CGWAS Exercises - GW Burst Analysis Solutions

July 8 2015

DYI excess power algorithm
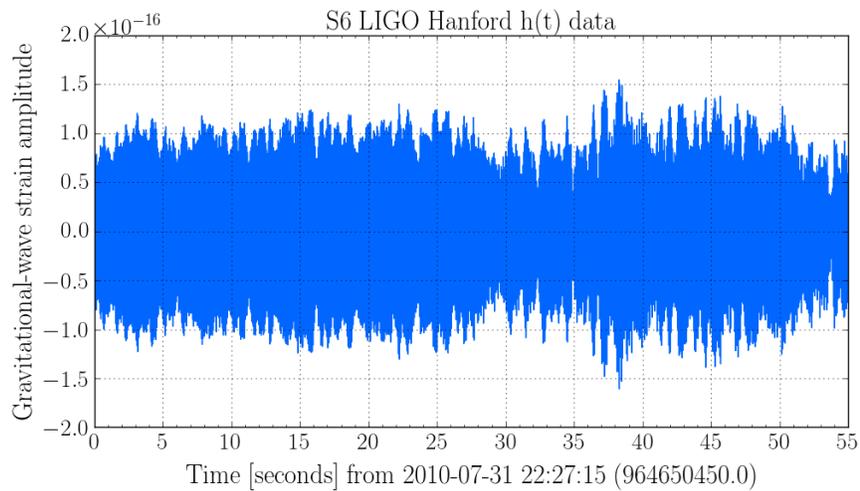
Step 2 - Plotting a first glimpse

Figure 1: There are no obvious/clear excess power features in the unfiltered Hanford data during this time.
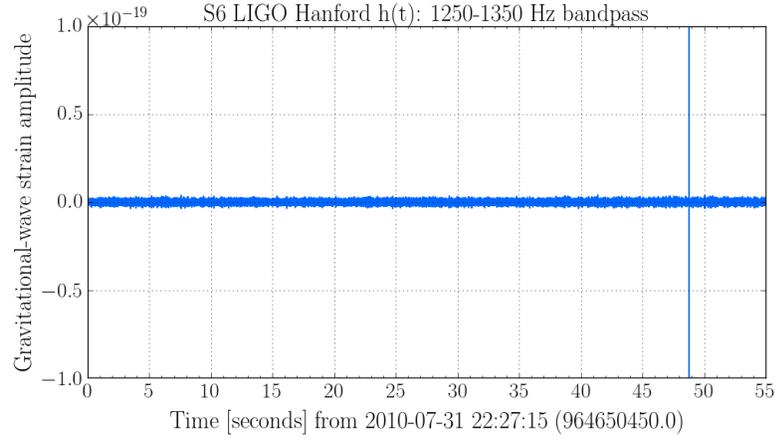
Step 3 - 'Tiling' the data in frequency

Figure 2: After applying a second order bandpass filter from 1250 to 1350 Hz, a very distinct peak appears 49 seconds after the start of the time interval (i.e. after 964650450).
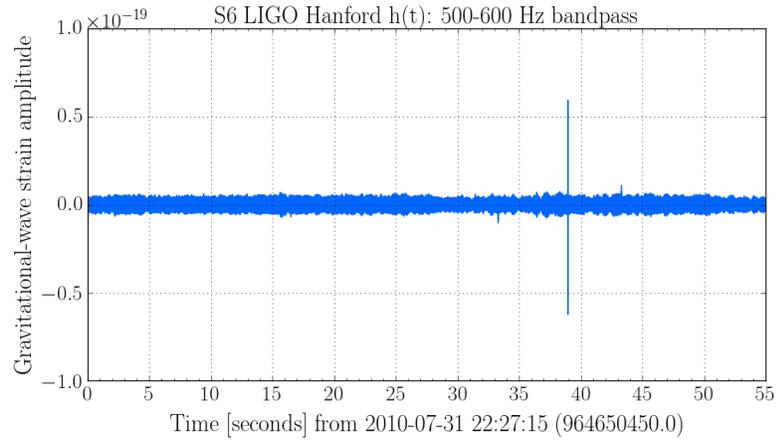

Figure 3: After applying a second order bandpass filter from 500 to 600 Hz, a *different* very distinct peak appears 39 seconds after the start of the time interval.
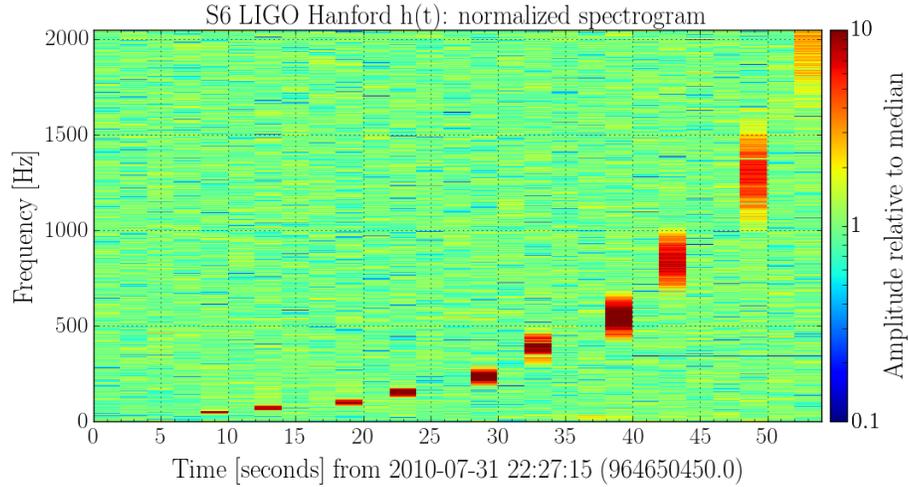
Step 4 - A more complete picture

Figure 4: The normalized spectrogram shows that our two identified events are only two in a series of bursts, each with discretely different frequency content.

These bursts are actually a series of sine-Gaussian hardware injections with the following times and frequencies:

Time (sec after 964650450)	Frequency (Hz)
9	50
14	70
19	100
23	153
29	235
33	393
39	554
43	850
49	1304
53	2000

(The 2000Hz event is a little hard to make out with the 4096 sampling rate.)

Advanced step: Design your own filters

Lower frequency events are a lot harder because they're so narrowband relative to the higher frequency SGs, plus the data gets much noisier very quickly below 100Hz. You'll need to use higher order filters to make out the events, so you'll probably see some filtering artifacts for events below 200Hz.

I had success with the following bandpass filters:

| SG event (Hz)	Filter parameters	Any notes
50	4th order from 46-54Hz	The event stands out, but the artifact peak at 0sec is giant
70	3rd order from 70-80Hz	This event is a smaller spike than the filtering artifact at 0sec
100	3rd order from 85-115Hz	Filtering artifact spike at 0sec
153	3rd order from 130-175Hz	Small filtering artifact spike at 0sec
235	2nd order from 220-250Hz	I had to zoom in to +/- 1e-19
393	2nd order from 340-440Hz	I had to zoom in to +/- 1e-19
554	(in exercise)	
850	2nd order from 800-900Hz	
1304	(in exercise)	
2000	2nd order from 1950-2040Hz	Careful of Nyquist at 2048Hz

Looking for coincident excess power
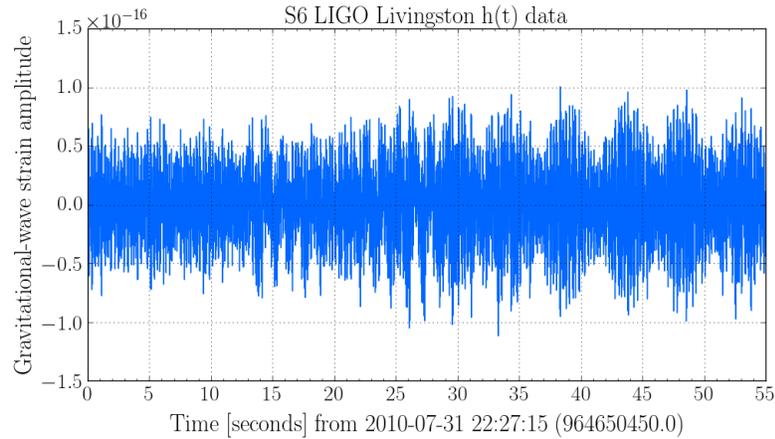
Figure 5: Nothing apparent in the Livingston unfiltered data for the same time (as we saw for Hanford).
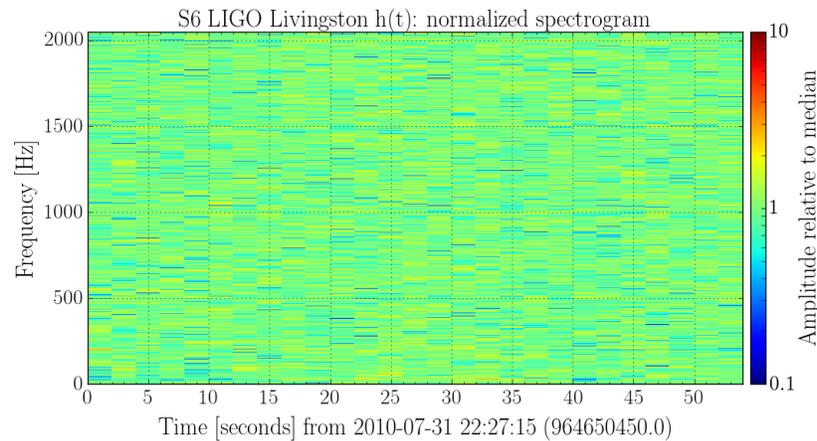

Figure 6: But contrary to Hanford, there's nothing interesting in the normalized spectrogram either. No evidence here for excess power coincident in time and frequency between the sites, at a rough glance.

As you may have guessed, the injections were single interferometer hardware injections.

Comments? Questions? jessica.mciver@ligo.org