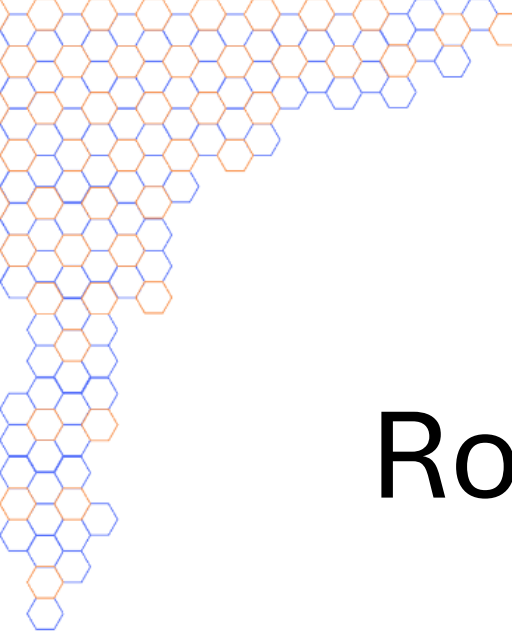




Rover for In-Situ Umzi eNyangeni (RISUN-1)

Presented by
Dirk Slabber

Team: Dirk Slabber, Victor van Aswegen

Powered by:



Habitation on the Moon?

- This decade has seen revived interest in the moon.
- Specifically quasi-permanent habitation in polar regions
- Suddenly focus on in-situ resource utilization
 - Water
 - Air
 - Food
 - Fuel
 - Electricity
- Plans set for 2030's – do we have the capacity to lay the foundations necessary to sustain life?



Image credit: NASA (left), ESA (bottom)



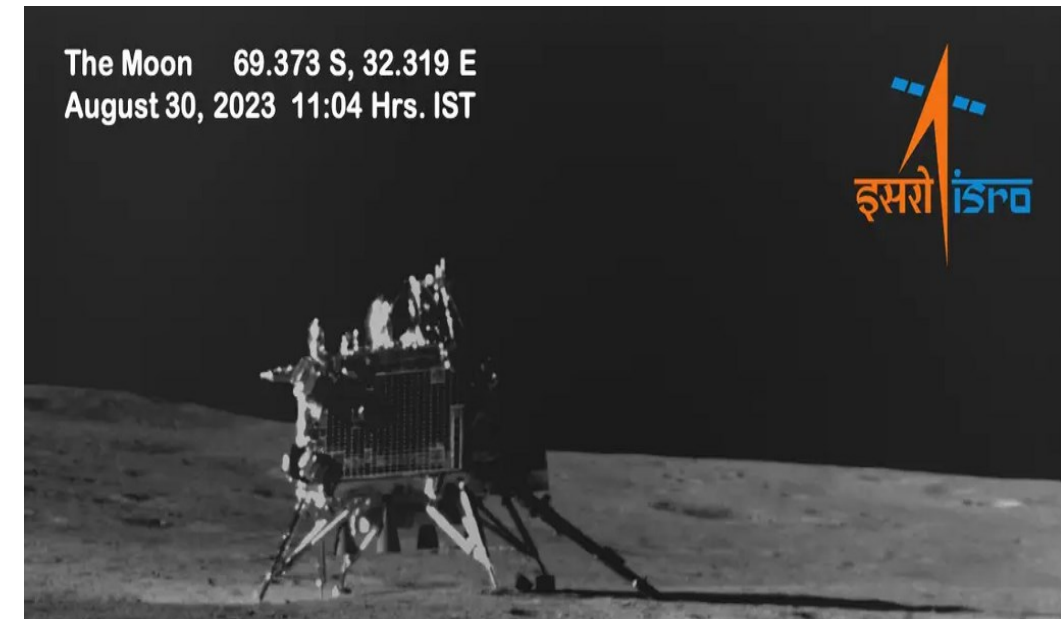
Mission Objectives

Goal: Perform experiment which will increase understanding of polar lunar regolith heat transfer properties for in-situ resource utilization

1. Deploy rover and explore area
2. Drill holes into lunar regolith
3. Install underground heating experiment equipment
4. Conduct underground heating experiment
5. Decommission
6. Extra : Achieve above mission objectives using rapidly deployable technology before 2030s.



Image credit:
Astrobotic (left),
Indian Space
Agency (bottom)



Concept of Operations

- RISUN-1 is aimed as first of a series of missions
- Building on CubeSat concept of modularity
 - Rover will consist of CubeSat components
 - Rover will utilize payload swapping system
- The mission will utilize four payloads
 - Exploration payload
 - Drilling payload
 - Heating payload
 - Sensing payload
- The mission will revolve around the lander which will supply power to:
 - stowed payloads
 - the rover when docking
 - payloads during the experiment
- Communication is done via the lander

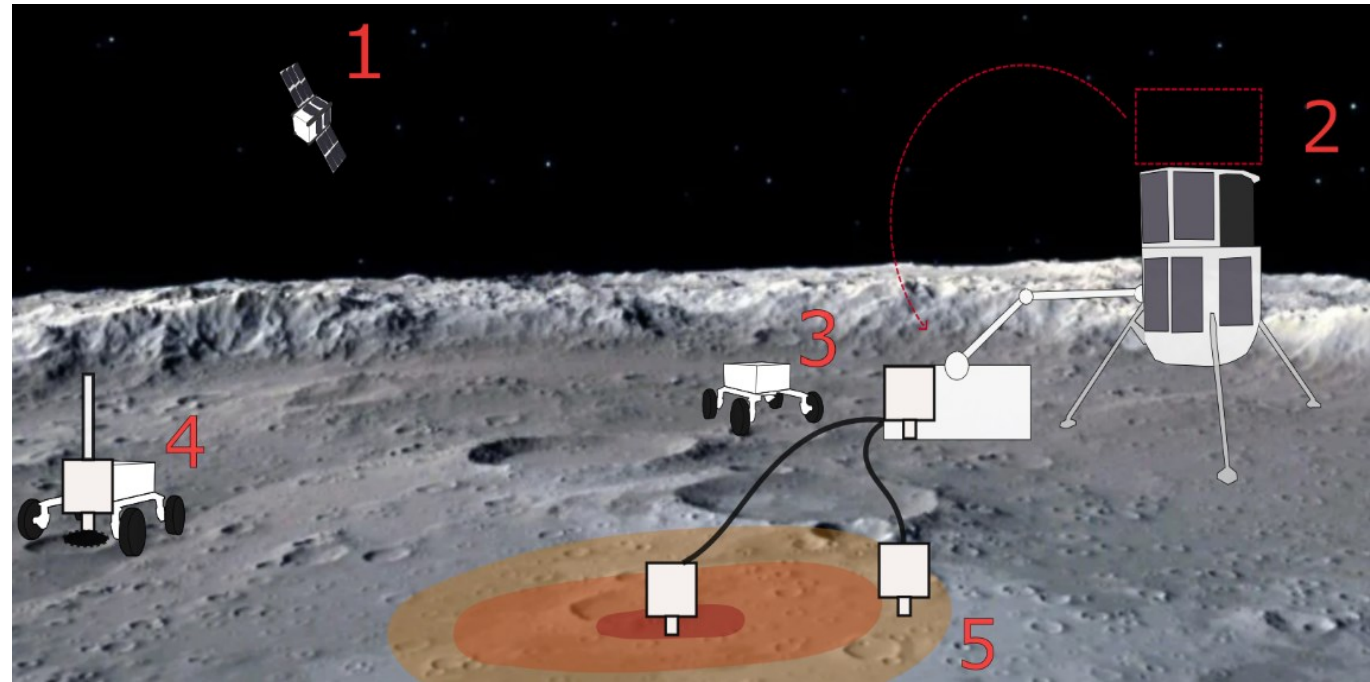
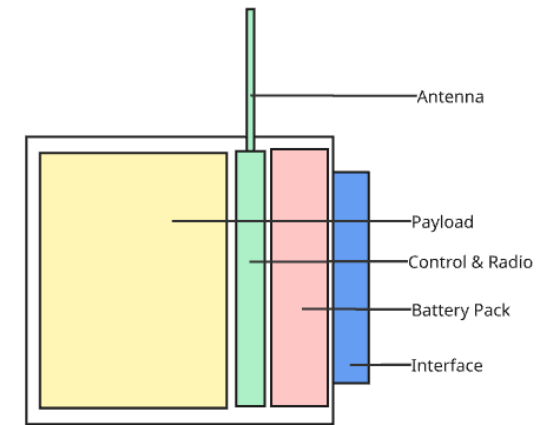


Image Credit : Stellenbosch University, Serfontein 2023

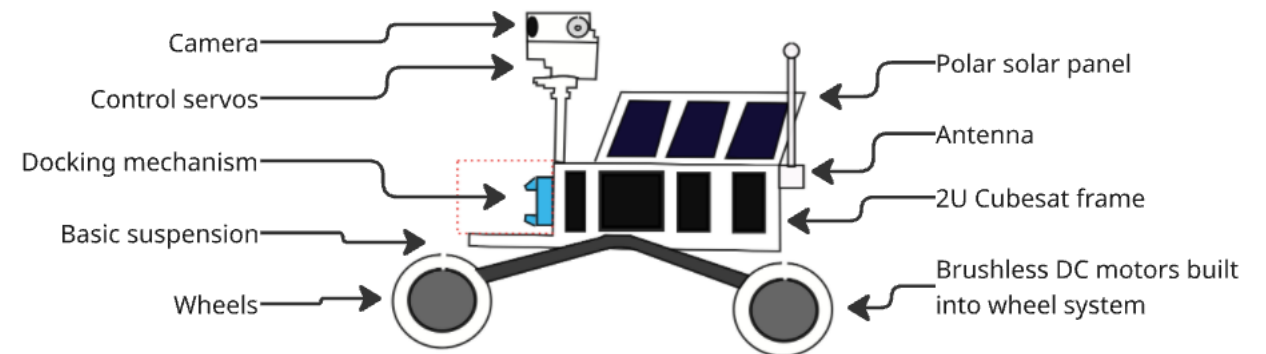
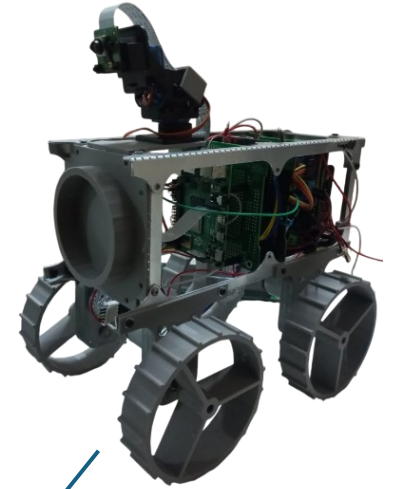


Rover design

- The rover follows similar design choices as the Astrobotic rover
- 2U CubeSat body utilizing mainly COTS CubeSat components – 6kg total weight
 - Each payload then weighs 1kg housed in 1U body
- The rover is made to be as generic as possible, with specialization being isolated to the payloads.
- Building a prototype was crucial in facilitating multiple design iterations.



Image: Astrobotic



Rover design (cont.)

- Those components that cannot be bought as COTS must be specifically developed for the mission.
- Communication to the lander remains major point of failure. Two UHF whip antennas facilitate telemetry and a S-band radio facilitates image transfer.
- Rudimentary power budgets and similar analyses were conducted, but these proved very superficial.

Table 1 : The components chosen for the RISUN-1 rover along with their mass and volume.

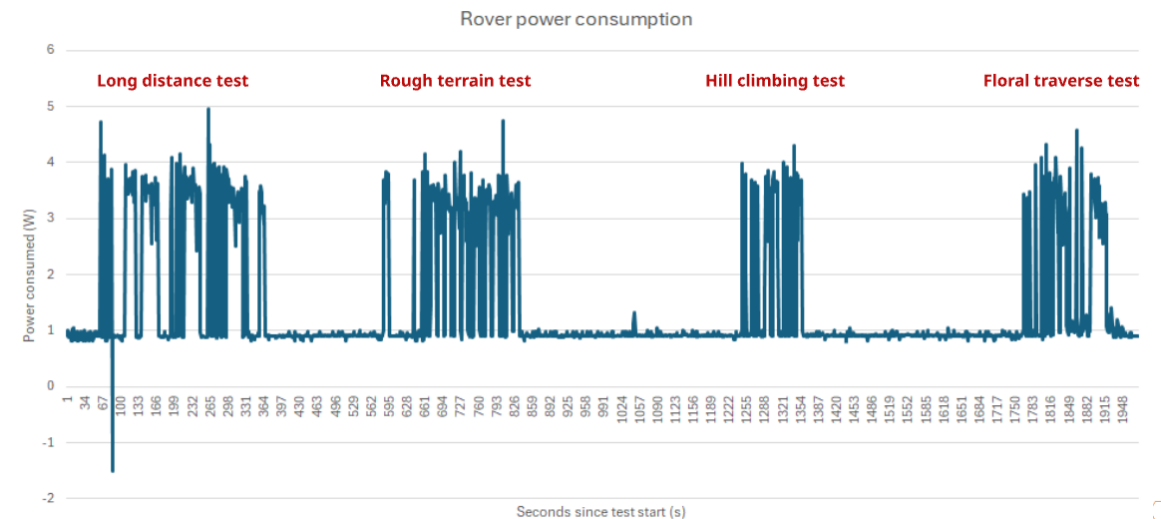
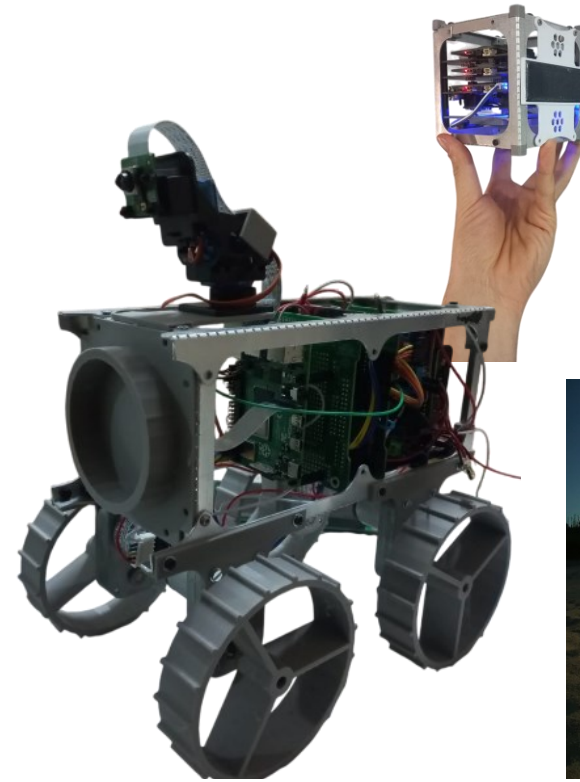
Components			
Subsystem	Component Model	Supplier	Mass (g)
OBC	EnduroSat OBC	Endurosat	130
EPS	isiLimela Modular EPS	isiLimela Space Systems	1000
Radio	Pulsar TMTC UHF Transiever	AAC Clyde Space	80
Radio	STXG2 S band Radio	Cube Com	80
Motor drivers	CubeSpace Rover Motor Driver Module	CubeSpace	150
Motors	CubeSpace Rover Motors (x4)	CubeSpace	540
Thermal regulator	Manufactured for mission	Stellenbosch University	300
Antenna	ANT-100 Whip UHF Antenna(x2)	AAC Clyde Space	30
Antenna	OMNI-A0142 S-Band Antenna	Alaris Antennas	82
Docking interface	ESL CubeSat Docking Mechanism	Stellenbosch University	150
Structure	2U CubeSat frame retrofitted for mission	isiLimela Space Systems	600
Suspension	Manufactured for mission	Stellenbosch University	400
Wheels	Manufactured for mission	Stellenbosch University	400
Solar panels	2U solar panel	NPC Spacemind	300
	Miscellaneous components		450
Total:			6312

Table 2 : The power budget of the RISUN-1 rover in different control modes and traversing different terrain types.

Power management				
	Full operation mode (W)	Hard terrain mode (W)	Scientific mode (W)	Idle (W)
Locomotion	4,5	9	0	0
Thermal control	2	3	2	2
Power management	0,5	1	1,5	1,5
Communications	0,5	0,5	1	0,25
Computing	1	1	2	2,5
Imagery	1	1	1	0
Total	9,5	15,5	7,5	6,25

Prototype rover

- To bridge the gap between theoretical design and an actual system, a prototype is built. This allows:
 - Better first pass analyses such as power consumption
 - Testing design decisions during operation
- Built by retrofitting educational satellite kit.
 - Could transfer images via wifi and be controlled via radio signals
- Operational tests were conducted on dry riverbed with white sand mimicking soft regolith.
- Tests identified sub optimal design choices:
 - Lack of suspension
 - Lack of having knowledge of traction per wheel
- Great learning exercise for members of team and to garner engagement.



Landing site

- Southern pole choice landing area due to future mission plans.
- Two landing sites are of interest:
 - Shackleton-de Gerlache ridge
 - Artemis mission landing zone
 - Mons Mouton
 - Viper mission landing zone
- Difficult areas to land in. It may be more feasible to aim for a large crater such as Amundsen.

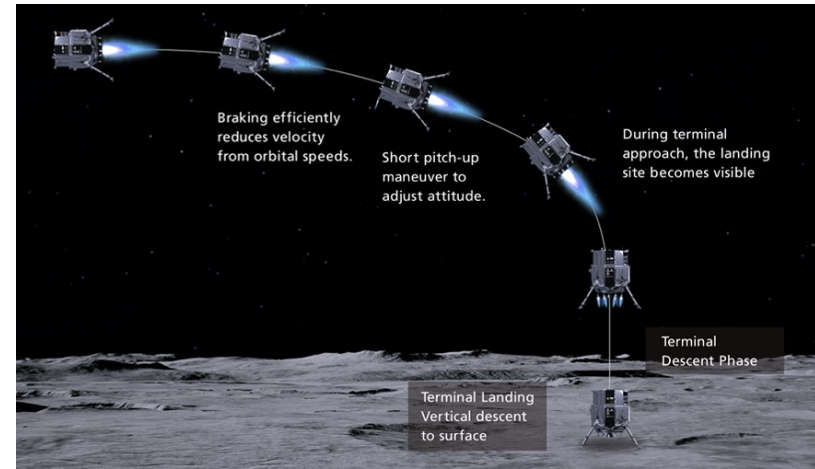
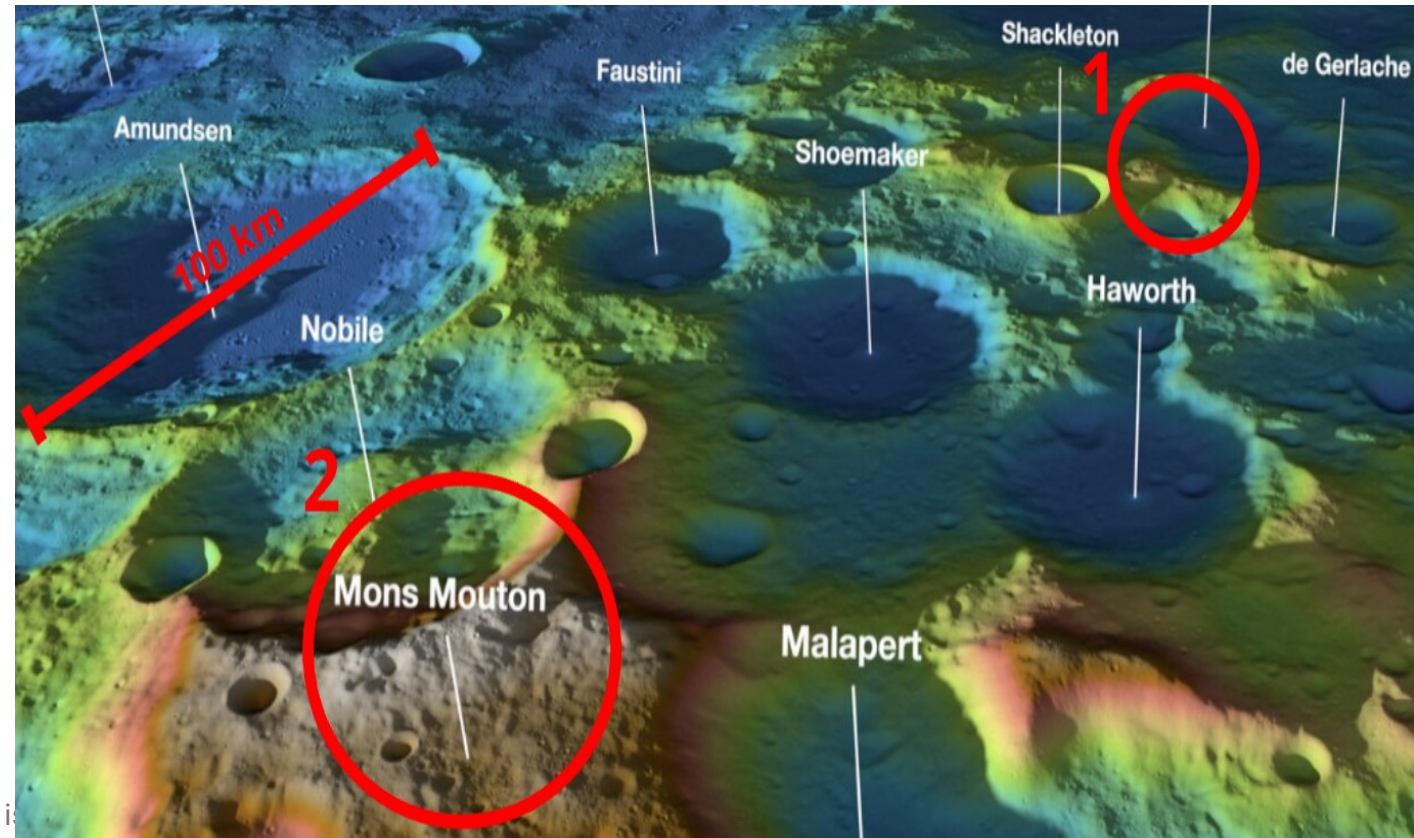


Image credits: iSpace (left), NASA (bottom)



Implementation plan

- Implementation timeline follows NASA satellite mission development framework.
- Will require collaboration of multiple stakeholders.
 - Universities to develop systems
 - Experts to advise on cis-lunar environment
 - Space agencies to facilitate launches and ground stations
 - Lander provider such as iSpace.
- Total rover section cost estimate: \$7M
- The main risk to this mission is losing stakeholder interest.

Development process	Time (months)	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Concept & prototype development	3																																							
Feasibility reviews	3																																							
Securing Funding	6																																							
Engineering model design	6																																							
Engineering model validation	3																																							
Mission coordination	12																																							
Mission documentation	5																																							
Flight model construction	12																																							
Mission readiness review	3																																							
Rover/lander integration	1																																							
Launch	1																																							
Mission operations	3																																							
		2026												2027												2028												2029		

Rover		Payload		Development		
Component	Cost (\$)	Component	Cost (\$)	Development process	Time (months)	Cost (\$)
OBC	\$ 5 100.00	Exploration payload	\$10 000.00	Concept & prototype development	3	\$ 167 010.00
EPS	\$ 4 500.00	Drilling payload	\$10 000.00	Feasibility reviews	3	\$ 167 010.00
Radio	\$ 6 000.00	Heating payload	\$10 000.00	Securing Funding	6	\$ 334 020.00
Motor drivers	\$ 6 000.00	Environmental payload	\$10 000.00	Engineering model design	12	\$ 668 040.00
Motors	\$ 10 000.00			Engineering model validation	3	\$ 167 010.00
Thermal regulator	\$ 2 000.00			Mission coordination	12	\$ 668 040.00
Antenna	\$ 5 000.00			Mission documentation	5	\$ 278 350.00
Docking interface	\$ 2 000.00			Flight model construction	12	\$ 668 040.00
Structure	\$ 1 000.00			Mission readiness review	3	\$ 167 010.00
Suspension	\$ 1 000.00			Rover/lander integration	1	\$ 55 670.00
Wheels	\$ 500.00			Launch	1	\$ 55 670.00
Solar panels	\$ 6 500.00			Mission operations	3	\$ 167 010.00
				Total		\$ 3 562 880.00
				Buffer multiplier		2.00
Total:	\$ 49 600.00		\$40 000.00			\$ 7 125 760.00
Grand Total:	\$ 7 215 360.00					

Thank you!

