

National Aeronautics and  
Space Administration



# EXPLORE SCIENCE

## Biological and Physical Sciences (BPS)

Craig Kundrot, Director

Diane Malarik, Deputy Director

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*Example of Physical Sciences research: Studying quantum gasses*



*Example of Space Biology research: Growing plants in space*

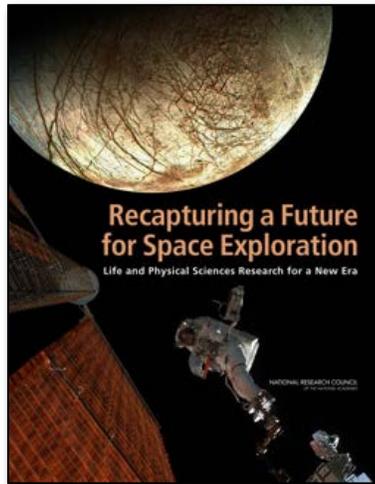
# What We Do

We use spaceflight environments to **study biological and physical systems.**

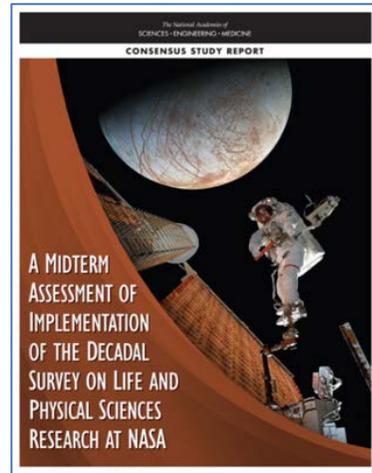
Examining phenomena under extreme conditions can **help us better understand how they function.**

This can contribute to significant scientific and technological advancements that **enable space exploration and benefit life on Earth.**

# BPS Mission & Goals



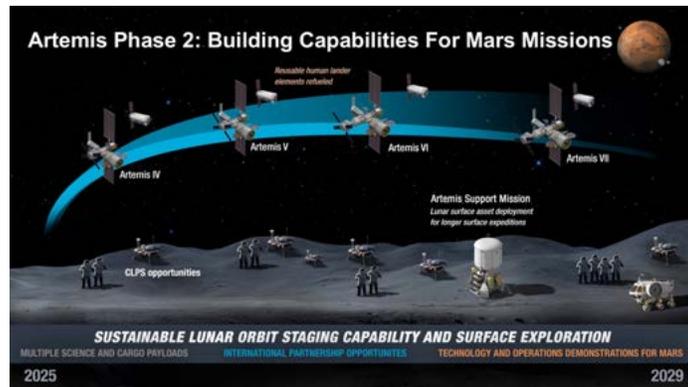
*Decadal Survey*



*Midterm Assessment*

## Pioneer Scientific Discovery

- Proactively seek out new ways to expand fundamental scientific knowledge
- Provide expertise and support to others seeking to utilize space

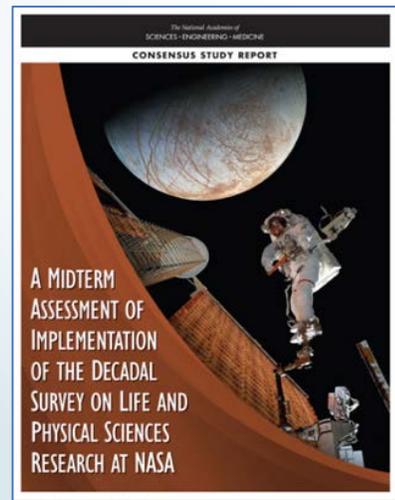
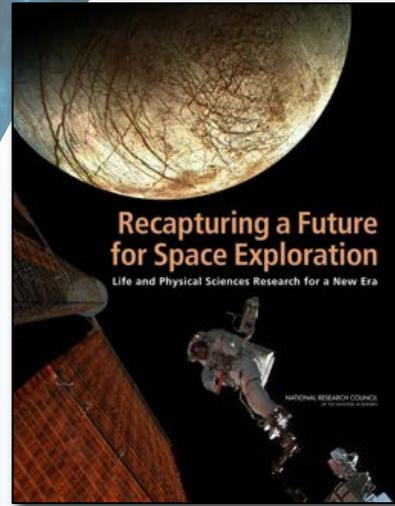


*Artemis Missions*

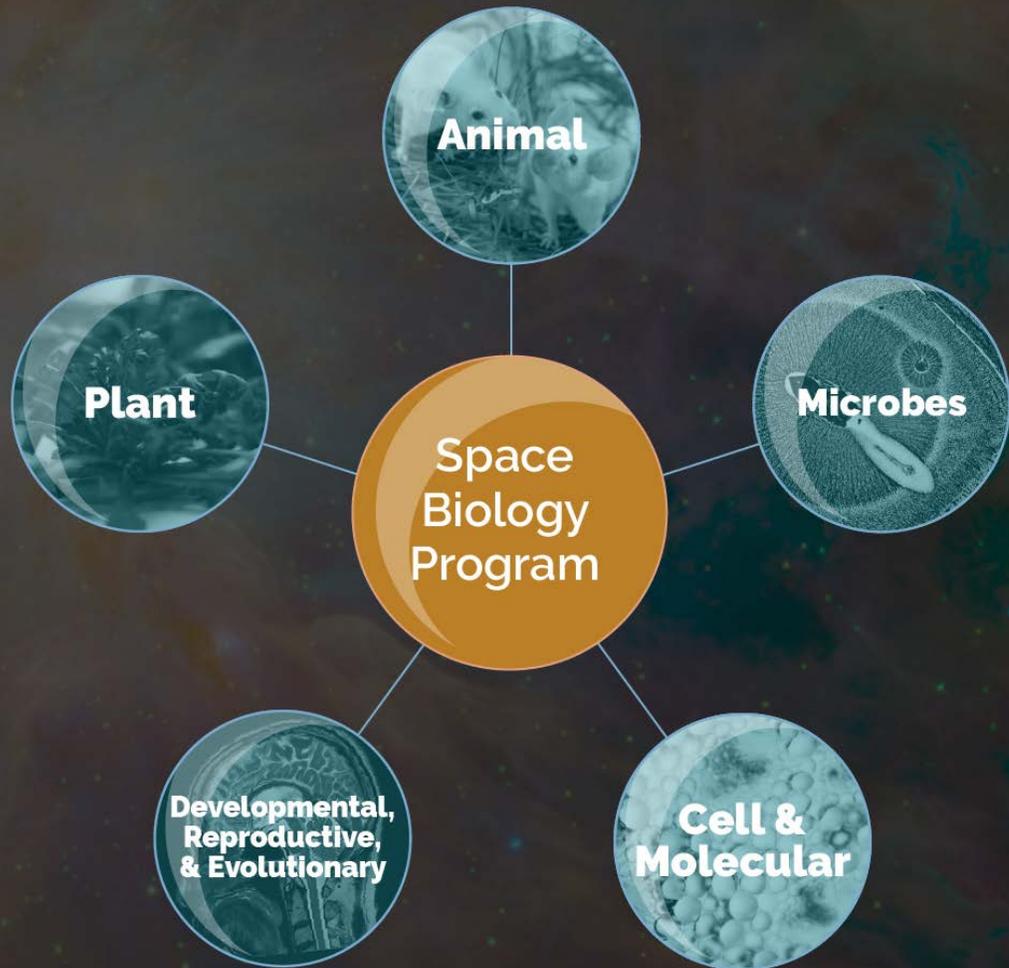
## Enable Exploration

- Anticipate and investigate critical areas for scientific knowledge and technology development
- Deliver results to STMD and HEOMD
  - *And SMD?*

# Decadal Survey



- 2011: Decadal Survey on Life and Physical Science Research at NASA
  - First decadal survey for these disciplines
  - 30+ year foundation of on-going research
    - 1970 In OMSF, OSSA and OART
    - 1992 OLMSA
    - 2000 OBPR
    - 2005 In ESMD
    - 2012: Prompted formation of HEOMD/SLPSRA
- 2017: Midterm Assessment of Implementation
- 2020: Biological and Physical Sciences moves to SMD
- Today:
  - Statement of Task for next Decadal Survey approved
  - Start late 2020 or early 2021

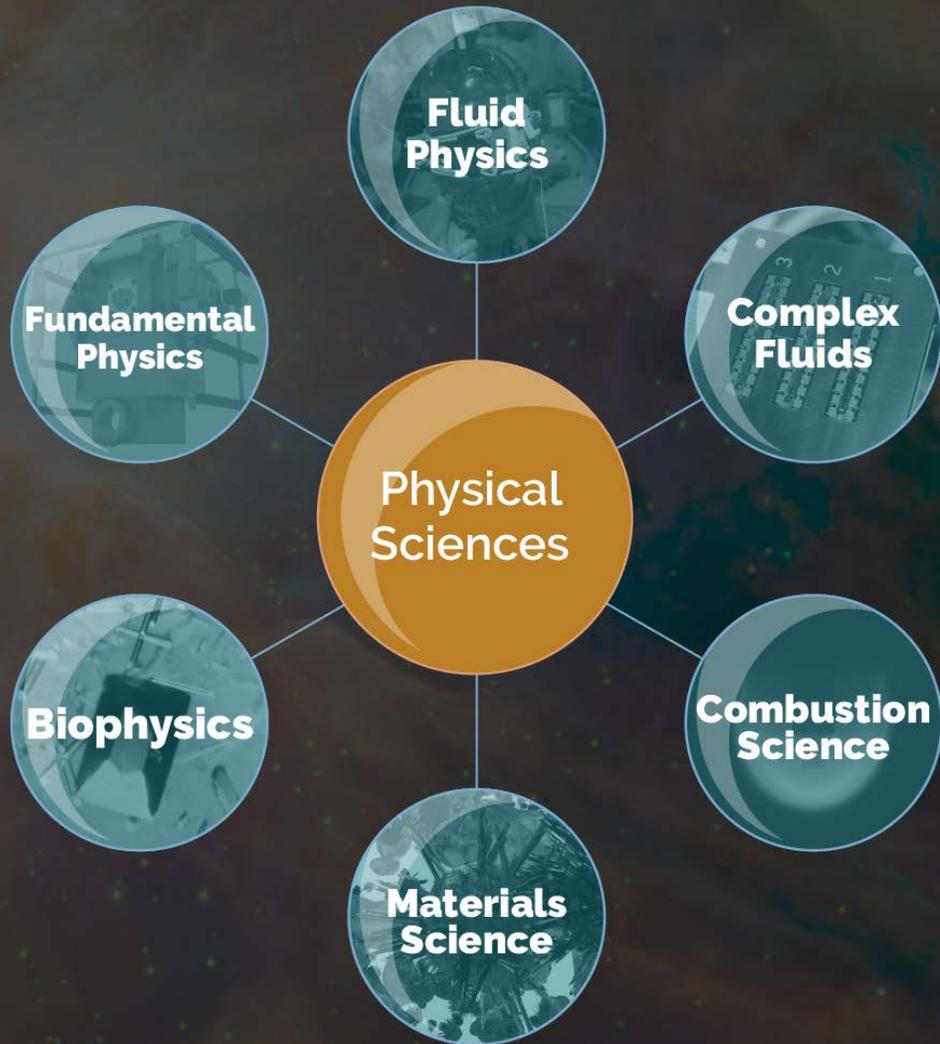


## Objectives

- Discover how biological systems **respond** to the space environment
- Identify the underlying **mechanisms** and develop physiological models for biological systems in space
- Developing cutting-edge biological **technologies** to facilitate spaceflight research
- Promote **open science** through the GeneLab Data System and Life Science Data Archive
- Provide mechanistic understanding to support human **health in space**
- Support the transfer of knowledge and technology of space-based research to the understanding of life on Earth to **benefit life on Earth**

## Databases and Biospecimen Sharing

- GeneLab ([genelab.nasa.gov](http://genelab.nasa.gov))
- Life Sciences Database Archive ([lsda.nasa.gov](http://lsda.nasa.gov))



## Objectives

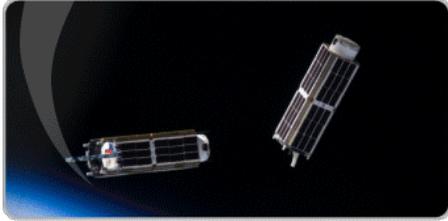
- Investigate fundamental laws of physics and physical processes, often using either microgravity or interplanetary distances as research tools
- Provide a mechanistic understanding of processes underlying space exploration technologies such as power generation and storage, space propulsion, life support systems, and environmental monitoring and control
- Develop cutting-edge technologies to facilitate spaceflight research
- Promote open science through Physical Science Informatics
- Support the transfer of knowledge and technology of space-based research to terrestrial systems to benefit life on Earth

## Database

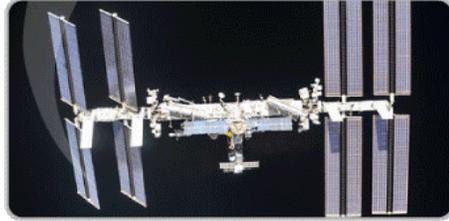
- Physical Sciences Informatics ([psi.nasa.gov](http://psi.nasa.gov))

# BPS Platforms for Research

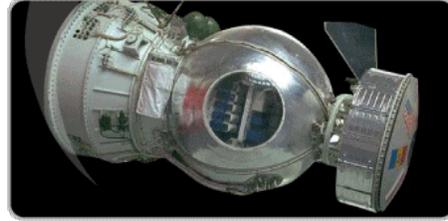
*\*Future Platforms*



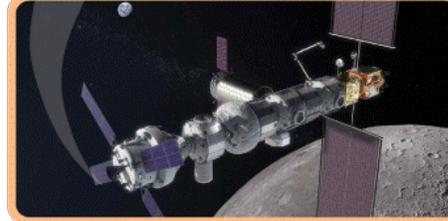
CubeSat



International Space Station



Free Flyers (BION)



*\*Lunar Gateway*



*\*Commercial Lunar Lander Services*



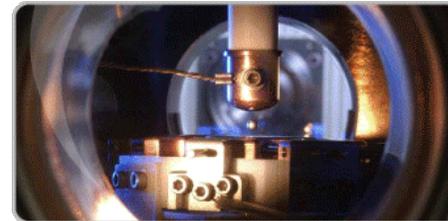
Drop Tower



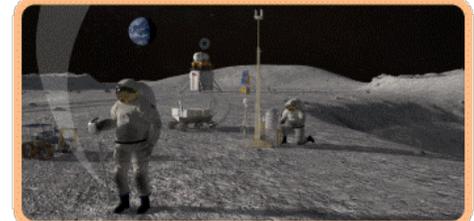
Parabolic Flight



Sounding Rocket  
Sub-orbital Vehicle



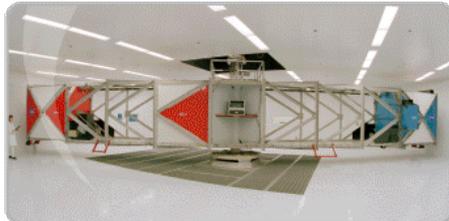
Electrostatic Levitator



*\*Human Landing System*



Rodent Unloading



Centrifuge



Balloon Flight



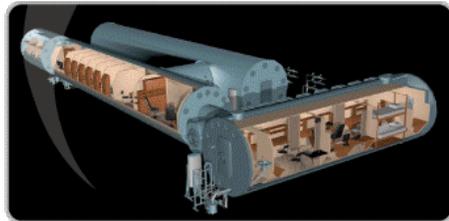
NASA Space Radiation Lab



NASA Isolation Chamber



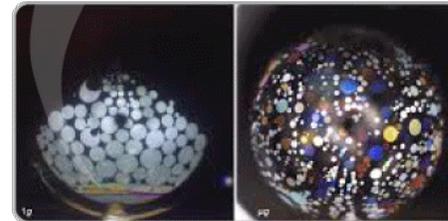
NSF Polar Station



Russian Isolation Chamber



Gravity Vector Averaging

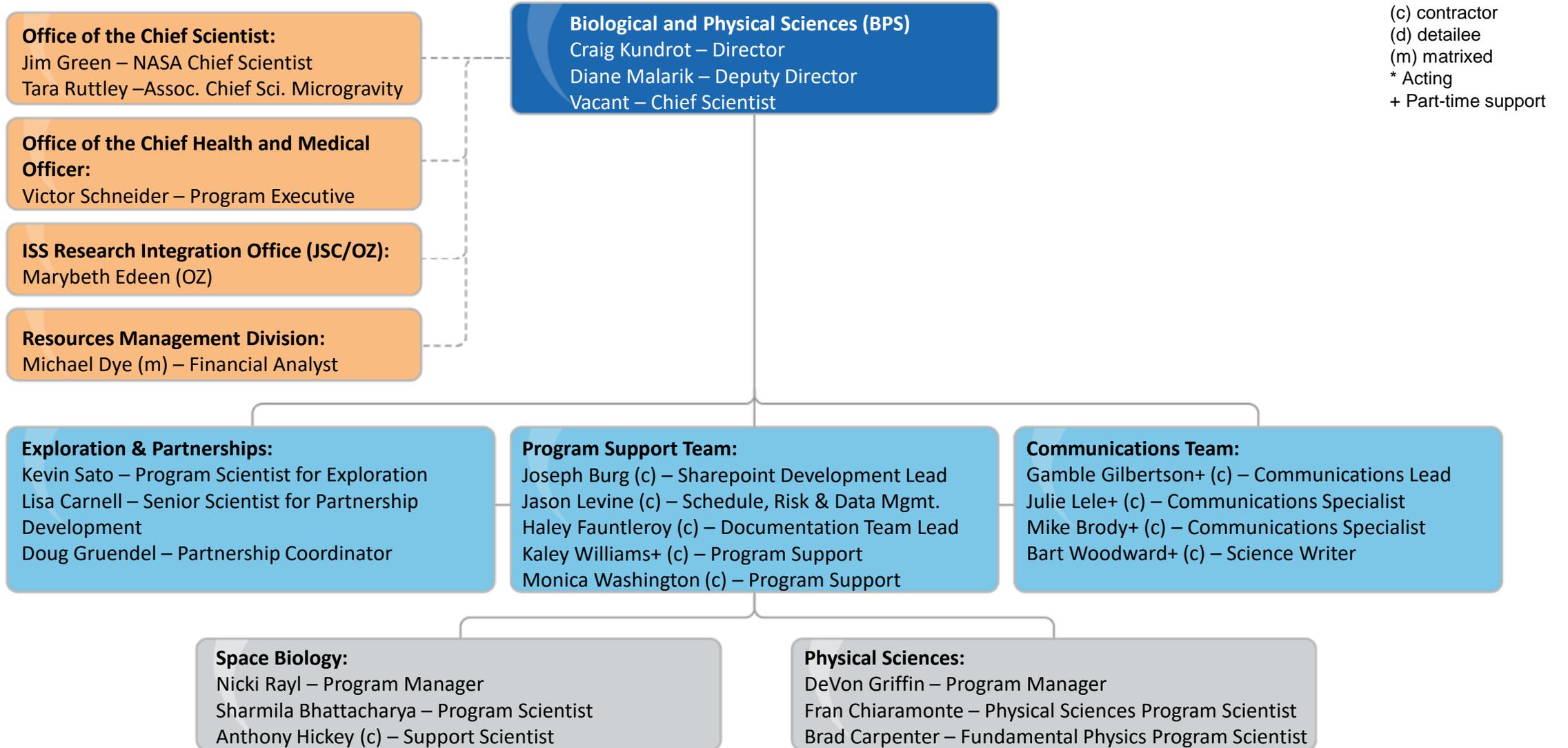


Physical Sciences  
Informatics



GeneLab

# Our Organization



# Leadership



Dr. Craig Kundrot  
*Division Director*



Diane Malarik  
*Deputy Director*

# Space Biology



Nicki Rayl  
*Program Manager*



Sharmila Bhattacharya  
*Program Scientist*



Anthony Hickey  
*Support Scientist*

# Physical Sciences



DeVon Griffin  
*Program Manager*

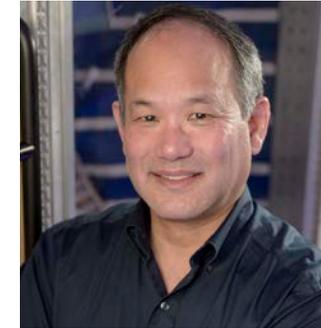


Bradley Carpenter  
*Fundamental  
Physics Program  
Scientist*



Fran Chiaramonte  
*Fundamental  
Physical Sciences  
Program Scientist*

# Exploration & Partnerships



Kevin Sato  
*Program Scientist  
for Exploration*



Lisa Carnell  
*Senior Scientist for  
Partnership  
Development*



Doug Gruendel  
*Partnership  
Coordinator*

# Program Support & Communications



Monica Washington  
*Administrative  
Assistant*



Haley Fautleroy  
*Documentation  
Team Lead*



Gamble Gilbertson  
*Communications  
Lead*



Joseph Burg  
*SharePoint  
Development Lead*



Kaley Williams  
*Program Support*



Julie Lele  
*Communications  
Specialist*



Jason Levine  
*Schedule, Risk and  
Data Management*



Bart Woodward  
*Science Writer*



Mike Brody  
*Communications  
Specialist*

# Crew Sampling for Microbial Inventory

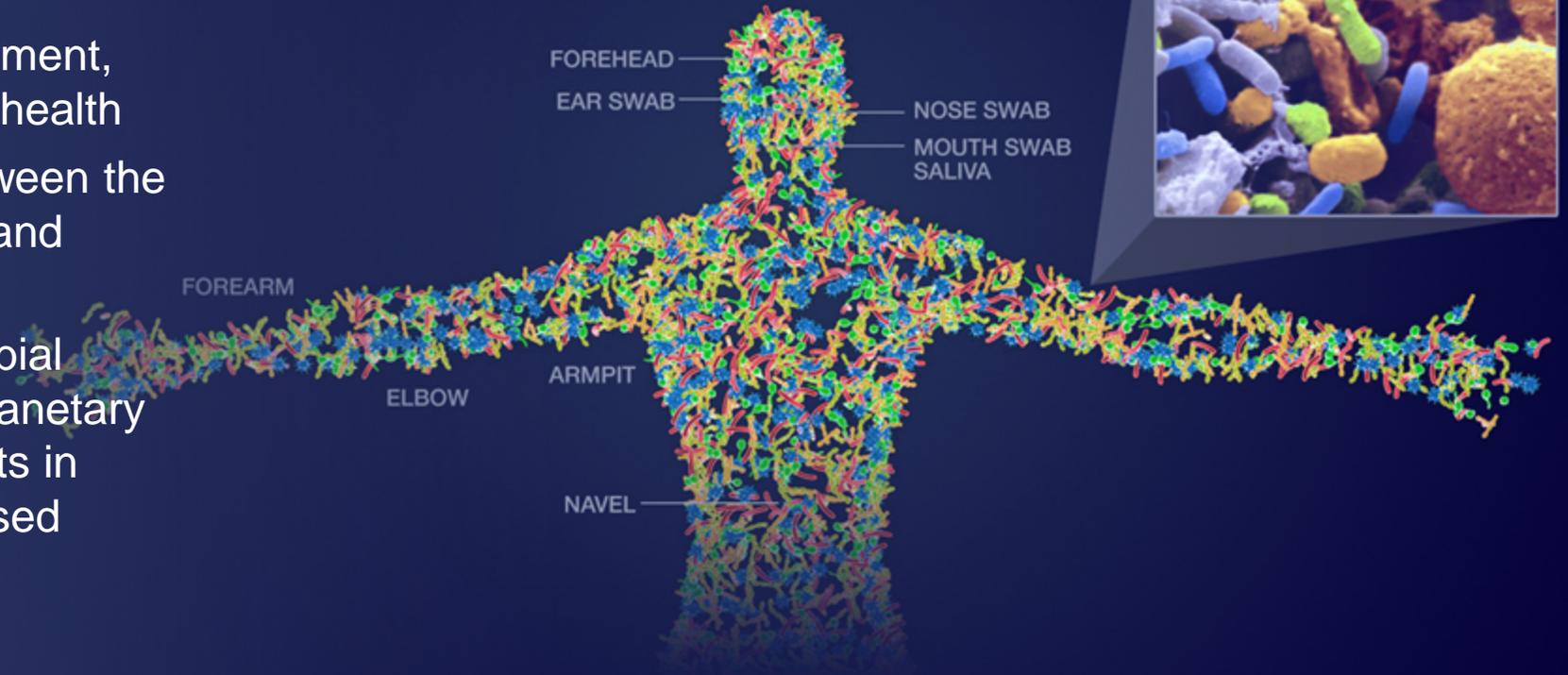
- Microbes in the built environment, including ISS, affect human health
- Examining the interplay between the ISS and crew microbiomes and changes over time
- Findings contribute to microbial control countermeasures, planetary protection, and Earth-benefits in human semi-closed and closed system habitats

E.g., Scientific Reports 8: 814 (2018)

Active experiment on ISS

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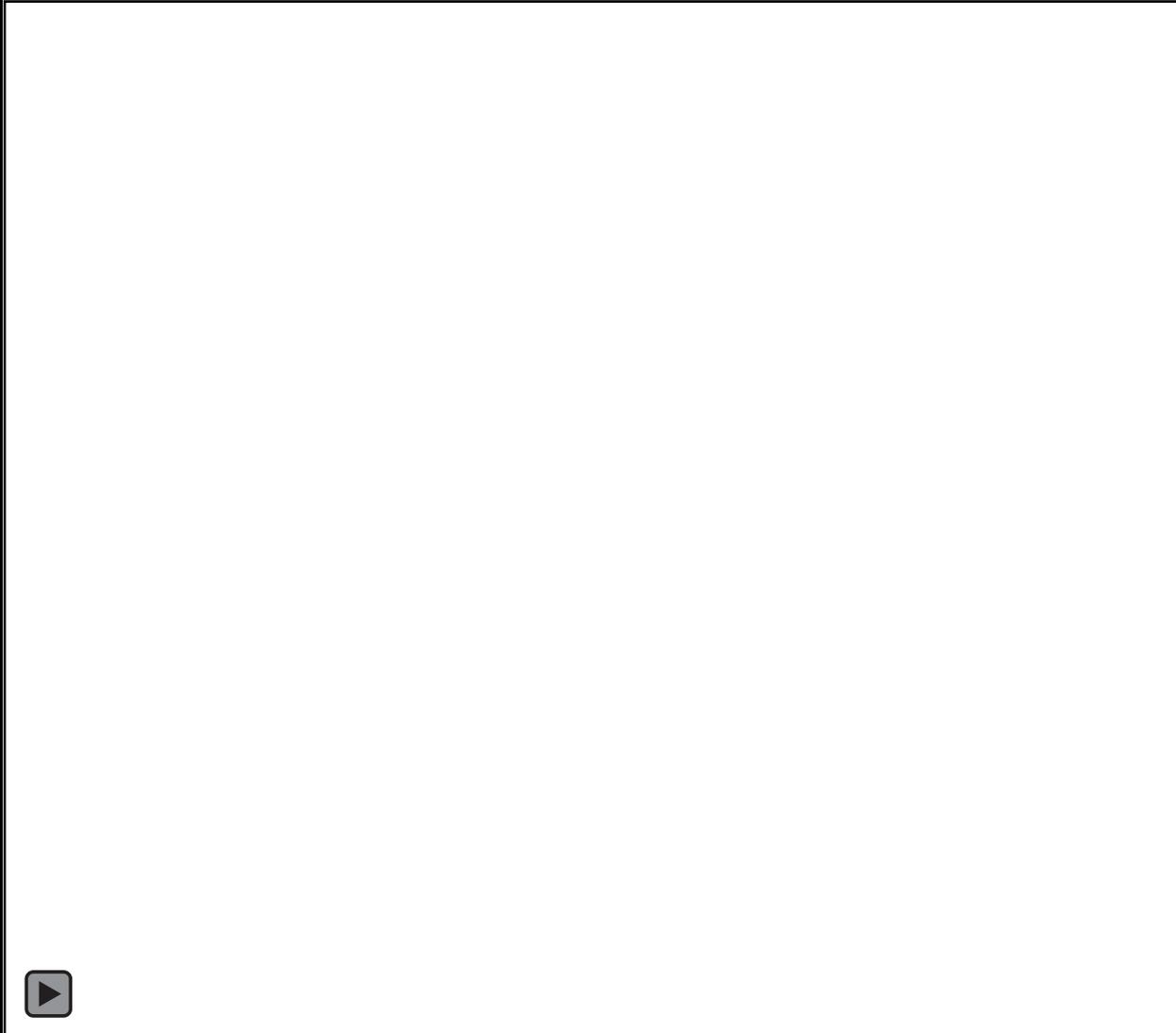


E.g., Scientific Reports 8: 814 (2018)

Active experiment on ISS



# Long Distance Plant Defense Signaling



- Preparation for a flight experiment leads to discovery published in *Science*
- Lack of laboratory capability on ISS drives need for remote monitoring of biological systems
- PI developed fluorescent method for monitoring  $\text{Ca}^{++}$  signaling
- Discovered glutamate triggered  $\text{Ca}^{++}$  wound signaling

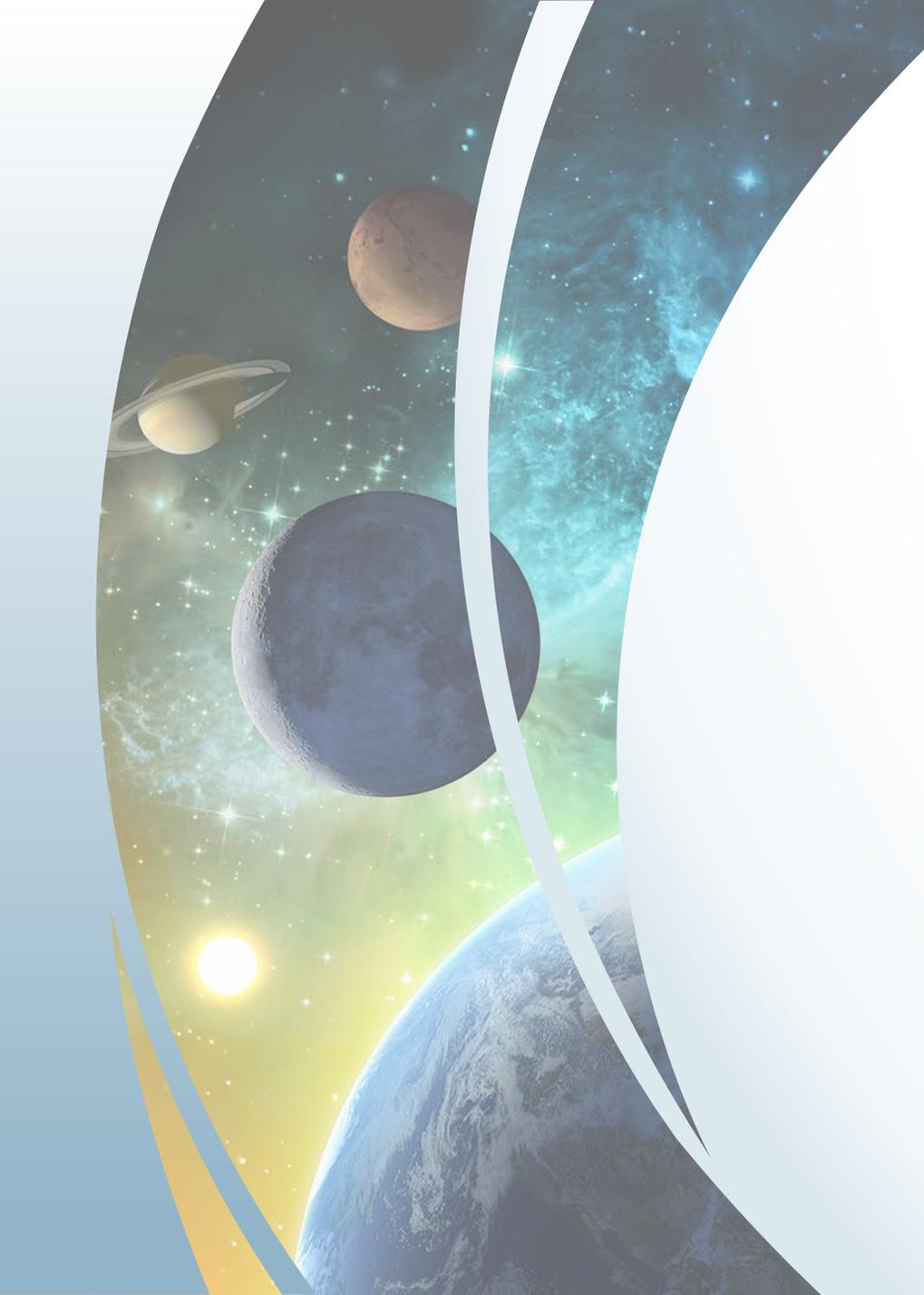
Science, 361:1112-1115  
(2018)

# E

- Verifying
- Practice
- Compiling

7



A vibrant, stylized illustration of outer space. It features a large, dark blue planet with a prominent ring system (resembling Saturn) in the upper left. Below it is a smaller, reddish-brown planet. In the center, a large, dark blue sphere (resembling the Moon) is visible. The background is filled with a starry field and a nebula with shades of blue and green. At the bottom, the curved horizon of the Earth is shown, with a bright sun or star in the lower left corner. A white, curved line sweeps across the scene from the top left towards the bottom right, separating the image from the text area.

# Conclusion

- **BPS uses the spaceflight environment (e.g., reduced gravity, radiation) to study biological and physical systems**
  - Two-fold mission
    - Pioneer scientific discovery
    - Enable exploration
  - Space Biology: microbes, cells, tissues, plants, animals
  - Physical Sciences: fluids, combustion, materials, fundamental physics
  - Moved from HEOMD to SMD July 2020
- **Decadal Survey**
  - Statement of Task finalized
  - Start late 2020 or early 2021
- **Looking forward to exploring opportunities to coordinate and to collaborate with the Astrophysics Division and other SMD Divisions**
- [science.nasa.gov/biological-physical](https://science.nasa.gov/biological-physical)

A decorative graphic on the left side of the slide features a curved, semi-circular shape. Inside this shape, there is a vibrant space scene. At the bottom, the blue and white horizon of Earth is visible. Above it, a bright yellow sun or star glows. Further up, a large, dark blue sphere (resembling the Moon) is prominent. To its left, a ringed planet (like Saturn) is shown. Above that, a reddish-brown planet (like Mars) is visible. The background is a deep blue space filled with numerous white stars and a glowing blue nebula. A white, curved line separates this graphic from the text on the right.

# Acronyms

BPS- Biological and Physical Sciences

ESMD- Exploration Systems Mission Directorate

HEOMD- Human Exploration and Operations Mission Directorate

OART- Office of Advanced Research and Technology

OBPR- Office of Biological and Physical Research

OLMSA- Office of Life and Microgravity Science and Applications

OMSF- Office of Manned Space Flight

OSSA- Office of Space Science and Applications

SMD- Science Mission Directorate

SLPSRA- Space Life and Physical Sciences Research and Applications

STMD- Space Technology Mission Directorate