

Searching for Gravitational Waves in Noisy Detector Data

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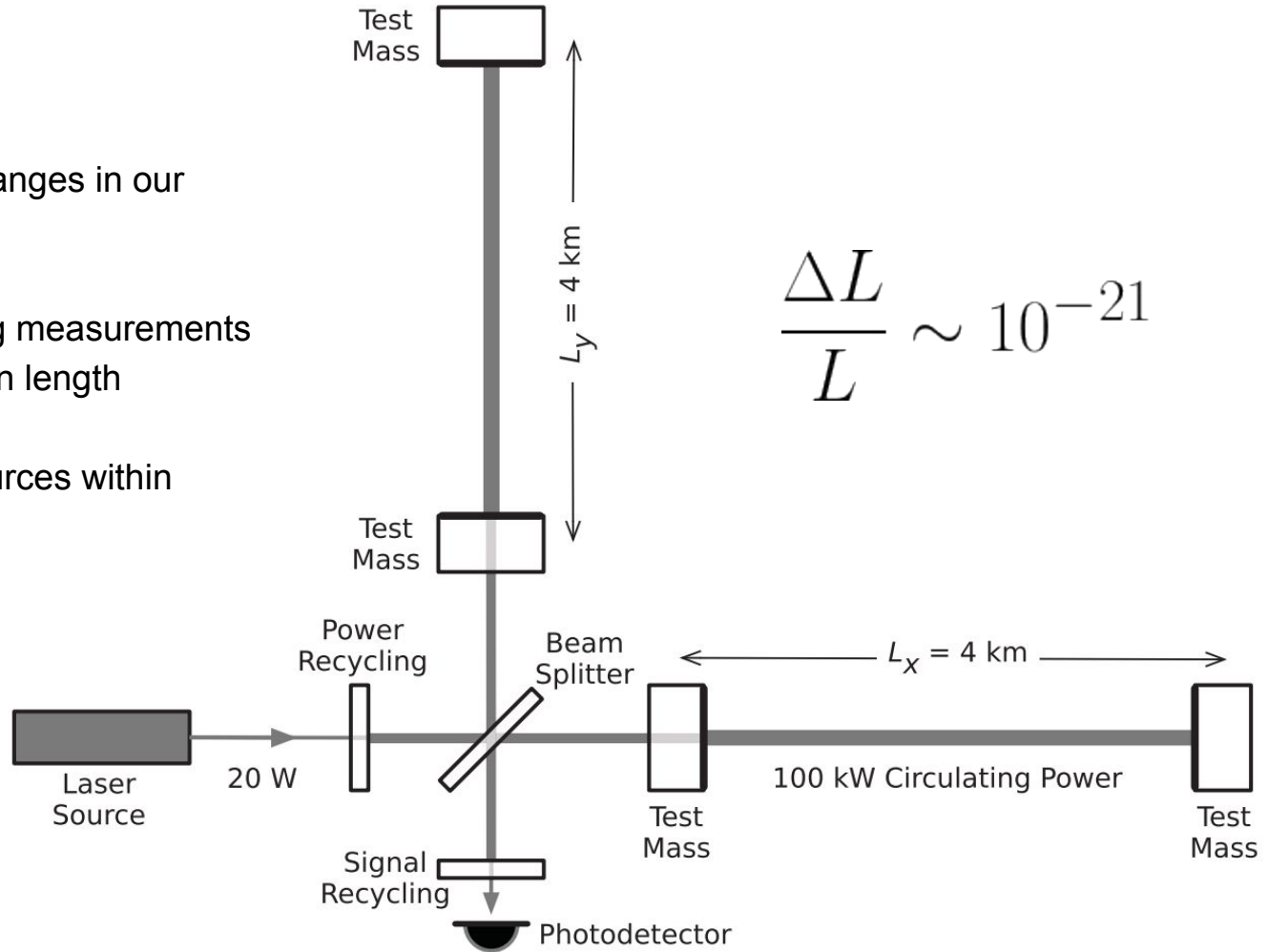
<https://github.com/reedessick/compton-lectures-2019>

Review

GWs manifest as length changes in our detector

Interferometers make timing measurements to measure changes in length

There are various noise sources within terrestrial detectors

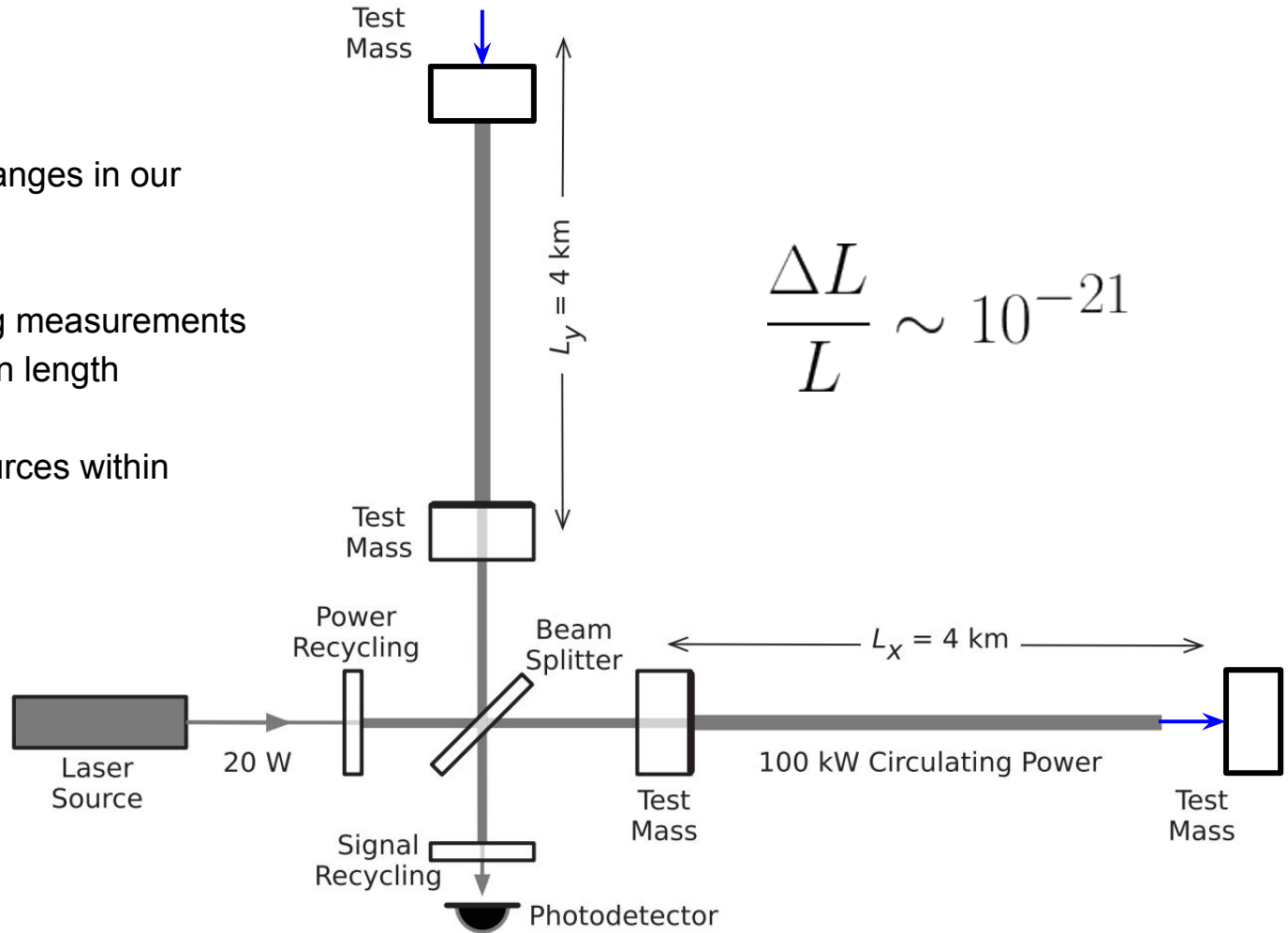


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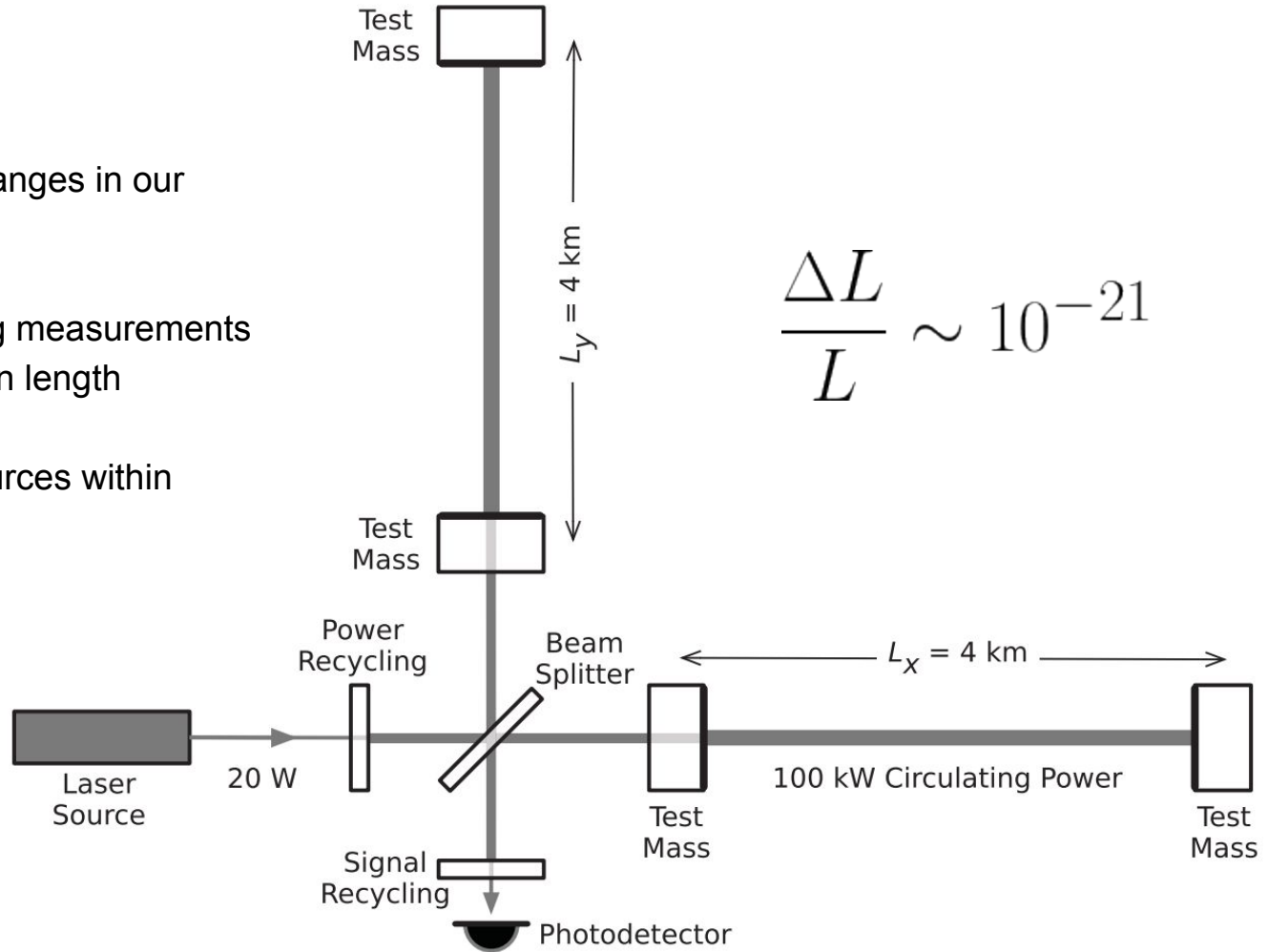


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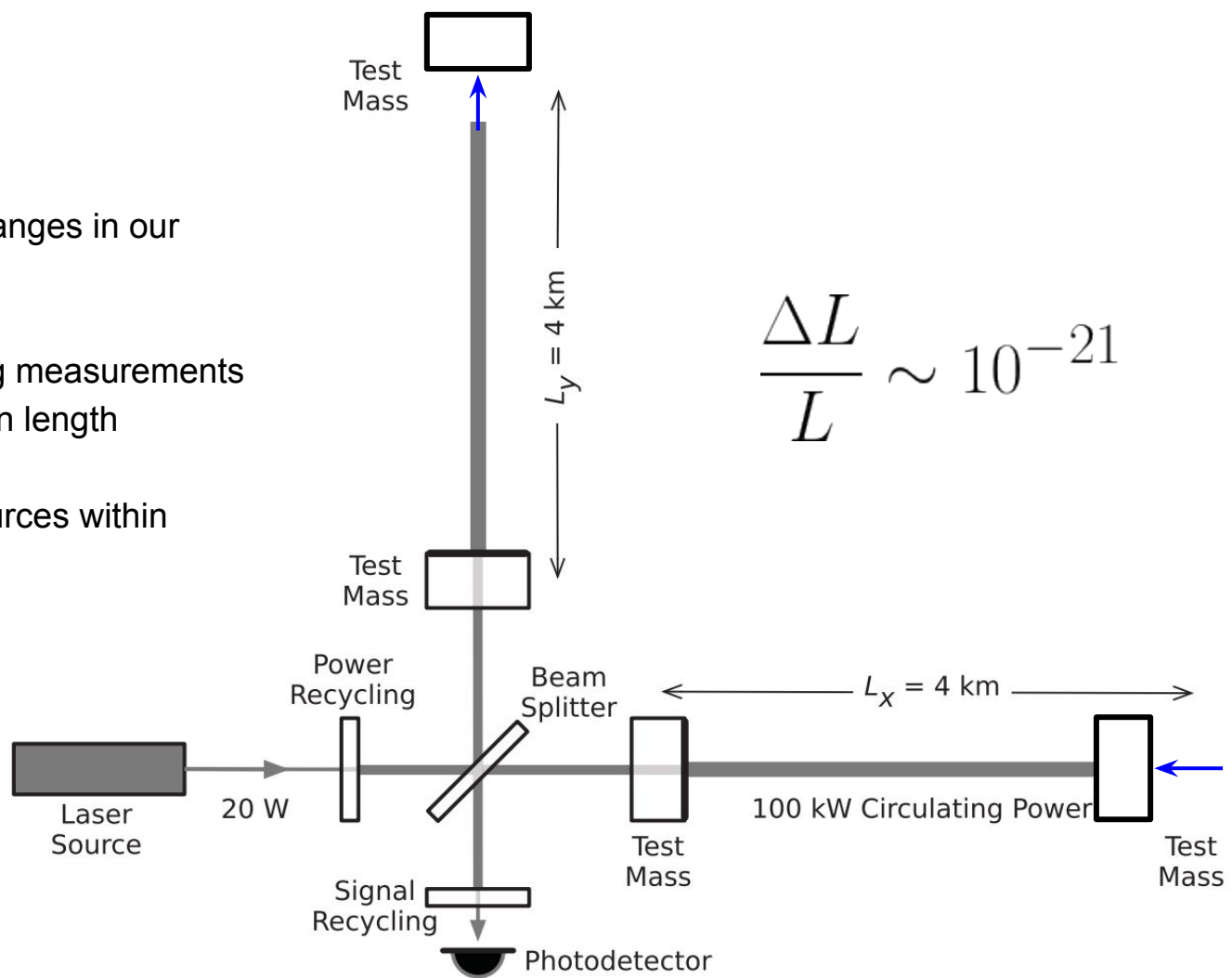


Review

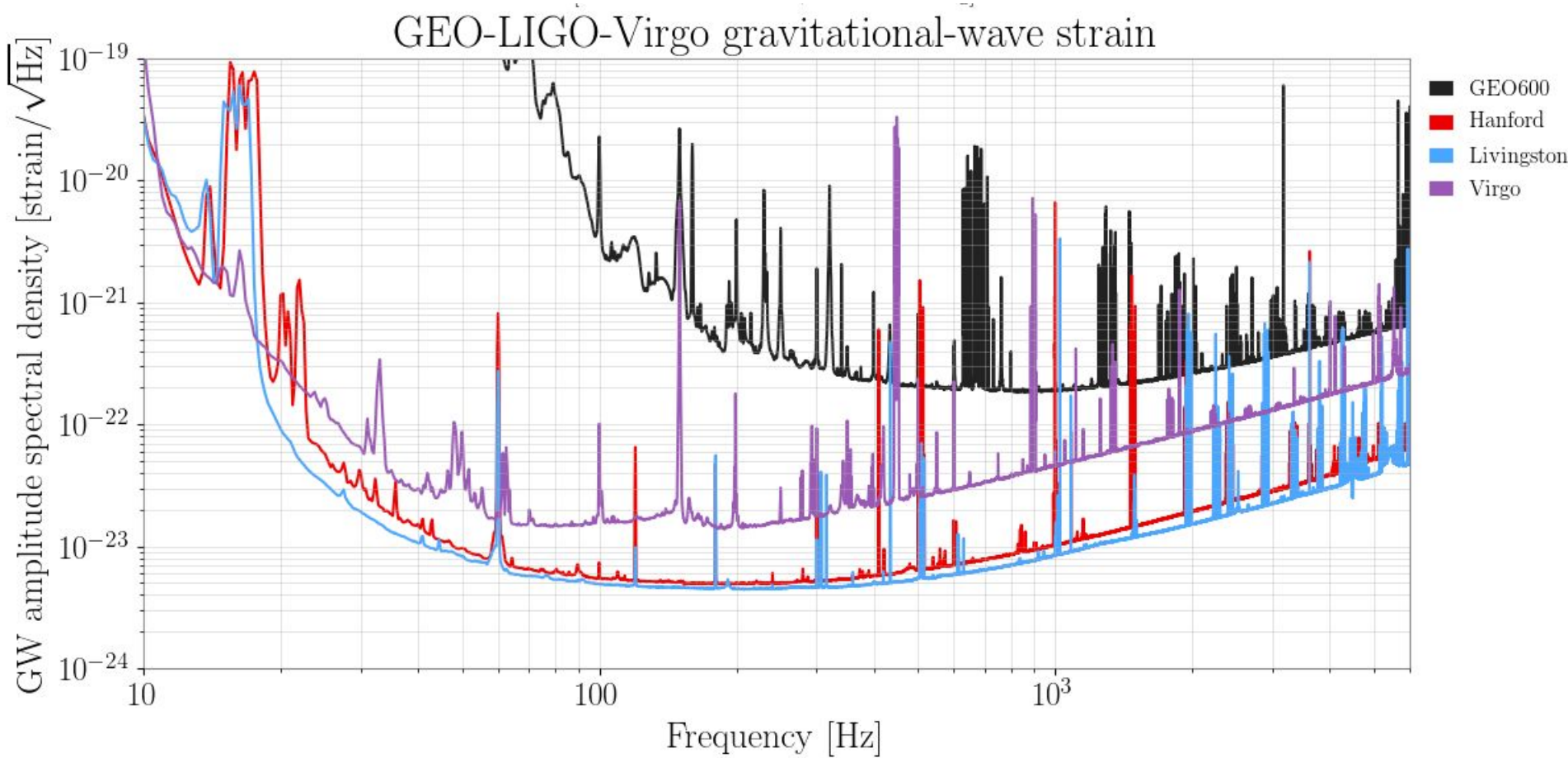
GWs manifest as length changes in our detector

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Interferometer Noise Characteristics



Search Techniques

modeled signals

If you know what the signal looks like, run a ***matched filter***.

Search Techniques

modeled signals

Search Techniques

unmodeled signals

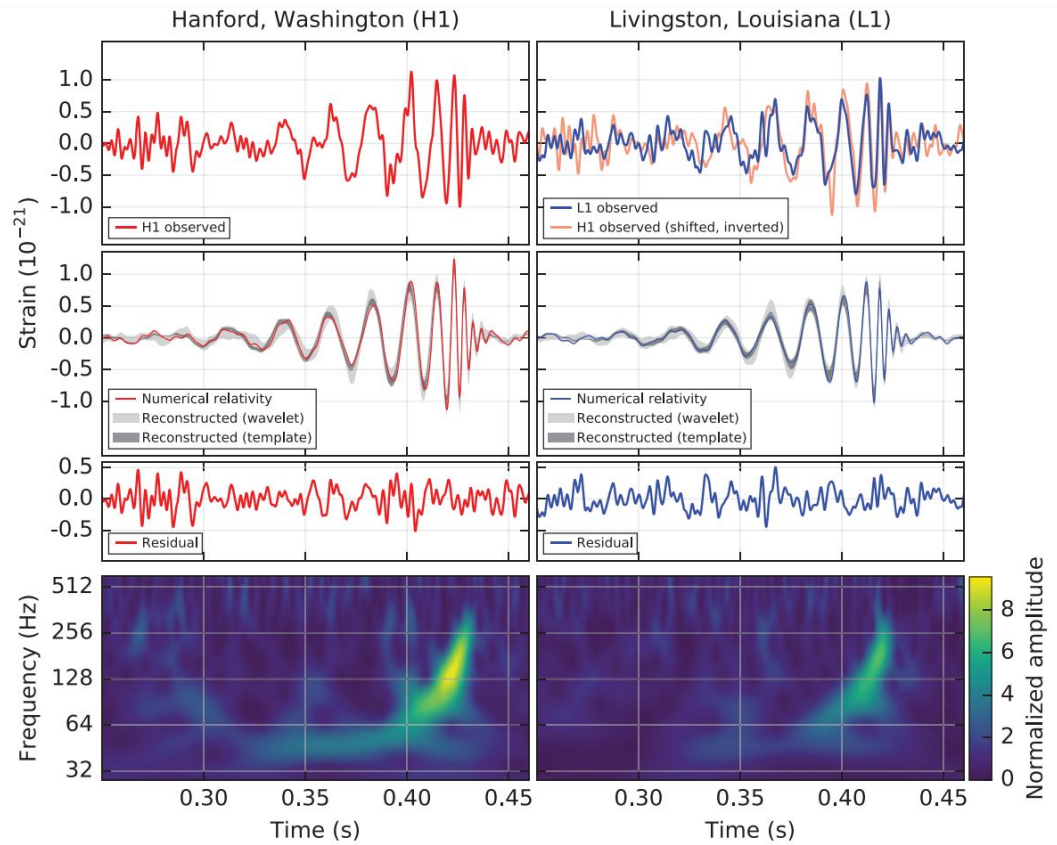
If you do not know what the signal looks like, use a ***coherent likelihood*** or ***cross-correlation between detectors***

- typically less sensitive than matched filter searches

Search Techniques

unmodeled signals

Establishing Detection Confidence



Establishing Detection Confidence

What is a “background”?

Establishing Detection Confidence

What is a “background”?

How well can we distinguish “background” (noise) from “foreground” (signals)?

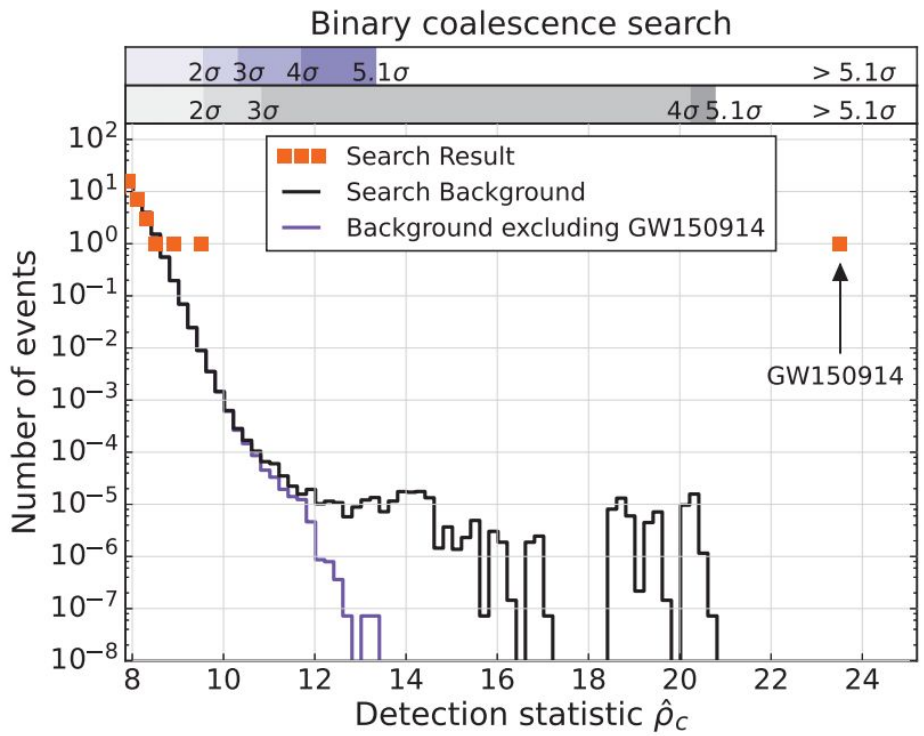
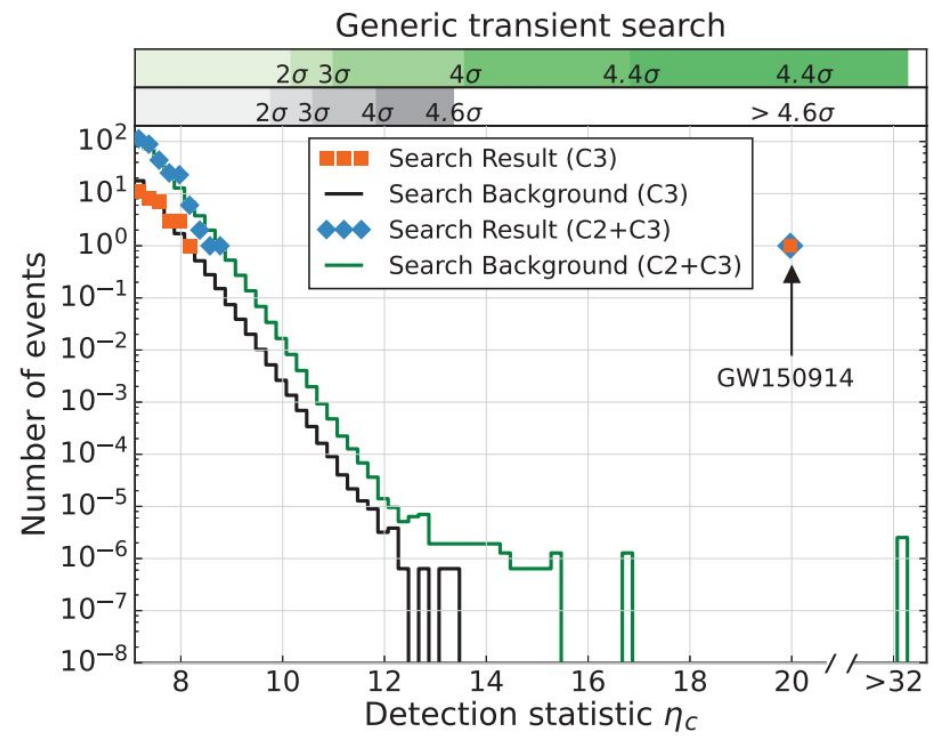
Establishing Detection Confidence

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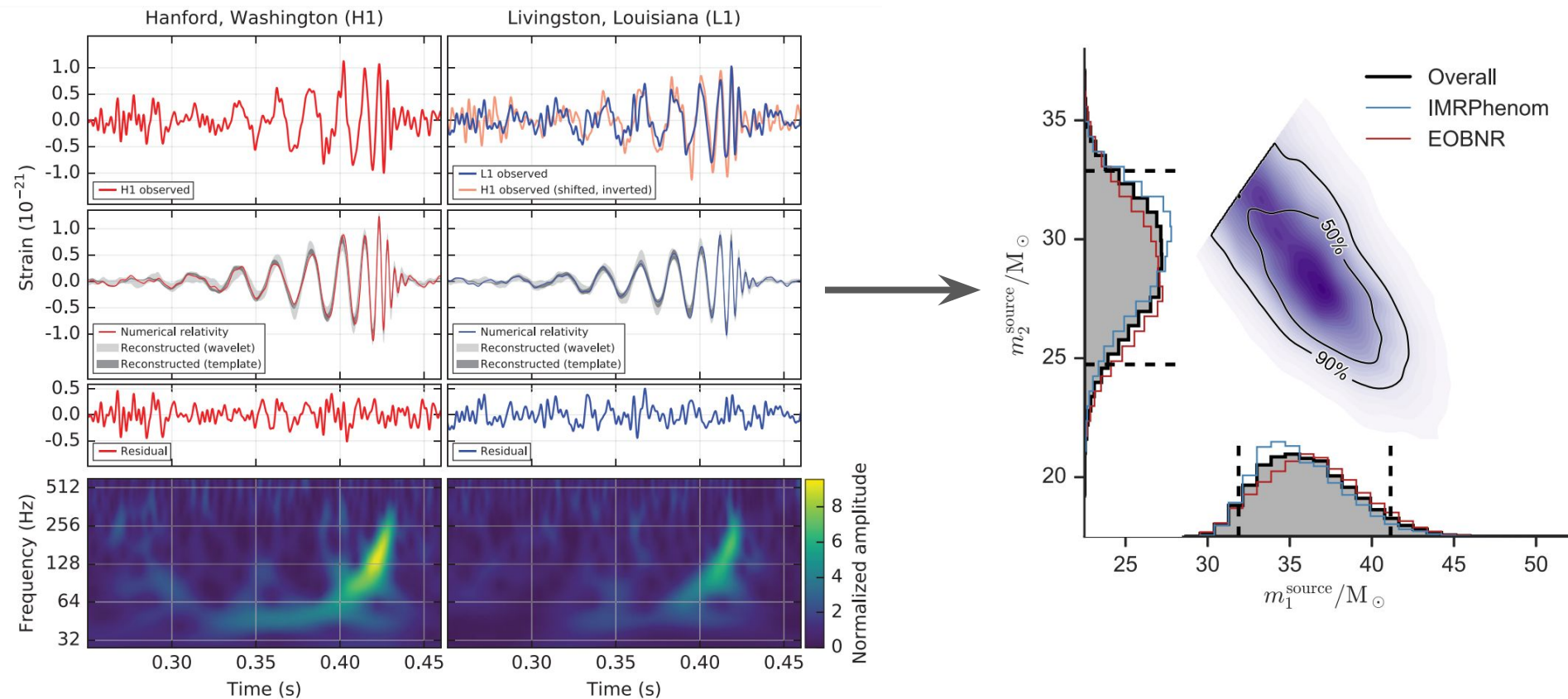
How well can we distinguish “background” (noise) from “foreground” (signals)?

How do we measure background distributions?

Establishing Detection Confidence



Estimating Signal Parameters



Estimating Signal Parameters

Why can't we know exactly what the signal parameters were?

Estimating Signal Parameters

Why can't we know exactly what the signal parameters were?

What is a probability distribution?

Estimating Signal Parameters

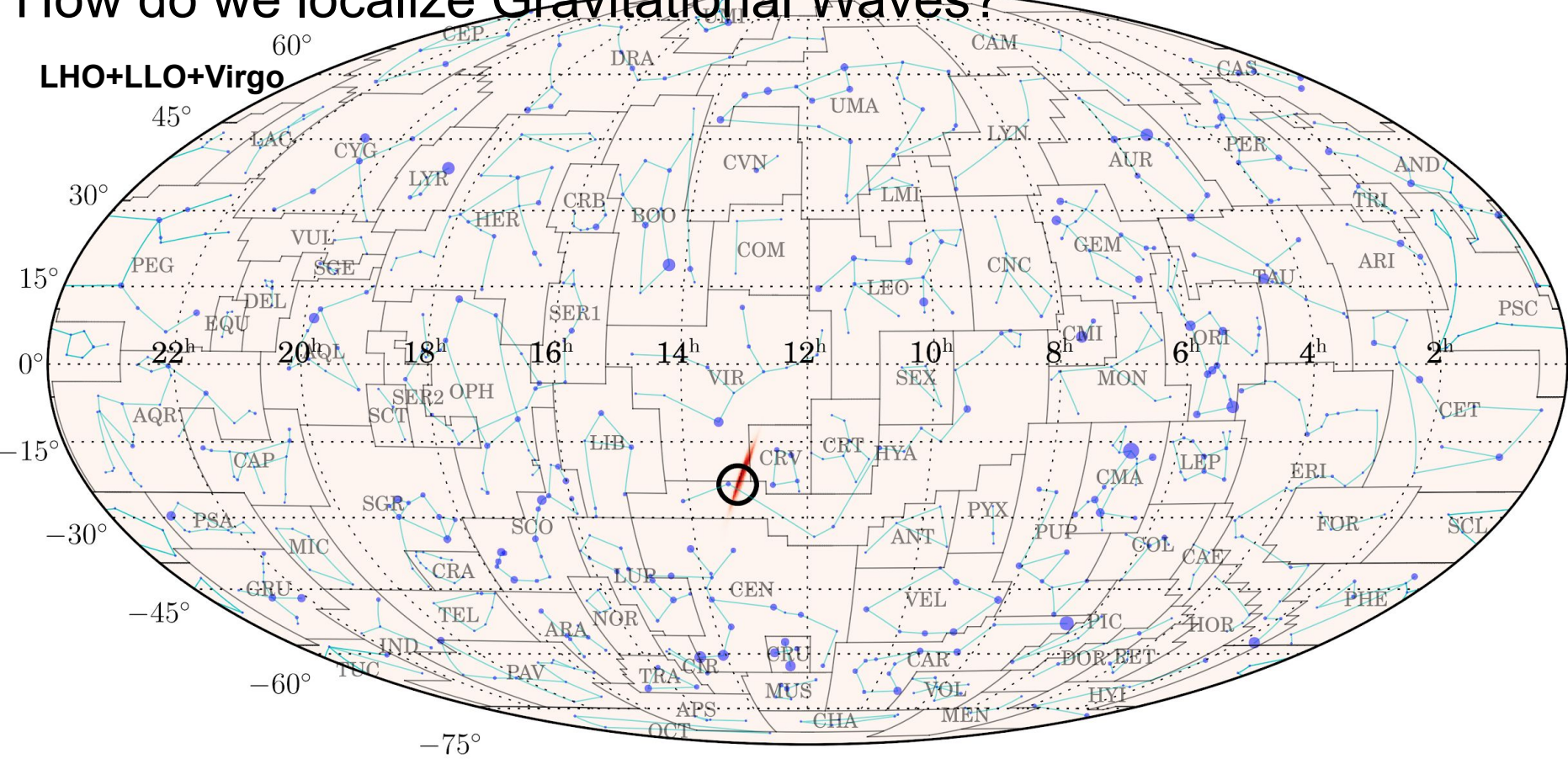
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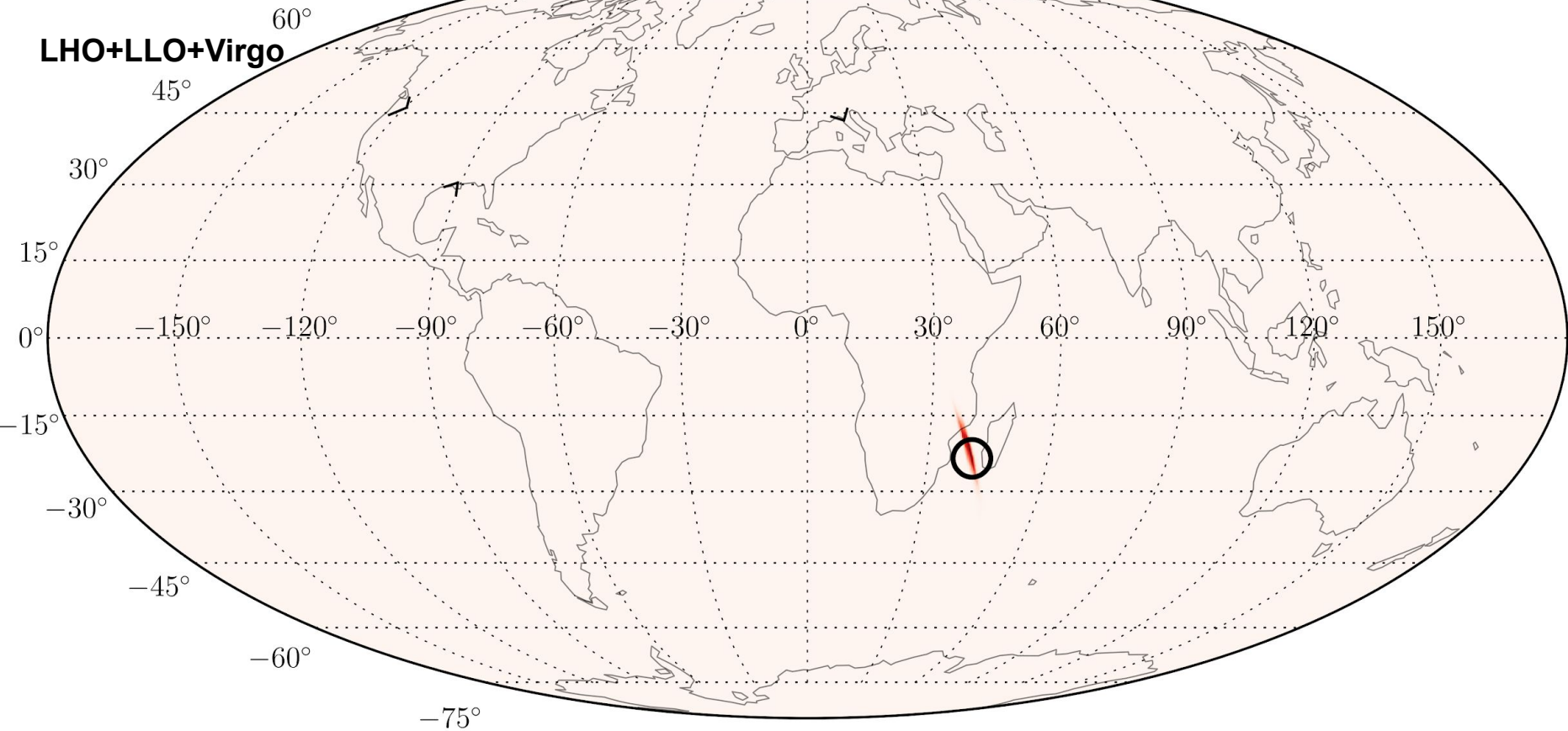
How do LIGO+Virgo come up with their probability distributions for signal parameters?

How do we localize Gravitational Waves?

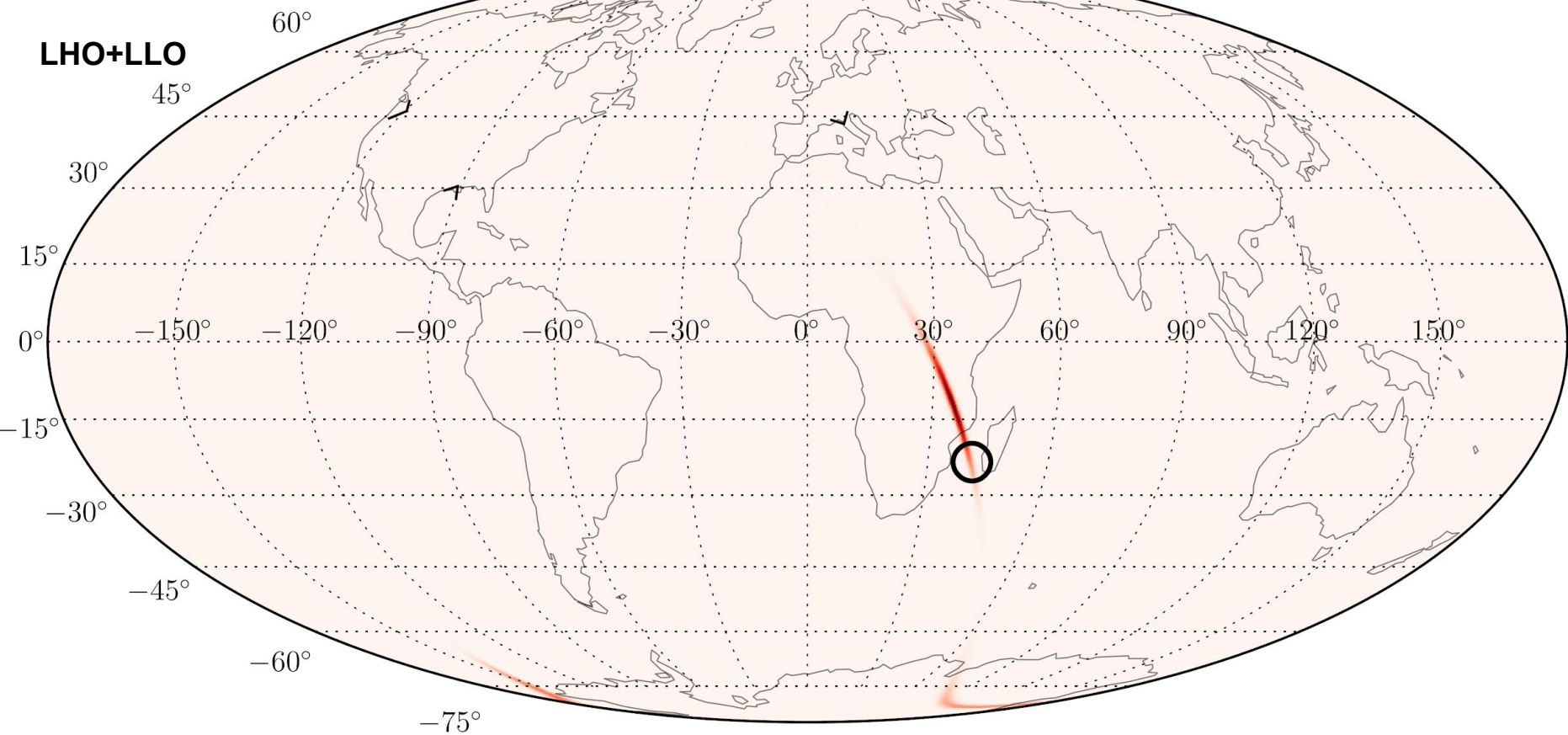
LHO+LLO+Virgo



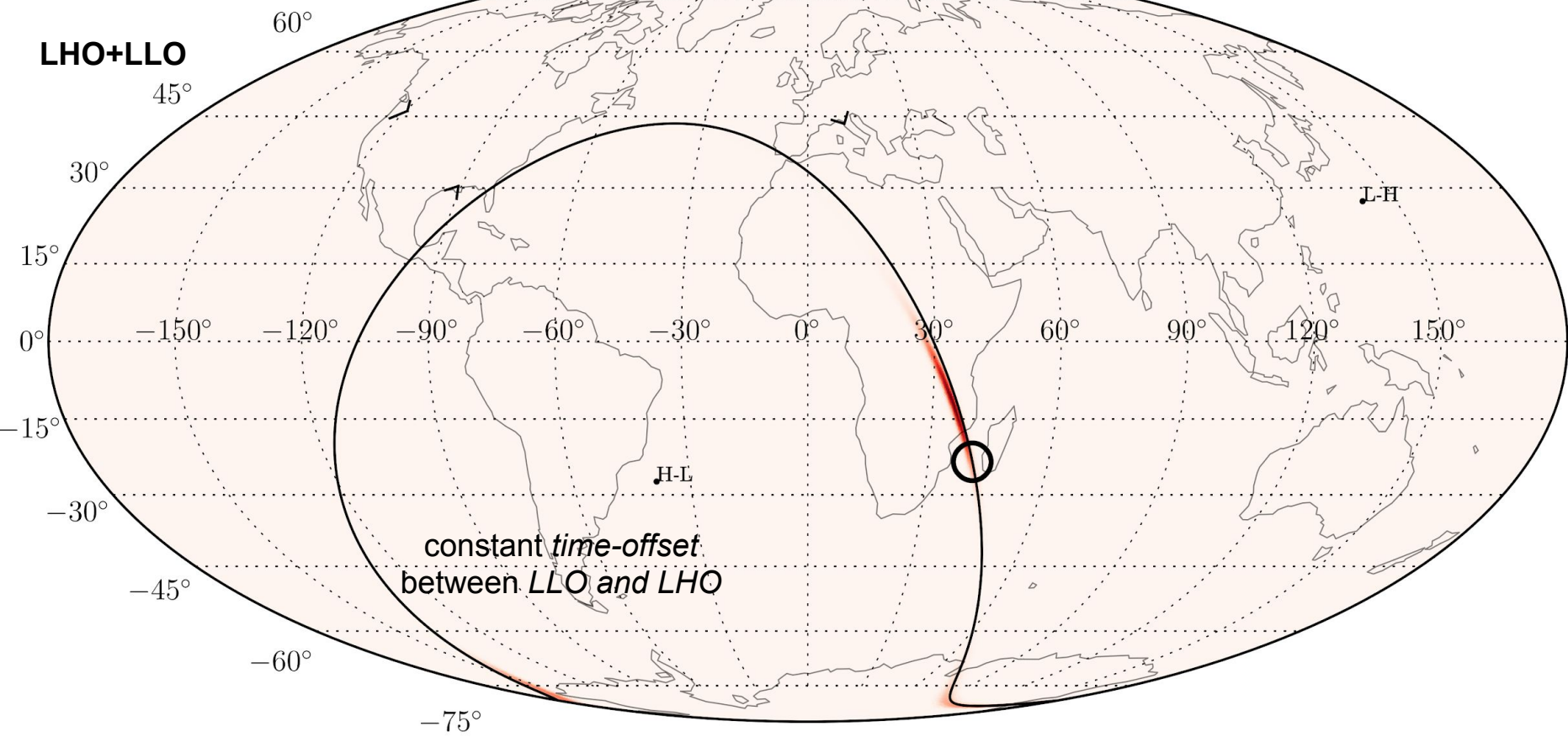
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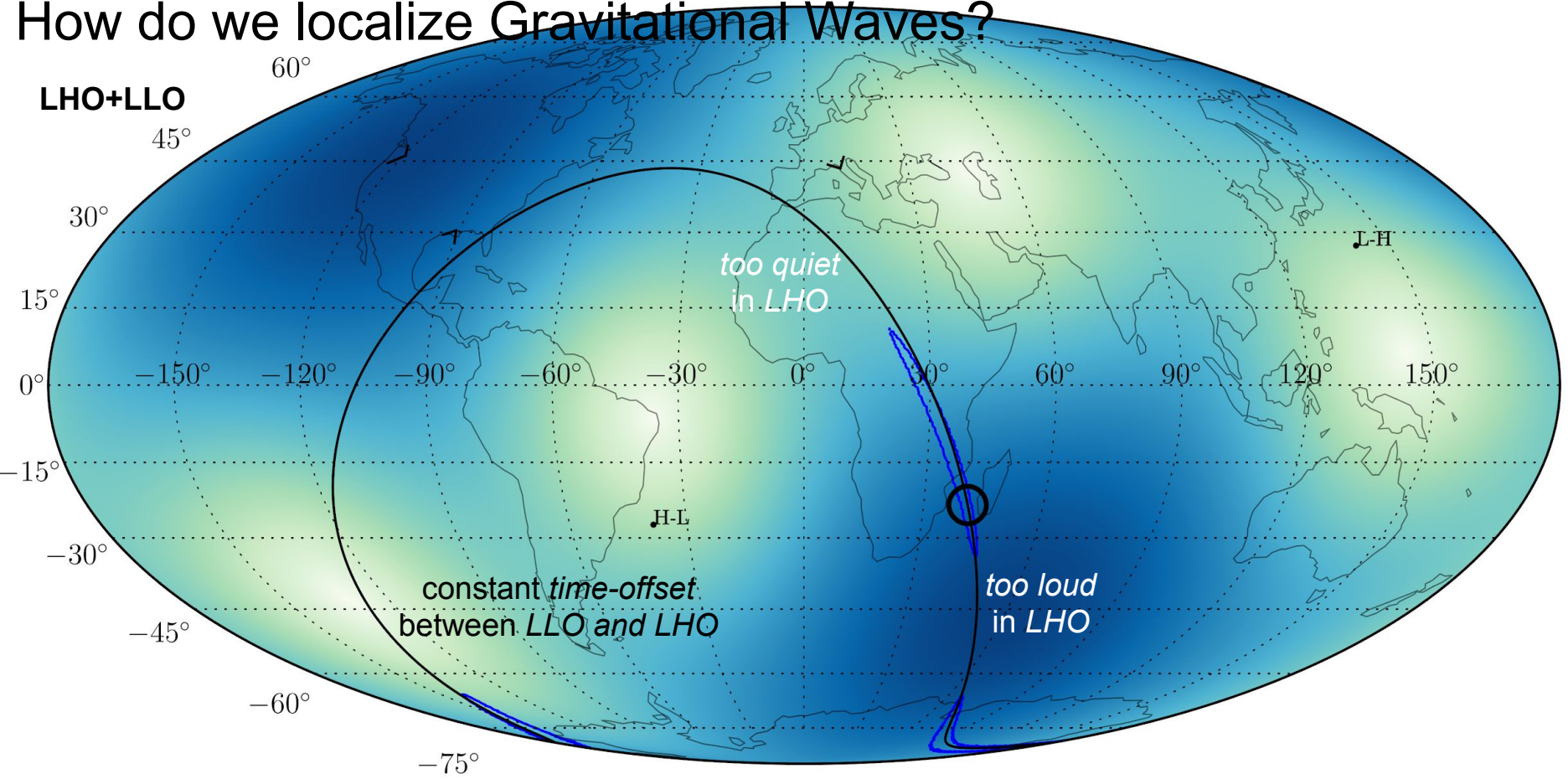
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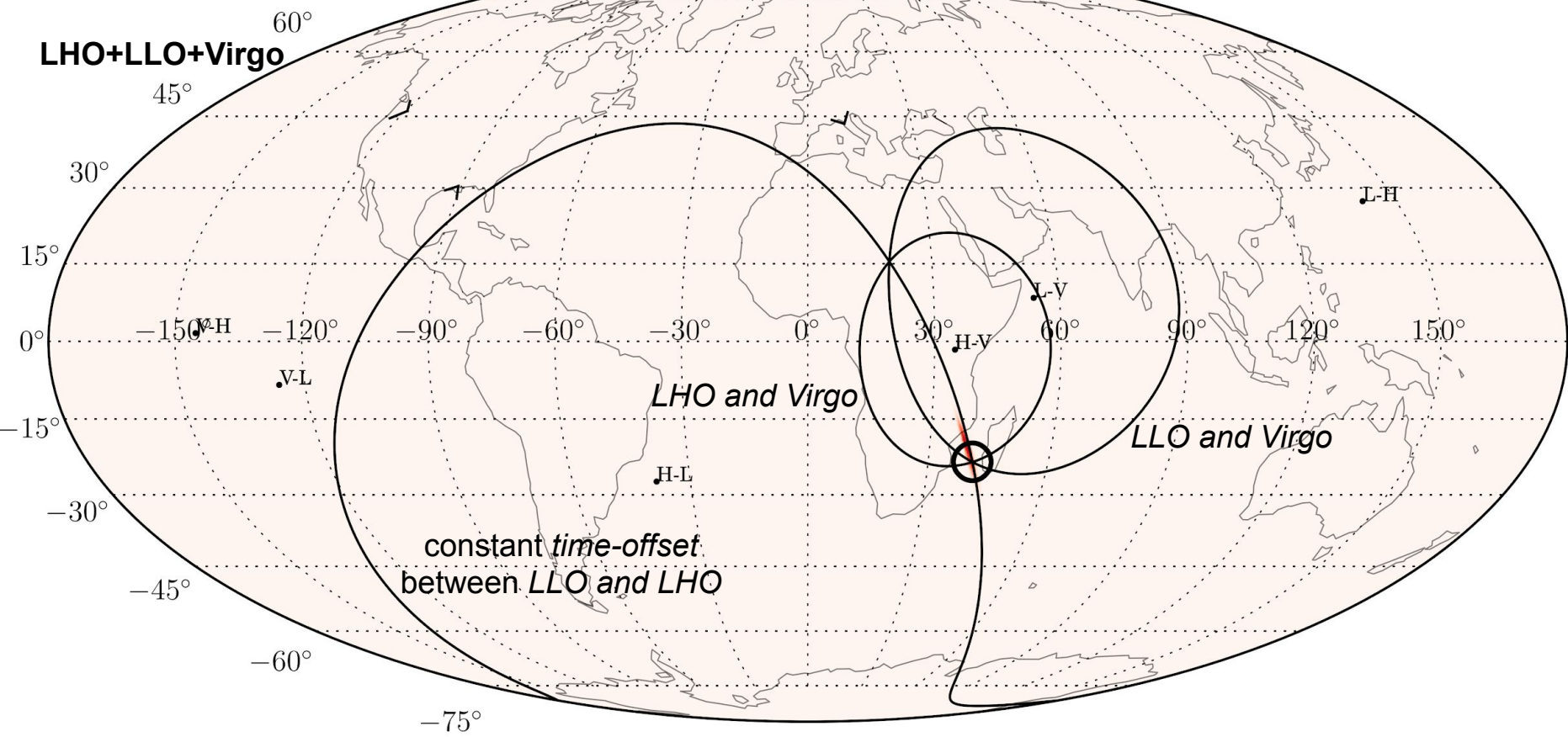
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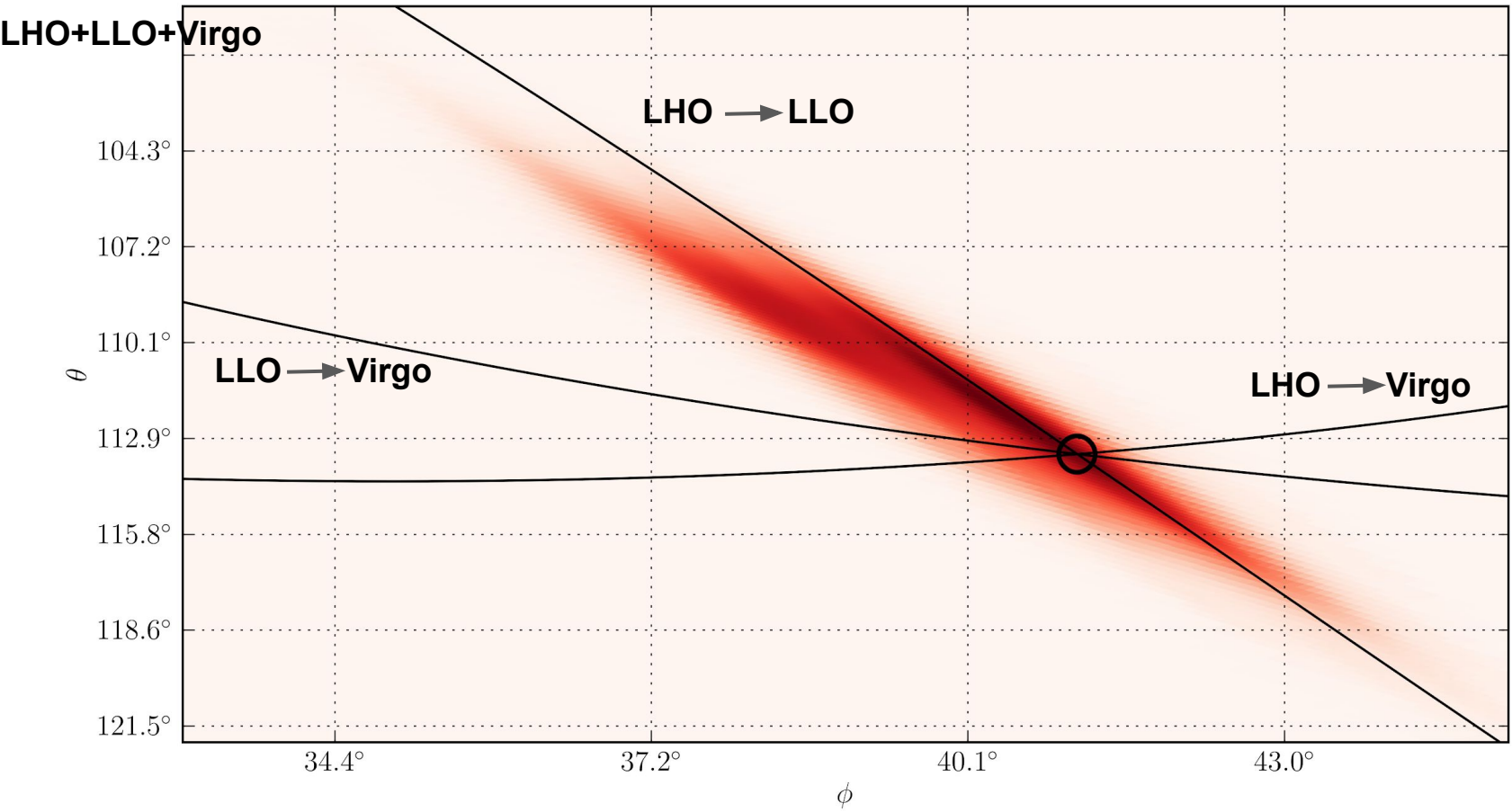
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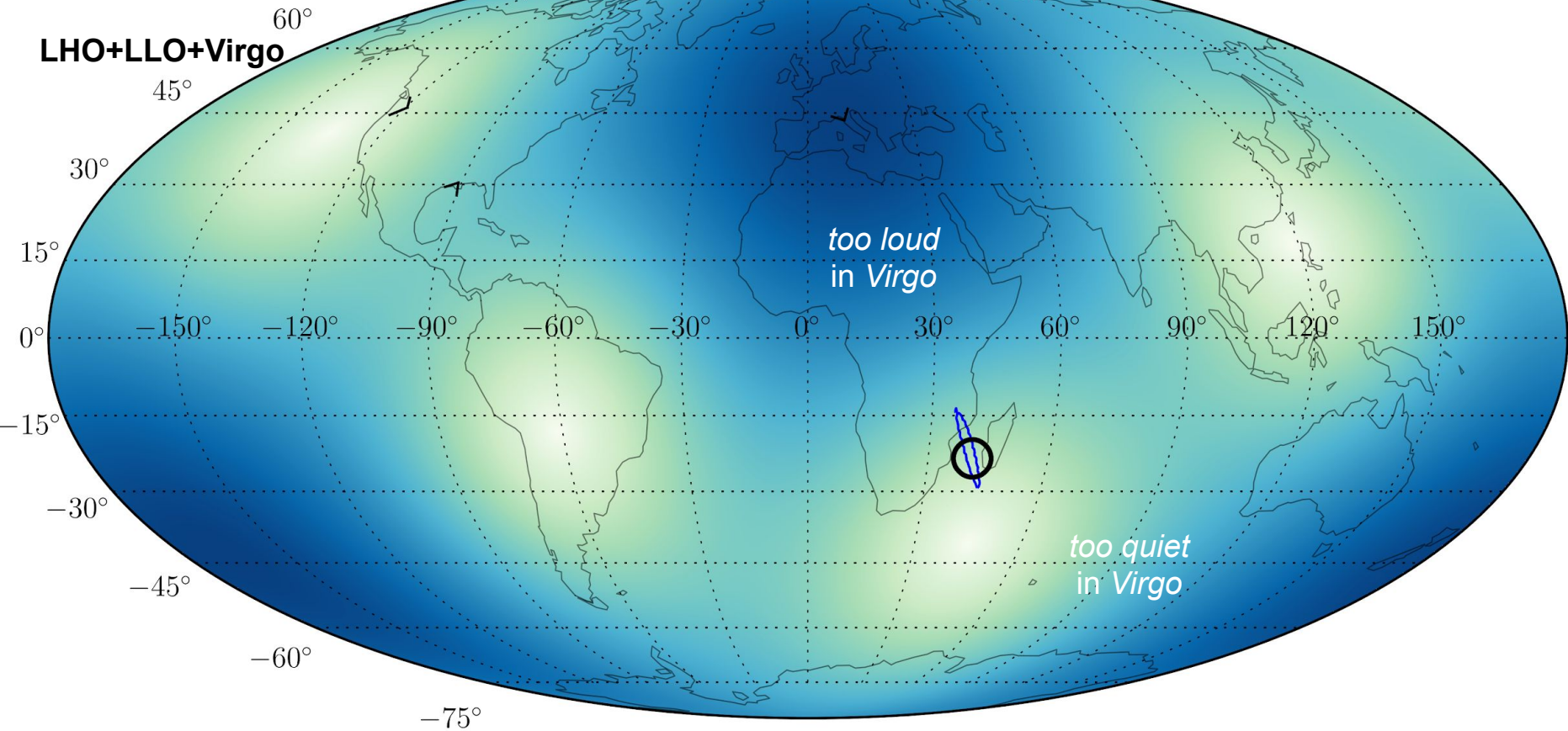
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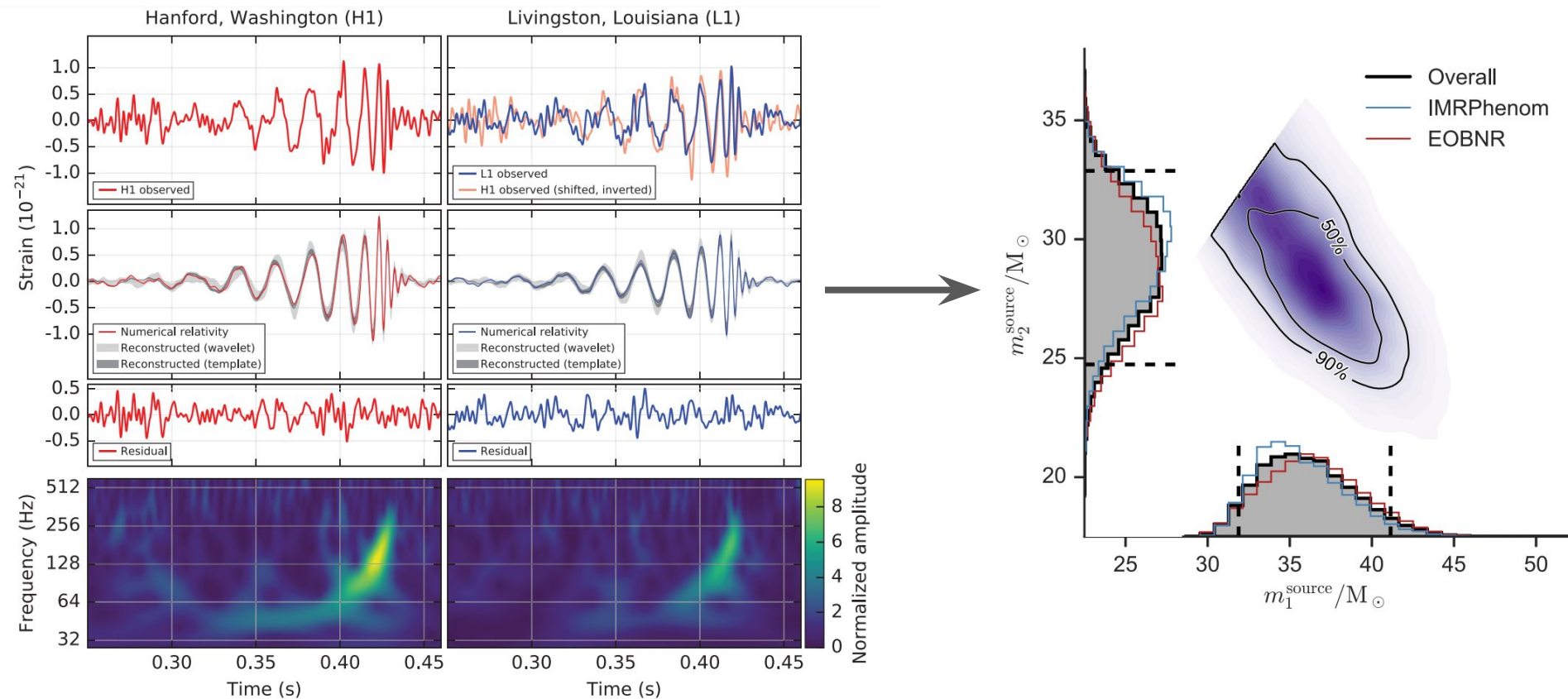
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How do we localize Gravitational Waves?



Estimating Signal Parameters



Next time

Gravitational-Wave Populations and Cosmology

- What do we mean by a population?
- Catalogs of detected events
- Cosmological effects on Gravitational Waves

Suggested Reading

- [*Observation of Gravitational Waves from a Binary Black Hole Merger*. Phys. Rev. Lett. 116, 061102 \(2016\).](#)
- [*Properties of the Binary Black Hole Merger GW150914*. Phys. Rev. Lett. 116, 241102 \(2016\).](#)