

Searching for Excess Noise in Suspensions

Andri M. Gretarsson

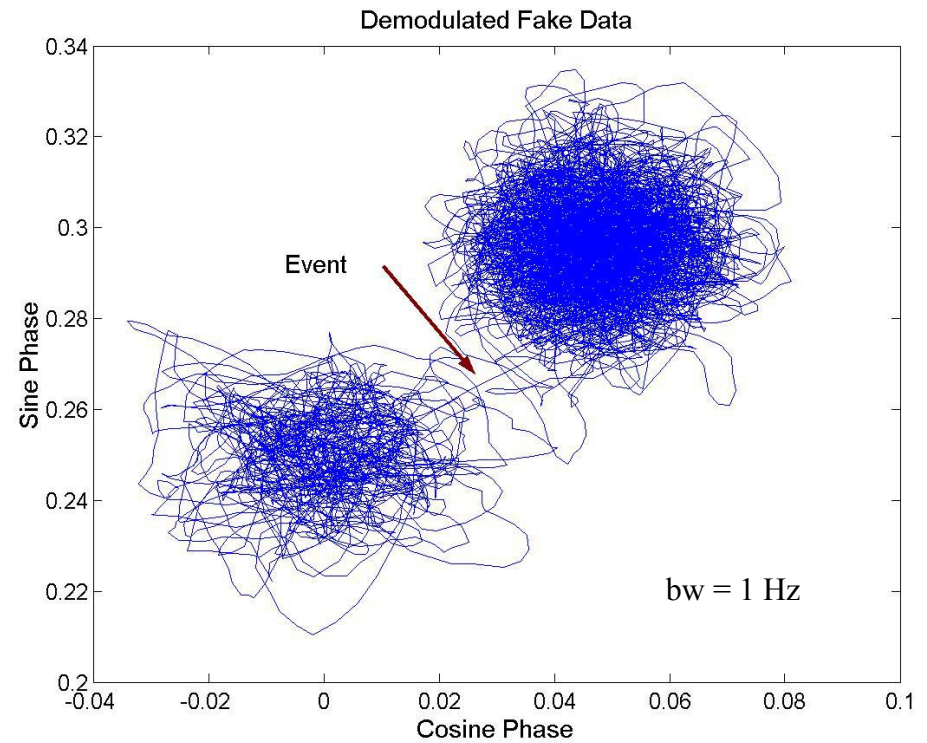
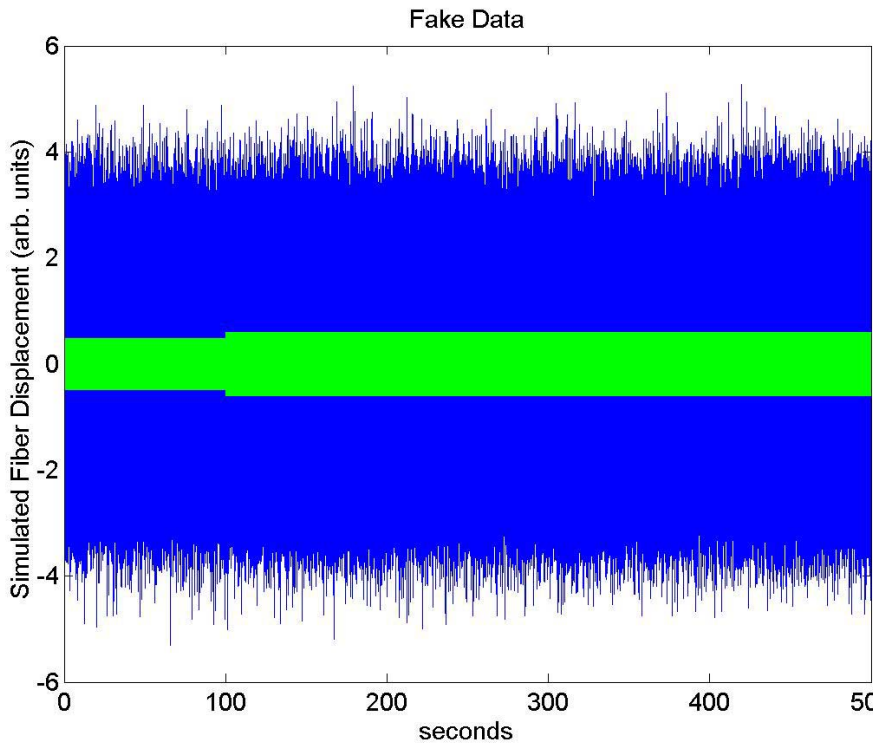
Livingston Observatory

How are resonances useful?

- Provide information about suspension-induced broadband signals (“creaks”).
- May report on unexpected high frequency coil activity.
- In prototype suspensions, look for excess mechanical noise at the level of the thermal noise.

Detecting creaks – First step: Heterodyne!

this page: Fake data set with no thermal noise



Energy Innovation

Mode amplitude and phase drift:

$$q(t) = r(t)\sin(\omega_0 t + \theta(t)) = x(t)\cos(\omega_0 t) + y(t)\sin(\omega_0 t)$$

For random driving:

$x(t)$ and $y(t)$ are Gaussian distributed.

Define the Energy Innovation, η^2 :

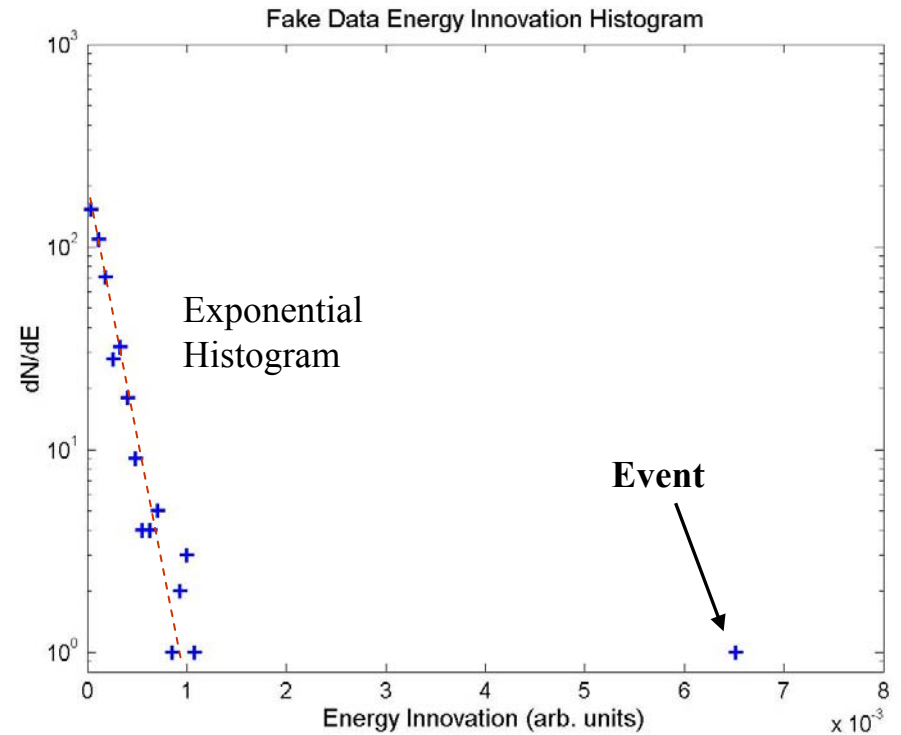
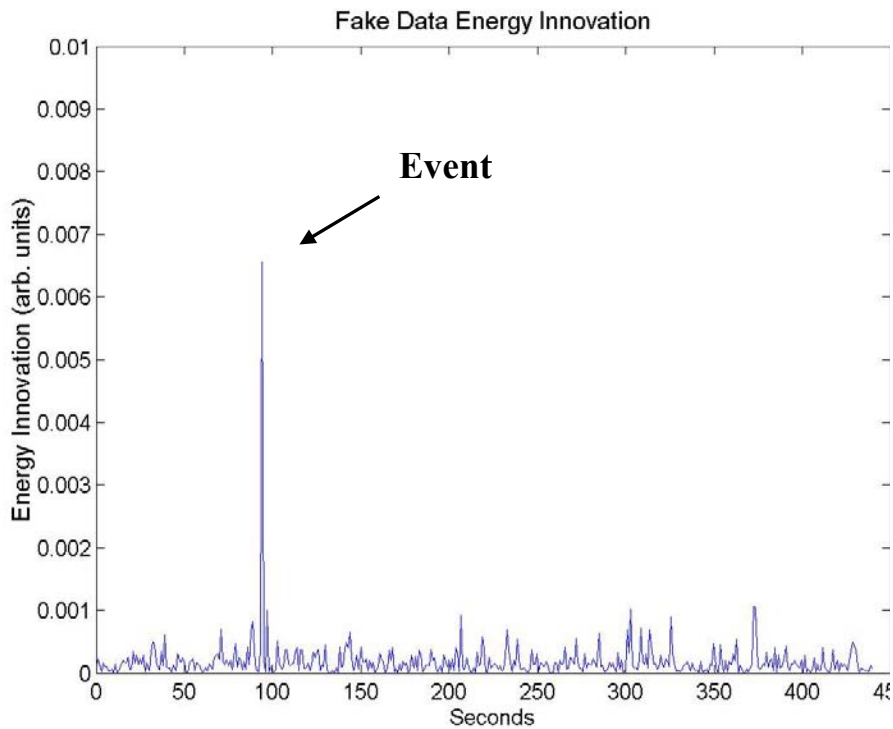
$$\eta^2(t, \Delta t) = [\bar{x}_{\Delta t}(t + \Delta t) - \bar{x}_{\Delta t}(t)]^2 + [\bar{y}_{\Delta t}(t + \Delta t) - \bar{y}_{\Delta t}(t)]^2$$

$\eta^2(t, \Delta t)$ is:

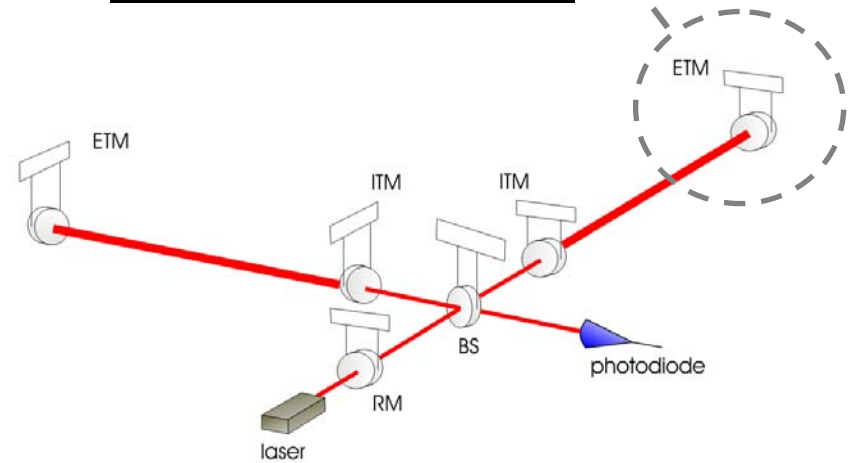
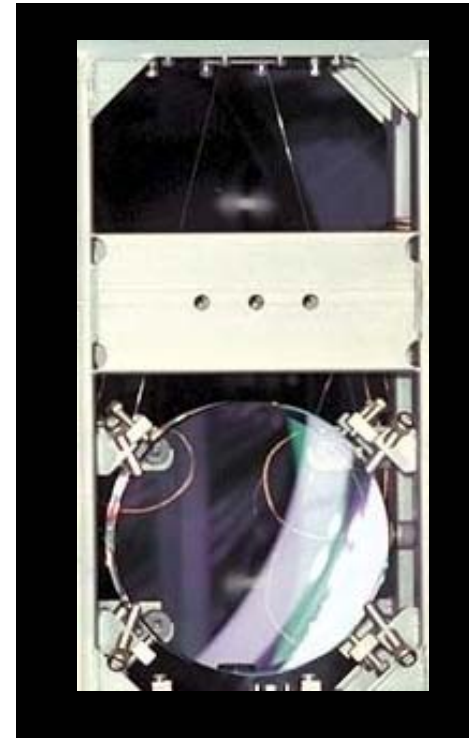
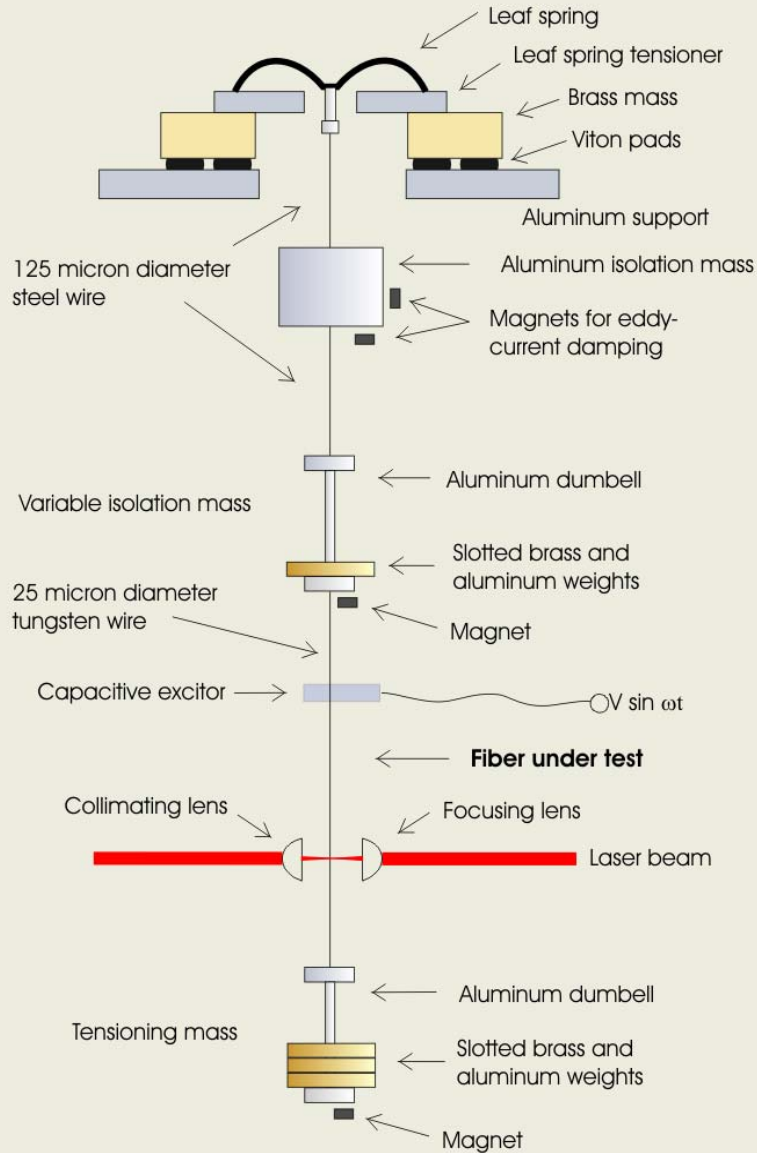
1. *Exponential* distributed.
2. Especially sensitive to *sudden* changes in the resonant mode amplitude or phase.

Creaks show up as outliers in η^2

this page: Fake data set with no thermal noise.

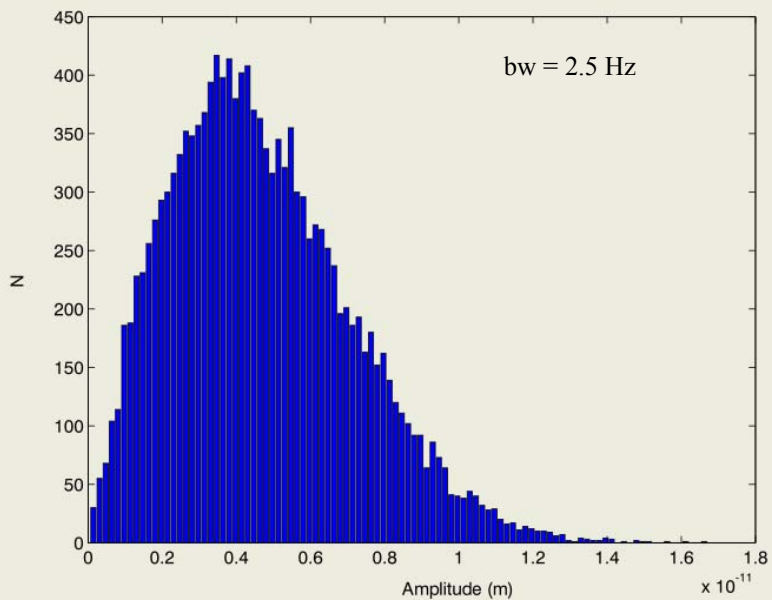


Compare

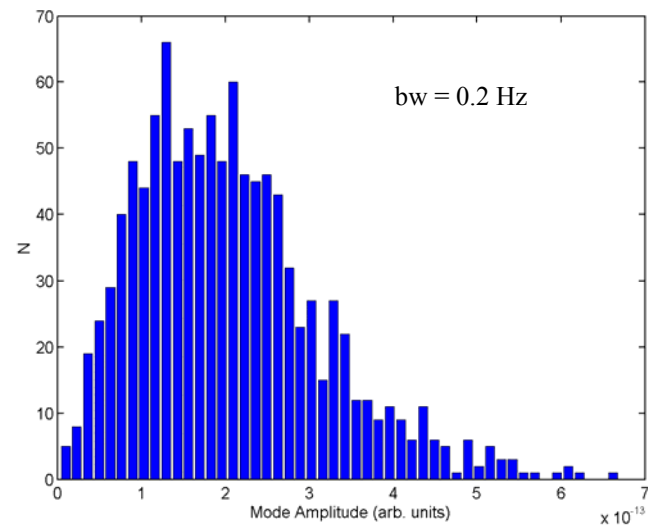
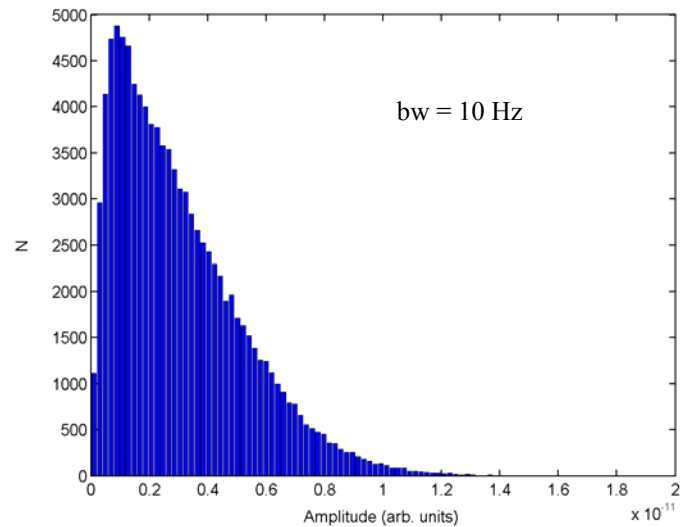


Mode Amplitude

Syracuse tungsten fiber

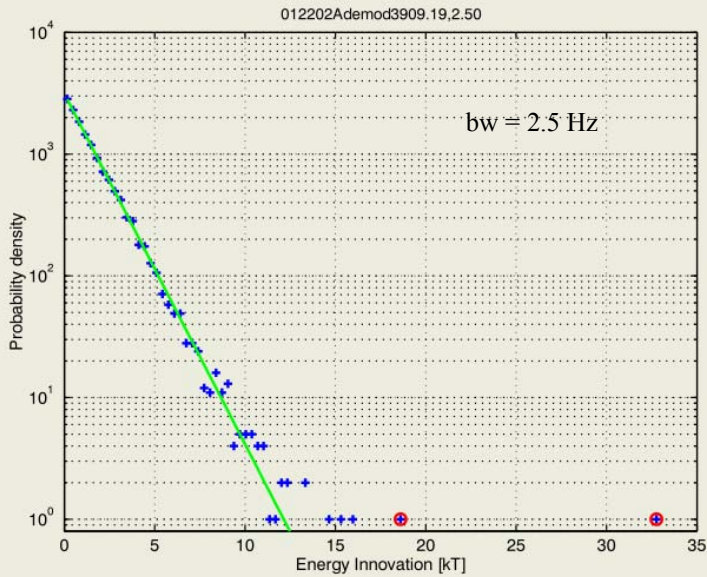


LLO violin mode

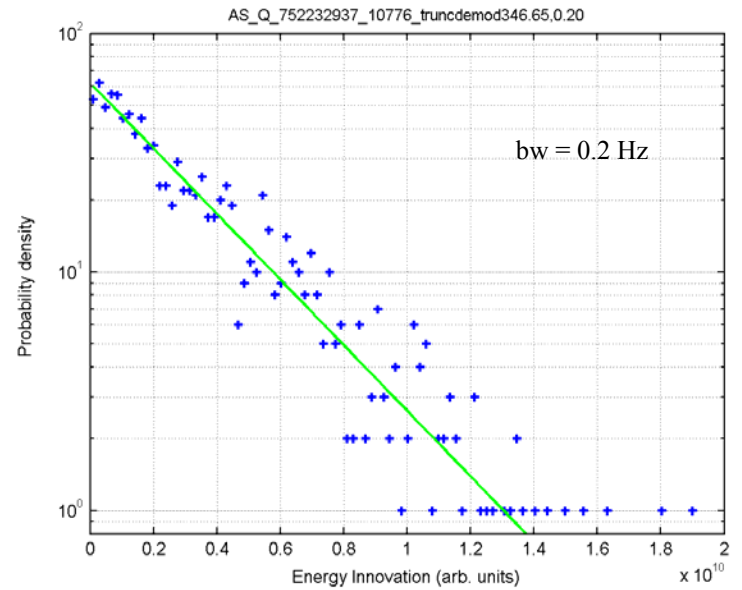
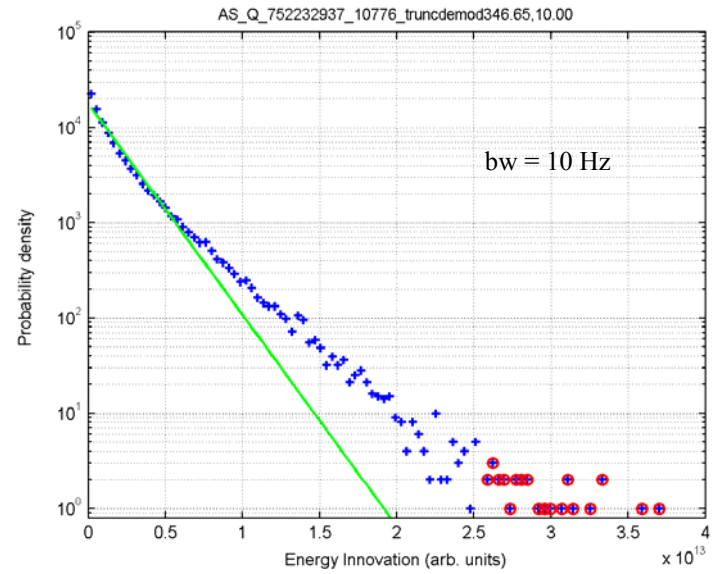


Energy Innovation

Syracuse tungsten fiber



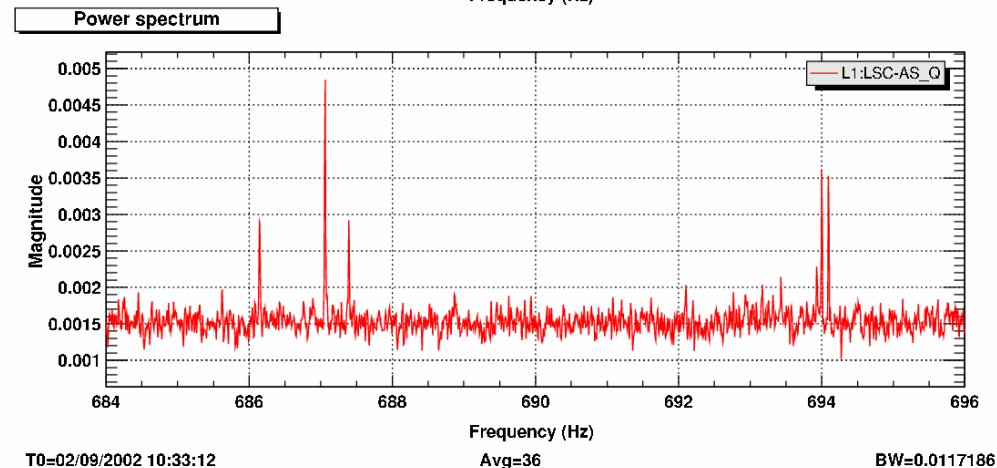
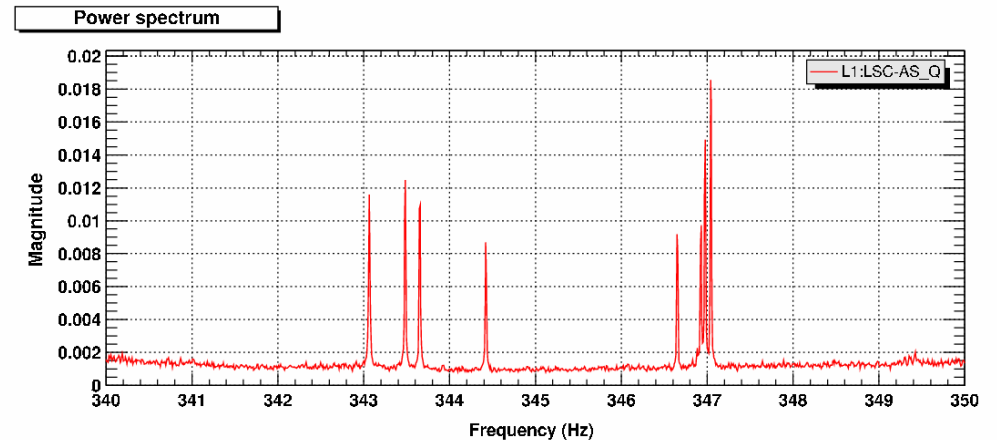
LLO violin mode

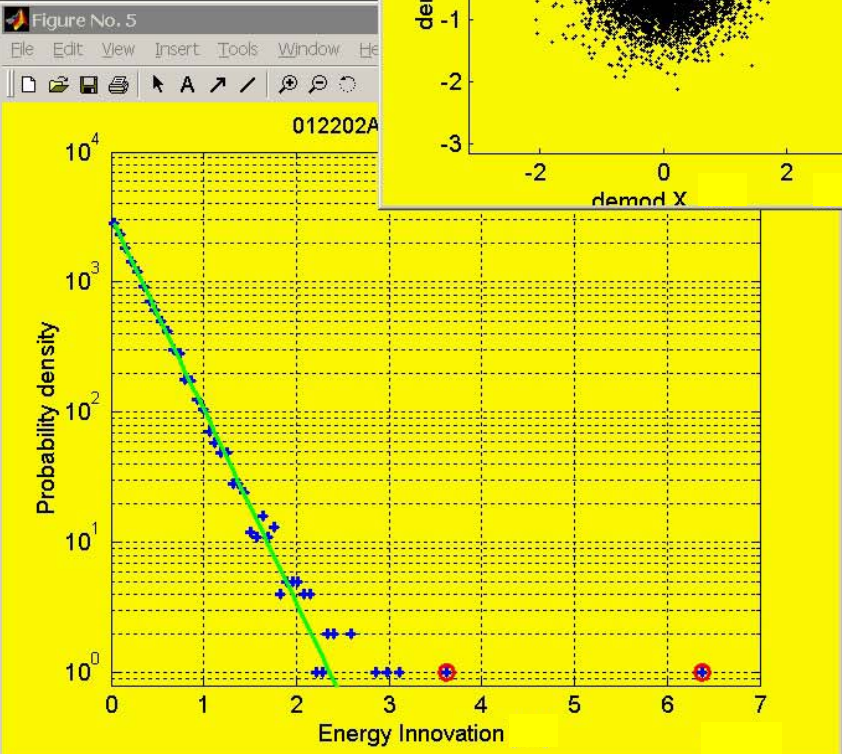
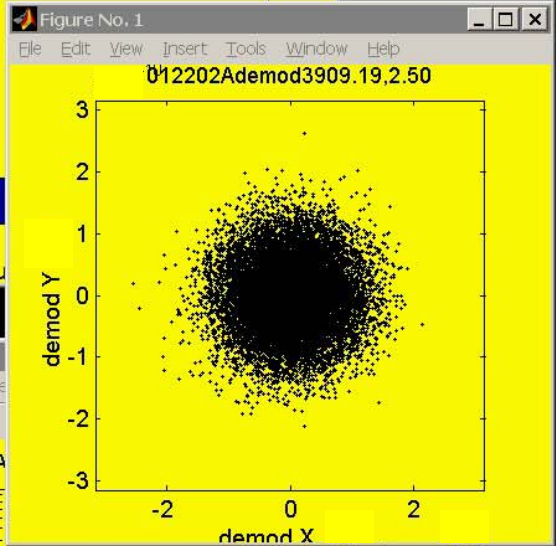
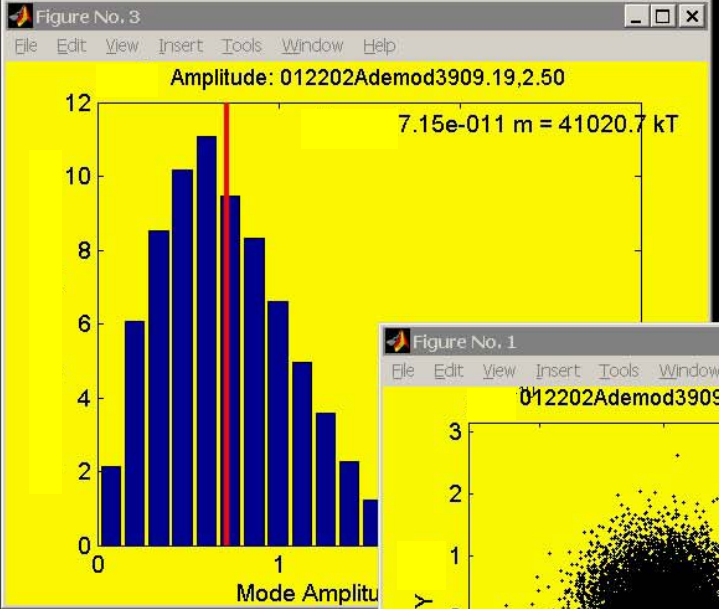


Correlations

Look for Correlations
between events:

- Between modes of the same wire
- Between identical modes of wires attached to same test mass
- Between modes of wires attached to the different test masses
- Between modes and nearby non-resonant frequencies





susmon

File Edit View Insert Tools Window Help

File RDS

FB I am at:

- llo
- lho
- cit
- mit

From:

- CDS
- GC

Demodulation
 Calibration
 Energy Innovation
 Candidate Search
 Equipartition
 Envelopes

Use manual control file Control file:

 Saved image format:

Auto display mode Single Re-use

Time

- 1s sample
- Envelope
- Candidates
- Histogram

FFT

- Power spectrum
- Energy vs. time
- Peak freq. vs time
- Freq. histogram

Demodulation

- Plane of quadratures plot
- Displacement histogram
- Energy innovation vs. time
- Energy innovation histogram

Channel/File:

GPS time:

Acquisition rate (Hz):

Reference frequency (Hz):

Averaging time (s):

Calibration:

Candidate threshold (%):

Input data type: