1. INTRODUCTION

The International Space Station (ISS) operates as a platform for humanity's most advanced laboratories, offering researchers a near-weightless "microgravity" environment for experiments that would be impossible on Earth where buoyancy, convection, sedimentation, and other gravity-driven mass transport forces dominate. Striving for a pristince microgravity environment requires careful monitoring of any activities that might introduce vibrations. A routine operation aboard the station is the depressurization of the Japanese Experiment Module (JEM) Airlock, located in the Kibo laboratory. This specialized airlock allows crew members to transfer small scientific payloads and satellites from the station's pressurized modules to the vacuum of space using an extendable slide table. The JEM Airlock Depress procedure involves safely venting the air inside the chamber, creating the vacuum conditions necessary to open the outer hatch without compromising the station's atmosphere.

During the first quarter of 2026, three such JEM Airlock Depress events took place on January 30, February 26, and March 13. Although these procedures are carefully controlled, they can generate measurable disturbances that propagate through the station's structure. This report analyzes high-resolution Space Acceleration Measurement System (SAMS) data collected during these three events to characterize their effects on the ISS vibratory environment. The findings provide valuable insights into the magnitude, frequency content, and duration of these disturbances, helping scientists and engineers better anticipate and mitigate impacts on sensitive microgravity research. A prior ISS handbook entry describing the general JEM Airlock Depress/Vent signature is available for reference at this link: GIPOC PIMS ISS Handbook — JEM Airlock Depress Vent [1].

All acceleration data presented here were collected by the SAMS sensor head es19, located at the JEM seat track position JPM1F6 (ER4). Measurements were acquired at 500.0 samples/second (200 Hz cutoff frequency). Two complementary data products are presented for each event: (1) a color spectrogram spanning the full depressurization window with 30-minutes of context before and after the depress, and (2) a narrowband RMS acceleration time history focused on the 23–29 Hz frequency range, which was identified as the band for the depress pump's fundamental frequency.

2. QUALIFY

The spectrograms shown in Figures 1, 2, and 3 were computed from SAMS sensor es19 measurements at the JEM seat track (JPM1F6, ER4). Each spectrogram displays RSS (Root Sum Square across all three, XYZ axes) power spectral density magnitude on a logarithmic color scale, with frequency on the vertical axis and time on the horizontal axis. The spectral resolution is $\Delta f = 0.061$ Hz (Nfft = 8192), using a Hanning window.

A. GMT 2026-01-30, Day 030 / 01:30 - 04:30

Figure 1 shows the spectrogram for the January 30 event starting at GMT 030/01:30, spanning approximately 4-hours for a half-hour of cushion before and after the depress event. The airlock depressurization signature is visible as a narrowband elevation in spectral energy. The narrow frequency band (between the annotated frequency markers at ~24 and ~28 Hz) shows a distinctive and repeatable excitation pattern characteristic of JEM Airlock Depress events. Spectral activity returns to the ambient background within the observation window, indicating a well-bounded disturbance. Upper harmonics of the pump's fundamental frequency (up to nearly 180 Hz) are not considered here.

B. GMT 2026-02-26, Day 057 / 04:10 - 07:10

Figure 2 shows the spectrogram starting at GMT 057/03:40, again with a span of 4-hours with a half-hour of margin before and after the depress. The depressurization onset is visible beginning near 04:10 GMT. The spectral character of this event is consistent with the January 30 event, with excitation concentrated in similar frequency bands. The narrowband fundamental starts to show signs of "fuzziness" starting just before GMT 06:10.

C. GMT 2026-03-13, Day 072 / 13:25 - 16:25

Figure 3 shows the spectrogram starting at GMT 072/12:55, again spanning 4 hours, with the airlock depress signature beginning near 13:25 GMT. This event shows comparable spectral character to the earlier two, reinforcing the repeatability of the JEM Airlock Depress signature as measured at the JEM seat track, however, now with increased "fuzziness" of the narrowband signature between 24–28 Hz band seemingly indicating more vibratory turbulence for reasons unknown to the authors.

Across all three events, the spectrograms confirm the JEM Airlock Depress procedure produces a consistent, recognizable vibratory signature at the JEM seat track, with the primary disturbance concentrated in a band roughly between 24 and 28 Hz and reverting to background when the pump cycles off with vent completion. The event onset times, as read from the spectrogram time axes, are summarized in Table 1 where we note a slight drift upward in approximate peak RMS between 23 and 29 Hz across the depress events. The Quantify section below explains in a bit more detail.

3. QUANTIFY

While the spectrograms in the preceding "Qualify" section display acceleration energy on a color scale (PSD magnitude), we now seek to better quantify the impact of each JEM Airlock Depress event using a more intuitive metric: narrowband RMS acceleration versus time.

Narrowband RMS Acceleration (23–29 Hz)

Figures 4 through 6 show the per-axis and total (RSS) narrowband RMS acceleration computed from SAMS es19 measurements, filtered to the 23–29 Hz band. This frequency range was selected because it captures the structural response associated with the JEM Airlock Depress/Vent pump's fundamental frequency/activity, as documented in prior ISS handbook analyses [1] and seen in the previous, Qualify, section's spectrograms.

Each plot covers a 4-hour span like the spectrograms described above with a half-hour of cushion on either end of the depressurization event to show excursions away from and back to ambient before/after the depress. The amplitude scale for each axis runs 0–3 mg, allowing direct comparison across all three events. Key observations are:

- **GMT 2026-01-30**: RMS amplitudes in the 23–29 Hz band rise sharply near 01:30 GMT and lasting 3 hours, with total (RSS) levels reaching approximately 1.5 mg transiently, before returning toward the "quieter" ambient background.
- **GMT 2026-02-26**: The onset near 04:10 GMT produces a similar amplitude excursion, with comparable peak and settling behavior. The observation window (03:30–07:30 GMT) confirms post-event settling within the span. For this depress, RMS levels reached a bit closer to 2.0 mg.
- **GMT 2026-03-13**: The onset near 13:25 GMT follows the same pattern. For this depress, RMS levels reached over 2.5 mg.

The frequency consistency of the narrowband RMS signature across all three events is notable with a bit of "fuzziness" developing more so as time transpires across the 3 events. Peak amplitudes, frequency character, and decay behavior are roughly the same but with a bit of elevation across the 3 months (3 depress events), which reinforces what is the consistent intent likely with the procedurally standardized nature of the JEM Airlock Depress operation. Table 1 summarizes the key event parameters extracted from both the spectrogram and narrowband RMS data products.

Table 1. JEM 3-Hour Airlock Depressurizations — SAMS es19 (JPM1F6)

Depress Start (GMT)	~Peak RMS, 23–29 Hz (mg)
2026-01-30 / 01:30	1.5
2026-02-26 / 04:10	2.0
2026-03-13 / 13:25	2.5

4. CONCLUSION

SAMS data from the JEM (JPM1F6, ER4) were analyzed for 3 airlock depress events occurring on GMT January 30, February 26, and March 13, 2026. Color spectrograms and narrowband RMS acceleration time histories were produced.

All three events exhibit a consistent and repeatable vibratory signature: a narrowband increase in vibratory energy around the pump's fundamental frequency, most distinctively concentrated in the ~24–28 Hz narrowband, with peak RMS levels reaching approximately 1.5–2.5 mg before returning to baseline/ambient background. Onset times are well-defined in both data products, and post-event settling is complete within the observation windows.

The repeatability of the signature across three independent events confirms that JEM Airlock Depress operations produce a predictable and bounded disturbance at the JEM seat track location. The ~24–28 Hz frequency range, consistent with the structural response documented in prior analyses [1], is the most diagnostic band for identifying and characterizing these events. Scientists scheduling sensitive microgravity experiments in or near the JEM should account for this disturbance during airlock depress operations and plan accordingly.

REFERENCES

[1] Physical and Inertial Measurements System (PIMS), *ISS Handbook — JEM Airlock Depress Vent*, NASA Glenn Research Center GIPOC, gipoc.grc.nasa.gov.

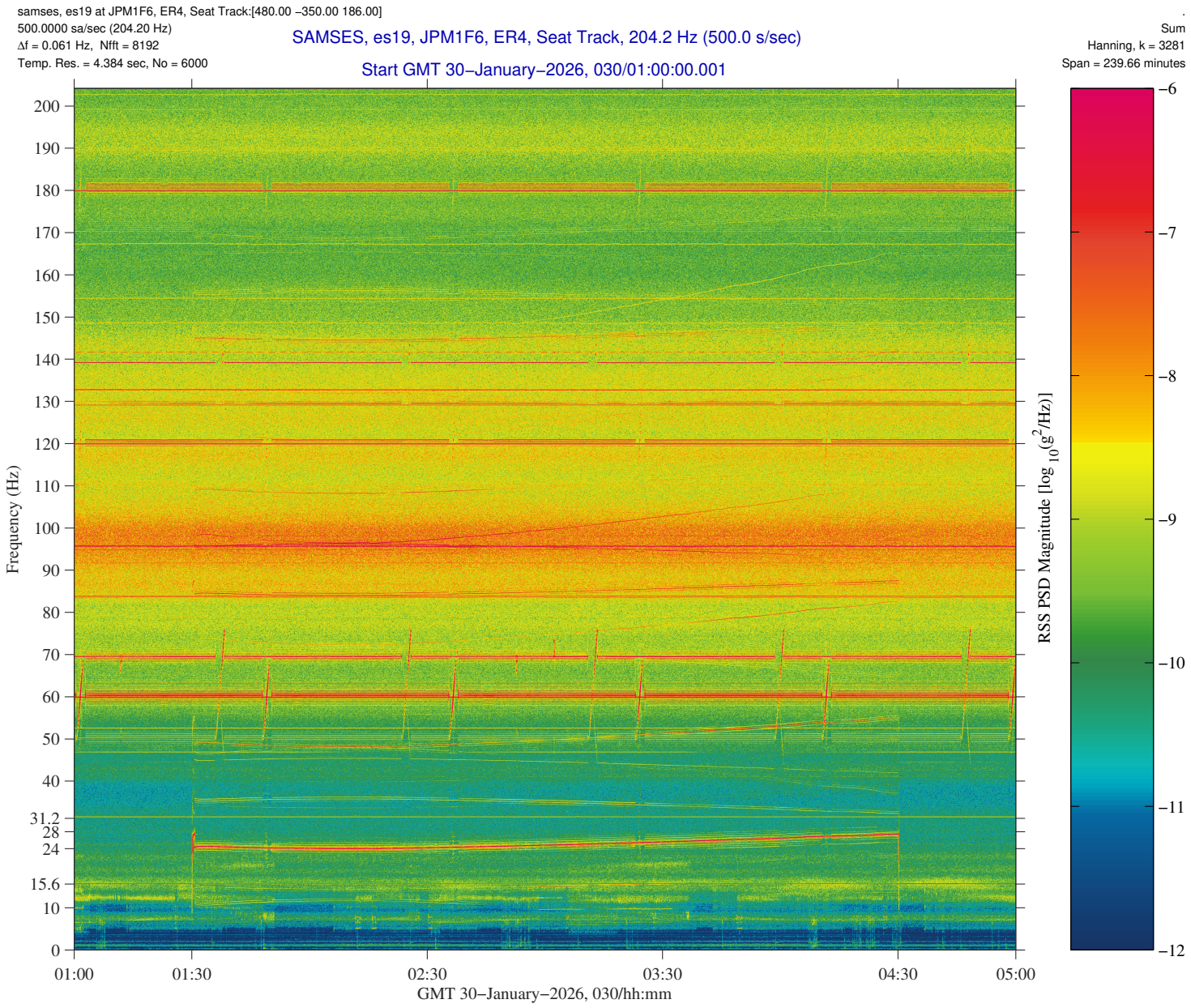

Fig. 1: 4-Hour, 200 Hz Spectrogram, JEM Airlock Depress, **GMT 2026-01-30**, SAMS Sensor es19 at JPM1F6 (ER4).

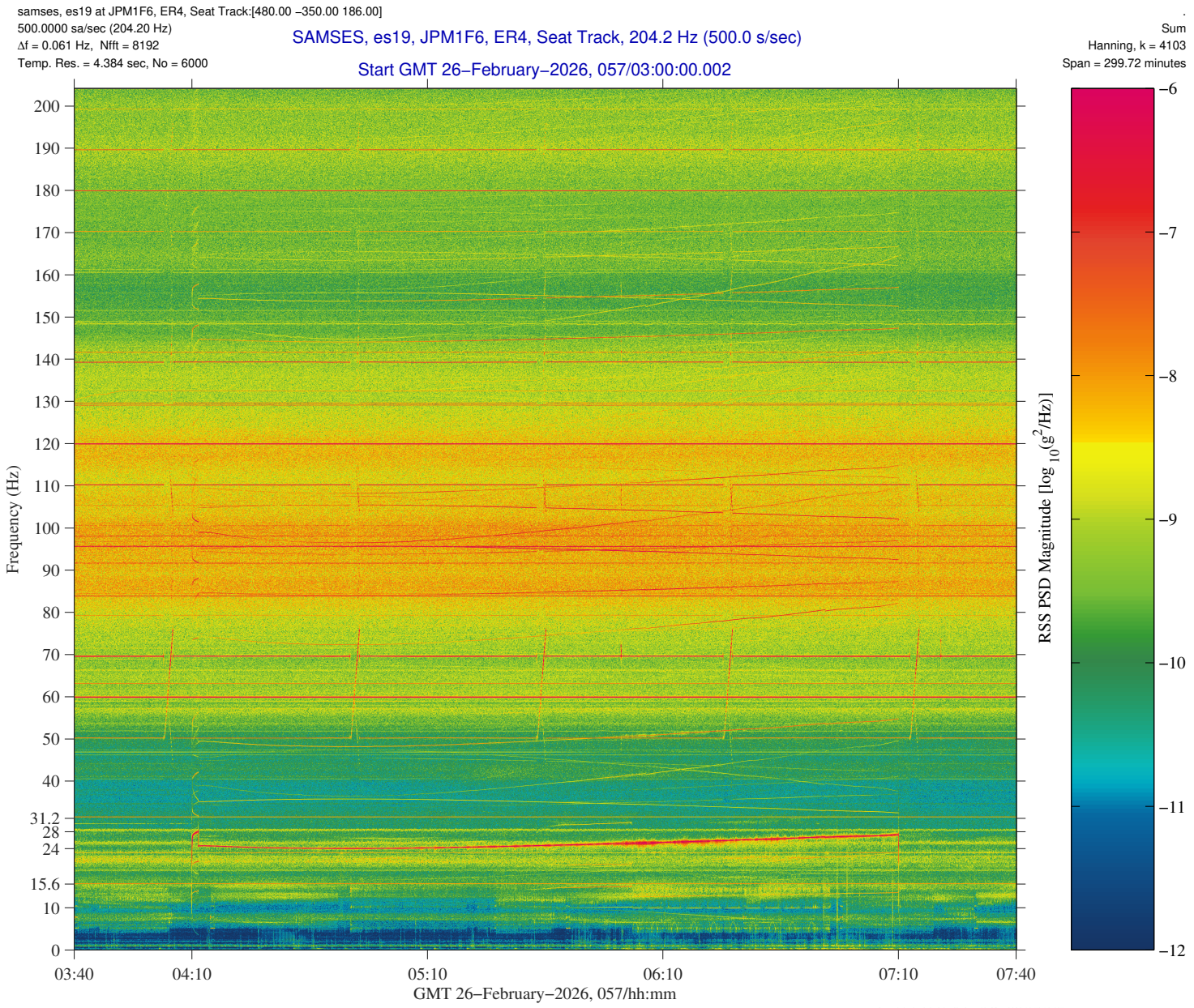

Fig. 2: 4-Hour, 200 Hz Spectrogram, JEM Airlock Depress, **GMT 2026-02-26**, SAMS Sensor es19 at JPM1F6 (ER4).

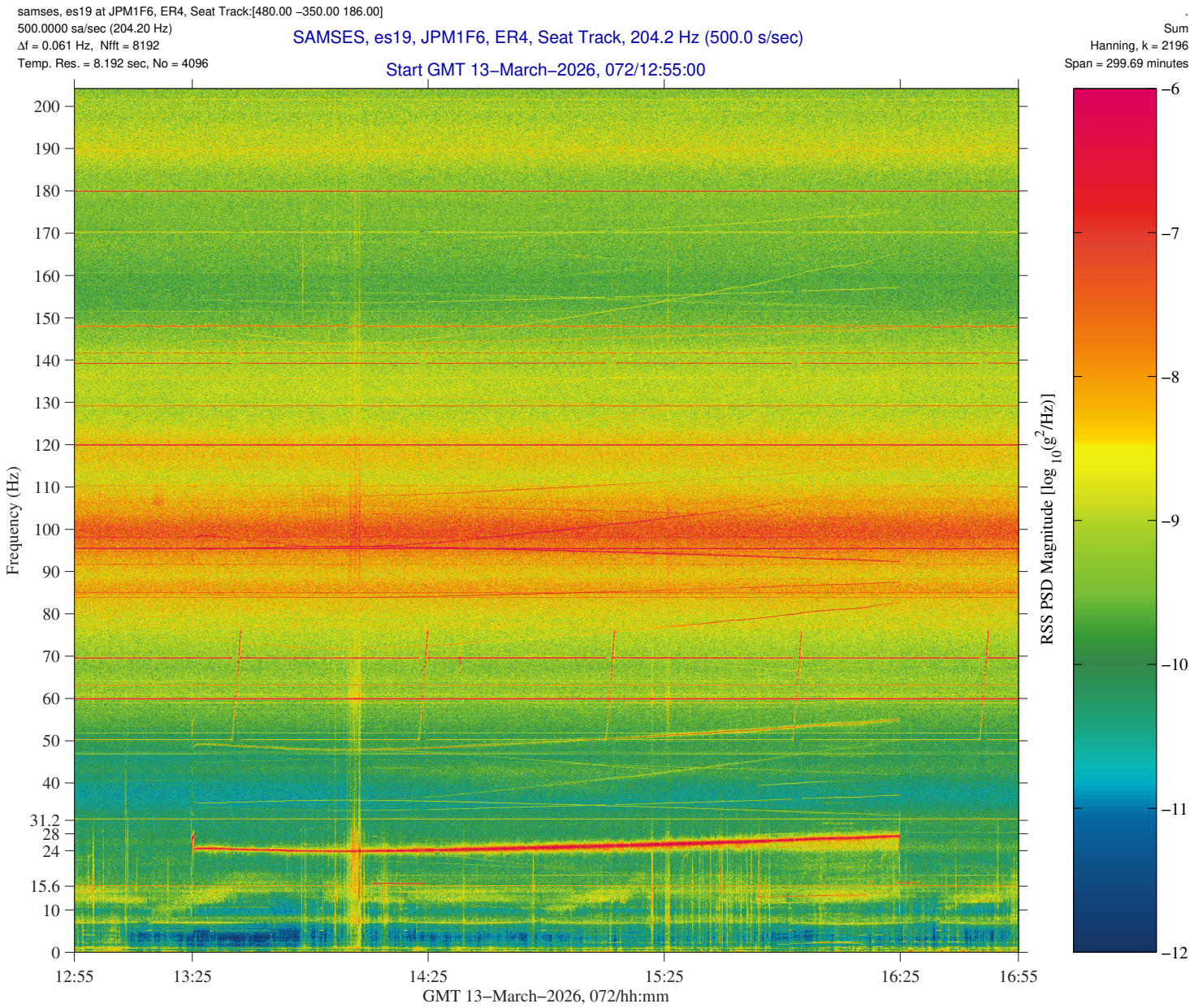

Fig. 3: 4-Hour, 200 Hz Spectrogram, JEM Airlock Depress, **GMT 2026-03-13**, SAMS Sensor es19 at JPM1F6 (ER4).

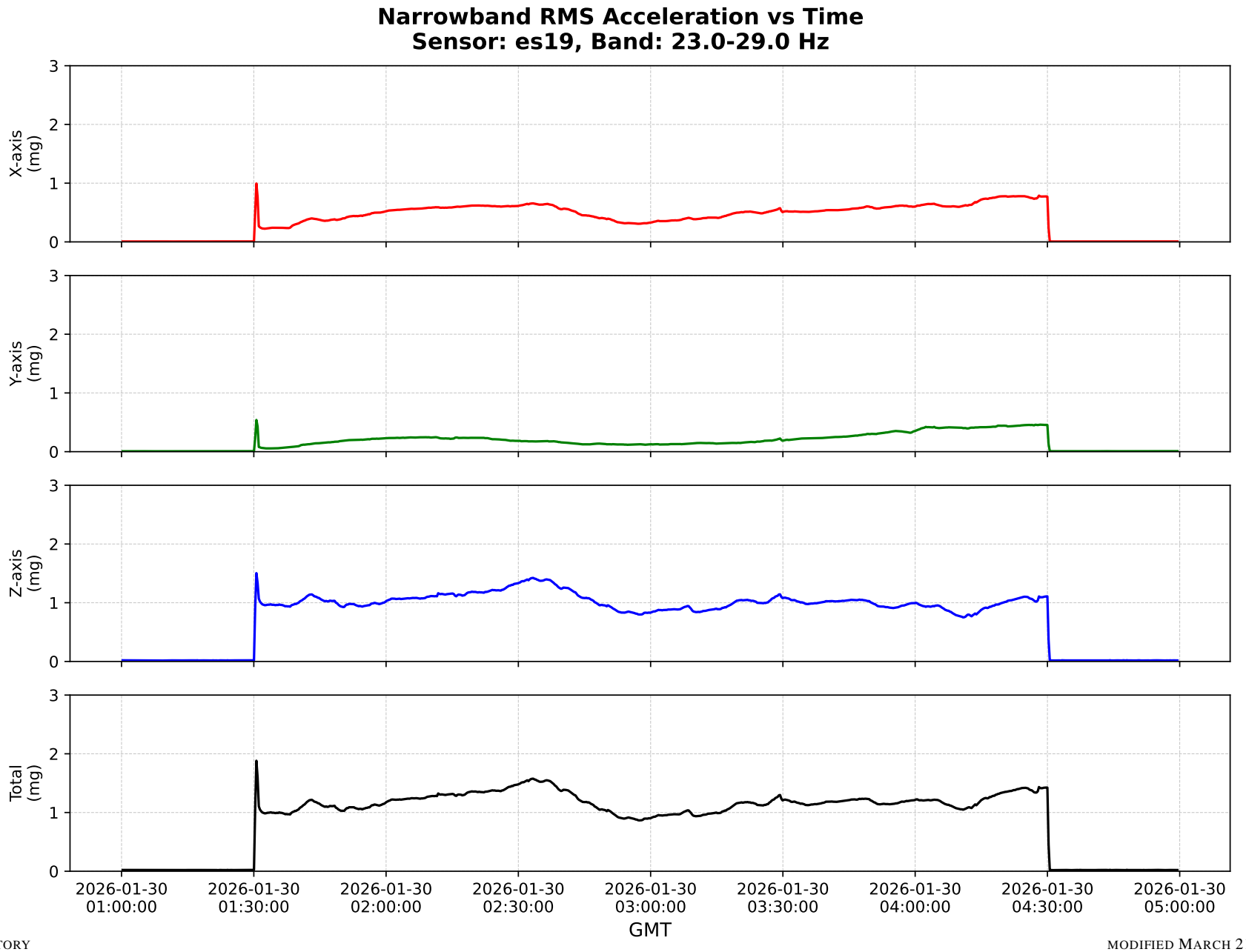

Fig. 4: Narrowband RMS acceleration vs. time (23–29 Hz), JEM Airlock Depress, **GMT 2026-01-30**, SAMS Sensor es19 at JPM1F6 (ER4).

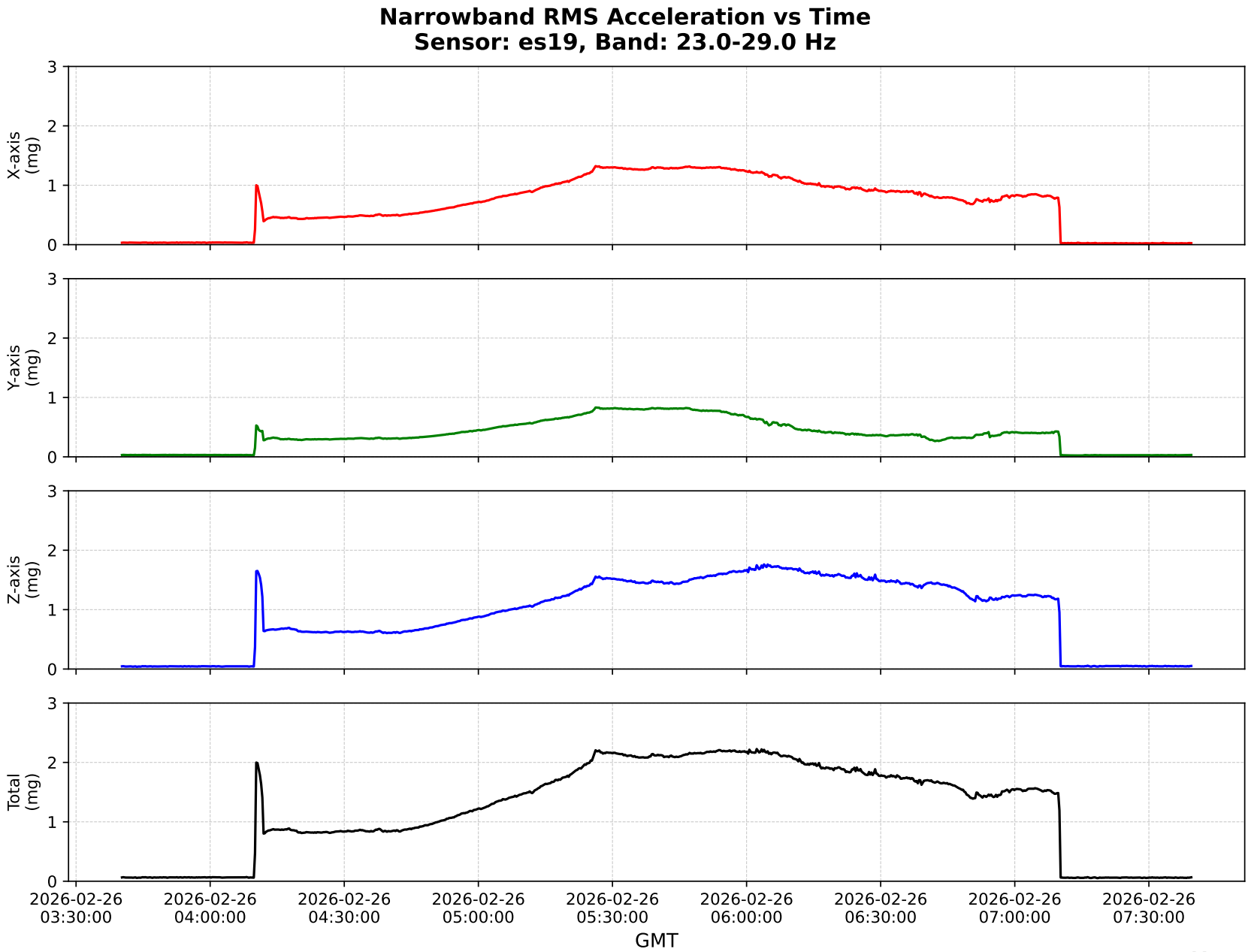

Fig. 5: Narrowband RMS acceleration vs. time (23–29 Hz), JEM Airlock Depress, **GMT 2026-02-26**, SAMS Sensor es19 at JPM1F6 (ER4).

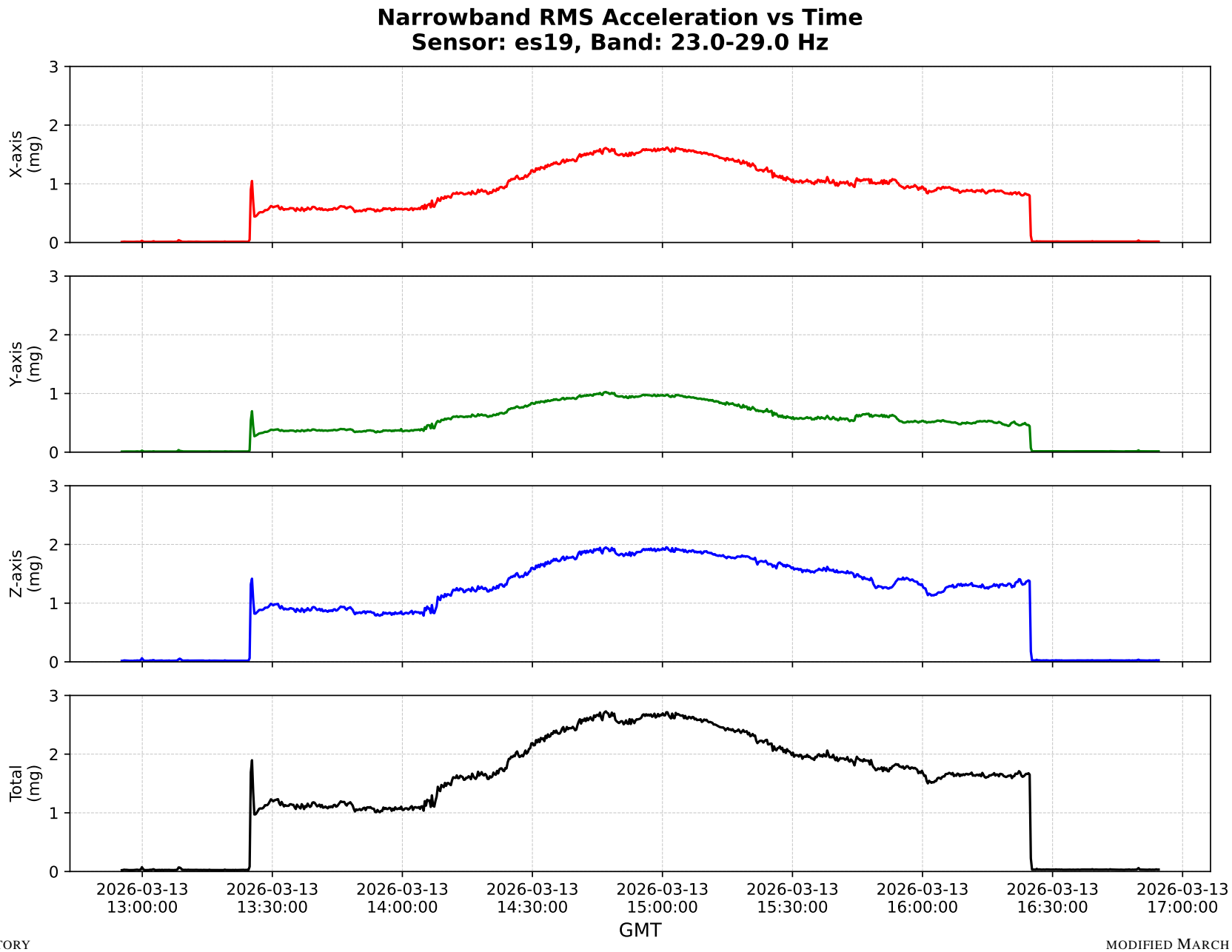

Fig. 6: Narrowband RMS acceleration vs. time (23–29 Hz), JEM Airlock Depress, **GMT 2026-03-13**, SAMS Sensor es19 at JPM1F6 (ER4).