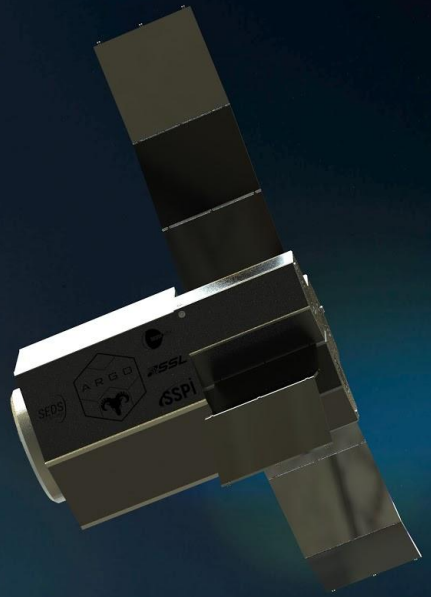
ARGO



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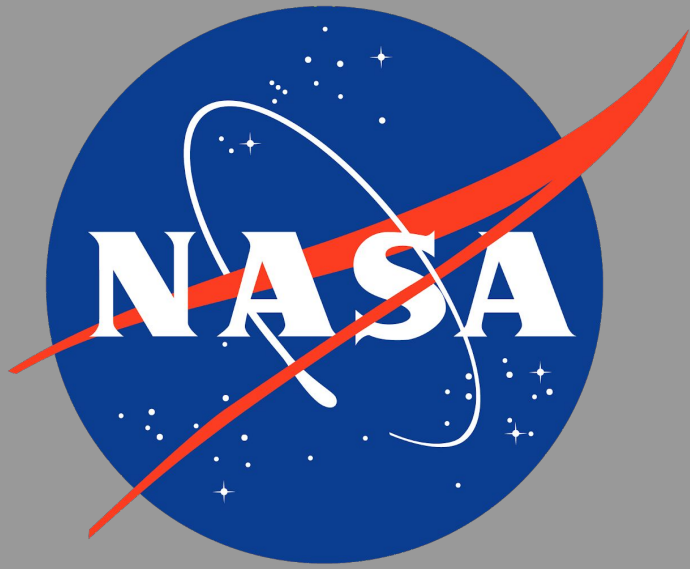
Design Purpose

- Space-tug for multiple trips between LEO, GEO and LLO carrying 34 metric tons of cargo
- Throttable propulsion with long lifespan and efficient fuel consumption
- Ideal lifespan of 30 clients for 7 years of continuous operation
- Modular assembly for repairs to extend life, and easy disposal of at-risk components through heliocentric graveyard orbit

Cost Analysis

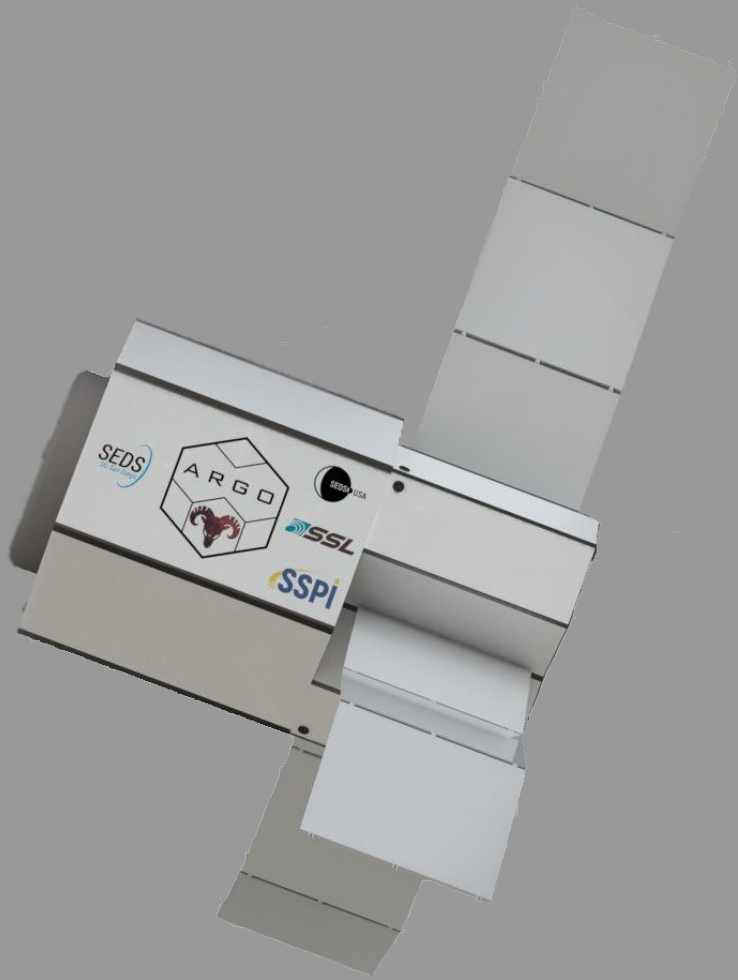


ISS Resupply	SpaceX	Orbital ATK
Contract Cost	$70M	$100-125M
Actual Cost	$30.6-40M	$75-100M
Mass per Payload	2MT	2MT

	GEO via Falcon 9	GEO via Argo x Falcon 9	LLO via SLS	LLO vis Argo x Falcon 9
Cost per Kilogram	$7,470	$4,000	$0.5-1M	$6,500

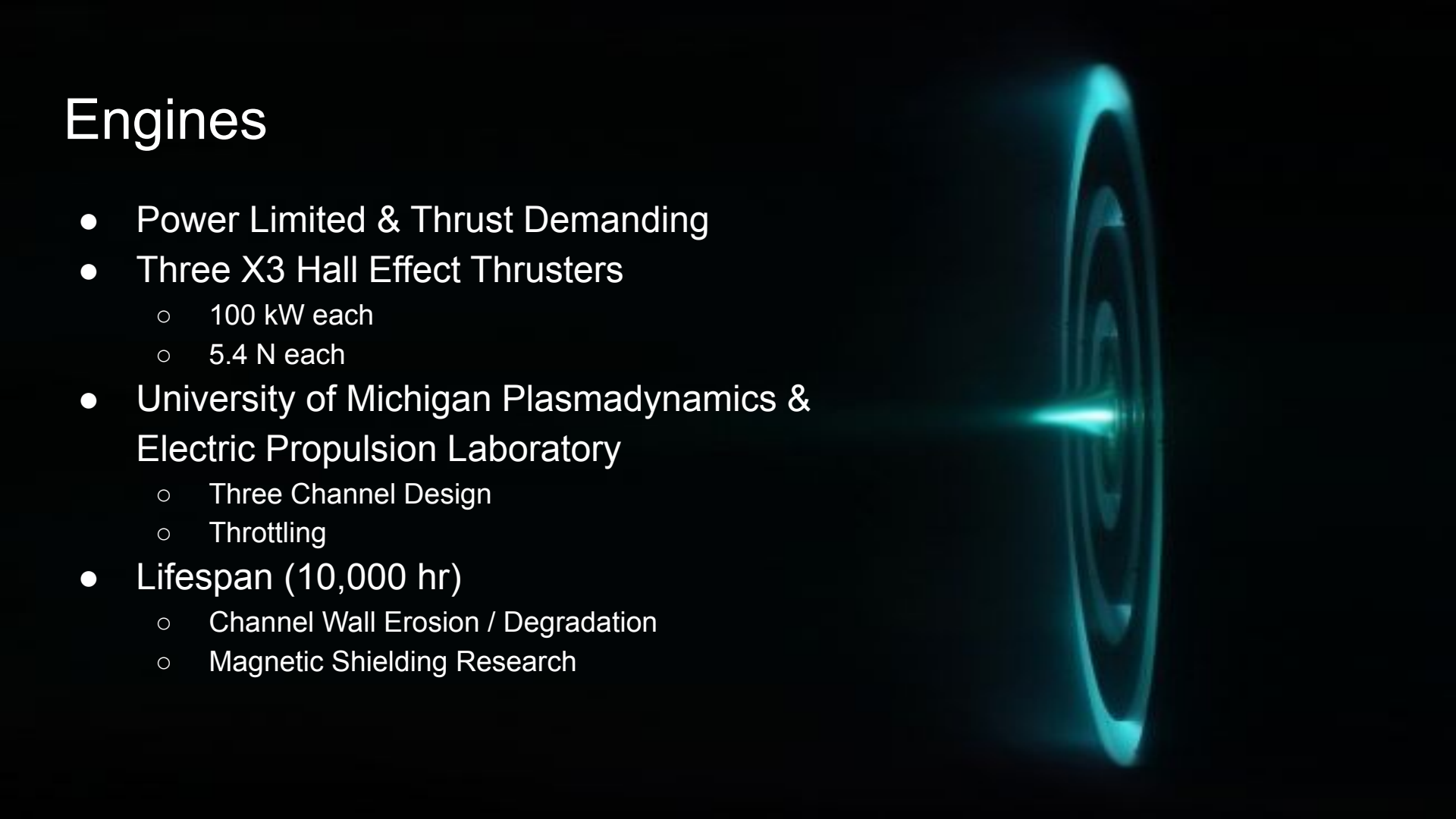
Structures/Propellant Feed

- Main structure is designed around the main tank. Comprised of aluminum and Titanium
    - COPV tank. Possible multiple tanks to maximize space efficiency
- Radiators leak off excess heat
- Propellant Feed system designed as an upscaled Xenon Feed currently featured on satellite
    - Flow control for throttle control; more power for more time critical missions
- System needs to be refuelable
- Provides propellant to ACS thrusters for both Attitude control and emergency venting



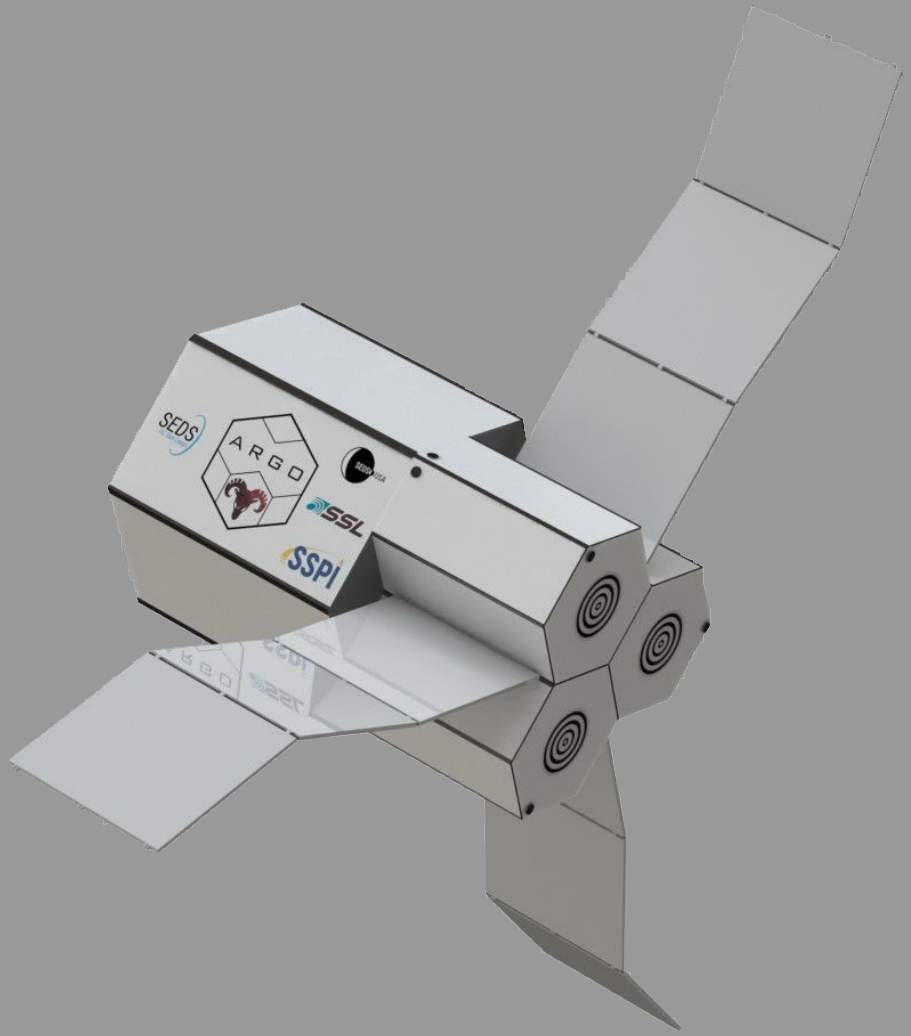
Engines

- Power Limited & Thrust Demanding
- Three X3 Hall Effect Thrusters
  - 100 kW each
  - 5.4 N each
- University of Michigan Plasmadynamics & Electric Propulsion Laboratory
  - Three Channel Design
  - Throttling
- Lifespan (10,000 hr)
  - Channel Wall Erosion / Degradation
  - Magnetic Shielding Research



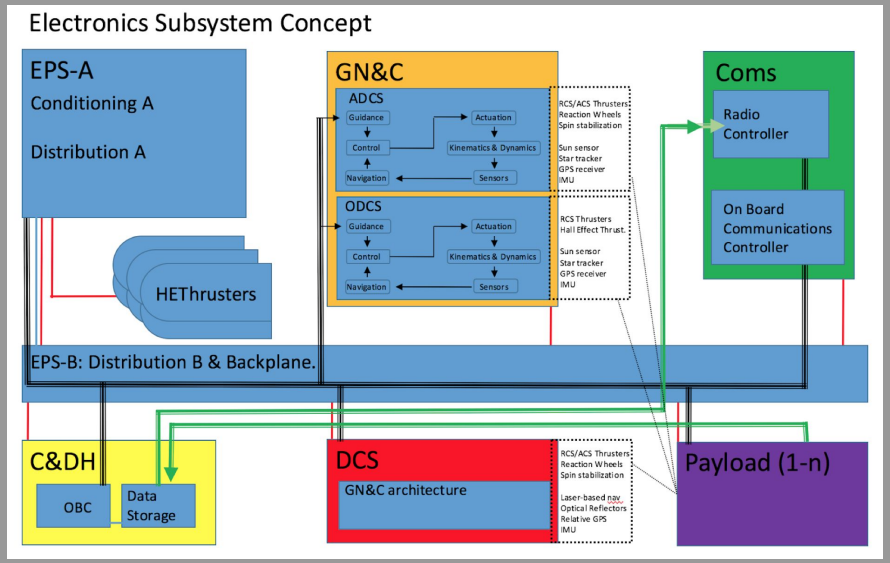
Power Systems

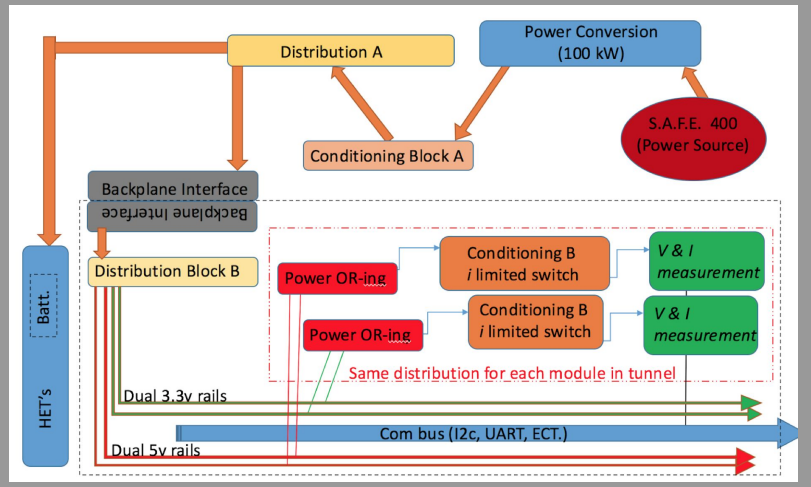
- SAFE-400 reactor with a Brayton Power system
- Brayton offers 100 kW electrical power with 300 kW waste - current design limitation
- Advancements in efficient power conversion required for feasible design



Electrical Systems

Track Study: Proposed 'Tunnel Swapping' vs Traditional Shielding Techniques		
TID calc for 8 years	Tunnel Swapping (5mm)	Traditional Shielding (10mm)
Additional Mass Al	2.028 kg	4.341 kg
TID Low Earth Orbit	6.2 krad	5 krad
Additional Mass Ta	12.316 kg	26.4 kg
assumed module 10 cm X 10 cm X 30 cm 1608 cm3 at 10mm thickness; 751 cm3 at 5mm thickness; Aluminium density 2.7 g/cm3, Tantalum density 16.4 g/cm3		





Results

- 34 MT to LLO in 45-90 (one way) days depending on mass and orbital positioning
- 34 MT to GEO in 7-14 (one way) days
- Reliable operation for 7 years with potentially 30 clients depending on mission parameters
- Retrofitting capabilities for future potential mission capabilities

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Questions?