



Feasibility Study of Raman Spectroscopy as an In Situ Mitigation Method for Molecular Contamination on Spacecraft

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Introduction



- During a routine visual inspection of the Clouds and the Earth's Radiant Energy System (CERES) FM6, CCE found potential molecular contamination on the Short Wave (SW) filter.
- The CERES FM6 team obtained a commercial off the shelf portable Raman spectrometer from B&W Tek to provide the ability to look at the potential contaminant on the shortwave filter.
- LaRC CCE team performed a series of trade studies to identify the risks, limitations, and optimal performance ranges of the portable Raman spectrometer.



CERES FM 6



Outline



➤ **Why Raman spectroscopy?**

- Advantages and Disadvantages
- Location of contaminant

➤ **Mechanical placement of the probe in the optical path**

➤ **Focal distance test**

➤ **Identification of minimal laser power to obtain a spectrum**

- What power will provide reliable characterization without creating laser induced damage
- Creation of a database of common contaminants using Raman spectroscopy



Advantages and Disadvantages of Raman Spectroscopy



Pros

- High Chemical Specificity
- Signatures relatively independent of presentation
- Can interrogate through glass and plastic containers
- Easily access low-wave number molecular vibrations
- In situ analysis
- Non-contact analysis
- Compatible with fiber optics

Cons

- Fluorescence can obscure signal (less common with 1064 nm excitation source)
- Very small optical cross sections; spot size is 85 μm
- Working distance is 5.4 mm from the surface of interest
- Limited capability for standoff trace detection; must scan area with the most possible contamination
- Not eye safe in standoff configuration; must wear appropriate laser eye protection
- If power is too high can burn materials within the optical path
- Limited database to identify contamination source

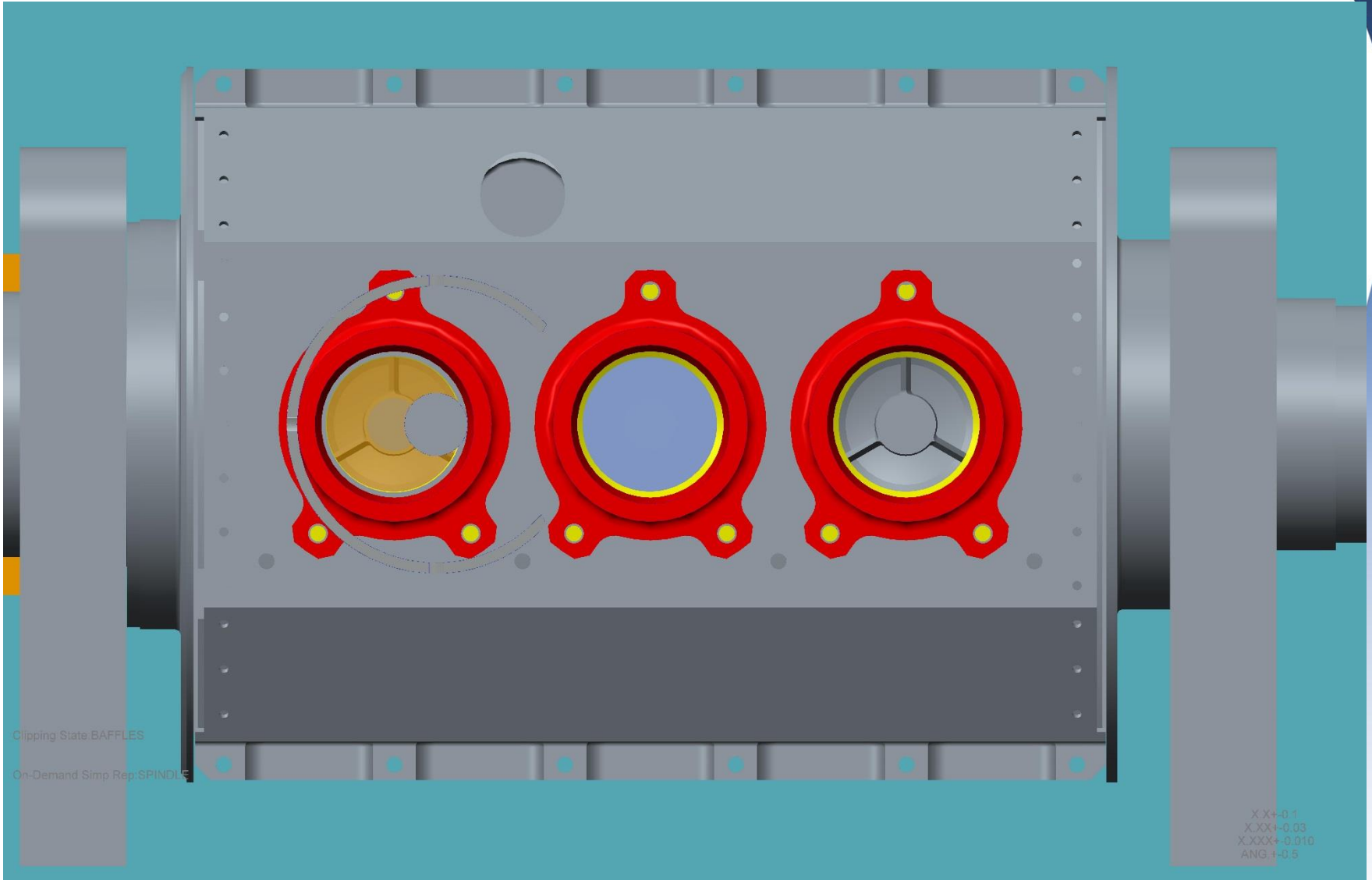


Credit: B&W Tek,
<http://bwtek.com/raman-technology/portable/>

The biggest concern was to provide the ability to characterize the SW filter with **Zero incidences of contact with stand-in hardware**



Location of The Contaminant on The Short Wave Filter



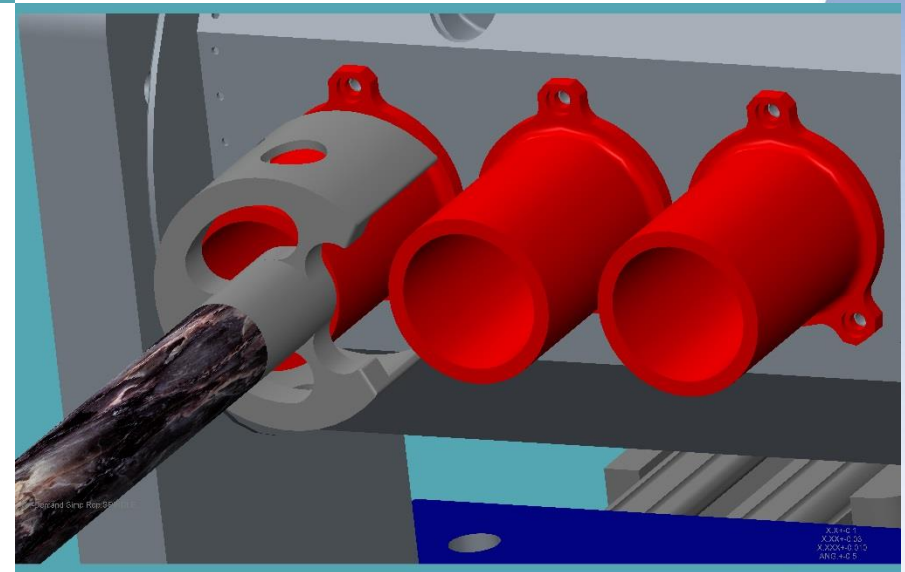
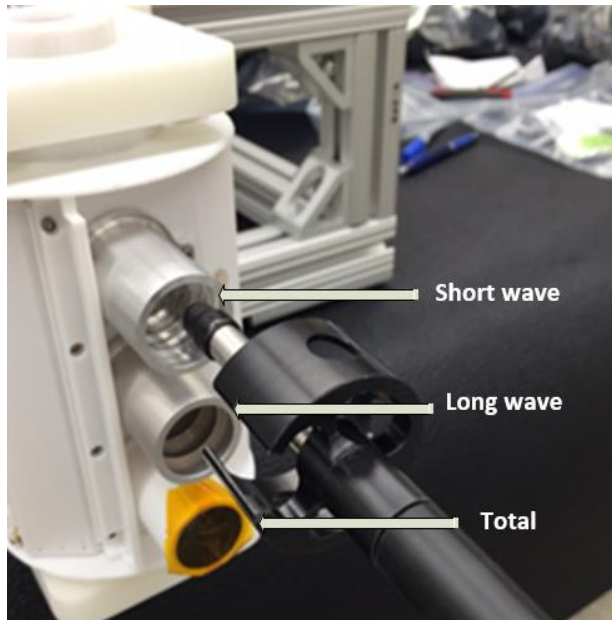
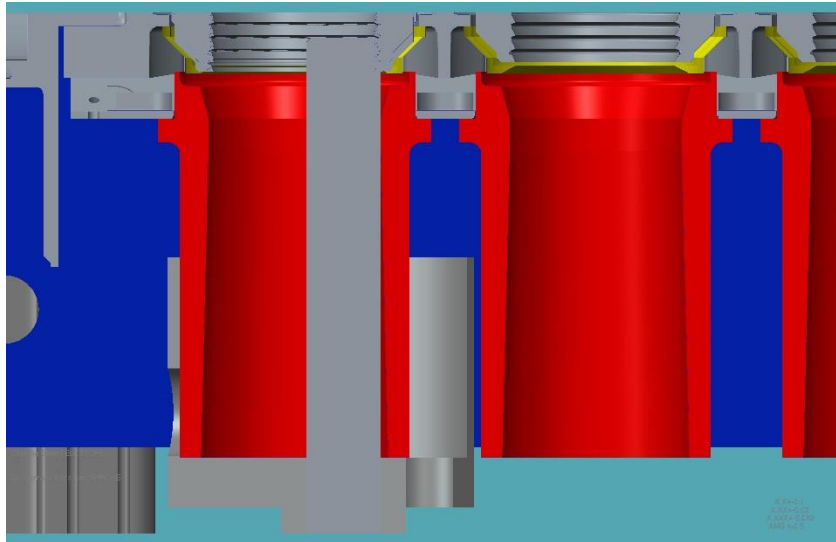
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On-Demand Simp Rep: SPINDLE

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X.XX+0.03
X.XXX+0.010
ANG 1-0.5

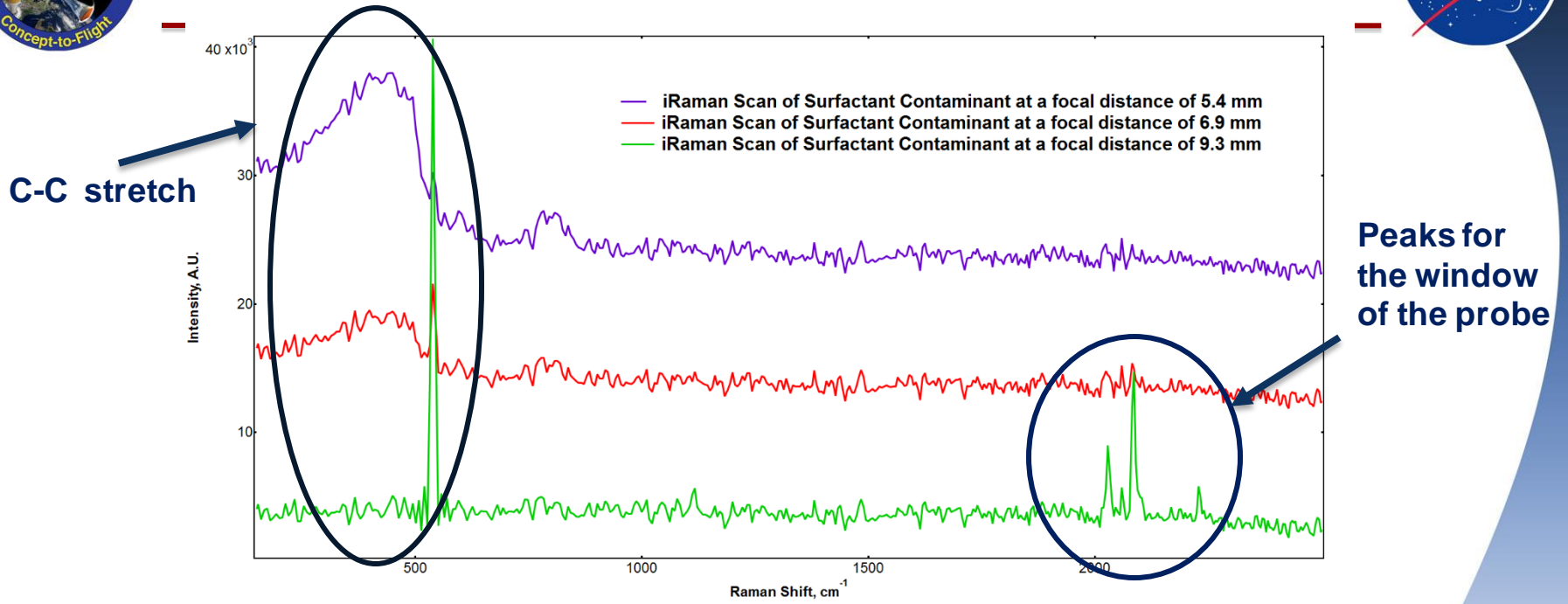


Mechanical Placement of the Raman Probe in The Optical Path



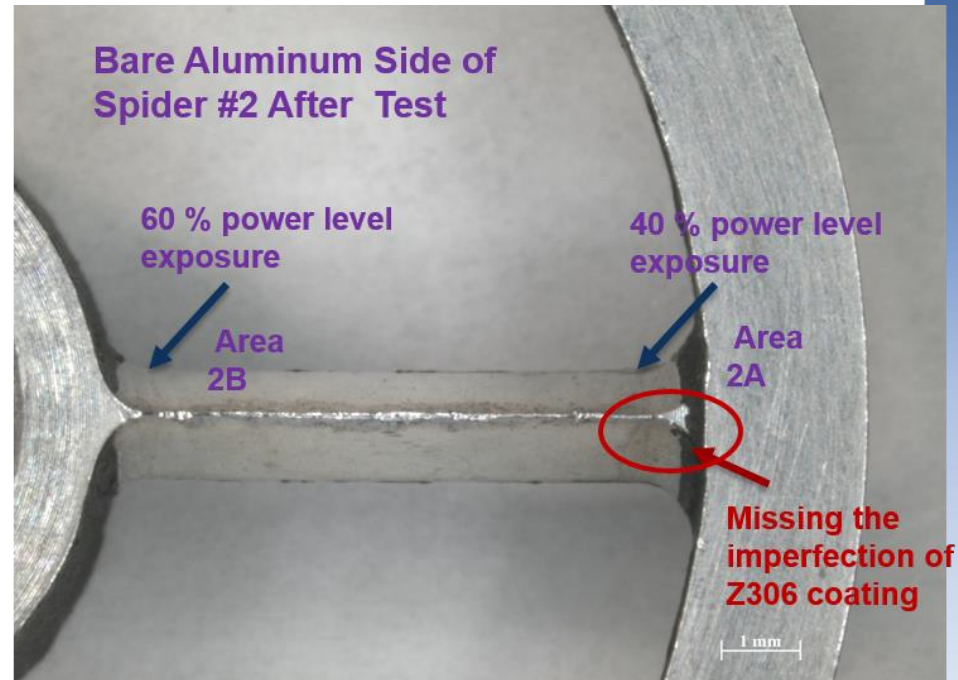
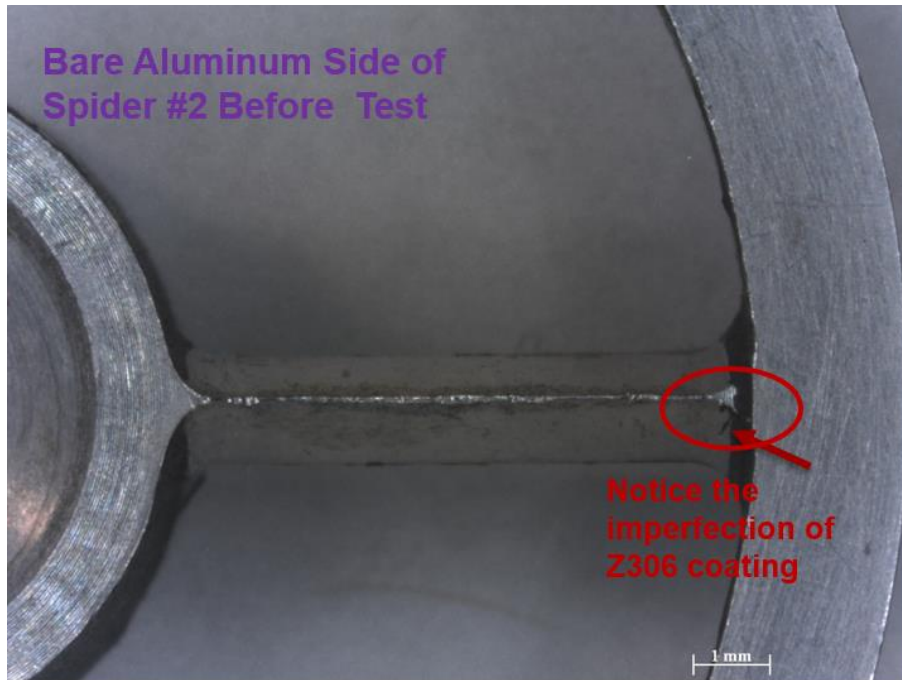


Focal Distance Test



Contaminant	Possible Source	Must be Removed?
Z-306 Species	Telescope Baffle Paint	Yes
Acrylic adhesive	Adhesive from survival heaters	Yes
Fingerprint oil	Glove bleed through	Maybe
Silicone	Lamp assembly potting material	Yes
Non Volatile Residue	Glove bleed through	Yes

Laser Power Test

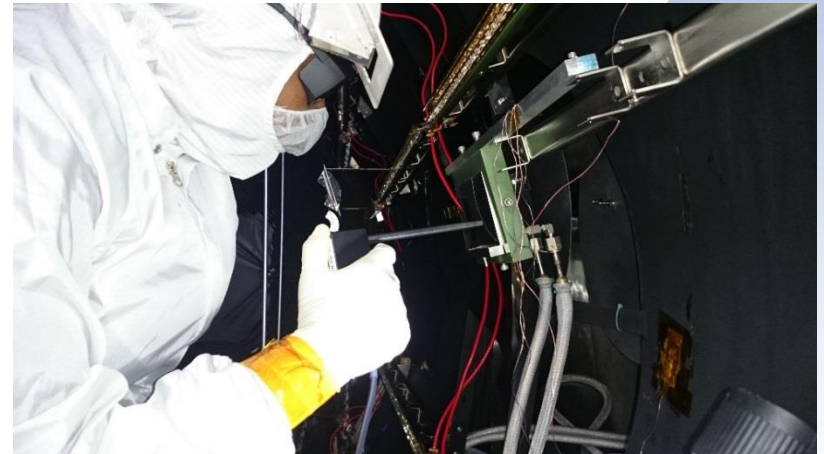




Conclusion



- Our team was able to successfully test the Raman spectroscopic characterization of the CERES FM6 SW filter with Zero incidences of contact with stand-in hardware
- The feasibility study of the Raman spectrometer provided the following limitations to ensure a safe scan:
 - Use the probe guide to ensure the Raman probe didn't contact the SW filter
 - Limit the scan distance to the recommended 5.4 mm focal length distance
 - Begin on the lowest setting of power (1%), then incrementally change to a max of 20% power to obtain a spectrum





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