1. INTRODUCTION

On Thursday, GMT 2019-04-25 (Day 115), Glacier-5 (S/N 009), located in Express Rack 9B (COL F2) was activated in preparation for SpX-17. Glacier-5 was placed in set-point mode (starting the cooling cycle) at GMT 16:51. Approximately 15 minutes later the crew reported a very loud, abnormal vibration from the area around Glacier-5. Power was removed from Glacier- 5 at 17:14 to safe the unit and reportedly, the vibration stopped.

A working theory by the Cold Stowage team is that there had been cryo-cooler launch locks still engaged. This is supported by audio recordings from when the crew called to report the vibrations. If all 4 locks were not fully released, a similar vibration would result after cryo-cooler activation. The Cold Stowage team will work with the MER to assess further. If approved, then the Cold Stowage team will then work with POIC to have the crew remove Glacier- 5 from ER9B and inspect the cryo-cooler locks, disengage as needed, and reinstall Glacier. Glacier-5 is needed for a Powered Ascent Utility Locker (PAUL) module insert at SpX-17 L+8 days. The unit must be active no later than 2 days prior to sample insertion to cool down.

2. QUALIFY

The Space Acceleration Measurement System (SAMS) had a sensor (S/N 121f08) operating in Express Rack 3 (COL1A3) at the time. The color spectrogram shown in Figure 1 shows the pronounced signature comprised of spectral components at 60, 120 and 180 Hz as indicated by the black arrows. Measurements from this sensor indicate that this vibration started at 16:51:40 and lasted until 17:14:29.

3. QUANTIFY

The power spectral density plots shown in Figure 2 on page 2 have light blue arrows that correspond to the same 60, 120 and 180 Hz spectral peaks as those in Figure 1 on page 1 – these indicate the Glacier-5 signature. A crude way to quantify the impact of Glacier-5 is shown in Figure 3 on page 2 where we can see the vibratory impact is primarily aligned with the XY-plane and mostly along the X-axis.

The plots of Figure 4 on page 3 and Figure 5 on page 4 show the best way to quantify the vibratory impact of Glacier-5 ops. Here we use the mathematical prism of the Fourier transform along with Parseval's theorem to show the impact of Glacier-5 ops over specific, narrow frequency bands. Figure 4 on page 3 shows

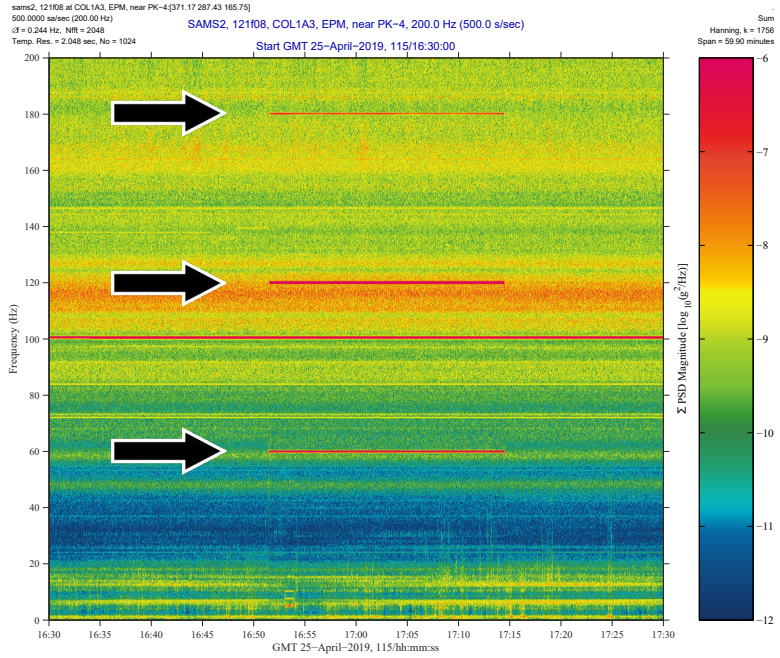

Fig. 1: Vibratory Spectrogram Computed for Noisy GLACIER Ops.

the impact of the largest spectral component at 120 Hz to be between 2.5 and 3 mg RMS (root mean square). Figure 5 on page 4 shows that the 60 Hz component is about one-fourth this amount, weighing in at around 0.6 mg RMS. The smallest spectral component at 180 Hz registers at about 0.2 mg RMS as seen in this same figure.

4. CONCLUSION

The Glacier-5 equipment had a strong vibratory impact on the microgravity environment in the Columbus module, primarily aligned with the XY-plane and loudest in a narrow band centered at 120 Hz.

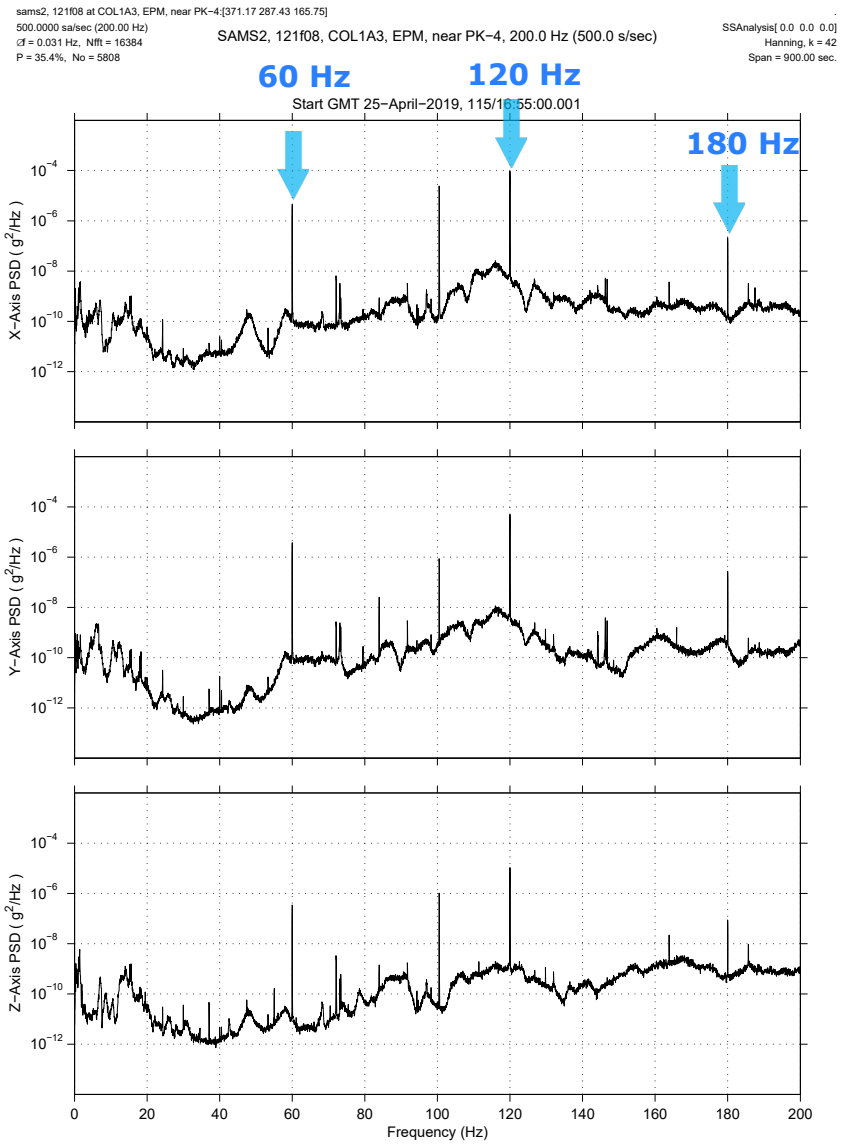

Fig. 2: Acceleration Power Spectral Density Plots Showing Per-Axis Distribution.

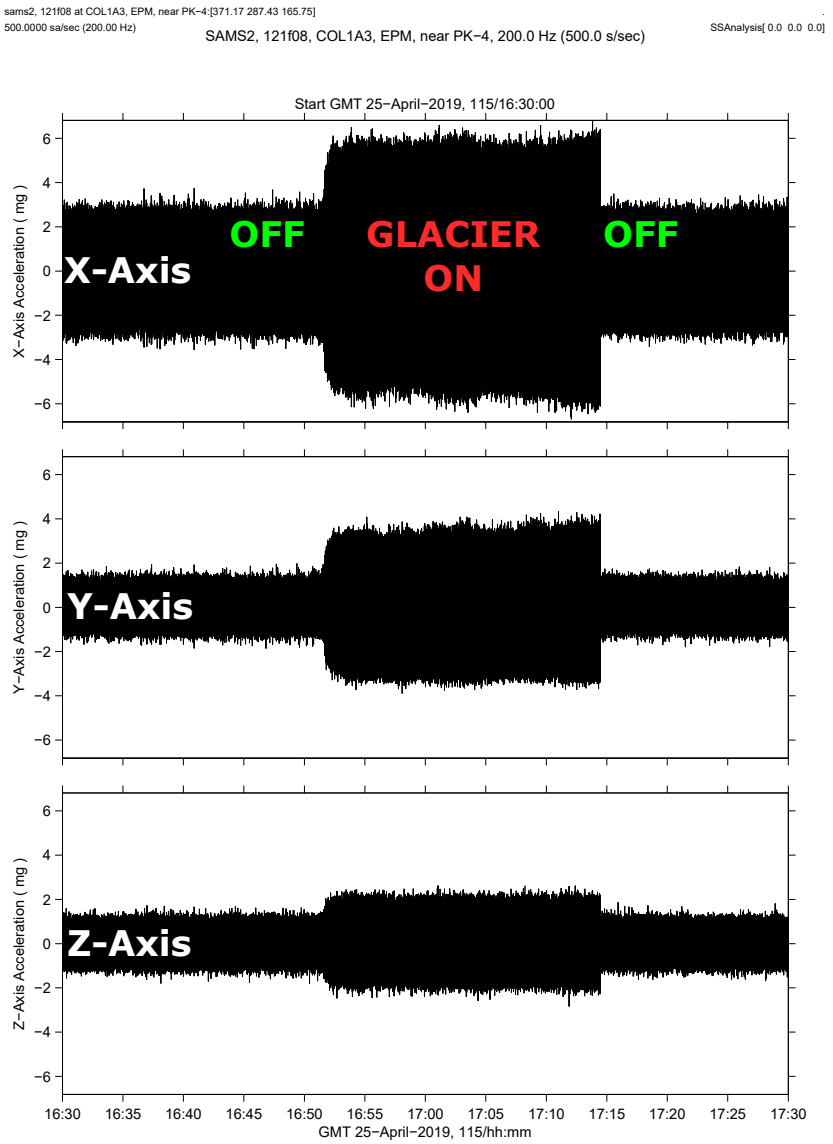

Fig. 3: Acceleration vs. Time Plots Before/During/After GLACIER Ops.

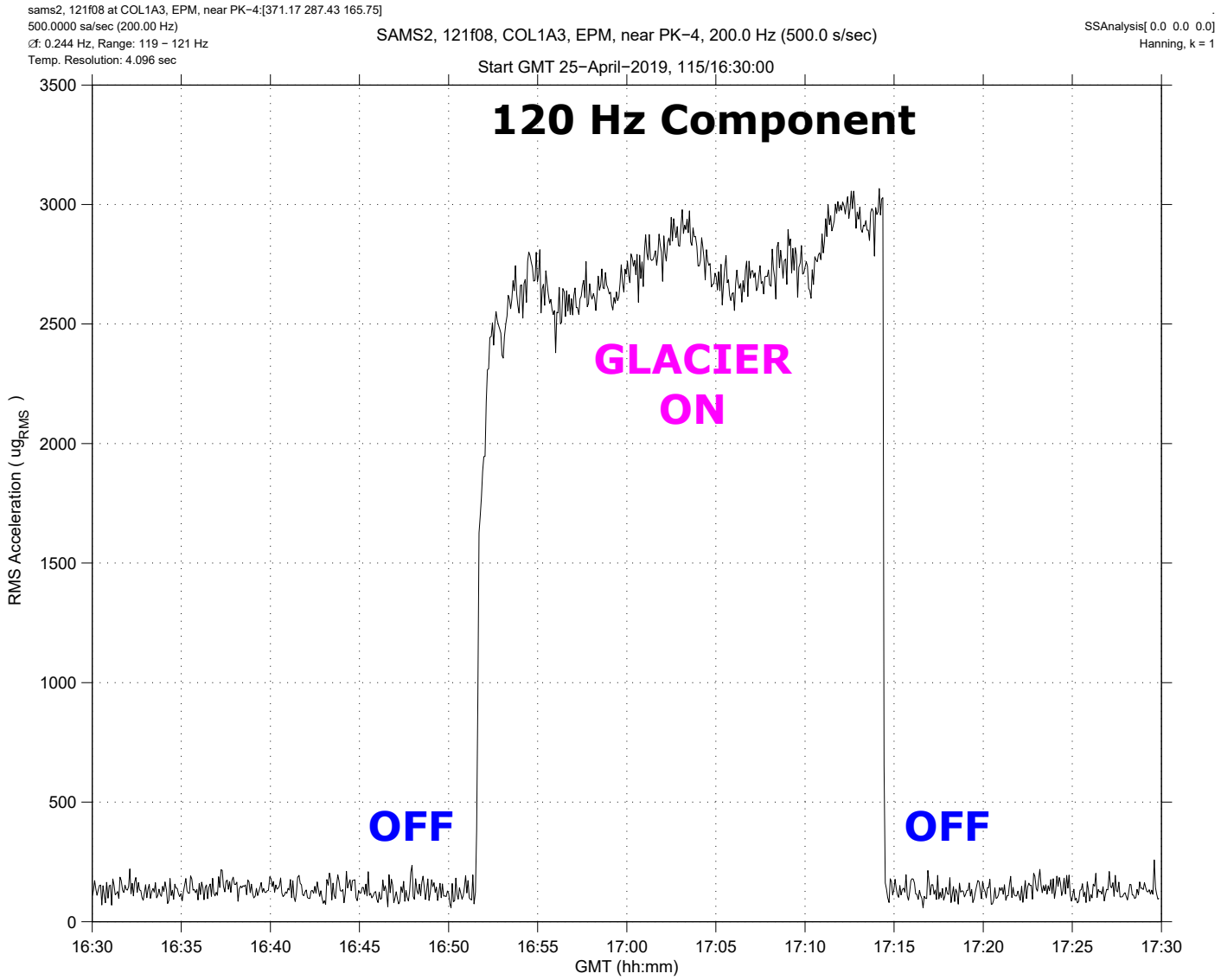

Fig. 4: RMS Acceleration at 120 Hz Before/During/After GLACIER Ops.

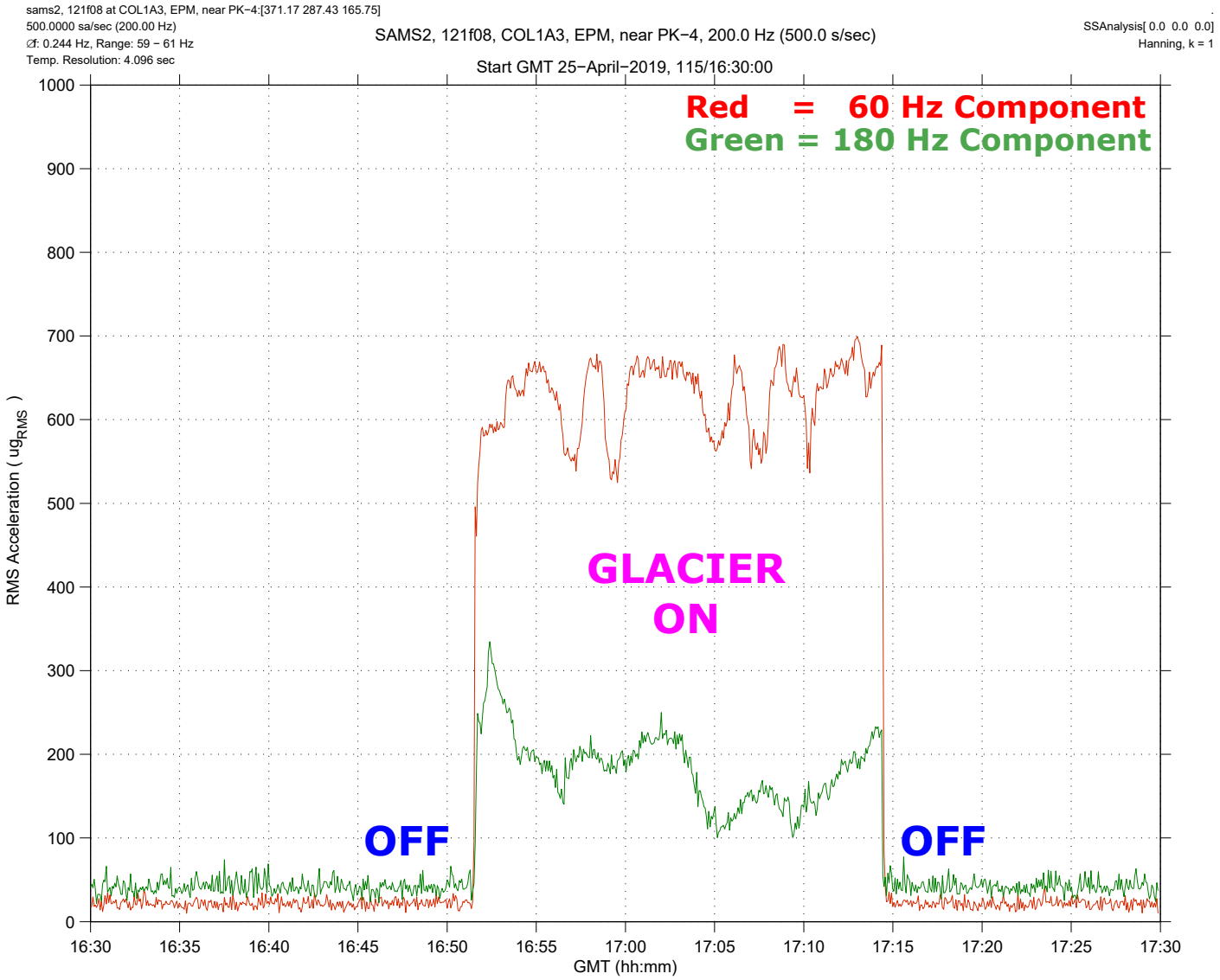

Fig. 5: RMS Acceleration at 60 & 180 Hz Before/During/After GLACIER Ops.