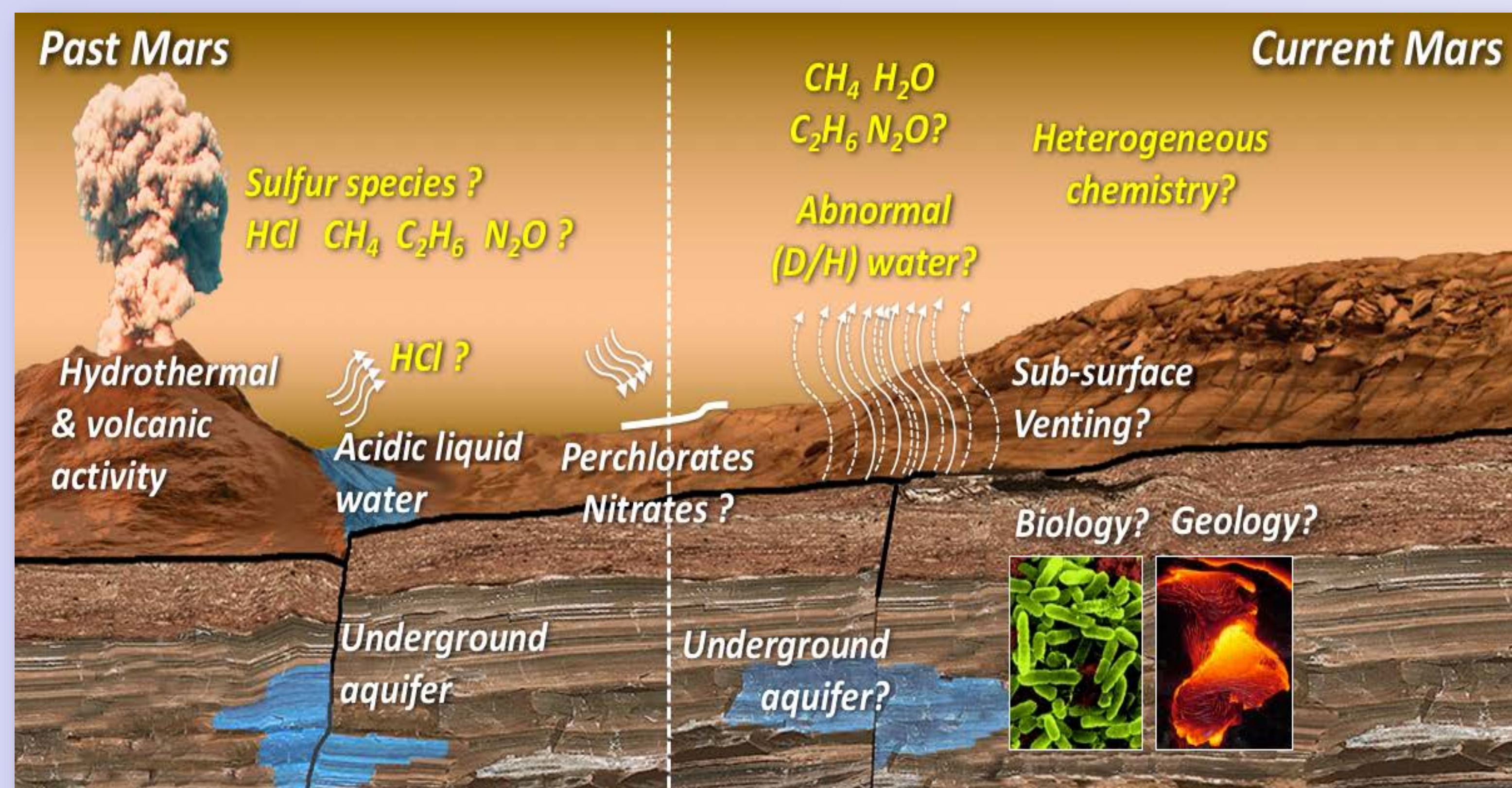


Laser Limb Sounding of Mars Atmosphere using SmallSats

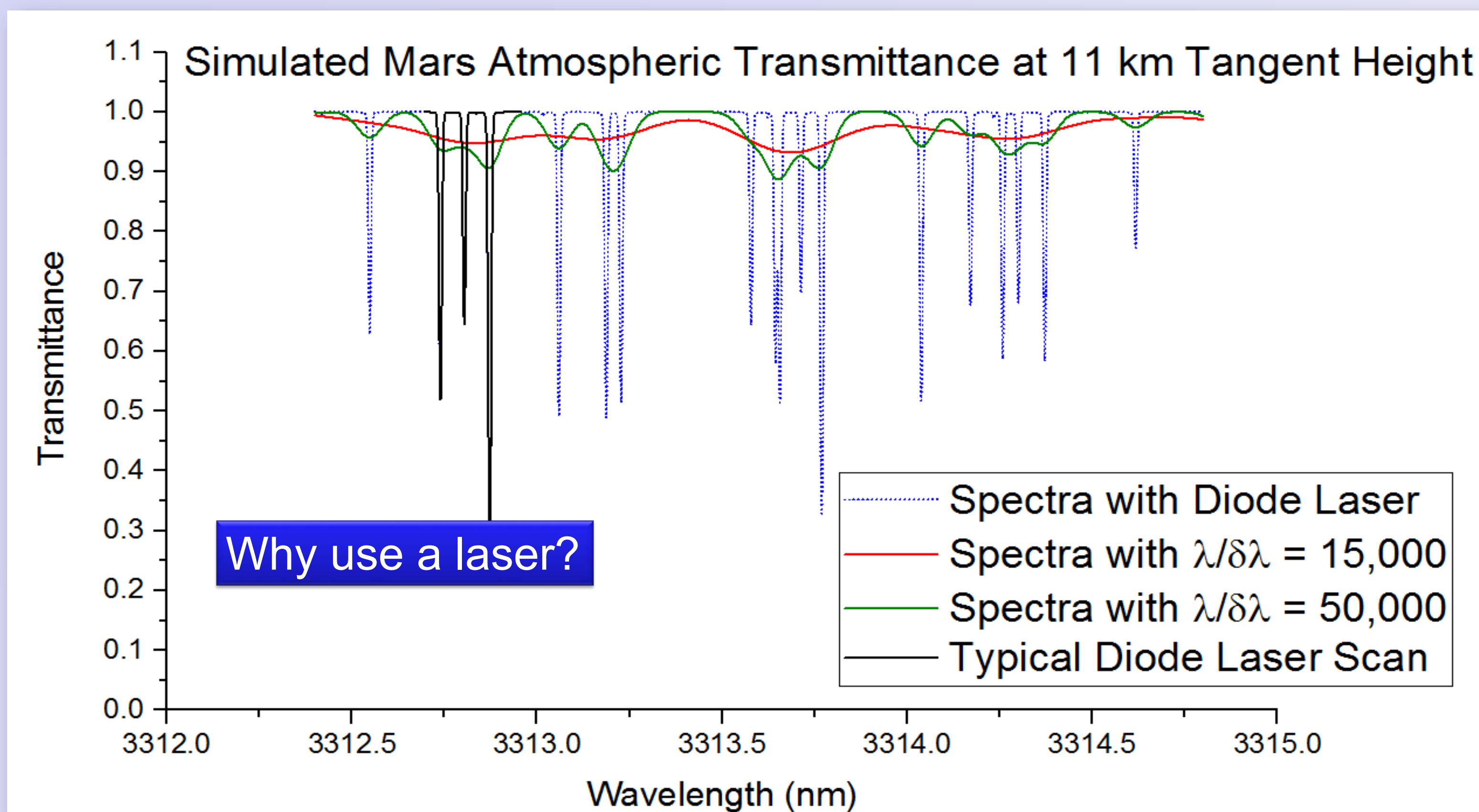
Haris Riris (GSFC), Jim Abshire (GSFC), Geronimo Villanueva (GSFC), Michael Mumma (GSFC), Xiaoli Sun (GSFC)

Science Goals:

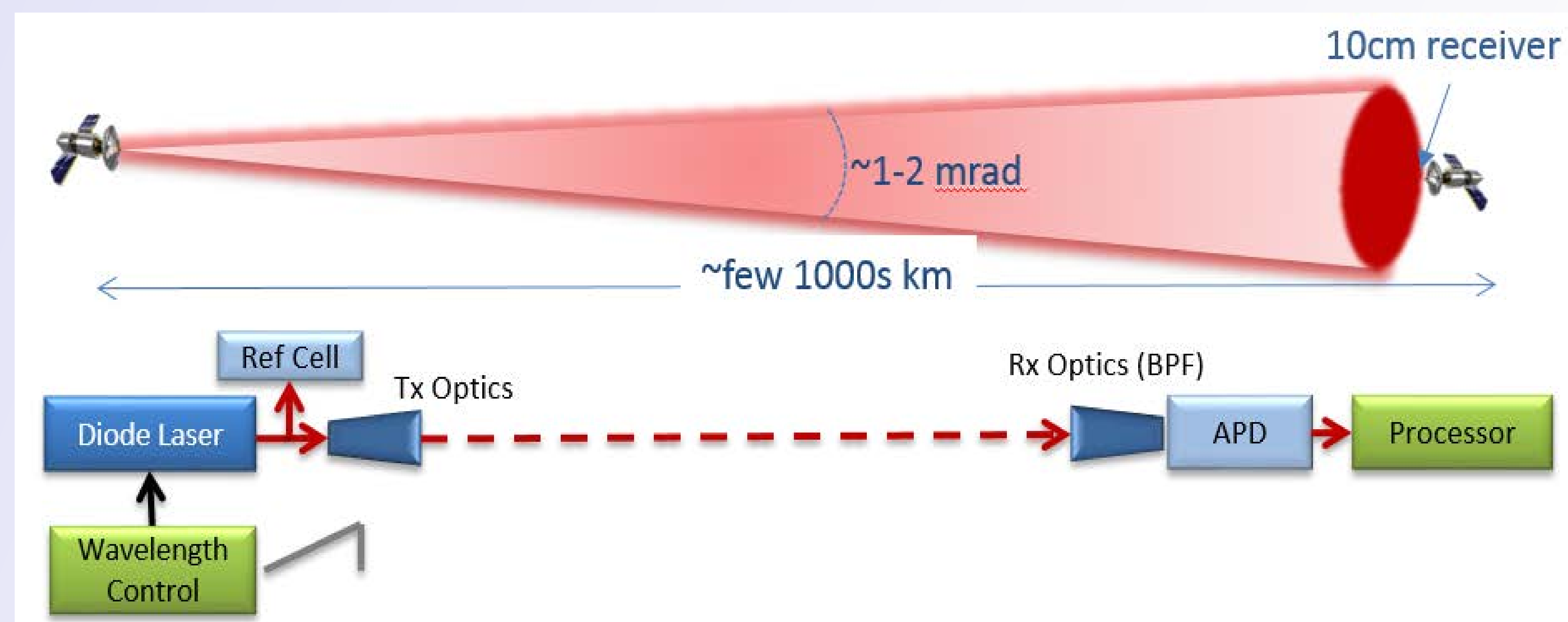
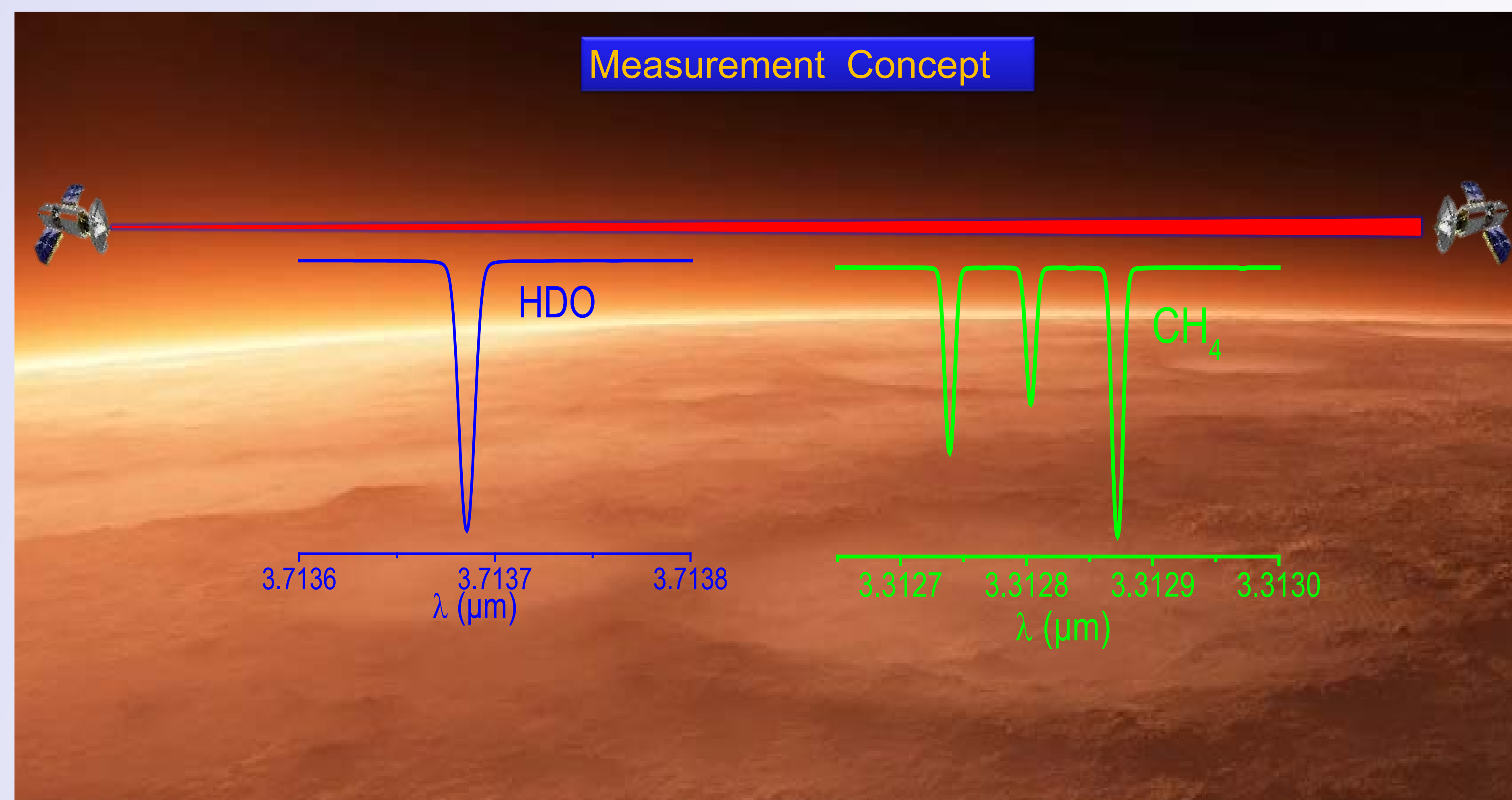
- Characterize the abundance and concentrations of atmospheric trace gases in planetary atmospheres.
- Measurements of key trace gases and isotopes (CH_4 , $\text{H}_2\text{O}/\text{HDO}$, CO , CO_2 etc.)
- Enable global trace gas measurements at all times (day and night and over seasons).
- Enable mapping atmospheric profiles by changing SmallSat orbits.
- Applicable to all planetary bodies with suitable atmospheres.
- Temperature measurements may also be possible.



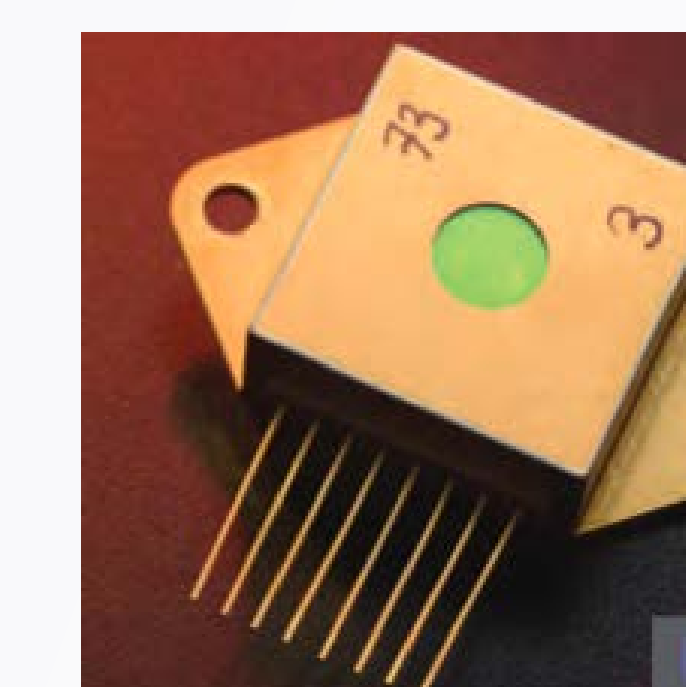
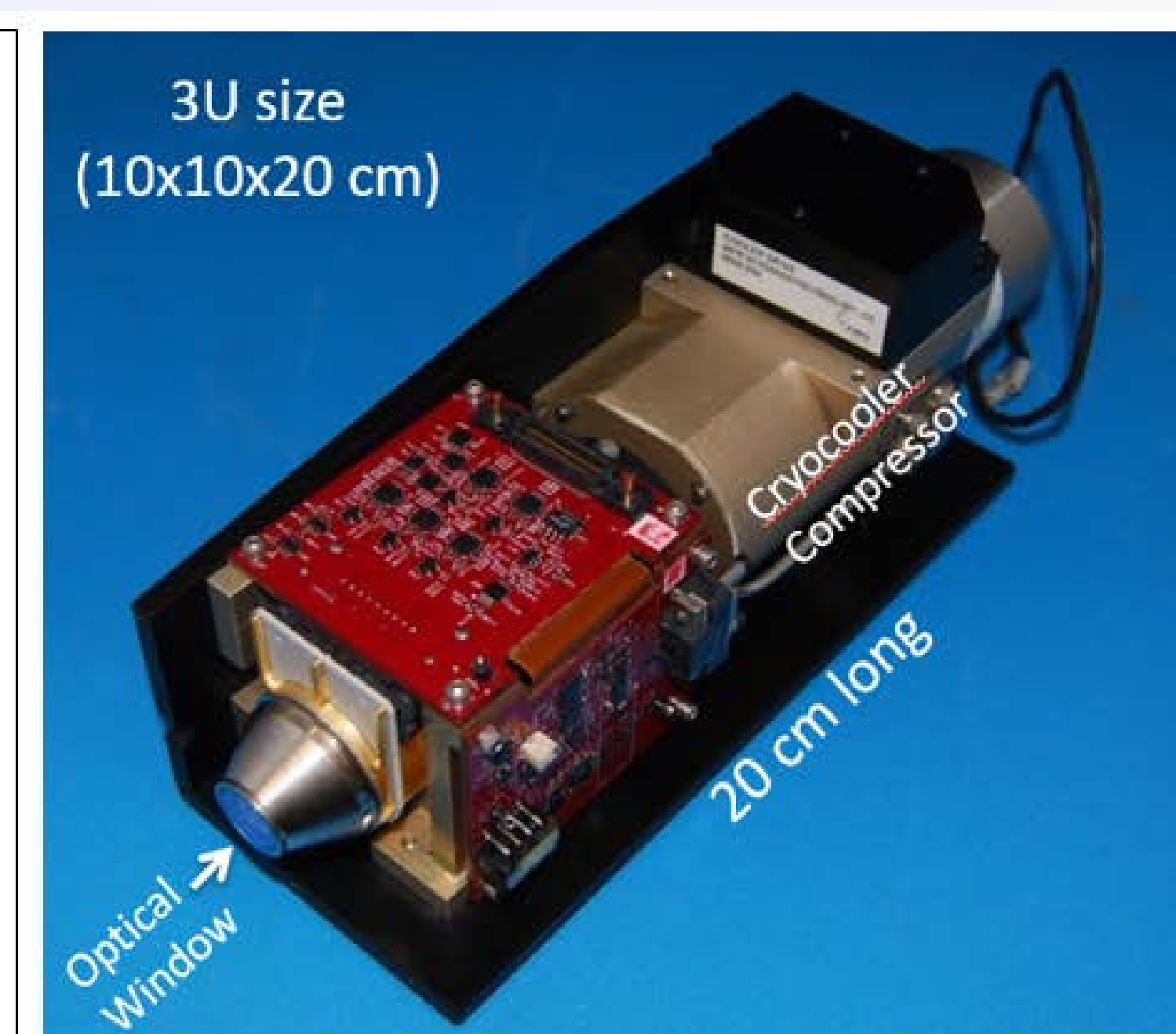
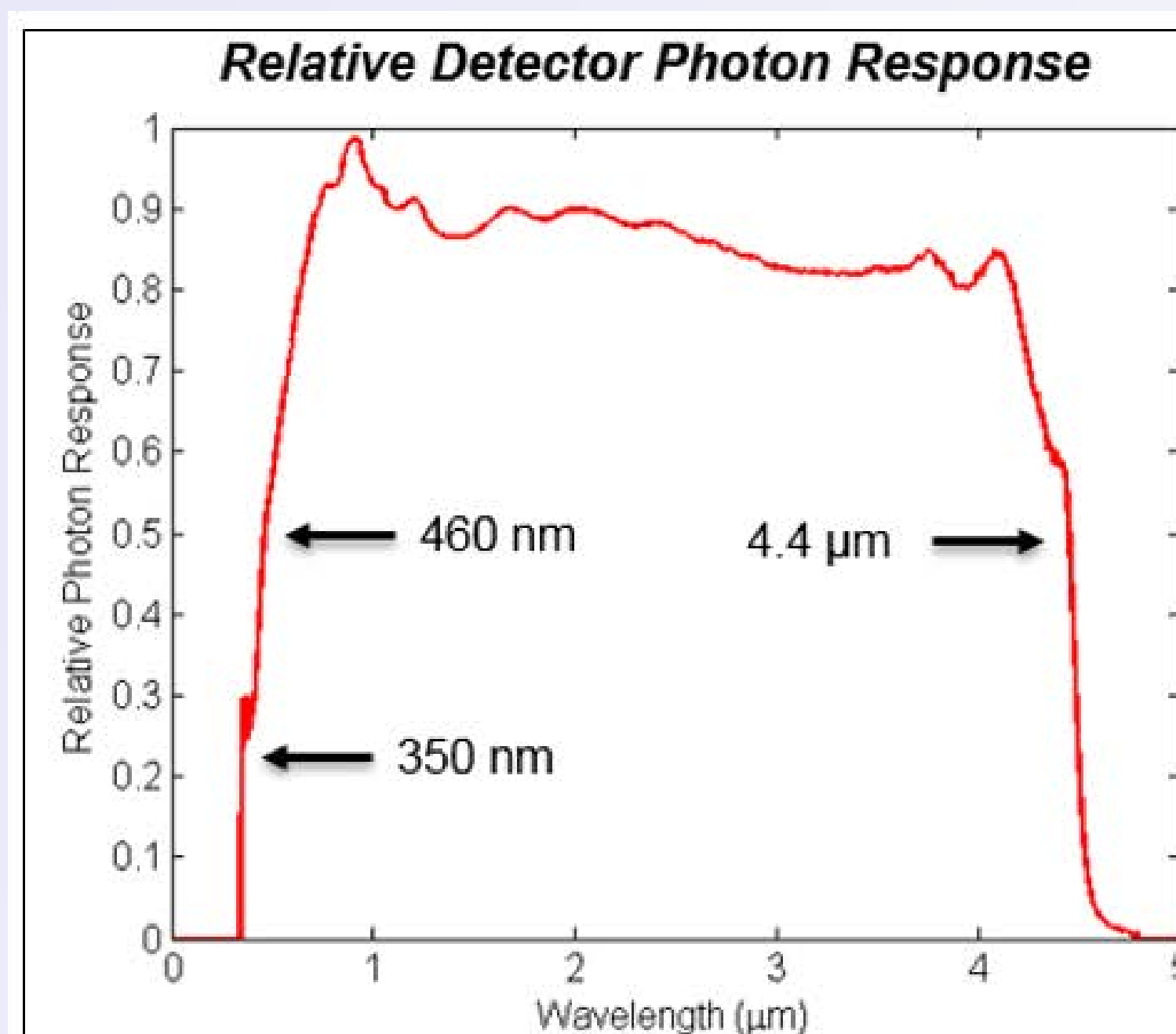
The proposed investigation will address fundamental questions about Mars: How wet was Mars? How is water exchanged between the different reservoirs on Mars? Are there sub-surface habitable reservoirs that also release organics? (Villanueva, G.L. et al., 2015. Strong water isotopic anomalies in the Martian atmosphere: Probing current and ancient reservoirs. *Science* 348(6), pp. 218–221.).



Simulated CH_4 Spectra calculated for a limb path through the Mars atmosphere at a tangent height of 11 km using a diode laser with a linewidth of 10 MHz ($0.00033 \text{ cm}^{-1} = 0.36 \text{ pm}$) (in blue) and a passive spectrometer with resolving power ($\Delta\lambda/\lambda$) of 15,000 ($0.2 \text{ cm}^{-1} = 218 \text{ pm}$) (in green) and $\Delta\lambda/\lambda$ of 50,000 ($0.060 \text{ cm}^{-1} = 218 \text{ pm}$) (in red) at 3300 nm used on the EXOMARS Trace Gas Orbiter. The black line shows the typical scan range of a diode laser for this application. A uniform 10 parts per billion (ppb) mixing ratio was assumed for CH_4 .



Technology



JPL Micro Devices Laboratory Interband Cascade Laser and Nanoplus Distributed Feedback laser used in the Tunable Laser Spectrometer on the Sample Analysis at Mars (SAM) Investigation. Webster, C.R. et al., 2015. *Science* 347 (6220).

High sensitivity and wide spectral response HgCdTe e-ADP detector developed by ESTO and used in Earth Science Lidars (Sun, Xiaoli, James B. Abshire, Jeffrey D. Beck, Pradip Mitra, Kirk Reiff, and Guangning Yang. "HgCdTe avalanche photodiode detectors for airborne and spaceborne lidar at infrared wavelengths." *Optics Express* 25, no. 14, 16589-16602, 2017).