Report on the First Search for BBH Inspiral Signals on the S2 LIGO Data

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Outline

- Target Signals and Waveforms
- Template Family
- Analysis Pipeline
- Playground Injection Results
- Preliminary Background Result
- Summary

Target Signals and Waveforms

- Detection search for binary black hole coalescences
  - » Non-spinning black holes
  - » Component mass: 3 – 20 M_{SUN}
  - » Inspiral phase
- Low frequency cutoff for s2: 100 Hz
- Innermost stable circular orbit for the inspiral phase of BH binaries
  - » 800 Hz for a 3 – 3 M_{SUN} binary
  - » 110 Hz for a 20 – 20 M_{SUN} binary
- Very few cycles in band
  - » Lots of waveforms available: Effective-One-Body, PadeT1, TaylorTx, but …
  - » They disagree with each other in our frequency band

Template Family

- Use phenomenological templates

- BCV templates
  - » Buonanno, Chen, Vallisneri, PRD 67, 2003
  - » $h(f) = f^{-7/6} (1 - \alpha f^{2/3}) \theta(f_{cut} - f) \exp\{ i (\varphi_0 + 2 \pi f t_0 + \psi_0 f^{-5/3} + \psi_3 f^{-2/3}) \}$
  - » Good match (0.90 – 0.99) with physical waveforms
  - » Good for identifying the signal in the data
  - » Not recommended for parameter estimation (masses, distance etc.)

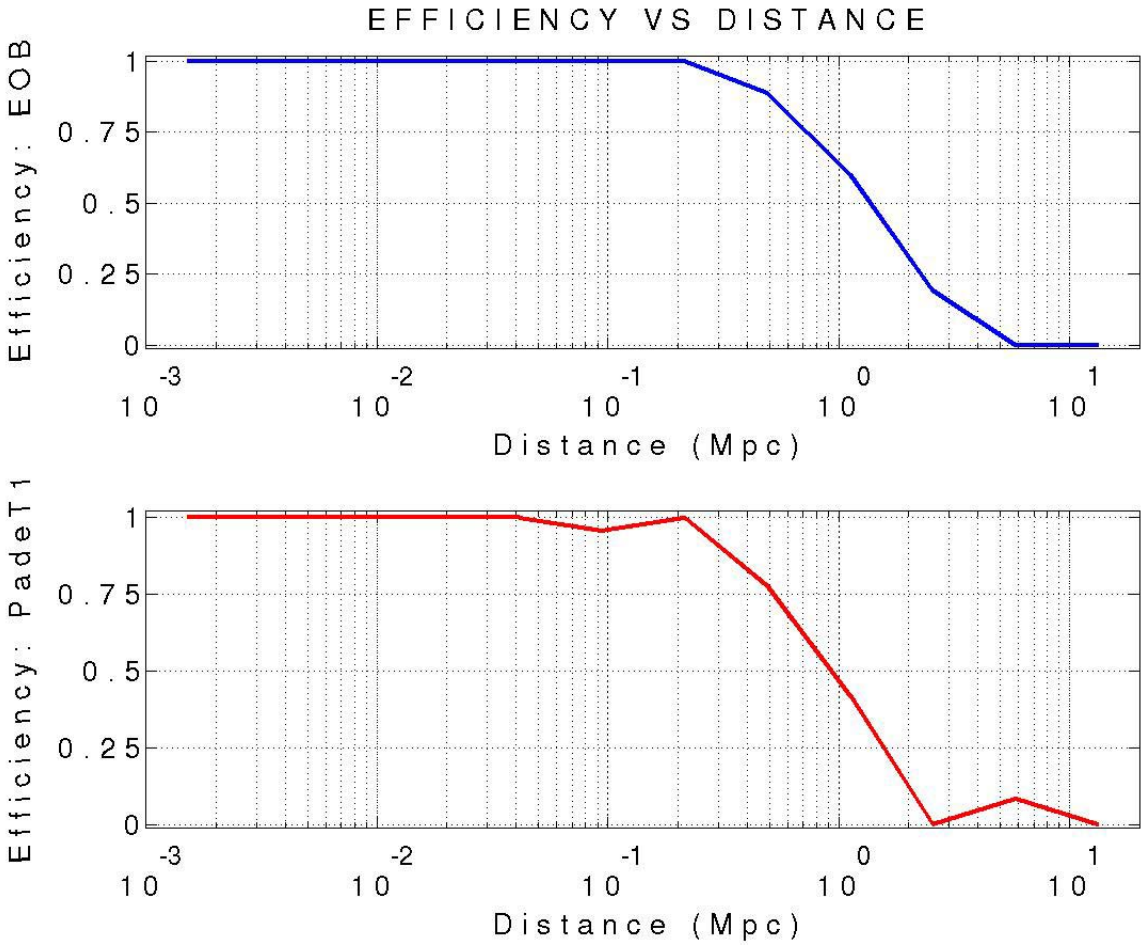
Analysis Pipeline

- Identify coincident data between LLO and LHO
  - » double coincident: L1/H1 (99 hours) and L1/H2 (32 hours)
  - » triple coincident : L1/H1/H2 (242 hours)
- Analyze L1 data
  - » create template bank (ψ_0, ψ_3, f_{cut})
  - » matched filter: we threshold on SNR; no χ^2 – veto
- Analyze 2nd (and if necessary 3rd) interferometer data
  - » create triggered bank from L1 triggers
  - » matched filter: we threshold on SNR; no χ^2 – veto
- Apply coincidence criteria
  - » time coincidence between interferometers
  - » template parameter coincidence (ψ_0 and ψ_3)
- The pipeline parameters were tuned on the playground

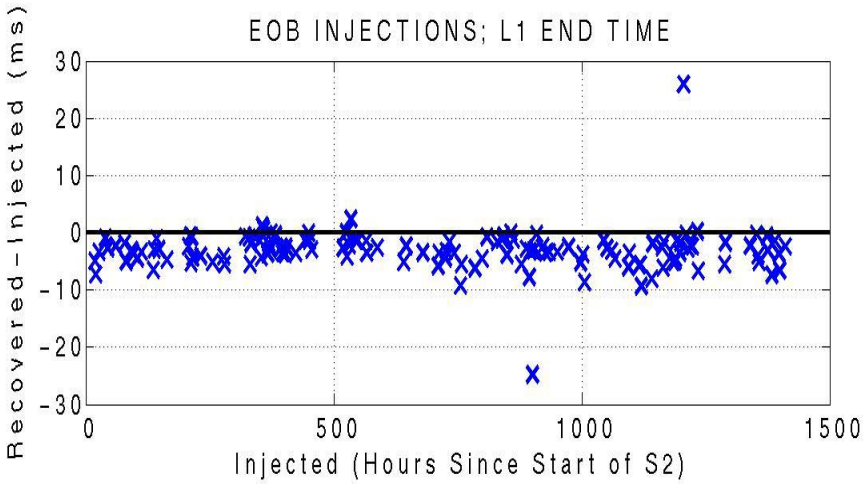
Playground Injections

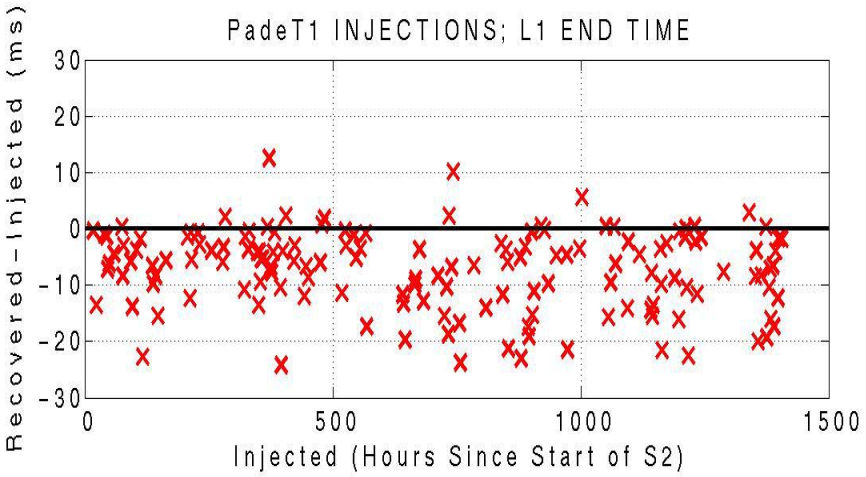
- Software injections
  - » validate and tune our pipeline
  - » quantify the sensitivity of the instruments
  - » test how well the BCV templates do at recovering different waveforms
- Inject 2pN waveforms
  - » Effective-One-Body (EOB)
  - » PadeT1
  - » TaylorT3
- “Population”
  - » Uniform in each component mass: 3 – 20 M_{SUN}
  - » Uniform in $\log_{10}$(distance): 1 kpc – 20 Mpc

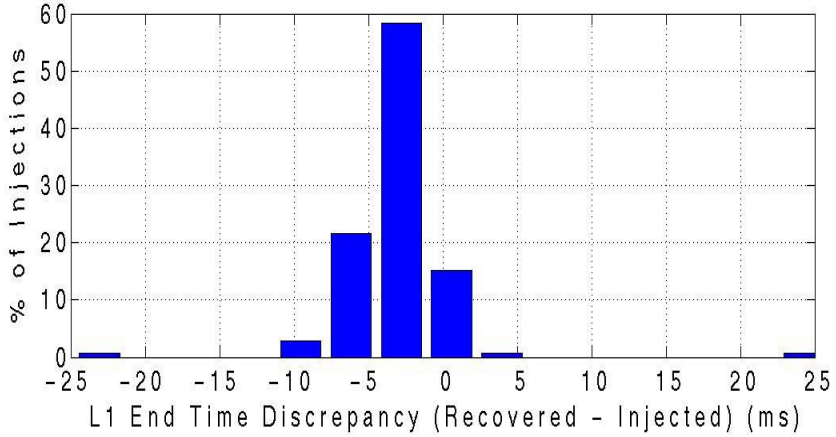
Playground Injections: Efficiency versus Distance

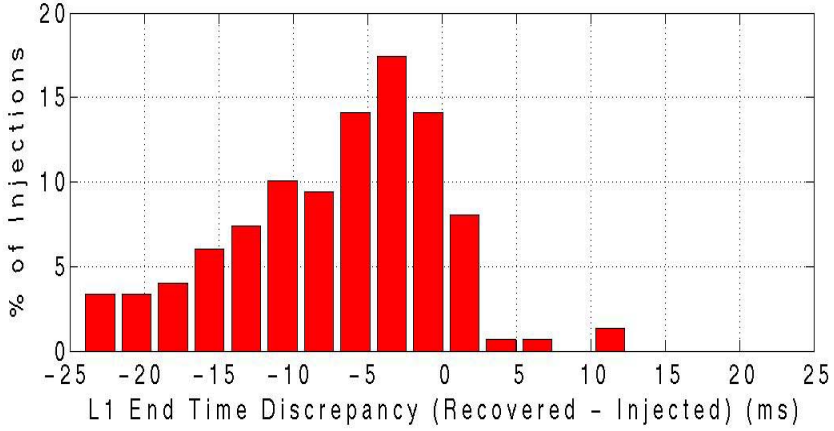


Playground Injections: End Time

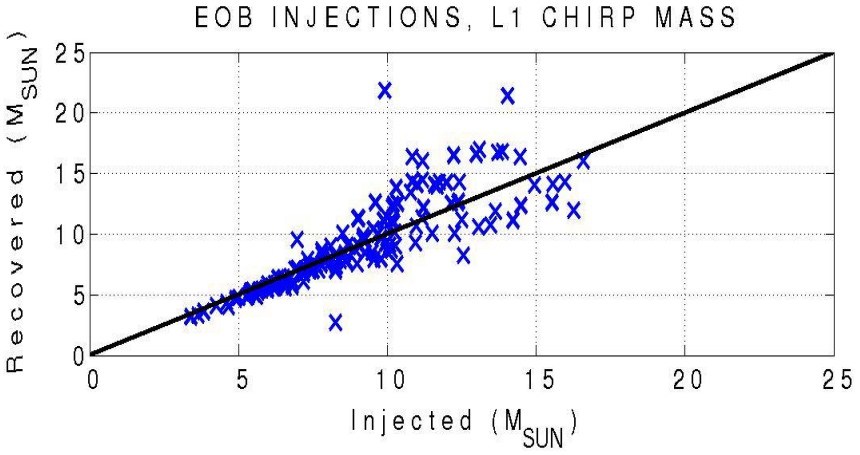


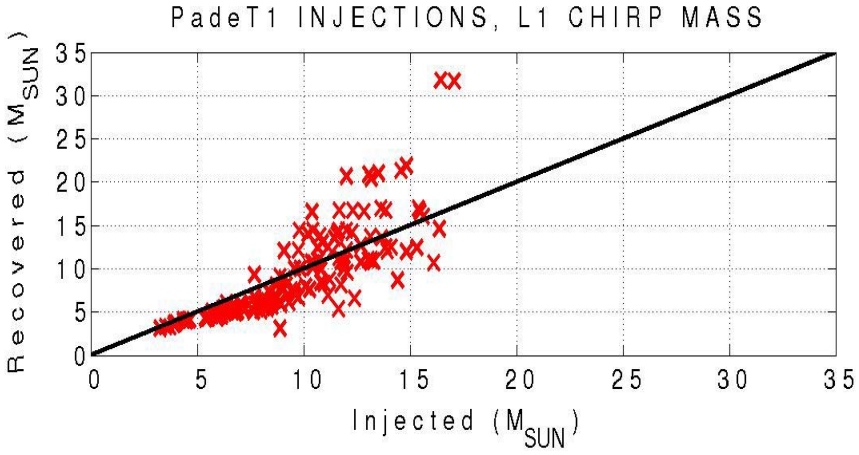


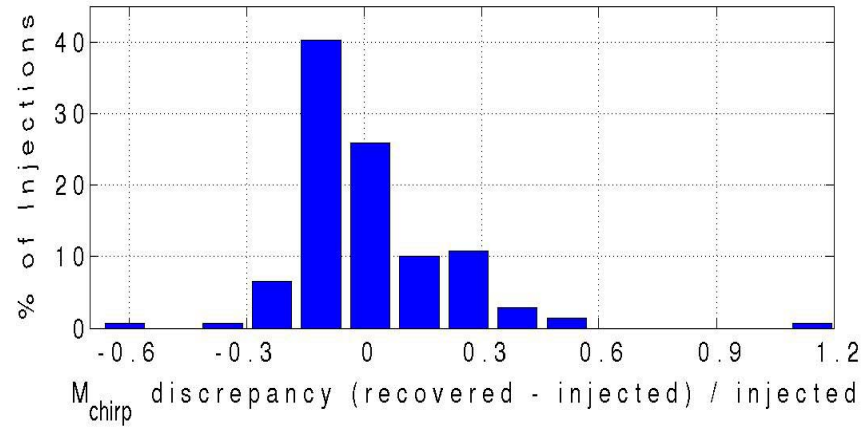


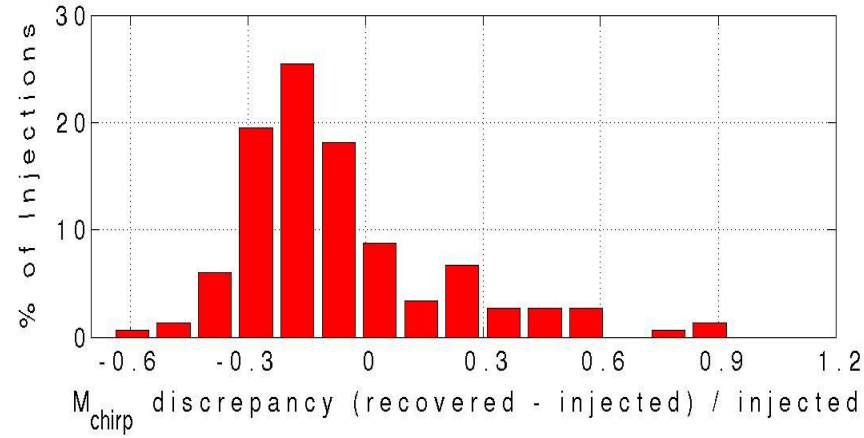


Playground Injections: Chirp Mass

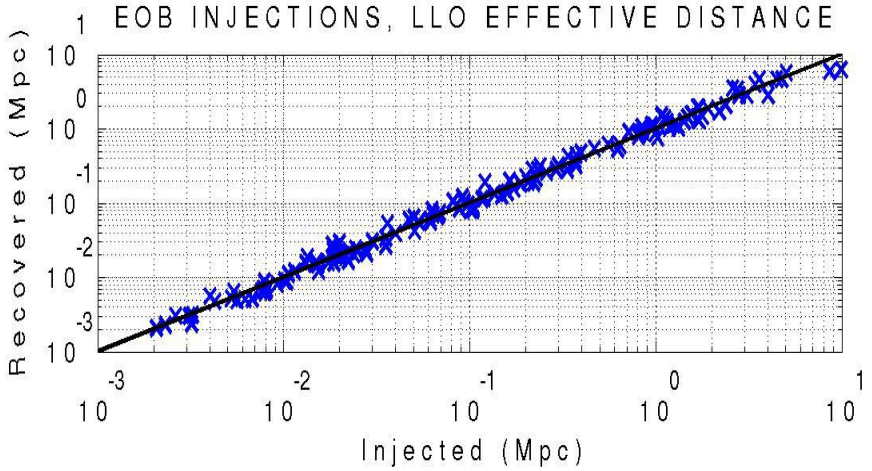


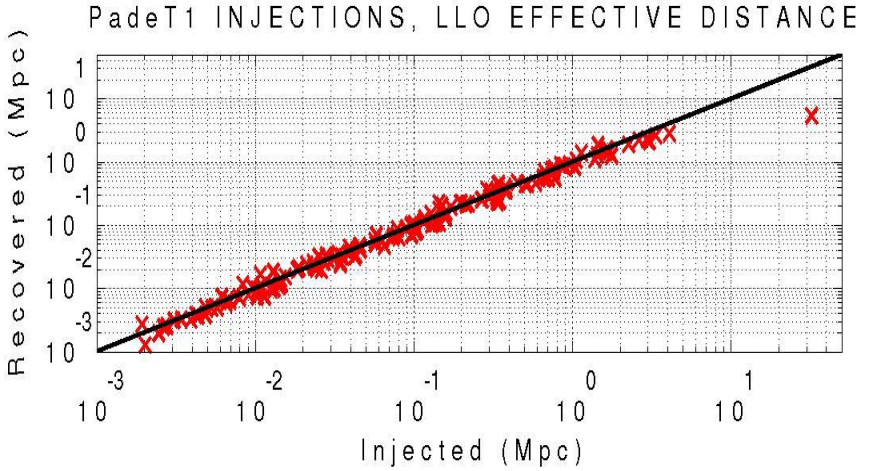


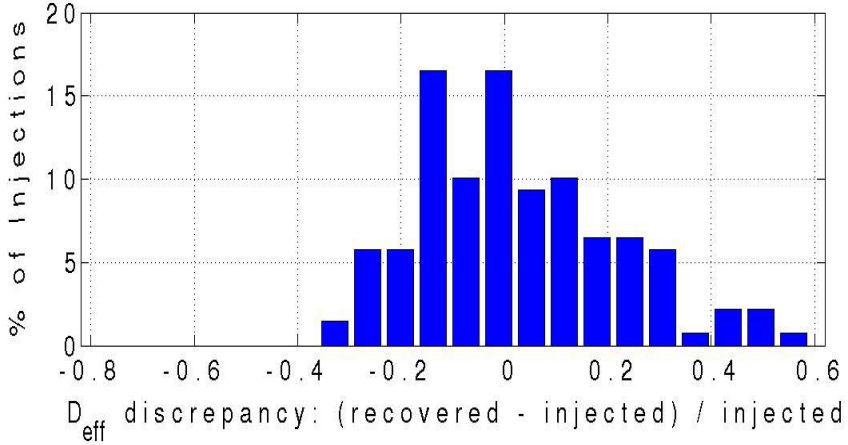


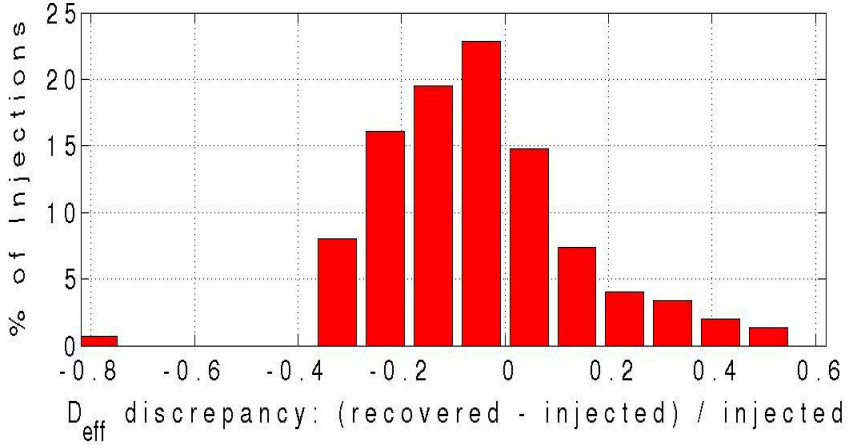


Playground Injections: Effective Distance



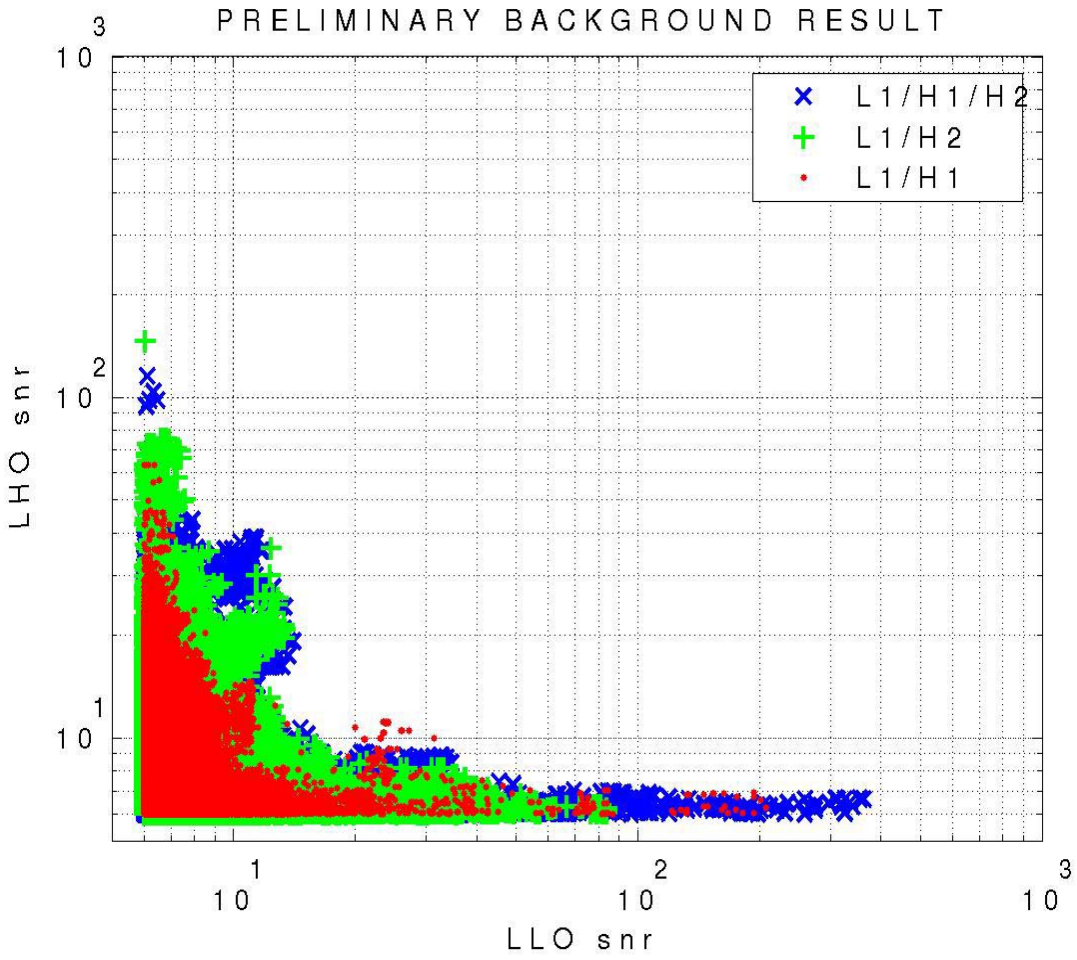






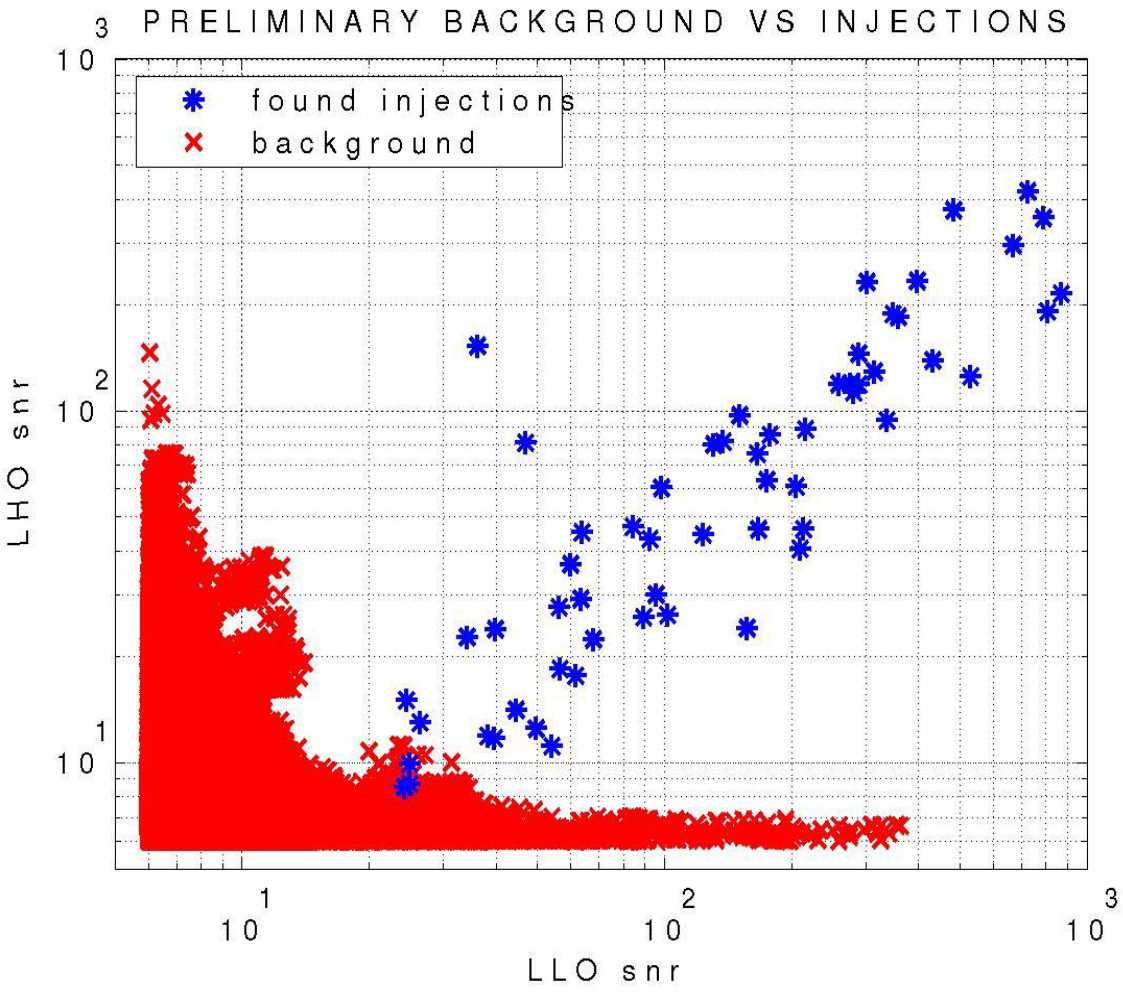
Preliminary Background Result

- Background estimation
  - » time slides
- **Preliminary** result
  - » based on 15 time slides
  - » more are in progress
- Need to finalize our coherent statistic



Preliminary Background vs Injections

- Very clear distinction between the distribution of background triggers and that of found injections



Summary

- We use the BCV templates to search for BBH coalescences
- We have done playground injections to tune our pipeline
- Time slides are in progress for background estimate