

# ADVANCED CRYOGENIC EVOLVED STAGE

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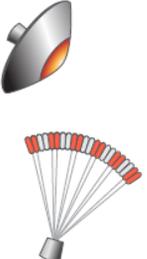
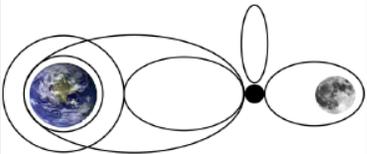


# LAUNCH HISTORY

**ULA's Vision: Unleashing Mankind's Potential in Space**  
ULA is developing the enabling transportation system for a Self Sustaining Space Economy



# PRODUCT ROAD MAP

	CURRENT	STEP ONE	STEP TWO	STEP THREE	STEP FOUR	STEP FIVE	
	2018	2020	2023	2023	2024	2024+	
<b>ATLAS V</b>	20t Class  0-5x	RD-180 Engine Retired					
<b>DELTA IV</b>	30t Class  Delta IV Medium Retired	30t Class 	Delta IV Heavy Retired				
<b>VULCAN CENTAUR/ACES</b>		Vulcan Centaur 25t Class  2-6x	Vulcan Centaur 35t Class  2-6x Single Core Heavy Capability	<b>Vulcan ACES</b>  2-6x Enhanced On-orbit Capability	SMART Reuse 	Distributed Lift, Propellant Transfer 	In CisLunar Space Transport and Refueling 

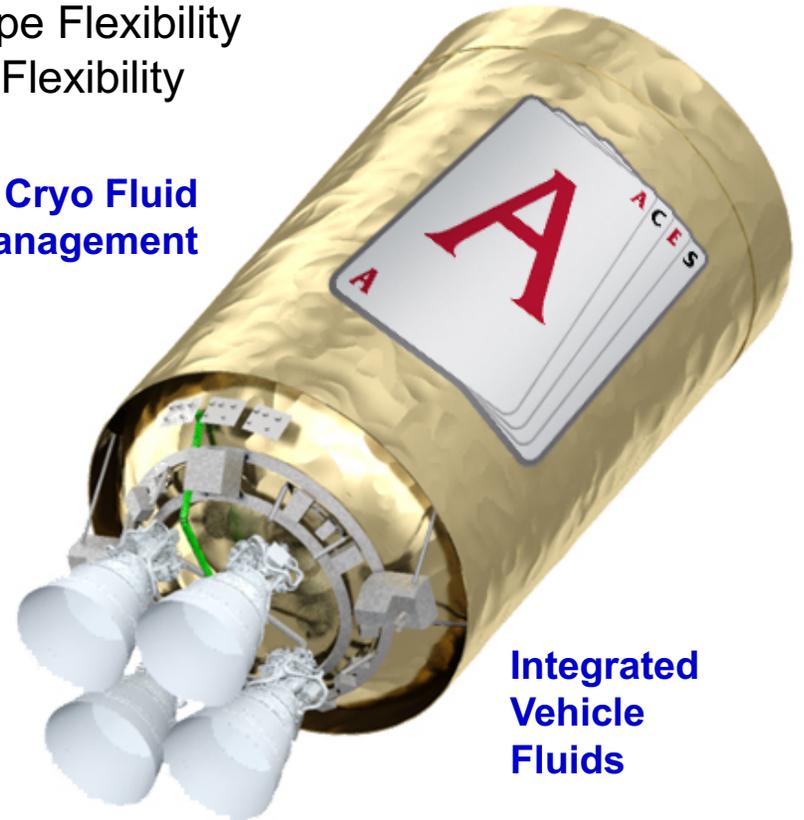
ACES Will Be the Space Transportation Workhorse

# ADVANCED CRYOGENIC EVOLVED STAGE

## New Mission Capability

- Weeks and Longer Duration
- Many Engine Burns
- Service Module Type Flexibility
- Increased Mission Flexibility

**Cryo Fluid  
Management**



150 klb LO<sub>2</sub>/LH<sub>2</sub>  
5.4m dia Tank  
Stainless Steel  
Monocoque  
Common Bulkhead

**Integrated  
Vehicle  
Fluids**

ACES Transforms Space Launch

Integrated Vehicle Fluids & Cryo Fluid Management are the Key Enabling Technologies

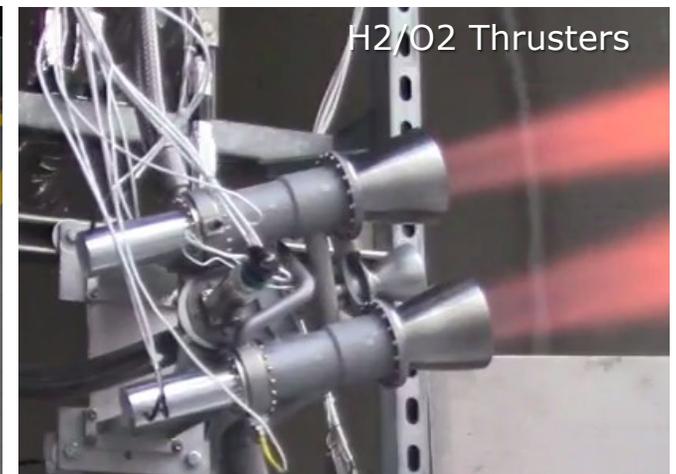
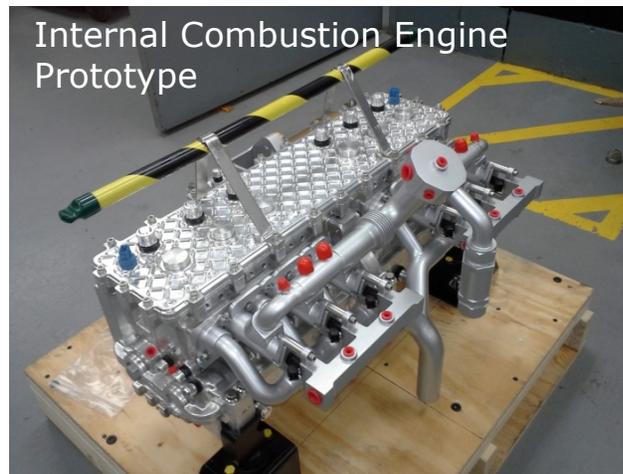
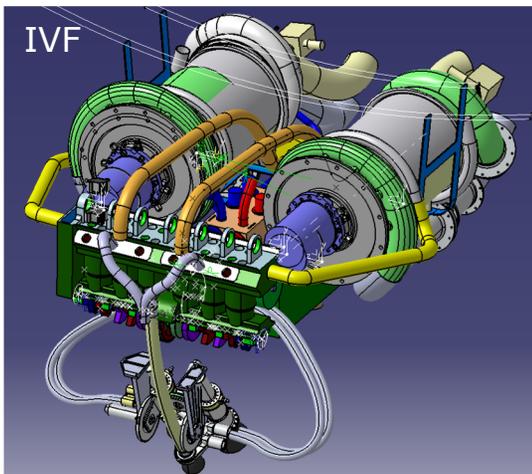
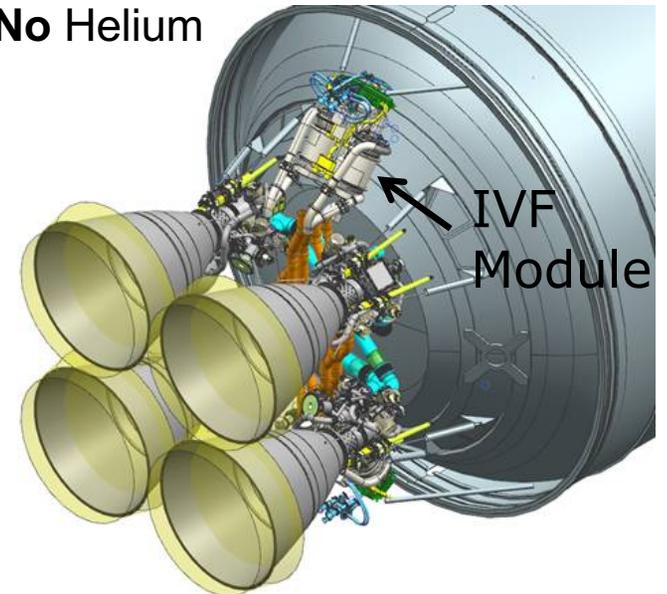
# INTEGRATED VEHICLE FLUIDS

Powers Subsystems with “Waste” Propellants

- Power —> **No** Main Batteries
- Reaction control —> **No** Hydrazine
- Pressurization —> **No** Helium

Enables

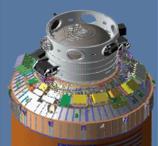
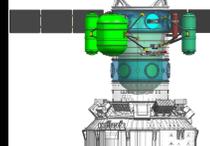
- Service Module Flexibility
- **Ultra-Long Duration**
- On Orbit **Refueling**
- **Reusable**



# ADVANCING CRYO FLUID MANAGEMENT

CRYOTE 3 at NASA MSFC



Initiate CRYOTE		CRYOTE 1 built		CRYOTE 1 LN2 Test		CRYOTE 3 Tank Delivery		CRYOTE 3 IVF Test	
2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
	CRYOTE Light		CRYOTE Grande		CRYOTE No Vent Fill		CRYOTE 3 Cryo Test		

# ACES AFT END

## ACES Eliminates:

- Helium System
- Hydrazine System
- 100's of penetrations

## Resulting in:

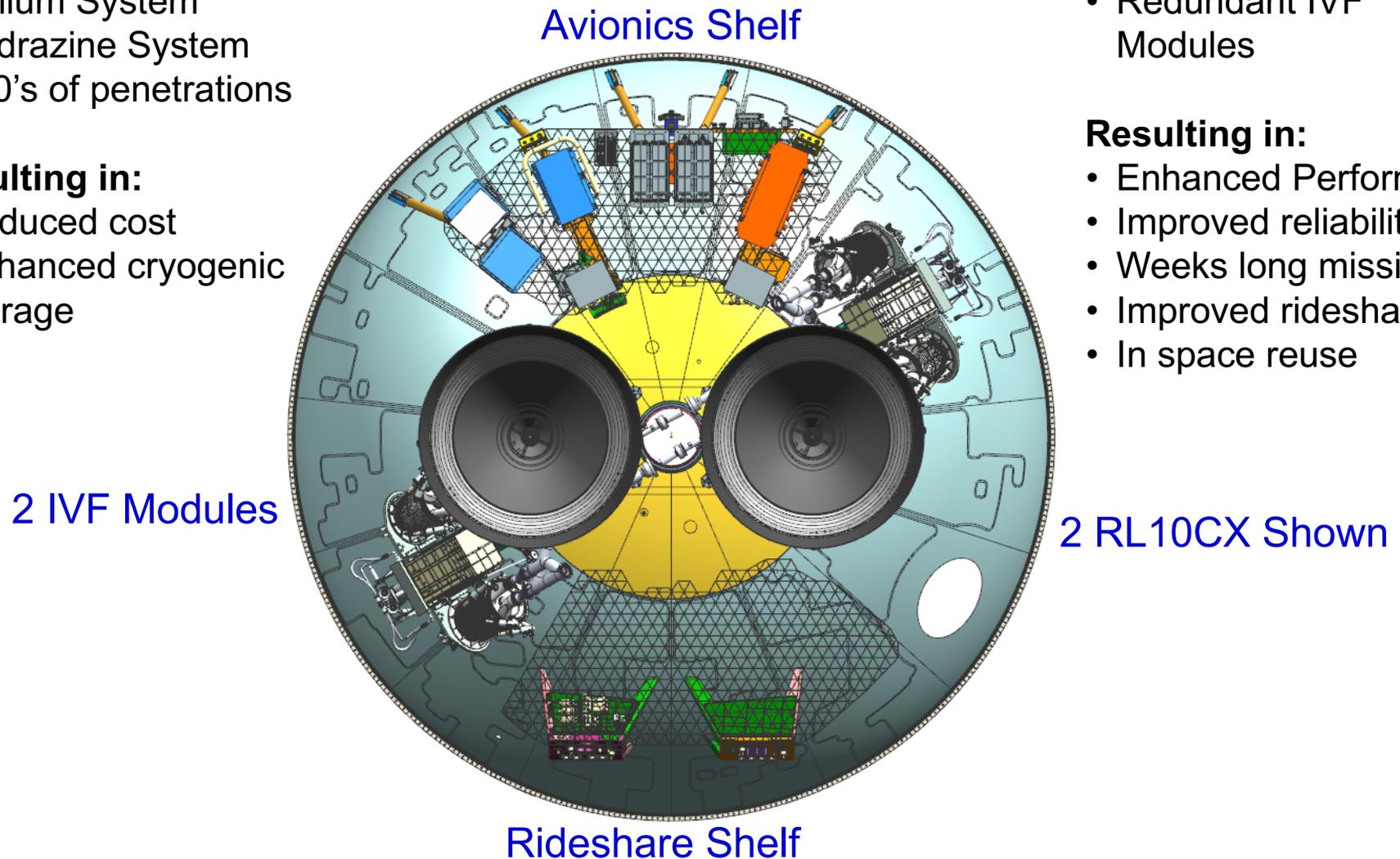
- Reduced cost
- Enhanced cryogenic storage

## ACES Provides:

- Redundant IVF Modules

## Resulting in:

- Enhanced Performance
- Improved reliability
- Weeks long missions
- Improved rideshare
- In space reuse



# ACES ENABLES MORE...

## **Commercial**

- Optimized Orbit Delivery
- Multiple Payload Direct Delivery
- Enhanced Direct to GSO Delivery
- Cislunar Transportation Enabler

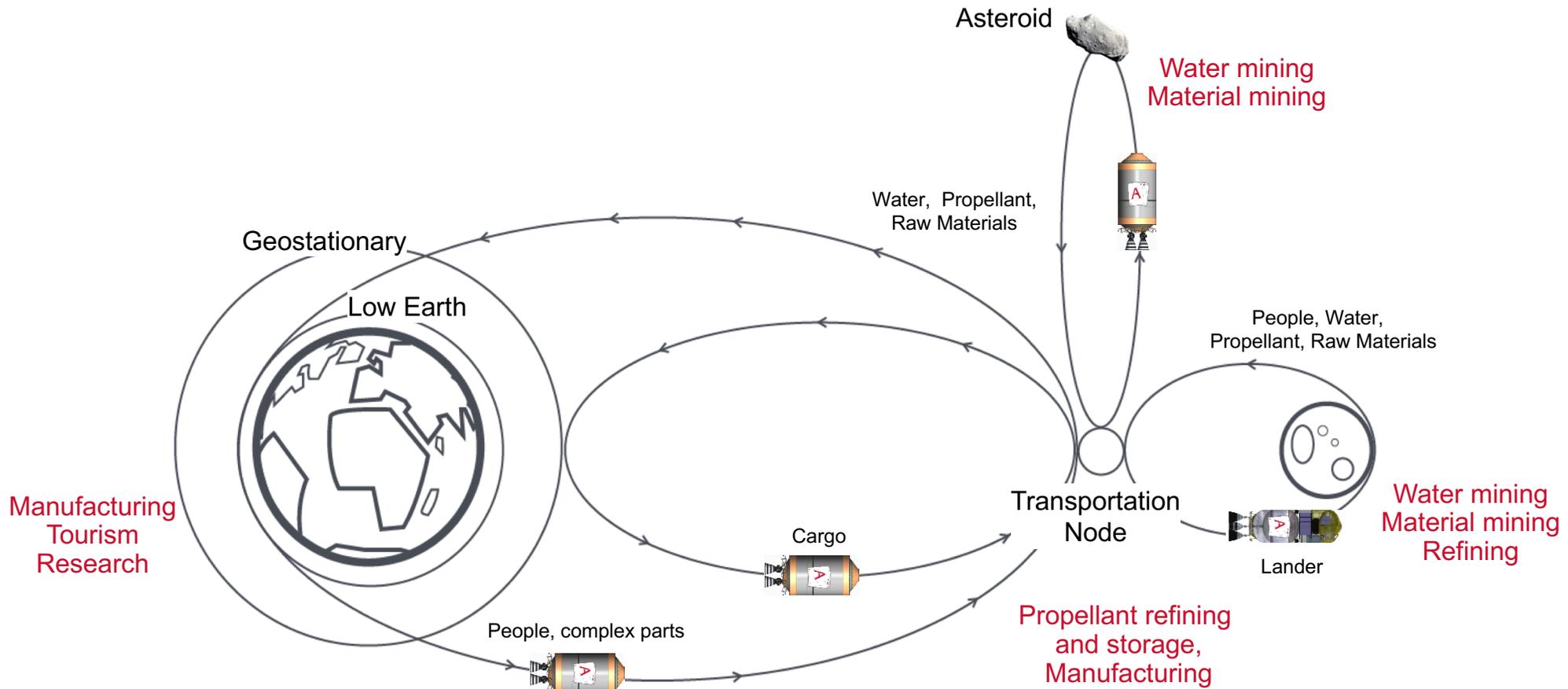
## **National Security**

- Enhanced Direct to GSO Delivery
- Superior delivery options with added duration, number of burns, payload electric power & ACS propulsion

## **Civil**

- Science – Direct insertion to orbits of interest (e.g. LOI)
- Exploration Enhancement – cargo to Gateway
- Following ISS decommission moving ISS to museum orbit (1,000 year orbit)

# THE BROAD CISLUNAR ECONOSPHERE



ACES Provides the Transportation Enabling the CisLunar Economy

- Impulsive Propulsion = Fast Trip Times
- LH<sub>2</sub> & LO<sub>2</sub> maximizes benefit of ISRU ICE from Moon & Asteroids
- IVF Eliminates He and N<sub>2</sub>H<sub>2</sub> from the resusability logistics stream