Time Resolution Determination for the BigBite Trigger Plane ($E/\Delta E$) and Auxiliary Plane Coincidence

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Auxiliary Plane Resolution

A prior test was performed for the resolution of the Auxiliary plane.

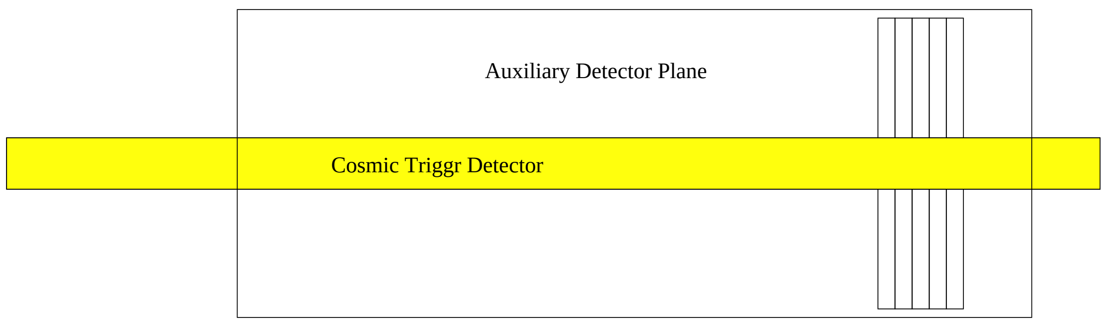
Results indicate that a resolution of 0.6 ns is achievable after performing corrections.

For the full report see:

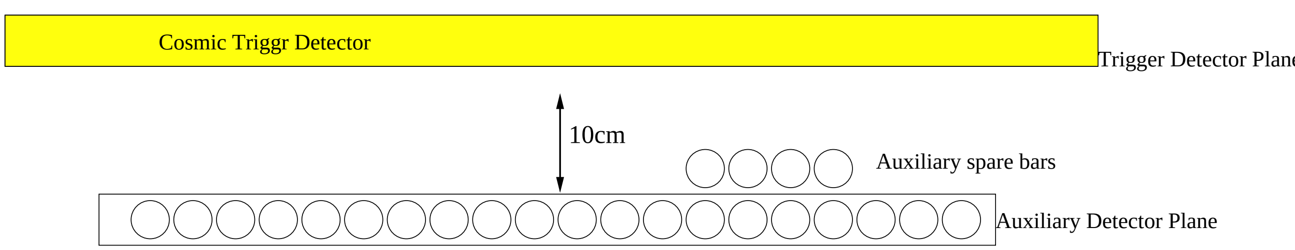
http://hallaweb.jlab.org/equipment/BigBite/Reports/aux-plane-tests.ps

Layout for Auxiliary Plane Resolution Test

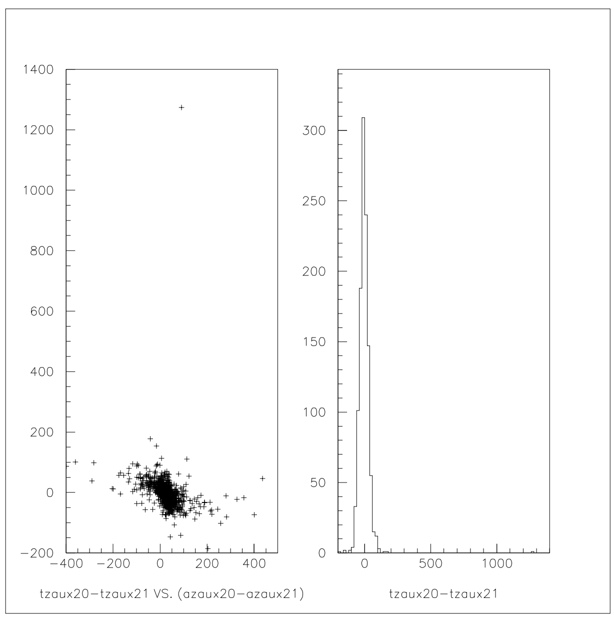
Top View



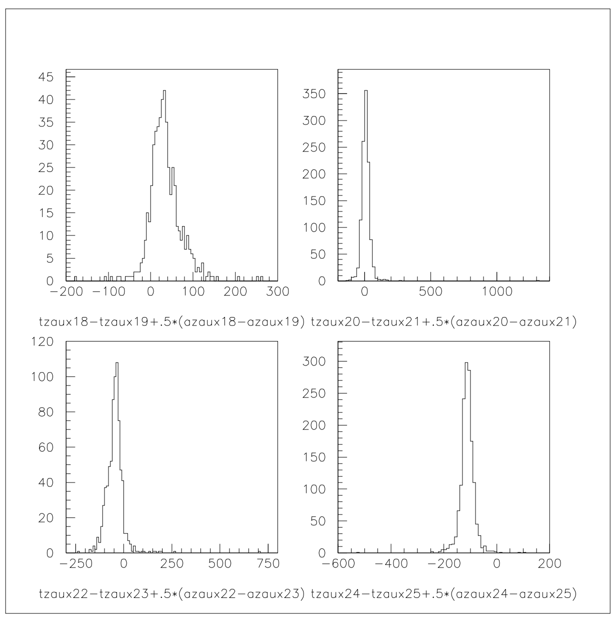
Side View



Results from the auxiliary resolution test before the ADC correction sigma=0.8 ns.

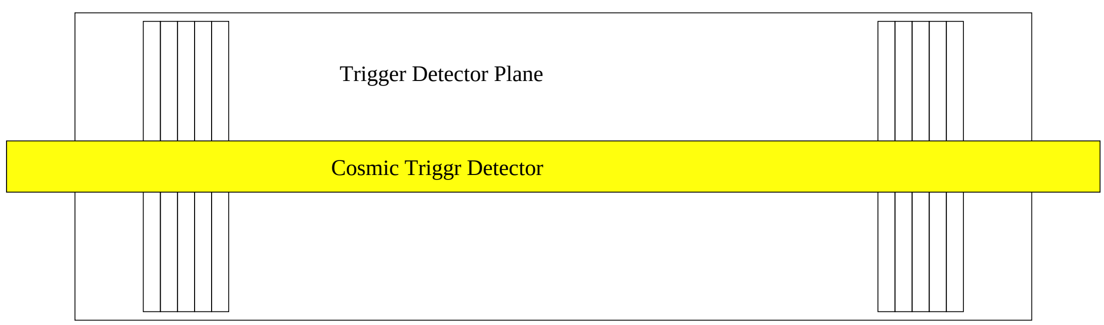


Ttop-Tbottom from the auxiliary resolution test after the ADC correction sigma=0.6 ns.

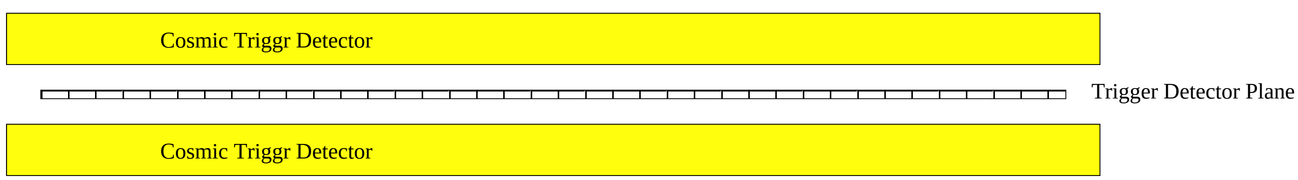


Layout for Trigger plane Resolution Test

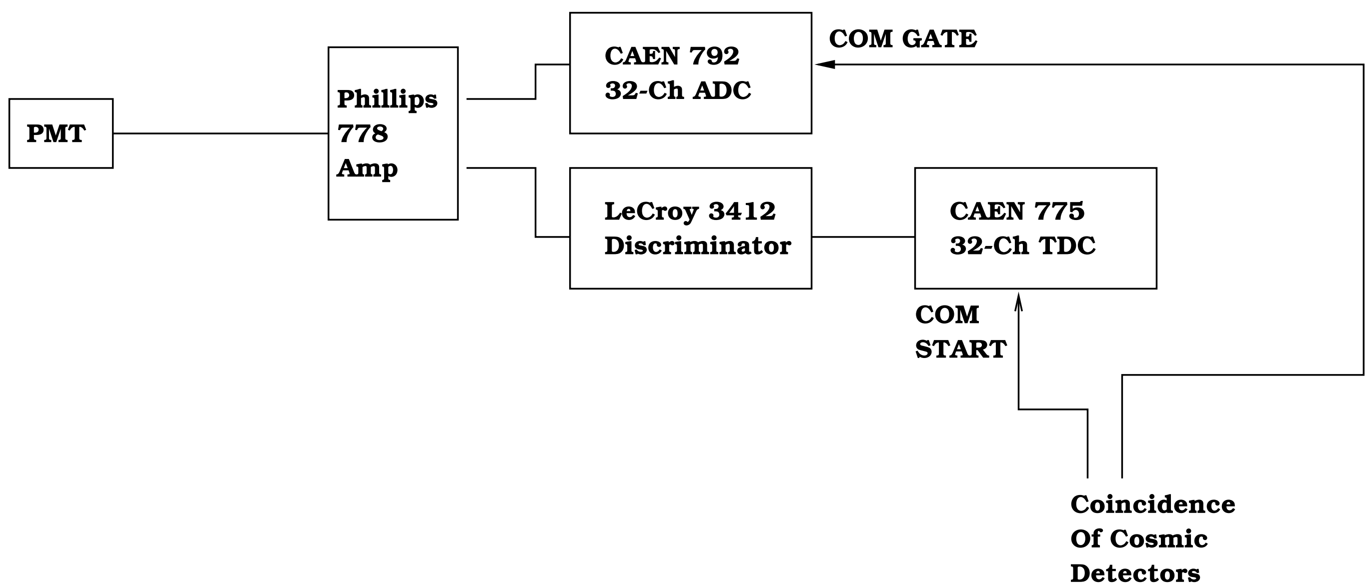
Top View



Side View



Electronics Layout (per channel)



The calculated resolution for a single detector is affected by both the intrinsic resolution and the cosmic trigger resolution.

$$\sigma_{calculated} \sim \sqrt{\sigma^2_{intrinsic} + \sigma^2_{trigger}}$$

In order to nullify the effects of the trigger another signal having the same trigger must be subtracted from the TDC signal.

Unfortunately all available signals (such as Auxiliary plane detectors) have a resolution worse then the trigger plane detector!

The Solution:
Substract Right side TDC signal from Left side signal.
Assuming Left and Right resolutions to be equal we get:

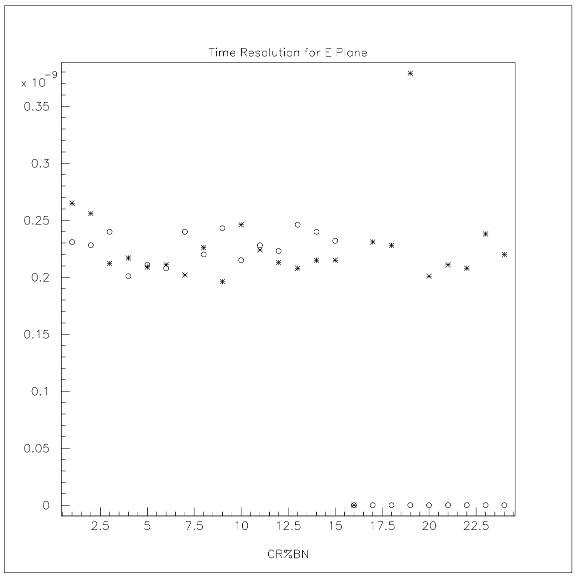
$$\sigma_{L-R} \sim \sqrt{2}\sigma_L \sim \sqrt{2}\sigma_R$$

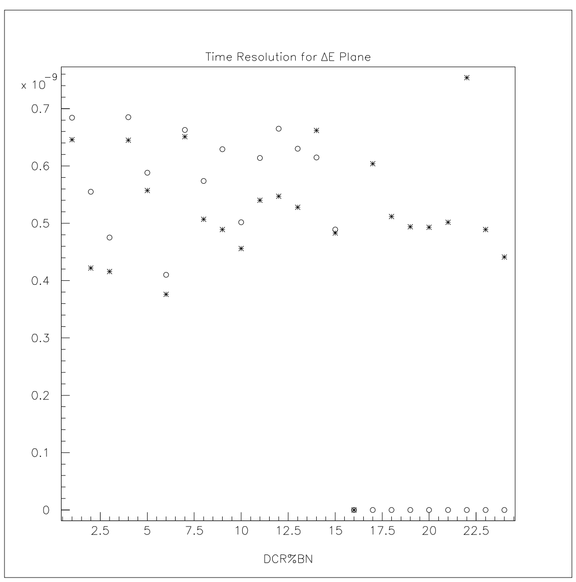
and also,

$$\sigma_{L+R} \sim \sigma_{L-R}$$

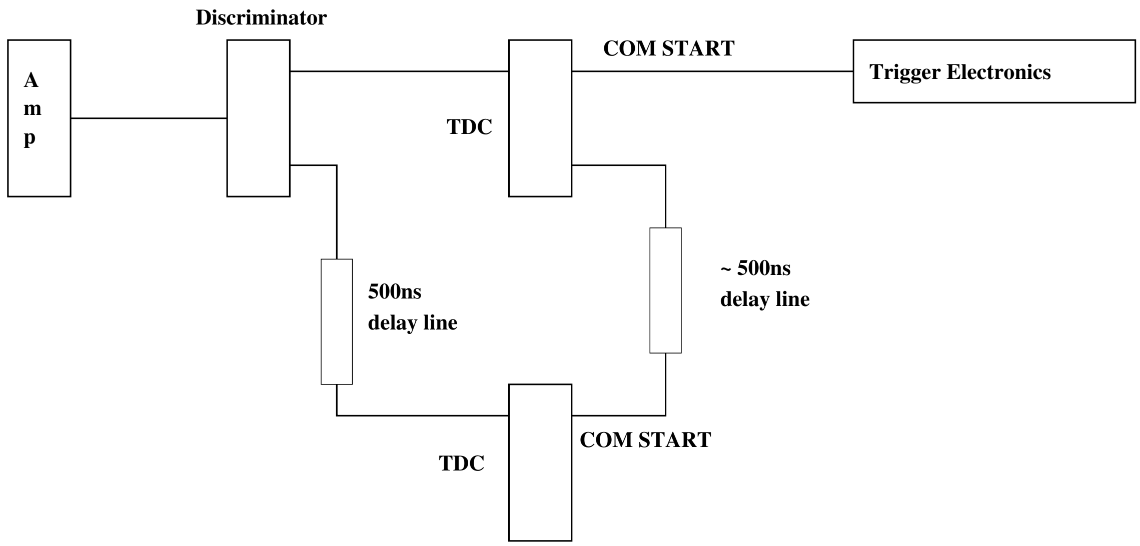
which is the experimental value we will measure.

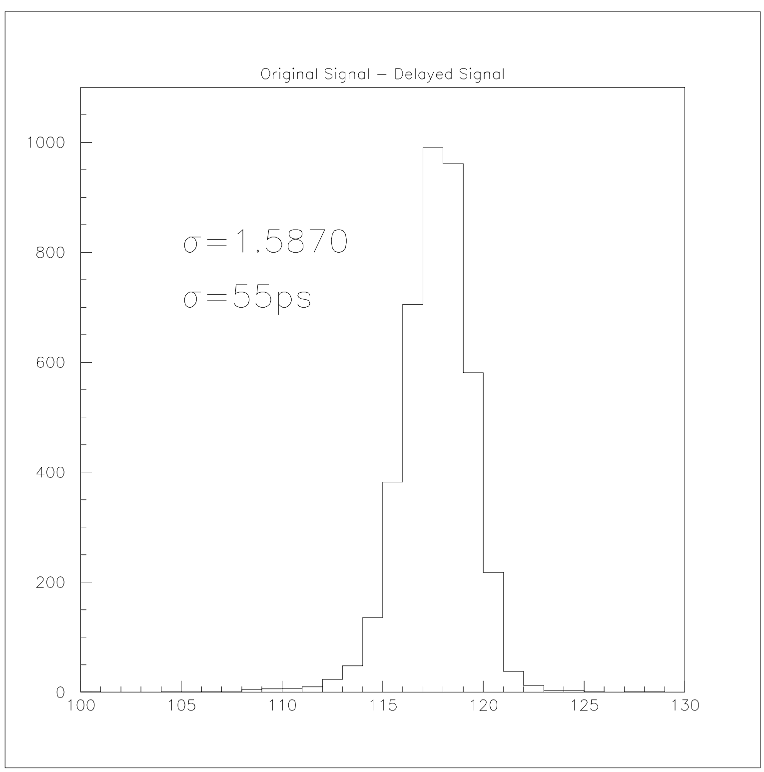
Calculated Resolution for $E/\Delta E$ Planes





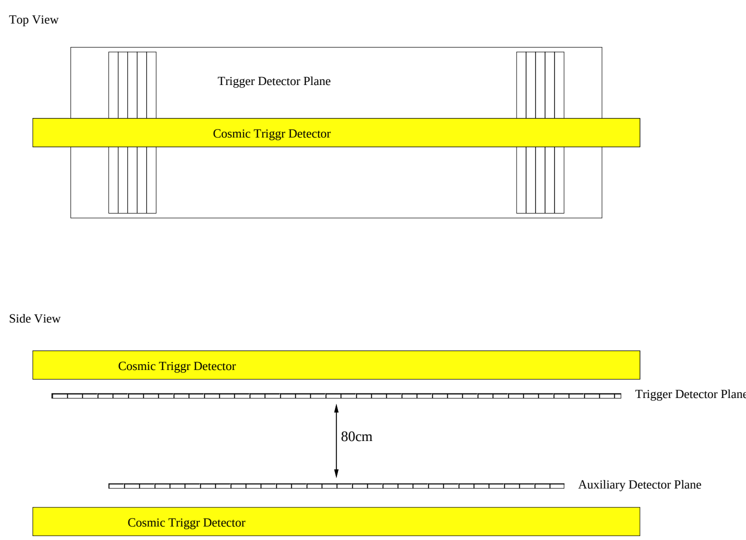
The Effect of the 500ns Delay Cable





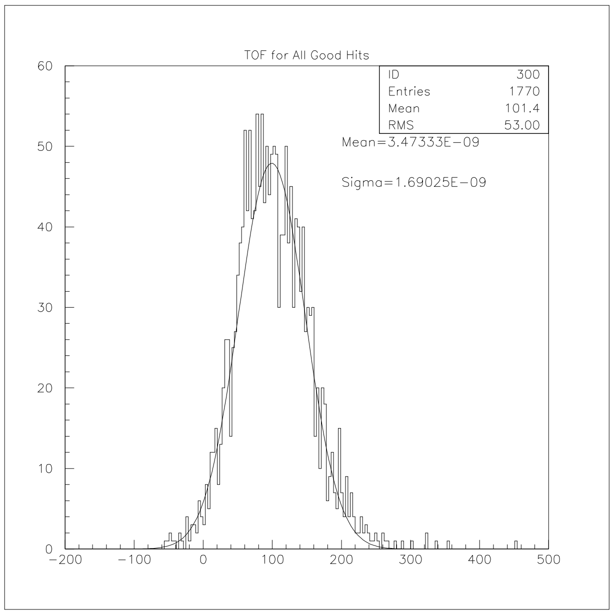
TOF Determination

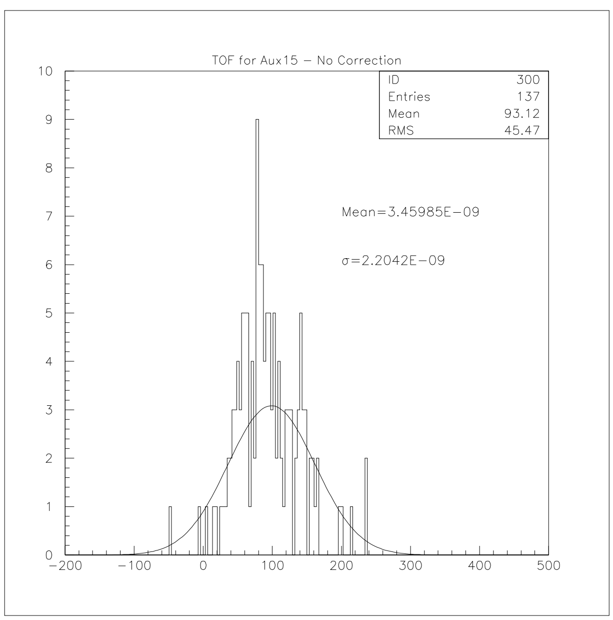
In order to test TOF resolution from both the Auxiliary and the Trigger plane we place the AUX plane beneath the Trigger plane at a distance of 80cm. In order to avoid introducing position dependent changes we used the two cosmic trigger bars placed above and beneath the two planes (Position 1).



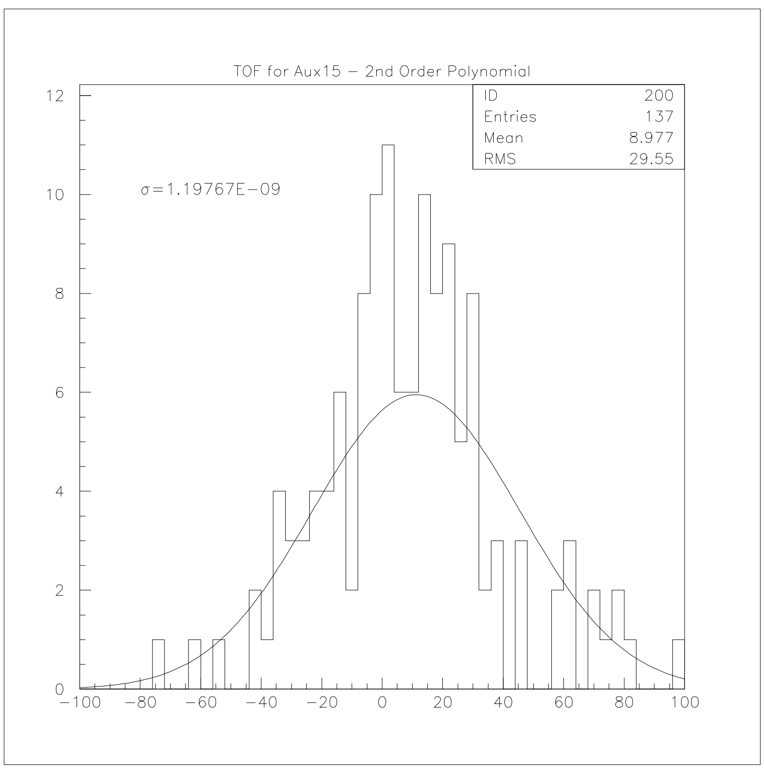
In order to further simplify analysis we selected only those events which described a specific path through both planes (i.e. hit only one Trigger and one Auxiliary bar).

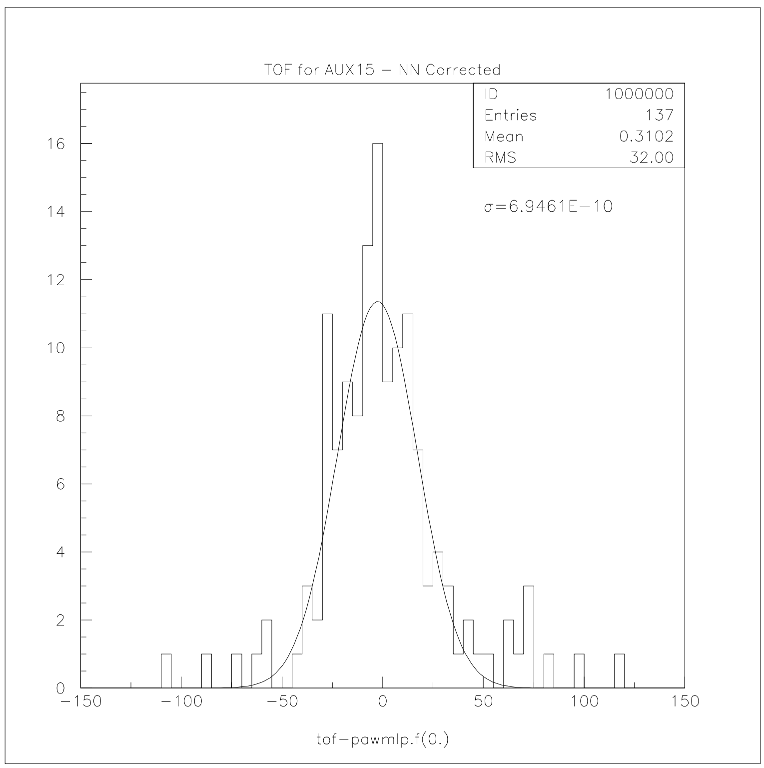
Results from the TOF determination for Position 1



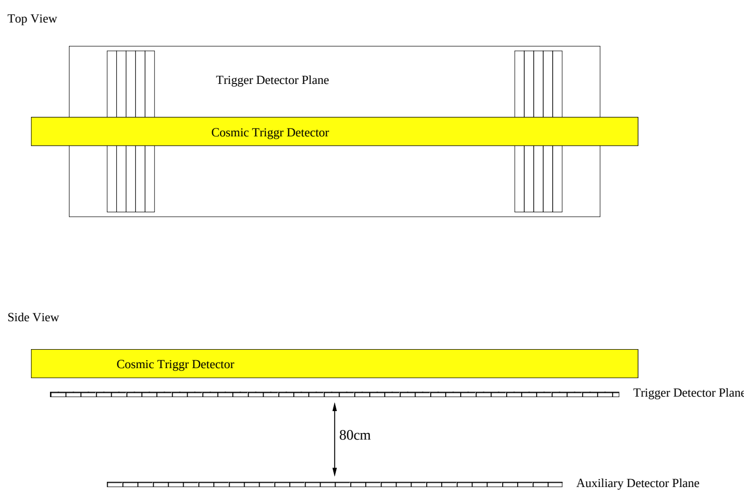


TOF measurements were corrected for each bar using ADC values for that bar (walk correction).
Both 2^{nd} Order polynomial fitting and Neural Net (MLP) methods were tested

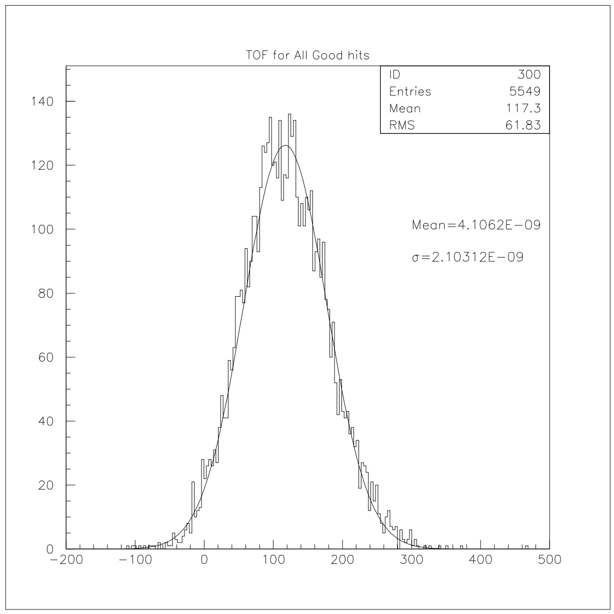


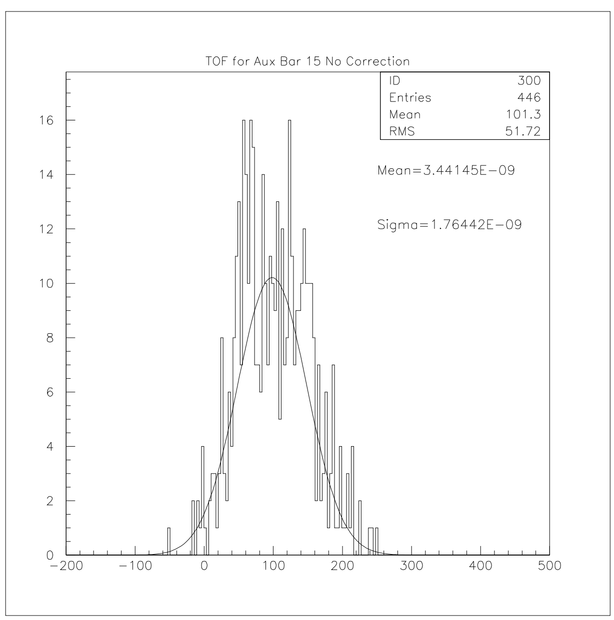

TOF for AUX15 − NN Corrected
ID 1000000
Entries 137
Mean 0.3102
RMS 32.00
σ=6.9461E−10
tof−pawmlp.f(0.)

We then removed the bottom cosmic trigger and used only the top bar to trigger the DAQ, giving us hits across all the length of the Auxiliary plane bars (position 2)

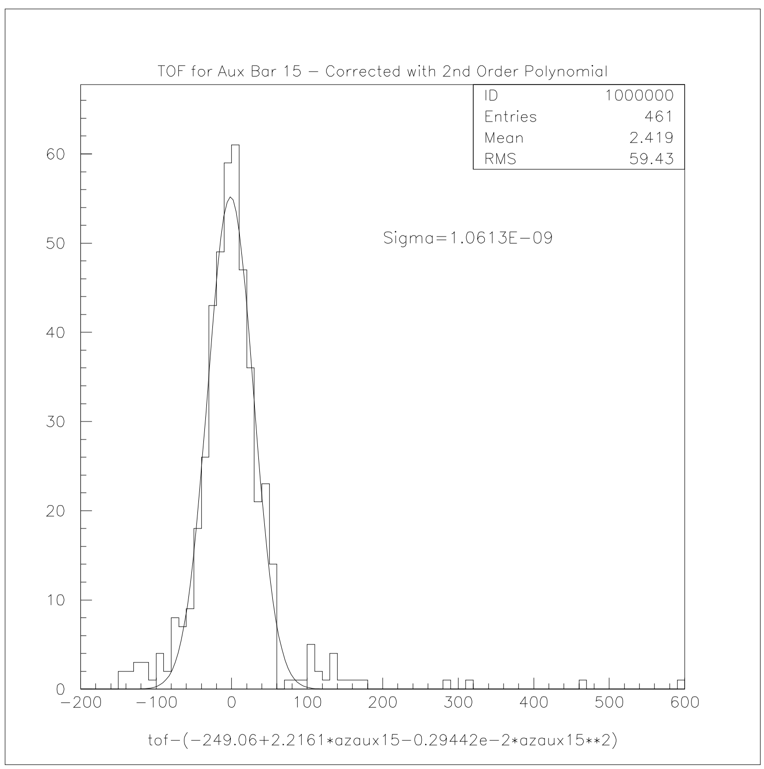


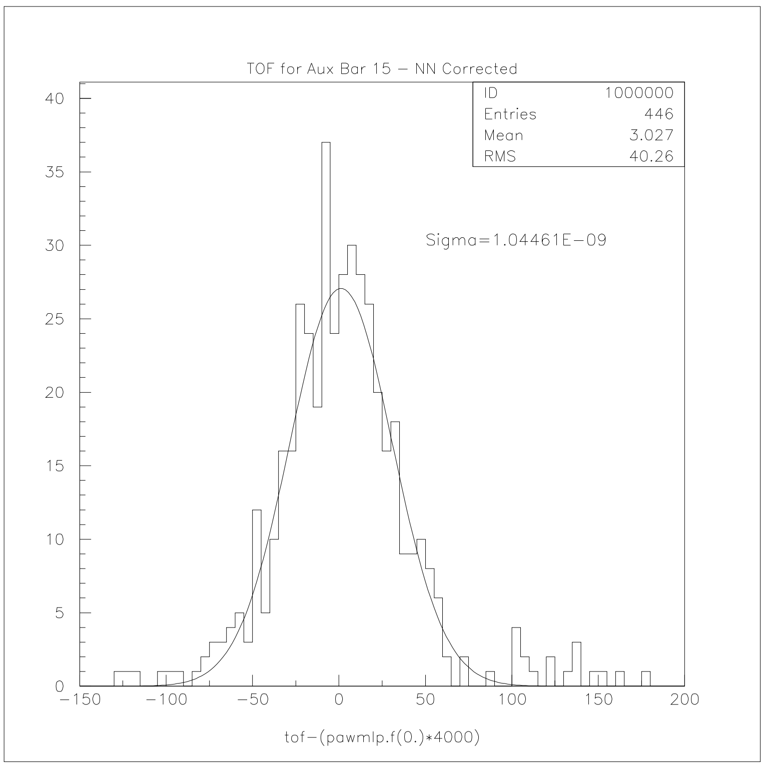
Results from the TOF determination for Position 2





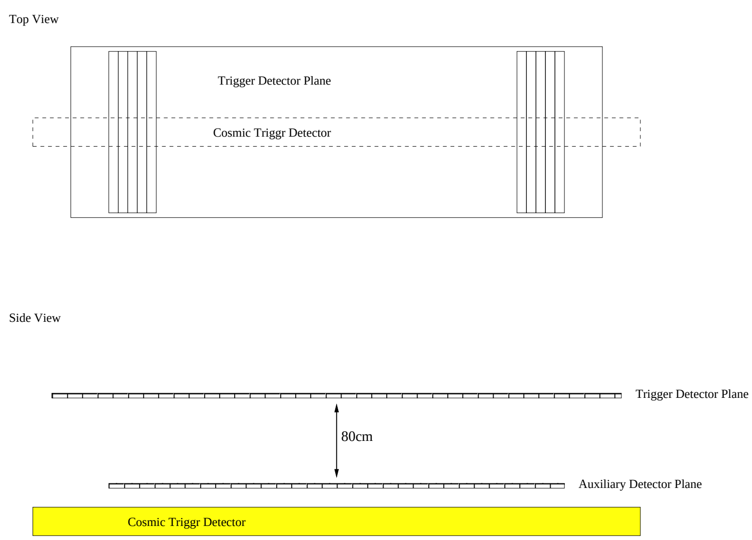
TOF measurements were corrected for each bar using ADC values for that bar (walk correction + position correction).
Both 2^{nd} Order polynomial fitting and Neural Net (MLP) methods were tested



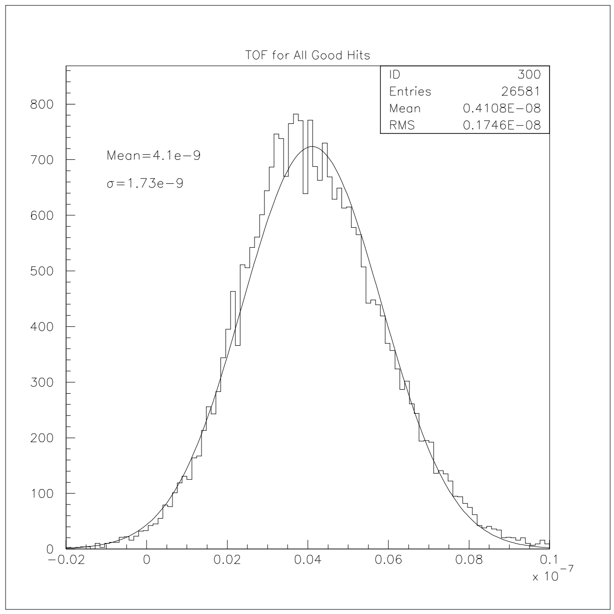


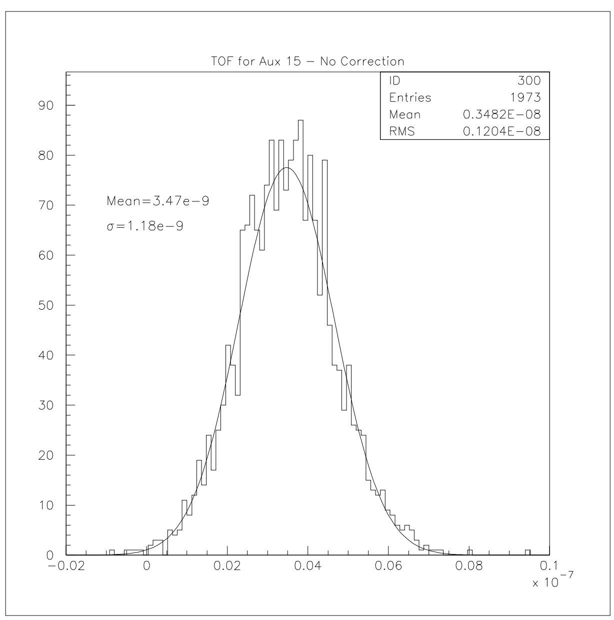
TOF for Aux Bar 15 – NN Corrected
ID 1000000
Entries 446
Mean 3.027
RMS 40.26
Sigma=1.04461E−09
0
5
10
15
20
25
30
35
40
−150
−100
−50
0
50
100
150
200
tof−(pawmlp.f(0.)*4000)

We then triggered from the bottom bar only giving us a definite position on the Auxiliary plane and hits across the entire length of the Trigger plane (position 3)

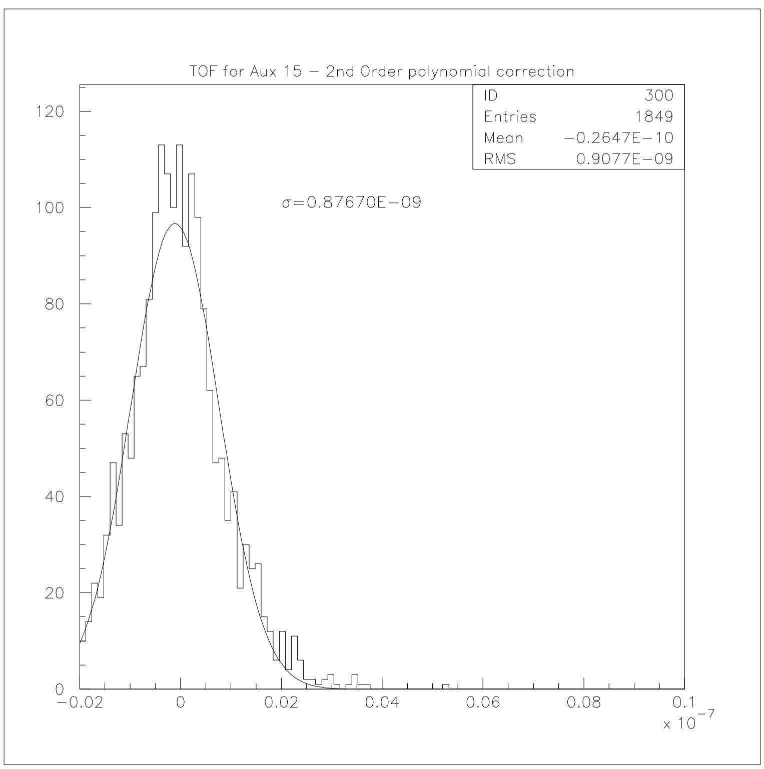


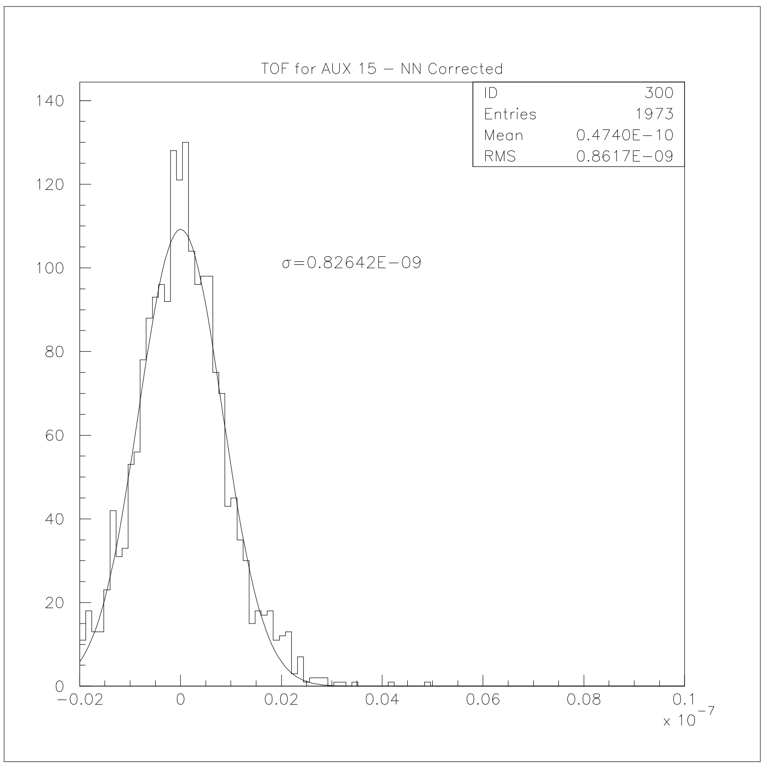
Results from the TOF determination for Position 3



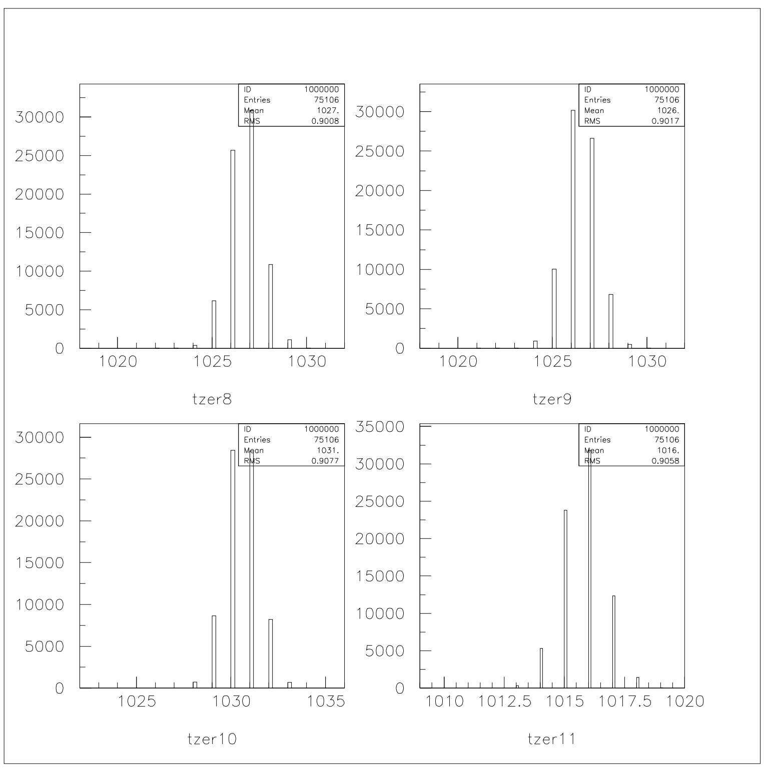


TOF measurements were corrected for each bar using ADC values for that bar (walk correction).
Both 2^{nd} Order polynomial fitting and Neural Net (MLP) methods were tested

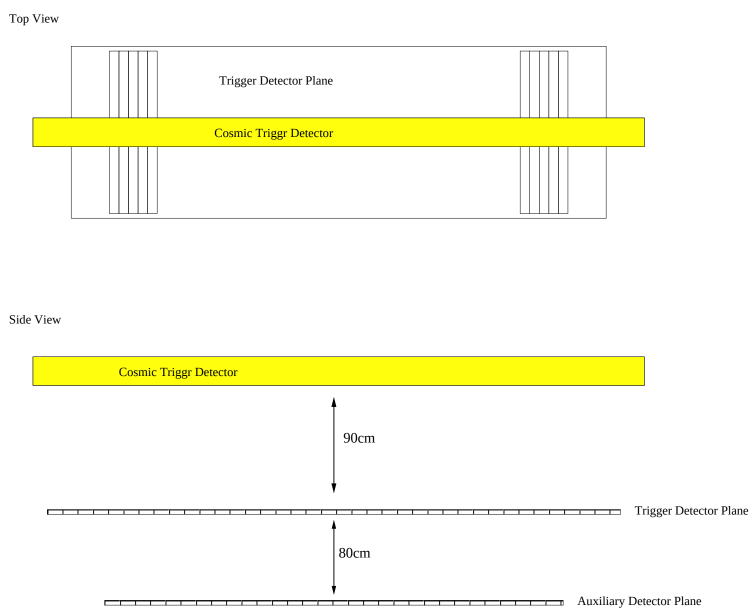



TOF for AUX 15 – NN Corrected
ID 300
Entries 1973
Mean 0.4740E–10
RMS 0.8617E–09
σ=0.82642E–09
140
120
100
80
60
40
20
0
–0.02
0
0.02
0.04
0.06
0.08
0.1
x 10⁻⁷

Delay corrections were done for each channel using relative pulser measurments values for that channel.



We then placed the top bar 90 cm above the E plane to trigger the DAQ, giving us hits across all the length of the E and Auxiliary plane bars,simulating an entire range of possible partical momentoms (position 4)



TOF measurements were corrected for each multiple hit event ,using the following method

- Correct the intrinsic delay for each of the E and Auxiliary channels.

- Performed ADC correction for E times

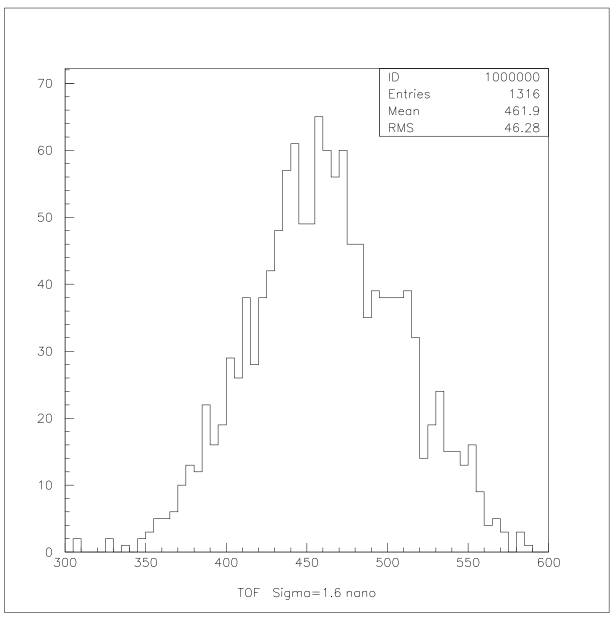
- Calculated the hit position along the E bar using Tleft-Tright.

- Calculated the coresponding hit position along the Auxiliary bar.

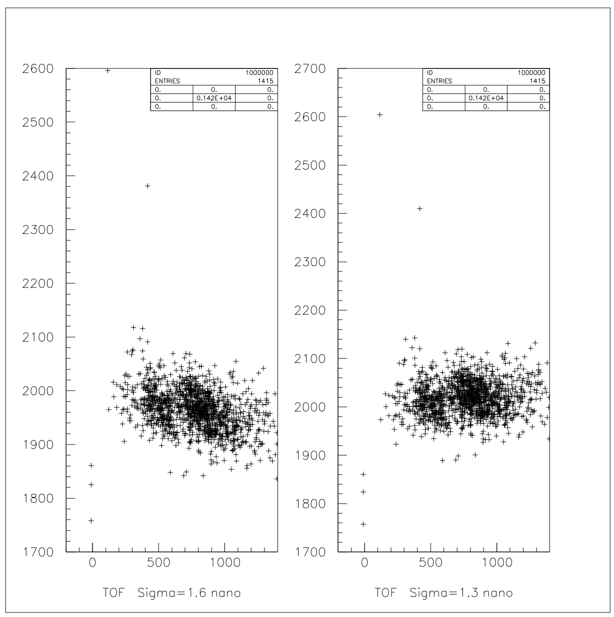
- Performed distance to PM and ADC correction for the Auxiliary time

- used the corrected E and Auxiliary times to calculate the final TOF

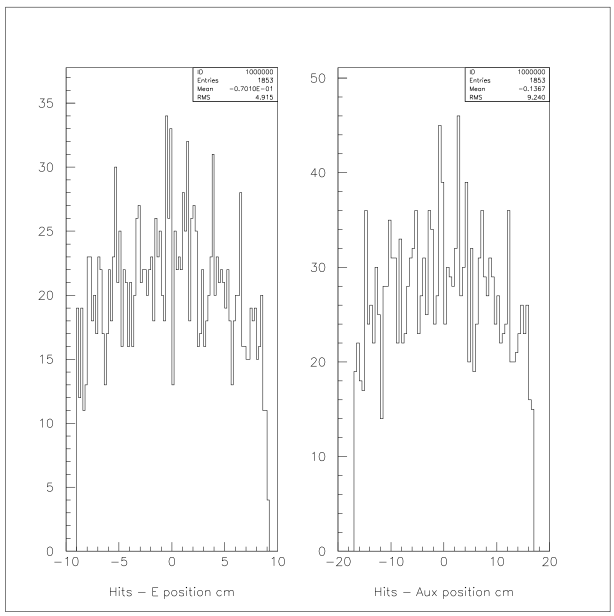
TOF determination for Position 4 before any correction



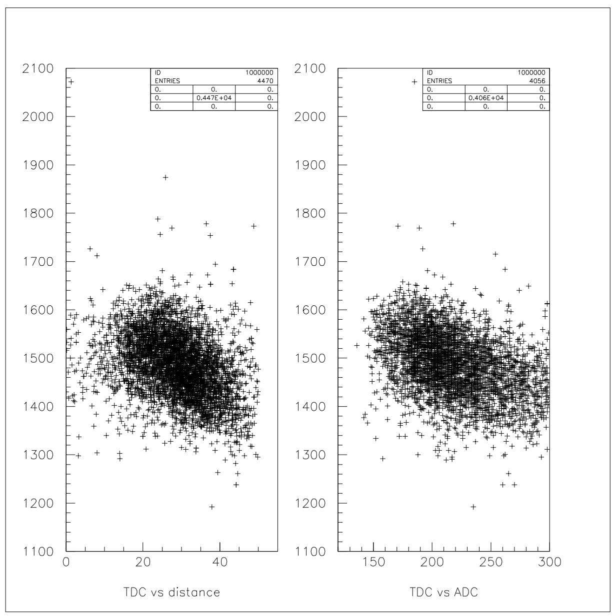
used the pulser delay tests,and made E bars ADC corections



calculated E and Aux hit position.


ID 1000000
Entries 1853
Mean −0.7010E−01
RMS 4.915
Hits − E position cm
ID 1000000
Entries 1853
Mean −0.1367
RMS 9.240
Hits − Aux position cm

corrected the Auxiliary time for the hit position and the ADC readings.



(Sigma = 1 ns after correction)

Final TOF/per meter sigma= 0.84 ns (top) and TOF vs Distance (bottom)