1. INTRODUCTION

At GMT 2021-05-20, 140/17:01:00, the International Space Station (ISS) began a 3-minute reboost using the Progress 77P mid-ring thrusters. This reboost set up phasing for the Progress 78P orbit rendezvous to come on June 29, 2021. The burn started on time at GMT 17:01 and completed after a duration of just about 3 minutes. The net increase in velocity in the forward/flight direction brought orbital mechanics into play so as to increase the altitude of the megastructure by about 0.35 km.

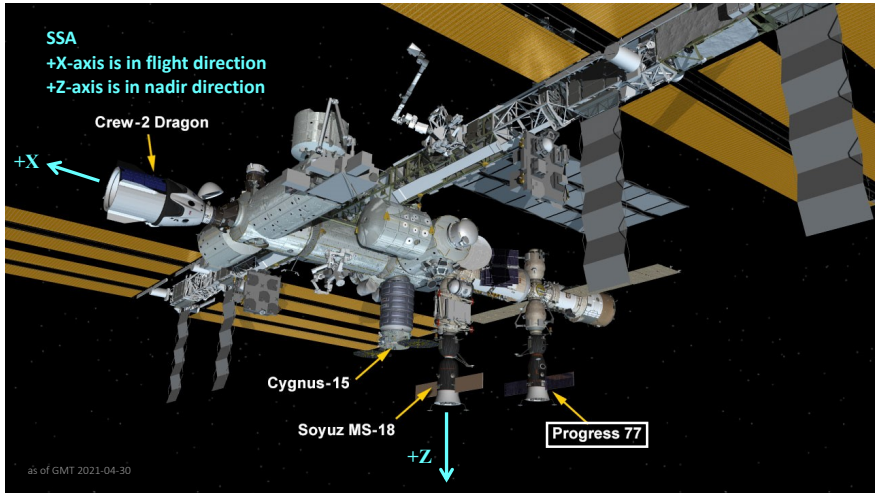

Fig. 1: Progress 77P's location and alignment during reboost.

2. QUALIFY

The information shown in Figure 2 was calculated from SAMS sensor es09 measurements made in the US Laboratory module from inside of the Microgravity Science Glovebox (MSG). This plot shows increased structural vibration excitation contained between about GMT 16:10 and 17:37. We attribute much of this increase to Russian Segment (RS) attitude control since the as-flown timeline shows that is the period that RS control was in 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 about an hour and 27 minutes. The actual reboost activity itself lasted about 3 minutes as evidenced by slightly more pronounced, vertical orange-red streaks in Figure 2 starting around GMT 17:01. 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 3 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.

3. QUANTIFY

The as-flown timeline for this event indicated the reboost would start at GMT 17:01:00 and have a duration of 3 minutes. Analysis of Space Acceleration Measurement System (SAMS) data recordings shows the tell-tale X-axis step that started on time but lasted about 30 seconds longer than planned, so the duration as seen in the top subplot of Figure 4 was about 3 minutes 30 seconds.

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 also given in Table 1.

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 the planned ΔV of about 0.2 meters/second was achieved. We also observed **a notable Z-axis disturbance** that came with the location of the Progress 77P and it using its mid-ring thrusters.

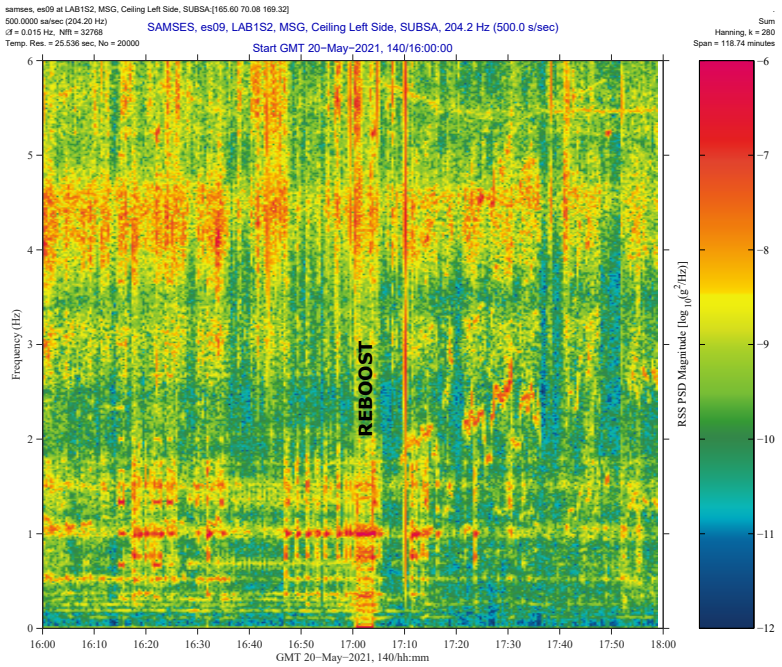

Fig. 2: Spectrogram showing Progress 77P Reboost on GMT 2021-05-20.

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

Sensor	X-Axis	Location
121f02	0.112	COL1A1 (ER3)
121f03	0.112	LAB1O1 (ER2)
121f04	0.111	LAB1P2 (ER7)
121f05	0.109	JPM1F1 (ER5)
121f08	0.112	COL1A3 (EPM)

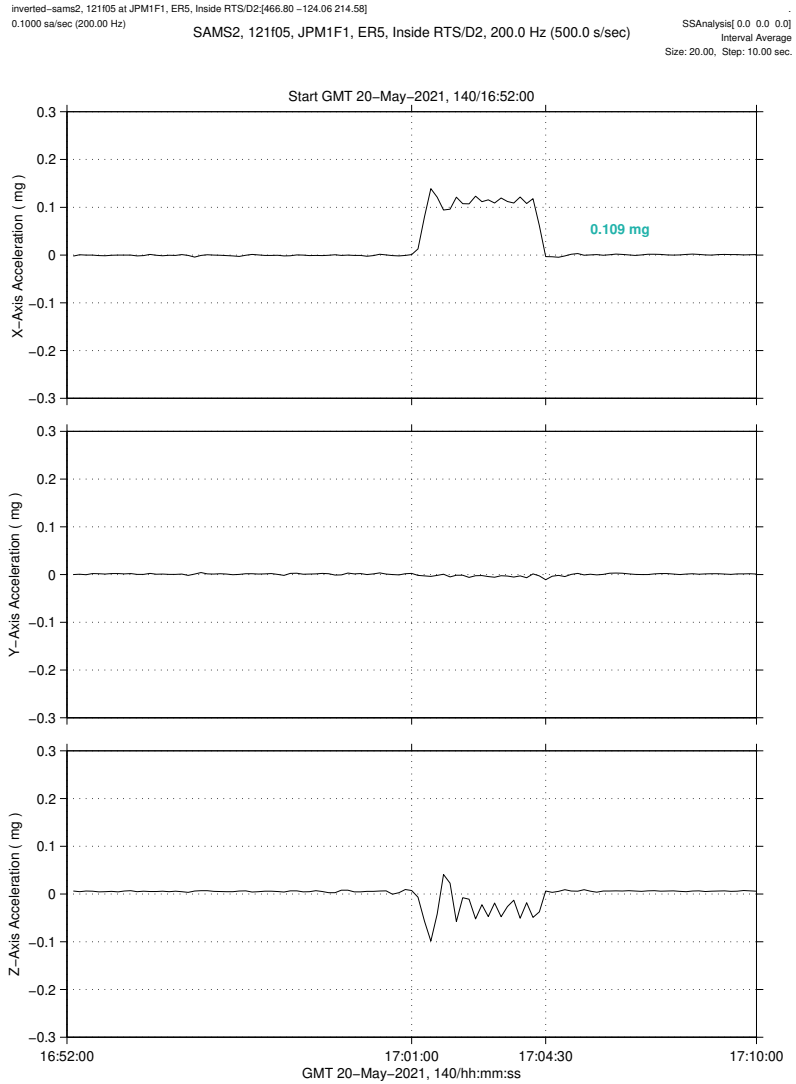

Fig. 3: 20-sec interval average for SAMS 121f05 sensor in the JEM.

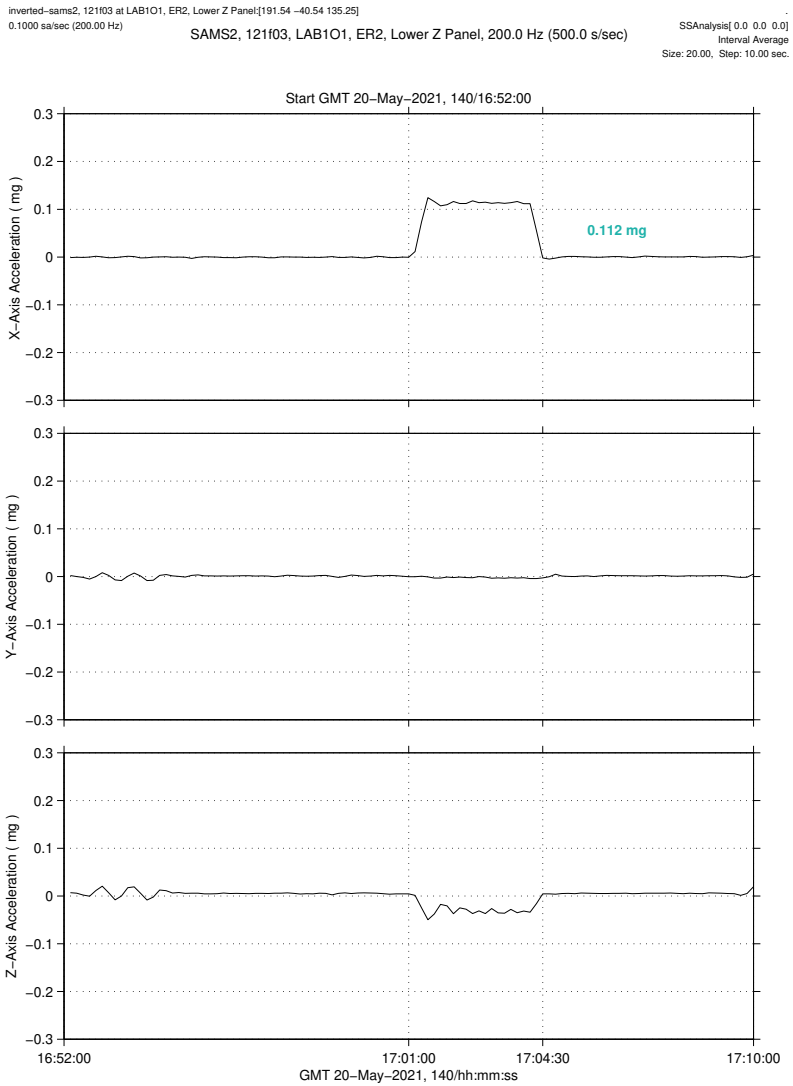

Fig. 4: 20-sec interval average for SAMS 121f03 sensor in the LAB.

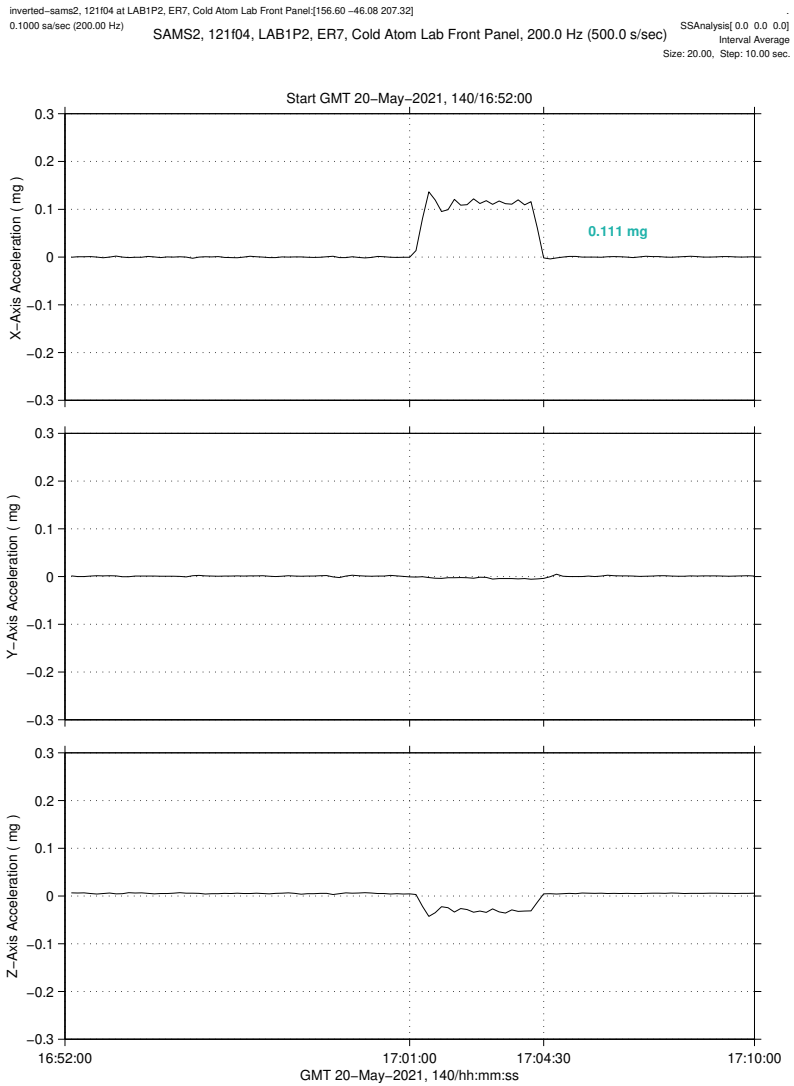

Fig. 5: 20-sec interval average for SAMS 121f04 sensor in the LAB.

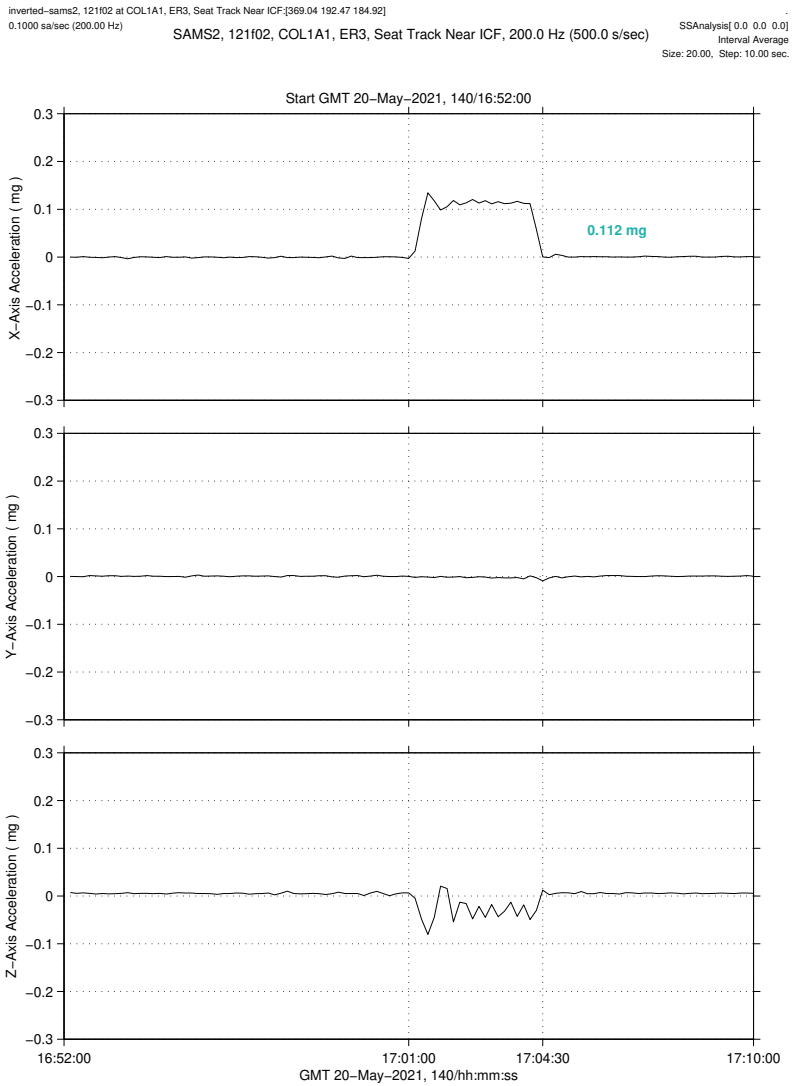

Fig. 6: 20-sec interval average for SAMS 121f02 sensor in the COL.

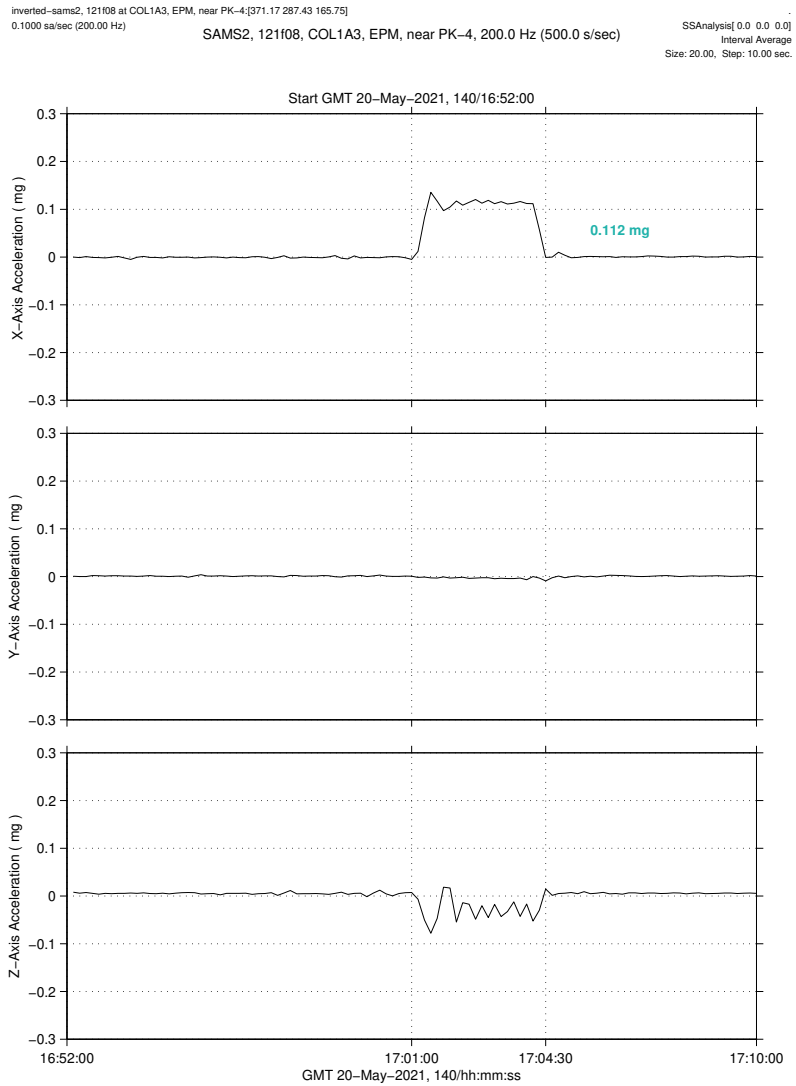

Fig. 7: 20-sec interval average for SAMS 121f08 sensor in the COL.