ULA Briefing to National Research Council

Ground and Launch Systems Roadmap

March 23, 2011

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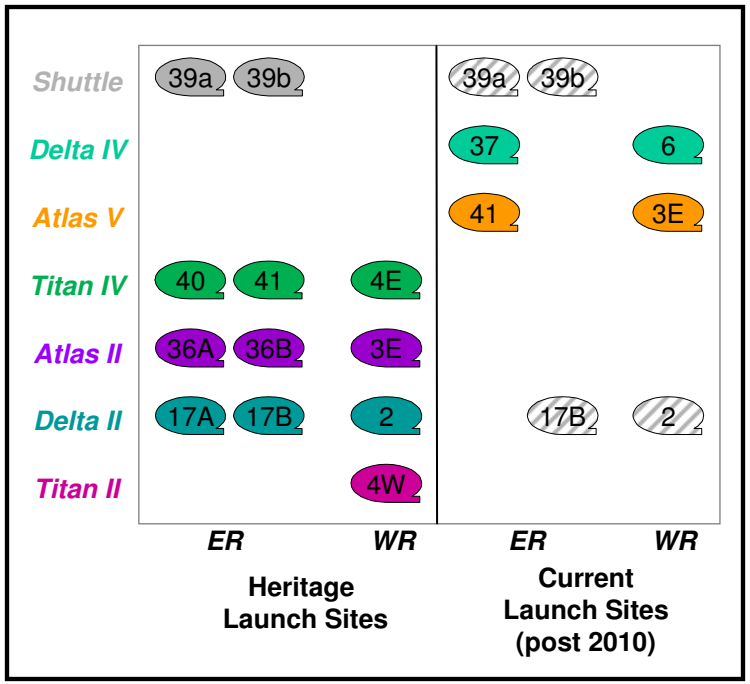
EELV Launch Operations Consolidation



Cape Canaveral Air Force Station (CCAFS), Florida

Atlas V Space Launch Complex 41

Delta IV Space Launch Complex 37B

Vandenberg Air Force Base (VAFB), California

Atlas V Space Launch Complex 3E

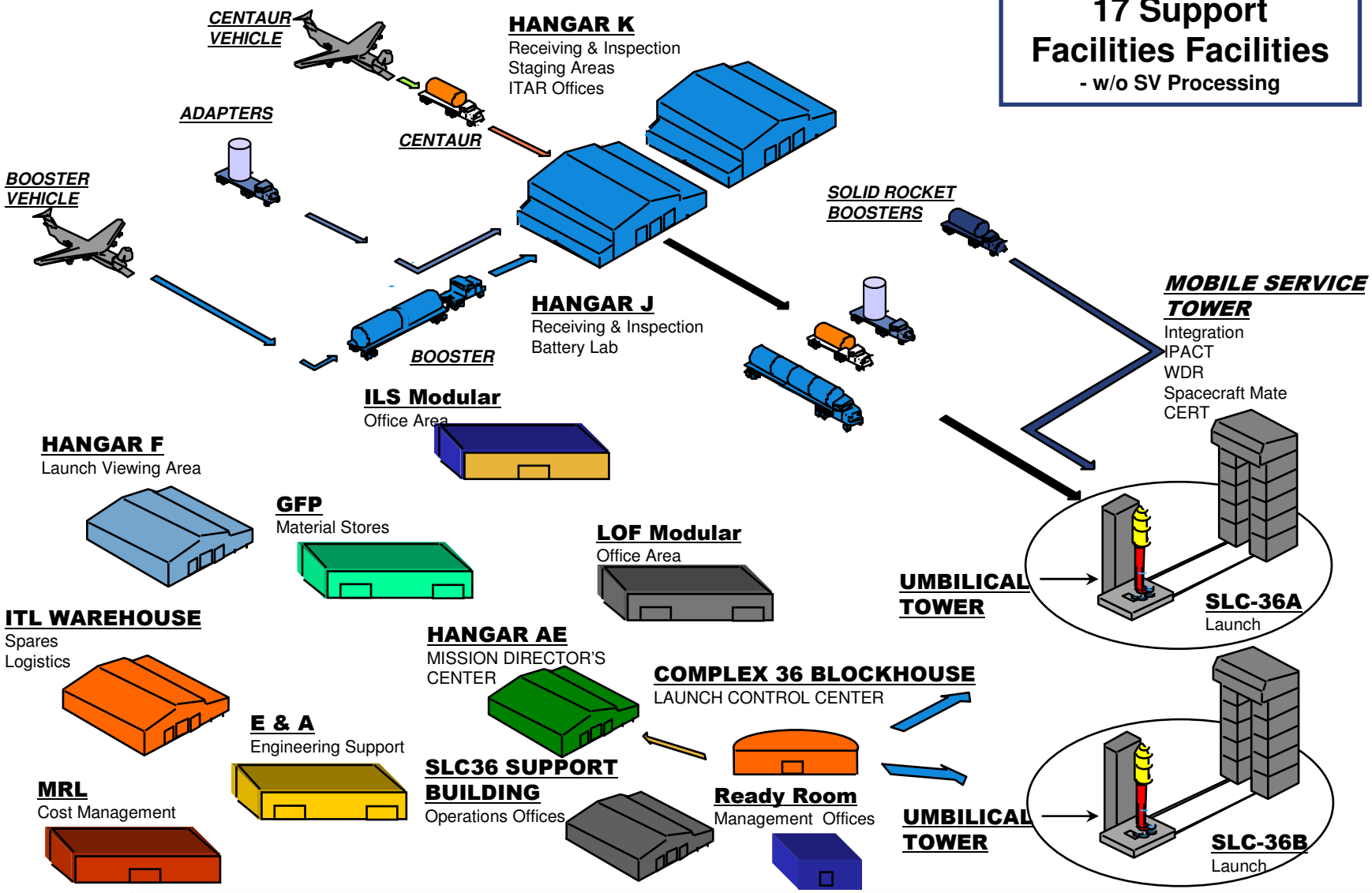
Delta IV Space Launch Complex 6

EELV and formation of ULA enabled the reduction of Ten Heritage Launch Complexes to Four

Heritage Facility Utilization

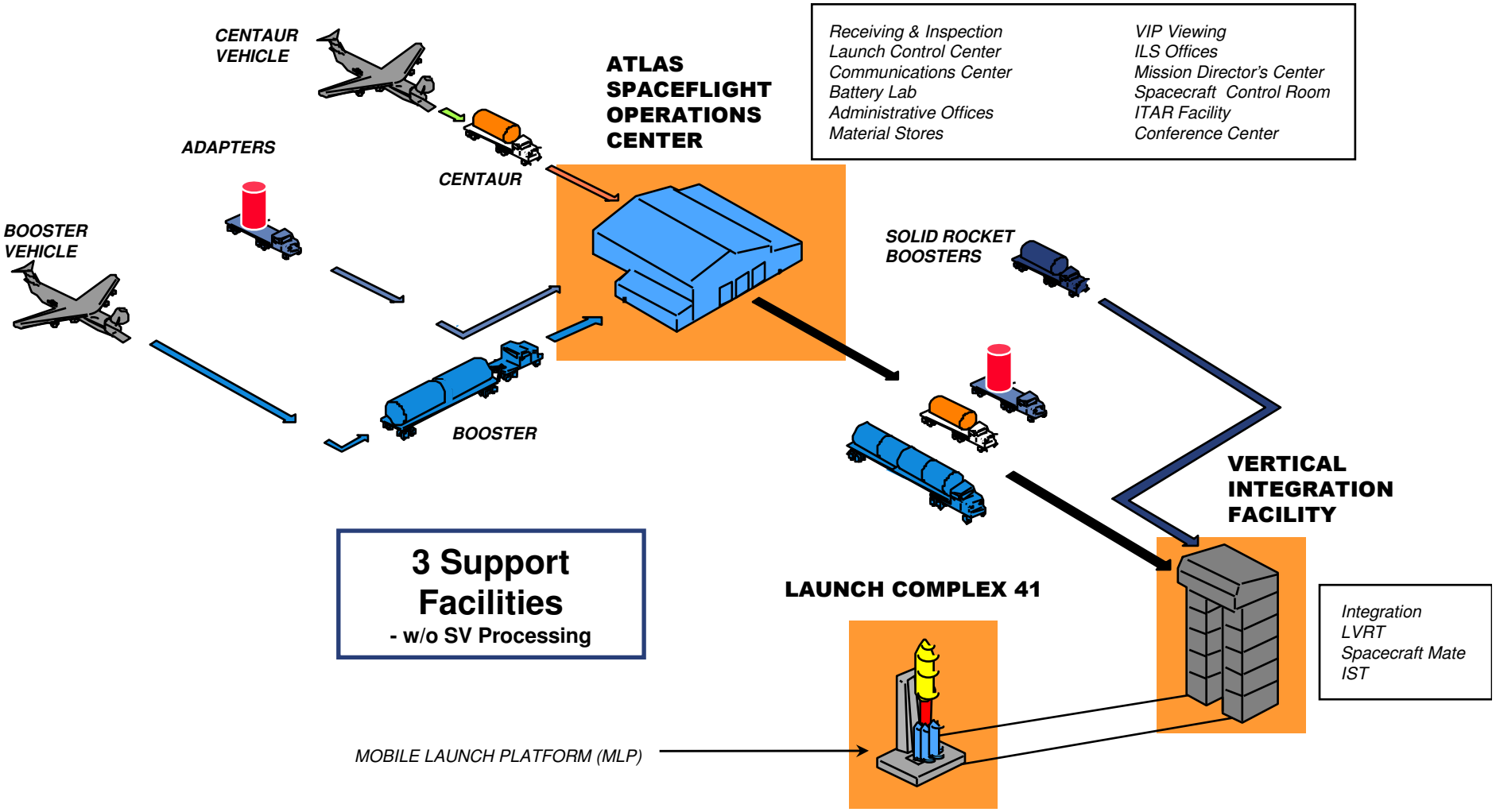
Atlas II/III Processing Flow—SLC36A/B

17 Support Facilities Facilities
- w/o SV Processing



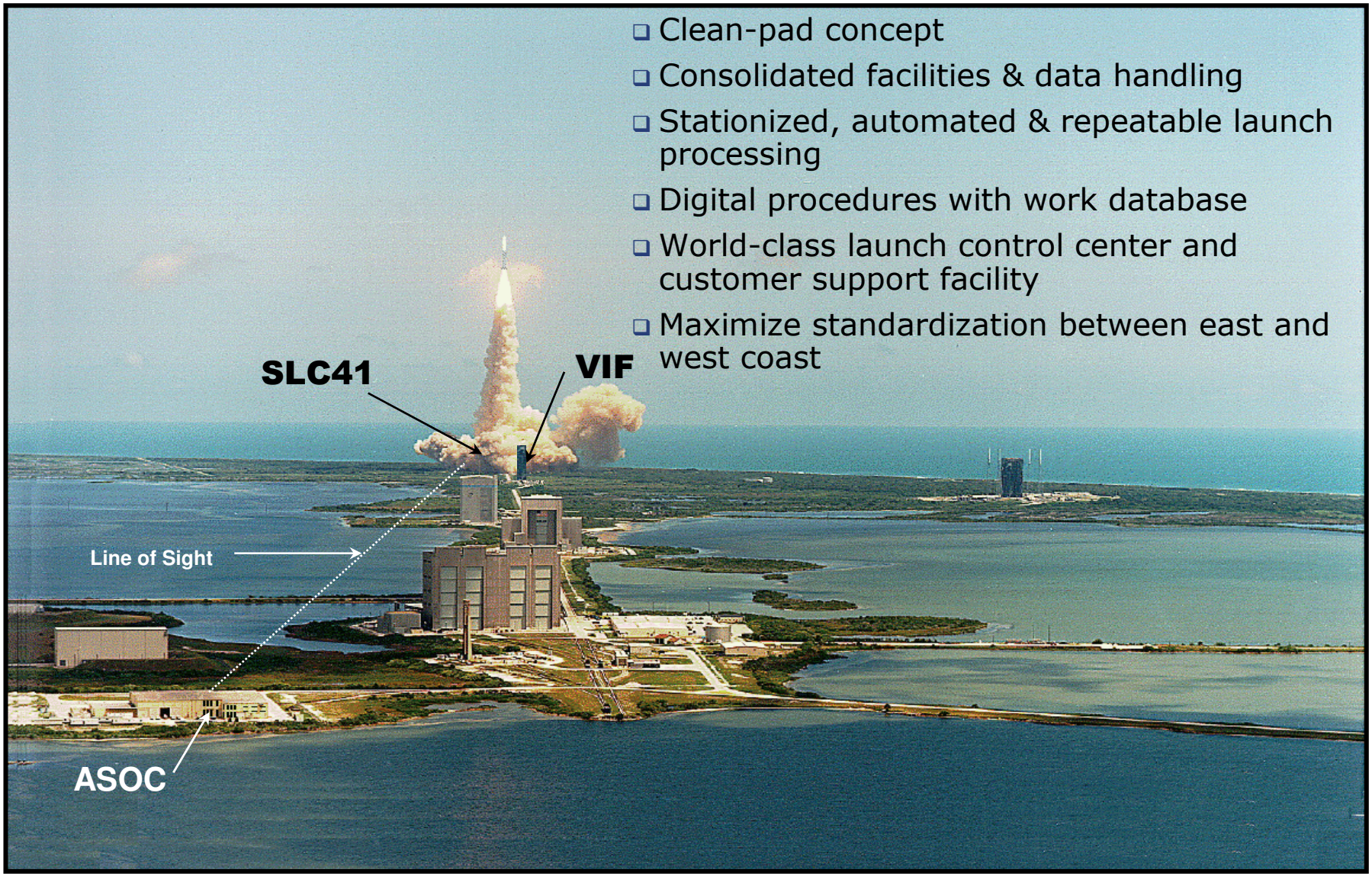
Current Facility Utilization

Atlas V Processing Flow - SLC-41



Consolidation Reduced Cost While Improving Through-Put

Atlas V Launch Operations

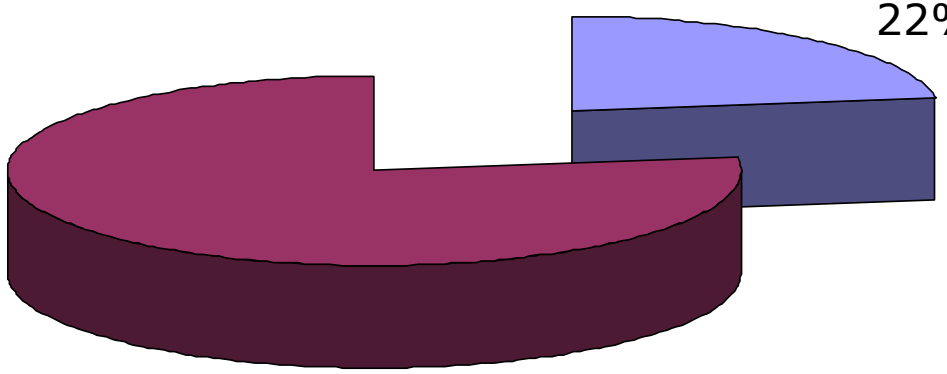


- Clean-pad concept
- Consolidated facilities & data handling
- Stationized, automated & repeatable launch processing
- Digital procedures with work database
- World-class launch control center and customer support facility
- Maximize standardization between east and west coast

Technology Opportunity

- Technology requirements/benefits very dependant on launch system architecture
- Atlas V and Delta IV implemented modern ground systems
  - Substantial cost/schedule reduction
  - Designed into Atlas V and Delta IV architecture

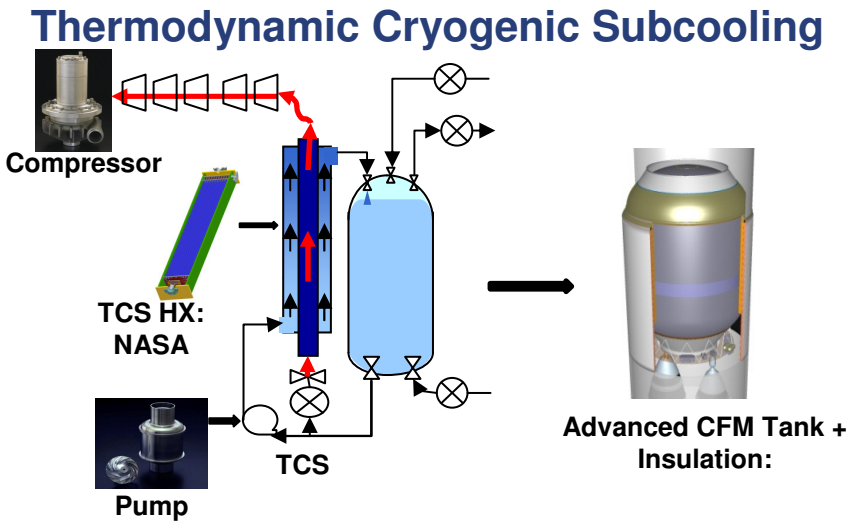
Ground and launch processing represent 22% of EELV personal

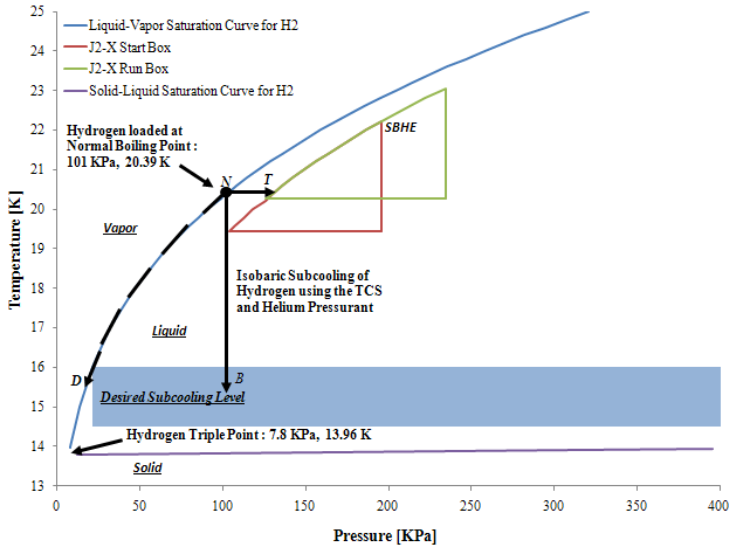


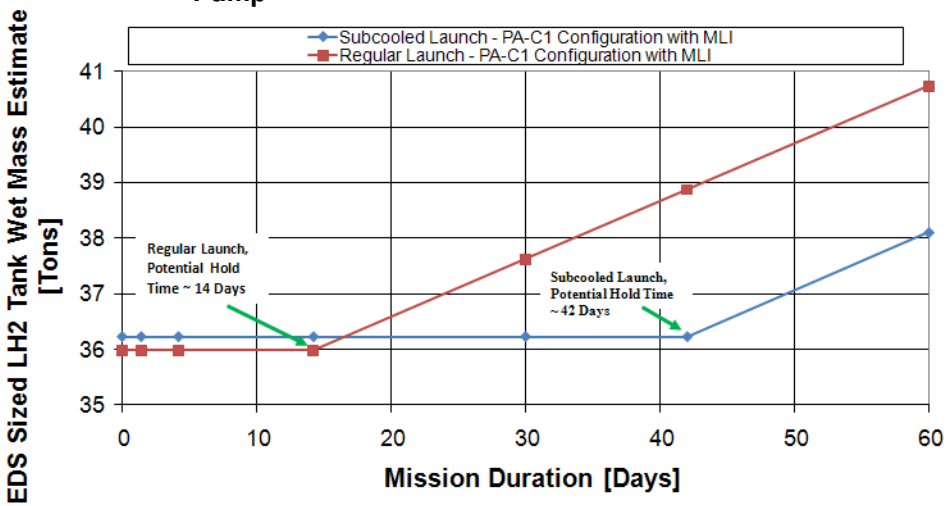
Ground and Launch Processing Offer Modest Further Opportunity for Technology Benefit

Cryogenic Propellant Sub-Cooling

- Extend vent free orbital duration
- Reduced launch mass
  - Higher mass fraction CPS
    - Simpler thermal protection







Courtesy NASA GSFC

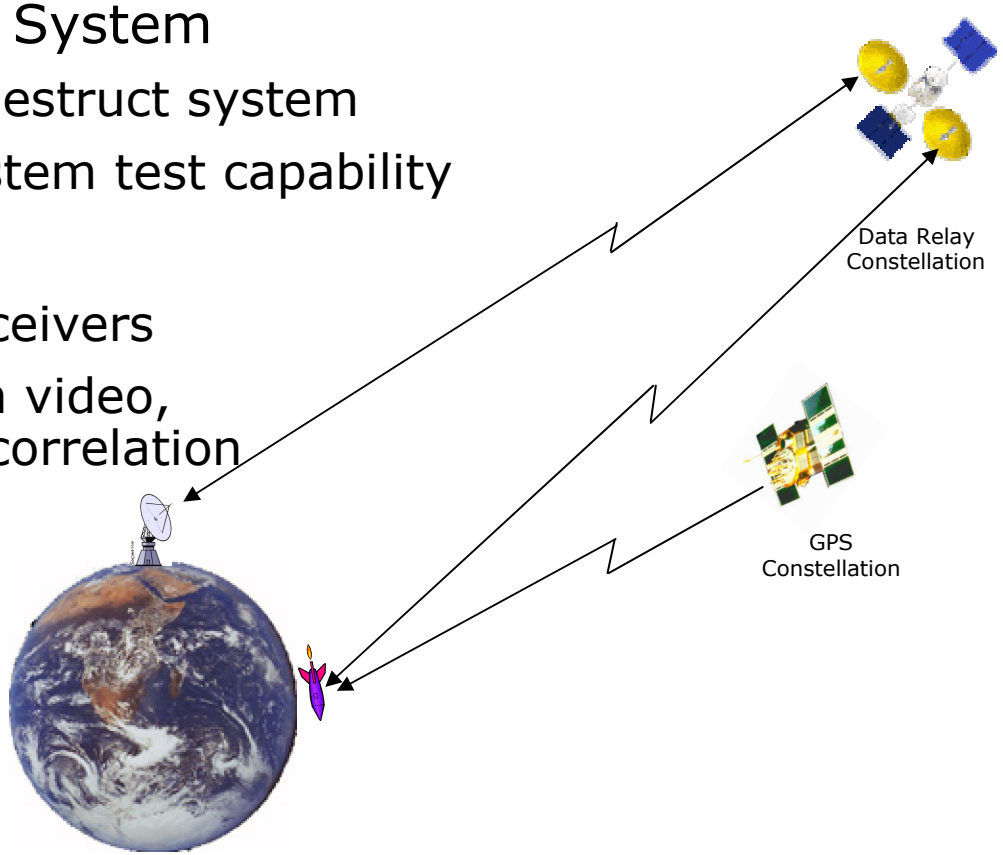
Integrate Sub-Cooling System with Launch Site and Vehicle

Water Acoustic Suppression

- Water layer sprayed on the plume dampens the shear mixing layer
  - Impedance miss match layer reducing reflection from the deck
  - Water layer seals acoustic emission energy
- Enhanced water acoustic suppression
  - Enable reduced launch vehicle acoustic environment
  - Especially important for heavy lift

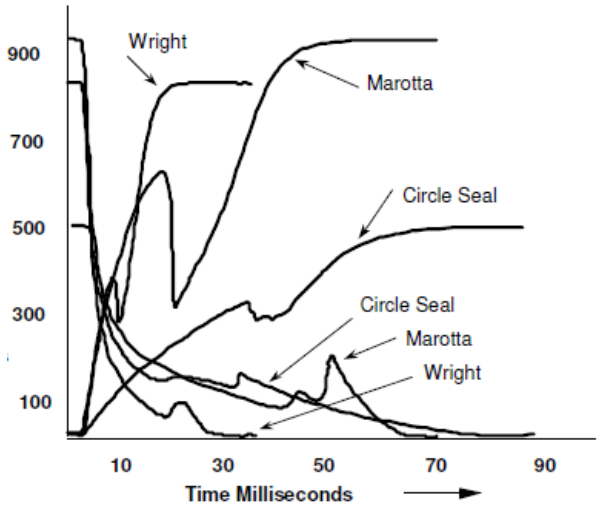
Space Based Range

- Reduce cost and enhance capability
- GPS Metric Tracking
  - Reduction of range tracking radars
- Enhanced Flight Termination System
  - Secure update to command destruct system
  - Open air, noninterference system test capability
- Advanced Telemetry
  - Elimination of down range receivers
  - Enhanced end-to-end mission video, bandwidth, coverage & time correlation

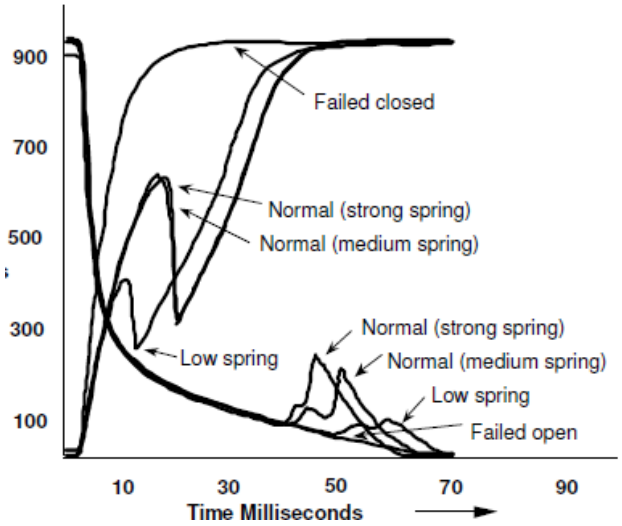


Current signature Characterization

- Improved reliability
  - Characterize current controlled devices preflight
    - Evaluate health
    - Determine trend to failure
  - Ability to separate multiple signatures
    - Account for environmental effects
  - Ability to see: change in state, level, complex signature, frequency effects



Sample Valves



Example Anomalies

Expert Systems
Ground C3 Automation

- Automated Data Monitoring System (**ADMS**)
  - Automate vehicle and ground telemetry GC3 system
- In the process of adapting ADMS to Delta GC3
- Expert Systems can mine enhance capability from existing systems
  - Diagnose and isolate a faults
  - Enhance reliability
  - Examples of ground system errors:
    - Inadvertent fuel spillage
    - Over differential pressurization of vehicle tanks
    - Over heating of He pressurization bottles

Summary

- Ground and launch system processing technology benefit is architecture specific
  - Atlas V and Delta IV took advantage of state of the art technology
- Ground and launch processing offer modest opportunity for technology benefit
  - Sub cooling to enhance orbital performance
  - Enhanced water suppression
  - Space based range
  - Expert system automation