




---

---

---

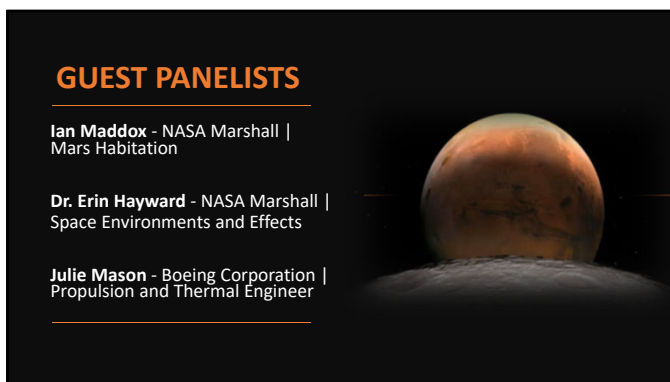
---

---

---

---

---




---

---

---

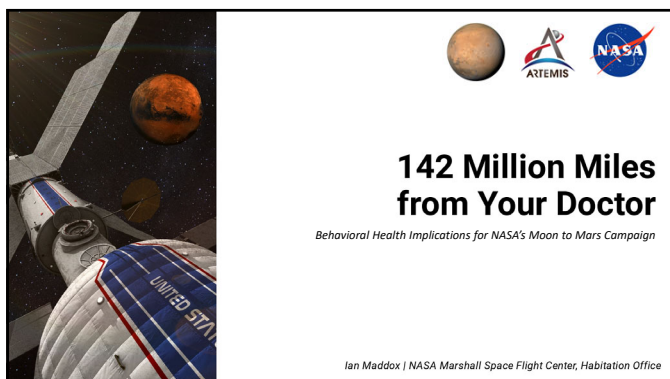
---

---

---

---

---




---

---

---

---

---

---

---

---

## Why Are We Going?



**Exploration**

The founding goal of NASA's Artemis campaign is to enable human expansion across the solar system.



**Discovery**

As Artemis progresses, we'll learn how to enable people to live and work safely in space... and leverage those discoveries here on Earth.



**Collaboration**

Artemis brings together international partners and commercial endeavors to spark a robust and inclusive cis-lunar ecosystem.



**Leadership**

NASA's Artemis campaign sets the vision for space exploration both at home and across the world, creating catalysts for innovation.

Art. Space Policy Directive 3 (Dec. 2017), US Space Priorities Framework (Dec. 2020), Artemis Accords (2023)

4

---

---

---

---

---





---

---

---

---

---

ARTEMIS I	ARTEMIS II	ARTEMIS III	ARTEMIS IV
First mission (uncrewed flight test)	First crew	First human surface landing	First lunar space station assembly mission
			
COMPLETE	CREW SELECTED		

---

---

---

---

---

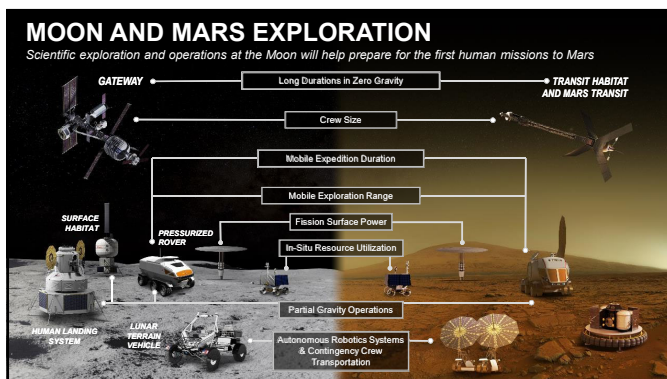
---

---

---

---

---




---

---

---

---

---

---

---

---

---

---

## 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. Traveling to and from their destinations, they will be in microgravity and will have to acclimate to one-sixth of Earth's gravity on the Moon or three-eighths of Earth's gravity on Mars.

**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.

---

---

---

---

---

---

---

---

---

---

## Earth Independence

Most of these hazards are made more challenging by the lack of ability to communicate with the ground – particularly in situations where crew rely on ground-based consults.

Determining what kinds of human health (including behavioral health) countermeasures need to be in place is the subject of research both in space and here on Earth.

ISS: 254 miles

**~0 sec**

Lunar Orbit: 239,000 miles

**~2.5 sec**

Mars Orbit: 142,000,000 miles

**~ 22 min + 528%**

---

---

---

---

---

---

---

---

---

---

## Notional Human Spaceflight Strategy for Integrated Research and Testing for Mars Mission Readiness

**FIRST MISSIONS TO MARS**

**OPERATIONAL VALIDATED** → CREW HEALTH & PERFORMANCE

**MISSION VERIFICATION & VALIDATION**

**ARTEMIS LUNAR-BASED ANALOGS**

**LOW-EARTH ORBIT RISK REDUCTION**

**GROUND-BASED RESEARCH**

**LEO COMMERCIALIZATION**

**ARTEMIS BASECAMP**

**FIRST MISSION TO MARS**

**TIME**

---

---

---

---

---

---

---

---

---

---




---

---

---

---

---

---

---

---




---

---

---

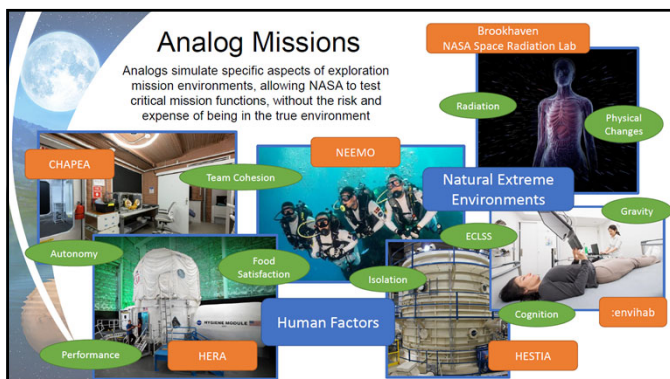
---

---

---

---

---




---

---

---

---

---




---

---

---

## HERA Basics

- HERA = Human Exploration Research Analog
- Multiple campaigns of 4 missions each, ranging from 1 week to 45 day missions, simulating a realistic mission profile and activities
- 2.5 story habitat at Johnson Space Center, roughly 650 sq ft
- ICC Analog
  - Isolated
  - Confined
  - Controlled
- Primarily a human factors & behavioral study, with some medical assessments as well
  - 'Astronaut-like' candidates are selected after undergoing rigorous physical and psychological evaluation


---

---

---

---

---


---

---

---

## Day-to-Day Astronaut Life...

- Conduct scientific experiments
- Routine spacecraft maintenance
- Deal with anomalies
- Train for the mission
- Eat!
- Exercise
- Public outreach
- Fill out lots of surveys
- Fill "white space"
- Sleep!




---

---

---

---

---


---

---

---

## Very Brief Overview of HERA Research Topics...

- Sleep deprivation**
  - Measures - Cognitive
  - Counter measures - Lighting
- Isolation**
  - Autonomy / time delay
  - Monotony
- Teams**
  - Decision making & roles
  - Crew selection
- Health measures**




---

---

---

---

---

---

---

---






---

---

---

---

---

---

---

---




---

---

---

---

---

---

---

---

Engineering, Test & Technology Boeing Research & Technology | HERA

### NASA HERA Campaign Stressors/Manipulations

- Common stressors/manipulations
  - On-board emergencies
  - Limited time to switch between different tasks
  - Within tasks unexpected failures and time limits
  - Operational communication delays between 30 seconds to 5 minutes
  - No windows or exposure to outside world
  - Limited contact with outside world

	Duration	Campaign Manipulations (Partial List)
Campaign 1	7-day	Sleep Restriction
Campaign 2	14-day	Sleep Restriction
Campaign 3	30-day	Self Scheduling Exercises Mass Reduction Food Bars
Campaign 4	45-day	Sleep Deprivation/Restriction Dynamic lighting, Enhanced Diet
Campaign 5	45-day	Reduced privacy and habitable volume
Campaign 6	45-day	Increased Comm Delay Self Scheduling Exercises Virtual Assistant for Spacecraft Anomaly Treatment

Copyright © 2018 Boeing. All rights reserved. Boeing Research & Technology | HERA | 2

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

Engineering, Test & Technology

### NASA Desert RATS X-Hab Challenge

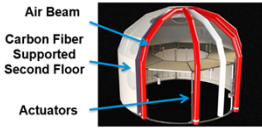
Students participated in NASA Review Process

- System Definition Review
- Preliminary Design Review
- Critical Design Review

Students performed their own testing and analysis to prove out concepts

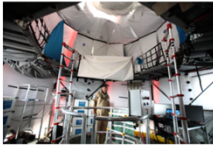
- Researched material strengths, flammability, temperature resistance, outgassing, etc.
- Conducted carbon fiber, fabric, air beam testing, etc.
- Performed analysis for structural loads provided by NASA, thermal loads to maintain a comfortable environment in the desert, and CFD for airflow through air ducting throughout living quarters

Boeing Research & Technology | HE/RA



Air Beam  
Carbon Fiber Supported Second Floor  
Actuators

Students Design Concept



Loft Interior at D-RATS

Copyright 2018 Boeing. All rights reserved.

BOEING PROPRIETARY

10/18/2023 10:00:00 AM Page 16

---

---

---

---

---

---

---

---



## QUESTION AND ANSWER

Alabama Psychiatric Physicians Association  
Fall Conference  
October 13, 2023

National Aeronautics and Space Administration




## EXPLORE MARSHALL

---

---

---

---

---

---

---

---



## THANK YOU

For inquiry, please contact:  
Christopher Blair  
NASA Marshall Space Flight Center  
[christopher.e.blair@nasa.gov](mailto:christopher.e.blair@nasa.gov)

Alabama Psychiatric Physicians Association  
Fall Conference  
October 13, 2023

National Aeronautics and Space Administration




## EXPLORE MARSHALL

---

---

---

---

---

---

---

---