MNFT : Robust detection of slow nonstationarity in LIGO Science data

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Why :

- Interferometric data has three components : Lines, transients, noise floor.
- Study of a change in any one of these without elimination of the other two will cause interference.
- Lines dominate.
- Presence of transients change the central tendency.
- "SLOW" nonstationarity of noise floor interesting in the analysis of several astrophysical searches, e.g. Externally triggered search.
- To be able to simulate the non-stationarity to test the efficiencies of various algorithms.

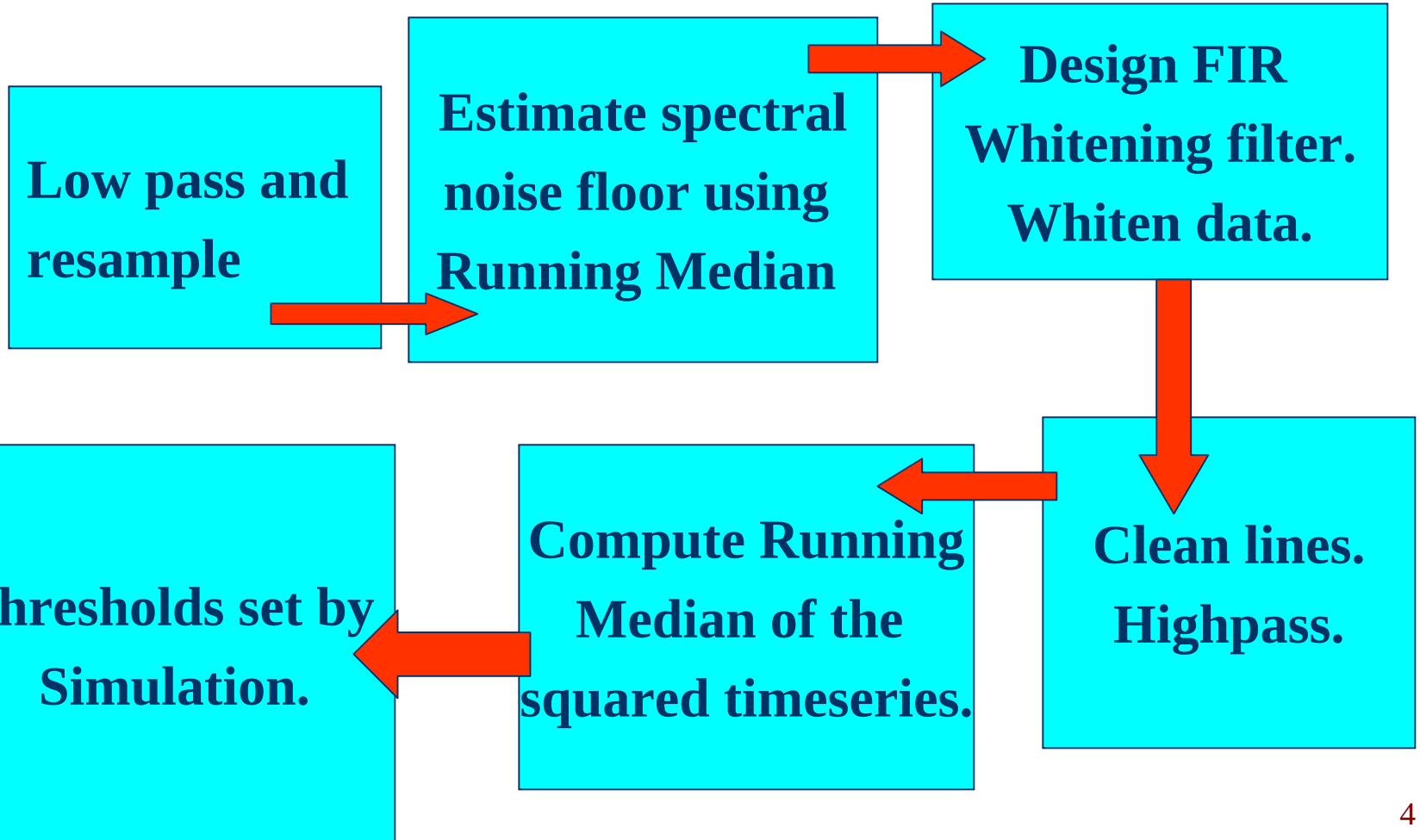
Method :

- **MNFT :**

1. Bandpass and resample given timeseries *x(k)*.
2. Construct FIR filter than whitens the noise floor. Resulting timeseries : *w(k)*
3. Remove lines using notch filter. Cleaned timeseries : *c(k)*
4. Track variation in second moment of *c(k)* using Running Median*.
5. Obtain significance levels of the sampling distribution via Monte Carlo simulations.

* *Mohanty S.D., 2002, CQG*

Sequence :


Low pass and resample
Estimate spectral noise floor using Running Median
Design FIR Whitening filter. Whiten data.
Clean lines. Highpass.
Compute Running Median of the squared timeseries.
Thresholds set by Simulation.

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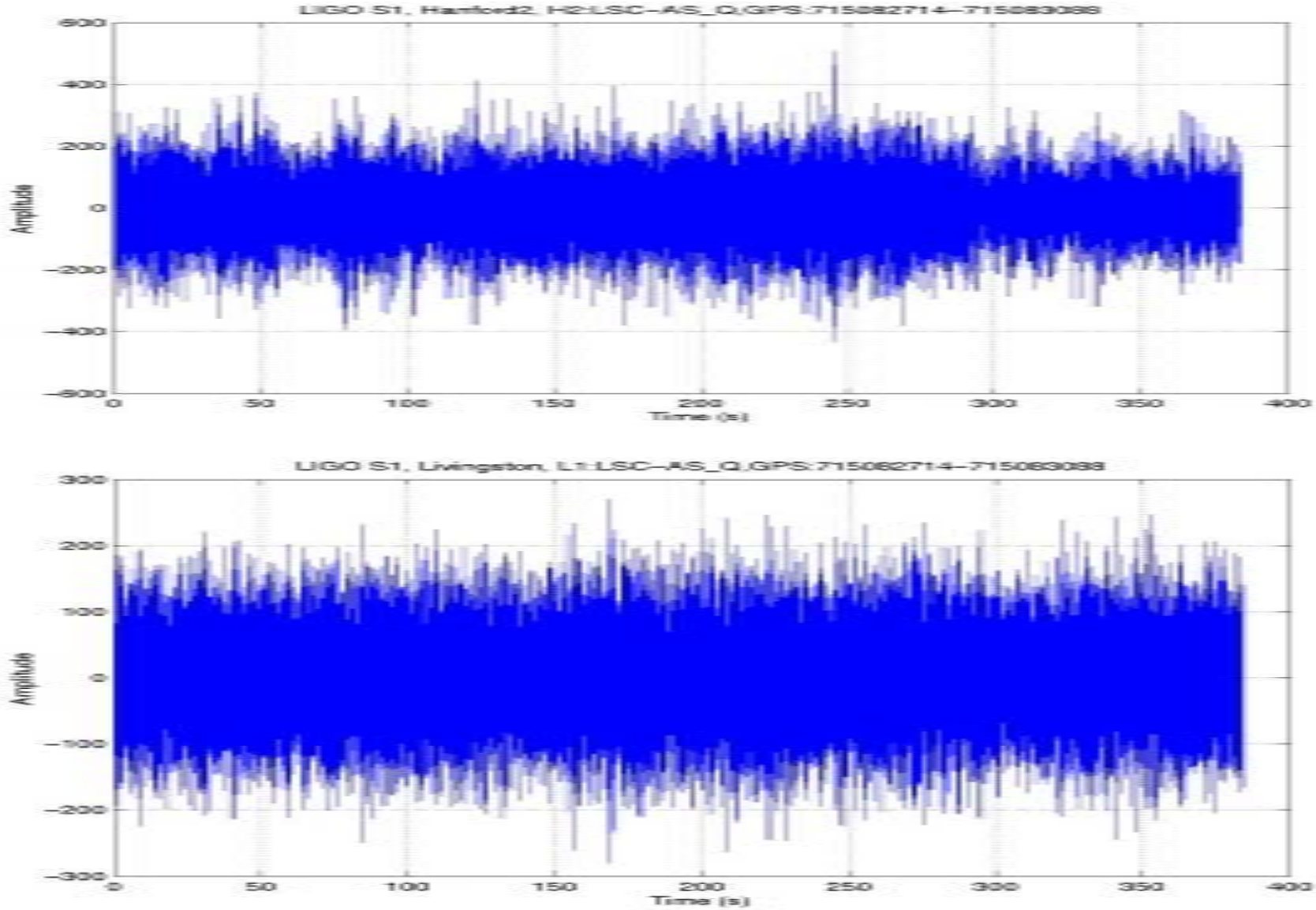
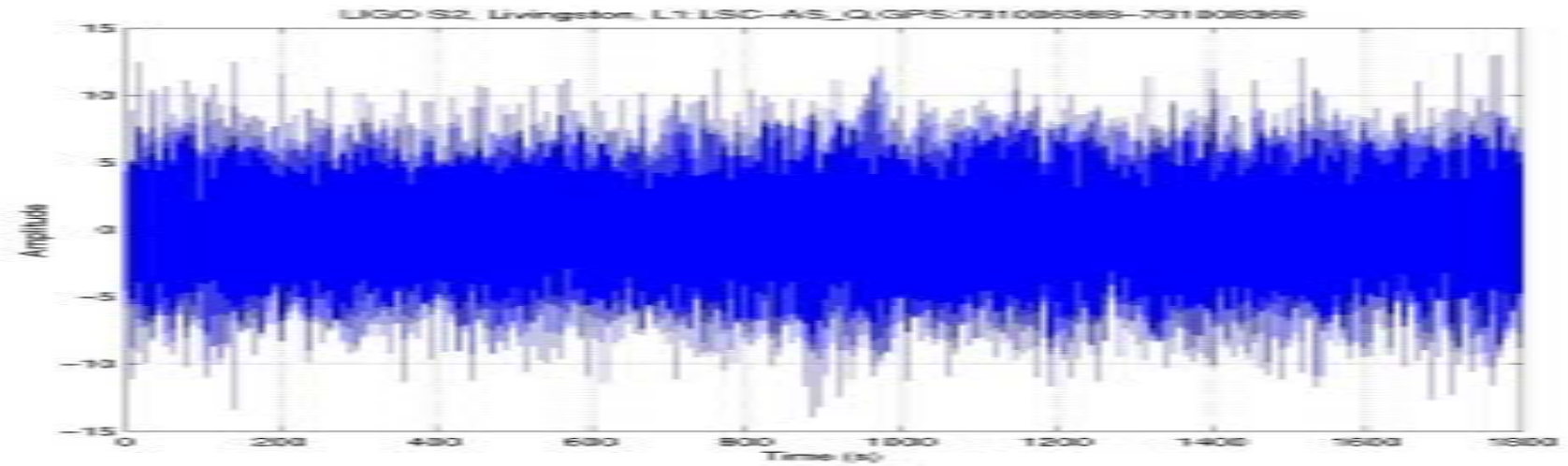
Data :

Locked segments from :

- LIGO S1 : L1 and H2
- LIGO S2 : L1 and H1


LIGO S1, Hanford2, H2:LSC-AS_Q,GPS:715082714-715083098
Amplitude
Time (s)
LIGO S1, Livingston, L1:LSC-AS_Q,GPS:715082714-715083098
Amplitude
Time (s)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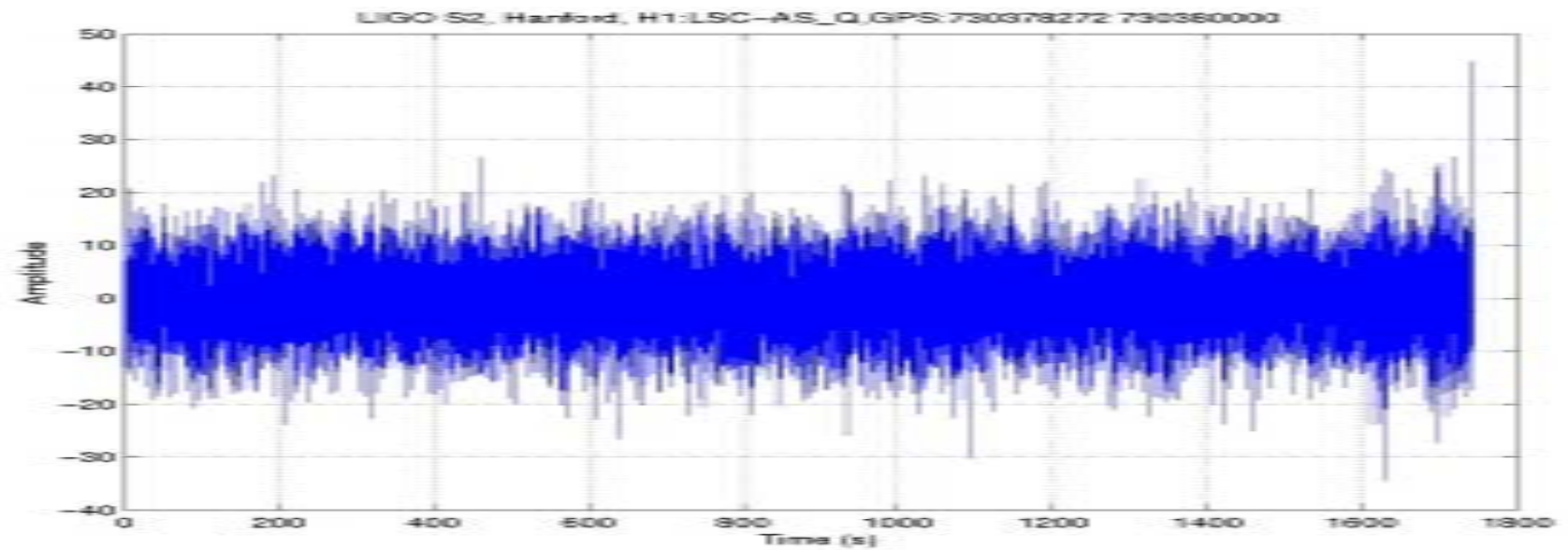
Amplitude
Time (s)


LIGO S2, Hanford, H1:LSC-AS_Q,GPS:730378272 730380000
Amplitude
Time (s)

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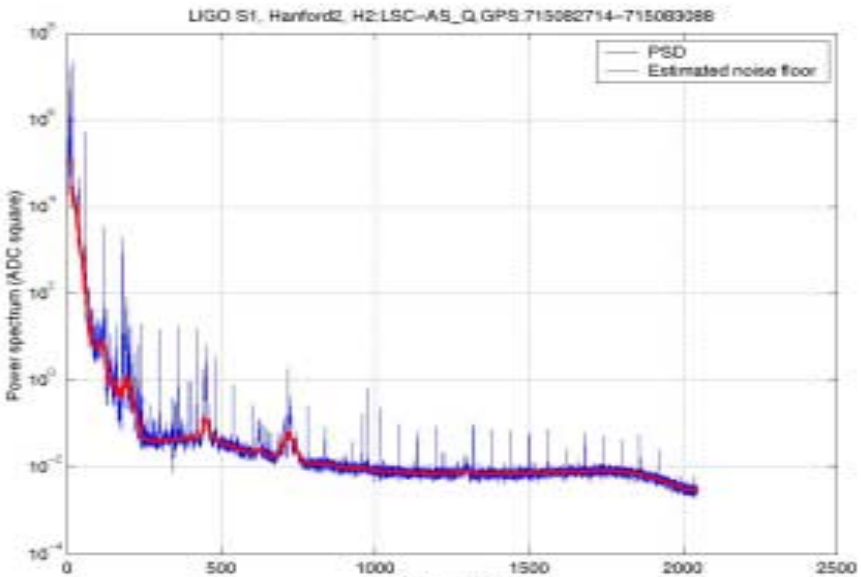

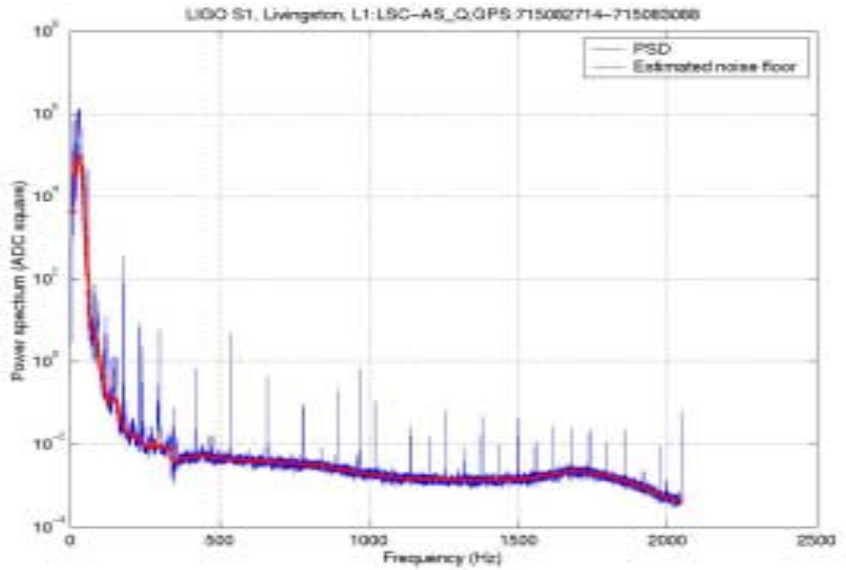

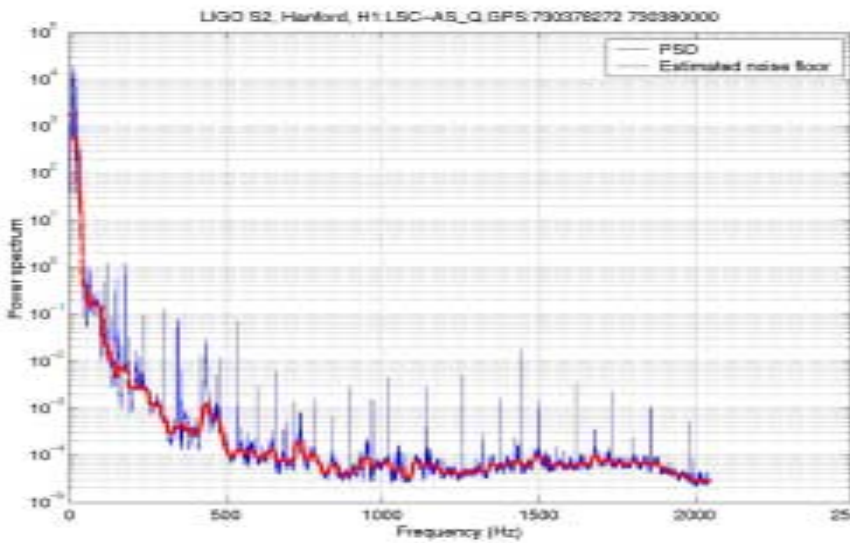

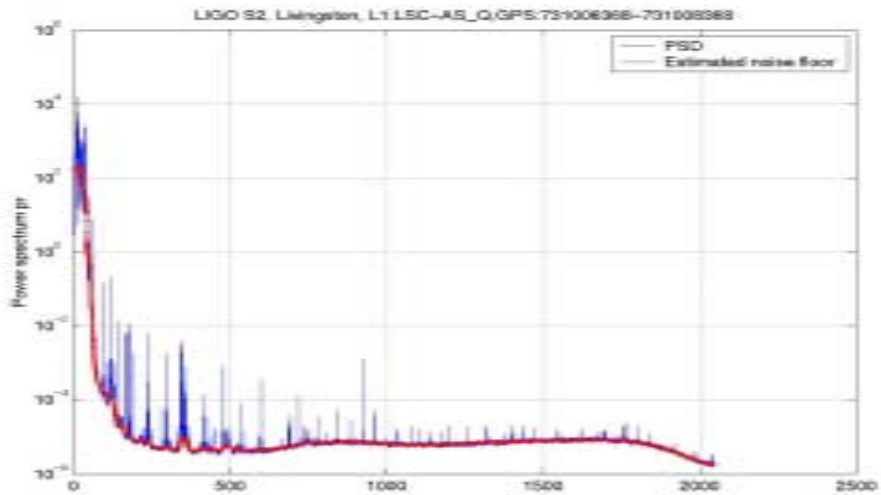

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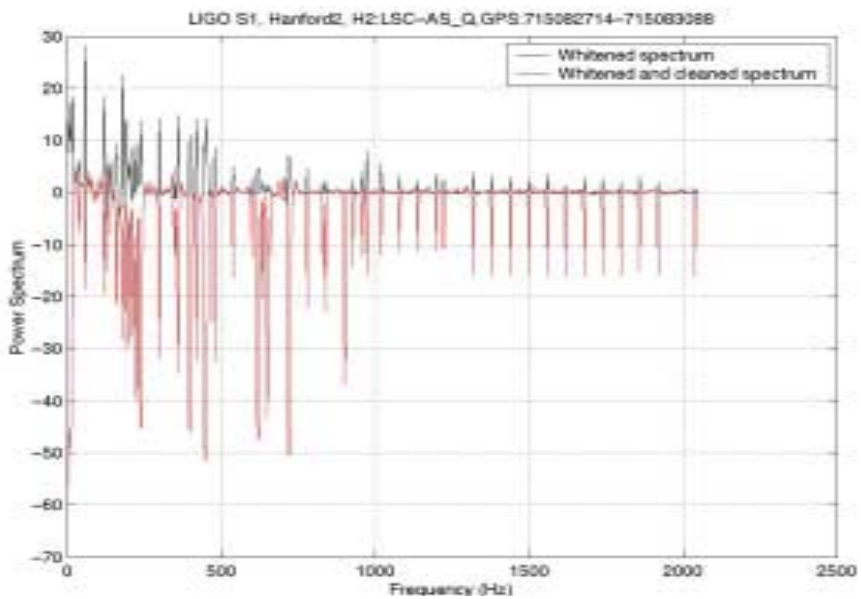

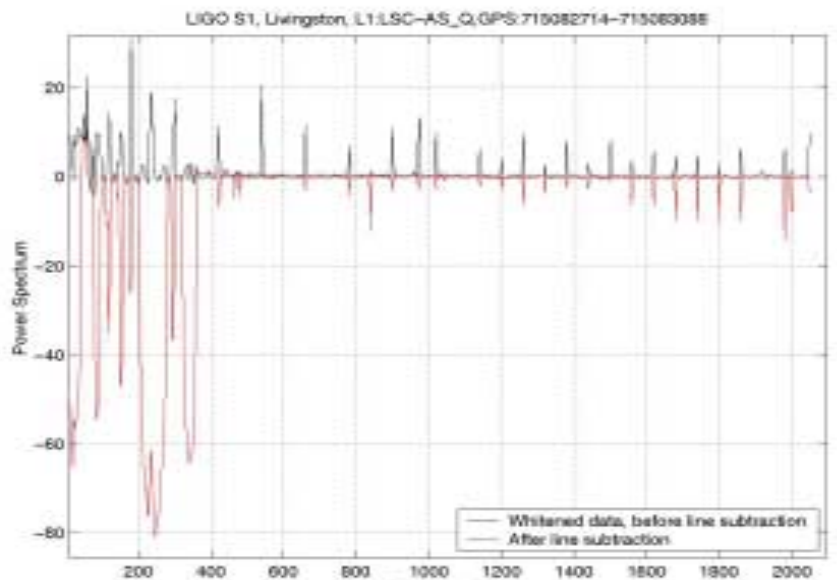

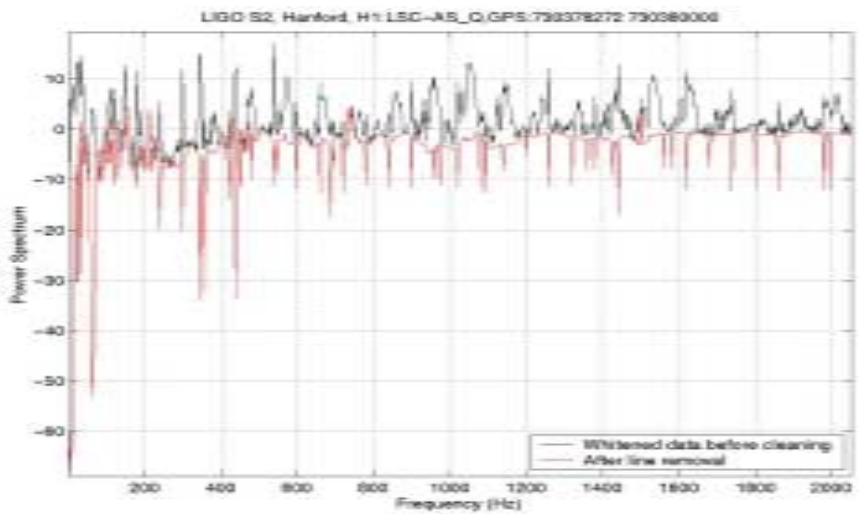

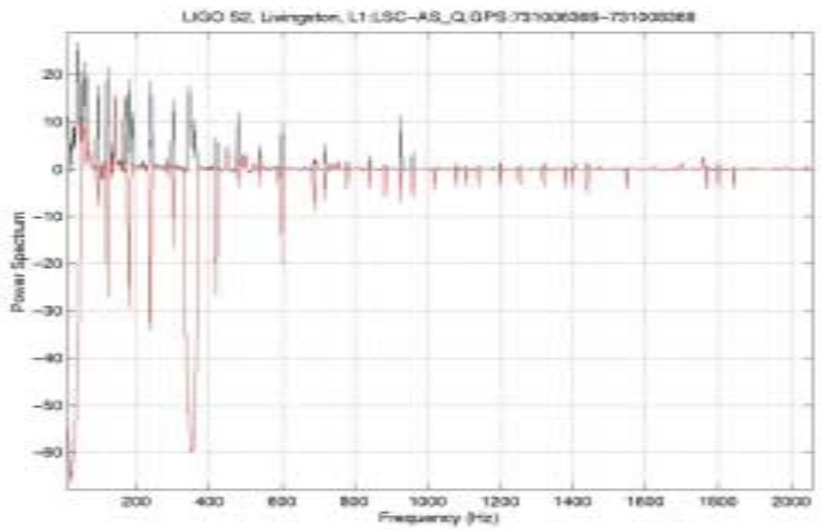

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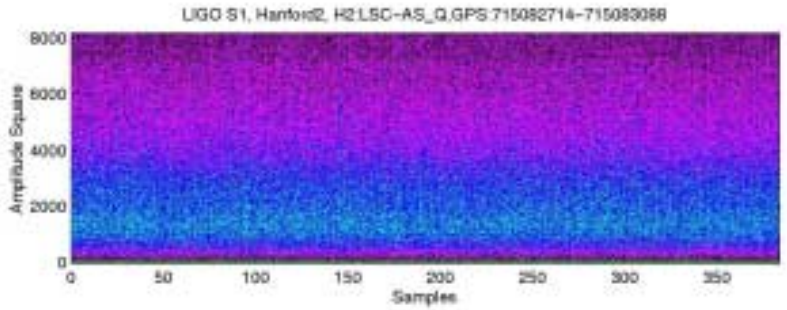

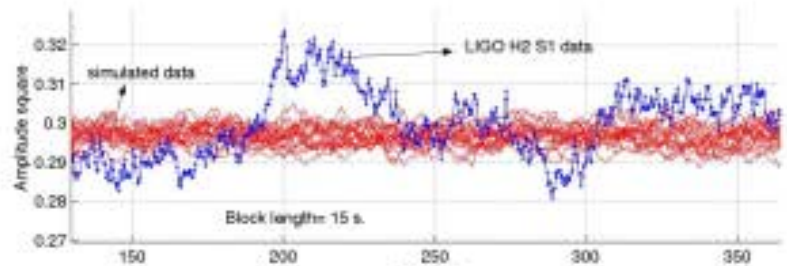

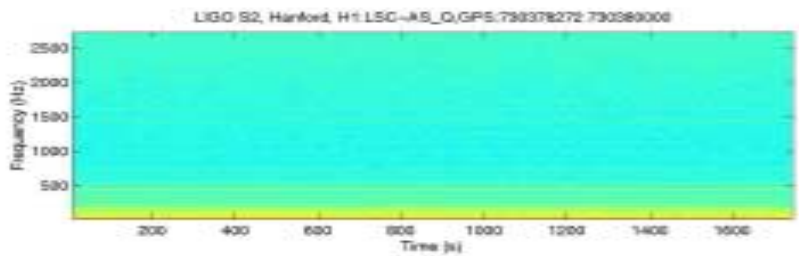

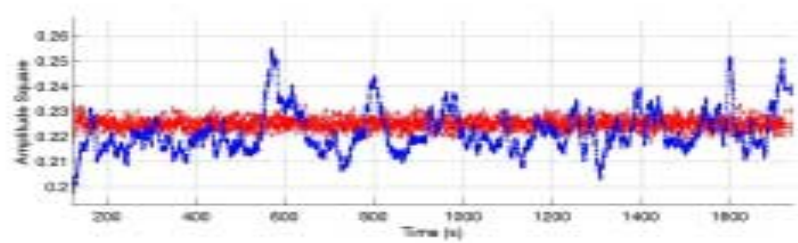

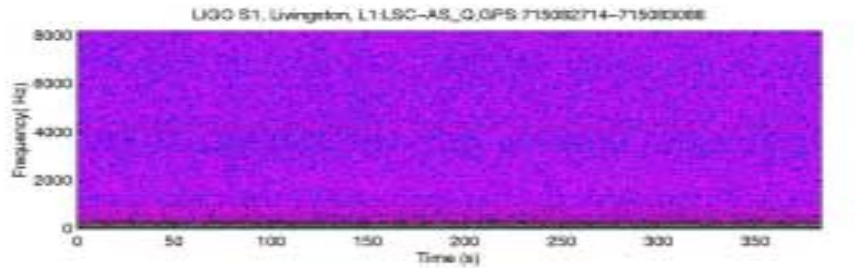

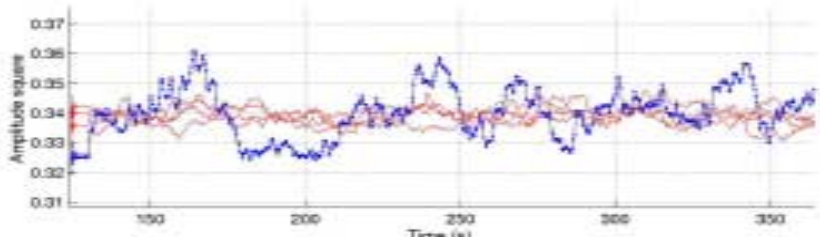

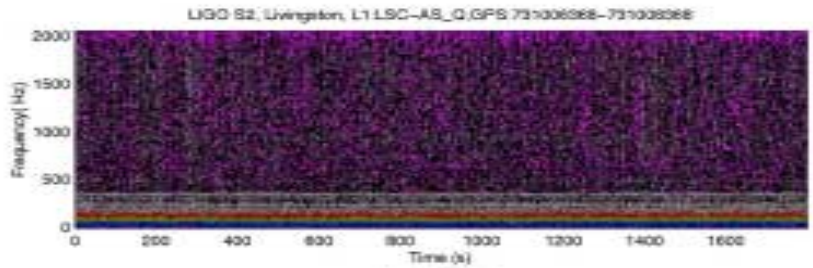

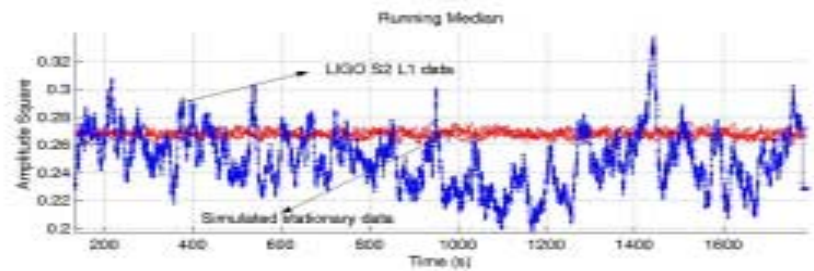

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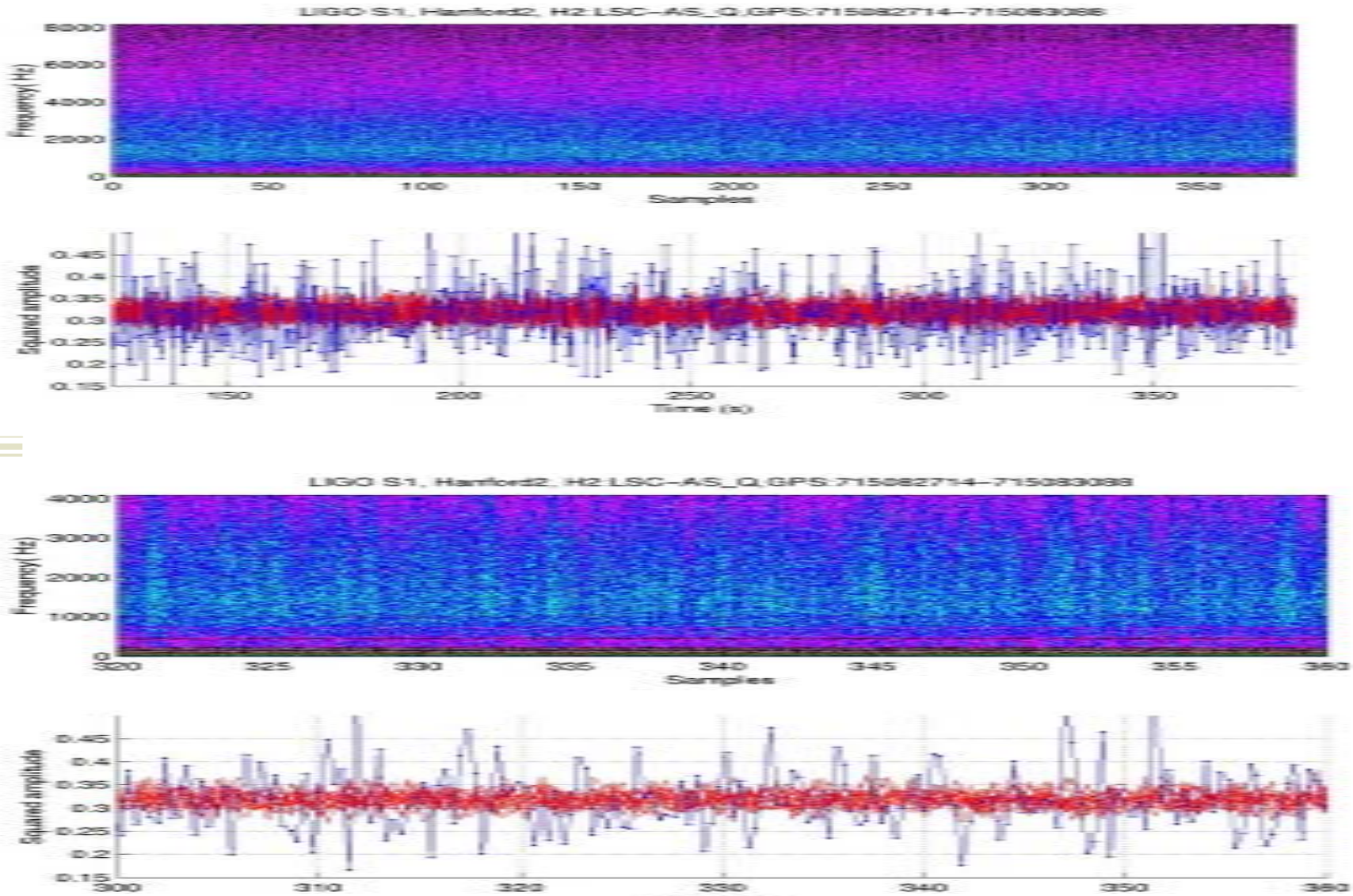

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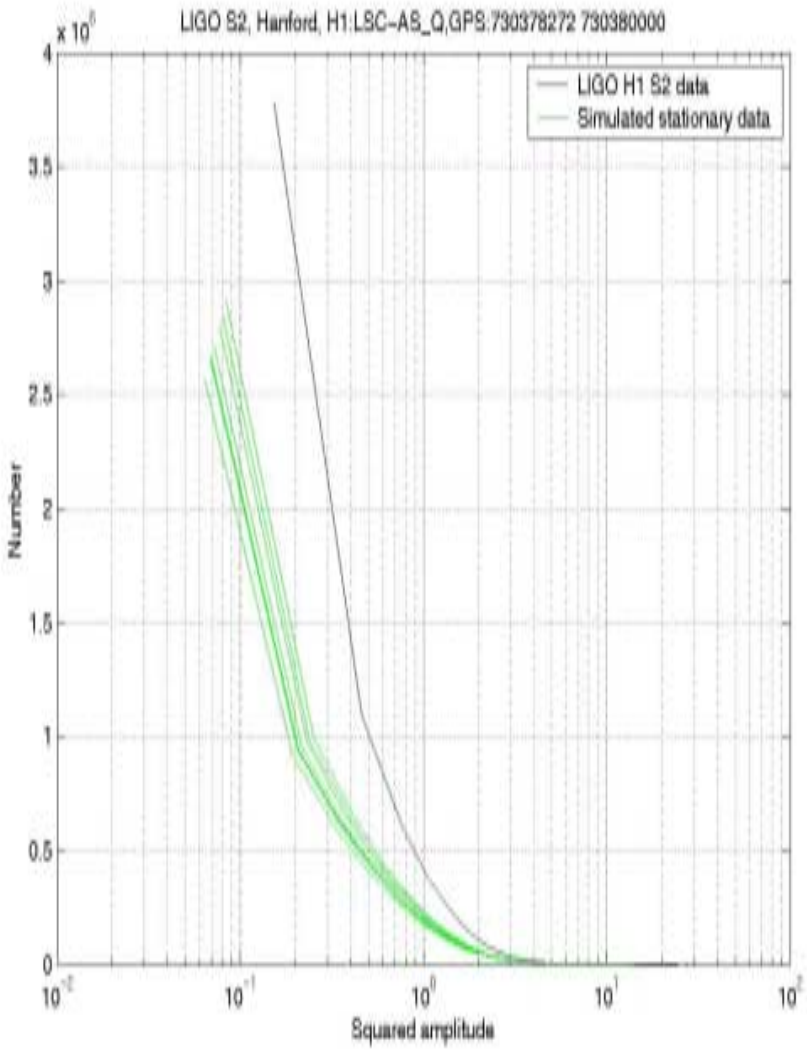

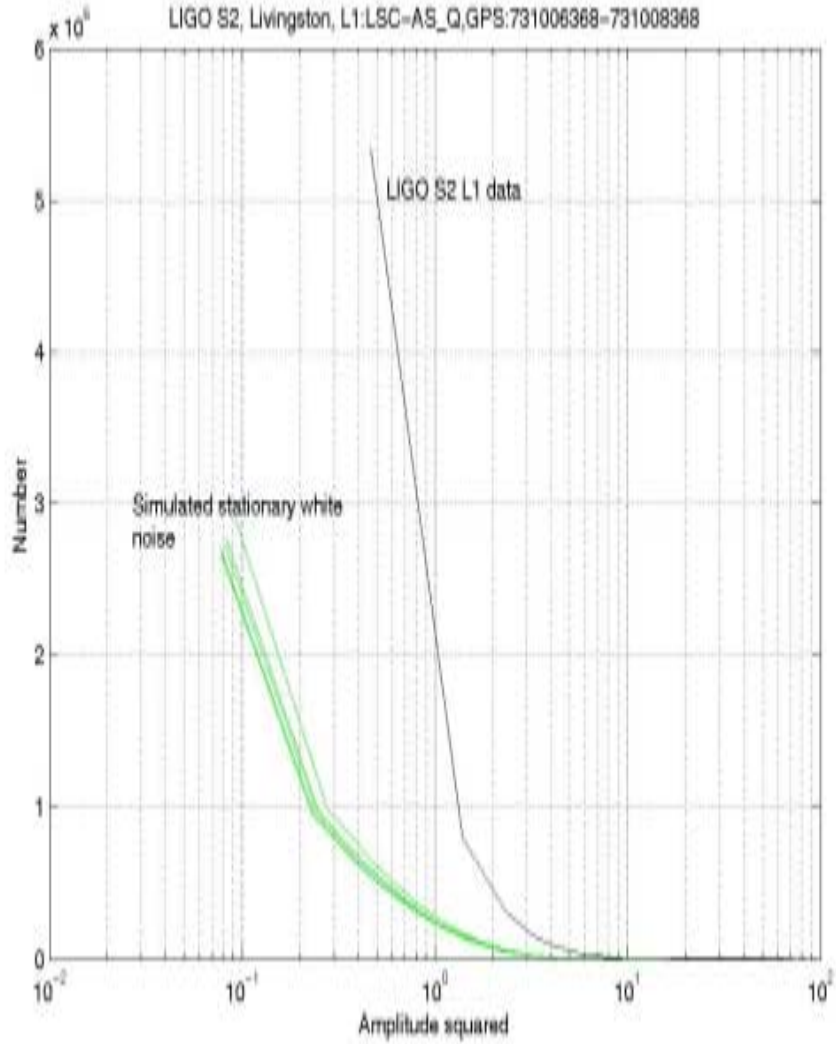

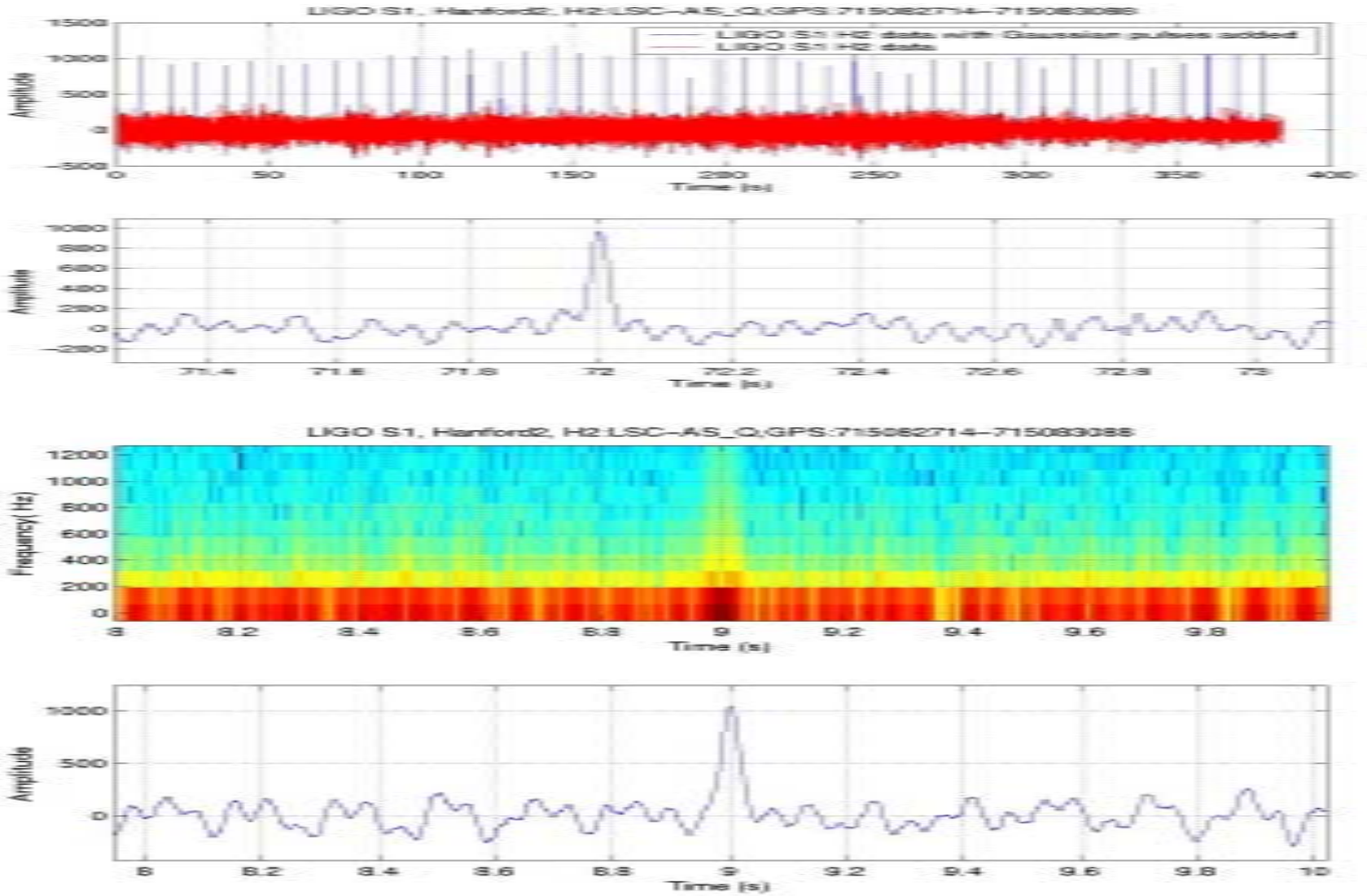
LIGO S1, Hanford2, H2:LSC-AS_Q,GPS:715082714-715083088
LIGO S1 H2 data with Gaussian pulses added
LIGO S1 H2 data
Amplitude
Time (s)
Amplitude
Time (s)
LIGO S1, Hanford2, H2:LSC-AS_Q,GPS:715082714-715083088
Frequency (Hz)
Time (s)
Amplitude
Time (s)

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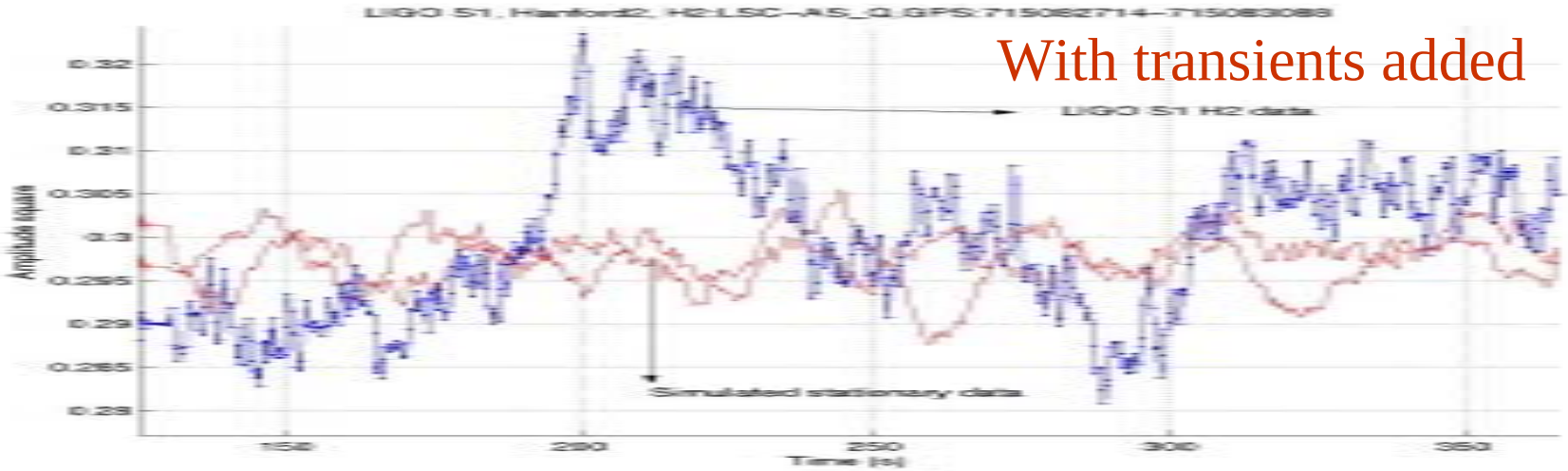
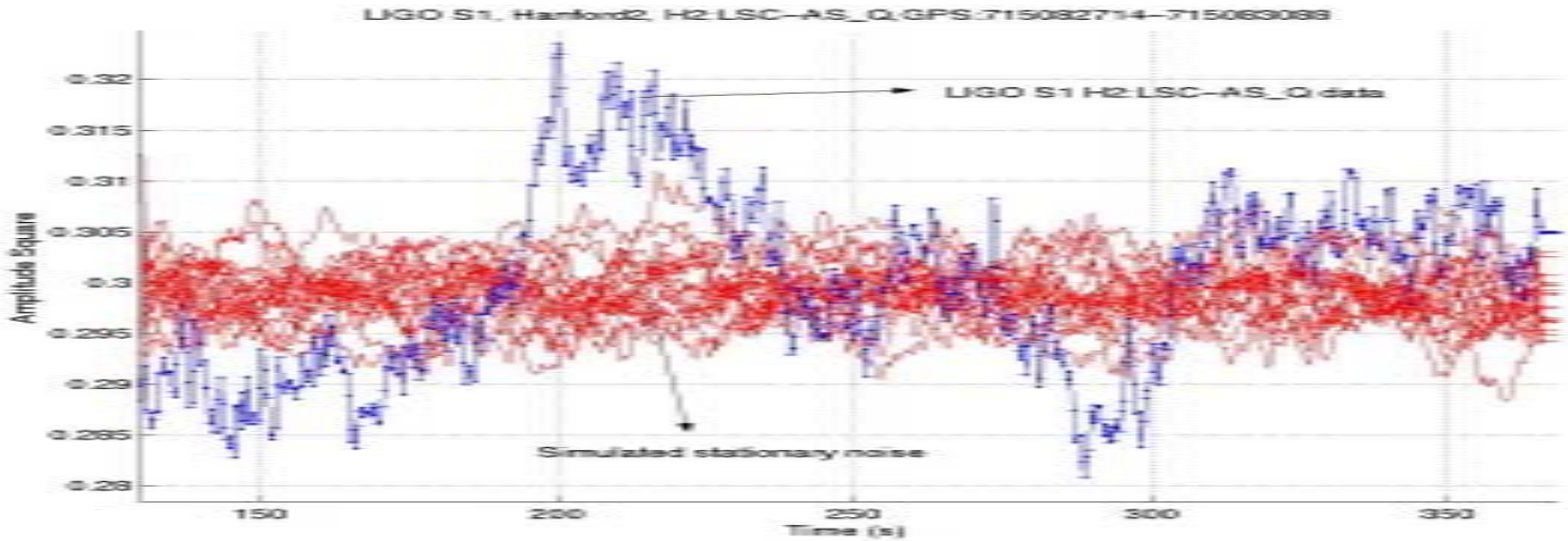
With transients added





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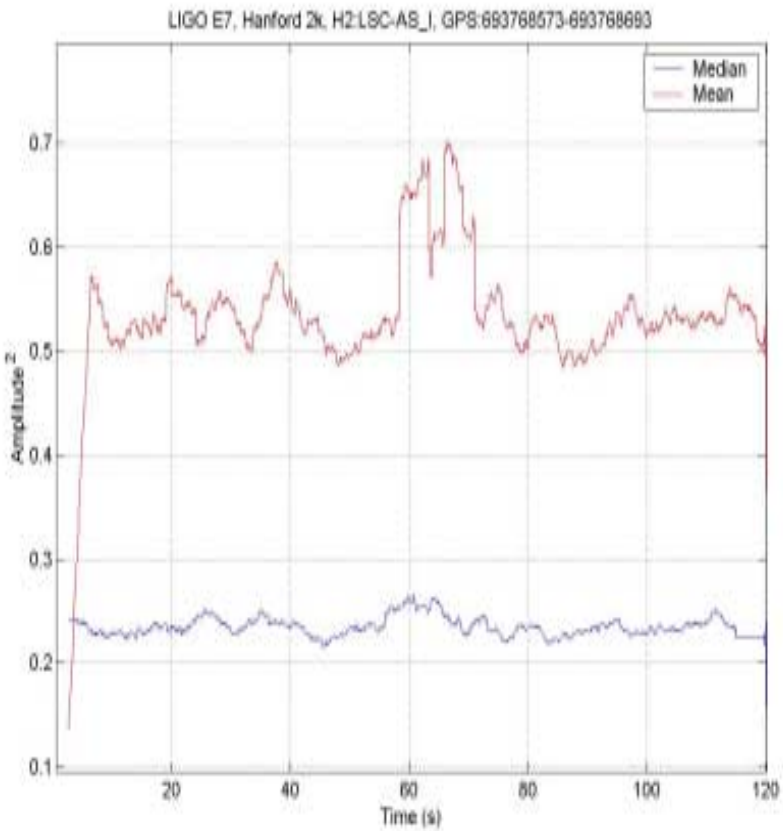

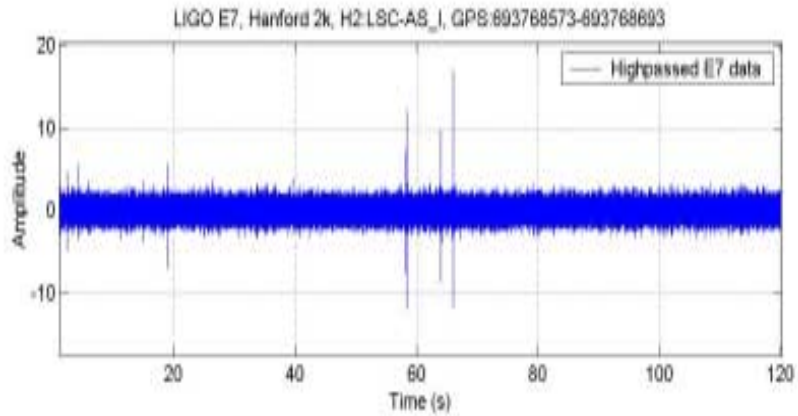

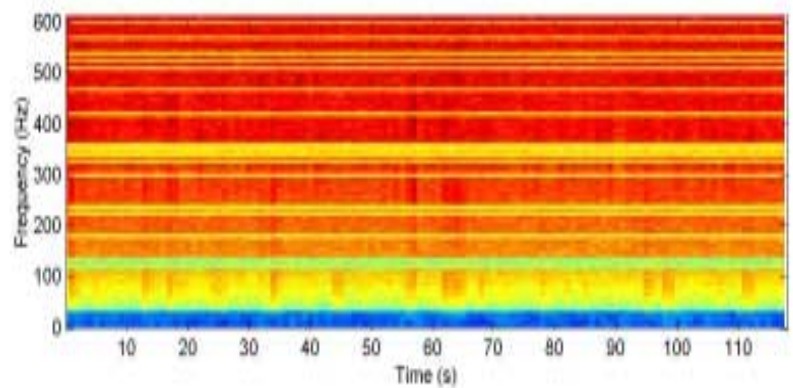

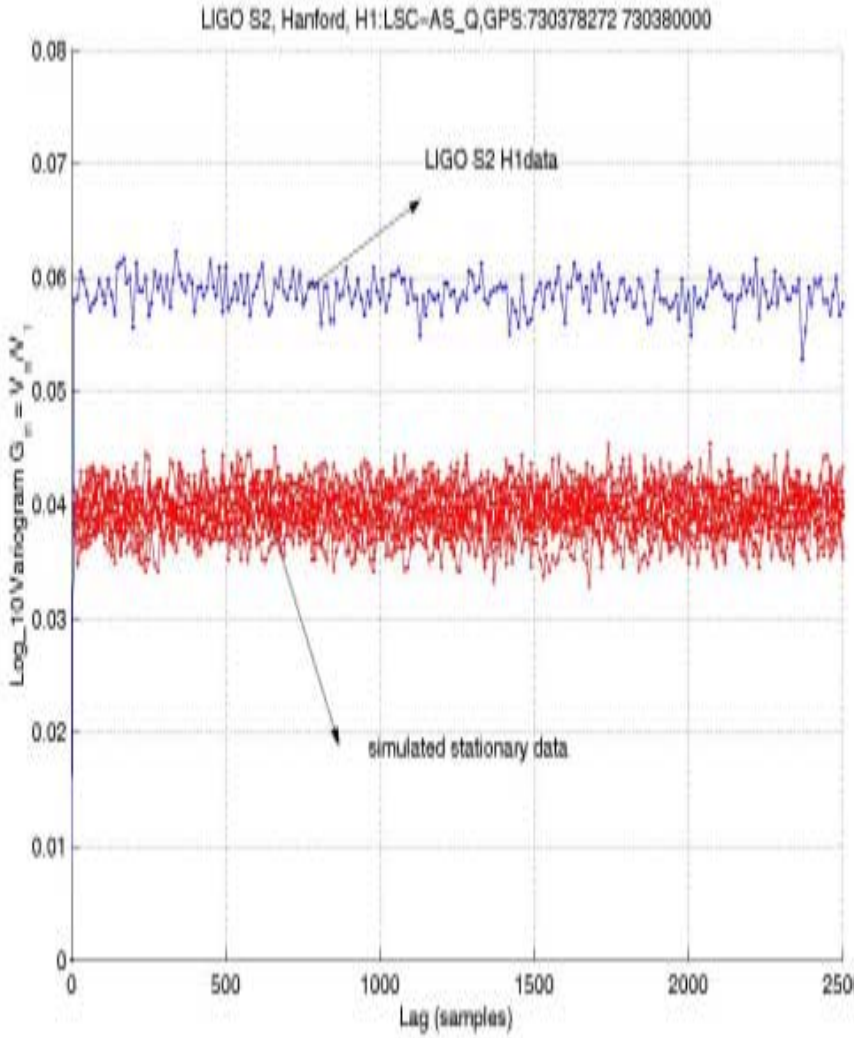

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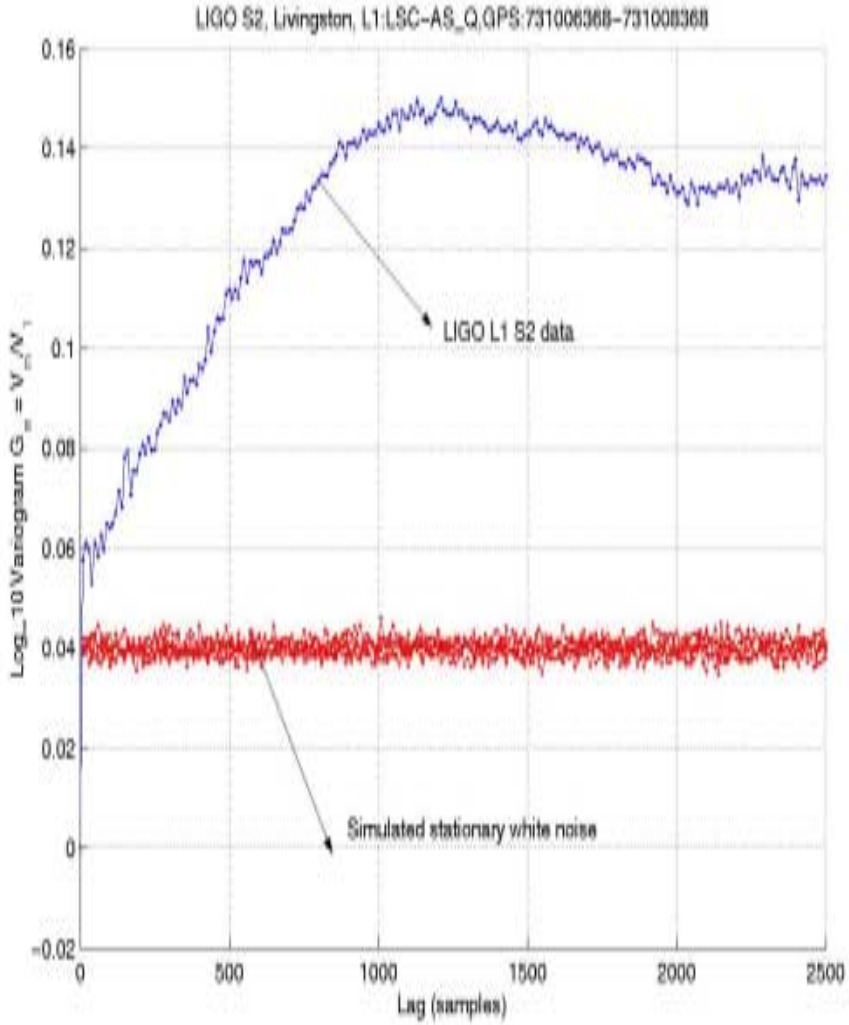

- Computation of :

$$G(m)=V(Z_{t+m} - Z_t)/V(Z_{t+1} - Z_t)$$

Z_t : t th sample of a timeseries.

m: Lag.

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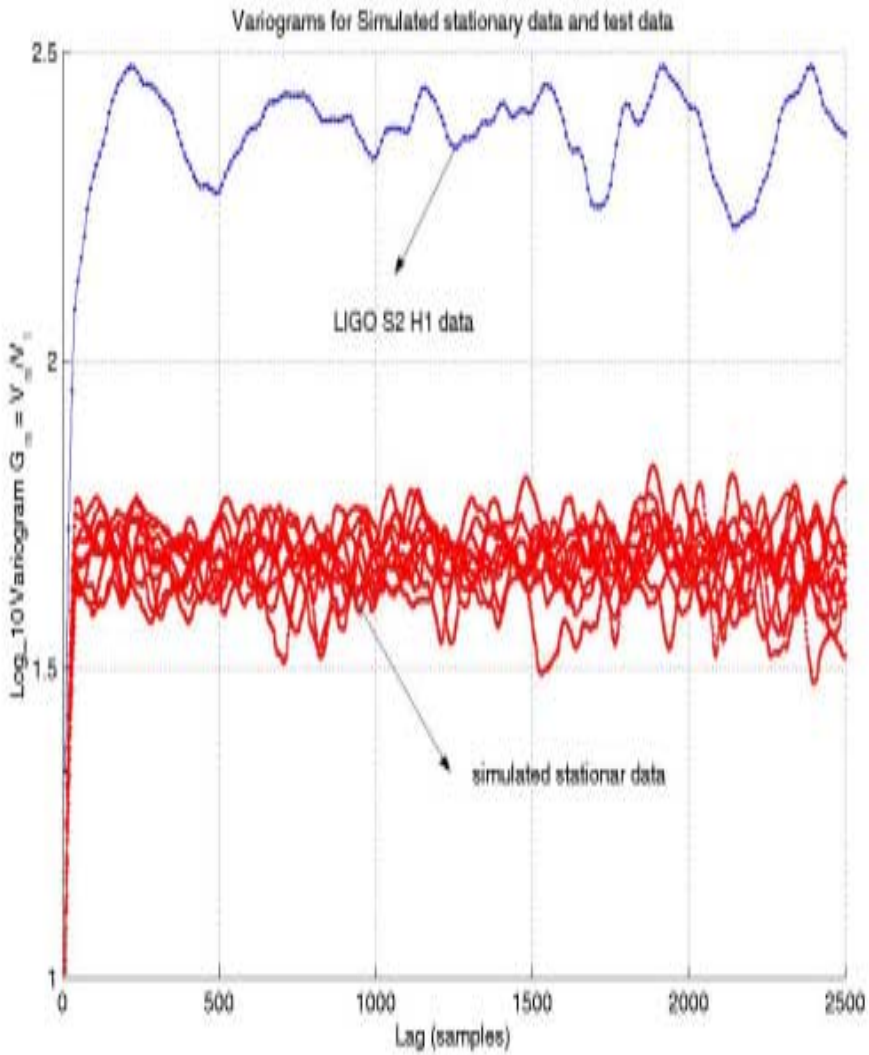

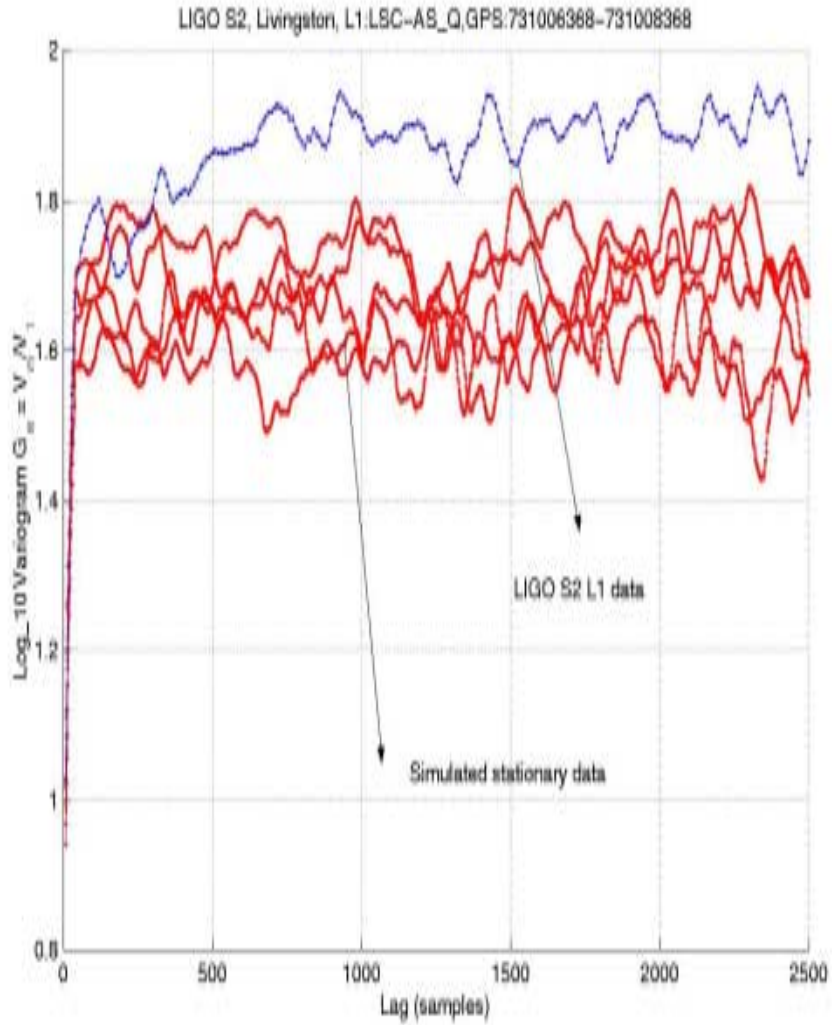

Comments :

- LIGO Tech doc : LIGO-T030019-00-Z.
- Threshold setting by single simulation.
- Discussions underway for incorporation in the externally triggered burst search analysis.
- Automation.
- Use MBLT for line removal.
- C++ codes underway.
- DMT monitor ? (*may be*)

Questions wrt Astrophysical Search

- Threshold and tolerance.

. . . *being worked up on.*