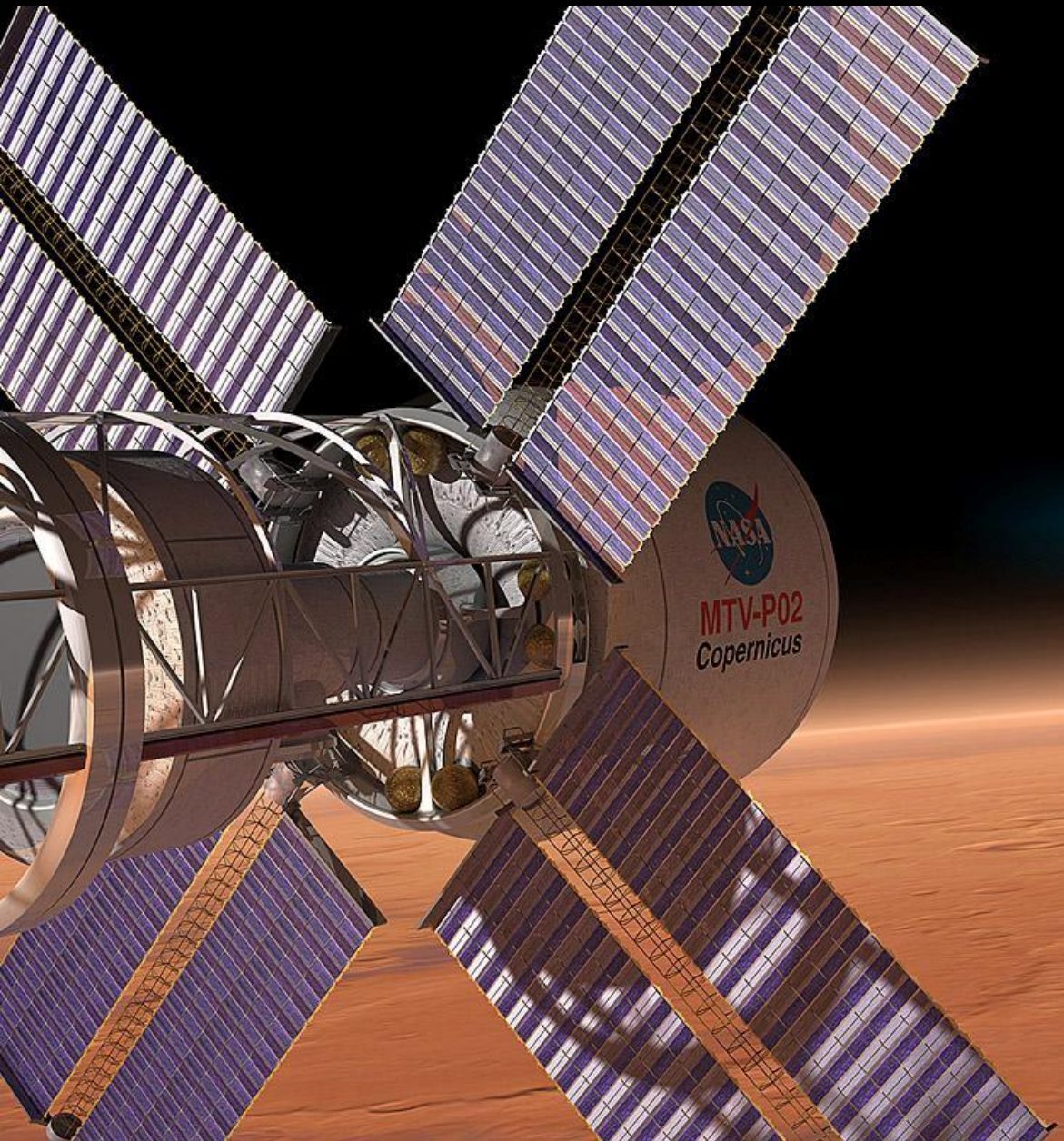

# orion

## MULTI-PURPOSE CREW VEHICLE

# Deep Space Exploration Vehicle

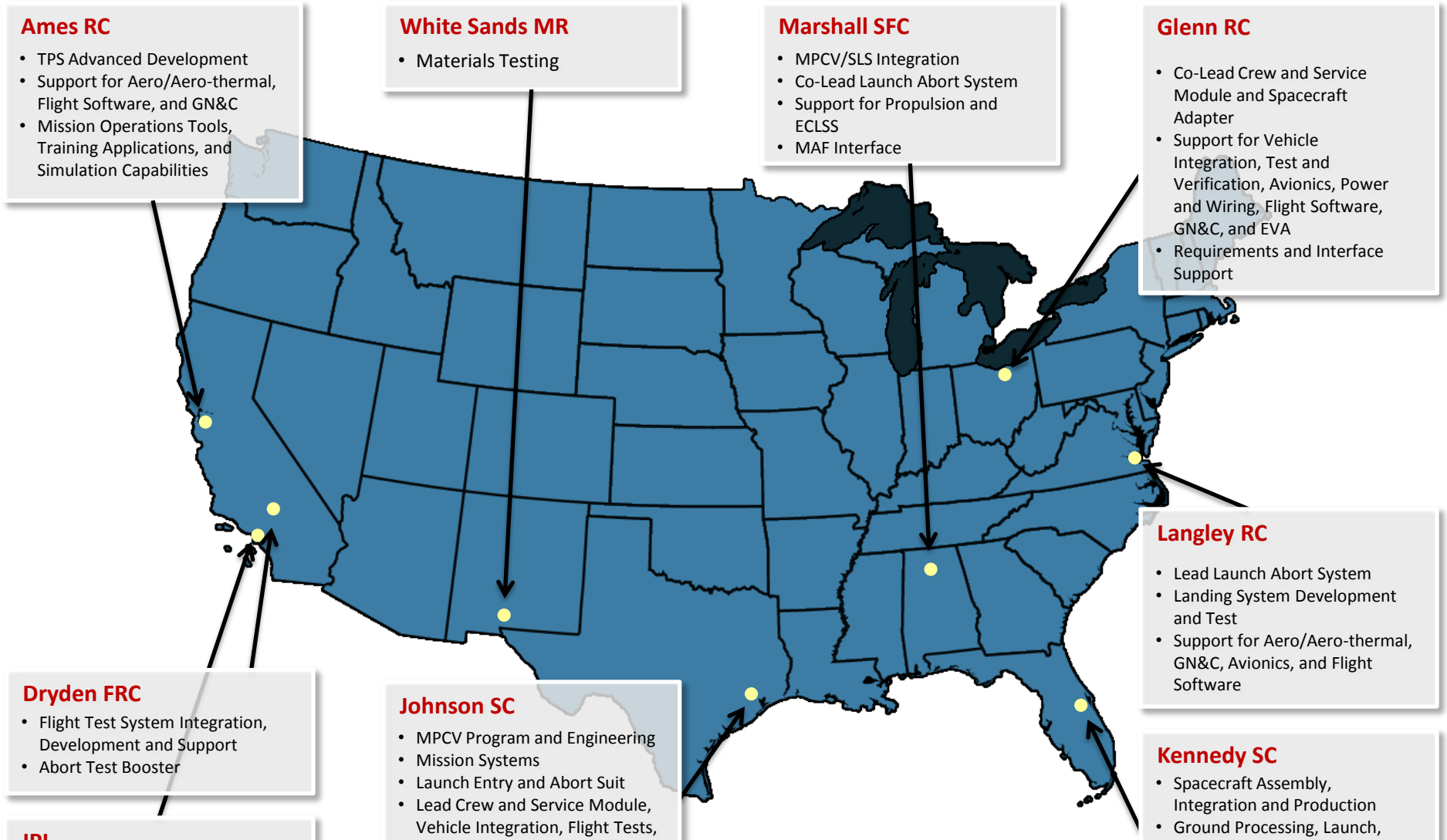



The Orion Multi-Purpose Crew Vehicle will be capable of sustaining a crew of up to six astronauts on deep-space missions that could last anywhere from six days for a lunar flyby mission to up to 900 days for a Mars exploration mission when paired with additional propulsion and habitation systems.

# Technical Trade Studies Completed under Cx


- **Orion conducted thousands of trade studies on architecture, systems and technologies since Program inception. Most important:**
  - Composite vs. Aluminum crew module
    - NASA, contractor, and NESC independently concluded composites offer no production cost or mass benefit and will increase DDT&E cost and schedule
  - Size (diameter) of crew module: 4.5m vs. 5m vs. 5.5m
    - 5m selected as optimum for longer BEO missions
  - Launch abort system: pusher vs. puller rockets
    - Pusher ok for lighter LEO spacecraft; Puller best for heavier BEO spacecraft
  - Land vs. water landings
    - Weight, reliability and cost drove water landing decision
  - Size (diameter) of EVA umbilical and ECLSS fan design
    - Driven by “one hose does all” requirement and unpressurized support for 6 crew
- **System and sub-system trades were analyzed on 20 different CEV and MPCV spacecraft configurations**

# NASA Center Roles



## Ames RC
- TPS Advanced Development
- Support for Aero/Aero-thermal, Flight Software, and GN&C
- Mission Operations Tools, Training Applications, and Simulation Capabilities

## White Sands MR
- Materials Testing

## Marshall SFC
- MPCV/SLS Integration
- Co-Lead Launch Abort System
- Support for Propulsion and ECLSS
- MAF Interface

## Glenn RC
- Co-Lead Crew and Service Module and Spacecraft Adapter
- Support for Vehicle Integration, Test and Verification, Avionics, Power and Wiring, Flight Software, GN&C, and EVA
- Requirements and Interface Support

## Langley RC
- Lead Launch Abort System
- Landing System Development and Test
- Support for Aero/Aero-thermal, GN&C, Avionics, and Flight Software

## Dryden FRC
- Flight Test System Integration, Development and Support
- Abort Test Booster

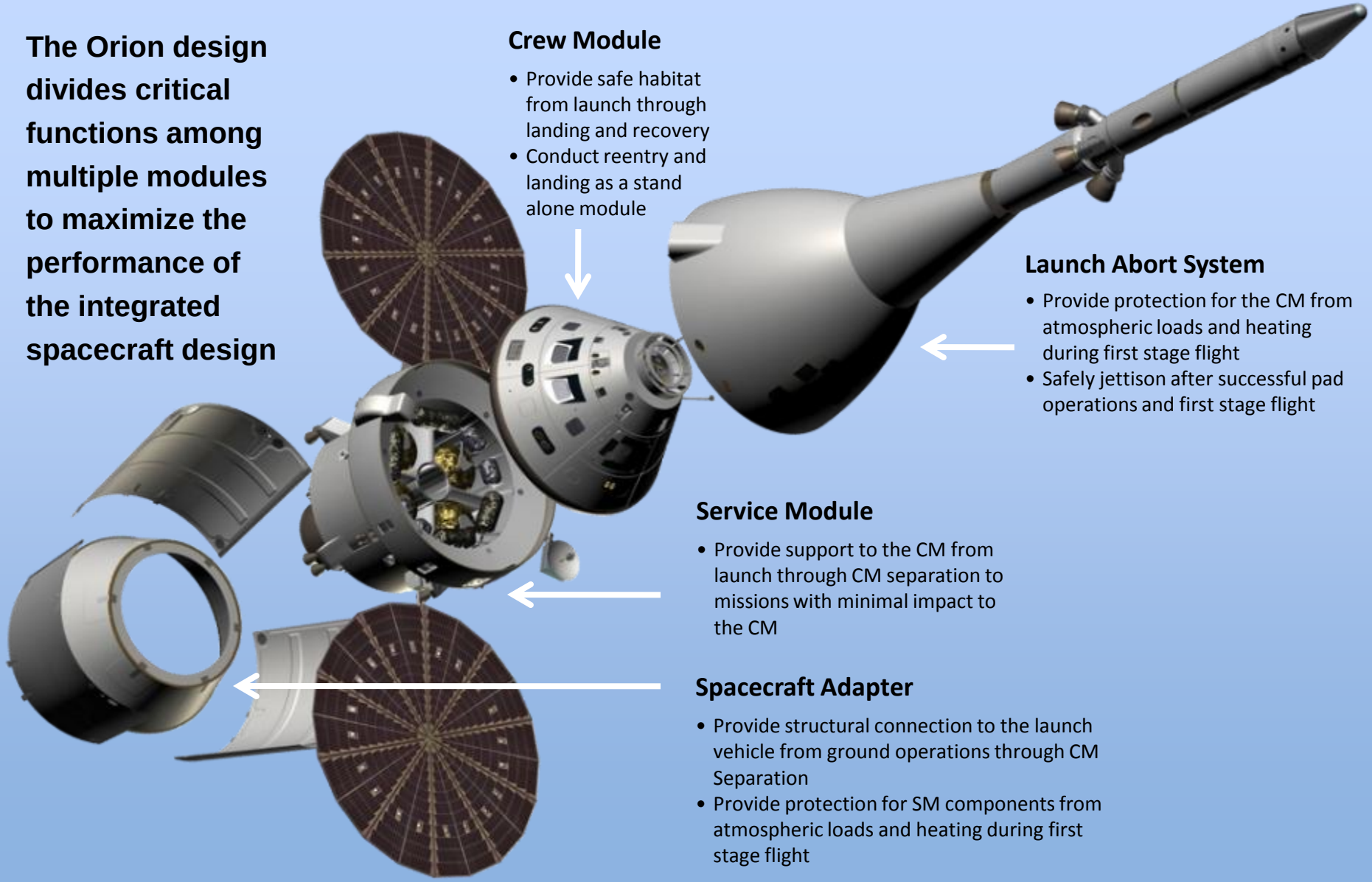
## JPL
- Independent Validation for CPAS and TPS

## Johnson SC
- MPCV Program and Engineering
- Mission Systems
- Launch Entry and Abort Suit
- Lead Crew and Service Module, Vehicle Integration, Flight Tests, GFE
- Crew Habitation and Life Support Systems

## Kennedy SC
- Spacecraft Assembly, Integration and Production
- Ground Processing, Launch, Landing, and Recovery Planning and Operations
- Air Force Eastern Range

# Spacecraft Overview

**The Orion design divides critical functions among multiple modules to maximize the performance of the integrated spacecraft design**



### Crew Module

- Provide safe habitat from launch through landing and recovery
- Conduct reentry and landing as a stand alone module

### Launch Abort System

- Provide protection for the CM from atmospheric loads and heating during first stage flight
- Safely jettison after successful pad operations and first stage flight

### Service Module

- Provide support to the CM from launch through CM separation to missions with minimal impact to the CM

### Spacecraft Adapter

- Provide structural connection to the launch vehicle from ground operations through CM Separation
- Provide protection for SM components from atmospheric loads and heating during first stage flight

# MPCV Test Campaign Reduces Risk While Maturing the Design

**GTA Acoustic, Modal, Vibe Testing**

*Environment compatibility*

**Water Drop Tests**

*Correlate structural math models in water landing conditions*

**Parachute Tests**

*Nominal and contingency parachute performance tests*

**Wind Tunnel Testing**

*Aero/aerothermal database validation for Orion configuration*

**TPS Arc Jet Testing**

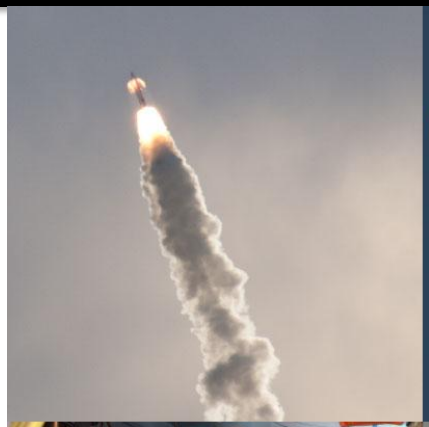
*Heatshield model correlation for entry performance*

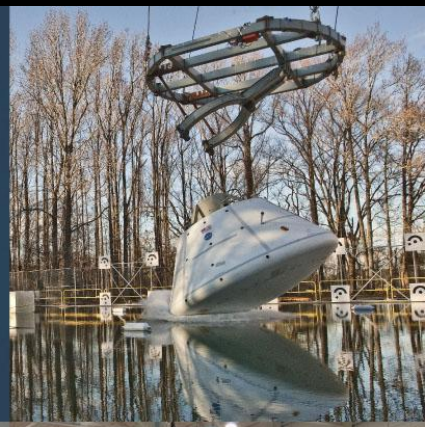
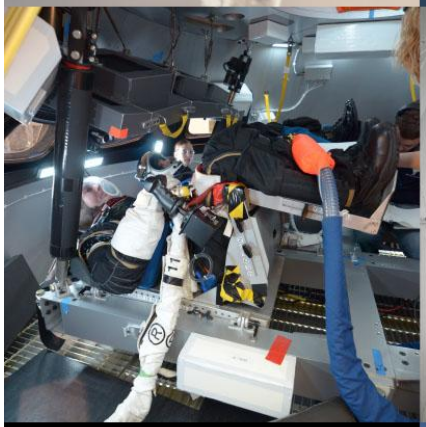
**EFT-1 Test Article Manufacturing and Assembly**

*First production primary structure built for orbital flight*

**Pad Abort Test**

*Demo abort capability with prototype LAS*





# Ground Test Article (GTA) in LM Facility in Denver

# GTA Acoustic Testing

**NOTE**: Test 1a,1,2 steps at three different levels:
- -9dB (i.e. 140.8dB)
- -3dB (i.e. 146.8dB)
- 0dB (i.e. 149.8dB)

**NOTE**: Test 3 steps at:
- -9dB (i.e. 140.1dB)
- -3dB (i.e. 146.1dB)
- 0dB (i.e. 149.1dB)

**Test 1A**
Crew Module only configuration
July 13-21

**COMPLETED**

**Test 1**
LAV Internal Cavity Configuration
August 16-19

**COMPLETED**

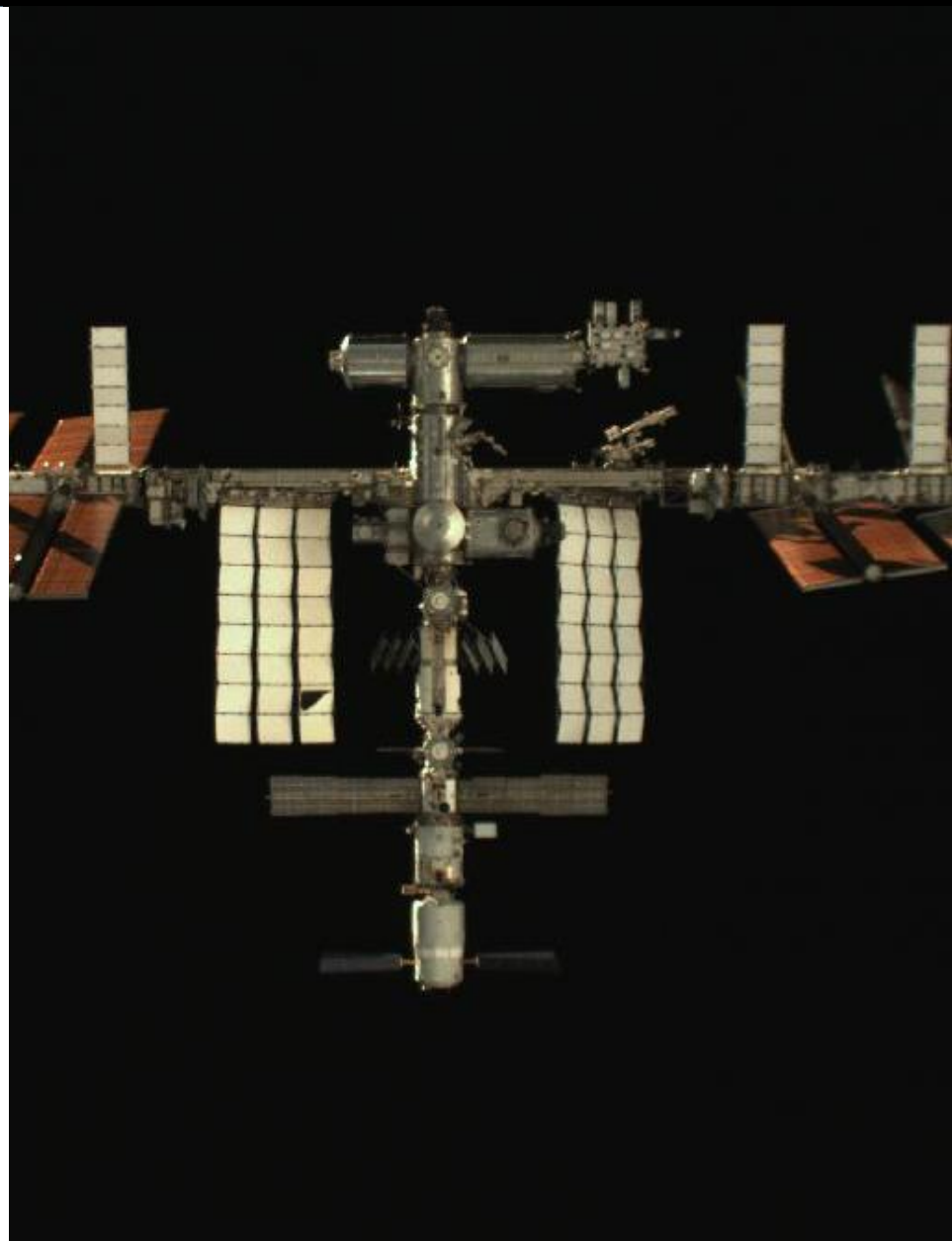
**Test 2**
Launch Abort Vehicle Configuration
Sep 20-22

**COMPLETED**

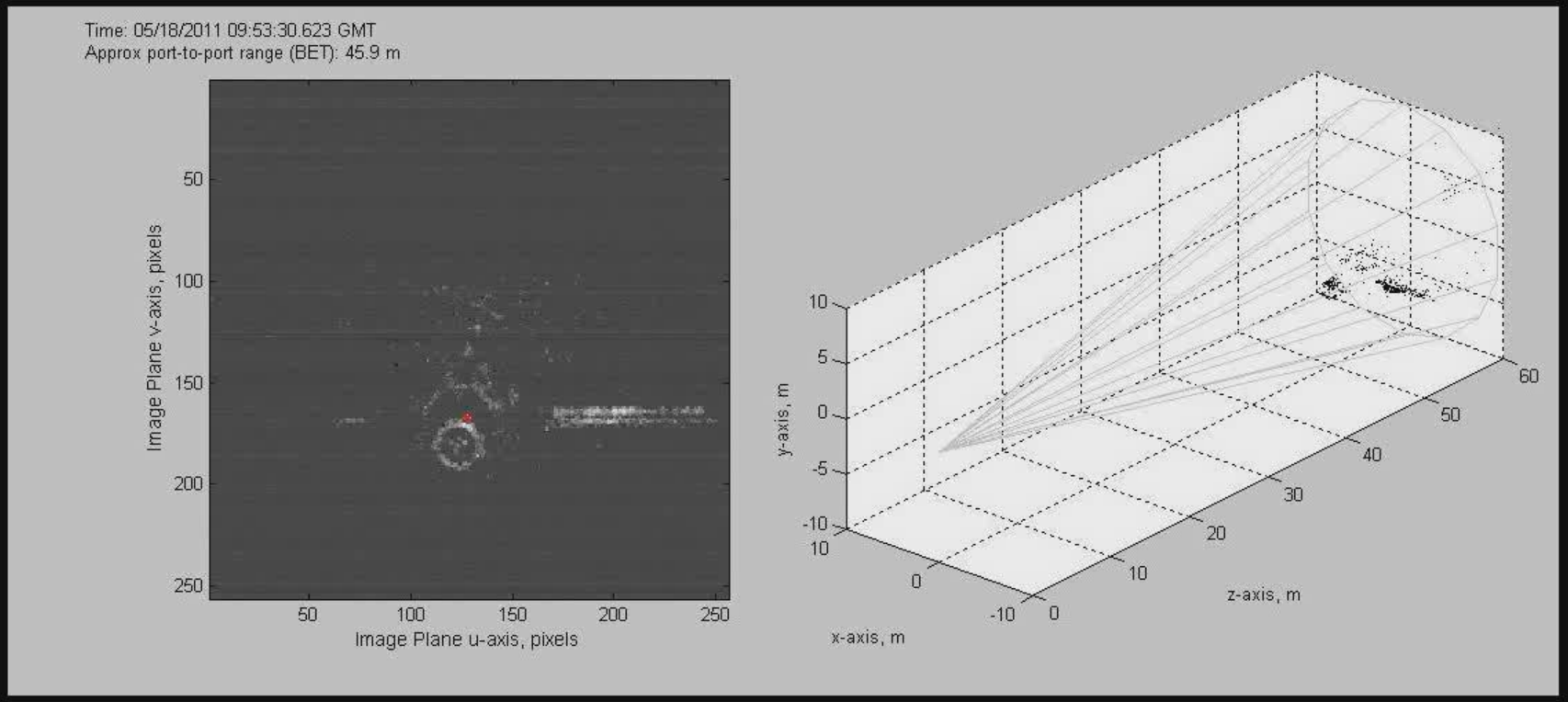
**Test 3**
Nominal Launch Configuration
October 17-19

**COMPLETED**

# Sensor Test for Orion Rel/Nav Risk Mitigation (STORRM)

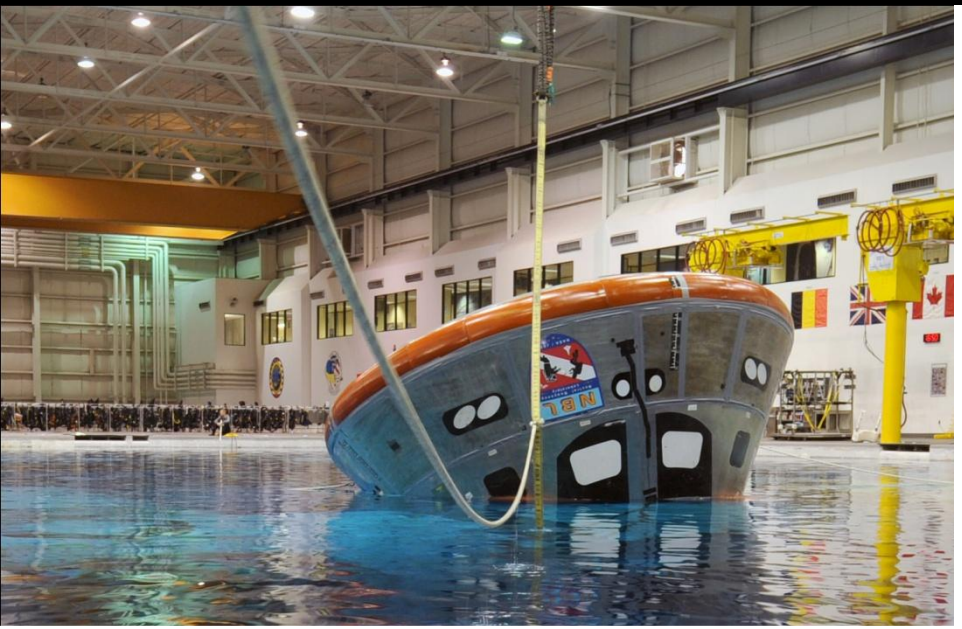


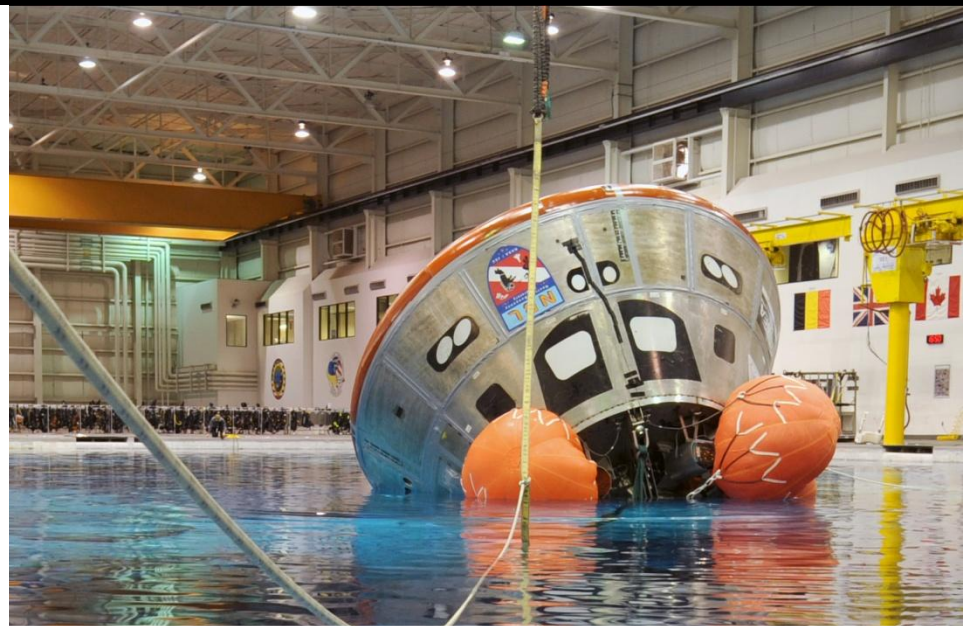
# STORRM

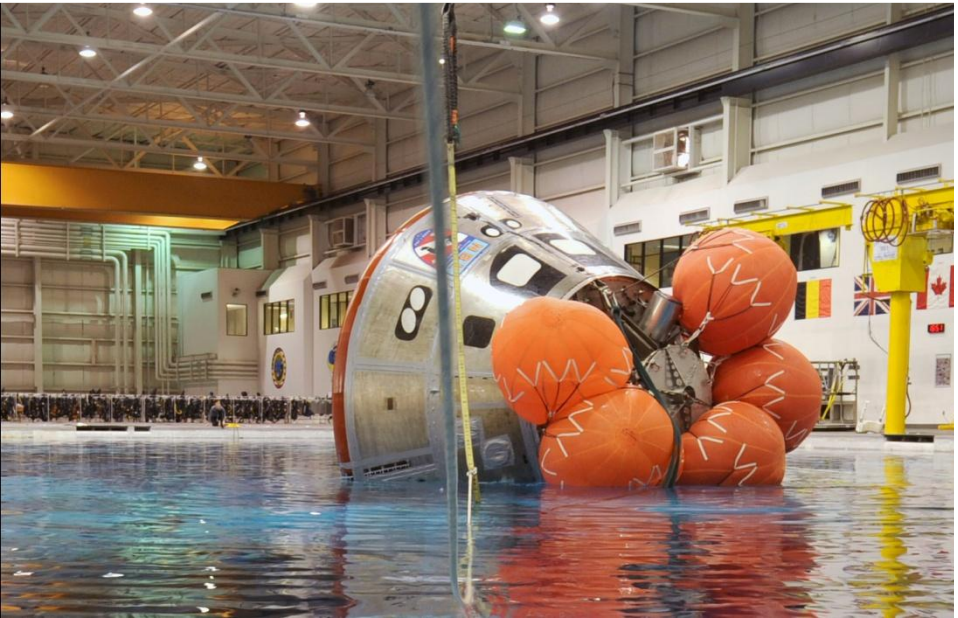

Time: 05/18/2011 09:53:30.623 GMT
Approx port-to-port range (BET): 45.9 m
Image Plane v-axis, pixels
50
100
150
200
250
Image Plane u-axis, pixels
50
100
150
200
250
y-axis, m
10
5
0
-5
-10
x-axis, m
10
0
-10
z-axis, m
0
10
20
30
40
50
60

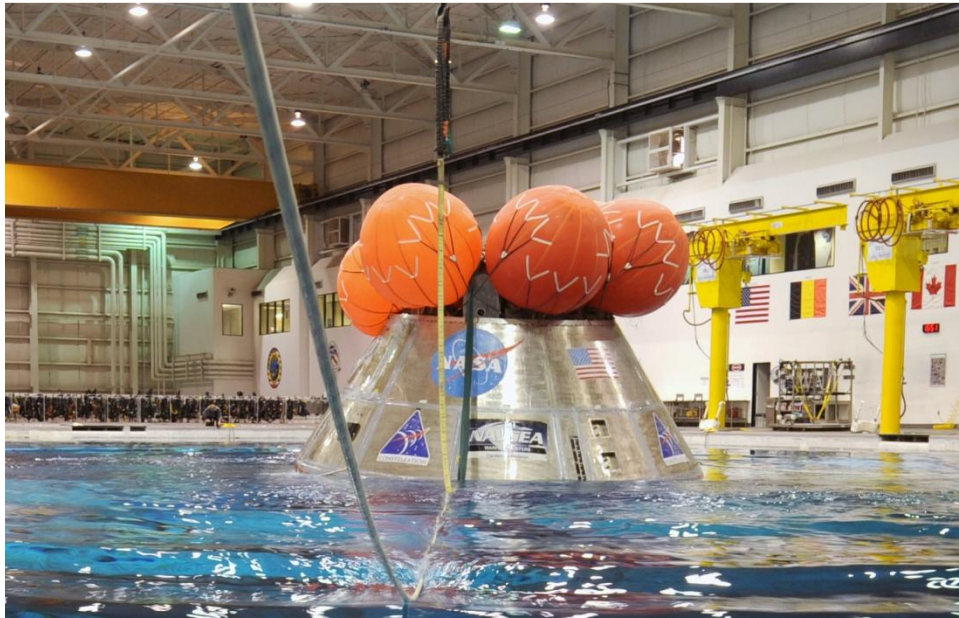
# Suit Evaluation at the LM Exploration Development Lab (EDL) in Houston

# Crew Module Uprighting System Tests At the NBL

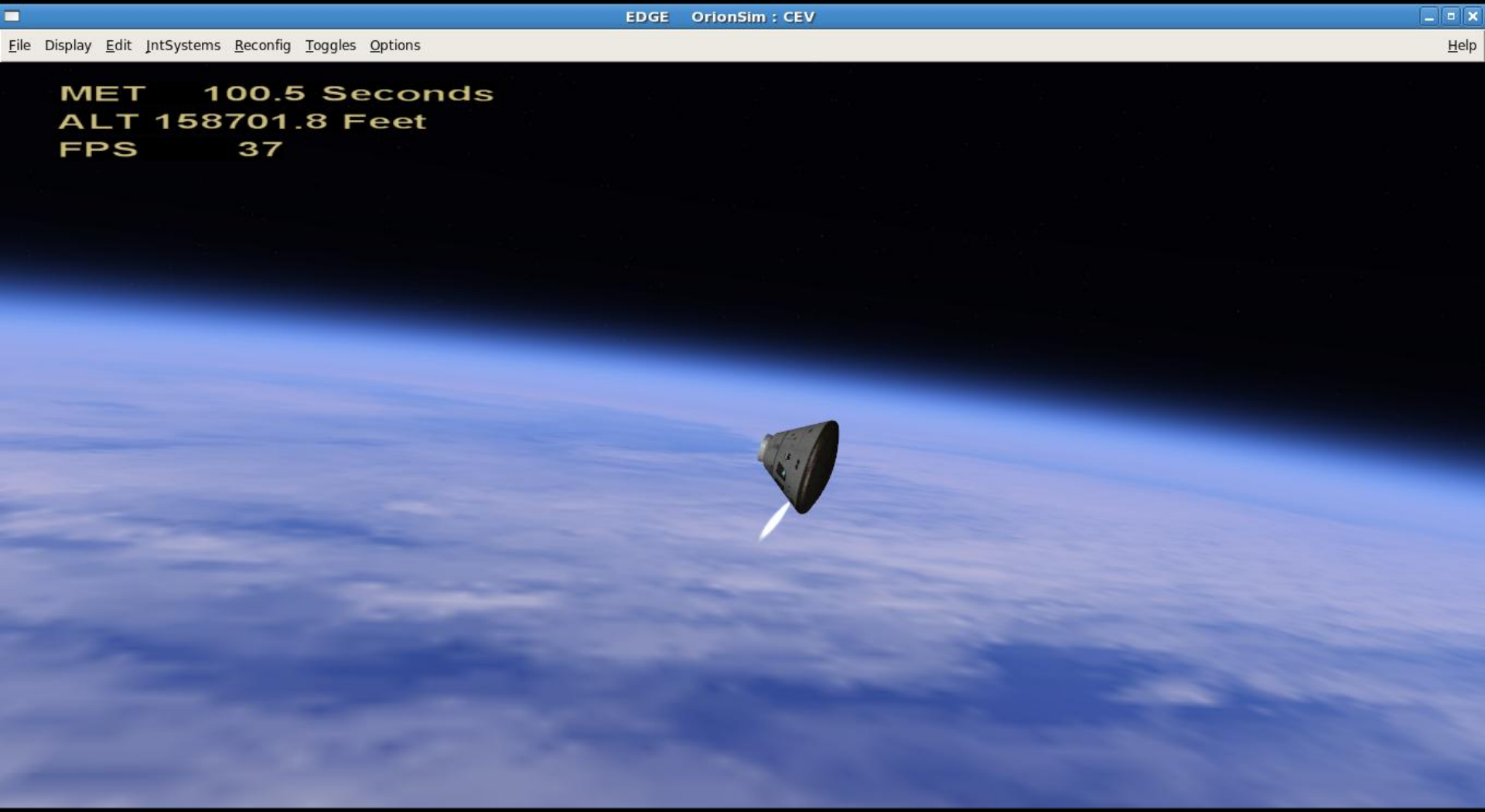








# Avionics Software / Hardware

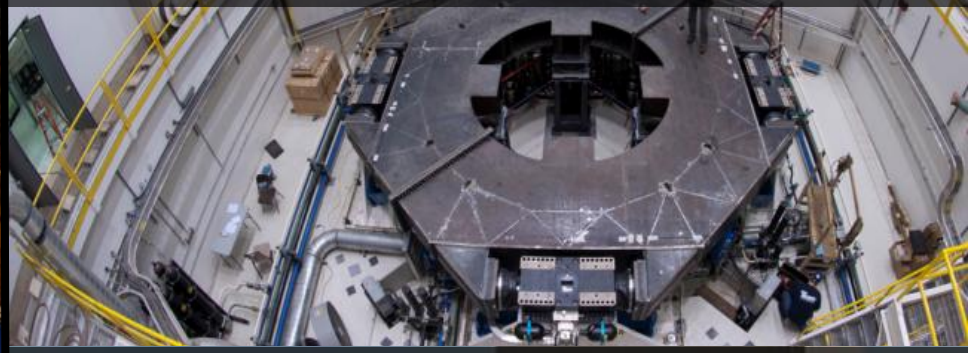


# Manufacturing and Test Facilities

Michoud Assembly Facility - New Orleans, Louisiana

Operations and Checkout Facility – Kennedy Space Center

Space Environmental Test Facility, Glenn Research Center

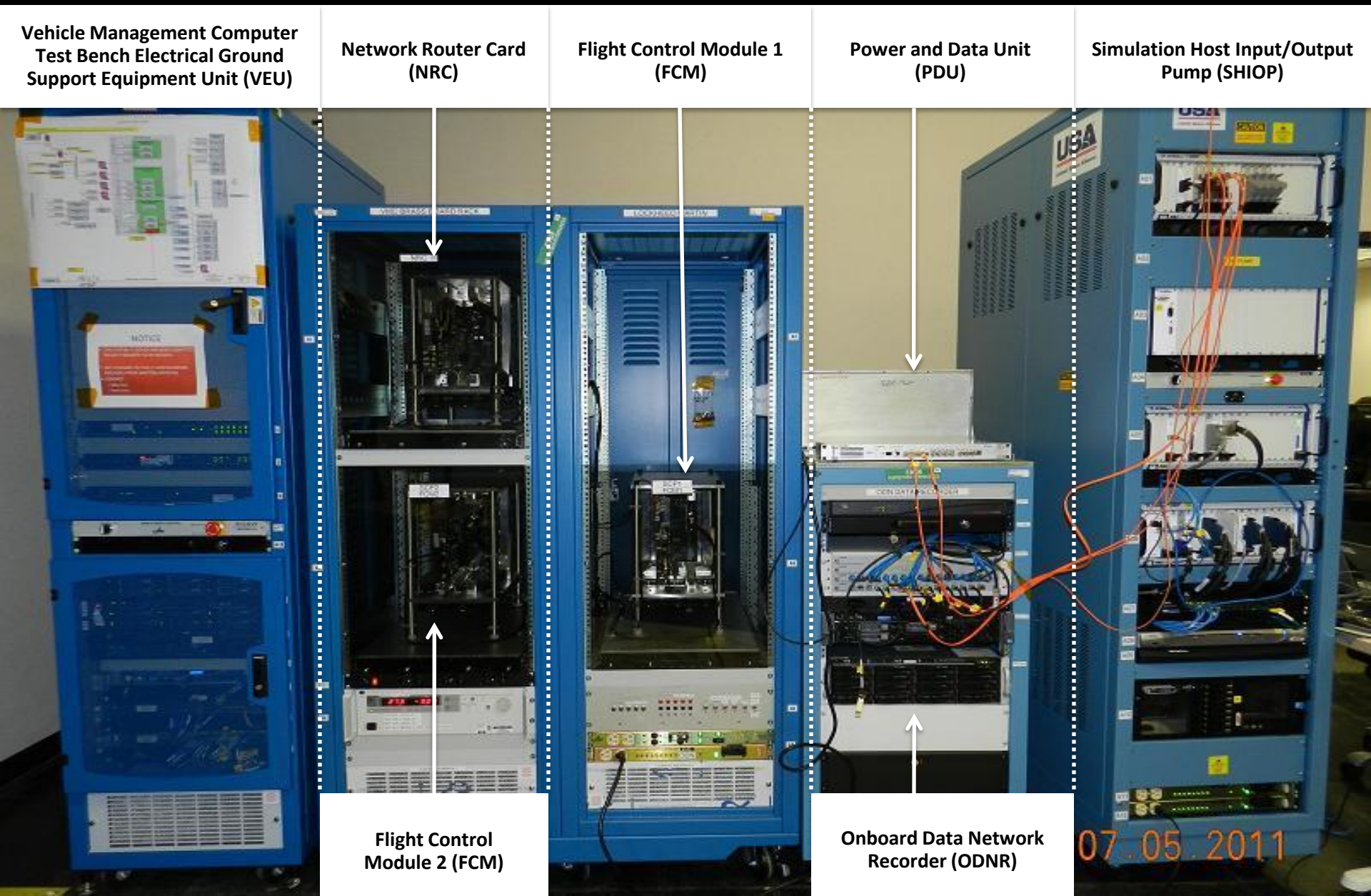


Canister Rotation Facility, Kennedy Space Center

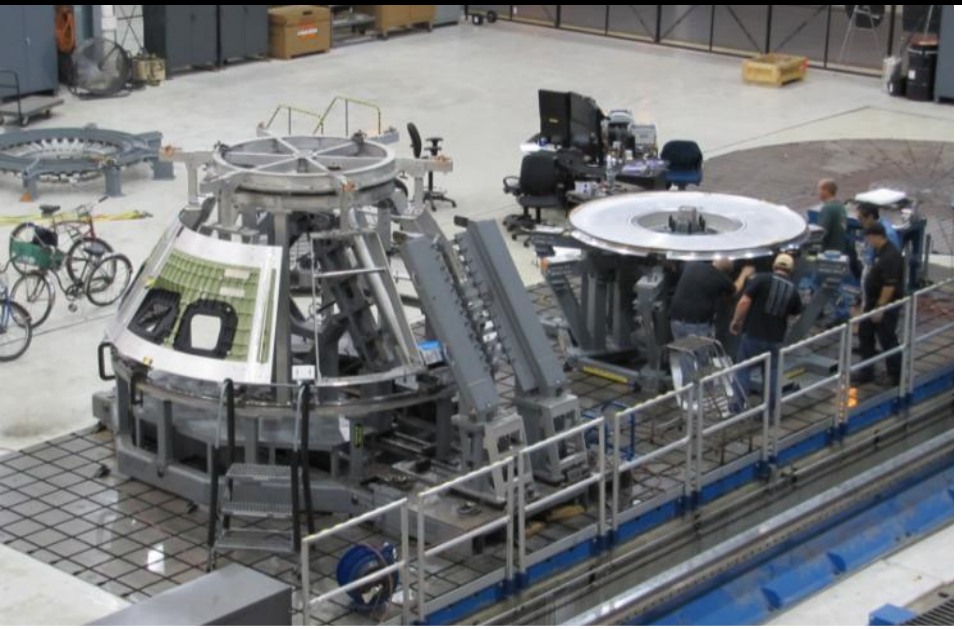
Hydro Impact Basin, Langley Research Center

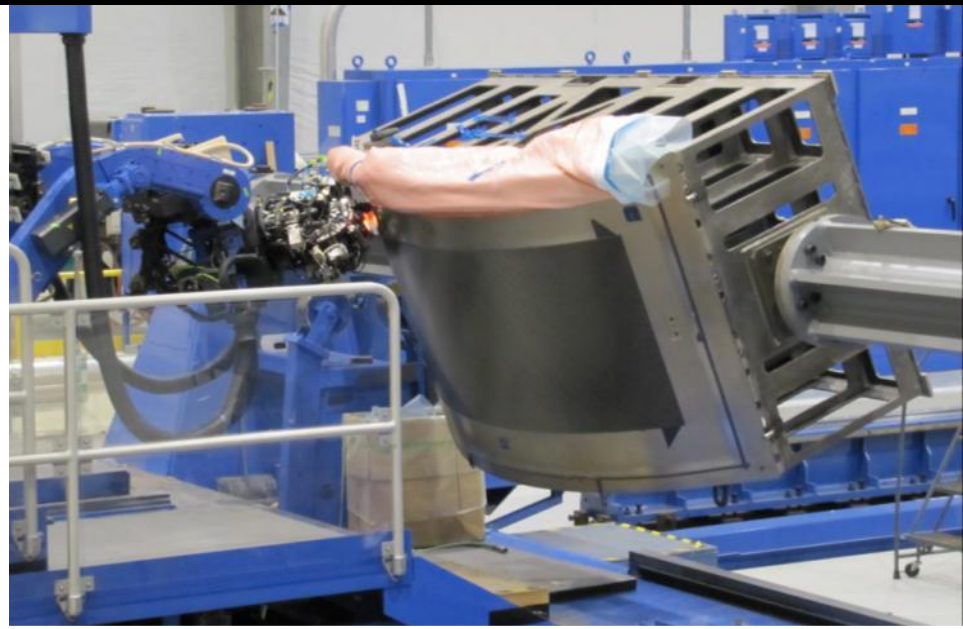
# Houston Orion Test Hardware (HOTH)

## ISP ITL_01 Test Configuration



# EFT-1 Test Article Manufacturing/Assembly





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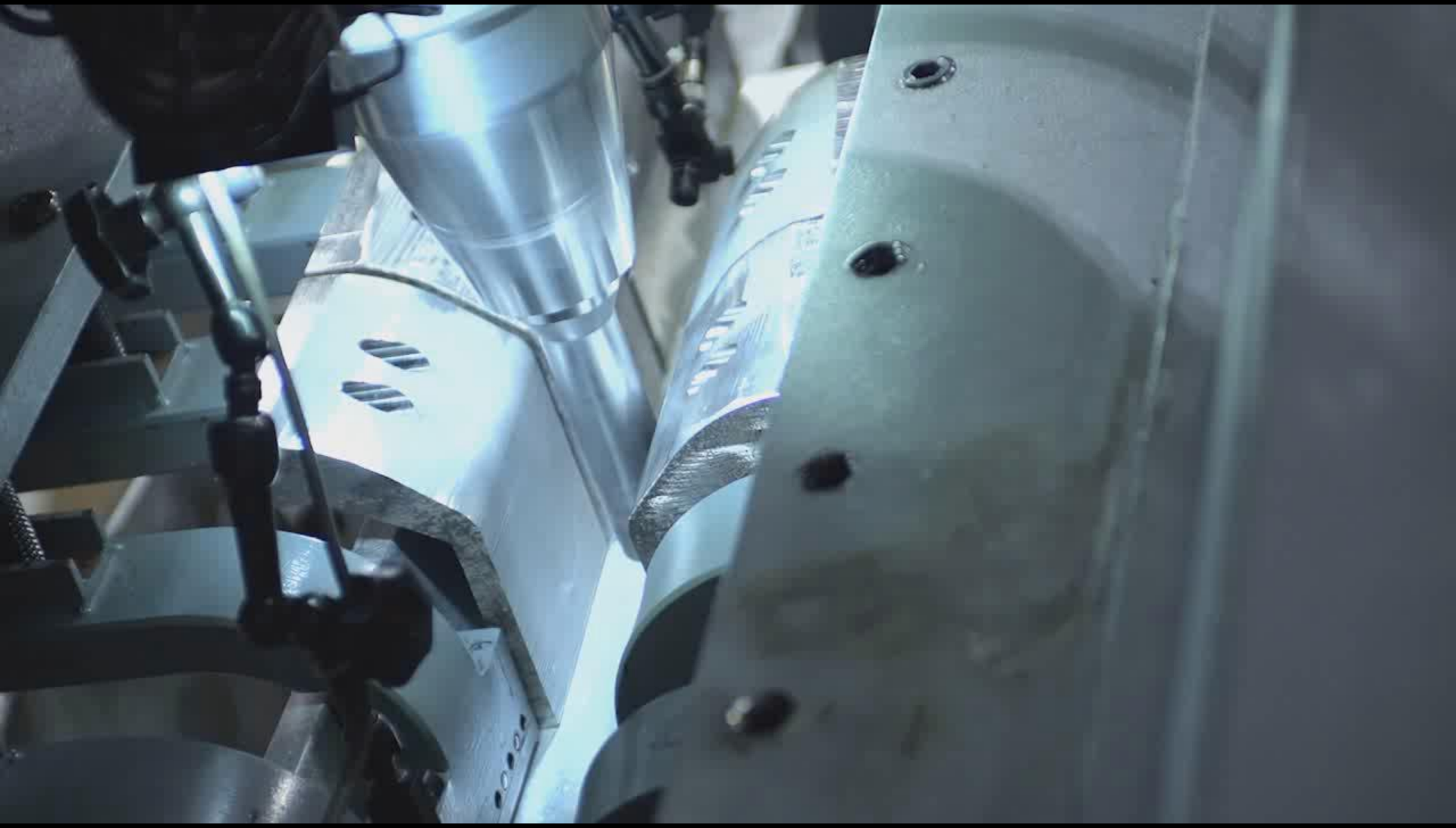

# Water Drop Tests at Langley Research Center

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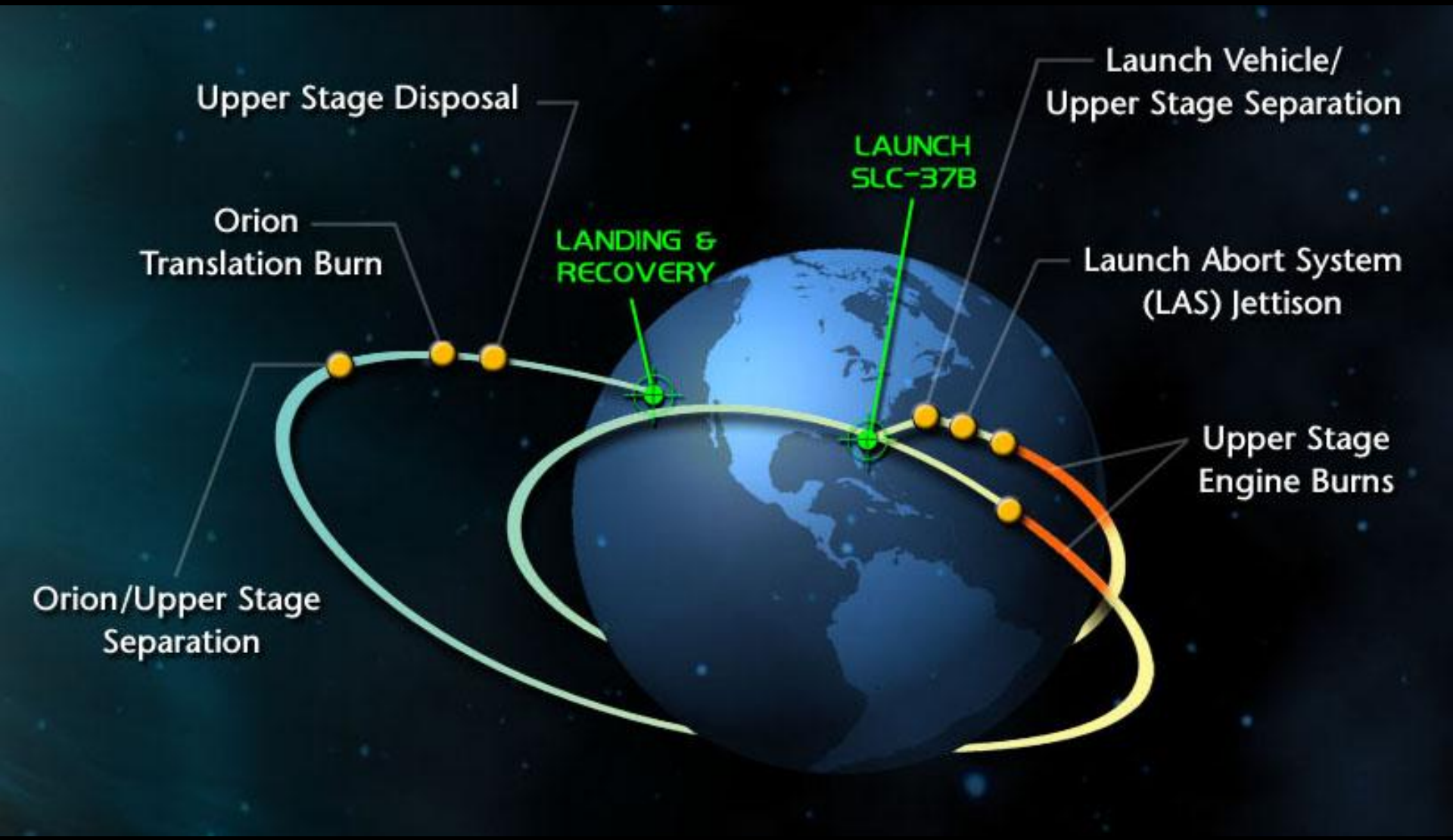
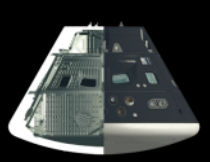
# Crew Module Parachute Test #1

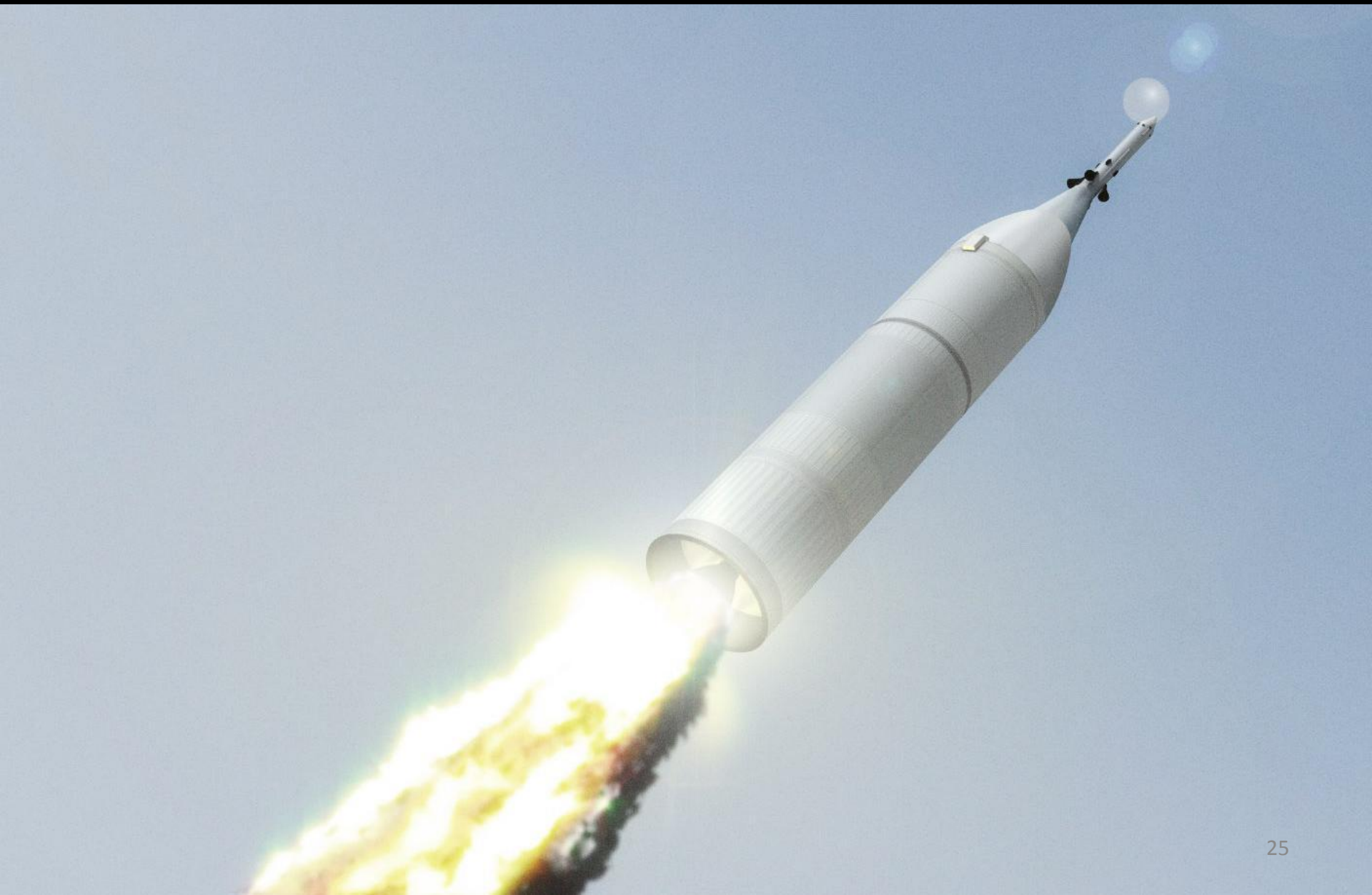
# Exploration Flight Test 1



# Exploration Flight Test 1



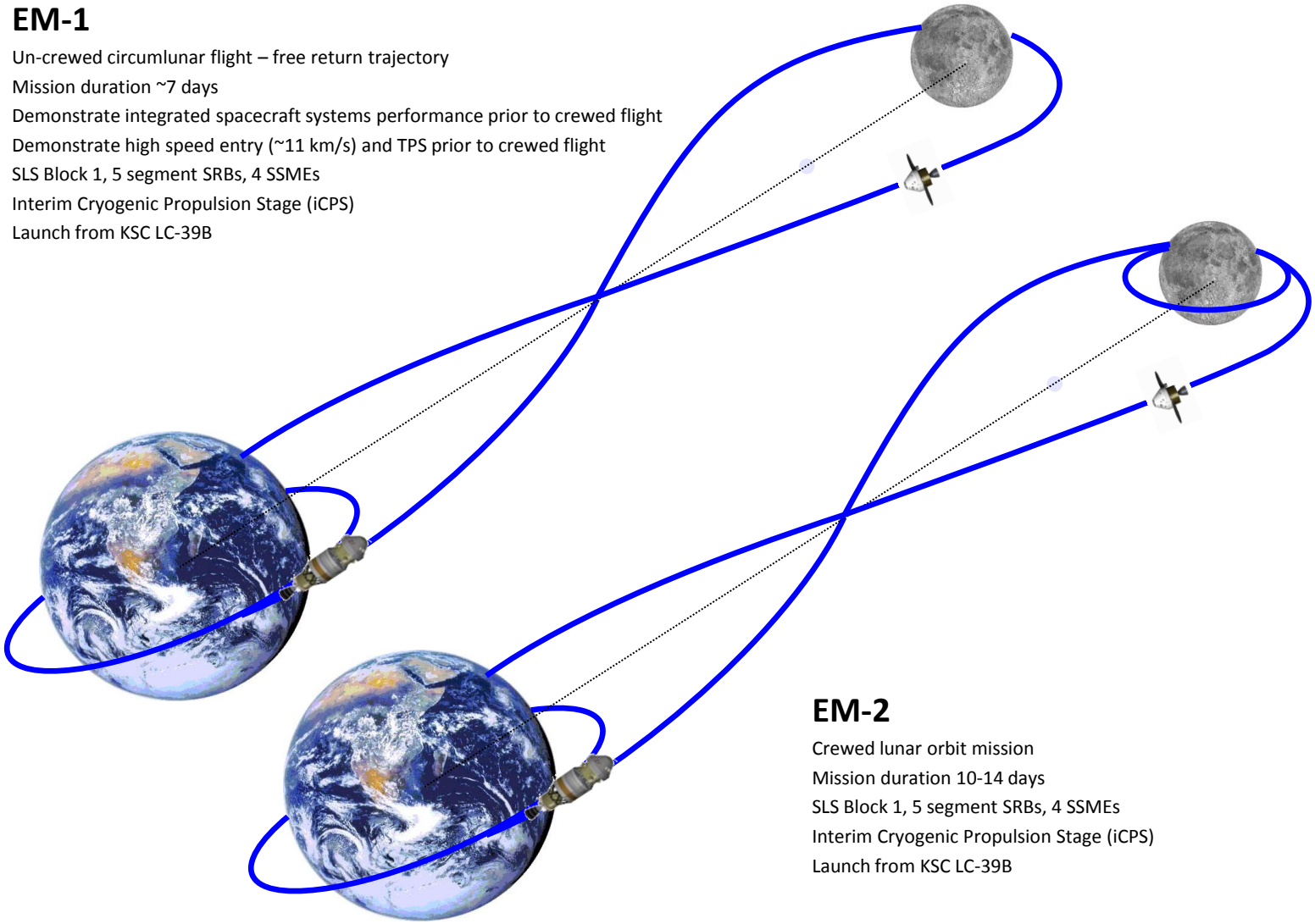
# Ascent Abort 2 Test



# Proposed EM-1 & EM-2 Flights

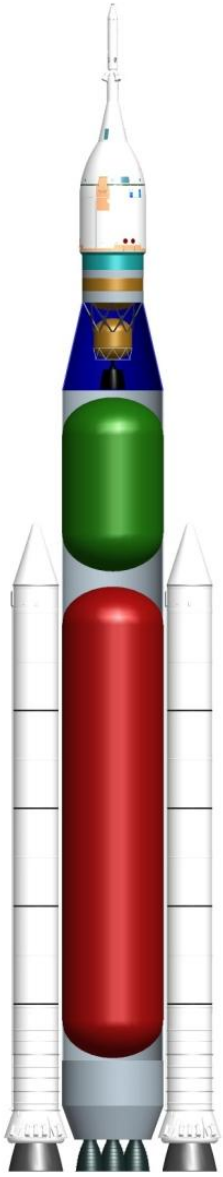
## EM-1

Un-crewed circumlunar flight – free return trajectory
Mission duration ~7 days
Demonstrate integrated spacecraft systems performance prior to crewed flight
Demonstrate high speed entry (~11 km/s) and TPS prior to crewed flight
SLS Block 1, 5 segment SRBs, 4 SSMEs
Interim Cryogenic Propulsion Stage (iCPS)
Launch from KSC LC-39B



## EM-2

Crewed lunar orbit mission
Mission duration 10-14 days
SLS Block 1, 5 segment SRBs, 4 SSMEs
Interim Cryogenic Propulsion Stage (iCPS)
Launch from KSC LC-39B



# Returning to Our Core Mission

## Exploration of Space