LIGO

RayleighMonitor: A Time-Frequency Gaussianity Monitor for the DMT

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Overview

- Stand-alone DMT monitor which tests Gaussianity of data as a function of frequency & time.
- Input: Data from arbitrary set of channels.
- Output: Scrolling time-frequency plots of (a) power spectrum and (b) Rayleigh statistic (variability of the power compared to Gaussian noise).
- Potentially useful for studying statistics of noise as function of frequency & time, and generally for seeing what's going on in a channel.

Rayleigh Statistic

- RayleighMonitor tests Gaussianity as function of frequency. It provides

  (a) Power spectrum (PSD) - power in frequency band, averaged over time. No info on the statistical properties of the noise.

  (b) Rayleigh statistic (R) - normalized variability of PSD:

  $$R(f) = \hat{a}(f)\frac{1}{2}\ddot{U}(f)$$

  For Gaussian noise, this is unity for all frequencies:

  Gaussian: $R(f) = 1$

- Rayleigh statistic is a `white' measure of Gaussianity.

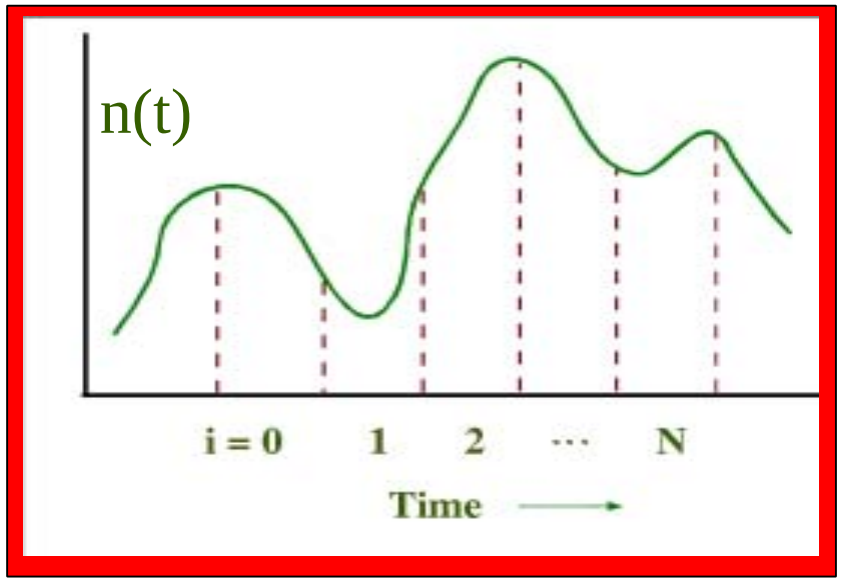
Procedure

- Divide data up into N equal segments $n_i(t)$.
- Window, Fourier transform to get $|n_i(f)|^2$.
- Monitor avg, st dev:

$$PSD = \bar{U}[\,|n_i(f)|^2\,]$$

$$R = \hat{a}[\,|n_i(f)|^2\,]\,/\bar{U}[\,|n_i(f)|^2\,]$$

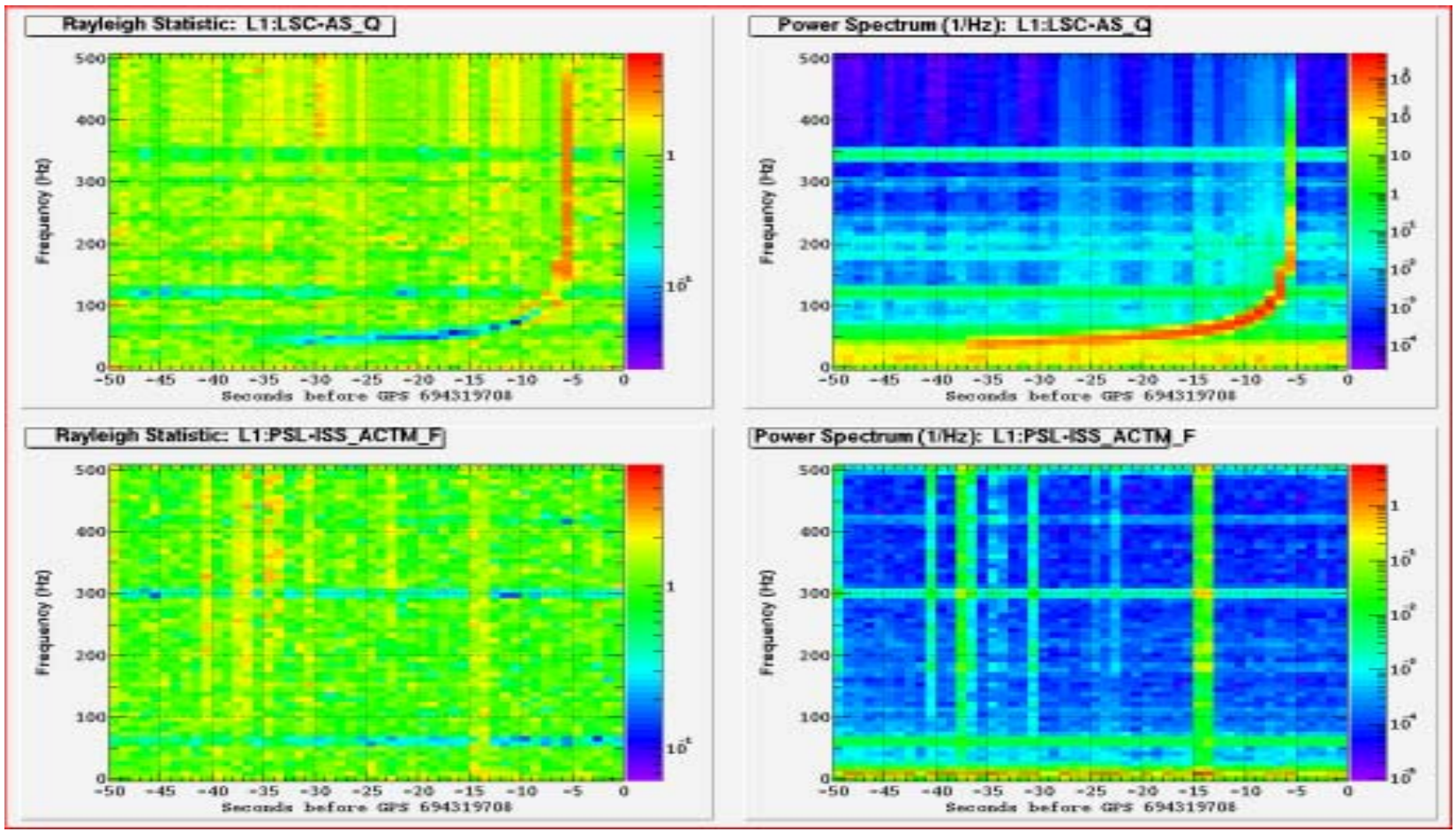
R << 1 1 coherent R >> 1 1 incoherent



Example: Injected Chirp in E7

- Each PSD used 1 sec of data divided into N=8 pieces.
- Top: Rayleigh statistic (left) and power spectrum (right) for L1:LSC-AS_Q showing injected chirp.
  - R << 1 (blue) shows power is coherent on 1/8-1 sec scale at low frequencies, where chirp spends many cycles.
  - R >> 1 (red) shows power is incoherent on 1/8-1 sec scale at high frequencies, where chirp spends few cycles.
- Bottom: Data for L1:PSL-ISS_ACTM_F (renamed for E7) showing many glitches. These transients do not show clear correspondence with glitches in AS_Q.

Example: Injected Chirp in E7



Rayleigh Monitor: Current Status

- Available as stand-alone data monitor for the DMT.
- Input: GUI front end (partially functional) reads channel list, frequency ranges, number and length of data segments to average.
- Output: Scrolling, interactive time-frequency plots of Rayleigh statistic and PSD.
- Updates and error messages to web page.
- Finished version in ~month.