Einstein Telescope Mock Data Analysis

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*(with many slides and plots shamelessly stolen from Katarzyna Wójcik)*

Outline

- Introduction
- ET Mock Data
- Pipeline
- Results
- Summary

About the ET Mock Data

- Binary neutron star signals (TaylorT3, 3.5PN in phase) injected into simulated Gaussian noise coloured with the ET pre-design PSD
  - Signals injected according to a Poisson rate up to $z = 6$
  - Distribution as a function of red-shift according to some plausible model (for more details, see Tania's talk from yesterday)
  - All the parameters fixed but not known during search
- No glitches

Data characteristics

- Distribution of injections as a function of some parameters:
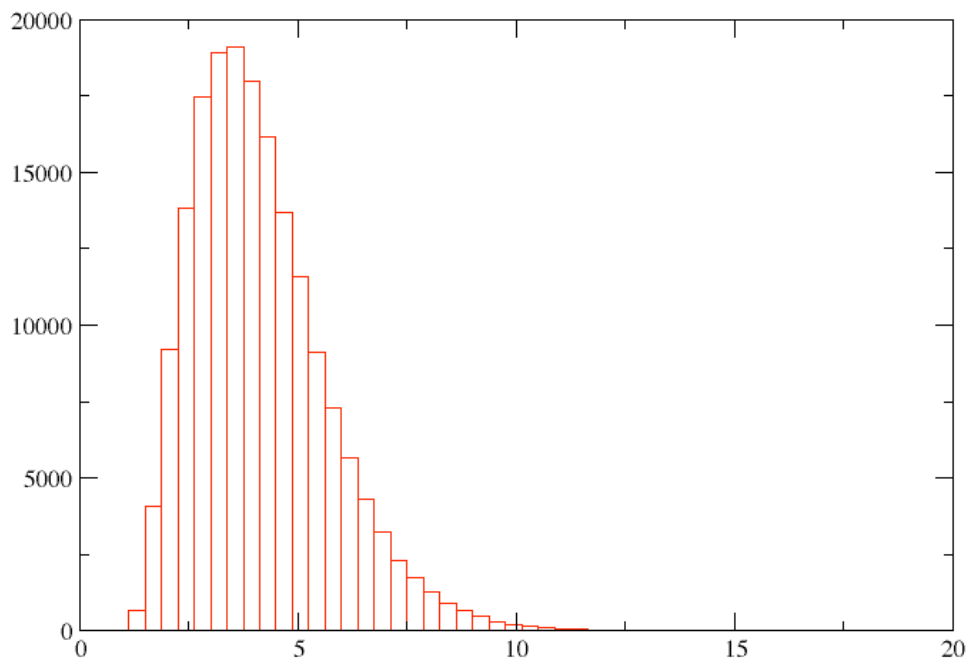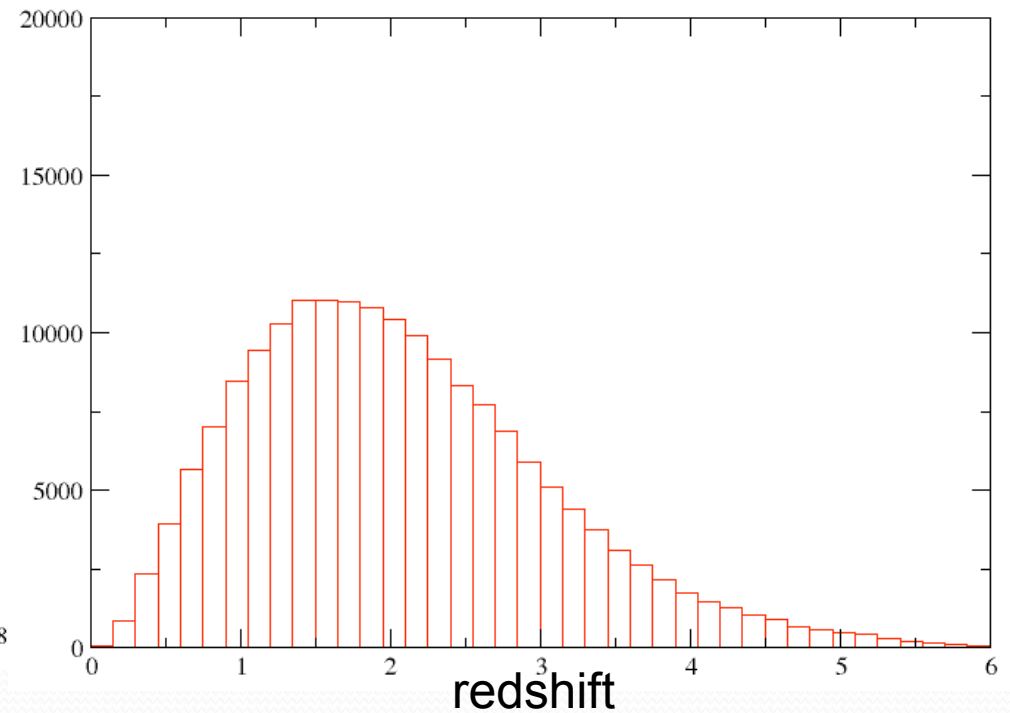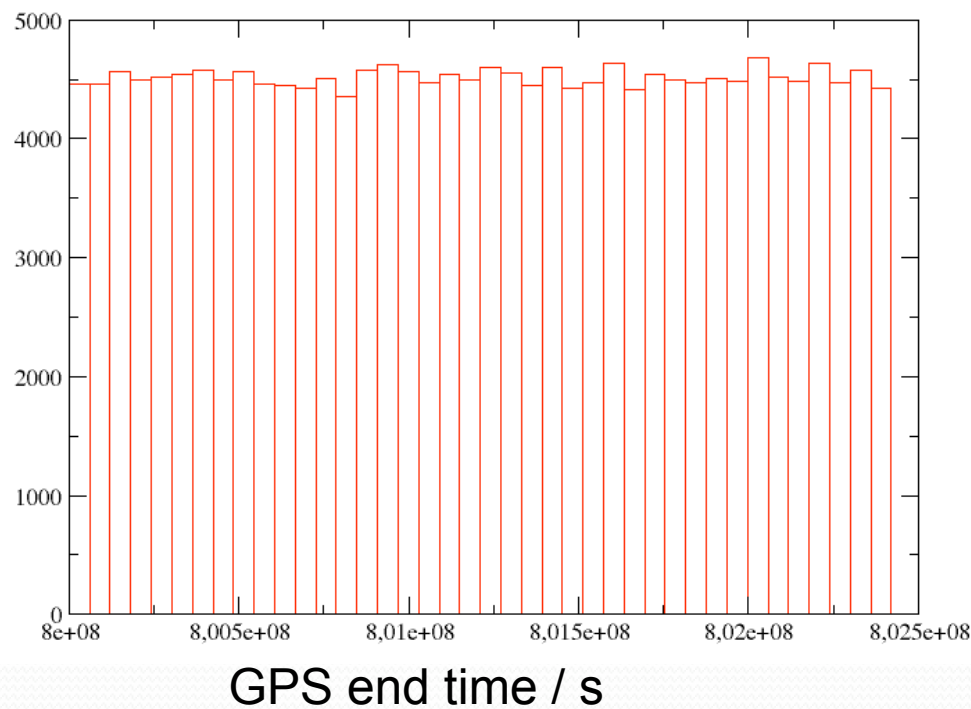

Chirp mass / solar mass
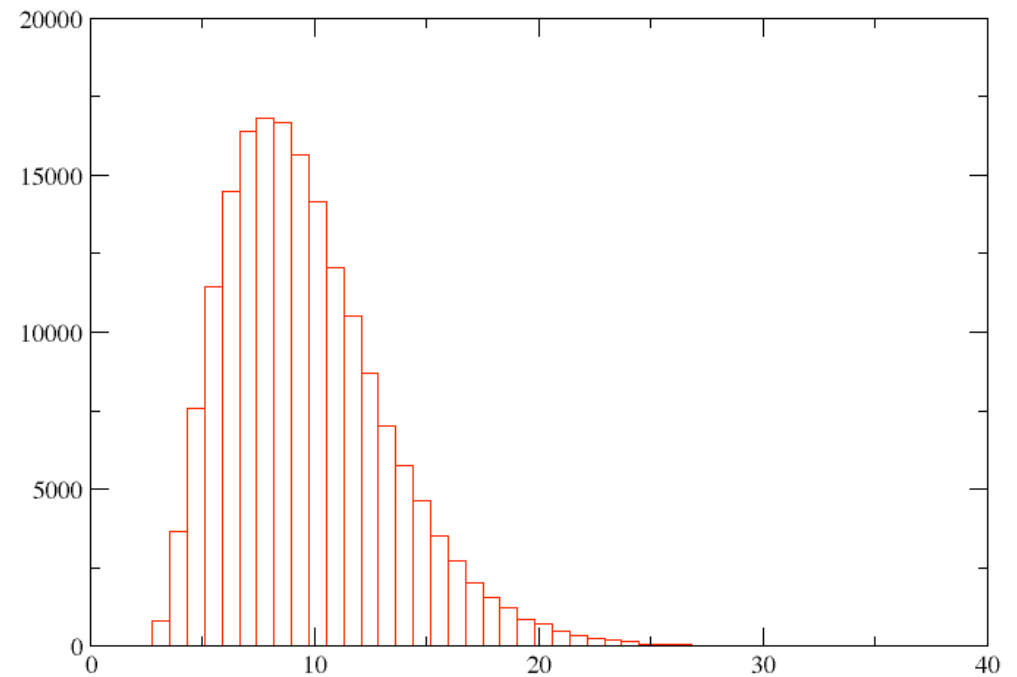
Total mass / solar mass

Distribution of injection as a function of (redshifted) chirp mass and (redshifted) total mass

Data characteristics

- Distribution of injections as a function of some parameters:

GPS end time / s

redshift

Distribution of injection as a function of time and redshift
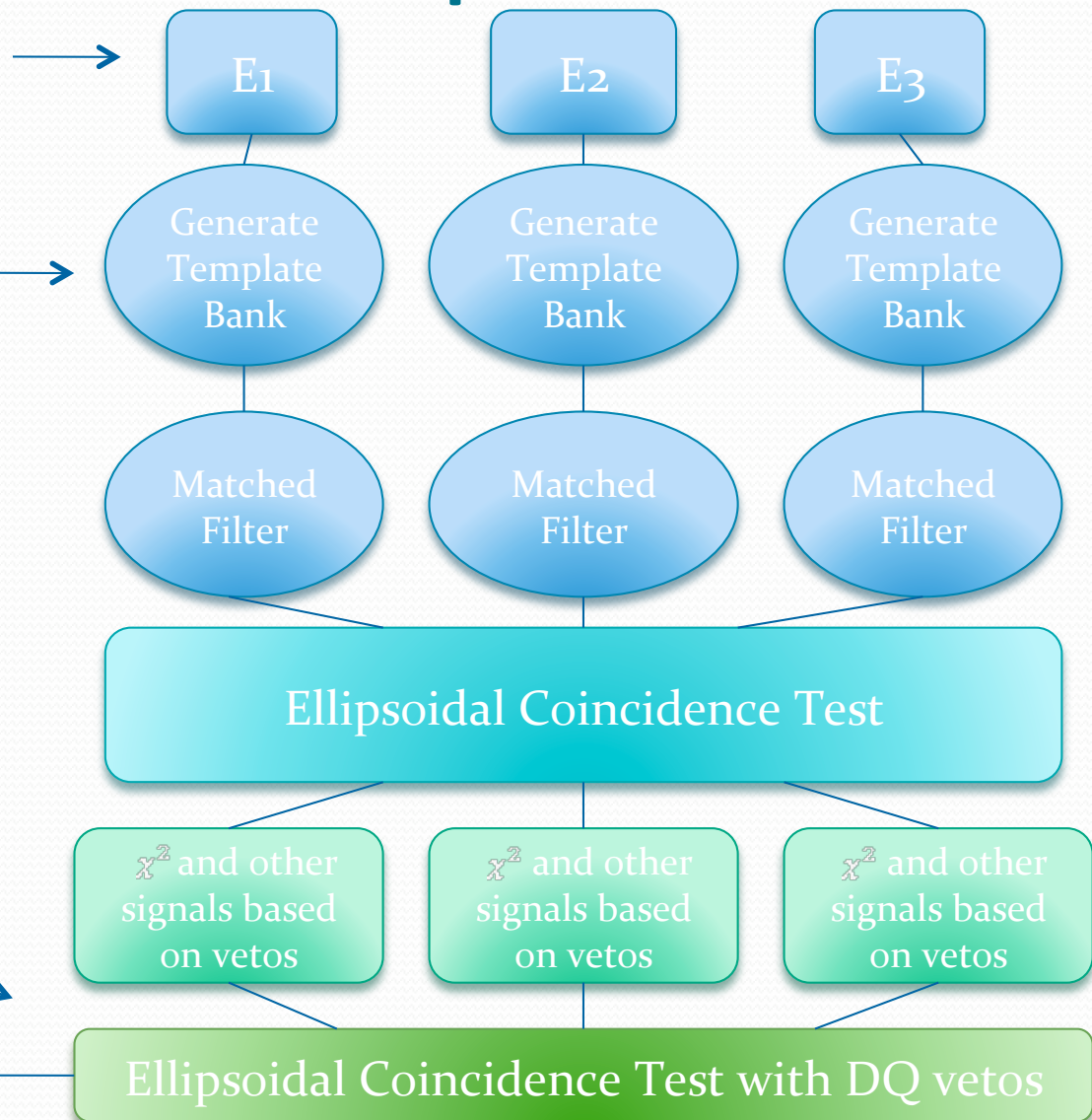
Data analysis - the Pipeline

One data set per detector $\rightarrow$

The waveform depends
On the system parameters

Require coincidence
between detectors

Signal based vetos

Instrumental vetos

E1 E2 E3

Generate Template Bank Generate Template Bank Generate Template Bank

Matched Filter Matched Filter Matched Filter

Ellipsoidal Coincidence Test

x^2 and other signals based on vetos x^2 and other signals based on vetos x^2 and other signals based on vetos

Surviving coincidence triggers $\leftarrow$ Ellipsoidal Coincidence Test with DQ vetos

Pipeline details

- Standard ihope pipeline – similar to that used in current LV searches
- Parameters chosen largely conform to those used in current searches
  - e.g. low frequency cutoff set to 40Hz
  - Tuning of coincidence tests etc taken straight out of recent ini files
  - False alarm rate estimates obtained from time-slides – inappropriate in the presence of many strong signals
  - Almost certainly not optimal for ET, but a good test to see how we do 'out of the box'

Template bank

- Covering the full space of low-mass CBC search leads to huge numbers of templates (~20 000 templates)
- Reduction of number of templates by making changes in parameters:

- Assume reasonably symmetric systems

  minimum eta =0.18

  maximum eta=0.25

- restriction of other parameters:

  minimum mass =1.2$M_\odot$

  maximum mass =7.0$M_\odot$
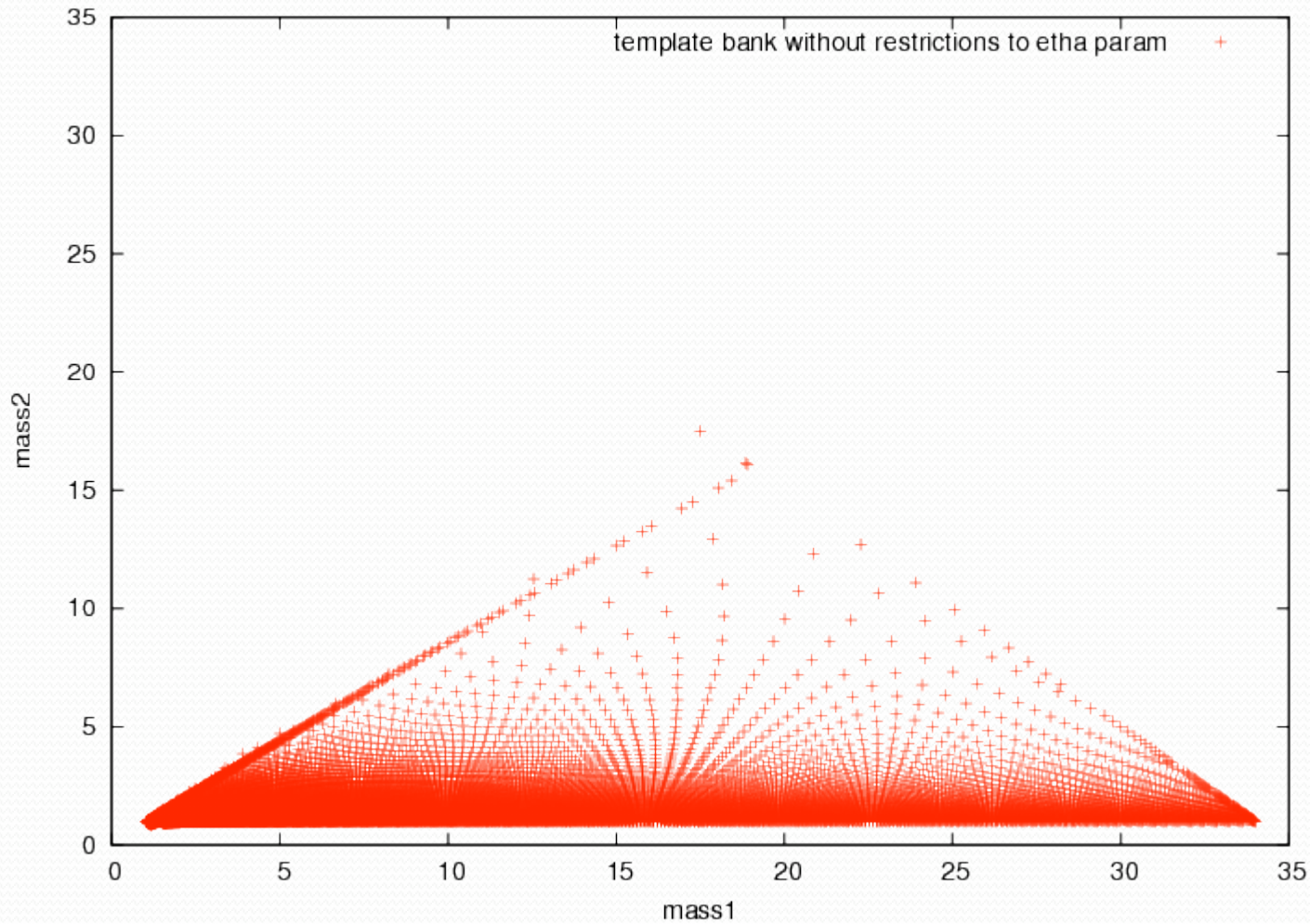
  maximum total mass =14.0$M_\odot$

Template bank

Figure 1. Plot of about 20 000 templates before changes in parameters
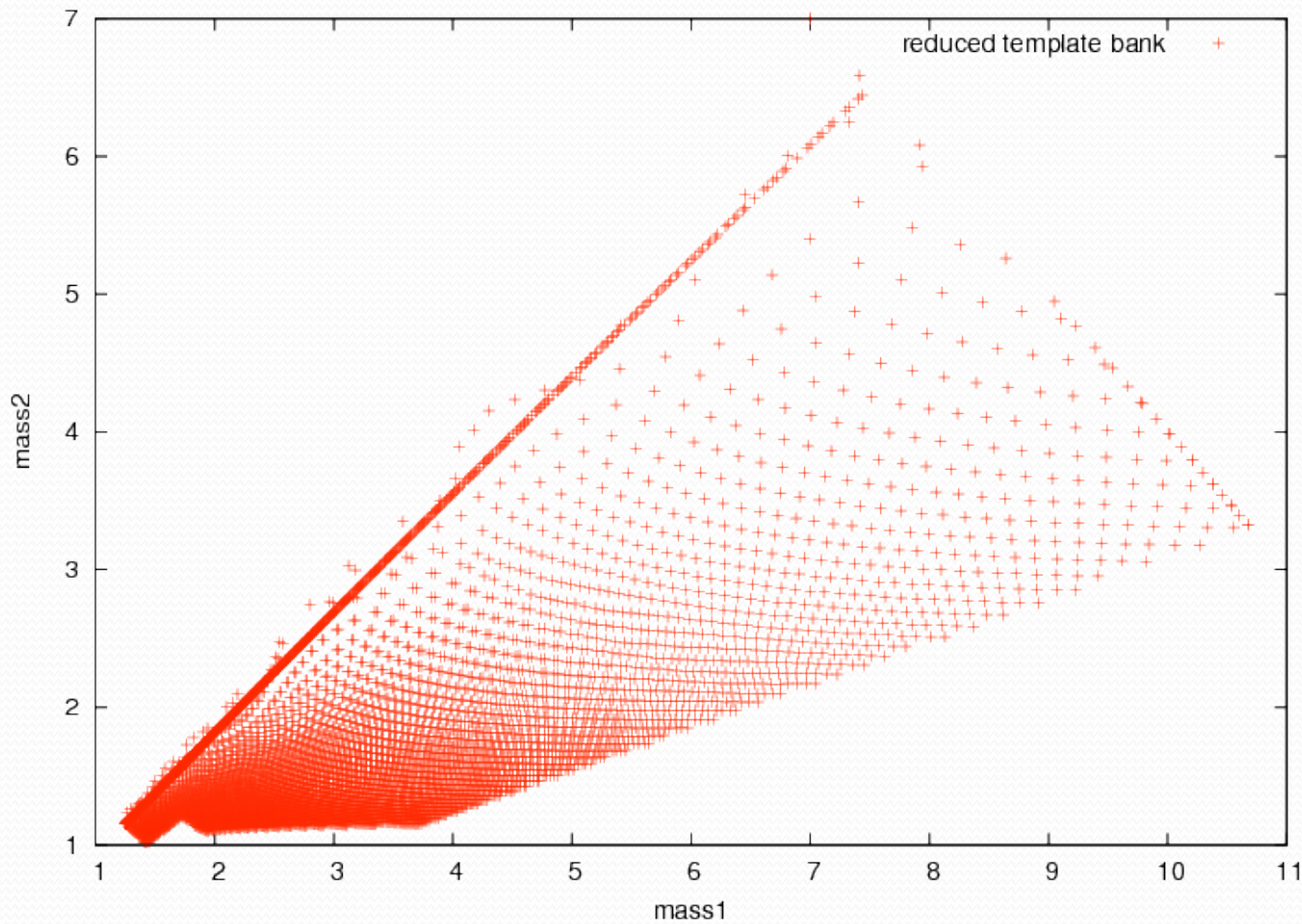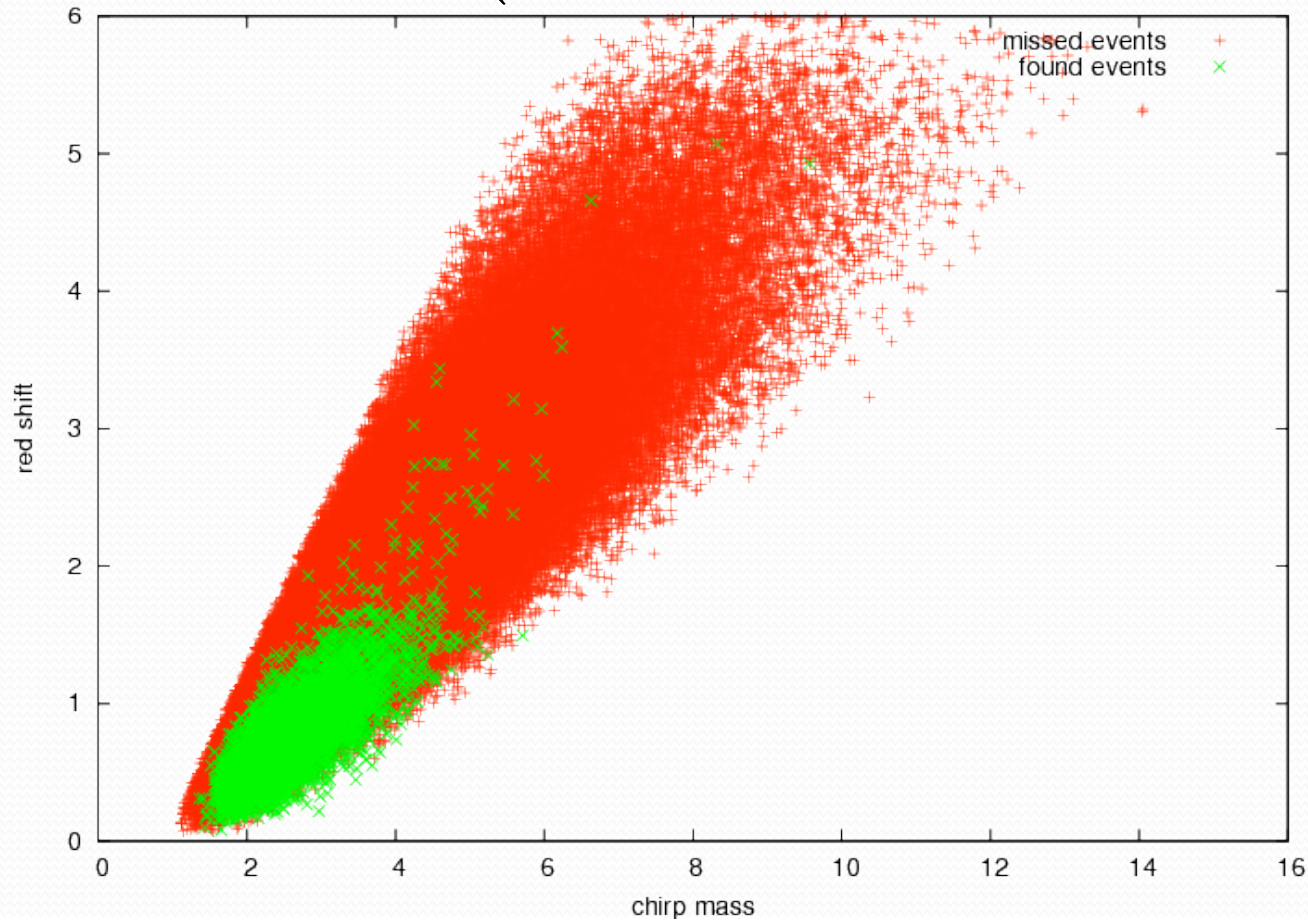
Template bank

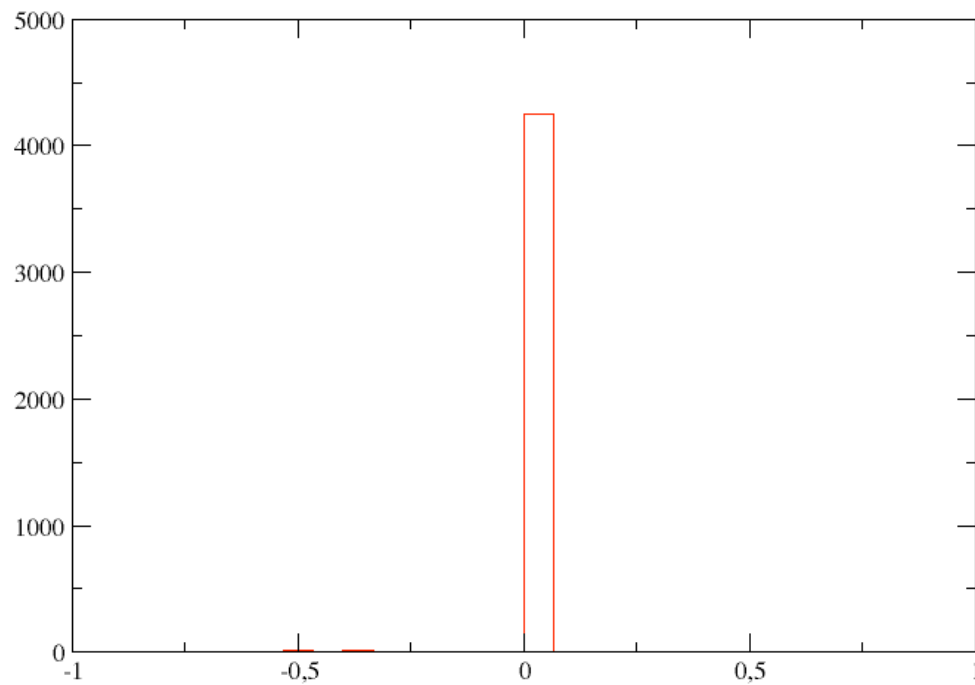Figure 2. Plot of reduced template bank including around 6000 templates

Results

- The simulated ET data included 180062 injections
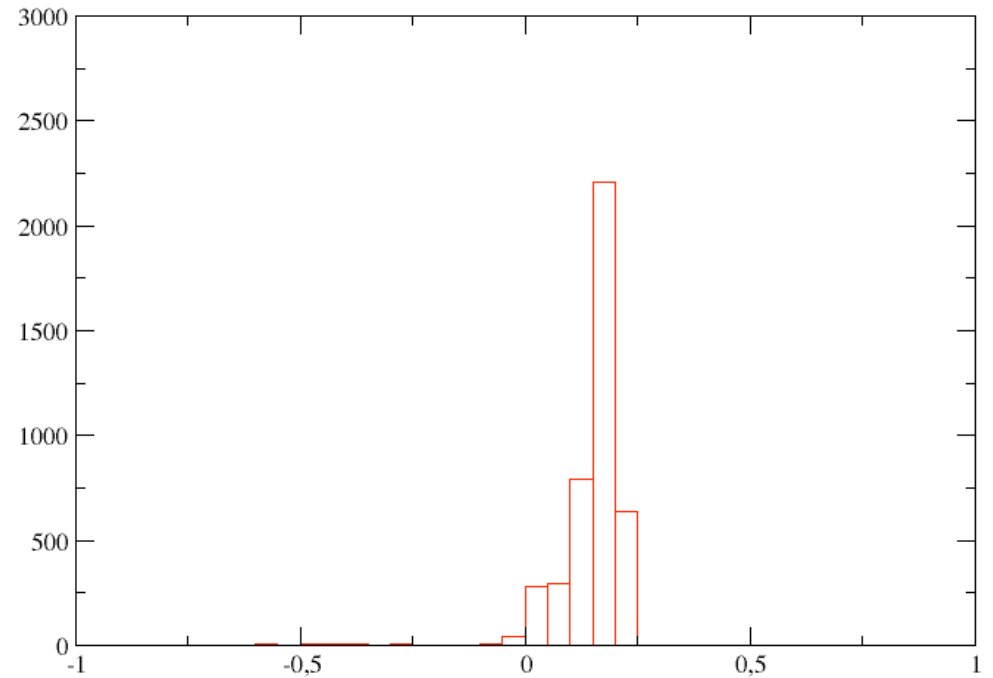- We managed to find 4953 unique events with estimated FAR of 0 (i.e. louder than all time slides)

Results
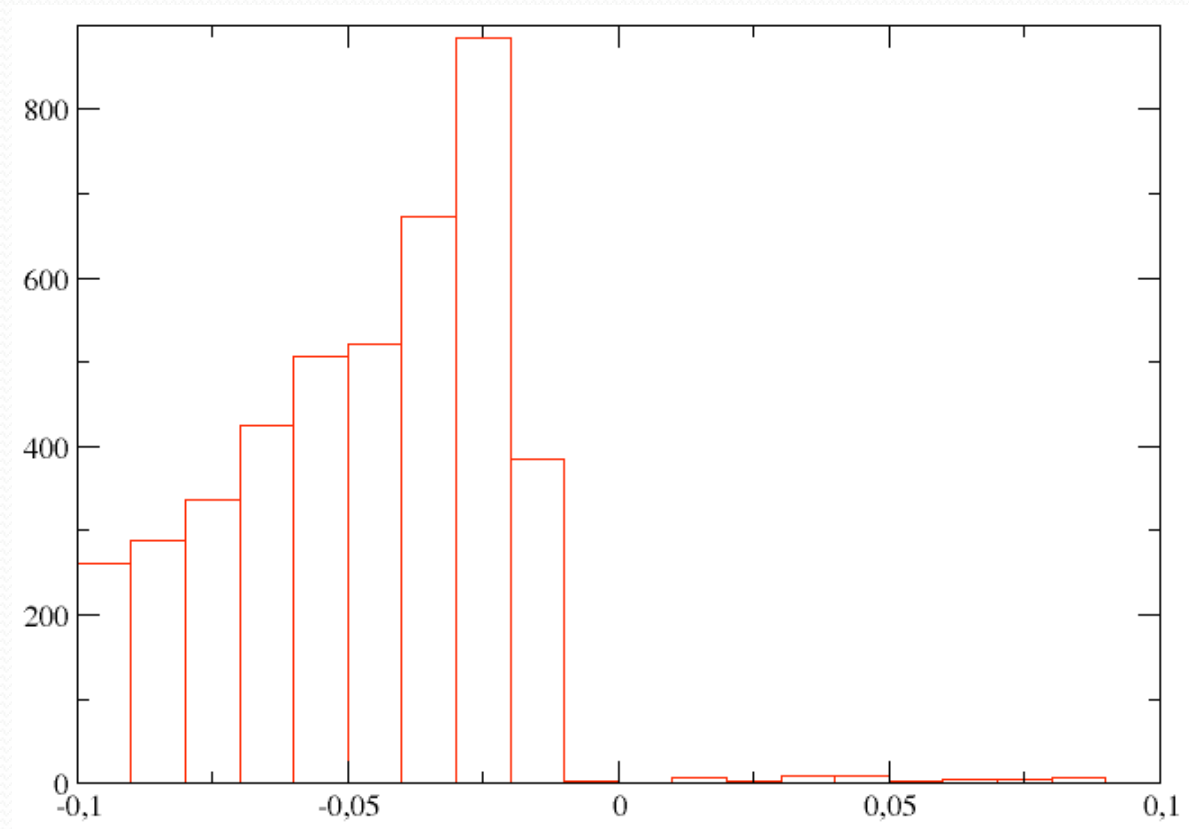
Histograms of errors in the measured parameters:

Fractional error in Mchirp

Fractional error in total mass
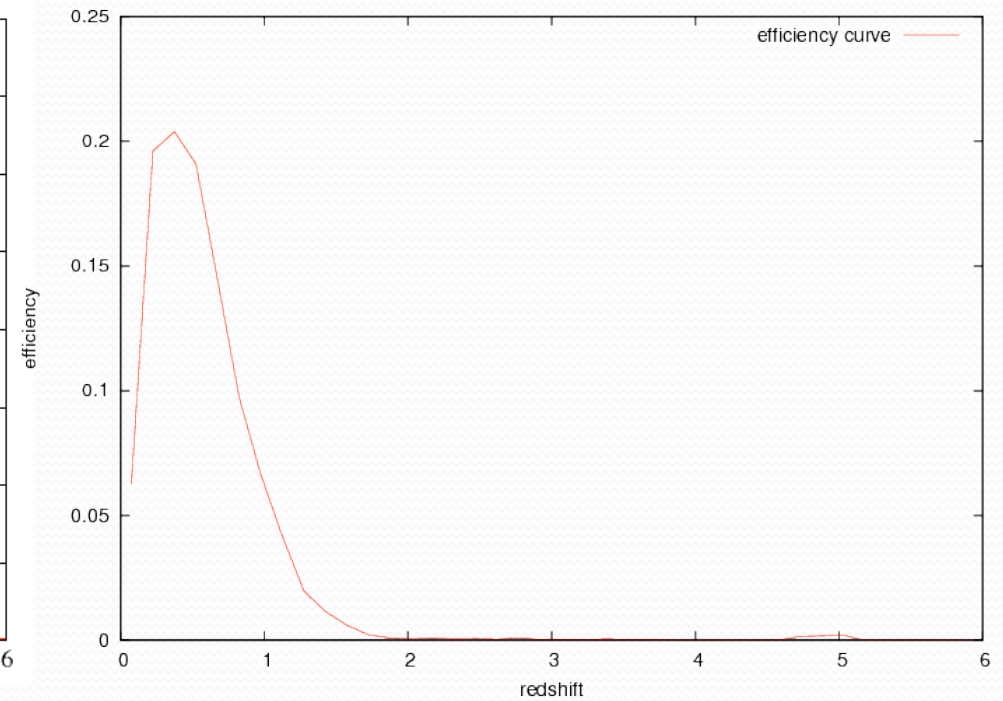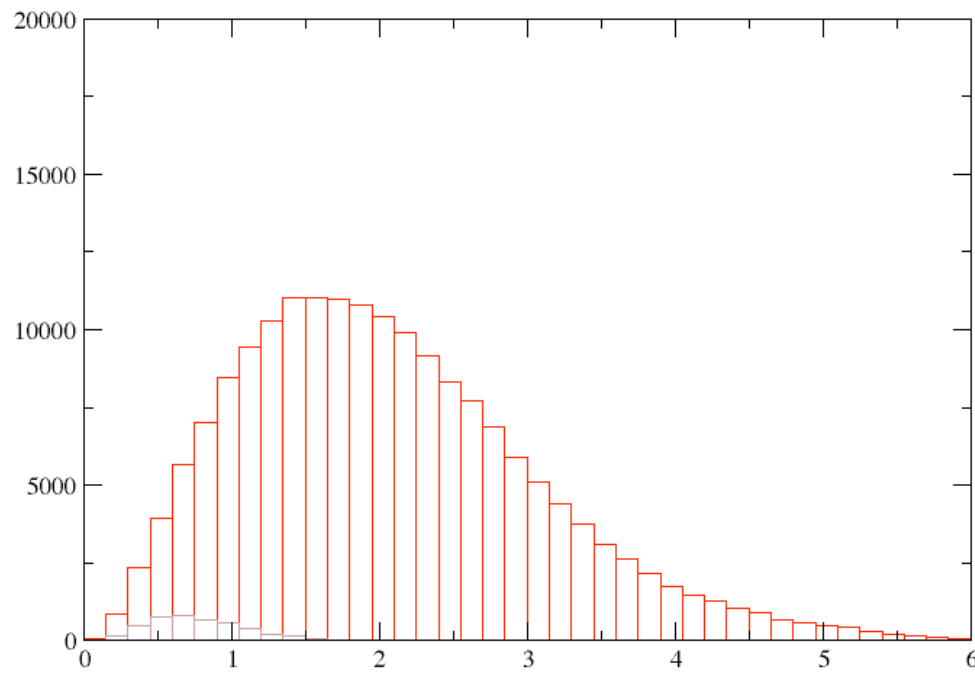
Results

Histograms of errors in the measured parameters:

Error measured in the end time

Results

Efficiency curve:

Distribution of injection and found events as a function of redshift and efficiency as a function of redshift

Summary

- We managed to find only a fraction of signals which were hidden in the data using standard pipeline
- Only nearby events were found, and even then many were missed
  - Systematic at low chirp masses likely due to template bank used
- Detailed information and plots are on the webpage:
  https://atlas.atlas.aei.uni-hannover.de/~kwojcik/LSC/ETData/800000000-802420736/