COLLEGE OF ENGINEERING
KEVIN T. CROFTON DEPARTMENT OF AEROSPACE AND OCEAN ENGINEERING
VIRGINIA TECH

RASC-AL 2021: Project TAURUS

Moon To Mars Ice & Prospecting Challenge

Purpose:

Design and build a prototype ISRU system to extract and filter water from subsurface Lunar and Martian ice while simultaneously generating a report on the hardness of the soil layers encountered.

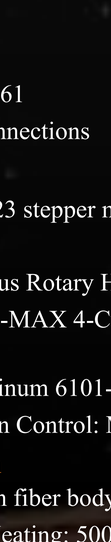
Subsystems:

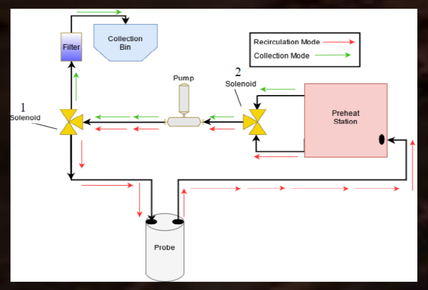
Chassis
- Aluminum 6061
- Fiberglass connections

Traverse
- Three Nema 23 stepper motors

Drilling
- Drill: SDS-Plus Rotary Hammer Drill
- Drill bit: SDS-MAX 4-Cutter Carbide-Hammer Bit
- Sleeve: Aluminum 6101-T61
- Drill Direction Control: MG995 Servo

Recirculation
- Probe: Carbon fiber body with copper tip
- Conductive Heating: 500 W insertion heater with internal temperature sensor
- Convective Heating: 300 W insertion heater
- Multistage canister filter





Digital Core
- Calculated from Mechanical Specific Energy

$$MSE = \frac{WOB}{A} + \frac{2\pi * RPM * \tau}{A * ROP}$$

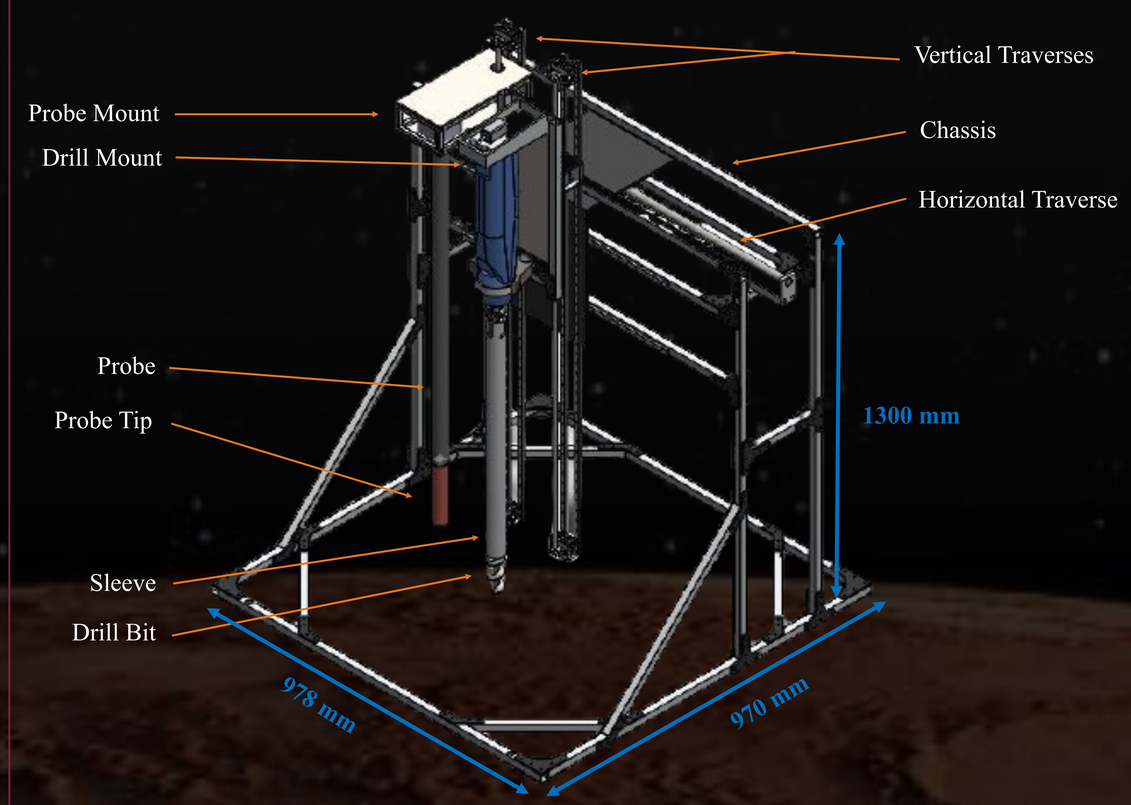
- Values from sensor data collected during drilling and stored in MySQL database

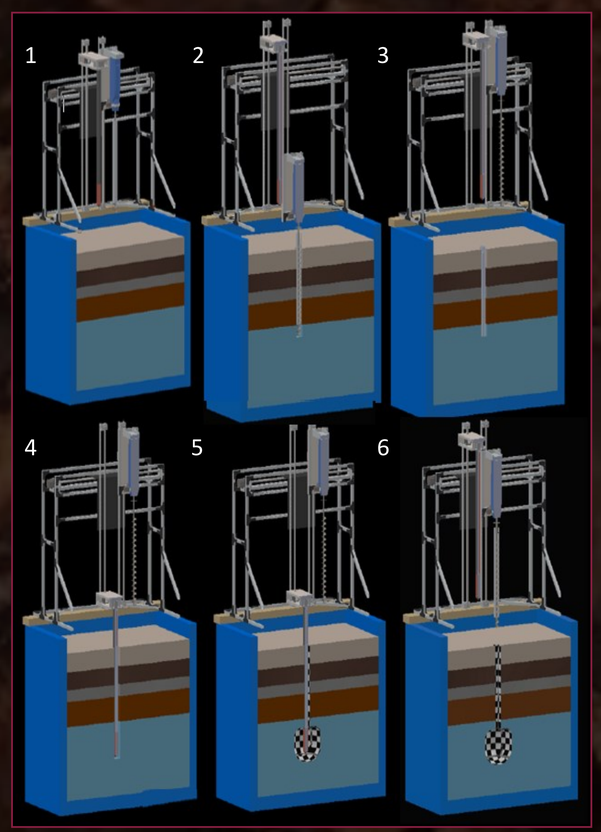
Graphic User Interface (GUI)
- GUI hosted on network
- Tabs: Status, Rodwell Probe, Drill, Traverse

Mass Table:

Subsystem	Mass	% Overall Mass
Chassis	8.11 kg	20.91%
Traverse	14.07 kg	36.27%
Drilling	8.47 kg	21.84%
Recirculation	8.14 kg	20.98%
Total:	38.79 kg	100.00%

CAD model of TAURUS:





Concept of Operations:

Step 1: Auger and sleeve align with desired location
Step 2: Auger and sleeve drill through overburden
Step 3: Auger disconnects from sleeve and is extracted
Step 4: Probe aligns with sleeve and descends
Step 5: Probe melts ice, recirculates and extracts water
Step 6: Probe is extracted, auger aligns with sleeve, descends into hole, reconnects with and extracts the sleeve

Power Table (Watts):

Subsystem	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Traverse	65	65	65	65	19	65
Drilling	5	600	5	5	5	5
Recirculation	344	344	344	344	925	344
Total:	414	1009	414	414	949	414

Changes needed for off Earth Application:

Considering the key differences between the Martian & Lunar to Earth's environments is necessary in order for TAURUS to be operational during off Earth applications.

Martian Extraction:
- Power generated using a radioisotope thermoelectric generator or Solar panels (will need panel cleaning system)
- Inflatable balloon attached to probe to sop sublimation of ice.
- PDC drill-bit to deal with stronger surface composition of Mars (150+ MPa)
- Change materials used to better suit Martian temperatures (-65 °C average)
- Radiation hardened boards should be implemented to ensure mission lifetime operability.
- LAN communication will not be viable, so parts of the mission will need to be programmed into the system.

Lunar Extraction:
- All mobile components of the prospector and drill should be sealed to mitigate negative effects of lunar dust.
- Water collection will needed to be modified to ensure continu-ous water flow.

Challenges Faced:

- Zoom meetings stunted production and interaction
- Person limit in Advanced Engineering Design Lab
- NASA funding delay due to resource reallocation
- Shipping delays on key components
- Graduating seniors/ team members

Cost Table:

Subsystem	Cost	% Overall Cost
Chassis	$1222.81	19.62%
Traverse	$1334.89	21.42%
Drilling	$2645.78	42.46%
Recirculation	$1028.00	16.50%
Total:	$6231.46	100.00%

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