1. INTRODUCTION

Starting at about GMT 2022-11-01, 305/10:33, one of the International Space Station (ISS) crew began about a 45-minute exercise period using the BD-2 treadmill equipment located in Zvezda Service Module. This exercise period was relatively rare in that it was the only exercise happening during that period of time aboard the space station. A unique opportunity to isolate the impact of this device with the major disclaimer that crew input typically is a dominant factor for exercise vibrations.

2. QUALIFY

The treadmill is depicted in the historic photograph of Figure 1. Note the shoulder harness that anchors the crew to the treadmill, providing at least partial "down" force that otherwise comes from gravity in a 1g field. The spectrogram of Figure 2 on page 2 was calculated from SAMS sensor 121f08 acceleration measurements made in the Columbus module. This plot focuses on a lower-frequency portion of the acceleration spectrum usually dominated by vehicle structural modes and crew activity such as exercise. This plot also includes a yellow annotation for the signature of the Urine Processing Assembly (UPA), with narrowband operations near 3.7 Hz. It also shows increased structural vibration excitation for the BD-2 exercise period from GMT 10:33 to 11:17 along with a mix of exercise devices overlapping each other between about GMT 08:00 and 09:00. BD-2 treadmill exercise seen here gives rise to heightened vibrations (red, horizontal streaks) during the exercise period, primarily below about 2 Hz. The next 3 spectrograms for the X-, Y-, and Z-axis on the subsequent 3 pages starting with Figure 3 shows that BD-2 exercise is dominant at this sensor location on the X-axis. This will become more evident in the next, "Quantify", section.

3. QUANTIFY

In order to quantify the impact of this BD-2 exercise, we again focus our attention below 5 Hz and show root-mean-square (RMS) values for five SAMS sensor heads distributed throughout the ISS. For example, Figure **??** shows X-, Y-, and Z-axis values in red computed during the exercise period and we contrast that to the black trace for data outside of the exercise period **and** between GMT 11:00 and 15:00. Four more plots of RMS acceleration values versus time for SAMS sensors distributed throughout the ISS are shown, and similarly marked in red, starting with Figure **??** on page **??**.

Fig. 1: Historic Photo of ISS Crew BD-2 Exercise.

4. CONCLUSION

The RMS values for the two SAMS sensors in Columbus show the largest impact due to BD-2 exercise, followed by a sensor in the JEM and finally, the two SAMS sensors in the US LAB. This is reinforced by the median values tabulated in the Table **??** on page **??**. Those interested in the impact of BD-2 exercise can also take a look at another, less-impactful data set at this link.
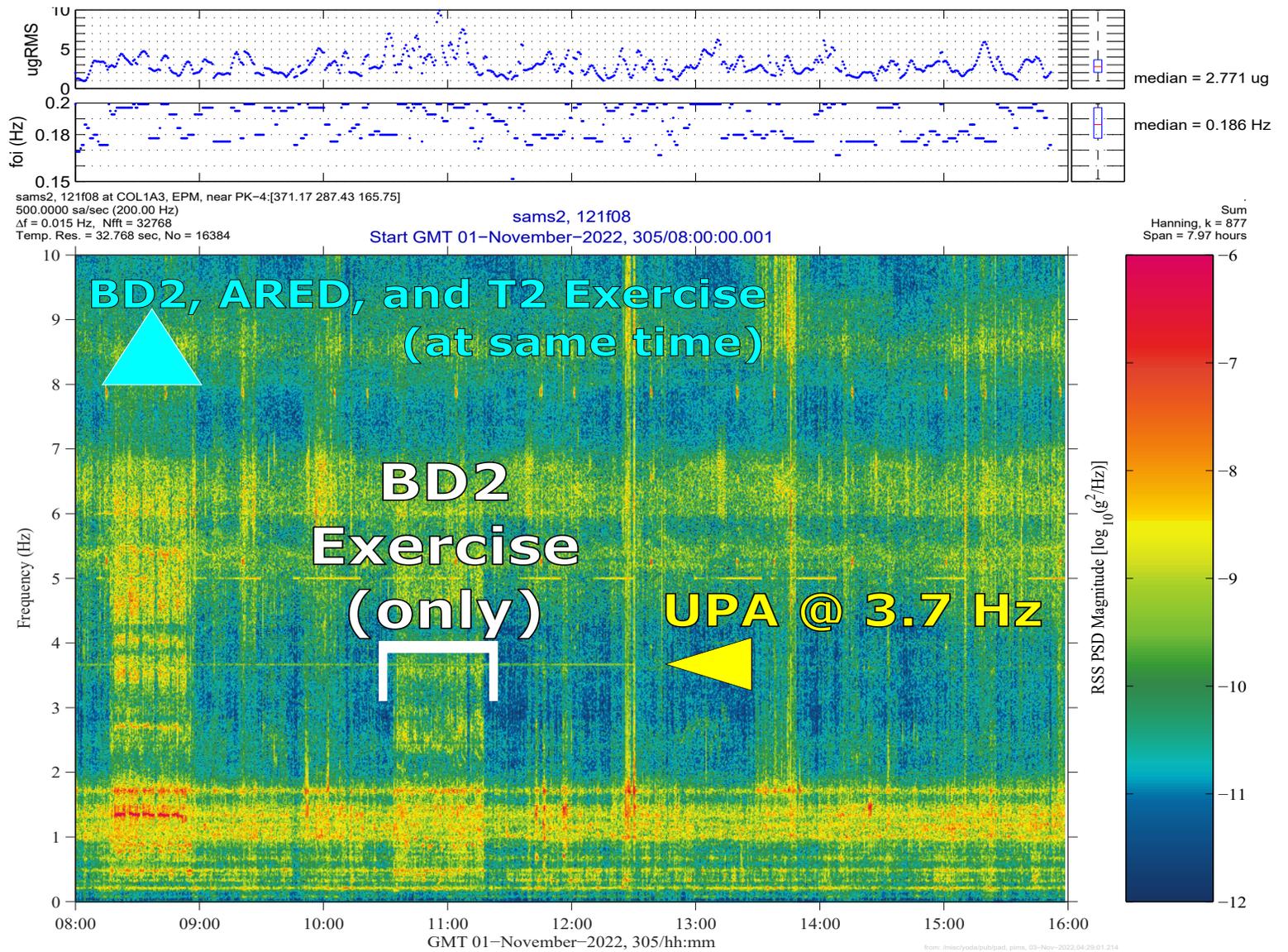
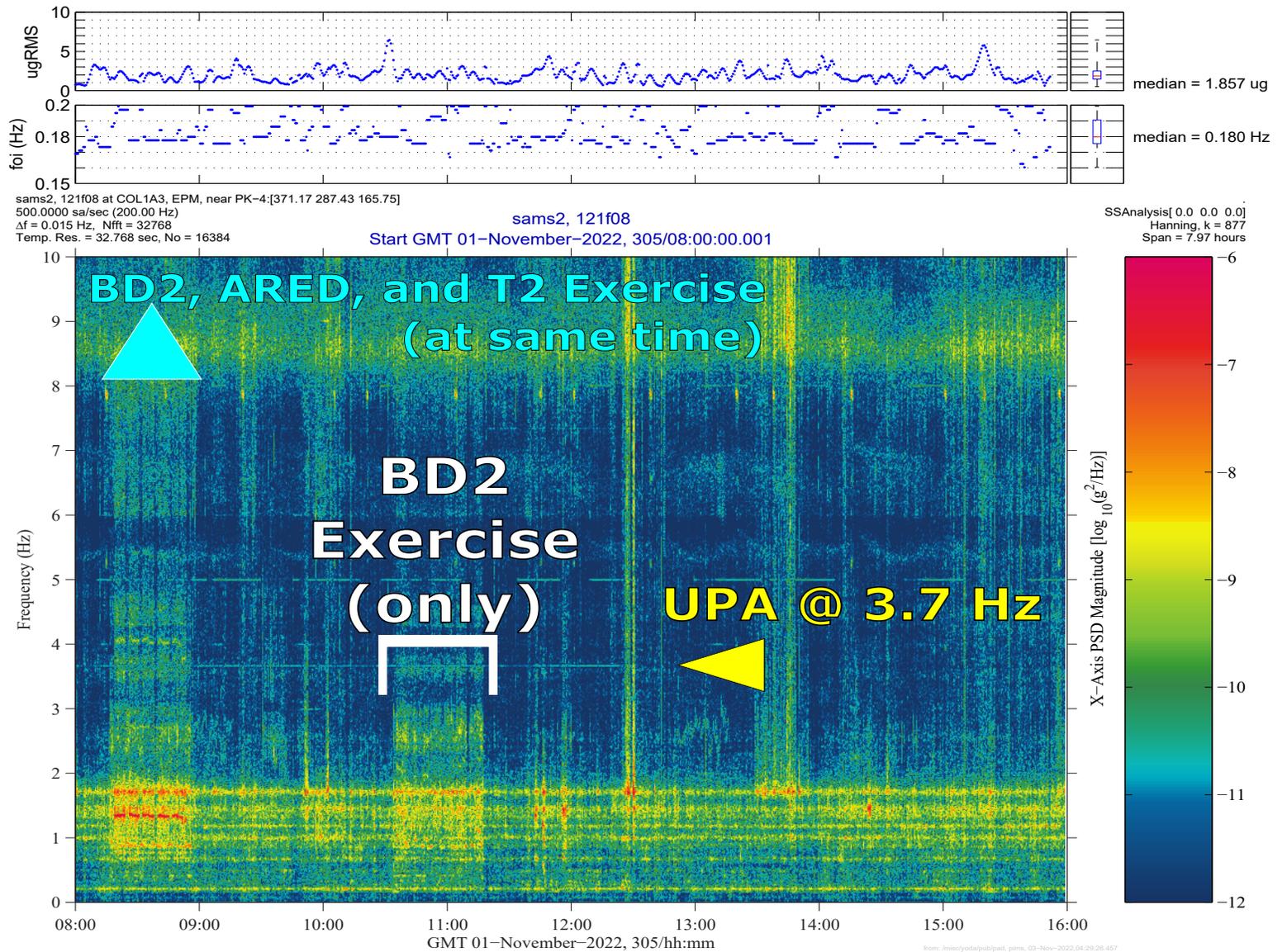Fig. 2: 8-Hour **RSS Spectrogram**, SAMS Sensor 121f08 (COL1A3), Shows Exercise on GMT 2022-11-01.

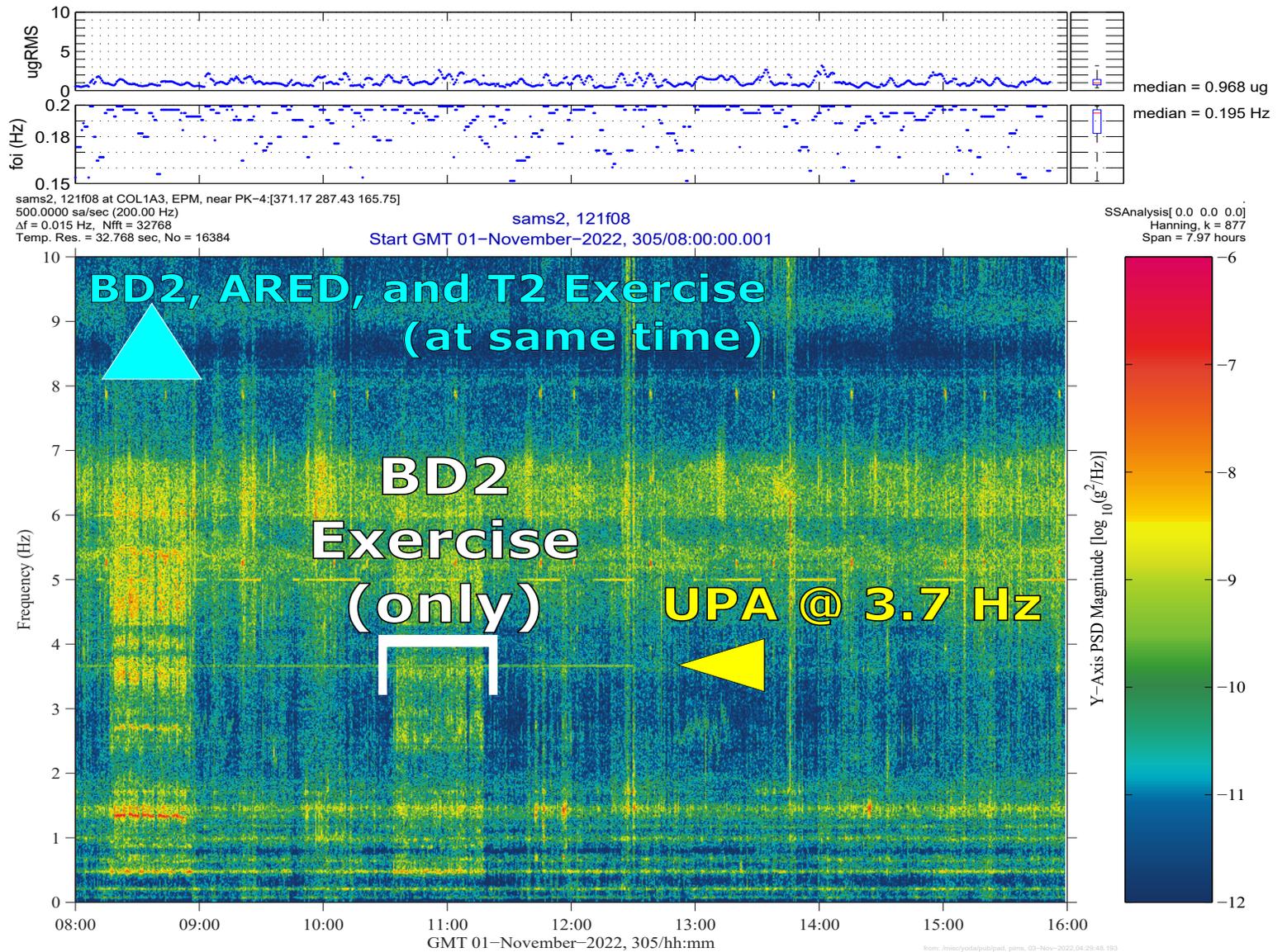Fig. 3: 8-Hour **X-Axis Spectrogram**, SAMS Sensor 121f08 (COL1A3), Shows Exercise on GMT 2022-11-01.

Fig. 4: 8-Hour **Y-Axis Spectrogram**, SAMS Sensor 121f08 (COL1A3), Shows Exercise on GMT 2022-11-01.
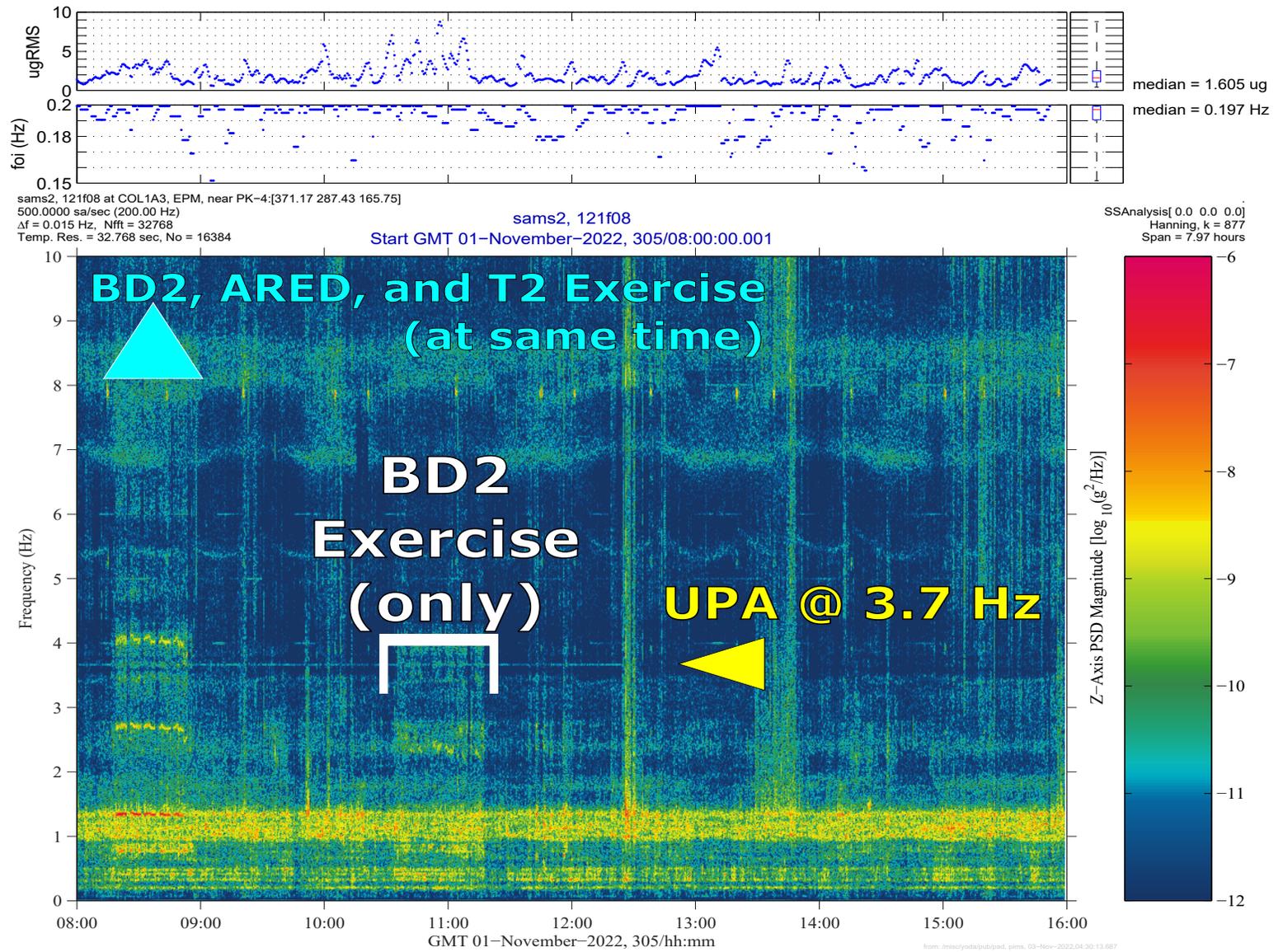
Fig. 5: 8-Hour **Z-Axis Spectrogram**, SAMS Sensor 121f08 (COL1A3), Shows Exercise on GMT 2022-11-01.