



One More Step: Beyond Earth


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Key Legislation: Establishing the Commercial Space Industry

1958	National Aeronautics and Space Act	Authorized the creation of NASA and established the priorities of the Agency scientifically, diplomatically, and industrially
1984	Commercial Space Launch Act	Recognized private sector as key suppliers of commercial services in space; assigned launch oversight, licensing, and safety standards to the Dept. of Transportation
1998	Commercial Space Act	Allowed NASA to purchase space science data and air-borne data, services, distribution, and applications from commercial providers
2005	NASA Authorization Act	Set forth the initial Moon to Mars objectives of the Agency by means of working as closely as possible with the private sector, and other nations to the extent appropriate
2008	NASA Authorization Act	Addressed gap of U.S. capability to return astronauts to the International Space Station; emphasized national need for commercial services post Shuttle Program
2010	NASA Authorization Act	Expanded support for Commercial Crew and Cargo development; initiated studies to model NASA's oversight requirement of commercial providers
2015	U.S. Commercial Space Launch Competitiveness Act	Facilitated growth for the commercial space industry; encouraging private sector investment and creating more stable and predictable regulatory conditions

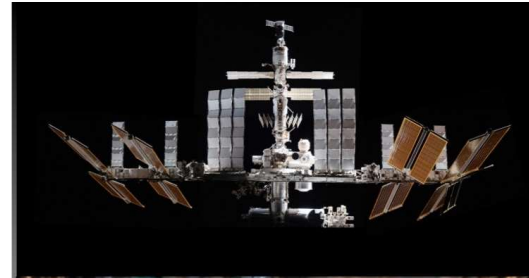


Maximizing the Potential of the International Space Station

- Over 251 launches*
- Over 250 spacewalks*
- 20 commercial facilities
- 263 people from 20 countries
- Involves 100,000+ people
- Over ~3,000 investigations
- ~4,400 investigators represented
- 235 current investigations (Exp. 68)
- 3.5 million images of Earth captured
- 1.5 million student activities in 2020

*As of October 12, 2022

2020s: the decade of results



Exp. 68: First European female Commander



CASIS extended through 2027



Seeking Research Proposals



Commercial LEO Destinations



Hubble Reboost Study



Crew-5 Launch, Oct. 5, 2022



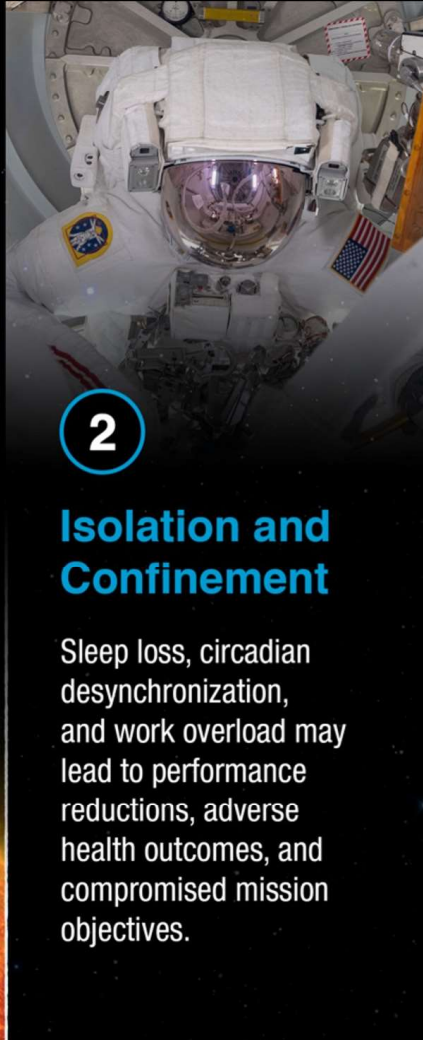
Crew-4 Return

The Hazards of Human Spaceflight

1

Space Radiation

Invisible to the human eye, radiation increases cancer risk, damages the central nervous system, and can alter cognitive function, reduce motor function and prompt behavioral changes.



2

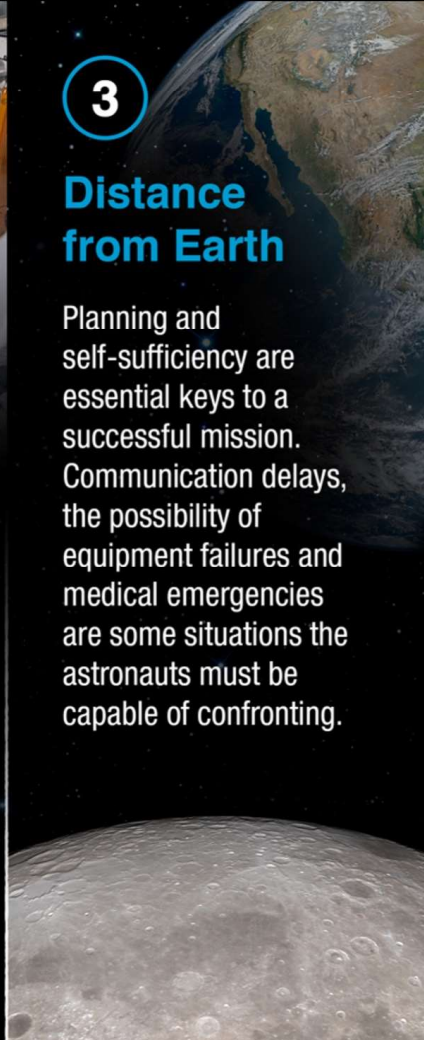
Isolation and Confinement

Sleep loss, circadian desynchronization, and work overload may lead to performance reductions, adverse health outcomes, and compromised mission objectives.

3

Distance from Earth

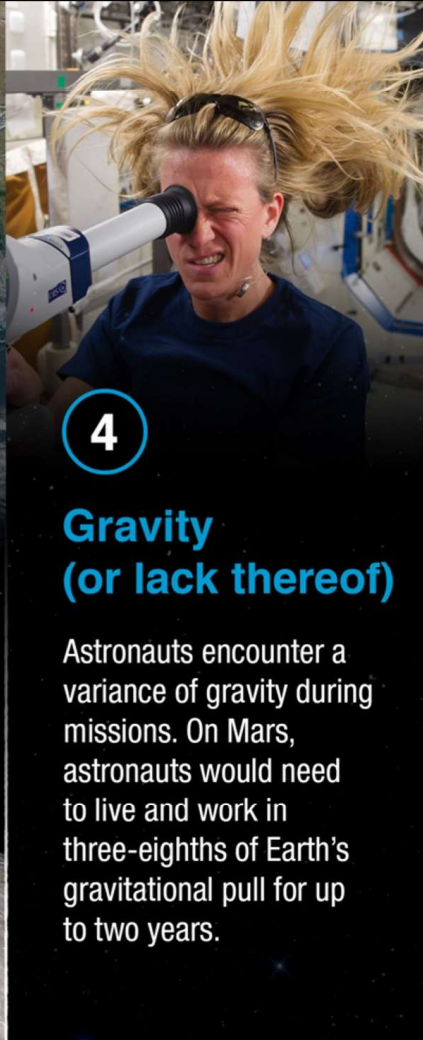
Planning and self-sufficiency are essential keys to a successful mission. Communication delays, the possibility of equipment failures and medical emergencies are some situations the astronauts must be capable of confronting.



4

Gravity (or lack thereof)

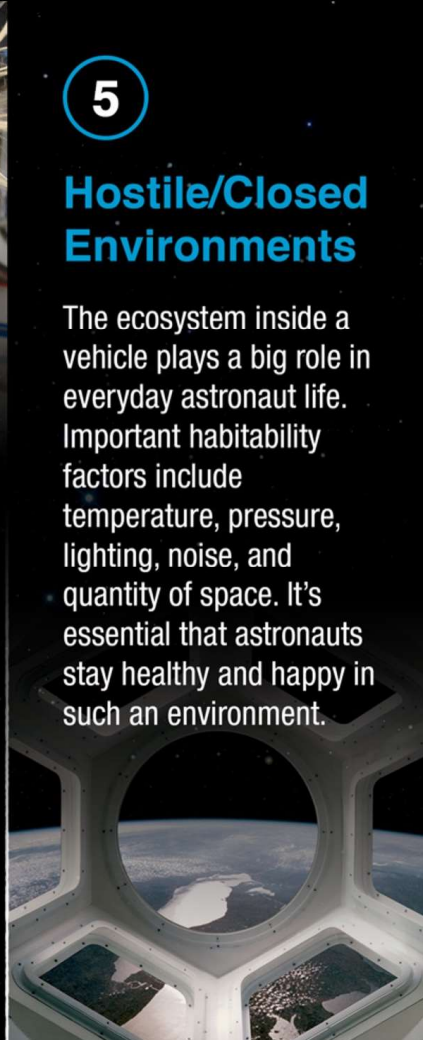
Astronauts encounter a variance of gravity during missions. On Mars, astronauts would need to live and work in three-eighths of Earth's gravitational pull for up to two years.



5

Hostile/Closed Environments

The ecosystem inside a vehicle plays a big role in everyday astronaut life. Important habitability factors include temperature, pressure, lighting, noise, and quantity of space. It's essential that astronauts stay healthy and happy in such an environment.



A Recipe for LEO Economic Success

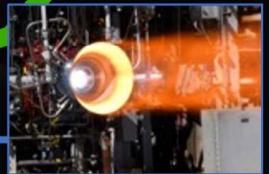
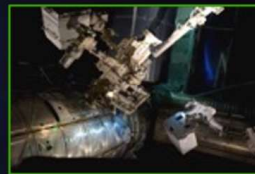
Cost/Kg to Low-Earth Orbit (LEO)

Shuttle and Evolved Expendable Launch Vehicles (EELVs) are the predominate capabilities



Commercial Cargo launch service providers enter the market

Satellite servicing and advanced technologies become commercialized



Ingenuity in rocket technology

Number of Active Satellites

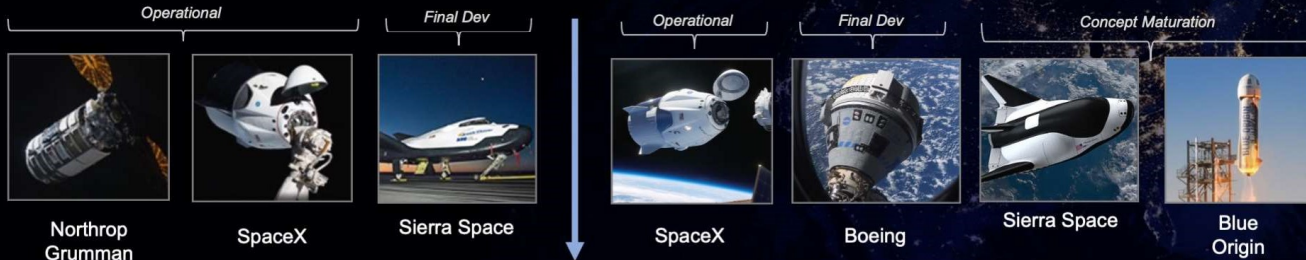
2005 2010 2015 2020s

Procurement models, partnerships, policy, and technology breakthroughs have sparked a LEO economic boom



A New Future in Space

Commercial Cargo & Crew Transportation



Commercial LEO Destinations



More Elements of a Strong LEO Economy



NASA's Future LEO Needs

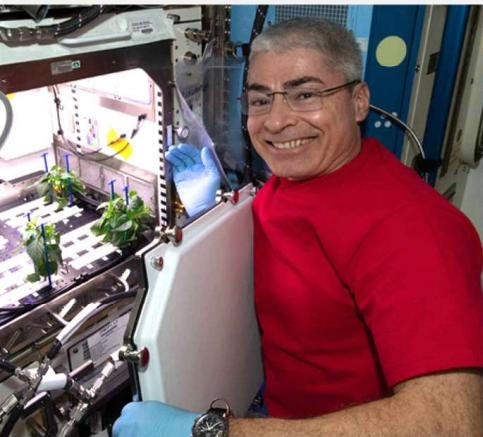
- Continuous accommodations and training for at least two crew members
- The ability to support a national orbiting laboratory
- Conducting approximately 200 investigations annually to support human research, technology demonstrations, biological and physical science



Science



Human Research



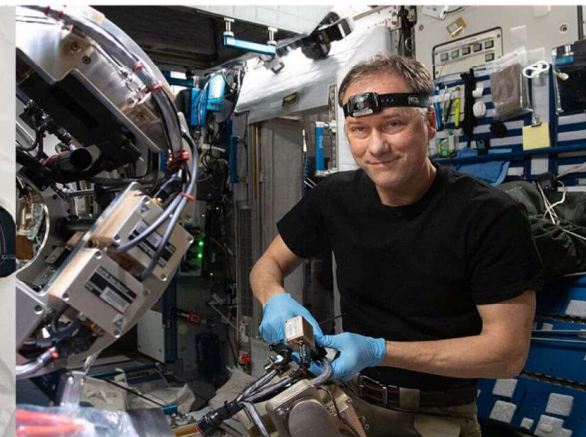
Physical and Biological Research



Technology Demonstrations



Crew Accommodations and Training



National Lab Services

Commercial Space is Happening Now

Near Term

Mid Term

Long Term

International Space Station (ISS) Operations

Commercial LEO Destinations (CLDs) Development

CLD Operations

Phase 1: Early Design Maturation

Phase 2: Certification & Services

Design and Development

LEO economy developed by enabling a supply side and actively maturing a sustainable demand side

Transition

Plan based on NASA readiness, maturation of destinations, and market demand

End Goal

Sustainable Commercial Operations with multiple customers

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Commercial Destinations on ISS (CDISS)

Commercial Destinations Free Flyer (CDFF)



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Demand Stimulation (In-Space Manufacturing, R&D to Applications)

ISS National Lab/CASIS (Science, Applied R&D, Tech Dev, STEM)

Commercial Use of ISS (Commercial and Marketing Activities)

Private Astronaut Missions (Tourism & Research)

Gov't LEO Requirements (Human Research, Life & Physical Sciences)

Transition LEO Economy Activities from ISS to Commercial Destinations



Looking Ahead

- Participating in the U.S. government regulatory framework activity to enable expansion of commercial operations in LEO
- Determining paradigm for NASA partnerships with non-U.S. government space agencies
- Refining NASA demand for Commercial LEO Destinations (CLDs)
- Defining NASA's safety and certification requirements for CLDs
- Defining a LEO National Laboratory concept
- More detailed planning for ISS-to-CLD transition
- Defining "flexible science" concept (i.e. platform agnostic science)

National Aeronautics and
Space Administration



THANK YOU



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