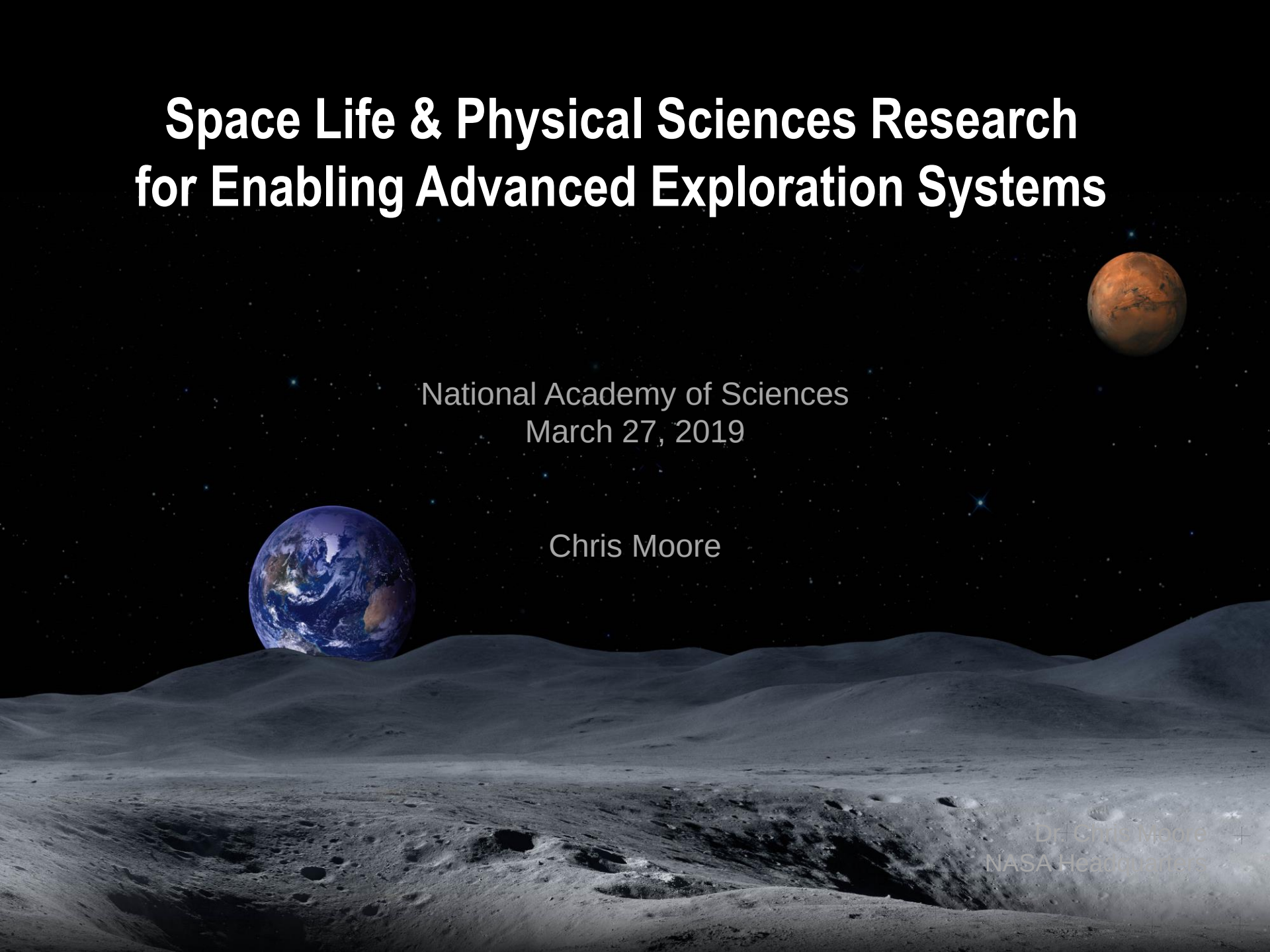
Space Life & Physical Sciences Research for Enabling Advanced Exploration Systems



National Academy of Sciences
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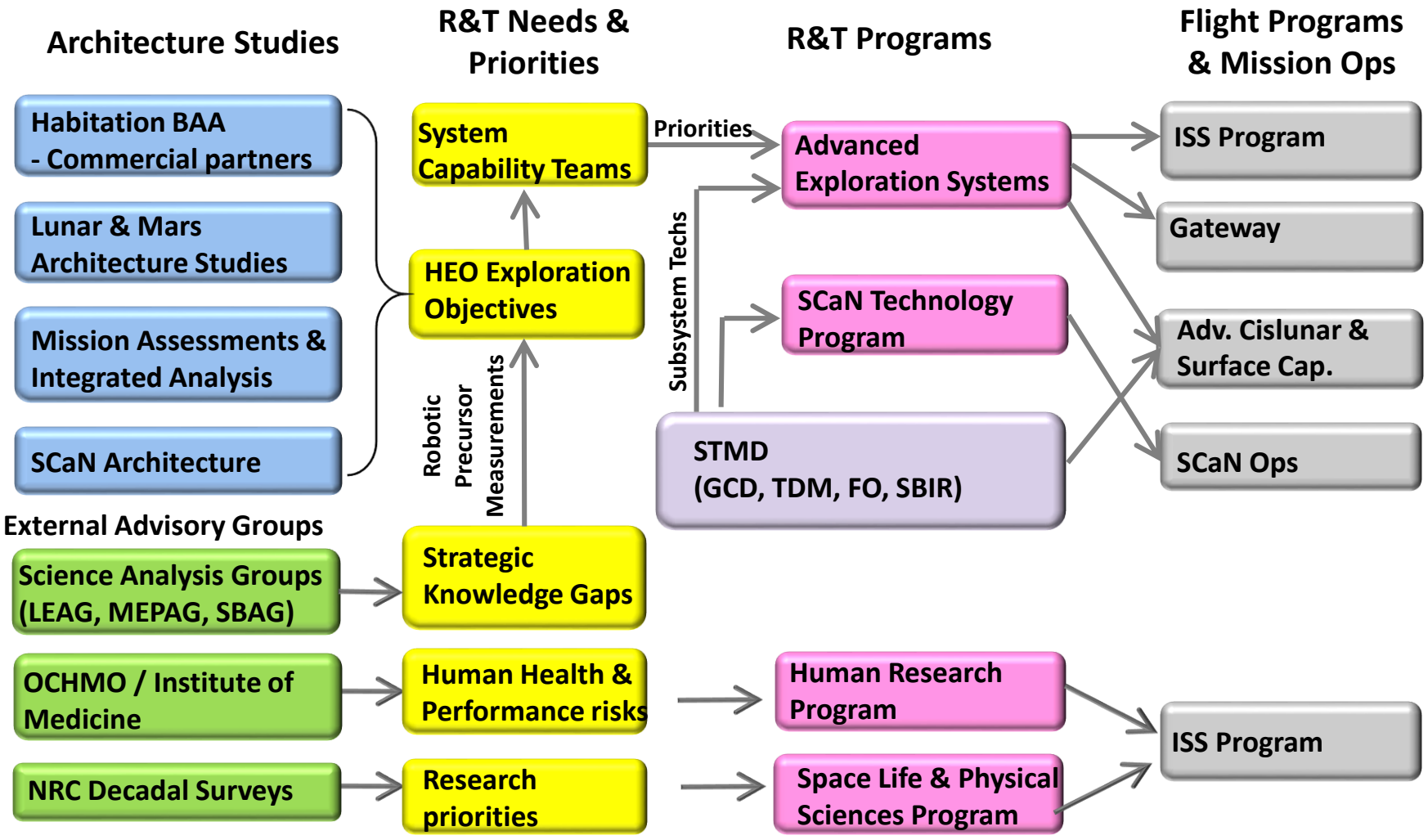
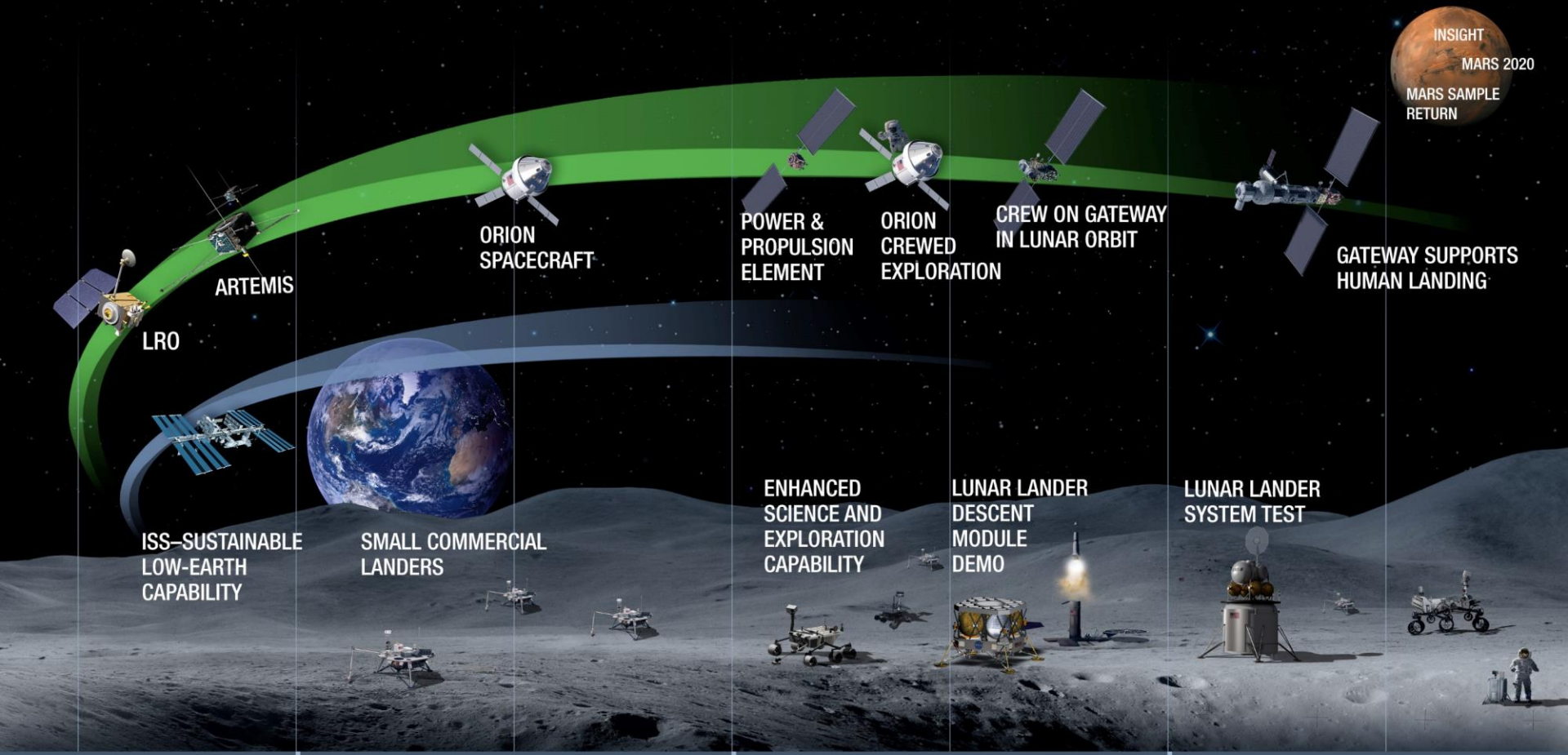
Chris Moore

Dr. Chris Moore
NASA Headquarters

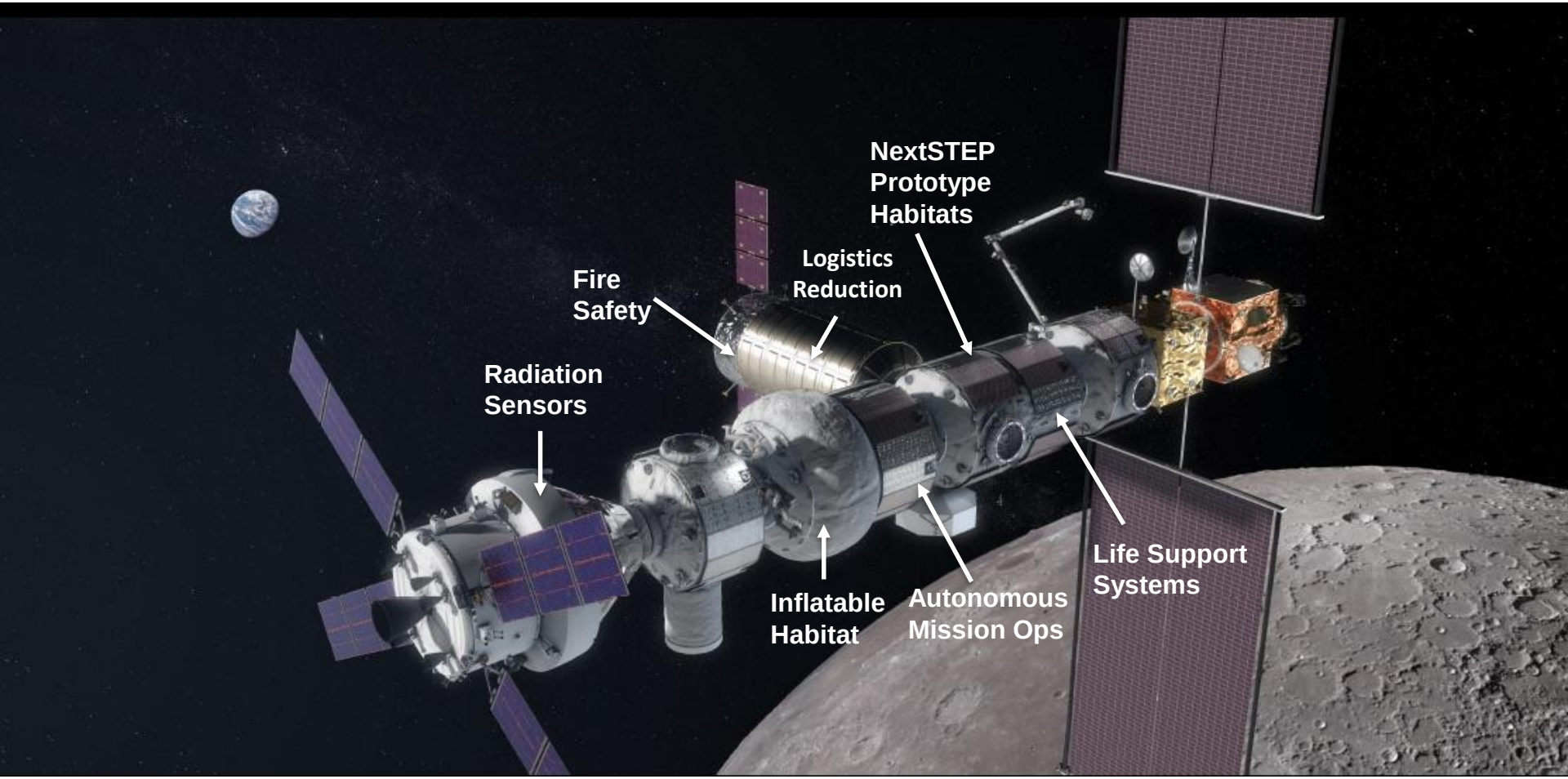
HEOMD Research & Technology Process



NASA Lunar Exploration Campaign



AES Technology Development for the Gateway



Biology-Based Life Support Systems

- **Objectives:**
  - Demonstrate hybrid biological/physical life support systems for long duration missions.
  - Demonstrate plant growth in microgravity to supplement crew's diet.

- **Current Activities:**
  - Texas Tech is developing a biological waste water processor using Membrane Aerated Bioreactors (MABR).
  - Sierra Nevada Corp. is planning to demonstrate the AstroGarden plant growth module on ISS.

- **Potential SLPS Contributions:**
  - Plant and bacteria growth in microgravity

Biological water processor

AstroGarden plant growth module

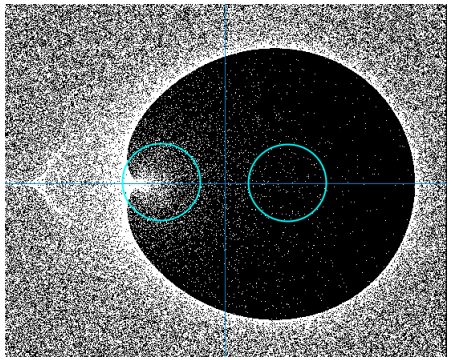
Radiation Protection

- **Objectives:**
  - Develop radiation sensors for monitoring exposure and shielding for radiation protection.

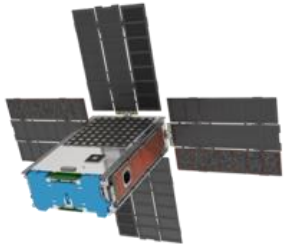
- **Current Activities:**
  - Developing Hybrid Electronic Radiation Assessor (HERA) for ISS and Orion.
  - Conducting active shielding experiments using a dipole electric field to deflect incoming particles.
  - BioSentinel CubeSat to be launched on EM-1 will investigate the effects of deep space radiation on yeast DNA.

- **Potential SLPS Contributions**:
  - Biological effects of radiation on simple organisms

ISS HERA



Simulation of Active Radiation Shielding



BioSentinel

Synthetic Biology

- **Objectives:**
  - Genetically engineer yeast to produce plastics from atmospheric CO_2, which can be used as feedstock for 3D printers.
  - Supplement crew's diet by producing essential nutrients

- **Current Activities**
  - CO_2-based manufacturing
  - Developing BioNutrient growth packet to produce zeaxanthan for ISS crew

- **Potential SLPS Contributions**
  - Genetically engineering microorganisms for in-situ production of desirable products
  - Using extremophiles to understand the effectiveness of planetary protection techniques.

Membrane bioreactor

BioNutrient packet

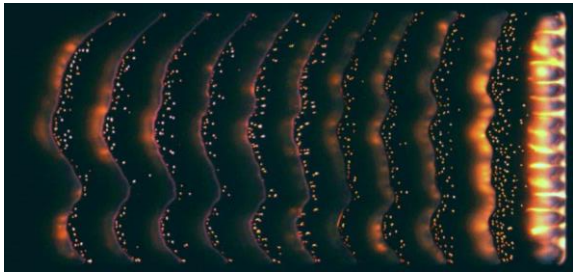
Spacecraft Fire Safety

- **Objectives:**
  - Demonstrate fire monitoring and clean-up technologies in a realistic spacecraft environment
  - Characterize fire growth in high oxygen, low pressure atmospheres
  - Provide data to validate models of realistic spacecraft fire scenarios.

Saffire Flow Unit

- **Current Activities:**
  - Assembly of Saffire-IV, V, VI fire safety experiments.

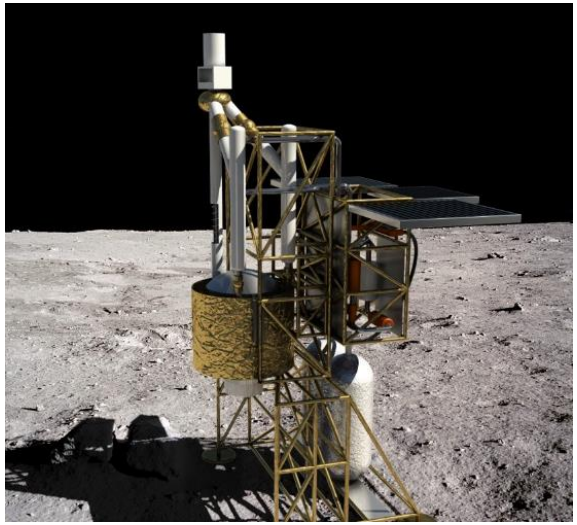
- **Potential SLPRS Contributions**
  - Combustion physics experiments and models



Saffire-I flame propagation

In-Situ Resource Utilization (ISRU)

- **Objectives**
  - ISRU is a fundamental capability for sustainable and affordable transportation and surface operations
- **Current Activities**
  - Studying a range of possible capabilities including regolith excavation, oxygen production from regolith, and water extraction from surface
- **Potential SLPS Contributions**
  - Physics of granular materials in 1/6-gravity
  - Dust mitigation techniques



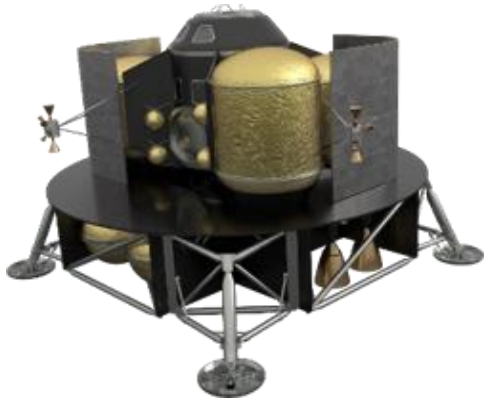
ISRU pilot plant on lunar surface

Cryogenic Fluid Management

- **Objectives**
  - Cryogenic fluid management enables long-term use of liquid oxygen, hydrogen, and methane and in situ propellant production

- **Current Activities**
  - Tipping Point contracts with Blue Origin and Paragon for technology development leading to potential flight demonstration and infusion into human-class landers
  - Propellant liquefaction tests in a vacuum chamber with brassboard tank and refrigeration loop.

- **Potential SLPRS Contributions**
  - Cryogenic fluid mechanics



Cryogenic propellants for lunar landers and in-space transportation stages.

Space Durable Materials

- **Objectives**
  - Develop space-durable materials for use in the dusty lunar surface environment, particularly softgoods for inflatable habitats and space suits.
- **Current Activities**
  - Materials International Space Station Experiment (MISSE)
- **Potential SLPS Contributions**
  - Lunar MISSE

Summary

Space Life & Physical Sciences Research	Infusion into Advanced Exploration Systems
Biology-based life support; plant growth in microgravity	Life Support Systems
Biological effects of radiation	Radiation Protection
Synthetic biology	In-Space Manufacturing
Combustion physics in microgravity	Spacecraft Fire Safety
Granular material physics	In-Situ Resource Utilization; Lunar lander dust plumes
Cryogenic fluid physics in microgravity	In-space refueling; cryogenic propellant storage
Space environmental effects on materials	Space-durable materials