Medium Burst Search update: Probability Distributions from 6/02−1/04

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Our paper from Miguel's 40 second − 3 hour burst search, recently published in ApJ Letters, includes data through May22, 2002. The analysis is performed through May 22nd because the old SGI "Kahuna" was retired at this time, producing some disruptions in the data. Other changes including the X2 cut change in November 2002 made this newer data set different from the previous set, and in the interest of getting a paper ready for publication rapidly, it was decided to only include the data through May 2002 in the ApJ paper. Here, I present the raw probability distributions (called the test statistic distributions in the paper, since they are an approximation to the actual probability distributions) from the more recent data. Work still needs to be done to turn these distributions into flux limits for VHE transient signals for a given energy spectrum and spectral cutoff.

I looked at data taken from May 23rd, 2002 through January 31st , 2004 and analyzed for 40s − 3hr bursts using the medium burst search framework. Nearly all of these data are analyzed in real time, and raw probability histograms are calculated daily (or more frequently) for the nine search intervals. These probability histograms are searched for problems with the data that correspond to problems noted in the logbook, seen in the EMS plots, or inconsistencies in the medium burst search log file. These individual distributions are then summed to make the total distributions.

When major changes are made to the experiment, such as the installation of new calibrations or changes to the event cuts, the integral probabilities used to create the background maps need to be recalculated. This process is done manually, and it causes some dead time in the analysis. Changes made to the search code and computer problems (typically disk mount and communication issues) also add to the search's dead time, though some of this was recovered after the problems were corrected if the REC data was still on disk at the site. The remainder of these runs are in principle recoverable from archived data, but unless there was a long break in the online medium burst analysis (a day or more) , I did not go back and analyze the data offline. Experimental dead time and runs removed due to problems with the data also reduce the total exposure. The total exposure for each search interval is shown in Table 1. This shows now much data is added to the amount published (through 5/22/02). Through the most major experimental change during this period (the change in the X2 cut 11/14/02) the data set is increased by a factor of 1.5, and for the entire new set this represents a factor of 2.8 increase. A table of the data removed from the analysis because of problems is shown at the end of this memo. This is included since it has some information about which REC subruns

showed problems in the medium search and thus may be a problem for other analyses as well.

Search Duration(s)	***Exposure through 5/22/02 (days)***	***Additional exposure 5/23/02 − 11/13/02***	***Additional exposure 5/23/03 − 1/31/04***
40	290.2	146.5	522.4
80	290.2	146.5	522.4
160	290.2	146.5	522.3
320	289.7	145.7	521.3
640	289.2	145.3	520.8
1280	288.1	144.2	519.4
2560	286.1	142.5	516.2
5124	282.2	138.2	510.7
10240	275.7	130.8	500.8

Table 1. Exposure (in days) for each search interval.

The probability distributions for each search interval are shown in Figure 1. The lowest probability observed is $10^{-11.9}$. In the medium burst search paper 10^{-12} was taken as the threshold to set a limit on the maximum flux. This threshold can still be used for these additional data, though given the additional exposure, a few events below 10^{-12} could still be consistent with background.

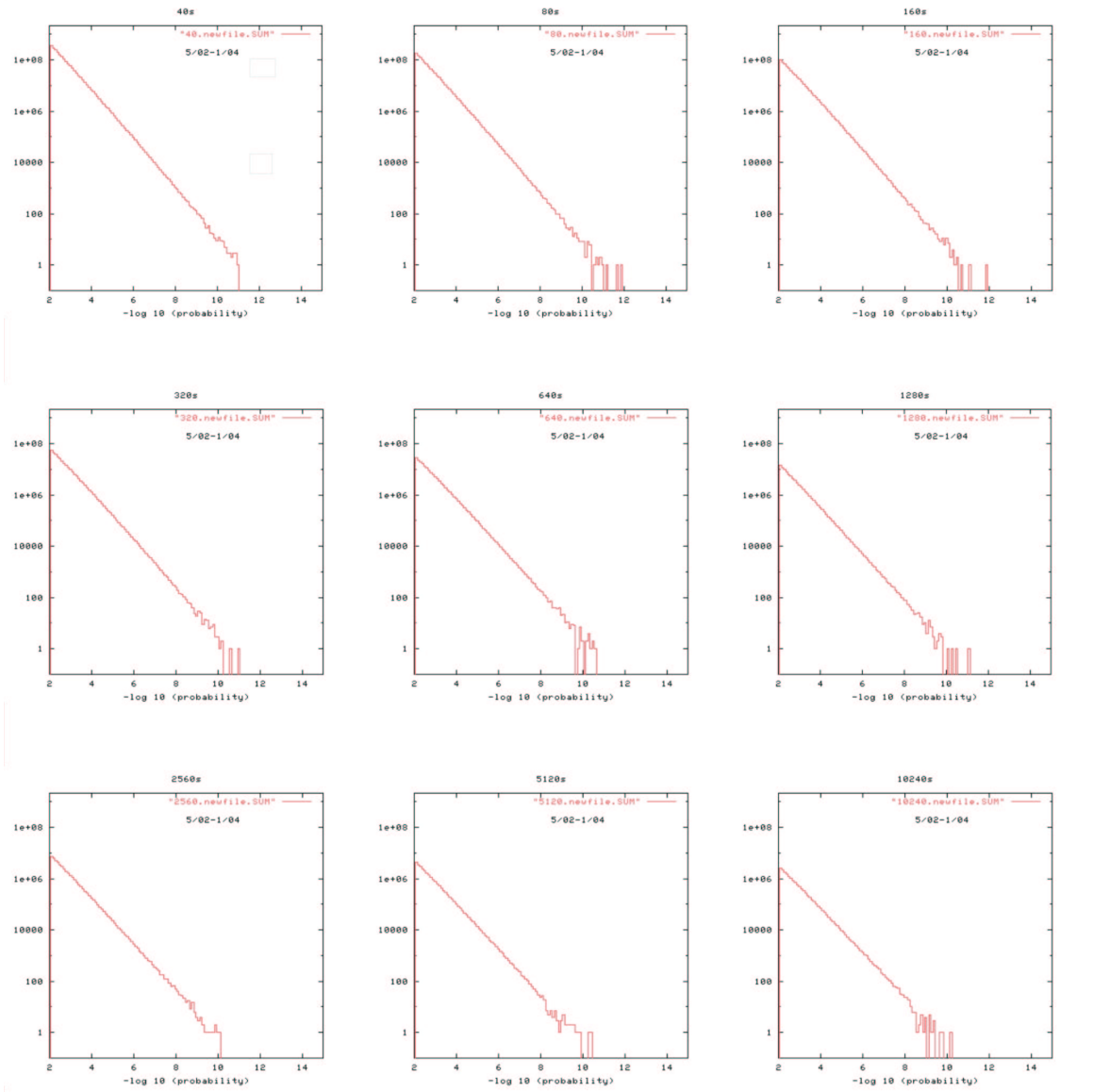

Figure 1. Probability distributions for each of the 9 time intervals. 5/23/02 − 1/31/04

Date (file name)	*Search int.*	*problem*	*Approx. runs*
05/25/02 8:47, 11:45UT	All	DAQ problems starting ~6:00UT	REC_4158_0075 − _0179
07/04/02 3:06UT	1280s	Starting ~7/03 18:25UT	~REC_4322_0200
08/06/02 18:47UT	40s, 80s	Bad deleo, TDC prob. ~18:30	REC_4393_0212 − 0243
10/11/02 3:54UT	40s	Rate problems??	REC_4534_0045 −0063
10/23/02 23:44, 5:23UT	All	Lightning strike 14:24UT	REC_4557_0231 −
11/14/02 6:00, 18:21UT	ALL	X2 cut change	REC_4604_0001 −
11/18/02 6:00UT	All	DAQ / FSCC problems	~REC_4615_0280
02/26/03 6:00UT	320s	Power outage, reboot problems?	REC_4843_0057 −0060
05/27/03 10:17, 11:05, 13:38, 15:12	All	Thunder storms, lightning strike	REC_4974_0001 − 4978_0244
06/15/03 18:18UT	1280s	Short run, DAQ crashes	~REC_5011_0001
06/18/03 6:00UT	all	? DAQ testing	
06/18/03 21:11UT	All	? starting~18:24UT	REC_5017_0275 − _0279
06/19/03 19:28UT	All	Trigger/ADC testing ~17:11	REC_5019_0001 − _0021
07/02/03 6:00UT	All	Wact calib? Starting ~4:35	REC_5035_0070 −
07/03/03 6:00UT	All	?	REC_5035_0070 − 5040_0006
12/04/03 6:00UT	All	Bad rates? Starting ~12/3 23:50	REC_5248_0221 − _0227

Table 2. Bad data removed, with some information about the time of the problem and the starting REC subrun or subrun range.