Definition of Bicoherence

\[ b(k, l) = \frac{< X_k X_l X_m^* >}{\sqrt{|X_k X_l|^2 |X_m|^2}} \]

Y = y1 + y2 + y1*y2 + noise, 15Hz, 120Hz
15 + 105 = 120; 15 + 120 = 135

Bicoherence => degree of coherence between k, l and m = k+l

\[ e^{i\phi_1} e^{i\phi_2} e^{-i(\phi_1+\phi_2)} \]

\[ |b|^2 = \frac{P_{m^{\text{upconv}}}}{P_m^{\text{upconv}} + P_m^{\text{noise}}} \]
Tracking Bicoherence

Bicoherence trends will be useful to characterise instrument. Which couplings change during the course of a lock? By How much do they change?

Pendular modes

Vibrational modes
Average Bilinearity

\[ \beta = \frac{\sum_{L} b^2(k, l)}{L} \]

\( \beta \) indicates the average bilinearity, chi-sq distributed in 2L deg of freedom, \( L \)=number of f1-f2 frequency pairs.

Measure of bilinearity
For diff inspiral ranges
Bilinear Glitchiness

Which couplings are glitchy, thereby causing upconversion to increase/decrease? Do new couplings arise? Compare Bicoherence from overlapping windows—select a criteria (example: |bic1-bic2| >= .2) - write out frequency pairs to text file- Make a 2-D Histogram.
BACKGROUND MONITOR- 3 TASKS

- **Tracking Bicoherence** Identify pairs of frequencies (f1-f2) – compute Bicoherence - Track it for overlapping windows, as selected by user.

- “**Average Bilinearity**” A measure of bilinearity of data, Sum up bicoherence over entire f1-f2 space - Track it for overlapping windows.

- “**Bilinear Glitchiness**” Look for changes in bicoherence in overlapping windows – construct 2-D histogram-relative probability of occurrence of f1-f2.
BicoMon (Current)

• **Function:** A stand-alone workstation for analyzing the bicoherence.
  
  – Allows the choice of any channel combination
  
  – Automatically sets the data rate and duration for the required frequency resolution and range
  
  – Output of plots to GIF files.
  
  – Allows simultaneous viewing of bicoherence, bispectrum, and 1–3 power spectra
BicoMon (Pending)

- Utilize FFTW 3. Unify calculation engine method.

- Heterodyning: to allow finer resolution around interesting features (only for autobicoherence).

- Track integrated autobicoherence with time (test for gaussianity)

- Track 2D plot of variance of bicoherence (running average of the difference squared). This is a measure of the “glitchiness” of the data.

- Ability to spawn jobs in background monitor
BicoMon Background

- Track the average bicoherence in a region around an interesting feature. The channels and frequency pairs are stored in a configuration file that is updateable directly or from BicoMon.

- Gaussianity: Track the average autobicoherence of a channel as a measure of its gaussianity.

- Once 2D histogramming is feasible within the DMT Viewer, we should track the mean and variance of the autobicoherence of given channels (AS-Q).
Timeframe

• Steve (and possible one summer student) will work on BicoMon & plan to finish by August
  – calculation upgrade (FFTW3 + unified engine)
  – heterodyning
  – writing jobs to background monitor

• Vijay will work on BicoMon Background and plans to finish by August
  – tracking integrated autobicoherence of AS-Q
  – tracking bicoherence of interesting events as listed in the bicomon configuration file.

• We have set-up weekly telecons for the project. Anyone wishing to join the project or the telecons, please contact us.