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The Space Congress® Proceedings

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May 24th, 10:00 AM

## CST-100 STARLINER: Boeing's Commercial Crew Program

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# CST-100 **STARLINER**

**Boeing's Commercial Crew Program**  
Danom Buck, Manager  
Manufacturing Engineering  
**Space Congress**  
May 24, 2016





# STARLINER

## Mature System Design



### United Launch Alliance Atlas V Rocket

- More than 60 successes and counting!
- Proven rocket significantly reduces system risk
- Human-rating of Space Launch Complex 41 at Cape Canaveral Air Force Station in progress



### CST-100 Starliner Spacecraft

- Flight-proven systems, high-technology readiness level
- Firm configuration established



### Mission Operations

- Integrated with the world's experts on mission control: NASA Mission Operations Directorate
- Crew engagement through plan, train and fly phases

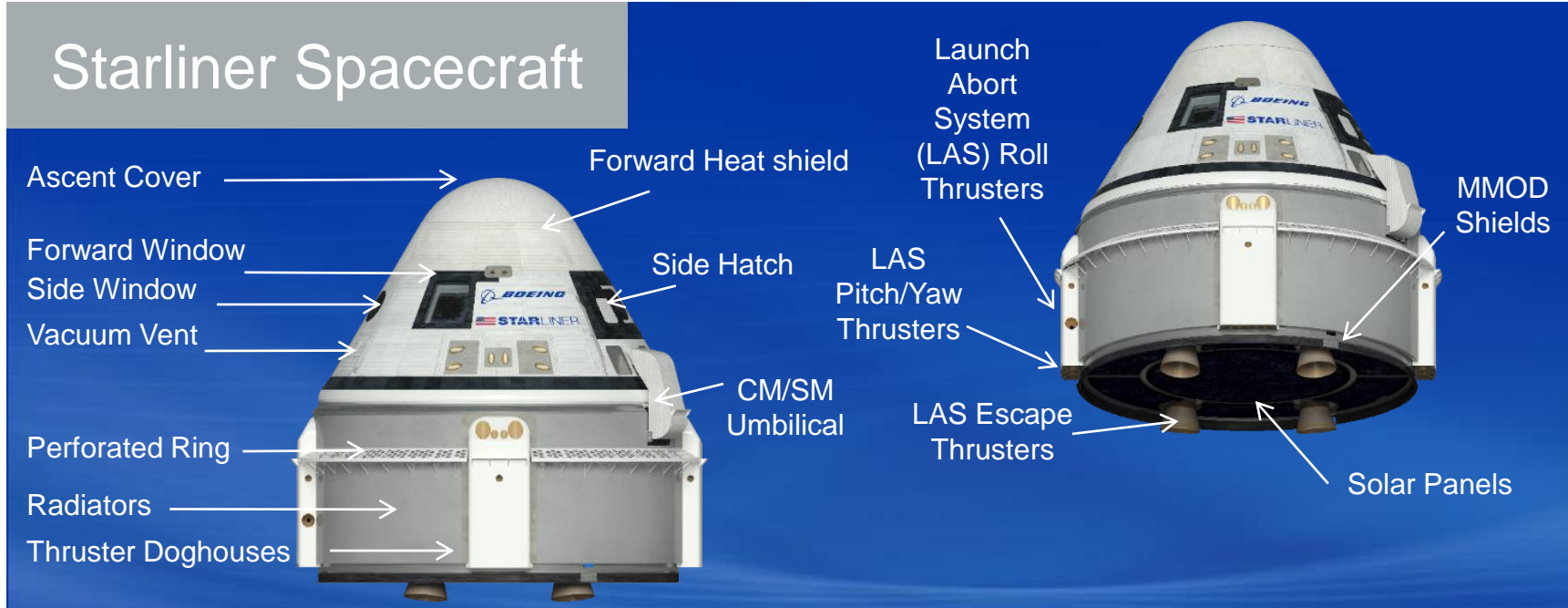


### Ground Processing Operations

- Commercial Crew and Cargo Processing Facility modernized at NASA's Kennedy Space Center
- Lean production based on Boeing's commercial approach
- Integration testing and quality processes based on space shuttle and International Space Station approaches

# STARLINER

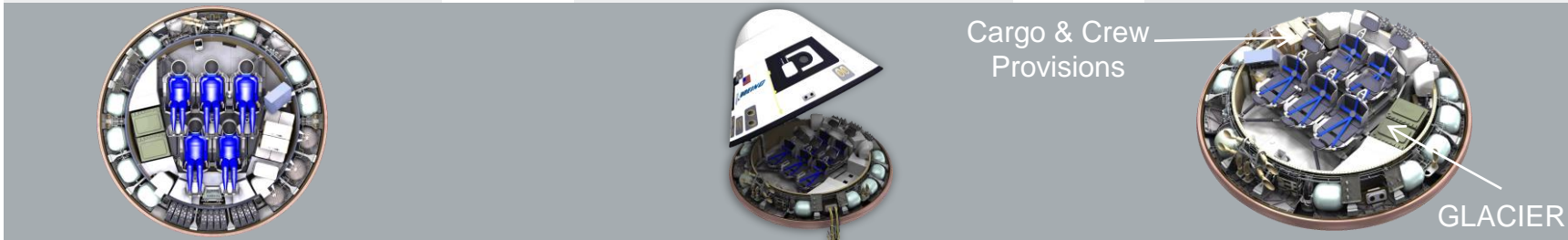
## Mature System Design



**SEATING FOR SEVEN**  
(5 CREW + 2 CREW EQUIVALENT OF CARGO SHOWN)

**CLAM SHELL DESIGN**  
ALLOWS FOR EASY HARDWARE INSTALLATION

**FLEXIBLE CABIN DESIGN**  
ACCOMMODATES MIX OF CREW AND CARGO



# STARLINER

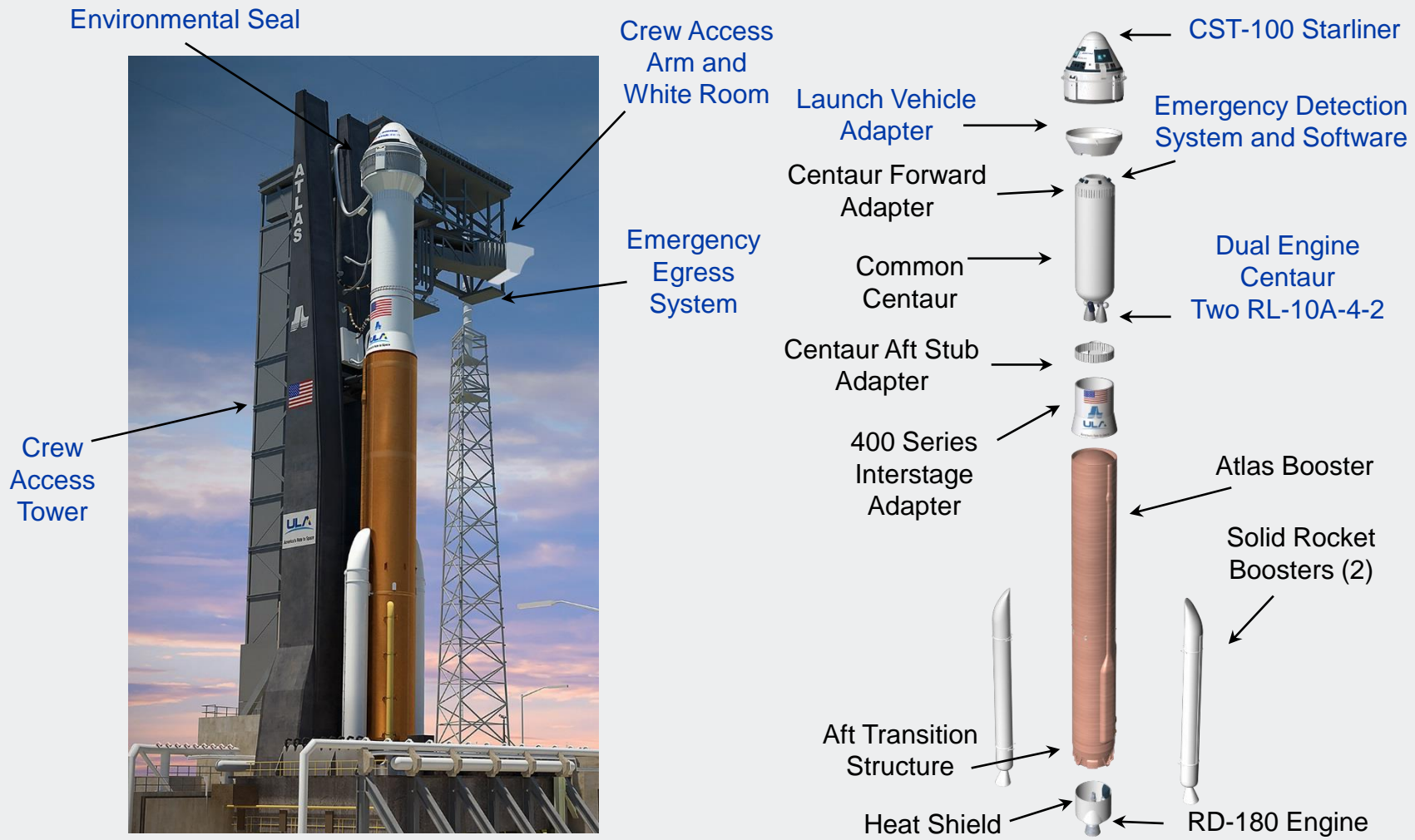
## Mature System Design

### Atlas V Launch Vehicle

#### LEGEND

BLACK = HERITAGE

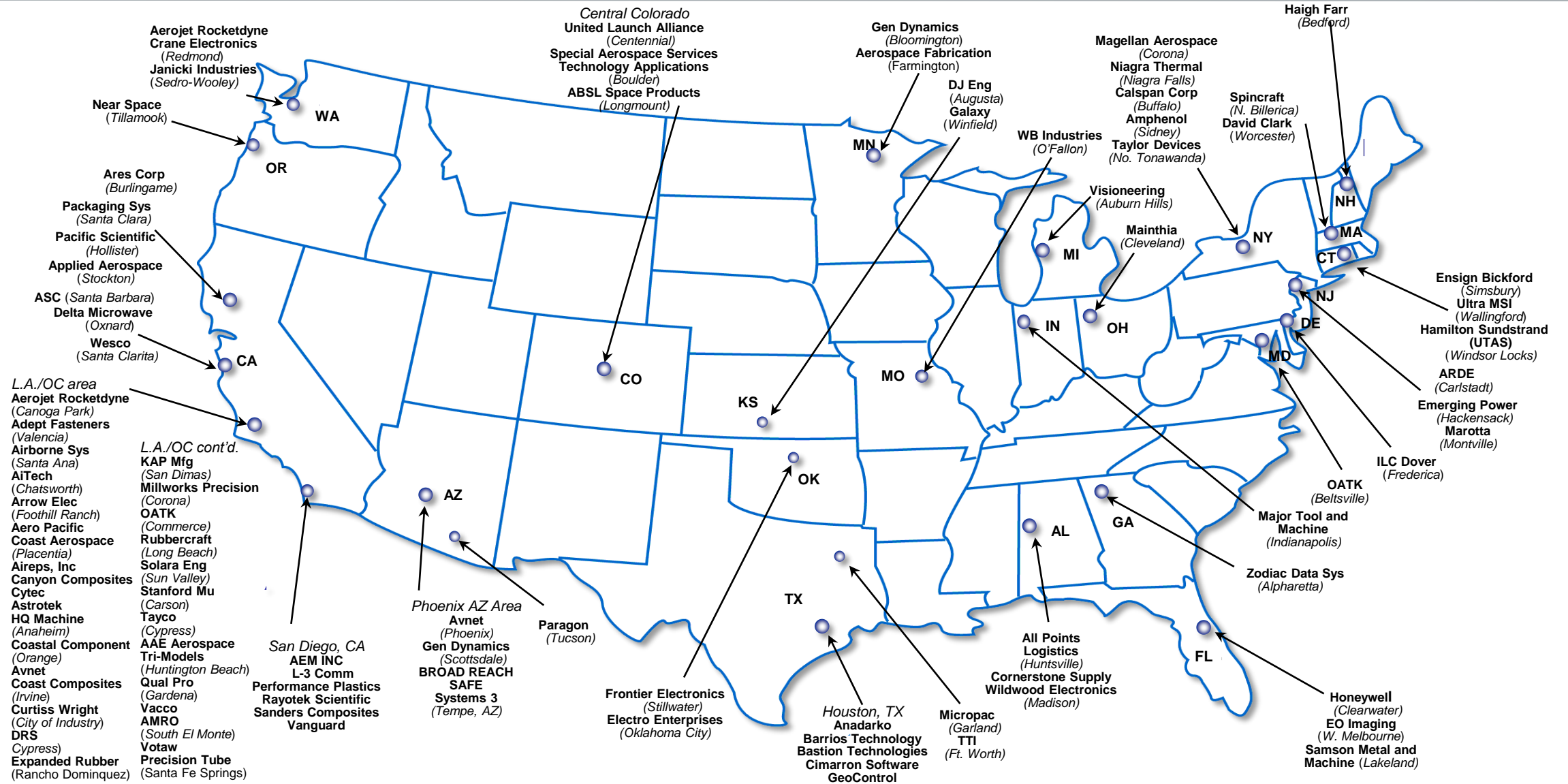
BLUE = NEW SYSTEMS





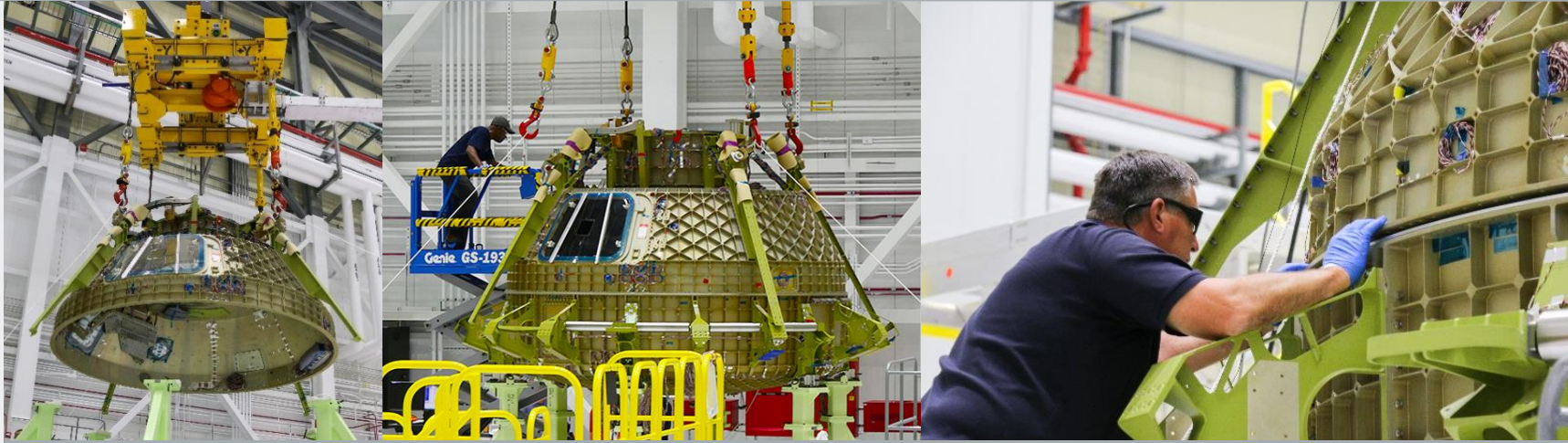
# STARLINER

## Nationwide Supplier Base



# STARLINER

## Build Progress



Structural Test Article build-up in Commercial Crew and Cargo Processing Facility at Kennedy Space Center, Florida



Spacecraft 1 hardware progressing across supply base and arriving to Commercial Crew and Cargo Processing Facility at Kennedy Space Center, Florida



# STARLINER

## Test Progress



Starliner performs first contingency water drop qualification test at Langley Research Center, Virginia



NASA and Det 3 rehearse rescue and recovery operations with Starliner



Crew Access Arm and White Room undergoing testing through various lighting conditions in Oak Hill, Florida



# STARLINER

## Astronaut Training and Supplier Visits



Astronauts receive Atlas V familiarization training with United Launch Alliance in Decatur, Alabama



Astronaut Megan McArthur visits LIDAR manufacturer in Santa Barbara, California



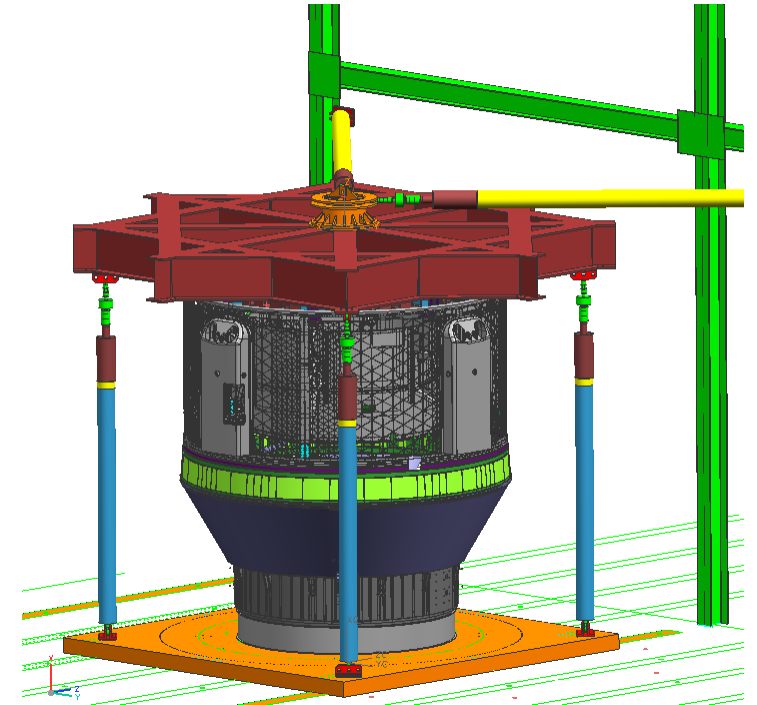
Astronaut Ricky Arnold visits ECLSS manufacturer in Connecticut



Astronauts run through simulations on Crew Part-Task Trainers built in St. Louis

## What's Next? Qualification Test Campaign

Test	Location	Primary Purpose
Structure Verification Testing	NASA Kennedy Space Center, Florida & Huntington Beach, California	<ul style="list-style-type: none"> <li>• CST-100 structure verification                             <ul style="list-style-type: none"> <li>• Modal survey</li> <li>• Structures loading for critical load conditions</li> <li>• Structural integrity</li> <li>• Ordnance-actuated device shock levels</li> <li>• Separation system performance</li> <li>• FEM validation</li> </ul> </li> </ul>
Service Module Hot Fire Test	NASA White Sands Test Facility, New Mexico	<ul style="list-style-type: none"> <li>• Demonstrate integrated propulsion system performance and system dynamics</li> </ul>
Ground Verification Testing / Environmental Qualification Testing	NASA Kennedy Space Center, Florida & El Segundo, California	<ul style="list-style-type: none"> <li>• Perform vehicle-level environmental verification testing and system-level non-chamber qualification:                             <ul style="list-style-type: none"> <li>• Verify system performance verification</li> <li>• Electromagnetic compatibility</li> <li>• Thermal vacuum and acoustic environments</li> </ul> </li> </ul>



Structure Verification Testing



# STARLINER

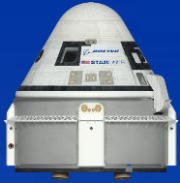
## What's Next? Qualification Test Campaign

Test	Location	Primary Purpose
Full-Scale Crew Module Drop Tests	Dugway Proving Ground, Utah & NASA Langley Research Center, Virginia	<ul style="list-style-type: none"><li>• Verify spacecraft landing impact attenuation performance</li><li>• Verify parachute system performance, forward heat shield separation and base heat shield jettison across various nominal and off-nominal conditions</li></ul>
Integrated System Verification Test (ISVT)	Multiple	<ul style="list-style-type: none"><li>• Demonstrate the integrated spacecraft / space station performance</li></ul>
End-to-End (E2E)	Multiple	<ul style="list-style-type: none"><li>• Complete crew transportation system end-to-end connectivity and integration across the segments and external interfaces</li></ul>
Pad Abort Test (PAT)	NASA White Sands Test Facility, New Mexico	<ul style="list-style-type: none"><li>• Demonstrate the abort system performance</li></ul>
Orbital & Crew Flight Tests (OFT, CFT)	Multiple	<ul style="list-style-type: none"><li>• Demonstrate complete crew transportation system orbital mission – uncrewed flight test and crewed flight test to space station</li></ul>



Full-Scale Crew Module Drop Tests

### Test Articles



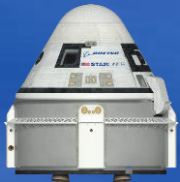
Structural Test Article Crew Module – Structure Verification Testing; Training Article  
Structural Test Article Service Module – Structure Verification Testing  
Service Module – Hot Fire Testing  
*\* Test Articles in flow in C3PF at Kennedy Space Center \**

### Spacecraft 1



Crew Module – Ground Verification Testing; Pad Abort Test  
Service Module – Ground Verification Testing; Pad Abort Test  
*\* Spacecraft 1 hardware in C3PF at Kennedy Space Center with more on the way \**

### Spacecraft 2



Crew Module – Environmental Qualification Testing; Crew Flight Test; PCM-2  
Service Module – Environmental Qualification Testing; Crew Flight Test  
*\* Spacecraft 2 hardware in production via supply base \**

### Spacecraft 3



Crew Module – Orbital Flight Test; PCM-1  
Service Module – Orbital Flight Test  
*\* Progressing through unit and subsystem build via supply base \**

