Waveburst version 5 performance

Sergey Klimenko and Igor Yakushin

LSC meeting, ASIS, LHO, August 2004

LIGO-G040389-00-Z

Changes from v3 to v5

- V3 (LAL/LDAS) was presented at March LSC meeting;
- V4 fixed some minor bugs found during waveburst review: asymmetry in coincidence, error in TCL script that threw out some good data (<2%), bugs in livetime calculations. This is the reviewed version used for S2 paper.
- V5 is a major upgrade to be used in S3 and S4:
  - Multiresolution wavelet analysis makes waveburst sensitive to a wider range of signals, in particular, the sensitivity at low frequencies is improved by a factor of 2;
  - DMT/Condor platform: while doing 5 times more, it runs at least 10-15 times faster; shorter development cycle;
  - No longer limited to work with fixed size time intervals (120s), only 4 seconds at the beginning and at the end of a lock segment is lost (but lock segment should be at least 60 seconds) ;

- V5 is a major upgrade to be used in S3 and S4:
  - The ETG is organized as a ROOT script that loads compiled C++ dynamic libraries; as a result it is very easy to change the data pipeline and try different configurations without recompiling;
  - V5 can be easily configured to run in a single-, double- or N-ifo mode (v4 was limited to double coincidence jobs); the results in this presentation are obtained using triple coincidence mode: instead of running 3 jobs on each ifo pair we now run just one job on 3 ifos simultaneously;
  - Each Condor job puts an output into a ROOT file;
  - The size of data products is reduced by a factor of 50 in comparison with v4.

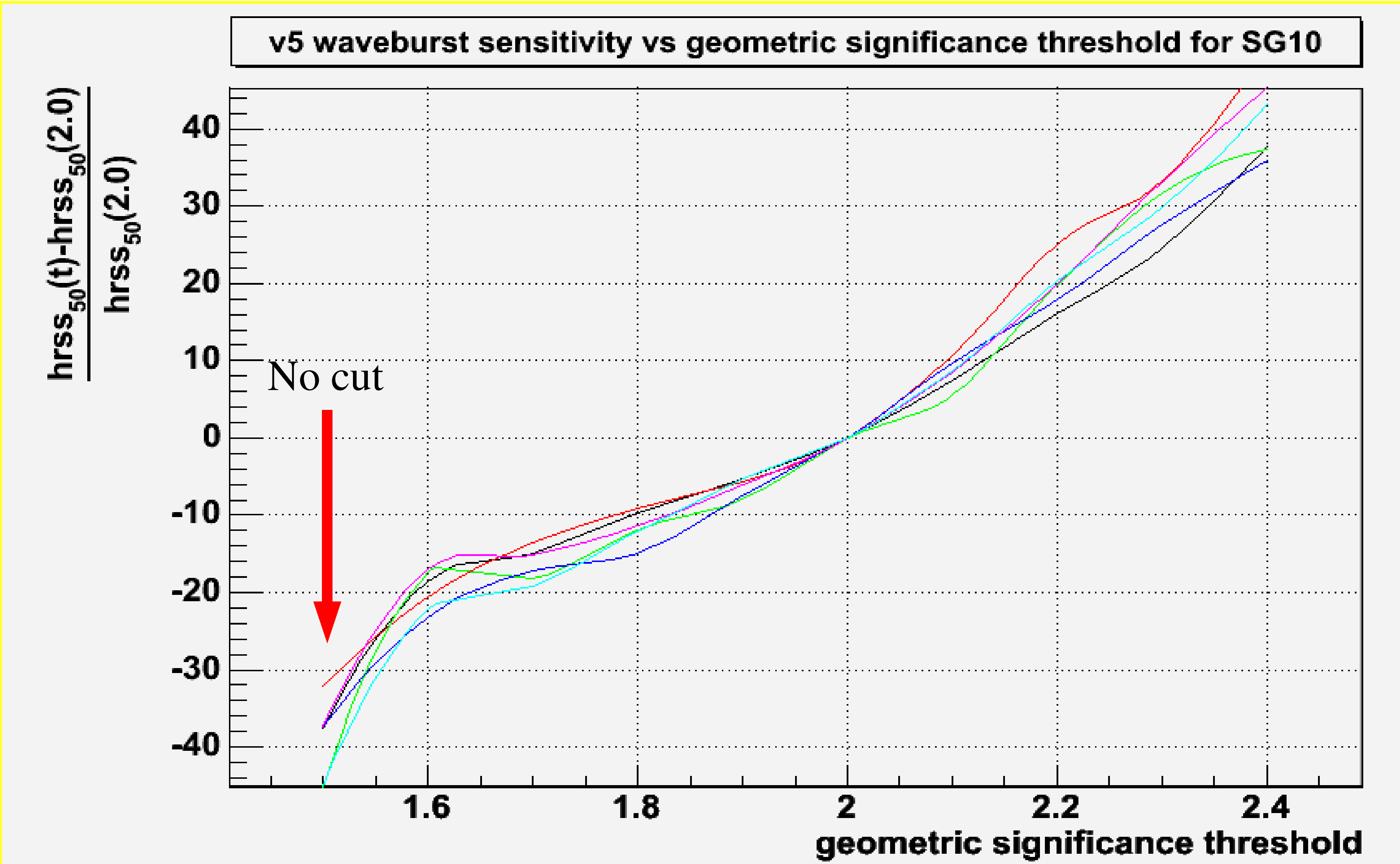
Testing v5 waveburst on S2 MDC frames

SG10

Threshold on gs	No cut	1.6	1.7	1.8	1.9	2	2.1	2.2	2.3	2.4	V4, gs=1.7
SG100Q9, hrss50*1.0e+20	3.57	4.66	4.86	5.17	5.42	5.72	6.15	6.64	7.13	7.88	7.96
SG153Q9, hrss50*1.0e+20	1.65	1.93	2.1	2.21	2.29	2.43	2.69	3.04	3.24	3.65	5.32
SG235Q9, hrss50*1.0e+20	0.69	1.04	1.03	1.11	1.16	1.26	1.33	1.51	1.66	1.73	1.33
SG361Q9, hrss50*1.0e+20	0.84	1.03	1.11	1.14	1.24	1.34	1.47	1.58	1.71	1.82	1.6
SG554Q9, hrss50*1.0e+20	1.32	1.75	1.79	1.87	1.98	2.11	2.29	2.53	2.81	3.07	2.17
SG849Q9, hrss50*1.0e+20	1.95	2.76	2.87	3.12	3.36	3.55	3.86	4.27	4.61	5.08	3.64
Rate (microHz), 64-1100Hz			208	69	22	8	2.6				15

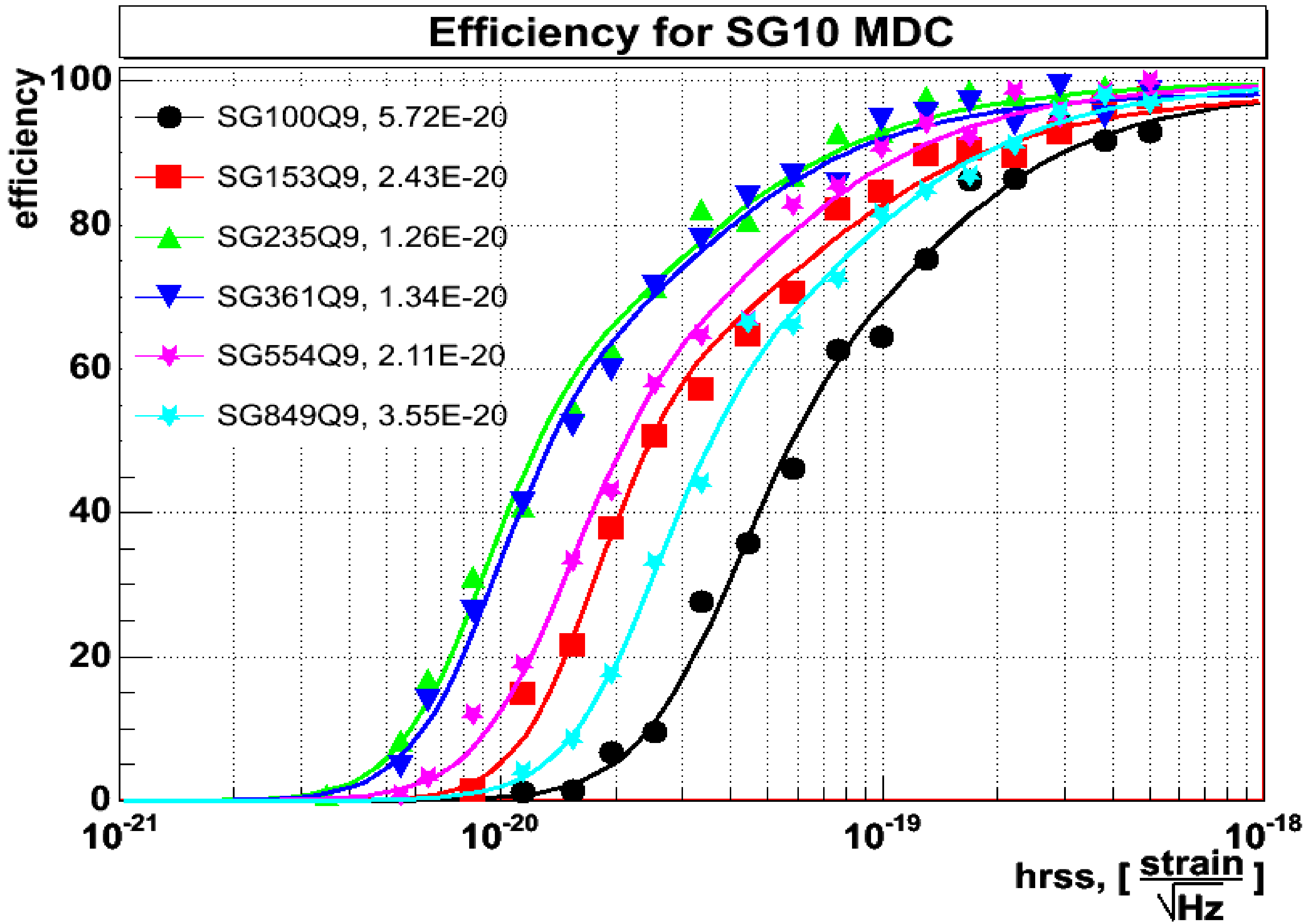
- The last column corresponds to v4 as used in S2 analysis.
- For the new version we would use geometric significance threshold 2 that corresponds to 8 microHz background rate.

SG10

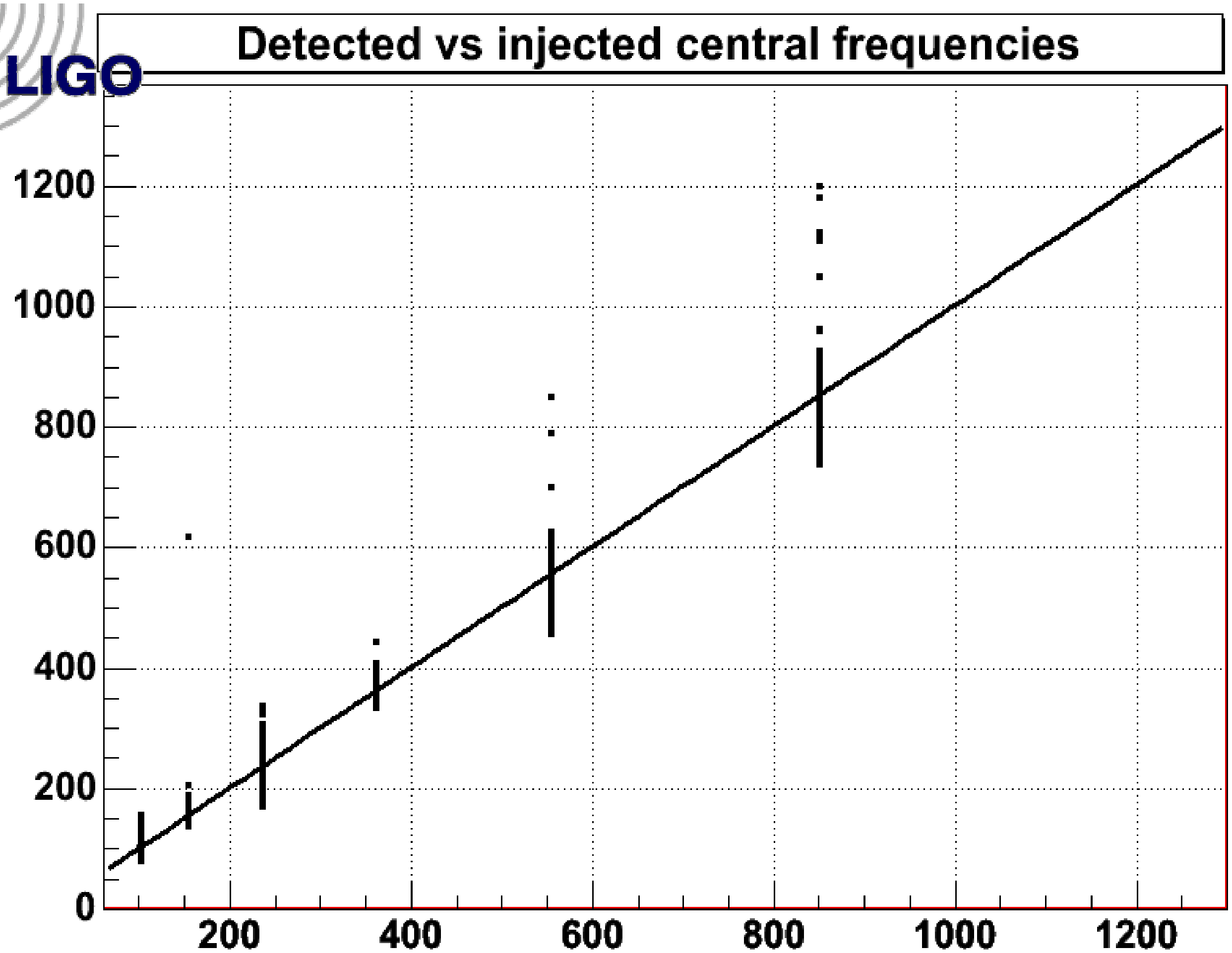


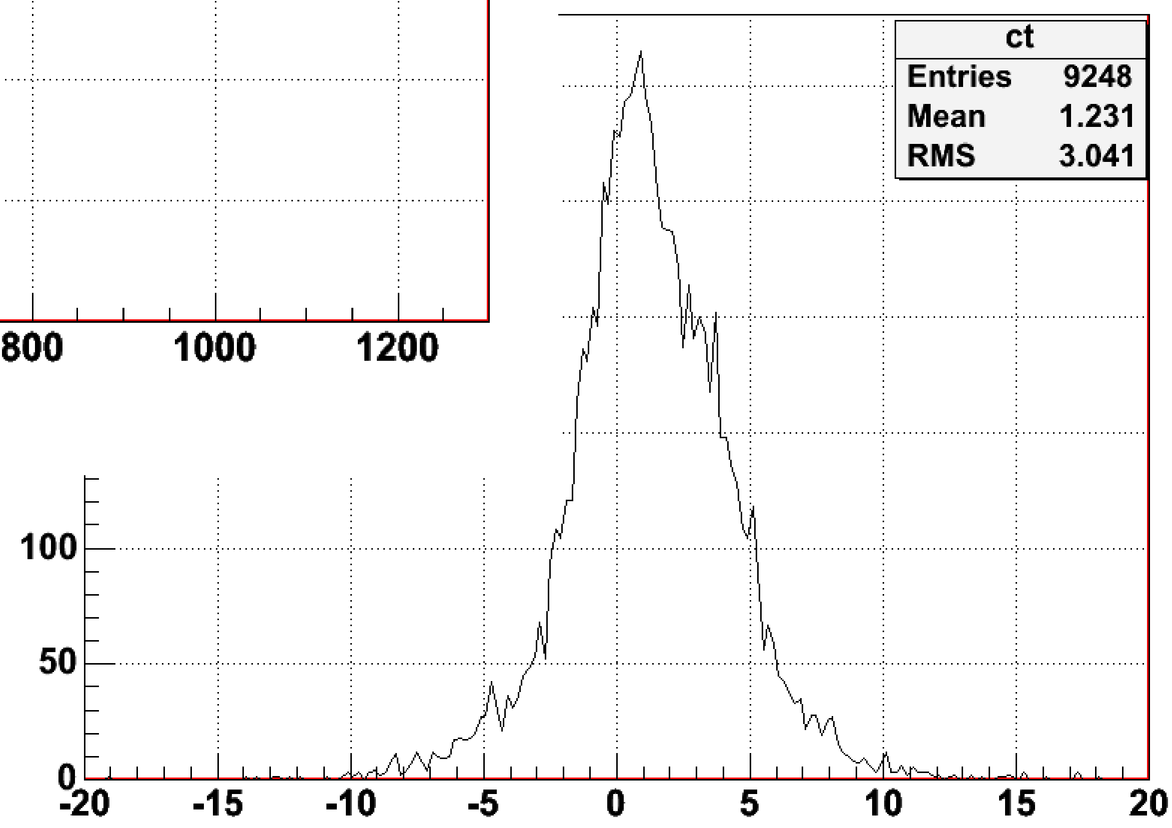
v5 waveburst sensitivity vs geometric significance threshold for SG10
$\frac{hrss_{50}(t)-hrss_{50}(2.0)}{hrss_{50}(2.0)}$
40
30
20
10
0
-10
-20
-30
-40
1.6
1.8
2
2.2
2.4
geometric significance threshold
No cut

SG10


Efficiency for SG10 MDC
efficiency
100
80
60
40
20
0
SG100Q9, 5.72E-20
SG153Q9, 2.43E-20
SG235Q9, 1.26E-20
SG361Q9, 1.34E-20
SG554Q9, 2.11E-20
SG849Q9, 3.55E-20
10^-21
10^-20
10^-19
10^-18
hrss, [strain / √Hz]

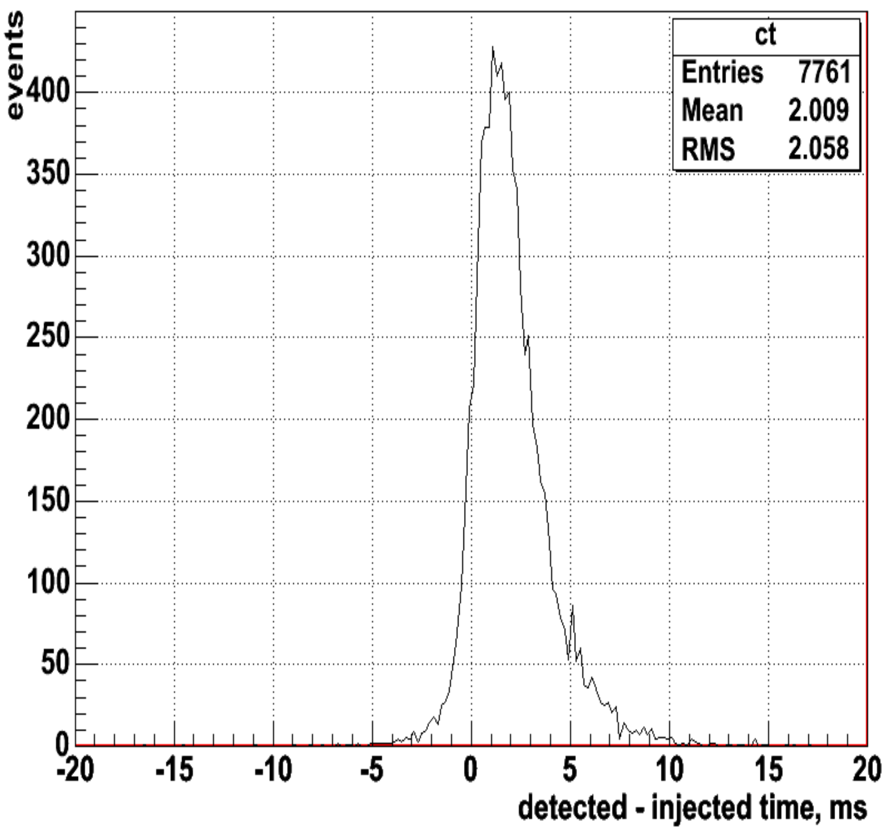
SG10

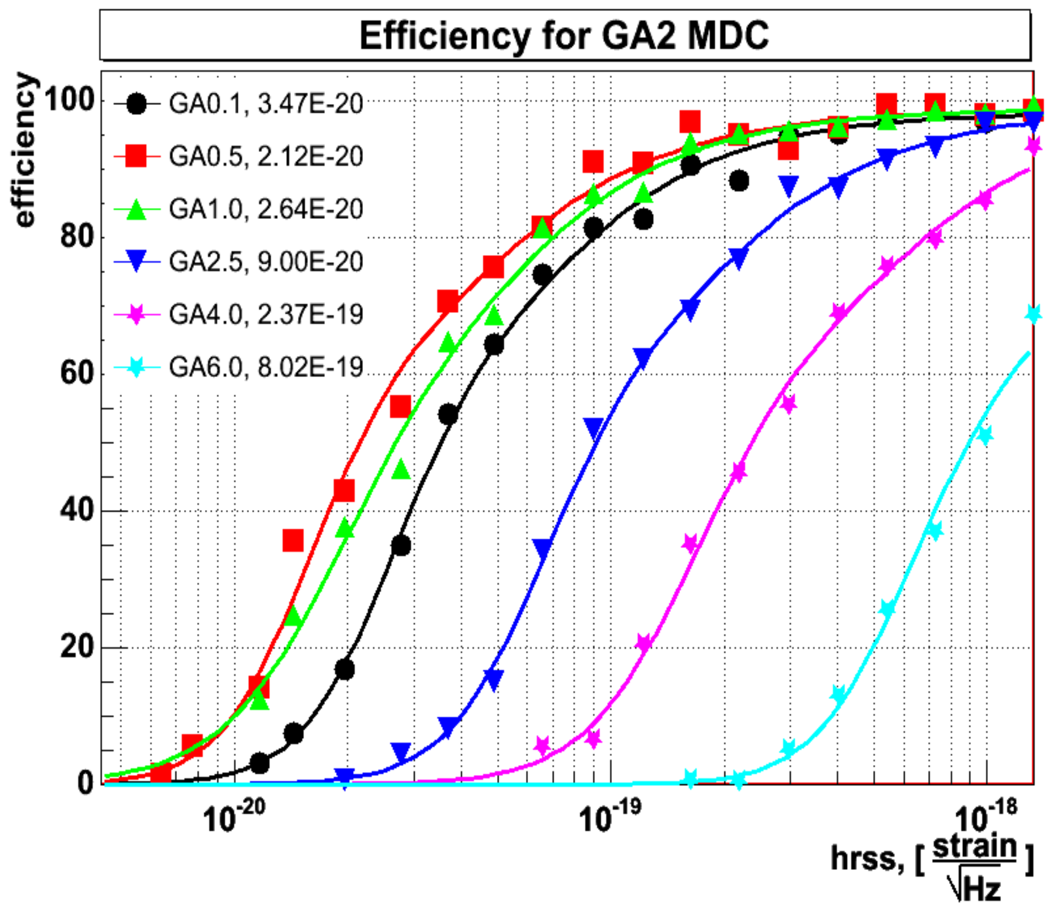

Detected vs injected central frequencies
0
200
400
600
800
1000
1200
200
400
600
800
1000
1200


ct
Entries 9248
Mean 1.231
RMS 3.041
0
50
100
-20
-15
-10
-5
0
5
10
15
20

Threshold on gs	No cut	2	V4, gs=1.7
Tau=0.1ms, hrss50*1.0e-20	2.19	3.47	3.98
Tau=0.5ms, hrss50*1.0e-20	1.28	2.12	2.55
Tau=1.0ms, hrss50*1.0e-20	1.59	2.64	3.2
Tau=2.5ms, hrss50*1.0e-20	6.22	9	12.5
Tau=4.0ms, hrss50*1.0e-20	12.8	23.7	31.9
Tau=6.0ms, hrss50*1.0e-20	62	80.2	98.1

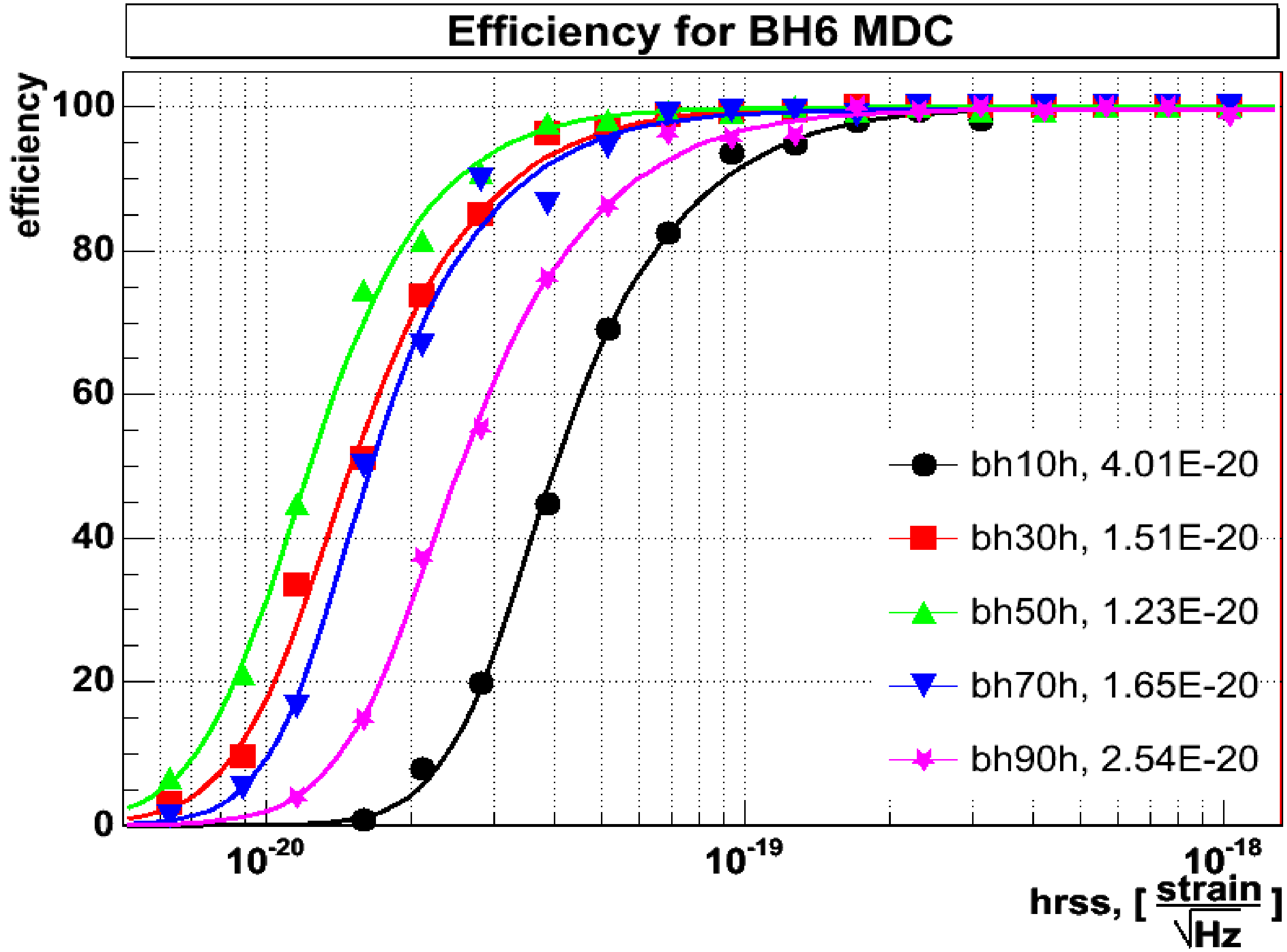
GA2



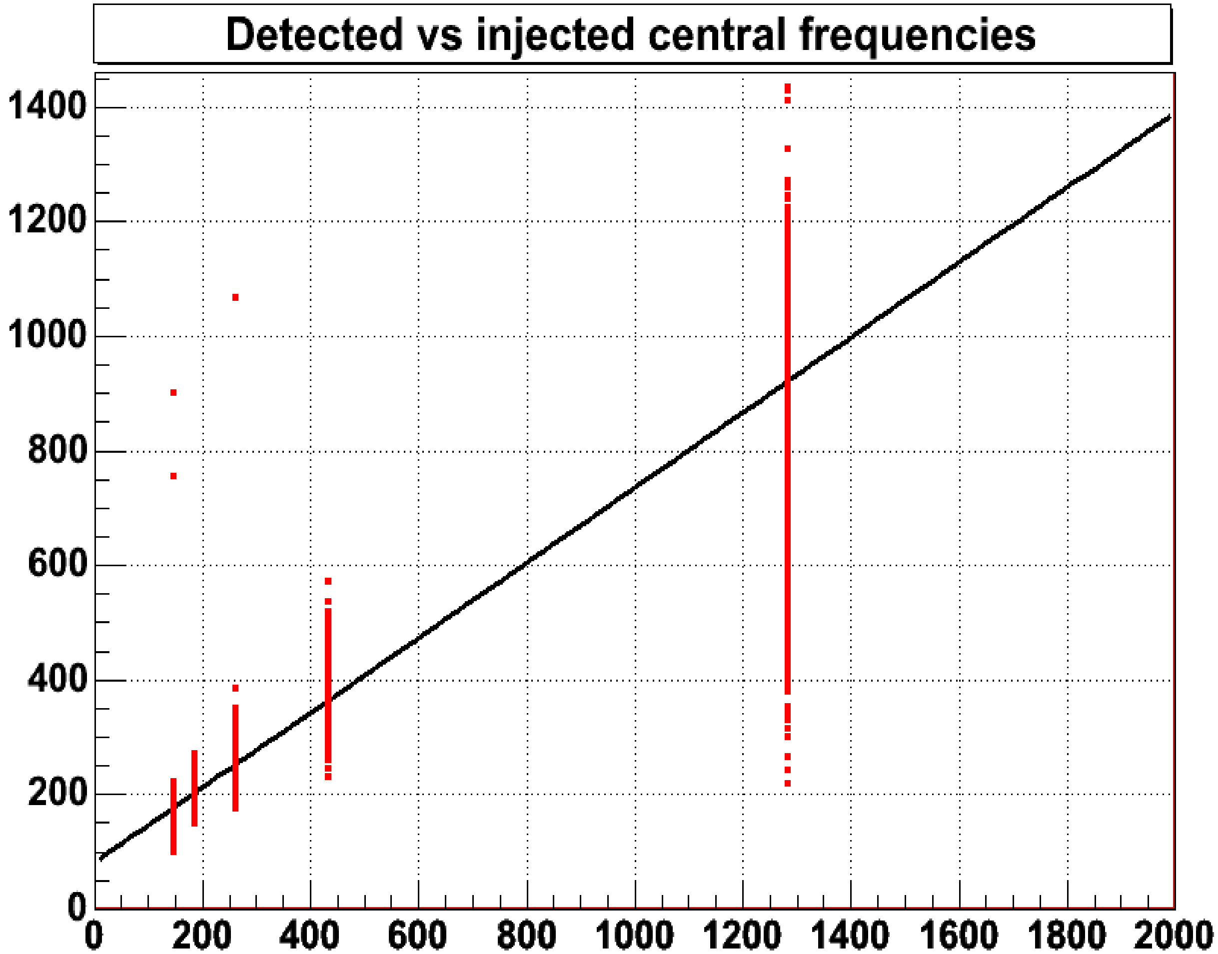


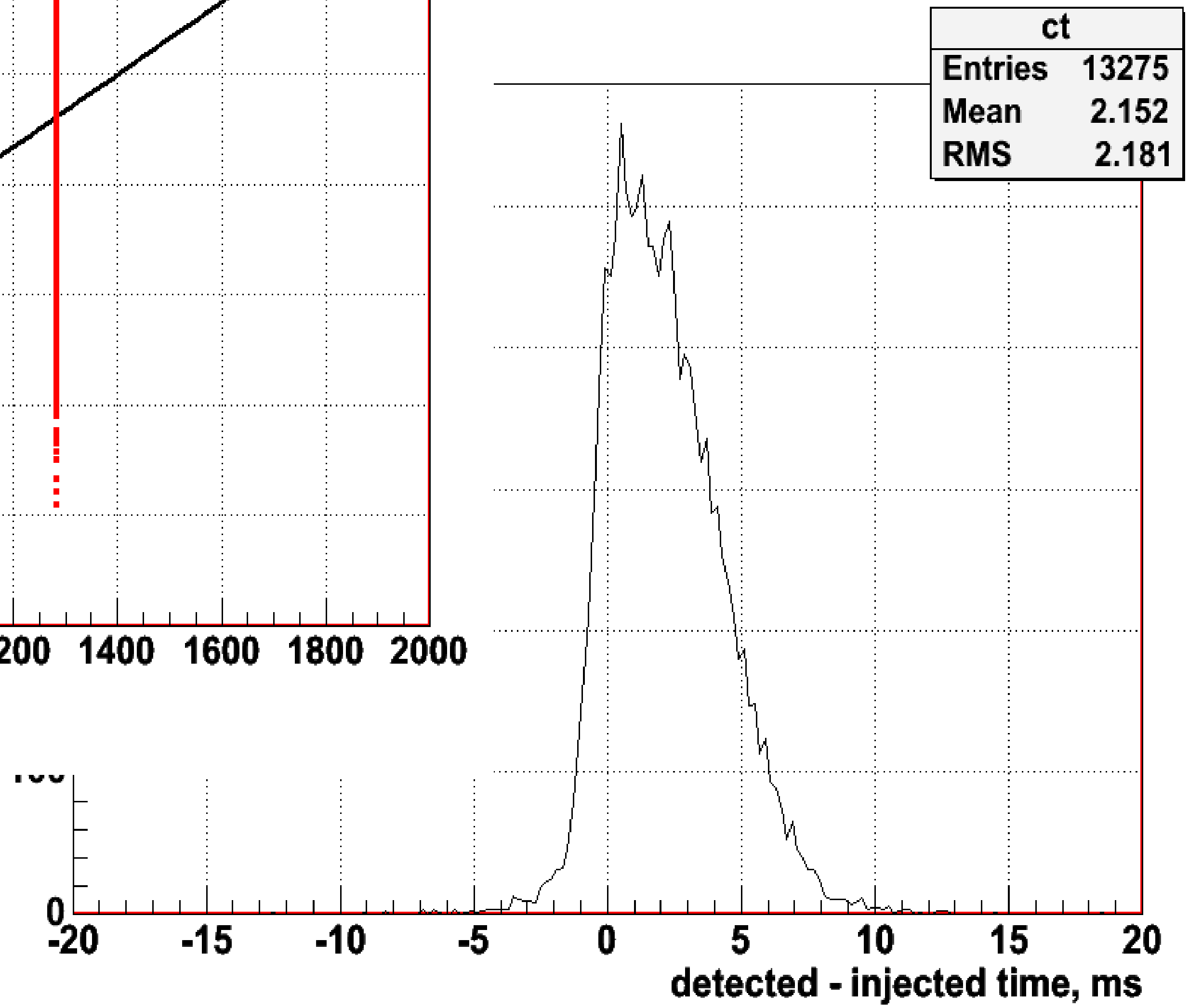
Threshold on gs	No cut	2	v4, gc=1.7
10M, hrss50*1.0e+20	2.94	4.01	5.77
30M, hrss50*1.0e+20	0.93	1.51	1.77
50M, hrss50*1.0e+20	0.74	1.23	1.44
70M, hrss50*1.0e+20	1.08	1.65	2.13
90M, hrss50*1.0e+20	1.71	2.54	4.23

BH6



BH6

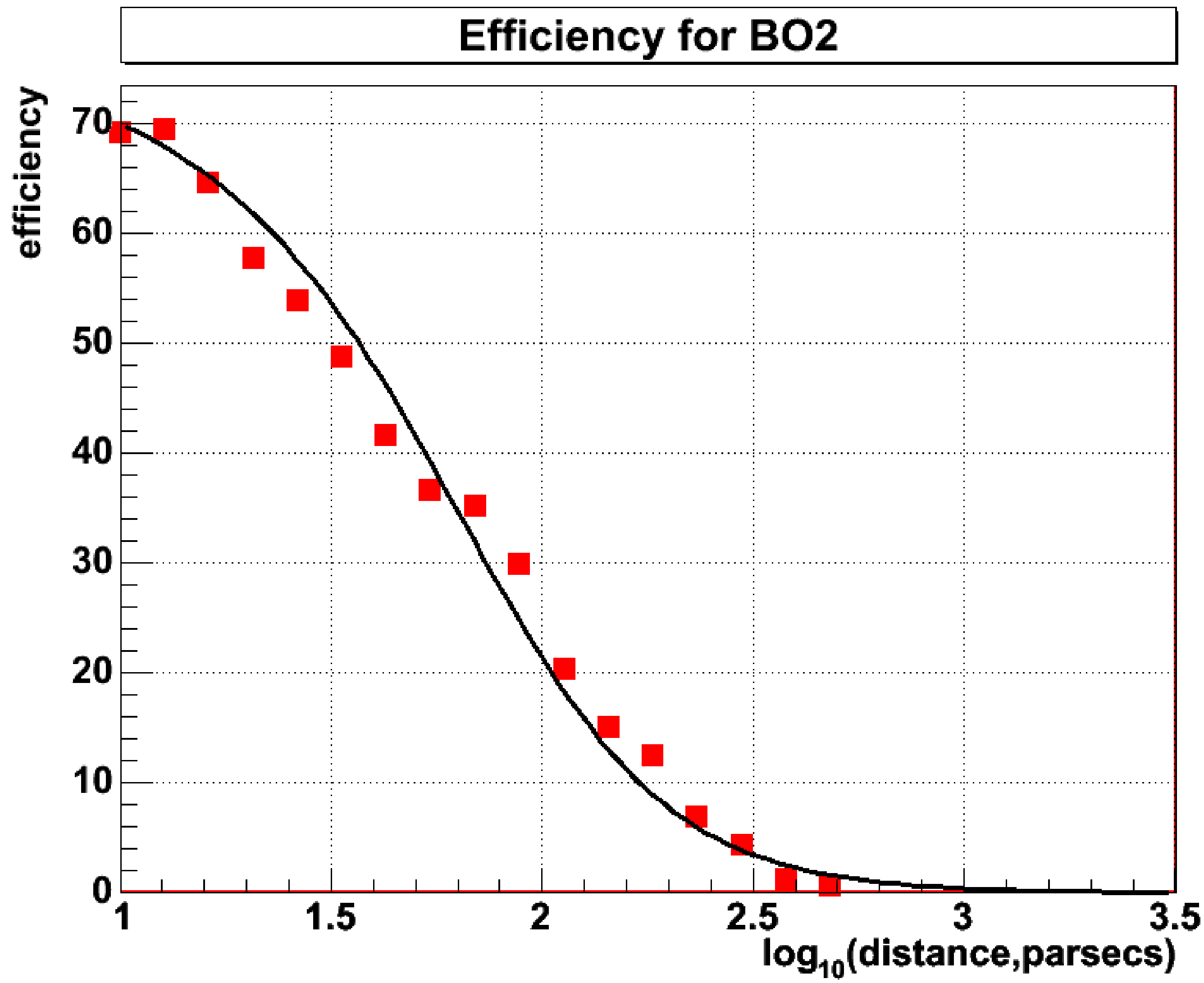

Detected vs injected central frequencies
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
1600
1800
2000


ct
Entries 13275
Mean 2.152
RMS 2.181
0
-20
-15
-10
-5
0
5
10
15
20
detected - injected time, ms

LIGO

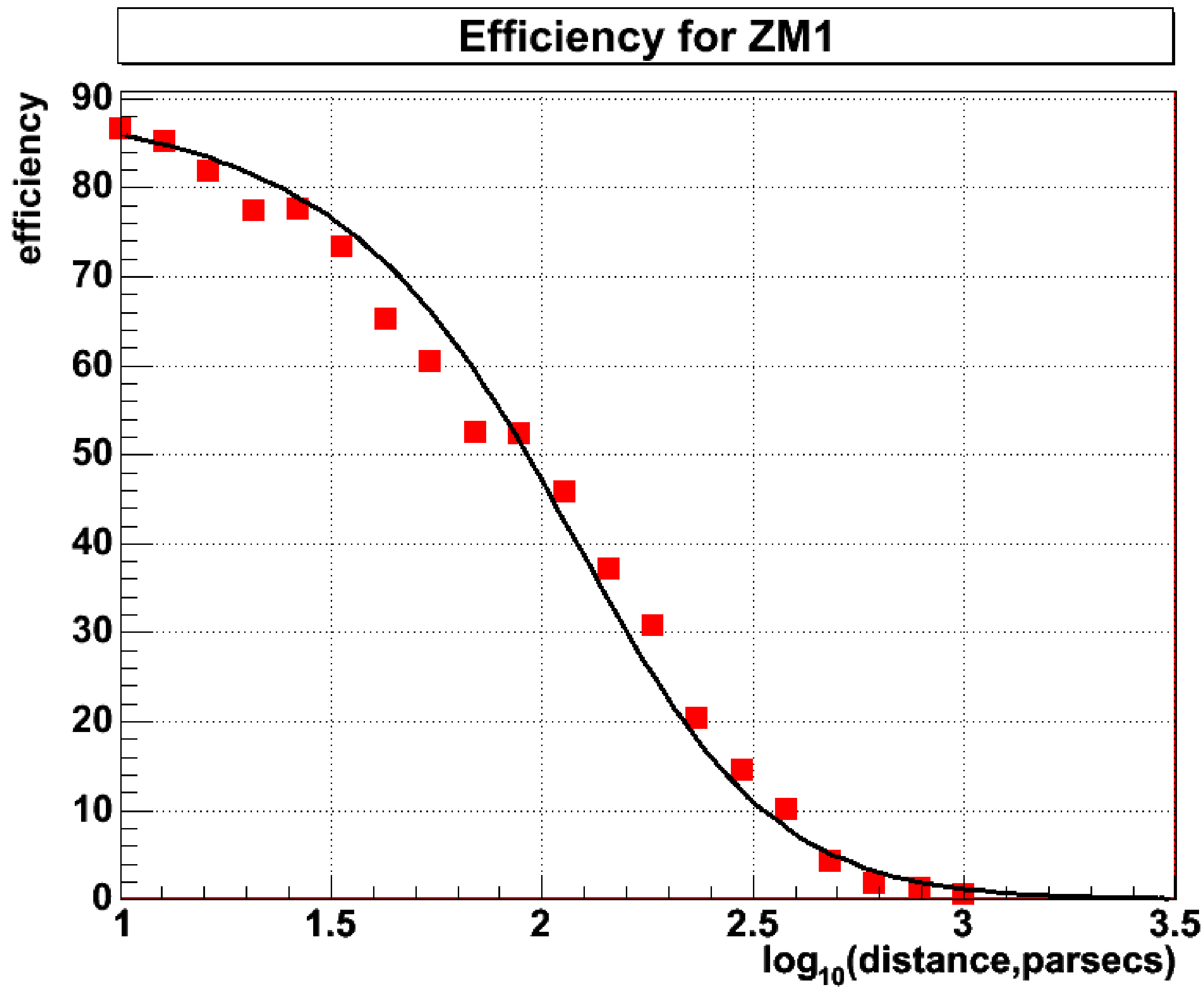
Threshold on gs	No cut	2	V4, gs=1.7
Distance at 50% efficiency, parsecs	65	37	25

BO2



Threshold on gs	No cut	2	V4, gs=1.7
Distance at 50% efficiency, parsecs	156	92	58

ZM1



Conclusion

- Version 5 waveburst shows a significant improvement in sensitivity and performance.
- Precision of time and frequency reconstruction of the detected events remained about the same as in v4.
- One thing that still needs to be added is calibration so that we can estimate hrss of the detected signal (calibration is implemented in v3 and v4 but not yet in v5). If we run on h(t), then it would not matter.
- Other than calibration, version 5 waveburst is fully functional and ready for S3 and S4 analysis.

ROOT files for trigger archiving and publishing advertisement

- ROOT file is an extremely convenient format for storing and publishing triggers. http://root.cern.ch;
- ROOT file can store tables of triggers, associated plots...
- One can browse, impose various selection cuts, and plot data in a ROOT file without any programming either using ROOT file browser or executing simple commands from ROOT C++ interpreter. One can do arbitrarily complicated operations on data stored in a ROOT file from ROOT C++ script or a program.
- All waveburst postproduction analysis is done with ROOT files

ROOT files for trigger archiving and publishing advertisement

- If several ROOT files store tables of the same structure, one can add these tables (TTree) to a chain (TChain inherits from TTree) so that logically to a user it would look like a single table.
- There is Carrot module for Apache web server that allows to publish root files on the web so that one can get the same kind of access to data as from ROOT file browser. http://carrot.cern.ch
- The above two properties make it very convenient to use ROOT file for online data analysis: each Condor job writes to a separate ROOT file that is added to a big chain browsable from the web.