Search for inspiraling black holes with the LIGO gravitational wave detectors

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LIGO-G050249-00-Z

Outline

- **Analysis Pipeline**
- **Injections & Templates**
- **Background Estimate**

LIGO Observatories

Hanford: two interferometers in same vacuum envelope (4km, 2km)

Livingston: one interferometer (4km)

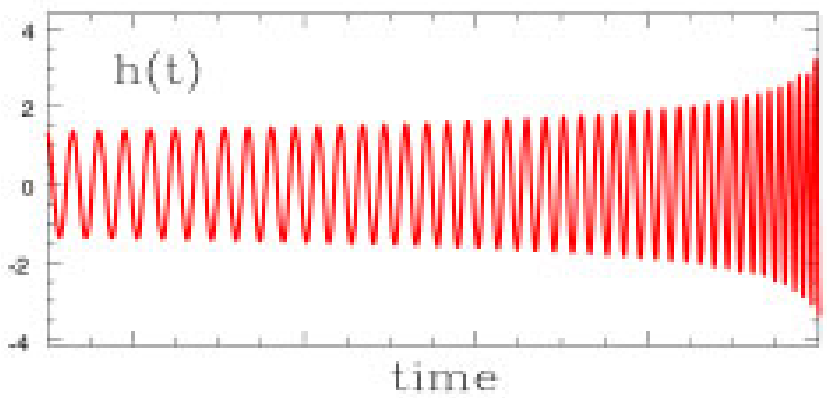
Inspiral and Merger of Compact Binaries

Neutron Star

- Component Masses of 1 to 3 M_{SUN}
- f_{ISCO}= 800 Hz

➢ Use post-Newtonian waveform

$$h(f) = f^{-7/6}\, e^{i\,\Psi_{SP}(f;m_1;m_2)}$$



Black Holes

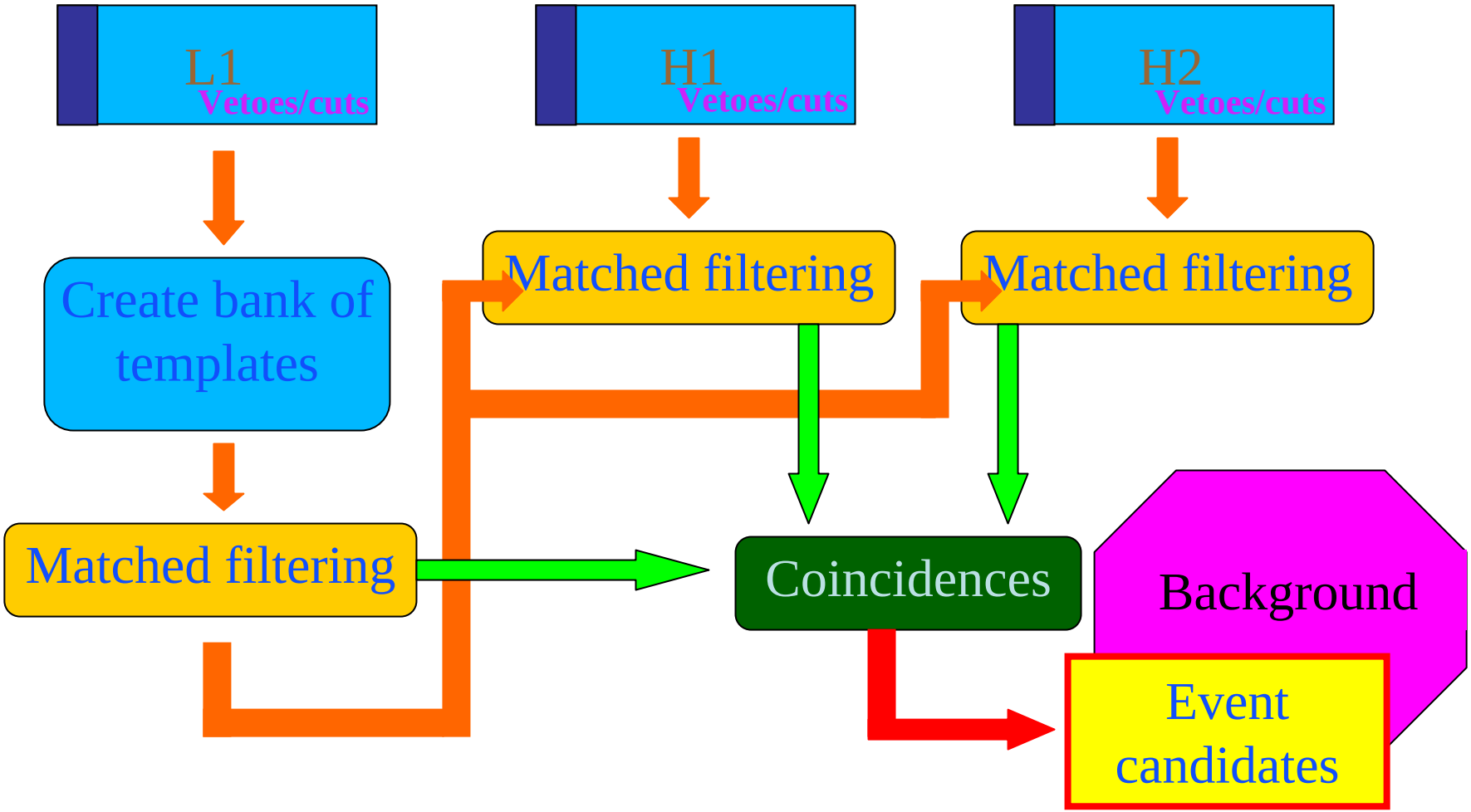
- Component Masses of >3M_{SUN}
- f_{ISCO}= 110 Hz

➢ Use template (BCV)

$$h(f) = f^{-7/6}\,(1-\alpha f^{2/3})\,\Theta(f_{cut}-f)\, e^{i\,\Psi_{BCV}(f;\psi_1;\psi_2)}$$

Buoanno, Chen, Vallisneri, PRD 67, 2003

Analysis Pipeline (S2)



Injections

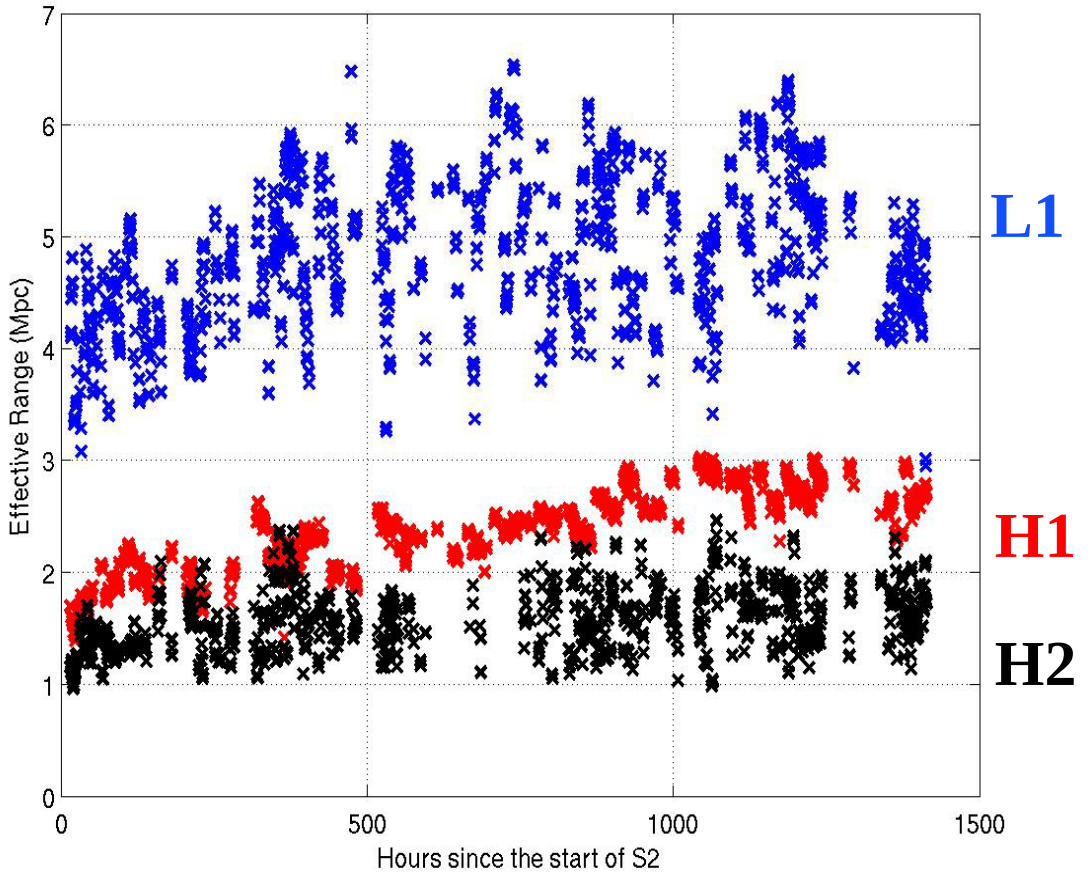
- **Software injections**
  - validate and tune the pipeline
  - quantify the sensitivity of the instruments
  - test how well the BCV templates can be used for recovering different waveforms and parameters (PPN, Pade, EOB)
- **"Population"**
  - Uniform in each component mass: 3 – 20 M_{SUN}
  - Uniform in $\log_{10}$(distance): 1 kpc – 20 Mpc

Inspiral range

- Inspiral range during S2:

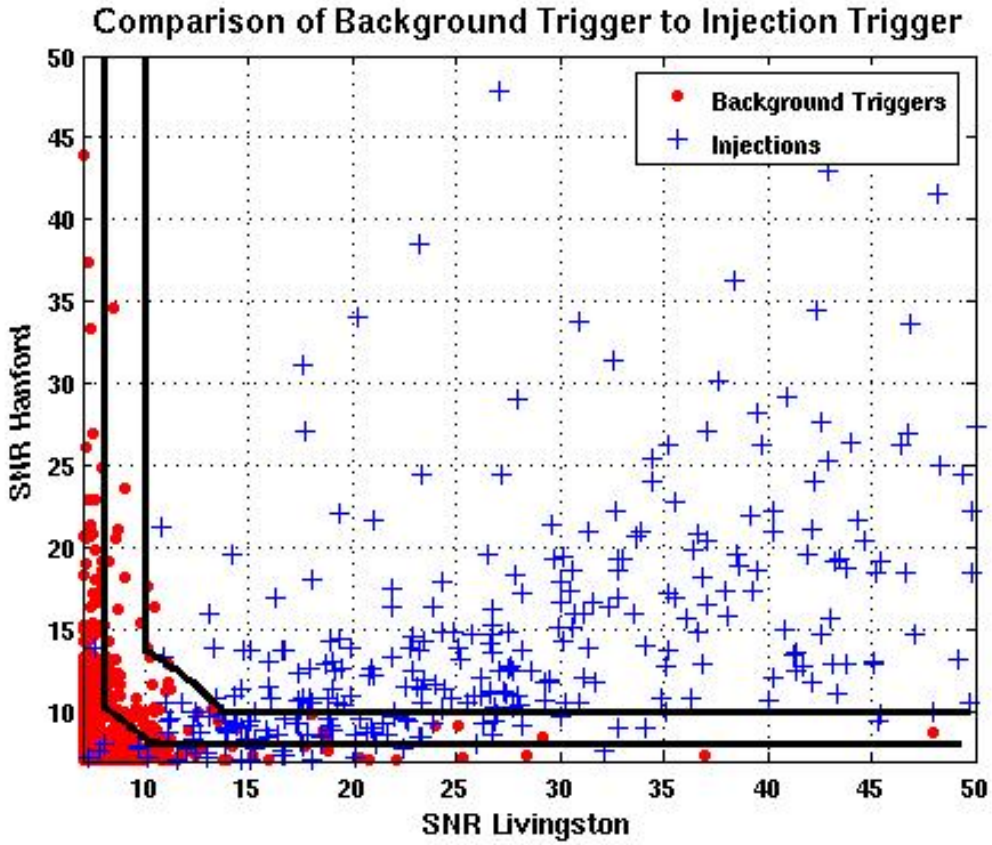
➢ Up to 6 Mpc for L1

❖ Neutron Star: about 3Mpc



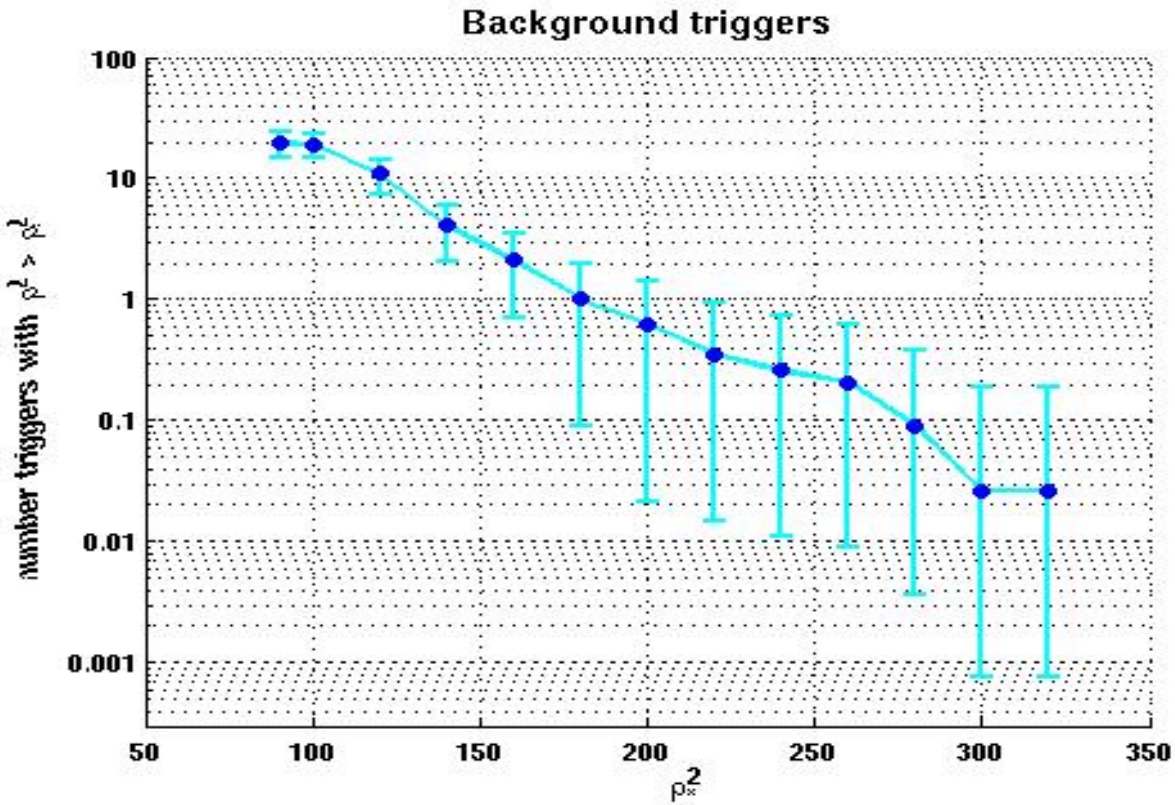
Background vs Injections

- **Very clear distinction between:**
  - Background triggers
  - Found injections



Background estimate

- Using combined statistic:



Conclusion

- ✓ Using ‘BCV’ templates to search for coalescences of binary black holes
- ✓ Software injections done to tune pipeline, calculate efficiencies and test parameter recovery
- ✓ Time slides are used for background estimations
- ➢ Final results will be published soon