Results and status of searches for binary coalescences in LIGO data

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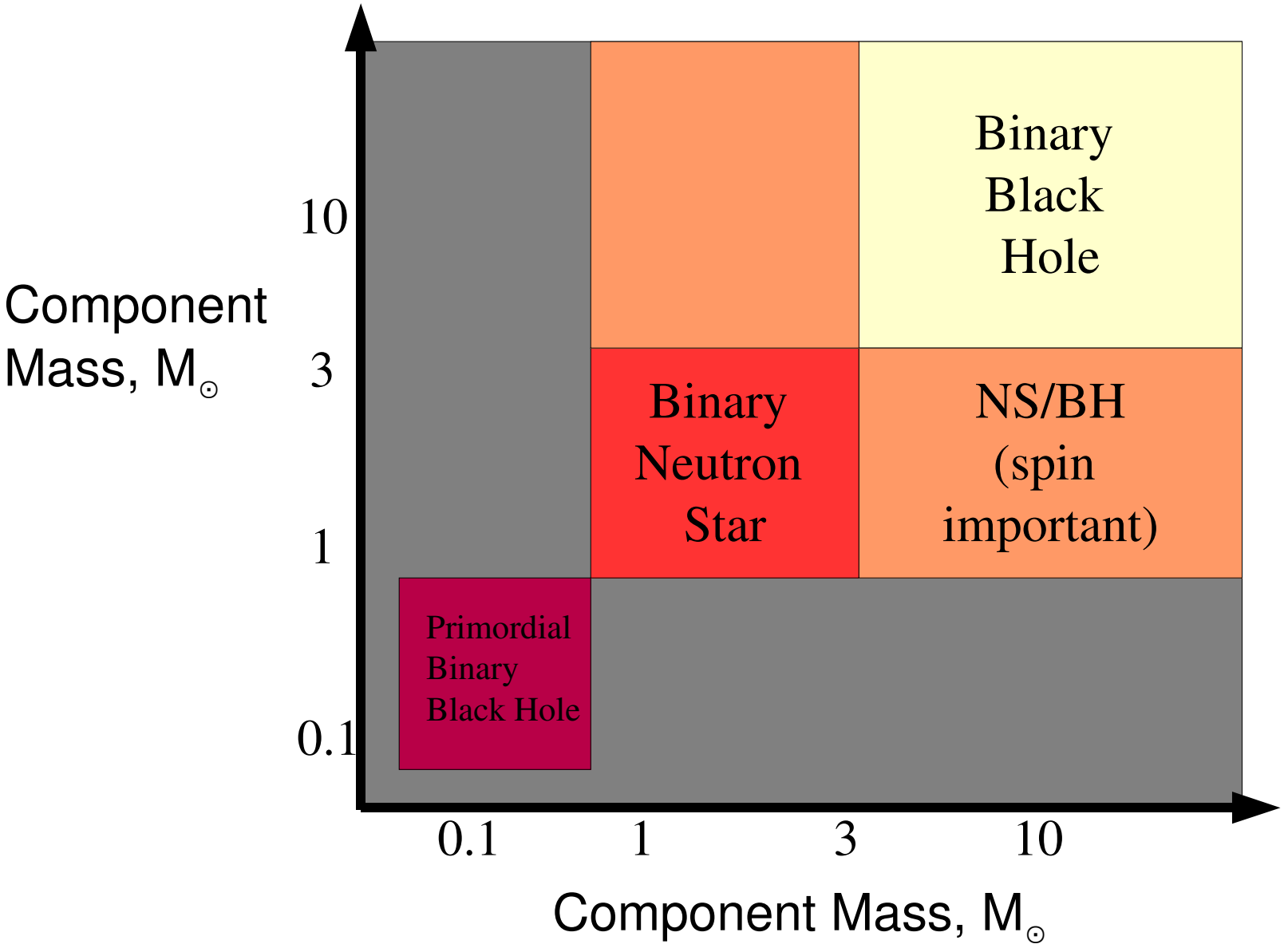
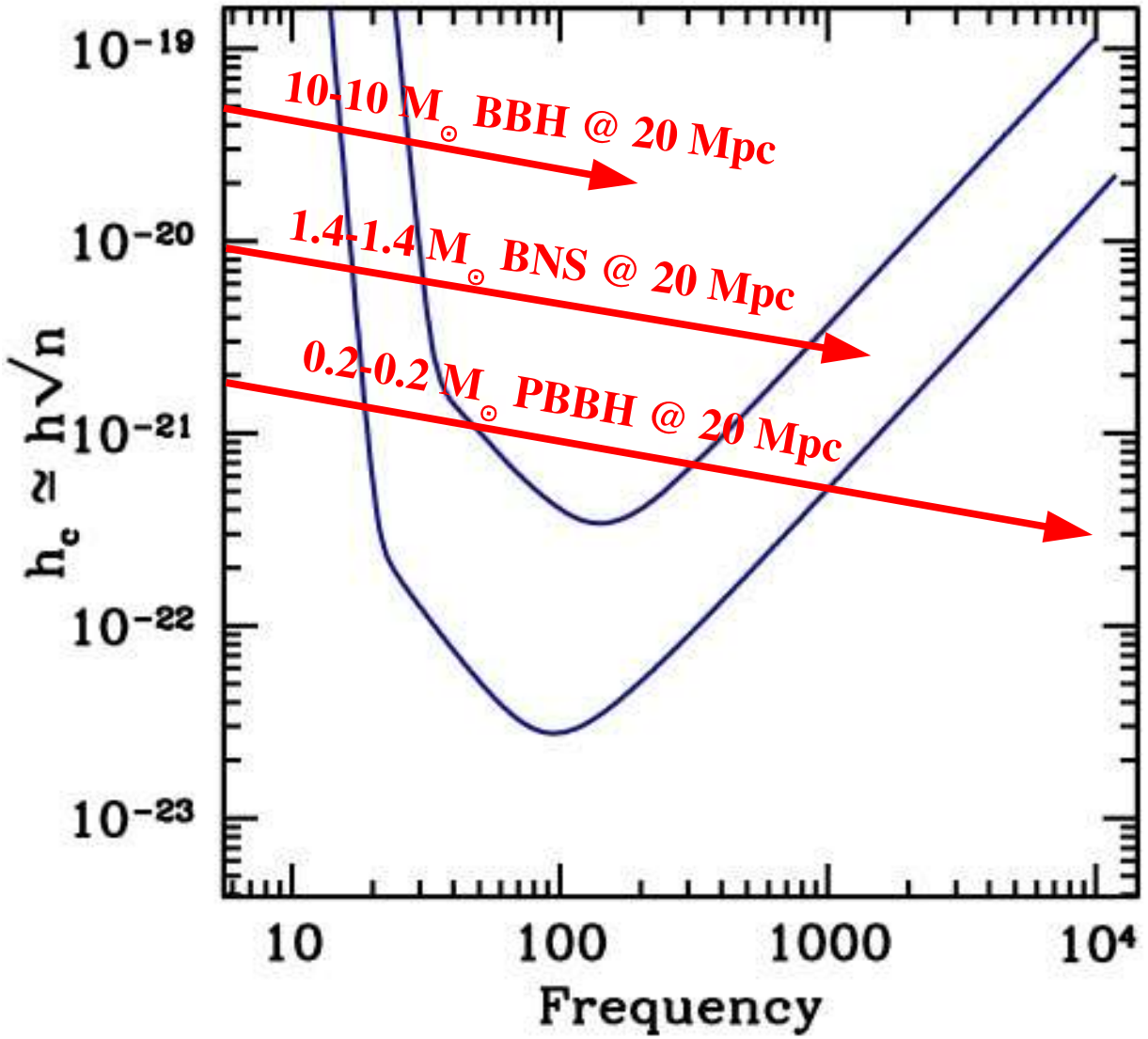
for the LIGO Scientific Collaboration

LIGO-G050056-00-Z

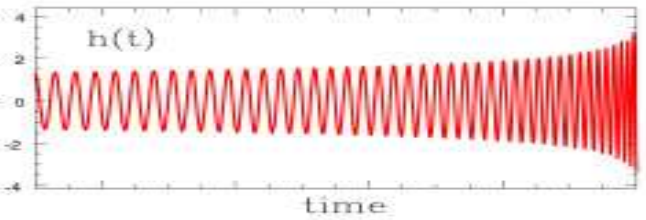
Target Sources



Target Sources



Chirp Waveform

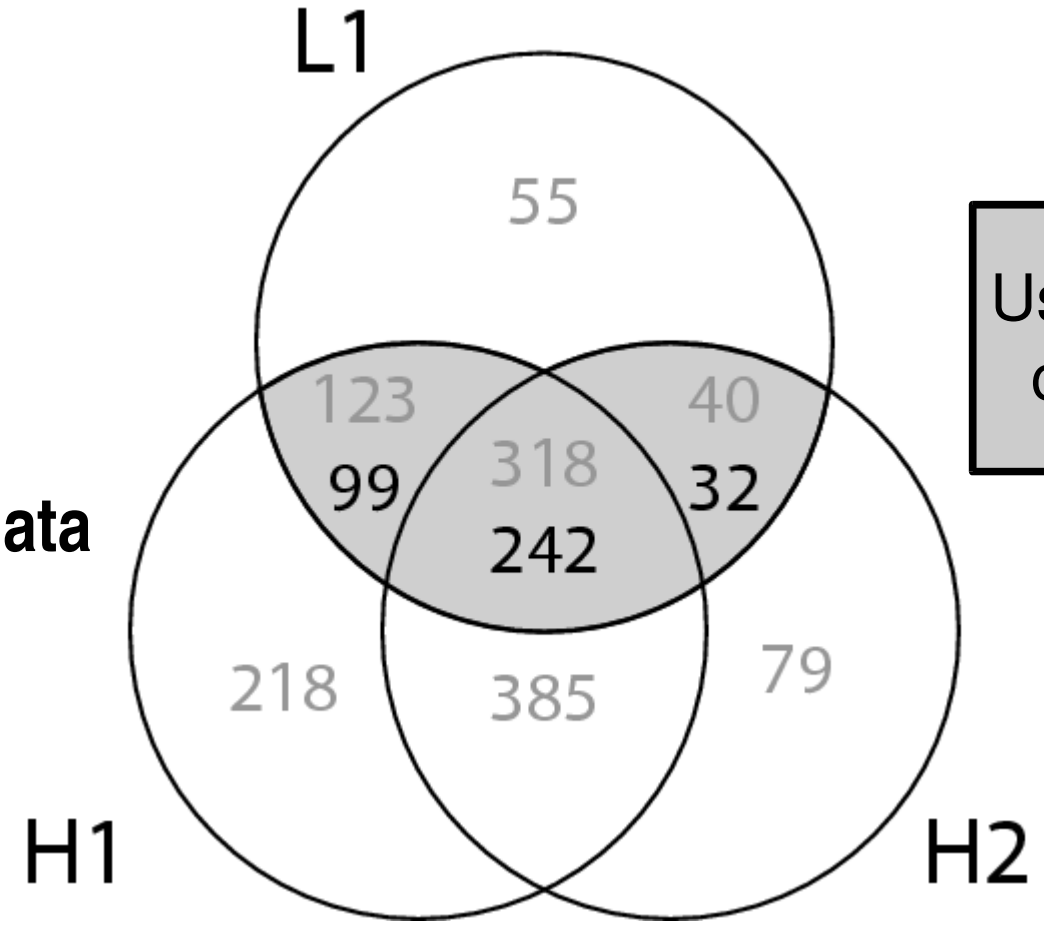


S2 Analysis Times

14 Feb – 14 April 2003

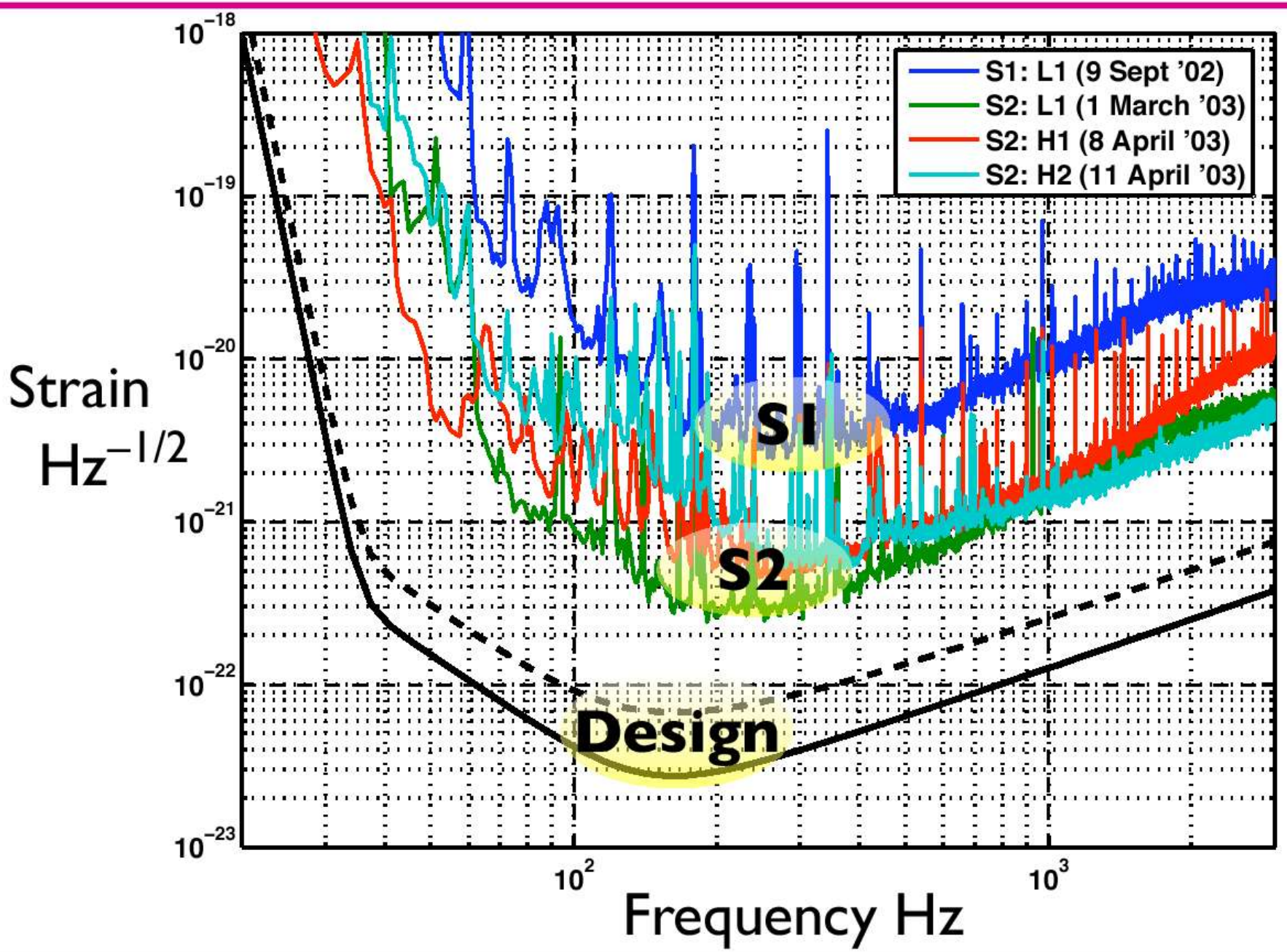
373 hours of
data analyzed

339 hours
non-playground data



Use only inter-site coincident data

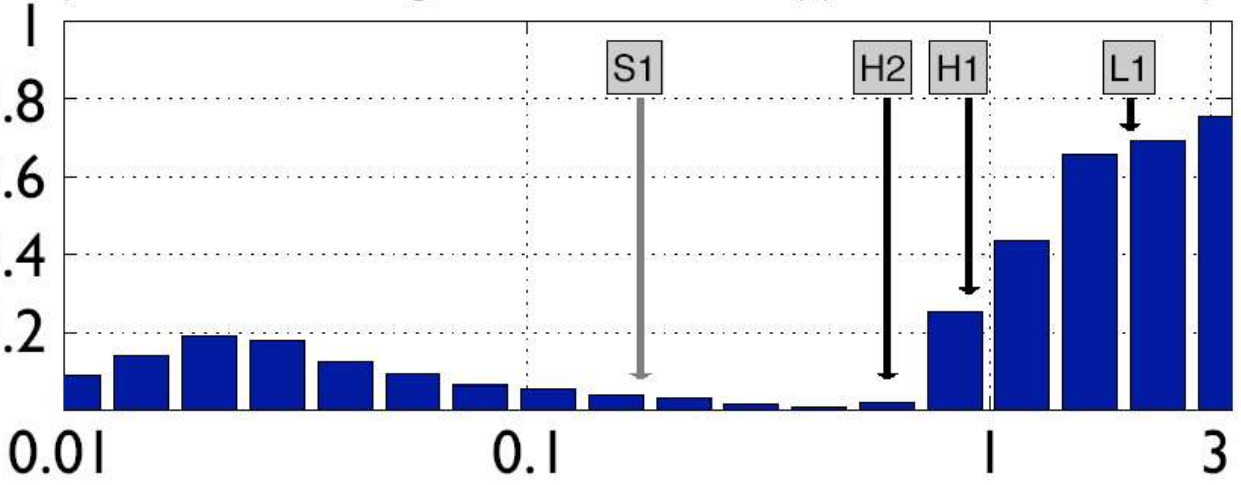
S2 Sensitivity: Strain

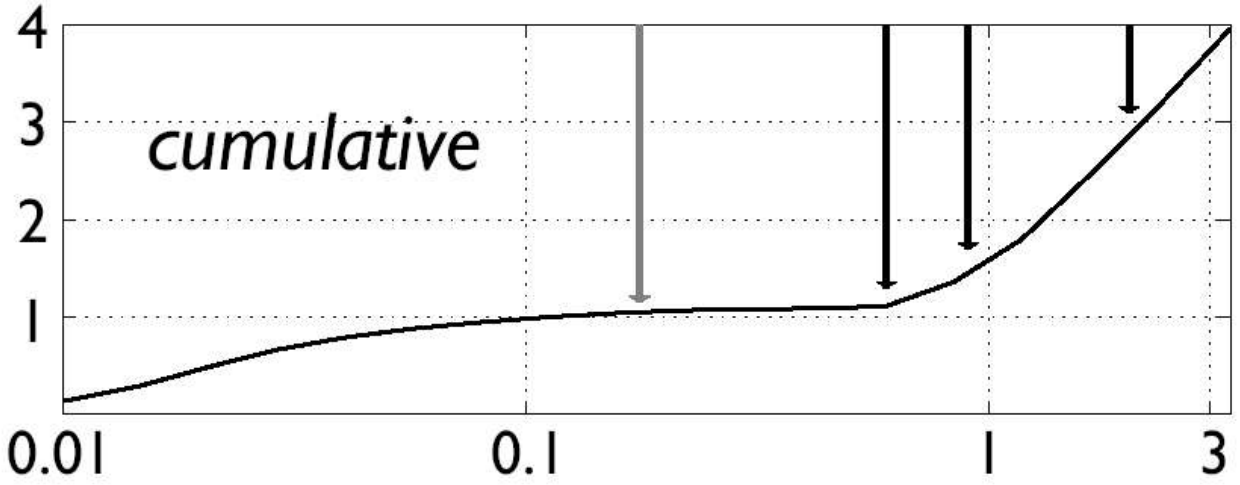


S2 Reach: Number of Galaxies

(theoretical ranges based on a typical noise curve)

Number of "Milky-Way Equivalent" galaxies, N_G



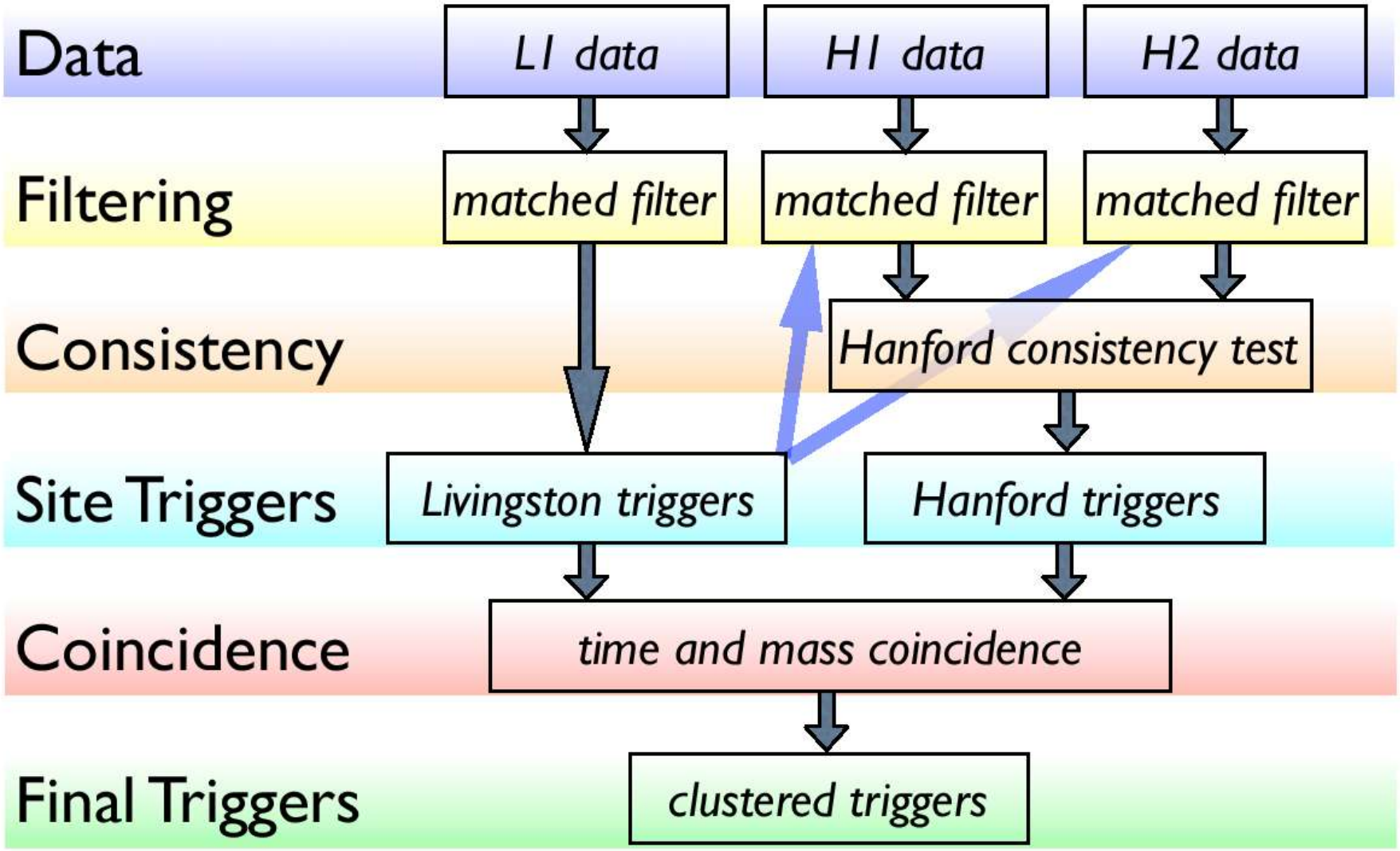


Effective Distance (Mpc)

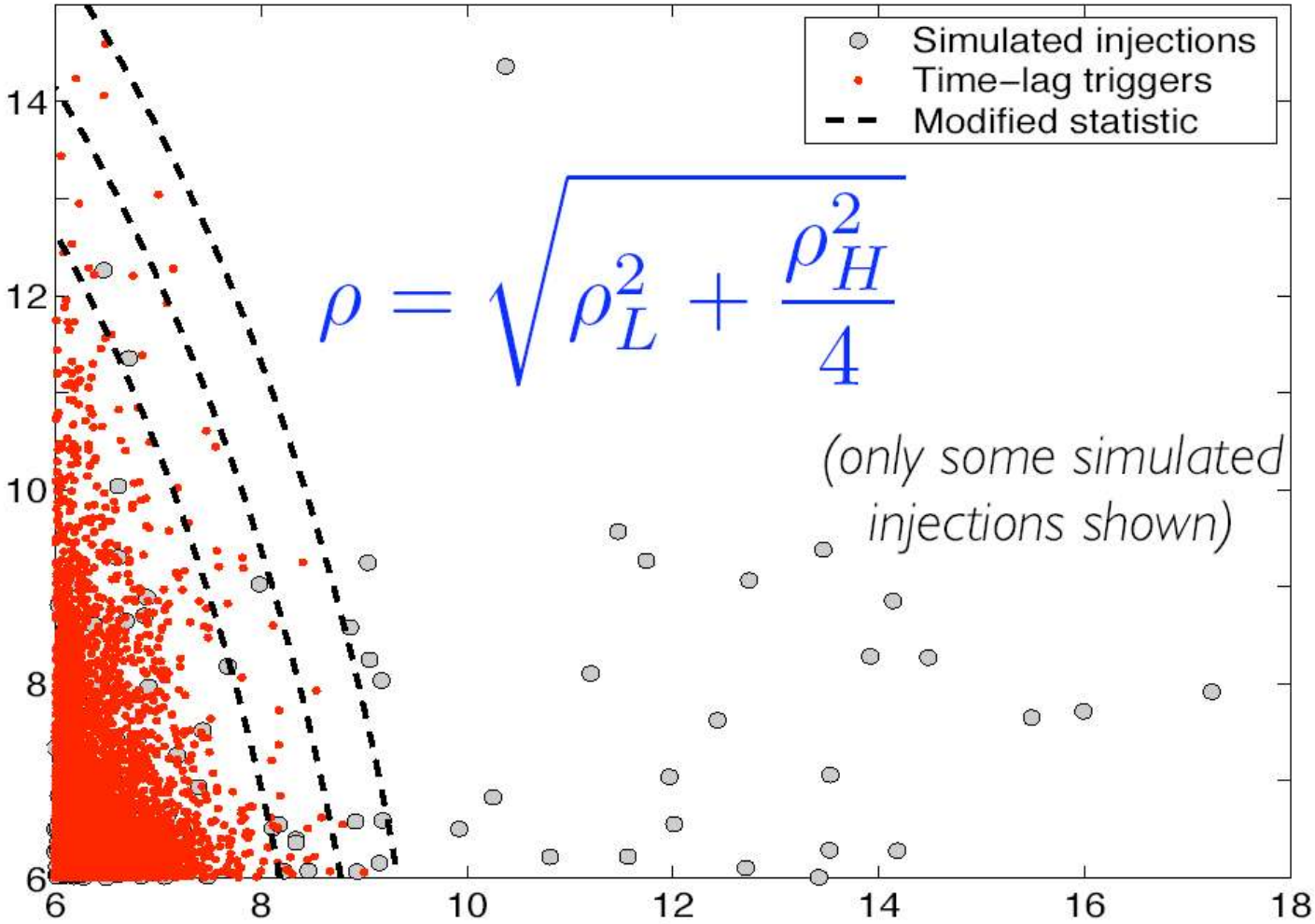
LIGO

(Simplified) Pipeline

LSC

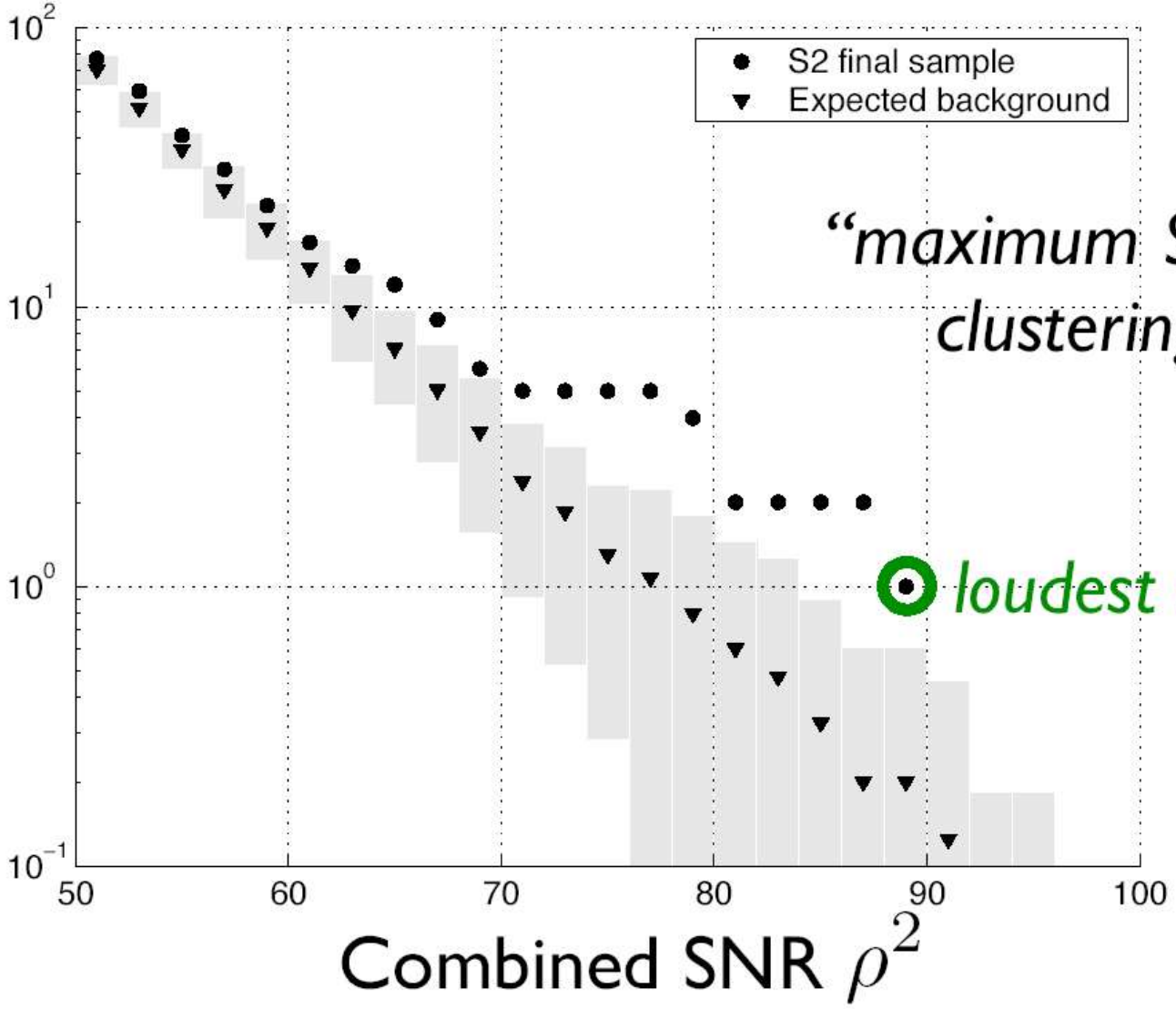


BNS Background Estimate



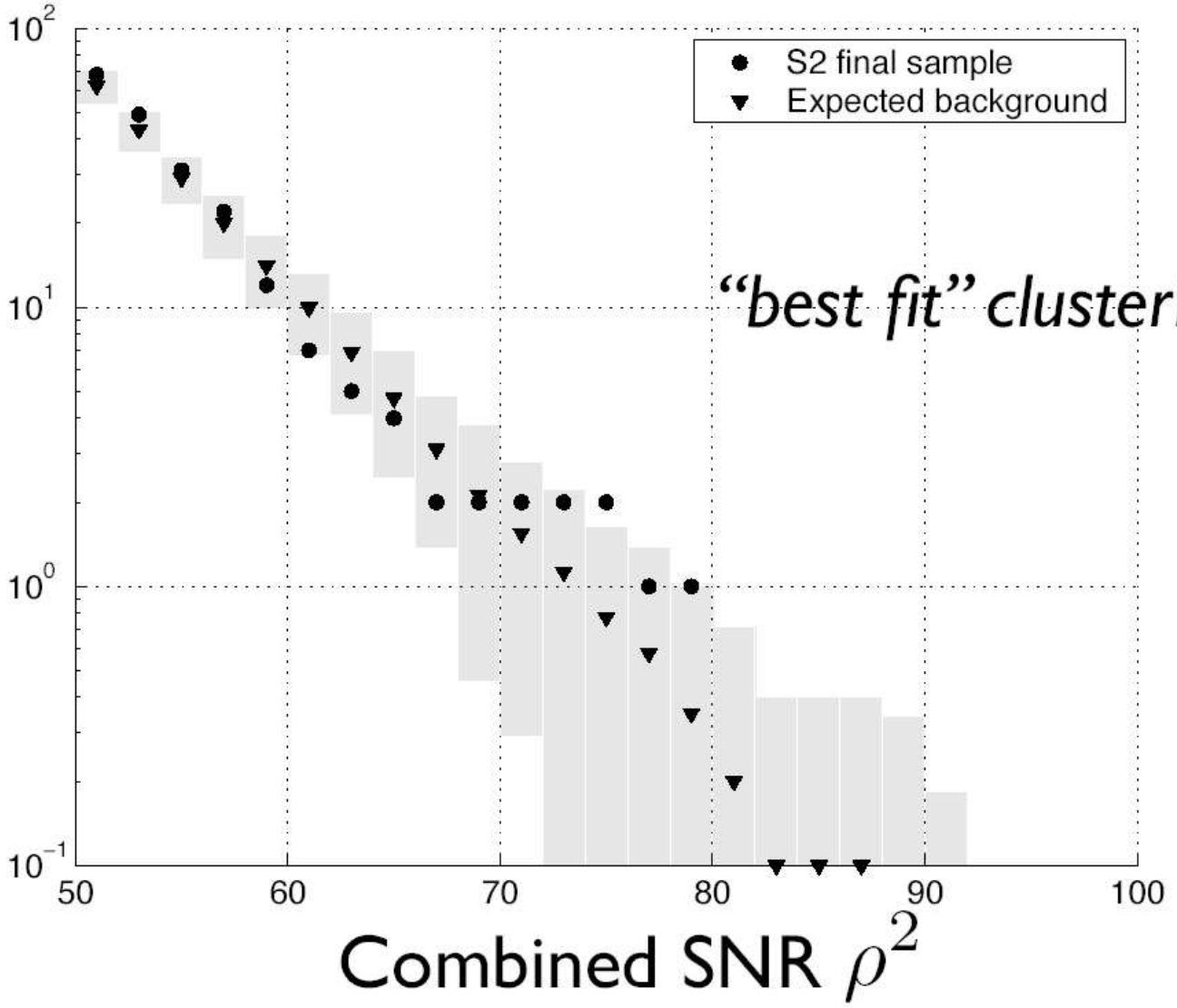
BNS Results: Number of Triggers

Cumulative Number / Expected Background



BNS Results: Number of Triggers

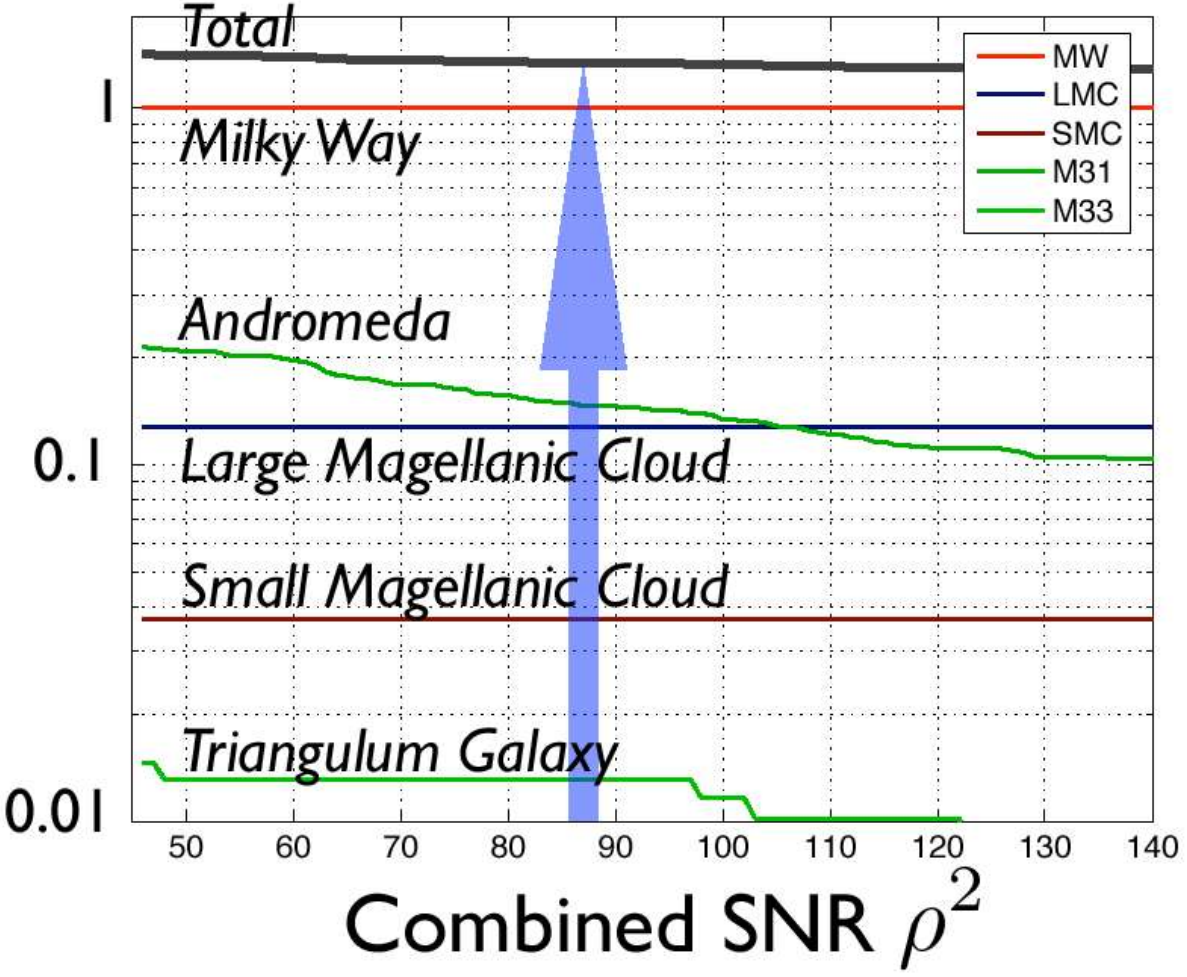
Cumulative Number / Expected Background



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



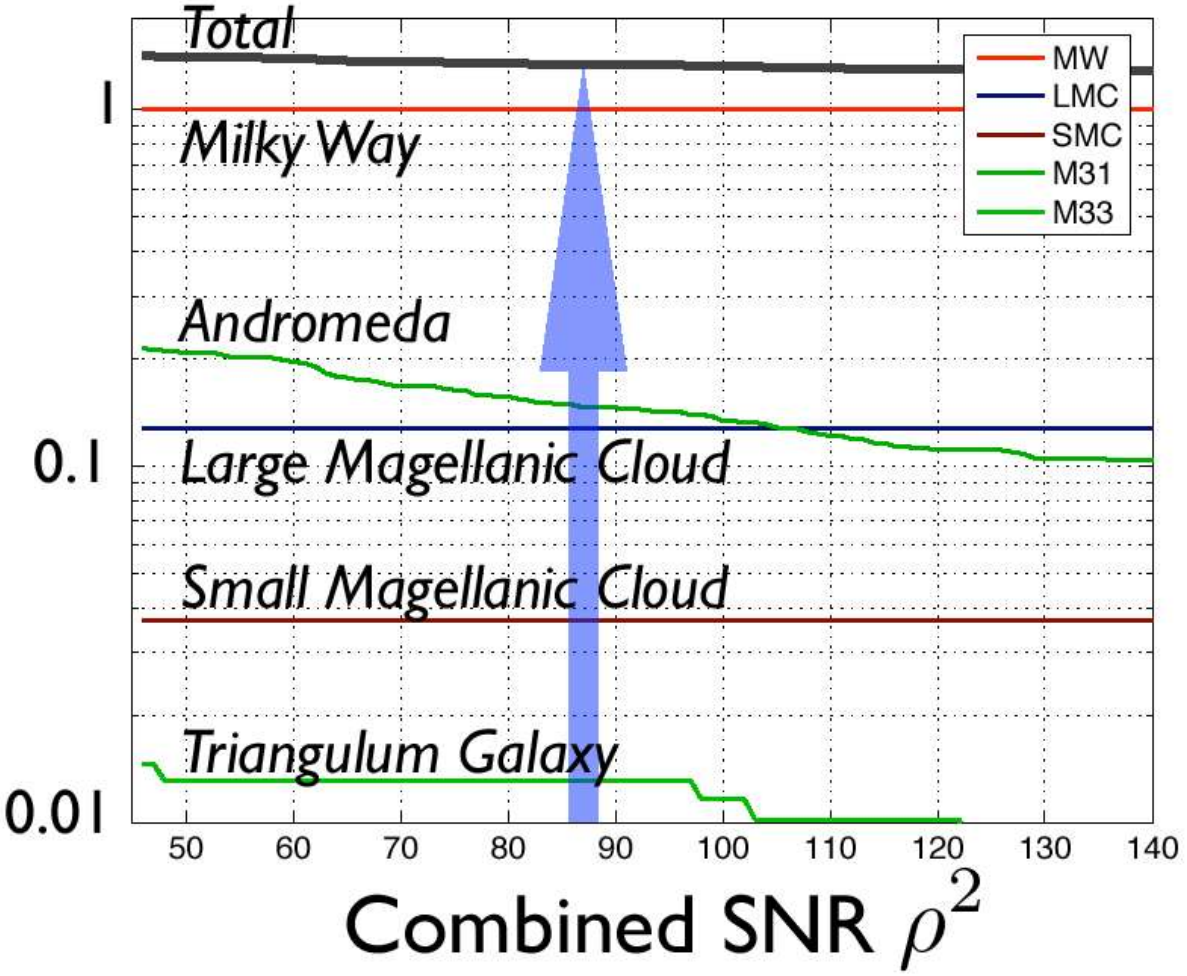
BNS Results: Rate Limit

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

Preliminary

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

Number of "Milky-Way Equivalent" galaxies, N_G

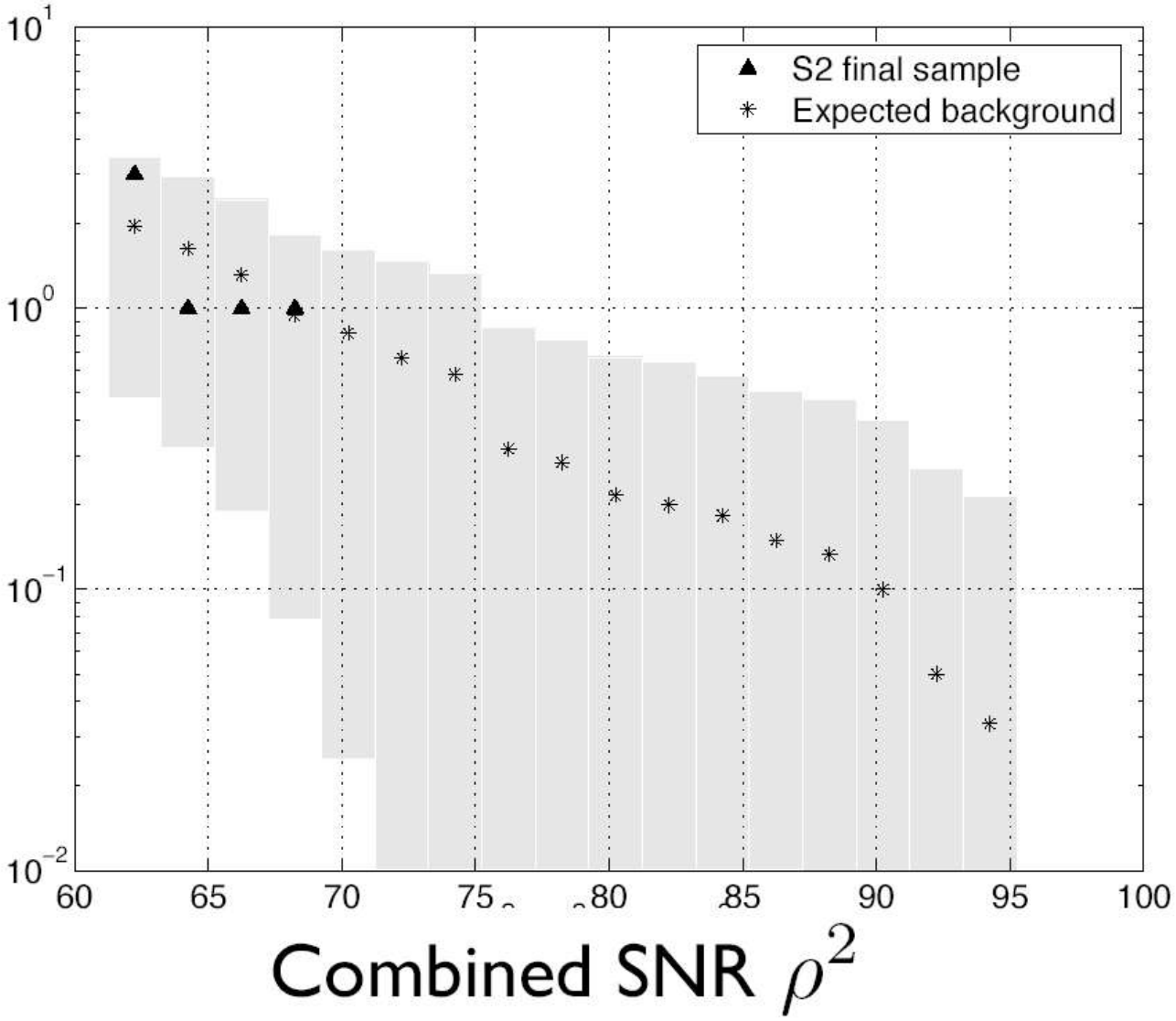


Primordial Binary Black Holes

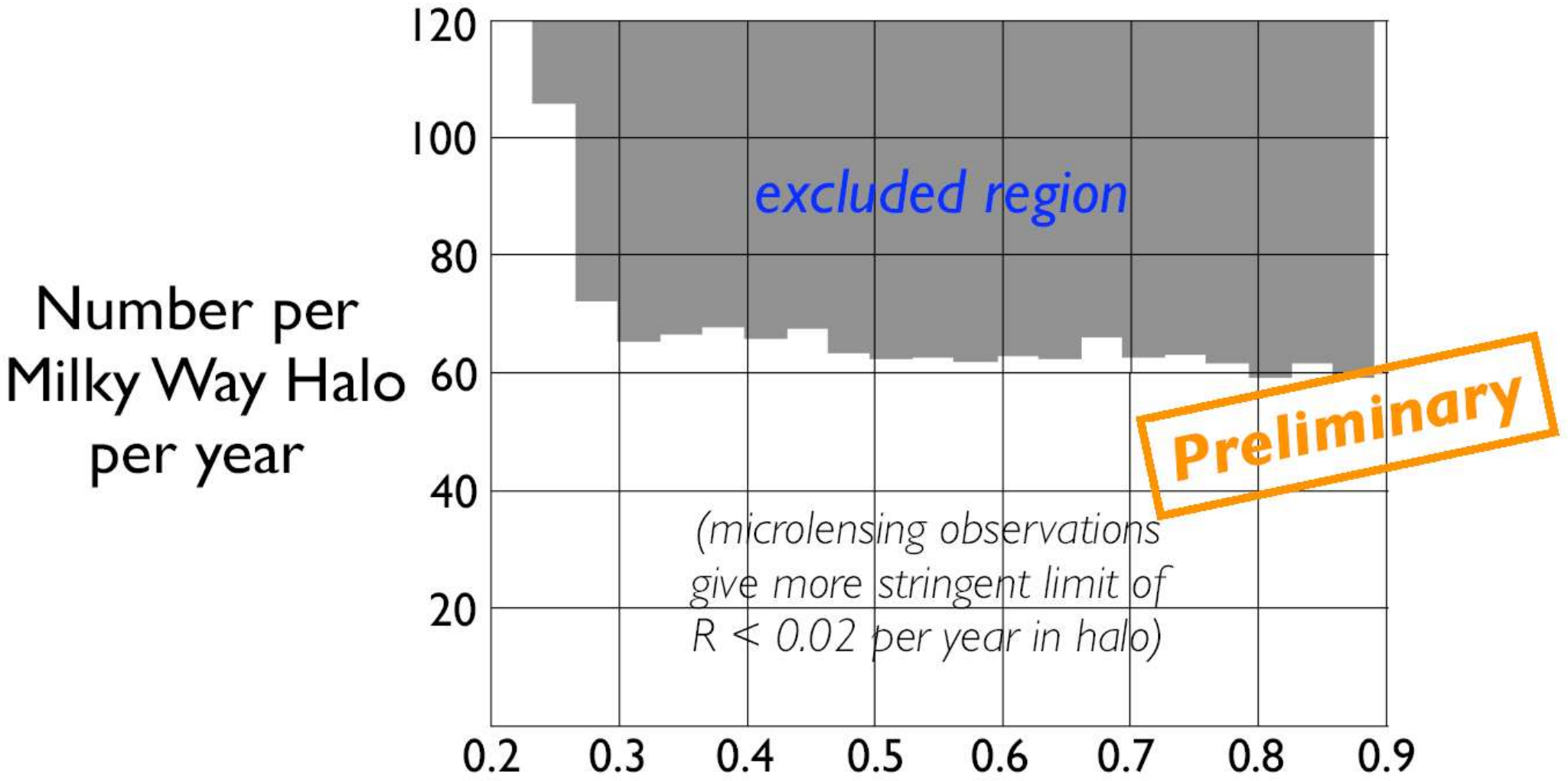
- Search for inspiral of primordial binary black holes (PBBH) in the mass range 0.2 – 1.0 $M_{\odot}$
- Number of PBBH in galactic halo is constrained by MACHO microlensing surveys
  - Assume a spherical halo with core radius of 5 kpc and maximum radius of 50 kpc
  - Rate from a 20% MACHO halo could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

PBBH Results: Number of Triggers

Cumulative Number / Expected Background



PBBH Results: Upper Limit

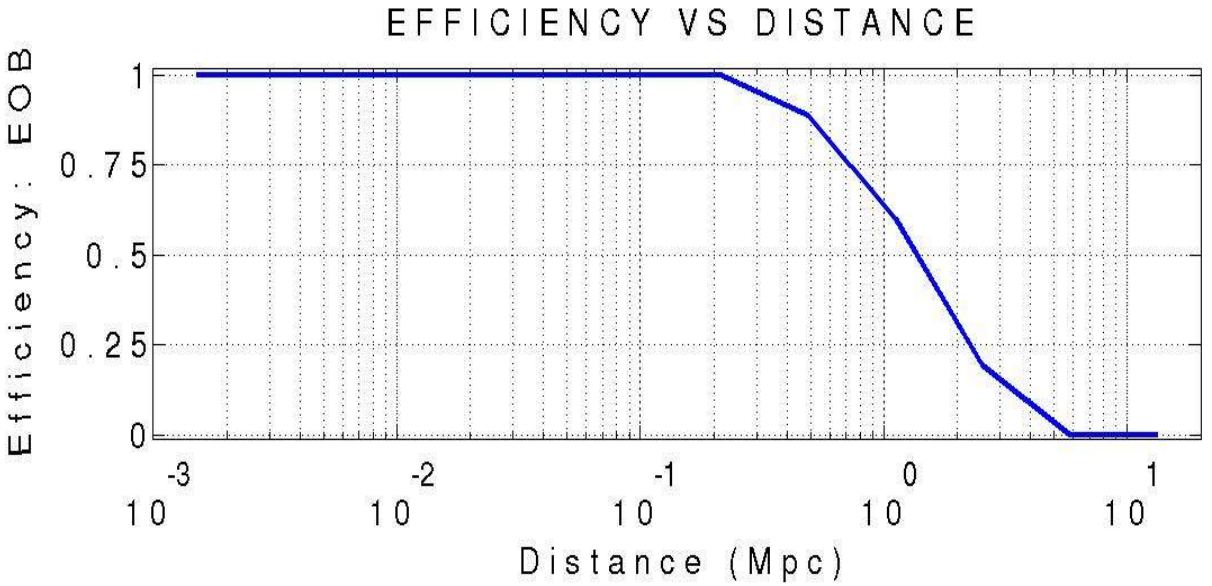


$$\left(\frac{\mathcal{M}}{M_\odot}\right)^{5/6} = \left(\frac{\mu}{M_\odot}\right)^{1/2} \left(\frac{M}{M_\odot}\right)^{1/3}$$

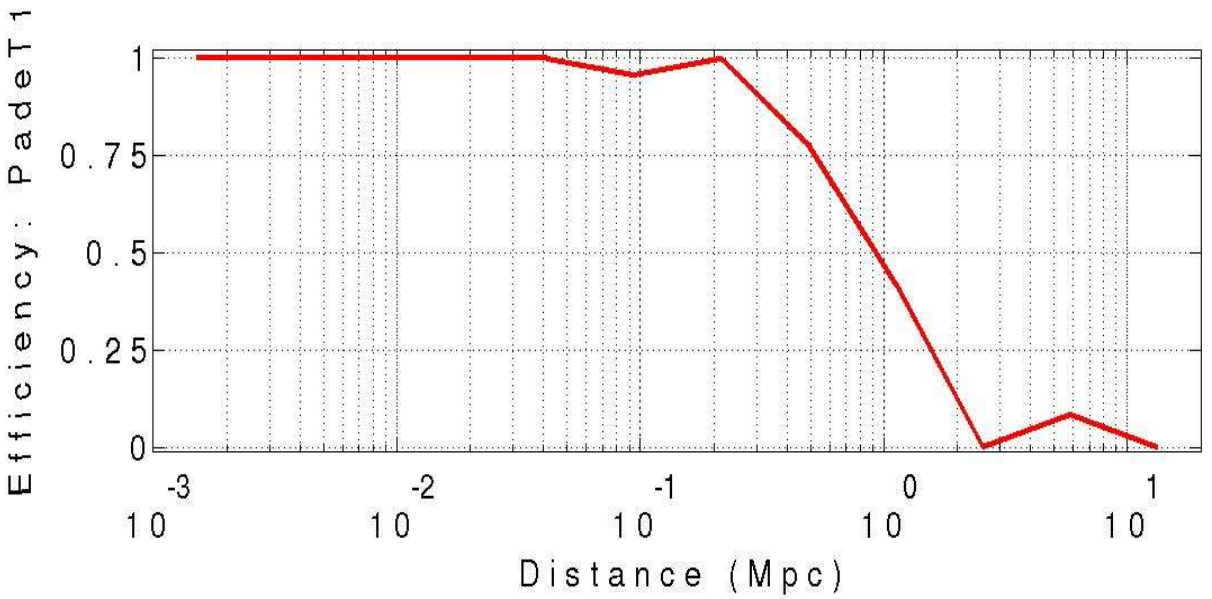
Binary Black Holes

- Search for inspiral of binary black holes (BBH)
  - mass range 3 – 20 $M_\odot$ for each component
  - few cycles in LIGO band for S2 (~10 for 10 – 10 $M_\odot$)
- Use detection template family
  - Many “physical” waveforms available
    - poor agreement near coalescence
  - BCV templates
    - Buonanno, Chen, Vallisneri, PRD 67, 2003
    - Good match with all physical waveforms

Preliminary Injection Results



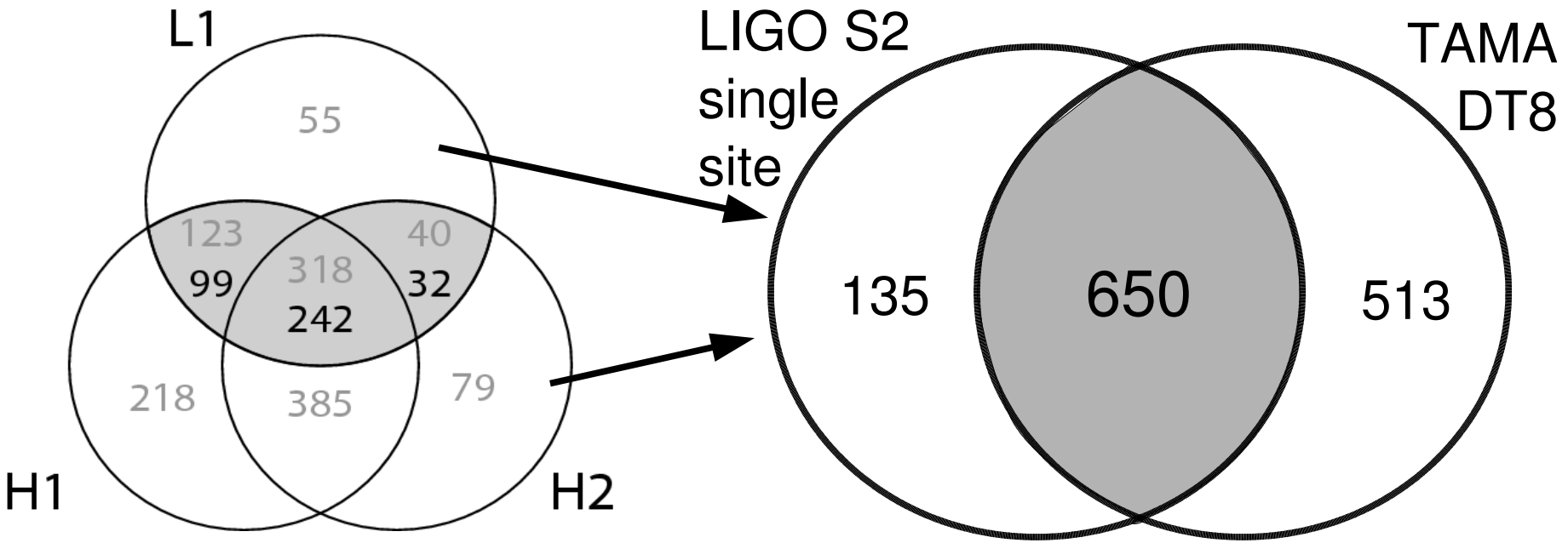
Inject two families of waveforms, recover using BCV templates



Sensitive to injections at distances up to few Mpc

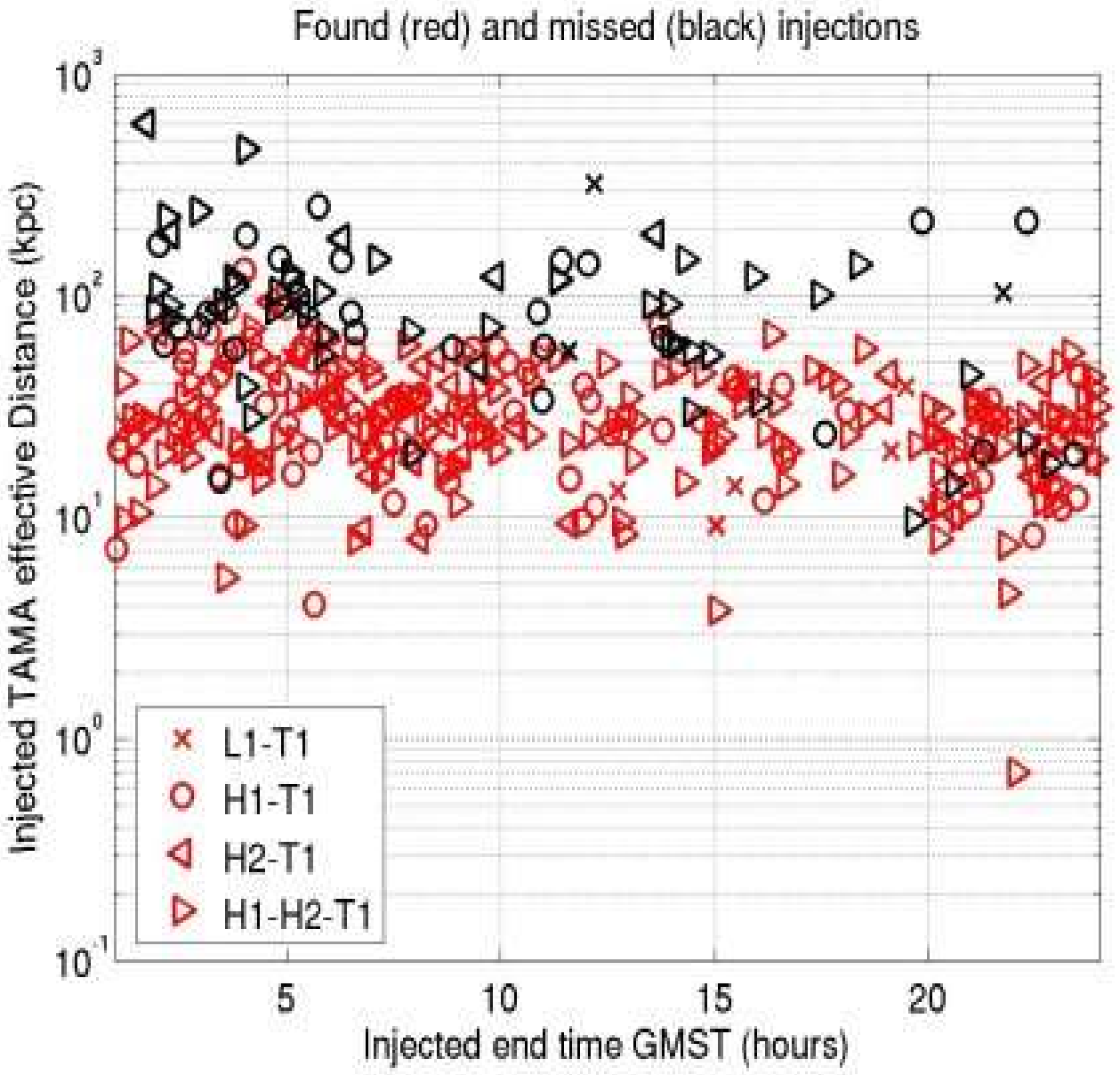
LIGO – TAMA Analysis

Search own data and exchange triggers



Preliminary search
on 64 hours of
playground data

Preliminary Injection Results



Majority of "missed" injections too distant to be visible in TAMA

Preliminary studies indicate sensitivity to **0.78 MWEG**

Summary

- Binary Inspiral Searches
  - Binary Neutron Star (BNS), 1 – 3 $M_\odot$
  - Primordial Binary Black Hole (PBBH), 0.2 – 1 $M_\odot$
  - Binary Black Hole (BBH), 3 – 20 $M_\odot$
- Results from S2 analysis
  - No evidence of 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 MW halo for 0.6 $M_\odot$ components
  - BBH and LIGO-TAMA BNS searches well underway

Preliminary