1. EXECUTIVE SUMMARY

The ESA E4D Cycling analysis summarizes approximately six months (April 27–October 19, 2026) of nearly continuous International Space Station (ISS) acceleration measurements from seven Space Acceleration Measurement System (SAMS) sensor heads. It compares vibration levels below 2 Hz during eleven E4D cycling periods with a large volume of the measured space station's vibratory environment in that portion of the acceleration spectrum.

The standout finding is the October 16, 2026 cycling event, when vibration levels were extraordinarily high across all seven sensors, apparently associated with the vibration isolation system (VIS) being partially locked. The two Columbus sensors nearest E4D, 121f02 and 121f08, recorded mean accelerations of 1,627.9 and 1,140.7 μg RMS, respectively, dramatically exceeding other cycling periods. Even after excluding the narrow 1.27–1.44 Hz band containing the fundamental frequency of the Multi-use Variable-g Platform (MVP) – installed in the JPM1F6 rack –, with corresponding mean values remained exceptionally high at 799.6 and 558.5 μg RMS. Although the MVP disturbance falls within the structural response frequency band below 2 Hz and therefore contributes to (and somewhat confounds) the measured vibration levels therein, the unusually elevated structural response observed during this cycling event on October 16, 2026 cannot be explained solely by or attributed to the energy concentrated within the narrow MVP frequency band.

Weekly, per-sensor RMS acceleration percentile plots supply statistical context using the 1st, 25th, 50th, 75th, and 99th percentiles, both including and excluding the MVP band. The central conclusion is that October 16 represents an exceptional, widely observed station vibration event, while the remaining cycling periods establish comparison cases against nearly six months of ISS acceleration monitoring.

2. SCOPE AND INTERPRETATION

This report deliberately focuses on the **0.02–2 Hz** frequency range, where large-structure response to crew-induced excitation is particularly important. The measurements reflect response at specific sensor locations, not a single station-wide acceleration amplitude. A companion assessment based on SAMS measurements over **2–5 Hz** can be undertaken if requested, to include additional structural response and a greater share of exercise-associated vibration signatures. No 2–5 Hz numerical result is implied by this report.

The eleven cycling windows run from April 29 through October 18, 2026; the SAMS monitoring backdrop spans **nearly continuously** from April 27 to October 19, 2026 GMT. The October 16 operations note states that MVP operations began and VIS was locked; the attribution to a partially locked VIS should be regarded as the reported, likely explanation rather than an independently established causal finding. It was shown that the MVP fundamental frequency near 1.35 Hz can be notched out of the analysis, but the remaining vibration levels are still exceptionally high, demonstrating that the unusually elevated structural response during the October 16 cycling event extends well beyond the narrow MVP frequency band.

Table 1: SAMS sensor locations. The two Columbus heads are closest to E4D.

Sensor	Module	Rack / location
121f02	COL	COL Starboard Endcone
121f08	COL	COL1A3 (EPM)
121f03	LAB	LAB1O1 (ER2)
es18	LAB	LAB1P2 (ER7)
es20	LAB	LAB1S2 (MSG)
121f05	JEM	JPM1F1 (ER5)
es19	JEM	JPM1F6 (ER4); shares MVP rack

3. SENSORS AND MEASUREMENT METHOD

For each available measurement unit, the three disjoint bands are $B_1 = [0.02, 1.27)$ Hz, $B_2 = [1.27, 1.44)$ Hz and $B_3 = [1.44, 2)$ Hz. Their root-sum-square (RSS) band-limited RMS is computed *per unit* before summarization:

$$R_{\text{complete}} = \sqrt{R_1^2 + R_2^2 + R_3^2}, \tag{1}$$

$$R_{\text{notched}} = \sqrt{R_1^2 + R_3^2}. \tag{2}$$

For each cycling event, the root-sum-square (RSS) acceleration is first calculated separately for each measurement interval by combining the contributions from the selected frequency bands. The reported as-run value is then the arithmetic mean of these individual RSS values over the exact cycling window. Importantly, RSS is calculated before averaging, not afterward. The removed B_2 band contains the narrow MVP fundamental near 1.35 Hz; the same exclusion is applied for all dates for consistent comparison, although MVP operations began on October 16.

4. CYCLING RESULTS

Table 2 reports the two nearest E4D sensors for all eleven cases, alongside the October 16 full seven-sensor survey in Table 3. All values are in μg RMS and

Table 2: As-run mean band-limited acceleration at the two Columbus sensors. Columns headed "full" include 0.02–2 Hz; "notch" excludes 1.27–1.44 Hz.

Date (GMT)	121f02 full	121f02 notch	121f08 full	121f08 notch
2026-04-29	298.3	213.9	232.2	170.2
2026-06-18	121.9	95.3	97.2	77.0
2026-07-23	189.5	96.7	139.5	72.1
2026-07-26	192.2	115.9	141.7	86.2
2026-07-29	165.9	54.3	120.6	41.1
2026-09-30	67.0	55.9	50.1	42.3
2026-10-06	207.7	173.1	153.5	126.1
2026-10-10	143.6	105.4	108.3	78.7
2026-10-16	**1,627.9**	**799.6**	**1,140.7**	**558.5**
2026-10-17	223.0	78.6	156.8	59.1
2026-10-18	202.1	85.5	141.1	64.5

Table 3: October 16, 2026 E4D cycling (18:16:15–18:49:45 GMT): all seven sensors, with and without MVP band.

Sensor	Full (μg RMS)	Notched (μg RMS)
121f02 (COL)	1,627.9	799.6
121f08 (COL)	1,140.7	558.5
121f03 (LAB)	249.6	118.3
es18 (LAB)	253.1	118.1
es20 (LAB)	268.5	121.4
121f05 (JEM)	182.3	87.4
es19 (JEM)	252.9	114.6

rounded to one decimal. Full seven-sensor values for every cycling window, with per-sensor clickable weekly plots, are available by clicking the "Weekly Percentile Plots" button at the source results page.

For each Columbus head, October 16 exceeded the next-highest full-band cycling mean by more than fivefold. Its notched mean was more than threefold the next-largest corresponding cycling mean, emphasizing that removal of the narrow MVP band substantially reduced, but did not eliminate, the unusually large response to this day's E4D cycling activity. The spatially dispersed LAB and JEM sensor readings in Table 3 establish that the elevated response was observed beyond Columbus.

5. STATISTICAL CONTEXT: WEEKLY DISTRIBUTIONS

The source's weekly box-and-whisker figures at the plots results page show the *median* (50th percentile), interquartile box (25th–75th), and 1st–99th percentile whiskers for the monitoring backdrop. Dashed horizontal reference lines mark as-run mean RMS values for each sensor and band selection. The figures use sensor-specific vertical axes and should not be compared by apparent height without checking scale. A cycling *mean* placed above a week's 99th-percentile whisker underscores its extremeness, but the two statistics summarize different populations and durations. The dashed lines indicate just several minutes of the cycling period whereas the box/whisker indicators mark statistical summary of one week about 6 months of measurements.

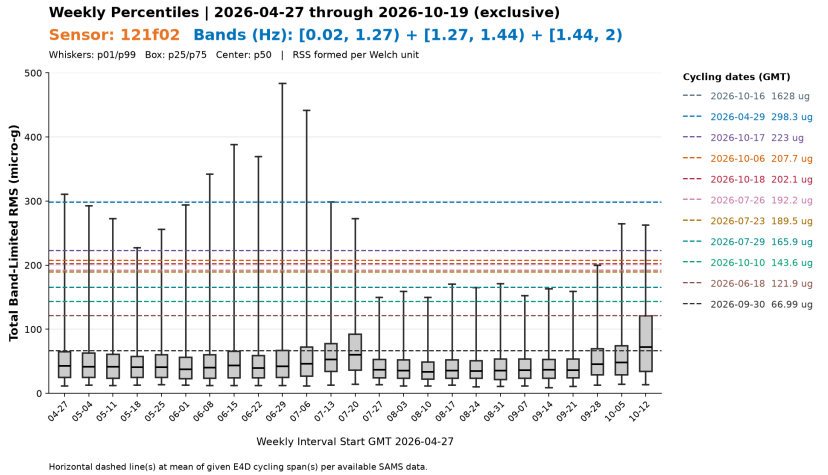


Fig. 1. Sensor 121f02 weekly acceleration distributions for the complete 0.02–2 Hz band. Vertical scale is limited to 0–500 μg RMS; the October 16 as-run mean of 1,627.9 μg RMS exceeds this displayed range, but all other cycling sessions shown.

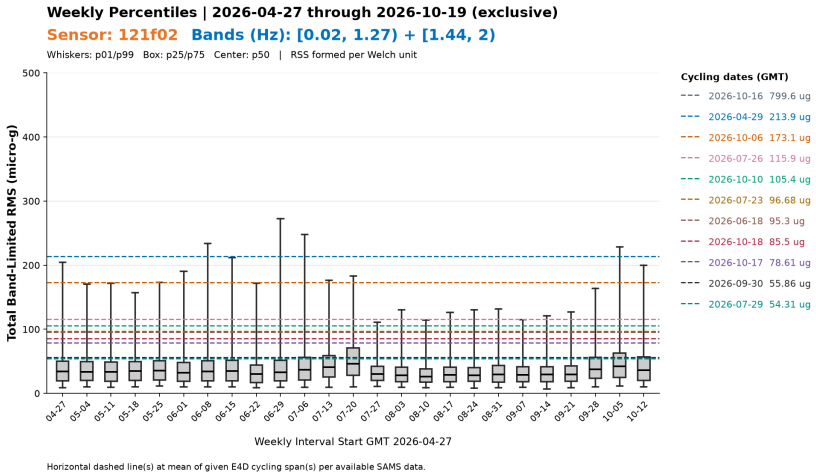


Fig. 2. Sensor 121f02 weekly acceleration distributions with the 1.27–1.44 Hz MVP band excluded. Vertical scale is limited to 0–500 μg RMS; the October 16 notched as-run mean of 799.6 μg RMS exceeds this displayed range, but all other cycling sessions shown.

6. CONCLUSIONS AND POSSIBLE FOLLOW-UP

The below-2-Hz E4D cycling record demonstrates a singular October 16 disturbance across all seven sampled locations, strongest at the two Columbus sensor heads nearest E4D. Its persistence after notch exclusion mostly alleviates confound of attributing the entire event to the narrow MVP fundamental. Other cycling windows, while variable, are comparatively moderate and provide practical reference cases within the six-month measurement distribution.

The two included 121f02 weekly percentile figures provide complementary full-band and notched comparisons on matching vertical scales. A subsequent 2–5 Hz companion study would address higher-frequency structural and exercise-related response using the same event-window comparisons and percentile framework. For further information or to request additional analysis, contact the SAMS team at pimsops@lists.nasa.gov.

DATA SOURCE

https://gipoc.grc.nasa.gov/pims/pub/plots/user/handbook/source_docs/e4d_2026/e4d_cycling/index.html
https://gipoc.grc.nasa.gov/pims/pub/plots/user/handbook/source_docs/e4d_2026/e4d_cycling/weekly-percentile-plots.html