GRB-triggered searches for gravitational waves from compact binary inspirals in LIGO and Virgo data during S5/VSR1

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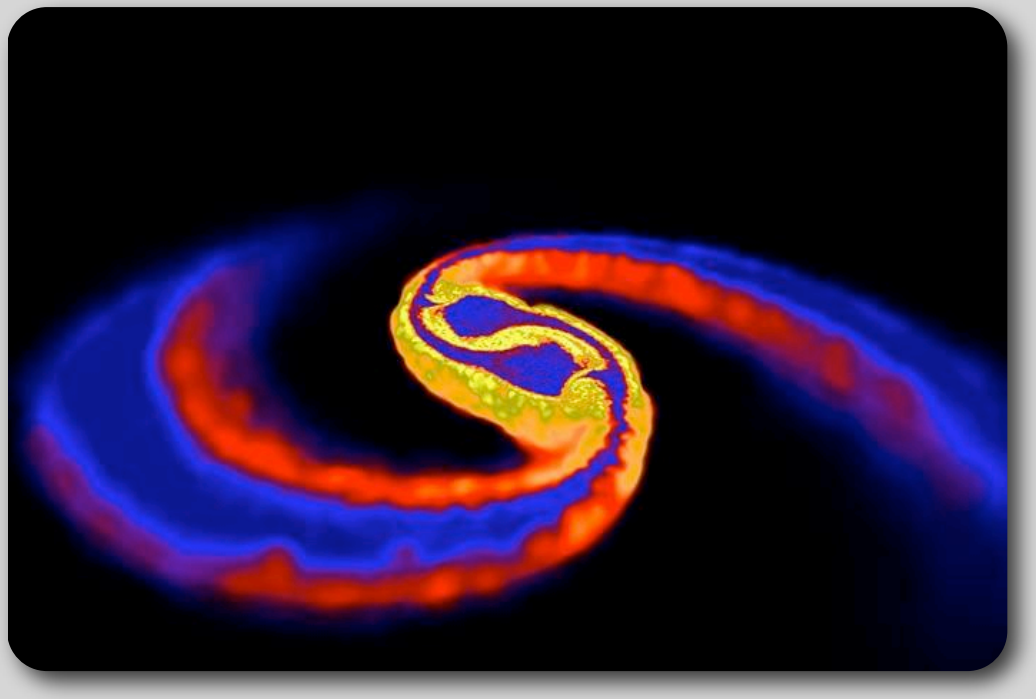
LIGO-G0900368-v4

Short GRBs: ideal targets for GW astronomy (I)

- Most short GRBs are probably NSs disrupted by compact companions in the final stages of inspiral.
- A detection will constrain component masses and spins.*
- A high-SNR detection will constrain NS equations of state.†
- Simultaneous EM/GW observations can measure absolute luminosity distance.‡

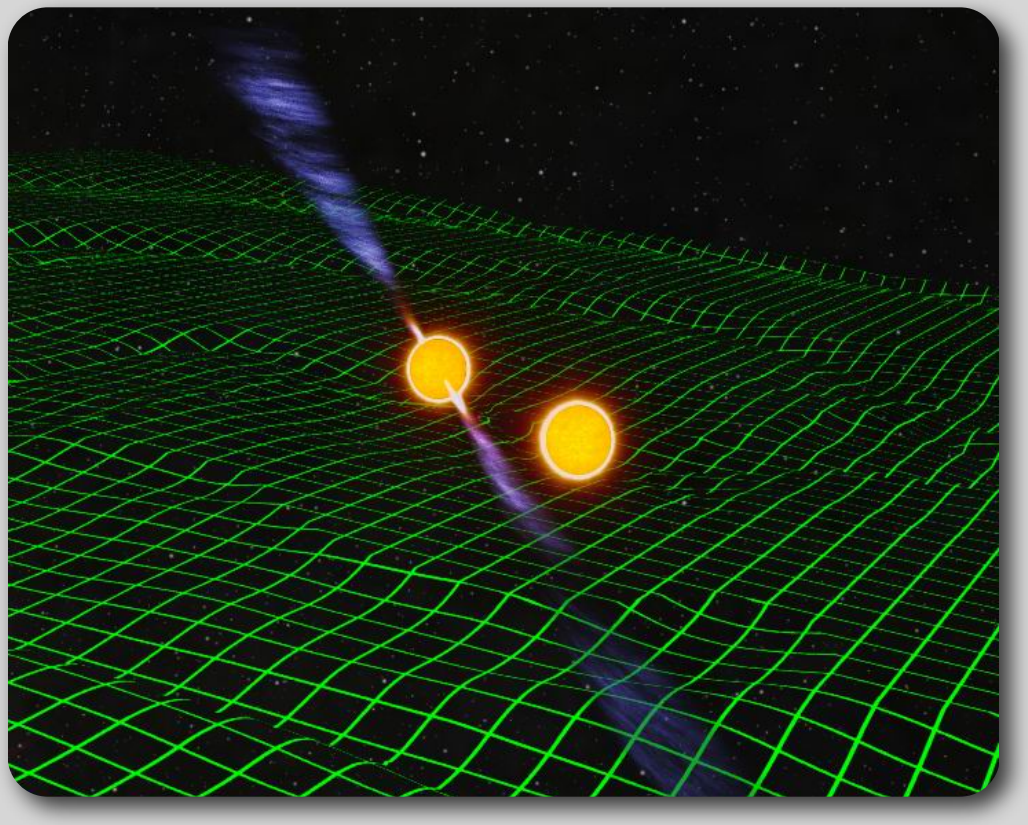


NS-NS merger simulation
Price and Rosswog

* Cutler and Flanagan, PRD 1994; Finn and Chernoff, PRD 1993; Poisson and Will, PRD 1995
† Flanagan and Hinderer, PRD 2008; Read et al, arXiv:0901.3258
‡ Nissanke et al, arXiv:0904.1017

Short GRBs: ideal targets for GW astronomy (II)

- A significant GW candidate with an EM counterpart is a far more compelling detection.
- The GW emission during inspiral is well modeled. This enables matched filtering, which digs deeply into the detector noise.
- A known time and sky location can be searched with significantly lowered thresholds.



NS-NS inspiral depiction
John Rowe Animation

S5: Nov 2005 – Nov 2007 | VSR1: May 2007 – Oct 2007

- 213 GRBs
- 33 short GRBs
- 22 short* GRBs while two+ GW detectors were taking good data (duty cycle, data quality)

051114	070209
051210	070429B
051211	070512
060121	070707
060313	070714
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Already published: no inspiral in M31 (Abbott et al, ApJ 2008)

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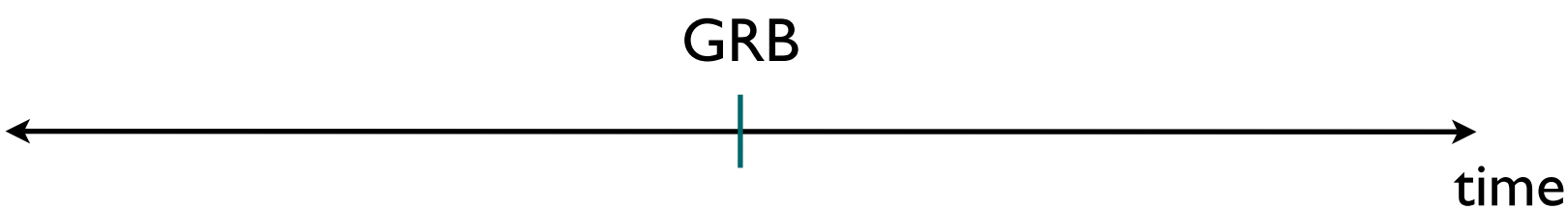
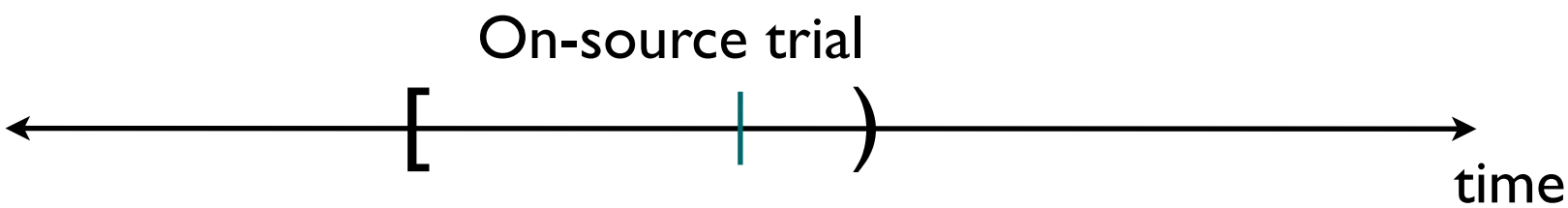
Long duration but other suggestive features

Experiment overview



Experiment overview

- We associate GW triggers with GRBs within $[-5, +1)$ s of the reported GRB time. This is the on-source trial.



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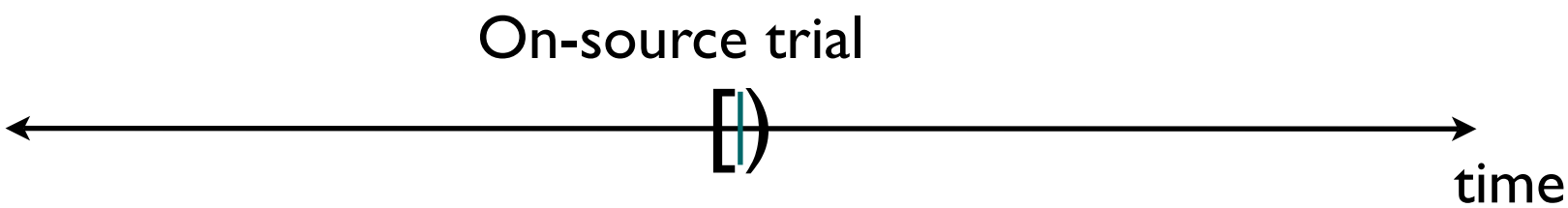

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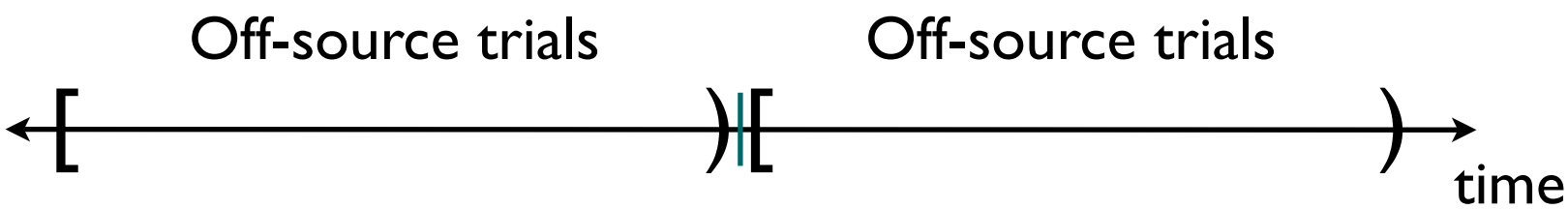

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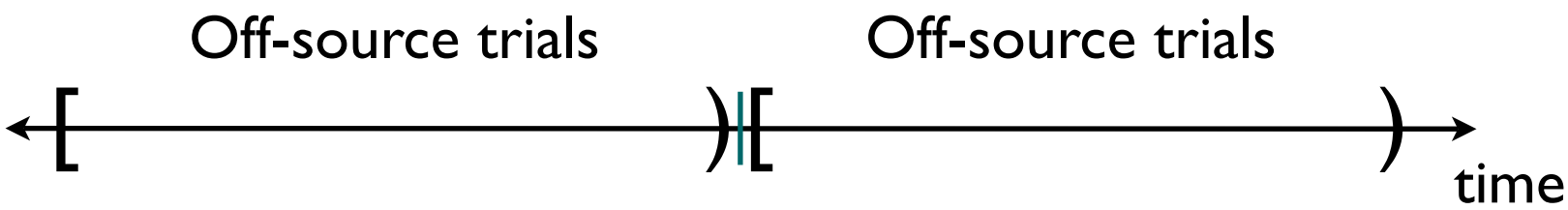

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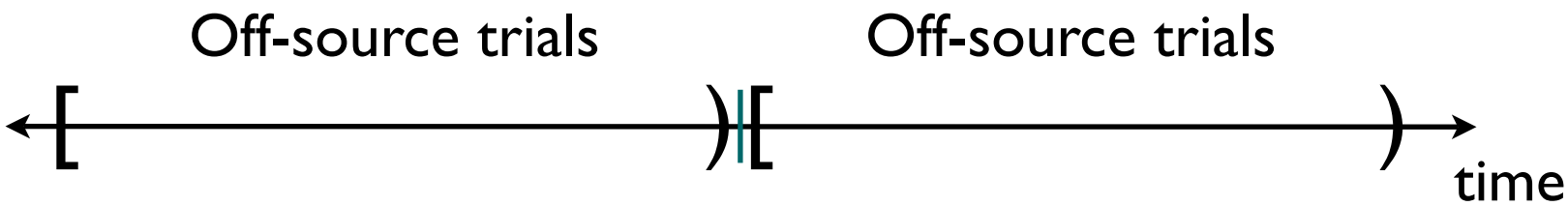

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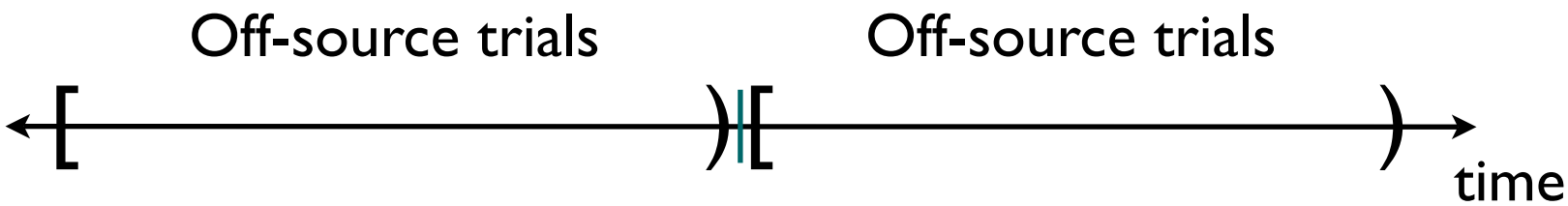

- We reuse the hierarchical inspiral search pipeline used in previous LIGO analyses.*
- We combine injection and off-source trials to form a likelihood statistic.

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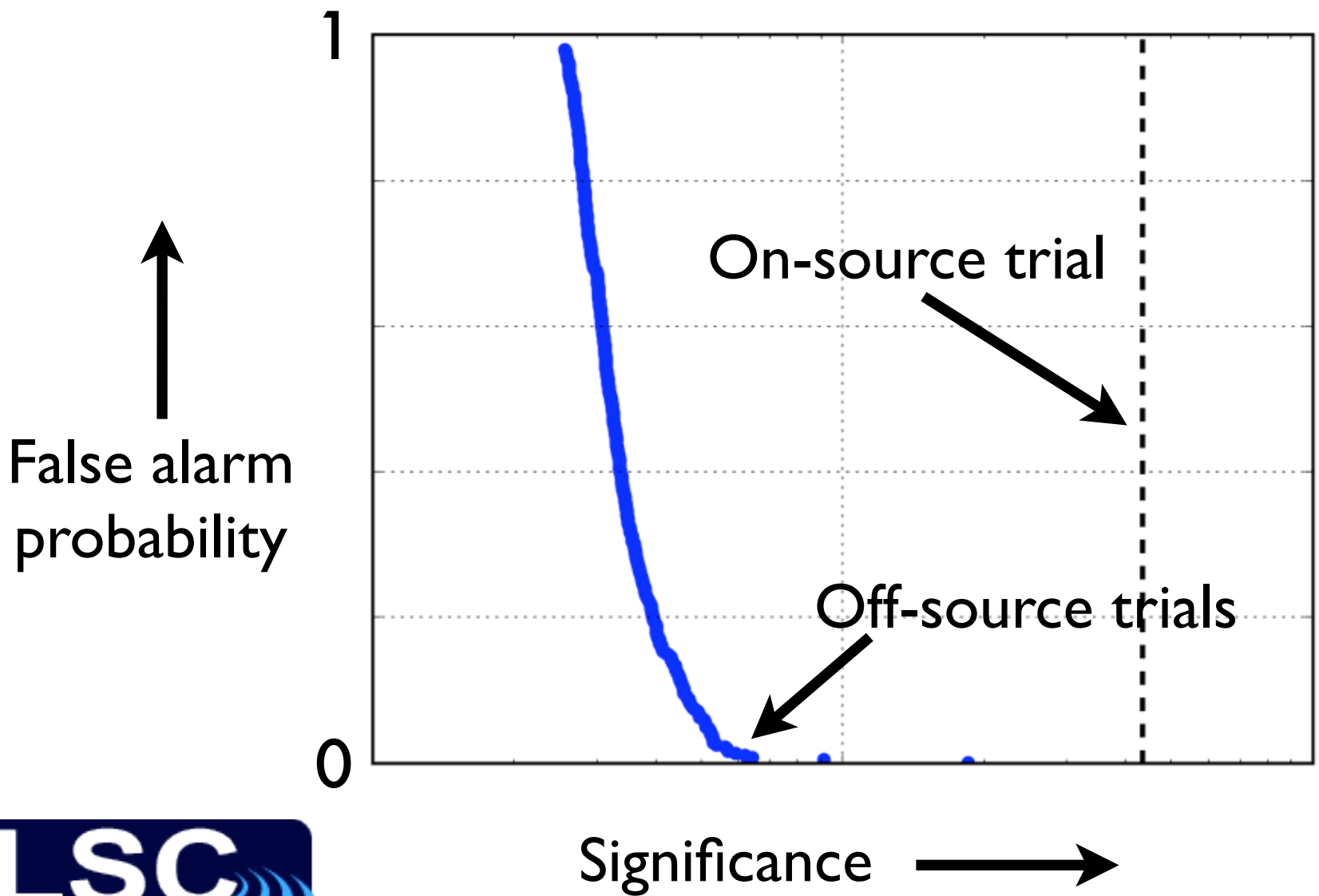
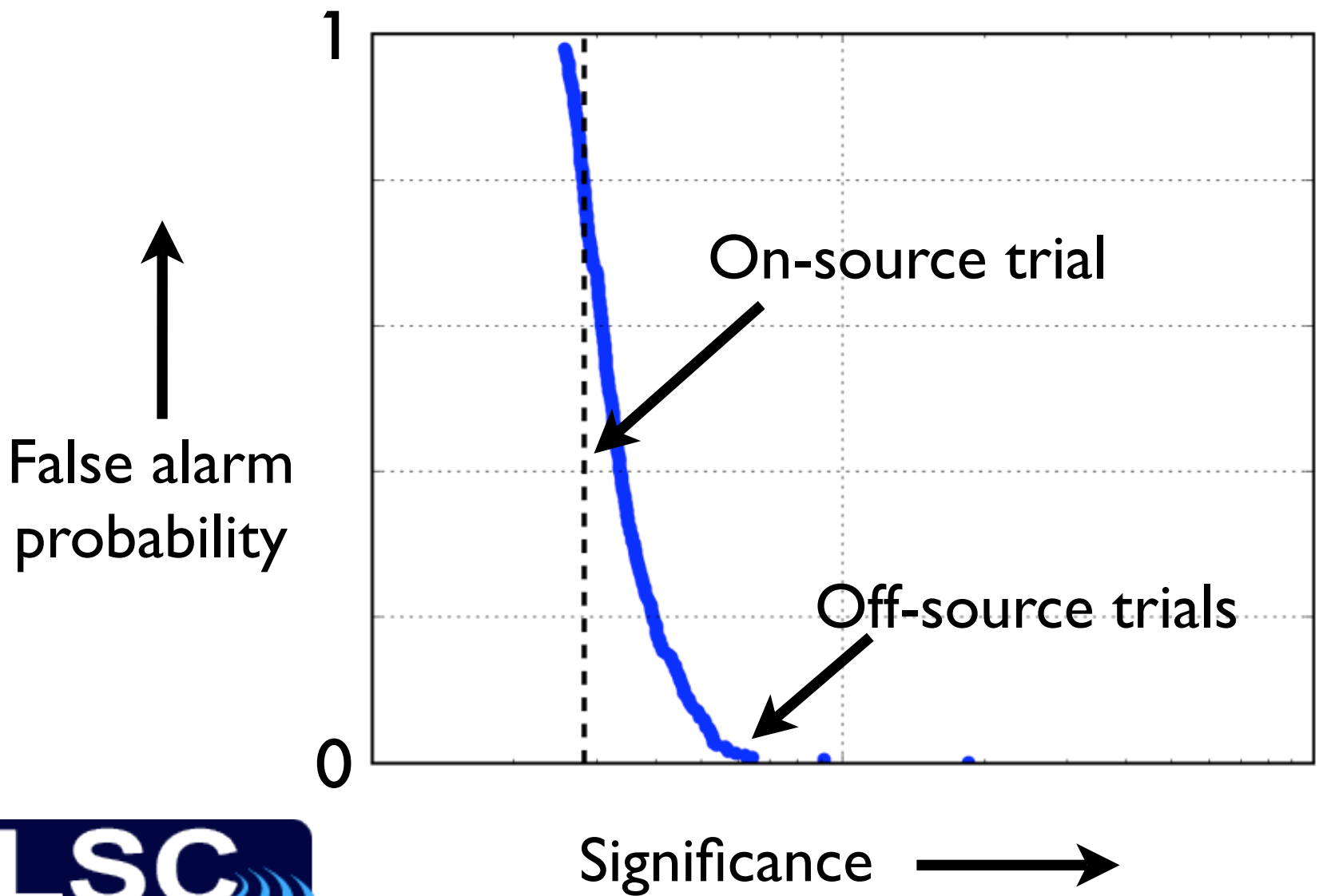
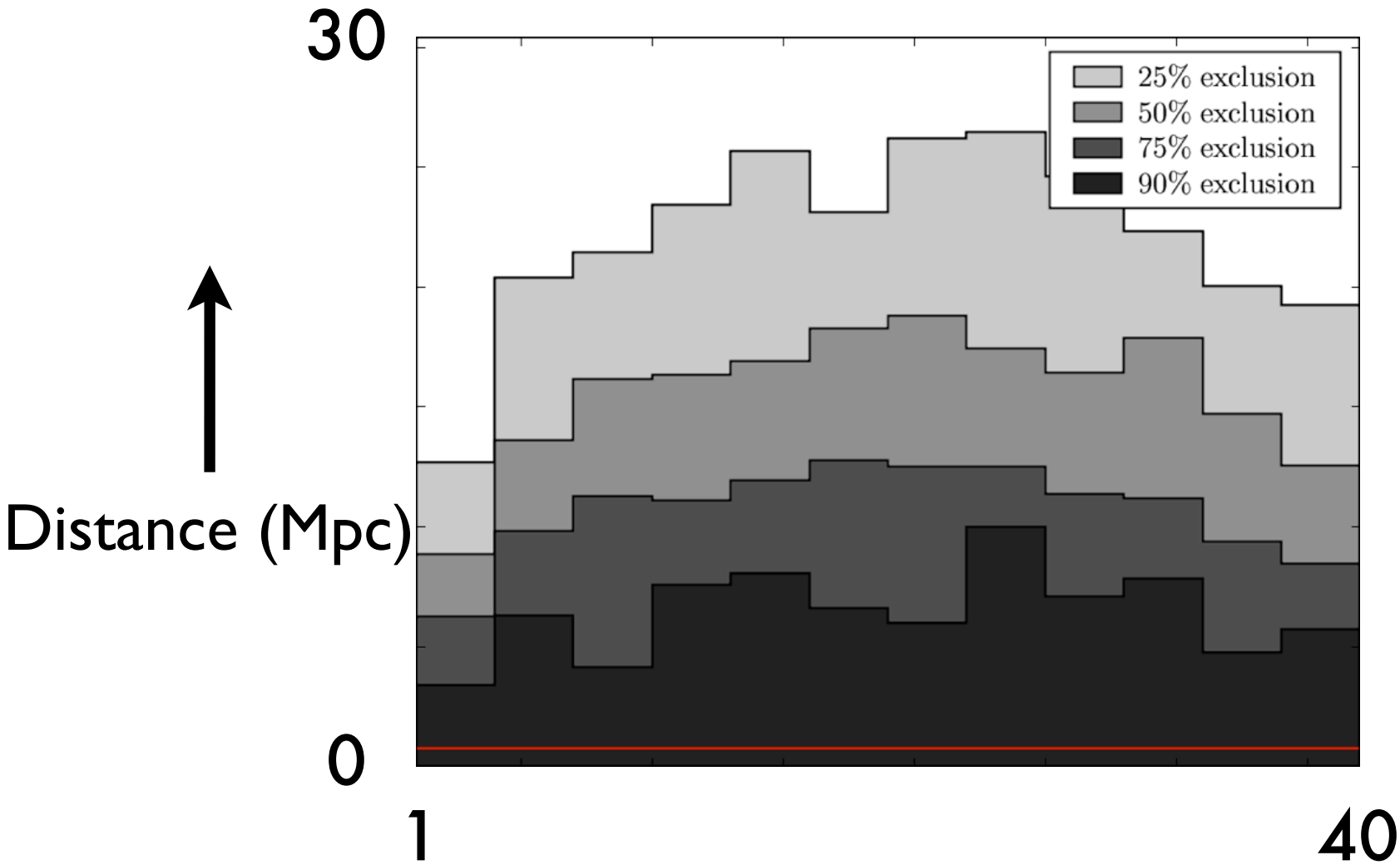
What a detection might look like



What a null result might look like



Astrophysical exclusions* from null results



* example recycled from GRB 070201

Where we are, where we will be

- LIGO and Virgo are committed to multi-messenger astronomy. A coincident detection would provide enormous science.
- We are searching for GWs from compact binary inspirals in coincidence with 22 short* GRBs in S5/VSR1.
- S6/VSR2 begins soon with enhanced detectors. Advanced detectors should routinely record detectable GWs.