National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology

PALMER QUEST: A FEASIBLE AND VALUABLE VISION MISSION TO THE MARS POLAR CAPS

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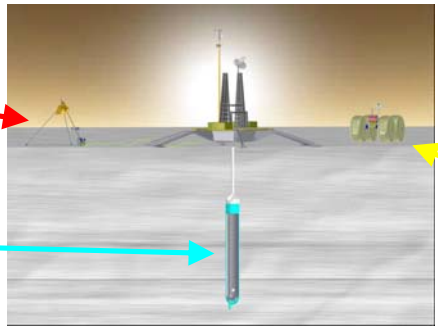
Surface Station: Unique, small surface-atmosphere observation platform

Cryobot: Nuclear fission powered thermal probe



FRAM Rover: Long-range inflatable, powered by RPS

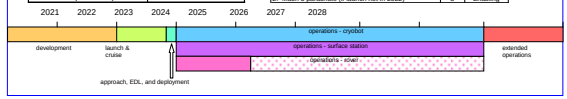
PQ Mission Architecture

Mission Design	
Launch and trajectory	
Launch vehicle	Delta 4050H-19
Injection C3	22 m^2/s^2
Trajectory	Type II
Launch date	August 2022
Arrival date	June/July 2023
Arrival V_{inf}	2.39 km/s
Target landing site	83 deg N, 4 deg E
EDL	
Landing method	Powered descent
Parachute	Mach 1.8
Telecommunications	
Data transmission	UHF relay via MTO (8 kbps downlink, 128kbps uplink
Surface/sub-surface operations	
Surface mission duration	5 Earth years
Cryobot fission power output	1100We
Rover RPS power output	120We

Spacecraft Elements	Mass (kg)
Payload Mass	
Cryobot	1457
Rover	222
Instrument Sled	125
Total Payload mass	1804
Landed Mass	
Pallet Lander	1392
Total landed mass	3196
Mars Entry Mass	
Aeroshell	1069
Total entry mass	4265
Launch Mass	
Cruise Stage	597
Wet Launch Mass	4862

* Preliminary masses based on Team X studies, 30% contingency included

Technologies:	TRL	Type
1. 1500kWt HOMER-15 fission reactor	4	Enabling
2. Mach 3 parachute (if launch not in 2022)	3	Enabling



Nathaniel Brown Palmer

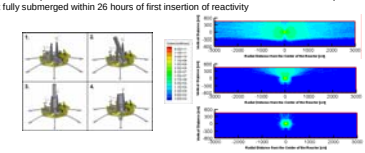
Palmer Quest mission goals

- **Determine the presence of amino acids, nutrients, and geochemical heterogeneity in the ice sheet.**
- **Quantify and characterize the provenance of the amino acids in Mars' ice.**
- **Assess the stratification of outcropped units for indications of habitable zones.**
- **Determine the accumulation of ice, particulate matter, and amino acids in Mars ice caps over the present epoch.**

Reactor Startup

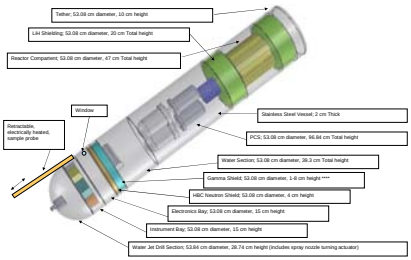
•Period of Reactor Startup is critical as a result of radiation dose to surroundings and lander avionics

•A detailed startup scenario has been devised that would have the reactor started at low power and the cryobot fully submerged within 26 hours of first insertion of reactivity



Cryobot deployment sequence (conceptual)

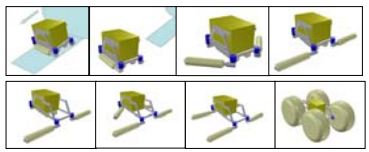
Gamma-radiation profile during descent

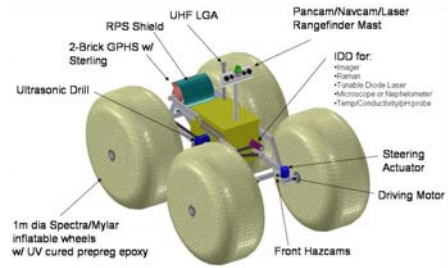


Cryobot Science Goals and Measurements

1. Characterize the biologic potential of the Basel layer.
   1. Identify and quantify organic material at the Basel layer, including determination of amino acid chirality
   2. Measure energy sources available for sustaining of life
   3. Identify nutrients available for life at the boundary layer.
   4. Image any potential microorganisms present in the melt water around the stationary cryobot.
2. Characterize the chemical composition of the Martian northern polar cap during descent
   1. Identify and quantify organic material, including determination of amino acid chirality
   2. Measure inorganic material present in the ice
   3. Measure isotopic ratio of H/D, C12/C13, and O16/O18 of material through the cryobot descent
3. Characterize the properties of solid material in the ice sheet.
   1. Determine chemical and mineralogical composition of particulate matter present in ice sheet
   2. Continually image ice sheet to determine past impacts/volcanism through particulate layers.

Rover Deployment

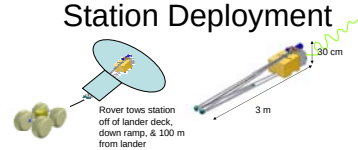


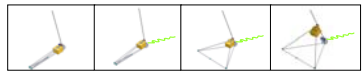


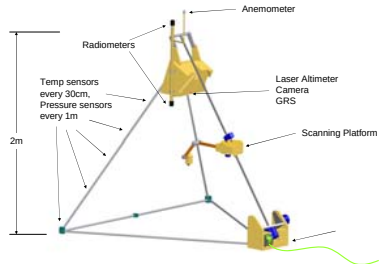
FRAM Rover Science Goals and Measurements

1. Characterize the Basal Unit (BU)
   1. Determine the characteristics of the Basal Unit including the mineralogy, chemistry, and ice component inventory
   2. Characterize the transition between the PLD and BU
   3. Identify the sedimentary structures and nature of material derived from the BU
2. Characterize the stratigraphy of the Polar Layer Deposits (PLD)
   1. Determined the relative proportions of ice and dust
   2. Identify the layers size distributions.
3. Investigate the PLD formation
   1. Identify relative proportions of ices and dusts
   2. Determine ice characteristics and grain sizes with depth
   3. Characterize pole-face and equatorial facing troughs
4. Identify PLD modification mechanisms
   1. Image the morphology and structure of the surface expression of different layers of the stratigraphy
   2. Measure H_2O vapor pressure with Altitude

Station Deployment







Surface Station Science Goals and Measurements

1. Associate the internal properties of the PLD with mass accumulation at the surface
   1. Determine rates of accumulation of accumulation/ablation of CO_2, H_2O and Dust.
   2. Estimate annual net CO_2, H_2O and Dust accumulation/ablation
   3. Determine fine-scale structure and morphology of seasonal frost layer
   4. Relate fine-scale morphology and structure to current polar climate.

Acknowledgement
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