1. INTRODUCTION

T2 (Treadmill 2) exercise was performed on GMT 2024-07-05 with all four alignment guides installed. Nominally, these guides are removed for exercise sessions, so the session on this date was considered as unisolated in terms of vibration propagation. The T2 equipment is mounted in the Tranquility module of the International Space Station (ISS), also known as Node 3. Tranquility is one of the modules of the ISS that provides life support and environmental control systems, and it also houses various exercise equipment to help astronauts maintain their physical health during long-duration missions.

Astronauts living and working on the International Space Station exercise for around two hours a day six days a week to stay fit and healthy in orbit. This helps counteract muscle and bone loss caused by life in microgravity.

2. QUALIFY

The SAMS sensor head (S/N 121f03) used for much of the analysis here was mounted in the LAB on the LAB1O2 rack (EXPRESS Rack 2, ER-2). Figure 2 on page 2 shows an 8-hour, typical 10 Hz "roadmap" color spectrogram computed from Space Acceleration Measurement System (SAMS) sensor 121f03 measurements. In broad terms, this shows the T2 exercise session followed by the vibratory environment showing the crew transitioning to a sleep period over the 8-hour span. The zoomed-in spectrogram in Figure 3 on page 3 better reveals a spectral characterization of the exercise period, ostensibly an "interval training" protocol was used with warm-up and cool-down periods as bookends to the more intense workout.

3. QUANTIFY

To quantify and compare the unisolated T2 exercise period, we employ Parseval's theorem to compute root-mean-square (RMS) acceleration as a function of frequency. Refer back to Figure 2 to get an overview of 3 labeled periods all on one plot, while the cumulative RMS acceleration versus frequency plot in Figure 4 on page 4 shows 3 colorized traces for those 3 periods: (1) unisolated T2 exercise from GMT 17:00 to 17:20 (red trace), (2) crew wake period from GMT 18:00 to 18:20 (green trace), and (3) crew sleep period from GMT 23:00 to 23:20 (blue trace).

These RMS results show nearly an order of magnitude higher vibration levels during the unisolated T2 exercise period (488 μg) relative to crew wake (72 μg) and crew sleep (63 μg). We can also compare this unisolated session in 2024 to another one from 2009 (click here).

The seven figures starting with Figure 5 on page 5 show a comparison across these sensors (below 10 Hz) via interval RMS acceleration versus time for the entirety of GMT 2024-07-05.

4. CONCLUSION

We have shown that SAMS vibratory sensor measurements in the LAB module during an unisolated T2 treadmill exercise session closely matched a previous one from 2009. Furthermore, we have shown about an order of magnitude higher vibration levels below 25 Hz during the unisolated T2 treadmill exercise period relative to both a crew sleep and a crew wake period on GMT 2024-07-05.

Fig. 1: T2 Treadmill Mounted on "Wall" in Node 3.

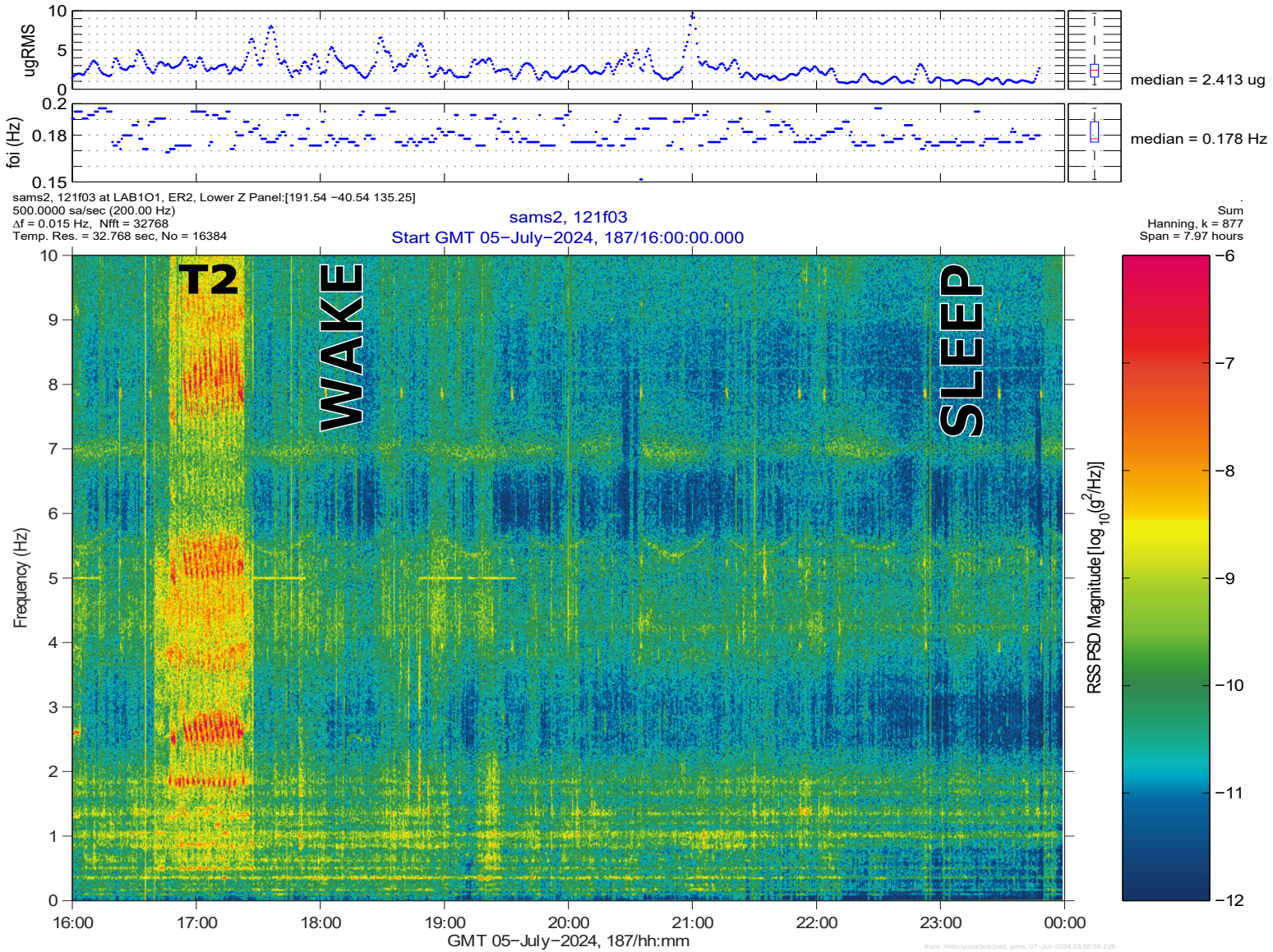

Fig. 2: 8-Hour Roadmap Spectrogram, SAMS Sensor 121f03 (LAB), Shows T2 Exercise on GMT 2024-07-05.

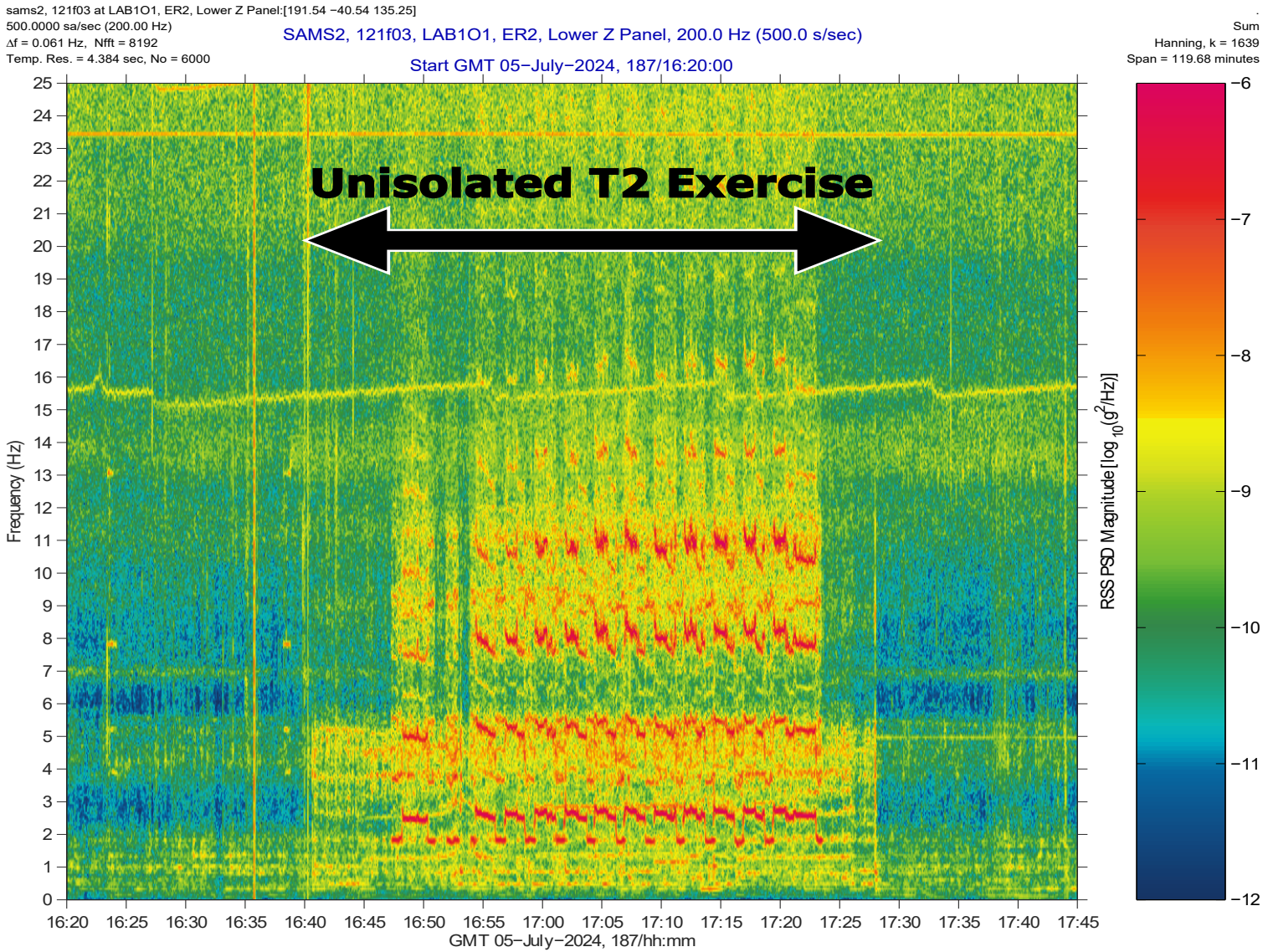

Fig. 3: 75-Minute Spectrogram, SAMS Sensor 121f03 (LAB), Shows Better Zoom in on Exercise on GMT 2024-07-05.

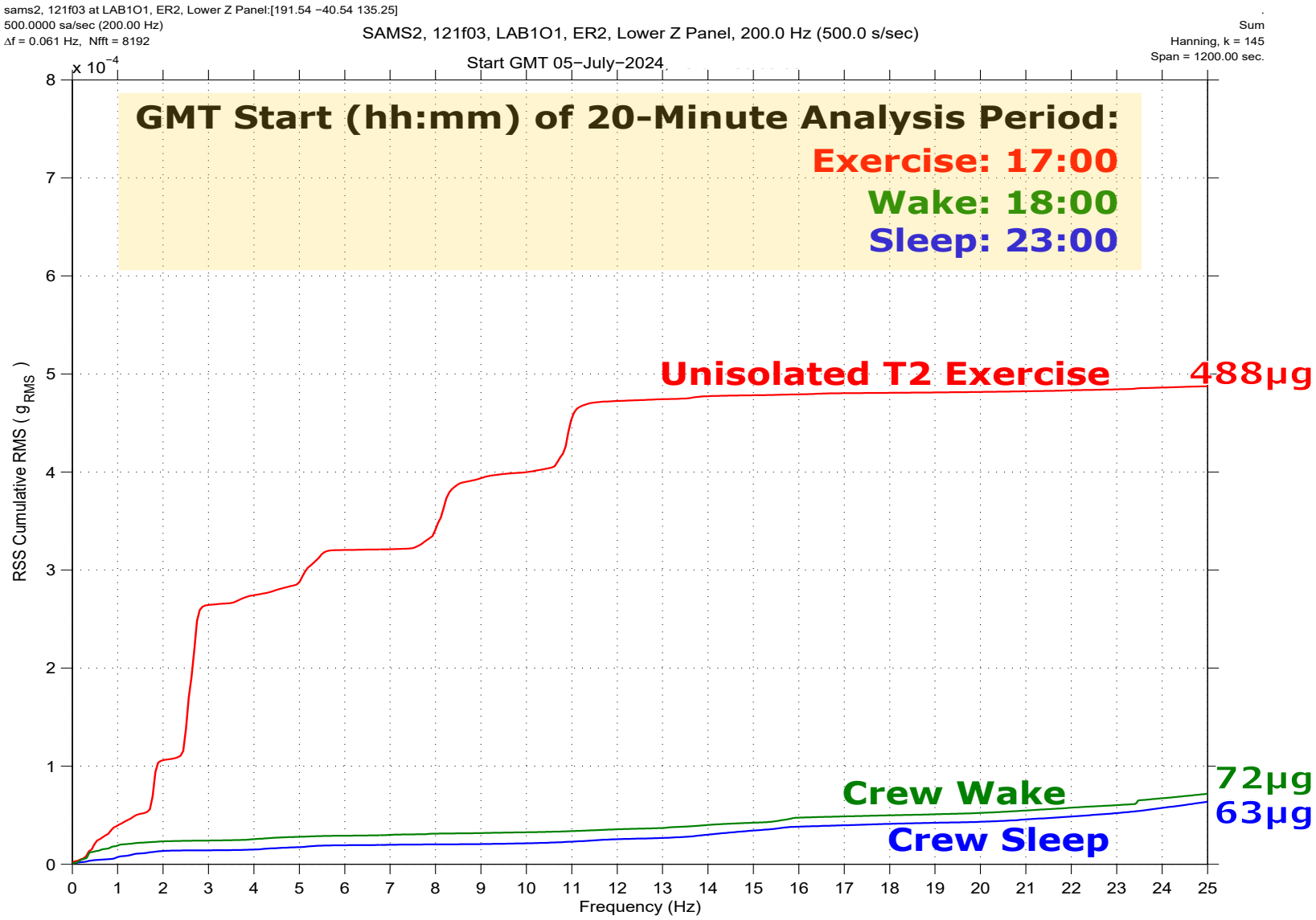

Fig. 4: Compare 20-Minute Cumultaive RMS vs. Frequency, SAMS Sensor 121f03 (LAB), GMT 2024-07-05.

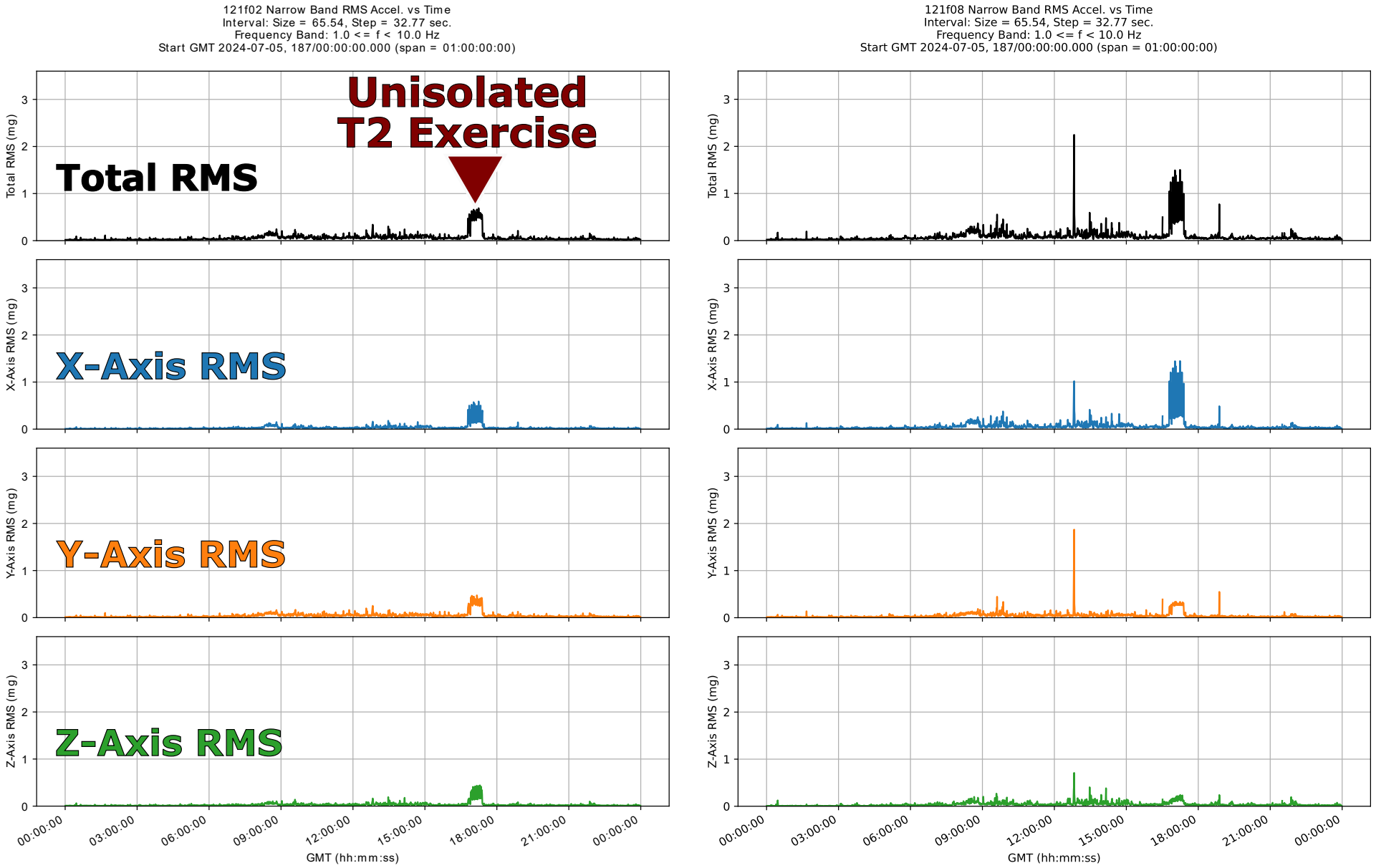

Fig. 5: Interval RMS Accel. for **(left) SE-F02, ER-3** & **(right) SE-F08, EPM**, Showing Unisolated T2 Exercise Below 10 Hz on GMT 2024-07-05.

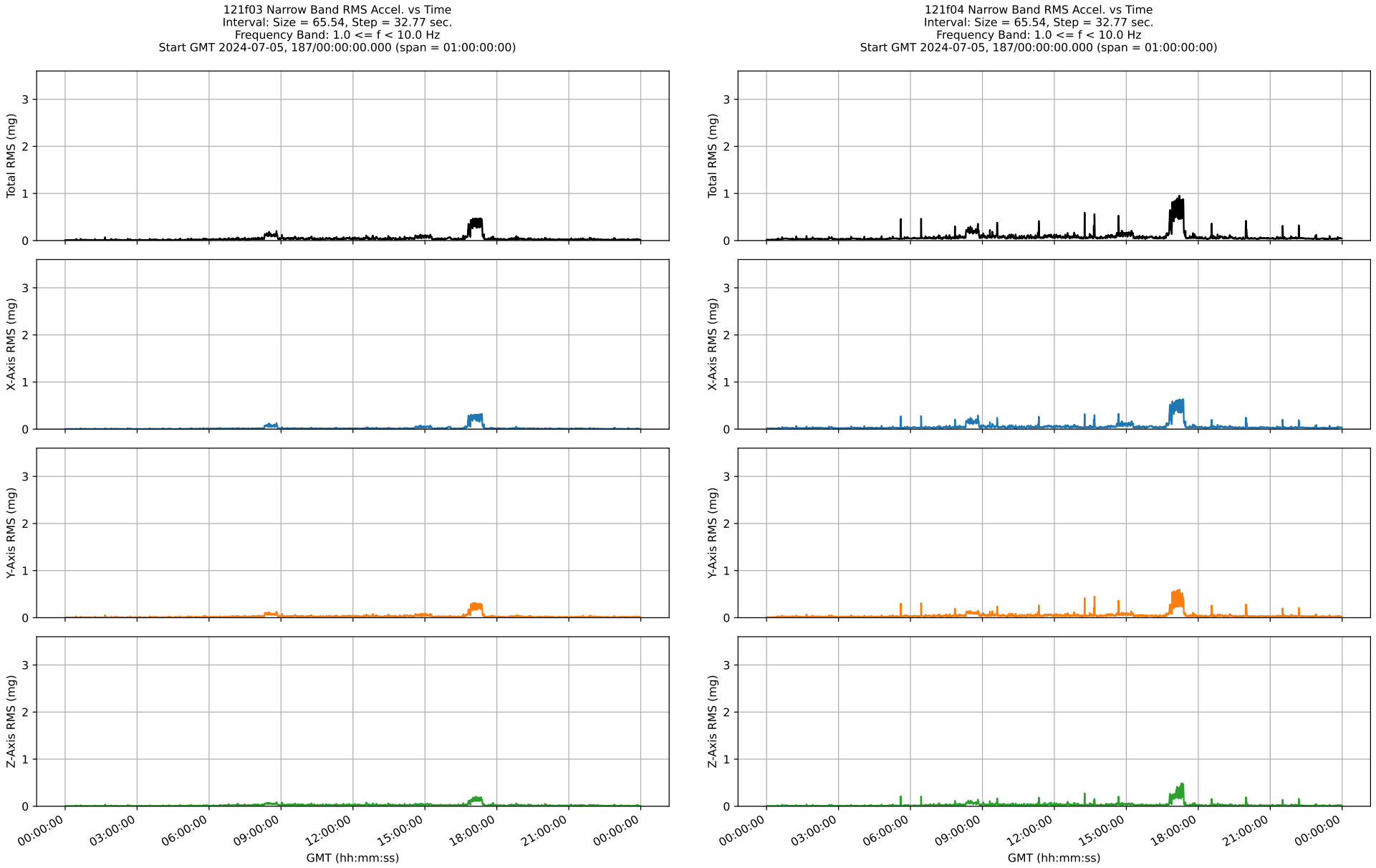

Fig. 6: Interval RMS Accel. for **(left) SE-F03, ER-2** & **(right) SE-F04, ER-7**, Showing Unisolated T2 Exercise Below 10 Hz on GMT 2024-07-05.

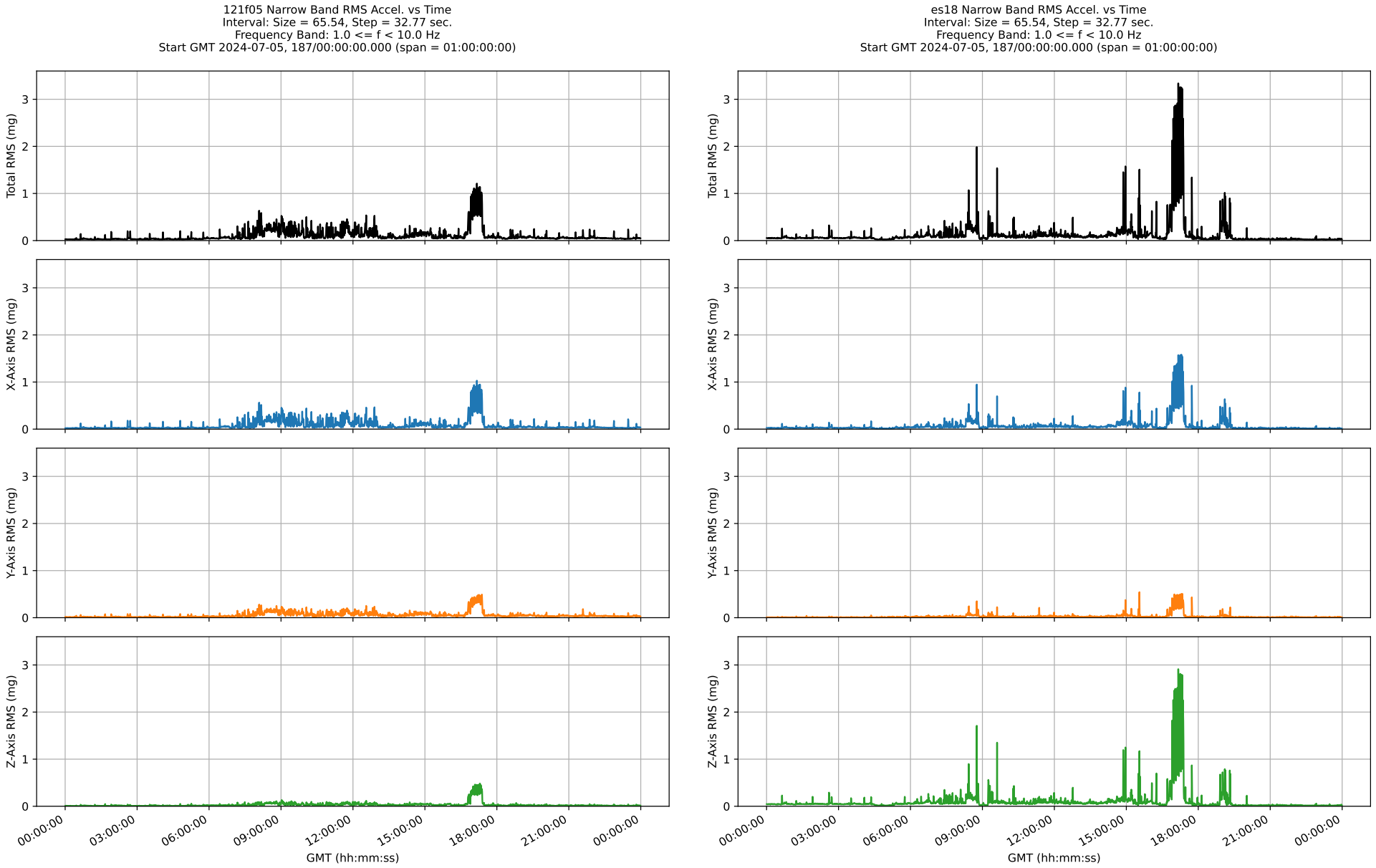

Fig. 7: Interval RMS Accel. for **(left) SE-F05, ER-5** & **(right) es18, ER-6**, Showing Unisolated T2 Exercise Below 10 Hz on GMT 2024-07-05.

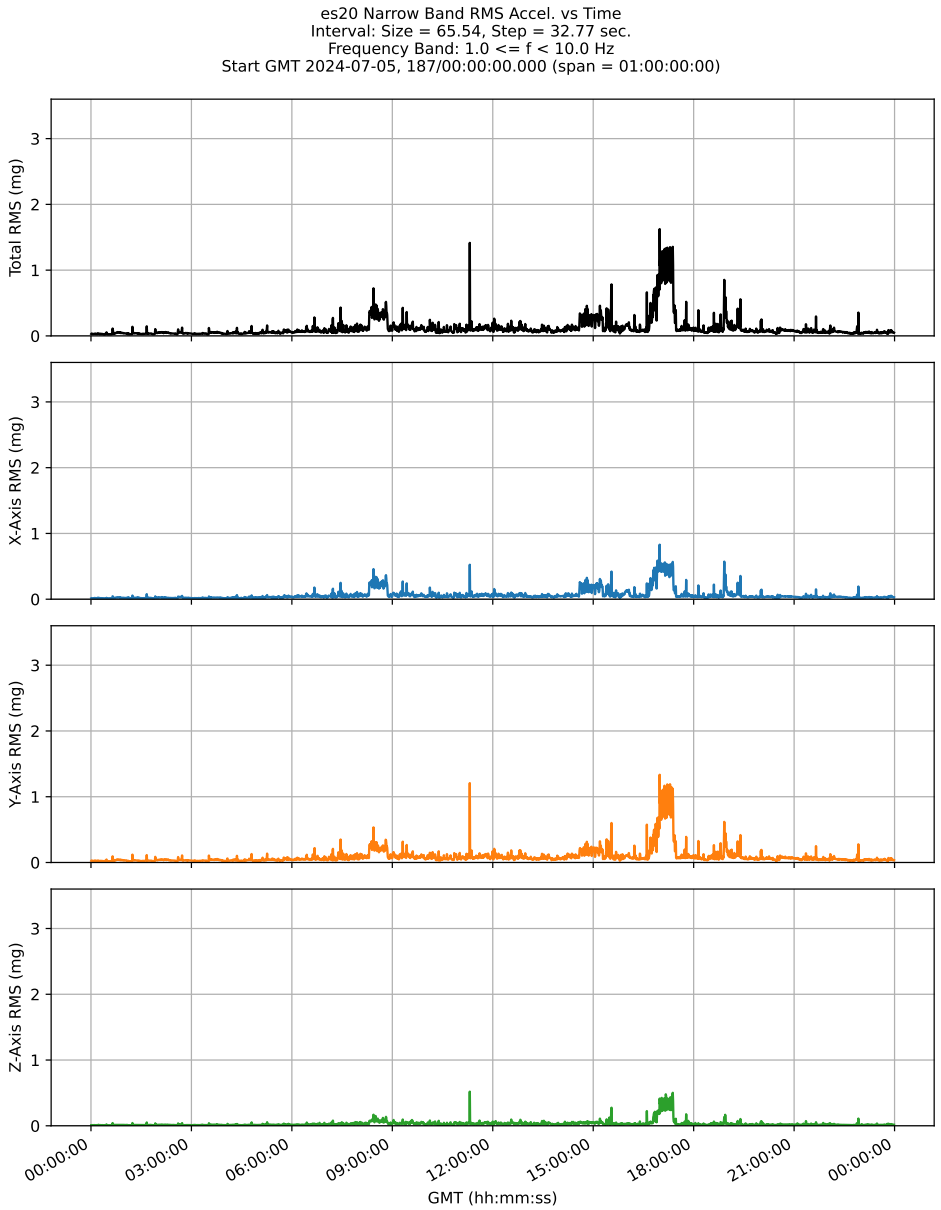

Fig. 8: Interval RMS Accel. for **es20, MSG** Showing Unisolated T2 Exercise Below 10 Hz on GMT 2024-07-05.