

# Joint parameter estimation on overlapping gravitational wave signals from coalescing compact binaries with Einstein Telescope and Cosmic Explorer

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# Signals we get with ET + CE

## Over a year:

- 104 889 detected BBHs
- 44 138 detected BNSs
- 100 588 detected NSBHs

## Overlaps within 0.1 s

- 32 BBH-BBH
- 46 BBH-BNS
- 78 BBH-NSBH
- 1 NSBH-NSBH
- 0 BNS-BNS
- 0 BNS-NSBH

# Size of the data

	Property	BBH (GW150914 like)	BNS (GW170817 like)
	Chirp mass	31 $M_{\odot}$	1.195 $M_{\odot}$
	Sampling frequency	2048 Hz	4096 Hz
Current detectors	Minimum frequency	20 Hz	20 Hz
	Signal duration	3 s	185 s
	Waveform size	3 072	378 880

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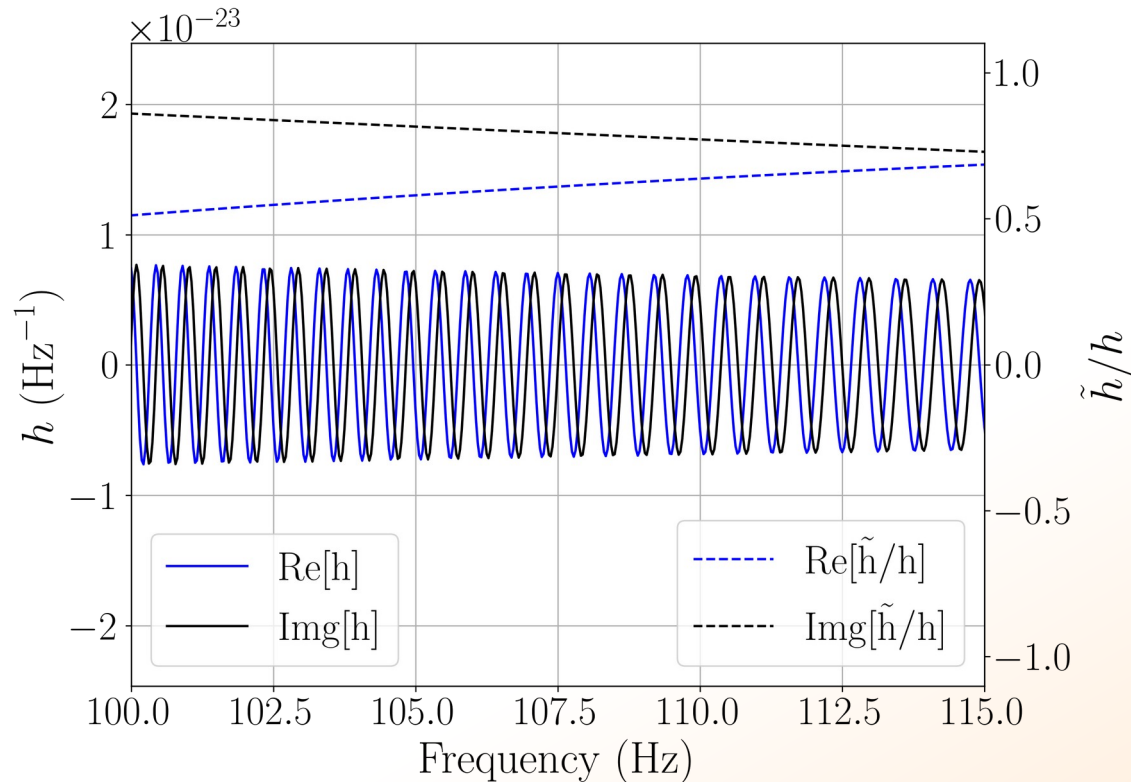
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BBHs impractical to do with ET, while BNSs computationally impossible

# Relative binning



- Choose a reference waveform
- Express other waveforms as ratios to the reference waveform
- The ratios close to reference are well approximated by piecewise linear functions
- Divide the waveform to frequency bands and do computations only on the edges

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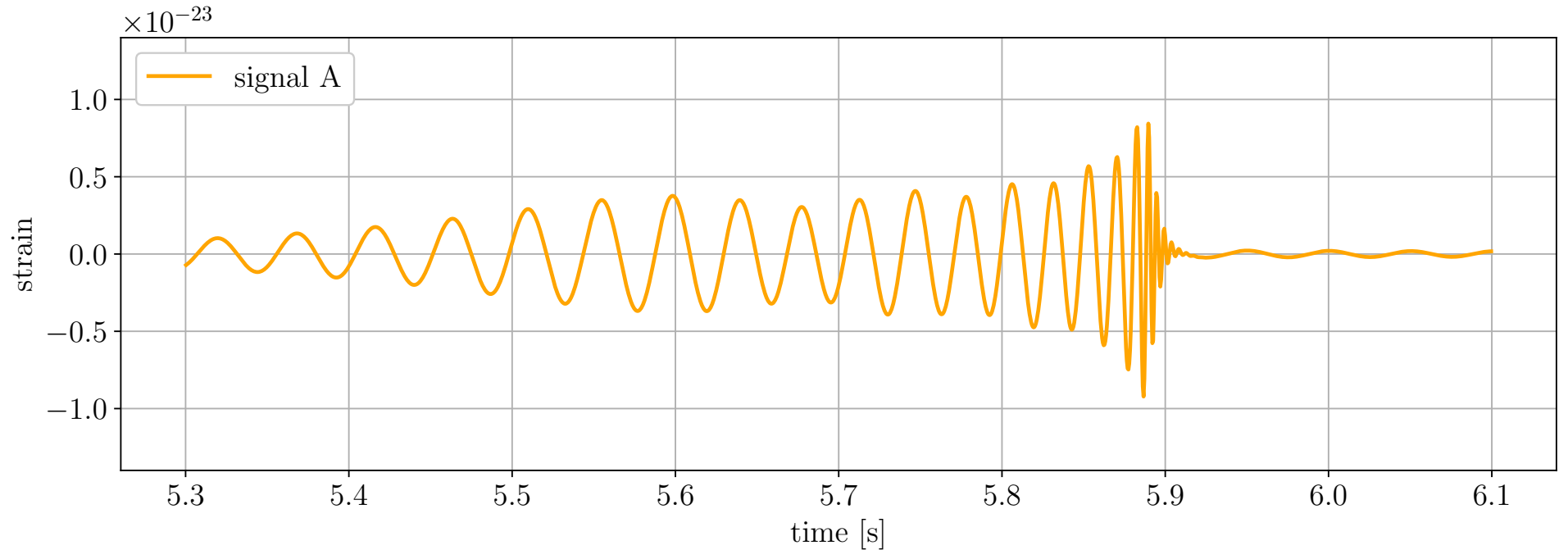


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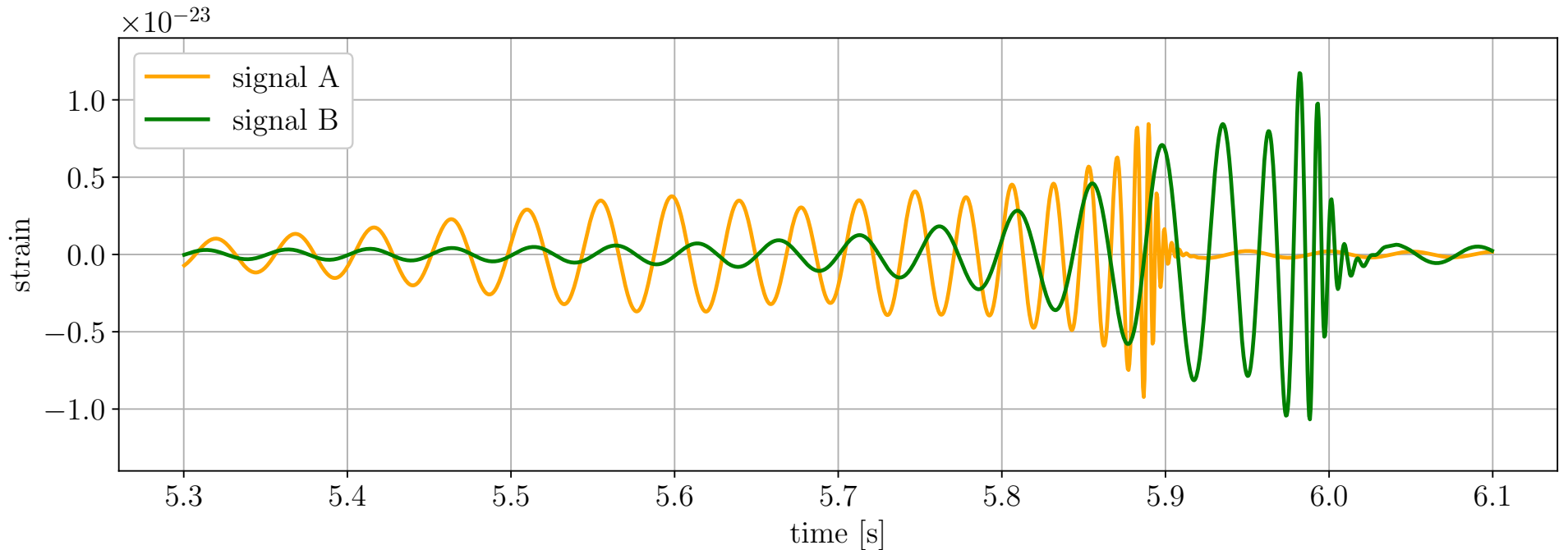
With Relative binning parameter estimation is as fast as for the shortest BBHs now

# Overlapping signals



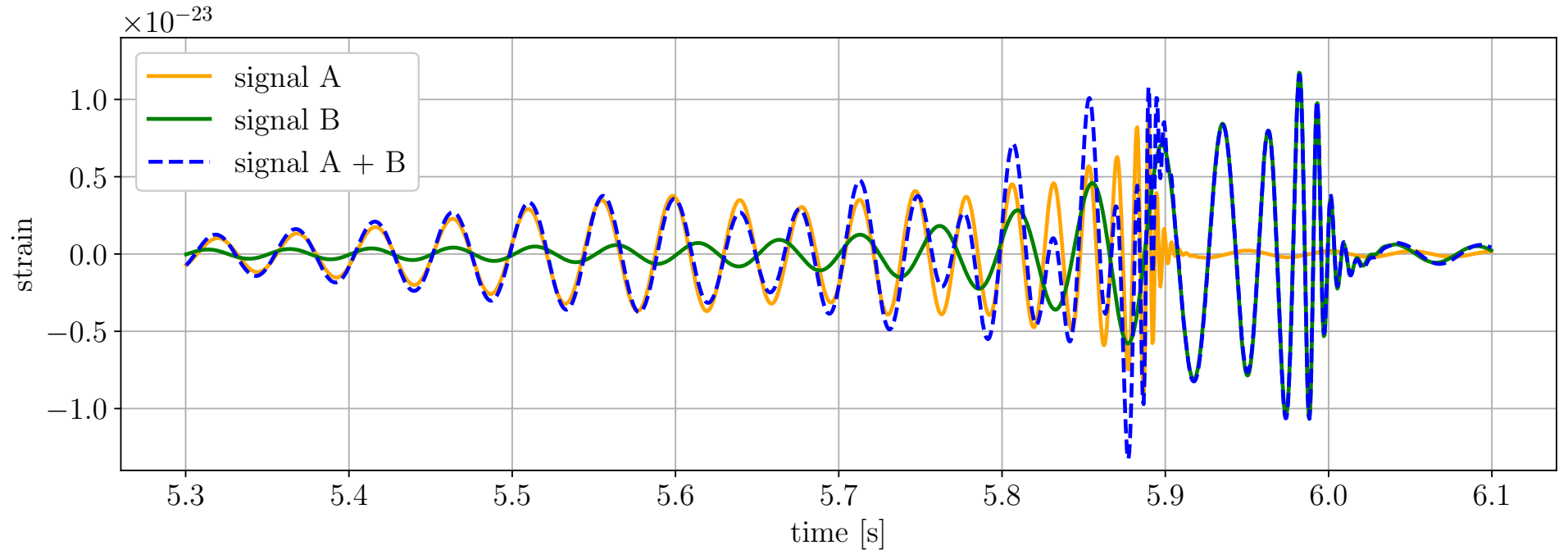
Signal A

# Overlapping signals



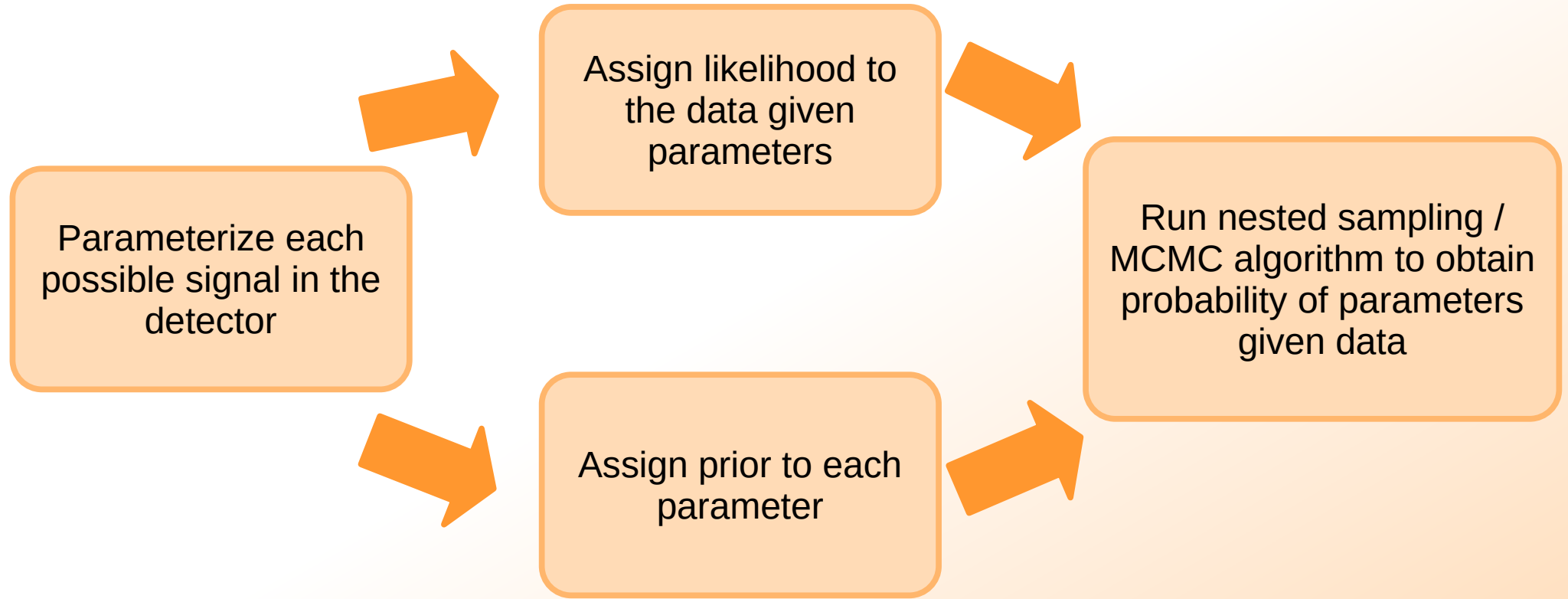
Signal A + Signal B

# Overlapping signals

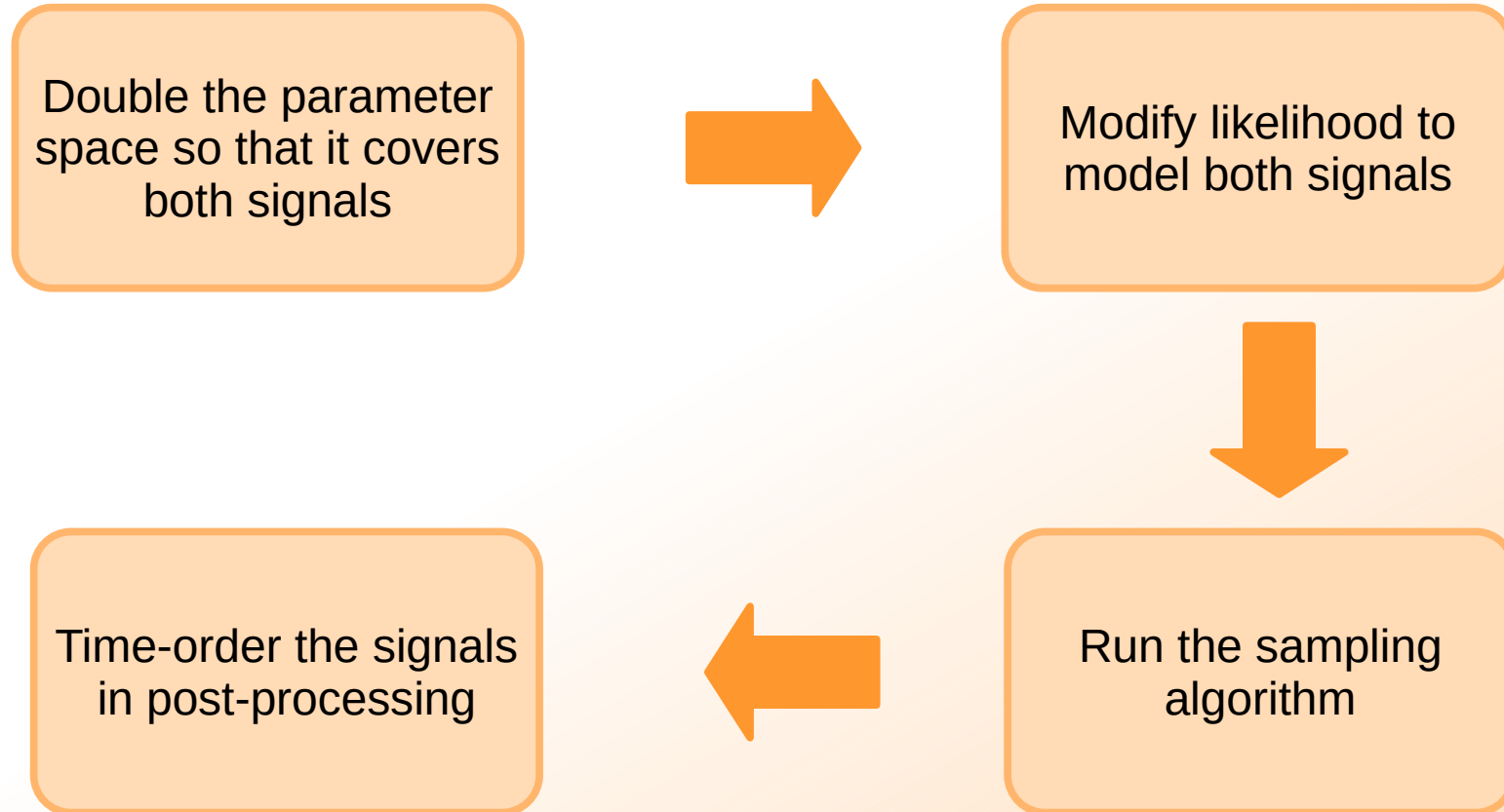


Signal A + Signal B = Overlapping signal

# How parameter estimation works?

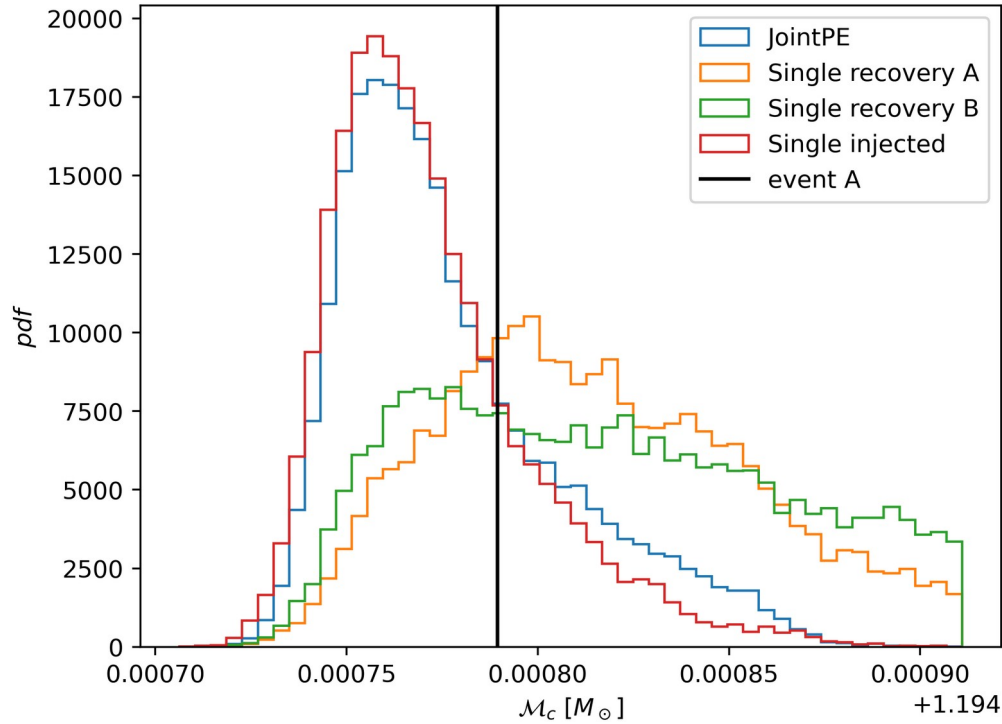


# How joint parameter estimation works?

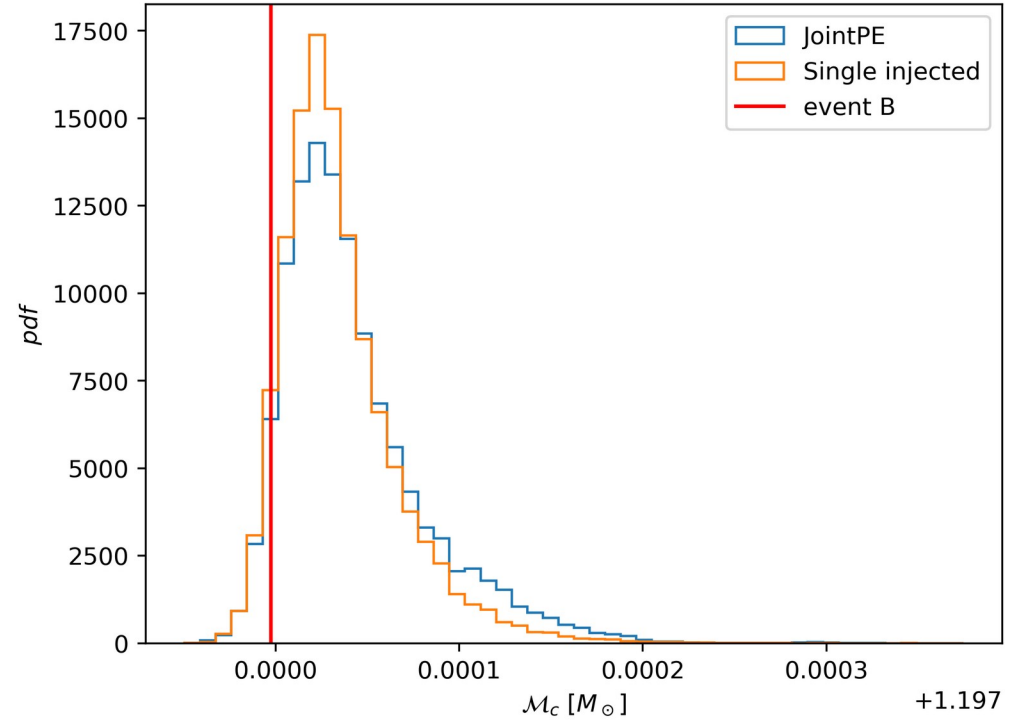


# BNS, zero noise

event A recovery

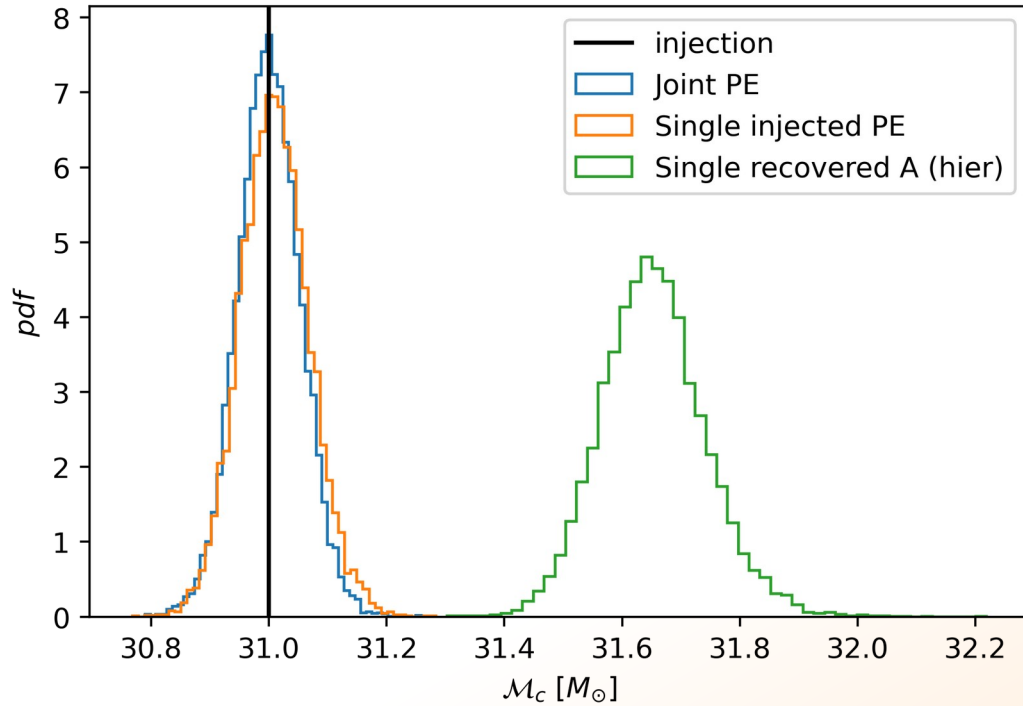


event B recovery

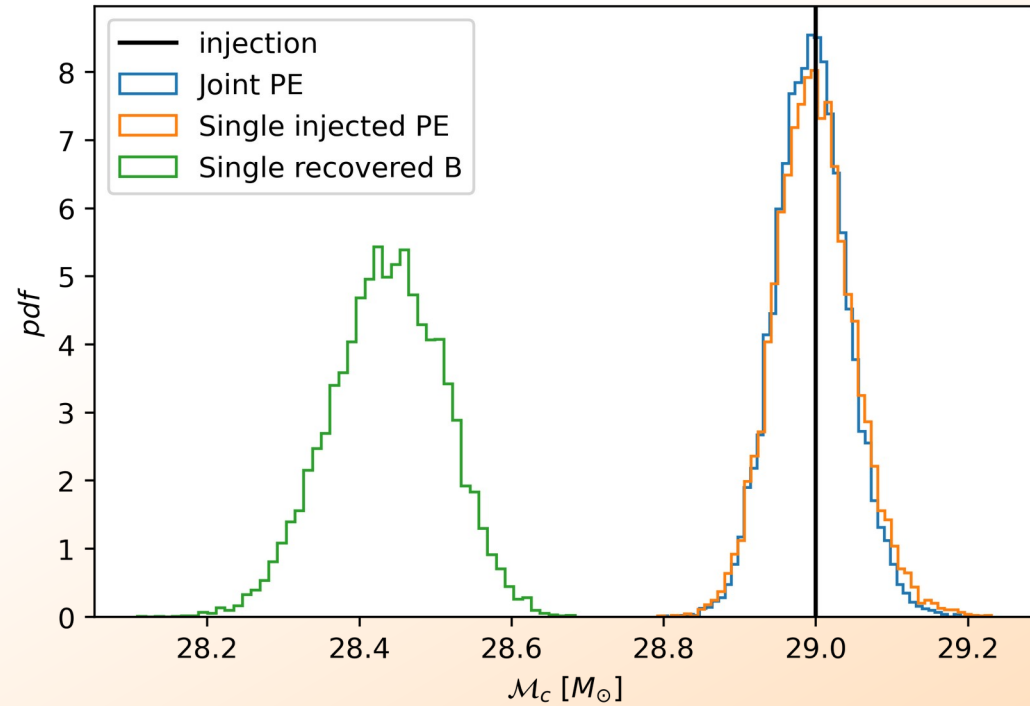


# BBH, zero noise

$\delta t$  0.06s, event A

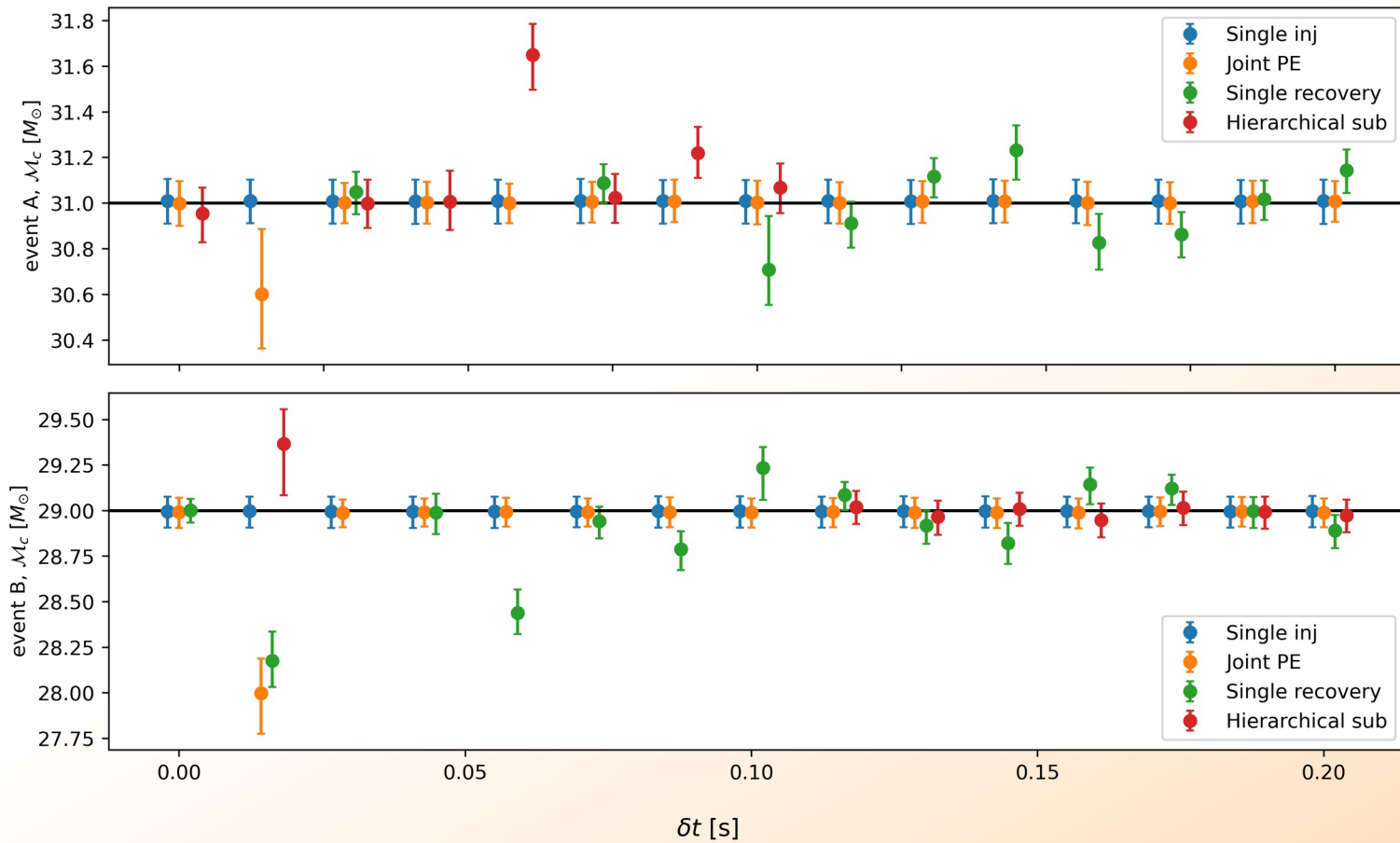


$\delta t$  0.06s, event B

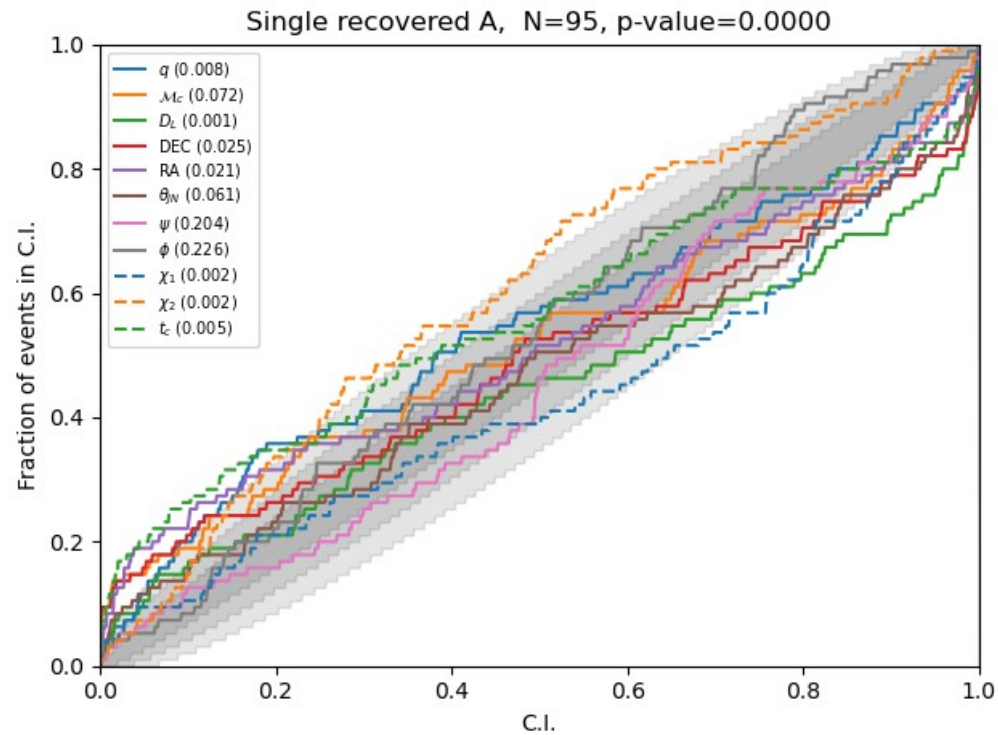
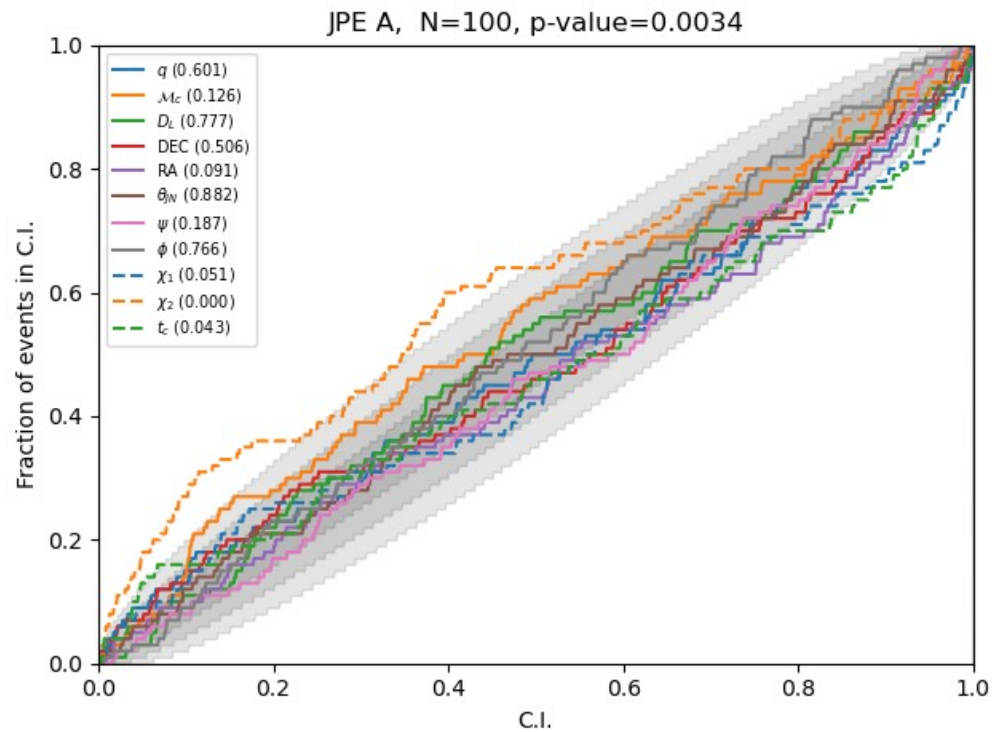




# BBH, noise



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# Conclusions

- Relative binning generalizes to multiple signals without problem and approximates the likelihood accurately
- We can do accurate PE on overlapping signals modeling both signals at once
- We properly recover injected parameters and the posteriors have appropriate shape (apart from spin parameters)
- Ignoring one of the signals and hierarchical subtraction can often fail to recover injected parameters, even with no noise