LIGO

The Gravitational-wave Network: 2017-2020+

Stan Whitcomb

Supernova Workshop 2017

18 March 2017

LIGO-G1700530-v1

LIGO-Virgo Observing Plans

General Relativity and Quantum Cosmology

Prospects for Localization of Gravitational Wave Transients by the Advanced LIGO and Advanced Virgo Observatories

LIGO Scientific Collaboration, Virgo Collaboration: J. Aasi, J. Abadie, B. P. Abbott, R. Abbott, T. D. Abbott, M. Abernathy, T. Accadia, F. Acernese, C. Adams, T. Adams, P. Addesso, R. X. Adhikari, C. Affeldt, M. Agathos, O. D. Aguiar, P. Ajith, B. Allen, A. Allocca, E. Amador Ceron, D. Amariutei, S. B. Anderson, W. G. Anderson, K. Arai, M. C. Araya, C. Arceneaux, S. Ast, S. M. Aston, P. Astone, D. Atkinson, P. Aufmuth, C. Aulbert, L. Austin, B. E. Aylott, S. Babak, P. Baker, G. Ballardin, S. Ballmer, Y. Bao, J. C. Barayoga, D. Barker, F. Barone, B. Barr, L. Barsotti, M. Barsuglia, M. A. Barton, I. Bartos, R. Bassiri, M. Bastarrika, A. Basti, J. Batch, J. Bauchrowitz, Th. S. Bauer, M. Bebronne, B. Behnke, M. Bejger, M.G. Beker, A. S. Bell, C. Bell, G. Bergmann, J. M. Berliner, A. Bertolini, et al. (775 additional authors not shown)

(Submitted on 2 Apr 2013)

We present a possible observing scenario for the Advanced LIGO and Advanced Virgo gravitational wave detectors over the next decade, with the intention of providing information to the astronomy community to facilitate planning for multi-messenger astronomy with gravitational waves. We determine the expected sensitivity of the network to transient gravitational-wave signals, and study the capability of the network to determine the sky location of the source. For concreteness, we focus primarily on gravitational-wave signals from the inspiral of binary neutron star (BNS) systems, as the source considered likely to be the most common for detection and also promising for multimessenger astronomy. We find that confident detections will likely require at least 2 detectors operating with BNS sensitive ranges of at least 100 Mpc, while ranges approaching 200 Mpc

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New edition expected soon!

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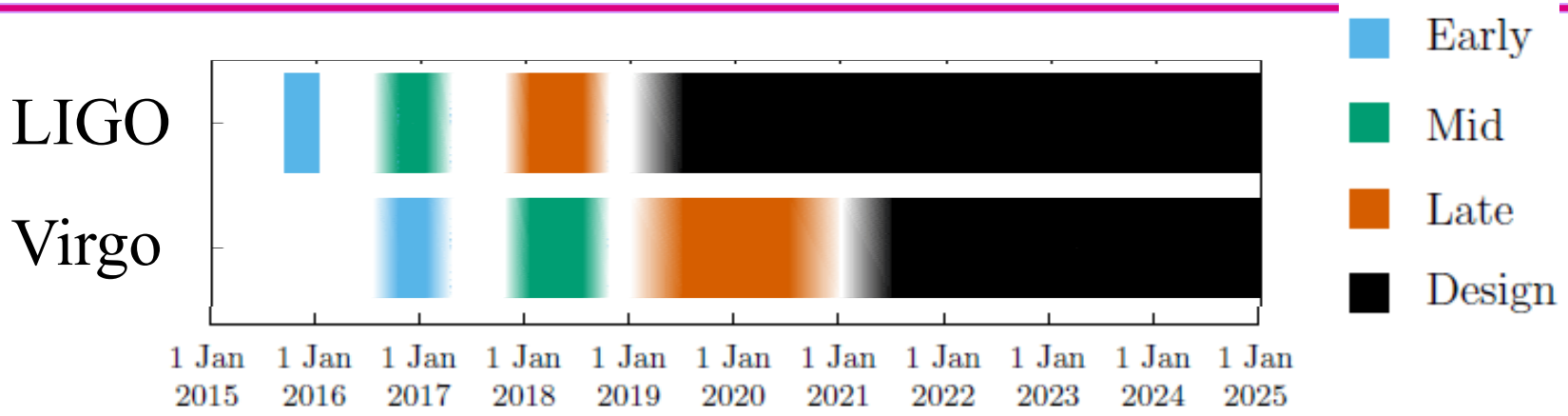
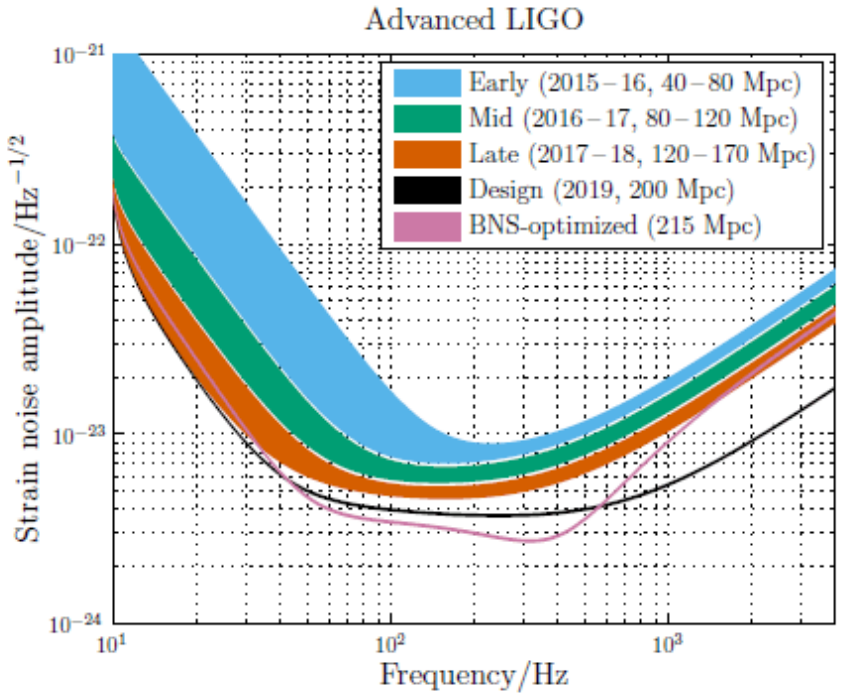
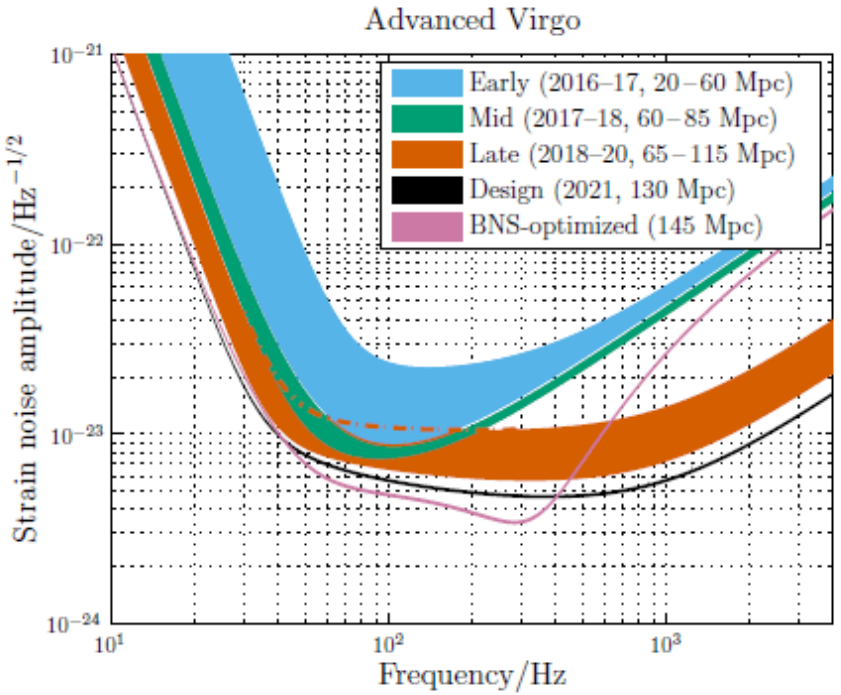
LIGO-Virgo Observing Plans







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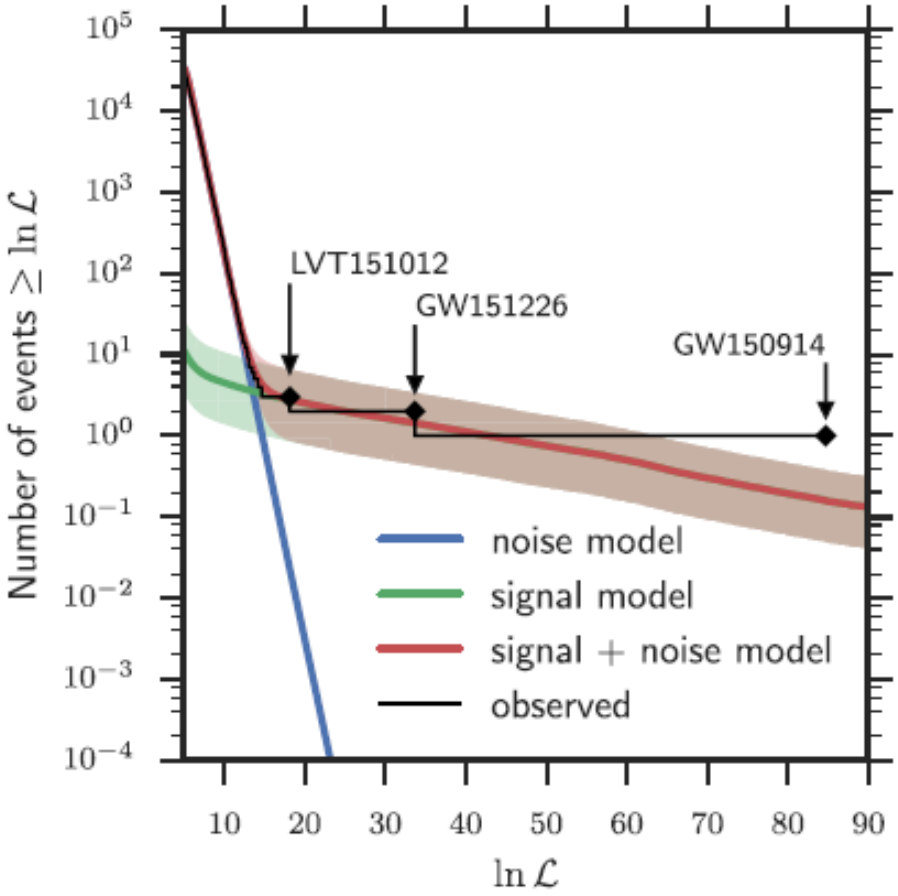
Sensitivity

Lessons from LIGO O1

- Steep drop in false alarm rate versus size means edge of observable space is very sharp
  - » Very far out on tail of noise due to need to overcome trials factor

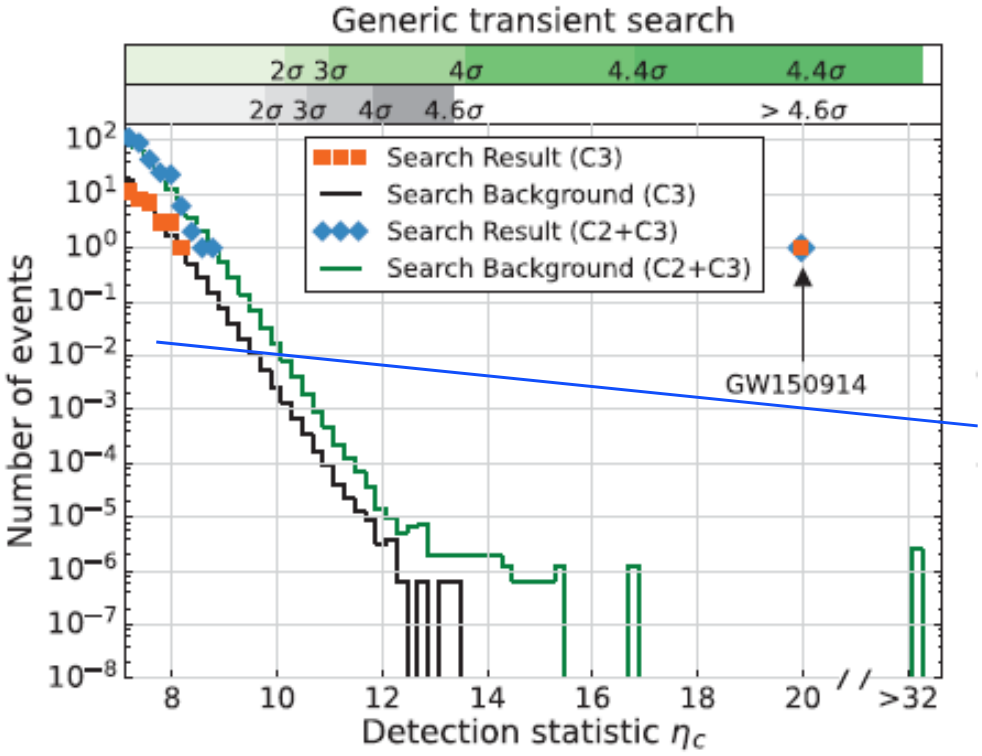


O1 BBH Search

Sensitivity

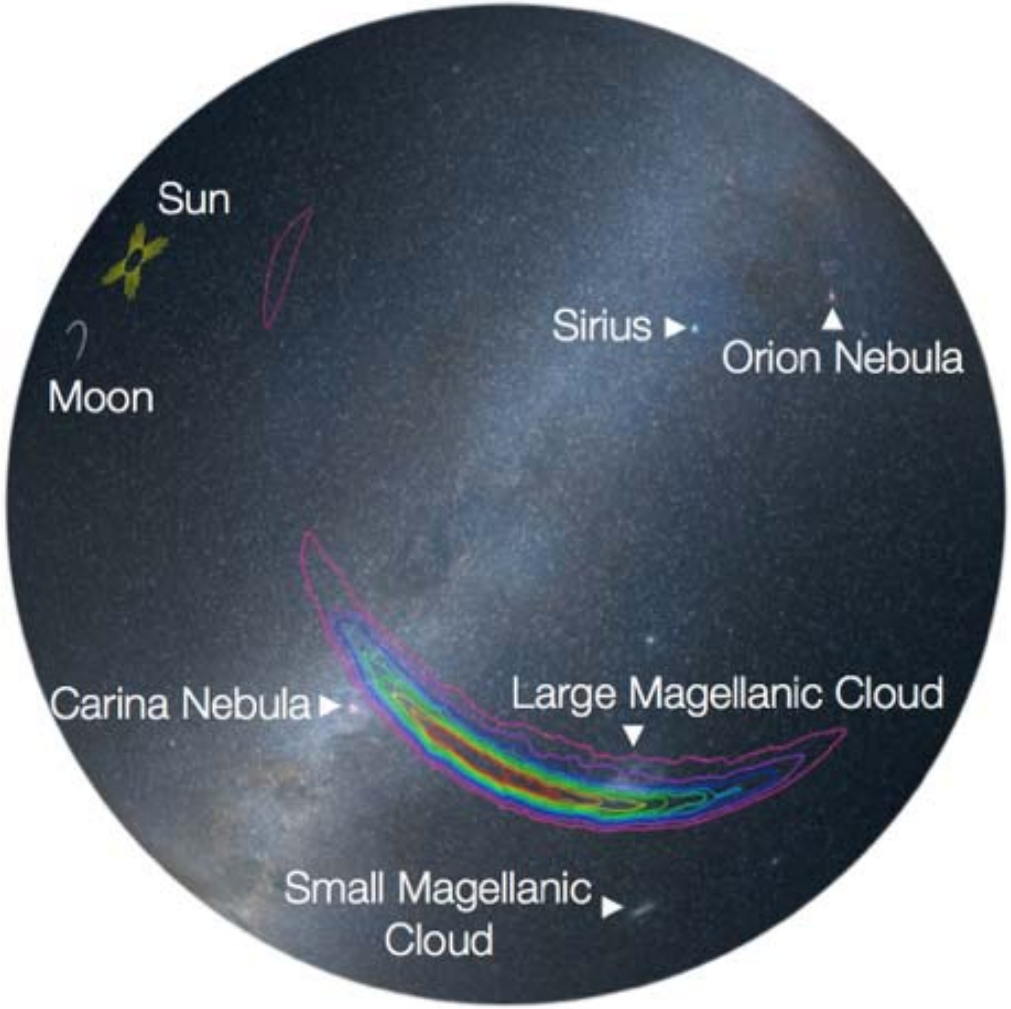
Lessons from LIGO O1

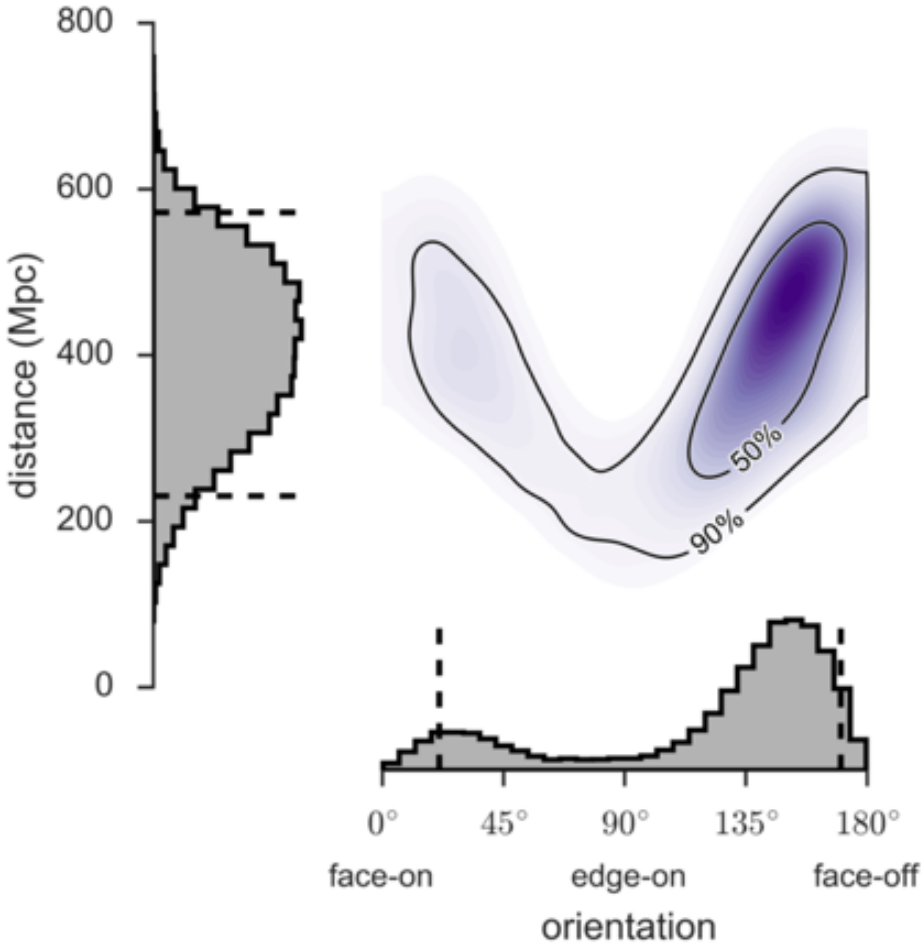
- Steep drop in false alarm rate versus size means edge of observable space is very sharp
  - » Very far out on tail of noise due to need to overcome trials factor
- Narrow time window lowers probability of noise triggers linearly
  - » Neutrino trigger would help sensitivity a lot, optical trigger not so much



O1 Burst Search

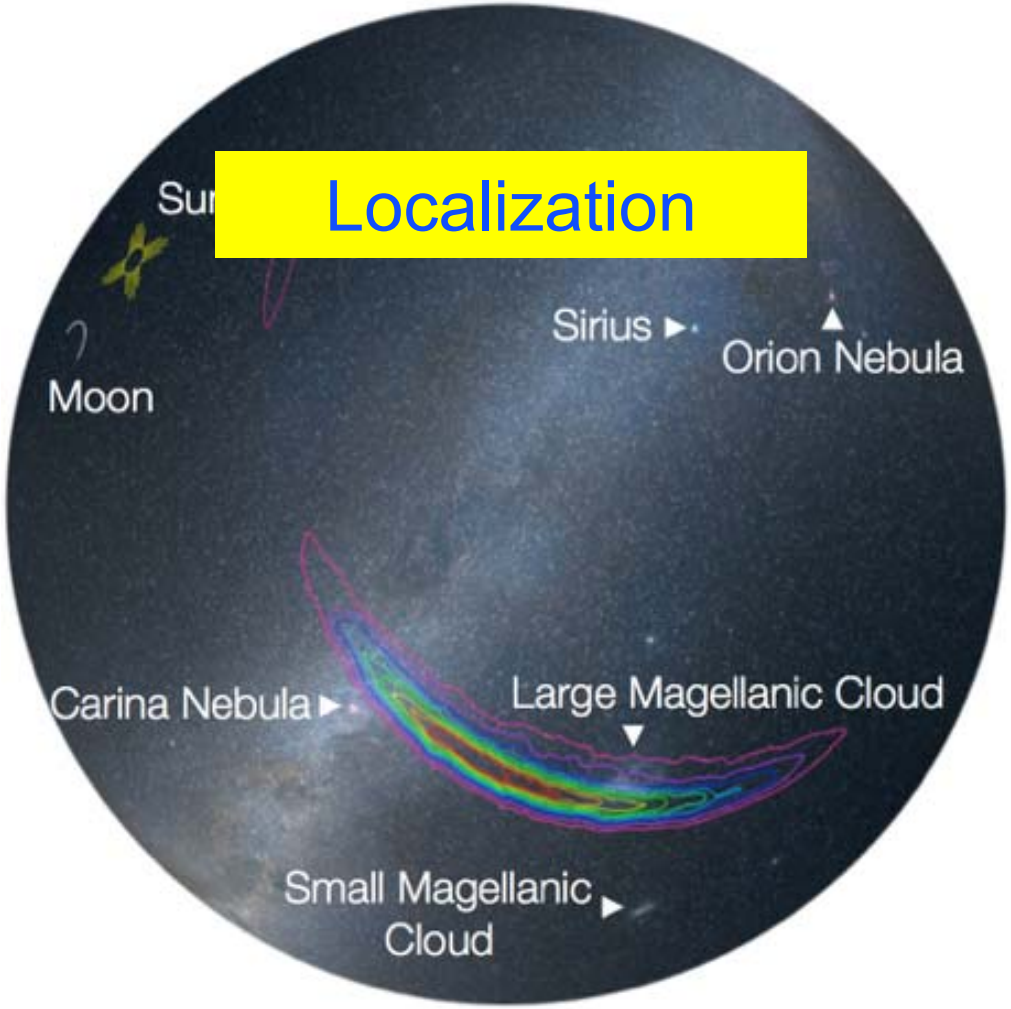
Limitation of a 2-Detector Network

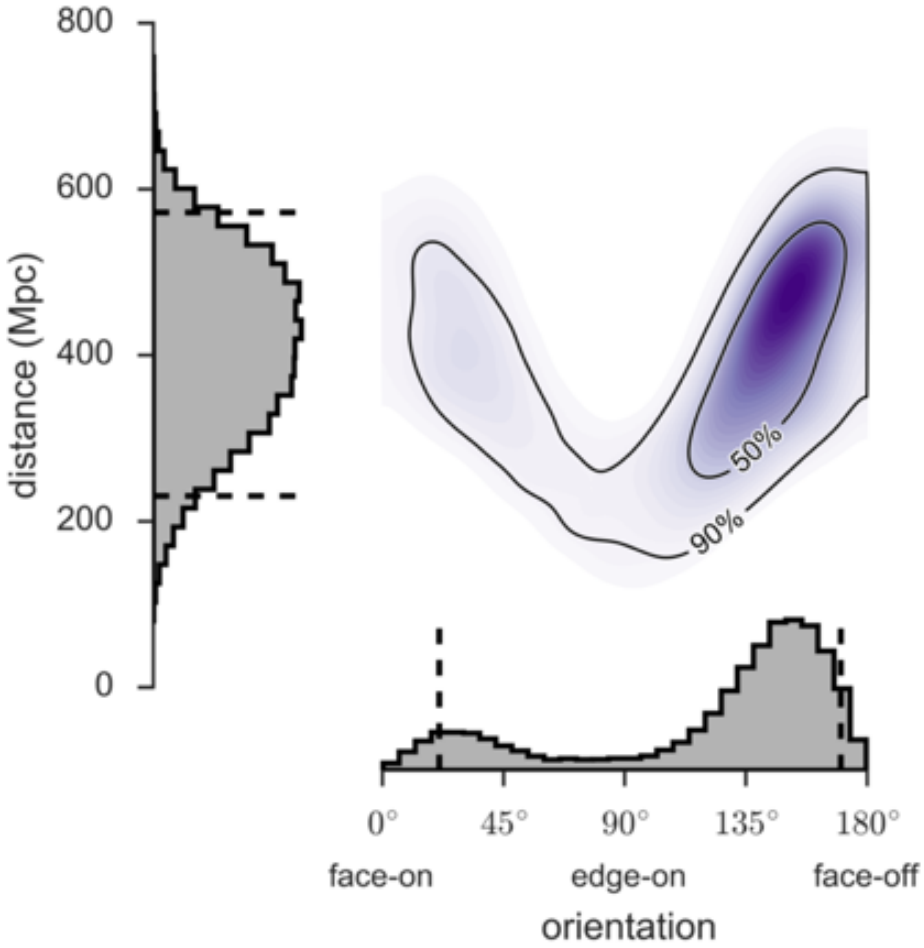




LIGO & Virgo Collaborations: Properties of the binary black hole merger GW150914, arXiv:1602.03840

Limitation of a 2-Detector Network





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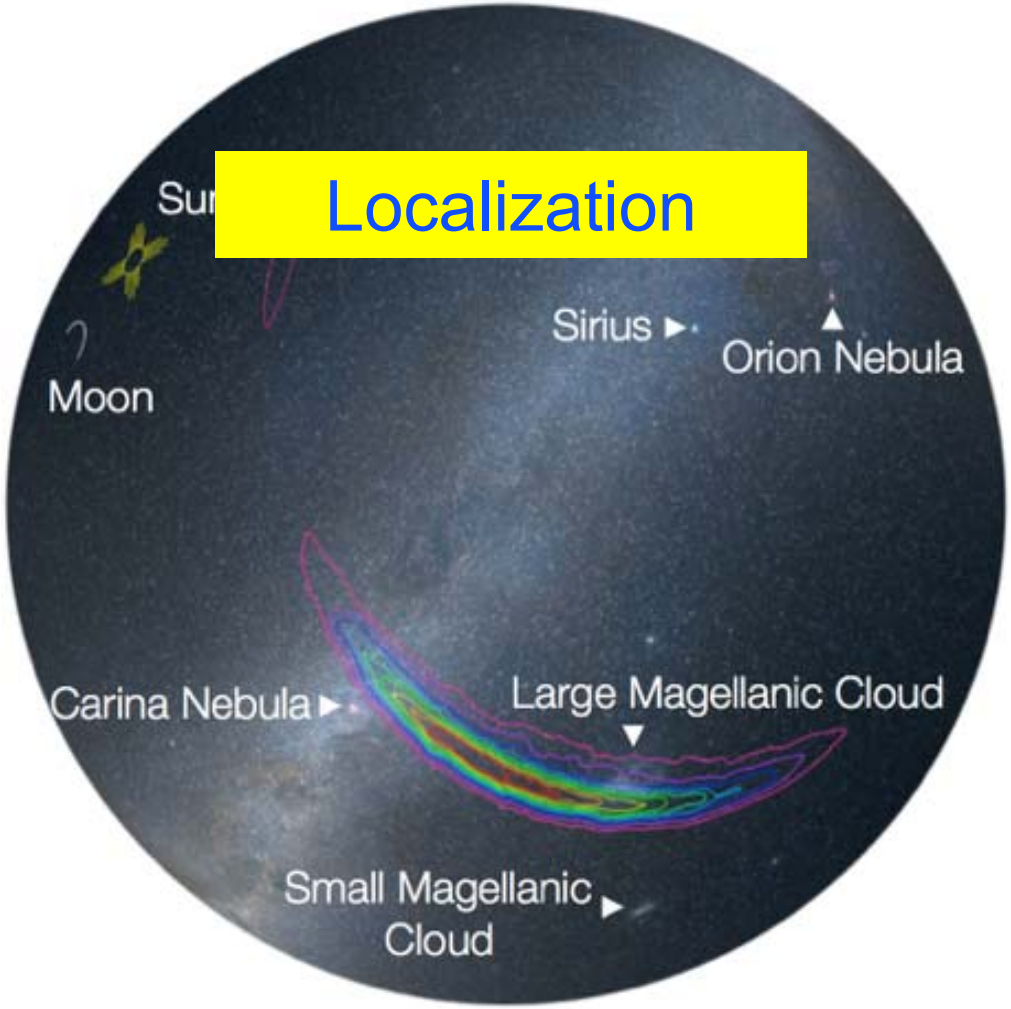

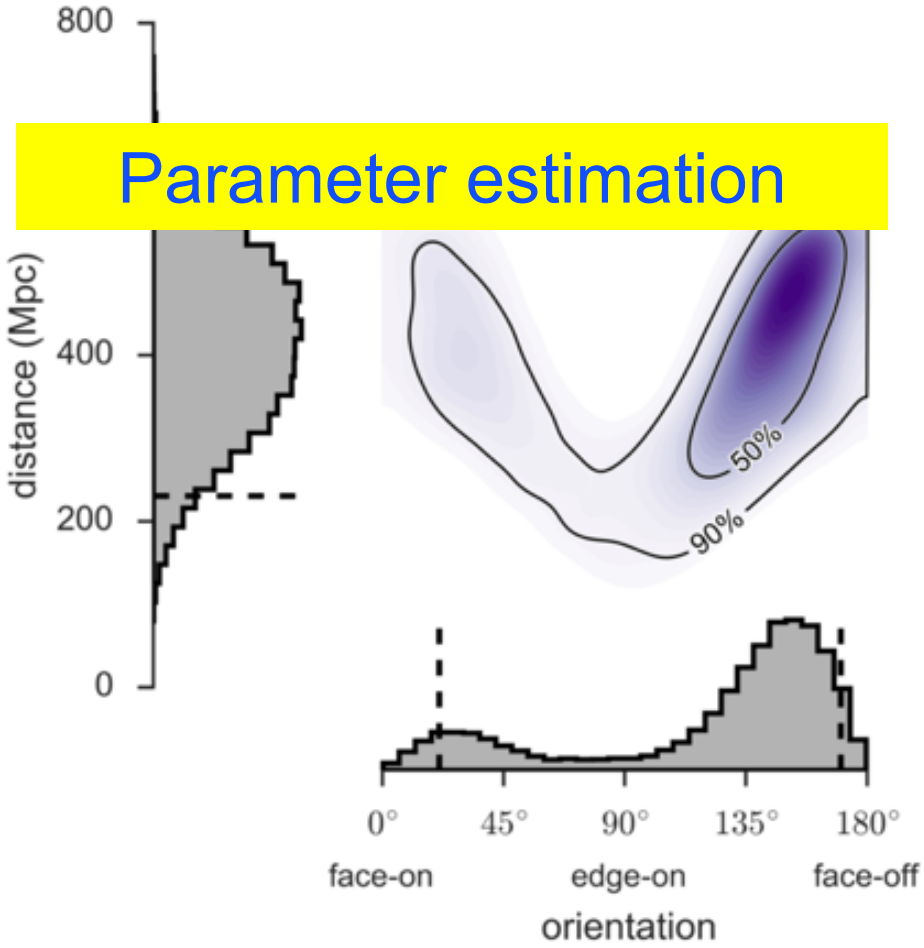

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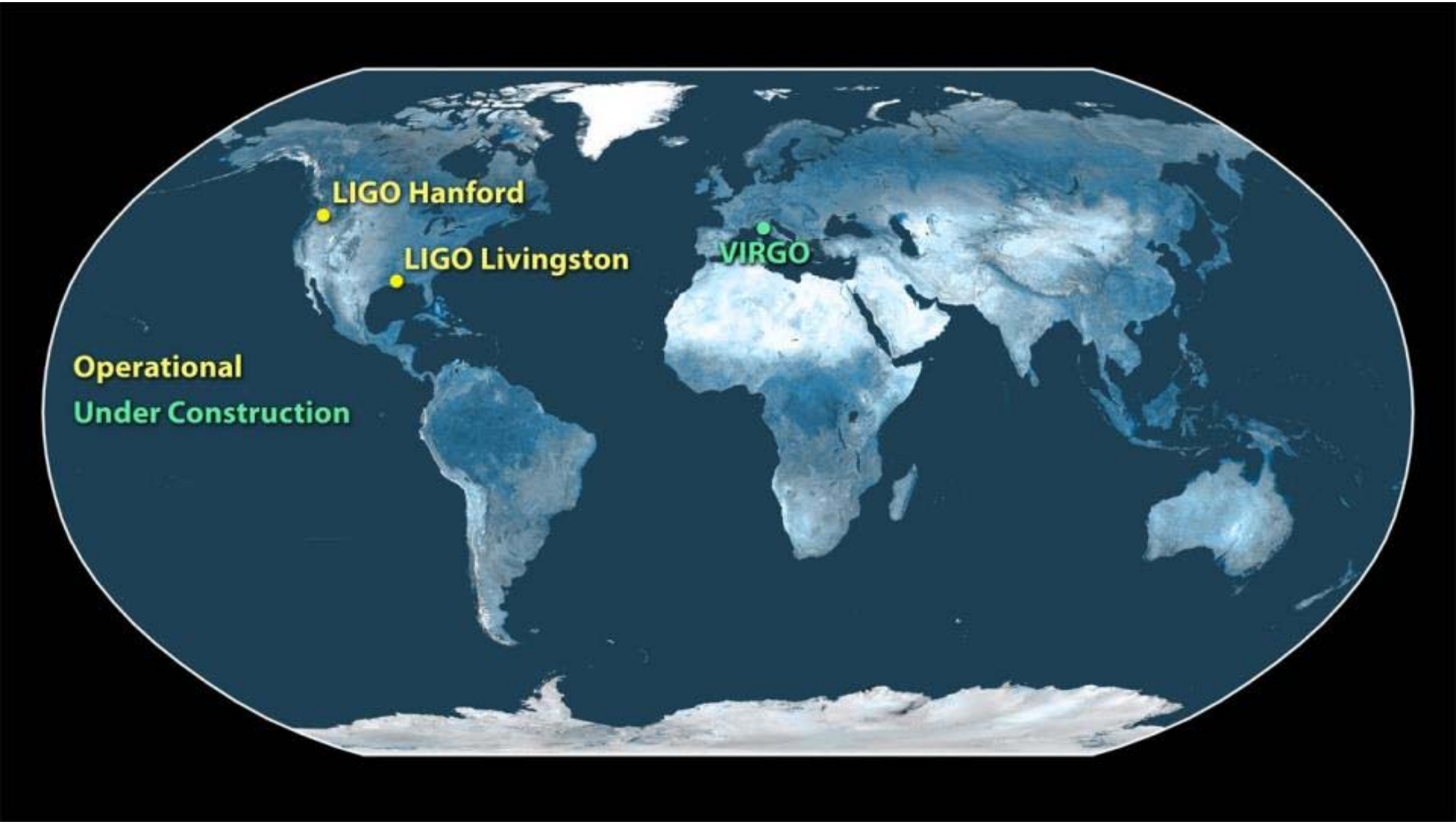
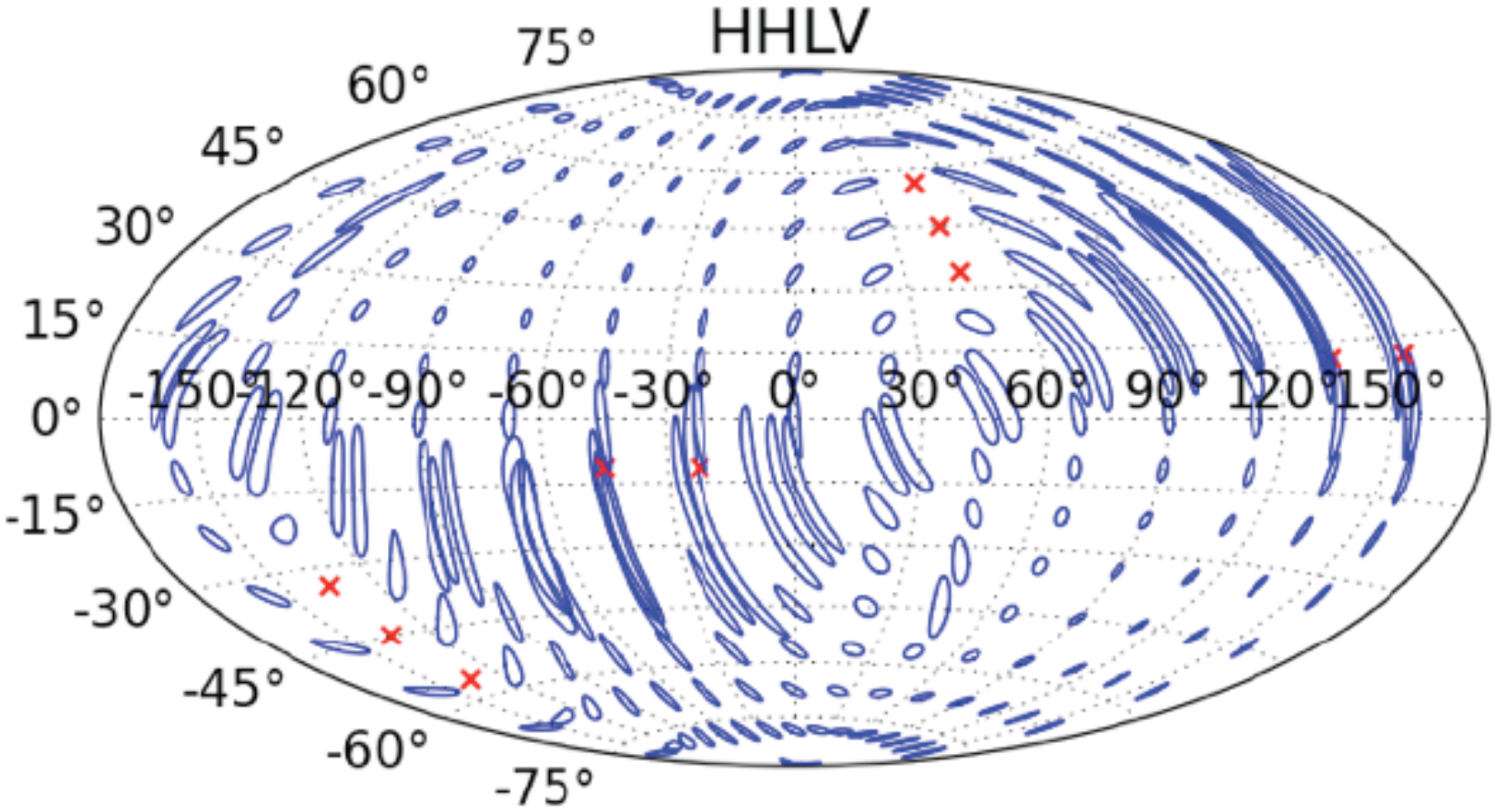
LIGO-Virgo Network

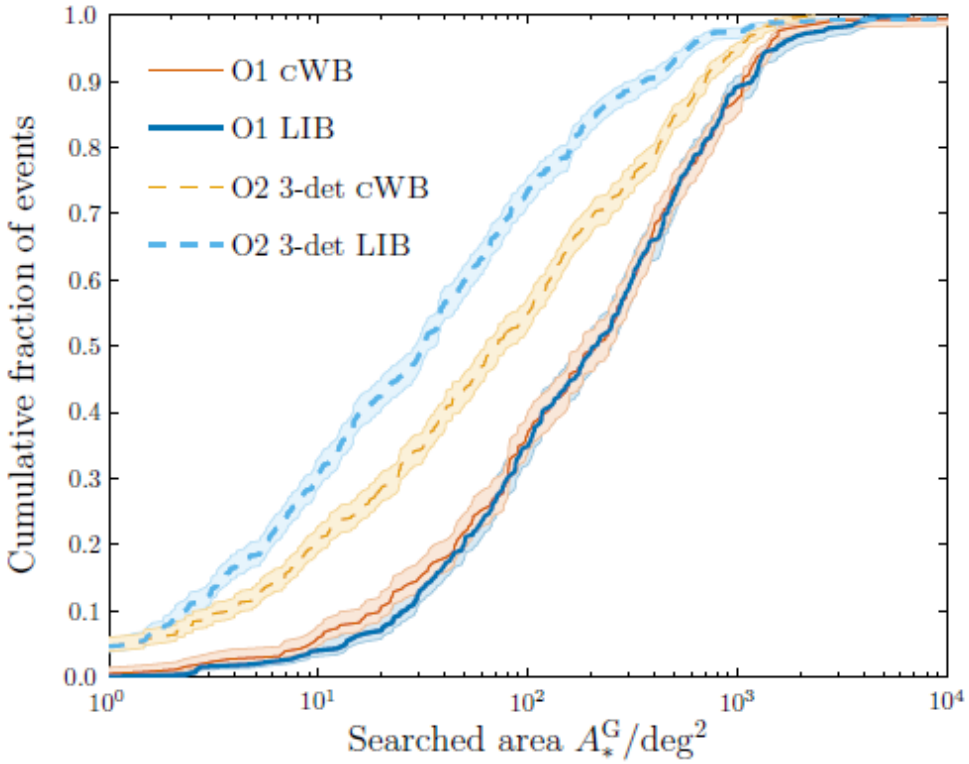


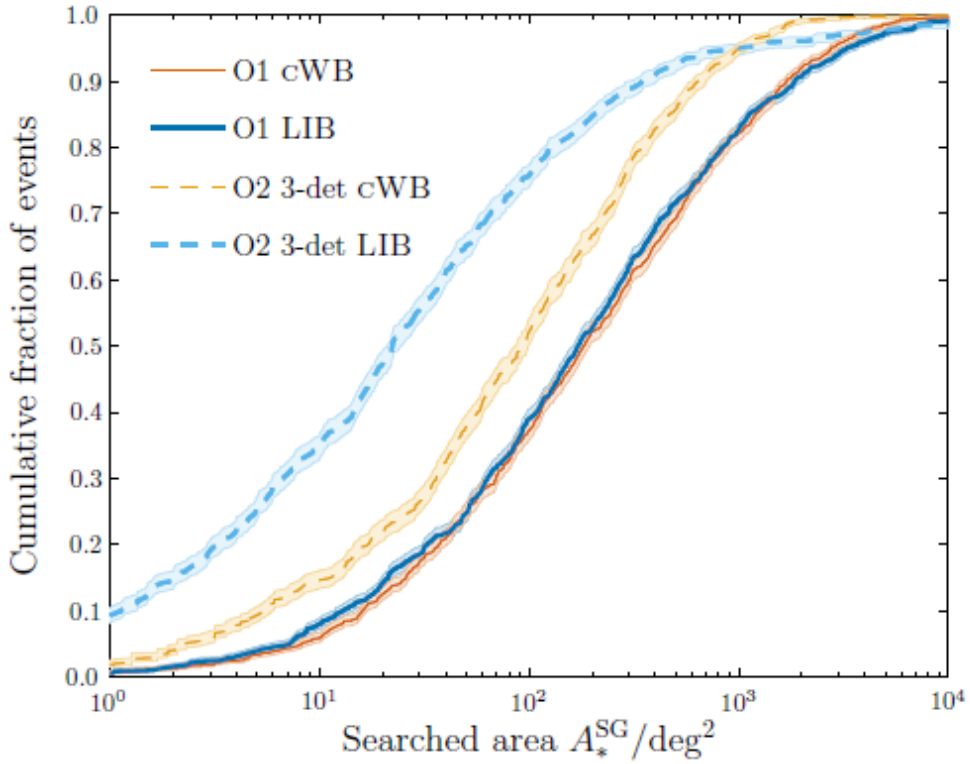
Localization Capability: LIGO-Virgo Working Together



*S. Fairhurst, "Improved source localization with LIGO India", J. Phys.: Conf. Ser. **484** 012007*

Localization--Bursts





- Two different algorithms, two different waveforms
- Effect of individual detector duty factors on network effectiveness

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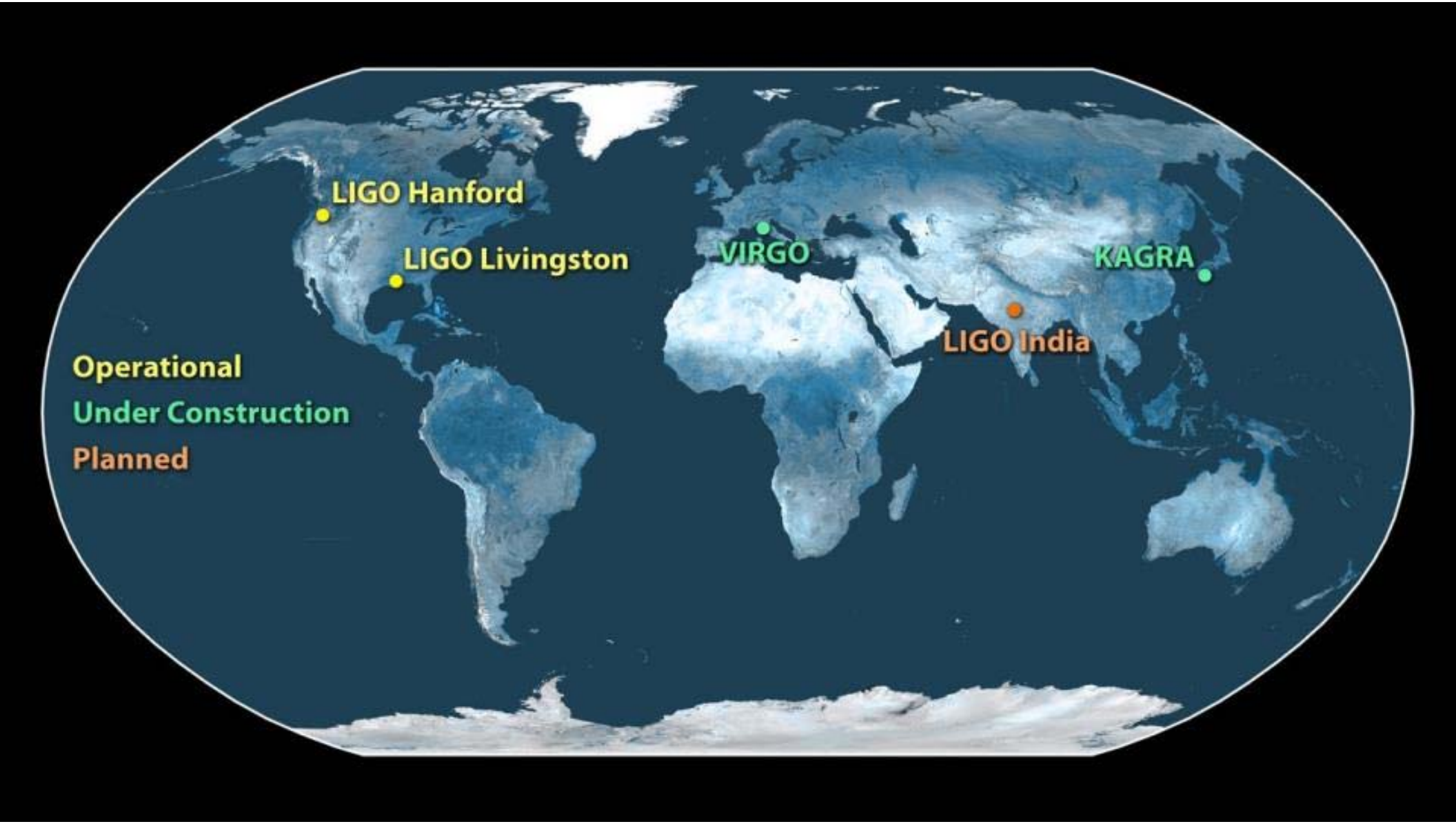
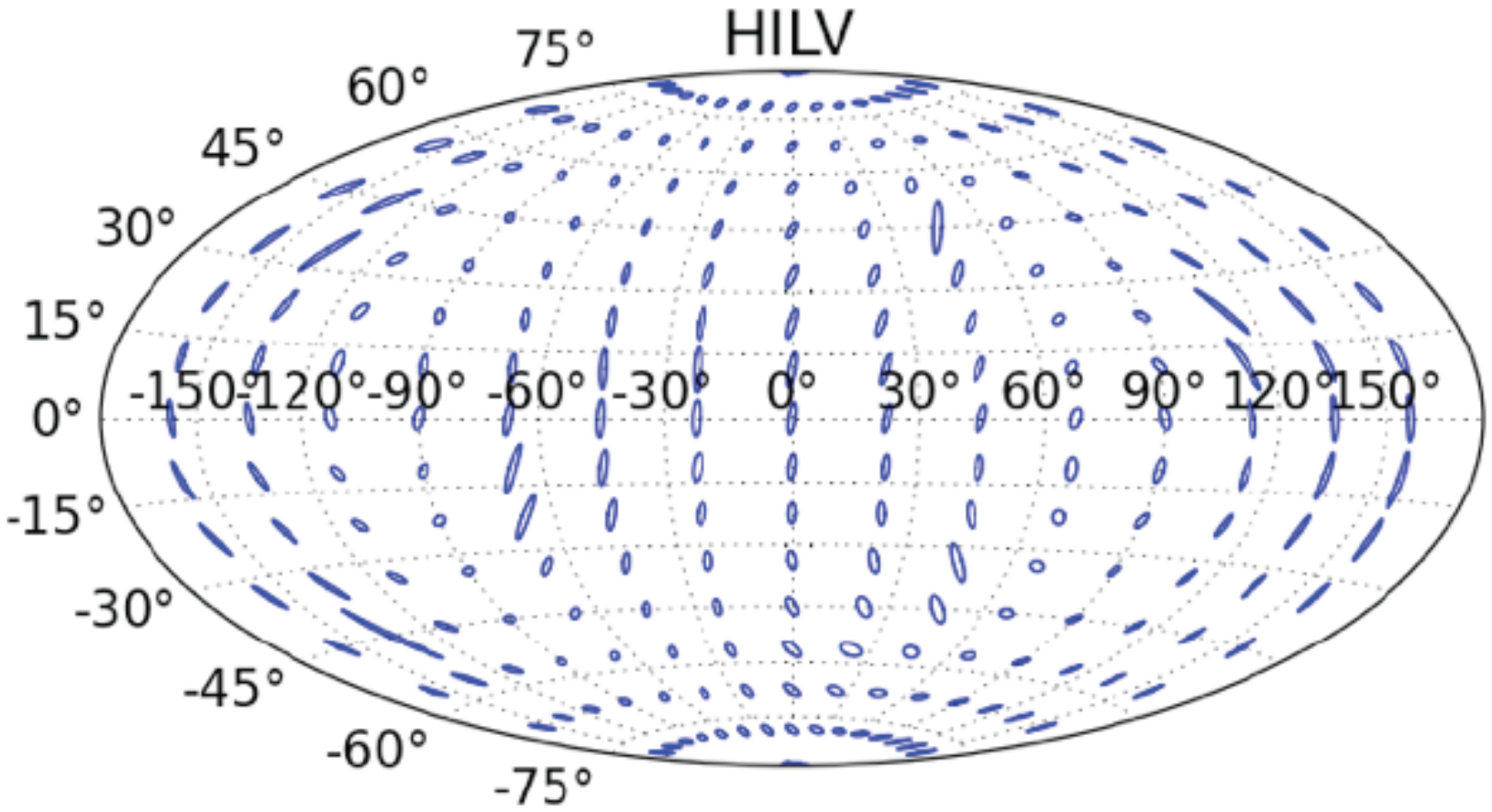
The Global Network



Localization Capability: LIGO-Virgo plus LIGO-India



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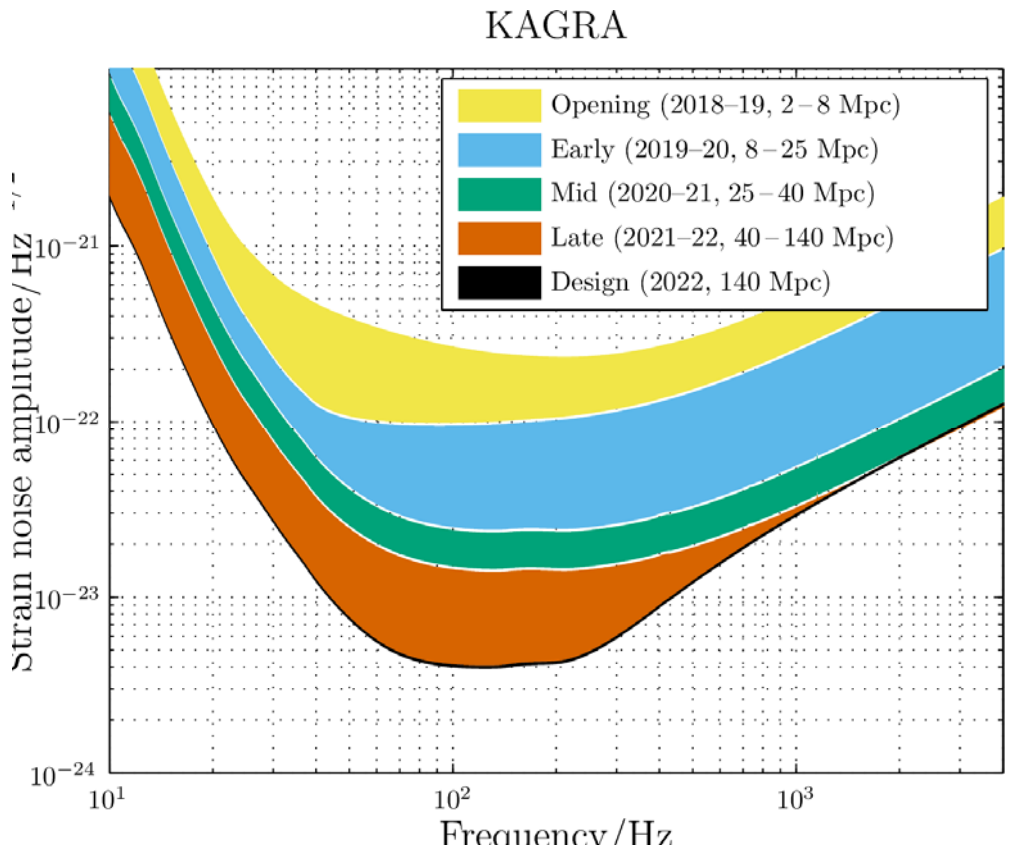
LIGO

KAGRA

- Next iteration of “Observing Scenario” paper will include KAGRA
- VERY preliminary guesses about sensitivity in different years
- Commissioning begins in 2018
- First observing run in 2020?



LIGO-India

- Initial observations 2024?
- Outside the time window for this session