A Venus SmallSat Orbiter for Remote Sensing of Seismic Activity, the VAMOS Concept

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Introduction to the Planetary Science Deep Space SmallSats (PSDS3) Program

- ROSES 2016
  - Explore mission concepts for SmallSats (< 180 kg) at planetary targets, identify critical technology gaps
- Proposed concepts:
  - VAMOS
  - Cupid's Arrow
  - CUVE
  - CubeX
  - BOLAS
  - APEX
  - CAESAR
  - Chariot to the Moons of Mars
  - Aeolus
  - SNAP
  - JUMPER
  - …and others!

Planetary Quakes on Rocky Bodies

Deep Insight via Global Observations

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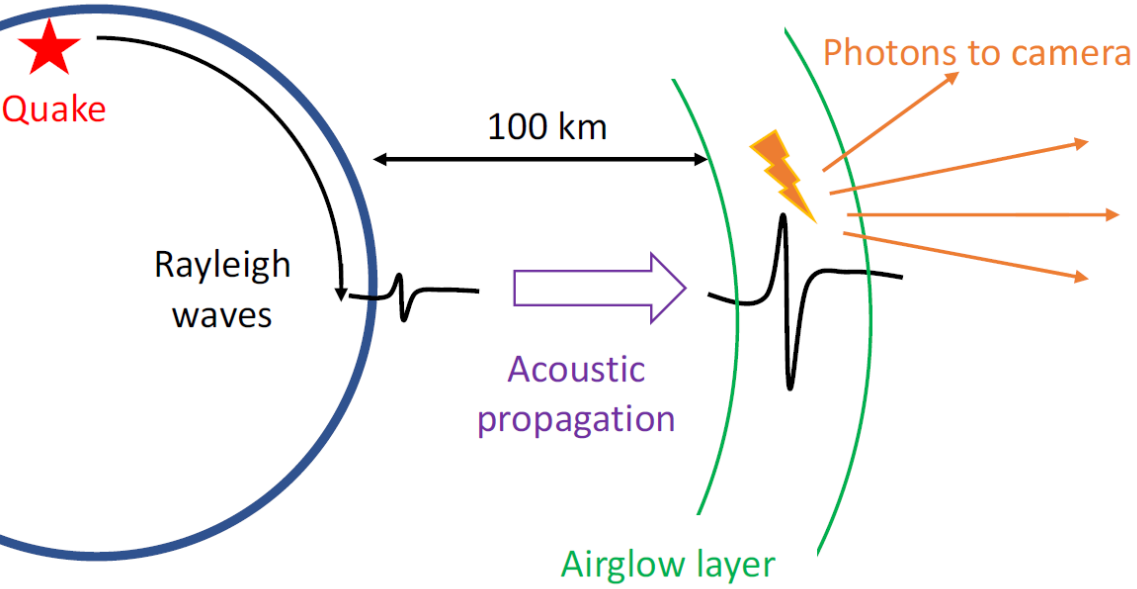


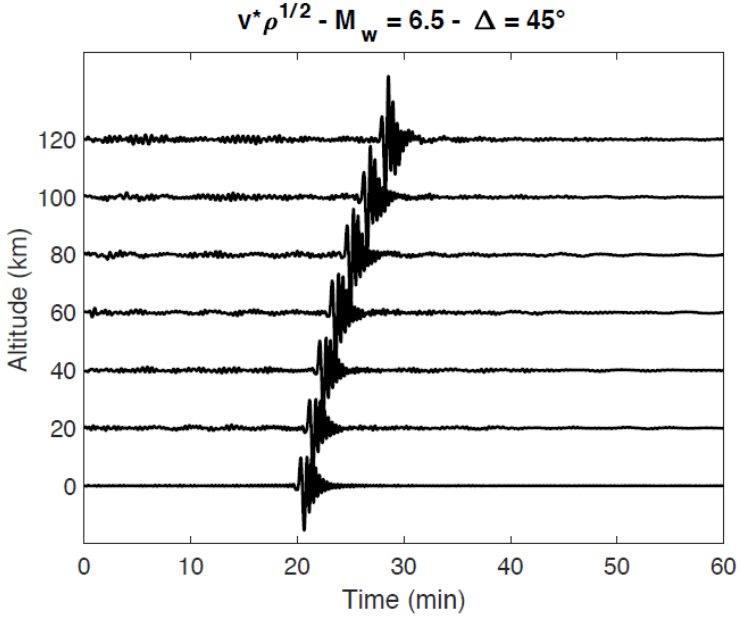
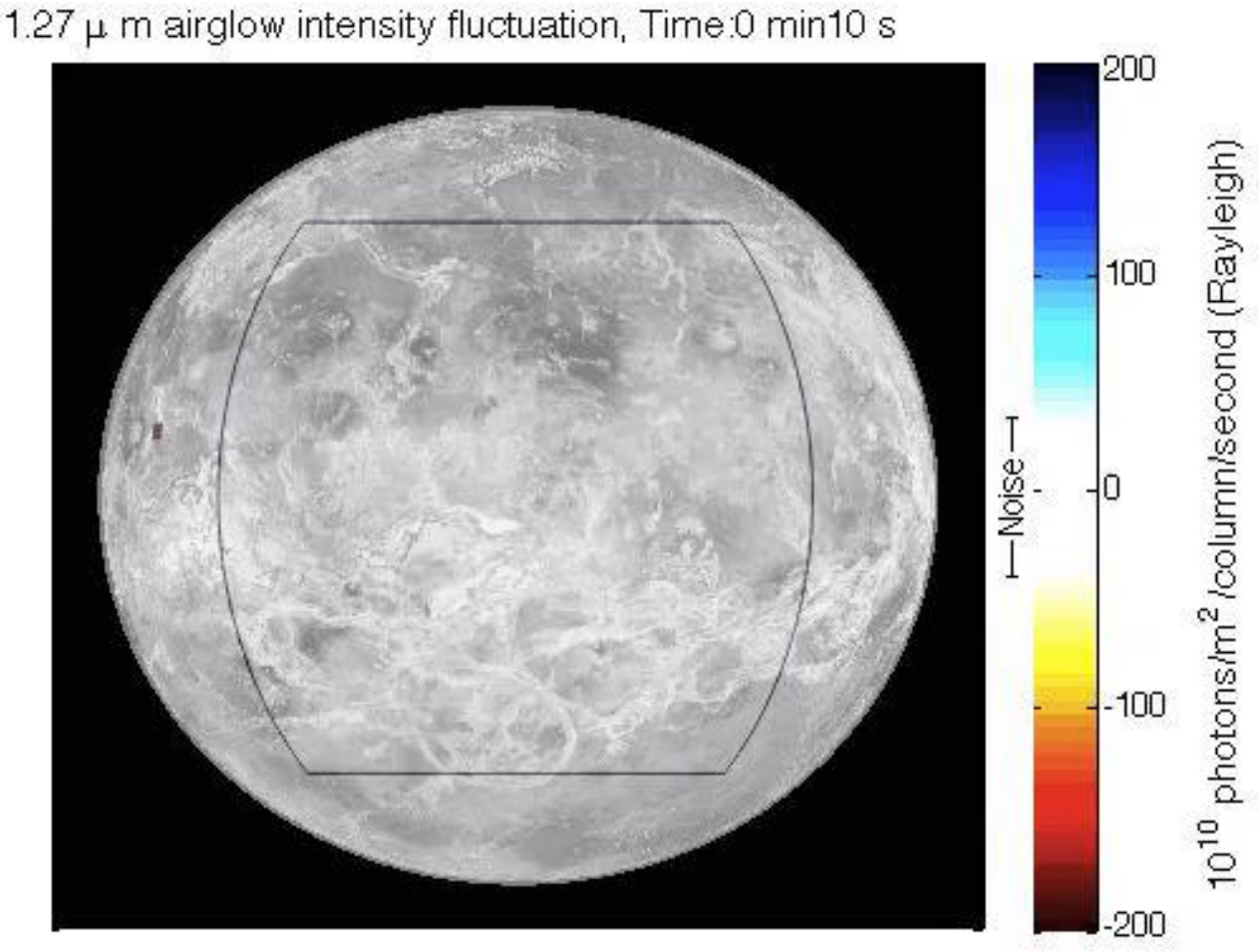


Fig. 5 Synthetic seismograms at different altitudes in the atmosphere; the product of vertical velocity by the square root of density is shown.

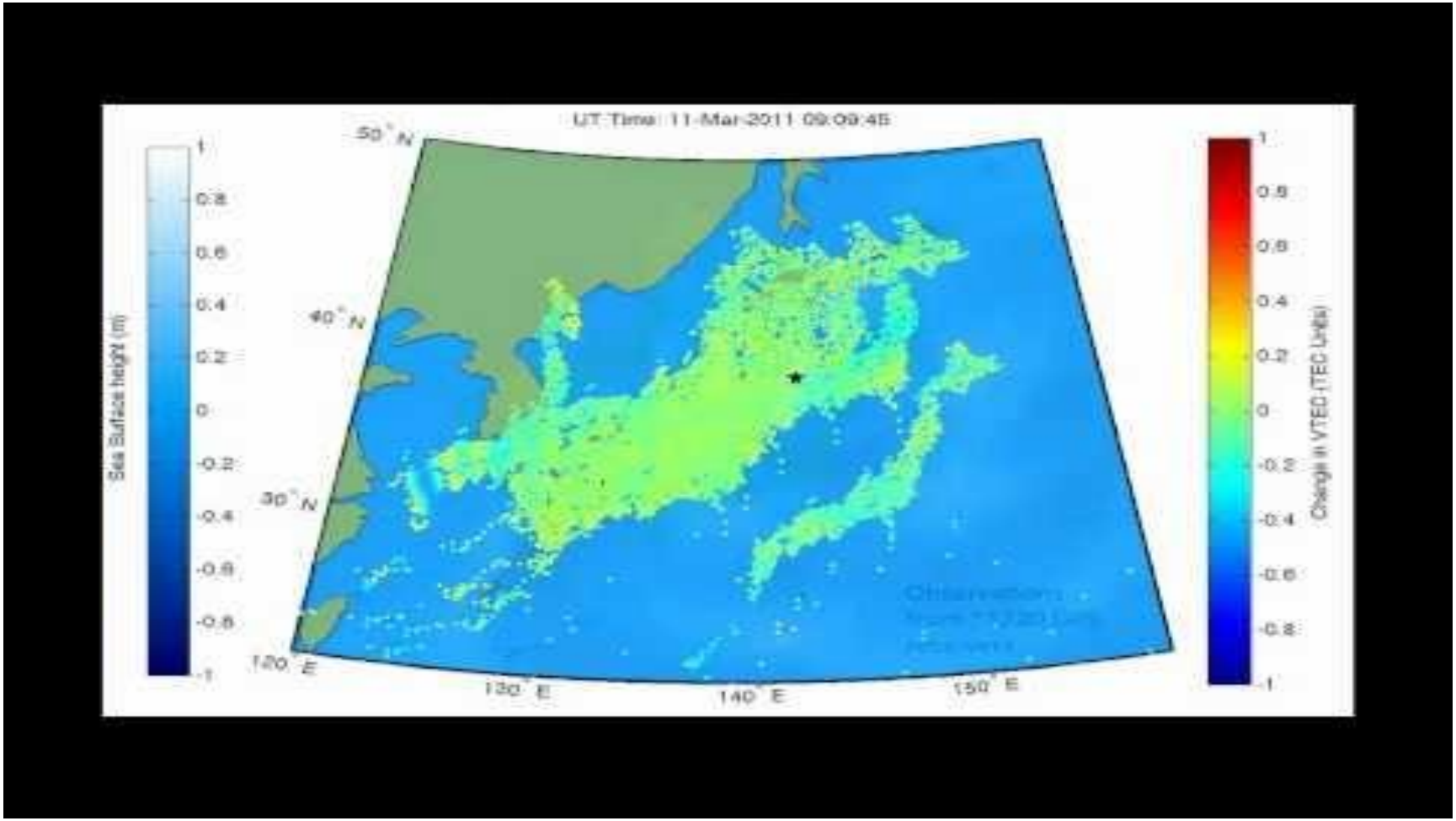
Atmospheric Airglow

Ionospheric Modulation Reveals Surface Displacement



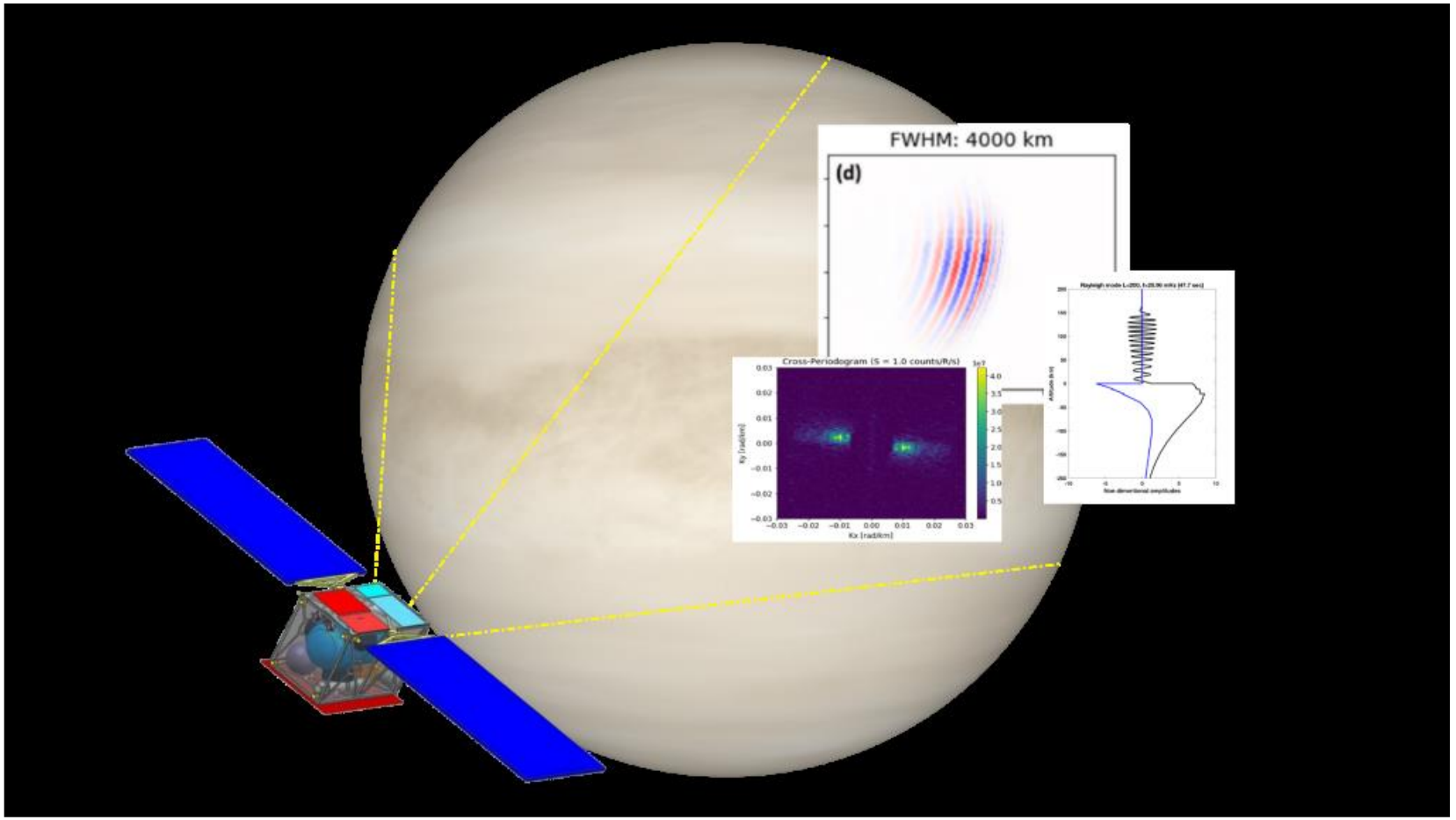
Atmospheric Excitation by Planetary Quakes

An Earth Analog- Japan Earthquake & Tsunami: March 11, 2011



Mission Concept Overview

A Vigilant Small Spacecraft in High Circular Venusian Orbit



Instrument & Spacecraft Description

A Simple Infrared Telescope with Dual Detectors on a SEP SmallSat

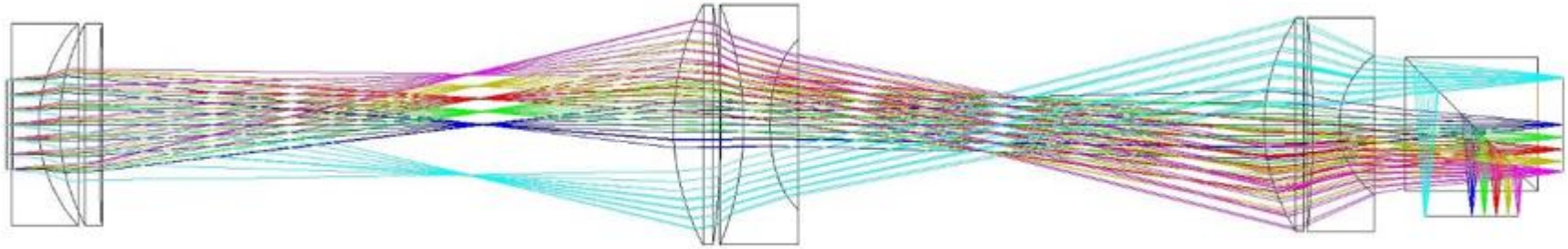
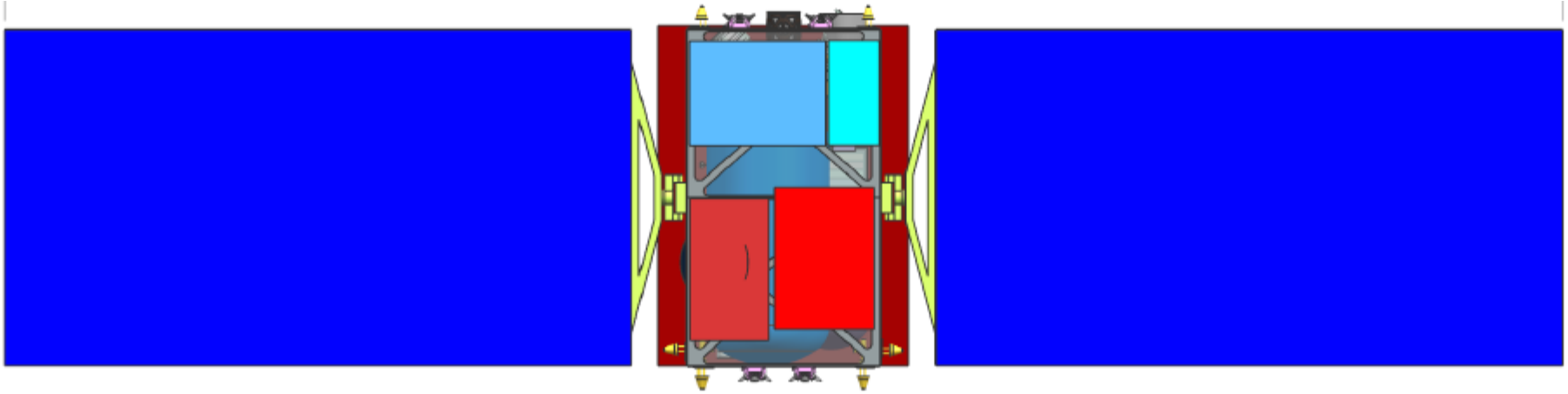


Figure 13- Baseline concept refractive design (aperture to the left, detectors behind a beamsplitter to the right)



Event Detection Algorithms

Real-time Wavefront Detection

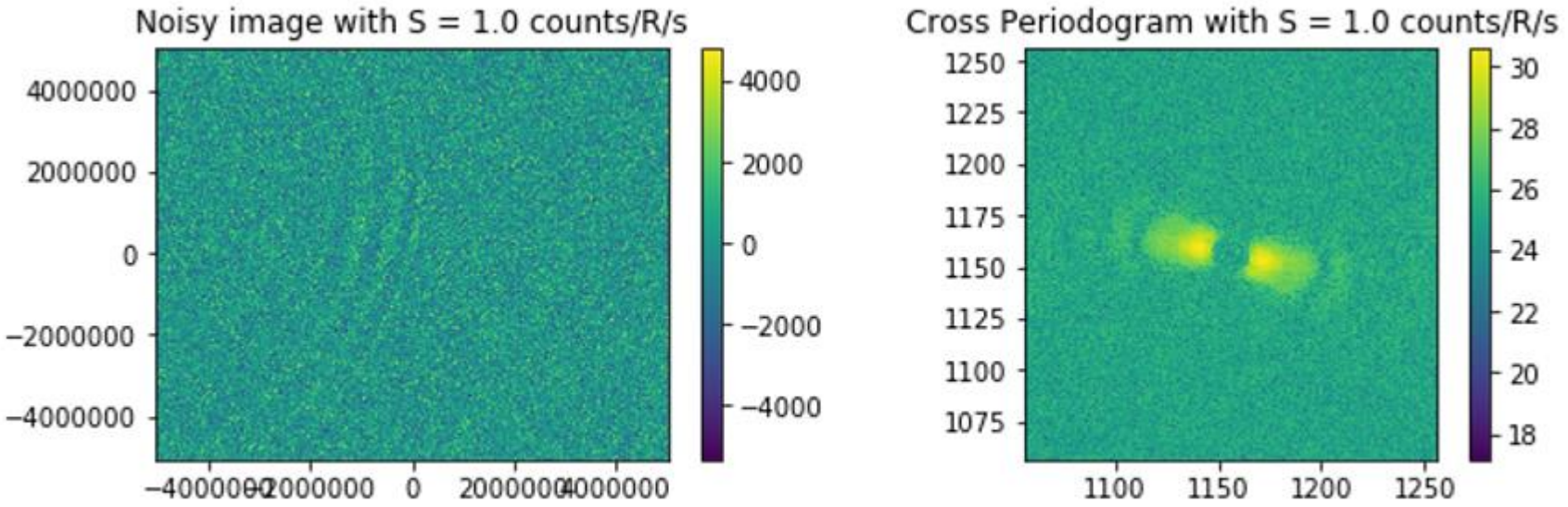
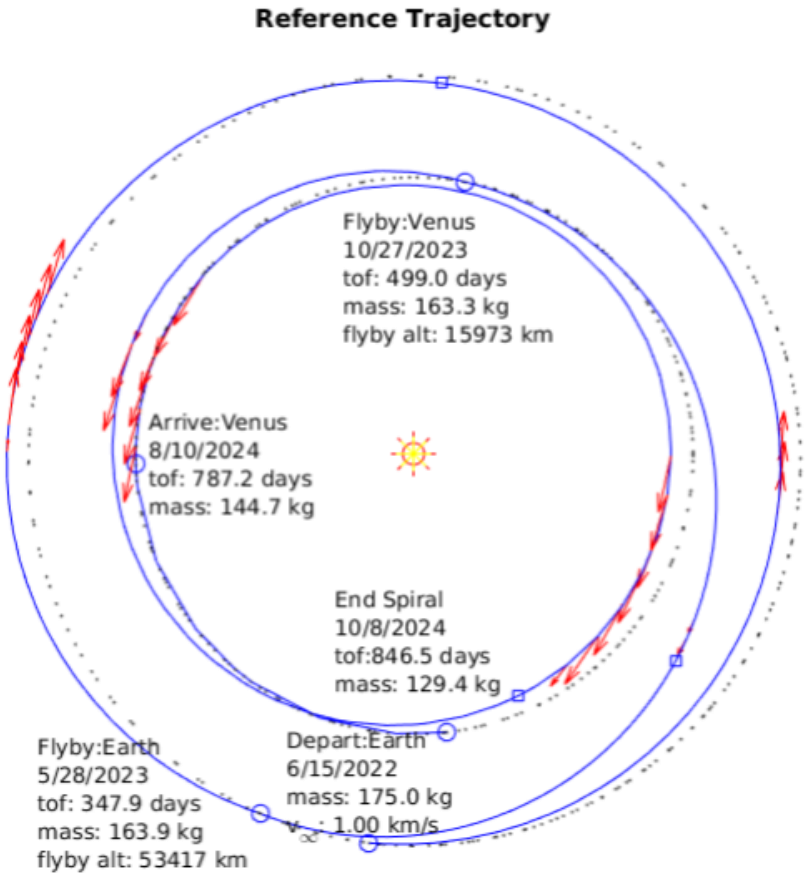
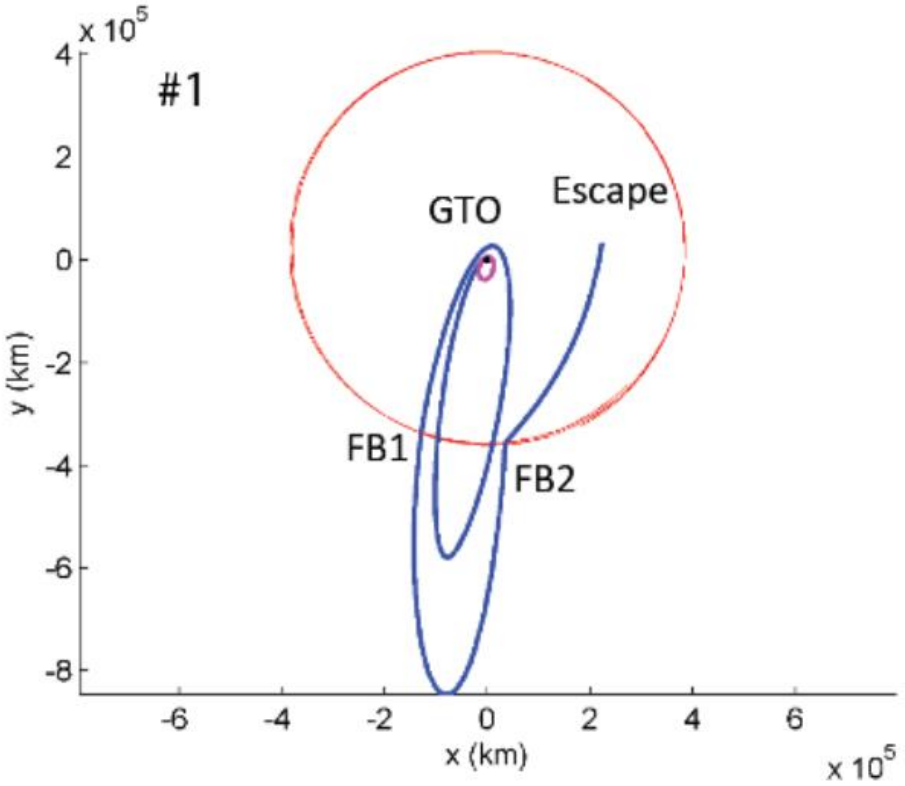


Figure 2- Simulated image of raw data (left); periodogram showing detection (right)

Trajectory Design

Solar Electric Propulsion- EEVV Transfer





Trajectory Design

Rideshare Flexibility- GTO Escape from the Earth-Moon System

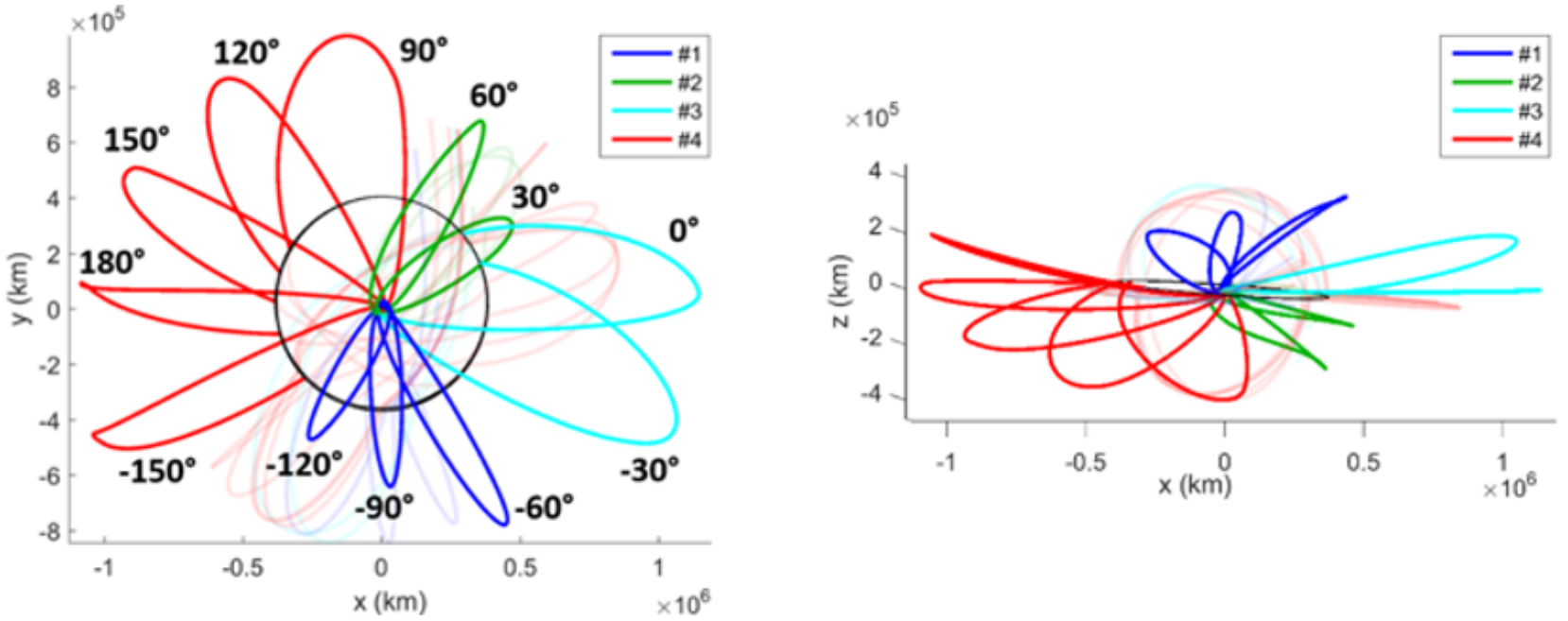


Figure 8- Trajectory solutions for 360 degree range initial GTO LAN in 30-degree increments. Left: top view; right: side view. For easier visualization, all trajectories are transparent after the first lunar flyby.

Trajectory Design

Rideshare Flexibility- GTO Escape from the Earth-Moon System

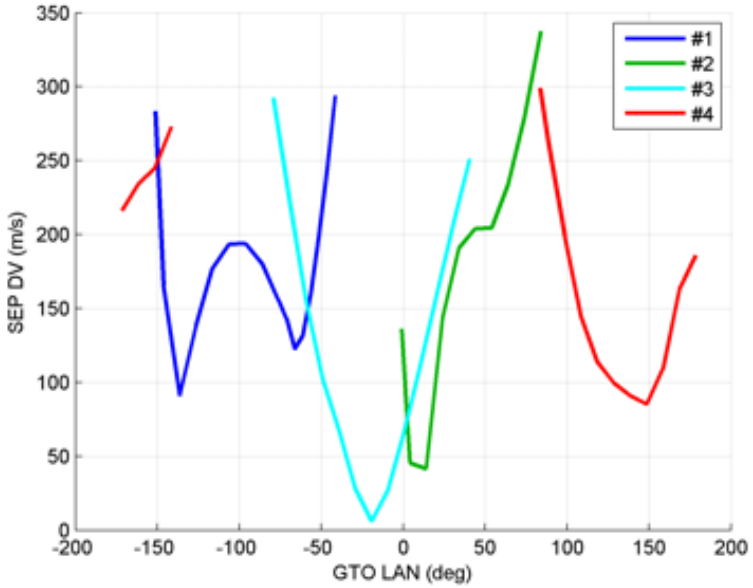


Figure 9- SEP ΔV required for initial GTO LAN values ranging from -180 to 180 degrees

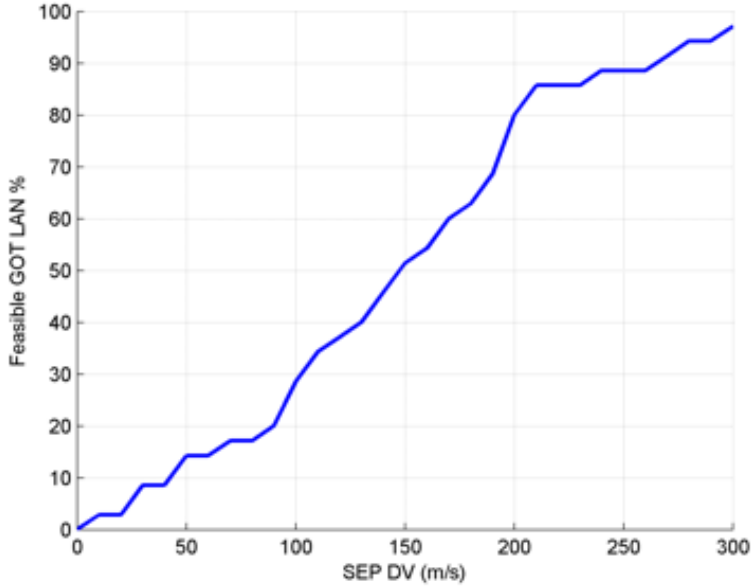
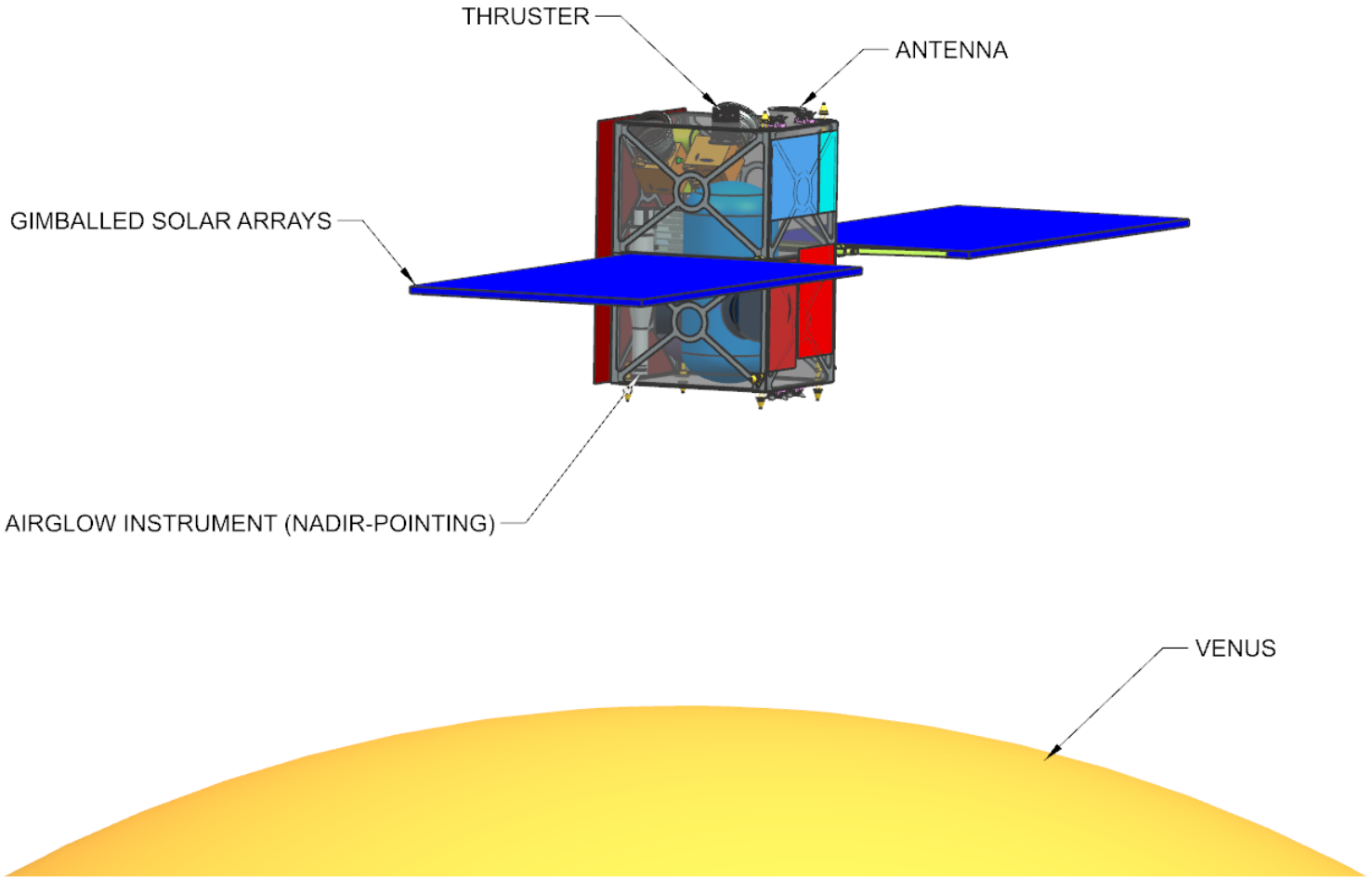


Figure 10- Percentage of allowable GTO LAN as a function of SEP ΔV

Concept of Operations

Constant Observation of the Venusian Disc

Not to scale!



Option Comparison & Major Trades

- Chemical propulsion option for lower cost at the expense of suboptimal science orbit
- Advanced CubeSat/SmallSat CDHS vs. RAD750-based systems
- Possible commercial bus partnerships
- Direct-delivery via Venus-bound mission
  - Simplifies propulsion, power design, but drastically limits launch flexibility
  - Unique VAMOS orbit further unlikely to be offered

Meet the Authors

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- DLR
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- A. Didion, A. Komjathy, B. Sutin, et al., (2018) “Remote Sensing of Venusian Seismic Activity with a Small Spacecraft, the VAMOS Mission Concept”, IEEE Aerospace Conference, Big Sky, MT, March 3-10.

Q&A, Acknowledgements

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