



Payload Processing Capabilities in Support of Ares V Planetary Missions

Solar System Science Enabled by Ares V Workshop
NASA Ames Research Center, Mountain View CA

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Introduction

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■ Objective

- Discuss requirements and capabilities needed to service and process Ares V class payloads

■ Approach

- Discuss current launch site (KSC) processing capabilities
- Identify Ares V scale impacts/constraints
- Demonstrate simulation of payload processing and operation capabilities
 - Identify science community requirements/needs
 - Prioritize payload processing steps for simulation to best NASA support decision making and life cycle CONOPS

Ground Processing: Spacecraft vs. Launch Vehicle

Flight Hardware Processing Flow Capabilities

(Arrival through Return)



- **Spacecraft Fueling**
- **Ammonia Operations**
- **Vacuum Chamber Element Tests**
- **Remote Spacecraft Checkout**
- **Multiple Element Integrated Testing**
- **Weight & CG Determination**
- **Logistics and Transportation**
- **Emergent Manufacturing**

Integrated Operations



Vehicle Processing



Spacecraft processing is fundamentally different from launch vehicle processing but understanding both ensures optimal interfacing, servicing and operation

Boeing Payload and Vehicle Processing Experience

A photograph of a space shuttle launching, with the orbiter and external tank visible against a blue sky with clouds.

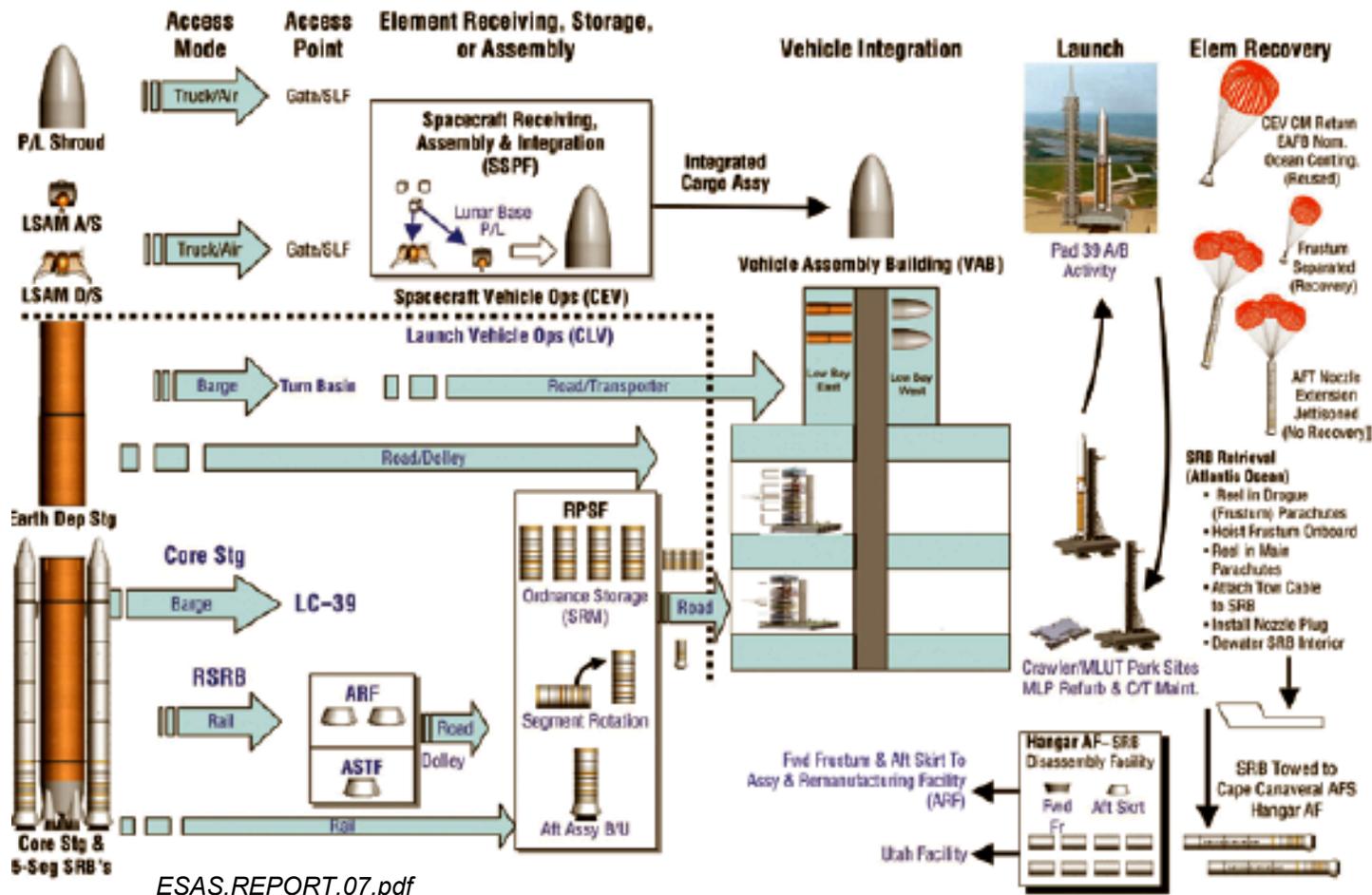
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- **KSC Payload Processing (CAPPS)**
 - Shuttle Pressurized and Unpressurized payloads (<4.5 m)
 - ISS Pressurized and Unpressurized payloads (<4.5 m)
- **Delta (Florida and CCAFB)**
 - Launch Vehicle (Delta, now ULA)
 - Payloads (<5 m) at Astrotech
- **Sea Launch**
 - Payloads via Boeing PAF and Fairing (<4 m)
- **Boeing Satellite Systems**
 - Satellites (<5m)

Current Ares V Payload Processing Flow

Limited lower processing definition available

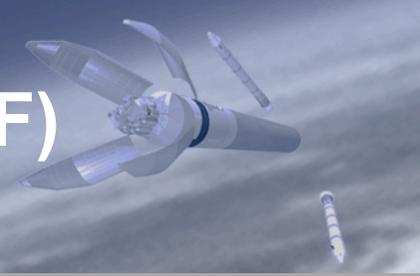
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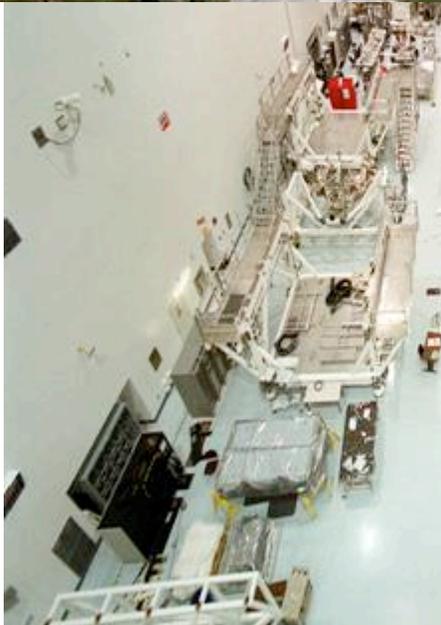
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Space Station Processing Facility (SSPF)

Future Constellation Payload Processing Facility



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SSPF is slated for lunar lander processing operations

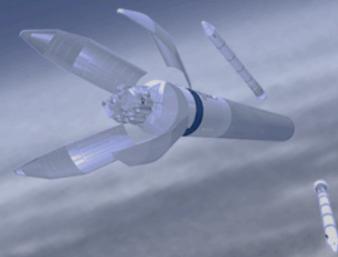
SSPF: Non-hazardous
Location: KSC Industrial Area-NASA Causeway
Cleanliness: 100K
Processing Area Size (WxLxH):
Airlock: 46' x 108' x 61'6"
Highbay: 105' x 362' x 61'6"
Lowbay: 50' x 338' x 30'/15'
Crane Capacity:
Airlock: 15 Ton Bridge
50'7" max hook height
Highbay: (2) 30 Ton Bridge
50' max hook height
Lowbay: (2) 5 Ton Bridge
25' max hook height
Door Size (WxH):
Airlock: 42' x 49'6" (both ends)
Payload Canister Compatible:
Yes-horizontal orientation only
Other Capabilities:
Offline laboratories
Control/user rooms

3-D models exist for all NASA facilities

Shroud Encapsulation Issues

From Lunar Capability Concept Review (LCCR)

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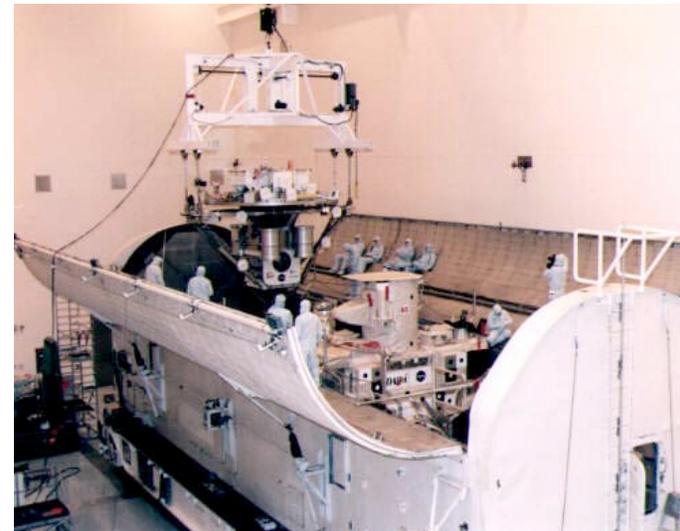


- ◆ Shroud quad sector configuration will likely preclude partial encapsulation in SSPF
- ◆ Shroud Encapsulation risks are the same for all 51 Series Ares V variants
- ◆ GO and Ares V teams will continue to study shroud ground processing alternatives.

Multi-Payload Processing Facility (MPPF)

Non-hazardous payload facility

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- Two major structures make up the MPPF complex: the MPPF itself, which contains an airlock and processing highbay and lowbay, and the Multi-Operations Support Building (MOSB), which contains offices and control rooms.

Facility	# P/L's at one time	Processing Space, WxLxH	Clean Room Class	Door Size	Hoisting Equipment, Tons & Max Hoisting Height	Control Room Size, Sq Ft	Haz Ops Cap
Multi-Payload Processing Facility (MPPF)	Sm=4 Med=2 Lg=1	Airlock: 39'x28'x20' Highbay: 60'x135'x62'	Airlock: 300,000 Highbay: 100,000	Airlock: 20'x15' Highbay: 28'x42'	Airlock: None Highbay: 20 Ton Bridge 50' HH	2900 sq-ft	Non Haz

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Payload Hazardous Servicing Facility (PHSF)

Hazardous or non-hazardous processing facility

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- The PHSF accommodates such payload activities as ordnance installation, loading of liquid propellants (hypergols, etc.), hazardous systems tests/checkout, buildup/mating of a payload to a solid propellant upper-stage motor, propellant leak tests and other potentially hazardous operations
- The PHSF contains hazardous operations service bays and airlocks

Facility	# P/L's at one time	Processing Space, WxLxH	Clean Room Class	Door Size	Hoisting Equipment, Tons & Max Hoisting Height	Control Room Size, Sq Ft	Haz Ops Cap
Payload Hazardous Servicing Facility (PHSF)	Sm=3 Med=2 Lg=1	Airlock: 85'x50'4" x 89'10" Highbay: 107'x60'4" x 94'10"	Airlock: 300,000 Highbay: 100,000	Airlock: 35'5" x 7' Highbay: 35'5" x 7'	Airlock: 15 Ton Bridge 75' HH Highbay: Qty 2 50 Ton Bridge 83' HH	4140 sq-ft	Haz Bi-Prop

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Payload Processing Range of Capabilities in Vicinity of KSC

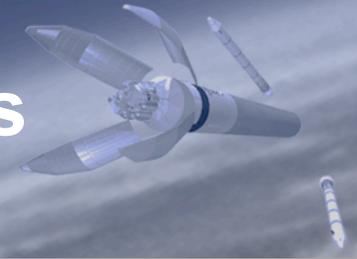
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- **Spacecraft lifting and handling from/to transport**
- **Assembly and Check-out**
 - Ground handling equipment
 - Resources (power, fluids, thermal and contamination control)
 - Certified technicians
- **Engineering support**
 - Provide logistics and depot support
 - Design, sustaining engineering, operation and maintenance of flight and ground systems; information technology; and institutional support

Key to reducing life cycle cost and schedule risk: include in launch processing features in up front design (e.g., support equipment attach locations, electrical grounding provisions, fueling/servicing ports, etc.)

Payload Transportation and Logistics

Logistics can be painful if ignored



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An example of leaving logistics to the end of the design cycle



400 km trip turned into 9000 km trip when scientists discovered a transportability problem after vessel was built

KATRIN spectrometer is about the size of a Ares V 10 m diameter payload

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Many Lessons Learned on the Transport and Logistics of Past Large Spacecraft

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Shuttle External Tank Carrier



Delta IV Common Booster Core loaded in Delta Mariner

Saturn IB stage at Michoud Assembly Facility

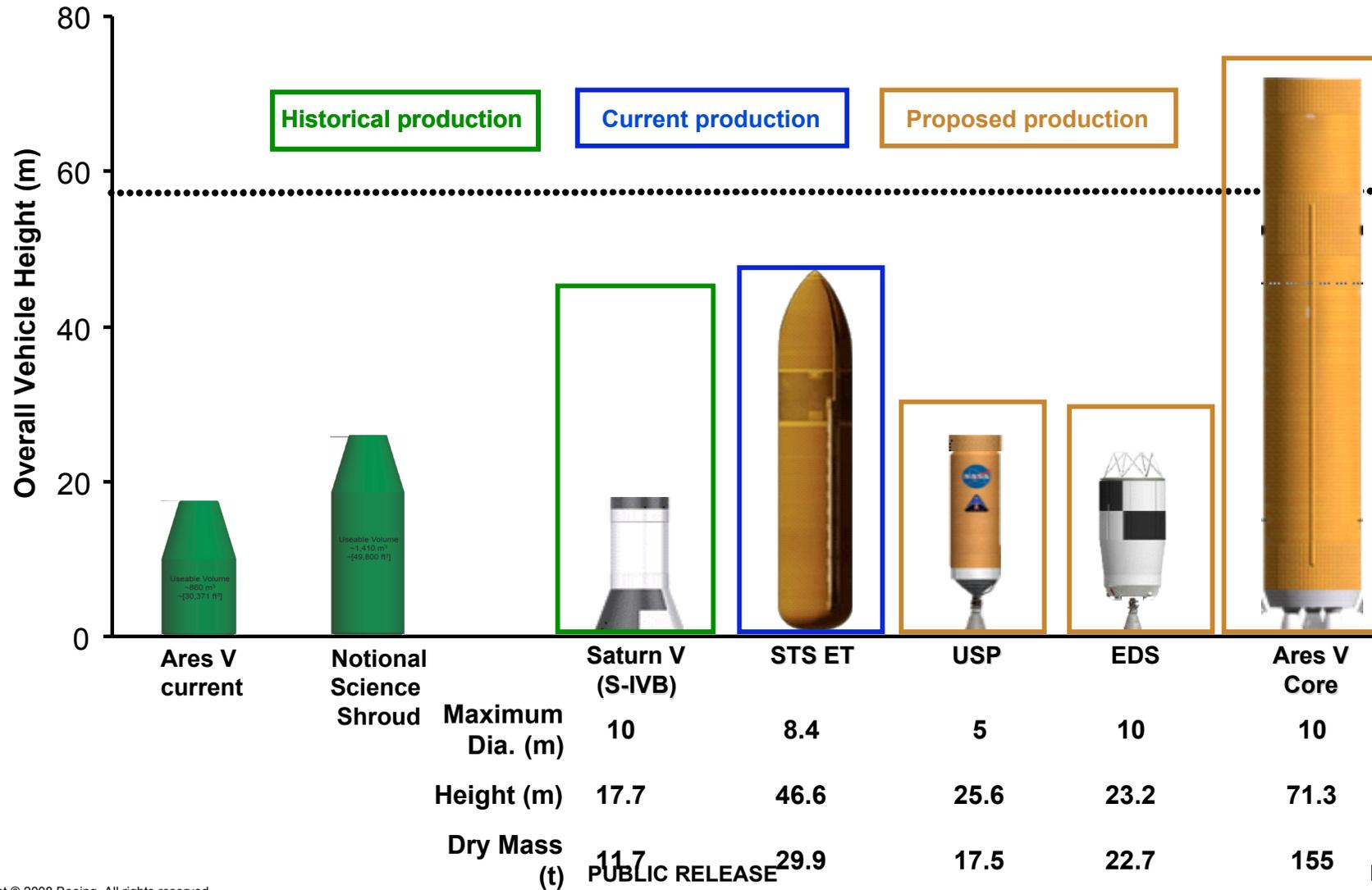


The Super Guppy takes on an S-IVB stage



Payload Size Comparison to Other Elements

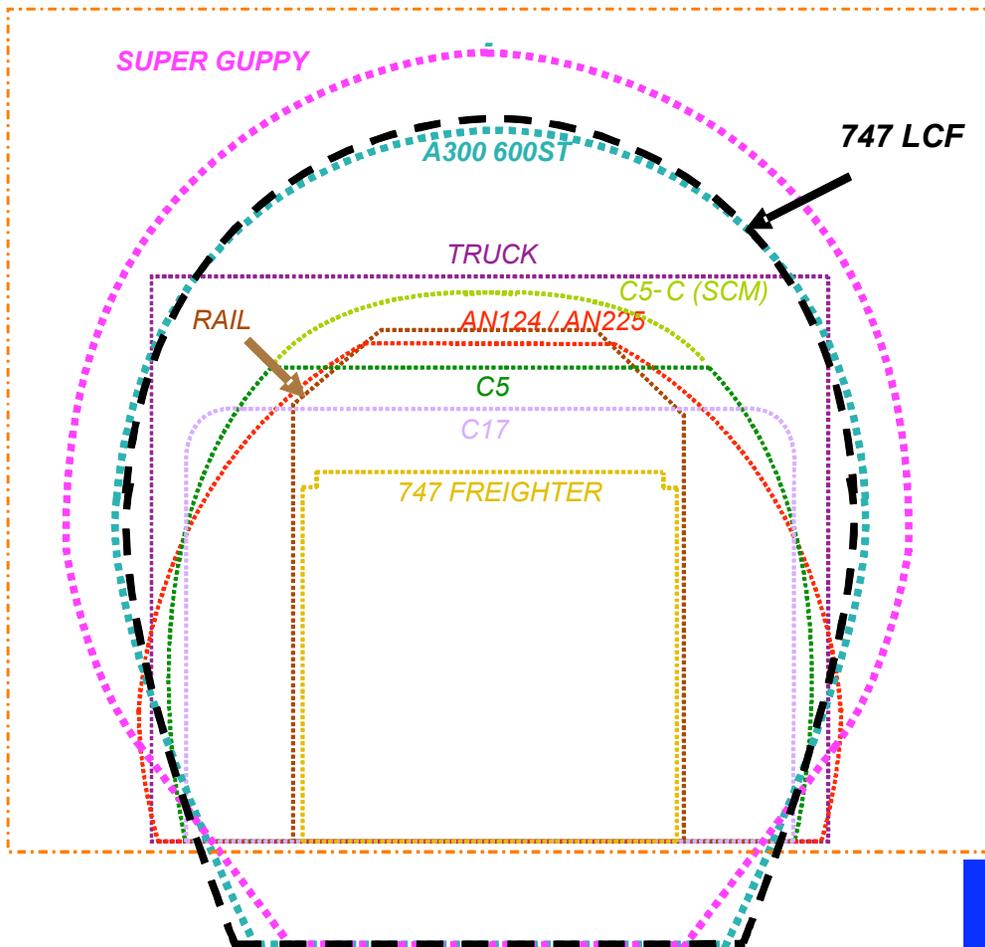
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Transport Options for Large Payloads

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WATER VESSEL / HELICOPTER



Oversize Truck

C-17

C-5C (SCM)

C-5

AN124/AN255

Airbus Beluga (A300-600ST)

Super Guppy

747 Large Cargo Freighter

747 SCA w/cargo pod

Helicopter with sling lift

Water vessels

**Maximum Super Guppy Payload
is less than 7.5 m**

Payload Processing Issues

Based on past processing experience

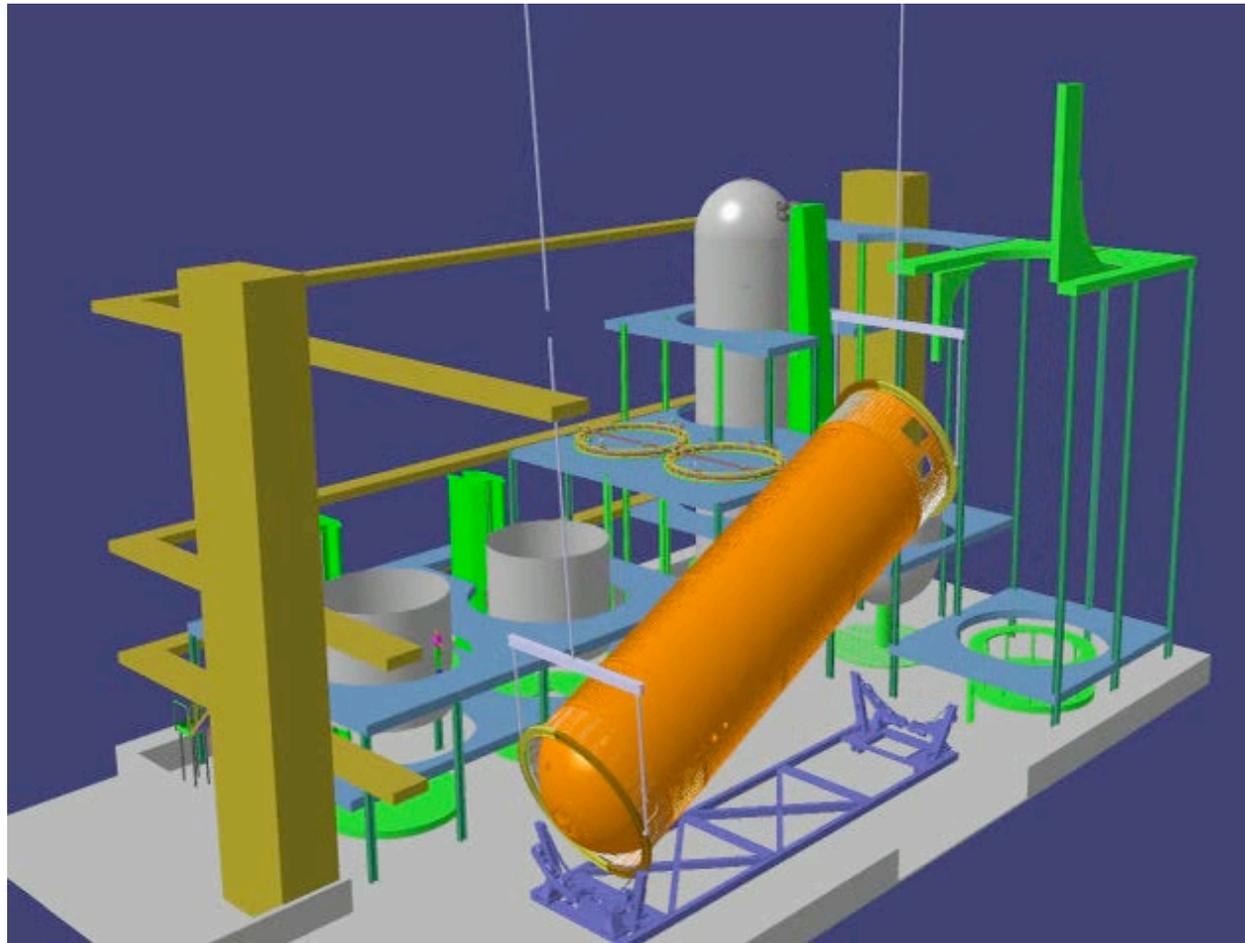
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- **Transportation of 8.8 m payloads to KSC (10 m fairing)**
- **Late Access to Payloads**
- **Umbilical's to “Active” Payloads**
- **Payload natural frequency & dynamic envelope**
- **Fairing Environments (acoustics, thermal, cleanliness)**
- **Upper Stage Payload vs. Shuttle deployment**

Payload Processing Modeling & Simulation

DELMIA

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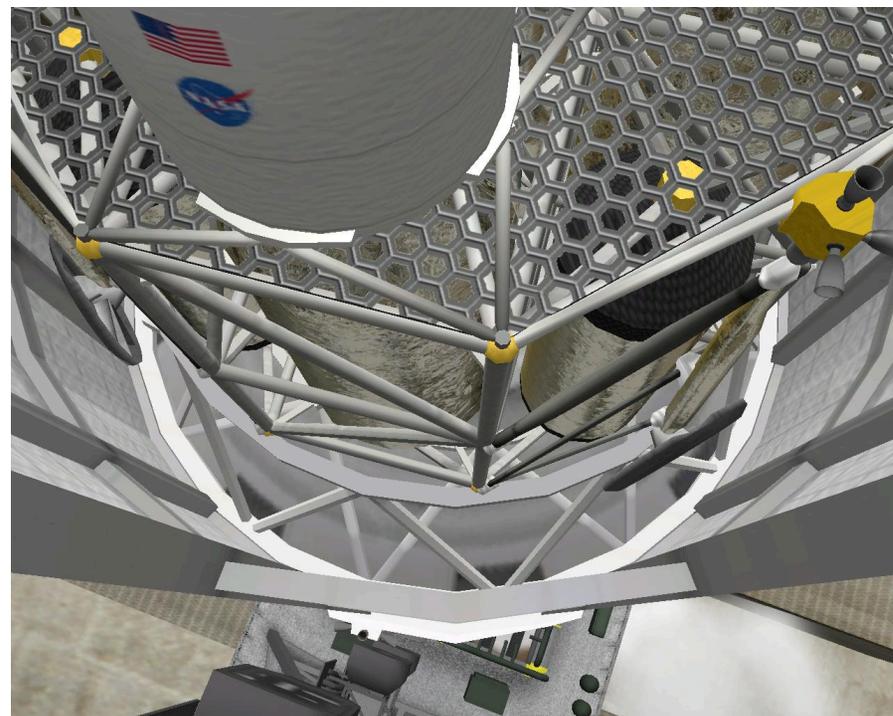


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Flight Operations Interactive Simulation

ICON (Interactive Concept of Operations)

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Show ICON 6.2K (moon mission) or 7.0 (ESL2 telescope) if available



Conclusions

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- **Payload processing requirements are large life cycle cost drivers and are developed too late in the process or ignored**
- **Ares V class payload processing requirements need to be defined soon to support future planning**
 - Trade between existing infrastructure and new
 - Will impact development of Constellation infrastructure requirements
- **Boeing is currently evaluating Ares V class vehicle and payload processing requirements/impacts under IRAD**
 - Leveraging on Shuttle, ISS and Ares I involvement
 - Developing production and flight analysis and simulation to enhance understanding of issues and communicate Constellation objectives
- **Help needed to define user communities processing needs (e.g., payload models, CONOPS, requirements)**