An Introduction to the Mars Atmospheric Trace Molecule Occultation Spectrometer (MATMOS)

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MATMOS is a partnership between Caltech, JPL, and the Canadian Space Agency and has been selected for the 2016 ExoMars TGO Mission.

PI Team Masters Forum – 3

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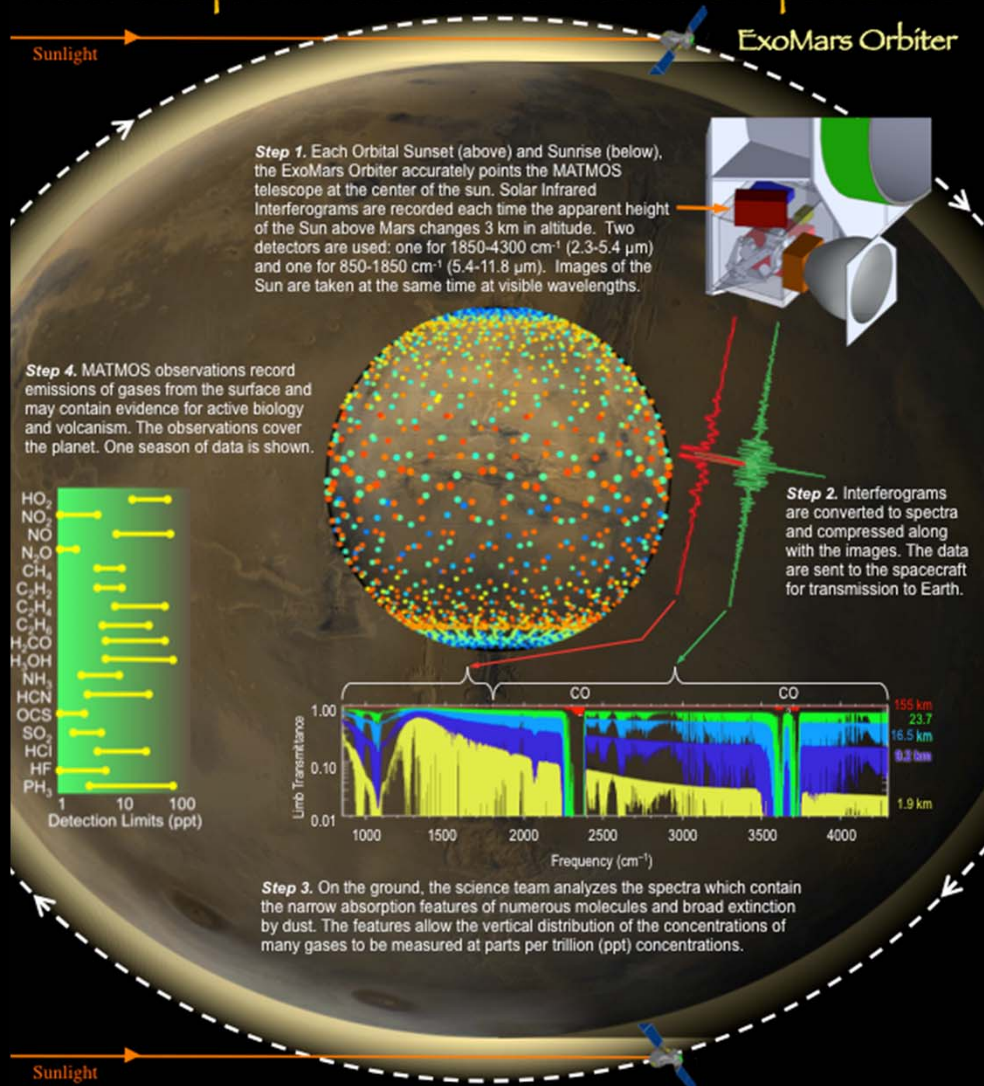
Mars Atmospheric Trace Molecule Occultation Spectrometer



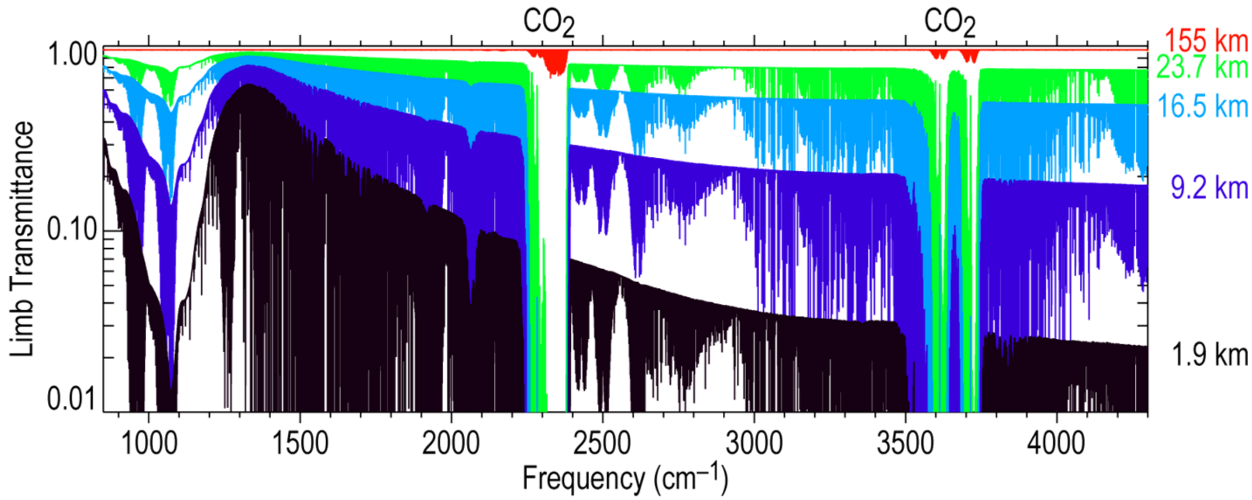
MATMOS directly addresses key goals of the ExoMars Trace Gas Orbiter mission:

Determine the origin of trace gases diagnostic of active geological and biogenic activity; Quantify the lifetimes of these diagnostic gases in the context of the atmospheric state; Provide definitive detections and essential support for source localization through identification of target gases and regions for focused mapping; Solve the mystery of Mars methane.

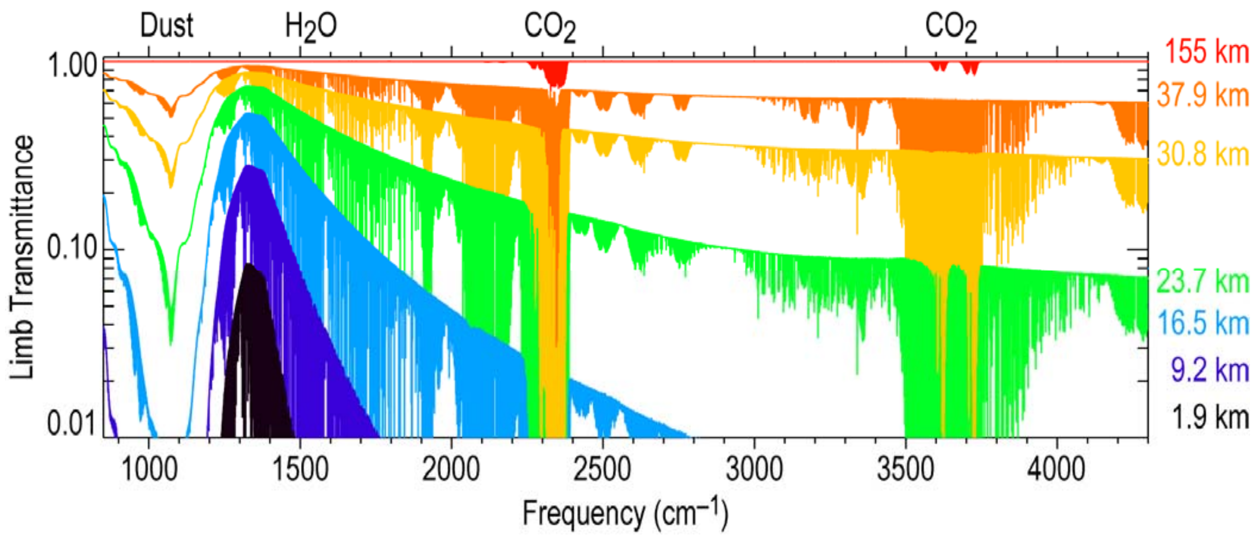
Key Science Objectives

- Search for atmospheric chemical tracers of geological and biogenic activity.
- Quantify the sources and sinks of trace gases including methane.
- Quantify the exchange of water, carbon dioxide, and their isotopologues between the atmosphere and the surface.
- Understand the coupling between the upper and lower atmosphere toward improving the description of atmospheric escape.

Calculated Mars Limb Transmittance Spectra



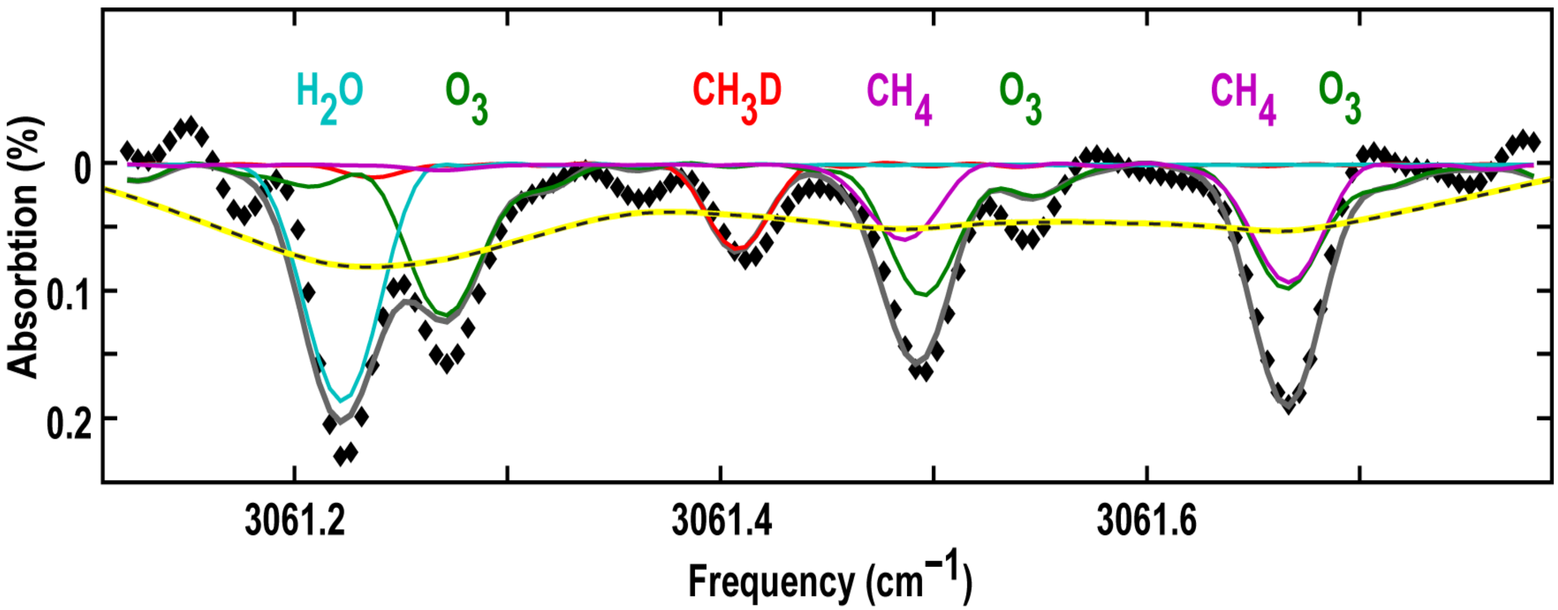
τ Dust = 0.1



τ Dust = 0.6

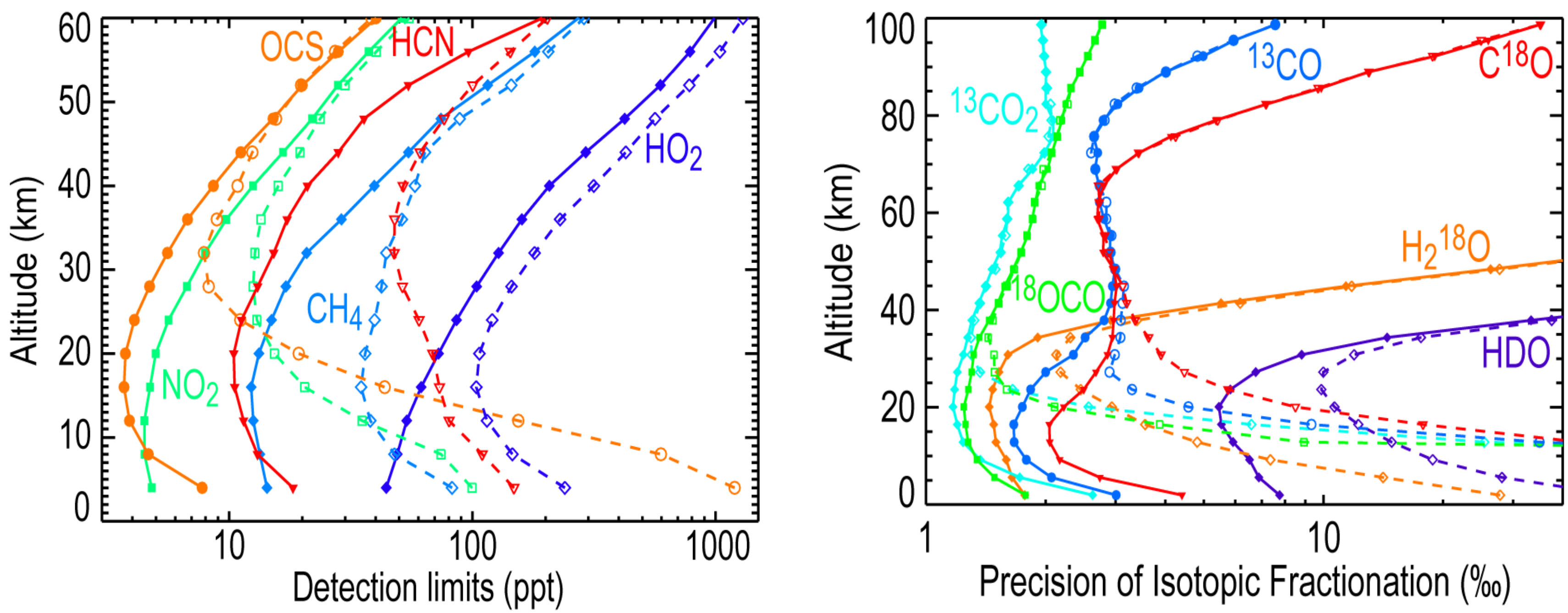
With extra atmospheric spectra obtained on each occulation, the SFTIR technique yields a series of self-calibrated limb transmittance spectra spaced by a few km

SFTIR – Terrestrial Example



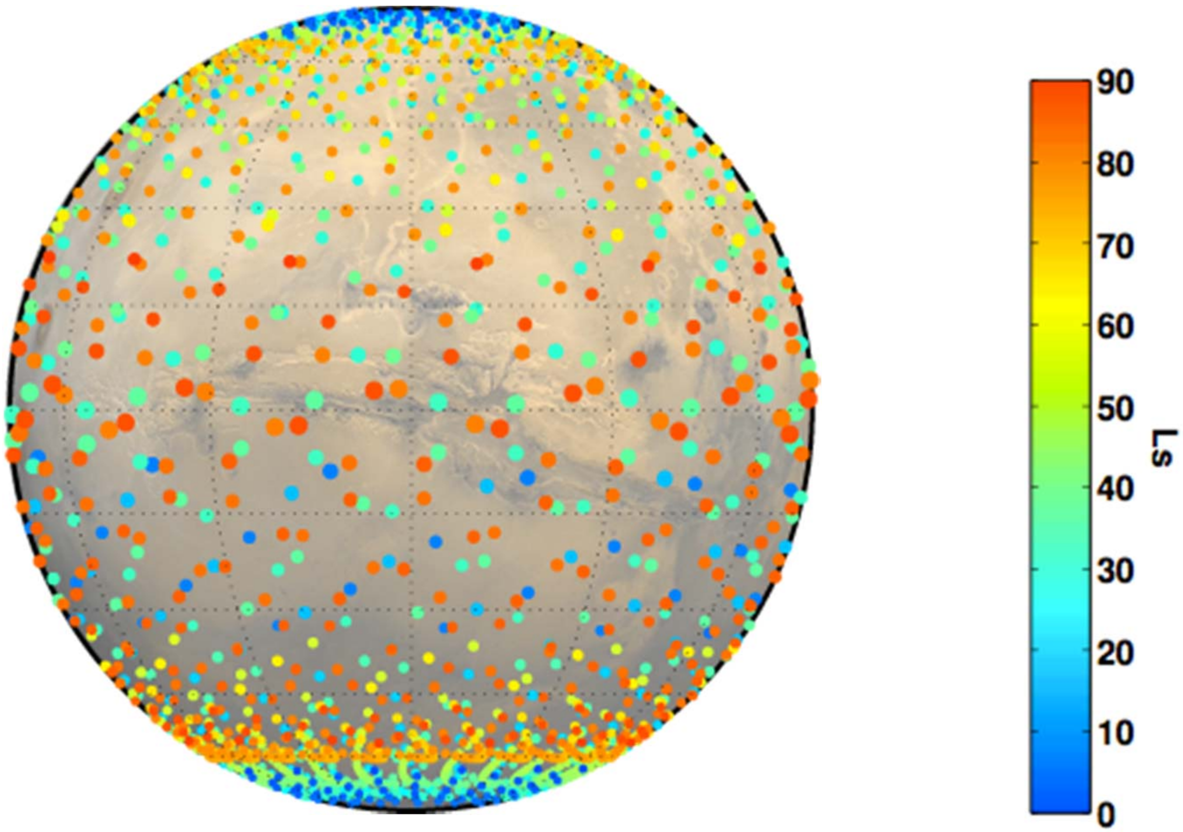
The average of 189 spectra acquired at ~50 km altitude in the Earth's stratosphere by ACE-FTS (tangent pressure 0.8 mbar), illustrate the capability of SFTIR for trace gas detection. The black points are the data; the gray line shows the fitted calculation using the retrieval code that will be adapted for MATMOS. This small region (less than 0.04% of the total spectral range of MATMOS) is one of dozens in which CH_4 can be measured. The spectra are fit to 0.02%, consistent with photon source noise limited performance (single spectrum SNR of 350:1). For comparison, the individual gas absorption features would not be resolved using a lower resolution spectrometer such as SOIR on Venus Express (yellow).

L2-B Trace Gas Retrievals



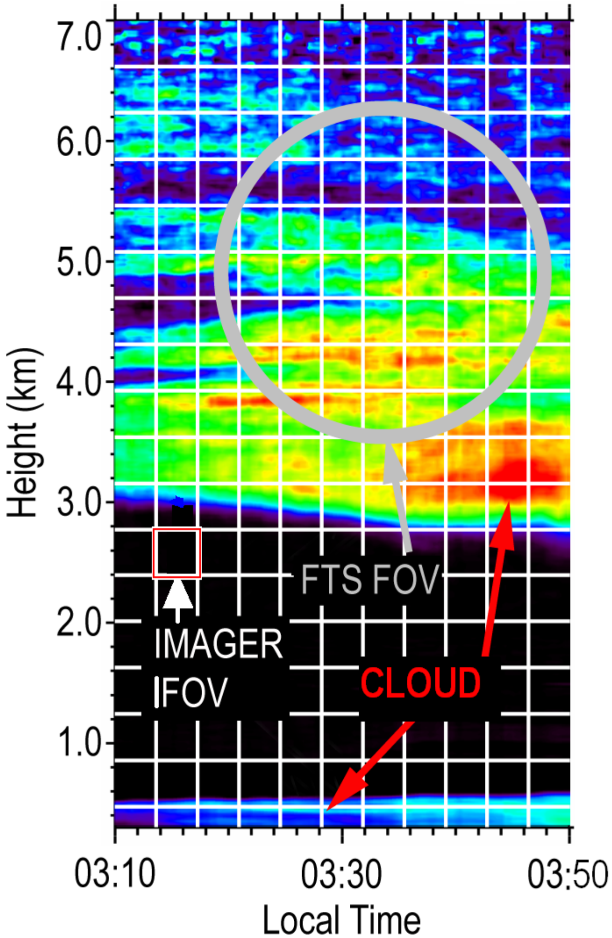
MATMOS will produce profiles of the concentrations of numerous trace gases and the isotopic abundance of CO, CO_2, and H_2O to high altitude. Shown is the expected performance for 100 occultation average under low (τ = 0.1, solid) and high (τ = 0.6, dashed) dust opacity. The graphic table on the Fact Sheet illustrates the limits of detection for trace gases under high (right end of bar) and low (left end of bar) dust averaging 100 occultations over all altitudes.

L3 – Observations Over One Season



With the planned orbit, occultations are observed at all latitudes each season.

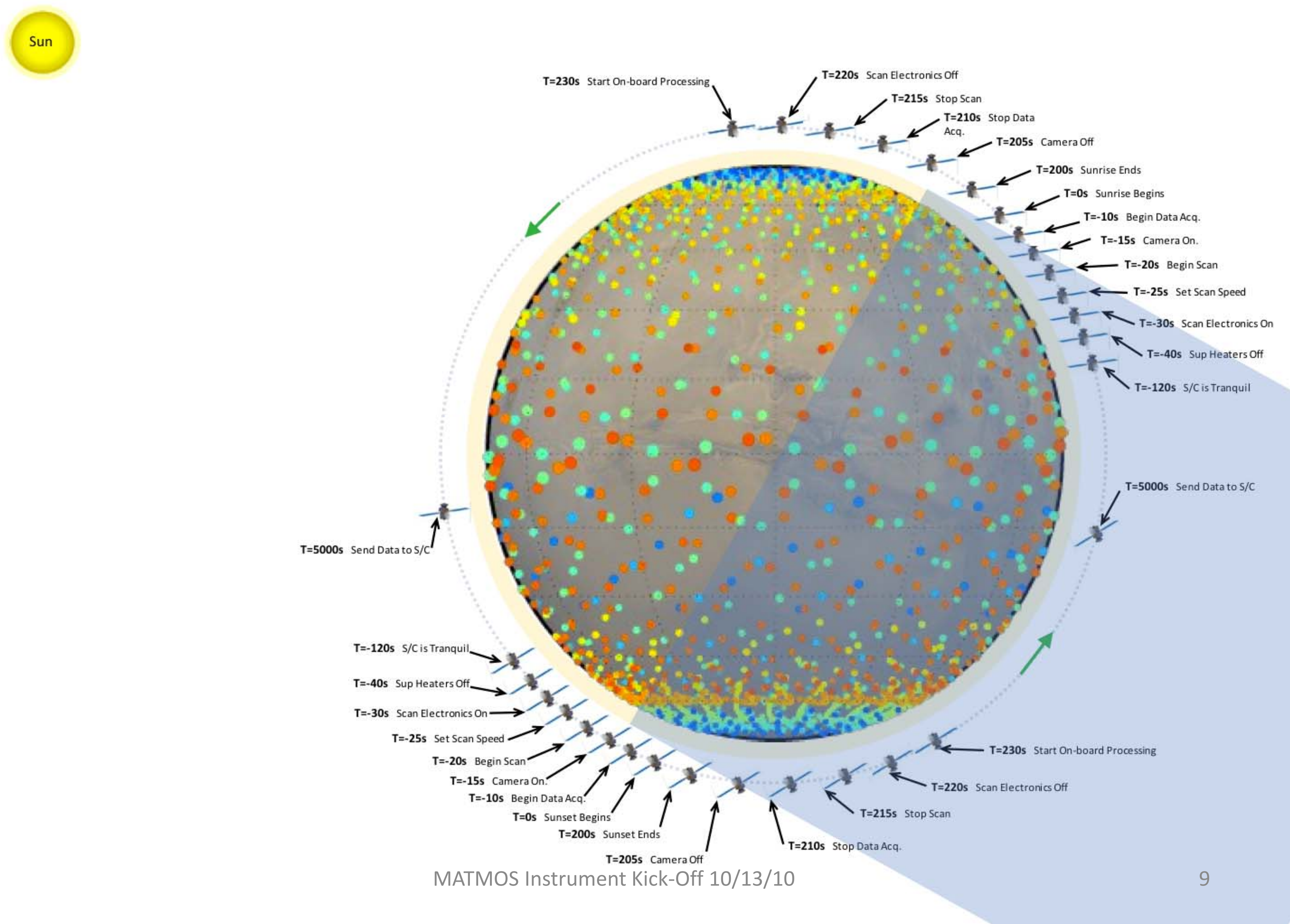
Visible Images



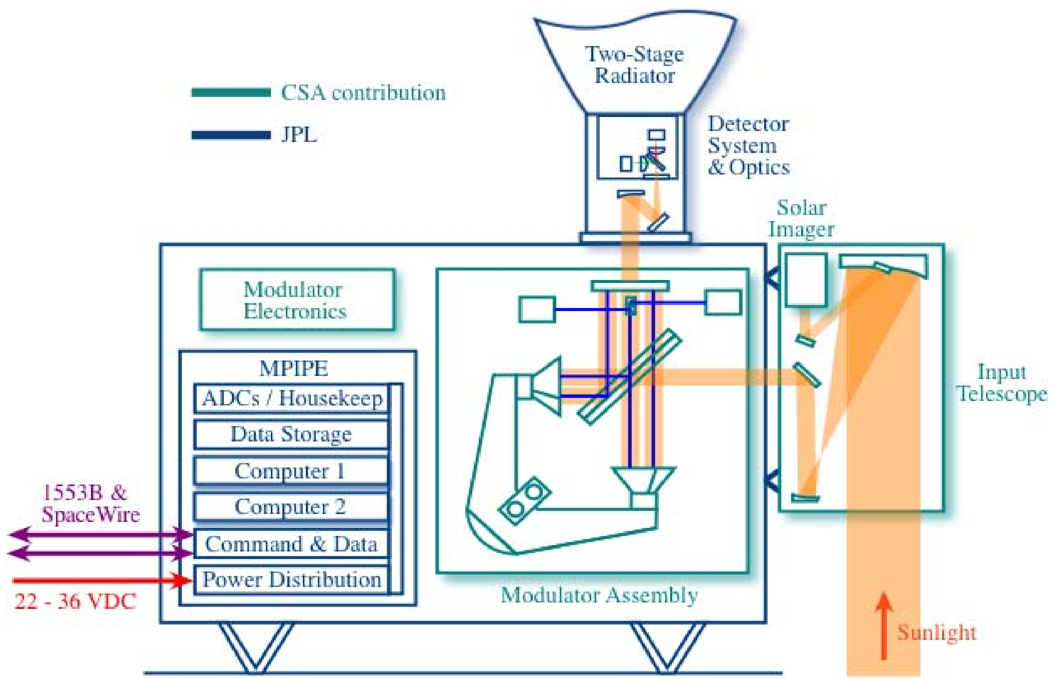
The MATMOS imager, bore sighted with the FTS resolves structure within the extended FTS FOV (~3 km). These thin cloud layers were observed by Phoenix for ~30 min. near dawn. Colors represent LIDAR backscatter. Each spectrum will be accompanied by an image of the extended field of view. The imager will allow the pointing of the space craft to be evaluated.

With four colors, the imager in combination with the IR spectra will allow the optical properties of dust and cloud to be determined.

Operations – a MATMOS / TGO orbit



MATMOS Block Diagram



A small telescope is used to bring sunlight into the interferometer. MATMOS itself has no active pointing capability and so relies completely on the s/c to couple the center of the sun into the instrument.

The modulator (next slide) couples the sunlight onto the detectors mounted on the cold stage of the passive radiator.

Extensive onboard processing is required to compress - by 100 fold - the raw interferograms to spectra for transmission to s/c and Earth. Downlink is ~1.9 Mbits / day.