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HUSKYWORKS
PLANETARY SURFACE TECHNOLOGY DEVELOPMENT LAB

Six years of Lunar Environment Testing and Technology Development at the MTU Planetary Surface Technology Development Lab

Introduction

Since the DTVAC facility at MTU became operational in 2019, we have worked with academia, industry and government to research and facilitate lunar regolith simulant interaction studies and technology development. We have developed extensive experience designing and building custom test setups and doing thermal testing in dusty thermal vacuum conditions at a large and small scale, long duration and short testing, both for in-house projects and commercial customers/partners. We have tested under vacuum and/or cryo and/or hot conditions, with and without lunar simulant interaction. Some project examples:

- **Dust tolerant linear actuators**
- **Docking mechanisms**
- **Friction Stir welding**
- **Lunar road construction technology**
- **Paver construction and curing**
- **Power storage, transfer and conversion technologies**
- **Excavation systems**
- **Wheel testing (26,000 km, 42 day cryo and vacuum test)**
- **Durability testing of material wear samples (modified ASTM G65 test)**
- **Durability testing of regolith transfer mechanisms (15 day non-stop)**
- **Regolith load bearing capacity tests**
- **Regolith compaction system tests**
- **Icy Regolith thermal property testing**
- **Icy Regolith excavation**
- **Lunar mechanism testing for dust tolerance and thermal performance**
- **And others, including larger scale field tests**

Figure 1: The T-REX rover (Left) demonstrating superconducting cable deployment while descending into a crater, the PRIMROSE rover (center) as part of the NASA Break the Ice Challenge and the LuSTR20 PHCP project (right).

Testing Available to the Community :

We work with small and large businesses, government and other academic institutions to test and develop your and our hardware to prepare for deployment on the lunar surface. From TRL-1 to TRL-6, development and testing advise to early prototype testing, engineering and durability testing to proto-flight hardware testing. Custom testing services and rigs is important for meeting the widely varying needs of the community. Test campaigns can vary from a few days to months or many months spread over a longer timeframe. As an academic institution, prices are cost + F&A without any profit motive. Working with Non-disclosure statements and proprietary information as well as intellectual property is handled routinely in various ways depending on the partner's requests.

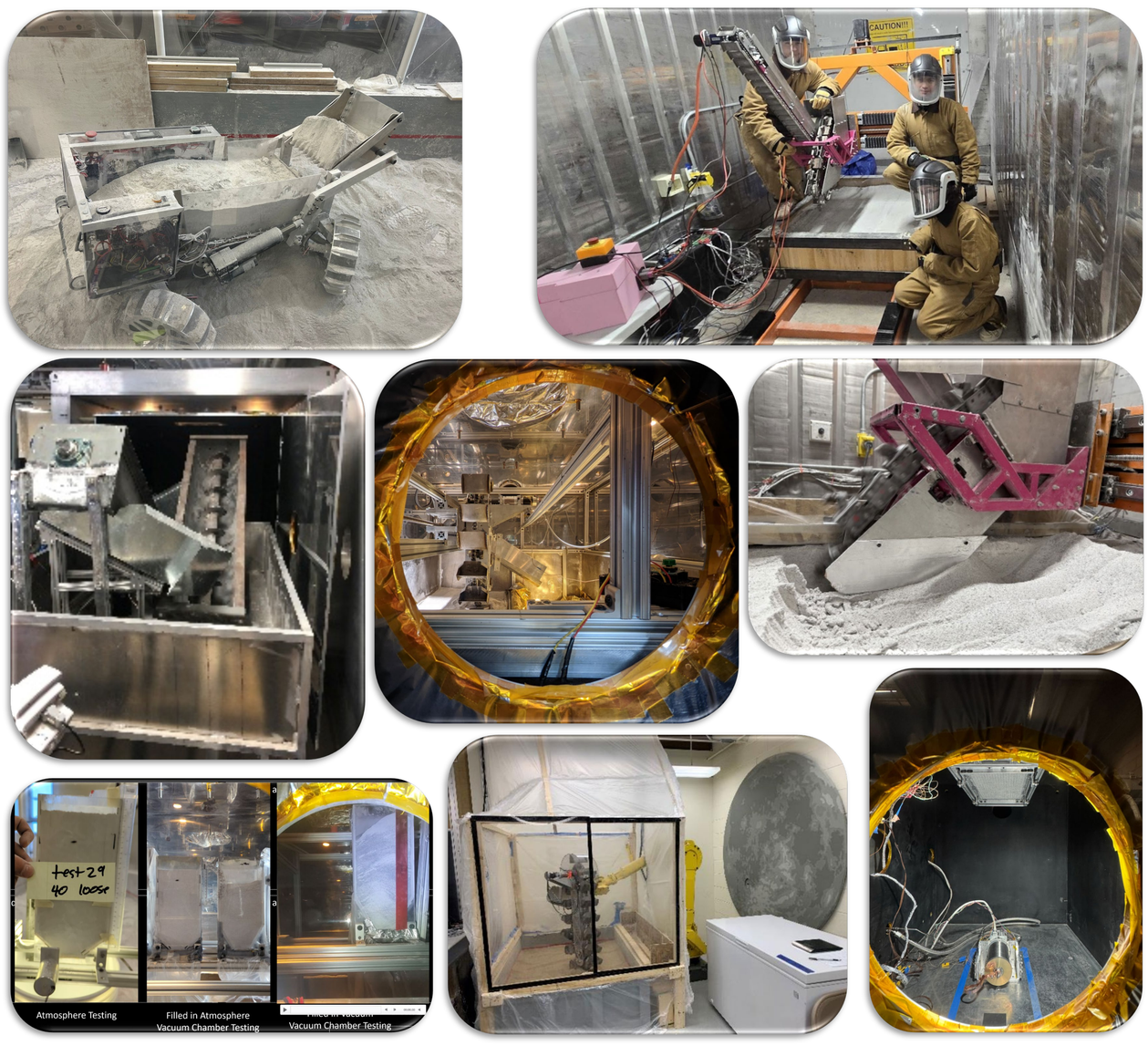

Figure 2: Various excavation robotics and technologies testing are shown here for granular regolith, icy regolith and ice-cemented regolith. Long duration testing (15 days+) is performed in DTVAC, sometimes at Cryo temperatures. Dust exposure and thermal cycle testing is performed under vacuum and cryo/hot conditions.

Figure 3: Regolith mixing for the trench testing for the LuSTR20 integrated culminating field test of the cone penetrometer and ground penetrating radar. Up to 30,000 kg of lunar simulant is available for creating testbeds as desired.

Figure 4: Field testing with field rover (HOPLITE) with the LuSTR20 PHCP and GPR measuring properties down to 1 m depth. Wheel durability (26k km at -196C) and traction testing on flat and sloped terrain was done for LTV prototype development.

Facilities

Our facilities consist of various testing setups that can be customized (e.g. a sandbox filled with regolith simulant in a particular slope). One of the key lunar relevant environment testing is a dusty thermal vacuum chamber (1.7m long x 1.25m wide x 1.3m tall) that can reach 10-7 Torr and has a cooling/heating thermal shroud that is cooled with LN2 and can reach -190°C and can be heat-ed to +150°C for thermal cycling under vacuum and dust conditions. Dust deposition in vacuum, high resolution video in the chamber and long duration testing, a wide range of AC/DC power supplies and a wide range of fluid, power and data feedthroughs are available for customization. A 900-acre proving ground facility including large -40°C cold soak chambers are available for vehicle testing under customizable conditions. Figure 1 shows some example tests performed in lunar environmental conditions.

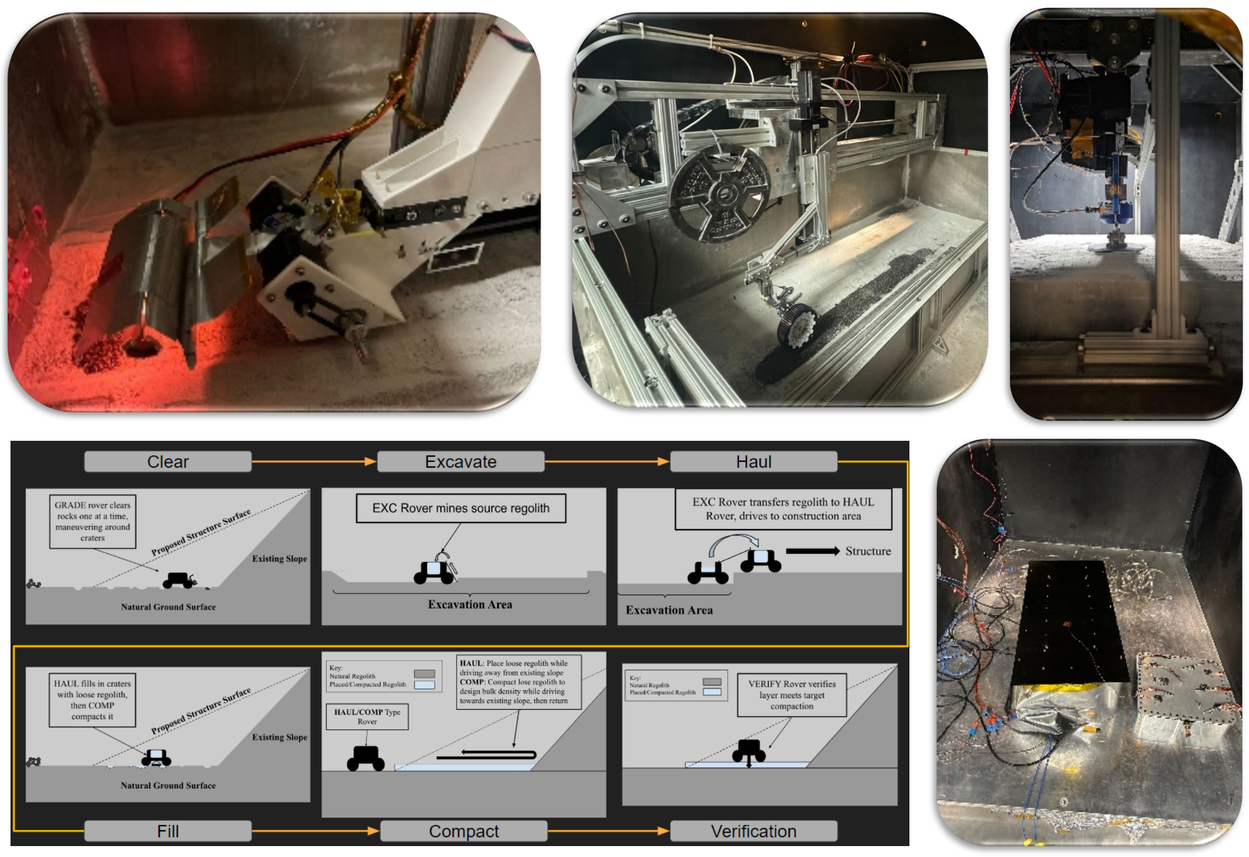

Figure 5: The first lunar road built and tested in vacuum conditions (Top left and center), bearing capacity testing (Top right), Site preparation (regoworks) planning software developed (Bottom left) and Power solution testing in DTVAC (Bottom right).

Partner with us at MTU PSTDL

Over the past 6 years we have received approximately $6M for NASA technology development and have brought several technologies to TRL-5 and TRL-6. Central to our lunar ambitions is collaboration with commercial, academic and other partners to create sustained human lunar presence and a commercial lunar ecosystem, starting with MoonBase. We customize testing according to your needs and work with you for lunar and Mars technology development. We love to help you be successful!

Some of our current and past Partners:

Honeybee Robotics (Blue Origin)
Lunar Outpost
Astrobotic
Intuitive Machines
SpaceFactory
APECH
Dynovas
CSM / UCF / UND / UArk / etc.
MTRI / Keweenaw Research Center
JPL & NASA (KSC, JSC, GRC, MSFC, STMD, etc.)

Figure 6: MTU KRC 900 acre proving ground terrain for robotic and vehicle testing on custom terrains

This work was supported by many students and several NASA STMD grants as well as two NASA centennial challenges