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

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Introduction: 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.

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.

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 LN_2 and can reach -190°C and can be heated 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 1: Various relevant environment tests for lunar technology development. Vehicle, construction, power, regolith transfer and wear testing shown in DTVAC as well as in regolith sandbox.