

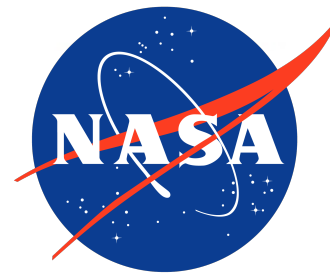
LCOE Tech Talk

Austin J. Moore
Aerospace Engineer

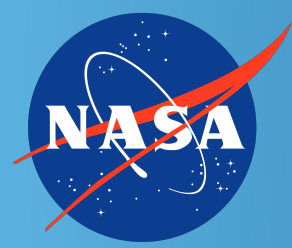
17 November 2021

California State University, Fresno

National Aeronautics and
Space Administration



MARSHALL
SPACE FLIGHT CENTER



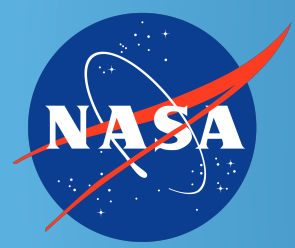
Environmental Test Facility



Left: V20 Test Chamber
Spare LOX tank from a Saturn V (the 'moon rocket') converted into a thermal-vacuum chamber. Currently being fitted to test lunar and Martian regolith for the Artemis program and beyond.



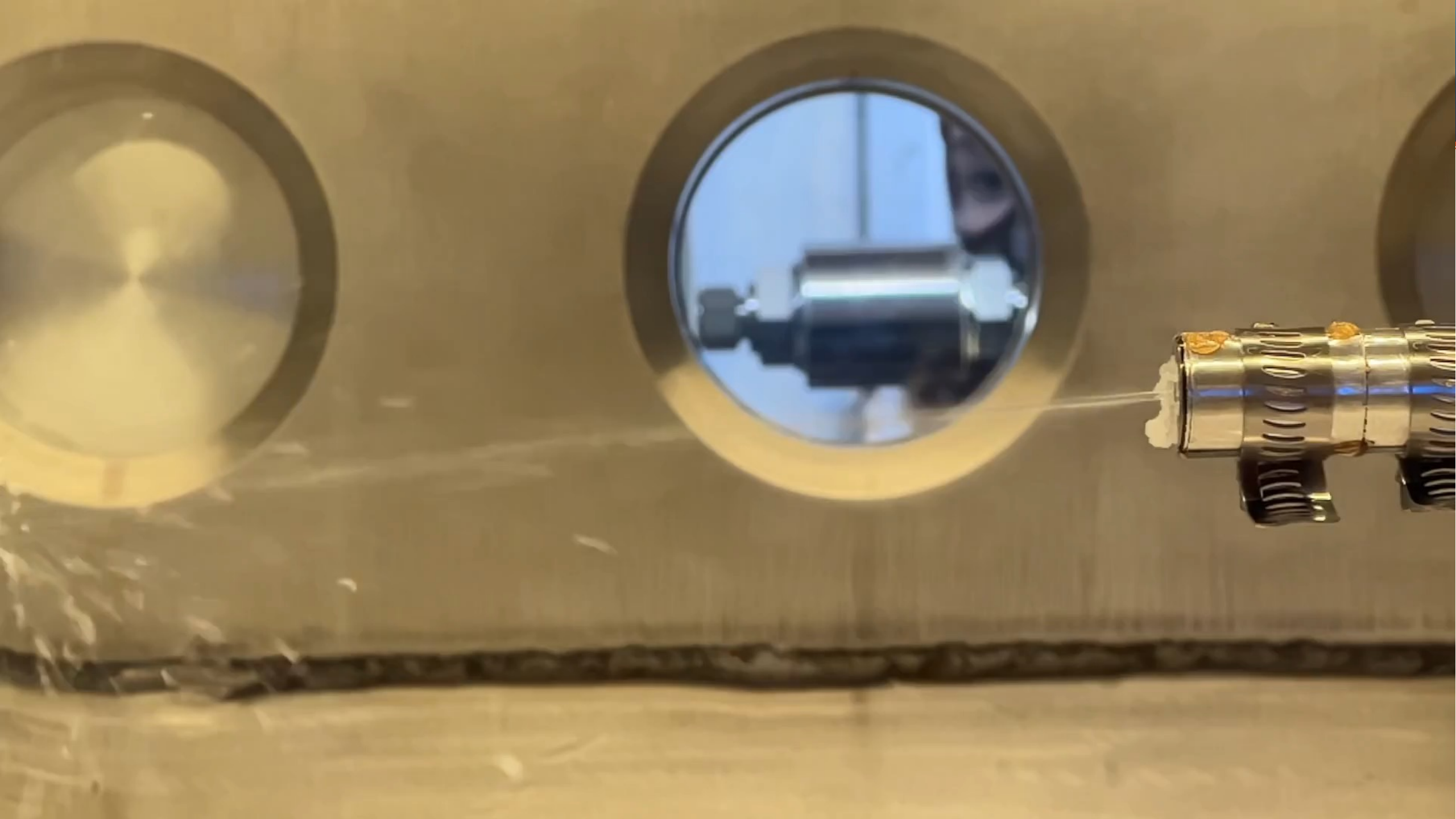
Right: V16 Test Chamber
Chamber is being built up for thermal-vac and rapid ascent/descent testing for a joint-DOD, air-to-air missile program.

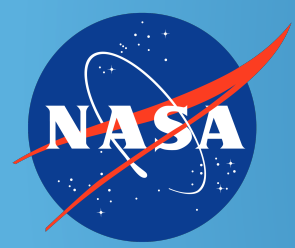


Environmental Test Facility



OUT Test Chamber
'Hodge-podge' facility consisting of an unused vacuum chamber from a canceled program (left) and a thrown-out explosives test chamber turned vacuum chamber (right). Facility has been built up upon request of the Johnson Space Center for testing urine expulsion from the Orion space capsule.

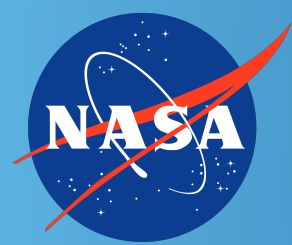




Mars Ascent Vehicle

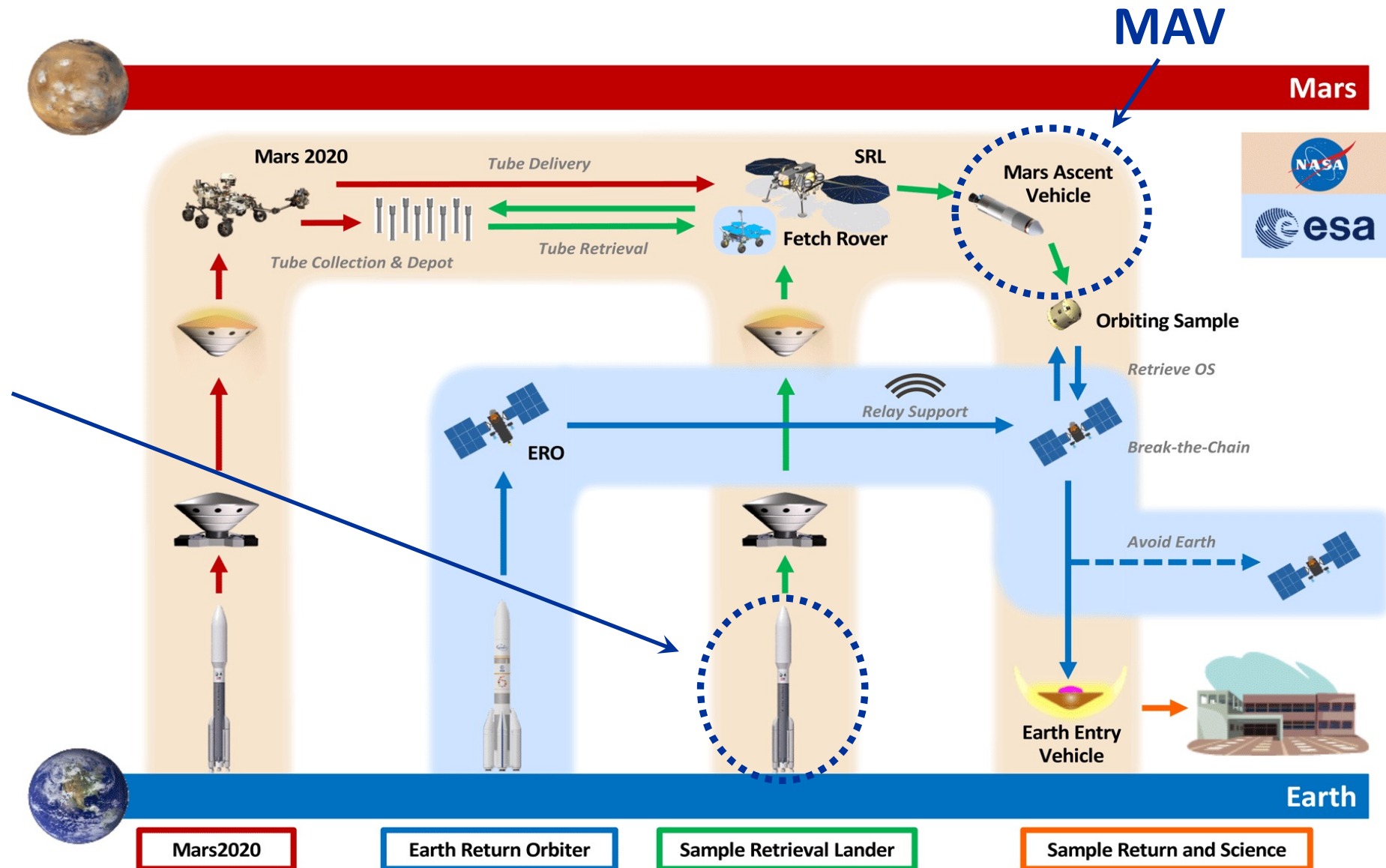


*All images, concepts, and dates contained within are pre-decisional and subject to change.
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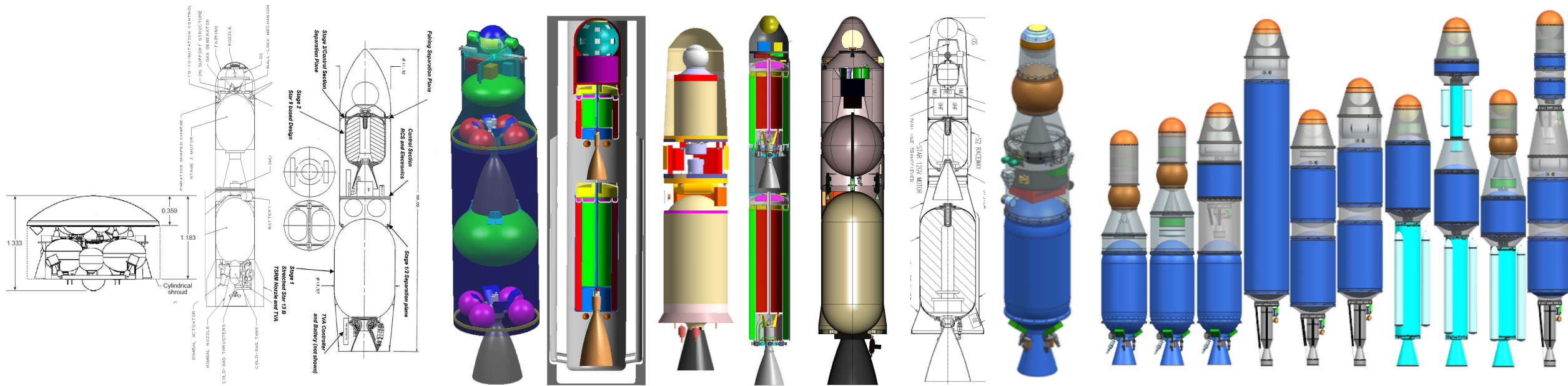
Mars Sample Return Overview

Recently, this has been changed to a dual launch architecture. SFR and MAV will have separate landers.



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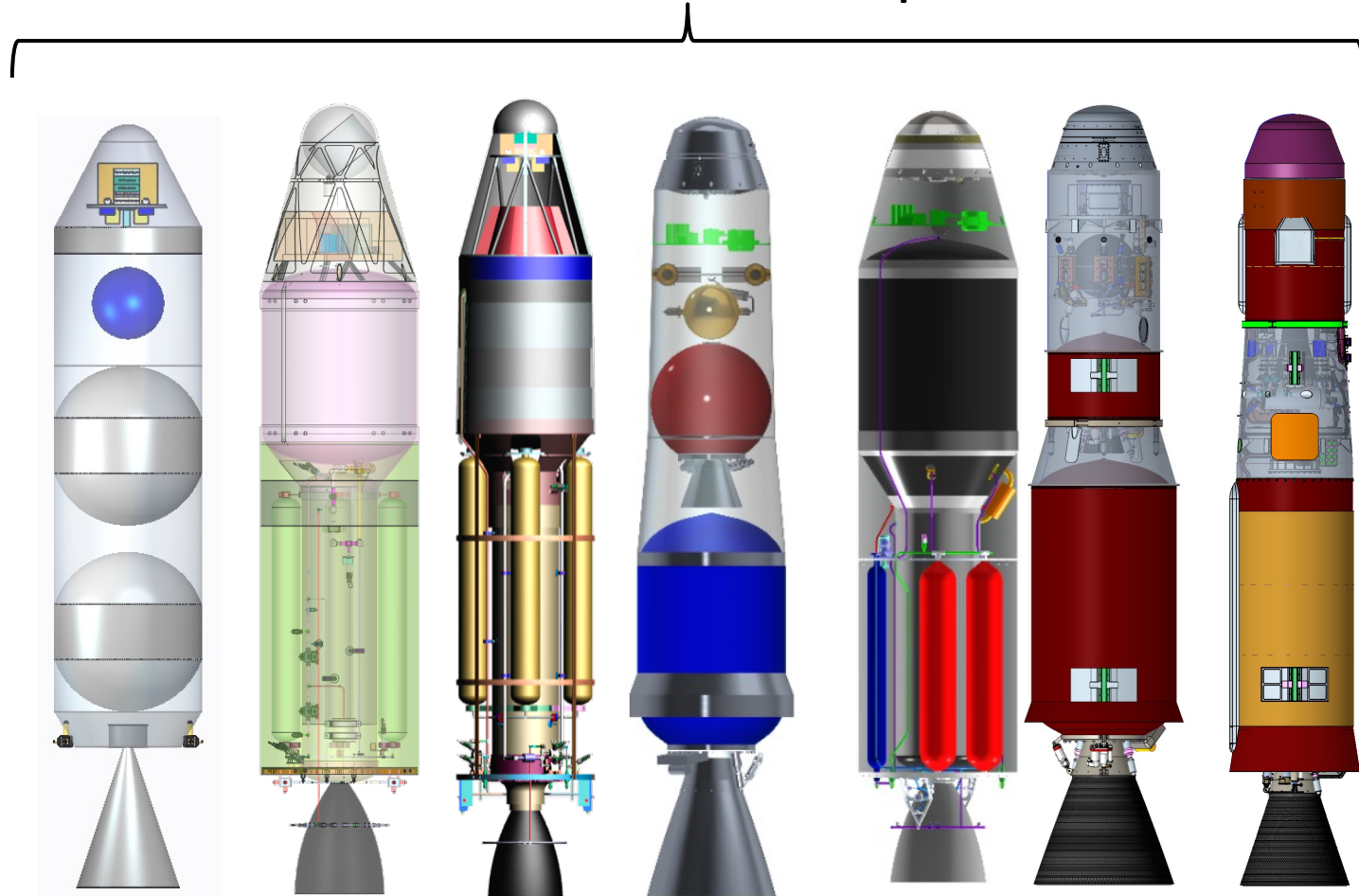
- Preliminary concepts for a Mars Ascent Vehicle were examined to varying levels of configuration and fidelity as far back as the 1970s.



- Current concept has evolved over the past ~25 years with multiple studies, each with independent assumptions on key mission parameters.

- Most MAV concepts developed by JPL up until recent iterations, being developed by MSFC.
- Current MAV study began in 2017 as part of the Mars Sample Return Campaign, initially visualized with a hybrid propulsion system.

MSFC Ownership

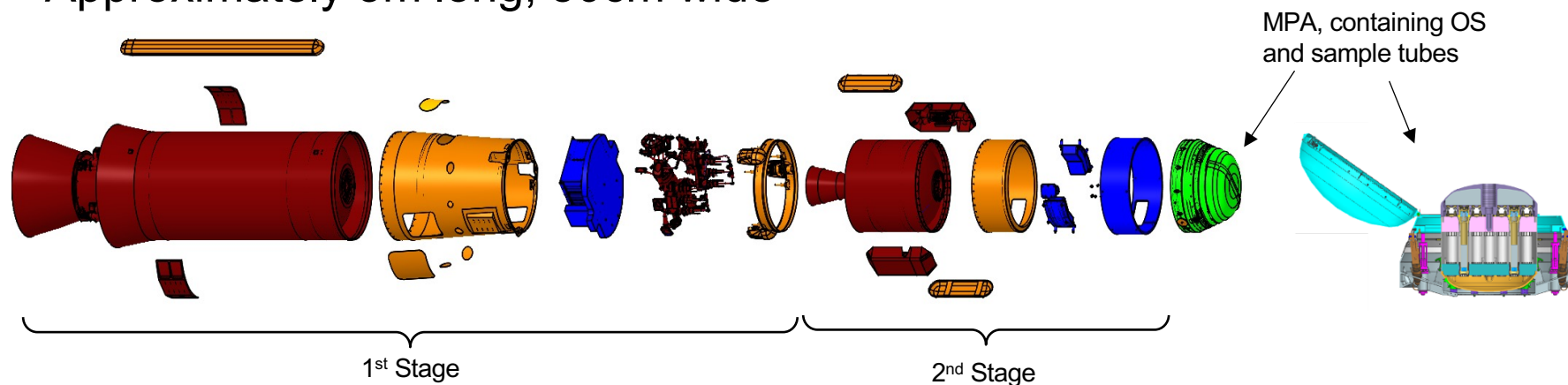
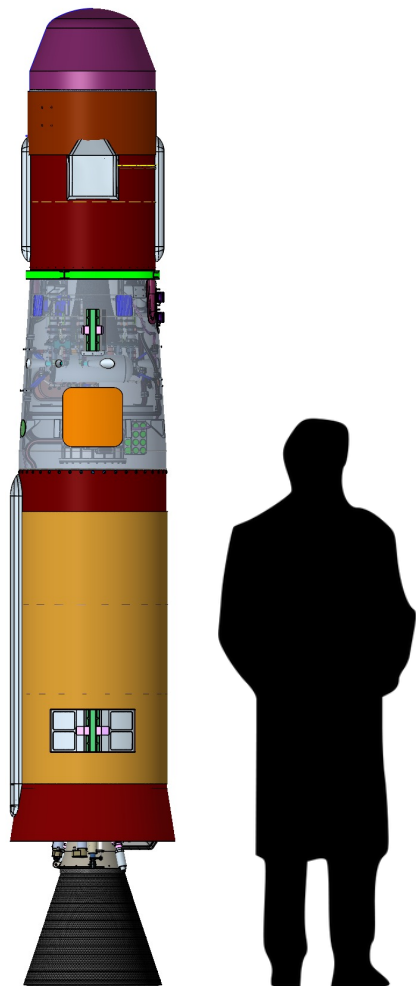


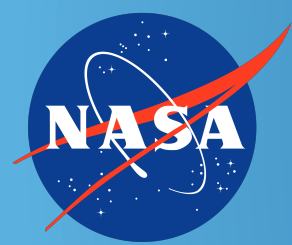
Images not to scale

Current MAV Architecture

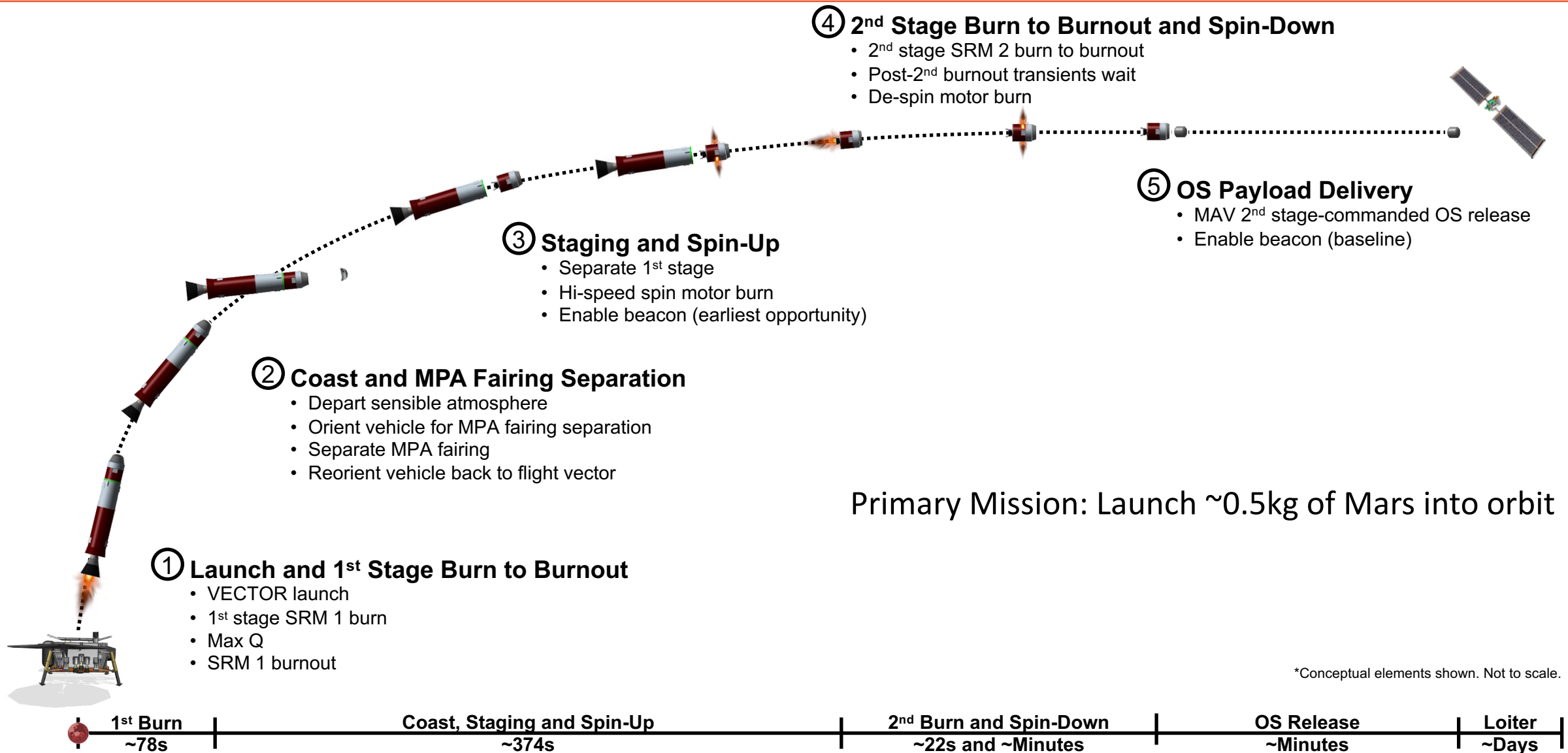
SSGU Mars Ascent System (MAS) consists of:

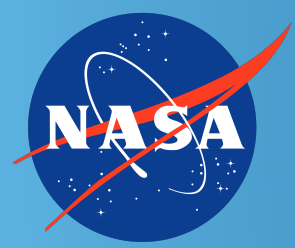
- Mars Ascent Vehicle (MAV)
 - Two-stage (guided, unguided) solid motor vehicle
 - Non-explosive actuator stage separation
 - Electrical-mechanical Thrust Vector Control (TVC) on 1st stage
 - 2x Spin Motors and 2x De-spin motors on 2nd stage, enabling spin stabilization
 - Monopropellant Reaction Control System (RCS)
- MAV Payload Assembly (MPA)
 - Ejectable fairing
 - Orbital Sample (OS)
- Approximately 3m long, 50cm wide





MAV Ascent Mission Overview

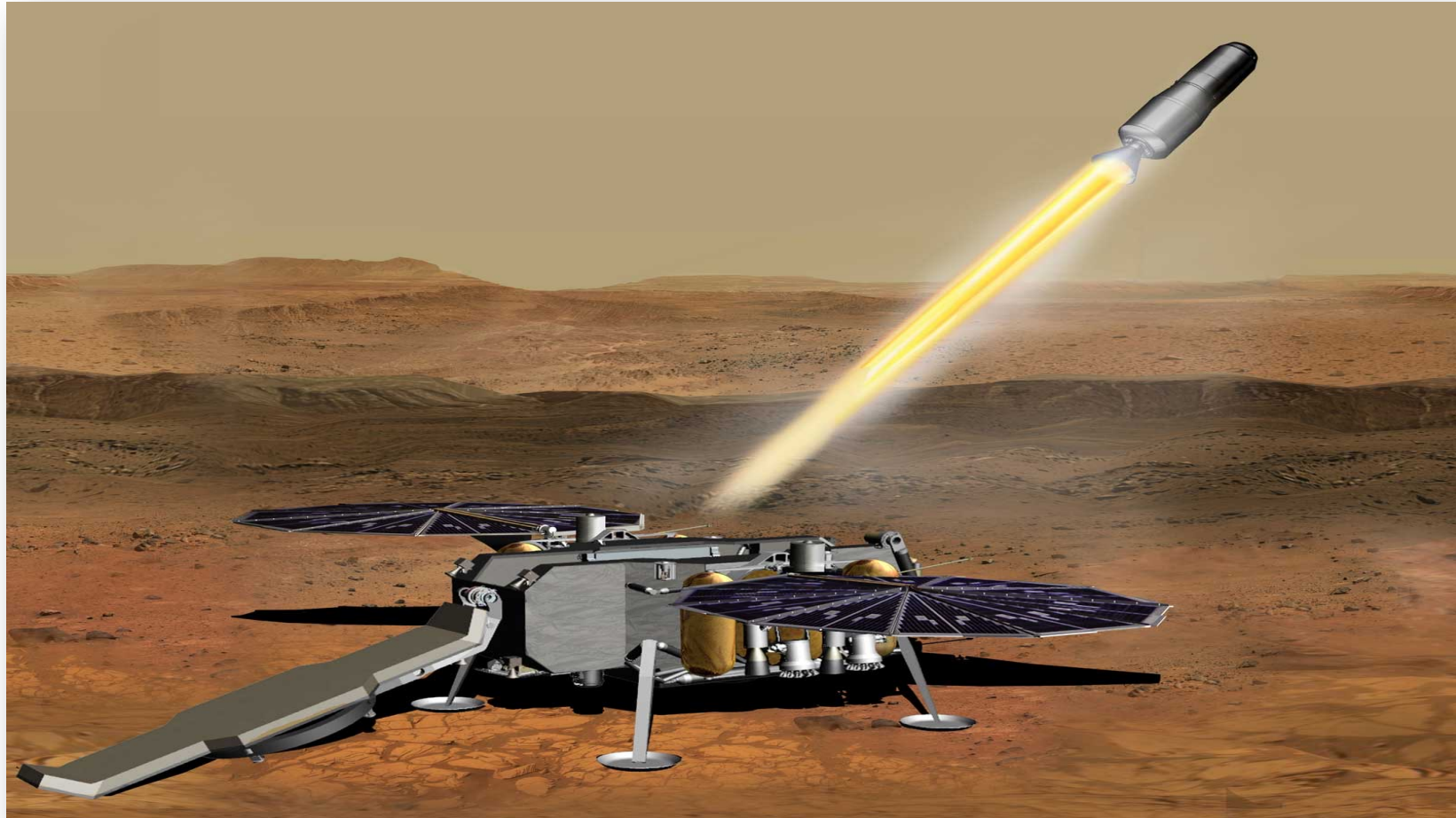




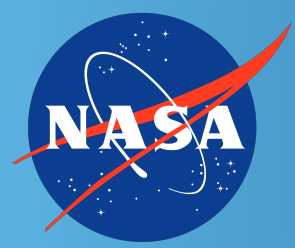
Unique MAV Challenges



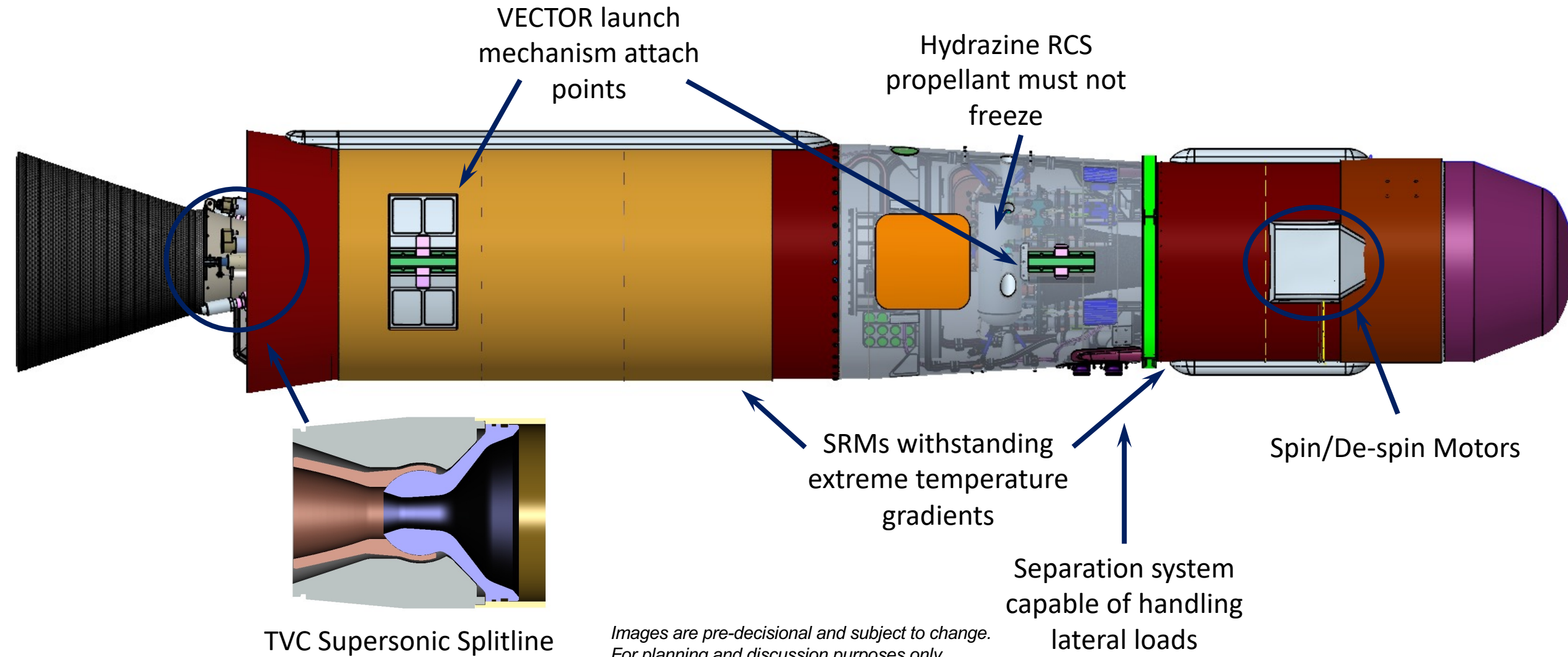
- Never done before
- MAV is a payload before its mission begins
- Orbit window
- Martian environment
 - Remote
 - Temperature
 - Atmosphere
 - Radiation
 - Dust

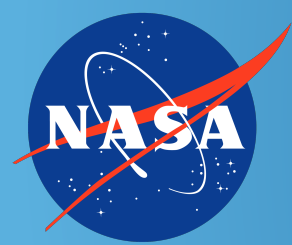


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MAV Overall Design, March 2021



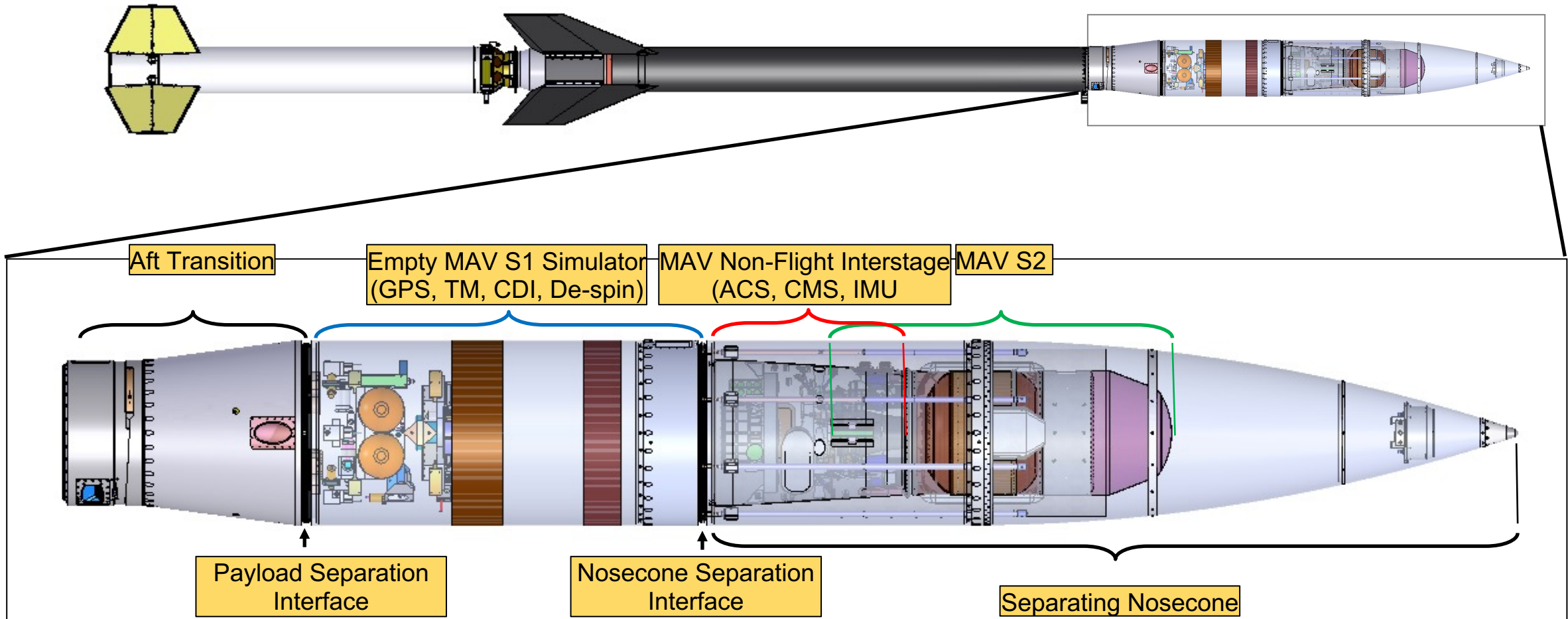


Earth-based Flight Test Scheme

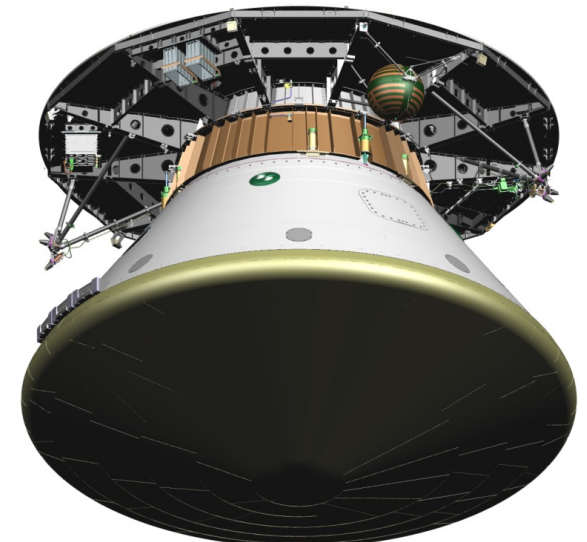
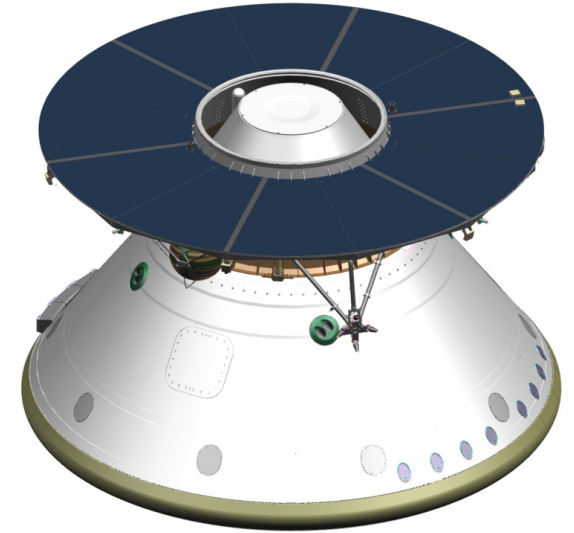
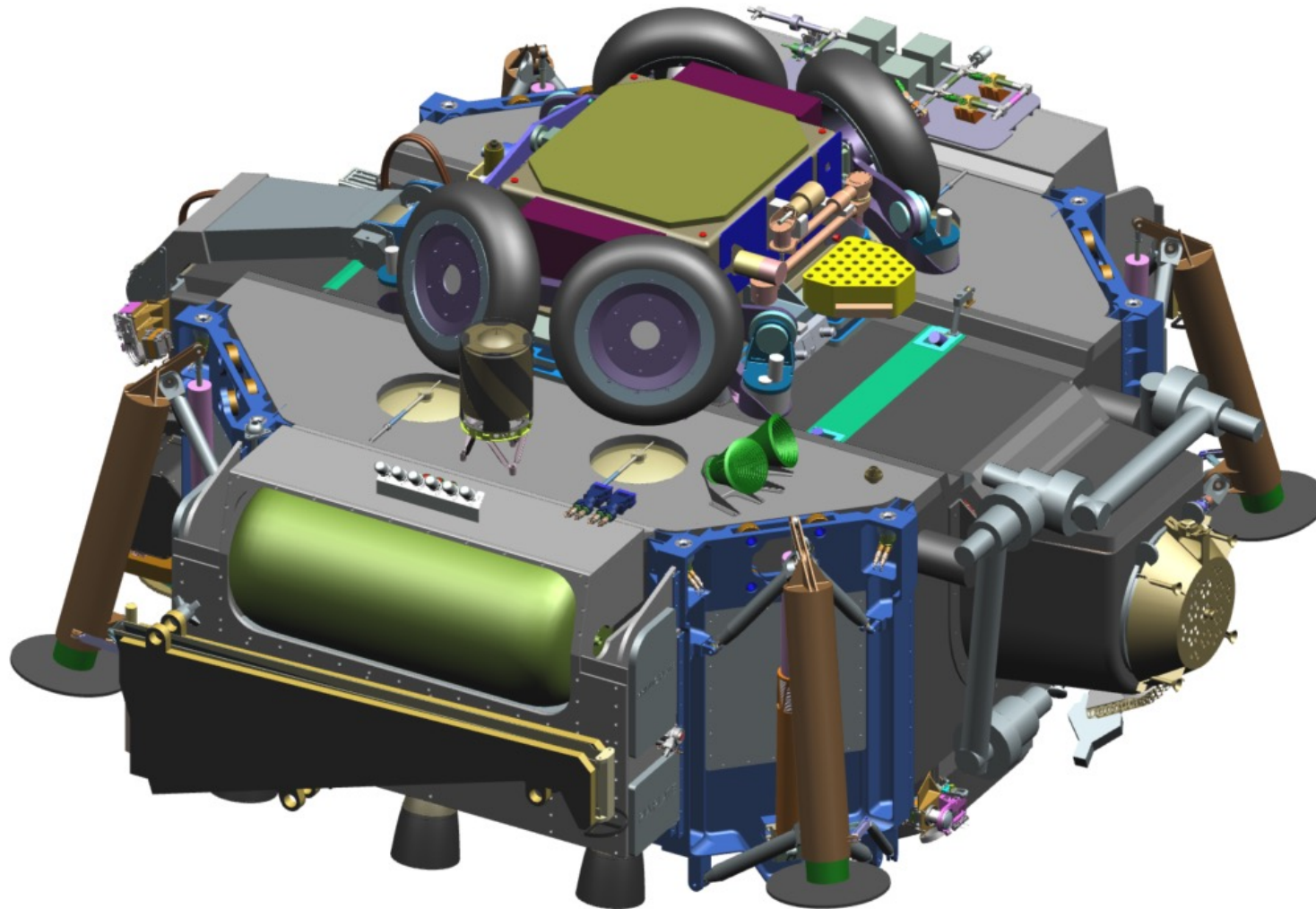
Terrier Mk12

Black Brant IX

MAV Payload

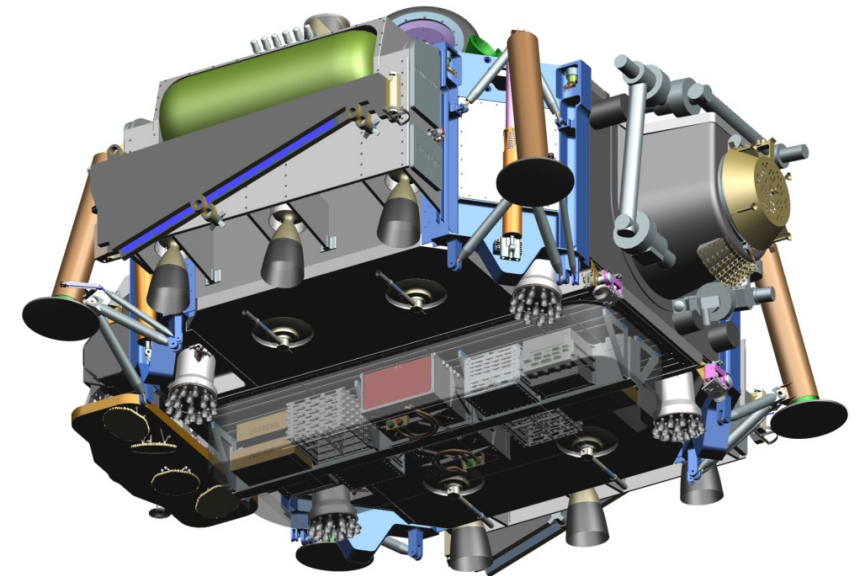
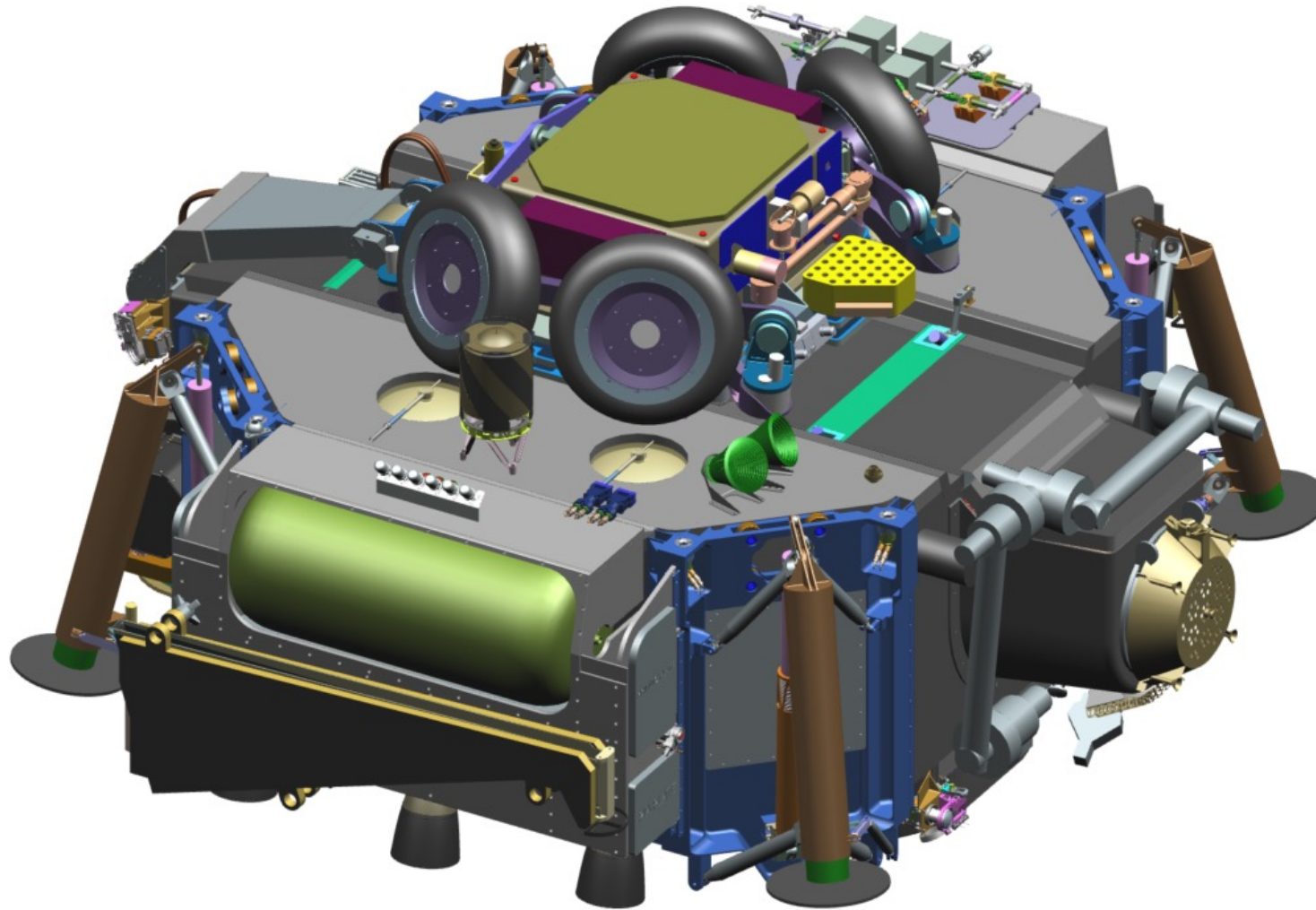


MAV-SRL Spacecraft Interface, Cruise to Mars



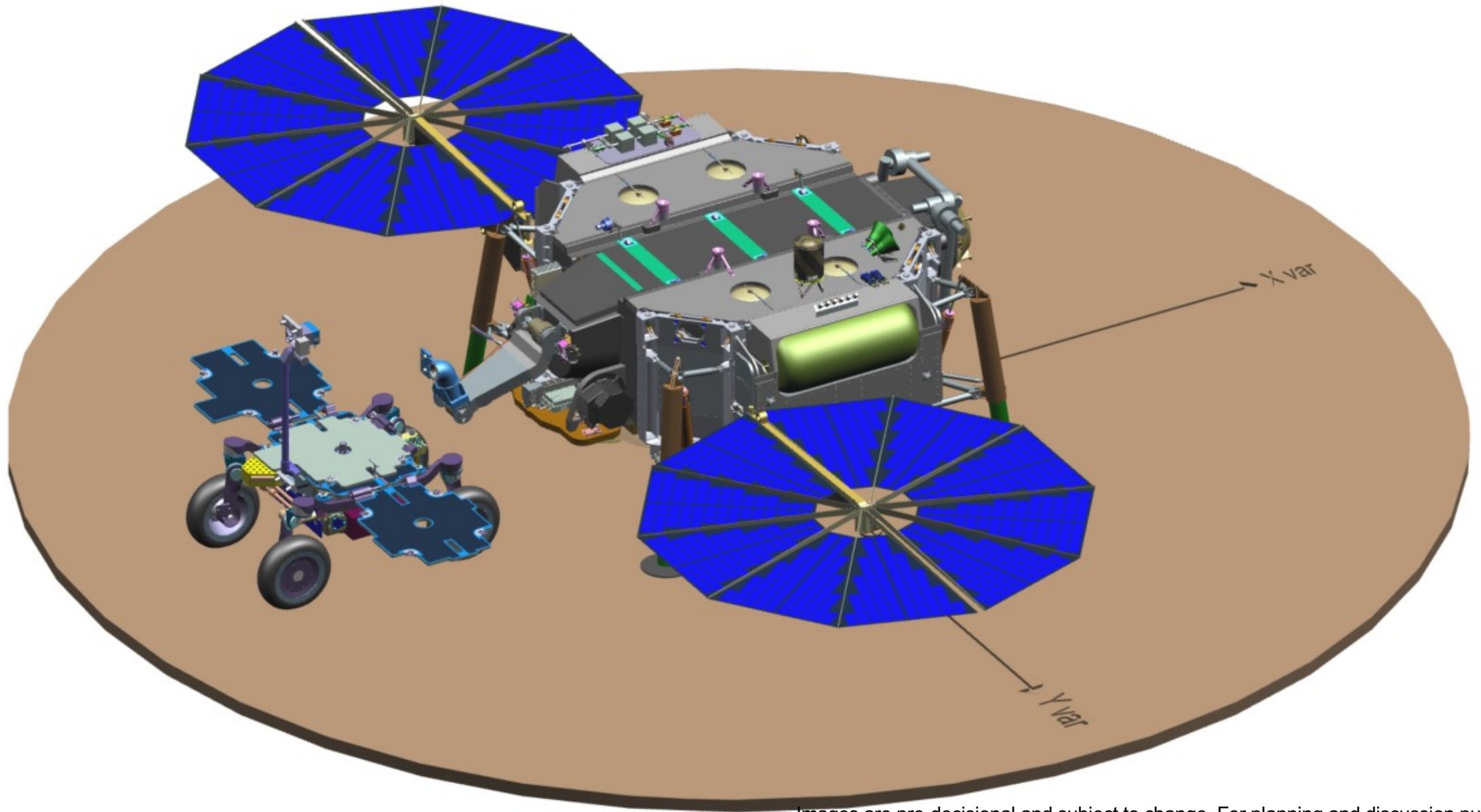
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MAV-MLV Interface, Surface Configuration



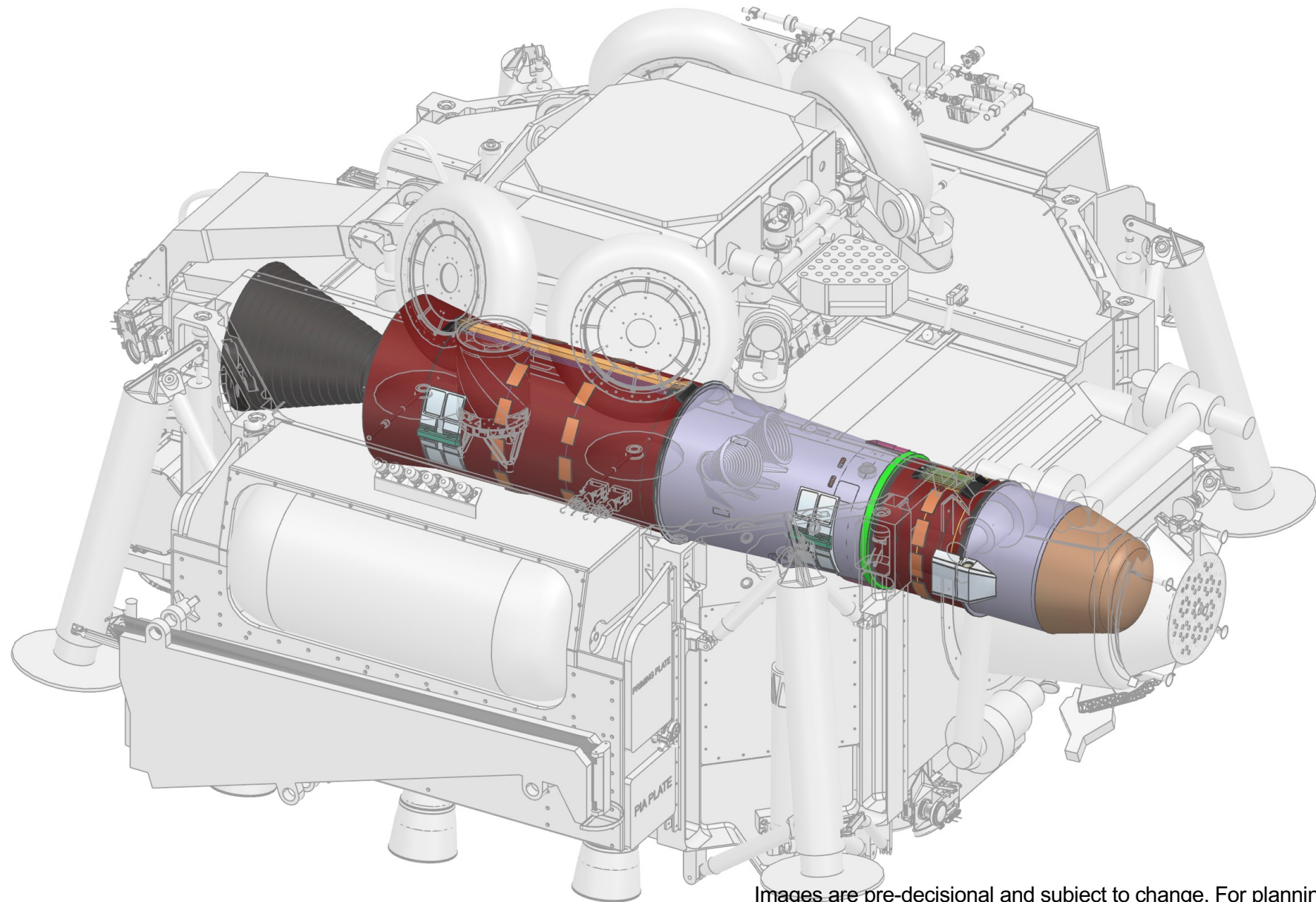
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MAV-MLP Interface, Surface Operations/SFR Egress

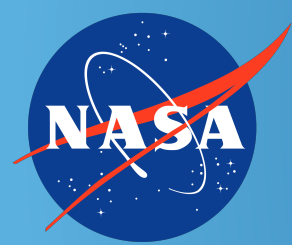


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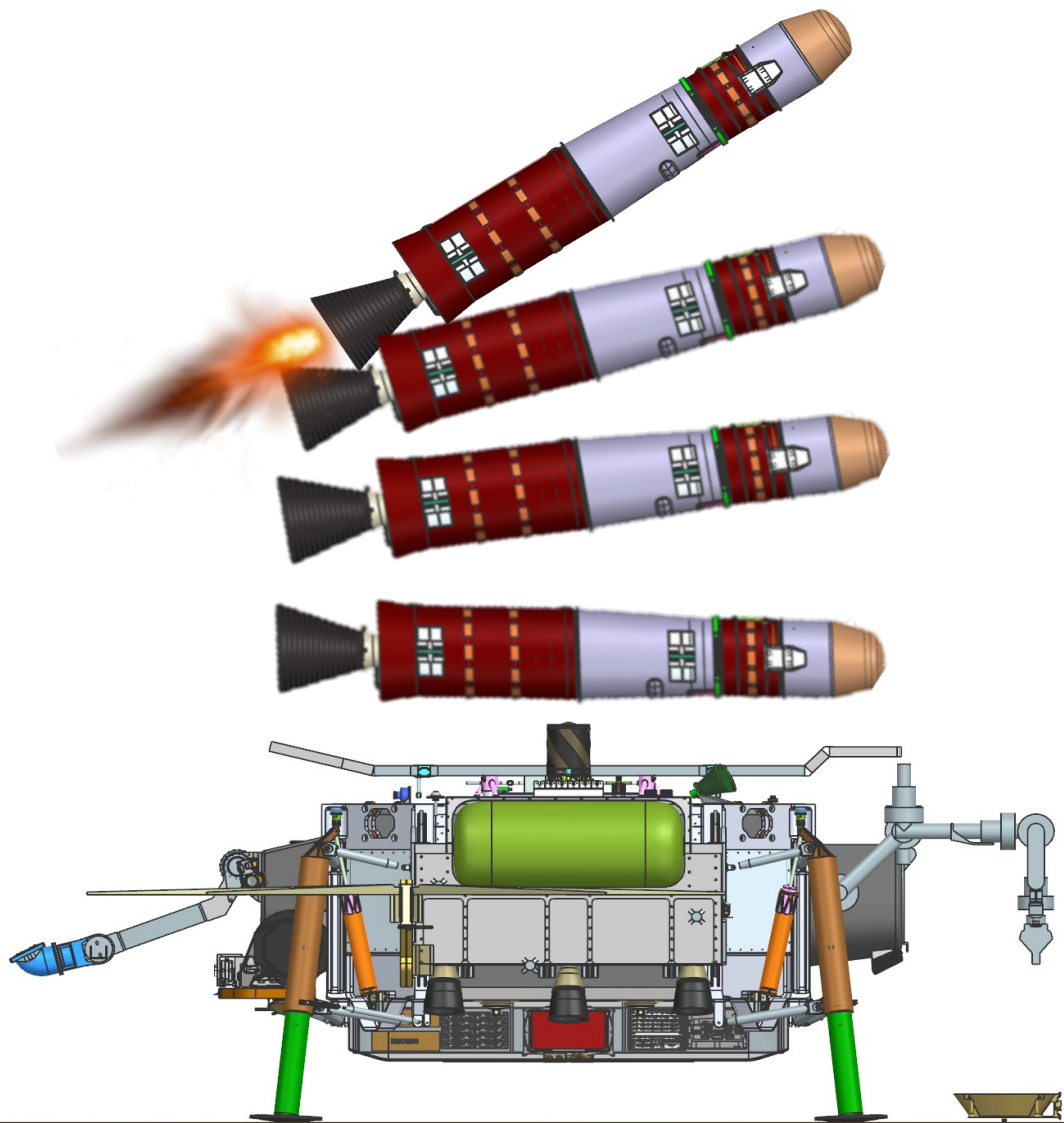
MAV-MLP Interface, Pre-Launch



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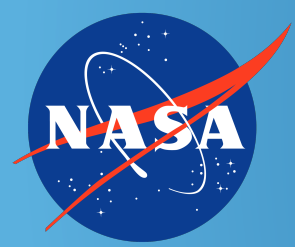


VECTOR Launch Mechanism

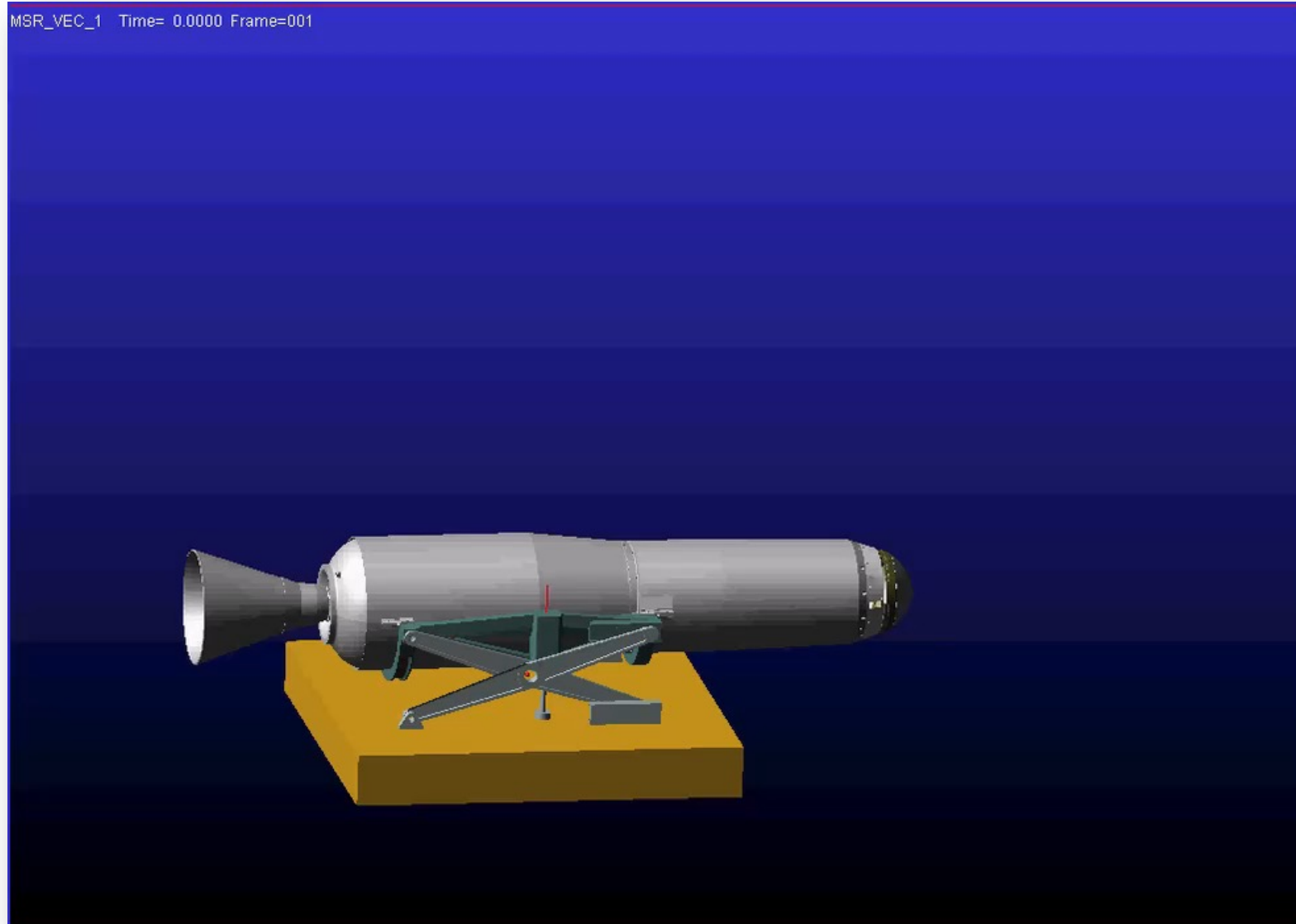


- Launch rail system originally assumed. This presented issues with EDL loads and dust.
- Vertically Ejected, Controlled Tip-Off Rate (VECTOR) adopted to mitigate issues.
- 0.37g accel field, no substantial atmosphere or dynamic environments. Two bodies are similar in mass (2:1).

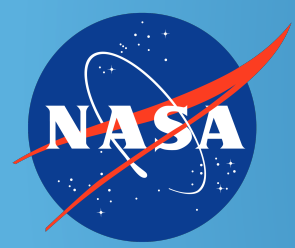
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VECTOR Launch Mechanism



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Looking to the Future...



- ☒ Perseverance, Landed: Feb 2021
- ☐ MAV Flight Test #1: "Soon"
- ☐ MAV Launch, Earth: A dozen or so MCU movies from now
- ☐ MAV Arrival, Mars: 18 months after
- ☐ MAV Launch, Mars: Another year later
- ☐ Martian Samples Returned to Earth:
Next Hohmann Transfer
- ☐ Crewed Mars Mission: Early 2040s?