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Parameter estimation with Advanced LIGO

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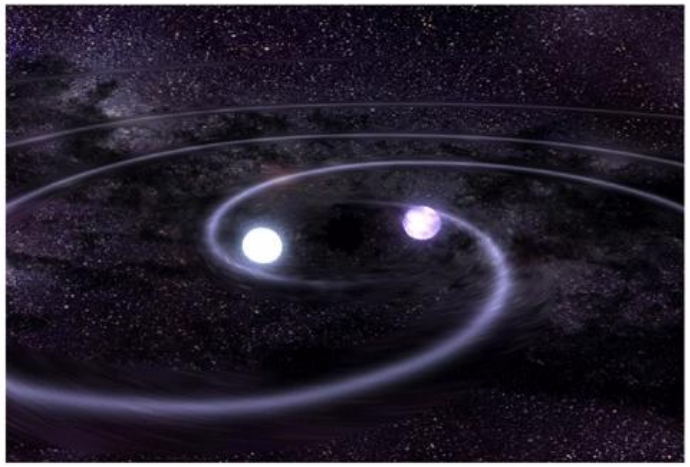
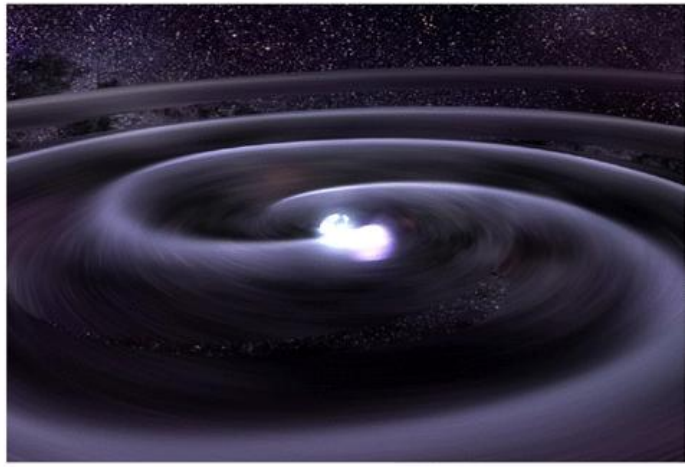
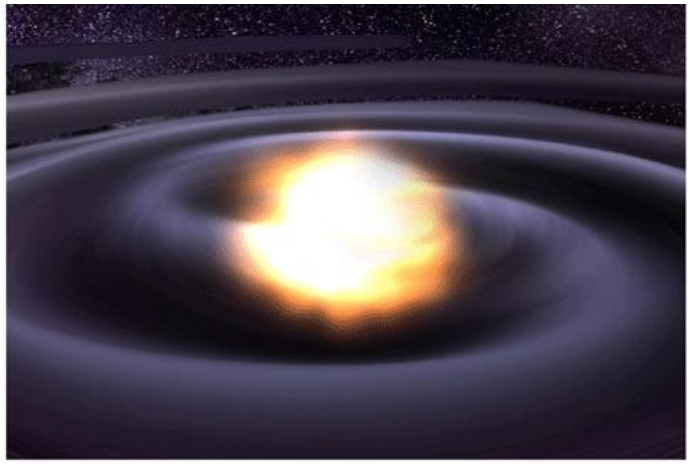
Construction of Advanced LIGO is on time and on budget

Credit: LIGO, NSF, Caltech

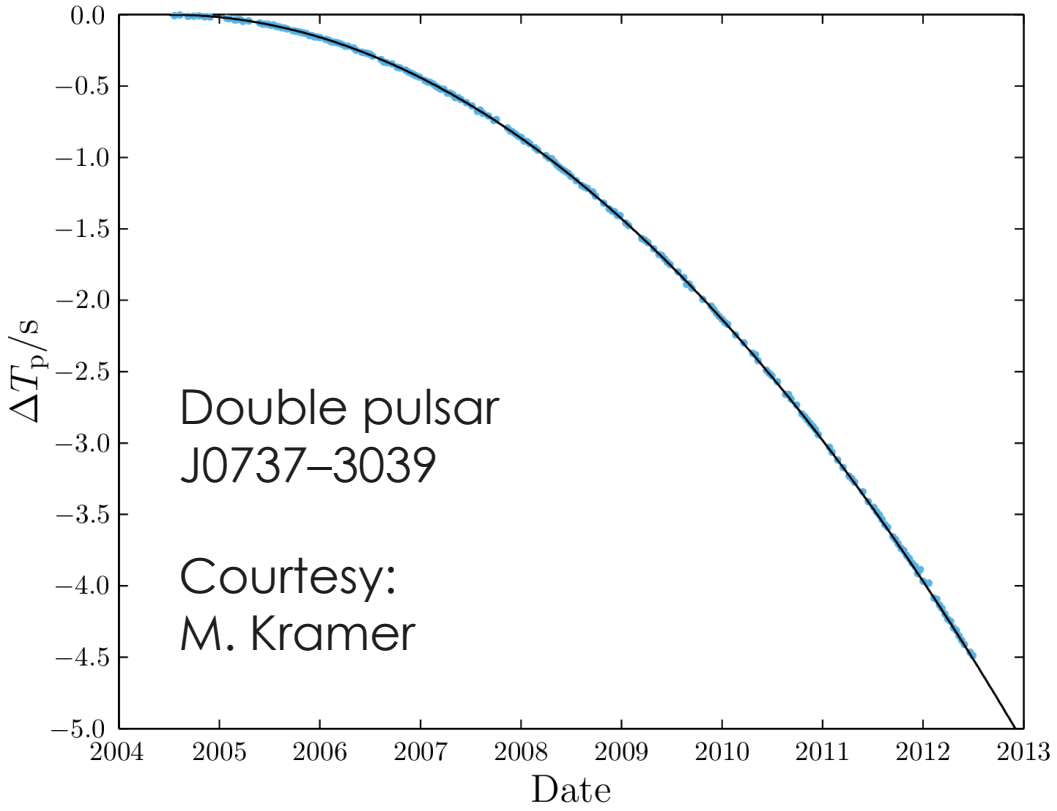






Binary neutron stars

0.4–400 events per year at design sensitivity (arXiv:1003.2480)

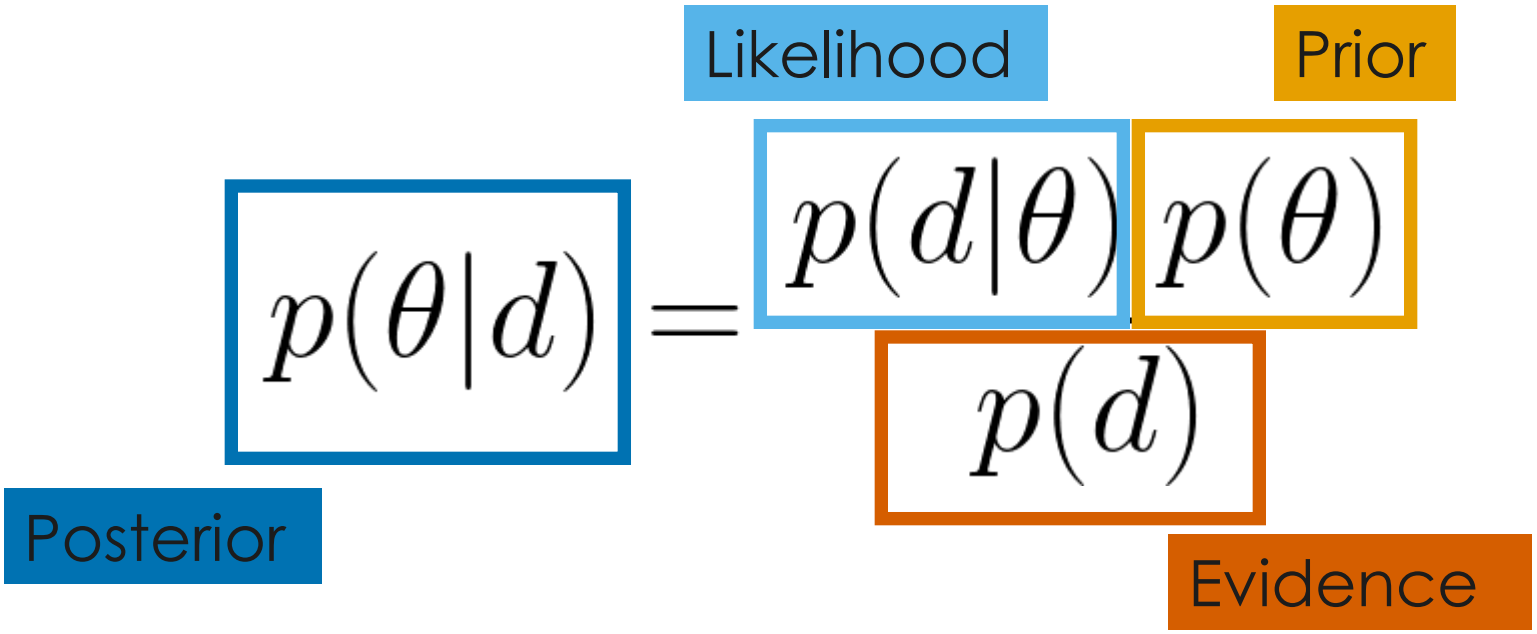


Credit: NASA

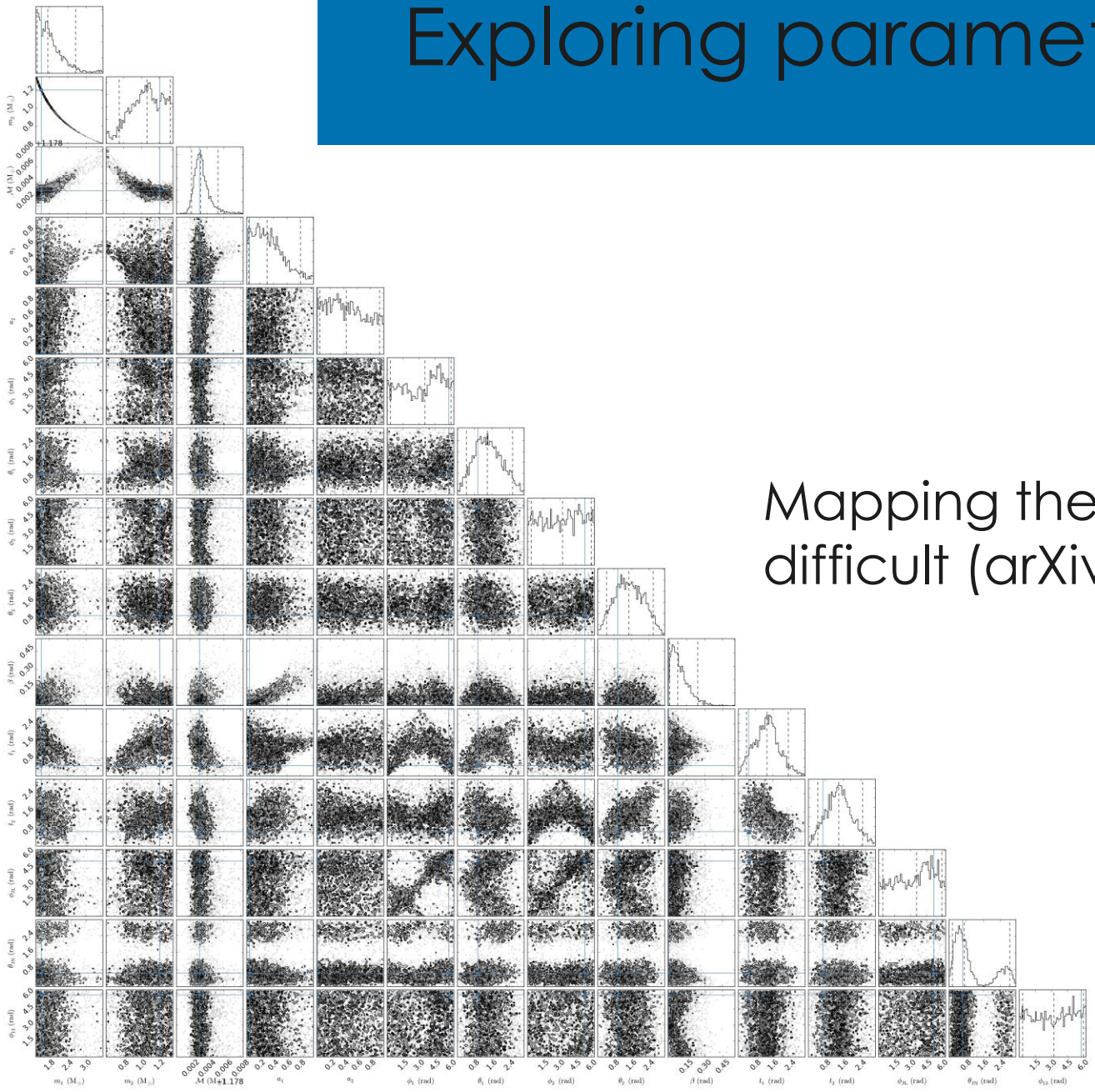
Bayes' theorem

$$p(\theta|d) = \frac{p(d|\theta)\, p(\theta)}{p(d)}$$

Bayes' theorem

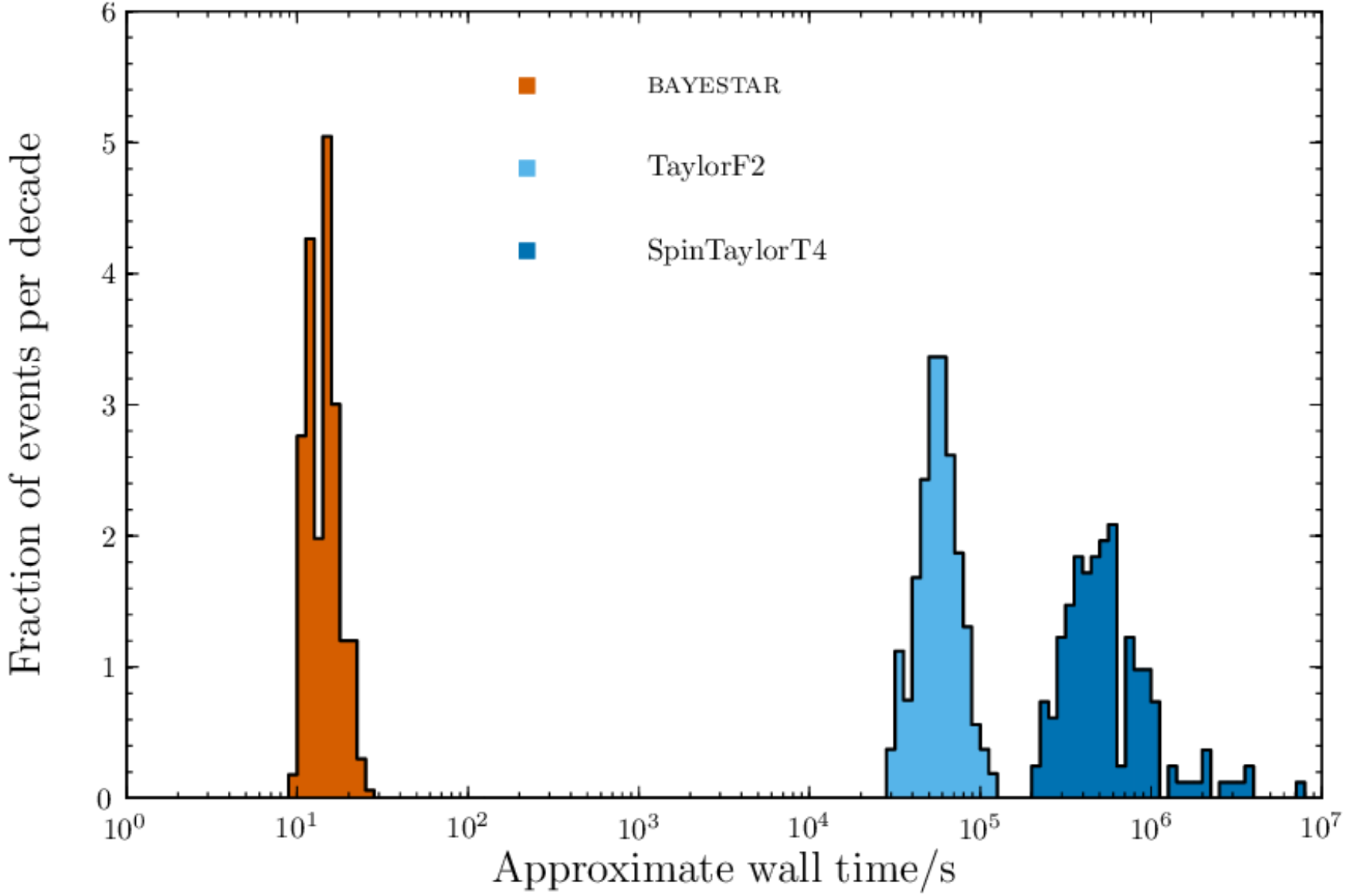


Exploring parameter space

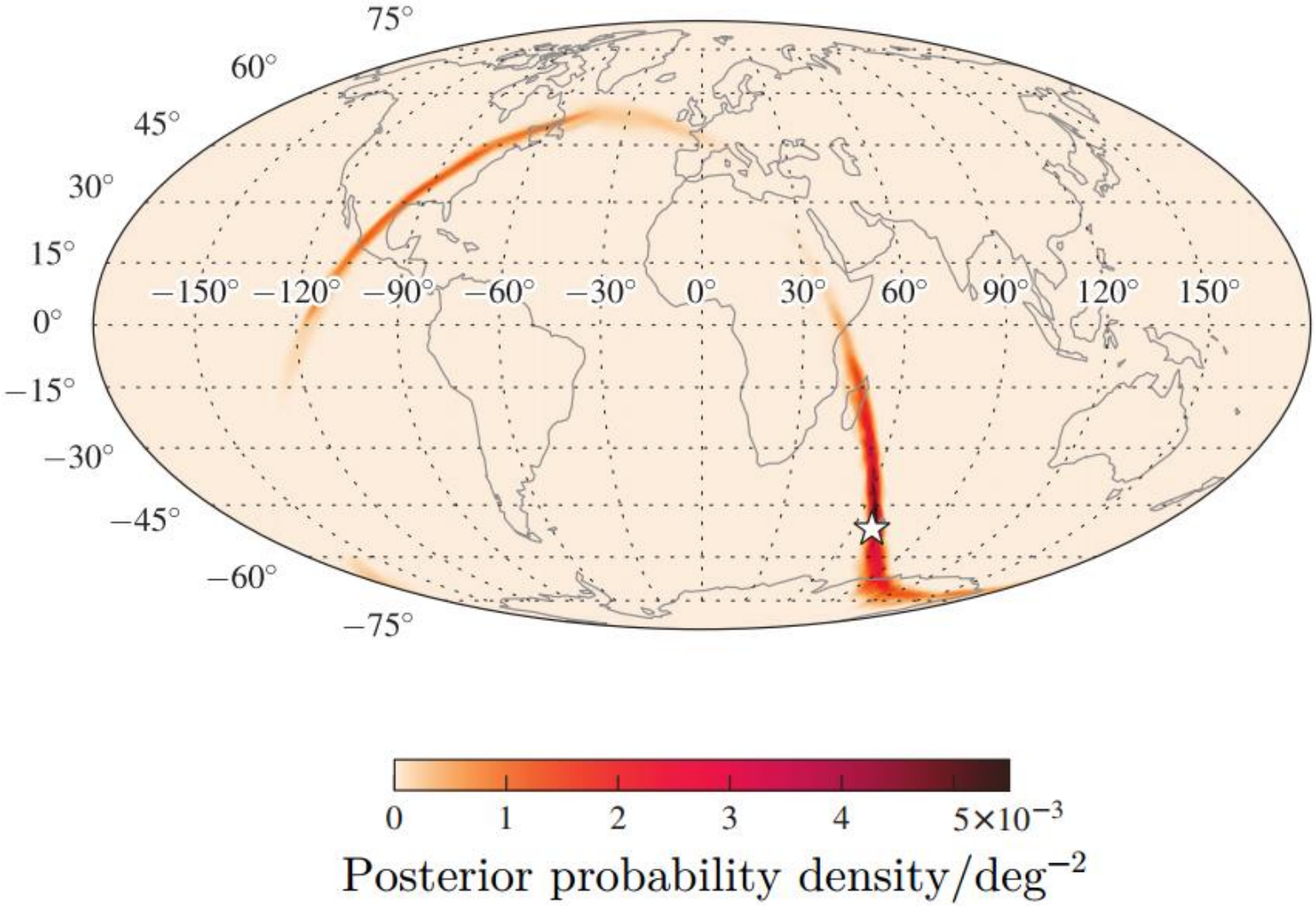


Mapping the posterior is difficult (arXiv:1409.7215)

Time taken


BAYESTAR
TaylorF2
SpinTaylorT4
Fraction of events per decade
Approximate wall time/s
0
1
2
3
4
5
6
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7

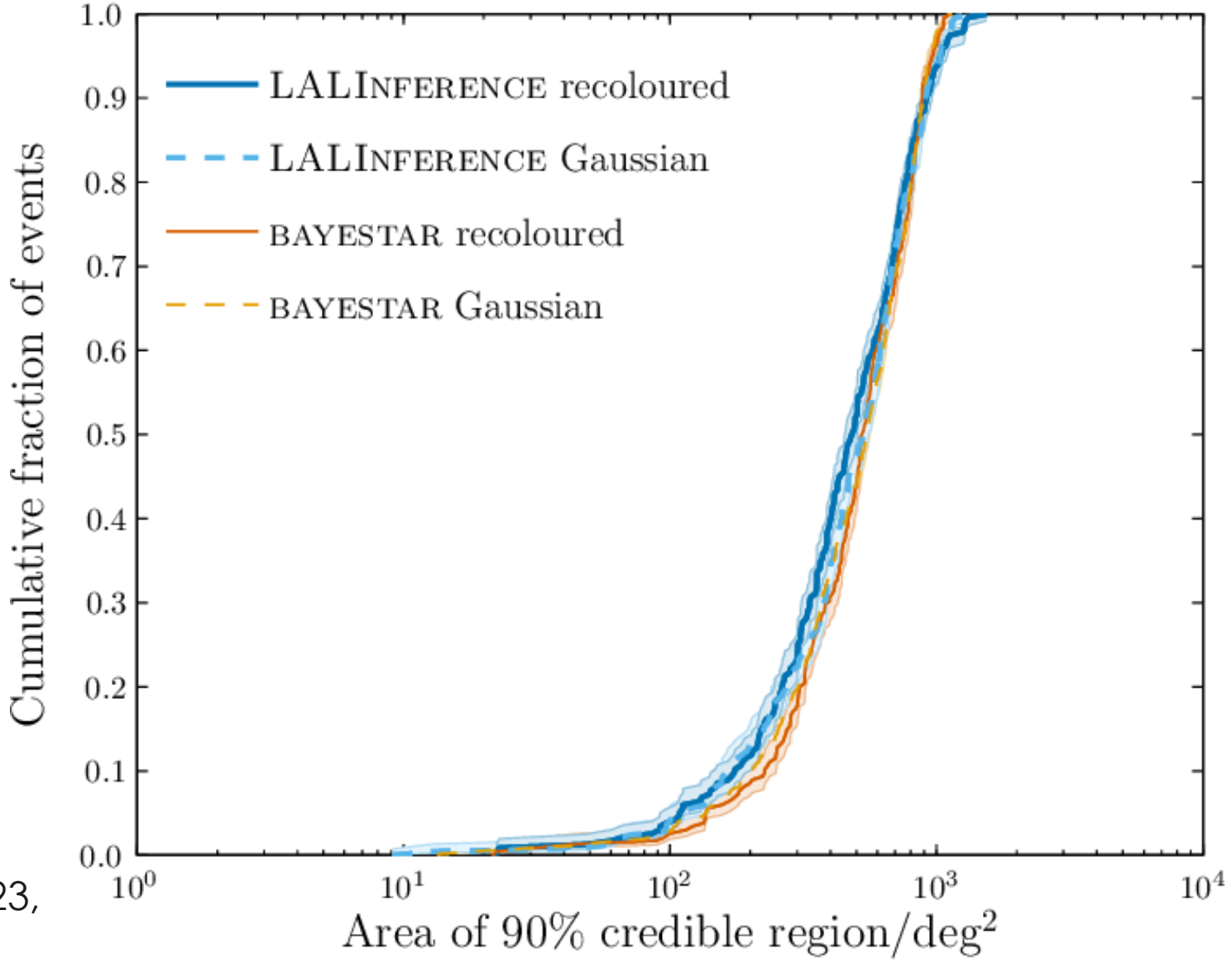
Sky localization



www.ligo.org/scientists/first2years/

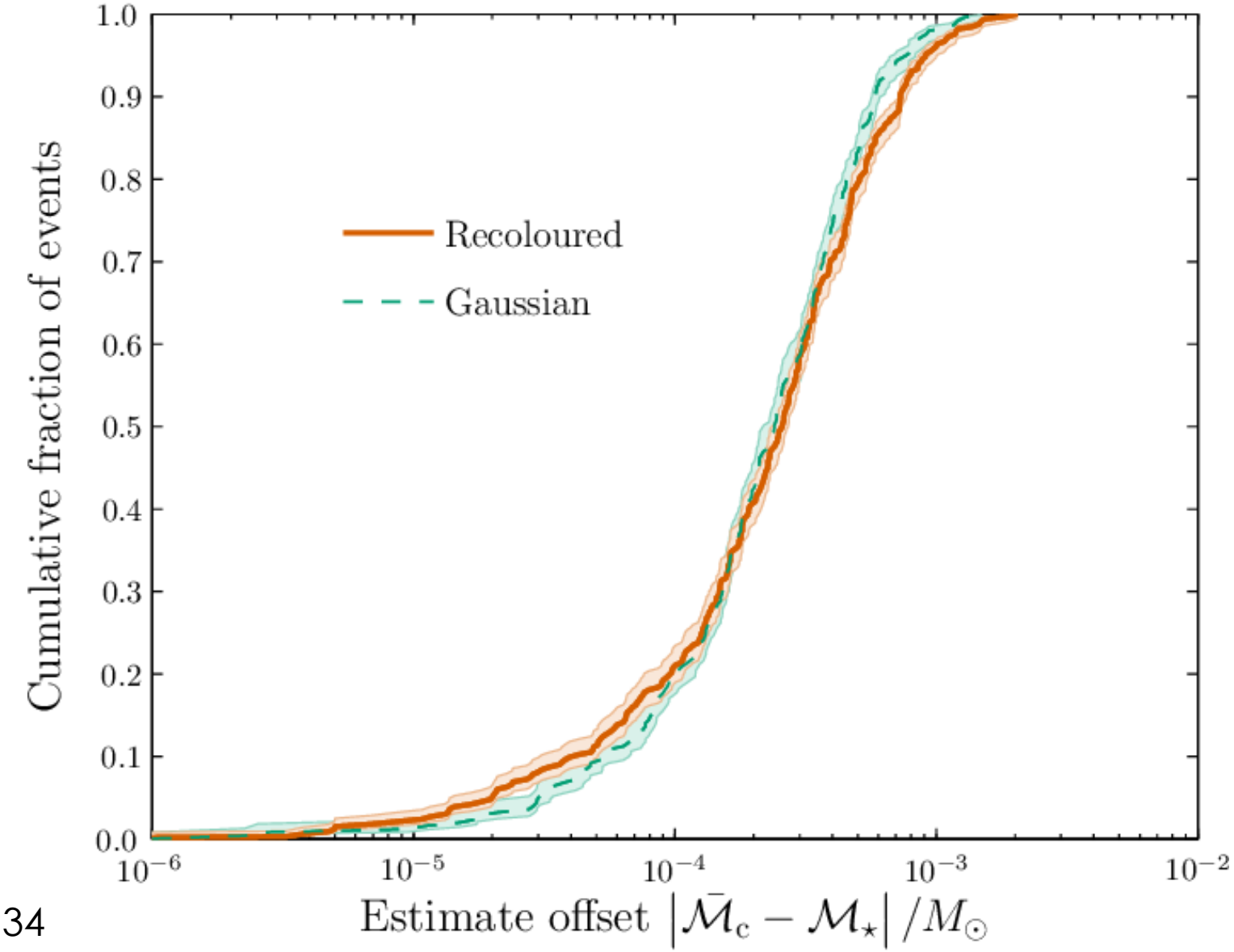
arXiv:1411.6934

Sky localization



arXiv:1406.5623,
1411.6934

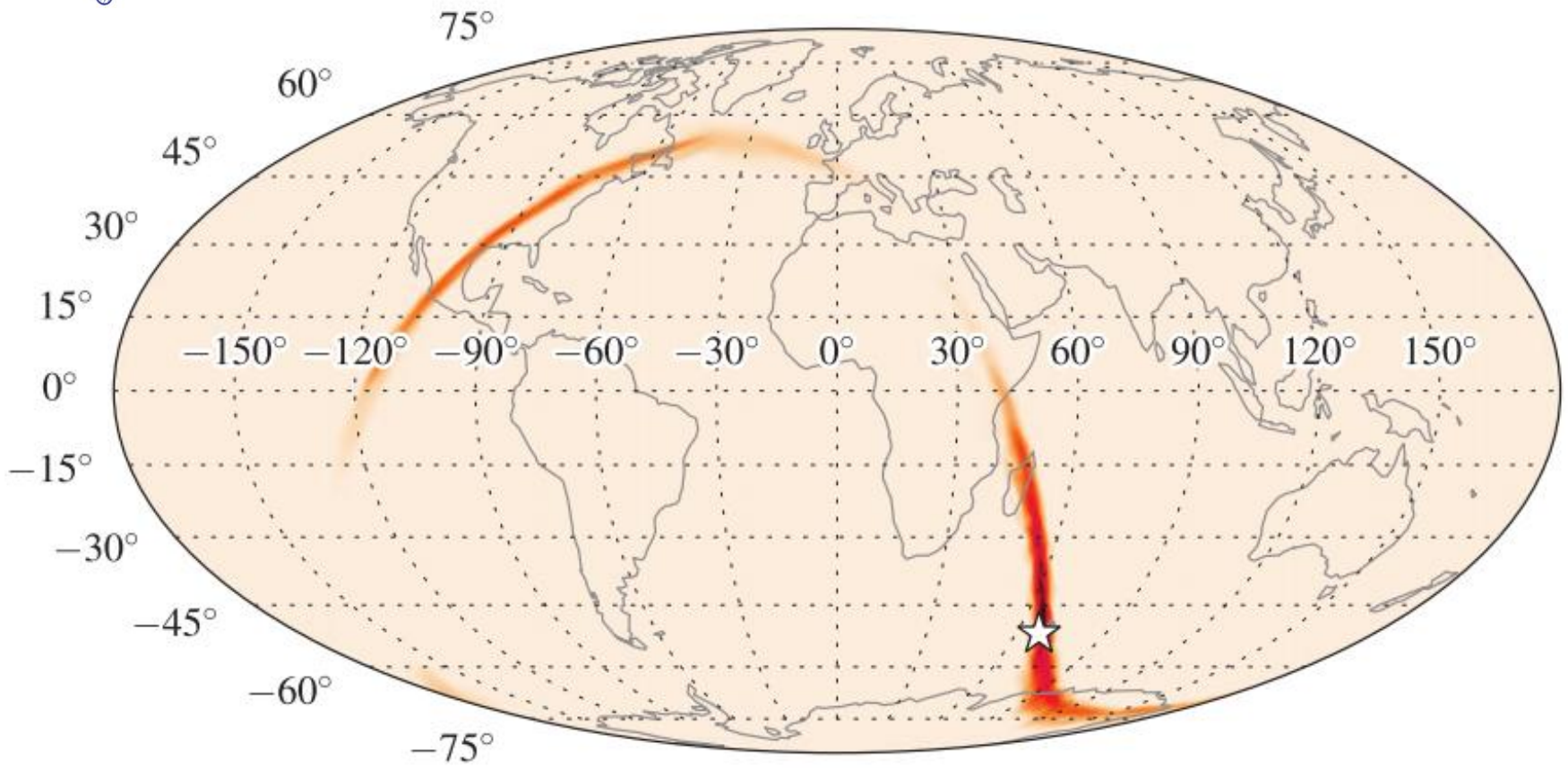
Chirp mass



arXiv:1411.6934

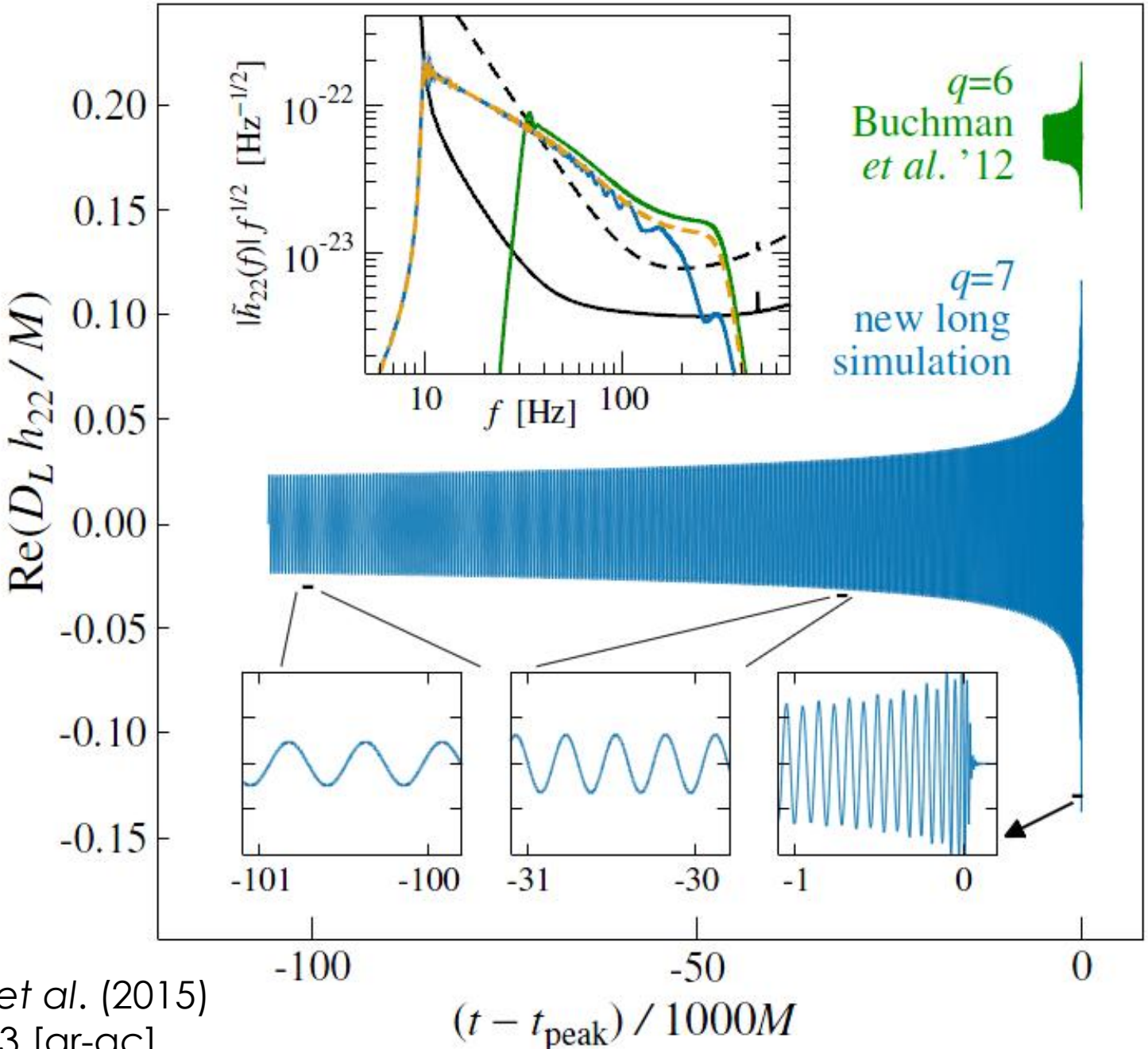
- Advanced LIGO is nearly here
- Binary neutron star end-to-end analysis
- Parameter estimation is expensive
- Sky localization is hundreds of square degrees
- Spin needed for best mass measurements

Thank you



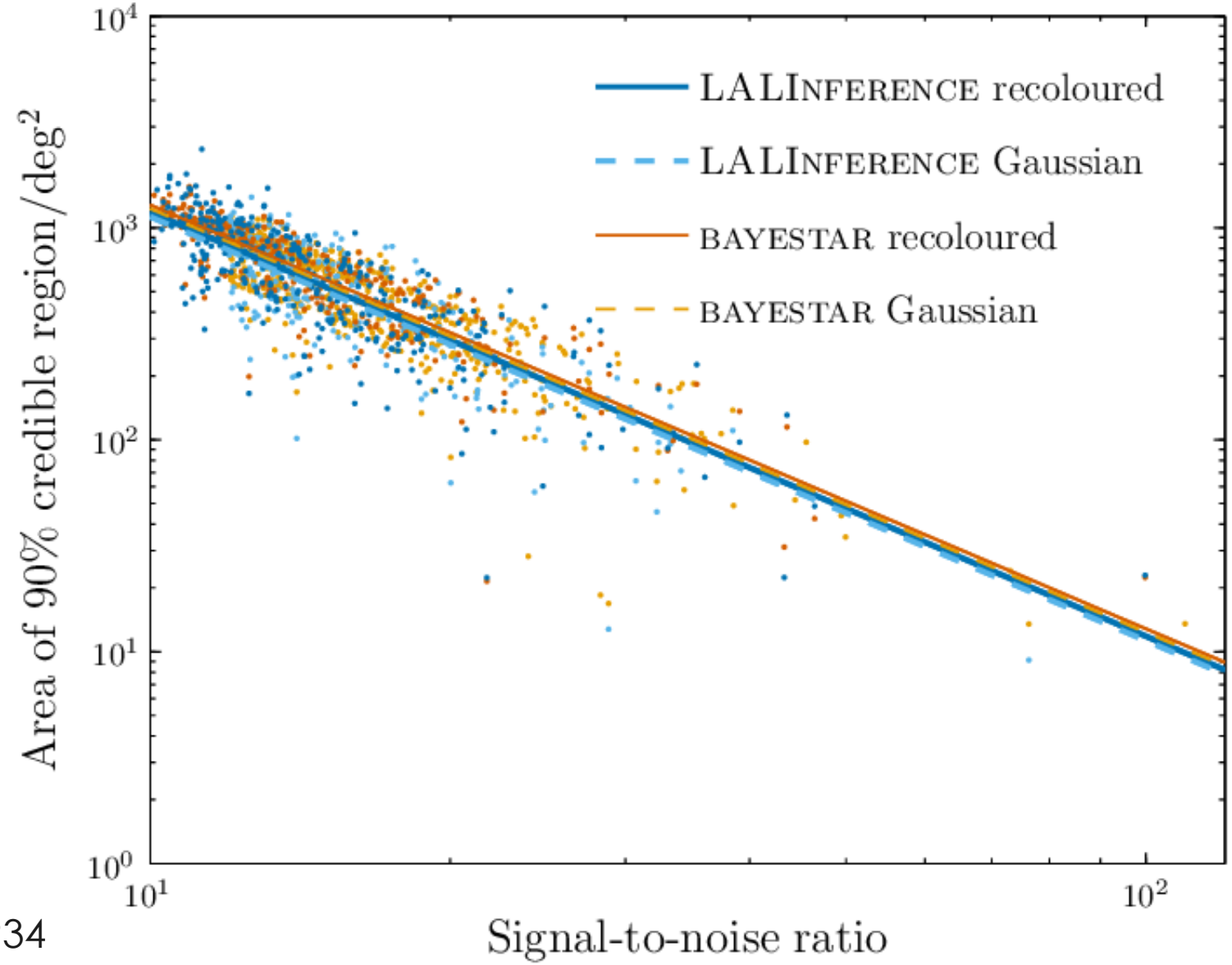
arXiv:1411.6934
www.ligo.org/scientists/first2years/

Inspirals are well under-stood



Credit: Szilàgyi *et al*. (2015)
arXiv:1502.04953 [gr-qc]

Sky localization



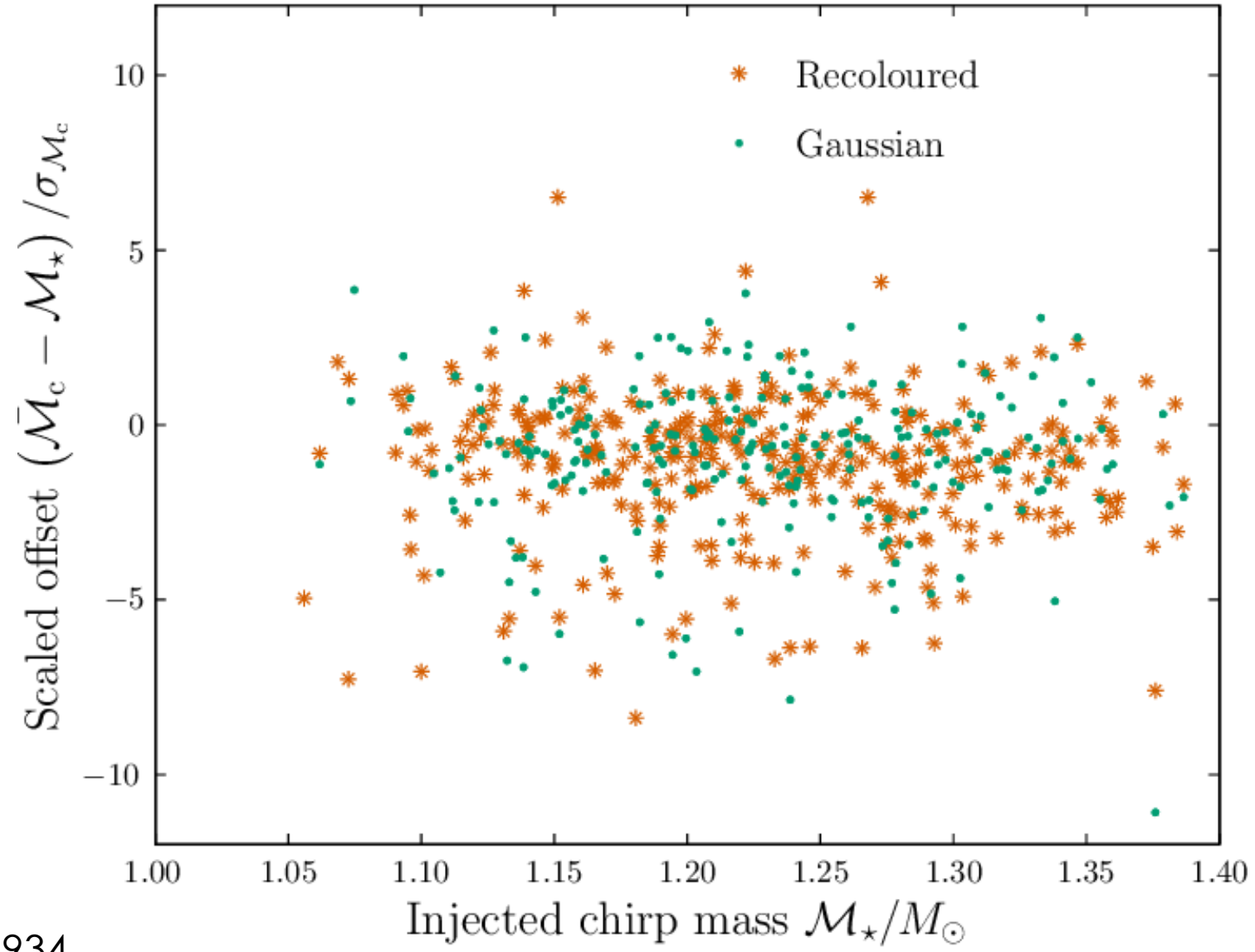
arXiv:1411.6934

Chirp mass

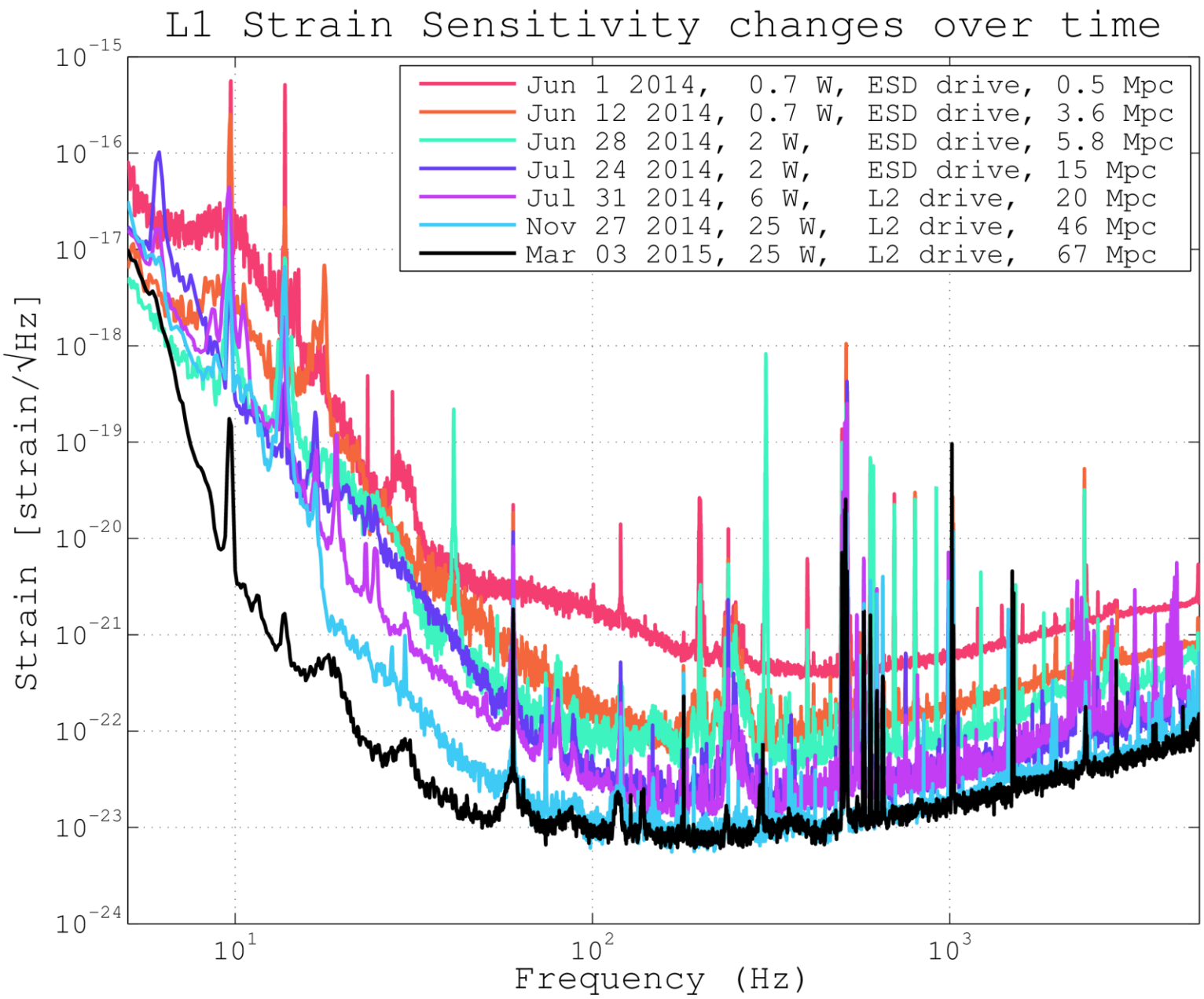
$$\mathcal{M}_{\rm c} = \frac{(m_1 m_2)^{3/5}}{(m_1 + m_2)^{1/5}}$$

Chirp mass gives leading-order amplitude and phase evolution (arXiv:0903.0338)

Chirp mass



arXiv:1411.6934



Credit: LIGO Document G1401390-v8

Data release 2015, HL 2016, HLV new 2015, recoloured Show/hide columns

The First Two Years of Electromagnetic Follow-Up with Advanced LIGO and Virgo

Singer et al. 2014 arXiv:1404.5623

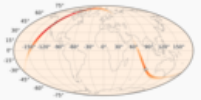
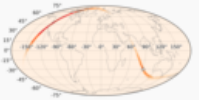
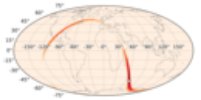
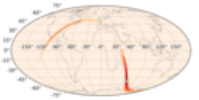
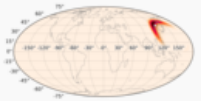
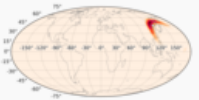
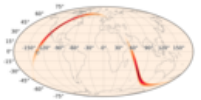
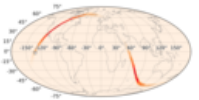
Berry et al. 2015 arXiv:1411.6934

www.ligo.org/scientists/first2years/

Data release 2015, HL 2016, HLV new 2015, recoloured Show/hide columns

This web page additional onli related to the p Two Years of I Follow-Up with and Virgo" and paper "Parame for Binary Neu Coalescences

Catalog of simulated events and sky maps for two-detector, HL, 2015 configuration. This is the same configuration as the 2015 tab, except that the simulated detector noise is data from initial LIGO's sixth science run, recoloured (filtered) to have the same PSD as the early Advanced LIGO configuration. See also ASCII tables of simulated signals, detections, and parameter-estimation accuracies in Machine Readable Table format.

event ID	sim ID	network	SNR			BAYESTAR			LALINFERENCE_NEST			sky maps	
			net	H	L	50%	90%	searched	50%	90%	searched	BAYESTAR	LALINFERENCE_NEST
4532	899	HL	13.9	10.1	9.5	180	750	190	170	790	150		
4572	1243	HL	13.2	10.0	8.7	230	830	45	200	920	33		
4618	1768	HL	10.8	8.0	7.3	160	540	220	130	440	280		
4647	1964	HL	12.4	8.6	9.0	260	890	1200	190	780	780		
4711	2704	HL	10.7	8.0	7.1	370	1200	300	450	1600	520