Vertex Time difference fitting results

Fitting Function candidates

- Sqrt(P0+p1/x)
- Sqrt(P0 + (p1+p2/sqrt(x))^2)

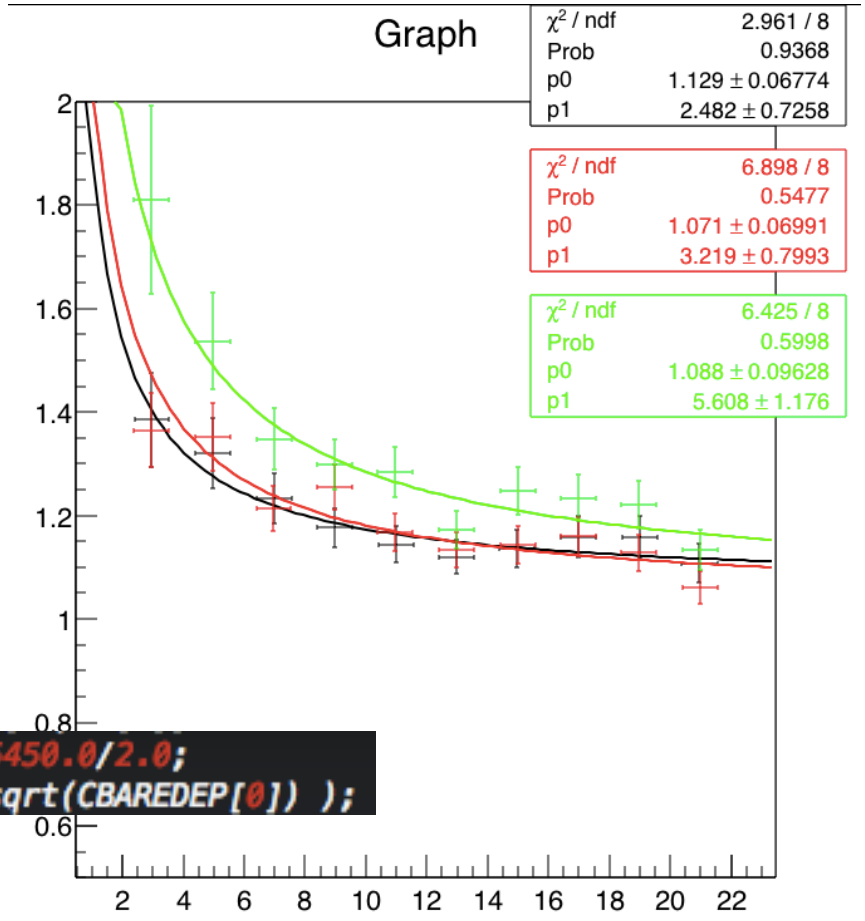
With Function 1, MC check

- 1) MC without smearing on Barrel + Detector Veto
- 2) MC without smearing on Barrel
- 3) MC with smearing on Barrel

P0 : overestimated CsI resolution in MC

P1 : after smearing, MC reproduces data well

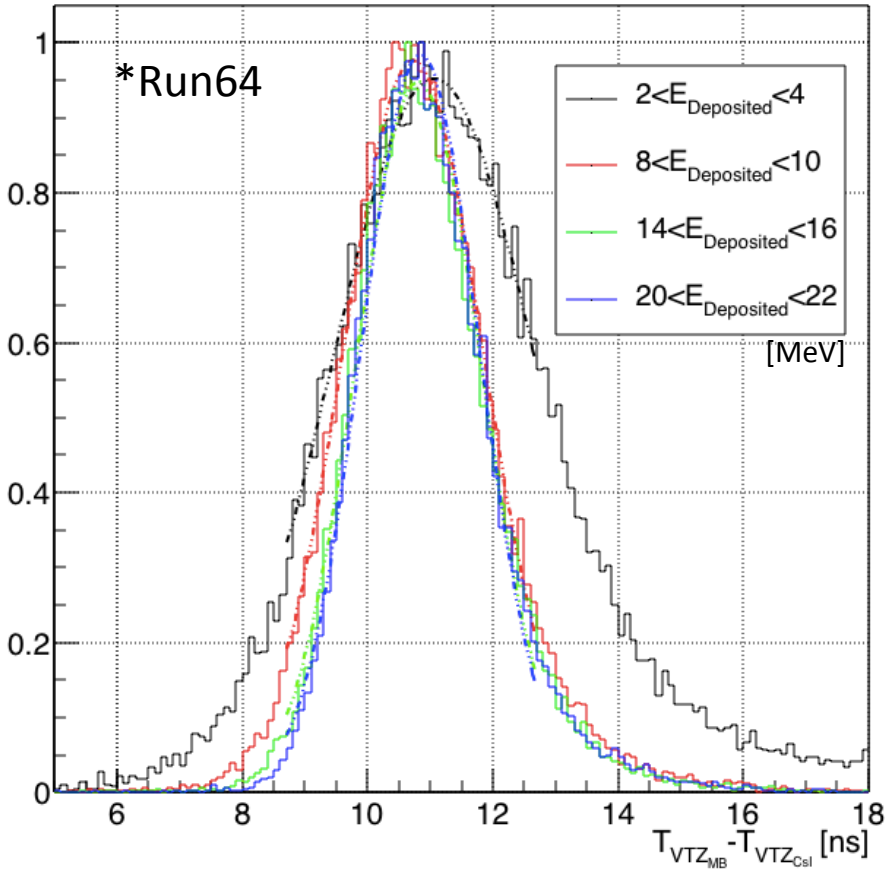
- result of cosmic-ray data analysis is used




```
IMBz = 8.0*CBARTDIF[tmpMB[0]]*178.5/2.0 + 1348.0 + 5450.0/2.0;
CBARt0[tmpMB[0]] = r->Gaus( CBARt0[tmpMB[0]], 1.64/sqrt(CBAREDEP[0]) );
```

Smearing

Spectra. & Fitting



Entries	27426
Mean	11.36
RMS	1.953
χ^2 / ndf	0.05763 / 37
Prob	1
Constant	0.9522 ± 0.2389
Mean	11.06 ± 0.53
Sigma	1.617 ± 0.711

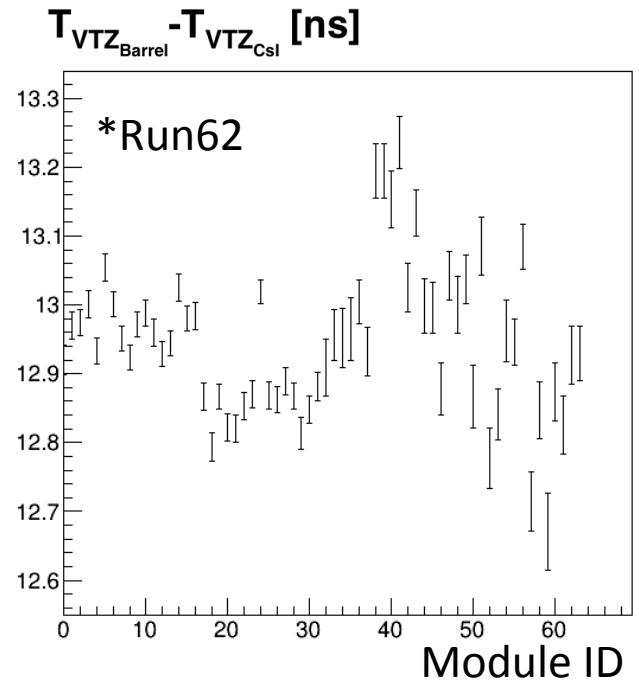
Entries	32418
Mean	10.86
RMS	1.298
χ^2 / ndf	0.05593 / 37
Prob	1
Constant	0.9767 ± 0.2610
Mean	10.73 ± 0.27
Sigma	1.113 ± 0.287

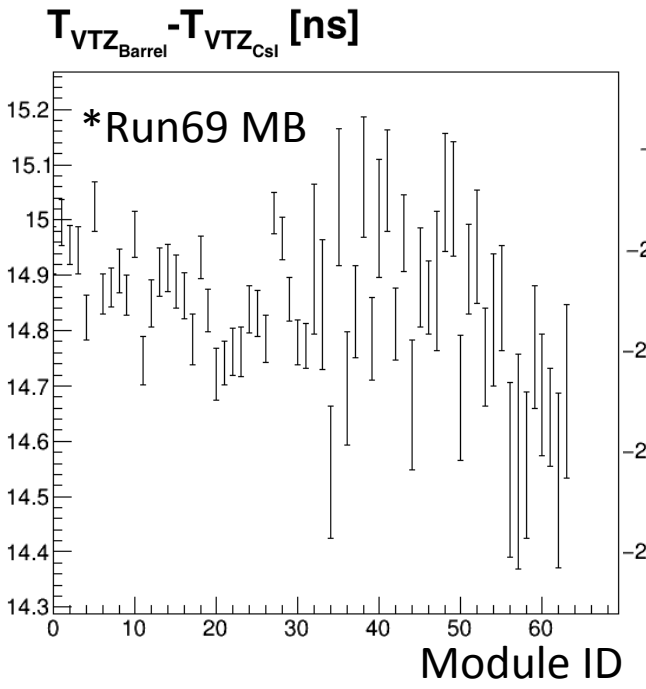
Entries	31757
Mean	10.94
RMS	1.181
χ^2 / ndf	0.1342 / 37
Prob	1
Constant	0.9481 ± 0.2623
Mean	10.81 ± 0.25
Sigma	0.9944 ± 0.2316

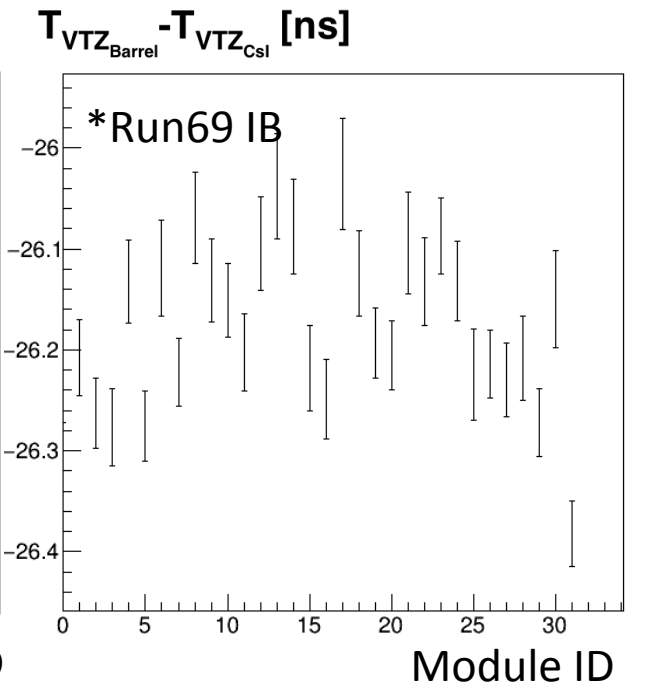
Entries	26230
Mean	10.99
RMS	1.139
χ^2 / ndf	0.1437 / 37
Prob	1
Constant	0.9842 ± 0.2691
Mean	10.84 ± 0.23
Sigma	0.9409 ± 0.2025

- Fitted with Gaussian
  - Mean : Offset
  - Sigma : Time Resolution affected by CsI and Barrel
- All modules are integrated

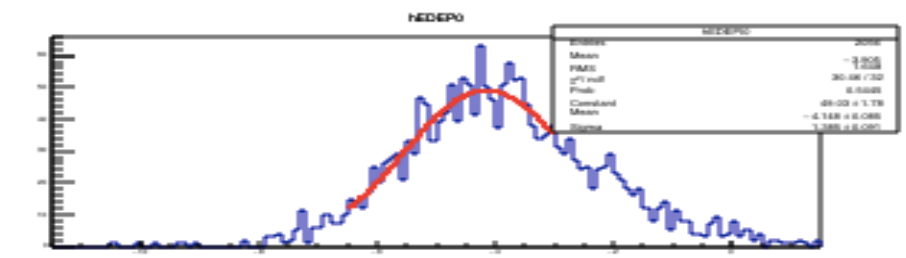
Module stability

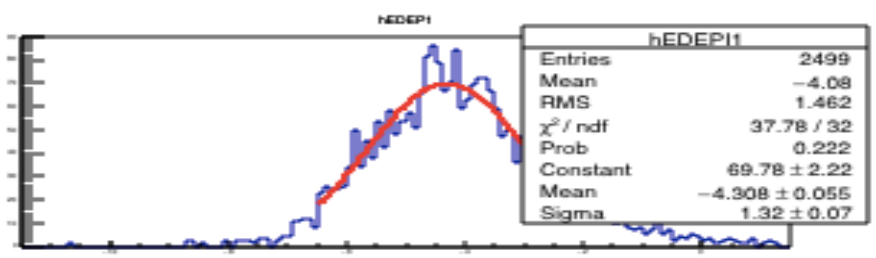


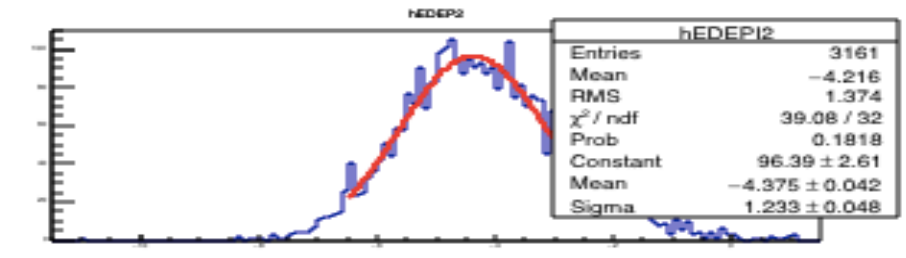


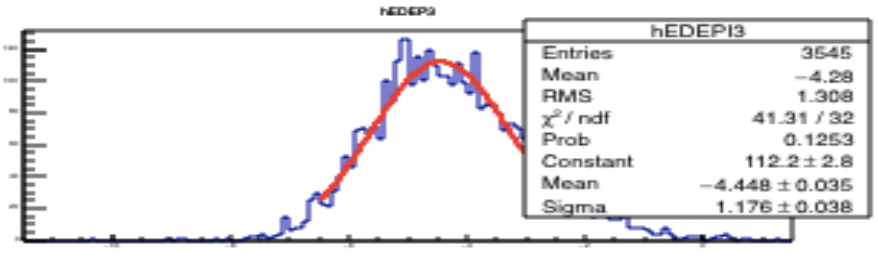


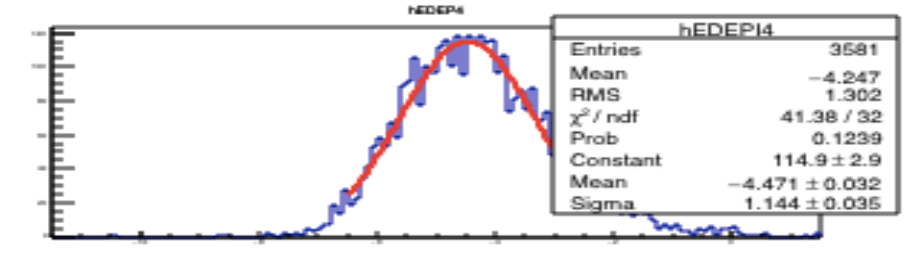
- Evaluation of Barrel Calibration from Fitting of Vertex Time Difference distributions

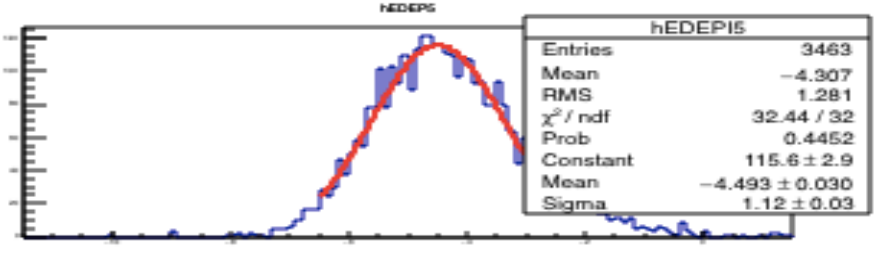



hEDEPI1
Entries 2499
Mean −4.08
RMS 1.462
χ² / ndf 37.78 / 32
Prob 0.222
Constant 69.78 ± 2.22
Mean −4.308 ± 0.055
Sigma 1.32 ± 0.07

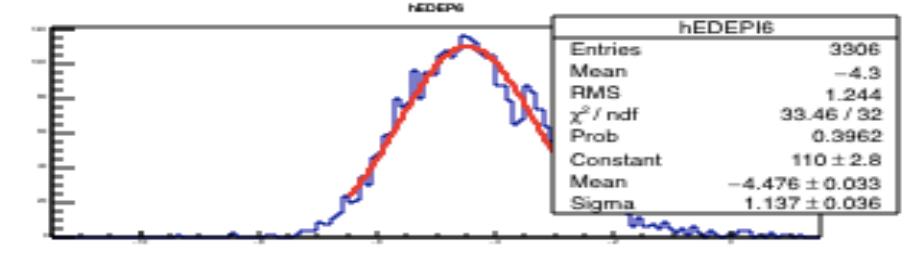

hEDEPI2
Entries 3161
Mean −4.216
RMS 1.374
χ² / ndf 39.08 / 32
Prob 0.1818
Constant 96.39 ± 2.61
Mean −4.375 ± 0.042
Sigma 1.233 ± 0.048

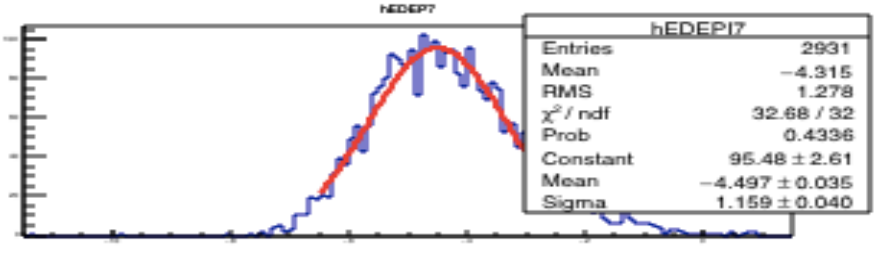

hEDEPI3
Entries 3545
Mean −4.28
RMS 1.308
χ² / ndf 41.31 / 32
Prob 0.1253
Constant 112.2 ± 2.8
Mean −4.448 ± 0.035
Sigma 1.176 ± 0.038

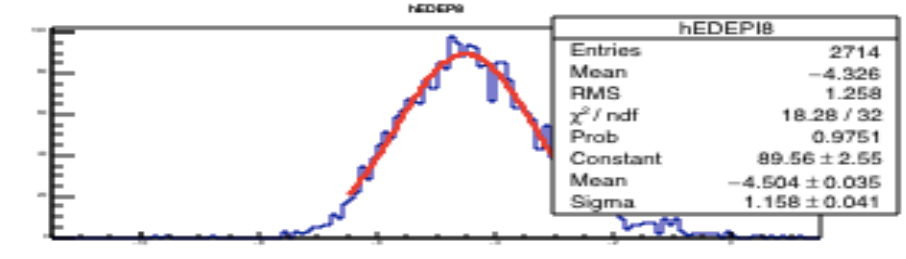

hEDEPI4
Entries 3581
Mean −4.247
RMS 1.302
χ² / ndf 41.38 / 32
Prob 0.1239
Constant 114.9 ± 2.9
Mean −4.471 ± 0.032
Sigma 1.144 ± 0.035

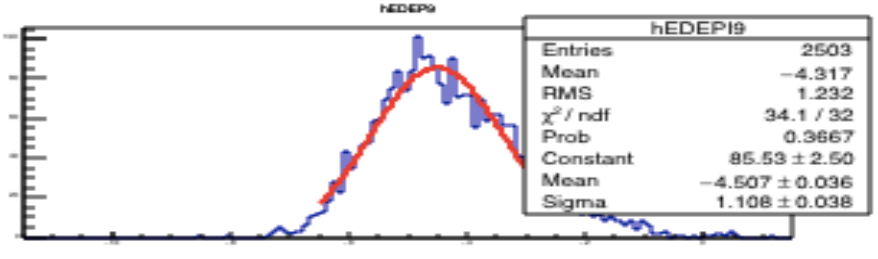

hEDEPI5
Entries 3463
Mean −4.307
RMS 1.281
χ² / ndf 32.44 / 32
Prob 0.4452
Constant 115.6 ± 2.9
Mean −4.493 ± 0.030
Sigma 1.12 ± 0.03

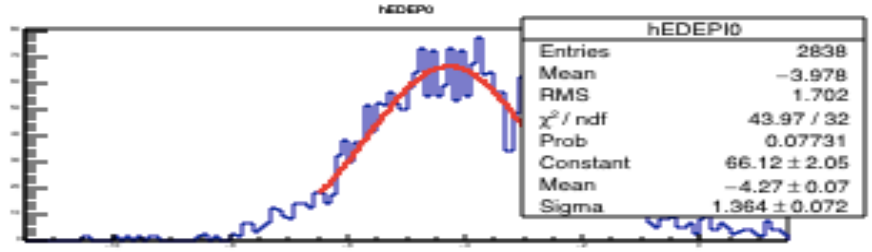
CASE1

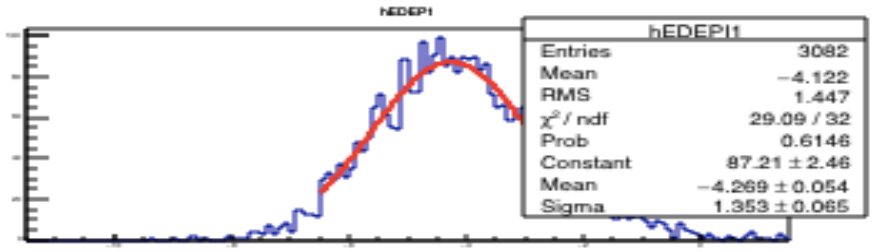

hEDEPI6
Entries 3306
Mean −4.3
RMS 1.244
χ² / ndf 33.46 / 32
Prob 0.3962
Constant 110 ± 2.8
Mean −4.476 ± 0.033
Sigma 1.137 ± 0.036

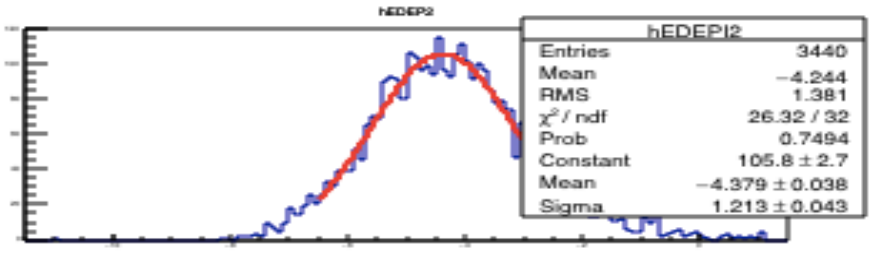

hEDEPI7
Entries 2931
Mean −4.315
RMS 1.278
χ² / ndf 32.68 / 32
Prob 0.4336
Constant 95.48 ± 2.61
Mean −4.497 ± 0.035
Sigma 1.159 ± 0.040

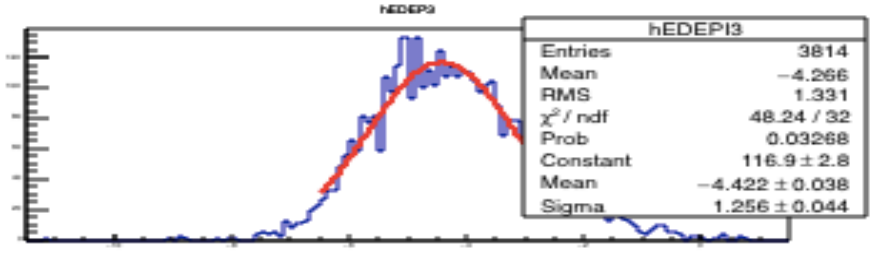

hEDEPI8
Entries 2714
Mean −4.326
RMS 1.258
χ² / ndf 18.28 / 32
Prob 0.9751
Constant 89.56 ± 2.55
Mean −4.504 ± 0.035
Sigma 1.158 ± 0.041

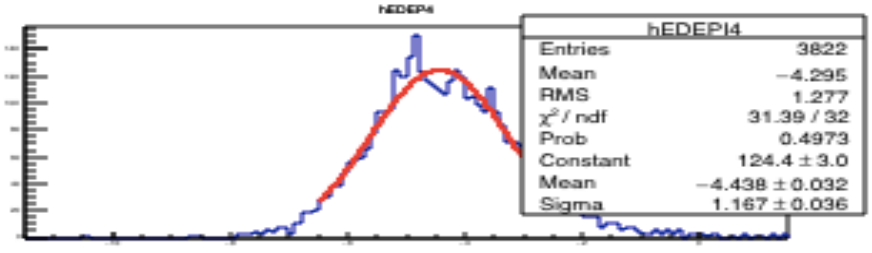

hEDEPI9
Entries 2503
Mean −4.317
RMS 1.232
χ² / ndf 34.1 / 32
Prob 0.3667
Constant 85.53 ± 2.50
Mean −4.507 ± 0.036
Sigma 1.108 ± 0.038

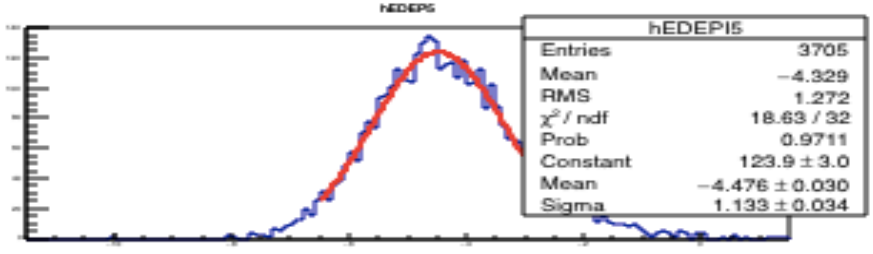

hEDEPI0
Entries 2838
Mean −3.978
RMS 1.702
χ² / ndf 43.97 / 32
Prob 0.07731
Constant 66.12 ± 2.05
Mean −4.27 ± 0.07
Sigma 1.364 ± 0.072


hEDEPI1
Entries 3082
Mean −4.122
RMS 1.447
χ² / ndf 29.09 / 32
Prob 0.6146
Constant 87.21 ± 2.46
Mean −4.269 ± 0.054
Sigma 1.353 ± 0.065

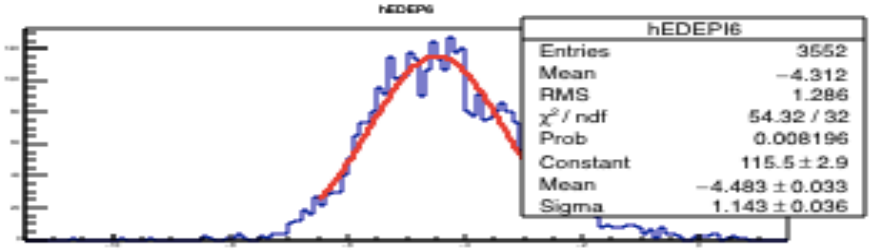

hEDEPI2
Entries 3440
Mean −4.244
RMS 1.381
χ² / ndf 26.32 / 32
Prob 0.7494
Constant 105.8 ± 2.7
Mean −4.379 ± 0.038
Sigma 1.213 ± 0.043

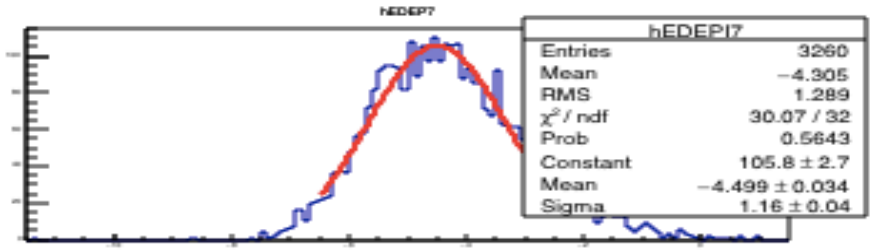

hEDEPI3
Entries 3814
Mean −4.266
RMS 1.331
χ² / ndf 48.24 / 32
Prob 0.03268
Constant 116.9 ± 2.8
Mean −4.422 ± 0.038
Sigma 1.256 ± 0.044

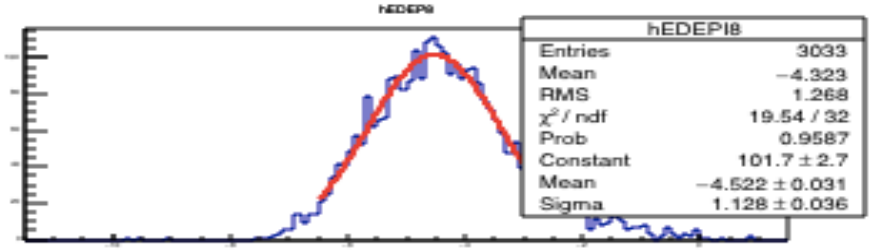

hEDEPI4
Entries 3822
Mean −4.295
RMS 1.277
χ² / ndf 31.39 / 32
Prob 0.4973
Constant 124.4 ± 3.0
Mean −4.438 ± 0.032
Sigma 1.167 ± 0.036

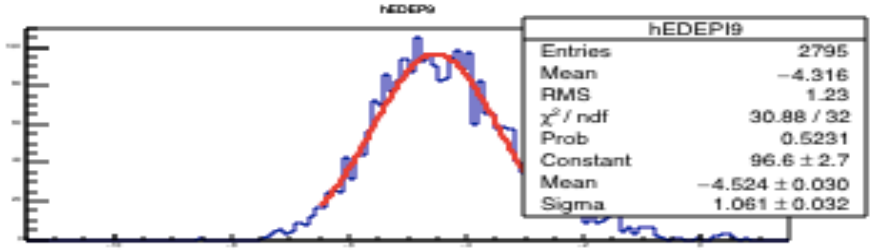

hEDEPI5
Entries 3705
Mean −4.329
RMS 1.272
χ² / ndf 18.63 / 32
Prob 0.9711
Constant 123.9 ± 3.0
Mean −4.476 ± 0.030
Sigma 1.133 ± 0.034

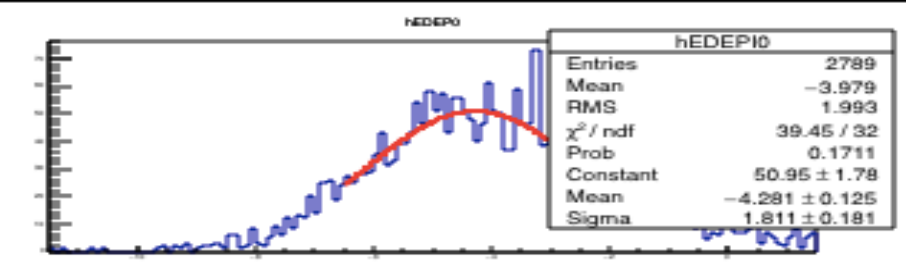
CASE2

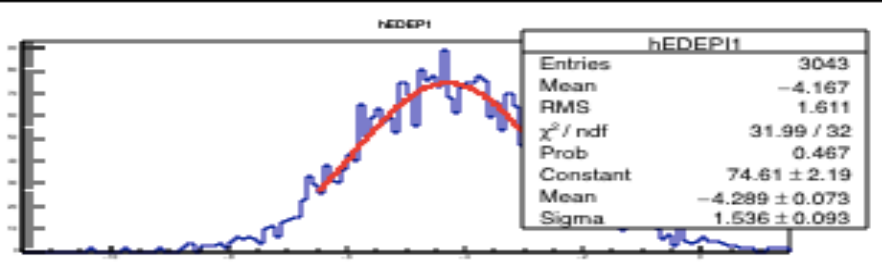

hEDEPI6
Entries 3552
Mean −4.312
RMS 1.286
χ² / ndf 54.32 / 32
Prob 0.008196
Constant 115.5 ± 2.9
Mean −4.483 ± 0.033
Sigma 1.143 ± 0.036

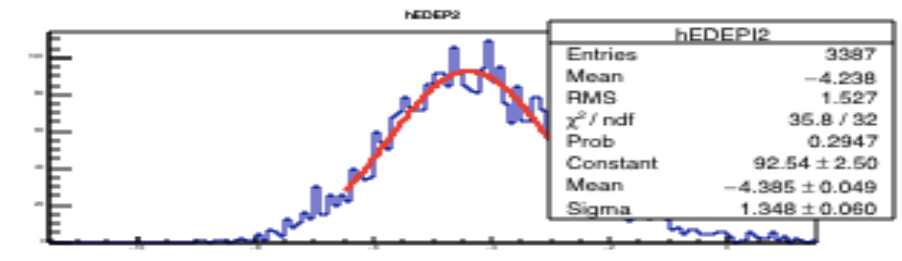

hEDEPI7
Entries 3260
Mean −4.305
RMS 1.289
χ² / ndf 30.07 / 32
Prob 0.5643
Constant 105.8 ± 2.7
Mean −4.499 ± 0.034
Sigma 1.16 ± 0.04

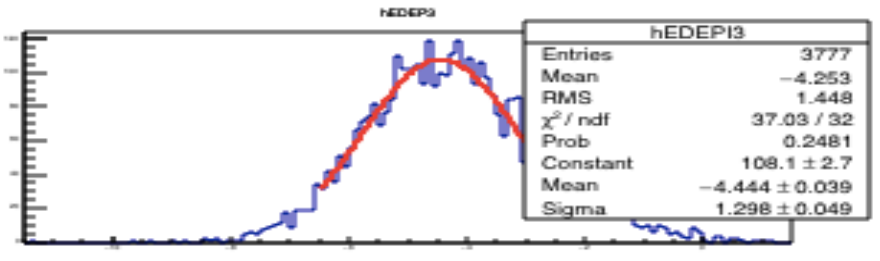

hEDEPI8
Entries 3033
Mean −4.323
RMS 1.268
χ² / ndf 19.54 / 32
Prob 0.9587
Constant 101.7 ± 2.7
Mean −4.522 ± 0.031
Sigma 1.128 ± 0.036

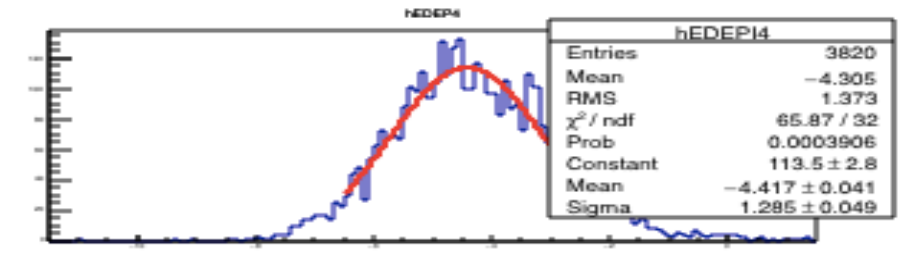

hEDEPI9
Entries 2795
Mean −4.316
RMS 1.23
χ² / ndf 30.88 / 32
Prob 0.5231
Constant 96.6 ± 2.7
Mean −4.524 ± 0.030
Sigma 1.061 ± 0.032


hEDEPI0
Entries 2789
Mean −3.979
RMS 1.993
χ² / ndf 39.45 / 32
Prob 0.1711
Constant 50.95 ± 1.78
Mean −4.281 ± 0.125
Sigma 1.811 ± 0.181

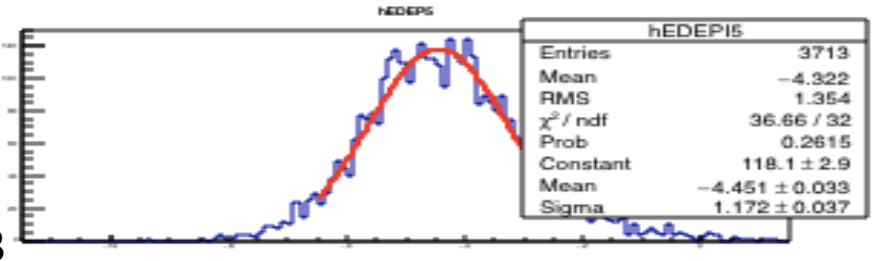

hEDEPI1
Entries 3043
Mean −4.167
RMS 1.611
χ² / ndf 31.99 / 32
Prob 0.467
Constant 74.61 ± 2.19
Mean −4.289 ± 0.073
Sigma 1.536 ± 0.093

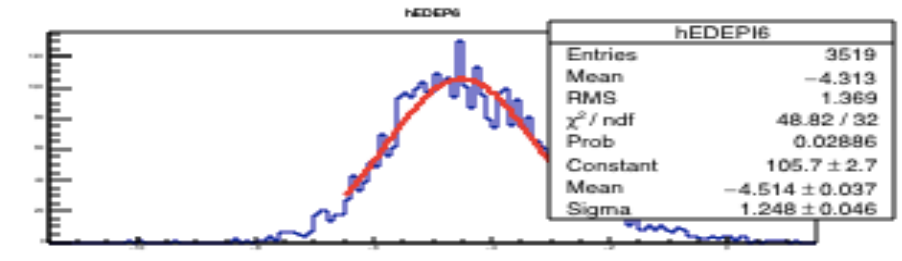

hEDEPI2
Entries 3387
Mean −4.238
RMS 1.527
χ² / ndf 35.8 / 32
Prob 0.2947
Constant 92.54 ± 2.50
Mean −4.385 ± 0.049
Sigma 1.348 ± 0.060

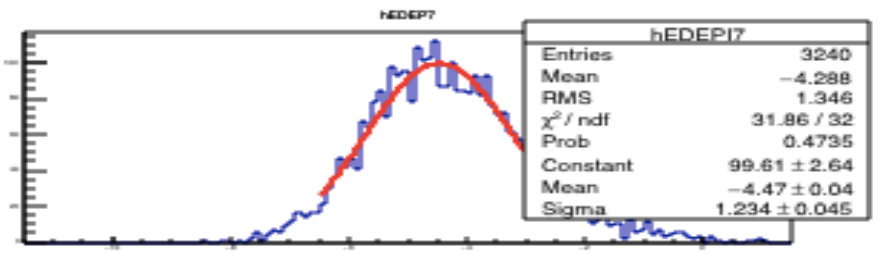

hEDEPI3
Entries 3777
Mean −4.253
RMS 1.448
χ² / ndf 37.03 / 32
Prob 0.2481
Constant 108.1 ± 2.7
Mean −4.444 ± 0.039
Sigma 1.298 ± 0.049

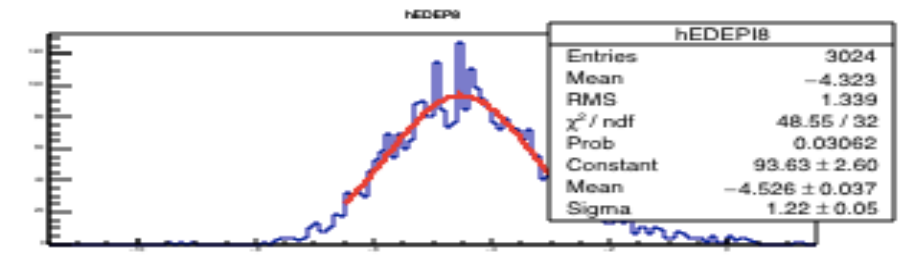

hEDEPI4
Entries 3820
Mean −4.305
RMS 1.373
χ² / ndf 65.87 / 32
Prob 0.0003906
Constant 113.5 ± 2.8
Mean −4.417 ± 0.041
Sigma 1.285 ± 0.049

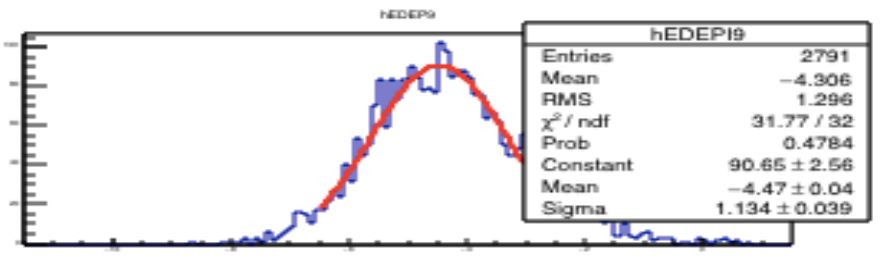
CASE3


hEDEPI5
Entries 3713
Mean −4.322
RMS 1.354
χ² / ndf 36.66 / 32
Prob 0.2615
Constant 118.1 ± 2.9
Mean −4.451 ± 0.033
Sigma 1.172 ± 0.037


hEDEPI6
Entries 3519
Mean −4.313
RMS 1.369
χ² / ndf 48.82 / 32
Prob 0.02886
Constant 105.7 ± 2.7
Mean −4.514 ± 0.037
Sigma 1.248 ± 0.046

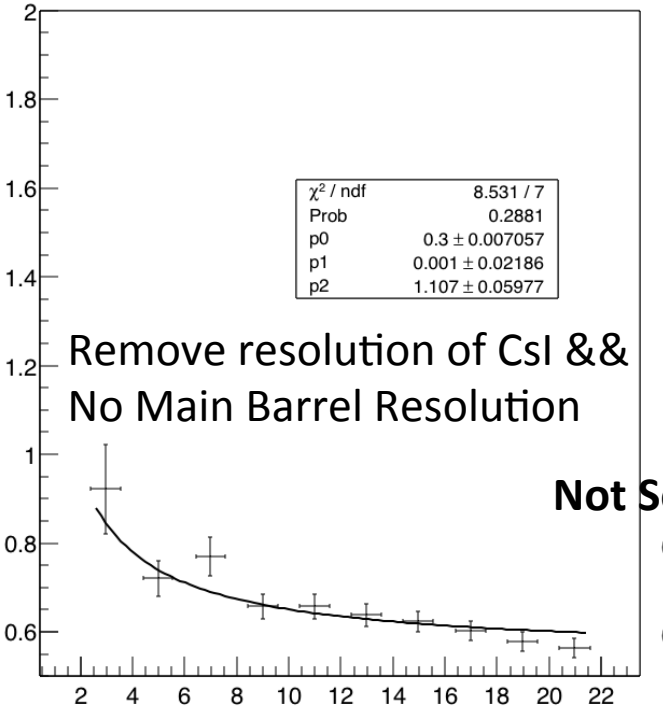

hEDEPI7
Entries 3240
Mean −4.288
RMS 1.346
χ² / ndf 31.86 / 32
Prob 0.4735
Constant 99.61 ± 2.64
Mean −4.47 ± 0.04
Sigma 1.234 ± 0.045

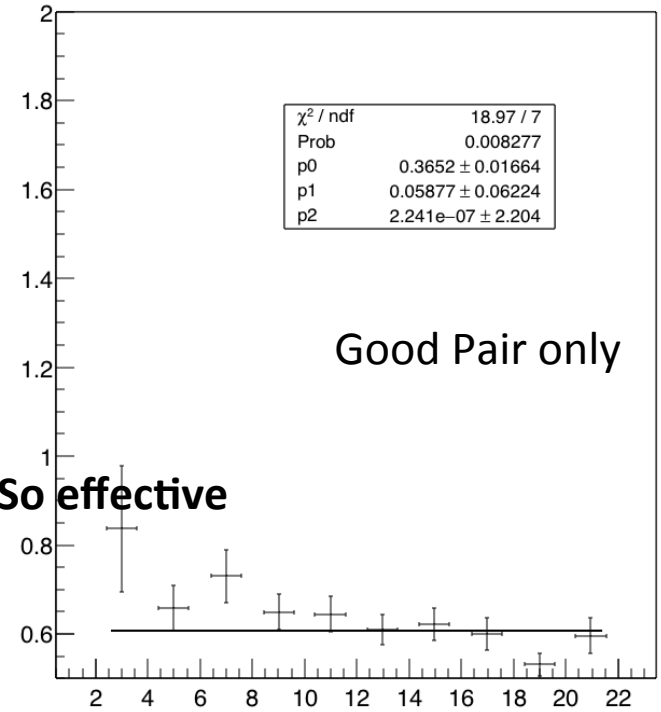

hEDEPI8
Entries 3024
Mean −4.323
RMS 1.339
χ² / ndf 48.55 / 32
Prob 0.03062
Constant 93.63 ± 2.60
Mean −4.526 ± 0.037
Sigma 1.22 ± 0.05


hEDEPI9
Entries 2791
Mean −4.306
RMS 1.296
χ² / ndf 31.77 / 32
Prob 0.4784
Constant 90.65 ± 2.56
Mean −4.47 ± 0.04
Sigma 1.134 ± 0.039

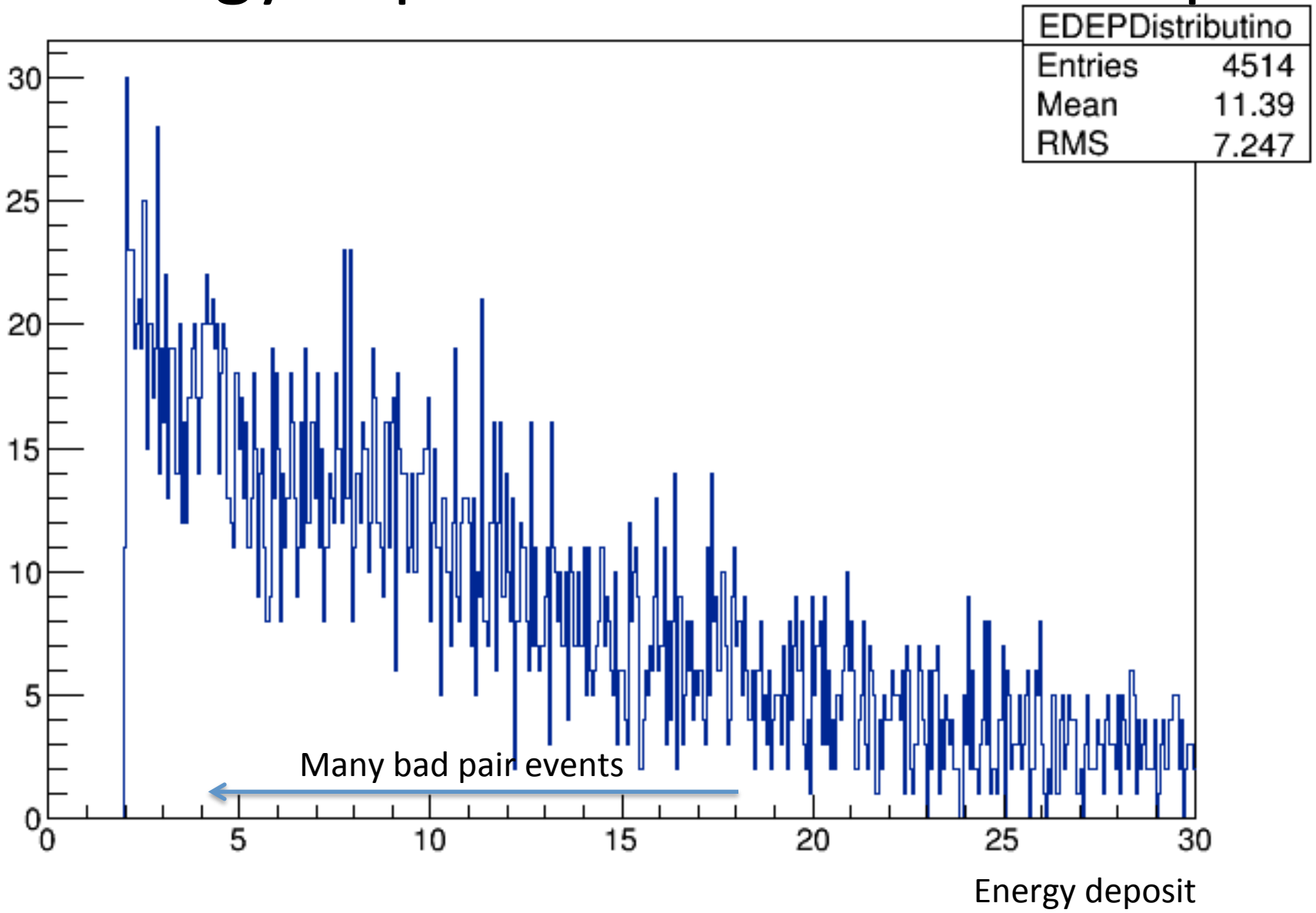
MC without Resolution of MB

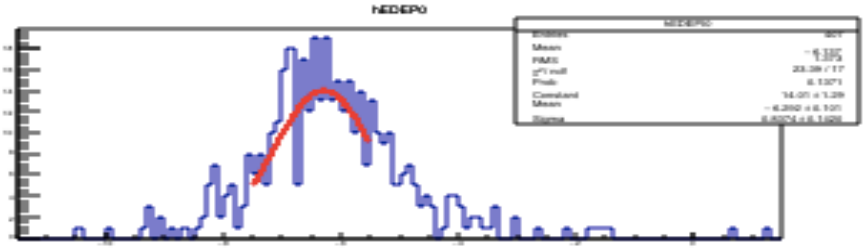
- Even if Barrel Resolution is 0, resolution of Vertex Time Difference is dependent on Barrel deposit energy
  - Does barrel deposit energy selection affect CsI selection?

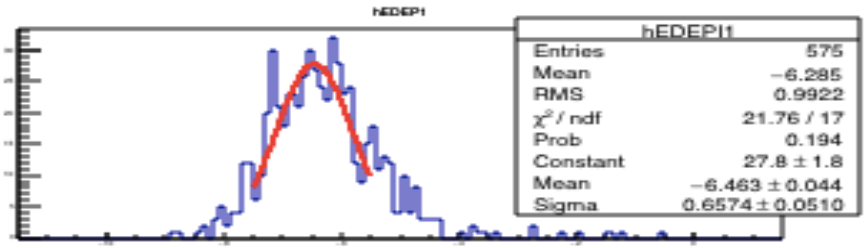


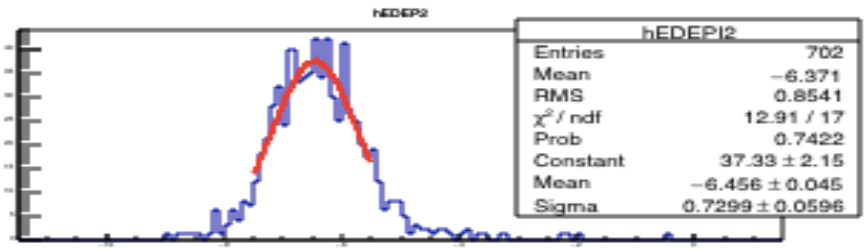


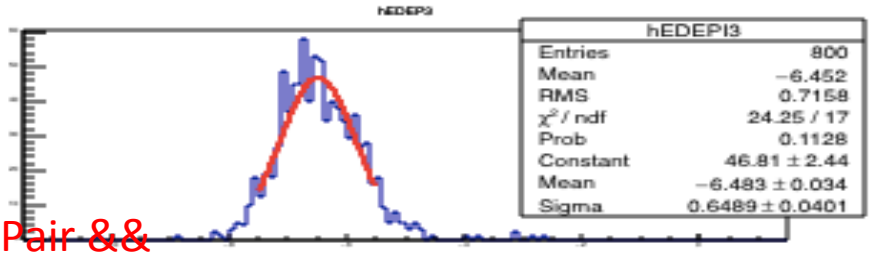
Energy deposit in the case of bad pair



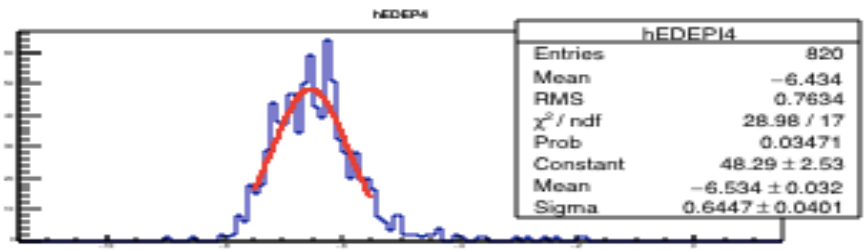


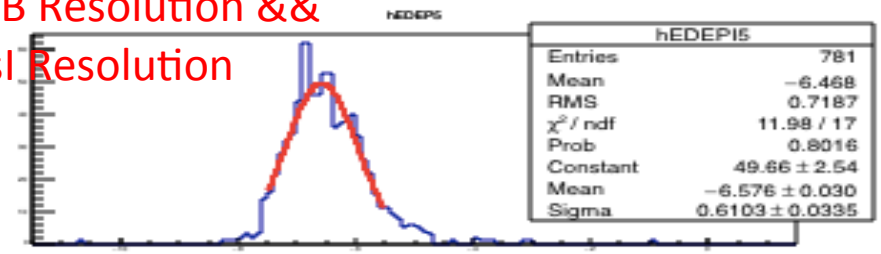


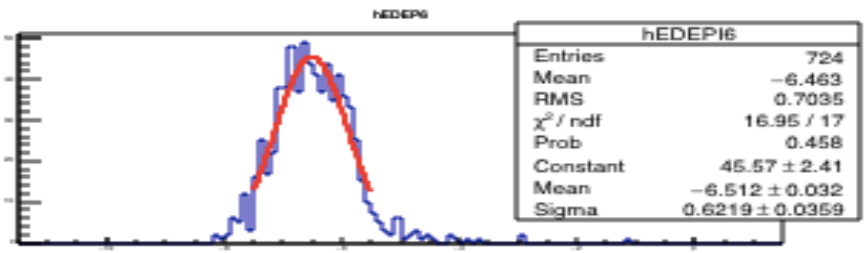


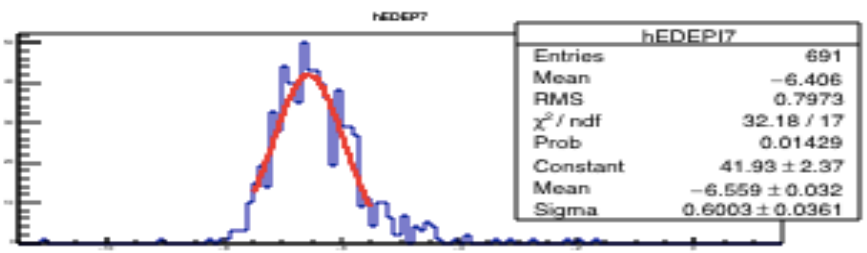


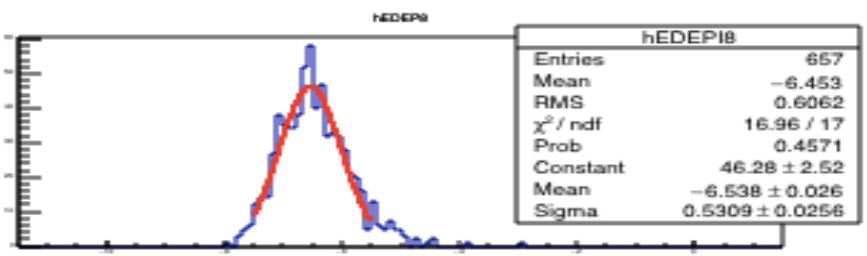
Good Pair &&
No MB Resolution &&
No CsI Resolution

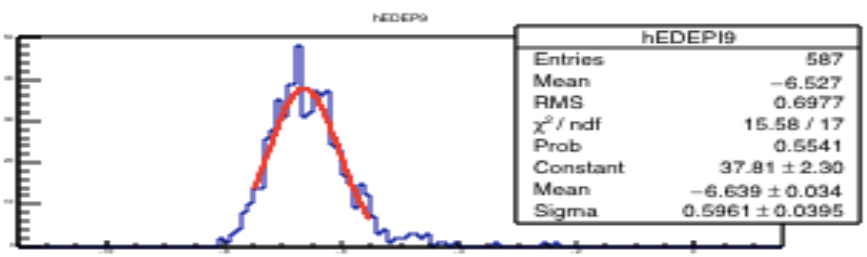








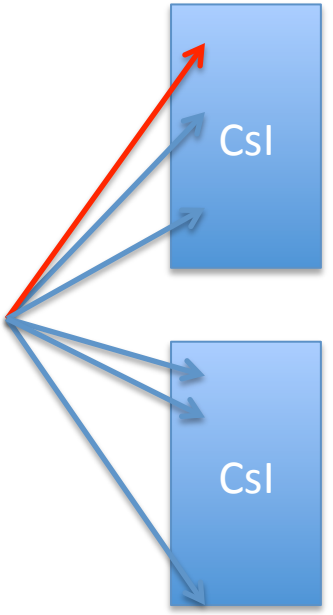




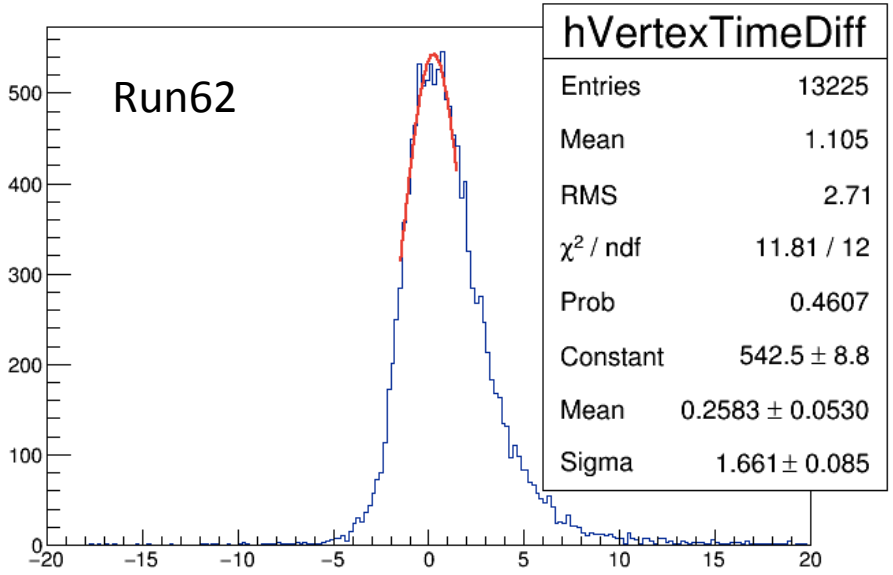
CsI resolution effect

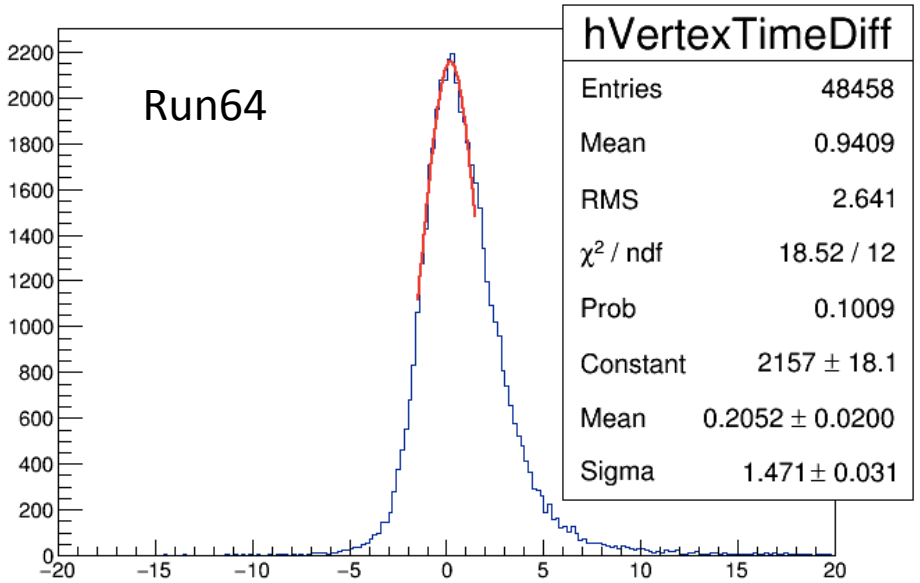
- Vertex Time difference in 6g
- 6g yield dependency on time resolution
- Cases
  - Run62(bad calib.), Run64(good calib.), MC default(overestimated), MC with no CsI resolution
- 6g yield
  - MC default : 53420
  - MC with no smearing : 53681

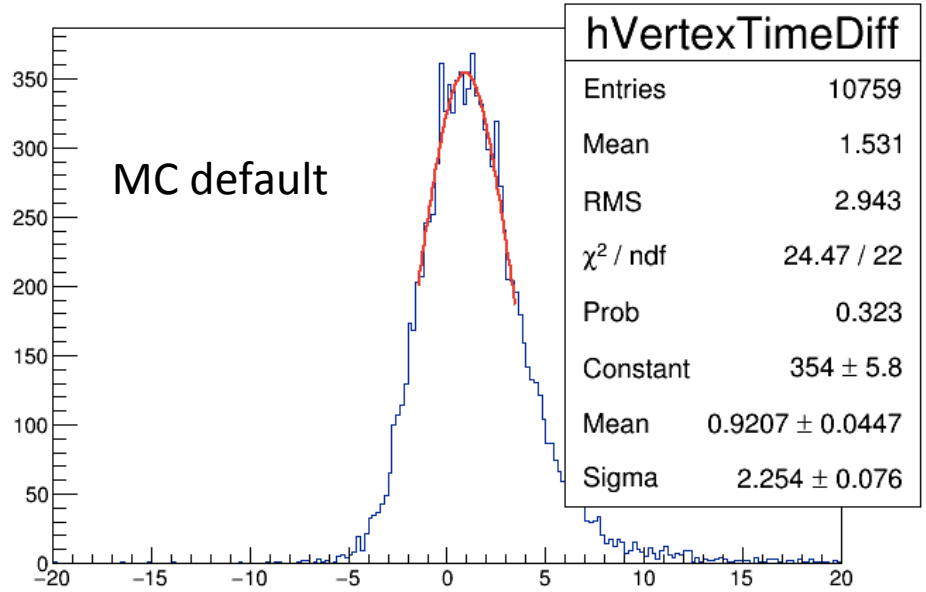
Vertex Time Difference = VertexTime(Red) – MeanVertexTime(Blue)

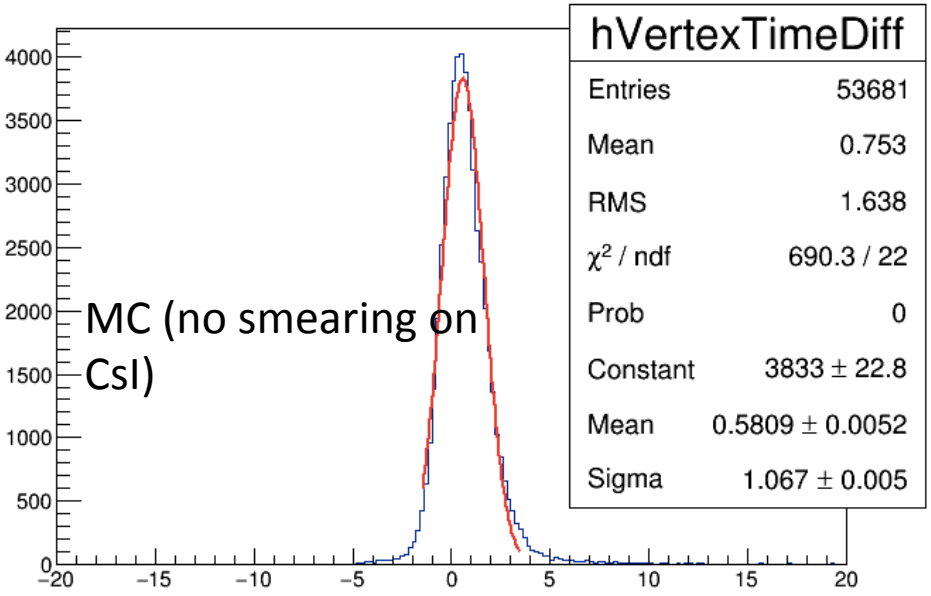


Vertex time difference in 6g





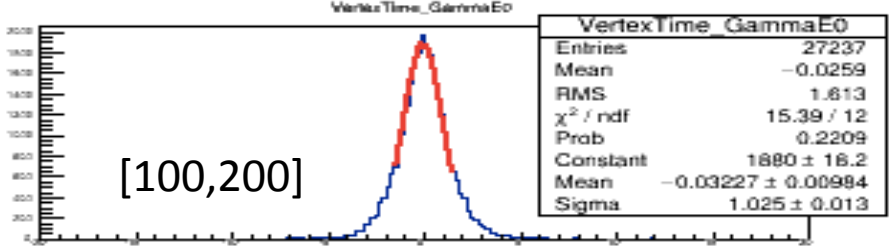




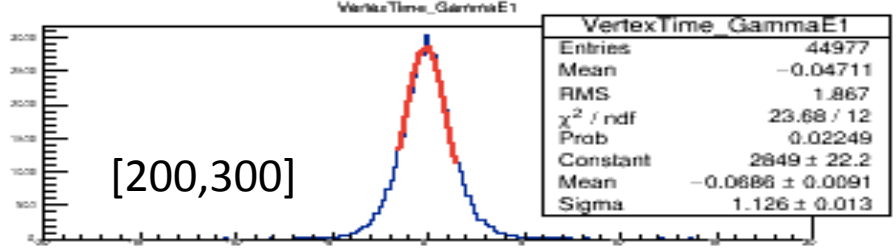
Gamma Reconstruction dependency on Gamma Energy

- Vertex Time Difference between two gammas
- No Smearing on CsI for this study
- Condition
  - $100<GammaE_i<200$ && $100<GammaE_j<200$ .. [MeV]
  - [100,200], [200,300] ….
- High Gamma Energy -> Large Sigma of gaussian

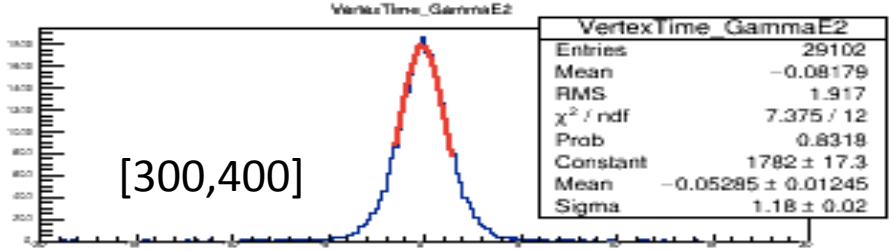
[100,200]



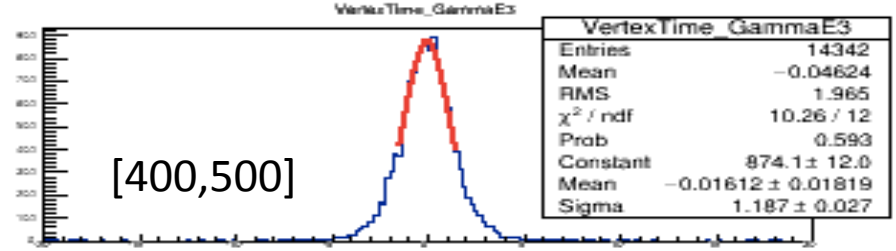
[200,300]



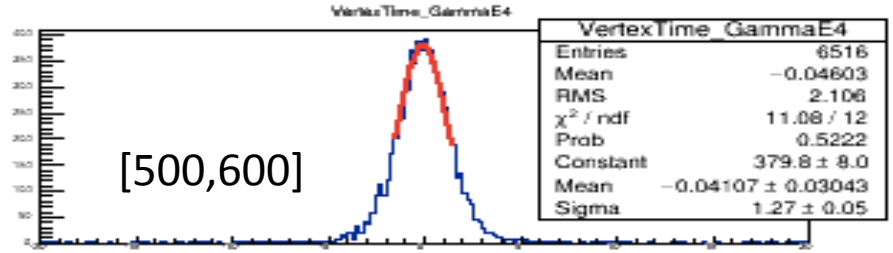
[300,400]



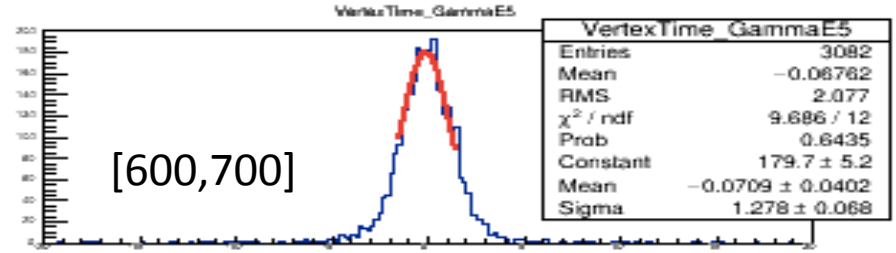
[400,500]



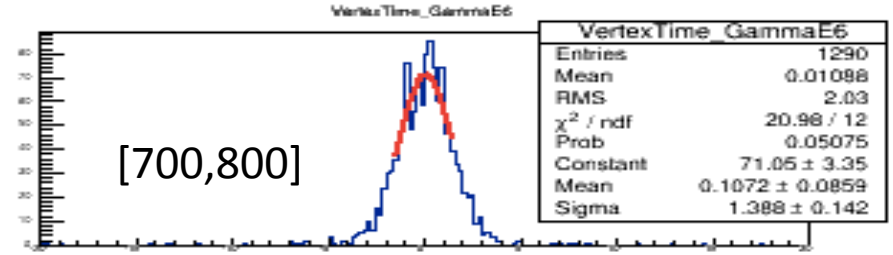
[500,600]



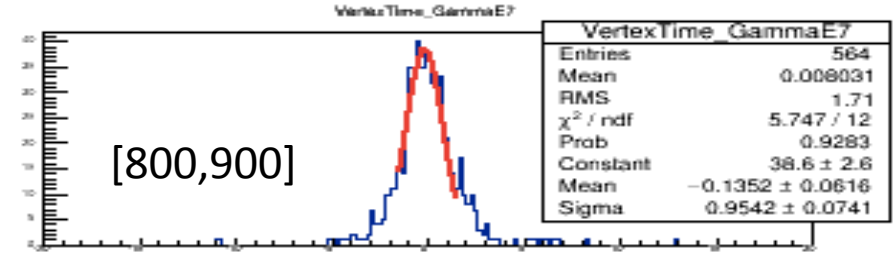
[600,700]



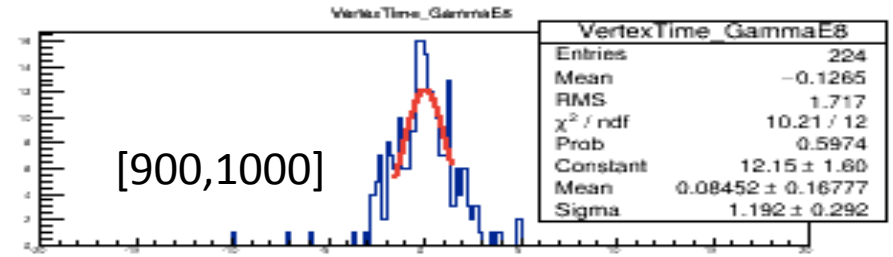
[700,800]



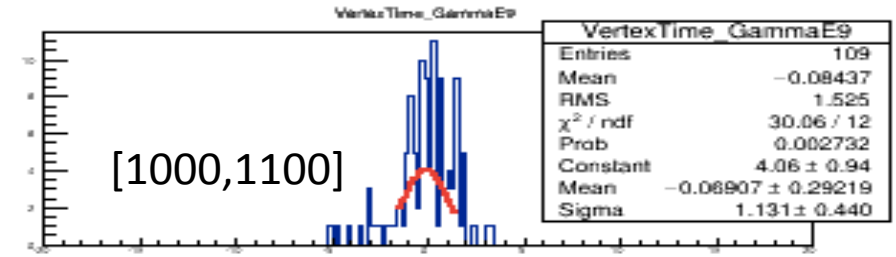
[800,900]



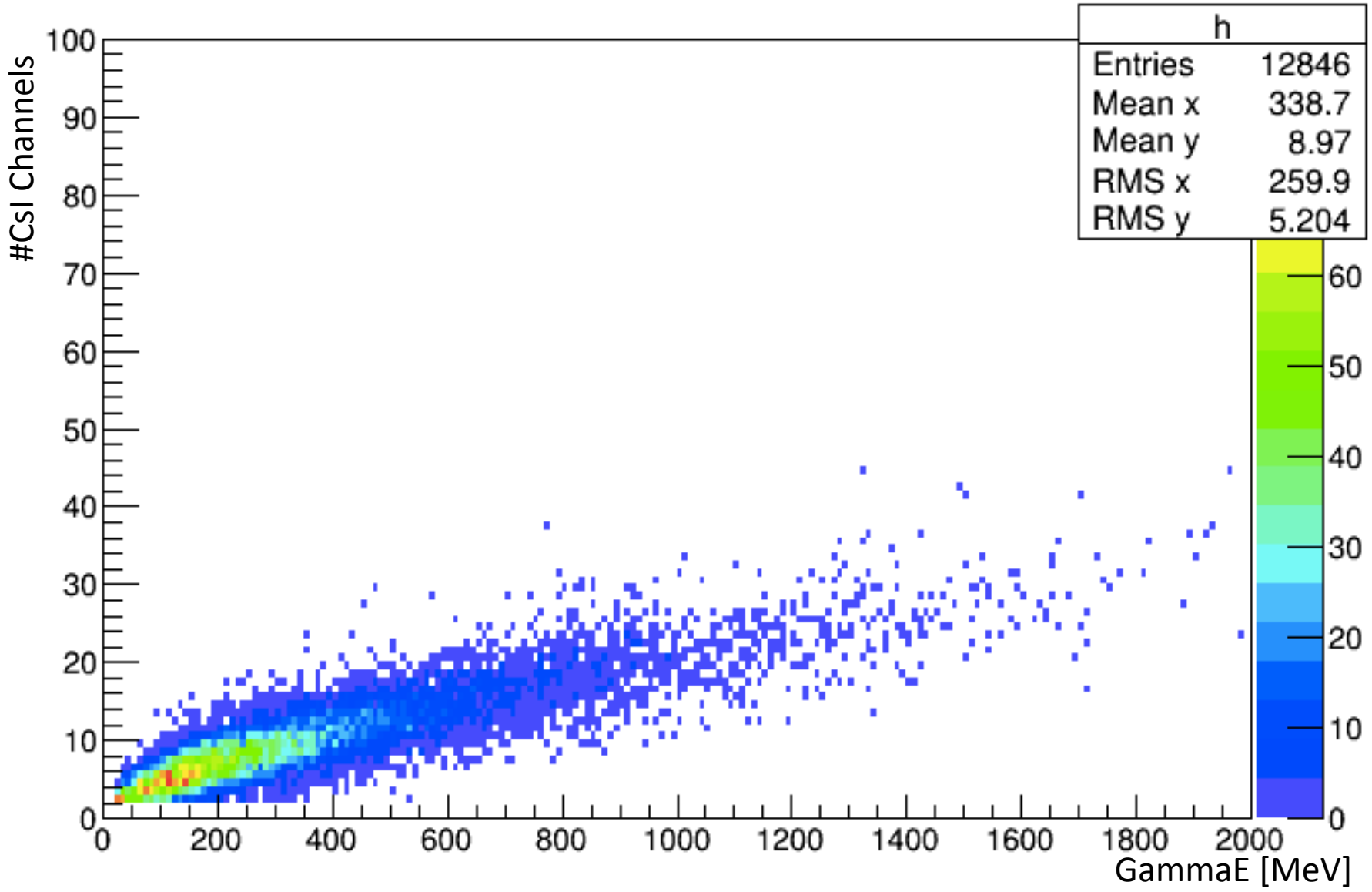
[900,1000]

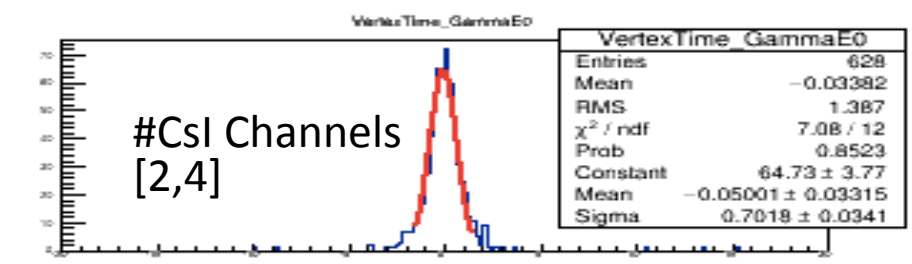


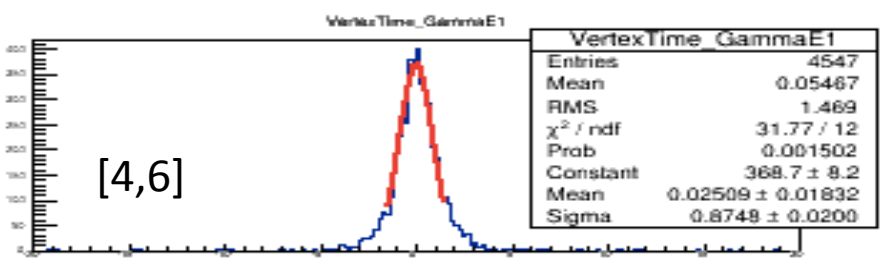
[1000,1100]

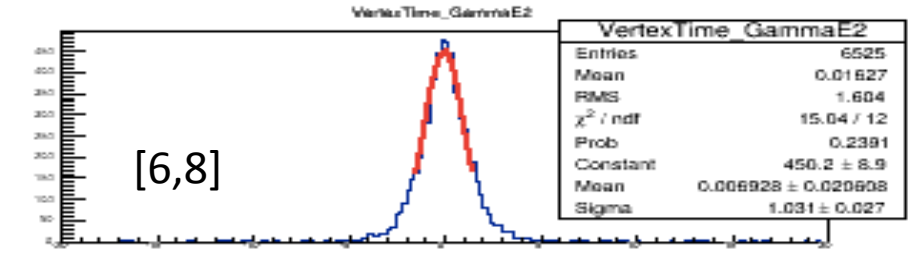


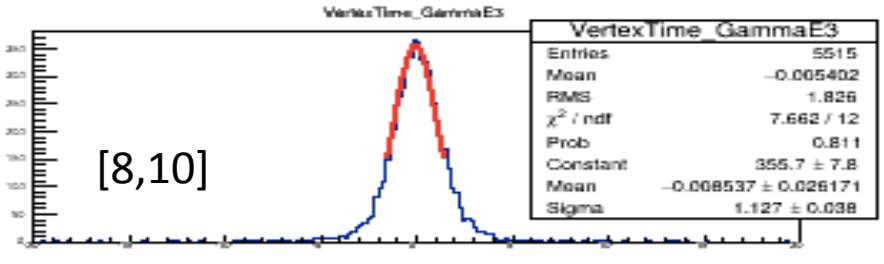
With Regard to #CsI Channels

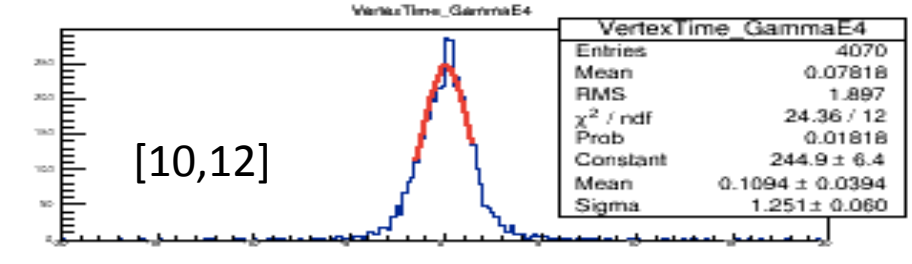


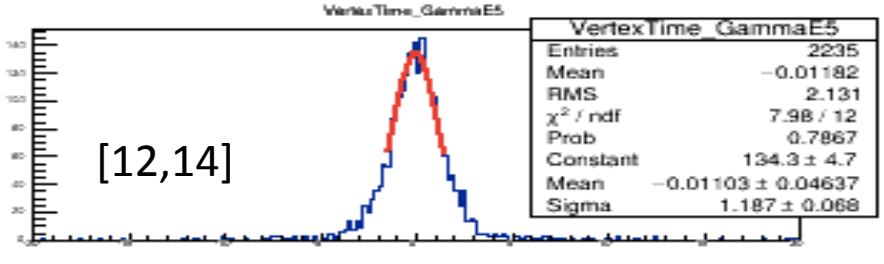

#CsI Channels
[2,4]
VertexTime_GammaE0
Entries 628
Mean −0.03382
RMS 1.387
χ² / ndf 7.08 / 12
Prob 0.8523
Constant 64.73 ± 3.77
Mean −0.05001 ± 0.03315
Sigma 0.7018 ± 0.0341

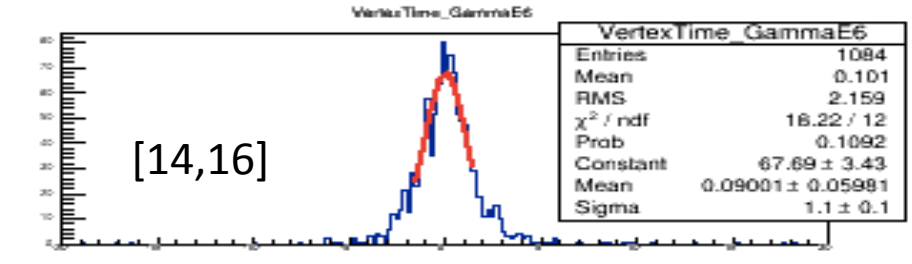

[4,6]
VertexTime_GammaE1
Entries 4547
Mean 0.05467
RMS 1.469
χ² / ndf 31.77 / 12
Prob 0.001502
Constant 368.7 ± 8.2
Mean 0.02509 ± 0.01832
Sigma 0.8748 ± 0.0200

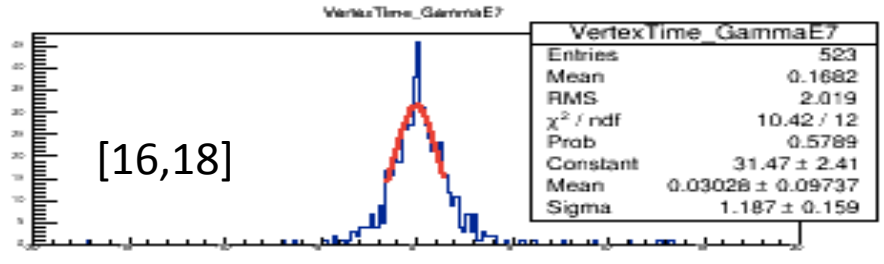

[6,8]
VertexTime_GammaE2
Entries 6525
Mean 0.01627
RMS 1.604
χ² / ndf 15.04 / 12
Prob 0.2391
Constant 450.2 ± 8.9
Mean 0.006928 ± 0.020608
Sigma 1.031 ± 0.027

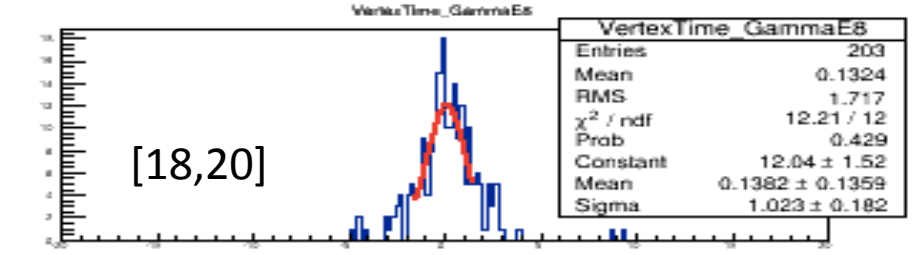

[8,10]
VertexTime_GammaE3
Entries 5515
Mean −0.005402
RMS 1.826
χ² / ndf 7.662 / 12
Prob 0.811
Constant 355.7 ± 7.8
Mean −0.008537 ± 0.026171
Sigma 1.127 ± 0.038

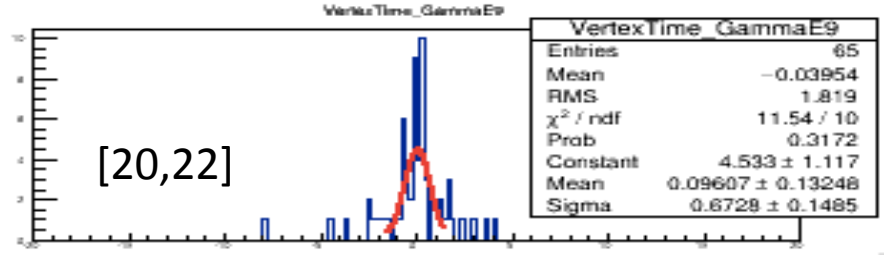

[10,12]
VertexTime_GammaE4
Entries 4070
Mean 0.07818
RMS 1.897
χ² / ndf 24.36 / 12
Prob 0.01818
Constant 244.9 ± 6.4
Mean 0.1094 ± 0.0394
Sigma 1.251 ± 0.060


[12,14]
VertexTime_GammaE5
Entries 2235
Mean −0.01182
RMS 2.131
χ² / ndf 7.98 / 12
Prob 0.7867
Constant 134.3 ± 4.7
Mean −0.01103 ± 0.04637
Sigma 1.187 ± 0.068


[14,16]
VertexTime_GammaE6
Entries 1084
Mean 0.101
RMS 2.159
χ² / ndf 18.22 / 12
Prob 0.1092
Constant 67.69 ± 3.43
Mean 0.09001 ± 0.05981
Sigma 1.1 ± 0.1

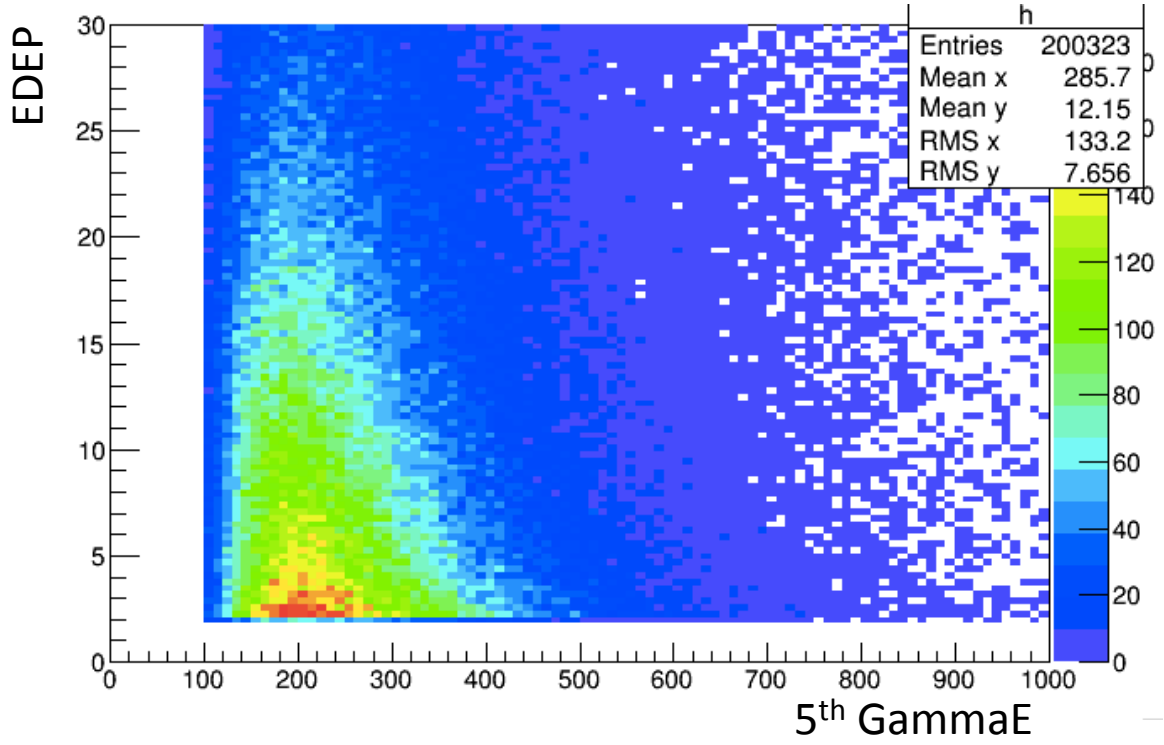

[16,18]
VertexTime_GammaE7
Entries 523
Mean 0.1682
RMS 2.019
χ² / ndf 10.42 / 12
Prob 0.5789
Constant 31.47 ± 2.41
Mean 0.03028 ± 0.09737
Sigma 1.187 ± 0.159

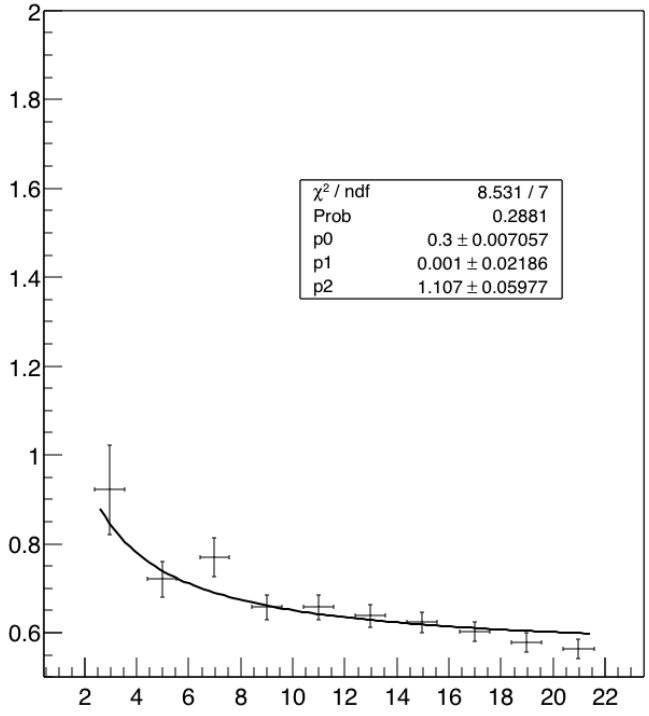

[18,20]
VertexTime_GammaE8
Entries 203
Mean 0.1324
RMS 1.717
χ² / ndf 12.21 / 12
Prob 0.429
Constant 12.04 ± 1.52
Mean 0.1382 ± 0.1359
Sigma 1.023 ± 0.182


[20,22]
VertexTime_GammaE9
Entries 65
Mean −0.03954
RMS 1.819
χ² / ndf 11.54 / 10
Prob 0.3172
Constant 4.533 ± 1.117
Mean 0.09607 ± 0.13248
Sigma 0.6729 ± 0.1485

Brief summary

- Low energy deposit selection ->
- Low energy photon selection on barrel ->
- High energy photon selection on CsI ->
- Worse quality of Gamma Reconstruction





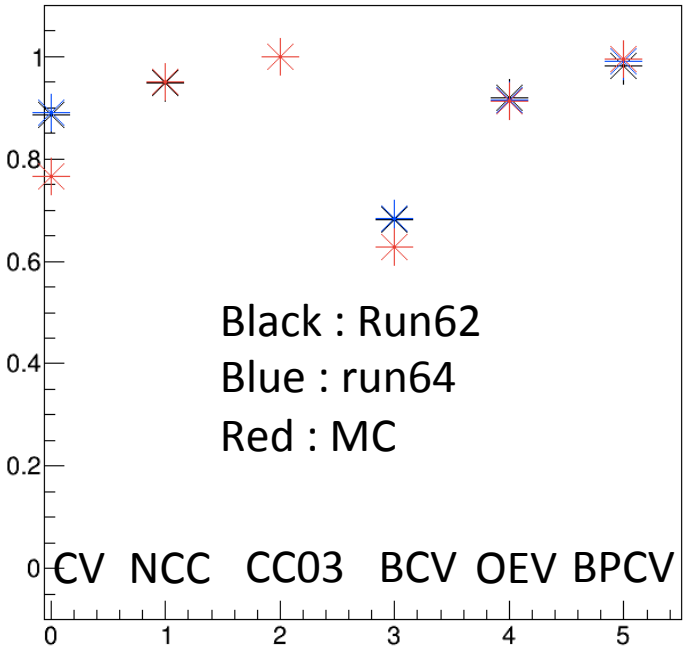
P.O.T.

With 3.6e7 #KL = 2e14 POT

- Run62 : 1.39e18
  - /300 = 4.63e15 -> 8.33e8
  - # KL3pi0 reconstructed : 9110
- Run64 : 4.38e18
  - /300 = 1.46e16 -> 2.63e9
  - # KL3pi0 reconstructed : 31347 (9941)
- Run69 : 5.21e17
  - /70 = 7.44e15 -> 1.34e9
  - # KL3pi0 reconstructed : 12799 (7950)
- MC Generation
  - KL3pi0 Gen : 1e6*2000
  - #KL ~ 5.13*1e6*2000 = 1.03e10
  - # KL3pi0 reconstructed : 132659 (10729)

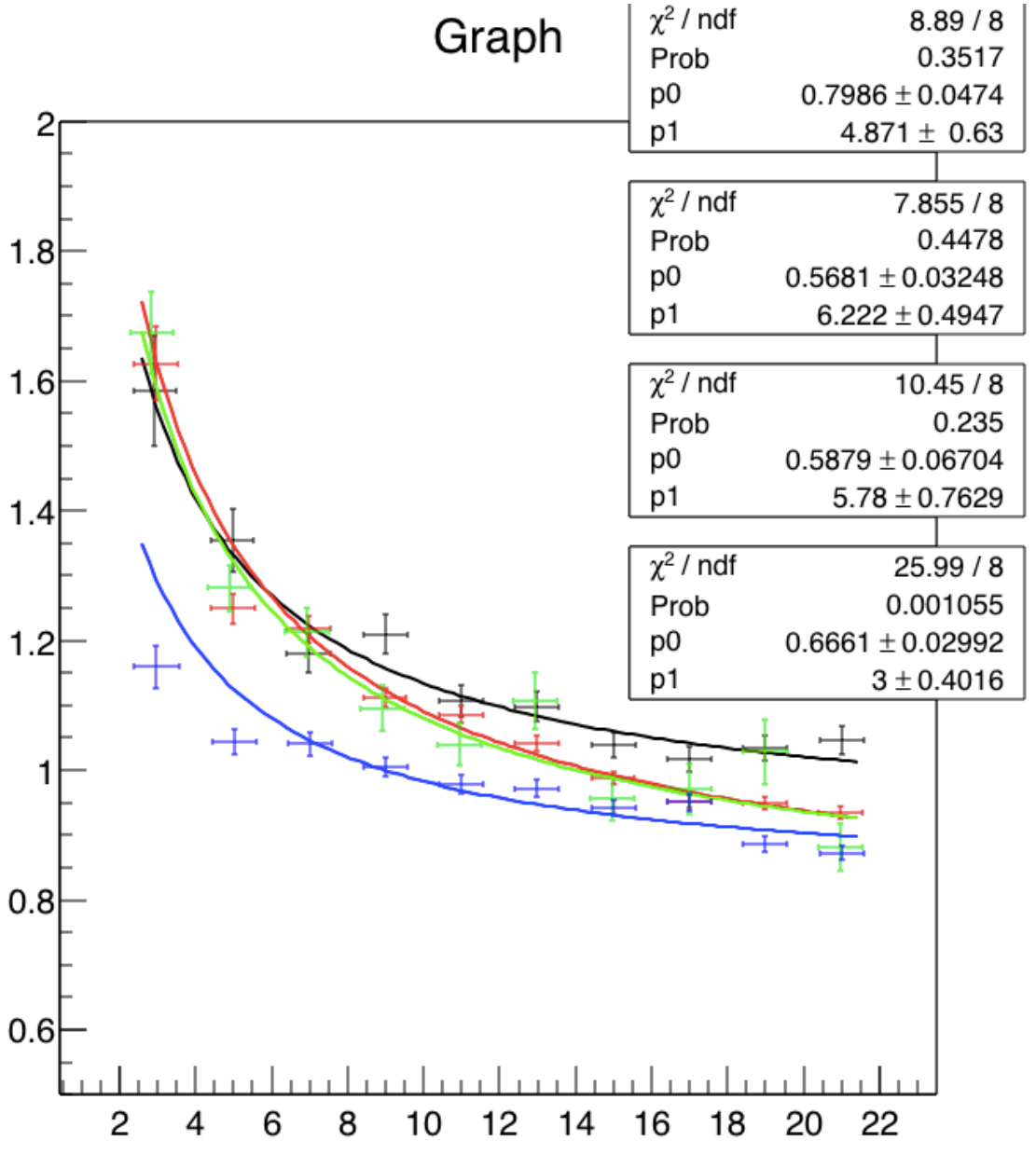
POT -> #KL

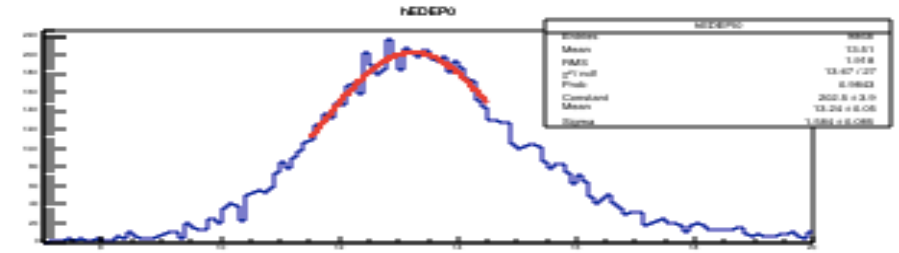
Single Veto Efficiency

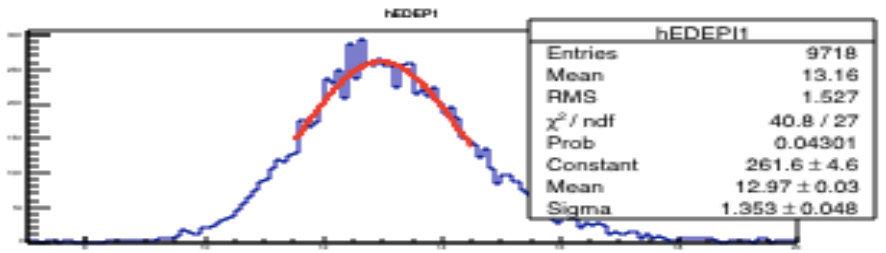


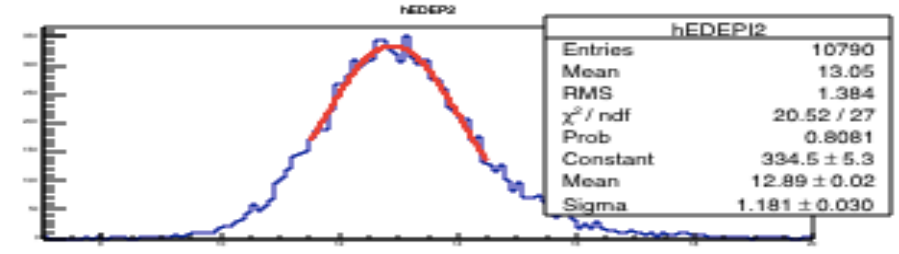
With Function 1, data check

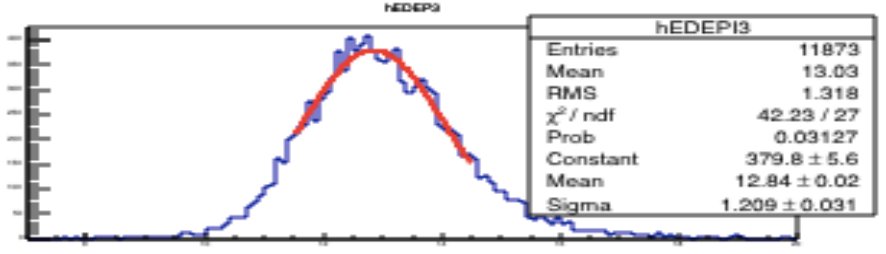
- Black
  - Run62
- Red
  - Run64
- Green
  - Run69 MB
- Blue
  - Run69 IB

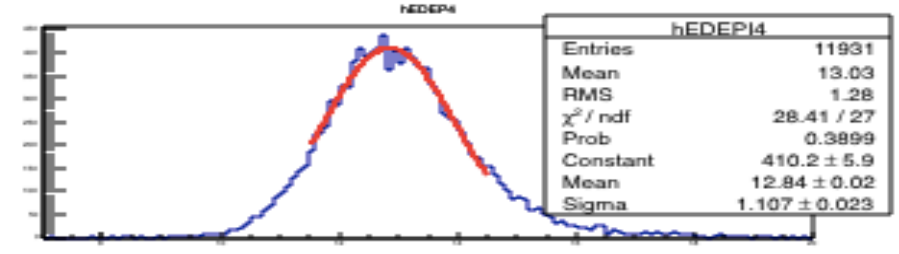


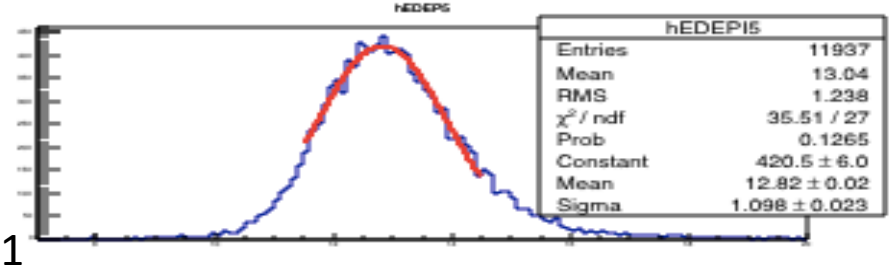

hEDEPI0


hEDEPI1
Entries 9718
Mean 13.16
RMS 1.527
χ² / ndf 40.8 / 27
Prob 0.04301
Constant 261.6 ± 4.6
Mean 12.97 ± 0.03
Sigma 1.353 ± 0.048

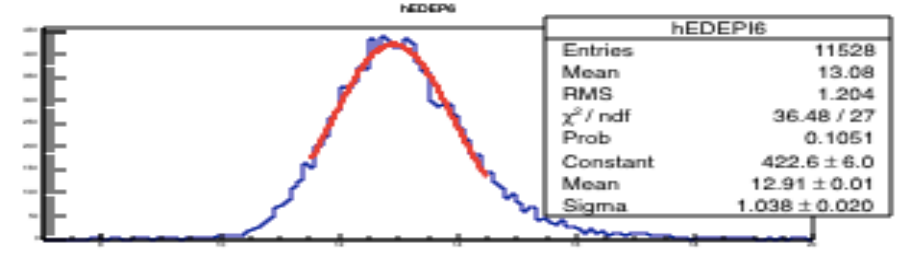

hEDEPI2
Entries 10790
Mean 13.05
RMS 1.384
χ² / ndf 20.52 / 27
Prob 0.8081
Constant 334.5 ± 5.3
Mean 12.89 ± 0.02
Sigma 1.181 ± 0.030

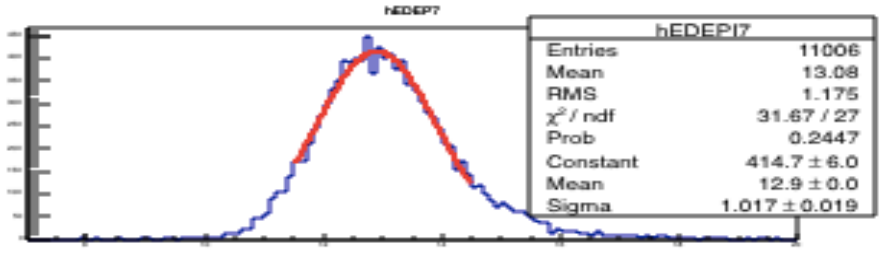

hEDEPI3
Entries 11873
Mean 13.03
RMS 1.318
χ² / ndf 42.23 / 27
Prob 0.03127
Constant 379.8 ± 5.6
Mean 12.84 ± 0.02
Sigma 1.209 ± 0.031

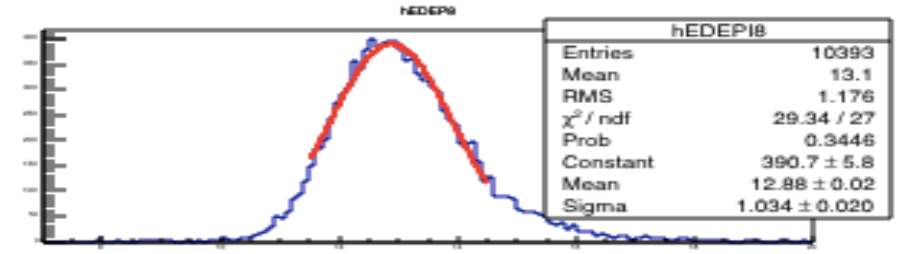

hEDEPI4
Entries 11931
Mean 13.03
RMS 1.28
χ² / ndf 28.41 / 27
Prob 0.3899
Constant 410.2 ± 5.9
Mean 12.84 ± 0.02
Sigma 1.107 ± 0.023

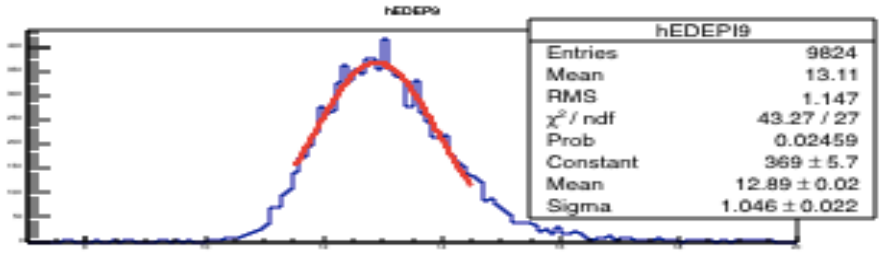

hEDEPI5
Entries 11937
Mean 13.04
RMS 1.238
χ² / ndf 35.51 / 27
Prob 0.1265
Constant 420.5 ± 6.0
Mean 12.82 ± 0.02
Sigma 1.098 ± 0.023

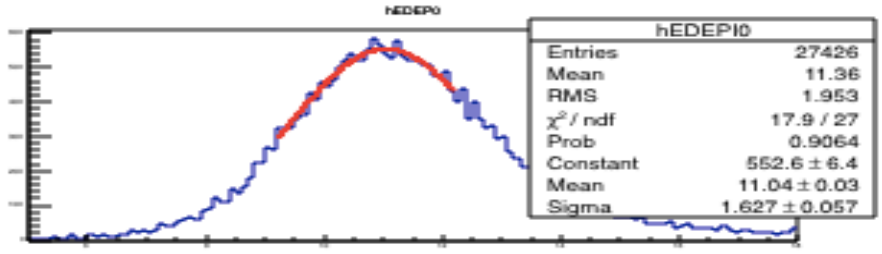
CASE1

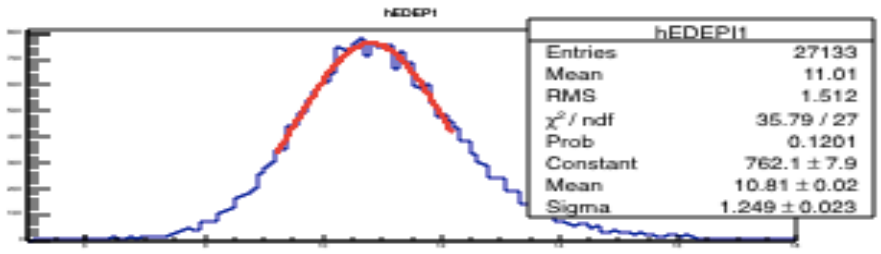

hEDEPI6
Entries 11528
Mean 13.08
RMS 1.204
χ² / ndf 36.48 / 27
Prob 0.1051
Constant 422.6 ± 6.0
Mean 12.91 ± 0.01
Sigma 1.038 ± 0.020

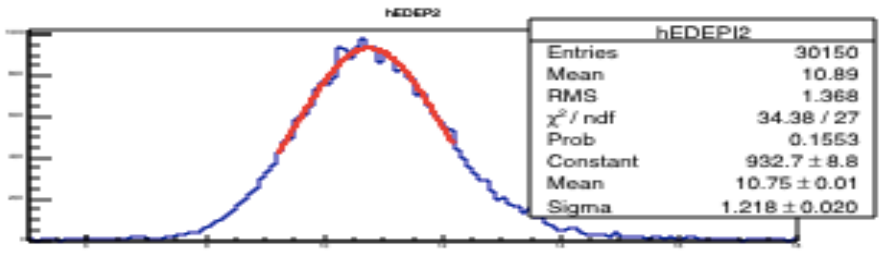

hEDEPI7
Entries 11006
Mean 13.08
RMS 1.175
χ² / ndf 31.67 / 27
Prob 0.2447
Constant 414.7 ± 6.0
Mean 12.9 ± 0.0
Sigma 1.017 ± 0.019

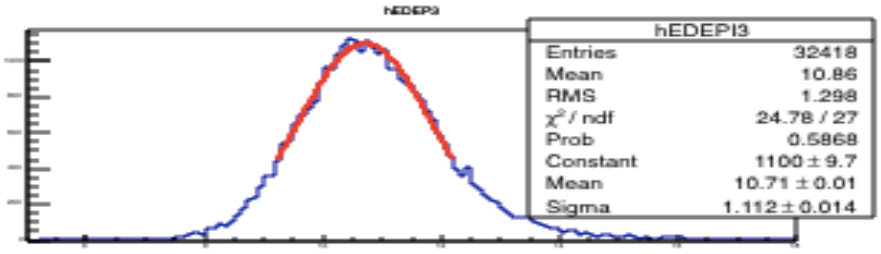

hEDEPI8
Entries 10393
Mean 13.1
RMS 1.176
χ² / ndf 29.34 / 27
Prob 0.3446
Constant 390.7 ± 5.8
Mean 12.88 ± 0.02
Sigma 1.034 ± 0.020

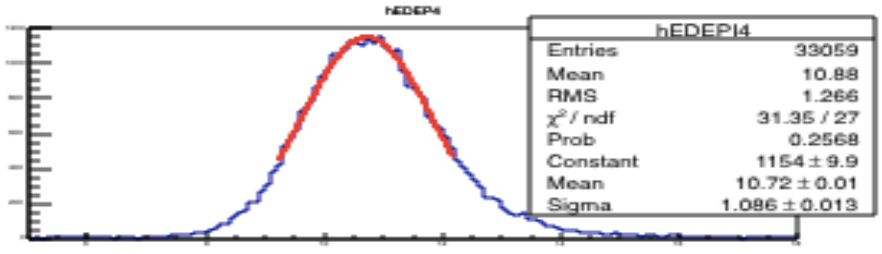

hEDEPI9
Entries 9824
Mean 13.11
RMS 1.147
χ² / ndf 43.27 / 27
Prob 0.02459
Constant 369 ± 5.7
Mean 12.89 ± 0.02
Sigma 1.046 ± 0.022

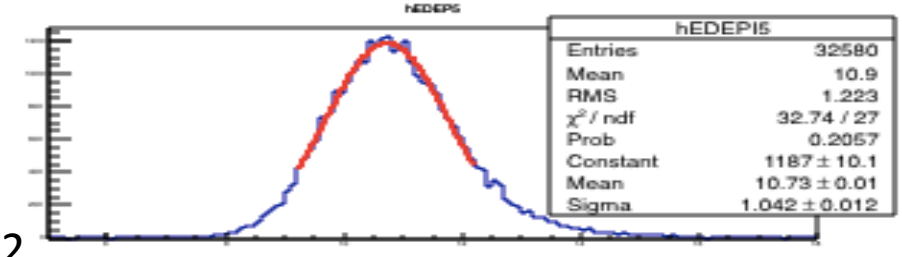

hEDEPI0
Entries 27426
Mean 11.36
RMS 1.953
χ² / ndf 17.9 / 27
Prob 0.9064
Constant 552.6 ± 6.4
Mean 11.04 ± 0.03
Sigma 1.627 ± 0.057


hEDEPI1
Entries 27133
Mean 11.01
RMS 1.512
χ² / ndf 35.79 / 27
Prob 0.1201
Constant 762.1 ± 7.9
Mean 10.81 ± 0.02
Sigma 1.249 ± 0.023

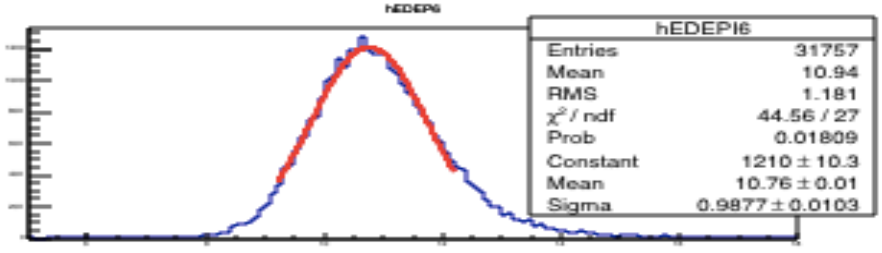

hEDEPI2
Entries 30150
Mean 10.89
RMS 1.368
χ² / ndf 34.38 / 27
Prob 0.1553
Constant 932.7 ± 8.8
Mean 10.75 ± 0.01
Sigma 1.218 ± 0.020

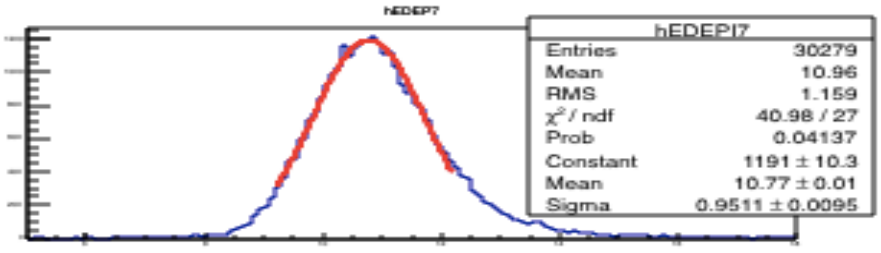

hEDEPI3
Entries 32418
Mean 10.86
RMS 1.298
χ² / ndf 24.78 / 27
Prob 0.5868
Constant 1100 ± 9.7
Mean 10.71 ± 0.01
Sigma 1.112 ± 0.014

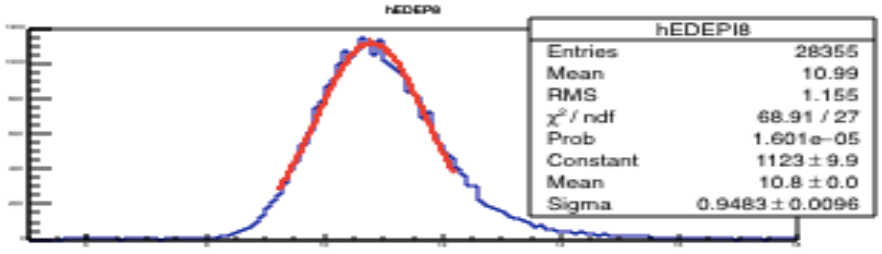

hEDEPI4
Entries 33059
Mean 10.88
RMS 1.266
χ² / ndf 31.35 / 27
Prob 0.2568
Constant 1154 ± 9.9
Mean 10.72 ± 0.01
Sigma 1.086 ± 0.013

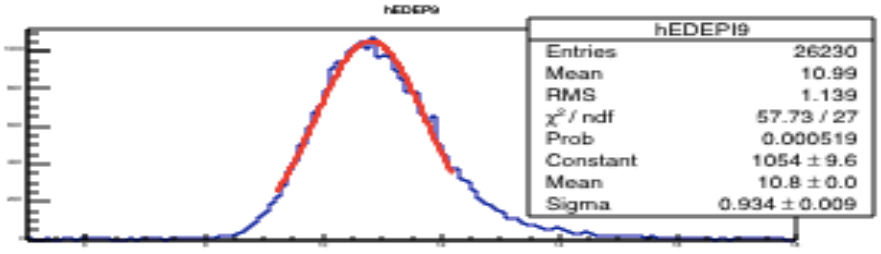

hEDEPI5
Entries 32580
Mean 10.9
RMS 1.223
χ² / ndf 32.74 / 27
Prob 0.2057
Constant 1187 ± 10.1
Mean 10.73 ± 0.01
Sigma 1.042 ± 0.012

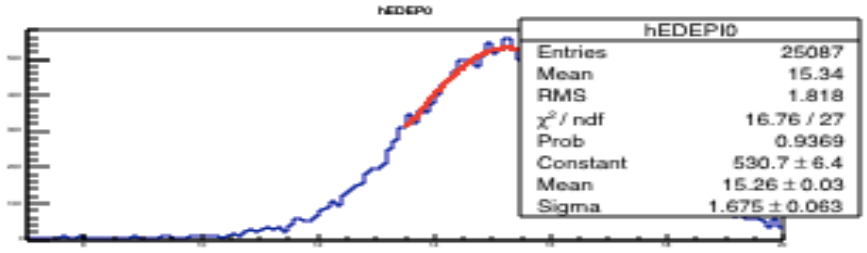
CASE2

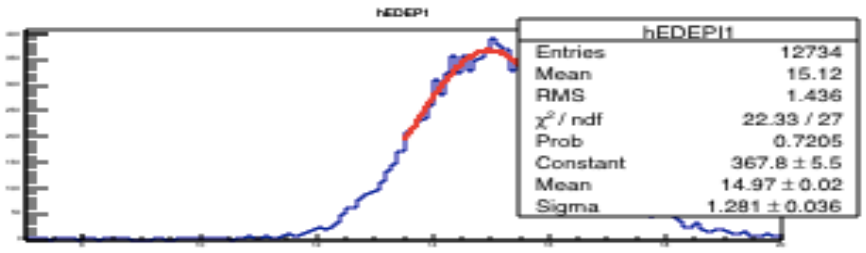

hEDEPI6
Entries 31757
Mean 10.94
RMS 1.181
χ² / ndf 44.56 / 27
Prob 0.01809
Constant 1210 ± 10.3
Mean 10.76 ± 0.01
Sigma 0.9877 ± 0.0103

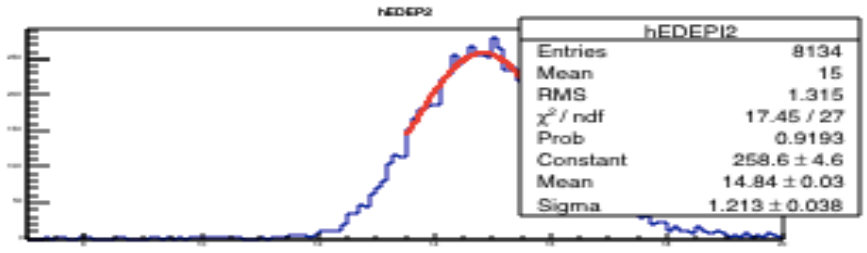

hEDEPI7
Entries 30279
Mean 10.96
RMS 1.159
χ² / ndf 40.98 / 27
Prob 0.04137
Constant 1191 ± 10.3
Mean 10.77 ± 0.01
Sigma 0.9511 ± 0.0095

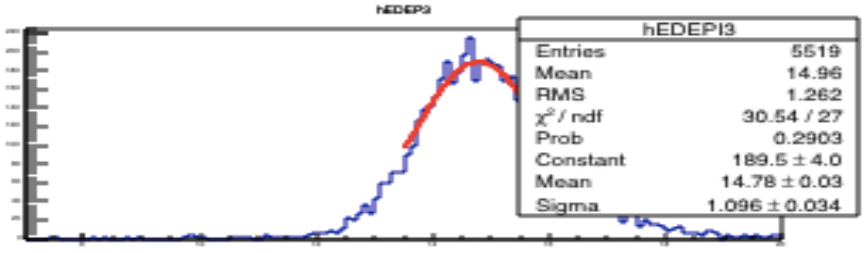

hEDEPI8
Entries 28355
Mean 10.99
RMS 1.155
χ² / ndf 68.91 / 27
Prob 1.601e−05
Constant 1123 ± 9.9
Mean 10.8 ± 0.0
Sigma 0.9483 ± 0.0096

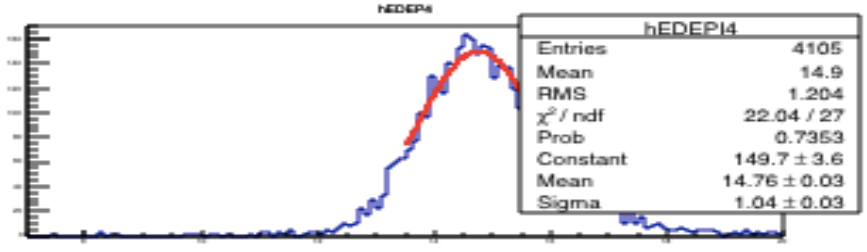

hEDEPI9
Entries 26230
Mean 10.99
RMS 1.139
χ² / ndf 57.73 / 27
Prob 0.000519
Constant 1054 ± 9.6
Mean 10.8 ± 0.0
Sigma 0.934 ± 0.009

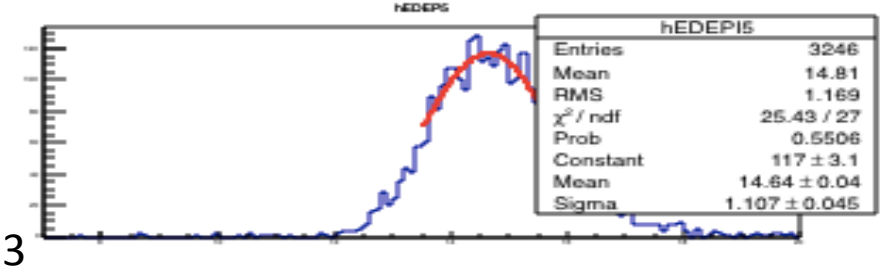

hEDEPI0
Entries 25087
Mean 15.34
RMS 1.818
χ² / ndf 16.76 / 27
Prob 0.9369
Constant 530.7 ± 6.4
Mean 15.26 ± 0.03
Sigma 1.675 ± 0.063


hEDEPI1
Entries 12734
Mean 15.12
RMS 1.436
χ² / ndf 22.33 / 27
Prob 0.7205
Constant 367.8 ± 5.5
Mean 14.97 ± 0.02
Sigma 1.281 ± 0.036

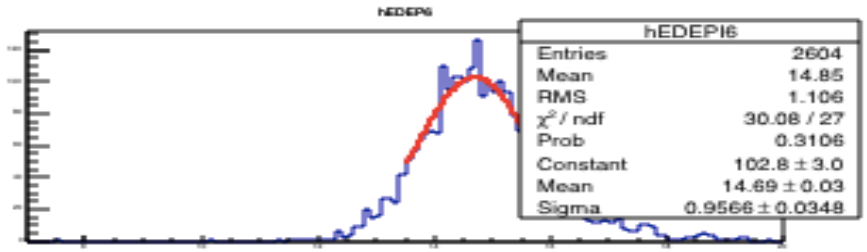

hEDEPI2
Entries 8134
Mean 15
RMS 1.315
χ² / ndf 17.45 / 27
Prob 0.9193
Constant 258.6 ± 4.6
Mean 14.84 ± 0.03
Sigma 1.213 ± 0.038

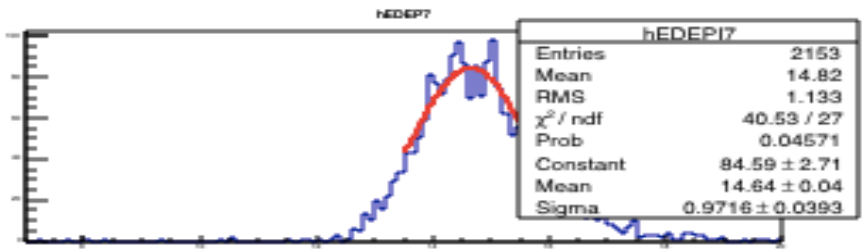

hEDEPI3
Entries 5519
Mean 14.96
RMS 1.262
χ² / ndf 30.54 / 27
Prob 0.2903
Constant 189.5 ± 4.0
Mean 14.78 ± 0.03
Sigma 1.096 ± 0.034

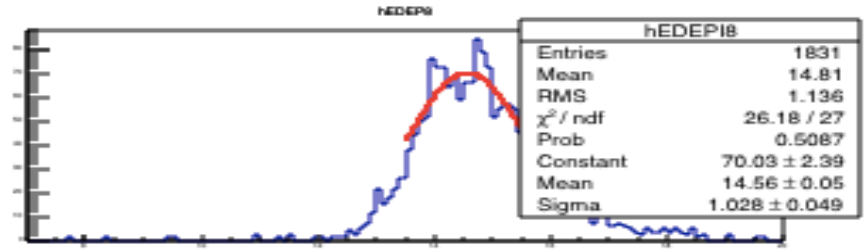

hEDEPI4
Entries 4105
Mean 14.9
RMS 1.204
χ² / ndf 22.04 / 27
Prob 0.7353
Constant 149.7 ± 3.6
Mean 14.76 ± 0.03
Sigma 1.04 ± 0.03

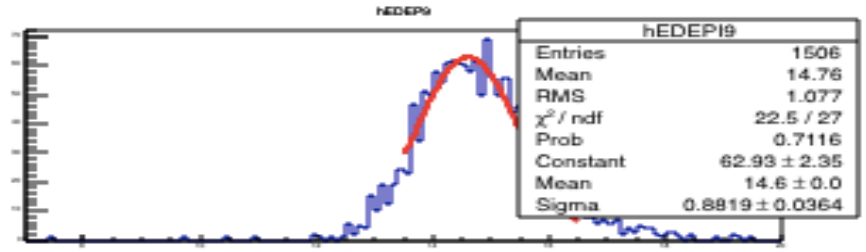

hEDEPI5
Entries 3246
Mean 14.81
RMS 1.169
χ² / ndf 25.43 / 27
Prob 0.5506
Constant 117 ± 3.1
Mean 14.64 ± 0.04
Sigma 1.107 ± 0.045

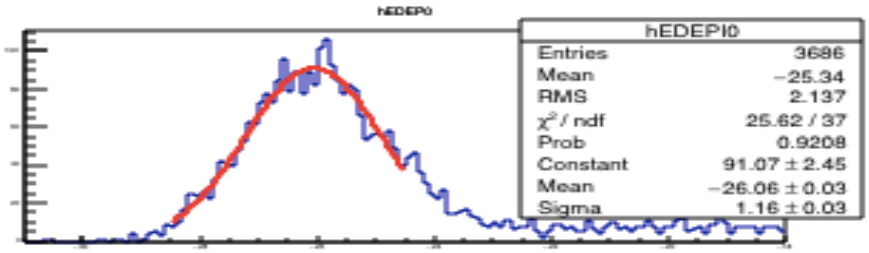
CASE3

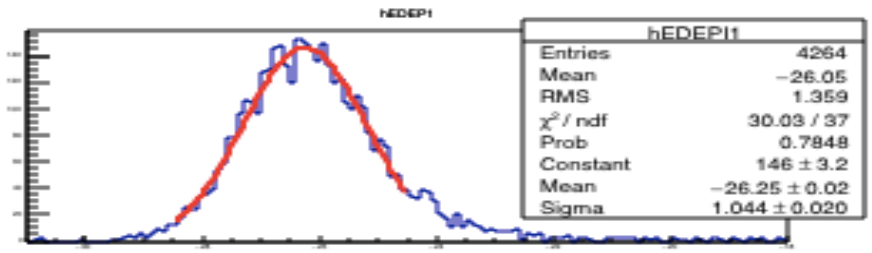

hEDEPI6
Entries 2604
Mean 14.85
RMS 1.106
χ² / ndf 30.08 / 27
Prob 0.3106
Constant 102.8 ± 3.0
Mean 14.69 ± 0.03
Sigma 0.9566 ± 0.0348

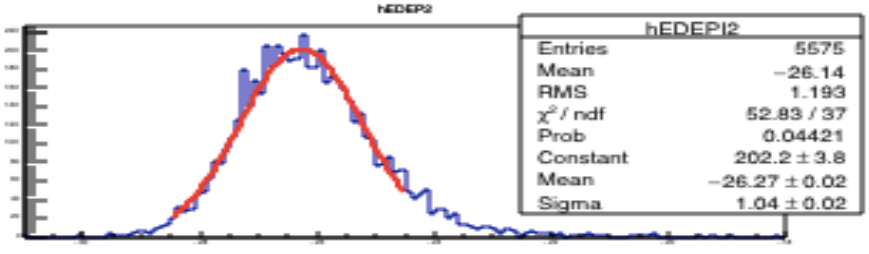

hEDEPI7
Entries 2153
Mean 14.82
RMS 1.133
χ² / ndf 40.53 / 27
Prob 0.04571
Constant 84.59 ± 2.71
Mean 14.64 ± 0.04
Sigma 0.9716 ± 0.0393

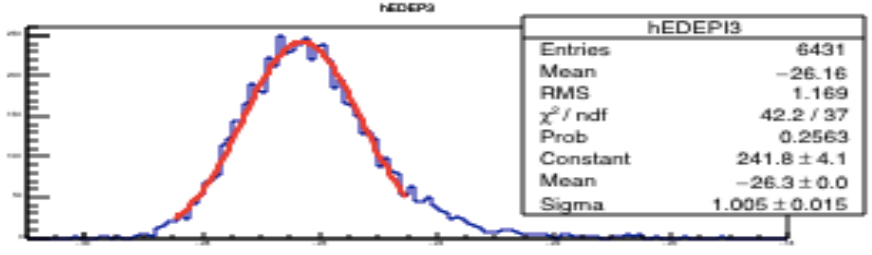

hEDEPI8
Entries 1831
Mean 14.81
RMS 1.136
χ² / ndf 26.18 / 27
Prob 0.5087
Constant 70.03 ± 2.39
Mean 14.56 ± 0.05
Sigma 1.028 ± 0.049

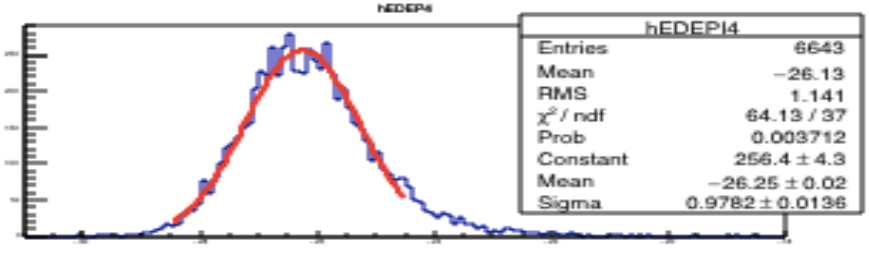

hEDEPI9
Entries 1506
Mean 14.76
RMS 1.077
χ² / ndf 22.5 / 27
Prob 0.7116
Constant 62.93 ± 2.35
Mean 14.6 ± 0.0
Sigma 0.8819 ± 0.0364

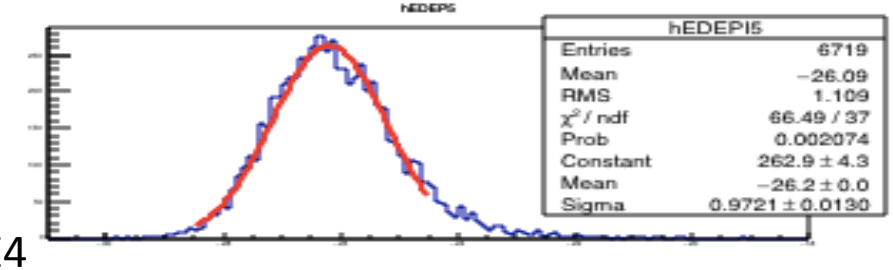

hEDEPI0
Entries 3686
Mean −25.34
RMS 2.137
χ² / ndf 25.62 / 37
Prob 0.9208
Constant 91.07 ± 2.45
Mean −26.06 ± 0.03
Sigma 1.16 ± 0.03


hEDEPI1
Entries 4264
Mean −26.05
RMS 1.359
χ² / ndf 30.03 / 37
Prob 0.7848
Constant 146 ± 3.2
Mean −26.25 ± 0.02
Sigma 1.044 ± 0.020

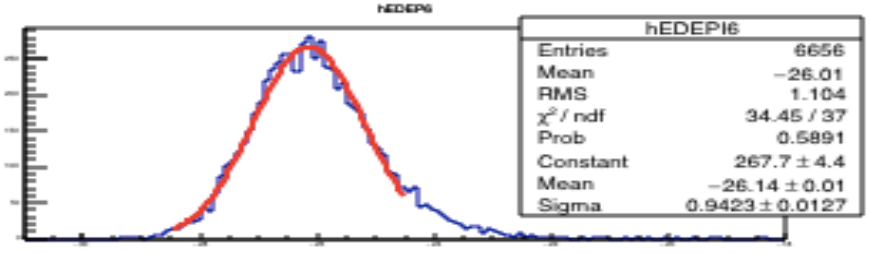

hEDEPI2
Entries 5575
Mean −26.14
RMS 1.193
χ² / ndf 52.83 / 37
Prob 0.04421
Constant 202.2 ± 3.8
Mean −26.27 ± 0.02
Sigma 1.04 ± 0.02

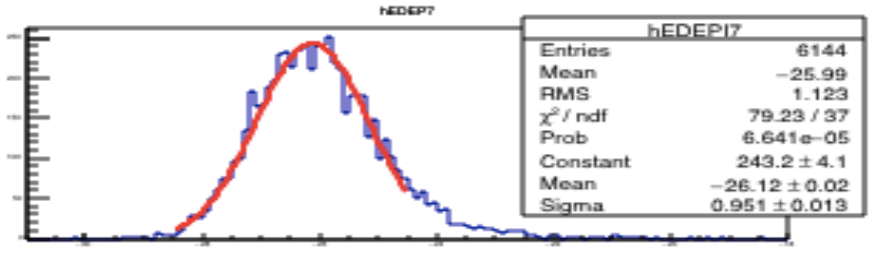

hEDEPI3
Entries 6431
Mean −26.16
RMS 1.169
χ² / ndf 42.2 / 37
Prob 0.2563
Constant 241.8 ± 4.1
Mean −26.3 ± 0.0
Sigma 1.005 ± 0.015

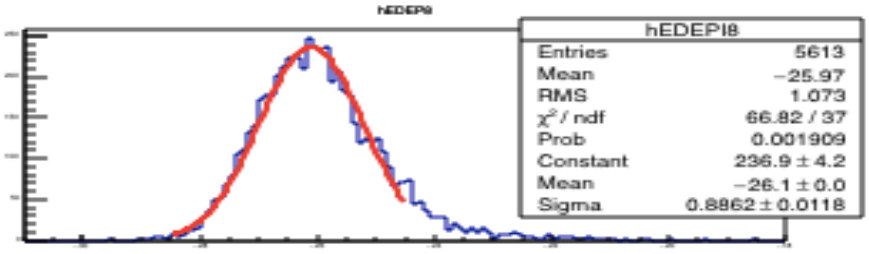

hEDEPI4
Entries 6643
Mean −26.13
RMS 1.141
χ² / ndf 64.13 / 37
Prob 0.003712
Constant 256.4 ± 4.3
Mean −26.25 ± 0.02
Sigma 0.9782 ± 0.0136

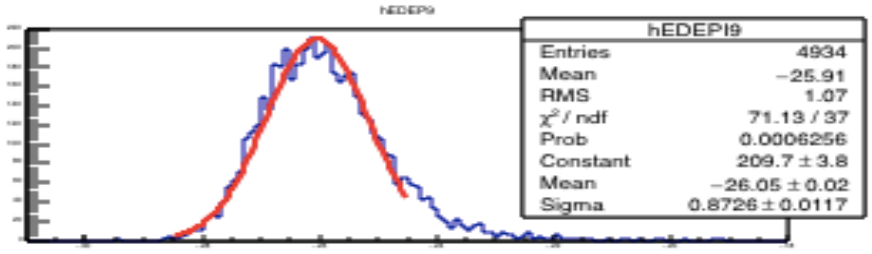

hEDEPI5
Entries 6719
Mean −26.09
RMS 1.109
χ² / ndf 66.49 / 37
Prob 0.002074
Constant 262.9 ± 4.3
Mean −26.2 ± 0.0
Sigma 0.9721 ± 0.0130

CASE4


hEDEPI6
Entries 6656
Mean −26.01
RMS 1.104
χ² / ndf 34.45 / 37
Prob 0.5891
Constant 267.7 ± 4.4
Mean −26.14 ± 0.01
Sigma 0.9423 ± 0.0127


hEDEPI7
Entries 6144
Mean −25.99
RMS 1.123
χ² / ndf 79.23 / 37
Prob 6.641e−05
Constant 243.2 ± 4.1
Mean −26.12 ± 0.02
Sigma 0.951 ± 0.013


hEDEPI8
Entries 5613
Mean −25.97
RMS 1.073
χ² / ndf 66.82 / 37
Prob 0.001909
Constant 236.9 ± 4.2
Mean −26.1 ± 0.0
Sigma 0.8862 ± 0.0118


hEDEPI9
Entries 4934
Mean −25.91
RMS 1.07
χ² / ndf 71.13 / 37
Prob 0.0006256
Constant 209.7 ± 3.8
Mean −26.05 ± 0.02
Sigma 0.8726 ± 0.0117

With Function 2, data check

- P0 of Function 1
  - P0 of Function2
- P1 of Function 1
  - = p2^2 of Function2
- P1 of Function 2
  - Too small
  - Range of p1
    - [0.001,0.3]