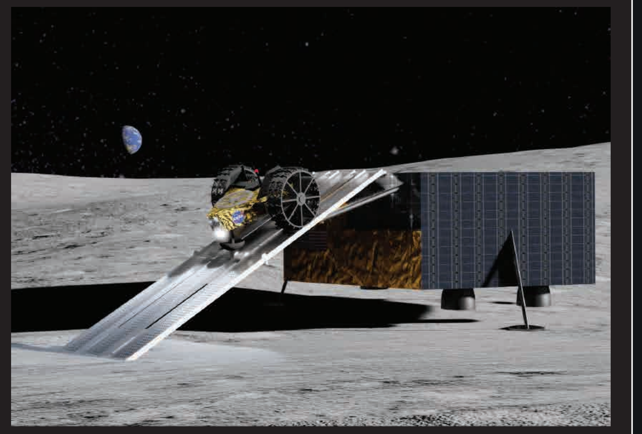
The Tethered permanetly shadowed Region EXplorer (T-REX)

Planetary Surface Technology Development Lab, Michigan Technological University, 1400 Townsend Dr., MEEM815, Houghton, MI 49931 (Contact: pjvansus@mtu.edu). Web: www.huskyworks.space

Concept of Operations

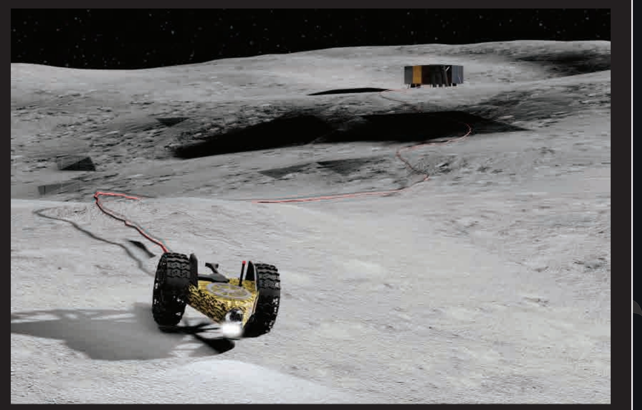
Lander Egress

T-REX performs a systems checkout and egresses from the lander via a ramp or similar method. During egress, the rover deploys a conventional conducting tether from its secondary spool. T-REX is remotely operated for the duration of its mission with commands sent via deep space network to the CLPS lander



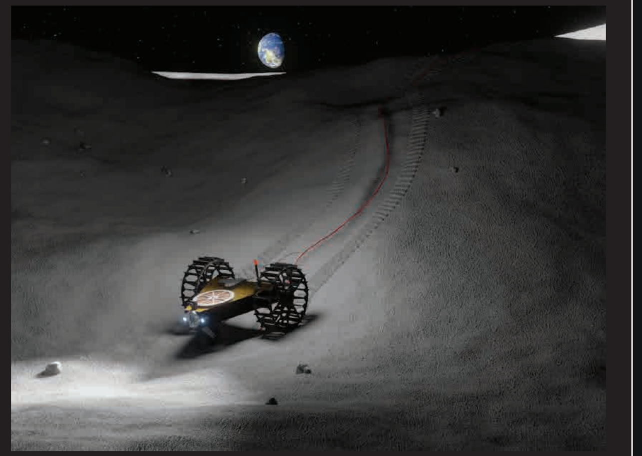
Illuminated Traverse

Next, T-REX will traverse from the lander towards the rim of the PSR. While the landers will land a nominal 125m straight-line distance from a crater rim, 250m of tether is brought for landing location error and deviations from the direct path. The conventional tether is deployed using tension only



PSR Descent

The rover will descend over the rim of the crater and begin descent into the PSR. Upon reaching a sufficiently shaded region, the rover will stop movement until the primary spool stored on top of the lander has reached near the ambient cryogenic temperature of the PSR



CCT SPOOL EJECTION AND SCT UNSPOOLING

Once this temperature is reached, it will eject the secondary spool and start a powered, low-tension unspooling from the primary spool attached in series. This primary spool holds a 2 kilometer long multi-channel superconducting tether (or SCT) which can conduct up to 75 amperes of power. Communication is routed through the tether using VDSL protocol

PSR Permanent Deployment

After traversing down the up to 45 degree downward slope, the rover parks at a relatively flat region. T-REX will remain in the PSR, acting as a power and comms hub for other missions in the PSR. A coupling interface then provides power to any rover which docks with the T-REX rover. After recharging is complete, client rovers can then detach and continue their missions. Communications in the PSR between the T-REX and client missions are performed using a full duplex RF communication system. Two-way communication is then established from Earth to client missions via our mission. This mission is baselined to last 1 lunar day.

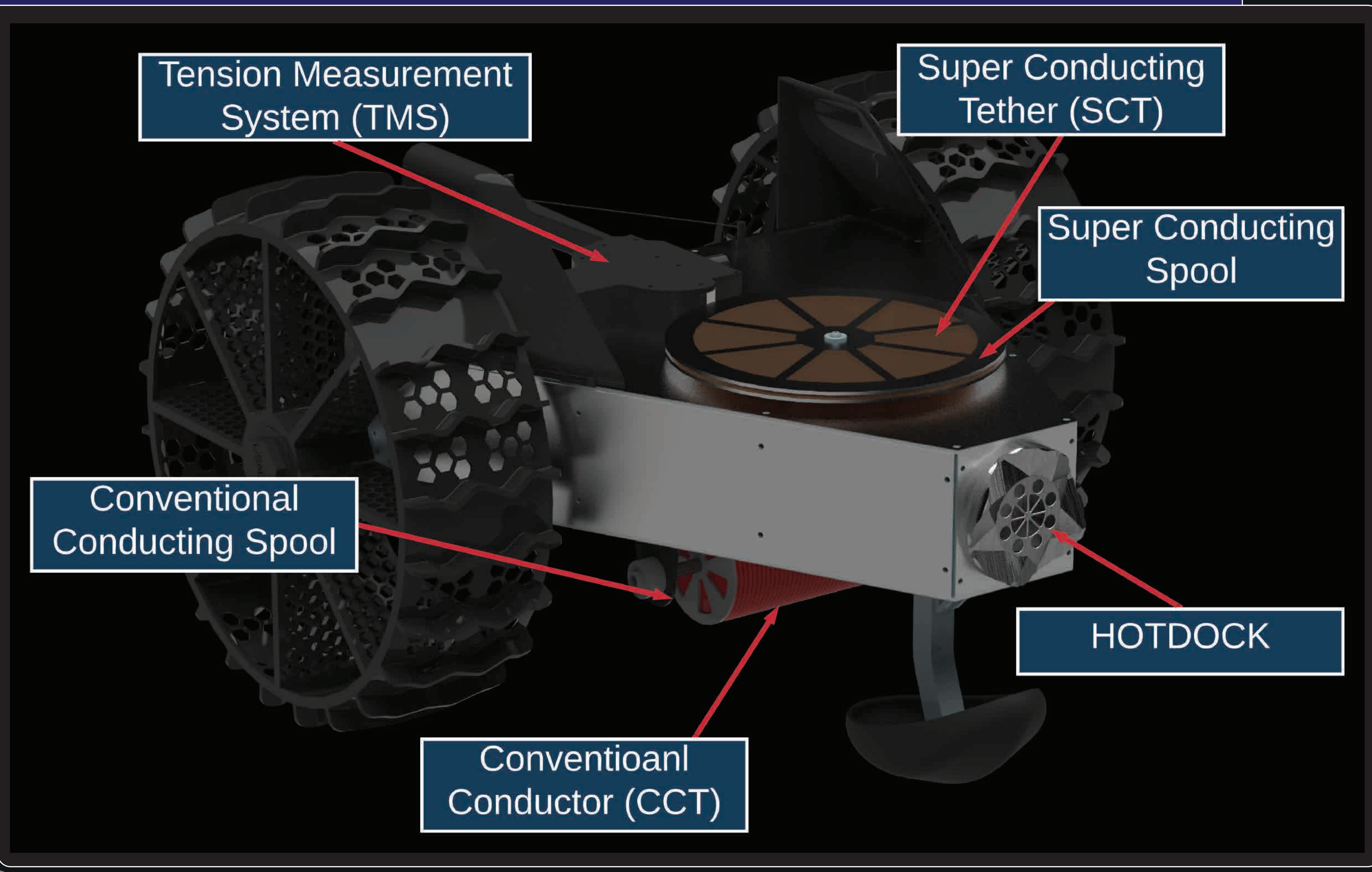
Mission Statement

The Tethered permanently-shadowed Region EXplorer (T-REX) is an infrastructure technology demonstrator mission whose goal is to provide reliable power and data to other operations within Permanently Shadowed Regions (PSRs) of the Moon, where conventional line-of-sight radiofrequency (RF) communications and solar power generation is limited.

Rover Specifications

- Rover mass: ~30kg
- Rover size: ~50cm x 50cm x 50 cm
- Conventional tether length: 250m
- Superconducting tether (SCT) length: up-to 2km
- Communication protocol: VDSL-2
- SAS HOTDOCK power transfer capability: 40A/100V
- Tether data rate: 1.82Mbps up, 11.65 Mbps down
- Max VDSL-provided data rate: 100Mbps
- Max power from CLPS lander: 50W
- SCT max allowable current: ~90A
- SCT cross section: 4mm x 0.3mm
- SCT operating temperature: <92K

T-REX Rover Overview (Mk.2 Engineering Model)



Path Forward

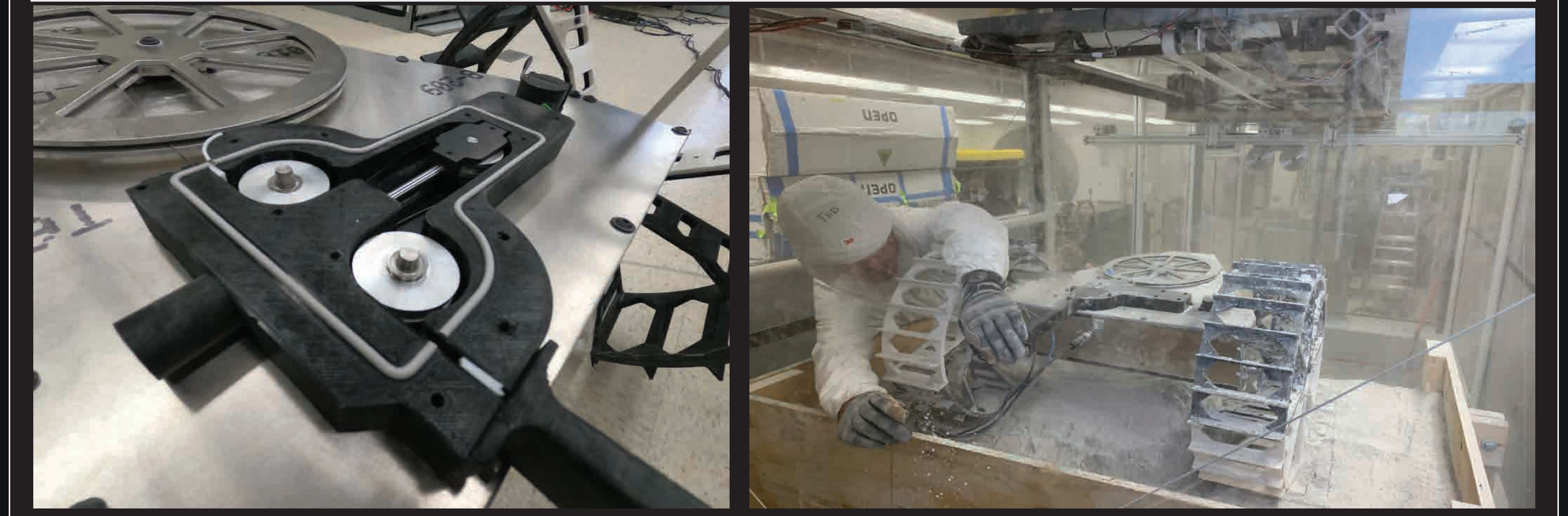
- Finish vacuum Testing of the MK 3 Rover in the DTVAC facility by April 2021.
- Transition superconducting tethered rover technology to compete in the Watts on the Moon Centennial challenge.
- Use Watts on the Moon for partnership oppertunities to get our technology to the Moon

NASA CENTENNIAL CHALLENGES

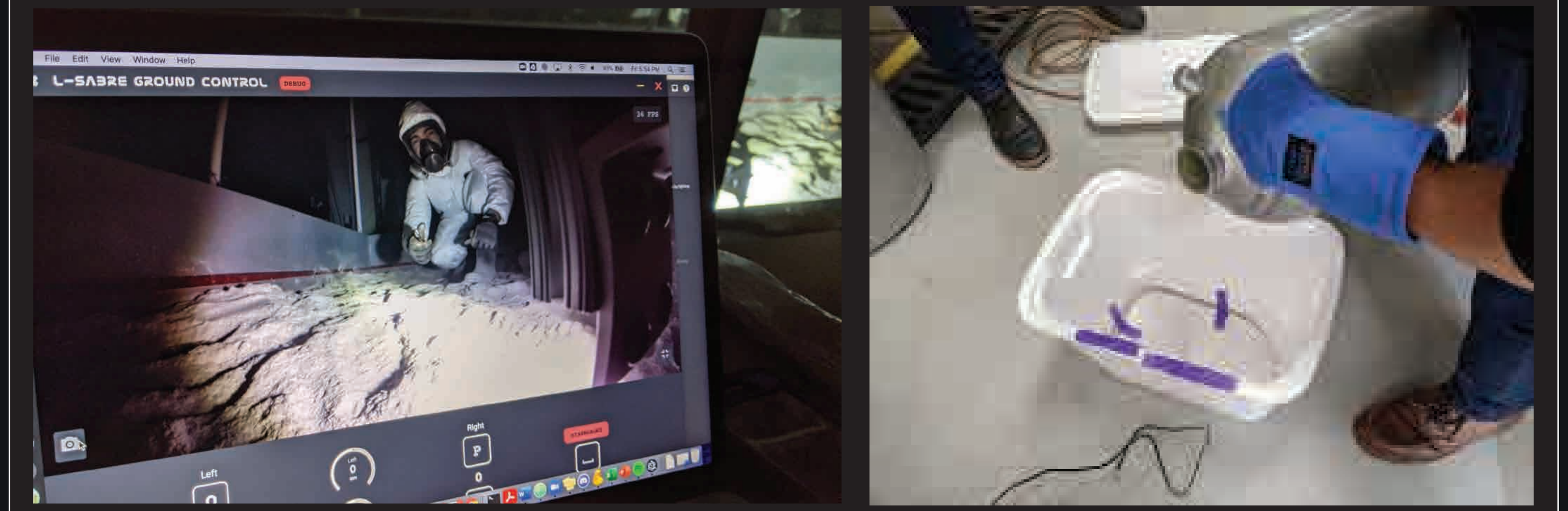
NASA'S WATTS ON THE MOON CHALLENGE

Proof of Concept Testing

Tension Measuring system testing and rover testing w/ gravity offloading



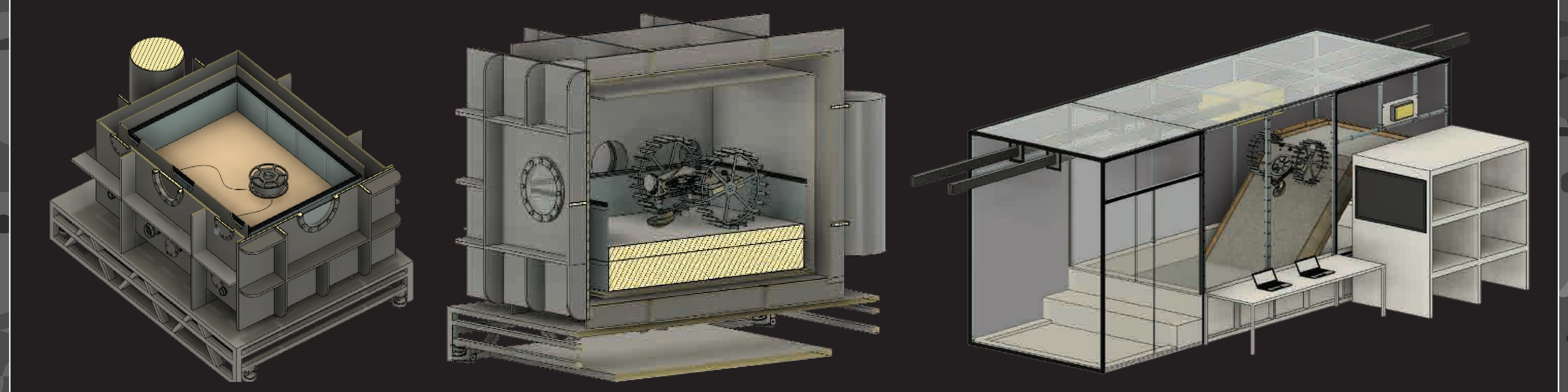
SCT Video Data and Power Testing in Liquid Nitrogen



SCT powered unspooling test down a 45-degree slope in regolith simulant

Future Testing

The MK.3 rover is designed and is being built to start testing in the 50 inch x 50 inch x 70 inch DTVAC with the superconducting cable deployment at -196°C and overall thermal systems testing as well as driving and docking in the DTVAC. When fully tested, the approximately 30 kg rover can deploy several kilometer of super-conducting cable down into a PSR. That will be tested in the DTVAC by 4/2021.



Now that everything talks to each other, it comes down to iterative testing and improvement. We have adopted an agile approach to development as of late December to speed up our testing and development cycle. Builds will be released bi-weekly in sprints. And during these cycles, lower-fidelity components will be switched out with higher fidelity versions until we have a vacuum-capable MK.3 rover

All Team Members: Dr. Paul van Susante, Marcello Guadagno, Elijah Cobb, Ted Gronda, Collin Miller, Hunter McGillivray, Nicholas Zamora, Austen Goddu Erik Van Horn, Wyatt Wagoner, Anthony Miller, Samuel Lakenen, Jacob Wolff, Mark Wallach, Alexander Mathias, Alec Miller, Jonathan Fritsch