Report on Spectral Lines found in Key H1 HIFO-Y Channels

(alog update to report presented at the Sept 2013 LVC meeting in Hannover)

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DCC: G1301314

Goals -- reminder

- Refine line-finding infrastructure in preparation for the A.D.E.
- Identify narrow line artifacts that can be mitigated before the A.D.E.
- Establish catalog of line artifacts

New:

- Looked at more y-arm longitudinal servo data in green-light lock state
- Looked at red-light transmitted light in half-fringe state (green lock)
- Looked at two terminated channels (tiltmeters) for purely digital effects

Wiki page for links, documentation and investigations:
https://wiki.ligo.org/DetChar/HalfInterferometerYHanfordLineInvestigations

Tools/methods used in HIFO-Y line studies to date:
NoEMi, Fscans, coherence, folding

State Selection

Several state conditions – segments created/inserted once per day (Greg)

Input mode cleaner locked:

mean(H1:IMC-MC2_TRANS_SUM_OUT_DQ) > 1500

mean(H1:IMC-REFL_DC_OUTPUT) < 1000

→ **H1:DCH-IMC_LOCKED**

Green laser locked to Y arm:

200 < Mean(H1:ALS-Y_REFL_B_LF_OUT_DQ)< 14000

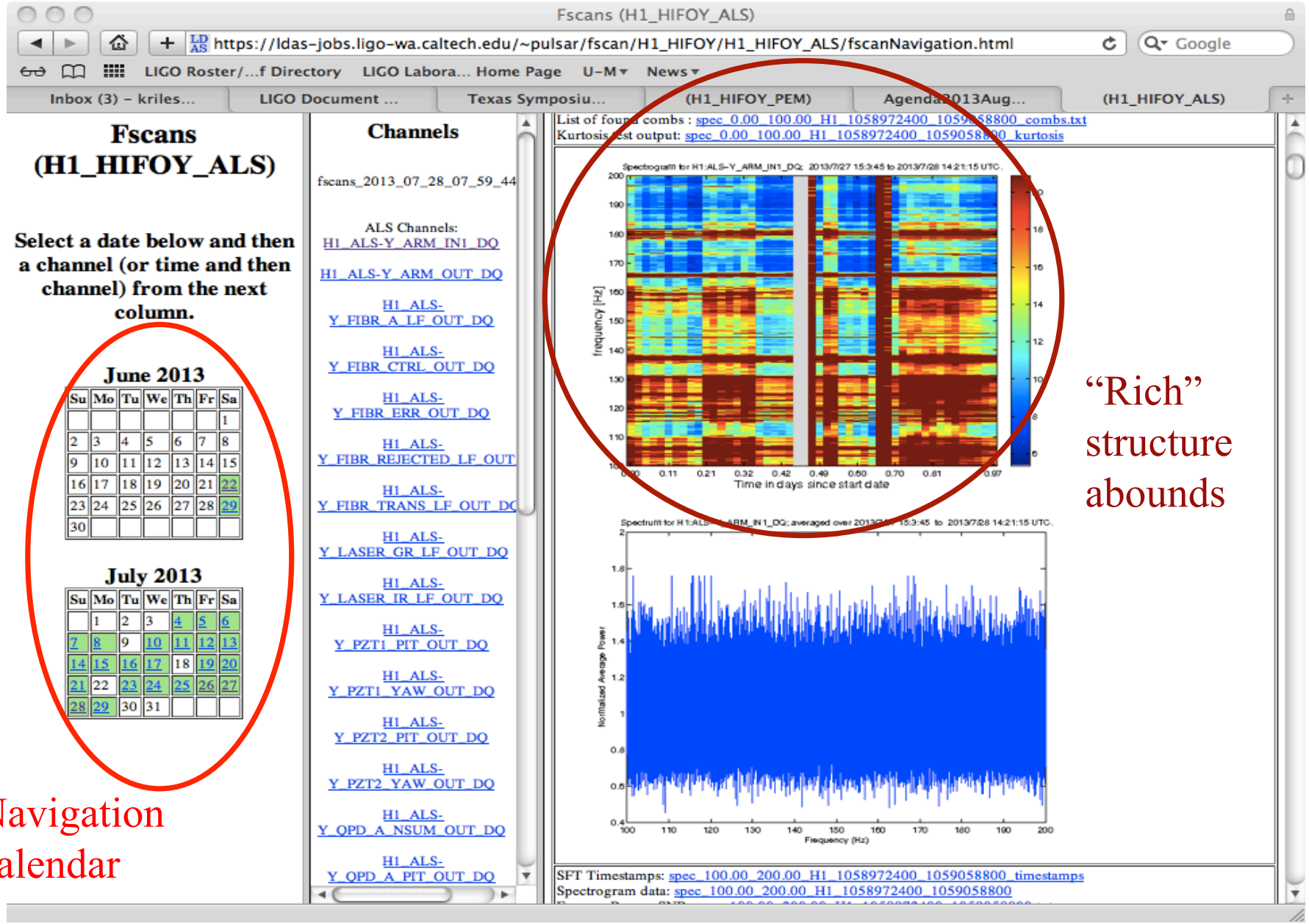
→ **H1:DCH-HIFOY_GREEN_LOCKED**

Transmitted infrared light at half-max-power (half-fringe)

200 < Mean(H1:ASC-Y_TR_A_NSUM_OUT_DQ) < 360

→ **H1:DCH-HIFOY_INFRARED_HALF_FRINGE**

Sample Fscan snapshot (green lock condition)



"Rich" structure abounds

Navigation calendar

Used Greg's Fscan SFTs from July 2013 to compute noise-weighted spectra for each day (green-arm lock for ≥30 contiguous minutes)

- July 4 – 9 hours
- July 5 – 16 hours
- July 6 – 13.5 hours
- July 7 – 7 hours
- July 8 – 15 hours
- July 10 – 3.5 hours
- July 11 – 6 hours
- July 12 – 2 hours
- July 13 – 10 hours
- July 14 – 10 hours
- July 15 – 4.5 hours

Note

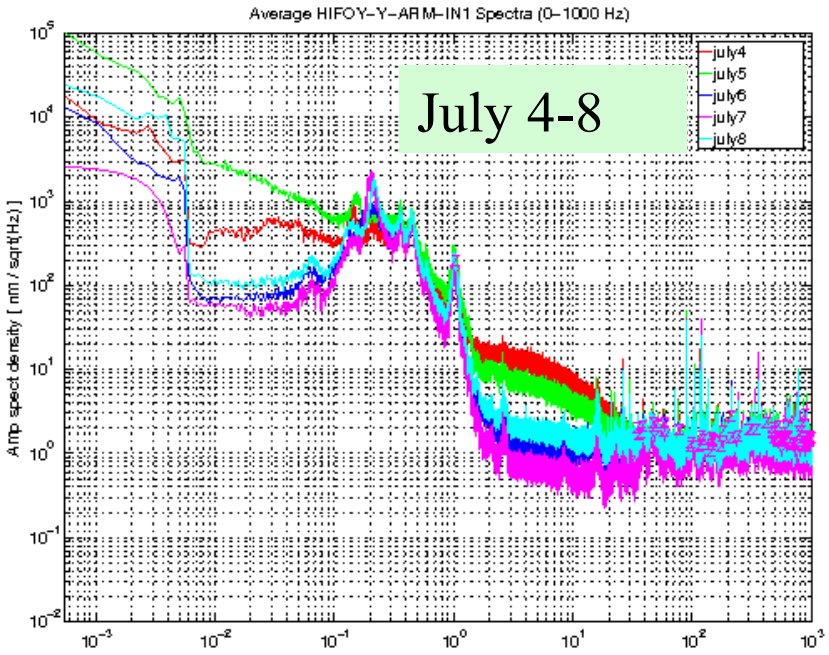
Date refers to day when interval ends
-- Now synchronized to daily segment generation:
"July 4" = [July 3 15:00 UTC – July 4 15:00 UTC]
= [July 3 08:00 PDT – July 4 08:00 PDT]

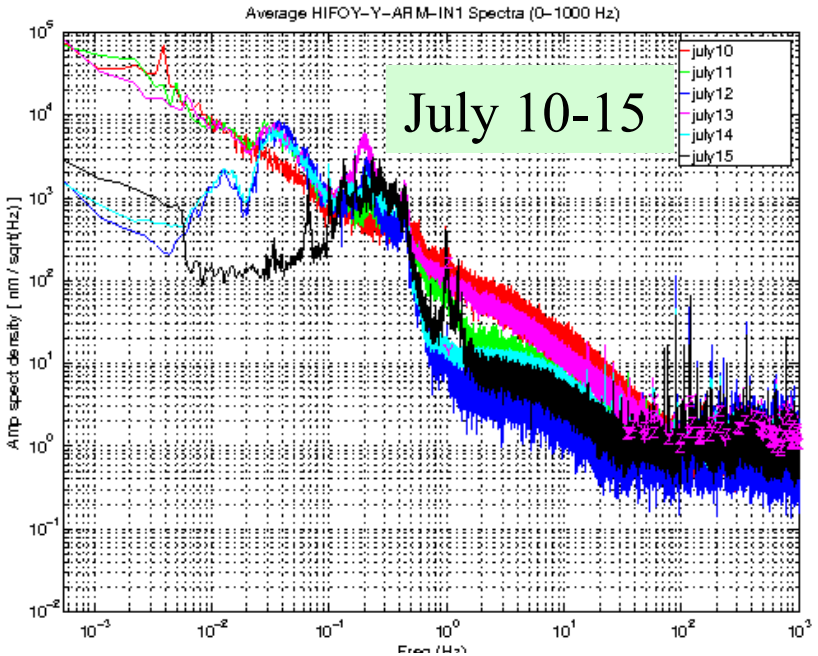
- July 19 – 10 hours
- July 24 – 15.5 hours
- July 25 – 14.5 hours
- July 26 – 20.5 hours
- July 27 – 17.5 hours
- July 28 – 23.5 hours
- July 29 – 22 hours

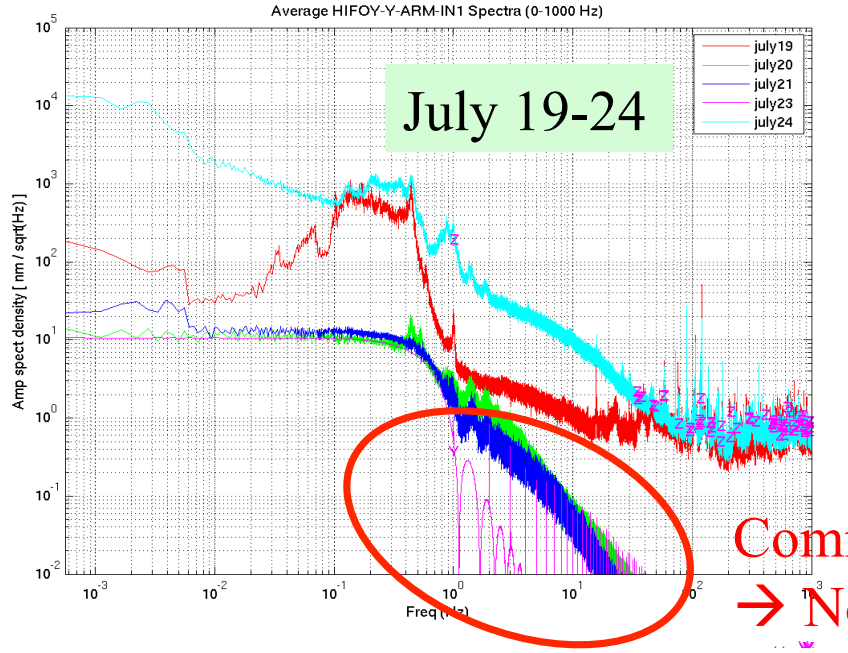
Added for this update

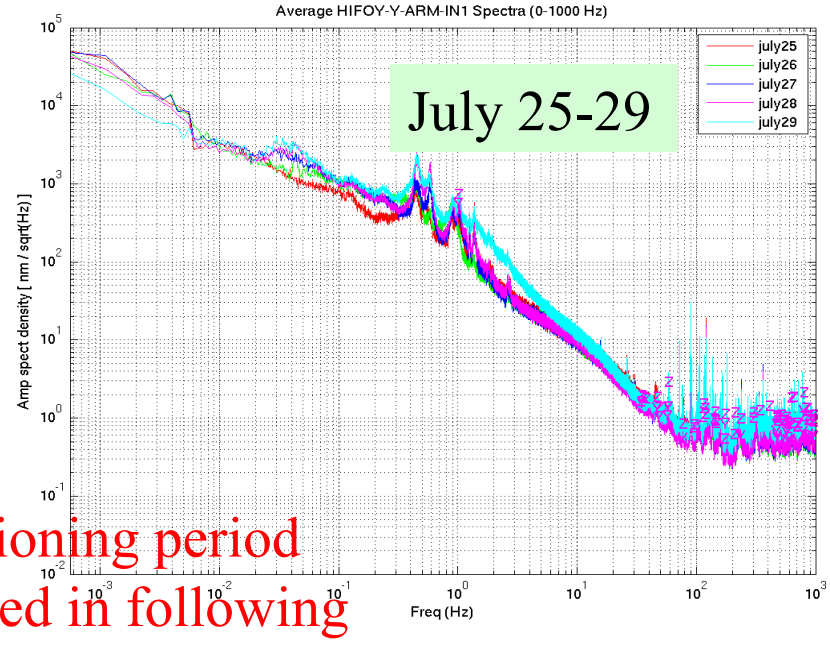
→ **210 total hours analyzed (420 1800-s SFTs)**

Daily spectra of **H1:ALS-Y_ARM_IN1_DQ**



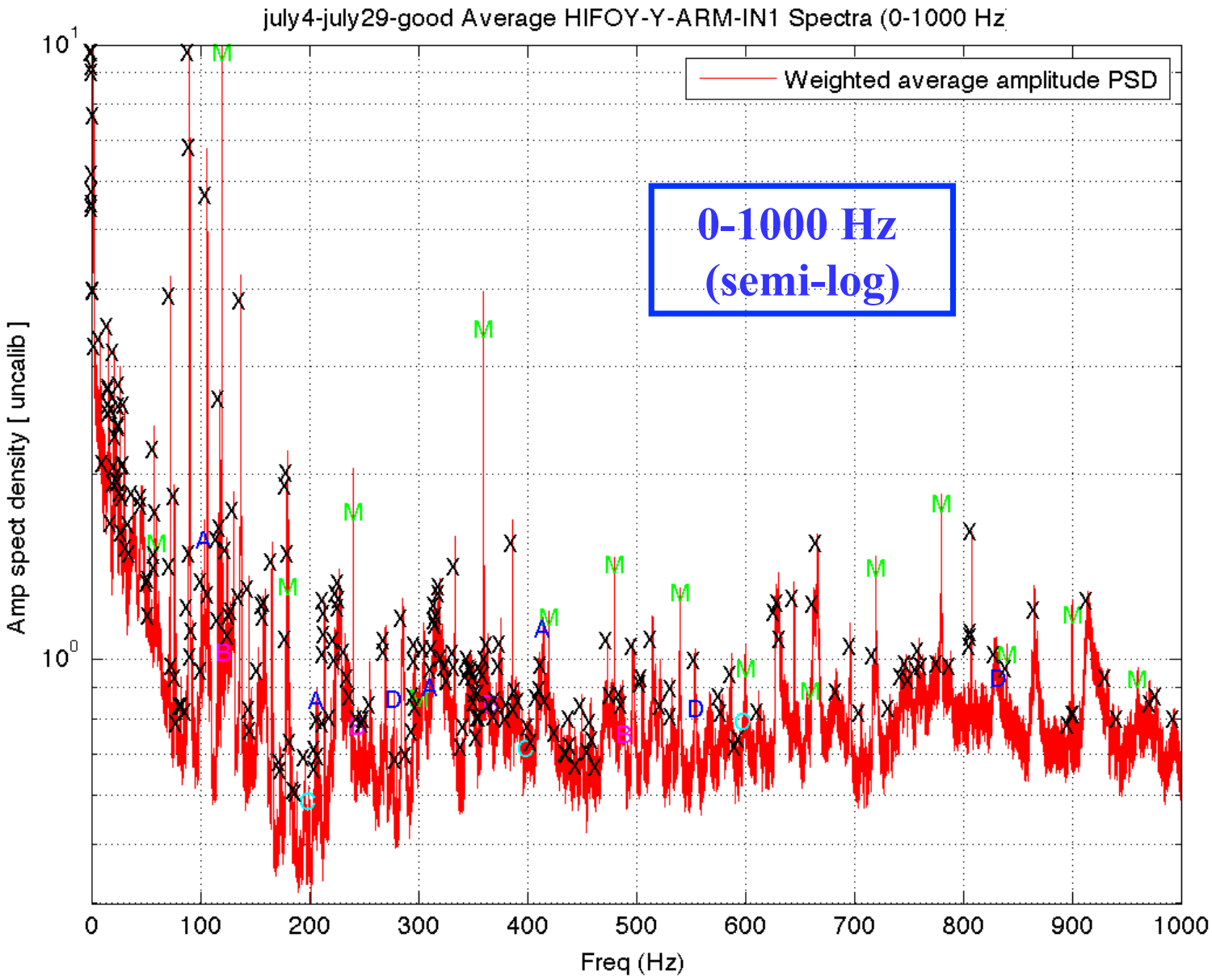


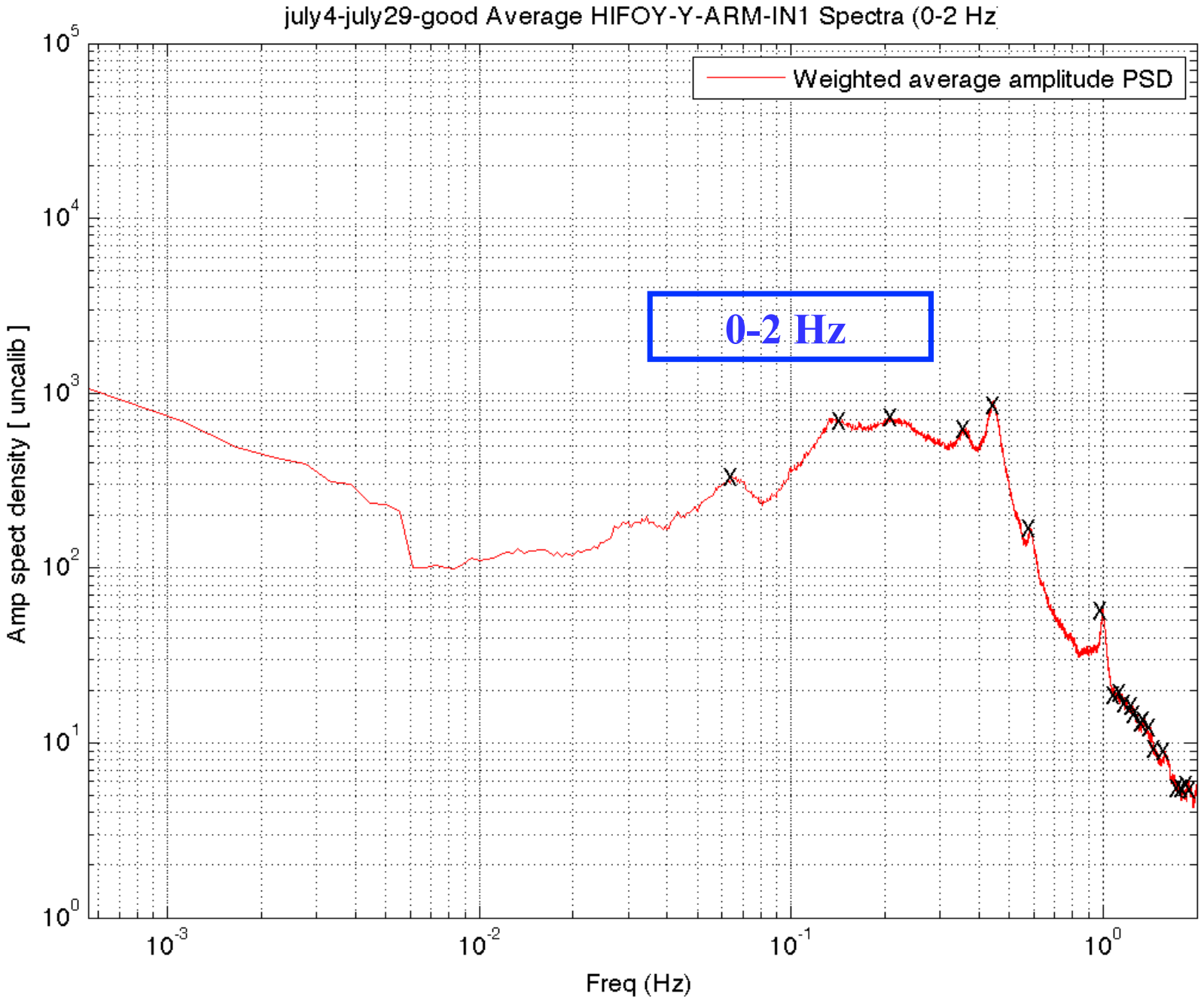


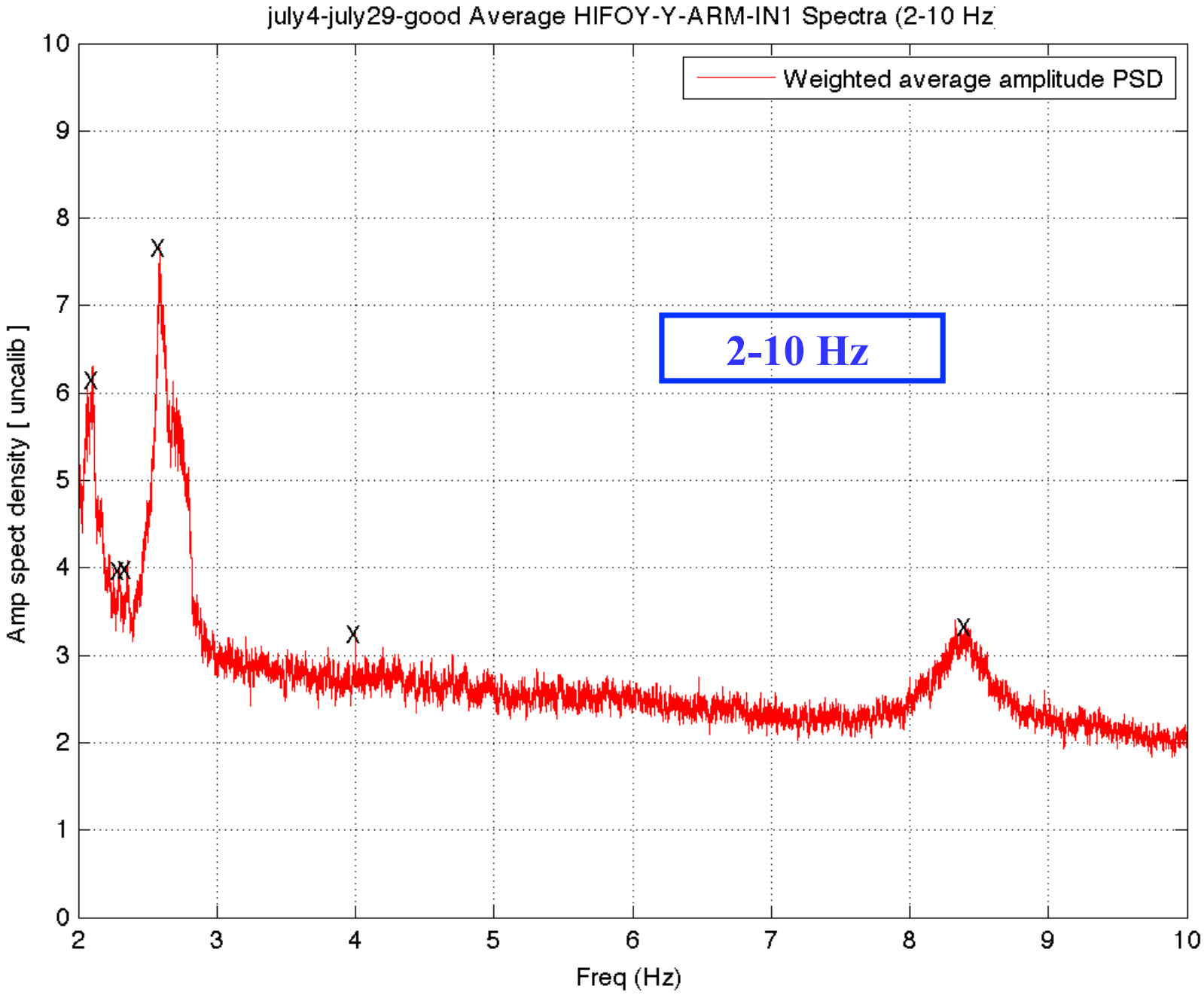


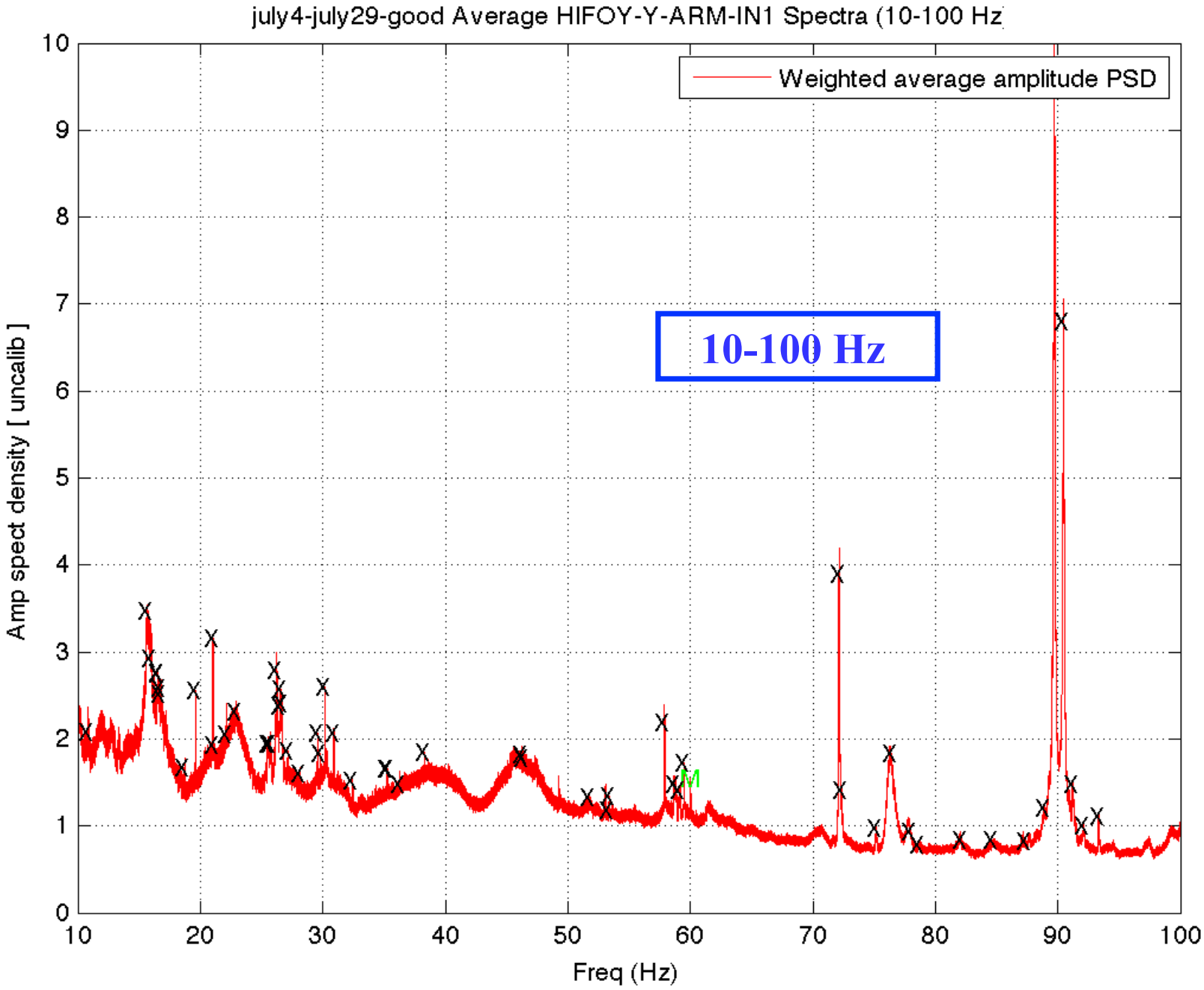
Commissioning period
→ Not used in following

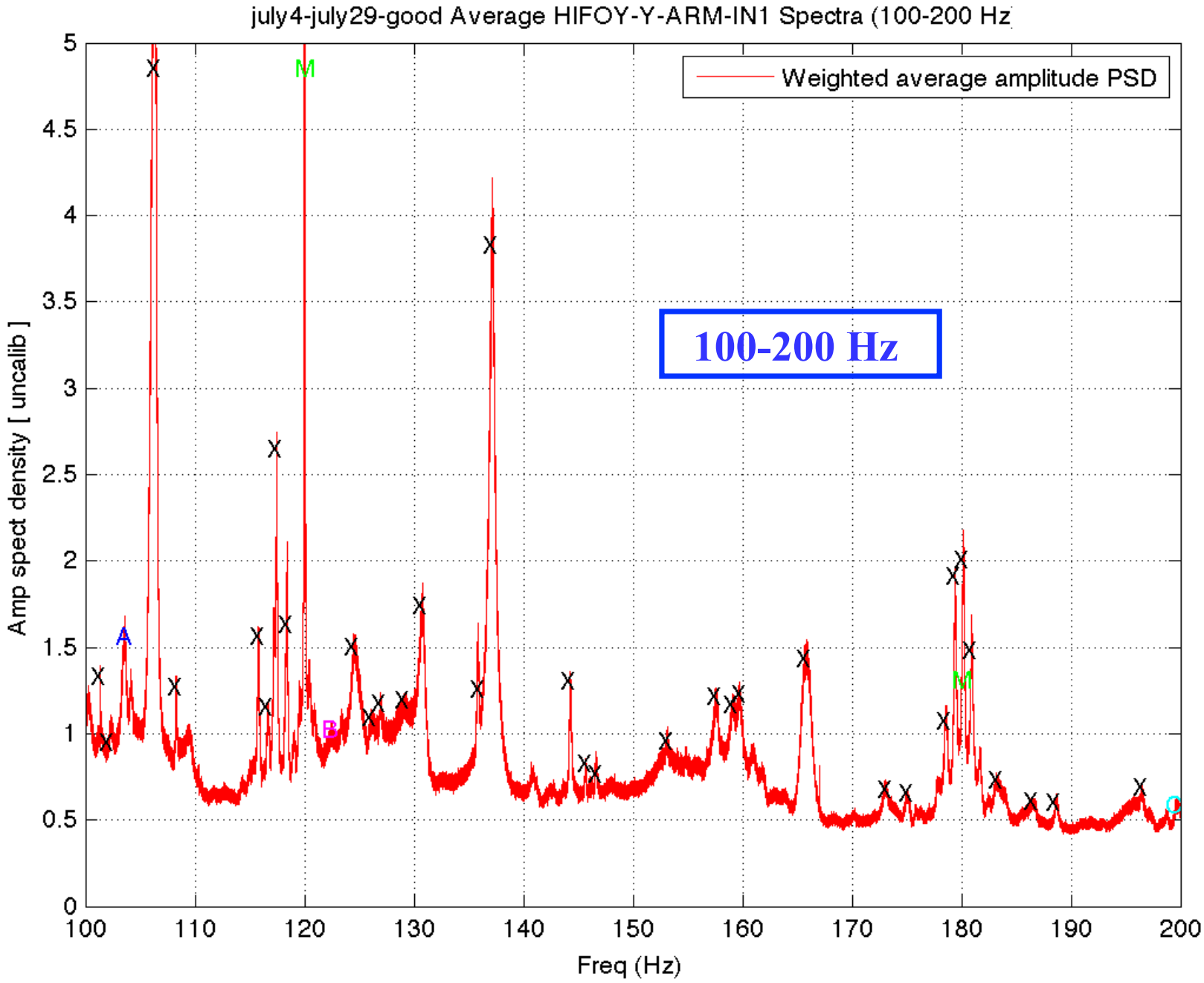
Big picture from epoch-weighted average

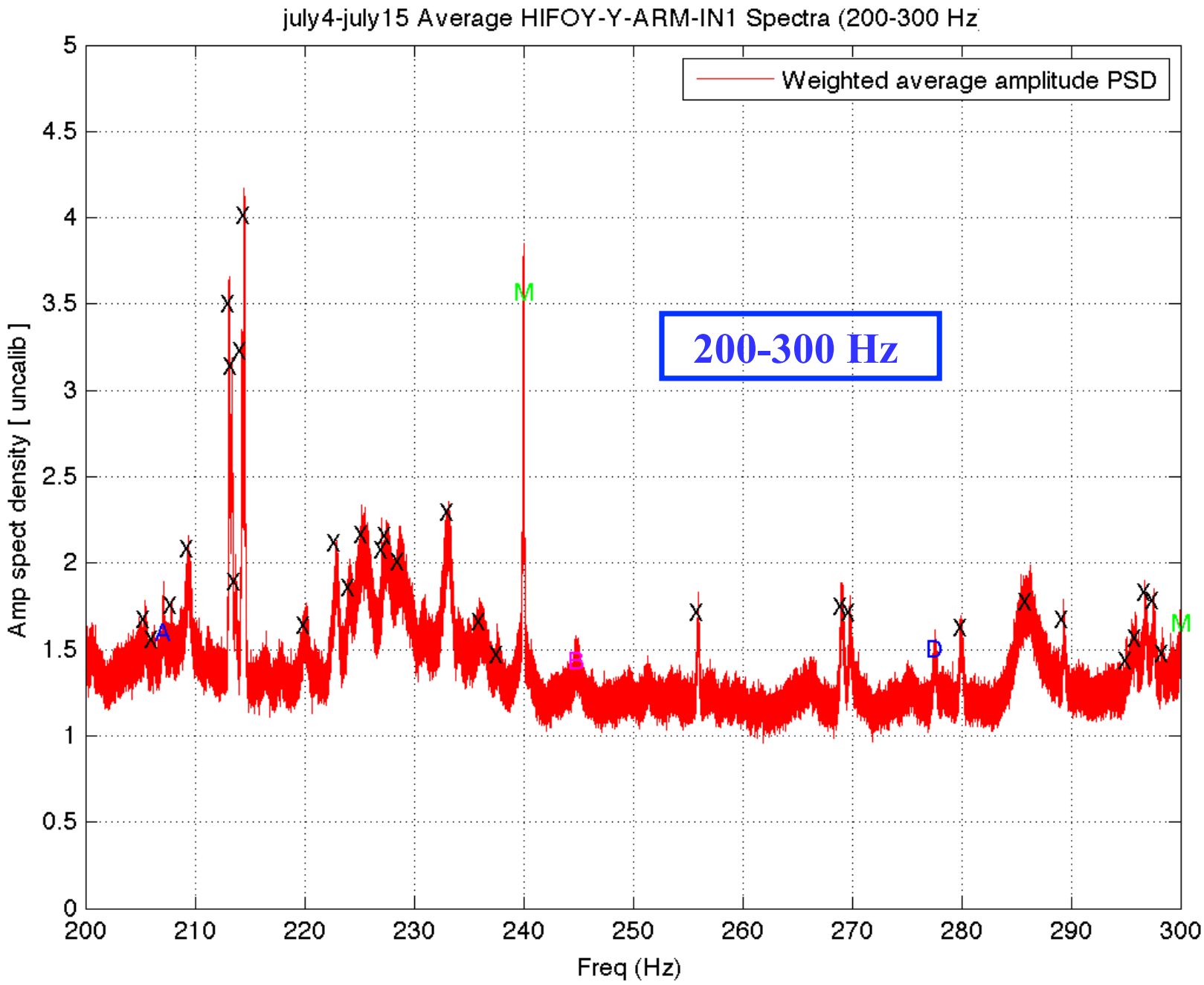


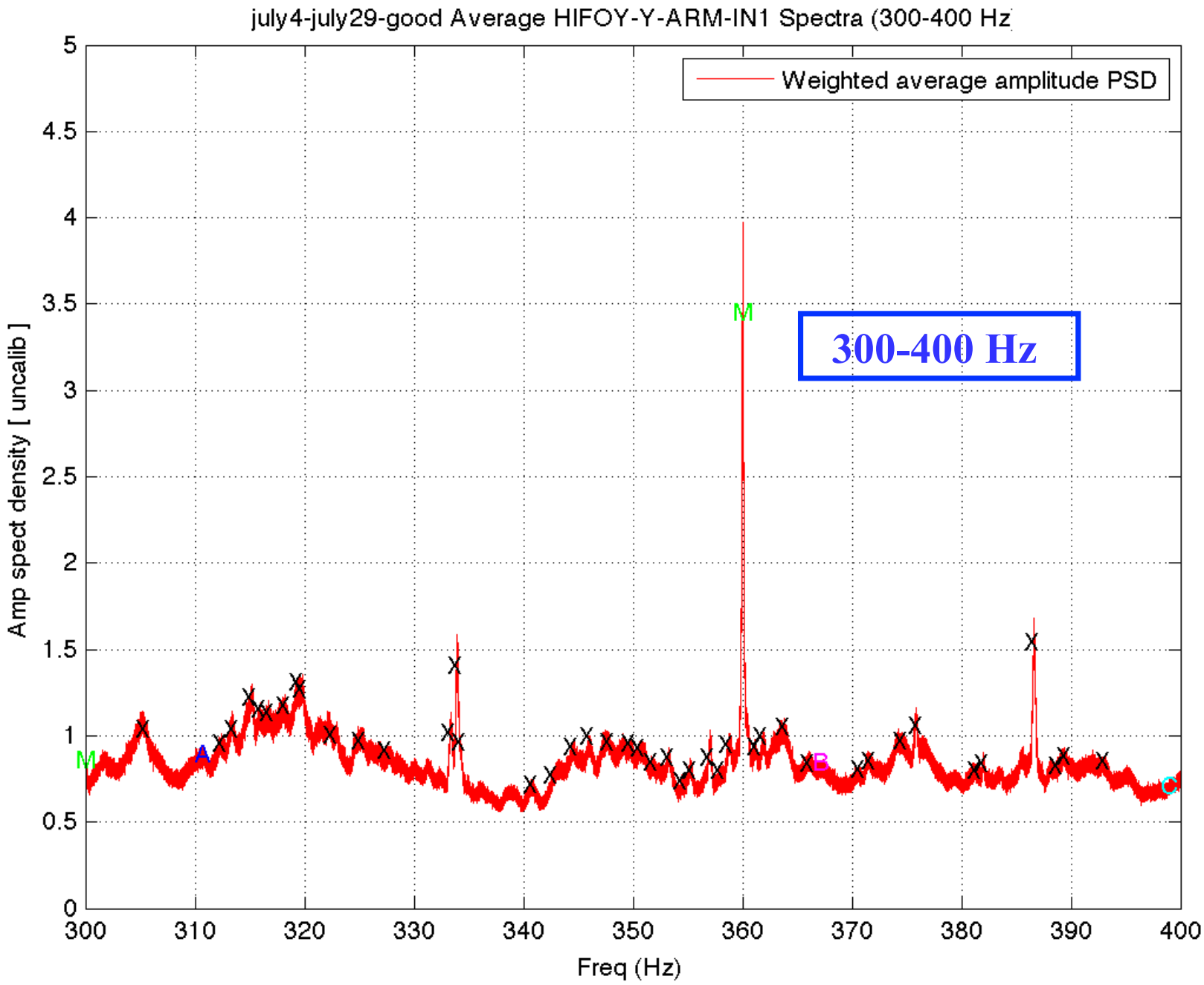

july4-july29-good Average HIFOY-Y-ARM-IN1 Spectra (0-2 Hz
Weighted average amplitude PSD
0-2 Hz
Amp spect density [uncalib]
Freq (Hz)
10^5
10^4
10^3
10^2
10^1
10^0
10^-3
10^-2
10^-1
10^0

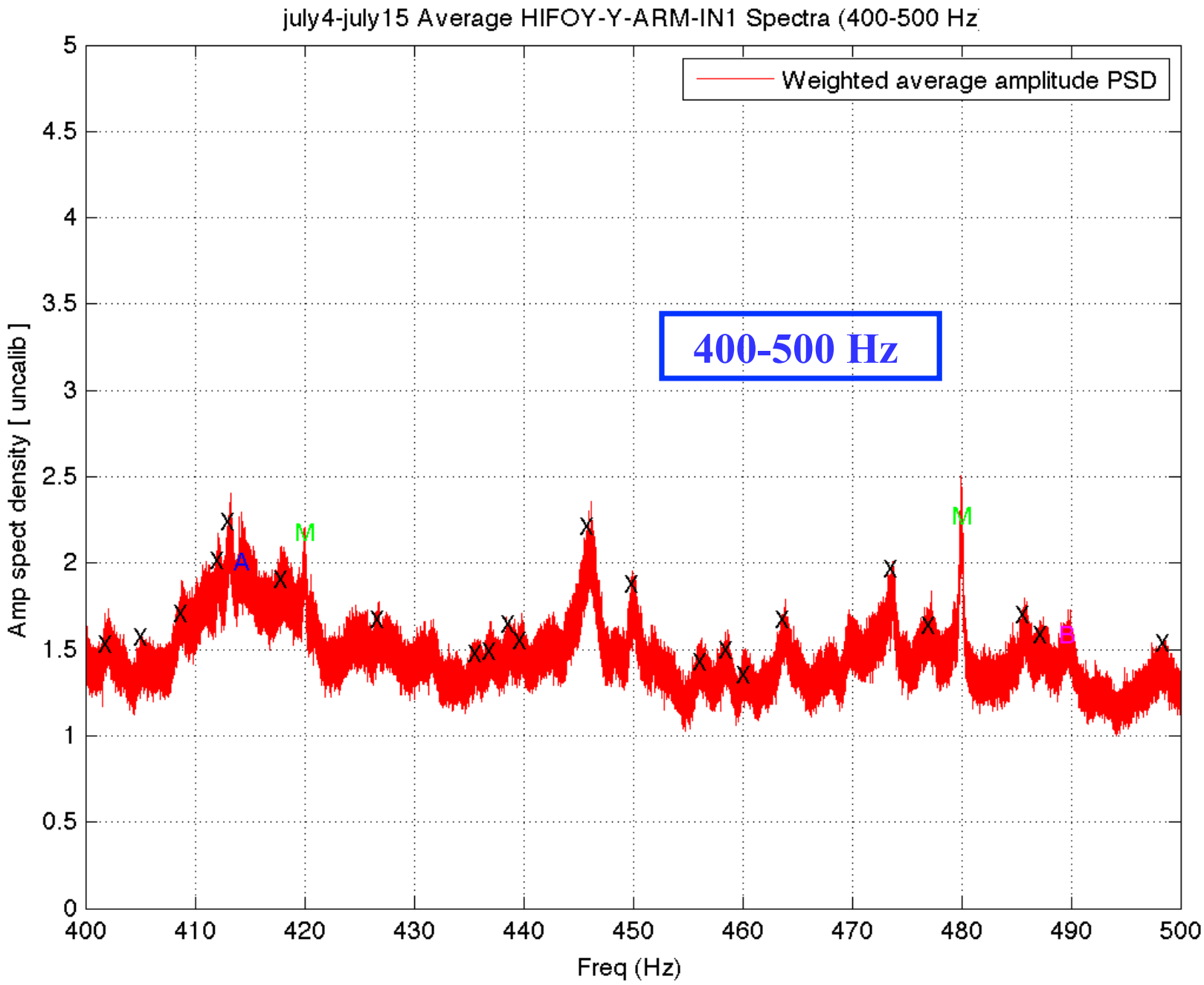

july4-july29-good Average HIFOY-Y-ARM-IN1 Spectra (2-10 Hz
Weighted average amplitude PSD
2-10 Hz
Amp spect density [uncalib]
Freq (Hz)
0
1
2
3
4
5
6
7
8
9
10
2
3
4
5
6
7
8
9
10

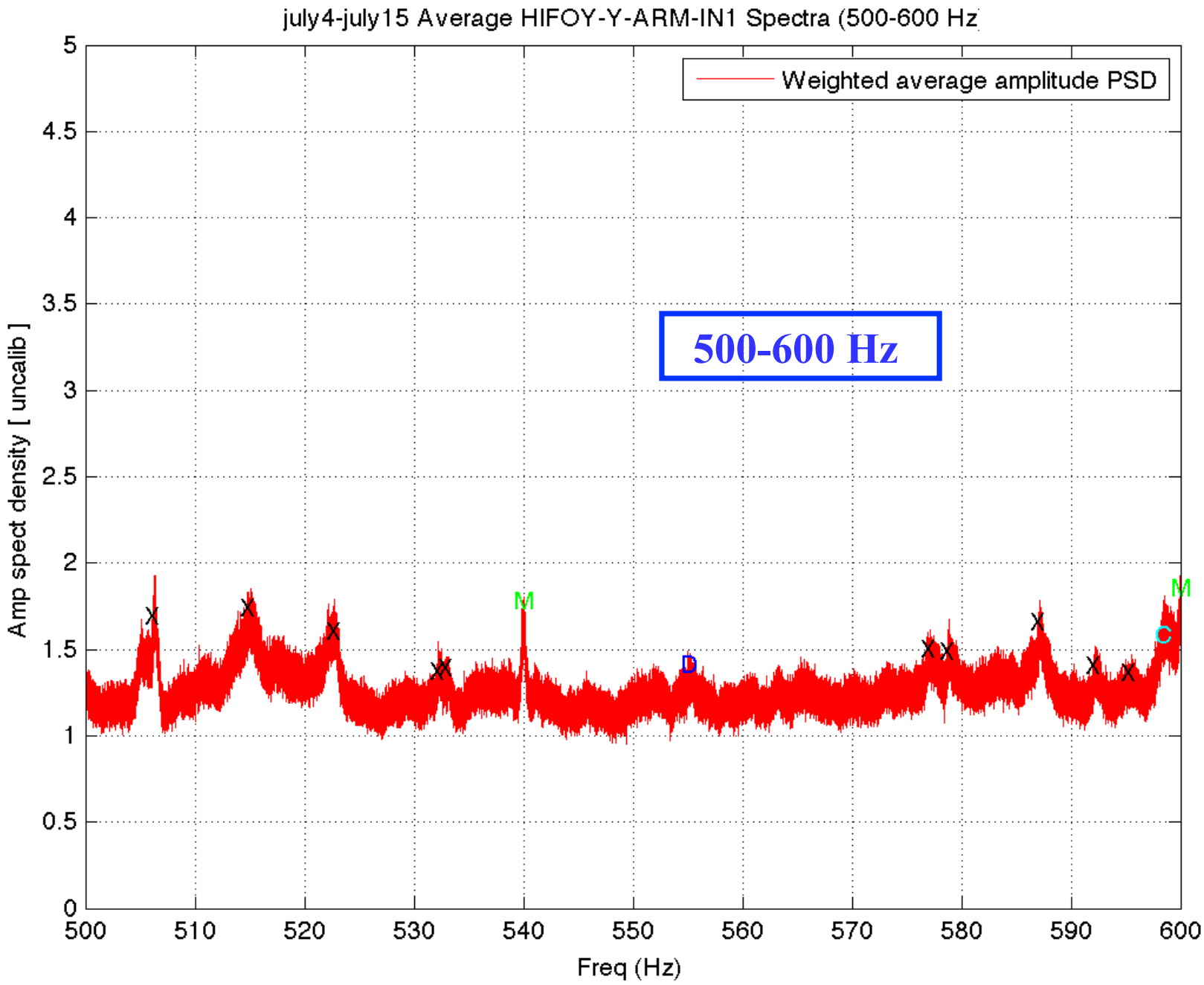

july4-july29-good Average HIFOY-Y-ARM-IN1 Spectra (10-100 Hz
Weighted average amplitude PSD
10-100 Hz
Amp spect density [uncalib]
Freq (Hz)
0
1
2
3
4
5
6
7
8
9
10
10
20
30
40
50
60
70
80
90
100

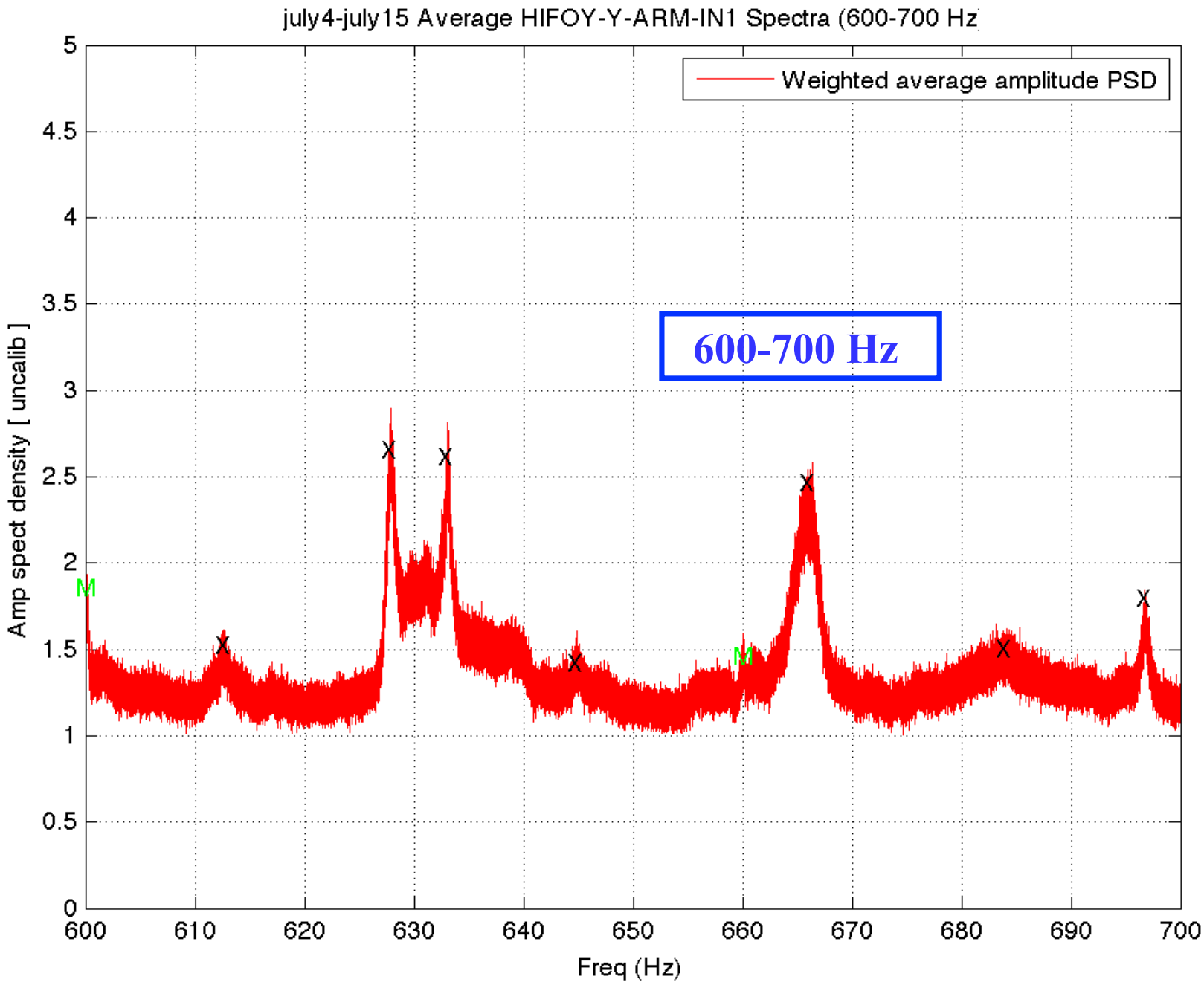

july4-july29-good Average HIFOY-Y-ARM-IN1 Spectra (100-200 Hz
Weighted average amplitude PSD
100-200 Hz
Amp spect density [uncalib]
Freq (Hz)
A
B
M
M
C
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
100
110
120
130
140
150
160
170
180
190
200

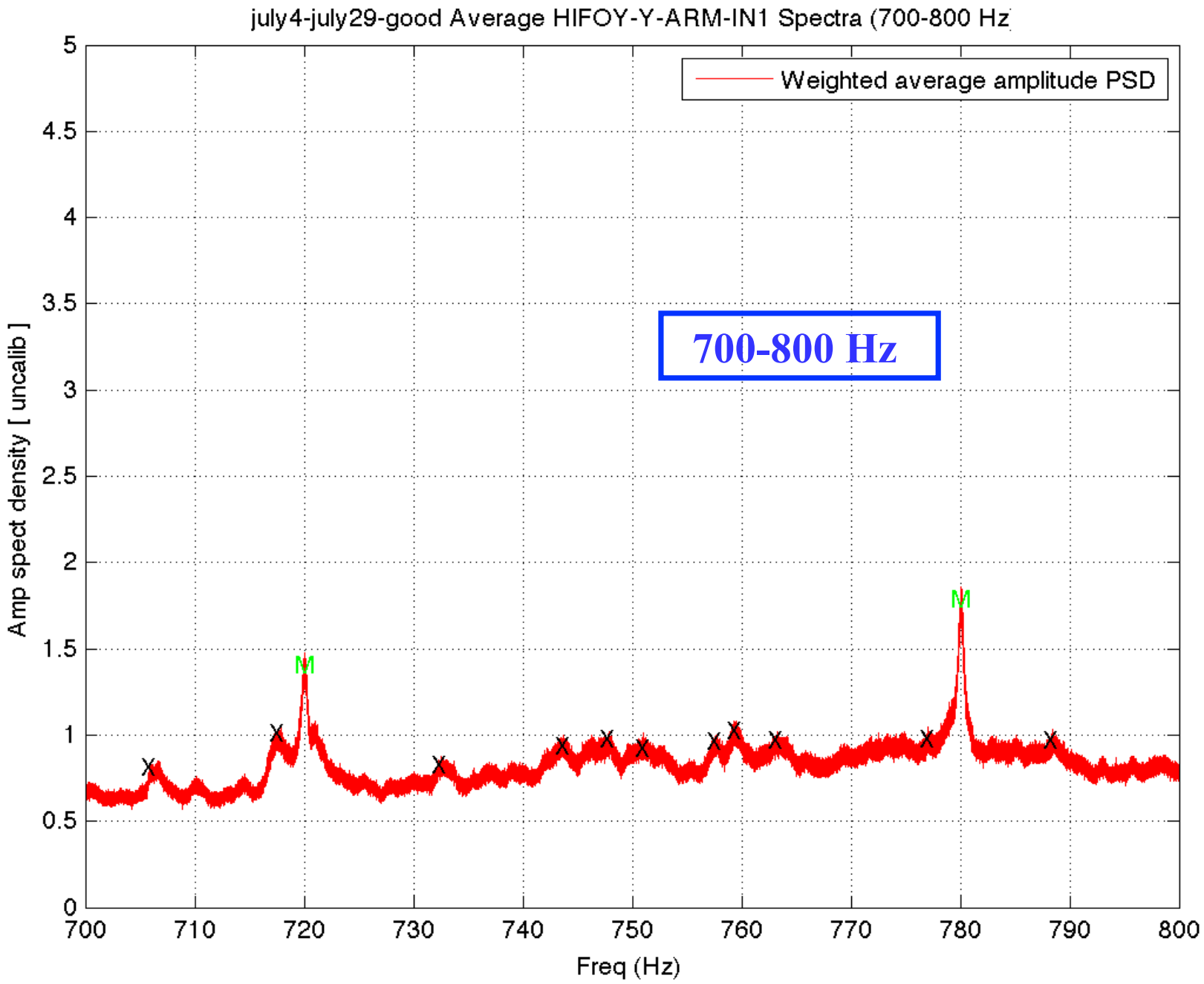

july4-july15 Average HIFOY-Y-ARM-IN1 Spectra (200-300 Hz
Weighted average amplitude PSD
200-300 Hz
Amp spect density [uncalib]
Freq (Hz)
M
A
B
D
M
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
200
210
220
230
240
250
260
270
280
290
300

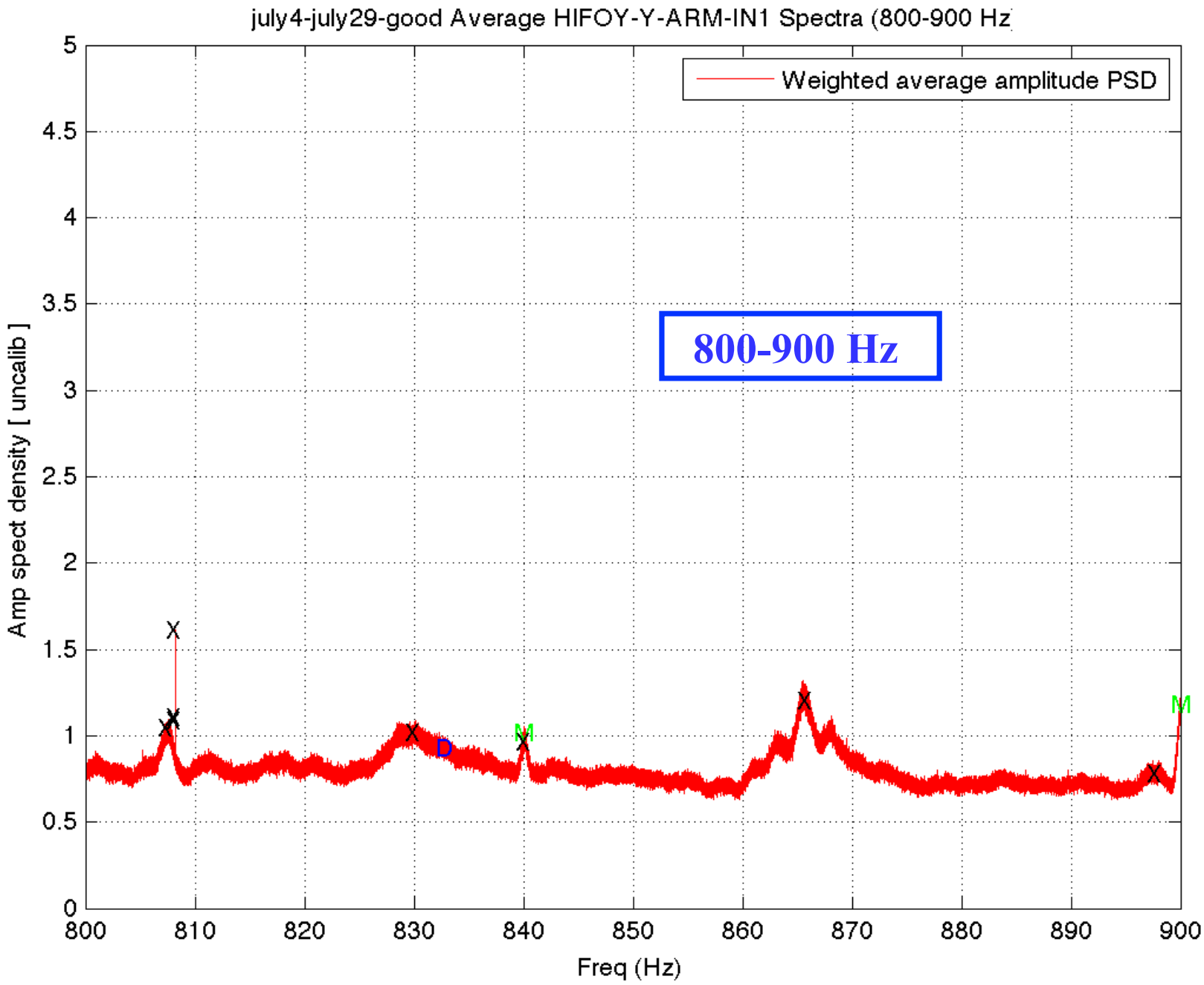

july4-july29-good Average HIFOY-Y-ARM-IN1 Spectra (300-400 Hz
Weighted average amplitude PSD
300-400 Hz
Amp spect density [uncalib]
Freq (Hz)
M
A
B
C
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
300
310
320
330
340
350
360
370
380
390
400

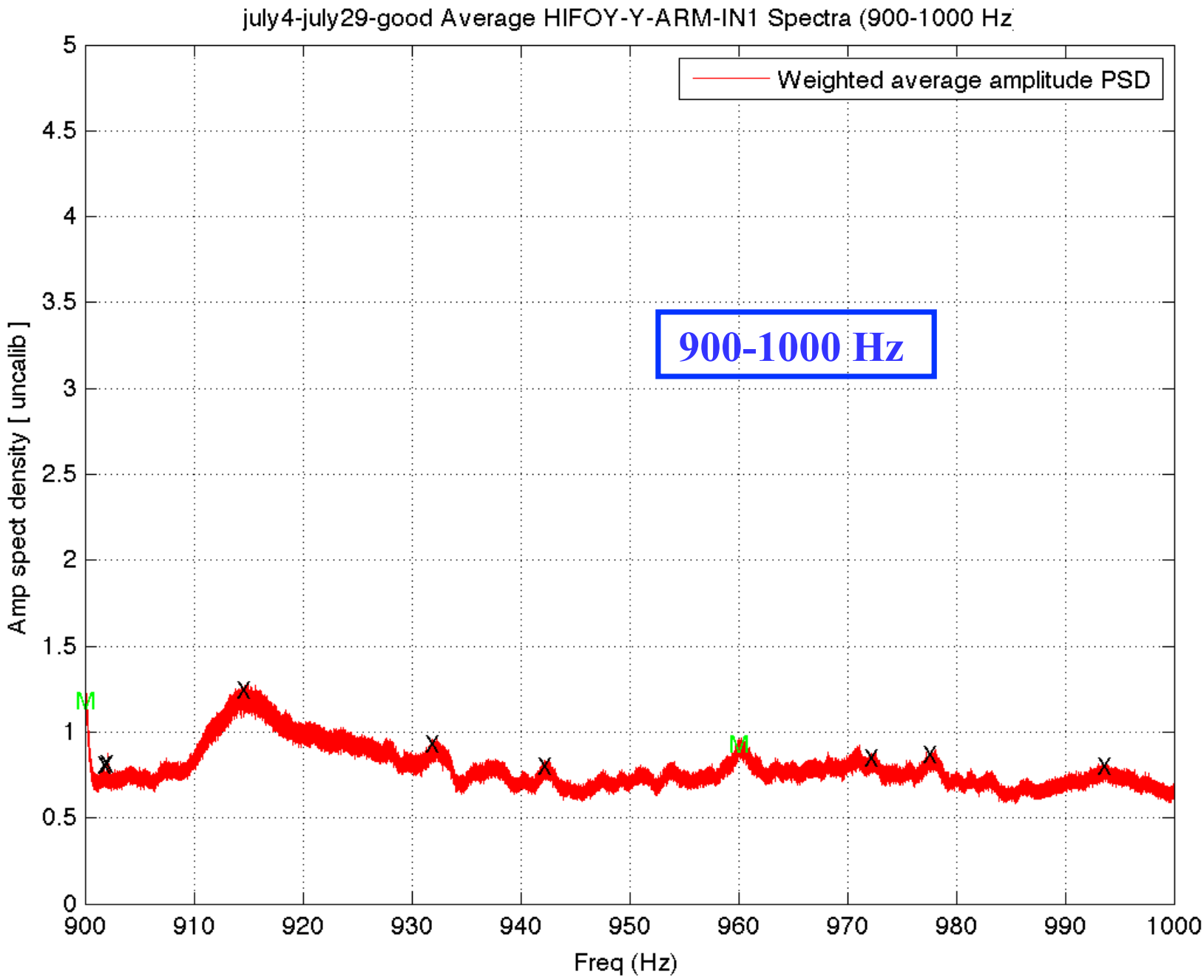

july4-july15 Average HIFOY-Y-ARM-IN1 Spectra (400-500 Hz
Weighted average amplitude PSD
400-500 Hz
Amp spect density [uncalib]
Freq (Hz)
A
M
M
B
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
400
410
420
430
440
450
460
470
480
490
500


july4-july15 Average HIFOY-Y-ARM-IN1 Spectra (500-600 Hz
Weighted average amplitude PSD
500-600 Hz
Amp spect density [uncalib]
Freq (Hz)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
500
510
520
530
540
550
560
570
580
590
600
M
D
C
M


july4-july15 Average HIFOY-Y-ARM-IN1 Spectra (600-700 Hz
Weighted average amplitude PSD
600-700 Hz
Amp spect density [uncalib]
Freq (Hz)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
600
610
620
630
640
650
660
670
680
690
700


july4-july29-good Average HIFOY-Y-ARM-IN1 Spectra (700-800 Hz
Weighted average amplitude PSD
700-800 Hz
Amp spect density [uncalib]
Freq (Hz)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
700
710
720
730
740
750
760
770
780
790
800
M
M


july4-july29-good Average HIFOY-Y-ARM-IN1 Spectra (800-900 Hz
Weighted average amplitude PSD
800-900 Hz
Amp spect density [uncalib]
Freq (Hz)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
800
810
820
830
840
850
860
870
880
890
900
X
D
M


july4-july29-good Average HIFOY-Y-ARM-IN1 Spectra (900-1000 Hz
Weighted average amplitude PSD
900-1000 Hz
Amp spect density [uncalib]
Freq (Hz)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
900
910
920
930
940
950
960
970
980
990
1000

Combs found:

Harmonic combs marked on spectra:
(digits after decimal depend on width and maximum harmonic)

M – 60.0 Hz	(up to 16th harmonic at 960 Hz) – Mains (even louder than odd)
A – 103.6 Hz	(up to 4th harmonic at 414.4 Hz)
B – 122.45 Hz	(up to 4th harmonic at 498.80 Hz)
C – 199.53 Hz	(up to 3rd harmonic at 598.59 Hz)
D – 277.6 Hz	(up to 3rd harmonic at 832.8 Hz)

Offset comb with 0.76 Hz spacing seen near 90 Hz

Other combs may be present, but are hard to nail down

Line clusters just below 120 Hz, 180 Hz
(but inconsistent with symmetric power mains sidebands)

Line clusters near 213 Hz (assoc with EY seismometers), 225 Hz

Coincidence of lines found in primary channel with auxiliary PEM channels based on the Virgo NoEMi program:

Noemi line summary page for primary channel:
https://ldas-jobs.ligo-wa.caltech.edu/~pulsar/NoEMi/H1/HIFO-Y/lines

Noemi index page for viewing all channels by date:
https://ldas-jobs.ligo-wa.caltech.edu/~keithr/noemi_H1_HIFO-Y/noemi_peakmap_day_select.html

0.065 Hz	1.36 Hz* – CS mic/accel	8.4 Hz, 10.8, 15.7 Hz (new since July)
0.145 Hz	1.429 Hz	15.95 Hz – EY seis/accel
0.21 Hz	1.47 Hz*	16.50 Hz
0.36 Hz	1.58 Hz*	16.54 Hz
0.45 Hz*	1.75 Hz	16.68 Hz
0.585 Hz	1.81 Hz	16.77 Hz, 18.7 Hz
0.995 Hz	1.88 Hz	19.635 Hz – CS accel
1.09 Hz*	1.925 Hz*	21.04 Hz – CS mic/accel/seis
1.14 Hz	2.11 Hz	21.12 Hz – CS seis, 22.1, 22.9 Hz
1.18 Hz	2.30 Hz	25.5 Hz
1.25 Hz	2.35 Hz	25.7 Hz – EY seis
1.275 Hz	2.59 Hz	26.25 Hz
1.34 Hz*	4.000 Hz – ???	26.53 Hz

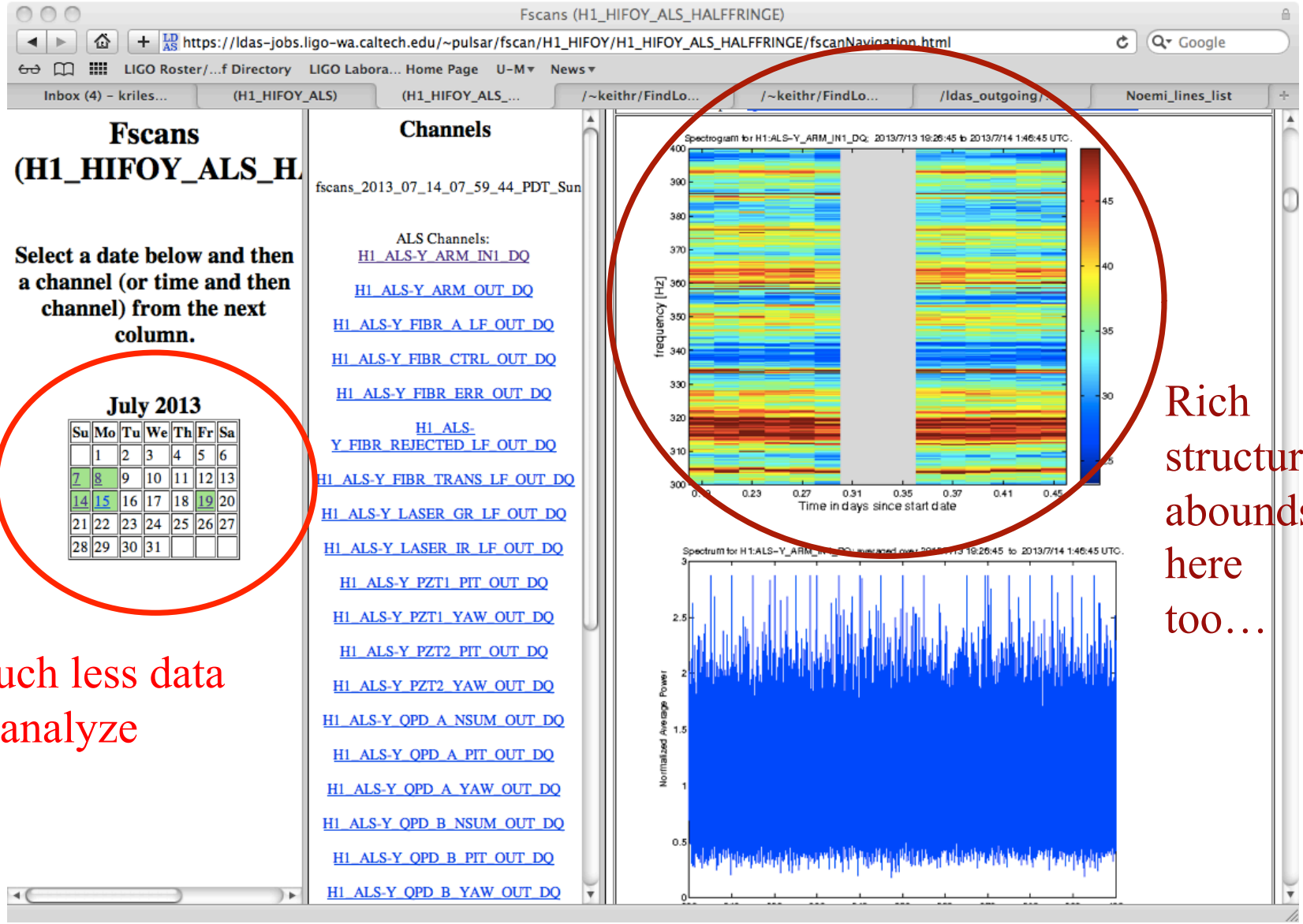
*Possible SUS resonance – see https://lhocds.ligo-wa.caltech.edu/wiki/Resonances (M. Barton)

26.63 Hz – EY seis/accel
26.68 Hz – EY seis/accel
27.19 Hz
28.13 Hz
29.60 Hz – CS/EY seis/accel
29.76 Hz
30.18 Hz – CS seis/accel/mic
30.91 Hz – CS seis/accel
32.45 Hz – CS seis
35.21 Hz – CS seis
35.26 Hz – CS seis
36.25 Hz
38.284 Hz
46.26 Hz
46.33 Hz
51.8 Hz
53.32 Hz
53.39 Hz – EY seis/accel/mic
57.89 Hz – CS seis/accel
58.7 Hz – CS seis/accel/mic
59.1 Hz
59.5 Hz – EY seis/accel/mic
72.16 Hz
72.34 Hz
75.15 Hz
76.4 Hz
78.0 Hz
78.7 Hz
82.1 Hz
84.7 Hz
87.4 Hz
88.9 Hz
89.71 Hz
90.47 Hz
91.25 Hz – CS mag
92.10 Hz
93.33 Hz – EY accel
101.38 Hz
102.1 Hz
103.6 Hz (comb)
106.4 Hz
108.3 Hz
115.82 Hz – EY mag
116.65 Hz
117.46 Hz – CS mag/seis
118.45 Hz
122.45 Hz (comb)
124.5 Hz
126.1 Hz
126.9 Hz
129.1 Hz
130.7 Hz
135.95 Hz – EY accel
137.1 Hz
144.3 Hz
145.7 Hz
146.7 Hz
153.2 Hz, 157.6 Hz
158.2 Hz , 159.1 Hz
159.8 Hz , 165.8 Hz
166.4 Hz
173.2 Hz
175.1 Hz
178.5 Hz
179.4 Hz
180.15 Hz – EY mag/accel
180.9 Hz
183.3 Hz
186.5 Hz

188.6 Hz
196.5 Hz
199.53 Hz (comb)
205.4 Hz
206.2 Hz
207.9 Hz
209.4 Hz
213.13 Hz – EY seis
213.37 Hz
213.75 Hz
214.30 Hz – EY seis
214.52 Hz – EY seis
220.1 Hz
222.9 Hz
224.1 Hz
225.3 Hz
227.10 Hz
227.5 Hz
228.7 Hz
233.2 Hz
236.1 Hz
237.7 Hz, 245., 249.6, 251.4 Hz
255.95 Hz
269.1 Hz
269.8 Hz
277.6 Hz (comb)
280.0 Hz
286.0 Hz
289.3 Hz
295.1 Hz
295.95 Hz
296.8 Hz
297.55 Hz
298.4 Hz
305.4 Hz
312.4 Hz
313.5 Hz
315.1 Hz
316.0 Hz
316.7 Hz
318.2 Hz
319.4 Hz
319.7 Hz
322.5 Hz
325.1 Hz
327.5 Hz
333.3 Hz
333.9 Hz – EY seis
334.3 Hz
340.8 Hz
342.6 Hz
344.5 Hz
346.0 Hz
347.8 Hz
349.7 Hz
350.6 Hz
351.8 Hz
353.25 Hz
354.5 Hz
355.3 Hz
356.9 Hz
357.9 Hz
358.7 Hz
361.2 Hz
361.8 Hz
363.8 Hz
366.1 Hz
370.7 Hz
371.7 Hz

374.6 Hz
375.95 Hz
381.3 Hz
382.0 Hz
386.66 Hz
388.8 Hz
389.5 Hz
393.1 Hz
402.0 Hz
405.2 Hz
408.9 Hz
412.2 Hz
413.2 Hz
418.0 Hz
426.8 Hz
435.8 Hz
437.0 Hz
438.8 Hz
439.8 Hz
446.0 Hz
450.0 Hz
456.25 Hz
458.7 Hz
460.25 Hz
463.8 Hz
473.7 Hz
477.1 Hz
485.8 Hz
487.4 Hz, 497. Hz
498.5 Hz , 504.8 Hz
506.4 Hz
515.0 Hz
522.8 Hz
532.3 Hz
533.1 Hz, 553.8 Hz
577.2 Hz
578.9 Hz
587.1 Hz
592.2 Hz
595.4 Hz
612.7 Hz
627.9 Hz, 631 Hz
633.1 Hz
645.1 Hz, 663.2 Hz
666.3 Hz
684.0 Hz
696.8 Hz, 706 Hz
707.8 Hz, 717.7, 732.5 Hz
733.8 Hz
738.8 Hz, 743.8 Hz
746.0 Hz, 747.9, 751.1 Hz
752.7 Hz, 757.7, 759.5 Hz
761.5 Hz, 763.3, 777.1 Hz
778.9 Hz, 788.1, 788.4 Hz
807.5 Hz
808.207 Hz
808.209 Hz, 808.213 Hz
808.219 Hz
830 Hz
840.2 Hz
865.9 Hz
897.8 Hz
902.018 Hz – CS accel
902.182 Hz – CS accel/mic
914.8 Hz
918. Hz, 932.1, 942.4 Hz
972.4 Hz, 977.8, 993.8 Hz

What about half-fringe data?



Much less data to analyze

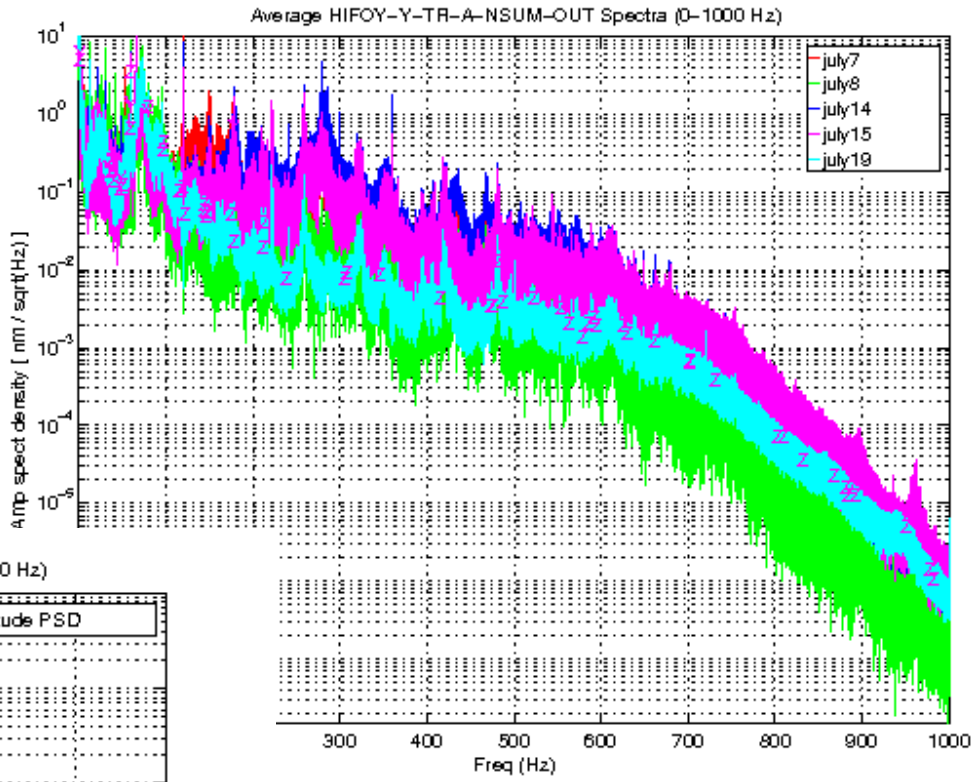
Rich structure abounds here too…

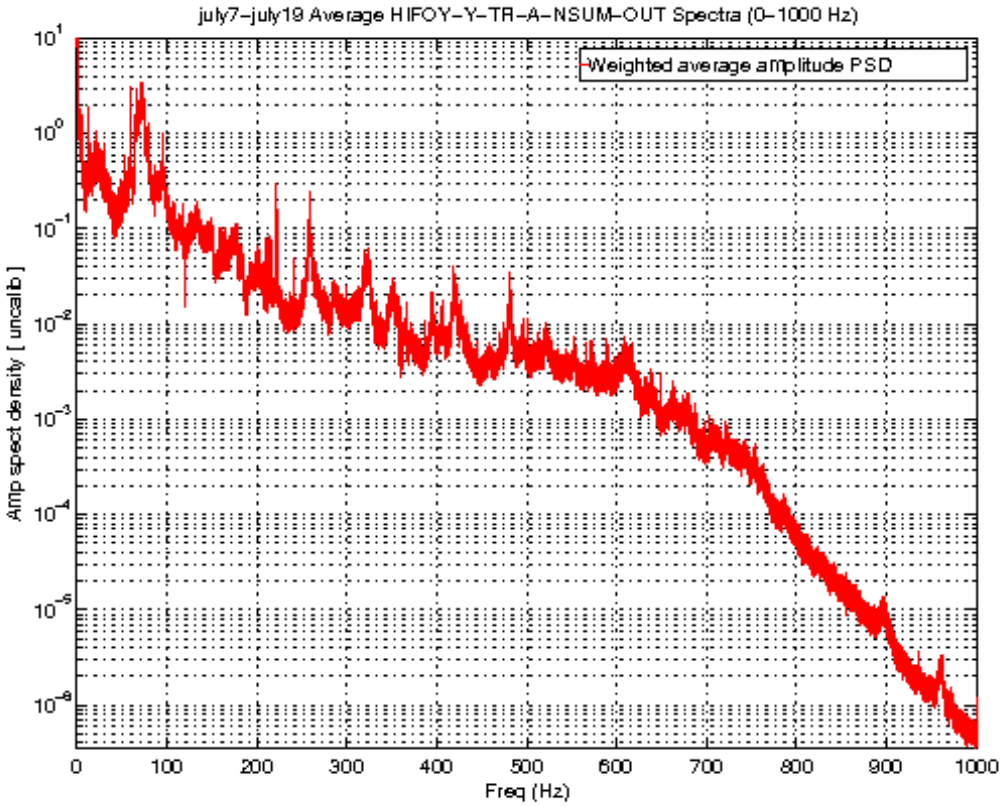
Using Fscan SFTs from July 2013 to compute noise-weighted spectra for each day

(Infrared half-fringe - H1:ASC-Y_TR_A_NSUM_OUT_DQ)

- July 7 – 4 hours
- July 8 – 1 hour
- July 14 – 6 hours
- July 15 – 2 hours
- July 19 – 4.5 hours → **17.5 total hours available (35 1800-s SFTs)**

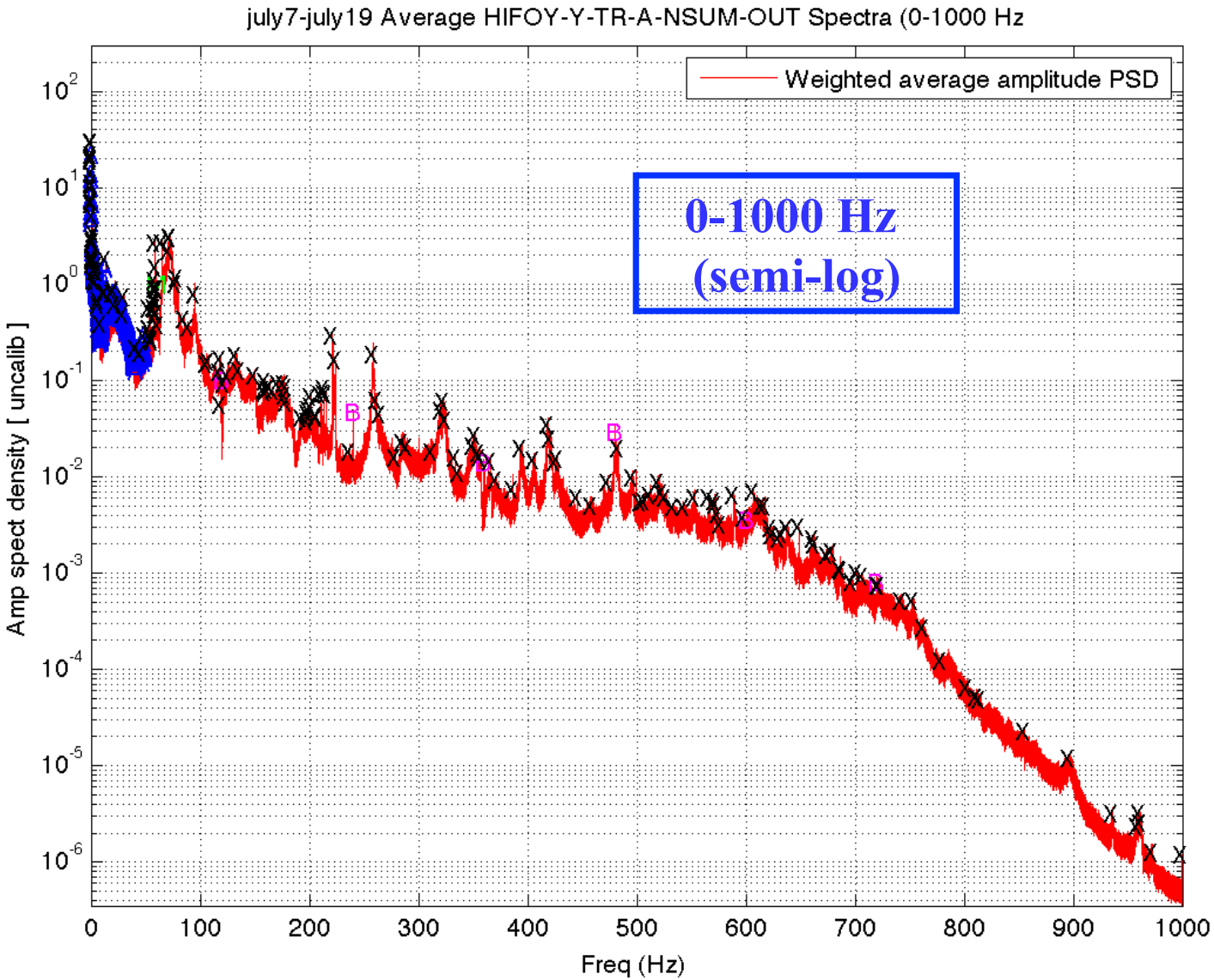
Daily spectra:
(July 7, 8, 14, 15, 19)

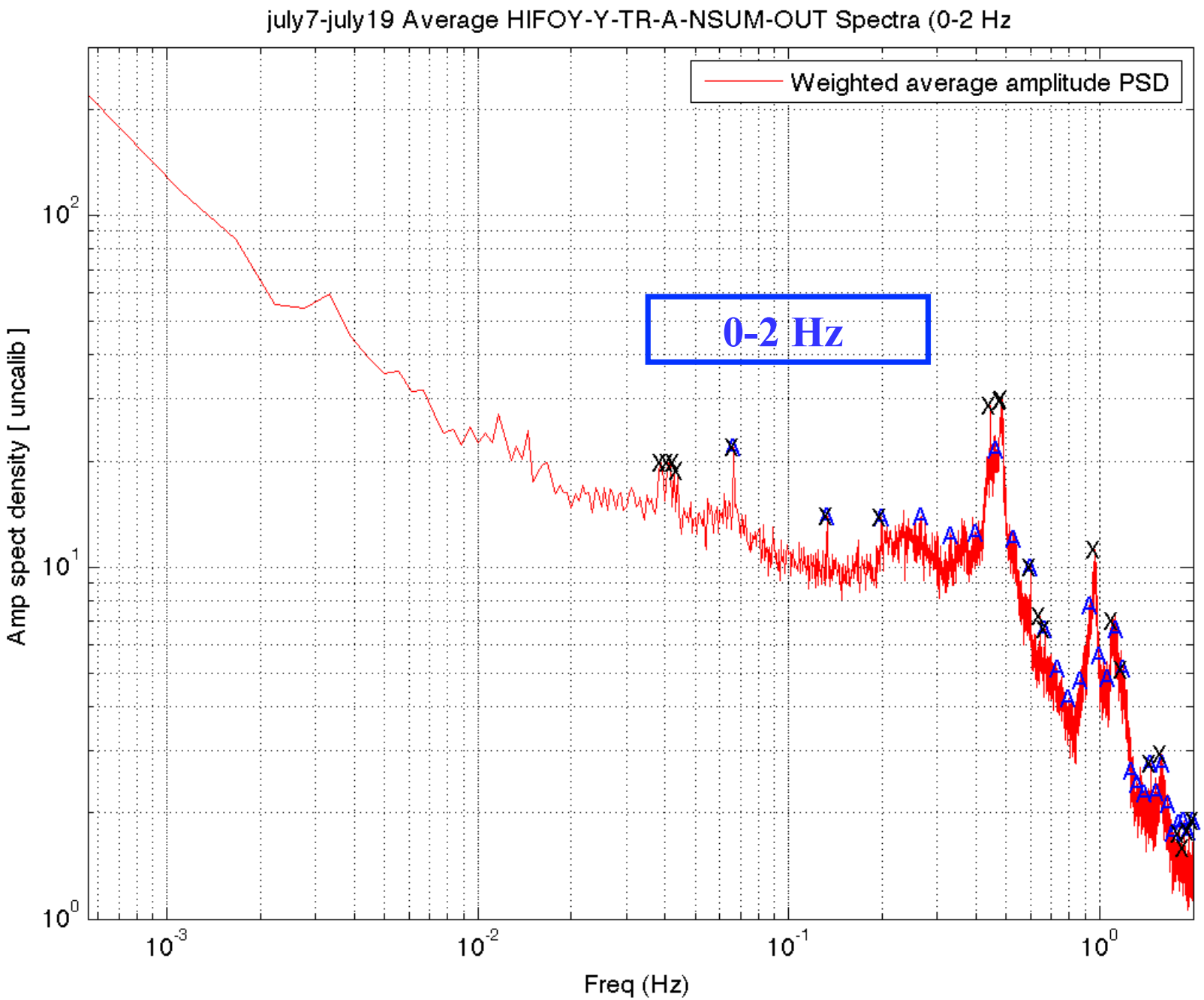


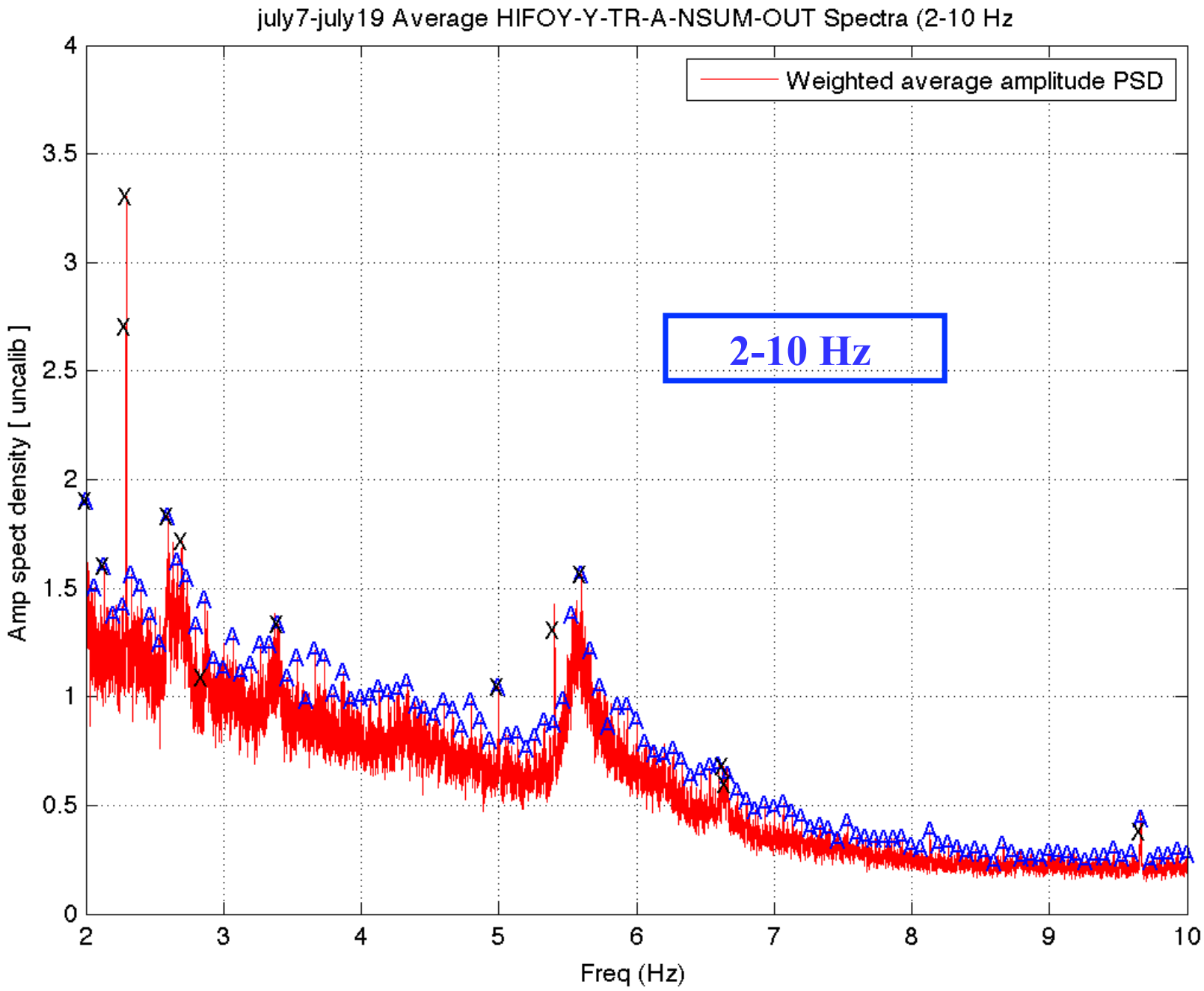


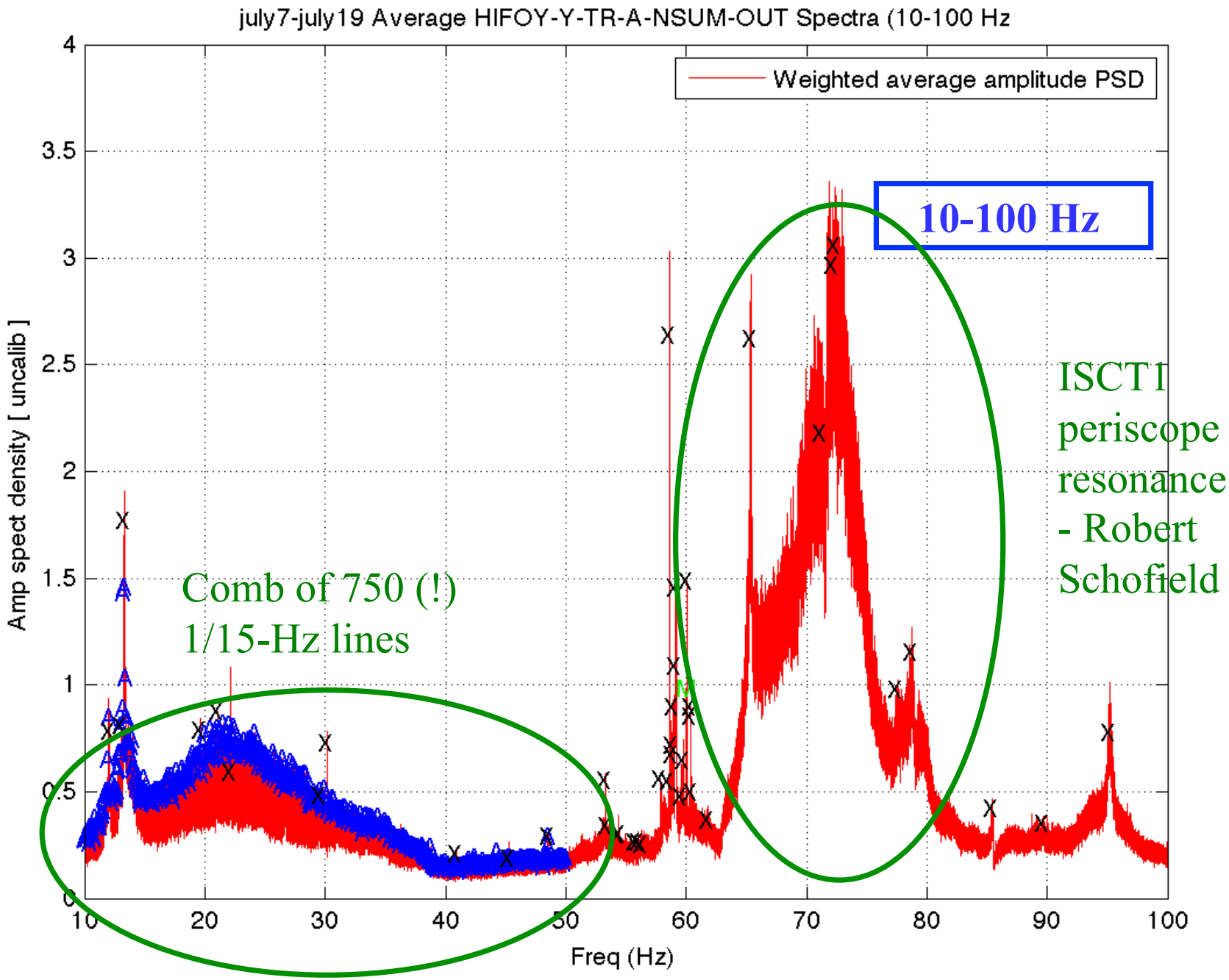
Weighted average
(17.5 hours)

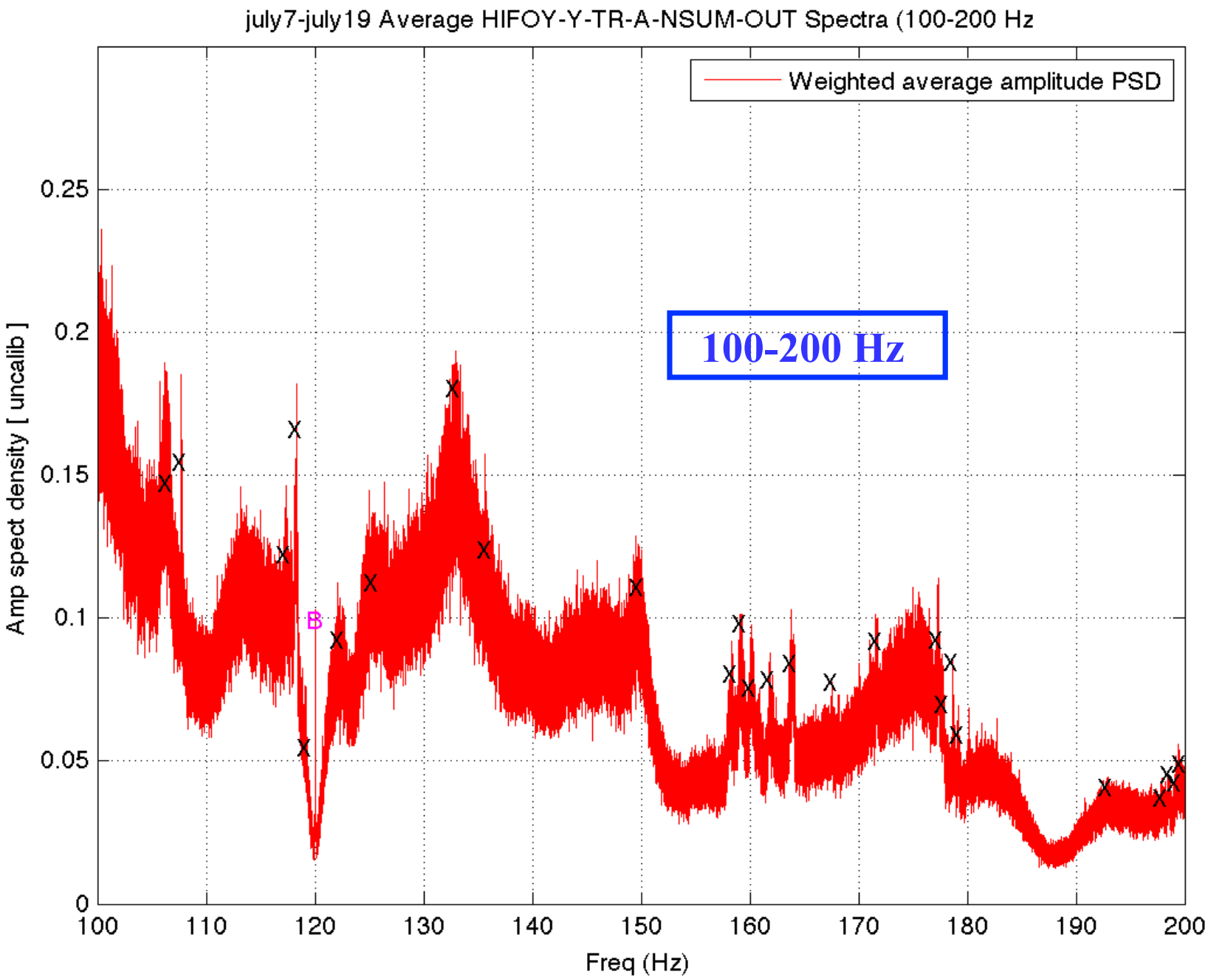
Big picture from epoch-weighted average

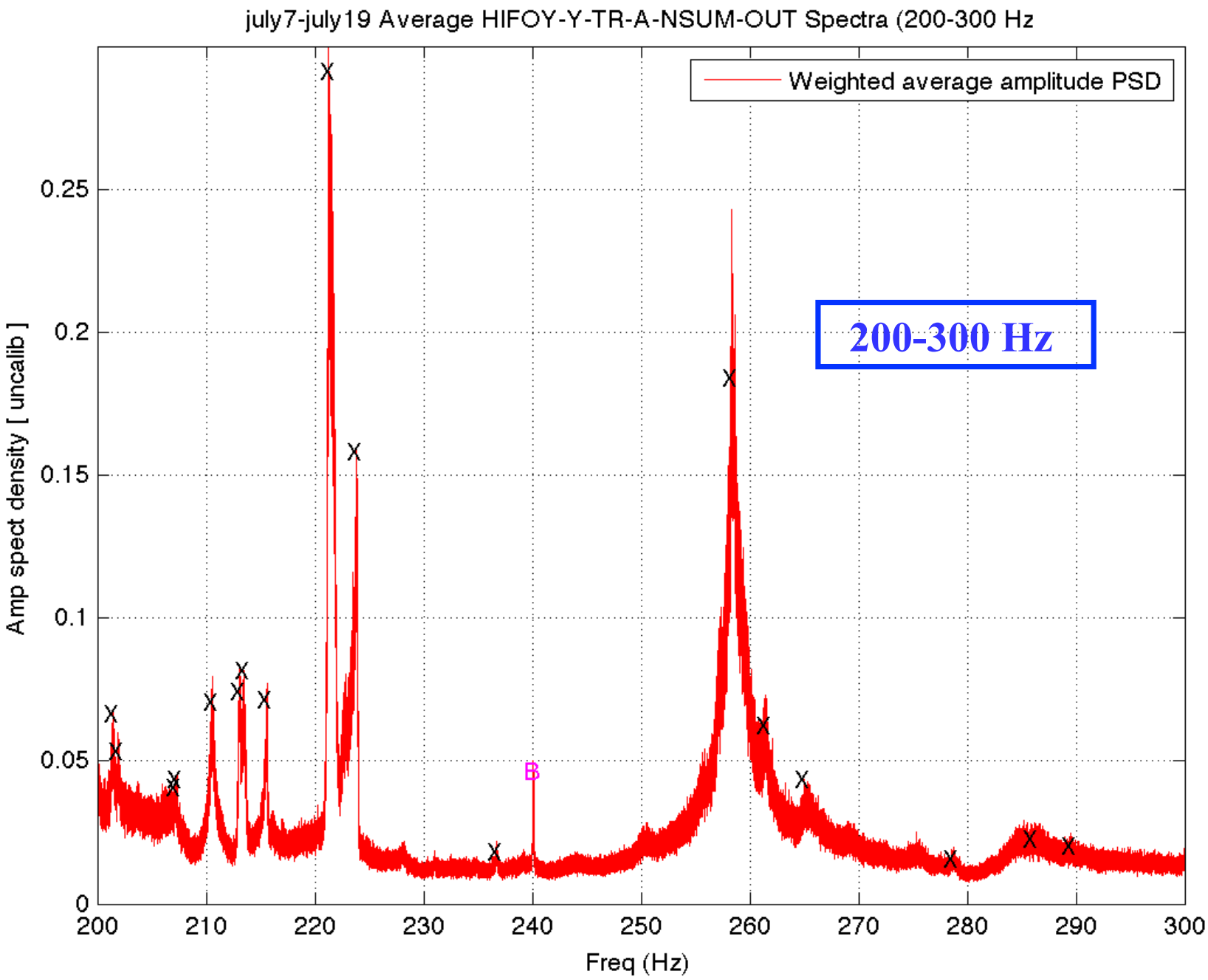


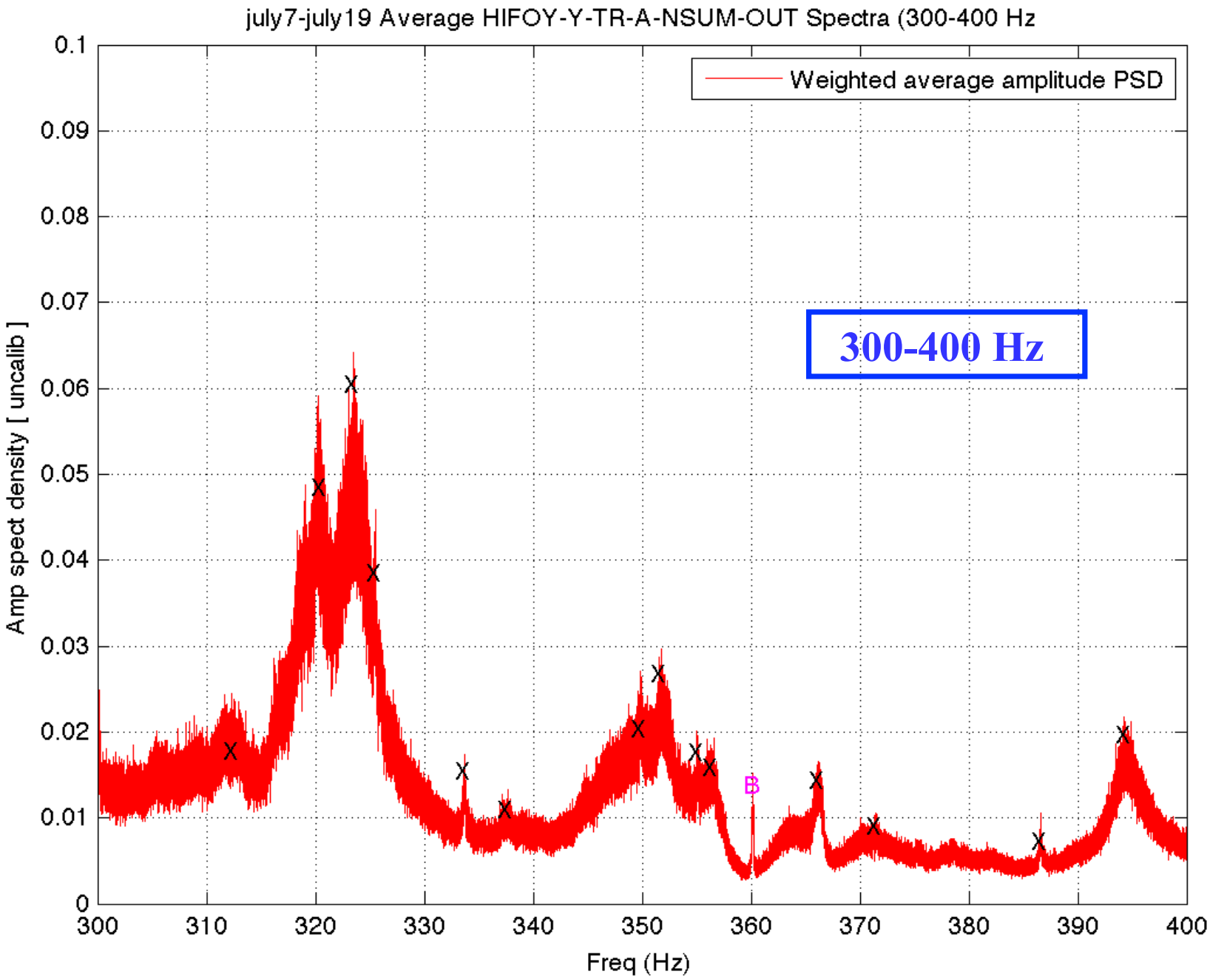

july7-july19 Average HIFOY-Y-TR-A-NSUM-OUT Spectra (0-2 Hz
Weighted average amplitude PSD
0-2 Hz
Amp spect density [uncalib]
Freq (Hz)
10^2
10^1
10^0
10^-3
10^-2
10^-1
10^0

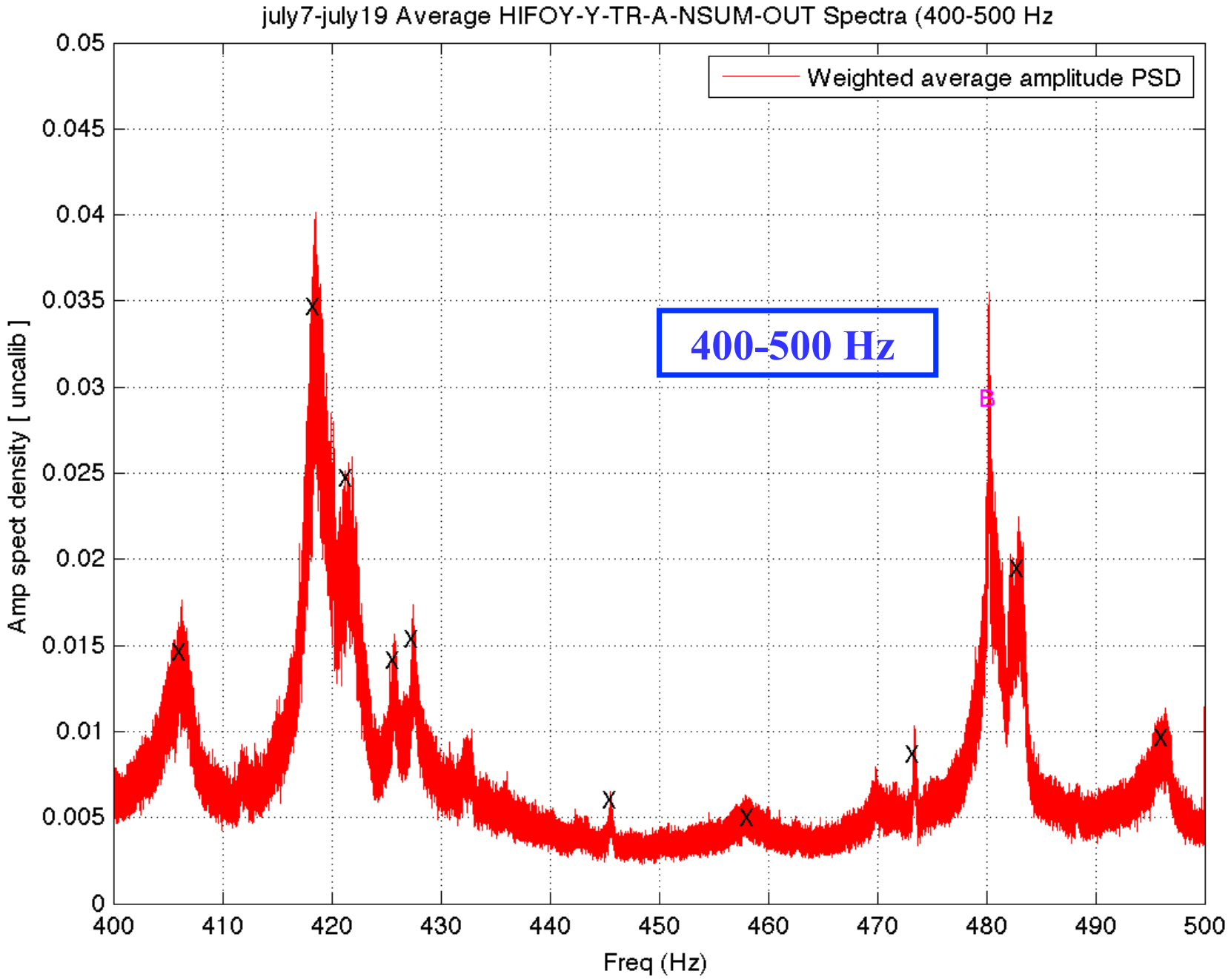

july7-july19 Average HIFOY-Y-TR-A-NSUM-OUT Spectra (2-10 Hz
Weighted average amplitude PSD
2-10 Hz
Amp spect density [uncalib]
Freq (Hz)
0
0.5
1
1.5
2
2.5
3
3.5
4
2
3
4
5
6
7
8
9
10

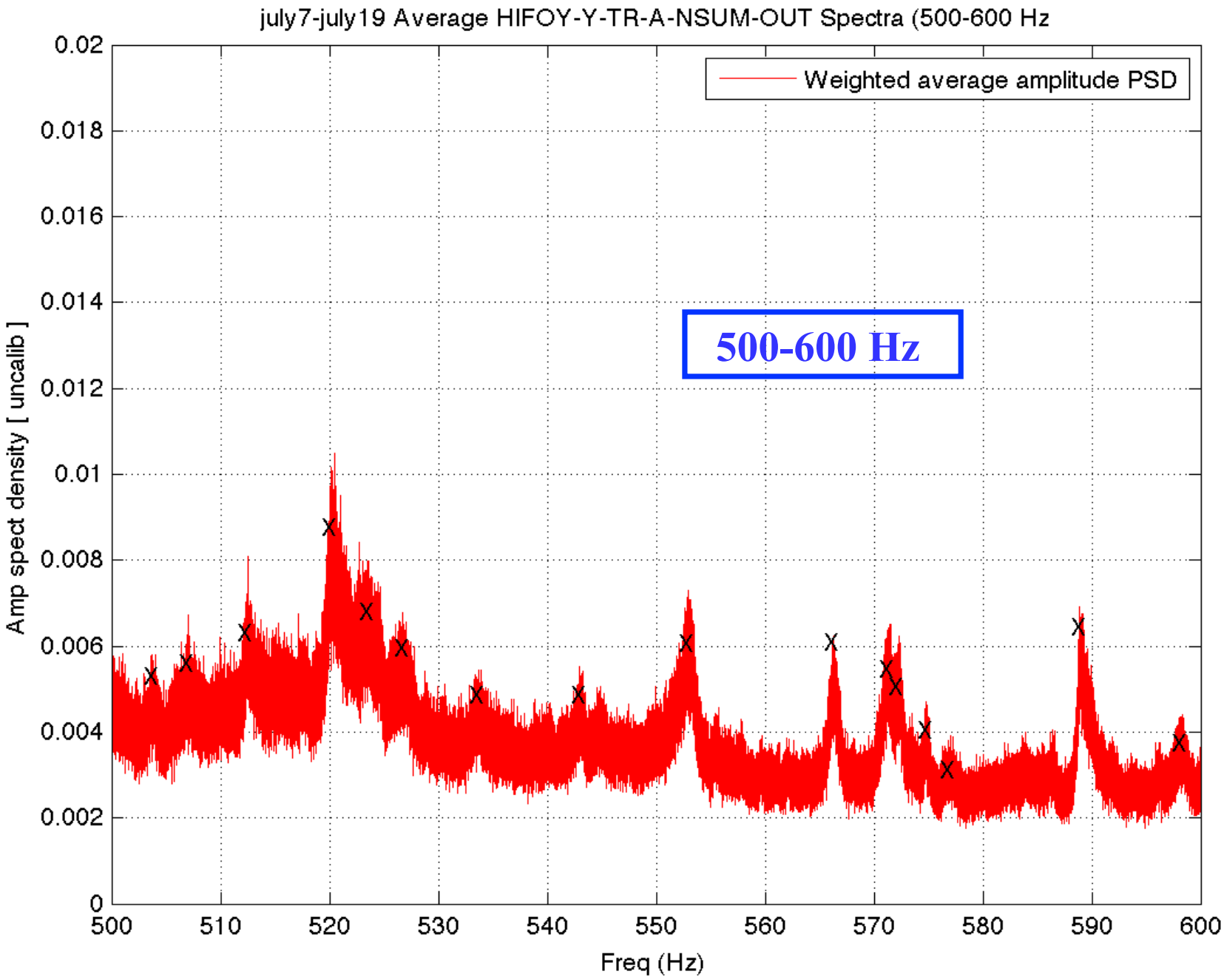

july7-july19 Average HIFOY-Y-TR-A-NSUM-OUT Spectra (10-100 Hz
Weighted average amplitude PSD
Amp spect density [uncalib]
Freq (Hz)
10-100 Hz
ISCT1 periscope resonance - Robert Schofield
Comb of 750 (!) 1/15-Hz lines

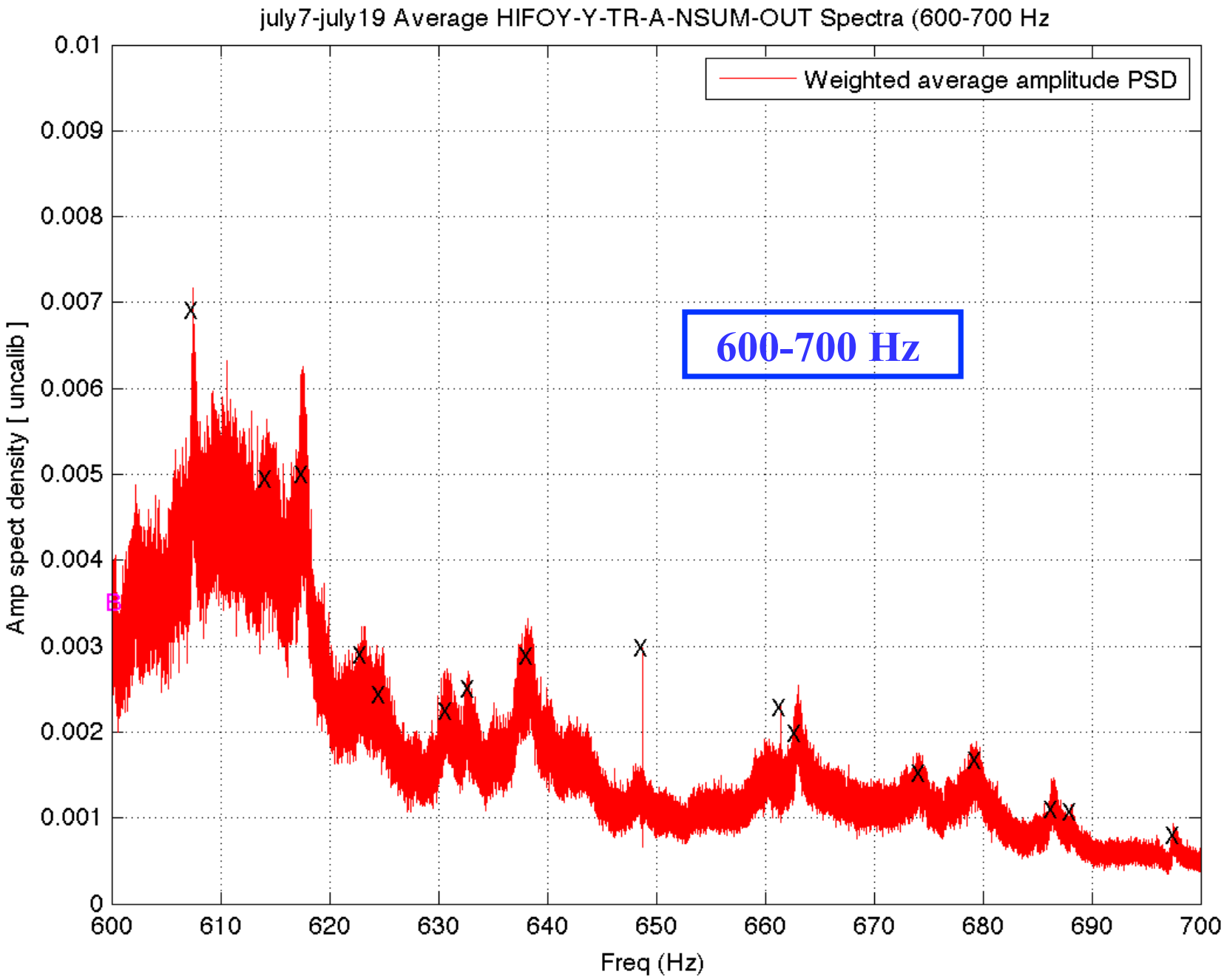

july7-july19 Average HIFOY-Y-TR-A-NSUM-OUT Spectra (100-200 Hz
Weighted average amplitude PSD
100-200 Hz
Amp spect density [uncalib]
Freq (Hz)
0
0.05
0.1
0.15
0.2
0.25
100
110
120
130
140
150
160
170
180
190
200

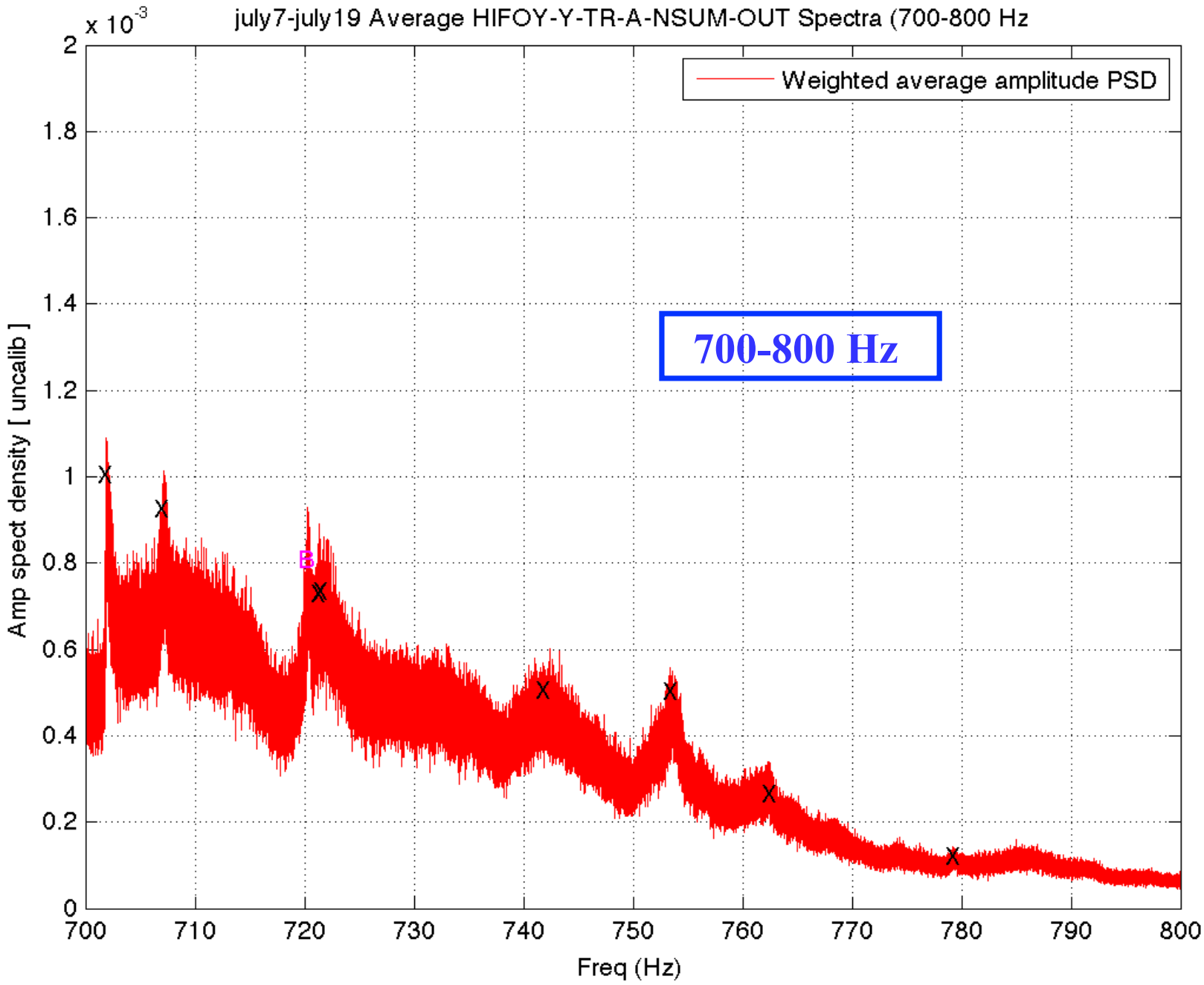

july7-july19 Average HIFOY-Y-TR-A-NSUM-OUT Spectra (200-300 Hz
Weighted average amplitude PSD
200-300 Hz
Amp spect density [uncalib]
Freq (Hz)
0
0.05
0.1
0.15
0.2
0.25
200
210
220
230
240
250
260
270
280
290
300
B

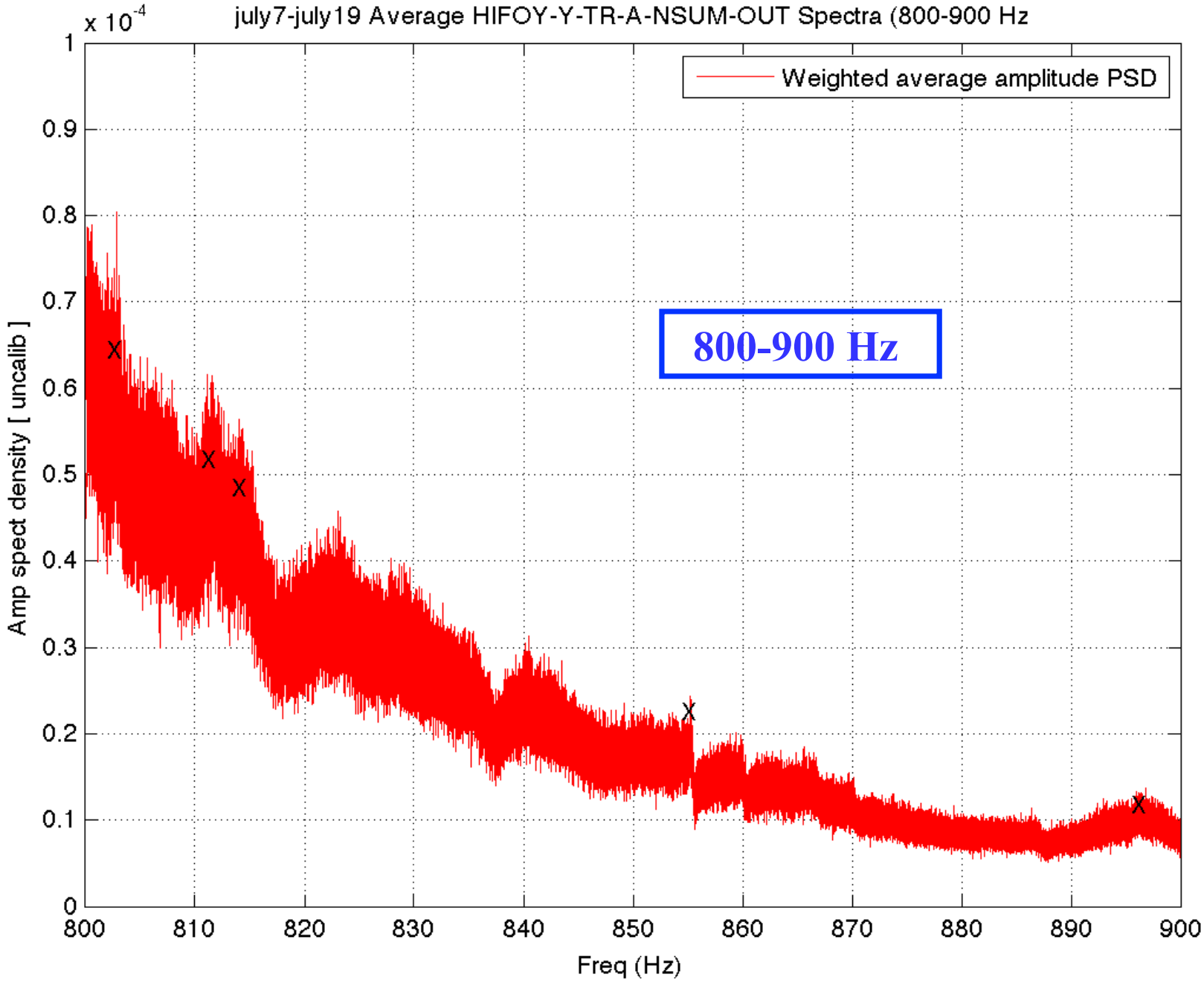

july7-july19 Average HIFOY-Y-TR-A-NSUM-OUT Spectra (300-400 Hz
Weighted average amplitude PSD
300-400 Hz
Amp spect density [uncalib]
Freq (Hz)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
300
310
320
330
340
350
360
370
380
390
400

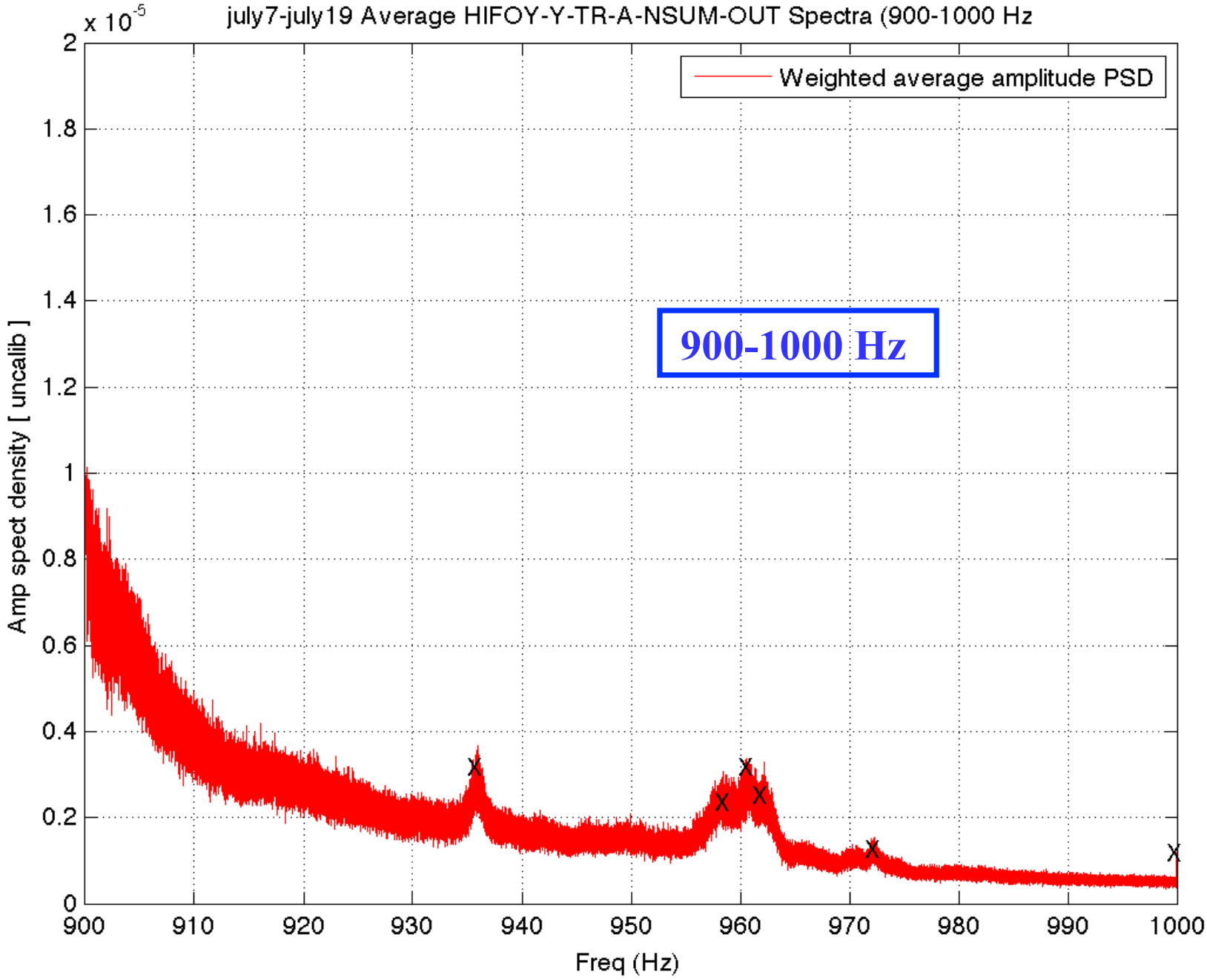

july7-july19 Average HIFOY-Y-TR-A-NSUM-OUT Spectra (400-500 Hz
Weighted average amplitude PSD
400-500 Hz
B
Amp spect density [uncalib]
Freq (Hz)
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
400
410
420
430
440
450
460
470
480
490
500


july7-july19 Average HIFOY-Y-TR-A-NSUM-OUT Spectra (500-600 Hz
Weighted average amplitude PSD
500-600 Hz
Amp spect density [uncalib]
Freq (Hz)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
500
510
520
530
540
550
560
570
580
590
600


july7-july19 Average HIFOY-Y-TR-A-NSUM-OUT Spectra (600-700 Hz
Weighted average amplitude PSD
600-700 Hz
Amp spect density [uncalib]
Freq (Hz)
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
600
610
620
630
640
650
660
670
680
690
700


july7-july19 Average HIFOY-Y-TR-A-NSUM-OUT Spectra (700-800 Hz
x 10^-3
Weighted average amplitude PSD
700-800 Hz
Amp spect density [uncalib]
Freq (Hz)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
700
710
720
730
740
750
760
770
780
790
800


x 10^-4
july7-july19 Average HIFOY-Y-TR-A-NSUM-OUT Spectra (800-900 Hz
Weighted average amplitude PSD
800-900 Hz
Amp spect density [uncalib]
Freq (Hz)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
800
810
820
830
840
850
860
870
880
890
900


july7-july19 Average HIFOY-Y-TR-A-NSUM-OUT Spectra (900-1000 Hz
x 10^-5
Weighted average amplitude PSD
900-1000 Hz
Amp spect density [uncalib]
Freq (Hz)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
900
910
920
930
940
950
960
970
980
990
1000

Obvious combs found:

Harmonic combs marked on spectra:
(digits after decimal depend on width and maximum harmonic)

M – 60.0 Hz	(only 1st harmonic clearly visible!)
A – 1/15 Hz	(up to 750th harmonic at 50 Hz!)
B – 120.05 Hz	(up to 6th harmonic at 720.30 Hz)

Remaining lines on following pages are not obviously due to combs and have now (since September) been checked against the NoEMi database for auxiliary channel correlations

Singles (at least not yet identified as combs)

0.039 Hz	2.000 Hz	30.18 Hz – CS Seis	60.036 Hz	132.9 Hz
0.041 Hz	2.133 Hz	40.915 Hz	60.358 Hz	135.7 Hz
0.043 Hz	2.292 Hz	45.29 Hz – CS Acc	60.362 Hz	149.7 Hz
0.044 Hz	2.295 Hz	48.55 Hz	60.43 Hz	158.3 Hz
0.0665 Hz	2.6 Hz	53.325 Hz	61.8 Hz	159.2 Hz
0.1335 Hz	2.7 Hz	54.36 Hz,	65.36 Hz,	160.1 Hz,
0.198 Hz	2.85 Hz	54.475 Hz	71.2 Hz	161.8 Hz
0.445 Hz	3.4 Hz	55.76 Hz	72.16 Hz	163.8 Hz
0.484 Hz	5.000 Hz	56.02 Hz	72.4 Hz	167.6 Hz
0.488 Hz	5.405 Hz	56.28 Hz	77.5 Hz	171.7 Hz
0.6000 Hz	5.6 Hz	53.39 Hz	78.8 Hz	177.3 Hz
0.647 Hz	6.63 Hz	57.89 Hz	85.46 Hz	177.8 Hz
0.667 Hz	6.65 Hz	58.5 Hz	89.74 Hz	178.7 Hz
0.97 Hz	9.66 Hz	58.65 Hz – CS Seis/Acc/Mic	95.25 Hz	179.2 Hz
1.1 Hz	12.05 Hz – EY Seis	58.8 Hz	106.4 Hz	192.9 Hz
1.18 Hz	13.000 Hz	58.85 Hz	107.7 Hz	197.9 Hz
1.467 Hz	13.3 Hz	58.95 Hz – CS Seis	117.3 Hz	198.55 Hz
1.58 Hz	19.63 Hz	59.1 Hz	118.3 Hz	199.2 Hz
1.81 Hz	21.04 Hz	59.15 Hz – CW Seis/Acc/Mic	119.2 Hz	199.6 Hz
1.87 Hz	22.12 Hz	59.55 Hz	122.2 Hz	201.4 Hz
1.935 Hz	29.57 Hz	59.75 Hz	125.3 Hz	201.9 Hz

Singles (at least not yet identified as combs)

207.15 Hz
207.31 Hz
210.55 Hz
213.05 Hz
215.55 Hz
221.3 Hz
223.85 Hz
236.75 Hz
258.3 Hz
261.5 Hz
265.0 Hz
278.7 Hz
286. Hz – EY Mag/Seis/Acc/Tilt*
289.5 Hz
312.4 Hz
320.5 Hz
323.5 Hz
325.5 Hz
333.7 Hz
337.6 Hz
349.8 Hz
351.7 Hz
355.1 Hz
356.4 Hz
366.2 Hz
371.5 Hz
386.66 Hz
394.4 Hz
406.2 Hz
418.4 Hz
421.5 Hz
425.8 Hz
427.5 Hz
445.6 Hz
458.2 Hz
473.4 Hz
483. Hz – EY Mag/Seis/Acc/Tilt*
496.2 Hz
503.8 Hz
507. Hz
512.4 Hz
520.2 Hz

*Association may be spurious – narrow correlations seen in broad lines

Singles (at least not yet identified as combs)

523.6 Hz
526.8 Hz
533.7 Hz
543.1 Hz
553. Hz – EY Mag*
566.3 Hz
571.3 Hz
572.2 Hz
574.9 Hz
576.9 Hz
589. Hz – EY Mag/Acc/Mic*
598.2 Hz
607.5 Hz
614.2 Hz
617.6 Hz
623. Hz – EY Mag/Mic*
624.7 Hz
630.8 Hz
632.8 Hz
638.2 Hz
648.7 Hz
661.495 Hz
662.9 Hz
674.2 Hz
679.4 Hz
686.4 Hz
688.1 Hz,
697.6 Hz
702.0 Hz
707.2 Hz
721.4 Hz
721.7 Hz
742. Hz – EY Mag*
753.6 Hz
762.6 Hz
779.4 Hz
802.8 Hz
811.5 Hz
814.2 Hz
855.3 Hz
896.4 Hz
935.9 Hz
958.5 Hz
960.7 Hz
962. Hz
972.3 Hz
999.959 Hz – CS Mag/Acc

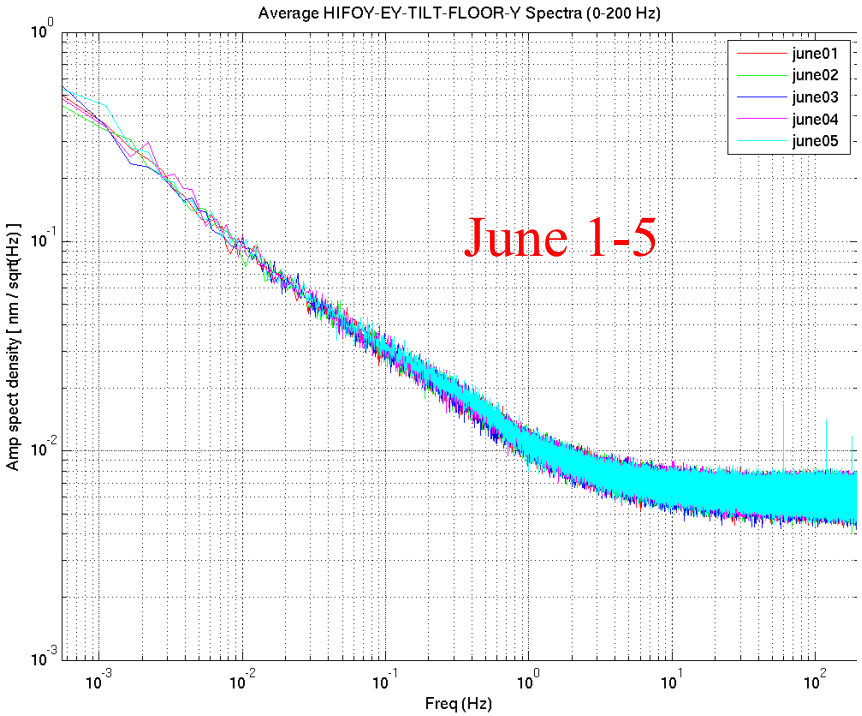
*Association may be spurious – narrow correlations seen in broad lines

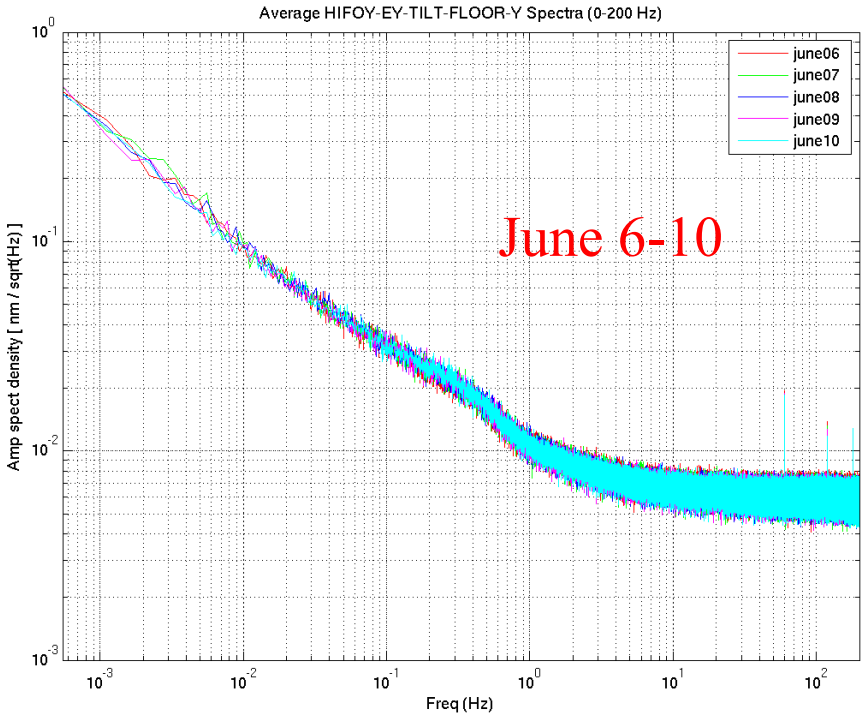
Looking for digital electronics artifacts

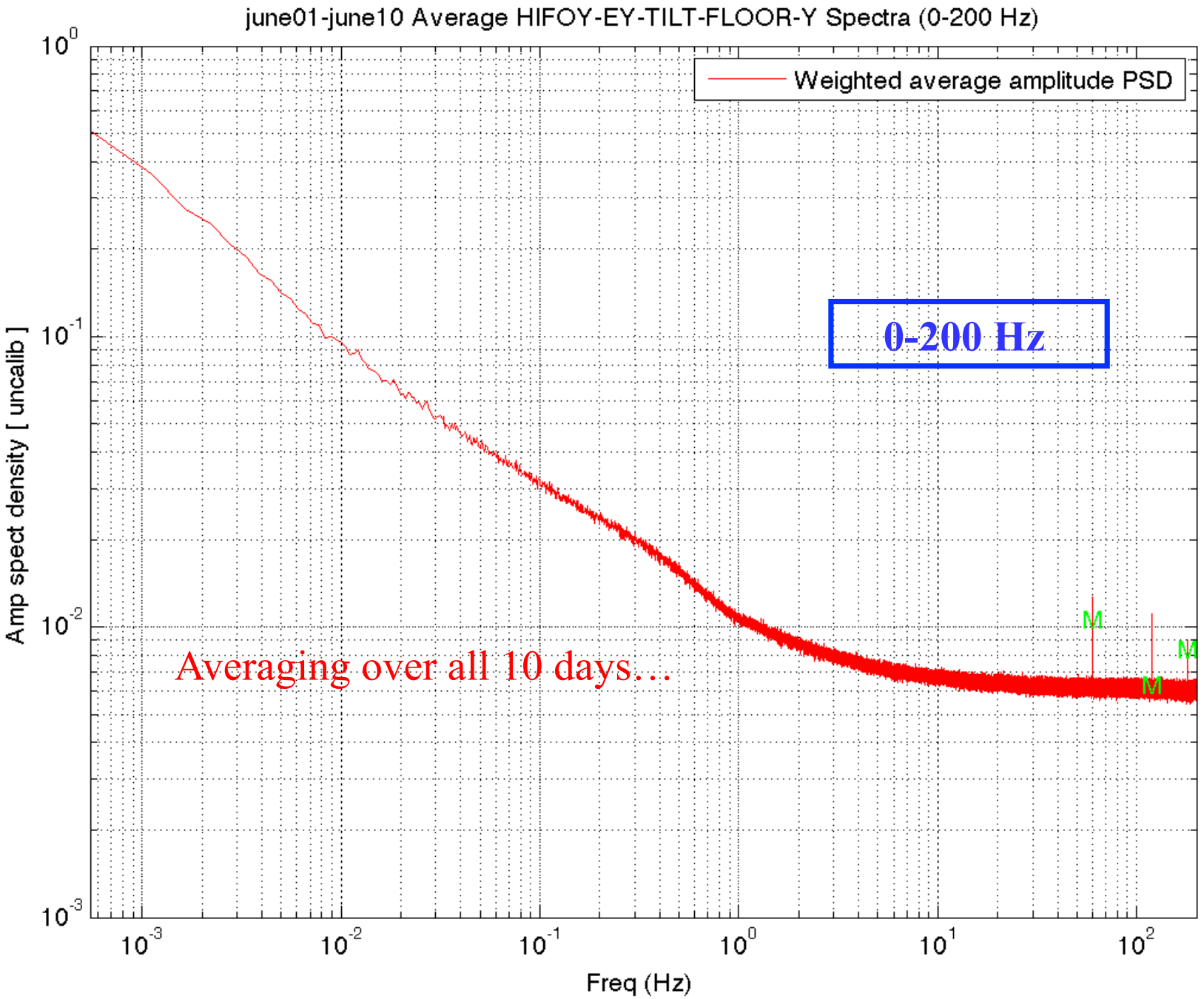
Before the start of the HIFO-Y test, two tilt-meter channels in the End-Y station were terminated at Josh's request:

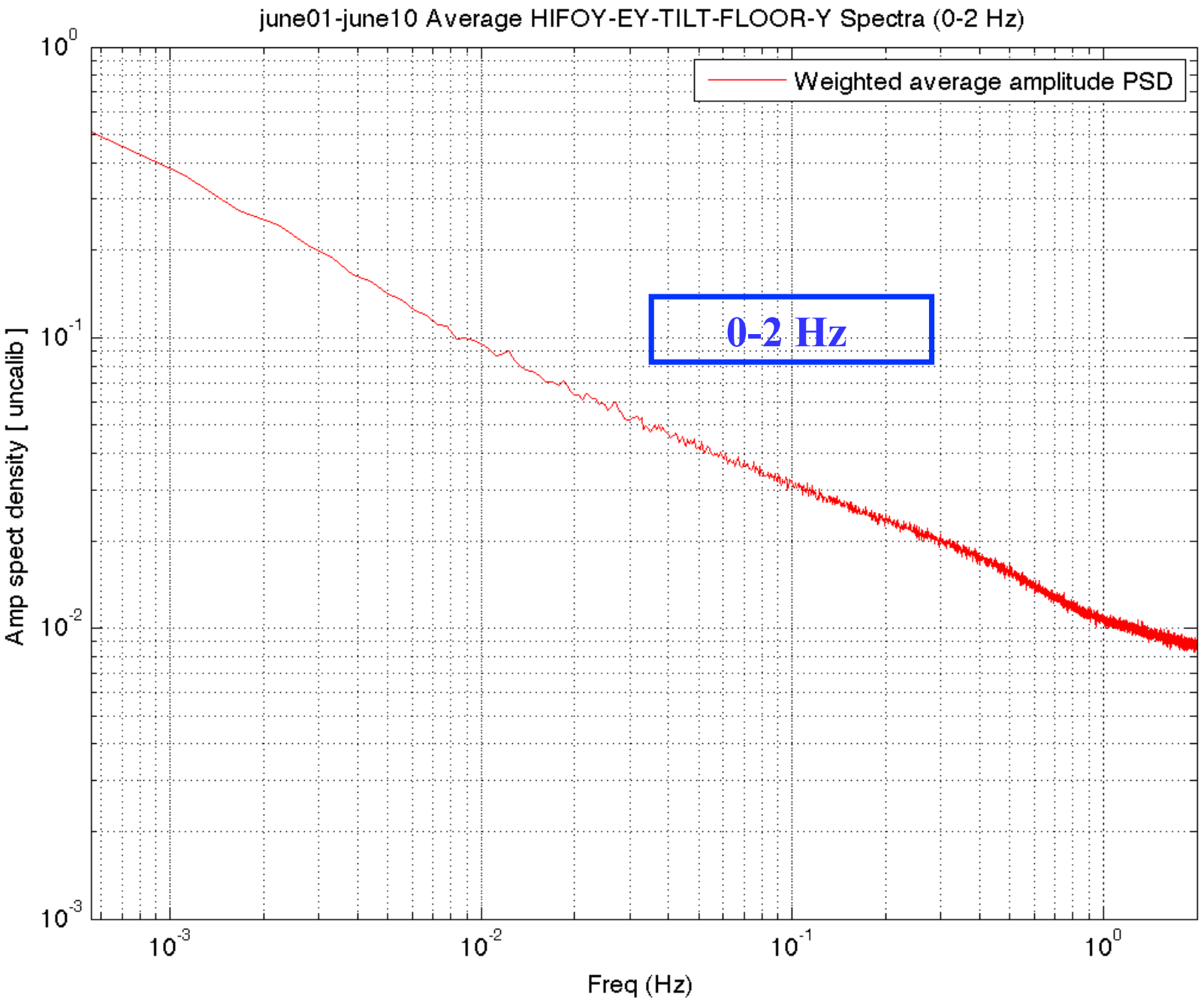
H1_PEM-EY_TILT_VEA_FLOOR_X_DQ
H1_PEM-EY_TILT_VEA_FLOOR_Y_DQ

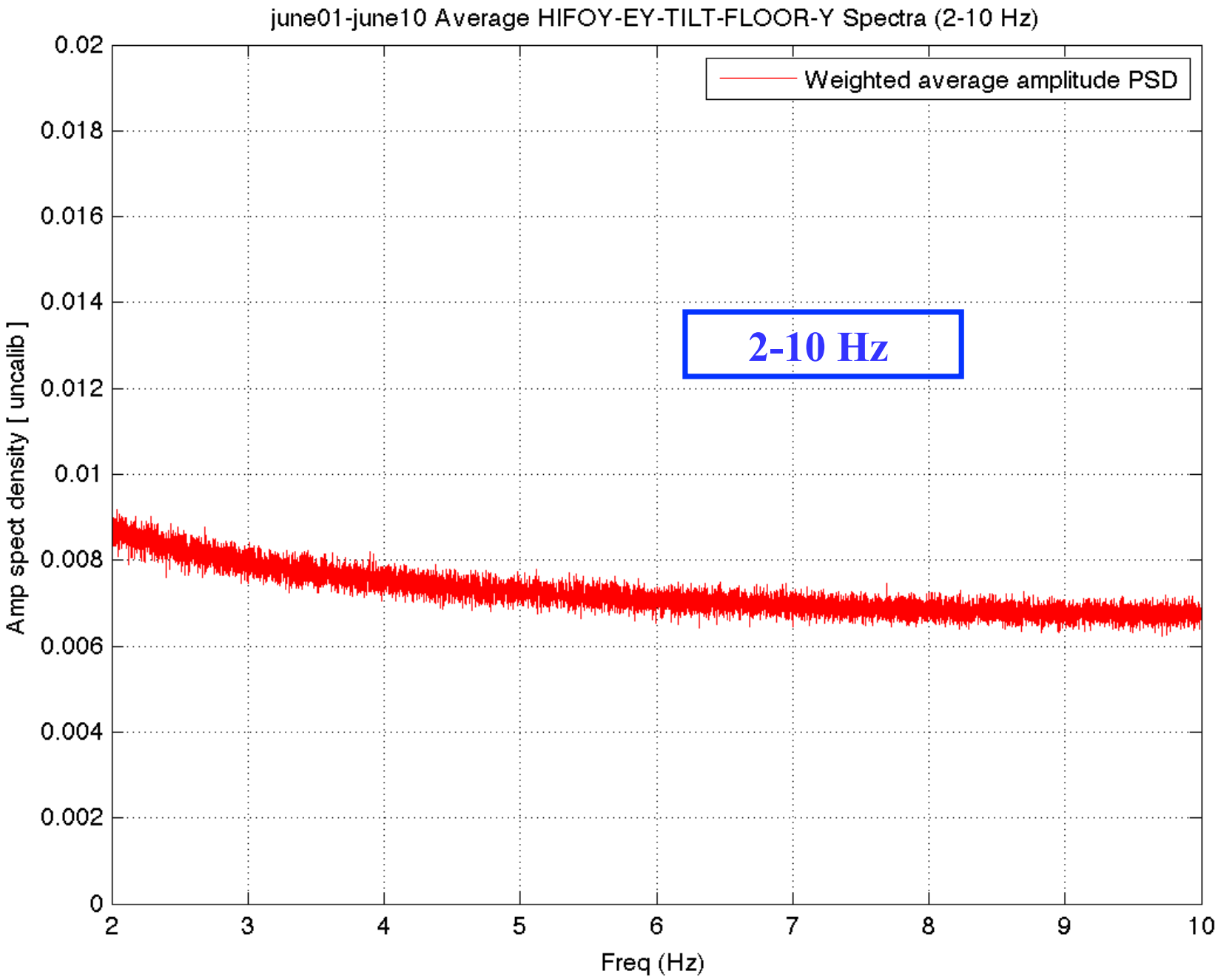
Let's look at the 2nd one 1st:

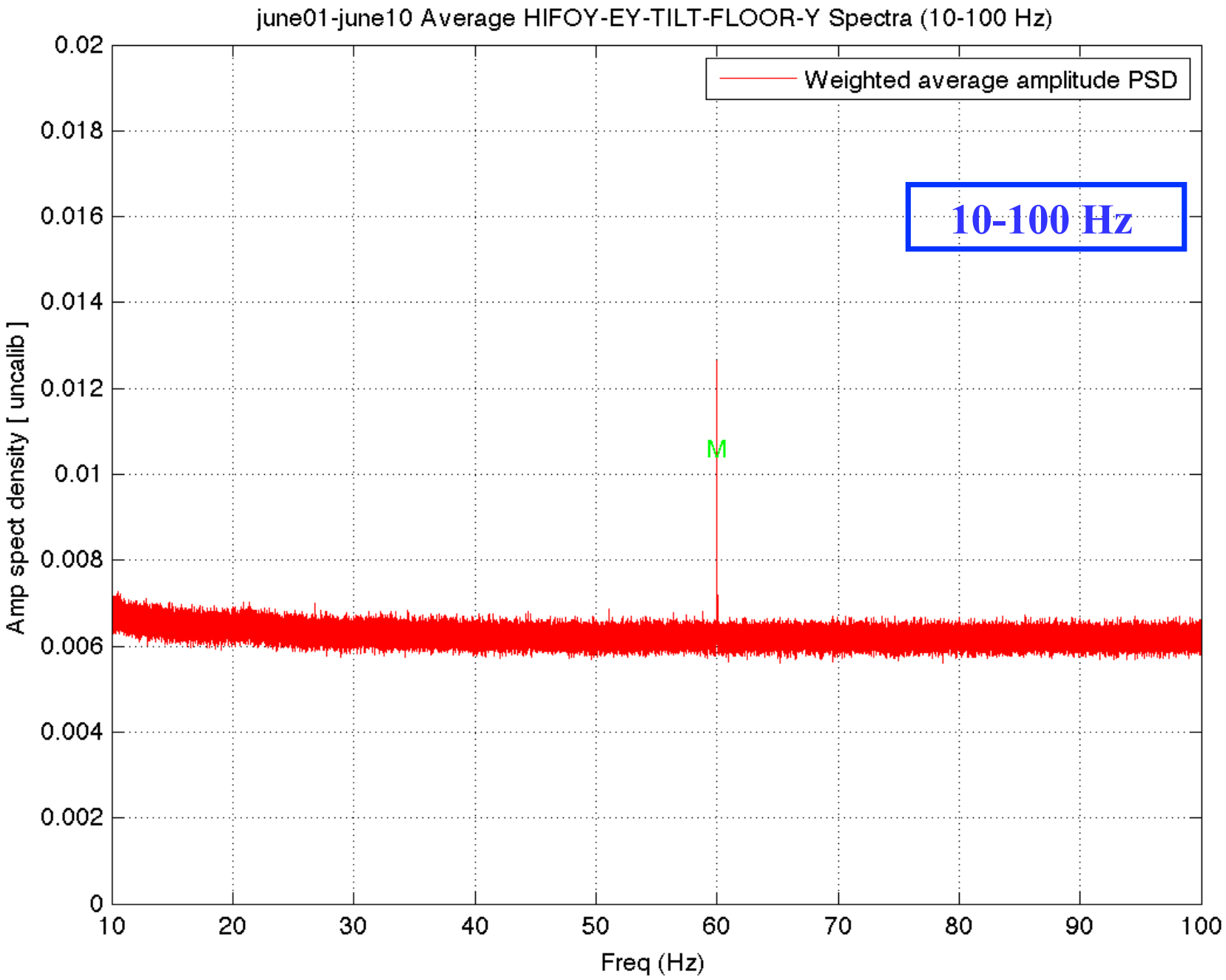


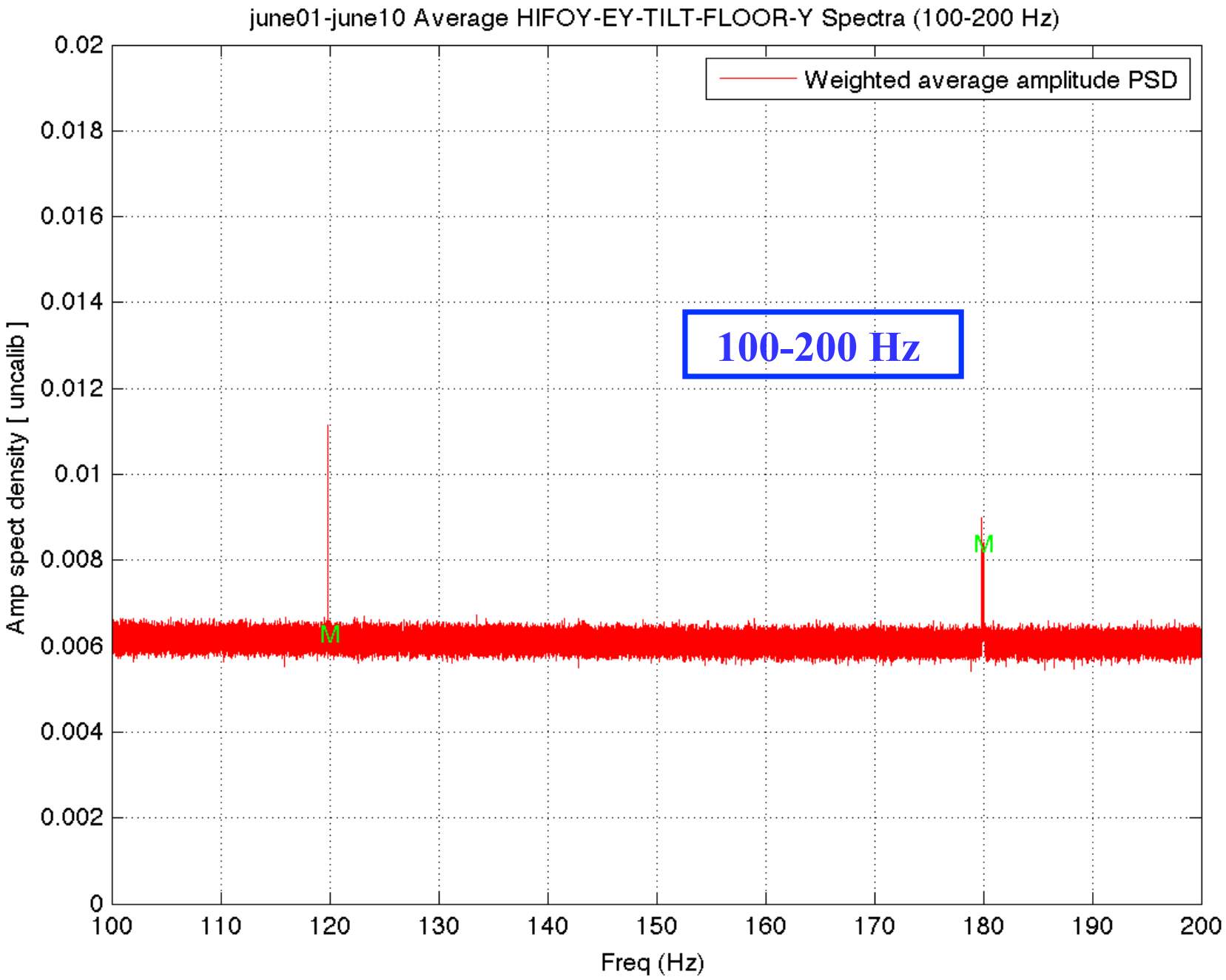



june01-june10 Average HIFOY-EY-TILT-FLOOR-Y Spectra (0-200 Hz)
Weighted average amplitude PSD
0-200 Hz
Averaging over all 10 days…
Amp spect density [uncalib]
Freq (Hz)
10^0
10^-1
10^-2
10^-3
10^-3
10^-2
10^-1
10^0
10^1
10^2


june01-june10 Average HIFOY-EY-TILT-FLOOR-Y Spectra (0-2 Hz)
Weighted average amplitude PSD
0-2 Hz
Amp spect density [uncalib]
Freq (Hz)
10^0
10^-1
10^-2
10^-3
10^-3
10^-2
10^-1
10^0

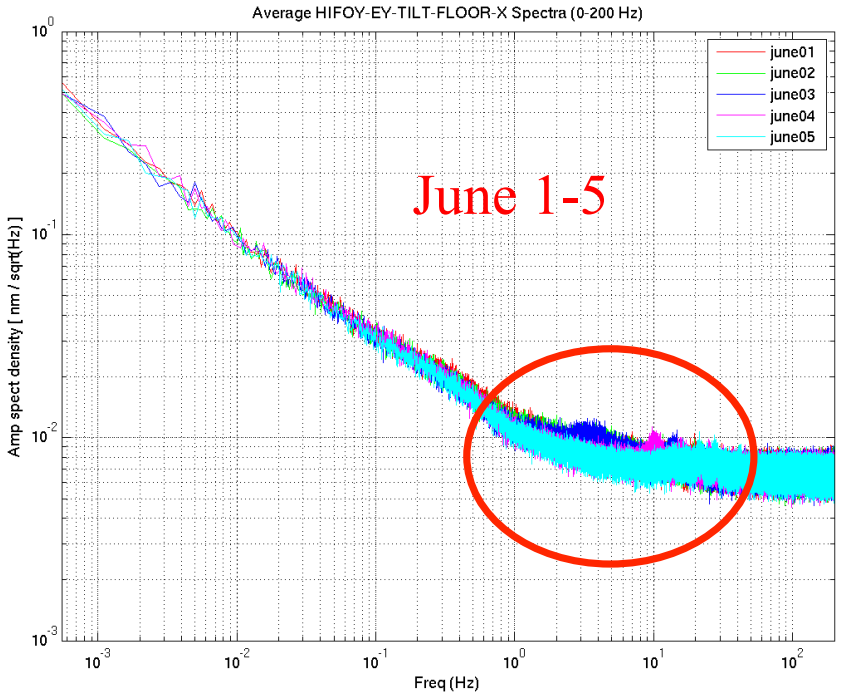

june01-june10 Average HIFOY-EY-TILT-FLOOR-Y Spectra (2-10 Hz)
Weighted average amplitude PSD
2-10 Hz
Amp spect density [uncalib]
Freq (Hz)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
2
3
4
5
6
7
8
9
10

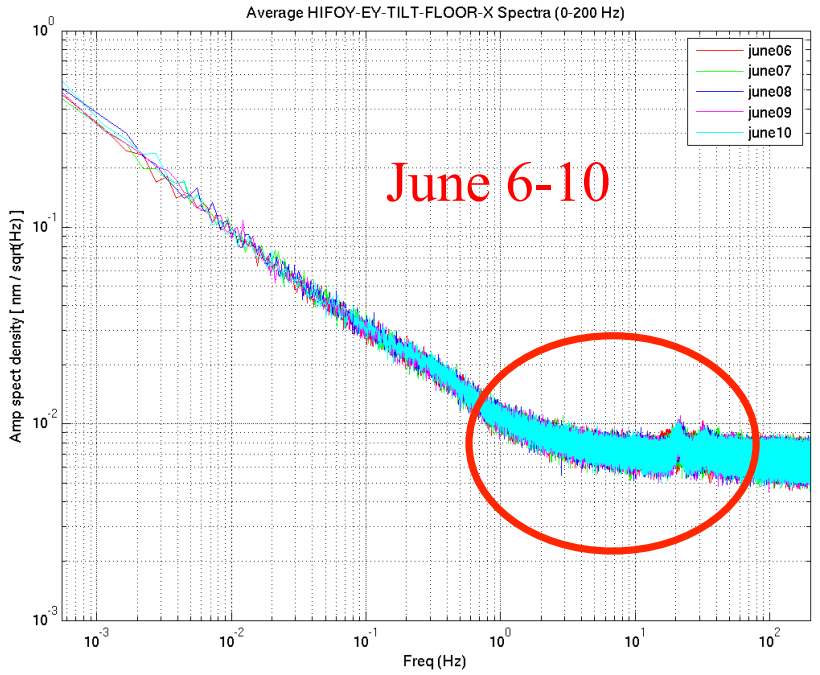

june01-june10 Average HIFOY-EY-TILT-FLOOR-Y Spectra (10-100 Hz)
Weighted average amplitude PSD
10-100 Hz
M
Amp spect density [uncalib]
Freq (Hz)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
10
20
30
40
50
60
70
80
90
100


june01-june10 Average HIFOY-EY-TILT-FLOOR-Y Spectra (100-200 Hz)
Weighted average amplitude PSD
100-200 Hz
M
M
Amp spect density [uncalib]
Freq (Hz)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
100
110
120
130
140
150
160
170
180
190
200

Looking for digital electronics artifacts

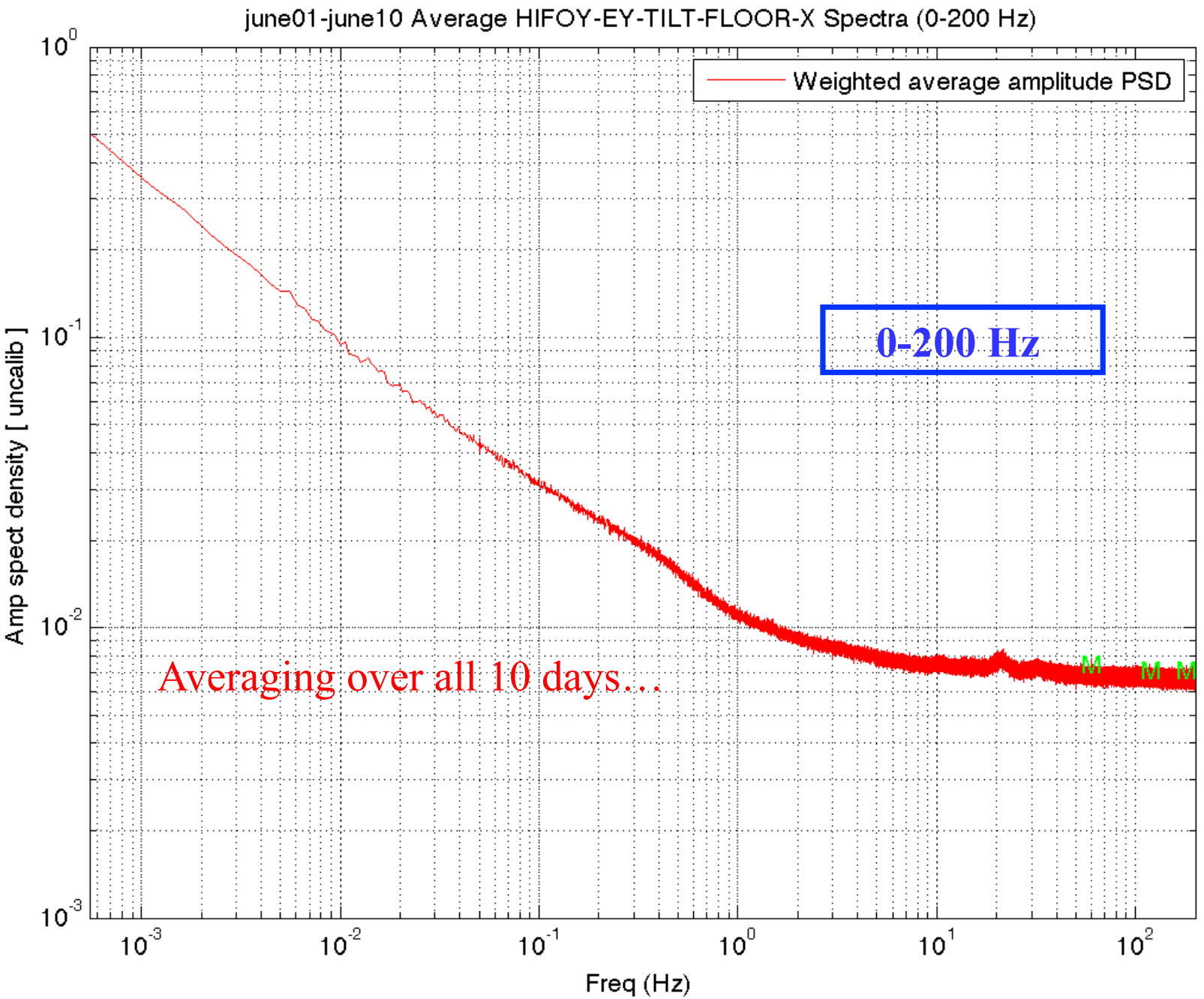
Now let's look at the other terminated channel…

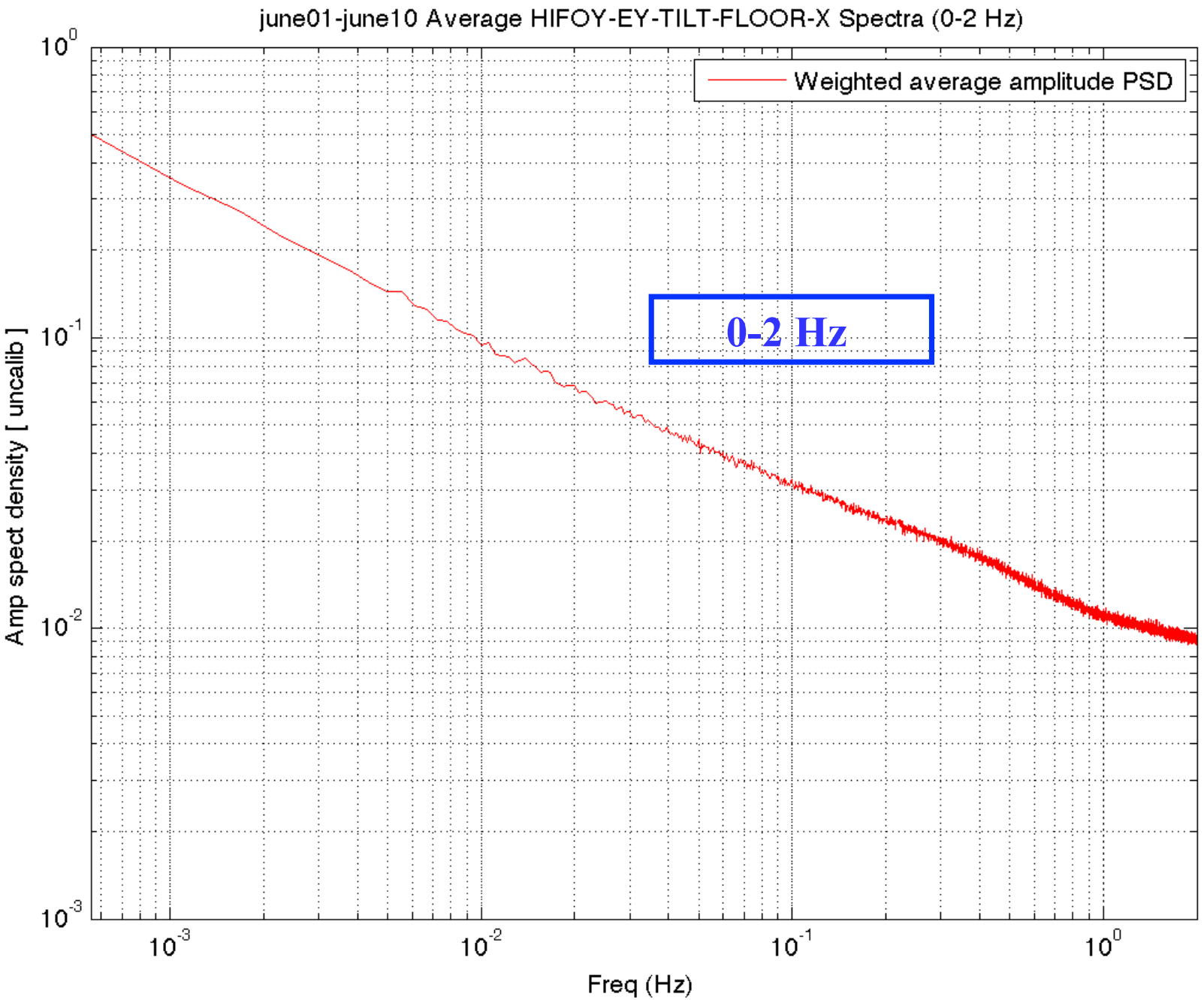


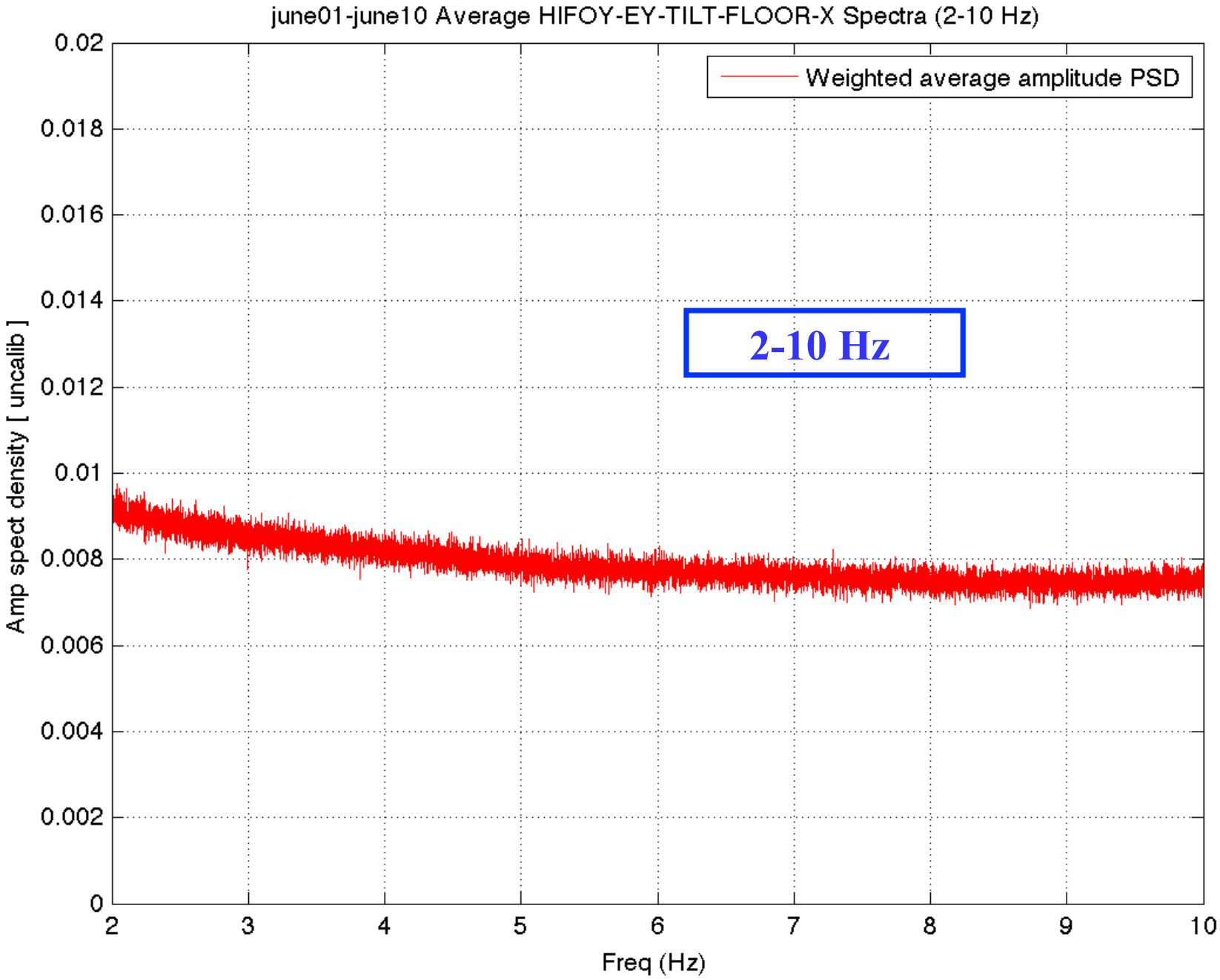


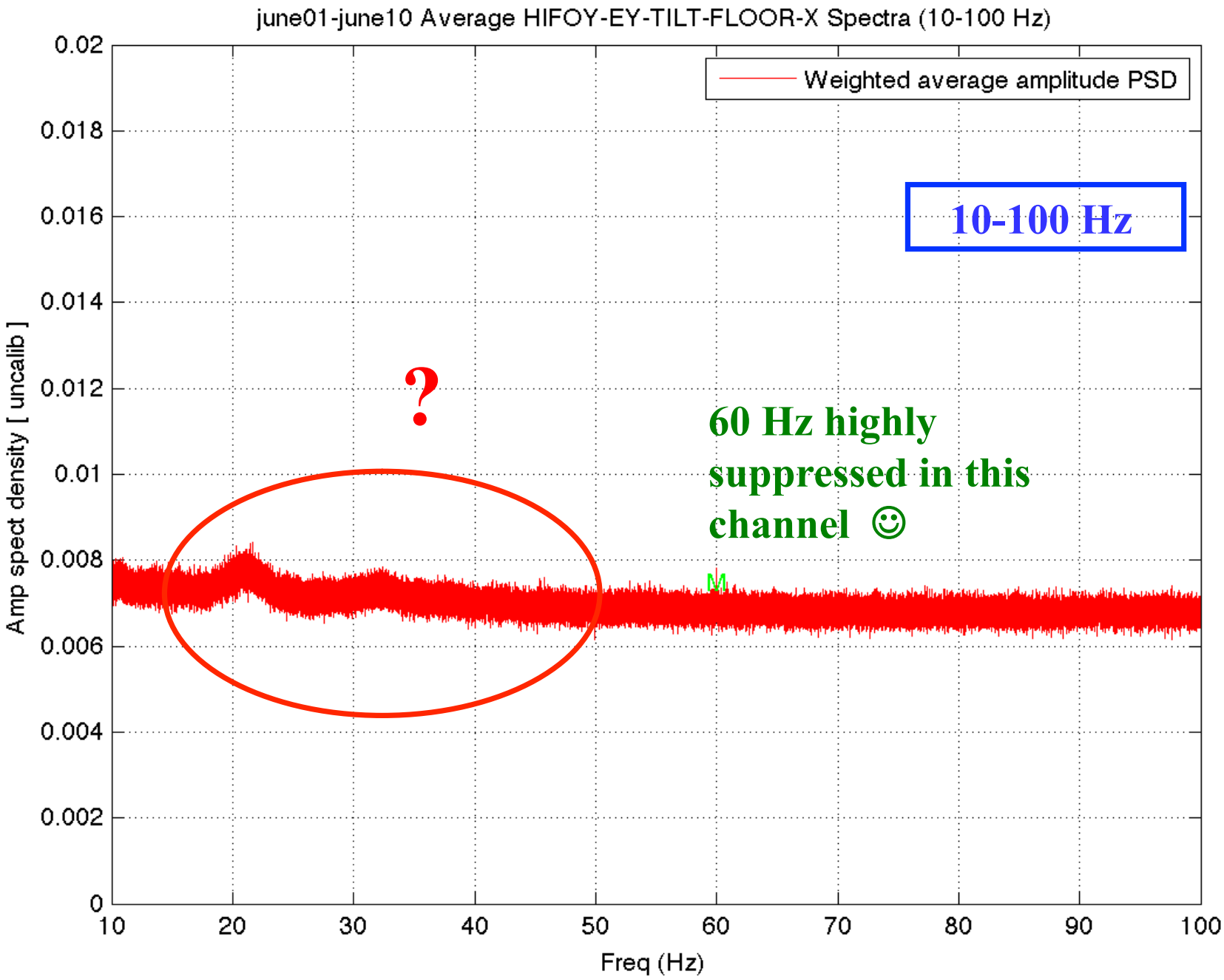
?

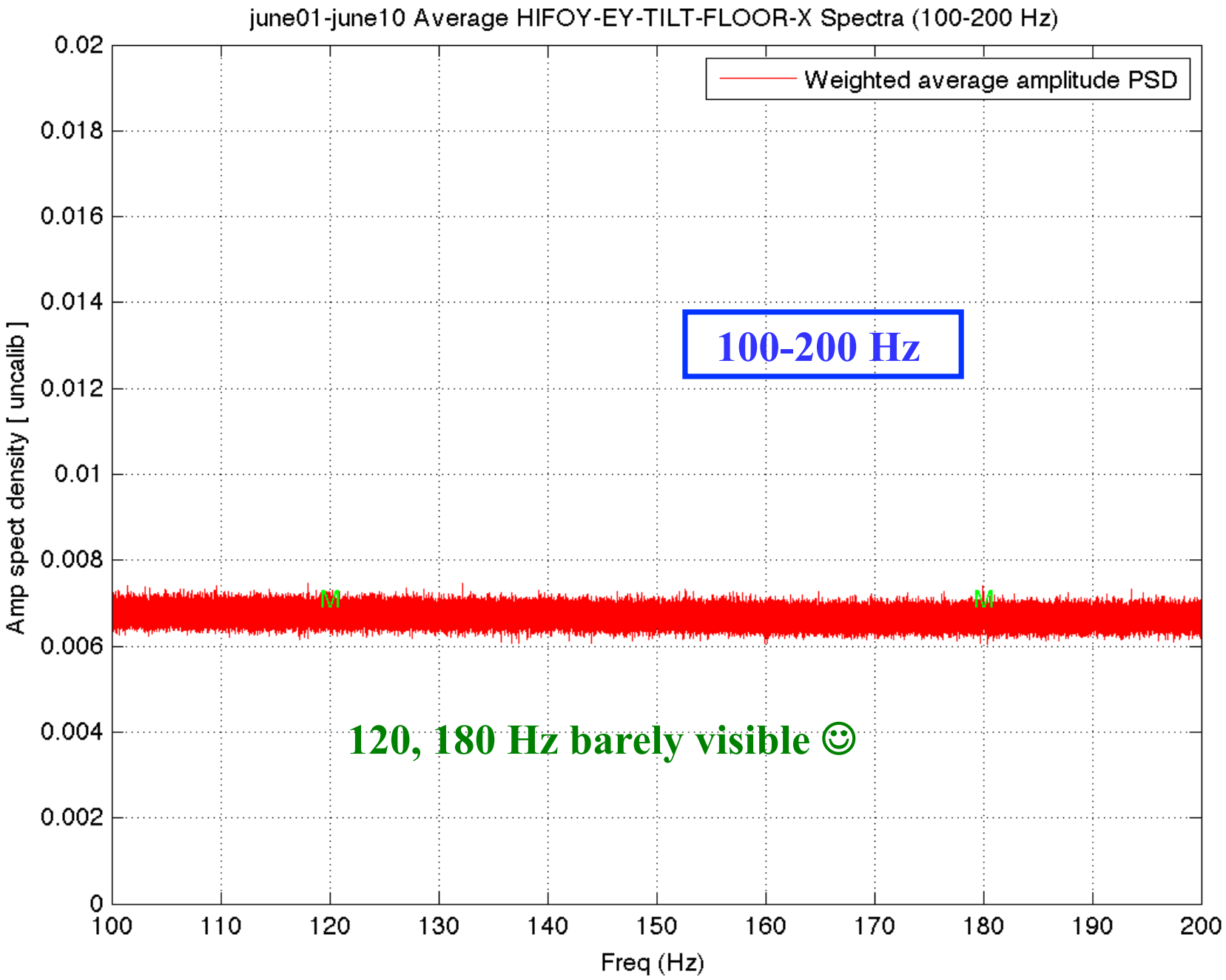
?


june01-june10 Average HIFOY-EY-TILT-FLOOR-X Spectra (0-200 Hz)
Weighted average amplitude PSD
0-200 Hz
Averaging over all 10 days…
Amp spect density [uncalib]
Freq (Hz)
10^0
10^-1
10^-2
10^-3
10^-3
10^-2
10^-1
10^0
10^1
10^2

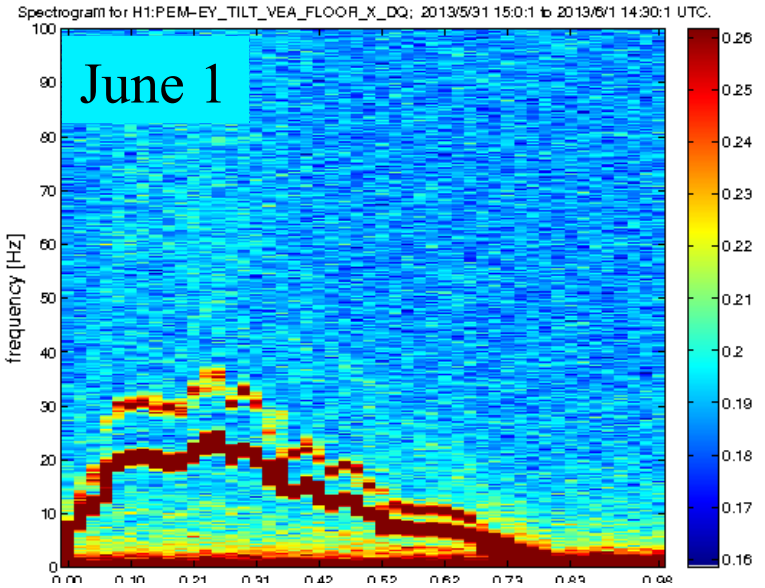

june01-june10 Average HIFOY-EY-TILT-FLOOR-X Spectra (0-2 Hz)
Weighted average amplitude PSD
0-2 Hz
Amp spect density [uncalib]
Freq (Hz)
10^0
10^-1
10^-2
10^-3
10^-3
10^-2
10^-1
10^0

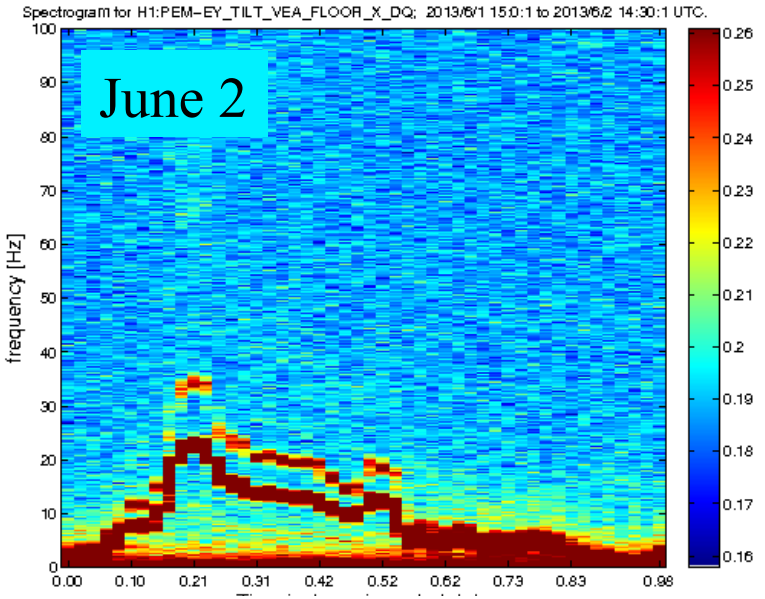

june01-june10 Average HIFOY-EY-TILT-FLOOR-X Spectra (2-10 Hz)
Weighted average amplitude PSD
2-10 Hz
Amp spect density [uncalib]
Freq (Hz)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
2
3
4
5
6
7
8
9
10

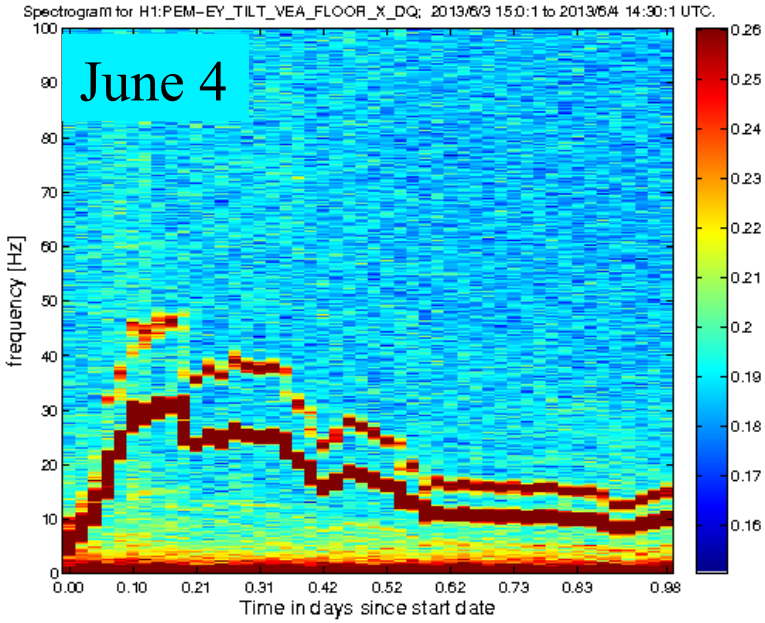

june01-june10 Average HIFOY-EY-TILT-FLOOR-X Spectra (10-100 Hz)
Weighted average amplitude PSD
10-100 Hz
?
60 Hz highly suppressed in this channel ☺
M
Amp spect density [uncalib]
Freq (Hz)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
10
20
30
40
50
60
70
80
90
100

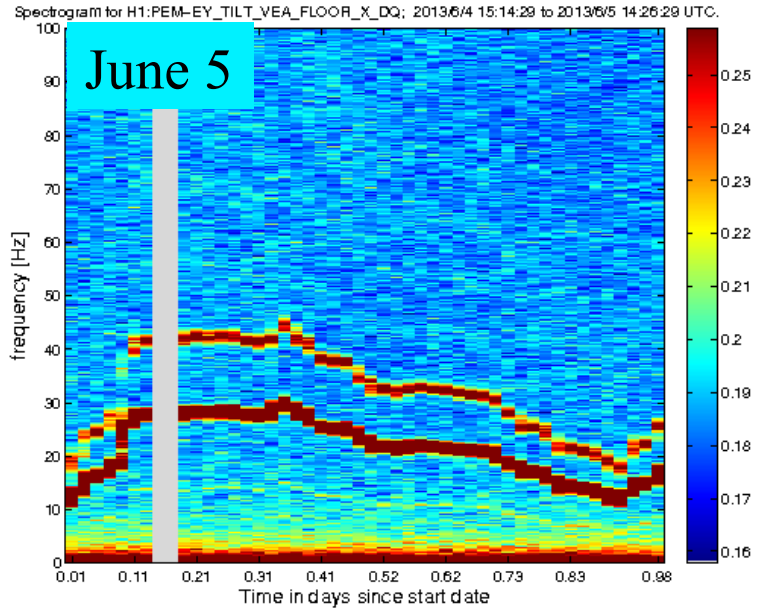

june01-june10 Average HIFOY-EY-TILT-FLOOR-X Spectra (100-200 Hz)
Weighted average amplitude PSD
100-200 Hz
120, 180 Hz barely visible ☺
Amp spect density [uncalib]
Freq (Hz)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
100
110
120
130
140
150
160
170
180
190
200

But what's the funny ripple in the tens of Hz band?

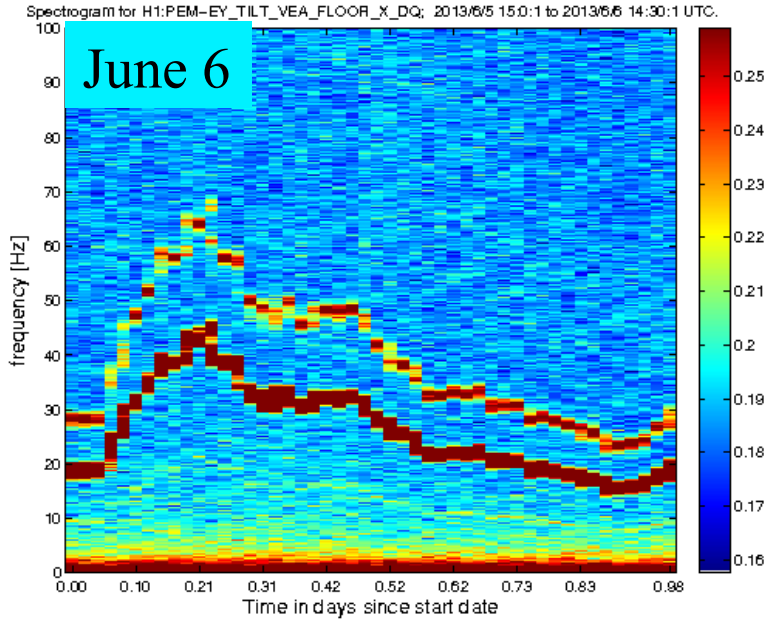


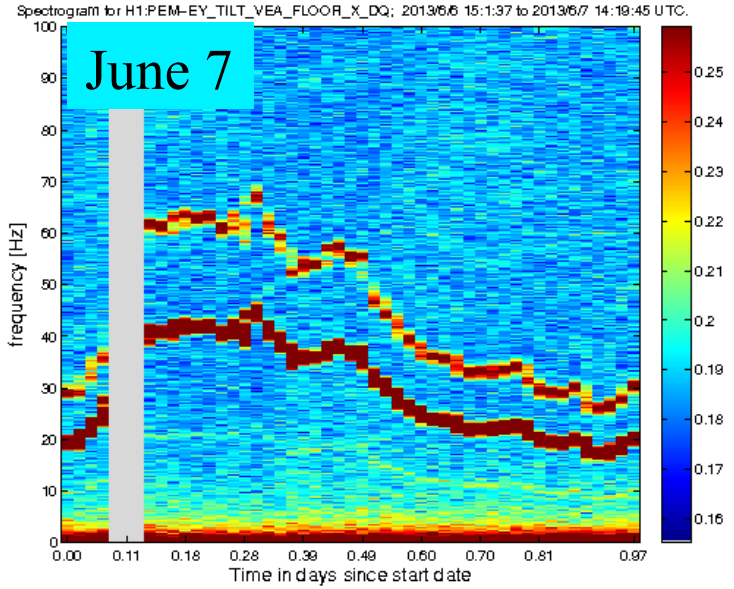


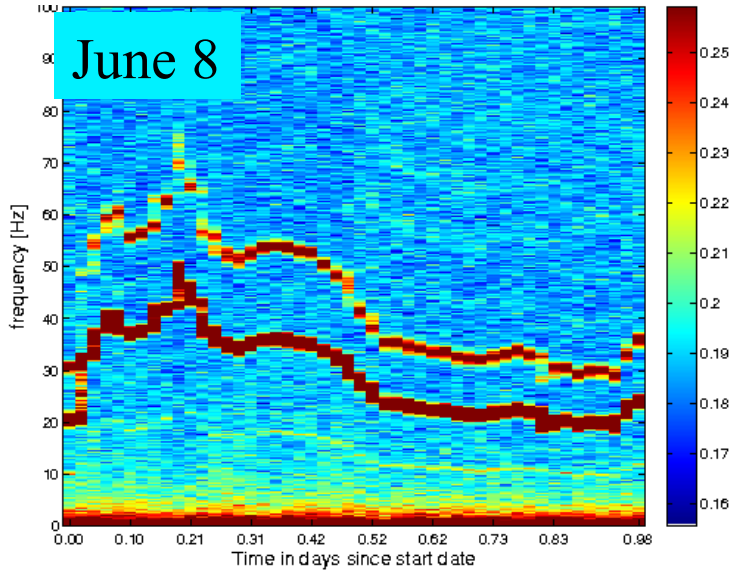


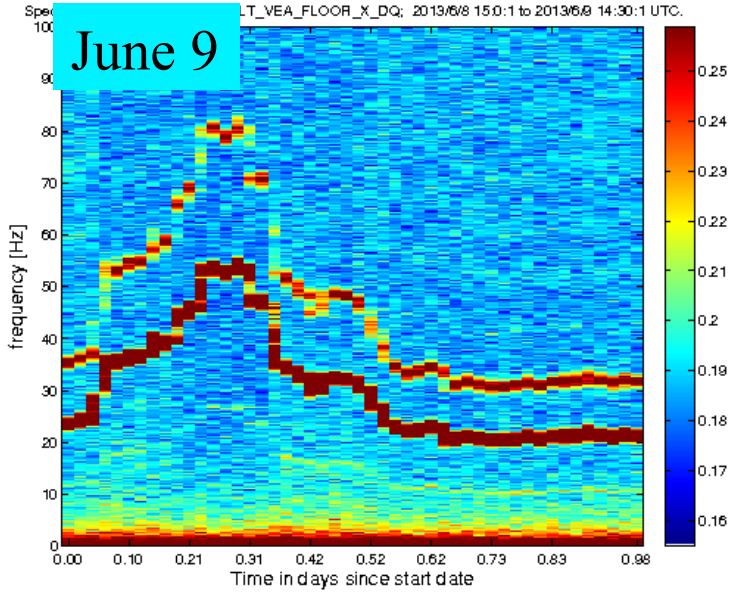


Idea from Robert: Beat of two high frequencies subject to diurnal temperature drifts (seen faintly in Y channel too)









Summary

HIFOY line investigations wrapping up

- Unfortunately, many lines seen – stationary and wandering
- Cataloguing them for future reference – just in case…
- But hoping many are due to hybrid aLIGO/iLIGO configurations used

Now preparing for simultaneous HIFO-X tests at Hanford and Livingston in January

Wiki pages (under construction):

https://wiki.ligo.org/DetChar/HalfInterferometerXHanfordLineInvestigations

https://wiki.ligo.org/DetChar/HalfInterferometerYLivingstonLineInvestigations