



E3/E4

Line Noise Investigation

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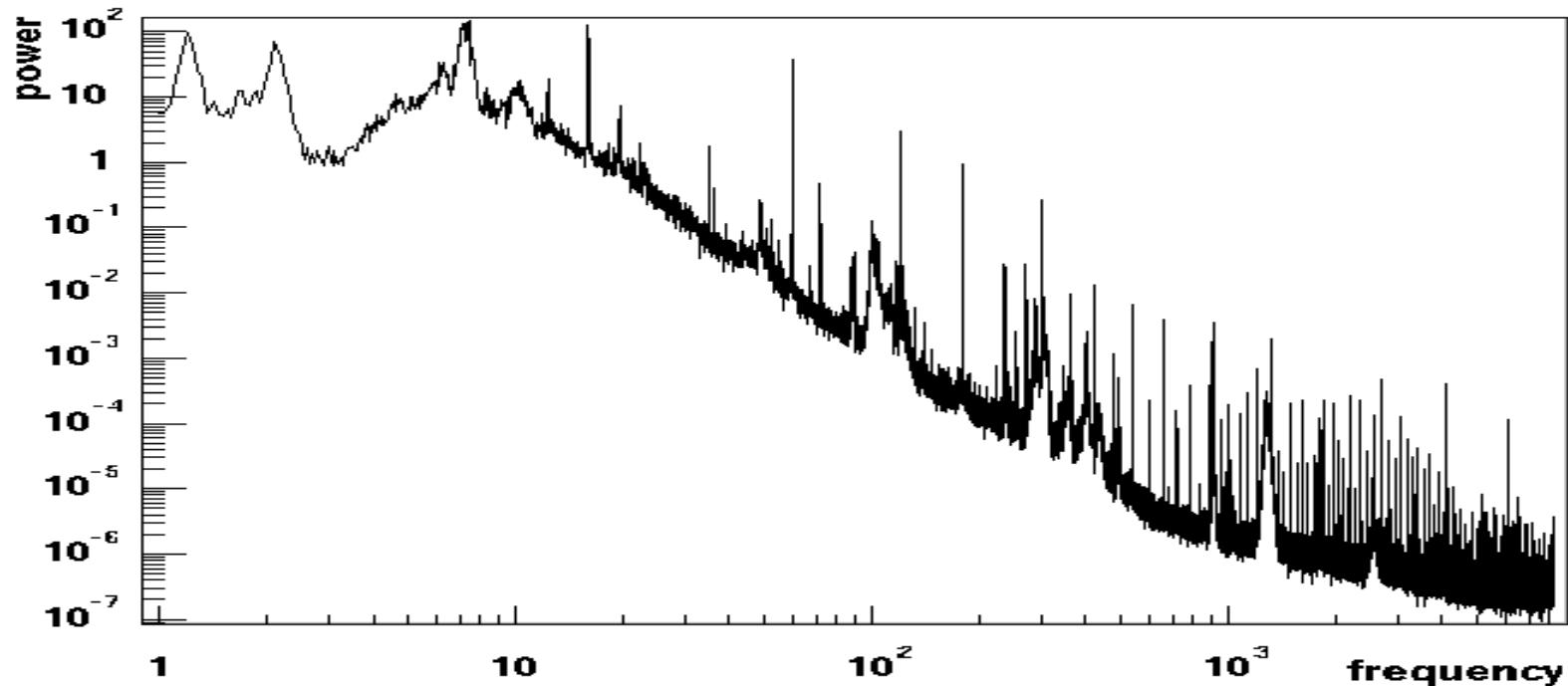
August 15, 2001

● Outline

- LLO line noise (E4 run)
- LLO calibration lines (E4 run)
- Magnetometer studies (E3 run)
- LLO violin modes (E4 run)



E4 L1:LSC-AS_Q Lines

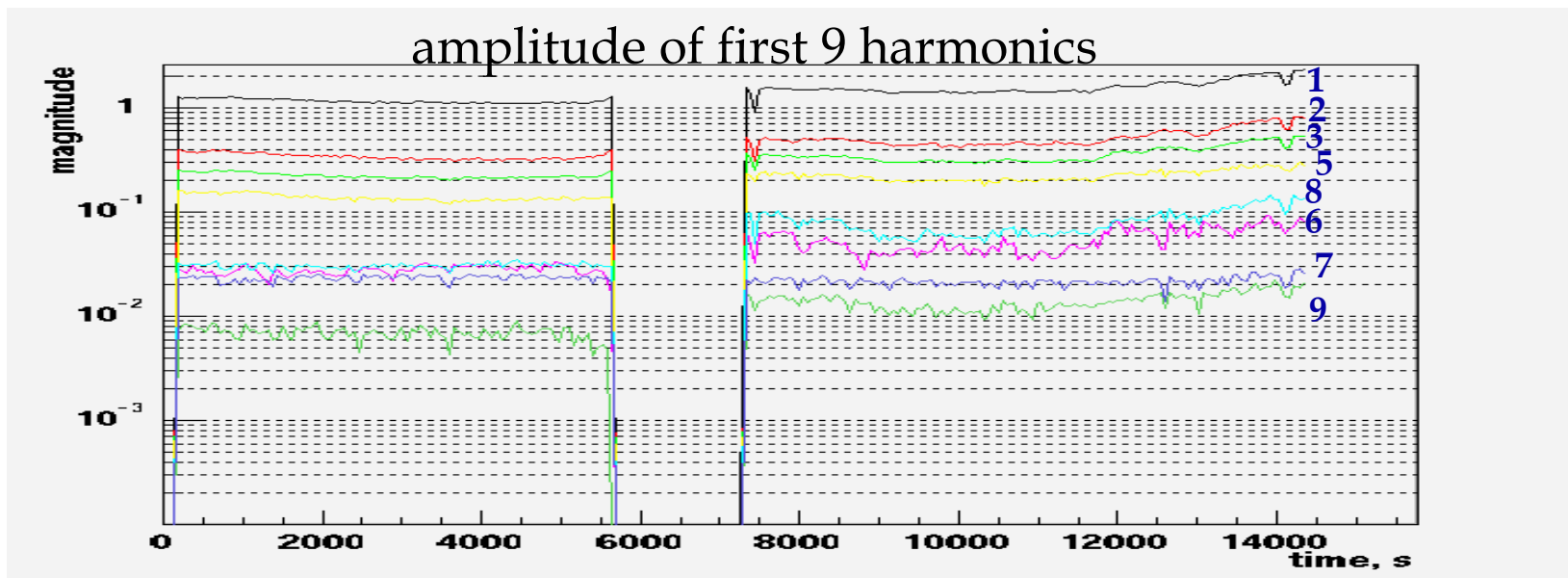
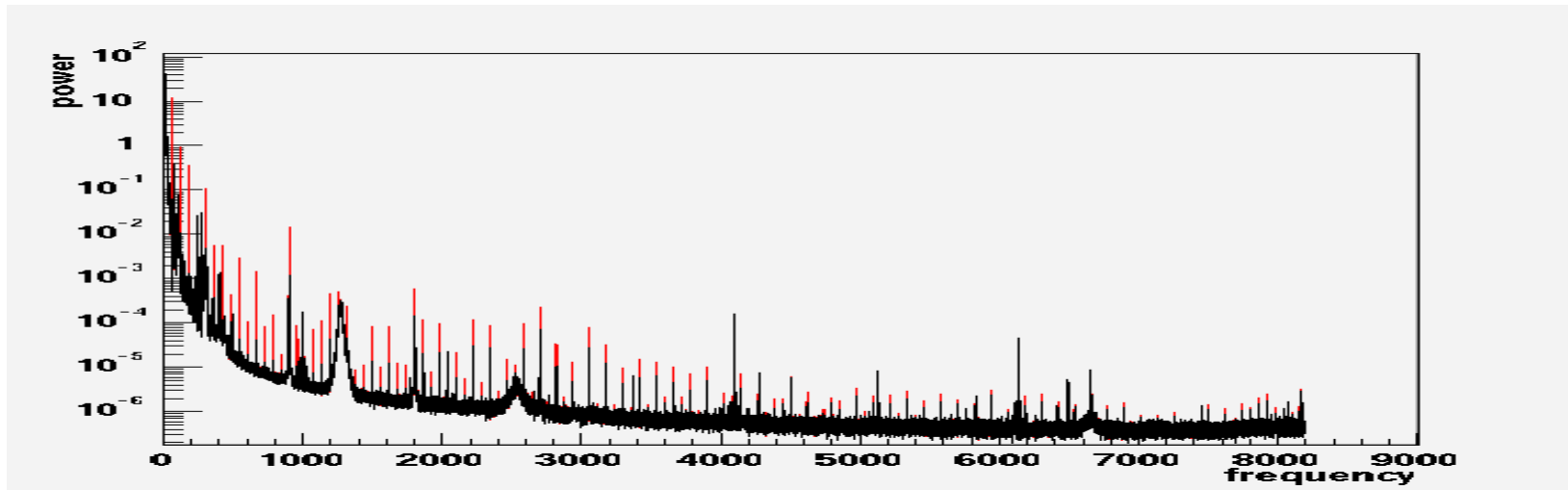


- LLO lines:
 - Power lines (60Hz and harmonics): ~130
 - Sampling lines (2048, 4096, 6144) + sidebands
 - Calibration lines + sidebands (16Hz)
 - Single lines: ~ 15
- E4 data
 - 5 hours starting at 673681395 (15&16 lock sections)



L1:LSC-AS_Q power lines

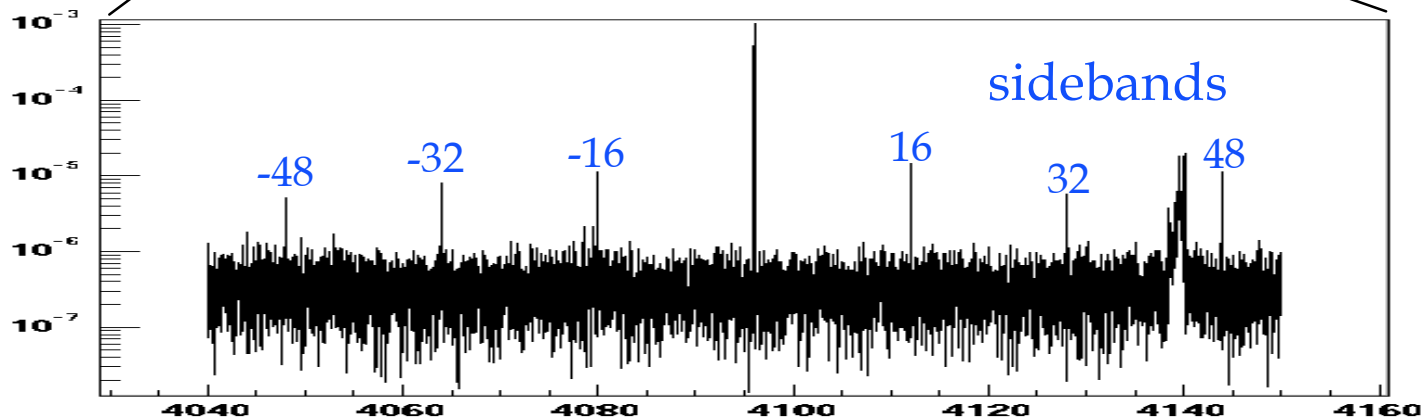
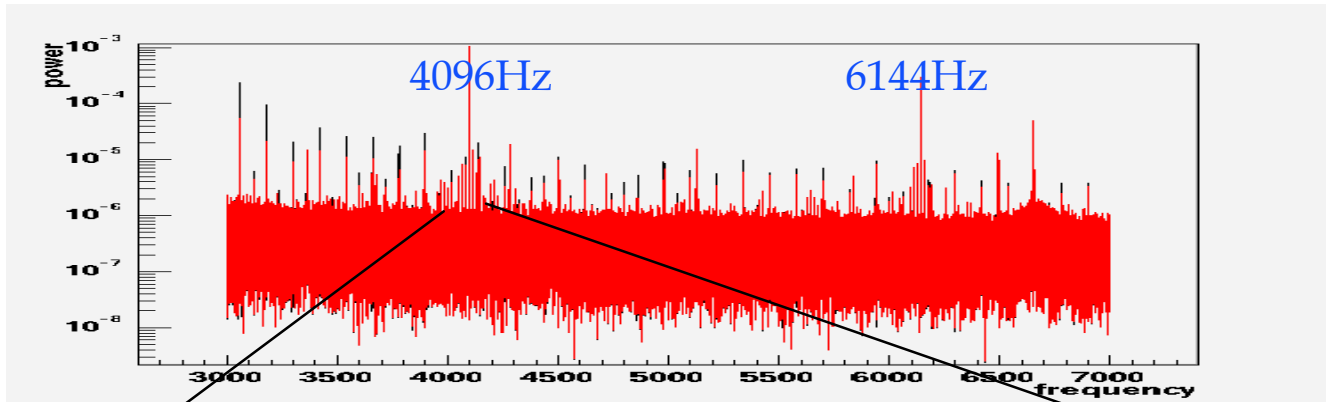
- 136 harmonics (all lines marked with red)





L1:LSC-AS_Q sampling lines

- Narrow lines at 2048Hz, 4096Hz, 6144Hz
 - Group of sidebands (modulation at 16Hz sharp)
 - Sidebands are extremely narrow

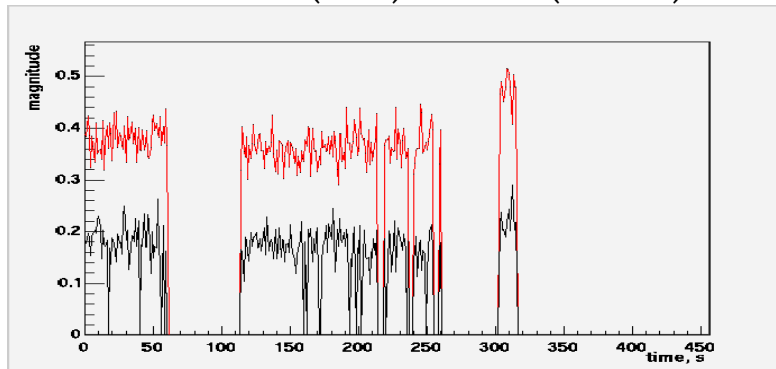




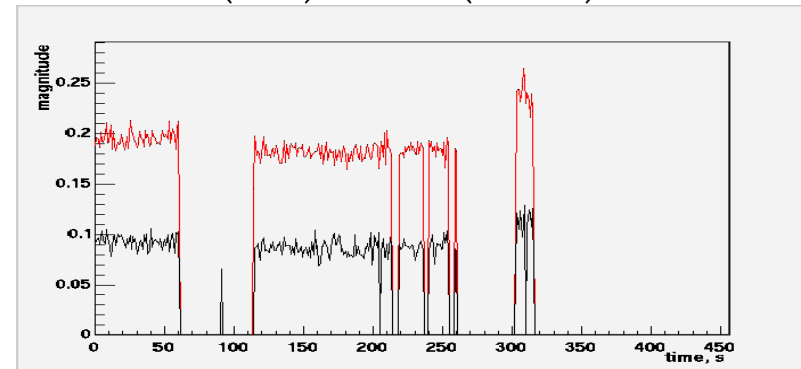
calibration lines (amplitude)

- E4 run
- 8 calibration lines for X arm
 - ITMX(35, 71, 271, 1001) (red curves)
 - ETMX(36, 72, 272, 1002) (black curves)

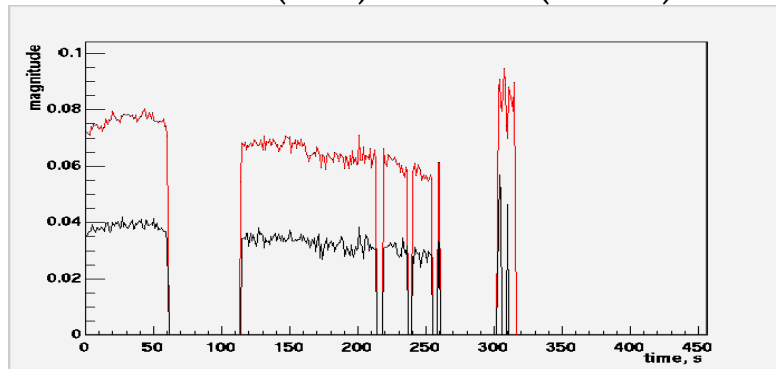
35Hz (red), 36Hz(black)



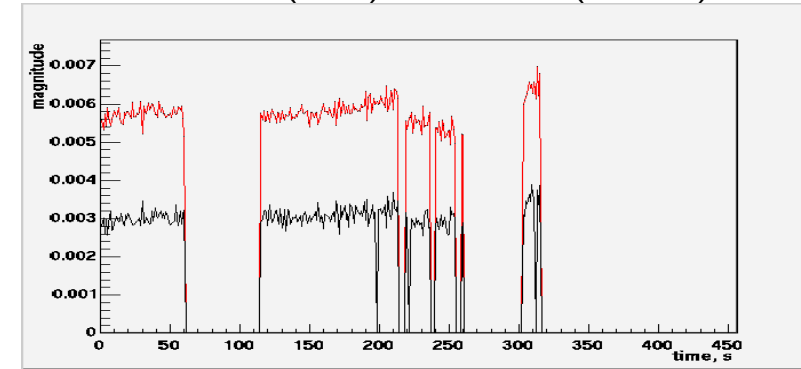
71Hz (red), 72Hz(black)



271Hz (red), 272Hz(black)



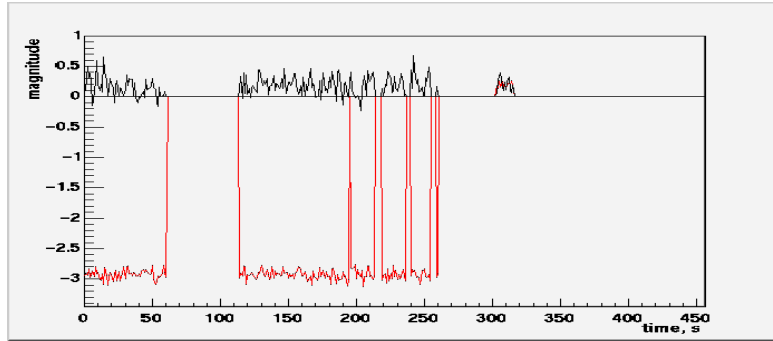
1001Hz (red), 1002Hz(black)



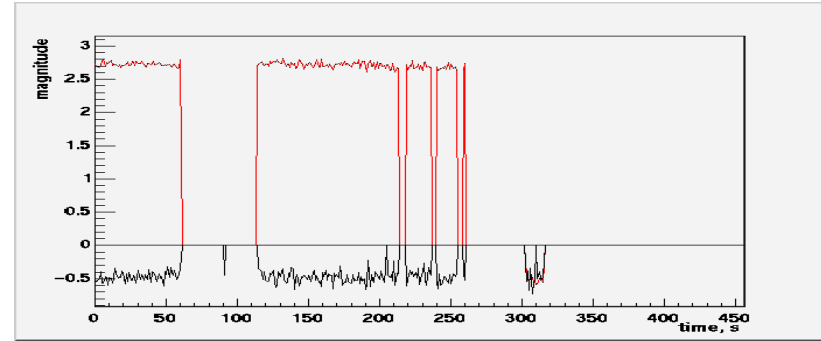


calibration lines (phase)

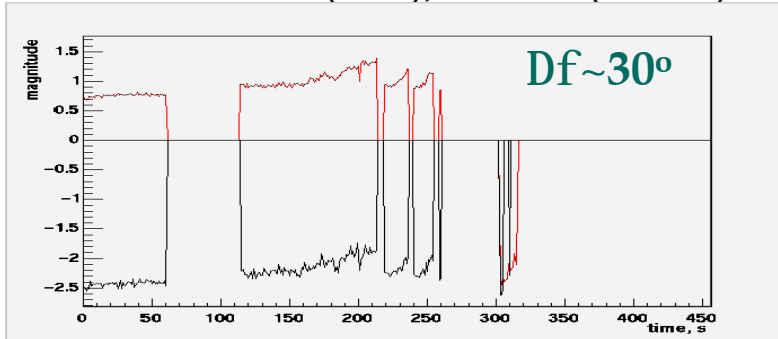
35Hz (red), 36Hz(black)



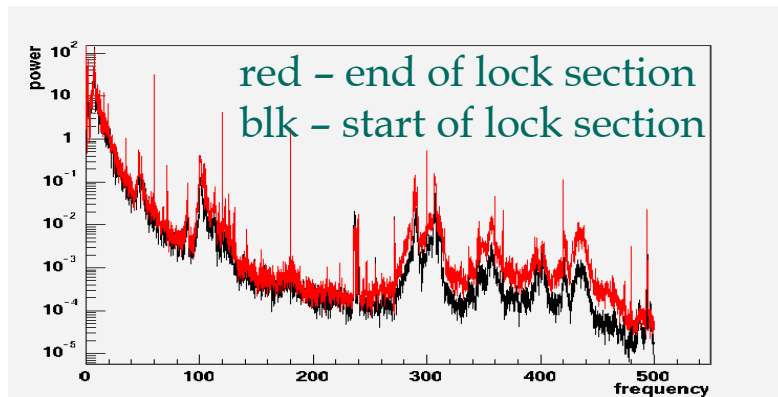
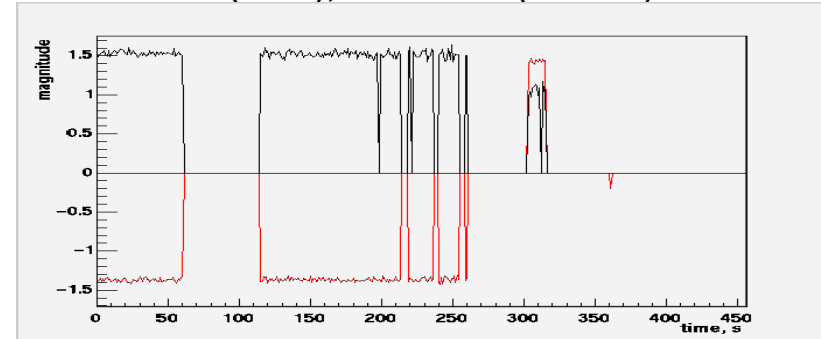
71Hz (red), 72Hz(black)



271Hz (red), 272Hz(black)



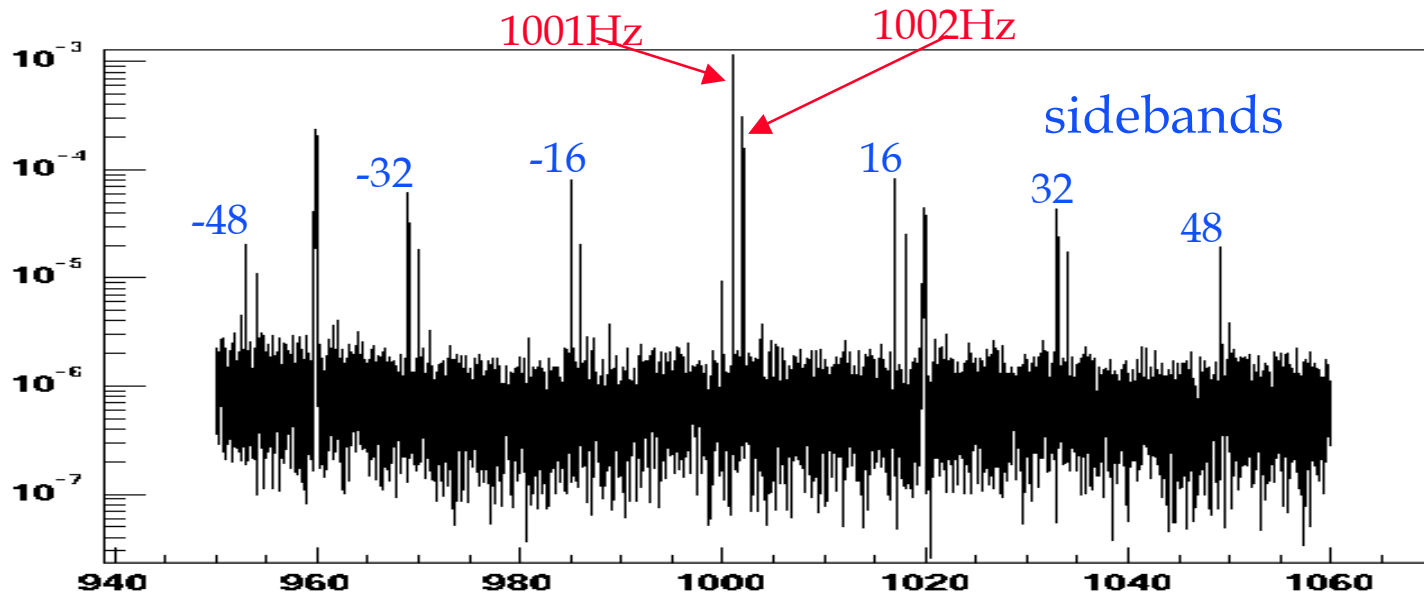
1001Hz (red), 1002Hz(black)



Non-stationary TF
around 270Hz



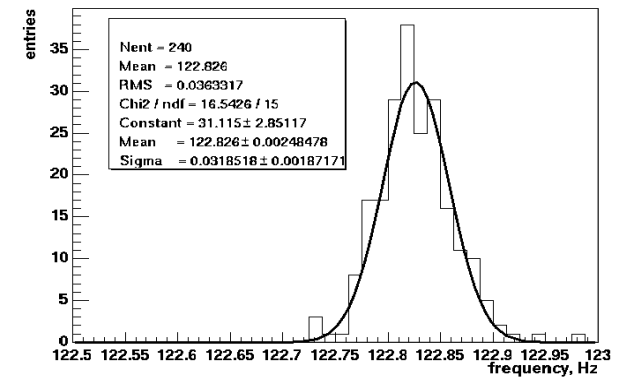
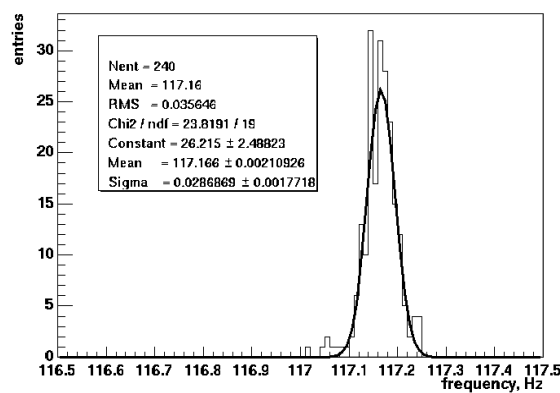
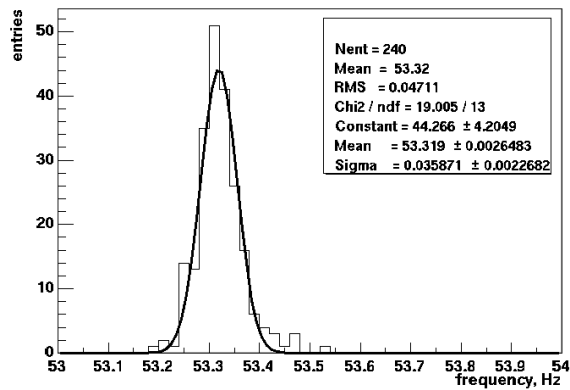
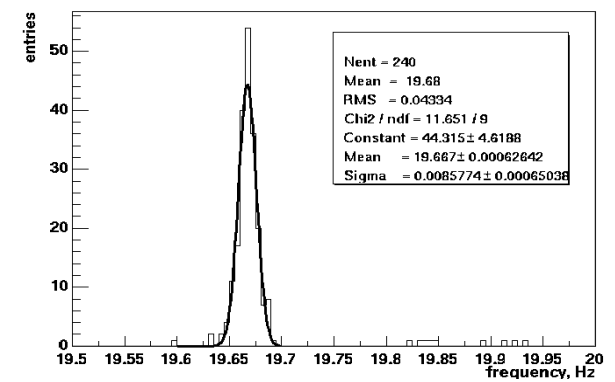
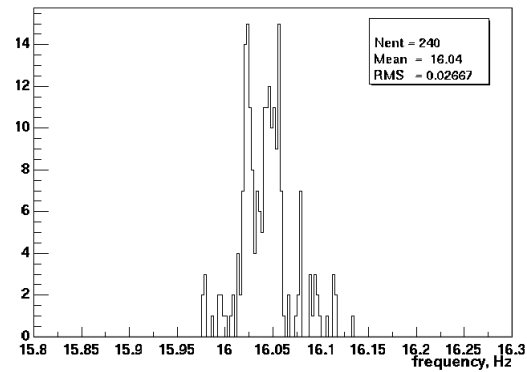
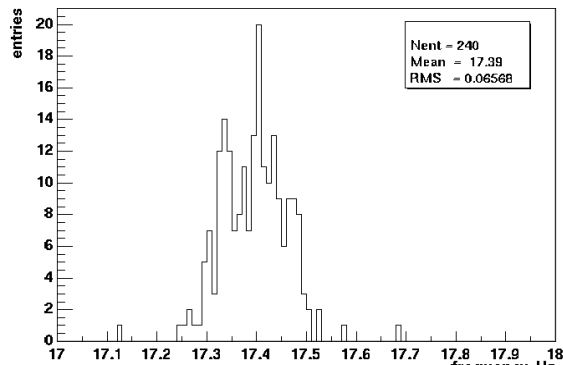
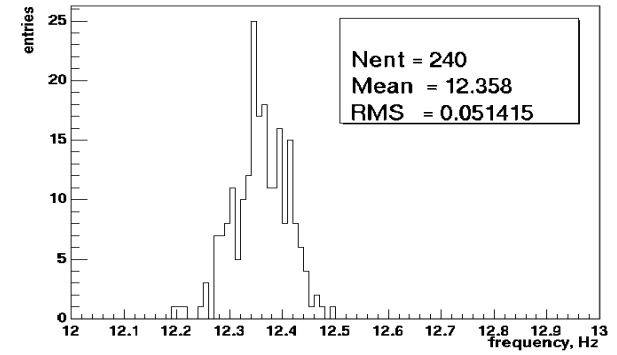
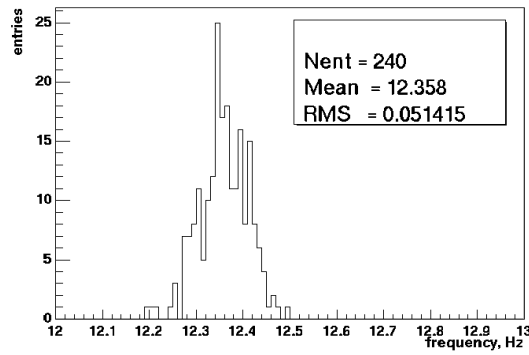
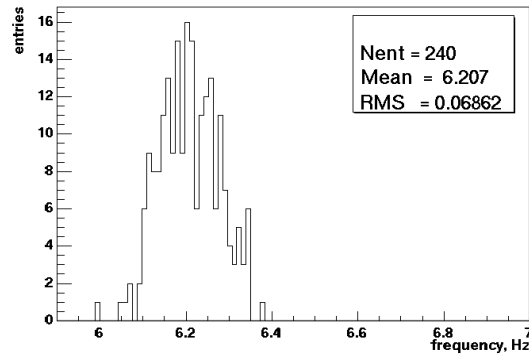
calibration lines (16Hz modulation)



- no 16 Hz sidebands observed for power lines
- perhaps sidebands for calibration and sampling lines are sampling artifacts



LSC-AS_Q "single" lines





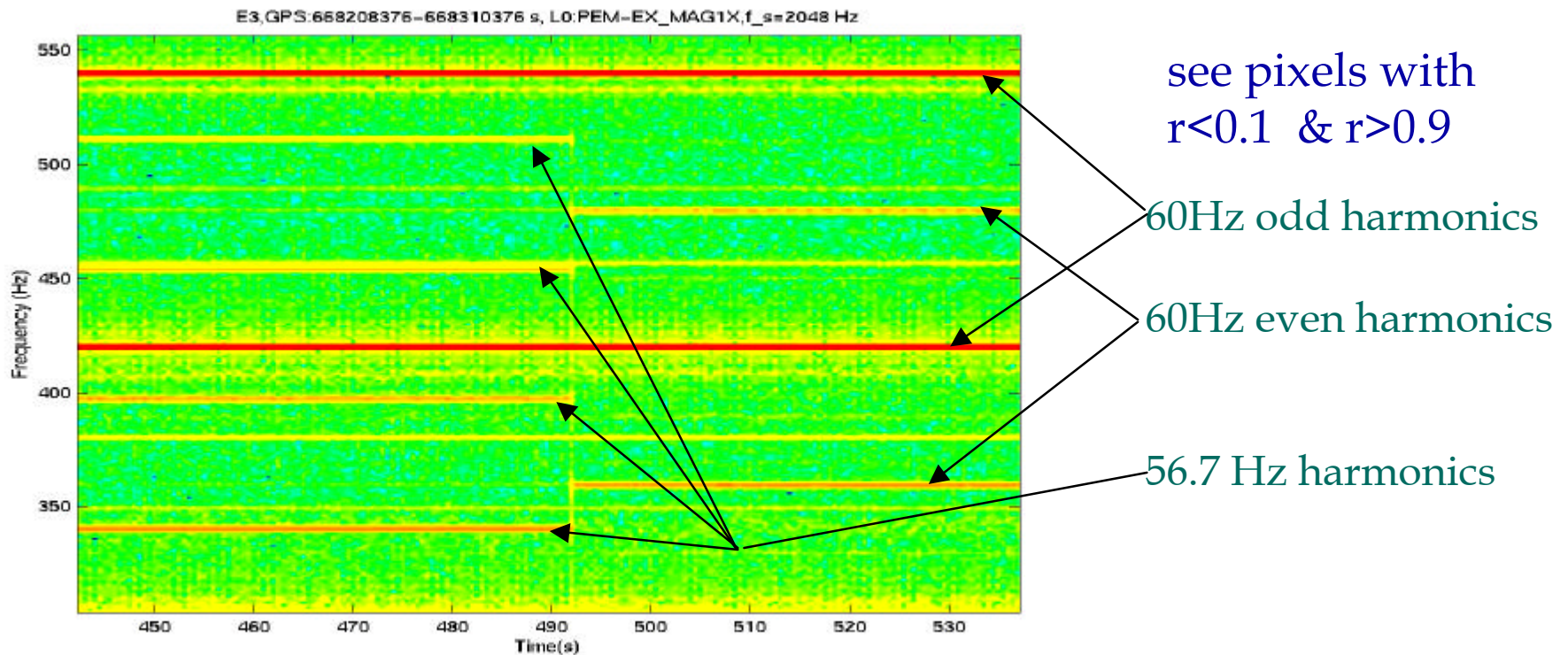
E4 L1:LSC-AS_Q Lines (summary)

F, HZ	W, Hz Rms	A, a.e.	SNR	Source	System
6.207	0.068	0.90	1.0	?	LSC
7.442	0.033	1.74	1.2	?	LSC
5.785	0.031	5.87	1.6	?	LSC
6.086	0.057	8.54	1.3	?	
12.358	0.052	0.66	1.7	HAM stack	LSC
16.025	~0.01	1.54	9.9	?	LSC
16.050	~0.01			?	
17.390	0.066	0.14	0.6		LSC
19.667	0.010	0.70	5.4		
53.319	0.036	0.03	0.8	HVAC system (?)	LSC
60.000 (V)	<0.01	1.50	300	Power lines	LSC, IOO...
117.166	0.020	0.03	2.4	?	LSC
122.826	0.030	0.03	1.9	?	
1775.35,	<0.05			?	LSC
1886.48	<0.05			?	
35,71,271, 1001	-			ITMX calibration lines + 16 Hz sidebands	LSC
36,72,272, 1002	-			ETMX calibration lines + 16 Hz sidebands	LSC
2048, 4096 6144	-			Sampling artifacts (1,2,3 harmonics +16Hz sidebands)	LSC



Magnetometers study

- time-frequency analysis of L0:PEM-EX_MAG1X & H0:PEM-EX_MAG1X
 - correlation of Im and Re parts of data in Fourier domain
 - for details see S.Mukherjee report at <http://blue.ligo-wa.caltech.edu/engrun/E3/Results/LineMonitor/index.html>
- data section (E3) 1800s long: GPS time 668208654-668210176

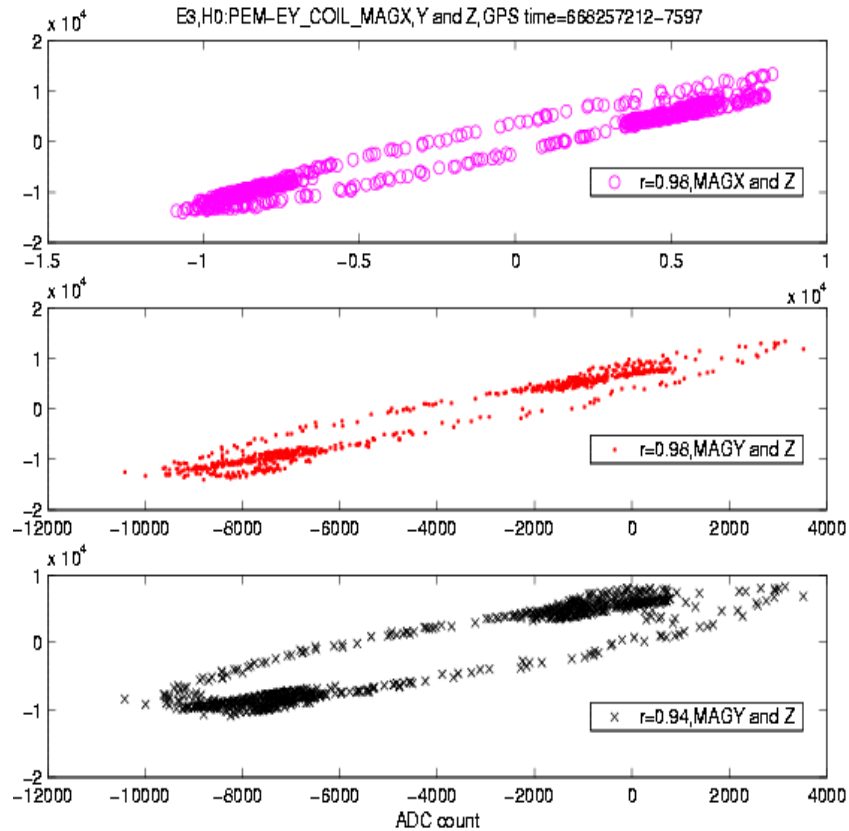




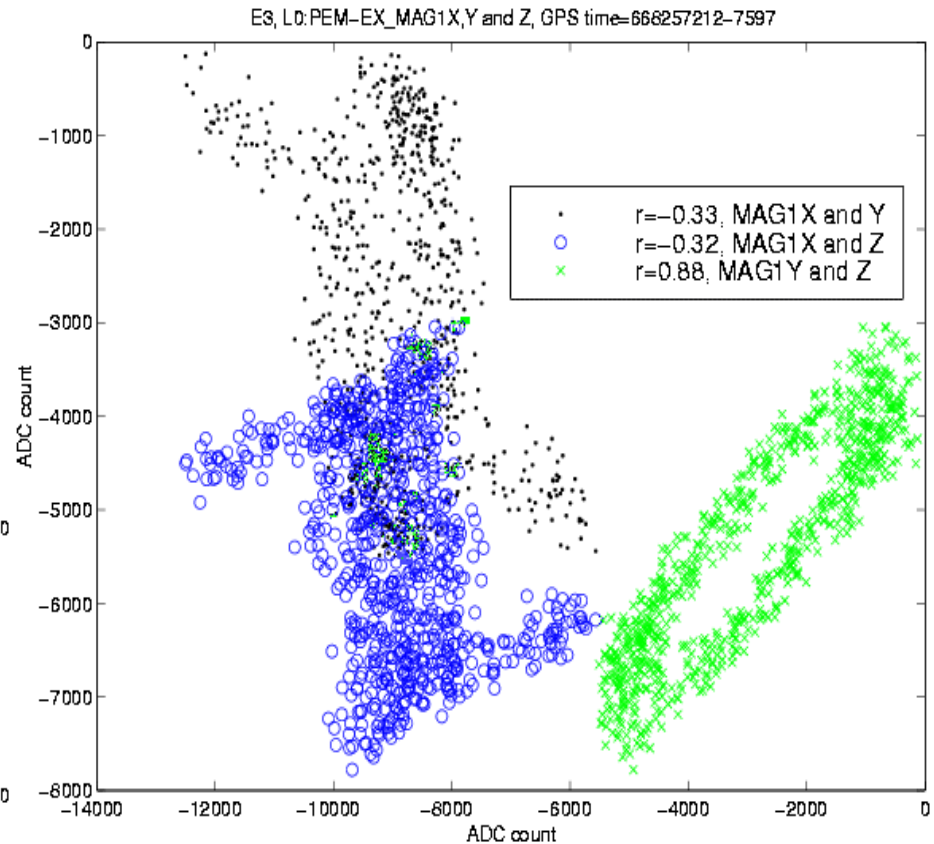
Magnetometers study

- coherence of PEM-EX_MAG1 XY, XZ and YZ pairs .
 - LHO - const orientation of the magnetic field vector (one source)
 - LLO - orientation of the magnetic field changes with time (many sources)

LHO



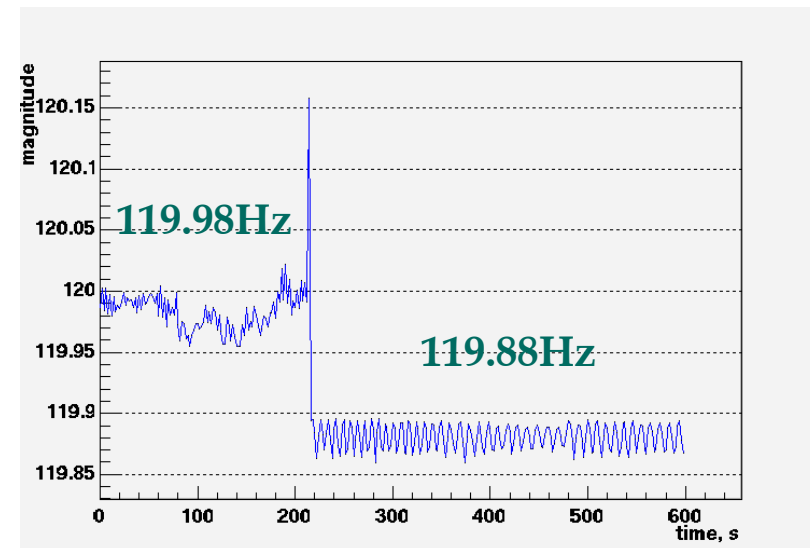
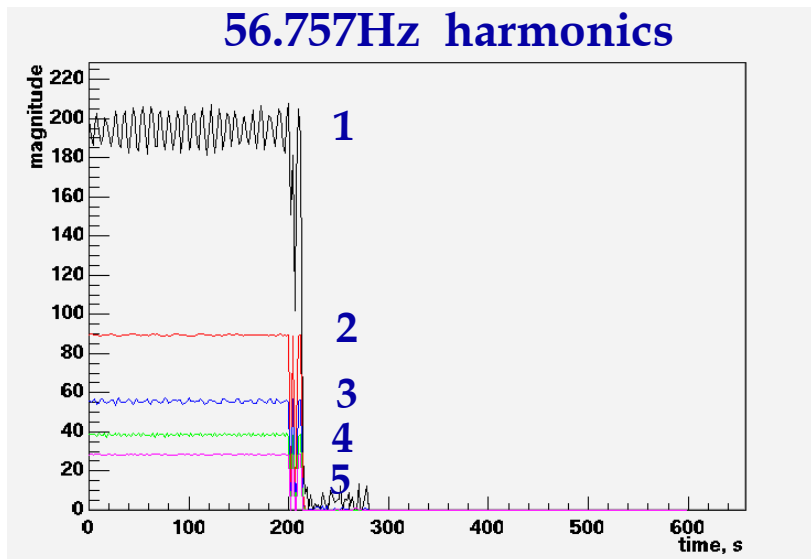
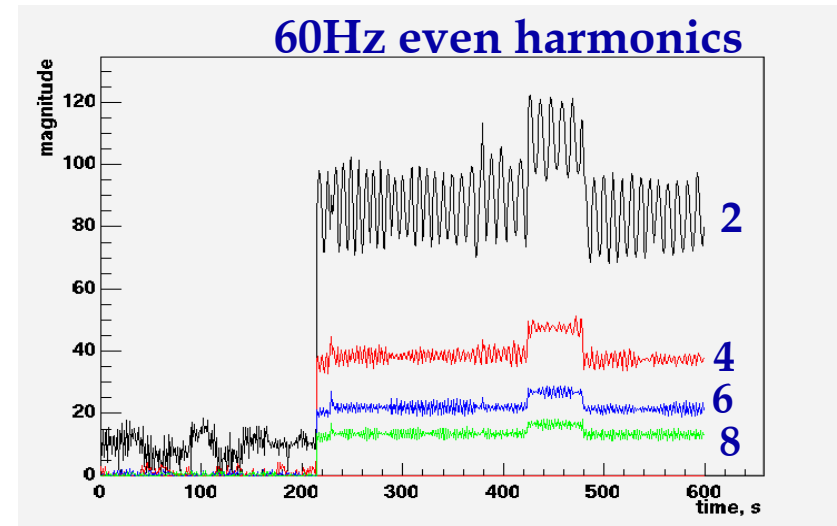
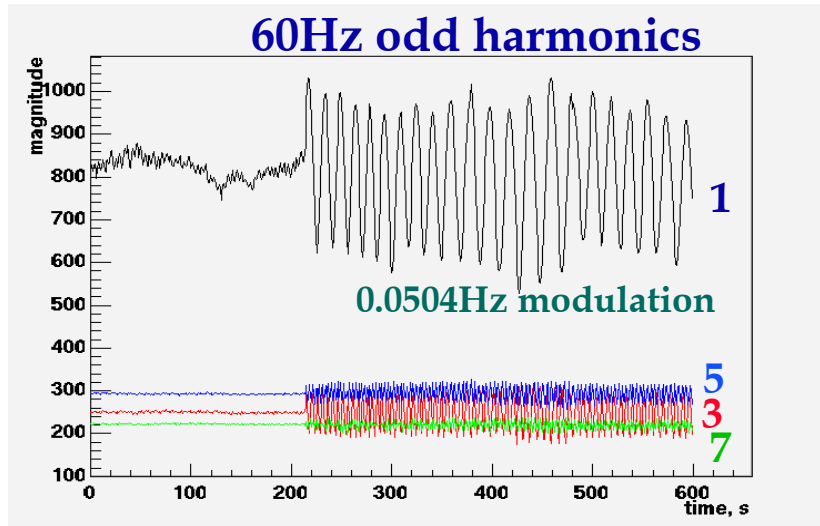
LLO





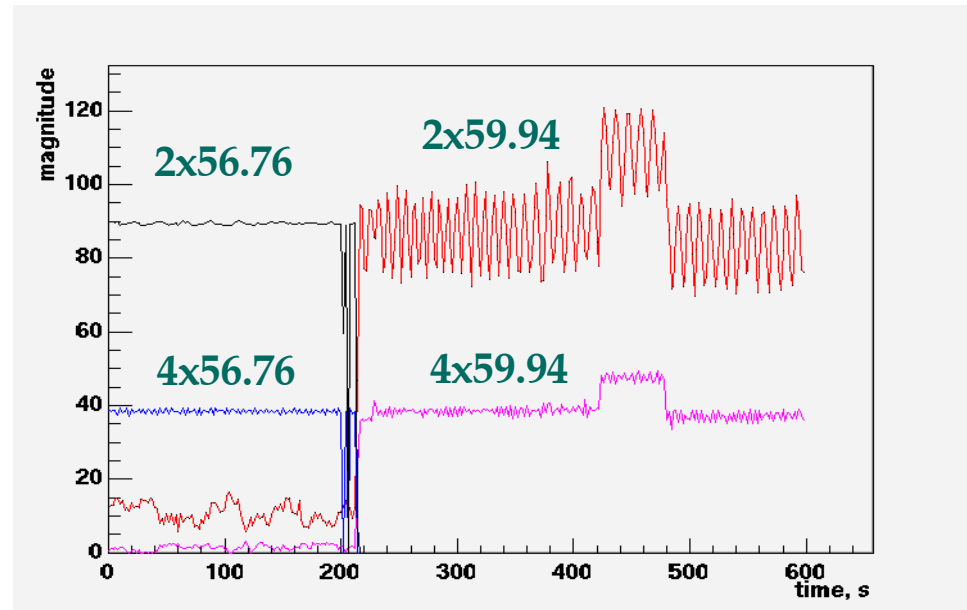
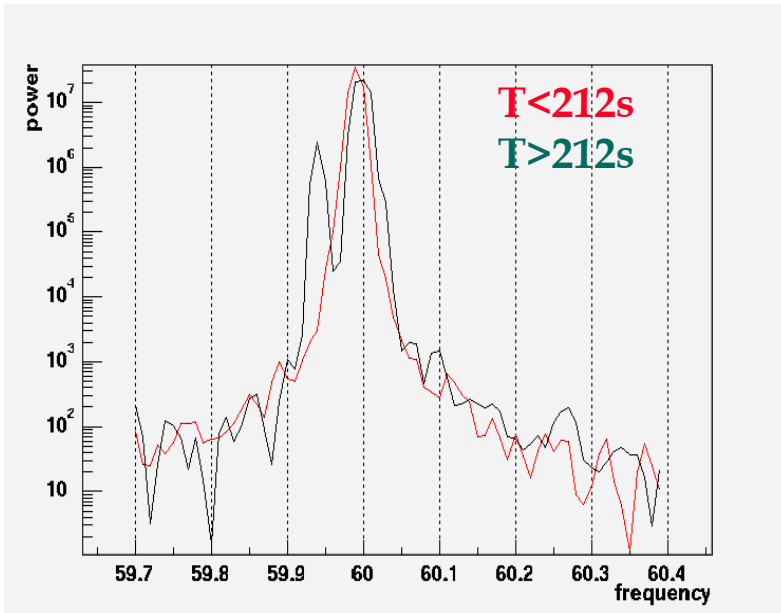
LineMonitor results

- close look at L0:PEM-EX_MAG1X with the Line Monitor





LineMonitor results (continue)

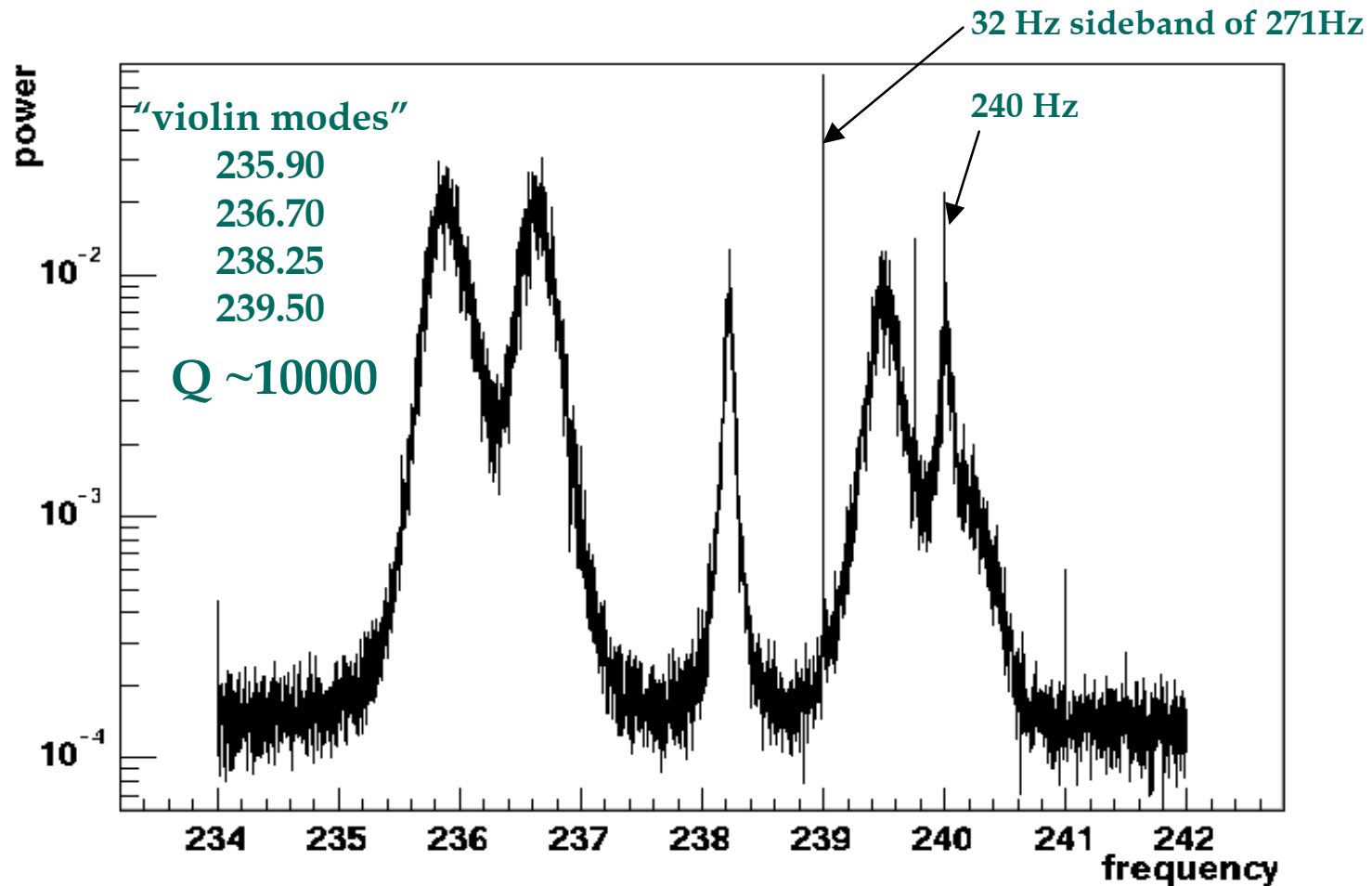


- What happened?
 - 2 sets of power lines – power mains & compressor
 - at 212sec motor was switched off -> 56.76Hz lines shifted to 59.94Hz
amplitudes of 56.76Hz & 59.94Hz harmonics are exactly the same
 - does it affect the interferometer channel?



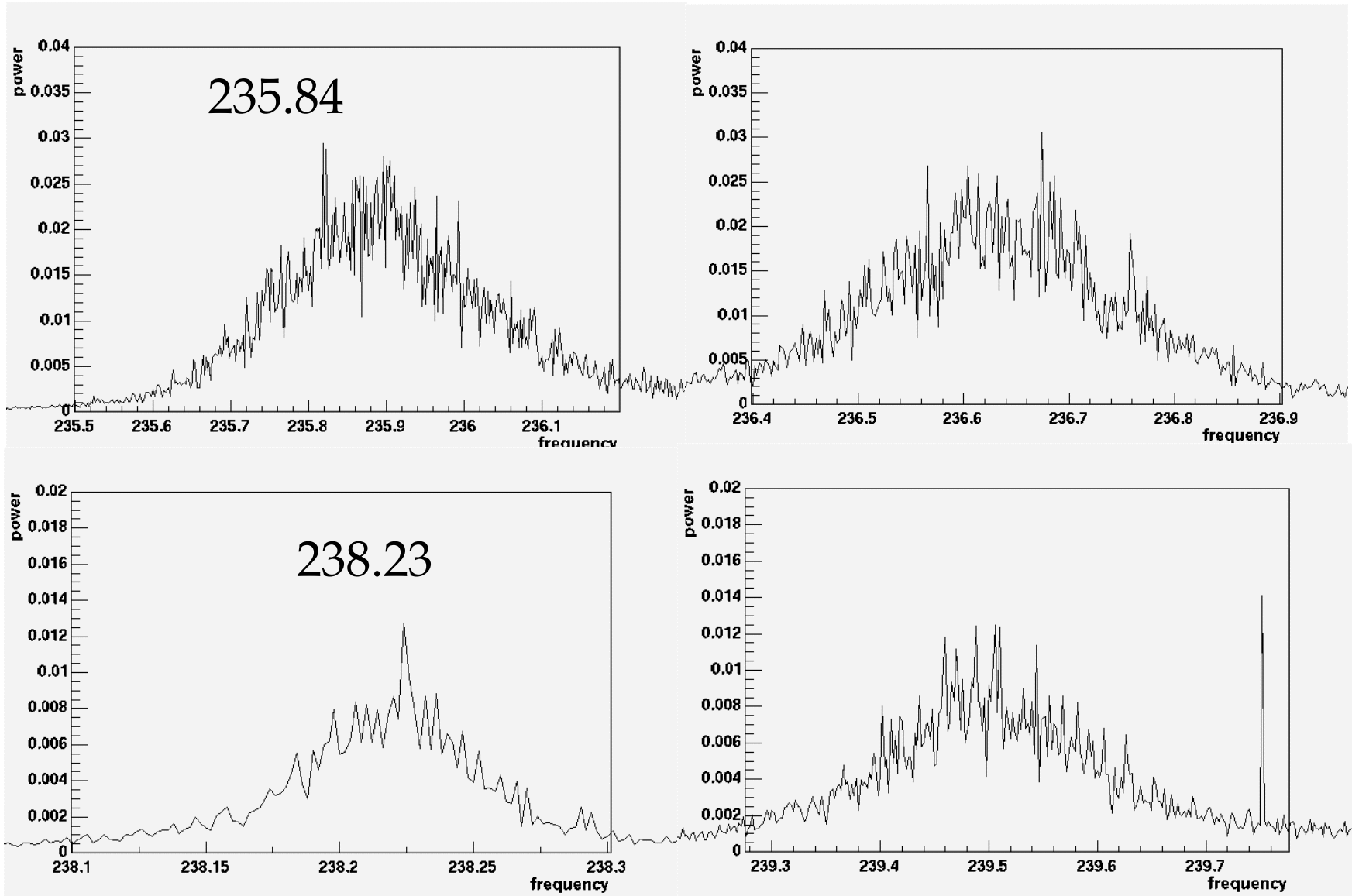
BS violin modes?

- BS violin modes are expected around 225Hz (T000020-01-W)
- group of lines in 235-240 Hz region was observed in the E4 LLO data
 - integrated 3.5h of data (673681395-673699395) with 2mHz resolution
 - too low Q to be violin modes...





BS violin modes?





Documentation & Plans

- <http://blue.ligo-wa.caltech.edu/engrun/E3/index.html>
 - See LNI results at LineMonitor
- Complete & submit E3/E4 final report by end of August
- Further LNI work
 - Look for magnetometer transients in E4 data & its correlation with interferometer channel
 - Need more data & more detail study of “violin modes” using Kalman filter
 - Analysis of E5 data