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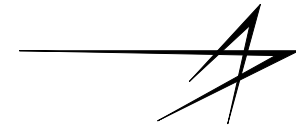


Atlas As A Human Rated LV

**STAIF Conference
2006**

Lockheed Martin Space Systems Company

Reliable and Versatile Launch Vehicle Family



Atlas I
AC-69

Atlas II
AC-102

Atlas IIA
AC-105

Atlas IIAS
AC-108

Atlas IIIA
AC-201

Atlas IIIB
AC-204

Atlas V-400
AV-001

Atlas V-500
AV-003

Jul 1990

Dec 1991

Jun 1992

Dec 1993

May 2000

Feb 2002

Aug 2002

Jul 2003

8/11

10/10

23/23

30/30

2/2

4/4

4/4

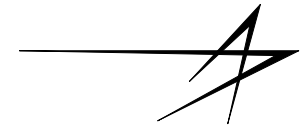
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Legend: ■ First Flight ■ X/Y X successes in Y flights

- 8 of 8 First Flight Successes
- 78 Consecutive Successful Atlas Centaur Flights
- 100% Mission Success Atlas II, IIA, IIAS, III & V Families
- 487 Total Launch Successes Since Atlas Program Inception

Mission Success—One Launch at a Time

AV-010 Launch

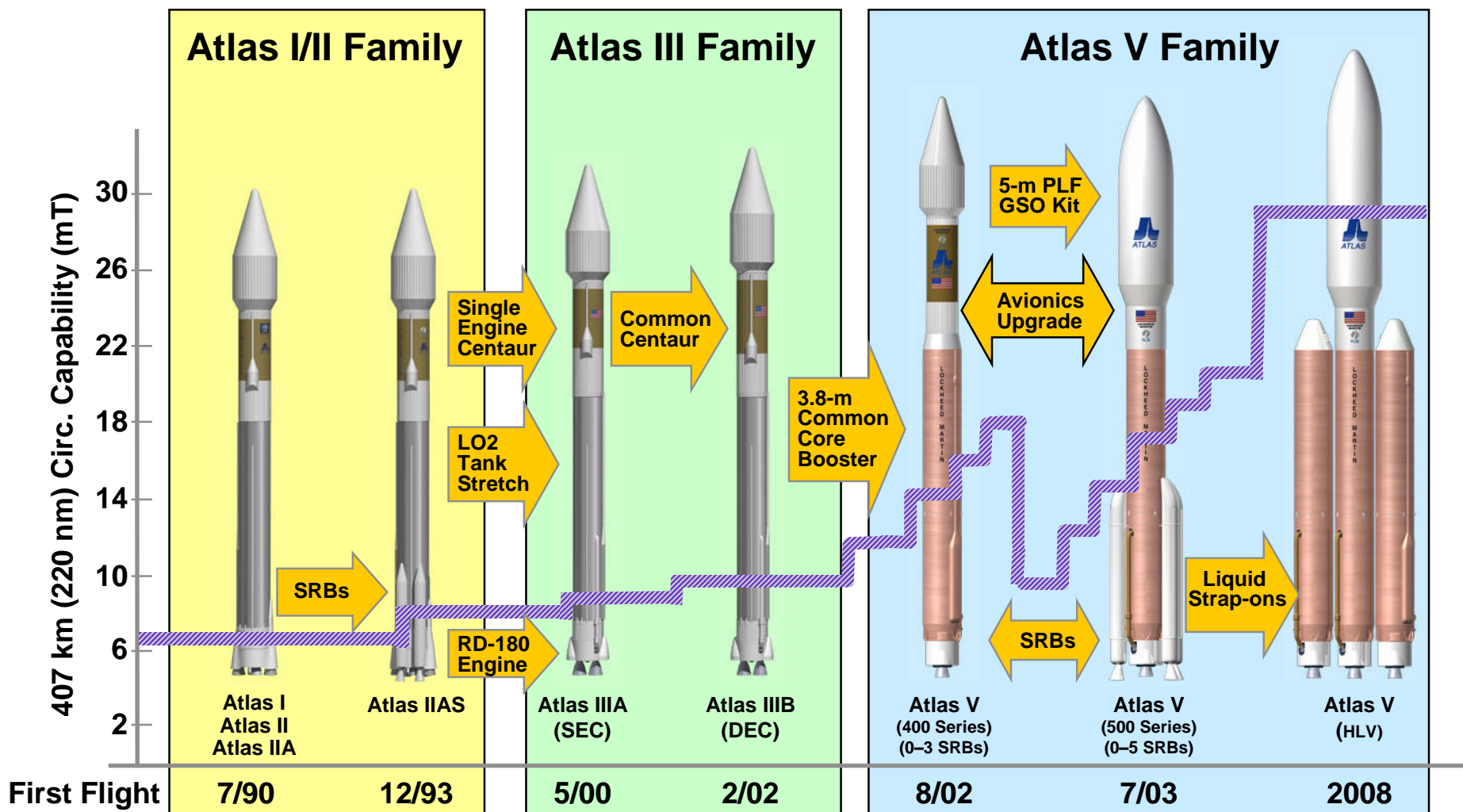


- January 19, 2006
- NASA Pluto New Horizons Spacecraft
- First 551 configuration
- First Block 2 Fault Tolerant Avionics
- First Block B SRB
- Nuclear certified
- Nominal flight profile
- Injection conditions well within 1 sigma
 - C3, RLA, DLA

***Fastest Spacecraft
Ever Launched***



Atlas Evolution History



Demonstrated Low-Risk Evolutionary Development

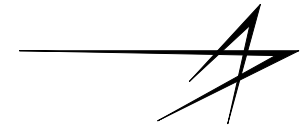
Atlas V HLV – Highlights

- **30 month order to launch**
- **All Common Element Design Criteria Envelope HLV Requirements**
- **Liquid Rocket Booster “Strap-Ons” Same as Flight Proven Common Core Booster**
- **RD-180 Engine HLV Certification Testing Complete**
- **RL10 Fully HLV Qualified, Including 3-Burn, Long-Coast Missions**
- **Most Common Hardware Already Qualified to HLV levels**
- **Minimal New HLV Hardware for Airborne and Ground Systems**
- **Block 2 Avionics Upgrade, Providing HLV Fault-Tolerance**
- **Software update < 25% Change to Current FSW**
- **Existing Facilities Accommodate HLV**

95% of HLV System Flight Proven

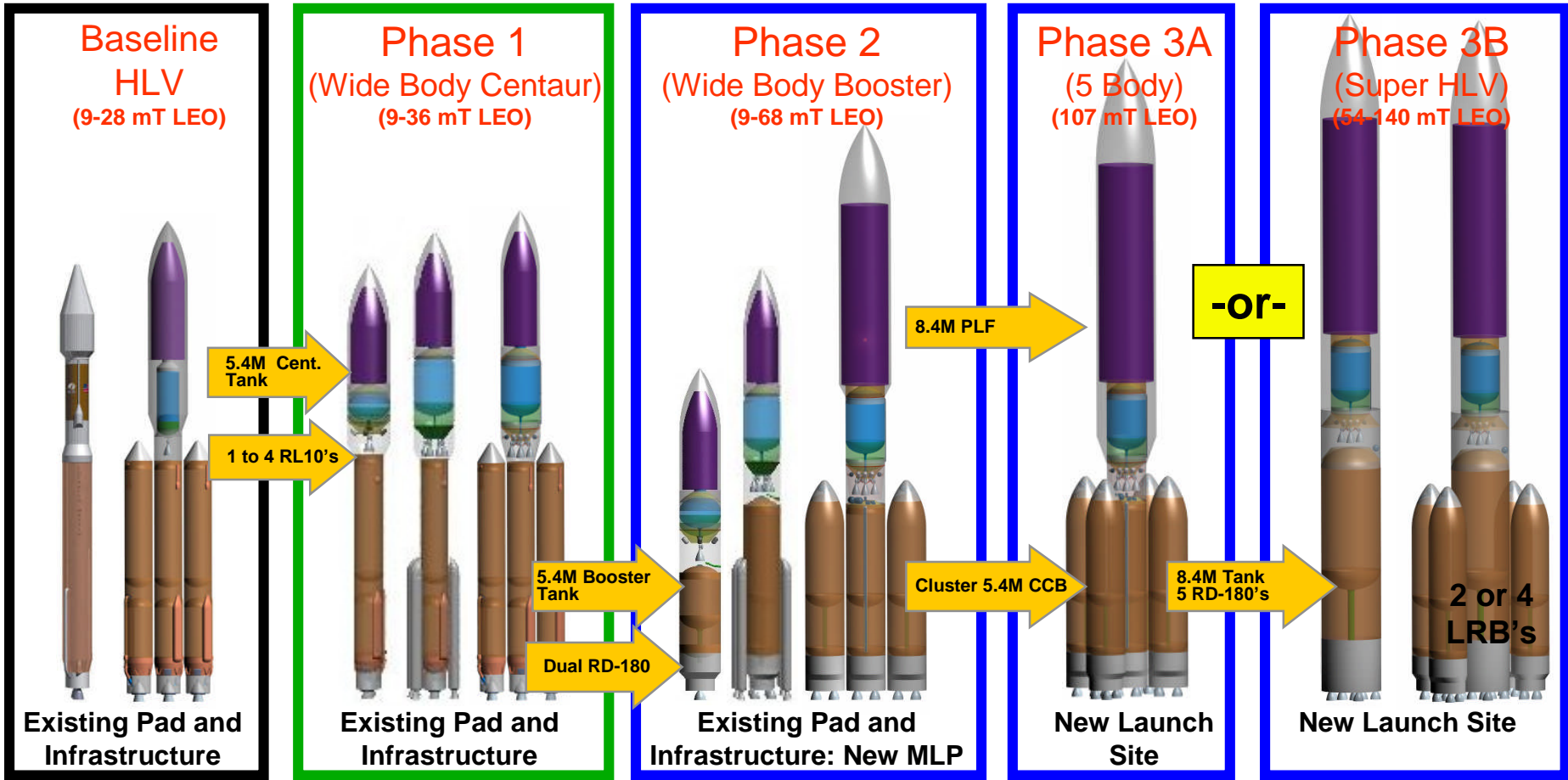
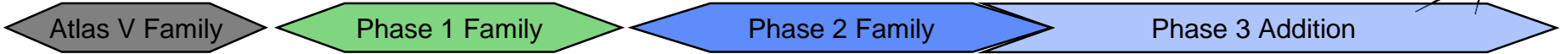
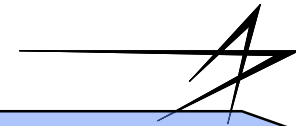


Atlas Program Evolution Approach



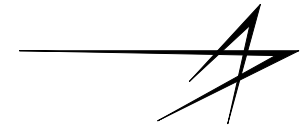
- **Atlas evolution elements become fleet baseline**
- **Atlas evolution benefits existing customer base**
 - **Maintain/improve Atlas 401 cost/launch**
 - Phase 1 Centaur (SEC) cost \leq Centaur III cost
 - Phase 2 Booster cost \leq Atlas V booster cost
 - **Improve cost at 5XY and HLV performance levels**
 - **Accommodate NASA Space Exploration and NRO growth requirements**
 - Both super heavy lift and CEV requirements
- **Maximize DoD/NASA/ Commercial synergy**
 - **Common element architecture**
 - **Enable NASA/ DoD sharing of investment**
- **Credible, sustainable program**
 - **Time phased to meet NASA affordability**
 - **Minimize use of new or risky technology, minimize complexity**
 - **No new engines required for baseline evolution**
 - No cross feed, limit clusters to five-body
- **Existing LC-41 infrastructure through Phase 2 development**
- **Current and evolved mission reliability and safety supports human rating**
 - **Inherent design reliability, demonstrated reliability through commonality**

Continued Atlas Evolution

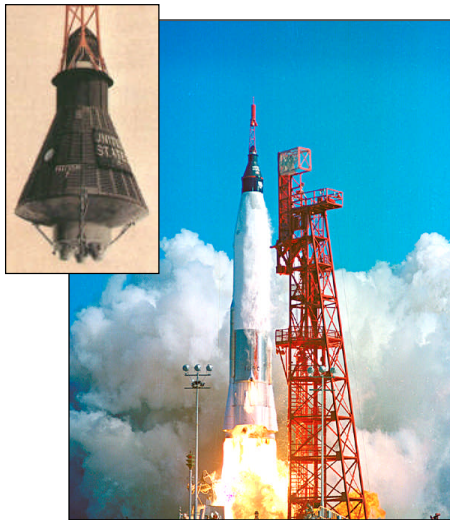


Atlas Evolution Meets Space Exploration & Nation's Needs

Atlas As A Human Rated LV



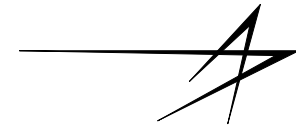
- **LM has a rich heritage in human spaceflight**
 - **First American in Space Flew Atlas / Mercury**
 - **Race to moon relied on flights of Atlas and Titan**
 - **Today's Atlas V is most reliable Atlas ever**
- **Human Spaceflight Opportunities extend beyond CEV**
 - **Commercial opportunities emerging**



Photos Courtesy NASA

Atlas-Mercury / Titan-Gemini Human Spaceflight 100% Successful

Human Launch Options



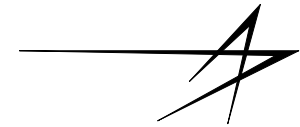
Proven

Some options	Maturity	Destination	Attributes
STS	Proven	LEO, ISS	NASA Owned Phasing Out 2010
Russian Soyuz	Proven	ISS	\$20M per Seat
<i>Atlas V</i>	<i>Proven (6 SC flights incl. 2 NASA planetary missions)</i>	<i>LEO, ISS, GEO, GSO Lunar Transfer, etc. Most Recently Pluto!</i>	<i>NASA Certified Human Spaceflight Heritage</i>

Development

Virgin Galactic	Infancy	Suborbital	Spaceship One technology
Clipper/Soyuz	In Design	ISS	Russian
Crew Launch Vehicle, CEV	In Design (replace STS)	ISS	NASA Owned (Currently 5 segment / J2)
“Low Cost” LV	Infancy	LEO, ISS	First Flight with payload only

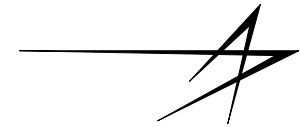
Commercial Opportunities



- **Commercial Orbital Transportation Services Demo**
 - **Capability D: Crew transportation**
- **Space Tourism**
- **Other**

- **Flight Proven Atlas V**
 - **Performance up to 28mT to LEO**
 - **Fault Tolerant Design**
 - **Potential for Mission Peculiar Kit additions for crew / cargo**

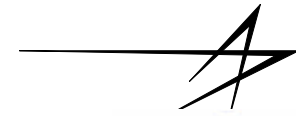
Atlas Design Philosophy Overview



- **Common elements**
 - **Commonality driven down to part level**
- **Flexibility, wide range of missions & capabilities**
- **Simplicity, fault elimination**
 - **Reduced part counts**
 - **Fewer stages, fewer engines, fewer sep. events**
- **Fault tolerance, high reliability**
 - **Eliminate single point failures**
- **Rigorous margins & testing**
 - **Comprehensive, test like you fly**
 - **Analysis anchored to test & flight data**

Detailed System Understanding Key to Mission Success

Atlas V Human Rating Configurations



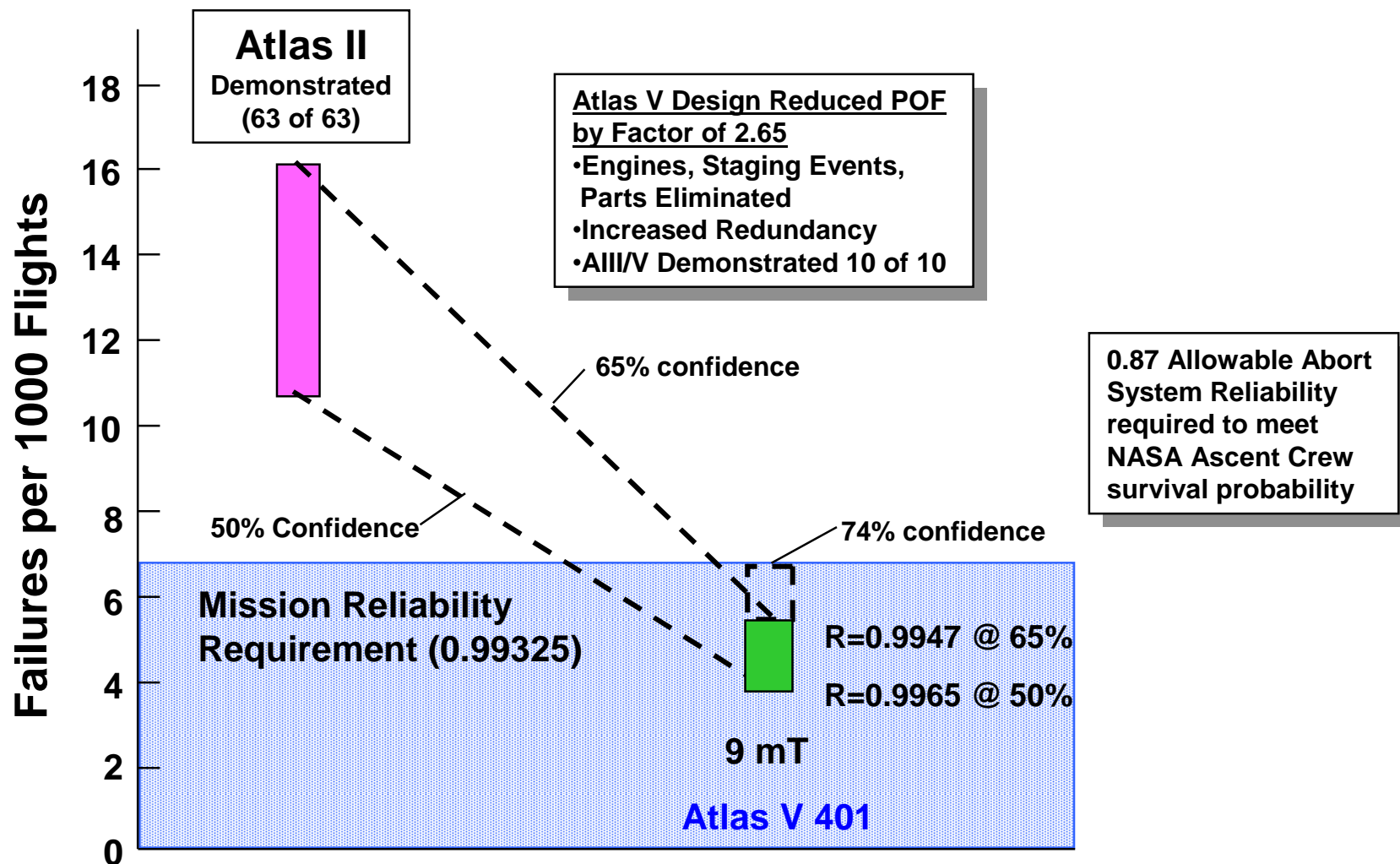
Atlas 401		Atlas HLV
8.2mT	Performance (220nmi. X 51.6)*	28mT
Yes	Black Zone Closure	Yes
> 99%	Reliability	>98%
All Liquid Rocket Single RD-180 Single RL-10 Low Cat Fraction Fault Tolerant Avionics High Margins	Configuration	All Liquid Rocket Single RD-180/Booster Dual RL-10's Low Cat Fraction Fault Tolerant Avionics High Margins

* Performance includes PLF, Margin and Optimized Trajectory

Reliable Human Spaceflight Vehicles

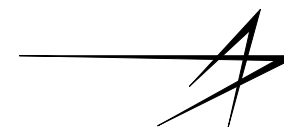


Atlas Reliability Improvement



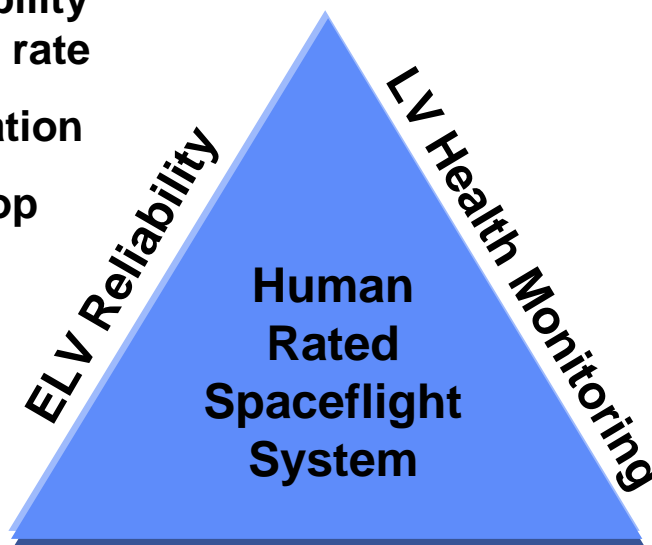
Atlas Reliability Meets NASA Standards

System-Level Human Rating



Reliability

- Fault-Tolerant Systems
- Centaur and Booster Engine-Out Capability
- Demonstrated Reliability through high launch rate
- Vehicle Characterization
- Rigorous, closed-loop processes
- Experienced People



Health Monitoring

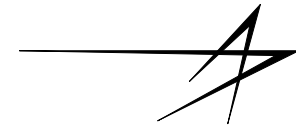
- Situational Awareness
- Monitor Critical Systems Using Independent Fault Tolerant Failure Sensing System
- Fly Monitoring System on All Missions
- Engine Out Detection and Abort Commands

Intact Abort Capability

- Catastrophic LV failures minimized
- Abort to Orbit under most engine failures

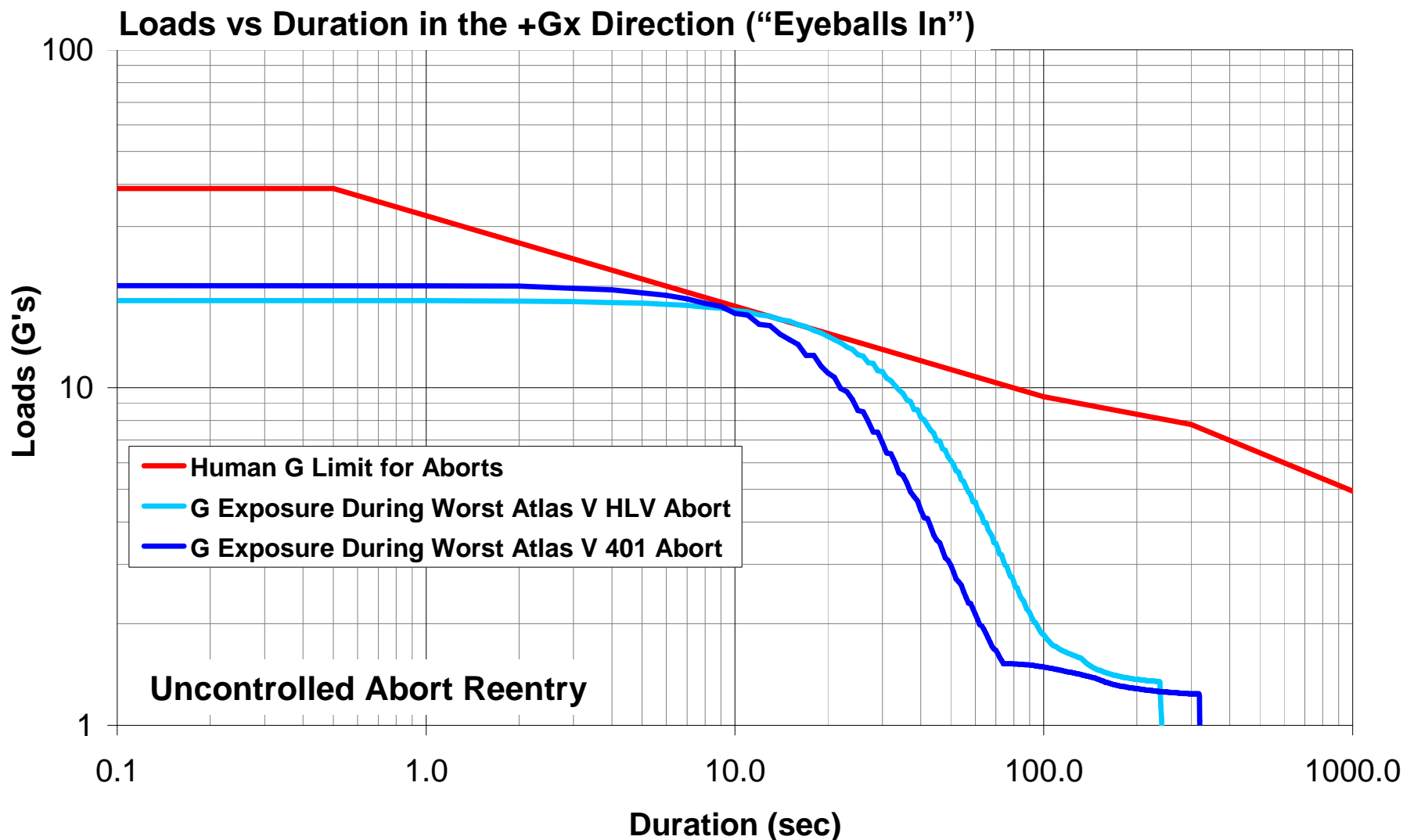
System Level Approach Meets Human Rating Requirements

Human Spaceflight Requirements



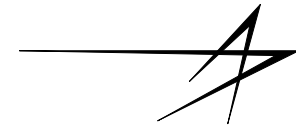
Human Rating Requirement	Atlas Approach	Comments
FAA - Crew and Public Safety	Maximize Safety and Reliability	Atlas V FAA Licensed and range Certified - Human Passenger requirements readily addressable
Reliability	Design POF reduced by factors relative to 100% successful Atlas II family	Atlas V: 62% reduction in POF High flight rate provides experience, cost reduction and alleviates “Infant mortality” failures
Demonstrated Reliability,	Common fleet provides flight tests & high flight rate. Atlas II/III/V 100% success.	Proven Mission Success Atlas : 78 Flights 100% Success including 8 new configurations, 3 new launch pads and 7 Atlas V Flights
Dual Fault Tolerance	Single fault tolerance (SFT)	Abort provides second fault protection
Robustness, Factors of Safety	Common elements designed to envelope of fleet requirements	Human rated configurations have robust margins relative to design
Common Cause Software Failures	Rigorous SW development & test processes provide necessary SW reliability	Backup flight control SW approach maximizes commonality

Atlas V Abort Black Zone Closure



Atlas V Closes Black Zones

Crew Access Alternatives



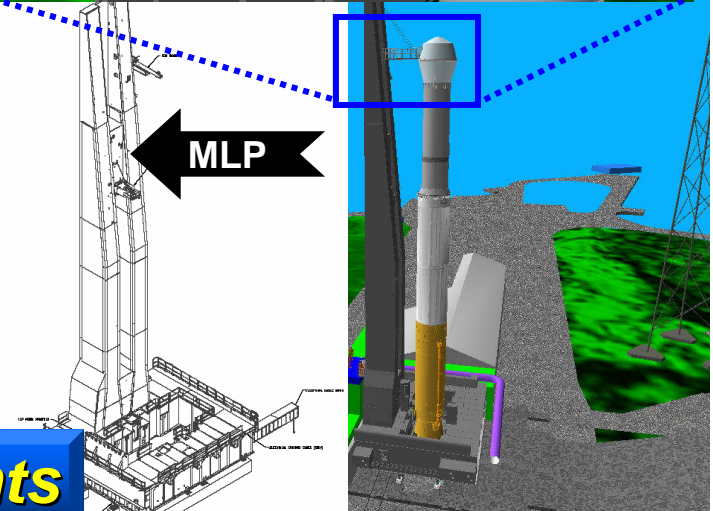
via MLP Fixed Crew Access Tower

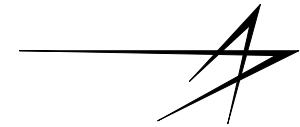


Crew Access Alternatives

- Fixed Crew Tower at CX-41
- Mobile Launch Platform existing lift

Crew access keyed to requirements

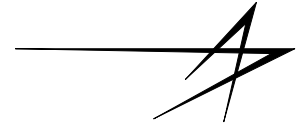




Summary

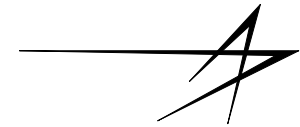
- **Flight Proven, Credible**
 - 8 of 8 first flight successes over 12 years
 - 78 consecutive successful flights
- **Available**
 - Atlas V with Mission Peculiar kit can be available for 2008 demo flight
 - Flight proven common Booster and Centaur provides path to HLV
 - Atlas HLV ready within 30 month order to launch timeline
- **Affordable**
 - Cost minimized using current Atlas to eliminate dedicated test flights
 - Fleet baseline approach minimizes recurring cost
- **Sustainable**
 - Substantial synergy with DoD
 - Infrastructure supported by total launch market
- **Safe and Reliable**
 - Human Rating requirements evaluated, analyzed and assessed
 - Atlas has the best demonstrated reliability of worlds launch vehicle
 - All liquid vehicles have low Cat Fraction

Atlas V - Ready to Support Human Spaceflight!



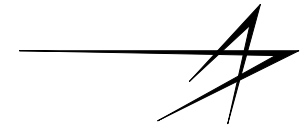
Backup

Atlas Program Approach

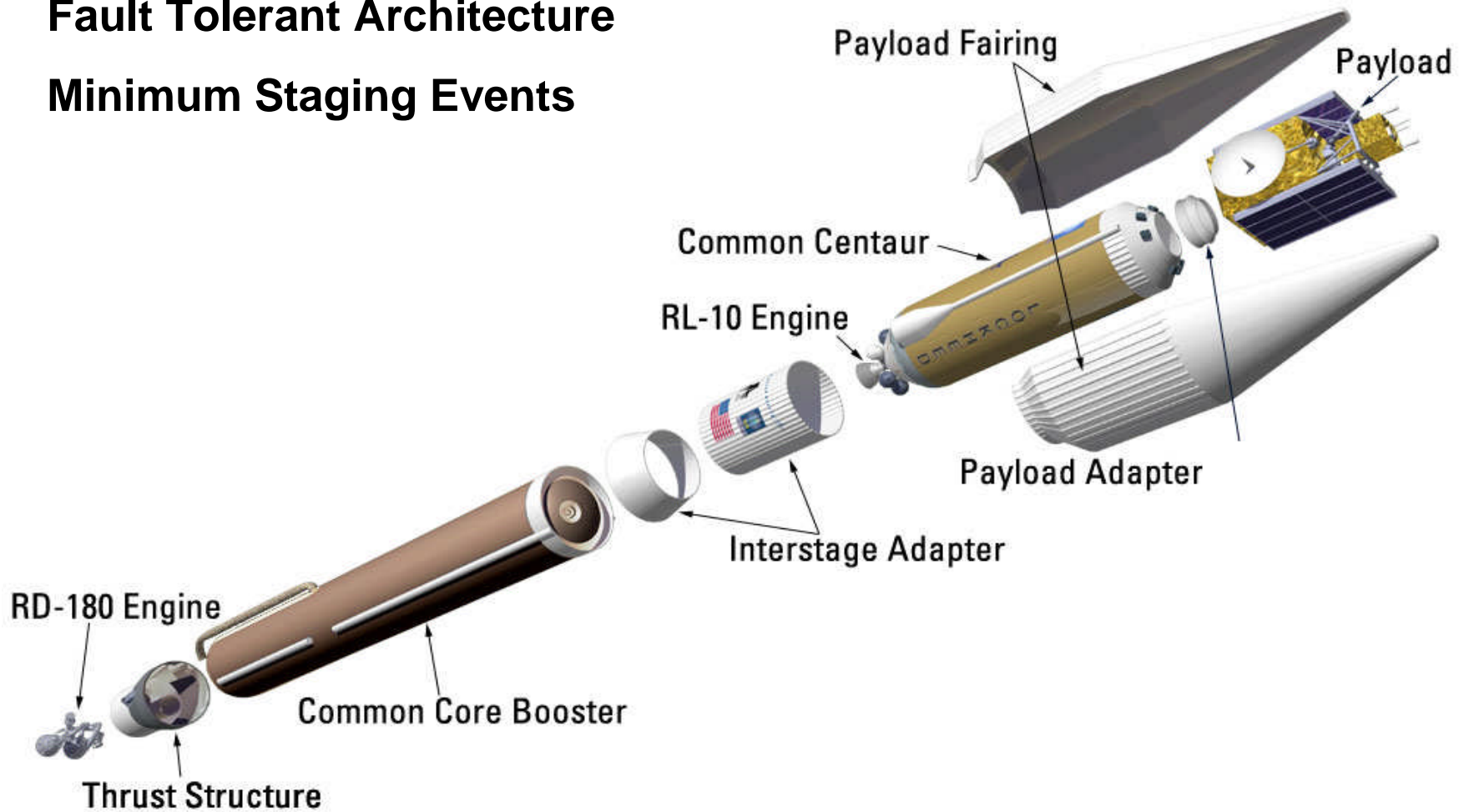


- **Minimize cost, risk & schedule**
 - Introduce improvements one step at a time
 - Ensure improved flying product at each step
 - Grow capability as needs mature – incremental cost
- **Maintain common vehicle configurations**
 - **Atlas Common Element Approach**
 - Common Booster
 - Common Centaur
 - Launch complex
 - **Flight Proven Hardware**
 - Eliminates risk prior to crewed flights
 - Evolving fleet baseline supports certification
 - High demonstrated reliability
 - **Affordability**
 - High production rates reduces cost
 - Shared infrastructure cost between users
- **Additional Enhancements to increase Reliability benefits all users**
 - **Critical one of a kind national missions**
 - **Enable human rating**

401 Vehicle Configuration

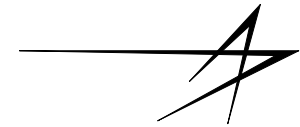


Fault Tolerant Architecture
Minimum Staging Events



Reliably Simple Vehicle Configuration

Atlas V Heavy Lift Vehicle



***Design complete,
Qual remaining**

**Composite 5.4 Meter Dia.,
87-ft Long Payload Fairing**

**Staging Thrusters & Separation*
Ordnance (In Development)**

Build 7 Flight Software

**Centaur
Forward
Load
Reactor
(CFLR)
Deck &
Fwd.
Bolt-Ons**

**Composite
Boattail ISA
& Aft Bolt-Ons
Centaur Interstage
Adapter (C-ISA)
- 12.5-ft Dia.
& Aft Bolt-Ons**

**Composite
Liquid Booster
Nose Cones***

**ATS Attach
Fittings &
Back-Up
Structure***

**Launch Site Additions:
Launch Heads,
HPSS & Decouplers Install
Mechanical GSE Fluid Lines
Pathfinder**

**Additional Performance with
Flight Proven Reliable Common Elements**

