National Aeronautics and Space Administration

Ares I-X Overview – The First Chapter in the Next Great Adventure

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Agenda

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- **Ares I-X Mission Background**
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  - Upper Stage Simulator (USS)
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  - First Stage
  - Avionics
- **Vehicle Assembly Building (VAB) Operations**
- **Processing Flow**
- **Launch Operations**
- **Summary**

Ares Launch Vehicles Background

- **Deliver crew and cargo for missions to International Space Station (ISS) and to Moon and beyond**
- **Continuing progress toward design, component testing, and early flight testing**
- **Ares I Crew Launch Vehicle**
  - Will carry 6 crew to ISS, 4 to Moon
  - First flight test 2009
  - Initial Operating Capability 2015
- **Ares V Cargo Launch Vehicle**
  - Will launch Earth departure stage and Altair lunar lander to low Earth orbit for lunar missions
  - Largest launch vehicle ever designed
  - Will begin detailed development work in 2011

Ares I-X Background

- **Ares I-X is a development test flight to provide engineering data to inform the design of the Ares I prior to CDR**
  - *Ares I will replace the Space Shuttle which is scheduled for 2010 retirement*
- **Ares I-X is an uncrewed, sub-orbital development flight tes**
- **Ares I-X will provide opportunity to test ground facilities and operations at NASA's Kennedy Space Center**

Ares I-X Flight Test Objectives

P(1) Demonstrate control of a dynamically similar, integrated Ares I/Orion, using Ares I relevant ascent control algorithms

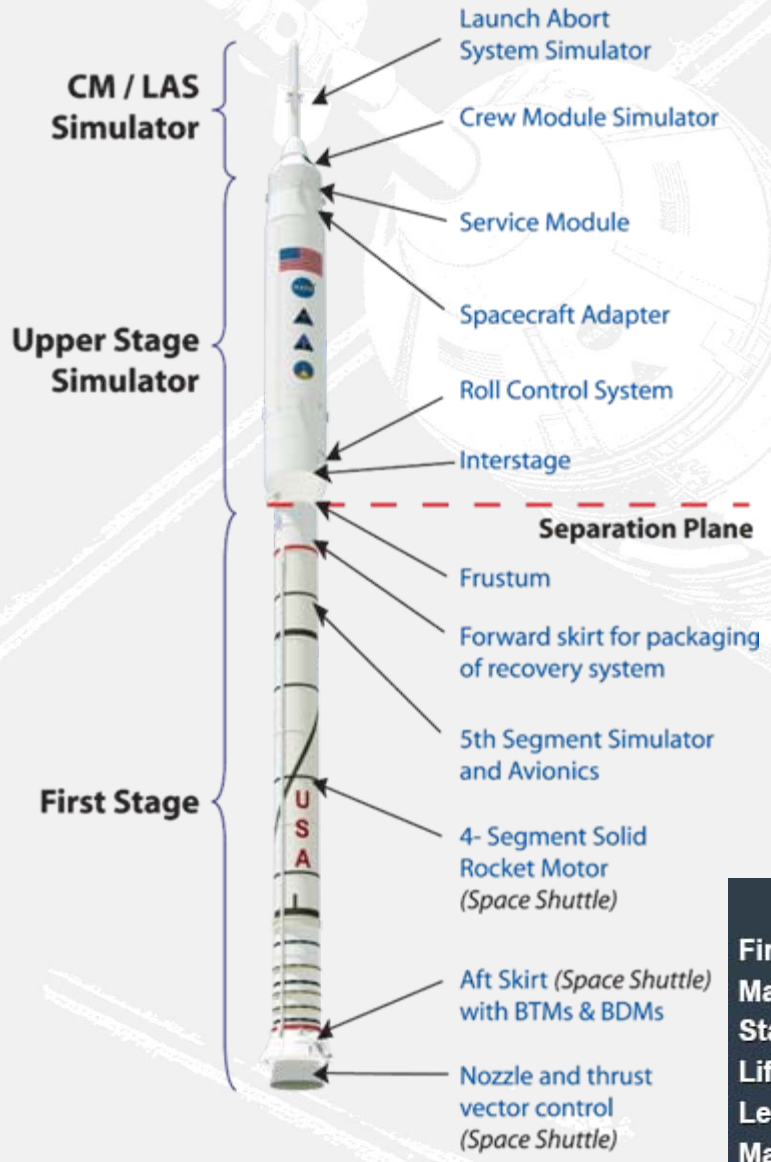
P(2) Perform an in-flight separation/staging event between a Ares I-similar First Stage and a representative Upper Stage

P(3) Demonstrate assembly and recovery of a new Ares I-like First Stage element at KSC

P(4) Demonstrate First Stage separation sequencing, and quantify First Stage atmospheric entry dynamics, and parachute performance

P(5) Characterize magnitude of integrated vehicle roll torque throughout First Stage flight

Vehicle Overview



- **Combines proven space flight and simulated hardware**
  - **Space flight hardware includes:**
    - Four-segment solid rocket booster (Space Shuttle)
    - Atlas V-based avionics
    - Roll control system (Peacekeeper)
    - Separation system (Space Shuttle)
    - Parachutes deceleration system (Space Shuttle)
    - Booster deceleration and tumble motors (Space Shuttle)
    - Developmental flight instrumentation
  - **Simulator hardware**
    - Upper stage
    - Orion crew module
    - Launch abort system
    - Fifth segment of booster

	Ares I–X	Ares I
First Stage Max. Thrust (vacuum):	14.1M N (3.13M lbf)	15.8M N (3.5M lbf)
Max. Speed:	Mach 4.7	Mach 5.84
Staging Altitude:	39,624 m (130,000 ft)	57,453 m (188,493 ft)
Liftoff Weight:	834k kg (1.8M lbm)	927k kg (2.0M lbm)
Length:	99.1 m (327 ft)	99 m (325 ft)
Max. Acceleration:	2.46 g	3.79 g

Ares I-X Development Flight Test

Vehicle Height:	327 feet
Weight at Ignition:	1.8 M-lbm
Max. Acceleration:	2.5 g's
Max. Speed:	Mach 4.7

~ 150,000 feet

P2) Perform in-flight separation/staging event at 124 sec ~ 130,000 feet

in-flight separation plane

P4) Demonstrate FS entry dynamics and sequencing of events (parachute deployment, etc.)

P5) Characterize integrated vehicle roll torque

P1) Demonstrate controlability

USS/CM/LAS Uncontrolled descent and impact

P3) Demonstrate assembly and recovery of an Ares I similar FS

Booster, parachutes and recovery

Orion Crew Module/ Launch Abort System (CM/LAS) Simulator

LAS Party Hat Assembly

LAS Tube Machining

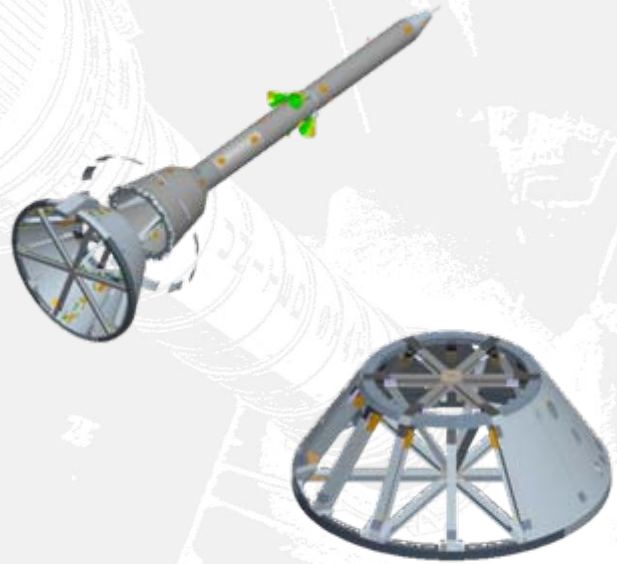
CM Lower Ring

CM Upper Ring

CM/LAS Transport Vehicle

LAS Transition Fitting

- Outer mold line (OML) resembles earlier Ares I design due to flight test schedule
- Developmental flight instrumentation sensors will measure aerodynamic and acoustic loads
- Developed at the NASA Langley Research Center, Hampton, VA



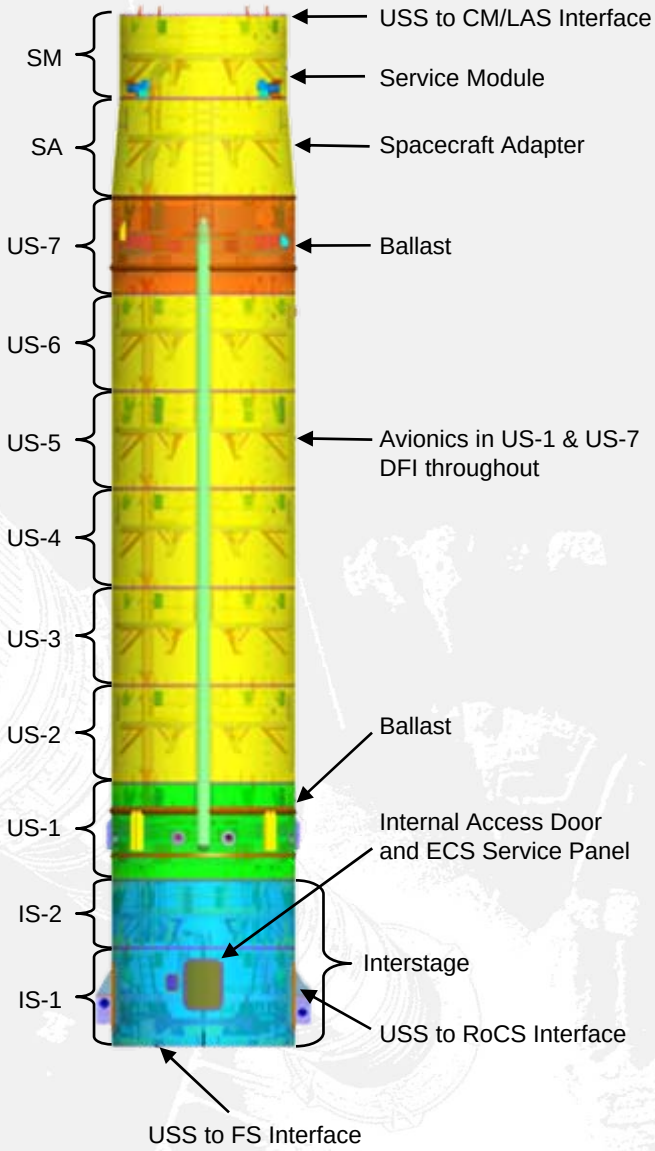
Upper Stage Simulator (USS)

- **USS is a mass and Outer Mold Line (OML) simulator**
- **Hardware includes:**
  - Interstage (IS) Simulator
  - Upper Stage (US) Simulator
  - Spacecraft Adapter (SA) Simulator
  - Service Module (SM) Simulator
- **Developed at the NASA Glenn Research Center, Cleveland, OH**

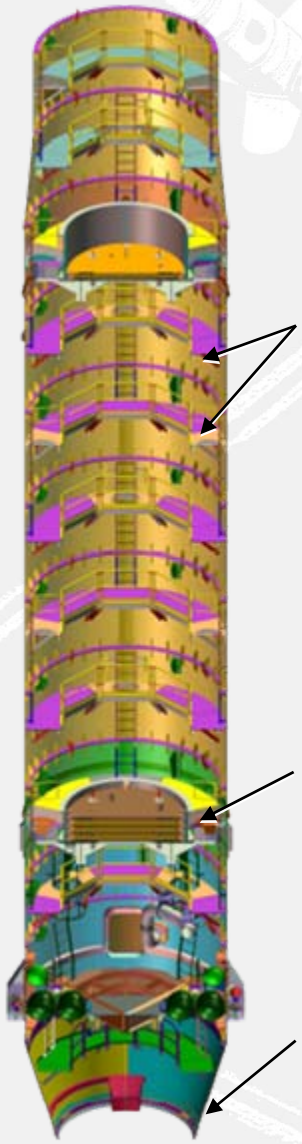
Flange Machining

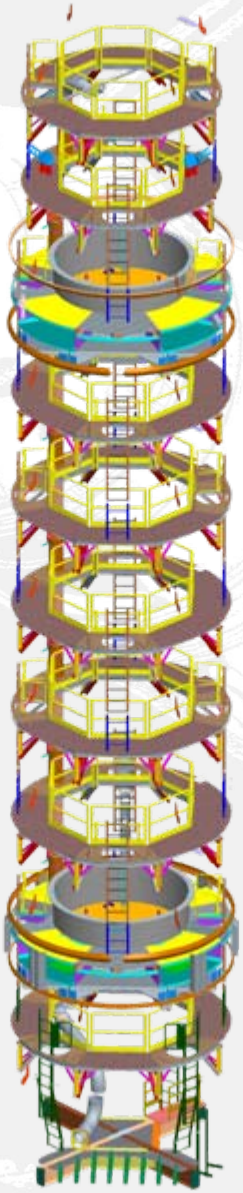
Support Welding

Super Stack



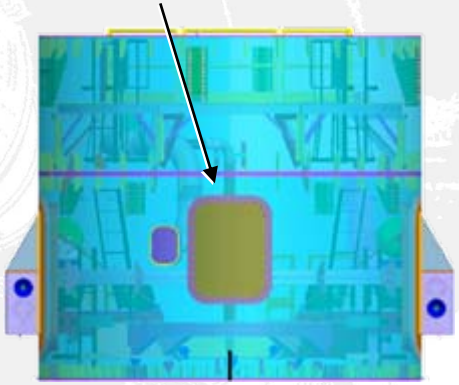
USS Internal Access Concept





- **Provides access from the Frustum to the CM/LAS**
- **Door in the IS-1 segment**
  - Internal access platforms and ladders
  - Provides Environmental Control System (ECS) ductwork to maintain a safe work temp, air flow and controlled humidity

Internal access door

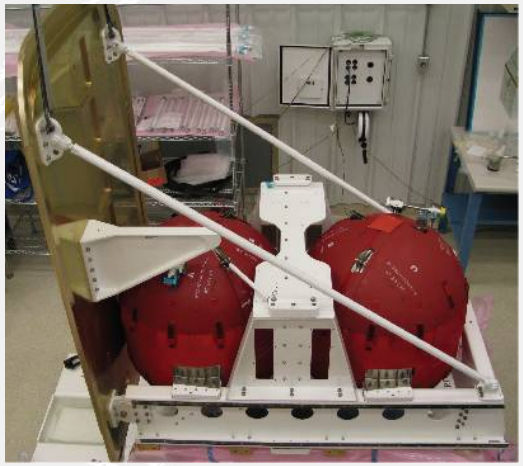


IS-1 Segment

Roll Control System (RoCS)

Propellant Tank

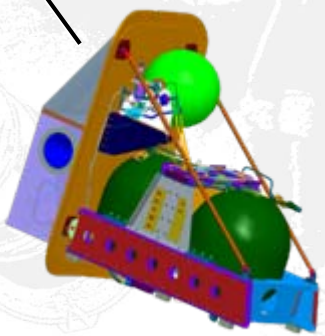
Pressurization System



Cold Flow Assembly

Thruster

- Provides post-launch 90-degree roll and mitigation against adverse roll torques
- Modular propulsion system housed in the Ares I-X USS Interstage
- Proven space hardware harvested from Peacekeeper 4th Stage
- Managed at the NASA Marshall Space Flight Center, Huntsville, AL

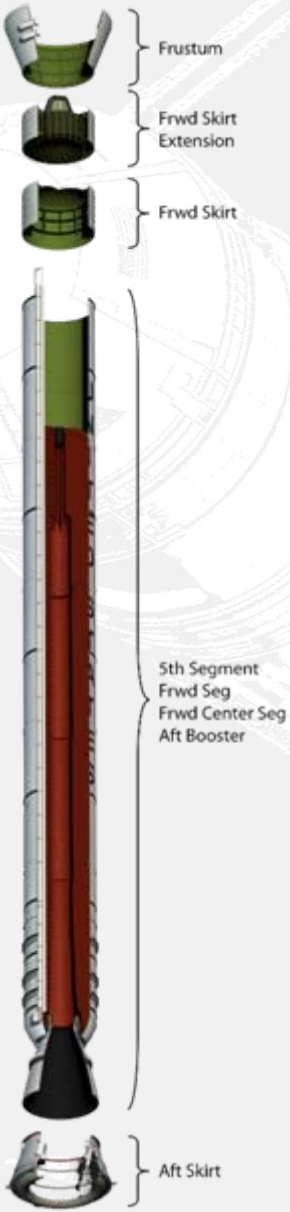


First Stage

Main Parachute

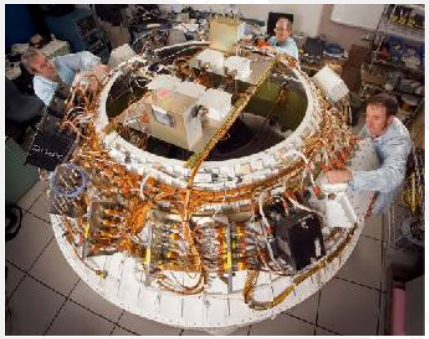
Frustum Forward Ring

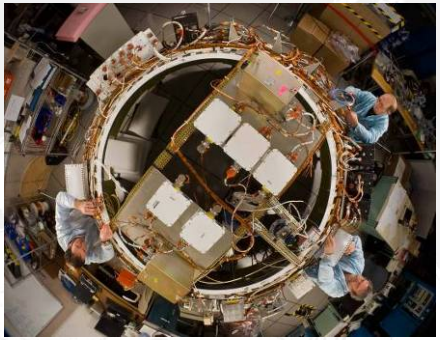
Aft Skirt at ARF



- **Heritage Hardware**
  - 4 Segment Reusable Solid Rocket Motor (RSRM) w/Nozzle
  - Thrust Vector Control (TVC)
  - Flight Termination System (FTS)
  - Nose Cap w/Thrusters
  - Booster Separation Motors (BSMs)
- **Modified Heritage Hardware**
  - Shuttle Derived Avionics
  - Aft Skirt
- **New Developments for Ares I-X**
  - Fifth Segment Simulator (5SS)
  - Forward Skirt (FS)
  - Forward Skirt Extension (FSE)
  - Main Parachute Support Structure (MPSS)
  - Frustum
- **Ares I Designs**
  - Parachutes
  - FTS Extension to Aft Segment
- **Managed at the NASA Marshall Space Flight Center, Huntsville, AL**

Avionics

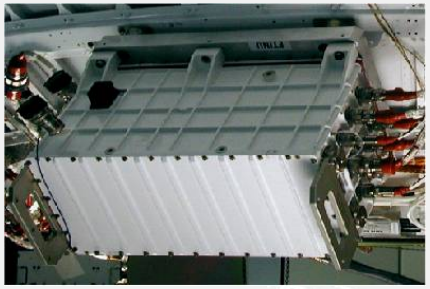




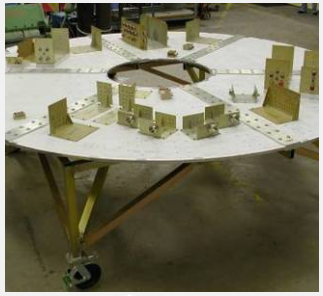
Avionics SIL

FSAM Assembly

ATVC Testing



FTINU (Flight Computer)



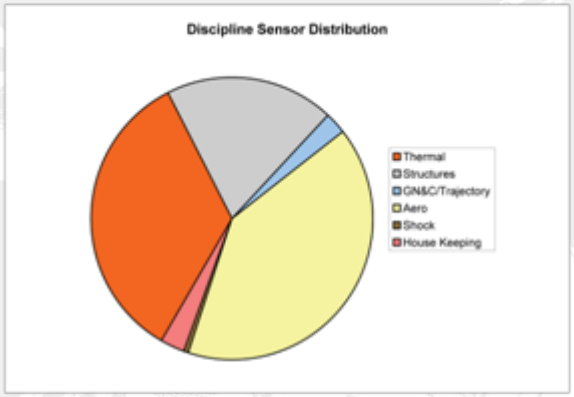
FSAM Harness Template

- **Primary avionics subsystems:**
  - FSAM (located in First Stage fifth segment)
  - Guidance & Control System
  - Ground Command, Control, and Communication (GC3)
- **Managed at the NASA Marshall Space Flight Center, Huntsville, AL**

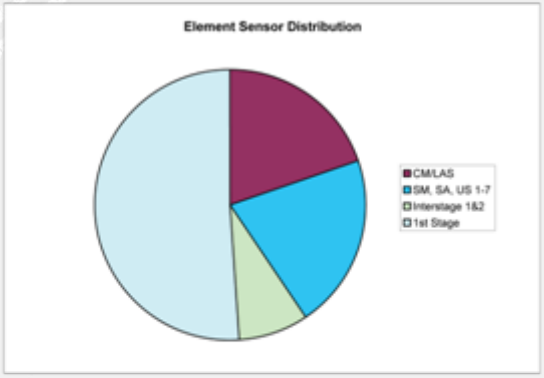
FSAM

Development Flight Instrumentation (DFI) and Video

Sensor Summary Appendix



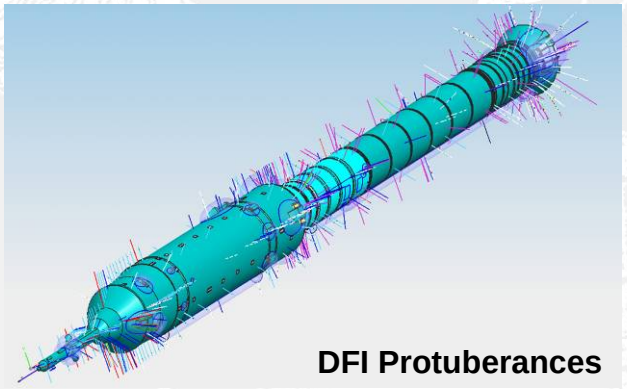
Discipline	Number of Sensors	% of Total
Thermal	256	34%
Structures	147	20%
GN&C/Trajectory	18	2%
Aero	305	41%
Shock	4	1%
House Keeping	21	3%
Total	751	100%



Element	Number of Sensors	% of Total
CM/LAS	149	20%
SM, SA, US 1-7	156	21%
Interstage 1&2	62	8%
1st Stage	384	51%
Total	751	100%

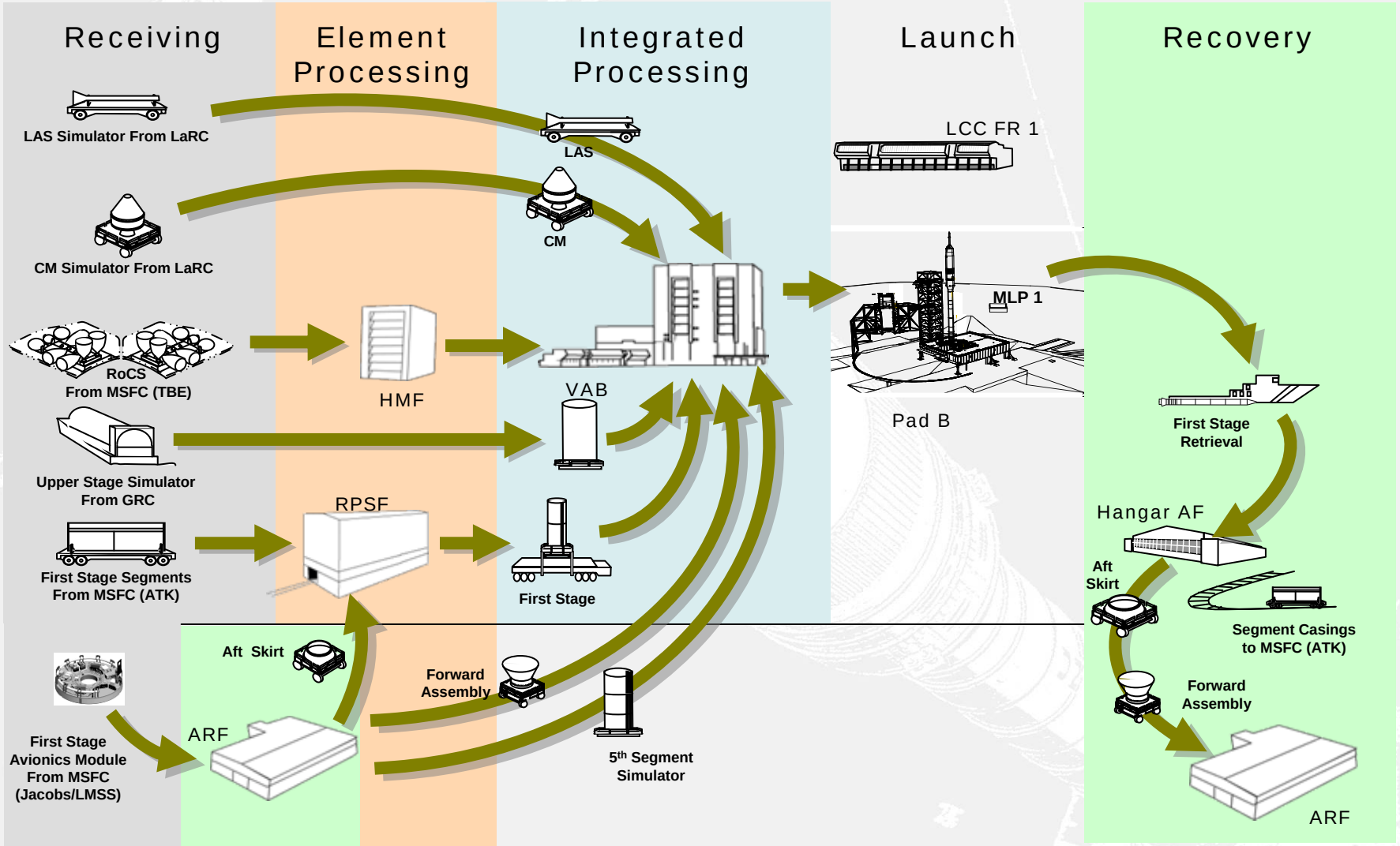
Note: Totals include Pyro Sensor Counts

- **Instrumented for 924 measurements**
  - Thermal
  - Structures
  - GNC/Trajectory
  - Aero
  - Shock
- **Cameras strategically located**
- **Data to be retrieved via telemetry and a data recorder box that is recovered from the First Stage after flight**
- **Managed at the NASA Langley Research Center, Hampton, VA**

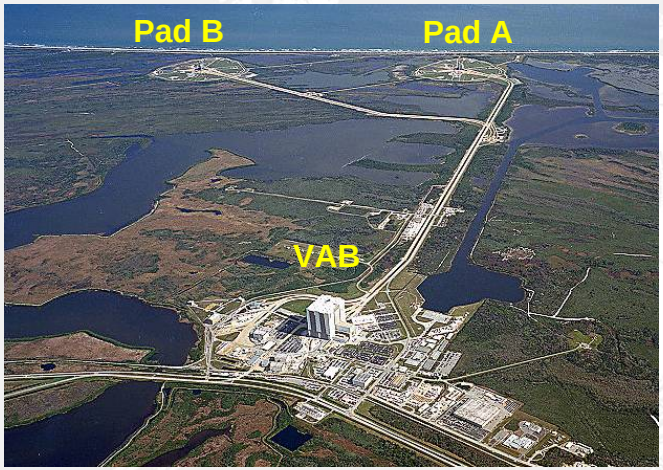


DFI Protuberances

Ares I-X Processing Flow



Vehicle Assembly Building (VAB) Operations



Arial of the VAB, Pad B, and Pad A

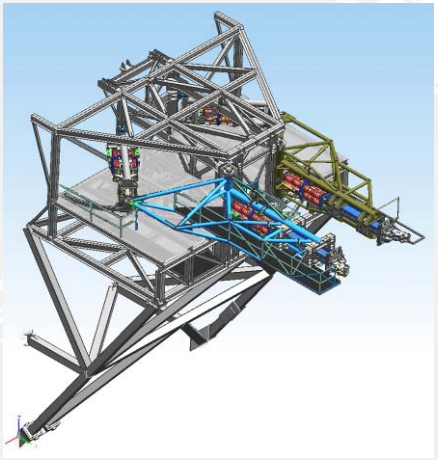
- The Upper Stage Simulator (USS) segments and Orion Crew Module/Launch Abort System (CM/LAS) will be assembled into stacks and Development Flight Instrumentation (DFI) tested in VAB Hi-Bay 4.
- The First Stage segments and stacks will be integrated in Hi-Bay 3.

FTV in VAB

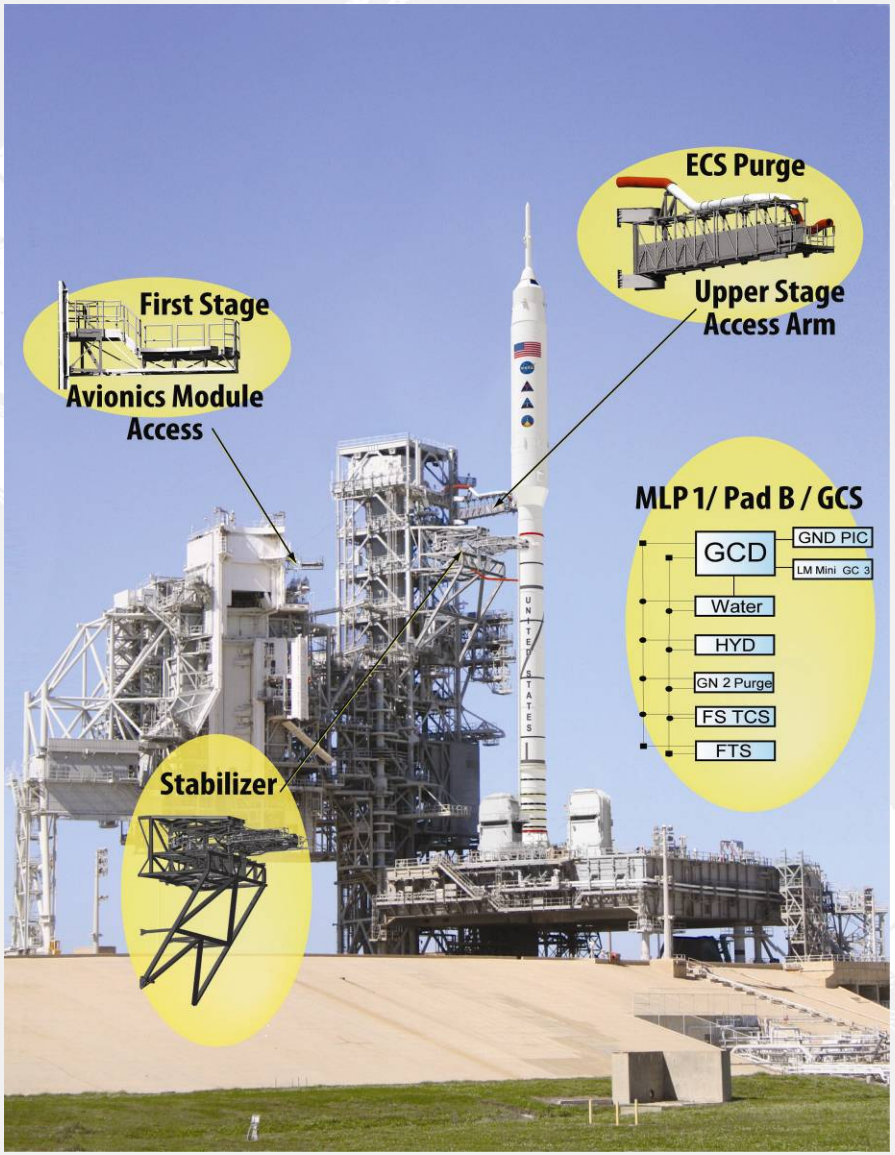
USS Segments and CM/LAS in Hi-Bay 4

Ares I-X on Mobile Launch Platform

Pad 39B at NASA Kennedy Space Center, FL



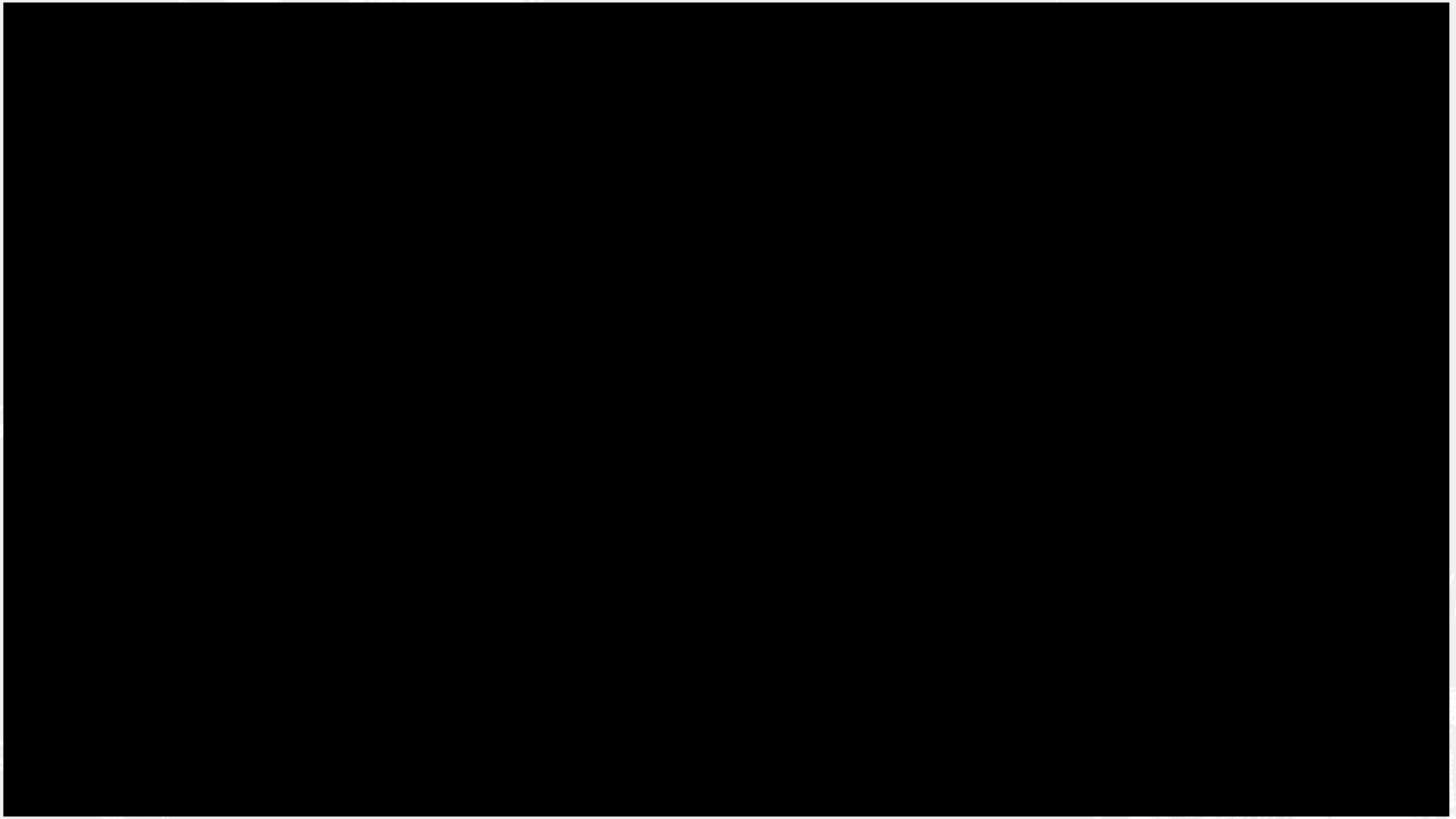
Stabilizer



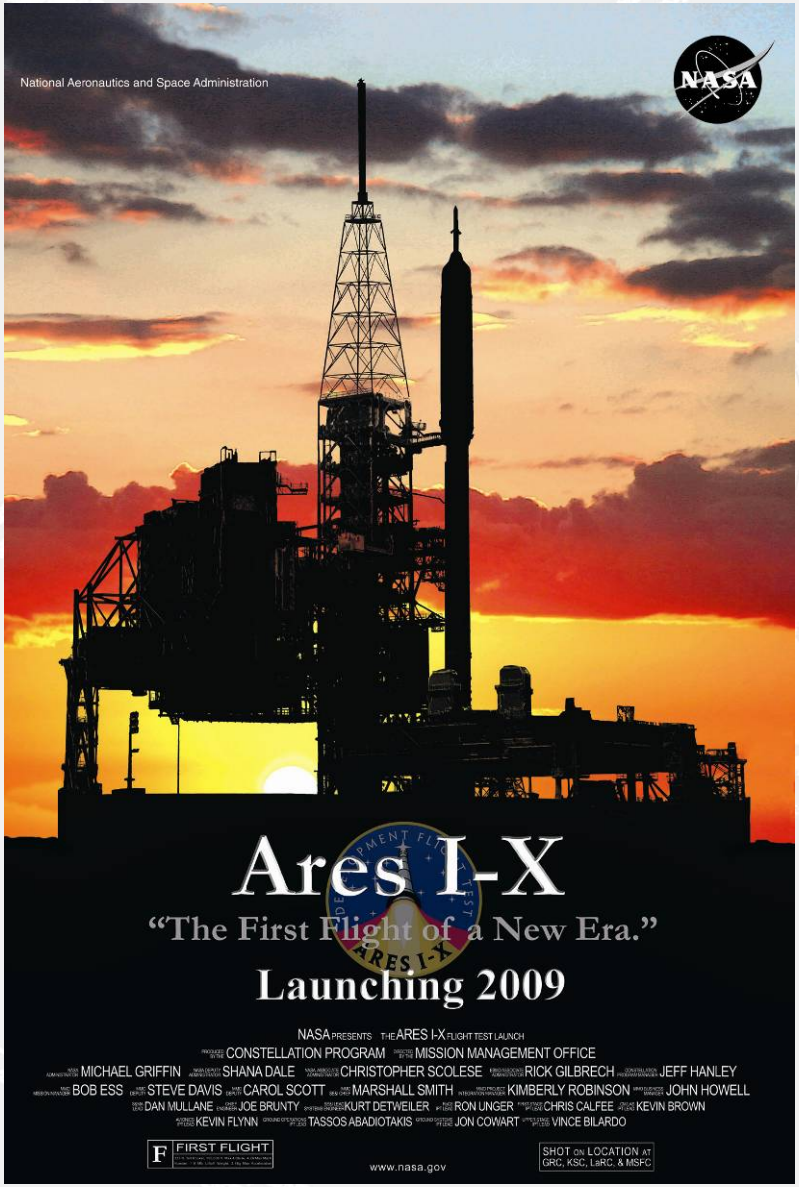
Upper Stage Access Arm

1st Stage Avionics Module Access

Video



Summary



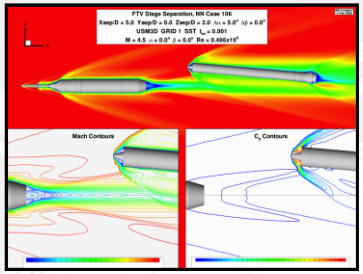
- Ares I-X is the first flight of NASA's new Constellation Program
- Ares I-X is a developmental test flight to support the Ares I
- Ares I-X is on track for May 2009 launch date
- For more information, see http://www.nasa.gov/mission_pages/constellation/ares/flighttests/aresIx/index.html or http://staging.cms.nasa.gov/mission_pages/constellation/ares/flighttests/aresIx/index.html

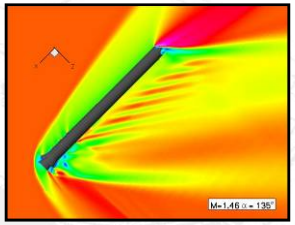

DEVELOPMENT FLIGHT TEST
ARES I-X

Backup Slides

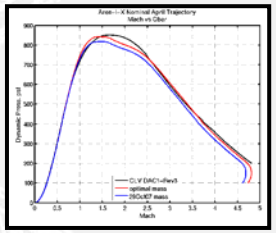
Systems Engineering & Integration

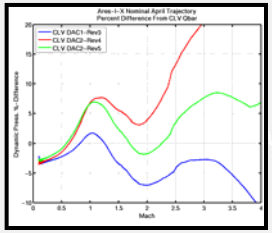
Integrated Design & Analysis



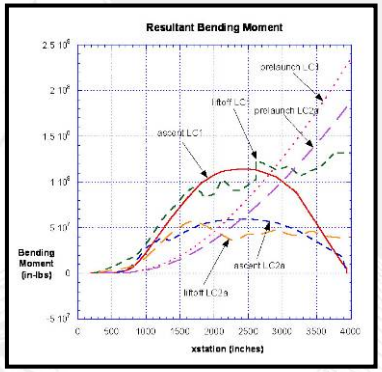


Aerodynamics
- Ascent Aero
- Transition Lift-off CFD
- Stage Separation CFD
- Rigid Buffet

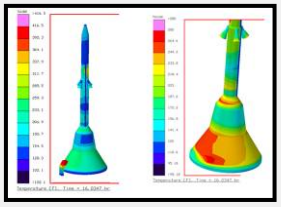


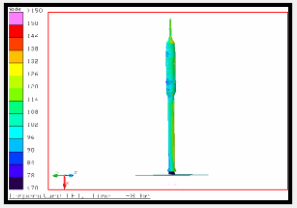


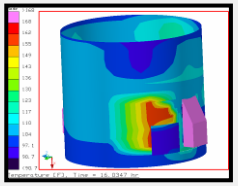
Trajectory
- Trajectories
- Malfunction Turn
- Baseline Databook
- Prelim Range Data Package



Structures
- Coupled Loads Cycle 1
- Cycle 2 Update
- Assess Rigid Buffet data

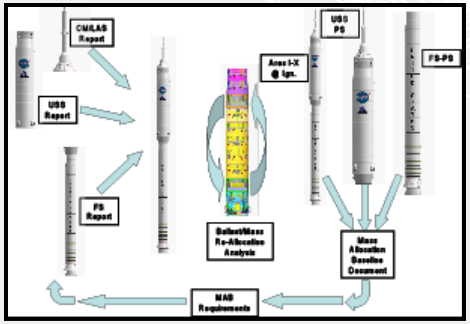




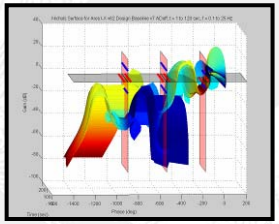


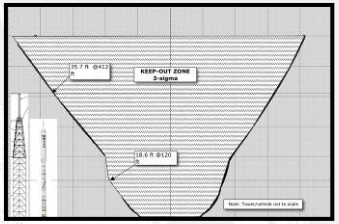
Thermal
- Preliminary Stack
- Ascent on Pad
- Thermal Prediction Report & Databook

Integrated Mass Properties



-Mass Allocation



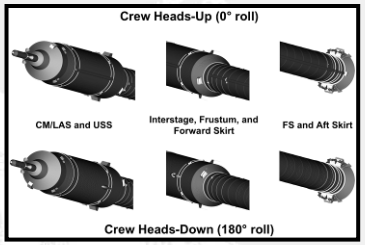


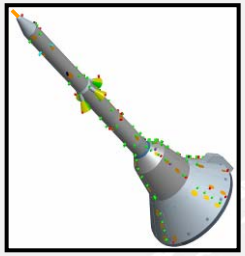
Guidance, Navigation & Control
- Initial Flight Control Architecture
- Preliminary Stability Analysis
- Updated Drift Analysis
- Stage Separation Analysis

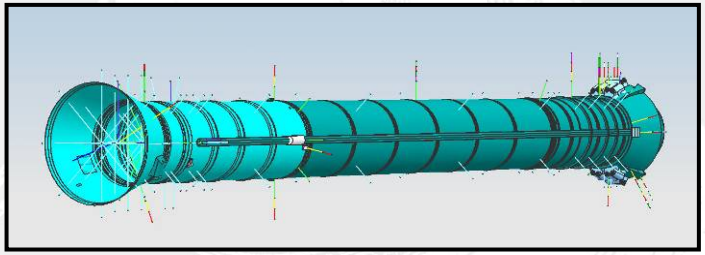
Systems Engineering & Integration

Systems Engineering

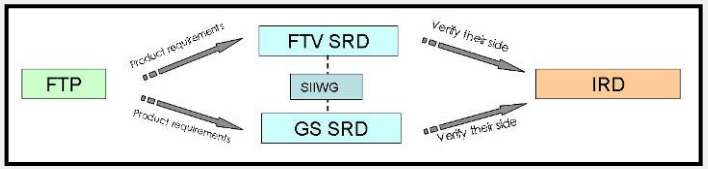
- Outer Mold Line
- Development Flight Instrumentation
- Design Definition Document

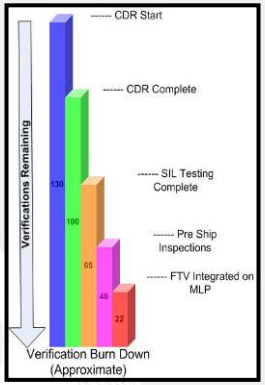


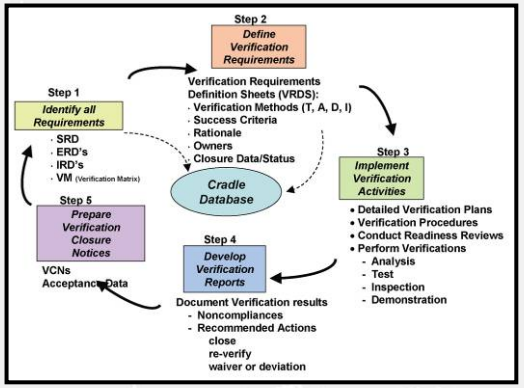




- Systems Engineering
- System Requirements & Verification
- Launch Operations & Flight Integration

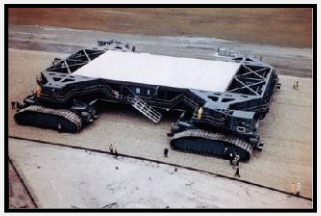






System Requirements & Verification

- System Requirements Document
- Verification Requirements Document
- Interface Control Documents
- Interface Requirements Documents

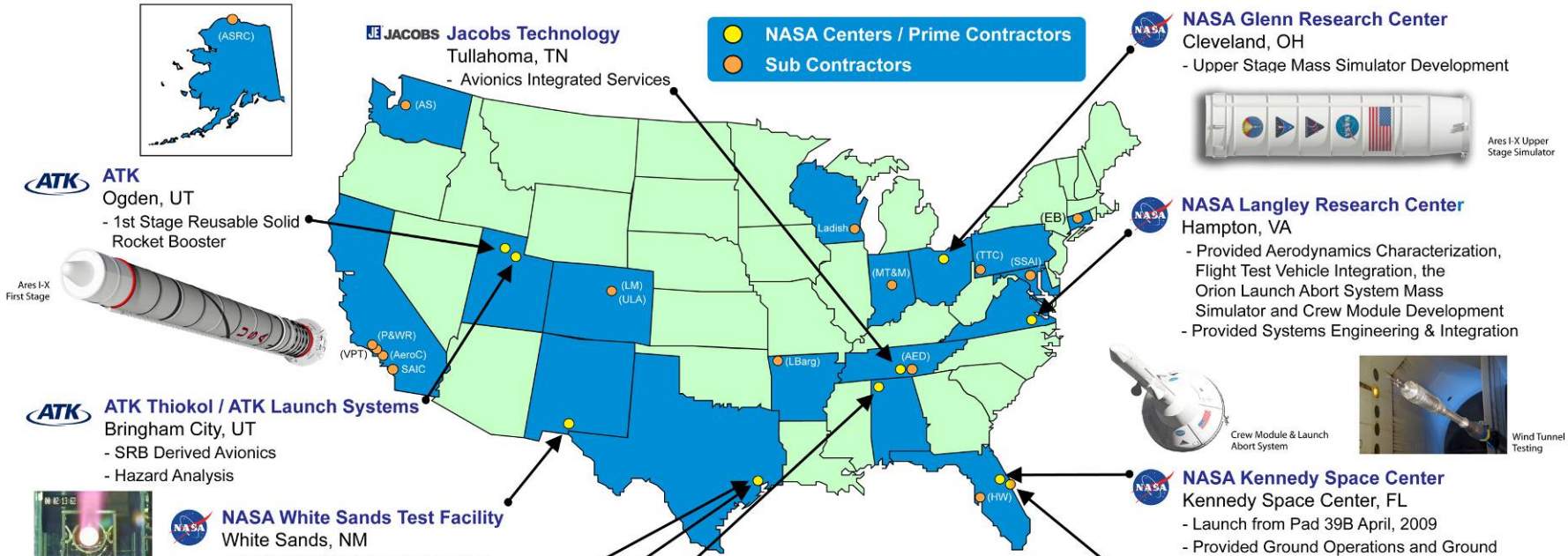


Launch Operations & Flight Integration

- Tailored Range Document
- Launch Commit Criteria
- Flight Data Package

Ares I-X FTV Integration

NASA Centers / Prime Contractors
Sub Contractors



Jacobs Technology
Tullahoma, TN
- Avionics Integrated Services

ATK
Ogden, UT
- 1st Stage Reusable Solid Rocket Booster

Ares I-X First Stage

ATK Thiokol / ATK Launch Systems
Bringham City, UT
- SRB Derived Avionics
- Hazard Analysis


RoCS Hot Firing Test

NASA White Sands Test Facility
White Sands, NM
- Roll Control System Hot Firing Test
- RoCS Peacekeeper Propulsion System Component Harvesting

NASA Johnson Space Flight Center
Houston, TX
- Constellation Program Office
- Ares I-X Mission Management Office
- Structural Analysis

United Space Alliance
Houston, TX
- Supporting Launch Operations at KSC

NASA Marshall Space Flight Center
Huntsville, AL
- Provided Management, Including MMO support for Avionics, Roll Control Systems, First Stage, and Project Integration

Jacobs Engineering
Huntsville, AL
- Avionics Integrated Services

Teledyne Brown
Huntsville,AL
- Roll Control System

NASA Glenn Research Center
Cleveland, OH
- Upper Stage Mass Simulator Development

Ares I-X Upper Stage Simulator

NASA Langley Research Center
Hampton, VA
- Provided Aerodynamics Characterization, Flight Test Vehicle Integration, the Orion Launch Abort System Mass Simulator and Crew Module Development
- Provided Systems Engineering & Integration

Crew Module & Launch Abort System

Wind Tunnel Testing

NASA Kennedy Space Center
Kennedy Space Center, FL
- Launch from Pad 39B April, 2009
- Provided Ground Operations and Ground Systems Including MMO Support

United Space Alliance
Cape Canaveral, FL
- Avionics and Launch Operation Support


Ares I-X Rocket on Pad 39B - KSC, FL


Lift Off from Pad 39 B

- **Votaw Precision Technologies**
  Santa Fe Springs,CA
  - Rolled FS/5SS Steel Structures
- **Andrews Space**
  Seattle, WA
  - Deceleration Subsystem Management and Engineering Support
- **Ensign Bickford**
  Simsbury, CT
  - First Stage
  - Roll Control System
- **Ladish**
  Milwaukee, WI
  - Pyro Component Manufacturer
- **Major Tool and Machine**
  Indianapolis, IN
  - Forward Assemblies Manufacturer
- **Science Systems & Applications**
  Lanham, MD (home)
  - Engineering analysis support
- **Honeywell**
  Clearwater, FL
  - Avionics Command and Control Line Replaceable Units
- **Lockheed Martin**
  Denver, CO
  - Avionics Integrated Services and Primary Avionics Hardware Provider
- **Arctic Slope Research**
  Barrow, AK
  - Scheduling Support
- **United Launch Alliance**
  Denver, CO
  - Avionics Integrated Services
- **LaBarge**
  Berryville, AR
  - Wire Harness Assemblies
- **Arnold Engineering Development Center**
  Tullahoma,TN
  - Wind tunnel support
- **Teletronics Technology Corp**
  Newton, PA
  - Development Flight Instrumentation Line Replaceable Units
- **Aerospace Corp**
  Altadena, CA
  - Verification & Validation
- **Manthia Corp**
  Hampton, VA
  - Contamenation Assessment Support
- **United States Air Force**
  Cape Canaveral, FL
  - Range Management
- **Pratt & Whitney Rocketdyne**
  Canoga Park, CA
  - Roll Control System