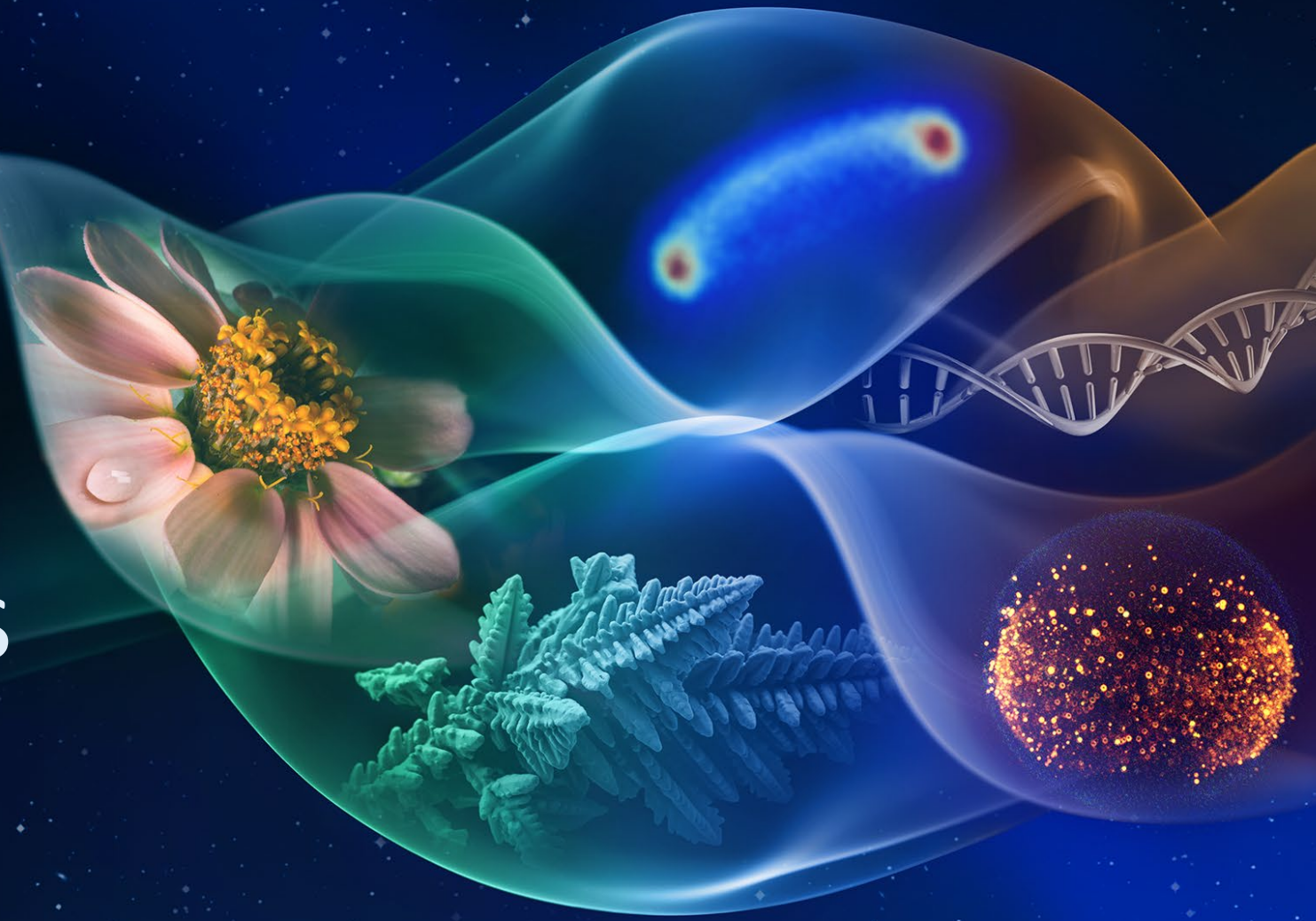
National Aeronautics and Space Administration

BPS
BIOLOGICAL AND PHYSICAL SCIENCES

BPS Status: CBPSS

Diane Malarik
Acting Division Director
March 29, 2023

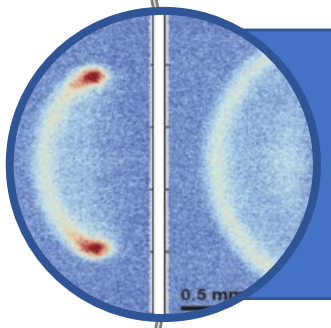


BPS Overview

NASA's Biological and Physical Sciences Division will…

Lead the world in fundamental space-based research

- Pioneer transformational discoveries
- Enable sustained deep-space human exploration
- Improve life on Earth and in space



Focus on three initiatives

- Thriving In Deep Space (TIDES) (animal biology, plant biology, microbiology)
- Quantum Science
- Commercially Enabled RapId Space Science (CERISS)

Prepare for the 2023-2032 Decadal Survey

- Prepare for release in summer 2023
- Host public Town Hall within ~90-120 days of receipt
- Stand up working groups, committees, and roadmaps

- Red text indicates a new hire to BPS, or a new role for the individual, if the role is also in red
- A red box indicates a new program element in BPS

BIOLOGICAL AND PHYSICAL SCIENCES (BPS) ORGANIZATIONAL CHART

3/3/2023

Director – Diane Malarik*
Deputy Director – DeVon Griffin*
R&A Lead – Francis Chiaramonte

Sarah Veasaw (c)+ – Program Support Specialist

Executive Officer – Haley Fauntleroy (c)

Partnerships
Lisa Carnell – Program Scientist for Translational Research, HRP Liaison

Doug Gruendel – Partnerships, EPSCoR and Launch Guest Services

Fran Chiaramonte – Emerging International

TBD – BPS Scientist for OGA Partnerships

Exploration (ESDMD)
Kevin Sato (d) – Program Scientist for Exploration

LEO (SOMD)
Mary Walsh – ISS Lead
Lisa Carnell – CLD Lead

Technology (STMD)
Hans Hansen – Tech Fed Rep, SBIR Topic Manager

Education and Early Career
Lisa Carnell – Lead

IDEA Coordination
Mary Walsh
Kevin Sato (d)

ISS Payload Office (JSC/OZ)
Ryan Prouty – OZ Division Chief
Kirt Costello – ISS Chief Scientist
Kevin Hames – Manager, Natural Sciences Client Support Office
Leslie Espino – BPS Physical Science Sphere Lead
Jenna Comella – BPS Space Biology Sphere Lead

Office of the Chief Scientist
Kate Calvin – NASA Chief Scientist
Mamta Nagaraja – Associate Chief Scientist for Exploration and Applied Research

Office of the Chief Health and Medical Officer
Victor Schneider – Program Executive

Matrixed Support

Admin Support
Sara Schwartzman – Program Support Specialist

Resources
Ralph Beaty – Financial Analyst

Policy
Shea Kearns – Policy Analyst
Madi Sengupta – Policy Analyst Support

OCFO
Claire Wilhelm – OCFO/SID Liaison to BPS

OIIR
Gib Kirkham – Science Division Director
Andy Masciola – OIIR Liaison to BPS

OLIA
Andy Rowe – OLA Liaison to BPS

Communications Team
Gamble Gilbertson (c)+ – Communication Team Lead

Julie Lele (c) – Messaging and Communications Strategist

Bryana Quintana (c) – Communications Producer Social Media Lead

Keara Mangan – Event and Project Coordinator

Program Support Team
Joe Burg (c)+ – DATSS Task Lead, Program Support Team Lead

Aadel Ragaban (c)+ – GetSmart Technical Developer Lead

Jason Levine (c) – Schedule, Risk, & Data Manager

Hannah Cubberley (c) – Process and Documentation Support

Space Biology
John Howard – Program Manager

Sharmila Bhattacharya – Program Scientist

Mary Walsh – Rodent Research Policy and Implementation

Lynn Harrison (I) – Deputy Program Scientist, Rodent Research Policy and Implementation Scientist

Anthony Hickey (c) – Support Scientist

CERISS
Mary Walsh – Program Manager

Lisa Carnell – Program Scientist

Physical Sciences
Hans Hansen – Program Manager

Bradley Carpenter – Program Scientist, Fluids, Combustion, Materials

Mike Robinson – Program Scientist, Fundamental Physics, Soft Matter

ARC
Amy Gresser – Portfolio Manager

Jonathan Galazka* – Portfolio Scientist

KSC
Bryan Onate – Portfolio Manager

Howard Levine – Portfolio Scientist

GRC
Kelly Bailey – Portfolio Manager

David Urban – Portfolio Scientist

MSFC
Shawn Reagan – Portfolio Manager

Mike SanSoucie – Portfolio Scientist

JPL
John Callas – Portfolio Manager

Nan Yu – Portfolio Scientist

Key

- Level 1
- Level 2
- Level 3
- External

(d) Detailee
(c) Contractor
(I) IPA
* Acting
\+ Part-Time

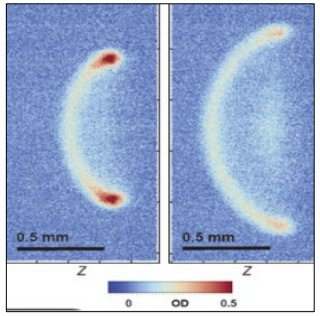
Acronyms

ARC	Ames Research Center	KSC	Kennedy Space Center
CERISS	Commercially Enabled Rapid Space Science	LEO	Low-Earth Orbit
CLD	Commercial LEO Destinations	MSFC	Marshall Space Flight Center
EPSCoR	Established Program to Stimulate Competitive Research	OCFO	Office of the Chief Financial Officer
ESDSM	Exploration Systems Development Mission Directorate	OGA	Other Government Agency
GRC	Glenn Research Center	OIIR	Office of International & Interagency Relations
HRP	Human Research Program	OLIA	Office of Legislative & Intergovernmental Affairs
IDEA	Inclusion, Diversity, Equity, and Accessibility	SBIR	Small Business Innovation Research
ISS	International Space Station	SOMD	Space Operations Mission Directorate
JPL	Jet Propulsion Lab	STMD	Space Technology Mission Directorate
JSC/OZ	ISS Research Integration Office		

BPS Successes

- **Pioneered scientific firsts**
  - First biological experiments to study combined effects of microgravity and radiation on living systems
  - Quantum bubbles and dual-species Bose-Einstein Condensates in orbit using the Cold Atom Lab (CAL)
  - Researchers grew plants in lunar regolith from Apollo missions for first time
  - Mitochondrial dysregulation across all biological systems in microgravity; applicable to aging on Earth
- **Contributed to commercial spinoffs**
  - Zero Boil-Off Tank data informed improvements to Ansys Fluent computation fluids dynamics software utilized by Space-X, interest from other commercial launch providers
  - Flow Boiling and Condensation Experiment contributing to improved advanced cooling techniques which will improve electric vehicle charging systems
  - Space Biology and related studies led to the isolation of compounds that reduce oxidative damage and activate the body's repair enzymes, which contributed to the commercialization of a skincare product; initiated research that led to numerous patents
  - Soft Matter colloids data was fundamental to development of Proctor & Gamble products
- **Contributed to agricultural, biomedical, and technology advancements**
  - Utilized partnerships with USDA, FDA, and NIH
- **Student and education programs**
  - Focused on Inclusion, Diversity, Equity, and Accessibility (IDEA) principles
- **Contributed to open science databases**
  - Contribute to high-impact peer-reviewed publications on data gathered over many decades
  - GeneLab and Ames Life Sciences Data Archive include 430 studies and 813 PI datasets; 45 species and >150TB of data

Experiments aboard Artemis I



Quantum bubbles

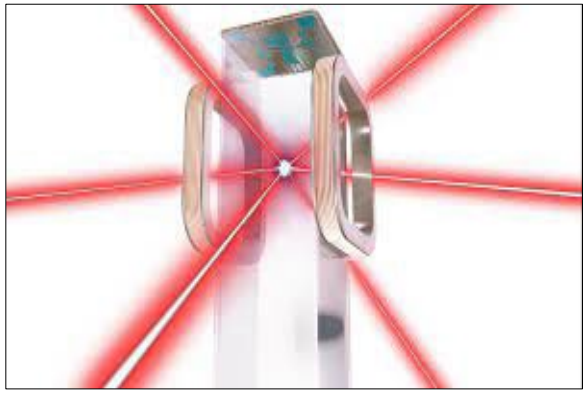
Plants grown in lunar regolith

Focus Areas

Using Space as a Laboratory

Thriving in Deep Space:

Keeping astronauts healthy and productive



Quantum Science:

Making the unknown known

Commercial Initiatives:

Developing the next generation of research capabilities

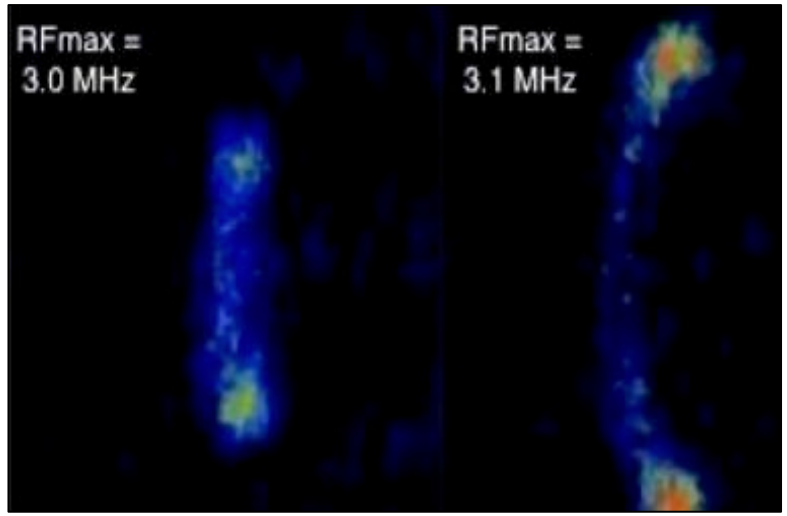
Thriving in Deep Space (TIDES)

- **Focus Area**
  - Determine the mechanisms of how animal models and plants respond to deep-space stressors in combination
- **Long-Range Goal**
  - Enable sustainable, long duration human exploration of the solar system
  - Discover new biological processes in animals and plants
- **Approach**
  - Released regular grant calls soliciting research on the ground and in low-Earth orbit in the areas of space radiation, altered gravity, and the effects of regolith
  - Also solicited research for beyond low-Earth orbit application including on Artemis missions
  - Partnered with NASA's Human Research Program (HRP), Astromaterials Research & Exploration Science (ARES), and Exploration Science Strategy and Integration Office (ESSIO) to release these solicitations to the community
- **Context**
  - Enable sustainable human exploration of space by understanding human physiology in flight and how to provide crop plants on missions
  - Identify responses to combined effects of space radiation, microgravity, altered atmospheres, etc., common across spectrum of model organisms
  - Progress from unicellular organisms to vertebrate animals and crop plants
- **Benefits**
  - Identify potential biomarkers and countermeasures for crew health and performance
  - Enable crop plant production for micronutrients and improved behavioral health
  - Test utility of spaceflight for identifying mechanisms in aging and disease
  - Improve terrestrial controlled-environment agriculture

University of Florida researcher, Dr. Anna-Lisa Paul, harvesting the Arabidopsis thaliana plants for genetic analysis

Quantum Science

- **Focus Area**
  - Properties of quantum matter/quantum gases
- **Long-Range Goal**
  - High-precision tests of General Relativity and Quantum Mechanics
  - Direct gravitational detection of Dark Matter and Dark Energy
- **Approach**
  - Upgrades to Cold Atom Lab –SM-3B
  - 2022 NRA: 7 new investigations (4 ground, 3 flight)
- **Context**
  - Conduct high-precision experimental space physics
    - Studies of quantum matter and spacetime using space laboratories
      - Test-mass or specimen under study in the laboratory
      - Einstein equivalence principle, gravitational physics, physics beyond the Standard Model, quantum mechanics
- **Benefits**
  - Potential innovations in sensors, computing, memory, navigation, and communications



Quantum Matter condensate bubbles enabled by microgravity using Cold Atom Lab aboard the ISS (PI: Nathan Lundblad)

Paul Rudd, actor, "Ant-Man and the Wasp: Quantumania," discusses Quantum Science with NASA

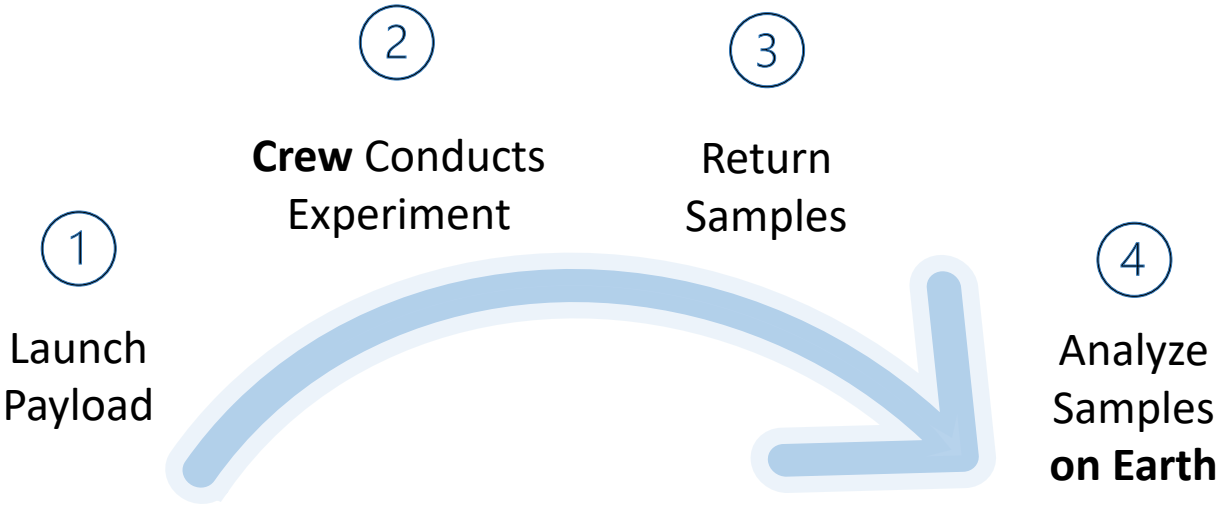
Commercially Enabled RapId Space Science (CERISS)

- **Focus Area**
  - Develop transformative research capabilities with commercial space industry to dramatically increase pace of research
- **Long-Range Goals**
  - Emulate ground-based laboratory in LEO for end-to-end research (e.g., mixing a powder in a solvent)
  - 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)
- **Approach**
  - Collaborating with Flight Opportunities Program on research solicitations to test concepts via suborbital flights, progressing hardware via contracts and grants
  - Reviewing Requests for Information from commercial companies and research community to determine capabilities
- **Context**
  - New capabilities for platforms and payload are being developed now by commercial space in preparation for the transition from ISS in 2030
  - There are gaps in the development of capabilities for in situ analysis and in situ experiment preparation
  - Private Astronaut Missions provide a new mechanism for hyper-specialized researchers to conduct research in LEO
- **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

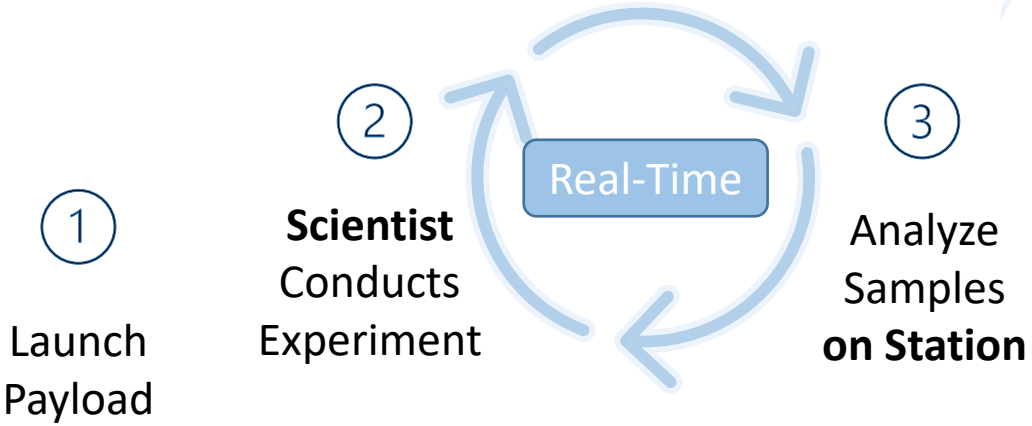
Astronaut Christina Koch works on Cold Atom Lab aboard the ISS

CERISS Accelerates the Pace of Research

- **TODAY**
  - Linear process
  - Crew may not have science background
  - Inability to refine experiment in situ
  - 6-12 months for sample return, single experiment

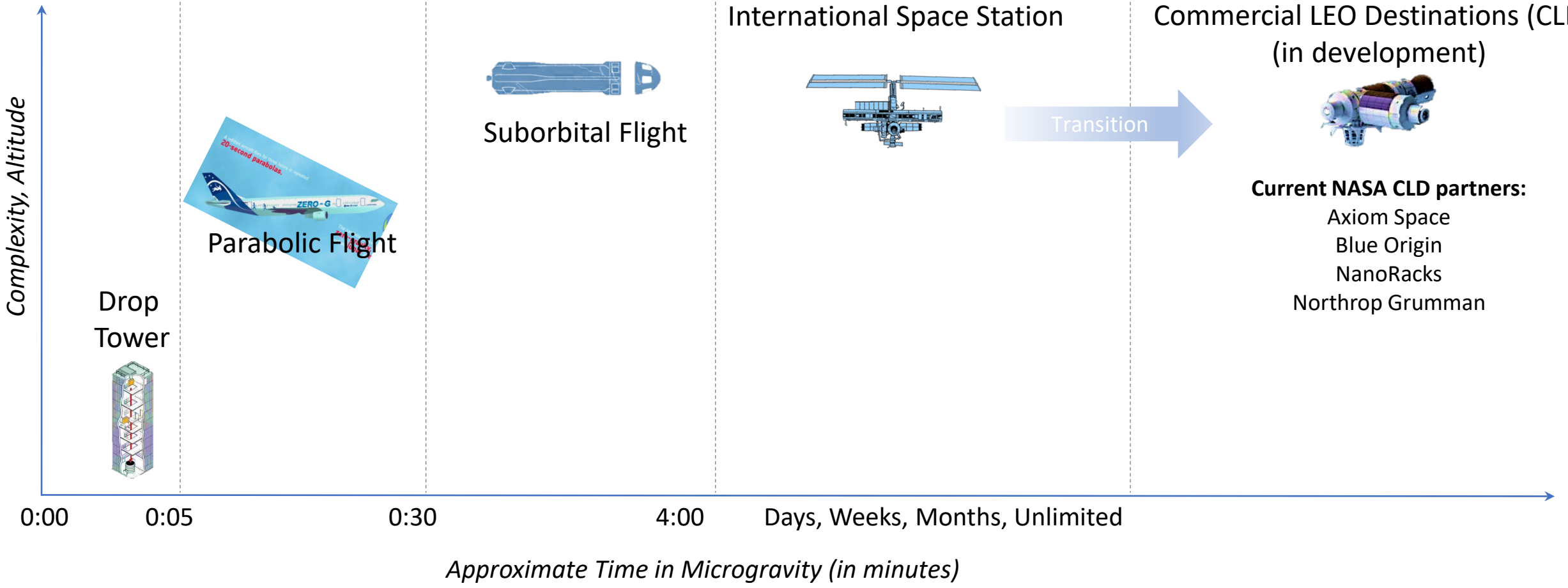


- **CERISS**
  - Scientist astronaut performs experiment
  - Iterative, in situ sample prep and analysis
  - Real-time results
  - Multiple experiments
  - Increases pace 10- to 100-fold
  - Requests for Information due 3/31/2023

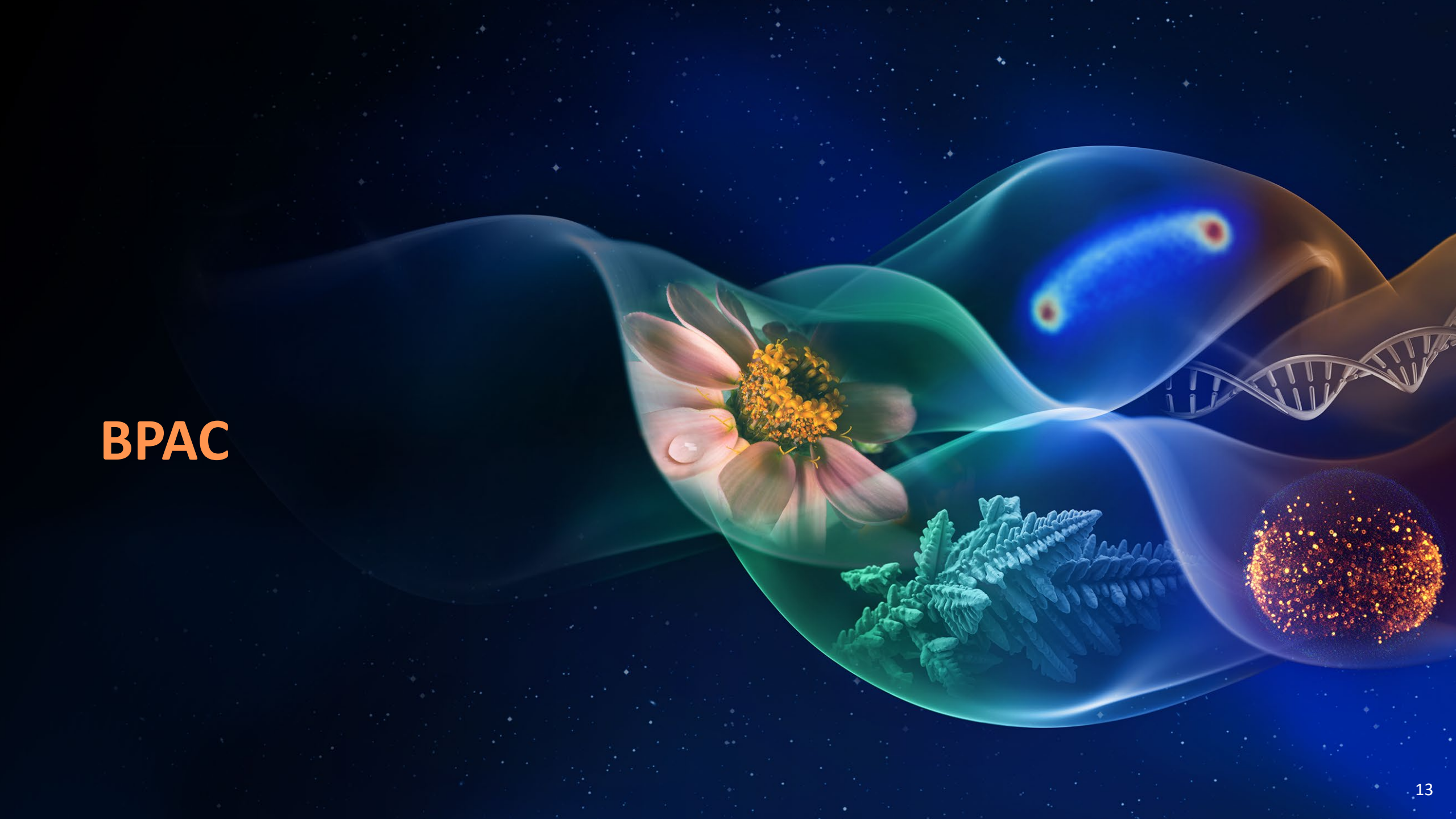


BPS's Suborbital to Orbital Progression

***Flight Opportunities solicitation planned for April 2023 for "TechFlights" to support CERISS – up to $1M in proposed flight services**



BPAC



The Biological and Physical Sciences Advisory Committee (BPAC)

- **Advisory committee chartered under the Federal Advisory Committee Act (FACA)**
- **Provides BPS advice that is relevant, objective, and open to the public**
- **Serves to fulfill GPRAMA review requirement**
  - Government Performance And Results Modernization Act of 2010 (GPRAMA)
- **Reports delivered promptly**
- **Meets 1-2 times per year**
  - Dr. Jamie Foster – Chair (UF)
  - Dr. Ken Davidian (Impossible Research LLC)
  - Will Davis (NASA)
  - Dan Dumbacher (AIAA)
  - Dr. Simon Gilroy (UW)
  - Mary Guenther (CSF)
  - Dr. Nathan Lundblad (Bates)
  - Dr. Maren Mossman (UCSD)
  - Dr. Jim Pawelczyk (PSU)
  - Dr. Aleksandra Radlinska (PSU)
  - Dr. Ali Rangwala (WPI)
  - Dr. Kate Rubins (NASA)
  - Dr. Dan Tagle (NCATS)
  - Dr. Mark Weislogel (IRPI LLC)

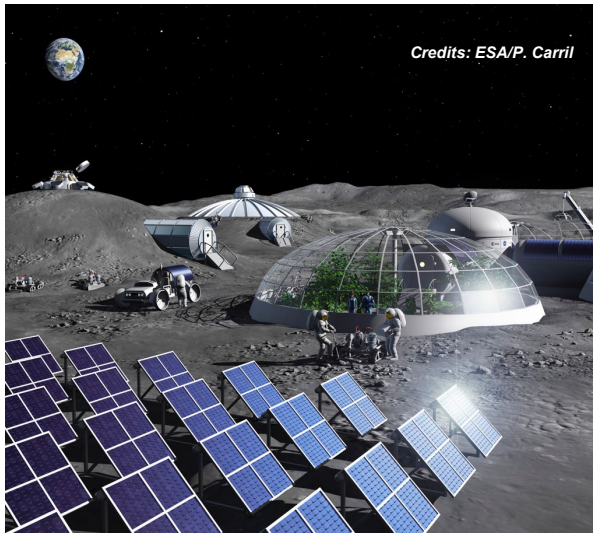
Priorities, Challenges & Opportunities

BPS Priorities

- **Continuing to honor its previous commitments to the research community**
- **Using ISS to the maximum extent possible; BPS utilizes an average of 18% of ISS crew time available**
- **Prioritizing Quantum and TIDES via NRAs for flight and ground investigations**
- **Beginning CERISS initiative**
- **Continuing to leverage strategic partnerships within NASA, inter-agency, and internationals**
  - For example, Tissue Chips with NIH and HRP; Regolith studies with JSC using Apollo samples; Cold Atom research and Plasma Physics research with DLR
- **Maintaining core capabilities across all disciplines in anticipation of release of decadal survey**
- **Eliminated new major hardware developments to focus on three emphasis areas**
  - Modest-cost hardware upgrades to existing facilities in Fluids (cryogenic fluid management and thermal control) and Quantum
- **Conducting fundamental experiments critical for supporting Moon and Moon2Mars missions**

Moon to Mars

- **Focus Areas**
  - Integrative physiology and molecular omics studies to understand biological responses and adaptation to extreme planetary and deep space environments (Space Biology)
  - Multi-disciplinary physical sciences studies to understand how partial gravity and other planetary and deep-space environmental factors affect physical system behavior and dynamics (Physical Sciences)
  - High-precision experimental space physics in Einstein Equivalence Principle, Gravitational Physics, Physics beyond the Standard model, Quantum Matter, and soft matter (Fundamental Physics)
- **Long-Range Goal**
  - Advance fundamental scientific knowledge that answer theories and hypotheses of long standing
  - Reveal the underlying mechanisms that govern fundamental life and physical processes according to the laws of nature and physics in any exploration mission location and environment
  - Develop high fidelity computational and functional models that will aid in developing technologies and applications to maintain human health and safety during long duration, deep-space and planetary exploration missions
- **Approach**
  - Use all Earth-based, low-Earth orbit, Moon, and Mars platforms to conduct research investigations
  - Develop collaborations within and external to NASA and engage the diverse science communities to identify high priority science and conduct research that will provide the greatest return on science and investments



Living on the Moon

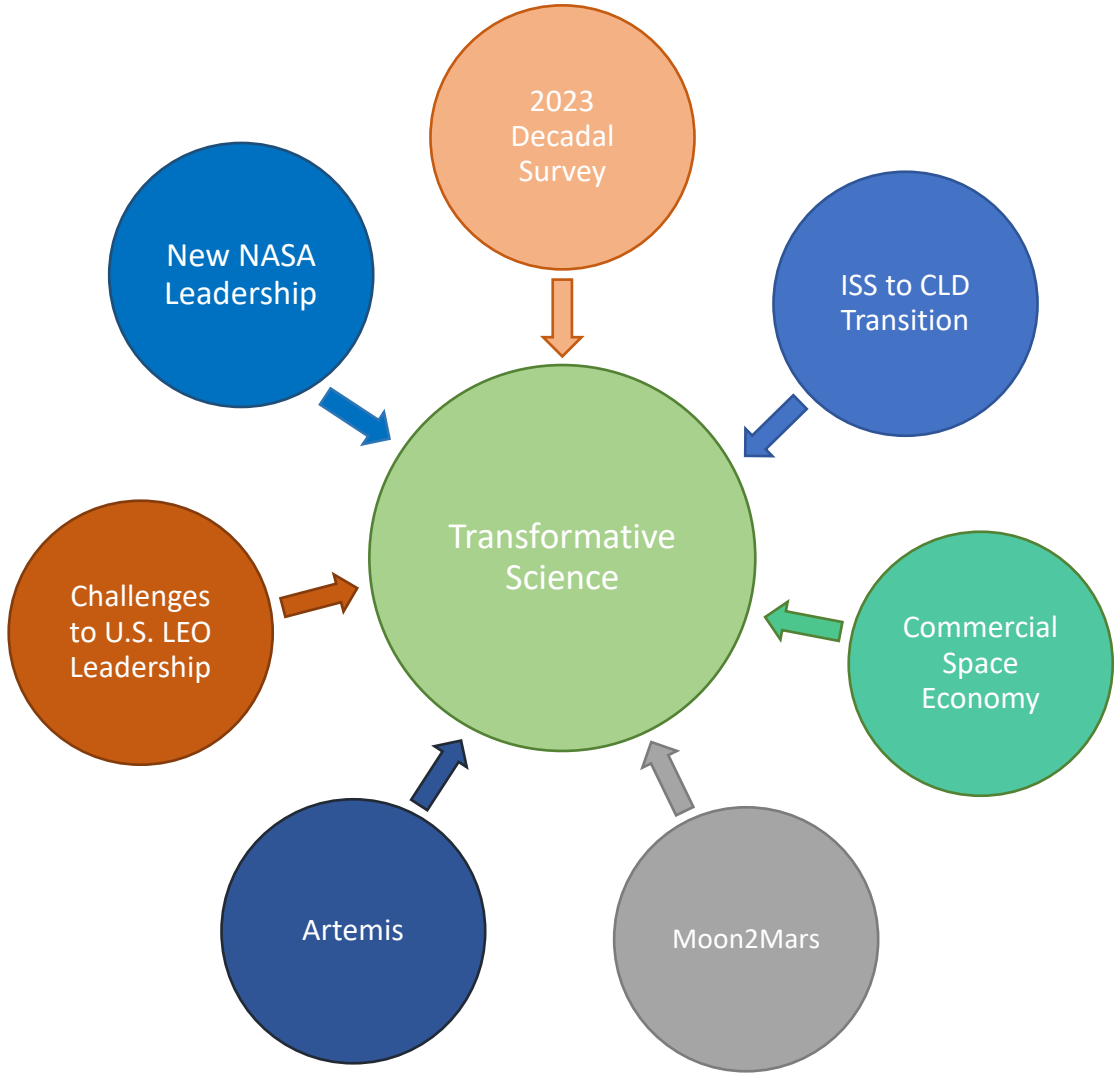
- **Context**
  - Enable sustained human exploration in the solar system through scientific discovery
  - Close important knowledge gaps the eliminate barriers to successfully developing exploration enabling technologies and applications
- **Benefits**
  - Deliver new scientific knowledge that will translate to advancements in research, research and development, engineering, technologies, and medical health benefits for both space exploration and humans on Earth
  - Provide enabling data and knowledge to private industry that is essential for developing a sustainable commercial space economy
  - Advance Mars exploration through knowledge gained from biological and physical sciences research on the Moon

BPS Challenges

- **Limits on crew time, up-mass, down-mass, and stowage have constrained BPS research aboard ISS**
  - BPS is unable to complete planned research at planned pace, due to number of other users
- **BPS responsible for content previously provided by ISS Program (database management, Mission Integration & Operations costs)**
- **Uncertainty in CLD capabilities (and costs) and international participation; research facilities should be in development now for use in 2028**
- **FY 2023 enacted budget of $85M ($15.4M below request) has resulted in delays to:**
  - Awarding CERISS contracts for LEO hardware and research grants to increase pace of LEO research
  - TIDES and Quantum research planned to fly aboard Artemis-II and ISS, respectively
- **Current budget profile presents challenges in accomplishing:**
  - Timely implementation of decadal recommendations
  - Development of new LEO research capabilities in partnership with the Commercial LEO Destinations (CLD)
  - Development of robust ground research programs to feed into flight programs; affecting next generation of space scientists
  - Soliciting and developing unique, critical hardware for Artemis-III and beyond
  - Soliciting and developing a regular cadence of CLPS-based research payloads
  - Development of partial g facilities to inform science and technology needs as NASA moves from LEO to Moon2Mars
  - Soliciting for lunar science
  - Enabling research in non-focus area disciplines

New Environment Creates New Opportunities

2023-2032 Decadal Survey:
- A pivotal time to prepare for a myriad of challenges and opportunities on the horizon
- Shaping research for the decade ahead



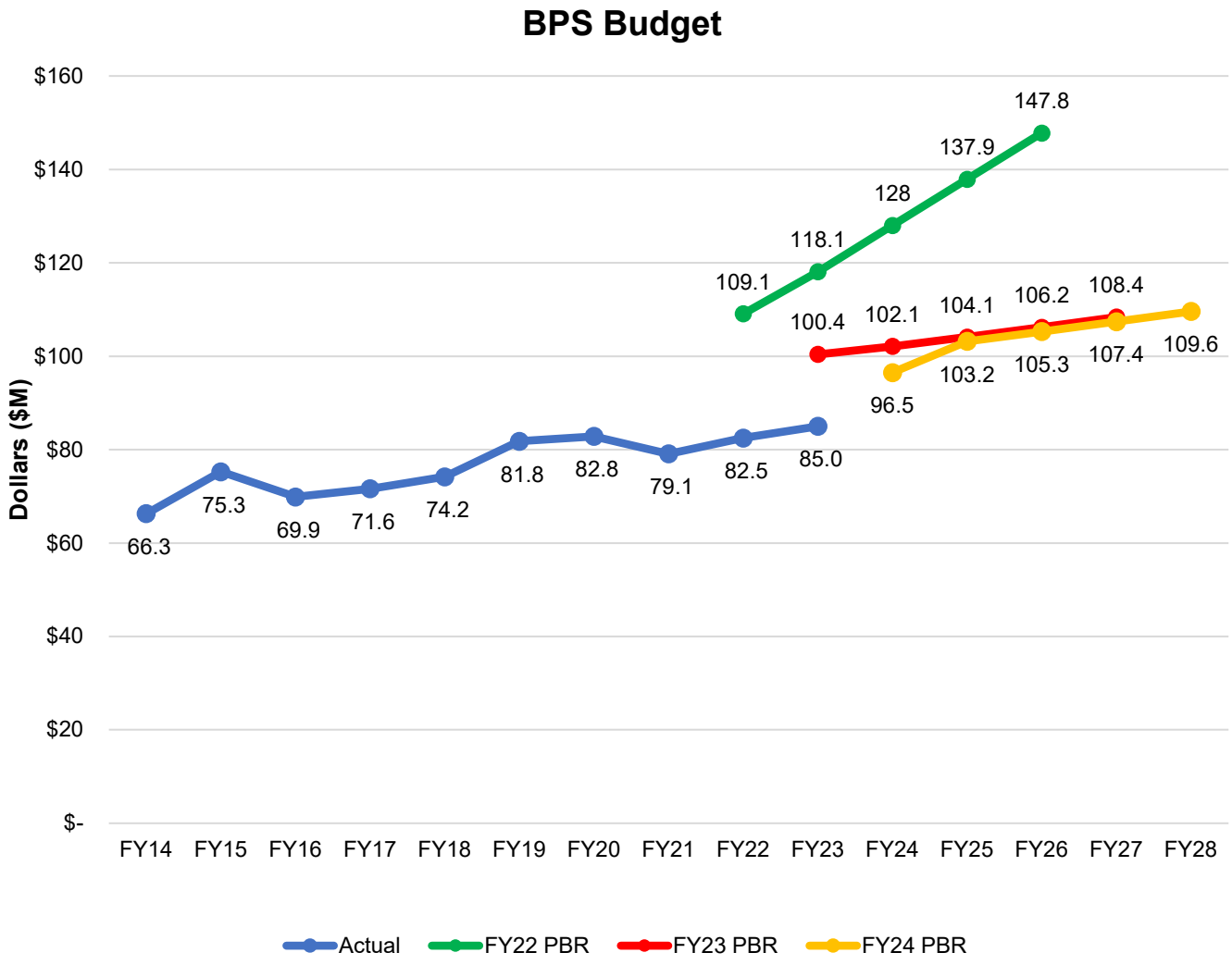
Commercial:
- Leveraging commercial capabilities will enable new science
- BPS currently utilizes ISS infrastructure and support
- Pricing of commercial capabilities unknown at this time

Competition:
- Other existing and planned platforms are courting potential partners

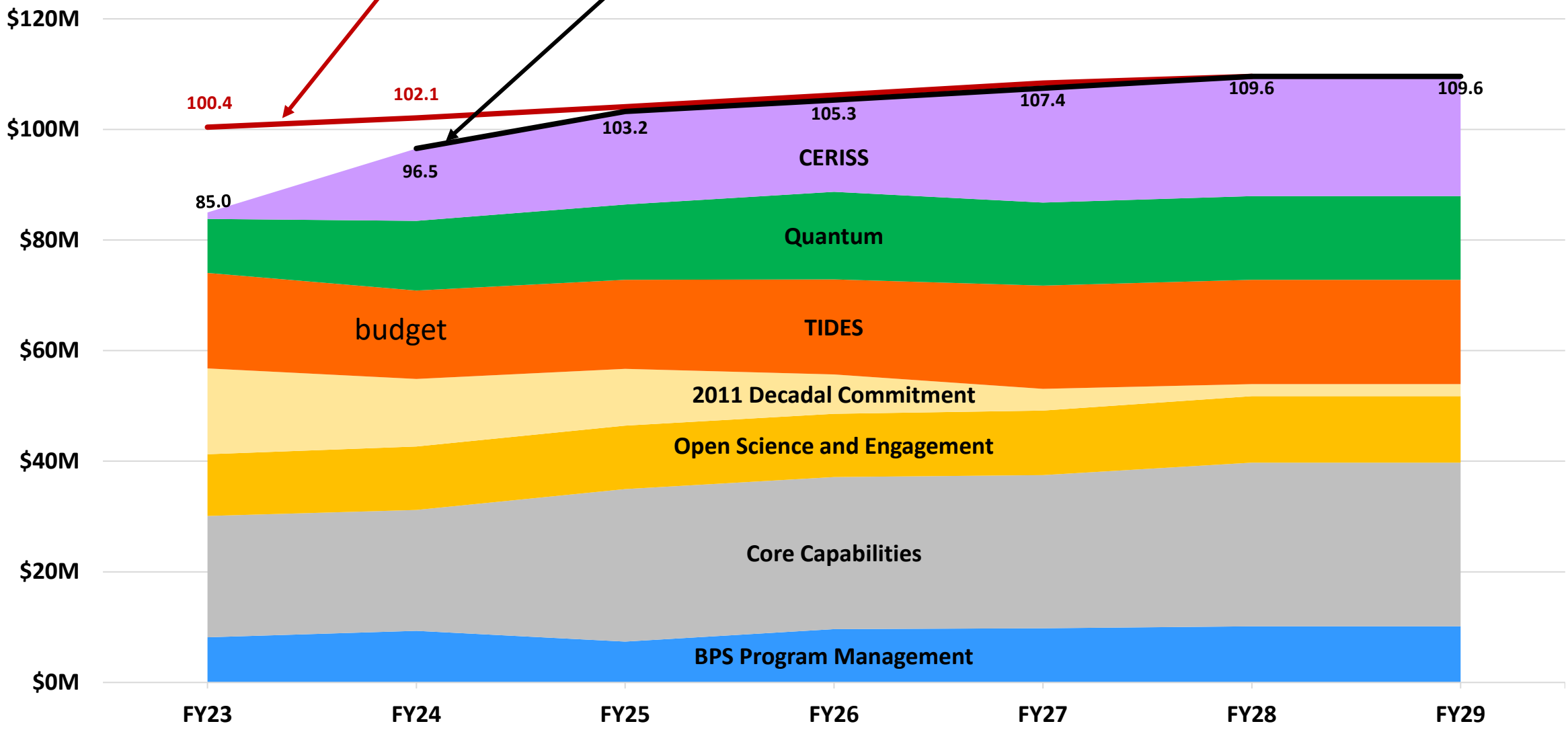
Artemis & Moon2Mars:
- Anticipate the risks to human health in deep space
- Grow sustainable crops for long missions
- Enable sustained exploration (e.g., fuel depots in space, in situ resource utilization)

BPS Budget

- **Moving from Human Exploration and Operations Mission Directorate (HEOMD) to Science Mission Directorate (SMD) has been beneficial to the BPS research community**
  - Advocacy within NASA HQ Senior Leadership
  - BPS has its own line in the congressional budget; no longer buried within the ISS budget in HEOMD
  - Decadal Survey will provide small number of highest priority transformational science recommendations
  - Small growth in appropriations but moderate growth in President's Budget Request (PBR) in Mar 2022
- **2005 BPS budget of $450M = $690M in 2023 $**

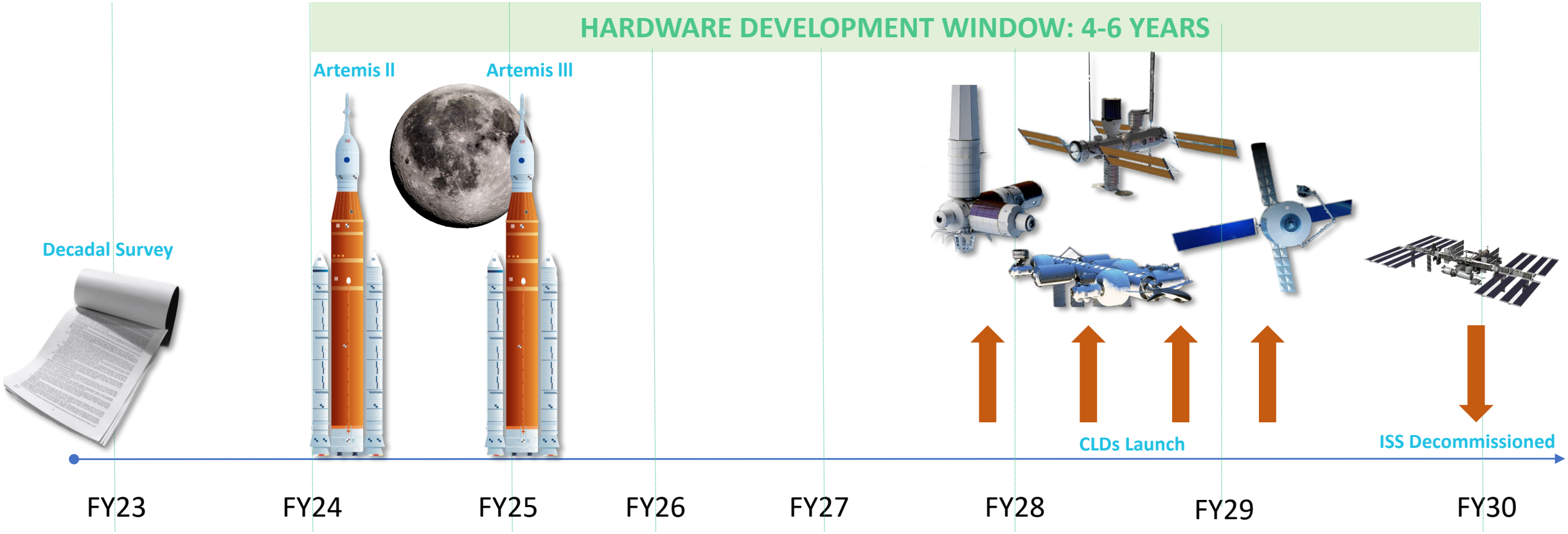


BPS Budget: FY23 PBR and FY24 PBR



Impacts: Hardware Development Timing*

To respond to Decadal recommendations and ensure a successful transition to CLDs, BPS would require budget in FY24 to support hardware development.



*Dates subject to change

Summary

- **Within BPS, we will be developing NASA's implementation plans and assessing associated resource needs based on the Decadal Survey and other national priorities.**
- **Transformative research leads to breakthroughs in fundamental knowledge and technology advancements which benefit space exploration and humanity.**
- **CLDs, with BPS as an important customer, must be successful to ensure the US maintains its leadership in LEO research and remains the partner of choice.**
- **BPS understands the importance of leveraging commercial capabilities to accelerate the pace of research in space, especially as we transition from the ISS to future CLDs.**

BIOLOGICAL & PHYSICAL SCIENCES FLEET

- FORMULATION
- IMPLEMENTATION
- OPERATIONAL
- PARTNER-LED*

LEIA

BIOEXPT-02

ELF*
EML*
FBCE
DECLIC*
FLARE*
CAL
SPECTRUM
MICRO
VEGGIE
SOFIE
MHU*
BRIC-LED
RR
MSRR
XROOTS
PK-4*
PH
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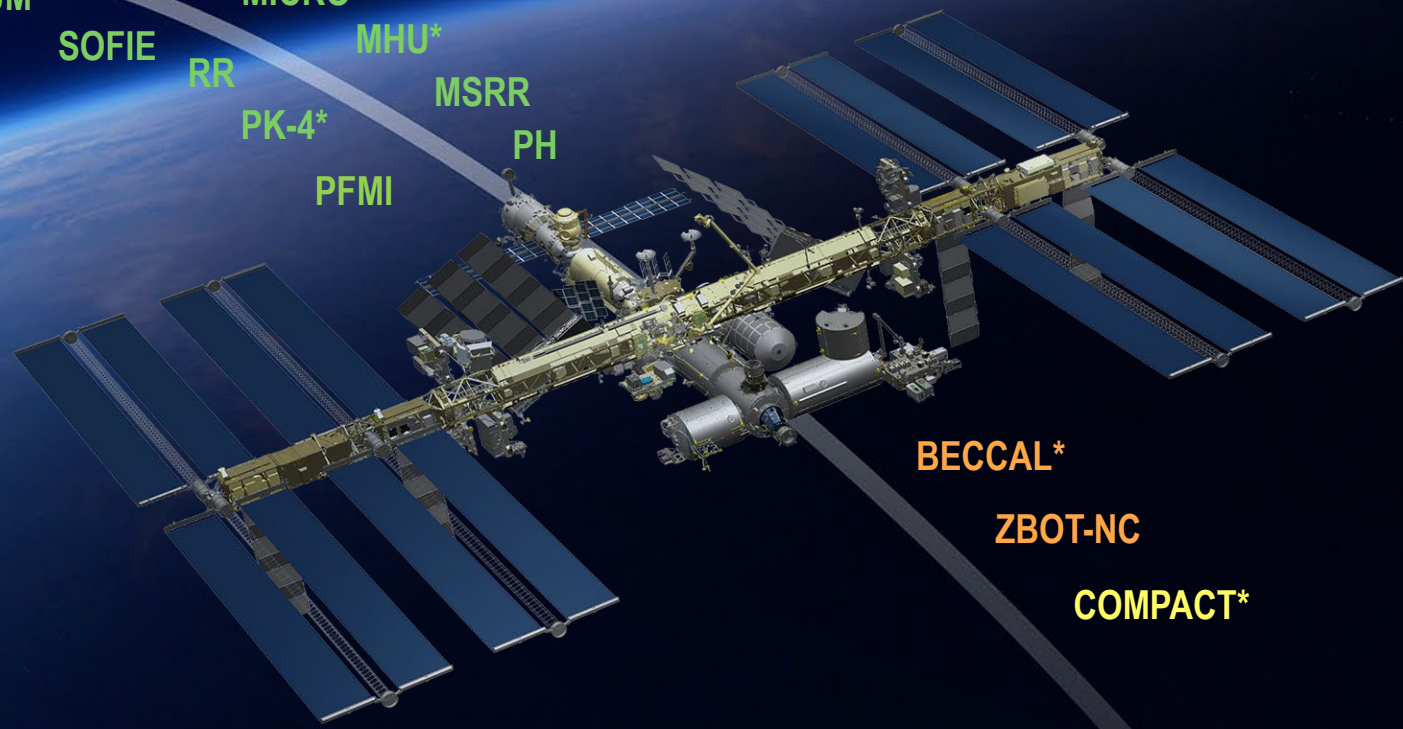

BECCAL*

ZBOT-NC

COMPACT*

Thank you!