Milagro Memo
The Events : Part 1
Scaler Data

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I. Introduction

During my shift in November 2004 I noticed a large bump in most of the EMS plotted scaler values on 11/20/2004 (see Fig 1a). I also noticed that trigger type 1 (nas>74) had a large spike and trigger type 4 (nas>20 & 50ns risetime cut) had many dips (see Fig. 1b). At the time I sent a email message with a few of the plots to the collaboration. Jim Ryan initially looked at solar activity in the standard neutron monitors and emailed me that there was no flares reported there. My teaching duties kept me from doing much more about this "event" at that time.

During the beginning of December 2004 I, with David William's help, "saved" the RAW data on the disk archiver that was collected during this time (about 125 GB). I also copied all the scaler data from UCSC to UCI so I could have easy access to it. I also have access to other EMS monitoring data such as front-end-board low voltages and AC power.

Understanding this event fully is turning out to be a pretty big job so I am going to break it up into several "parts". In this memo I will present Part 1 which is examining the scaler data. I will try to check for various instrumental effects which could cause this "event". In Part 2 (distributed next week?), I will examine the triggered data which is perhaps much harder to understand. Part 3 (which is perhaps beyond me) should address a "physics event" (if there is one) that might have caused what I see.

II. Event Characteristics

There are about 1054 channels of scaler data (not all of which have valid data, dead PMTs, etc.) that can be used to understand this "event". In just about every one of them, this event is seen, but in different ways, which I think I understand. But what is the "event"? What I am calling the event is easiest to see in the 6-PMT multiplicity rates (see Fig. 2a.). Generally I am focusing on the large spike, but the smaller spikes are obviously significant and interesting as well.

The spike occurred at about JD 2453330.0125 (12:18 UT on 11/20/04) (see Fig. 2b). Its FWHM is about 107 sec, duration, about 432 sec. Its peak above background rate is about 140 kHz. This spike is seen in all the multiplicity rates that we record (6,8,10,12,16,25,32,40 PMTs) (see Fig. 3).

The spike was also seen in all high threshold or'ed Airshower, Muon and Outrigger patches. Representative ones are shown in Fig. 4, 5 & 6. The Muon layer rates are strangely low, but do show the same feature. Fig. 7, 8, and 9 show the spike also in the low threshold data.

Perhaps even more interesting is that the spike occurs in the raw trigger rate, but at the same time a dip occurs in the gated trigger rate (see Fig 10). I will address trigger rates and the properties of trigged events in Part 2.

III.Instrumental Checks

In this section I will try to address possible instrumental problems that may be responsible for the spike. By no means do I examine all possible detector issues, but hopefully I address the obvious ones. If you think of any issues that should be checked, please let me know.

The first check is the overall behavior of the scaler data over a larger time interval centered on the spike. Generally I will use the 6-PMT multiplicity rate as my diagnostic. Fig 11 shows this rate for a five day period, centered on the spike. You can see that except for one data outage at mjd 3329.25 the rate is reasonably stable, with the usual slowly varying atmospheric effects. The spike(s) by far are the largest features in the plot.

All raw scaler values are divided by an appropriately scaled reference scaler, with is the vary stable 10 mHz gps clock. I have checked this reference throughout the event period and it is generally rock solid stable, except for some 20% variations on mjd 3327.95 (see Fig. 12). The variations produced no effects on the 6-PMT rate. It could have been that this reference was unstable and would have effected all scaler channels.

Per David Williams' suggestion and help, I have also looked at the behavior of the low voltage power supplies during the event. All three supplies for all three voltage values of +5.0V, -5.0V and -5.2V are plotted for 11/20/2004 in Fig. 13. These plots show that these voltages were reasonably stable.

Finally I looked at monthly plots of our 6-PMT multiplicity rates for Jan-Nov 2004. At the risk of killing more trees, I have included these plots in Figures 14-24. These look reasonably well behaved, except for four other “events” which are somewhat similar to the 11/20/2004 event. These I address in the next section. However, from these plots, the 11/20/2004 spike is a fairly rare event.

IV.The “Other” Events

There are four other spikes in the 6-PMT multiplicity rates which are on a similar time scale as 11/20/2004 and that do not occur right before or after a system turn-on or shutdown. Table I lists the characteristics of these.

MJD	***Date UT***	***FHWM (s)***	***Duration(s)***	***PMT Multiplicities***
3330.015	11/20/2004 12:21	107	432	All, & trigger
3099.315	04/03/2004 19:33	90	180	All, & trigger
3079.495	03/14/2004 23:53	80	150	6 thru 16
3073.490	03/08/2004 23:45	900	1800	6 thru 16
3072.490	03/07/2004 23:45	900	1300	6 thru 16

Figures 25-28 show plots of the PMT multiplicity rates for these four events. The 04/03/2004 event is very similar to the 11/20/2004 event. The final three events seem to be “weaker” and the last two events are weak and broad.

V. Conclusions

Actually I have very little I can conclude, except that I feel that these are “real events”, not instrumental effects. They are perhaps solar generated events, but only because I can't think of anything else they could be. I am certainly open to suggestions.

As stated earlier, I will produce a Part II of this memo sometime next week which will explore the triggered events in the “events” that saw a rise in the raw triggered rate. I have already looked at this a bit and there are certainly some surprises there, but, stay tuned...

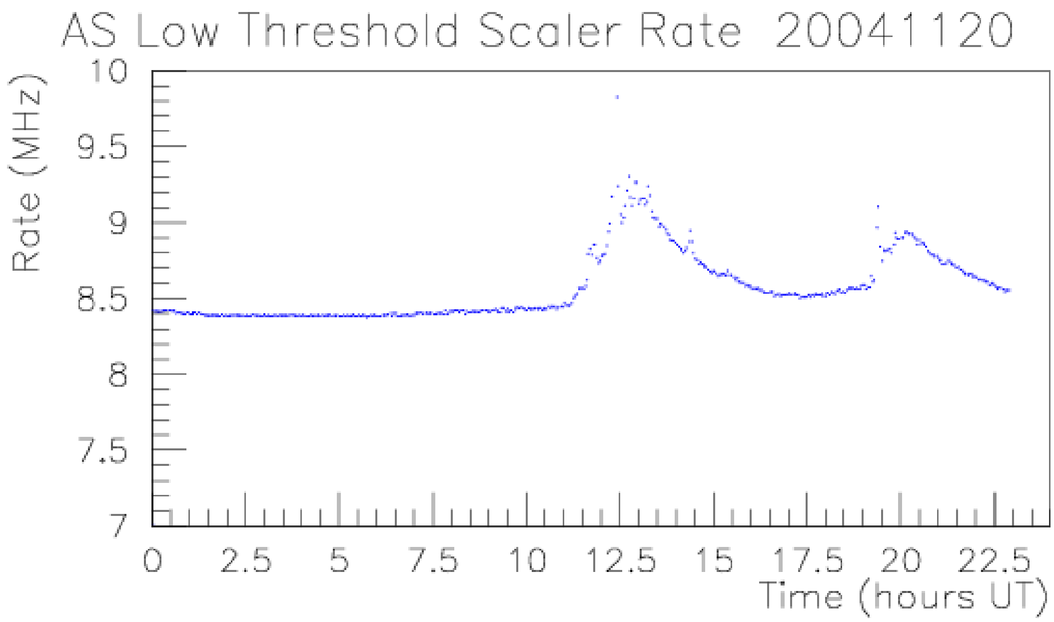

Fig. 1a. Air Shower Layer Low Threshold Rates on 11/20/2004

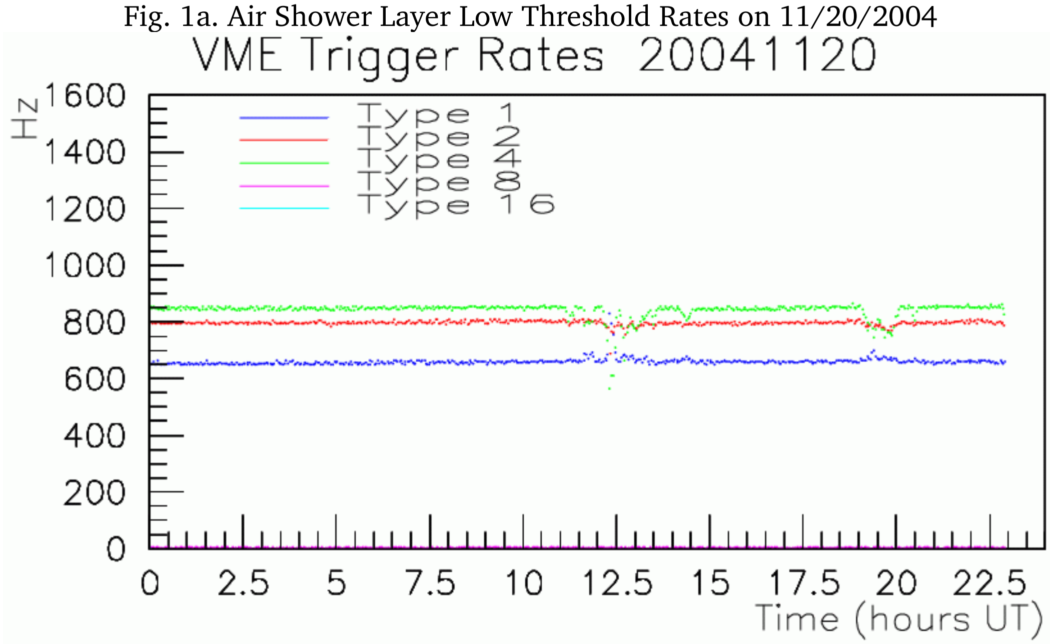

Fig. 1b. Trigger rates on 11/20/04.

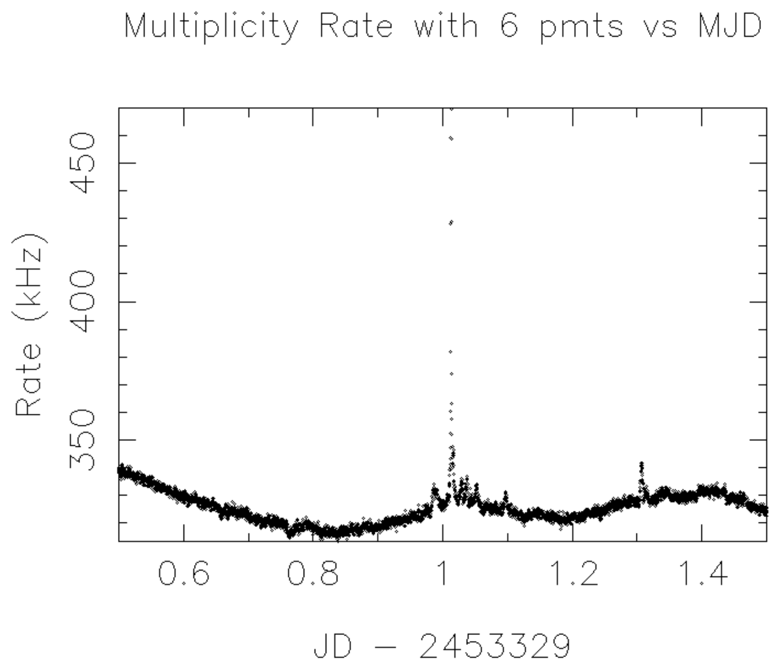

Fig 2a. 6-PMT multiplicity rate on mjd 3329 (11/20/04).

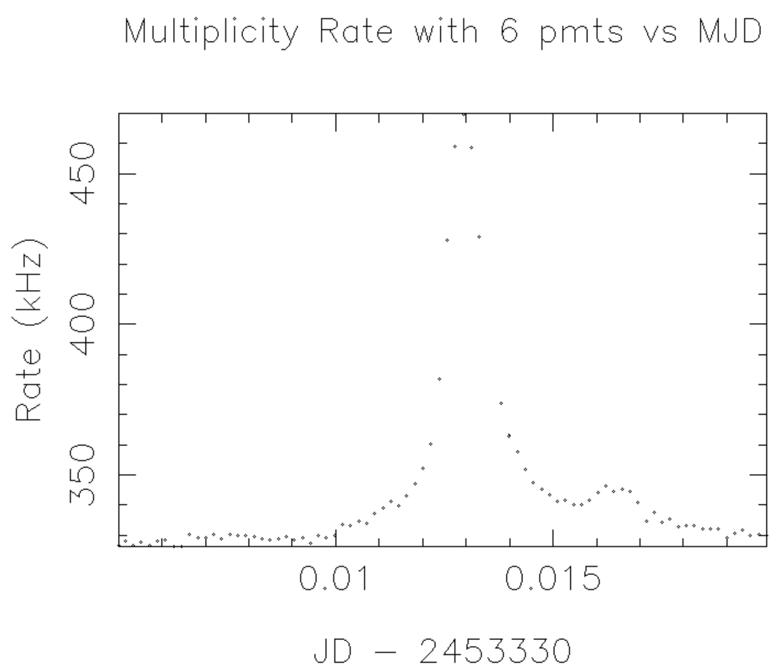

Fig. 2b. Same as 2a, but zoomed in time.

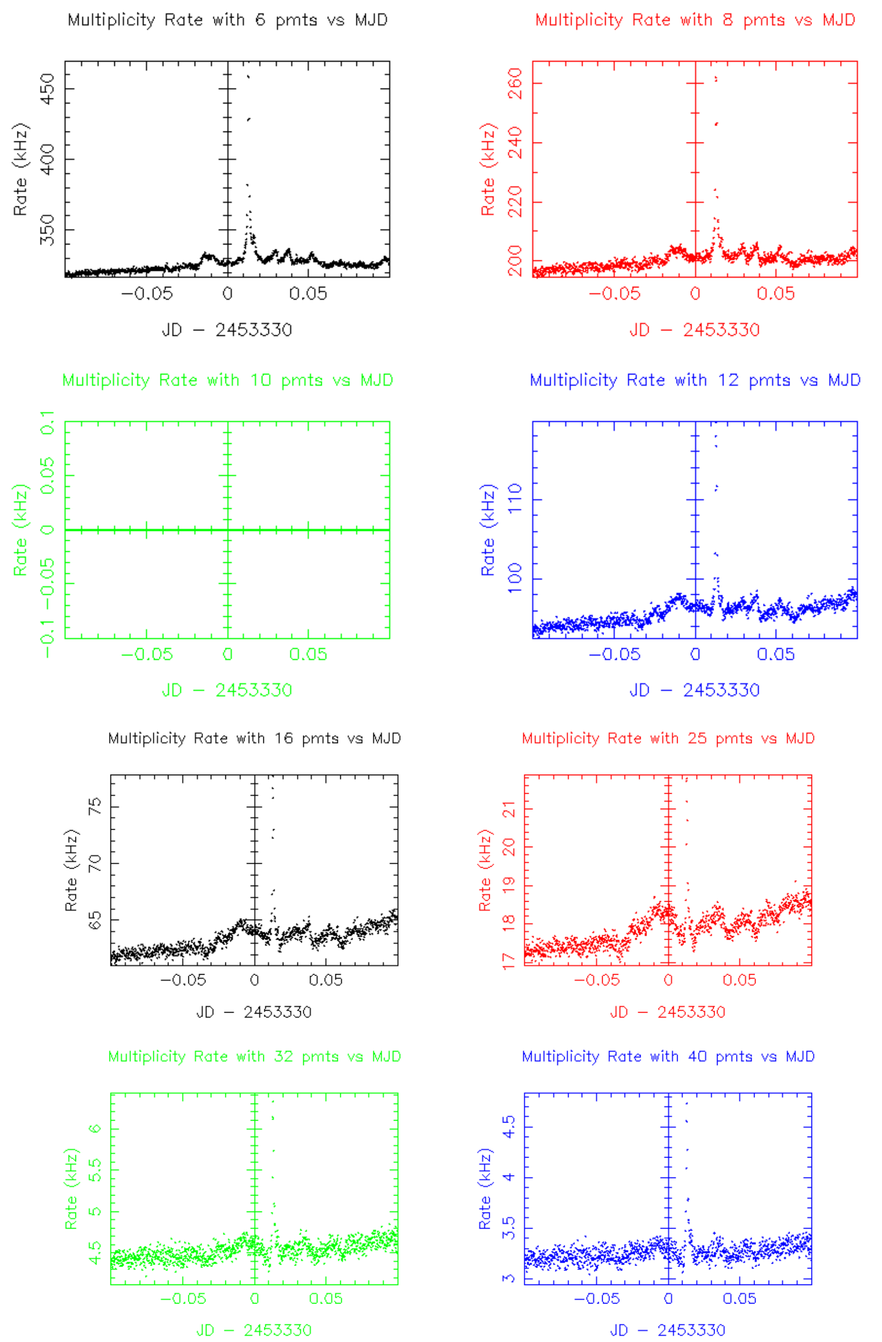

Fig. 3: Multiplicity rates on 11/20/2004

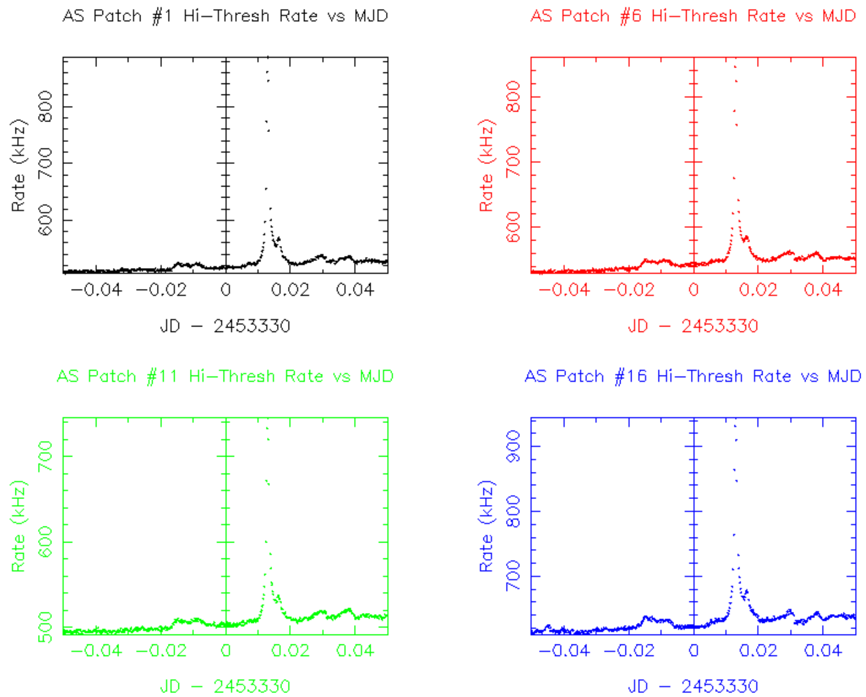

Fig. 4: Example AS high threshold rates

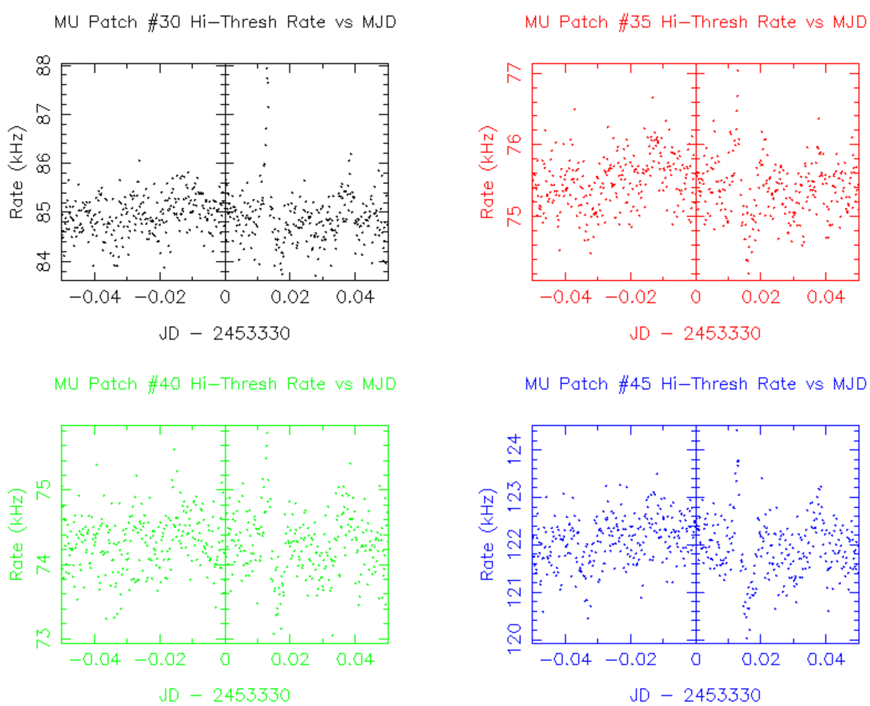

Fig 5: Example MU high threshold rates

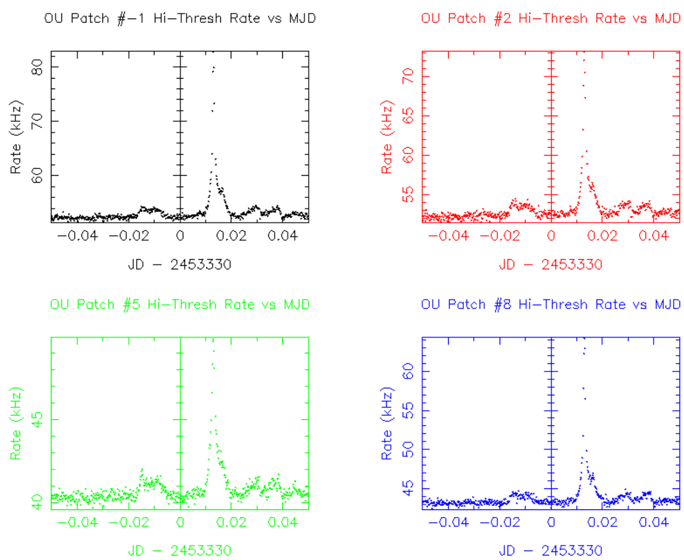

Fig 6: Example OU high threshold rates

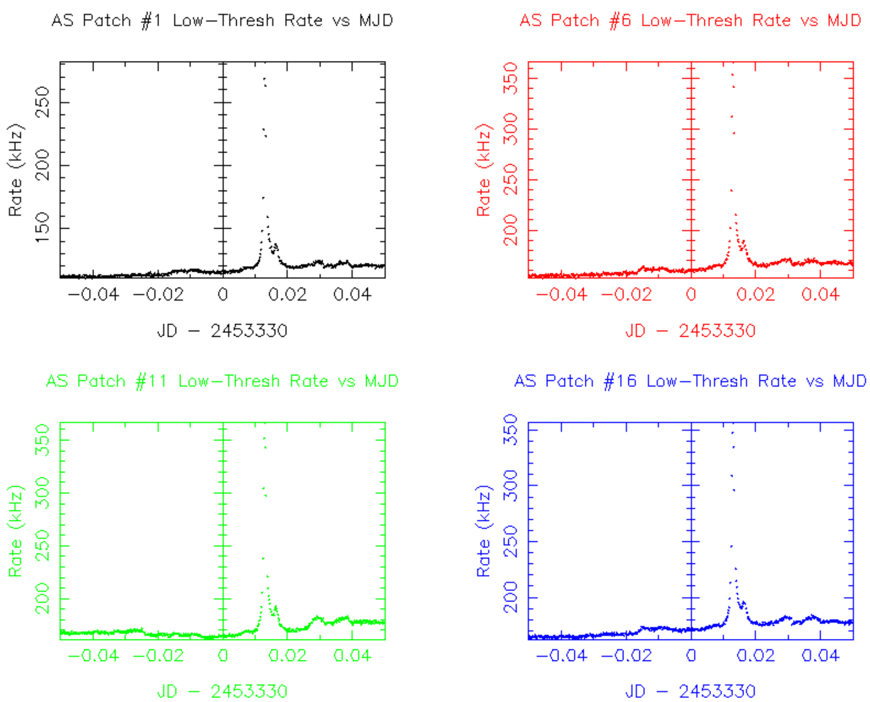

Fig 7: Example AS low threshold rates

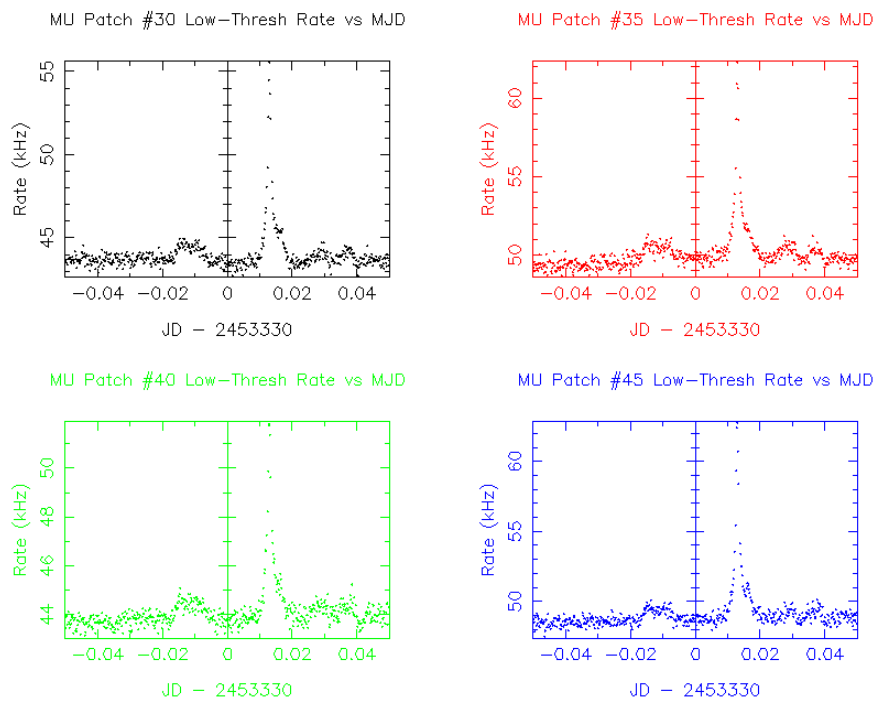

Fig 8: Example MU Low Threshold

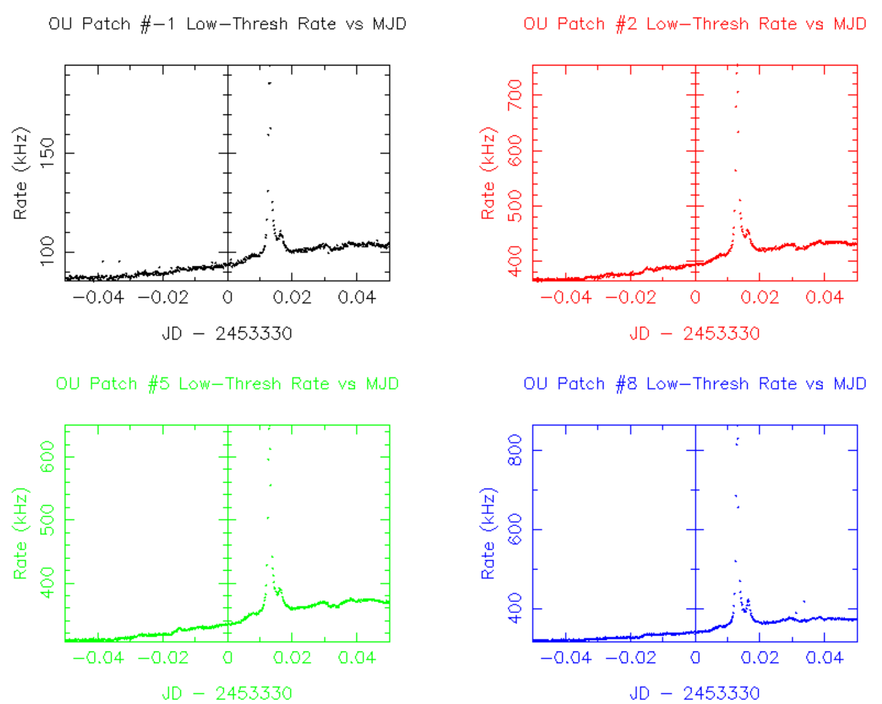

Fig 9: Example OU Low Threshold

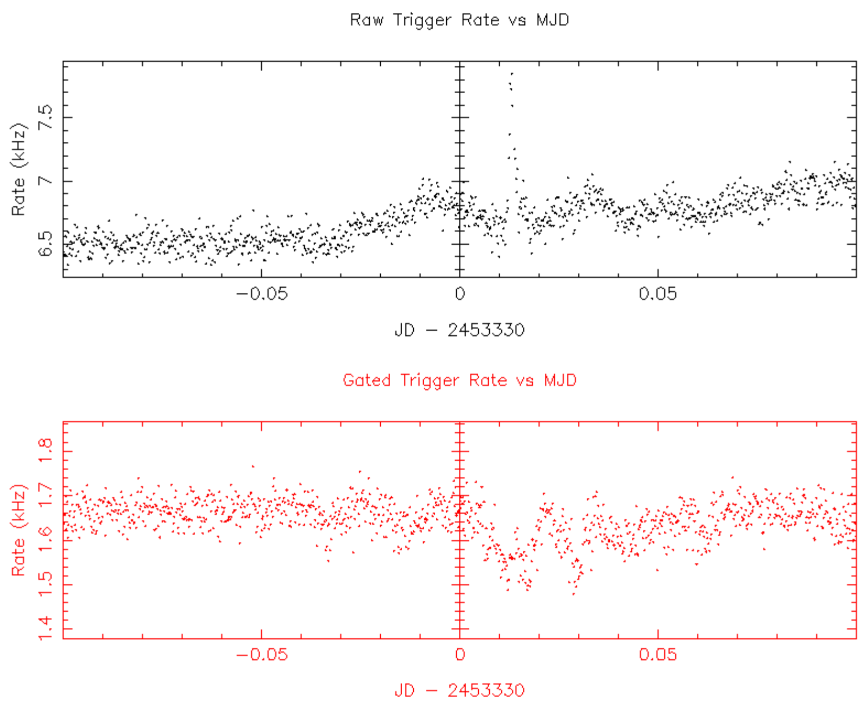

Fig 10: Raw and gated trigger rates

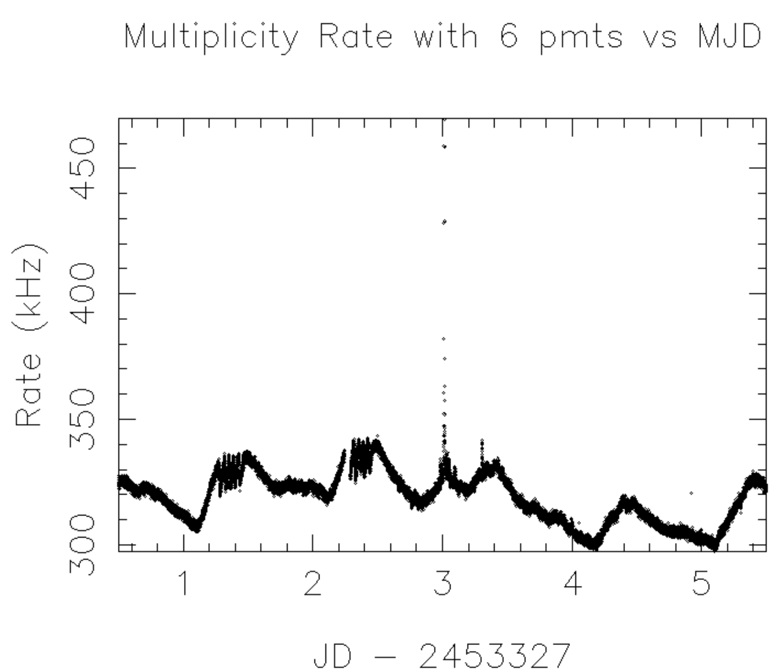

Fig 11: 6-PMT multiplicity rate for 5 day period, centered on spike.

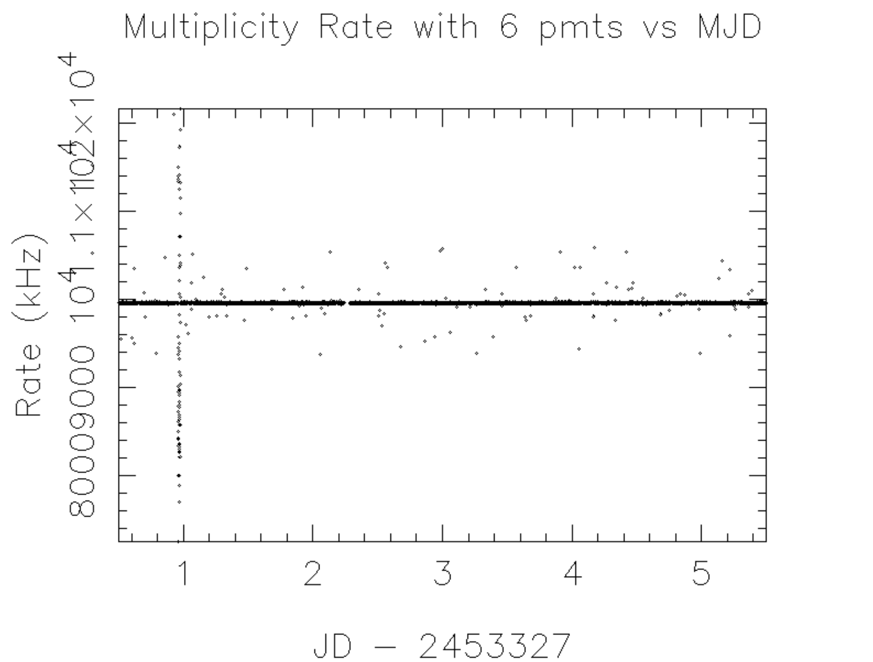

Fig 12: Reference scaler rate for 5 day period, centered on spike (**please ignore plot tittle**).

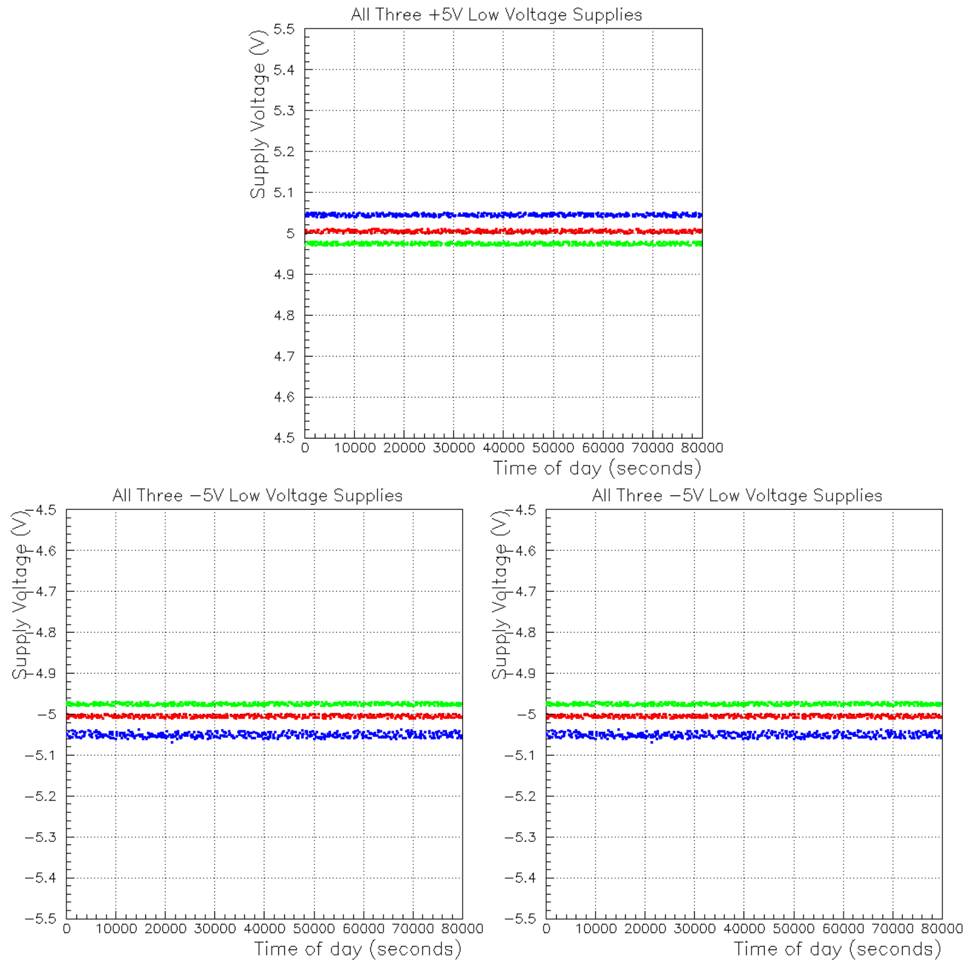

Fig 13: Low voltage supply voltages on 11/20/2004.

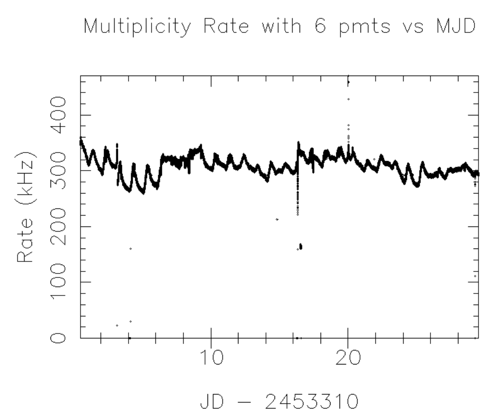

Fig 14: November 2004

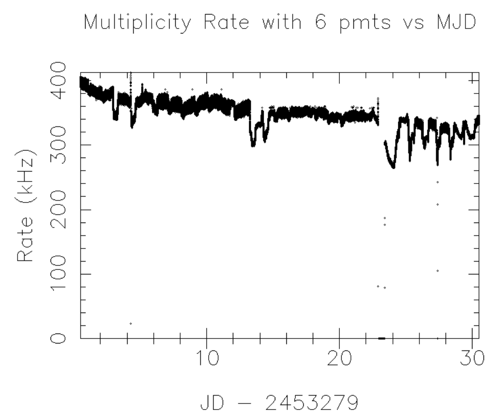

Fig 15: October 2004

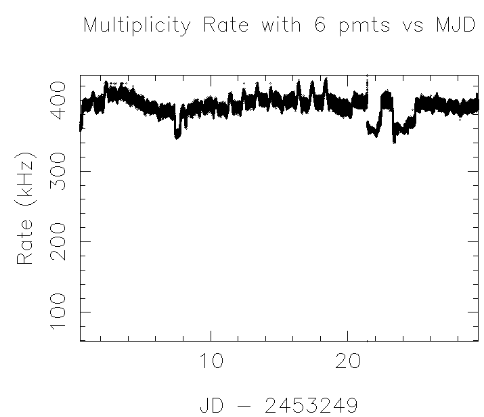

Fig 16: September 2004

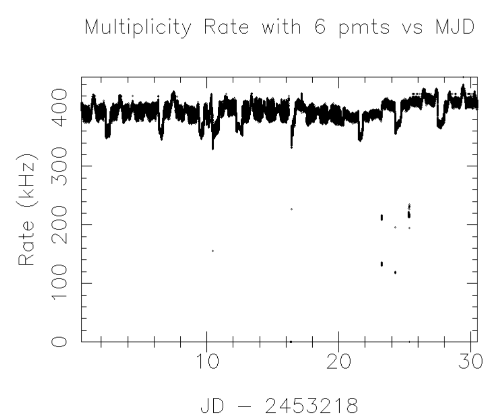

Fig 17: August 2004

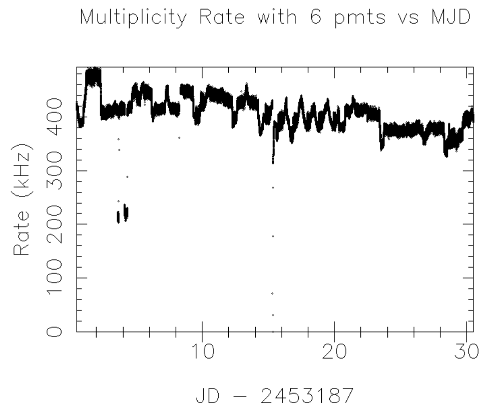

Fig 18: July 2004

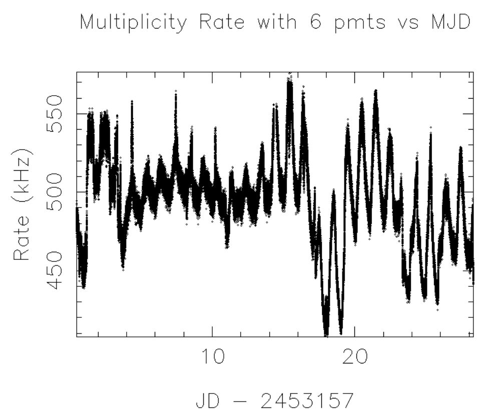

Fig 19: June 2004

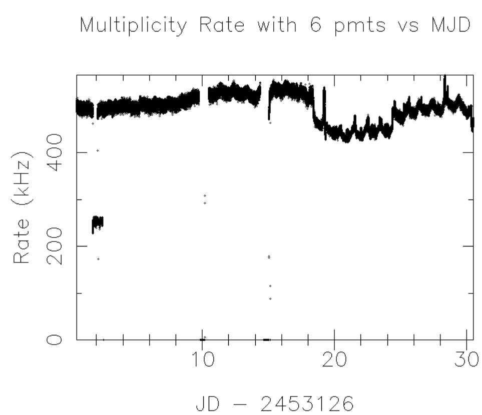

Fig 20: May 2004

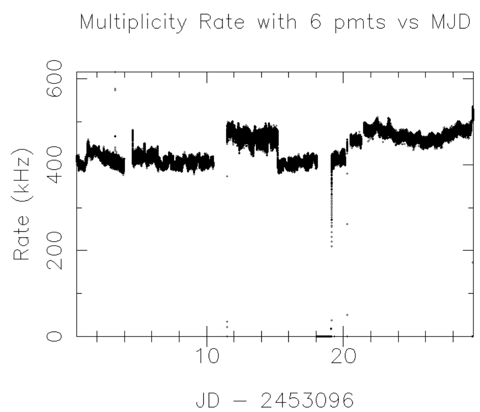

Fig 21: April 2004

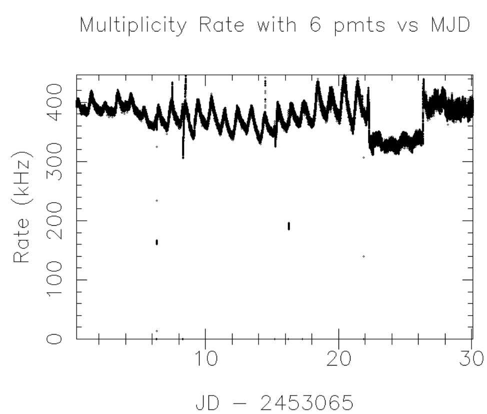

Fig 22: March 2004

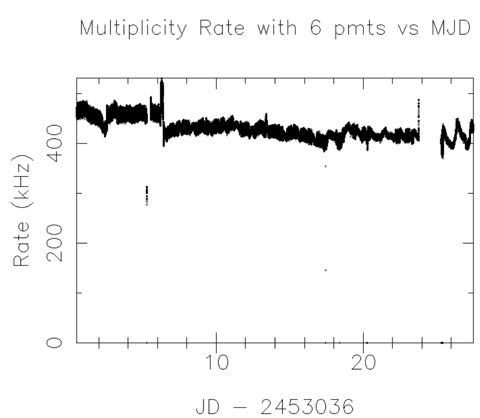

Fig 23: February 2004

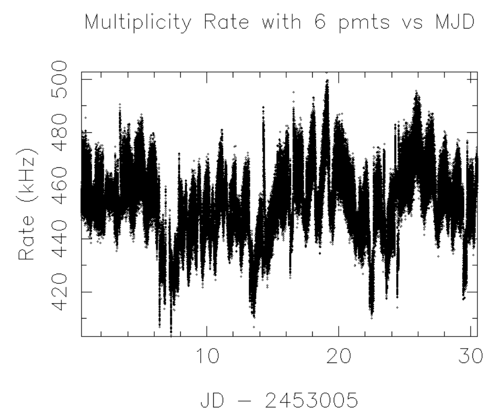

Fig 24: January 2004

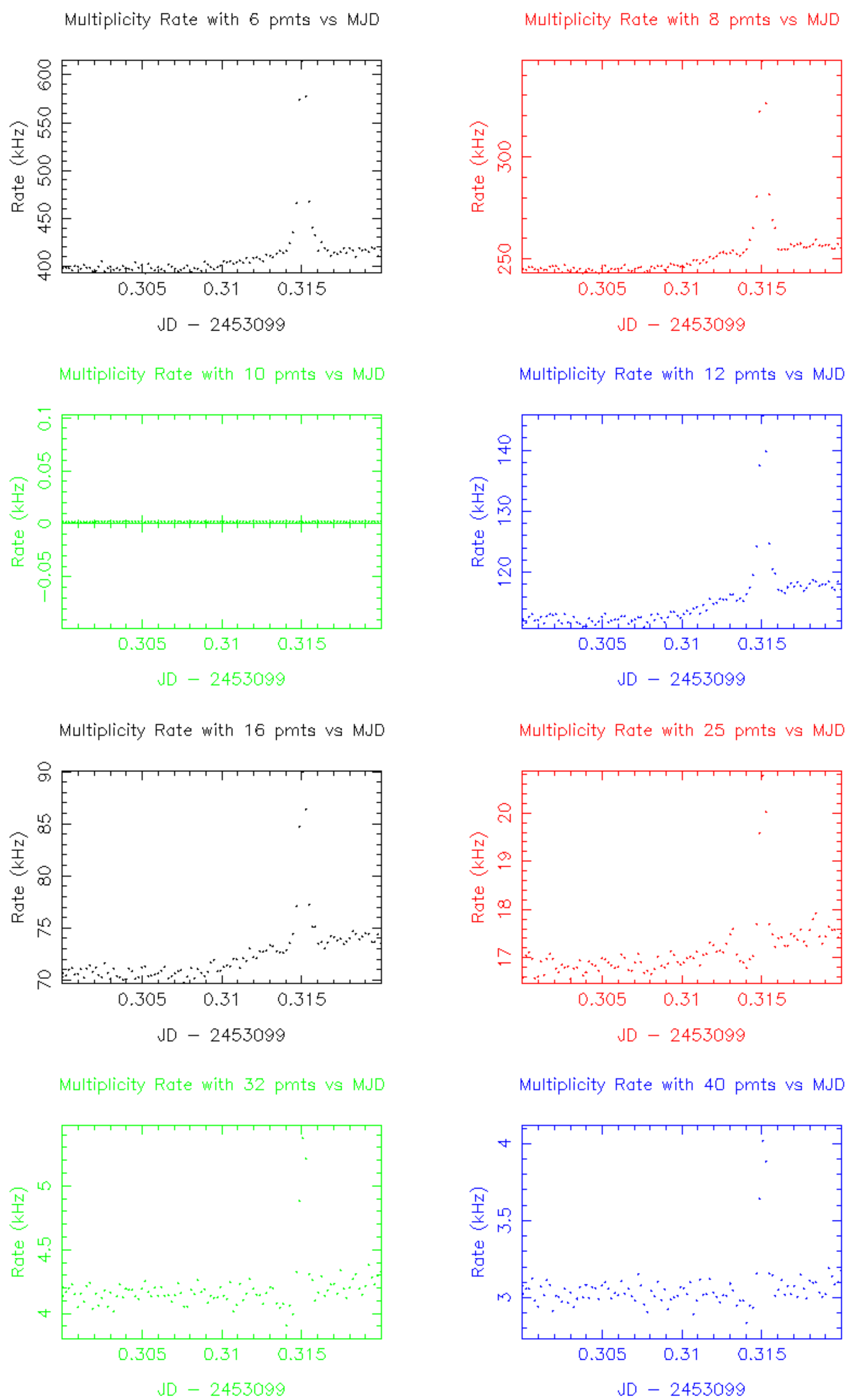

Fig 25: April 3, 2004 Event

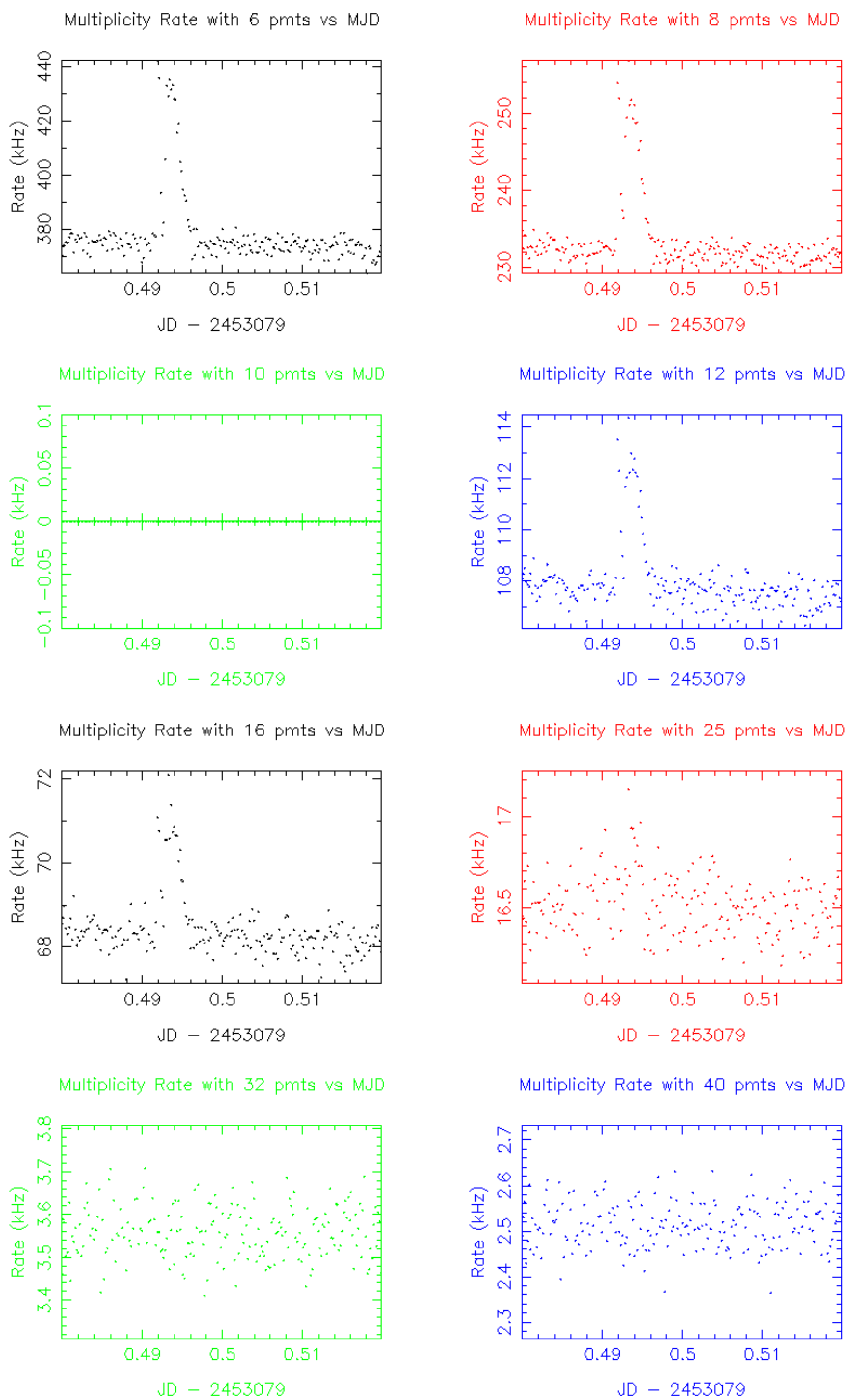

Fig 26: March 14, 2004 Event

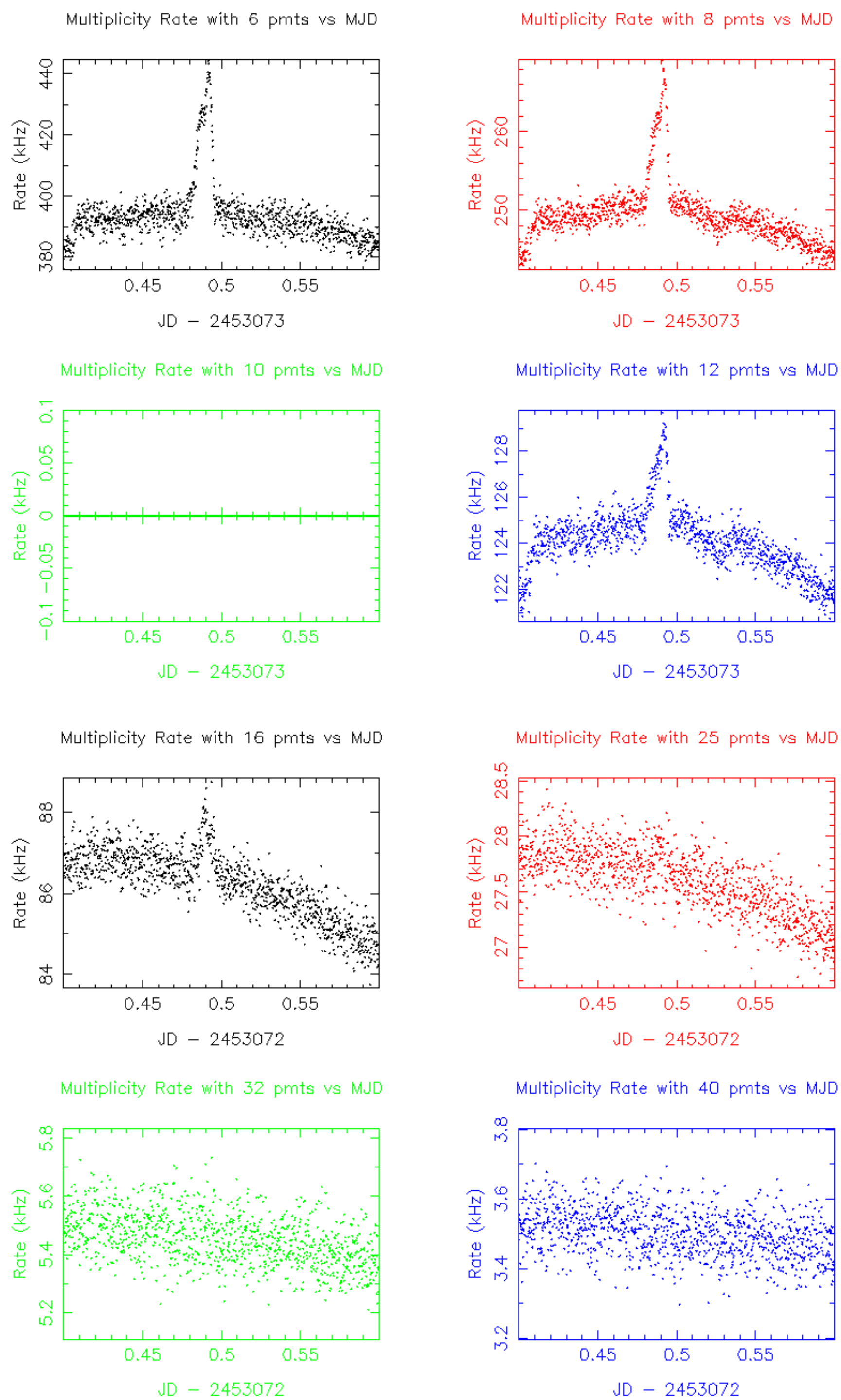

Fig 27: March 8, 2004 Event

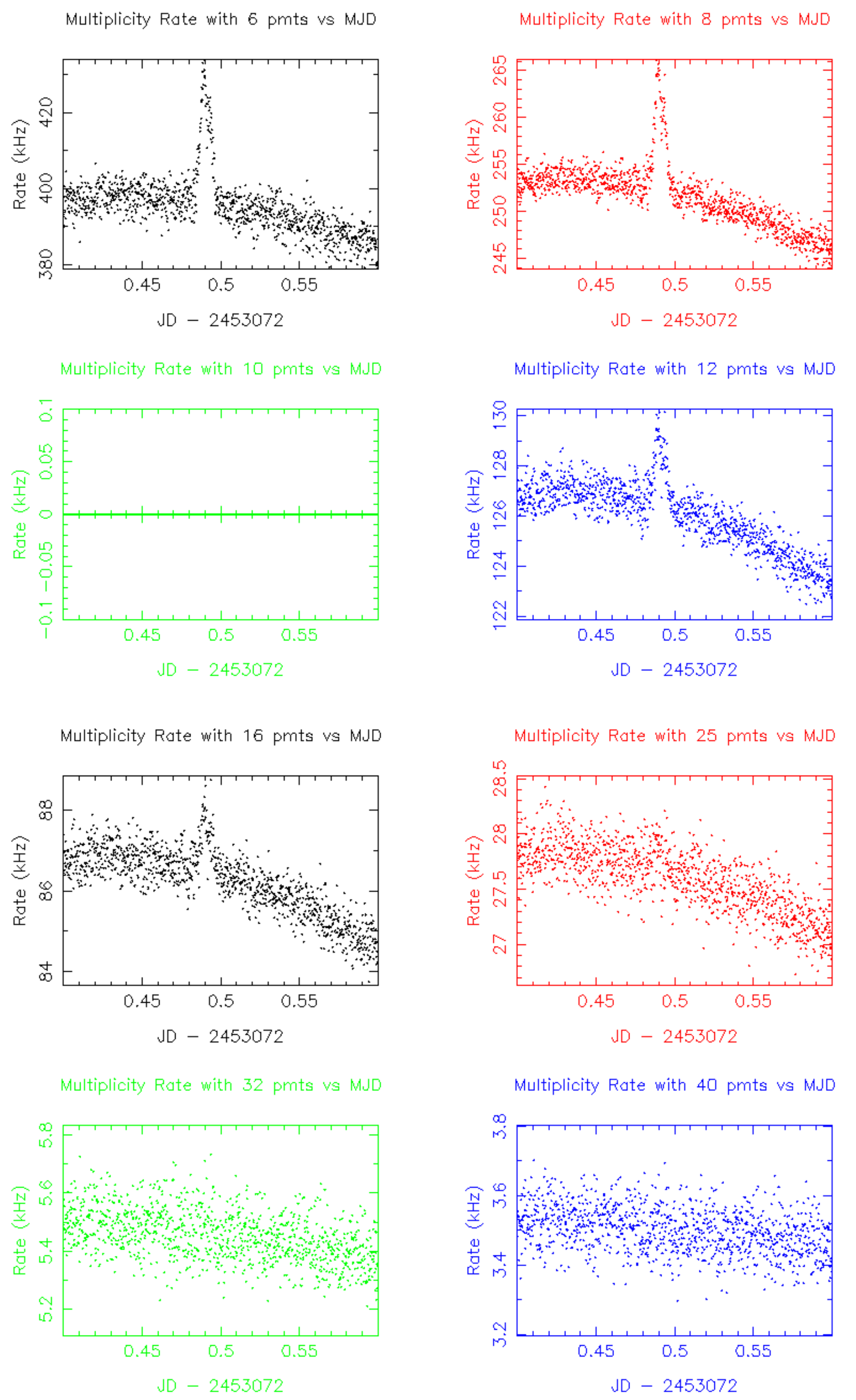

Fig 28: March 7, 2004 Event