NASA's Human Exploration Research Analog (HERA) for Studying Behavioral Effects of Exploration Missions

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I have no financial relationships to disclose.

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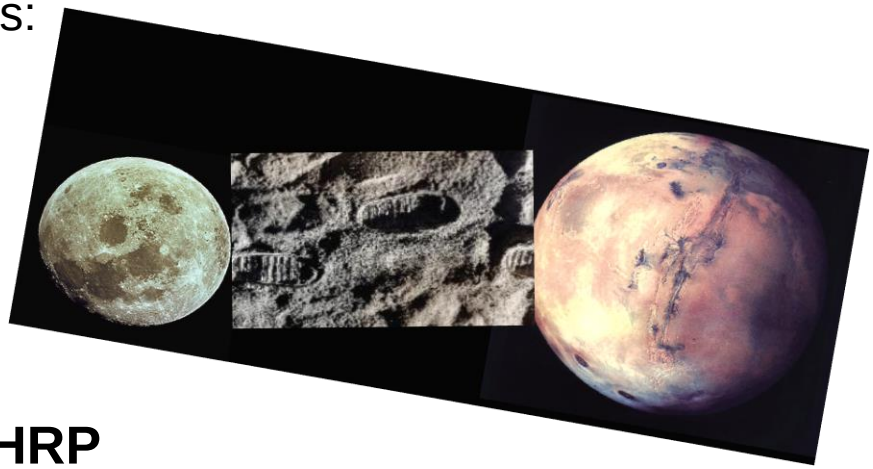
HRP Use of Analogs

- **Why do we use Analogs?**
  - Analogs provide conditions similar to some (but not all) conditions encountered in space flight such as:
    - Isolation
    - Confinement
    - Physiological stressors
    - Environmental danger



- **Benefits to HRP**
  - Ground-based analog studies are often completed more quickly and less expensively than flight studies
  - Analogs are often used as a “proving ground” before studies or countermeasures are implemented in space
  - Analogs provide a more “controlled” environment, often more repeatable scenarios, and higher “n” than available in space

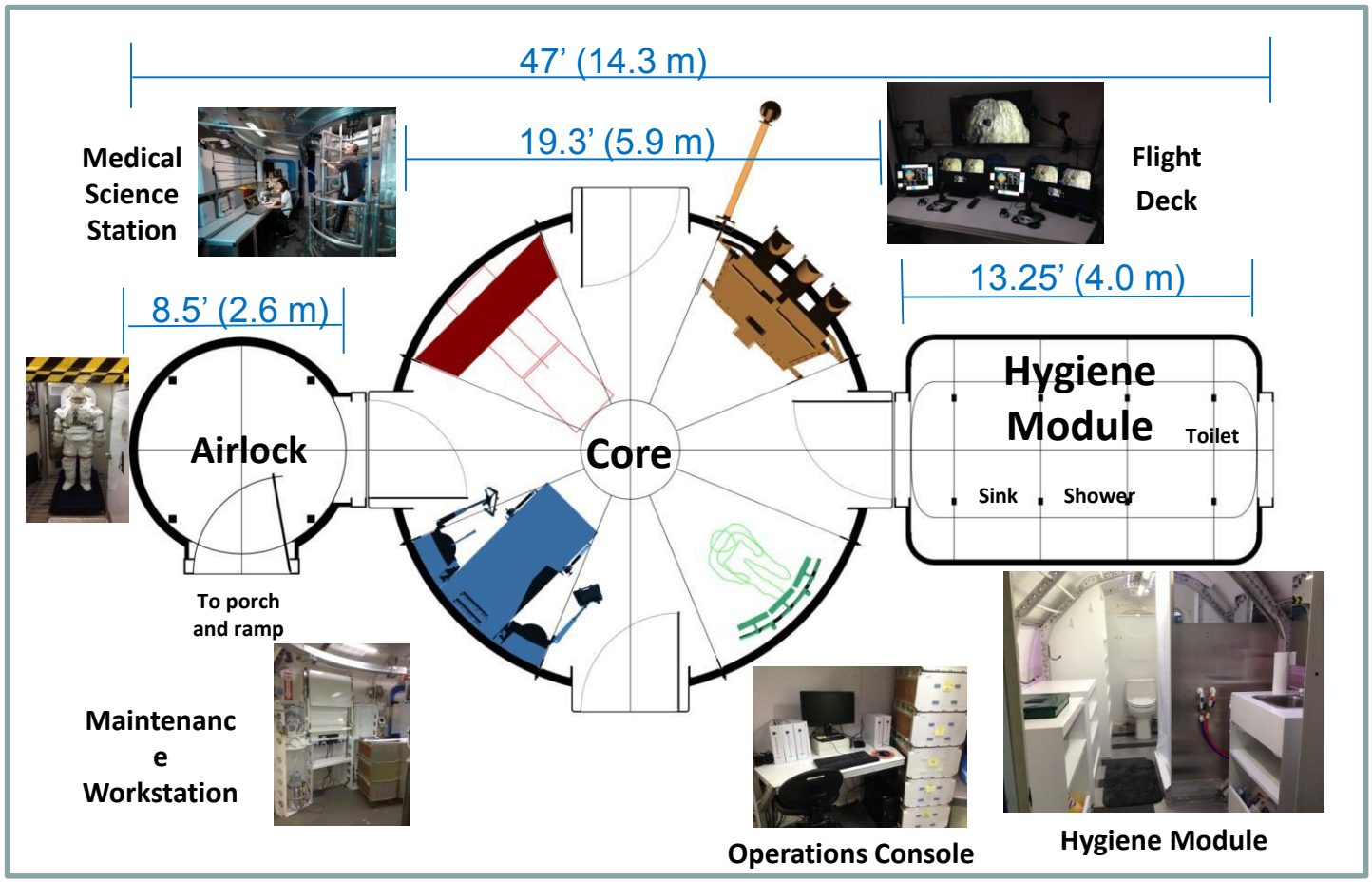
NASA Human Exploration Research Analog

- The Human Exploration Research Analog (HERA) was acquired by NASA's Human Research Program in 2013.
- Two-story, four-port habitat unit. Cylindrical with a vertical axis, and connected to a simulated airlock and hygiene module.
- Analog missions implemented for the purpose of human research in an isolated, confined, and controlled environment

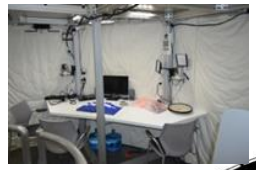
Total space: 148.1 m^3

- core (56.0 m^3)
- loft (69.9 m^3)
- airlock (8.6 m^3)
- hygiene module (14.1 m^3)

HERA Interior (1st floor)

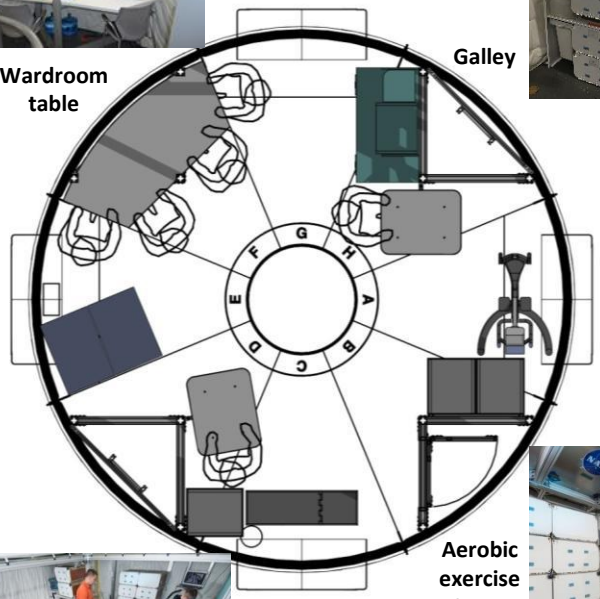


HERA Interior (2nd floor & Loft)



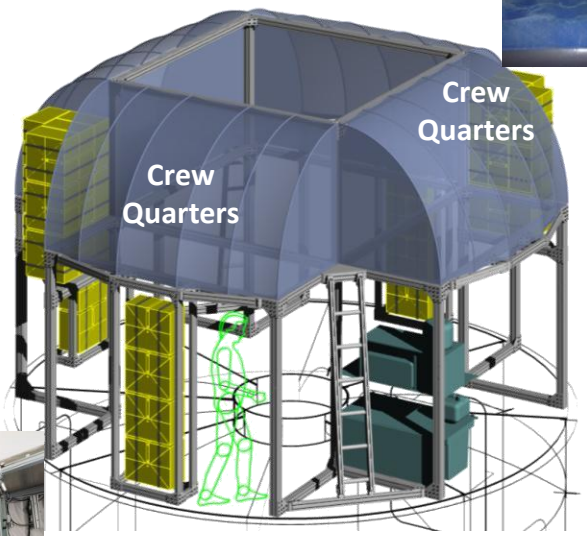
Wardroom table

Galley



Aerobic exercise device

2nd floor



Loft

HERA Subjects

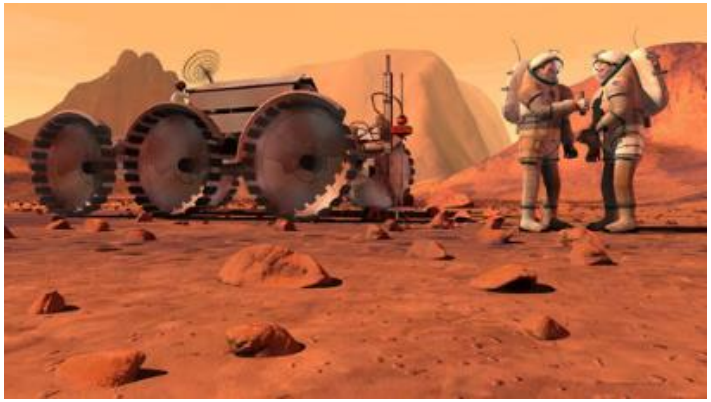
Selecting ‘astronaut-like’ individuals, using a modified version of astronaut minimum selection requirements

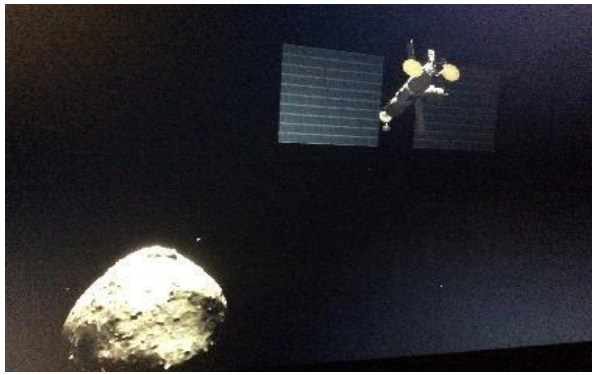
- 30-55 years old
- Demonstrated technical skills (e.g., Masters in STEM, equivalent years experience, military experience)
- Pass a JSC physical and psychological assessment
- No medications
- No dietary restrictions
- BMI 29 or less
- 74 inches or less in height

Mission Scenario

Mission scenarios define the HERA simulation

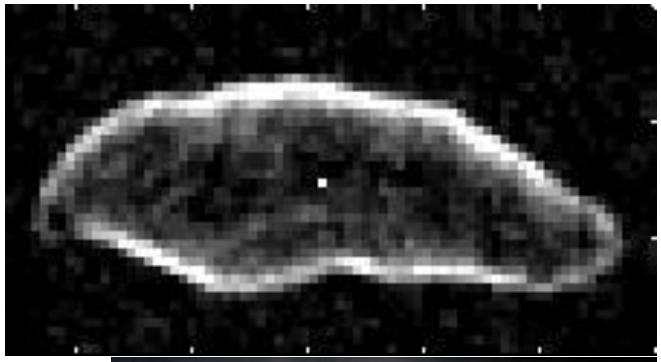
- Determines the types of activities the crew will do during the mission
  - Tasks related to mission objectives
  - Crew health and safety
- Provides crew with an overall context for the mission, allowing crew to engage in the simulation and forget about real world
  - Provides sense of purpose, goals, teamwork environment
- Provides a unique research environment and level of operational mission fidelity not available at most academic institutions
  - Developed by personnel with experience and expertise in spaceflight operations

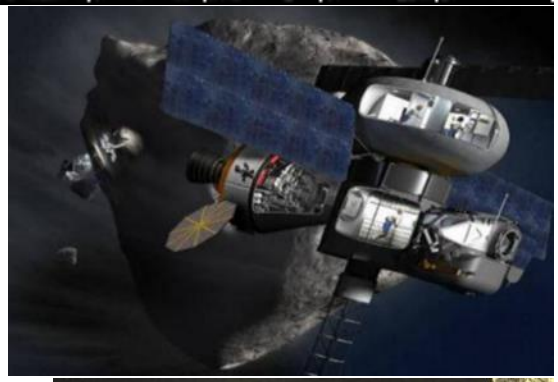




HERA Campaign 4 Mission Scenario

- **Destination:** Near-Earth asteroid 1620 - Geographos
- **Mission Duration:** 715 days
- **Crew Size:** Four (CDR, FE, MS1 & MS2)
- **Objectives:**
  - Crew health and safety
  - Conduct geological survey of Geographos
    - During transit, crew will use on-board training system to prepare for excursions to asteroid surface
  - Conduct scientific research in the areas of spaceflight psychology, physiology, and human factors/habitability
  - Vehicle systems maintenance
  - Education and outreach payloads



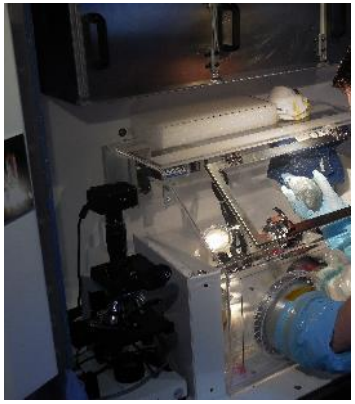


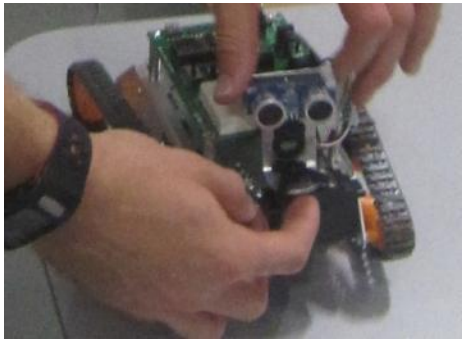
Simulated Mission Phases

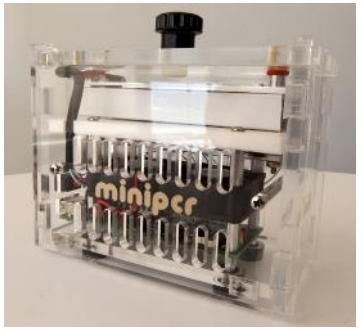
Mission Phase		Scenario Duration	Simulated Duration	Actual Mission Day
1	Orion launch, dock with Habitat vehicle, transit burn	2 days	1 day	MD1
2	**Transit to Geographos** *(comm delay phase in)*	330 days	18 days	MD2 – MD19
3	**Proximity Ops with Geographos** *(comm delay, 5 min one-way)*	21 days	5 days	MD20 – MD24
4	**Transit to Earth** *(comm delay phase out)*	360 days	20 days	MD25 – MD44
5	Enter in Earth orbit, Orion undocks and lands	2 days	1 day	MD45
	Total	715 days	45 days	

Mission Operations Tasks

- **Mission Objectives**
  - Multi-mission Space Exploration Vehicle (MMSEV) Flight Simulator & Virtual Reality EVA
- **Planetary Geology**
  - Asteroid Sample Processing
- **Educational Payload Operations**
  - Robotic Vehicle Concept
  - Animal Biology
  - Plant Biology
- **Human Research**
  - Microbiome
  - Mini PCR
  - Body Measures
- **Public Affairs Office Events**
- **Vehicle Operations**
  - Crew Health – Medical Drills
  - Vehicle Safety – Emergency Drills
  - Systems Status
  - Housekeeping

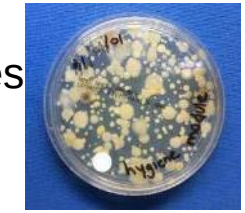






Mission Fidelity

- Aspects of the mission scenario used to create an operational environment that allows the crew to fully engage in the simulation
- Habitat systems
  - Voice loop communication system and use of voice protocol
  - Simulated Environmental Control and Life Support System (ECLSS)
  - Food rehydration system
  - View ports (virtual windows)
  - 3D printer
  - Sound system
- Operational processes
  - Mission Control Center (MCC) support
  - Full-day timelines for operational and research activities
  - Daily summary reporting
  - Habitat housekeeping and maintenance
  - Communication delay



Crew Daily Schedule

Timeline Activity	Duration (hrs)
Post-sleep, morning meal	1.5
Morning DPC, daily prep	1.0
Private conferences	0.5
Work - science & ops	***6.5 – 7.5***
Midday meal	1.0
Exercise	1.25
Evening DPC	0.5
Pre-sleep, evening meal	2.0

- Daily activity schedule similar to ISS flight plans
- Subjects awake at 0700, off duty at 2300 (CST)*

* Modified schedule for Campaign 4: M-F: 0700-0200; S-S: 0700-2300

Stressors/Manipulations

- Used to increase fidelity (Ops) and support research objectives (PI)
  - Simulate the types of stressors expected to occur naturally during long-duration space exploration missions
  - Implement study-specific stressors and research manipulations

- Examples
  - Full day (e.g., sleep deprivation)
  - Within task (e.g., unexpected failure)
  - Operational (e.g., comm delay)

- Assess PI stressors/manipulations to determine most effective implementation method
  - One or more operational tasks may be used
  - Activity and/or procedures are modified
  - Detailed, daily plan is implemented by MCC team

HERA C4 Research Studies

- 18 NASA funded studies
- 3 DLR funded studies

- Over 6500 planned data collection sessions during mission

- Research topics include:
  - Mission planning tools
  - Neuroplasticity
  - Maintaining team performance
  - Diet, immune response, and the microbiome
  - Sleep, fatigue, and performance monitoring
  - Lighting countermeasures
  - Team composition
  - Behavioral standard measures development and testing

Acknowledgments

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- Sarah Huppman
- The entire Flight Analogs team
- Our researchers
- Our HERA crews

HERA Subject Recruitment

Volunteers wishing to become HERA test subjects:

- **Phone NASA Test Subject Screening at 281-212-1492**
- **Email their CV to: *Jsc-hera@mail.nasa*.gov**