MSFC-458-Abstract

THERMAL & FLUIDS ANALYSIS WORKSHOP 2007
ARES THERMAL OVERVIEW – SEPT 13, 2007

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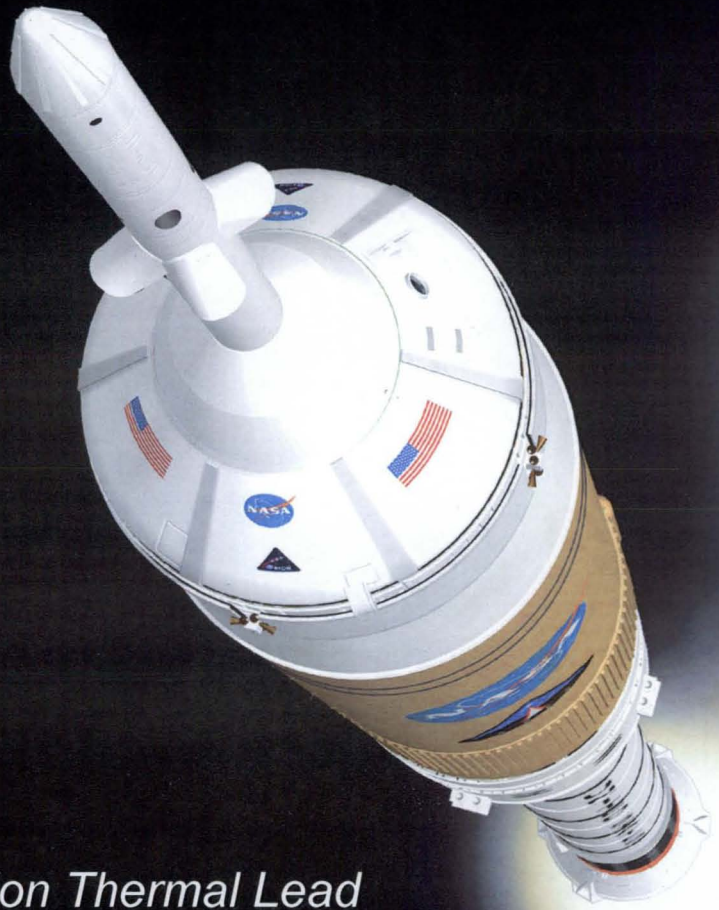
ABSTRACT:

As part of a Constellation session at the 2007 Thermal & Fluids Analysis Workshop (TFAWS), an overview of the Crew Launch Vehicle (CLV), Crew Exploration Vehicle (CEV) and Lunar Lander systems will be given. This presentation provides a general description of the CLV (also known as Ares-I) and Ares-V vehicles portion of the session. The presentation will provide an overview of the thermal requirements, design environments, challenges and thermal modeling examples.

MSFC-458-Presentation

TFAWS
Ares Thermal Overview
Sept. 13, 2007



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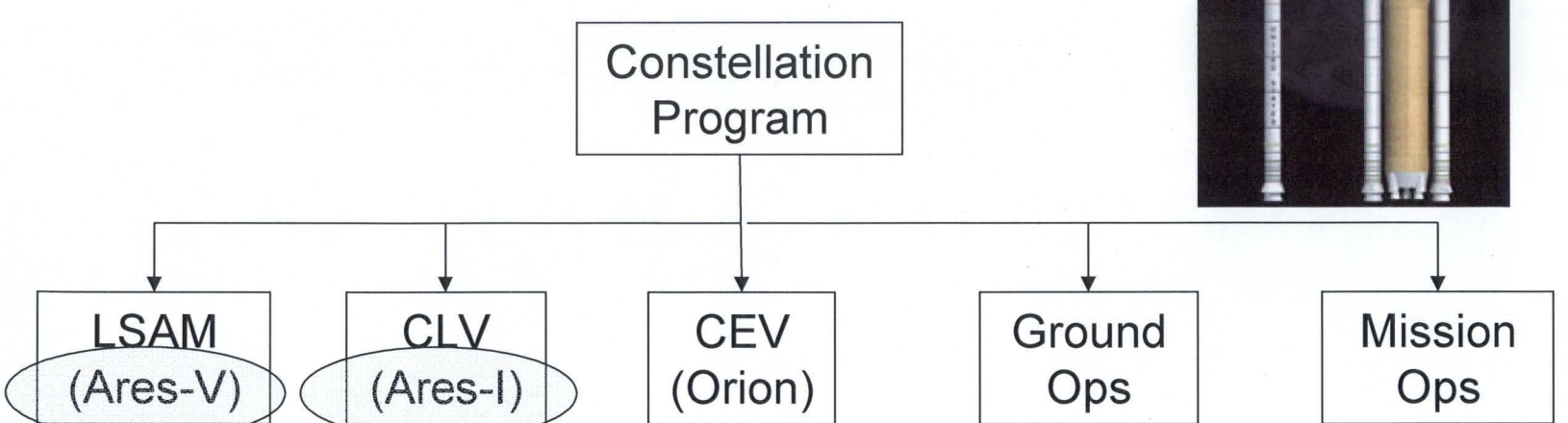
Topics

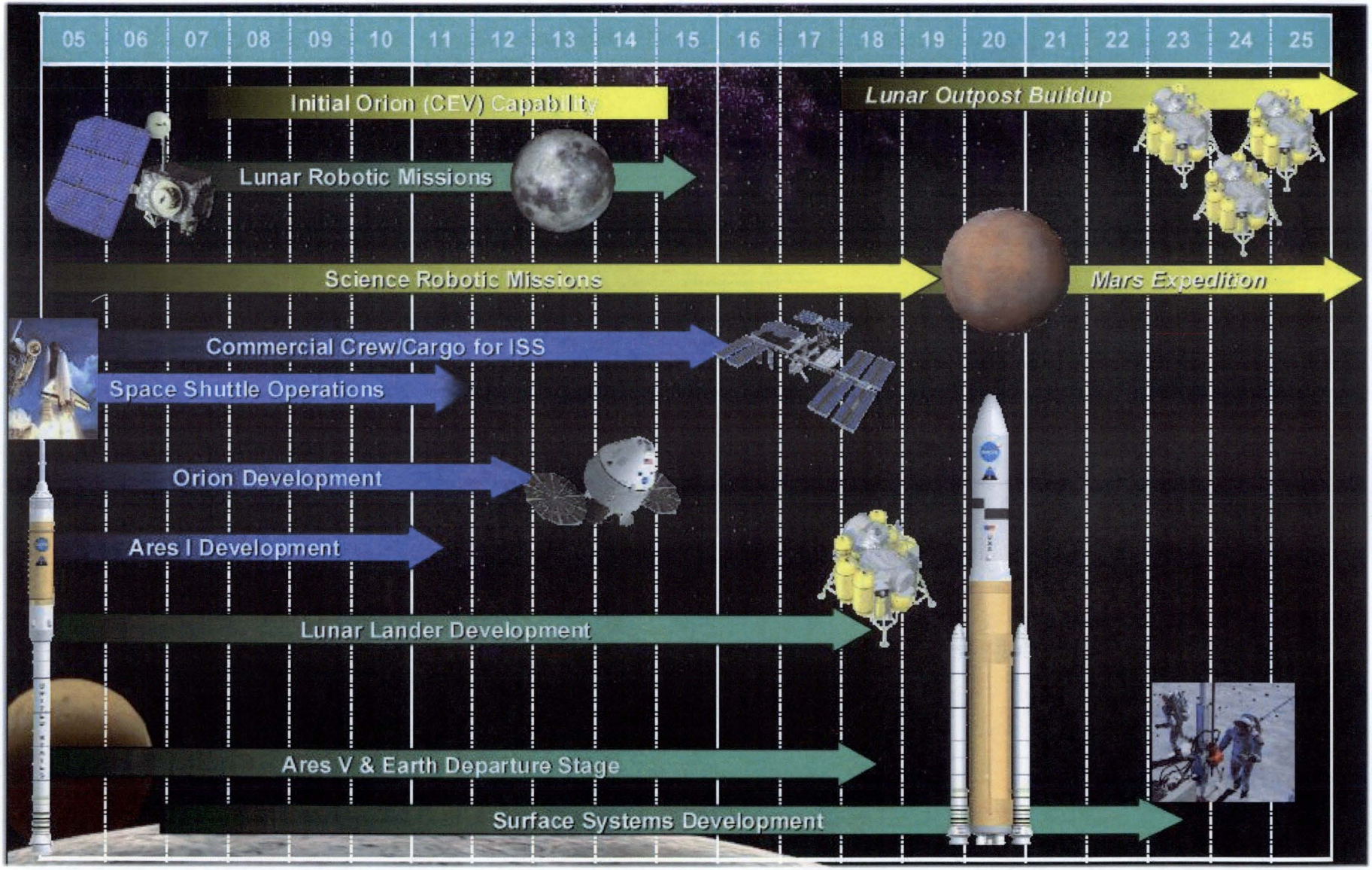
- **Ares in CxP Hierarchy**
- **General Ares Description/Orientation**
- **Ares I Thermal Overview**
  - Requirements
  - Design Environments
  - Challenges
  - Thermal Modeling
  - Status

Ares in CxP Hierarchy

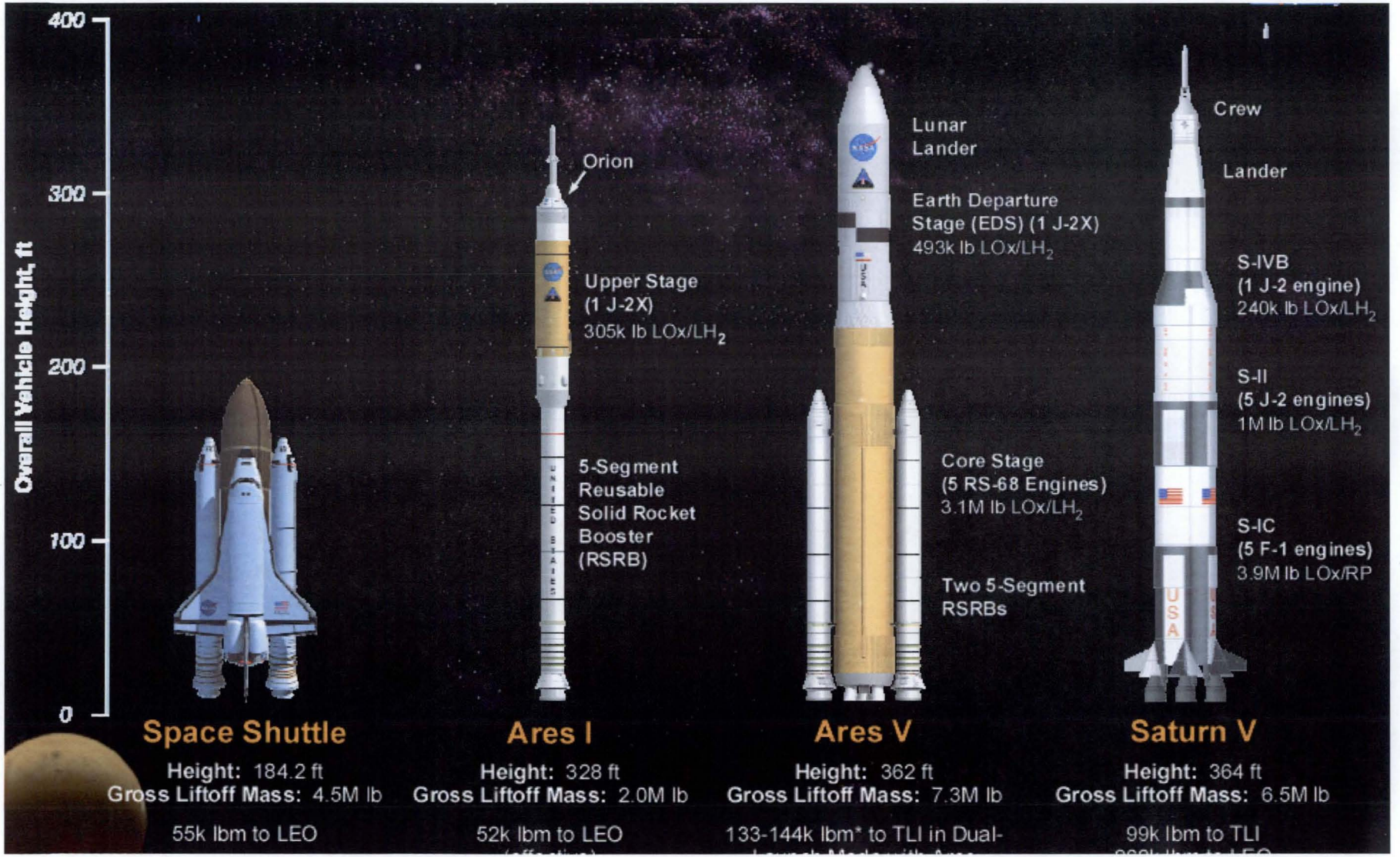
- Ares I is Two-Stage Launch System for the Orion Crewed Vehicle (CEV)
  - *The first test flight, Ares I-1, will be a suborbital test of the booster with an inert fifth SRB segment and a dummy second stage with mock-up engines. April 2009*
- Ares V is Cargo "heavy lift" launch system for the Lunar Surface Access Module (LSAM)



Ares in CxP Schedule

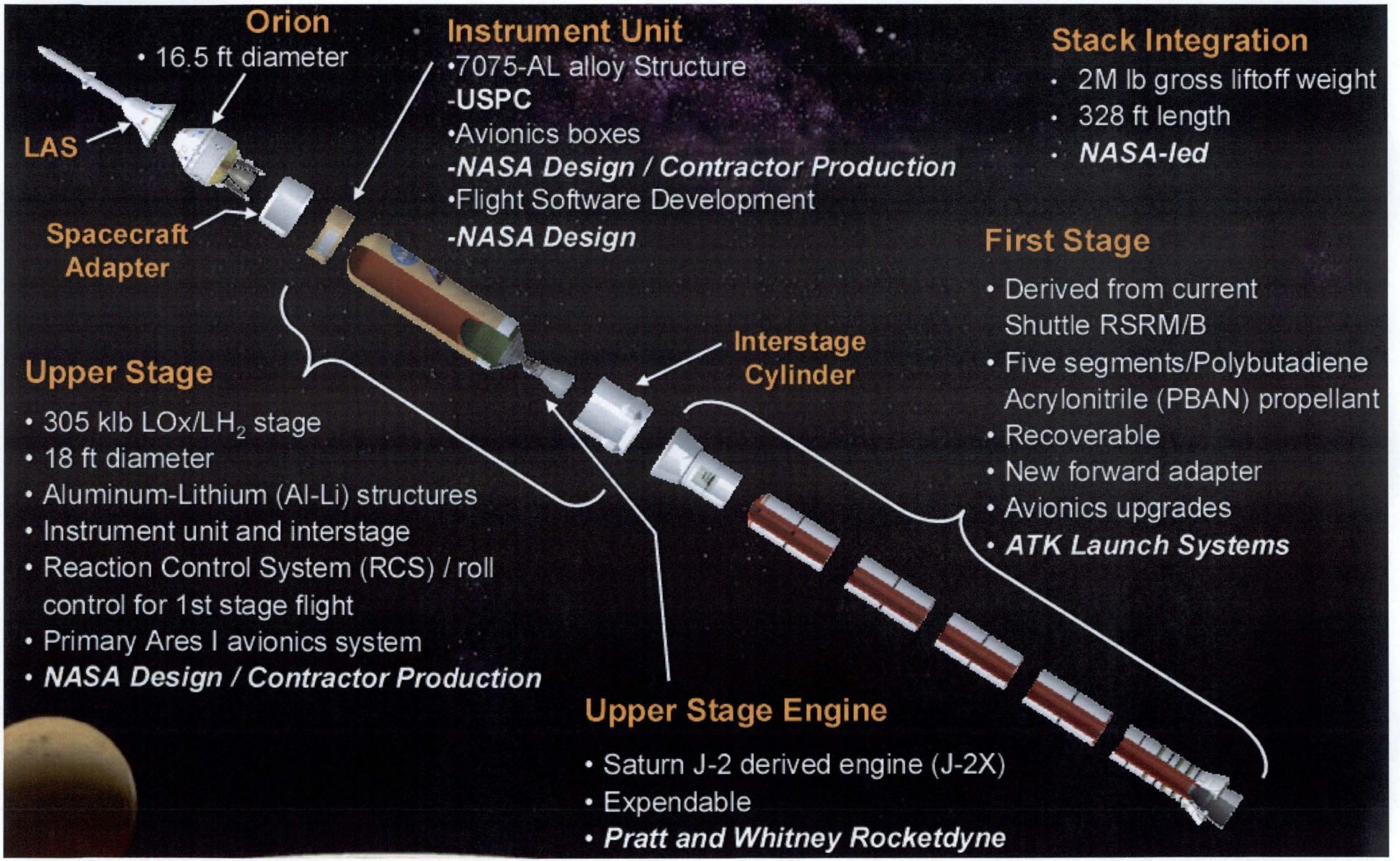


General Ares Description/Orientation



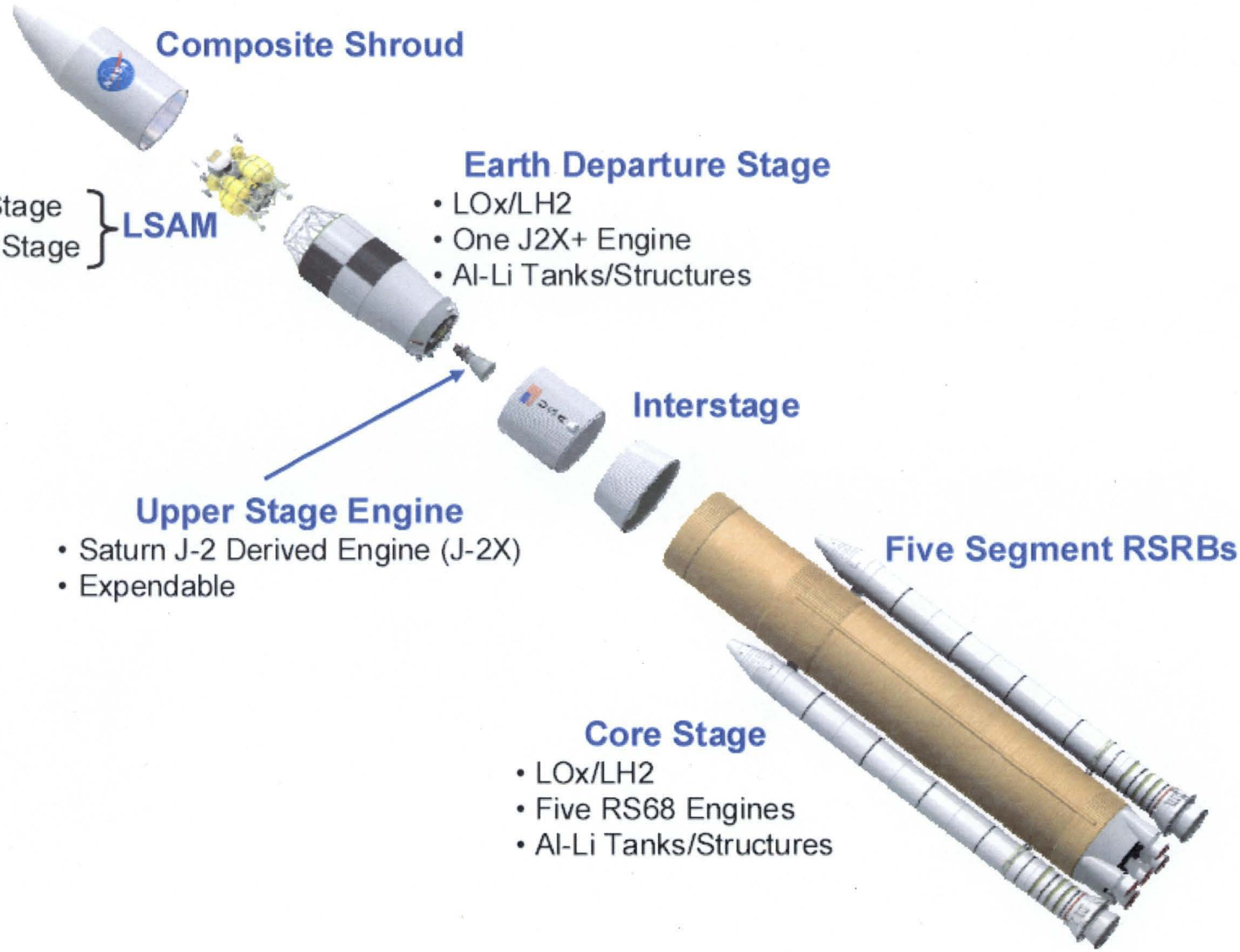
General Ares Description/Orientation

- ***Ares-I***

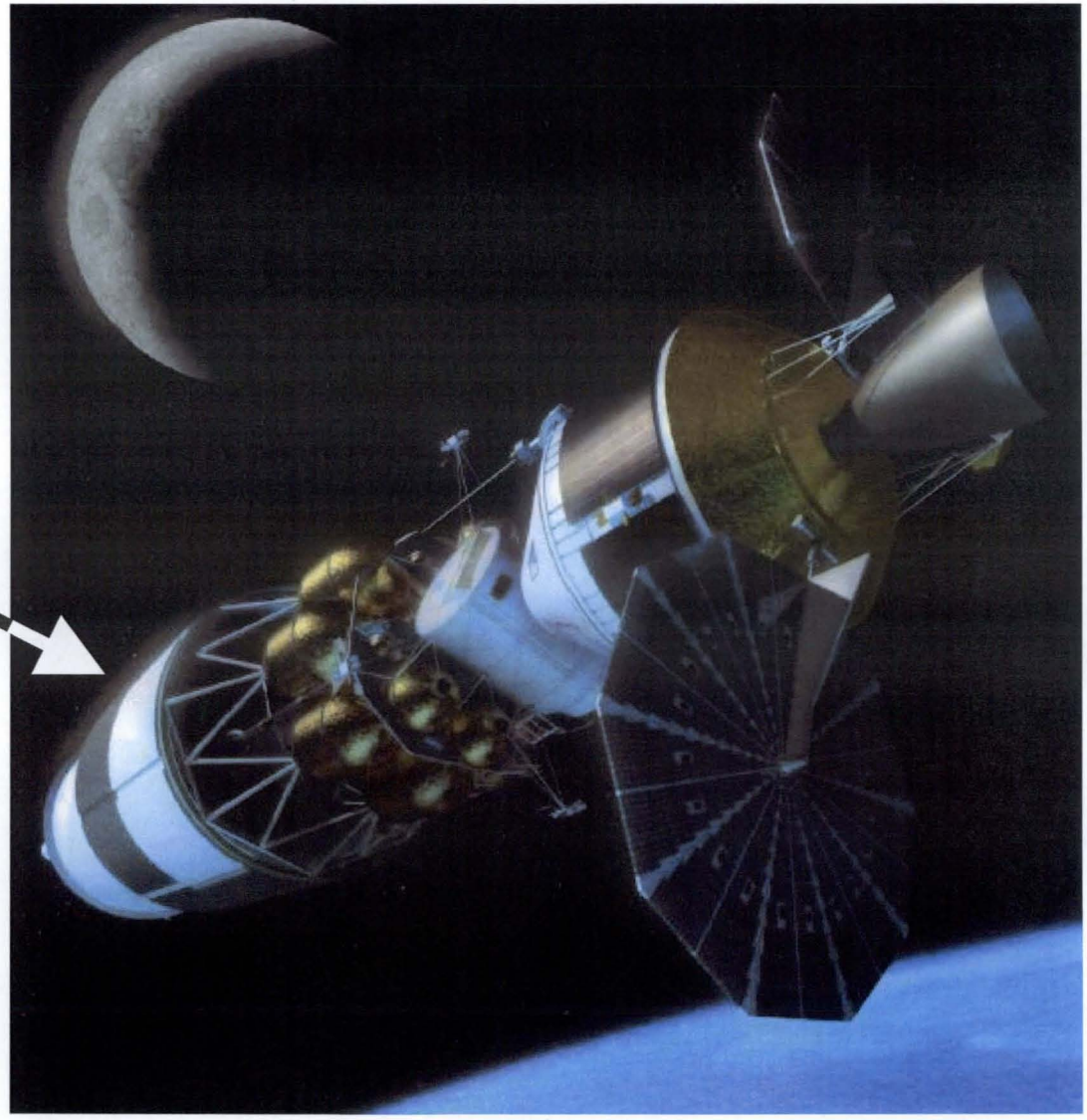


General Ares Description/Orientation

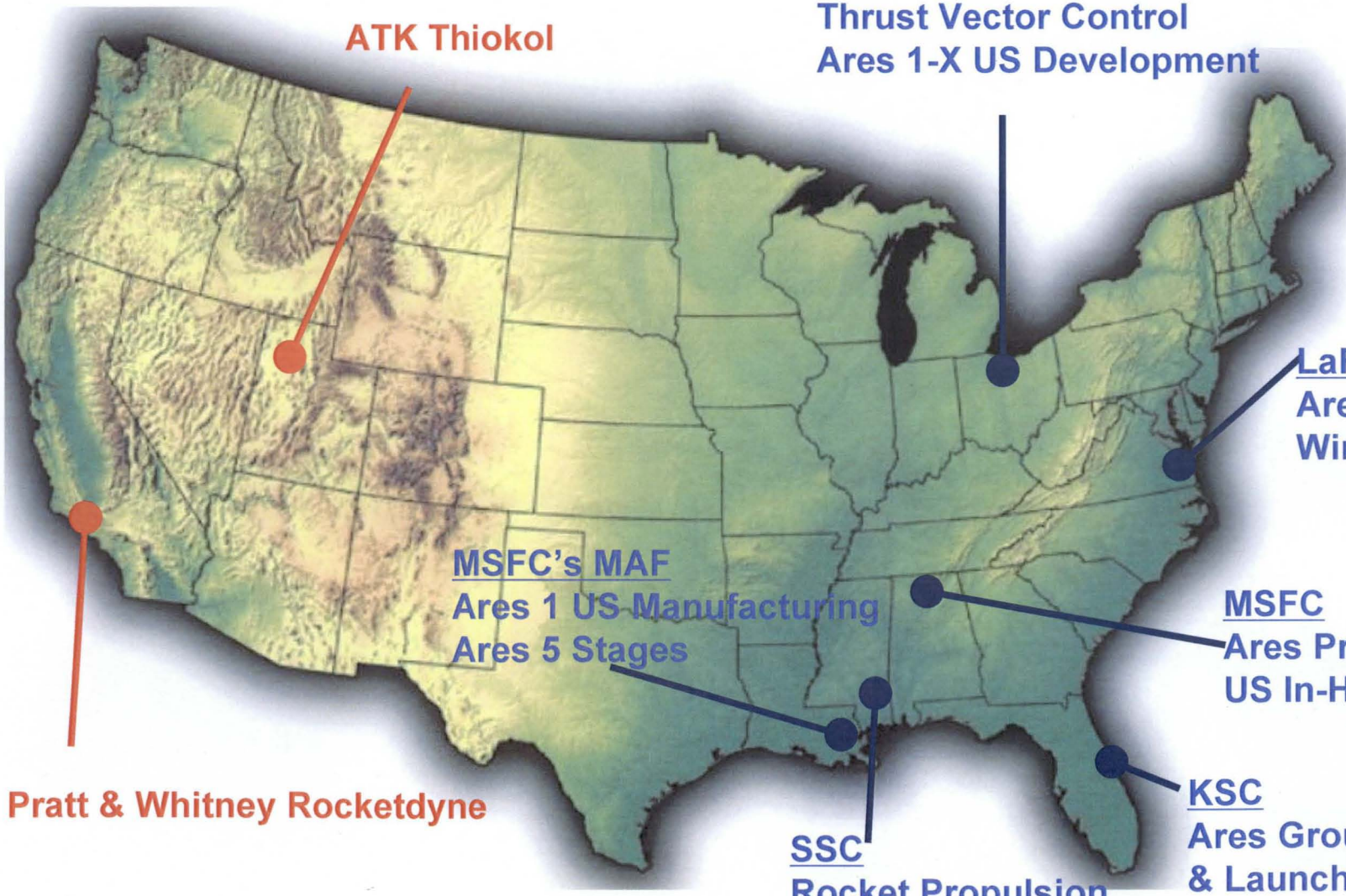
- ***Ares-V***



General Ares Description/Orientation



Ares I NASA Field Centers & Prime Contractors



Ares Thermal Requirements

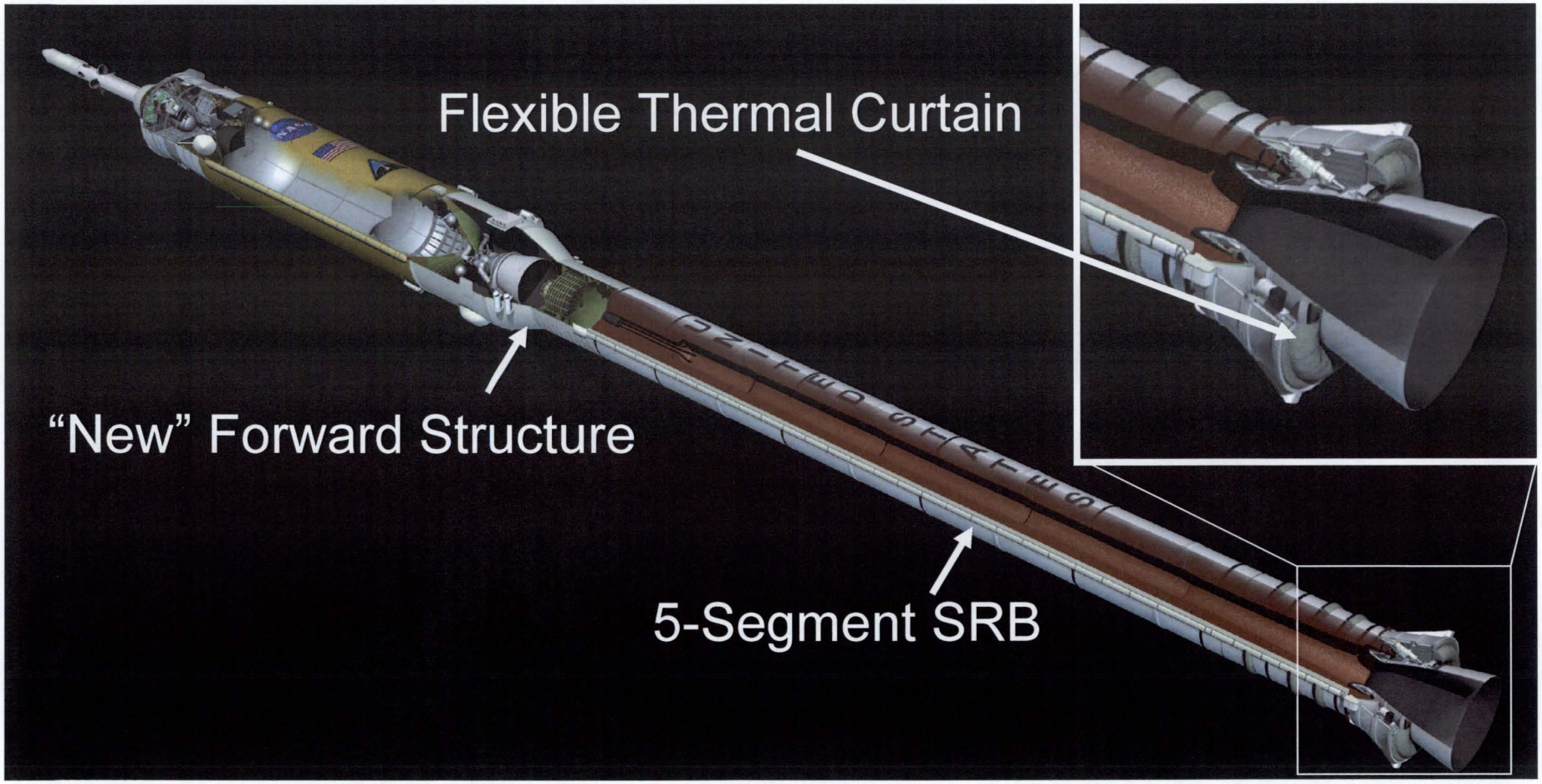
- **Top Level Thermally-Related Ares I Requirements:**
  - Maintain Structural Temperatures
  - Maintain Component Temperatures
    - Avionics, thrust vector control system, reaction control hypergolic thrusters, solid motors, parachutes, pyros, etc.)
  - Liquid Hydrogen/Liquid Oxygen Propellant Quality
    - J-2X propellant thermodynamic "start box" & "run box"
    - Stratification in propellant tanks
    - Heat leak allowable for tanks & feedlines
  - Preclude "hazardous" ice (allowable mass/locations TBD)

Ares Thermal Environments

- **Top Level Thermally-Related Ares I Environments:**
  - KSC Natural Environments (VAB, rollout, On-Pad)
    - Design Specification for Natural Environments
      - KSC ambient air temperature range, humidity, wind, solar, sky radiation, etc.
    - Natural Environments Definition for Design
    - Operability/Logistics Goal to eliminate roll-out power/purge
  - Ascent Aerothermodynamic and Plume Heating Environments
    - Ares-I Thermal Environments Data Book

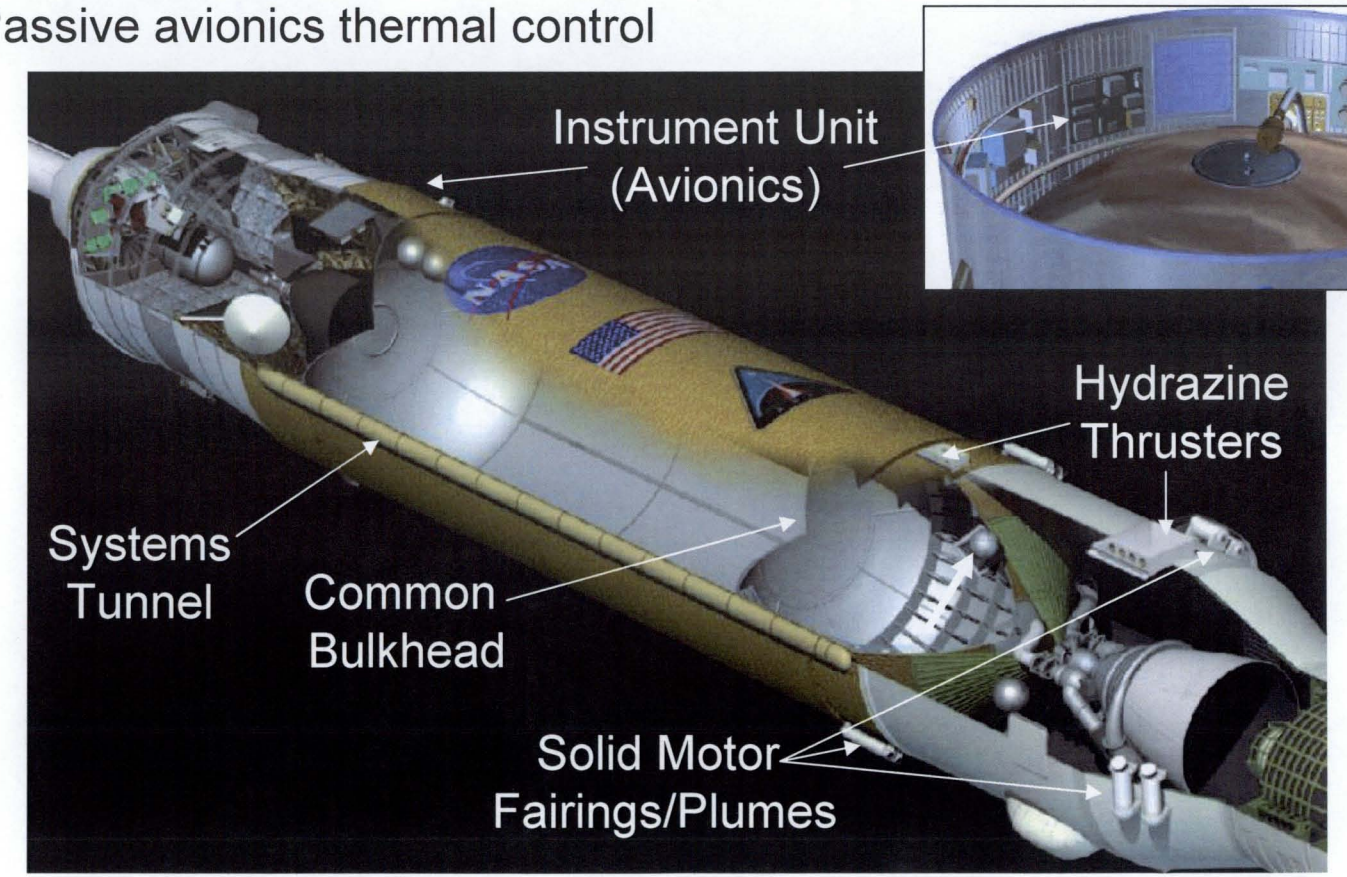
Ares Thermal Challenges

- **Ares I First Stage:**
  - Base Heating from 5-segment Solid Rocket Booster Plume (Thermal Curtain)
  - Re-entry environments (significantly higher than STS RSRB)
  - Re-qualification of TPS materials



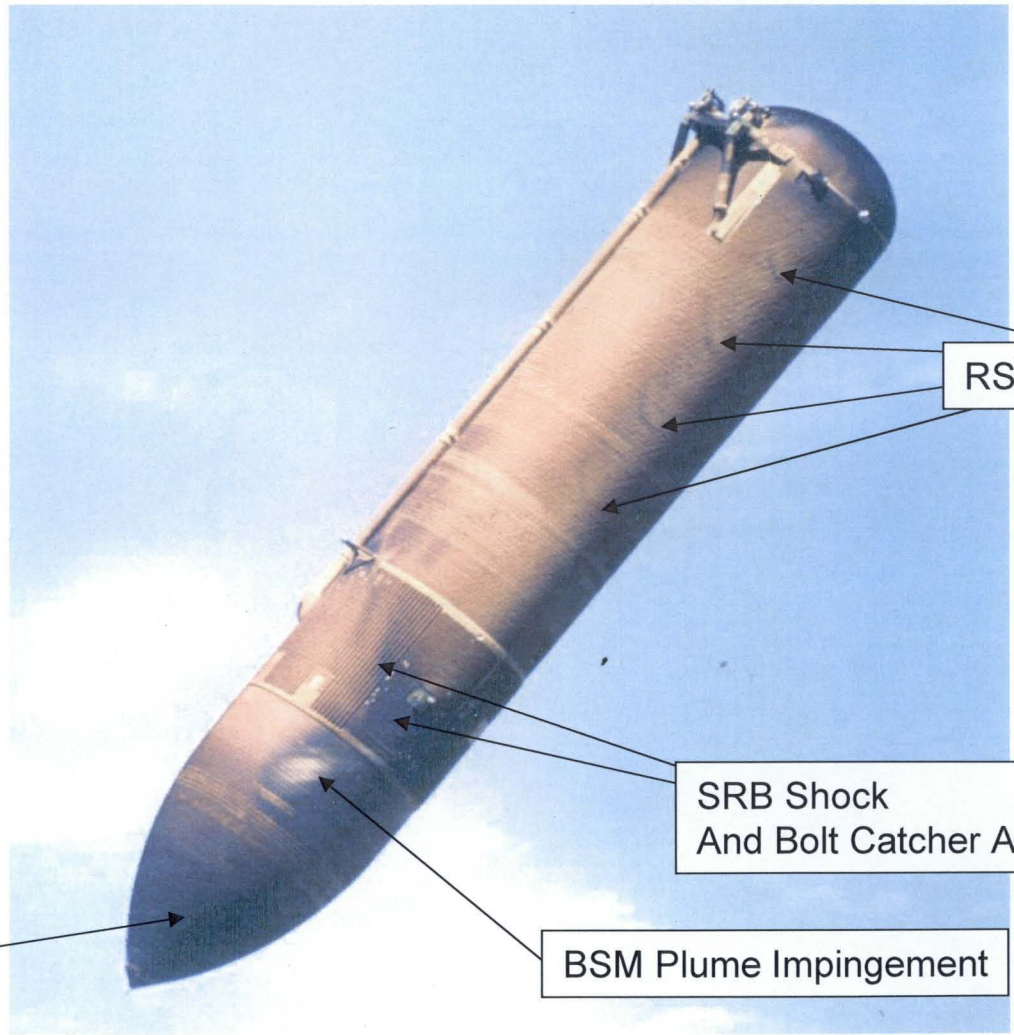
Ares Thermal Challenges

- **Ares I Upper Stage:**
  - Common Bulkhead between Liquid Hydrogen & Liquid Oxygen tanks
  - Liquid Hydrogen/Liquid Oxygen heat leak & stratification
  - Protuberance aero-thermal heating (various fairings, feedlines, systems tunnel)
  - Hydrazine temperatures for Reaction & Roll Control Thruster systems
  - Plume impingement from Solid Motors, RCS, J-2X
  - Passive avionics thermal control



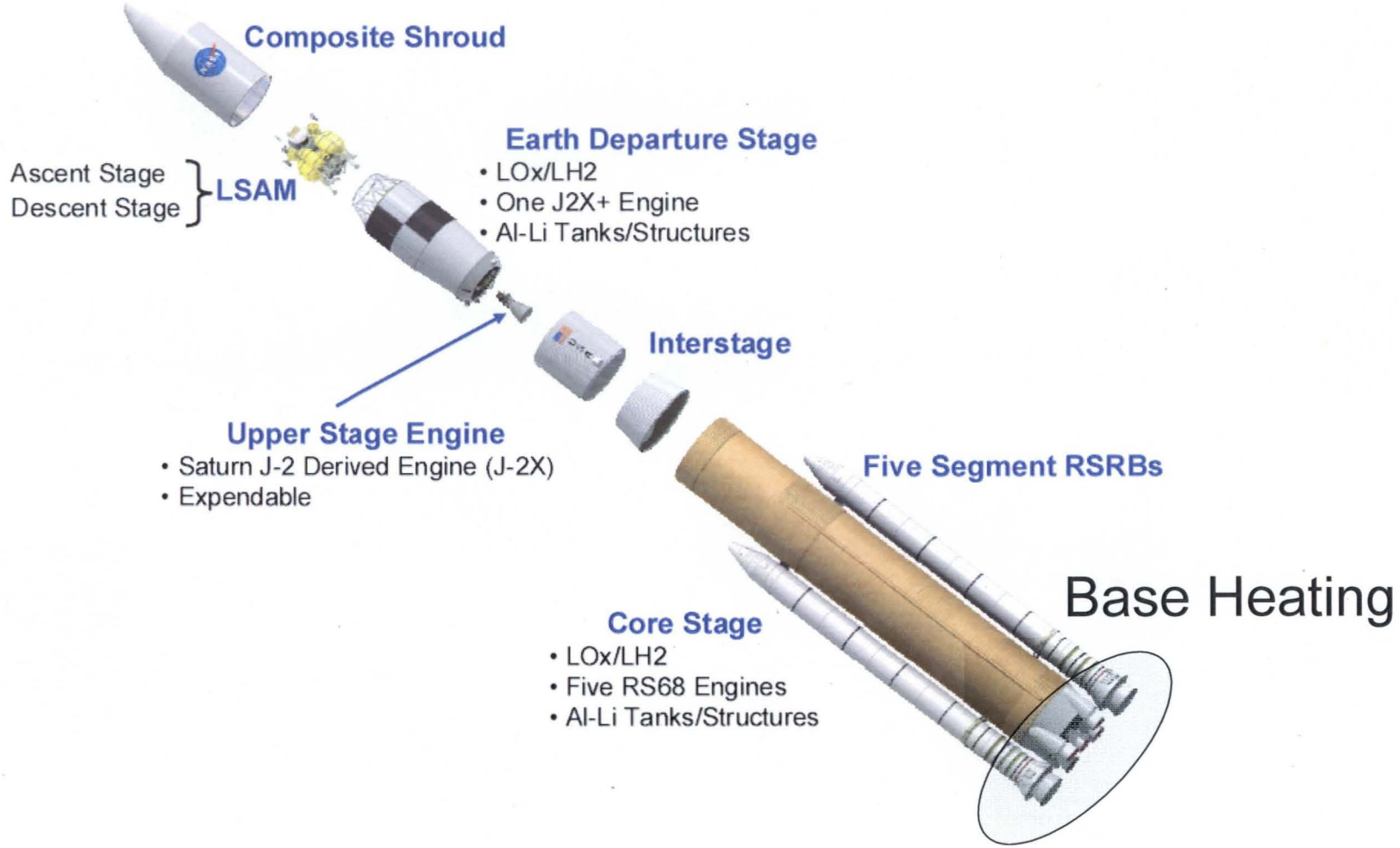
Ares Thermal Challenges

- External Tank Separation Photo Illustrating Plume Heating Charring/Ablation



Ares Thermal Challenges

- **Ares V**
  - Severe base heating environments for 5 RS-68 engines combined with 2 five-segment SRBs
  - Potential long duration orbital environment for EDS – maintaining cryogenic propellants

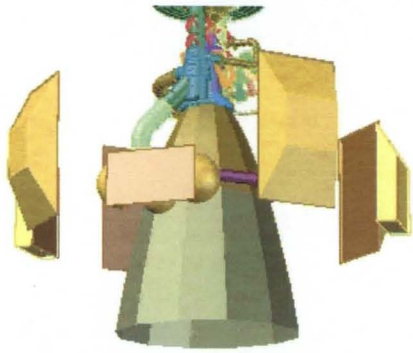


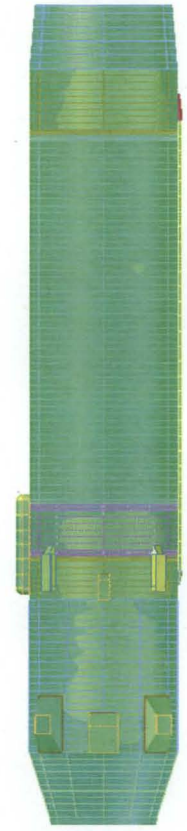
Ares Thermal Modeling

- **Ares I Thermal Modeling Tools:**
  - **First Stage (ATK)**
    - IDEAS-TMG, CMA, SINDA/G with proprietary Ablation routines
  - **J-2X (Pratt & Whitney Rocketdyne)**
    - TSS, SINDA/FLUINT, ANSYS, PATRAN
  - **Upper Stage (Marshall Space Flight Center)**
    - Thermal Desktop 5.0 (with AutoCAD 2007, SINDA/FLUINT, FloCAD)
    - PATRAN, P/Thermal
    - SINDA/G with ABL (in-house Ablation code)
    - FEMAP (as front end mesher to Thermal Desktop or SINDA/G)
    - CFD (various in-house CFD codes for compartment purge analyses)
    - CHCHVENT (in-house venting code)
    - GFSSP (in-house thermo fluid dynamics code)
    - MEIT - Momentum/Energy Integral Technique (Rocket Nozzles)
    - NAT (nozzle ablation)
    - ACE - Aerotherm Chemical Equilibrium
    - CMA - Charring Material Thermal Response and Ablation

Ares Thermal Modeling

- **Ares I Thermal Modeling Examples:**

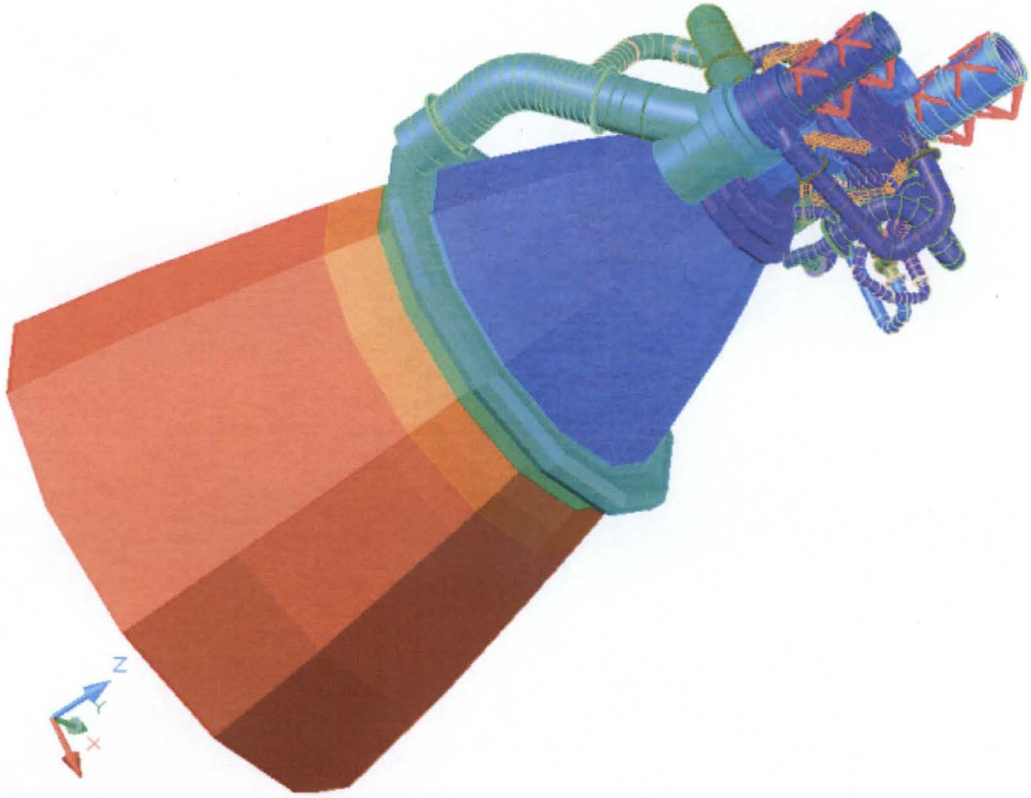




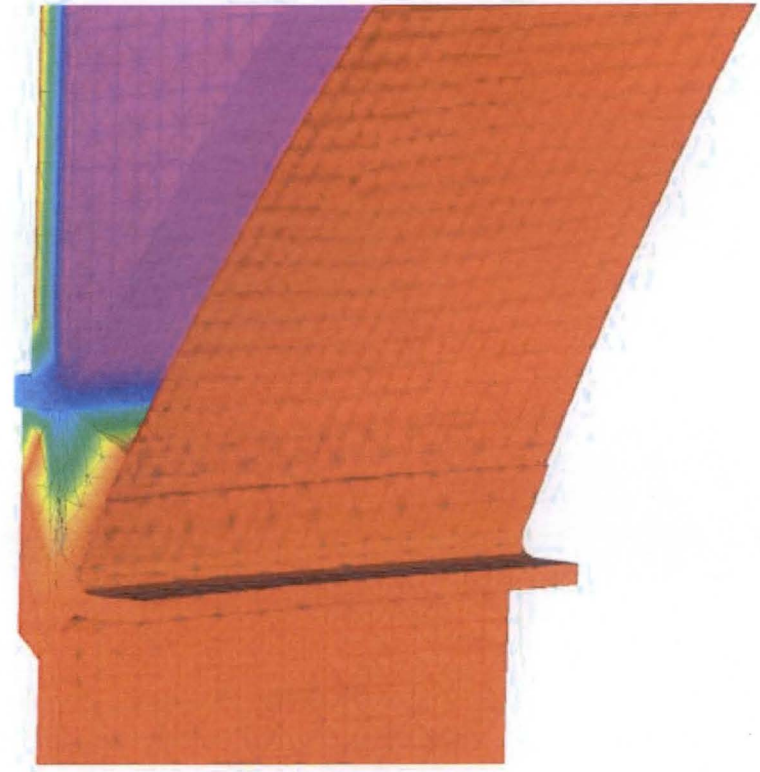
Integrated Upper Stage

Ares Thermal Modeling

- **Ares I Thermal Modeling Examples:**



J-2X



Common Bulkhead Joint

Ares Status

Ares Quarterly #5 Status August 2007