October commissioning ENV noise hunting plans (a proposal)

I.Fiori, F.Paoletti

10 of September 2019

Commissioning weekly meeting

VIR-0887A-19

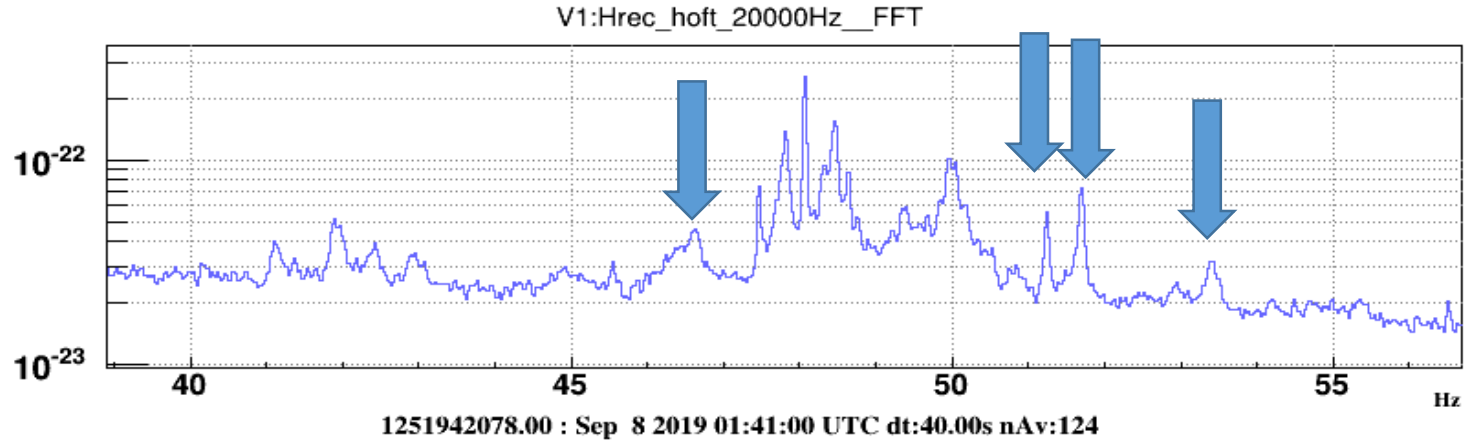
The team

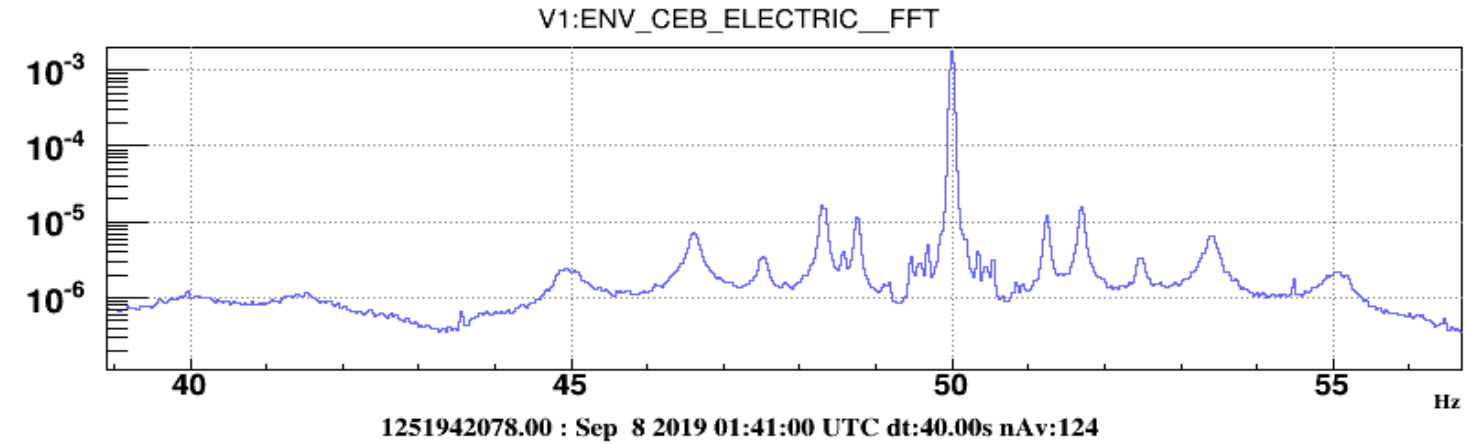
Senior investigators:

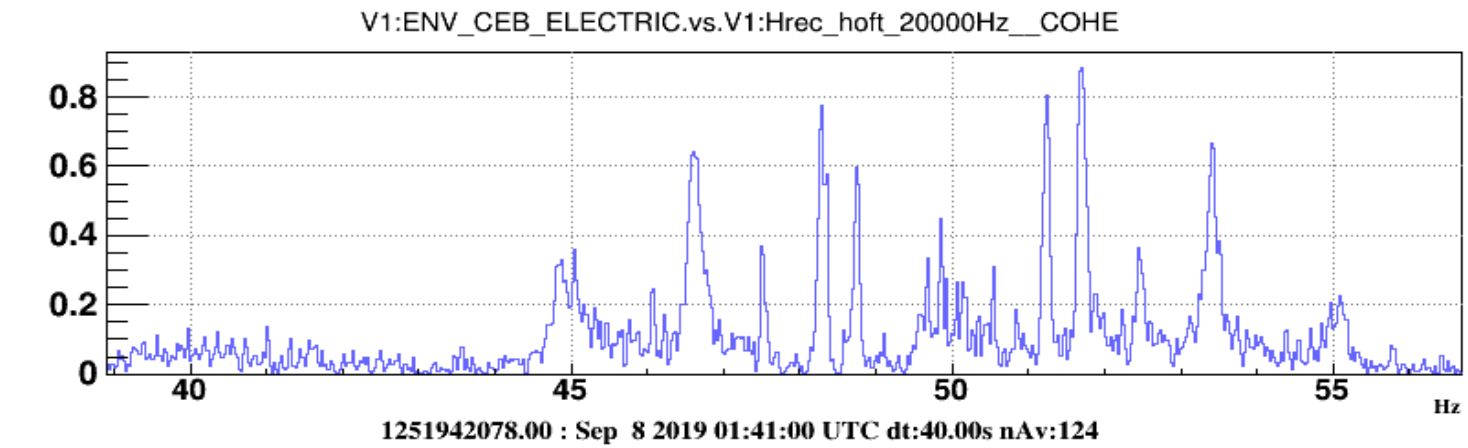
- Paoletti, Fiori, Mantovani, Chiummo, DeRossi, Ruggi …

Junior investigators:

- Tatsuki Washimi, Ryosuke Sugimoto (**KAGRA**)
- Alba Romero, Alexis Rodriguez, Christos Karathanasis (**IFAE**)
- Maria Tringali (**POLGRAW**)


V1:Hrec_hoft_20000Hz__FFT
10^-22
10^-23
40
45
50
55
Hz
1251942078.00 : Sep 8 2019 01:41:00 UTC dt:40.00s nAv:124

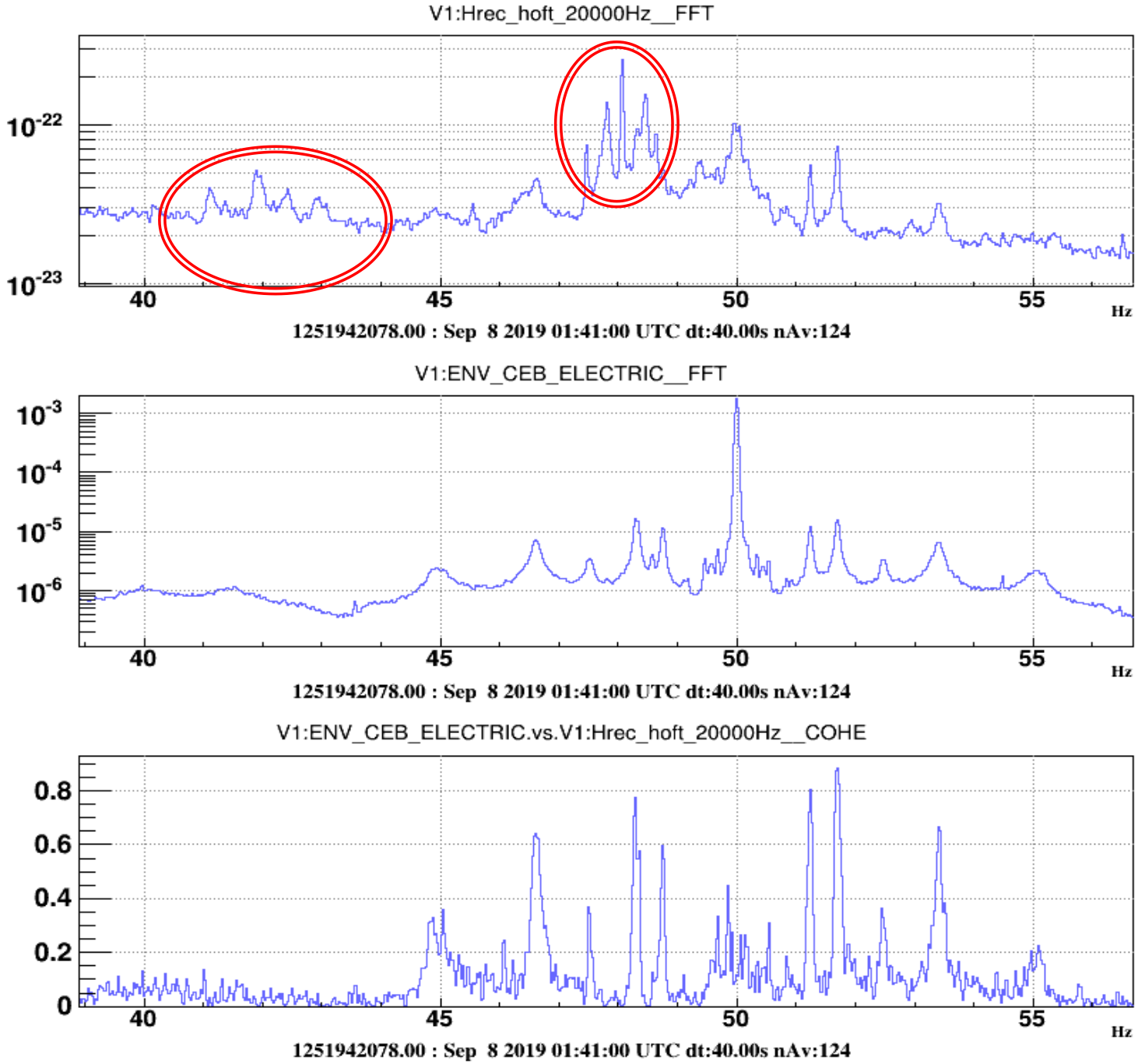

V1:ENV_CEB_ELECTRIC__FFT
10^-3
10^-4
10^-5
10^-6
40
45
50
55
Hz
1251942078.00 : Sep 8 2019 01:41:00 UTC dt:40.00s nAv:124


V1:ENV_CEB_ELECTRIC.vs.V1:Hrec_hoft_20000Hz__COHE
0.8
0.6
0.4
0.2
0
40
45
50
55
Hz
1251942078.00 : Sep 8 2019 01:41:00 UTC dt:40.00s nAv:124

50Hz sidebands

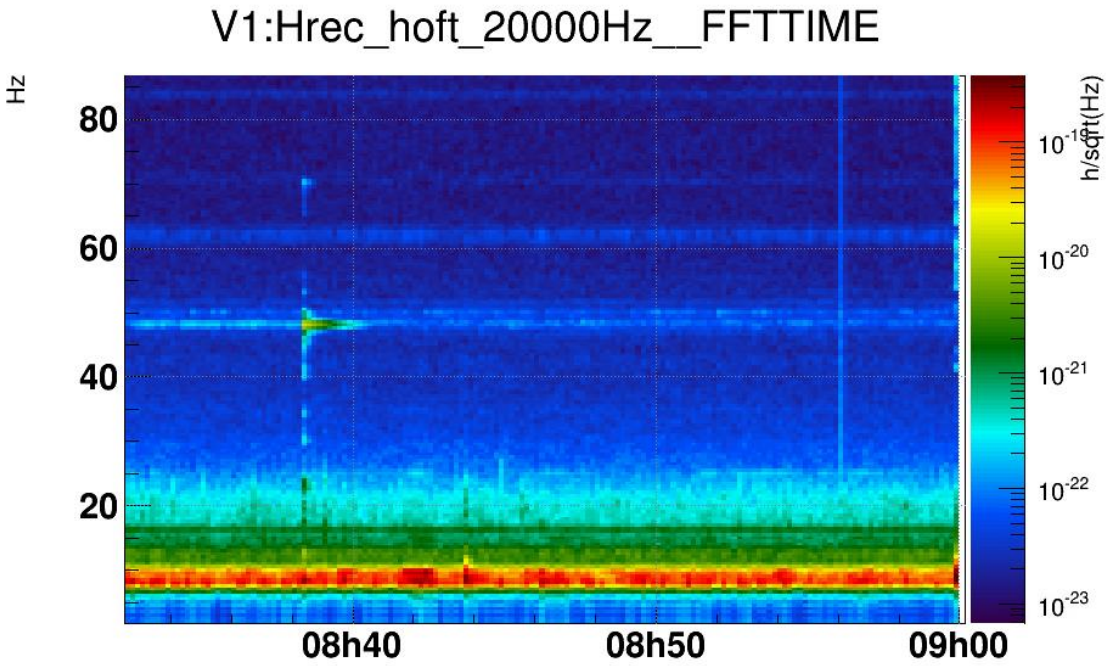
- What we know:
  - At least two sources: 0.6s and 0.8s, in CEB, under UPS (46837)

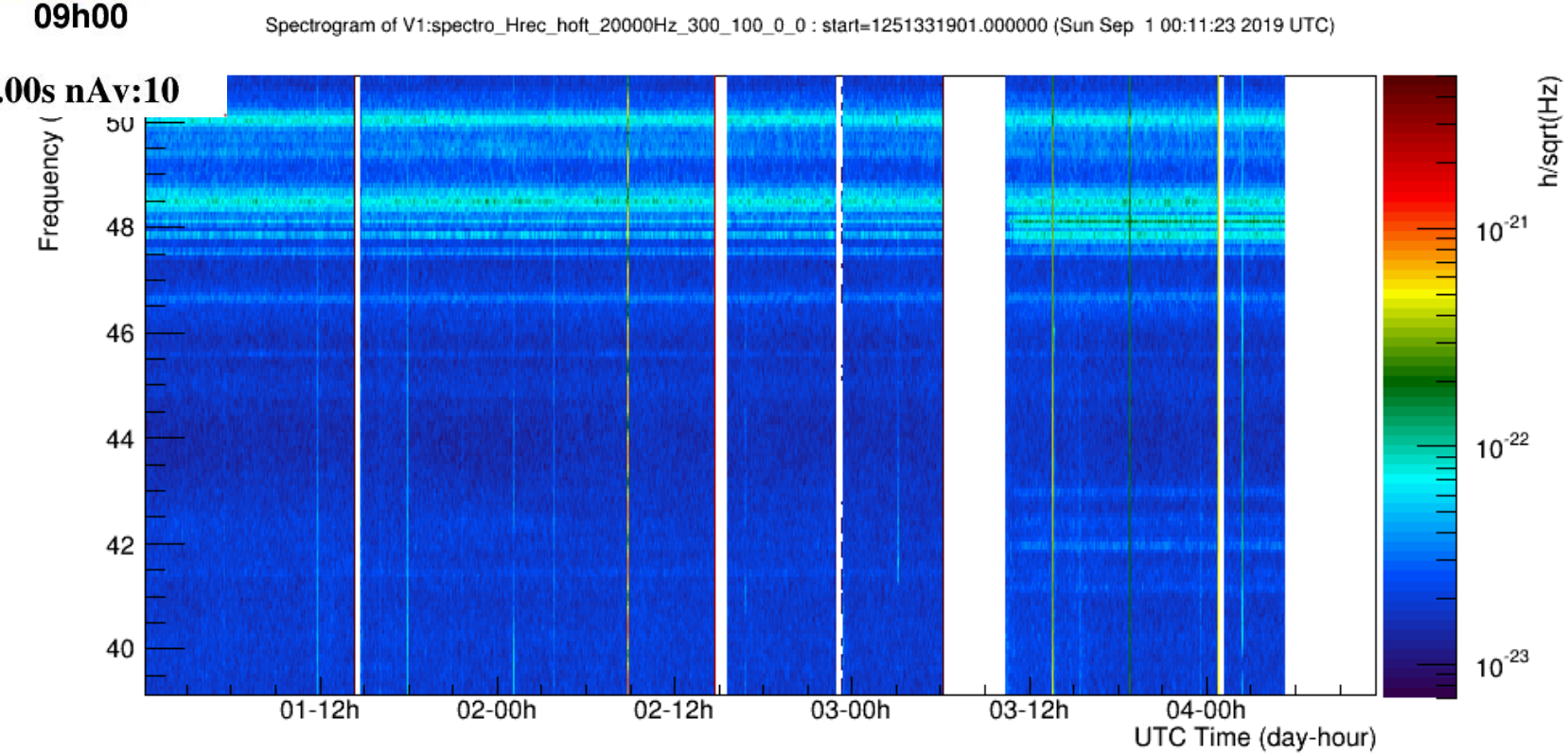
- Tentative activities:
  - Sniffing to locate sources: portable magnetic probe (**KAGRA**) **(2 shifts - no ITF – might be parallelized)**
  - Add Vdiff probe (similar to ENV_CEB_ELECTRIC) in other location(s) **Federico (during unlocked time)**
  - If needed, perform some switch off test **(shifts LN3, TBD)**

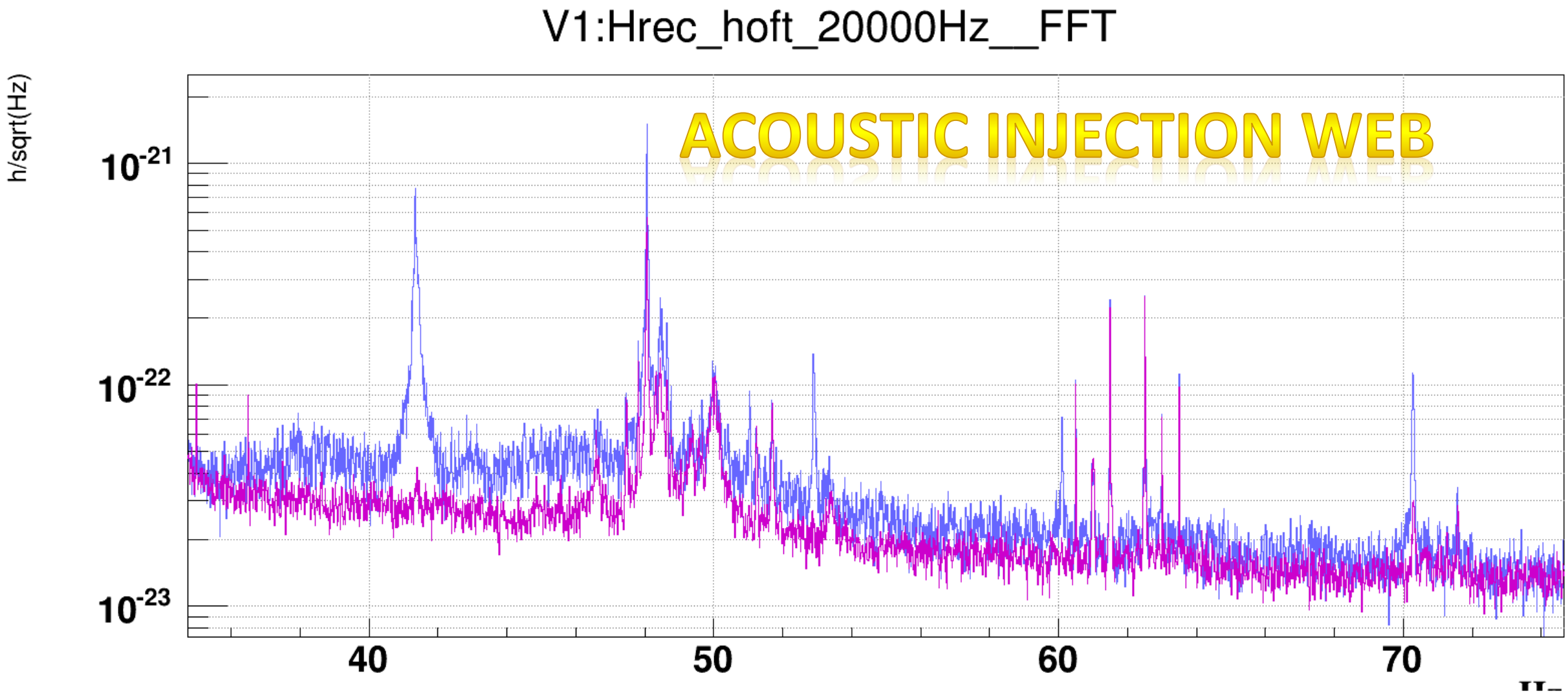

V1:Hrec_hoft_20000Hz__FFT
10^-22
10^-23
40
45
50
55
Hz
1251942078.00 : Sep 8 2019 01:41:00 UTC dt:40.00s nAv:124
V1:ENV_CEB_ELECTRIC__FFT
10^-3
10^-4
10^-5
10^-6
40
45
50
55
Hz
1251942078.00 : Sep 8 2019 01:41:00 UTC dt:40.00s nAv:124
V1:ENV_CEB_ELECTRIC.vs.V1:Hrec_hoft_20000Hz__COHE
0.8
0.6
0.4
0.2
0
40
45
50
55
Hz
1251942078.00 : Sep 8 2019 01:41:00 UTC dt:40.00s nAv:124

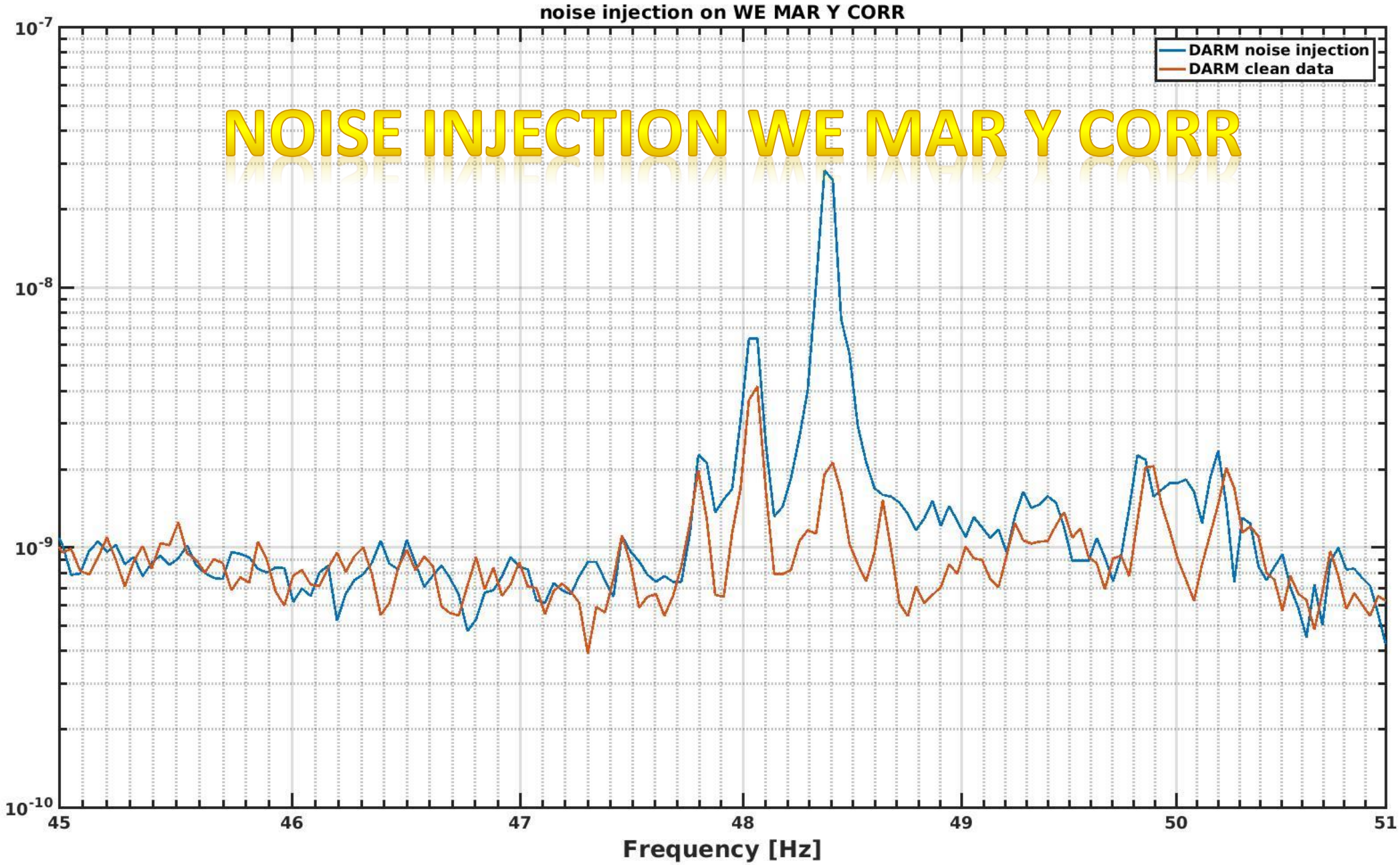
WE peaks
(40-45 Hz peaks, 48.05Hz peak)

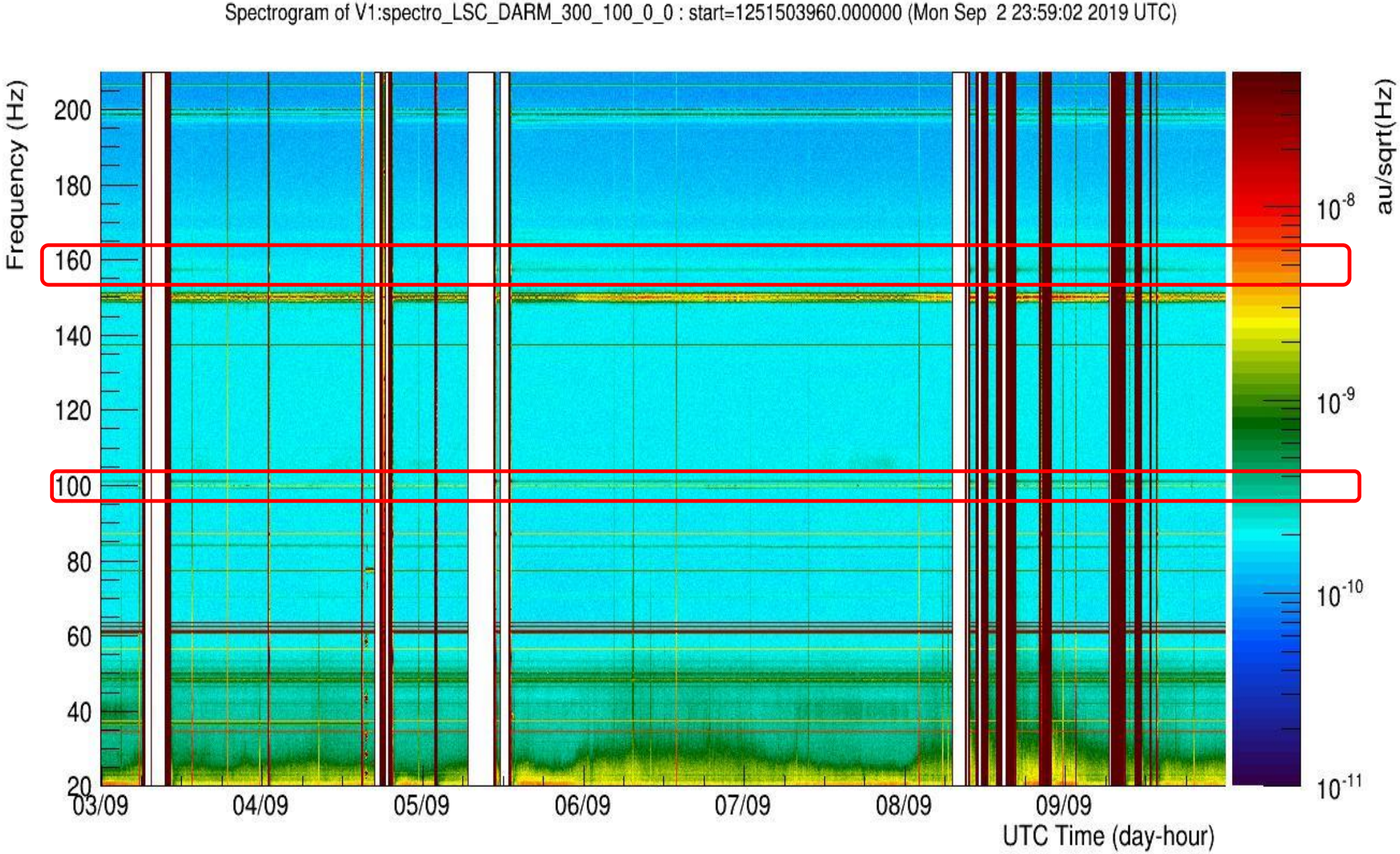
- What we know:
  - 40-45Hz peaks grow with WEB acoustic injection (46708), and maybe also coherent with magnetometers (TBC, 46050)
  - 48.05Hz peak also excites a bit with acoustic. Observed some sudden changes in amplitude (46834). Suspected PAY mode. Can also excite a bit x2 with F7/MARIO actuators, but actuation noise does not play a role (Paolo, 44915)
- Tentative plan:
  - Tapping tests (link pipe, vacuum chambers, cryoTrap) – **IFAE (1 shift, LN3)**
  - Switch off: Turbo's cooling fans, remote scroll - **VAC, POLGRAW (half shift, LN3)**
  - PAY mode? Try to identify using SAT actuators (**Paolo…**) **(1 shift, TBC)**
  - Repeat same injections & tappings at NEB – **IFAE (2 shifts, LN3)**


V1:Hrec_hoft_20000Hz__FFTTIME
Hz
80
60
40
20
08h40
08h50
09h00
h/sqrt(Hz)
10^-19
10^-20
10^-21
10^-22
10^-23


Spectrogram of V1:spectro_Hrec_hoft_20000Hz_300_100_0_0 : start=1251331901.000000 (Sun Sep 1 00:11:23 2019 UTC)
1250757168.0000 : Aug 25 2019 08:32:30 UTC dt:2.00s nAv:10
Frequency (
50
48
46
44
42
40
01-12h
02-00h
02-12h
03-00h
03-12h
04-00h
UTC Time (day-hour)
h/sqrt(Hz)
10^-21
10^-22
10^-23


V1:Hrec_hoft_20000Hz__FFT
h/sqrt(Hz)
10-21
10-22
10-23
40
50
60
70
ACOUSTIC INJECTION WEB
1250249778.0000 : Aug 19 2019 11:36:00 UTC
1250252998.00 : Aug 19 2019 12:29:40 UTC dt:100.00s nAv:10


noise injection on WE MAR Y CORR
DARM noise injection
DARM clean data
NOISE INJECTION WE MAR Y CORR
10^-7
10^-8
10^-9
10^-10
45
46
47
48
49
50
51
Frequency [Hz]


Spectrogram of V1:spectro_LSC_DARM_300_100_0_0 : start=1251503960.000000 (Mon Sep 2 23:59:02 2019 UTC)
Frequency (Hz)
200
180
160
140
120
100
80
60
40
20
03/09
04/09
05/09
06/09
07/09
08/09
09/09
UTC Time (day-hour)
au/sqrt(Hz)
10^-8
10^-9
10^-10
10^-11

INJ scattered light: 101Hz peak

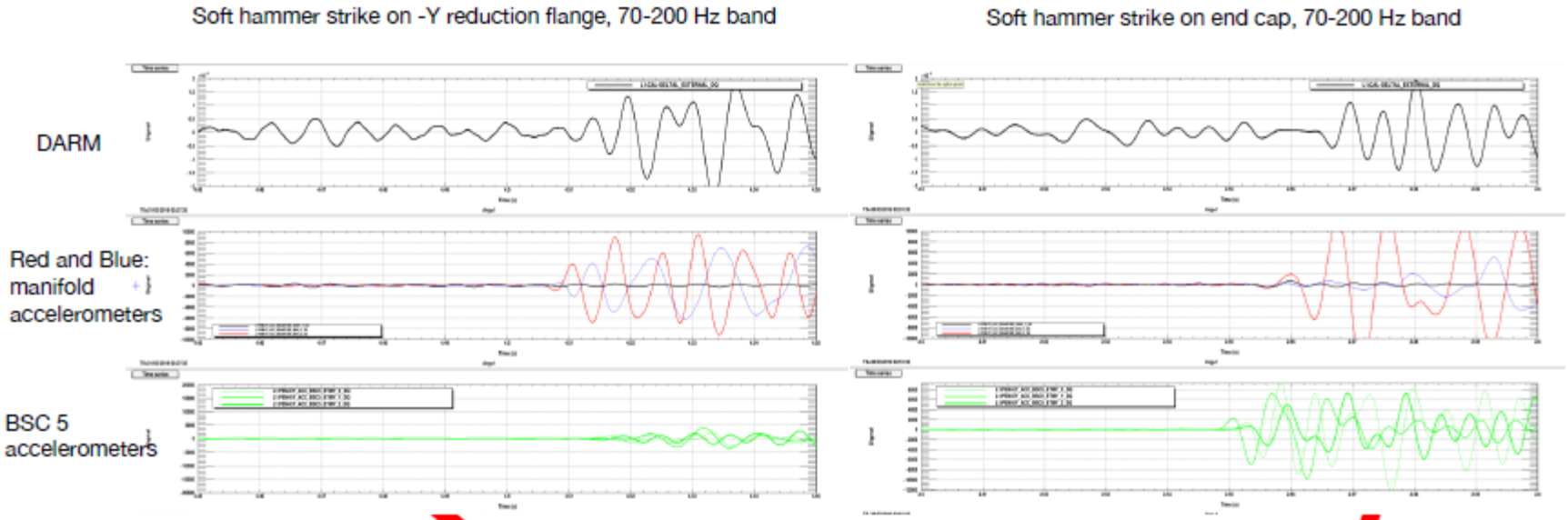
- What we know:
  - Seen as frequency noise (SSFS) and its coupling to Hrec correlates with FModErr accuracy (43619)
  - Coupling enhanced when IMC alignment is bad (45019) but it is not sustained by BsX corr
  - Excites when tapping on SIB1 vacuum chamber (42645) or shaking SIB1 suspended bench (45145) but seismic shortcut trough EIB or SIB1 suspension excluded.
  - Likely a mode of SIB1 or something on it

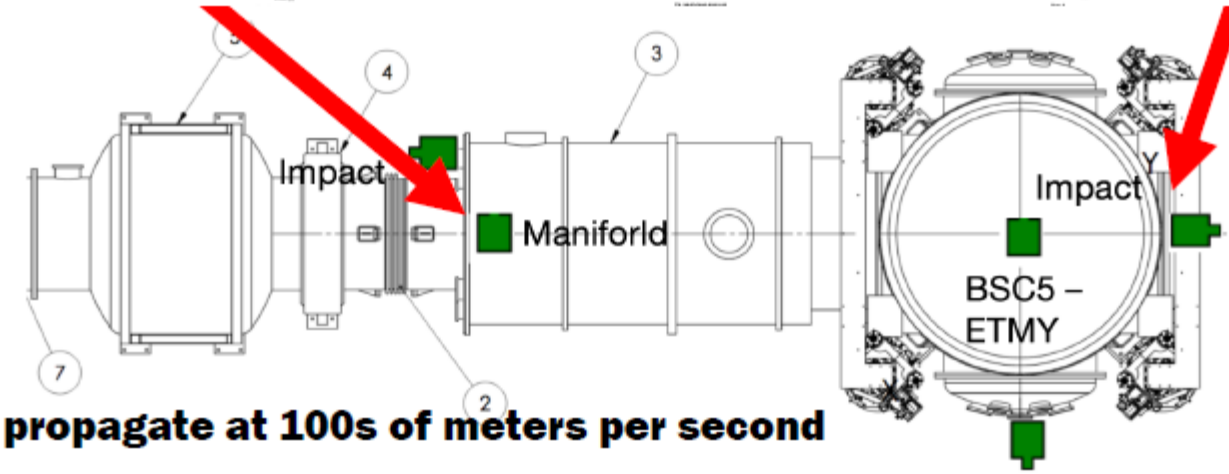
- Tentative plan:
  - Magnetic injection close to SIB1 – **KAGRA (1 shift, LN3)**
  - Schofield's technique to better located scattering on chamber walls– **IFAE (2 shifts, LN3)**

Schofield G1901683-v2

1. Impulse injected onto vacuum enclosure at multiple sites

- **a. consistency between accelerometer and DARM arrival times**
- **b. consistency between accelerometer/DARM amplitude ratios**
- **c. consistency between accelerometer and DARM frequency structure**



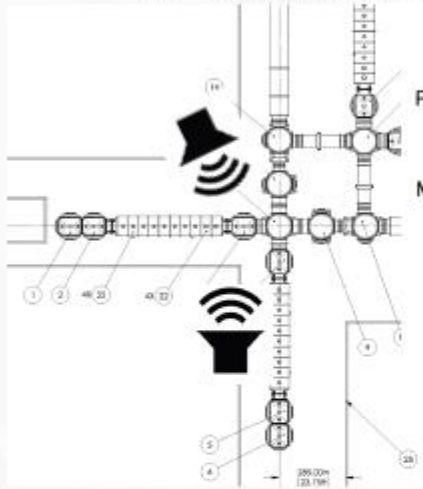


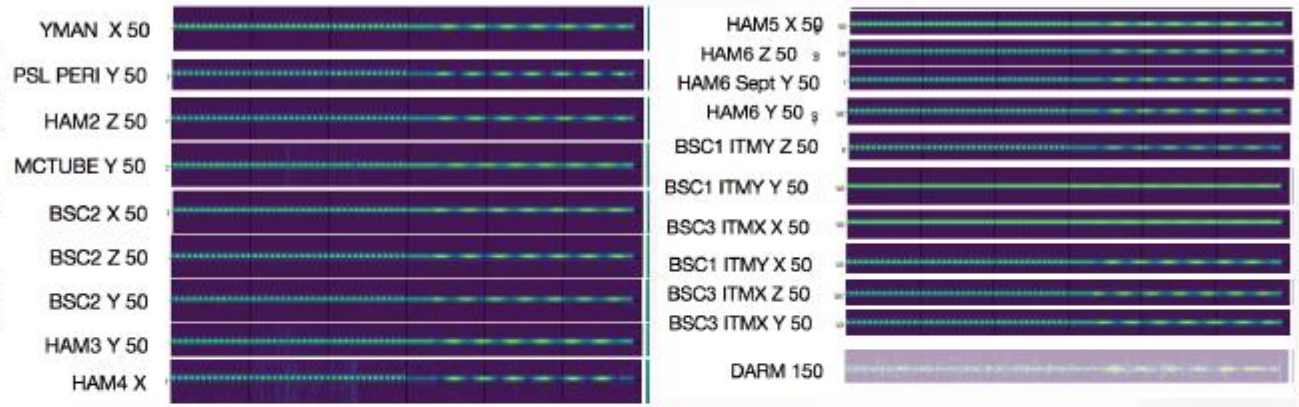
Impulses propagate at 100s of meters per second

2. Separated beating injections to produce location-dependent beat-envelope phase

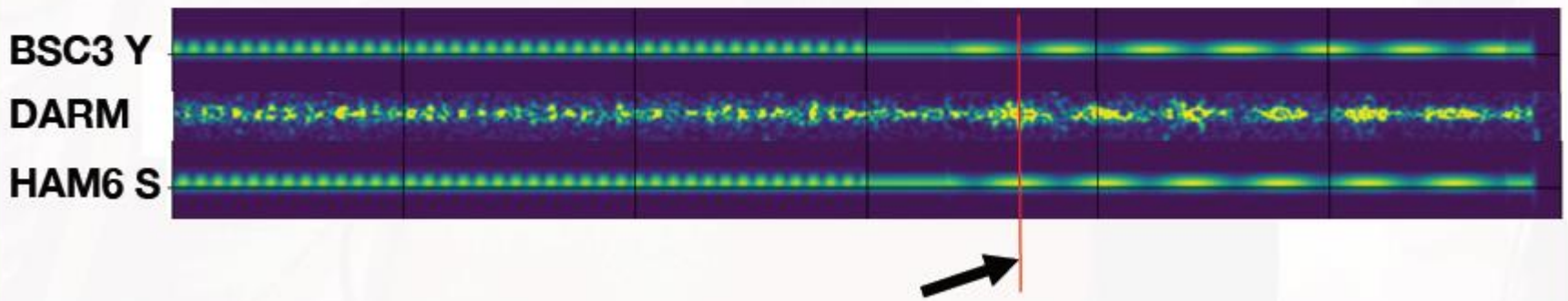
a. **Accelerometer and DARM consistency for acoustic injections**

b. **Accelerometer and DARM consistencv for vacuum enclosure**





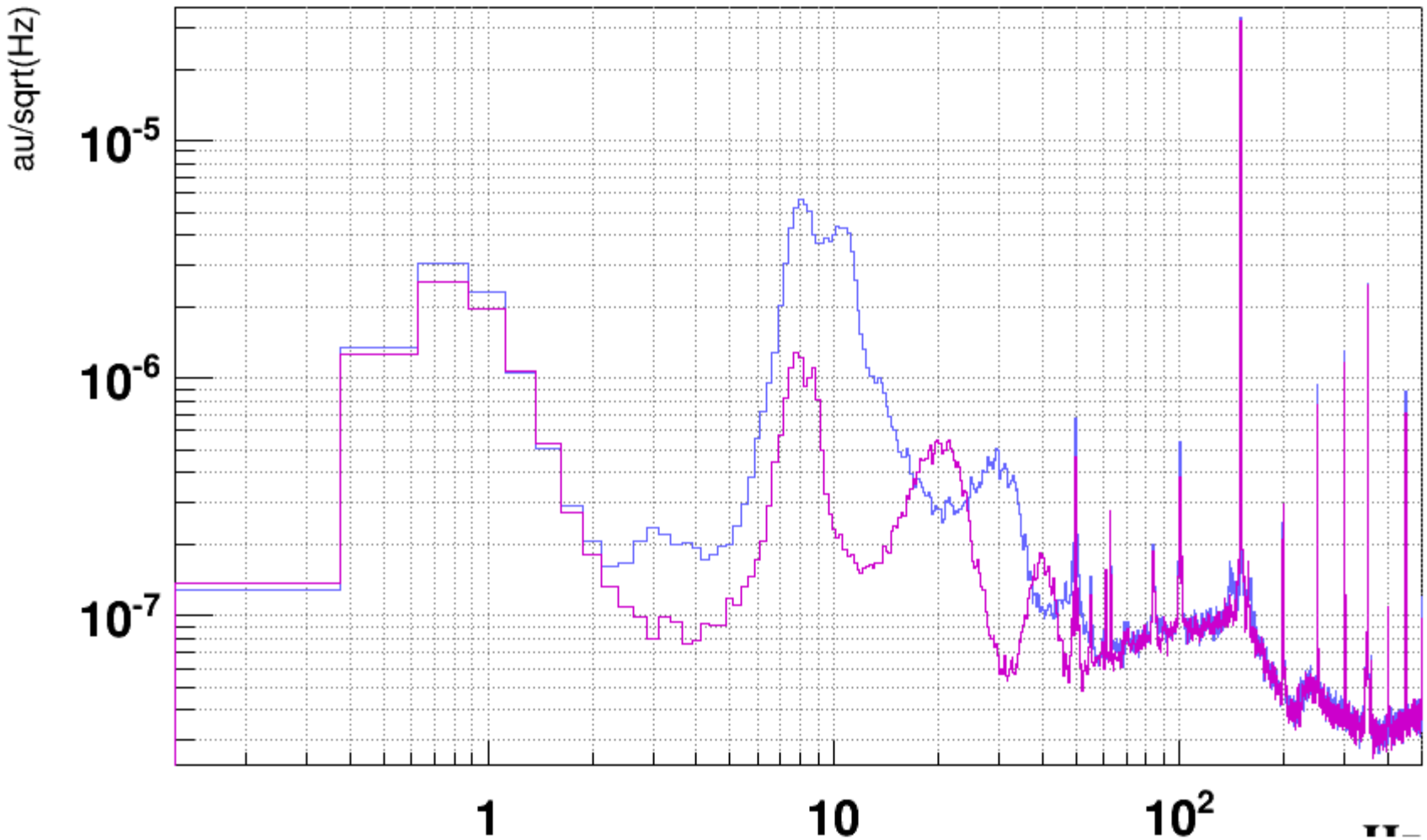
Strips of spectrograms with 20s 50, 50.05 Hz beats followed by 50, 50.01 Hz 100s beats



BSC3 accelerometer doesn't match DARM envelope but HAM6 septum does

dataDisplay v10r9p1 : started by derossi on Aug 22 2019 12:38:22 UTC

V1:LSC_PRCL__FFT



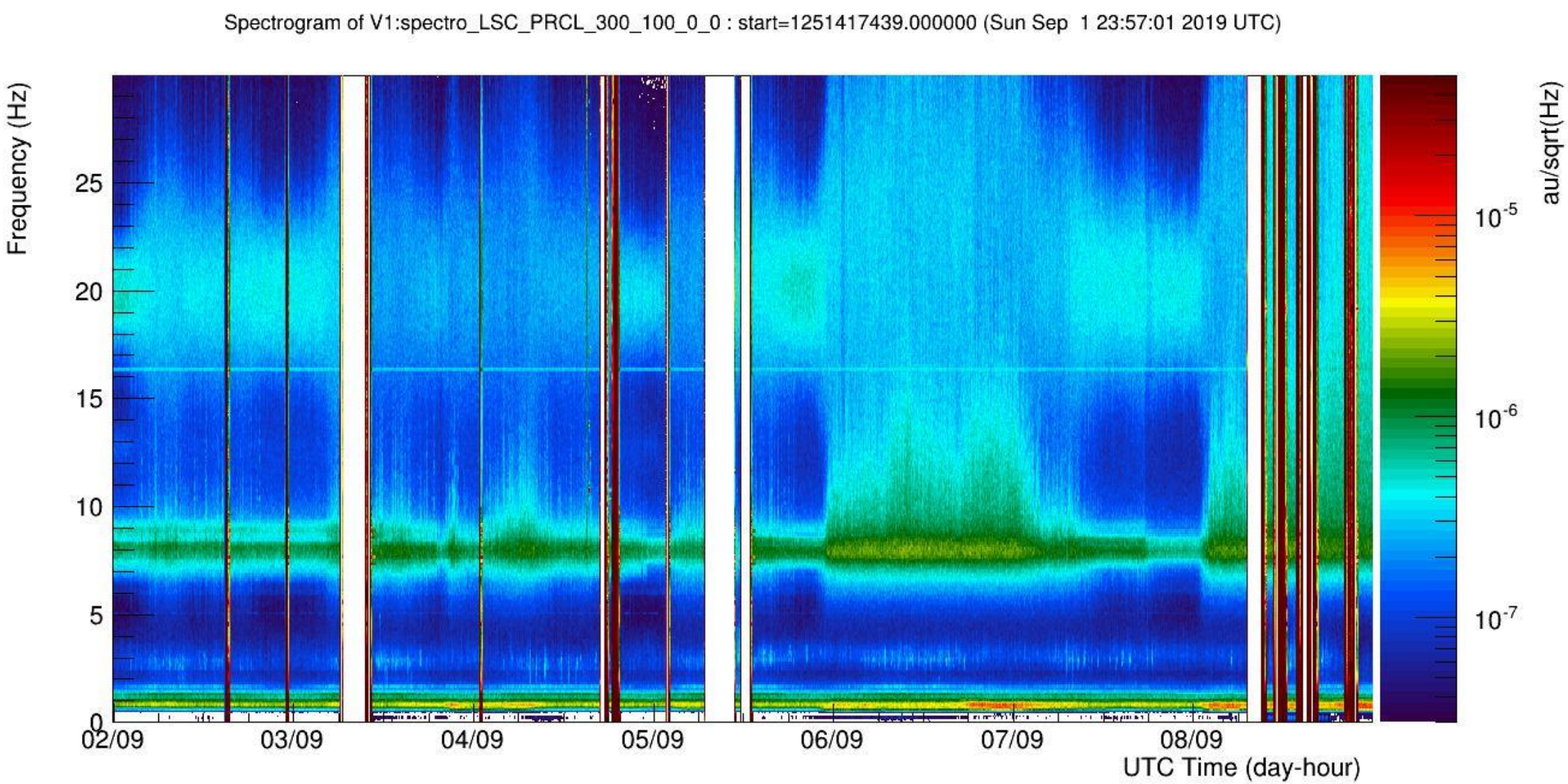
1250511154.0000 : Aug 22 2019 12:12:16 UTC

1250511384.00 : Aug 22 2019 12:16:06 UTC dt:4.00s nAv:53

INJ scattered light: 20-40Hz bumps

- What we know:
  - Present in PRCL
  - Breathes with micro-seism 0.1-1Hz (46852)
  - Scattering seems not to occur on EIB 46720
  - Reduces when switching off HVAC in Laser area (45150)
  - Affected by SIB1 motion (46744)

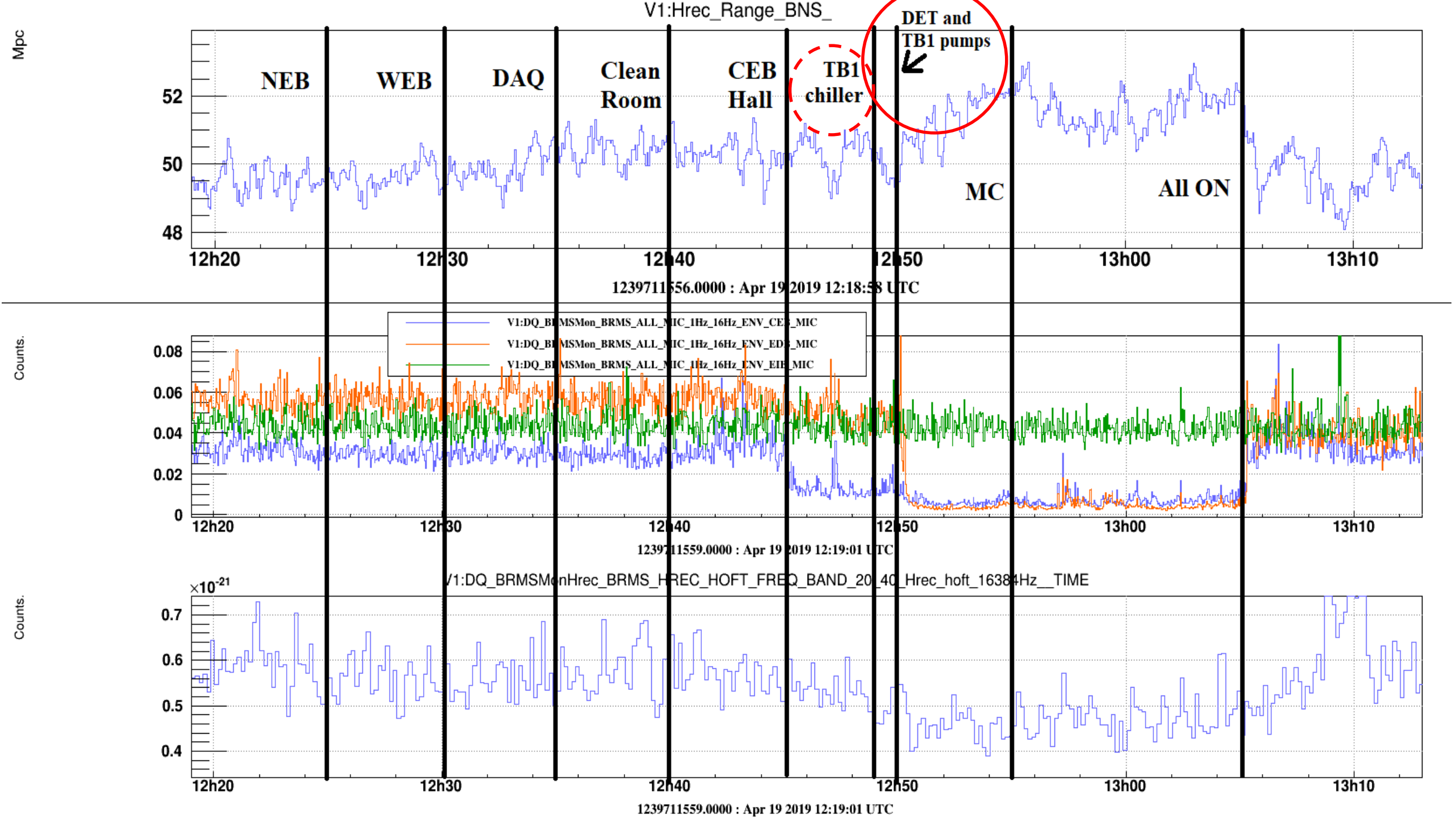
- Tentative plan:
  - Tapping Laser bench (**PSL, INJ, 1 IFAE**) (**1 shift in LN3, TBC**)
  - Tapping SIB2 and inspecting (**INJ, 1 IFAE**) (**1 shift in LN3, TBC**)
  - Add monitoring accelerometer on SIB2 (**INJ, 1 IFAE**) (included in previous shift)
  - Misalign beam on SIB2 (**INJ, 1 IFAE**) (**1 shift in LN3**)


Spectrogram of V1:spectro_LSC_PRCL_300_100_0_0 : start=1251417439.000000 (Sun Sep 1 23:57:01 2019 UTC)
Frequency (Hz)
0
5
10
15
20
25
02/09
03/09
04/09
05/09
06/09
07/09
08/09
UTC Time (day-hour)
au/sqrt(Hz)
10^-5
10^-6
10^-7

HVAC noise CEB

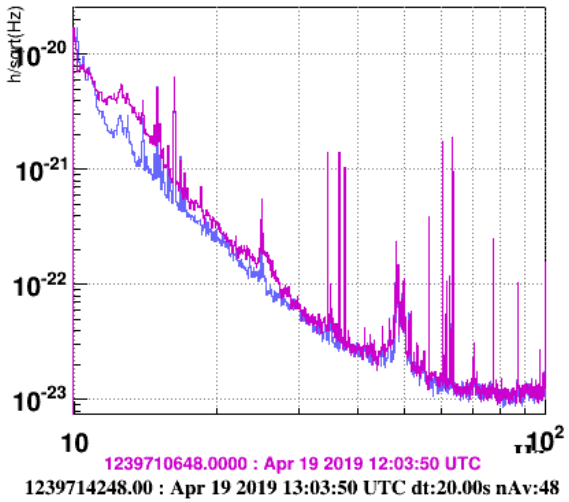
- What we know:
  - Range increased +2Mpc when all CEB HVAC sys was switched off (except INJ) (46432)
  - Suspect correlated to decrease of ambient noise in DET lab

- Tentative plan:
  - Perform more selective HVAC switch off, single and combinations (**POLGRAW**) (**2 shifts in LN3 @49Mpc**)
  - Recheck ESQZB scattering (**SQZ team**) (**1 shift, TBC**)
  - Tapping other locations in DET Lab (**IFAE**) (**1 shift in LN3**)
  - Tapping other places outside DET Lab (i.e. Cryo-trap also inner tank, link pipes) (**VAC**, **IFAE**) (**1 shift in LN3**)
  - Test of reducing DET HVAC fan rotation speed (**POLGRAW**) (**half shift, LN3**)
  - Perform INJ HVAC switch off (**POLGRAW**) (**1 shift in LN3**)

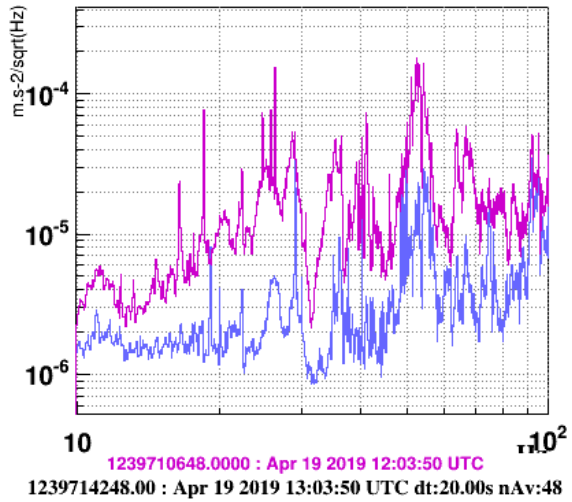

V1:Hrec_Range_BNS_
Mpc
NEB
WEB
DAQ
Clean Room
CEB Hall
TB1 chiller
DET and TB1 pumps
MC
All ON
52
50
48
12h20
12h30
12h40
12h50
13h00
13h10
1239711556.0000 : Apr 19 2019 12:18:58 UTC
V1:DQ_BRMSMon_BRMS_ALL_MIC_1Hz_16Hz_ENV_CEB_MIC
V1:DQ_BRMSMon_BRMS_ALL_MIC_1Hz_16Hz_ENV_EDB_MIC
V1:DQ_BRMSMon_BRMS_ALL_MIC_1Hz_16Hz_ENV_EIB_MIC
Counts.
0.08
0.06
0.04
0.02
0
1239711559.0000 : Apr 19 2019 12:19:01 UTC
V1:DQ_BRMSMonHrec_BRMS_HREC_HOFT_FREQ_BAND_20_40_Hrec_hoft_16384Hz__TIME
×10-21
0.7
0.6
0.5
0.4
1239711559.0000 : Apr 19 2019 12:19:01 UTC

https://logbook.virgo-gw.eu/virgo/?r=46432

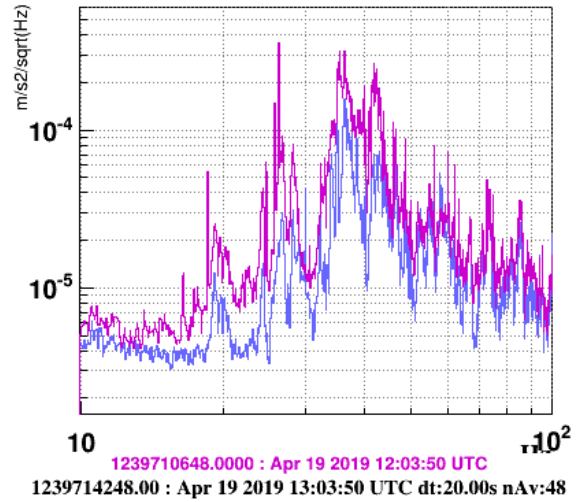
V1:Hrec_hoft_clean_20000Hz__FFT



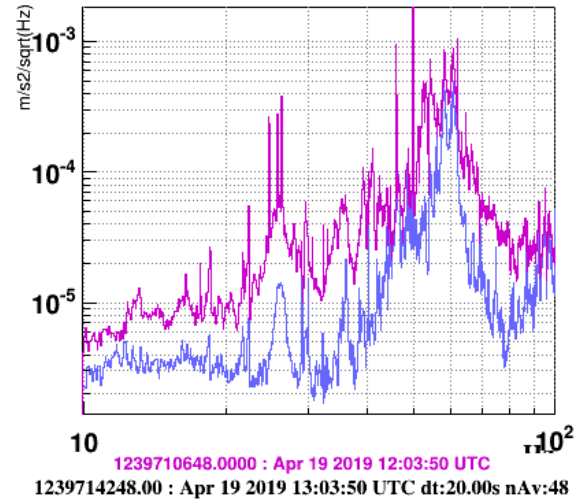
V1:ENV_DT_ACC_Z__FFT



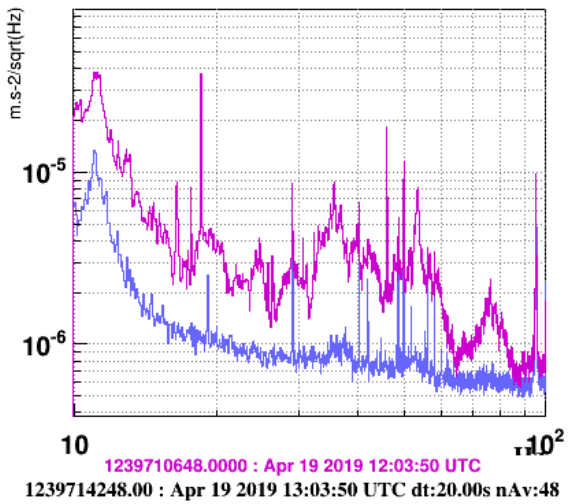
V1:ENV_DT_CT_ACC_Z__FFT



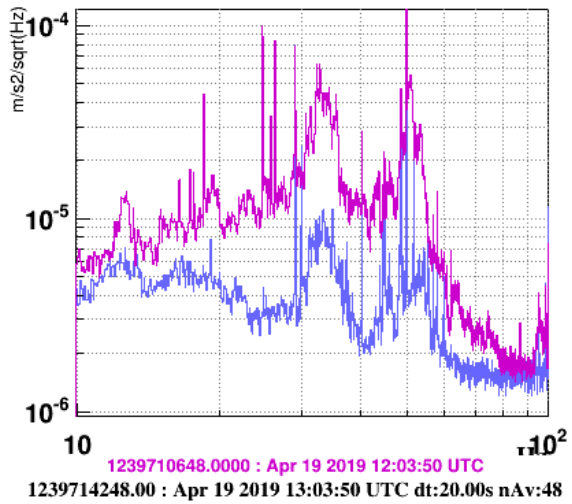
V1:ENV_SQZ_PIPE_ACC_Y__FFT



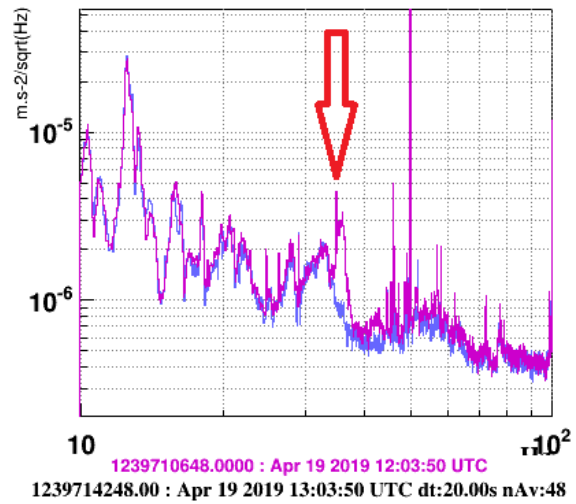
V1:ENV_EDB_ACC_Z__FFT



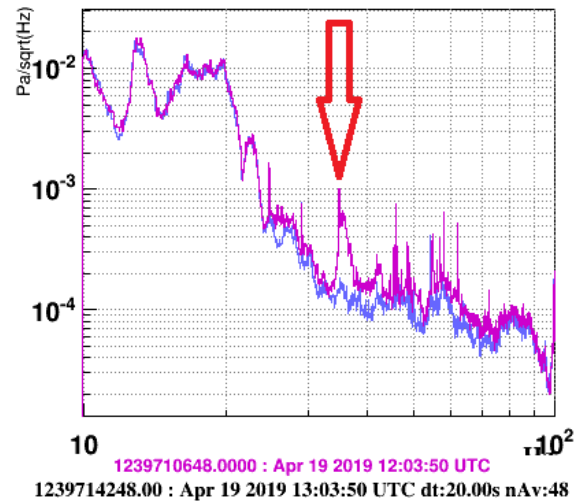
V1:ENV_SQZ_ACC_Y__FFT



V1:ENV_EIB_ACC_Y__FFT

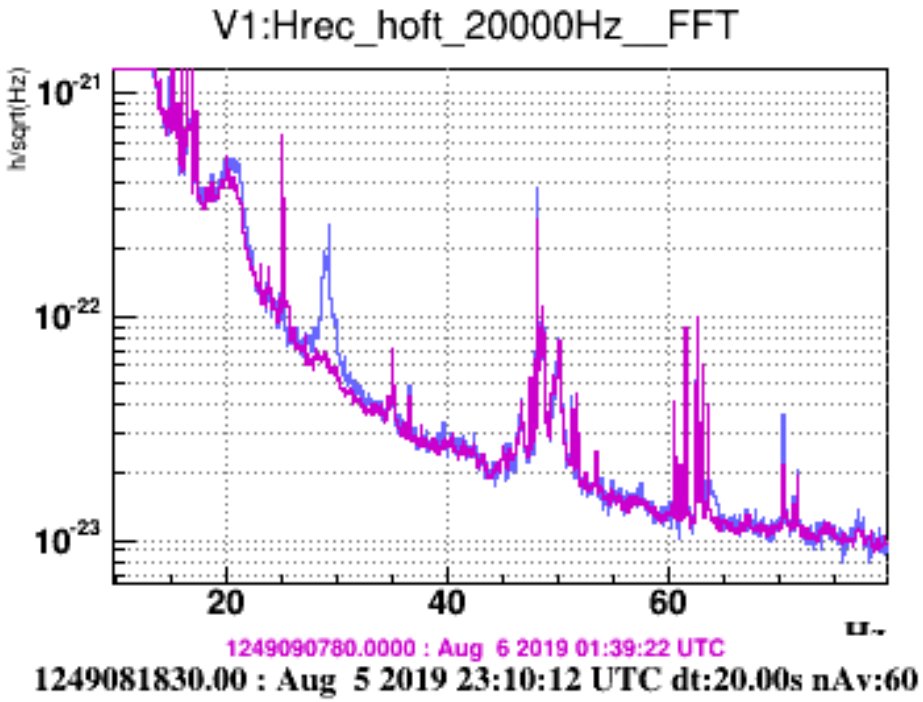


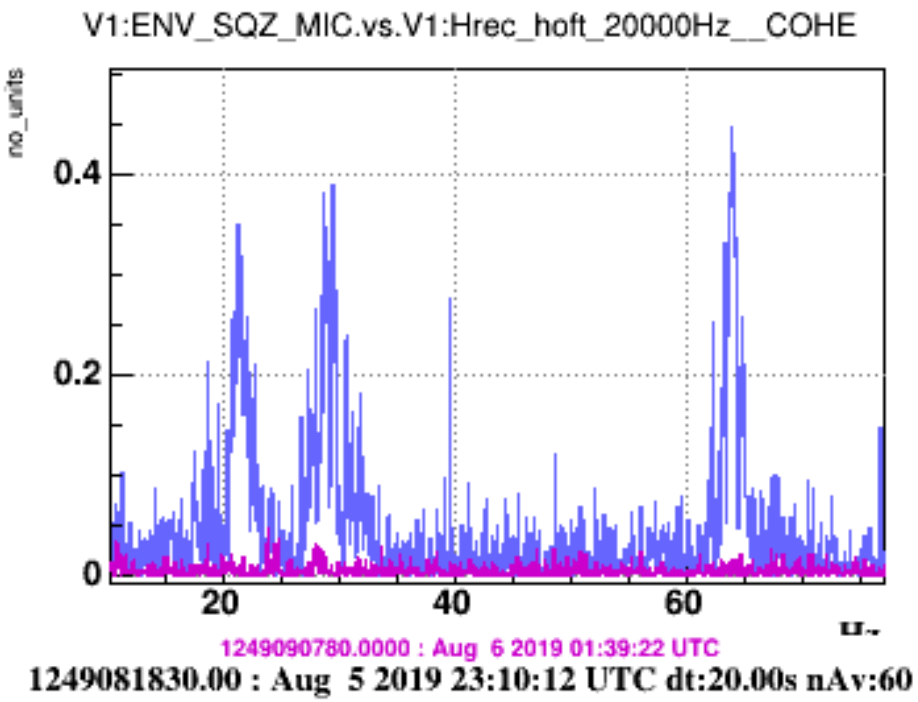
V1:ENV_EIB_MIC__FFT



Not necessarily HVAC noise …

- Intermittent bumps 28Hz, 60Hz (46602)





Magnetic unexpected coupling

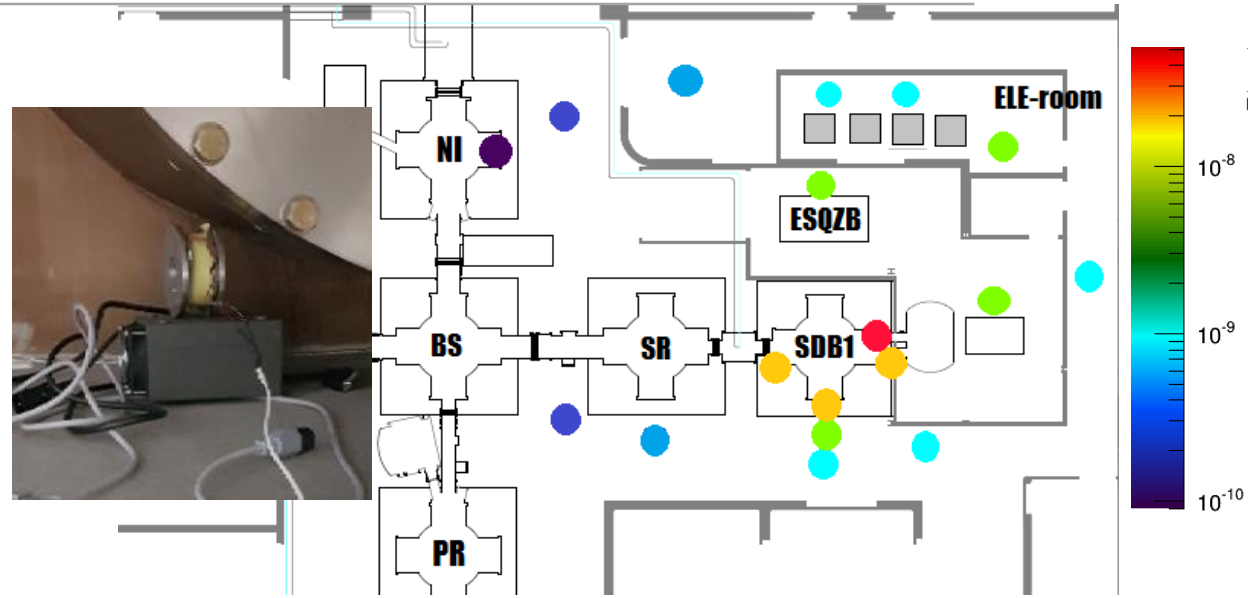
- What we know:
  - ➢ evidence of Coupling increase at high frequency during CEB weekly injections (46207)
  - ➢ evidence of SDB1 possible path (46228)

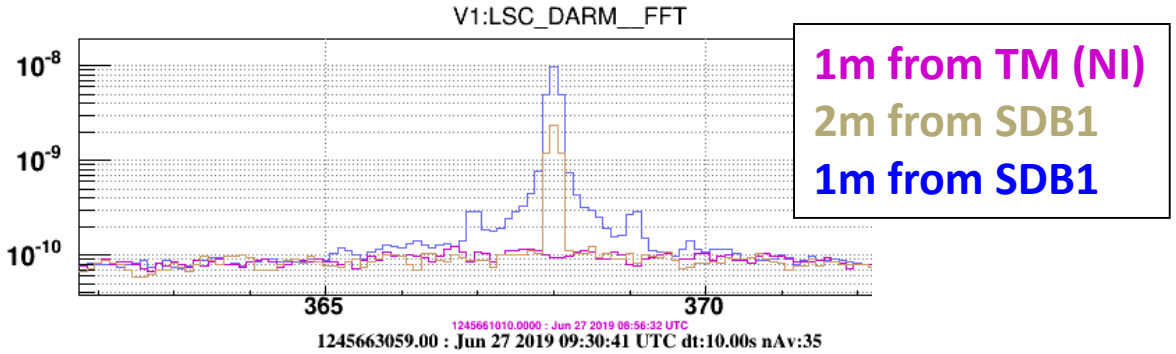
- Tentative plan:
  - ➢ Perform more selective near-field injection in order to disentangle the path: magnets, cables, electronics (**KAGRA**) (**1 shift LN3**)

Magnetic noise coupling at SDB1

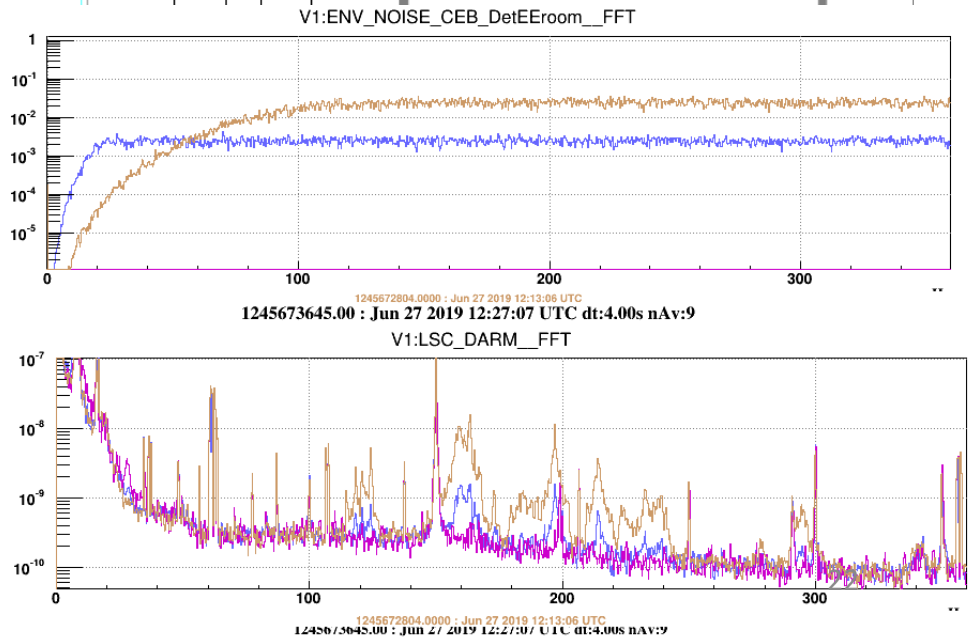
- Performed close-field injections with one small coil
- WE FOUND:
  - ✓ coupling grows as we went closer and closer to SDB1 vacuum chamber.
  - ✓ large coupling above 100Hz
  - ✓ Typical SDB1 scattered light structures get excited
- What happens:

  magnetic fields couple to bench actuation magnets and shake the bench → scattered light from the bench produce noise in Hrec.
- FURTHER WORK:
  - Understand why coupling grows with frequency
  - TO DO (after O3): measure residual B field inside vacuum chamber.



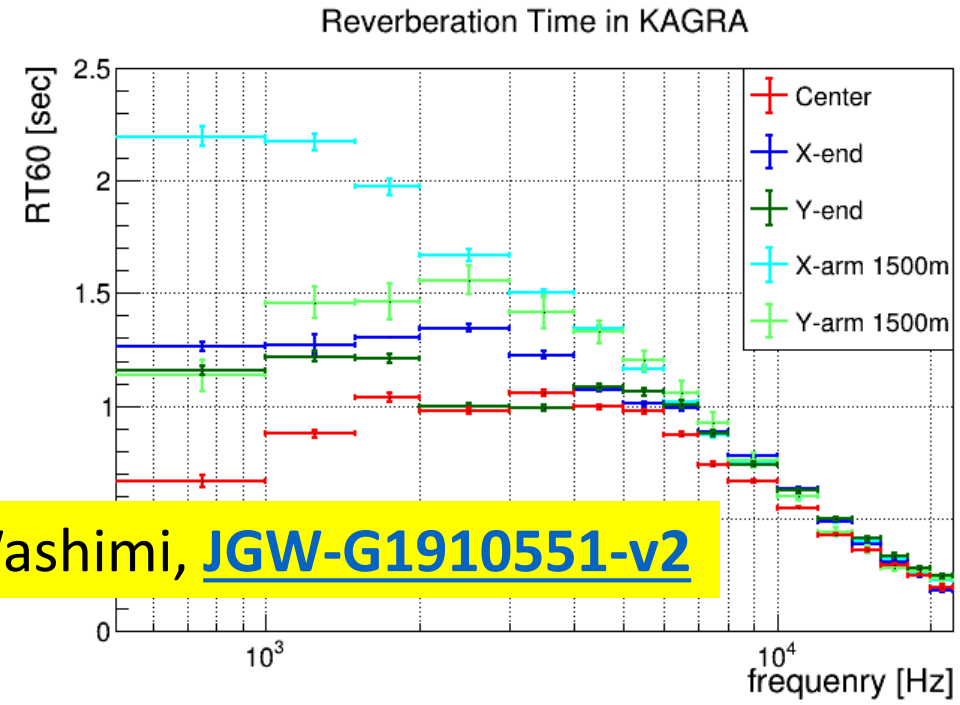


1m from TM (NI)
2m from SDB1
1m from SDB1

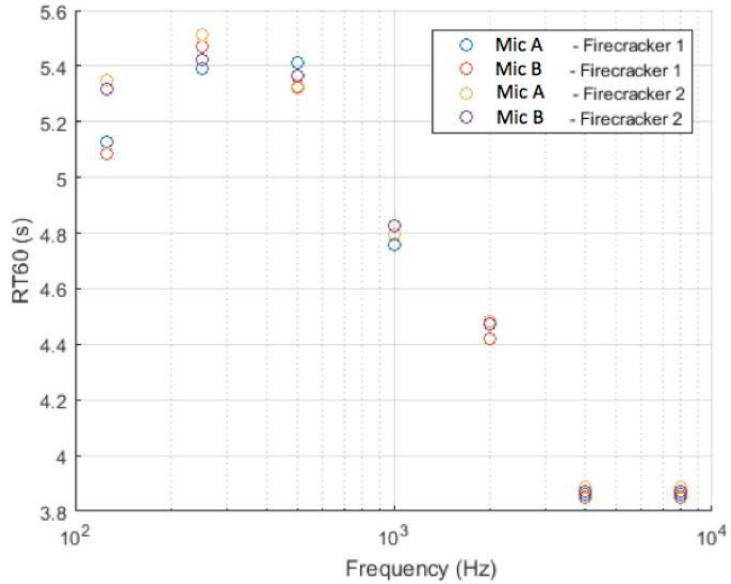


Acoustic characterization of Buildings

- Impulsive acoustic injections (fire-crackers and other tools) to measure Reverberation (**KAGRA**) **(no ITF, 1 shift)**



T.Washimi, [JGW-G1910551-v2]



RT60(s)		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Firecracker 1	MicA	5.1290	5.3936	5.4100	4.7556	4.4855	3.8582	3.8582
	MicB	5.0876	5.4713	5.3246	4.7940	4.4190	3.8506	3.8506
Firecracker 2	MicA	5.3489	5.5116	5.3302	4.7965	4.4838	3.8893	3.8893
	MicB	5.3189	5.4229	5.3636	4.8283	4.4719	3.8693	3.8693

RF injections

- **(KAGRA) (1 shift LN3)**

Summary

- Sniffing to locate sources: portable magnetic probe (KAGRA) (2 shifts - no ITF – might be parallelized)
- Add Vdiff probe (similar to ENV_CEB_ELECTRIC) in other location(s) Federico (during unlocked time)
- If needed, perform some switch off test (TBD, LN3)
- Tapping tests (link pipe, vacuum chambers, cryoTrap) – IFAE (1 shift in LN3)
- Switch off: turbo's cooling fans, remote scroll - VAC, POLGRAW (half shift, LN3)
- PAY mode? Try to identify using actuators (Paolo…) (1 shift , TBC)
- Repeat same injections & tappings at NEB – IFAE (2 shifts, LN3)
- Magnetic injection close to SIB1 – KAGRA (1 shift, LN3)
- Schofield's technique to better located scattering on chamber walls– IFAE (2 shifts, LN
- Tapping Laser bench and inspecting (PSL, INJ, 1 IFAE) (1 shift in LN3, TBC)
- Tapping SIB2 and inspecting (INJ, 1 IFAE) (1 shift in LN3, TBC)
- Add monitoring accelerometer on SIB2 (INJ, 1 IFAE) (as part of previous shift)
- Misalign beam on SIB2 (INJ, 1 IFAE) (1 shift in LN3)
- Perform more selective HVAC switch off, single and combinations (POLGRAW) (2 shifts in LN3 @49Mpc)
- Recheck ESQZB scattering (SQZ team) (1 shift , TBC)
- Tapping other locations in DET Lab (IFAE) (1 shift in LN3)
- Tapping other places outside DET Lab (i.e. Cryo-trap also inner tank, link pipes) (VAC, IFAE) (1 shift in LN3)
- Test of reducing DET HVAC fan rotation speed (POLGRAW) (half shift LN3)
- Perform INJ HVAC switch off (POLGRAW) (1 shift in LN3)
- Perform more selective near-field injection in order to disentangle the path: magnets, cables, electronics (KAGRA) (1 shift LN3)
- Impulsive acoustic injections (fire crackers and other tools) to measure Reverberation (KAGRA) (no ITF, 1 shift)
- RF injections (KAGRA) (1 shift LN3)

- **TOTAL 22 shifts listed**
  - **3 shifts with no ITF**
  - **3 shifts TBC (INJ, PSL, SQZ, Paolo)**
- **1 activity during unlocked time**
- **1 item TBD ("if needed")**