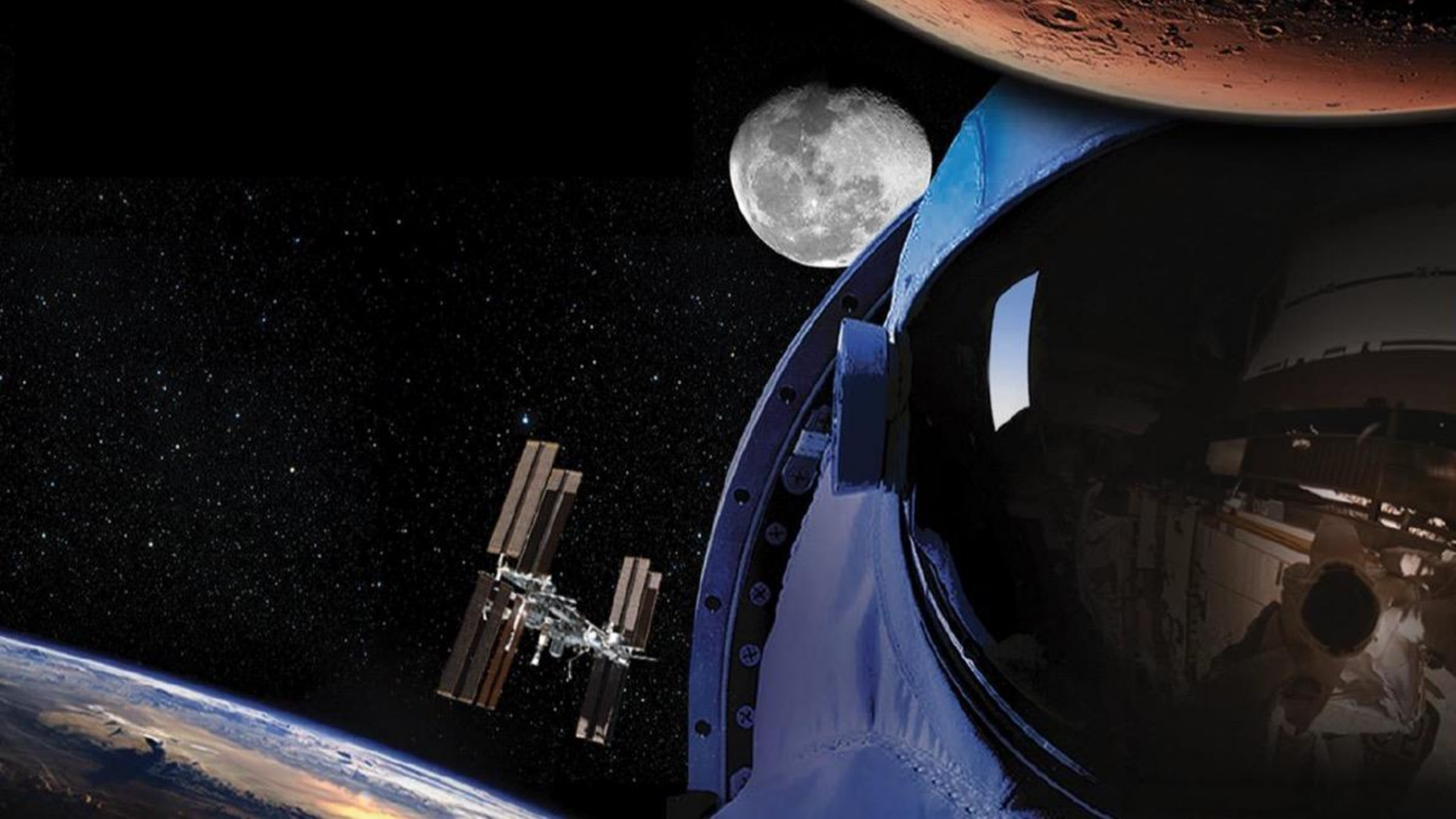


HABITATION CAPABILITY

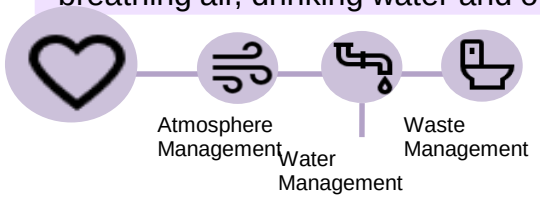
Systems to enable the crews to live and work safely in deep space. Capabilities and systems for use in conjunction with Orion and SLS on exploration missions in cislunar space and beyond.

Deep Space Habitation Systems

Habitation Systems Elements

LIFE SUPPORT

Excursions from Earth are possible with artificially produced breathing air, drinking water and other conditions for survival.



TODAY Space Station

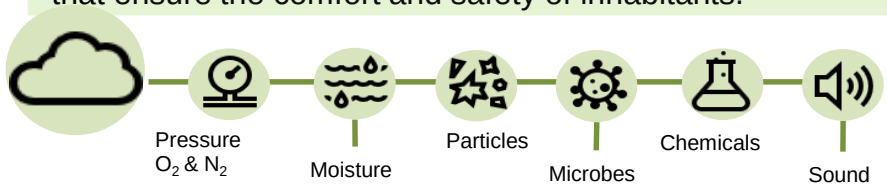
- 42% O_2 Recovery from CO_2
- 90% H_2O Recovery
- < 6 mo mean time before failure (for some components)

FUTURE Deep Space

- 75%+ O_2 Recovery from CO_2
- 98%+ H_2O Recovery
- >30 mo mean time before failure

ENVIRONMENTAL MONITORING

NASA living spaces are designed with controls and integrity that ensure the comfort and safety of inhabitants.



TODAY Space Station

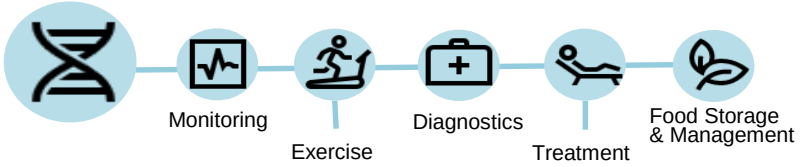
- Limited, crew-intensive on-board capability
- Reliance on sample return to Earth for analysis

FUTURE Deep Space

- On-board analysis capability with no sample return
- Identify and quantify species and organisms in air & water

CREW HEALTH

Astronauts are provided tools to perform successfully while preserving their well-being and long-term health.



TODAY Space Station

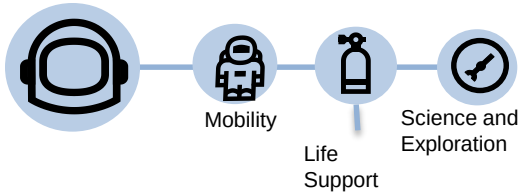
- Bulky fitness equipment
- Limited medical capability
- Frequent food system resupply

FUTURE Deep Space

- Smaller, efficient equipment
- Onboard medical capability
- Long-duration food system

EVA: EXTRA-VEHICULAR ACTIVITY

Long-term exploration depends on the ability to physically investigate the unknown for resources and knowledge.



TODAY Space Station

- High upper body mobility for limited sizing range
- Low interval between maintenance, contamination sensitive, and consumables limit EVA time
- Construction and repair focused tools; excessive inventory of unique tools

FUTURE Deep Space

- Full body mobility for expanded sizing range
- Increased time between maintenance cycles, contamination resistant system, 25% increase in EVA time
- Geological sampling and surveying equipment; common generic tool kit

Deep Space Habitation Systems

Habitation Systems Elements

RADIATION PROTECTION

During each journey, radiation from the sun and other sources poses a significant threat to humans and spacecraft.

Monitoring · Tracking · Modeling · Mitigation

FIRE SAFETY

Throughout every mission, NASA is committed to minimizing critical risks to human safety.

Detection · Protection · Suppression · Cleanup

LOGISTICS

Sustainable living outside of Earth requires explorers to reduce, recycle, reuse, and repurpose materials.

Tracking · Clothing · Packaging · Trash

CROSS-CUTTING

Powerful, efficient, and safe launch systems will protect and deliver crews and materials across new horizons.

Robotics · Communication · Power · Docking · Avionics, Autonomy & Software · Thermal · Materials

TODAY Space Station

- Node 2 crew quarters (CQ) with polyethylene reduce impacts of proton irradiation.
- Large multi-layer detectors & small pixel detectors – real-time dosimetry, environment monitoring, tracking, model validation & verification
- Bulky gas-based detectors – real-time dosimetry
- Small solid-state crystal detectors – passive dosimetry (analyzed post-mission)

- Large CO_2 Suppressant Tanks
- 2-cartridge mask
- Obsolete combustion prod. sensor
- Only depress/repress clean-up

- Manual scans, displaced items
- Disposable cotton clothing
- Packaging disposed
- Bag and discard

- Minimal on-board autonomy
- Near-continuous ground-crew communications
- Some common interfaces, modules controlled separately

FUTURE Deep Space

- Solar particle event storm shelter, optimized position of on-board materials and CQ
- Small distributed pixel detector systems – real-time dosimetry, environment monitoring, and tracking
- Small actively read-out detectors for crew – real-time dosimetry

- Water Mist portable fire extinguisher
- Single Cartridge Mask
- Exploration combustion product monitor
- Smoke eater

- Automatic, autonomous RFID
- Long-wear clothing/laundry
- Bags/foam repurposed w/3D printer
- Resource recovery, then disposal

- Ops independent of Earth & crew
- Up to 40-minute comm delay
- Widespread common interfaces, modules/systems integrated
- Manufacture replacement parts in space

University Engagement

Develop strategic partnerships and collaborations with universities and non-profit organizations to help bridge gaps and increase knowledge in architectural design trades, capabilities, and technology risk reduction related to AES activities.

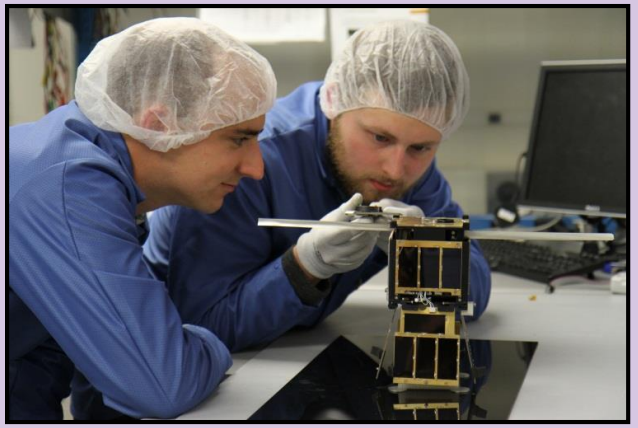
RASC-AL

Revolutionary Aerospace Concepts – Academic Linkages: Provide solutions to design problems and challenges currently facing human space exploration.

eXploration-Habitat Academic Innovation Challenge

eXploration-Habitat Academic Innovation Challenge: Develop concepts and prototypes of technologies necessary for future space missions.

CubeSat Launch Initiative

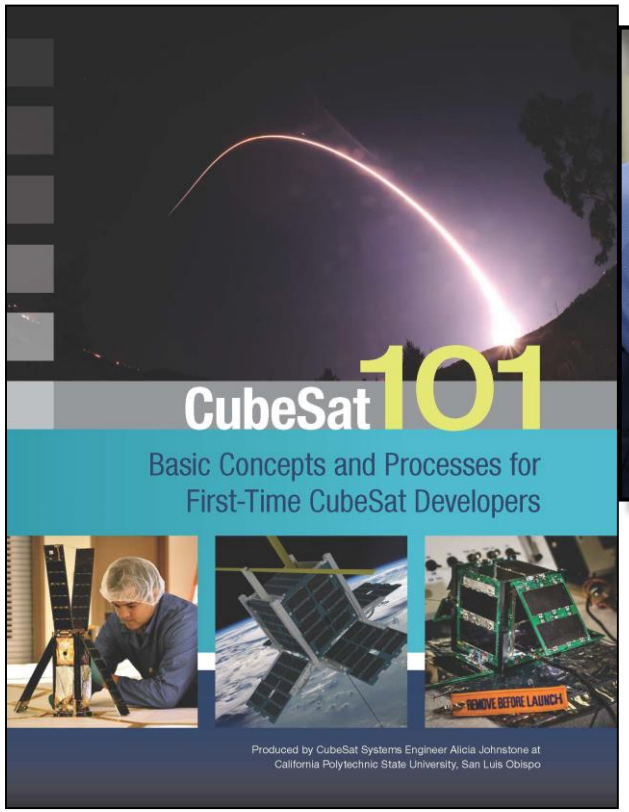


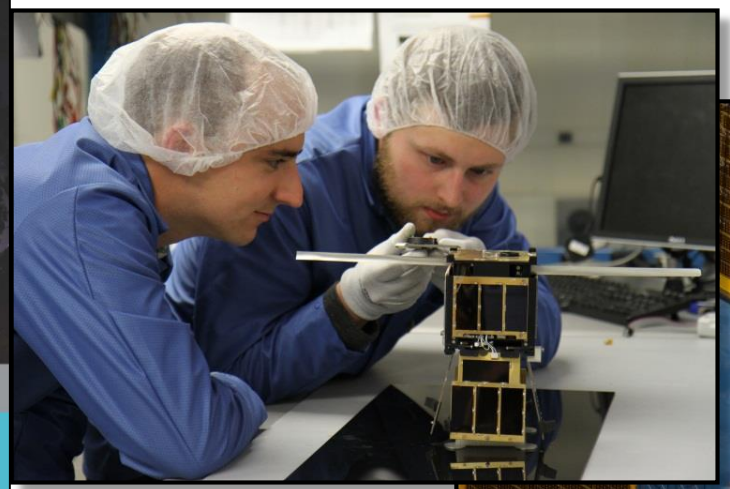
CubeSat Launch Initiative
Provides launch opportunities for low-cost technology development and scientific research.

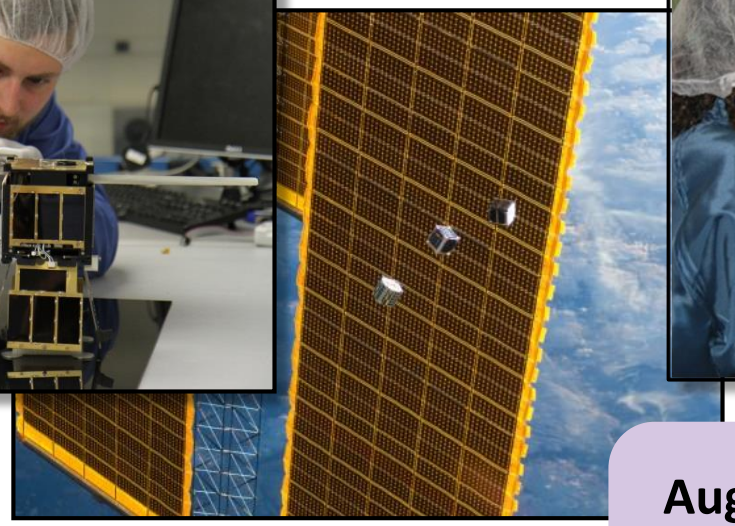
314 Selected Teams from 125 Higher Education Institutions in 43 States, PR and DC

CubeSat Launch Initiative

NASA's CubeSat Launch Initiative (CSLI) provides launch opportunities to United States educational institutions, non-profit organizations and NASA Centers who build small satellite payloads that fly as auxiliary payloads on previously planned launches or commercial missions or as International Space Station deployments.







159 Selected Missions
59 Flown – 49 Manifested

August 2	AO Released
November 20	Proposal Due
February	Selections

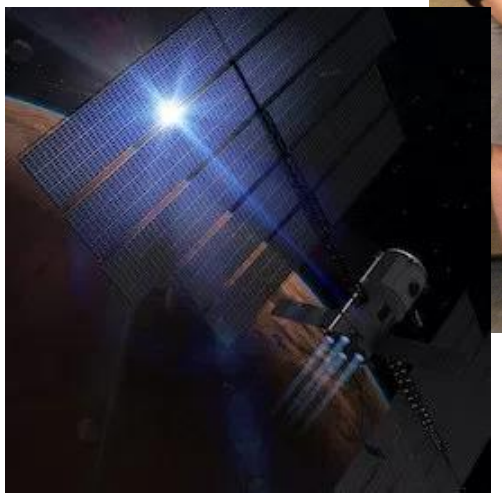
RASC-AL – Revolutionary Aerospace Concepts

The X-Hab Academic Innovation Challenge RASC-AL is a university-level, full mission architecture engineering design competition. Teams develop full mission architectures which are conceptual but based on solid engineering and costing. Selected teams develop high-level presentations to a panel of NASA/Industry judges at the RASC-AL Forum in Cocoa Beach, Florida.

2018 Themes

- Reusable Hybrid Propulsion Stage
- Artificial Gravity Reusable Crewed Deep Space Transport
- Propellant Resupply Capability
- Lunar Polar Sample Return Architecture

October	NOI
January	Abstracts
February	Selections
April 16	Down Select
June 18-21	Forum

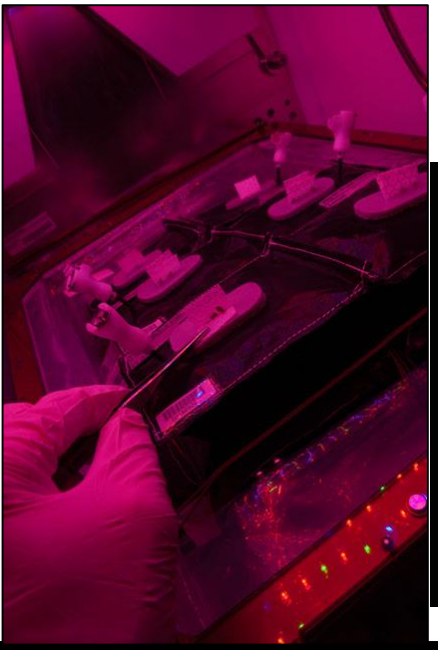


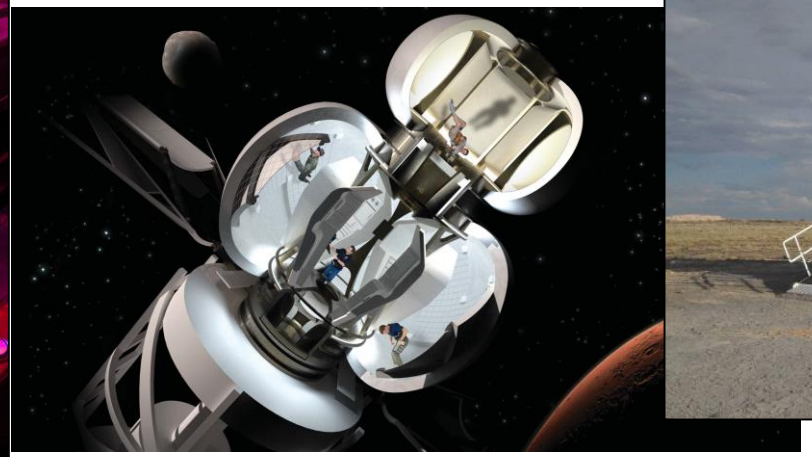
X-Hab - eXploration Systems and Habitation Challenge

The X-Hab Academic Innovation Challenge is intended to link NASA researchers with university senior- and graduate-level design curricula that emphasizes hands-on design, research, development, and manufacturing of functional prototypical subsystems. Through these strategic partnerships and collaborations students design, manufacture, assemble, test, and demonstrate functional prototypical subsystems and innovations that enable functionality for human space exploration missions.

In collaboration with and administered by:

National Space Grant Foundation





Feb 18	RFP Released
Apr 3	Questions Due
Apr 10	Responses published
Apr 27	Proposals Due
May 25	Awards Announced
Oct 9	System Definition Review
Nov 13	Prelim Design Review
Jan 22	Critical Design Review
Mar 12	Progress Review
May 7	Project Conclusion

2019 X-Hab Challenge Topics

Lunar Orbital Platform - Gateway

Inflatable/Deployable Crew-lock to Enhance Lunar Orbital Platform - Gateway Ground Test and Evaluation

- *Design, fabrication and delivery of a full-scale, low-pressure (0.1-0.5 psig) inflatable/deployable crew-lock structure that demonstrates the volume, operation and outfitting of a crew-lock for use in NASA Gateway ground test efforts.*

Life Support

Self-cleaning membrane unit for long-duration Environmental Control and Life Support

- *Develop a method of testing commercial membrane units for humidity or CO_2 control against fouling and trial methods for recuperating the membrane performance.*

Implement advanced sorbents such as supported-amine mesoporous silicas, metal organic frameworks (MOFs), and/or ionic liquids (ILs) in a CO_2 management unit

- *Develop a unit to either scrub dry CO_2 from air at 2650 ppm or thermally compress pure CO_2 for delivery to processor.*

Computer Modeling of Spacecraft Temperature Swing Compressor and Storage System

- *Develop a computer model of the Temperature Swing Adsorption and Storage System for spacecraft.*

2019 X-Hab Challenge Topics

In-Space Manufacturing

Development of Novel Feedstocks for In-Space Manufacturing Applications

- *Development of recyclable and/or regolith-based feedstocks for in-space manufacturing fused filament fabrication processes.*

Logistics Reduction

Deep Freeze for Deep Space: Passive Cold Food Storage

- *Using the natural cold environment of space, design a cold food storage system that can preserve frozen food for use by the crew of a deep space habitat.*

Human Research

Exploration Medical Architectural Design & Habitat Integration

- *Produce habitat conceptual VR models demonstrating integration of architectural, and ambient features required to support exploration class medical requirements.*

Space Life and Physical Sciences

Autonomous Space Biology at the Lunar Orbital Platform - Gateway

- *Development of a distributed, fault tolerant operating system to support the continuous operation of parallel science experiments with or without crew intervention.*

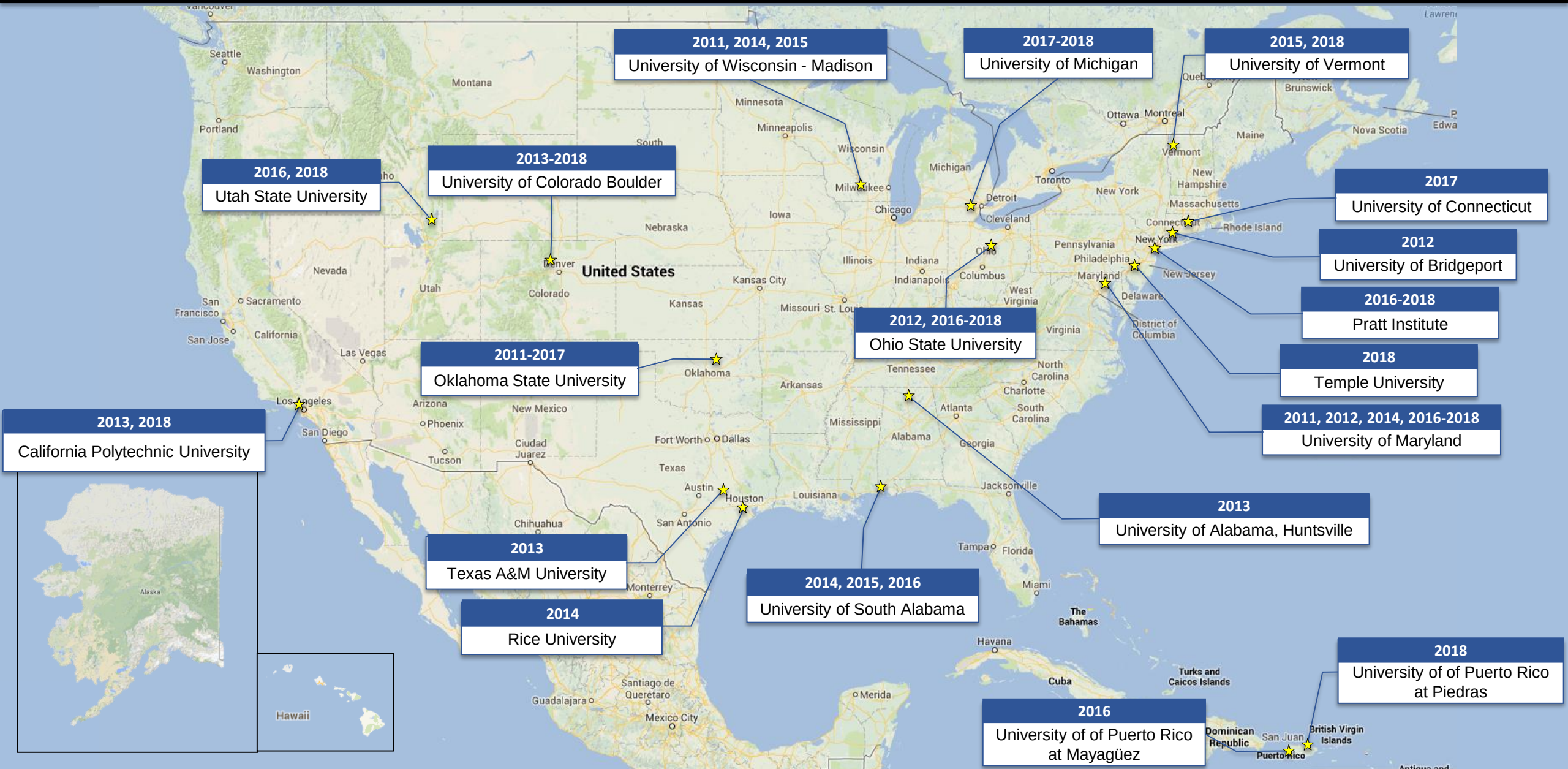
2019 X-Hab Challenge Topics +

3.2 X-Hab Proposal Topic List

"Proposals addressing the following topics will be given priority consideration. **Proposals that address other areas in direct support of the Advanced Exploration Systems Division will also be considered.**"

Back-Up Slides

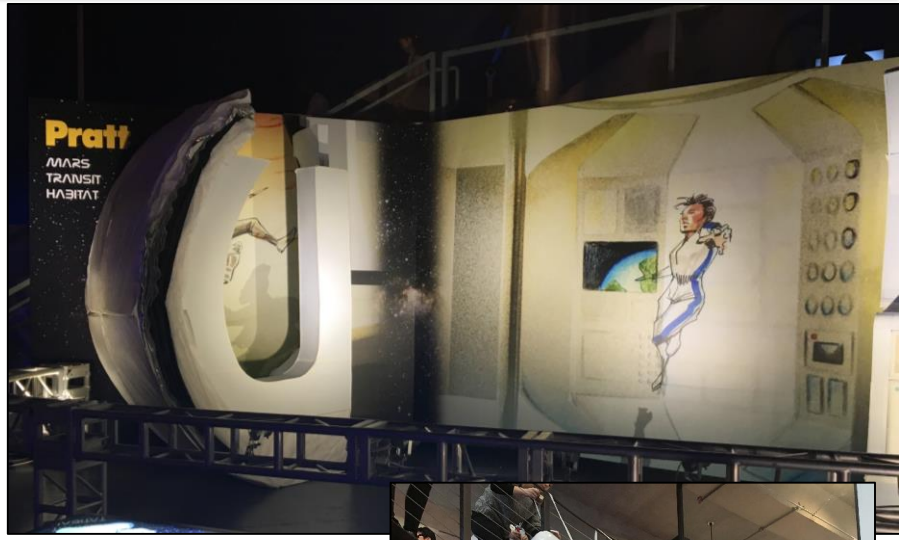
X-Hab Participants

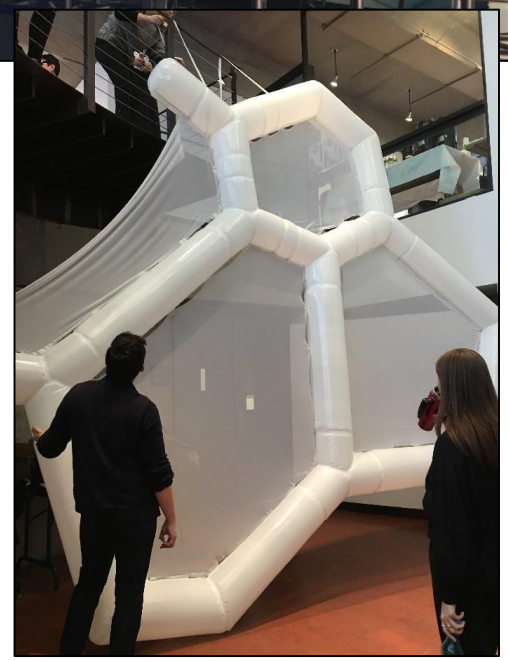


Results – Habitation

Pratt Institute

MOTH and HYDROS
Human Centered Design: Mars Transit to Surface Habitat



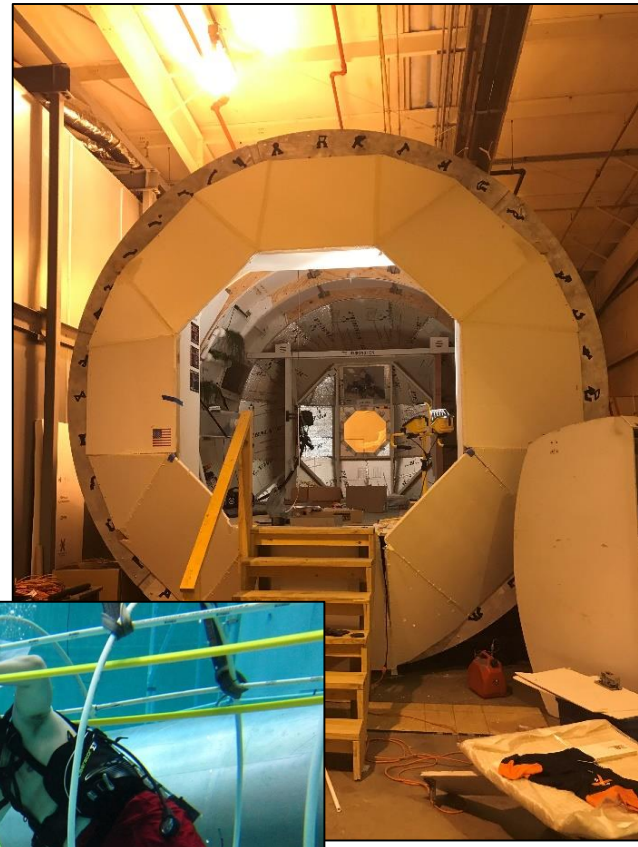


- Architecture and Design Team
- MOTH is a Mars Transit Habitat, prototype contained a kitchen area and a sleeping pod. Kitchen area would use a 3D food printer, plant growth area, rehydration and reheating stations, food storage area, waste compactor, sanitizer, and retractable table, and a voice operated control system.
- Hydros is a concept for a habitat within a crater on Mars that leverages local water resources by living off the land, while serving as both a home and research facility for crews.
- Developed a full-scale section of the habitat shell structure concept consisting of flexible material and inflatable air beams.
- This notional design for a transit habitat is being evaluated by NASA teams designing the habitation systems that may be used in the vicinity of the Moon.

Results – Habitation

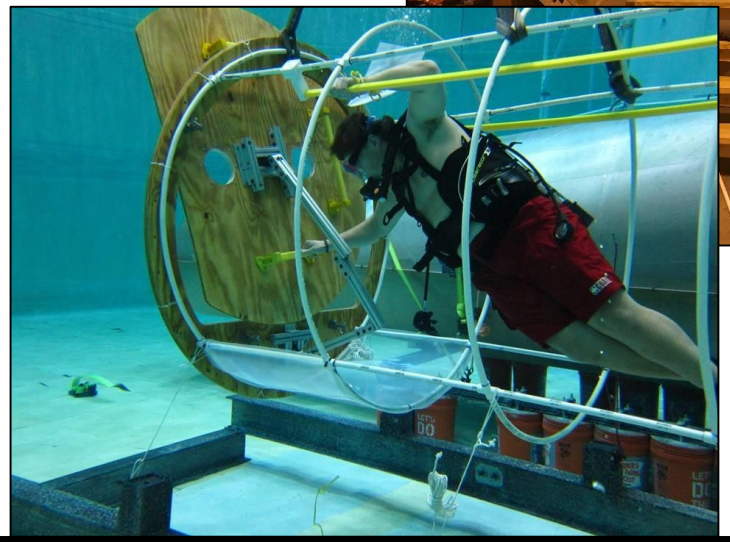
Oklahoma State University

- With the capabilities resulting from several years of X-Hab projects, they have developed a habitat system capability to be able to conduct analog missions and further studies for exploration architectures.
- Designed and built a prototype for a medical bay that could be housed within a reconfigurable wall of a Mars habitat.
- Designed and built prototypes for an exercise system that could be used by astronauts both in zero gravity during long term spaceflight missions.



University of Maryland

- Designed an inflatable airlock sized for two astronauts that could be used in space or on other planetary surfaces.
- Built a series of scale models of increasing size and tested them in a neutral buoyancy tank to simulate microgravity.
- Provided valuable data for airlock sizing and design approach that is benefiting the NASA team designing these systems.

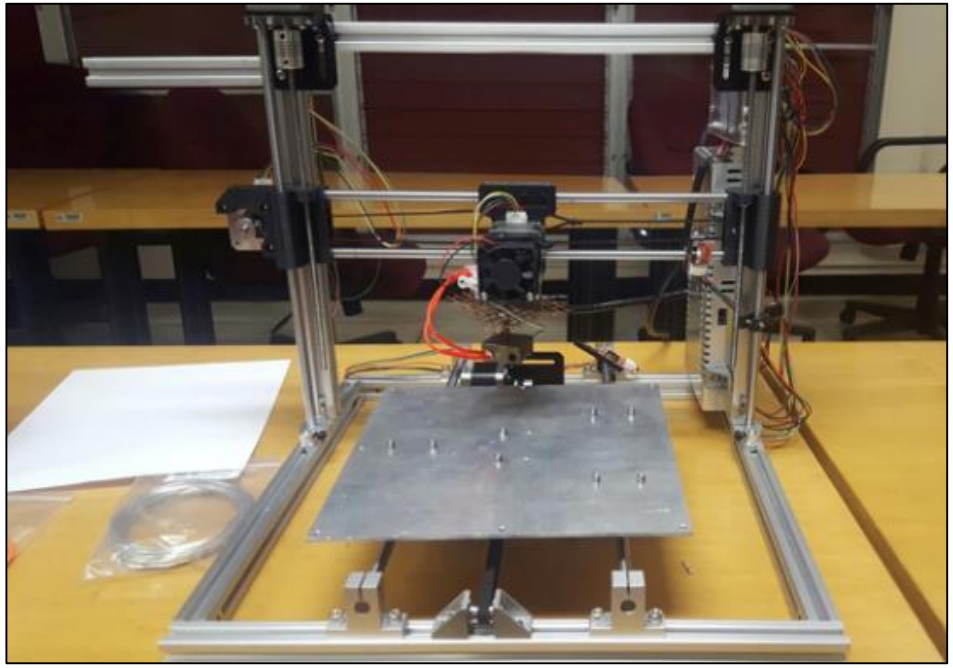


Results – In Space Manufacturing

University of Puerto Rico - Mayaguez

Technology for Metals in a Microgravity Environment (TIME)

- Developed and evaluated a prototype for improving current additive manufacturing capabilities to allow low-powered space metal manufacturing.
- Supporting more capable systems for printing using multiple materials with application for manned missions beyond low Earth orbit.
- The advanced concepts of this project are infusing into the approaches being used to expand the current additive manufacturing capabilities using plastic materials on the International Space Station.



Results – Plant Growth

Psychological and physiological benefits of growing plants

The Ohio State University

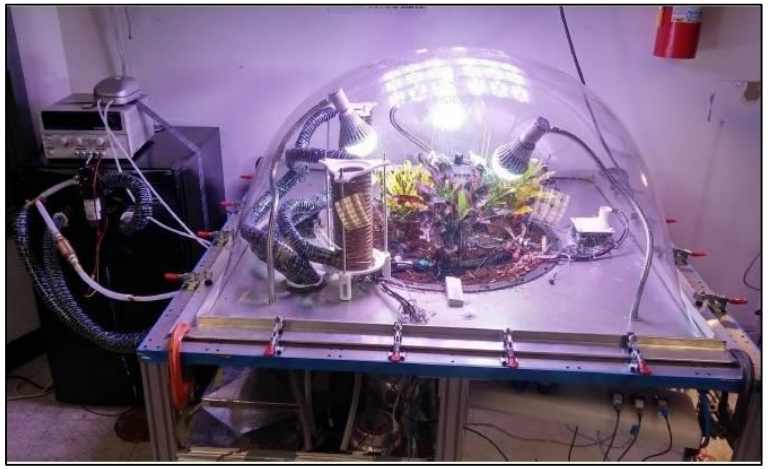
Water Assurance Delivery System.

- Passive watering system is capable of interfacing with the Vegetable Production System (Veggie) payload, which has grown plants on the International Space Station (ISS).
- Built prototypes with multiple different materials and conducted multiple 30 day plant growth experiments.
- Project has influenced the design of the next generation of the seed pillows.

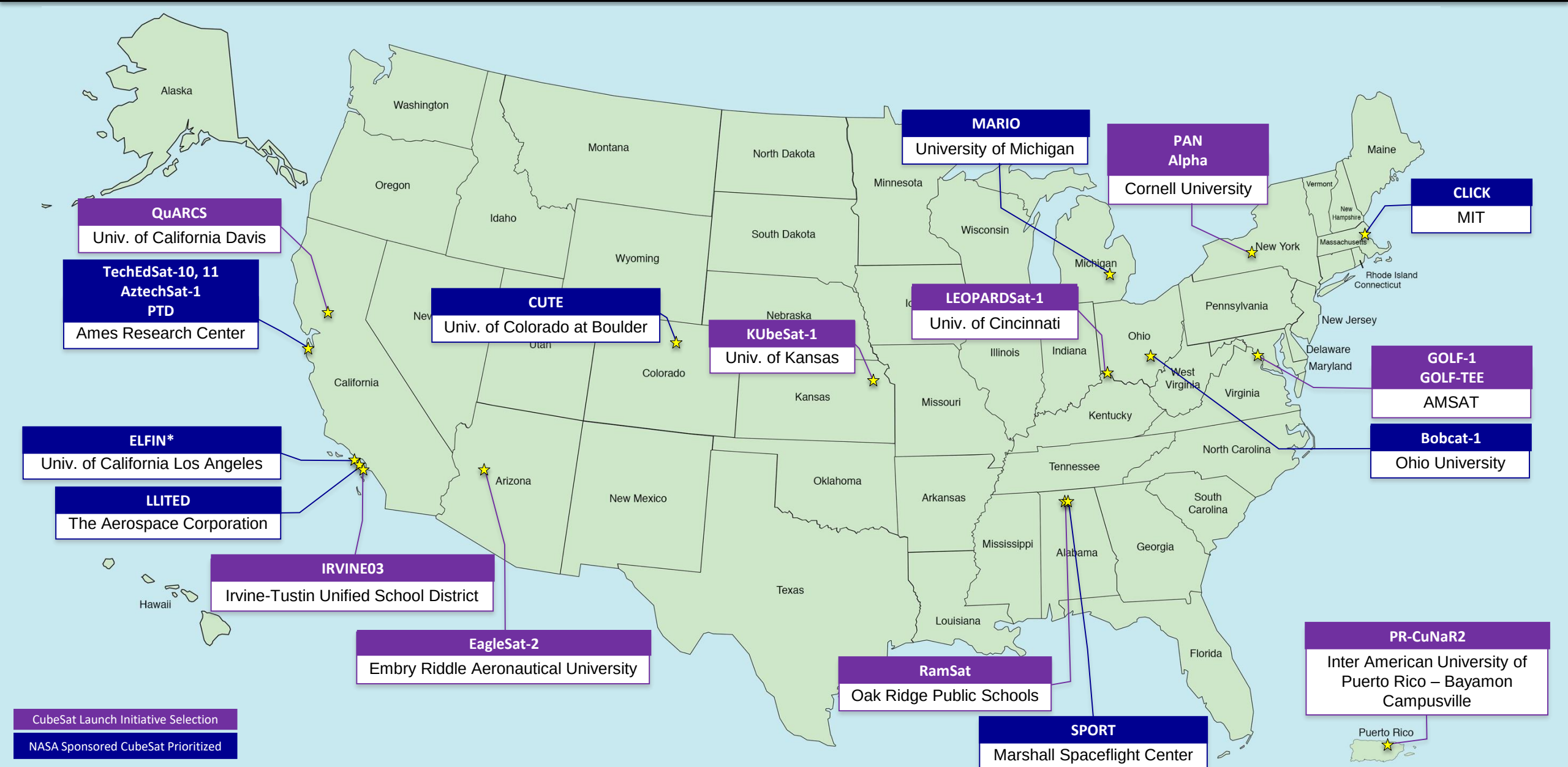
University of Colorado - Boulder

LabOasis

- Designed and built a ground prototype for MarsOasis, a conceptual design for a greenhouse to grow plants on Mars.
- Made improvements to lighting, and dehumidification over the course of multiple plant growth test cycles.
- Programmed software to autonomously operate the system.
- Autonomous plant growth systems for food production.



2018 CubeSat Launch Initiative Selections and NASA Sponsored CubeSats Prioritization



CubeSat Launch Initiative Selection

NASA Sponsored CubeSat Prioritized