

# NASA's Human Research Program

National Aeronautics and  
Space Administration



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Director, NASA Human Research Program





# VISION FOR TEXAS' NEXT GIANT LEAP

**TEXAS IS THE NEXUS AND ACCELERATOR OF RESEARCH, INNOVATION AND STEM WORKFORCE DEVELOPMENT FOR THE US HUMAN SPACE EXPLORATION ECONOMY.**



**MISSION CONTROL CENTER**



**ELLINGTON FIELD**



**SPACE VEHICLE MOCKUP FACILITY**



**NEUTRAL BUOYANCY LABORATORY**



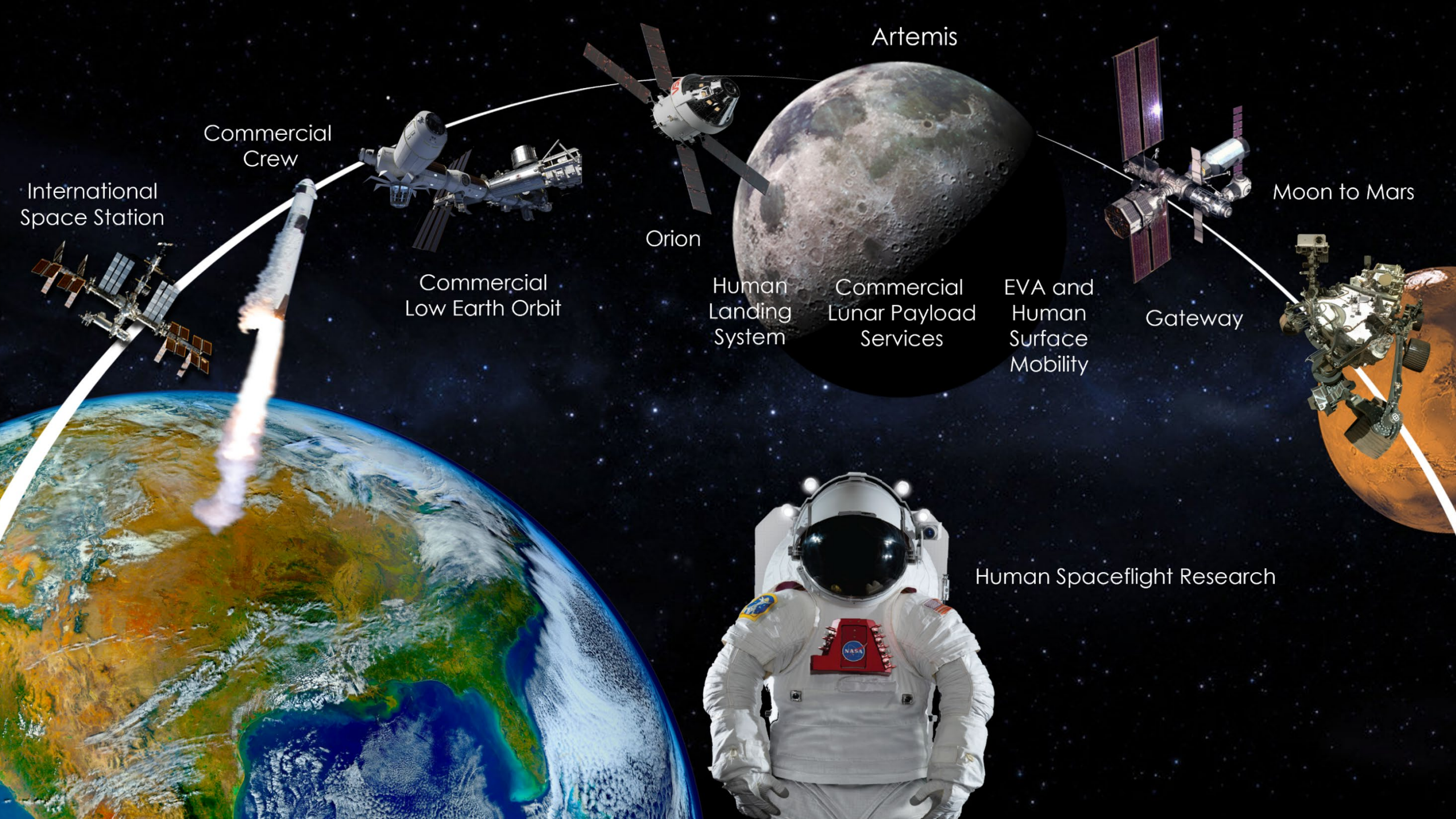
**FOOD LABORATORY**



**WHITE SANDS TEST FACILITY**

**11,639 Total Employees at JSC and WSTF**

**2,873 Civil Servants**



International  
Space Station

Commercial  
Crew

Commercial  
Low Earth Orbit

Orion

Artemis

Human  
Landing  
System

Commercial  
Lunar Payload  
Services

EVA and  
Human  
Surface  
Mobility

Gateway

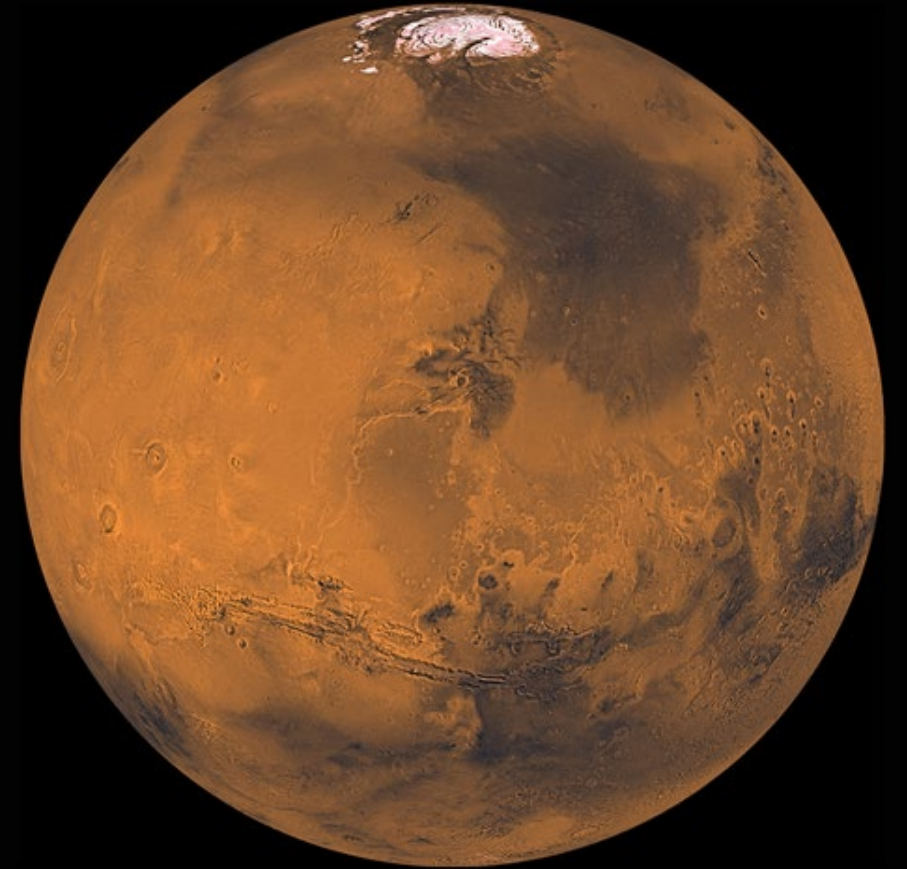
Moon to Mars

Human Spaceflight Research



# Human Research Program Mission

To enable space exploration beyond  
Low Earth Orbit by reducing the risks  
to human health & performance

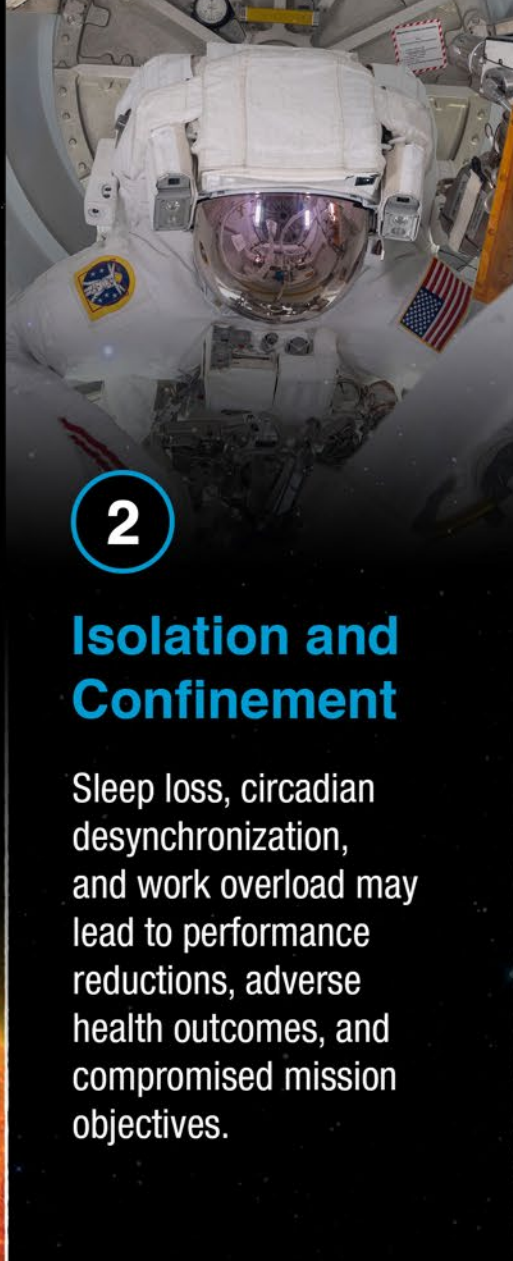


# Hazards of Human Spaceflight

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

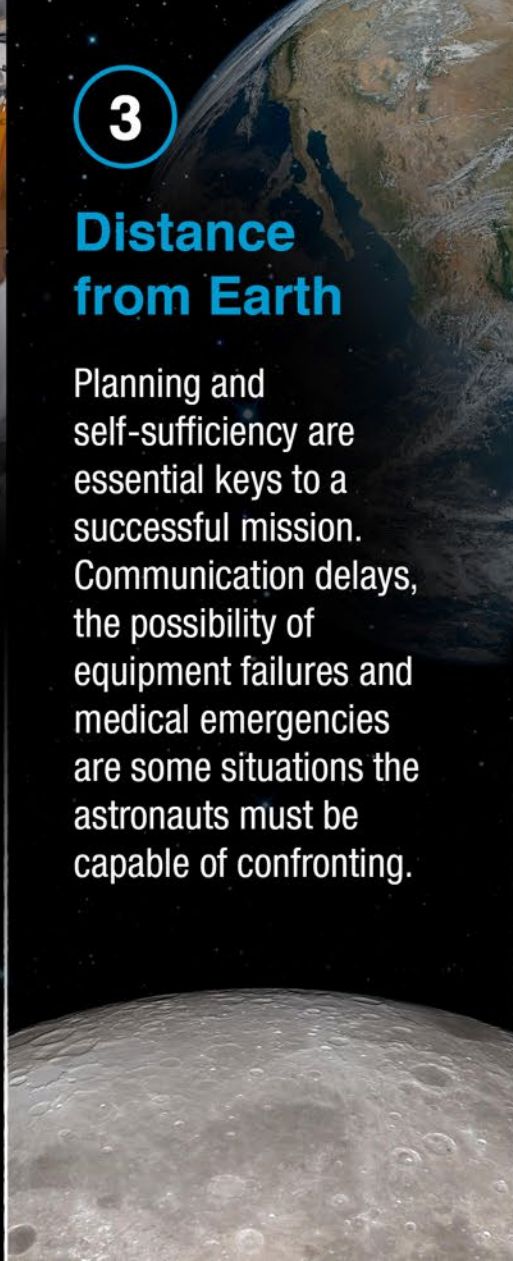
## Isolation and Confinement

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

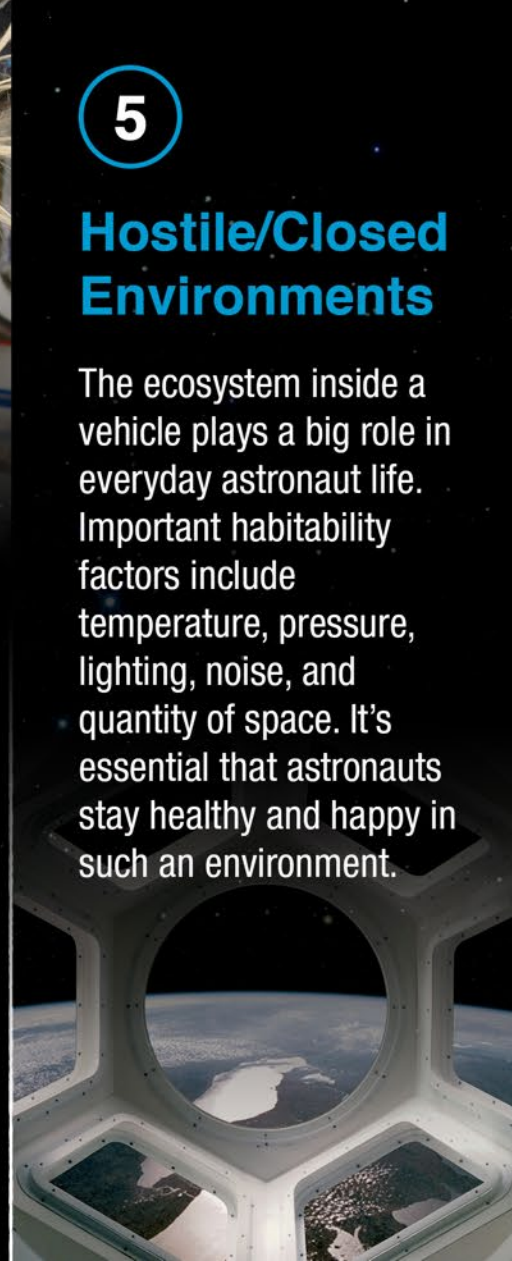
## Gravity (or lack thereof)

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.



Psychosocial Adaptation w/ Adequate Behavioral Conditions

Adequate Psychosocial Adaptation w/ Adequate Behavioral Conditions

Inadequate Human Systems Integration Architecture

Adequate Food and Nutrition

Inflight Medical Operations

Inadequate Human Systems Integration Architecture

Inadequate Food and Nutrition

Inflight Medical Operations

Ineffective Toxic Medications

Non-ionizing Radiation

Carcinogenesis

Bone Fracture

Reduced Muscle Size

Cardiac Rhythm Problems

Renal Stone Formation

Host-Microorganism Alterations

Orthostatic Intolerance

Spaceflight-Associated Neuro-ocular Syndrome (SANS)

Reduced Aerobic Capacity

Urinary Retention

Toxic Exposure

THE HUMAN SYSTEM RISKS

Cardiovascular Adaptations

Crew Egress

Celestial Dust Exposure

Hypoxia

Carbon Dioxide Exposure

Altered Immune Response

Decompression

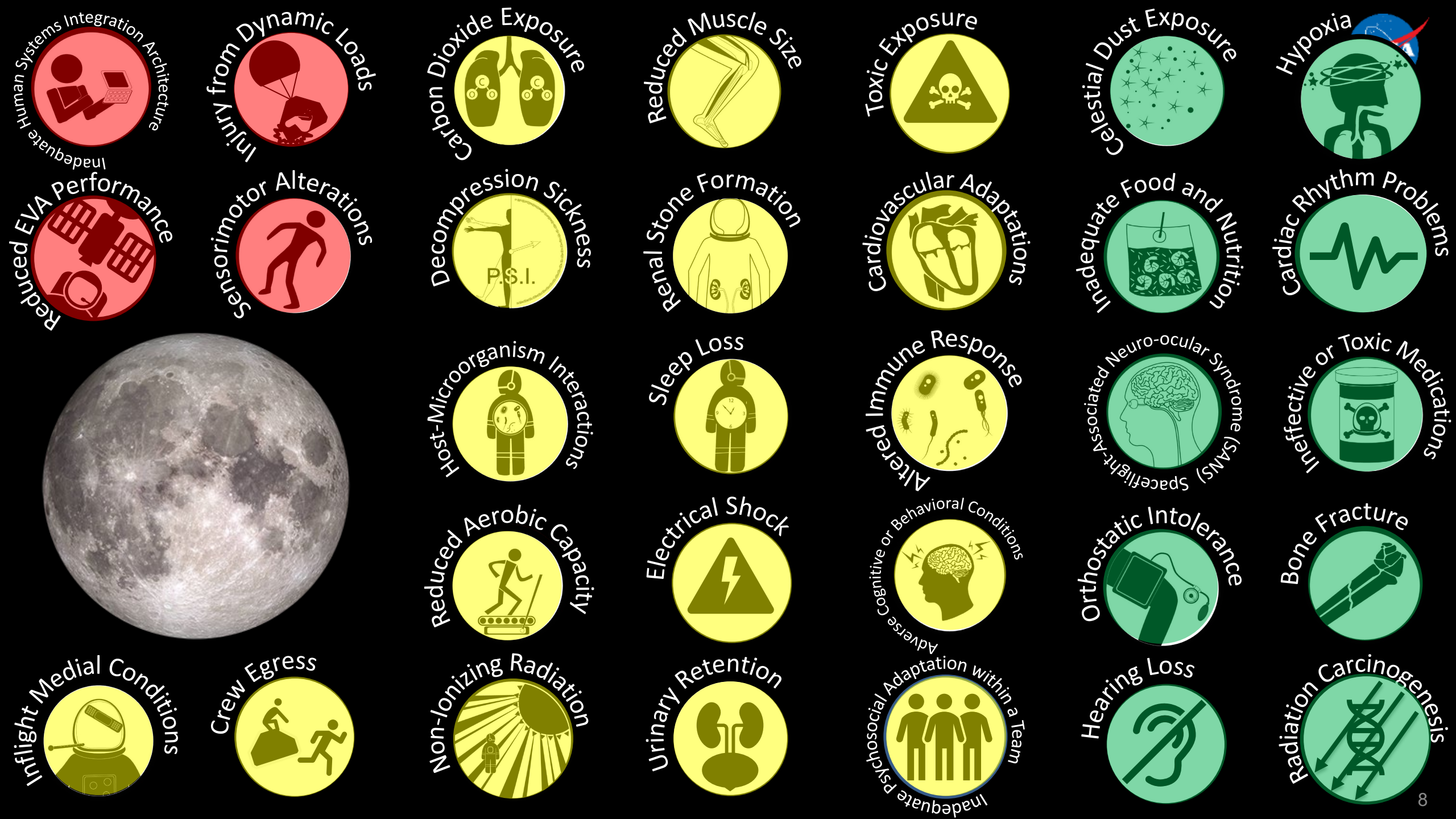
Performance

Electrical Shock

Sleep Loss

Hearing Loss

Injury from Dynamic Loads



Inadequate Human Systems Integration Architecture

Injury from Dynamic Loads

Carbon Dioxide Exposure

Reduced Muscle Size

Toxic Exposure

Celestial Dust Exposure

Hypoxia

Reduced EVA performance

Sensorimotor Alterations

Decompression Sickness  
P.S.I.

Renal Stone Formation

Cardiovascular Adaptations

Inadequate Food and Nutrition

Cardiac Rhythm Problems

Host-Microorganism Interactions

Sleep Loss

Altered Immune Response

Spaceflight-Associated Neuro-ocular Syndrome (SANS)

Ineffective or Toxic Medications

Reduced Aerobic Capacity

Electrical Shock

Adverse Cognitive or Behavioral Conditions

Orthostatic Intolerance

Bone Fracture

Inflight Medical Conditions

Crew Egress

Non-Ionizing Radiation

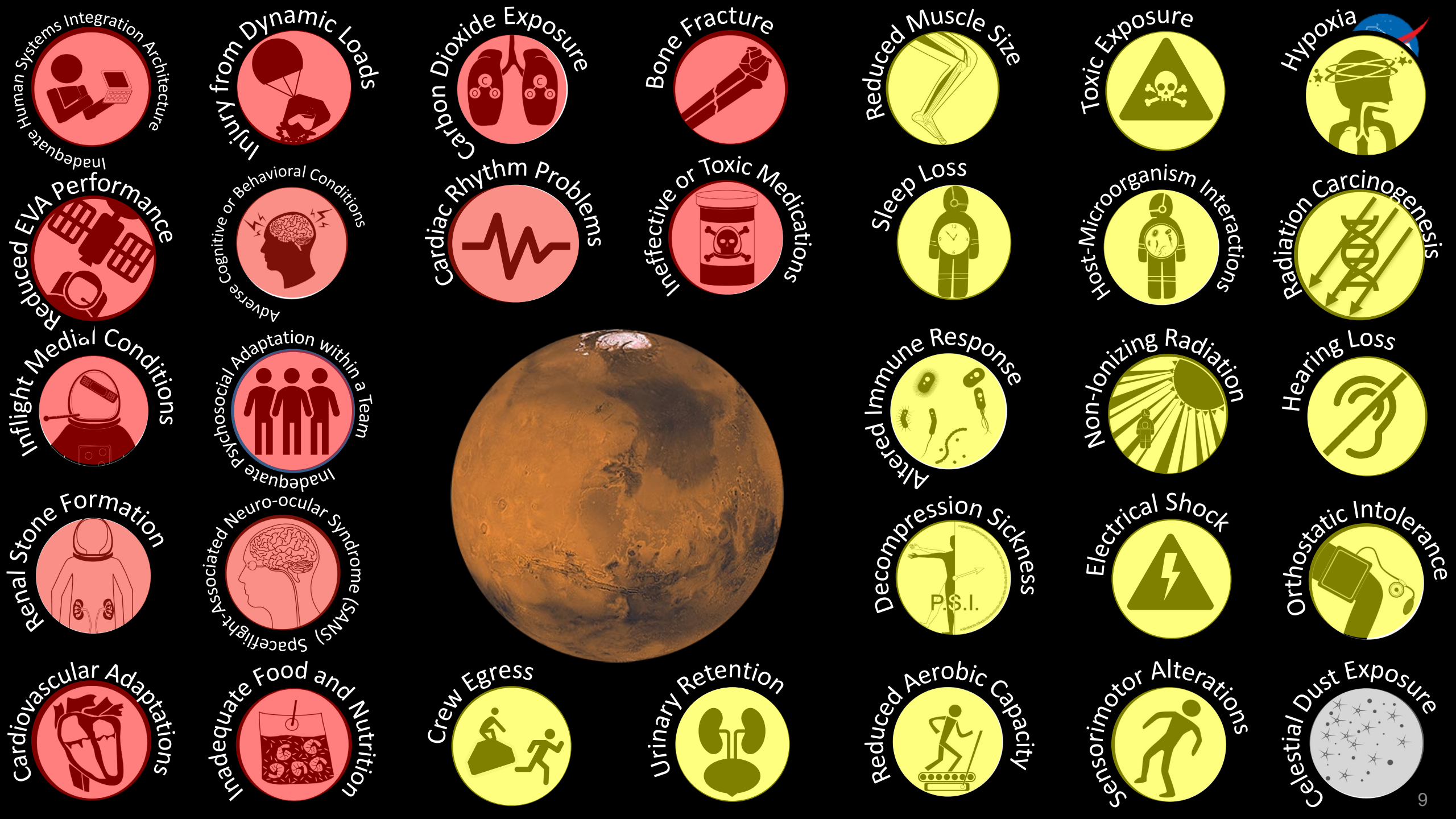
Urinary Retention

Inadequate psychosocial Adaptation within a Team

Hearing Loss

Radiation Carcinogenesis





# HRP addressing difficult challenges to enable Artemis and Mars Missions

HMTA High Priority Mitigation needed

*HMTA = Health and Medical Technical Authority*

## Artemis

Medical Conditions

What are the **most likely medical conditions** to occur in Artemis missions?

Dynamic Loads

Lack of a model to **integrate** commercial **vehicle** provider's seat model with another commercial provider's **EVA suit**

Sensorimotor/Manual Control

Lack of countermeasures to aid crews in **manually controlling** lunar landers when needed

EVA

How do we improve performance and **reduce injuries in EVA suits** that will be worn more than ever?

HSI

How do we perform **H**uman **S**ystem **I**ntegration (training, systems, procedures, etc.) across many programs and vehicles

## Mars

Pharm

How do we **store medications** to be efficacious in spaceflight for 5 years +?

Medical Conditions

What are the **most likely medical conditions** to occur in Mars missions?

EVA

How do we improve performance and **reduce injuries in EVA suits** that will be worn more than ever?

Dynamic Loads

Lack of a model to **integrate** commercial **vehicle** provider's seat model with another commercial provider's **EVA suit**

Food & Nutrition

How do we **ensure a food system for 5 years +** that is nutritious and something that crews want to eat?

Team

What are the top indicators of **Team performance in an isolated environment** and how do we proactively address decrements?

BMed

What are the top indicators of **psychological performance in an isolated environment** and how do we proactively address decrements?

HSI

How do we perform **H**uman **S**ystem **I**ntegration (training, systems, procedures, etc.) across many programs and vehicles

Cardiovascular (LTH)

How do we protect for the **L**ong-**T**erm **H**ealth effects of spaceflight and radiation on the cardiovascular system?

SANS

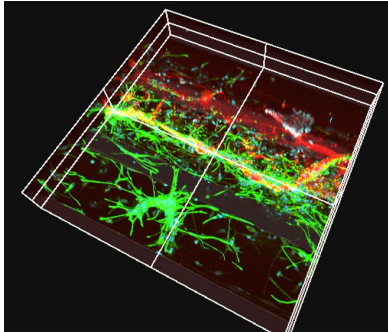
How do we protect against the Space flight-associated neuro-ocular syndrome (SANS)?

Example High Priority Knowledge and Capability Gaps



*Continuous Risk Management*

# Research funded across the country



**ARC** – Brain vascular cells on a chip



**GRC** – rHealth One ISS blood analyzer



**LaRC** – Space Radiation Modeling

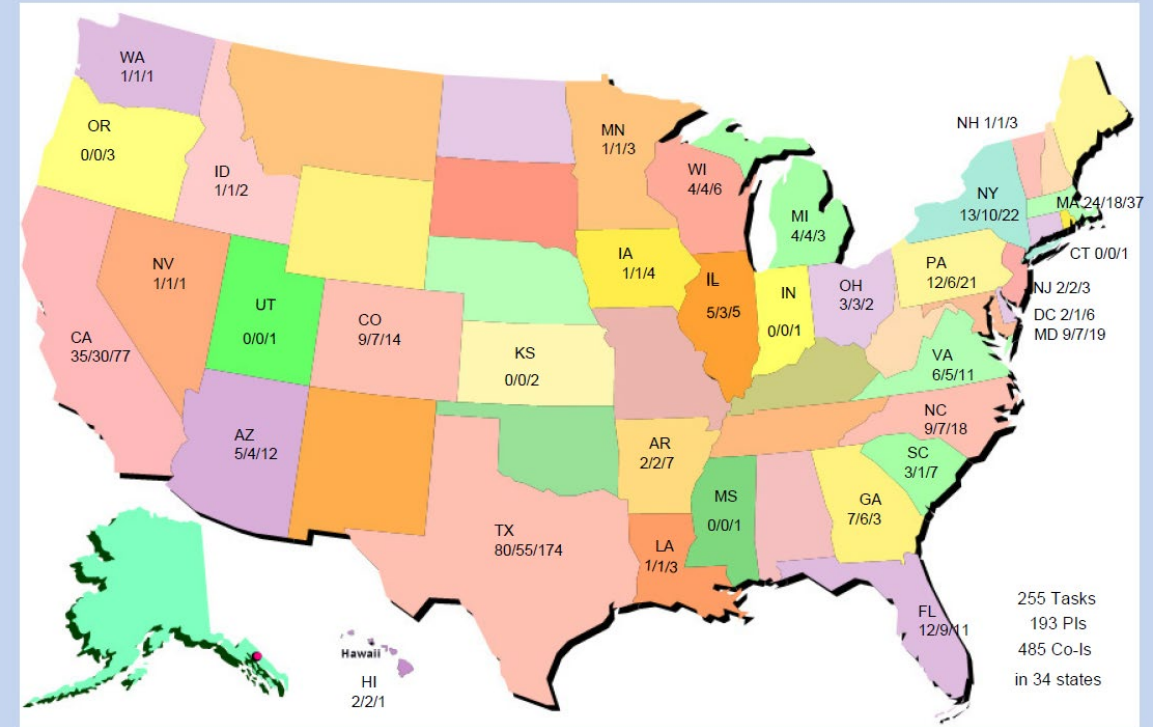


**JSC** – Postflight EVA performance testing



**KSC** - ISS crew during PH-04 Pepper harvest

## Human Research Program FY 2021 Tasks/Principal Investigators/Co-Investigators by State



255 Tasks  
193 PIs  
485 Co-Is  
in 34 states

Source for data, as of 10/13/2021 NASA Task Book

Five NASA Field Centers

Academic and Research Institutions

# Phased Approach to Risk Reduction

National Aeronautics and  
Space Administration



## Human Research Program **STEPS TO MARS**



### **EARTH:**

Simulated spaceflight hazards  
in Ground Analogs | :envihab |  
Antarctic Stations | NEK | HERA |  
Space Radiation Lab

### **LOW EARTH ORBIT:**

International Space Station –  
A unique testbed to study micro-  
gravity and environment hazards,  
with varying mission durations

### **LUNAR MISSIONS:**

Decreasing Earth-dependence  
around and on the lunar surface.  
Provides insight into deep space  
radiation; behavioral health, and  
gravity transitions





# Analog Missions

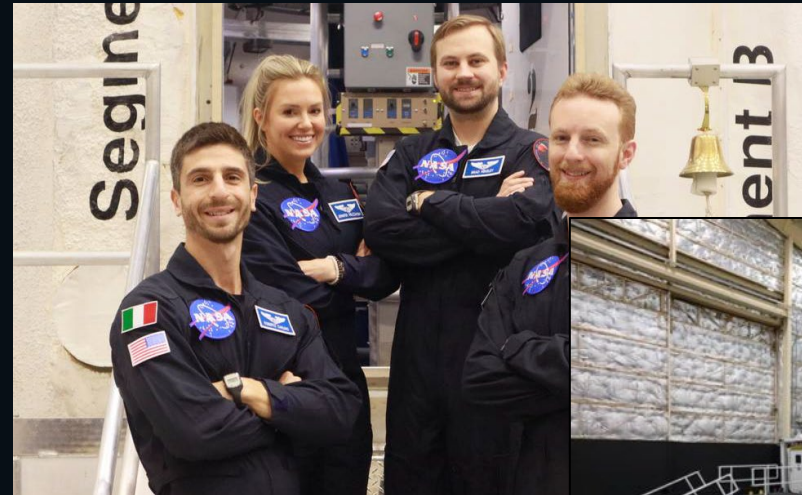
# NEK and CHAPEA

- Effects of long-duration isolation and confinement in an autonomous mission on individual, team, and multi-team functioning in a multi-national crew
- Completed July 2022
- NEK Facility, Moscow
- CHAPEA Facility, NASA JSC



# HERA Campaign 6

- Risk characterization and countermeasures to support autonomous crew operations and behavioral health and performance
- Mission 4 currently underway
- Johnson Space Center



# :envihab

- SANS Countermeasures
- Campaign 3 underway, Campaign 4 in May
- DLR Cologne, Germany



# Palmer Station

- Immune Countermeasures
- Antarctica





# NASA Space Radiation Laboratory

- Finishing first round of Galactic Cosmic Ray simulator studies
- NASA Space Radiation Lab at Brookhaven National Laboratory



# Parabolic Analog

- Parabolic Analog Flight Study
- Completed study characterizing jugular venous flow during acute weightlessness
- Novespace in Bordeaux, France



# Low Earth Orbit Phase: ISS as Exploration Analog





# Enabling Commercial Space Human Research

Establishing relationships on accelerating HRP's risk reduction mission



SpaceX  
Inspiration4



Axiom  
Ax-1, AX-2



SpaceX  
Polaris Dawn



- Funded by NASA's Human Research Program, the Translational Research Institute for Space Health (TRISH) has established relationships and agreements to fly human research experiments on free flyer and PAM missions.
- On upcoming Axiom and the Polaris Dawn mission, HRP will partner with TRISH on implementing research complements.

# COMMERCIAL LOW-EARTH ORBIT



**AXIOM SPACE**



**NORTHROP GRUMMAN**



**NANORACKS & LOCKHEED**



**BLUE ORIGIN & SIERRA**





**ORION**



**GATEWAY**



**COMMERCIAL LUNAR PAYLOAD SERVICES**



**SPACESUITS**

# Artemis: Landing Humans On the Moon



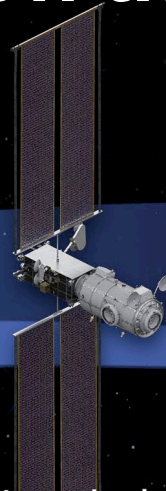
Lunar Reconnaissance Orbiter: Continued surface and landing site investigation



Artemis I: First human spacecraft to the Moon in the 21st century



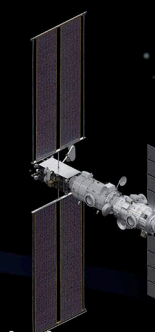
Artemis II: First humans to orbit the Moon and rendezvous in deep space in the 21st century



Gateway begins science operations with launch of Power and Propulsion Element and Habitation and Logistics Outpost



Artemis III-V: Deep space crew missions; cislunar buildup and initial crew demonstration landing with Human Landing System



**Early South Pole Robotic Landings**  
Science and technology payloads delivered by Commercial Lunar Payload Services providers

**Volatiles Investigating Polar Exploration Rover**  
First mobility-enhanced lunar volatiles survey

Uncrewed HLS Demonstration

**Humans on the Moon - 21st Century**  
First crew expedition to the lunar surface

**LUNAR SOUTH POLE TARGET SITE**



# Human Research Program Collaborations



## NASA Programs and Affiliates

- Biological & Physical Sciences (BPS)
- Health & Medical Technical Authority (HMTA)
- Advanced Exploration Systems (AES)



SBIR-STTR



TRANSLATIONAL RESEARCH INSTITUTE FOR SPACE HEALTH

## International



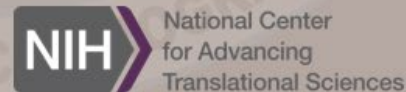
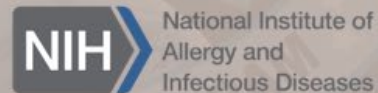
مركز محمد بن راشد  
للفضاء

MOHAMMED BIN RASHID SPACE CENTRE



## Domestic OGA

- NSRL Outside Users



## Industry / External

- Commercial Space Providers
- TRISH industry partners
- Others



National Council on Radiation Protection and Measurements

# CURRENT PARTNERSHIPS

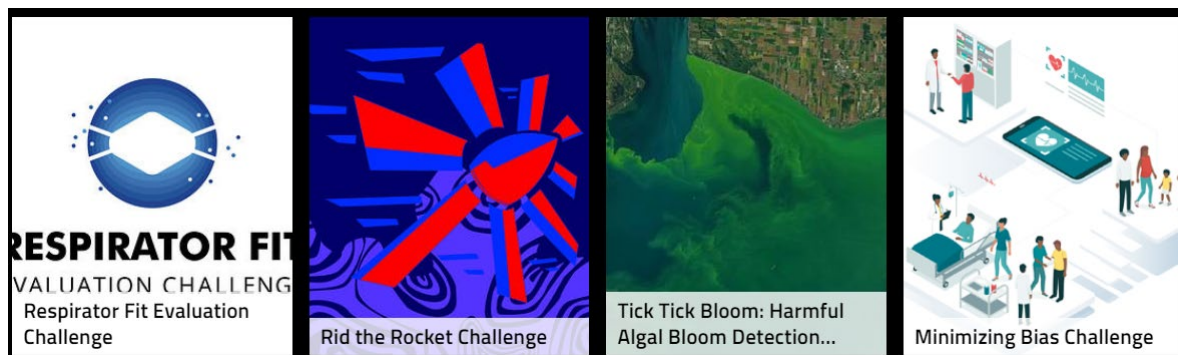




# How to work with JSC and the Human Research Program



- **NASA Research Announcements**
  - <https://nspires.nasaprs.com/external/>
- **HRP's Translational Research Institute for Space Health (TRISH)**
  - <https://www.bcm.edu/academic-centers/space-medicine/translational-research-institute/funding>
- **The Center of Excellence for Collaborative Innovation (CoECI)**
  - <https://www.nasa.gov/offices/COECI/index.html>
- **JSC Front Door**
  - Coming Soon!





Let's collaborate



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LinkedIn



