HERA Article for AIAA

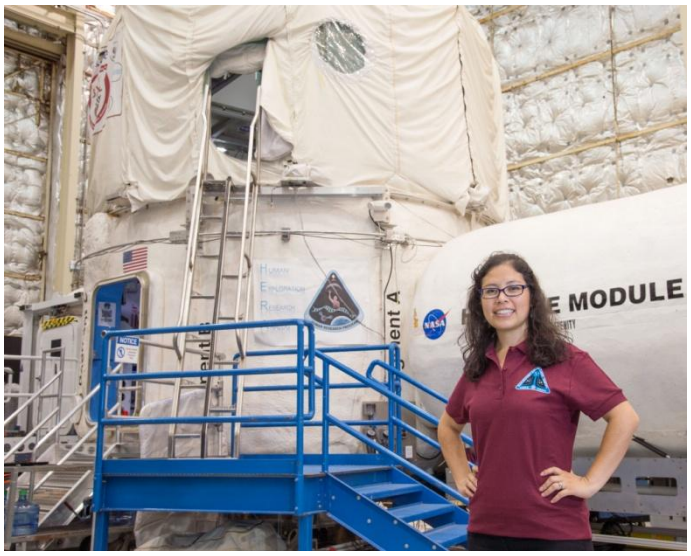
By Jackelynne Silva-Martinez

The Human Exploration Research Analog (HERA) is a NASA facility that provides a high-fidelity research venue for scientists to address risks and gaps associated with human performance during spaceflight. HERA is a demonstration habitat used to simulate a spacecraft-like environment, where researchers have the opportunity to evaluate how crew members respond to isolation, confinement, and remote conditions of mission exploration scenarios. HERA is a cylindrical three-story, four port habitat unit of approximately 47 feet across and 25 feet in height. This habitat was previously used as part of the Desert Research and Technology Studies, where the program goals were to use the arid climate, harsh winds, and rocky desert terrain to evaluate different conditions while developing and testing spaceflight equipment and technology. After some modifications made to support the Flight Analogs Project of the Human Research Program at NASA JSC, the habitat was ready for isolation and confinement studies in 2013. It is currently located in a building at the Johnson Space Center; it connects to a simulated airlock and hygiene module.

The 4 person crew for C2M4 (Campaign 2 Mission 4) on HERA

The NASA Flight Analogs Project selects 4 crew members, usually 2 men and 2 women from "astronaut-like" candidates who had to pass Air Force Class III equivalent physical exams and psychological tests. Each of the four crew members performs the same tasks during study duration. However, each member is assigned a different position (commander, flight engineer, mission specialist 1 and 2). I was part of the latest mission, Campaign 2 Mission 4 (C2M4) that was held in August 2015, where I served as the Mission Specialist. We simulated a mission to conduct a geological survey of the Geographos asteroid, where we were isolated for 2 weeks for behavioral research and test tools in an operational

environment. An outbound transit that would take about 370 days was simulated over the first six days. The asteroid proximity operations that would take about 20 days were simulated over the following four days, and the return transit was simulated over the last four days. Mission success depended on our ability to live and work with our crewmates during this long journey to achieve all mission objectives.

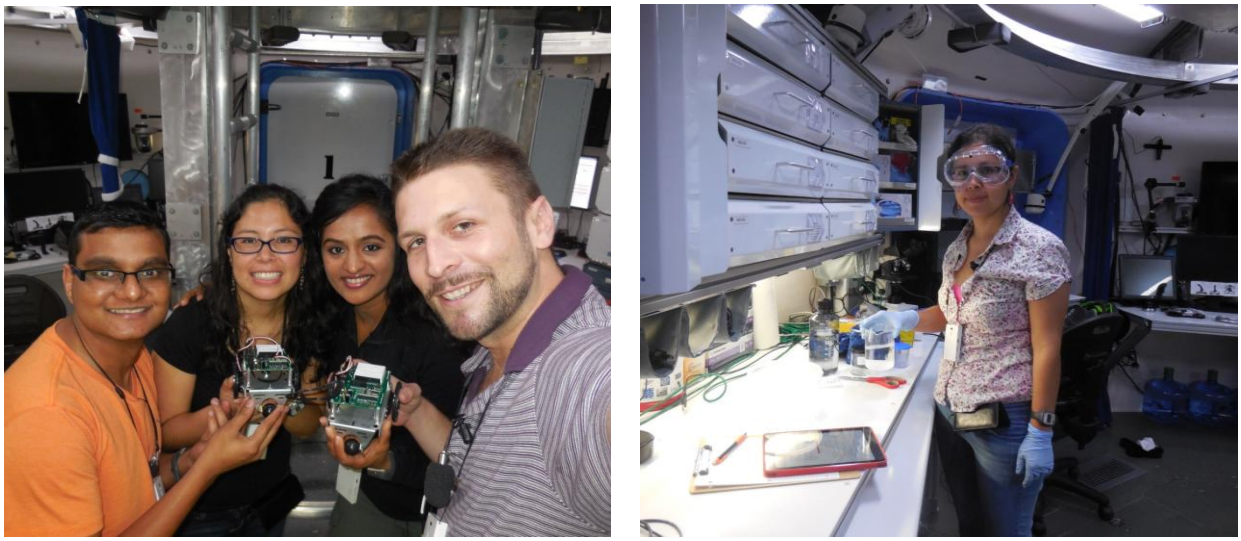


Jackelynne Silva-Martinez: HERA C2M4 Mission Specialist

We participated in scientific research in the areas of spaceflight psychology, physiology and human factors/habitability. Researchers were studying our personal and team behavior, including team cohesion fluctuations, cognitive skills at the end of a long work day, and how we managed unexpected surprises. They were also testing unobtrusive monitoring tools, validating new cognitive performance evaluation tools, and testing effects of communication delay on team performance. The communication with the outside world was limited to about 30 minutes conference call once a week with family, as well as private conference calls with our medical doctor and psychologist. Yet, we were in constant communication with the mission control center (MCC). They provided technical and logistical support via voice or text loops 24/7. We also simulated communication time delay of 5 minutes one-way for two days and 10 minutes one way for other two days.

Jackelynne Silva-Martinez at the MMSEV

During transit, we used on-board training systems to prepare for simulated excursions to the asteroid's surface. We used a flight simulator to fly the multi-mission space exploration vehicle (MMSEV) to the asteroid's surface that included a scatter of synthetic rocks for depth perception, locating different sites of geological interest and to position the MMSEV to collect samples. Facial recognition was used to track and detect ours signs of distress, fear, or joy during the asteroid inspections. We used a microscope to correctly identify and classify asteroid samples. We also got to assemble two rovers and test it in different configurations with various proximity sensing technologies of robotic spacecraft. We performed experiments with brine shrimp, seed and crystal growth experiments, collected bio samples from crewmembers and habitat surfaces for microbial analyses, and conducted drills to simulate the treatment of medical symptoms and response to vehicle emergencies. We also performed multiple system maintenance tasks of our vehicle, and worked on a few education and outreach payloads. During one of those nights, we were not allowed to sleep, simulating an encounter with comet debris field, which required us to keep a watch on vehicle status throughout the night.



HERA C2M4 assembling rovers and doing science experiments

Each activity of the mission was pre-planned and scheduled. We would wake up at 0700 and then spend the next 1.5 hours on post-sleep activities including breakfast. Then, we had a morning daily planning conference with MCC to review the activities of the day. Various operational activities, science experiments, and other tests took nearly 6.5 hours of a typical work day. Nearly 1.5 hours were set aside for exercise and personal hygiene. In the evening, we had a downtime of around 2 hours that included dinner, and any other fun activities we agreed as a crew; we enjoyed watching movies and playing cards. Some of the surveys and tests were scheduled right before going to bed at 2300 after a full and busy day. There were also some unplanned anomalies in systems' status such as a possible solar storm.

Level 1 of HERA

Throughout the mission we carried out a variety of alertness and mental tests to assess behavioral health and performance. We used the real time neurocognitive assessment toolkit for fatigue, optical computer recognition of stress and fatigue, audio and video recordings to dynamically monitor cognitive, emotional, and social mechanisms that influence performance. We monitored different parameters in response to stress like heart rate, blood pressure, and collected saliva and blood at different time points during our mission. Apart from these there were several tasks to measure, maintain and regulate team role and cohesion.

Level 2 of HERA

When isolated from the rest of the world in a place that, even in simulation seemed surprisingly alien, preparing and eating food were the most communal and humanizing of domestic rituals. It served to maintain group cohesiveness and foster teamwork. We ate freeze dried vacuum sealed food from the same lab that prepares food for the astronauts. We had to rehydrate it and let it sit for few minutes to be ready to eat. There was always more food than we could eat. We also had to track our food intake using an app that is being considered for use by astronauts on the ISS.

As our mission was approaching its end, suddenly the leisure of the first few days gave way to rush. Two weeks seems like a long time, but the days went by too soon. If our own crew found frustration at some point during this short stay, I can hardly imagine what it would be like to travel for a year, one way to an asteroid in a cramped spacecraft. Be it on an asteroid or inside HERA one must learn to adjust to situations and compromise. The best ideas are not always partnered with the best resources, and vice versa. One must learn to adapt to anomalous situations and unexpected turns. I am thankful for the opportunity to be a part of this exciting journey and contribute to the body of knowledge for future human spaceflight missions. Rather than the end of a mission this seems like the beginning of an exciting journey. I invite others to also participate in this exciting adventure.

There is a new call for the next round of HERA missions starting in January 2016. If you are interested, here is some info about it:

> *Want to participate in an "astronaut-like" high-fidelity analog study? Here is your chance! NASA JSC Test Subject screening is recruiting volunteers for a 51-day study to simulate flight operations and confinement. Subjects will spend 30 days in confined habitation in the Human Exploration Research Analog (HERA) facility at NASA JSC. Healthy, non-smoking volunteers, ages 30 to 55, must pass a JSC physical and psychological assessment to qualify. Subjects must take no medications, have no dietary restrictions, have a BMI of 29 or less, be 74 inches or less in height and have no history of sleepwalking or use sleep aids. Subjects must have highly technical skills and a Master of Science in a STEM discipline or equivalent years of experience. As long as you have a green card or have been vetted already and can be badged at any of the NASA centers then you can participate. If interested, Please call 281-212-1492 and leave your name and contact information and you will be called back.*