Venus Surveyor for Planetary Exploration Research (VeSPER)

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NASA POSTDOCTORAL PROGRAM

Motivation

- The surface of Venus has only been imaged six times and the final image was obtained by Venera-14 nearly forty years ago [1-2]
- These low-resolution images provided researchers with the first evidence of weathering on Venus [1-2]
  - Many details may have been lost due to the low-resolution of these cameras [1-3]
- Advances in technology have allowed researchers to send multiple landers equipped with high-resolution cameras to Mars [4]
  - The data has been used to characterize numerous geologic features and rocks [5]
- New, better resolution images are essential to characterize the surface geology of Venus
  - Can be used to identify geomorphological features, characterize different rocks, and theorize on chemical/mechanical weathering processes

Mission Overview

- Originally conceptualized as part of Seismic and Atmospheric Exploration of Venus (SAEVe) [6]
- The imaging system will obtain five images of Venus
  - Descent:
    1. 5 km (from the surface)
    2. 400 m (from the surface)
  - Ground:
    3. Surface before deployment of seismometer
    4. Surface after deployment of seismometer
    5. Panorama of horizon
- Wavelengths
  - 550-1020 nm
- Goal
  - Observe mechanical and chemical weathering artifacts on Venus
  - Observe topography and morphology of the surface

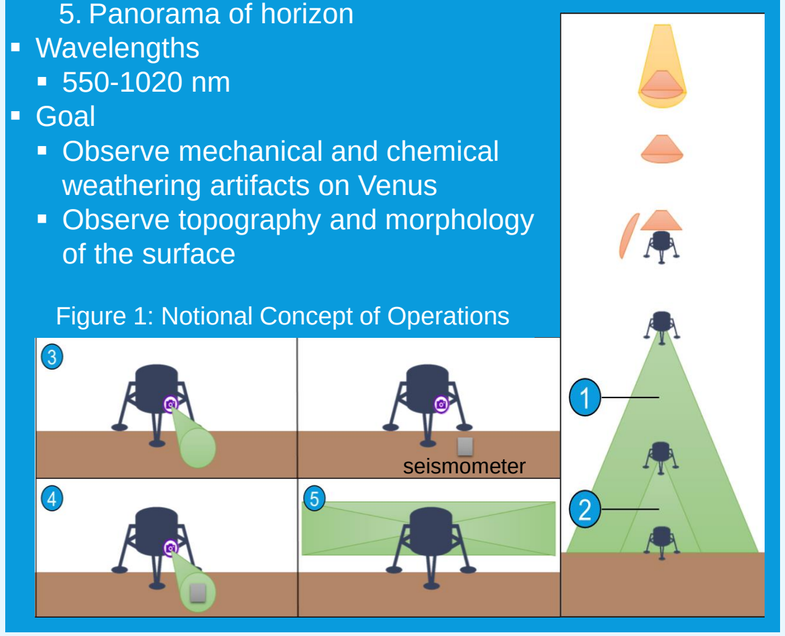


Figure 1: Notional Concept of Operations

The VeSPER Imaging System

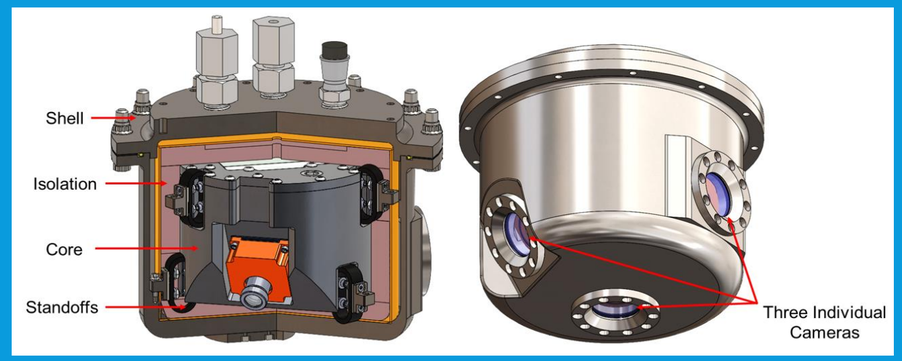
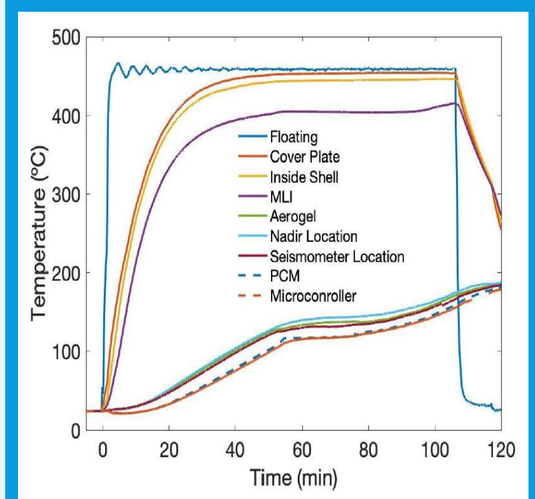


Figure 2: An overview of the VeSPER system and subsystems



Figure 3: The VeSPER system being tested in a furnace



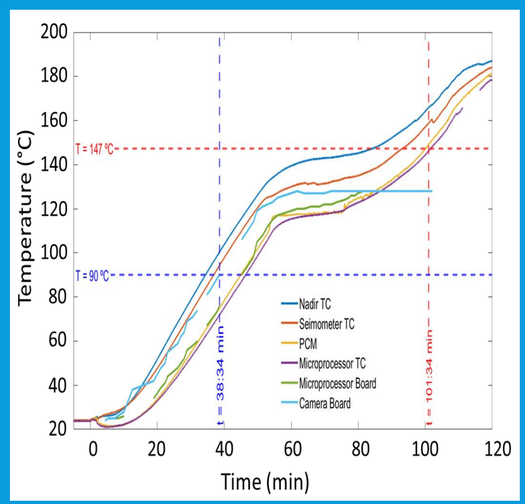


Figure 4: Thermocouple data from initial testing. The left image displays the temperature at different components. The right image displays the time and temperature when the camera stopped working (blue dashed lines) and the microcontroller stopped working (red dashed lines)

- The camera is intended to last 79 minutes and the microcontroller is intended to last 90 minutes
- Three major tests were completed on VeSPER to test its durability under Venus' surface temperature:
  1. VeSPER (minus the electronics) was heated in a furnace at 460°C (Fig. 3)
  2. The core (with electronics) was heated with flexible silicone strip heaters
  3. A fully integrated thermal experiment was completed in a furnace (Fig. 4)
- Future efforts will be made to improve thermal management and longevity

Future Work

- We will advance
  - The TRL of current technologies, seals, thermal management system, and optics
  - The demonstrable lifetime of VeSPER
- Test the durability of the system under simulated Venus surface environment (temperature, pressure, atmospheric chemistry) using the Glenn Extreme Environment Rig (GEER) located at NASA Glenn
- Successfully demonstrate system core capabilities in a relevant environment

References

[1] Florensky, C. P., et al. The surface of Venus as revealed by Soviet Venera 9 and 10. Geol. Soc. Am. Bull. 1977. 88. 1537–1545. [2] Basilevsky, A. T., et al. The surface of Venus as revealed by the Venera landings: Part II. Geol. Soc. Am. Bull. 1985. 96. 137–144. [3] Garvin, J. B., et al. Characterization of Rock Populations on Planetary Surfaces: Techniques and a Preliminary Analysis of Mars and Venus. The Moon and Planets. 1981. 24. 355-387. [4] Maki, J. N., et al. Mars Exploration Rover Engineering Cameras. J. Geophys. Res. 2003. 108. [5] Bell, J., et al. Compositional and Mineralogic Analyses of Mars Using Multispectral Imaging on the Mars Exploration Rover, Phoenix, and Mars Science Laboratory Missions. In Remote Compositional Analysis: Techniques for Understanding Spectroscopy, Mineralogy, and Geochemistry of Planetary Surfaces. 2019, pp. 513-537 [6] Kremic, T., et al. Long-Duration Venus Lander for Seismic and Atmospheric Science. 2020. 190. 104961.

Acknowledgments

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