Committee on Biological and Physical Sciences in Space

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SLPSRA Program Overview and Status

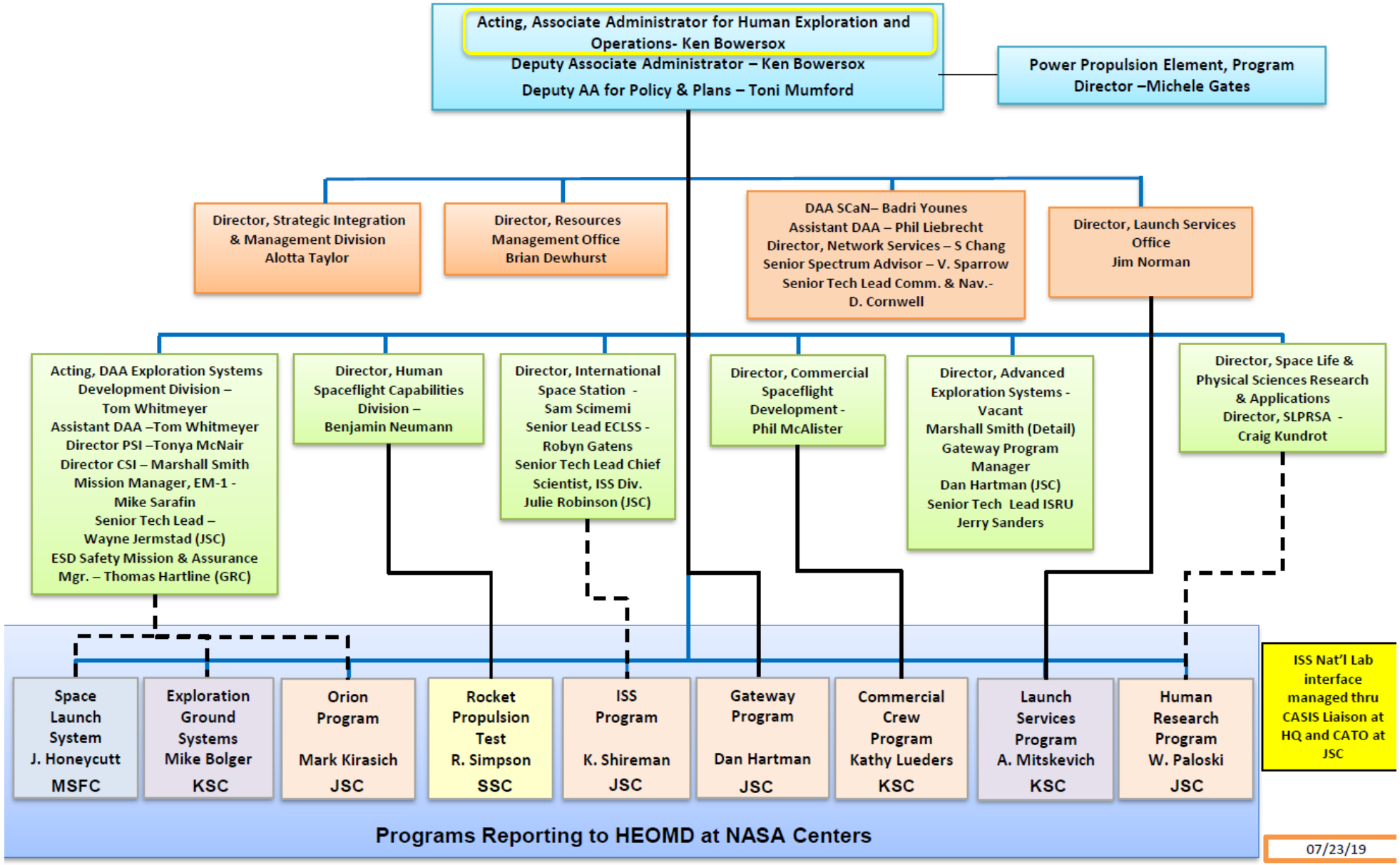
Irvine, CA

29 October 2019

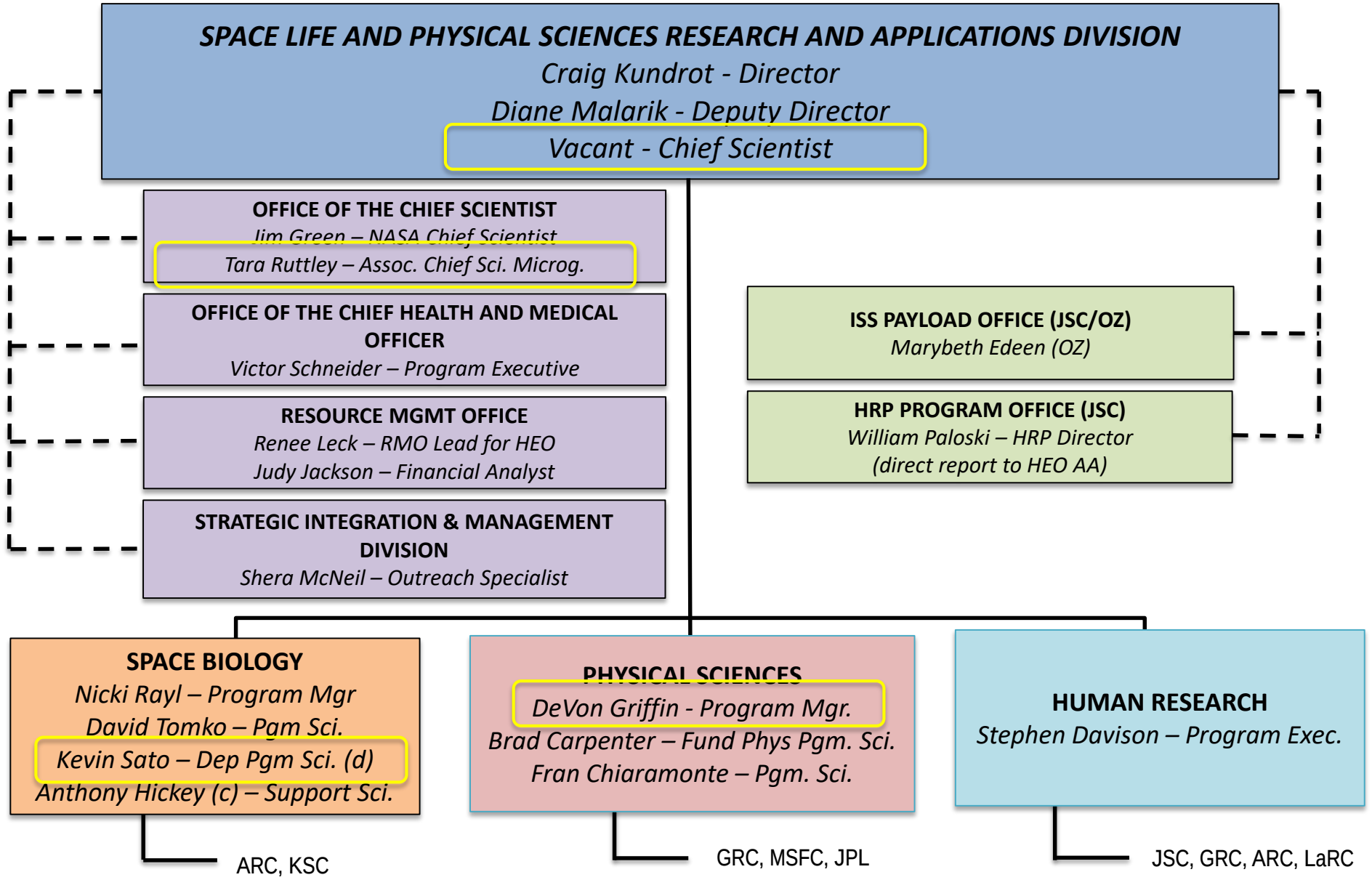
Outline

1. Program Status
2. Research Plans Overview
3. ISSNL Review and Reorganization Planning
4. ISS Issues and Status of Transition Planning
5. Program Challenges and Opportunities
6. How SLPSRA is Likely to Use the Decadal Survey
7. Other Issues to Share with Committee

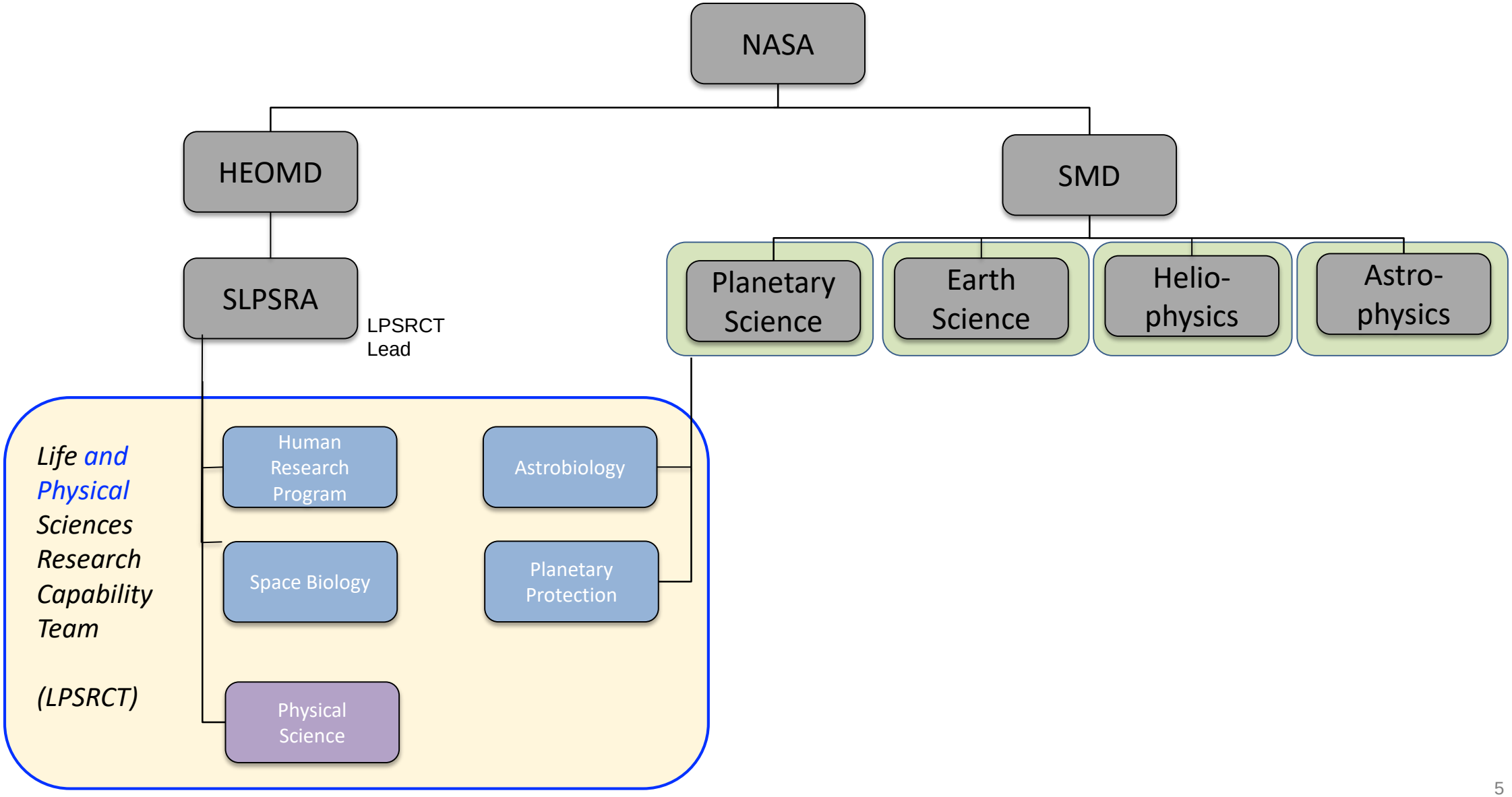
Human Exploration and Operations Mission Directorate



Space Life and Physical Sciences Research and Applications (SLPSRA) Division



Physical Sciences Added to Capability Leadership Model



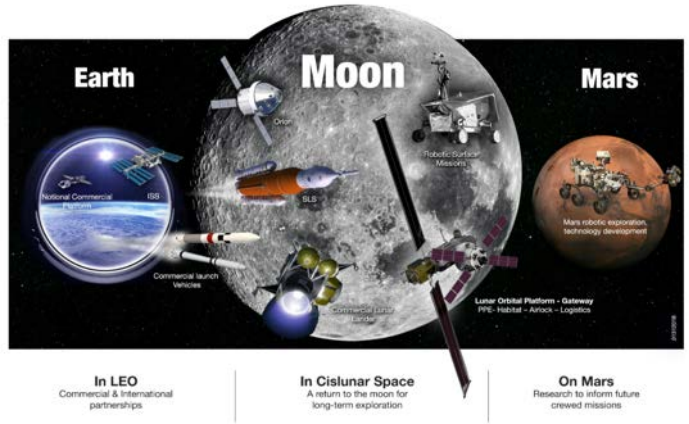
SLPSRA Strategic Framework Has Not Changed

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)

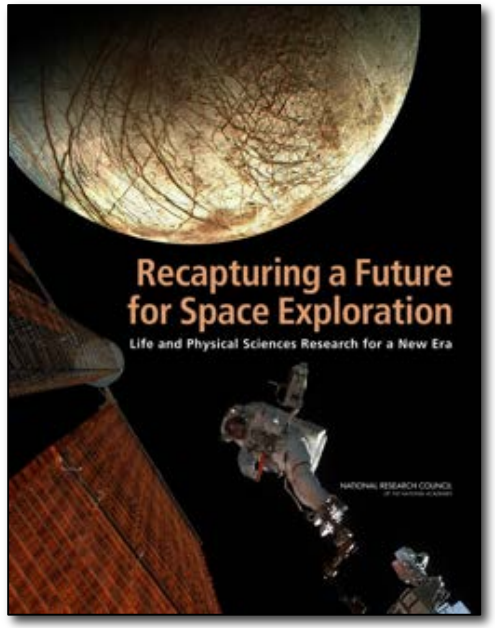


Goals

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

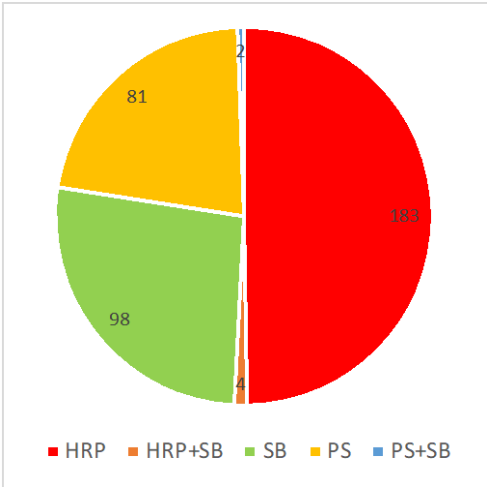
1. Ensure Scientific Integrity
2. Maximize Open Science
3. Cultivate Partnerships
4. Use Stepping Stones
5. Be an Early Adopter
6. Share Methods and Results

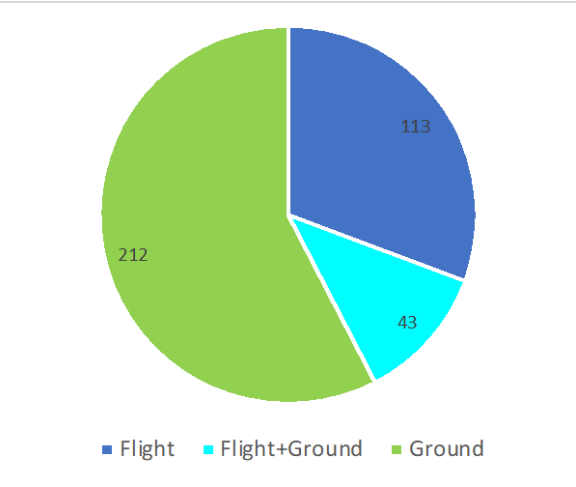


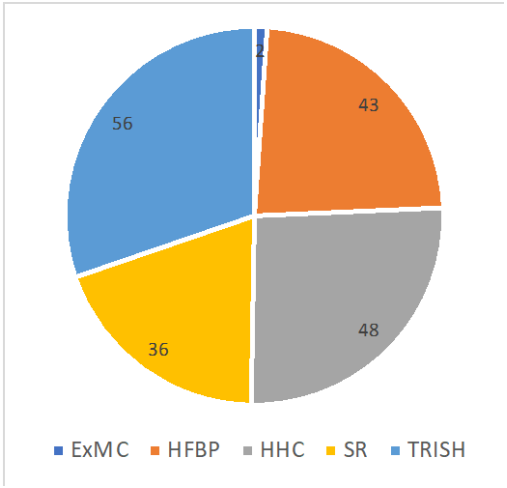
Research Portfolio

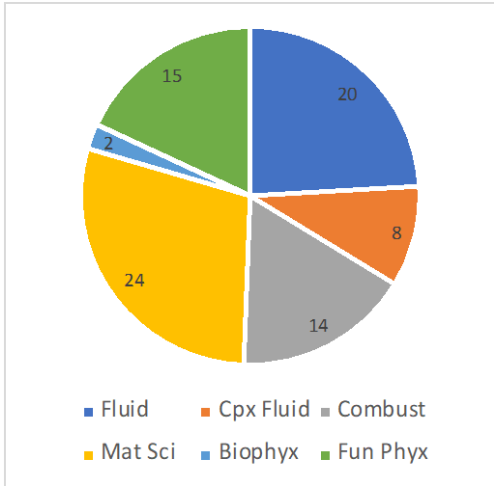
Program	Tasks	PIs	Co-Is	Post Docs	PhD students	Masters students	Bachelor students
Human Research	187	156	546	69	90	46	139
Space Biology	104	81	192	56	46	22	134
Physical Sciences	83	76	98	49	108	26	63
Total*	368	301	810	203	240	88	319

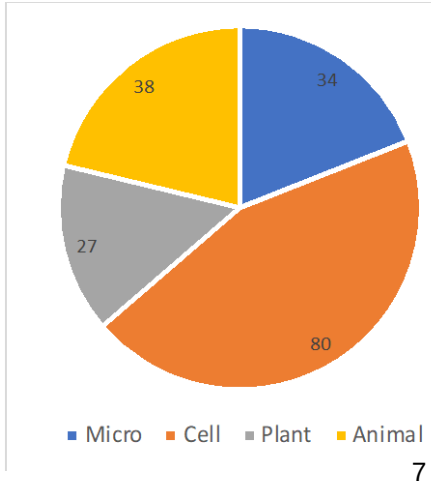
Personnel	1,961











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*Some tasks assigned to more than one program or discipline

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

Research Plans Overview

- **HRP**
  - Understand and mitigate the highest risks to crew health and performance
  - Coordinated through the Human System Risk Board
- **Space Biology**
  - Maximize use of GeneLab
  - Re-use of hardware enables NRAs for new research
  - New work focuses on areas that enable exploration through scientific discovery
    - Plant production as source of food
    - Microbiomes of the built environment, plants, and crew
    - Physiological adaptation to spaceflight in model organisms
- **Physical Sciences**
  - Maximize use of Physical Sciences Informatics (PSI)
  - Hardware development budget delays non-PSI NRAs to FY21
  - FY21 NRAs to focus on areas that enable exploration through scientific discovery
    - Workshops in Materials Science and Fluid Physics to inform future NRAs
  - FY22 NRAs to include more basic research
    - Cold atoms, liquid crystals

Plans for One Time Increase to Biological and Physical Sciences

- **$5M FY20 increase for Space Biology and Physical Sciences to be proposed in President's Budget Request**
- **Approach**
  - Cost funds over two years
  - Conduct early formulation activities (pre-Phase A or Phase A)
  - Result in a product
  - Sets the stage for future work
  - 10 of 12 are Science Definition Teams (SDTs)
    - free and open competition to identify team members
    - led by civil servant
    - members from govt, industry, academics
    - define scope of work, top level implementation plan
    - can act in the role of a PI in a classical investigation
    - benefits: broader input in experiment design, facile transfer of results to broader set of investigators

- **Areas pursued (12)**
  - Space Biology (6)
    - Enabling Rodent research in LEO (2)
      - Rodent Research Standard Configuration Flight Validation
      - Mouse Circling Behavior
    - Multi-purpose (4)
      - Microgravity Simulation SDT/DWG
      - Commercial Free Flyer SDT
      - Lunar Biological Payload Phase A
      - Standardized SB Research Capability
  - Physical Sciences SDTs (6)
    - LEO w/industry (3)
      - Microgravity Wind Tunnel
      - Transcritical Combustion (HP-TCC)
      - Materials Topic post ISSRDC W/S
    - Lunar (3)
      - Dust Mitigation
      - Deep Space Quantum Link
      - LEO Optical Time/Frequency Link Demo

ISS NL Review and Reorganization Planning

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ISS Commercial Program

- **CASIS (National Academies March 2019)**
- **ISSNL Objectives: Preparing for 2024 - 2035**
  1. Make ISS R&D platform available to the American Taxpayer
  2. Optimize & improve microgravity platform utilization
  3. Improve the natural R&D iteration cycle time
  4. Focus on promising R&D areas
  5. Support high-quality fundamental science
  6. Support ISS transition by building the commercial case
- **ISSNL Strategy: Widen the 2024 – 2035 Aperture**
  - ISSNL can support a broad set of microgravity research platforms
    - New orbital platforms (crewed, crew-tended, free fliers, cis-lunar)
    - Sub-orbital vehicles
    - Parabolic flight
    - Balloons
    - Drop towers
    - Ground-based laboratories
    - Big data platforms

ISS NL Review and Reorganization Planning

- **CASIS proposed changes to ISS NL**
  - Mission (March)
  - Budget (July)

- **NASA called for Independent Review Team to examine CASIS mission and resources**
  - August comissioned
  - December completion

- **Post-IRT expectations**
  - Possible adjustment to mission and budget
    - CASIS, ISS Commercialization, SLPSRA Biological and Physical Sciences
    - Many areas to coordinate SLPSRA's decades of scientific depth with CASIS ISS NL engagement with new users and ISS goal of commercializing LEO
  - NASA resumes consideration of moving Biological and Physical Sciences from HEOMD to SMD

ISS Issues and Status of Transition Planning

- **Unstable allocation of resources**
  - Finishing procurement of Soyuz seats
  - Beginning of commercial crew
  - Institutional Animal Care and Use Committee requirements for rodent research
- **Crew time and cold stowage are frequent limiting factors**
- **Feast or famine: resources available to SLPSRA vary greatly between increment pairs**

Increment Pair	55/56	57/58	59/60	61/62	63/64
Crew Hours	502	120	289	9*	0*

- **ISS resources distributed to all NASA investigations in a high priority category before considering any investigations in next highest priority category**
  - Categories such as non-exploration Decadal Survey research do not have minimum allocation
  - Exception: 5% of resources allocated to commercialization
- **ISS Commercialization solicitations**
  - June: Use of ISS port
  - July: Ideas for stimulating commercial demand in LEO
  - NET Nov: Crewed “free-flyer”

*Planned

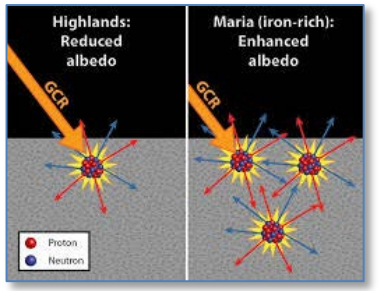
Program Challenges and Opportunities

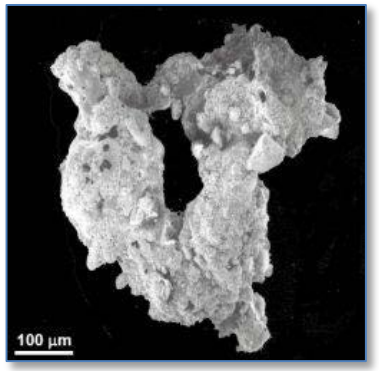
- **Challenges:**
  - Fluctuations in ISS resources available for non-exploration critical Decadal Survey science
  - Developing lunar science program
    - No de facto subsidy analogous to use of ISS
    - No additional resources

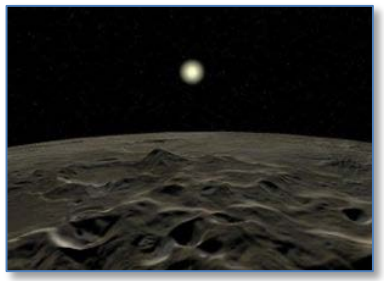
- **Opportunities:**
  - Cooperation with CASIS ISS NL, ISS Commercialization; OGAs; Industry
  - Pre-Phase A preparations for possible future work
  - Lunar science, especially surface science
  - Space Biology and Physical Sciences move from HEOMD to SMD

Example Research Areas for the Lunar Surface

- **Reduced gravity (1/6-*g*)**
  - Flammability, fire safety
  - Two phase flow (pool and flow boiling, packed bed reactors, cryogenic fuel storage and transfer)
  - Soldering, brazing, welding
  - Food crop production
  - Bone loss, muscle loss, cardiovascular deconditioning
- **Deep space radiation & albedo radiation**
  - Radiation effects on microbes, plants, crew
- **Lunar regolith and dust**
  - Granular materials processing
  - In-situ surface construction, cement/concrete production
  - Metal and/or O_2 extraction from regolith
  - Dust mitigation
- **Unattenuated solar spectrum and plant growth**
- **Closed habitat (pCO_2, pH_2O, T, infrequent influx of crew and materials)**
  - Microbiome of humans, plants, vehicle
  - Biofilm production, biocorrosion







How SLPSRA is Likely to Use the Decadal Survey

- **Shape Content**
  - Scope
    - EE pull: implement novel or improved approaches to meet exploration needs
    - EE push: invest in areas to determine ability to meet need
    - PSD platform refinement: use new platforms, improve utilization of existing platforms
    - PSD share results: ?
    - Capabilities: guide acquisition strategy and workforce development through the Life and Physical Sciences Research Capability Leadership Team
  - Prioritization
    - Employ prioritization framework to fund future research in light of evolving LEO capabilities and NASA exploration plans
- **Inform Budget Requests**
  - Based on a set of investigations in a topic area or “campaign” such as
    - Cryogenic fluid management
    - Crop production
    - Microbiomes of the built environment (MoBE) management

Other Issues to Share with Committee

- **Possible move of Biological and Physical Sciences from HEOMD to SMD**
  - A return “home” of sorts
    - OSSA ‘home’ of 1970’s to 1993 (~20 years)
    - Independent OLMSA and OBPR from 1993 to 2005 (12 years)
    - Under human space flight from 2005 to 2019 (14 years)
  - Many similarities between BPS and SMD
    - Decadal Survey, advisory committee, NRAs, peer review, open science, international
  - Major differences
    - BPS is primarily experimental science, SMD observational
    - BPS studies terrestrial systems in space; SMD studies space systems
    - BPS is a minor funder in its fields; SMD is core funder and scientific driver
  - Opportunity to explore synergies between Space Biology, Astrobiology and Planetary Protection research
  - BPS would retain its relationships with ISS and HRP
  - More prospects for growth in SMD
    - BPS is 1/8th its size under OBPR

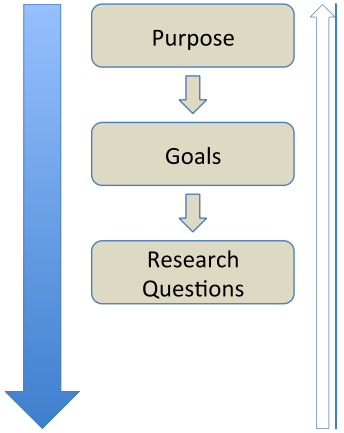
Thank you

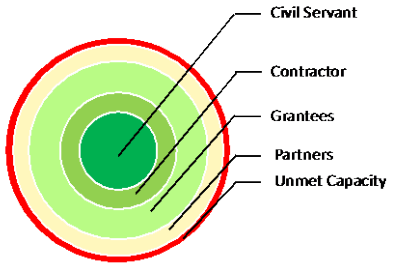
NASA Capability Leadership Model

- **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
    - 5 Research (Heliophysics, Earth, Planetary, Astrophysics, **Life and Physical Sciences**)
    - 7 Systems Capabilities (e.g., Environmental Control and Life Support Systems)
    - 4 Capability Portfolios (e.g., High End Computing)
    - 1 Service Capability (Aircraft Operations)
- **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





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

- **Approval to add Physical Sciences disciplines into the LSRCT to create the Life and Physical Sciences Research Capability Team (LPSRCT) granted October 2019**