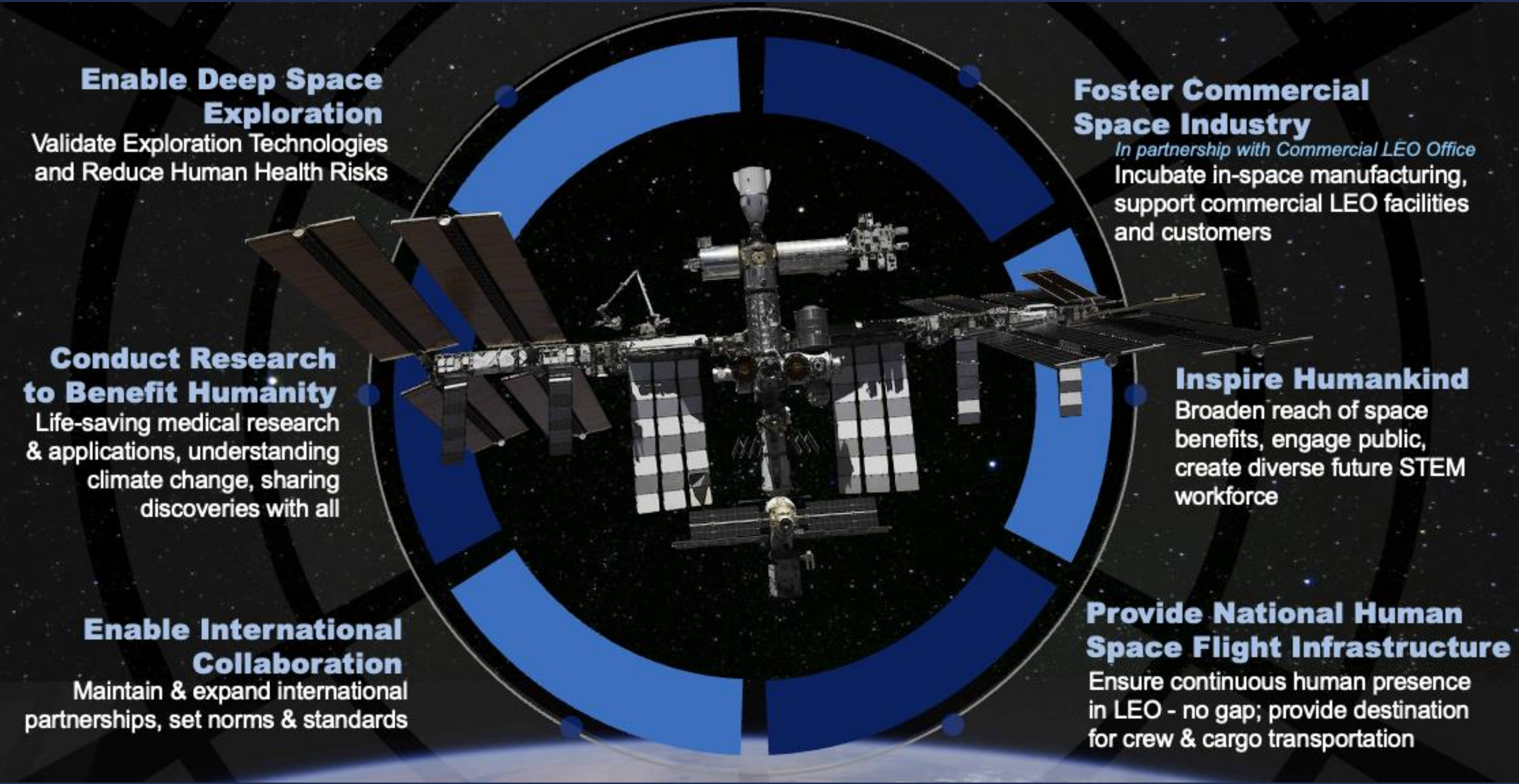
National Aeronautics and
Space Administration

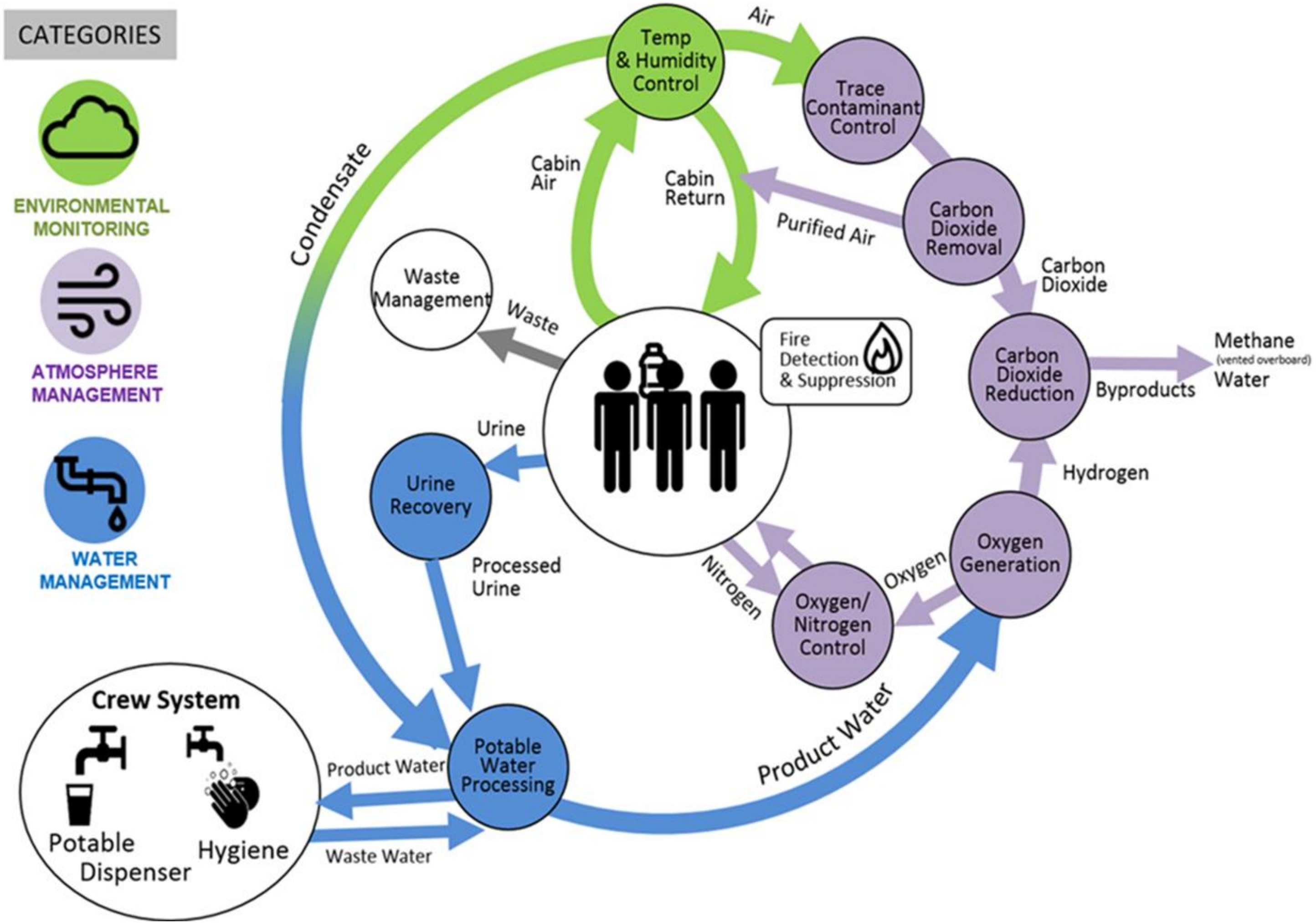
Exploration Lessons From
The International Space Station


Enable Deep Space Exploration
Validate Exploration Technologies and Reduce Human Health Risks
Foster Commercial Space Industry
In partnership with Commercial LEO Office
Incubate in-space manufacturing, support commercial LEO facilities and customers
Conduct Research to Benefit Humanity
Life-saving medical research & applications, understanding climate change, sharing discoveries with all
Inspire Humankind
Broaden reach of space benefits, engage public, create diverse future STEM workforce
Enable International Collaboration
Maintain & expand international partnerships, set norms & standards
Provide National Human Space Flight Infrastructure
Ensure continuous human presence in LEO - no gap; provide destination for crew & cargo transportation

ISS Exploration Lessons Learned

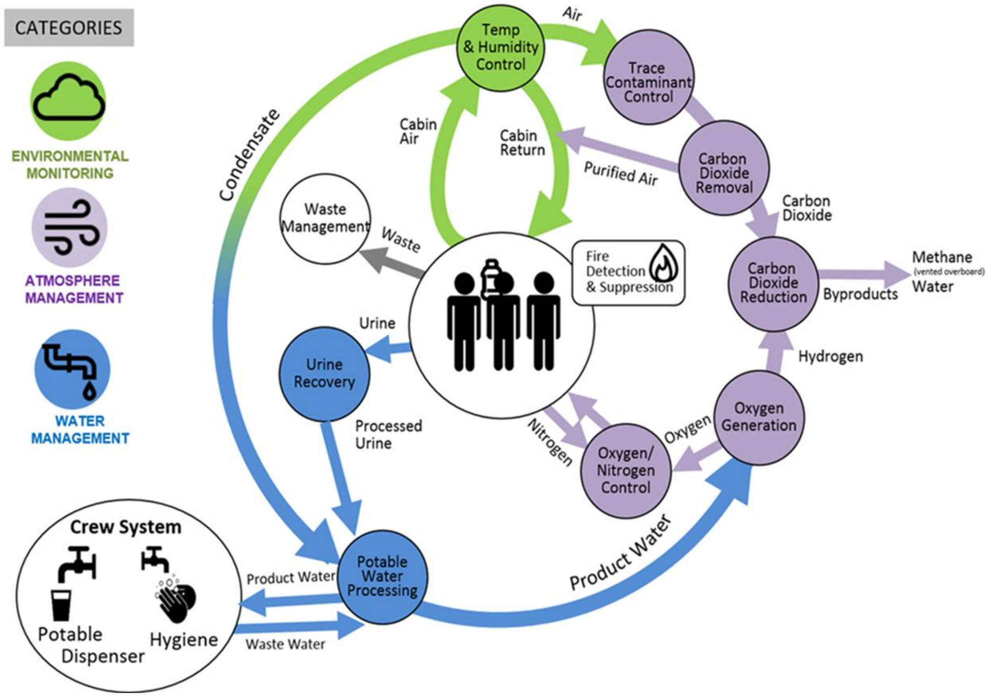
- Fly-Off Plans
- Environmental Control and Life Support Systems
- Navigation
- Food Storage Systems
- Extravehicular Activities
- Human Research

Environmental Control and Life Support Systems



Environmental Control and Life Support Systems

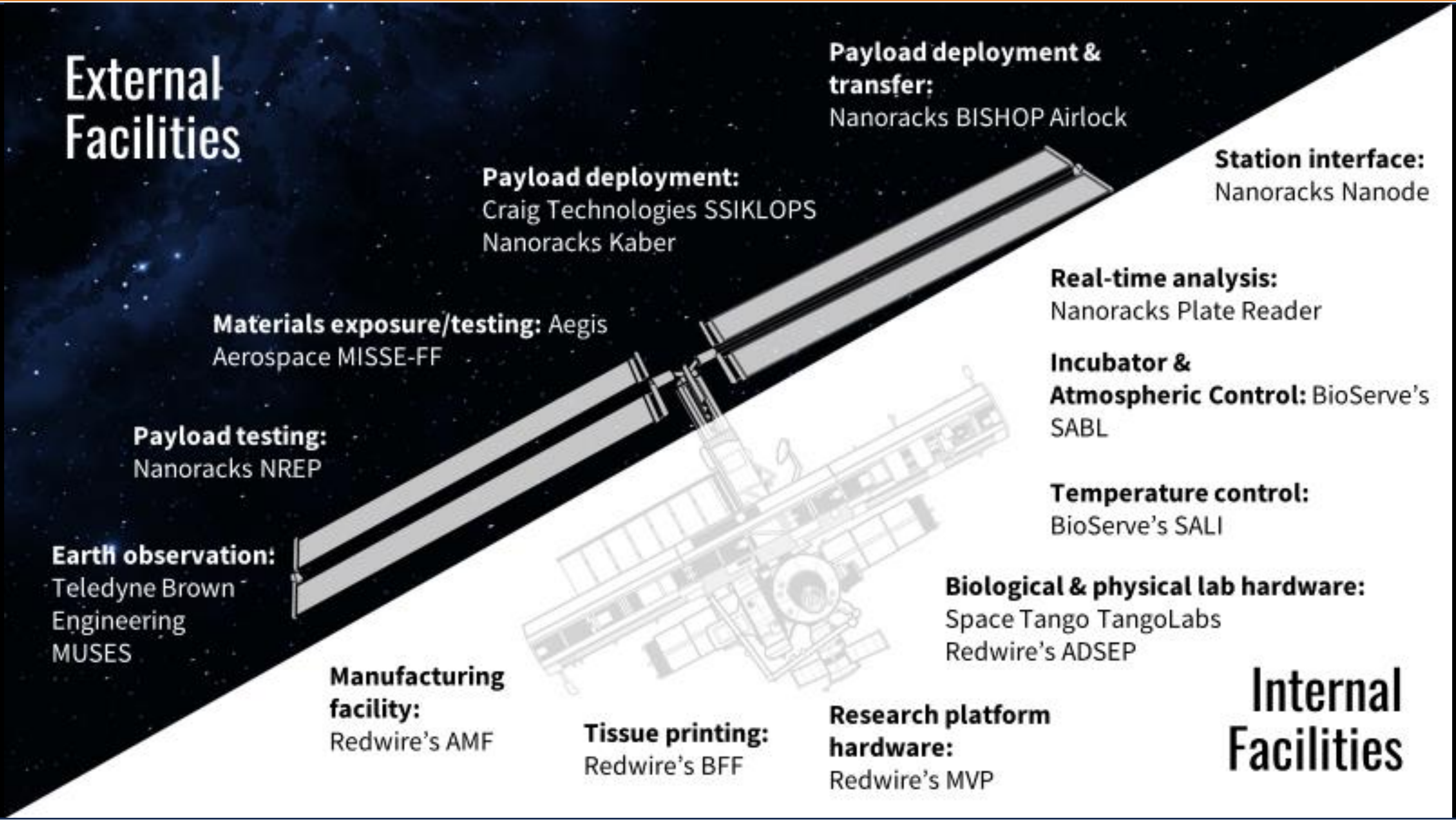
- Water Recovery System
  - Recycles urine, cabin humidity (crew respiration, sweat, hygiene)
  - Up to 98% Mars-class water recycling has been achieved
- Air Revitalization System
  - Next generation 4-bed CO2 scrubber
    - Lower CO2 levels improves crew health
  - Advanced Oxygen Generation Assembly will launch in 2024
  - CO2 reduction assembly to be added in 2025, completing the air string



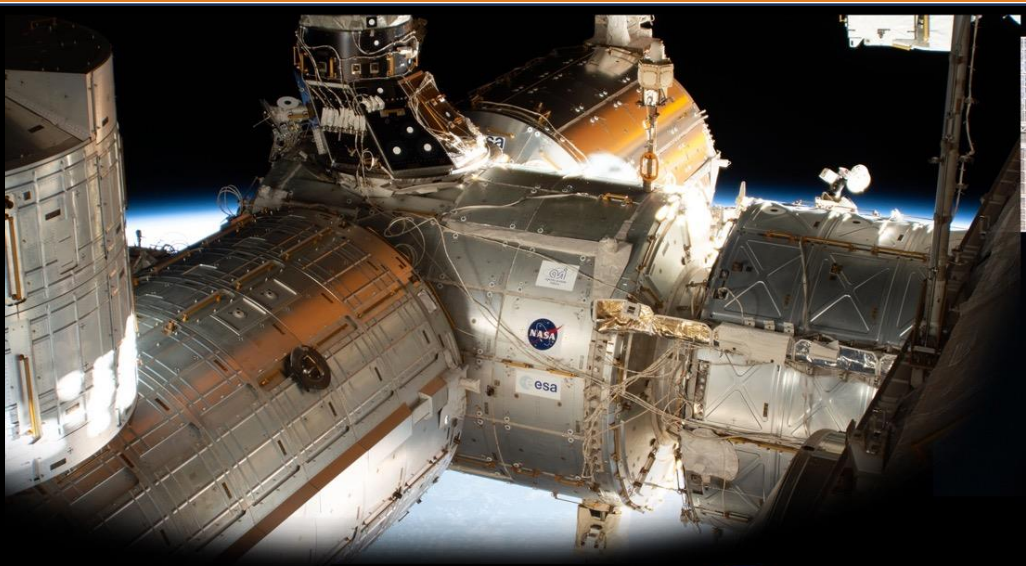
Navigation

- Orion uses an optical navigation system called OpNav
    - OpNav has been installed in the ISS cupola, using two cameras and an algorithm to demonstrate the system's accuracy in a real-world environment
- Neutron-star Interior Composition Explorer (NICER) studies neutron stars and pulsars for SMD's Astrophysics Division
    - Using the NICER payload, the Station Explorer for X-ray Timing and Navigation Technology (SEXTANT) uses pulsar's radiation flashes to determine position in space, similar to GPS

Commercial Partnerships



International Partnerships



International partnership is essential to space station operations and has created an infrastructure of cooperation that is the foundation for the future of human exploration.

Key Takeaways

- For more than 20 years, the ISS has provided a unique platform for conducting research in a variety of scientific fields
- The ISS also offers a platform for technology demonstrations in space, including those needed for future Moon and Mars missions

White Paper


National Aeronautics and Space Administration
Exploration Lessons from the International Space Station
Background
The International Space Station is the world's preeminent orbital microgravity platform. For more than 20 years, scientists have used the space station to conduct research into biological, physical, biomedicine, materials, and Earth and space science. Technology demonstrations aboard the space station have advanced state-of-the-art applications with benefits both on Earth and in space. The space station's redundant systems enable the crew to test multiple environmental systems simultaneously, creating a unique testbed for life support and environmental technology that will enable future exploration. Sensors deployed on the space station have validated climate models and contributed to host of new information about Earth's changing climate, while space science instruments on the orbiting laboratory have advanced our knowledge of phenomena like neutron stars and dark matter.
International Space Station crews have also been part of a critical experiment, volunteering themselves as test subjects for research into human adaptation to microgravity. These long-duration demonstrations and experiments into the joint human-and-vehicle system are enabling future human exploration of the solar system. The station will operate through 2030, continuing to offer benefits to humanity while paving the way for commercial industry to meet NASA's needs in low-Earth orbit and beyond.
The International Space Station has five major goals and has realized significant advances in each:
Enable deep space exploration.
Conduct research to benefit humanity.
Foster a U.S. commercial space industry.
Lead and enable international collaboration.
Inspire humankind.
Figure 1. This mosaic depicts the International Space Station pictured from the SpaceX Crew Dragon Endeavour during a fly around of the orbiting lab that took place following its undocking from the Harmony module's space-facing port on Nov. 8, 2021.
white paper
2023 Moon to Mars Architecture
2023 Moon to Mars Architecture Concept Review 1
Figure 2. Environmental Control and Life Support Subsystem Diagram
2023 Moon to Mars Architecture Concept Review 2
Food Storage Systems
Figure 3. Astronaut Frank Rubio checks tomato plants growing inside the International Space Station for the XROOTS space botany study.
3 Moon to Mars Architecture Concept Review 3
Human Research
2023 Moon to Mars Architecture Concept Review 4