

# Understanding Research Needs and Directions

National Aeronautics and  
Space Administration



## Committee on Biological and Physical Sciences in Space Washington, DC

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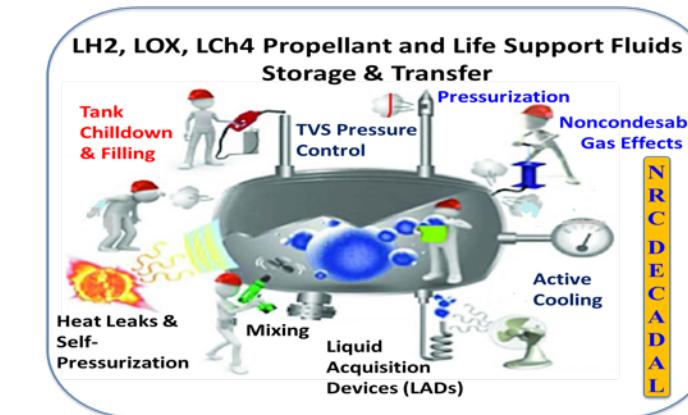
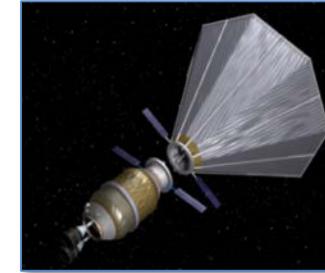
# Enabling Exploration: Starting with Pull Advanced Food Production

- **Collaboration with**
  - Environmental Control and Life Support Systems Systems Capability Leadership Team (ECLSS SCLT)
  - Space Technology Mission Directorate (STMD)
  - Human Exploration and Operations Mission Directorate Advanced Exploration Systems (HEOMD AES)
- **Provide**
  - Behavioral health benefits
  - Micronutrients that are not shelf stable
- **Research Challenges**
  - Plant selection / engineering
  - Growth conditions
    - Plant watering
  - Microbiome management
- **In early formulation stage**



# Enabling Exploration: from Push to Pull Zero Boil-Off Tank (ZBOT) Experiment(s)

- Cryogenic Fluids Management in microgravity
  - Complex fluid and heat transfer
- Zero Boil-Off
  - Saves mass
  - Costs complex design
- Cryogenic practitioners measure two scalars
  - Pressure, temperature
- ZBOT-1 imaged fluid flow and measured flow vector field
  - Informs CFD models used for design of real world systems
- STMD
  - From mild interest
  - To incorporation into STMD CFM roadmap



- ZBOT-1: Self-Pressurization & Jet Mixing (2017)
- ZBOT-NC: Effect of Non-Condensable Gases (2022)
- ZBOT-AC: Active Cooling Pressure Control (2025)
- ZBOT-FT: Filling & Transfer (Potential International Collaboration)



# Enabling Exploration: Push Artificial Gravity

- Artificial Gravity (centrifugation) could protect crew against
  - Bone loss
  - Muscle loss
  - Cardiovascular conditioning
  - Other conditions?
- Modalities
  - Whole vehicle
  - Part of vehicle
  - Within vehicle
    - e.g., 2 m radius centrifuge
- HRP obtaining data to inform trade studies
  - Duration
  - Intensity
  - Frequency

## 'Artificial Gravity' Bed-Rest Study to Track Space Travel's Effects on Human Body

By Mike Wall 3 days ago Tech

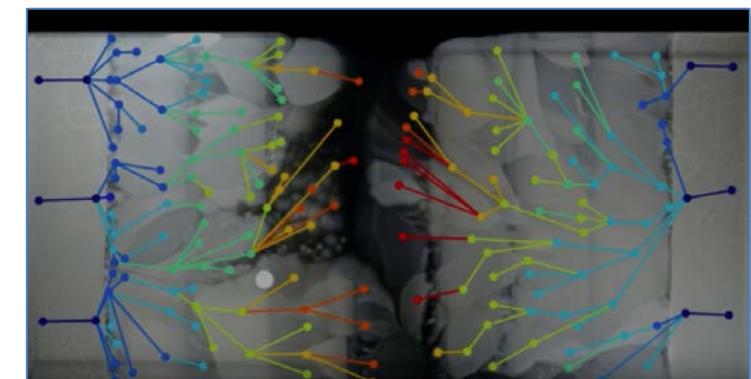
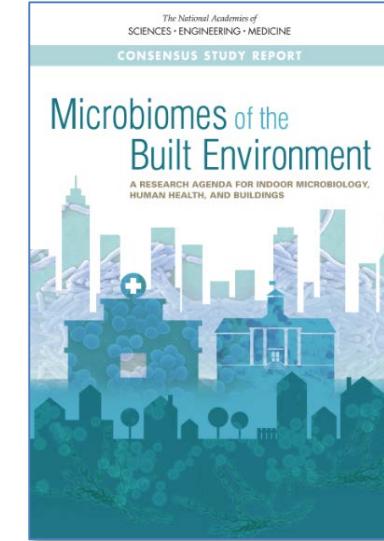


The short-arm centrifuge at the German Aerospace Center's :envihab facility in Cologne, Germany, will be used during the first joint long-term bed-rest study commissioned by the European Space Agency and NASA to investigate the potential of artificial gravity in mitigating the effects of spaceflight. The study begins March 25, 2019. (Image: © CC BY-SA 3.0 IGO)

[www.space.com/artificial-gravity-spaceflight-bed-rest-study](http://www.space.com/artificial-gravity-spaceflight-bed-rest-study)

# Enabling Exploration: Pre-Push Investigation Microbiomes of the Built Environment

- Crew and plants will be reservoirs of microbes in a Mars mission
- “Clean well” may not be a good strategy for a Mars mission
  - Antibiotic resistance in medicine
  - Bacterial growth in Superfund sites
- Provocative Notion
  - Maintain “designed” microbiomes in the built environment
- Space Biology
  - Monitoring state-of-the-art research
  - Convening a workshop to determine what NASA needs to know to decide how to manage (or not) the microbiomes of the built environment in a Mars mission



[www.youtube.com/watch?v=plVk4NVIUh8](https://www.youtube.com/watch?v=plVk4NVIUh8)

Thank you

