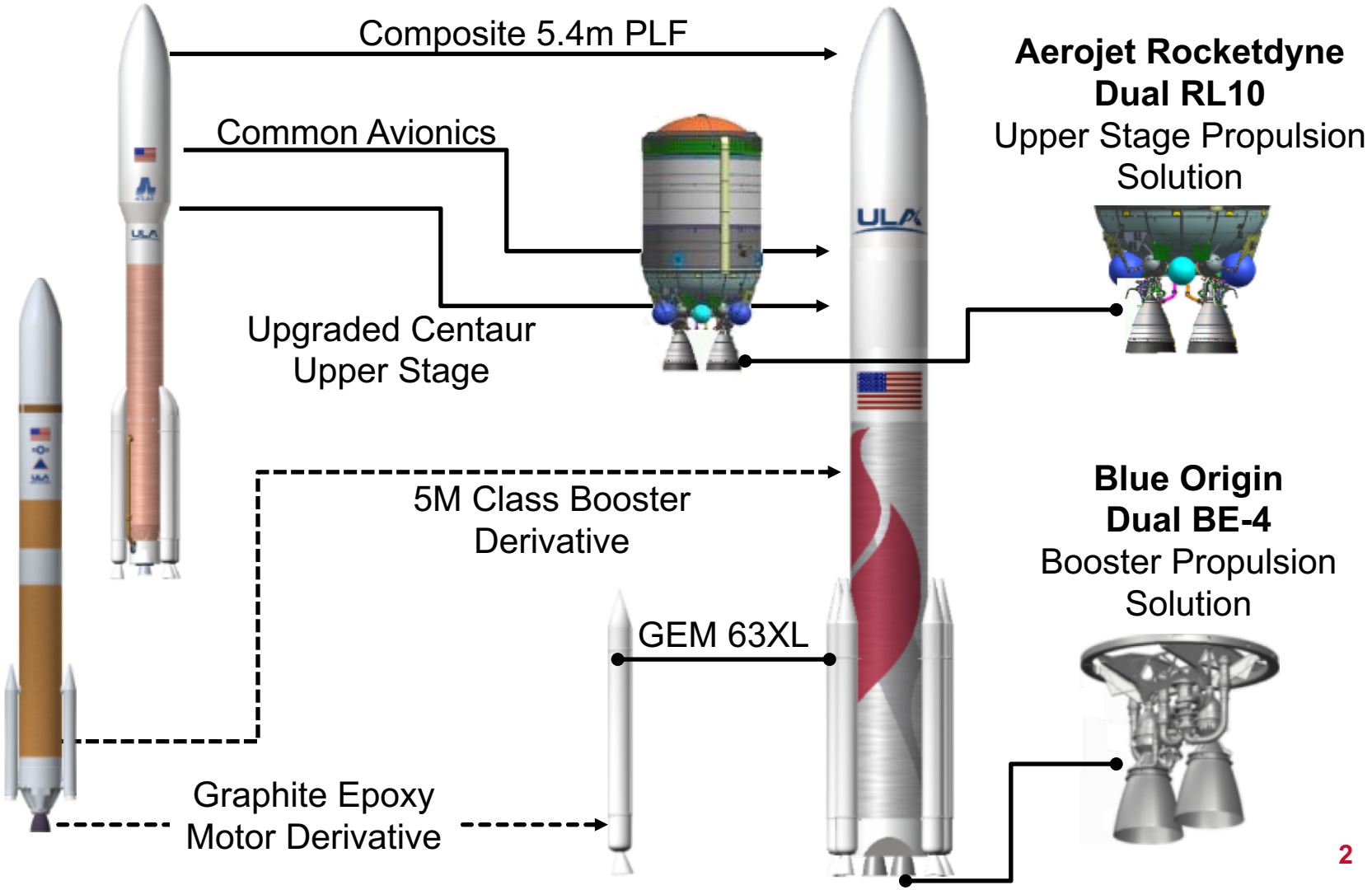
CUBESAT LAUNCH TO HIGH ENERGY ORBITS

April 2019

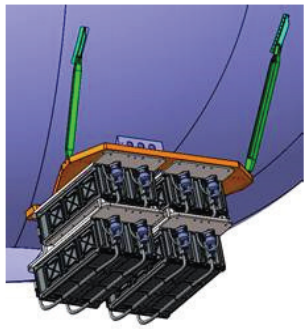
VULCAN CENTAUR EVOLUTION



MULTI-MISSION CAPABILITY OVERVIEW

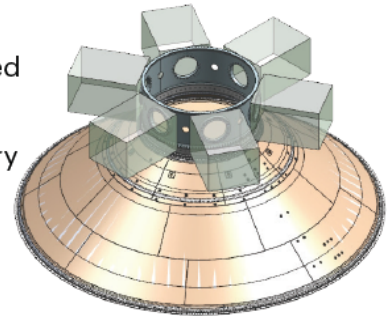
AFT BULKHEAD CARRIER (ABC)

Interface located at the aft end of the Centaur upper stage



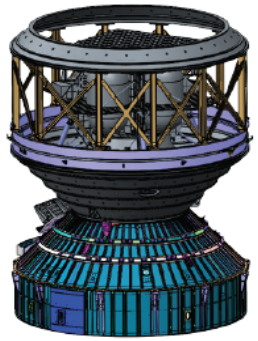
SECONDARY PAYLOAD ADAPTER (ESPA)

Adapter located between the upper stage and the primary payload



MULTI-PAYLOAD CANISTER SYSTEM

Load-bearing separating canister supporting forward traditional large satellite and enclosing aft small satellite

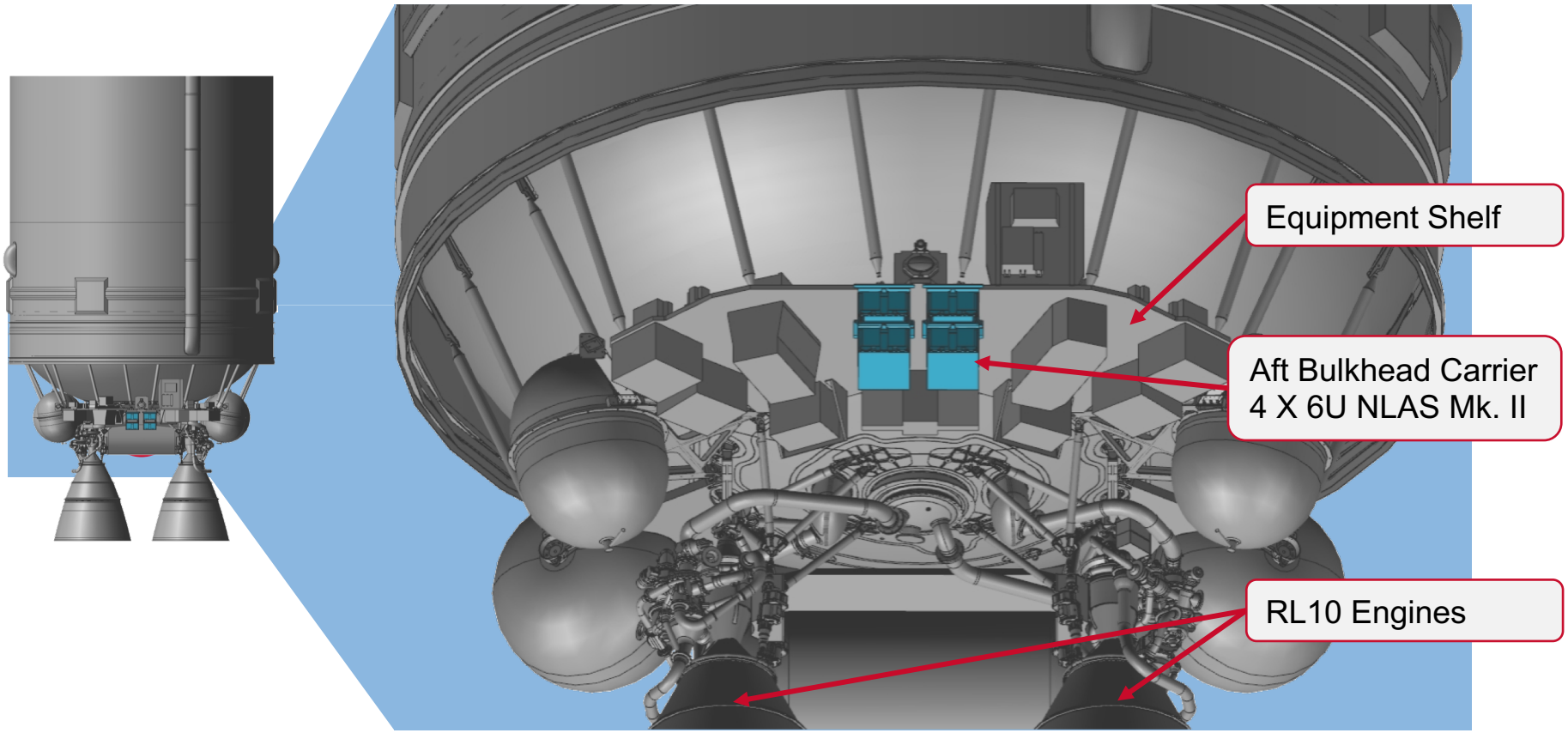


CubeSats	
Capacity	24U CubeSats
Interface	CubeSat Dispenser
Mass	80 kg (176 lb)

CubeSats to Small Satellites	
Capacity	4-6 payload modules per ESPA ring
Interface	15 in or 24 in bolted
Payload Mass	181-318 kg (400-700 lbs)
Volume (5-m PLF)	ESPA: 61 cm x 71 cm x 96 cm (24 in x 28 in x 38 in) Grande: 100 cm x 115 cm x 125 cm (39 in x 45 in x 49 in)

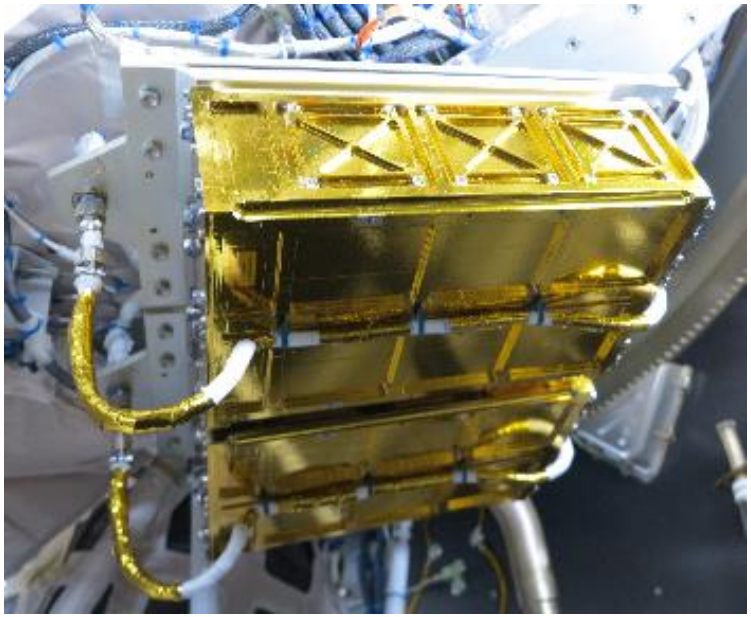
Small Satellites	
Capacity	Canister and forward payload volume
Interface	Fwd: 1575 standard interface Internal: 62 in bolted
Payload Mass	Small satellite masses exceeding ESPA capability
Canister Volume	218 cm-dia x 195 cm (86 in-dia x 77 in)

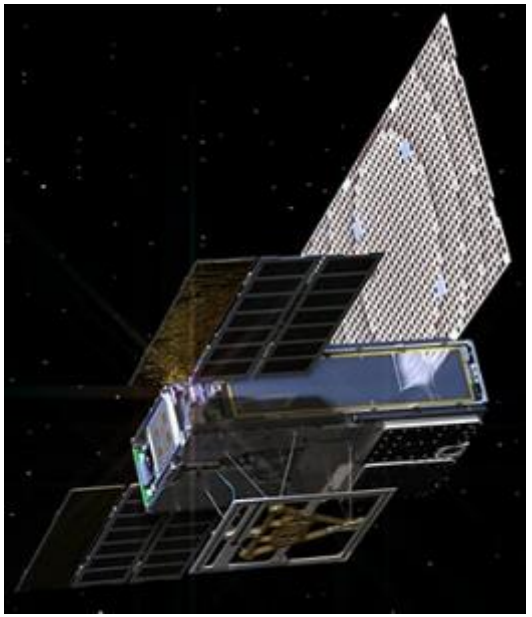
VULCAN CENTAUR
CUBESAT LAUNCH – AFT BULKHEAD CARRIER



CUBESAT LAUNCH SOLUTIONS TO HIGH-ENERGY ORBITS

MARCO - FIRST INTERPLANETARY CUBESATS





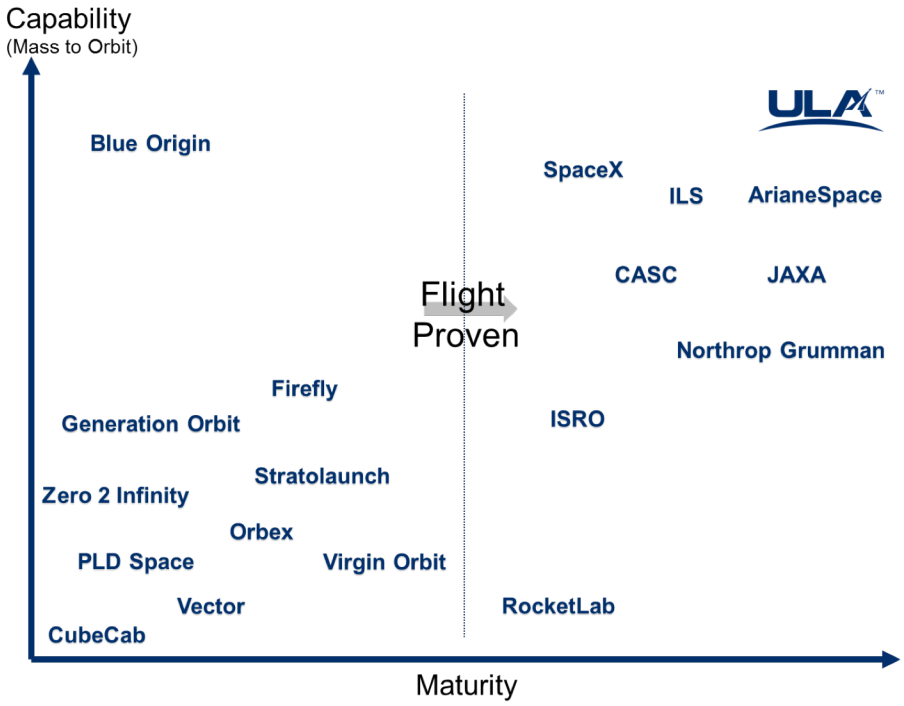
Launched on Atlas V May 5, 2018
Supported EDL of InSight

Photo from Marco-B cubesat, 1M km from Earth

CUBESAT LAUNCH
HIGH ENERGY ORBITS

- High energy orbits
  - MEO
  - GTO
  - GSO
  - Lunar
  - Earth Escape / Interplanetary

- Unique mission opportunities
  - Mission augmentation and support
  - Tech development
  - Science
  - Exploration



Requires high performance launch vehicle

LAUNCH MARKET COMPARISON

Dedicated Small Rockets

- High cost per kilogram
- Ability to choose launch window
- Capability limited to LEO orbits
- New entrants developing innovative solutions

Large Multi Launch

- Low cost per kilogram
- Launch timeline driven by primary spacecraft requirements
- Options for high energy orbits
- Providers enhancing capabilities to provide new and unique solutions

Trade-off between small and large launch vehicles

THANK YOU