1. INTRODUCTION

At GMT 2020-09-10, 254/20:32:00, the International Space Station (ISS) began a ~3-minute 45-second reboost using Progress 75P aft thrusters. The purpose of the reboost was to set up phasing conditions for the 63S rendezvous on October 14th and the 62S landing on October 21st. The visiting vehicles graphic of Figure 1 shows the location and alignment of the Progress 75P vehicle during this reboost. Newton's 3rd law is 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 increase the altitude of the space station. During this reboost, the ISS climbed about 0.8 km.

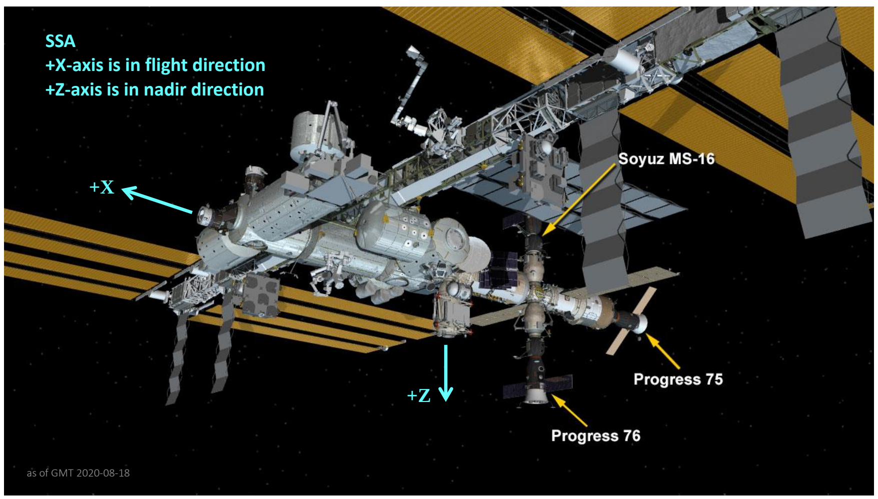

Fig. 1: Progress 75P's location and alignment during reboost.

2. QUALIFY

The information shown in Figure 2 was calculated from SAMS sensor 121f03 measurements made in the US Laboratory module. This plot shows increased structural vibration excitation between about 19:50 and 21:20. We can attribute some of this increase 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 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 over about 90 minutes. The actual reboost activity itself lasted about 3 minutes 45 seconds during the span indicated by the magenta symbol on the time axis of Figure 2. 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 – this one lasting about 4 minutes – but also during the span of Russian Segment attitude control as shown here.

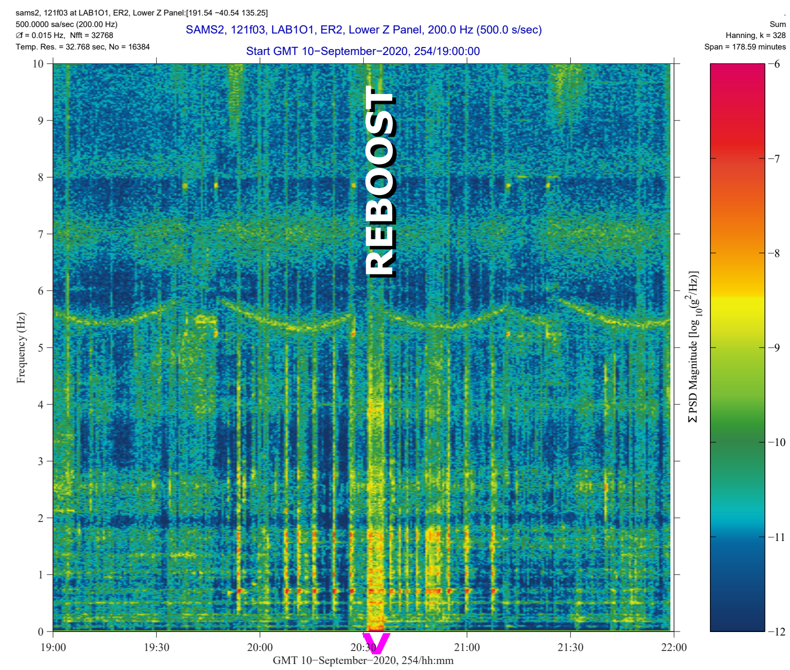

Fig. 2: Spectrogram showing Progress 75P Reboost on GMT 2020-09-10.

3. QUANTIFY

The as-flown timeline for this event indicated the reboost would start at GMT 20:32 and have a duration of about 3 minutes 45 seconds. Analysis of Space Acceleration Measurement System (SAMS) data recordings shows the tell-tale X-axis step that nearly matches the start time and the duration as seen in the top subplot of Figure 3.

Four 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 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 inversion issue inherent in SAMS transducers. A somewhat crude quantification of the reboost as measured by the 5 distributed SAMS sensors is given in Table 1.

Table 1. **X-axis** steps (mg) during reboost event for 5 SAMS sensors.

Sensor	X-Axis	Location
121f02	0.203	JPM1A6 (RMS Console)
121f03	0.195	LAB1O1 (ER2)
121f04	0.199	LAB1P2 (ER7)
121f05	0.200	JPM1F1 (ER5)
121f08	0.198	COL1A3 (EPM)

4. CONCLUSION

The SAMS sensors were designed to characterize the higher-frequency vibratory environment of the ISS, but not the lower-frequency, quasi-steady environment. However, they perform well for capturing the relatively large steps induced by reboost events. The SAMS sensor data analyzed showed an **X-axis** step during the Progress 75P 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 0.44 meters/second was achieved. This value nearly matched the planned value of ΔV = 0.45 meters/second. Flight controllers reported that this reboost elevated the space station's altitude by 0.8 km.

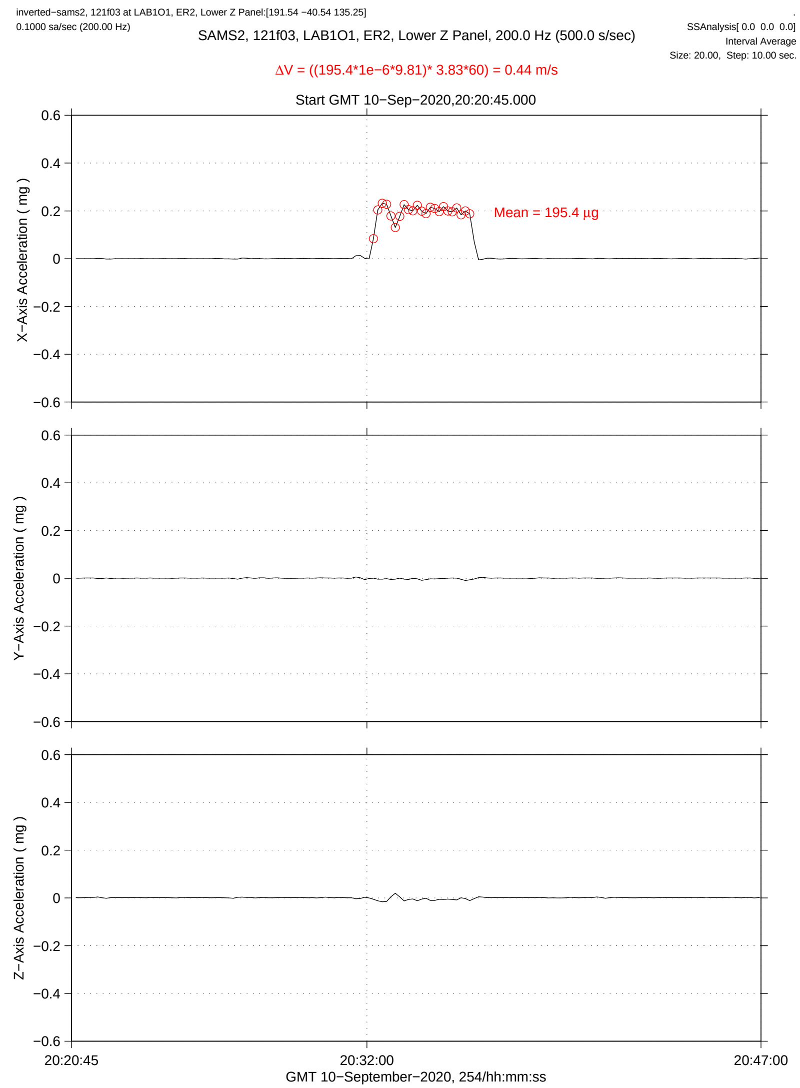

Fig. 3: Interval average of SAMS 121f03 sensor data shows Progress 75P reboost.

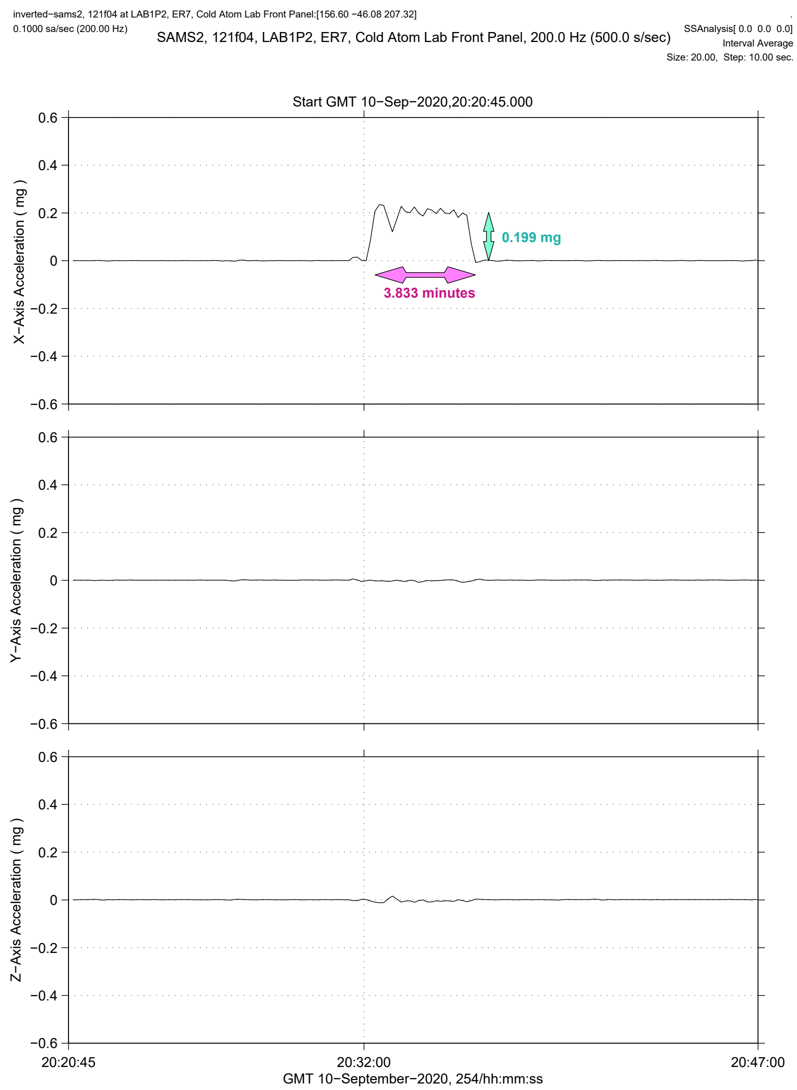

Fig. 4: 20-sec interval average for SAMS 121f04 sensor in the LAB.

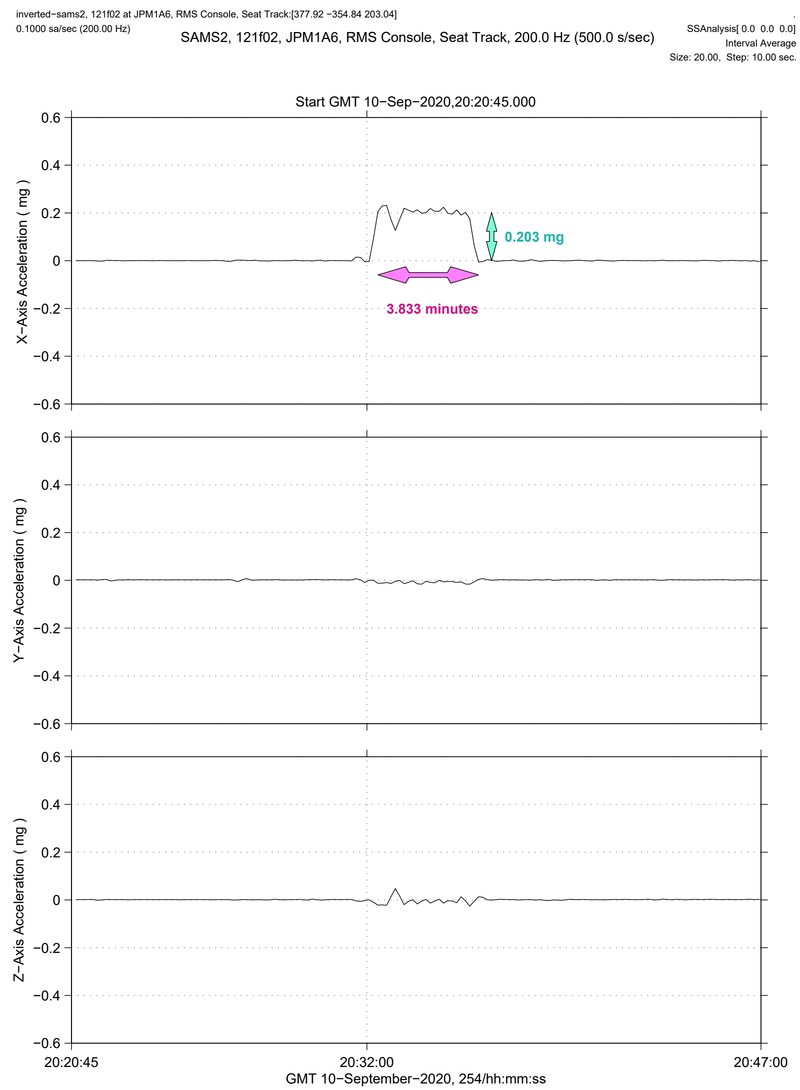

Fig. 5: 20-sec interval average for SAMS 121f02 sensor in the JEM.

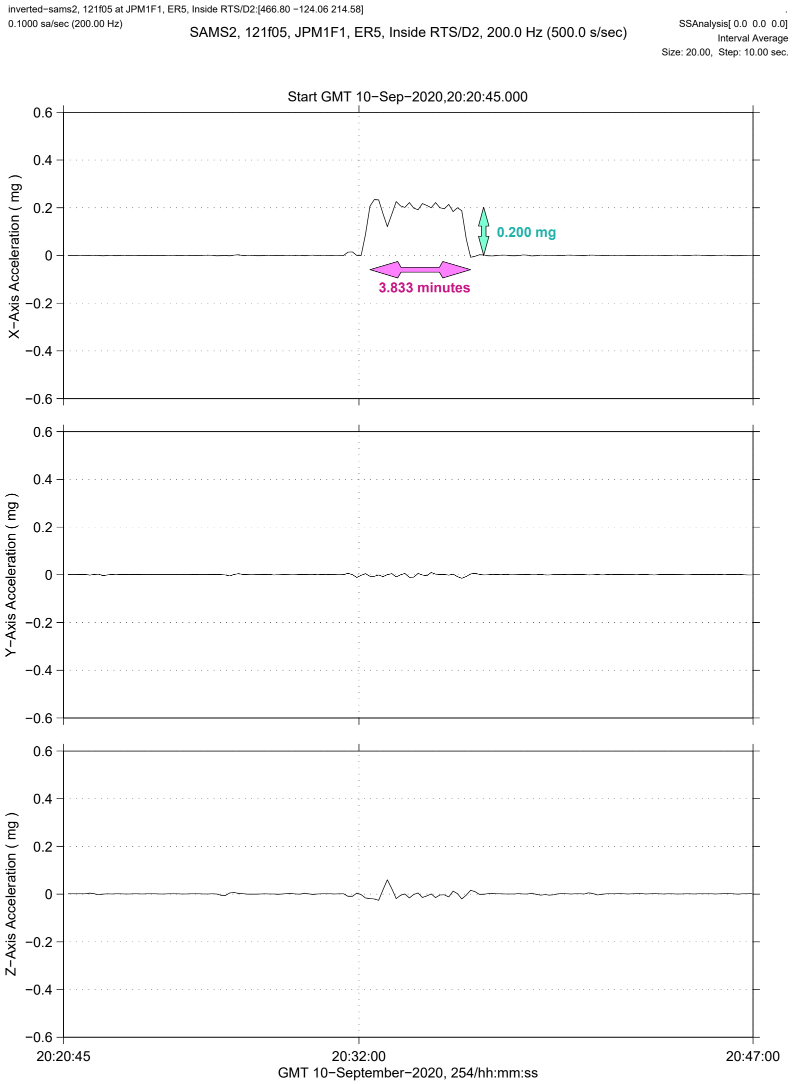

Fig. 6: 20-sec interval average for SAMS 121f05 sensor in the JEM.

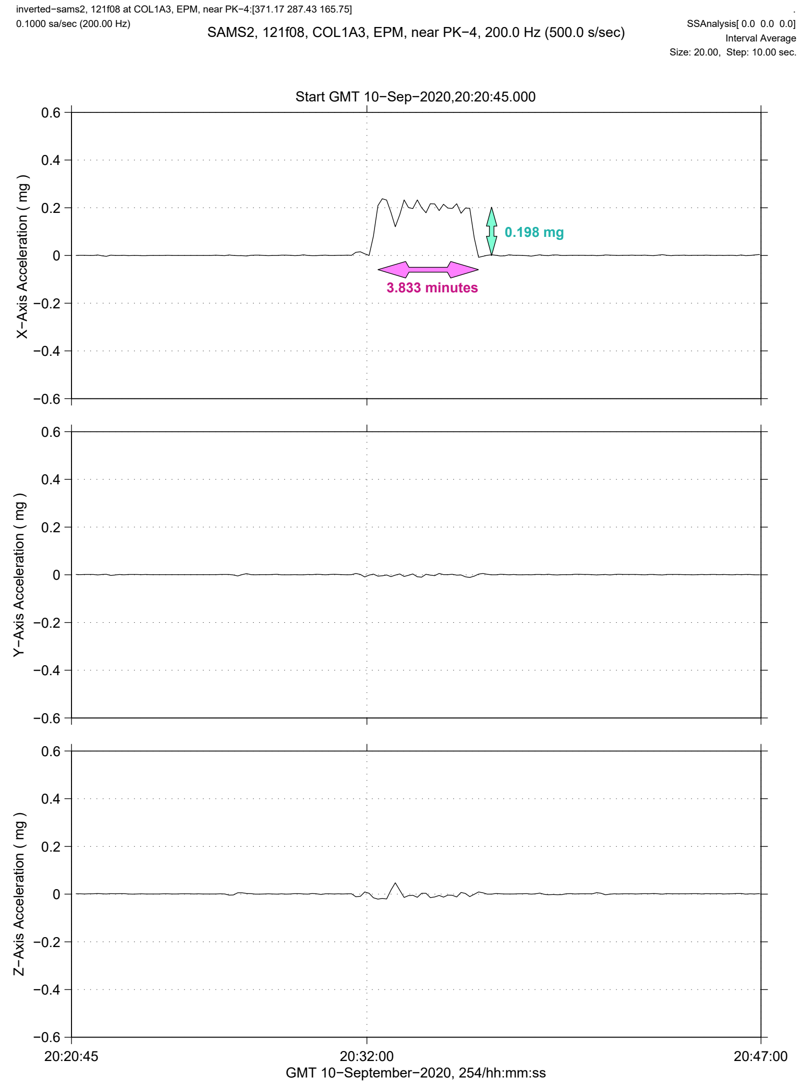

Fig. 7: 20-sec interval average for SAMS 121f08 sensor in the COL.