The LIGO Scientific Collaboration Search for Inspiralling Binary Neutron Stars

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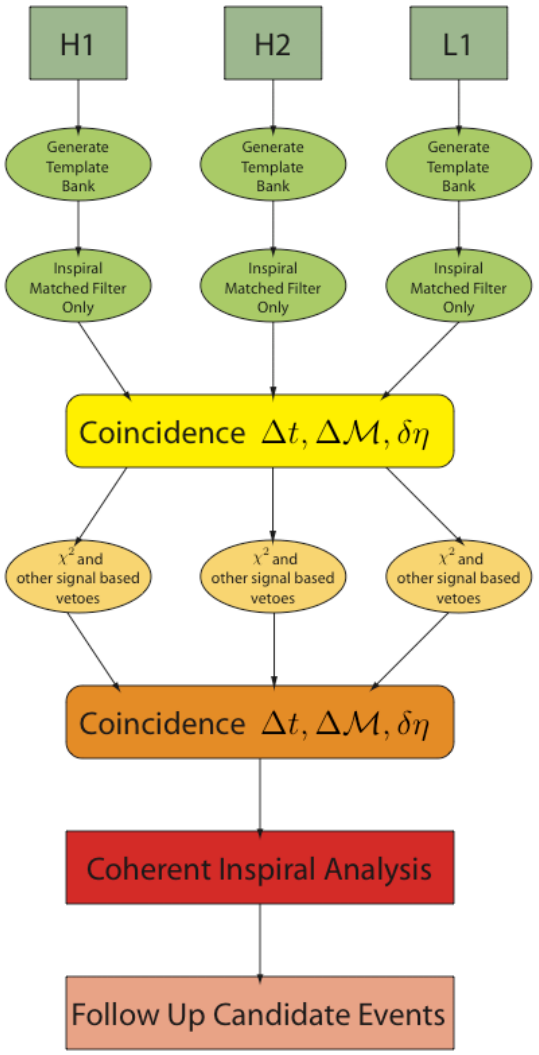
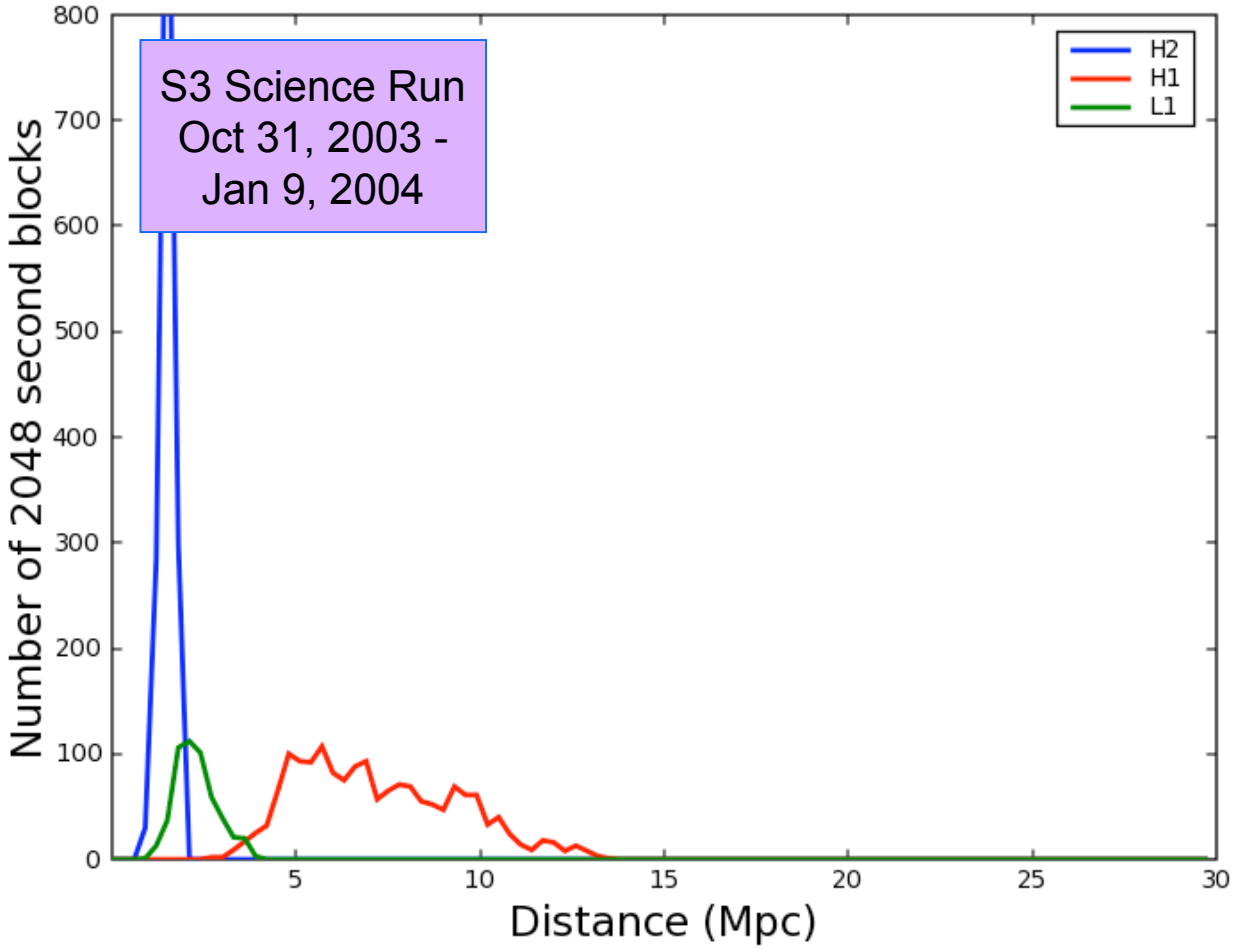
Binary Neutron Star Search

- Search for binaries with components between 1 and 3 solar masses
  - » Use data from three LIGO detectors
- Matched filter search using second order post-Newtonian templates
  - » Generates first stage triggers
- Apply time, mass, (amplitude) coincidence
  - » Ensure trigger is present in at least 2 LIGO detectors
- Apply signal based vetoes e.g. χ^2
  - » Vetoes are expensive: applying after first coincidence saves CPU
- Re-apply coincidence to get candidate triggers
- Construct coherent inspiral statistic
- Follow up event candidates remaining at end of pipeline



Inspiral Horizon Distance

Distance to optimally oriented 1.4,1.4 solar mass BNS at $\rho = 8$



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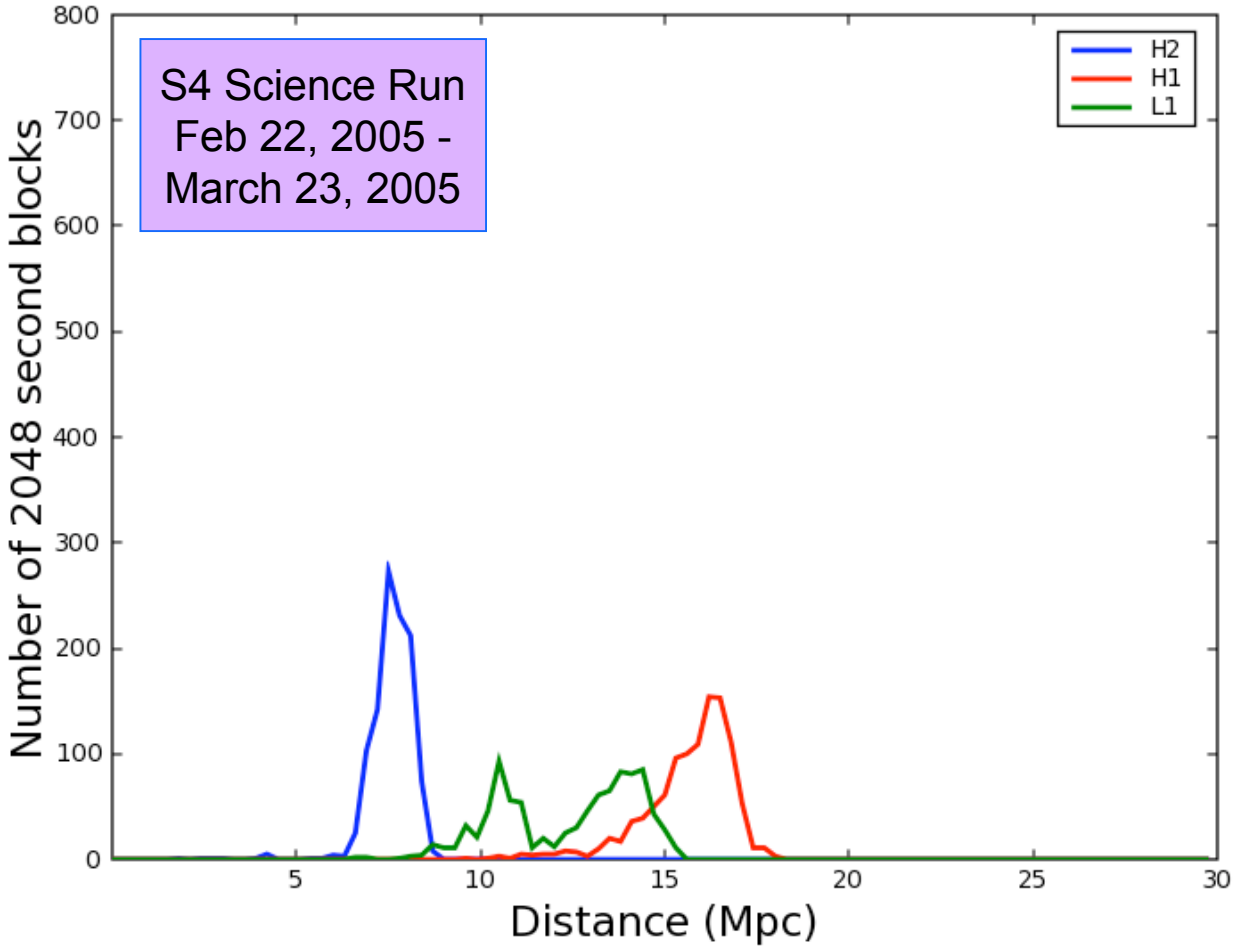

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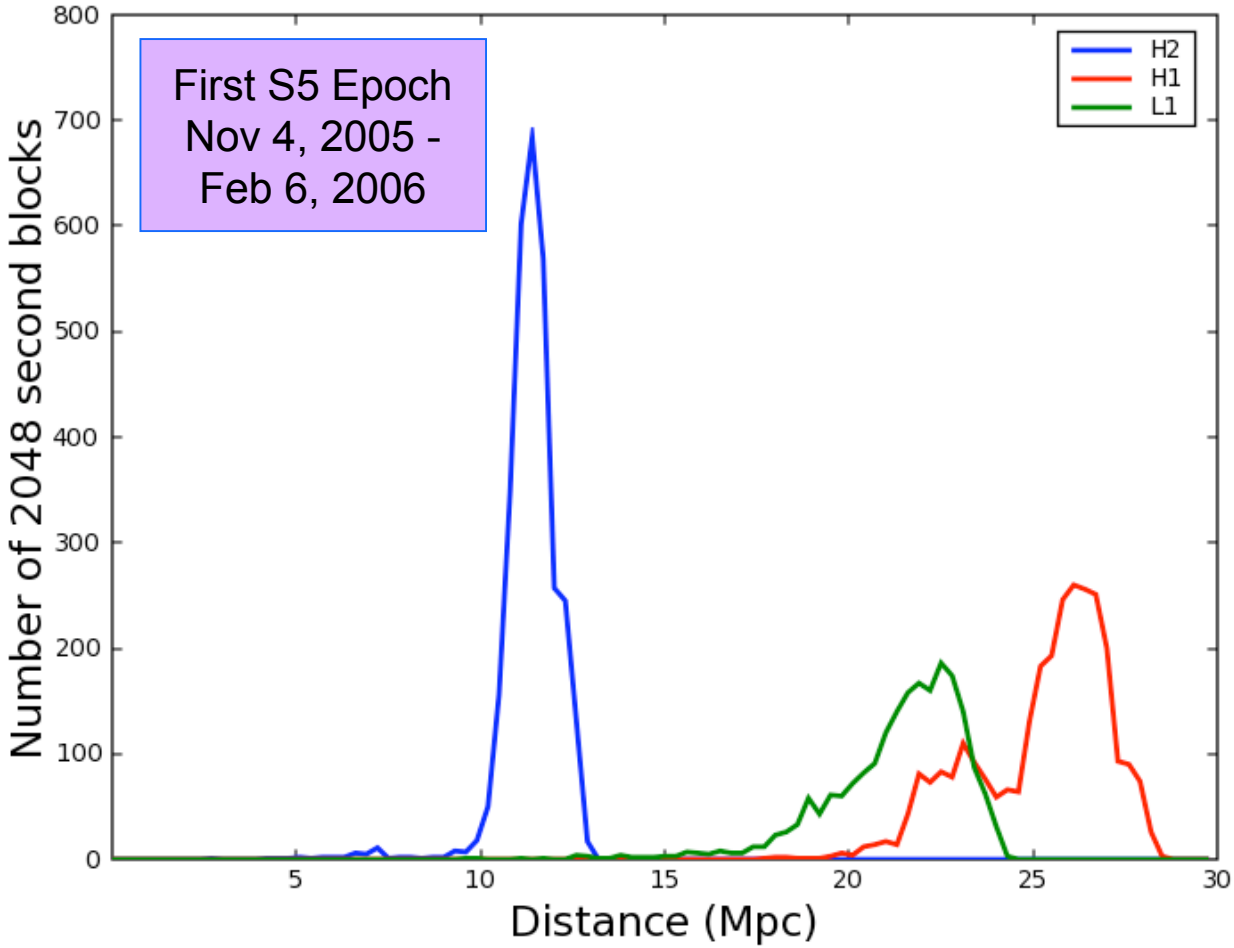
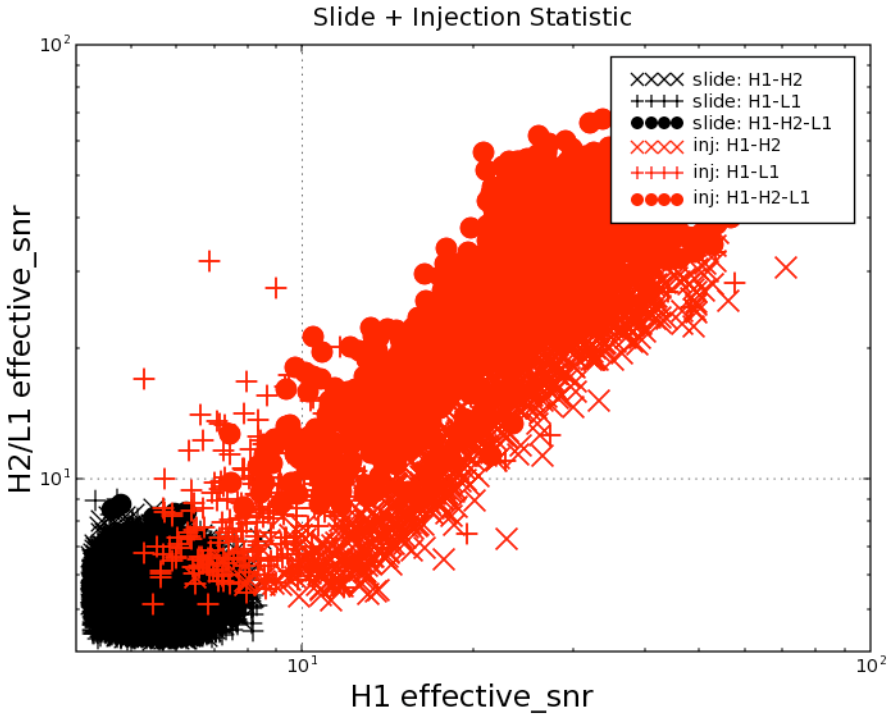
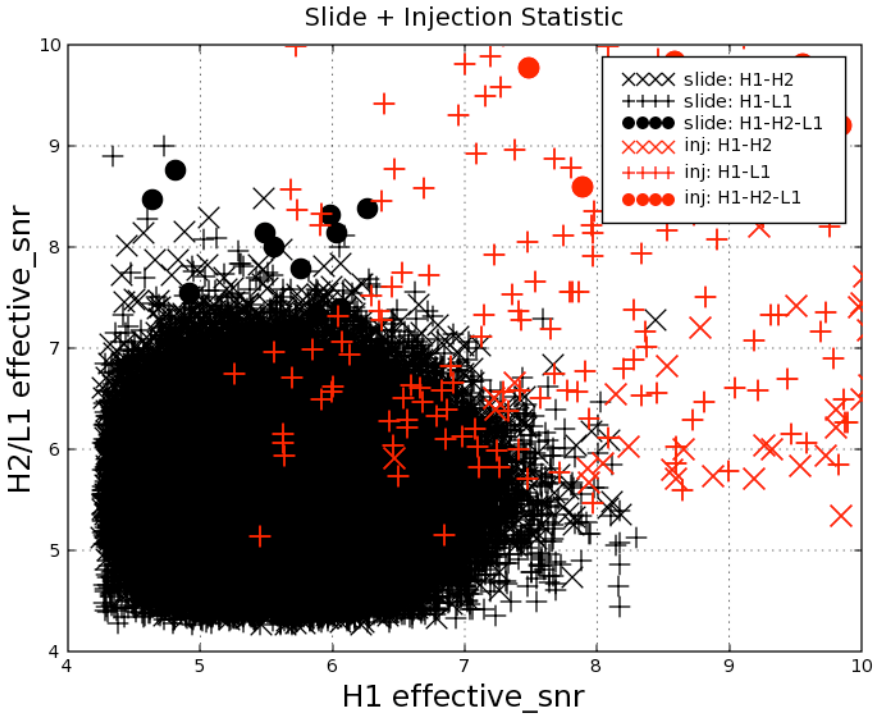


S5 Accidental Coincidences and Simulated Signals

- Tune pipeline using background, playground (10% of data) and injections
- Measure background by applying time slides before coincidence
- Add simulated signals to detector data to evaluate analysis performance

$$\rho_{\text{effective}} = f\left(\rho, \chi^2\right)$$



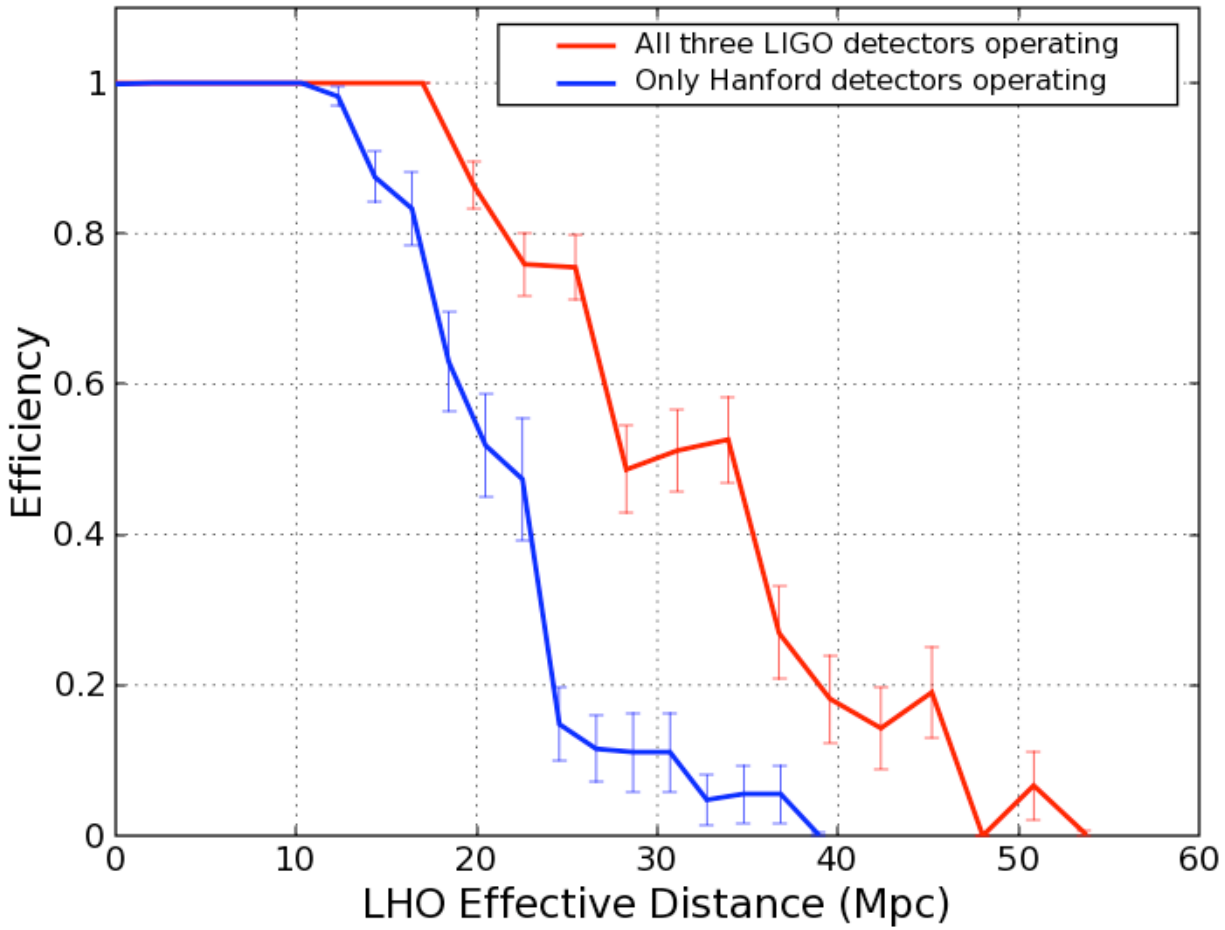


S5 Detection Efficiency

- First epoch of S5
- 32.6 days of triple coincident data
- 24.0 days of Hanford double coincident data

- Measure efficiency at signal-to-noise ratio of loudest background event

- Conservative estimate of efficiency used in upper limit calculation



Conclusions

- All S3 and S4 data has been analyzed for BNS
  - » “Box opened” on S3 data: no detections
  - » Final checks being performed on S4; result under internal review
- S5 data from first epoch (Nov 4 to Feb 6) analyzed
  - » Feb 6 is start of mid-run commissioning at Hanford
- Currently finalizing tuning of S5 instrumental vetoes
  - » Box will be opened shortly
- Expect first S5 result (upper limit or detection) soon!

Effective SNR Statistic

- The effective signal-to-noise statistic takes into account information from both the matched filter SNR and the χ^2 veto

$$\rho^2_{\text{effective}} = \rho^2 \Big/ \sqrt{\left(\frac{\chi^2}{2p-2}\right)\left(1+\frac{\rho^2}{250}\right)}$$

- p = 16 is number of bins used in χ^2 veto
- Factor of 250 comes from empirical tuning on data