Algorithm for recovering No-fits in Milagro

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1 Introduction

As pointed out recently by Gus, some 20 percent of Milagro events when running at a Khz or greater(post fix of PMTs) are not fitted by our on-line fitter. I have examined these nofits to determine what these are and how we can recover them. I used the raw data file GRB_1966_0007.dat to do this study.

I examined the nofits and determined that they fall into several categories. These categories are:

1. Triggers due to energetic 'single' hadrons

2. Triggers due to muons

3. Accidental coincidence between two showers, generally a small shower and a main shower.

4. Accidental coincidence between a shower and a relatively large hit due to an unassociated muon, either early or late with respect to the main shower.

When I use a method based on my earlier memo called hitcutmilagro.ps to throw out 'bad' hits I find that I can recover most of the events classified under categories 3 and 4. This corresponds to recovering half of all nofits.

In this memo I show examples of those which are recoverable and those which cannot be recovered, i.e. muons and singlehadrons.

2 Example of non-recoverable events:

1. **Single hadrons:**

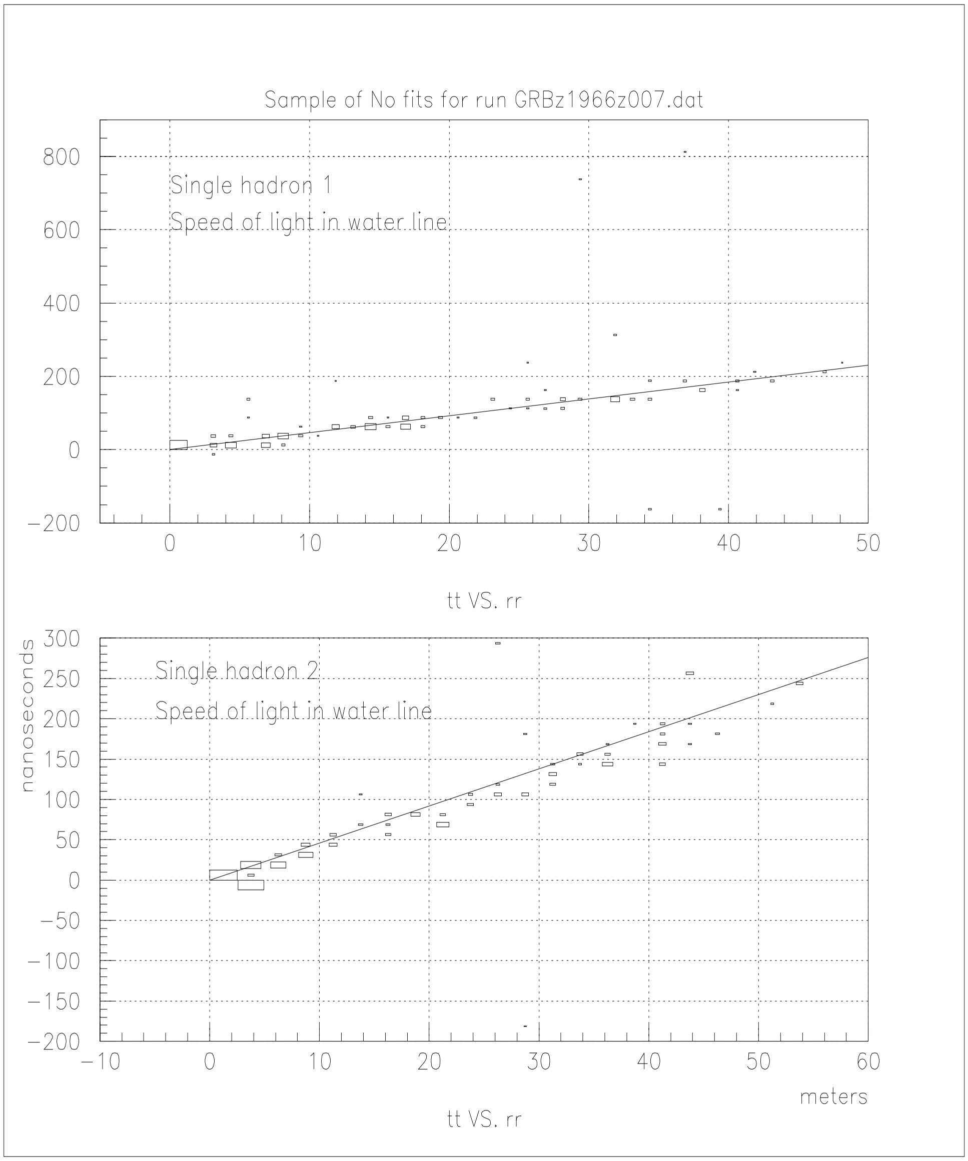


Figure 1: Distribution of hittimes and distance of hit tubes from the tube with maximum pulseheight for events which are clearly single hadrons.

In figure 1, single hadrons are identified by the hit pattern which corresponds to illumination due to light travelling with speed of light in water from the maximum tube hit.

2. **Muon events:**

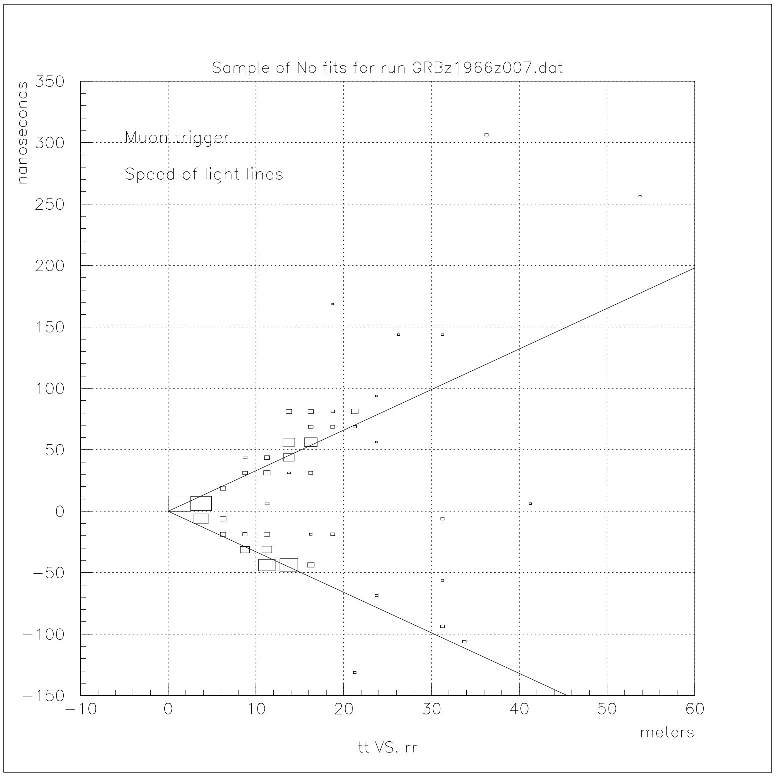


Figure 2: Time versus distance distribution for a typical muon event.

In Figure 2 the hit-times with respect to the max PH tube are distributed along two lines each of which corresponds to speed of light travel of the muon through Milagro. It must be a relatively large angle muon to produce the trigger.

3 Recoverable Events:

Events in which there is clear separation between the main shower which triggered the events and accidental accompanying hits can be recovered by a procedure which first finds the median hit time for all the events - this is dominated by the main shower, and then removing hits which are outside the time range for hit times for the main shower.

First, I show a single event to demonstrate how this cut works. This is shown in Figure 3 where the third figure shows the topology of the main shower after cuts and the fourth shows the fitted angle.

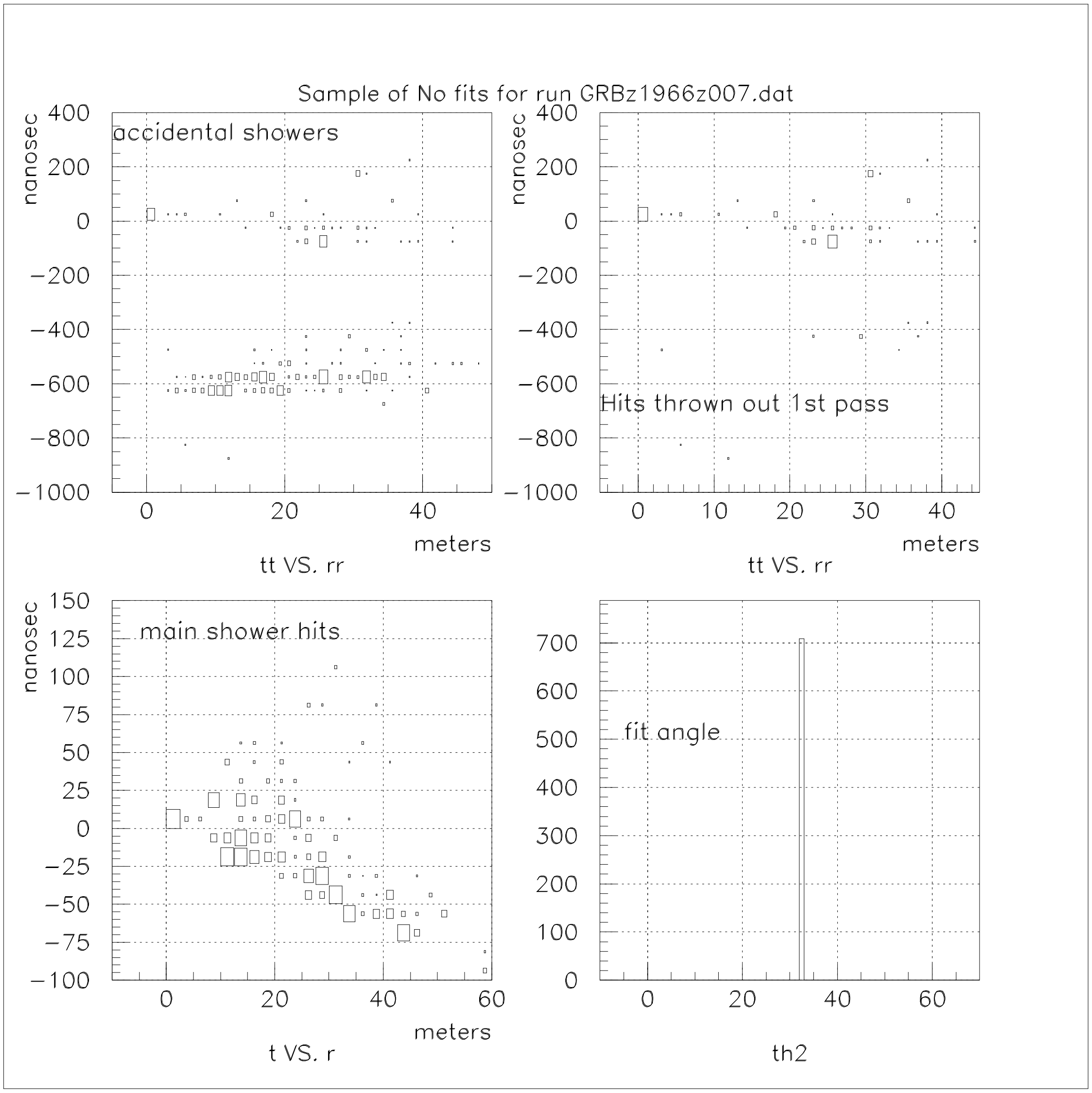
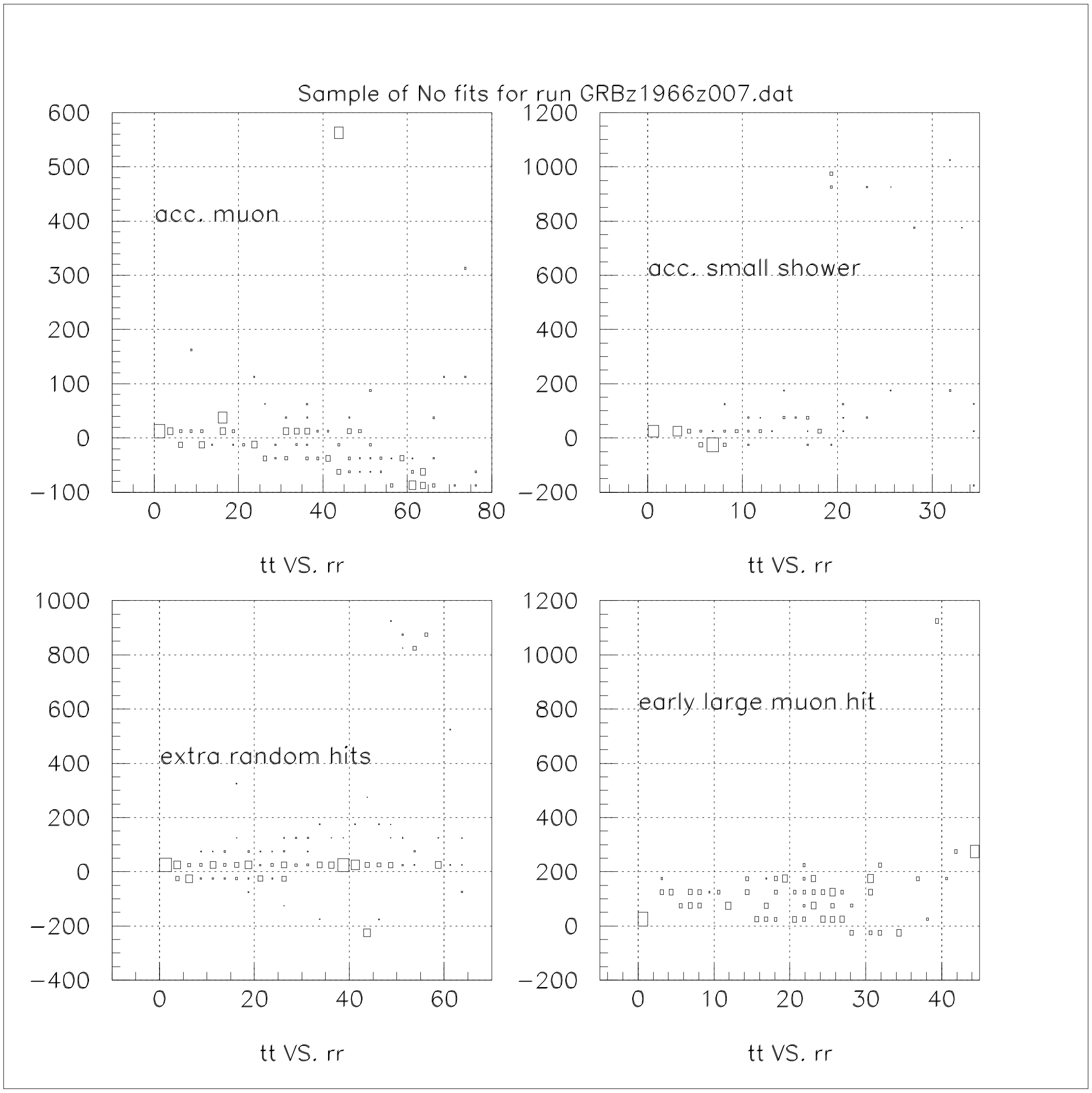


Figure 3: An event with two showers in coincidence

In the top left figure, two showers are seen on the time versus r plot. The upper shower is the accidental shower. The figure on top right shows the hits which were removed after making the time cut based upon the median time determined from the data. The lower left figure shows what remains after cuts and these hits are then fitted to obtain the angle shown in figure on lower right.

Figure 4 shows the hit patterns for a sample of nofits events that were recovered upon applying the cuts.



A sample of recoverable events

4 Conclusions

I have shown that we can reduce the nofit events by a factor of two by making a set of cuts on raw data from hit tubes. The procedure is simple and straightforward. In figure 5, I compare the zenith angle distribution of a sample of recovered events with that of fits which shows that there does not appear to be any substantial systematics. In Figure 6 I compare the zenith angle distributions for fit events as generated by on-line program with that obtained after 'bad' hits have been removed.

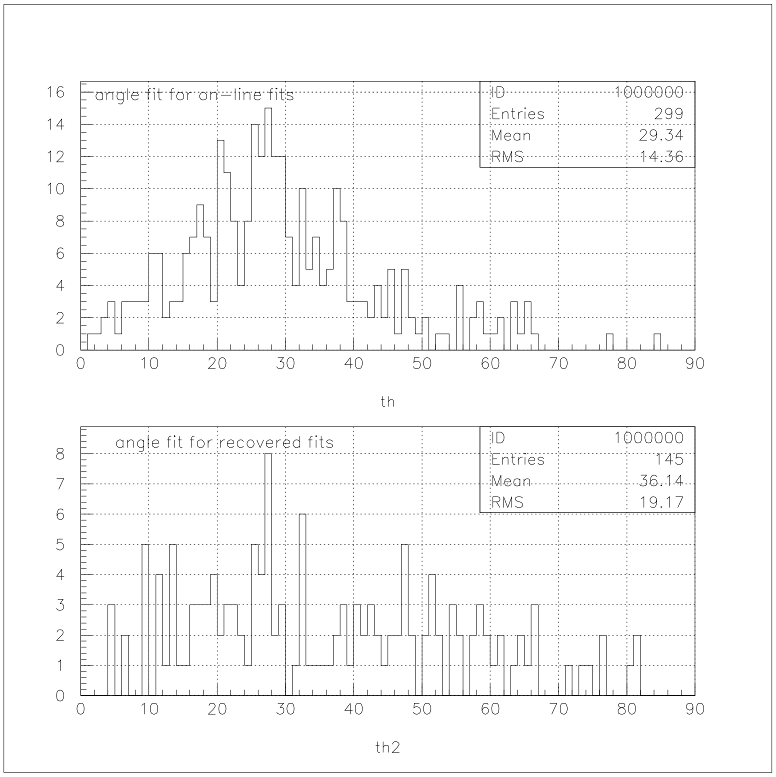


Fig. 5:Zenith angle fits for recovered events compared with those which had fits

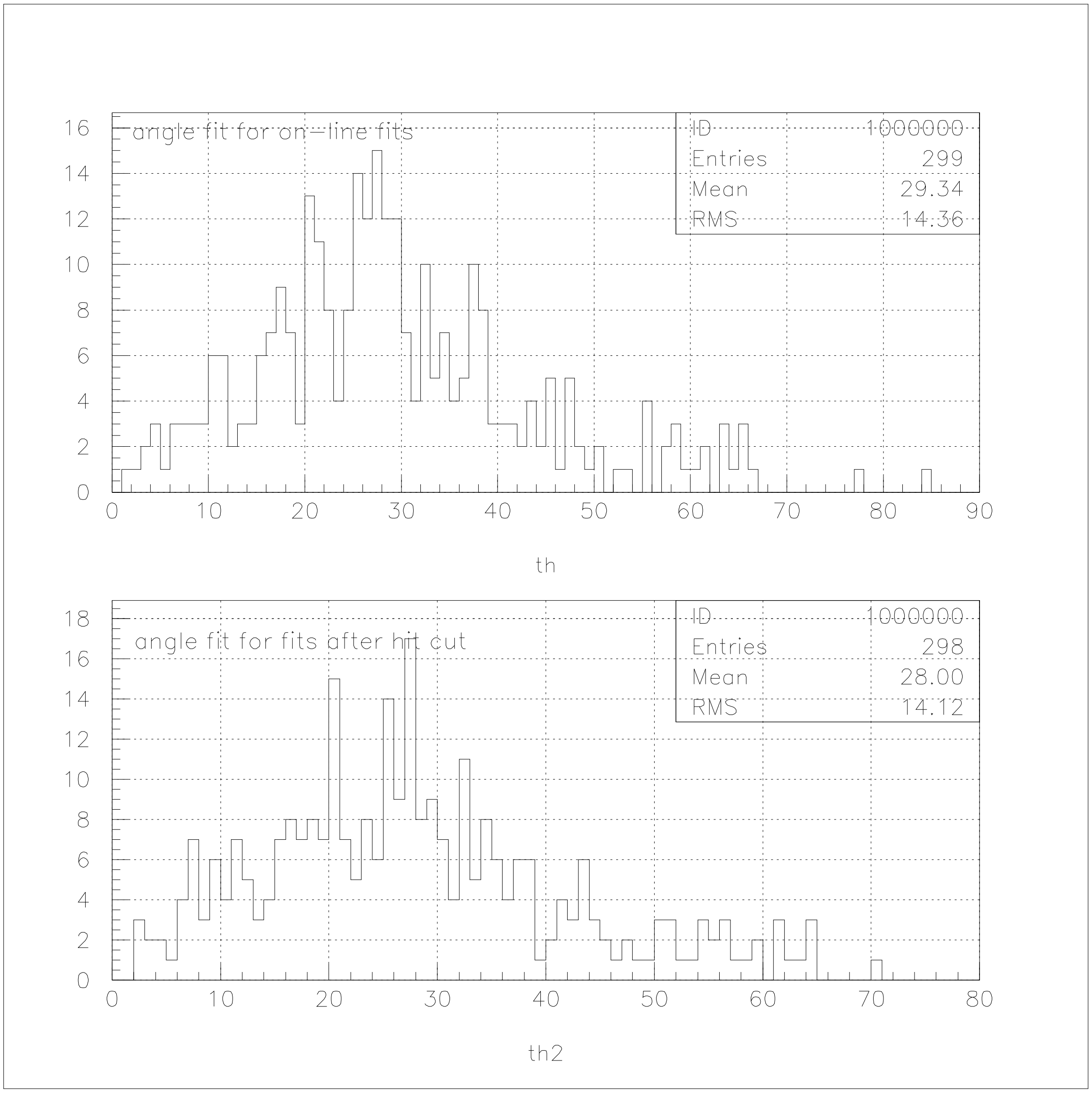


Fig 6:Zenith angle distribution of fit events before and after hit cuts