Milagro Energy Response

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1 Introduction

The aim is to try and find a way to quantify and describe the energy response of Milagro. This depends on many things: spectral index and shape, zenith angle and detector configuration (e.g. # dead tubes). Figure 1 shows the distribution of energies for Monte Carlo gamma-ray events which trigger Milagro. The gamma-ray simulations were thrown on an E-2.4 spectrum from 100 GeV to 100 TeV and at zenith angles from 0 to 45 degrees. The top plot shows the distribution in log10(energy) and the bottom plot (for Cy) has a linear energy scale. We often wish to convey the energies at which milagro operates (these plots) in words. I personally think that the concept of energy threshold is a misleading term for us to use, as it conveys the impression that we have no sensitivity below that energy. Quoting our median triggered energy to a specified spectrum is useful as it usually illustrates the peak in log(energy) and is the energy above which we should be quoting fluxes and upper limits. However, one number cannot describe the range of energies over which Milagro is sensitive. Instead I will use 3 numbers to describe the energy response of Milagro, the median energy, the energy (E5) at which 95 % of events had higher energies, the energy (E95) at which 95% of events had lower energies. Thus 90% of events are contained between E5 and E95 (the E90 interval?). For this particular combination of parameters, median = 4.89 TeV, E5 = 0.40 TeV and E95 = 52.24 TeV. However, this is not representative of any source.

2 Energy Response vs zenith angle

I divided the events into 3 groups. Zenith angles 0-15, 15-30 and 30-45 degrees. Table 2 lists the median triggered energy, E5 and E95 for the 3 different zenith angle ranges.

Zenith angle range	Trig			Trig+fit			Trig+fit+X2		
	Median	E5	E95	Median	E5	E95	Median	E5	E95
0-15	2.66	0.31	34.17	2.00	0.29	12.49	2.62	0.36	15.90
15-30	4.84	0.395	48.88	3.72	0.375	36.7	4.73	0.64	41.9
30-45	10.69	0.825	63.66	7.99	0.66	58.47	10.73	1.01	61.6

Our trigger theshold varies with time. Looking just at the 15-30 degree zenith angle range (this is where the Crab spends most of its time), I looked at the effect of different trigger thesholds. This is tabulated in Table 2. There does not seem to be a very strong dependence of median energy versus trigger criterion.

Trigger	Trig			Trig+fit		
	Median	E5	E95	Median	E5	E95
45	4.07	0.32	41.9	3.39	0.30	34.5
50	4.49	0.37	45.0	3.56	0.36	35.9
55	4.84	0.395	48.88	3.72	0.375	36.7
60	4.97	0.41	51.75	3.8	30.39	37.3
65	5.28	0.44	58.47	3.91	0.41	39.1

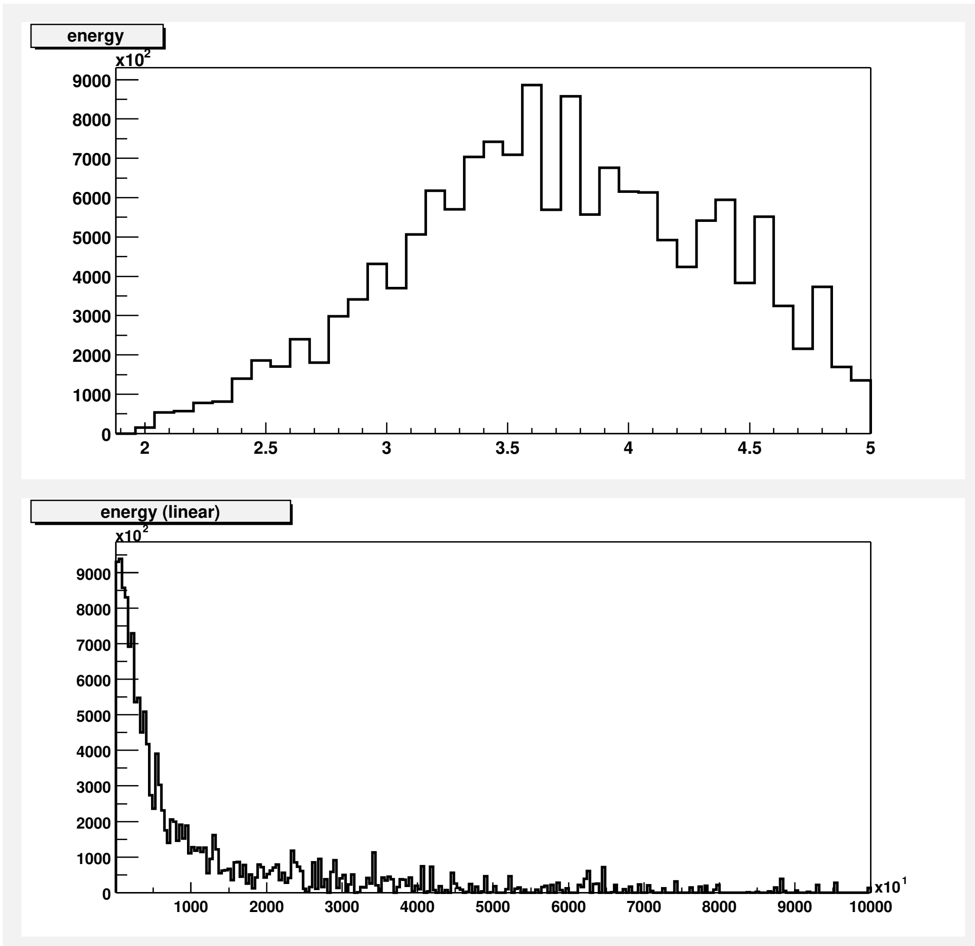

Figure 1: Triggered energy spectrum

I looked at the gamma-ray simulations which were thrown with no air layer between the water and and cover (no internal reflection). As discussed at the Wisconsin collaboration meeting, this detector configuration does not match the data very well (the predicted trigger rate is too low and the angular resolution is too good). However, often just after a rainstorm, the trigger rate does drop much more than would be expected from water overburden alone and deleo also improves. Perhaps what we are seeing is a transition from a mostly water-air-cover boundary to water-cover interface. Since we usually change the trigger threshold to compensate for rate drops (particularly if Gus leaves town), I have listed the median energy, E5 and E95 for these simulations in table 2 as a function of trigger theshold.

If you have made it this far through the memo, you are possibly wondering why I keep giving you tables, rather than nice plots. The tables that I have showing you give us a feel for how our energy response to GRB changes under a variety of conditions (zenith

Trigger	Trig			Trig+fit		
	Median	E5	E95	Median	E5	E95
45	4.50	0.44	41.4	3.26	0.37	26.3
50	4.96	0.47	44.1	3.46	0.39	27.6
55	5.29	0.50	45.5	3.65	0.41	28.0
60	5.65	0.57	47.3	3.85	0.45	29.7

angle, trigger threshold etc.). This is what I am mostly interested in. However, we also look for dc emission from sources which pass through a range of zenith angles. I made a set of triggered energy spectra as a function of declination. Figure 2 shows the median energy, E5 and E95 as a function of declination. We can probably make the general statement that the median energy for a source with an E-2.4 spectrum is 4 TeV with 90having energies between 400 GeV and 40 TeV. This is for a 55 tube trigger, 1.2 degree binsize and no X2 cut.

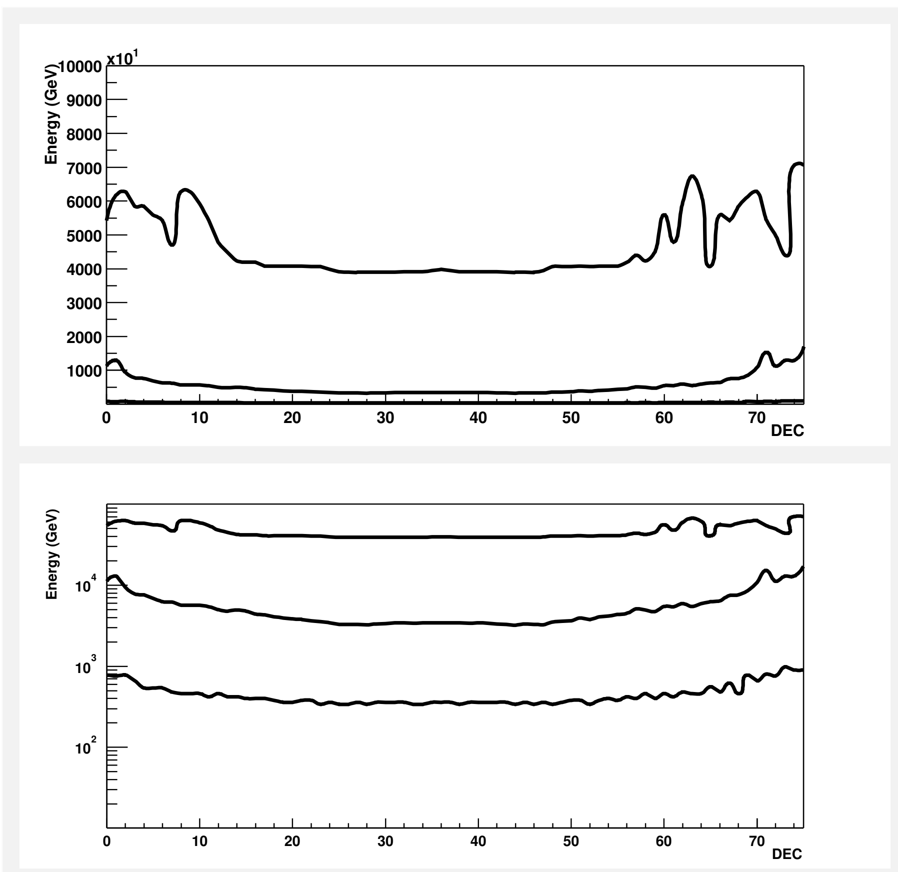

Figure 2: E95 (top), median energy (middle) and E5 (bottom) as a function of declination