Compact LAtching electro-Mechanical interface for Payloads (CLAMP)

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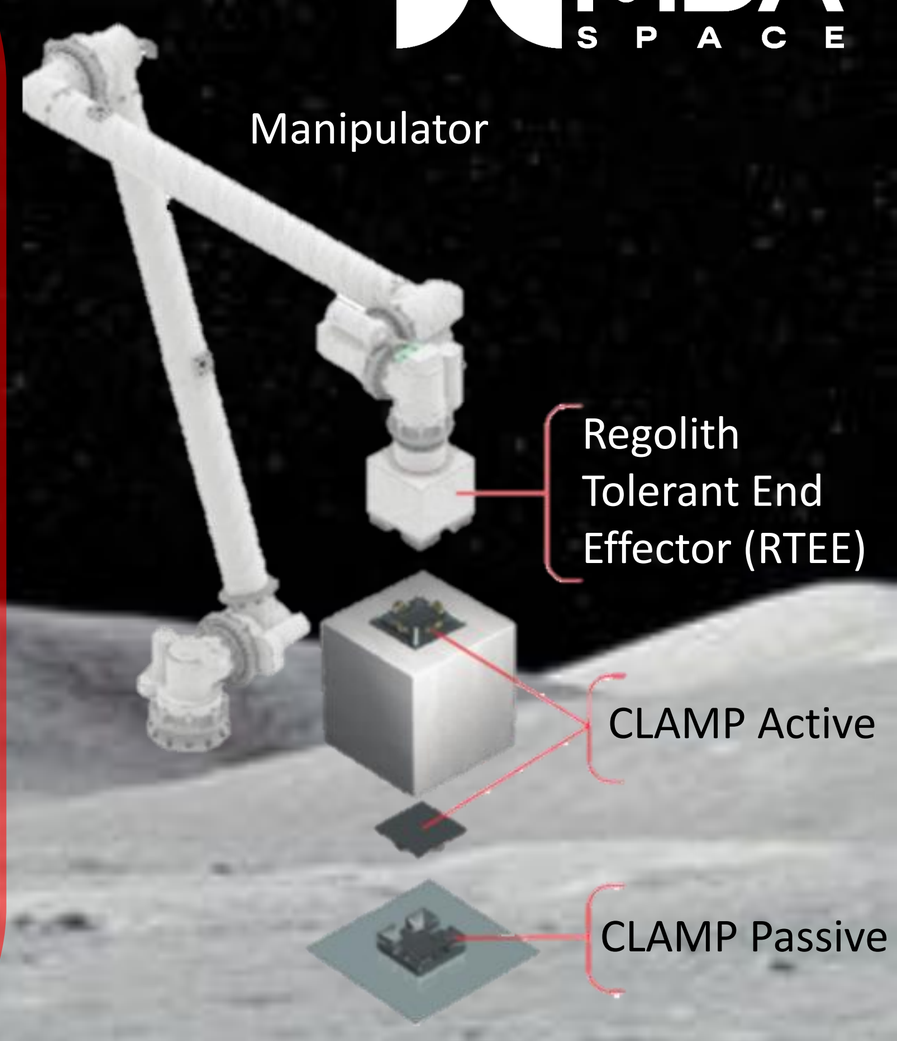
Introduction: With the recent global focus of establishing a sustainable infrastructure on the Moon, it has become universally evident that robotics is an essential part of this building endeavor. The challenging lunar environment of highly abrasive regolith combined with extreme temperatures is the future that the space community will overcome together. To date, there is an industry-wide technological gap for robotic interfaces that can repetitively mate and demate in these harsh environmental conditions.

A Common Robotic Interface: As part of the MDA SKYMAKER™ commercial robotics, MDA Space is developing the compact latching electro-mechanical interface for payloads (CLAMP), a universal grapple system fit for operations in the extreme lunar environment or in-orbit. Its compact packaging and high strength properties make it an ideal technology to be used as both a payload interface system as well the grapple mechanism for MDA Space's Regolith Tolerant End Effector (RTEE), as shown at right. Ideal for missions that need a reliable and secure universal interface connection (i.e. rover beds, landers, payloads, tools, instruments, orbital platforms, etc), the CLAMP includes a lunar regolith tolerant connector interface that provides reliable wired power and data transfer between the host platform or robotic manipulator and the payload.

Development and Testing: Through an agile development approach of "fail fast, learn fast" rapid prototyping, MDA Space has quickly matured the design beyond TRL-5. CLAMP Prototype III, as depicted below, was subjected to environmental tests for risk mitigation purposes. These include latching/unlatching tests at the extreme operational temperature limits, and life testing in a lunar regolith simulant environment. Test results confirm the CLAMP design is capable of, without degradation in mechanical performance or signal integrity, latching and unlatching:

- At the expected temperature extremes
- For the expected mission life cycles

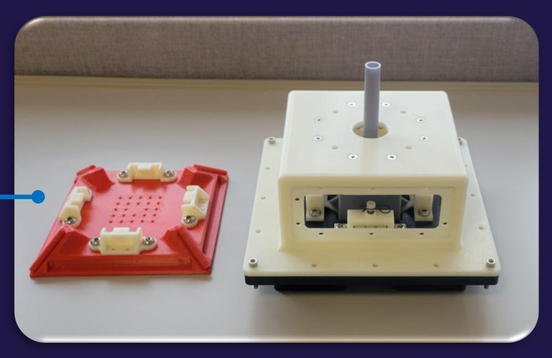
End-to-end signal integrity testing also confirms that the regolith-tolerant data pass-through design can reliably transfer Gig-E ethernet



TRL1

Product Needs Identified:
- Cost-effective
- Low mass
- Compatible with lunar surface, LEO, GEO, & EML1

JUN 2023

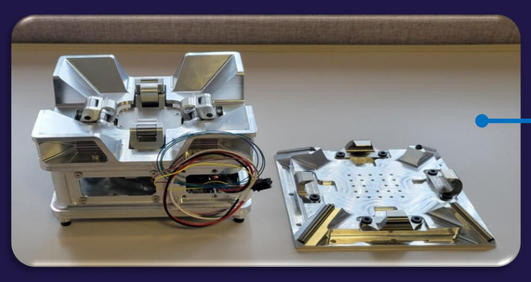


CLAMP Prototype I
- *Proof of concept,*
- *Robotic ops assessment as regolith tolerant*

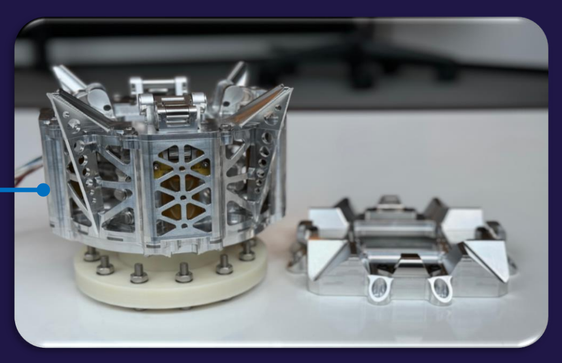
TRL3

CLAMP Prototype II
- *Dust sealing assessment*
- *Robotic ops as regolith tolerant*

TRL4

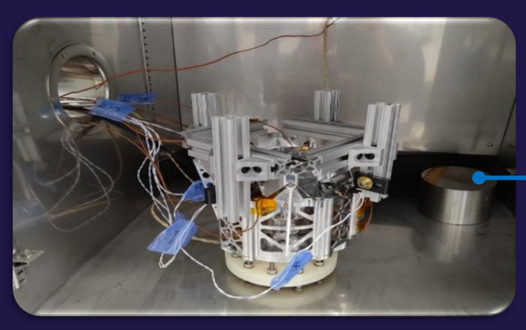


JAN 2024



CLAMP Prototype III

Latching & Unlatching Assessment at Operational Temperature Extremes



MAY 2024

End-to-End Gig-E Ethernet Signal Integrity Test

Robotic ops assessment as regolith tolerant

OCT 2024

Life Test in Regolith Simulant

TRL5

DEC 2024

CLAMP Engineering Model

Engineering Model Testing:
- Functional & Performance
- Environmental

Q1 2025

TRL6

Future Work: The third iteration of operational validation of using the CLAMP as an end-of-arm grapple system is expected to be successfully completed in early Q4 of 2024. Functional, performance and environmental testing of a flight-representative engineering model will bring the CLAMP design to TRL-6 in 2025 Q1.