Wireless Sensor Needs in the Space Shuttle and CEV Structures Communities

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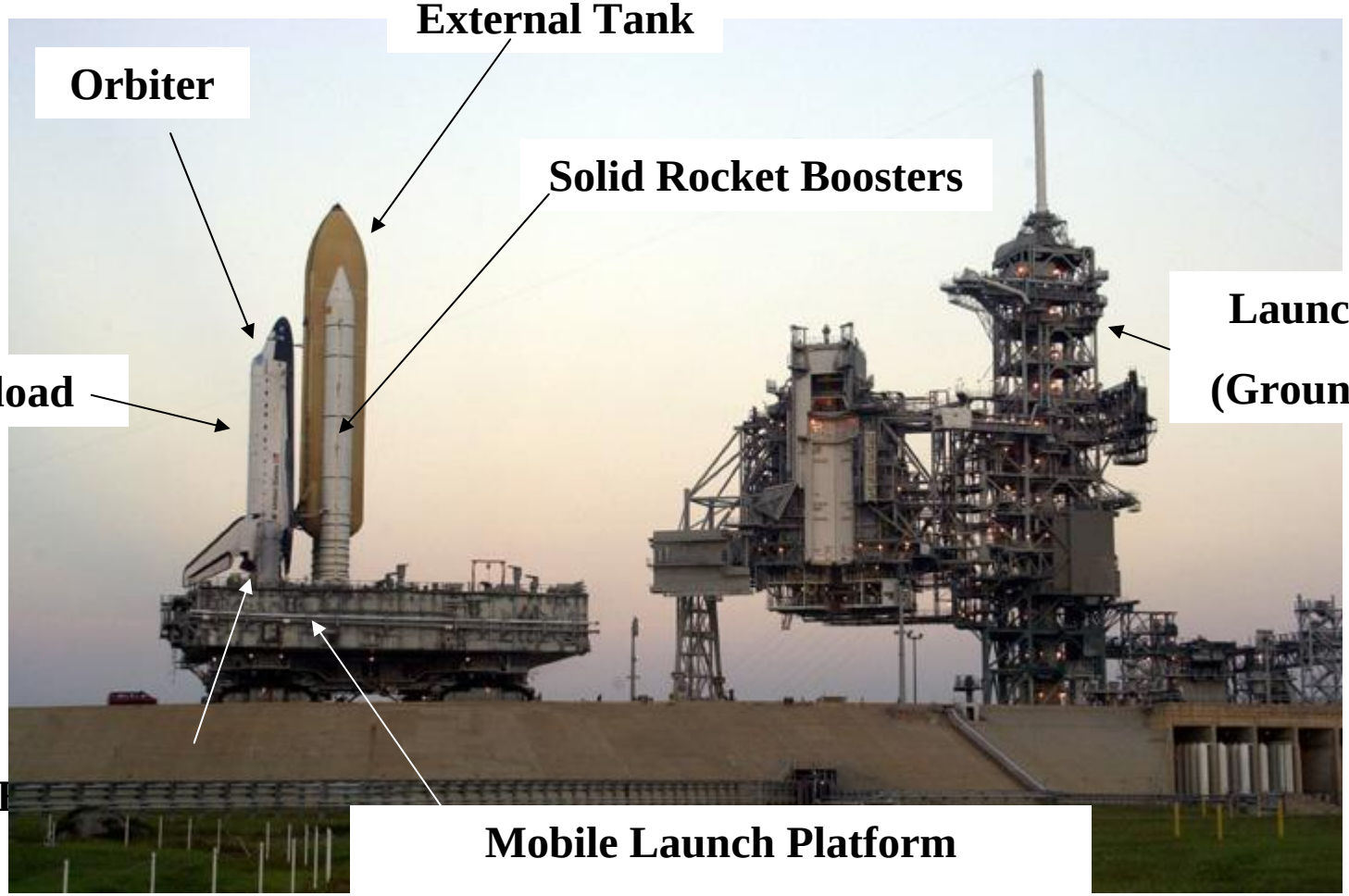
Space Shuttle - Hardware

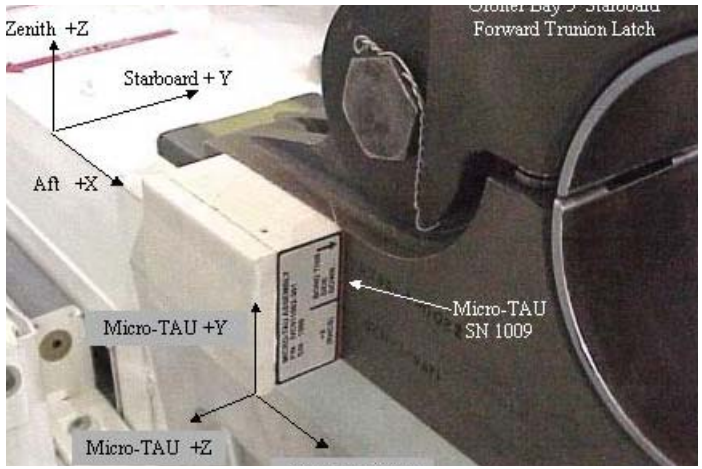


Space Shuttle - Constraints

- **Mature and Aging**
- **Operational and Developmental**
- **Flexible and Robust Sensors**
- **Low Operational Impacts**
  - Mass
  - Power
  - Storage
  - Volume
  - Safety
  - Schedule
  - Flight-Certified

Space Shuttle - Needs

- **Track Fatigue Life**
  - Maintain Proper Level of Conservatism
  - Monitor Known Loading Events
- **Detect Impacts**
  - Maintain Proper Level of Conservatism
  - Monitor Unexpected Loading Events
- **Verify Responses & Environment**
  - Maintain Proper Level of Conservatism
  - Allow the Implementation of New Models
- **Continuity of Engineering Expertise**
  - Maintain Proper Insight into the System
  - Allow Transitions between Generations



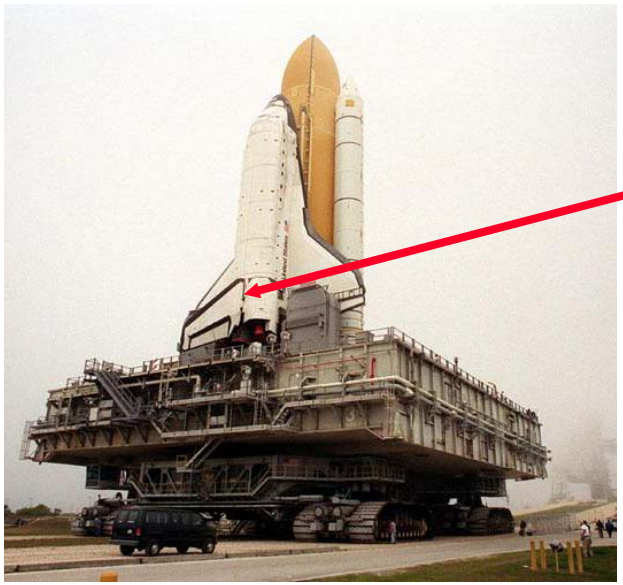
Wireless Accelerometer Package in Payload Bay

Space Shuttle – Recent Issues Summary

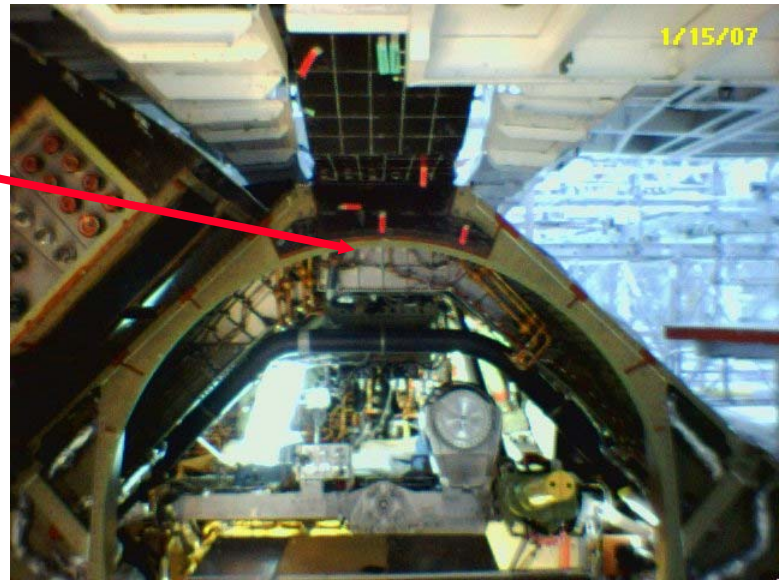
❑ Issues:

- Number of Sensors
- Certification
- Integration Engineering
- Dynamic Range
- Time Synchronization
- SRB Chamber Pressures
- No ET Recorder
- Internal ET Sensors in a Small Area
- External ET Debris Hazard
- ET LOX Feedline Bracket
- Orbiter Wiring
- Orbiter TPS Change-Out

Space Shuttle – Roll-Out Example

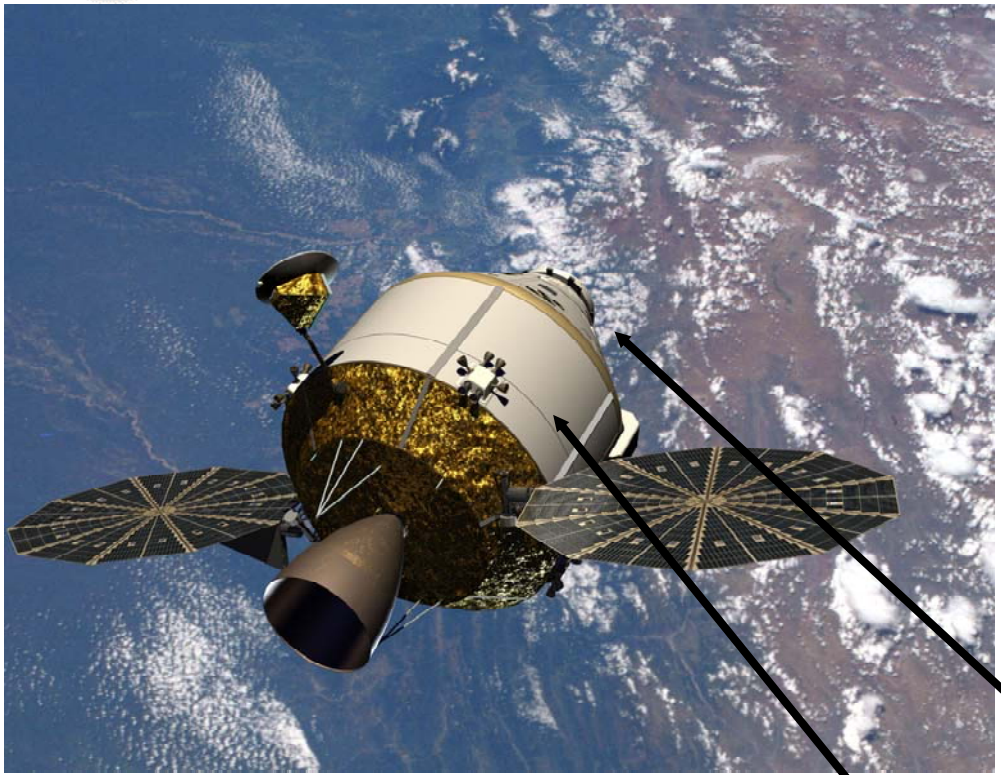


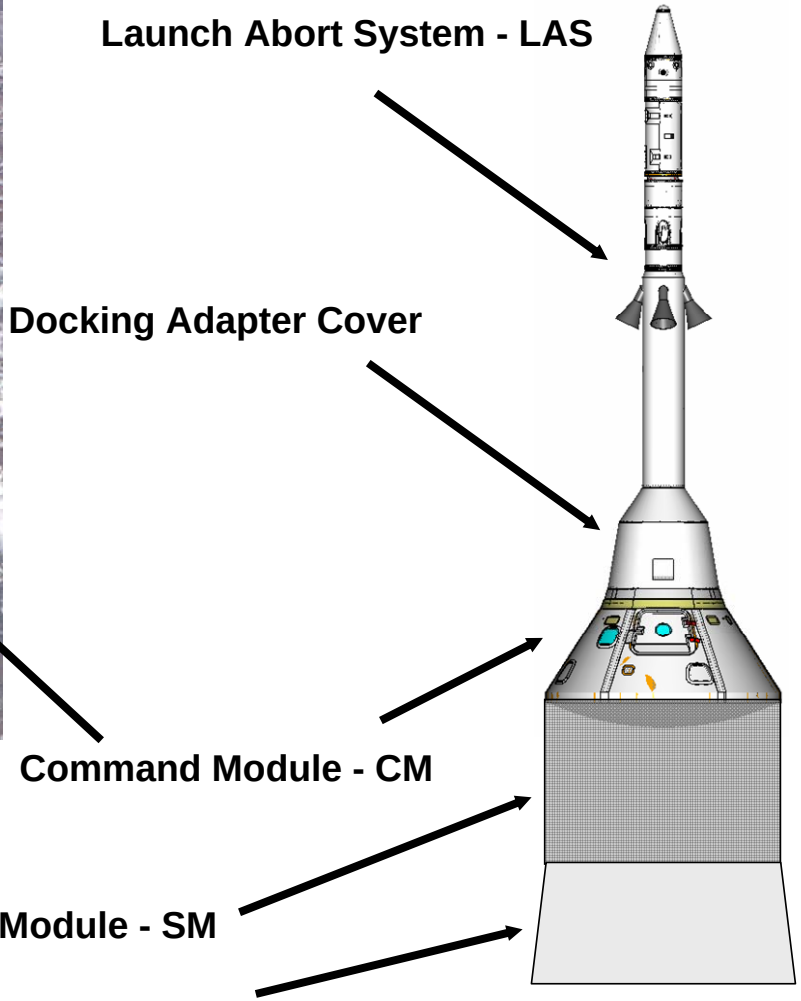
Orbiter Location



- Perform Fatigue Analysis of Roll-Out
- Temporarily Lower Speed
- Provide Minimal Instrumentation for Reconstruction
- Wired Sensors on Launch Platform and SRB's
- One Sensor Package in Orbiter
  - Must be Removed Before Flight

CEV - Hardware





CEV - Constraints

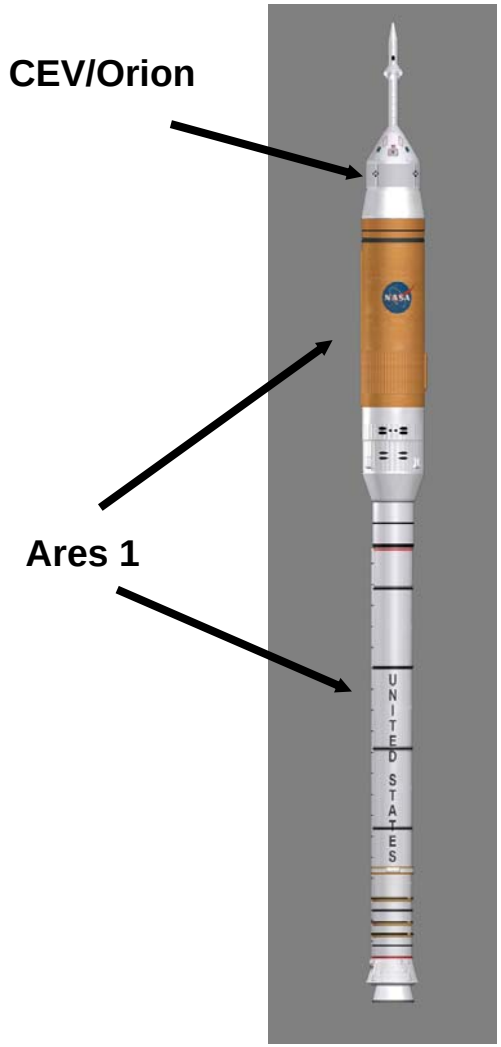
- Under Development
- Design and Mission Constantly Changing
- Large Range of Operational Missions
- Long Periods of On-Orbit Dwell
- Systems with Critical Functions
- Mass Constrained

CEV - Needs

- **Flexible Sensor System**
  - Adjust to New Needs
  - Rapid Implementation
- **High Channel Counts**
  - Distributed Storage
  - Installation Limitations
- **Mass Limited**
  - Operational Limitations
  - Early Removal
- **Large Operational Range**
  - High Sample Rates
  - Large Amplitude Range
  - High Temperatures
- **Off-the-Shelf Status**

CEV – Applications

- **Ares 1X roll-out** - cannot remove wires
- **Ares 1X flight test** – increase channel count, reduce installation time (wiring)
- **Pad Abort 1 flight test** – increase channel count, reduce installation time (wiring), high temperatures
- **CEV acoustics wind tunnel test** – increase channel count, decrease wires in sting, high temperatures
- **CEV acoustics structural test** – high channel count, internal sensors
- **CEV vibration test** – high channel count, internal sensors
- **CEV modal tests** – high channel count
- **Ares/Orion modal tests (GVT)** – high channel count, reduce test costs
- **CEV operational data** – low mass/volume/power, certified



CEV – Pad Abort 1 Example

- **September of 2008**
- **High Channel Count**
  - > 1000 Total Desired
  - ~ 500 Total Possible
- **High Sample Rates**
- **High Temperatures**
- **Limitations**
  - LAS is volume limited
  - 63 pounds in LAS
  - 14 Days for LAS Installation
  - 40 Days (shared) for CM Install
  - 6 Days of Pre-Flight Checkout

Apollo Pad Abort Test

Conclusions

❑ Space Shuttle

- Need to control analytical conservatism
- Need to monitor unexpected impacts
- Major constraint is the need for flight certification
- Wireless systems have been successfully implemented

❑ CEV

- Ground and flight needs
- Flexibility and high channel counts required
- Wired systems have proven limitations in test systems
- Major operational constraint is mass penalty