



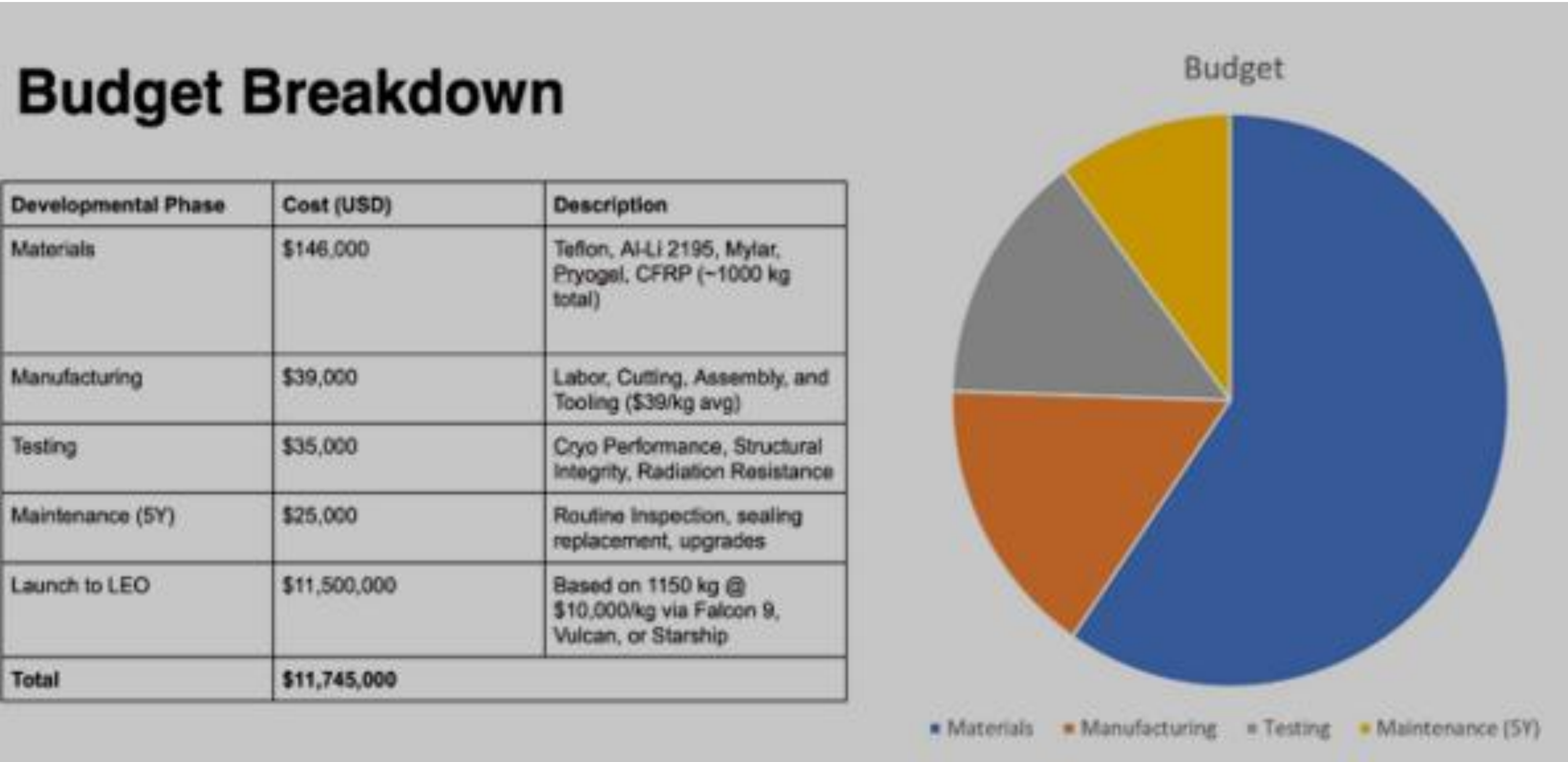
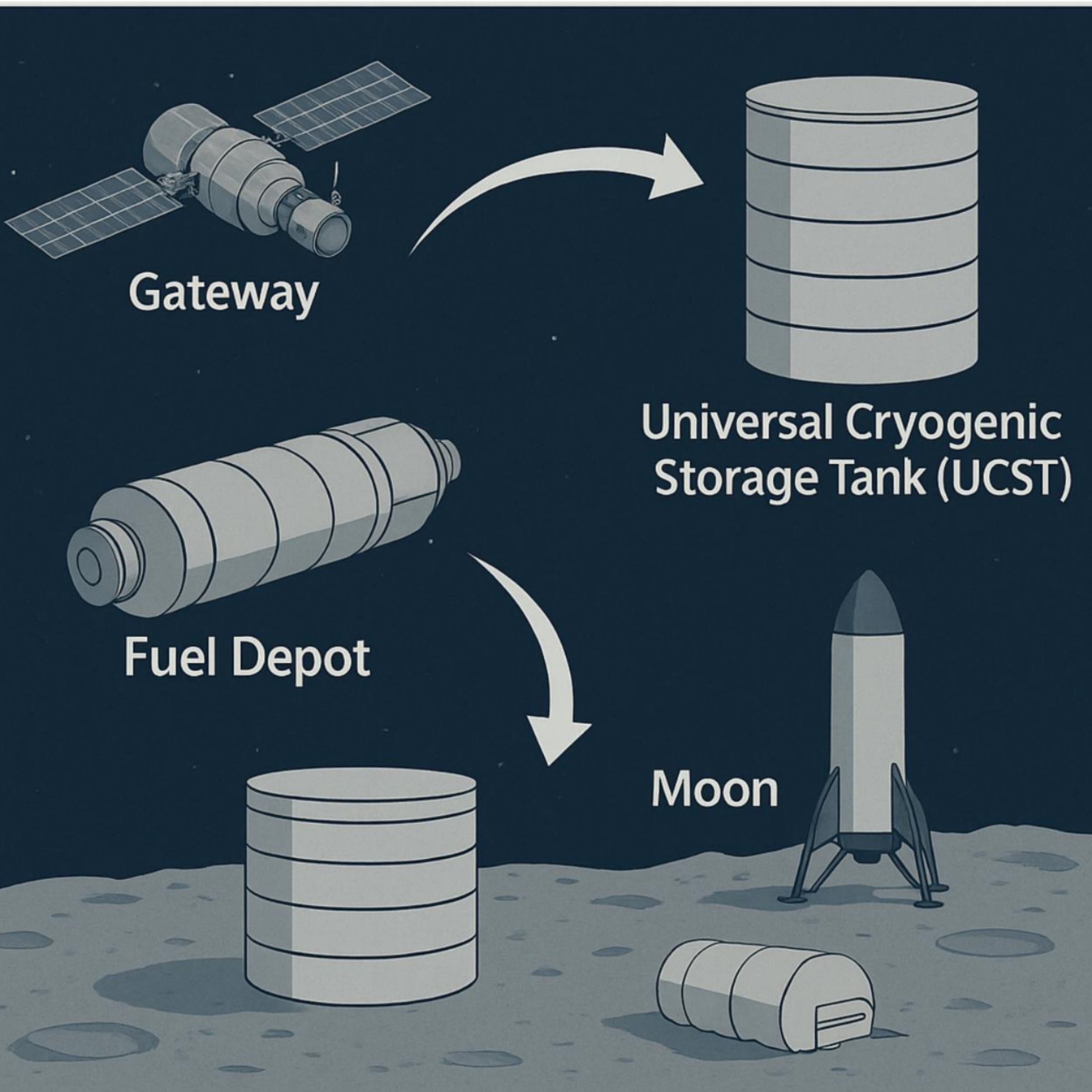
Cryogenic Complex: Modular Cryogenic Storage System for Lunar and Cislunar Missions- Universal Cryogenic Tank (UCST)



Team: Jeremy Carlson, Sandra Contafio, Bazir Kateti, Federico Mamone, Antonio Pedri

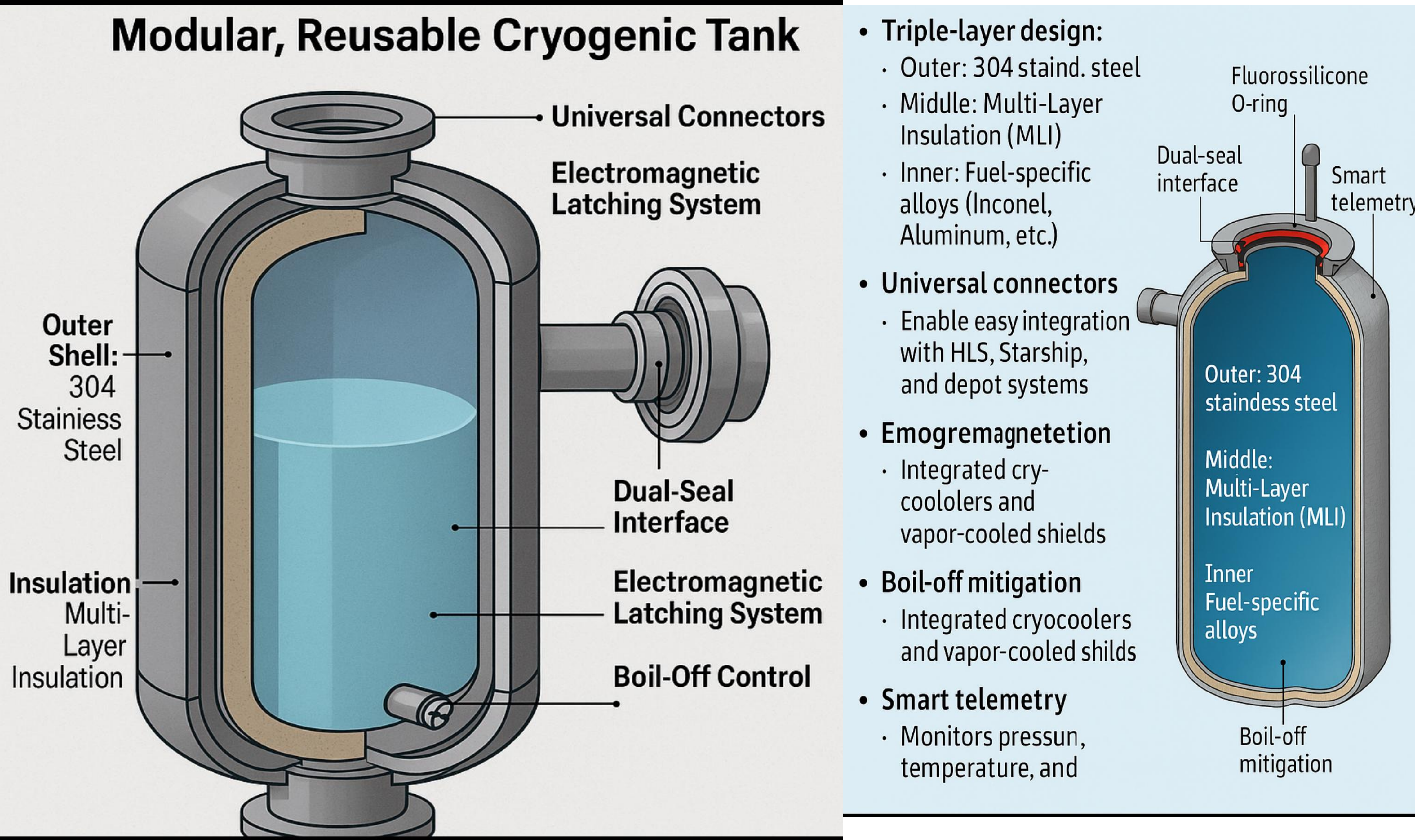
Introduction

This project supports NASA’s Human Lander mission by developing a modular, reusable cryogenic tank – the Universal Cryogenic Storage Tank (UCST). Designed for LOX, and LH₂, UCSTs enable fuel storage and transfer between the Moon, Gateway, and orbiting depots. It works with Starship and HLS systems and supports lunar refueling. “Crypods” help in long-term lunar exploration.



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Technical Innovation: Universal Cryogenic Storage Tank (UCST)



Timeline and Milestones

- 0–6 months**
 - Complete PDR/CDR reviews
 - Finalize CAD/FEA procure materials
 - Build 50 L LN subscale
- 6–12 months**
 - Subscale testing and seal/rib optimization
 - Document boil-off, leaks; seal review
- 12–18 months**
 - Fabricate 300 L prototype with full accessory suite
 - Run vacuum, thermal and vib-cycle tests
- 18–24 months**
 - Build and instrument full-scale tank
 - Life-cycle stress, automate operations
- 24–30 months**
 - Deploy AI health diagnostics
 - Conduct depot and grapppler interoperability drills
- 30–36 months**
 - Final documentation
 - Complete HLS certification
 - Deliver demo units to lunar orbit and surface

Key Functional Features of UCST

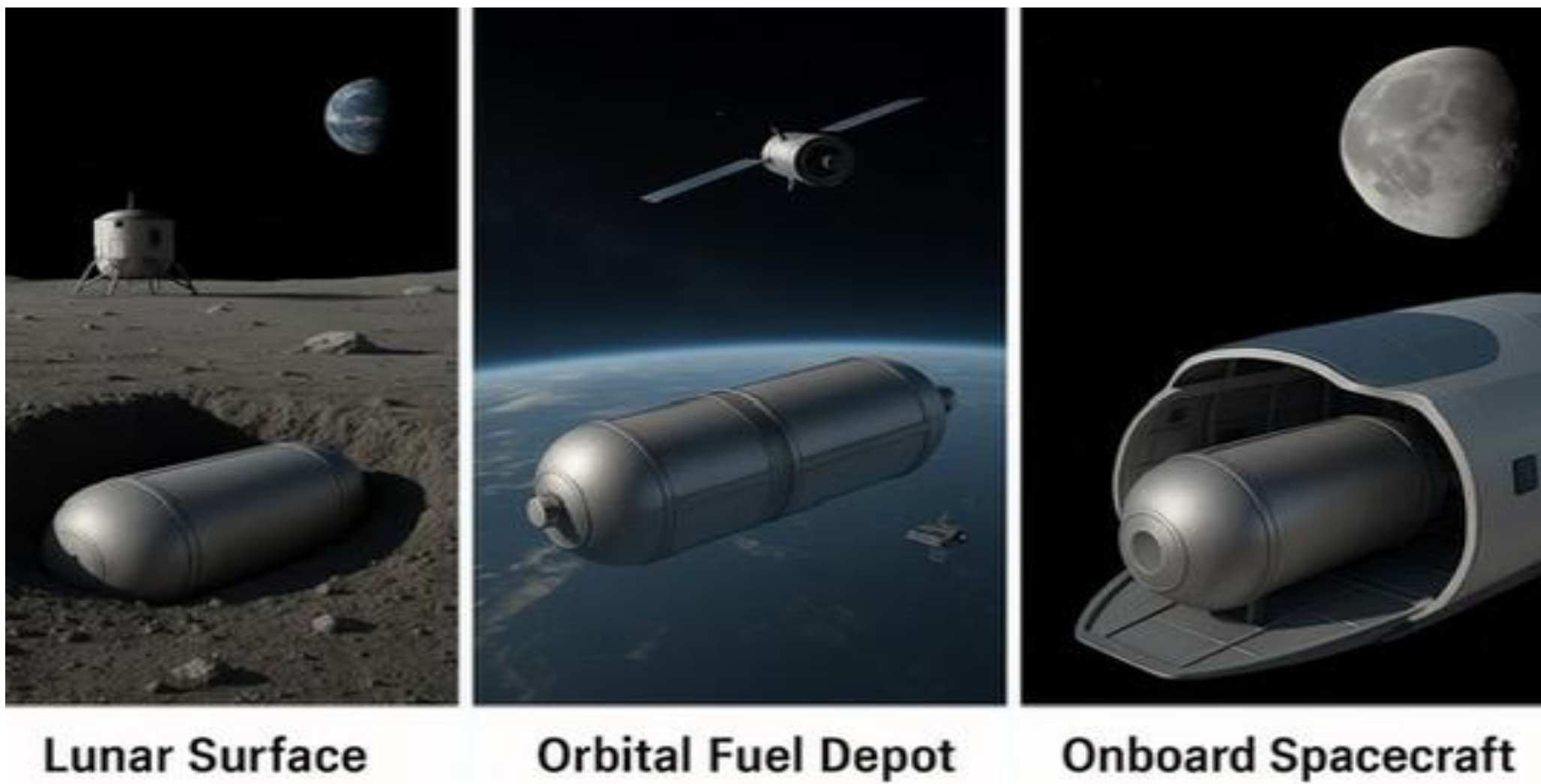
The UCST is a reusable, modular, cryogenic tank designed for storing and transferring LOX, and LH₂, across lunar and orbital operations. It works with HLS spacecraft, supports ISRU-based refueling, and ensures long-term sustainability in deep space missions.

- Key Features:**
 - Triple-layer construction:**
 - Outer shell: 304 stainless steel
 - Insulation: Multi-Layer Insulation (MLI)
 - Inner layer: Fuel-specific alloys (e.g., Inconel, Aluminum 5083)
 - Universal connectors** for fueling and docking across systems
 - Dual-seal interface:** Silver-coated nickel + fluorosilicone O-ring
 - Electromagnetic latching system** for modular tank grids
 - Boil-off control** using cryocoolers and vapor shields
 - Telemetry integration** for remote monitoring (temp, pressure, fuel)

UCST Deployment and Operational use cases

The Universal Cryogenic Storage Tank (UCST) is engineered for flexible deployment in various space environments, supporting Artemis refueling operations on the Moon, in cislunar orbit, and aboard spacecraft.

- Use Cases:**
 - Lunar Surface (Fuel Farm):**
 - Tanks buried 5–10 meters in regolith for insulation
 - Connected to ISRU systems for LOX/LH₂ generation
 - Robotic deployment and retrieval
 - Orbital Fuel Depot:**
 - Multiple UCSTs interlocked into modular grids
 - Serve as refueling nodes for transiting vehicles
 - Passive thermal shielding + active cooling
 - Onboard Spacecraft (HLS, Starship):**
 - Mounted internally or externally for transport
 - Quick-latch connectors and passive helium pressurization
 - Simplifies cryogenic fuel handling in space



Conclusion

The UCST offers a modular, scalable cryogenic solution for lunar and cislunar operations. Its reusable design, compatibility with ISRU, and robotic docking make it ideal for Artemis HLS missions. With phased testing, the system is positioned for NASA integration within 3–5 years.

