1. INTRODUCTION

At GMT 2022-01-12, 012/18:24, the International Space Station (ISS) began a 6-minute, 35-second reboost using the Progress 79P 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.

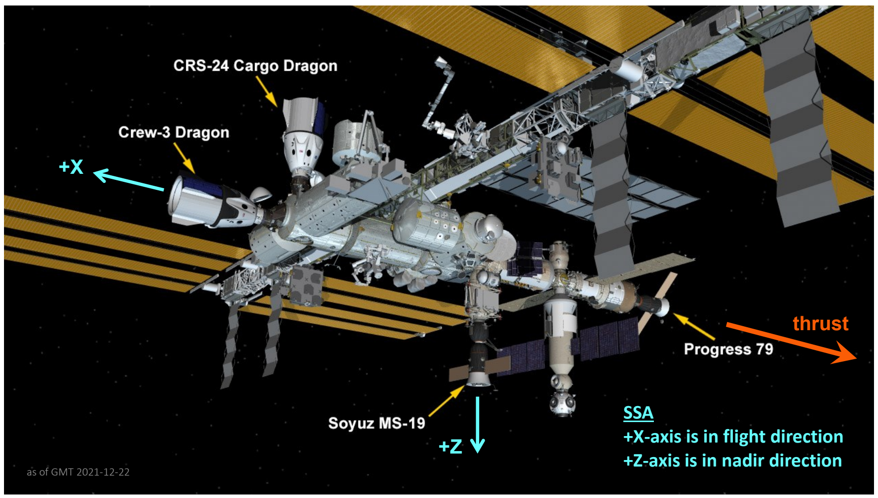

Fig. 1: Progress 79P's location and alignment during reboost.

2. QUALIFY

The information shown in Figure 2 was calculated from the Space Acceleration Measurement System (SAMS) sensor 121f03 measurements made in the US LAB from a sensor mounting location on the lower Z-panel of the LAB1O1 rack. This color spectrogram plot shows increased structural vibration excitation contained mostly below 1 Hz or so, and the 6-7 minute reboost (thruster firing) event itself is annotated in black starting at GMT 18:24. 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 17:40 to about 19:04 (as shown with white annotations). 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 84 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 less than 7 minutes as evidenced by slightly more pronounced, vertical orange-red streaks in Figure 2 starting around GMT 18:24. 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, 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 18:24 and have a duration of 6 minutes and 35 seconds. Analysis of Space Acceleration Measurement System (SAMS) data recordings in the US LAB – see Figure 3 on page 4 – shows the tell-tale X-axis step that started at GMT 18:24:16 and had a duration of 6 minutes and 41 seconds. We often see about 16-second discrepancy when comparing ground-based timing to on-orbit times even though both are given as GMT. The difference in that comparison of those two times might come from accounting for leap seconds (or not) one relative to the other. This would explain the discrepancy in start GMT of the reboost, but it would not account for the 6-second difference in duration.

Information from flight controllers indicated that this reboost event provided a space station rigid body ΔV of about 0.73 meters/second and the SAMS analysis indicated with red annotations in Figure 3 match the expected value. The SAMS does not directly measure altitude, but flight controllers indicated that the ISS gained 1.3 km in altitude above the Earth.

Five more plots of 20-second interval average acceleration versus time for SAMS sensors distributed throughout the ISS are shown at the end of this document starting with Figure 4 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 quantification of the reboost as measured by the 6 distributed SAMS sensors is also given in Table 1 – expectedly consistent impact results measured by SAMS throughout the giant structure, that is, the space station.

Table 1. **X-axis** steps (mg) during reboost event for 6 SAMS sensors.

Sensor	X-Axis	Location
121f02	0.184	COL1A1 (ER3)
121f03	0.184	LAB1O1 (ER2)
121f04	0.184	LAB1P2 (ER7)
121f05	0.184	JPM1F1 (ER5)
121f08	0.184	COL1A3 (EPM)
es18	0.185	MSRR (ER6)

4. CONCLUSION

The SAMS measurements for 6 sensor heads distributed across all 3 main labs of the ISS was analyzed and showed an **X-axis step during the Progress 79P reboost of just under 0.2 mg**. Furthermore, calculations based on SAMS sensor (121f03) mounted on EXPRESS Rack 2 (LAB1O1) in the US LAB indicate a ΔV metric of about 0.73 meters/second was achieved, and this result matched flight controllers' desired value.

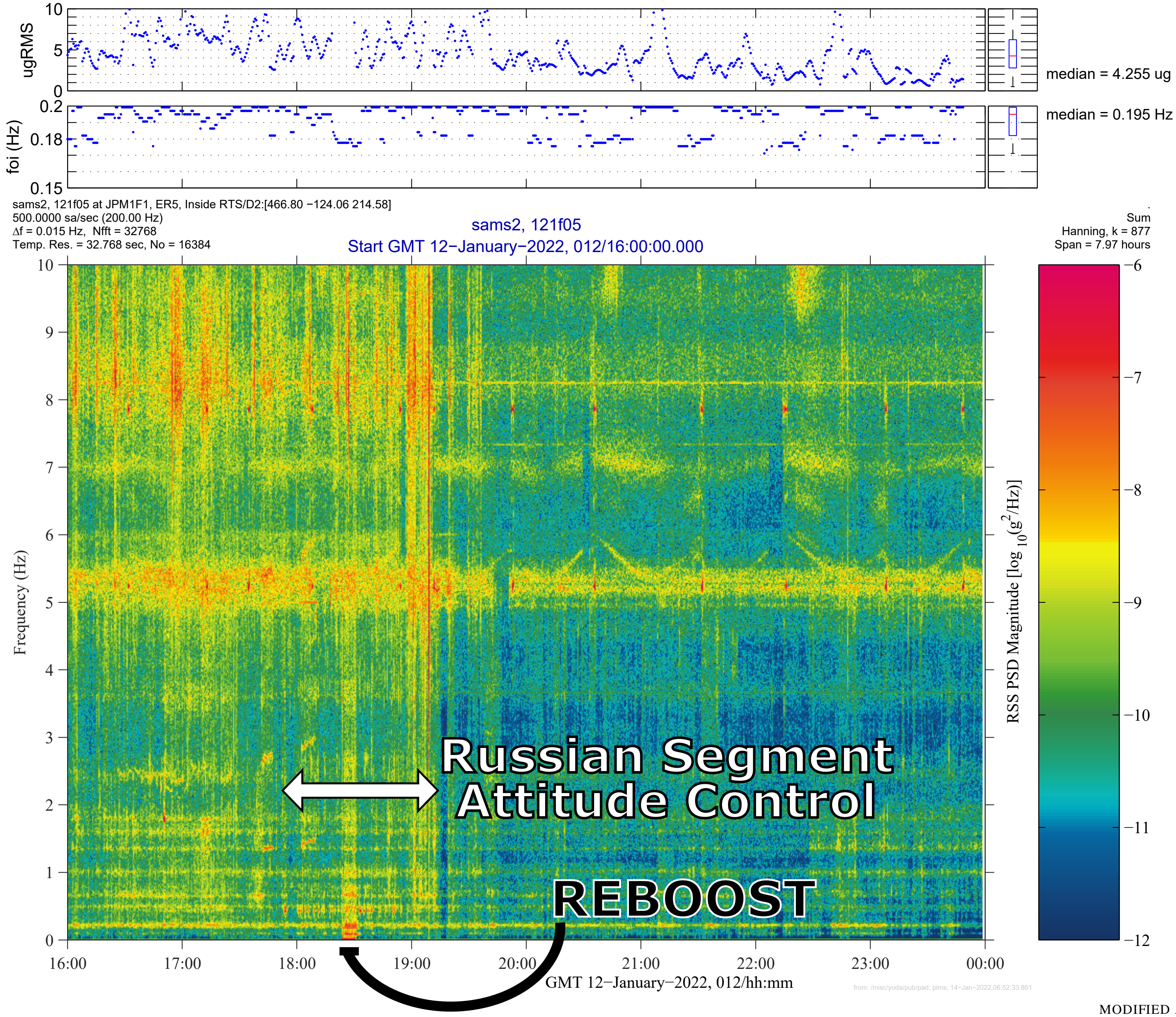

Fig. 2: Spectrogram showing Progress 79P Reboost on GMT 2022-01-12.

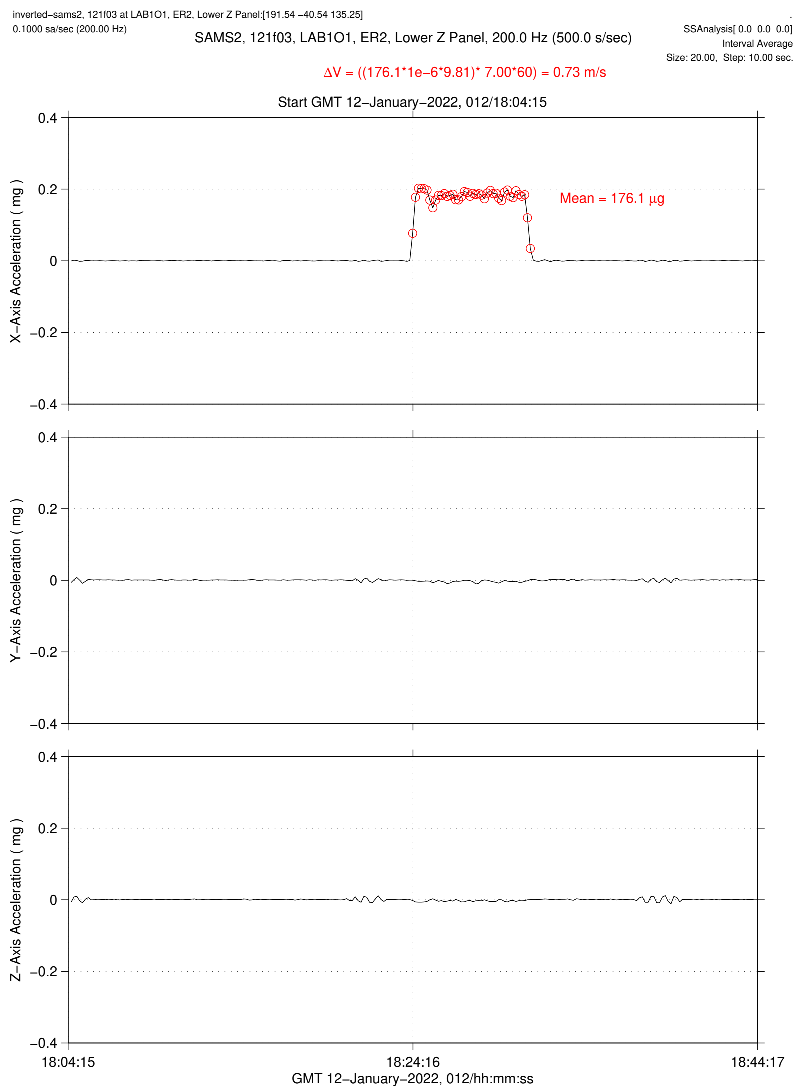

Fig. 3: 20-sec interval average for SAMS 121f03 sensor in the LAB.

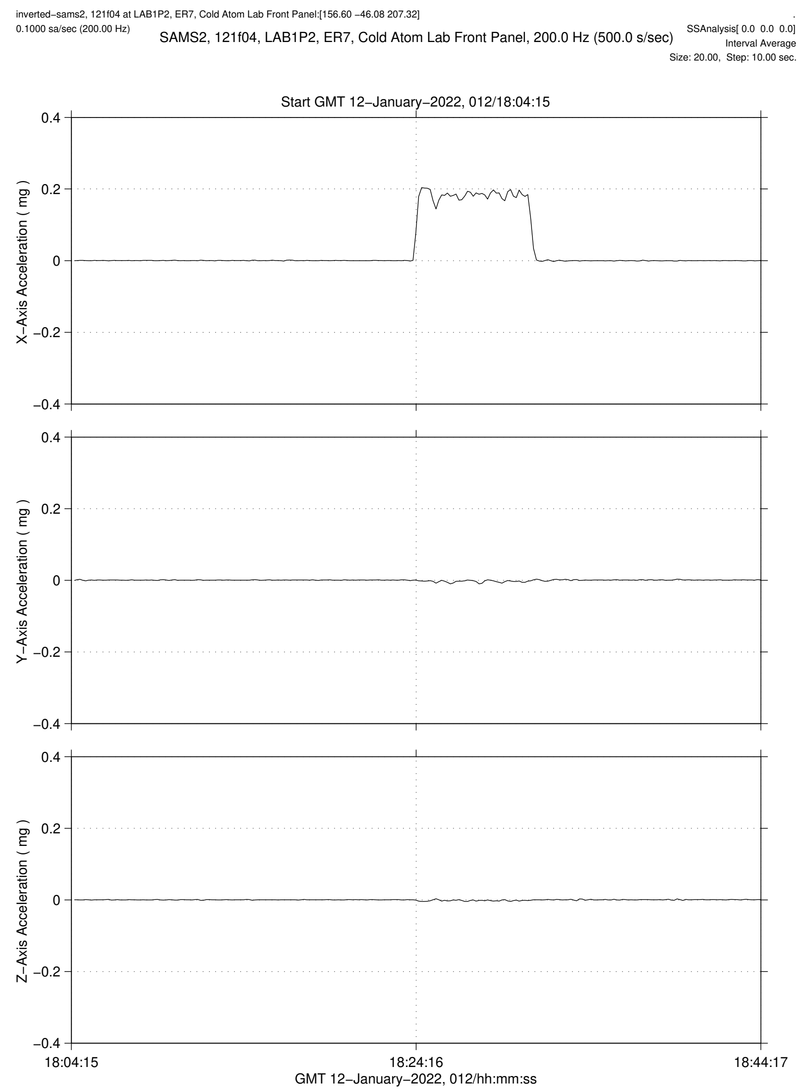

Fig. 4: 20-sec interval average for SAMS 121f04 sensor in the LAB.

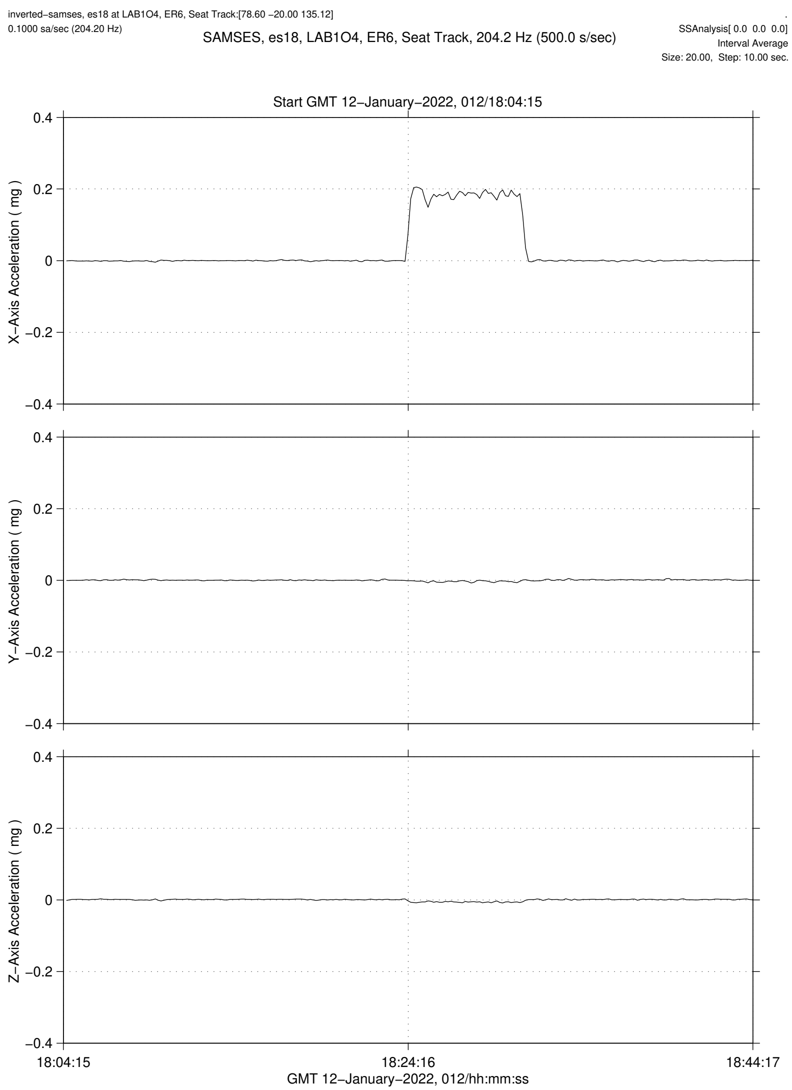

Fig. 5: 20-sec interval average for SAMS es18 sensor in the LAB.

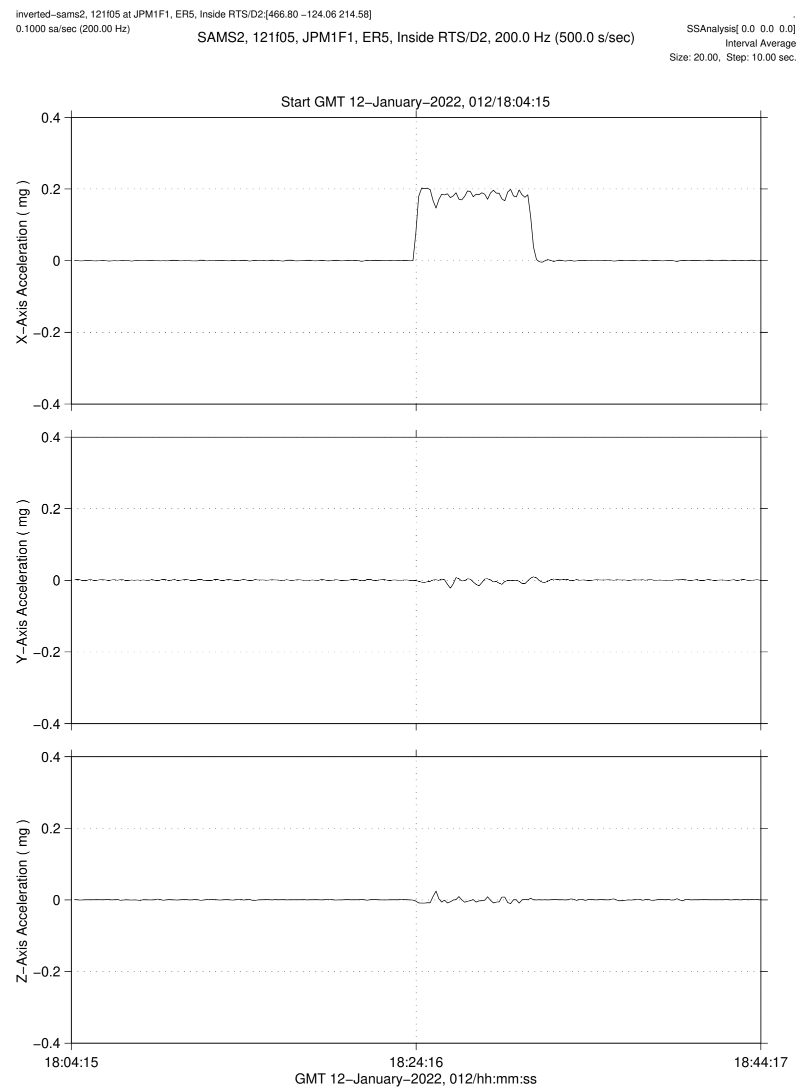

Fig. 6: 20-sec interval average for SAMS 121f05 sensor in the JEM.

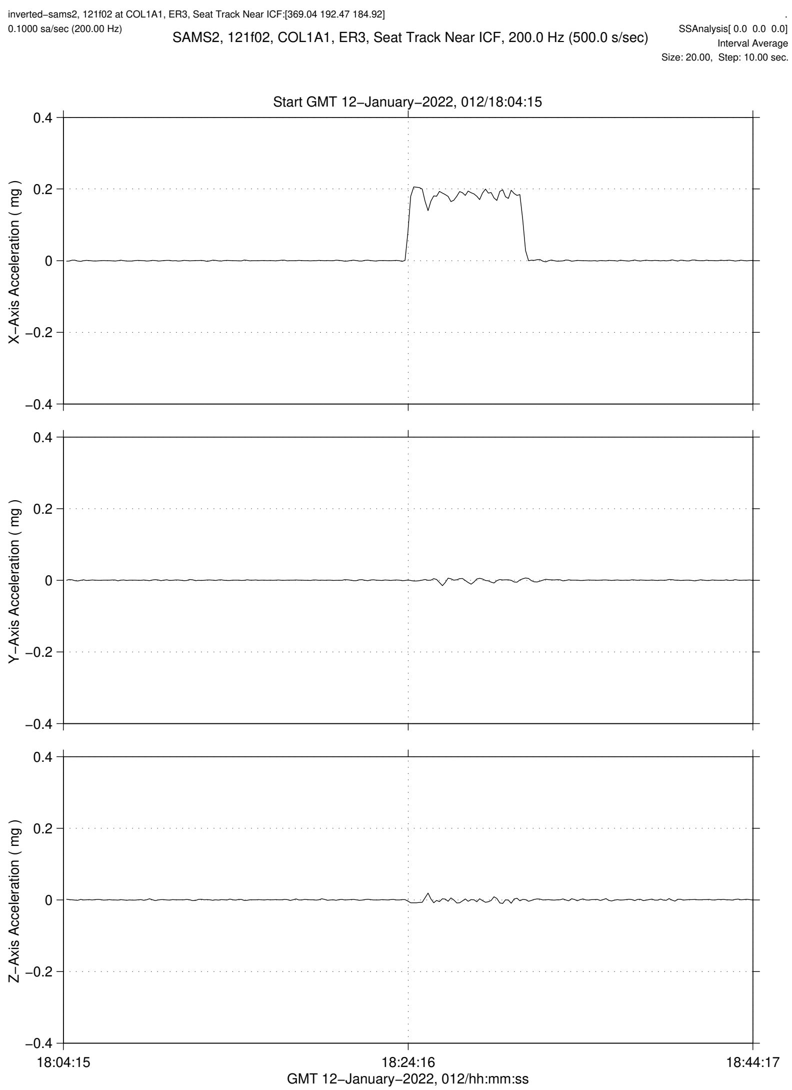

Fig. 7: 20-sec interval average for SAMS 121f02 sensor in the COL.

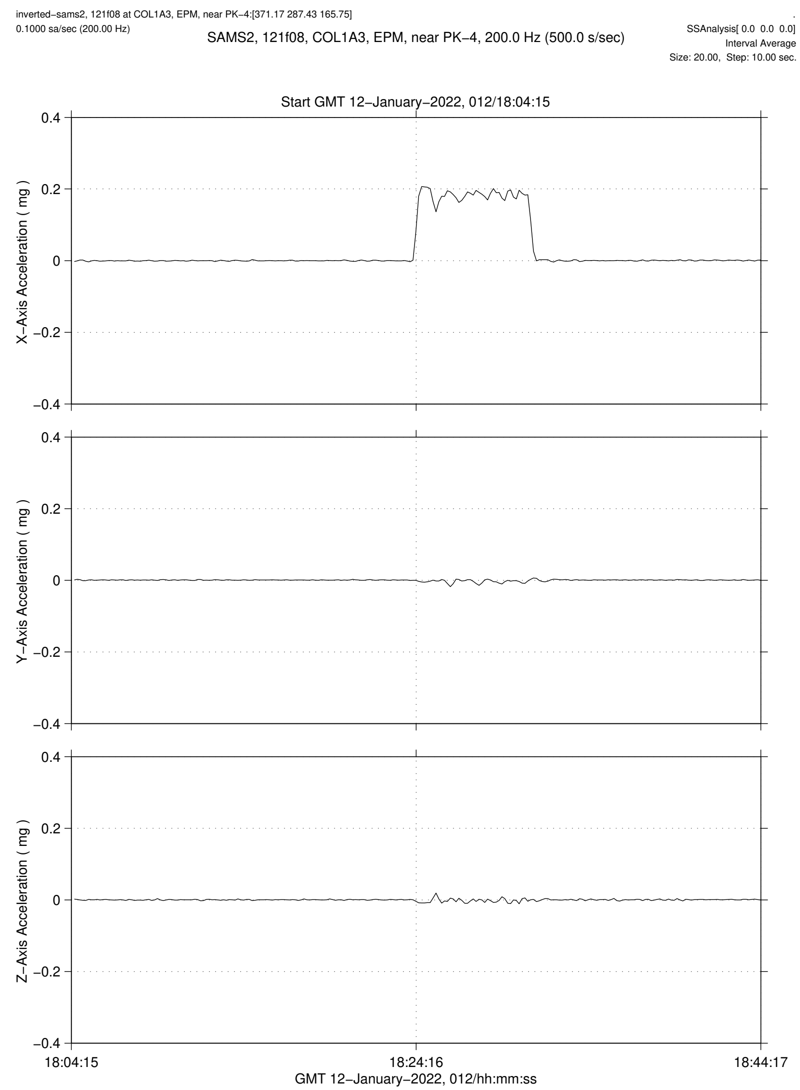

Fig. 8: 20-sec interval average for SAMS 121f08 sensor in the COL.