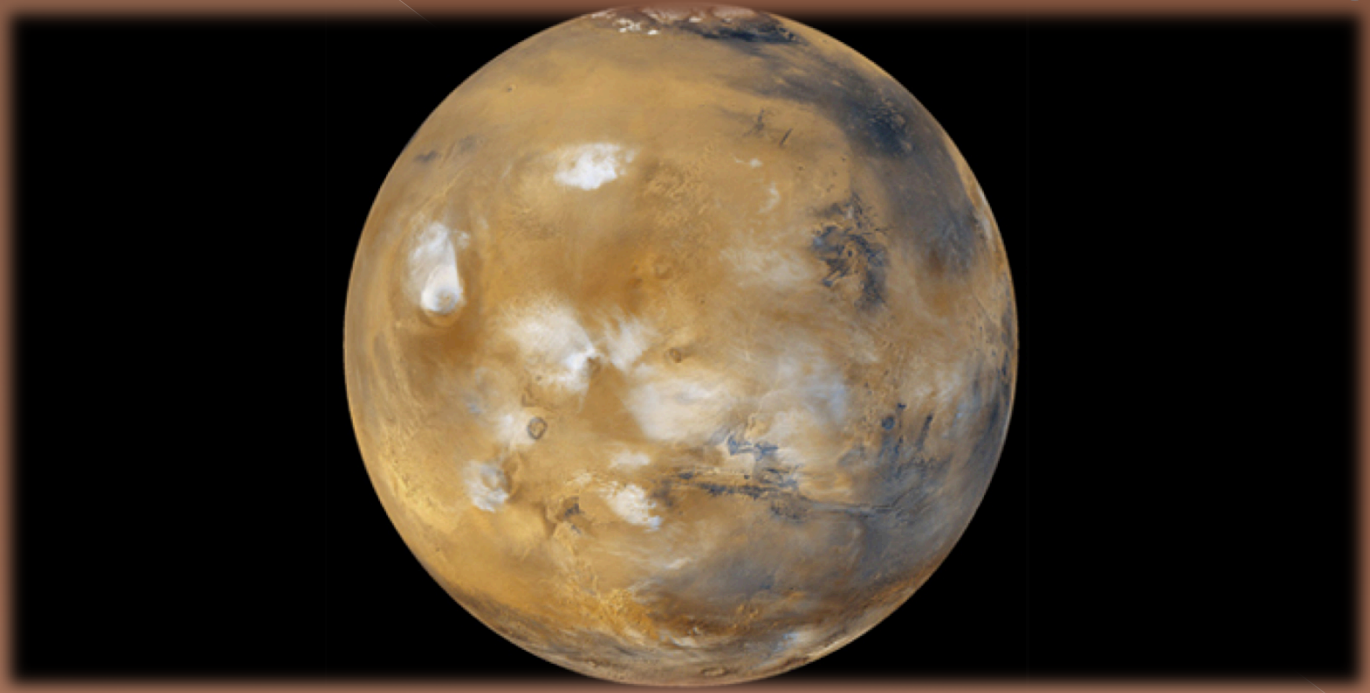
Raman Mapping of Mars Relevant Minerals Using Multiple Excitation Wavelengths



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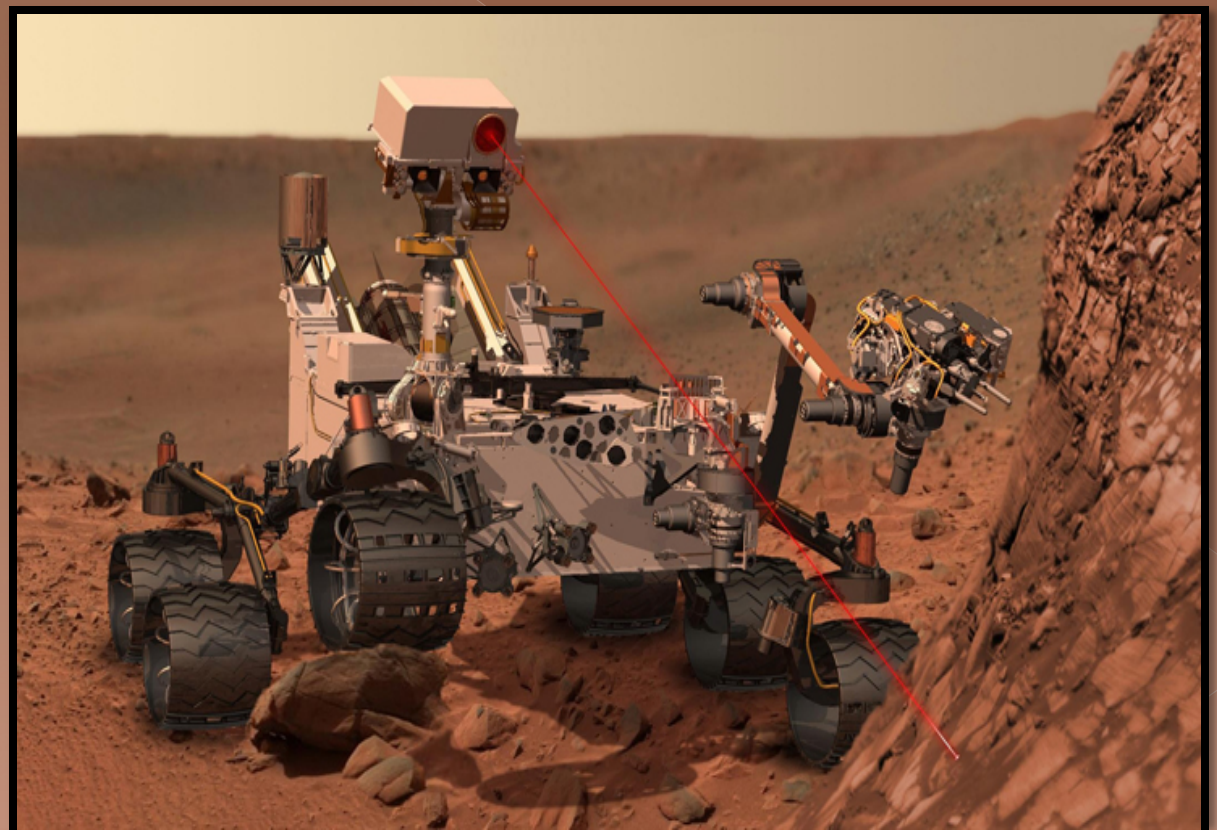
CSU STAR Program

The Ultimate Question

- How do we define the next generation in-situ instrument used to map minerals on Mars?



Why does this matter? "Big Picture"

This study is meant to eventually contribute to…

1. Non-invasive 'hands' free sampling
2. Detection and spatial correlation between minerals and trace organics
3. Spatial relationships which may provide contextual information about the origin of detected materials

Methodology

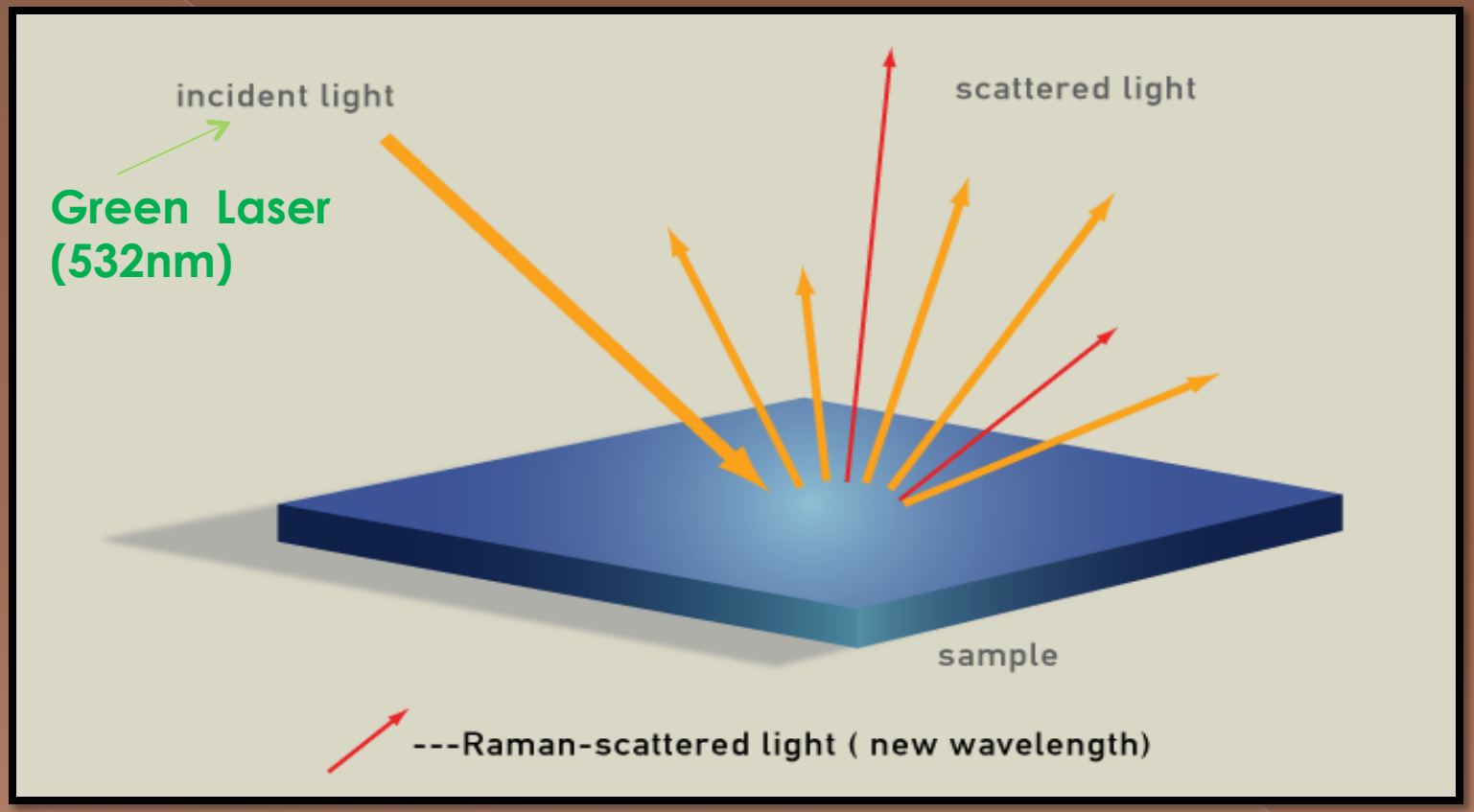
- Read about Raman Spectrometry and research Mars relevant minerals
- Create powdered samples for analysis of composition
- Use Raman Spectrometer given specific parameters (spot size, mineral types)
- Create data base for minerals

Why Raman Spectroscopy?

- The Raman spectrometer is a non-invasive sampling technique used to determine the 'Raman Shift' of each mineral

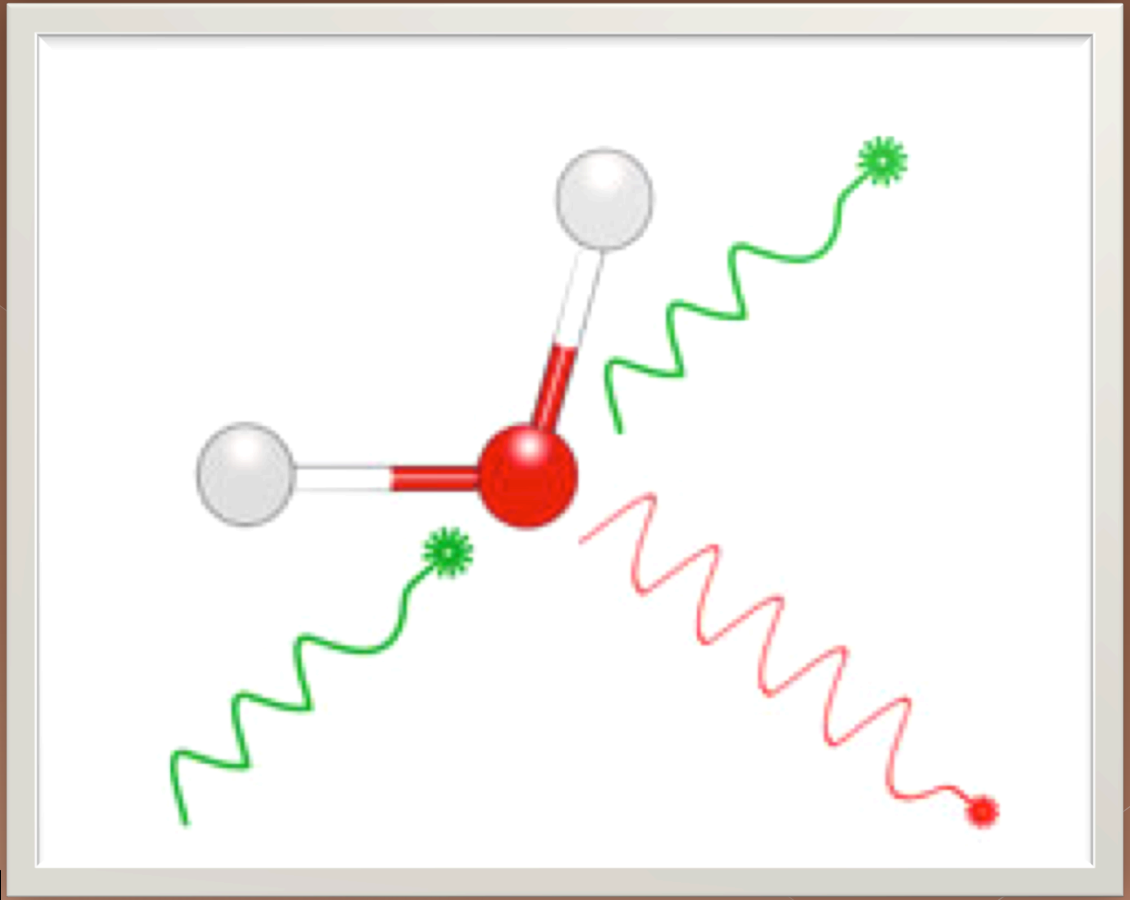
- The system provides high spectroscopic resolution and a unique wavelength range capability that offers both great flexibility and high performance.

How the Raman works



Light scattered from a molecule

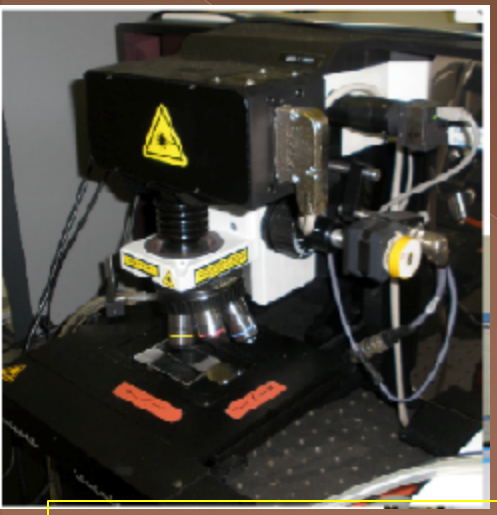
The incident photons interact with the molecules, and the amount of energy change (either lost or gained) by a photon is characteristic of the nature of each bond (vibration) present.



Green
Incident Rays

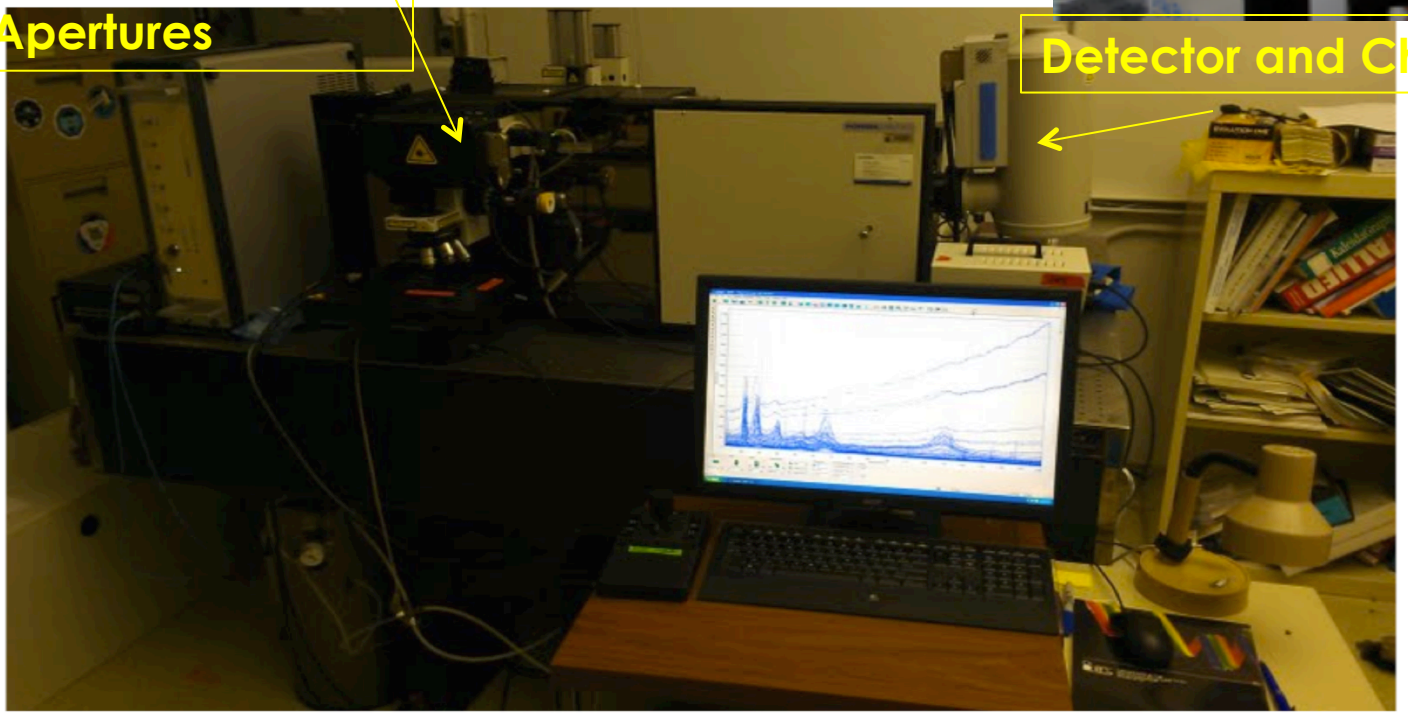
Red
Scattered Rays

The Spectrometer



Camera, Lenses and Laser Apertures

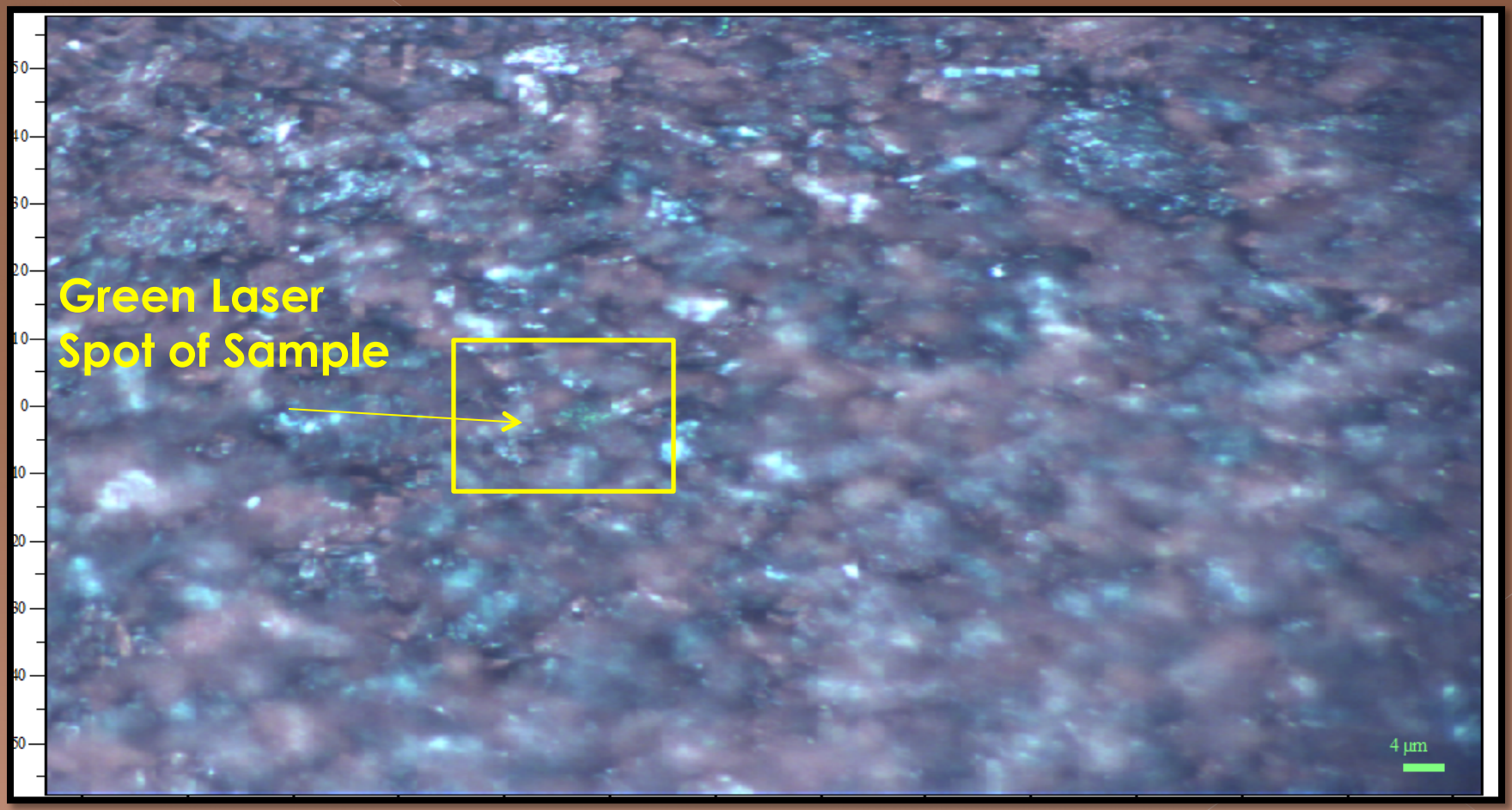
Detector and Chiller



List of Minerals Tested

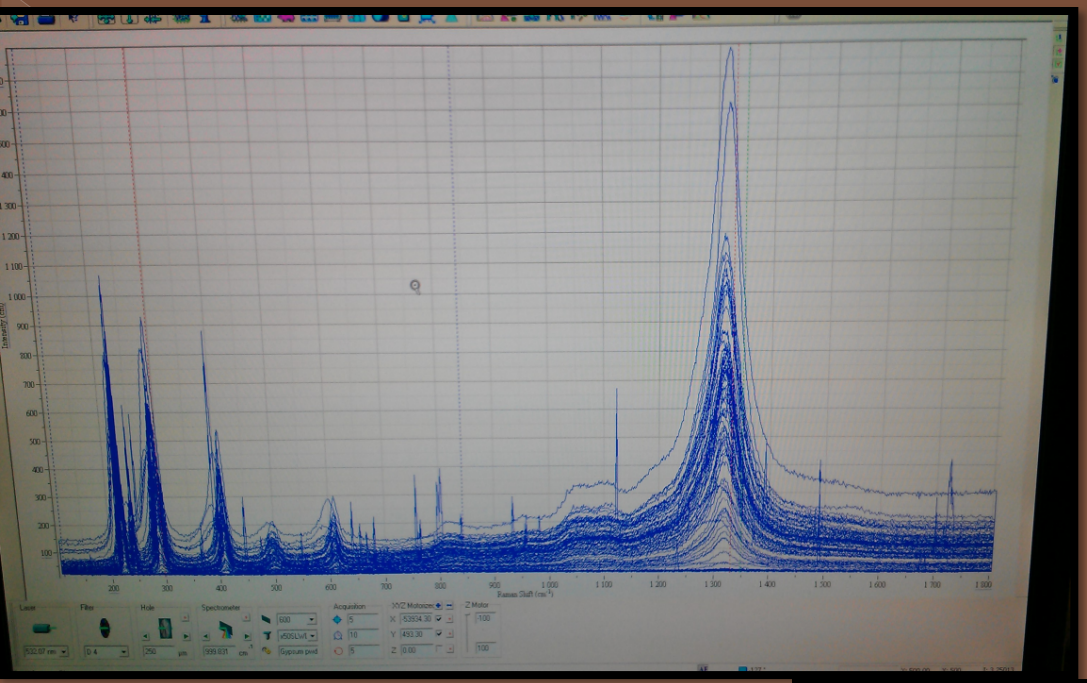
- **Enstatite** MgSiO3 Mg Silicate
- **Forsterite** MgSiO4 Mg Silicate
- **Hematite** Fe2O3 Iron Oxide
- **Magnetite** Fe3O4 Iron Oxide
- **Jarosite** $KFe^{3+}_3(OH)_6(SO_4)_2$ Hydrous Sulfate
- **Gyspsum** $CaSO_4 \cdot 2H_2O$ Hydrous Sulfate
- **Halite** NaCl Salt
- **Calcite** CaCO3 Carbonate
- **Pyrite** FeS2 Iron Sulfide

Hematite Powder Fe_2O_3 Iron Oxide



Mars Relevant Minerals

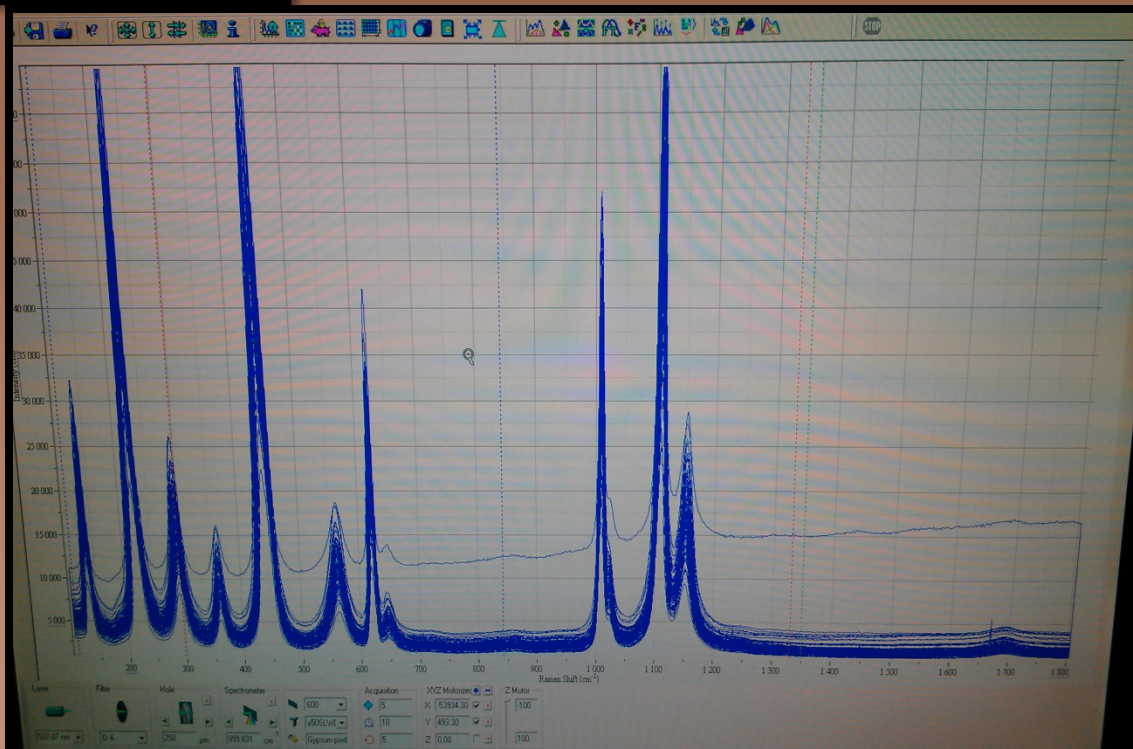
- Each mineral has a unique spectrum with peaks at certain wavelengths.
- By examining the spectrum and making note of where significant peaks are located, we can identify what mineral is present.



Hematite
(Fe_2O_3)
Iron Oxide

NatroJarosite
$KFe^{3+}_3(OH)_6(SO_4)_2$

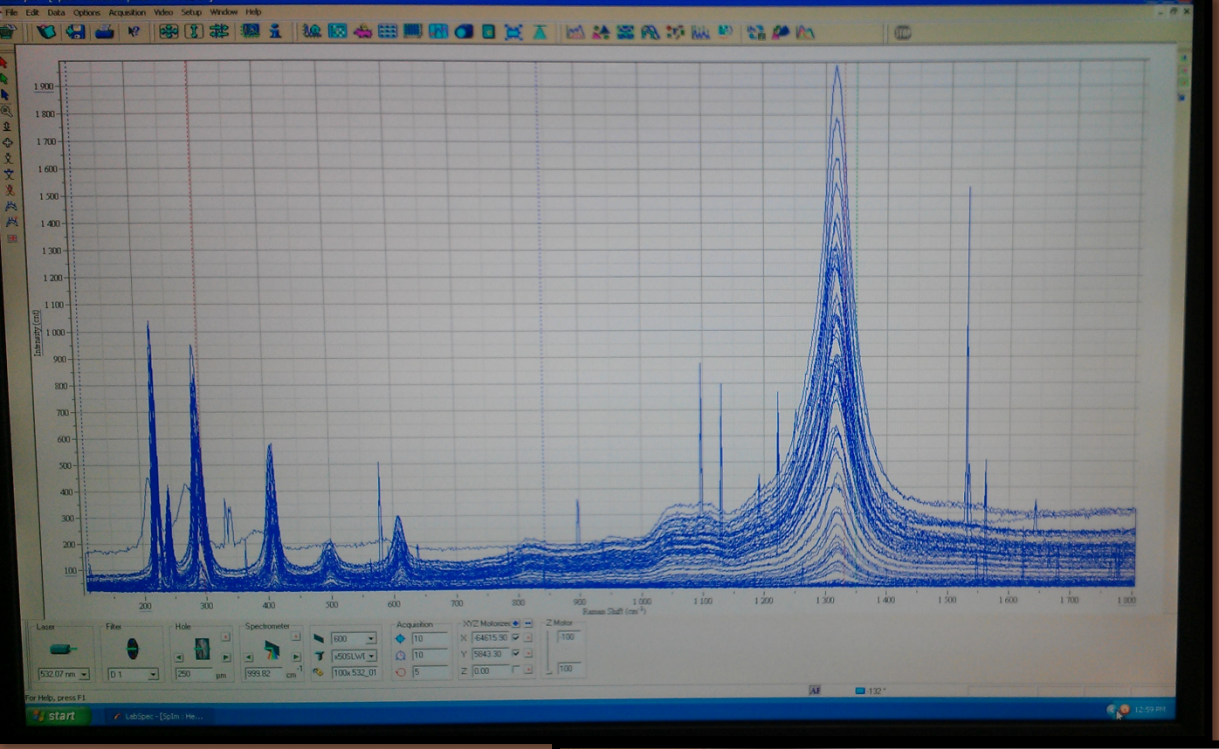
Hydrous Sulfate



Challenges

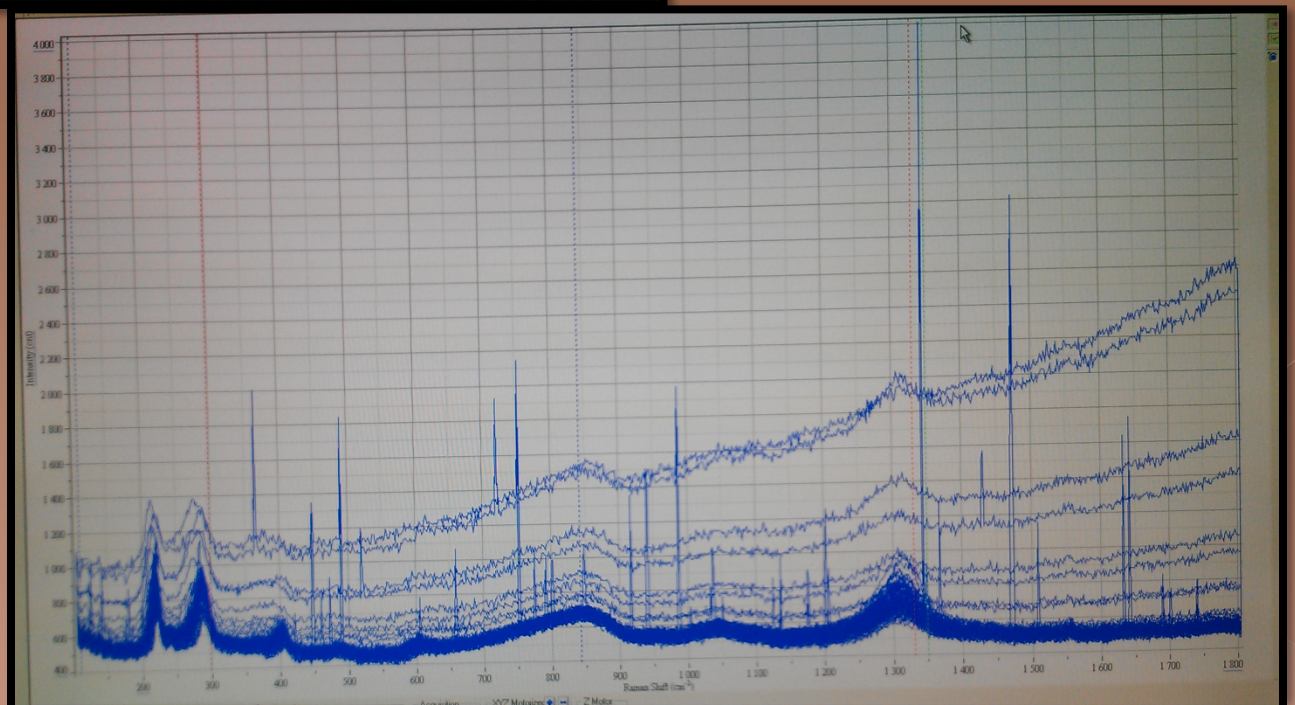
- Raman calibration
- Preparing the samples properly
- Grain alignment (clays)
- Time it takes to run scans and to clean the samples
- Obtaining data for 50x and 100x magnification
- Solar Flares

Hematite
100x



Variation within a sample due to lens size:
10x vs. 100x

Hematite
10x



Continued Research

- Switch to Red Laser(632 nm) then UV laser (325 nm)
- Compare data for each laser
- Determine which laser will work best for certain minerals

Predicted outcomes

- Looking for patterns in groups of minerals ex: Mg vs. Fe
- Identify which wavelength is best for different suites of minerals
- Use these parameters to determine the type of spectrometer used on next mission

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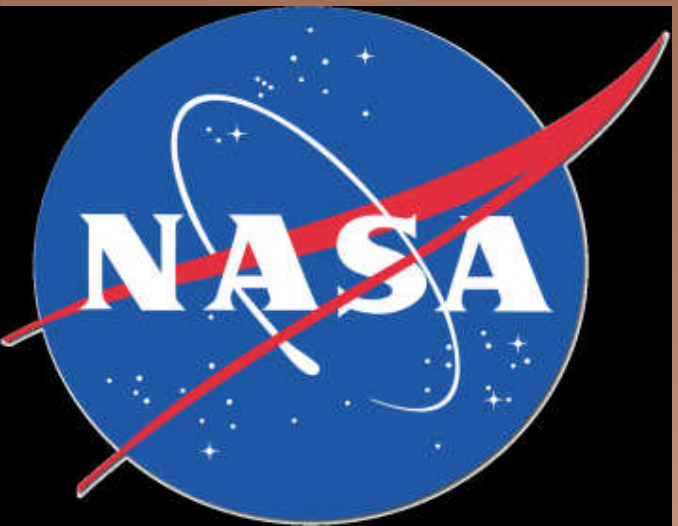

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