

Title: An alternative significance estimation for the evidence for echoes

Date: Nov 08, 2017 10:50 AM

URL: <http://pirsa.org/17110071>

Abstract: The noise dominated nature of the gravitational wave detectors requires an assessment of the noise background in the search for astrophysical signals. Starting with a frequentist approach, the original analysis used about 16 seconds of data after the merger signal to find how frequently random noise mimics the expected signal. We present the results of extending the background estimation to 4096 seconds of public LIGO data and discuss the concerns arising from subtleties in the analysis for the long and self-similar echo templates.

Analysing gravitational wave data for black hole echoes



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Quantum Black Holes in the Sky?
Perimeter Institute, Wednesday 8th Nov, 2017



Motivations

- Currently, data is ahead of theory. Try to use data to guide theory.
- Solar system well described by Newtonian gravity unless you look very closely.
- Quantum mechanics essential for White Dwarves and Neutron Stars, but not Black Holes?
- Observations of colliding black holes is as good as its going to get, for quite a while.

What the p-value tells us

$$p\text{-value} \sim 0.044$$

False Alarm Rate (FAR) ~ 1 per 100 hours

$$\frac{P(\text{echoes}|\text{data})}{P(\text{noise}|\text{data})} = \frac{P(\text{data}|\text{echoes})}{P(\text{data}|\text{noise})} \frac{P(\text{echoes})}{P(\text{noise})}$$

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Topics

- The impact of LVT151012
- Recovering injections – what could we recover/what could we (confidently) rule out?
- Comparison with Gaussian noise
- Laying out the templates, noise triggers should be uniformly distributed over templates

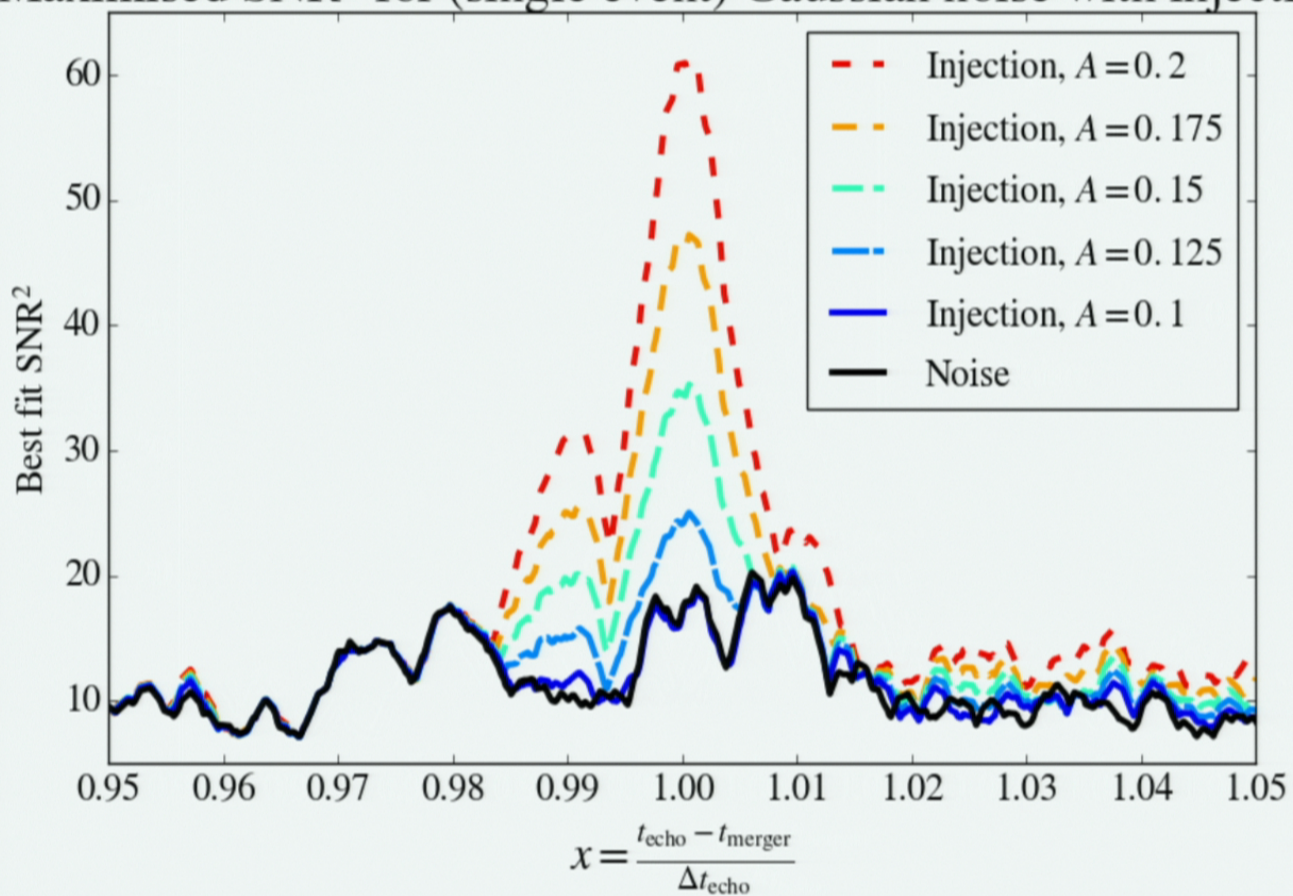
Using the LOSC open data

- LOSC URL: <https://losc.ligo.org/>

	SNR of main event	SNR of echoes	Echo amplitude relative to main event
GW150914	23.7	4.13	0.091
LVT151012	9.7	4.52	0.34
GW151226	13.0	3.83	0.33

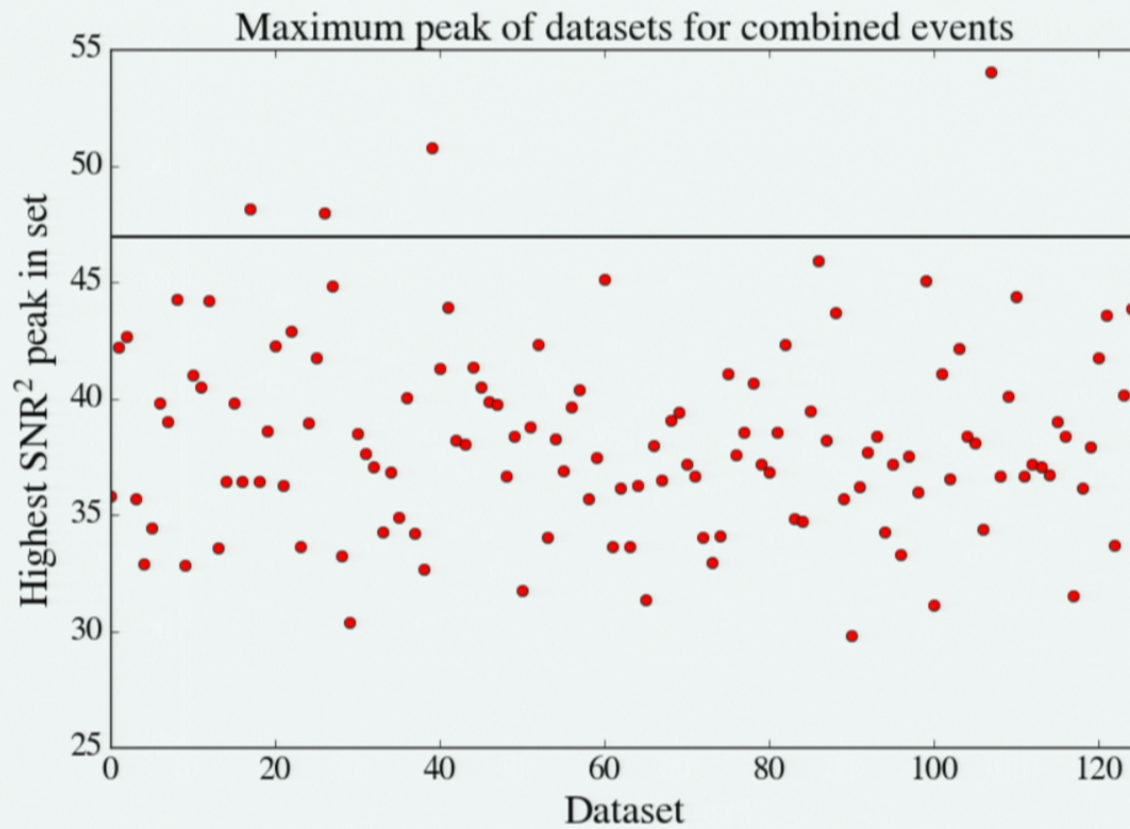
Recovering injections

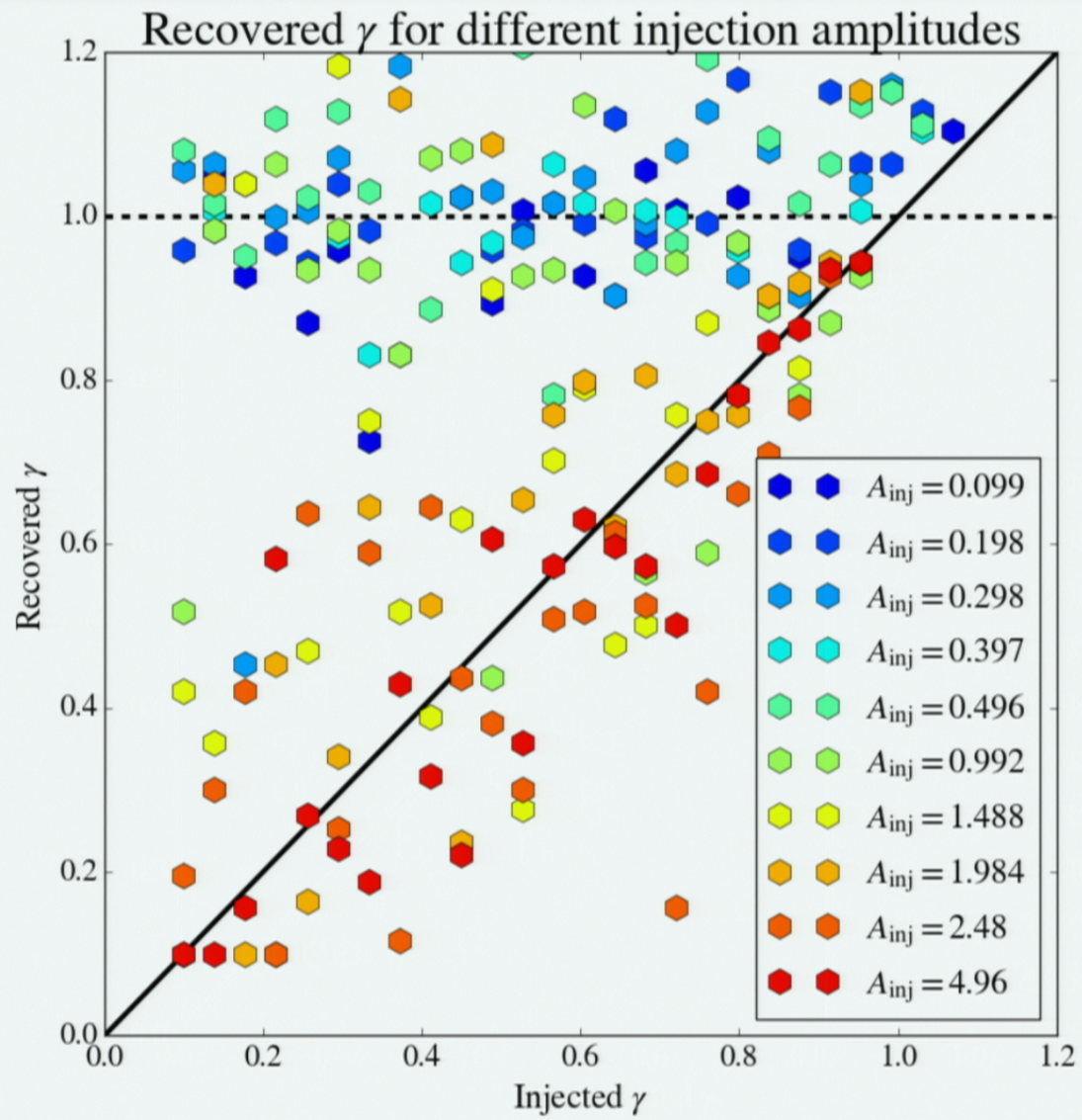
Maximised SNR^2 for (single event) Gaussian noise with injections



More data for background

We run on more of the LOSC open data to improve background estimation





Conclusions

- There is not sufficient evidence to claim the existence of echoes in the LIGO data.
- Our p-value estimate is 0.044 (corresponding significance $\sim 1.7\sigma$).
- Even without sufficient evidence, searching for horizon modifications remains relevant.
- It is likely that the physical template models for echoes will be improved and more refined search methods can be applied.