

Automated Noise Regression and Improved Parameter Estimation

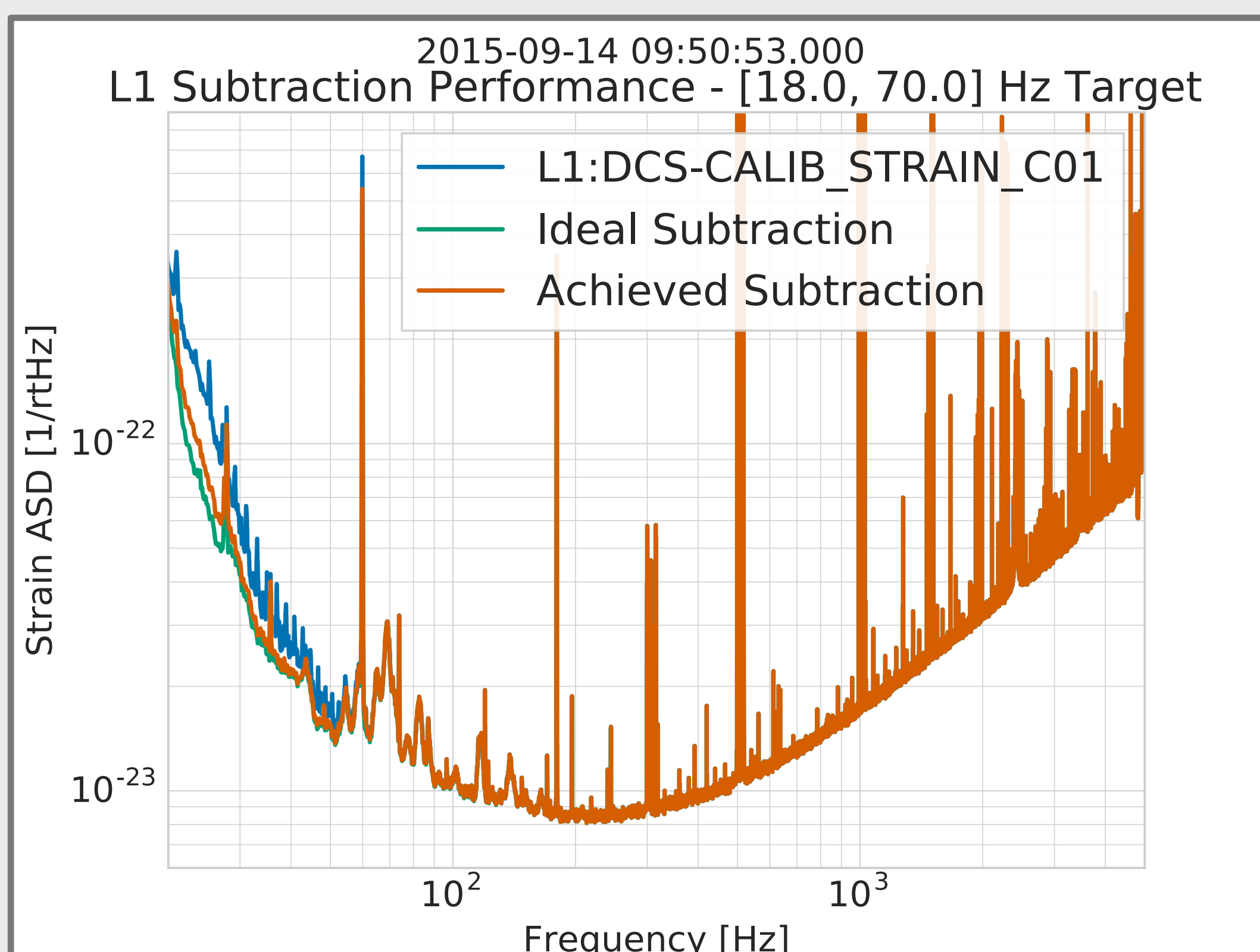
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Motivation

Noise couplings into the interferometer are inevitable, but some sources are witnessed in other sensors. We can remove some of this noise via Wiener filtering, a technique for estimating and regressing noise from a target signal that has been used with success in eLIGO and otherwise.

Methodology

In this work, we created a tool to automatically process hundreds of auxiliary channels around the time of a GW event, to coherently estimate their coupling into the GW signal. A “greedy ranking” algorithm determines the set of channels with the most coupling.

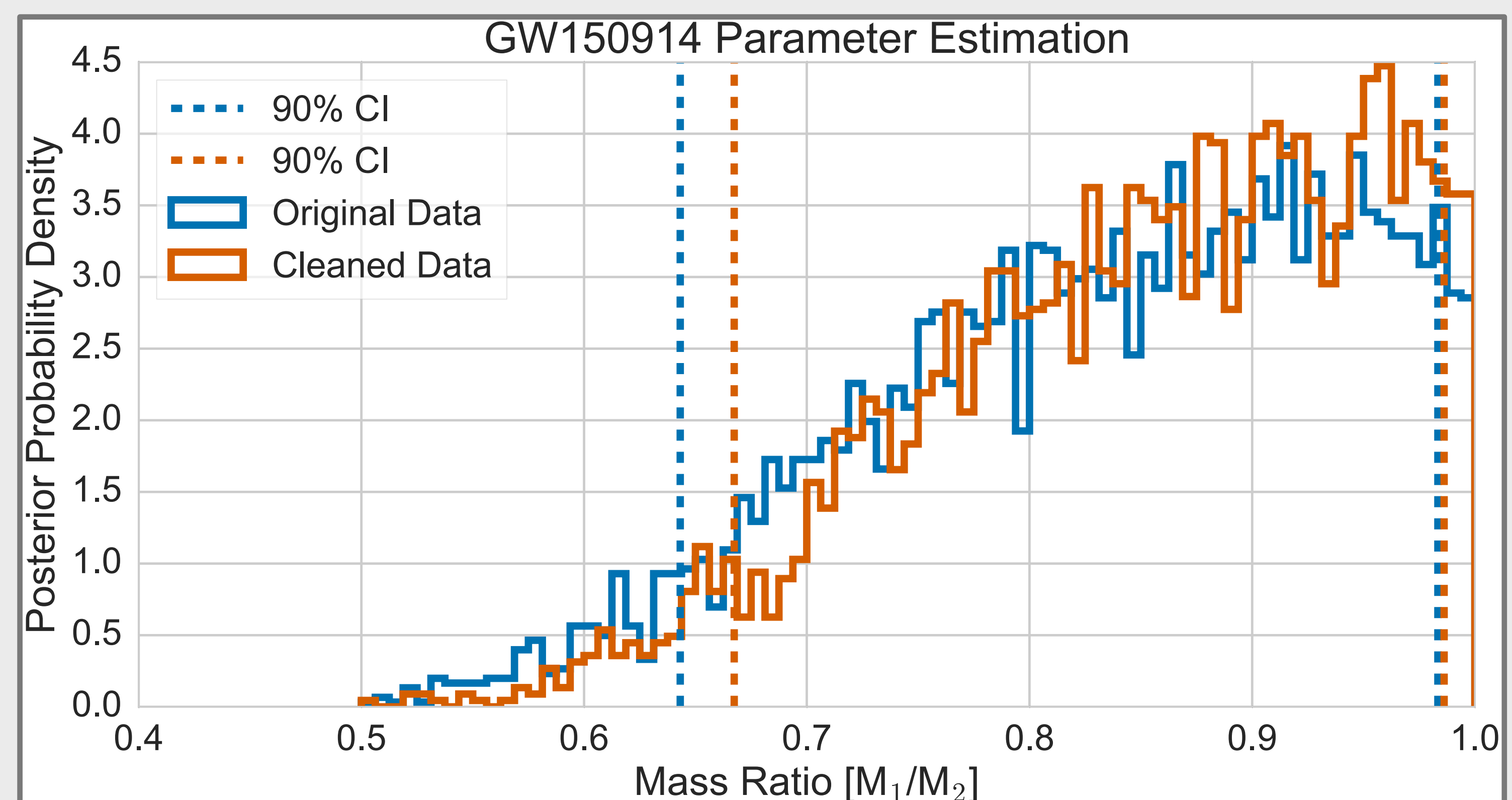
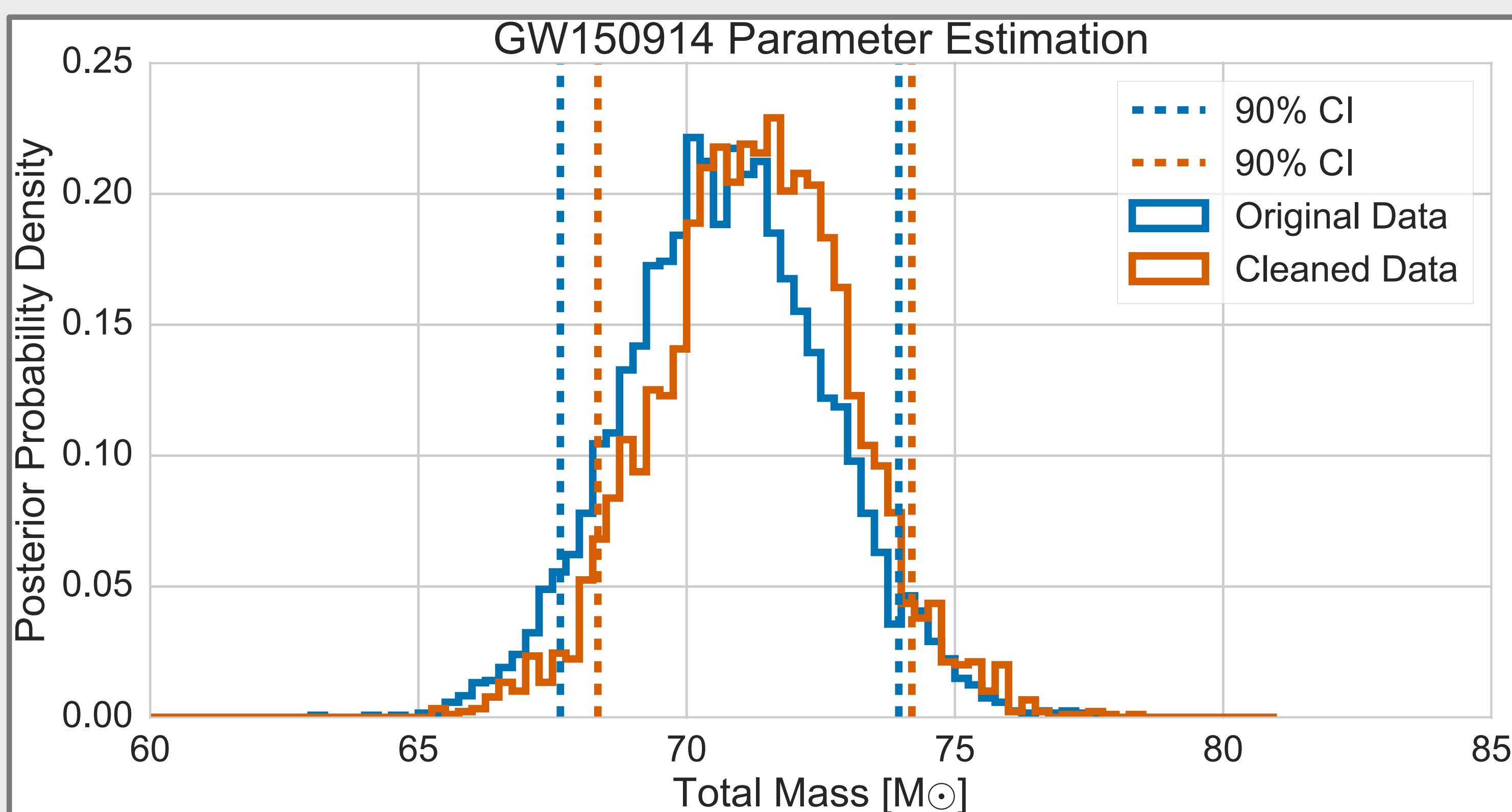
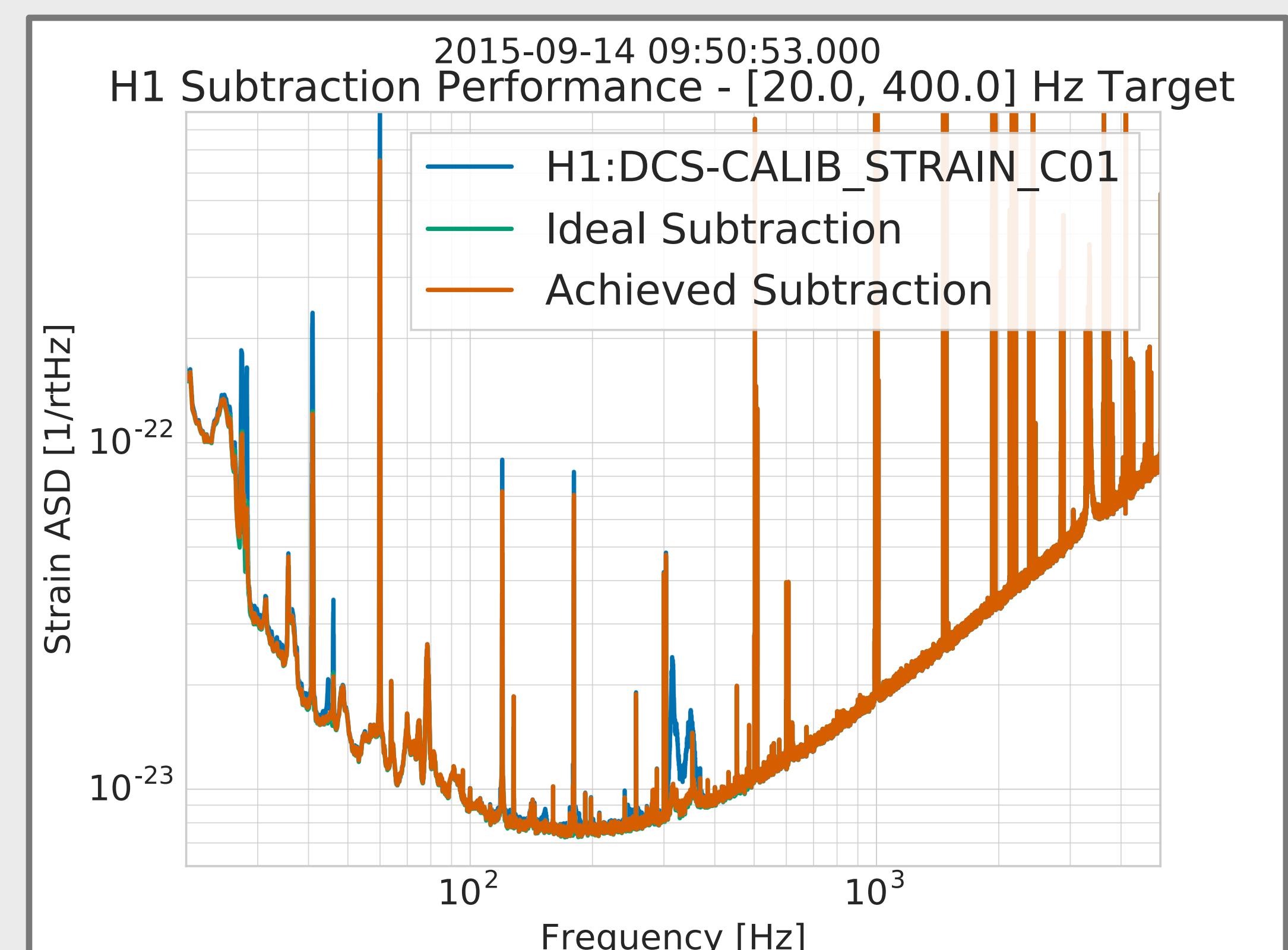


L1 Subtracted Channels:

- ▶ Calibration lines
- ▶ Test Mass angular controls
- ▶ DRMI cavity length
- ▶ ISI Seismometer signals
- ▶ Y End Tiltmeter signal (1Hz comb)

H1 Subtracted Channels:

- ▶ Calibration Lines
- ▶ PSL periscope jitter
- ▶ DRMI cavity length



Results

The Wiener filters performed as expected on validation data which was not used for training, suggesting the physical couplings are accurately captured. Furthermore, tests on hardware injections show no significant introduction of bias in the recovered parameters.

In the case of GW150914, we found this method to improve the network SNR of the event by **6%** and to improve the width of the mass parameter 90% confidence intervals by about **7%**.

Prospects

Going forward, this automated coupling search could inform commissioning and detector characterization efforts, as well as automatically “clean up” event candidates.

Efforts are also ongoing to extend this method to nonlinear noise couplings, such as “bilinear” couplings.

References:

- B. Allen, et al.* Automatic Cross-talk Removal from Multi-Channel Data (1999) [P990002]
- J. Driggers, et al.* Global feed-forward vibration isolation in a km scale interferometer (2010) [P1000088]
- J. Driggers, et al.* Subtraction of Newtonian Noise Using Optimized Sensor Arrays (2012) [P1200017]
- V. Tiwari, et al.* Regression of Environmental Noise in LIGO data [P1400004]

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