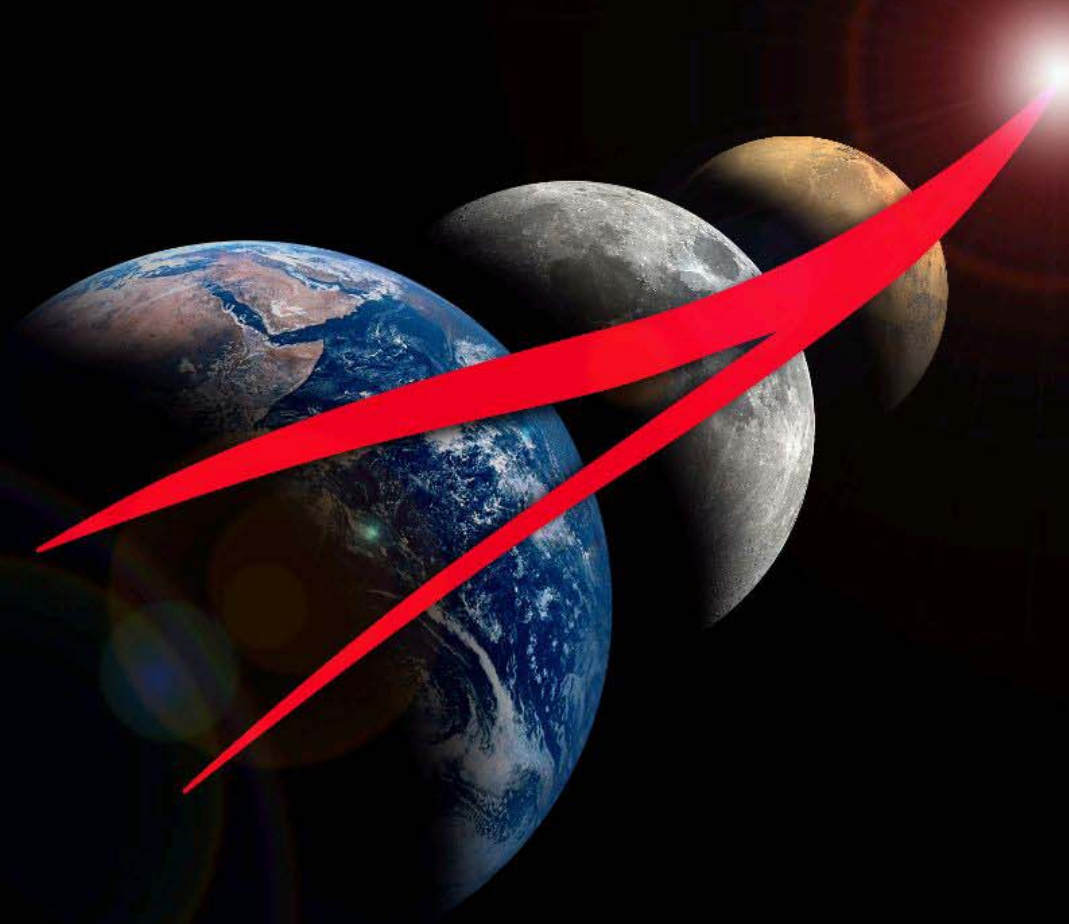
New Employee Orientation
Constellation Program Overview

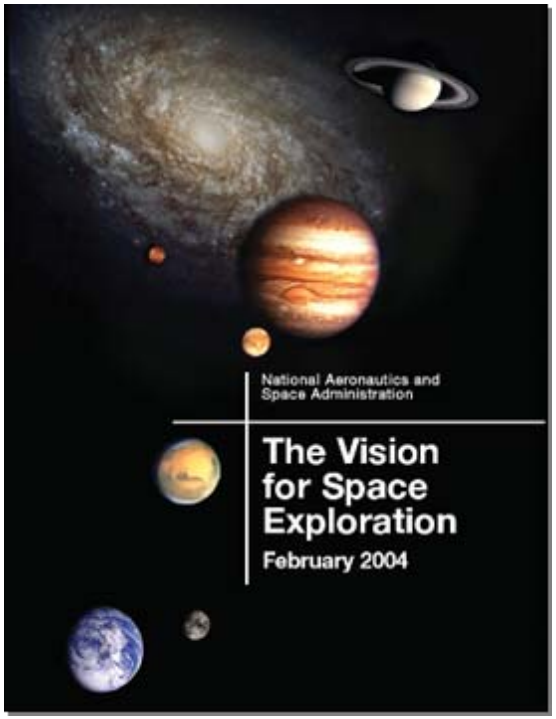
Jeff Hanley
NASA Constellation Program
January 16, 2008

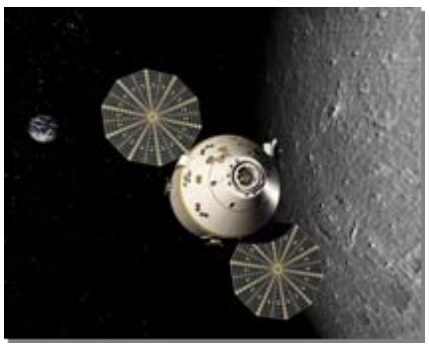


CONSTELLATION

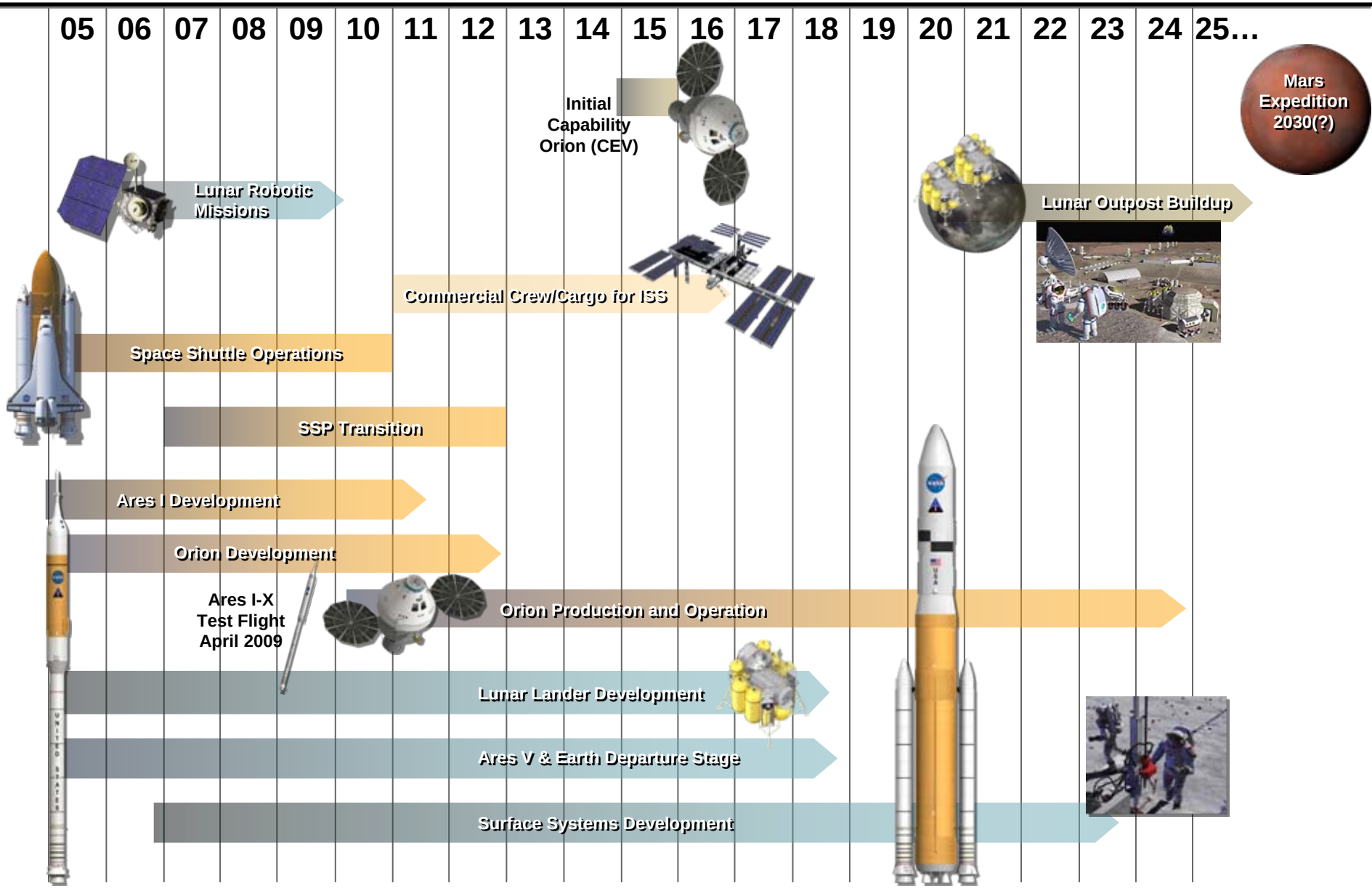
The Vision for Space Exploration: Foundations for Exploration

- Complete the International Space Station
- Safely fly the Space Shuttle until 2010
- Develop & fly the Crew Exploration Vehicle no later than 2014
- Return to the Moon no later than 2020
- Extend human presence across the solar system & beyond
- Implement a sustained & affordable human & robotic program
- Promote international & commercial participation in Exploration





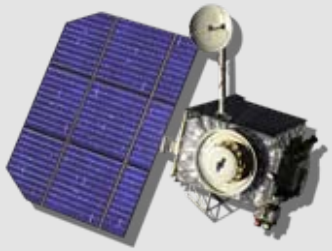
Exploration Roadmap

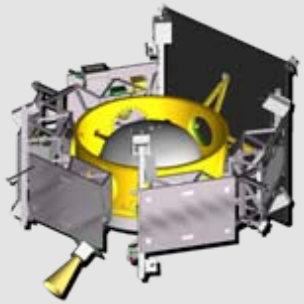


Enabling Exploration

Advanced Capabilities Division (ACD)

Lunar Precursor Robotic Program





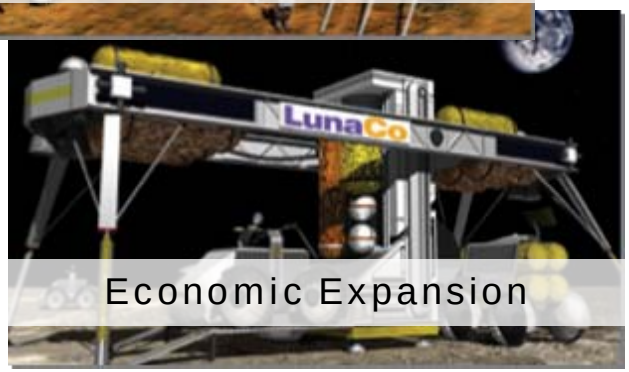
Human Program

Technology Program

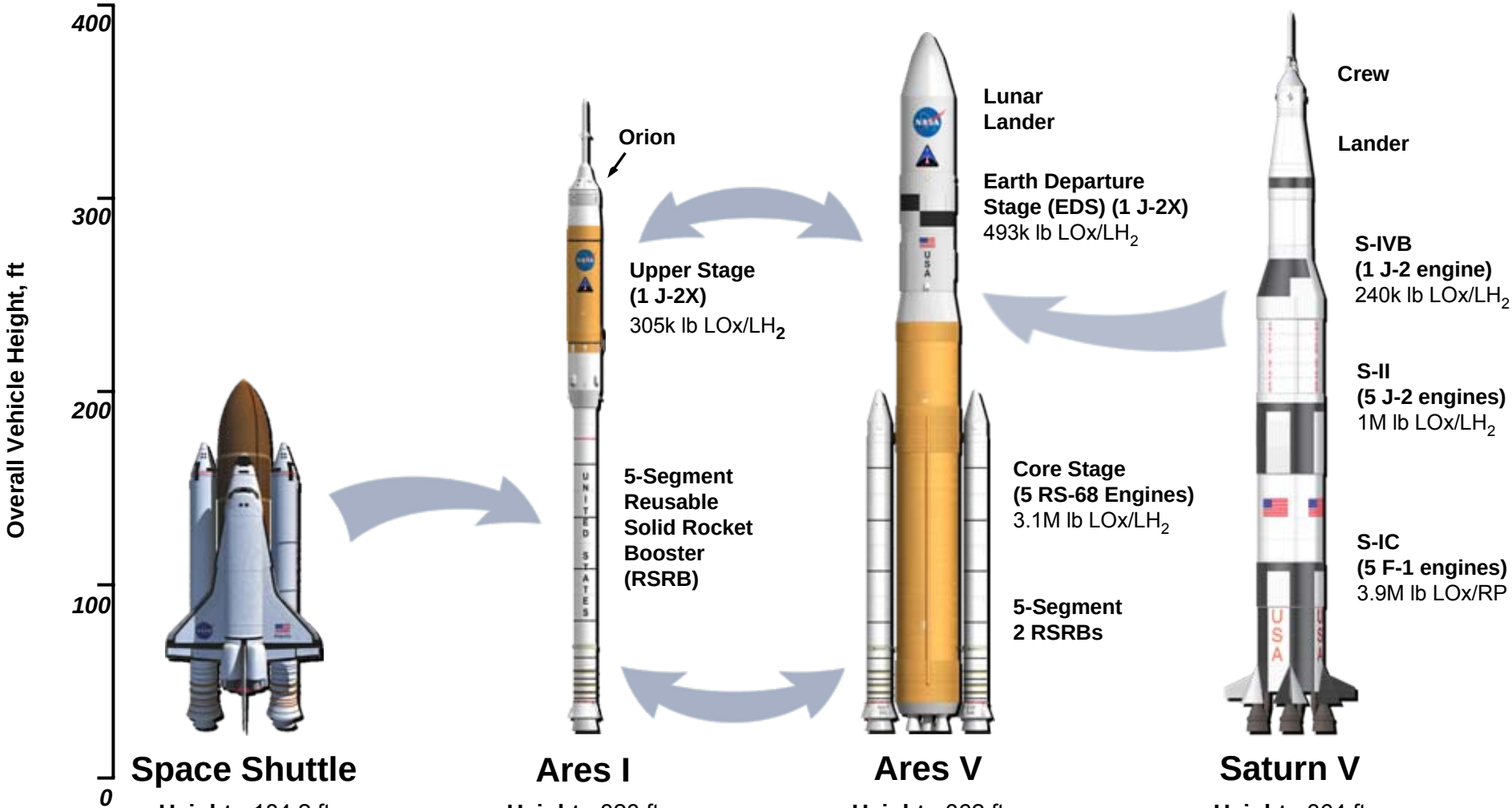
Commercial Crew Cargo Program

Constellation Program

Global Plan: Exploration Strategy



Leveraging Our Space Flight Heritage



Space Shuttle

Height: 184.2 ft
Gross Liftoff Mass: 4.5M lb

55k lbm to LEO

Ares I

Height: 328 ft
Gross Liftoff Mass: 2.0M lb

52k lbm to LEO
(effective)

Ares V

Height: 362 ft
Gross Liftoff Mass: 7.3M lb

133-144k lbm* to TLI in
Dual-Launch Mode with Ares I

Saturn V

Height: 364 ft
Gross Liftoff Mass: 6.5M lb

99k lbm to TLI
262k lbm to LEO

** Note: Depending on length of on-orbit LEO loiter time*

Leveraging Our Infrastructure

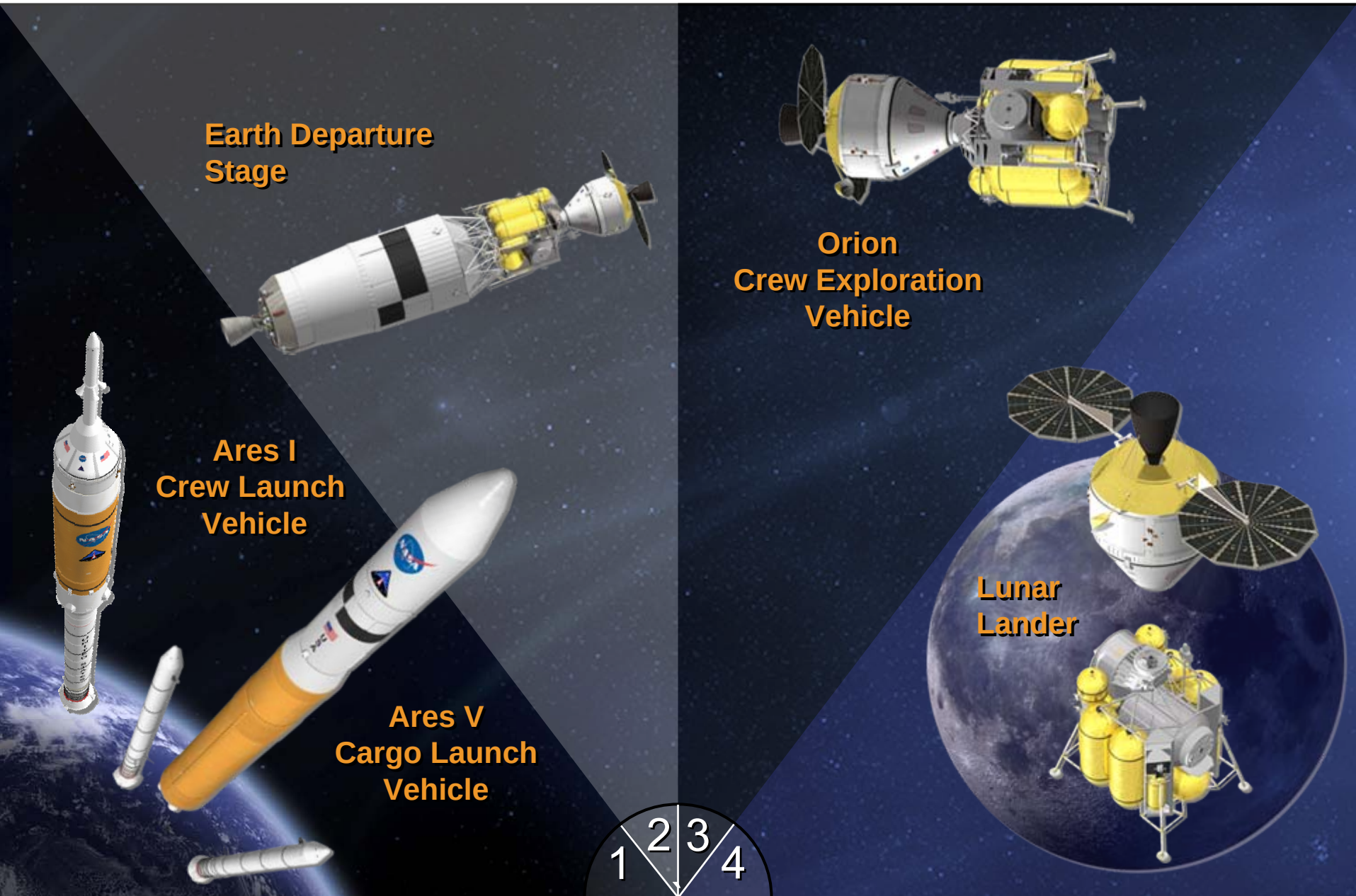
- **KSC / Operations & Checkout Building**
  - Highbay for Orion final assembly

- **SSC / A-1 & A-2 Test Stands**
  - J2-X Power Pack Assembly Installed

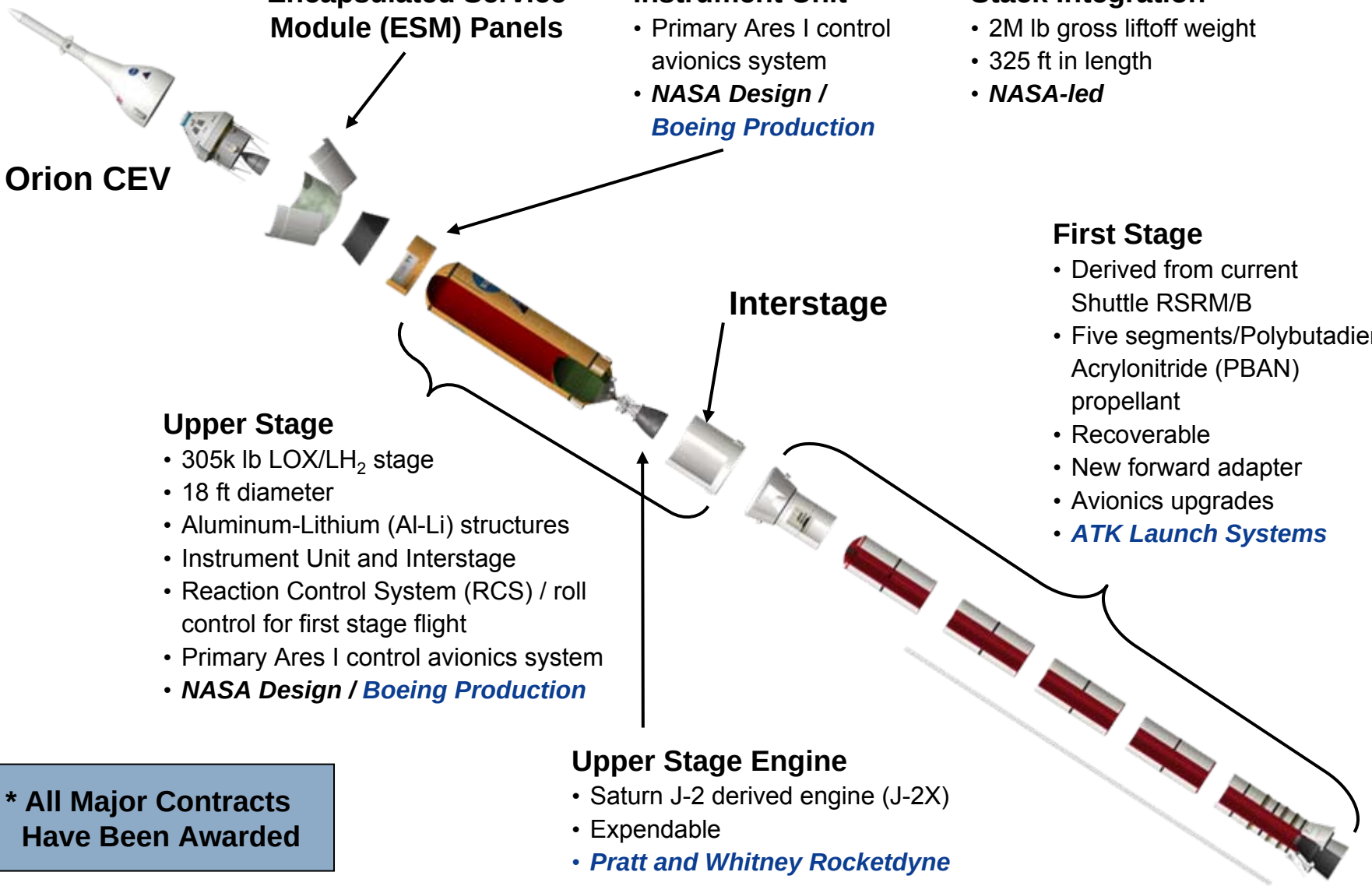
- **KSC / Pad 39B**
  - Launch Pad and Support Facilities
  - Lightning Protection System

- **Michoud Assembly Facility (MAF)**
  - Primary structure manufacturing
  - Composite and metal fabrication
  - Planned Users: Orion, Ares I Upper Stage, Ares V Earth Departure Stage, Ares V Core Stage, COTS

Constellation Program Fleet of Vehicles



Ares I Elements



Encapsulated Service Module (ESM) Panels

Instrument Unit
- Primary Ares I control avionics system
- ***NASA Design / Boeing Production***

Stack Integration
- 2M lb gross liftoff weight
- 325 ft in length
- ***NASA-led***

Interstage

First Stage
- Derived from current Shuttle RSRM/B
- Five segments/Polybutadiene Acrylonitride (PBAN) propellant
- Recoverable
- New forward adapter
- Avionics upgrades
- ***ATK Launch Systems***

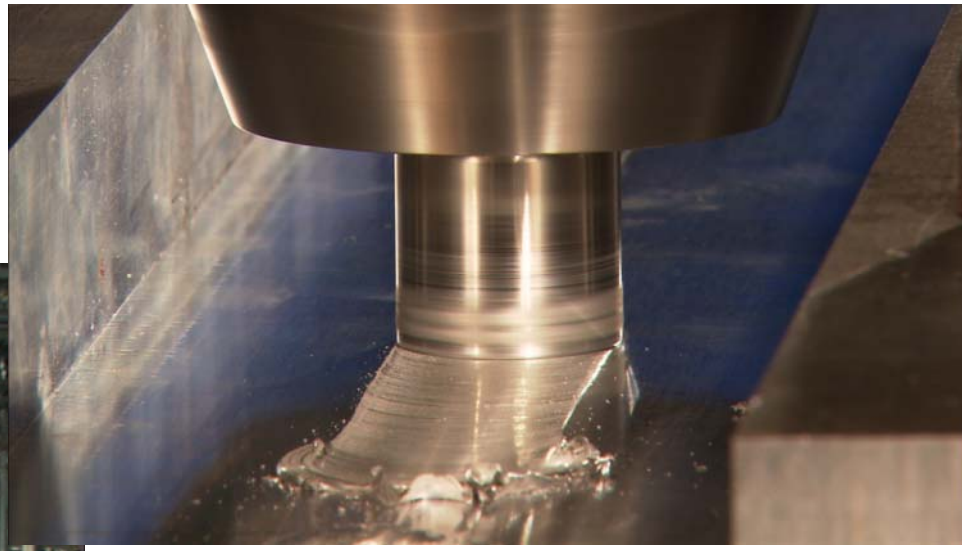
Upper Stage
- 305k lb LOX/LH_2 stage
- 18 ft diameter
- Aluminum-Lithium (Al-Li) structures
- Instrument Unit and Interstage
- Reaction Control System (RCS) / roll control for first stage flight
- Primary Ares I control avionics system
- ***NASA Design / Boeing Production***

Upper Stage Engine
- Saturn J-2 derived engine (J-2X)
- Expendable
- ***Pratt and Whitney Rocketdyne***

*** All Major Contracts Have Been Awarded**

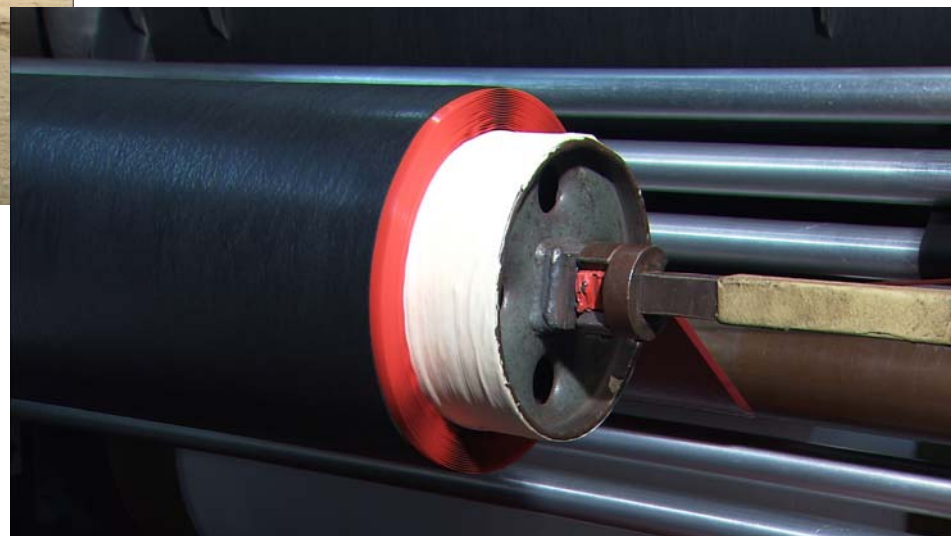
Ares Activities

Friction Stir Welding22



Injector Tests

New SRB Insulation



Ares I 1st Stage Components in Progress

Nose Inlet Billet

Forward Exit Cone

Forward End Ring

Nose Inlet Housing

Aluminum Ingots

Throat Housing

Ares 1-X Flight Test

Launch Date

April 15, 2009

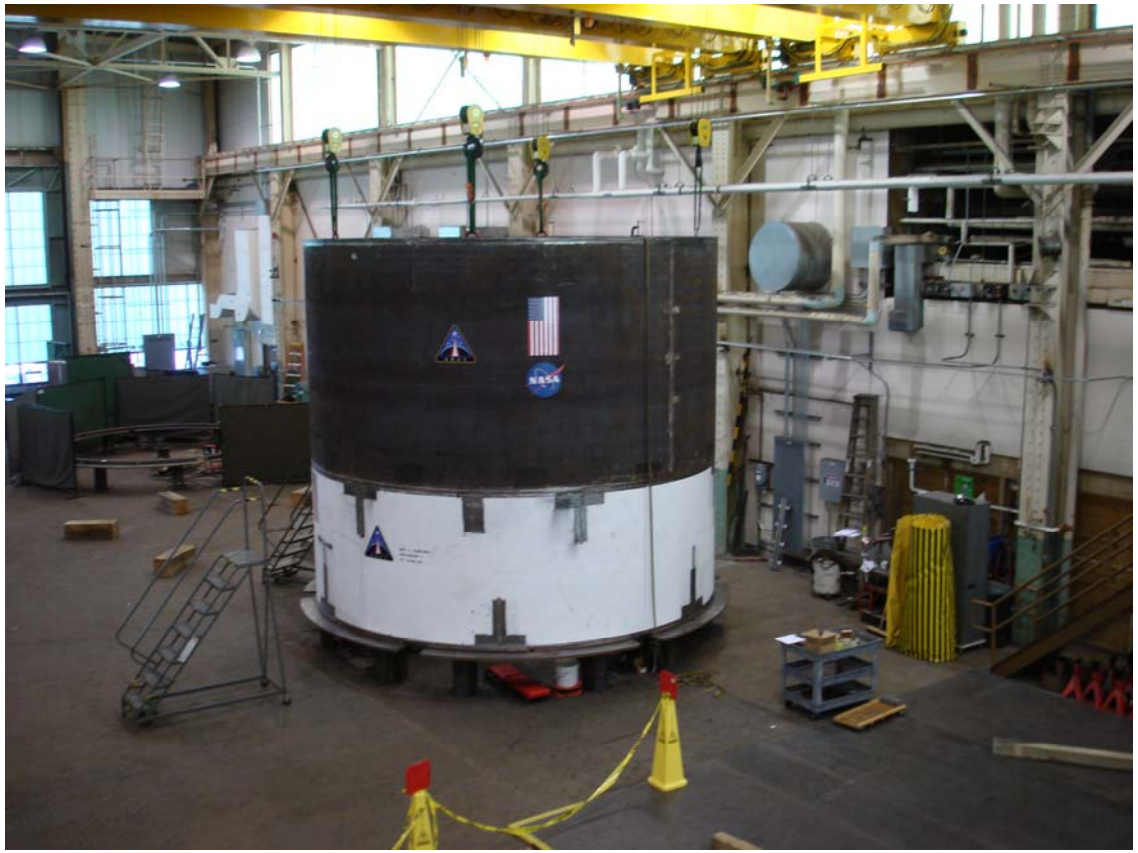
- Primary Flight Test Objectives
  - Demonstrate control of a dynamically similar, integrated CLV/CEV, using CLV ascent control algorithms.
  - Perform an in-flight separation/staging event between a CLV-similar First Stage and a representative Upper Stage.
  - Demonstrate assembly and recovery of a new CLV-like First Stage element at KSC.
  - Demonstrate First Stage separation sequencing, and quantify First Stage atmospheric entry dynamics, and parachute performance.
  - Characterize magnitude of integrated vehicle roll torque throughout First Stage flight.

Flight Test System

- Booster (4 Segment RSRM First Stage)
- Upper Stage Simulator (USS)
- Command Module/Launch Abort System (CM/LAS) Simulator
- Roll Control System (RoCS)
- Avionics
- Ground Systems (LP 39B, MLP, VAB)

Ares 1-X USS Pathfinder-1/2 Stacked Configuration

Stacking Accomplished 30-Jun-07



Orion Elements

Orion Crew Exploration vehicle (JSC)

- ***NASA Management and Integration***
- Prime contract Lockheed Martin:design , development, and production

Crew Module (JSC)

- Crew and cargo transport
- Under Prime contract

Launch Abort System (LaRC)

- Emergency escape during launch
- Under Prime contract

Spacecraft Adapter (GRC)

- Structural transition to Ares launch vehicle
- Under Prime contract

Service Module (GRC)

- propulsion, electrical power, fluids storage
- Under Prime contract

Test Abort Booster (DRC)

- Procured through USAF contract
- In-house design

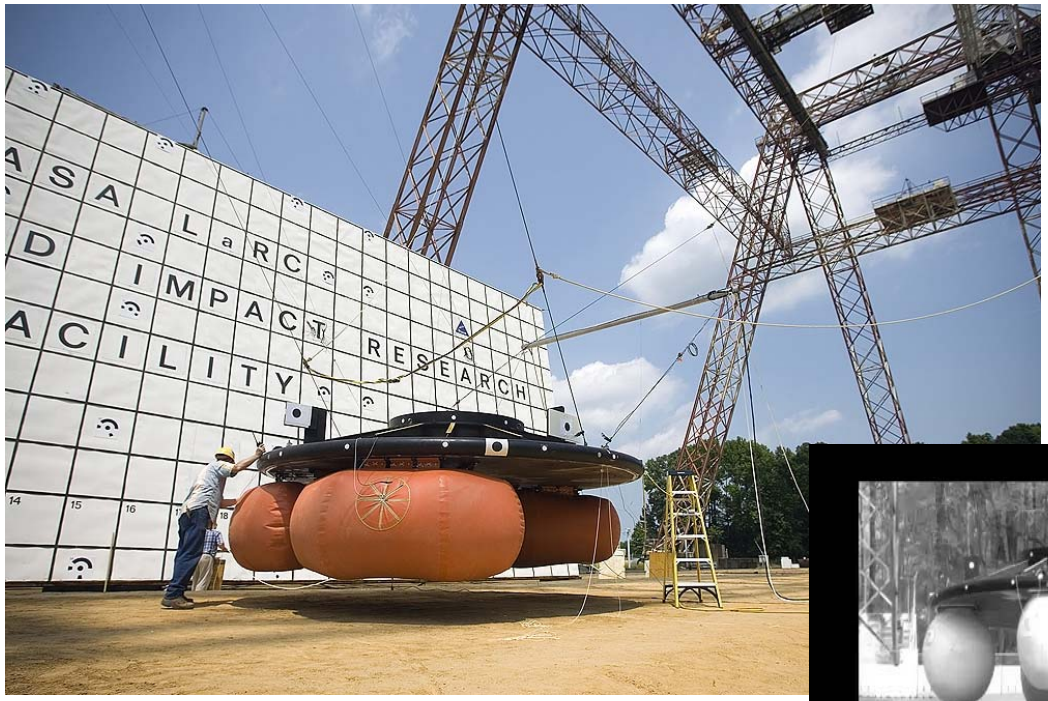
Orion Activities

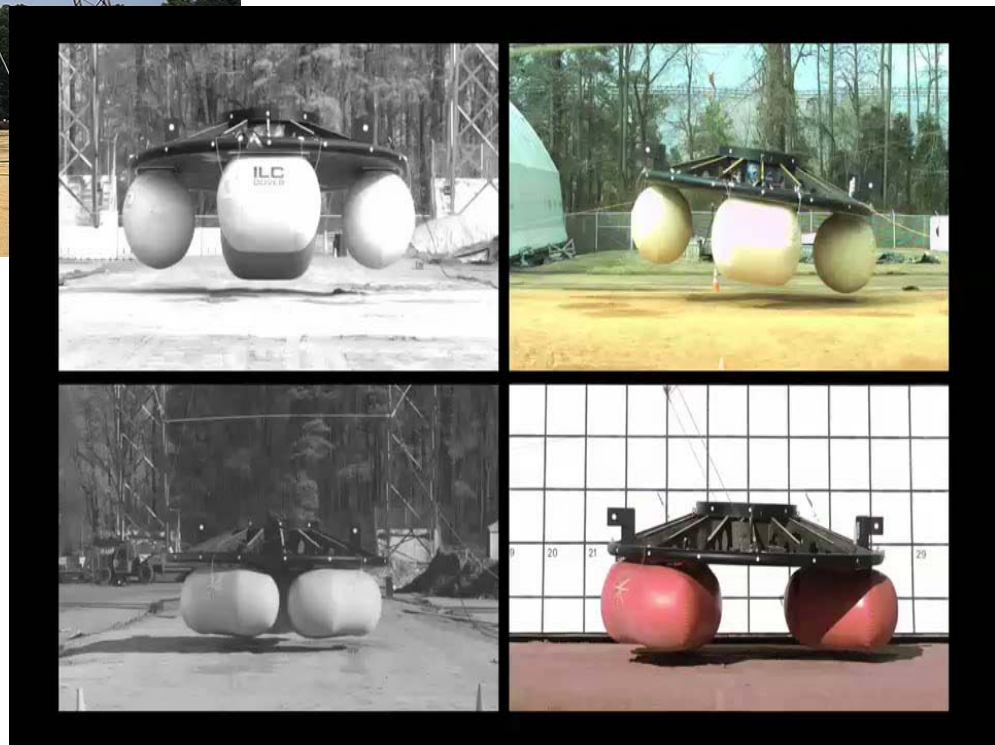
Ames Unitary Wind Tunnel test of the Orion Launch Abort system model

1/4 scale reverse thrust motor firing for LAS testing

Orion Landing System Tests

NASA Langley's Landing and Impact Research Facility





Project Summaries
Ground Operations

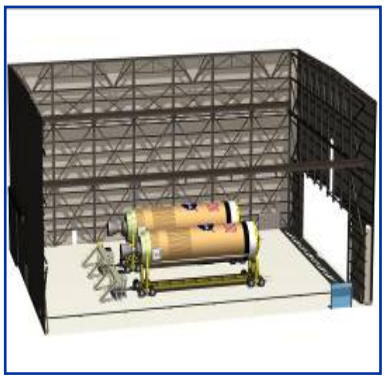
Ares I-X
- **Contract support from SPOC**
- **Mods to PAD 39B, MLP, LCC**

Infrastructure Mods
- **Construction IDIQ contracts to be awarded**

Ground Support Equipment
- **Possible multiple IDIQ contracts**

Spacecraft Standalone Processing

Launch Vehicle Standalone Processing



- **RFI issued for Industry comment – 2/08/07**
- **Industry Day - pending**

Integrated Operations & Launch Processing

Project Summaries
Mission Operations

Mission Control Center System
- Evolution of existing multi-program capability
- Use of existing Mission Systems Operation Contract (Lockheed Martin) through FY11

Constellation Reconfiguration System
- New Production System Development

Constellation Training Facility
- New Training Simulator Development
- Acquisition Strategy in formulation for 07/08 timeframe

Neutral Buoyancy Lab and Space Vehicle Mockup Facility
- Shared use with ISS, limited unique Constellation development
- Use of existing NBL and SVMF Operations Contract (Raytheon) through FY11

Plan, Train, Fly
- Transition selected elements of Shuttle operations workforce
- Use of SPOC Contracts (USA) through FY10
- Future Competitive Operations Contract by FY10

Project Summaries
"Altair" Lunar Lander

Representative design

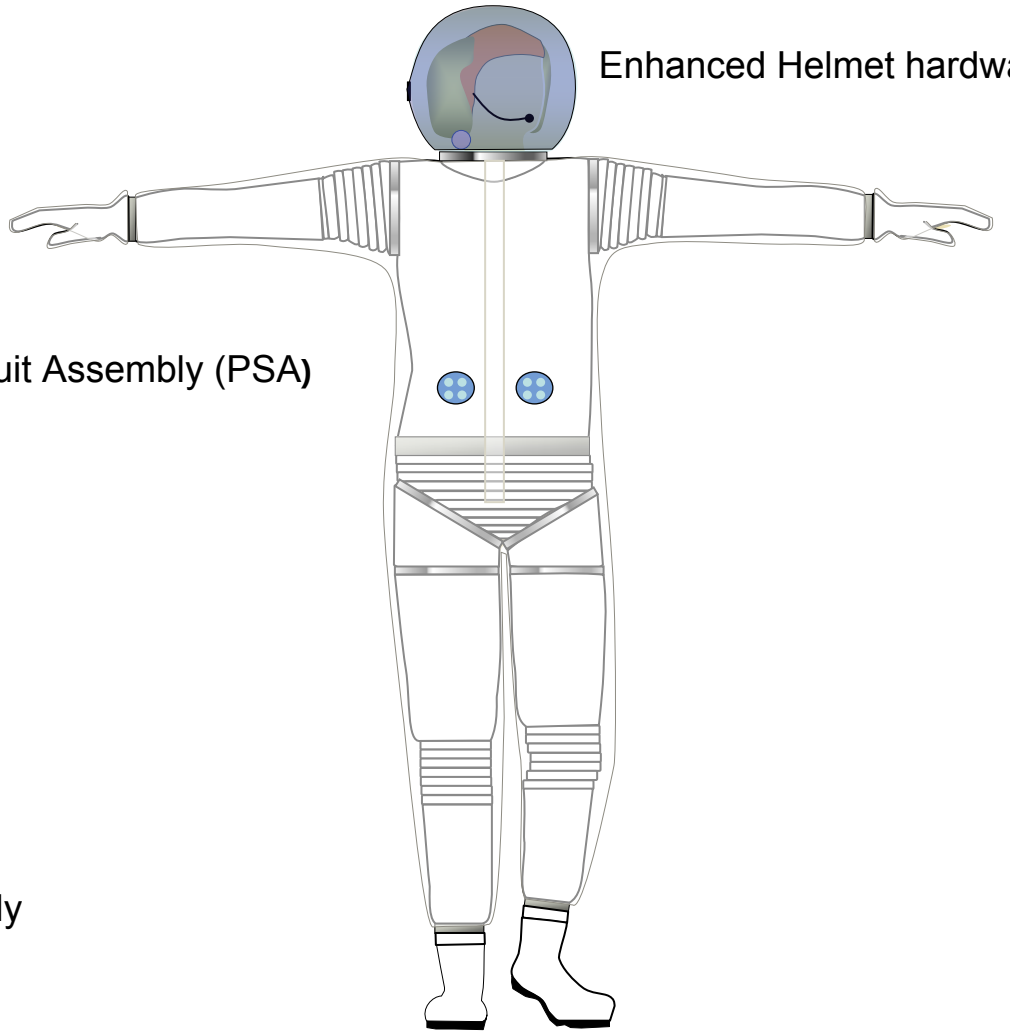
Ascent Module

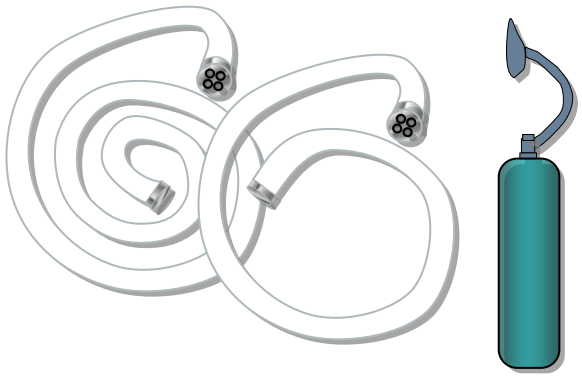
Descent Module

Project Summaries
EVA

Space Suit System

- **Draft RFP 6/07**
- **Final RFP 9/07**
- **Contract Award 3/08**





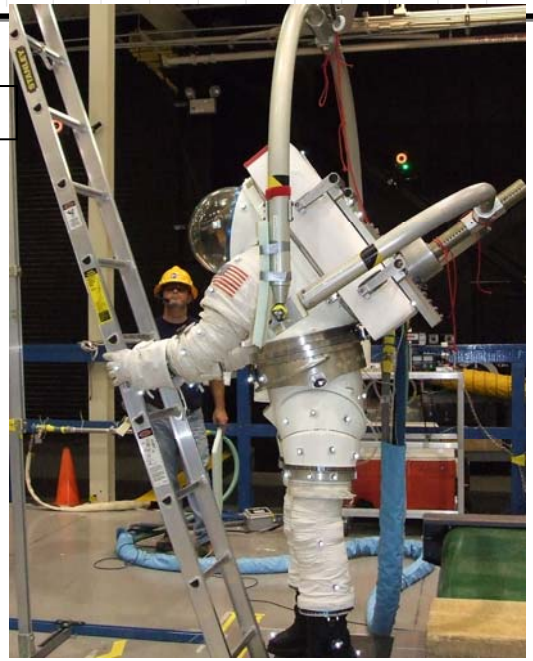
Umbilicals & Secondary Oxygen Supply
(SOP/Emergency O2)

EVA Project – Design Evaluations

1

1. I-Suit test on DC-9
2. Mark III ladder test
3. Suit-seat test
4. I-Suit though LIDS tunnel

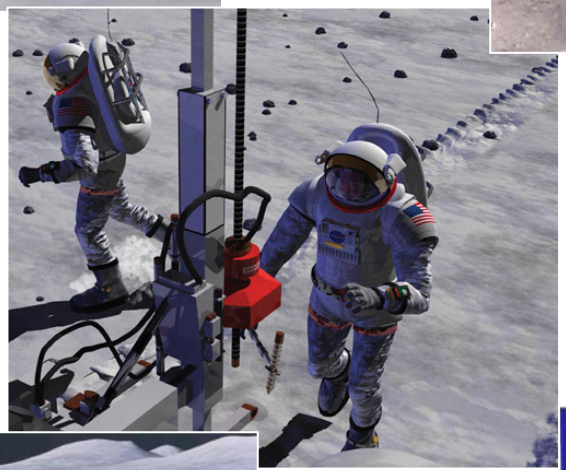
2

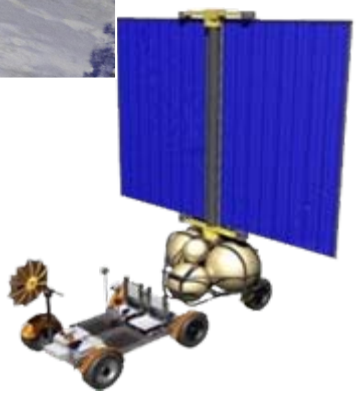


4

3

Project Summaries
Surface Systems

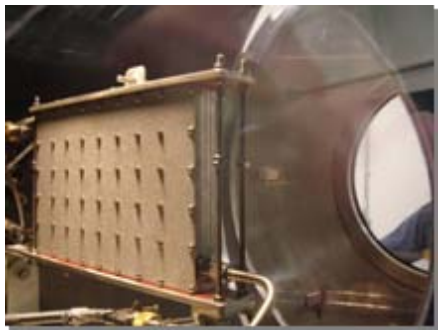




Technology Development for Orion

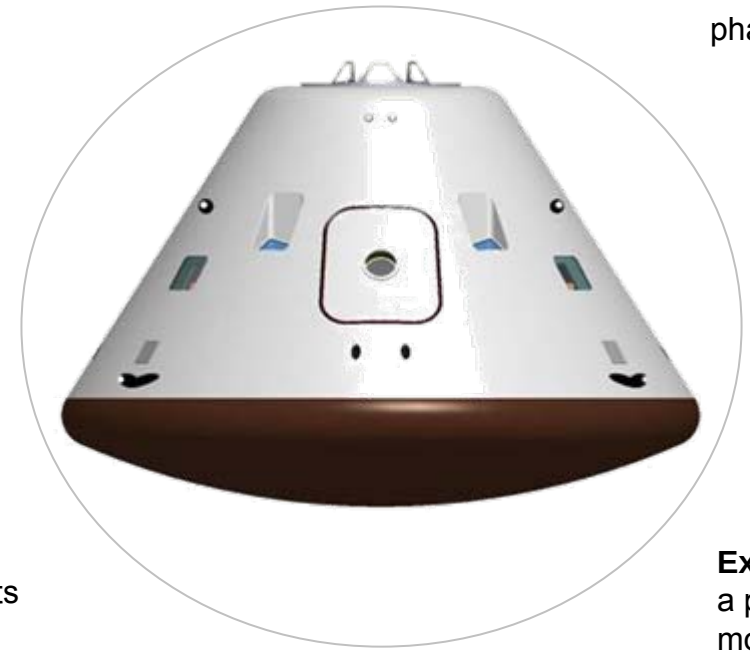
AR&D Sensors: Characterizing optical and laser sensors that measure the range and orientation of a target vehicle during autonomous rendezvous and docking.

Structures & Materials: Developing lightweight, high-strength parachute materials.



Thermal Control: Developing prototype flash evaporator, sublimator, and composite radiator for thermal control during different phases of mission.

Ablative TPS: Qualifying thermal protection system materials in arcjet tests and developing a prototype heat shield.



Exploration Life Support: Developing a prototype carbon dioxide and moisture removal system.

Technology Development for Ares

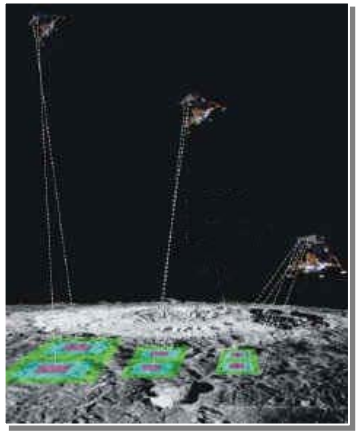
Structures & Materials: Developing friction stir welding and spin forming manufacturing processes for Ares I Upper Stage propellant tanks.

Integrated Systems Health Monitoring: Developing health monitoring system for Solid Rocket Motor.

Technology Development for the Lunar Lander

Propulsion & Cryogenics: Prototype LOX-Methane engine for ascent stage

Propulsion & Cryogenics: Prototype deep throttling RL-10 engine for descent stage



Autonomous Precision Landing: Guidance algorithms and lidar sensors to enable precision landing and hazard avoidance.

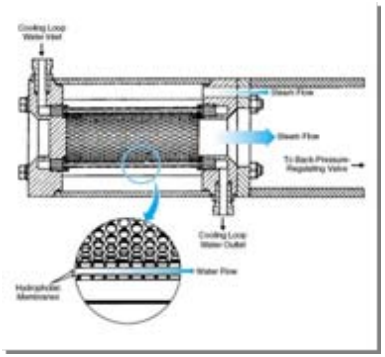
Propulsion & Cryogenics: Zero boil off cryogenic propellant storage to enable long duration missions

Technology Development for EVA

Energy Storage: High energy density lithium-ion batteries for Portable Life Support System

Life Support: High pressure oxygen supply and carbon dioxide removal systems

Dust Mitigation: Dust resistant fabrics and seals



Thermal Control: Suit water membrane evaporator

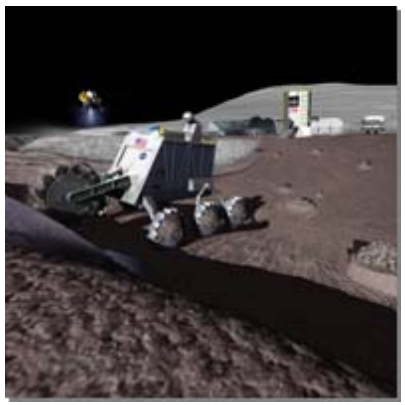
Technology Development for the Lunar Outpost

Human Robotic Systems: Developing surface mobility systems to transport crew and large payloads across lunar surface.

Energy Storage: Developing lithium-ion batteries and regenerative fuel cells to power lunar surface systems.

Fission Surface Power: Developing concepts and technologies for affordable nuclear power systems.

Structures & Materials: Developing structural concepts for lunar surface habitats.



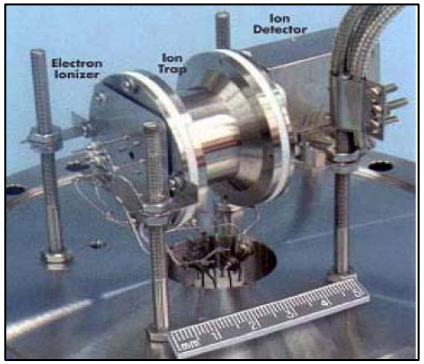
In-Situ Resource Utilization: Developing systems to produce oxygen from lunar regolith

Dust Mitigation: Characterizing effects of lunar dust on surface systems and developing technologies to prevent dust accumulation.

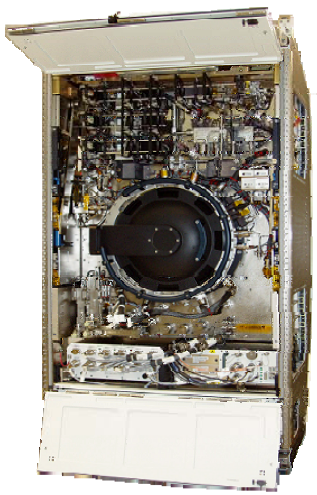
Technology Development on the ISS

Lab-on-a-Chip Application Development - Portable Test System

Advanced Environmental Monitoring & Control: Developing ENose and Vehicle Cabin Air Monitor (VCAM) instruments to detect atmospheric contaminants, and LOCAD-PTS instrument to detect harmful bacteria.

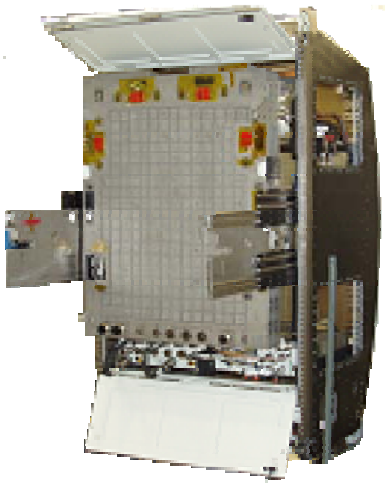


VCAM



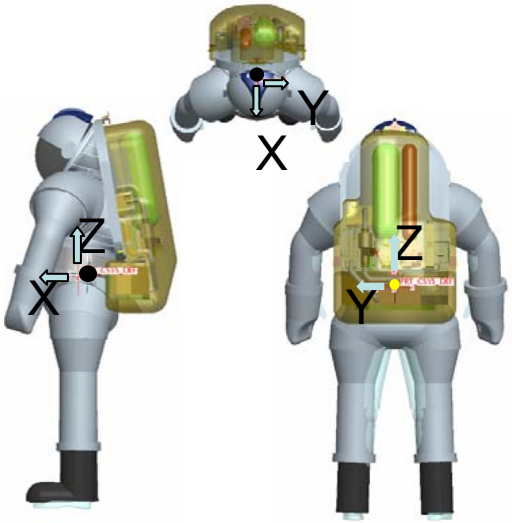
CIR

ISS Research: Developing Combustion Integrated Rack (CIR) and Fluids Integrated Rack (FIR) to conduct basic microgravity research on combustion and fluid physics

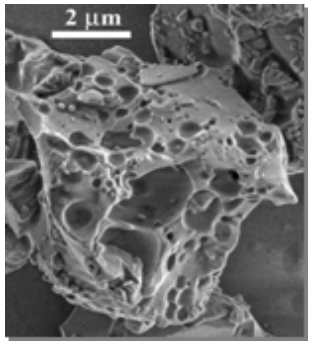


FIR

Technology Development on Human Research



EVA physiology testing has improved the design of the new planetary suit with a lower center of gravity.



NASA scientists have produced activated simulants of lunar dust for toxicity testing.

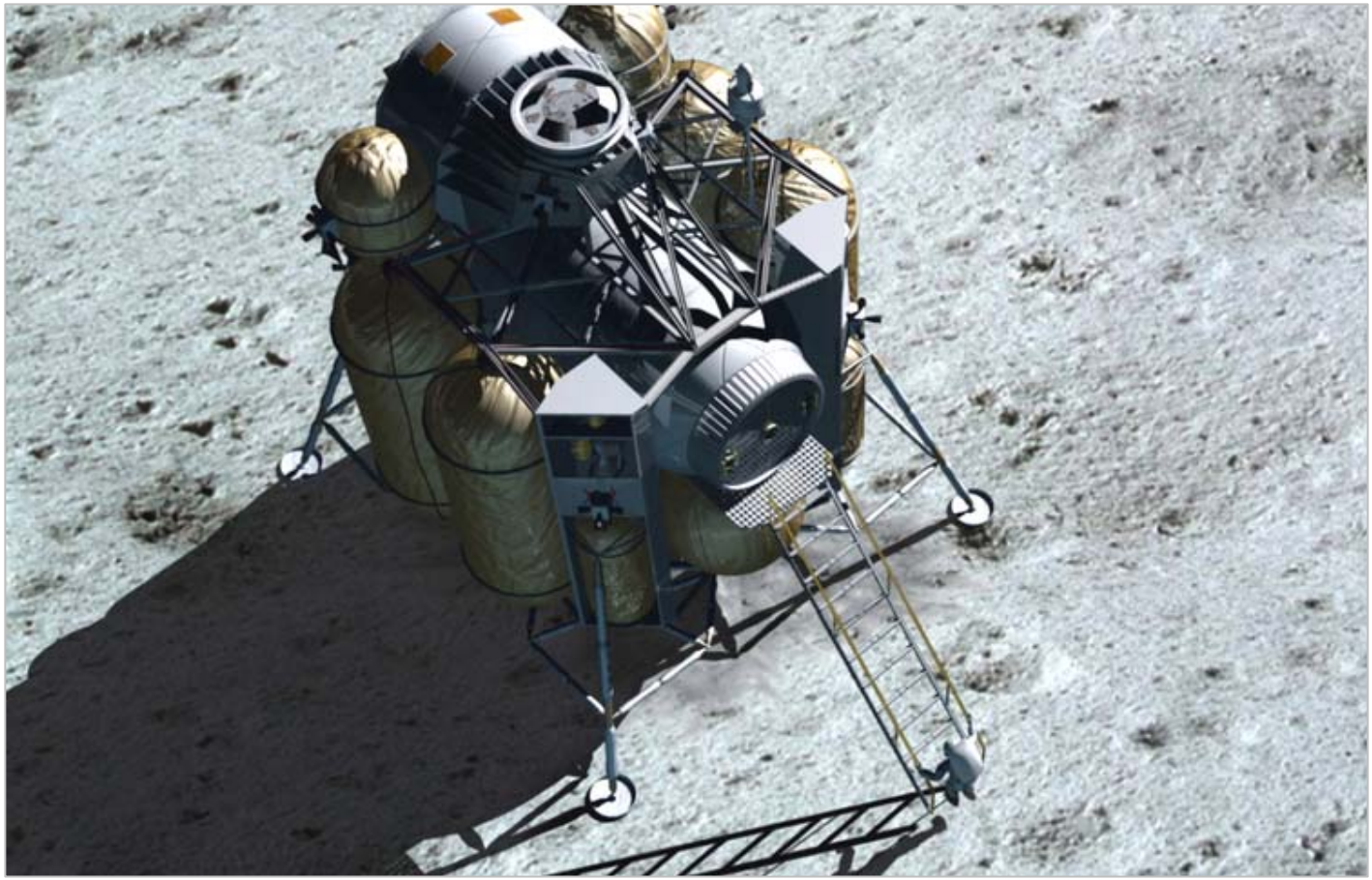
Completed pilot study on intermittent exposure to artificial gravity utilizing the short arm centrifuge at the University of Texas Medical Branch, Galveston, TX

Completed investigation of countermeasure for risk of renal stone formation during long duration missions

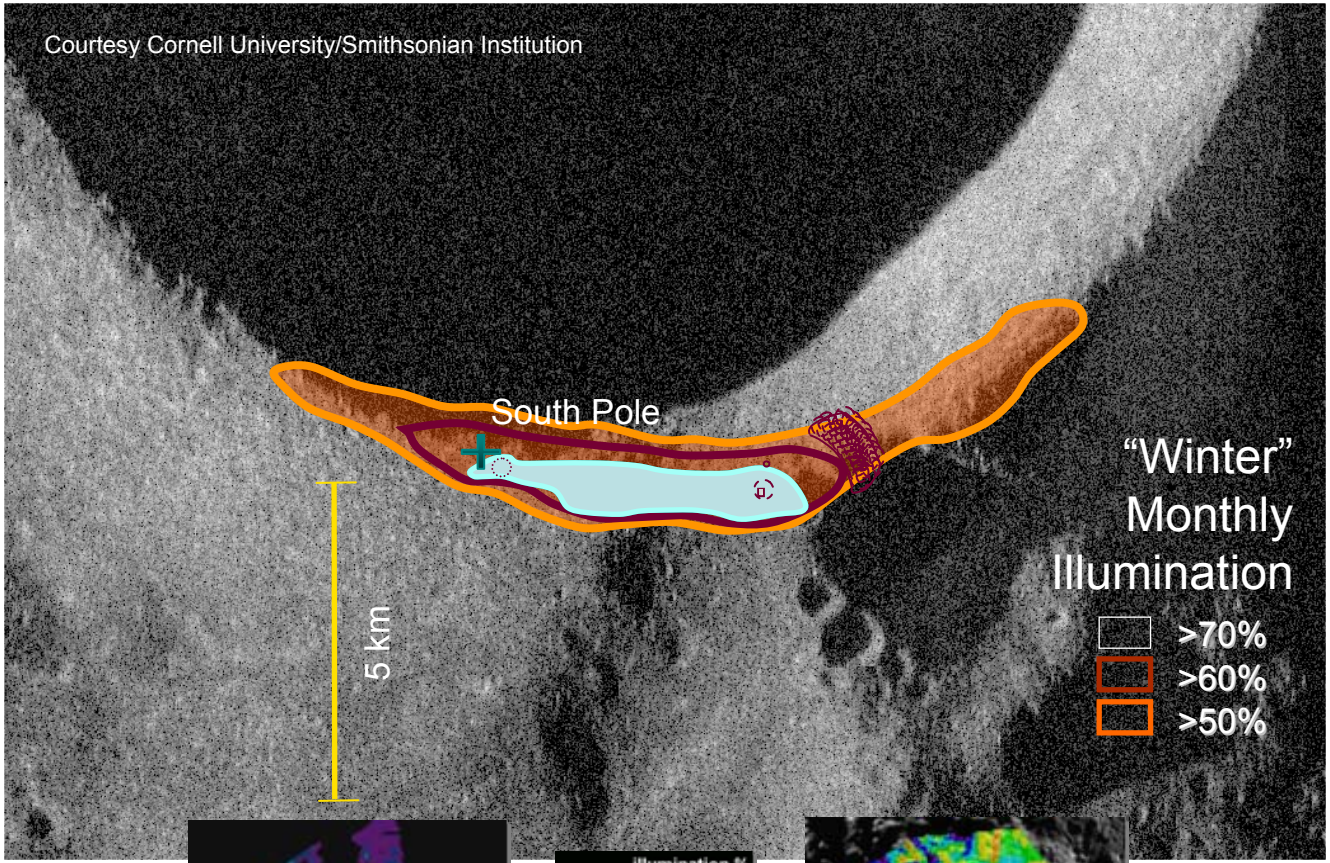
Direct measurements of Oxygen Uptake Measurement using Pulmonary Function System will improve understanding of astronaut fitness level in flight

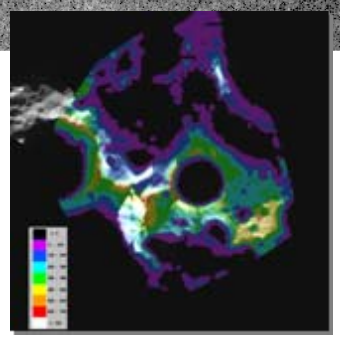
Nutritional Status Assessment investigation started. Will provide insights into time course of changes in nutritional status, bone loss

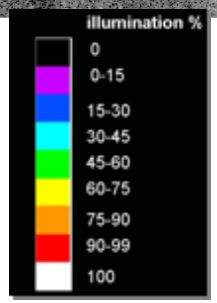
Outposts on the Moon



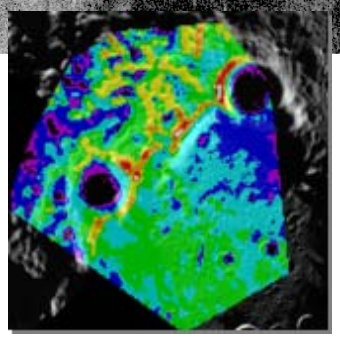
The Rim of Shackleton Crater





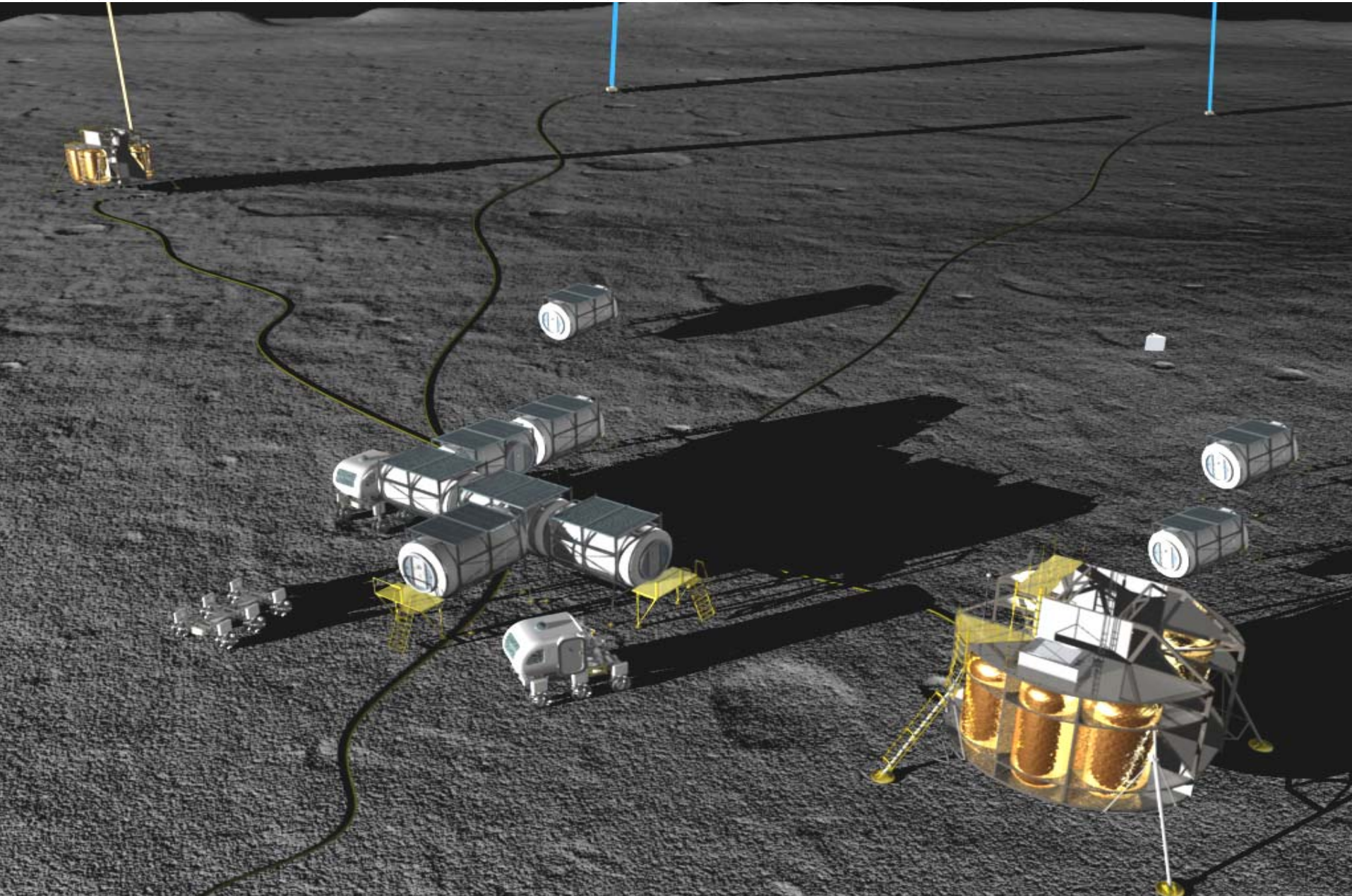


Bussey, et al, 1999



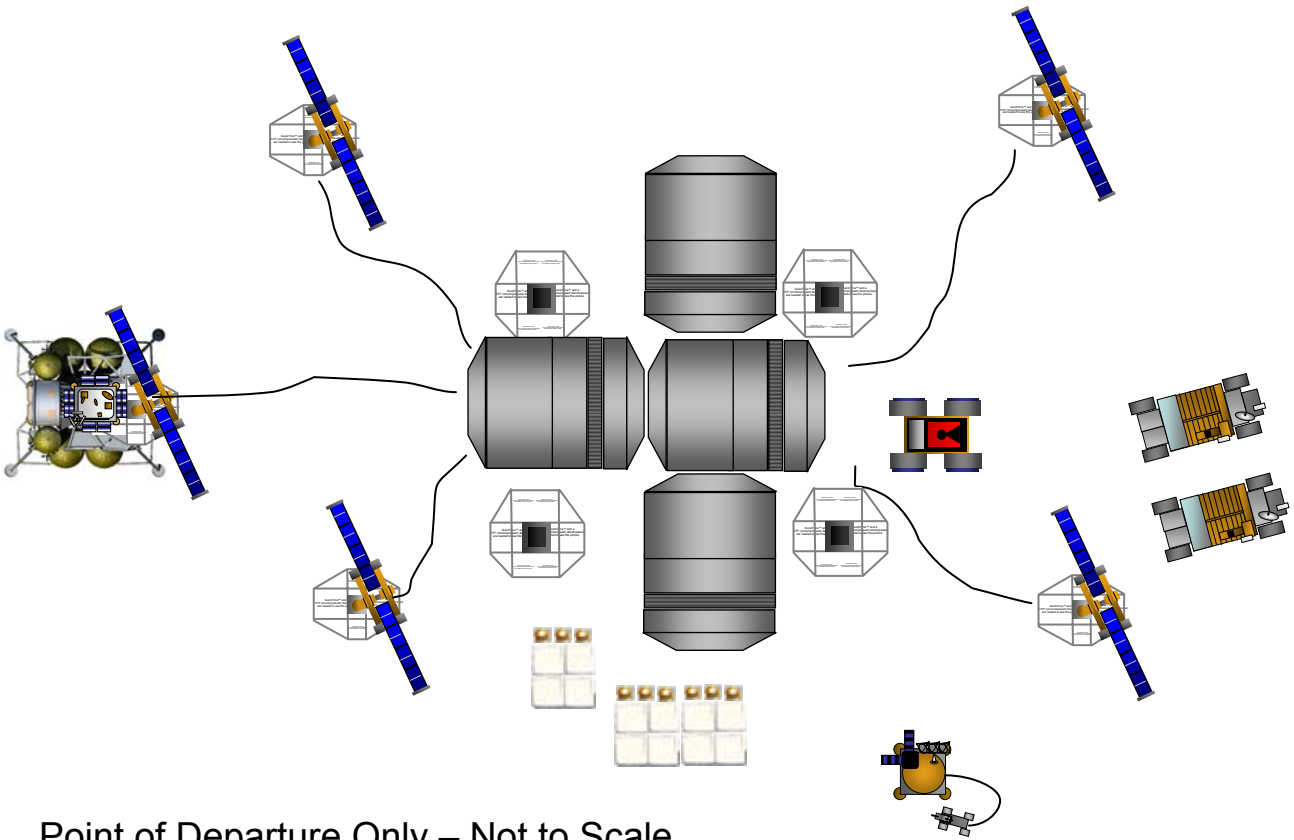
Data obtained during northern summer (maximum sunlight)

Building Outposts



Key Points: Outpost Build up

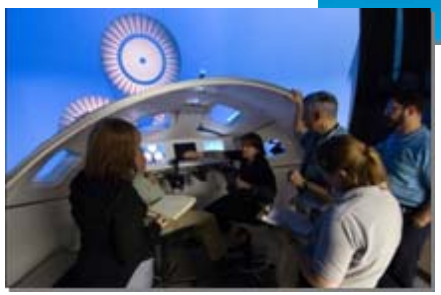
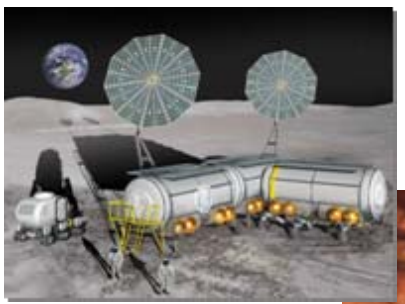
Starts 6 month increments



KEY

- Crew/Cargo Lander
- Solar Power Unit
- Unpressurized Rover
- Surface Mobility Carrier
- Habitation
- Power Storage Unit
- Logistics
- ISRU Module
- Pressurized Rover

Point of Departure Only – Not to Scale

Why Do We Explore?

- **Inspiration**
  - Inspire students to explore, learn, contribute to our nation's economic competitiveness, and build a better future
- **Innovation**
  - Provide opportunities to develop new technologies, new jobs, and new markets
- **Discovery**
  - Discover new information about ourselves, our world, and how to manage and protect it