1. INTRODUCTION

At GMT 2020-10-07, 281/08:26:30, the International Space Station (ISS) began a ~6-minute 53-second deboost using eight Progress 75P thrusters. This was the third of three planned burns to set up the phasing conditions for the Soyuz 63S rendezvous on GMT 2020-10-14 and the Soyuz 62S landing on GMT 2020-10-21. This burn was originally planned to occur posigrade (aka reboost), but needed to be switched to retrograde after the GMT 2020-09-22 Posigrade Debris Avoidance Maneuver (PDAM) to mitigate a conjunction risk.

The graphic of Figure 1 shows the location and alignment of the Progress 75P, and the cyan-colored annotations show flight attitude/directions. To prepare for this deboost, the space station was maneuvered on the previous day to what is referred to as a "-XVV" attitude, which means it was "flying backwards" and thereby pointing the Progress 75P main engine thrusters into the ram direction, or "into the wind". This alignment of the thrust vector to directly oppose the velocity vector (aka retrograde, which is to oppose the direction of flight) gives way to here citing Newton's 3rd law. You remember that..."for every action, there is an equal and opposite reaction". Well, that bit of physics was employed by flight controllers in Houston and Moscow to decelerate the ISS, and slow it down. It was this decrease of velocity in the direction of flight that put orbital mechanics into play to ultimately decrease the altitude of the space station and achieve the intended, lower orbital altitude needing for future rendezvous phasing.

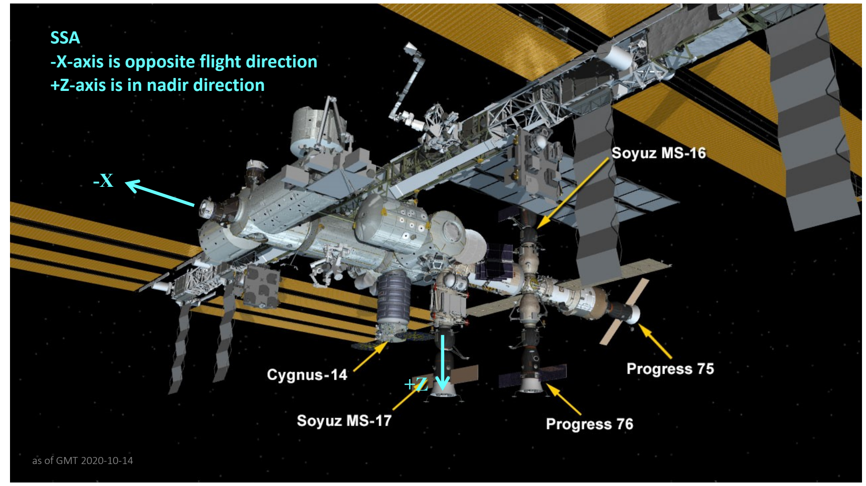

Fig. 1: Progress 75P's location and alignment during deboost.

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 GMT 08:00 and 09:06. It would actually show this back to GMT 07:21 if we extended the plot back to that time. 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 deboost event. The increased structural vibrations are evident as slightly 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 a couple of hours. The actual deboost activity was planned for 6 minutes 53 seconds, but actually lasted just about 7 minutes. 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 deboost event itself – this one lasting about 7 minutes – but also during the longer span of Russian Segment attitude control as shown here.

3. QUANTIFY

The as-flown timeline for this event indicated the deboost would start at GMT 08:26 and have a duration of 6 minutes 53 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 Figure 3. Notice that SAMS registers a +X-axis step during a **deboost** identical in polarity to that of a **reboost** and that is because the SAMS sensors themselves (and thus their polarity) get their attitude adjusted too as they were rigidly fixed to the ISS body when it was spun around to point the Progress 75P thruster vector counter (retrograde) to the velocity vector.

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 deboost event. It should also be noted that we flipped the

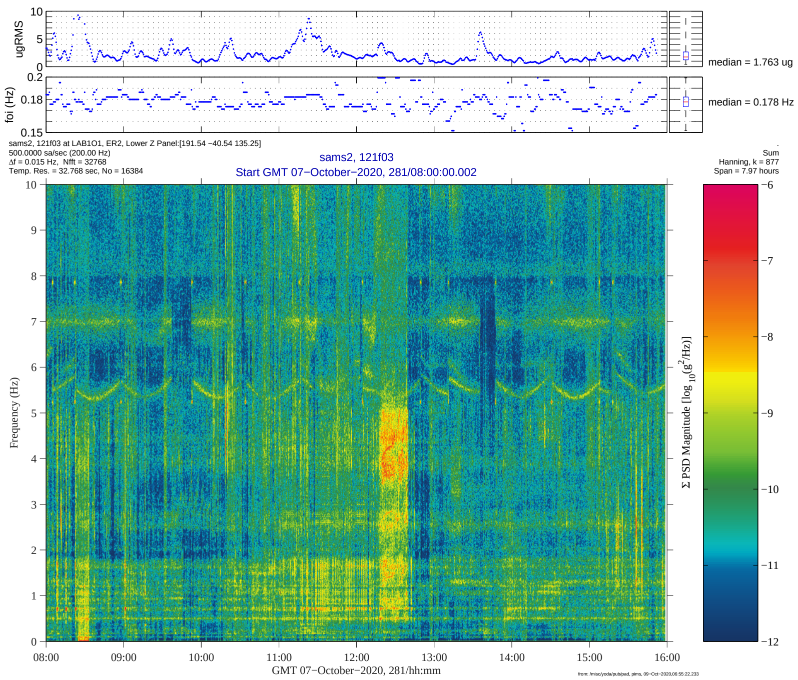

Fig. 2: Spectrogram showing Progress 75P Deboost on GMT 2020-10-07.

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 deboost as measured by the 5 distributed SAMS sensors is given in Table 1.

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 a deboost. Despite the underlying low-frequency & low-magnitude baseline being obscured by transducer bias/offset, SAMS sensors easily detect the gross acceleration step of deboost as again demonstrated here. The SAMS sensor data analyzed showed an X-axis step

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

Sensor	X-Axis	Location
121f02	0.177	JPM1A6 (RMS Console)
121f03	0.178	LAB1O1 (ER2)
121f04	0.178	LAB1P2 (ER7)
121f05	0.178	JPM1F1 (ER5)
121f08	0.177	COL1A3 (EPM)

during the Progress 75P deboost 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 0.73 meters/second was achieved. This value matched the planned value of ΔV = 0.72 meters/second. Not a calculation based on SAMS measurements, but flight controllers in Houston reported a decrease in altitude of about 1.3 km for this deboost.

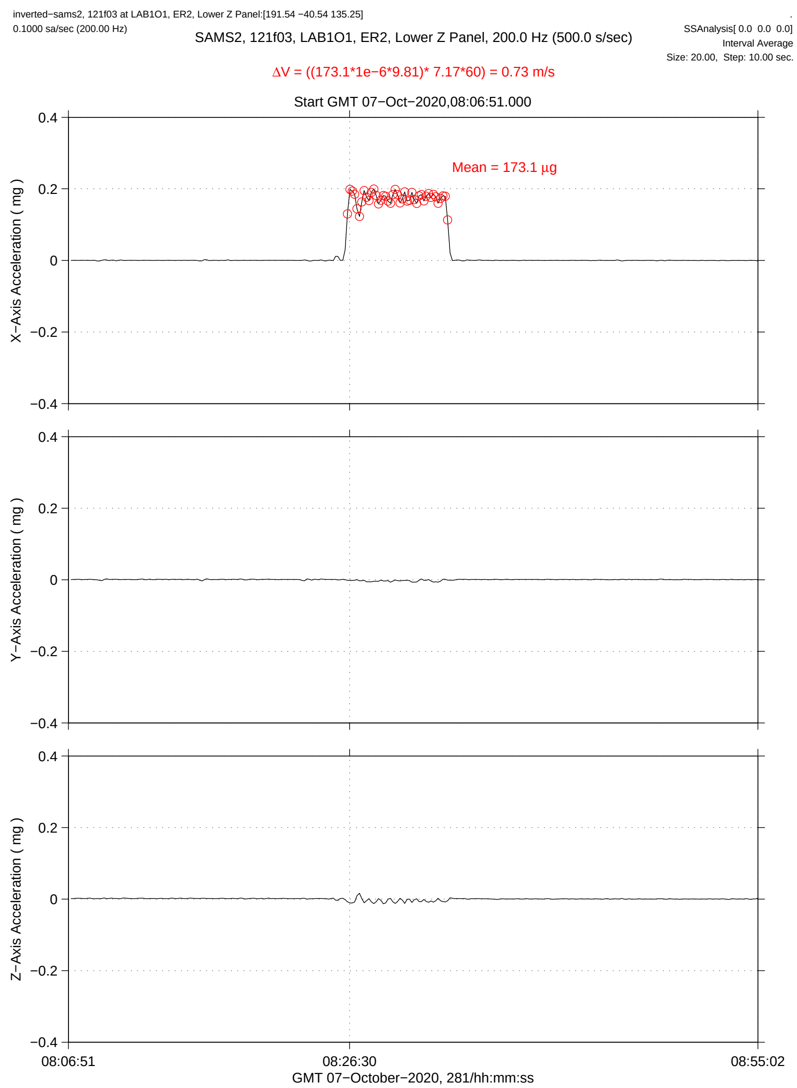

Fig. 3: Interval average of SAMS 121f03 data shows Progress 75P deboost.

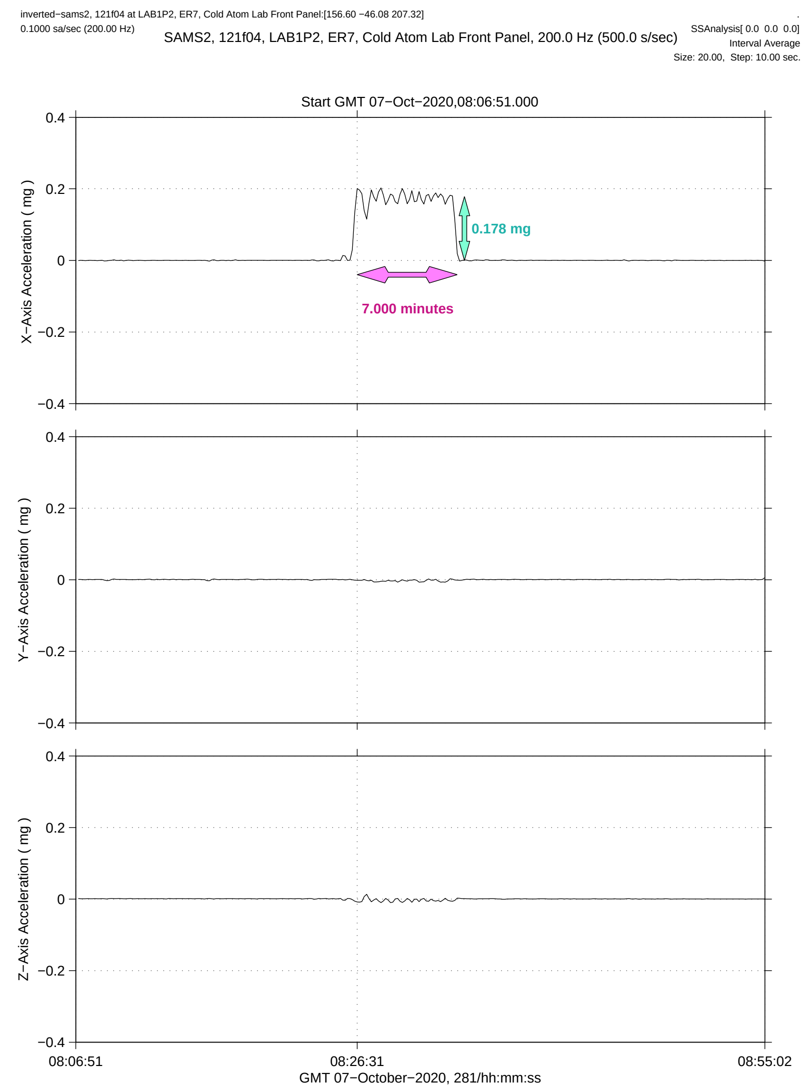

Fig. 4: 20-sec interval average for SAMS 121f04 sensor in the LAB.

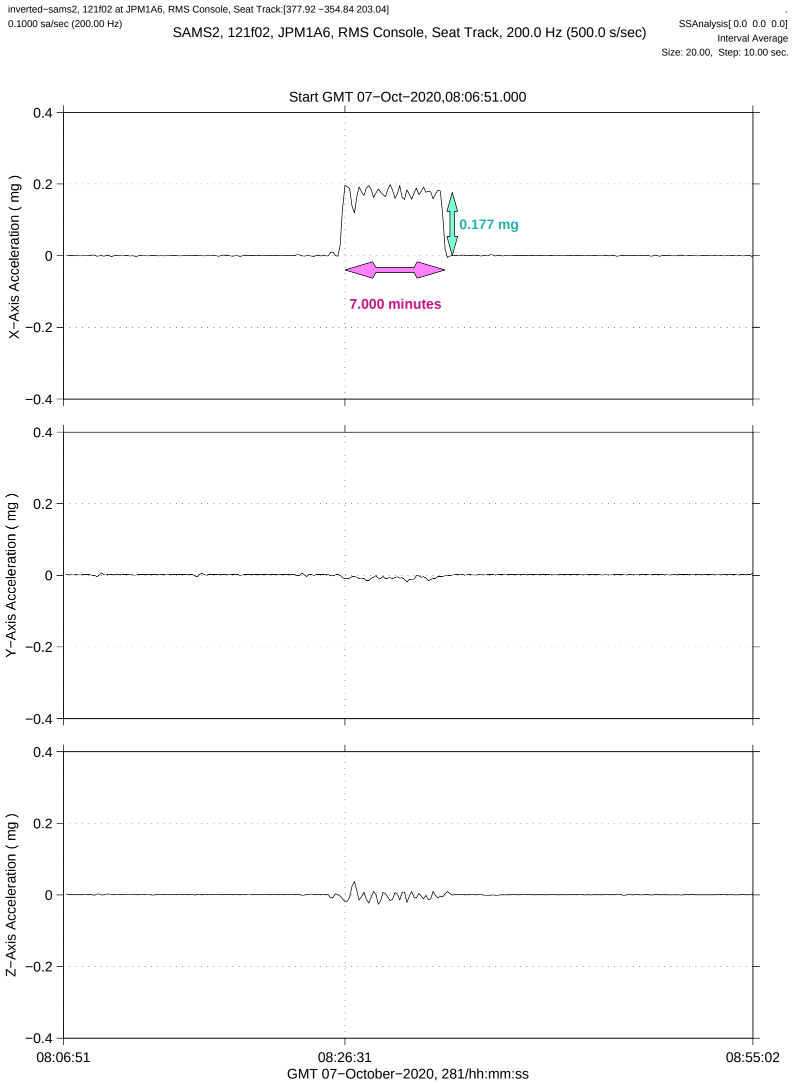

Fig. 5: 20-sec interval average for SAMS 121f02 sensor in the JEM.

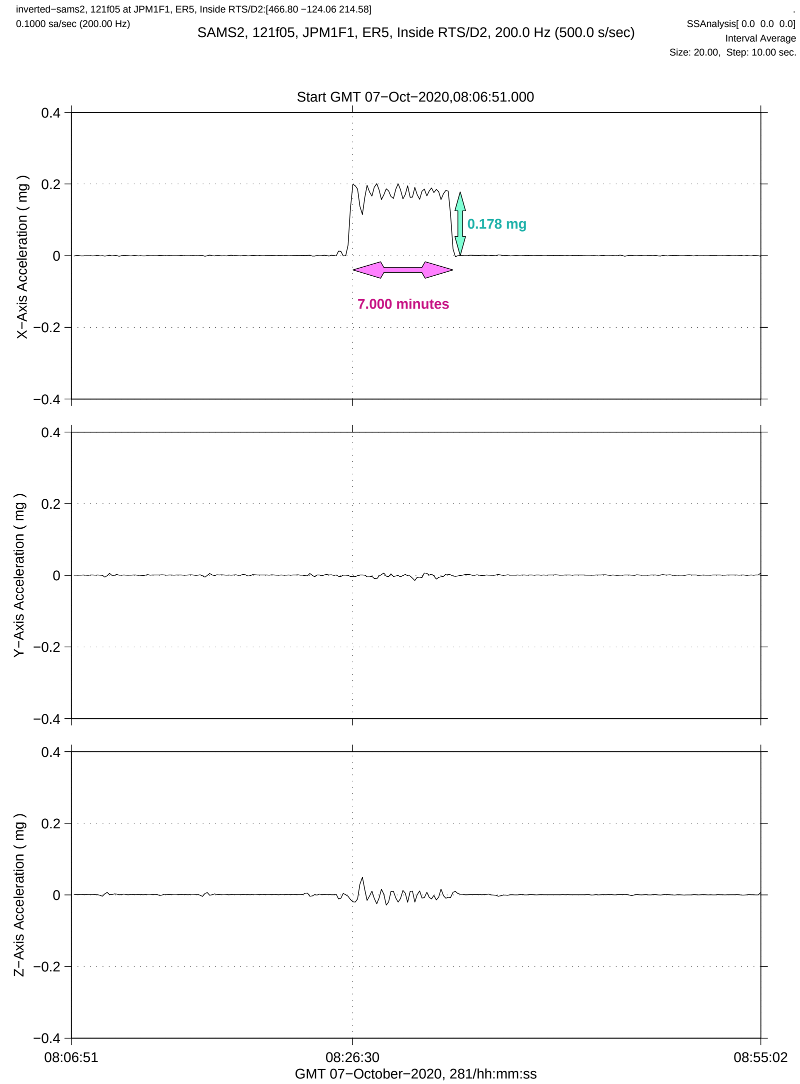

Fig. 6: 20-sec interval average for SAMS 121f05 sensor in the JEM.

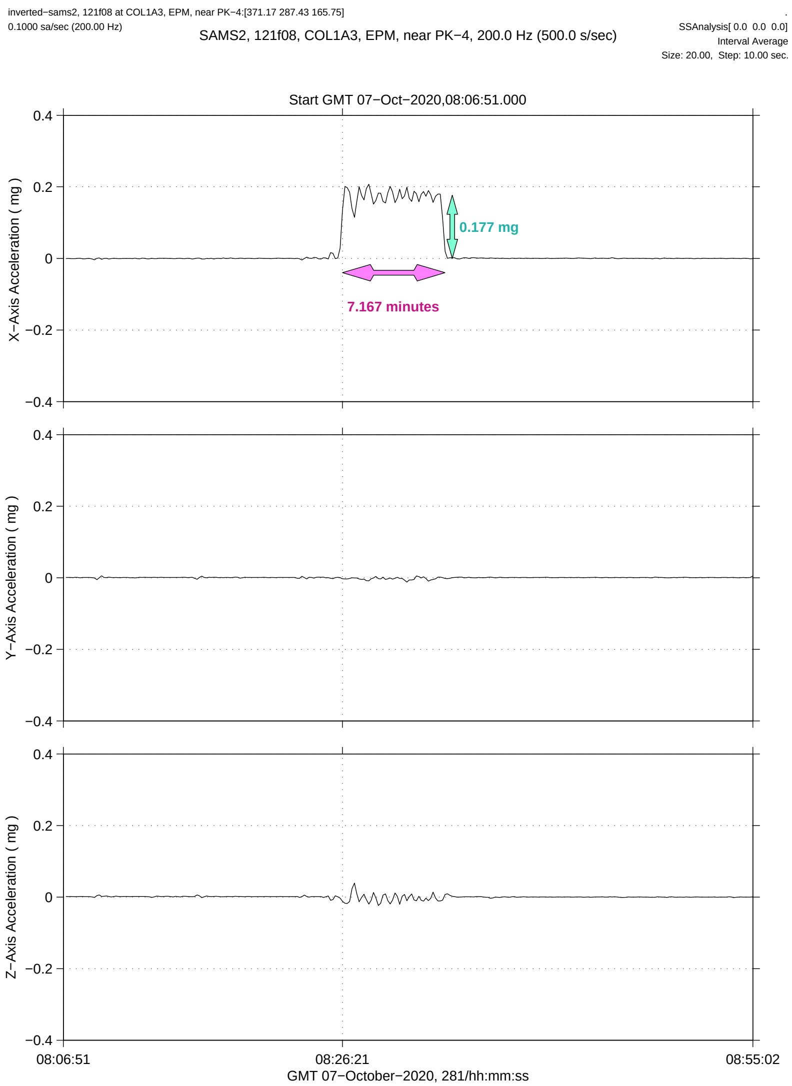

Fig. 7: 20-sec interval average for SAMS 121f08 sensor in the COL.