Update on SLPSRA Activities

National Aeronautics and Space Administration

Committee on Biological and Physical Sciences in Space
Washington, DC

Craig Kundrot
Space Life and Physical Sciences
Research and Applications Division
Human Exploration & Operations Mission Directorate

26 March 2019

Outline

- **Update on SLPSRA Roles and Responsibilities**
- **Program Status**
- **Status of ISS Transition Planning**
- **Update on Research Planning for Gateway and Lunar Surface**

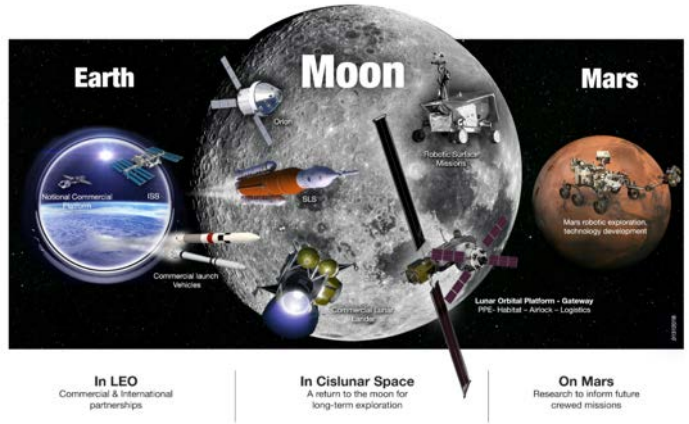
SLPSRA Strategic Framework Has Not Changed

Vision

We lead the space life and physical sciences research community to enable space exploration and benefit life on Earth

Mission

1. Enable exploration (EE)
2. Pioneer scientific discovery (PSD)

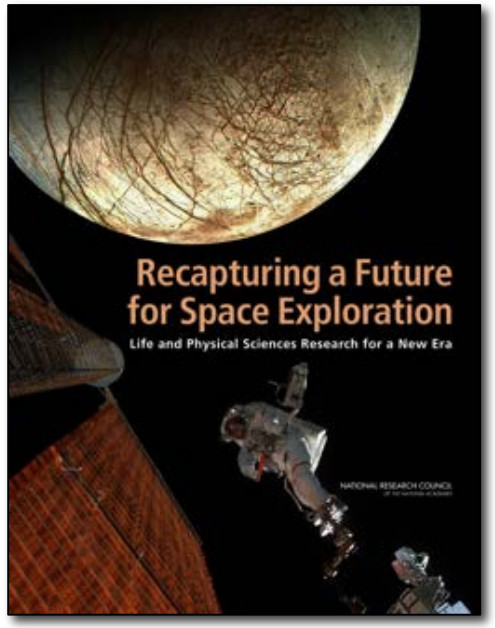


Goals

1. EE in response to pull
2. EE by providing push
3. PSD by refining use of all platforms
4. PSD by helping others utilize space
5. Maintain key capabilities

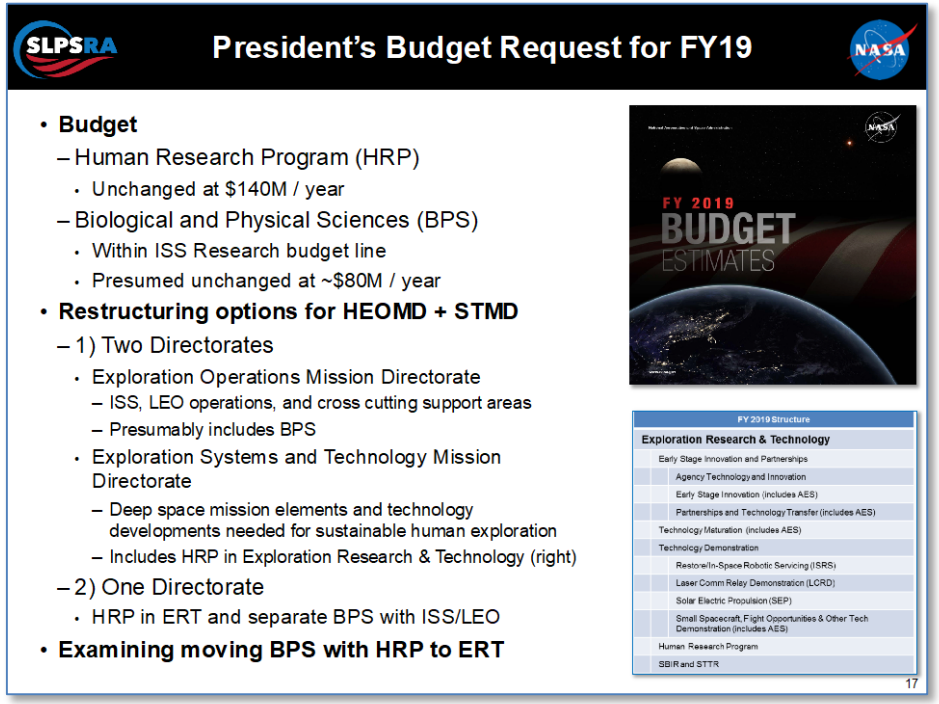
Implementation Principles

1. Ensure Scientific Integrity
2. Maximize Open Science
3. Cultivate Partnerships
4. Use Stepping Stones
5. Be an Early Adopter
6. Share Methods and Results

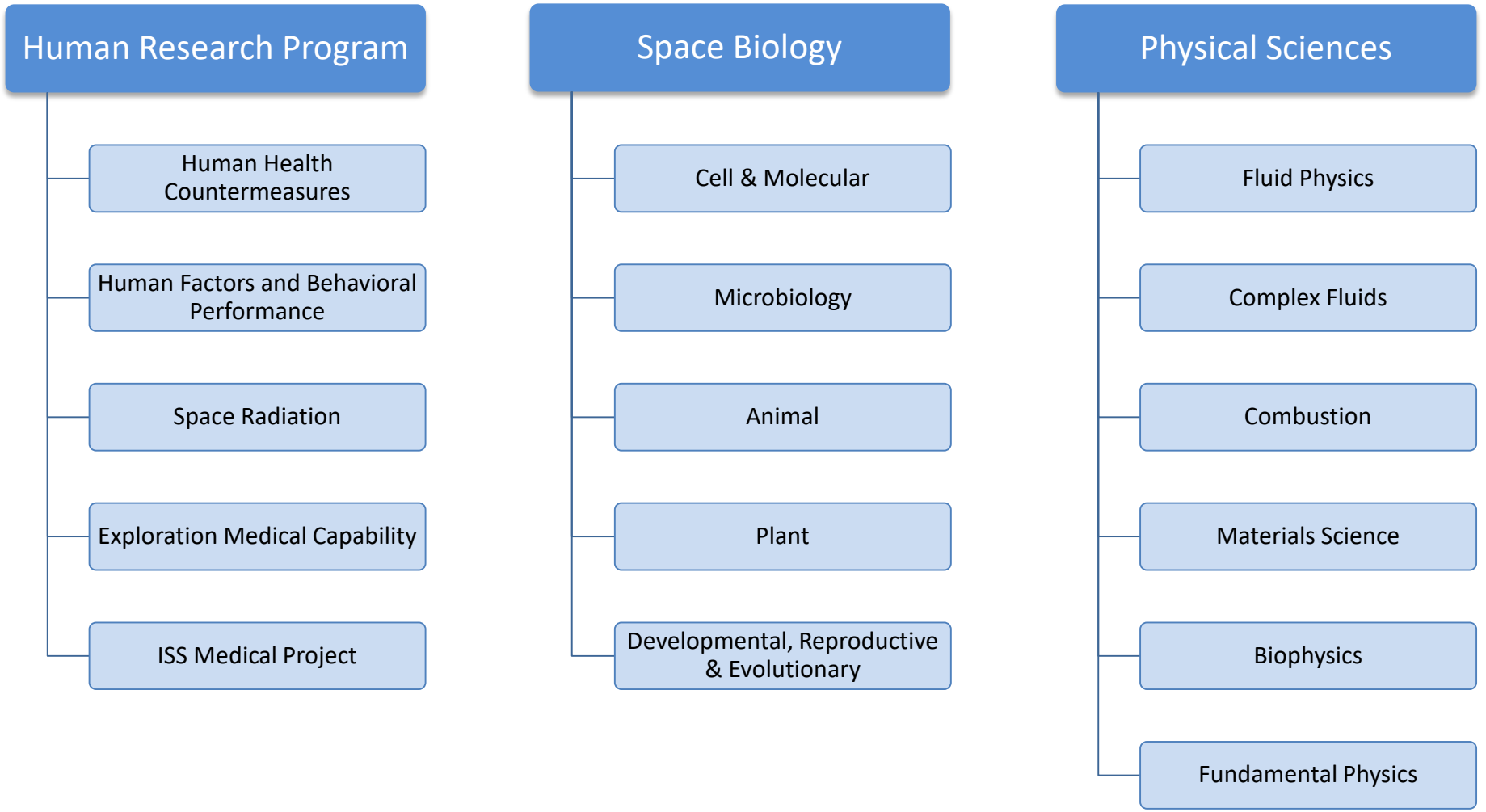


No Re-Organization (Yet)

- **2018**
  - President's Budget Request for FY19 discussed re-organization
  - Not implemented
- **Today**
  - President's Budget Request for FY20
    - "NASA continues to assess the proper organizational structure to manage the Exploration Campaign and intends to notify the Congress in FY 2019 if any reorganization is necessary"
  - SLPSRA interfaces to other NASA organizations may change



Space Life and Physical Sciences Research and Applications Division



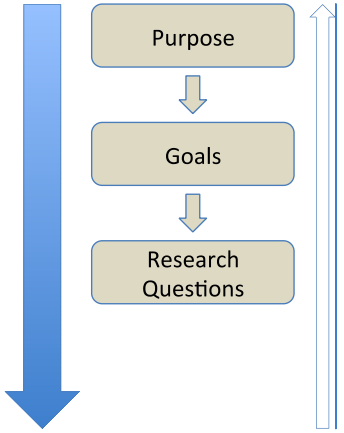
NASA Capability Leadership Model

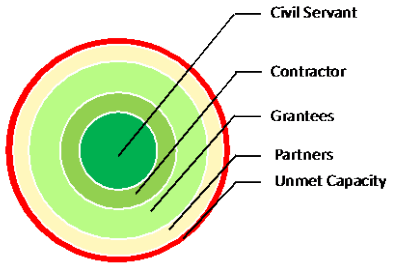
- **Started 2012**
- **Purpose: Close the gap between Agency plans and Agency resources**
  - Reduce duplication and therefore costs
  - Move resources from low priority to high priority activities
  - Capability Leadership Teams
    - ~20 Engineering Disciplines
    - ~7 Engineering Systems (e.g., In Situ Resource Utilization)
    - 5 Research (Heliophysics, Earth, Planetary, Astrophysics, **Life Sciences**)
    - ~6 Other
- **Capability Leadership Team functions**
  - Advises Agency and ensures proper alignment across Missions and Centers
  - Establishes plans/roadmaps to provide technical guidance to the Agency
  - Determine gap areas for advancement and strategic investment
  - *Advises on capability sizing and strategic hiring, including contracting, across all Centers*
  - Determines investments and divestments within capability scope, including advising Centers on assets
  - Solicits innovative ideas from outside the capability area
  - Establishes standards and specifications within capability scope

Life Sciences Research Capability Team

- **Established 2015**
- **Vision**
  - NASA has a clear understanding of its life science research capability needs and is executing a plan to meet those needs now and over the next 30 years
  - The plan makes extensive use of resources inside and outside of NASA and can be readily modified as circumstances change (e.g., technical advances, exploration goals)
  - The life sciences organizations have a sense of common identity and high level of coordination and collaboration in areas of common interest
- **Programs**
  - HEOMD: Human Research Program & Space Biology
  - SMD: Astrobiology and Planetary Protection

- **Studying how to incorporate Physical Sciences disciplines into the Capability Leadership Model**





Use multiple sources to obtain capability

Distinguish these levels of capability within NASA:
1. NASA LEADs field X
2. NASA knows HOW to do X
3. NASA knows ABOUT X
4. NASA knows WHO knows X

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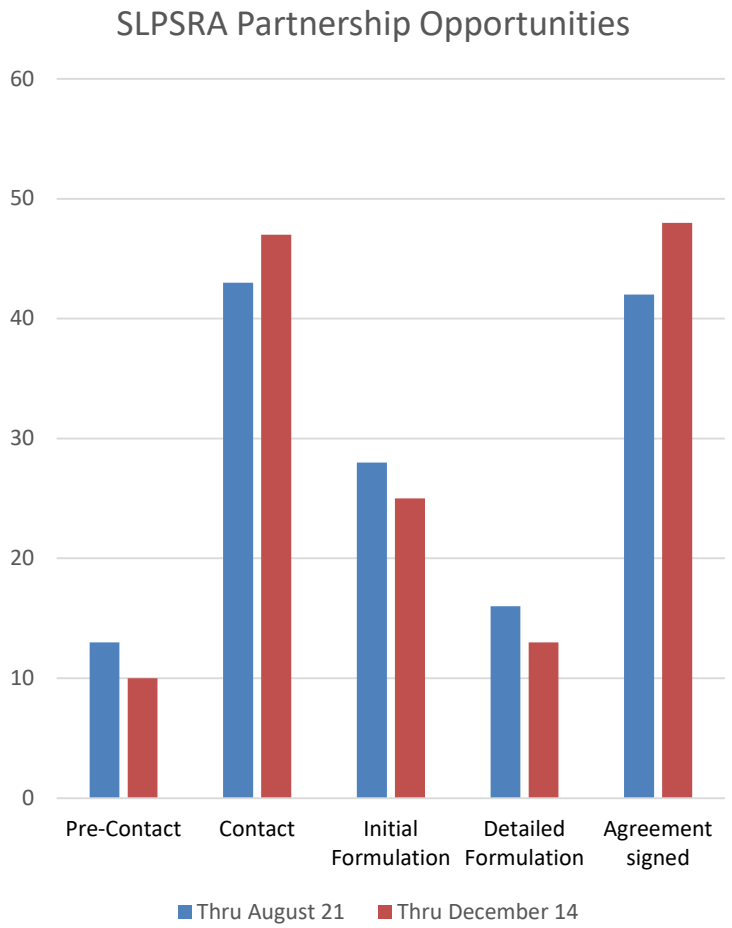
Tasks and Research Community

Program	Tasks	PIs	Co-Is	Post Docs	PhD students	Masters students	Bachelor students
Human Research Program	~~188~~ 192	~~156~~ 156	~~565~~ 625	~~74~~ 84	~~120~~ 144	~~35~~ 62	~~64~~ 113
Space Biology	~~77~~ 97	~~66~~ 80	~~142~~ 158	~~44~~ 50	~~50~~ 49	~~27~~ 24	~~132~~ 126
Physical Sciences	~~99~~ 103	~~92~~ 93	~~143~~ 136	~~48~~ 51	~~113~~ 138	~~27~~ 30	~~56~~ 62
Total	~~364~~ 392	~~314~~ 329	~~850~~ 919	~~166~~ 185	~~283~~ 331	~~89~~ 116	~~252~~ 301
							~~1,954~~ 2,181

Changes with respect to last year

https://taskbook.nasaprs.com/Publication/index.cfm

Cultivating Partnerships



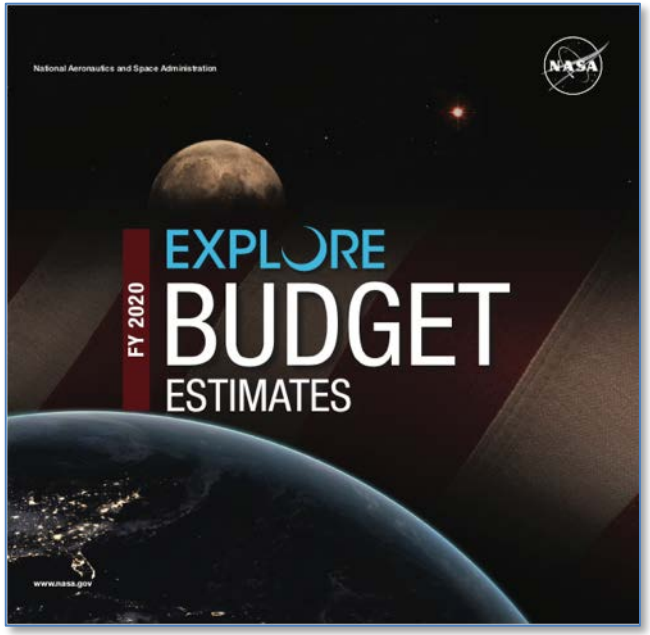
Note: Numbers above reflect progress on partnerships and increased capture of previous partnership activity

- Initial meetings with Department of Health and Human Services
  - Site visit to Administration for Community Living
  - WebEx meeting with Office of Global Affairs
  - Site visits to the FDA and CDC planned for mid 2019
- Workshops
  - NASA-NIH Workshop held before ASGSR conference. 170 attendees from NASA, NIH, academics
  - Hosted an Interagency “State-of-the-Science: 3D Tissues and Microphysiological Systems” meeting co-organized with NCATS. 60 attendees from DTRA, BARDA, DARPA, NSF, NIAID, NCATS, NHLBI, NIBIB, NCI, HHS, FDA, TRISH, NIDA, NIDDK, CASIS with presentations by academic experts
- Coordinated two joint meetings with USDA, DTRA and CASIS re controlled environment agriculture
  - Annex to the NASA/USDA IAA being drafted
- Signed
  - MOU with Food and Drug Administration (FDA) enabled HRP to receive proprietary data on drug shelf life
  - TU with JAXA to utilize ELF for thermophysical measurements
  - MOA with AES to collaborate on Astro Garden ISS Tech Demonstration
  - SAA with Mayo Clinic for radiation studies of cryopreserved mammalian cells on ISS

President’s Budget Request

- **Human Research Program (HRP)**
  - Unchanged at $140M / year

- **Biological and Physical Sciences (BPS)**
  - Within ISS Research budget line
  - Unchanged at ~$80M / year
    - FY20 budget includes an additional $5 million for Biological and Physical Sciences,
      - which will support additional research grant awards,
        - » increasing ISS utilization and
        - » expanding the fundamental knowledge base which
      - supports NASA's human spaceflight and
      - Low Earth Orbit commercialization activities.



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The US Space Policy Directive-1

“Lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities.

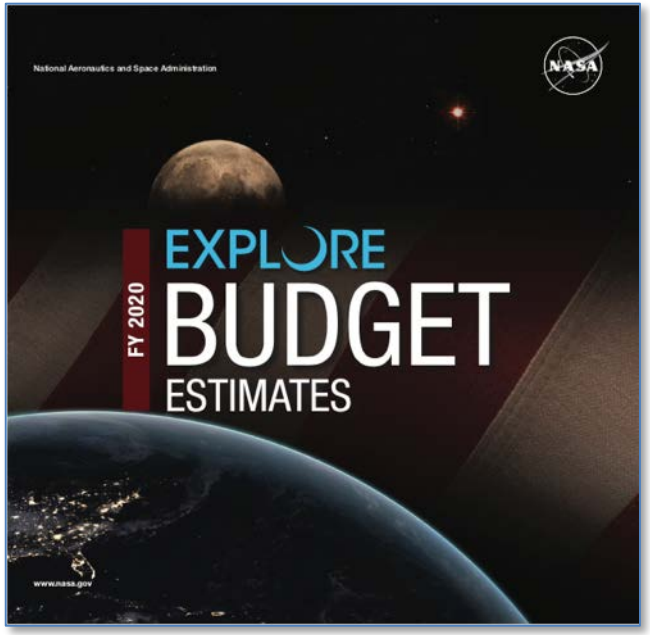
Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations.”

National Space Council Hosts Microgravity Roundtable

- **October 2018**
- **NSC seeks**
  - Commercialization of space
  - Constant presence in LEO
- **NSC acknowledges**
  - Supply abundant
  - Demand lacking
    - Government R&D must be part of the demand
- **NSC developing policy in 6-7 months**
- **NSC intends to have follow up meetings**
- **SLPSRA value proposition**
  - Pioneer Scientific Discovery
    - Test new platforms
    - Develop methodology
    - Assist new users

ISS Transition

- **President's Budget Request for FY20**
  - Step-wise transition
    - From NASA sponsorship and direct NASA funding
    - To NASA as one of many customers purchasing services from a LEO non-governmental human space flight enterprise
      - [By 2028…] Fund the deployment of at least one commercial space station in Low Earth Orbit and begin conducting science, technology development, and human research on this new platform
  - Transition such that the United States always has access to a crewed space station in LEO
  - NASA to purchase needed LEO services from a commercial operator of ISS and/or new commercial LEO destinations
  - NASA, as the U.S. partner, is shifting
    - From owner/operator
    - To being a customer and anchor tenant
  - A variety of potential models are under study



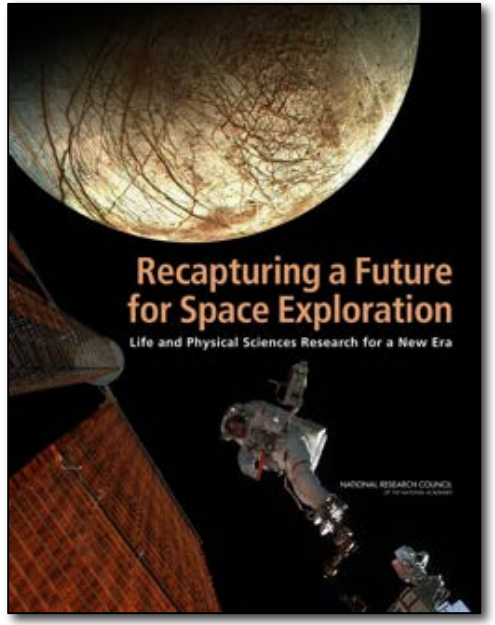
President's Budget Request FY20: Commercial LEO

- Assists commercial space industry to develop a sustained commercial low earth orbit presence.
- Continues transition of low Earth orbit human space flight operations to commercial partners.
- Encourages commercial development of platforms and capabilities for use by the private sector and NASA to enable a seamless transition from ISS.
- Increases efforts to develop a commercial space economy in LEO.

1. Research and Development (e.g., life sciences, astrophysics, space and Earth sciences)
2. Space Tourism
3. Technology Demonstrations
4. Films, TV, Sporting Events & Documentaries
5. Pharmaceutical Research and Products
6. United States Astronauts
7. Education
8. Satellite Servicing, Assembly and Manufacturing
9. Manufacturing of components for in-space and/or ground use
10. Advertising & Naming Rights
11. Foreign Government Astronauts

Facilitating Commercialization by Buying Research Services

- **Commercialization precedent: US Air Mail**
- **Demand can be increased by more funding of high value research and technology development identified in the 2011 Decadal Survey**
  - FY2005 NASA spending for Decadal Survey like R&D was ~$1B
  - In 2018 there are commercial providers for launch services, research platforms, and payload development
    - Platforms today and in the near future include sub-orbital flights, ISS, commercial free-flyers, commercial space stations, Gateway, lunar surface landers, lunar surface laboratories
- **SLPSRA procurement of spaceflight access and research capability can be one source of stable revenue that facilitates the development of a LEO economy**
- **Benefits to the Nation**
  - More Decadal Survey research and technology development is performed
    - Enabling exploration
    - Pioneering scientific discovery
  - Demand for commercial services to LEO and in LEO increases in reliable fashion



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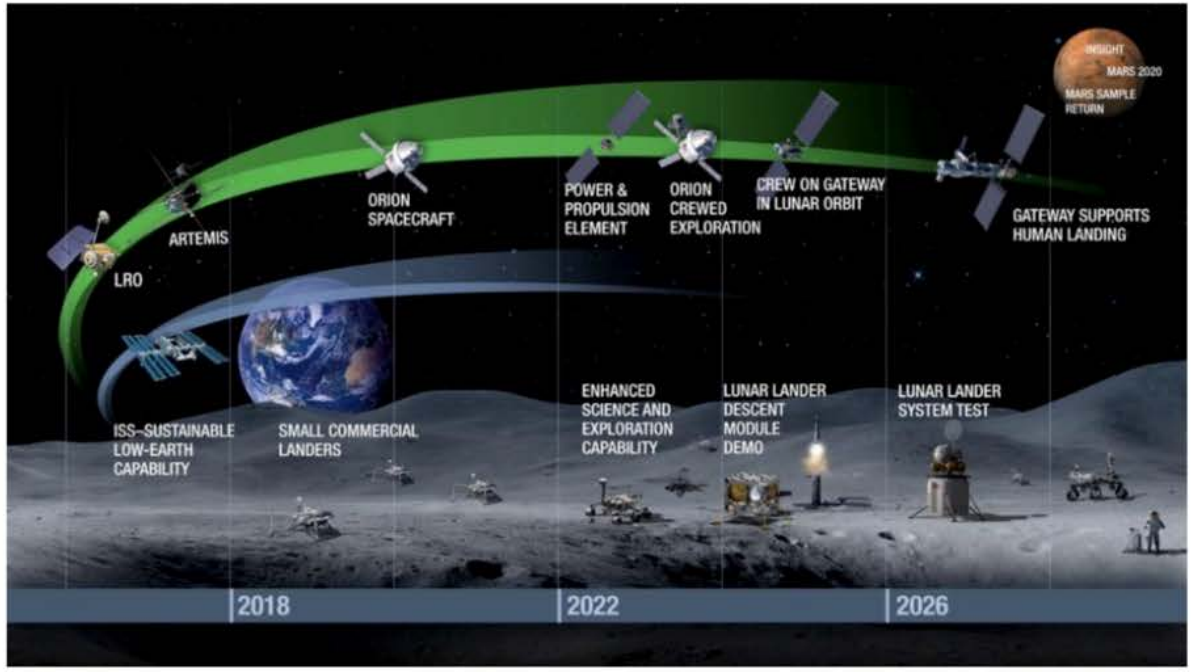
President's Budget Request FY20

- **Provides $21B, including $10.7B** to continue building the key components of the Exploration campaign that will send astronauts to the Moon and beyond, including:
  - ✓ The Space Launch System rocket, a heavy-lift expendable launch vehicle, to ensure the rocket is operational in the early 2020s when it will be needed to carry astronauts on board the Orion crew capsule to the vicinity of the Moon.
  - ✓ The Lunar Gateway, an outpost orbiting the Moon in the mid-2020s.
  - ✓ Commercial launch capabilities to enable regular, low-cost access to the lunar vicinity and surface.
  - ✓ Lunar landers to enable cargo delivery and human access to the lunar surface by the late 2020s.
  - ✓ Building commercial and international partnerships

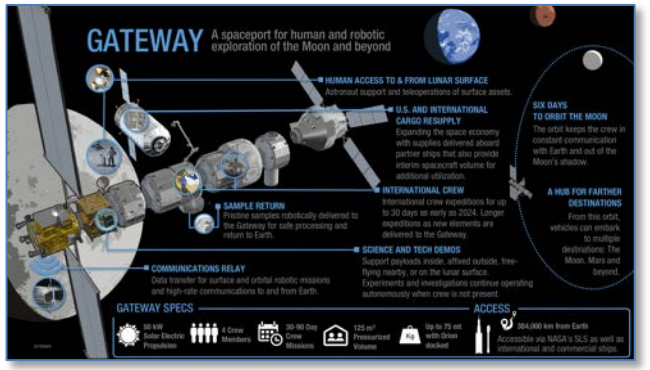


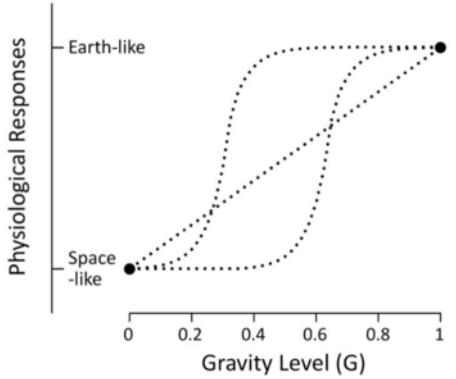
SLPSRA in the NASA Strategic Plan: Strategic Objective 1.2

NASA 2018 Strategic Plan Framework		
Theme	**Strategic Goal**	**Strategic Objective**
DISCOVER	EXPAND HUMAN KNOWLEDGE THROUGH NEW SCIENTIFIC DISCOVERIES.	1.1: Understand the Sun, Earth, Solar System, and Universe.
		1.2: Understand Responses of Physical and Biological Systems to Spaceflight.
EXPLORE	EXTEND HUMAN PRESENCE DEEPER INTO SPACE AND TO THE MOON FOR SUSTAINABLE LONG-TERM EXPLORATION AND UTILIZATION.	2.1: Lay the Foundation for America to Maintain a Constant Human Presence in Low Earth Orbit Enabled by a Commercial Market.
		2.2: Conduct Exploration in Deep Space, Including to the Surface of the Moon.
DEVELOP	ADDRESS NATIONAL CHALLENGES AND CATALYZE ECONOMIC GROWTH.	3.1: Develop and Transfer Revolutionary Technologies to Enable Exploration Capabilities for NASA and the Nation.
		3.2: Transform Aviation Through Revolutionary Technology Research, Development, and Transfer.
		3.3: Inspire and Engage the Public in Aeronautics, Space, and Science.
ENABLE	OPTIMIZE CAPABILITIES AND OPERATIONS.	4.1: Engage in Partnership Strategies.
		4.2: Enable Space Access and Services.
		4.3: Assure Safety and Mission Success.
		4.4: Manage Human Capital.
		4.5: Ensure Enterprise Protection.
		4.6: Sustain Infrastructure Capabilities and Operations.

Lunar Research and Technology Development

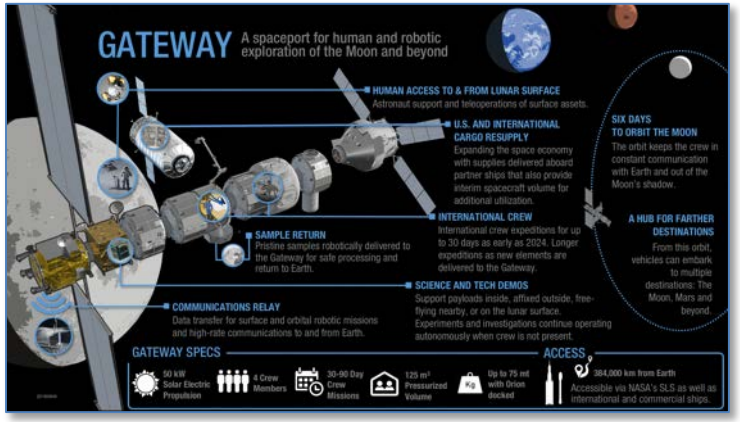
- **Gateway**
  - Deep space radiation effects on living systems
    - Real spectrum and dose rate; synergy with microgravity effects?
  - Quantum phenomena at large distances
- **Lunar Surface**
  - Every ”microgravity discipline area” will test and refine its understanding through experiments at 1/6-*g*
    - Microbe, plant, animal, and human health and performance
    - Fluids, combustion, materials science & complex fluids, biophysics, fundamental physics
  - Deep space radiation and neutron albedo effects on living systems
- **Benefits**
  - Understand system behavior at 1/6-*g* (lunar surface)
    - Aid technology development for lunar surface operations
  - Improve predictions of system behavior at 3/8-*g* (Martian surface)
    - Aid technology development for Mars surface operations





SLPSRA Research & Development is Multi-platform

- **Spaceflight factors are 1) experimental tools and 2) exploration challenges**
  - Acceleration (gravity)
  - Space radiation
  - Vacuum, hypomagnetic field, thermal cycling
  - Dust, lighting, isolation, confinement, $ppCO_2$, comm delays
- **SLPSRA uses and will use a broad range of environments**
  - Ground
  - Aircraft and balloons
  - Sub-orbital
  - Low Earth orbit
  - Lunar orbit (Gateway)
  - Mars transit
  - Lunar surface
  - Martian surface
- **As experimental tool, use most cost effective environment**
  - E.g., LEO for long duration microgravity studies
- **As exploration challenge, use sequence of "stepping stones" of increasing fidelity**
  - E.g., advance food production: ground to LEO to Gateway to Mars Transit Vehicle



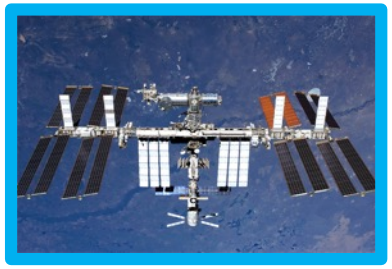
Unusual and Unique Facilities Are On Ramps & Stepping Stones

Gravity Vector Averaging

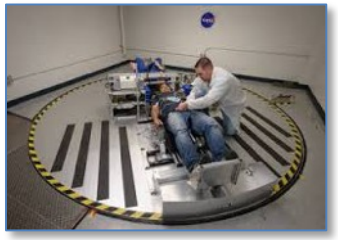

Drop Tower

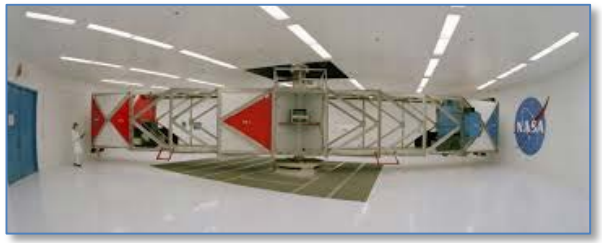

Low G Parabolic Flight


Sounding Rocket


Space Station *


Animal Centrifuge


Short Arm Human Centrifuge



Long Arm Human Centrifuge


NASA Isolation Chamber

NSF Polar Station

Russian Isolation Chamber


Balloon Flight


NASA Space Radiation Lab

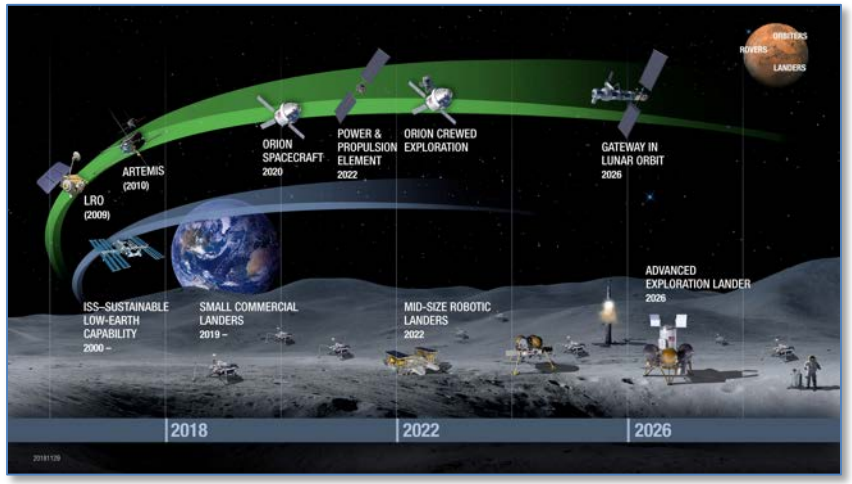

Neutral Buoyancy Facility

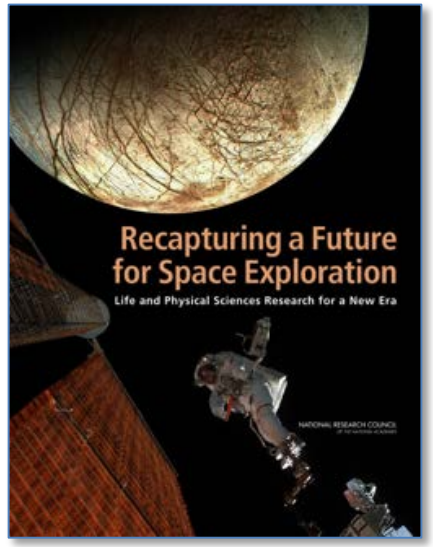
* Also through Center for the Advancement of Science in Space (CASIS)


GeneLab

Conclusion

- **SLPSRA Roles and Responsibilities**
  - Re-organization under consideration
  - Decadal Survey should consider what capabilities are unique to NASA
- **Program Status**
  - Space Biology has funded more investigations
  - Budgets are stable
  - Partnership development and execution is vibrant
- **ISS Transition Planning**
  - Commercialization of space is a priority
  - NASA will continue to be a major LEO user
  - Decadal Survey research can enable commercialization
- **Gateway and Lunar Surface**
  - New venues offer deep space radiation, distance, 1/6-*g*
  - Multi-platform SLPSRA can readily use the new venues to
    - Enable exploration
    - Pioneer scientific discovery





Thank you