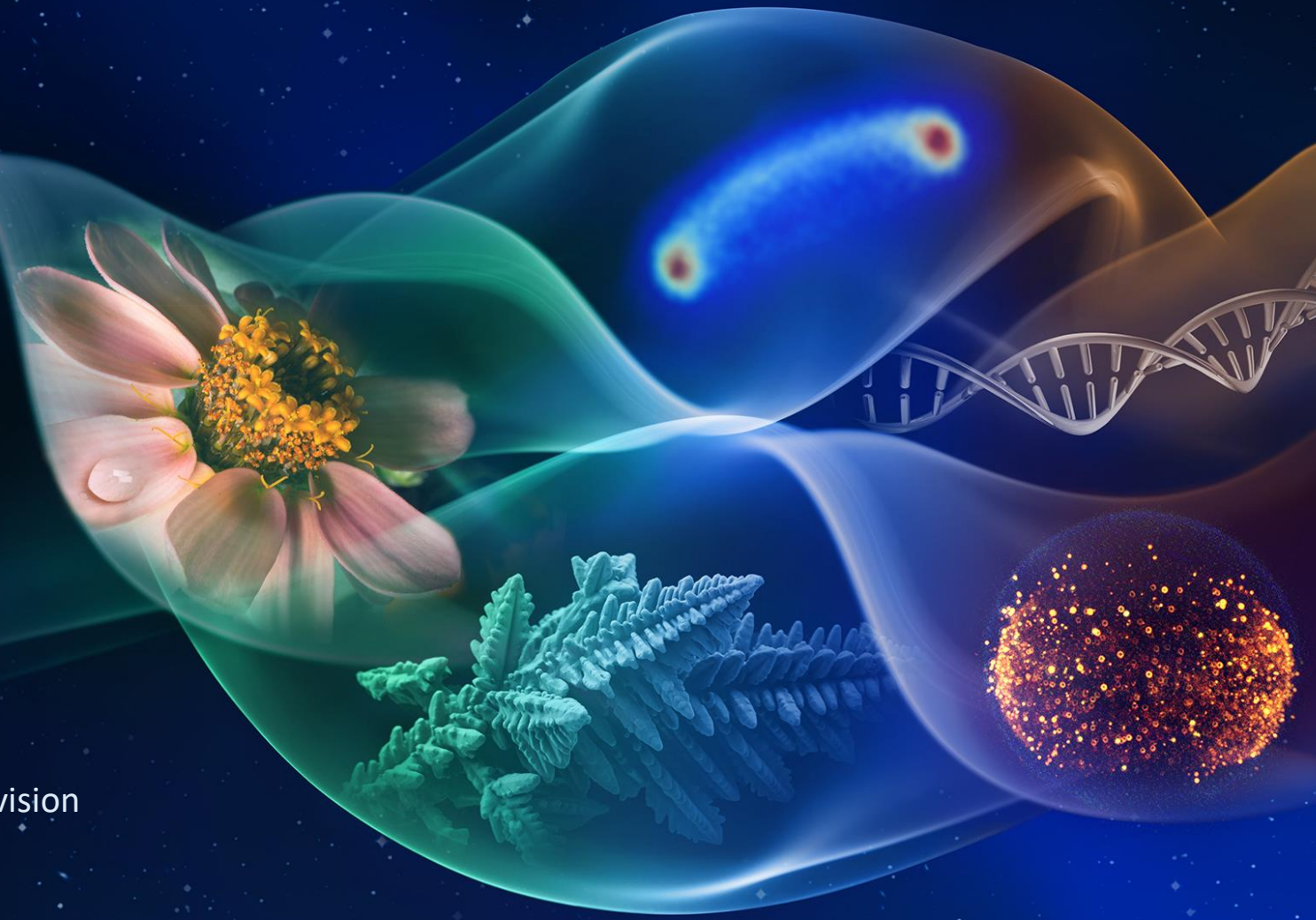
National Aeronautics and Space Administration

NASA

BPS

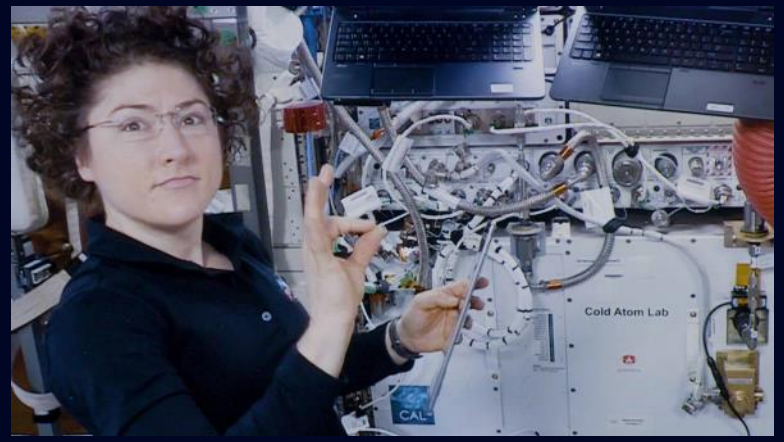
BIOLOGICAL AND PHYSICAL SCIENCES



Craig Kundrot
Director, Biological and Physical Sciences Division
NASA

Overview

BPS Vision



Example of Physical Sciences research: Studying quantum gasses

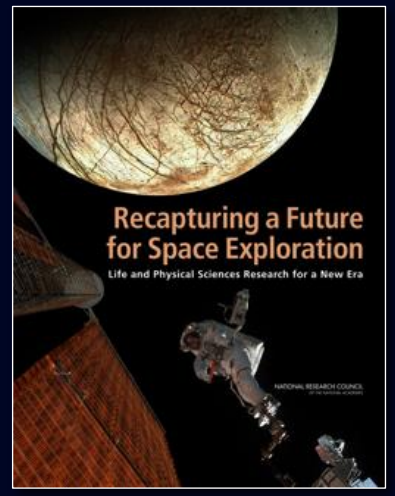
Example of Space Biology research: Growing plants in space

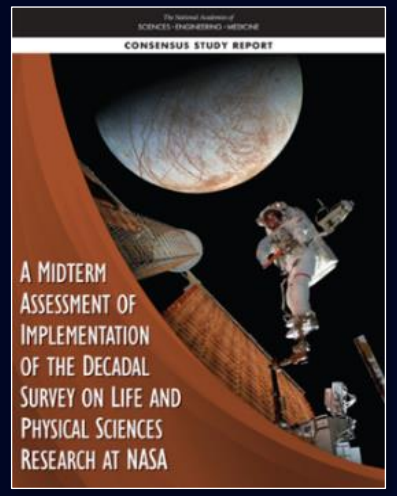
We use spaceflight environments to study biological and physical systems.

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

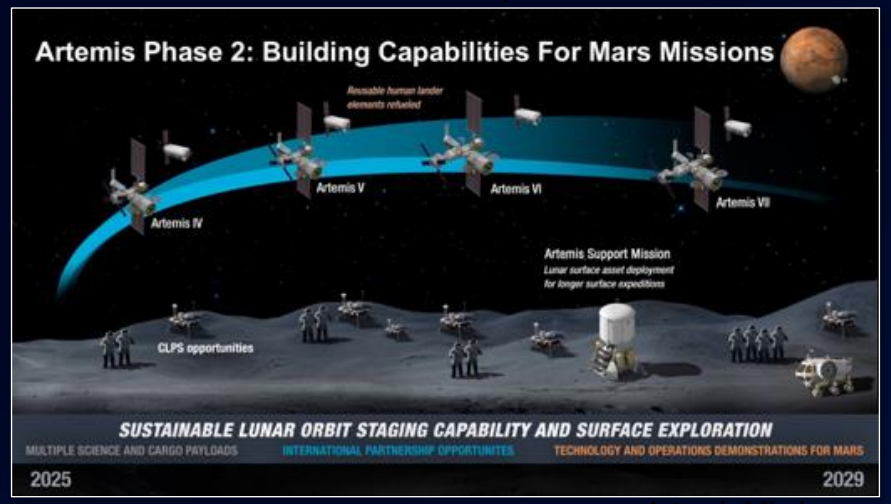
- **This can contribute to significant scientific and technological advancements that**
  - make fundamental advances in science,
  - enable space exploration, and
  - benefit life on Earth.

BPS Mission





Decadal Survey



Artemis Missions

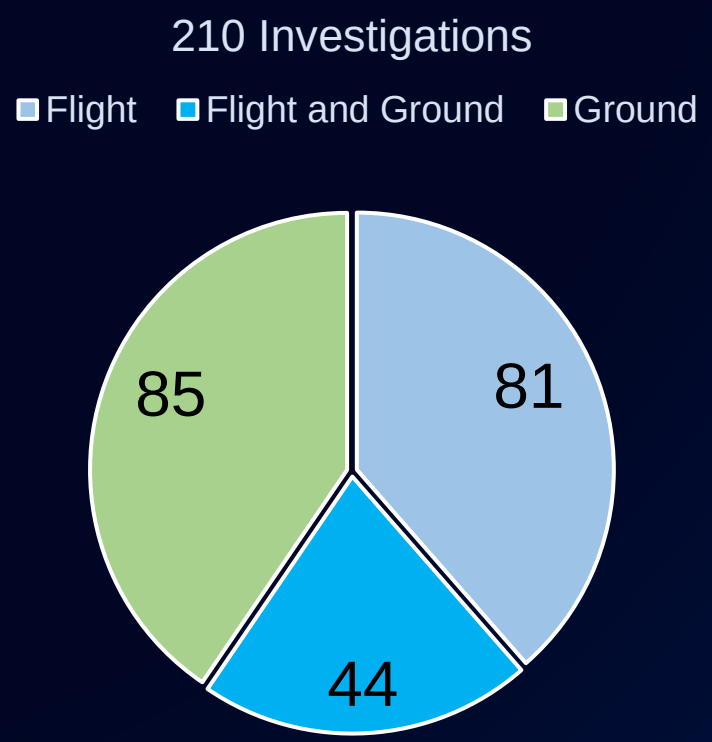
Pioneer Scientific Discovery

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

Enable Sustainable Exploration

- Anticipate and investigate critical areas for scientific knowledge and technology development
- Deliver results to other NASA organizations and industry

BPS Research Spans Many Disciplines

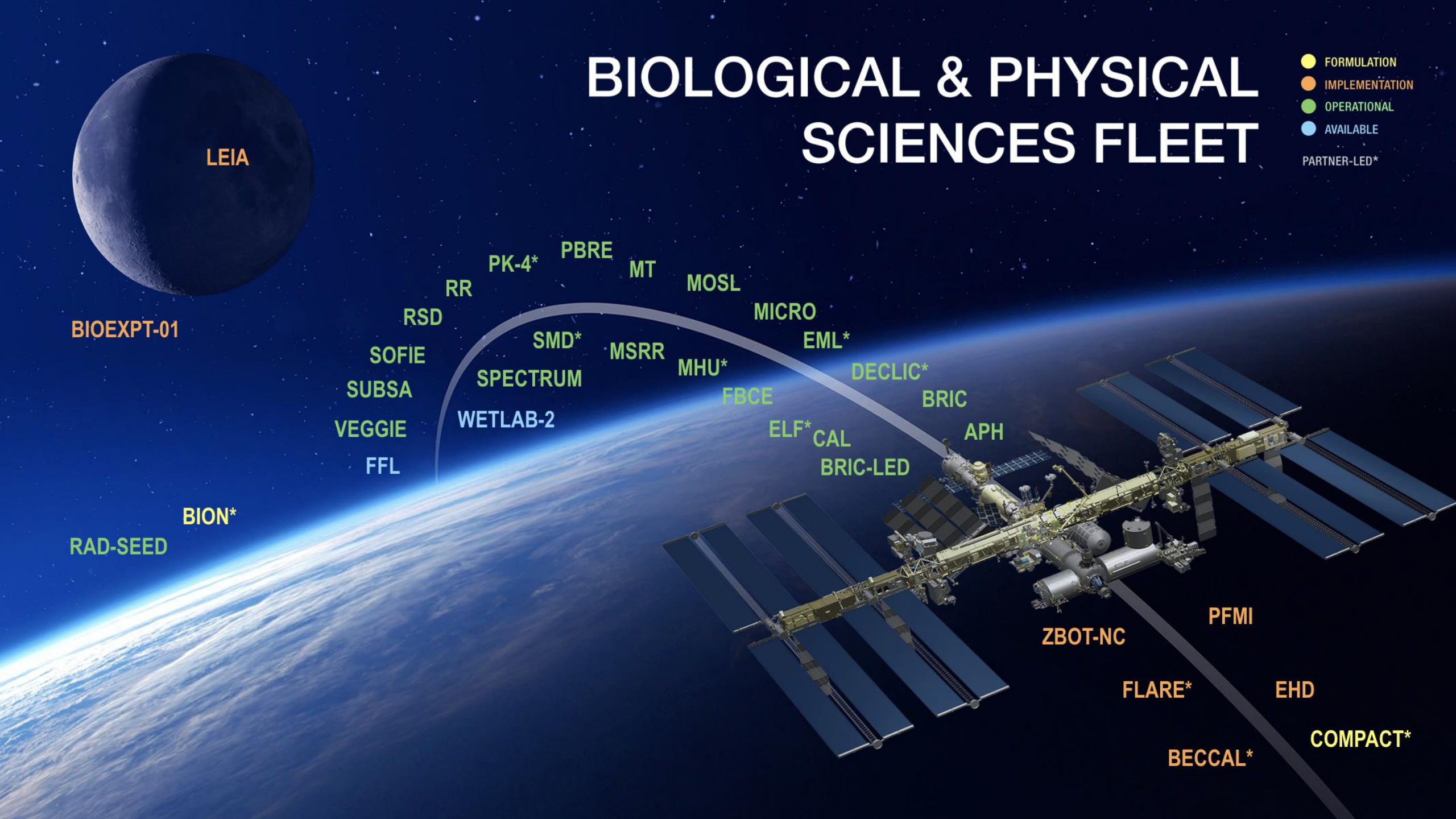


- Animal Biology
- Plant Biology
- Microbiology
- Soft Matter
- Fluid Physics
- Combustion
- Materials Science
- Fundamental Physics

BIOLOGICAL & PHYSICAL SCIENCES FLEET

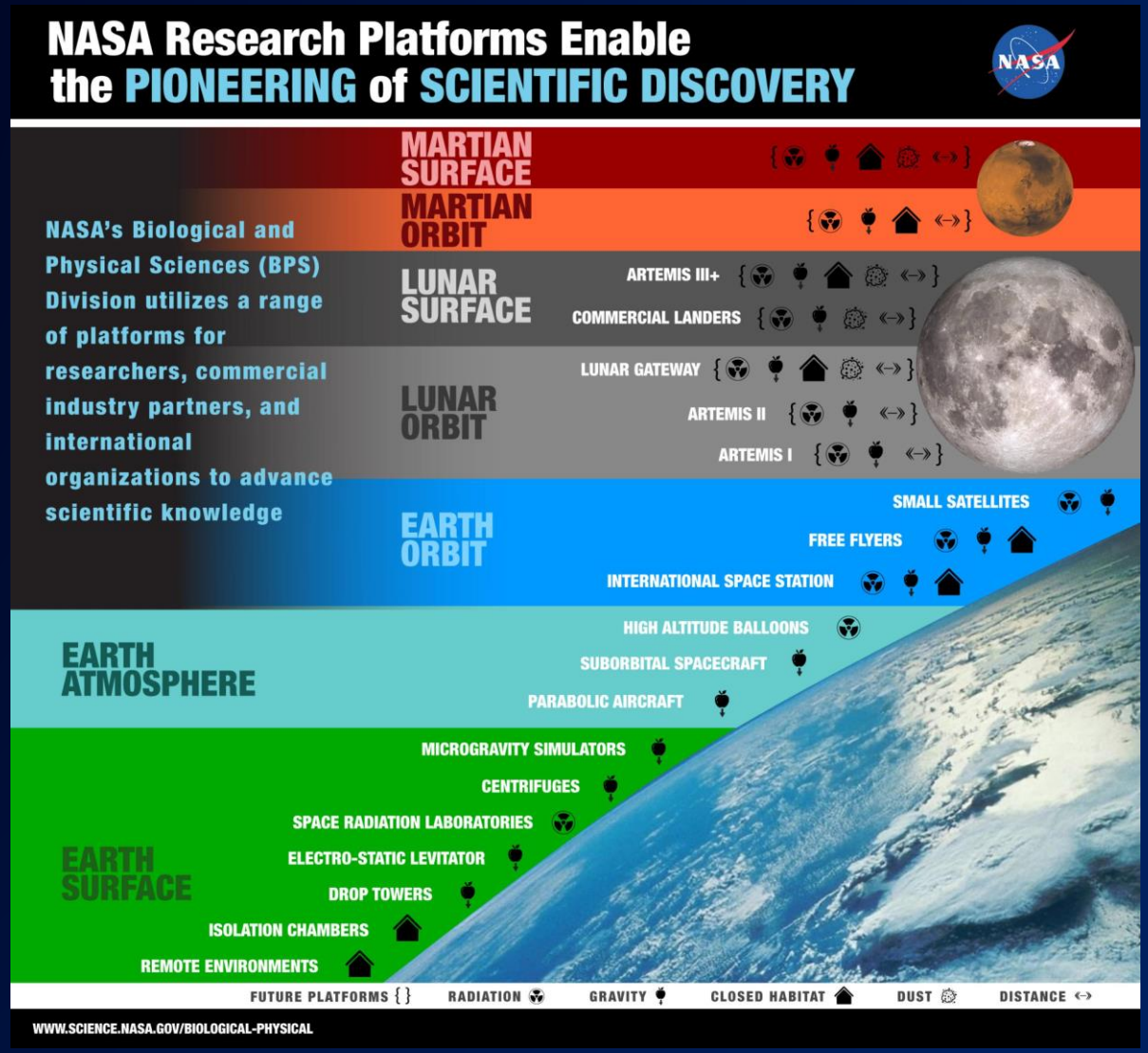
- FORMULATION
- IMPLEMENTATION
- OPERATIONAL
- AVAILABLE

PARTNER-LED*

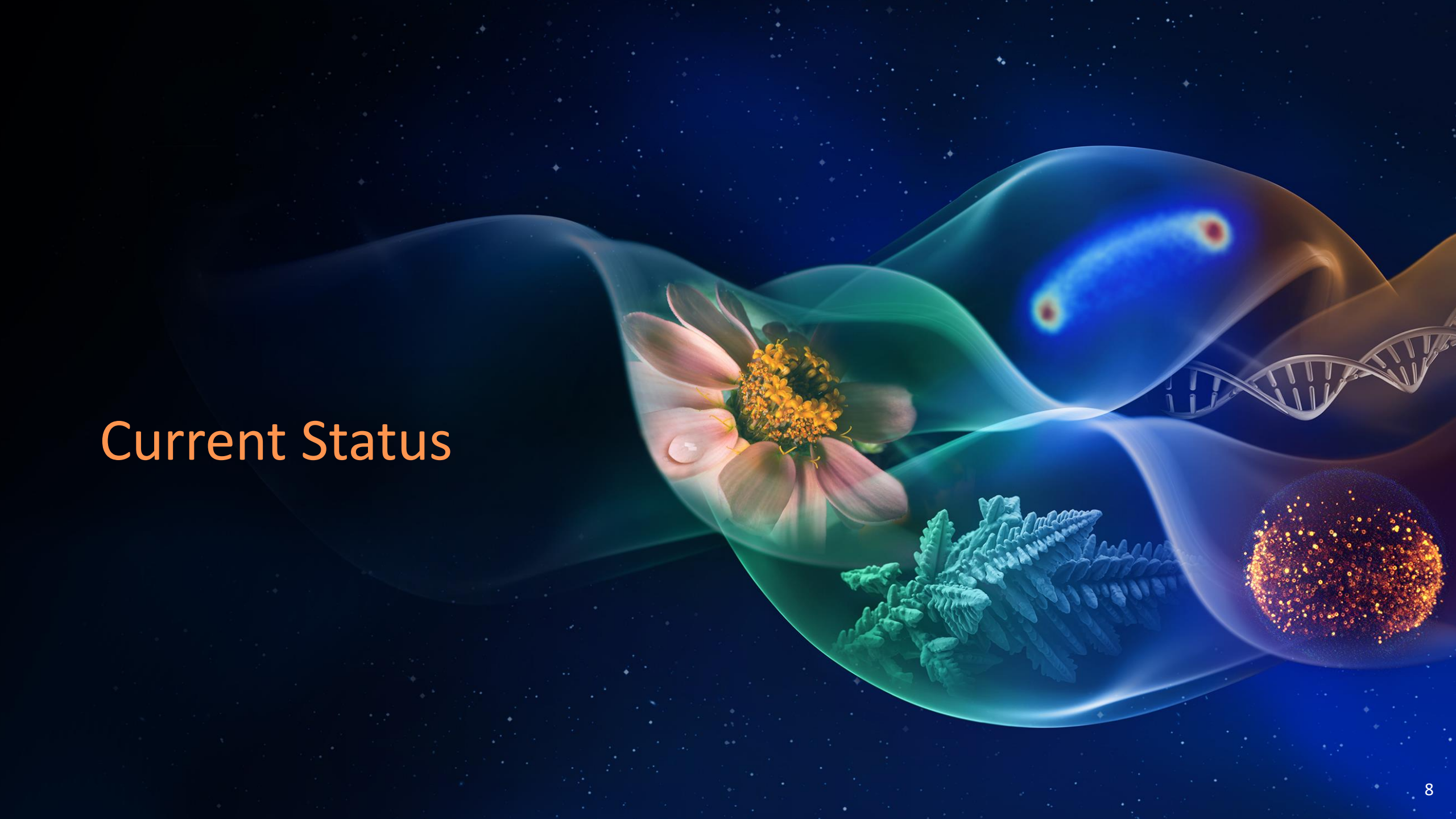


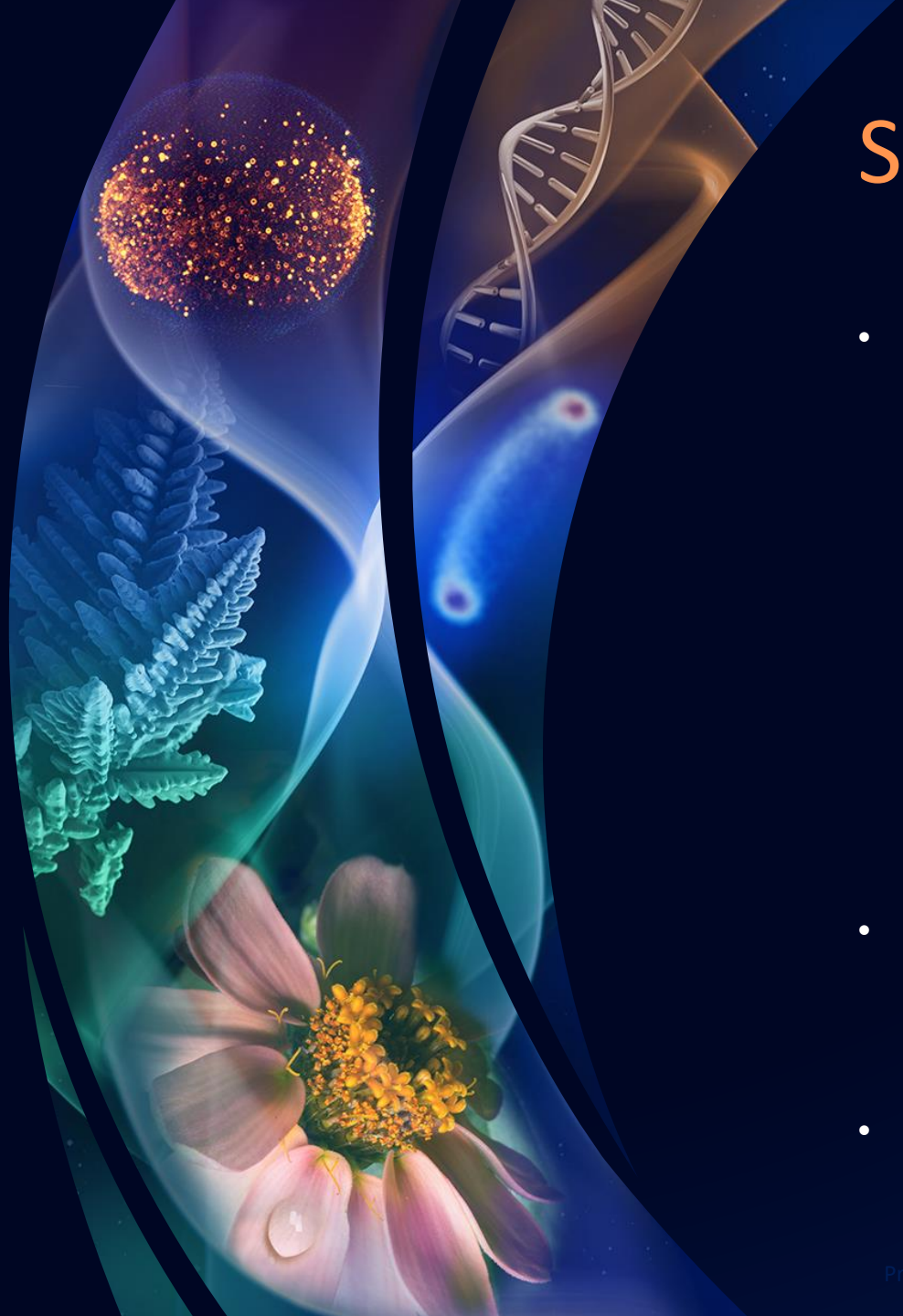
Research Platforms

The specific research questions drive the use of one or more platforms



Current Status



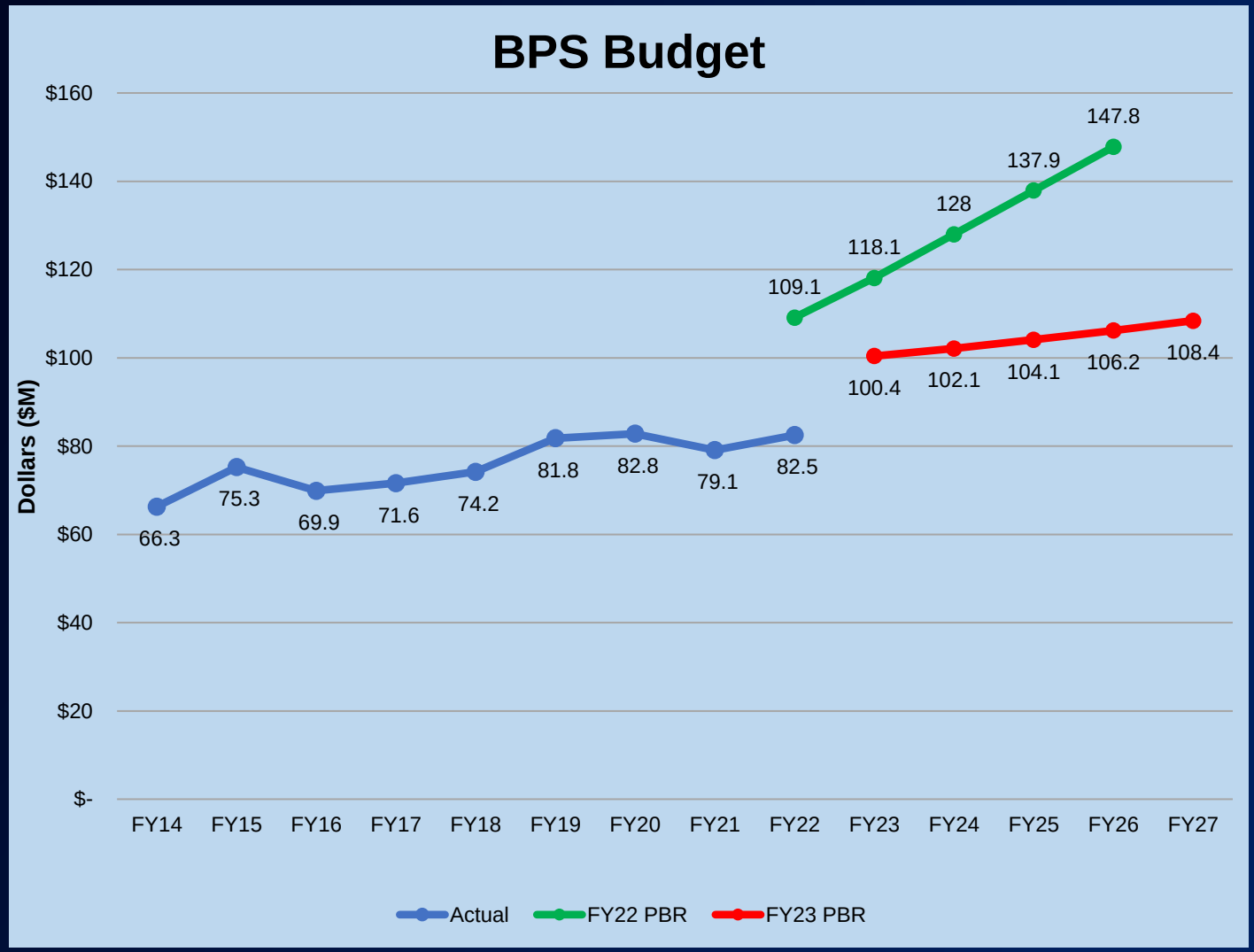


Strategy

- Continue “base” program
  - Maintain focus on and solicit new ground and flight research in two areas
    - Quantum science
    - TIDES (Thriving in Deep Space)
  - Fulfill 2011 Decadal commitments in other disciplines
    - No new research in soft matter, fluids, combustion, materials science
  - Expand Open Science and IDEA activities
- Launch commercial initiative (CERISS) to increase research productivity and research demand in low Earth orbit
- Prepare to respond to the 2023 Decadal Survey

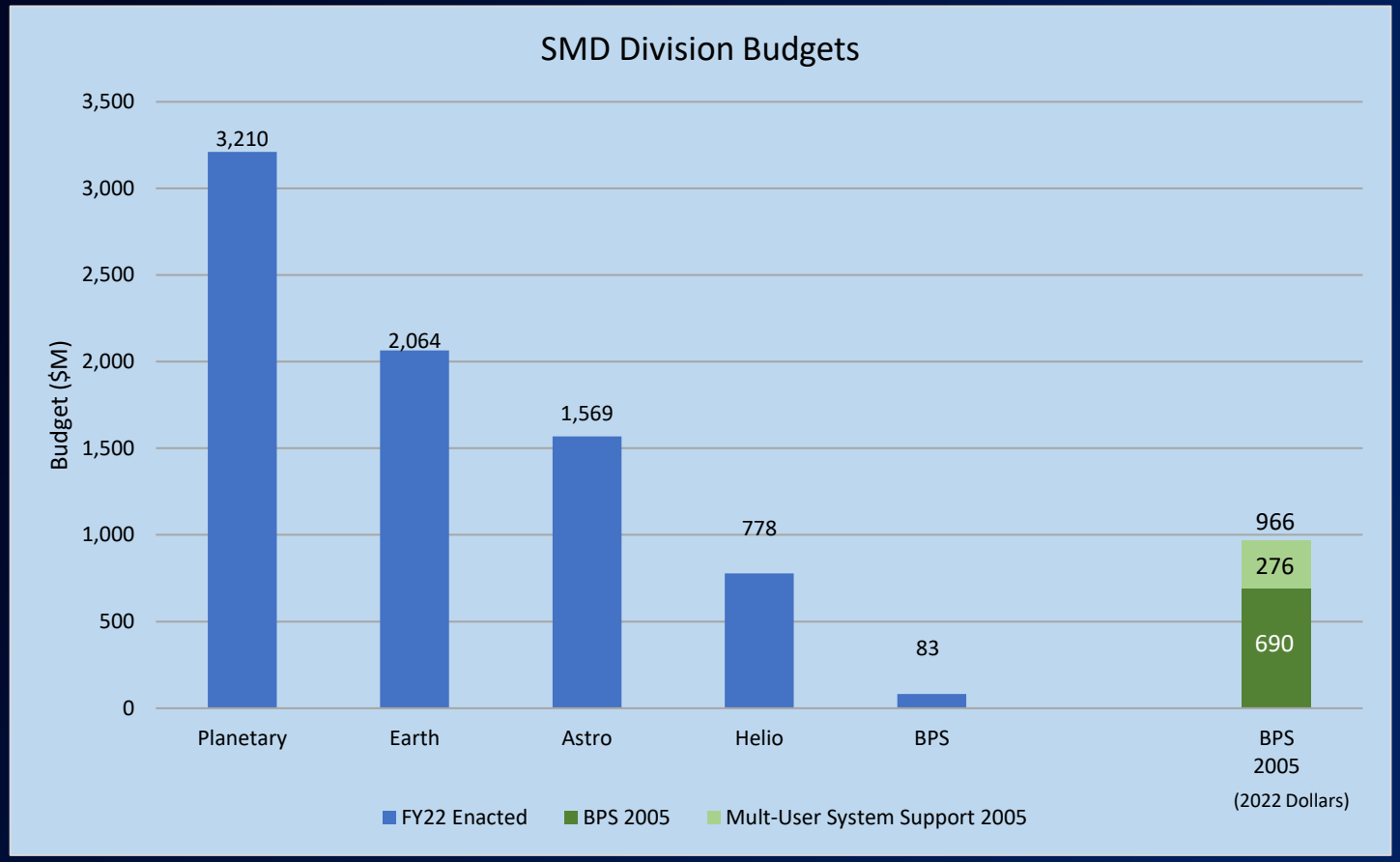
BPS Budget Plan

- **BPS move from Human Exploration and Operations Mission Directorate (HEOMD) to Science Mission Directorate (SMD) in 2020 has been beneficial**
  - BPS line added to the congressional budget (no longer embedded within ISS)
  - Pivot to focus areas generated advocacy from NASA Leadership and OMB
- **Base program to operate at FY22 levels**
- **Commercial initiative (CERISS) to be funded by planned budget growth starting in FY23**
- **Future challenges**
  - $5-10M/year ISS subsidy ends in FY25
  - Execute Decadal Survey recommendations
    - Build or "rent" new facilities for CLDs, Artemis, and/or free-flyers
    - Restore balance between ground-based research and flight-based



Budget Context

- Proposed growth in BPS budget is a small amount within the SMD budget
- Research funding (BPS) and research hardware development and operations (MUSS) were higher during the first phase of ISS utilization (2005)



Three Big Changes

The Next Decadal Survey for BPS (2023-2032)

- Recommendations for a decade of transformative science at the frontiers of biological and physical sciences research in space
  - Uniquely advance scientific knowledge,
  - Meet the needs of human and robotic exploration missions, and/or
  - Provide terrestrial benefits
- Recommendations for implementing the transformative science goals and objectives
  - Research activities
  - Associated facilities and platforms (“Keystone Capabilities/Missions”)
  - Research Campaigns

The transformative science conducted through Keystone Capabilities and Research Campaigns will be the building blocks of BPS’s scientific program for the next decade

Artemis

Orion Capsule
- Artemis I: BioExpt-01
- Artemis II: Solicited

Gateway

BPS

Human Landing Systems
- Planning

Commercial Lunar Payload Services Lander
- LEIA: Lunar Explorer Instrument for space biology Applications (SMD ESSIO funded)

Commercial Capabilities

- Sub-orbital
  - Blue Origin, Virgin Galactic
- Commercial LEO Destinations
  - Axiom Space, Blue Origin, Nanoracks, Northrop Grumman
- Commercial Lunar Payload Services
  - Astrobotic Technology, Blue Origin, Ceres Robotics, Deep Space Systems, Draper, Firefly Aerospace, Intuitive Machines, Lockheed Martin Space, Masten Space Systems, Moon Express, Orbit Beyond, Sierra Nevada Corporation, SpaceX, Tyvak Nano-Satellite Systems

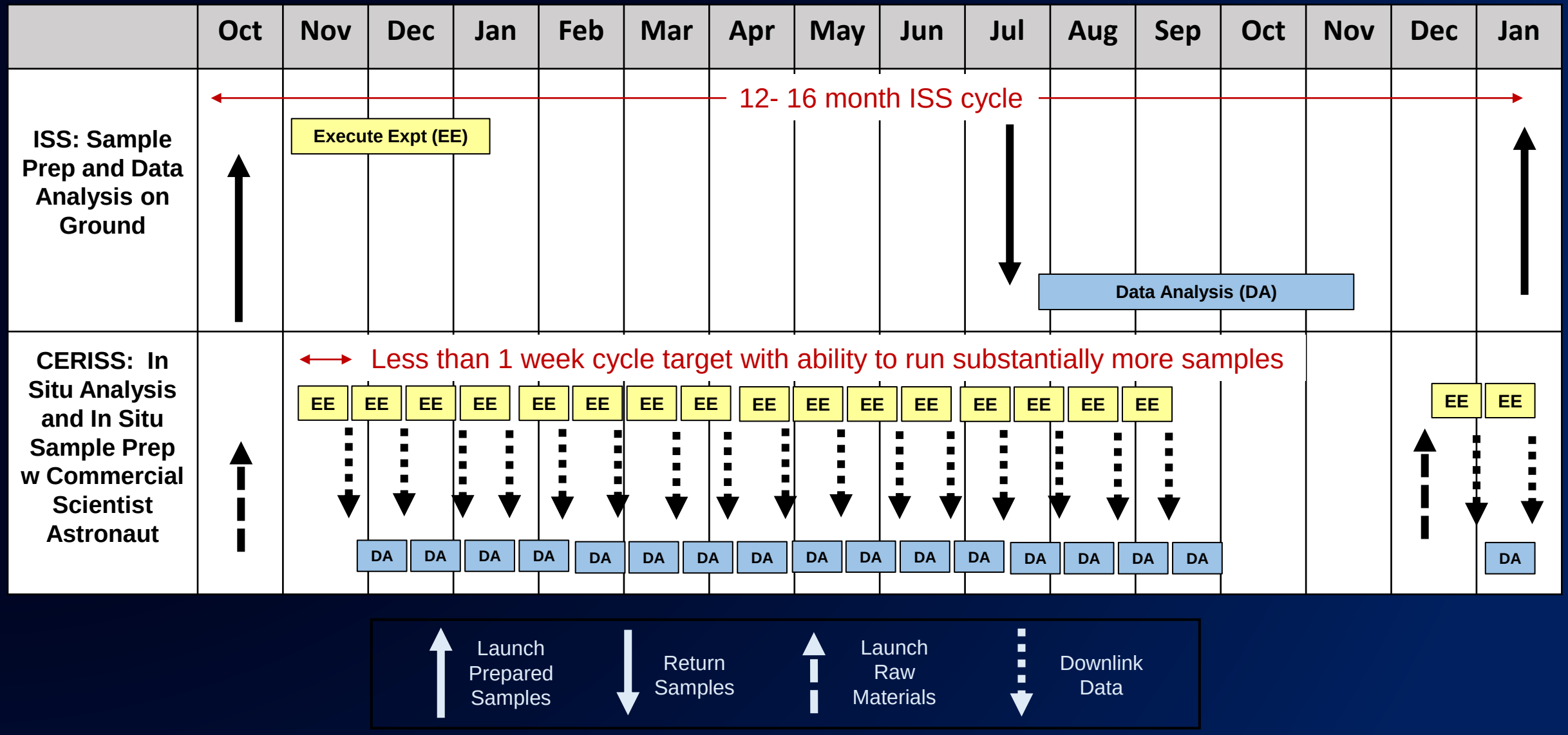
- Payload development and operations for all of the above
  - Dozens of companies

Commercially-Enabled RapId Space Science (CERISS)

Commercially-Enabled RapId Space Science (CERISS)

- Objective
  - Develop transformative research capabilities with commercial space industry to dramatically increase pace of research
- Long-Range Goals
  - Conduct Scientist Astronaut Missions (SAMs) on the ISS and Commercial LEO Destinations
  - Develop automated hardware for experiments beyond low Earth orbit (e.g., lunar surface)
- Motivation
  - The pace of ISS research is too slow for OGAs and industry; it can take years to plan, develop, launch, operate, return samples and begin the cycle again
- Benefits
  - 10- to 100- fold faster pace of research for a wide range of research sponsored by BPS, NASA Human Research Program, OGAs, and industry
  - Increases demand for R&D in low Earth orbit, facilitating growth of commercial space industry

CERISS Dramatically Improves Pace of ISS Research



CERISS Approach

- Develop and deploy in situ analysis and in situ preparation capabilities in low Earth orbit for use by all astronaut types (NASA, PAM, SAM)
  - Issue RFIs and conduct gap analysis with Space Operations Mission Directorate
    - RFI 1: Existing state-of-the-art capabilities, capabilities in development
    - RFI 2: Decadal Survey priorities that benefit most
  - RFP: Compete contracts for the development of in situ analysis and in situ preparation capabilities
  - ROSES: Compete research grants for using and refining capabilities
    - Ground-based
    - Commercial suborbital flight (crewed), as needed
  - ROSES: Compete research grants to use capabilities in low Earth orbit operated by NASA and/or private astronauts
    - Initially on ISS, then on Commercial LEO Destinations

- Develop plans for BPS missions building on in situ capabilities
  - Scientist Astronaut Missions (SAM)
    - Use Private Astronaut Mission (PAM) capability to fly hyper-specialized scientist for up to 30 days to conduct fast-paced transformative research
    - Initially on ISS, then on Commercial LEO Destinations
  - Automated experiments beyond low Earth orbit
    - Artemis Commercial Lunar Payload Services, Gateway, and Human Landing System
    - Deep Space Free-Flyers

Charge

Charge to BPAC

- Per the BPAC Charter
  - Provide advice and make recommendations to the Director on
    - Programs,
    - Policies,
    - Plans,
    - Priorities and
    - Their implementation
  - Enable a broad discussion of
    - BPS science
    - The role of BPS science within and outside NASA
  - Evaluate BPS annually for progress against its NASA performance objectives
- Process
  - Real-time feedback in the BPAC meeting
  - BPAC Chair provides BPS Division Director with a letter within 90 days of the meeting
    - Summary of meeting events
    - Findings (do not require a response)
    - Recommendations (require a response)
    - Requests for follow-up

Conclusion

BPS over the Next 10 Years

- Pioneer transformative science at the frontiers of biology and physical sciences in space
  - Frontiers: Conceptual and Physical
    - Areas where BPS can uniquely
      - Advance scientific knowledge
      - Meet the needs of exploration missions
      - Provide terrestrial benefits
    - Locations include
      - Commercial and governmental ground-based
      - Commercial sub-orbital
      - Commercial Low Earth Orbit
      - Lunar orbit (Gateway)
      - Lunar surface (Commercial Lunar Payload Services, Human Landing System)
      - Mars transit vehicle
  - Pioneer
    - BPS first or among first at a frontier
    - Expect other organizations (government, commercial, academic, international) may join or follow

Conclusion

- As commercial spaceflight capabilities expand in sub-orbital, LEO, and lunar domains and
  - As NASA plans to
    - return to the lunar surface,
    - develop sustainable lunar habitation, and
    - prepare to explore Mars

- Biological and Physical Sciences will, guided by the 2023 Decadal Survey, tackle the most transformative research questions
  - To pioneer scientific discovery,
  - Enable sustainable exploration,
  - Benefit life on Earth

Thank you

SMD FY23 Budget Status

$M	FY22 Enacted	FY23 President's Budget Request	FY23 draft House approp	*Delta to FY22 Enacted*	*Delta to FY23 PBR*	FY23 draft Senate approp	*Delta to FY22 Enacted*	*Delta to FY22 PBR*
Earth Science	2,064.7	2,411.5	2,334.8	*270.1*	*(76.7)*	2,346.1	*281.4*	*(65.4)*
Planetary Science	3,120.4	3,160.2	3,200.0	*79.6*	*39.8*	3.209.8	*89.4*	*49.6*
Astrophysics (incl. JWST)	1,568.9	1,556.0	1,525.0	*(43.9)*	*(31.0)*	1,561.0	*(7.9)*	*5.0*
Heliophysics	777.9	760.2	760.2	*(17.7)*	*-*	828.4	*50.5*	*68.2*
BPS	**82.5**	**100.4**	**85.0**	***2.5***	***(15.4)***	**100.4**	***17.9***	**-**
Total Science	**7,614.4**	**7,988.3**	**7,905.0**	*290.6*	*(83.3)*	**8,045.7**	*431.3*	*57.4*