SAMS Sensor Head TSH-ES S/N 20 One-Third Octave (OTO) Band Analysis for 4BCO2

INTRODUCTION

The focus of this analysis is SAMS sensor TSH-ES S/N 20 vibratory measurements made near 4BCO2's location in LAB1P4 of the US LAB given 2 conditions. We quantify and compare these two primary conditions: (1) one week's worth of "4BCO2 OFF" (baseline), with data from GMT 2022-01-28 through 2022-02-03, and (2) two days' worth of "4BCO2 ON", with data from GMT 2022-02-12 through 2022-02-13. For context, we also show SAMS measurements from another sensor in the US LAB (S/N 121f03) and a sensor in the Columbus module (S/N 121f08).

The following are observations from the next several pages in this document:

Page 2. 8-hour color spectrogram that shows annotation (#3) "**4BCO2 Turns ON"** with fan just over 80 Hz, (#4) 4BCO2 pump that comes on intermittently, and (#5) shows start of the 4BCO2 blower.

Page 3. 8-hour spectrogram that shows **nominal/representative 4BCO2 operations**. This 8-hour span covers about one-sixth of the two-day span we used for statistics (median) as "4BCO2 ON" condition. We note the three 4BCO2 equipment signatures for the: fan, intermittent pump, and blower.

Page 4. This is the **main set of results** for the analysis of vibratory measurements on 4BCO2 by the SAMS sensor at LAB1P4 near 4BCO2. This figure shows three Root-Mean-Square (RMS) Acceleration versus One-Third Octave (OTO) Band traces overlaid on same log-log axes as follows: (1) the light blue trace is from the ISS Microgravity Control Plan – the comparison benchmark, (2) the black trace shows RMS acceleration values (median for each band from *two days of 4BCO2 nominal ops starting on GMT 2022-02-12*), and (3) the red trace shows RMS acceleration values (median each band from *seven days of 4BCO2 off/baseline starting on GMT 2022-01-28*). **Details and observations are given on the 2nd last page of this document**. The next 2 pages for two other SAMS sensors help put some of the details and observations into context.

Page 5. A plot identical to what was shown on page 4, except **SAMS sensor/location is 121f03/LAB1O1**.

Page 6. A plot identical to what was shown on page 4, except **SAMS sensor/location is 121f08/COL1A3**.

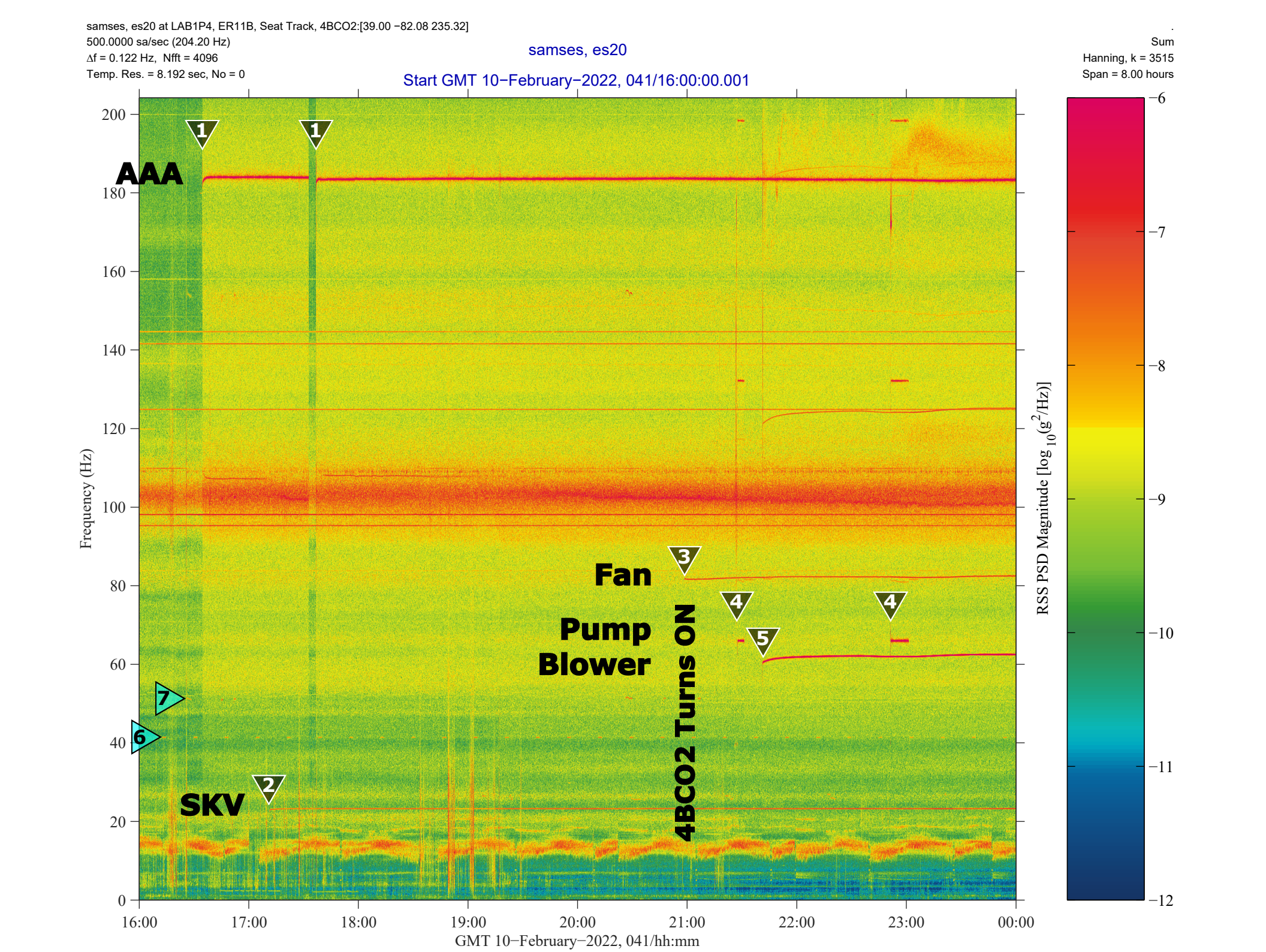
SUMMARY

Our objective was to apply one-third octave band analysis to vibratory (0.01 to ~200 Hz) measurements made by the SAMS sensor near the 4BCO2 equipment located within LAB1P4 rack on the ISS to compare two conditions: (1) 4BCO2 OFF (baseline), and (2) 4BCO2 ON to the ISS Microgravity Control Plan's stairstep curve. Page 4 shows these results minus a few bands[1].

Page 4 shows SAMS measurements, both the black trace (4BCO2 ON) and the red trace (4BCO2 OFF), with expected ramp up in RMS as the OTO bands' get ever wider with increasing frequency. All SAMS sensors distributed throughout the ISS show this same general characteristic.

The OTO band results on page 4 show that for the 4BCO2 OFF (red trace) condition, the RMS acceleration levels calculated from the SAMS measurements near 4BCO2 are all below the ISS Microgravity Control Plan curve for all OTO bands analyzed. The 4BCO2 ON (black trace) condition, shows that the RMS acceleration levels calculated from the SAMS measurements near 4BCO2 are all below the ISS Microgravity Control Plan curve except for the OTO band from 56.230 to 71.838 Hz, where it is ostensible that vibrations from the blower and intermittent pump give rise to median RMS acceleration levels of 1.232 milli-g_{RMS}, which is just over the ISS Microgravity Control Plan level of 1.152 milli-g_{RMS} for that band, and roughly an order of magnitude higher than the 4BCO2 OFF condition. See page 8 below.

[1] SAMS measures from (0.01 to ~200 Hz), while some of the OTO bands lie outside this range and were therefore not considered in this analysis.


samses, es20 at LAB1P4, ER11B, Seat Track, 4BCO2:[39.00 −82.08 235.32]
500.0000 sa/sec (204.20 Hz)
Δf = 0.122 Hz, Nfft = 4096
Temp. Res. = 8.192 sec, No = 0
samses, es20
Start GMT 10−February−2022, 041/16:00:00.001
Sum
Hanning, k = 3515
Span = 8.00 hours
AAA
Fan
Pump
Blower
4BCO2 Turns ON
SKV
1
2
3
4
5
6
7
Frequency (Hz)
RSS PSD Magnitude [log10(g2/Hz)]
GMT 10−February−2022, 041/hh:mm
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
00:00
0
20
40
60
80
100
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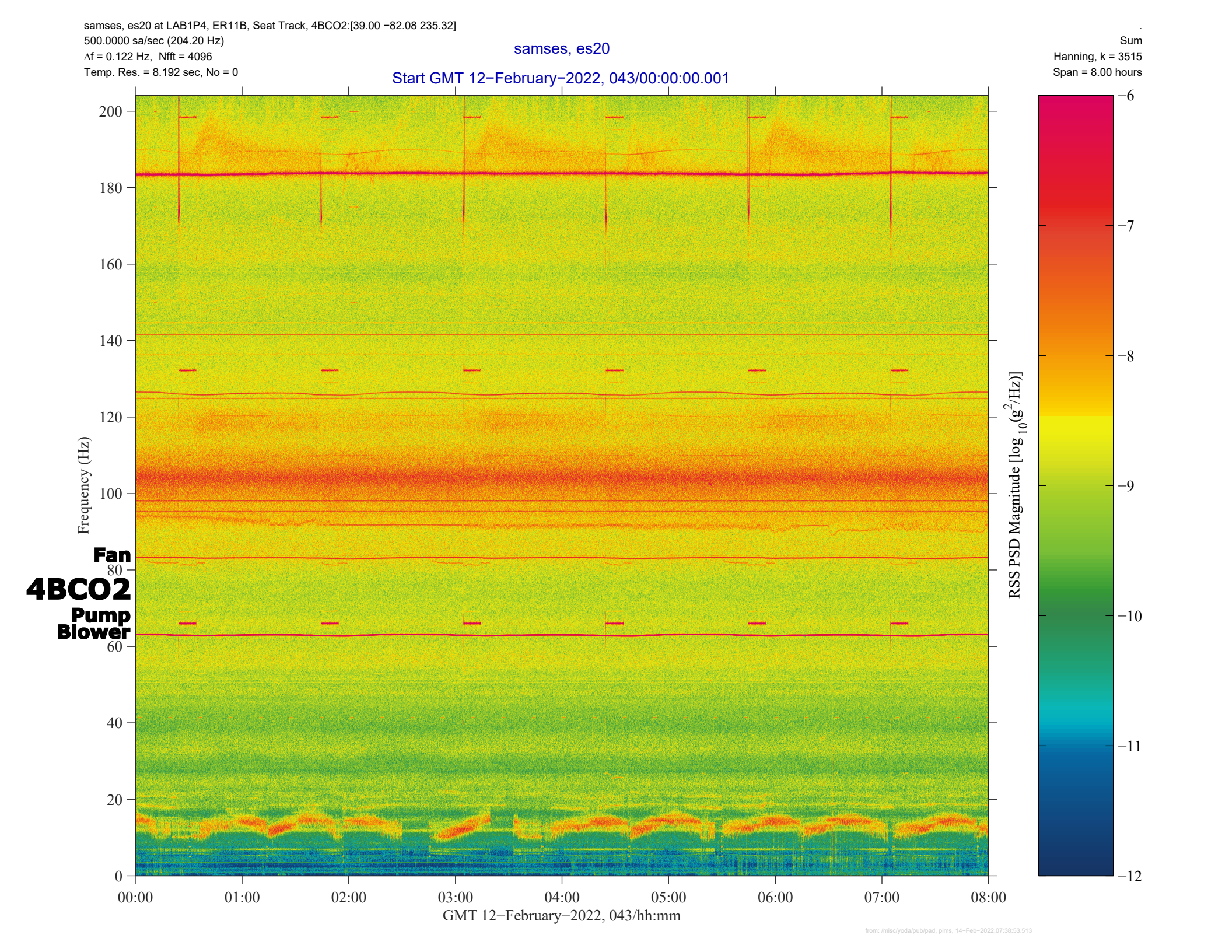
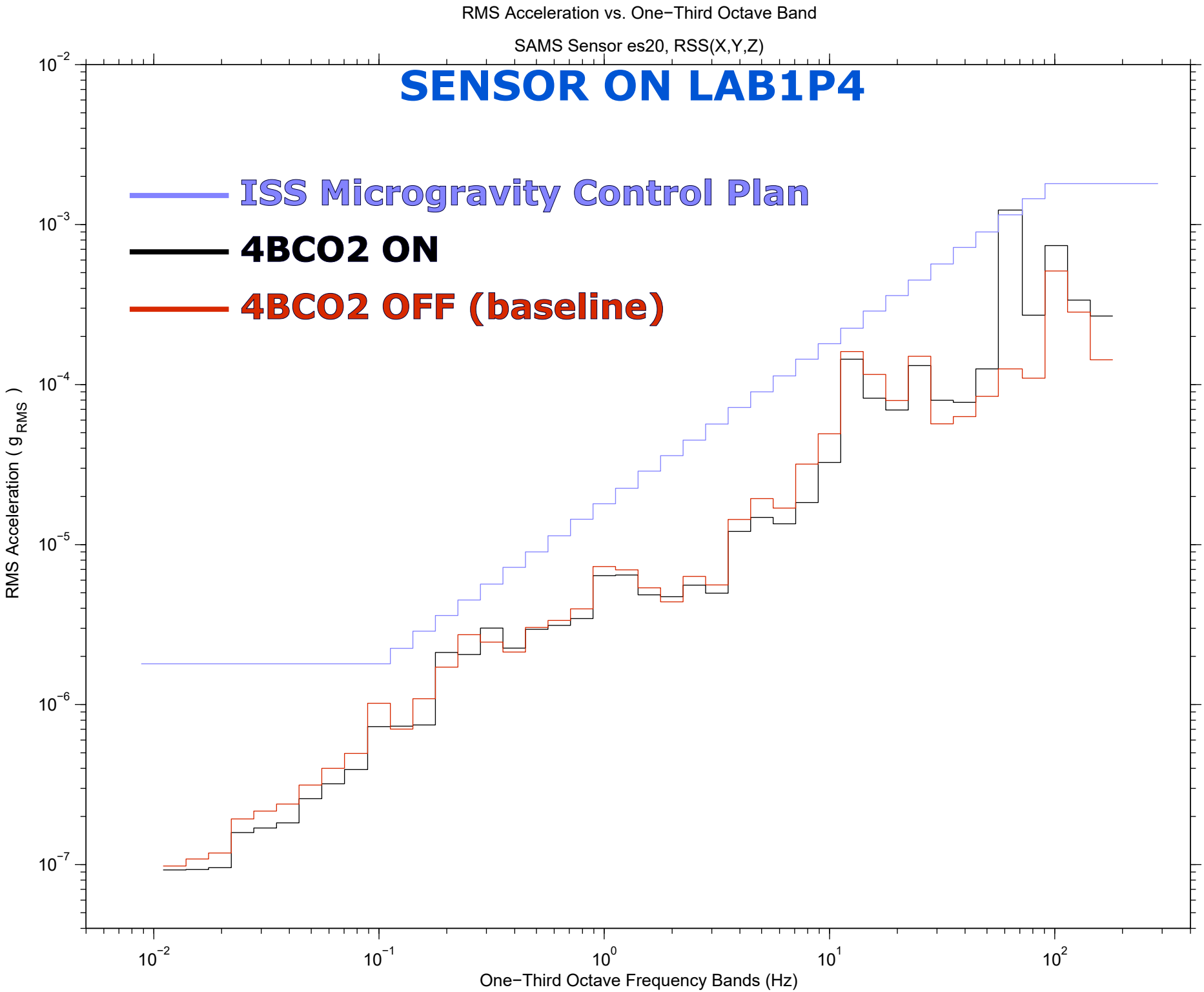
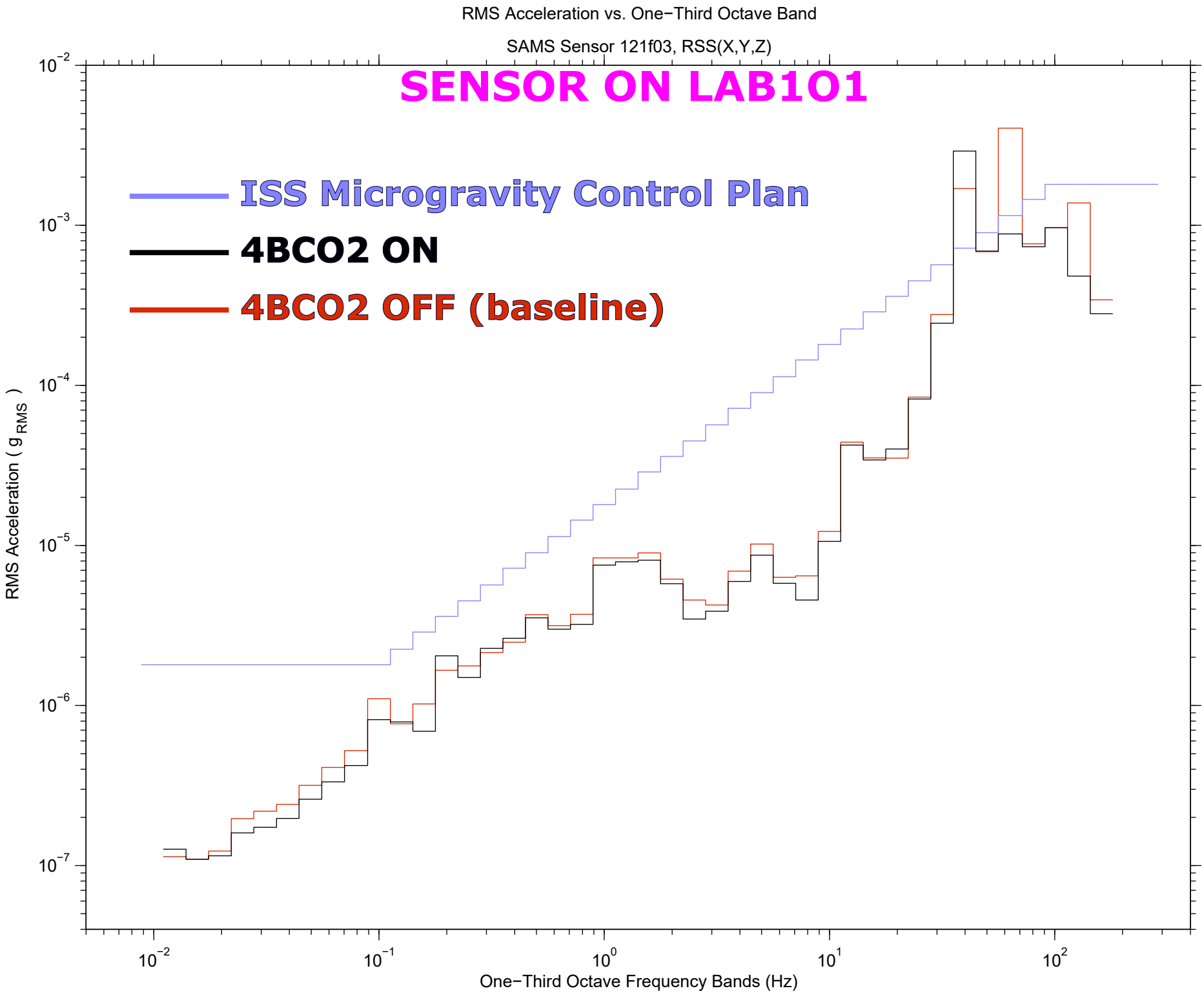
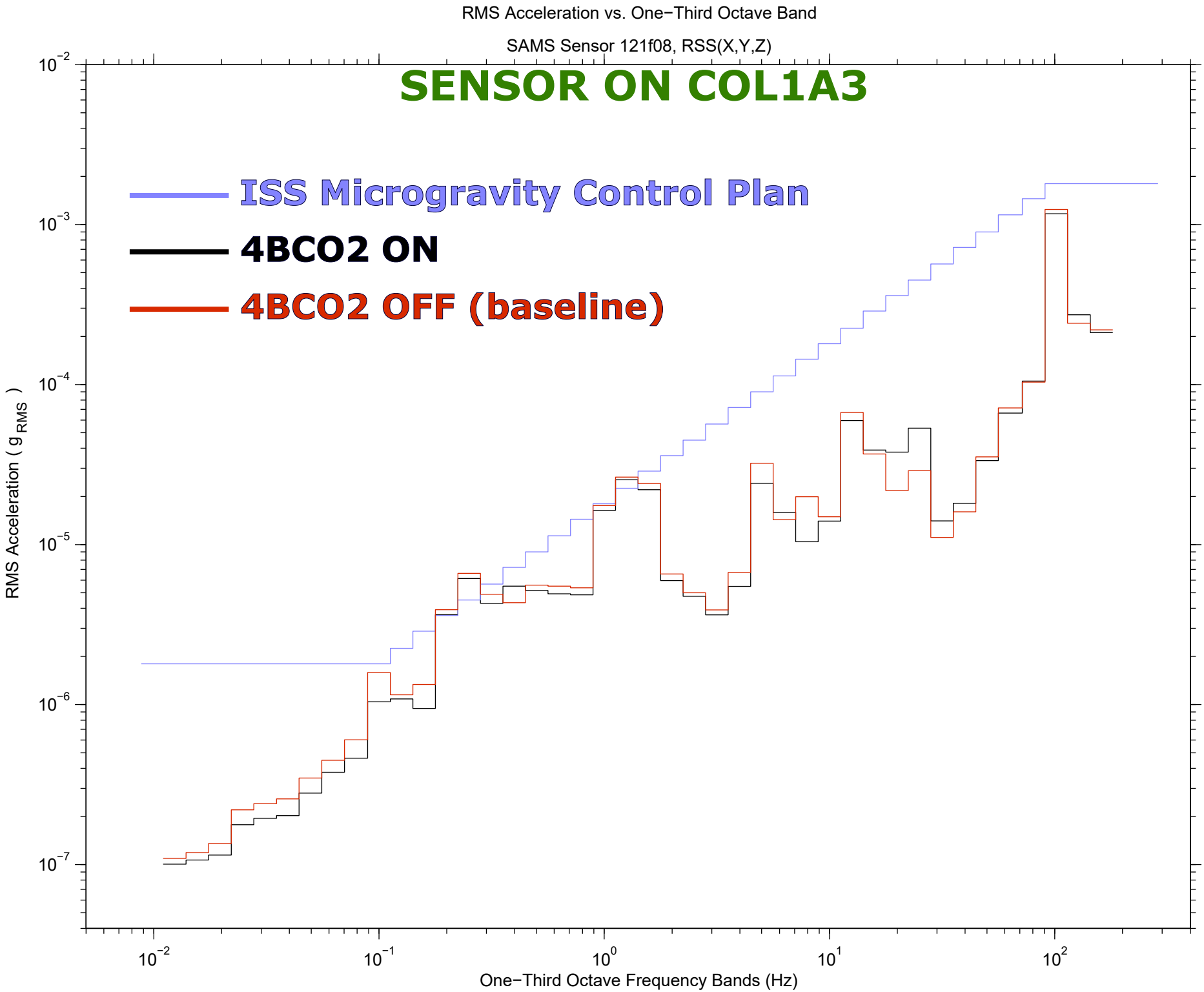
−6
−7
−8
−9
−10
−11
−12


samses, es20 at LAB1P4, ER11B, Seat Track, 4BCO2:[39.00 −82.08 235.32]
500.0000 sa/sec (204.20 Hz)
Δf = 0.122 Hz, Nfft = 4096
Temp. Res. = 8.192 sec, No = 0
samses, es20
Start GMT 12−February−2022, 043/00:00:00.001
Sum
Hanning, k = 3515
Span = 8.00 hours
Frequency (Hz)
200
180
160
140
120
100
80
60
40
20
0
Fan
4BCO2
Pump
Blower
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
GMT 12−February−2022, 043/hh:mm
RSS PSD Magnitude [log10(g2/Hz)]
−6
−7
−8
−9
−10
−11
−12
from: /misc/yoda/pub/pad, pims, 14−Feb−2022,07:38:53.513


RMS Acceleration vs. One−Third Octave Band
SAMS Sensor es20, RSS(X,Y,Z)
SENSOR ON LAB1P4
ISS Microgravity Control Plan
4BCO2 ON
4BCO2 OFF (baseline)
RMS Acceleration (g RMS)
One−Third Octave Frequency Bands (Hz)
10−2
10−3
10−4
10−5
10−6
10−7
10−2
10−1
100
101
102


RMS Acceleration vs. One−Third Octave Band
SAMS Sensor 121f03, RSS(X,Y,Z)
SENSOR ON LAB1O1
ISS Microgravity Control Plan
4BCO2 ON
4BCO2 OFF (baseline)
RMS Acceleration (g RMS)
One−Third Octave Frequency Bands (Hz)
10−2
10−3
10−4
10−5
10−6
10−7
10−2
10−1
100
101
102


RMS Acceleration vs. One−Third Octave Band
SAMS Sensor 121f08, RSS(X,Y,Z)
SENSOR ON COL1A3
ISS Microgravity Control Plan
4BCO2 ON
4BCO2 OFF (baseline)
RMS Acceleration (g RMS)
One−Third Octave Frequency Bands (Hz)
10−2
10−3
10−4
10−5
10−6
10−7
10−2
10−1
100
101
102

SAMS Sensor Head TSH-ES S/N 20 One-Third Octave (OTO) Band Analysis for 4BCO2

DETAILS AND OBSERVATIONS

Page 2) **GMT 2022-02-10**: this shows an 8-hour color spectrogram with these annotations[1] (numbered triangles):

Triangle #1) GMT 16:30 @ just above 180 Hz: a strong, narrowband spectral peak begins. We attribute this to an Avionics Air Assembly (AAA) Fan starting up. Notice near GMT 17:30 it briefly goes off, but then persists at least to the end of this 8-hour period.

Triangle #2) GMT 17:10 @ about 24 Hz: a strong, narrowband spectral peak begins. This is Russian air conditioner (SKV) spectral signature that persists to varying degrees (vibratory magnitudes, i.e. RMS) through the end of this plot. This signature shows up throughout to various degrees throughout the ISS.

Triangle #3) GMT 21:00 @ 80 Hz: 4BCO2 Equipment first turns ON with narrowband 4BCO2 Fan signature.

Triangle #4) GMT 21:15 and 22:50 @ 65 Hz: 4BCO2 Pump (narrowband peak) cycles on/off a couple of times.

Triangle #5) GMT 21:30 @ 60 Hz: 4BCO2 Blower's narrowband spectral peak begins.

Triangle #6) Somewhat regular on/off throughout @ 42 Hz: unidentified (for now).

Triangle #7) Sporadic on/off throughout @ 50 Hz: unidentified (for now).

Page 3) **GMT 2022-02-12**: this shows an 8-hour color spectrogram of [nominal/steady-state] 4BCO2 operations showing continuation of 4BCO2 Fan, Pump, and Blower narrowband signatures a couple days after those seen on the previous spectrogram from GMT 2022-02-10.

Page 4) One-Third Octave (OTO) Band Analysis/Comparison - ***This is the main set of quantitative results*** for the analysis of vibratory measurements on 4BCO2 by the SAMS sensor (TSH-ES S/N 20, aka "es20") at LAB1P4 near 4BCO2. This figure shows three Root-Mean-Square (RMS) Acceleration versus One-Third Octave (OTO) Band traces overlaid on log-log axes as follows: **(1)** the **light blue trace is from the ISS Microgravity Control Plan** – a comparison benchmark, **(2)** the **black trace shows RMS acceleration values (median for each band from *two days of 4BCO2 nominal ops starting on GMT 2022-02-12*)**, and **(3)** the **red trace shows RMS acceleration values (median each band from *seven days of 4BCO2 off/baseline starting on GMT 2022-01-28*)**. Here are some salient features:

1) SAMS measures from 0.01 to 200 Hz, while the ISS Microgravity Control Plan tops out at 300 Hz.
2) There was only one OTO frequency band where 4BCO2 operations impact put the local vibratory environment in exceedance of the ISS Microgravity Control Plan. That band spans from about 56 to about 72 Hz and is the band that contains both the 4BCO2 Blower and Pump.
3) In the OTO band referenced in the bullet above (also, see the very last, zoomed plot page):
   (a) for the "4BCO2 OFF" data set (red trace), the RMS level was at about 0.1 milli-g
   (b) for the "4BCO2 ON" data set (black trace), the RMS level was at about 1.23 milli-g
   (c) the ISS Microgravity Control Plan value is 1.15 milli-g for this band.

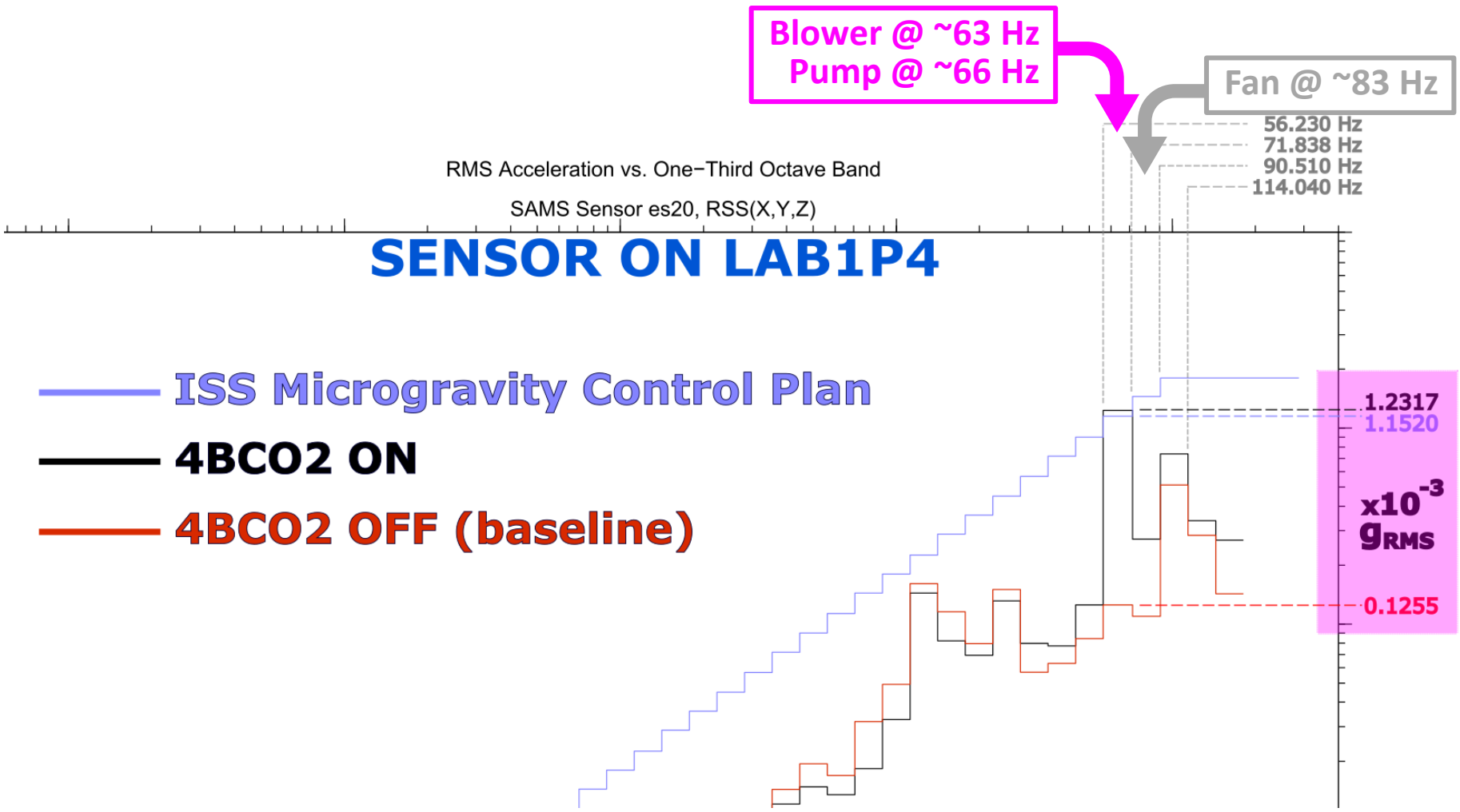
Page 5) For comparison in the US LAB, the analysis for this OTO plot was the same as the previous page/plot, but for a different SAMS sensor head (S/N 121-f03) located on LAB1O1 (ER-2). We note here that at frequencies above about 30 Hz, there are 2 notable bands with exceedance, even with 4BCO2 being OFF.

Page 6) For comparison in the Columbus module, the analysis for this OTO plot was the same as the previous 2 pages/plots, but for a different SAMS sensor head (S/N 121-f08) located on COL1A3 (EPM). We note here that at frequencies below about 2 Hz, there are a few notable bands with exceedance…and at this location, 4BCO2 has a negligible impact.

Page 7) This page.

Page 8) Zoom of Page 4 to better see the slight exceedance band.

[1] Greenwich Mean Time (GMT) hacks and frequencies shown in this narrative are approximate. If/when needed, we can get more precise values for either GMT and/or frequency.


Blower @ ~63 Hz
Pump @ ~66 Hz
Fan @ ~83 Hz
RMS Acceleration vs. One−Third Octave Band
SAMS Sensor es20, RSS(X,Y,Z)
56.230 Hz
71.838 Hz
90.510 Hz
114.040 Hz
SENSOR ON LAB1P4
ISS Microgravity Control Plan
4BCO2 ON
4BCO2 OFF (baseline)
1.2317
1.1520
x10-3
gRMS
0.1255