

Burst Search Report

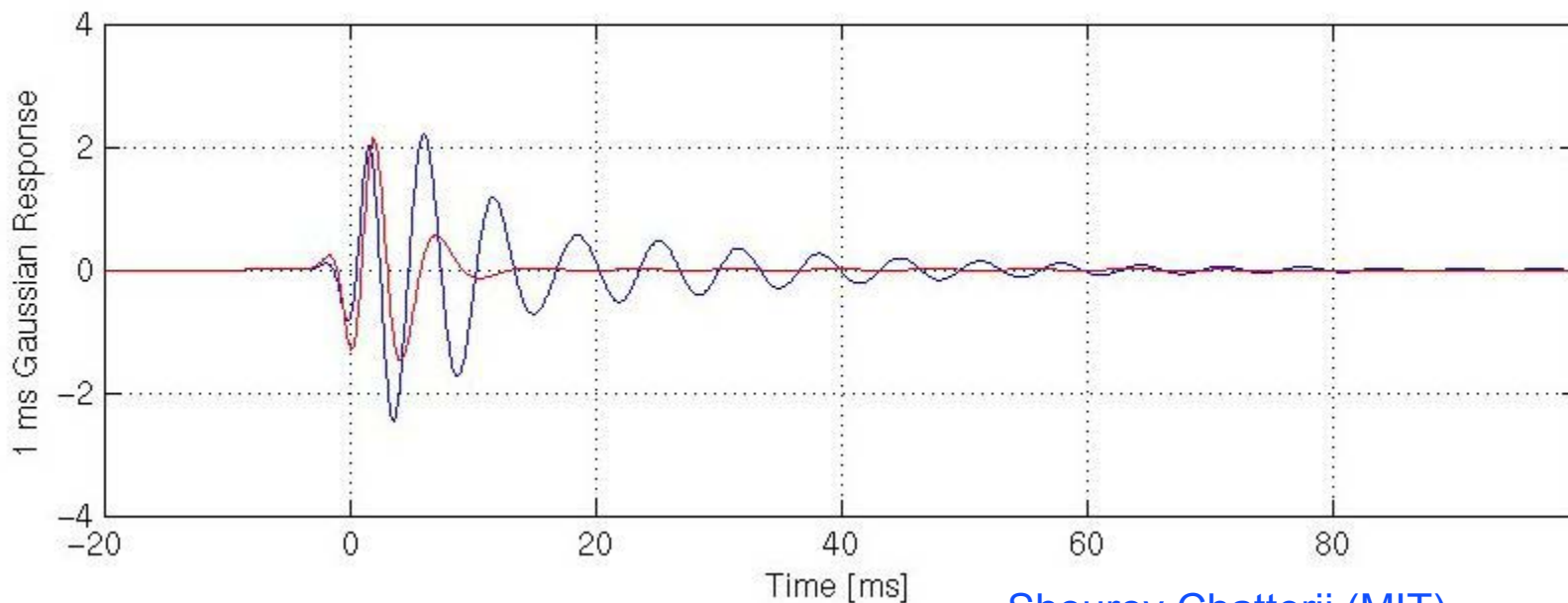
Stan Whitcomb
LIGO Caltech

LSC Meeting
LIGO1 Plenary Session
18 August 2003
Hannover

- Untriggered (“Flagship”) Search
 - » Data quality checks/Data selection
 - » Data conditioning (prefiltering)
 - Filter ringing
 - » Vetoes--investigated but not used
 - » Event trigger generation (two ETG’s: SLOPE and TFCLUSTERS)
 - Parameter space for tuning limited
 - » Time/Frequency coincidence
 - Temporal and frequency matching cuts very broad
 - » No post-coincidence analysis
 - » Hardware and software injections to determine efficiency
 - » Statistical analysis to determine upper limits
 - Nonstationarity of data presented some problems
- Triggered Search --GRBs to identify times for “deeper” searches
 - » No useful GRB triggers during triple coincidence times
 - » Used data to develop algorithms

- Untriggered Search
 - » Data Quality (lessons learned from S1 + earlier; Zweizig & Riles)
 - » Improved data conditioning
 - » Vetoes: reinvestigating
 - » More ETGs, better tuning
 - » Improved coincidence
 - » Post-coincidence processing
 - » Simulations include broader (more astrophysical) range of waveforms
- Triggered Search
 - » Next talk (Szabi Marka)
- Two template based searches
 - » BH Ringdowns (Rana Adhikari)
 - » Zwerger-Mueller core collapse waveforms (Masahiro Ito)
- Joint analysis with TAMA

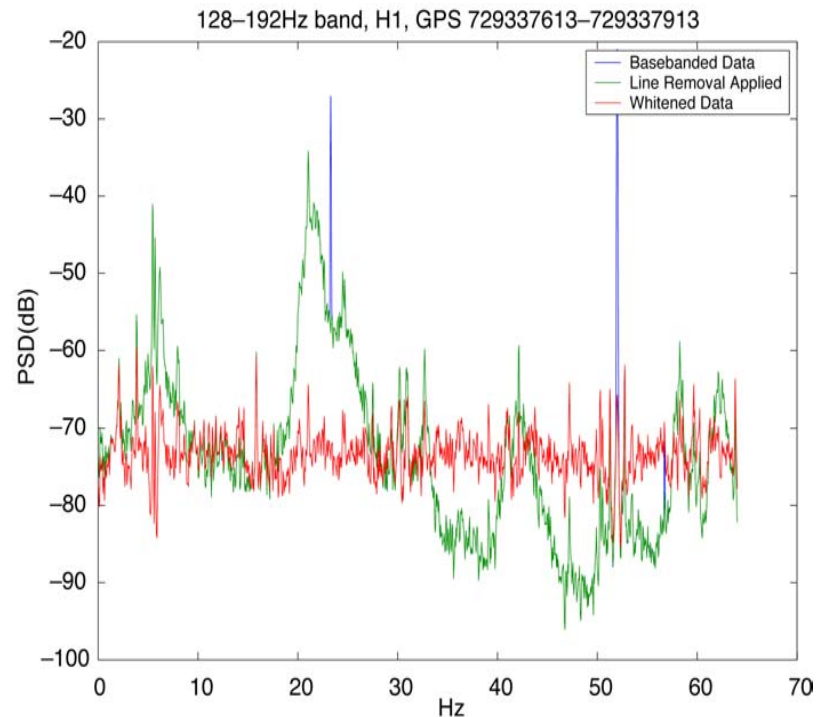
- Developing library of useful filters
 - » Linear predictive filters
 - » Zero phase filters
 - » ...
- Problem with S1 HP filter ringing fixed
 - » Modified Butterworth filter



Shourov Chatterji (MIT)

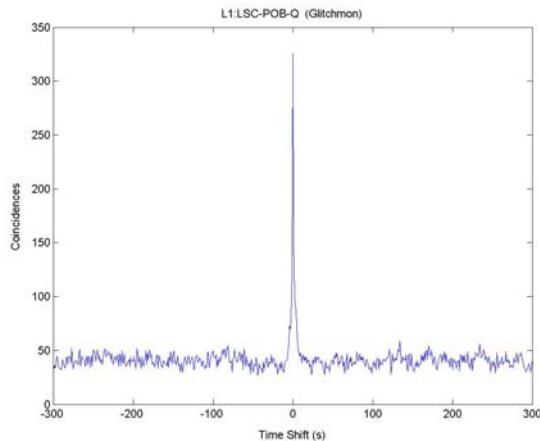
Data Conditioning: Line Features and Whitening

- Line features generally contain significant power and are source of strong glitches
- Burst search engines are most sensitive when input power spectrum is white
- Remove lines
 - » Regress power lines against magnetometers and power line monitors
 - » Model other lines as stochastically excited damped oscillators and Kalman filter
- Whiten
 - » Treat sub-bands separately

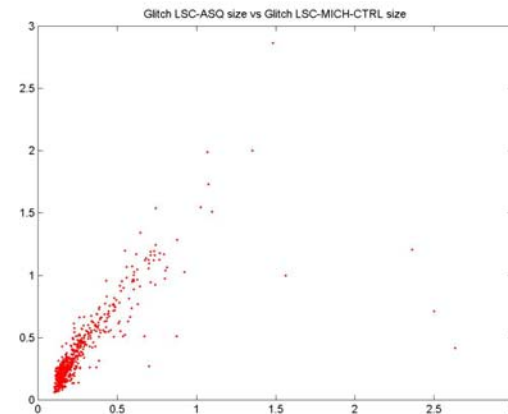


Tiffany Summerscales (PSU)

- Searched through the channels identified as useful in S1, but no dominant cause of false triggers identified
- Best results to date from LLO
 - » zGlitch : LSC-MICH_CTRL ($\epsilon=2.4\%$), LSC-AS_I ($\epsilon=7.0\%$)
 - » glitchMon : LSC-MICH_CTRL ($\epsilon=2.1\%$), LSC-AS_I ($\epsilon=1.9\%$), ASC-QPDY_DC ($\epsilon=4.4\%$)



Number of coincidences vs. Time lag

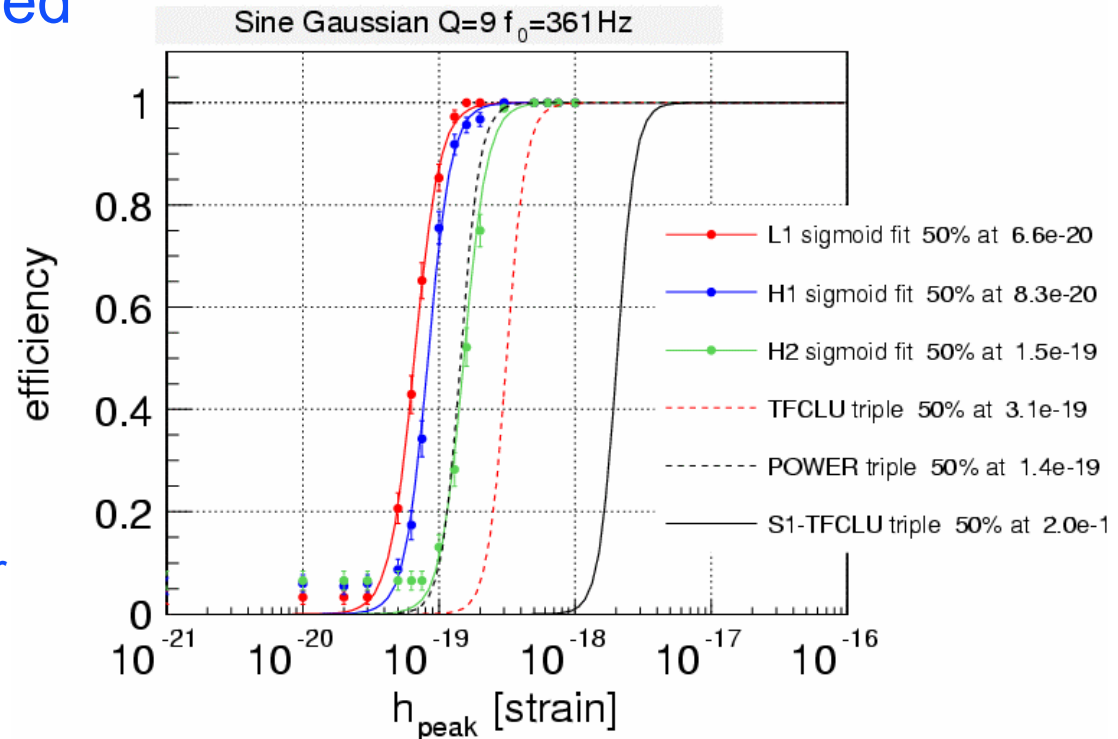


AS_Q strength vs. Veto strength

- Improved tuning for S1 ETGs
- Three “new” ETGs
 - » POWER: uses wavelet formalism to look for periods with excess power in certain frequency bands
 - » BlockNormal: based on identifying change points in data statistics
 - » WaveBurst: correlates excess power in two interferometers
- Where appropriate, process triggers through common Burst DSO for parameter estimation (J. Sylvestre)
 - » Standard Parameter estimator
 - » The fields describing the burst (time, frequency, SNR, amplitude, confidence) now have a physical meaning
 - » Time resolution within 10 ms
 - » Duration and BW estimators not yet implemented

Q=9 Sine Gaussian 361 Hz

- TFCLUSTERS: improved sensitivity
 - » Windowing is activated
 - » Double-threshold system
- The wrapper
 - » Reduced overhead allow faster simulations and parameter tweaking.
 - » PostProcessing also faster due to new interface with EventTool code.



Conversion factor:

$$h_{\text{RSS}} [\text{strain}/\text{rtHz}] = 0.06 h_{\text{peak}} [\text{strain}]$$

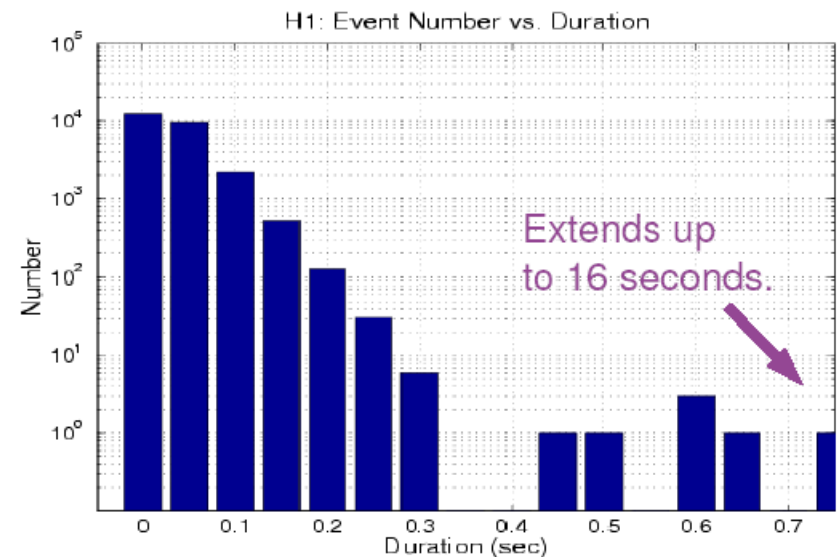
- Compare mean μ , variance σ^2 of each block to the background μ_0, σ_0^2 (measured over 128 sec).
- Accept block as event if

$$(\mu - \mu_0)^2 \geq X \sigma_0^2$$

or

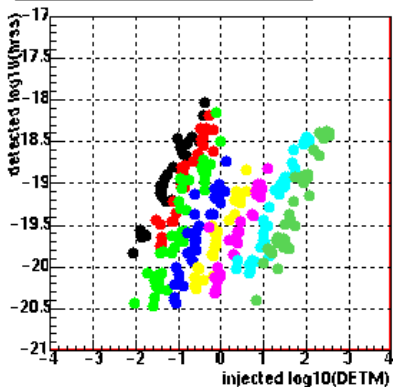
$$\sigma^2 \geq Z \sigma_0^2$$

Stuver, Sutton, Finn,
Ashley, McNabb (PSU)

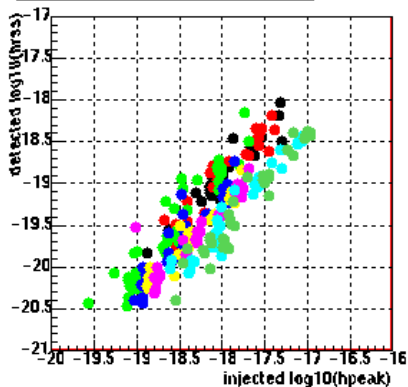


- Testing with Sine-Guassians
- Good agreement between injected and reconstructed hrss
- Good time and frequency resolution

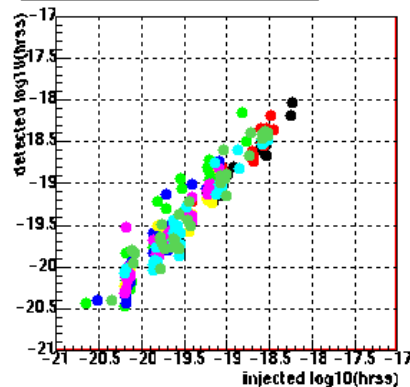
WaveBurst events for H1 injections



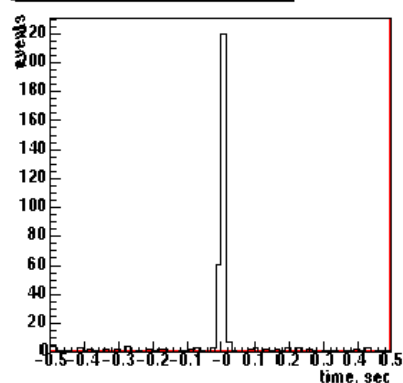
WaveBurst events for H1 injections



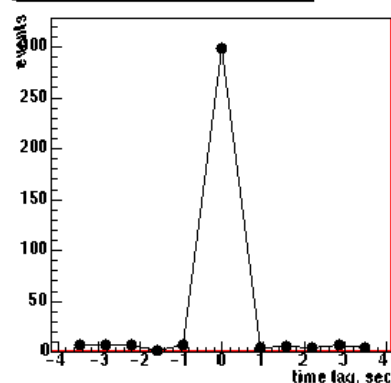
WaveBurst events for H1 injections



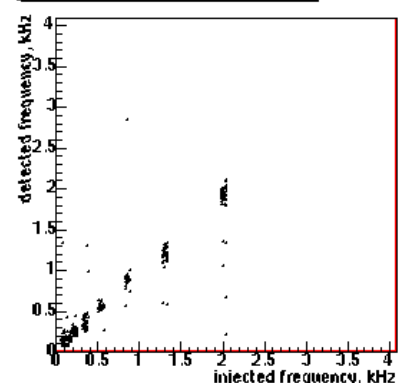
central time - injection time



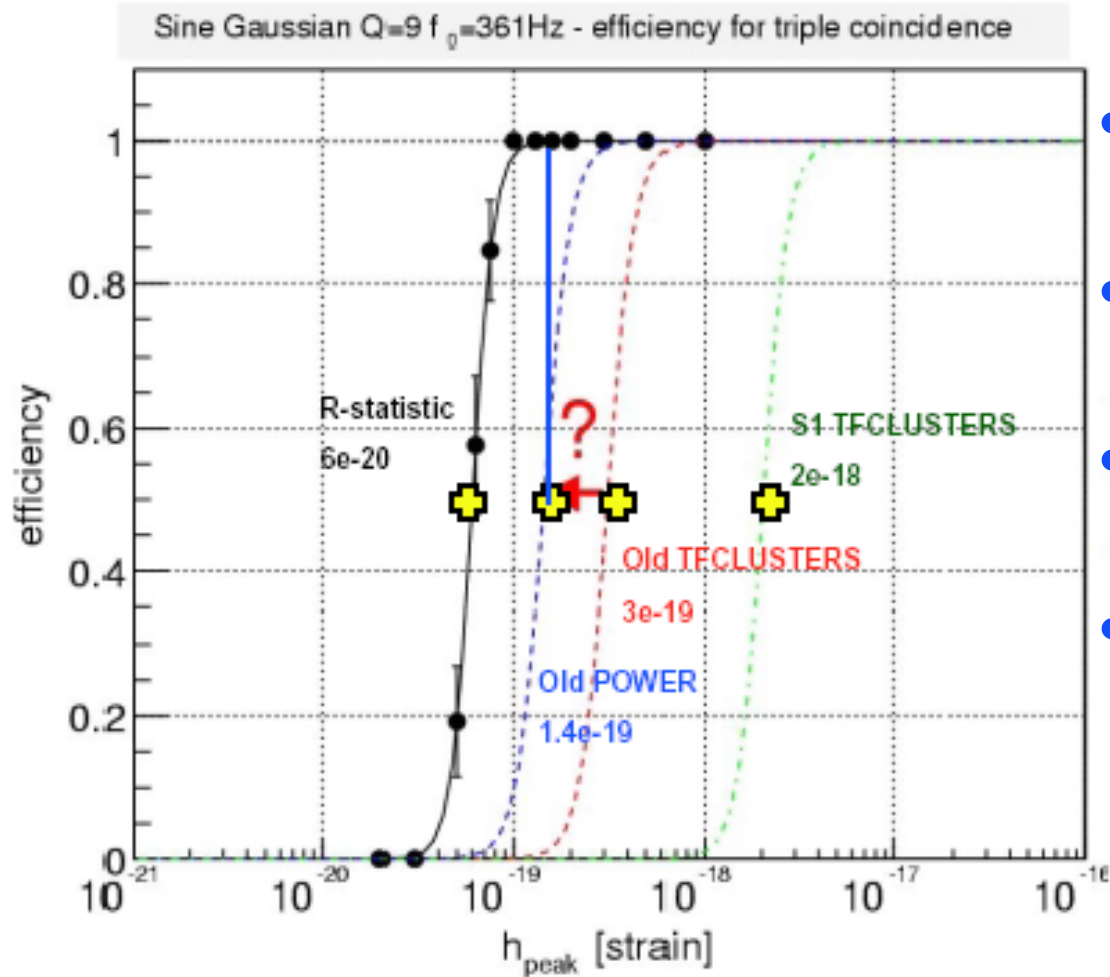
coincidence of WaveBurst triggers with injections



frequency detected by WaveBurst vs injected frequency

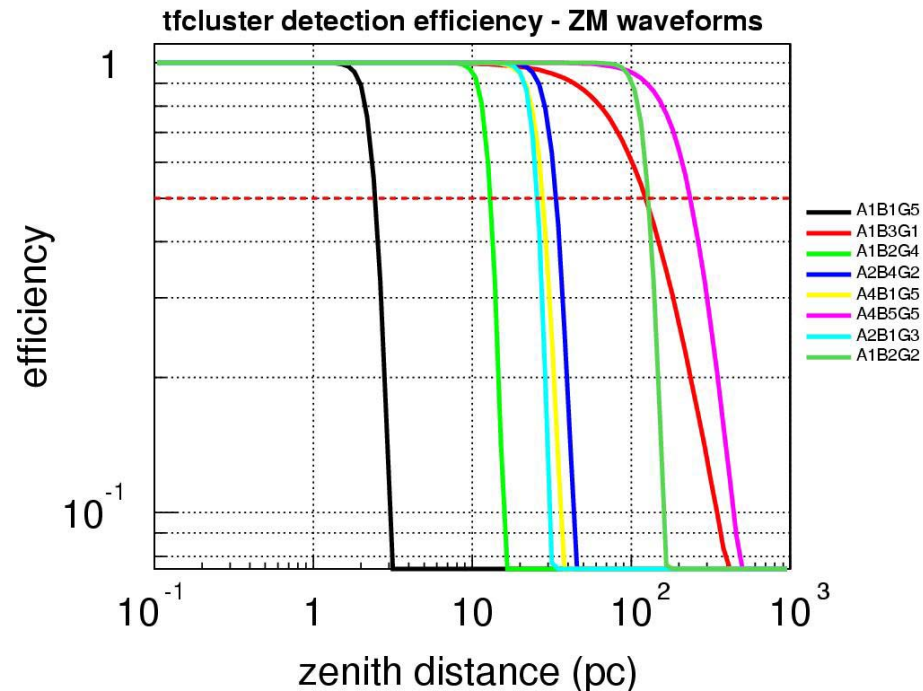
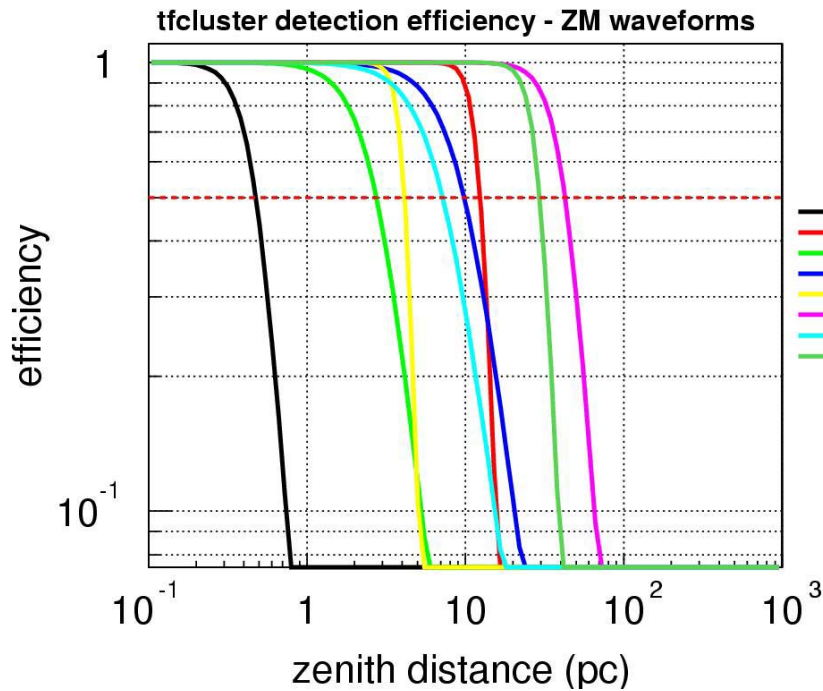


Klimenko (UFL),
Yakushin (LLO)



- Laura Cadonati's r-statistic test
- Tests IFO outputs for similar waveforms
- False coincidence suppression TBD
- Still working on amplitude checks

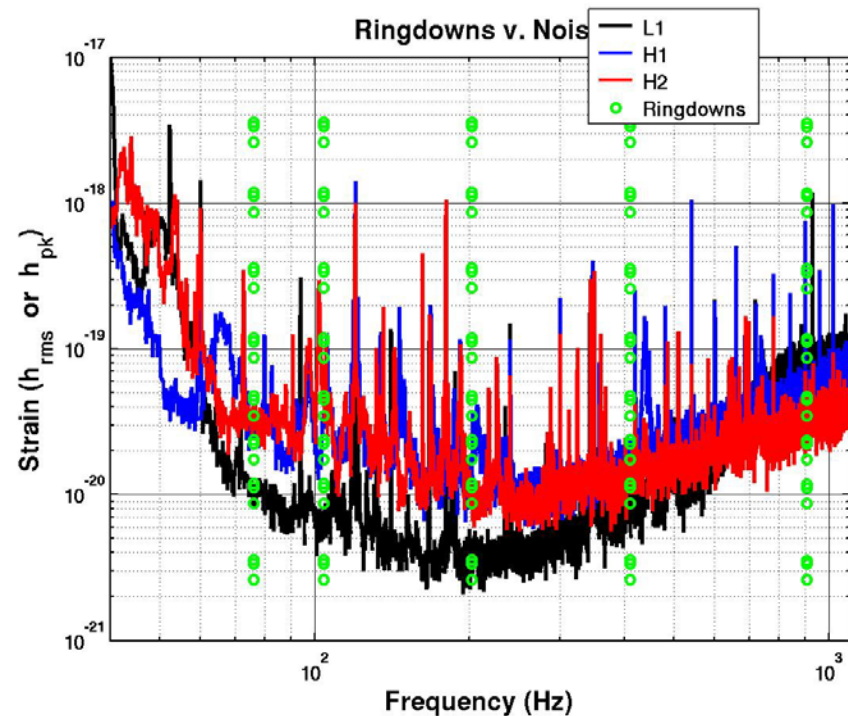
- Zwenger-Mueller core collapse waveforms



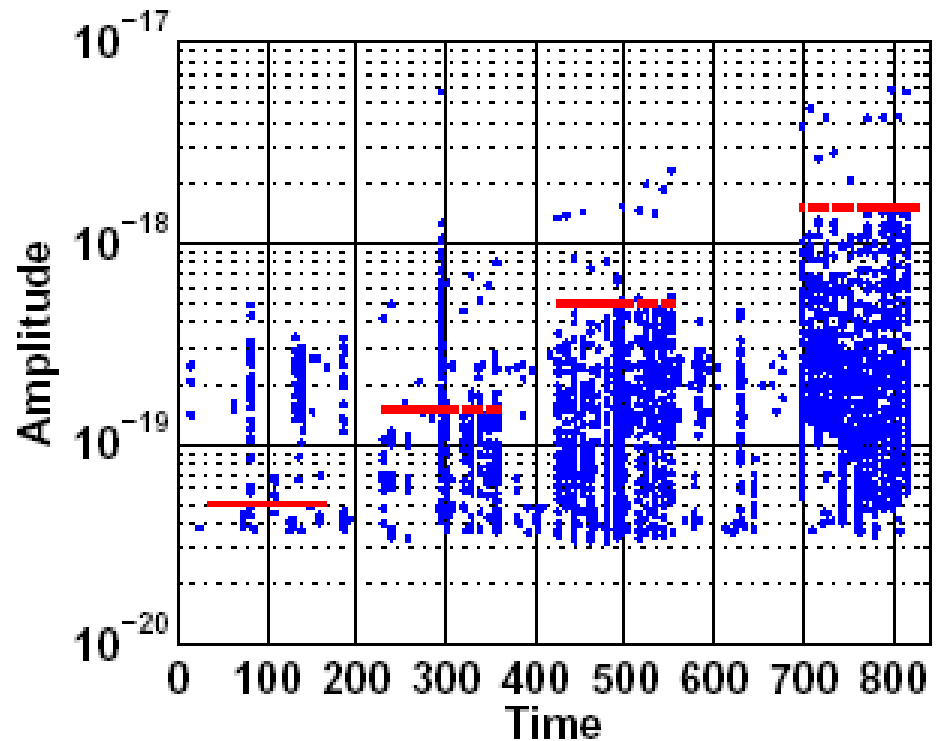
- Improvement from S1 to S2

- Template based search for BH ringdown waveforms
 - » Frequencies from 75-1000 Hz, Q's fro 2-16
 - » BH mass 13 – 350 solar masses, spin from 0 to .99 max
- Search code operational, tuning in progress
- Hardware injections
 - » Strengths spanning too small to see to obvious in time domain

Rana Adhikari (MIT)



- Preliminary analysis of hardware injections
 - » Raw triggers, not clustering or maximization over templates
 - » Indication that the search is able to detect things
- Rana:
 - » “Need to cluster/combine events”
 - » “Need to do frequency cut”
 - » “Need to do amplitude cut”
 - » “Should try to see if an χ^2 test would be useful”



Where do we go from here?

- Goal: to have S2 results to report at next LSC meeting
 - Data quality/selection nearing completion
 - Data conditioning SW functioning and ready for comparisons
 - ETG tuning on playground data underway
 - R-statistic ready for post-coincidence implementation
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- Possible results from template analysis