Schumann resonances in GW data - update

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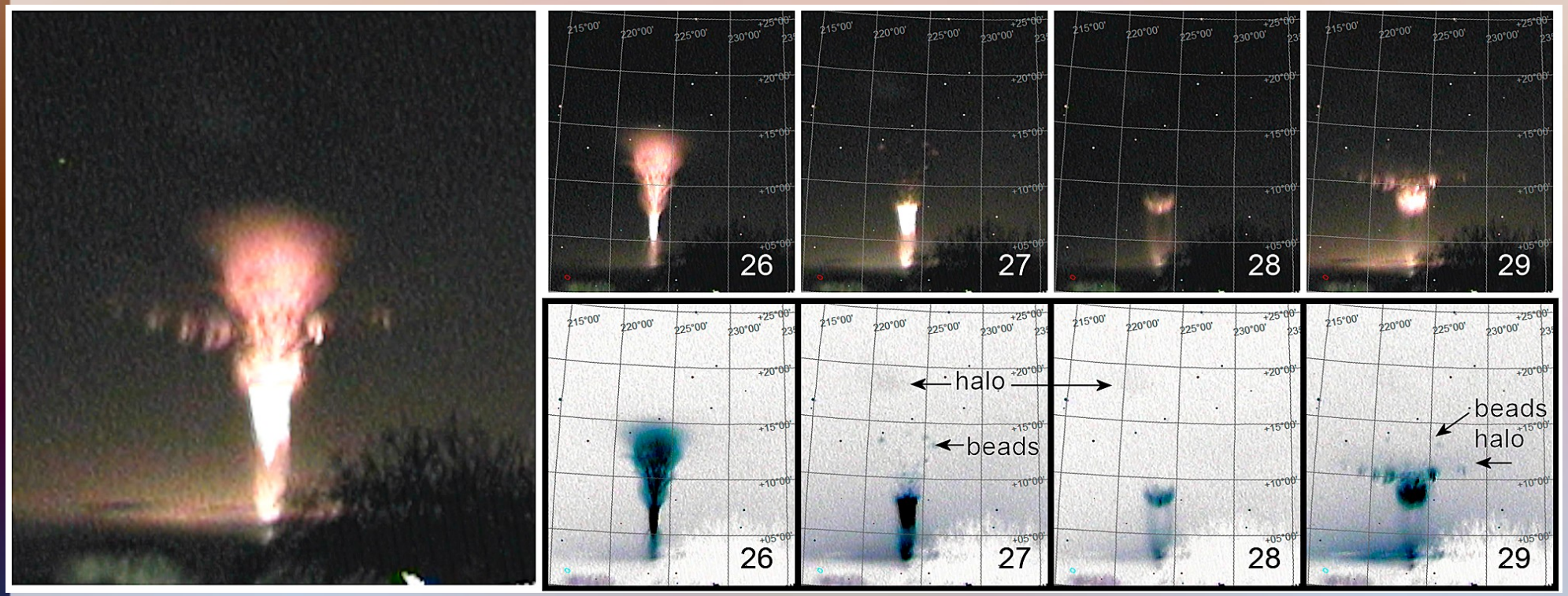
Schumann resonances

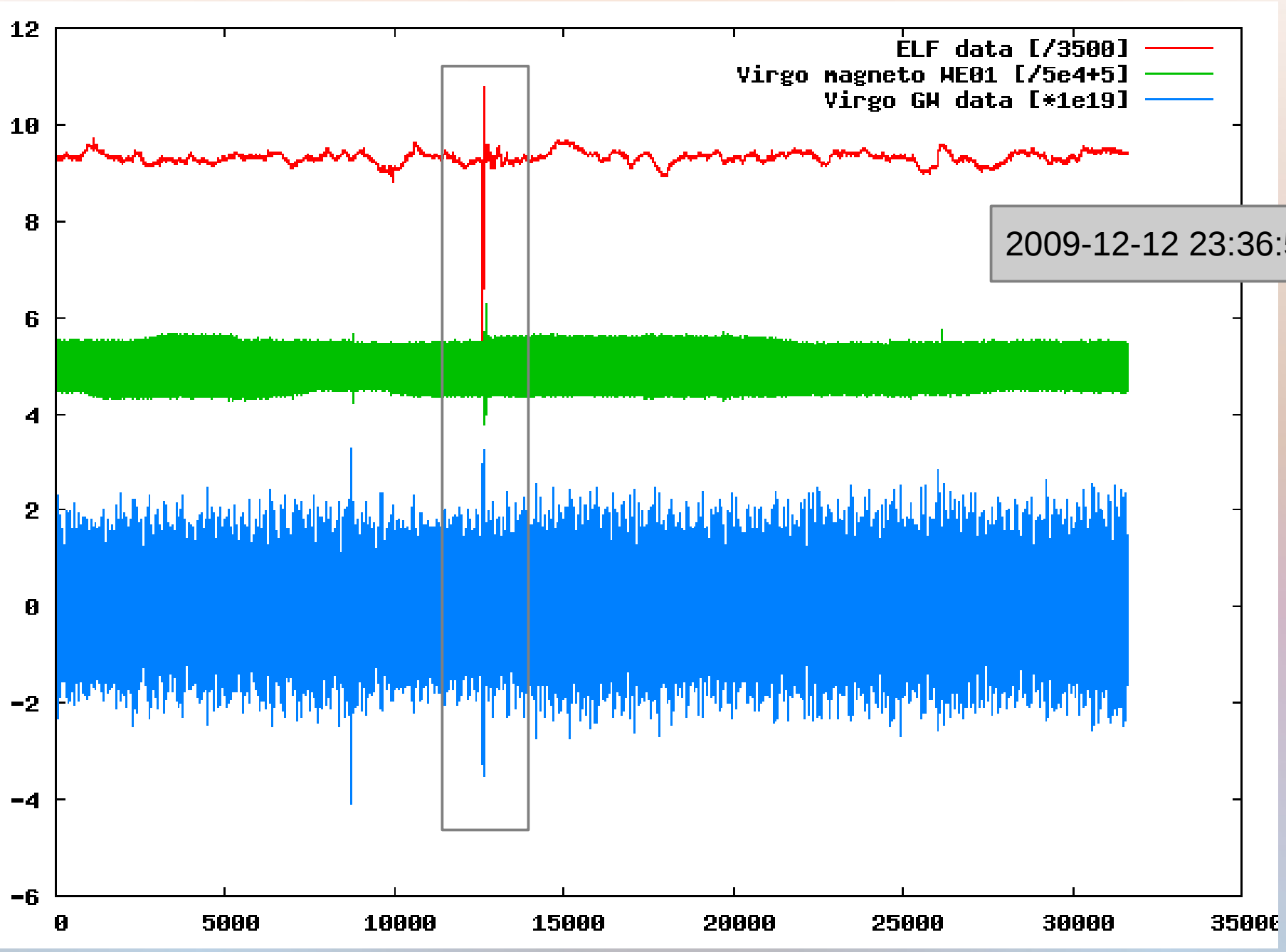
- Electromagnetic waves exited by lighting discharges
- Standing wave in Earth-ionosphere cavity
- Visible in extremely low frequency band (3-60 Hz)
- Global events – can mimic gravitational signal

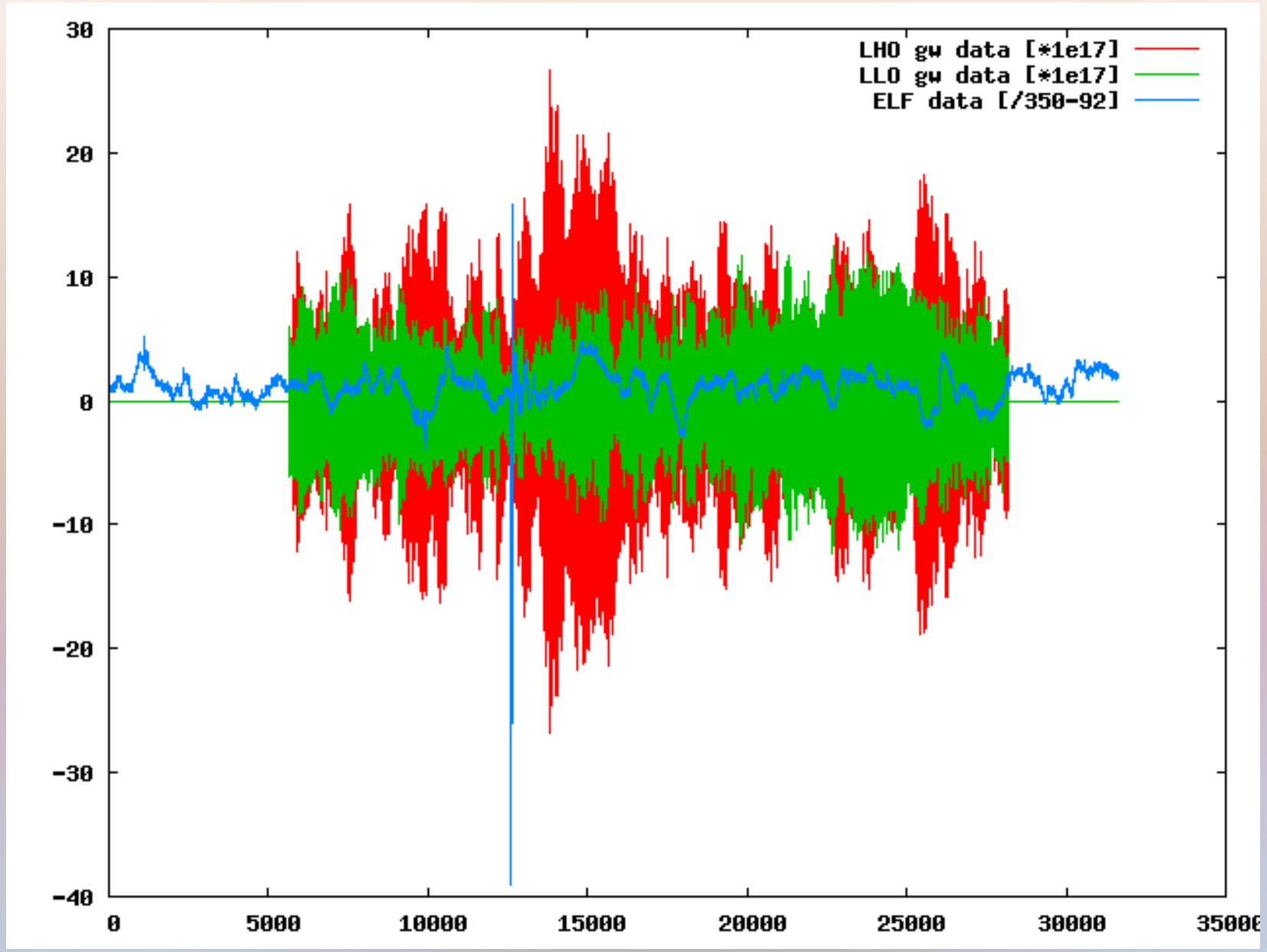
Storm in Corsica

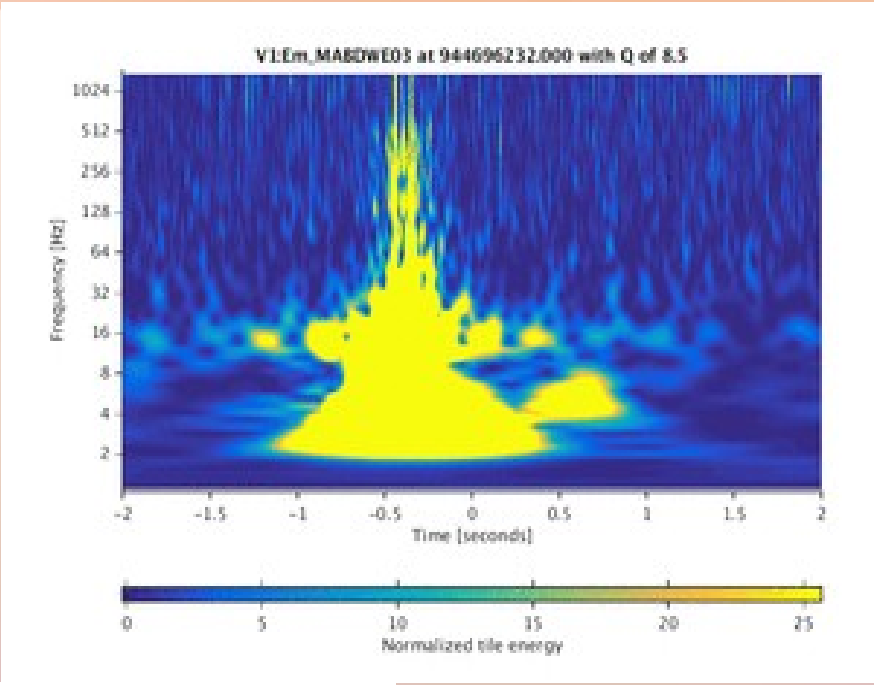
- 12.12.2009 23:36:56 UTC
- The most powerful event observed by group from Krakow

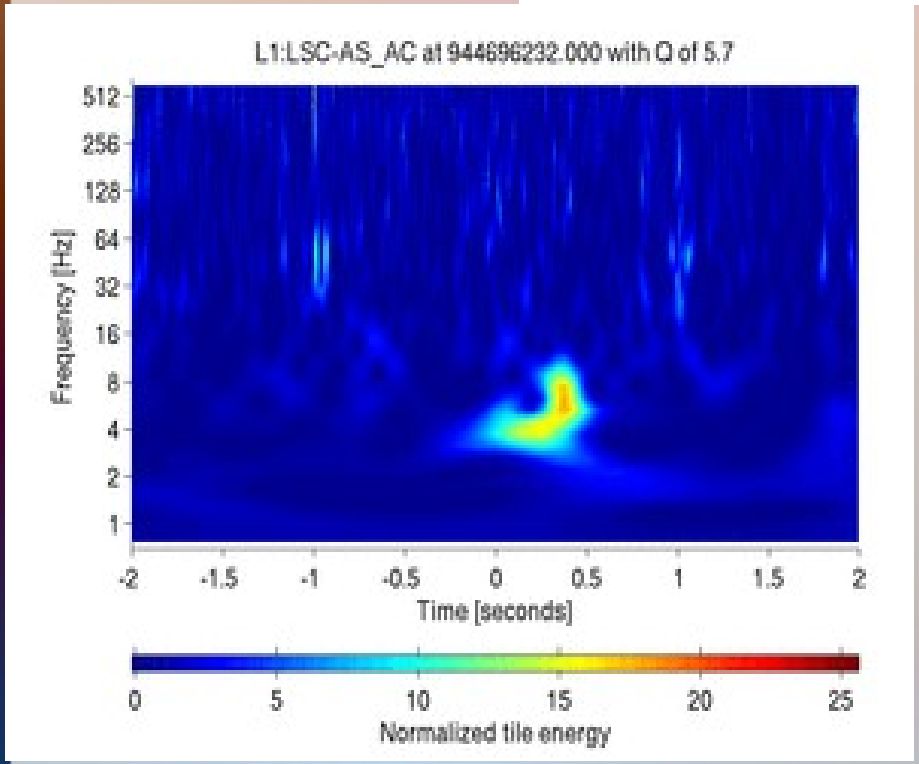


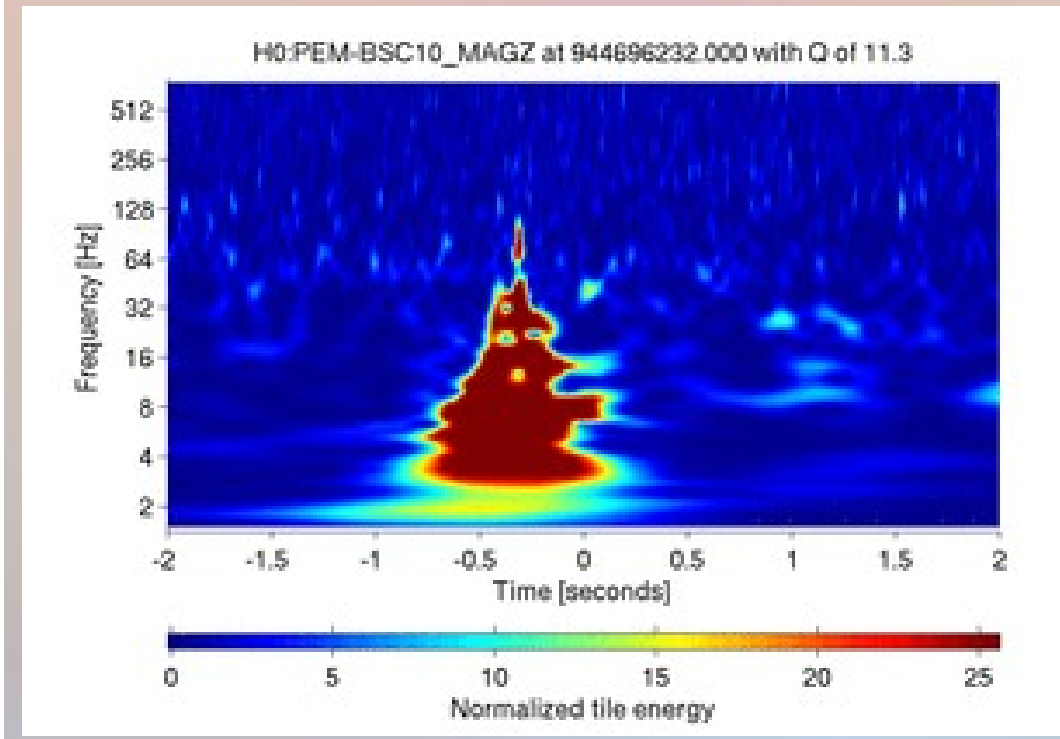
JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 115, D24301, doi:10.1029/2010JD014442, 2010


ELF data [/3500]
Virgo magneto WE01 [/5e4+5]
Virgo GW data [*1e19]
2009-12-12 23:36:56
12
10
8
6
4
2
0
-2
-4
-6
0
5000
10000
15000
20000
25000
30000
35000


LHO gw data [*1e17]
LLO gw data [*1e17]
ELF data [/350-92]
30
20
10
0
-10
-20
-30
-40
0
5000
10000
15000
20000
25000
30000
35000


V1:Em_MABDWE03 at 944696232.000 with Q of 8.5
Frequency [Hz]
1024
512
256
128
64
32
16
8
4
2
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
Time [seconds]
0
5
10
15
20
25
Normalized tile energy

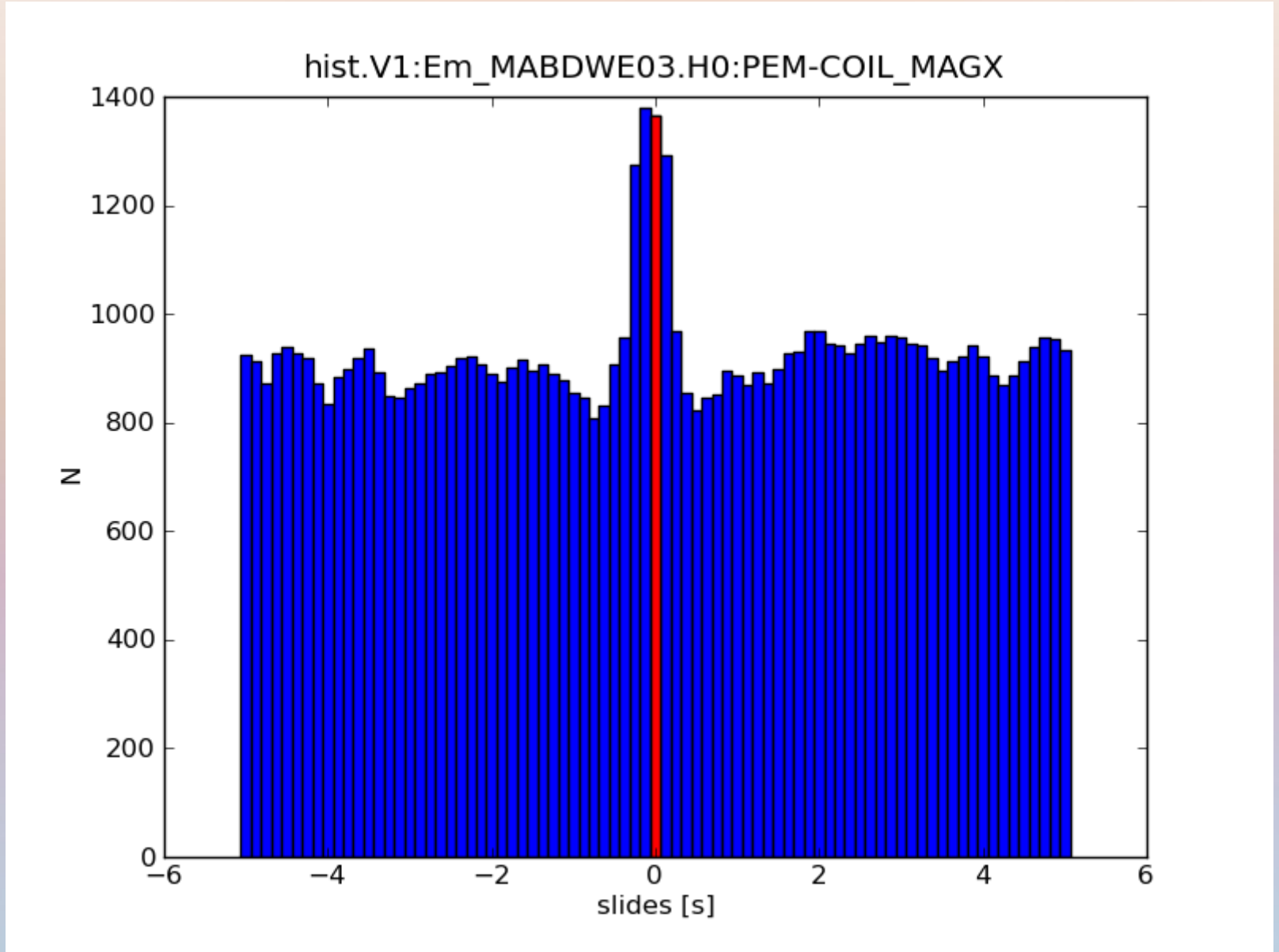

L1:LSC-AS_AC at 944696232.000 with Q of 5.7
Frequency [Hz]
512
256
128
64
32
16
8
4
2
1
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
Time [seconds]
0
5
10
15
20
25
Normalized tile energy

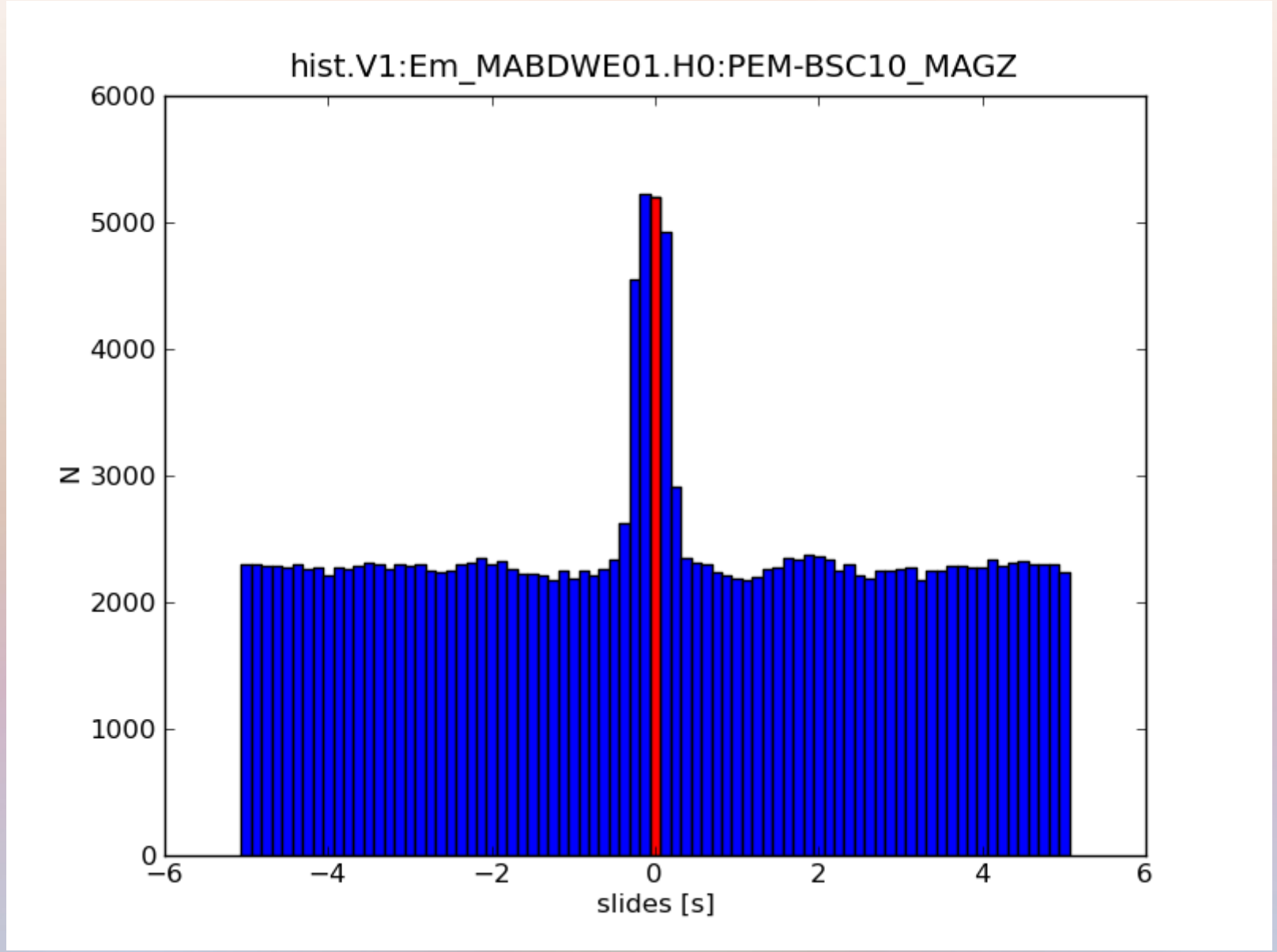

H0:PEM-BSC10_MAGZ at 944696232.000 with Q of 11.3
Frequency [Hz]
512
256
128
64
32
16
8
4
2
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
Time [seconds]
0
5
10
15
20
25
Normalized tile energy

S6/VSR2,3 burst-like search

- Data from science runs S6 and VSR2/3
- 2.5 months of data between 19.10.2009 r. - 08.01.2010 r.
  (940003217 - 946990984)
- Omicron was the main tool
- We analyzed magnetic channels of Virgo i LIGO
- We looked for a time coincidences (0.25s window)
- Times slides as a background estimation (80 slides form -5s to +5s)

S6/VSR2,3 results




hist.V1:Em_MABDWE01.H0:PEM-BSC10_MAGZ
6000
5000
4000
3000
2000
1000
0
N
−6
−4
−2
0
2
4
6
slides [s]

All results

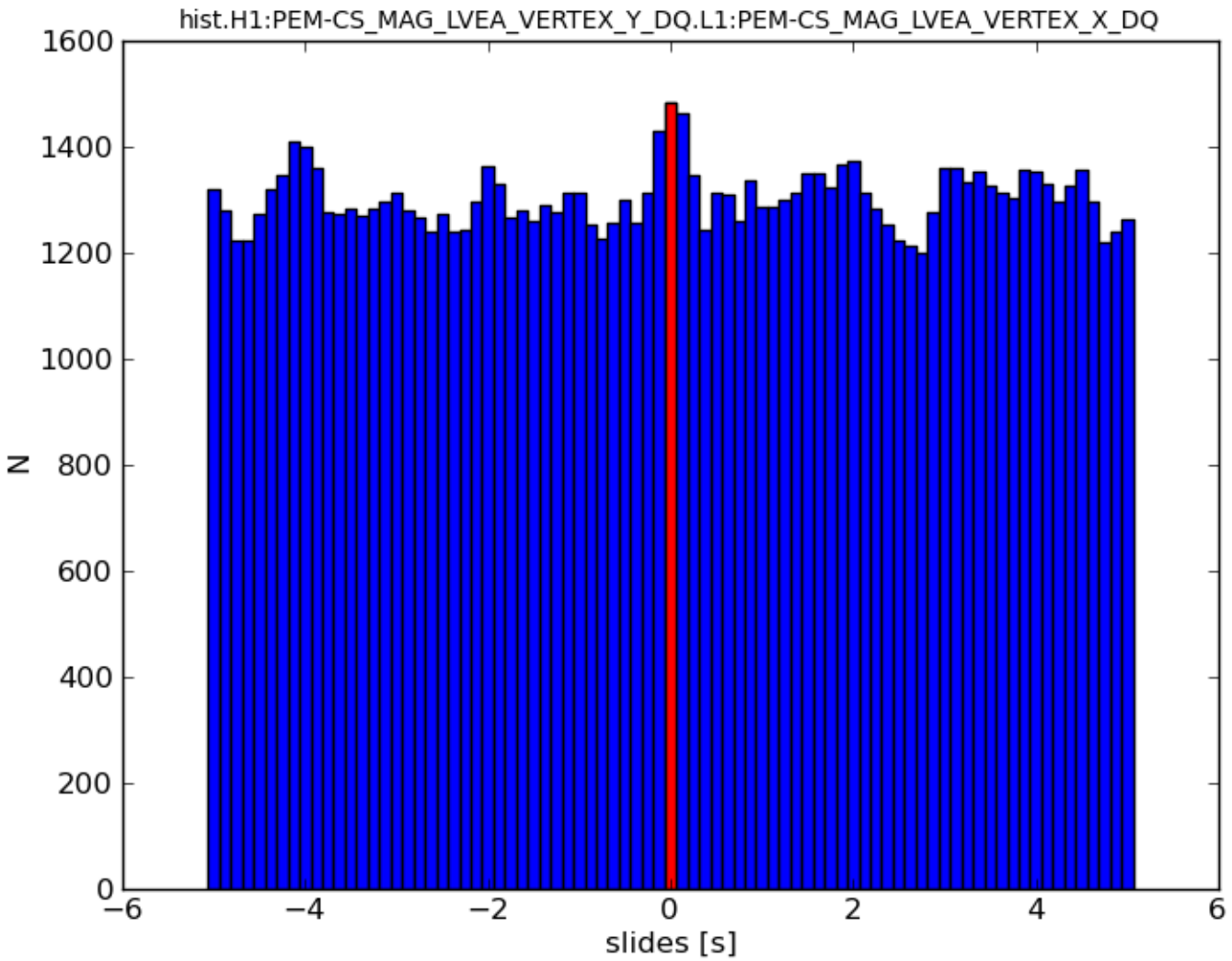
- https://ldas-jobs.ligo.caltech.edu/~izabela/schumann/H1L1/hist_H1L1/plots/
- https://ldas-jobs.ligo.caltech.edu/~izabela/schumann/L1V1/hist_L1V1/plots/
- https://ldas-jobs.ligo.caltech.edu/~izabela/schumann/V1H1/hist_V1H1/plots/

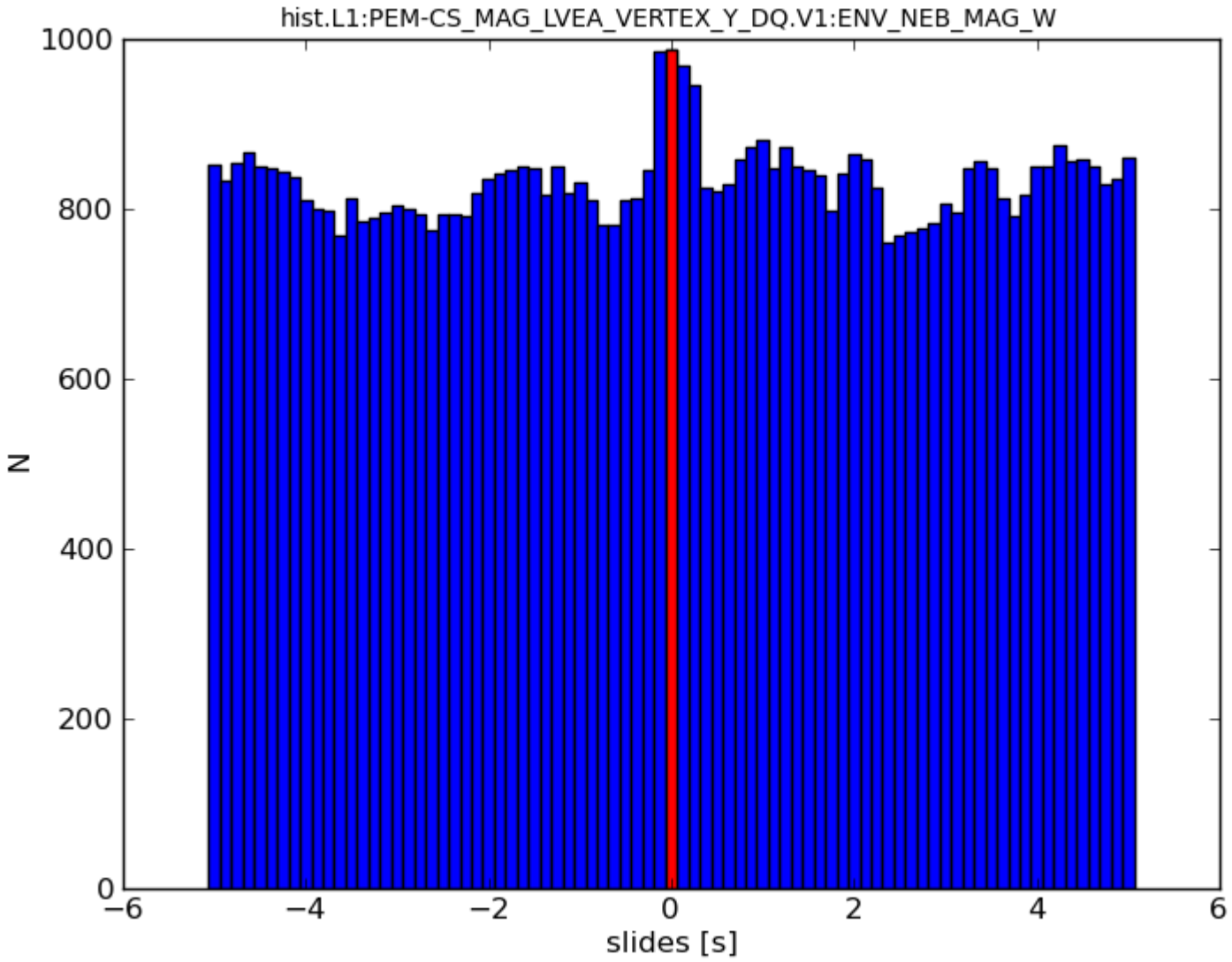
O1 burst-like search

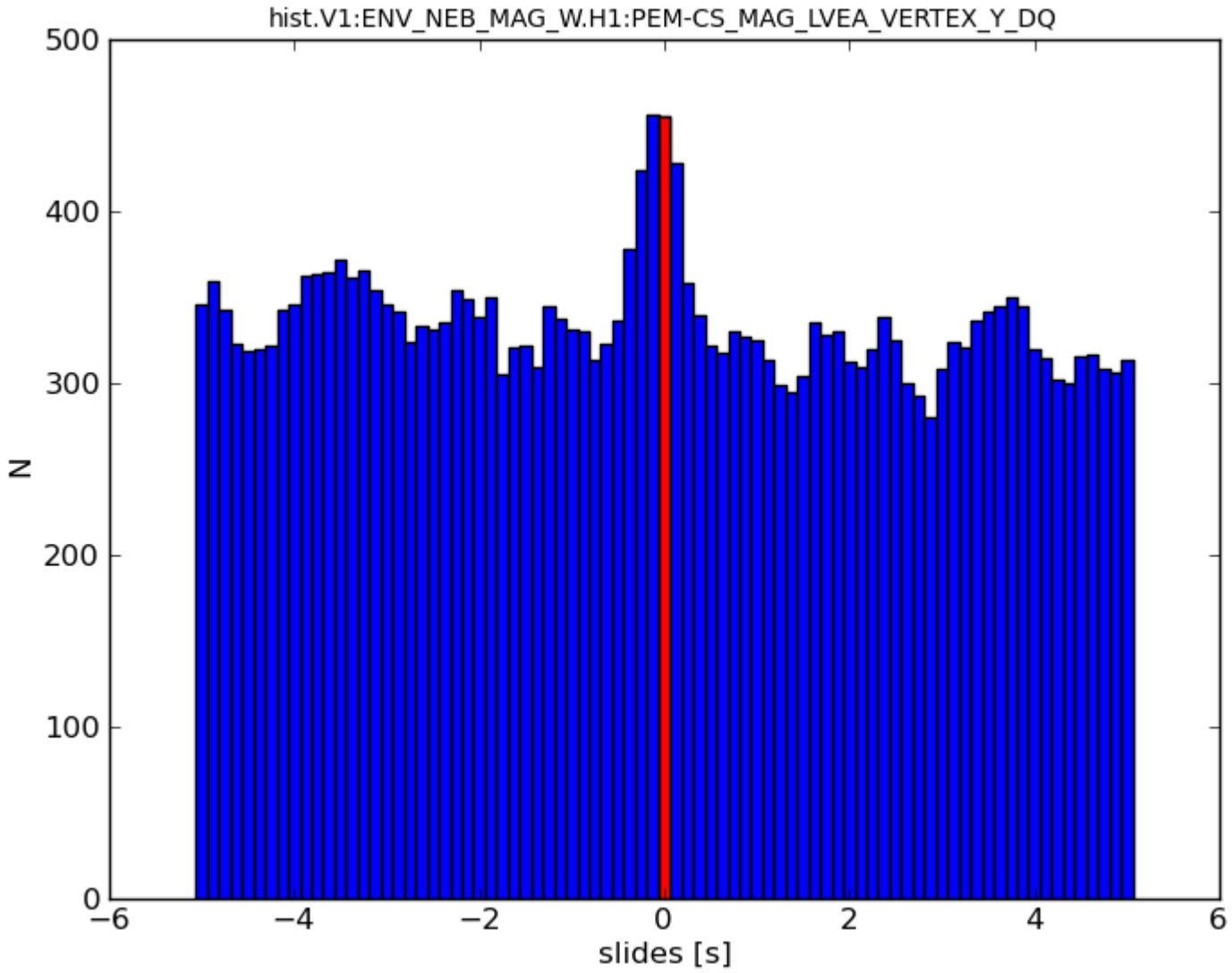
- Data from science run O1
- 2 months of data between 18.09.2015 r. - 12.01.2016 r.

  (1126623615 – 1135699215)
- LIGO: magnetic channels and strain channels
- Virgo: only magnetic channels

O1 results (interesting ones)




hist.L1:PEM-CS_MAG_LVEA_VERTEX_Y_DQ.V1:ENV_NEB_MAG_W
1000
800
600
400
200
0
N
−6
−4
−2
0
2
4
6
slides [s]


hist.V1:ENV_NEB_MAG_W.H1:PEM-CS_MAG_LVEA_VERTEX_Y_DQ
500
400
300
200
100
0
N
−6
−4
−2
0
2
4
6
slides [s]

All results

- https://ldas-jobs.ligo.caltech.edu/~izabela/schumann/O1/H1L1/
- https://ldas-jobs.ligo.caltech.edu/~izabela/schumann/O1/L1V1/
- https://ldas-jobs.ligo.caltech.edu/~izabela/schumann/O1/V1H1/

Effect on the h(t) channels

- Coincidences between strain channel of one detector and magnetic channels of the other
- No magnetic triggers in the h(t)

Summary

- We can see Schumann resonances in GW detectors
- There is clear correlation between magnetic channels of different detectors
- There is no evidence that any magnetic event during S6 and O1 caused triggers in GW channel
- Advanced detectors are more sensitive to the lower frequencies, so we need to monitor that phenomena.