1. INTRODUCTION

At GMT 2022-10-01, 274/11:05:17, the International Space Station (ISS) began a reboost with duration of over 11 minutes using the Progress 81P thrusters. Figure 1 shows that the Progress vehicle was docked with its thrusters facing aftwards, which put thrust and the necessary orbital mechanics into play so as to speed up the ISS in its direction of flight. This directional acceleration, increase in velocity, resulted in a reboost of altitude of the space station during this dynamic event.

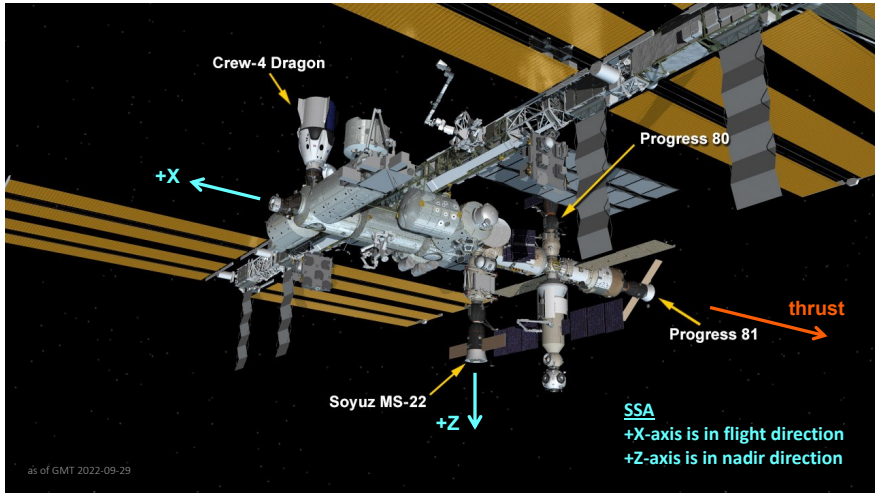

Fig. 1: Progress 81P's location and alignment during reboost.

2. QUALIFY

The information shown in Figure 2 was calculated from the Space Acceleration Measurement System (SAMS) sensor 121f02 measurements made in the Columbus module from a sensor mounting location on EXPRESS Rack 3 (COL1A1). The color spectrogram (bottom) subplot shows increased structural vibration excitation contained mostly below 1 Hz or so, and the 11-12 minute reboost (thruster firing) event itself is annotated at GMT 11:05. We attribute much of the structural vibration increase to Russian Segment (RS) attitude control since the as-flown timeline shows RS control from about GMT 10:15 to about 12:00 (as shown with text annotations at those times). The RS thrusters were used for station attitude control during the time around the reboost activity. This is expected, and typical behavior. The increased structural vibrations are evident as more noticeable horizontal streaks (structural/spectral peaks) that change from quieter (green/yellow) to more energetic (orange/red) sporadically during this period of RS control spanning about 105 minutes. The flare up of these nebulous horizontal (spectral peak) streaks are the tell-tale signatures of large space station appendages as they flex, twist, or bend in reaction to impulsive attitude control thruster forces. The actual reboost activity itself lasted a bit over 11 minutes as evidenced by slightly more pronounced, vertical orange-red streaks in Figure 2 starting around GMT 11:05. For science operations and general situational awareness, it is prudent to be aware that the transient and vibratory environment (primarily below about 10 Hz or so) is impacted not only during the reboost event itself, but also during the much longer span of Russian Segment (RS) attitude control too. The difference being that during the reboost itself, the dominant factor might be considered to be the highly-directional step in the +X-axis (typically), while in the much longer case of RS attitude control, the dominant impact was the excitation of lower-frequency vibrational modes of large space station structures.

3. QUANTIFY

The as-flown timeline for this event indicated the reboost would start at GMT 11:05 and have a duration of just under 12 minutes. Analysis of Space Acceleration Measurement System (SAMS) data recordings in the US LAB, COL, and JEM – see figures starting with Figure 3 on page 4 – shows the tell-tale +X-axis step that started at GMT 11:05:17 and had a duration of about 11 minutes and 18 seconds.

Information from flight controllers indicated that this reboost event provided a space station rigid body ΔV of about 1.36 meters/second, while analysis of SAMS measurements yielded a value of 1.35 meters/second. These results are shown in the five plots of 5-second interval average acceleration versus time for SAMS sensors distributed throughout the ISS at the end of this document starting with Figure 3 on page 4. The interval average processing effectively low-pass filtered the data so as to help emphasize the acceleration step that occurs on the X-axis during the reboost event. It should also be noted that we flipped the polarity of each axis (inverted each) in the SAMS plots owing to a polarity inversion issue inherent in SAMS transducers. A somewhat crude (time-averaged) quantification of the reboost as measured by the 5 distributed SAMS sensors shows that the gigantic space station

structure maintained an average acceleration of about 0.2 mg continuously (and mainly in the +X-direction) for over 11 minutes.

4. CONCLUSION

The SAMS measurements for 5 sensor heads distributed across all 3 main labs of the ISS was analyzed and showed tell-tale **+X-axis step during the Progress 81P reboost of just about 0.2 mg**. Furthermore, calculations based on SAMS sensor data mounted in various, distributed locations indicated **a ΔV metric of about 1.35 meters/second** was achieved, and this result nearly matched flight controllers' desired value. The ultimate objective, to boost altitude, was also achieved with a reported **altitude increase of 2.39 km**.

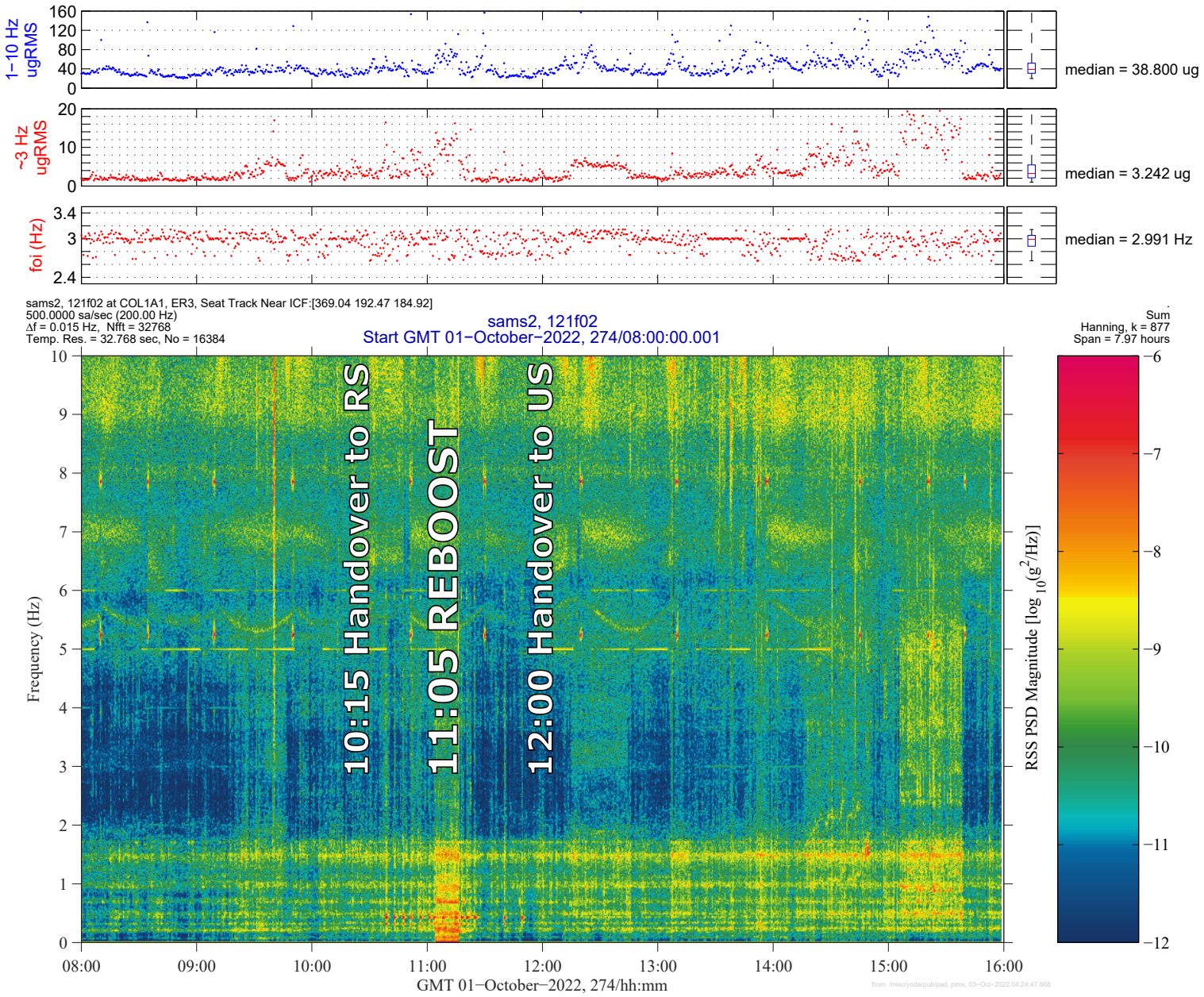

Fig. 2: Spectrogram (at bottom) showing Progress 81P Reboost on GMT 2022-10-01.

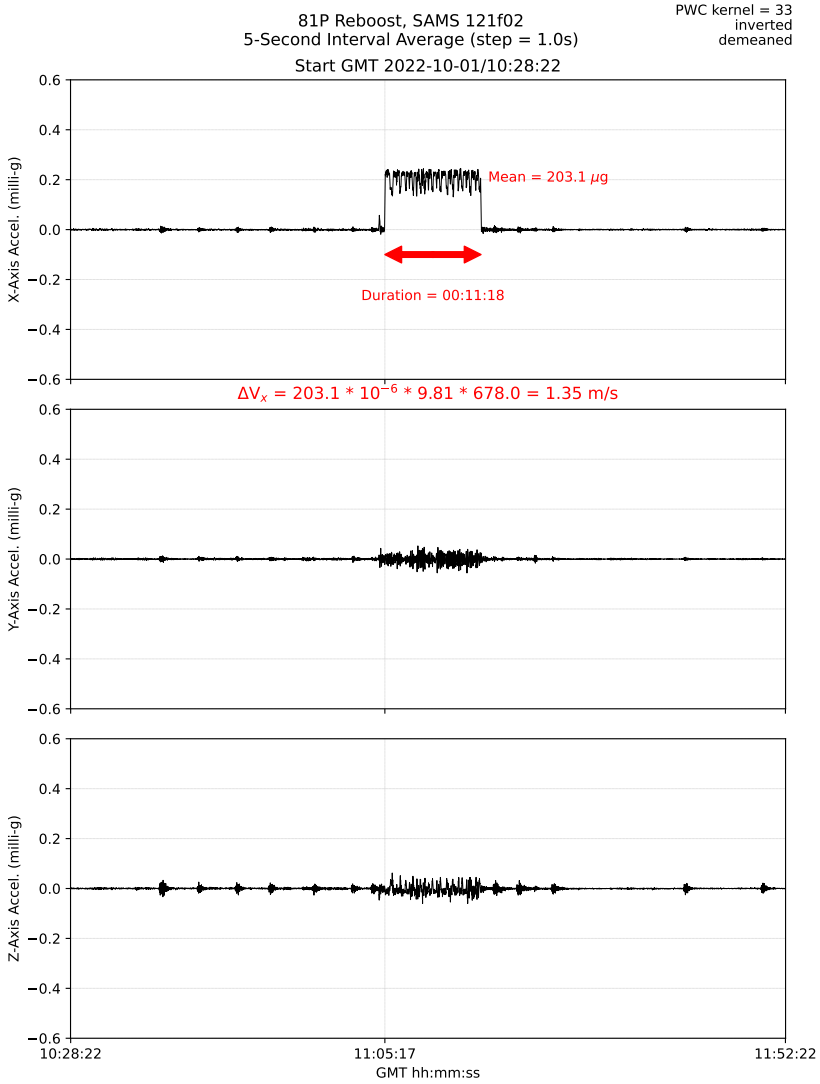

Fig. 3: 5-sec interval average for SAMS 121f02 sensor in the COL.

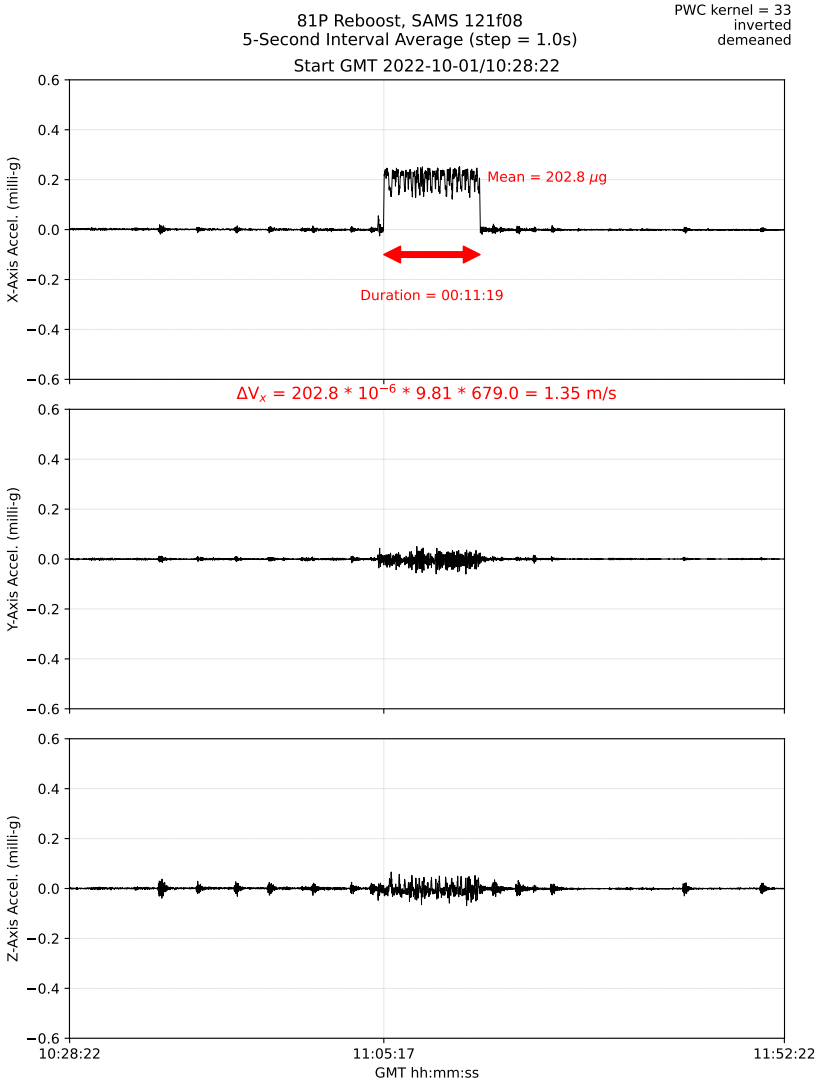

Fig. 4: 5-sec interval average for SAMS 121f08 sensor in the COL.

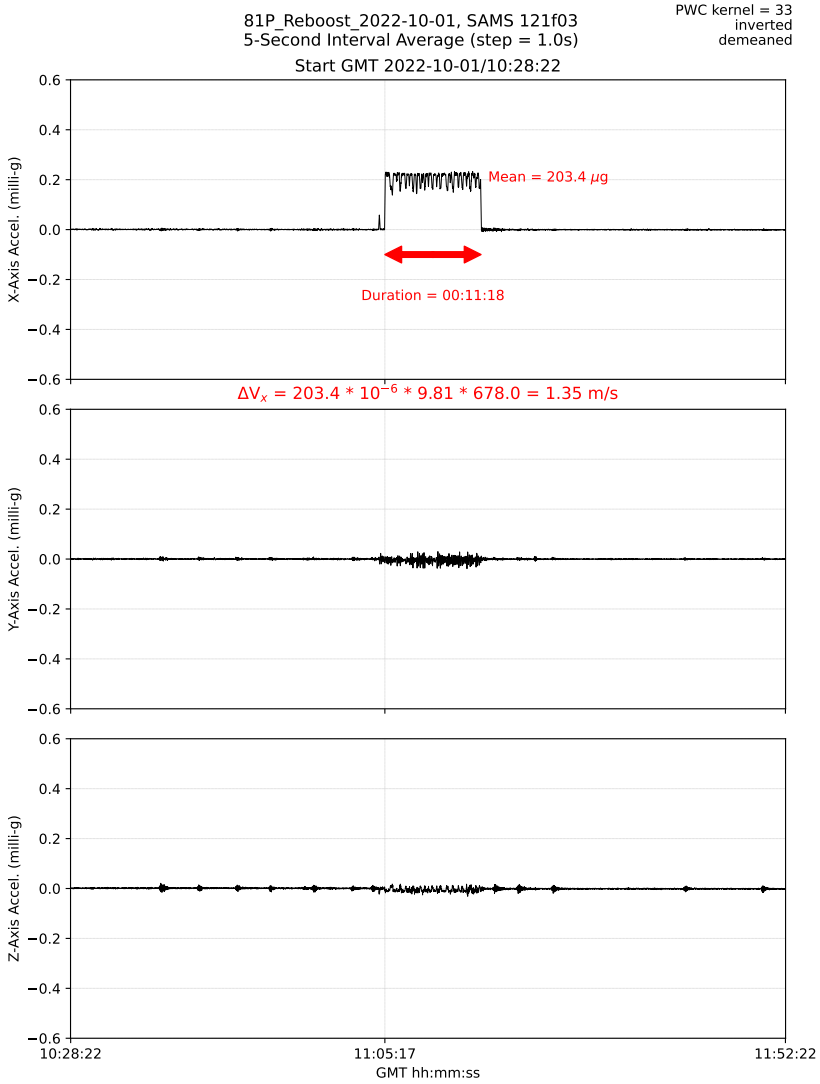

Fig. 5: 5-sec interval average for SAMS 121f03 sensor in the LAB.

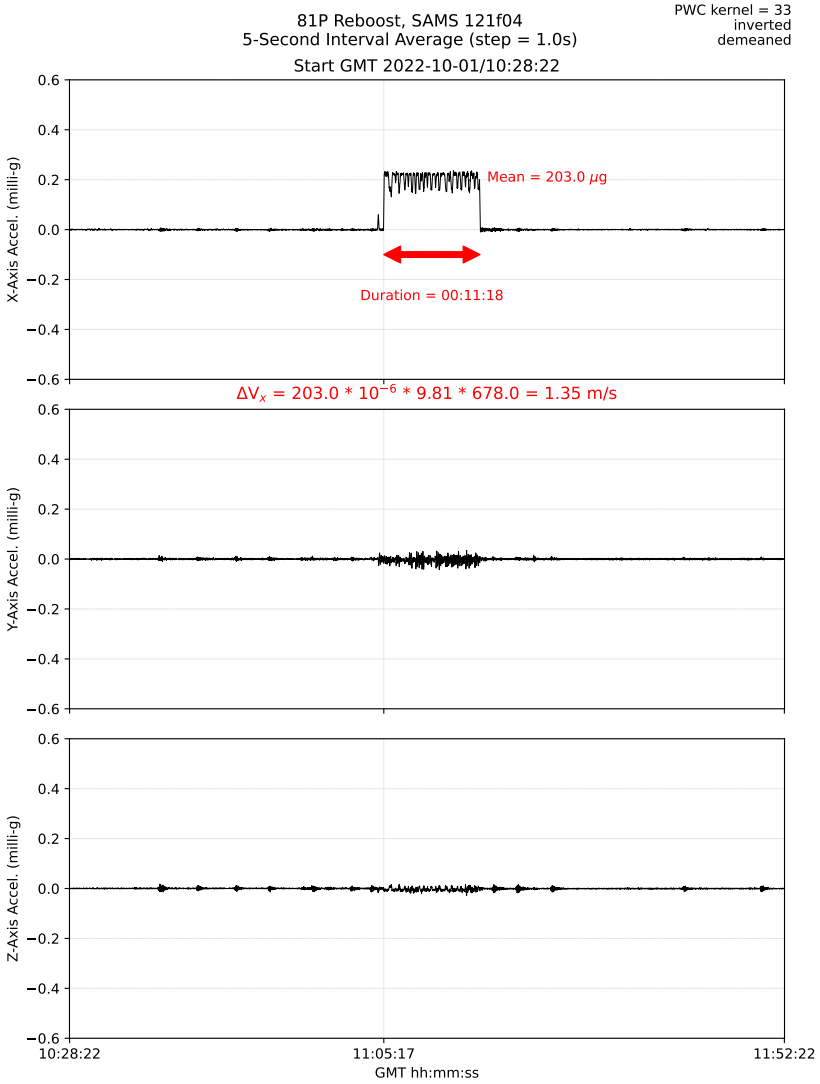

Fig. 6: 5-sec interval average for SAMS 121f04 sensor in the LAB.

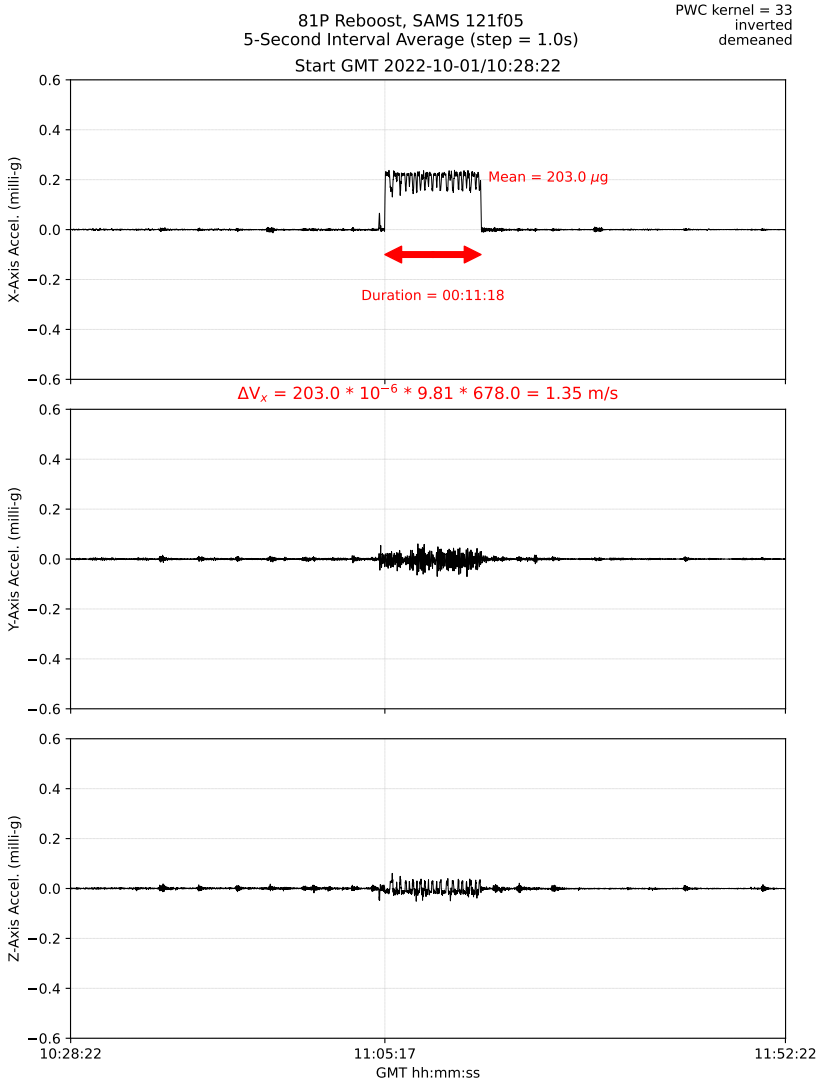

Fig. 7: 5-sec interval average for SAMS 121f05 sensor in the JEM.