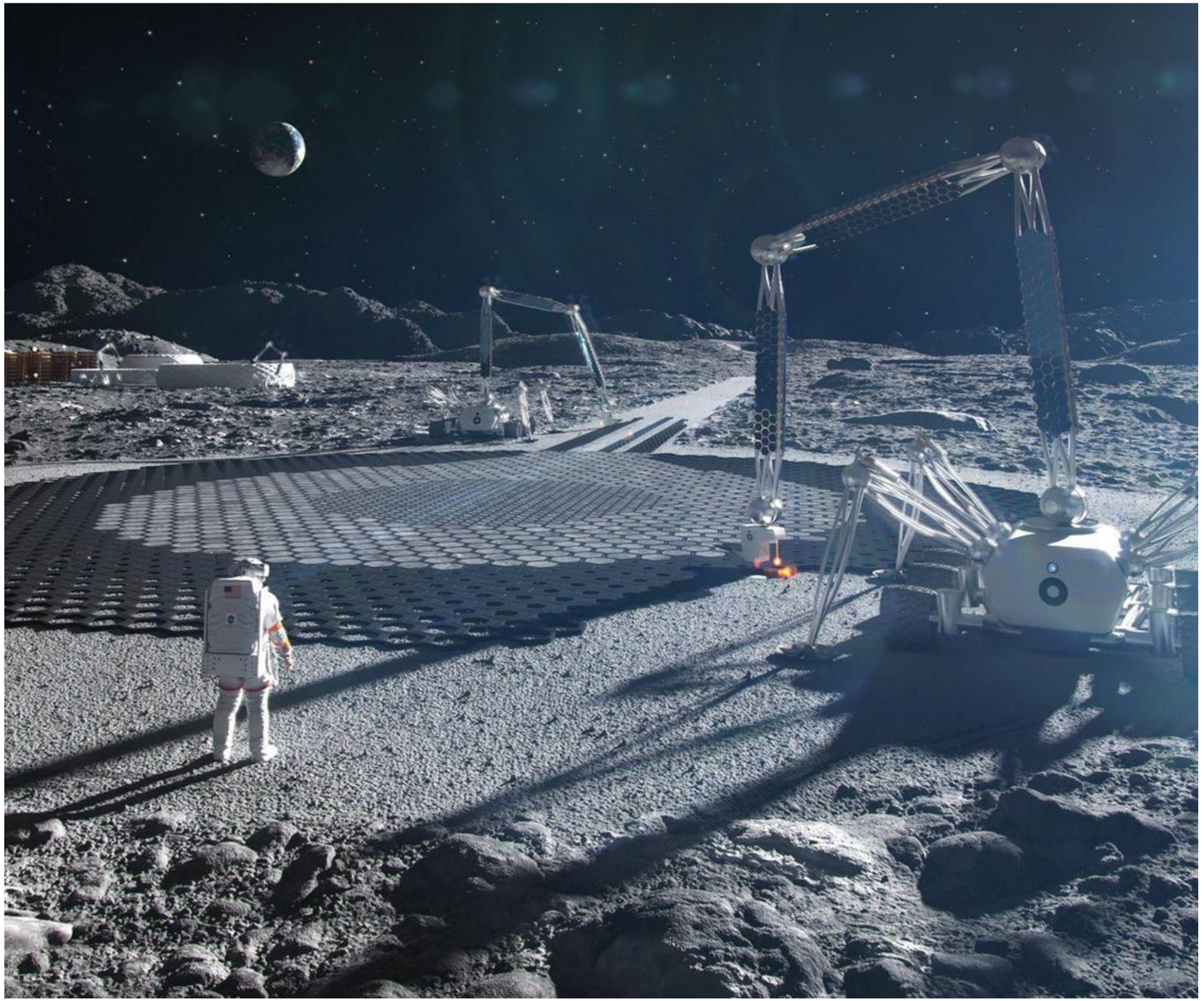
ICON
Project Olympus // MMPACT

Moon To Mars Planetary Autonomous Construction Technology

Lunar Applied Science Panel

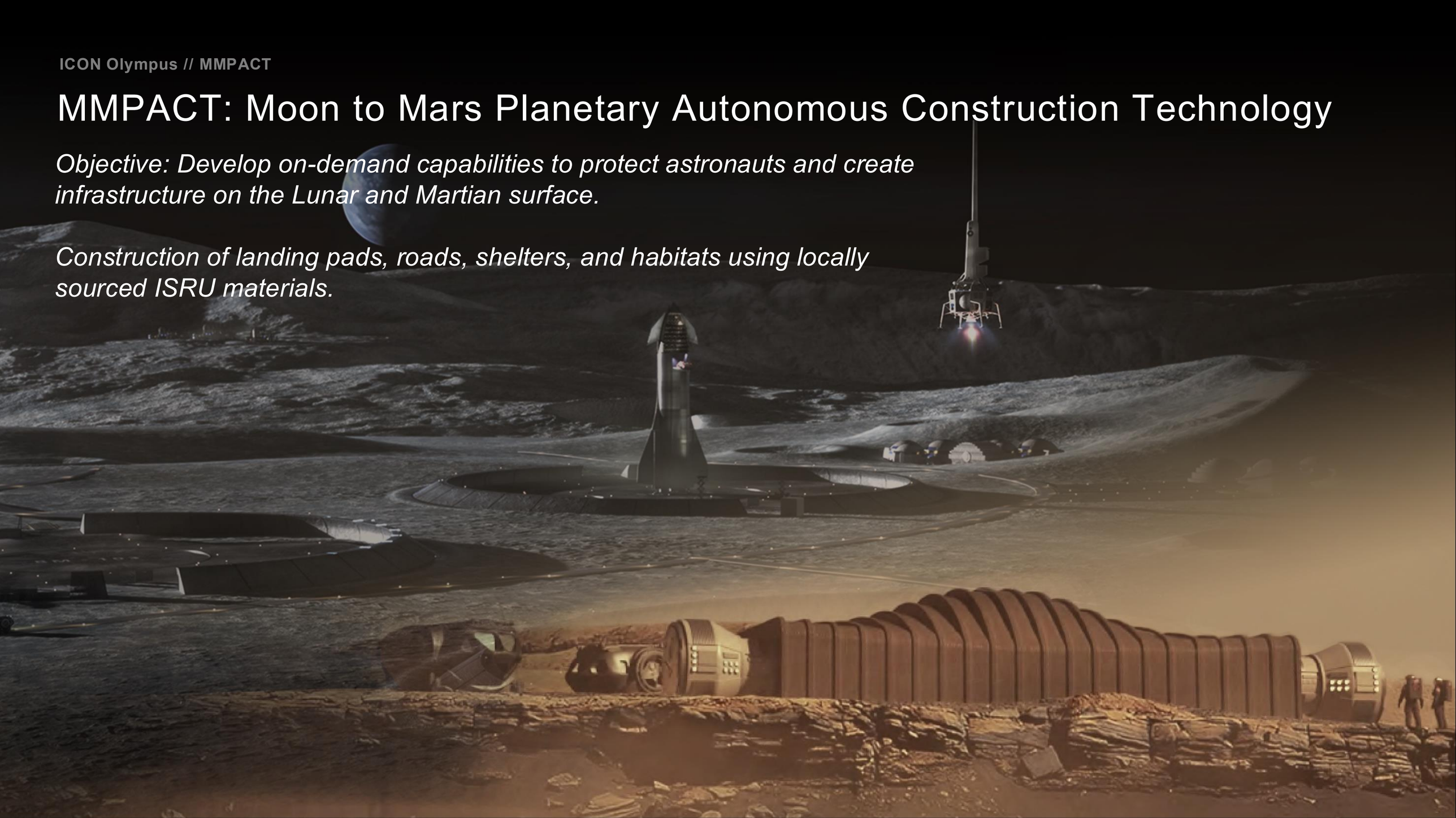


AUG 11, 2025

MMPACT: Moon to Mars Planetary Autonomous Construction Technology

Objective: Develop on-demand capabilities to protect astronauts and create infrastructure on the Lunar and Martian surface.

Construction of landing pads, roads, shelters, and habitats using locally sourced ISRU materials.



TRL1 Basic principle: What if there was a moon base?

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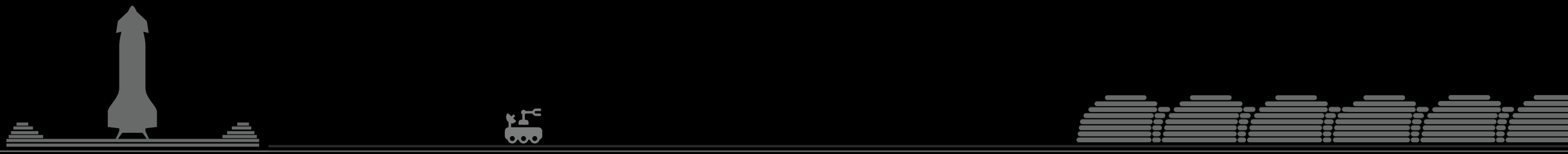
TRL1 Basic principle: What if some day… there was a *Mars* base?

TRL2 Application Formulation: Surface Structure Elements

The MMPACT work has identified a wide range of structures, under two main types of critical infrastructural elements, that will be needed for long-term habitation of the lunar surface.



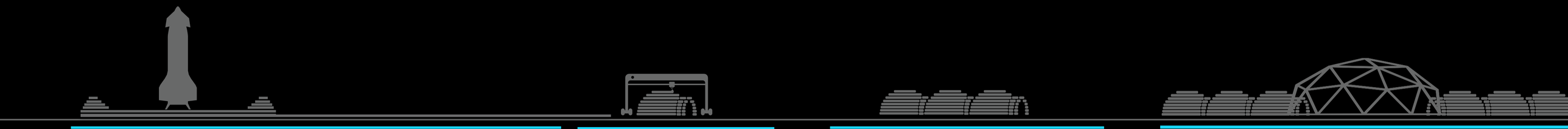
Landing Pads | Berms | Roads | Foundations | Protective Structures | Habitats

Horizontal Construction

Vertical Construction

Phased construction / Master planning for the Moon and Mars

An ISRU-based Additive Construction system on the lunar surface builds in phases starting critical infrastructure. Subsequent phases build from this initial infrastructure as a foundation of a permanent settlement.



Phase 1

Initial construction focus is on creating critical infrastructure such as landing pads, roadways, blast walls, etc.

Phase 2

With established infrastructure in place, construction begins on the initial protective structures.

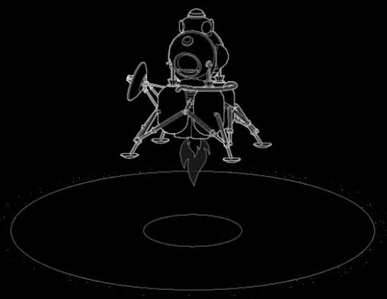
Phase 3

The lunar base according to master plan is built out to support the determined population size for the first permanent settlement off of Earth. Current NASA thinking is more on the scale of an outpost, rather than a city.

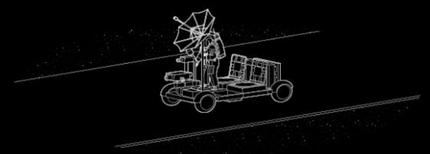
Strategic Expansion

Building towards the complete master plan for the Lunar bases, additional structures are constructed as the growing needs change over time.

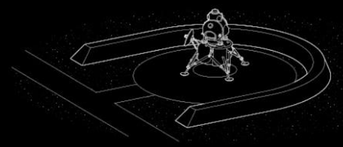
Infrastructure services in support of multiple possible futures



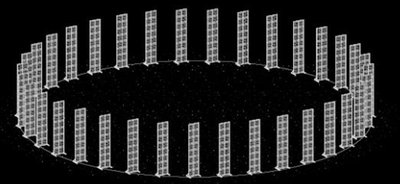
LANDING PADS



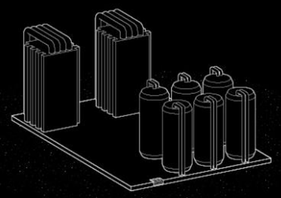
ROADS



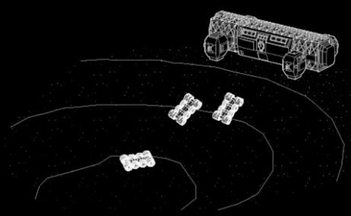
BERMS



SOLAR ARRAY

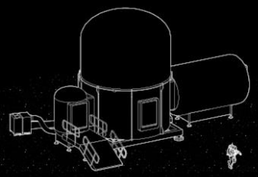


NUCLEAR POWER



ISRU PROCESSING FACILITY

UN-PRESSURIZED SHELTER



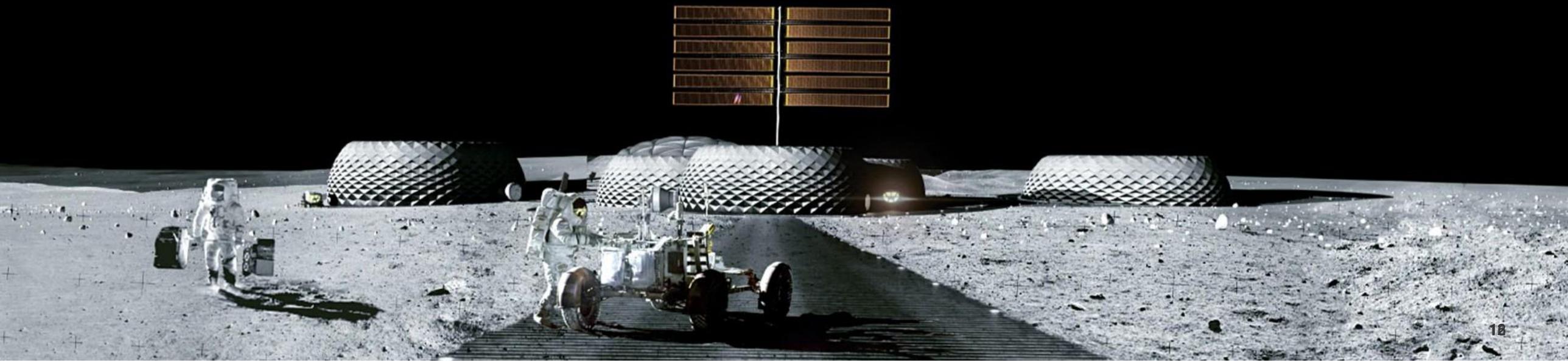
HABITAT

Architecting from ”From the Right”

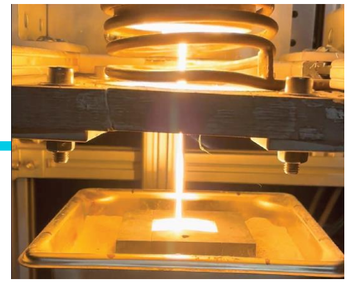
Working with two architectural partners, SEArch+ and BIG, we have studied and assessed master planning strategies, zoning requirements and the potential for expansion of an initial lunar base. Through that study common infrastructure elements were identified.

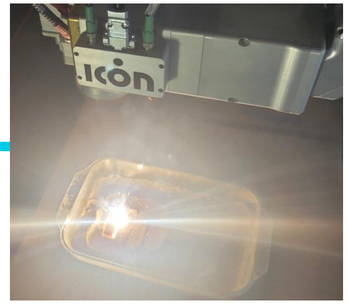
Common Principles for the Lunar base plan include:

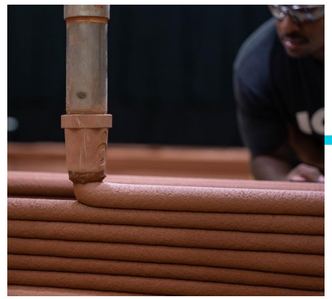
- Adaptability: accommodating off-nominal conditions
- Flexibility: adapting to changing requirements
- Resilience : accommodating failure
- Multi-use commonality: using the same product line for more than one application & reusing the same hardware more than once.



TRL3: Proving the concept, materials and processes…







Molten Extrusion

Laser Directed Energy Deposition

Microwave Sintering

Cementitious

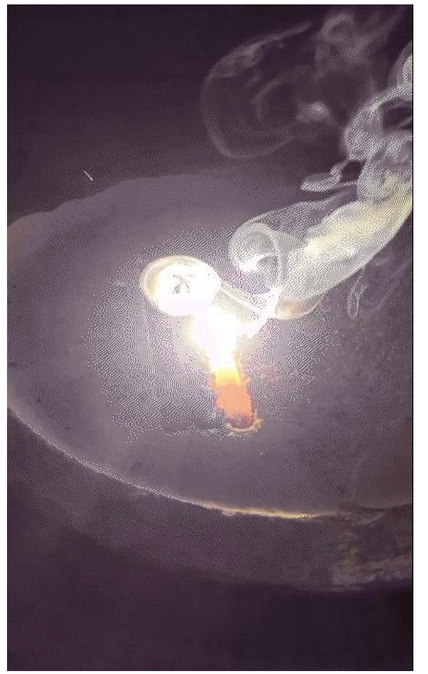
High TRL Viability and Favorable Structural Properties

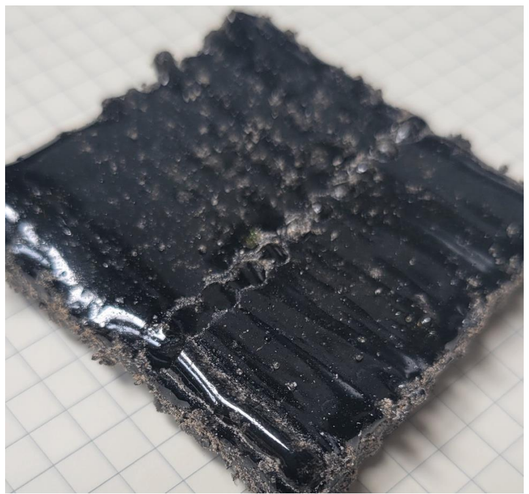
Relevant Environment Production and Testing Results

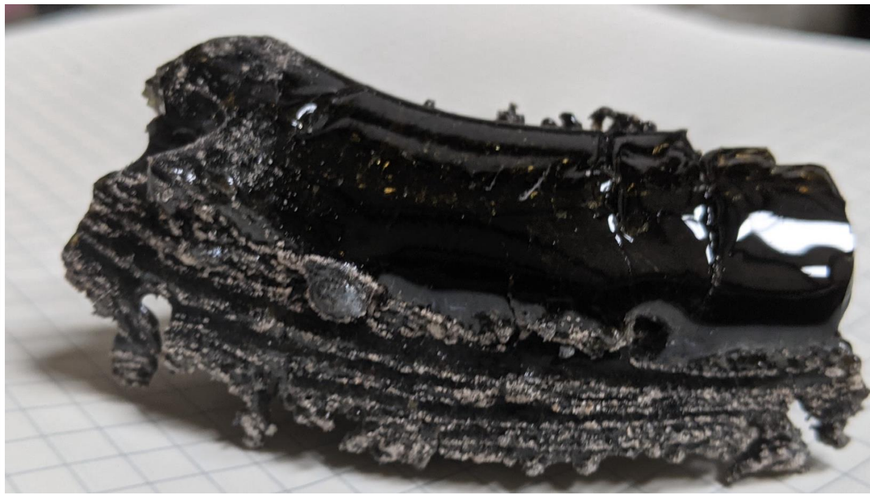
Technology Demonstration

TRL3: Proving the concept, materials and processes…

Technology Maturation for the Laser VMX Process

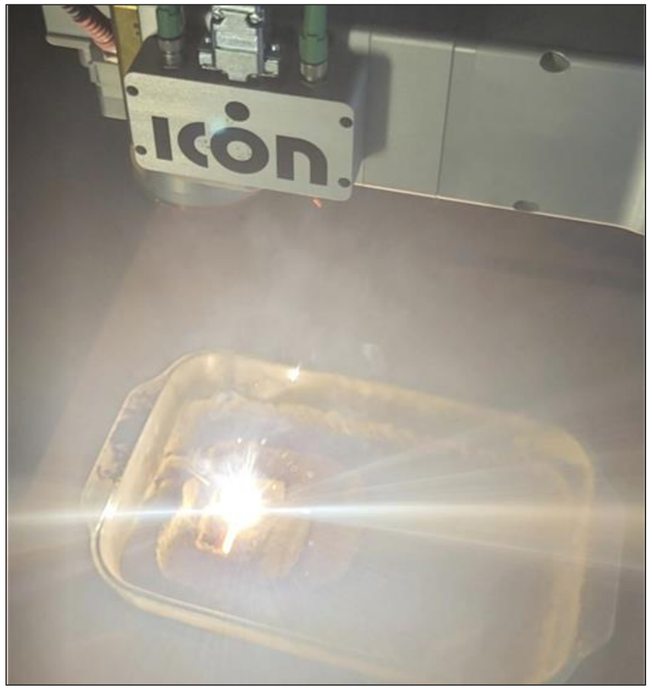






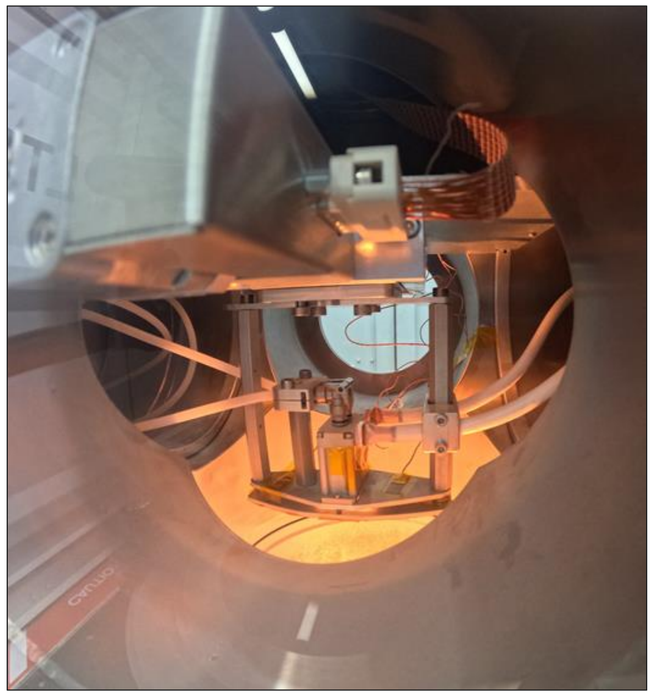
TRL3: Proving the concept, materials and processes…

Technology Maturation for the Laser VMX Process



Process located in **atmosphere**
Laser hardware located in **atmosphere**

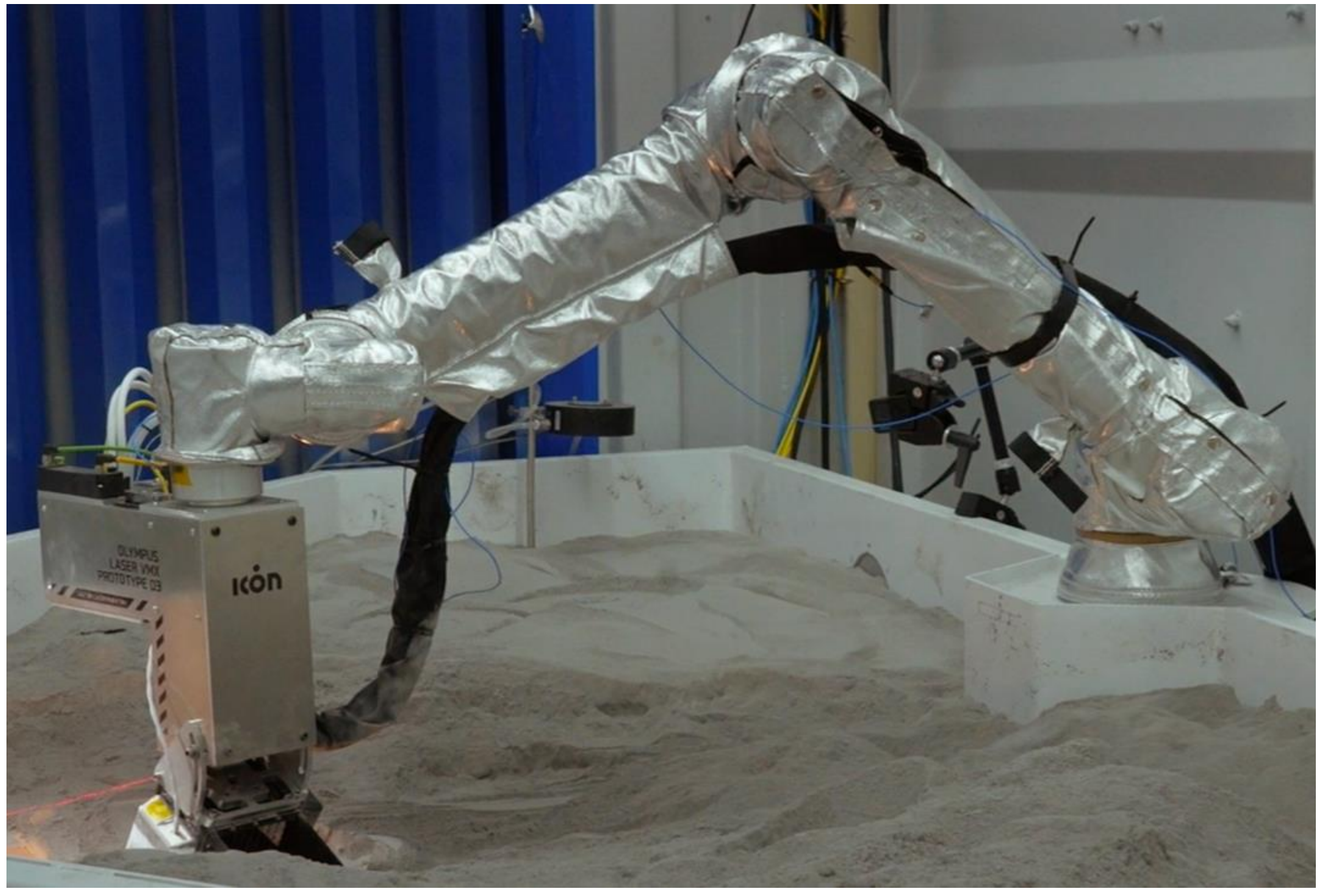
Process located in **vacuum**
Laser hardware located in **atmosphere**



Process located in **vacuum**
Laser hardware located in **vacuum**

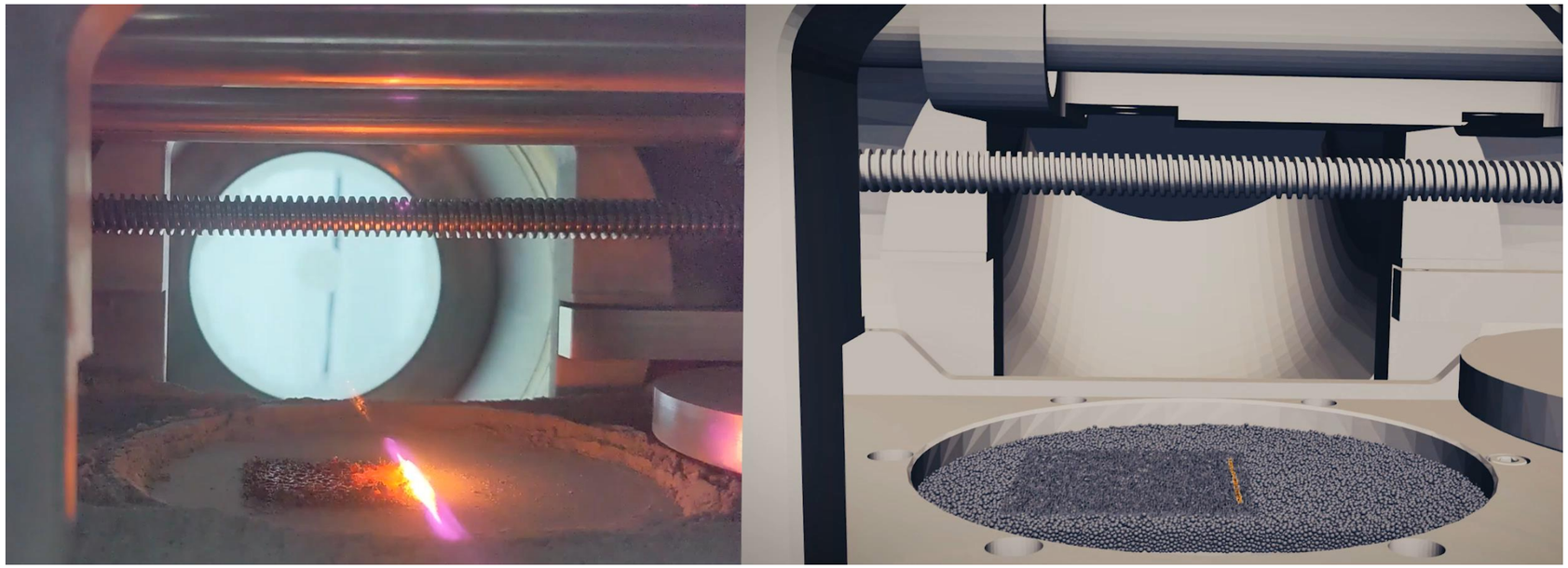
TRL4: Component and Process Validation

ICON's Prototype Laser VMX toolhead in atmospheric lunar regolith simulant test bed at ICON's Off-Planet Systems lab in Austin, TX. Designed in collaboration with NASA KSC, ICON's integrated Scoop/Tamp/Filter system is capable of meeting NASA MMPACT Key Performance Indicators (atmospheric and in vacuum).

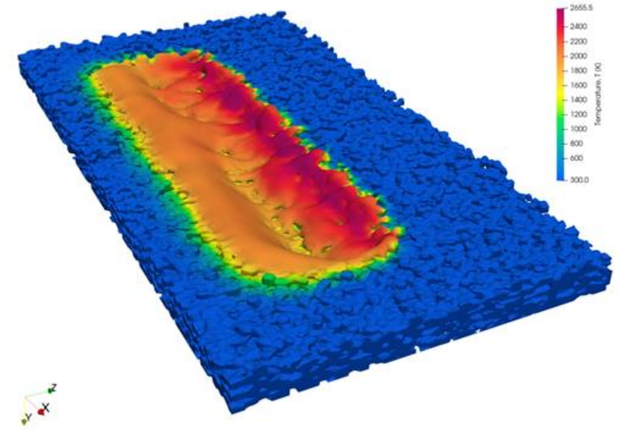


TRL4: Component and Process Validation

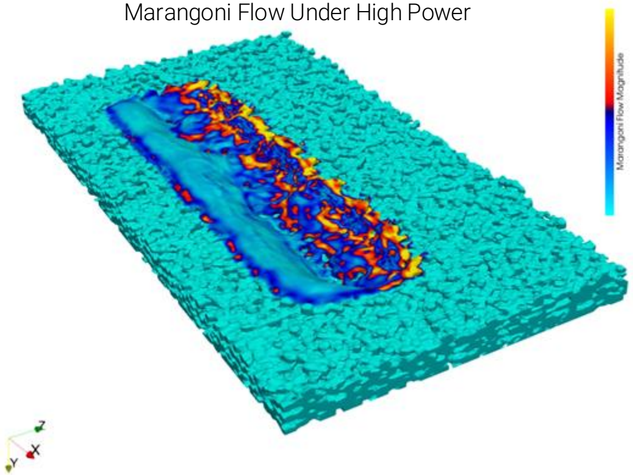
The team began using laboratory tests to “close the loop” on Integrated Computational Materials Engineering (ICME) simulations.



Temperature Under High Power

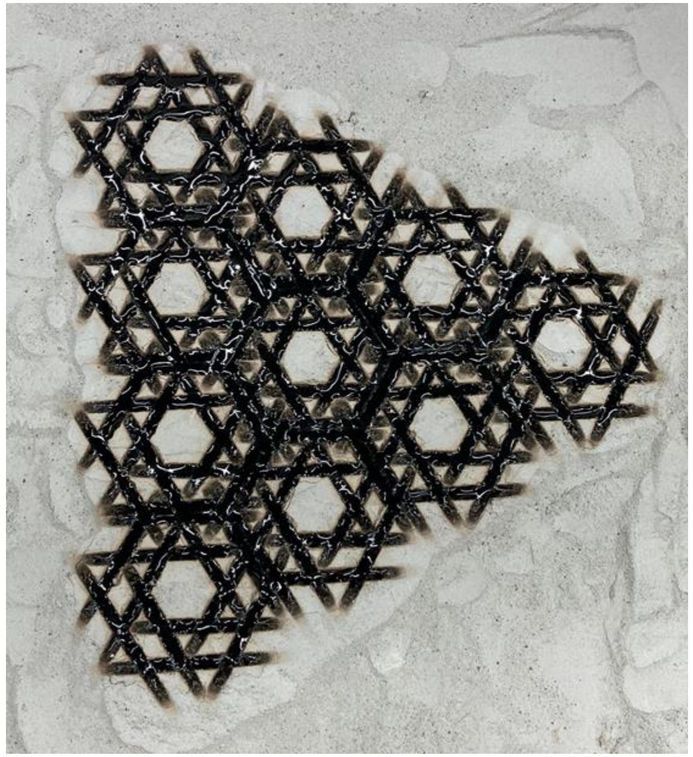


Marangoni Flow Under High Power



TRL4: Component and Process Validation

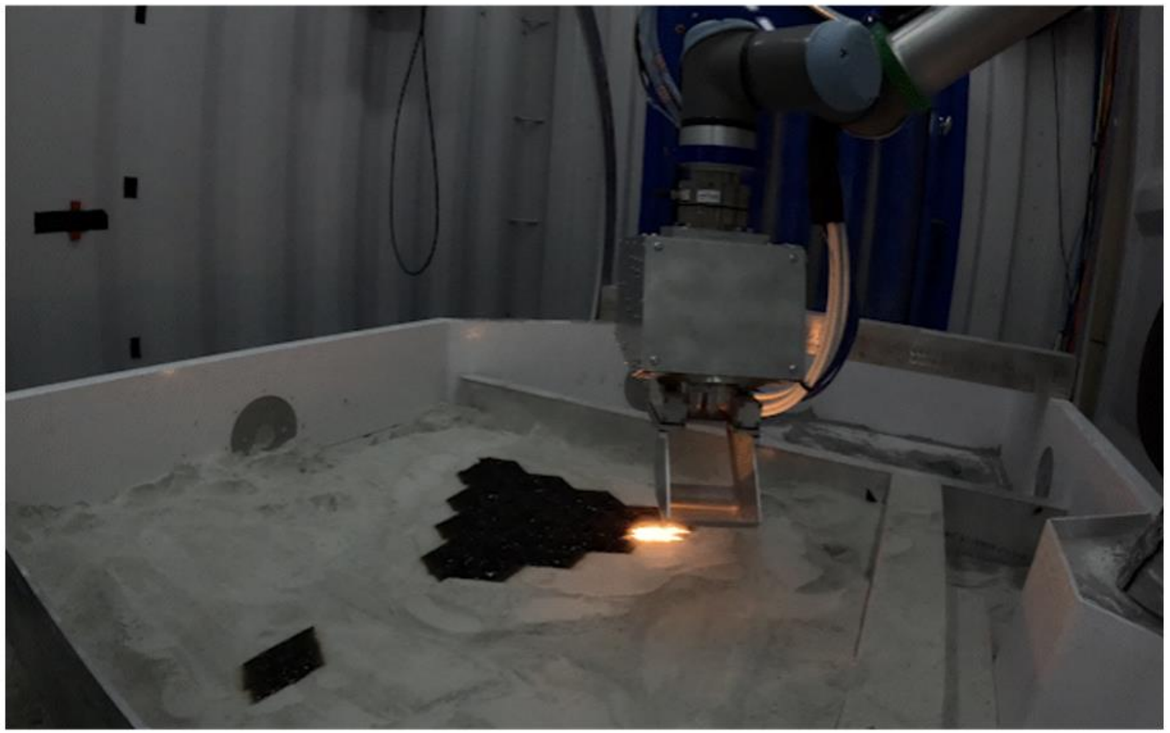
...while working in “atmosphere” to develop the “extensibility” and topology optimization to be successful in a future scale-up.



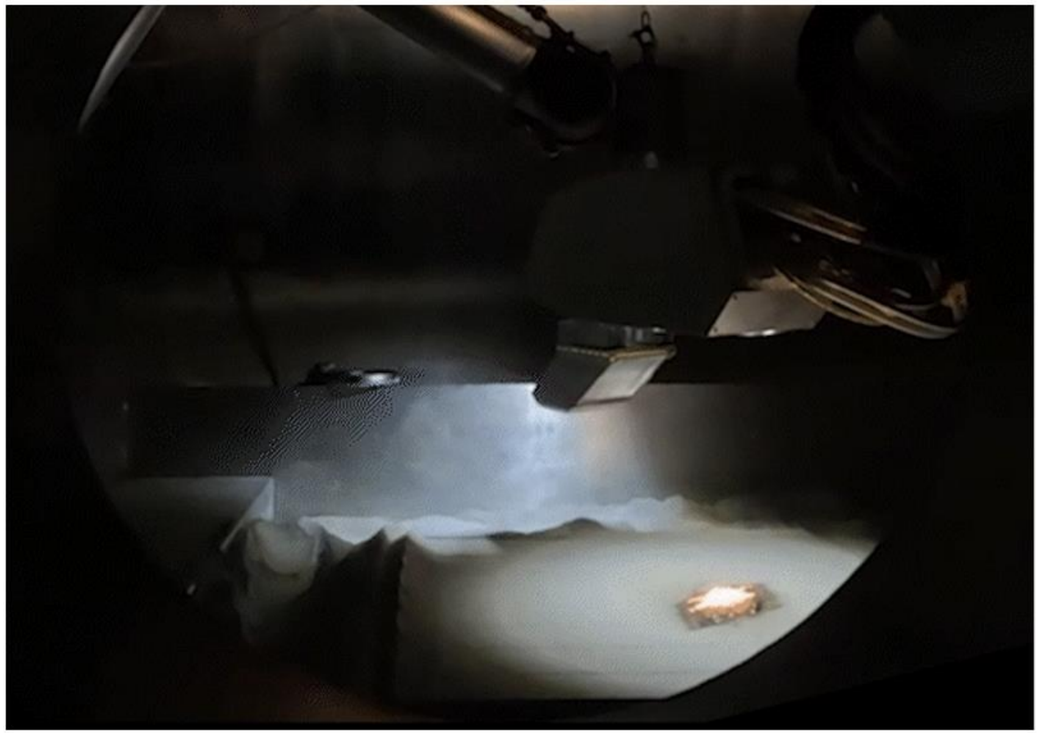
TRL5 to TRL6: Prototype System in Relevant Environment

Transitioning from TRL 4 to TRL 5/6 requires testing in a “Relevant Environment”.

The team has moved to testing the Laser VMX toolhead and associated processes in TVAC.

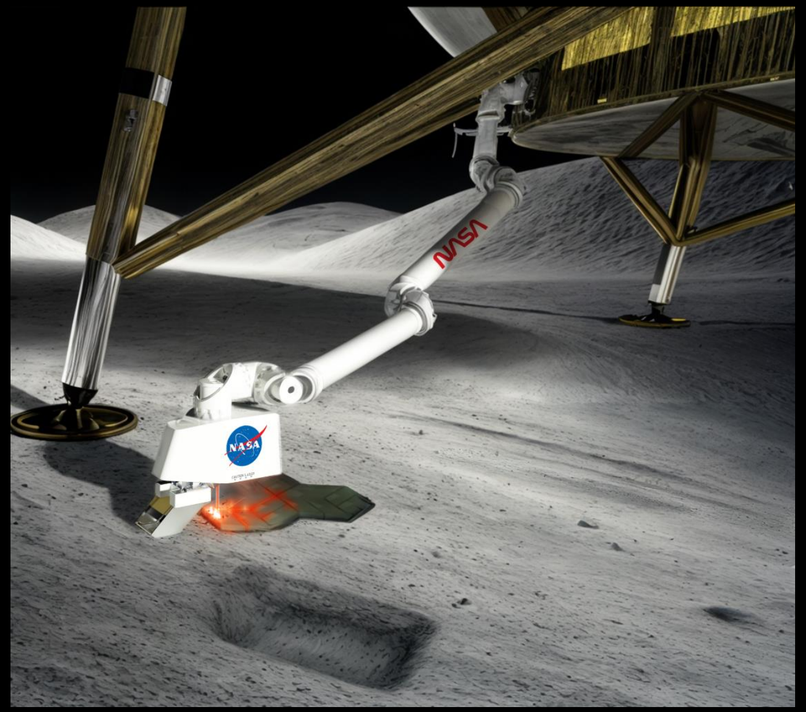


Integrated Process located in **atmosphere**
Prototype hardware located in **atmosphere**

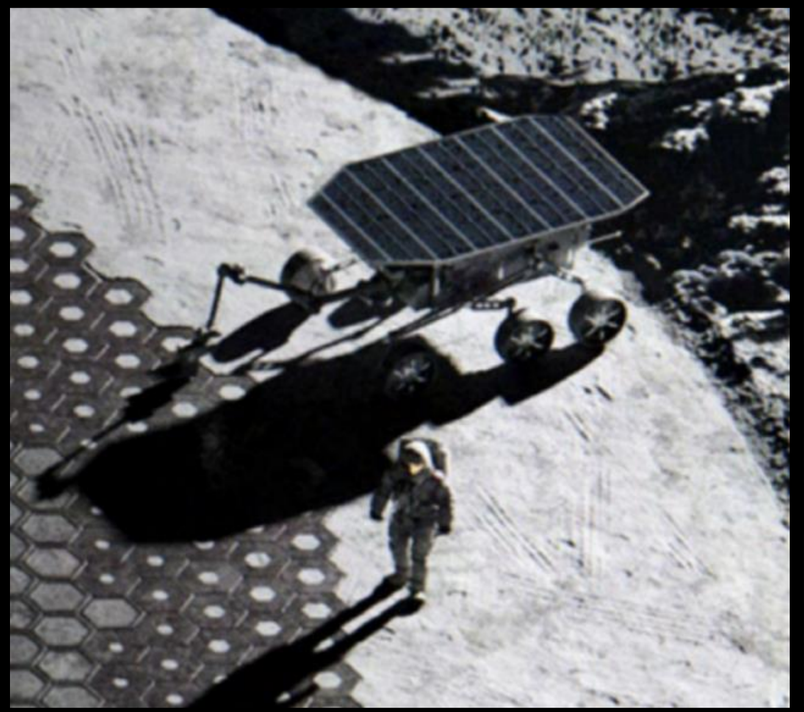


Integrated process located in **vacuum**
Prototype hardware located in **vacuum**

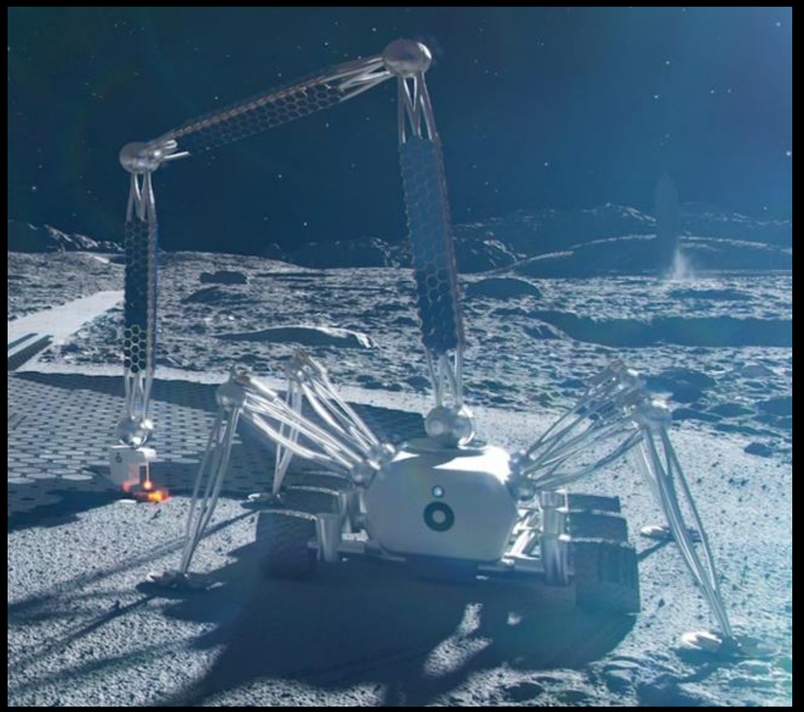
Where to go from here…



Lunar demonstration mission to validate the process



A system that scales to enable a sustained presence



Commercially scalable habitat capable system

TRL7 | TRL8 | TRL9

IMPACT

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