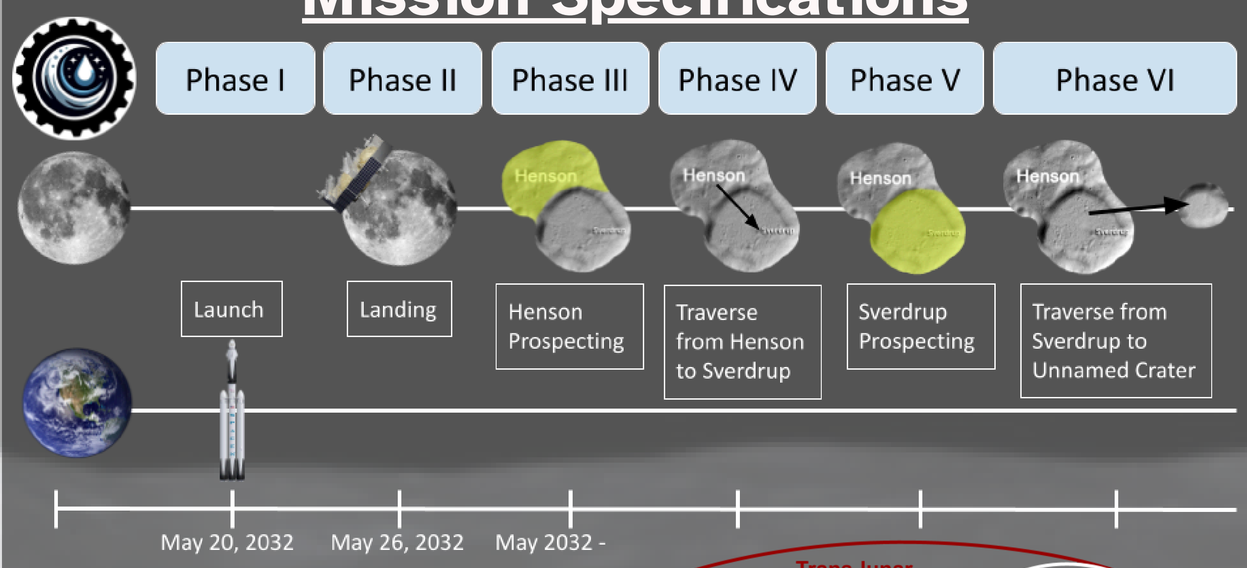
SITIS

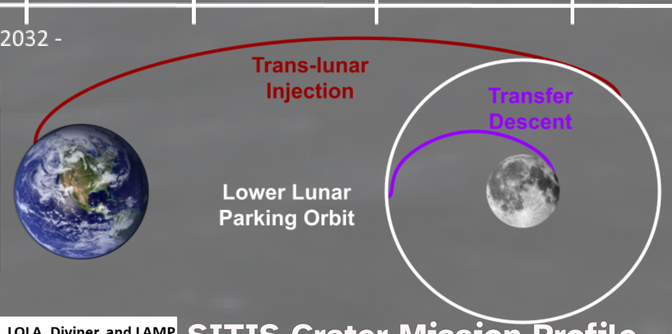
Subsurface Ice and Terrain In-situ Surveyor

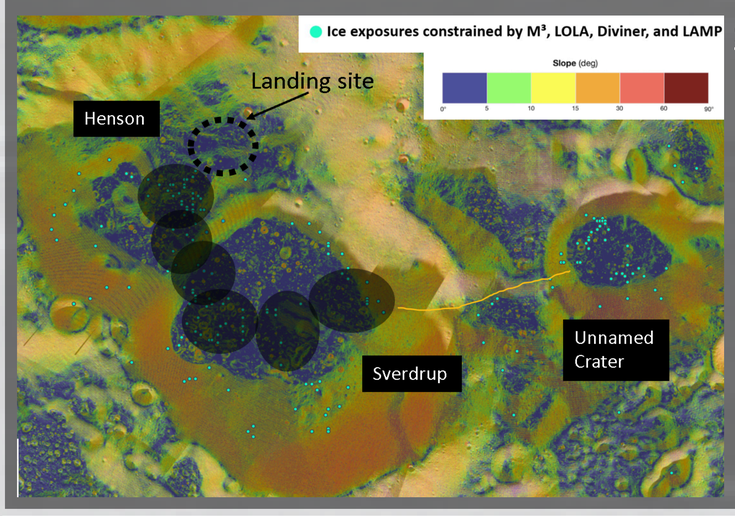
Mission: Characterize potential water ice and volatiles that could be harvested by deploying a large-scale prospector in the Permanently Shadowed Regions (PSRs) at the lunar south pole to support the Artemis program returning a human presence to the Moon.

Mission Specifications



Burn	ΔV(m/s)
Trans-Lunar Injection	3145
TLI to Lower Lunar Parking Orbit	818.2
Transfer Descent	23
Retro Engine Breaking	1704



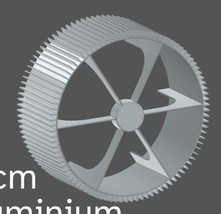


SITIS Crater Mission Profile

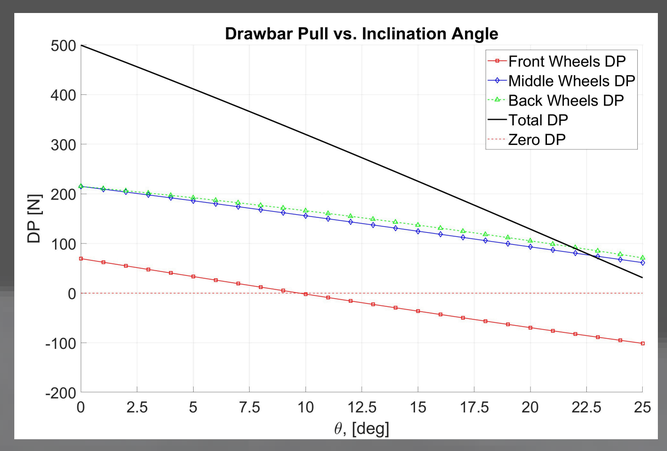
- Identify PSR water-ice/volatiles
- Prospect Sverdrup and Henson Craters on the lunar south pole
- Traverse to Unnamed Crater nearby for further exploration
- Mass spectrometry to identify hydrogen and water content
- Numerical data, photos, videos, and location relayed to Earth
- Preliminary path determined by locations of known ice points and terrain slope
- Handle slopes up to 25 degrees

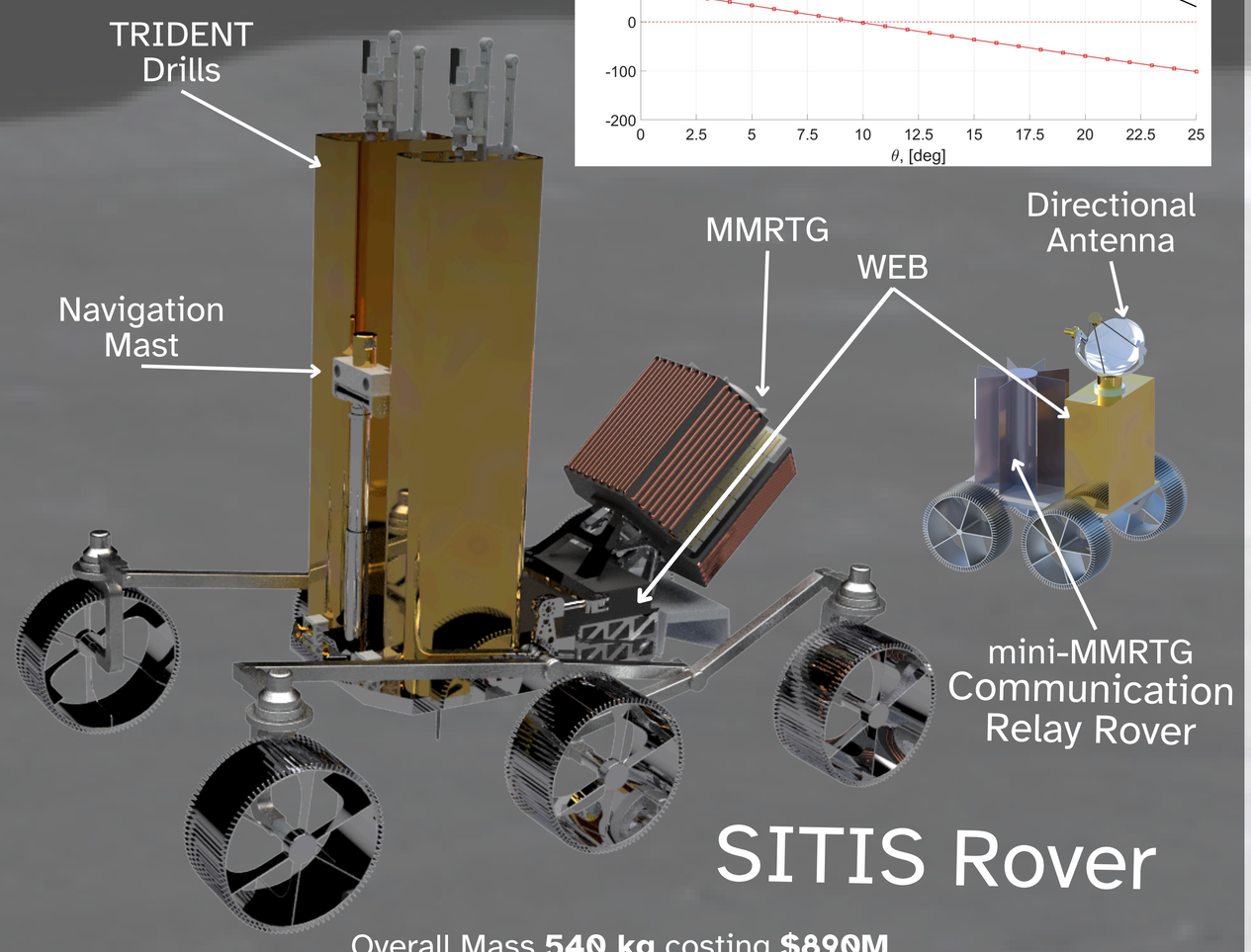
Rover Design

Terramechanics



- Diameter: 0.5m
- Width: 0.25m
- Grouser: 95
- Grouser height: 2cm
- Material: 6061 Aluminium



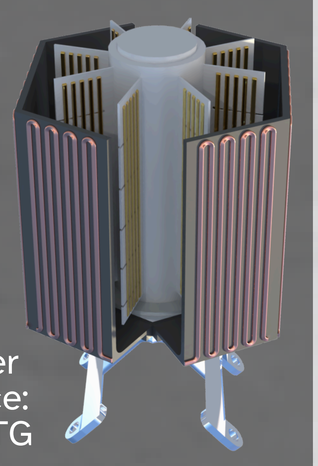


Overall Mass **540 kg** costing **$890M**

Power and Thermals

Power Breakdown

Modes	Power(W)	Time (hr)	Energy(W-hr)
Driving	234.3	8.5	1991
Drilling/Sampling	168.8	1.7	287
Analyzing	69.8	.85	58.33
WIEE	29.1	.85	24.7
Communication	10	10	100
Total			2461

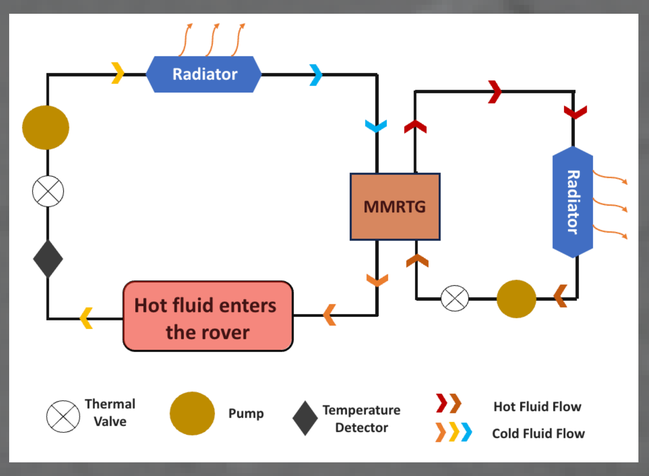


Power Source: MMRTG

Thermal Management

- The MMRTG emits 1890 Watts of heat; 1000 Watts carried to the rover to maintain the temperature of the rover at 293 K
- The Hot loop is operated at 450K while the Cold loop is kept at 293K

Working Fluid	Chemical Formula	Operational Temperature [°C]	Heat Capacity [J/kg-K]
Terphenyl /quaterphenyl	C18H14/ C24H18	80 to 385	1500 to 2000
Methylcyclohexane /trimethylpentane	C7H14/ C8H18	-115 to 175	1300 to 2500



- Two pumps are used to guarantee a steady flow of fluids with maximum mass flow rate of 10 g/sec
- ~1 squared-meter Carbon Fiber radiators (8 kg) with emissivity 0.85 to dissipate excess heat
- Copper pipes with thermal conductivity of 401 J/kg*K, diameter 3/8 inch and a length of 40 m are used to carry the fluids

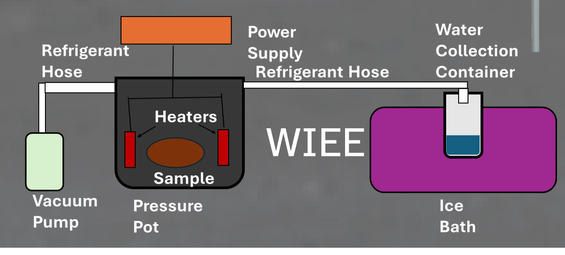
Science and Avionics

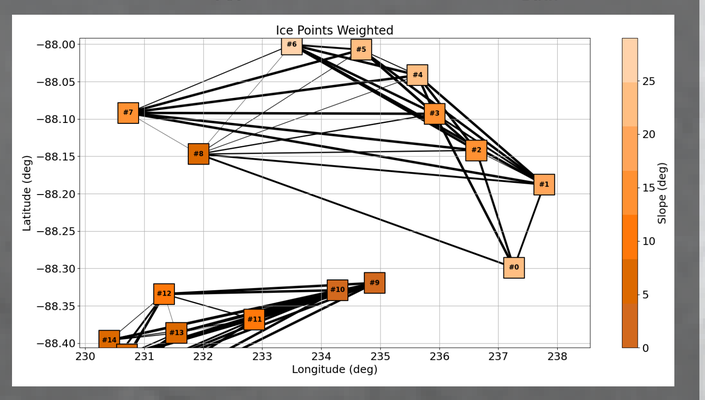
Science Experiments

	Purpose	Specification
Radar Imager for Mars' Subsurface Experiment	Characterize subsurface regolith and identify water-ice content	Sends periodic radar pulse via antenna every 4cm of rover movement
Near InfraRed Volatile Spectrometer System	Mass spectral analysis to identify CO_2, H_2O, H_2S, and other H-bearing compounds	Can identify water in lunar sample when concentration is >0.5% by weight
Neutron Spectrometer System	Characterize H_2 content in lunar subsurface to determine drilling points	Detects H_2 up to 1m under the lunar surface
The Regolith and Ice Drill for Exploration of New Terrains	Break down and shoot up lunar regolith for spectral analysis and water-ice extraction	Drills up to 2m under the lunar surface
Water-Ice Extraction Experiment	Separate and contain liquid water from lunar regolith sample	Produces ~37g of liquid water every 42 minutes

Communication

	UHF	Ka-Band
Max Data Rate	1 Mbps	2 Mbps
Direction	Two-way	Two-way
Antenna	Omni-directional	High Gain Parabolic Directional
Gain	-2.04 dB	35.8 dB
System Power	10W	15W
RF Power	1W	1.5W
Link Margin	6.13dB	6.07dB





Command and Data Handling

- GR740 Processor (250 MHz, interfaces with FPGA).
- RTEMS OS with cFS/F' software and data storage in 1 TB Mercury SSDR.

Navigation and Autonomy

- Use lidar for terrain-relative navigation source to correct drift errors from IMU, which provides motion/position data, recalibrate IMU frequently to combat position error compounding
- Autonomous Path planning