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Results of searches for low-mass binary coalescences using LIGO data

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for the LIGO Scientific Collaboration

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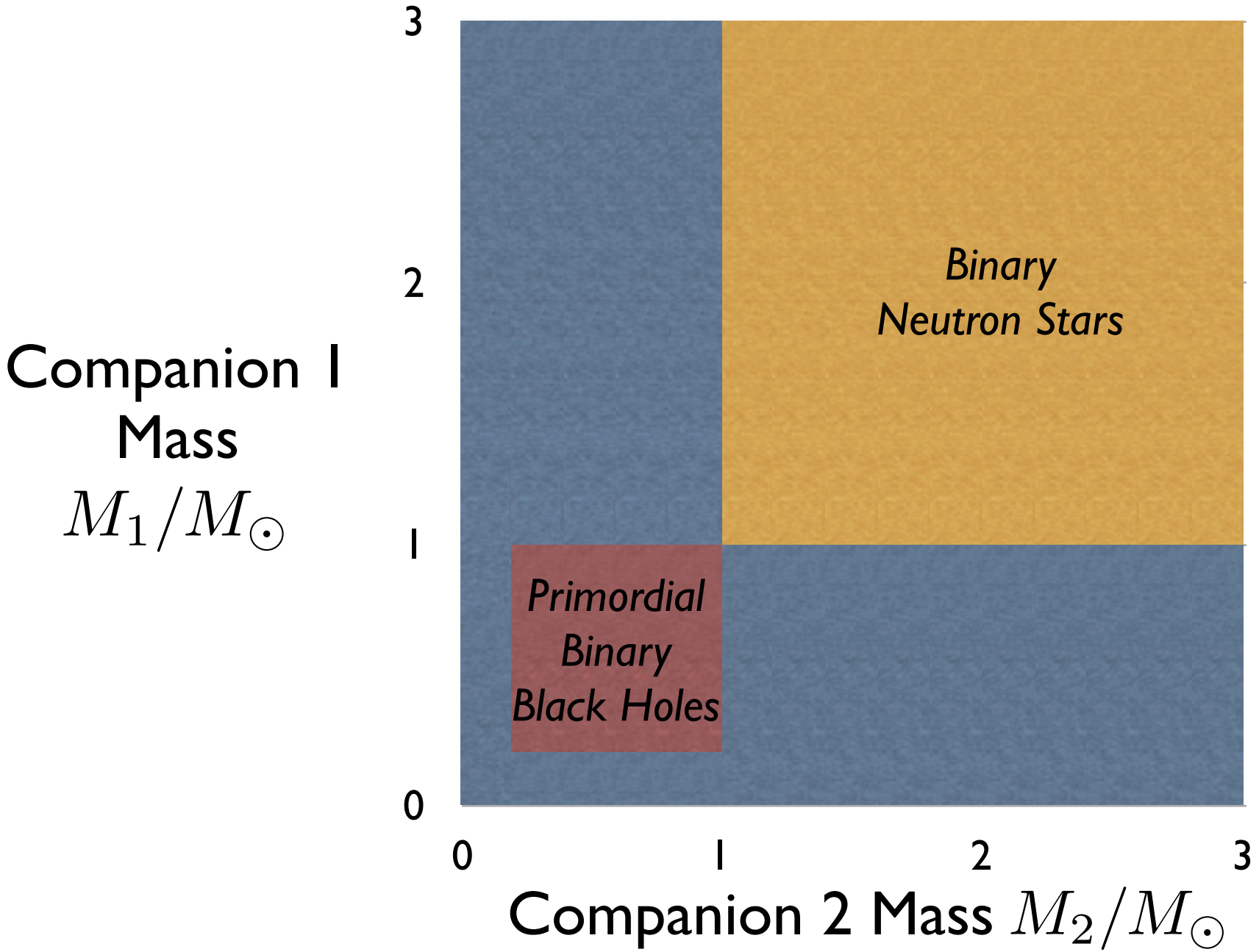
Target Sources



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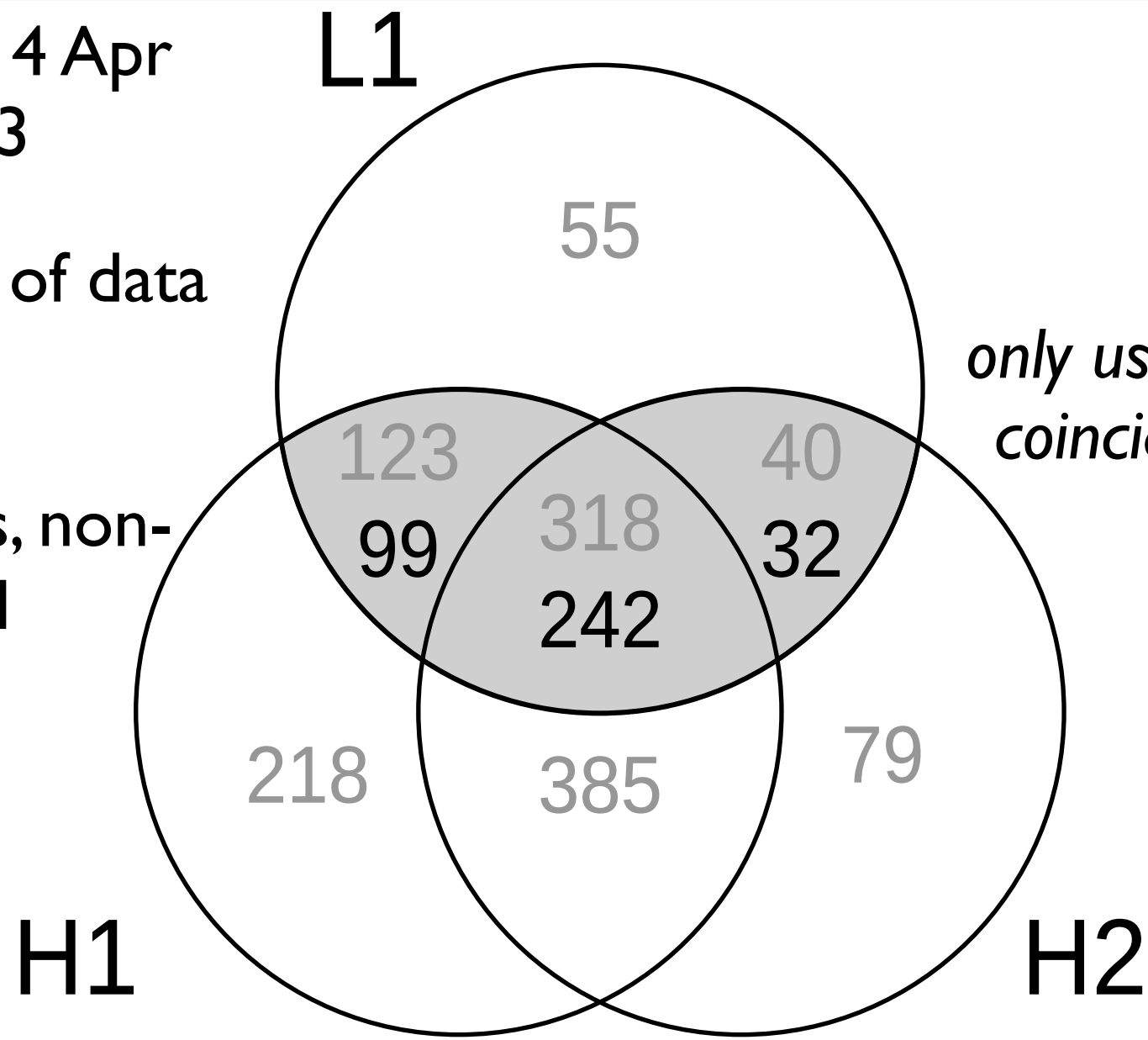
S2 Times Analyzed

14 Feb–14 Apr 2003

373 hours of data analyzed;

339 hours, non-playground



only use inter-site coincident data

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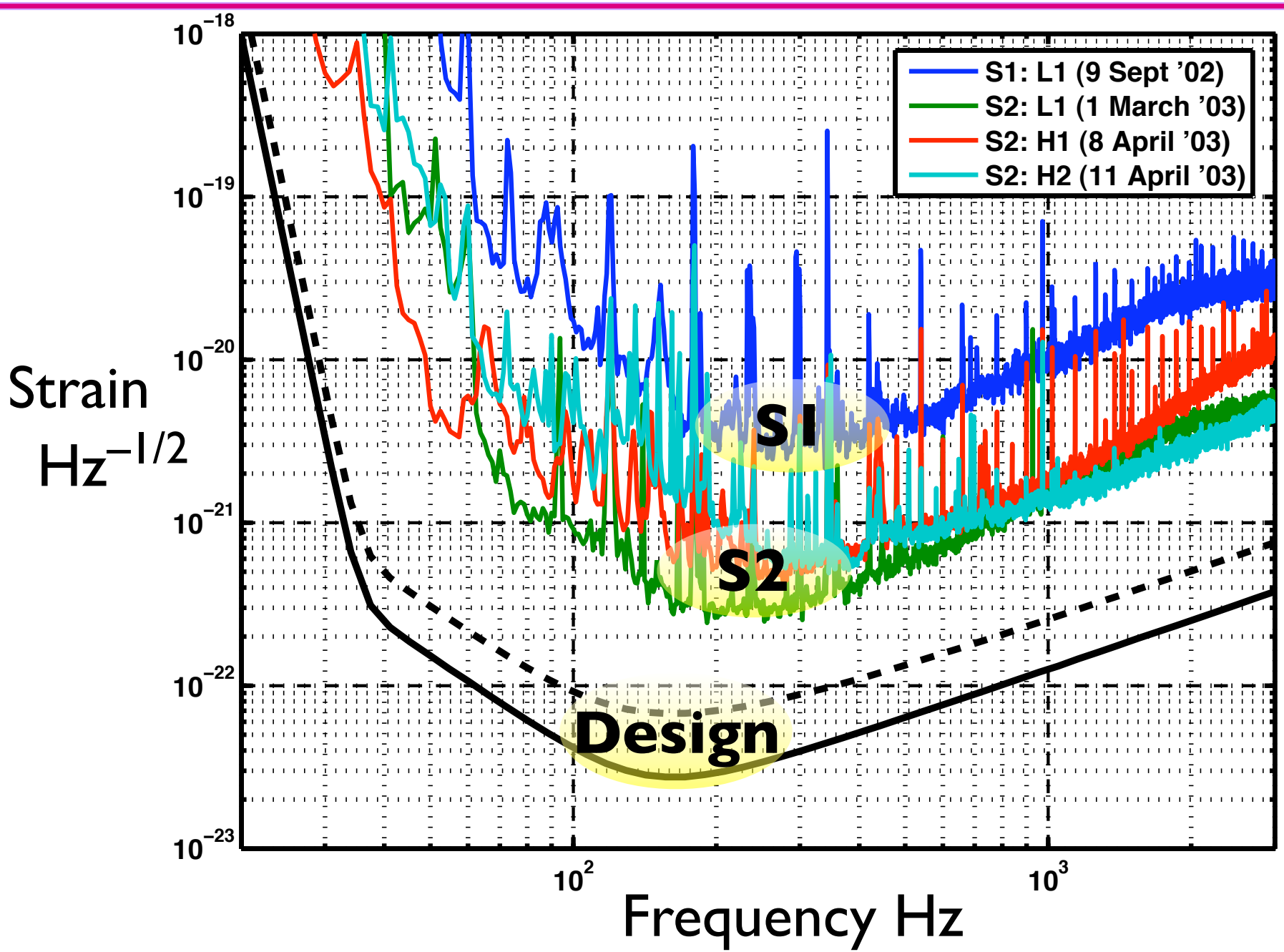
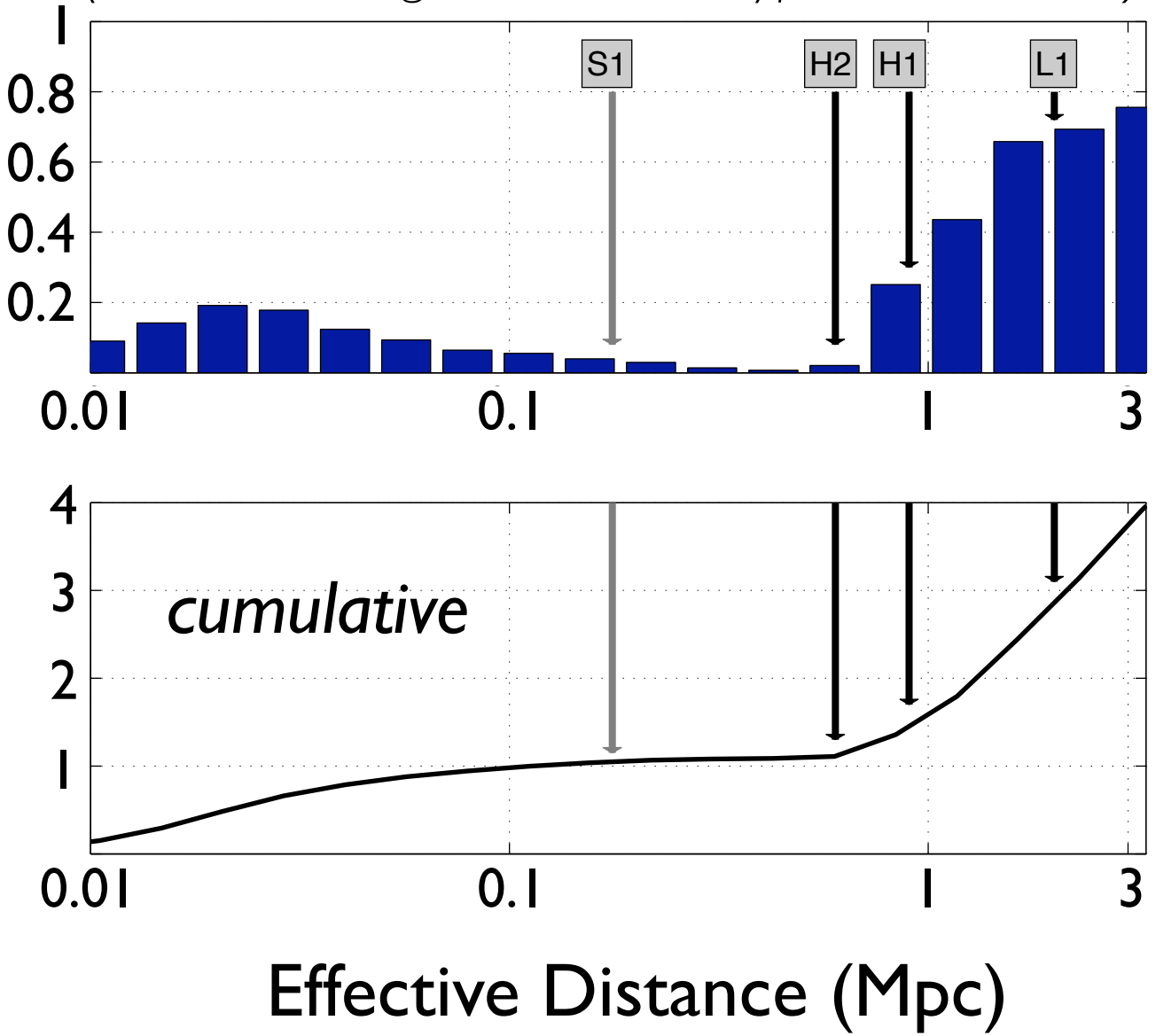
S2 Sensitivity: Strain



S2 Reach: Number of Galaxies

(theoretical ranges based on a typical noise curve)

Number of "Milky-Way Equivalent" galaxies, N_G



Effective Distance (Mpc)

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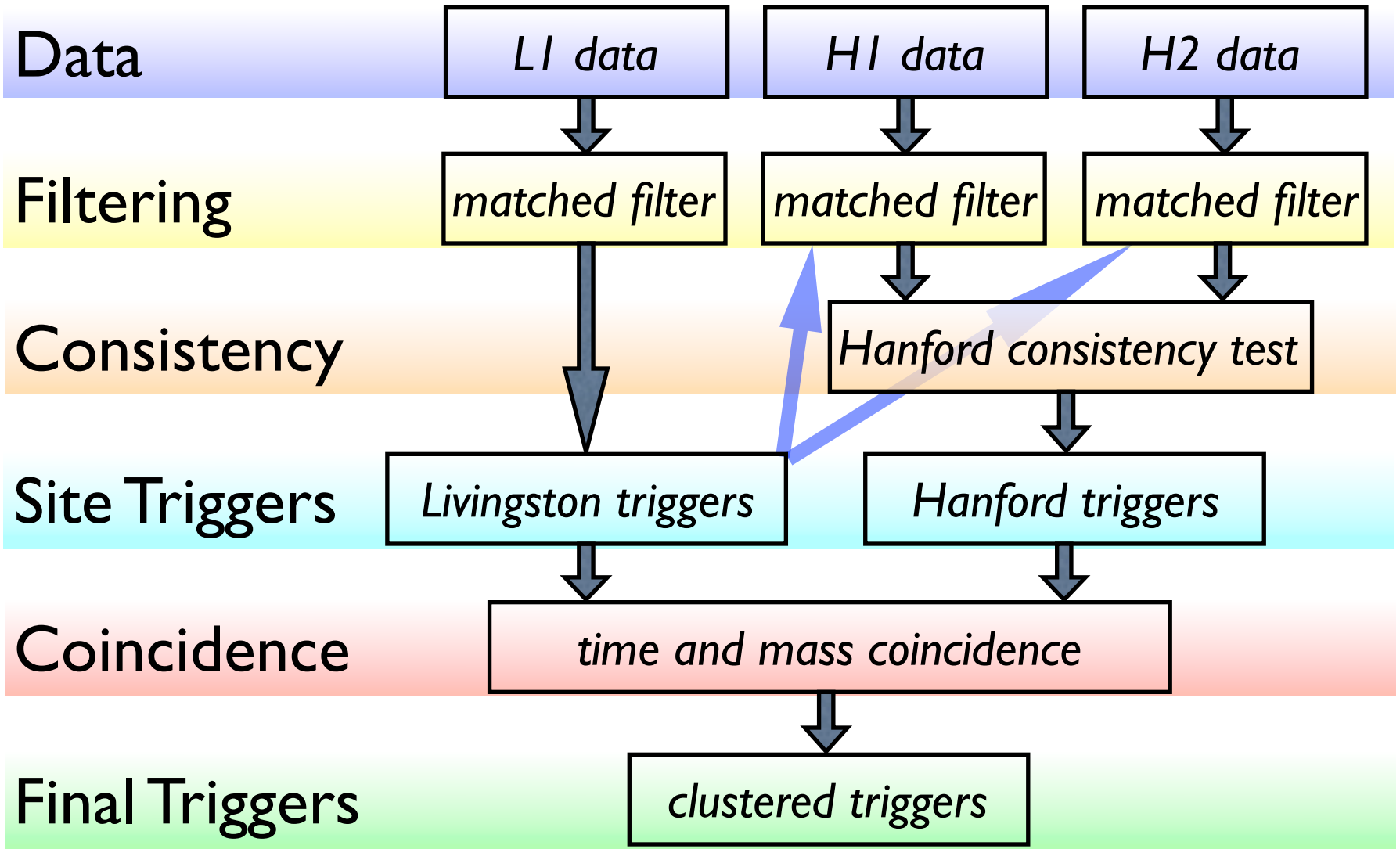
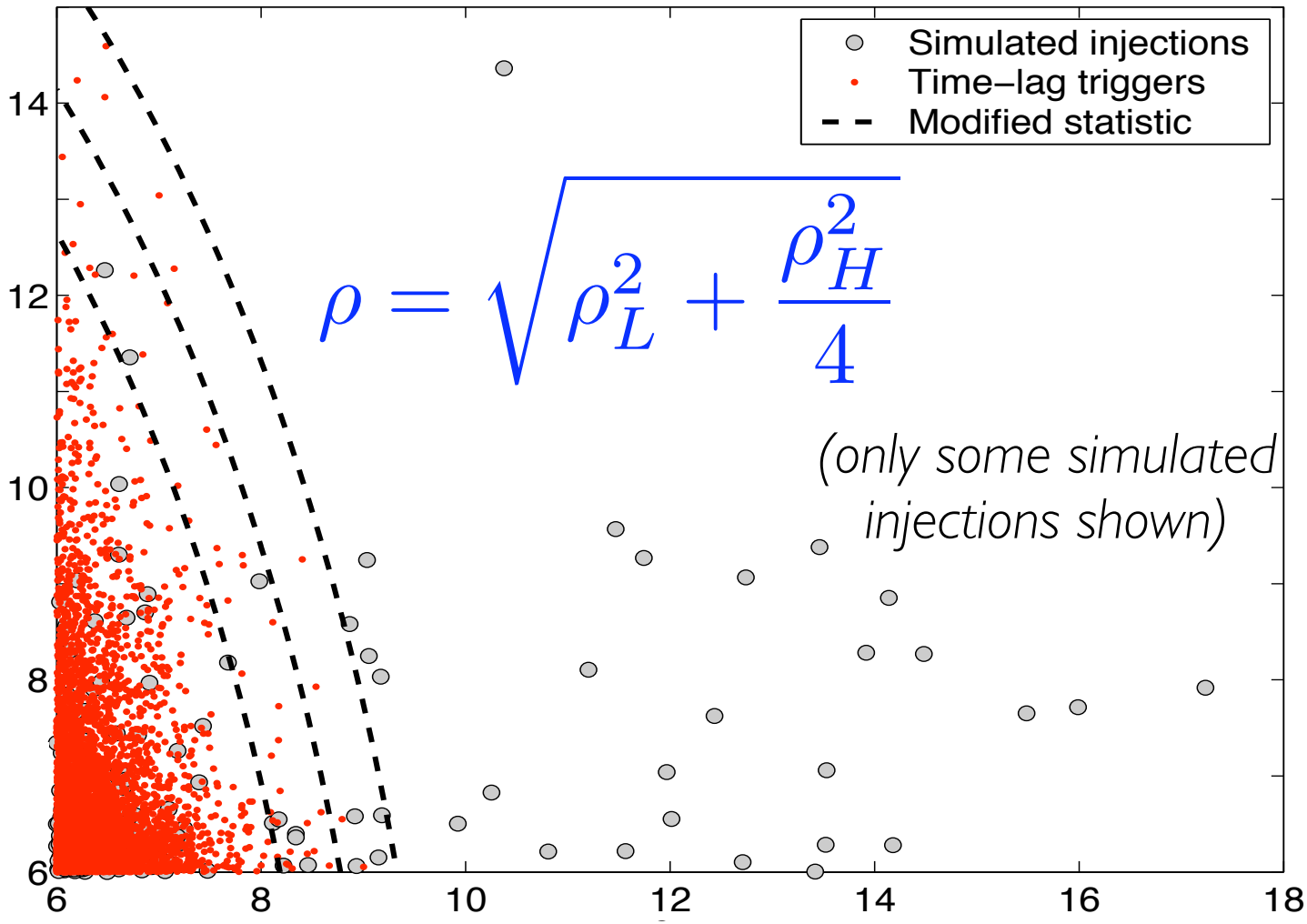
(Simplified) Pipeline

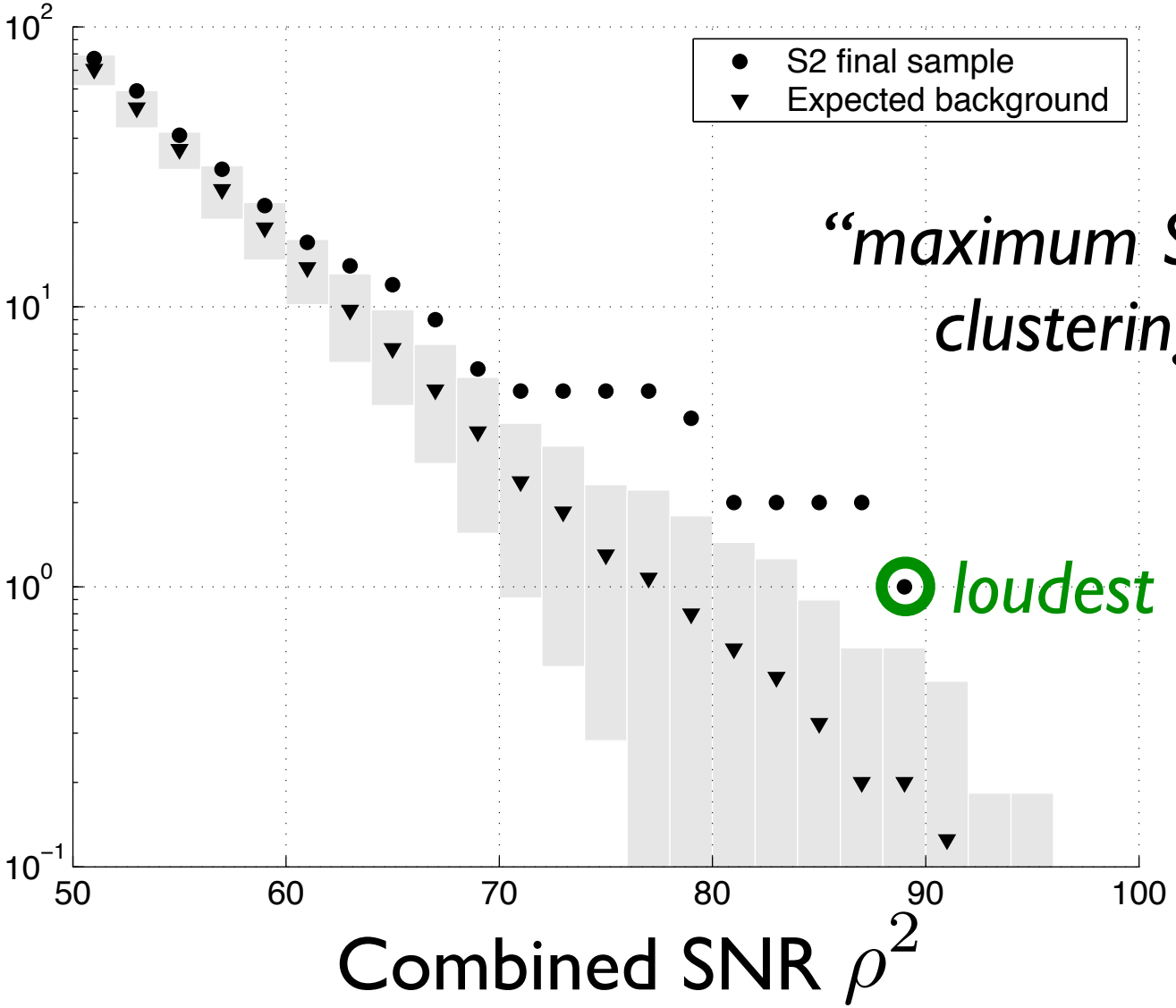


BNS Background Estimate



BNS Results: Number of Triggers

Cumulative Number / Expected Background

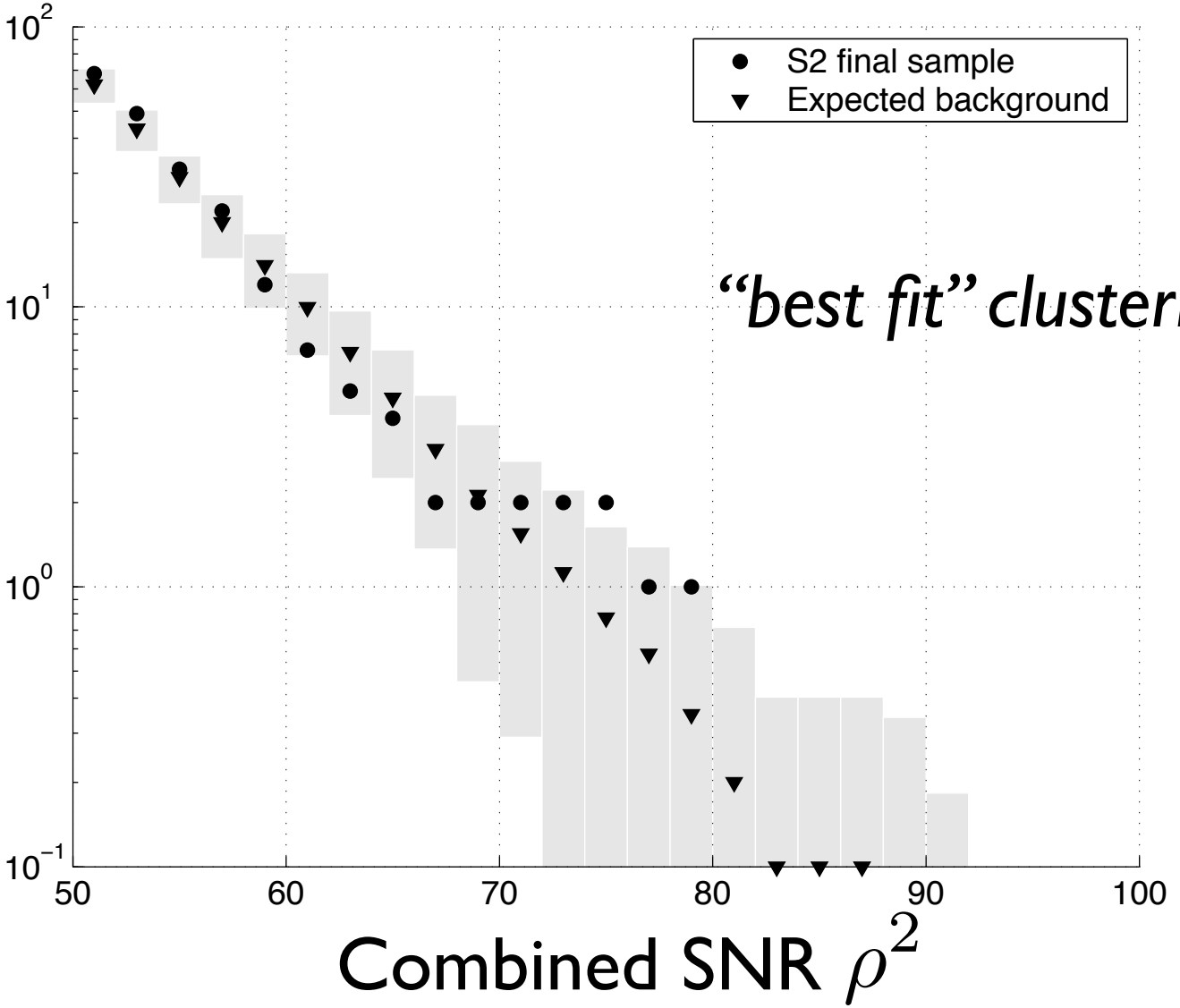


"maximum SNR" clustering

loudest event

BNS Results: Number of Triggers

Cumulative Number / Expected Background



"best fit" clustering

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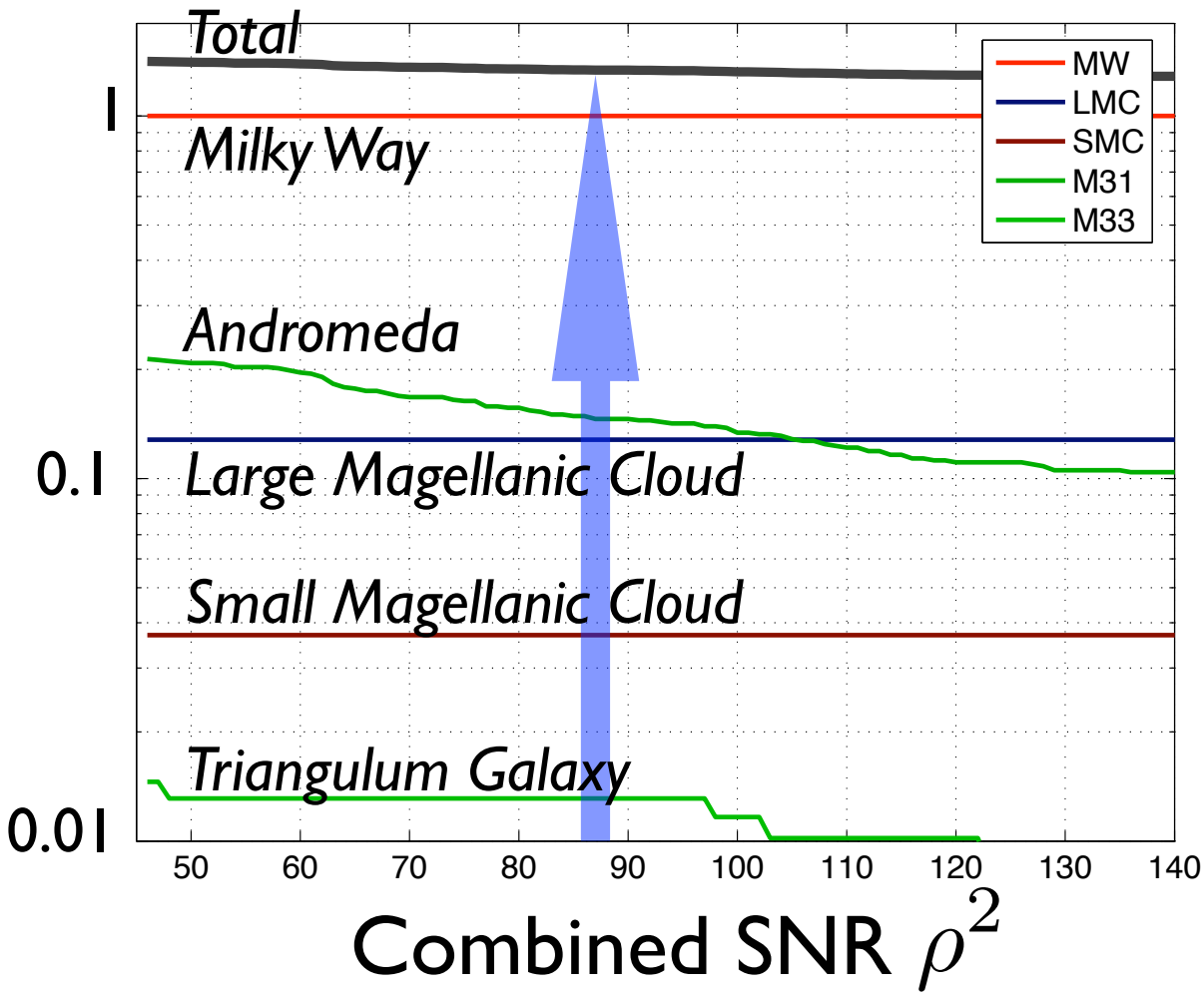
BNS Results: Rate Limit

$$\mathcal{R}_{90\%} = \frac{2.303 + \ln P_b}{T N_G(\rho^*)}$$

Number of "Milky-Way Equivalent" galaxies, N_G



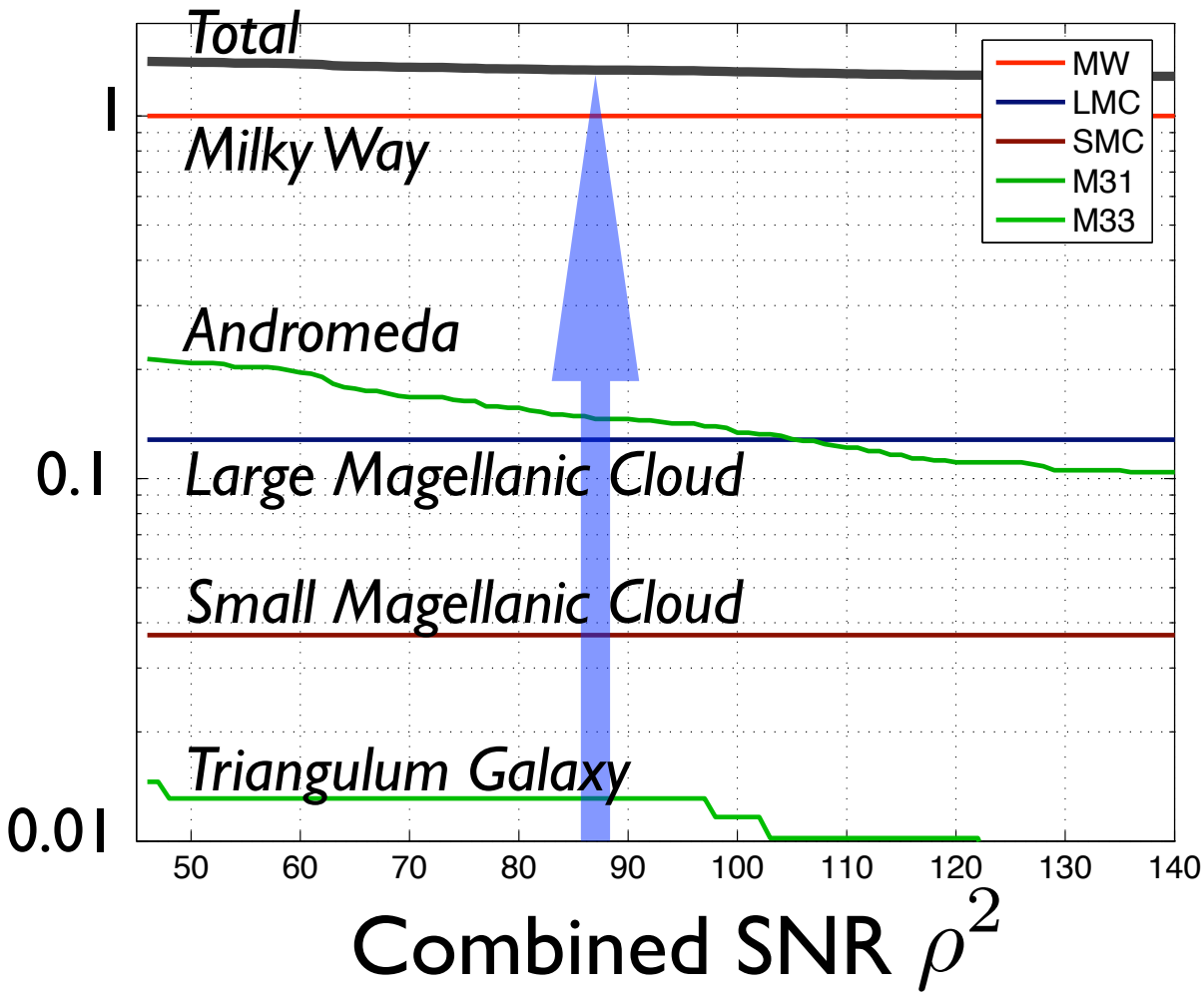
BNS Results: Rate Limit

$$\mathcal{R} < 50\ \mathrm{y}^{-1}\ \mathrm{MWEG}^{-1}$$

Preliminary

(includes systematic errors, e.g. due to finite number of simulated injections)

Number of "Milky-Way Equivalent" galaxies, N_G



Combined SNR ρ^2

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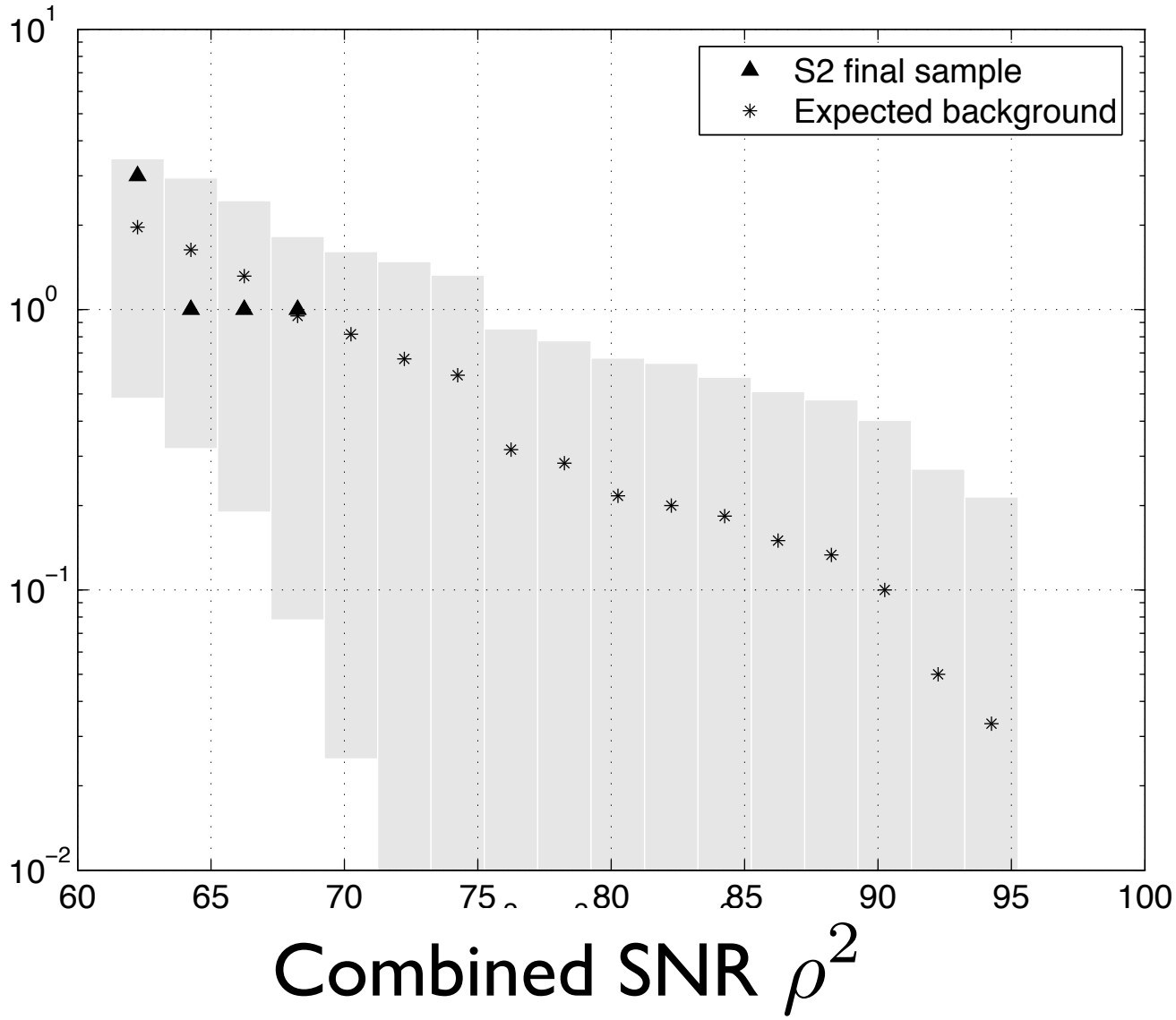
Primordial Binary Black Holes

- Search for inspiral of primordial binary black holes (PBBH) in the mass range 0.2–1.0 $M_{\odot}$
- Number of PBBHs in Galactic Halo is constrained by MACHO microlensing surveys
  - Assume a spherical halo with core radius of 5 kpc and maximum radius of 50 kpc
  - Rate from a 20% MACHO halo could be 0.02 per year if all MACHOs are primordial black holes

PBBH Results: Number of Triggers

Cumulative Number / Expected Background



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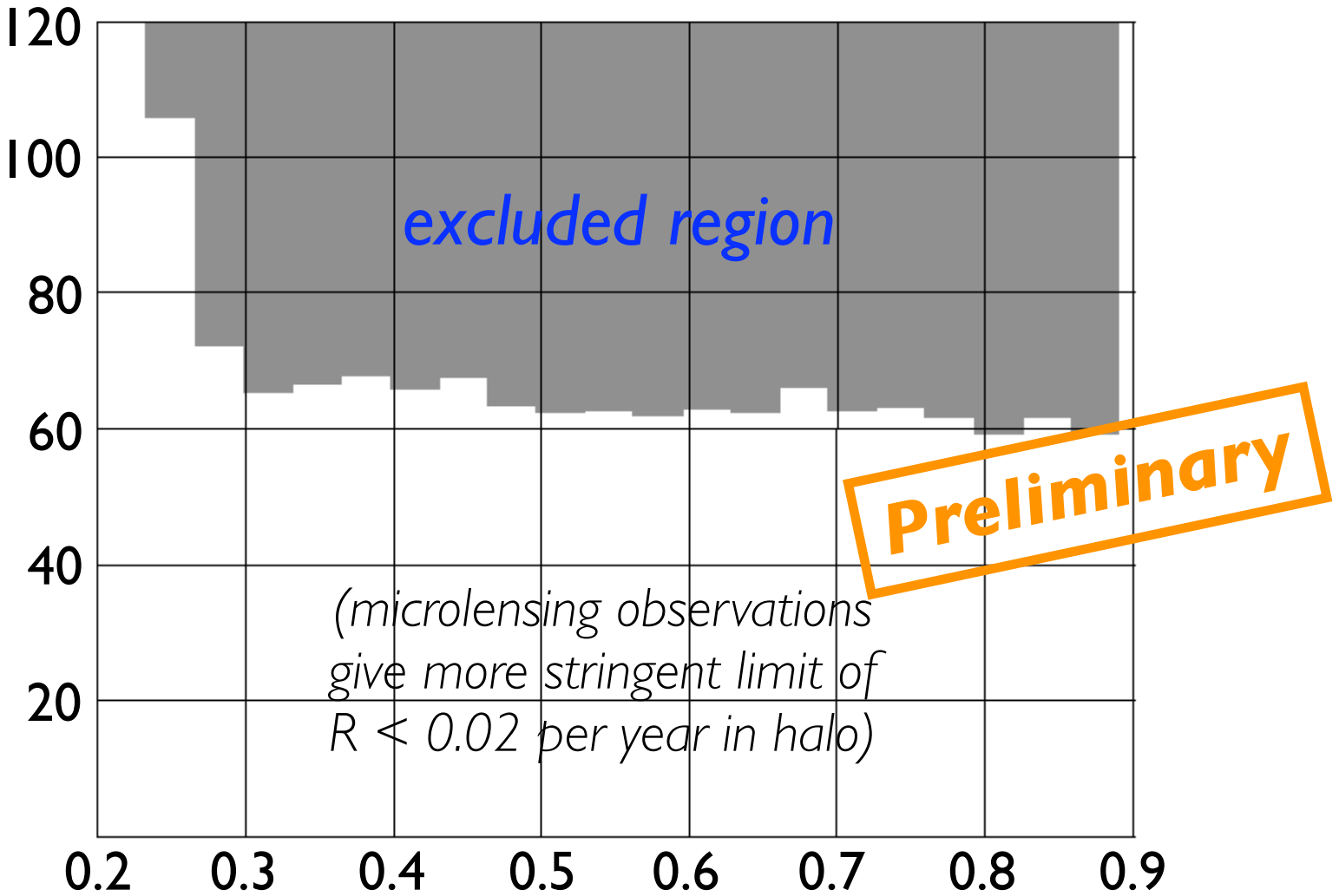
PBBH Results: Upper Limit



$$\left(\frac{\mathcal{M}}{M_\odot}\right)^{5/6} = \left(\frac{\mu}{M_\odot}\right)^{1/2} \left(\frac{M}{M_\odot}\right)^{1/3}$$

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Summary

- Low Mass Binary Inspiral Searches
  - Binary Neutron Star signals (BNS)
  - Primordial Sub-Solar Mass Binary Black Holes (PBBH)
- S2 Run (Early 2003)
  - Inter-site coincidence requirement
  - 339 hours of data used
  - Sensitive to part of the Local Group of galaxies (BNS) and nearly the entire Milky Way Halo (PBBH)
- Results
  - No evidence of a gravitational wave detection: loudest events occurred during times of instrumental instability
  - BNS upper limit: R < 50 per year per MWEG
  - PBBH upper limit: R < ~65 per year per Milky Way Halo for component masses of 0.6 solar masses

Preliminary