SUPERCAM TRANSMISSION SPECTROMETER RESPONSE VARIABILITY DURING PASSIVE OBSERVATIONS.

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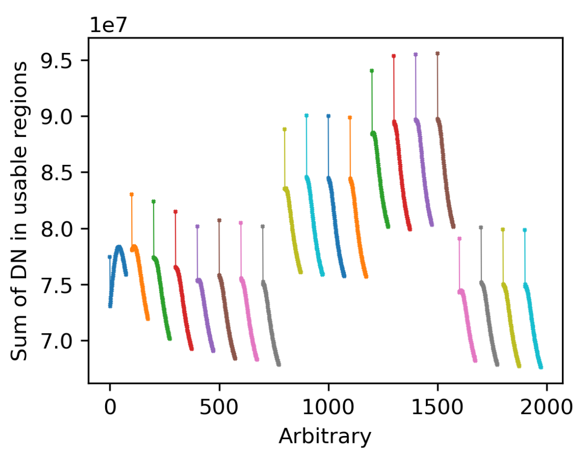
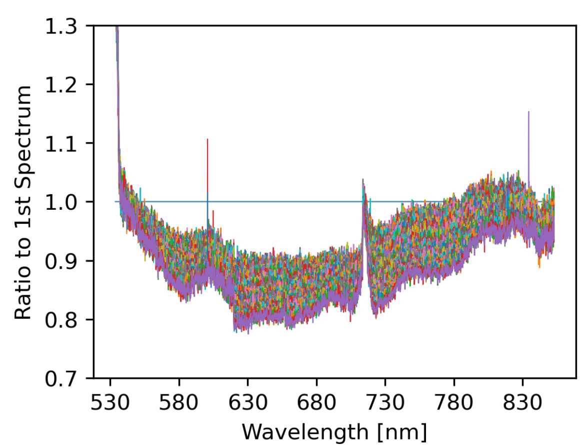
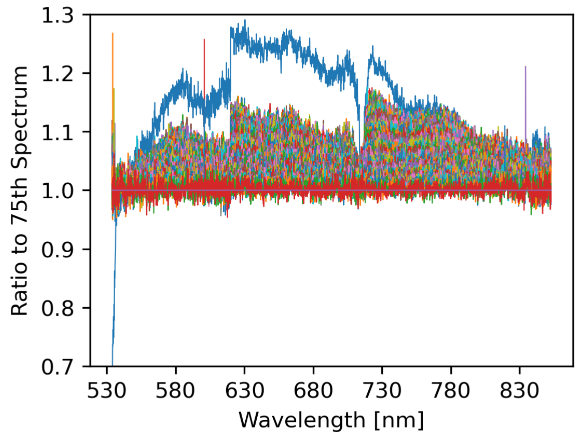
Introduction: The SuperCam transmission spectrometer uses three transmission gratings, an image intensifier, and a CCD to record spectra in the 535-853 nm range [1]. This range is split into three band on the CCD, referred to as the green (535-619 nm), orange (619-714 nm), and red (714-853 nm) regions [1,2]. Calibration of the instrument optical response is reported in [2,3]. In examining the passive sky observation [4,5] collected on sol 133, we recognized that there were unexpected intensity and spectral shape changes occurring between repeat observations collected on sub-second intervals. Subsequent investigation of these changes suggests that they are likely due to a varying reference voltage that occurs when the intensifier is in use longer than a very short time (approx. >1-5 ms). Because LIBS, Raman, and time resolved luminescence observations use much shorter timescales (generally <40 µs), the issue only affects passive observations, which typically use integration times of 10s-100s of ms. This effect has since been replicated using the lab model of SuperCam at LANL, suggesting that this is an intrinsic behavior of the instrument in this mode of use, and not due to a component failing or aging. Our goal going forward is to develop collection methods that avoid this behavior, likely through shorter integration times.



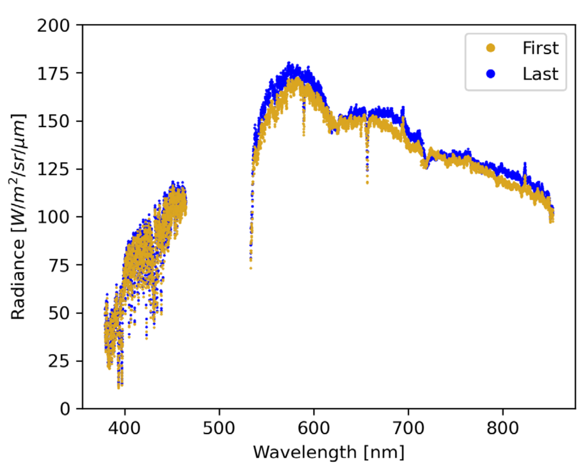
Intensity Variation: Figure 1 shows the integrated intensity recorded during the sol 133 passive sky observation, which pointed at multiple locations in the sky. The large vertical offset in observations 9-16 relative to the others is expected due to pointing at a relatively brighter portion of the sky. The feature of interest is the variation in intensity among the 75 repeated spectra within a single commanded observation. The expected outcome of this plot would be 20 effectively horizontal lines with vertical offsets from each other depending on pointing. Each set of 75 spectra was collected in approximately 8.8 seconds.

Shape Changes: Figure 2 shows the ratio of the 75 repeated spectra from the 2nd collect (orange in Figure 1) to the first spectrum in that collect. Figure 3 shows the ratio of those spectra to the last spectrum in that collect. These figures demonstrate how the shape of the spectrum changed during one collect. The first spectrum is always an outlier in this sequence, with the remaining 74 being more "in-family" but still varying over approximately 15%.

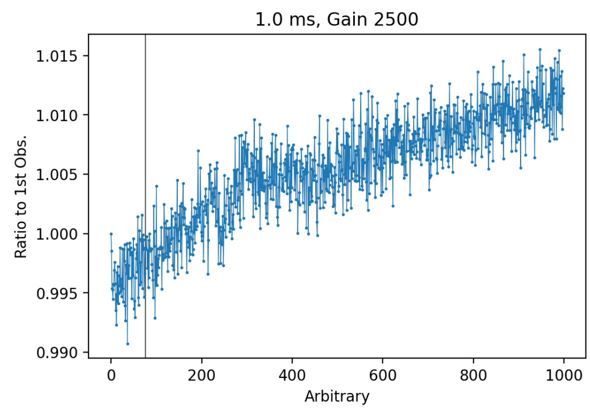




Surface Characterization Activities: Several observations have been collected by SuperCam to characterize these effects. The most important one is an observation of the SuperCam Calibration Target (SCCT) White target collected on sol 184. This observation returned all 50 spectra collected individually instead of calculating and returning only the mean, median, and standard deviation of the spectra. These spectra exhibited similar variations to those described above. When converted to radiance, the first observation exhibits less band-to-band curvature than the last (Figure 4). Since this was collected, the SuperCam team has used this single spectrum as the SCCT White reference for calculating relative reflectance of Mars targets in the visible wavelength range [6], pending further analysis and improvements.



Compensation and Future Work: Ongoing lab work at LANL suggests that the issue may be avoided by significantly shortening the duration the intensifier is in use for each observation to <5 ms. Preliminary data suggest that using a time of 1 ms would reduce the overall intensity variations to approx.. 2.5 % (Figure 5) over 999 observations. Because spectra are typically returned to Earth only as the mean, median, and standard deviation of the observations collected, future work is planned to determine the number of spectra needed to reach sufficient signal to noise with these shorter observations. Additionally, since the currently used amplification setting (gain) is on the low end of what is available, we plan to investigate the use of higher gain settings. Finally, we are investigating the use of significantly slower repetition rates for spectra within a single collect to see if that mitigates the issue.



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References: [1] Wiens, R.C. et al. (2021) *SSR, 217:4*, https://doi.org/10.1007/s11214-020-00777-5. [2] Legett, C. et al. (2021) *LPSC LII,* Abstract #1516. [3] Legett, C. et al. (2022) *Applied Optics*, in review. [4] McConnochie T. H. et al. (2021) *LPSC LII,* Abstract #1367. [5] Montmessin, F. et al. (2021) *AGU Fall Meeting,* P32C-04; [6] Johnson, J.R. et al., this conf.