The GEO Line detection Monitor

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What we want:

1 - A systematic detection of line frequencies in a spectrum.

Taking into account:

(i) The huge amount of data to process: we need a fast algorithm (at least real time).

(ii)The eventual high dynamic range of the spectrum.

(iii)A rate of false alarm --> user parameter 1.

2 – Keep the relevant information in a database (amplitude, bandwidth...).

Method overview 1\2 (Preprocessing data):

For different discrete time *k* = [1 .. n]

1. Compute the Spectrum at a given time *k* (Welch Periodogram):

2. Compute its equivalent noise floor (method = user parameter 2, bandwidth = user parameter 3):

3. Choose to detect lines in the normalized spectrum

rather than on the original spectrum.

Method overview 2\2 (the detection):

1. The distribution of the normalized spectrum *P(f)* follows a gamma distribution whose order depends on the spectrum estimator.

2. We fix the probability of false alarm (Pfa). Then the Neyman Pearson test gives us the threshold to apply:

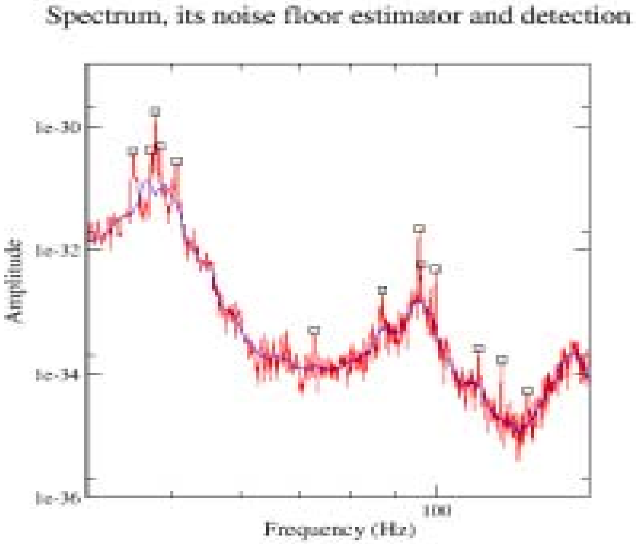
Pfa --> λ

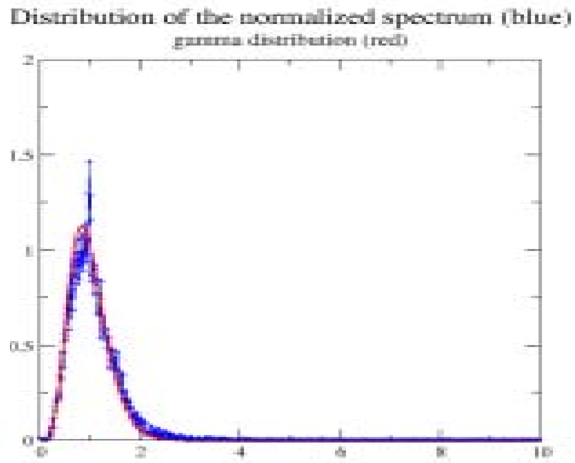
3.We extract local maximum for which

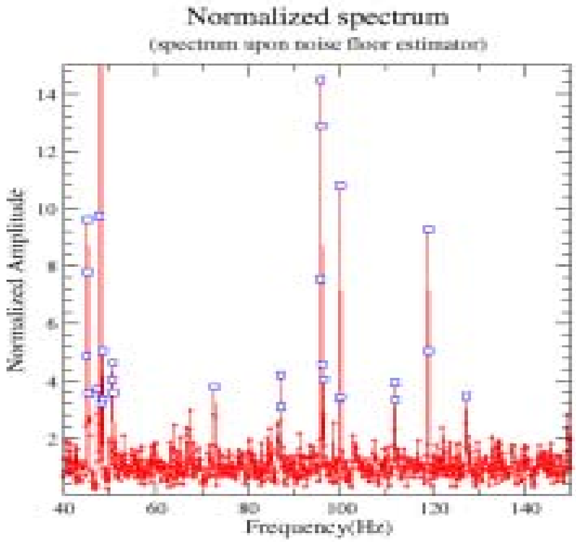
$P(f) > \lambda$

Example: Line detection (GEO data)

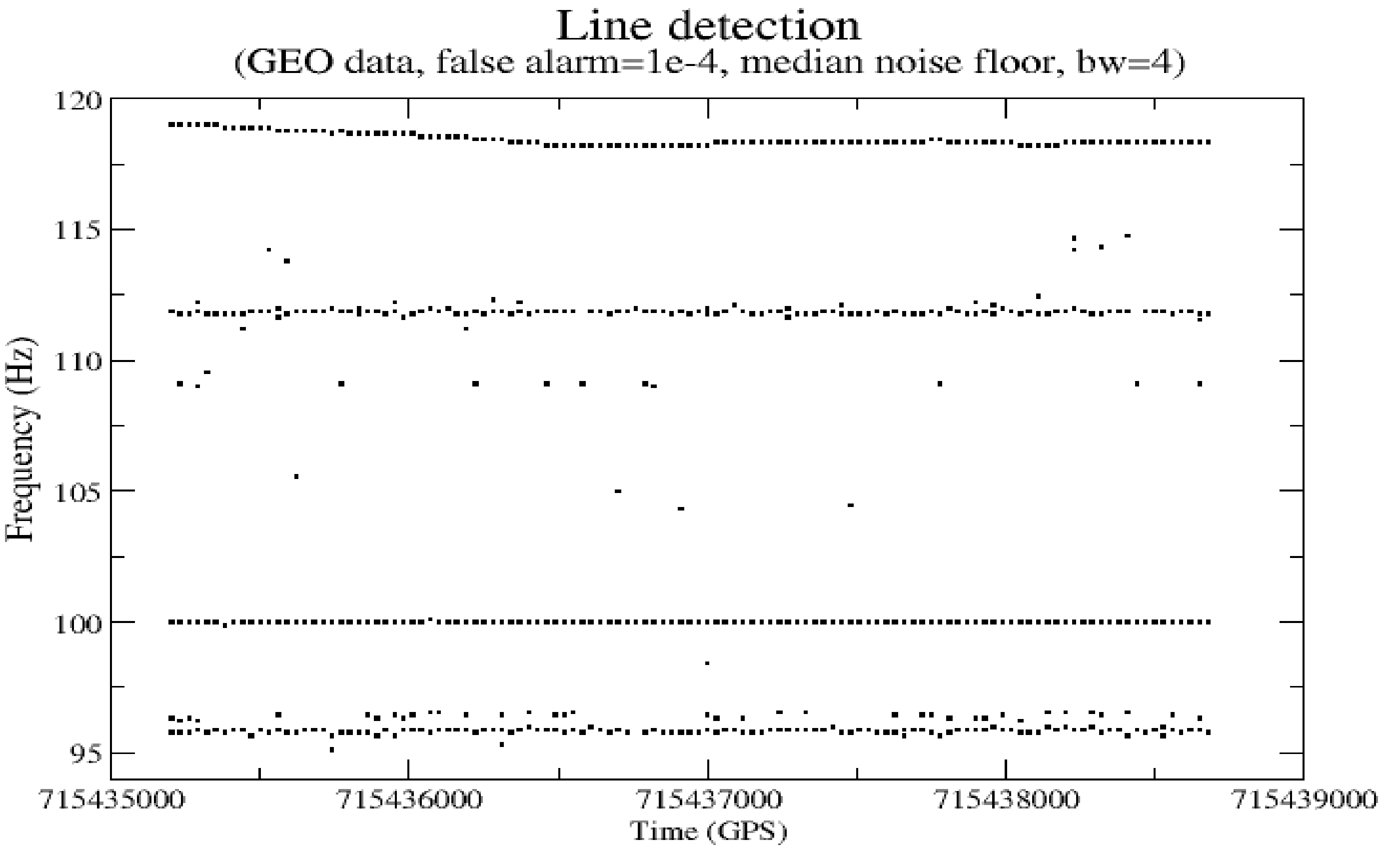
And







Example: Line detection @ different time = Time Frequency distribution

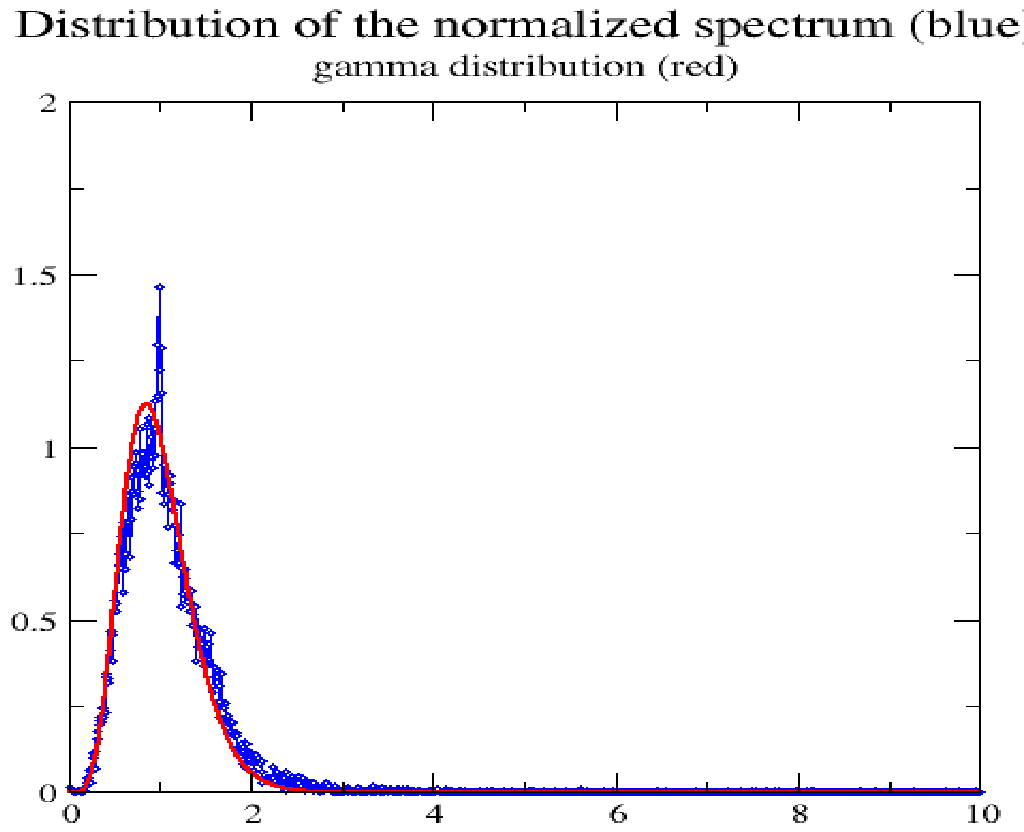


Conclusions:

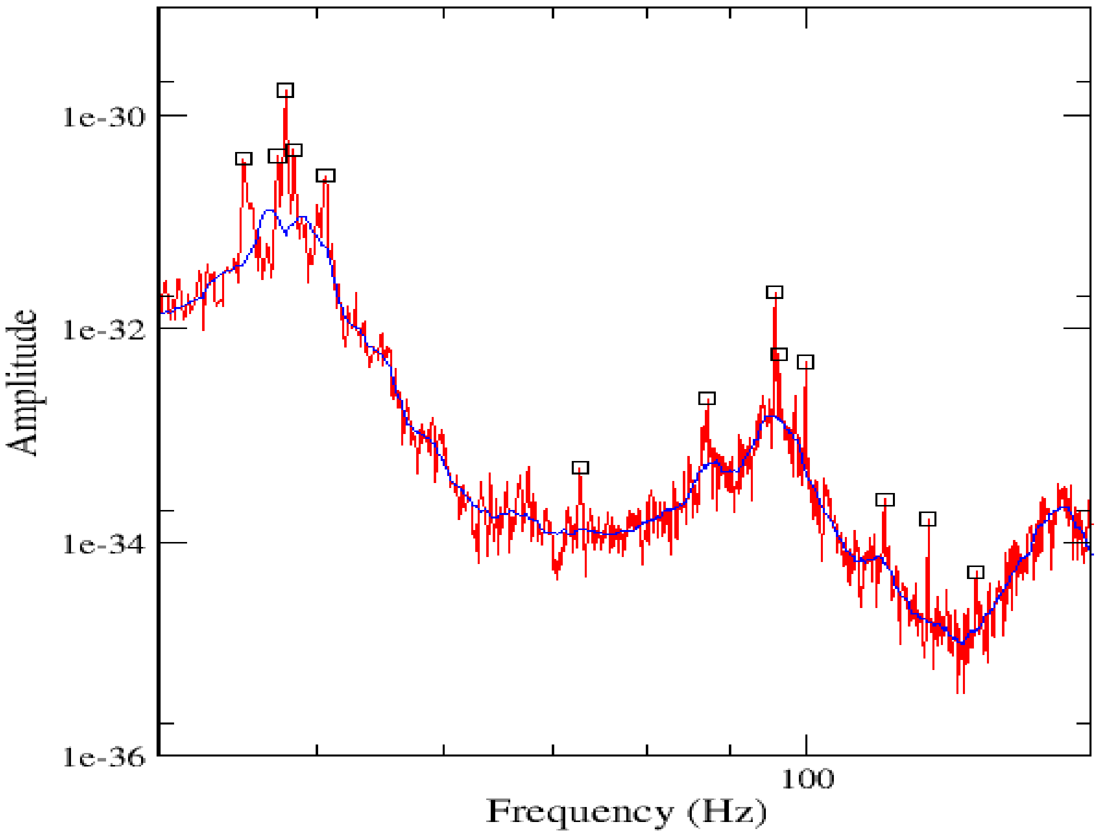
The line detector monitor seems to be suitable for both faint and strong line detection (since user can adjust the false alarm rate).

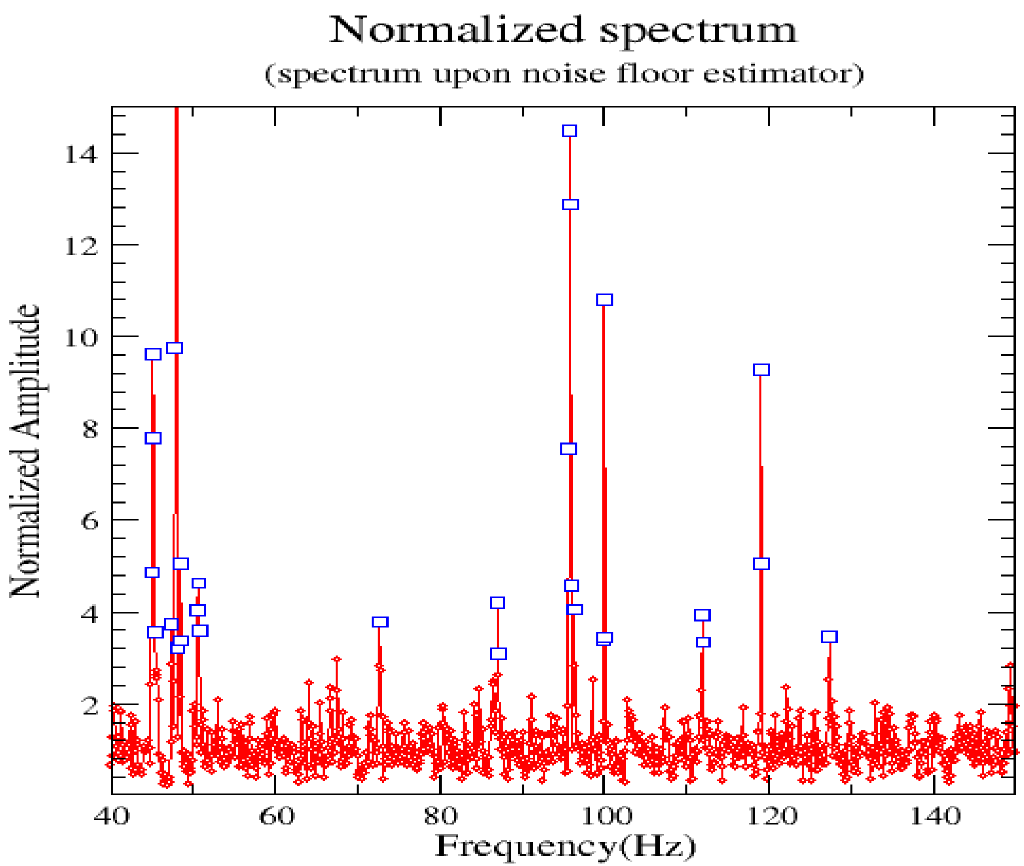
This monitor is now implemented in the GEO++ package.
Triana provides an interface to the results written into the database.

However, investigations need to be done on (i) the effects of the noise floor estimator on the detection probability and on (ii) the influence of non gaussian noise on the final false alarm rate.

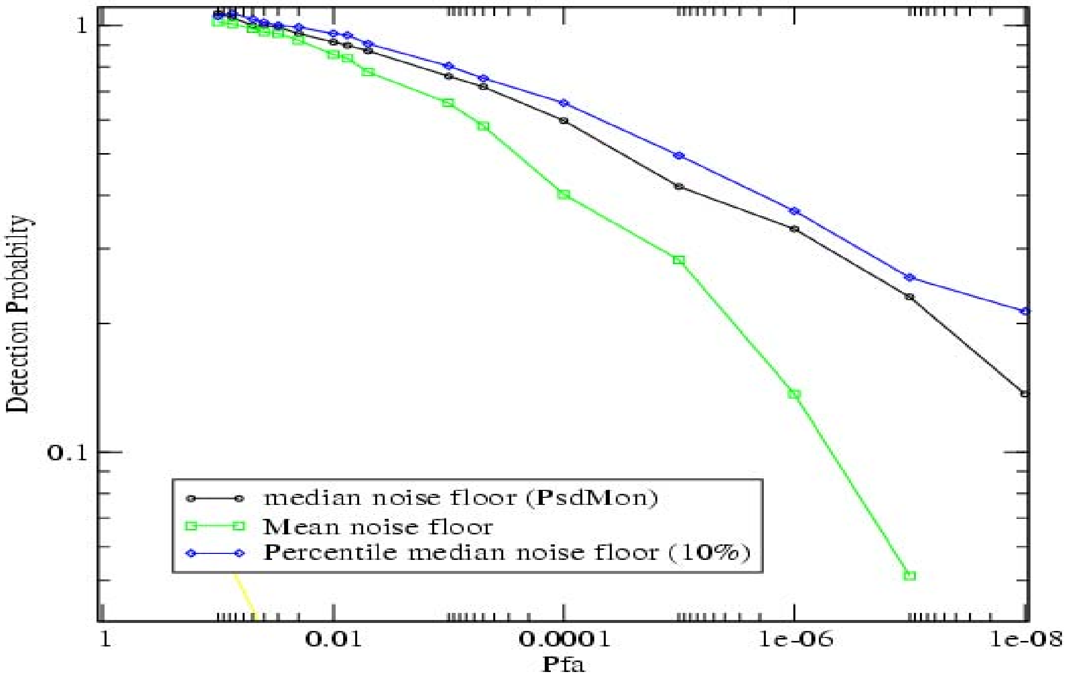

Distribution of the normalized spectrum (blue)
gamma distribution (red)
2
1.5
1
0.5
0
0
2
4
6
8
10

Spectrum, its noise floor estimator and detection




Normalized spectrum
(spectrum upon noise floor estimator)
Normalized Amplitude
Frequency(Hz)
2
4
6
8
10
12
14
40
60
80
100
120
140

Probability of detection vs probability of false alarm for different noise floor estimator . (Peak at 72.8 Hz, GPSTime=715435200, Geo data)



Probability of detection vs probability of false alarm for different bandwidth (Peak at 72.8 Hz, GPSTime=715435200, Geo data) .