1. Introduction

At GMT 2019-01-18, 018/18:01, the International Space Station (ISS) began an ~8-minute reboost using Progress 71P aft thrusters. This was was planned as one of a series of reboosts to set up phasing conditions for rendezvous with Soyuz 58S and Progress 72P launches. The visiting vehicles graphic of Figure 1 shows the location and alignment of the Progress 71P during this reboost. Newton's 3rd law in action (and reaction) here with Progress thrusters firing in the aft direction to accelerate the ISS in the forward direction. It is this increase in velocity in the forward/flight direction that puts orbital mechanics in play to also increase the altitude of the space station. During this reboost, the ISS climbed about 1.8 km. Another recent reboost using the Progress 71P thrusters can be seen here.

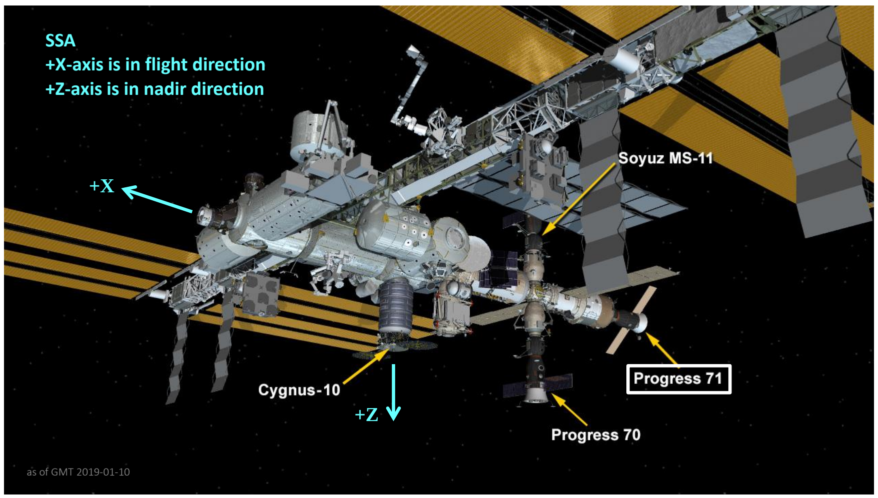

Fig. 1: Progress 71P's location and alignment during reboost.

2. Qualify

The spectral information of figure 2 was computed from SAMS sensor 121f03 measurements made in the US Laboratory (LAB). This plot shows increased structural vibration excitation between about 17:10 and 18:41 that we attribute to Russian Segment (RS) attitude control. RS control took place for a span before, during and some time after the reboost event. The increased structural vibrations are evident as horizontal streaks (structural/spectral peaks) that change from quieter (yellow) to more energetic (orange/red) sporadically during this period of RS control. 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 itself, but also during the span of Russian Segment attitude control.

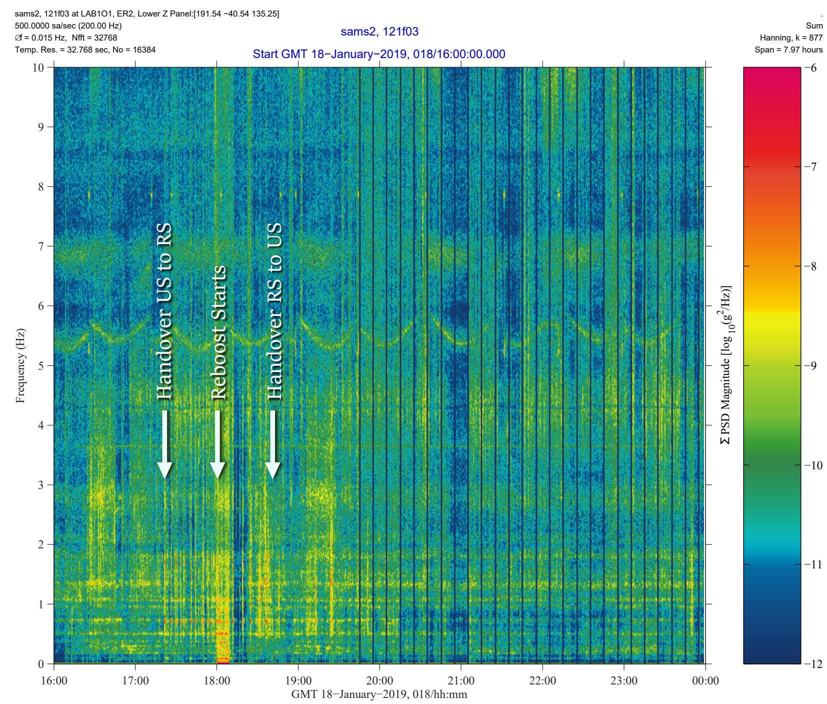

Fig. 2: Spectrogram showing Progress 71P Reboost on GMT 2019-01-18.

3. Quantify

The as-flown timeline for this event indicated the reboost would start at GMT 18:01 and have a burn duration of 8 minutes and 20 seconds. Analysis of

Space Acceleration Measurement System (SAMS) data recordings made during the reboost shows the tell-tale X-axis step that matches the start time, but the duration seemed to only last about 7 minutes and 44 seconds as seen in Figure 3.

Five plots of 32-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 3. 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 (inverted) of each axis in the SAMS plots owing to a polarity flip issue inherent in SAMS transducers. A crude quantification of the reboost as measured by the 5 distributed SAMS sensors is given in Table 1.

Table 1. X-axis step values during reboost event for 5 SAMS sensors.

Sensor	X-Axis Step (mg)	Location
121f02	0.210	JPM1A6 (RMS Console)
121f03	0.210	LAB1O1 (ER2)
121f04	0.210	LAB1P2 (ER7)
121f05	0.210	JPM1F1 (ER5)
121f08	0.210	COL1A3 (EPM)

4. CONCLUSION

While SAMS sensors were designed to characterize the vibratory environment of the ISS, and not so much the quasi-steady environment, they perform well for capturing the relatively large X-axis step induced by reboost events. Despite the underlying low-frequency & low-magnitude baseline being obscured by transducer bias/offset, SAMS sensors easily detect the crude acceleration step of reboost as demonstrated here. The SAMS sensor data analyzed showed an X-axis step during the Progress 71P reboost of about 0.2 mg. Furthermore, calculations based on SAMS sensor (121f03) mounted on EXPRESS Rack 2 in the US LAB indicate a ΔV of about 0.96 meters/second was achieved. This was close to the predicted value, ΔV = 1.00 meters/second.

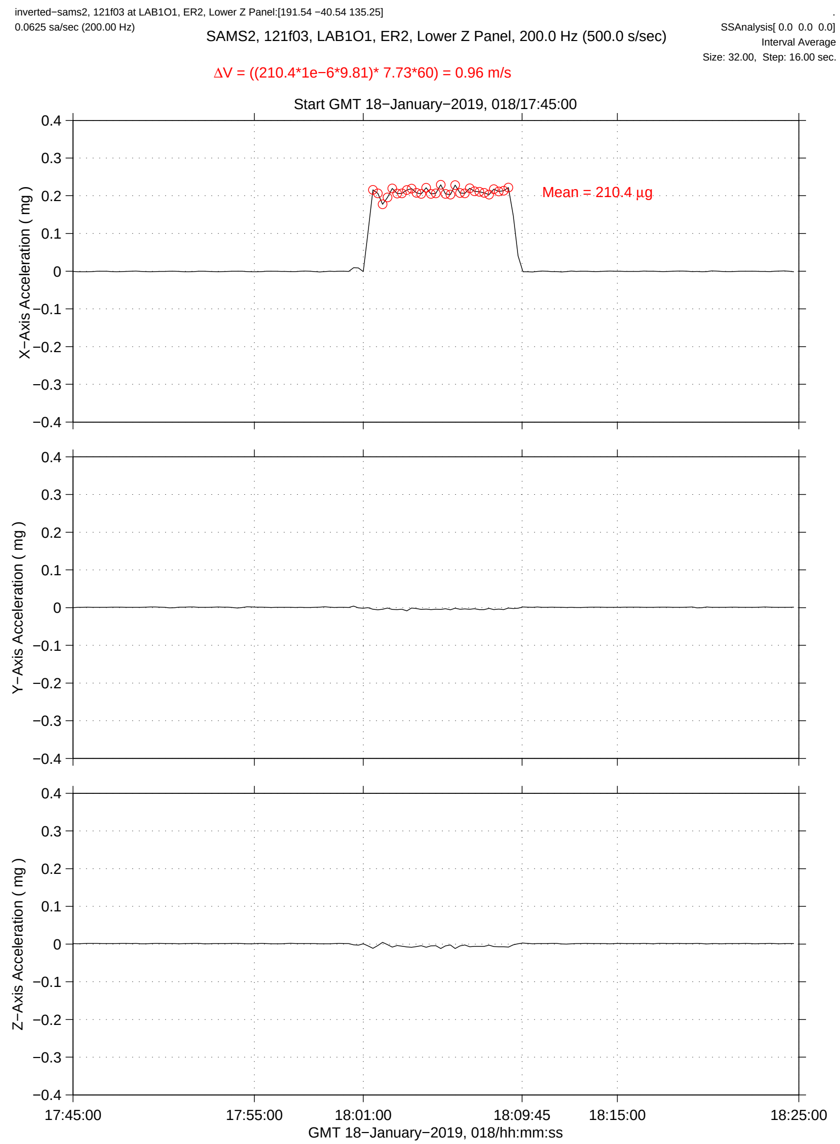

Fig. 3: Interval average of SAMS 121f03 sensor data shows Progress 71P reboost.

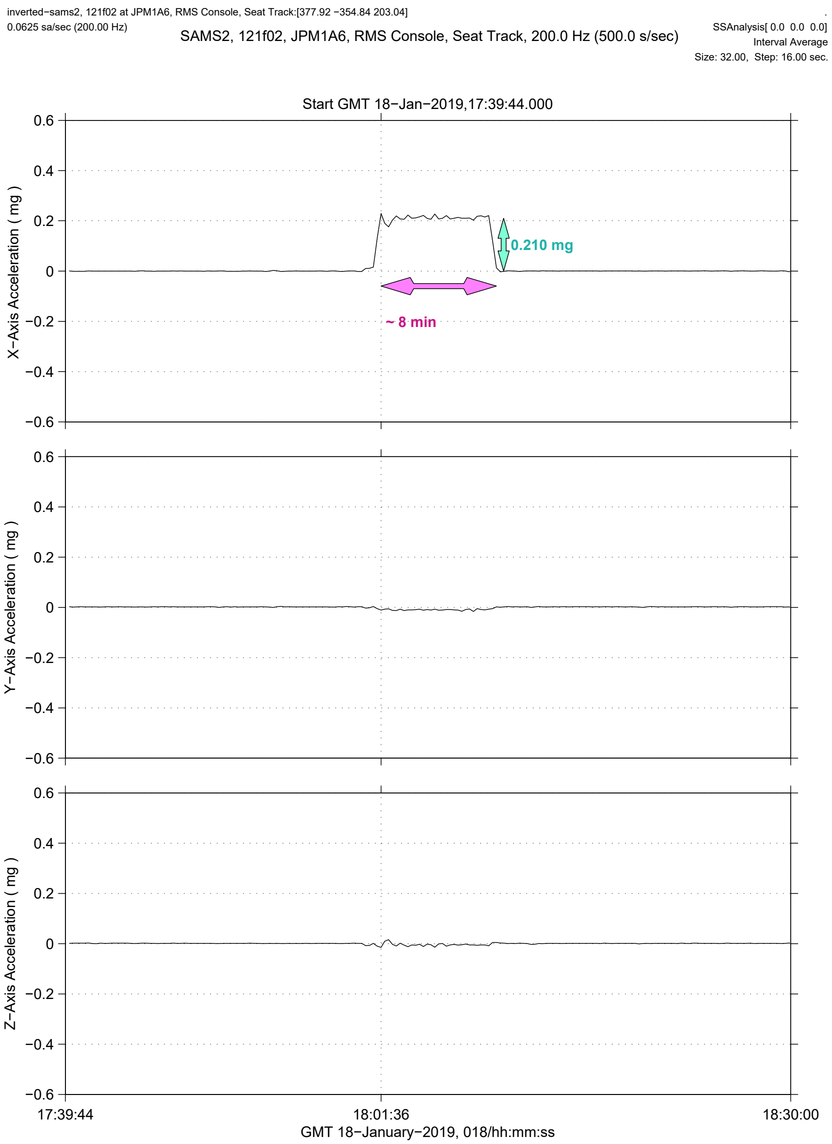

Fig. 4: 32-sec interval average for SAMS 121f02 sensor in the JEM.

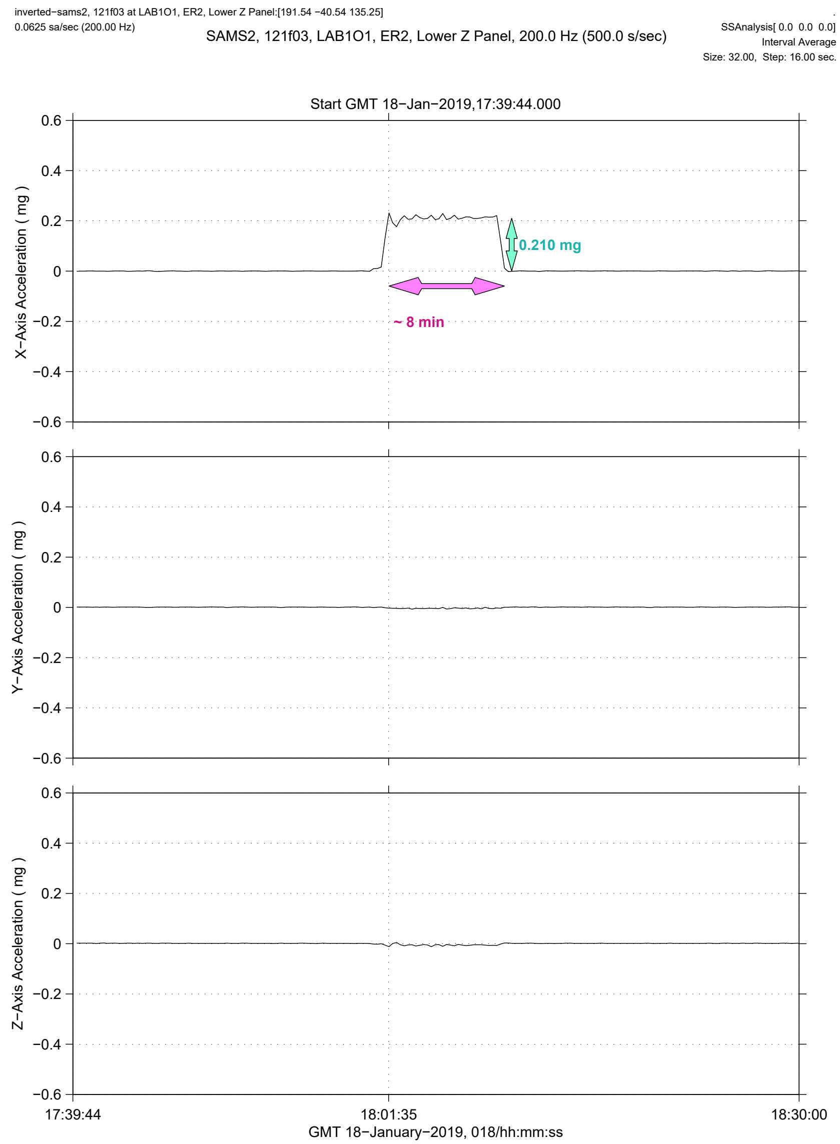

Fig. 5: 32-sec interval average for SAMS 121f03 sensor in the LAB.

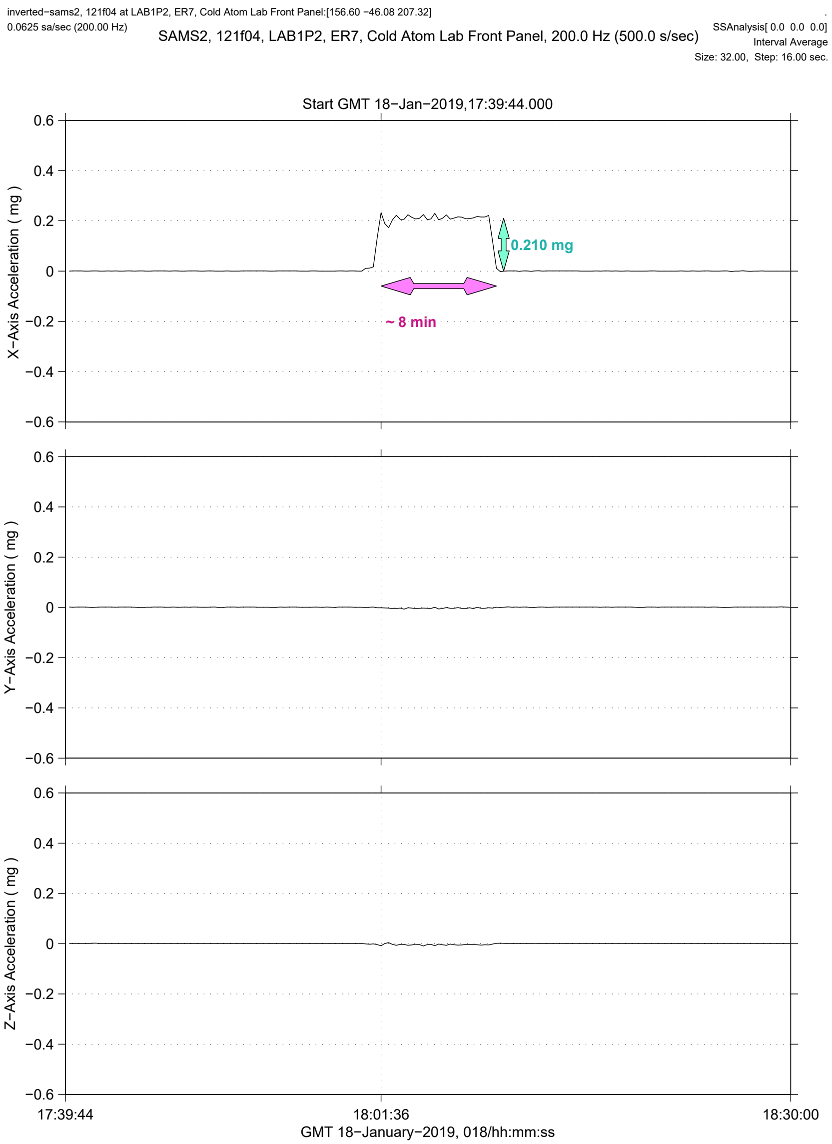

Fig. 6: 32-sec interval average for SAMS 121f04 sensor in the LAB.

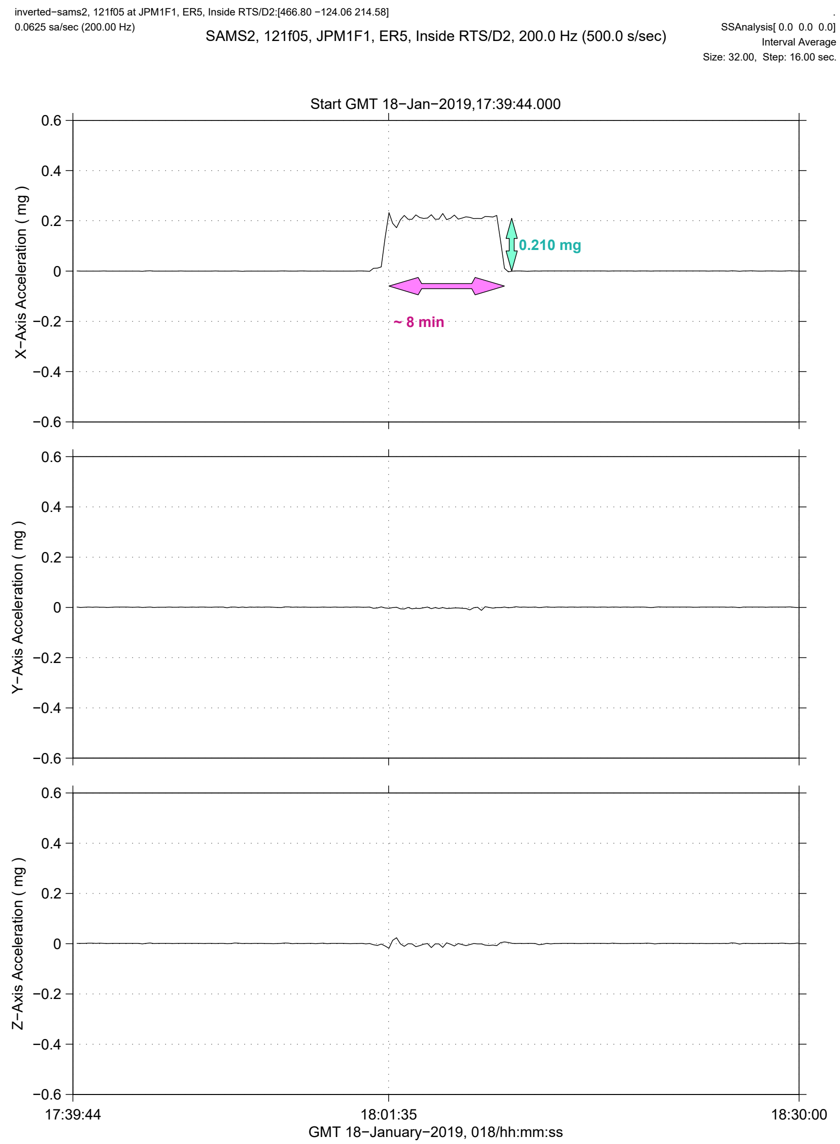

Fig. 7: 32-sec interval average for SAMS 121f05 sensor in the JEM.

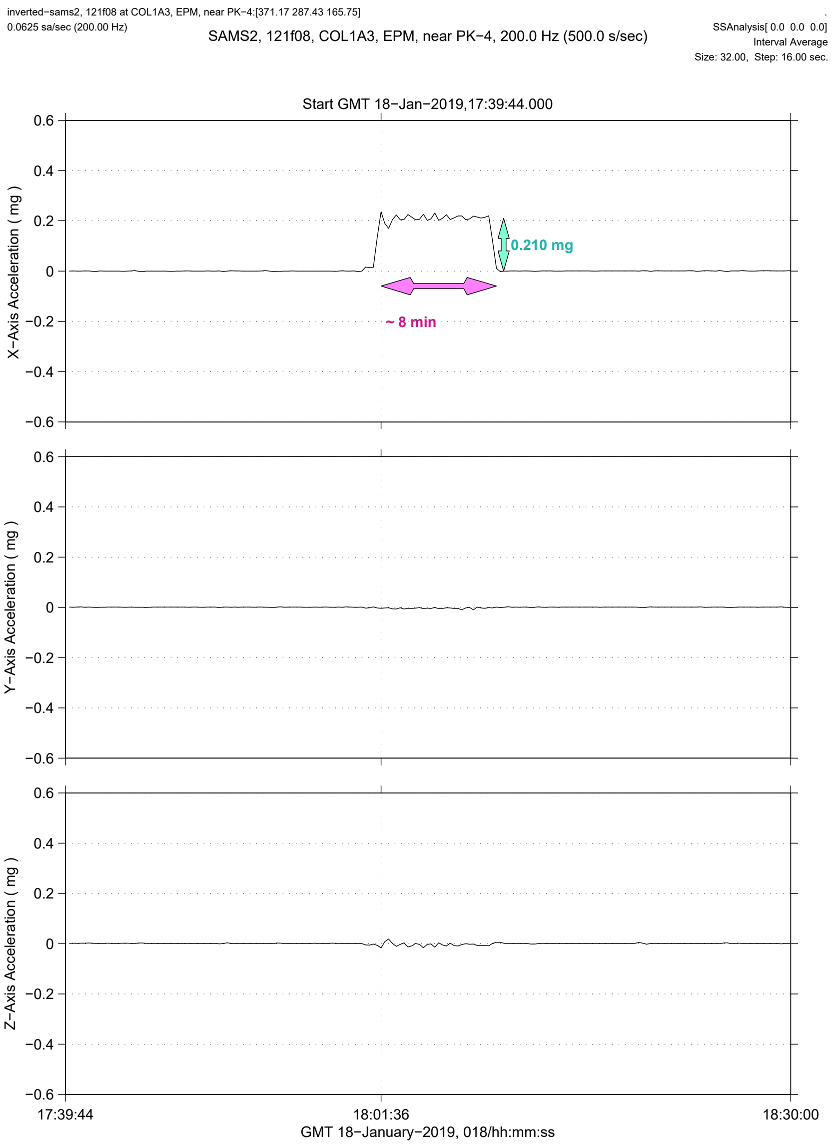

Fig. 8: 32-sec interval average for SAMS 121f08 sensor in the COL.