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SPACE LAUNCH SYSTEM
Developing the World's Most Powerful Solid Rocket Booster
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May 5, 2016
Space Propulsion Conference
SLS
SPACE LAUNCH SYSTEM
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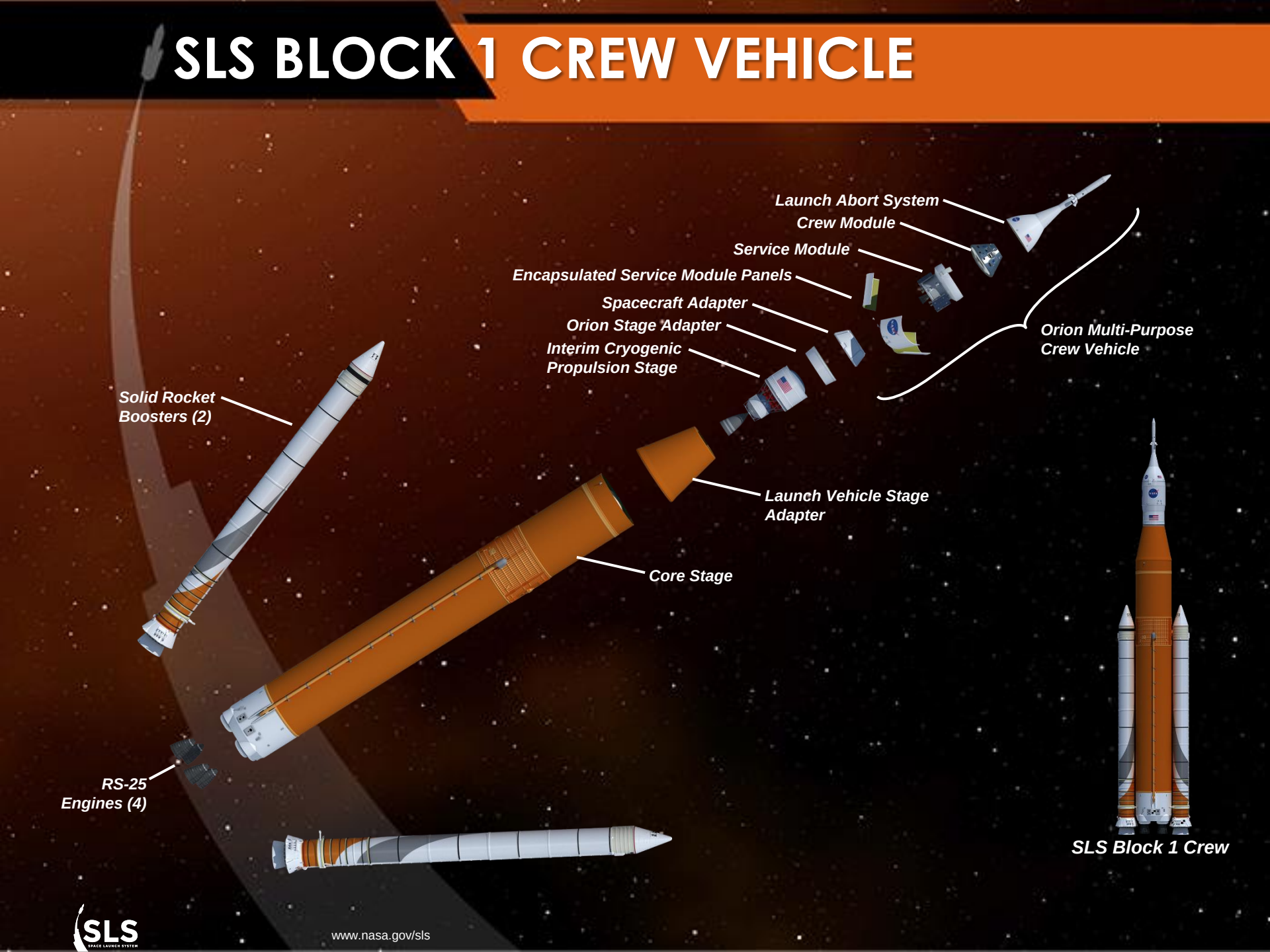
Agenda

- **SLS Overview**
- **Booster Overview**
- **Significant Accomplishments**
- **Challenges**
  - Forward Skirt
  - Abnormal nozzle erosion
  - PLI unbond
- **A Look Ahead**

SLS BLOCK 1 CREW VEHICLE



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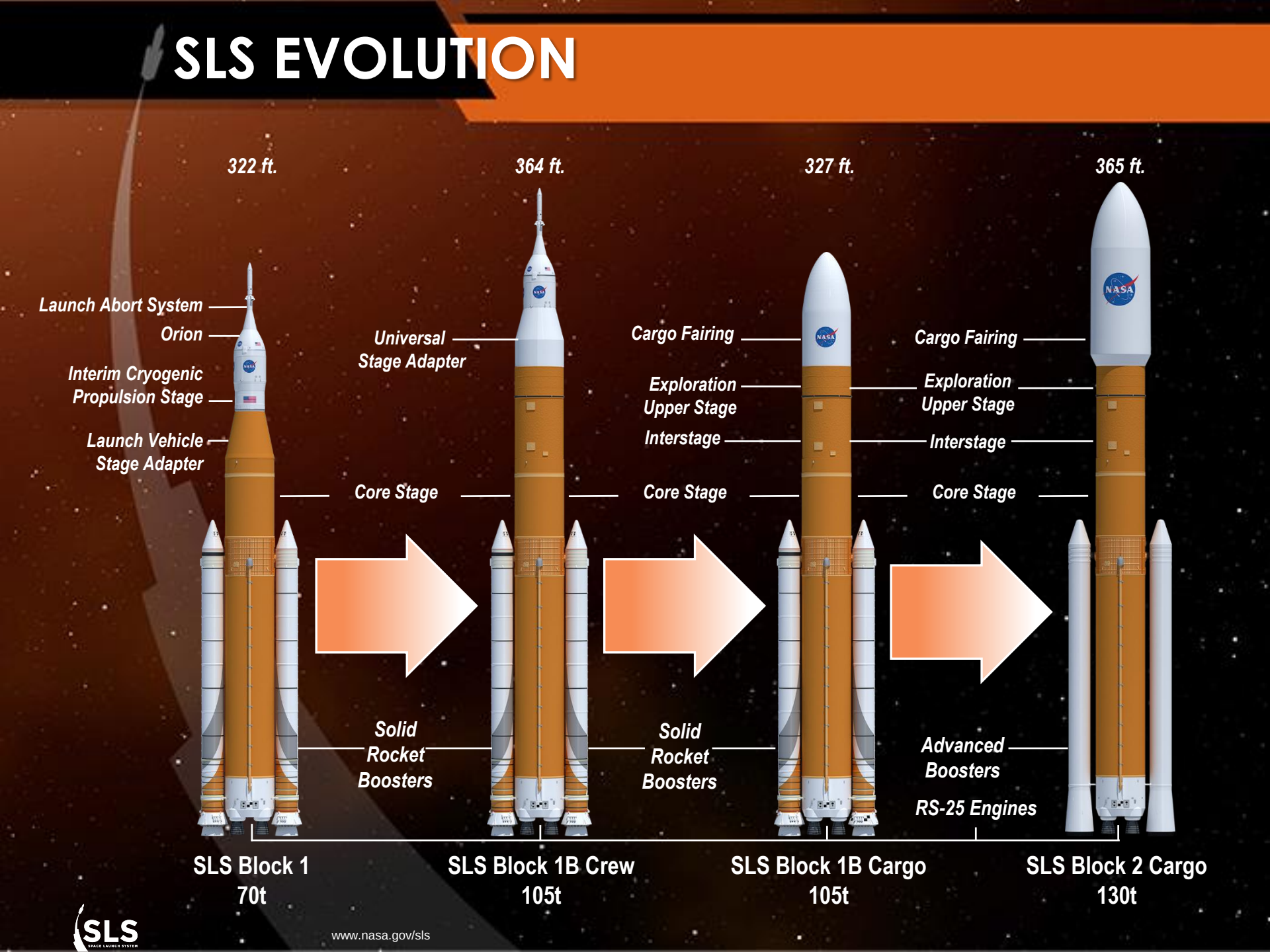
SLS EVOLUTION



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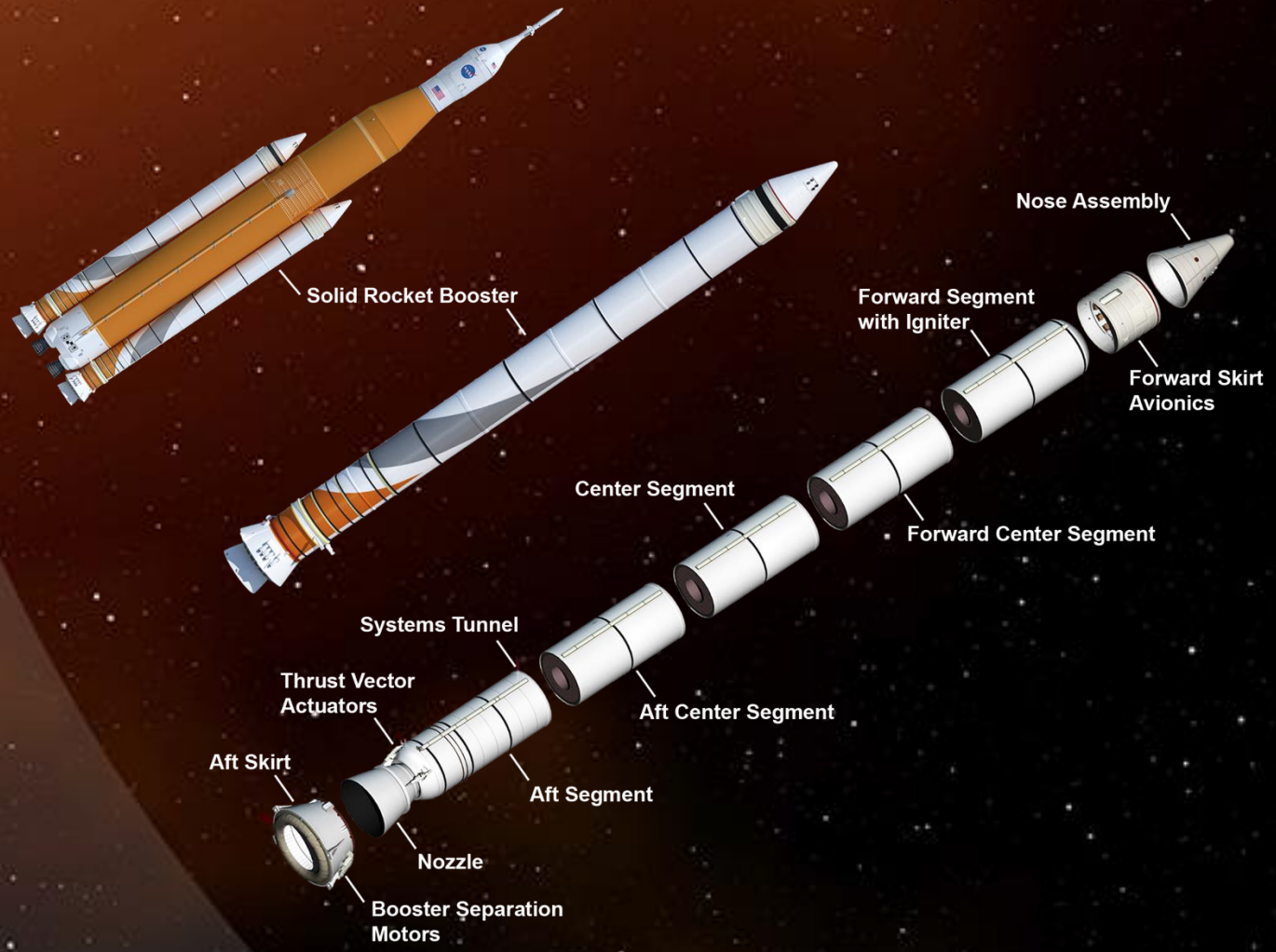
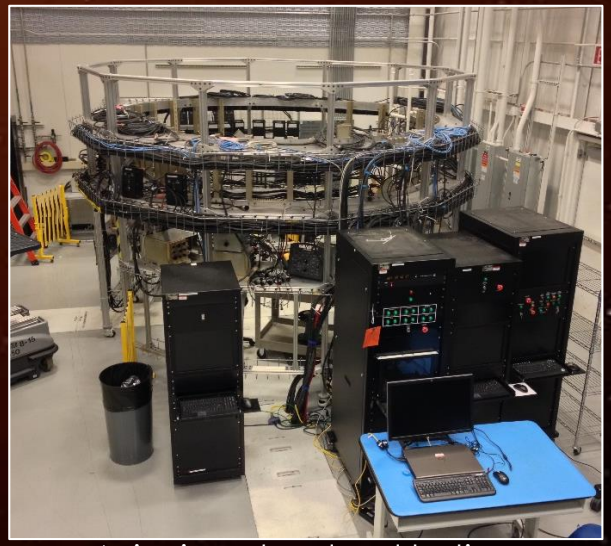
SLS FIVE-SEGMENT BOOSTERS



Significant Accomplishments

EM-1 motor case hardware refurbishment



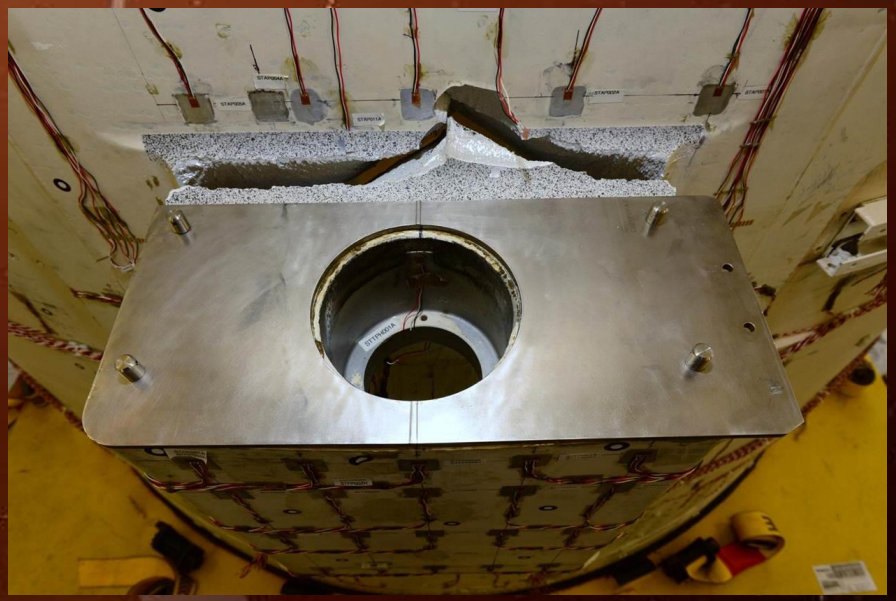
Avionic system level testing

EM-1 LH aft skirt refurbishment

QM-2 aft segment delivery to test stand

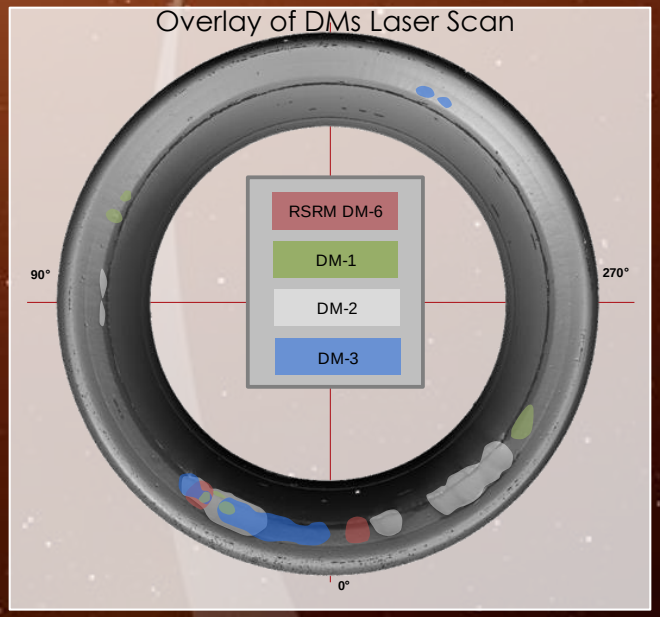
QM-1 static test

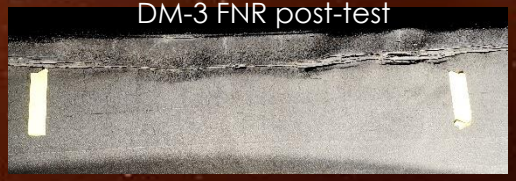
Challenges – Forward Skirt

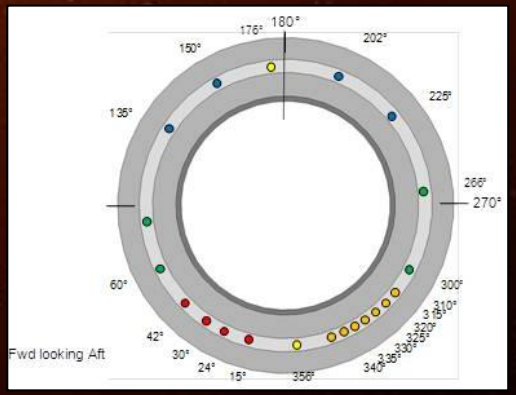


- **Issue**
  - Predicted SLS loads at the forward thrust post were increased over what was seen during the SSP.
- **Action Taken**
  - Two forward skirt structural test articles were tested to failure (liftoff and ascent loads).
- **Results**
  - Both tests determined the failure point was beyond required capability.
  - Testing and analysis showed that the heritage forward skirt design can be used for SLS, eliminating the need for a redesign.

Challenges – Abnormal Nozzle Erosion





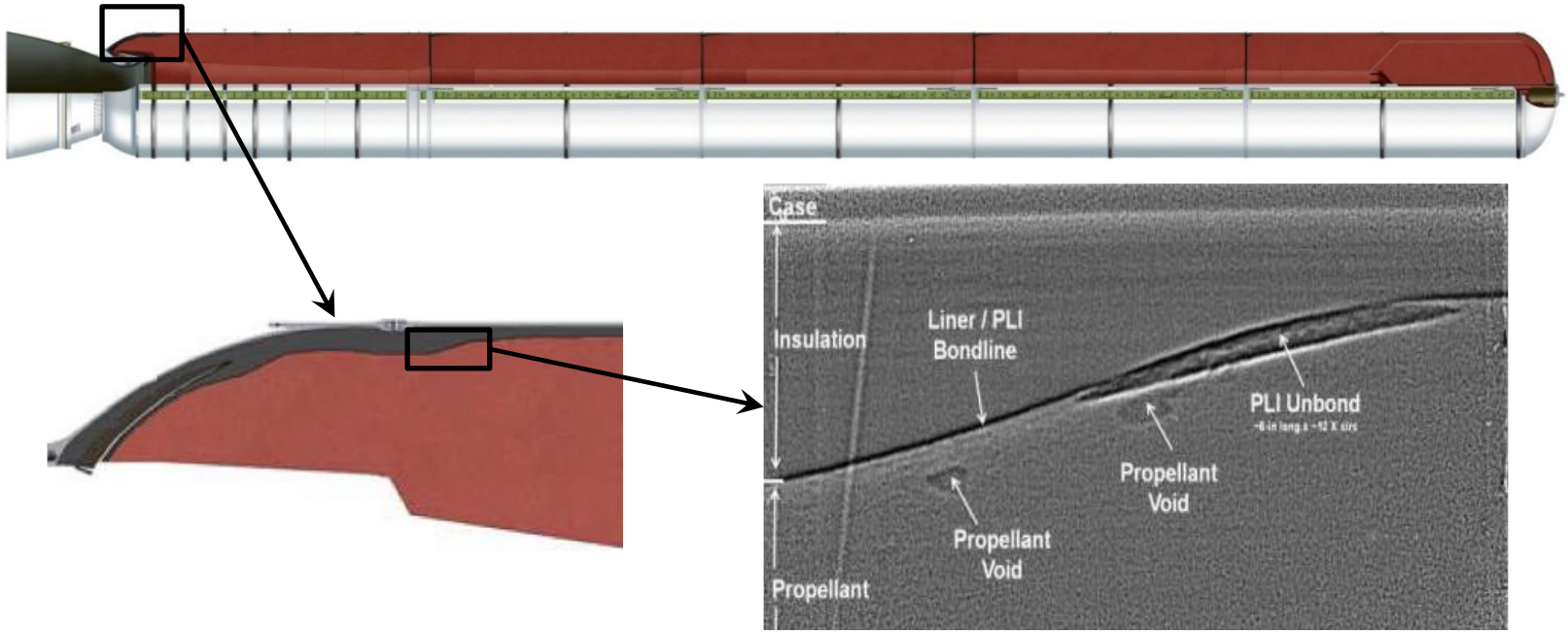


DM-3 UT Locations

- **Issue**
  - DM-2 and DM-3 FNR experienced abnormal erosion at the bottom of the nozzle
- **Likely causes: TVC duty cycle, slag**
  - Needed validation by additional testing

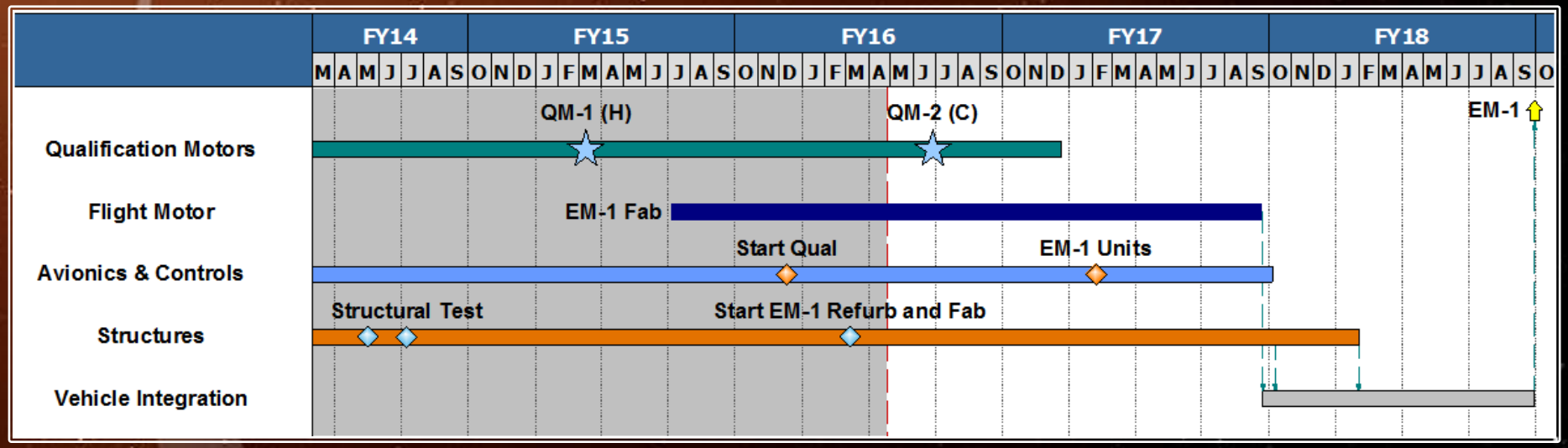
- **Action Taken**
  - Instrumented DM-3 with ultrasonic gauges, capturing the timing and magnitude of erosion
  - TVC duty cycle and slag were not contributors to abnormal erosion; particle impingement and environments found to be the contributors
- **List of mitigations**
  - FNR ply angle change
  - FNR material change
  - Additional mid-span support to reduce sag during static test

Challenges – PLI Unbond



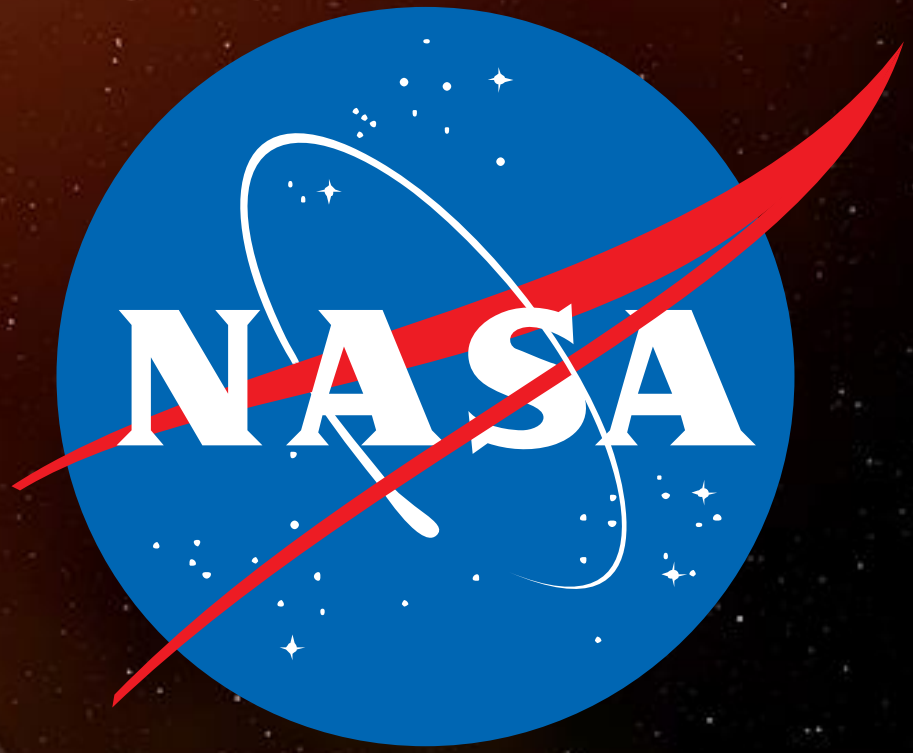
- **Issue**
  - PLI unbonds found during x-ray inspection of the QM-1 aft segment
- **Root cause**
  - Insulation outgassing during cast/cure
- **Initial mitigation**
  - Drive out all gases from the insulator with a VDVC
  - Unsuccessful cast of 2nd aft segment
- **Follow-on investigation**
  - Additional subscale and substantial full-scale testing
  - Dissection of 2nd aft segment unbond
  - Validated original root cause
- **Follow-on mitigation**
  - Improved insulation layup
  - Improved vacuum cycle
  - Barrier and cap ply design

A Look Ahead at the Home Stretch



- Currently finishing up qualification efforts
- Fabrication of EM-1 hardware is underway
- Preparing for launch site testing and integration

Questions



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