


Johnson Space Center Engineering Directorate

L-8: Enabling Human Spaceflight Exploration Systems & Technology Development

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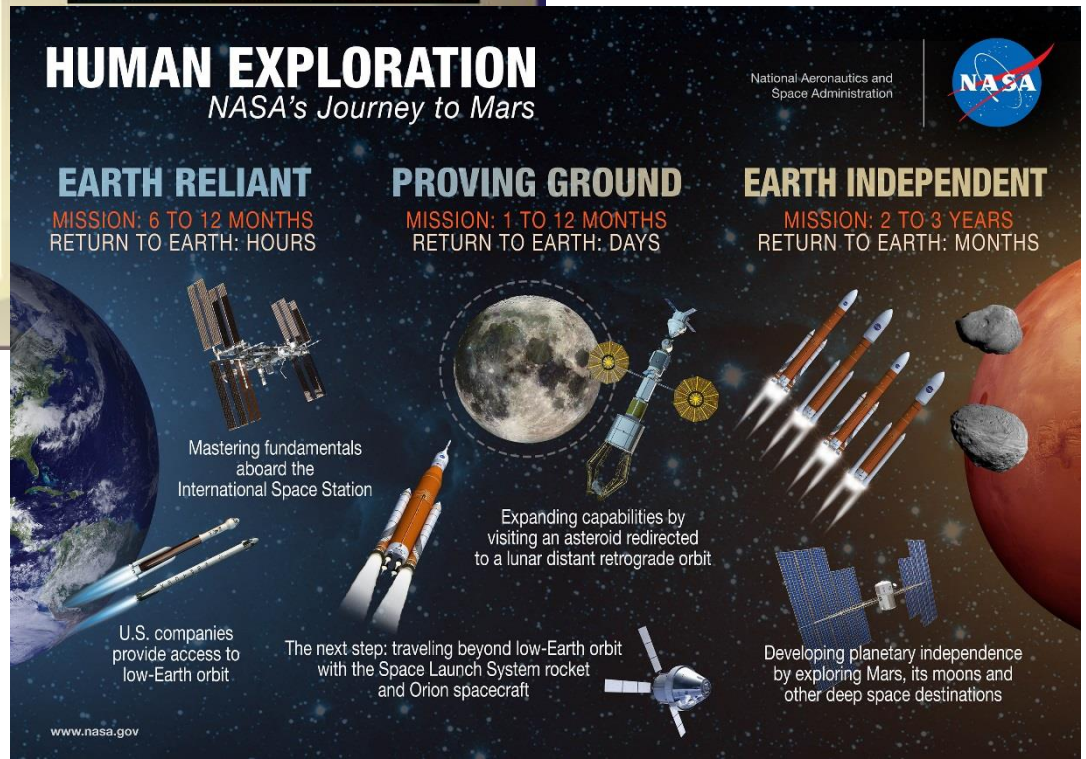
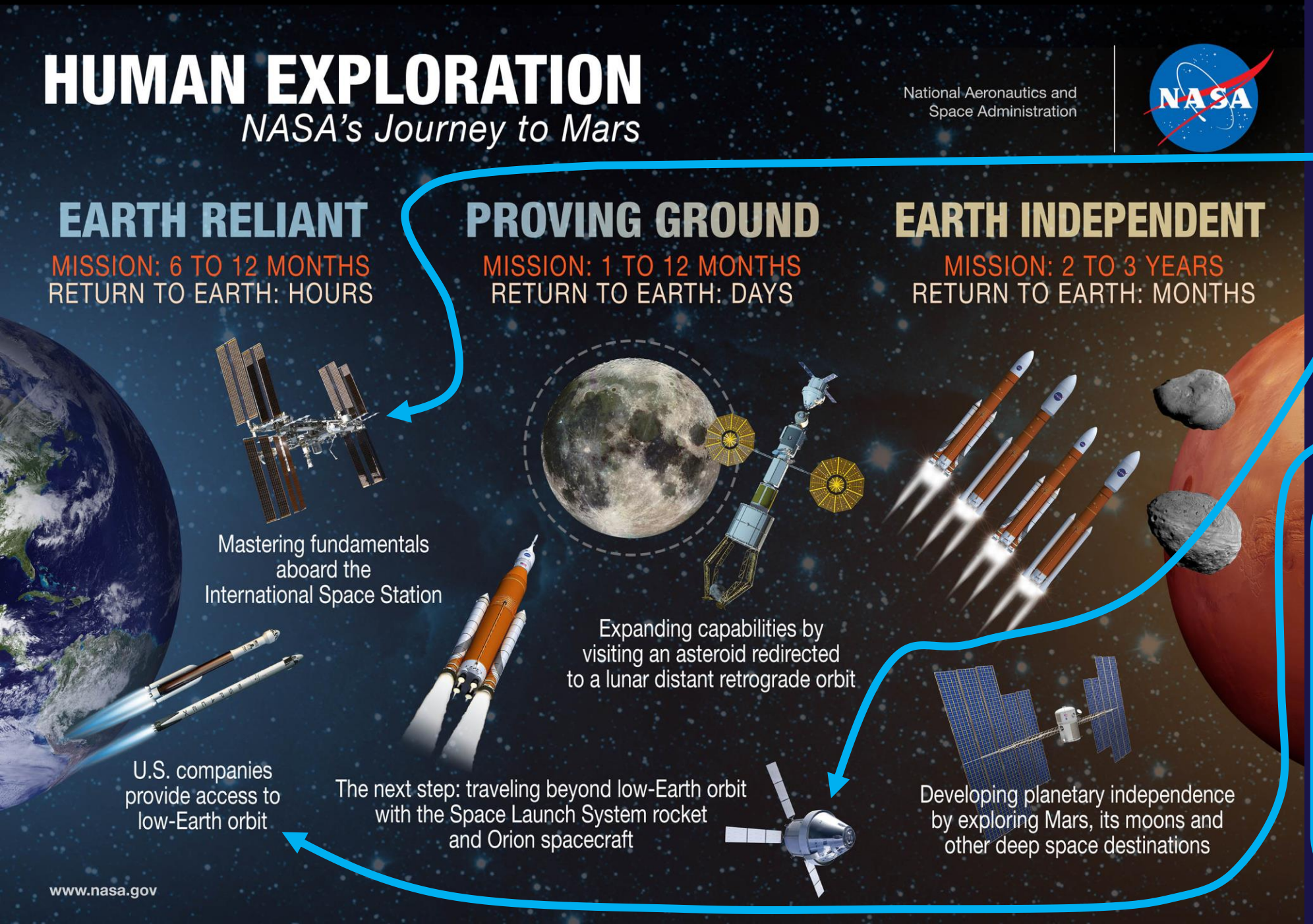
November 2016



NASA's Journey to Mars





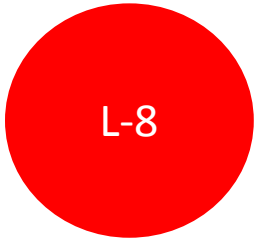
Engineering Priorities

1. Enhance ISS: Enhanced missions and systems reliability per ISS customer needs
2. Accelerate Orion: Safe, successful, affordable, and ahead of schedule
3. Enable commercial crew success
4. Human Spaceflight (HSF) exploration systems development
   - Technology required to enable exploration beyond LEO
   - System and subsystem development for beyond LEO HSF exploration

JSC Engineering's Internal Goal for Exploration

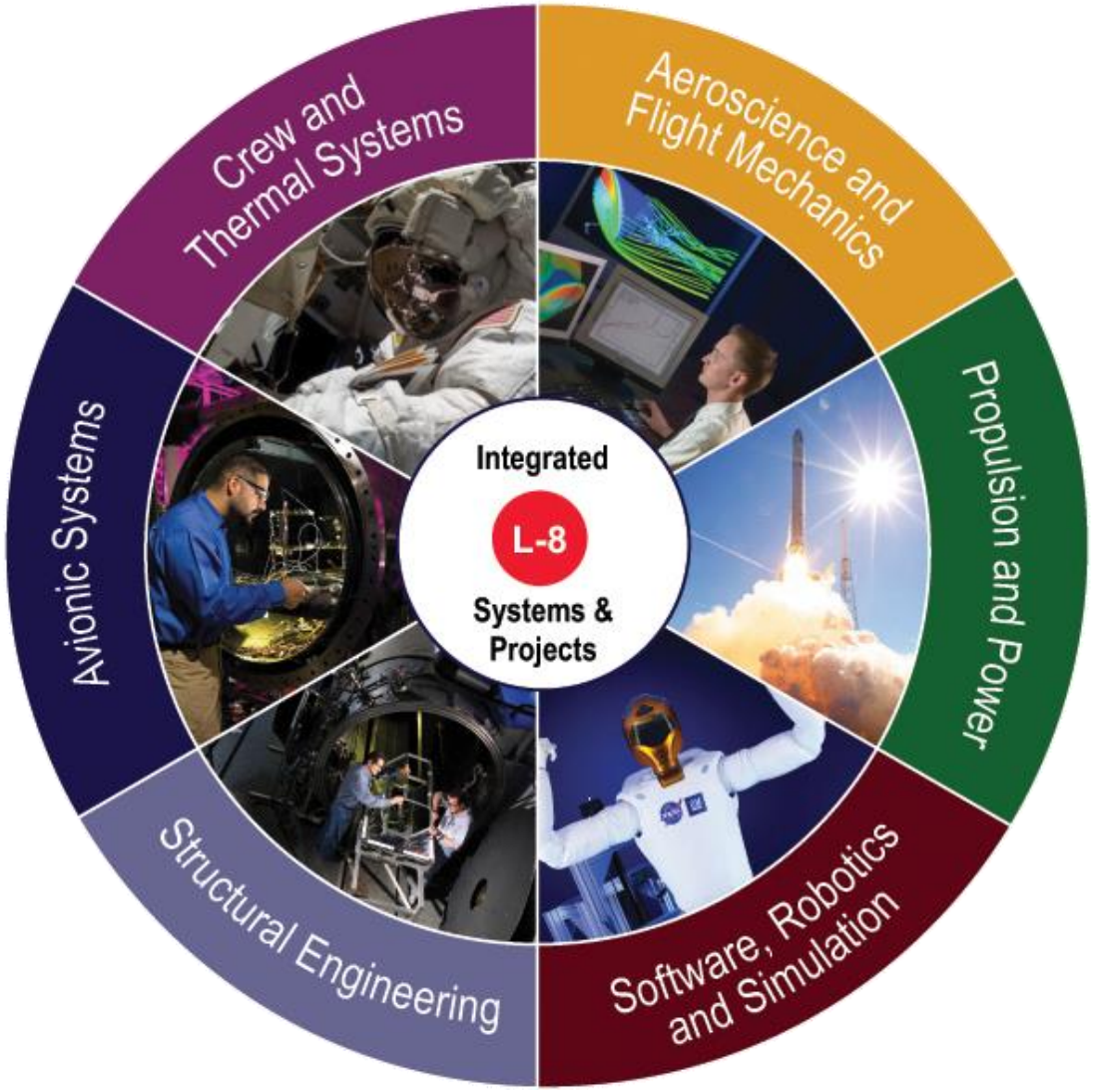
- Priorities are nice, but they are not enough.
- We needed a meaningful goal.
- We needed a deadline.

- Our Goal: Get within 8 years of launching humans to Mars (L-8) by 2025
  - Develop and mature the technologies and systems needed
  - Develop and mature the personnel needed



Characterizing L-8

- L-8 Is Not:
  - A program to go to Mars
  - Another Technology Road-Mapping effort
- L-8 Is:
  - A way to translate Agency Technology Roadmaps and Architectures/Scenarios into a meaningful path for JSC Engineering to follow.
  - A way of focusing Engineering's efforts and identifying our dependencies
  - A way to ensure Engineering personnel are ready to step up to the plate when the next program is defined
  - A framework supplying rationale for our proposals to obtain funding for technology development
  - An organizing principle for our Domain Implementation Plans



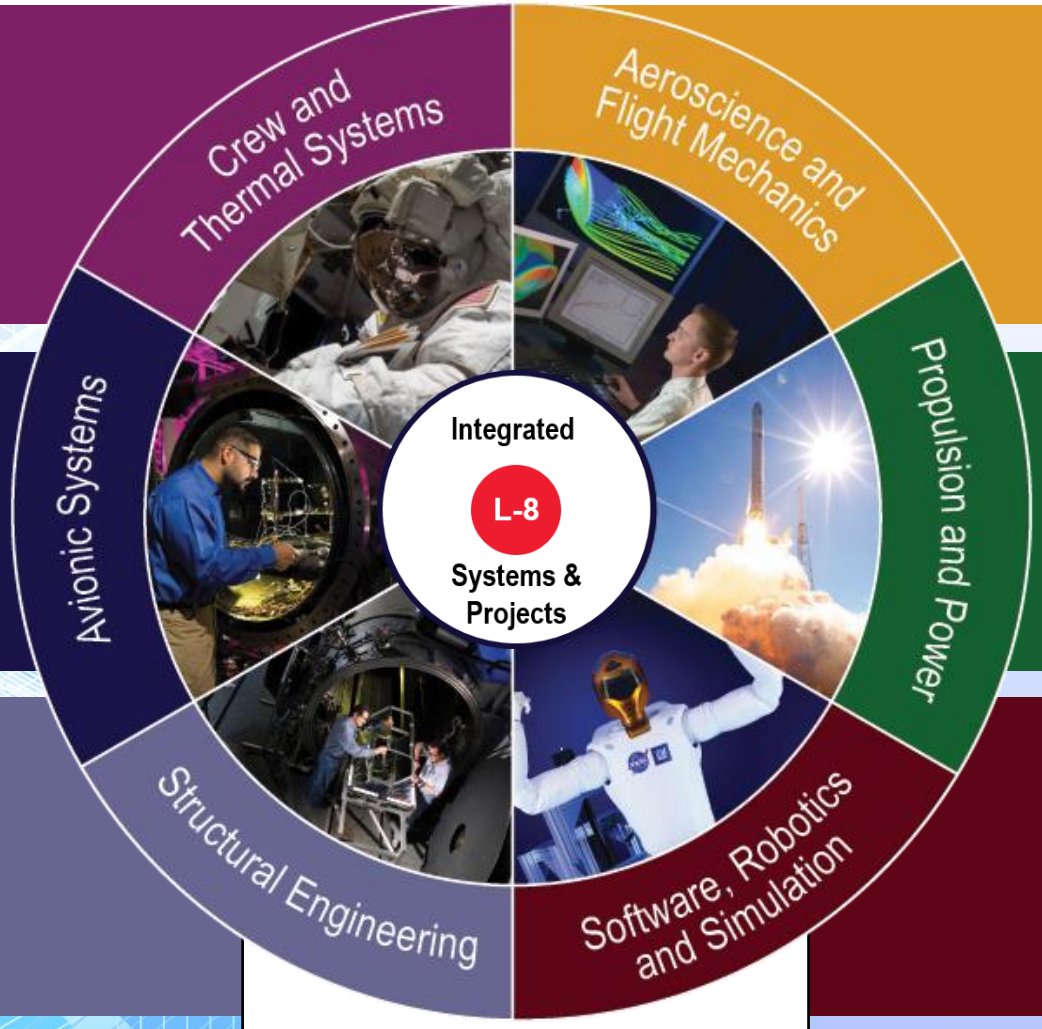
JSC Engineering's Domain Implementation Plan

JSC Engineering: HSF Exploration Systems Development

- Life Support
- Active Thermal Control
- EVA
- Habitation Systems

- Human System Interfaces
- Wireless & Communication Systems
- Command & Data Handling
- Radiation & EEE Parts

- Lightweight Habitable Spacecraft
- Entry, Descent, & Landing
- Autonomous Rendezvous & Docking
- Vehicle Environments



AA-2 | iPAS | HESTIA | Morpheus

Entry, Descent, & Landing -
Autonomous Rendezvous & Docking -
Deep Space GN&C -

Reliable Pyrotechnics -
Integrated Propulsion, Power, & ISRU -
Energy Storage & Distribution -
Breakthrough Power & Propulsion -

Crew Exercise -
Simulation -
Autonomy -
Software -
Robotics -

Avionics Systems Domain Implementation Plan Decomposition Example

- Wireless & Communication Systems
- Command & Data Handling
- Human System Interfaces
- Radiation & EEE Parts

Areas of Emphasis (AOEs):

- RFID ALM
- RFID Sensing
- Delay Tolerant Networking (DTN)
- Mesh Networking
- Wireless Development Flight Instrumentation
- Proximity Communications
- Reconfigurable/Software defined radio
- Innovations for C&T testing and validation
- Innovative applications of RF technology
- Proximity antenna technologies
- Optical Communication

Pathstones:

Gap • RF Interrogator development
Gap • Fabric antenna development
Gap • System integration and modularization

A SpaceCom 2016 Collaboration Opportunity
"L-8: RFID technology and sensor interrogators for wireless sensing/telemetry "
– Ray Wagner

EA Domain Implementation Plan Overview

JSC Engineering: HSF Exploration Systems Development

- Life Support
- Active Thermal Control
- EVA
- Habitation Systems

34 AOEs,
27 w/ Gaps
166 Pathstones
48 Gaps

11 AOEs,
9 w/ Gaps
71 Pathstones,
36 Gaps

Entry, Descent, & Landing -
Autonomous Rendezvous & Docking -
Deep Space GN&C -

- Human System Interfaces
- Wireless & Communication Systems
- Command & Data Handling
- Radiation & EEE Parts

28 AOEs, 19 w/ Gaps
116 Pathstones, 63 Gaps

Reliable Pyrotechnics -
Integrated Propulsion, Power, & ISRU -
Energy Storage & Distribution -
Breakthrough Power & Propulsion -

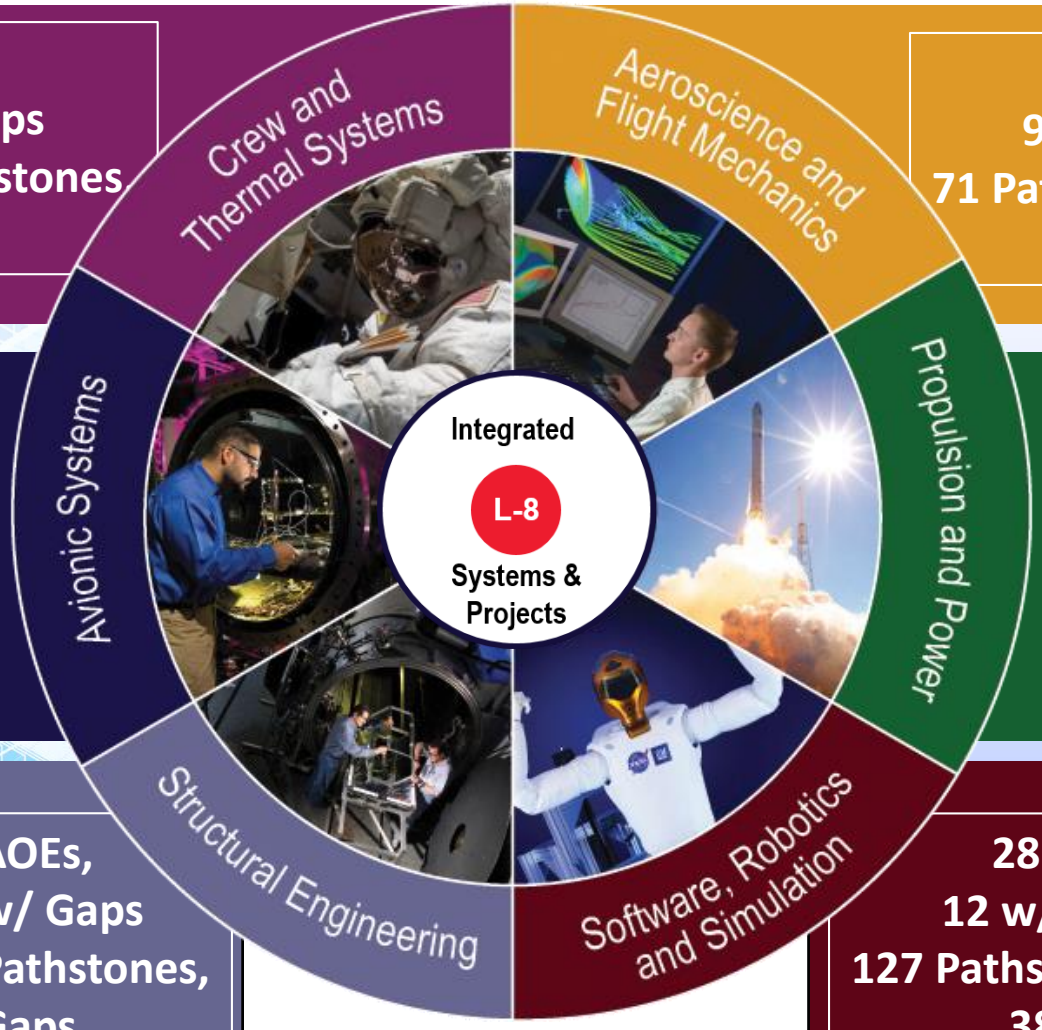
14 AOEs, 9 w/ Gaps
66 Pathstones, 18 Gaps

- Lightweight Habitable Spacecraft
- Entry, Descent, & Landing
- Autonomous Rendezvous & Docking
- Vehicle Environments

20 AOEs,
19 w/ Gaps
86 Pathstones,
58 Gaps

28 AOEs,
12 w/ Gaps
127 Pathstones,
38 Gaps

Crew Exercise -
Simulation -
Autonomy -
Software -
Robotics -



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FY 2016 IRAD Investments Tied to L-8

JSC Engineering: HSF Exploration Systems Development

Shape-Morphing Adaptive Radar Technology (SMART) – L. Erickson

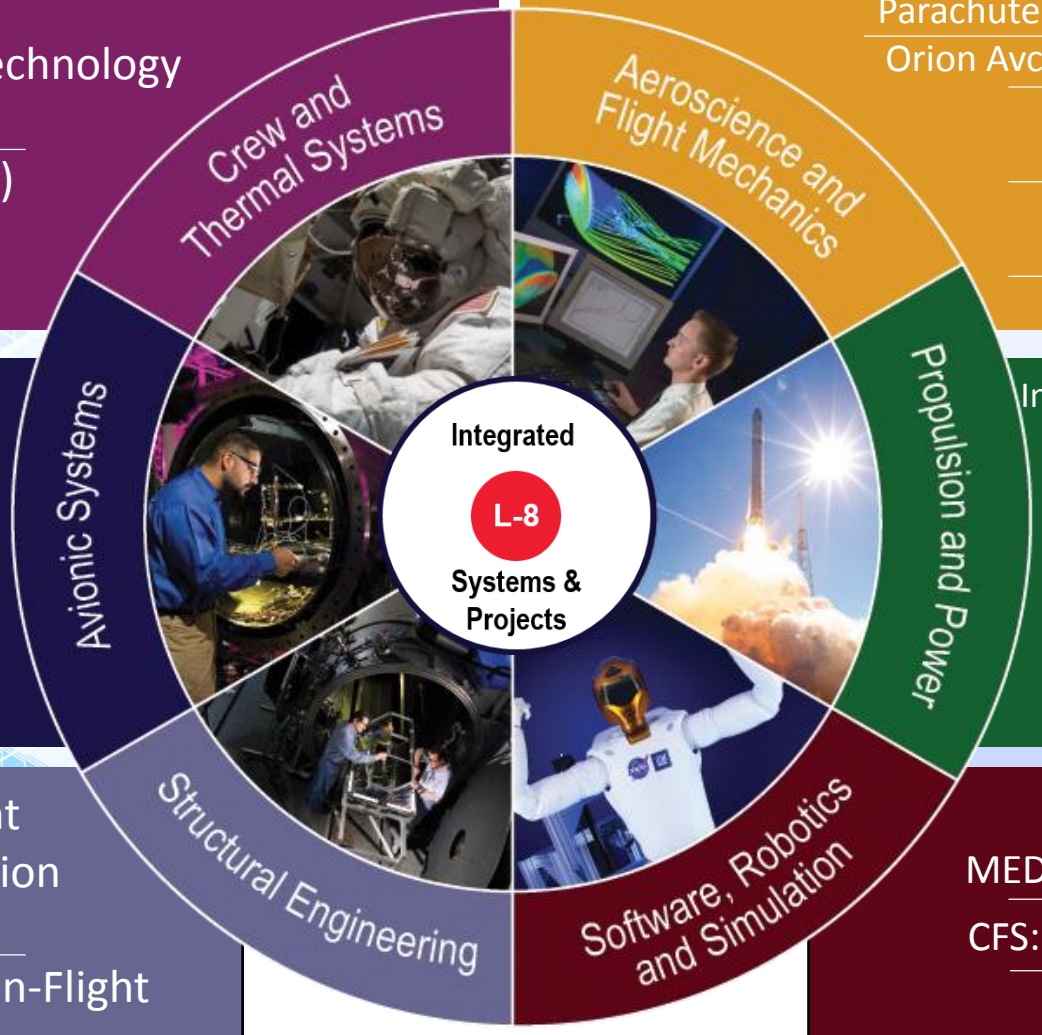
ISS Capillary Development (CapDev) Test Bed - Sargusingh

The Modular Wearable Architecture: Lowering the Human-System Barrier – Simon

Software Graphics Processing Unit (sGPU): Solving the Visual Display Problem for BEO Missions – McCabe

Novel Passive Thermal Management Systems for Future Human Exploration – Alvarez-Hernandez

Novel Passive Thermal Technology In-Flight Demonstration – Alvarez-Hernandez



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Parachute Canopy Instrumentation Package - Alshahin

Orion Avcoat Material Heat Shield Flight Test - Salazar

Visual Odometry for Autonomous Deep-Space Navigation – Robinson

Advanced Analytic Tools & Capabilities for Aerosciences – Kirk

Mid L/D Mars EDL Pathfinder – Campbell

Integrated Lox/LCH4: A Unifying Technology for Future Exploration (Phase II Work) – B. Banker

Solid State Thermionics Power – J. George

Regenerative Gas Dryer for Integrates ISRU Systems – A. Paz

LOX/LCH4 Propulsion Test in Space Environment – Morehead

Q-Thruster Work

MED-2 Exercise Device Operations – Zumbado

CFS: Human Spaceflight Product Line – Prokop

HESTIA Sim Support – Bielski

FY 2017 IRAD Investments Tied to L-8

JSC Engineering: HSF Exploration Systems Development

Shape-Morphing Adaptive Radar Technology (SMART) II – Erickson

Laser Processed Heat Exchangers - Hansen

A Low Power, Solid State, Method of Oxygen Supply - Graf

Magnetic Radiation Shielding for Human Space Exploration - Arndt

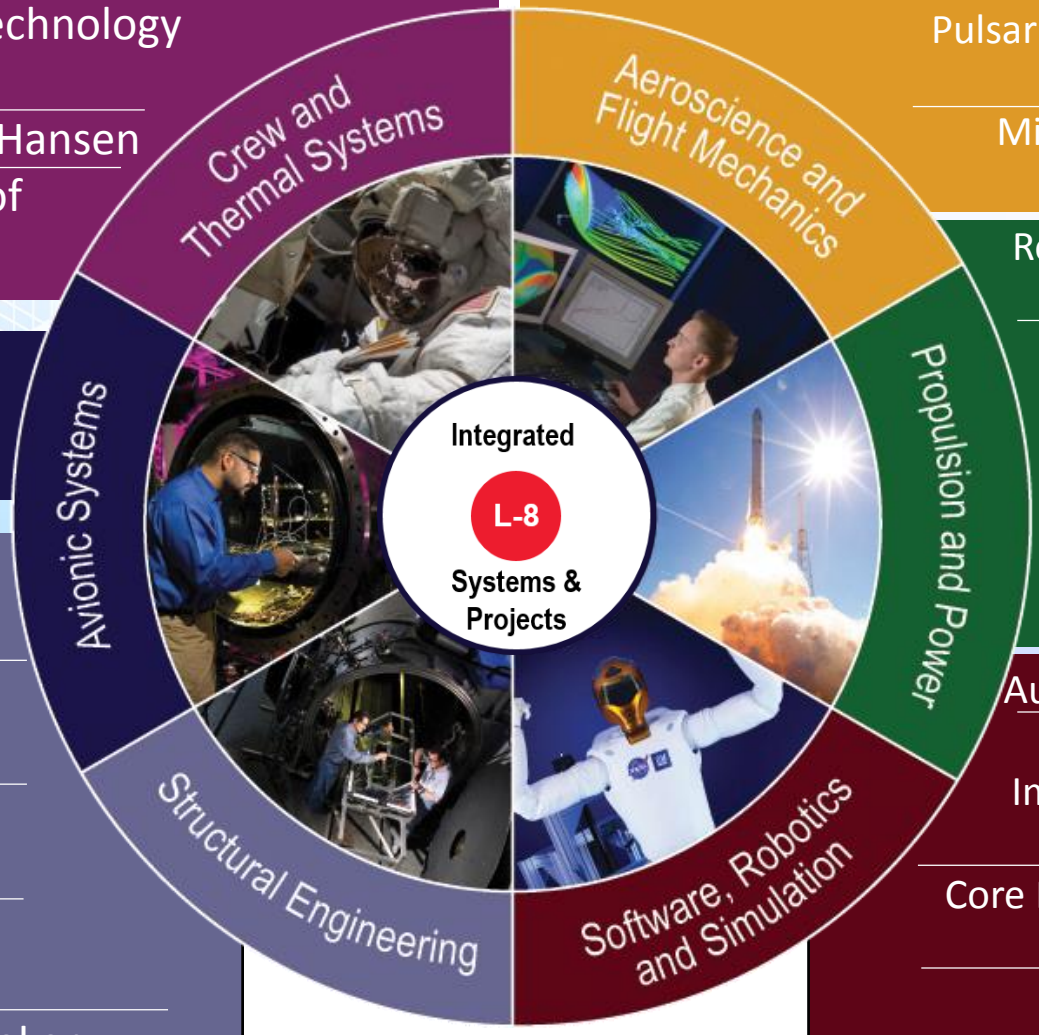
Orion Heat Shield Spectrometer – Holland

Entry Vehicle (Dragon) On Demand Instrumentation - Wells & Bouslog

Charring Ablator Response (CHAR) Sublimation - Remark

Aluminum Orbital Arc Weld Development - Luna

Inflatable Airlock EVA Interface - Litteken



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Pulsar Navigation for Crewed Exploration of the Solar System - D'Souza

Mid-L/D Ballistic Range Aerodynamics Test - Sostaric

Retiring the Side Wall Rupture Risk with Li-Ion – Darcy

SMR/SOFC System Integration for LOx/LCH4/ISRU – Mwara

Cubesat Q-Thruster Technology for Exploration – White

Flat H Redundant Frangible Joint (RFJ) - Brown

Augmented Reality Authoring Tool - Wang

Fatigue Reduction and Dexterity Improvements via Space Suit Glove Grasp Strength Augmentation - Rogers

Core Flight Software (CFS) Human Spaceflight Product Line (CITO) - Prokop

Integrated System Demonstration for Spacecraft Autonomy (Basics) - Badger

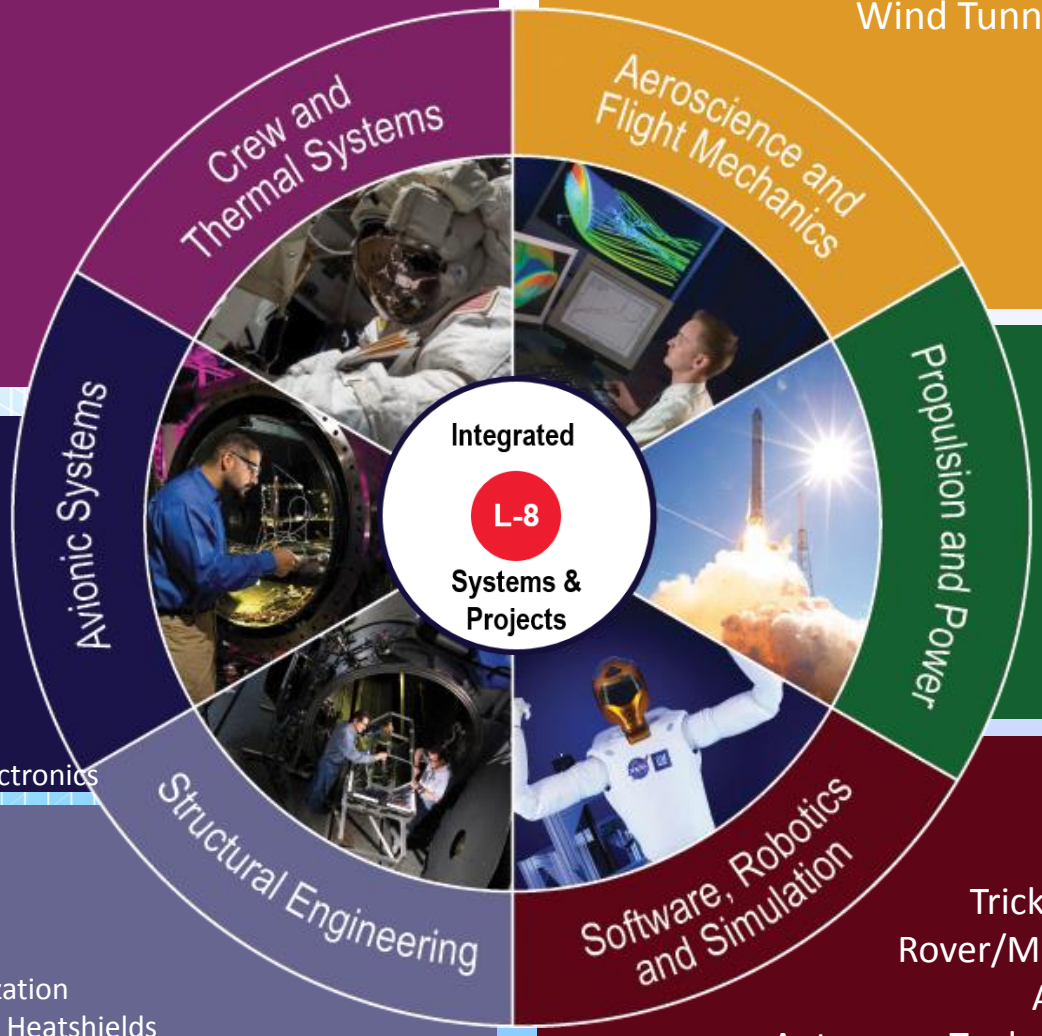
Potential Collaborations with Academia

JSC Engineering: HSF Exploration Systems Development

CO2 Removal, CO2 Reduction
Trace Contaminant Control, Particulate Filtration
Reliable Brine Water Recovery (Low Volume)
Air Monitoring Techniques/Strategies
Variable Heat Rejection Technologies/Trades
Lightweight Bio-resistant CHX
Advanced Phase Change Materials
In-Situ Thermal Fluids Chemical Analysis
Solvent Generation for Reusable Wipes
Antimicrobial Omniphobic Surface Coatings

Speech Recognition Evaluation
Natural Language Processing
Acoustic Echo Cancelation Algorithms
(e.g., in a spacesuit)
Wearable Technologies
Power Scavenging Sensors
Mesh Network Implementations
RF over IP for testing
E-textile & 3D-printed antennas
Advanced manufacturing techniques for Sparing of Electronics

Additive Manufactured Lattice Core Designs
Thin Ply Composites
Inflatable materials Creep characterization
Impact & Leak Detection for Inflatables
Acrylic & Ceramic Window Development & Characterization
Integrated Thermoelastic Design/Analysis Methods for Heatshields



Wind Tunnel Tests for Supersonic Retro Propulsion & Mid-L/D Re-entry bodies,
Large Mass Mars Entry Trades,
Autonomous Landing Hazard Avoidance Algorithms,
Optical Tracking and Navigation

NDE Tools/Methods for Pyros,
LOx/LCH4 Propulsion Systems,
Lunar/Planetary In-Situ Resource Utilization,
"Propellant-less" Thrusters,
Thermionic Energy Conversion,
Non-Maxwellian Plasma Confinement Systems

Autonomous Grasping
Humanoid Walking
Integrated Dynamic Systems Simulation
Trick-based Software Simulation Enhancements
Rover/Mars Ascent Vehicle Cabin Design Integration
Augmented Reality Research & Applications
Autonomy Tools (Robotics Planning, Flight Director In a Box)

SpaceCom 2016: NASA Challenges & Solutions Pavilion

JSC Engineering: HSF Exploration Systems Development

Advanced Concepts for O2 Concentration and storage – Graf

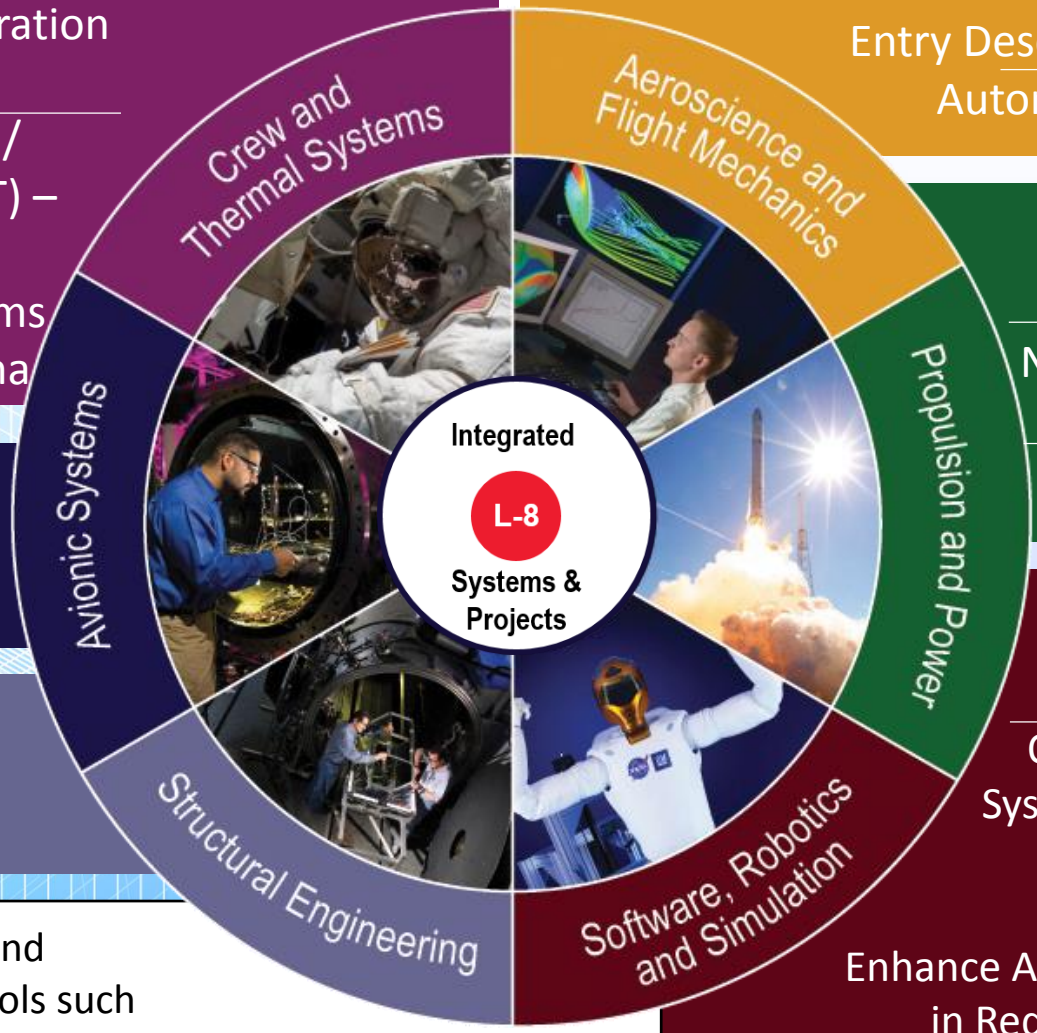
Space Environments Test Capability / James Webb Space Telescope (JWST) – Holman

Non-Venting Thermal Control Systems for Space Vehicles – Smith & Massina

RFID technology and sensor interrogators to develop low cost sensor suites - Wagner

Docking Systems and other Attachment/Release mechanisms and related technologies – Lewis

Modeling the integration of hardware and software systems of spacecraft using tools such as SysML - Carrejo



Entry Descent and Landing at Mars - Sostaric

Autonomous Mission Planning – Condon

In Situ Resource Utilization (ISRU) Capabilities – Sanders

NDE Methods for Ultimately Reliable Pyrotechnics – Scott & Hinkel

Safe Li-Ion batteries – Darcy & Scott

Spacecraft Autonomy – Badger

Advanced Vehicle Mobility – Junkin

Optimizing Virtual Reality and Tracking Systems for Zero-G Space Environments - Paddock

Using Human-Machine Interactions to Enhance Astronaut Performance and Adaptation in Reduced Gravity Environments - Burkhart

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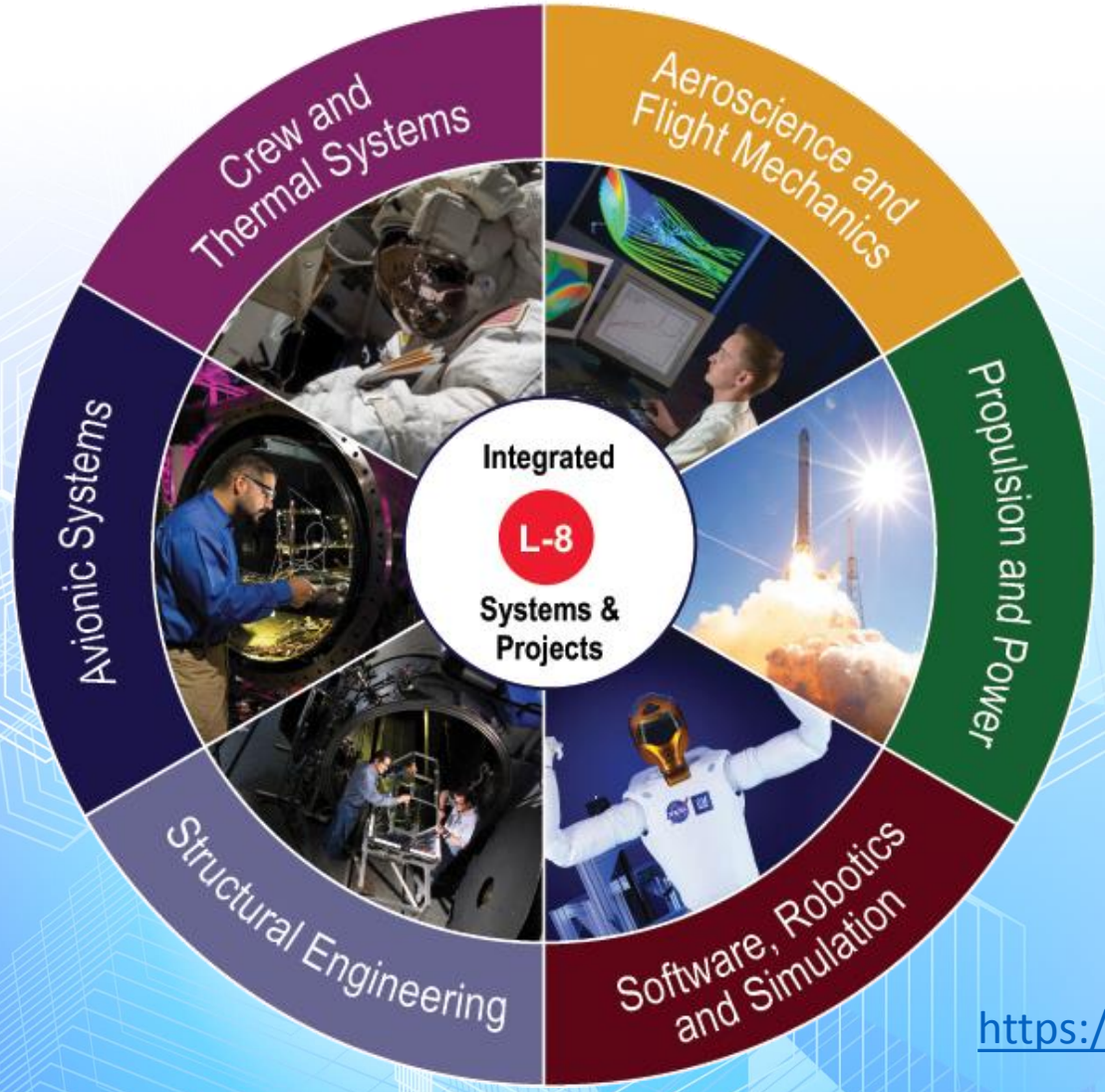
We Want Your Help!

- Our L-8 efforts have identified a lot of problems to be solved before we can go to Mars, and we need partnerships to help solve them.

- Partnerships with NASA JSC can take many forms:
  - Similar Problems, Different Capabilities → Technology Collaboration → Solution
  - Partner Technology → NASA Evaluation/Test → Increased Knowledge
  - Partner Need → NASA-unique technology/capability/facility → Desired Results
  - NASA Technology → Partner adapts to terrestrial need → NASA harvests improvements
  - Partner Technology → NASA Adapts to Spaceflight Needs → Partner harvests improvements

JSC Engineering: HSF Exploration Systems Development



- We want to ensure that HSF technologies are ready to take Humans to Mars in the 2030s.
- Our Goal: Get within 8 years of launching humans to Mars (L-8) by 2025
- We have a number of specific partnership opportunities we're discussing at SpaceCom 2016.
- If you're interested in one of these, or you have other ideas, let us know at:

https://nasajsc.secure.force.com/ConnectForm