1. INTRODUCTION

At GMT 2021-06-24, 175/02:40:25, the International Space Station (ISS) began a 7-minute reboost using the Progress 77P thrusters. This reboost put the necessary orbital mechanics into play so as to increase the altitude of the space station.

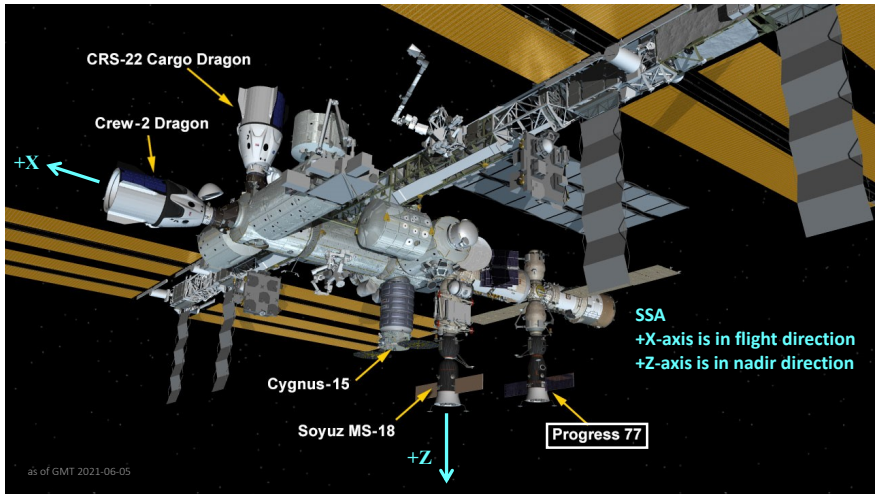

Fig. 1: Progress 77P's location and alignment during reboost.

2. QUALIFY

The information shown in Figure 2 was calculated from the Space Acceleration Measurement System (SAMS) sensor 121f03 measurements made in the US Laboratory module from it sensor mounting location on the lower Z-panel of EXPRESS rack 2. This plot shows increased structural vibration excitation contained mostly below 2 Hz or so. We attribute much of this increase to Russian Segment (RS) attitude control since the as-flown timeline shows RS control from about GMT 01:35 to about 03:20 (as shown with white annotations) for the reboost activity, as usual. 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 just under 2 hours. 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 response to attitude control thruster forces. The actual reboost activity itself lasted about 7 minutes as evidenced by slightly more pronounced, vertical orange-red streaks in Figure 2 starting around GMT 02:40:25 per SAMS measurements. 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 or so – 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 step in the X-axis, while in the much longer case of RS attitude control, the dominant impact was the excitation of large space station structures' vibrational modes.

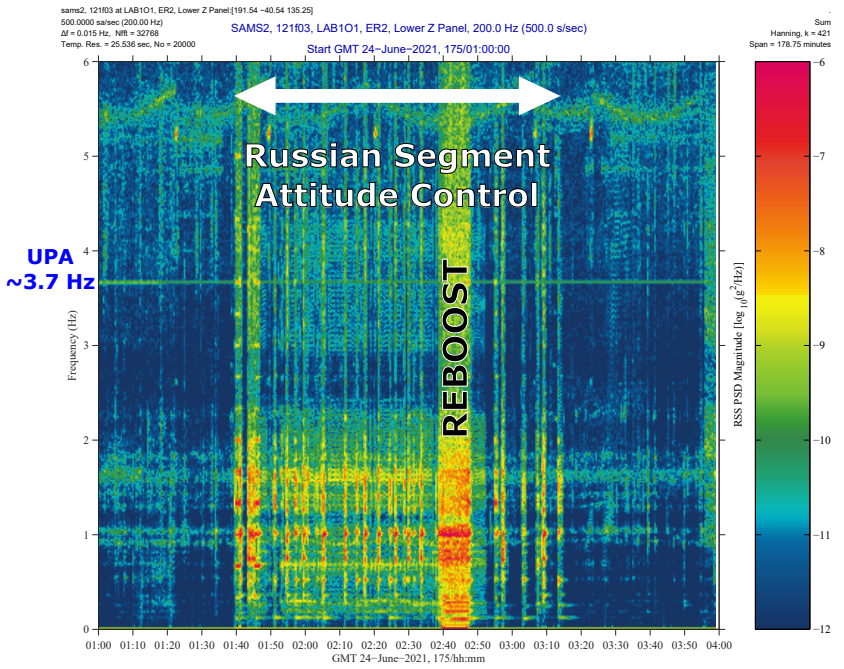

Fig. 2: Spectrogram showing Progress 77P Reboost on GMT 2021-06-24.

3. QUANTIFY

The as-flown timeline for this event indicated the reboost would start at GMT 02:40 and have a duration of 7 minutes and 45 seconds. Analysis of Space Acceleration Measurement System (SAMS) data recordings in the US LAB shows the tell-tale X-axis step that started on time (within resolution of interval averaging process) and lasted about 8 seconds less than planned (again within resolution of the interval averaging process) as shown in 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 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 5 distributed SAMS sensors is also given in Table 1 – expectedly consistent impact results measured by SAMS throughout the megastructure of the space station.

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

Sensor	X-Axis	Location
121f02	0.111	COL1A1 (ER3)
121f03	0.111	LAB1O1 (ER2)
121f04	0.111	LAB1P2 (ER7)
121f05	0.111	JPM1F1 (ER5)
121f08	0.111	COL1A3 (EPM)

4. CONCLUSION

The SAMS sensor data analyzed showed an **X-axis step** during the Progress 77P reboost of about 0.1 mg. Furthermore, calculations based on SAMS sensor (121f03) mounted on EXPRESS Rack 2 in the US LAB indicate a ΔV metric of about 0.46 meters/second was achieved. We also observed **a notable Z-axis disturbance** (a slight negative step) that came with the location of the Progress 77P and this likely due to the orientation of its thrusters relative to the desired thrust direction.

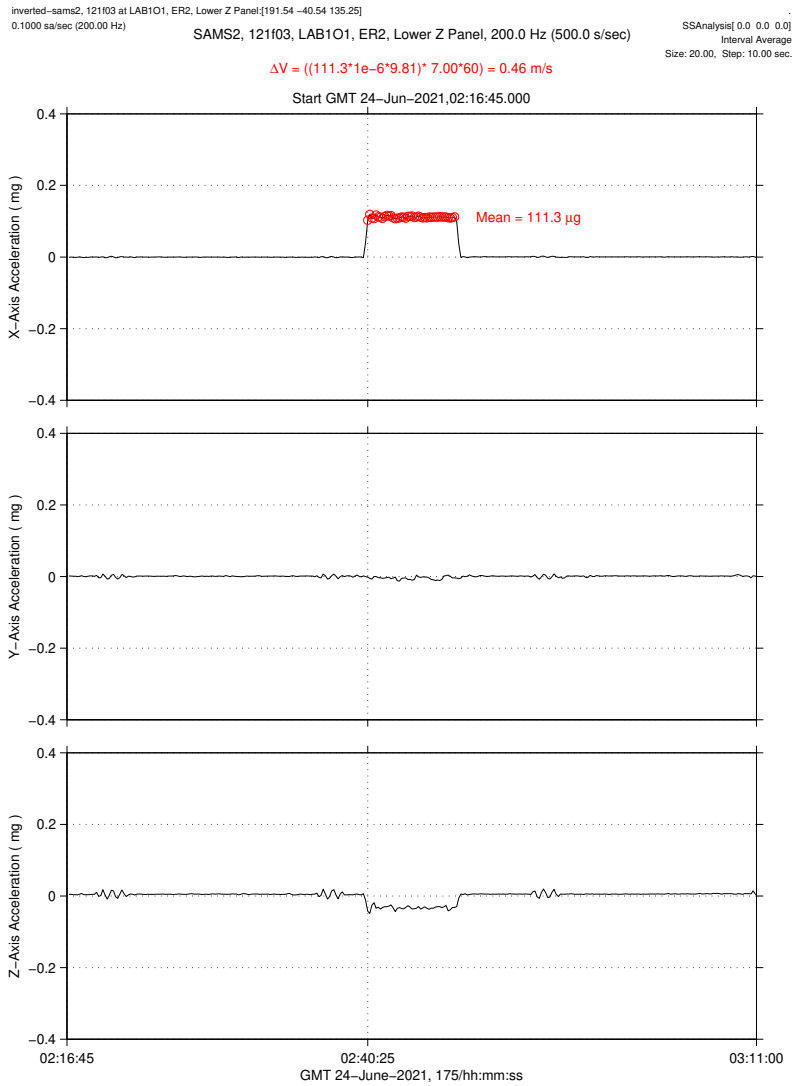

Fig. 3: 20-sec interval average for SAMS 121f03 sensor in the LAB.

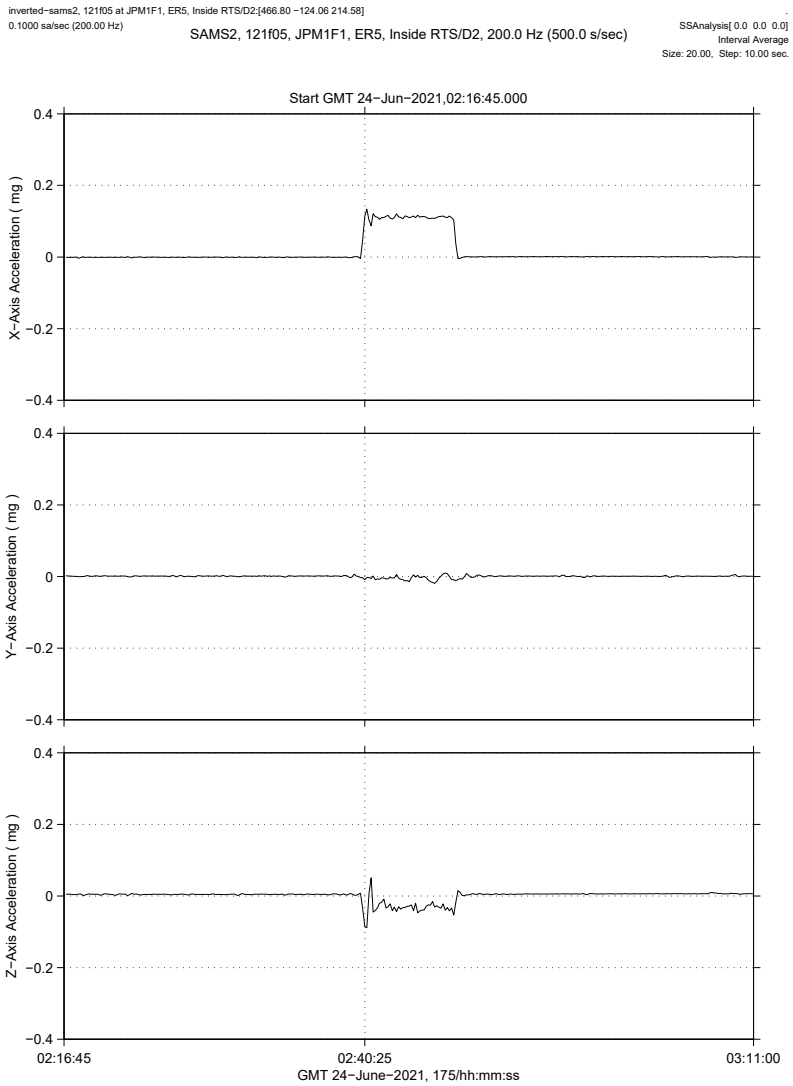

Fig. 4: 20-sec interval average for SAMS 121f05 sensor in the JEM.

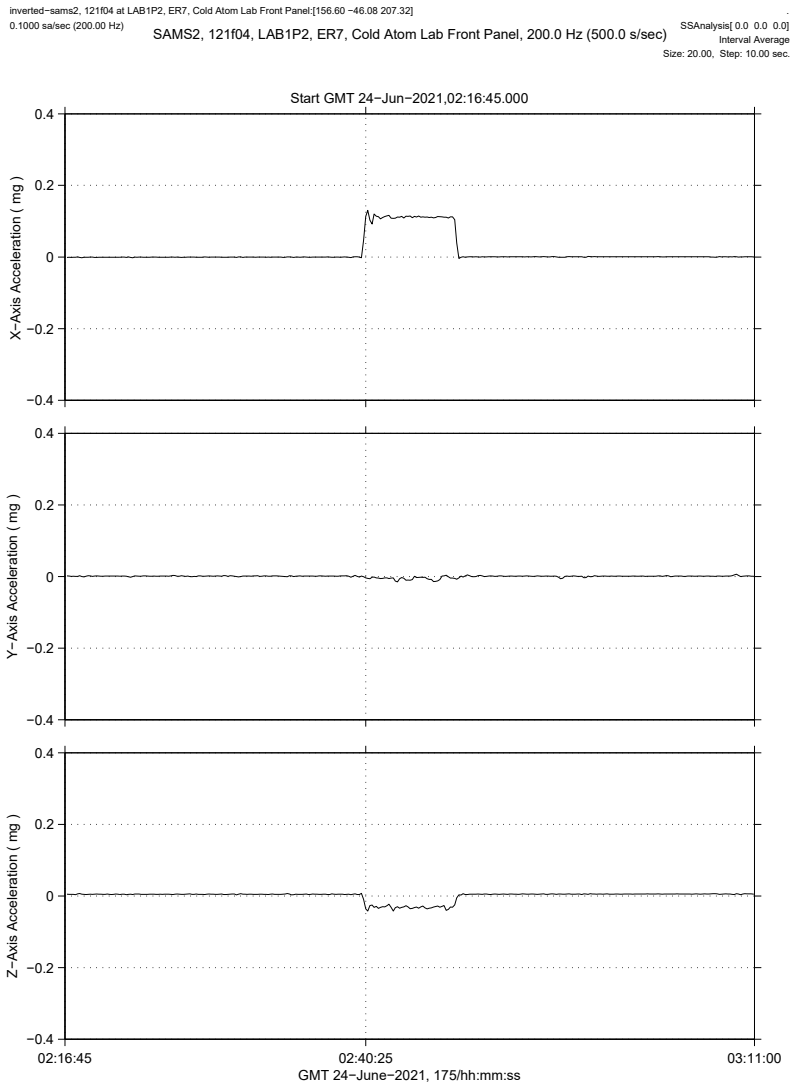

Fig. 5: 20-sec interval average for SAMS 121f04 sensor in the LAB.

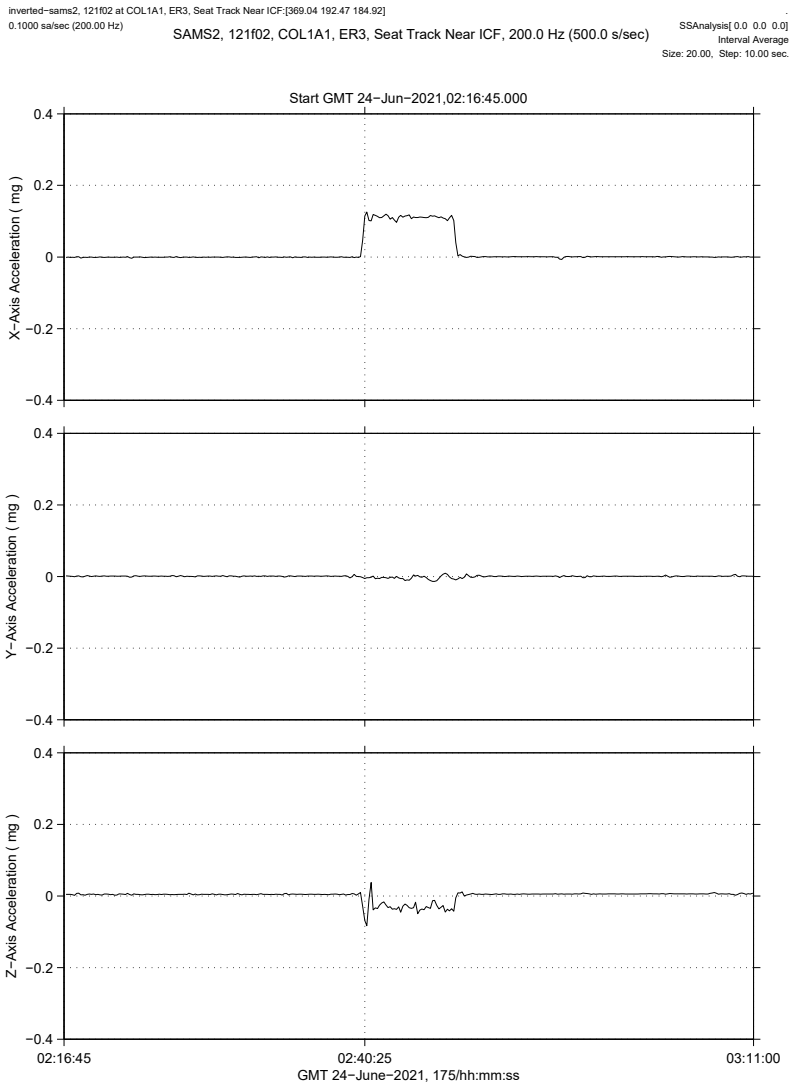

Fig. 6: 20-sec interval average for SAMS 121f02 sensor in the COL.

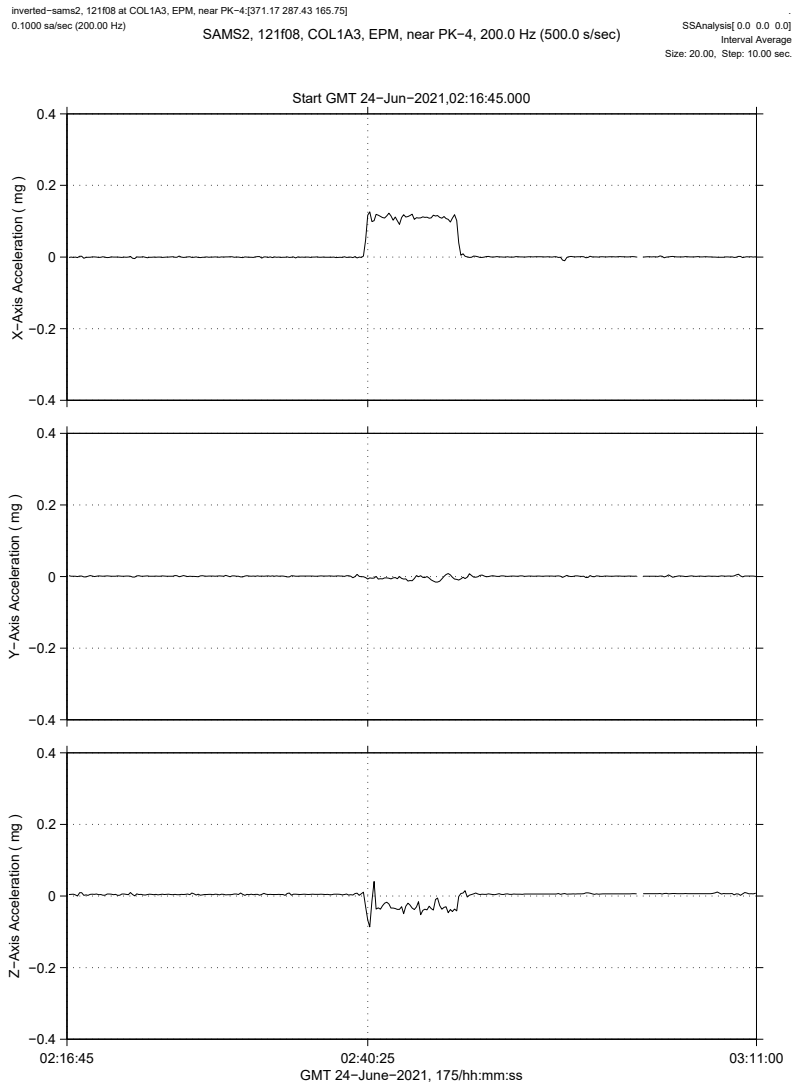

Fig. 7: 20-sec interval average for SAMS 121f08 sensor in the COL.