Progress Report on the Auxiliary Plane for the the Triple Coincidence Experiment with BigBite

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Abstract

The auxiliary plane is ready to be installed as a part of the BigBite detector system. One can expect that its contribution to a TOF measurement between it and the trigger plane will be about 0.6 ns.

1 Introduction

The BigBite auxiliary plane has been shipped from Tel Aviv University, reassembled at TJNAF, and tested using cosmic rays. The experimental setup that was used during the cosmic tests is shown in Fig. 1. Triggering of the readout electronics was performed using coincidence between two 2" $\times$ 2" $\times$ 78" (5x5x200 cm^3) scintillators centered above and below the auxiliary plane and perpendicular to the direction of the tested scintillators. This setup enabled us to test the entire auxiliary plane simultaneously. The H.V. was set for the counters and the scintillators counters were tested for time resolution and signal/noise separation. Data acquisition was performed using CODA and analyzed with PAW.

2 Results

A typical ADC spectrum for one of the scintillators detectors (#3) is shown in Fig. 2. A typical TDC spectrum for the same counter is shown is Fig. 3. Using an oscilloscope the cosmic ray events were found to cause pulses in the range of $50 \sim 100mV$ as shown in Fig. 4.

3 ADC spectrum analysis

The ADC spectrum shows a clear distinction between pedestal values and actual cosmic ray events. The protons of 250-500 MeV/c that will be detected during the E01-015 experiment will create signals even larger than the minimum ionizing cosmic rays. The channel differences between pedestal and cosmic event values were found to be in the range of 150-300 channels; note, the input to the fastbus ADCs is after a UVA splitting panel that reduced the analog signal by a factor. The difference in channel number between the pedestal position and the position of a Gaussian fitted to the data is shown in Fig. 5 for all the detectors. Measurements were performed with the cosmic trigger counters across the center (typically it is 200 ± 20) and also near the even and the odd photomultiplier tubes. The ratio between the pulse height at the "near" and "far" ends are shown for all counters in Fig. 6. That difference ranges from 100 to 200 channels for the different counters. A correction to the time based on the ADC values was performed as detailed below.

4 TDC spectrum analysis

The time distribution for the detectors is influenced by both the time resolution of the tested detector as well as that for the trigger detectors. Both of those resolutions together result in a Gaussian distribution with a standard deviation in the order of $25 \sim 30$ TDC channels (50 psec each), corresponding to $1.2 \sim 1.5$ ns.

In order to determine the actual time resolution, we installed one of the spare counters in parallel to counter #40 between and perpendicular to the two cosmic trigger scintillators. We then looked at the time difference between these two counters. The trigger being two cosmic ray detectors below and above the counters as shown in Fig. 1. The "start" time was always determined by one of the upper cosmic detector photomultipiler tubes. This distribution is shown in Fig. 7. Assuming the time resolution of both is equal, the width of the distribution (σ: 32 channels = 1.6 nsec) is $\sqrt{(2)}$ times the detectors resolution (σ of about 1.1 nsec).

We also found a clear correlation between the ADC pulse height and the size of the TDC signal. An example is shown in Fig. 8 for counter 40 and the extra counter we installed above it for the time resolution measurements. Similar behavior was found to exist in all counters. We fitted the TDC value as a function of the ADC value using the data from the central position trigger. The fit was to a second order polynomial as shown in Fig. 8. We defined a corrected time as the time obtained for the counter corrected for the ADC value using the 3 fitted parameters for that particular counter. The corrected time distribution under the same conditions as for Fig. 7 now has a σ of 17.26 channels. Assuming equal contribution from the two equal detectors it results a time resolution for each counter of :

$$\sigma = 17.26 * 0.05/\sqrt(2) = 0.6nsec.$$

Figure 9 shows for counter #2 the time distribution for the central trigger before and after the correction. Figure 10 shows the corrected time distribution for counter 2 for the "near", "far", and "center" trigger positions. Figure 11 shows the corrected time distributions for the full array. The values are the TDC positions and σs for the "near", "far", and "center" triggers. In Fig. 12 shows the time difference between "far" and "center" as well as "near" and "center".

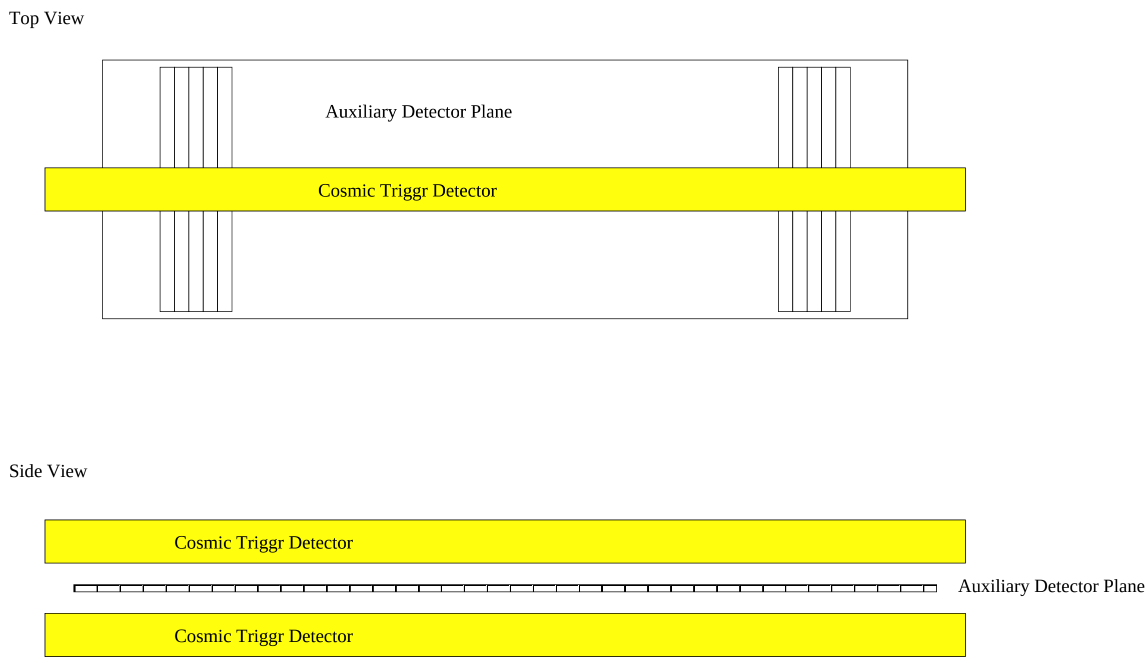

Fig. 1. The setup used for testing the auxiliary plane

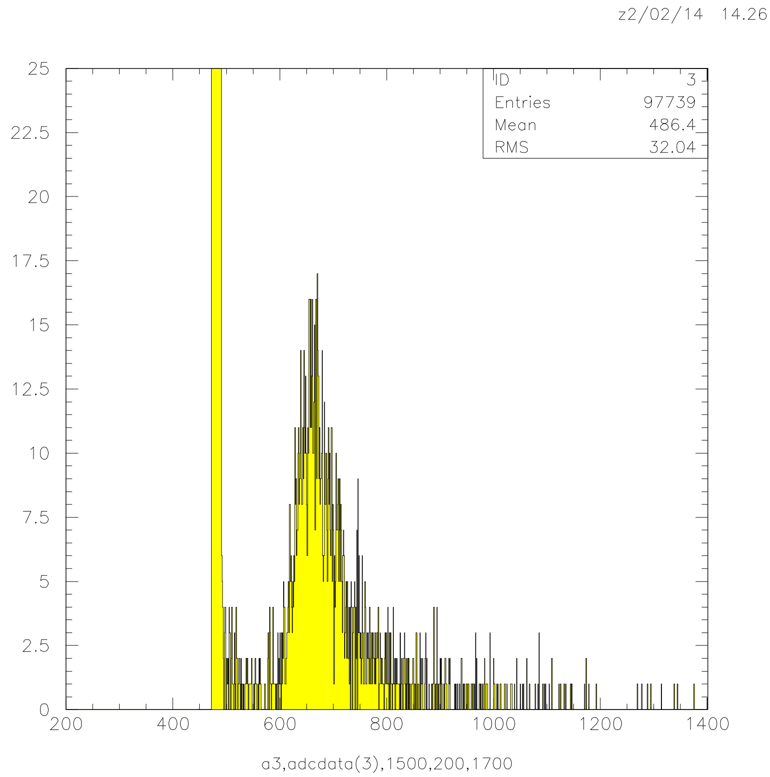

Fig. 2. The ADC spectrum for detector #3

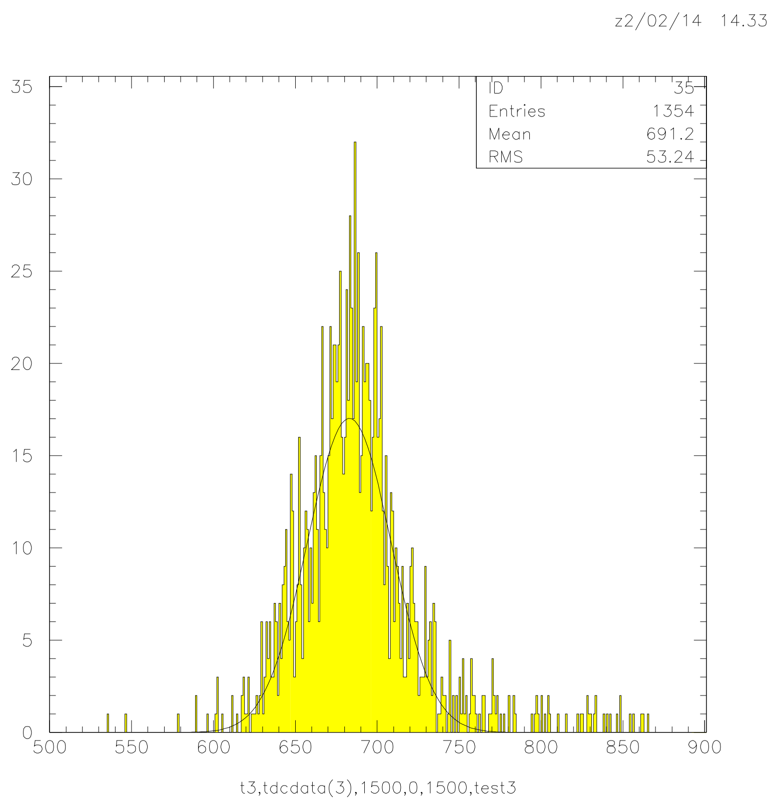

Fig. 3. The TDC spectrum for detector #3

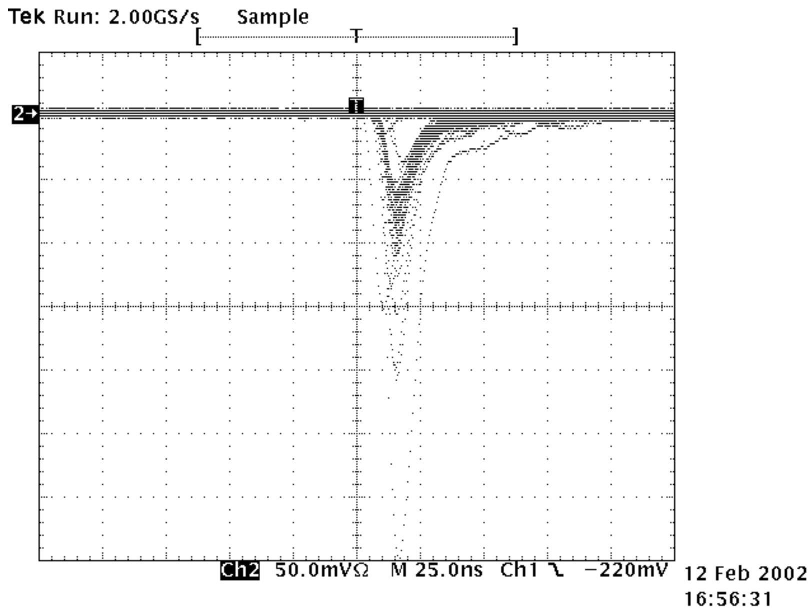

Fig. 4. Cosmic ray events as viewed using an Oscilloscope on detector #3

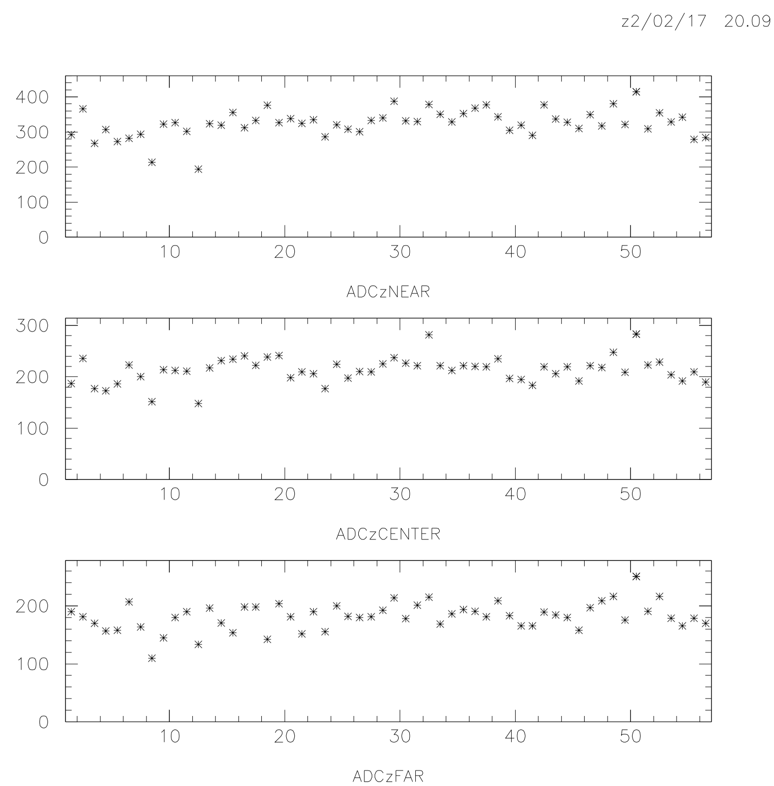

Fig. 5. The difference between the pedestal and the cosmic peak positions for all the counters. Shown are the obtained values for “near”,”far” and “center” positions. All are in ADC channel numbers.

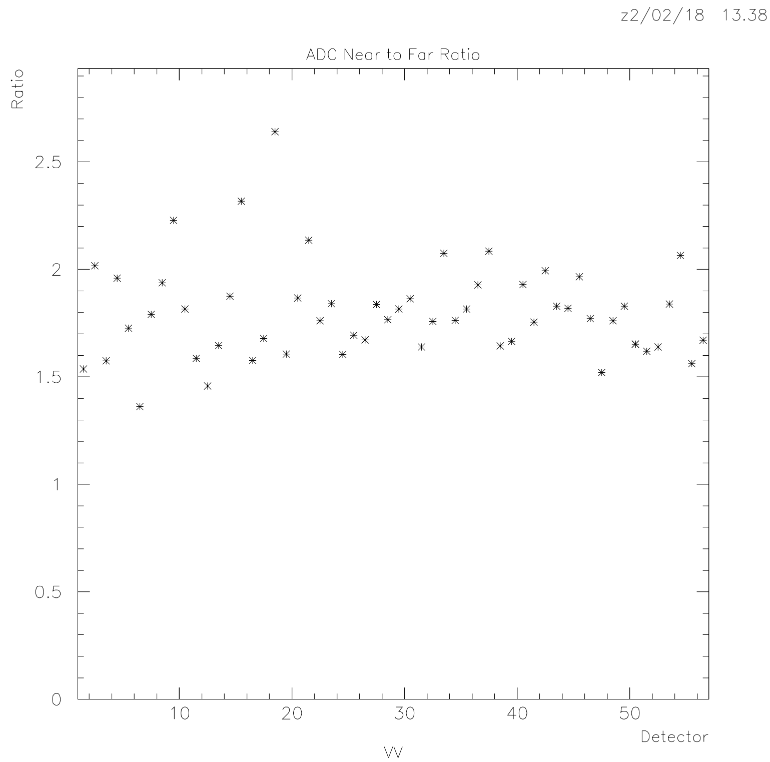

Fig. 6. The ratio between the ADC peak positions of the “near’ and “far” triggers.

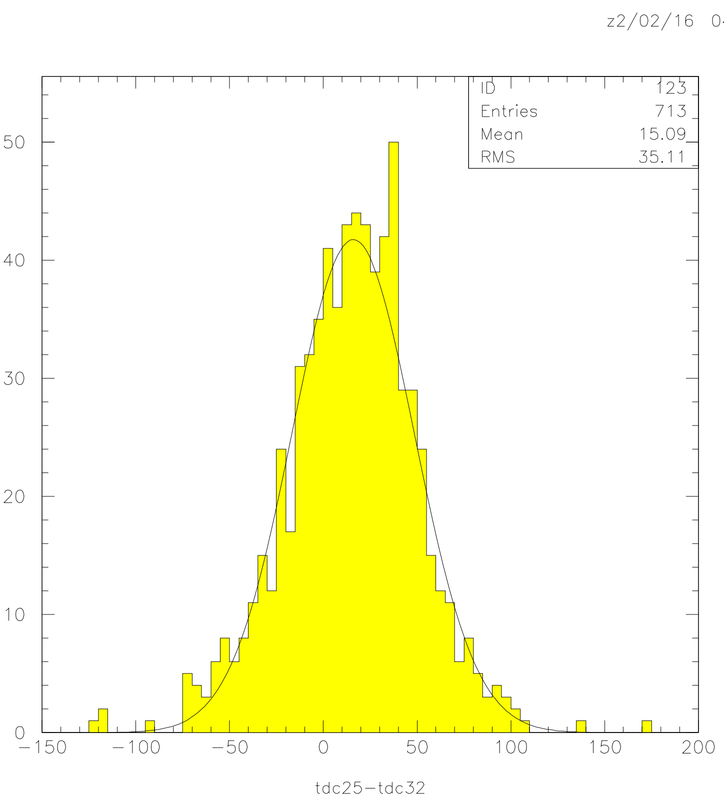

Fig. 7. The time difference between two parallel auxiliary plane counters triggered by two cosmic ray trigger detectors set perpendicular above and below the center of the two tested counters

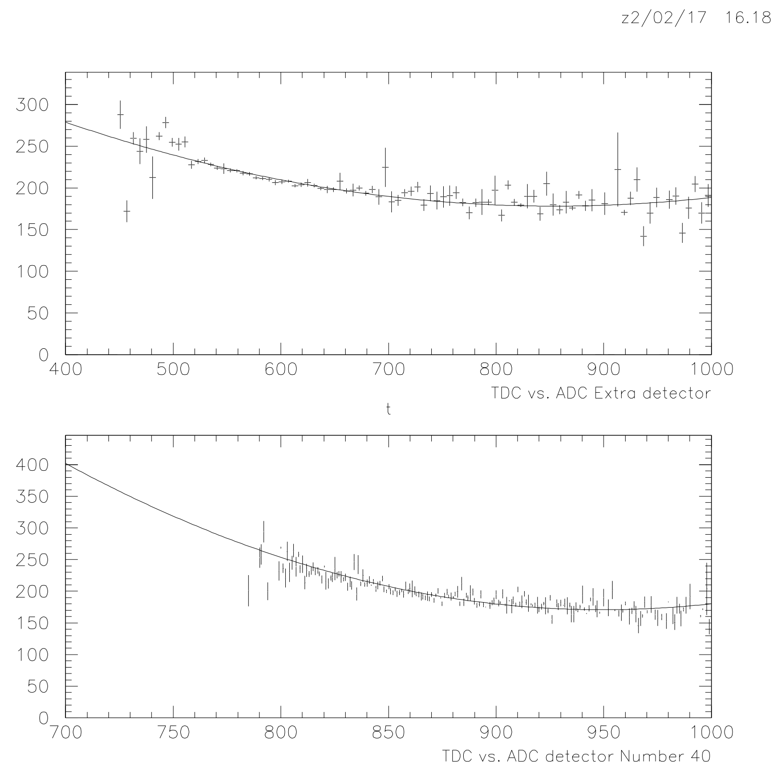

Fig. 8. TDC vs. ADC for the two counters mounted one above the other. The cosmic ray trigger counters are above and below the center of the tested counters. Similar behavior is exhibited for all the counters and also for the "far" and "near" trigger positions.

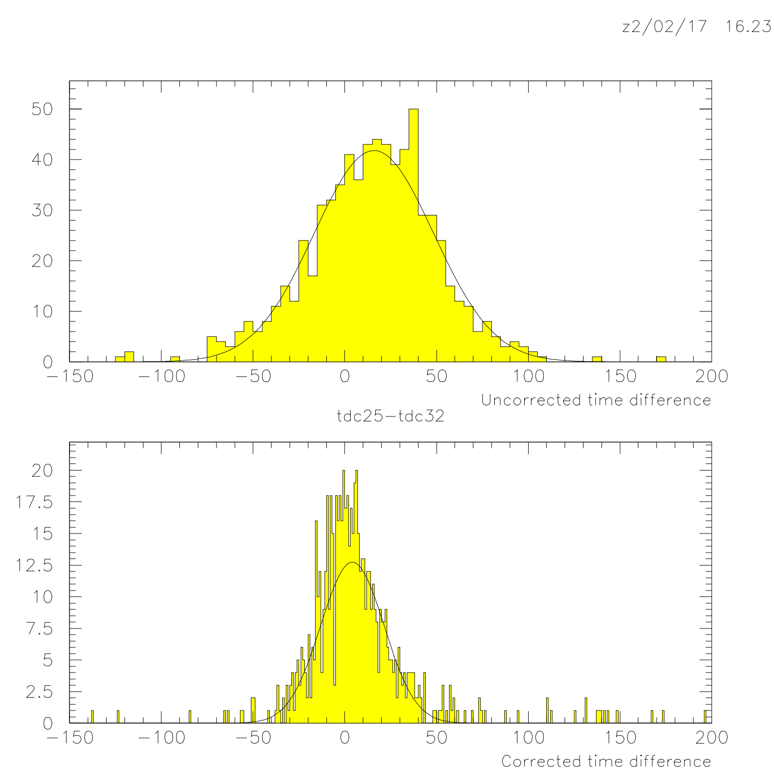

Fig. 9. The time spectra of detector 2 before and after the ADC correction done.

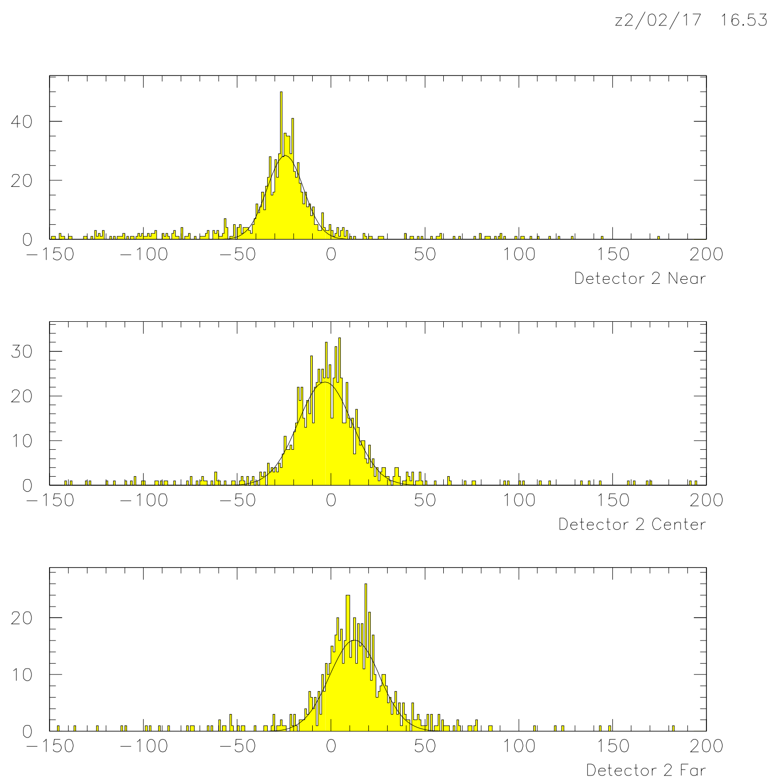

Fig. 10. Time corrected distributions for detector 2 with cosmic trigger at the "near","far" and "center" positions.

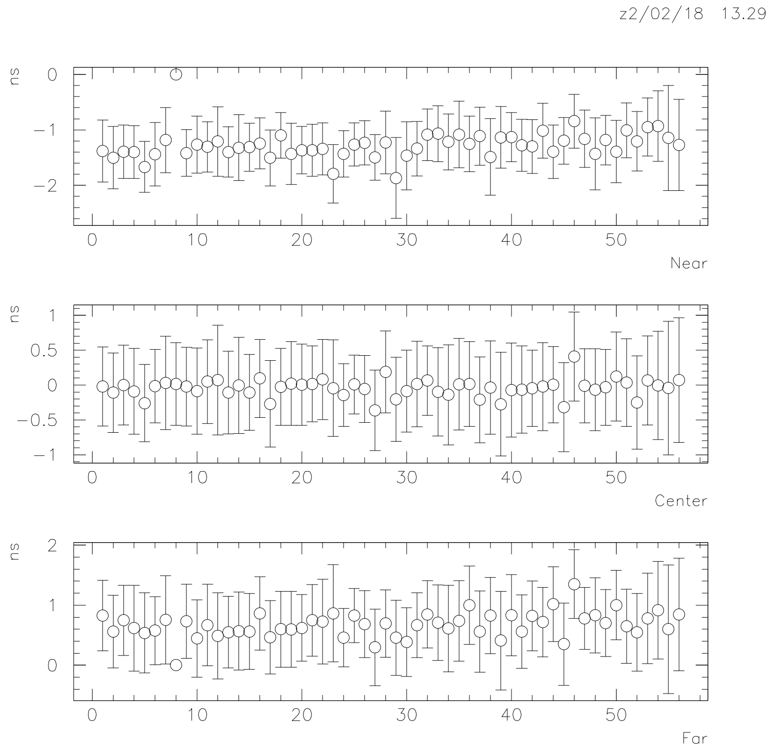

Fig. 11. The peak of the time spectra of all the detectors after the ADC correction. The errors are the widths (standard deviations) of the fits. All in nsec.

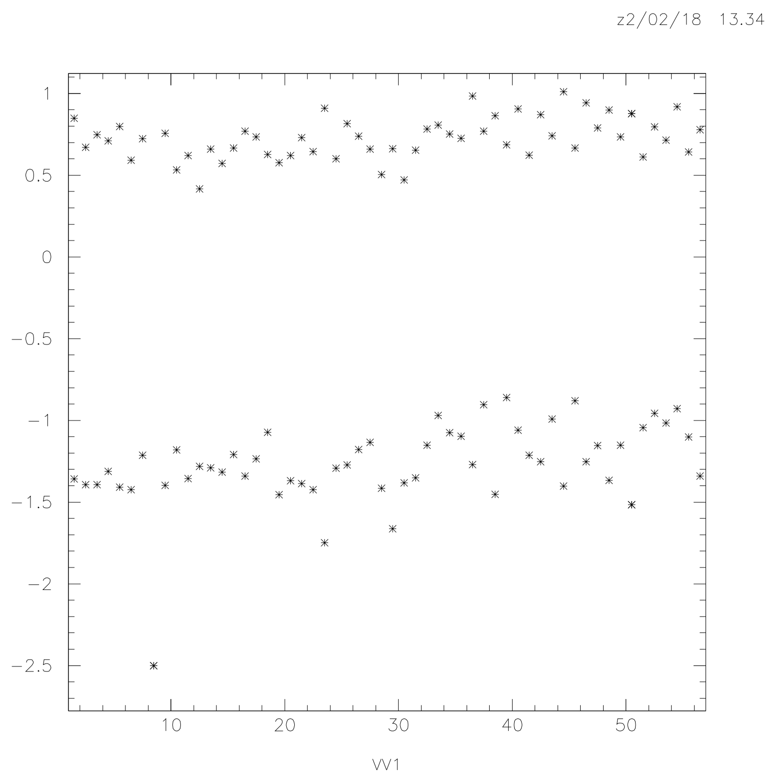

Fig. 12. The time difference between the peak positions of the spectra. For all the detectors after the ADC correction performed. All in nsec.