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SDC
SOLENOIDAL DETECTOR NOTES

PULSE SHAPE STUDY FOR SDC MUON CHAMBER

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Abstract

I studied signal shape of SDC Muon Chamber Prototype. I found Signal Band Width is about 40MHz and two track separation is about 5mm.

Setup

Figure 1 shows setup of test stand. Diameter of test tube is 76mm and length is 500mm. This tube were proposed by University of Washington/SSCL for SDC Muon Chamber.[1] Two scintillation counter (Top and Bottom) provide Cosmic ray trigger. Signal were fed into preamplifier [2] via twinax cable. We shielded all connection for to avoid a noise. Output from preamplifier was into LeCroy 7200 digital Oscilloscope and signal form was recorded.

Signal Band Width

Signal band width is studied by using Fast Fourier Transform (FFT.) analysis. Both background noise and Cosmic ray signals were recorded. Figure 2 shows FFT analysis of Noise and Signal. Noise distribution is subtracted from Signal is shown by solid line in Figure 2. This distribution falls below noise level at about 40MHz.

Pulse Shape

Report of T816 muon beam test[3] shows high energy muons create electromagnetic particles. In order to avoid confusion the chamber must have good two track separation capability. This is strongly dependent on field shaping and pulse shaping.

For this study one hundred signals with different field configurations were recorded. These fields are shown in Figure 3a and 3b. Figure 4a and 4b show pulse width distributions of narrower and wider shape, respectively. These show that the wider field results in wider pulse width.

Figure 5a and 5b show typical signal shape before and after shaping. I assumed simple CR-RC shaping shown in Figure 6.

Two Track Separation

For this study I picked up two independent signals and simply added them and applied shaping algorithm. Figure 7c shows signal after shaping and full circles show original leading edges (before adding). Open circles show leading edges after adding and shaping.

I calculated **finding efficiency** using this criteria

- Find at least two tracks.
- Difference between track separation of original and after shaping is less than 20nsec.

Figure 8 shows track finding efficiency of three different pulse shaping times. Those efficiencies do not reach 100% because of undershoot. Pole-zero cancellation circuit will improve this but undershoot will still occur due to unwanted residual differentiations. 30nsec shaping is relatively better efficiency and good two track separation. This efficiency reaches 80% at 110nsec. Figure 9b shows track finding efficiency of different field shaping with 30nsec pulse shaping. Effect of field shape is relatively small.

Figure 10 shows time difference between original pulse and after shaping. All plots in Figure 10 are shifted to negative values because of a undershoot. These show we lose resolution because signal tail and undershoot.

Summary

I studied pulse shape of SDC Muon Chamber. It shows this chamber has two track separation capability of about 5mm. (I assumed drift velocity is 47μm/nsec) This is achieved by using 30nsec CR-RC circuit.

Acknowledgement

I wish to thank to J.Oliver for his work on SSCL to setup his electronics. Also I wish to thank : H.Lubatti, T.Zhao and SSCL electronic staff.

REFERENCES

1. "SDC Muon Detector Design Barrel and Intermediate Chambers Round Tube Option", SDC-91-135 (1991).

2.F.M.Newcomer *et.al.*, "High Speed Bipolar Integrated Circuits for SSC Applications", NIM A283, 806 (1989).

3."Conceptual Design Report for the SDC Barrel and Intermediate Muon Detectors Base on a Jet-type Drift Chamber",SDC-92-169.

FIGURE CAPTION

1.Setup of test stand

2.Fast Fourier Transform analysis of noise and cosmic ray signal.

3.Field shape of different High Voltage configuration. 3a is 5.7kV on anode and 5.77kV on electrode and 3b is 4.05kV on anode and 2.7kV on electrode. These plot were made by T.Zhao (Univ. of Washington).

4.Pulse width distribution with different field shape configuration.

5.Typical signal shape. 5a is before pulse shaping and 5b is after pulse shaping of same pulse as 5a.

6.Simple CR-RC circuits

7.Pulse shape for two track separation. 7a is original pulse and 7b is after added and 7c is after pulse shaping of same pulse as 7b.

8.Track finding efficiency of three different pulse shaping time with narrower field..

9.Track finding efficiency of different field shaping configuration.

10.Distribution of time variation. Difference of each plot is separation of two tracks.

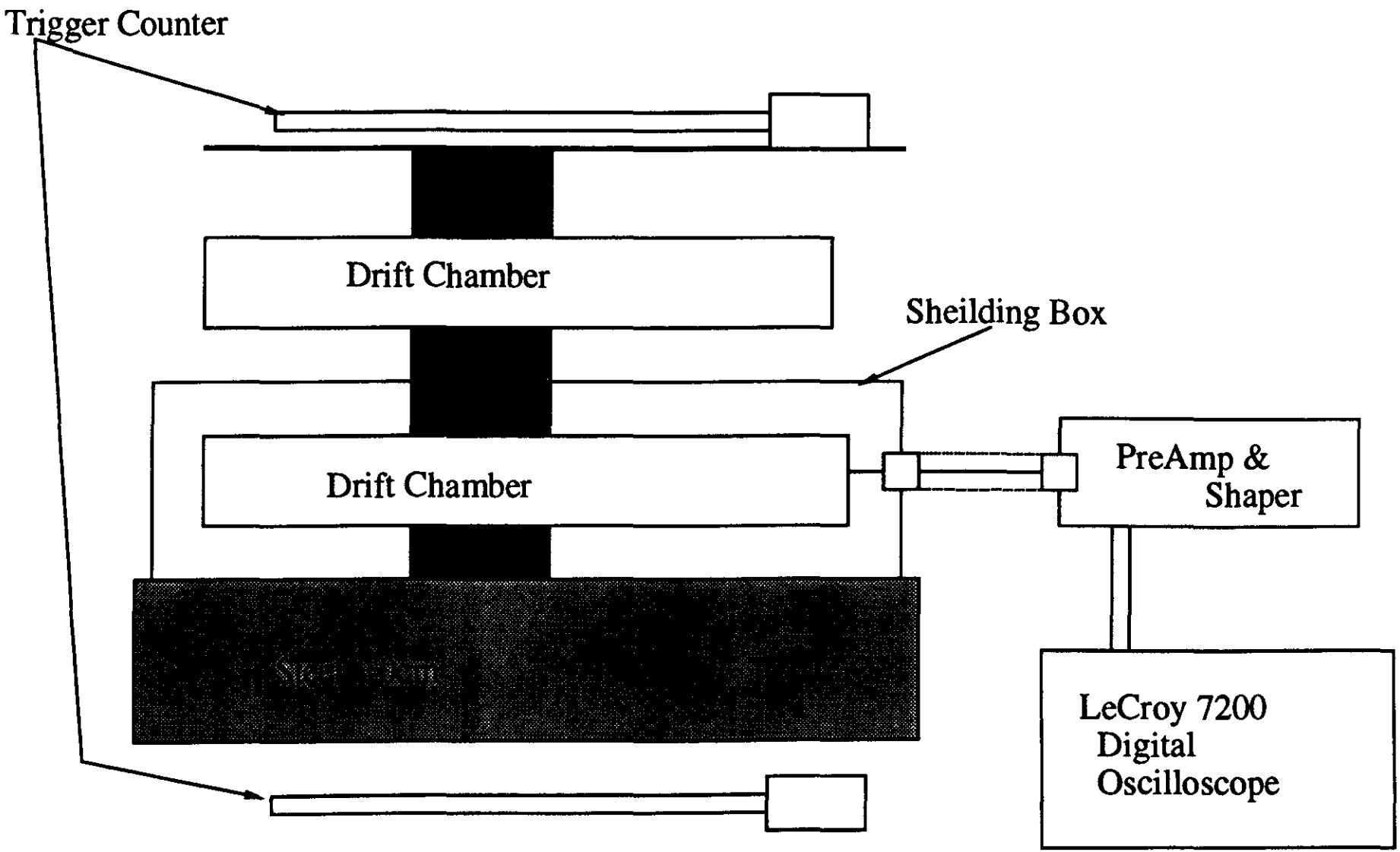

Trigger Counter
Drift Chamber
Sheilding Box
Drift Chamber
PreAmp &
Shaper
LeCroy 7200
Digital
Oscilloscope

Figure 1

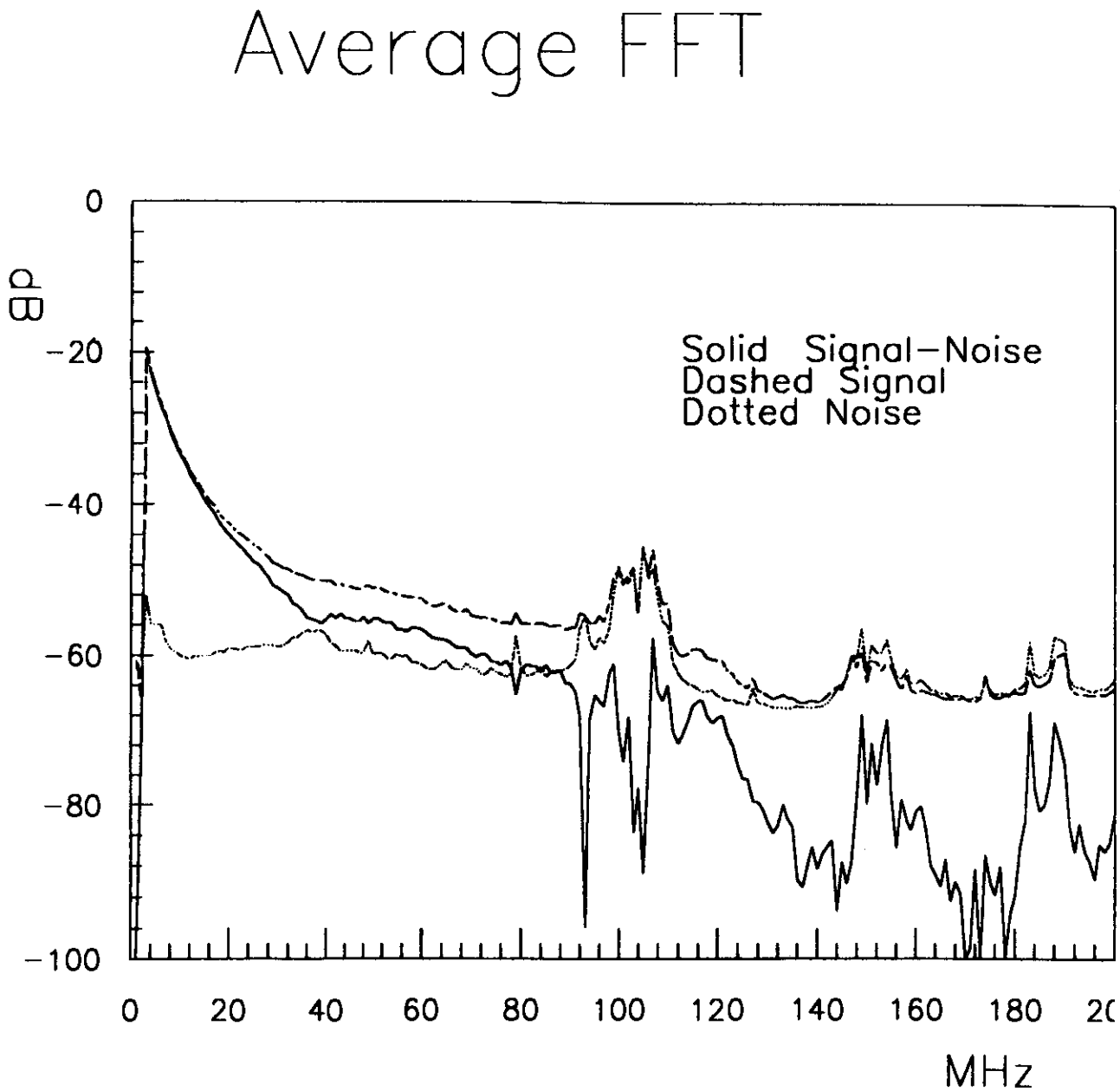

Average FFT
dB
0
-20
-40
-60
-80
-100
Solid Signal-Noise
Dashed Signal
Dotted Noise
0
20
40
60
80
100
120
140
160
180
MHz

Figure 2

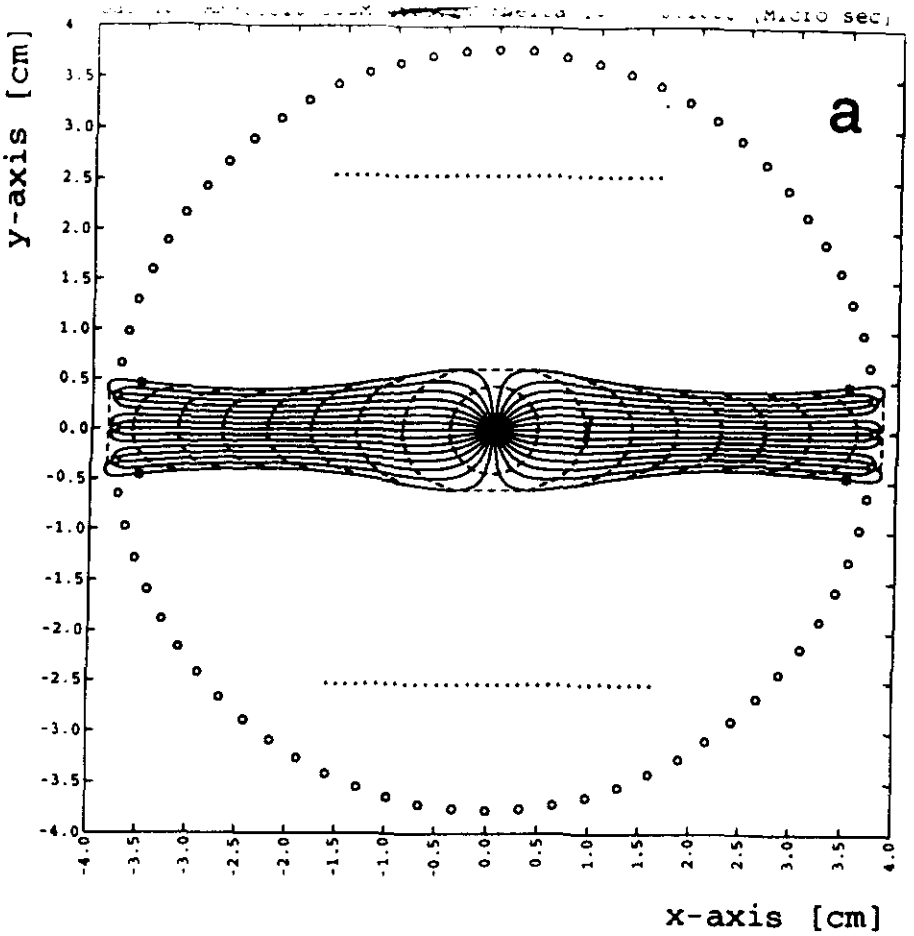
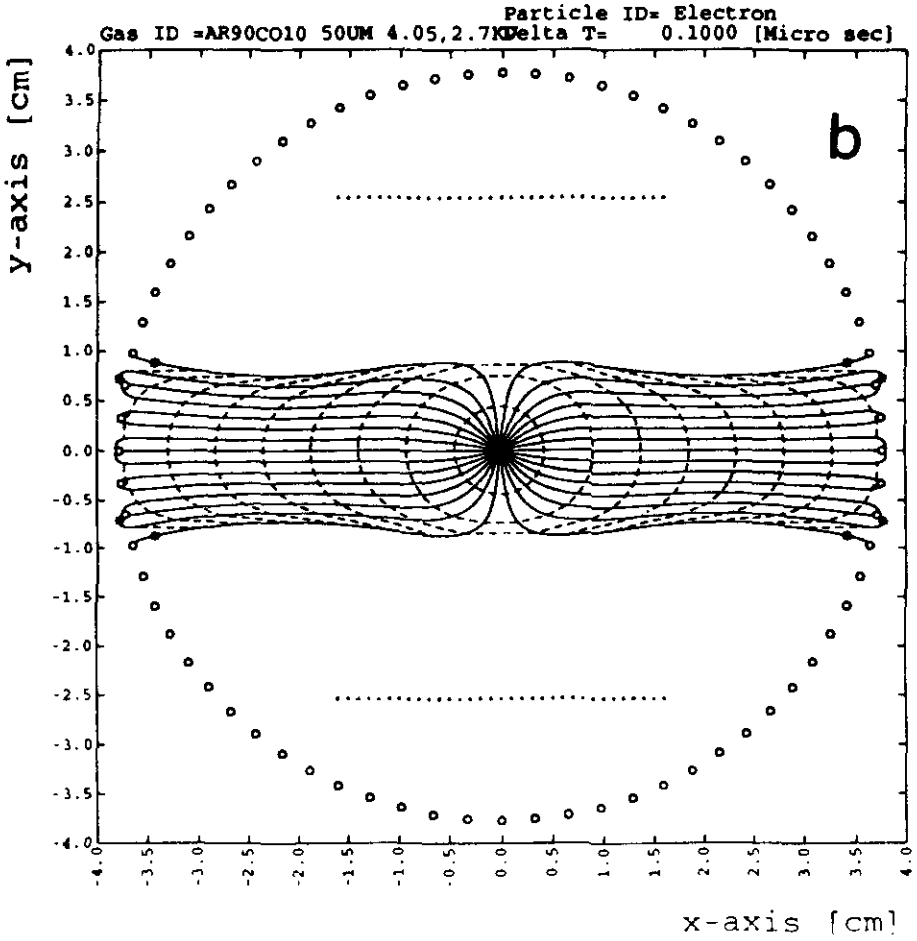
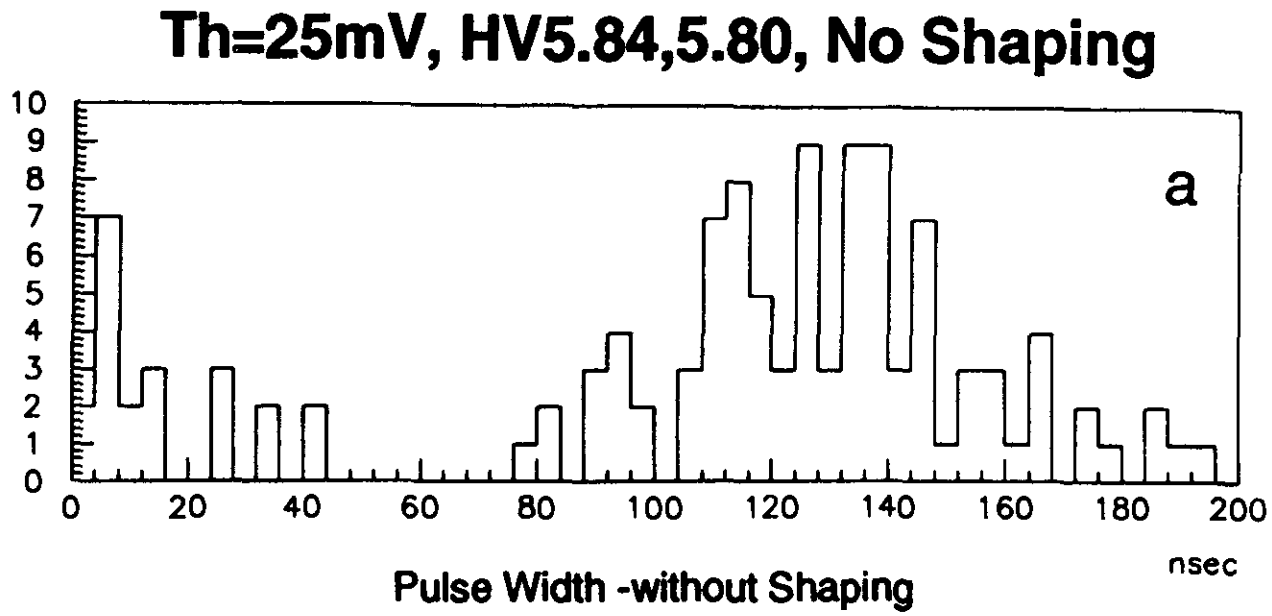

a
y-axis [cm]
x-axis [cm]

Figure 3


Particle ID= Electron
Gas ID =AR90CO10 50UM 4.05,2.7K
Delta T= 0.1000 [Micro sec]
b
y-axis [cm]
x-axis [cm]


Th=25mV, HV5.84,5.80, No Shaping
a
0 1 2 3 4 5 6 7 8 9 10
0 20 40 60 80 100 120 140 160 180 200
nsec
Pulse Width -without Shaping

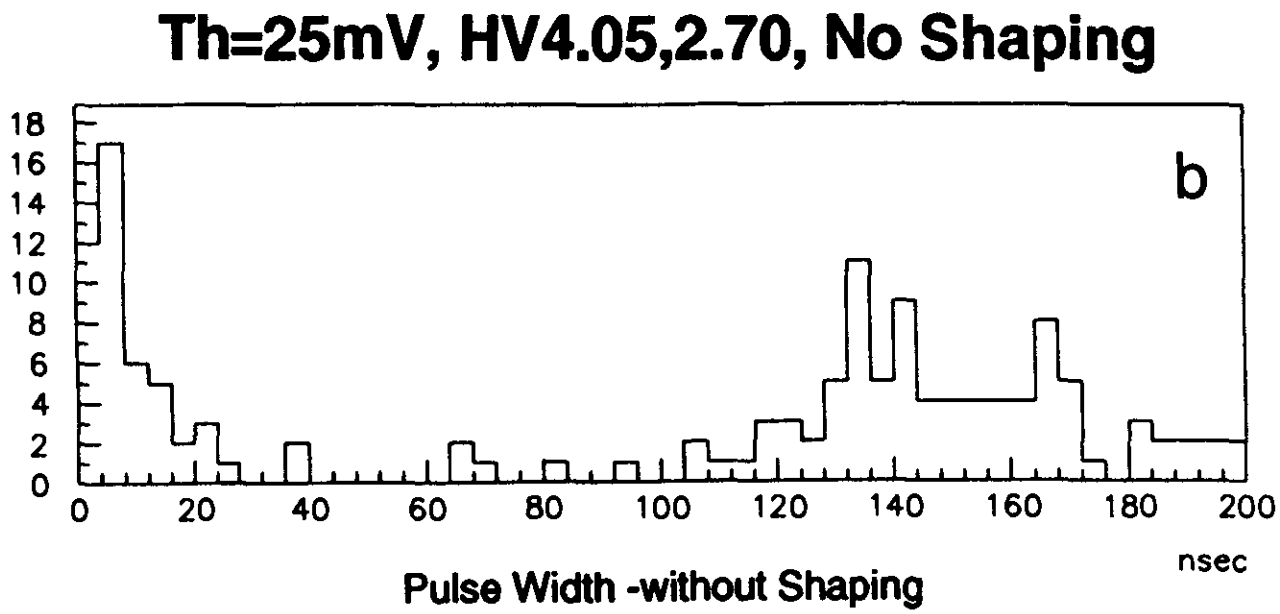
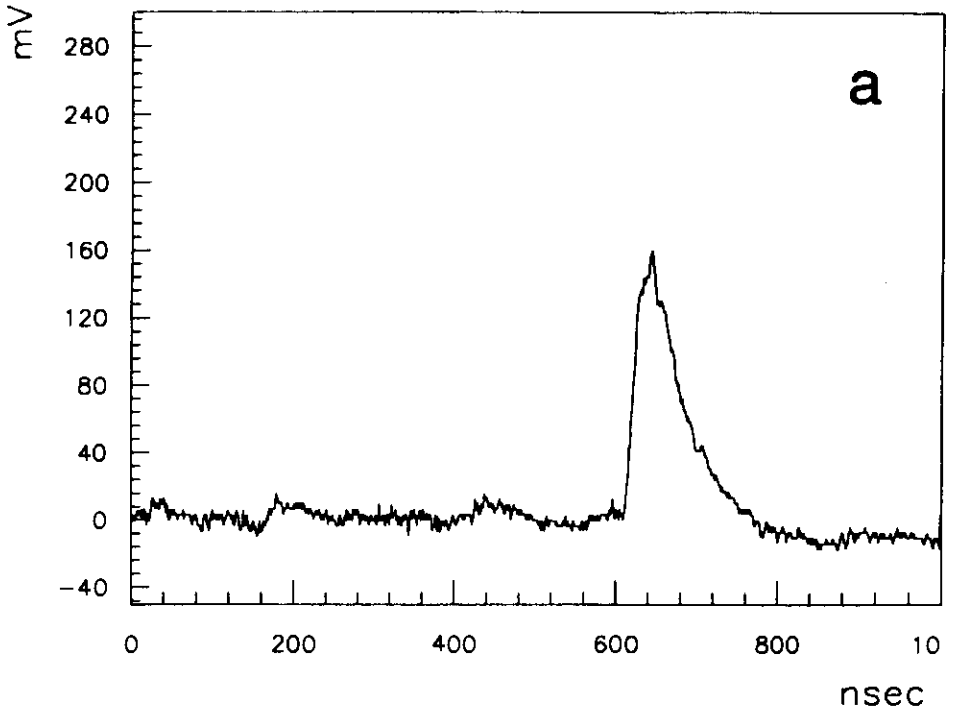

Th=25mV, HV4.05,2.70, No Shaping
b
0 2 4 6 8 10 12 14 16 18
0 20 40 60 80 100 120 140 160 180 200
nsec
Pulse Width -without Shaping

Figure 4

Muon Signal



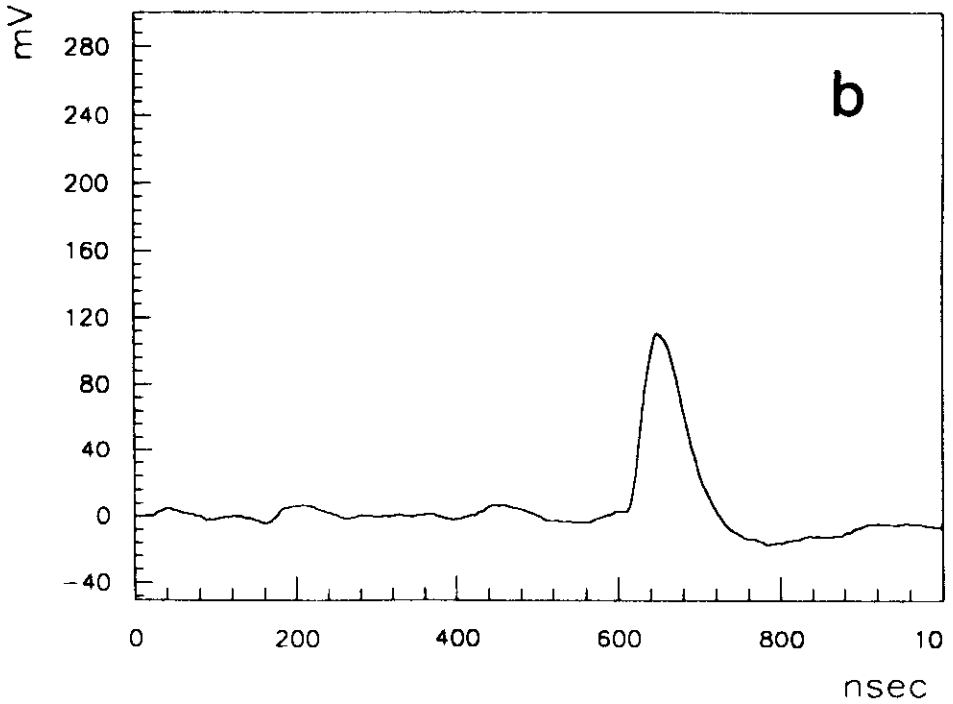
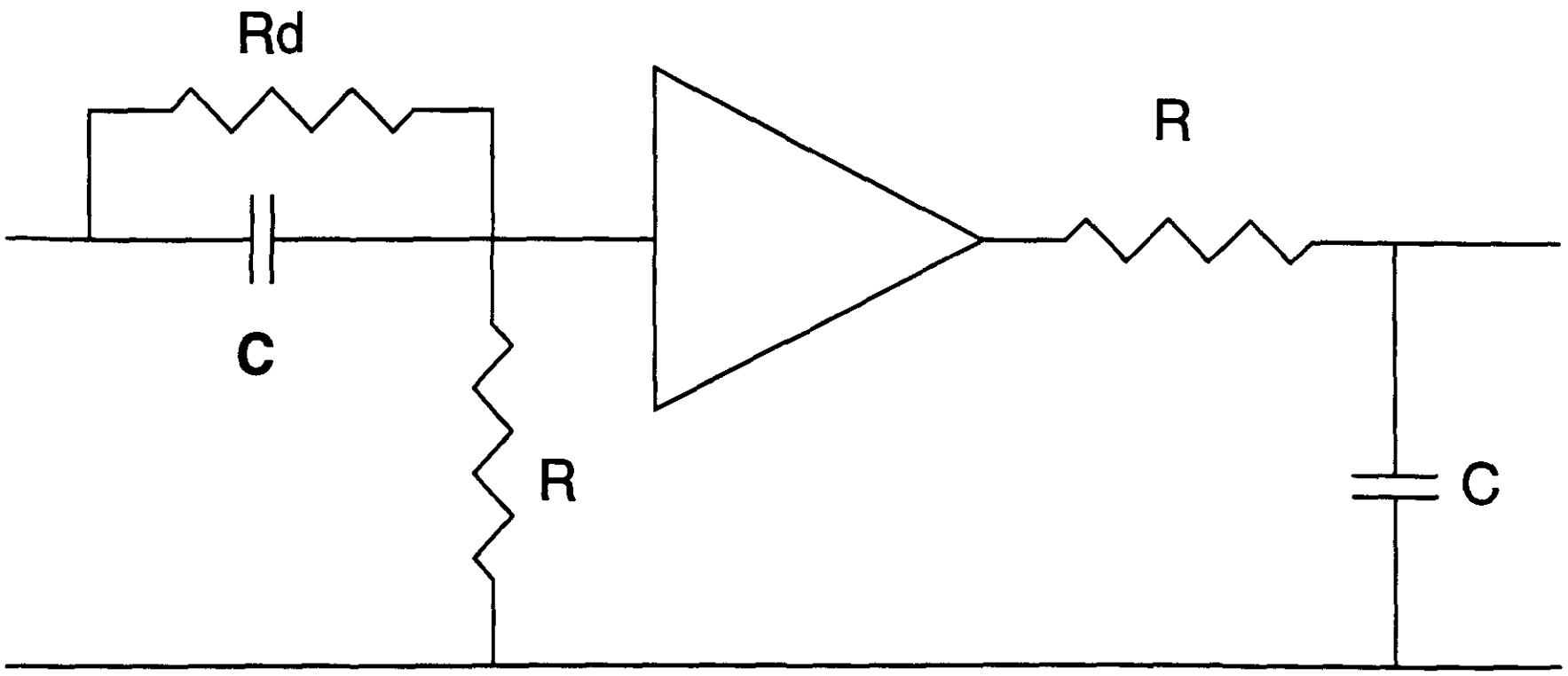


Figure 5



R = 500 C = 120pF
60pF
30pF

Figure 6

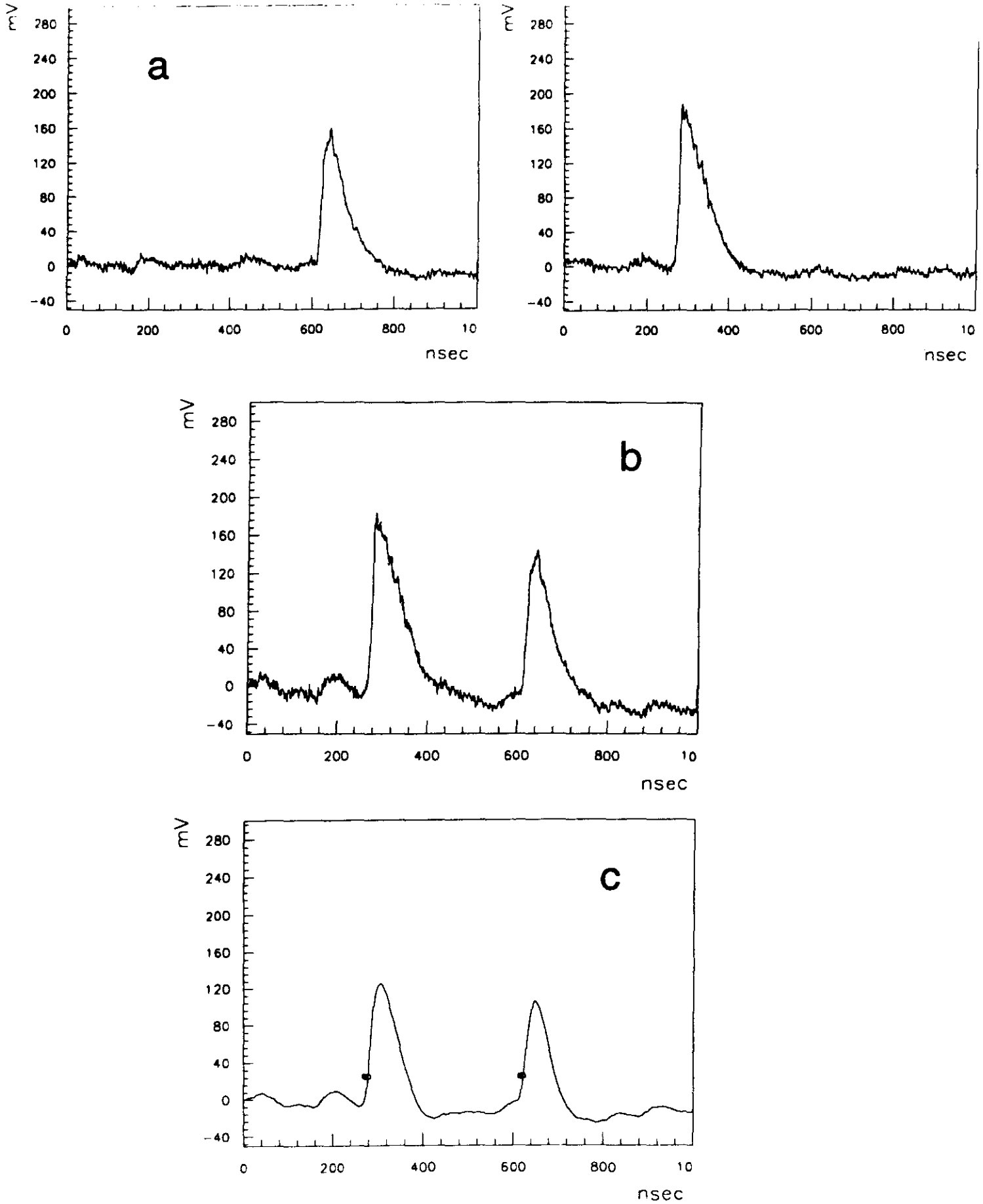
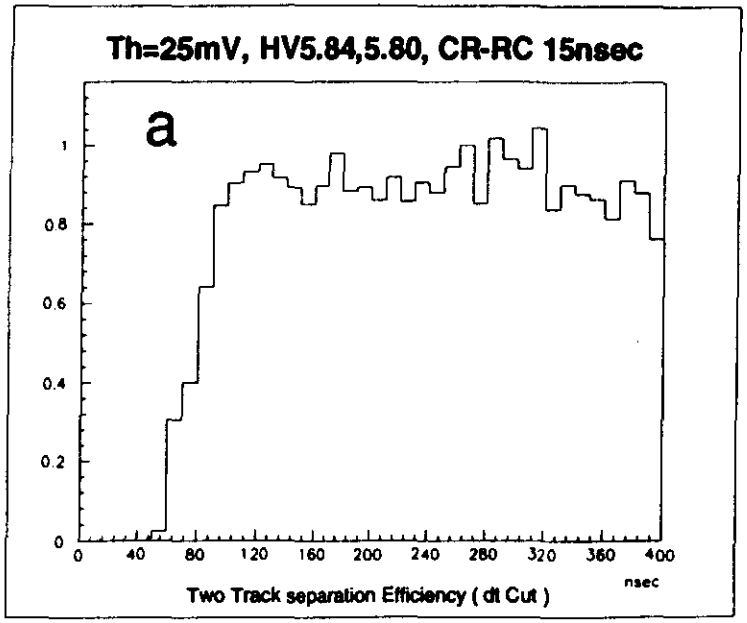
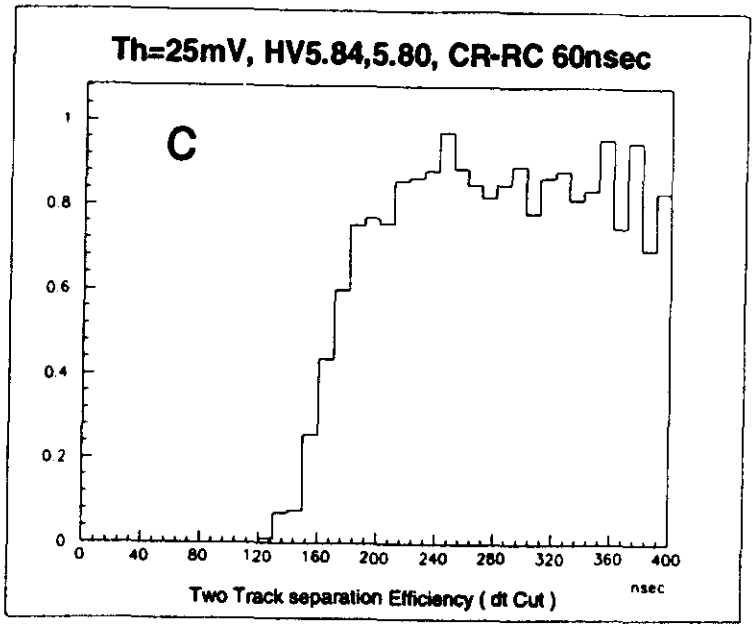


Figure 7


Th=25mV, HV5.84,5.80, CR-RC 15nsec
a
0
0.2
0.4
0.6
0.8
1
0 40 80 120 160 200 240 280 320 360 400
nsec
Two Track separation Efficiency (dt Cut)


Th=25mV, HV5.84,5.80, CR-RC 60nsec
c
0
0.2
0.4
0.6
0.8
1
0 40 80 120 160 200 240 280 320 360 400
nsec
Two Track separation Efficiency (dt Cut)

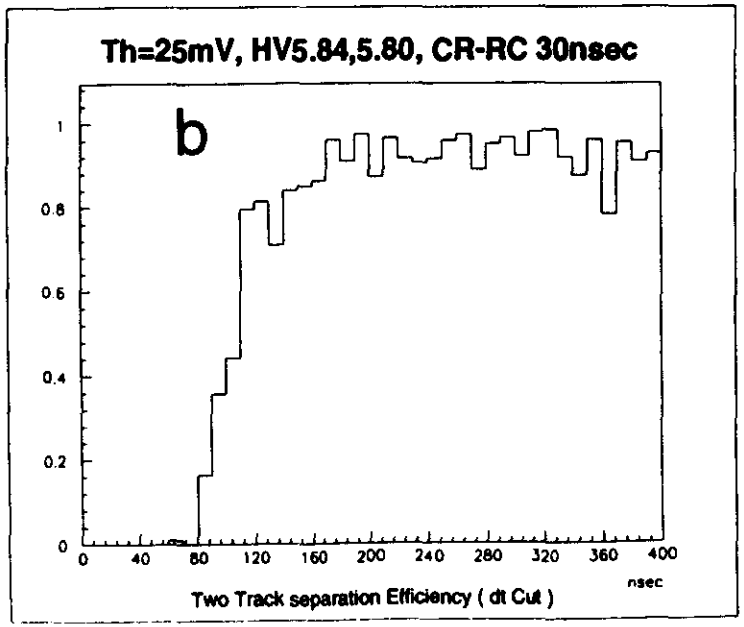
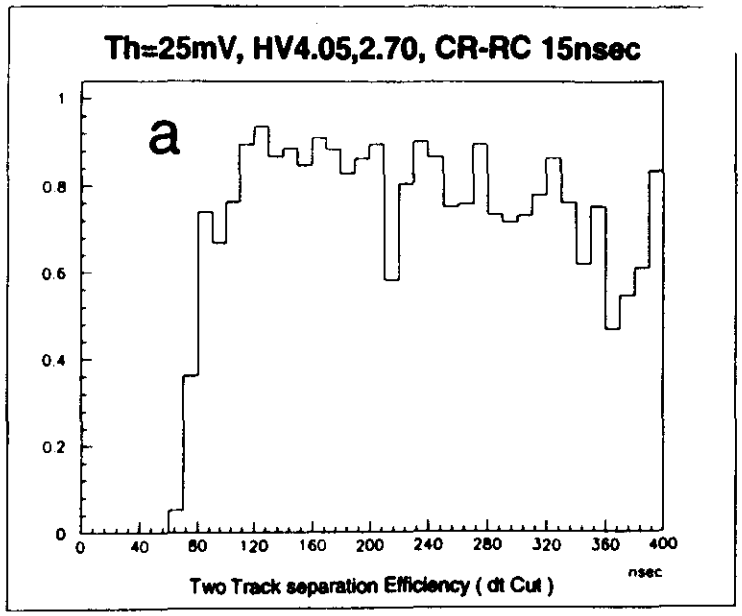
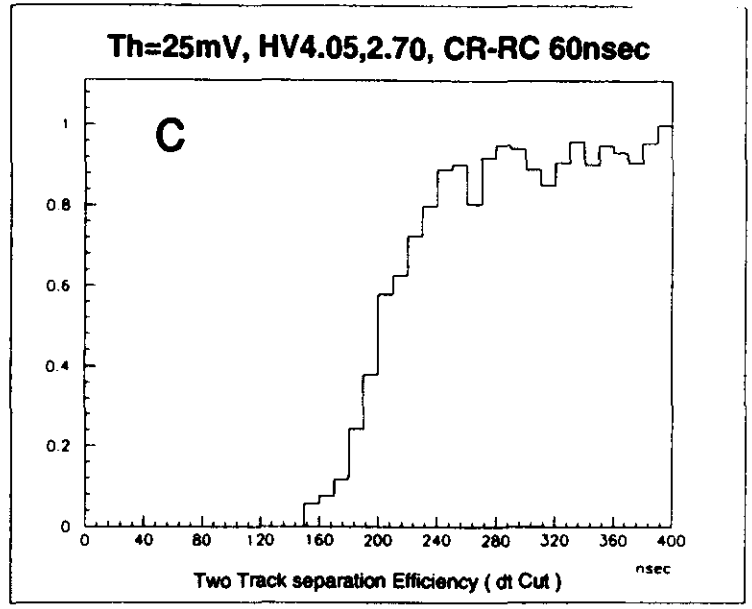

Th=25mV, HV5.84,5.80, CR-RC 30nsec
b
0
0.2
0.4
0.6
0.8
1
0 40 80 120 160 200 240 280 320 360 400
nsec
Two Track separation Efficiency (dt Cut)

Figure 8


Th=25mV, HV4.05,2.70, CR-RC 15nsec
a
0
0.2
0.4
0.6
0.8
1
0 40 80 120 160 200 240 280 320 360 400
nsec
Two Track separation Efficiency (dt Cut)


Th=25mV, HV4.05,2.70, CR-RC 60nsec
c
0
0.2
0.4
0.6
0.8
1
0 40 80 120 160 200 240 280 320 360 400
nsec
Two Track separation Efficiency (dt Cut)

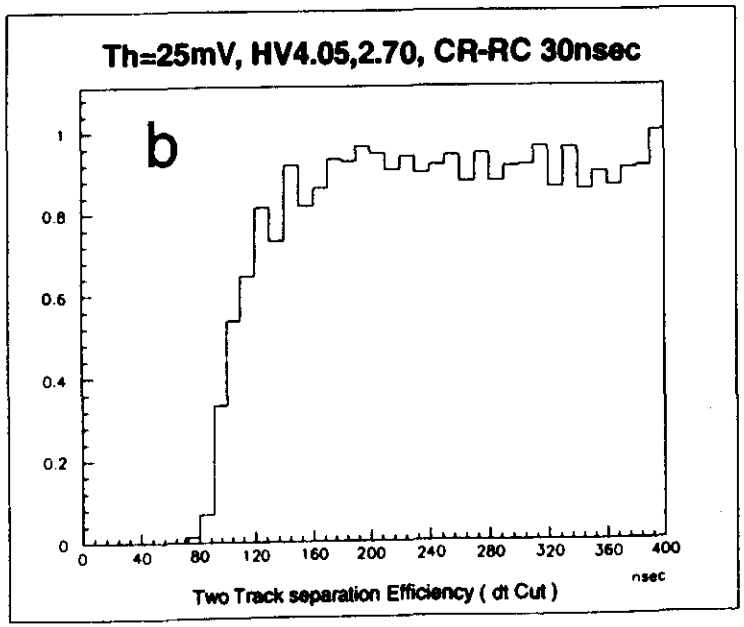
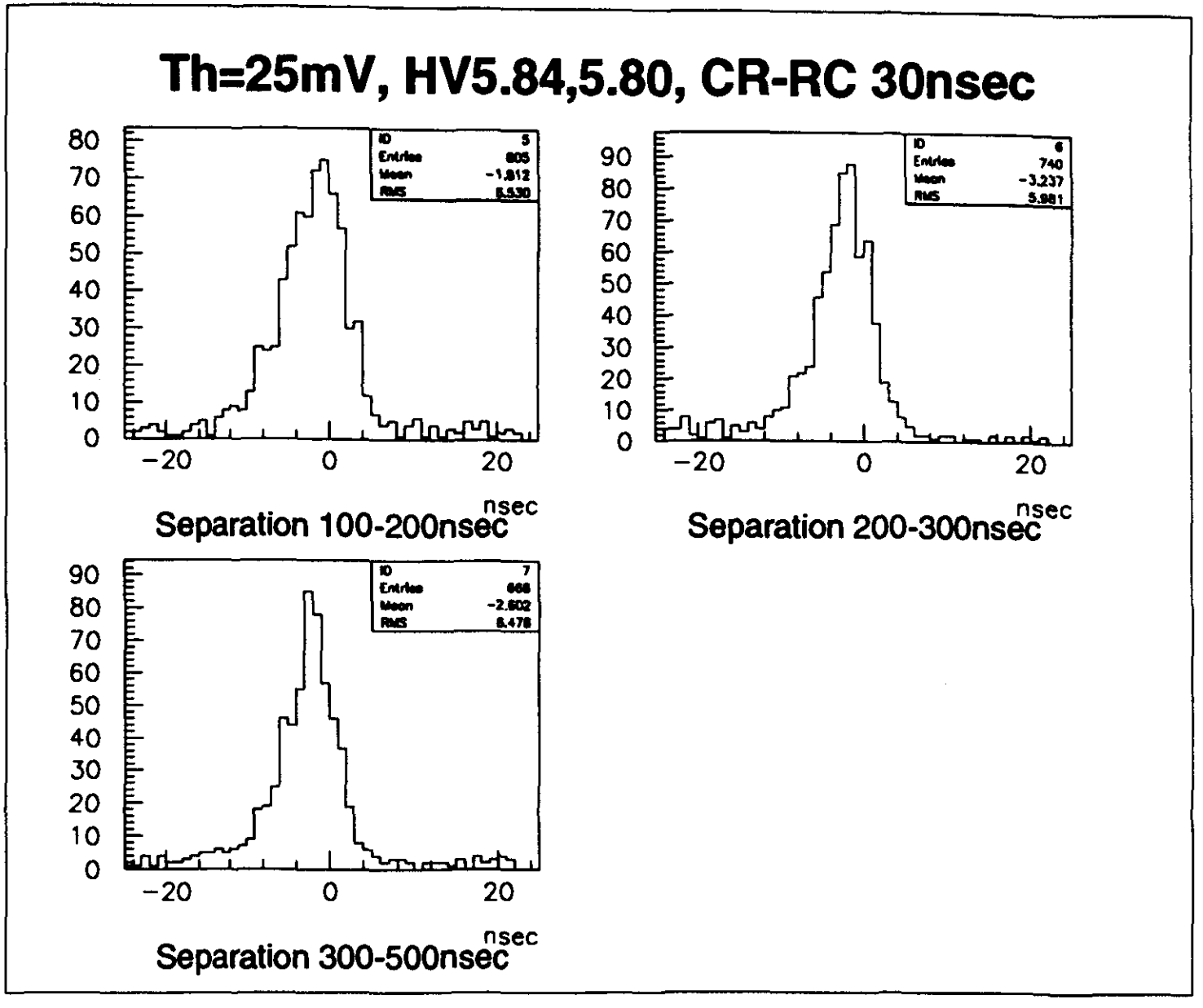

Th=25mV, HV4.05,2.70, CR-RC 30nsec
b
0
0.2
0.4
0.6
0.8
1
0 40 80 120 160 200 240 280 320 360 400
nsec
Two Track separation Efficiency (dt Cut)

Figure 9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ID 5
Entries 805
Mean -1.812
RMS 5.530
80
70
60
50
40
30
20
10
0
-20
0
20
nsec
Separation 100-200nsec
ID 6
Entries 740
Mean -3.237
RMS 5.981
90
80
70
60
50
40
30
20
10
0
-20
0
20
nsec
Separation 200-300nsec
ID 7
Entries 668
Mean -2.602
RMS 5.478
90
80
70
60
50
40
30
20
10
0
-20
0
20
nsec
Separation 300-500nsec

Figure 10