

Noise!

Data Analysis : testing  
for stationarity

(applied to LIGO prototype)

G. González

(+ L.S. Finn, S. Mukherjee,  
S. Mohanty, M. Hug, M. Beilby)

Penn State University.

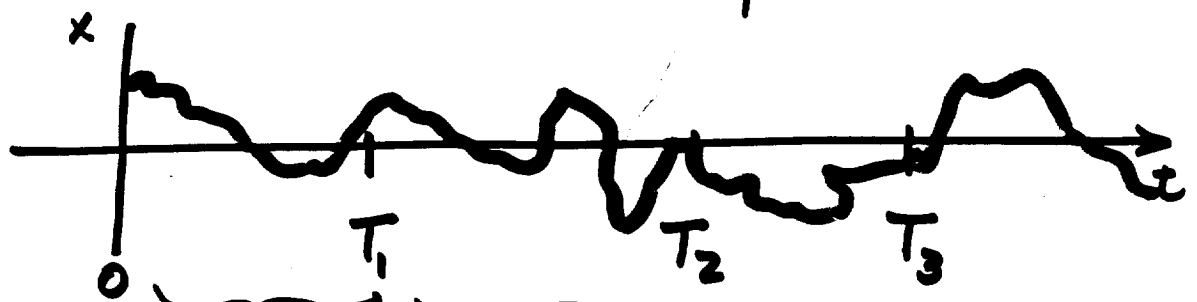
Most GW searches assume  
 the detector noise is  
random and stationary.

Not always so!

How to test?

1) Calculate PSD as a function of  
 time:

$$\text{PSD} = \frac{|\tilde{X}(f)|^2}{T} \quad [\text{PSD}] = \text{m}^2/\text{Hz}$$



$$\begin{aligned} & \text{PSD}_1(f) \quad \text{PSD}_2(f) \\ & \text{PSD}(f, T_1) \quad \text{PSD}(f, T_2) \\ & \Rightarrow \text{PSD}(f, T) \end{aligned}$$

2) If noise is random and stationary,  $\text{PSD}_{f_i}(T)$  has a Rayleigh distribution :

$$\overline{\text{PSD}}(f) = \frac{1}{N} \sum_i \text{PSD}(f, T_i)$$

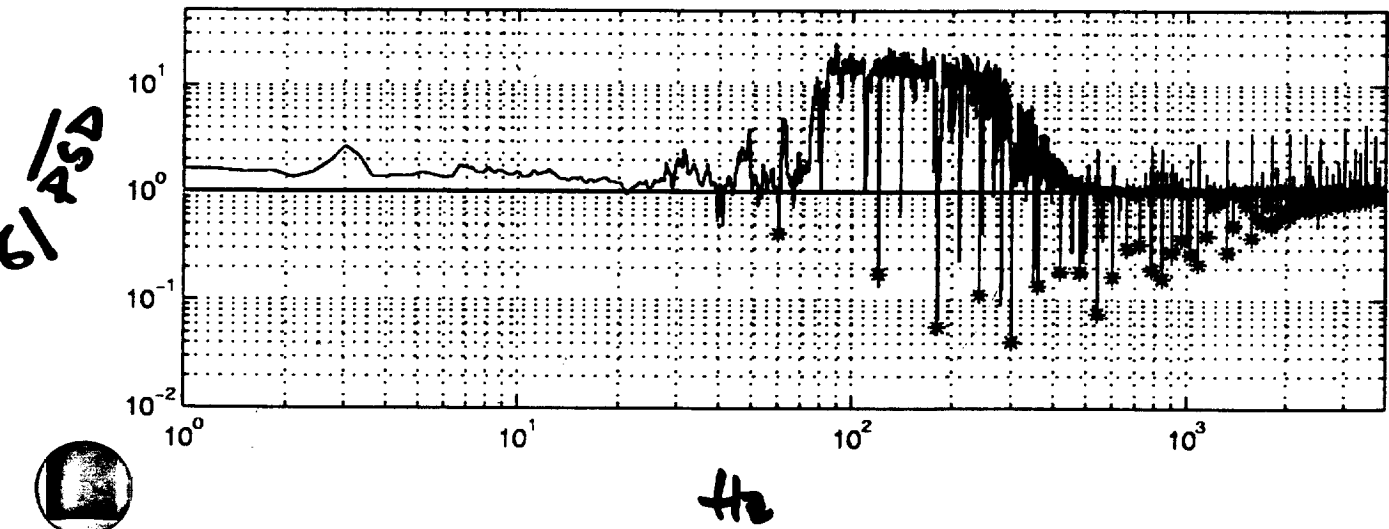
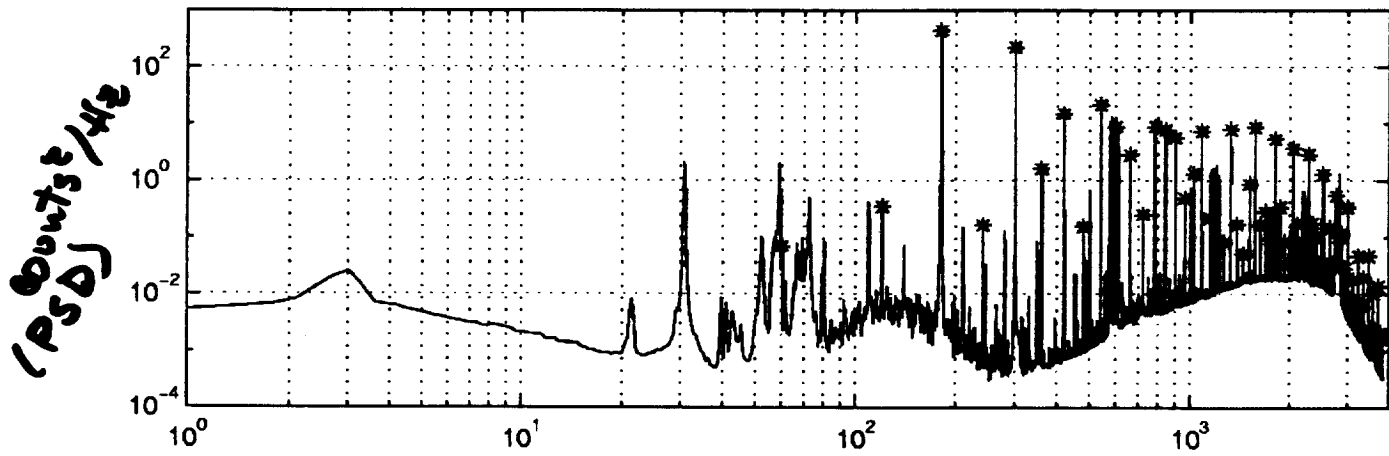
$$\sigma_{\text{PSD}}^2(f) = \frac{1}{N} \sum_i (\text{PSD}(f, T_i) - \overline{\text{PSD}}(f))^2$$

$$\Rightarrow \overline{\text{PSD}}(f) = \sigma_{\text{PSD}}(f)$$

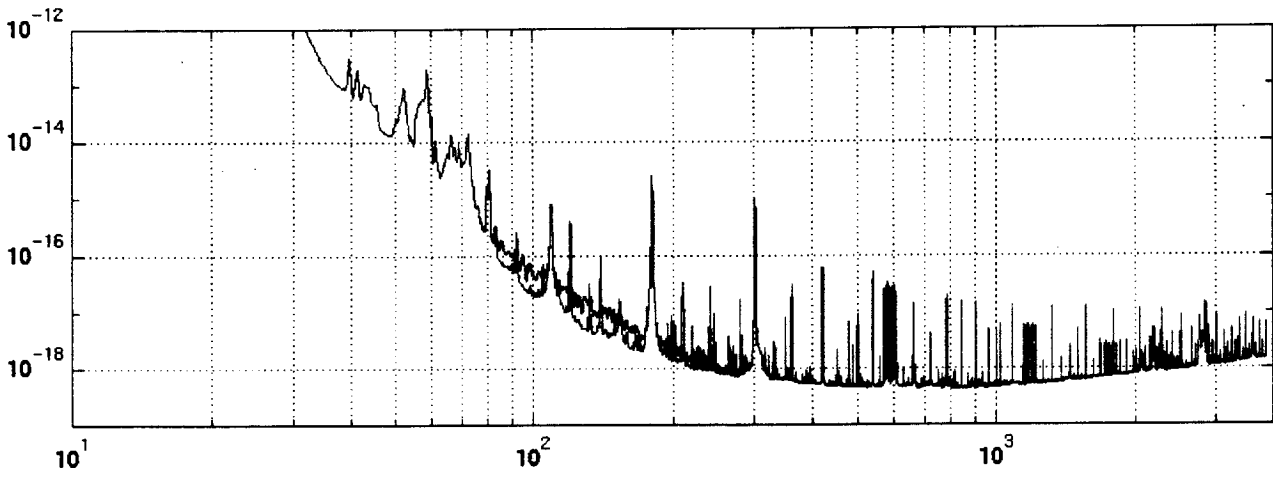
(!!)

This is a test for stationarity as a function of frequency

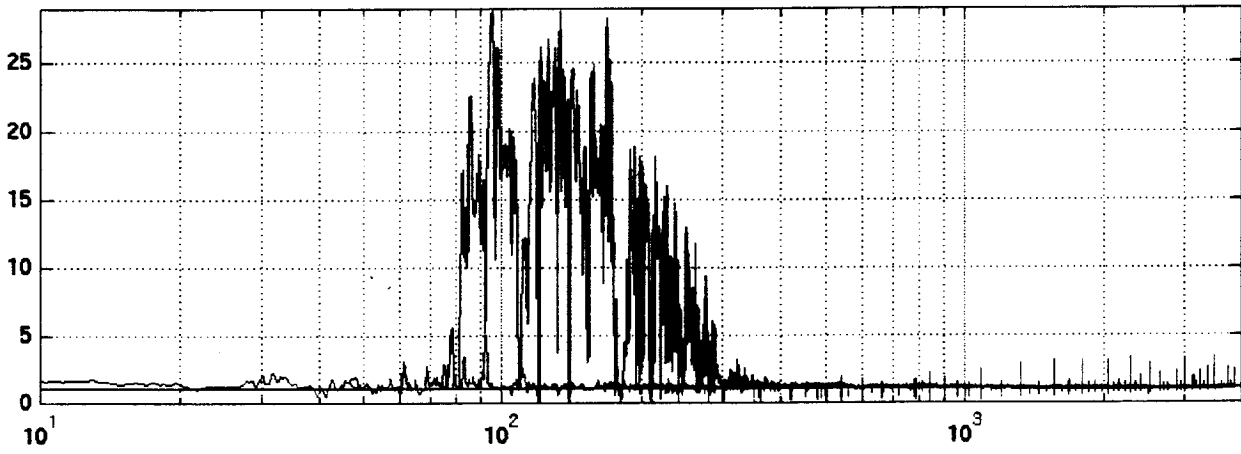
$\Rightarrow$  helps to distinguish noise sources w/ different statistics



$\sigma/\omega/\sqrt{Hz}$

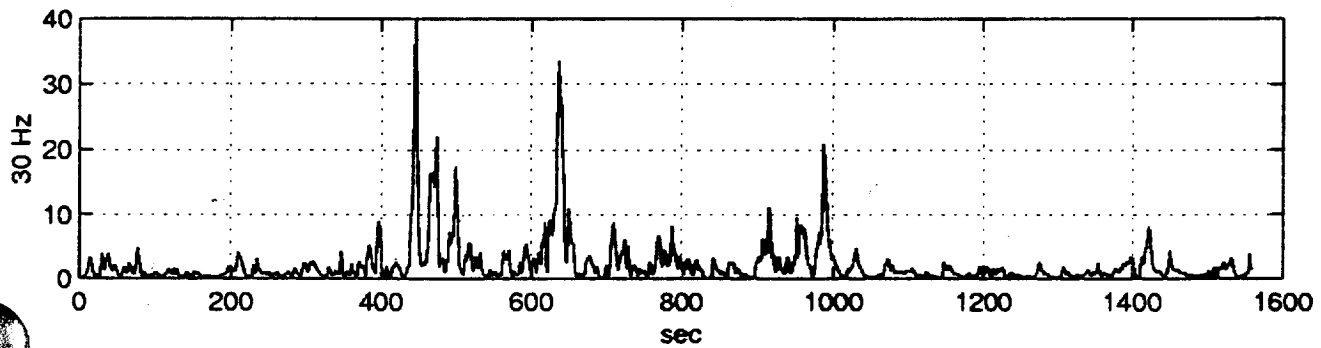
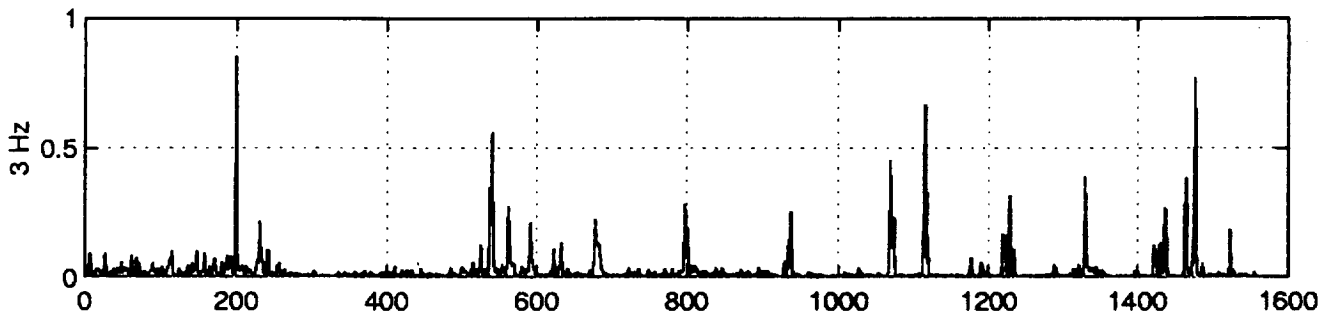
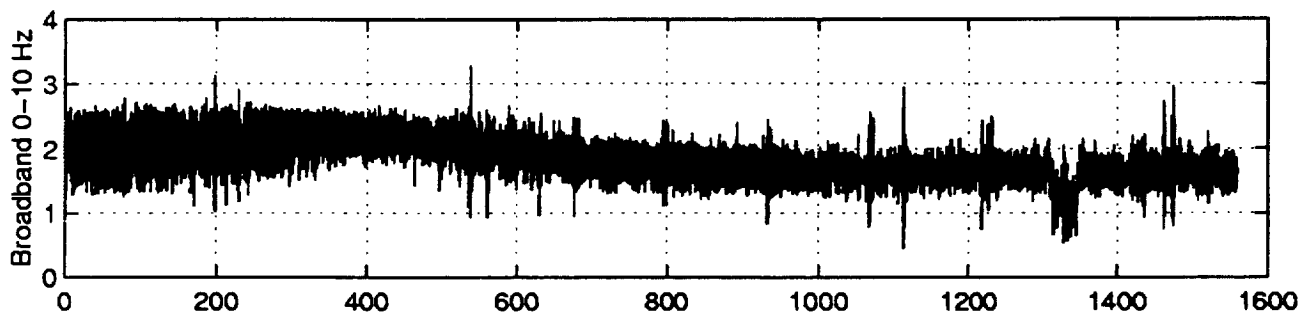


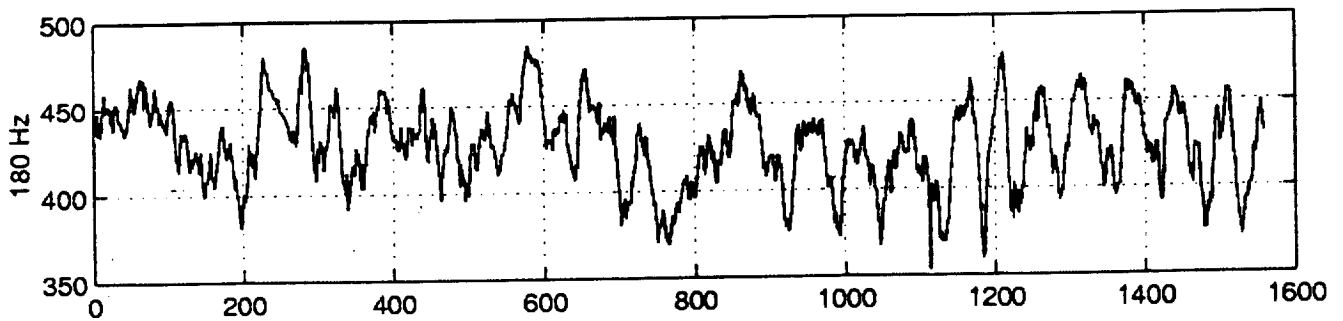
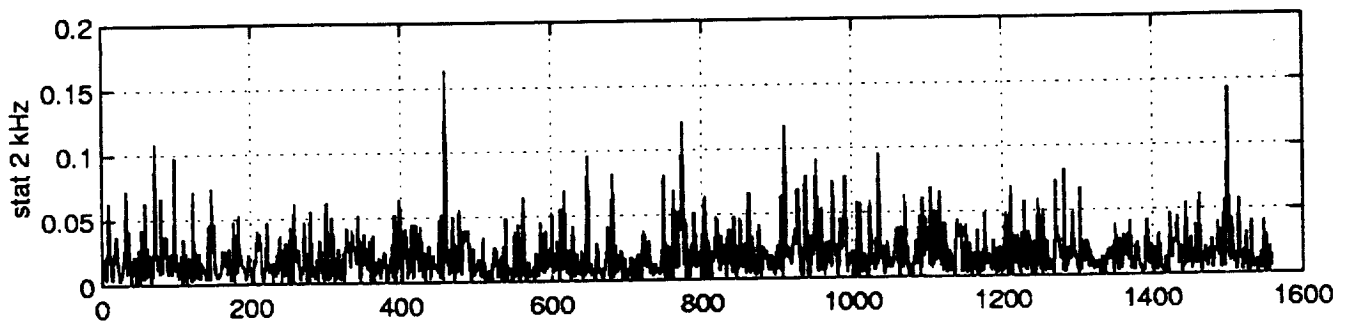
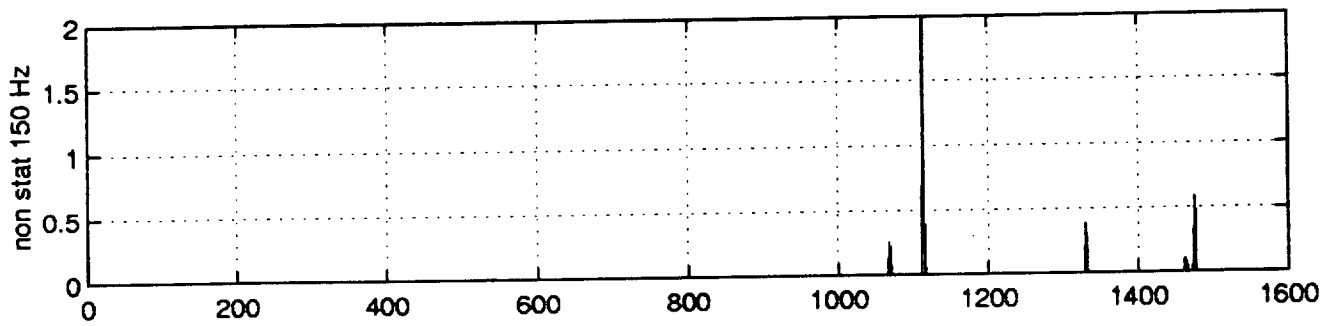
$\sigma/PSD$



$Hz$



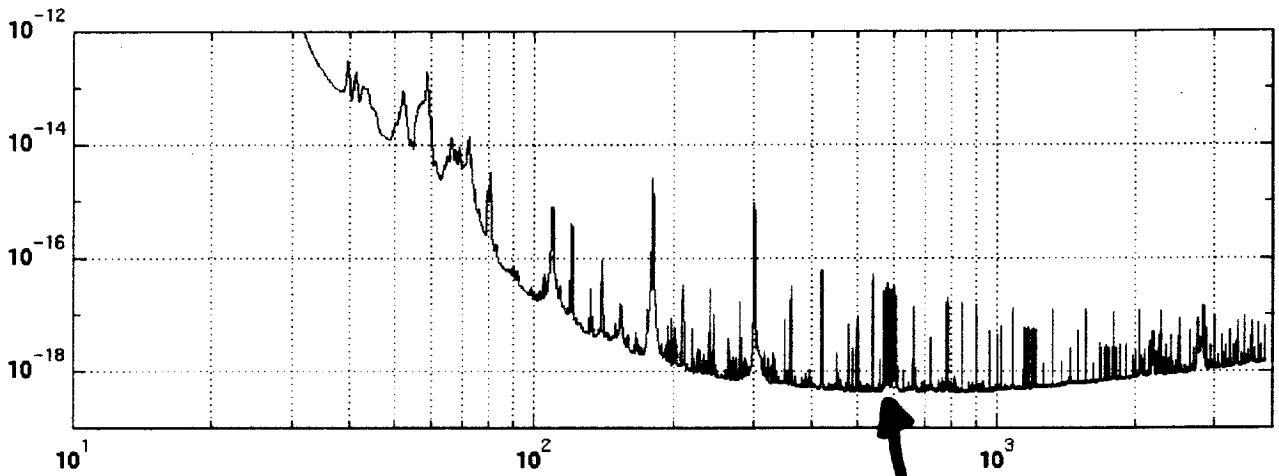




**SEC**

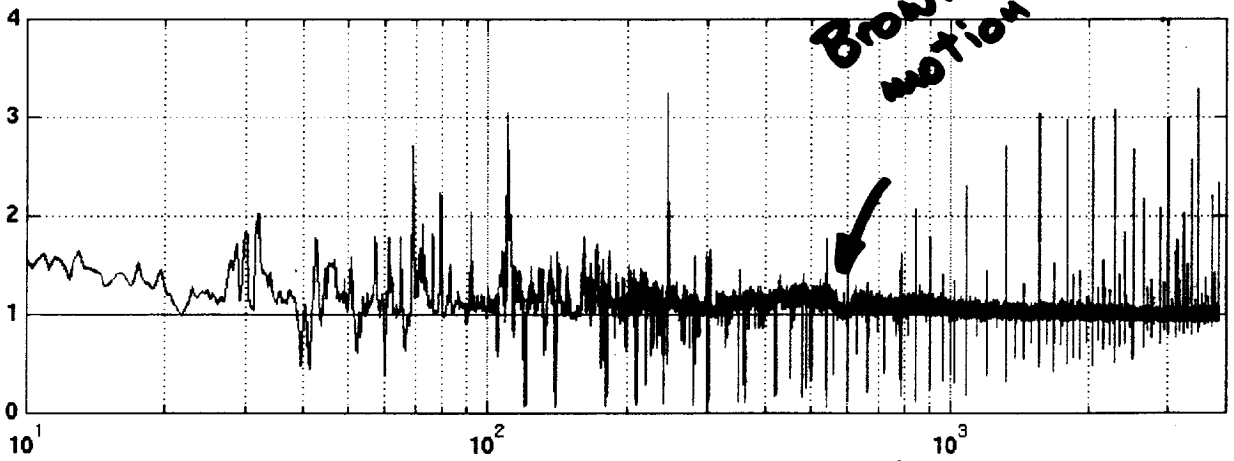


PSD  $(m/\sqrt{Hz})$



Brownian motion

6/PSD



seismic

brownian motion?

shot noise

seismic

brownian motion?

shot noise





*Note 1, Linda Turner, 08/17/99 09:11:03 PM*  
LIGO-G990079-39-M