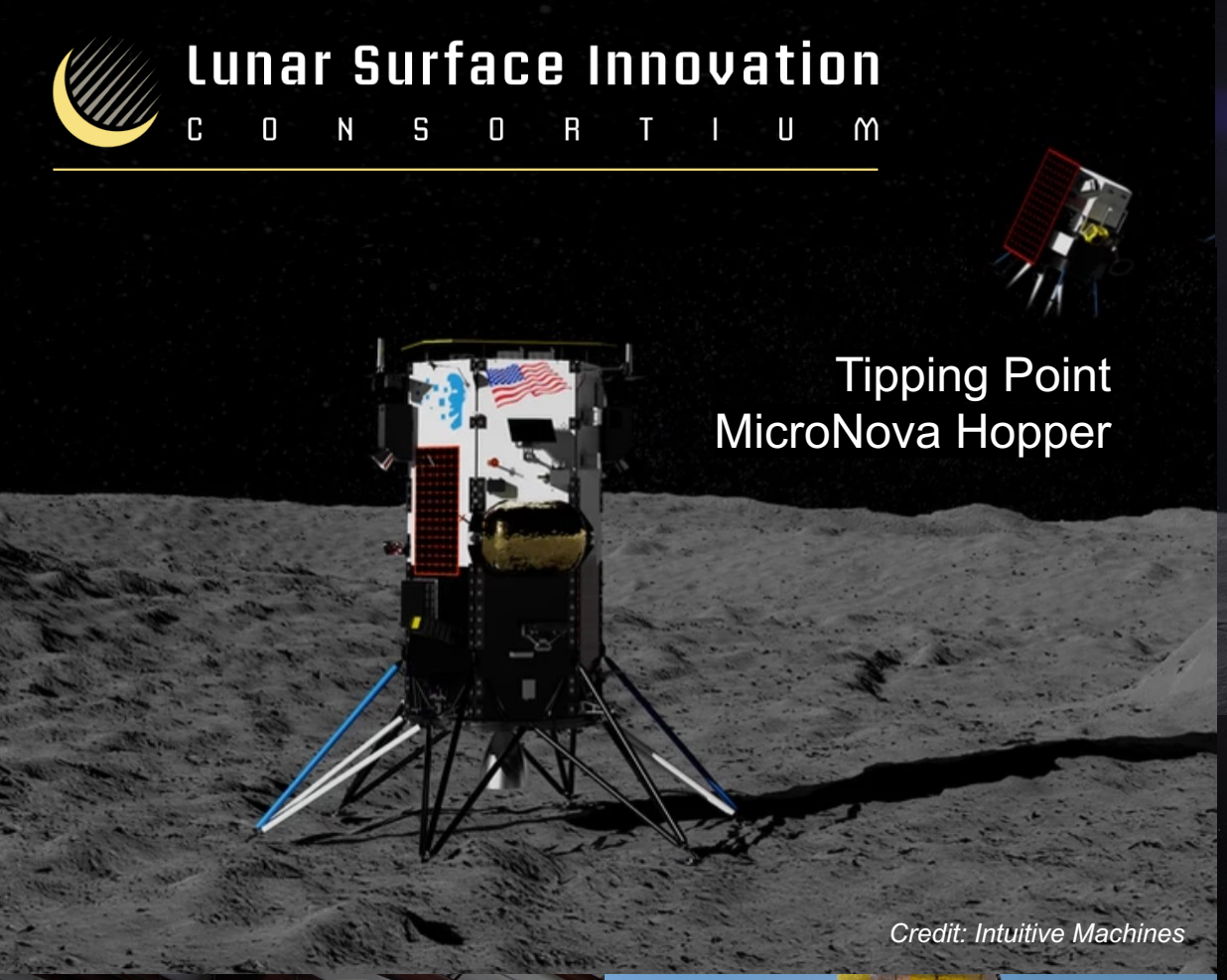
- In-situ resource utilization
- Surface power
- Dust mitigation
- Extreme environment
- Extreme access
- Excavation and construction

LSII Representation



lsic.jhuapl.edu

Lunar Surface Innovation
CONSORTIUM



Tipping Point
MicroNova Hopper

Credit: Intuitive Machines

Vertical Solar Array
Technologies

Excavation &
Construction

Credit: ICON

Landing Technologies

Credit: Blue Origin

Credit: Masten Space Systems

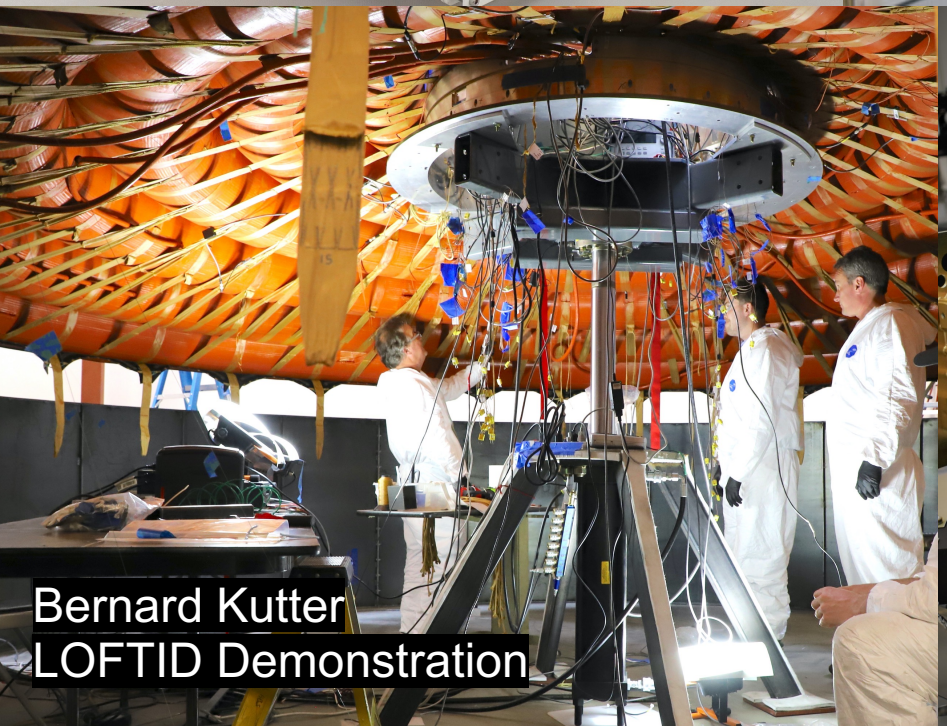
Polar Resources Ice
Mining Experiment

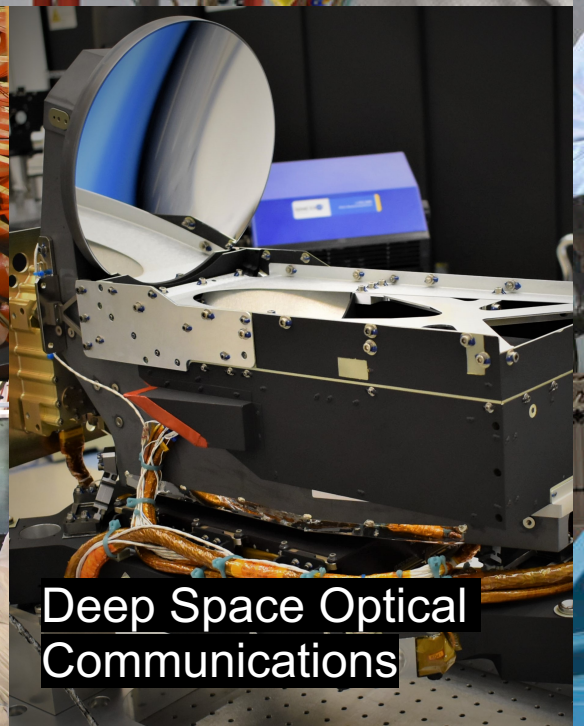
PRIME-1


CAPSTONE
CubeSat


Deep Space Atomic Clock


Laser Communications
Relay Demonstration
LCRD


Bernard Kutter
LOFTID Demonstration


Deep Space Optical
Communications

Flight Opportunities

Since 2011*

- 230 successful flights
- 778 payload tests
- 336 total technologies in portfolio


Credit: Blue Origin


Credit: Masten Space Systems

Testing Landing Technologies

* As of September 30, 2021

FY2021 Activity*

Provider	Flights	Payload Tests
High-Altitude Balloons		
AM0CAL	1	1
Near Space Corp.	1	1
Raven Aerostar	4	4
Stratodynamics	3	3
World View		
Parabolic Flights		
Zero Gravity Corp.	14	43
Rocket-Powered Vehicles		
Blue Origin	2	15
Masten Space Systems	4	12
UP Aerospace	1	1
Virgin Galactic	2	4
TOTALS	**32**	**84**

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NASA
TECHRISE
STUDENT CHALLENGE