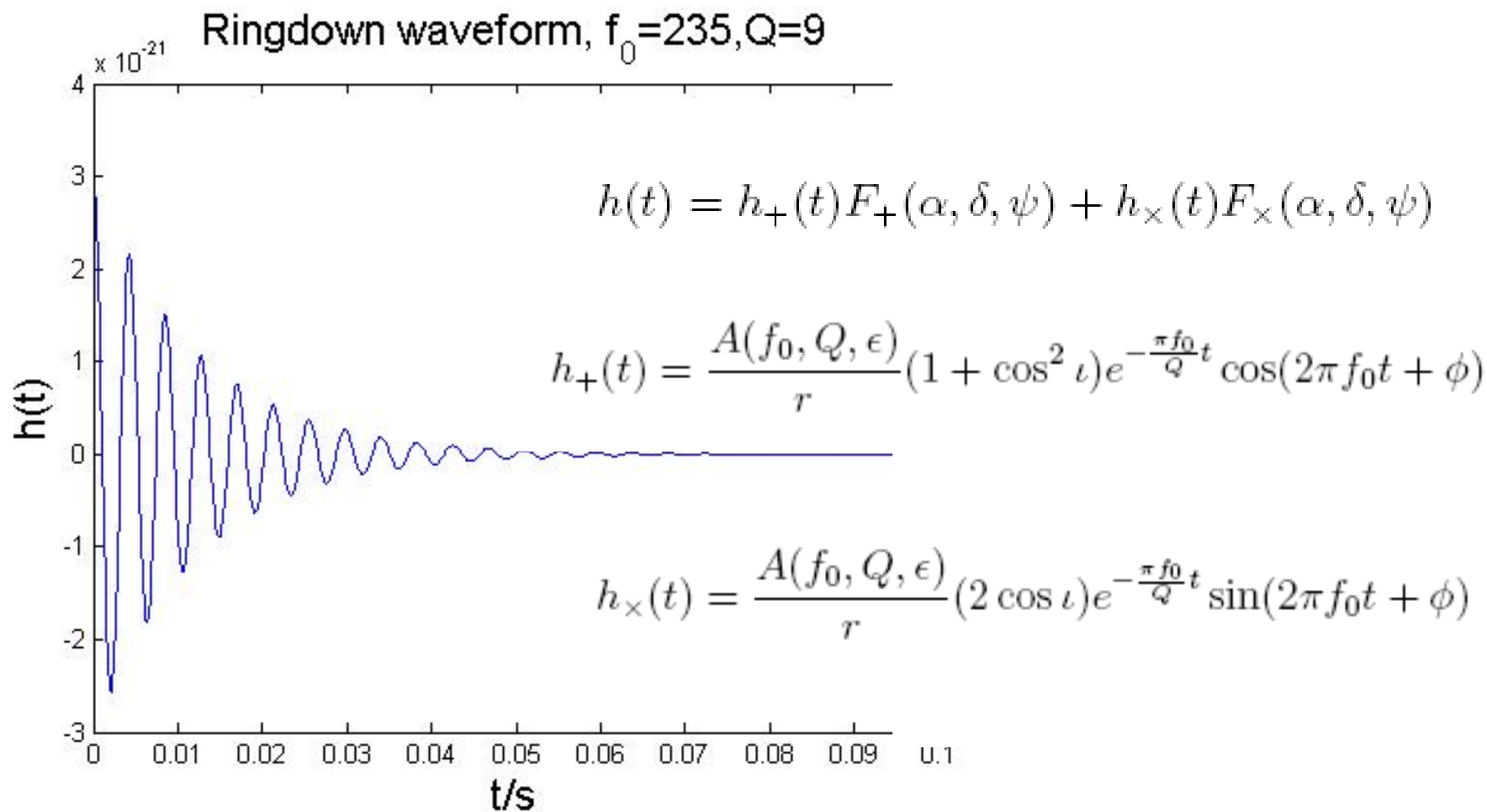


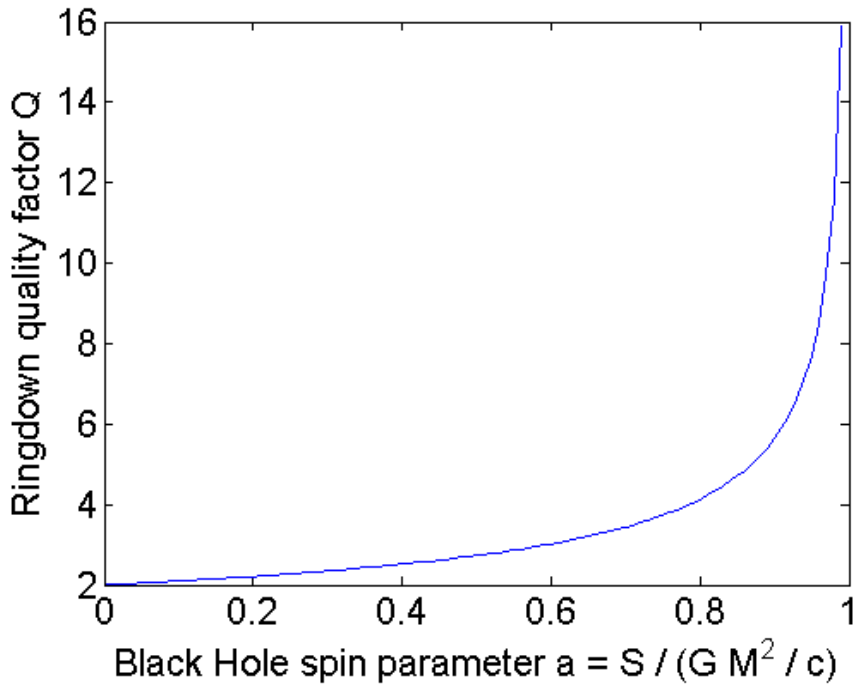
Status of the S4 Ringdown search

Lisa Goggin, Caltech
with Duncan Brown & Alan Weinstein

Aug LSC meeting
LSU, 14 August 2006
G060460-00-Z

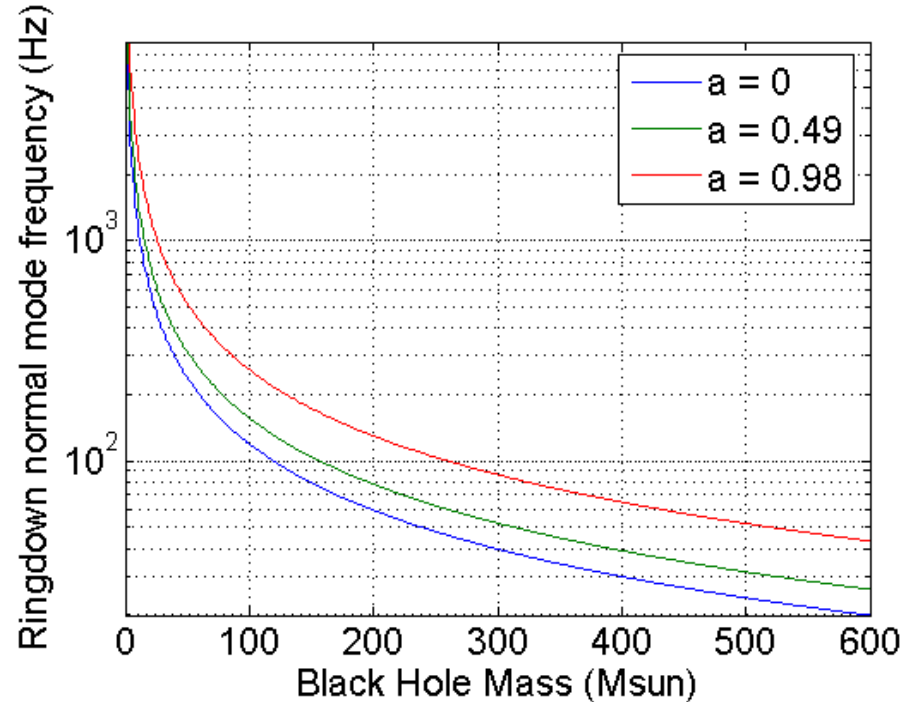


Waveform parameters ↔ Astrophysical quantities



$$Q \approx 2(1 - a)^{-\frac{9}{20}}$$

$$0 \leq a \leq 1$$

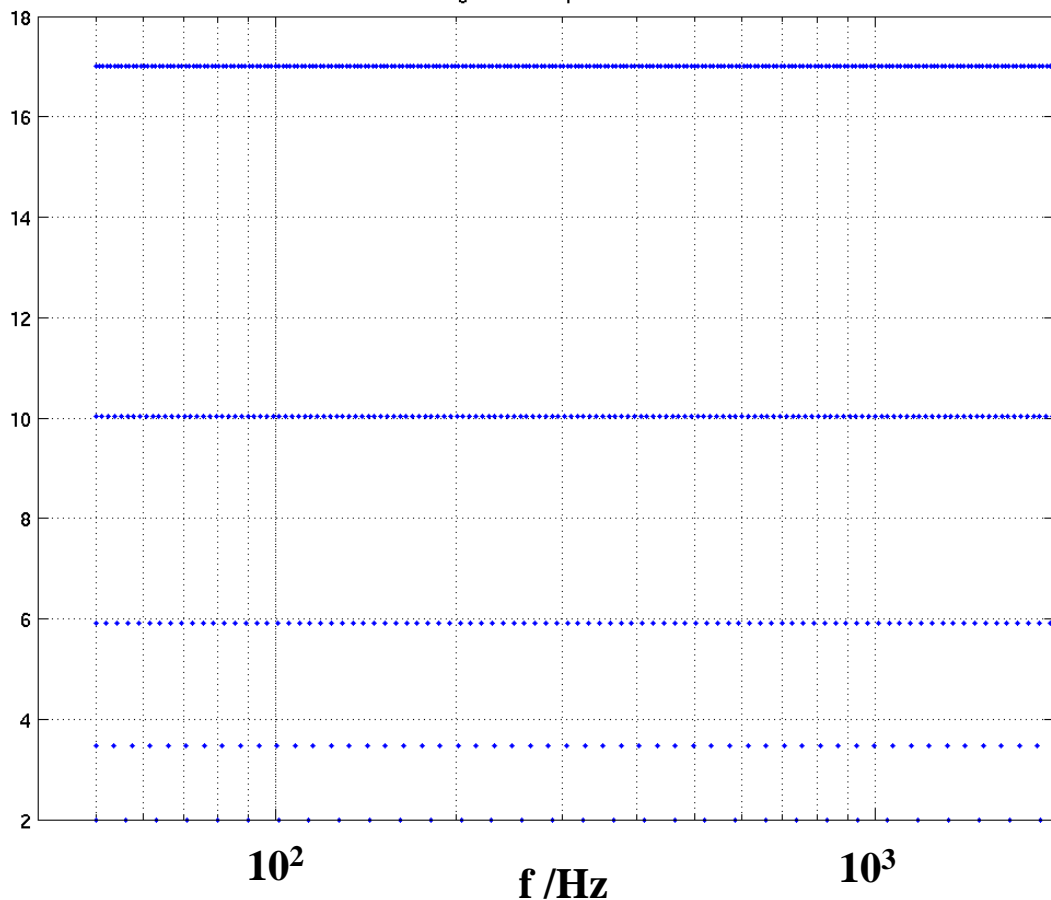


$$f_0 = \frac{c^3}{2\pi GM} \left[1 - 0.63(1 - a)^{\frac{3}{10}} \right]$$

(Echeverria, 1989)

□ Creighton '99

Ringdown Template Bank



$$ds^2 \approx \frac{1}{8} \frac{dQ^2}{Q^2} - \frac{1}{4} \frac{dQ}{Q} \frac{df}{f} + Q^2 \frac{df^2}{f^2}$$

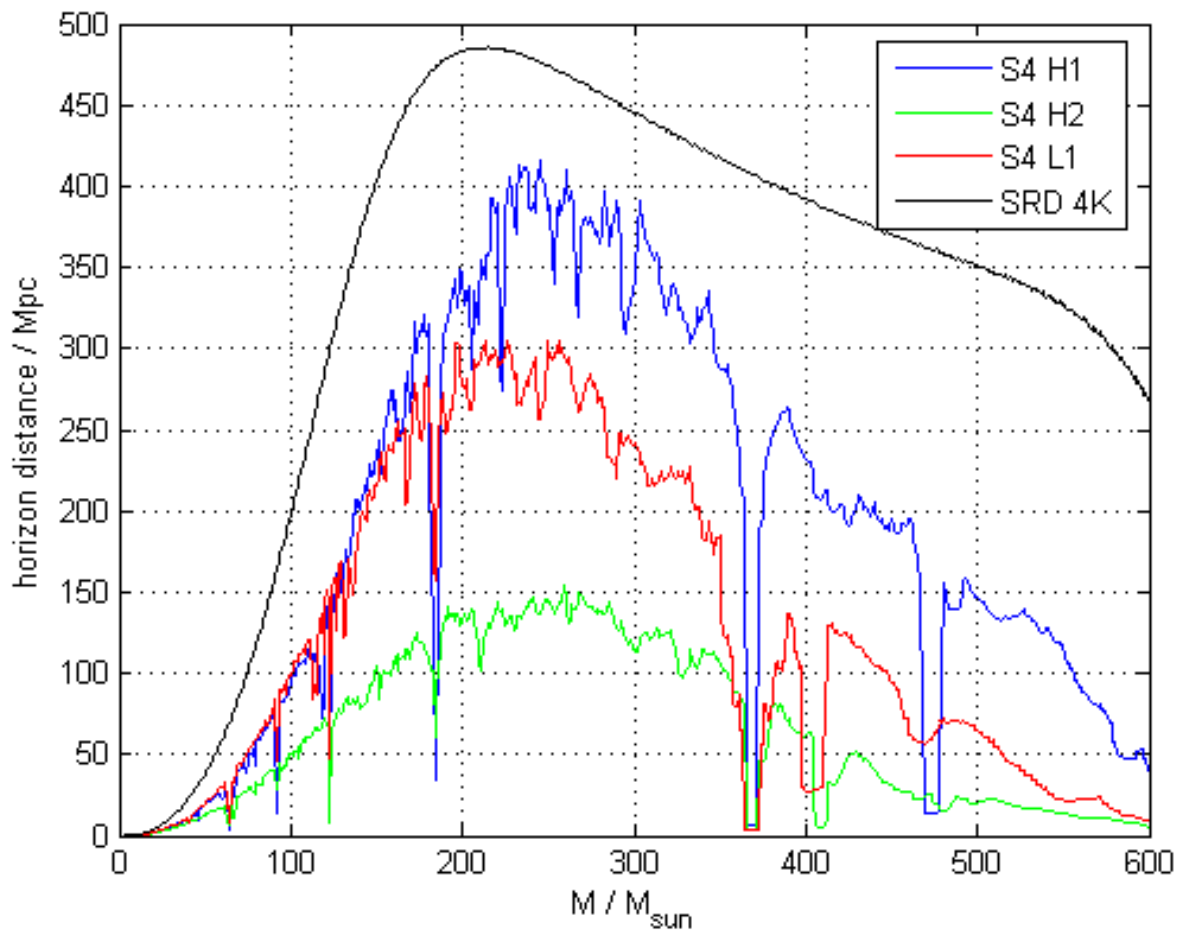
$$40 \leq f \leq 4000 Hz$$

$$2 \leq Q \leq 20$$

• **N~700**

• **mismatch~=0.03**

$$h(t - t_0) = e^{-\frac{\pi f_0}{Q} t} \cos(2\pi f_0 t)$$



- Optimally oriented source
- Single detector
signal-to-noise ratio = 8
- Spin $a = 0.9$

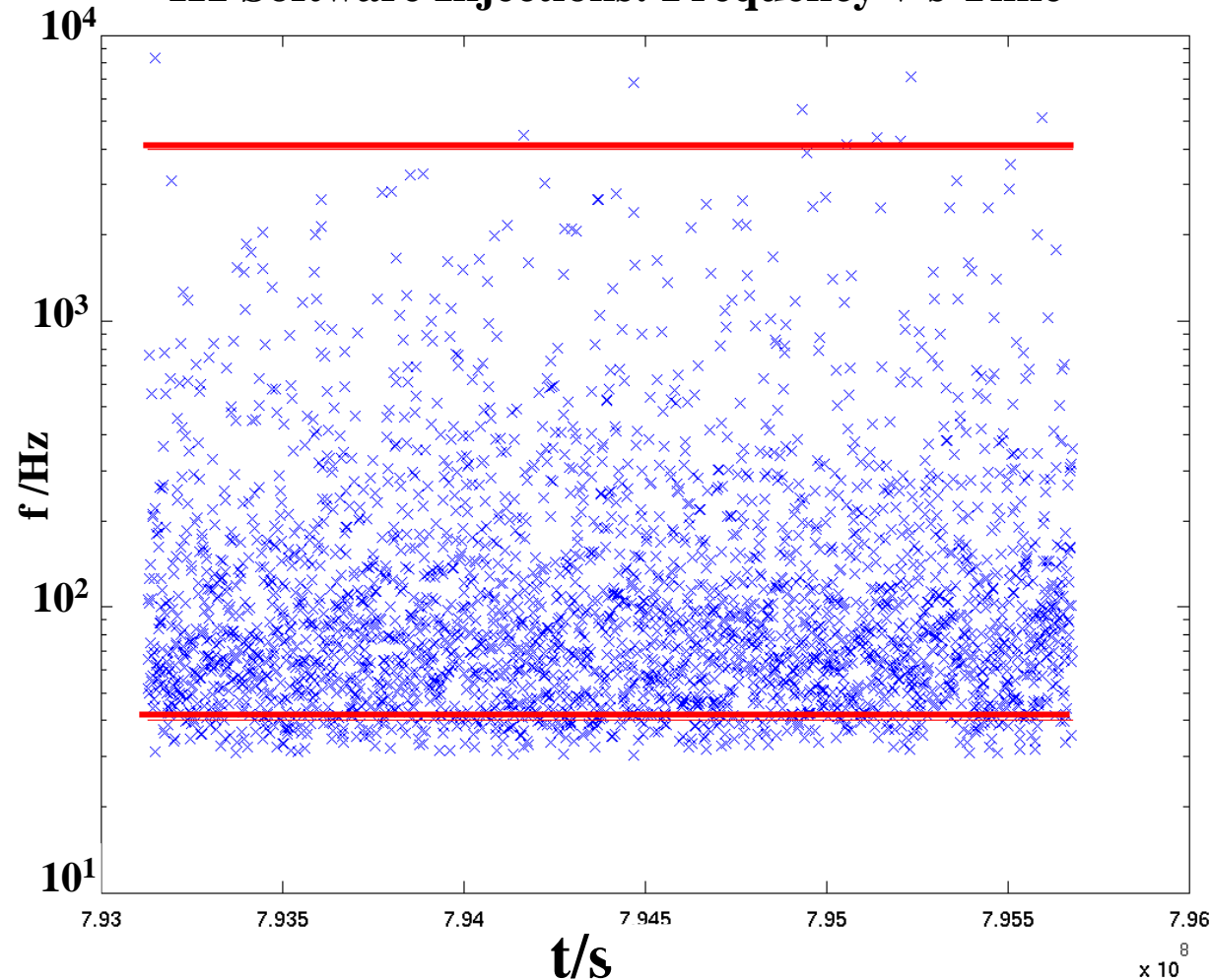
For $M=230M_{\text{sun}}$,
sensitive to black hole
ringdowns at a
distance of

H1: 400 Mpc

H2: 150 Mpc

L1: 300 Mpc

- Analysing data in triple time in S4
- Look for coincidences in t , f_0 , Q
- Zero-lag playground
- times slides
- Injection analysis (all S4)
- threshold 5.5

H1 Software Injections: Frequency ν 's Time

uniform in :

$$\langle M/M_{\text{sun}} \rangle < 400$$

$$0 < a < 1$$

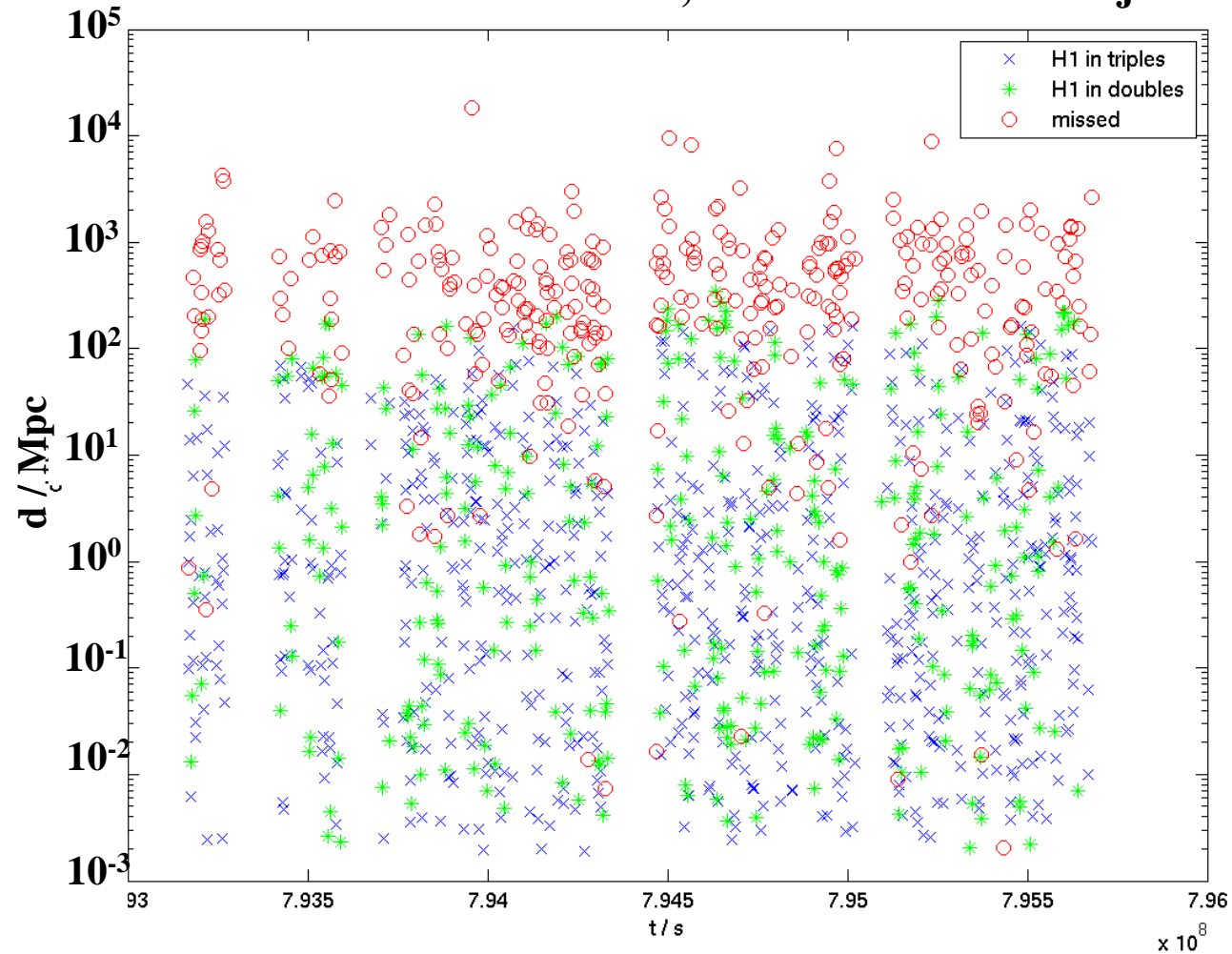
$\log(d)$:

$$1 \text{ kpc} < d < 500 \text{ Mpc}$$

random angles, phase

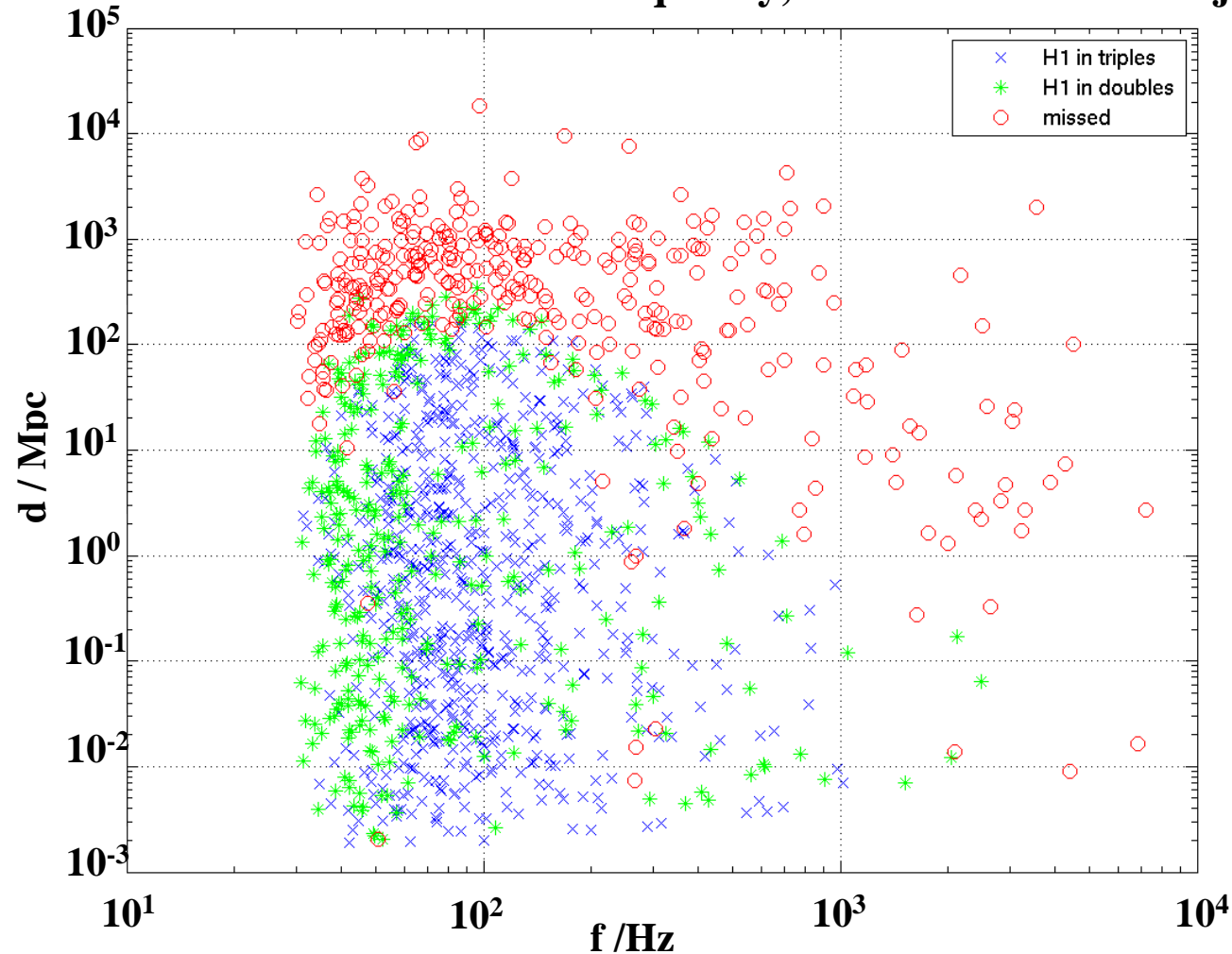
Coincident Injections

Effective Distance v's Time, Missed and Found Injections



- 1508 injections made into triple time
- 1165 found
 - of which
 - 729 triples
 - 436 doubles

Effective Distance v's Frequency, Missed and Found Injections



- 1508 injections made into triple time

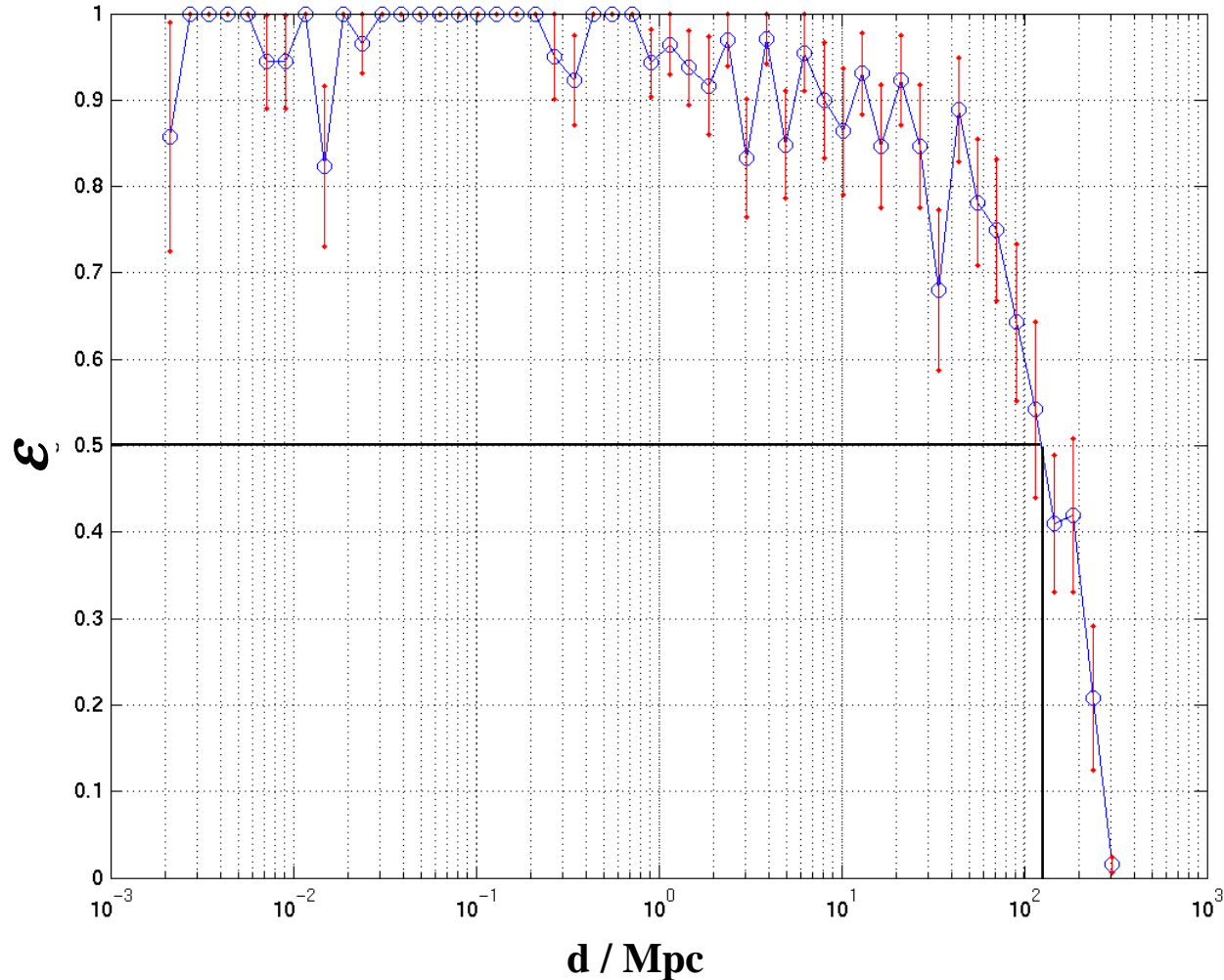
- 1165 found

of which

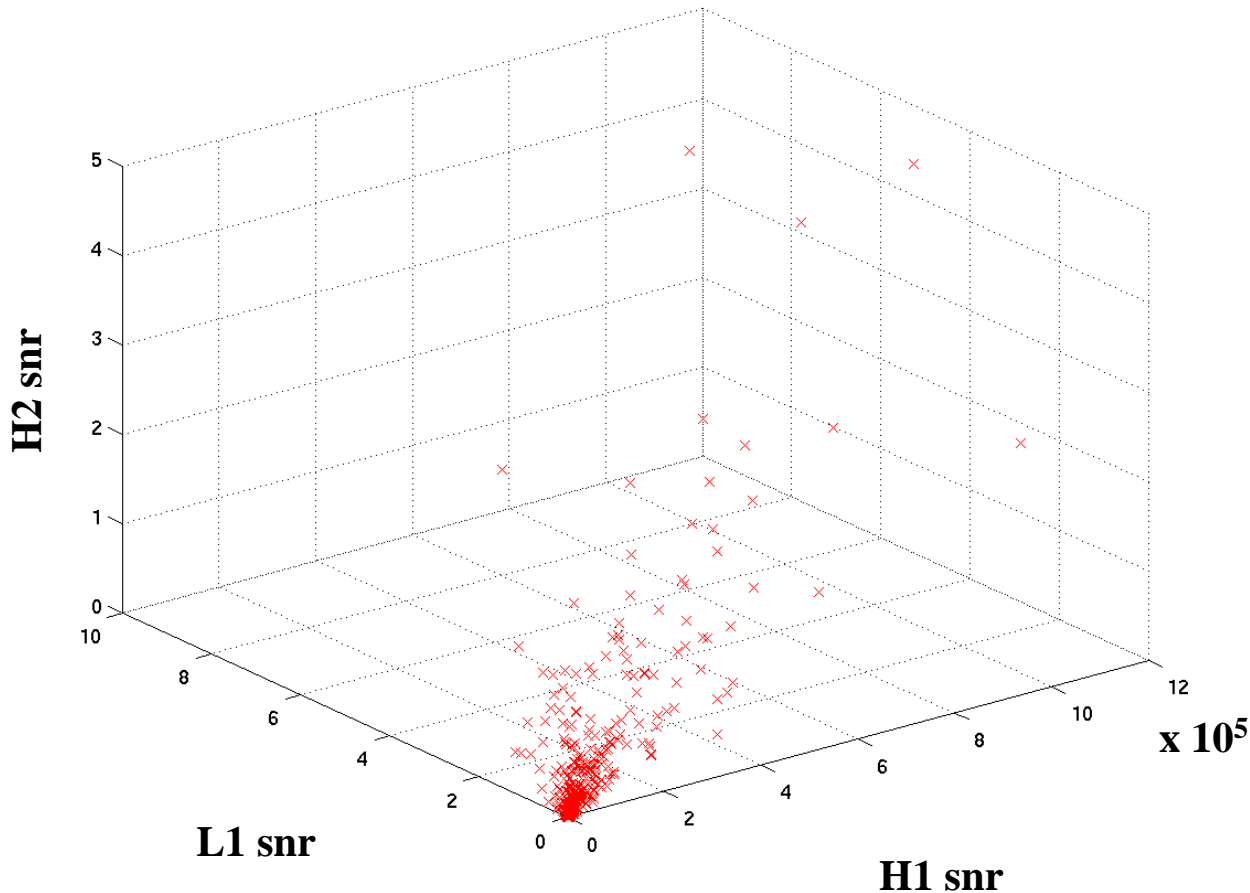
- 729 triples
- 436 doubles

Coincidence Efficiency

Injections found in coincidence in H1 and L1 and/or H2

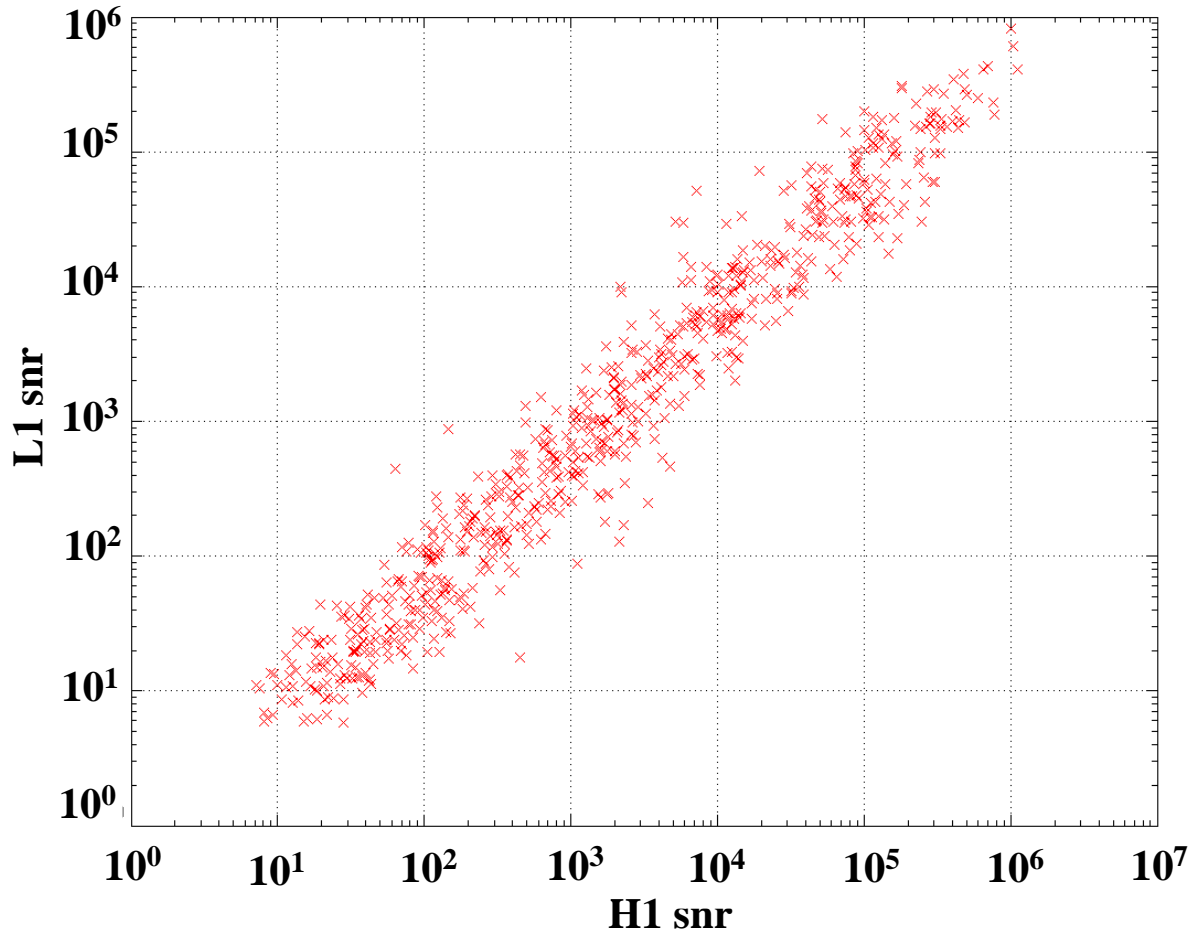


H1H2L1 coincident triggers in H1H2L1 data: **injections**



- No zero-lag playground triggers
- No time-slide events
- 729 injections found

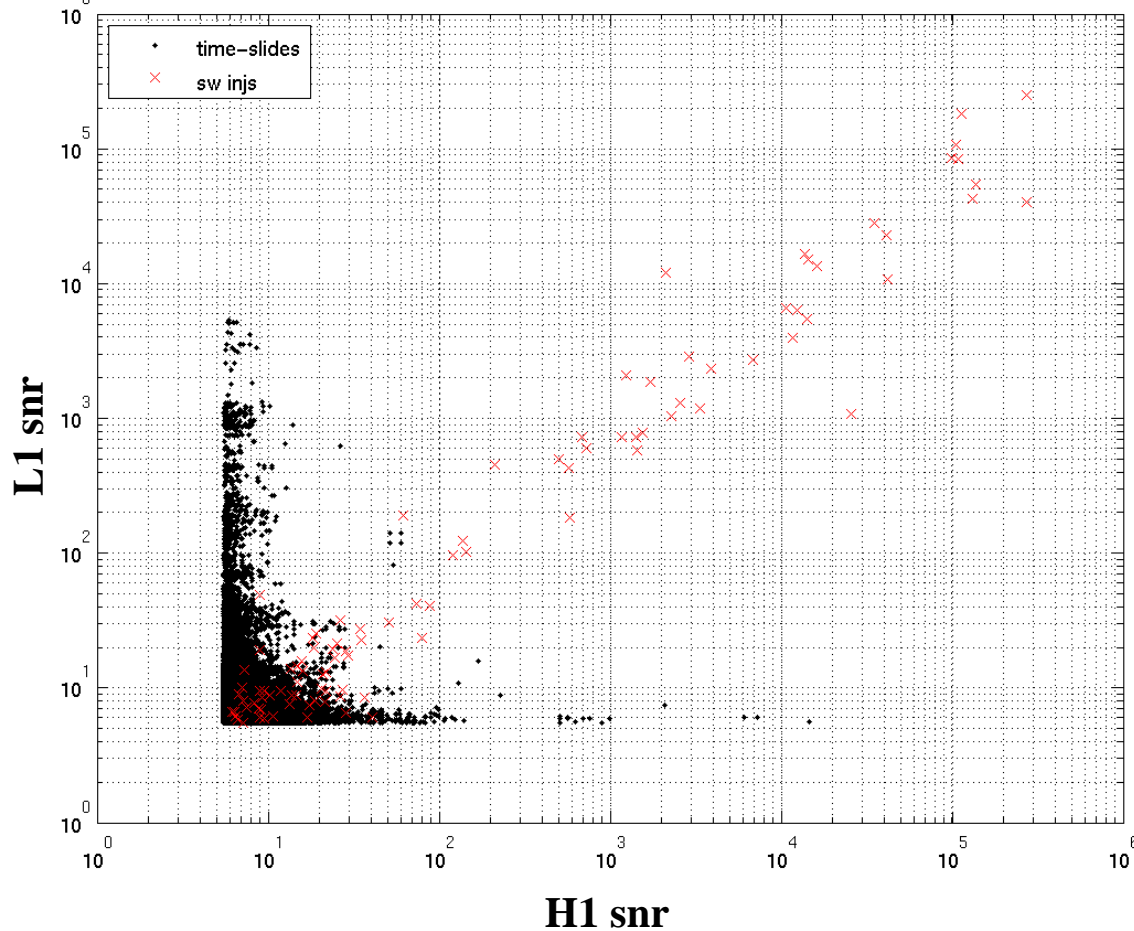
H1H2L1 coincident triggers in H1H2L1 data: **injections**



- No zero-lag playground triggers
- No time-slide events
- 729 injections found (all S4)

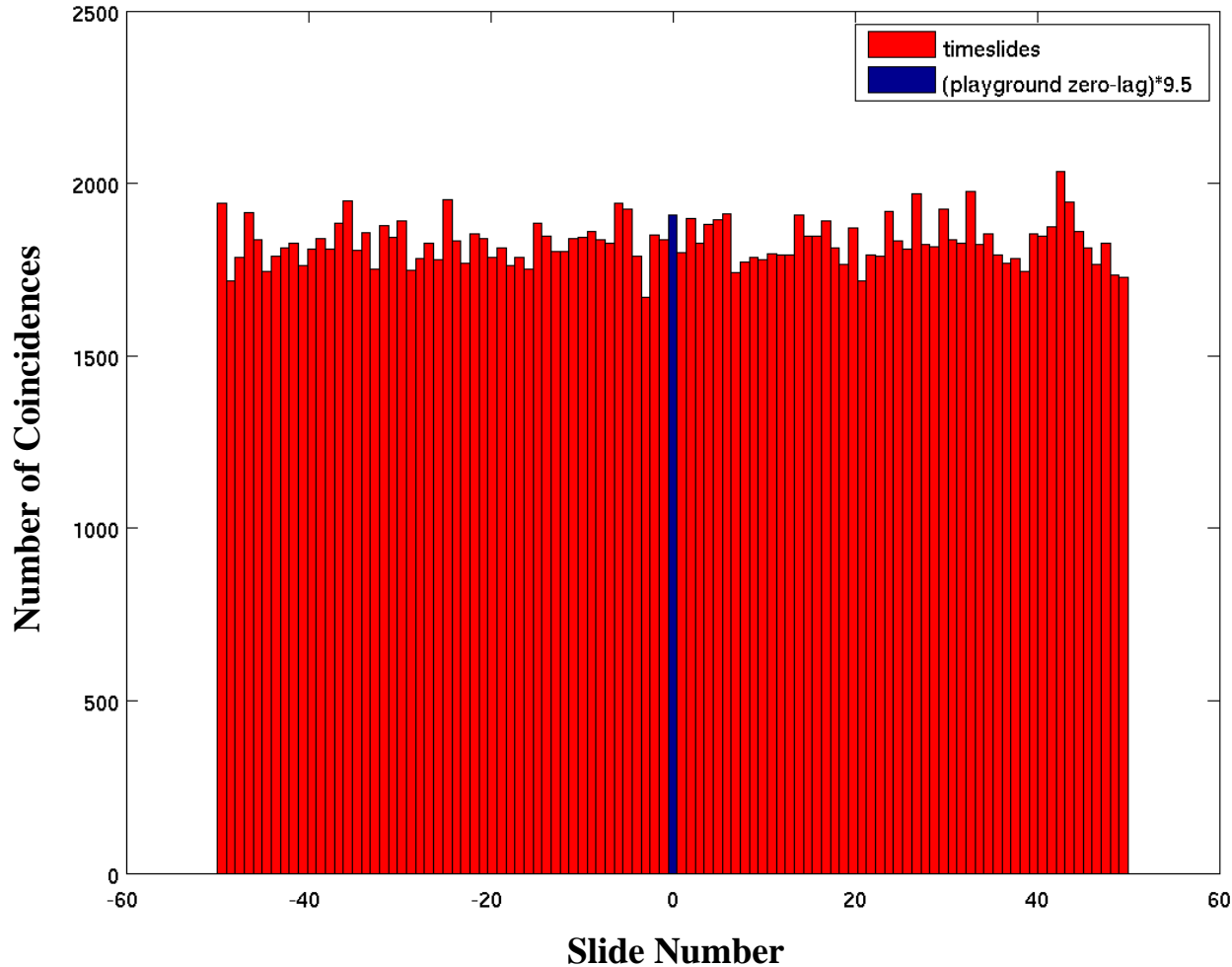
H1L1 Double Coincident Triggers in triple time

H1L1 (double) coincident triggers in H12L1 data: **injections** and time-slides



- Timeslides are unclustered & vetoes have not yet been applied

H1L1 coincidences in H1H2L1 data



- zero-lag consistent with background

- *Veto analysis*
- *Tune coincidence parameters*
- *Open box before Nov LSC meeting*
- *Paper before March LSC meeting*
- *Follow-up on candidates*
- *Coincidence with inspiral & bursts and parameter consistency tests*
- *S5, GEO?*