BURST MDC FRAMES

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Motivation

- There are currently several algorithms for burst searches: tfclusters, slope, power, waveburst, blocknormal, external trigger search. Each data pipeline has its own way of measuring efficiency and other characteristics of the algorithms.
- There is a need for a common benchmark test that would compare algorithms by
  - triple coincidence efficiency for various waveforms;
  - an ability to accurately reconstruct properties of the detected events;
  - background event rate.

Motivation

- Some of these algorithms use LDAS and LAL (tfcluster, slope, waveburst), some only use LAL and run under Condor (power), some use Matlab (blocknormal, external trigger, r-statistics), etc. The only common denominator is that all the ETGs must be able to read frames.
- Therefore we proposed at last LSC meeting to generate burst MDC frames in which a software generated signals are added to AS_Q channel in all interferometers.

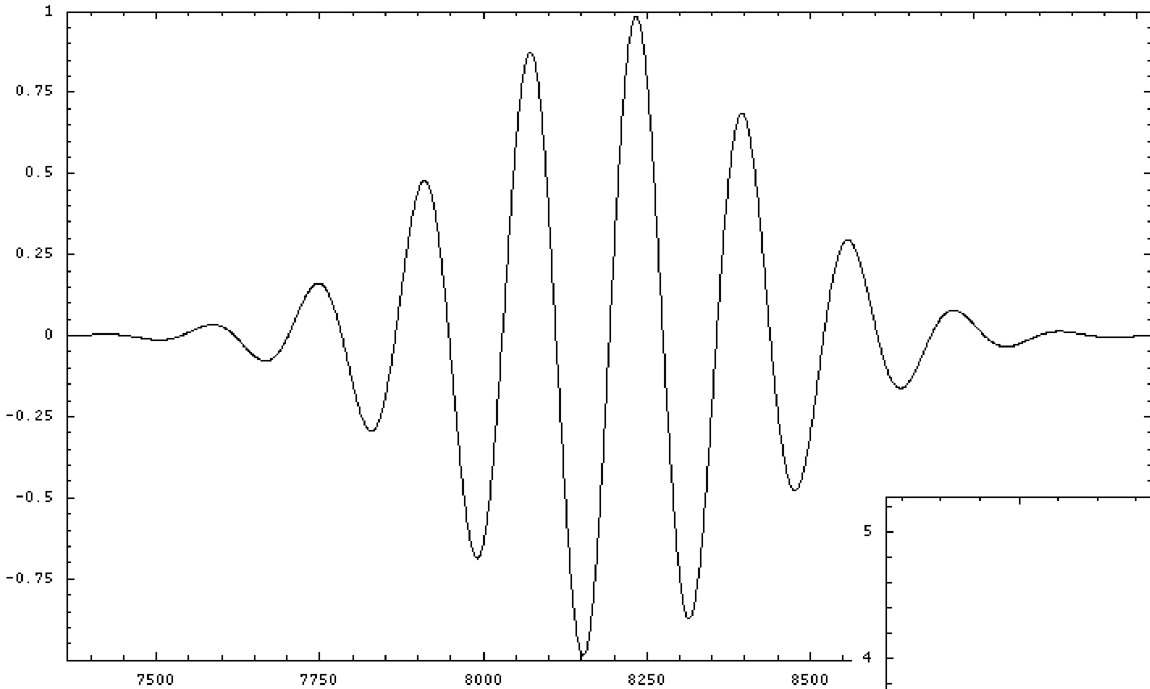
Choice of time intervals

- Playground S2 data is chosen according to [1] . Only those 600s playground time intervals were used that were entirely inside a triple coincidence lock segment. The total number of such intervals is 128, ≈21 hours.
- Each frame consists of 20+600+20 seconds of AS_Q data from all three interferometer. Injections are done only into playground 600s interval, one injection per 9 s.

Currently available MDC frames:

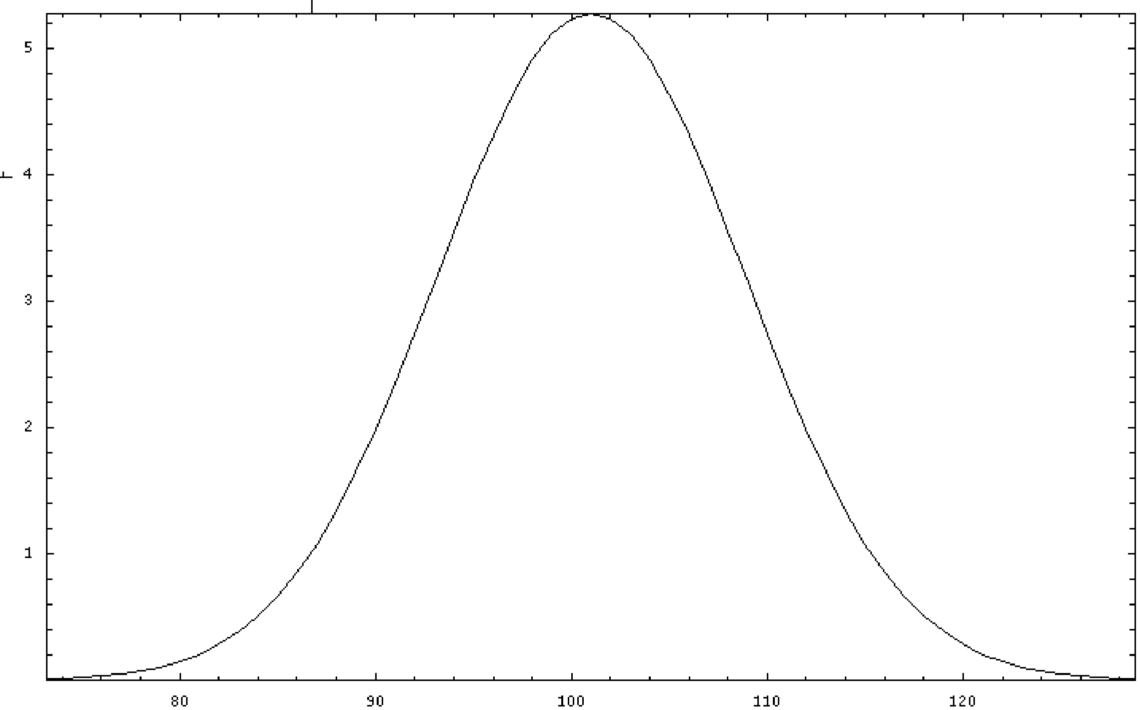
- Sine-gaussian, optimal orientation, one polarization: SG153Q3, SG153Q9, SG235Q3, SG235Q9, SG554Q3, SG554Q9, SG1304Q3, SG1304Q9 generated as in [2].
- BH-BH merger, all sky, two polarizations for 10, 20, ..., 100 solar masses [3].
- Gaussian, optimal orientation, one polarization with duration 0.1, 0.5, 1.0, 2.5, 4.0, 6.0, 8.0, 10.0 ms generated as in [2].
- Time shifted injections where SG235Q9, hrss=1.0E-20 was injected at some random 5*n time shift between LLO and LHO, n=-23,-22,...,0,...,23.

Waveforms: sine-gaussian

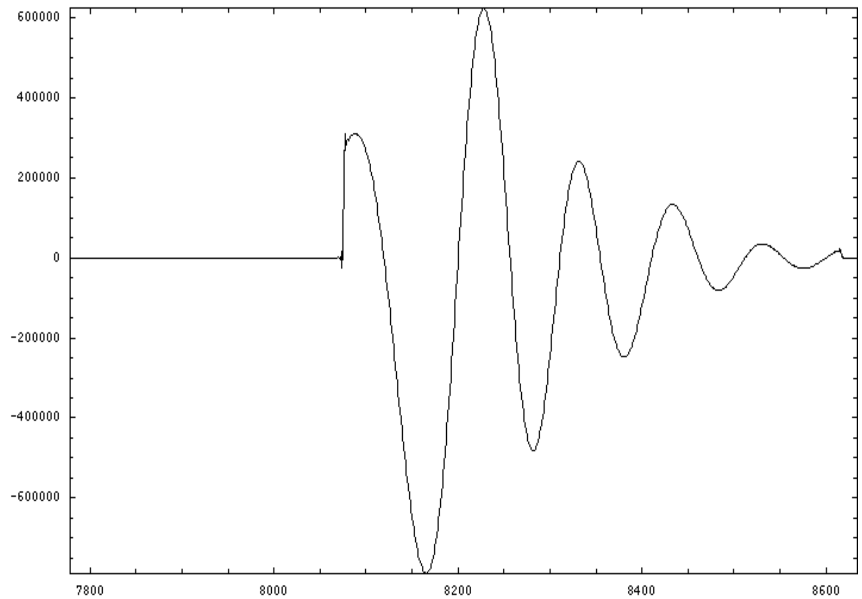


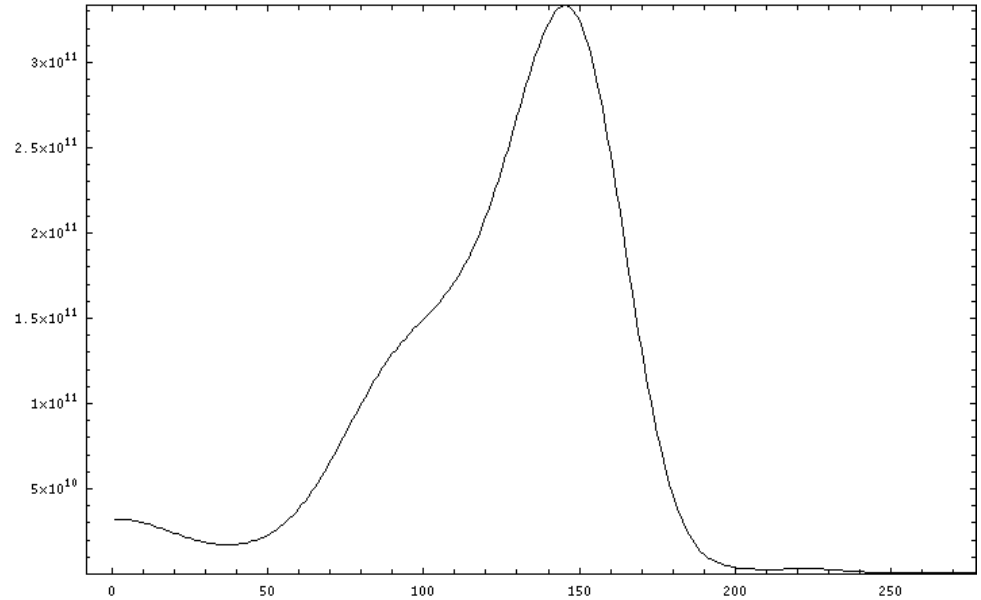
Time series

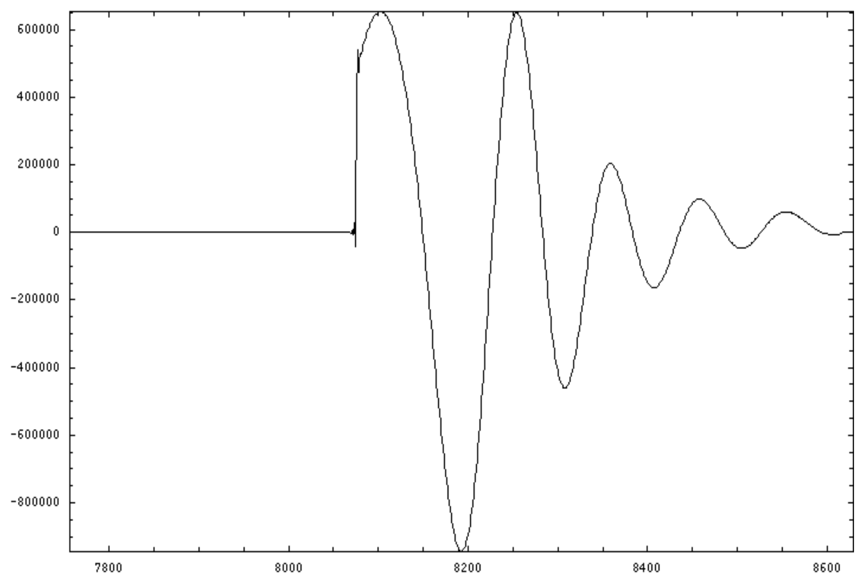
Spectrum

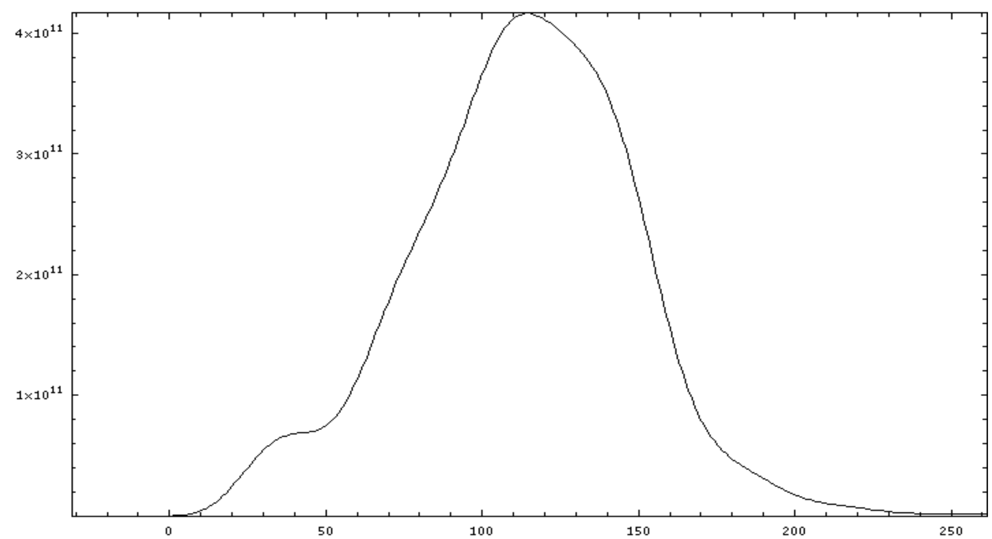


Waveforms: BH-BH merger

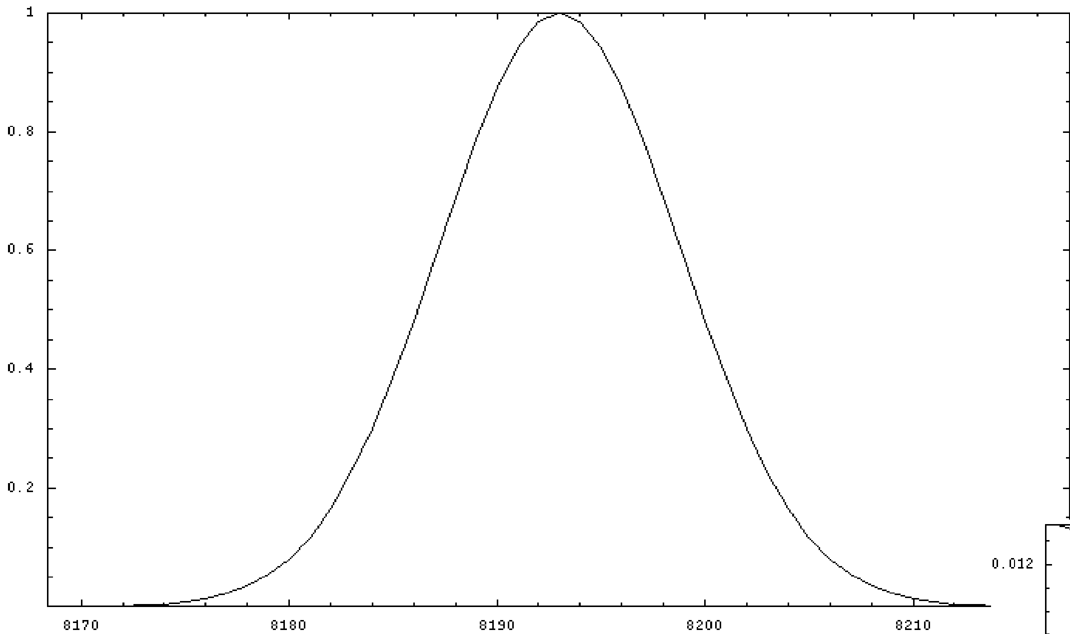






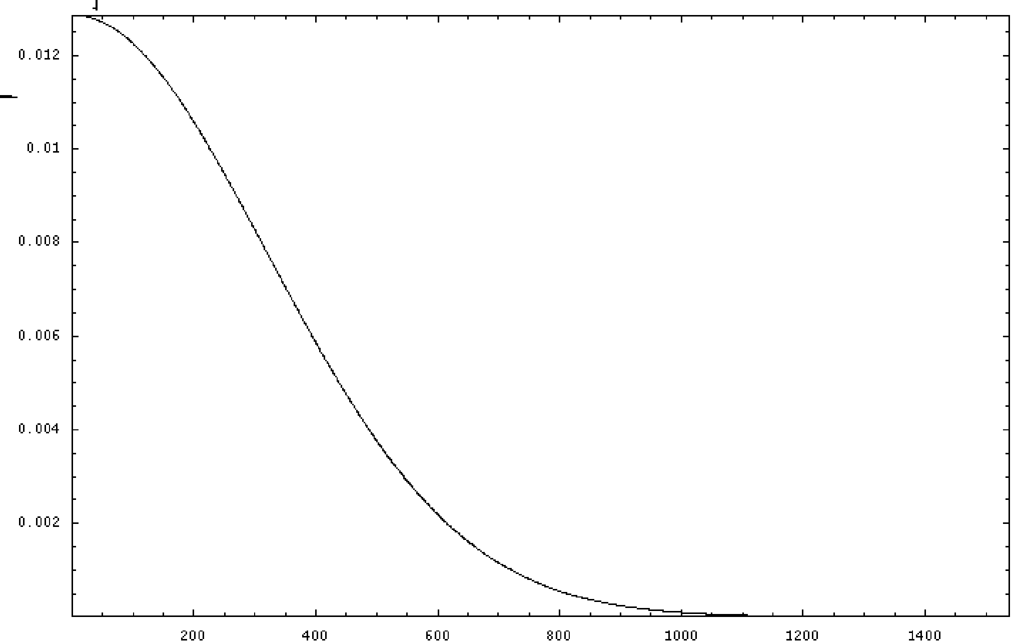


Waveforms: gaussian



Time series

Spectrum



Constructing frames

- Optimal orientation, one polarization frames (sine-gaussian, gaussian) are generated as follows:
  - Delay in arrival time between LLO and LHO is uniformly distributed between -10 and +10 ms;
  - An extra common delay from 20 to 200 ms is added to both sites to simulate random arrival time within time resolution of the algorithms;
  - Strains are randomly chosen from a list of ≈10 strains;
  - Waveforms are randomly chosen from the lists above;
  - One injection per 9 seconds;
  - FpLLO=FpLHO=1, FxLLO=FxLLO=0.

Constructing frames

- All sky, two polarization (bh-bh merger) frames are constructed as follows:
  - A source position is uniformly chosen over the sphere;
  - Polarization angle is generated randomly from a uniform distribution;
  - Beam pattern coefficients and delays are computed from the source position and polarization angle, see [5,6] for details.

Implementation

- A sky position and polarization are randomly chosen and the corresponding delays and beam pattern coefficients are computed in Matlab (Malik wrote this program based on [6]).
- The above list together with lists of strains, waveforms and lock intervals are taken by a perl script to generate the final list of injections into all 3 ifos.
- A TCL script takes the list of injections and ilwd files with waveform time series and submits an LDAS job that creates frames.
- Each frame is 120Mb. Total size of generated frames for each set of injections is 14Gb. It takes about 12 hours to generate these frames using LDAS.

Summary and plans

- MDC frames proved to be very useful to compare performance of burst ETGs.
- We plan to generate more MDC frames for various astro-physically motivated waveforms.
- Proposal: Use MDC frames for 1) detection fire drill and 2) black box software validation. Let the burst group reviewers generate MDC frames (without showing the list of injections to the burst group!) and ask all ETGs to find the injections and reconstruct their properties. Validate each ETG separately and the burst group data pipeline as a whole.

References

1. T030020-01. S2 Playground data. L.S. Finn and P. Saulson.
2. Gr-qc/0312056. First upper limits from LIGO on gravitational wave bursts.
3. Astro-ph/0202469. Modeling gravitational radiation from coalescing binary black holes. J. Baker , M. Campanelli , C.O. Lousto, R. Takahashi. Phys.Rev. D65 (2002) 124012
4. Burst MDC page:http://www.ligo-la.caltech.edu/~igor/MDC
5. T040042-00-Z. Burst MDC frames (in preparation).
6. T030215-00-D. Angular correlation of LHO and LLO interferometers. S. Klimenko, M. Rakhmanov