



---

# **Human Research Program Human Exploration Research Analog (HERA) Facility and Capabilities Information**

**July 2016**

**Flight Analogs Project  
Human Research Program**

**NASA FLIGHT ANALOGS PROJECT  
HERA FACILITY AND CAPABILITIES INFORMATION**

---

This document provides an overview of the HERA facility, its operations, and capabilities for the purpose of preparing research protocols.

**NASA FLIGHT ANALOGS PROJECT  
HERA FACILITY AND CAPABILITIES INFORMATION**

---

**Table of Contents**

INTRODUCTION ..... 4

HERA FEATURES ..... 4

HERA STANDARDIZED MISSION CONDITIONS ..... 5

HERA FACILITY CAPABILITIES..... 6

HERA DIETARY CONDITIONS..... 7

CAMPAIGN CHARACTERISTICS AND STUDY REQUIREMENTS ..... 7

SUBJECT DAILY AND WEEKLY WORK REQUIREMENTS..... 8

SUBJECT REQUIREMENTS..... 8

HERA SUBJECT RECRUITMENT AND SCREENING ..... 9

    Pre-Mission..... 9

    Mission..... 10

    Post Mission..... 10

INVESTIGATOR RESPONSIBILITIES ..... 10

INVESTIGATOR PREPARATIONS FOR HUMAN SUBJECTS BOARDS ..... 11

INVESTIGATOR RESOURCE/FISCAL RESPONSIBILITIES ..... 11

**Table of Figures**

Figure 1 Schematic representation of HERA..... 5

**Appendix**

[Appendix A HERA Facility Layout ..... A-11](#)

# NASA FLIGHT ANALOGS PROJECT

## HERA FACILITY AND CAPABILITIES INFORMATION

---

### INTRODUCTION

The NASA Flight Analogs Project (FAP) conducts research utilizing ground-based facilities that provide scenarios and environments analogous to those anticipated for exploration missions. The FAP supports the accomplishment of Human Research Program (HRP) objectives by investigating, acquiring, utilizing or operating high fidelity ground analogs of the space exploration environment aiming at the conservation of spaceflight resources while expeditiously and efficiently addressing research questions for future manned exploration missions.

The information within this document describes the standard conditions and capabilities provided for experiments performed in the Human Exploration Research Analog (HERA), as well as the services provided by FAP.

The Human Exploration Research Analog (HERA) plans for campaigns of incremental duration began in 2014 with four 7-day missions. A campaign is defined as one integrated protocol with one primary mission scenario consisting of multiple missions in order to meet study subject requirements. Studies designed to utilize the capabilities of HERA described in this document are integrated with other investigations on a non-interference basis and run together as one integrated campaign.

Planned mission durations may range from 7 days up to 45 days. The HERA planning schedule currently anticipates 4 missions per year (one per quarter) of 45-day duration in 2018.

### HERA FEATURES

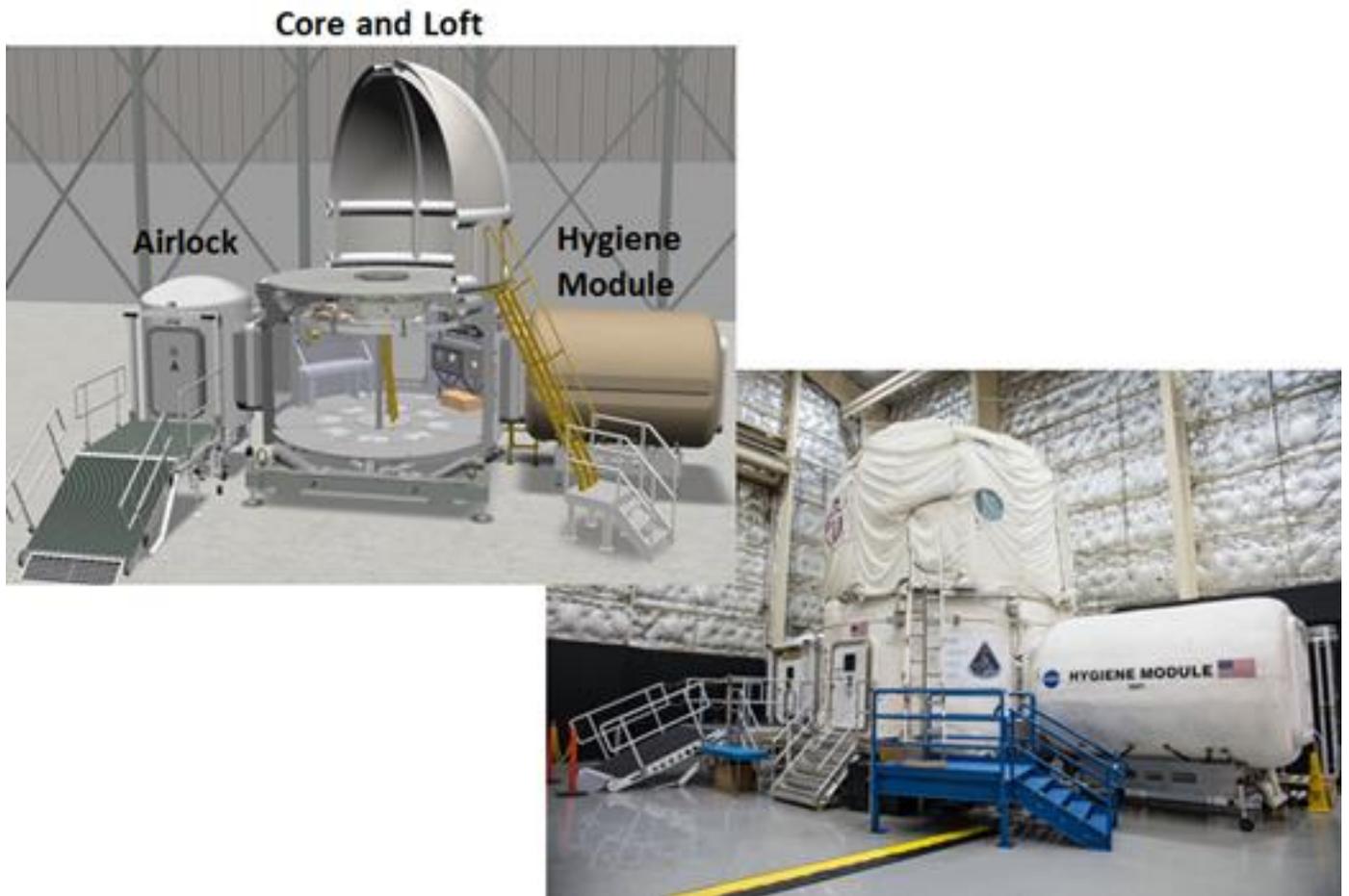
The HERA is a two-story, four-port habitat unit residing in Building 220 at NASA Johnson Space Center (JSC). It is cylindrical with a vertical axis, and connects to a simulated airlock and hygiene module (Figure 1). The total space comprises 148.6 m<sup>3</sup> or 636sq. ft., distributed as follows: core (56.0 m<sup>3</sup>) or 187 sq. ft., loft (69.9 m<sup>3</sup>) or 349 sq. ft., airlock (8.6 m<sup>3</sup>) or 42 sq. ft., and hygiene module (14.1 m<sup>3</sup>) or 58 sq. ft. (see Appendix A).

HERA facility capabilities include a network that allows electronic research data and voice communications to be exchanged between the crew and ground controllers located in Building 220. The research data can be securely accessed by remote investigators real-time or near real-time through the JSC Telescience Center (TSC). HERA has a surveillance video and audio system, flight-like timeline and procedure viewer to provide a space mission experience.

Currently, the HERA represents an analog for simulation of isolation, confinement and remote conditions of exploration mission scenarios. Studies suitable for this analog may include, but are not limited to behavioral health and performance assessments, communication and autonomy studies, human factors evaluations, human health countermeasures, and exploration medical capabilities assessments and operations.

# NASA FLIGHT ANALOGS PROJECT HERA FACILITY AND CAPABILITIES INFORMATION

---



*Figure 1 Schematic representation of HERA*

The following sections describe the conditions and capabilities that are considered the baseline for operations with HERA. Researchers may propose modifications to any of these parameters; such proposed modifications will be evaluated for feasibility by the Flight Analogs Project (FAP) team. They will also be considered during the study integration phase, taking into account the impact of such modifications on all other studies proposed for the research campaign. If modifications cannot be accommodated, FAP may recommend a study be moved either to a later HERA campaign, or to a different analog environment.

## **HERA STANDARDIZED MISSION CONDITIONS**

- Duration: Up to 45 days confined habitation specific to science requirements; approximately 66 total study days inclusive of 14 days pre- and 7 days post-confinement
- Light/Dark Cycle: Lights on 0700, lights out 2300, 7 days per week
- Typical crew day schedule requires 16 hours awake, 8 hours sleep scheduled, no napping is permitted

# NASA FLIGHT ANALOGS PROJECT

## HERA FACILITY AND CAPABILITIES INFORMATION

---

- Crew mission schedule based on ISS crew schedule, modified to reflect exploration mission activities and events
- Mission scenario constructed to simulate varying degrees of workload and includes specific stressful conditions commonly encountered in space flight
- Crew has no access to internet content, social media, television/radio, and telephone. However, will receive uplinks of Houston Chronicle and USA Today Monday – Friday. Crew allowed private family conference, private medical conference, and private psychological conference once per week.
- Continuous monitoring of crew members during isolation, excluding sleep quarters, hygiene module, and during private family/medical/psychological conferences

### HERA FACILITY CAPABILITIES

- Mission Control Center (MCC) for real-time interaction with HERA subjects
  - 24/7 mission video surveillance with audio, recorded during mission
  - Voice communication recordings between HERA and MCC during the mission
    - Comm delay, voice and/or text, up to 10 minutes each way
    - Simulation of AOS/LOS (Acquisition of Signal/Loss of Signal) of varying duration
- Ability for investigator data collection to occur via the internet through pre-approved websites and forms
- Study and mission data product distribution through TSC WebMirage
  - Mission data includes temperature, relative humidity, eLog, and Mission Log
- Surveillance video from up to 9 cameras, with limited real time access for study teams during mission
- Medical Workstation
  - Remote medical procedures and examinations
  - Biological sample collection
    - Venous blood/saliva/urine/fecal collection
  - Heart Rate Monitor to support exercise or research
  - Ultrasound to support research or medical objectives
  - Actigraphy
- Adjustable LED lighting on L2
- Simulated stowage module (pass through for hardware and garbage chute)
- Flight Simulators to support an exploration mission scenario (Multi Mission Space Exploration Vehicle (MMSEV) & Robotic On-Board Trainer (ROBoT))
- Virtual reality for simulated EVA tasks
- Modifiable virtual window views
- Ability to control temperature for subject comfort.
- Exercise equipment (aerobic and resistive) to simulate daily operational activities.
- HERA-provided Windows-based laptops run Windows 7.0 Enterprise 64-bit and iPads run Apple iOS 9.3.3 for each crew member for investigator data collection
- Charging station for devices with Alternating Current (AC) and USB ports.
- Simulated Environmental Control and Life Support System (ECLSS) to support complex operational activities

# NASA FLIGHT ANALOGS PROJECT

## HERA FACILITY AND CAPABILITIES INFORMATION

---

- 3D printer to support vehicle maintenance and operational tasks
- Simulated alarm system to support emergency rescue drills
- Flight-similar galley capabilities for preparing meals
- Plumbed water for crew consumption and food rehydration
- Shower/sink with hot and cold running water for crew hygiene

### HERA DIETARY CONDITIONS

Participating subjects will be provided a minimum of 3 meals each day. Diet and core menu is based on NASA spaceflight nutritional requirements. Once a crew is selected, specific crew caloric requirements are determined by using the Mayo Clinic calculator. A core menu of food items is provided with a flight like combination of thermo stabilized, rehydratable, and natural food items. Food items may be provided by the JSC Food Lab as well as off the shelf food items as needed to meet caloric requirements. Feasibility of studies with specific dietary needs will be assessed on a per study basis.

### CAMPAIGN CHARACTERISTICS AND STUDY REQUIREMENTS

A HERA Campaign is defined as one integrated protocol with one primary mission scenario. An integrated protocol consists of a number of individual investigator studies that can be combined on a non-interference basis. Each campaign is expected to consist of 4 missions, providing a total of 16 subjects for each study. Power analyses for each study will determine the number of missions needed to achieve the required study sample size.

- Each HERA mission will consist of:
  - *Access to the subjects for mission activities:*
    - Up to 14 days of pre-confinement activities (i.e. baseline data collection (BDC), training, informed consent); final duration will be dependent on research requirements
    - In mission confinement activities (i.e. operational activities expected for an exploration mission along with research activities) 45 days depending on campaign requirements.
    - Up to 7 days of post-confinement activities (i.e. endpoint data collection, debriefing); final duration will be dependent on research requirements
- To support the isolation requirement, test subjects will be informed of restrictions to their activities and access to communications channels (i.e. no access to email, personal work, phone calls, or the internet will be allowed; family conferences are scheduled weekly). FAP personnel will provide news items via periodic uplinks (exception for family emergencies which require intervention) consistent with simulating the space flight condition.
- A mission control center (MCC) is located within Building 220 to support HERA operations including surveillance, communications, computers and phones. The extent of investigator support during the testing will be determined in each case.

# NASA FLIGHT ANALOGS PROJECT

## HERA FACILITY AND CAPABILITIES INFORMATION

---

### SUBJECT DAILY AND WEEKLY WORK REQUIREMENTS

The operational plan uses the ISS Program nominal 24-hour work day structure as a guideline. Below is the HERA mission plan:

- All time spent in the facility will be working on tasks related to the study.
- Subjects awake at 0700 and are off duty at 2300 with one shift operation for all subjects.
  - Sleep period (8.0 hours).
- Post-sleep period, includes morning meal (1.5 hours).
- Daily planning conferences, medical conferences, work preparation, and plan familiarization (2.0 hours).
- Work, consisting of scheduled research tasks and HERA operations tasks, i.e. HERA maintenance, flight simulator for an asteroid based rendezvous mission, public affairs activities, education outreach, etc. (6.5-8.0 hours).
- Midday meal (1 hour).
- Exercise period (1.25-2.5 hours, includes time for setup, cardiovascular/resistive exercise, stowage, hygiene (cool down and cleanup)).
- Pre-sleep period, includes evening meal (2.0 hours).
- A nominal 7 day work/rest cycle will consist of 5.5 days available for conducting planned utilization and non-utilization activities and 1.5 consecutive off-duty days. Housekeeping and 1.0 hour of scheduled work on the weekends is included in the 5.5 working days.
  - Rationale: The crew week should align as closely as possible to the typical ground work week. Nominal scheduling of consecutive days off during a 7 day week for ISS crews is a behavioral health and medical countermeasure necessary for maintaining individual health and performance as well as maintaining performance and effective functioning of the entire crew as a unit. In a nominal 7-day week the crew works 5 days and the 6th day is a half duty day for housekeeping and 1 hour of scheduled work. The 7th day is a full off duty day. For planning purposes, the one hour of scheduled work may be planned across the 6th and 7th day.

### SUBJECT REQUIREMENTS

- Four subjects per mission
- Must be US citizens, or hold a US Permanent Resident Card (Green Card)
- Goal of 50/50 male:female ratio for each mission and campaign but the actual crew mix is contingent on subject pool availability
- Age range from 26 – 60 may be considered for candidate subjects; the preferred age range is from 30 to 55.
- Height limited to 6'2" maximum
- Pass a Class III flight physical
- Technical Skills demonstrated through professional experience. Advanced degree (e.g. M.S.) or equivalent years of experience.
- Must have demonstrated motivation and work ethic similar to the current astronaut population.

# NASA FLIGHT ANALOGS PROJECT

## HERA FACILITY AND CAPABILITIES INFORMATION

---

- Psychological assessment by a clinical psychologist to qualify for participation
- Astronaut-like characteristics that are considered during HERA test subject selection include the following criteria used in astronaut selection:
  - The requirements for Astronaut Candidates are a bachelor's degree from an accredited institution in engineering, biological science, physical science, or mathematics. Quality of academic preparation is important.
  - An advanced degree is desirable and may be substituted for experience as follows:  
master's degree = 1 year of experience,
  - Doctoral degree = 3 years of experience.

### **HERA SUBJECT RECRUITMENT AND SCREENING**

The NASA JSC Test Subject Screening (TSS) provides advertising, recruiting and health screening for subject candidates. Once subjects pass the health requirements of the TSS, they will be provided to FAP to coordinate any additional screening required by investigator studies. Only subjects who pass all screening (psychological and physiological) criteria will be considered for enrollment in the campaign.

### **NASA FLIGHT ANALOGS PROJECT TEAM RESPONSIBILITIES**

The NASA Flight Analogs Project team is responsible for all HERA facility preparations, maintenance, upgrades and integration activities prior to the start of a research campaign, as well as any required maintenance between missions within the campaign. The FAP team performs a feasibility assessment of each research proposal to determine the degree of adherence to the standard conditions described in this document, and makes recommendations for admission of the study to the HERA complement, assignment to a future complement, or assignment to a different analog. The FAP Team assigns individuals to work directly with each researcher to ensure that individual research protocols are integrated into the complement with the goal of maximizing science return while mitigating confounds between studies. The FAP team members also ensure researchers maintain cognizance of schedule deadlines, and recommend removal of a study from the complement if deadlines are not likely to be met. The FAP Team strives to:

- Maximize resources by combining individual investigations into integrated studies within a campaign.
- Develop customized mission scenario, supporting activities, and stressor plan as needed to meet investigator requirements
- Ensure consistency for studies in the campaign by maintaining identical HERA study conditions and mission scenario for all missions in the campaign

#### ***Pre-Mission***

- Develop and manage schedules associated with the implementation of integrating studies
- Coordinate investigator meetings

## NASA FLIGHT ANALOGS PROJECT HERA FACILITY AND CAPABILITIES INFORMATION

---

- Identify opportunities for data sharing among researchers using common measures
- Prepare complement protocol submission for the JSC Institutional Review Board (IRB) for the campaign.
- Develop and baseline the complement requirements document which contains agreed upon protocols, data collection, and data sharing
- Assist the investigator in acquiring a Telescience Center (TSC) account to enable the capability to transfer electronic data from HERA to remote investigators via the TSC
- Facilitate access to NASA TSC for approved PI data sharing agreements
- Recruit and perform standard subject screening through the JSC TSS facility
  - Provide subject reimbursement and transport for study purposes
- Coordinate receipt of investigator hardware shipment and coordinate with the investigator for integration, setup and checkout of their hardware
- Design and execute an integrated test to ensure all PI hardware and software compatible with HERA facility systems; resolve any interference issues between PI systems
- Provide facility and mission training
  - Coordinate PI specific training for all primary and secondary crew members
  - Provide test subject facility orientations
- Coordinate on-site PI baseline data collections
- Conduct integrated Test Readiness Reviews, safety walk-throughs and operations check-outs prior to starting the study

### *Mission*

- Provide 24/7 real-time on-site mission support for all mission operations
- Provide medical monitor and psychological support as required throughout mission operations
- Provide a daily operational status report during mission
- Document and report all off-nominal or adverse events to the JSC IRB

### *Post Mission*

- Coordinate post study subject follow up testing and debriefings as required.

### **INVESTIGATOR RESPONSIBILITIES**

- Participate in meetings with Flight Analogs Project team and investigators of other studies to develop integrated protocols to support a campaign (i.e. Science Requirements Document and Integrated Requirements Document)
- Adhere to the campaign schedule deliverables for investigators. **NOTE:** Failure to meet target deadlines for the campaign schedule can result in removal of an investigation from the complement, and assignment to either a later complement or to a different analog environment.

## **NASA FLIGHT ANALOGS PROJECT HERA FACILITY AND CAPABILITIES INFORMATION**

---

- Obtain institutional IRB approvals, if required
- Submit Stand-alone Protocol to JSC IRB
- Provide all hardware and software required for testing
- Provide all training materials and procedures required for crew and mission operations
- Ensure the investigator study requirements are compatible with the standard conditions of HERA to the degree possible without compromising scientific results
- Work closely with the assigned FAP team member to identify incompatibilities with the HERA standard conditions and/or with other investigations, and propose solutions to enable maximum scientific results
- Provide for on-site or remote study support at the HERA facility at Johnson Space Center, Houston TX including investigator resources and scientific expertise as needed.
- Budget for costs associated with on-site support
- Carry out investigator science protocols with integrity and professionalism
- Provide in-mission support as required for anomaly resolution
- Participate in periodic data debriefs
- Conduct negotiations required for data sharing (e.g. publication rights, etc.)
- Provide complete experimental data sets to the NASA Life Sciences Data Archive per the terms and conditions of their grant
- Provide manuscript(s) within 2 years of study completion for inclusion into final project report

### **INVESTIGATOR PREPARATIONS FOR HUMAN SUBJECTS BOARDS**

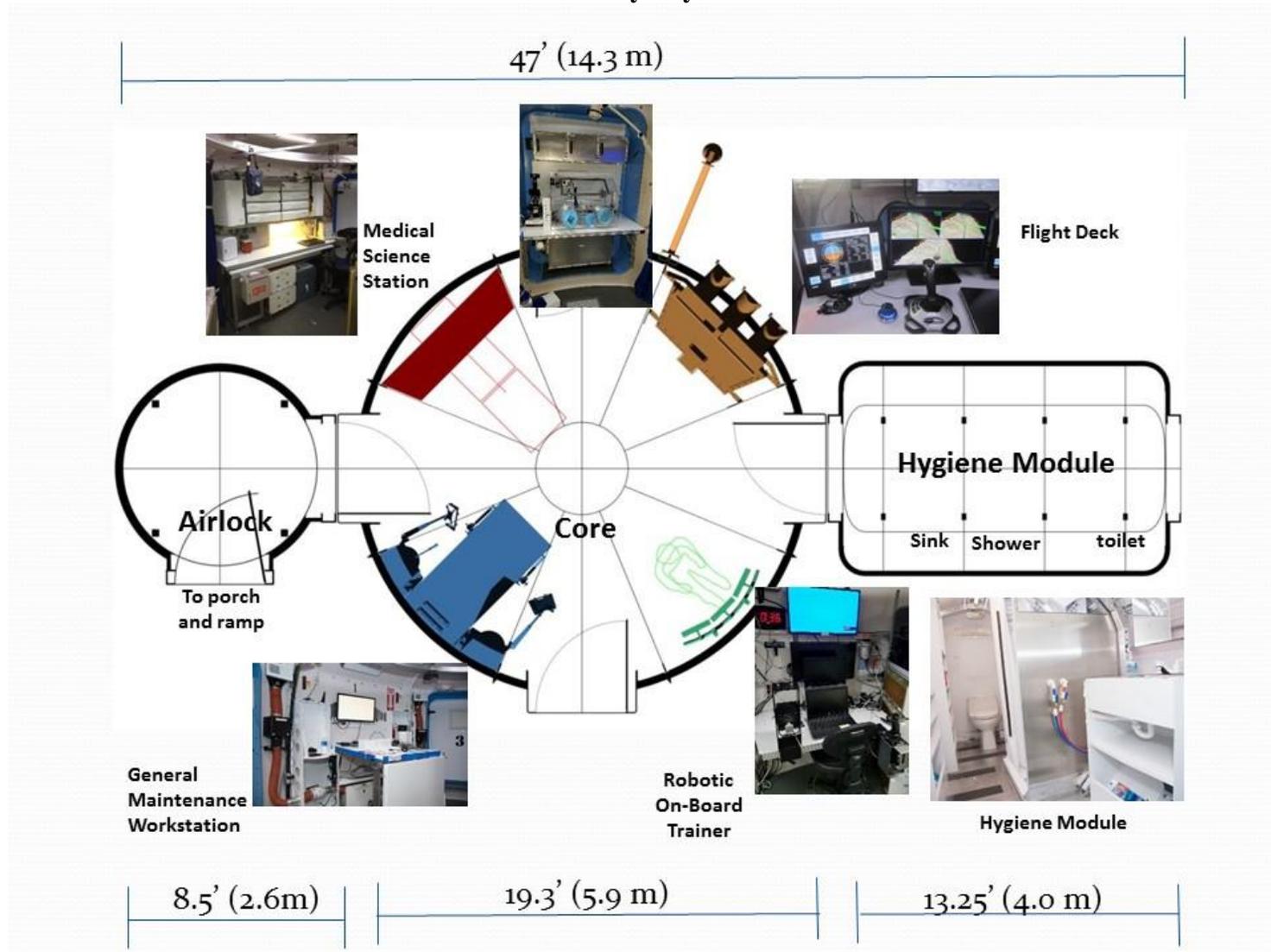
- Work with the FAP Project team members to determine needed approvals from the investigator's home institution.
- Prepare individual protocol submissions to the JSC IRB with the assistance of FAP Project team member

### **INVESTIGATOR RESOURCE/FISCAL RESPONSIBILITIES**

- The investigator will provide resources for their experiment unique requirements
- The investigator will provide subject consent briefings for their specific study
- The investigator will have responsibility for the costs of any investigator protocol specific test subject screening requirements, equipment, and other investigation specific requirements.
- The investigator is responsible for costs associated with his specific protocol operations, consumables, sample collection, etc.
- The investigator is responsible for test subject travel costs for follow up testing required beyond the standard schedule
- The investigator is responsible for data sharing arrangements with other investigators.

# NASA FLIGHT ANALOGS PROJECT HERA FACILITY AND CAPABILITIES INFORMATION

## Facility Layout



# NASA FLIGHT ANALOGS PROJECT HERA FACILITY AND CAPABILITIES INFORMATION

## Appendix A HERA Facility Layout

