

Study of Non-stationarity on LIGO S2 data : thresholds, tolerance and models

LIGO-G030374-00-Z

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References :

- *LIGO Technical document : S. Mukherjee T030019-00-Z*
(also, <http://www.ligo.caltech.edu/docs/public/T/T030019-00>)
- S. Mukherjee, *CQG*, In press, 2003
- <http://www.aei.mpg.de/~soma/exttrig.html>

Some facts – I :

1. Example data taken from LIGO S2 (H1 and H2) around the chosen GRB 030329, GPS : 732973008-732973360 s.
2. Method applied to detect non-stationarity : **MNFT** (references cited earlier). The test statistic is the *smoothed running median* (**SRM**) of the preprocessed interferometric data.
3. Threshold determined by making a 2σ (chosen ad hoc for the time being) cut on the amplitude. σ determined from simulation.
4. The method shows that S2 H1 and H2 data are non-stationary over minutes.

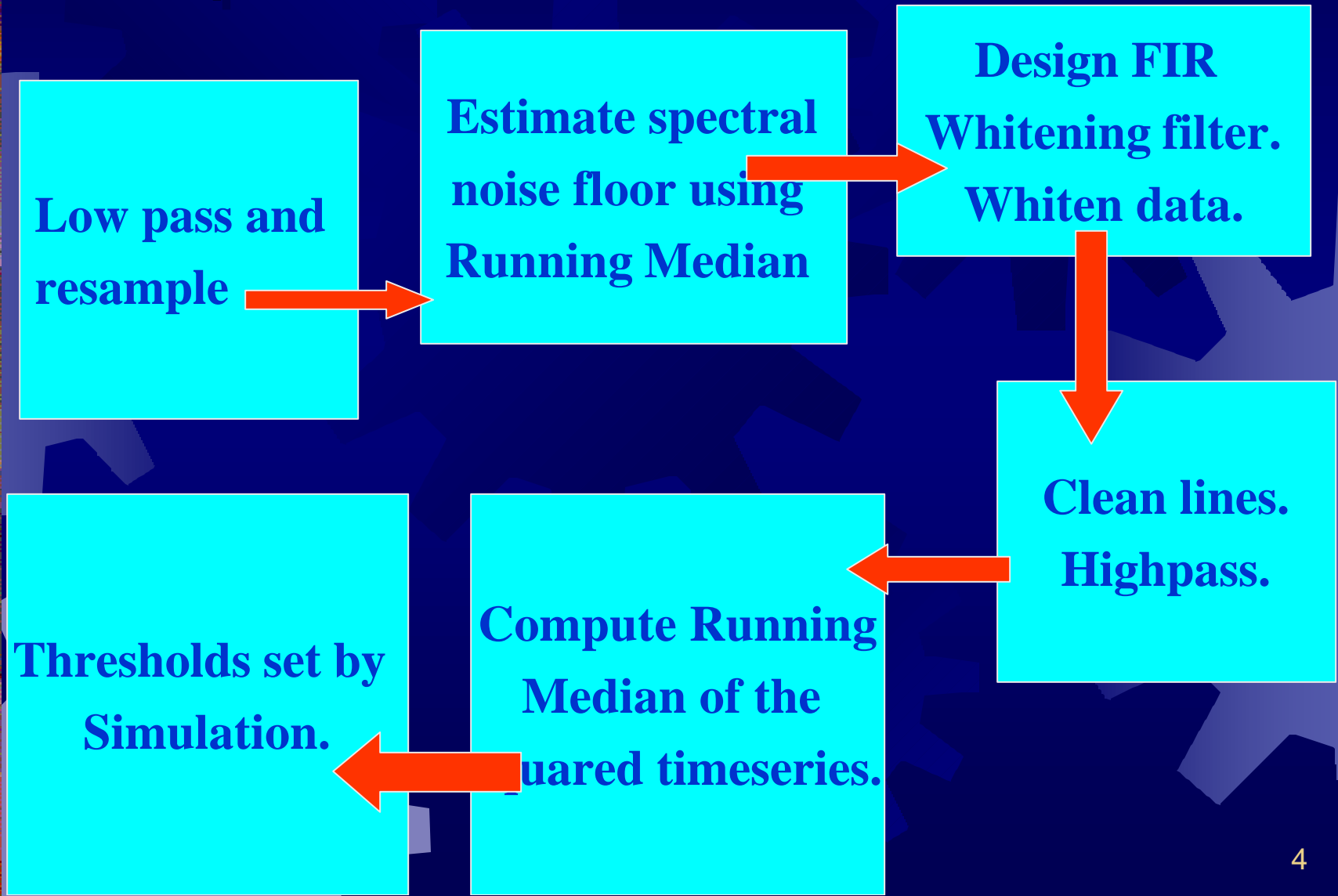
MNFT outline:

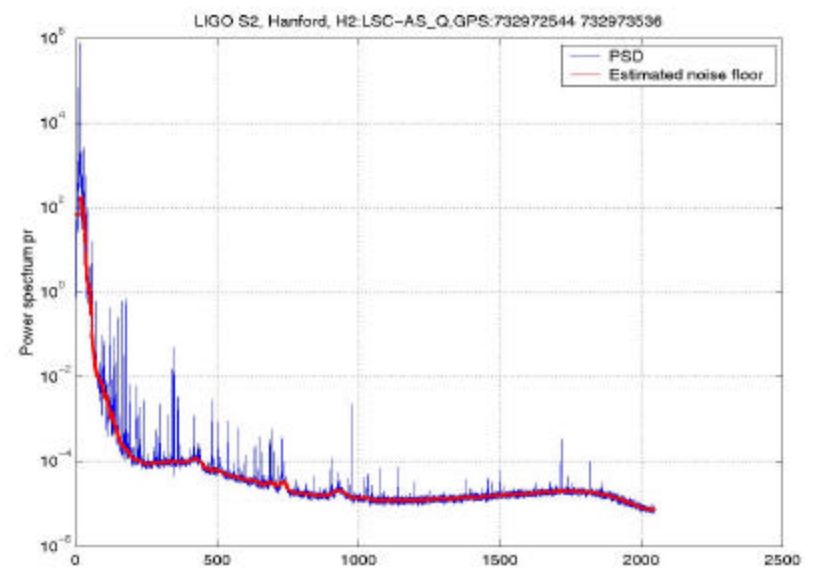
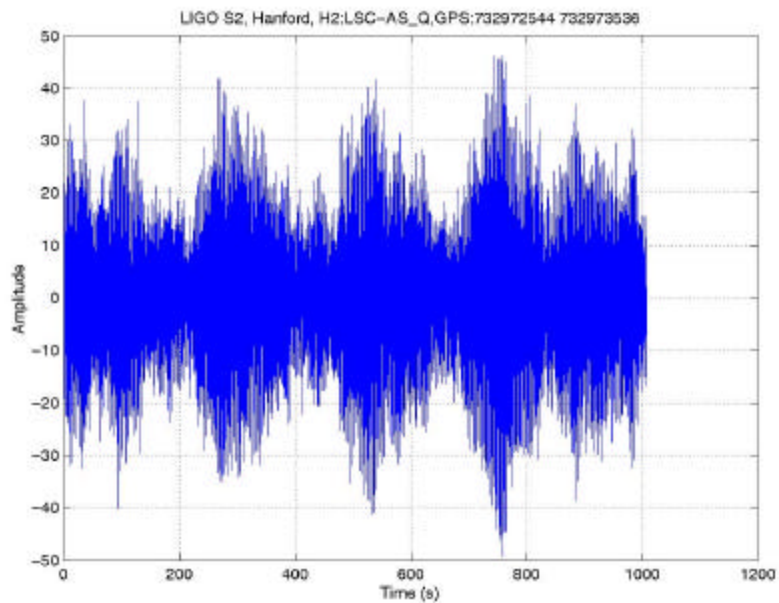
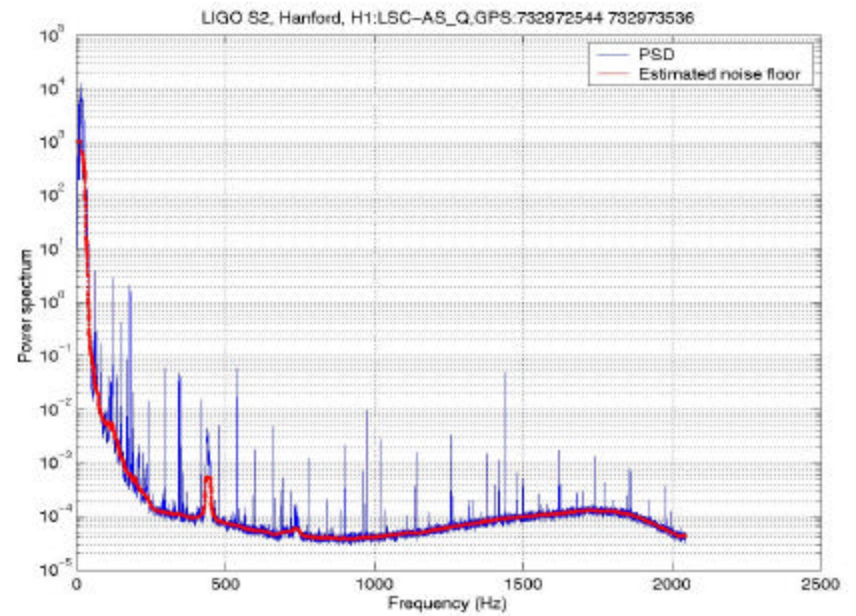
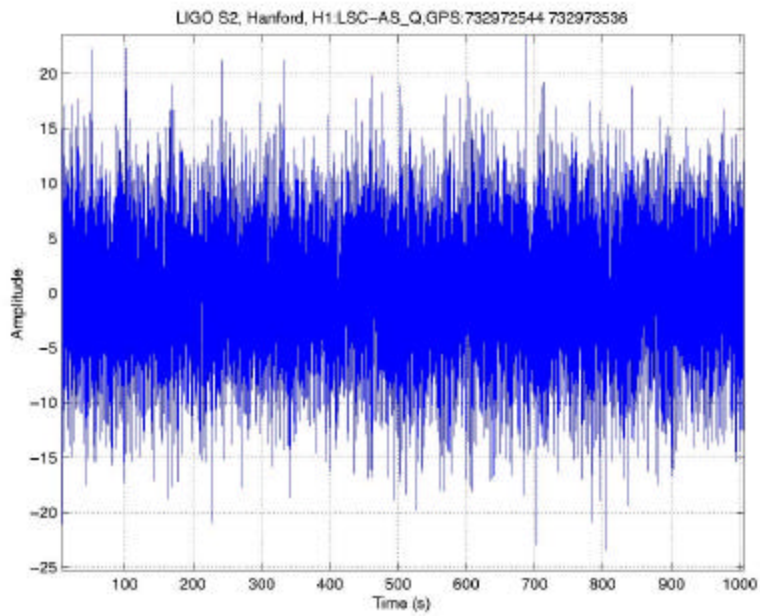
Algorithm:

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 :

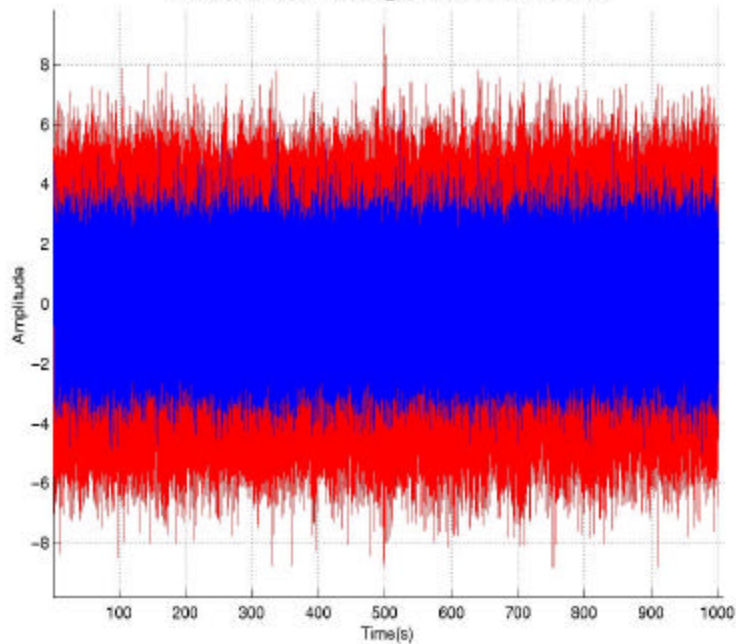




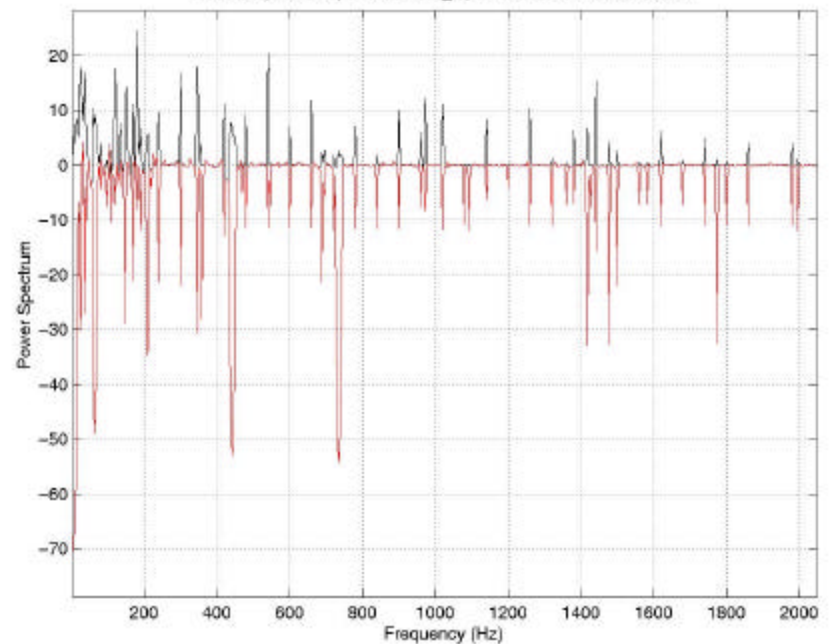
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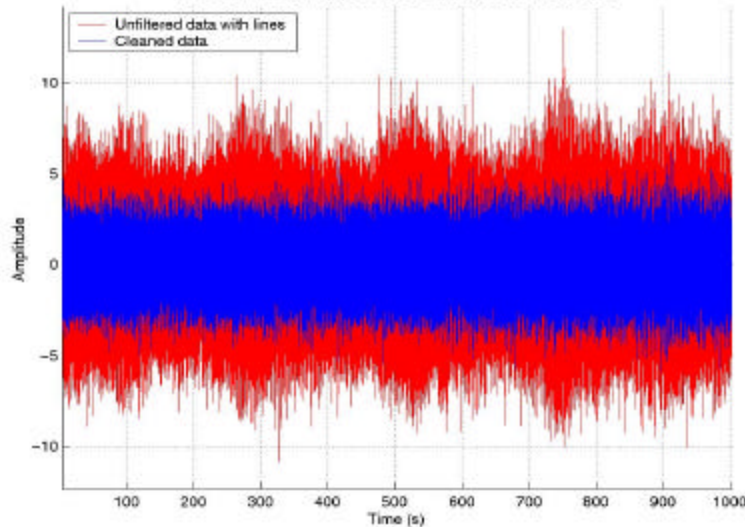
LIGO S2, Hanford, H1:LSC-AS_Q,GPS:732972544 732973536



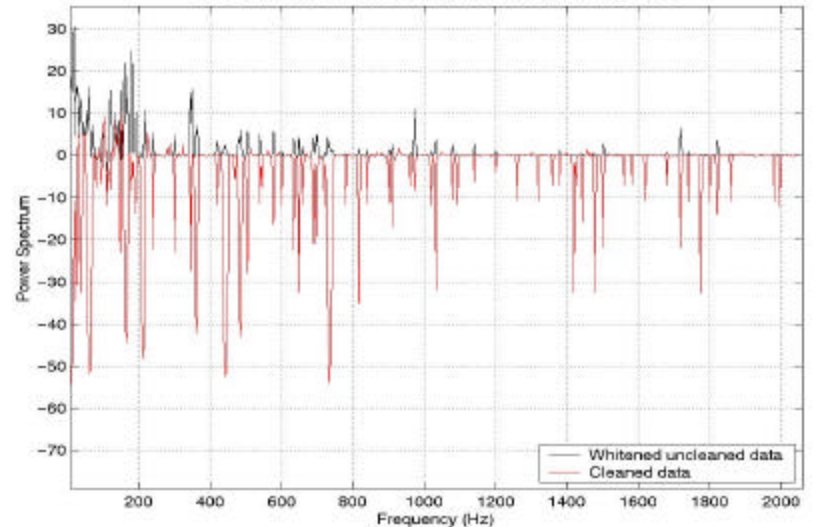
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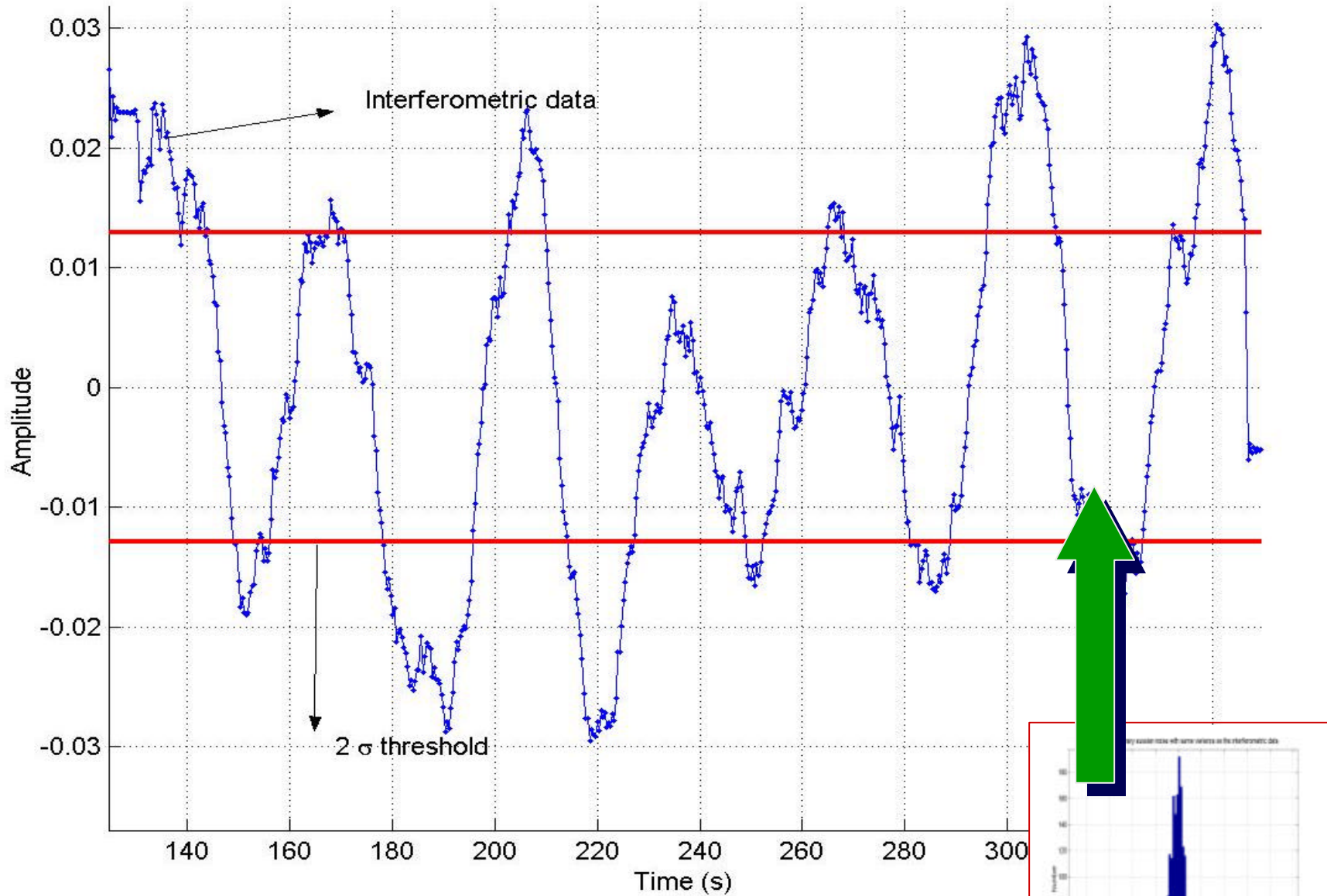
LIGO S2, Hanford, H2:LSC-AS_Q,GPS:732972544 732973536



LIGO S2, Hanford, H2:LSC-AS_Q,GPS:732972544 732973536

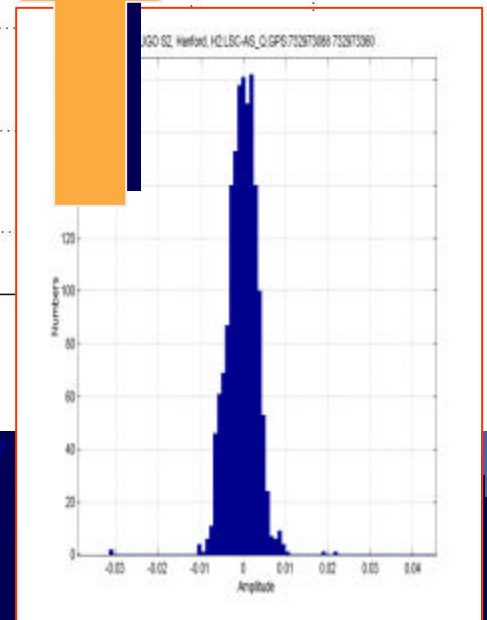
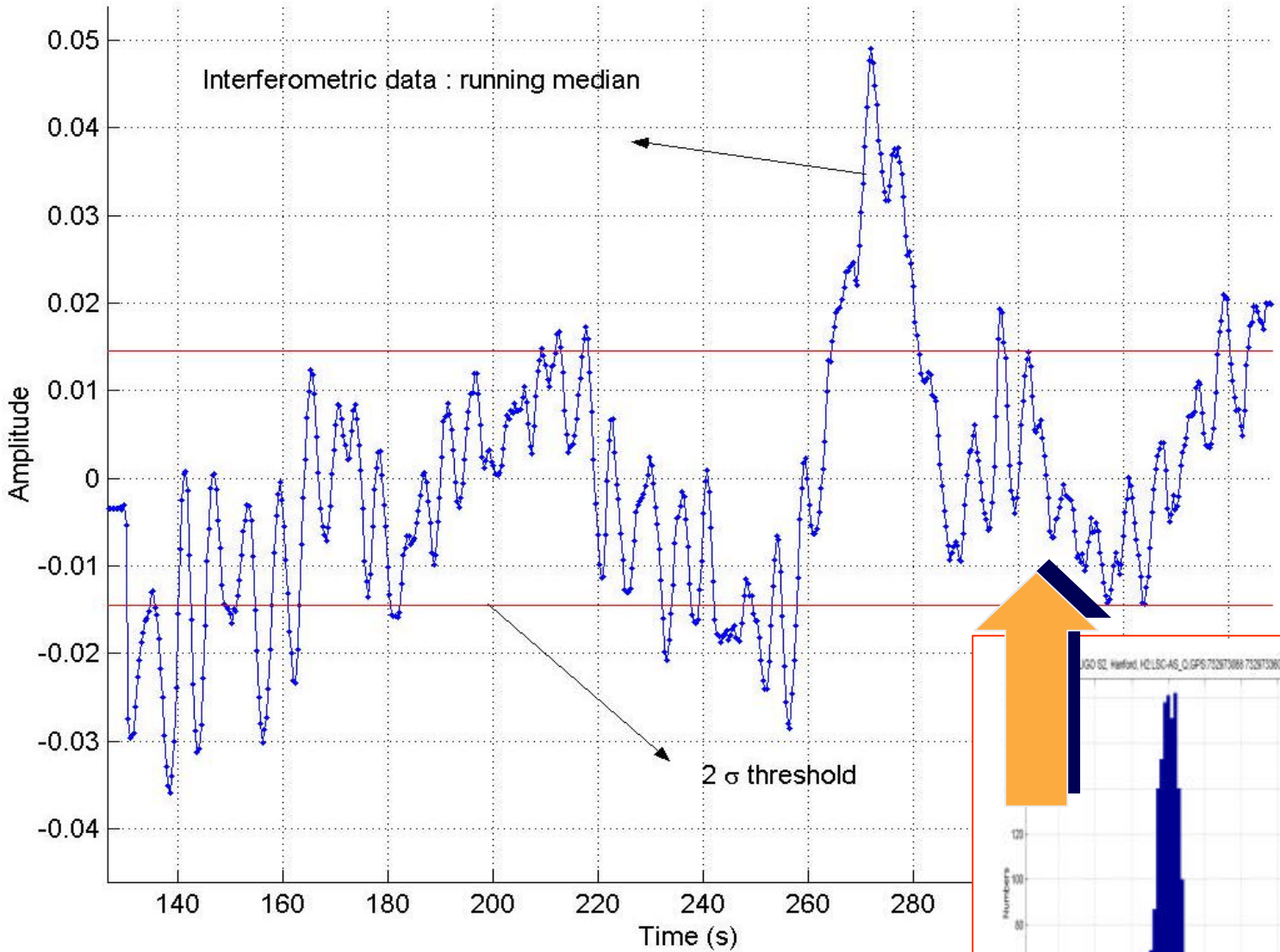


LIGO H1 S2 data : GPS : 732973008-732973360s



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ARMA (p, q)

$$\star A(q) y(t) = C(q) e(t)$$

$Y(t)$: Output

$e(t)$: White noise

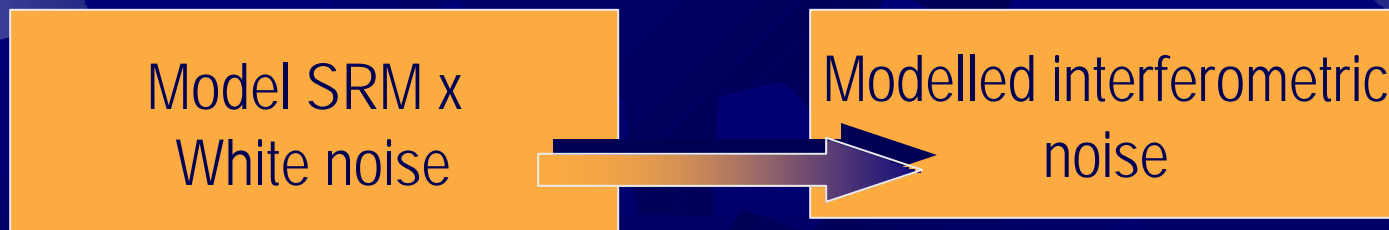
$C(q)/A(q)$: Transfer function

q : Time shift operator

A and C : Polynomials

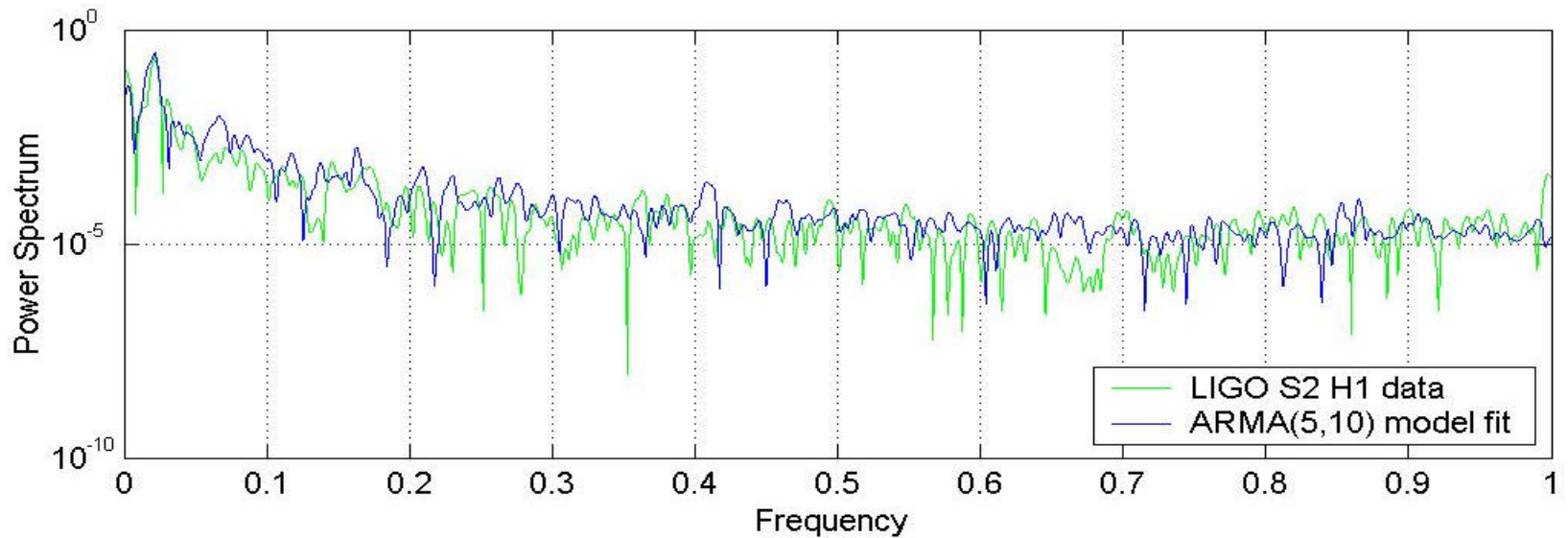
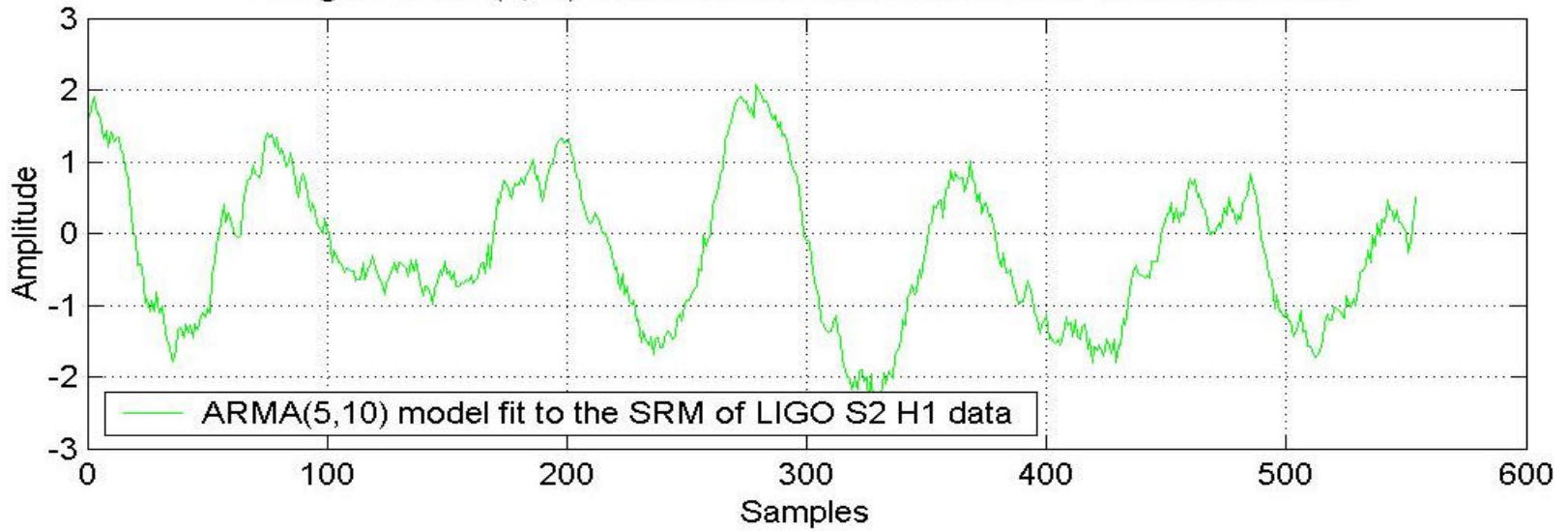
Facts – II

- ★ SRM fitted with small order ARMA models which provide an estimator for the time evolution of the variance.
- ★ Model noise generated by using the above estimator.



- ★ *Tolerance* determined by executing the search algorithm using different realizations of the model noise.

Fitting an ARMA(5,10) model to the time evolution of the variance estimator



Fitting an ARMA(2,15) model to the time evolution of the variance estimator

