Distillation of LVC Detchar presentation in Rome – Sept 10, 2012 with additional plots and tables based on further analysis of August H2 OAT data

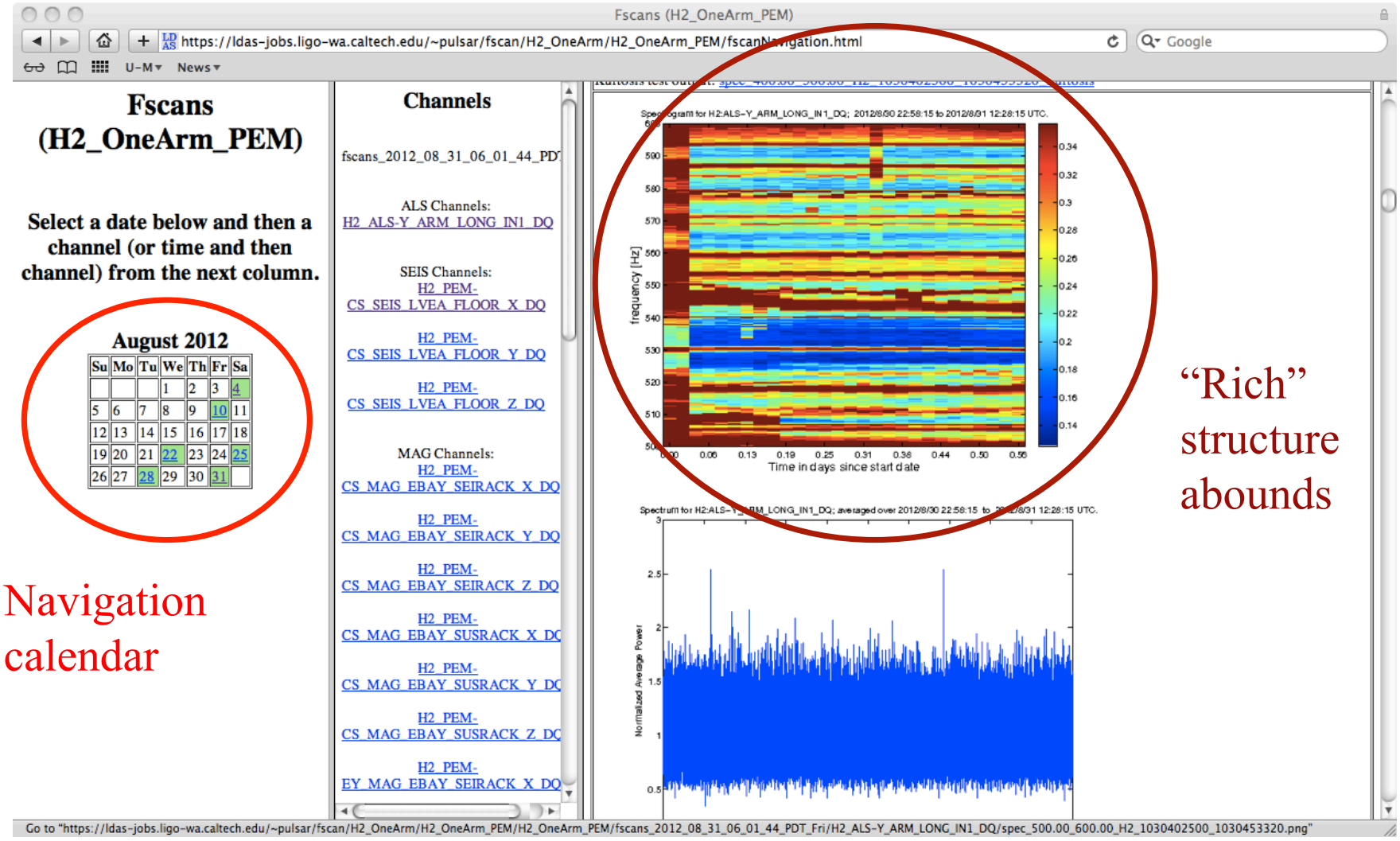
The original presentation with extra material on line investigation infrastructure and channel selection can be found in the DCC: (G1200923)
https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=96244

Results here based partly on Fscans and SFTs generated by Greg Mendell and on reports from Alberto Colla's Noemi line-finding program

Wiki page for H2 OAT line investigations:
https://wiki.ligo.org/foswiki/bin/view/DetChar/OneArmTestLineInvestigations

Keith Riles – U. Michigan – September 27, 2012 – Report for LHO alog

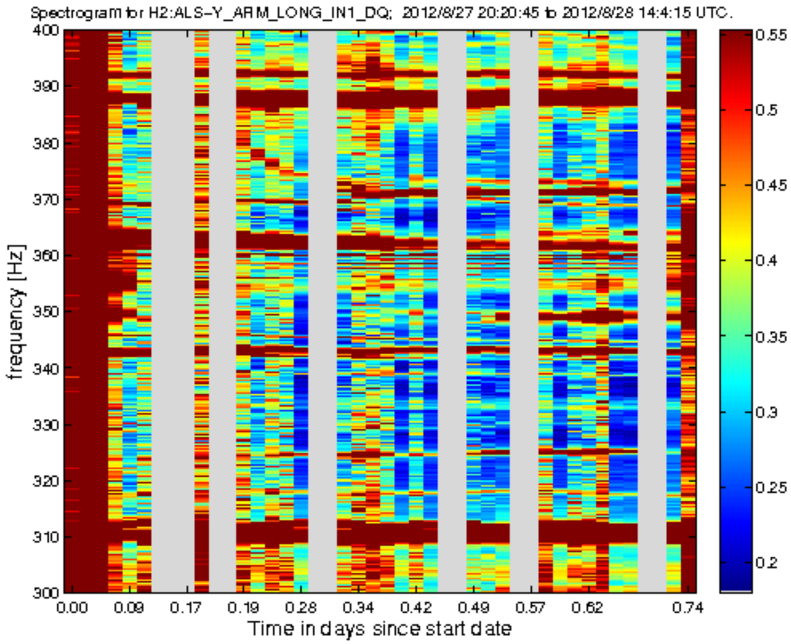
Sample Fscan snapshot

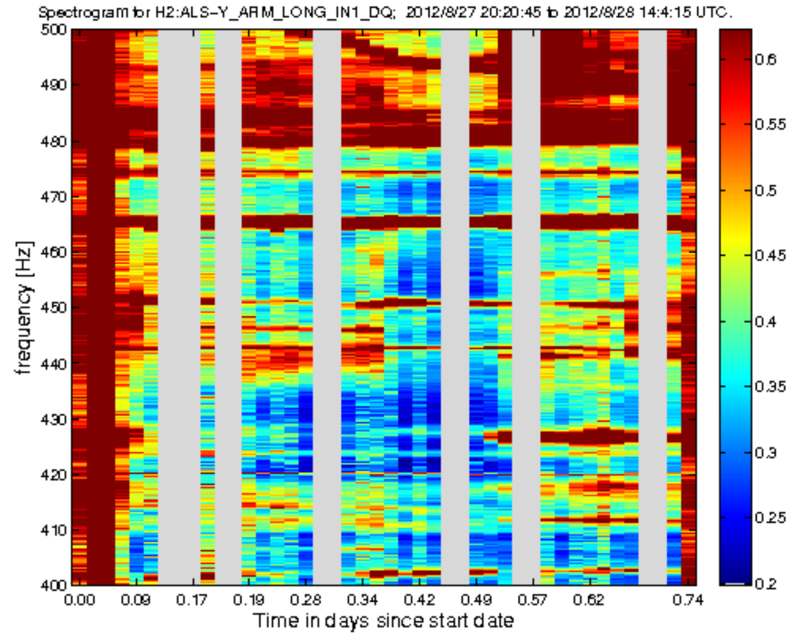


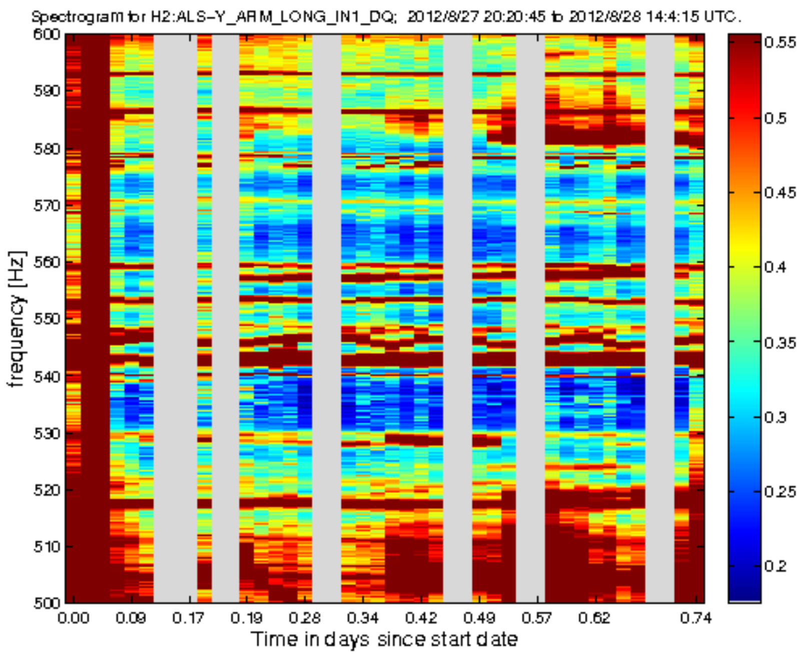
"Rich" structure abounds

Navigation calendar

Only 6 days in August with enough livetime for measurements





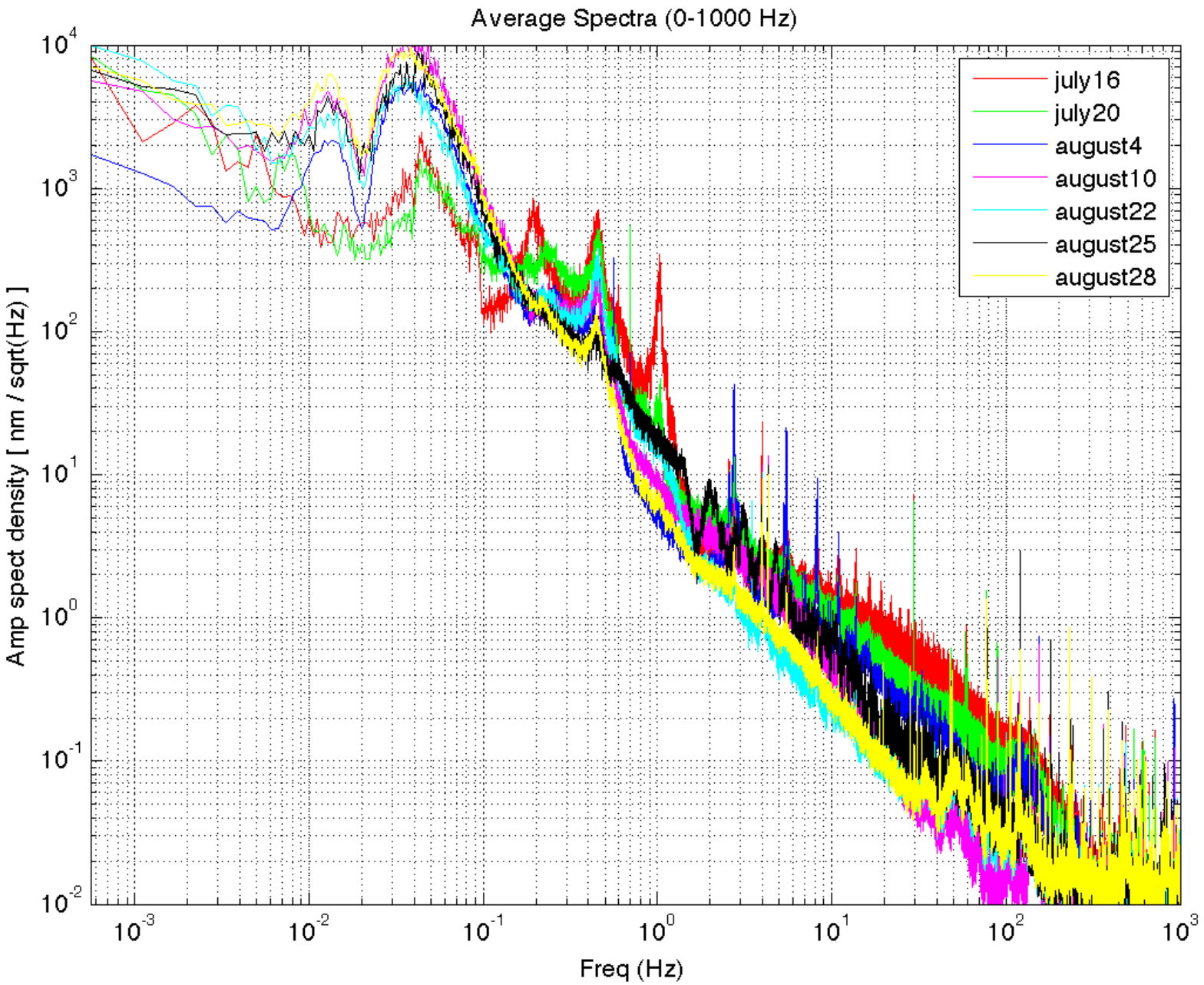


More sample Fscan spectrograms

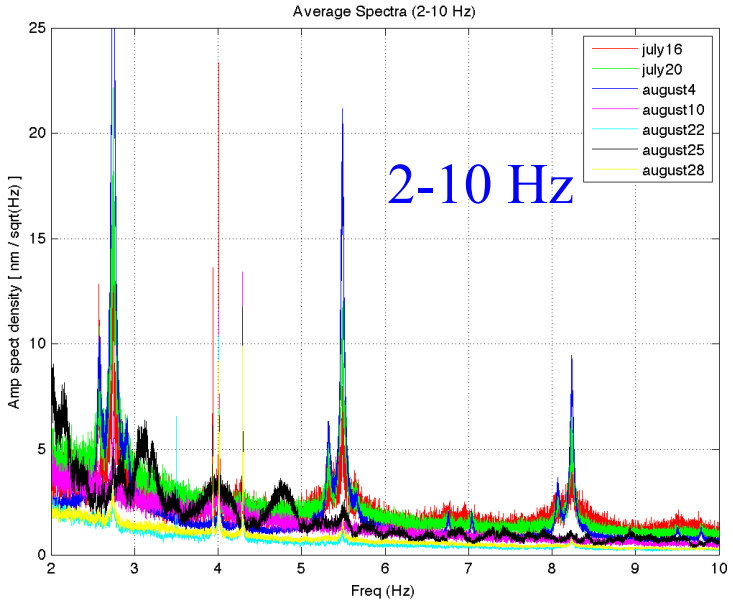
(arbitrary selection)

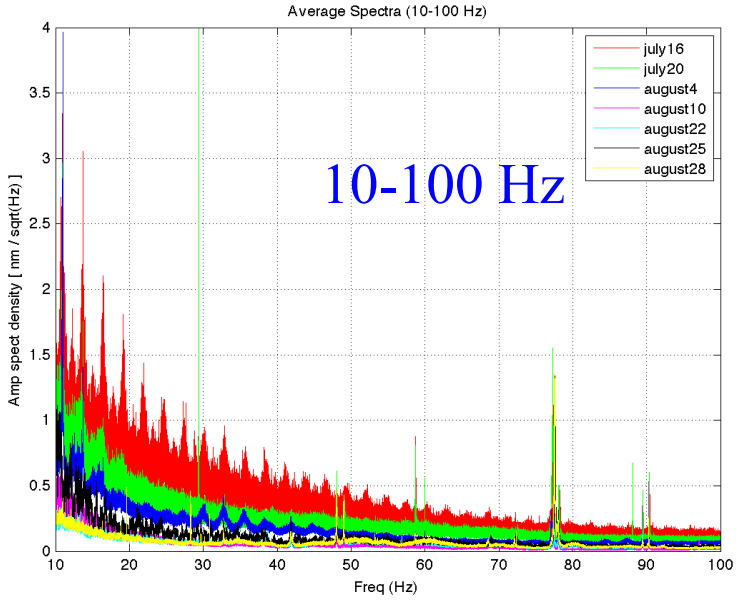
Used Greg's SFTs from July and August to compute noise-weighted spectra for each day

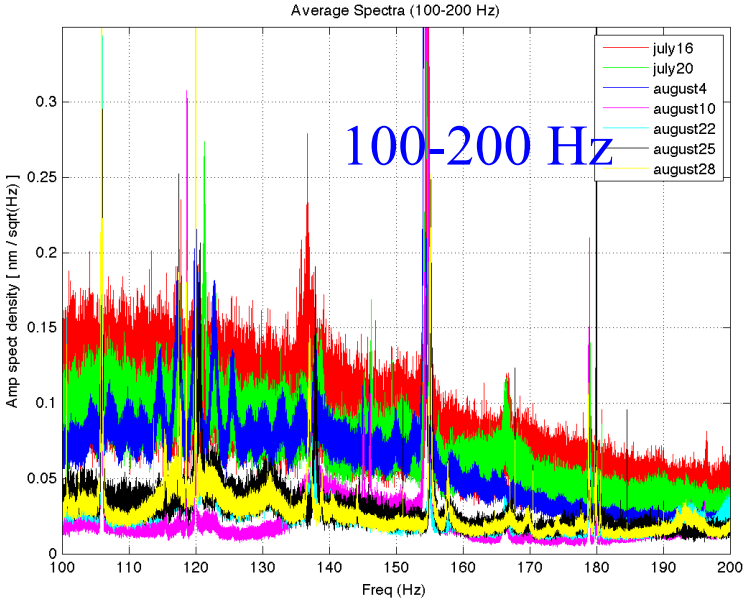
- July 16 – 5 hours
- July 20 – 9 hours
- August 4 – 23.5 hours
- August 10 – 9 hours
- August 22 – 10.5 hours
- August 25 – 6 hours (included, but affected by measurements)
- August 28 – 15 hours
- August 31 – 13.5 hours (excluded – measurement period)

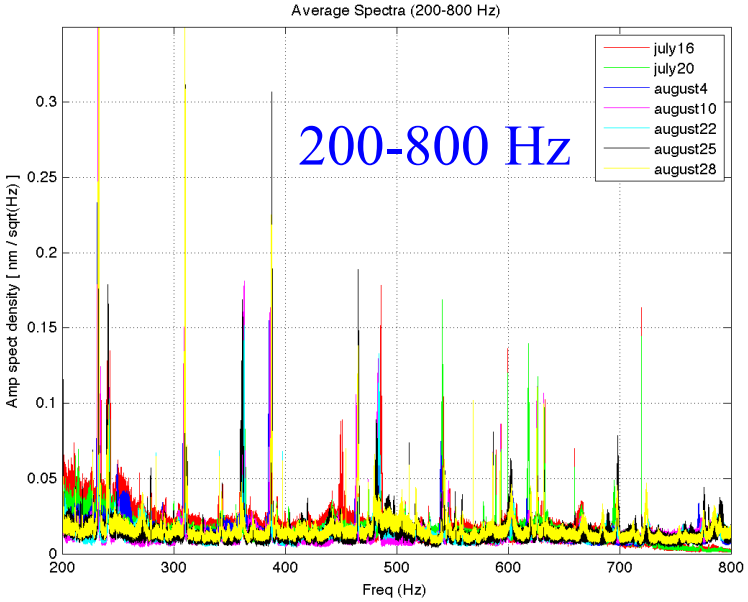

Average Spectra (0-1000 Hz)
Amp spect density [nm / sqrt(Hz)]
Freq (Hz)
july16
july20
august4
august10
august22
august25
august28

Selected Zooms









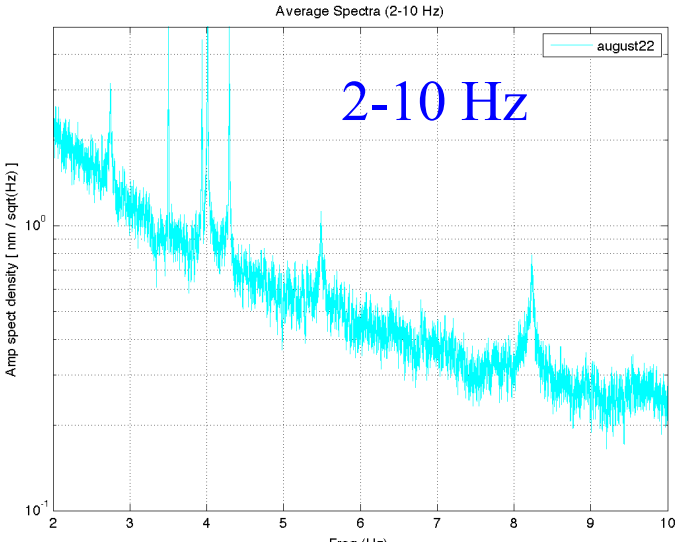
Dramatic noise improvements between mid July and late August – Congratulations to the commissioners!

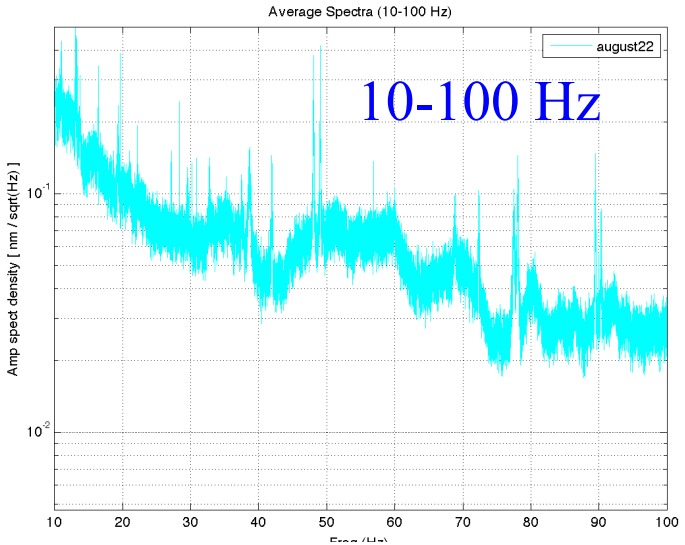
Improvements included identification and mitigation of combs of lines reported by line-finding team at end of July from looking at July 16 & 20 SFTs:

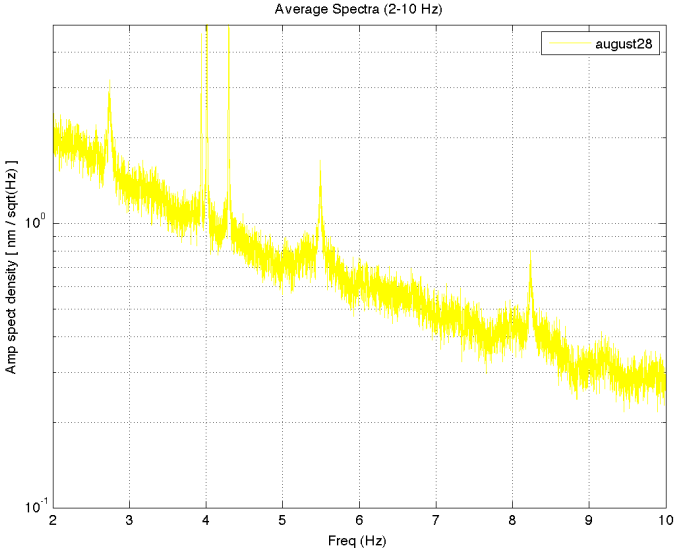
Robert Schofield & Maggie Tse found End-Y station environmental disturbances that accounted for the 29.375-Hz and 89.54-Hz combs

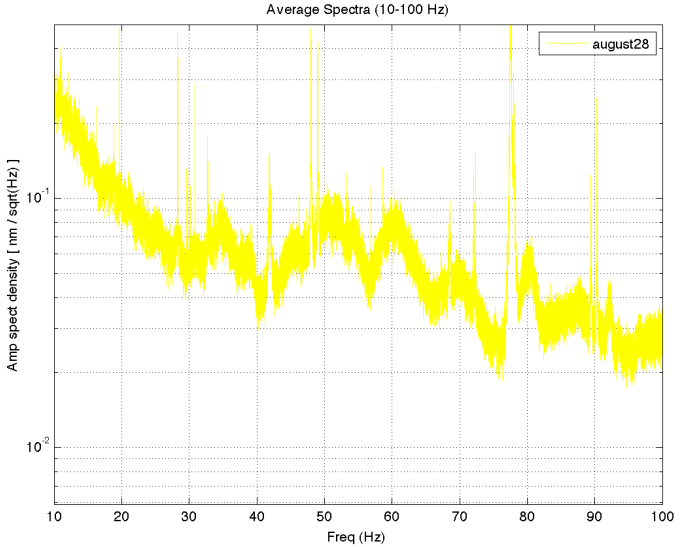
Bram Slagmolen found an environmental disturbance creating 2.74-Hz and 4.0-Hz combs in the corner station reference laser signal

But many lines still remain (including previous combs at much suppressed levels) – Comparison of Aug 22 and Aug 28 spectra

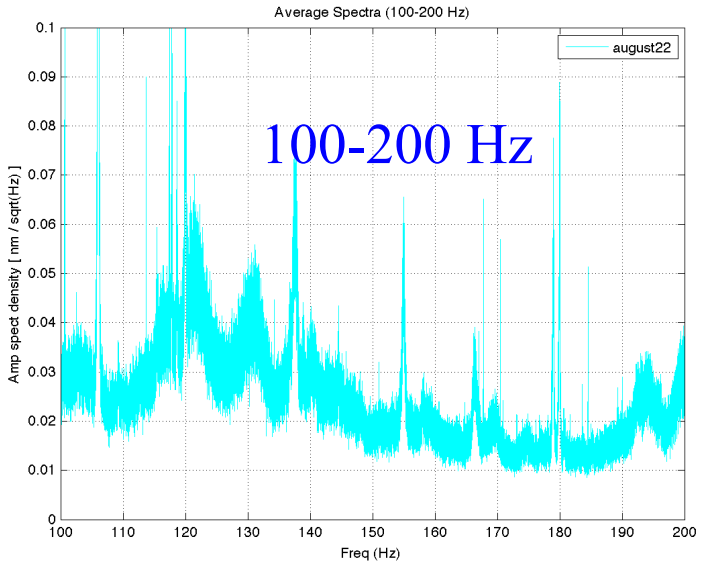


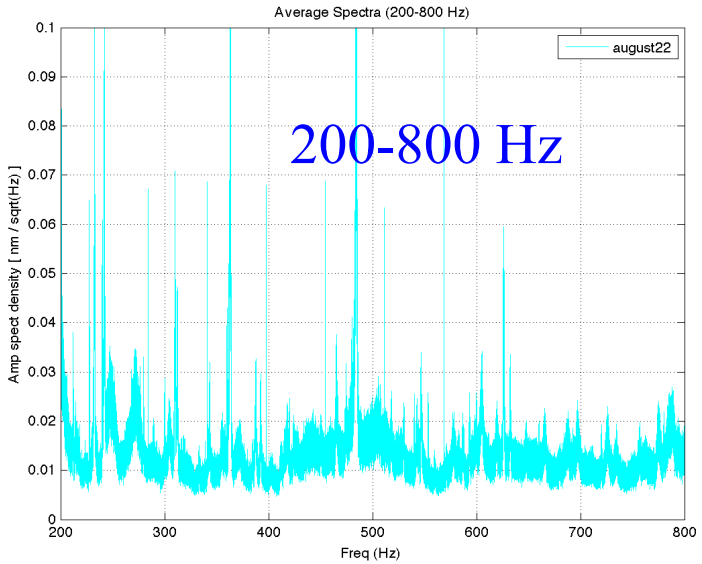


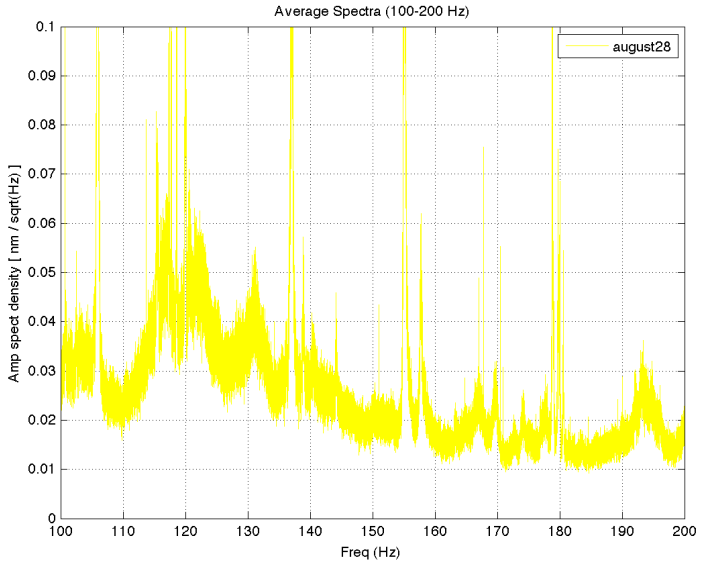


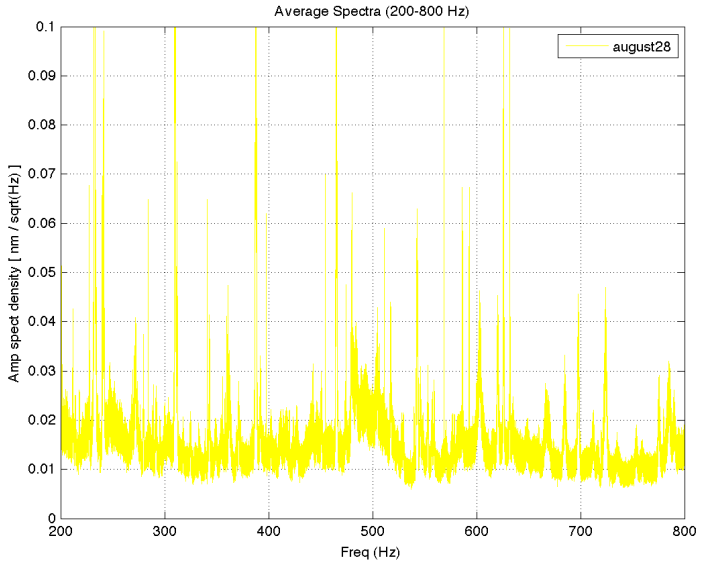


Some degradation on Aug 28 at higher frequencies (higher lines & additional lines – but some improvements too)









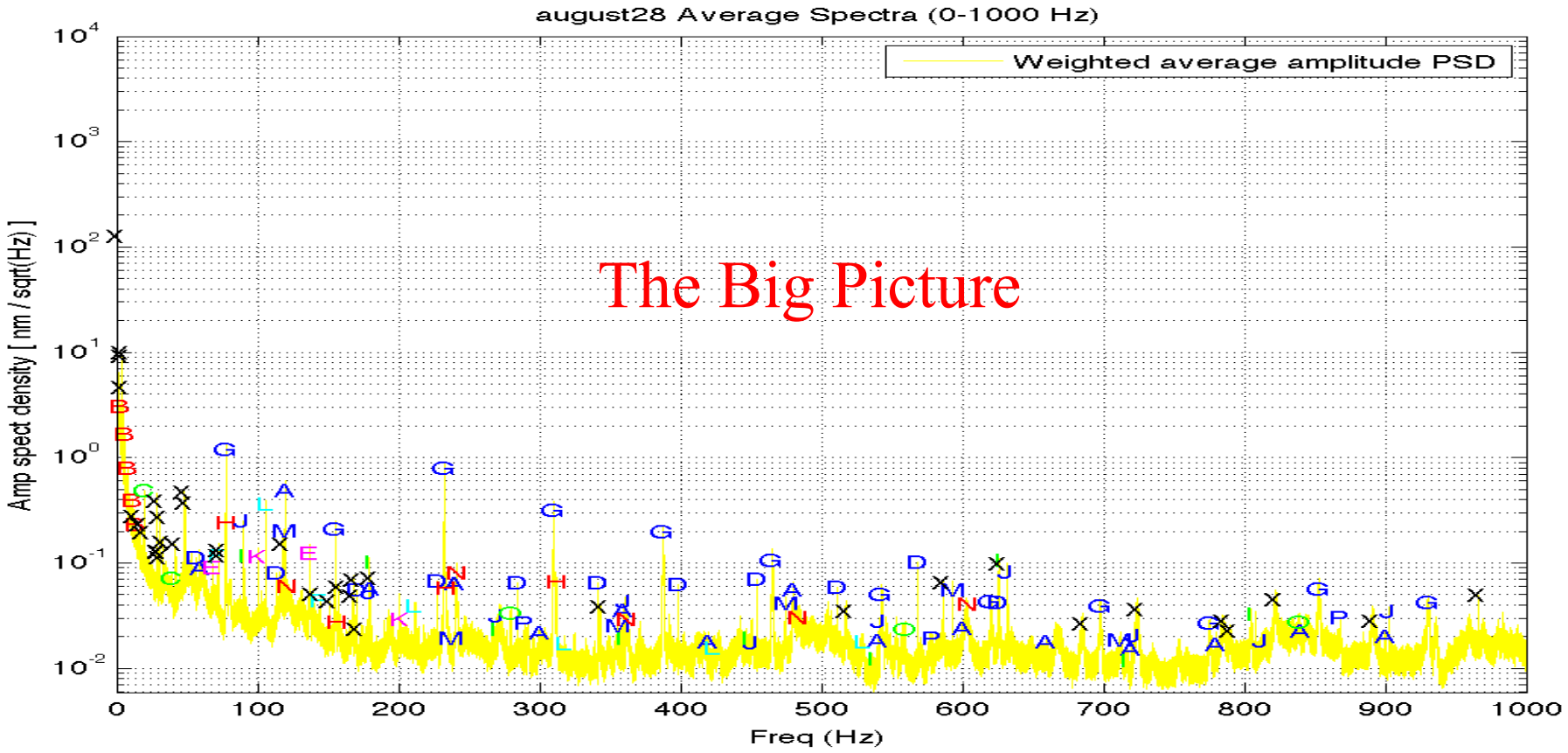
Focus now on last day in sample (August 28)
The following band spectra have these letter/color codings

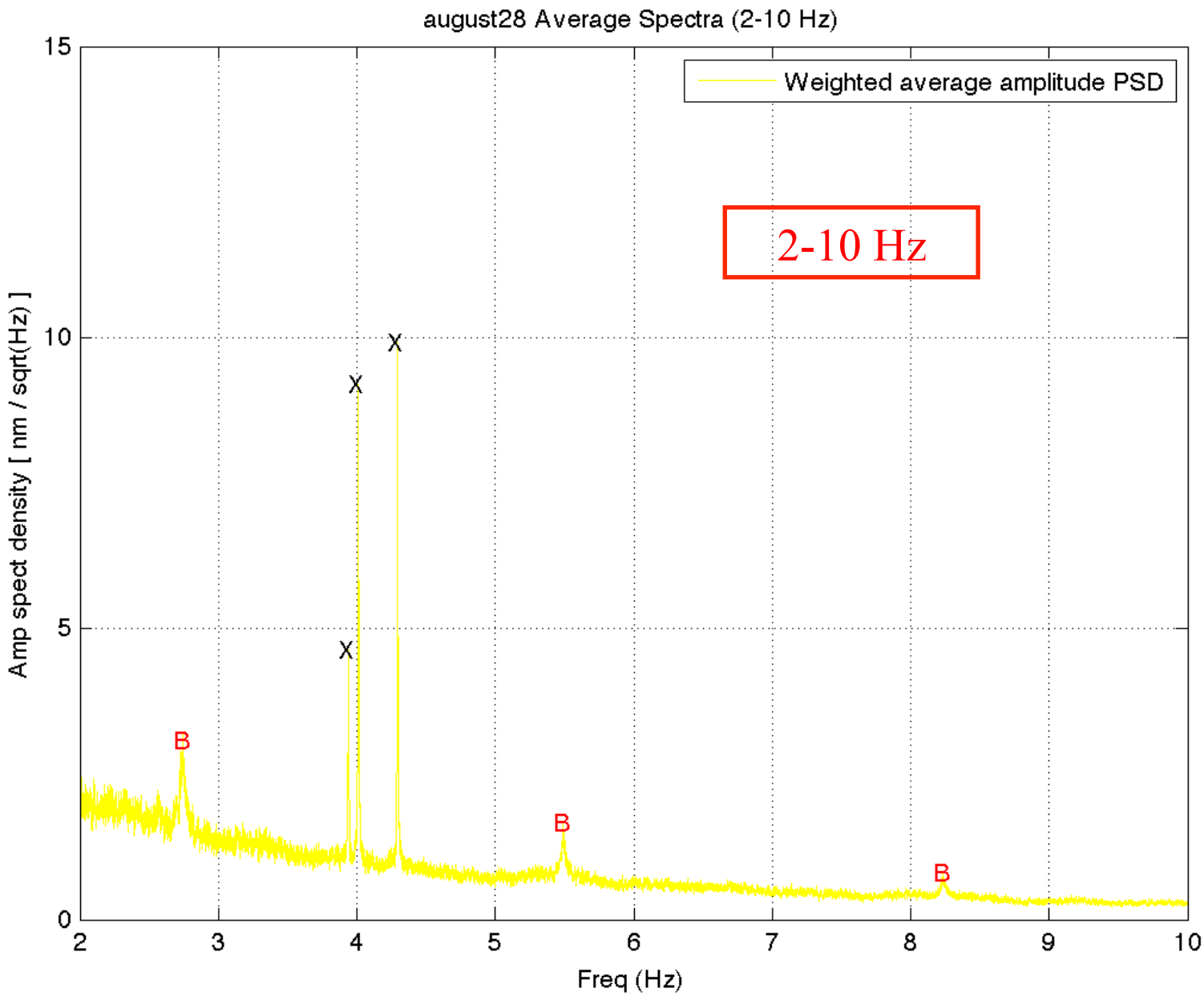
Combs marked on spectra: (digits after decimal depend on width and maximum harmonic)

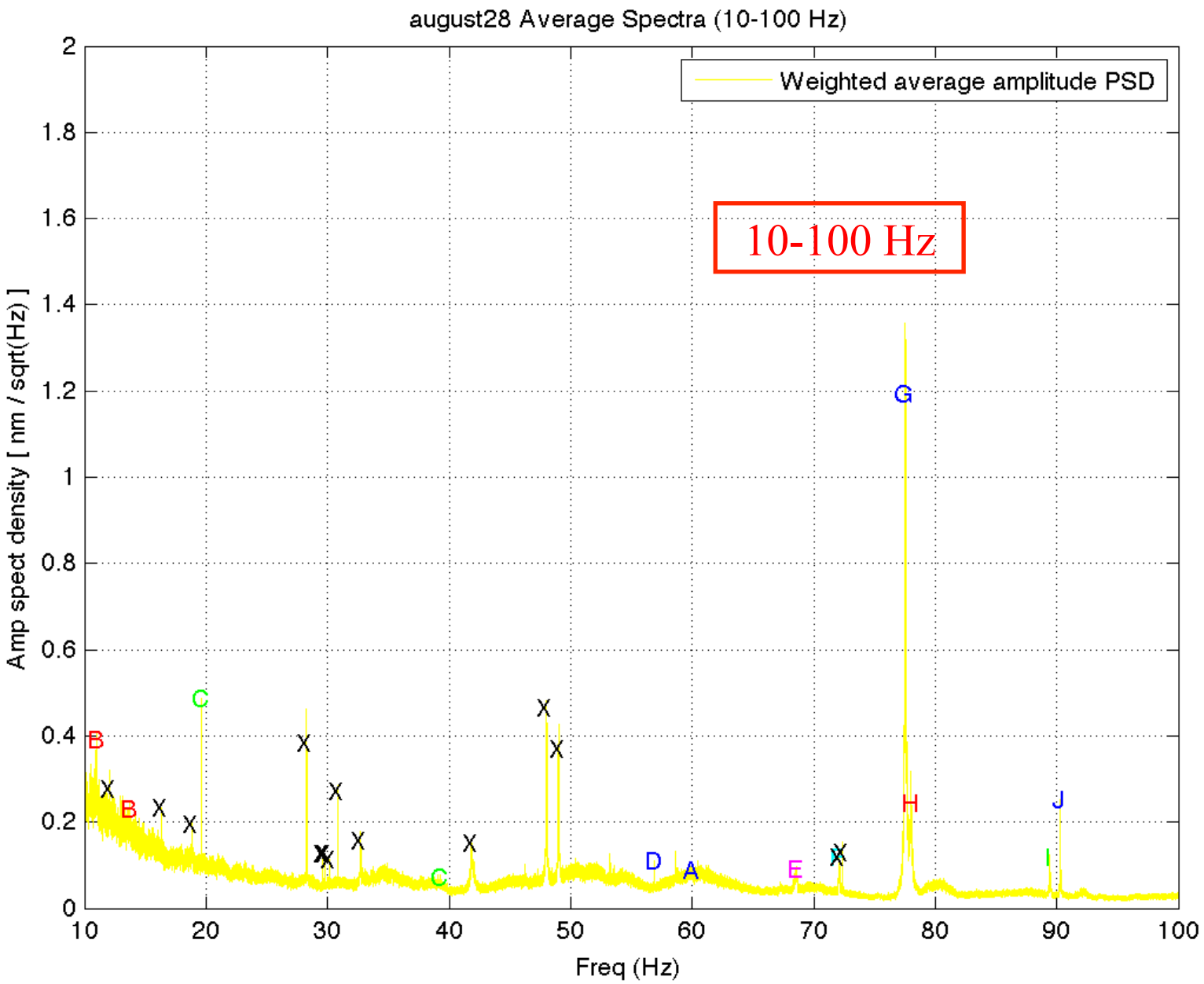
A – 60.0 Hz	(up to 15th harmonic at 900 Hz)
B – 2.745 Hz	(up to 5th harmonic at 13.725 Hz) – big improvement!
C – 19.62 Hz	(up to 2nd harmonic at 39.24 Hz)
D – 56.84065 Hz	(up to 11th harmonic at 625.2472 Hz)
E – 68.59 Hz	(up to 2nd harmonic at 137.18 Hz)
F – 72.09 Hz	(up to 2nd harmonic at 144.18 Hz)
G – 77.54 Hz	(up to 12th harmonic at 930.48 Hz)
H – 78.00 Hz	(up to 4th harmonic at 312.00 Hz)
I – 89.415 Hz	(up to 9th harmonic at 804.735 Hz)
J – 90.29 Hz	(up to 10th harmonic at 902.90 Hz)
K – 100.678 Hz	(up to 2nd harmonic at 201.356 Hz)
L – 105.91 Hz	(up to 5th harmonic at 529.55 Hz)
M – 118.59 Hz	(up to 6th harmonic at 711.54 Hz)
N – 120.7 Hz	(up to 5th harmonic at 603.5 Hz)
O – 279.60 Hz	(up to 3rd harmonic at 838.80 Hz)
P – 289.48 Hz	(up to 3rd harmonic at 868.44 Hz)

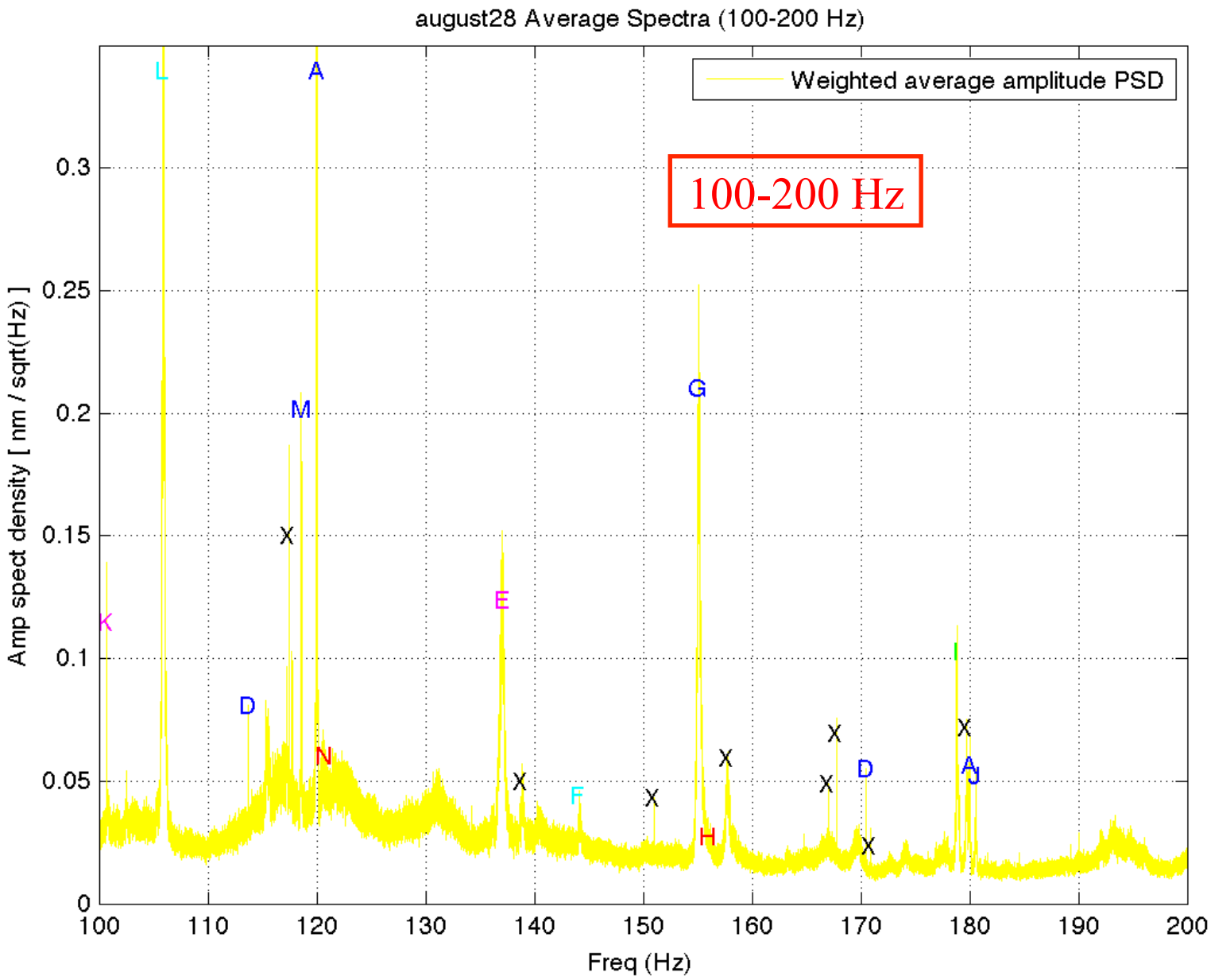
Additional single lines (marked with black ‘x’ in spectra):

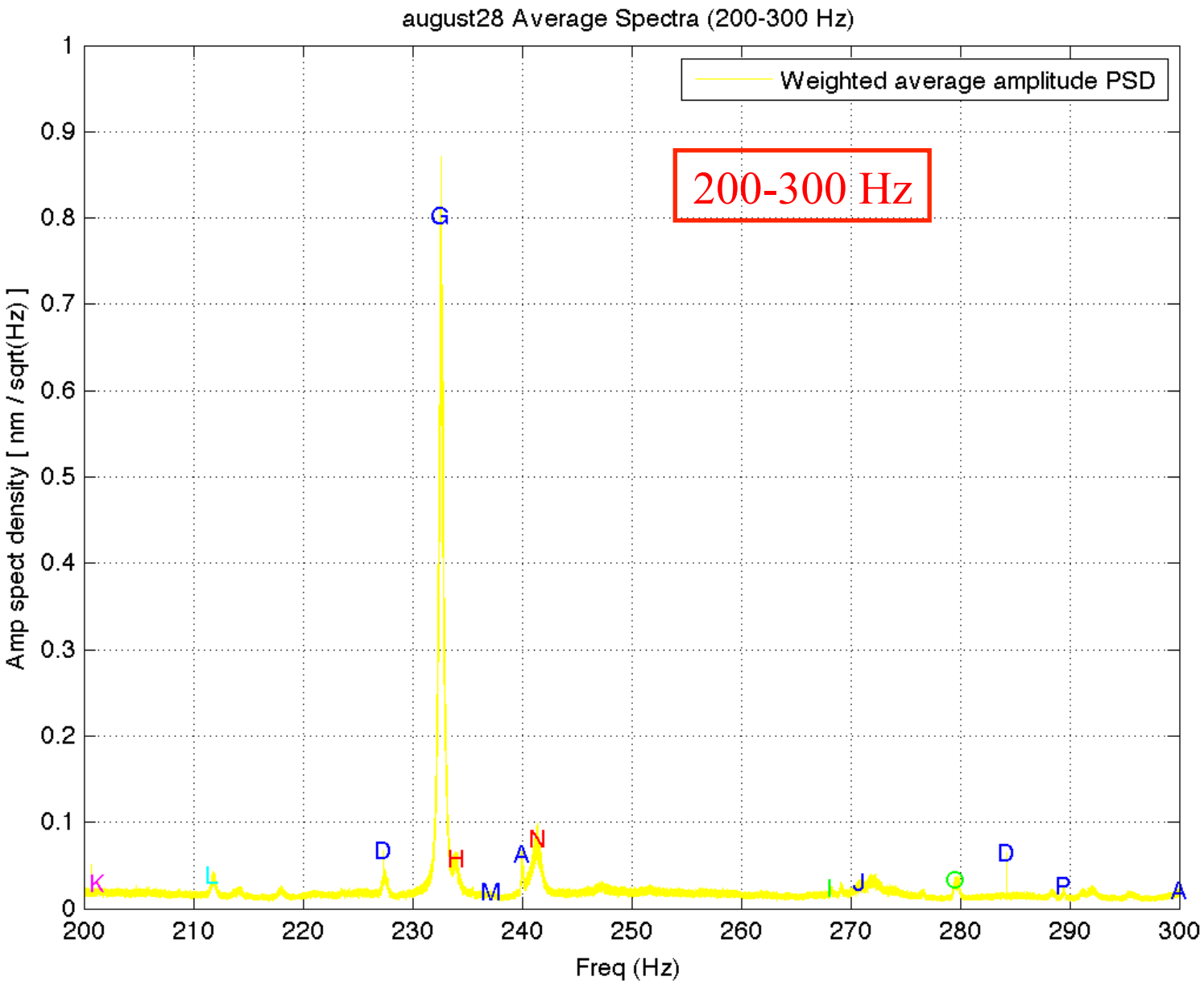
0.45, 3.938, 4.012, 4.294, 12.08, 16.36, 18.83, 28.28, 29.625, 29.78, 30.18, 30.86, 32.73, 41.88, 48.02, 49.01, 72.37, 117.455, 138.9, 151.02, 157.75, 167.018, 167.80, 170.93 179.73, 343.05, 517.5, 586.3, 625.9, 685.0, 724.2, 785.1, 789.9, 822.5 891.2, 966.291 Hz

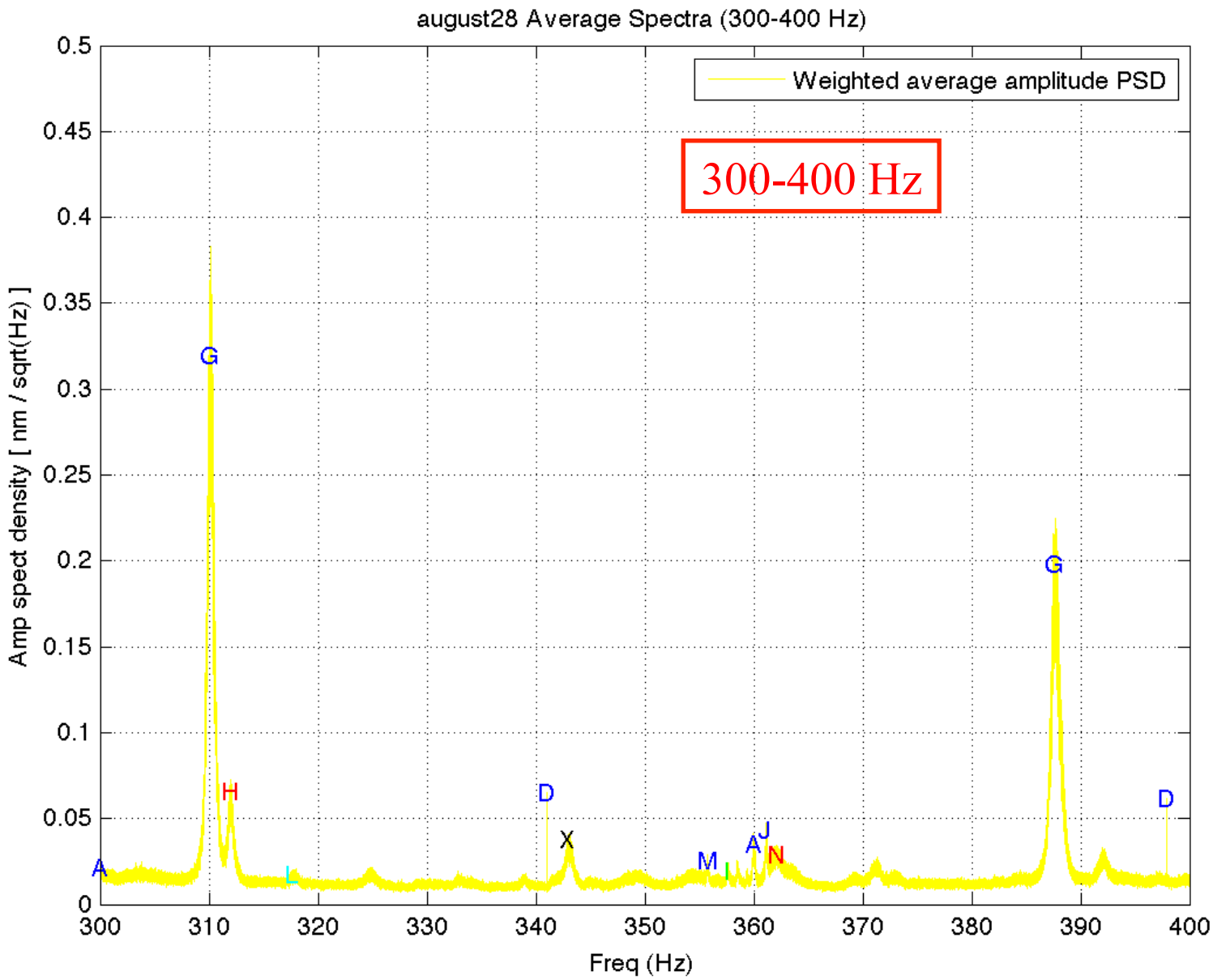


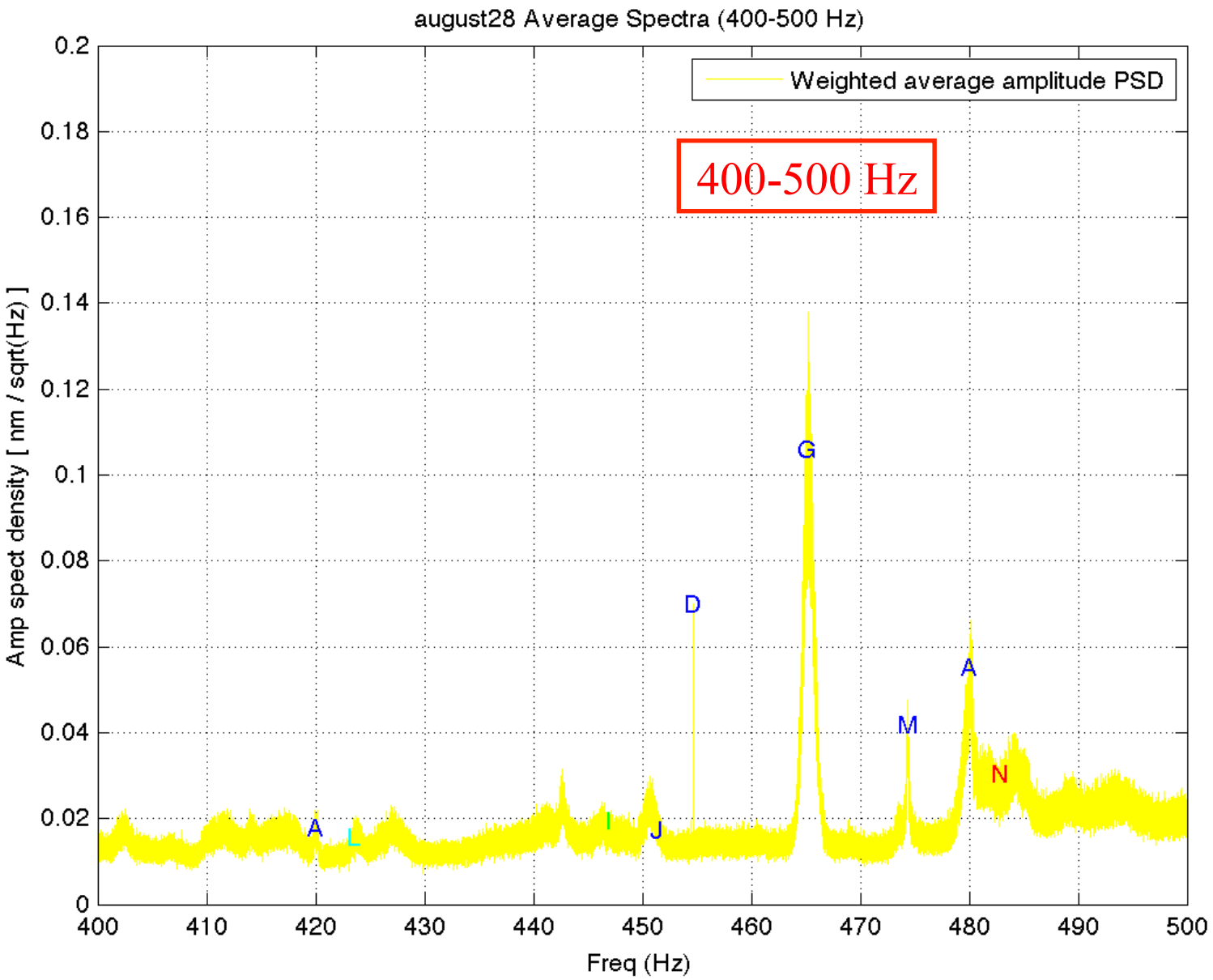

august28 Average Spectra (2-10 Hz)
Weighted average amplitude PSD
2-10 Hz
Amp spect density [nm / sqrt(Hz)]
Freq (Hz)
0
5
10
15
2
3
4
5
6
7
8
9
10
X
X
X
B
B
B

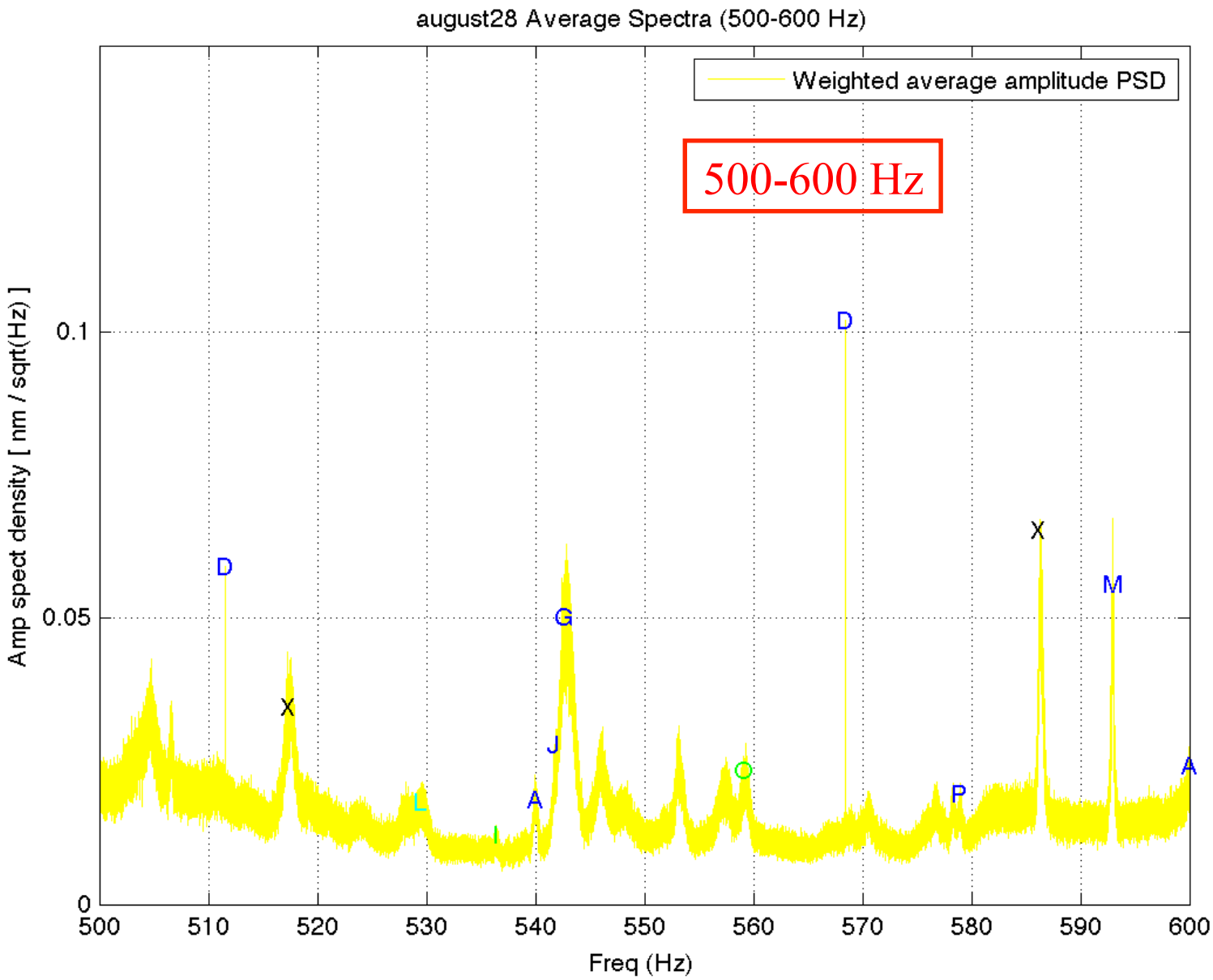

august28 Average Spectra (10-100 Hz)
Weighted average amplitude PSD
10-100 Hz
Amp spect density [nm / sqrt(Hz)]
Freq (Hz)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
10
20
30
40
50
60
70
80
90
100
B
C
G
H
J
D
A
E
I

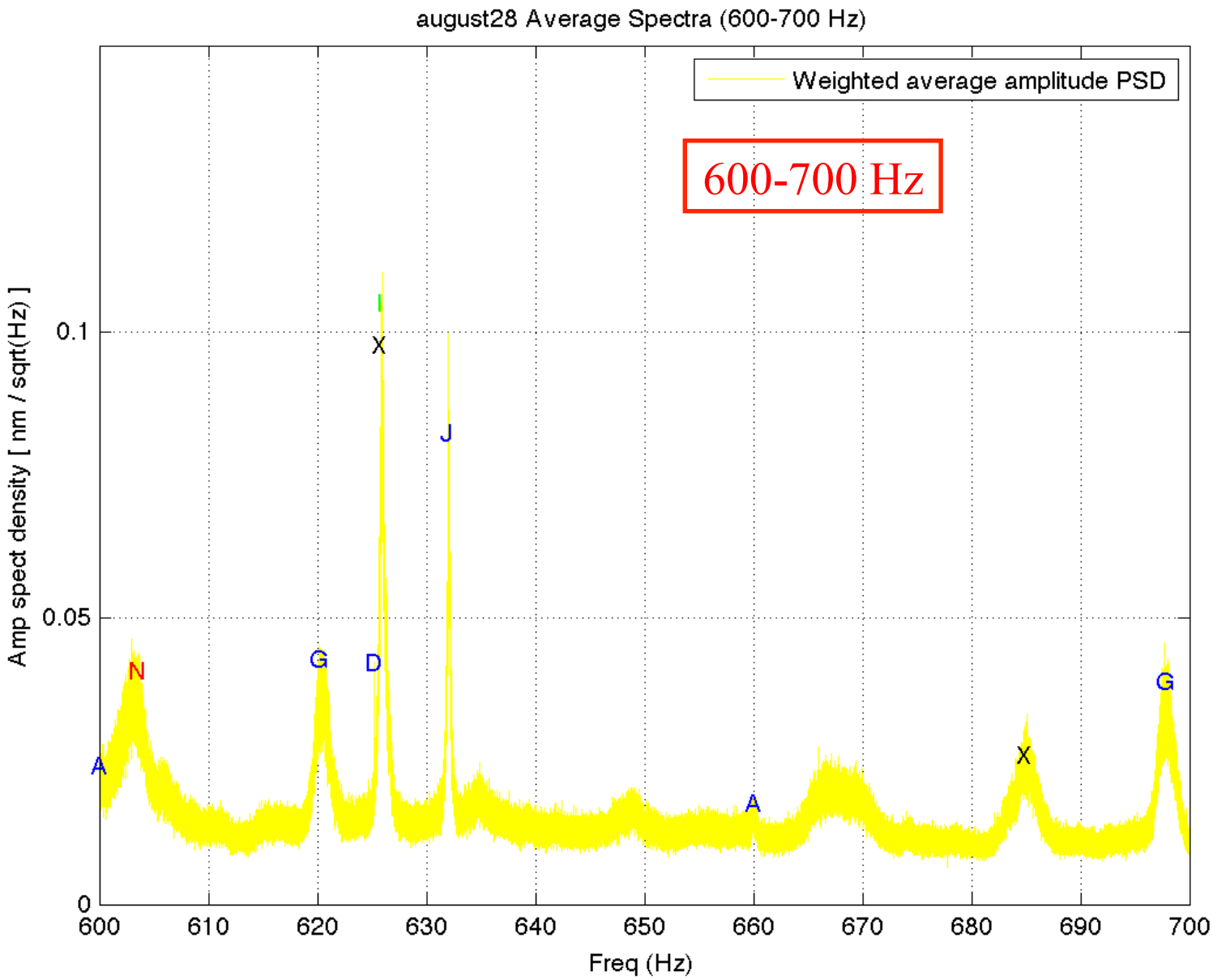

august28 Average Spectra (100-200 Hz)
Weighted average amplitude PSD
100-200 Hz
Amp spect density [nm / sqrt(Hz)]
Freq (Hz)
0
0.05
0.1
0.15
0.2
0.25
0.3
100
110
120
130
140
150
160
170
180
190
200
L
A
M
G
E
K
D
N
F
H
I
J

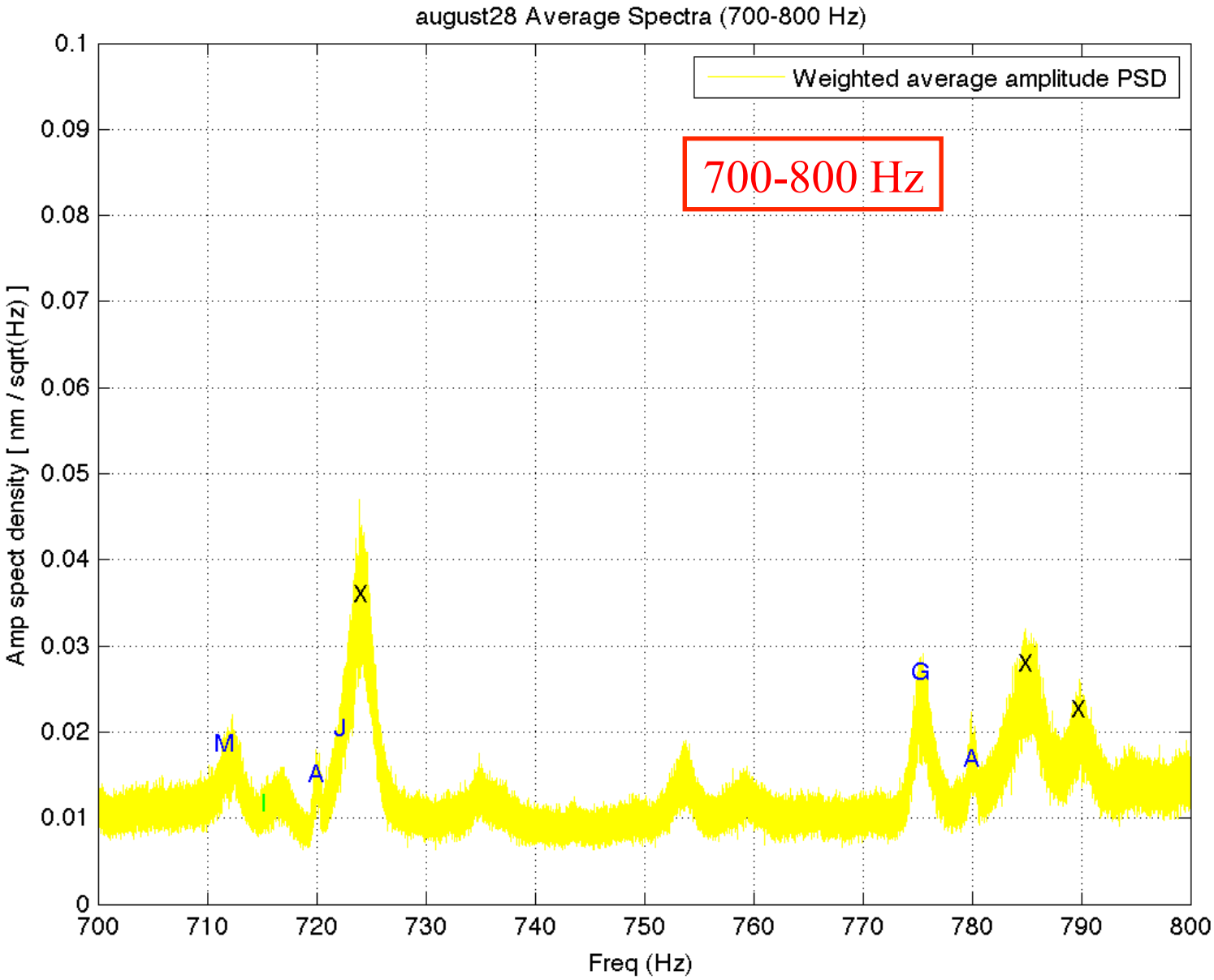

august28 Average Spectra (200-300 Hz)
Weighted average amplitude PSD
200-300 Hz
Amp spect density [nm / sqrt(Hz)]
Freq (Hz)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
200
210
220
230
240
250
260
270
280
290
300
K
L
D
G
H
M
A
N
I
J
G
D
P
A

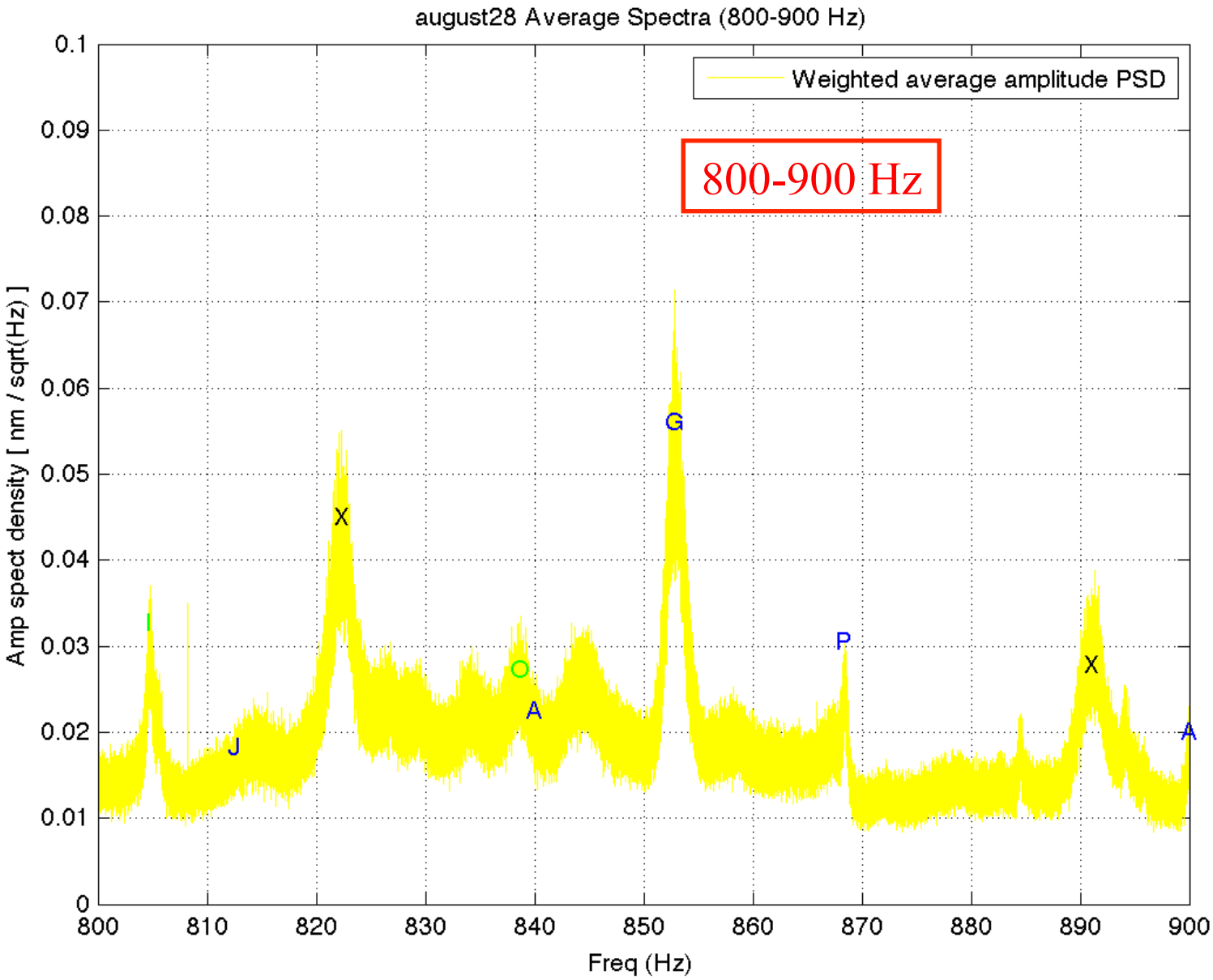

august28 Average Spectra (300-400 Hz)
Weighted average amplitude PSD
300-400 Hz
Amp spect density [nm / sqrt(Hz)]
Freq (Hz)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
300
310
320
330
340
350
360
370
380
390
400
A
G
H
L
D
X
M
I
A
J
N
G
D

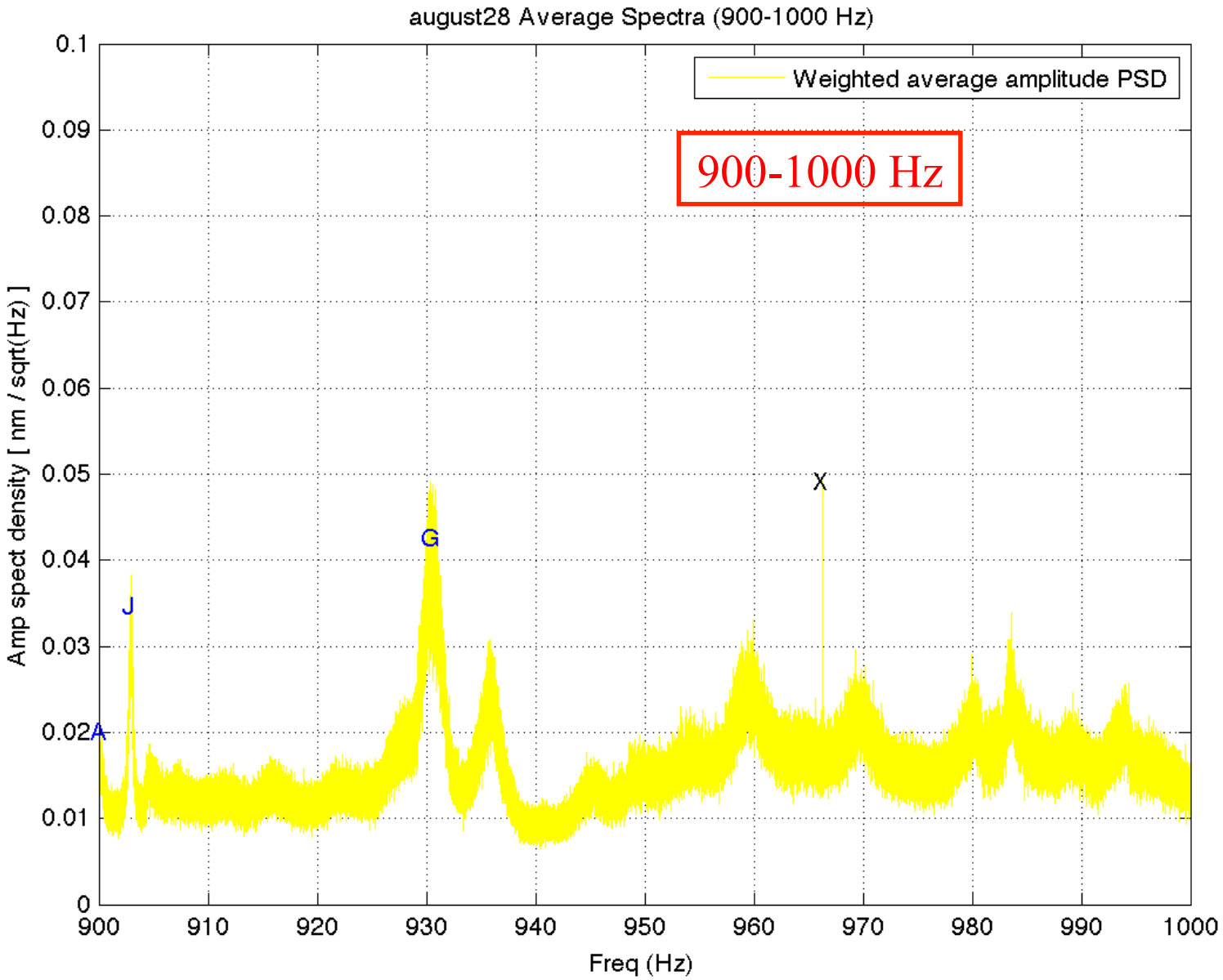

august28 Average Spectra (400-500 Hz)
Weighted average amplitude PSD
400-500 Hz
Amp spect density [nm / sqrt(Hz)]
Freq (Hz)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
400
410
420
430
440
450
460
470
480
490
500
A
L
I
J
D
G
M
A
N


august28 Average Spectra (500-600 Hz)
Weighted average amplitude PSD
500-600 Hz
Amp spect density [nm / sqrt(Hz)]
Freq (Hz)
0
0.05
0.1
500
510
520
530
540
550
560
570
580
590
600
D
X
L
I
A
J
G
O
D
P
X
M
A


august28 Average Spectra (600-700 Hz)
Weighted average amplitude PSD
600-700 Hz
Amp spect density [nm / sqrt(Hz)]
Freq (Hz)
0
0.05
0.1
600
610
620
630
640
650
660
670
680
690
700
A
N
G
D
I
X
J
A
X
G


august28 Average Spectra (700-800 Hz)
Weighted average amplitude PSD
700-800 Hz
Amp spect density [nm / sqrt(Hz)]
Freq (Hz)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
700
710
720
730
740
750
760
770
780
790
800
M
I
A
J
X
G
A
X
X


august28 Average Spectra (800-900 Hz)
Weighted average amplitude PSD
800-900 Hz
Amp spect density [nm / sqrt(Hz)]
Freq (Hz)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
800
810
820
830
840
850
860
870
880
890
900
I
J
X
O
A
G
P
X
A


august28 Average Spectra (900-1000 Hz)
Weighted average amplitude PSD
900-1000 Hz
Amp spect density [nm / sqrt(Hz)]
Freq (Hz)
A
J
G
X
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
900
910
920
930
940
950
960
970
980
990
1000

Information from commissioner investigations and from auxiliary channels showing correlations with these lines
(using the Virgo Noemi coincidence finder)

Noemi line summary page for primary channel:
https://ldas-jobs.ligo-wa.caltech.edu/~pulsar/NoEMi/OAT/lines_page/LIGOH_OAT/

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

A – 60.0 Hz	Power mains
B – 2.745 Hz	Laser reference cavity
X – 4.012 Hz	Laser reference cavity
X – 4.294 Hz	Correlations with LVEA seis / mag channels
X – 12.08 Hz	?
X – 16.36 Hz	?
X – 18.83 Hz	?
C – 19.62 Hz	Correlations with LVEA seis / mag channels
X – 28.28 Hz	?
X – 29.625 Hz	Correlations with LVEA & EY seis / mag / accel channels
X – 29.78 Hz	?
X – 30.18 Hz	Correlations with LVEA & EY seis / mag / accel / mic channels

X – 30.86 Hz	Correlations with LVEA seis / mag / accel / mic channels
X – 32.73 Hz	?
X – 41.88 Hz	?
X – 48.02 Hz	Correlations with LVEA seis / mag / mic channels
X – 49.01 Hz	Correlations with EY seis / mag / accel / mic channels
D – 56.84065 Hz	Correlations with EY seis / mag / accel / mic channels
E – 68.59 Hz	?
F – 72.09 Hz	?
X – 72.37 Hz	Correlations with LVEA & EY seis / accel channels
G – 77.54 Hz	Correlations with EY mag / accel channels
H – 78.00 Hz	Correlations with EY accel channel
I – 89.415 Hz	Correlations with EY accel channel
J – 90.29 Hz	Correlations with LVEA seis / mag / mic channels
K – 100.678 Hz	?
L – 105.91 Hz	?
X – 117.455 Hz	?
M – 118.59 Hz	?
N – 120.7 Hz	?
X – 138.9 Hz	?
X – 151.02 Hz	?
X – 157.75 Hz	?
X – 167.018 Hz	?

X – 167.80 Hz	?
X – 170.93 Hz	?
X – 179.73 Hz	?
O – 279.60 Hz	?
P – 289.48 Hz	?
X – 343.05 Hz	?
X – 517.5 Hz	?
X – 586.3 Hz	?
X – 625.9 Hz	?
X – 685.0 Hz	?
X – 724.2 Hz	?
X – 785.1 Hz	?
X – 789.9 Hz	?
X – 822.5 Hz	?
X – 891.2 Hz	?
X – 966.291 Hz	Correlations with EY seis / mag / accel / mic channels