1. INTRODUCTION

At GMT 2020-04-02, 093/12:41:00, the International Space Station (ISS) began a ~7-minute reboost using Progress 74P mid-ring thrusters. The purpose of the reboost was to set up conditions for the 62S 4-Orbit rendezvous on April 9th and the 61S landing on April 17th. The visiting vehicles graphic of Figure 1 shows the location and alignment of the Progress 74P vehicle during this reboost. When you consider the fact that the space station's attitude was adjusted (with about 18 degrees of pitch) to align the thrust vector of the Progress with the velocity vector of the space station, then it becomes apparent that Newton's 3rd law is in action (and reaction) here with Progress thrusters firing aftward of the direction of flight to accelerate the ISS and speed up into the direction of flight. It is this increase in velocity in the flight direction that puts orbital mechanics in play to increase the altitude of the space station.

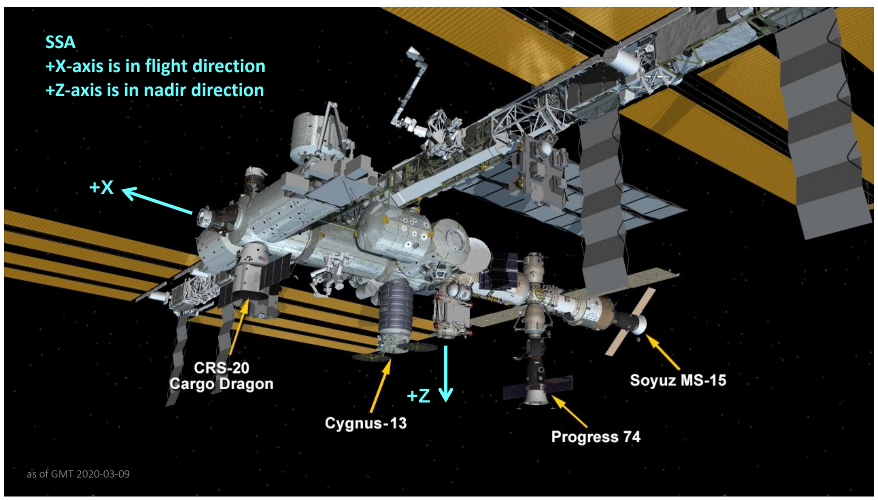

Fig. 1: Progress 74P's location and alignment during reboost.

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 11:50 and 13:40. We can attribute much 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 2 hours. The actual reboost activity itself lasted about 7 minutes 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 7 minutes – but also during the span of Russian Segment attitude control (~2 hours) as shown here.

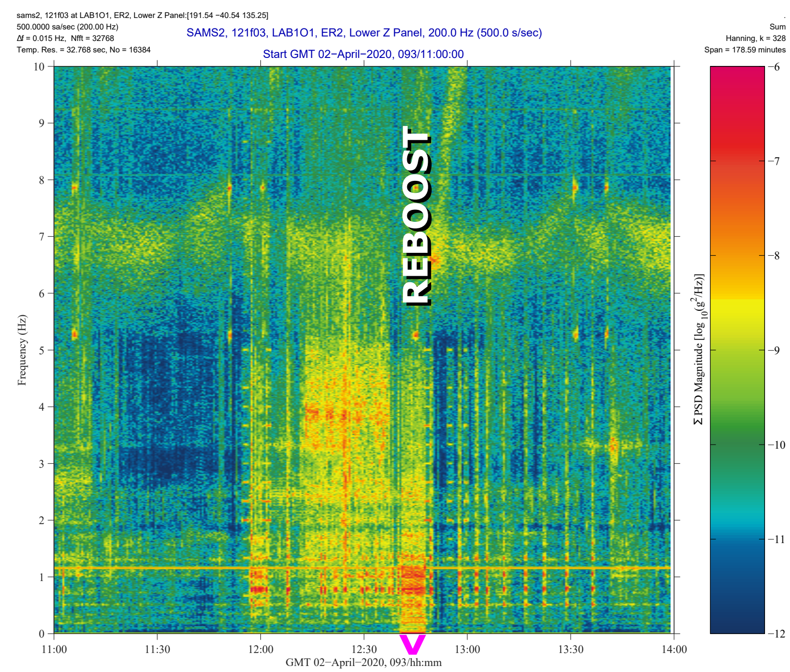

Fig. 2: Spectrogram showing Progress 74P Reboost on GMT 2020-04-02.

3. QUANTIFY

The as-flown timeline for this event indicated the reboost would start at GMT 12:41 and have a duration of about 7 minutes. Analysis of Space Acceleration Measurement System (SAMS) data recordings show an XZ-plane step that nearly matches the start time and the duration as seen in Figure 3.

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 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 6 distributed SAMS sensors is given in Table 1.

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

Sensor	X-Axis	Z-Axis	Location
121f02	0.115	0.034	JPM1A6 (RMS Console)
121f03	0.113	0.035	LAB1O1 (ER2)
121f04	0.115	0.034	LAB1P2 (ER7)
121f05	0.116	0.033	JPM1F1 (ER5)
121f08	0.115	0.034	COL1A3 (EPM)
es20	0.115	0.035	LAB1O4 (ER6)

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 **XZ-plane** step during the Progress 74P reboost of about 0.119 mg, where the Z-axis component is not typical. Furthermore, calculations based on SAMS sensor (121f03) mounted on EXPRESS Rack 2 in the US LAB indicate a ΔV of about 0.47 meters/second was achieved. This value for change in velocity matched the planned value of ΔV = 0.47 meters/second. Flight controllers reported that this reboost elevated the space station's altitude by 0.77 km.

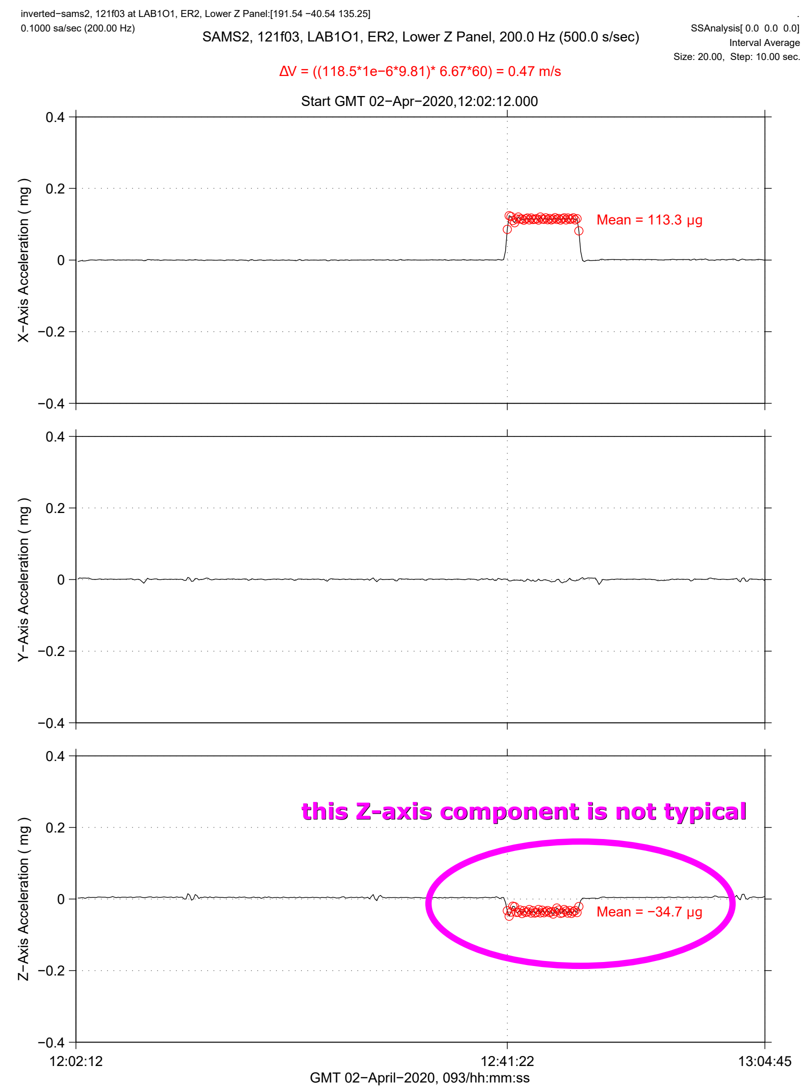

Fig. 3: Interval average of SAMS 121f03 sensor data shows Progress 74P reboost.

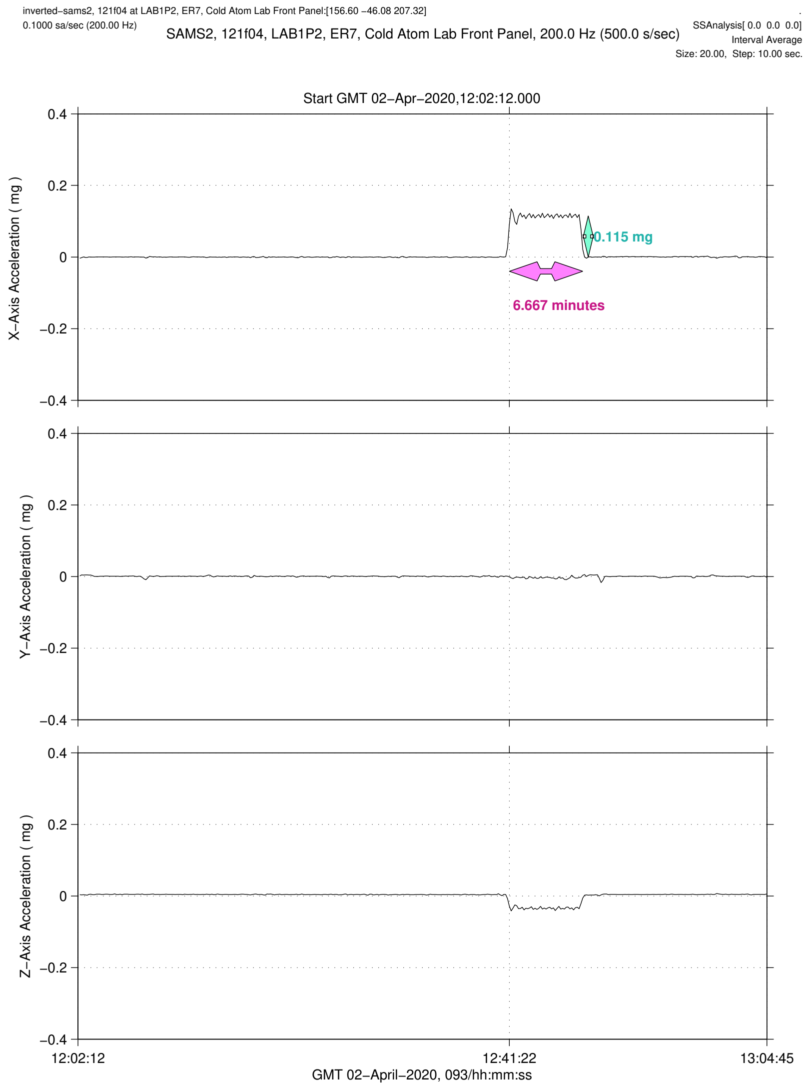

Fig. 4: 20-sec interval average for SAMS 121f04 sensor in the LAB.

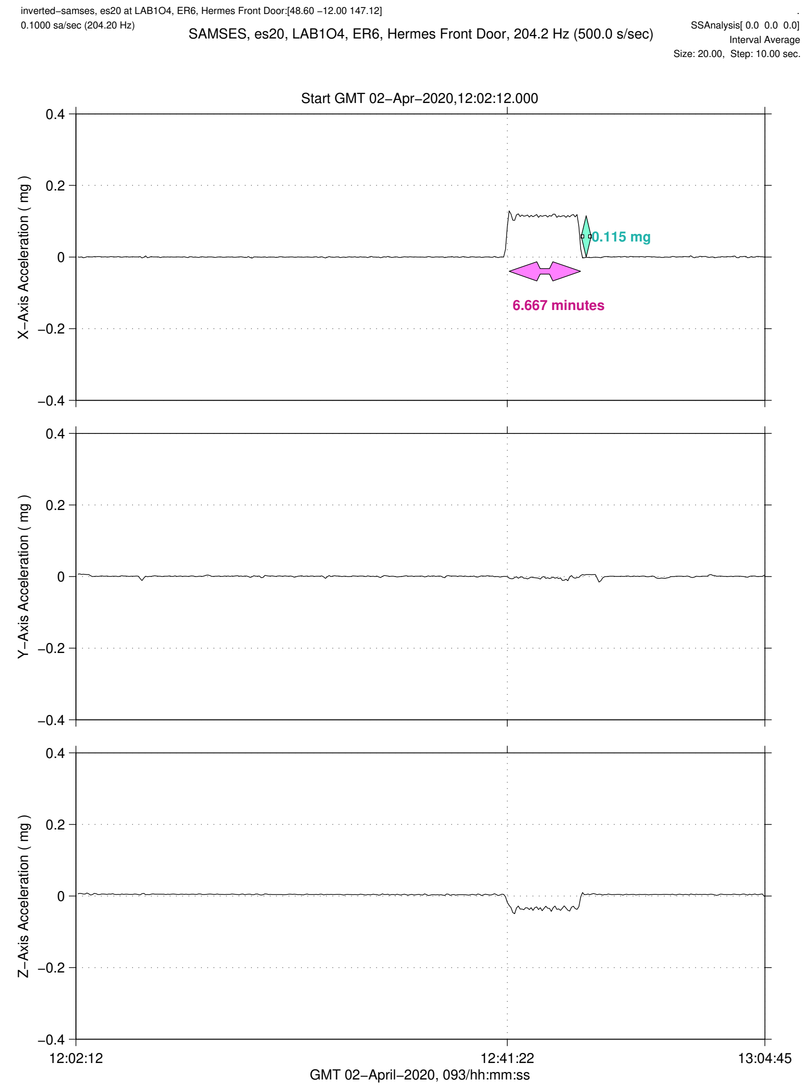

Fig. 5: 20-sec interval average for SAMS es20 sensor in the LAB.

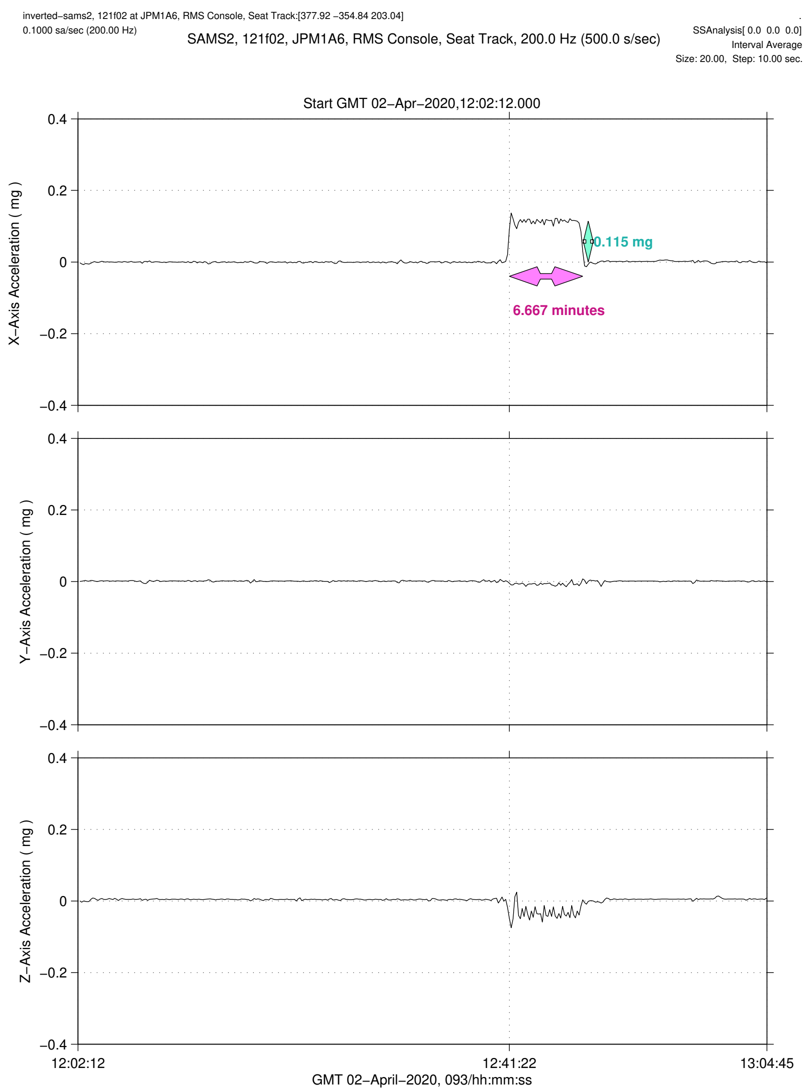

Fig. 6: 20-sec interval average for SAMS 121f02 sensor in the JEM.

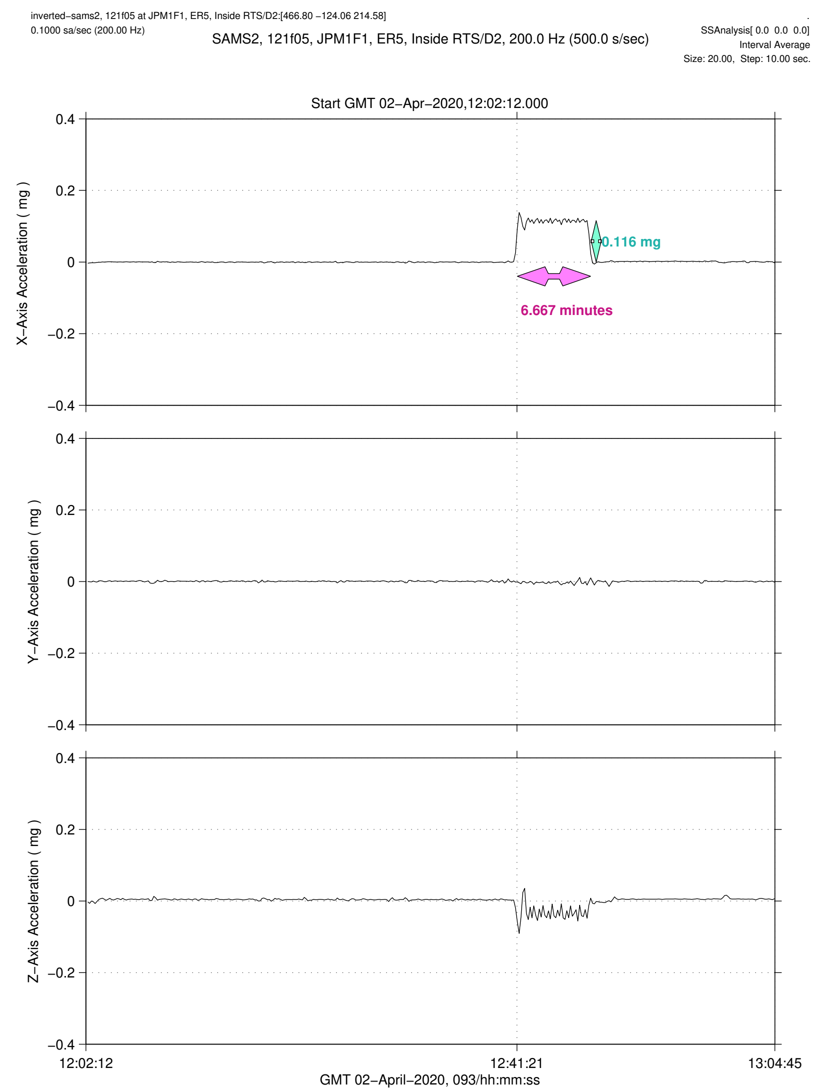

Fig. 7: 20-sec interval average for SAMS 121f05 sensor in the JEM.

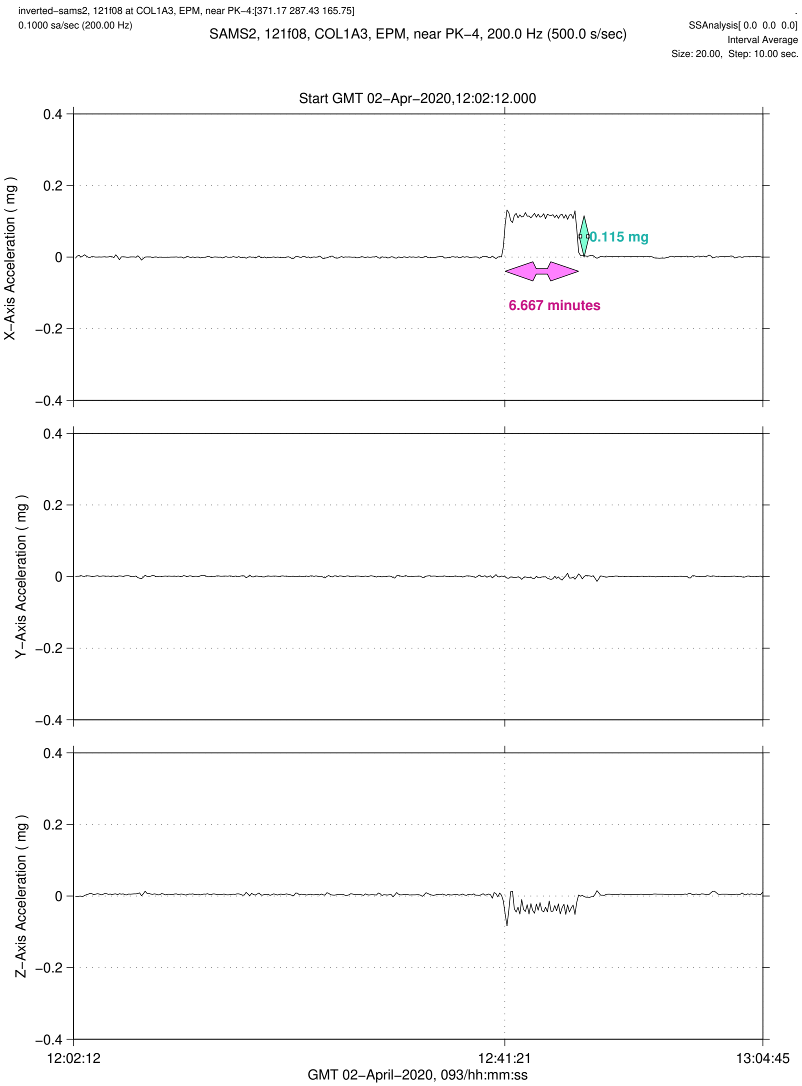

Fig. 8: 20-sec interval average for SAMS 121f08 sensor in the COL.