Robotic Arm Camera (RAC) for the 2007 Phoenix Mars Scout Lander

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Outline

I. Background

II. Mission Overview

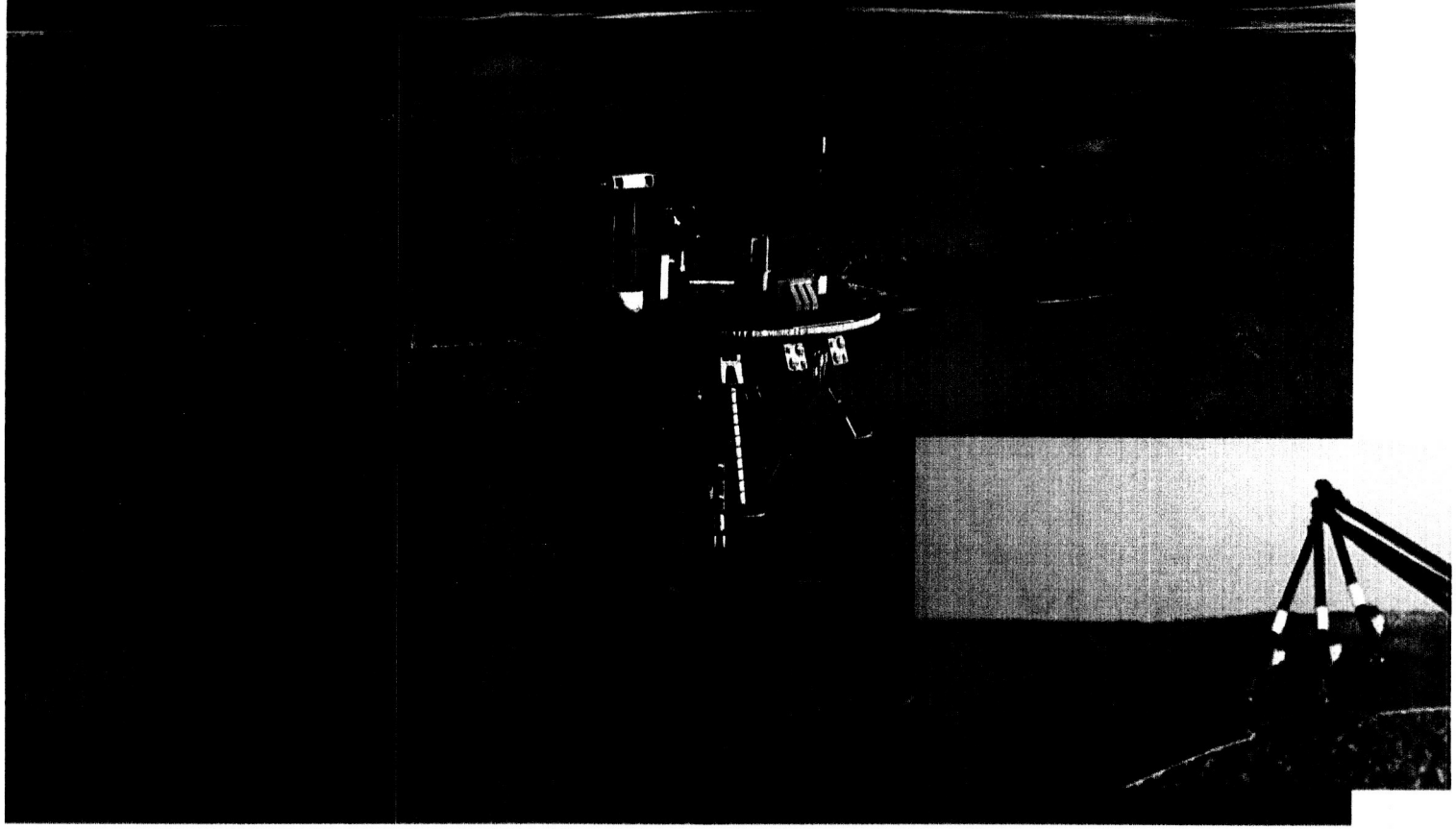
III. Robotic Arm Camera (RAC)

IV. Ongoing Work

Background

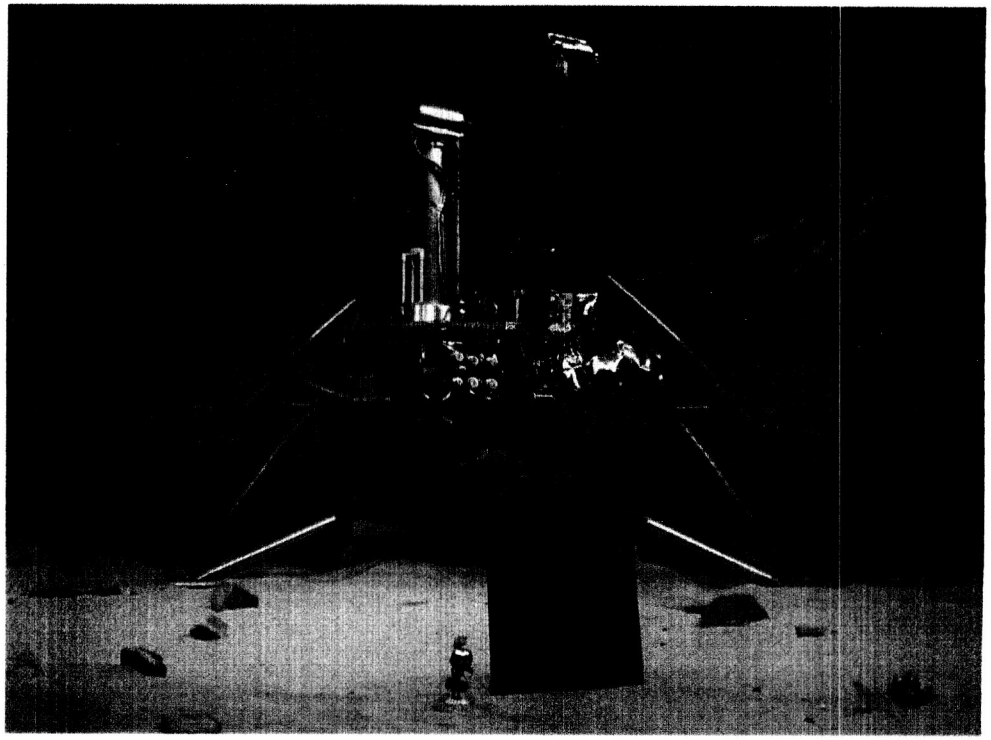
Phoenix Mars Lander

"Follow the water"



Background cont.

- Phoenix is a 2007 Mars lander mission born out of the embers of previous missions.
- Based on flight hardware from the cancelled 2001 Mars lander.



- Re-coups much of the science from the ill-fated 1999 Mars Polar Lander.

Background cont.

- Phoenix is being led by Principal Investigator Peter H. Smith of the University of Arizona Lunar and Planetary Laboratory.

- First time a Mars mission is being led and managed by a university – largest single grant ever won by the University of Arizona.

- Launch occurs in 2007 with a landing in Spring 2008.

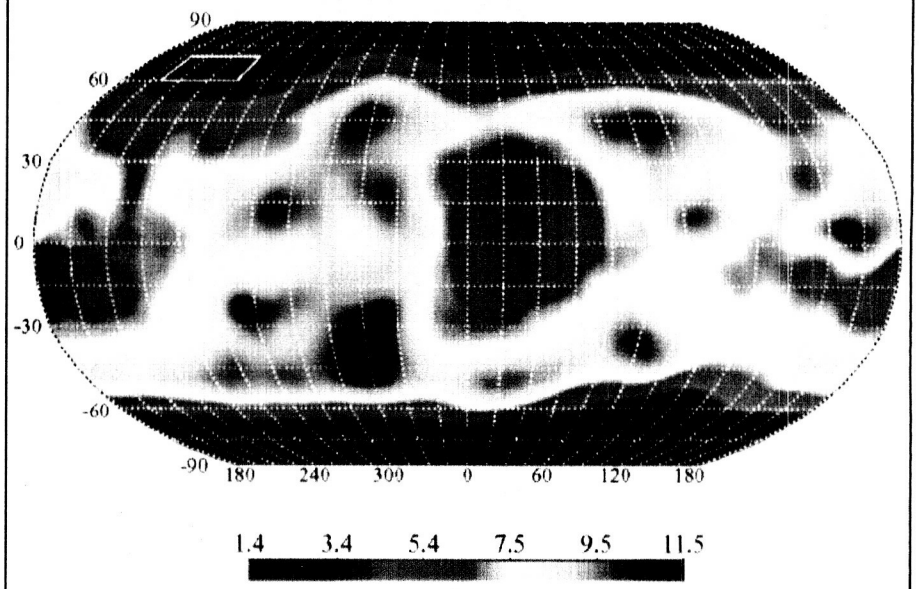
Primary Science Goals

1. Study the history of water in all its phases.
   - Quantify the volatiles locked into the Martian arctic soils.
   - Characterize the chemistry of dry and wet soils.

2. Search for evidence of a habitable zone and assess the biologic potential of the ice-soil boundary.
   - Detect organic molecules.
   - Assess soil habitability.

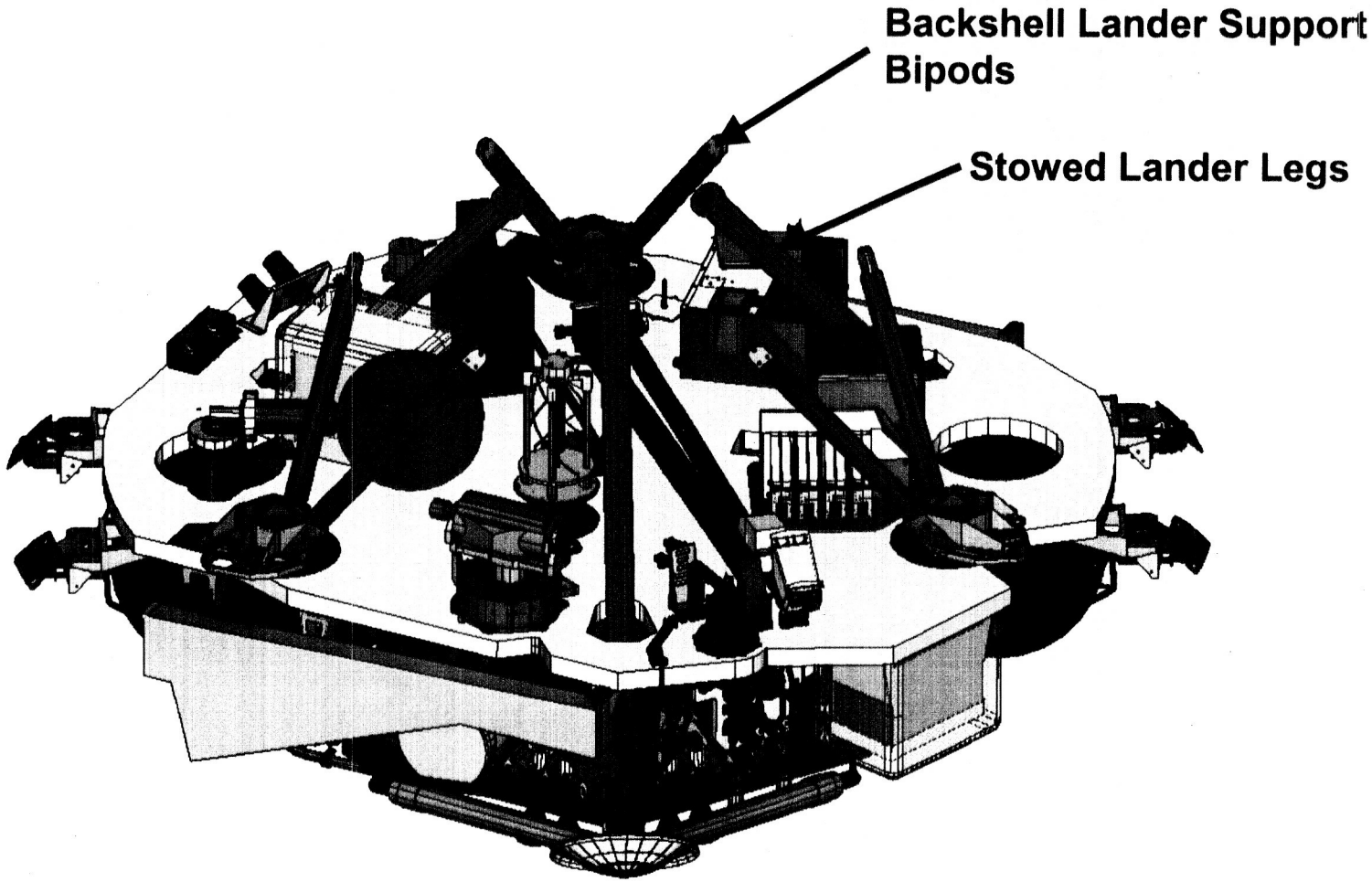
Mission Baseline

- Launch ~August 2007 for a landing in May/June 2008.
- Landing site in the northern arctic plains between 65 and 75N where high concentrations of water ice, up to 80% by volume, are to be found within 50 cm (1.6 feet) of the surface.
- A robotic arm will dig trenches in the Martian surface for in-situ sampling and analysis of soils by the Phoenix instrument suite.



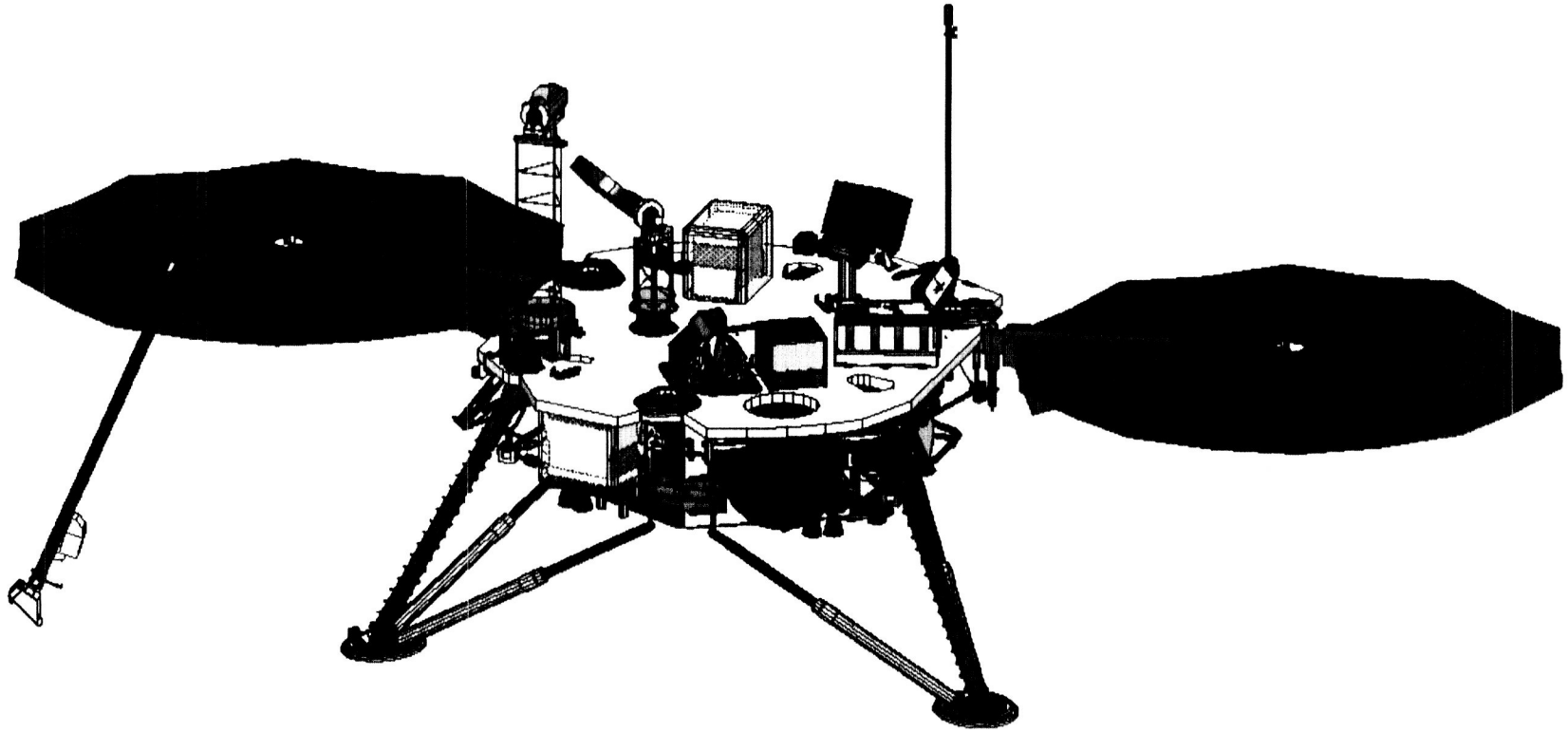
Blue areas indicate high-concentrations of water ice detected by the Mars Odyssey gamma-ray spectrometer.

Science Deck Layout

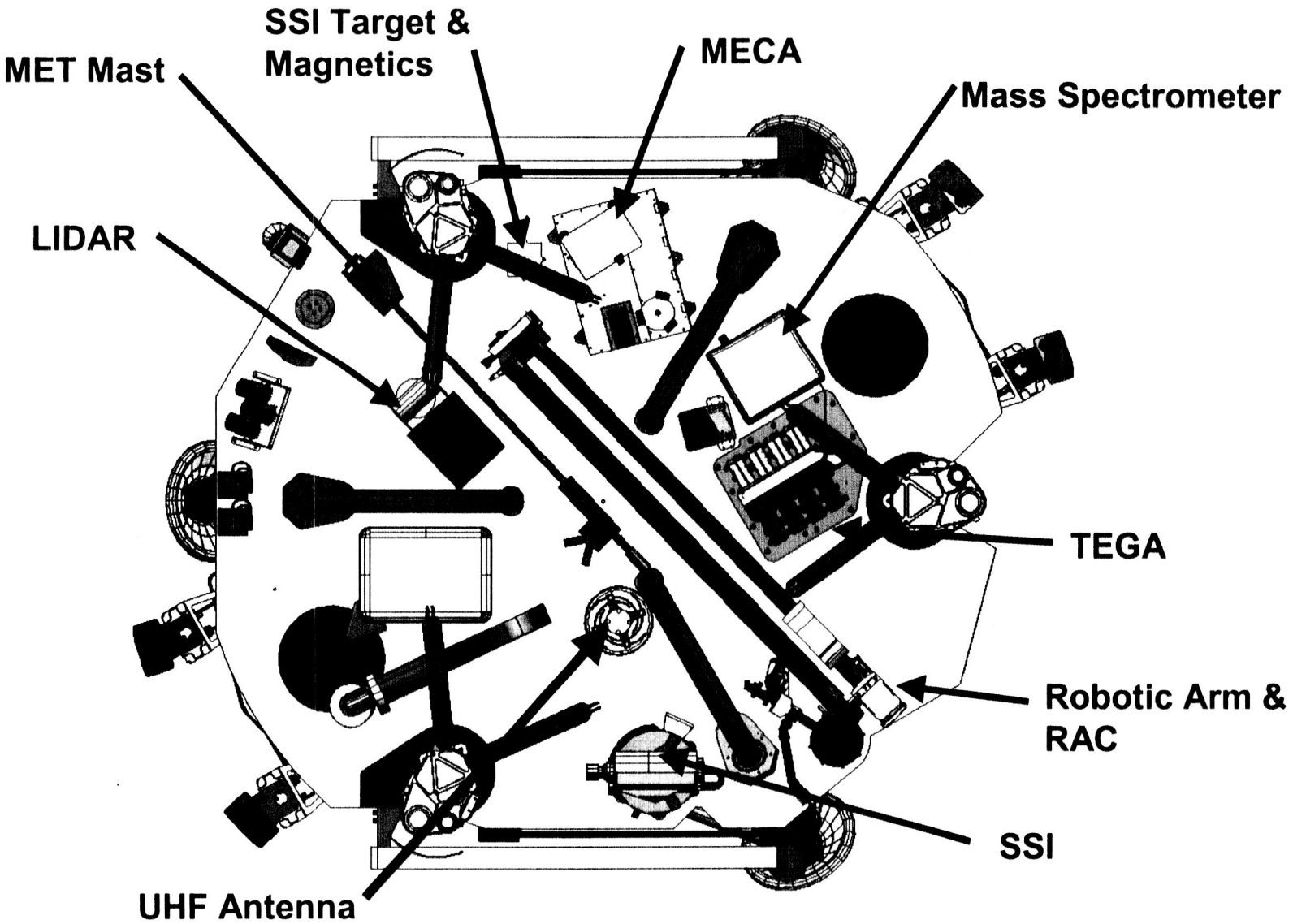


Science Deck Layout

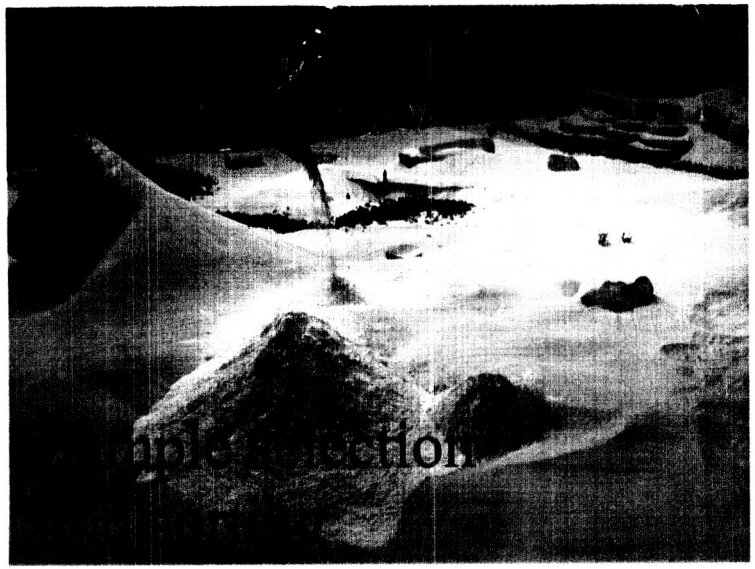
Deployed Lander

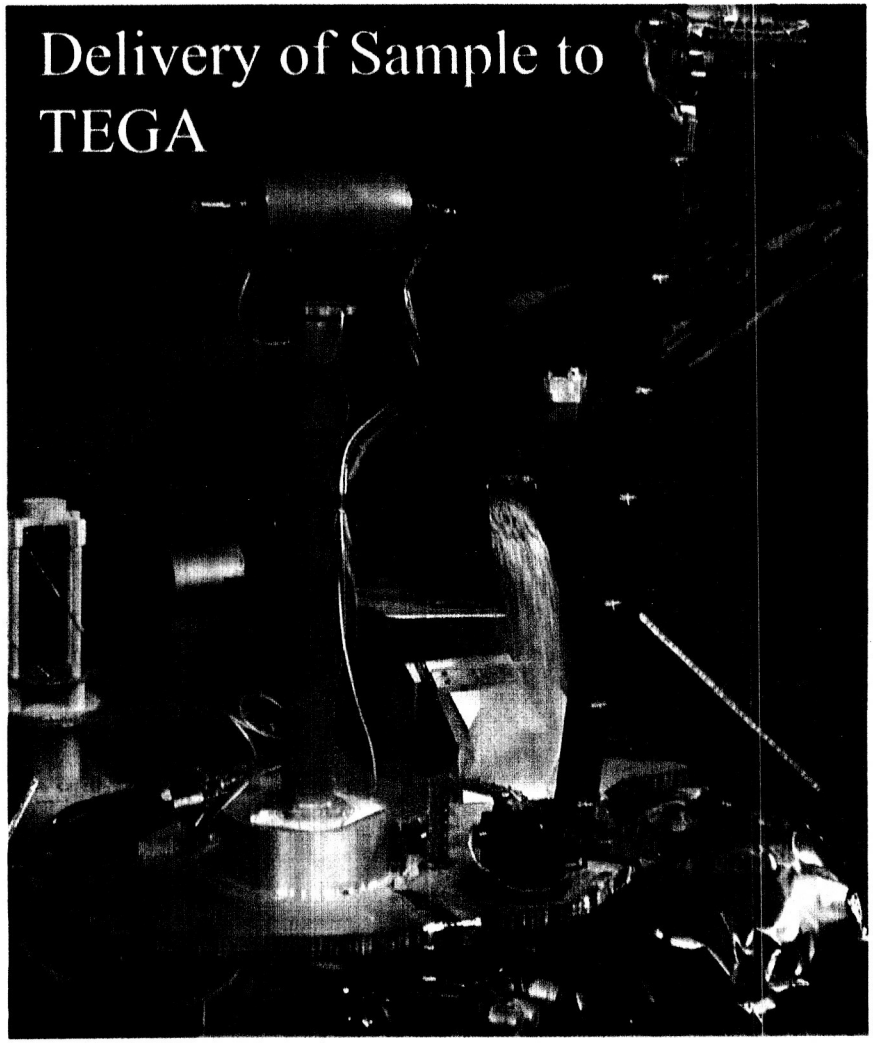


Science Deck Layout



Digging and Sampling Operations





Robotic Arm (RA) and Robotic Arm Camera (RAC)

- The Robotic Arm (RA) and Robotic Arm Camera (RAC) are enabling technologies for achieving the primary mission objectives.

- RA is 2.35 m (7.71 feet) long to facilitate soil sampling to depths of 1 m (3.28 feet).

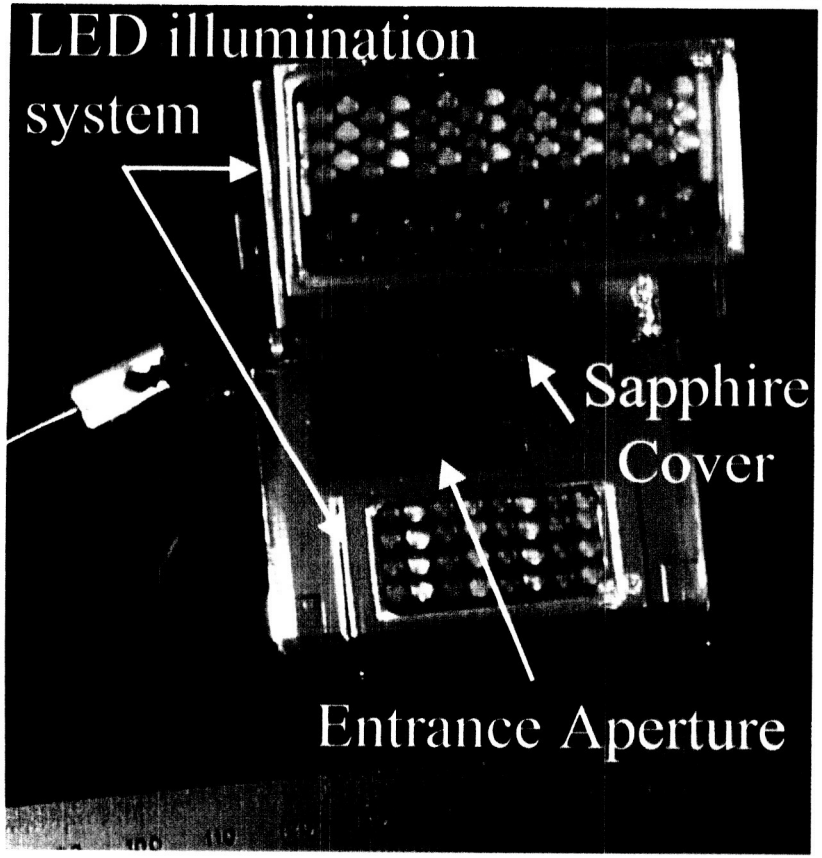
- RA will be capable of digging into ice-soil conglomerates with shear strengths of up to 40×10^6 N/m^2.

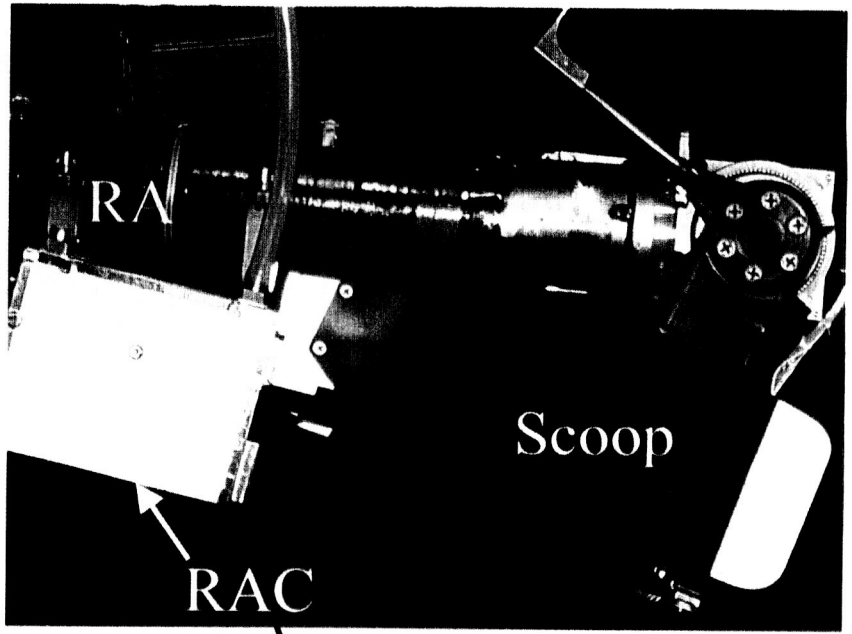
Robotic Arm Camera (RAC) Objectives

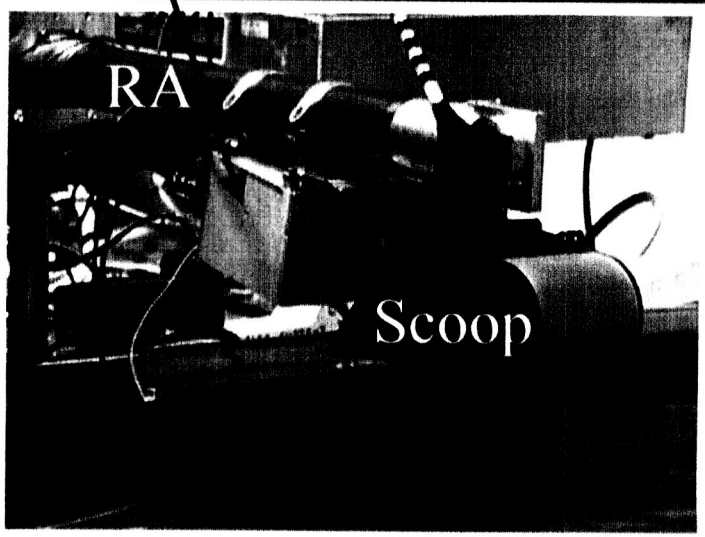
- High-resolution (23μm/pixel highest magnfication), color imaging of the trench floor and walls.
- Acquire images for verification of soil delivery to TEGA and MECA Chambers.
- Provide close-up images of soil in scoop, patch plates on TEGA and MECA housing and deck, scratch pad on the scoop.
- Supplement/back-up SSI landing site imaging (2 mrad/pixel at ∞) – longer stereo baselines possible with RAC than SSI.

The RAC will be the most versatile imager yet to operate on the Martian surface.

RAC Overview





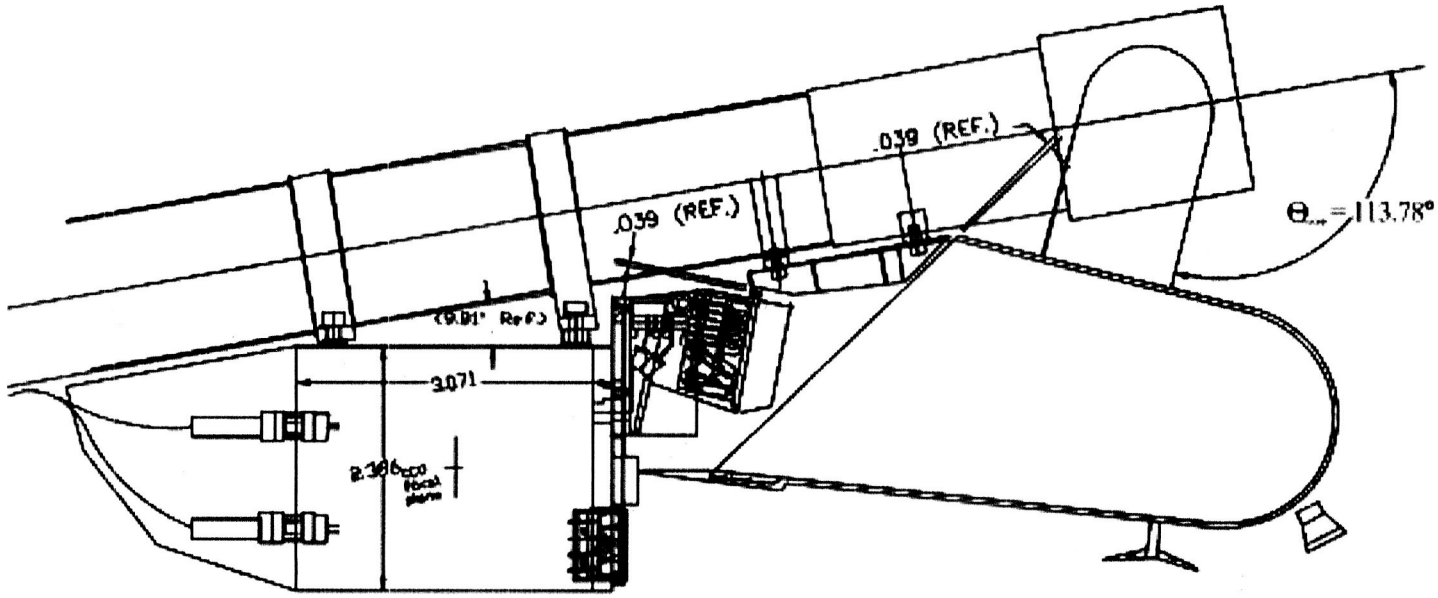


RAC Overview

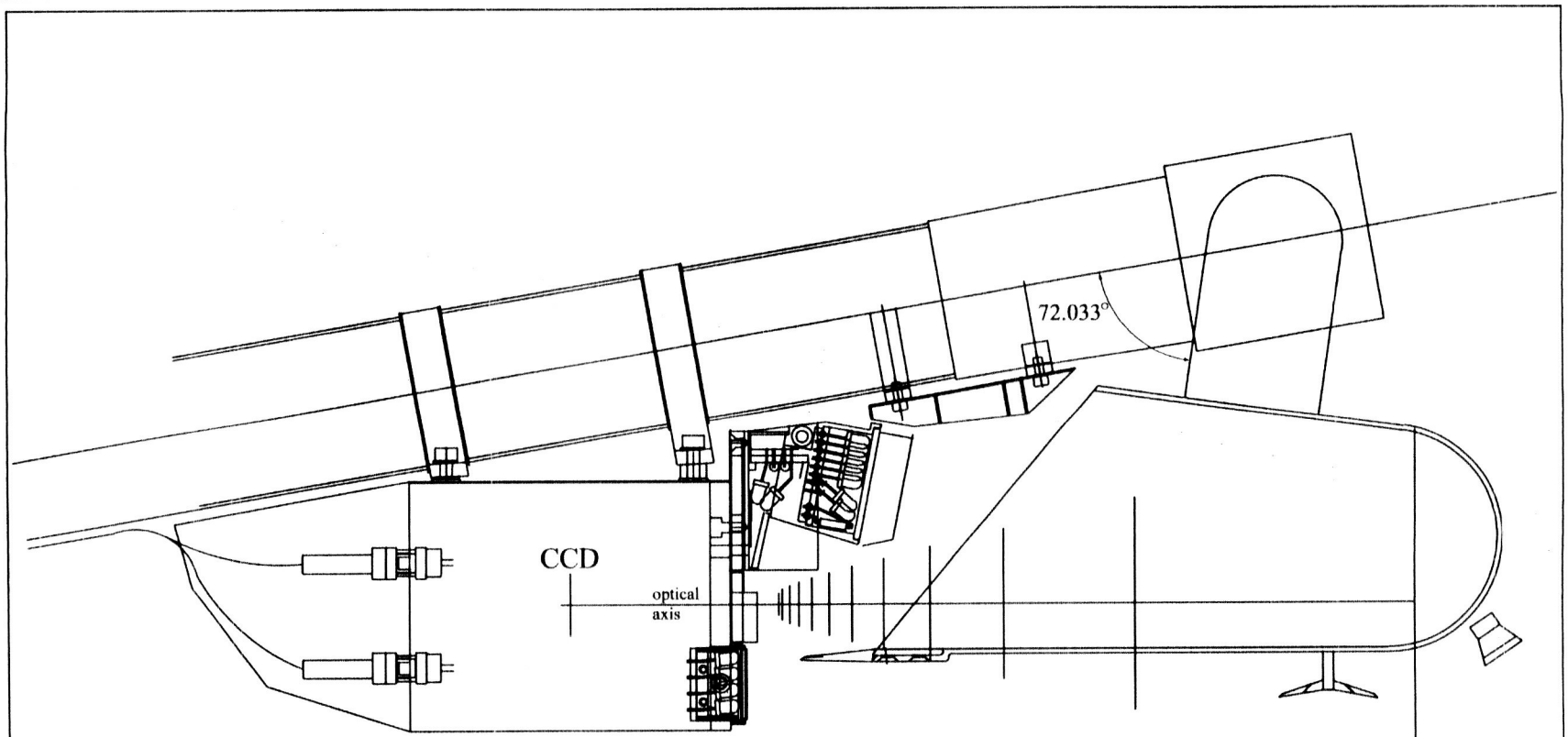
- CCD detector (512 x 256 exposed) 23 x 17 μm pixels.
- Broadband, 400-700 nm response.
- Color imaging utilizing red, green and blue LED's.
- 313 focus positions provided by a focus motor:

  23 μm/pixel for close-up imaging

  1.85 mrad/pixel for infinity imaging
- 4-element, Double-Gauss, 12.5 mm, *f*/11-*f*/23 lens.
- 12 bit pixel depth.

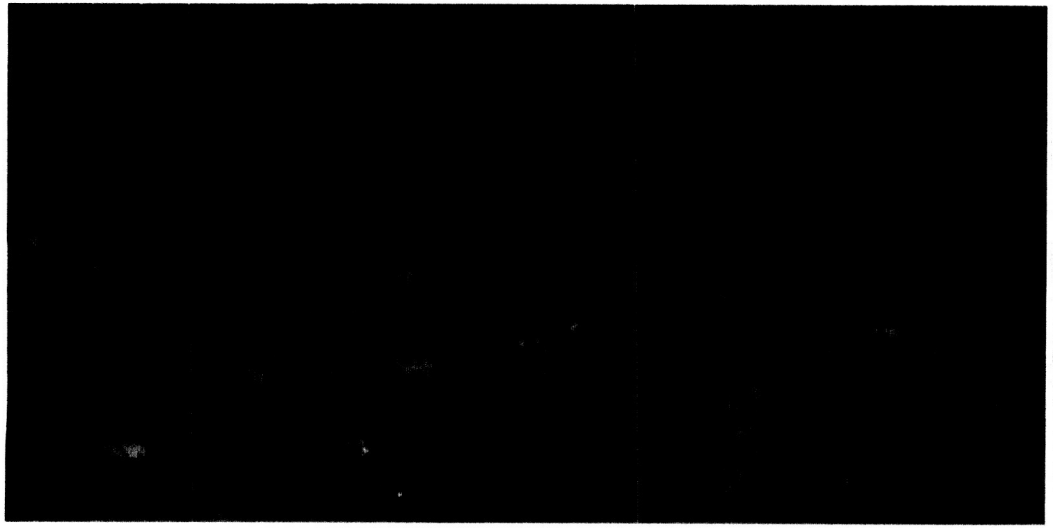


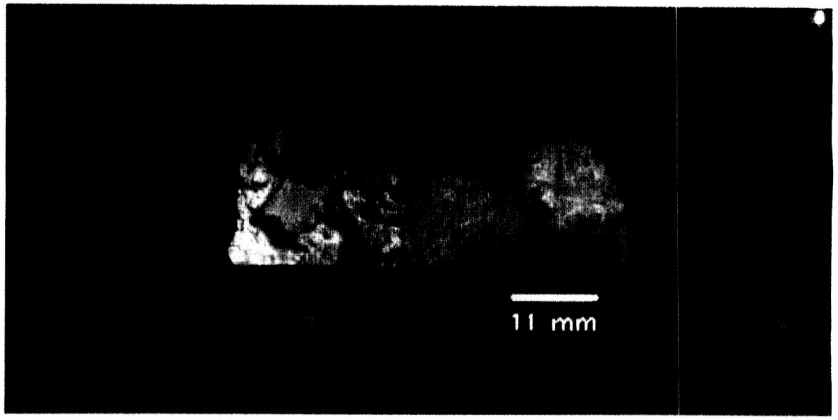
RAC Focus Capability



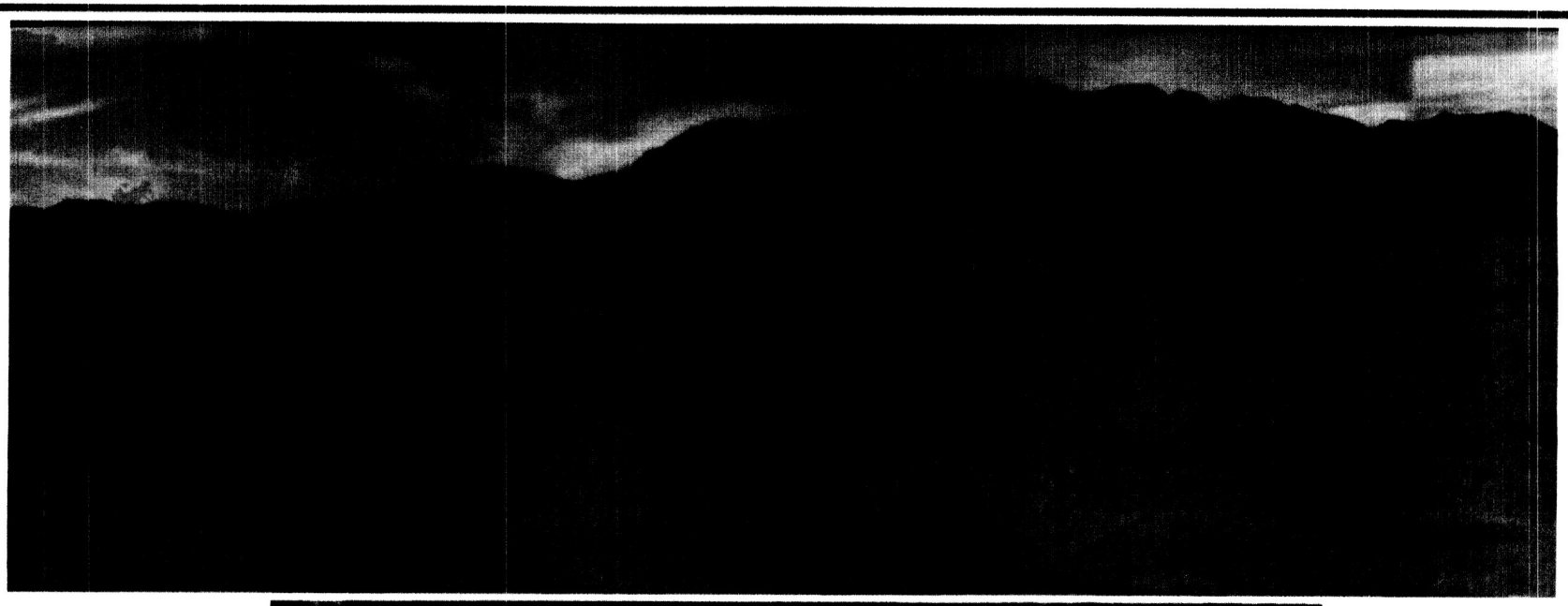
Object planes shown are for focus motor steps:
0, 87, 125, 153, 177, 198, 217, 234, 250, 265, 279 and 292.

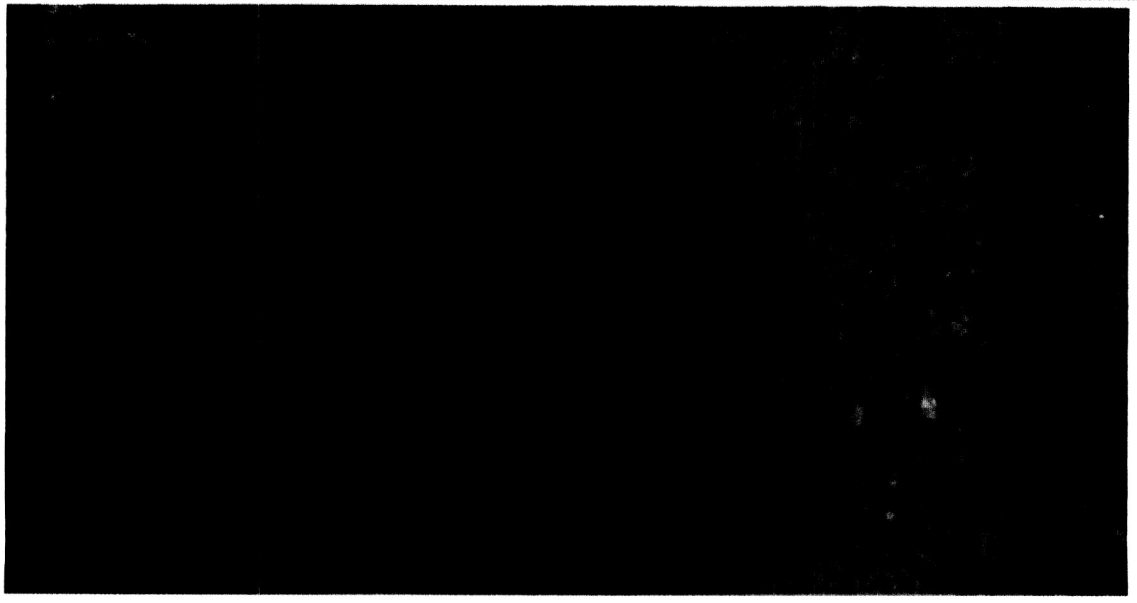
RAC Images



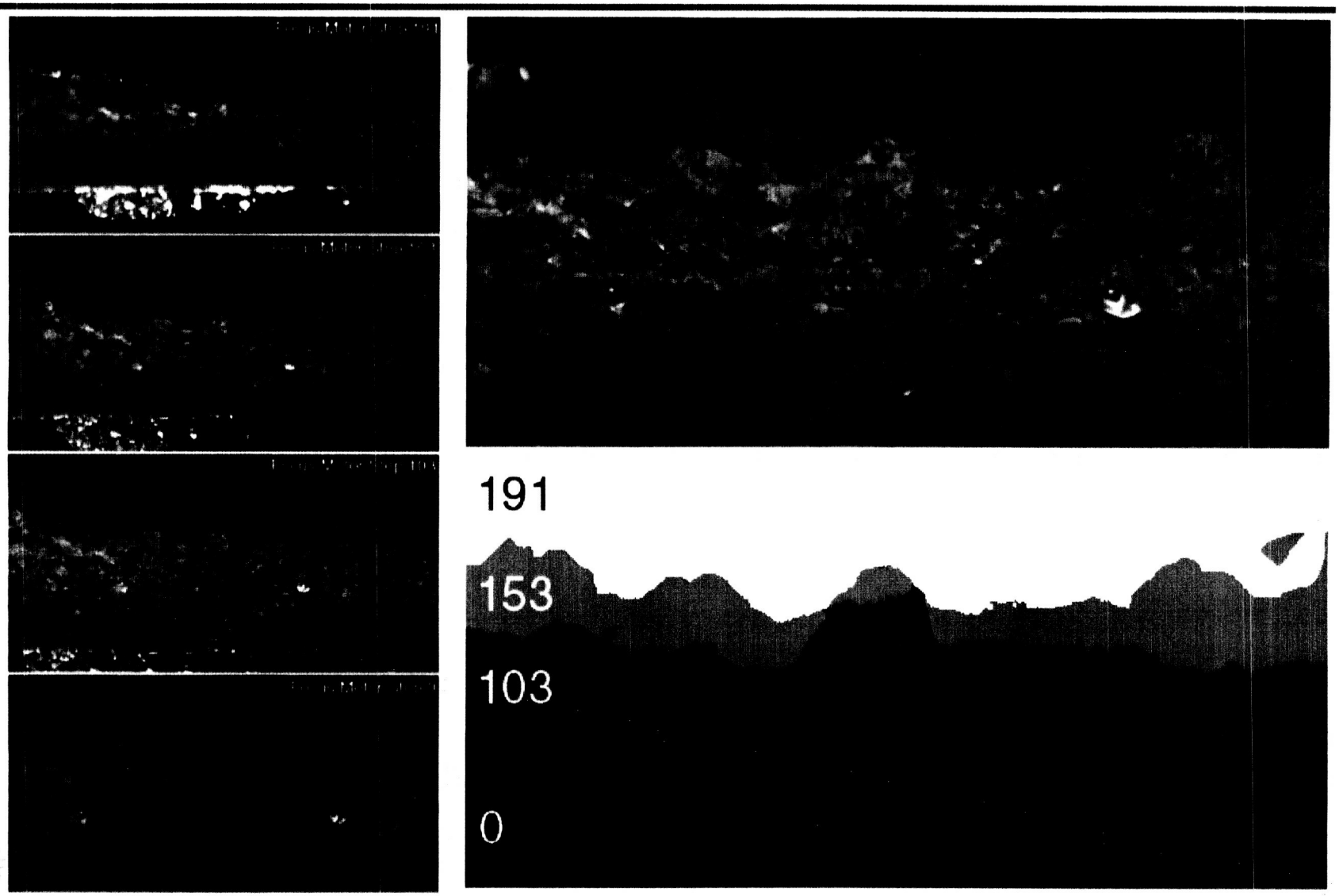


RAC Stereo Capability





RAC Depth of Focus Algorithm

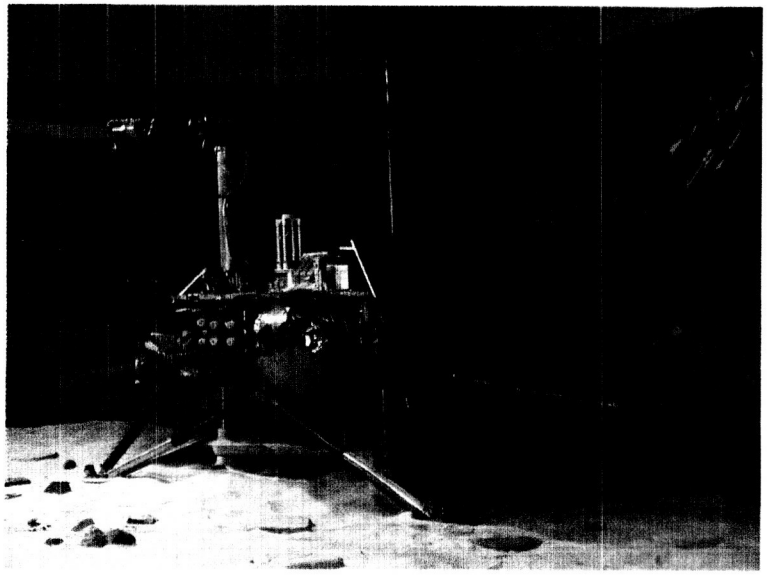


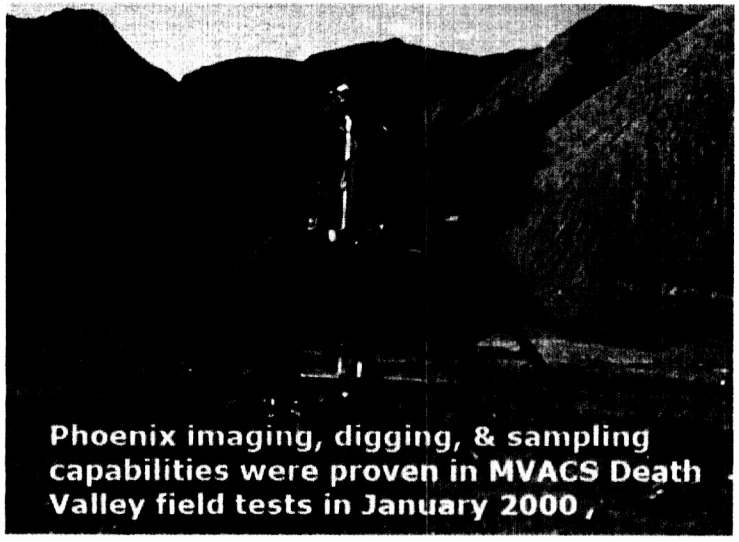
RAC and RA Operations Research

RAC and RA System have been put through an unprecedented amount of operations research.

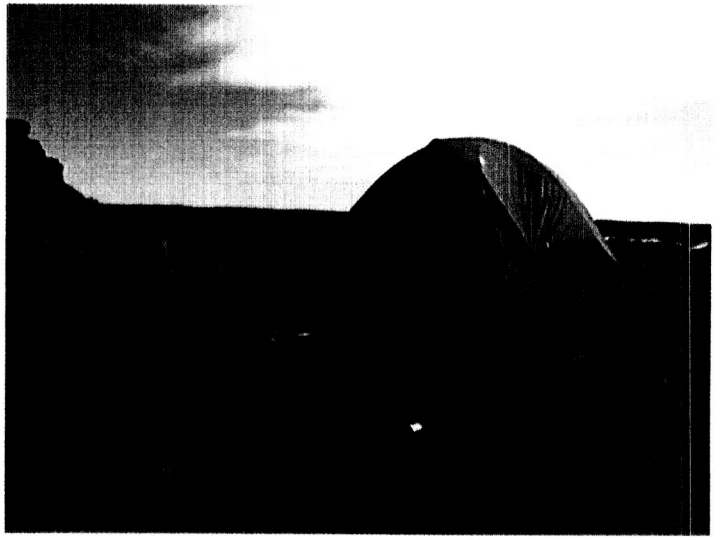
- 1999 field deployment in the Mojave Desert (*Yingst et al.* 2001).
- Mars Polar Lander Mission Operations and Readiness Tests during Fall of 1999 at UCLA.
- Death Valley flight spare deployment in early 2000.
- Devon Island Mars analog research in the high Arctic during summer of 2001 – partially funded by Mars Society as part of FMARS project.

RAC and RA Operations Research





Phoenix imaging, digging, & sampling capabilities were proven in MVACS Death Valley field tests in January 2000 ,



Current Work

- Recent discoveries have increased the scrutiny on planetary protection.
- Current flight RAC may not survive decontamination procedures.
- Testing is currently underway to understand the full impact of the decontamination procedures.