Comparison of Located Event Distributions with Equivalent Spectrometer and MC distributions

• The sample used in this comparison is the located events (Phase I and Phase II - 395 events). If you look at the attached plots (only those comparing emulsion to spectrometer) you'll notice that the histograms have only 300 entries. We required that a reconstructed spectrometer vertex FROM the analysis code existed. The missing 95 events are either single track events or the code did not reconstruct a vertex from the spectrometer.

- The first set of plots just show general properties of the located events using emulsion information only:

1) Figure 1 contains a series of scatter plots to see if there is any bias in the located emulsion vertex positions – I can't see any.
2) Figure 2 is the distribution of located Z vertex locations. We have defined the most upstream section of all the modules to be zero. As can be seen we are still a bit inefficient in locating events from the most upstream sections of the emulsions. (Ignore the bottom plot)

- The next set of plots compare emulsion with spectrometer vertex information:

3) Figure 3 is a scatter plot comparing the difference in the emulsion to predicted spectrometer z vertex position versus the emulsion z vertex prediction (event by event). We have defined the most upstream section of all the modules to be zero. As one can see if the interaction occurs in the upstream section of the module the predicted spectrometer vertex is pulled downstream.
4) Figures 4, 5, and 6 shows the differences between located vertex predictions (i.e. emulsion info) and predicted spectrometer positions. We have split up the modules into three sections – upstream, middle, and downstream. As can be seen, the spectrometer vertex predictions improve the farther downstream in the module the interaction takes place – not surprising.
5) Figure 7 show distributions of the U, V, and Z vertex locations from the emulsion and spectrometer. The spectrometer data are the dashed curves. Other than the spectrometer distributions extending past the boundaries of the emulsion, both are very similar.

- The next set of plots compare emulsion with Monte Carlo distributions (All MC distributions are dashed. Emulsion data solid):

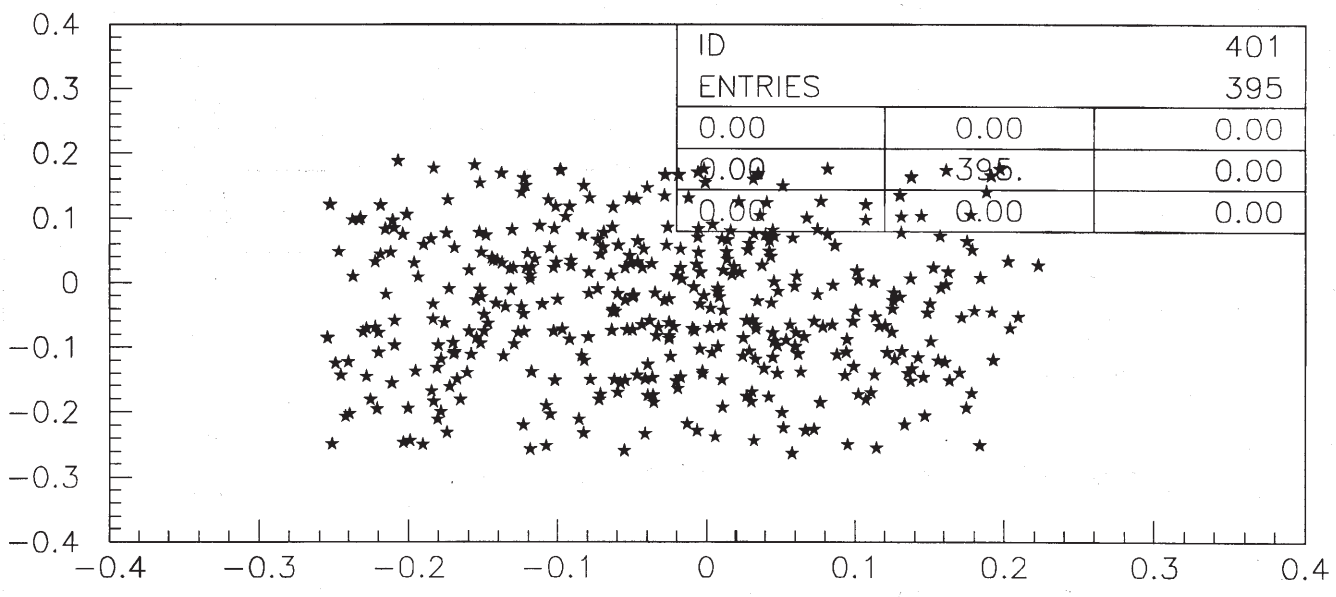
→ We generated 1,000 events with the following parameters:

ratio of $\nu_e / \nu_\mu / \nu_\tau$: 0.37/0.58/0.05
ratio of cc/nc interactions: 0.67/0.33
ratio of neutrino/anti-neutrinos: 0.5/0.5
fraction of nonprompt ν's: 0.19

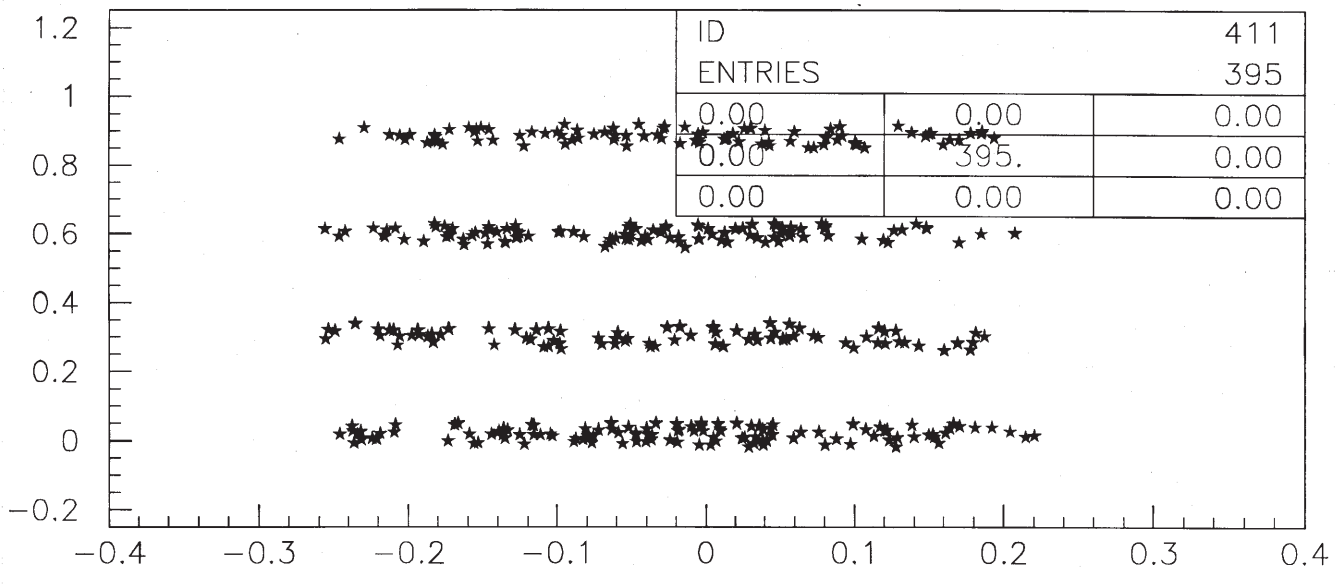
(We realize these are not the parameters we are suppose to use (E-mail from Bruce several days ago) – I have not been able to generate a new MC file yet.)

1) Figures 8 and 9 are a comparison of U, V and total angle distributions between MC and emulsion data for charged primary tracks only. One should look at the middle set of plots where one-segment tracks are removed and the dashed curve is the MC distribution. The agreement is very good. Compared to phase I emulsion data the number of one segment tracks is much smaller! (One segment tracks tend to be large angle tracks)
2) Figure 10 compares U and V emulsion vertex distributions with the MC. I'm sorry the statistics are poor but I had difficulty running many events with GEANT on without having the MC crash... The shapes look similar, however the peaks are a bit shifted. Did we ever put into the MC the relative vertical shift between T3 and the fibers?
3) Figure 11 compares the charged primary track multiplicities (for angles < 350mr) between emulsion(solid) and MC(dashed). The agreement is good. Compared to the phase I distribution more low multiplicity events have been located – not a surprise. In fact we've over done it. At low multiplicities we now have more low multiplicity events than expected from the MC. The high multiplicity tail is in good agreement.

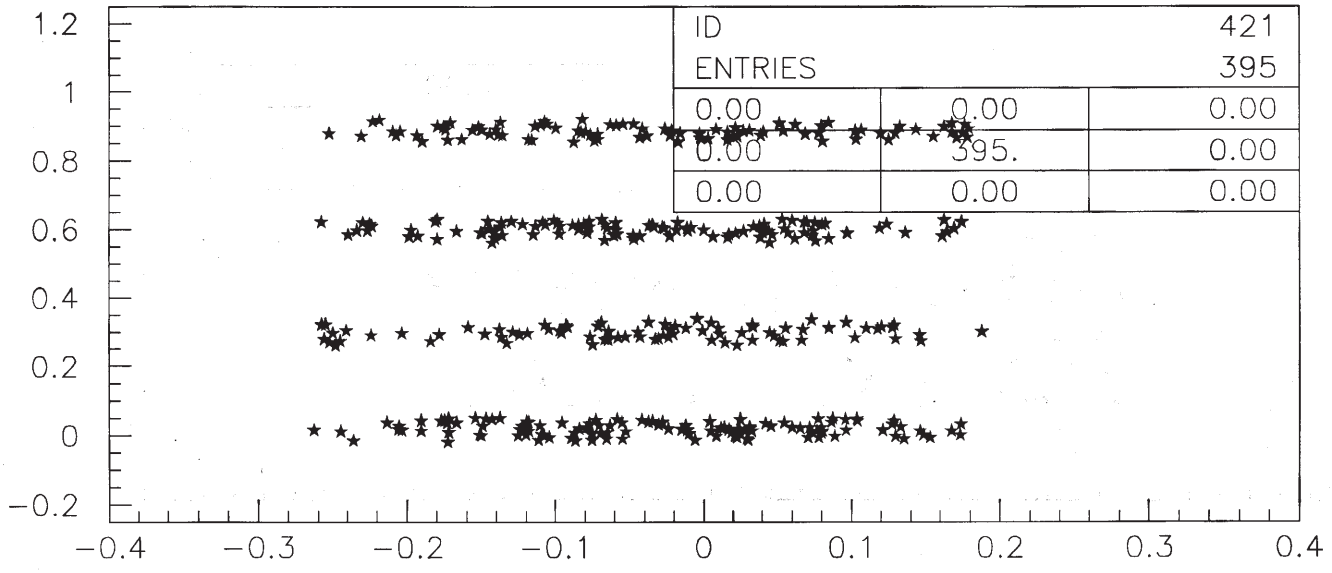
Figure 1



eu vs ev

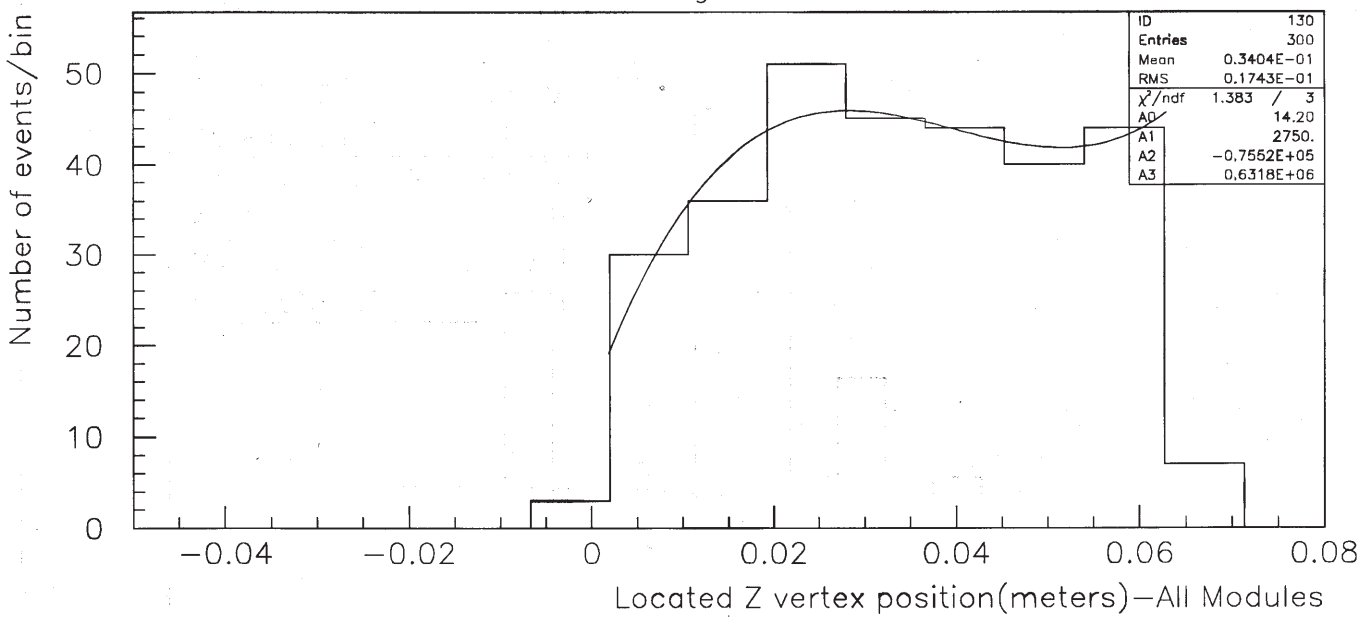


eu vs ez


ID 421
ENTRIES 395
0.00 0.00 0.00
0.00 395. 0.00
0.00 0.00 0.00
1.2
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4 −0.3 −0.2 −0.1 0 0.1 0.2 0.3 0.4

ev vs ez

Figure 2


ID 130
Entries 300
Mean 0.3404E-01
RMS 0.1743E-01
χ²/ndf 1.383 / 3
A0 14.20
A1 2750.
A2 -0.7552E+05
A3 0.6318E+06
Number of events/bin
0
10
20
30
40
50
−0.04
−0.02
0
0.02
0.04
0.06
0.08
Located Z vertex position(meters)−All Modules

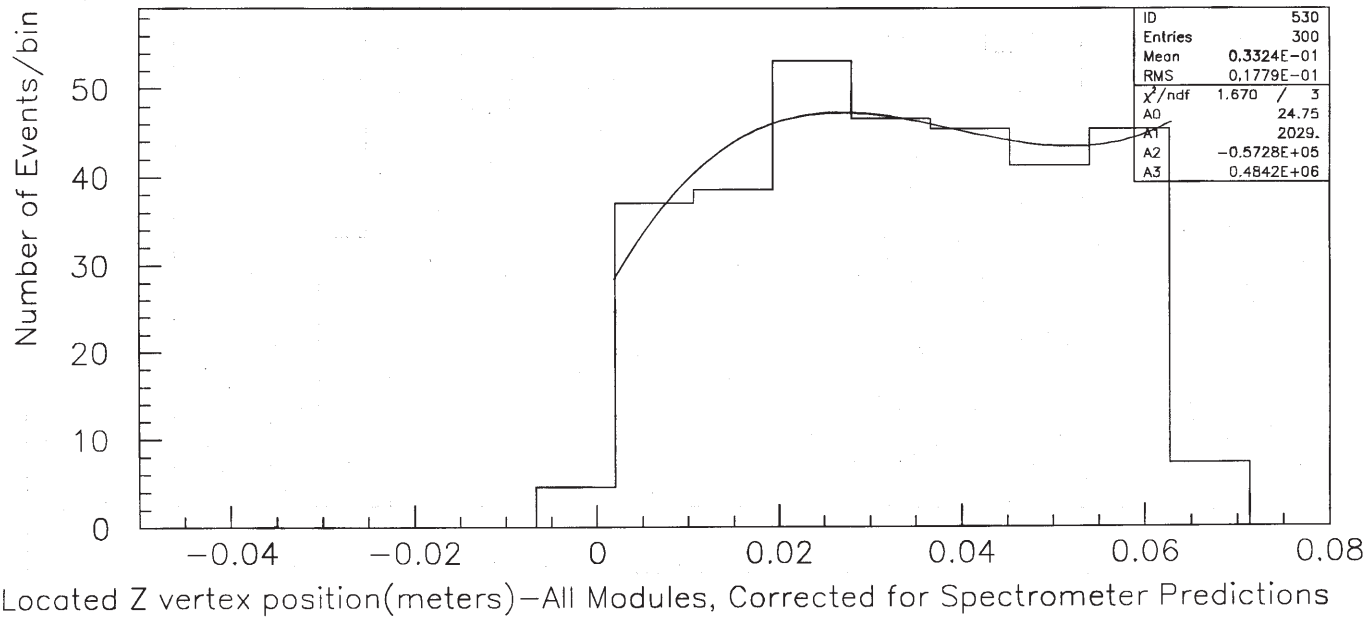

ID 530
Entries 300
Mean 0.3324E-01
RMS 0.1779E-01
χ²/ndf 1.670 / 3
A0 24.75
A1 2029.
A2 -0.5728E+05
A3 0.4842E+06
Number of Events/bin
0
10
20
30
40
50
−0.04
−0.02
0
0.02
0.04
0.06
0.08
Located Z vertex position(meters)−All Modules, Corrected for Spectrometer Predictions

Figure 3

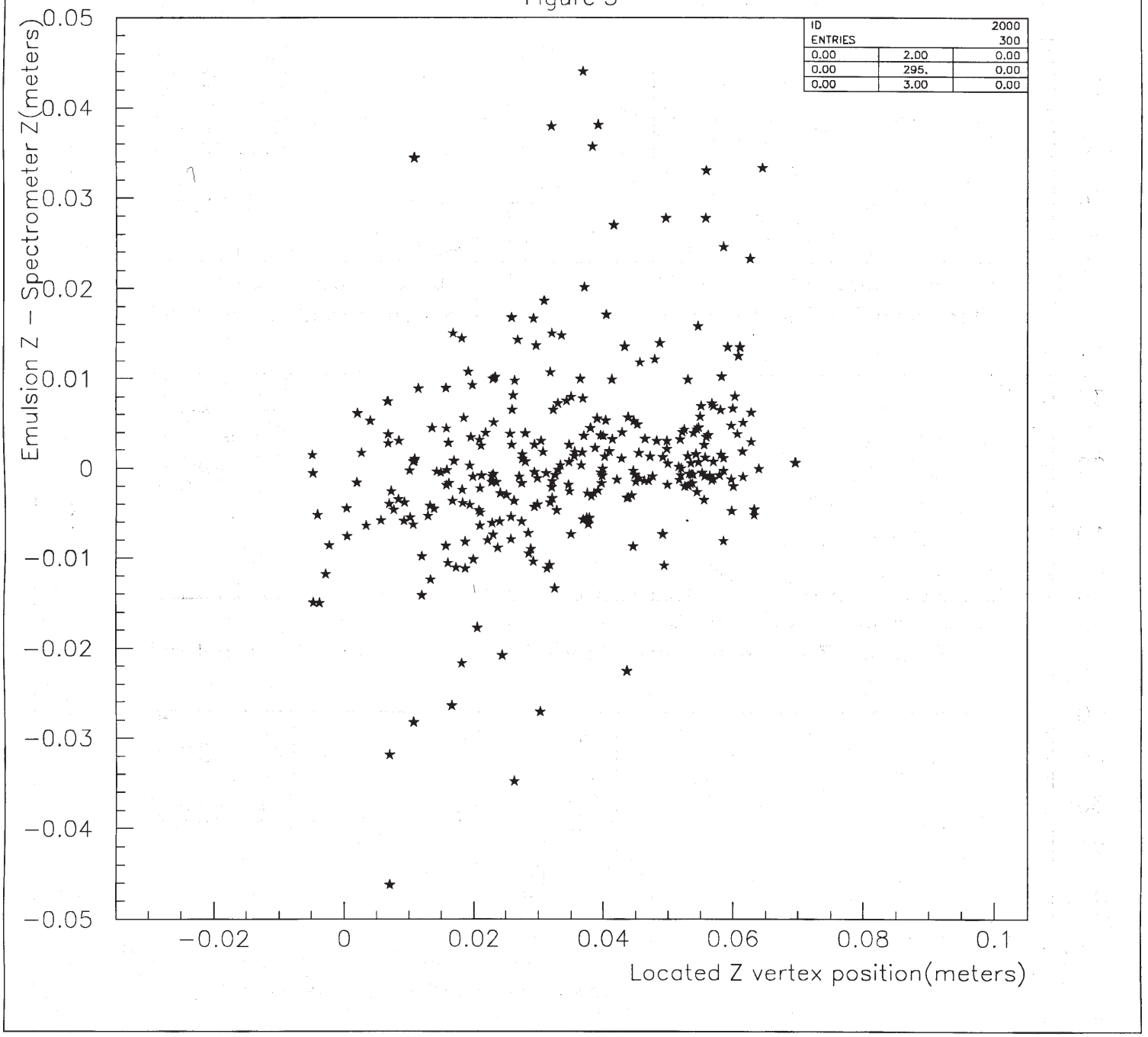
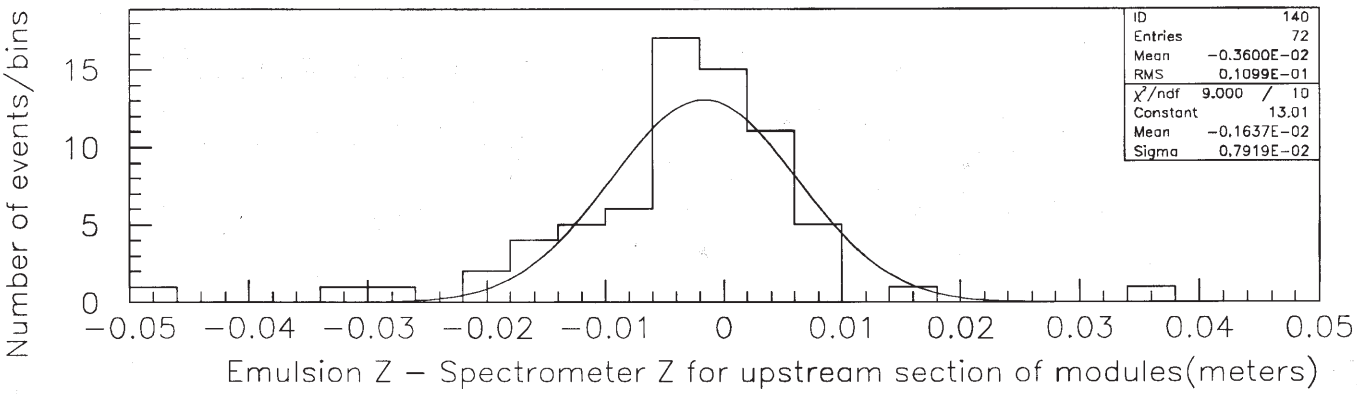
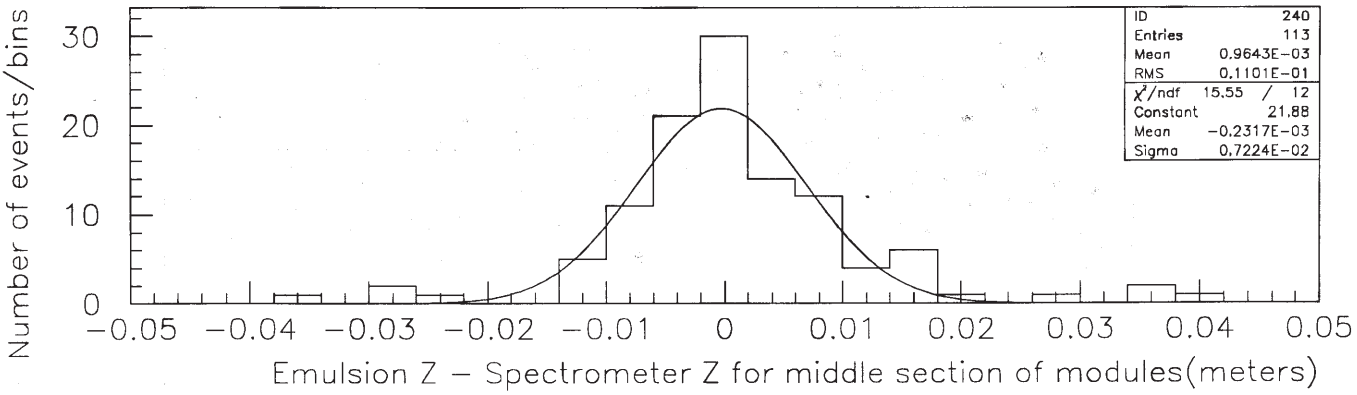

ID 2000
ENTRIES 300
0.00 2.00 0.00
0.00 295. 0.00
0.00 3.00 0.00
Emulsion Z – Spectrometer Z(meters)
0.05
0.04
0.03
0.02
0.01
0
−0.01
−0.02
−0.03
−0.04
−0.05
−0.02
0
0.02
0.04
0.06
0.08
0.1
Located Z vertex position(meters)

Figure 4


ID 140
Entries 72
Mean −0.3600E−02
RMS 0.1099E−01
χ²/ndf 9.000 / 10
Constant 13.01
Mean −0.1637E−02
Sigma 0.7919E−02
Number of events/bins
Emulsion Z − Spectrometer Z for upstream section of modules(meters)


ID 240
Entries 113
Mean 0.9643E−03
RMS 0.1101E−01
χ²/ndf 15.55 / 12
Constant 21.88
Mean −0.2317E−03
Sigma 0.7224E−02
Number of events/bins
Emulsion Z − Spectrometer Z for middle section of modules(meters)

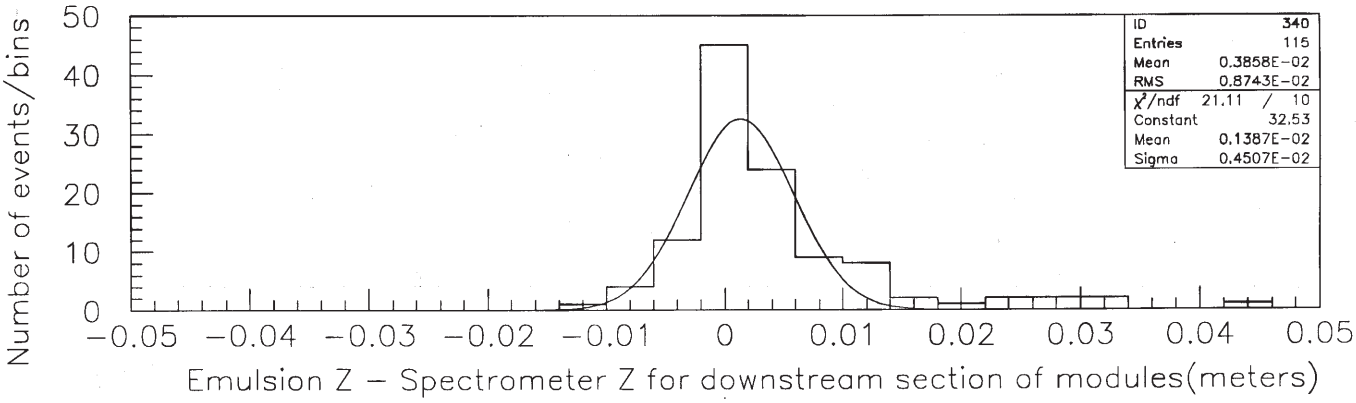
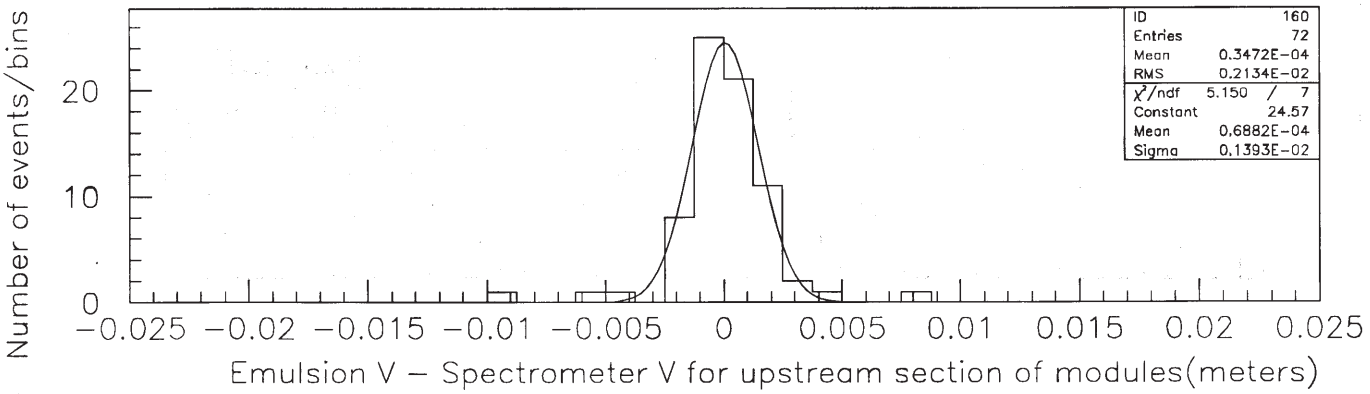
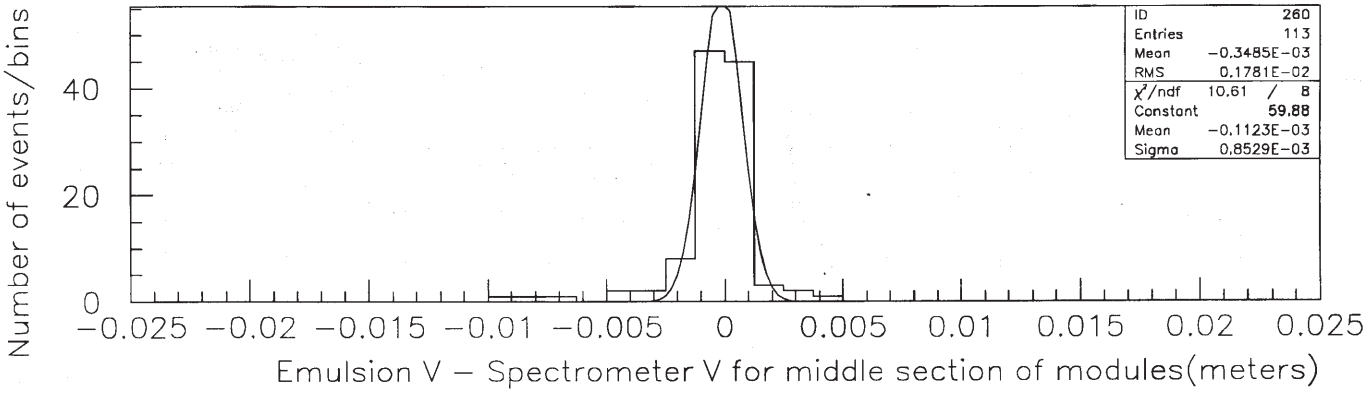

ID 340
Entries 115
Mean 0.3858E−02
RMS 0.8743E−02
χ²/ndf 21.11 / 10
Constant 32.53
Mean 0.1387E−02
Sigma 0.4507E−02
Number of events/bins
Emulsion Z − Spectrometer Z for downstream section of modules(meters)

Figure 6


ID 160
Entries 72
Mean 0.3472E-04
RMS 0.2134E-02
χ²/ndf 5.150 / 7
Constant 24.57
Mean 0.6882E-04
Sigma 0.1393E-02
Number of events/bins
0
10
20
−0.025 −0.02 −0.015 −0.01 −0.005 0 0.005 0.01 0.015 0.02 0.025
Emulsion V − Spectrometer V for upstream section of modules(meters)


ID 260
Entries 113
Mean −0.3485E-03
RMS 0.1781E-02
χ²/ndf 10.61 / 8
Constant 59.88
Mean −0.1123E-03
Sigma 0.8529E-03
Number of events/bins
0
20
40
−0.025 −0.02 −0.015 −0.01 −0.005 0 0.005 0.01 0.015 0.02 0.025
Emulsion V − Spectrometer V for middle section of modules(meters)

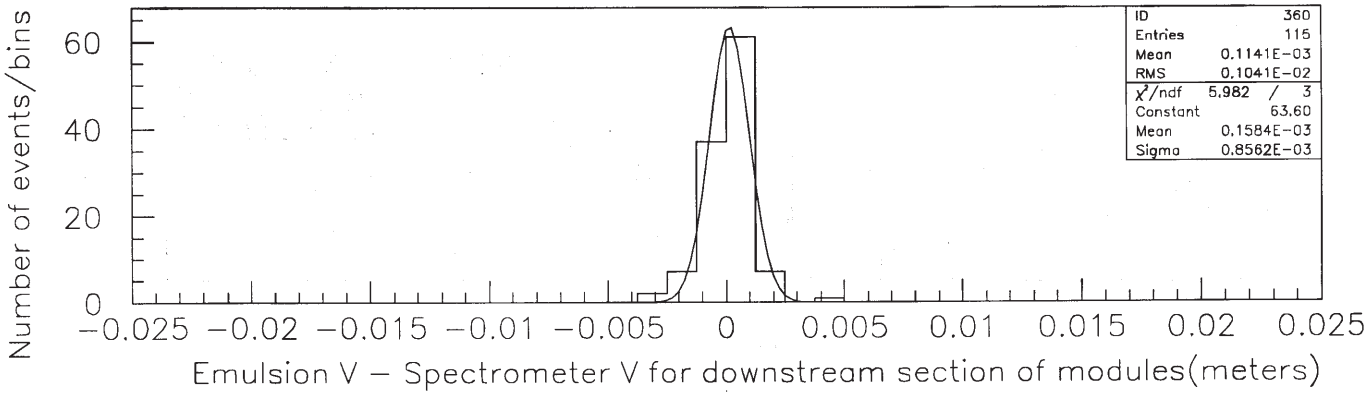
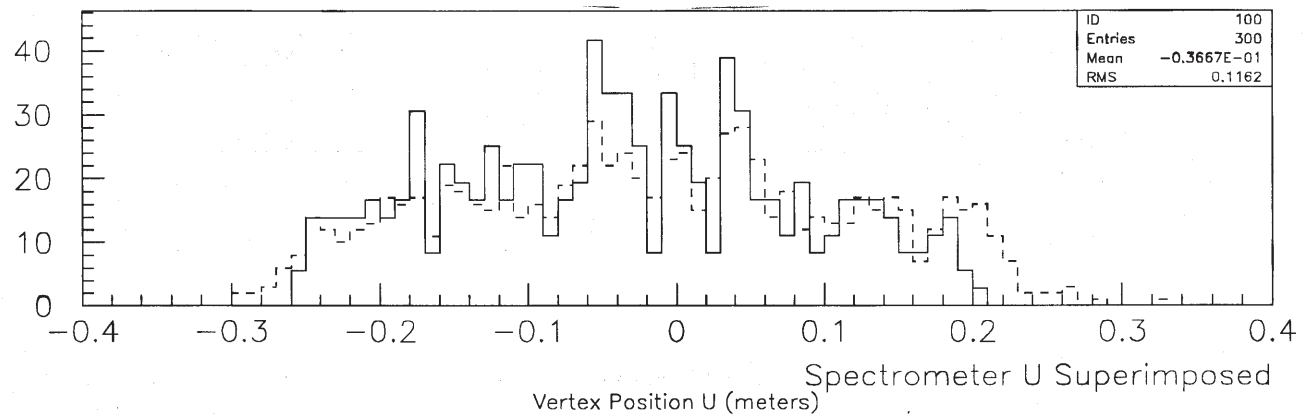
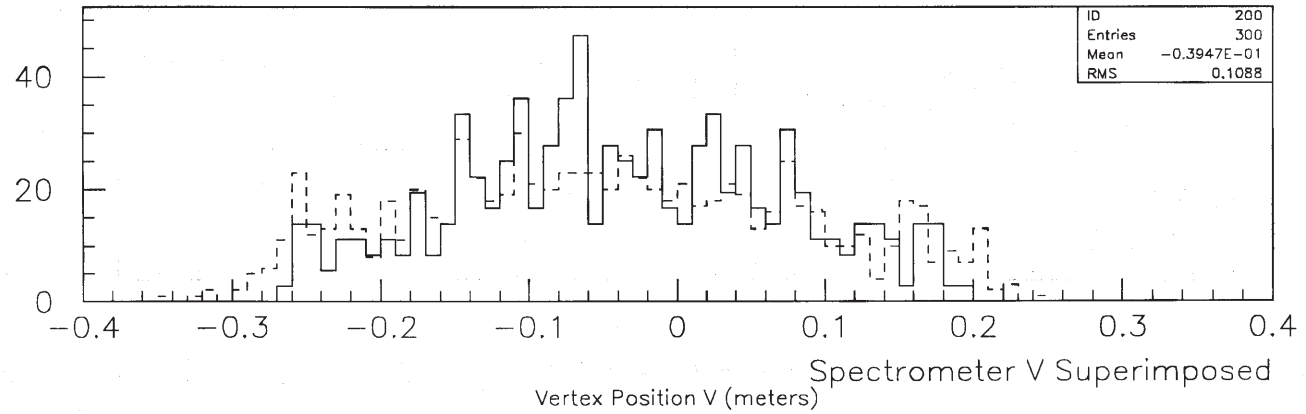

ID 360
Entries 115
Mean 0.1141E-03
RMS 0.1041E-02
χ²/ndf 5.982 / 3
Constant 63.60
Mean 0.1584E-03
Sigma 0.8562E-03
Number of events/bins
0
20
40
60
−0.025 −0.02 −0.015 −0.01 −0.005 0 0.005 0.01 0.015 0.02 0.025
Emulsion V − Spectrometer V for downstream section of modules(meters)

Figure 7


ID 100
Entries 300
Mean −0.3667E−01
RMS 0.1162
40
30
20
10
0
−0.4
−0.3
−0.2
−0.1
0
0.1
0.2
0.3
0.4
Spectrometer U Superimposed
Vertex Position U (meters)


ID 200
Entries 300
Mean −0.3947E−01
RMS 0.1088
40
20
0
−0.4
−0.3
−0.2
−0.1
0
0.1
0.2
0.3
0.4
Spectrometer V Superimposed
Vertex Position V (meters)

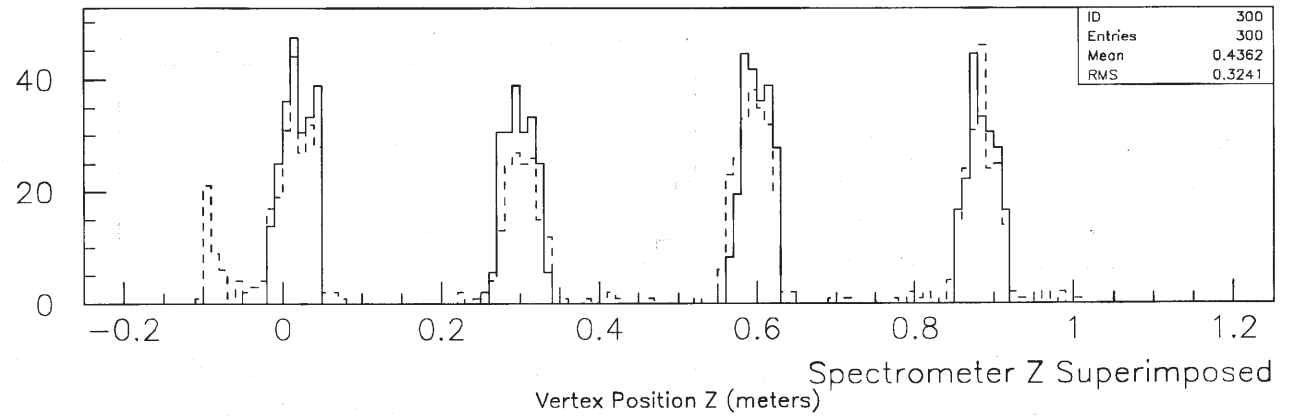
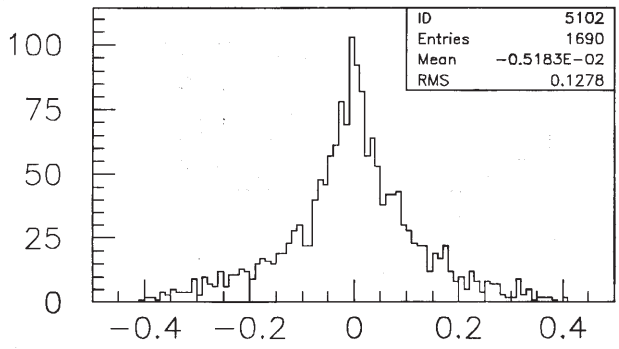
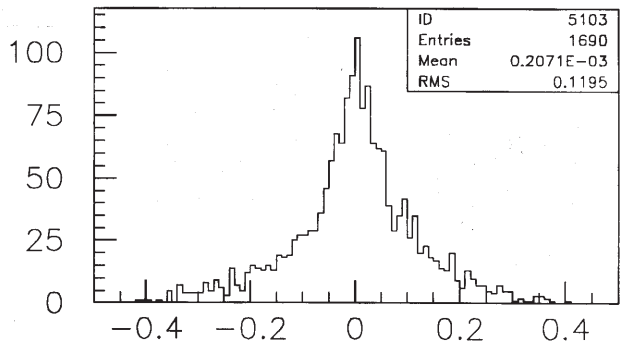

ID 300
Entries 300
Mean 0.4362
RMS 0.3241
40
20
0
−0.2
0
0.2
0.4
0.6
0.8
1
1.2
Spectrometer Z Superimposed
Vertex Position Z (meters)

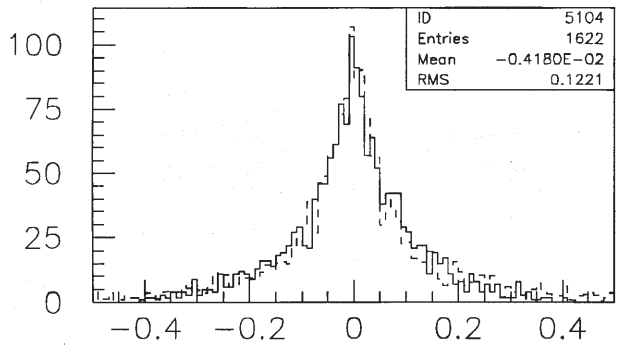
Figure 8



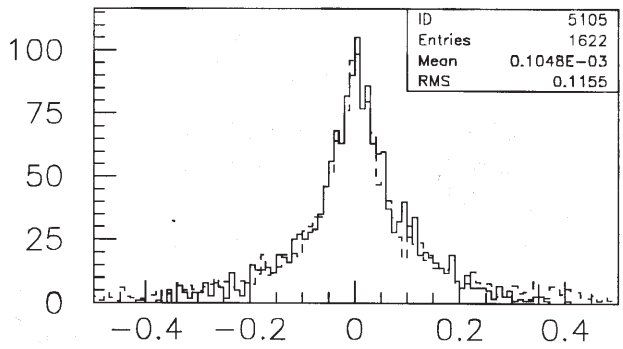
u angles



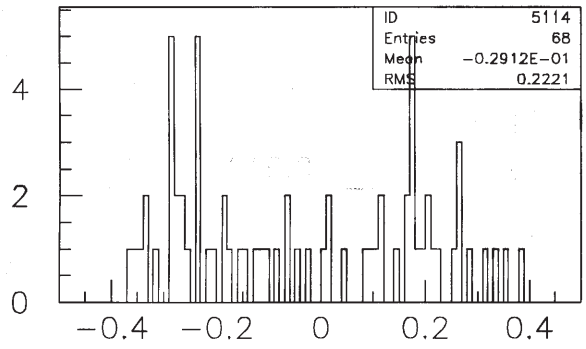
v angles



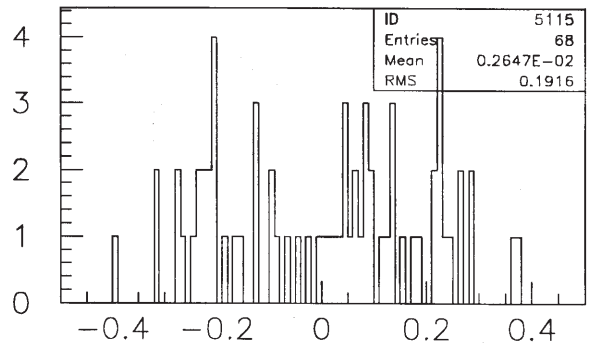
u angles−nseg.gt.1



v angles−nseg.gt.1

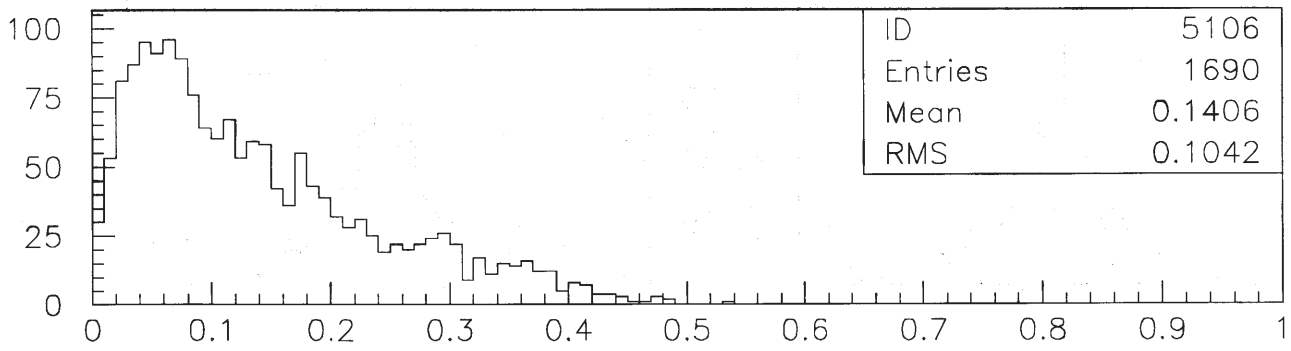


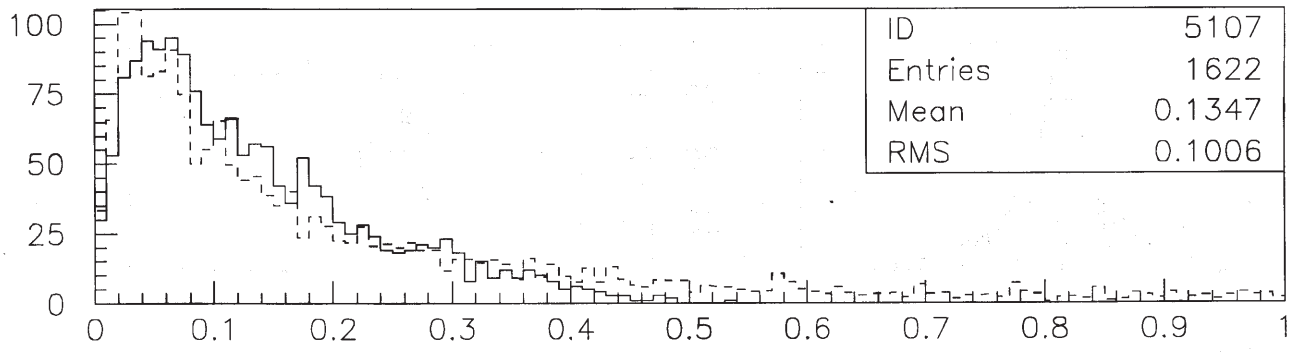
u angles−nseg.eq.1



v angles−nseg.eq.1

Figure 9


ID 5106
Entries 1690
Mean 0.1406
RMS 0.1042
Total angle


ID 5107
Entries 1622
Mean 0.1347
RMS 0.1006
Total angle—nseg.gt.1

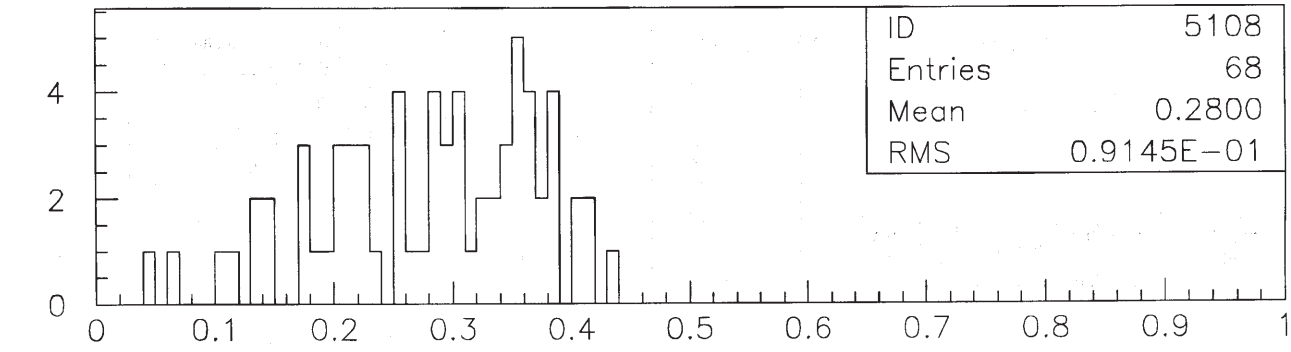

ID 5108
Entries 68
Mean 0.2800
RMS 0.9145E-01
Total angle—nseg.eq.1

Figure 10

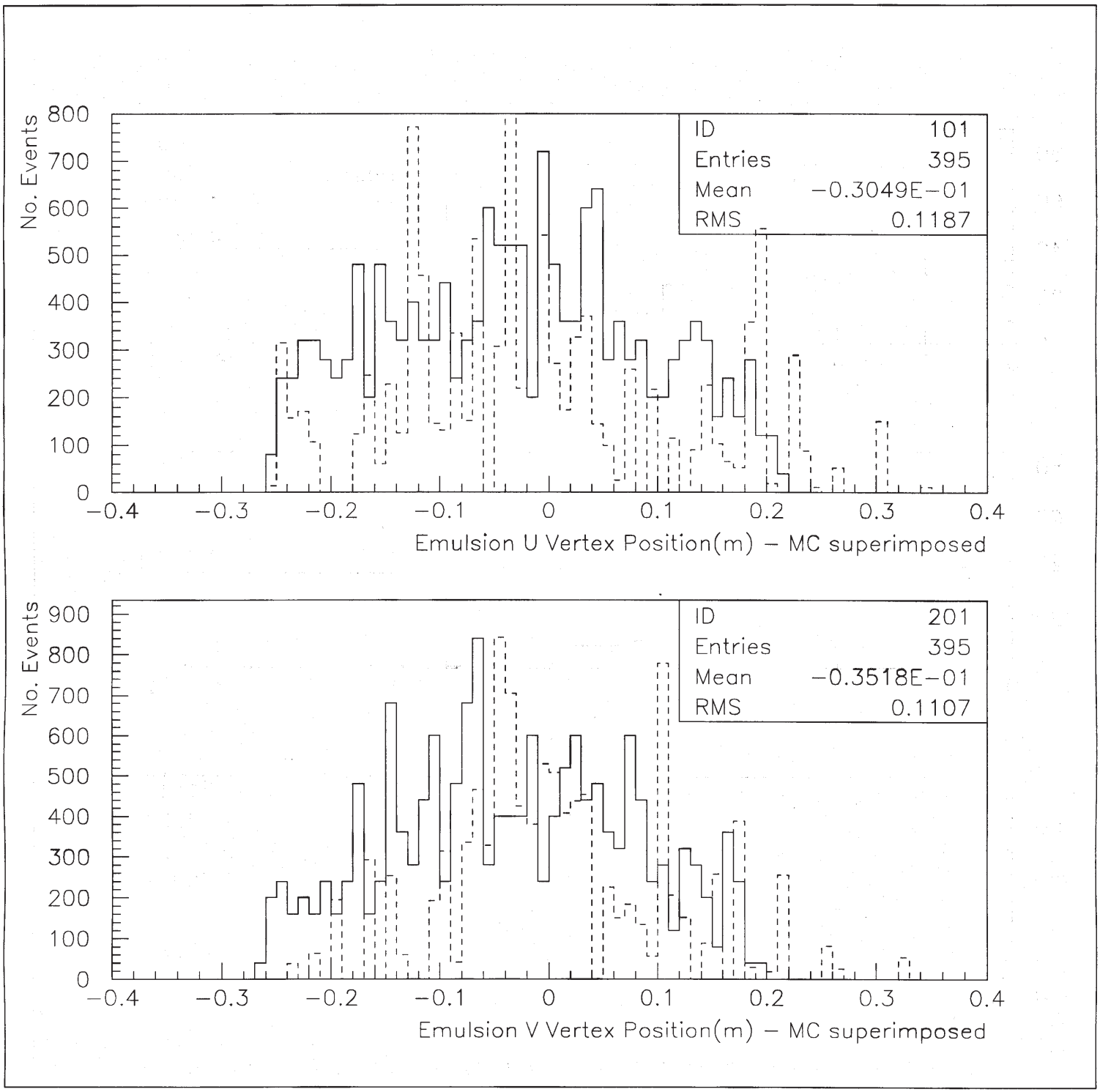

No. Events
800
700
600
500
400
300
200
100
0
−0.4
−0.3
−0.2
−0.1
0
0.1
0.2
0.3
0.4
ID 101
Entries 395
Mean −0.3049E−01
RMS 0.1187
Emulsion U Vertex Position(m) − MC superimposed
No. Events
900
800
700
600
500
400
300
200
100
0
−0.4
−0.3
−0.2
−0.1
0
0.1
0.2
0.3
0.4
ID 201
Entries 395
Mean −0.3518E−01
RMS 0.1107
Emulsion V Vertex Position(m) − MC superimposed

Figure 11

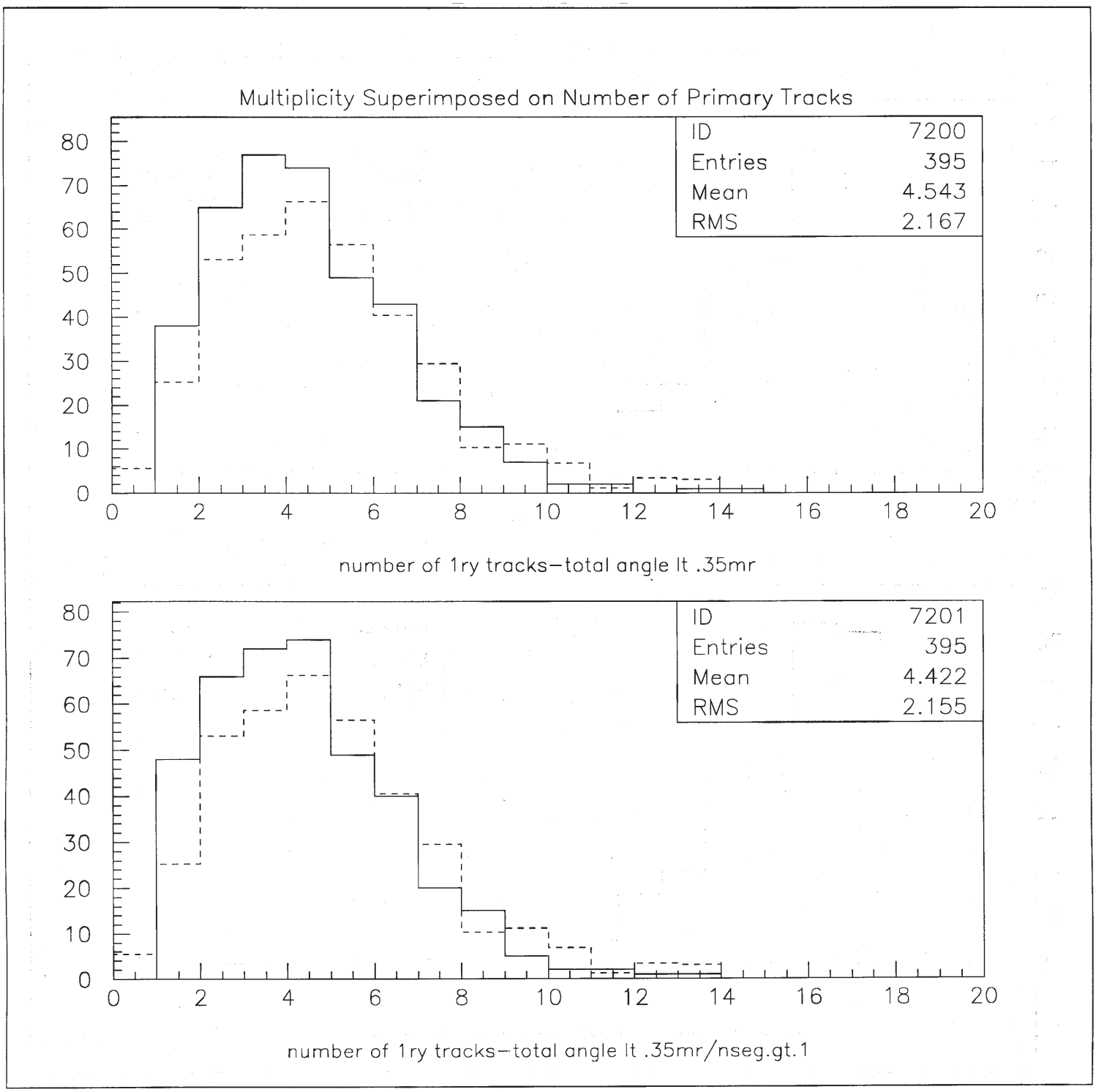
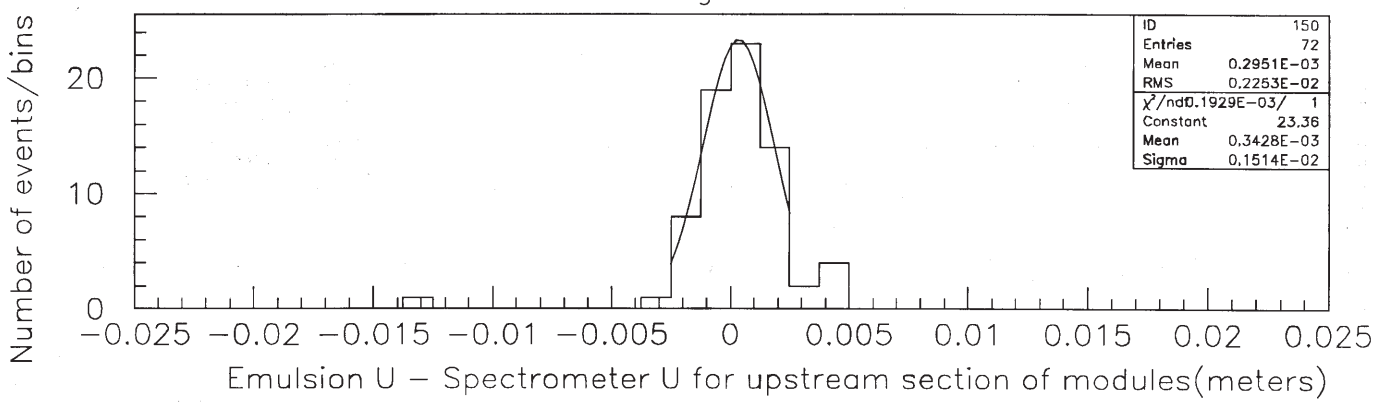
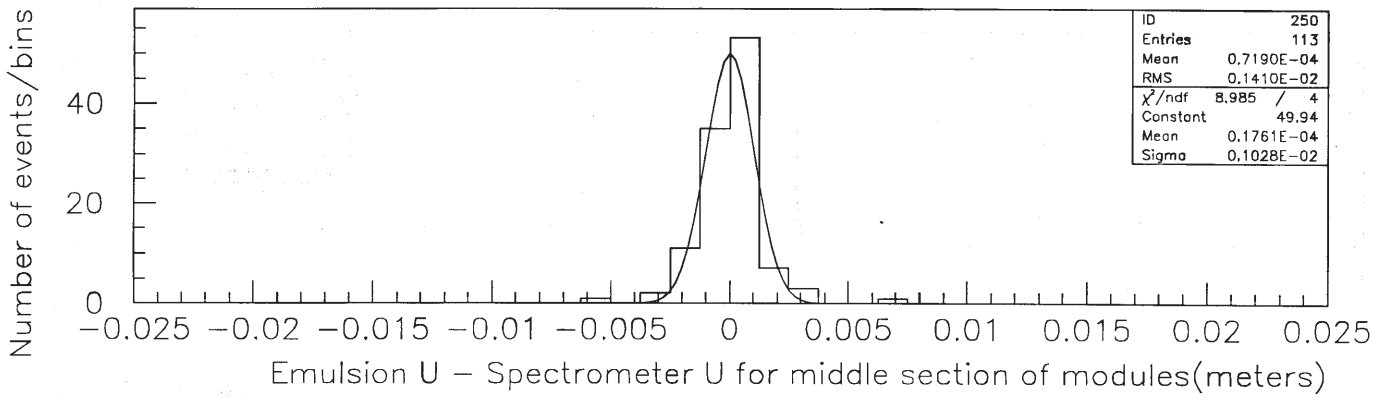
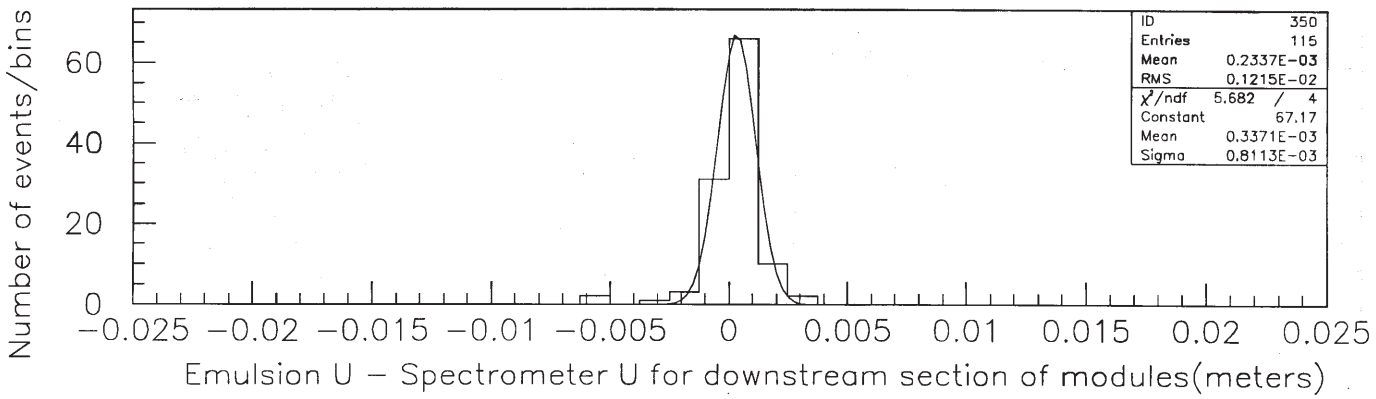

Multiplicity Superimposed on Number of Primary Tracks
ID 7200
Entries 395
Mean 4.543
RMS 2.167
number of 1ry tracks–total angle lt .35mr
ID 7201
Entries 395
Mean 4.422
RMS 2.155
number of 1ry tracks–total angle lt .35mr/nseg.gt.1

Figure 5


ID 150
Entries 72
Mean 0.2951E-03
RMS 0.2253E-02
χ²/ndf 0.1929E-03 / 1
Constant 23.36
Mean 0.3428E-03
Sigma 0.1514E-02
Number of events/bins
0
10
20
−0.025 −0.02 −0.015 −0.01 −0.005 0 0.005 0.01 0.015 0.02 0.025
Emulsion U − Spectrometer U for upstream section of modules(meters)


ID 250
Entries 113
Mean 0.7190E-04
RMS 0.1410E-02
χ²/ndf 8.985 / 4
Constant 49.94
Mean 0.1761E-04
Sigma 0.1028E-02
Number of events/bins
0
20
40
−0.025 −0.02 −0.015 −0.01 −0.005 0 0.005 0.01 0.015 0.02 0.025
Emulsion U − Spectrometer U for middle section of modules(meters)


ID 350
Entries 115
Mean 0.2337E-03
RMS 0.1215E-02
χ²/ndf 5.682 / 4
Constant 67.17
Mean 0.3371E-03
Sigma 0.8113E-03
Number of events/bins
0
20
40
60
−0.025 −0.02 −0.015 −0.01 −0.005 0 0.005 0.01 0.015 0.02 0.025
Emulsion U − Spectrometer U for downstream section of modules(meters)