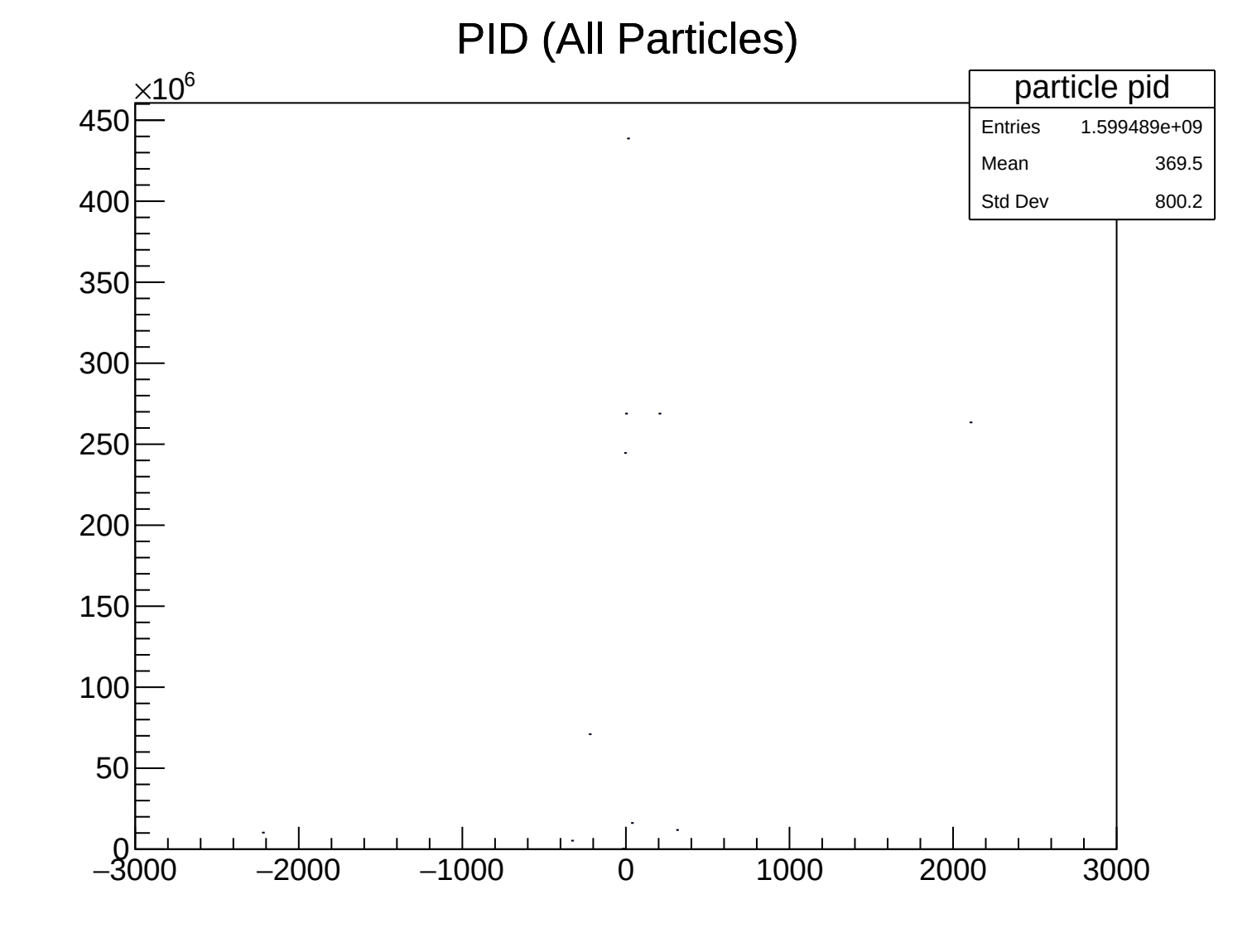
Basic electron cuts

Hydrogen

p(e,e'π^+)n

final state: 0p, 1pi+, 1e

θ_e **< 35**

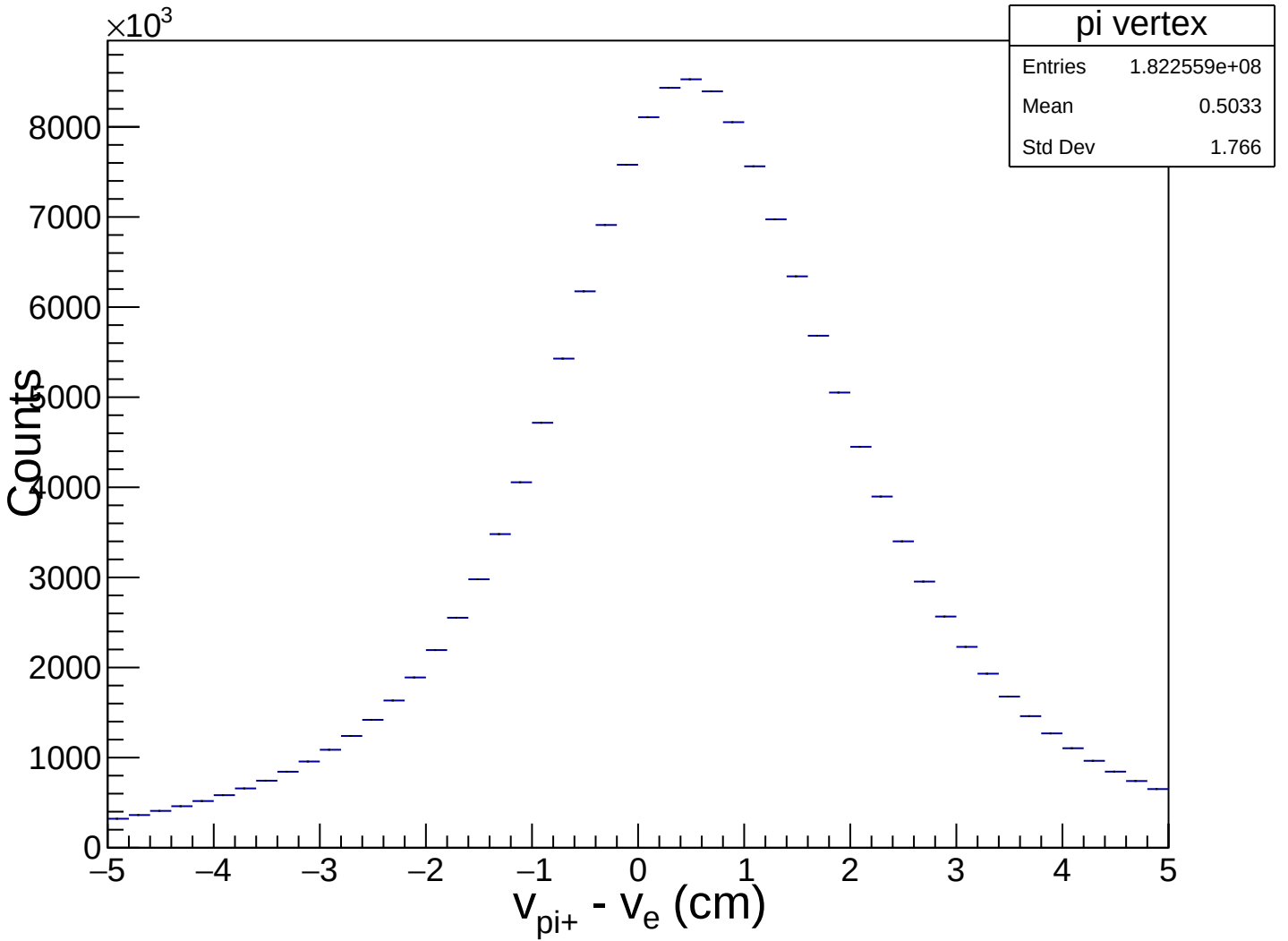

PID (All Particles)
particle pid
Entries 1.599489e+09
Mean 369.5
Std Dev 800.2
×10^6
450
400
350
300
250
200
150
100
50
0
−3000
−2000
−1000
0
1000
2000
3000

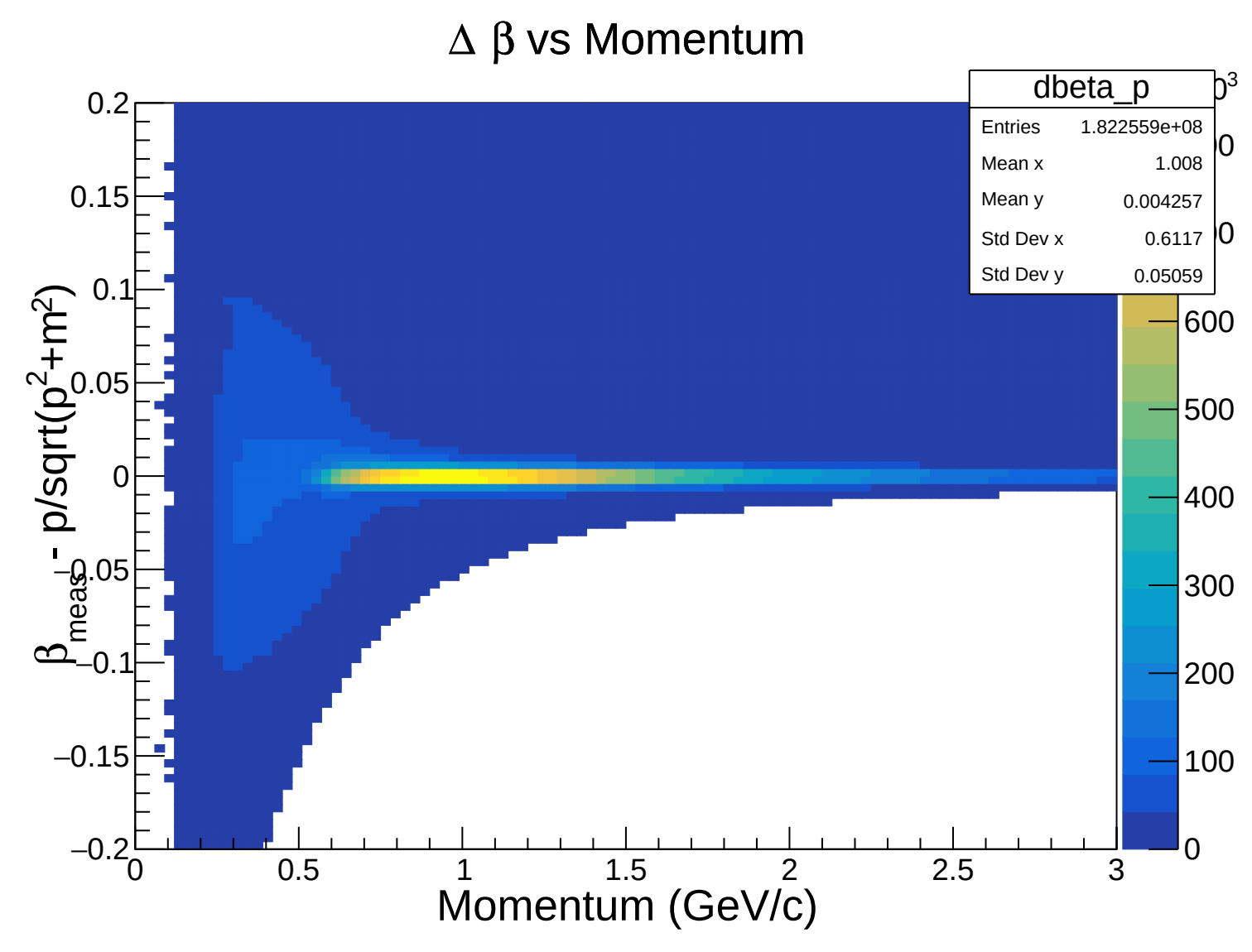
Basic electron cuts

Hydrogen

p(e,e'π^+)n

allow only PID=0,11,22,211,2112


Pion vertex - electron vertex
pi vertex
Entries 1.822559e+08
Mean 0.5033
Std Dev 1.766
×10^3
8000
7000
6000
5000
4000
3000
2000
1000
0
Counts
−5 −4 −3 −2 −1 0 1 2 3 4 5
v_pi+ - v_e (cm)


Δ β vs Momentum
dbeta_p
Entries 1.822559e+08
Mean x 1.008
Mean y 0.004257
Std Dev x 0.6117
Std Dev y 0.05059
β_meas - p/sqrt(p²+m²)
Momentum (GeV/c)
0.2
0.15
0.1
0.05
0
−0.05
−0.1
−0.15
−0.2
0
0.5
1
1.5
2
2.5
3
600
500
400
300
200
100
0

Basic electron cuts

Hydrogen run 015017

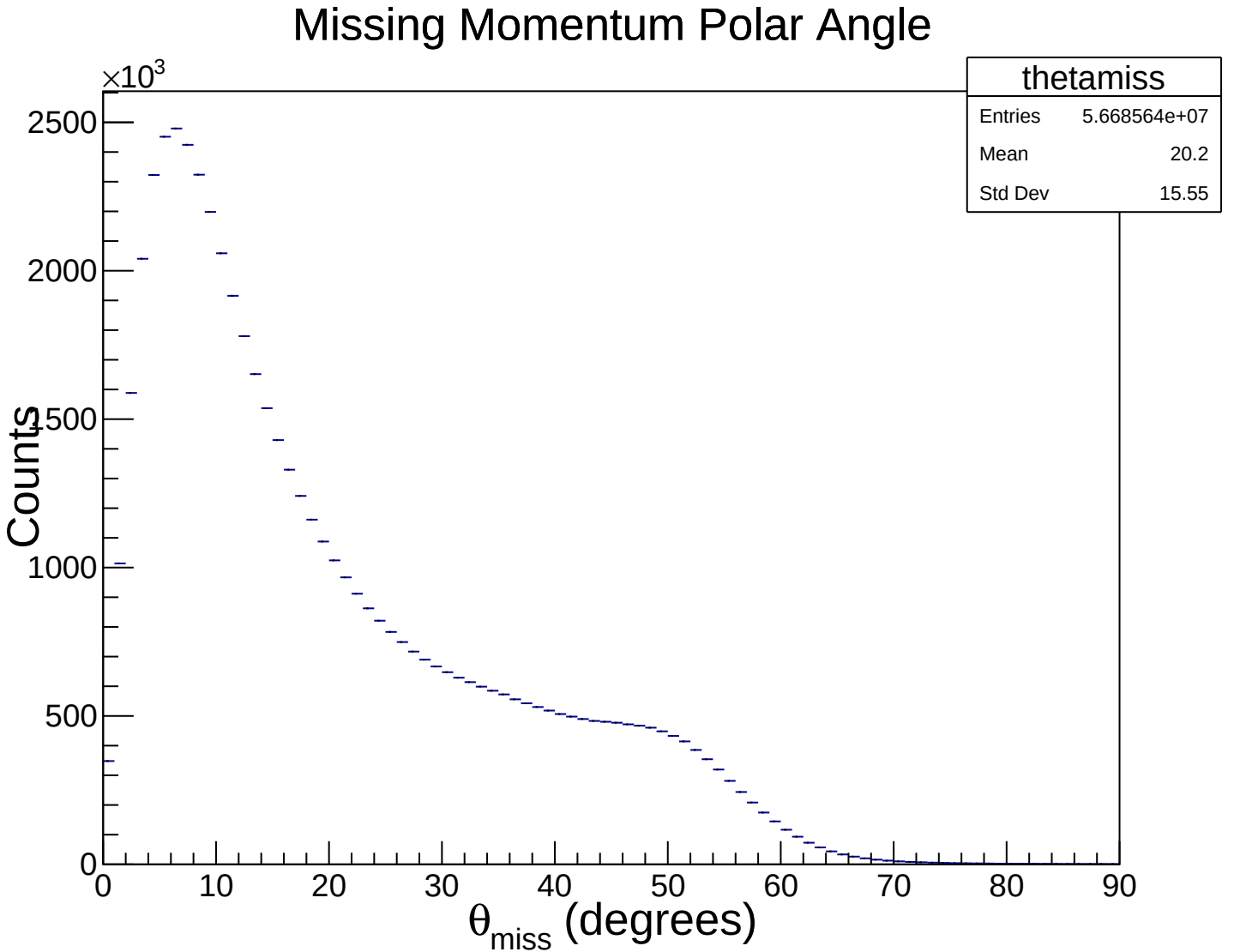
p(e,e'π^+)n

-4 cm < $v_{\pi+}$-v_e < 2 cm

-0.03 < $\Delta\ \beta$ < 0.03

$p_{\pi+}$ > 0.4 GeV/c

θ_π < 35


Missing Momentum Polar Angle
thetamiss
Entries 5.668564e+07
Mean 20.2
Std Dev 15.55
×10^3
2500
2000
1500
1000
500
0
Counts
0
10
20
30
40
50
60
70
80
90
θmiss (degrees)

Basic electron cuts

Hydrogen run 015017

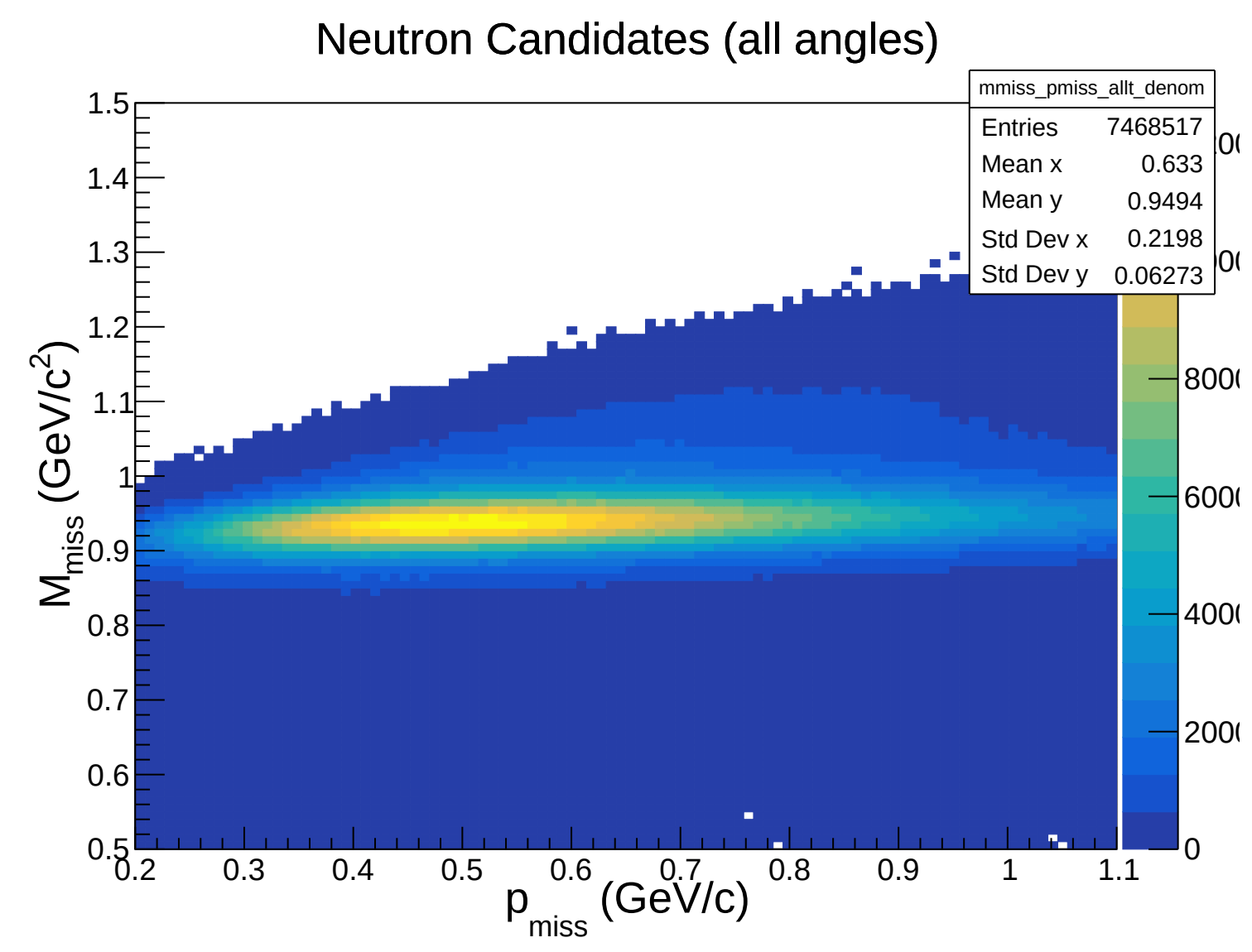
p(e,e'π^+)n

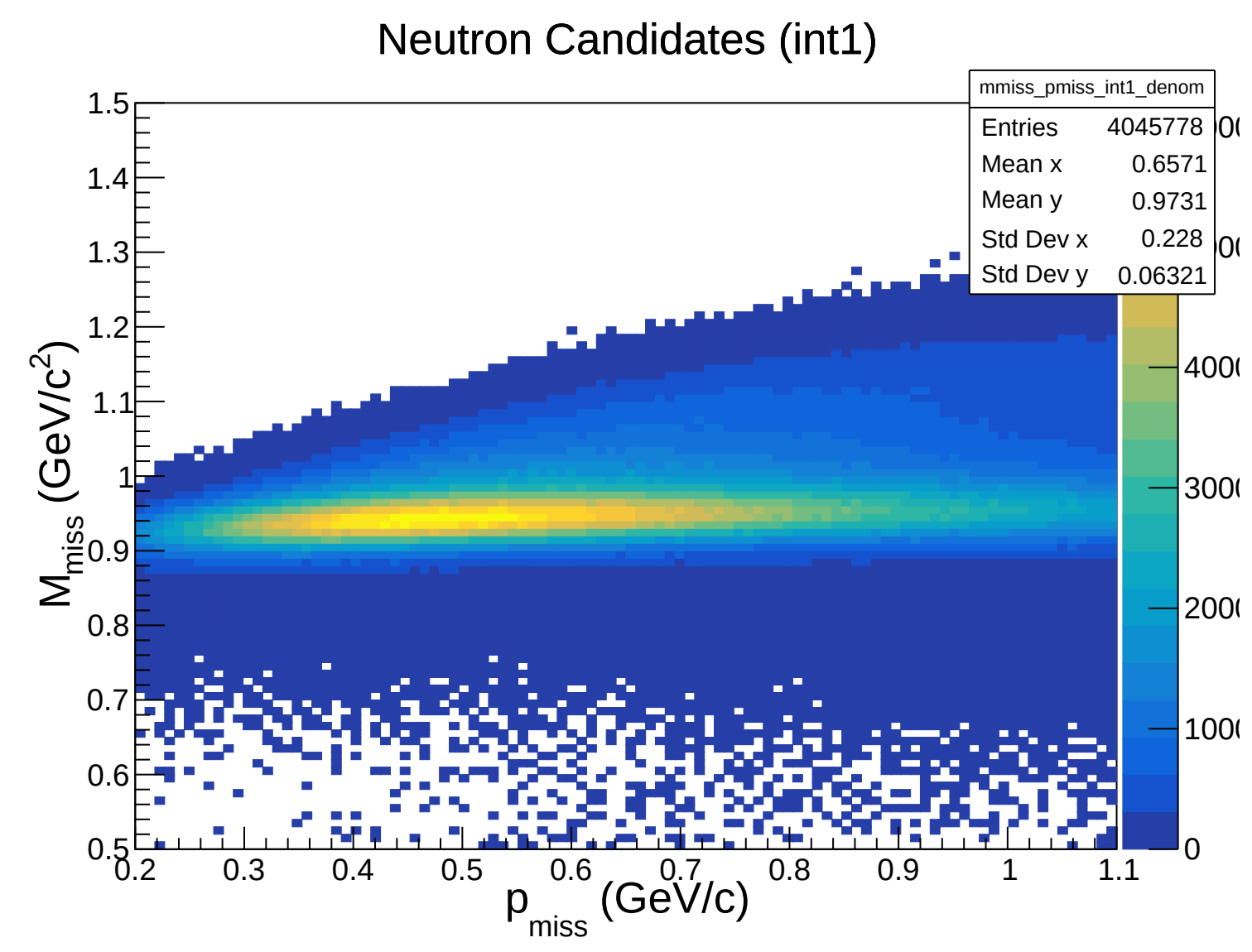
pion cuts

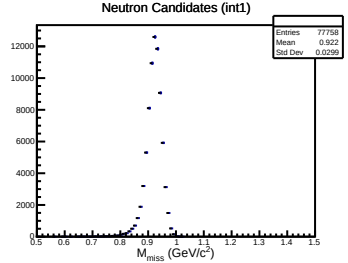
40 deg < θ_{miss} < 140 deg

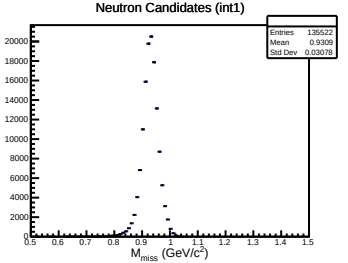
0.094 GeV/c < p_{miss} < 1.25 GeV/c

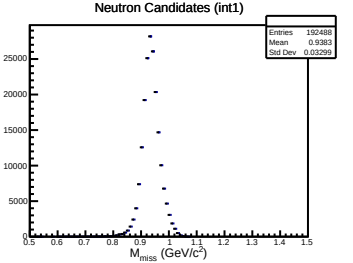
Get n_{eff} vs p (denominator)

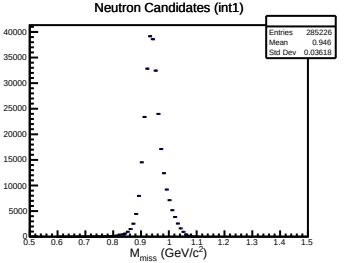

Neutron Candidates (all angles)
mmiss_pmiss_allt_denom
Entries 7468517
Mean x 0.633
Mean y 0.9494
Std Dev x 0.2198
Std Dev y 0.06273
M_miss (GeV/c^2)
p_miss (GeV/c)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
8000
6000
4000
2000
0

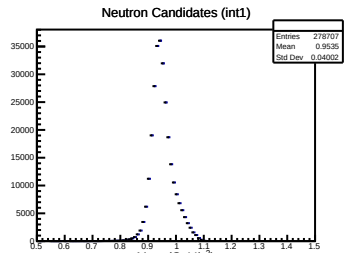

Neutron Candidates (int1)
mmiss_pmiss_int1_denom
Entries 4045778
Mean x 0.6571
Mean y 0.9731
Std Dev x 0.228
Std Dev y 0.06321
M_miss (GeV/c^2)
p_miss (GeV/c)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
4000
3000
2000
1000
0

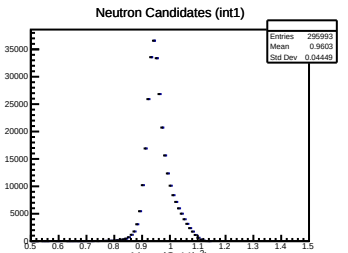

Neutron Candidates (int1)
Entries 77758
Mean 0.922
Std Dev 0.0299
M_{miss} (GeV/c^2)

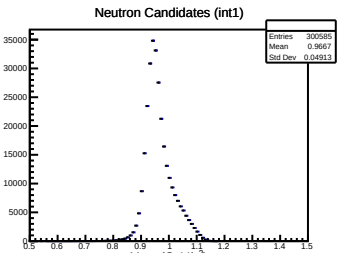

Neutron Candidates (int1)
Entries 135522
Mean 0.9309
Std Dev 0.03078
M_{miss} (GeV/c^2)

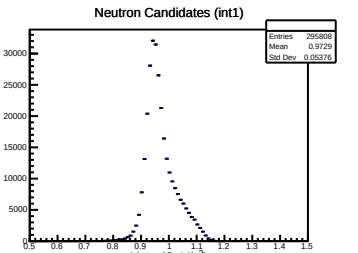

Neutron Candidates (int1)
Entries 192488
Mean 0.9383
Std Dev 0.03299
M_{miss} (GeV/c^2)

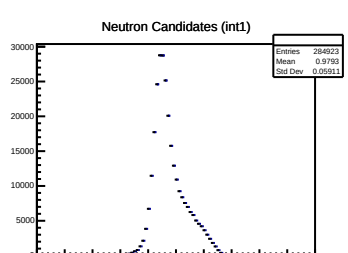

Neutron Candidates (int1)
Entries 285226
Mean 0.946
Std Dev 0.03618
M_{miss} (GeV/c^2)

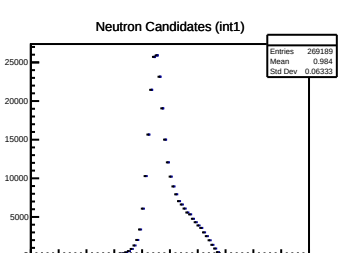

Neutron Candidates (int1)
Entries 278707
Mean 0.9535
Std Dev 0.04002
M_{miss} (GeV/c^2)

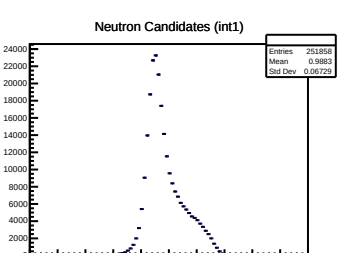

Neutron Candidates (int1)
Entries 295993
Mean 0.9603
Std Dev 0.04449
M_{miss} (GeV/c^2)

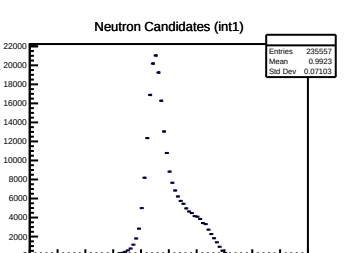

Neutron Candidates (int1)
Entries 300585
Mean 0.9667
Std Dev 0.04913
M_{miss} (GeV/c^2)

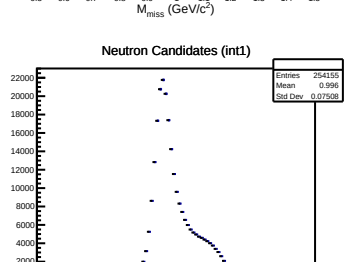

Neutron Candidates (int1)
Entries 295808
Mean 0.9729
Std Dev 0.05376
M_{miss} (GeV/c^2)

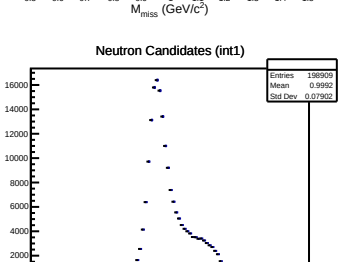

Neutron Candidates (int1)
Entries 284923
Mean 0.9793
Std Dev 0.05911
M_{miss} (GeV/c^2)

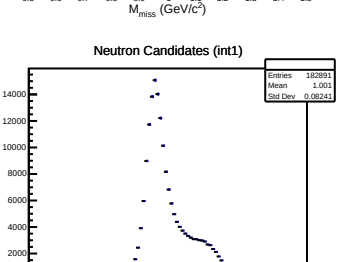

Neutron Candidates (int1)
Entries 269189
Mean 0.984
Std Dev 0.06333
M_{miss} (GeV/c^2)

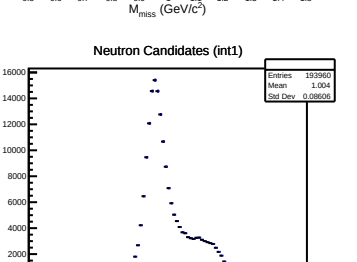

Neutron Candidates (int1)
Entries 251858
Mean 0.9883
Std Dev 0.06729
M_{miss} (GeV/c^2)

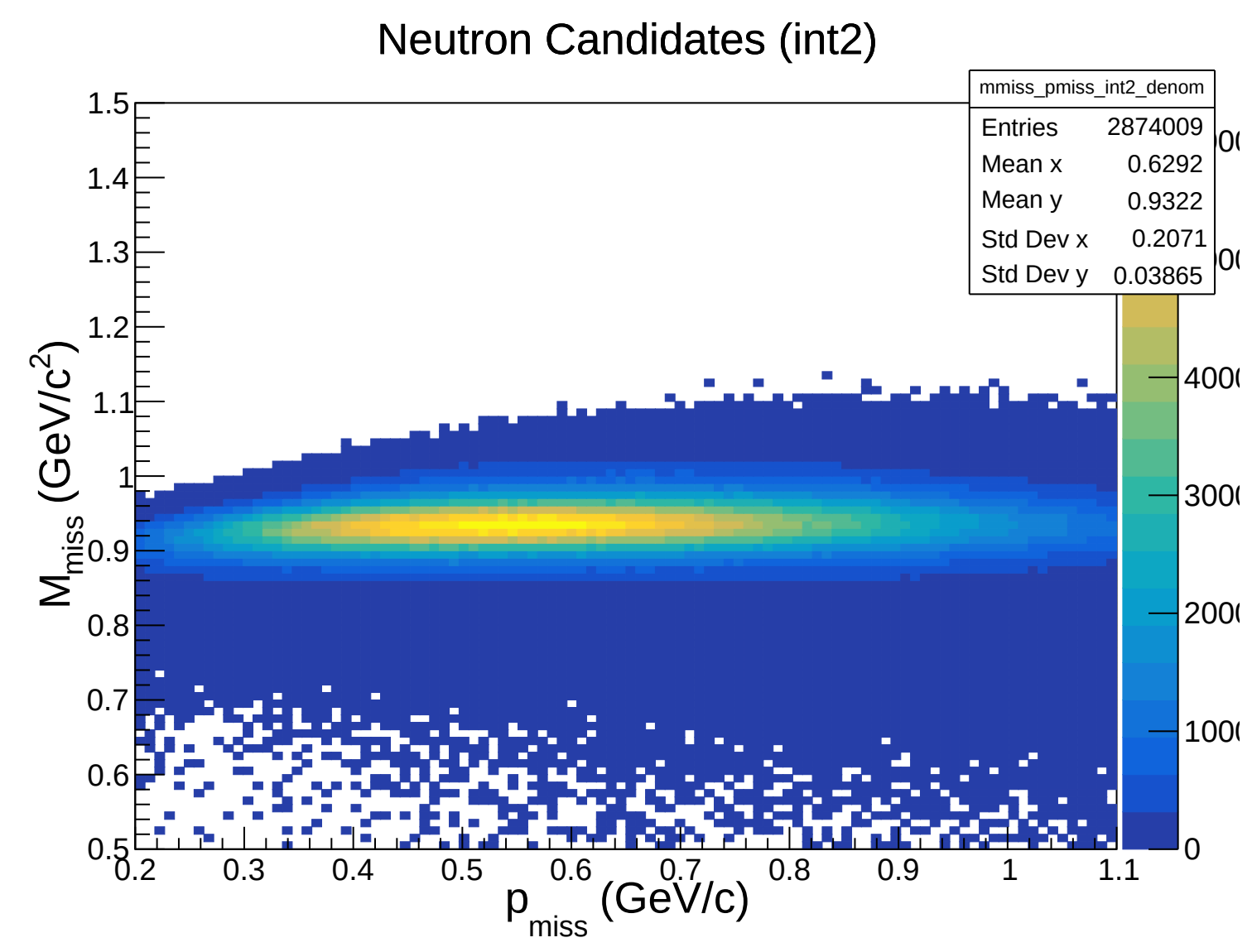

Neutron Candidates (int1)
Entries 235557
Mean 0.9923
Std Dev 0.07103
M_{miss} (GeV/c^2)

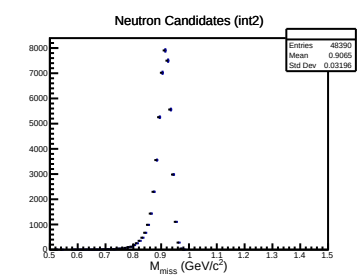

Neutron Candidates (int1)
Entries 254155
Mean 0.996
Std Dev 0.07508
M_{miss} (GeV/c^2)

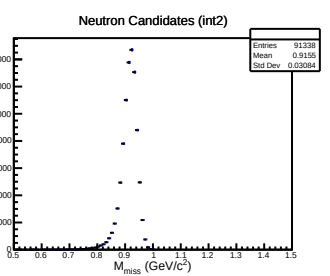

Neutron Candidates (int1)
Entries 198909
Mean 0.9992
Std Dev 0.07902
M_{miss} (GeV/c^2)

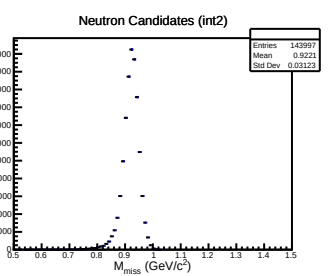

Neutron Candidates (int1)
Entries 182891
Mean 1.001
Std Dev 0.08241
M_{miss} (GeV/c^2)

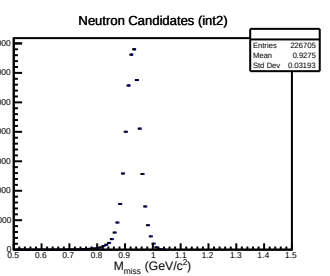

Neutron Candidates (int1)
Entries 193960
Mean 1.004
Std Dev 0.08606
M_{miss} (GeV/c^2)

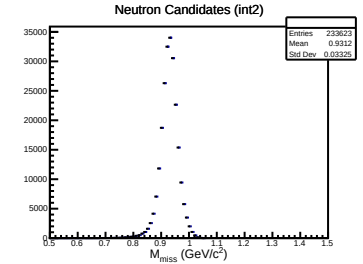

Neutron Candidates (int2)
mmiss_pmiss_int2_denom
Entries 2874009
Mean x 0.6292
Mean y 0.9322
Std Dev x 0.2071
Std Dev y 0.03865
M_miss (GeV/c^2)
p_miss (GeV/c)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
4000
3000
2000
1000
0

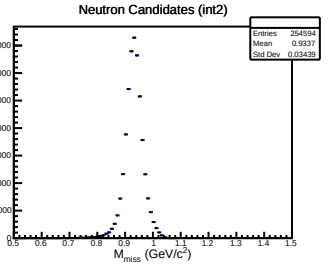

Neutron Candidates (int2)
Entries 48390
Mean 0.9066
Std Dev 0.03196
M_{miss} (GeV/c^2)

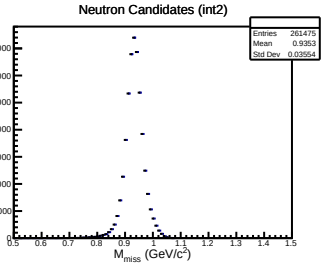

Neutron Candidates (int2)
Entries 91338
Mean 0.9156
Std Dev 0.03084
M_{miss} (GeV/c^2)

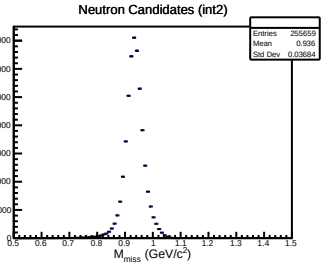

Neutron Candidates (int2)
Entries 143997
Mean 0.9221
Std Dev 0.03123
M_{miss} (GeV/c^2)

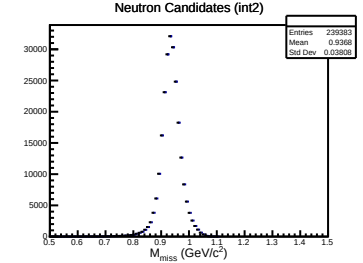

Neutron Candidates (int2)
Entries 226705
Mean 0.9275
Std Dev 0.03193
M_{miss} (GeV/c^2)

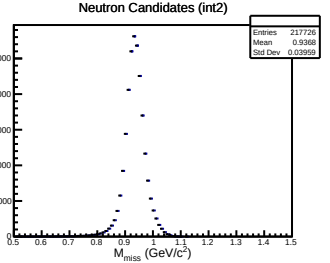

Neutron Candidates (int2)
Entries 233623
Mean 0.9312
Std Dev 0.03325
M_{miss} (GeV/c^2)

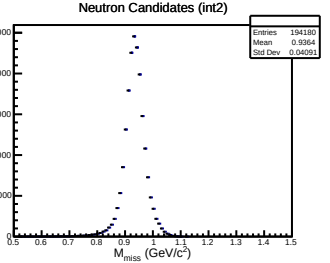

Neutron Candidates (int2)
Entries 254594
Mean 0.9337
Std Dev 0.03439
M_{miss} (GeV/c^2)

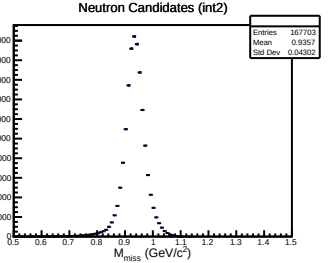

Neutron Candidates (int2)
Entries 261475
Mean 0.9353
Std Dev 0.03554
M_{miss} (GeV/c^2)

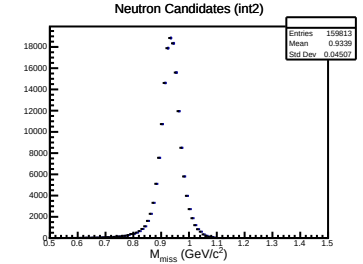

Neutron Candidates (int2)
Entries 255659
Mean 0.936
Std Dev 0.03684
M_{miss} (GeV/c^2)

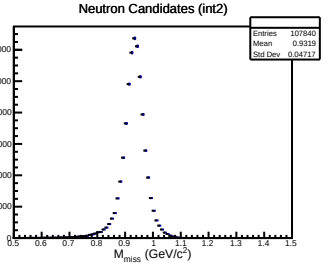

Neutron Candidates (int2)
Entries 239383
Mean 0.9368
Std Dev 0.03808
M_{miss} (GeV/c^2)

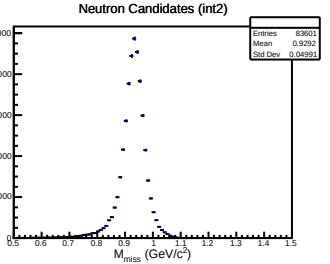

Neutron Candidates (int2)
Entries 217726
Mean 0.9368
Std Dev 0.03959
M_{miss} (GeV/c^2)

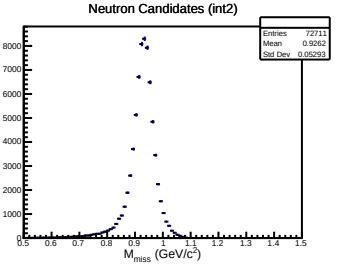

Neutron Candidates (int2)
Entries 194180
Mean 0.9364
Std Dev 0.04091
M_{miss} (GeV/c^2)

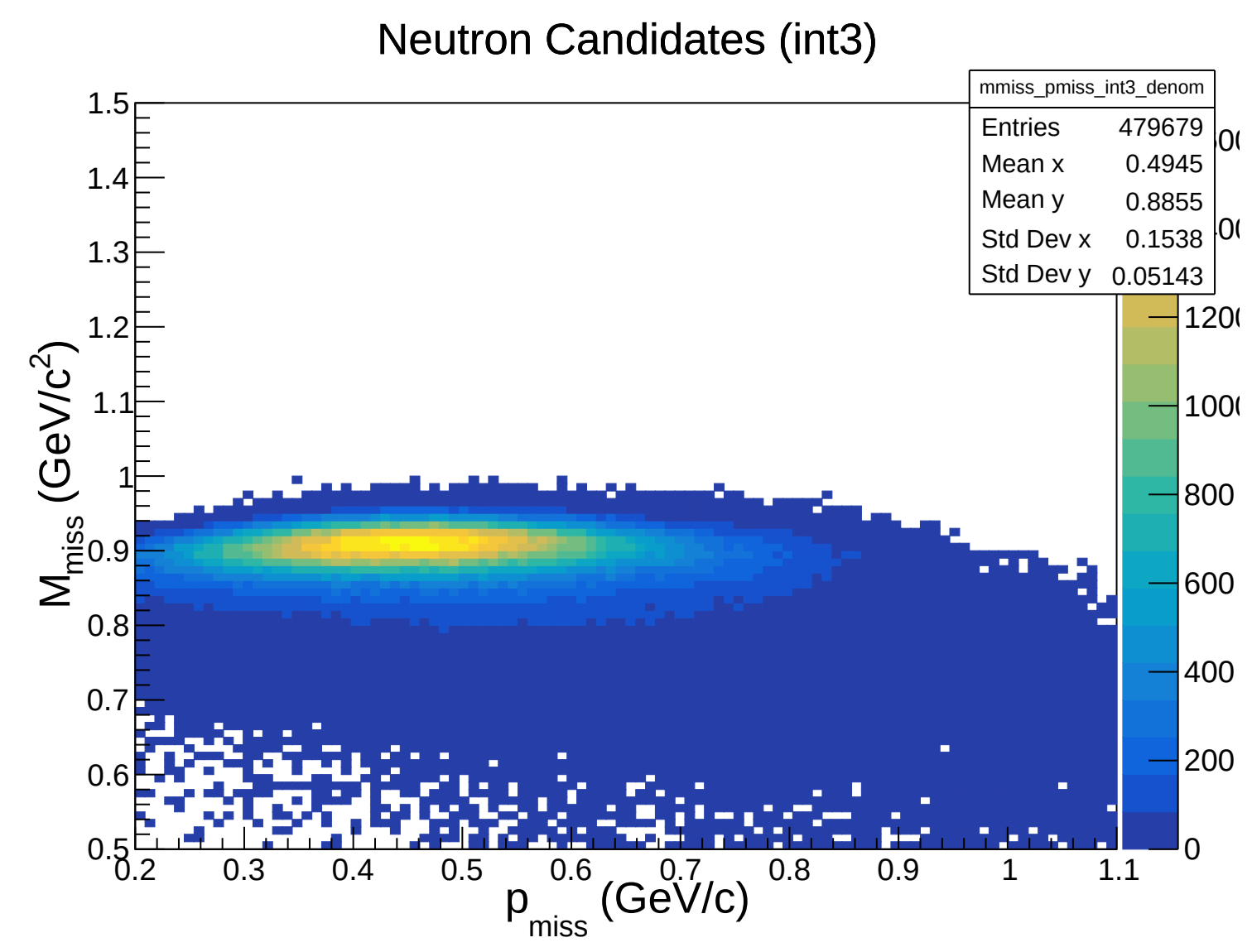

Neutron Candidates (int2)
Entries 167703
Mean 0.9357
Std Dev 0.04302
M_{miss} (GeV/c^2)

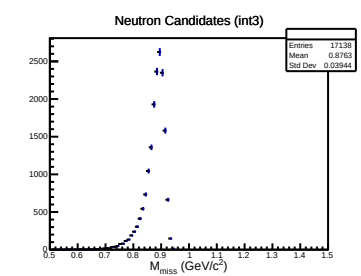

Neutron Candidates (int2)
Entries 159813
Mean 0.9339
Std Dev 0.04507
M_{miss} (GeV/c^2)

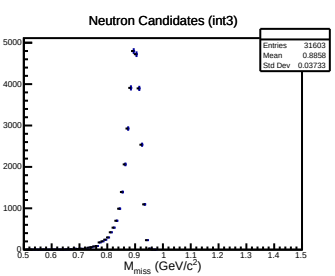

Neutron Candidates (int2)
Entries 107840
Mean 0.9319
Std Dev 0.04717
M_{miss} (GeV/c^2)

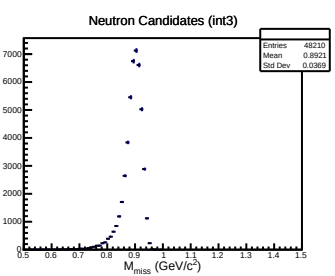

Neutron Candidates (int2)
Entries 83601
Mean 0.9292
Std Dev 0.04991
M_{miss} (GeV/c^2)

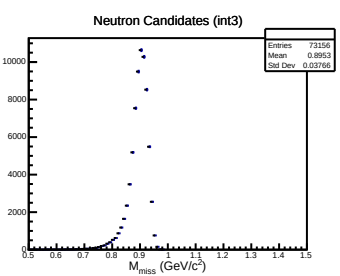

Neutron Candidates (int2)
Entries 72711
Mean 0.9262
Std Dev 0.05293
M_{miss} (GeV/c^2)

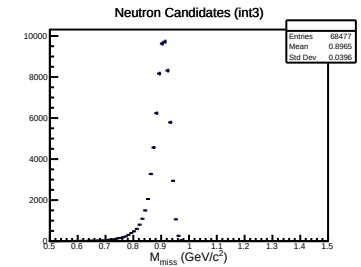

Neutron Candidates (int3)
mmiss_pmiss_int3_denom
Entries 479679
Mean x 0.4945
Mean y 0.8855
Std Dev x 0.1538
Std Dev y 0.05143
M_miss (GeV/c^2)
p_miss (GeV/c)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1200
1000
800
600
400
200
0

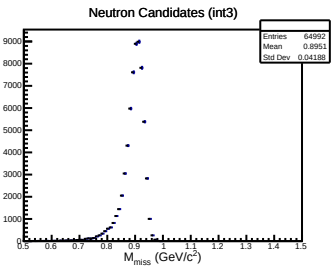

Neutron Candidates (int3)
Entries 17138
Mean 0.8763
Std Dev 0.03944
M_{miss} (GeV/c^2)

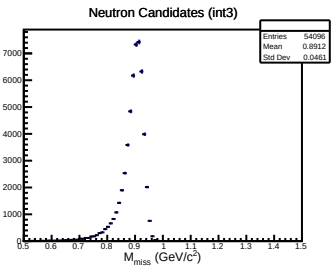

Neutron Candidates (int3)
Entries 31603
Mean 0.8858
Std Dev 0.03733
M_{miss} (GeV/c^2)

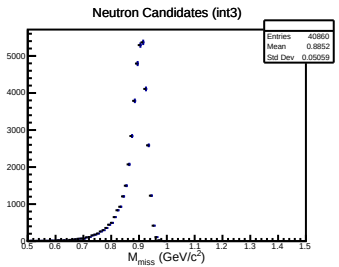

Neutron Candidates (int3)
Entries 48210
Mean 0.8921
Std Dev 0.0369
M_{miss} (GeV/c^2)

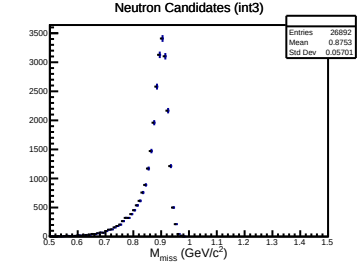

Neutron Candidates (int3)
Entries 73156
Mean 0.8953
Std Dev 0.03766
M_{miss} (GeV/c^2)

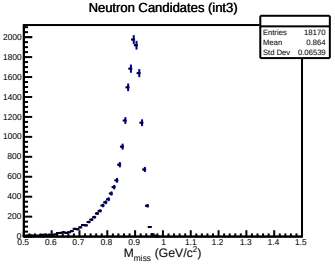

Neutron Candidates (int3)
Entries 68477
Mean 0.8965
Std Dev 0.0396
M_{miss} (GeV/c^2)

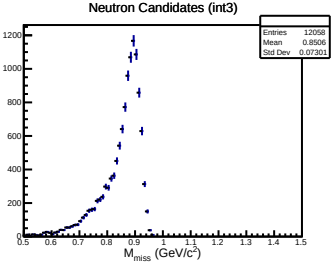

Neutron Candidates (int3)
Entries 64992
Mean 0.8951
Std Dev 0.04188
M_{miss} (GeV/c^2)

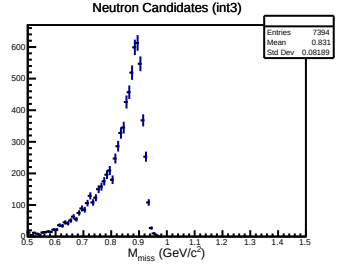

Neutron Candidates (int3)
Entries 54096
Mean 0.8912
Std Dev 0.0461
M_{miss} (GeV/c^2)

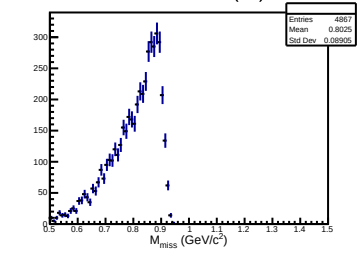

Neutron Candidates (int3)
Entries 40860
Mean 0.8852
Std Dev 0.05059
M_{miss} (GeV/c^2)

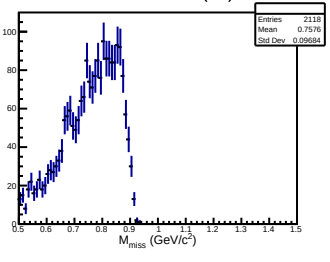

Neutron Candidates (int3)
Entries 26892
Mean 0.8753
Std Dev 0.05701
M_{miss} (GeV/c^2)

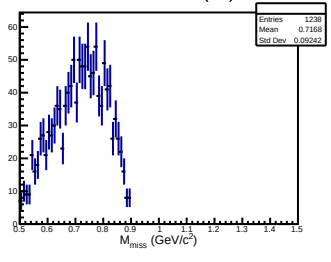

Neutron Candidates (int3)
Entries 18170
Mean 0.864
Std Dev 0.06539
M_{miss} (GeV/c^2)

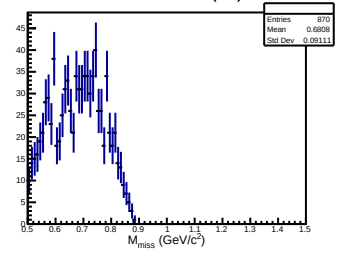

Neutron Candidates (int3)
Entries 12058
Mean 0.8506
Std Dev 0.07301
M_{miss} (GeV/c^2)

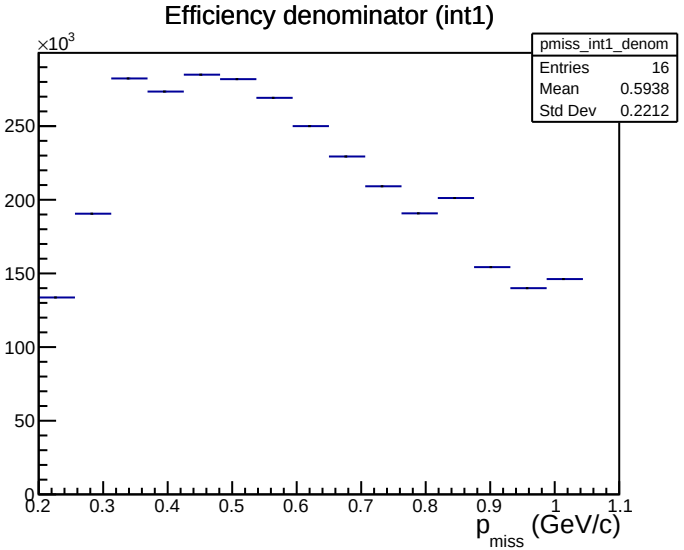

Neutron Candidates (int3)
Entries 7394
Mean 0.831
Std Dev 0.08189
M_{miss} (GeV/c^2)

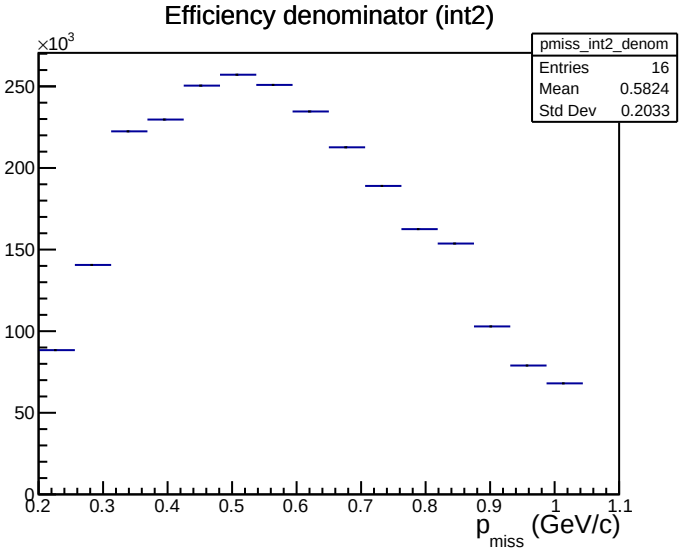

Neutron Candidates (int3)
Entries 4867
Mean 0.8025
Std Dev 0.08905
M_{miss} (GeV/c^2)

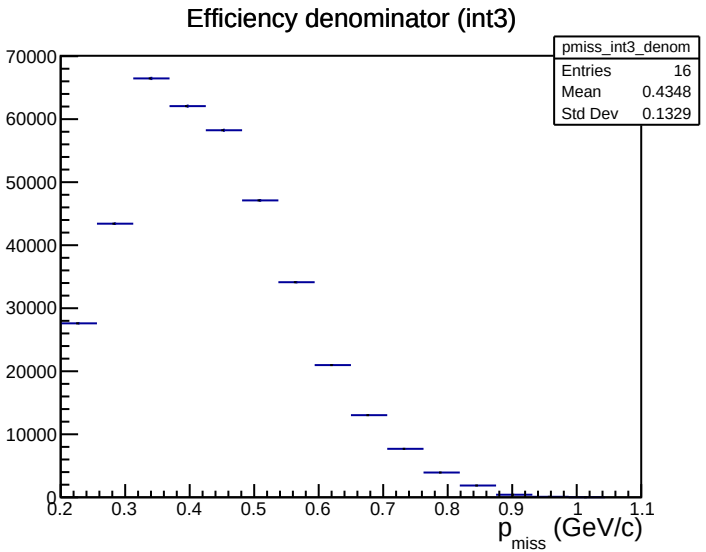

Neutron Candidates (int3)
Entries 2118
Mean 0.7576
Std Dev 0.09684
M_{miss} (GeV/c^2)


Neutron Candidates (int3)
Entries 1238
Mean 0.7168
Std Dev 0.09242
M_{miss} (GeV/c^2)


Neutron Candidates (int3)
Entries 870
Mean 0.6808
Std Dev 0.09111
M_{miss} (GeV/c^2)

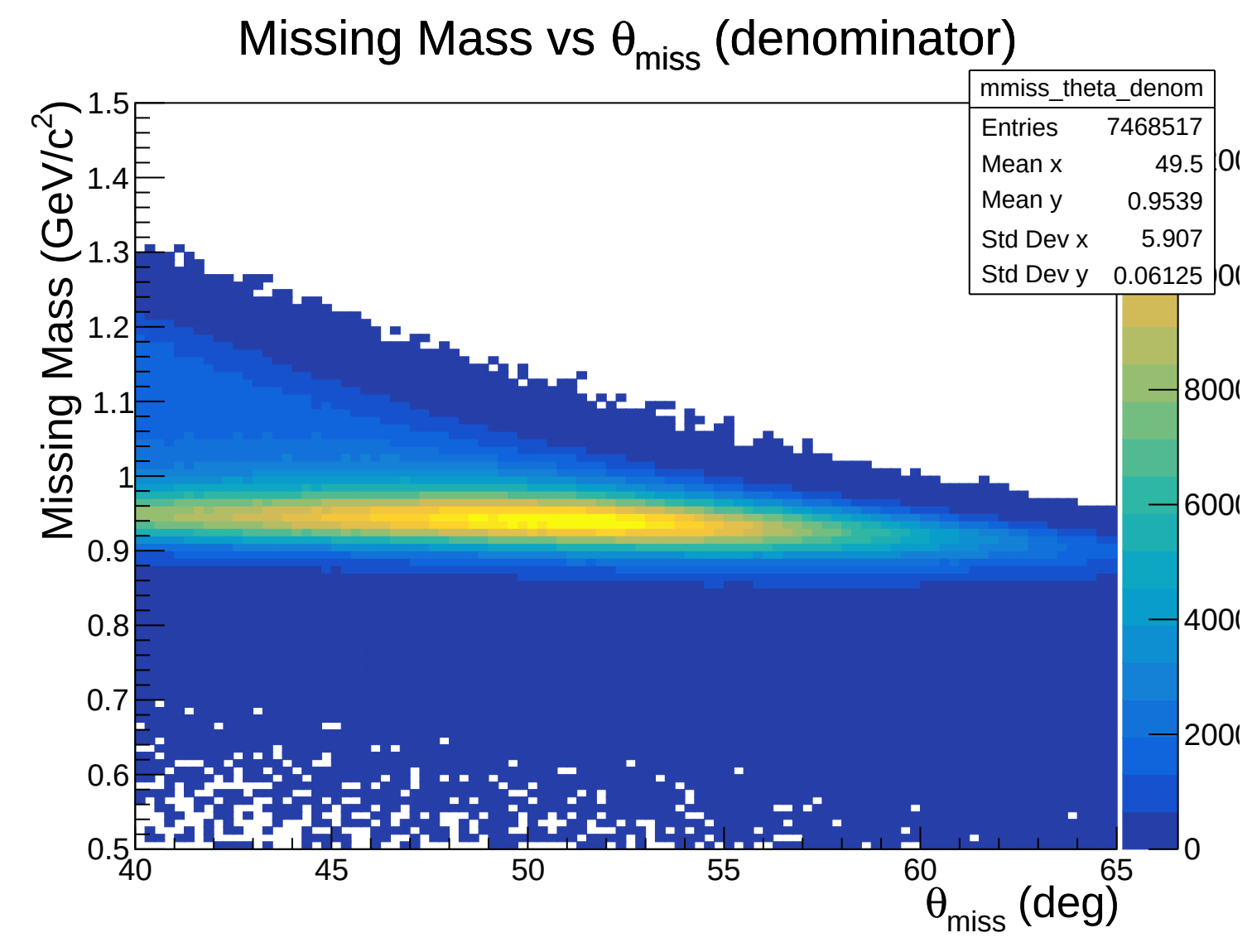

Efficiency denominator (int1)
pmiss_int1_denom
Entries 16
Mean 0.5938
Std Dev 0.2212
×10^3
p_miss (GeV/c)

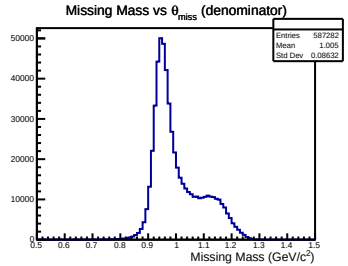

Efficiency denominator (int2)
pmiss_int2_denom
Entries 16
Mean 0.5824
Std Dev 0.2033
×10^3
p_miss (GeV/c)

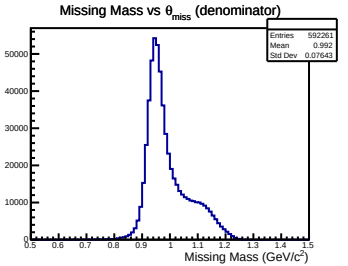

Efficiency denominator (int3)
pmiss_int3_denom
Entries 16
Mean 0.4348
Std Dev 0.1329
p_miss (GeV/c)

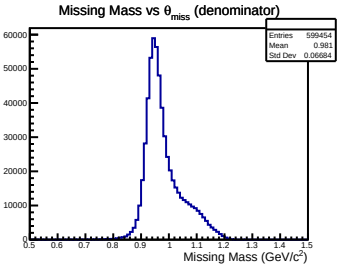
Get n_{eff} vs θ (denominator)

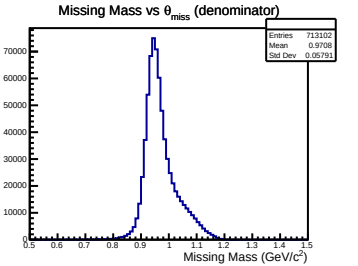
Theta denominator

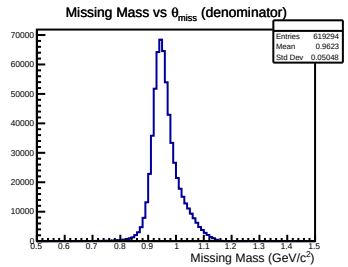

Missing Mass vs θmiss (denominator)
mmiss_theta_denom
Entries 7468517
Mean x 49.5
Mean y 0.9539
Std Dev x 5.907
Std Dev y 0.06125
Missing Mass (GeV/c2)
θmiss (deg)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
40
45
50
55
60
65
8000
6000
4000
2000
0

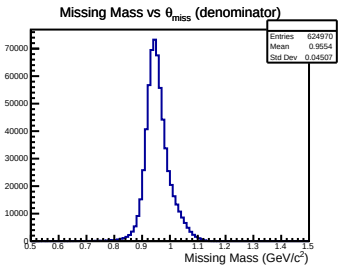

Missing Mass vs θmiss (denominator)
Entries 587282
Mean 1.005
Std Dev 0.08632
Missing Mass (GeV/c2)

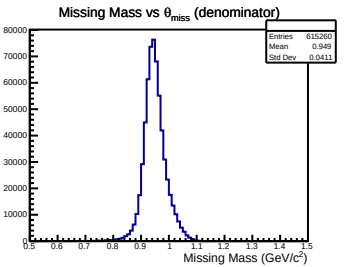

Missing Mass vs θmiss (denominator)
Entries 592261
Mean 0.992
Std Dev 0.07643
Missing Mass (GeV/c2)

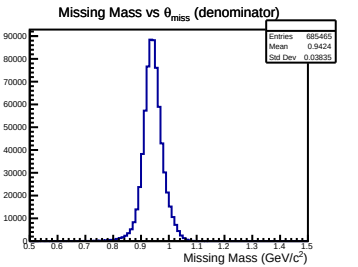

Missing Mass vs θmiss (denominator)
Entries 599454
Mean 0.981
Std Dev 0.06684
Missing Mass (GeV/c2)

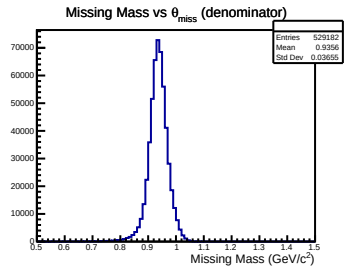

Missing Mass vs θmiss (denominator)
Entries 713102
Mean 0.9708
Std Dev 0.05791
Missing Mass (GeV/c2)

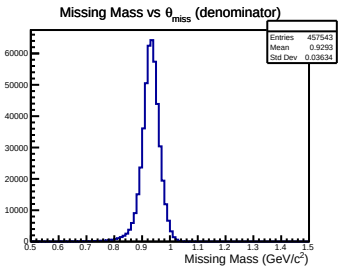

Missing Mass vs θmiss (denominator)
Entries 619294
Mean 0.9623
Std Dev 0.05048
Missing Mass (GeV/c2)

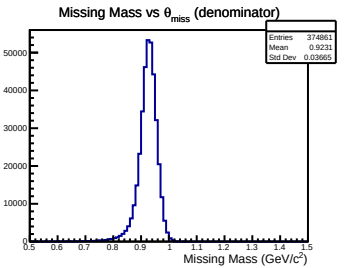

Missing Mass vs θmiss (denominator)
Entries 624970
Mean 0.9554
Std Dev 0.04507
Missing Mass (GeV/c2)

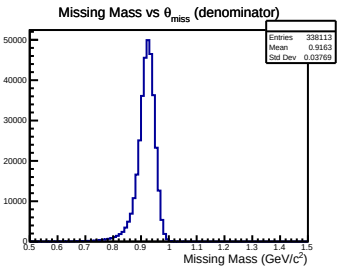

Missing Mass vs θmiss (denominator)
Entries 615260
Mean 0.949
Std Dev 0.0411
Missing Mass (GeV/c2)

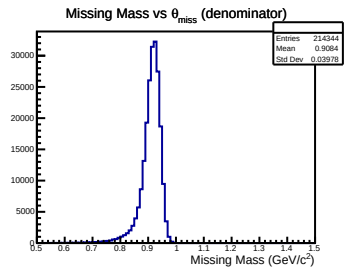

Missing Mass vs θmiss (denominator)
Entries 685465
Mean 0.9424
Std Dev 0.03835
Missing Mass (GeV/c2)

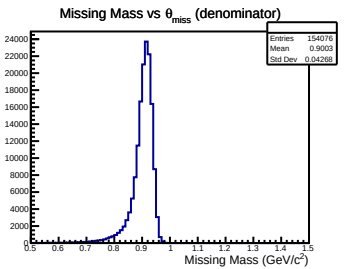

Missing Mass vs θmiss (denominator)
Entries 529182
Mean 0.9356
Std Dev 0.03655
Missing Mass (GeV/c2)

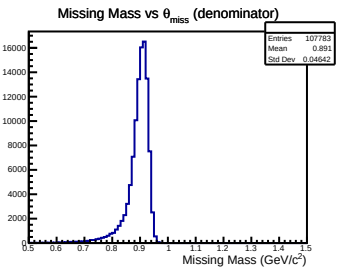

Missing Mass vs θmiss (denominator)
Entries 457543
Mean 0.9293
Std Dev 0.03634
Missing Mass (GeV/c2)

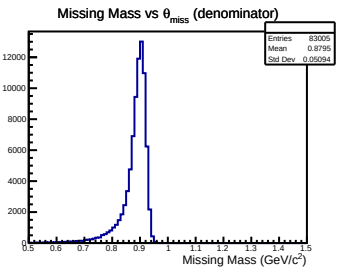

Missing Mass vs θmiss (denominator)
Entries 374861
Mean 0.9231
Std Dev 0.03665
Missing Mass (GeV/c2)


Missing Mass vs θmiss (denominator)
Entries 338113
Mean 0.9163
Std Dev 0.03769
Missing Mass (GeV/c2)

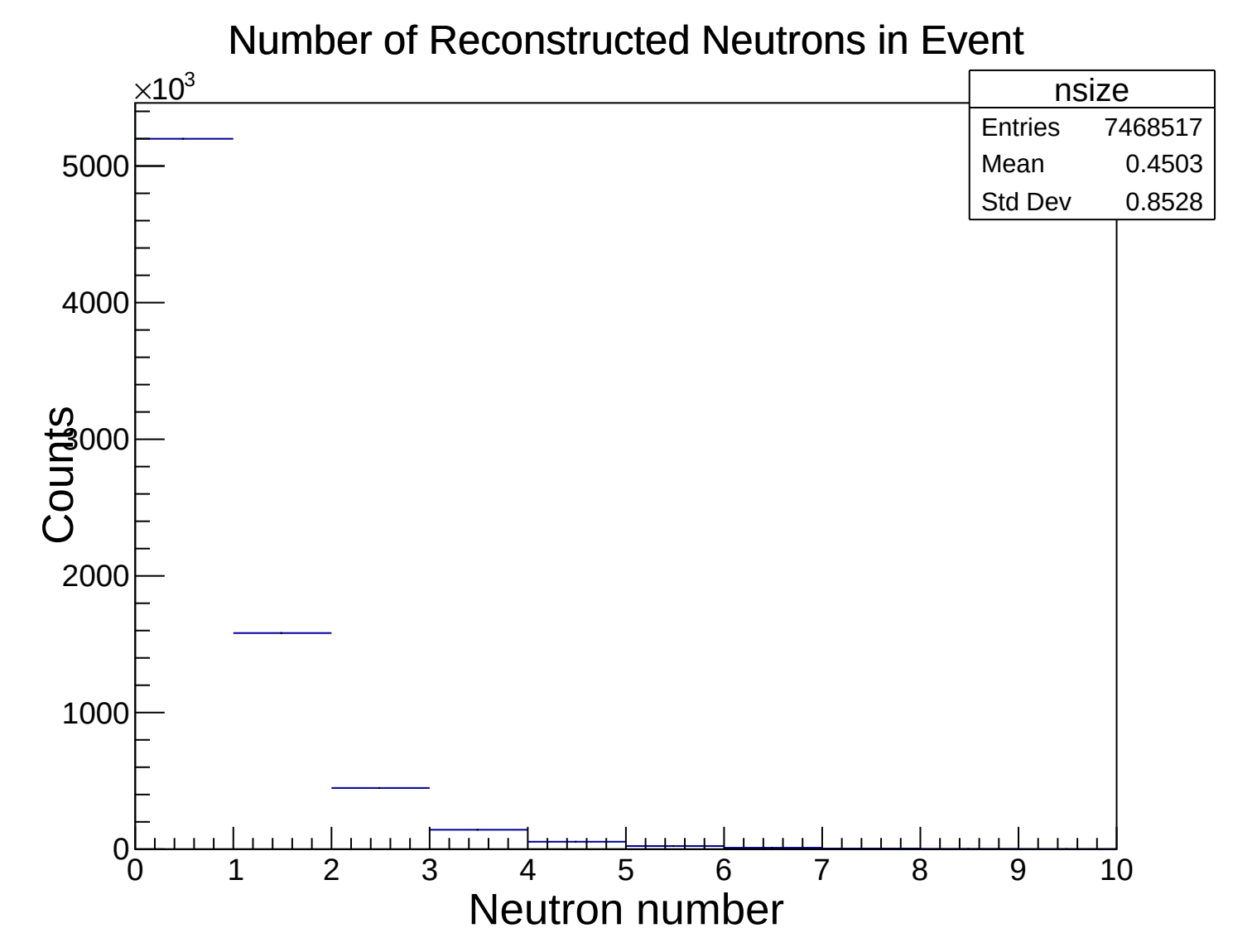

Missing Mass vs θmiss (denominator)
Entries 214344
Mean 0.9084
Std Dev 0.03978
Missing Mass (GeV/c2)


Missing Mass vs θmiss (denominator)
Entries 154076
Mean 0.9003
Std Dev 0.04268
Missing Mass (GeV/c2)


Missing Mass vs θmiss (denominator)
Entries 107783
Mean 0.891
Std Dev 0.04642
Missing Mass (GeV/c2)


Missing Mass vs θmiss (denominator)
Entries 83005
Mean 0.8795
Std Dev 0.05094
Missing Mass (GeV/c2)

p(e,e'π^+n)


Number of Reconstructed Neutrons in Event
nsize
Entries 7468517
Mean 0.4503
Std Dev 0.8528
×10^3
5000
4000
3000
2000
1000
0
Counts
0 1 2 3 4 5 6 7 8 9 10
Neutron number

Basic electron cuts

Hydrogen run 015017

p(e,e'π^+)n

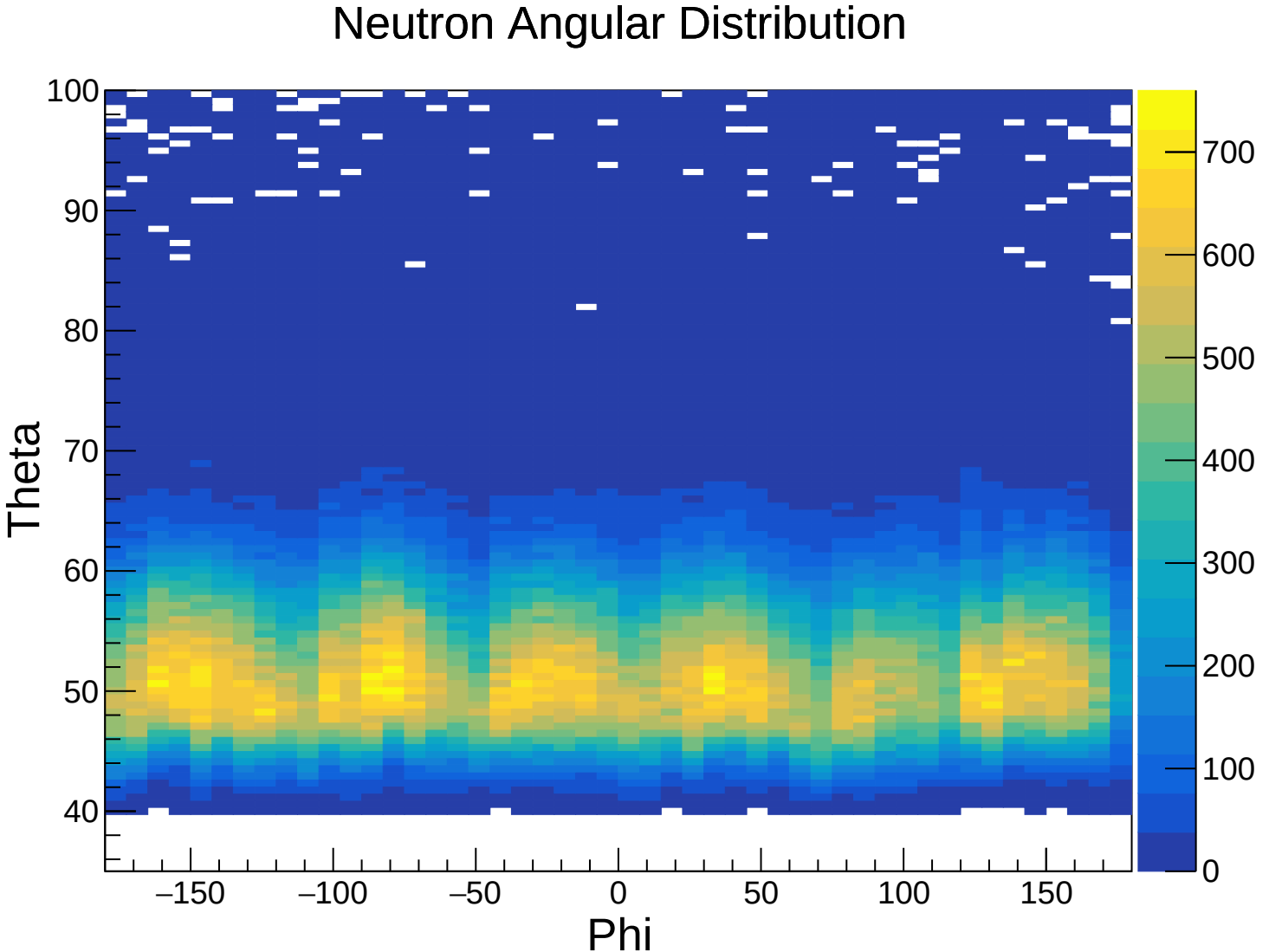
pion cuts

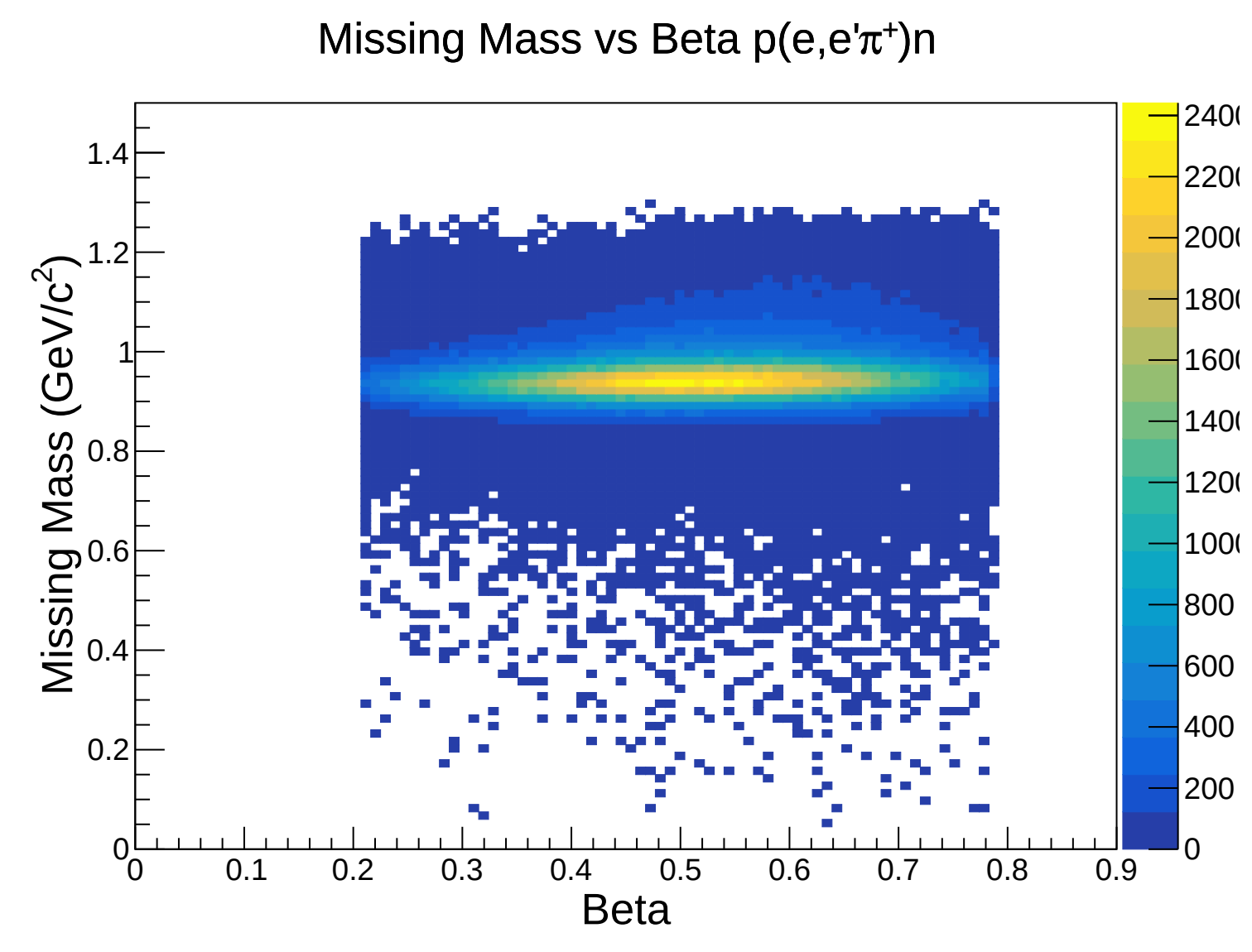
p_{miss}, M_{miss} cuts

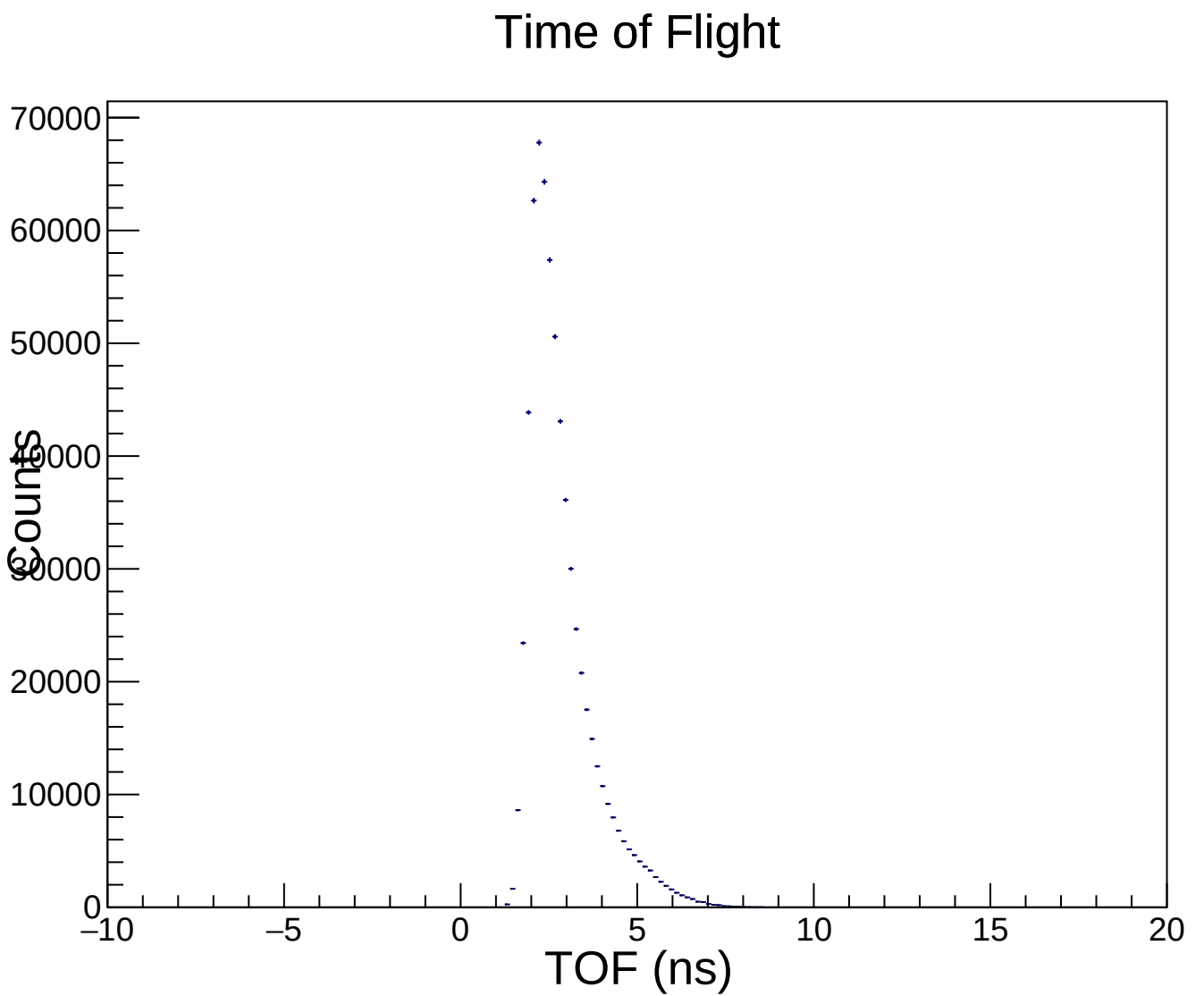
Require at least 1 neutron in CND

Neutron in at least 1 lever of CND

Pick neutron closest to p_{miss} in ϕ


Neutron Angular Distribution
Theta
Phi
100
90
80
70
60
50
40
–150
–100
–50
0
50
100
150
700
600
500
400
300
200
100
0


Missing Mass vs Beta p(e,e'π+)n
Missing Mass (GeV/c2)
Beta
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0.1
0.3
0.5
0.7
0.9
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200


Time of Flight
Counts
70000
60000
50000
40000
30000
20000
10000
0
–10
–5
0
5
10
15
20
TOF (ns)

Basic electron cuts

Hydrogen run 015017

p(e,e'π^+)n

pion cuts

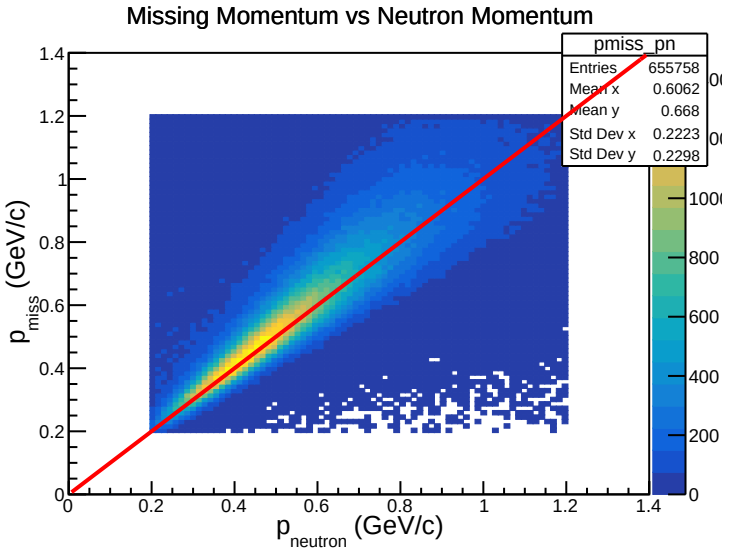
p_{miss}, M_{miss} cuts

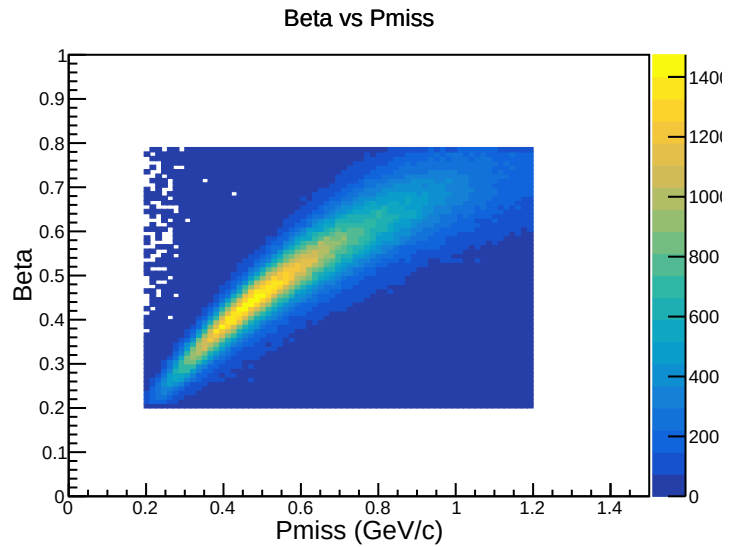
Require 1 neutron in CND

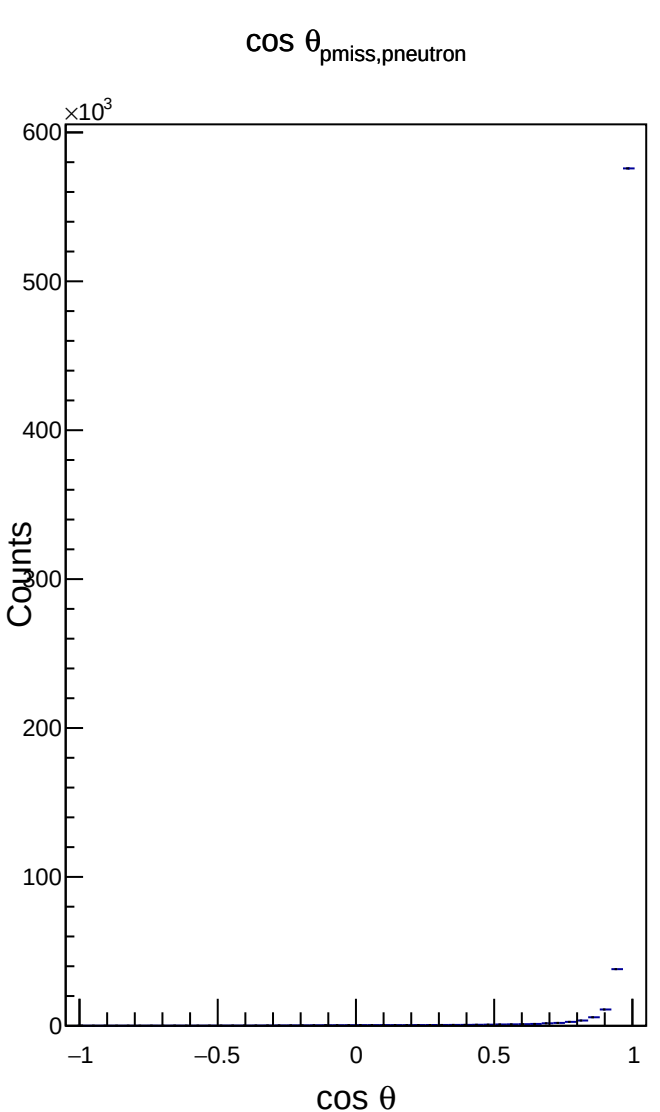
exclude θ_n=0, ϕ_n=0

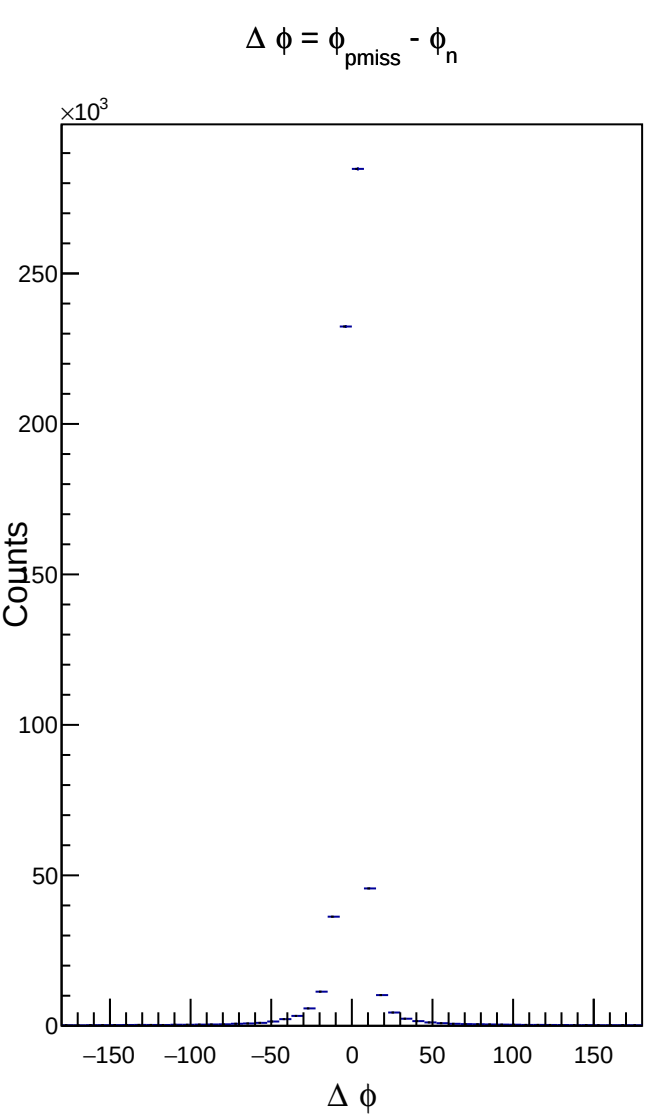
40 deg < θ_n < 140 deg

0.1 < β_n < 0.8


Missing Momentum vs Neutron Momentum
pmiss_pn
Entries 655758
Mean x 0.6062
Mean y 0.668
Std Dev x 0.2223
Std Dev y 0.2298
p_miss (GeV/c)
p_neutron (GeV/c)


Beta vs Pmiss
Beta
Pmiss (GeV/c)


cos θpmiss,pneutron
×10^3
600
500
400
300
200
100
0
Counts
−1
−0.5
0
0.5
1
cos θ


Δ ϕ = ϕpmiss - ϕn
×10^3
250
200
150
100
50
0
Counts
−150
−100
−50
0
50
100
150
Δ ϕ

Basic electron cuts

Hydrogen run 015017

p(e,e'π^+)n

pion cuts

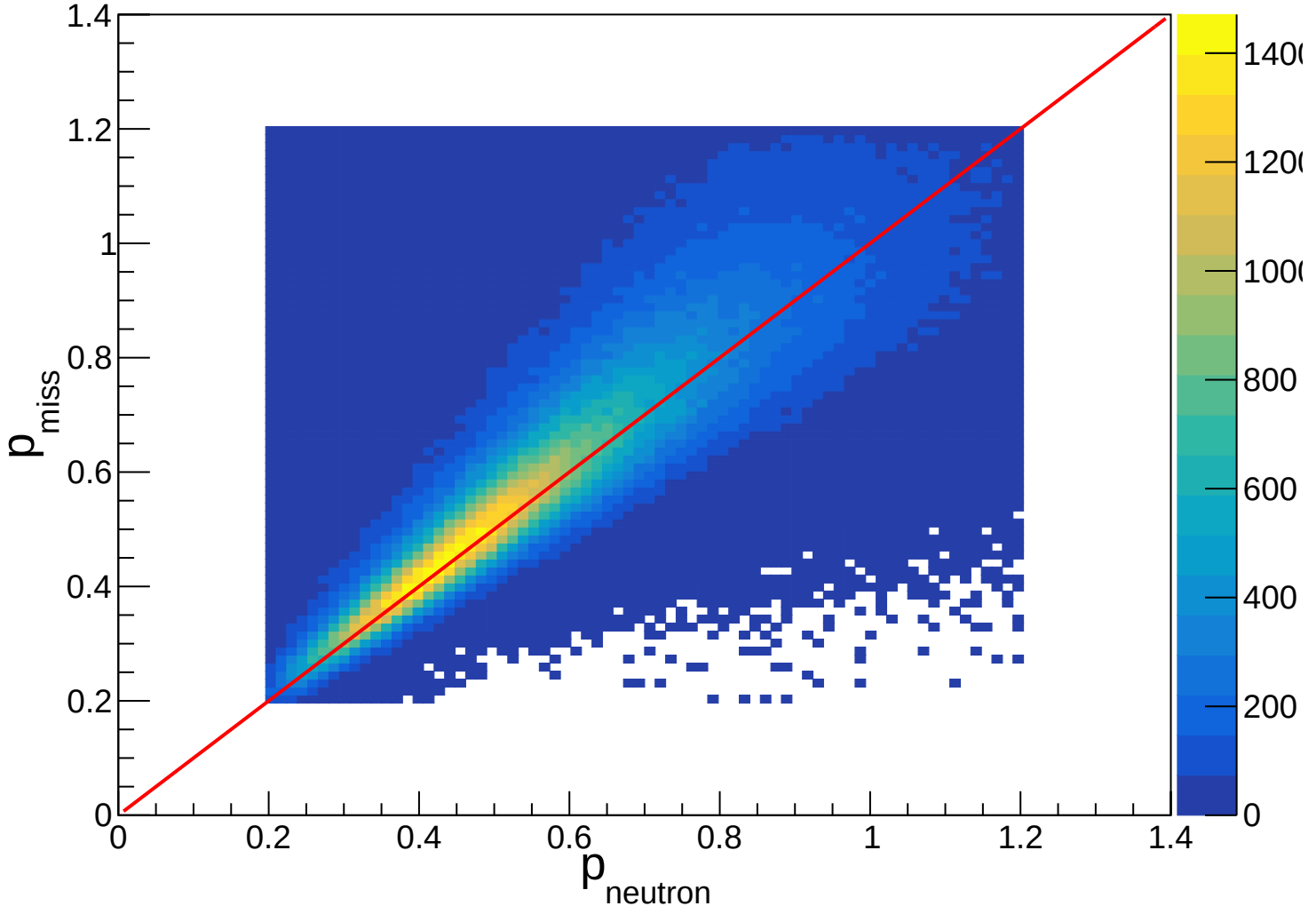
p_{miss}, M_{miss} cuts

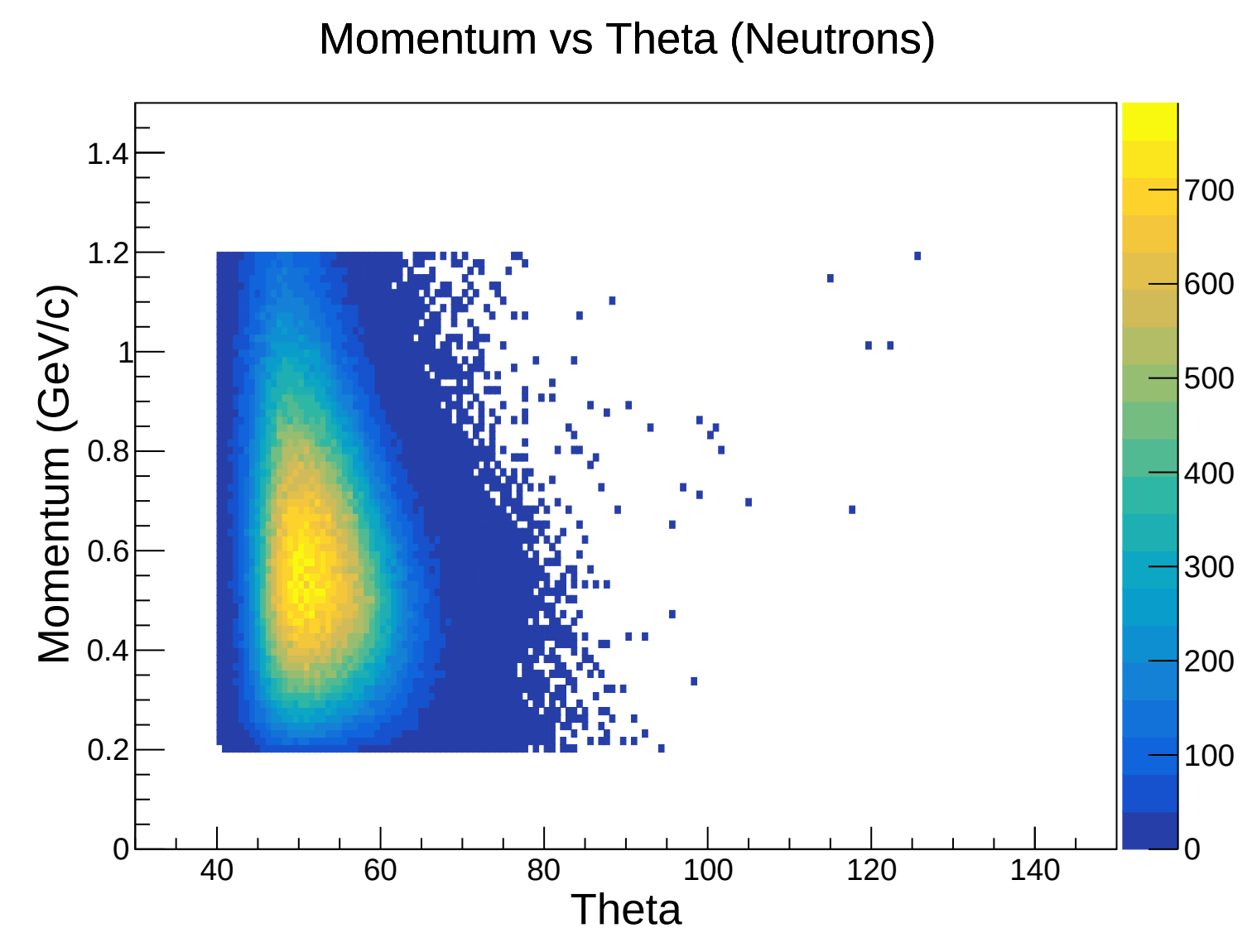
exclude θ_n=0, ϕ_n=0

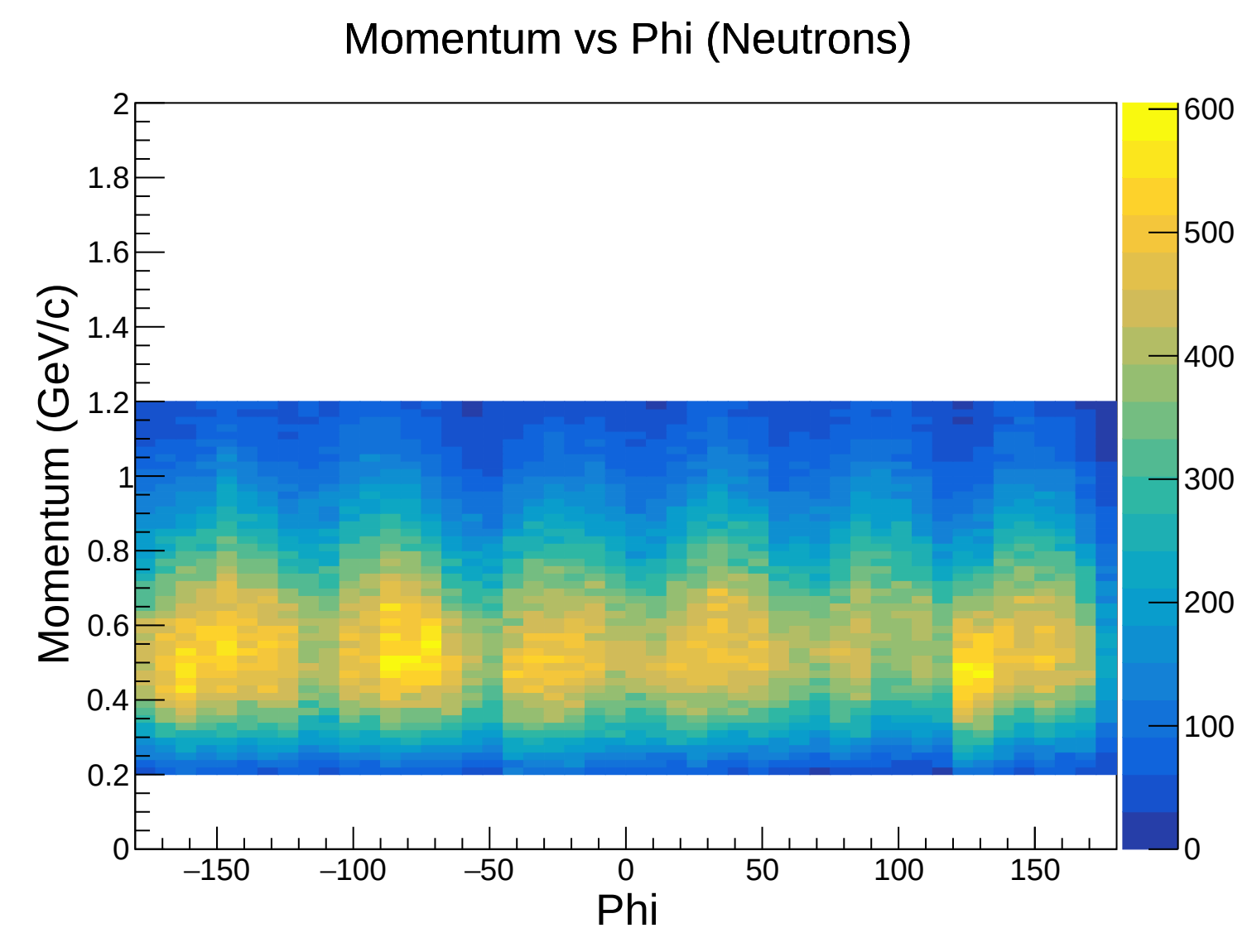
40 deg < θ_n < 140 deg

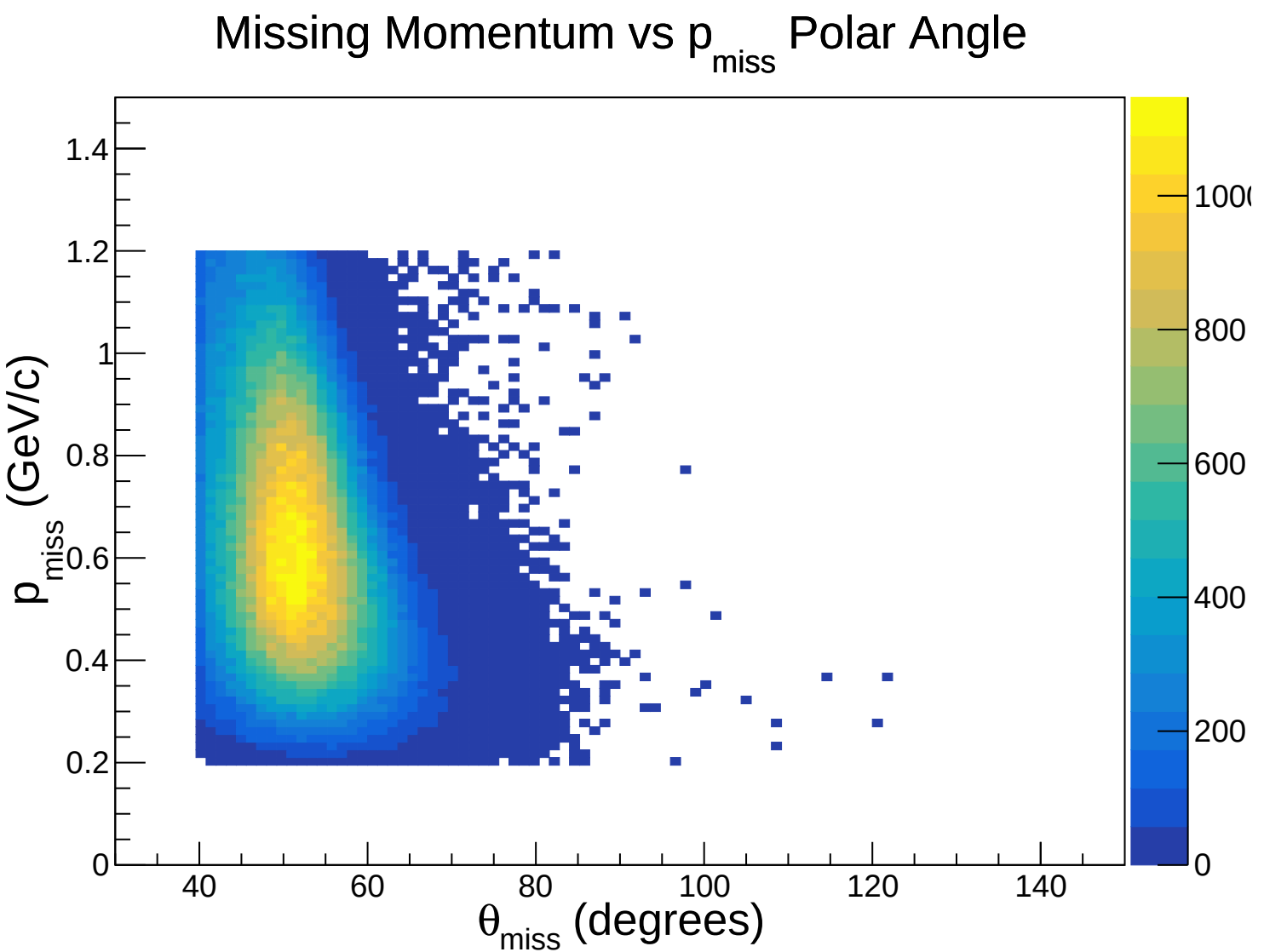
0.1 < β_n < 0.8

cos $\theta_{pmiss,pn}$ > 0.9

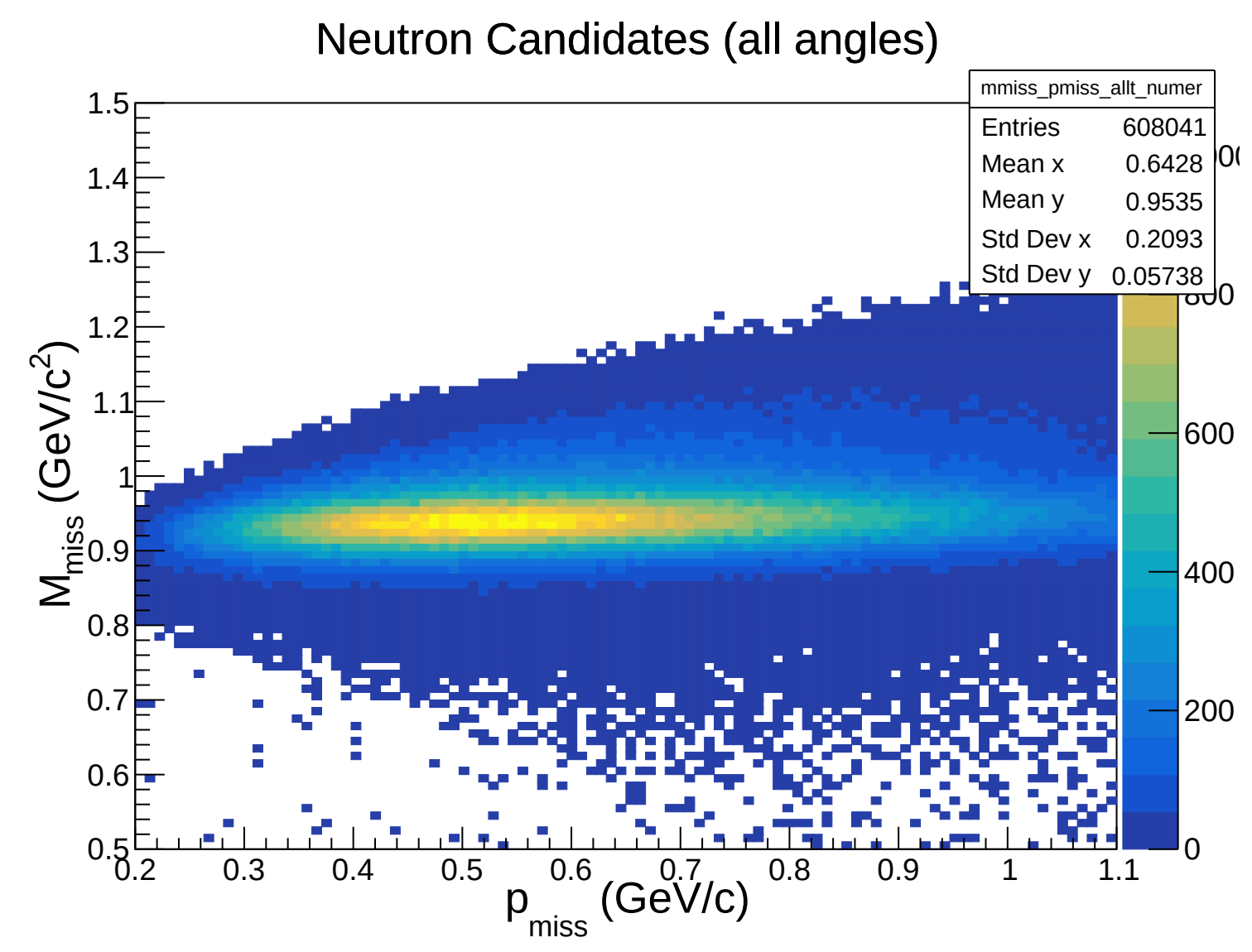

Missing Momentum vs Neutron Momentum
p miss
p neutron
0
0.2
0.4
0.6
0.8
1
1.2
1.4
200
400
600
800
1000
1200
1400

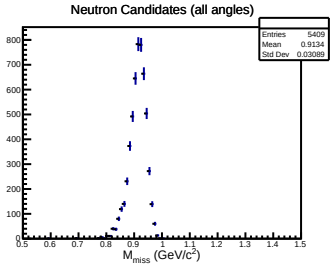

Momentum vs Theta (Neutrons)
Momentum (GeV/c)
Theta
0
0.2
0.4
0.6
0.8
1
1.2
1.4
40
60
80
100
120
140
0
100
200
300
400
500
600
700

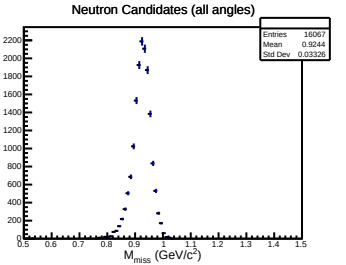

Momentum vs Phi (Neutrons)
Momentum (GeV/c)
Phi
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
−150
−100
−50
0
50
100
150
600
500
400
300
200
100
0

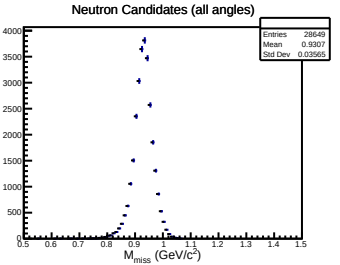

Missing Momentum vs p_miss Polar Angle
p_miss (GeV/c)
θ_miss (degrees)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
40
60
80
100
120
140
0
200
400
600
800
1000

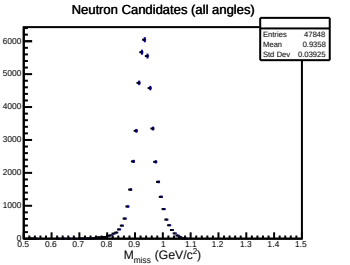
Get n_{eff} vs p (numerator)

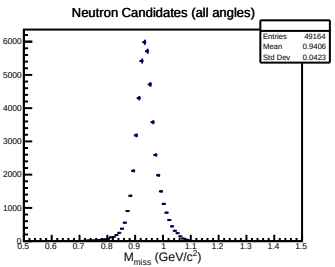

Neutron Candidates (all angles)
mmiss_pmiss_allt_numer
Entries 608041
Mean x 0.6428
Mean y 0.9535
Std Dev x 0.2093
Std Dev y 0.05738
M_miss (GeV/c^2)
p_miss (GeV/c)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
600
400
200
0

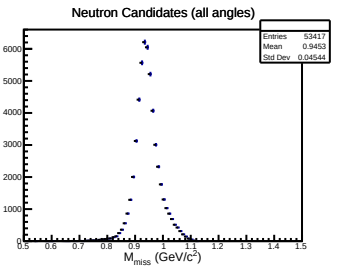

Neutron Candidates (all angles)
Entries 5409
Mean 0.9134
Std Dev 0.03089
M_miss (GeV/c²)

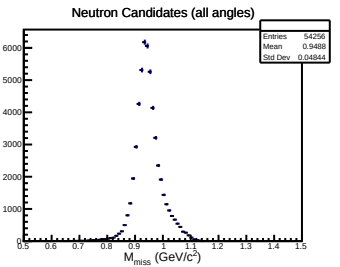

Neutron Candidates (all angles)
Entries 16067
Mean 0.9244
Std Dev 0.03326
M_miss (GeV/c²)

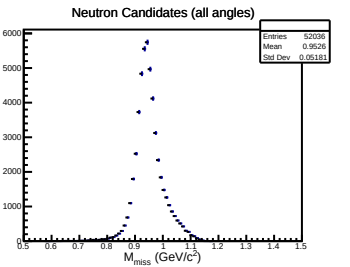

Neutron Candidates (all angles)
Entries 28649
Mean 0.9307
Std Dev 0.03565
M_miss (GeV/c²)

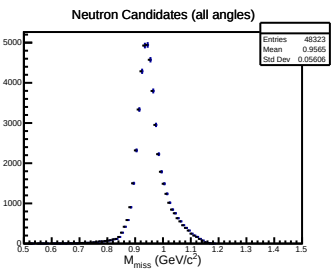

Neutron Candidates (all angles)
Entries 47848
Mean 0.9358
Std Dev 0.03925
M_miss (GeV/c²)

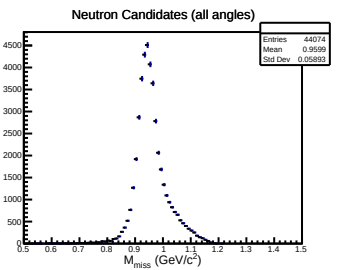

Neutron Candidates (all angles)
Entries 49164
Mean 0.9406
Std Dev 0.0423
M_miss (GeV/c²)

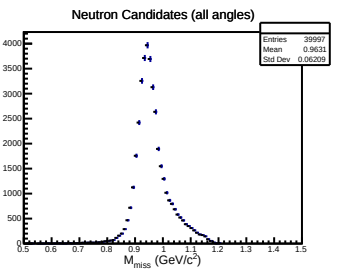

Neutron Candidates (all angles)
Entries 53417
Mean 0.9453
Std Dev 0.04544
M_miss (GeV/c²)

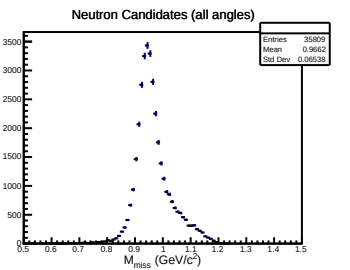

Neutron Candidates (all angles)
Entries 54256
Mean 0.9488
Std Dev 0.04844
M_miss (GeV/c²)

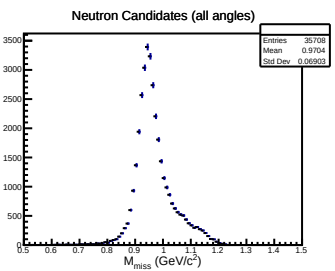

Neutron Candidates (all angles)
Entries 52036
Mean 0.9526
Std Dev 0.05181
M_miss (GeV/c²)

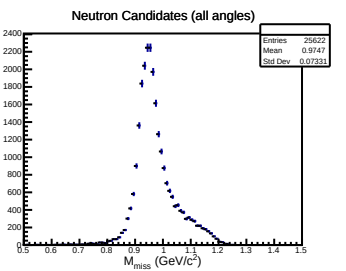

Neutron Candidates (all angles)
Entries 48323
Mean 0.9565
Std Dev 0.05606
M_miss (GeV/c²)

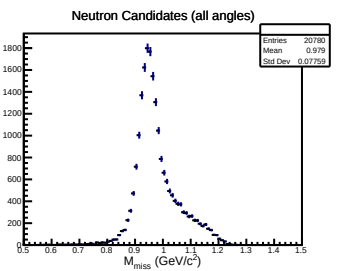

Neutron Candidates (all angles)
Entries 44074
Mean 0.9599
Std Dev 0.05893
M_miss (GeV/c²)

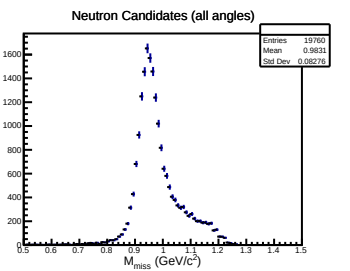

Neutron Candidates (all angles)
Entries 39997
Mean 0.9631
Std Dev 0.06209
M_miss (GeV/c²)

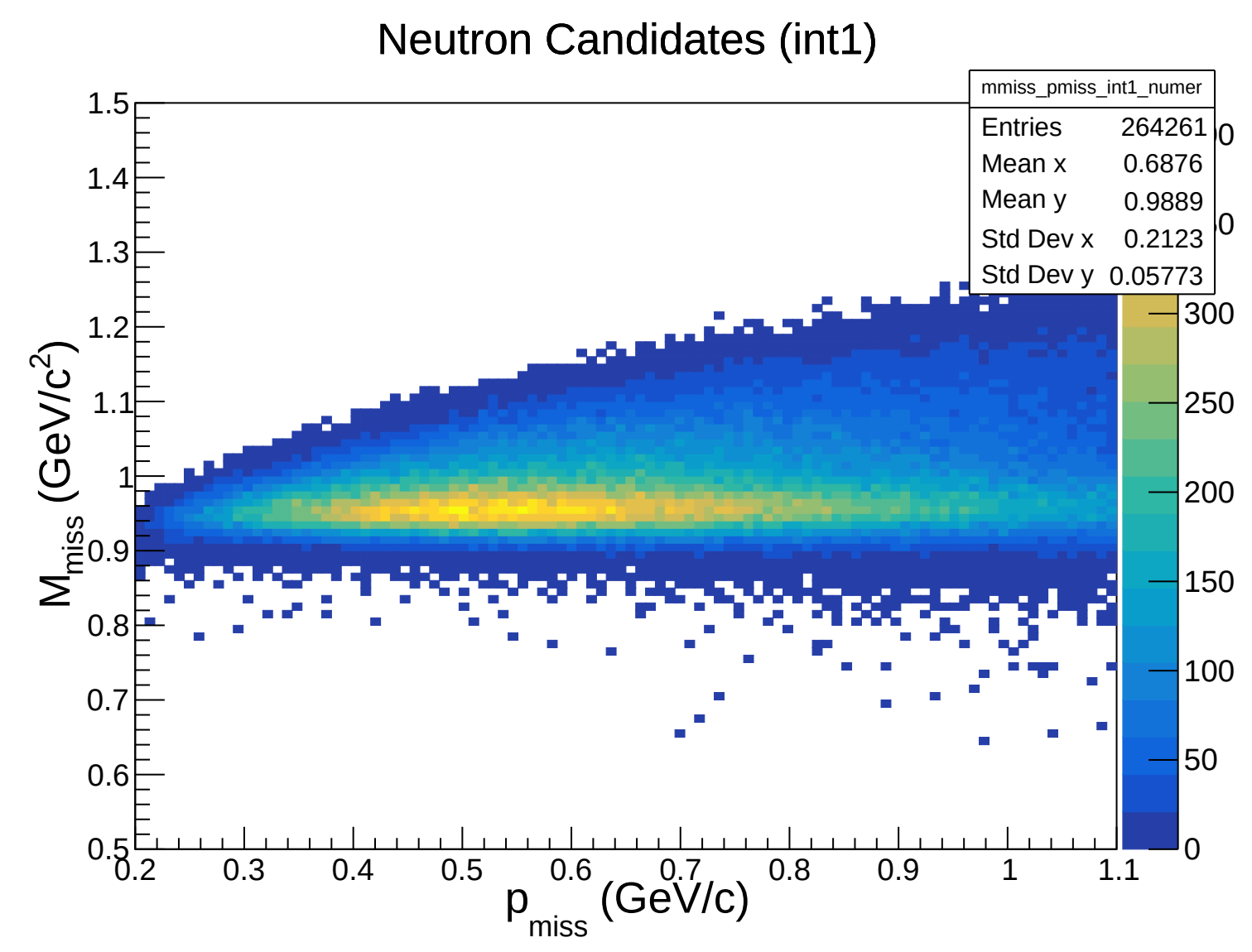

Neutron Candidates (all angles)
Entries 35809
Mean 0.9662
Std Dev 0.06538
M_miss (GeV/c²)

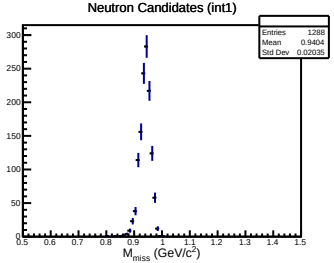

Neutron Candidates (all angles)
Entries 35708
Mean 0.9704
Std Dev 0.06903
M_miss (GeV/c²)

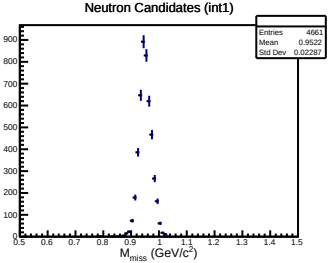

Neutron Candidates (all angles)
Entries 25622
Mean 0.9747
Std Dev 0.07331
M_miss (GeV/c²)

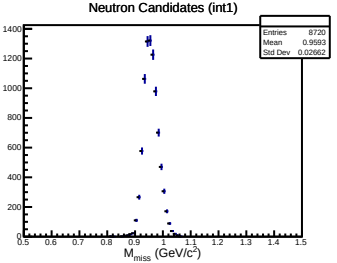

Neutron Candidates (all angles)
Entries 20780
Mean 0.979
Std Dev 0.07759
M_miss (GeV/c²)

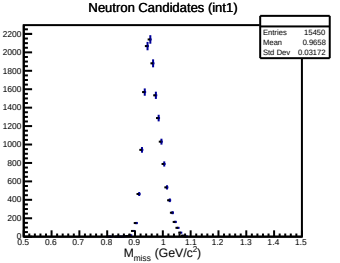

Neutron Candidates (all angles)
Entries 19760
Mean 0.9831
Std Dev 0.08276
M_miss (GeV/c²)

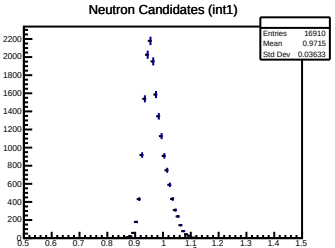

Neutron Candidates (int1)
mmiss_pmiss_int1_numer
Entries 264261
Mean x 0.6876
Mean y 0.9889
Std Dev x 0.2123
Std Dev y 0.05773
M_miss (GeV/c^2)
p_miss (GeV/c)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
300
250
200
150
100
50
0

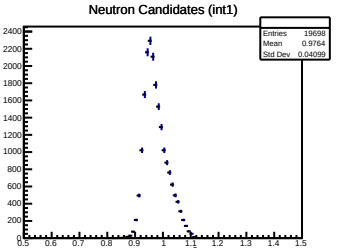

Neutron Candidates (int1)
Entries 1288
Mean 0.9404
Std Dev 0.02035
M_miss (GeV/c²)

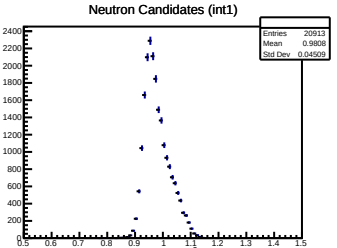

Neutron Candidates (int1)
Entries 4661
Mean 0.9522
Std Dev 0.02287
M_miss (GeV/c²)

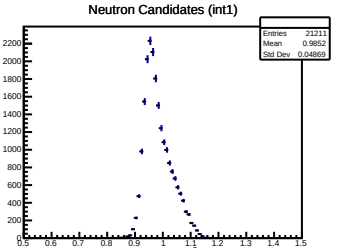

Neutron Candidates (int1)
Entries 8720
Mean 0.9593
Std Dev 0.02662
M_miss (GeV/c²)

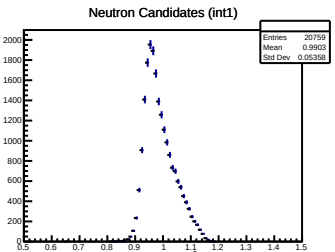

Neutron Candidates (int1)
Entries 15450
Mean 0.9658
Std Dev 0.03172
M_miss (GeV/c²)

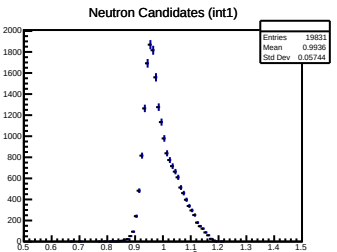

Neutron Candidates (int1)
Entries 16910
Mean 0.9715
Std Dev 0.03633
M_miss (GeV/c²)

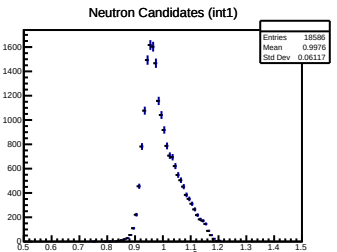

Neutron Candidates (int1)
Entries 19698
Mean 0.9764
Std Dev 0.04099
M_miss (GeV/c²)

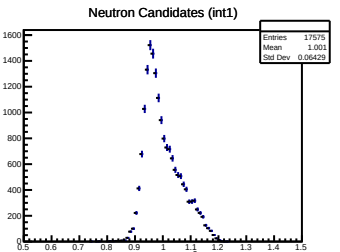

Neutron Candidates (int1)
Entries 20913
Mean 0.9808
Std Dev 0.04509
M_miss (GeV/c²)

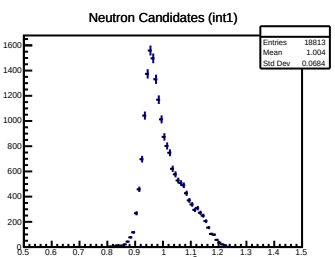

Neutron Candidates (int1)
Entries 21211
Mean 0.9852
Std Dev 0.04869
M_miss (GeV/c²)

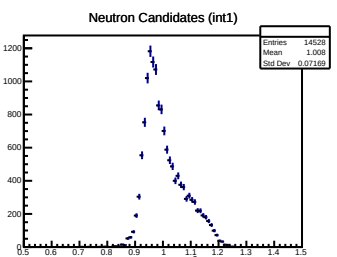

Neutron Candidates (int1)
Entries 20759
Mean 0.9903
Std Dev 0.05358
M_miss (GeV/c²)

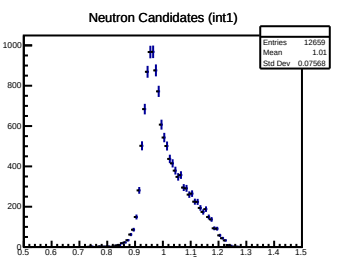

Neutron Candidates (int1)
Entries 19831
Mean 0.9936
Std Dev 0.05744
M_miss (GeV/c²)

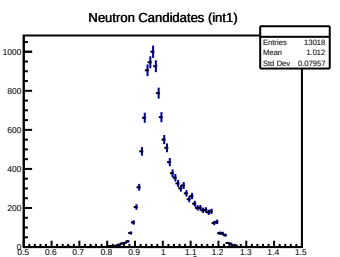

Neutron Candidates (int1)
Entries 18586
Mean 0.9976
Std Dev 0.06117
M_miss (GeV/c²)

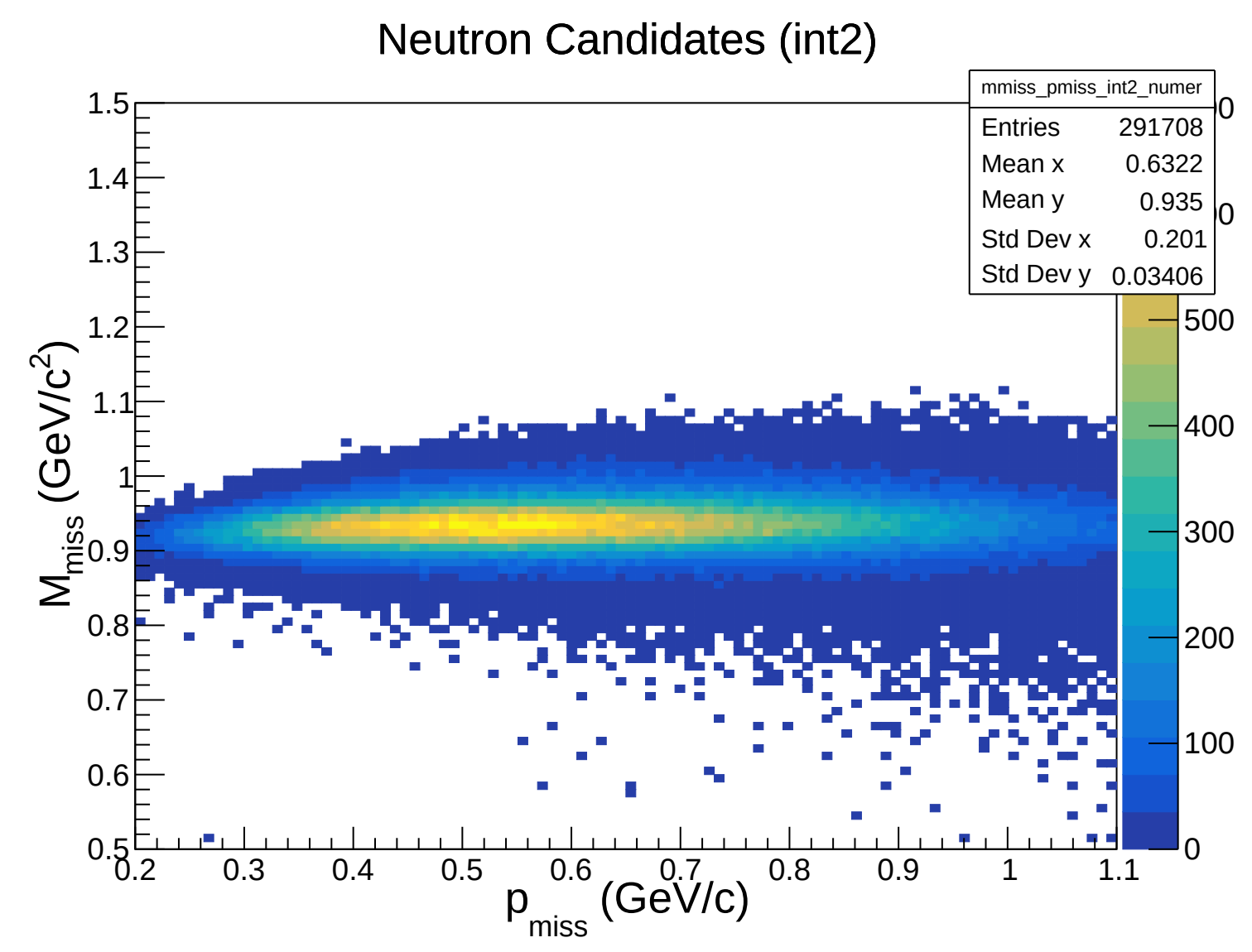

Neutron Candidates (int1)
Entries 17575
Mean 1.001
Std Dev 0.06429
M_miss (GeV/c²)

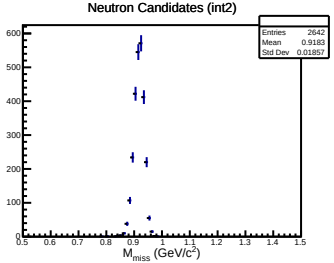

Neutron Candidates (int1)
Entries 18813
Mean 1.004
Std Dev 0.0684
M_miss (GeV/c²)

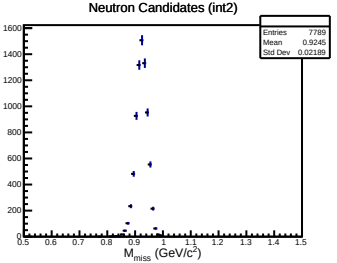

Neutron Candidates (int1)
Entries 14528
Mean 1.008
Std Dev 0.07169
M_miss (GeV/c²)

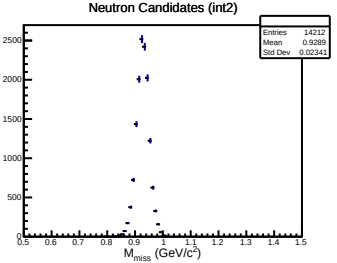

Neutron Candidates (int1)
Entries 12659
Mean 1.01
Std Dev 0.07568
M_miss (GeV/c²)

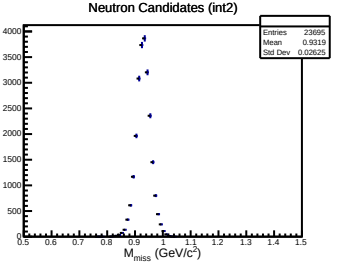

Neutron Candidates (int1)
Entries 13018
Mean 1.012
Std Dev 0.07957
M_miss (GeV/c²)

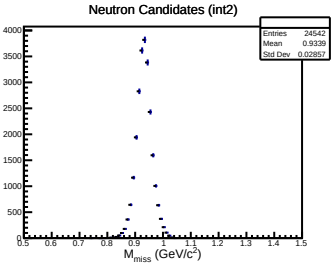

Neutron Candidates (int2)
mmiss_pmiss_int2_numer
Entries 291708
Mean x 0.6322
Mean y 0.935
Std Dev x 0.201
Std Dev y 0.03406
M_miss (GeV/c^2)
p_miss (GeV/c)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
500
400
300
200
100
0

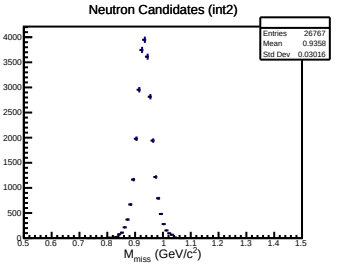

Neutron Candidates (int2)
Entries 2642
Mean 0.9183
Std Dev 0.01857
M_{miss} (GeV/c^2)

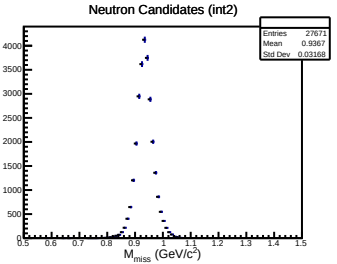

Neutron Candidates (int2)
Entries 7789
Mean 0.9245
Std Dev 0.02189
M_{miss} (GeV/c^2)

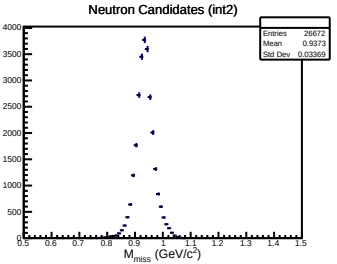

Neutron Candidates (int2)
Entries 14212
Mean 0.9289
Std Dev 0.02341
M_{miss} (GeV/c^2)

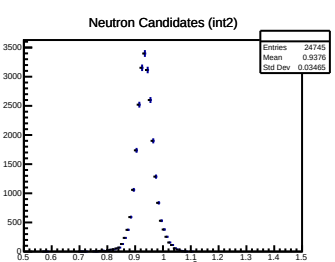

Neutron Candidates (int2)
Entries 23695
Mean 0.9319
Std Dev 0.02625
M_{miss} (GeV/c^2)

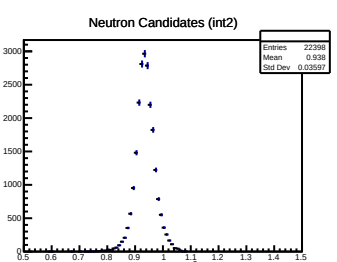

Neutron Candidates (int2)
Entries 24542
Mean 0.9339
Std Dev 0.02857
M_{miss} (GeV/c^2)

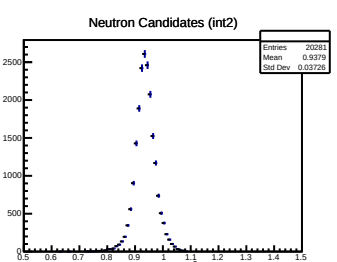

Neutron Candidates (int2)
Entries 26767
Mean 0.9358
Std Dev 0.03016
M_{miss} (GeV/c^2)

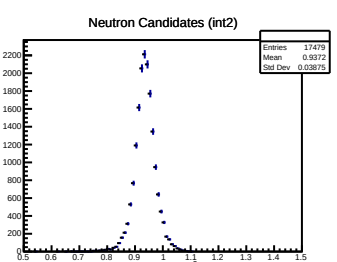

Neutron Candidates (int2)
Entries 27671
Mean 0.9367
Std Dev 0.03168
M_{miss} (GeV/c^2)

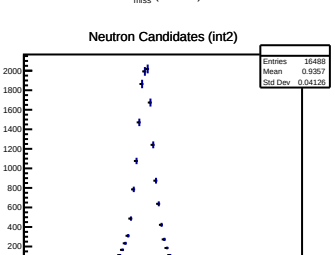

Neutron Candidates (int2)
Entries 26672
Mean 0.9373
Std Dev 0.03369
M_{miss} (GeV/c^2)

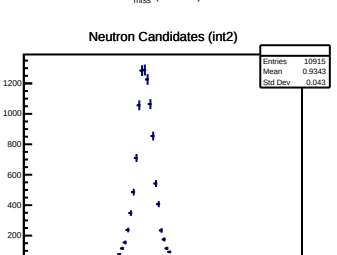

Neutron Candidates (int2)
Entries 24745
Mean 0.9376
Std Dev 0.03468
M_{miss} (GeV/c^2)

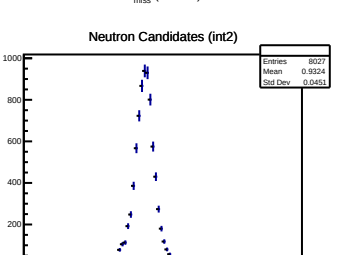

Neutron Candidates (int2)
Entries 22398
Mean 0.938
Std Dev 0.03597
M_{miss} (GeV/c^2)

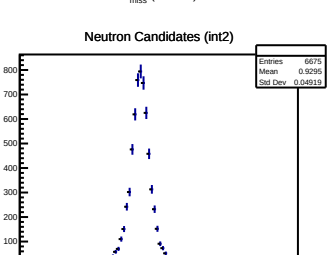

Neutron Candidates (int2)
Entries 20281
Mean 0.9379
Std Dev 0.03726
M_{miss} (GeV/c^2)

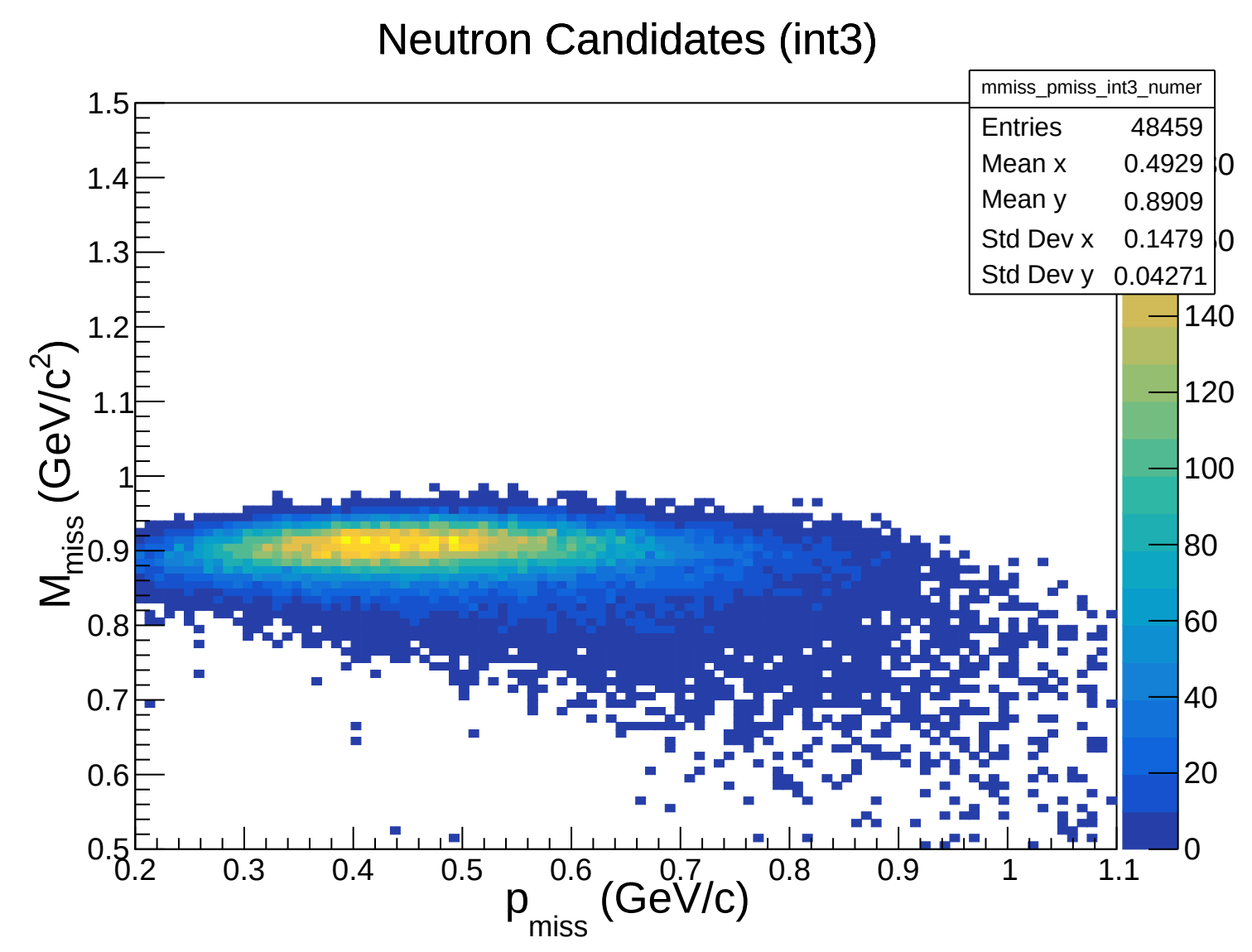

Neutron Candidates (int2)
Entries 17479
Mean 0.9372
Std Dev 0.03875
M_{miss} (GeV/c^2)

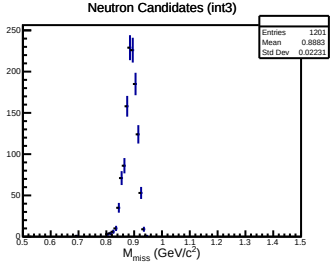

Neutron Candidates (int2)
Entries 16488
Mean 0.9357
Std Dev 0.04126
M_{miss} (GeV/c^2)

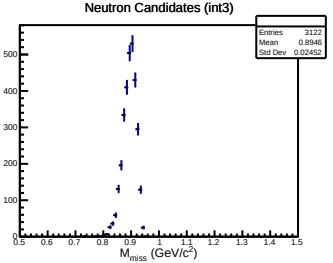

Neutron Candidates (int2)
Entries 10915
Mean 0.9343
Std Dev 0.043
M_{miss} (GeV/c^2)

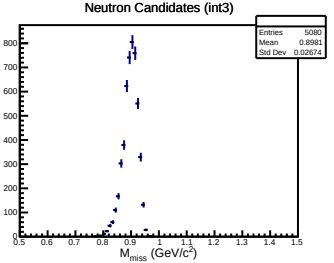

Neutron Candidates (int2)
Entries 8027
Mean 0.9324
Std Dev 0.0451
M_{miss} (GeV/c^2)

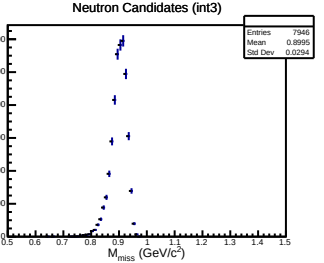

Neutron Candidates (int2)
Entries 6675
Mean 0.9295
Std Dev 0.04919
M_{miss} (GeV/c^2)

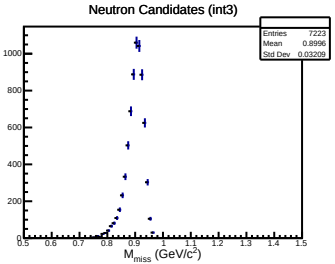

Neutron Candidates (int3)
mmiss_pmiss_int3_numer
Entries 48459
Mean x 0.4929
Mean y 0.8909
Std Dev x 0.1479
Std Dev y 0.04271
M_miss (GeV/c^2)
p_miss (GeV/c)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
140
120
100
80
60
40
20
0

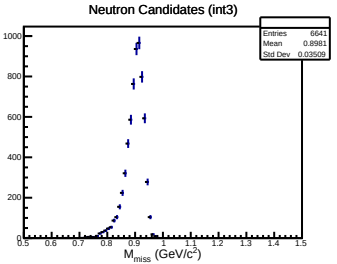

Neutron Candidates (int3)
Entries 1201
Mean 0.8863
Std Dev 0.02231
M_miss (GeV/c²)

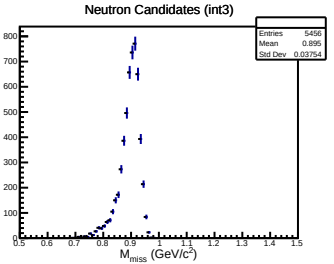

Neutron Candidates (int3)
Entries 3122
Mean 0.8946
Std Dev 0.02452
M_miss (GeV/c²)

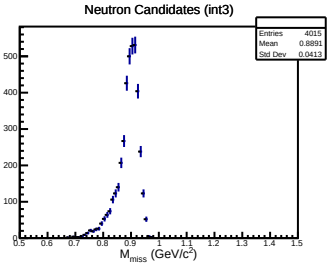

Neutron Candidates (int3)
Entries 5080
Mean 0.8981
Std Dev 0.02674
M_miss (GeV/c²)

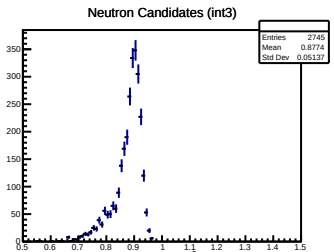

Neutron Candidates (int3)
Entries 7946
Mean 0.8995
Std Dev 0.0294
M_miss (GeV/c²)

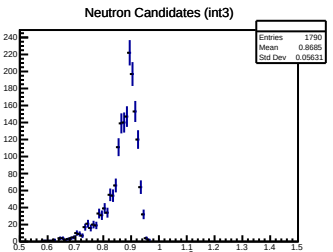

Neutron Candidates (int3)
Entries 7223
Mean 0.8996
Std Dev 0.03209
M_miss (GeV/c²)

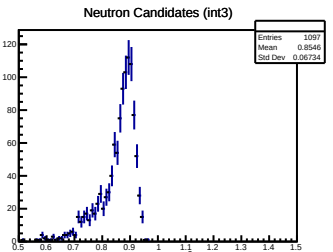

Neutron Candidates (int3)
Entries 6641
Mean 0.8981
Std Dev 0.03509
M_miss (GeV/c²)

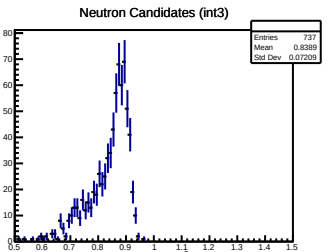

Neutron Candidates (int3)
Entries 5456
Mean 0.895
Std Dev 0.03754
M_miss (GeV/c²)

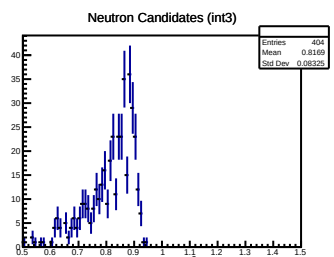

Neutron Candidates (int3)
Entries 4015
Mean 0.8891
Std Dev 0.0413
M_miss (GeV/c²)

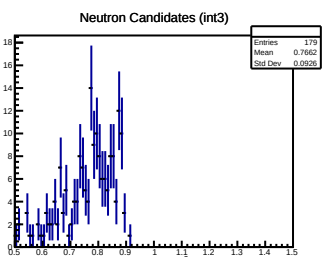

Neutron Candidates (int3)
Entries 2745
Mean 0.8774
Std Dev 0.05137
M_miss (GeV/c²)

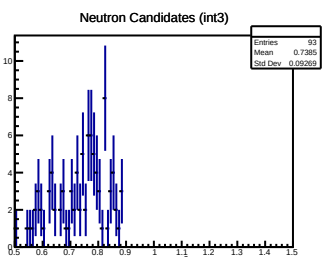

Neutron Candidates (int3)
Entries 1790
Mean 0.8685
Std Dev 0.05631
M_miss (GeV/c²)

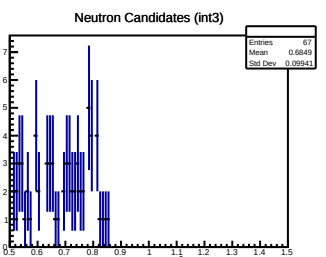

Neutron Candidates (int3)
Entries 1097
Mean 0.8546
Std Dev 0.06734
M_miss (GeV/c²)

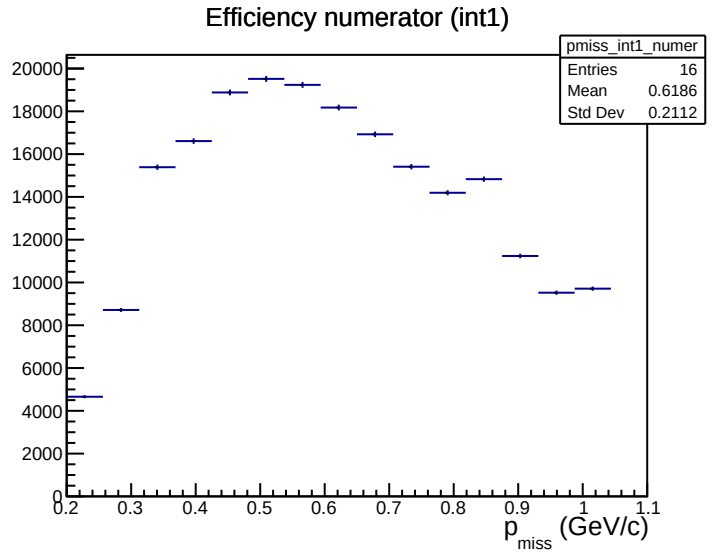

Neutron Candidates (int3)
Entries 737
Mean 0.8389
Std Dev 0.07209
M_miss (GeV/c²)

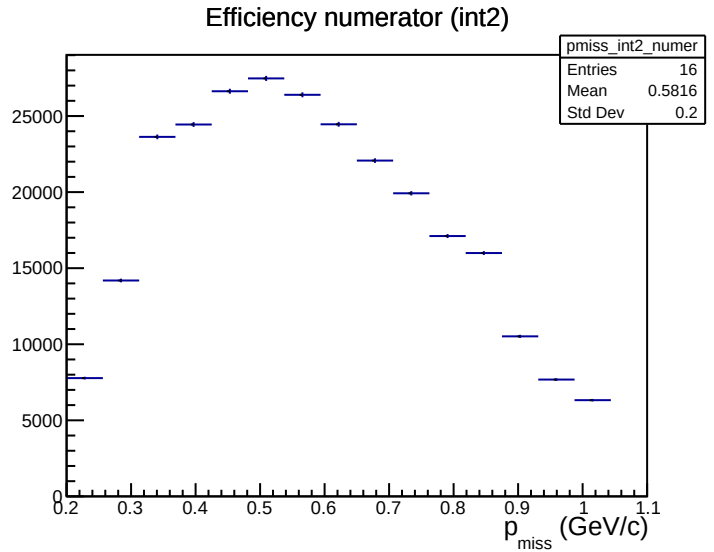

Neutron Candidates (int3)
Entries 404
Mean 0.8169
Std Dev 0.08325
M_miss (GeV/c²)

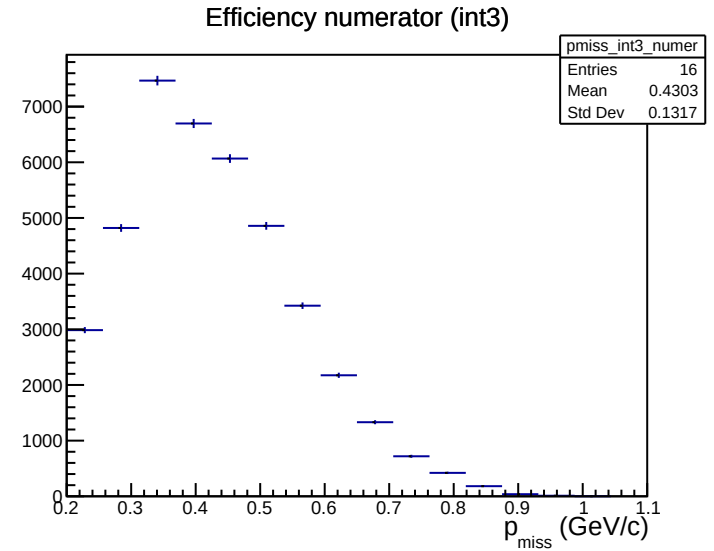

Neutron Candidates (int3)
Entries 179
Mean 0.7662
Std Dev 0.0926
M_miss (GeV/c²)


Neutron Candidates (int3)
Entries 93
Mean 0.7385
Std Dev 0.09269
M_miss (GeV/c²)

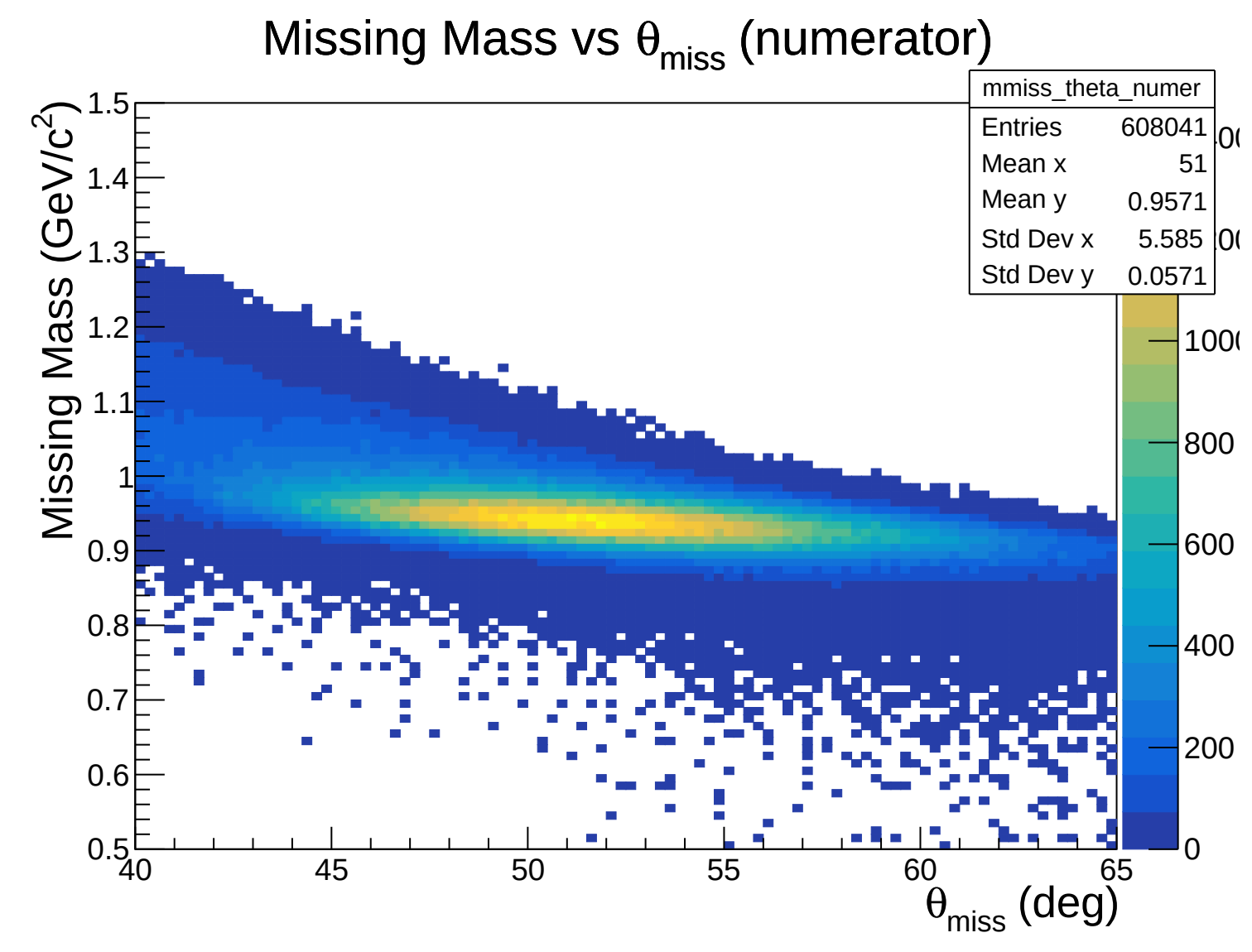

Neutron Candidates (int3)
Entries 67
Mean 0.6849
Std Dev 0.09941
M_miss (GeV/c²)

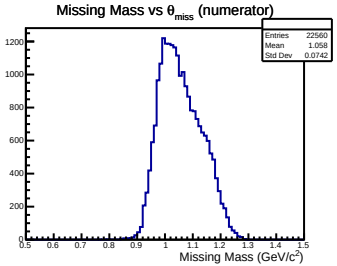

Efficiency numerator (int1)
pmiss_int1_numer
Entries 16
Mean 0.6186
Std Dev 0.2112
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1
p_miss (GeV/c)

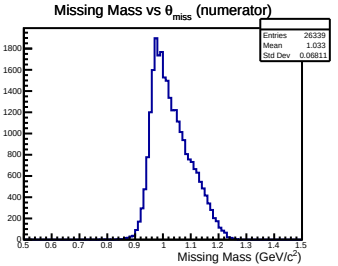

Efficiency numerator (int2)
pmiss_int2_numer
Entries 16
Mean 0.5816
Std Dev 0.2
25000
20000
15000
10000
5000
0
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1
p_miss (GeV/c)

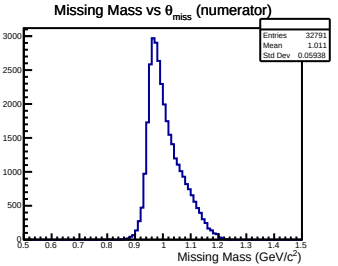

Efficiency numerator (int3)
pmiss_int3_numer
Entries 16
Mean 0.4303
Std Dev 0.1317
7000
6000
5000
4000
3000
2000
1000
0
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1
p_miss (GeV/c)

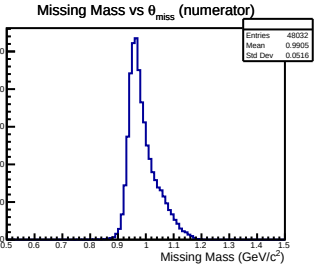
Theta numerator

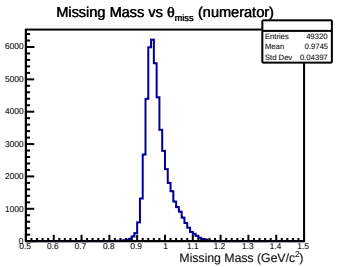

Missing Mass vs θmiss (numerator)
mmiss_theta_numer
Entries 608041
Mean x 51
Mean y 0.9571
Std Dev x 5.585
Std Dev y 0.0571
Missing Mass (GeV/c2)
θmiss (deg)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
40
45
50
55
60
65
1000
800
600
400
200
0

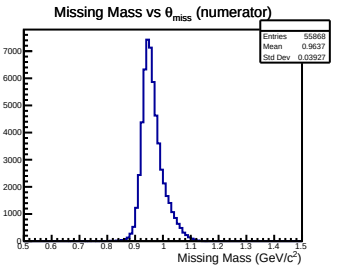

Missing Mass vs θmiss (numerator)
Entries 22560
Mean 1.058
Std Dev 0.0742
Missing Mass (GeV/c2)

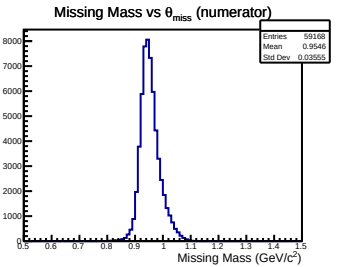

Missing Mass vs θmiss (numerator)
Entries 26339
Mean 1.023
Std Dev 0.06811
Missing Mass (GeV/c2)

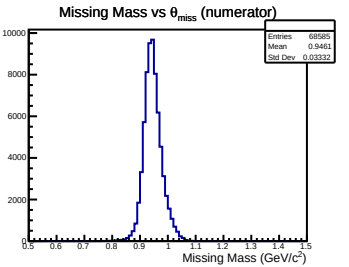

Missing Mass vs θmiss (numerator)
Entries 32791
Mean 1.011
Std Dev 0.05938
Missing Mass (GeV/c2)

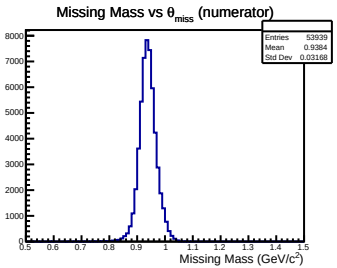

Missing Mass vs θmiss (numerator)
Entries 48032
Mean 0.9905
Std Dev 0.0516
Missing Mass (GeV/c2)

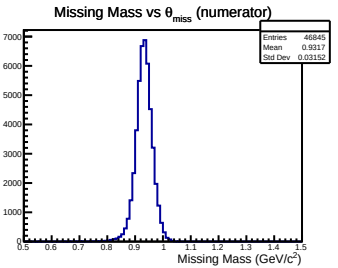

Missing Mass vs θmiss (numerator)
Entries 49320
Mean 0.9745
Std Dev 0.04397
Missing Mass (GeV/c2)

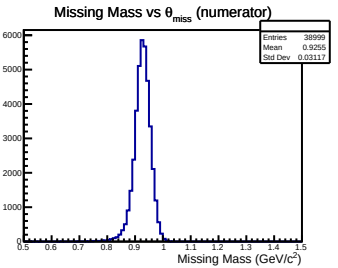

Missing Mass vs θmiss (numerator)
Entries 55868
Mean 0.9637
Std Dev 0.03927
Missing Mass (GeV/c2)

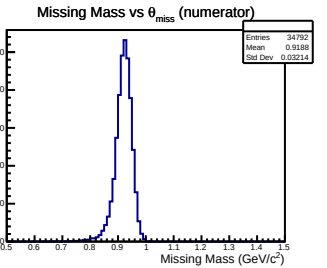

Missing Mass vs θmiss (numerator)
Entries 59168
Mean 0.9546
Std Dev 0.03555
Missing Mass (GeV/c2)

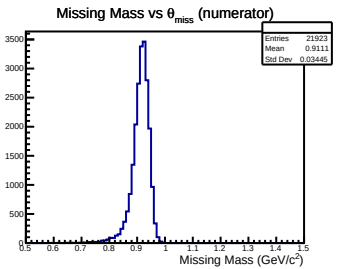

Missing Mass vs θmiss (numerator)
Entries 68585
Mean 0.9461
Std Dev 0.03332
Missing Mass (GeV/c2)

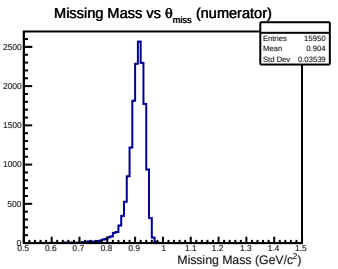

Missing Mass vs θmiss (numerator)
Entries 53939
Mean 0.9384
Std Dev 0.03168
Missing Mass (GeV/c2)

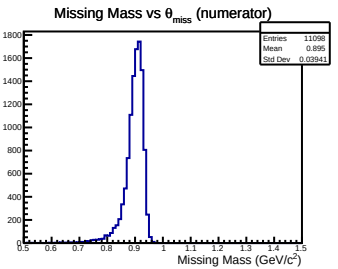

Missing Mass vs θmiss (numerator)
Entries 46845
Mean 0.9317
Std Dev 0.03152
Missing Mass (GeV/c2)

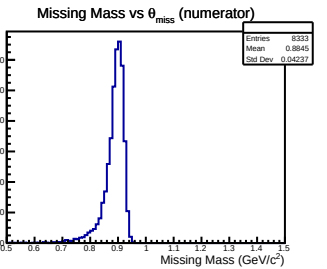

Missing Mass vs θmiss (numerator)
Entries 38999
Mean 0.9255
Std Dev 0.03117
Missing Mass (GeV/c2)

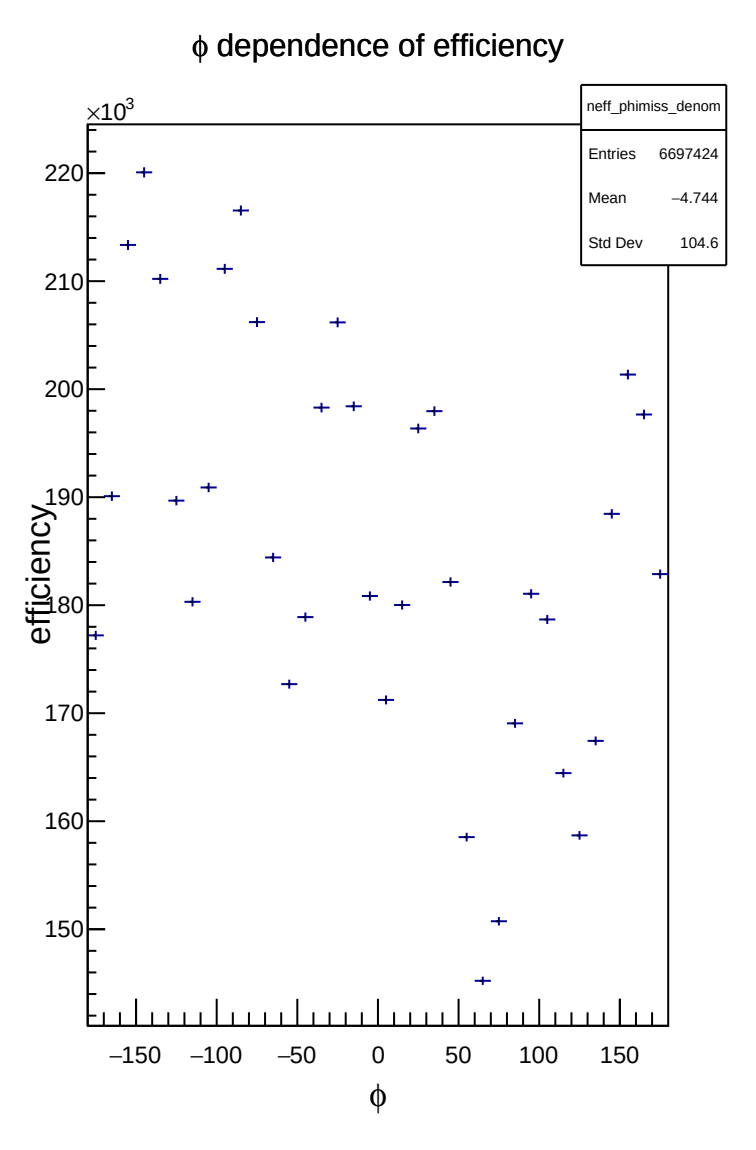

Missing Mass vs θmiss (numerator)
Entries 34792
Mean 0.9188
Std Dev 0.03214
Missing Mass (GeV/c2)

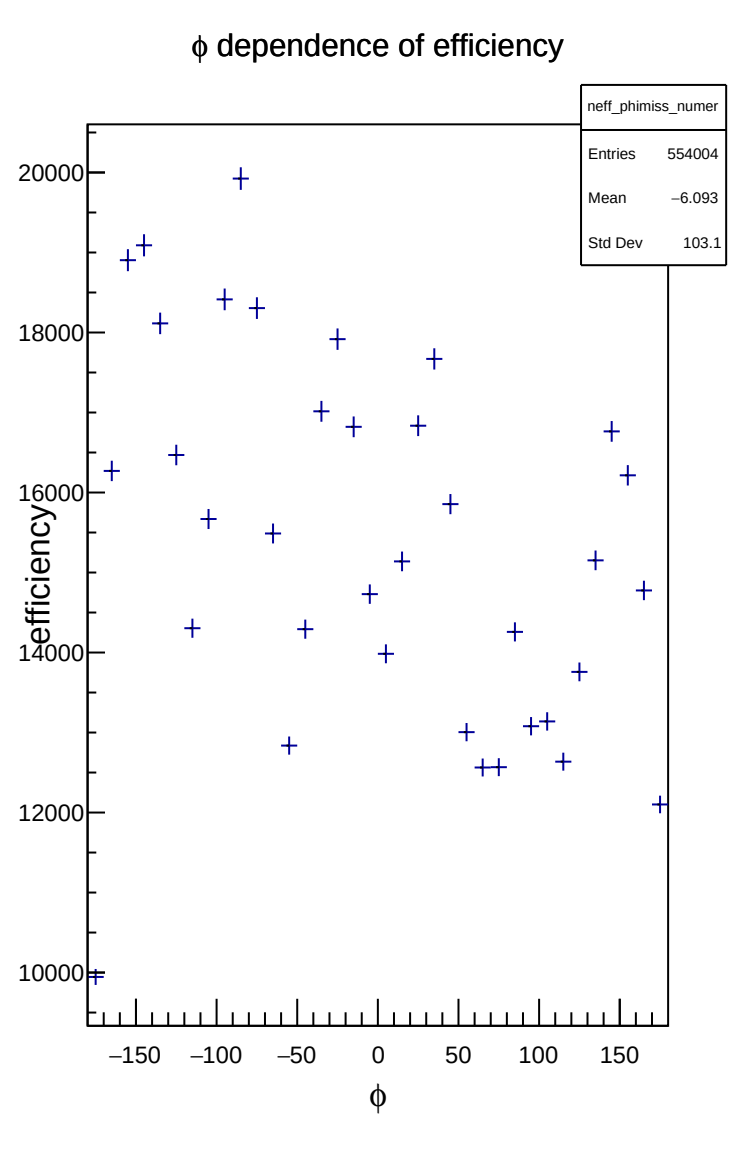

Missing Mass vs θmiss (numerator)
Entries 21923
Mean 0.9111
Std Dev 0.03445
Missing Mass (GeV/c2)

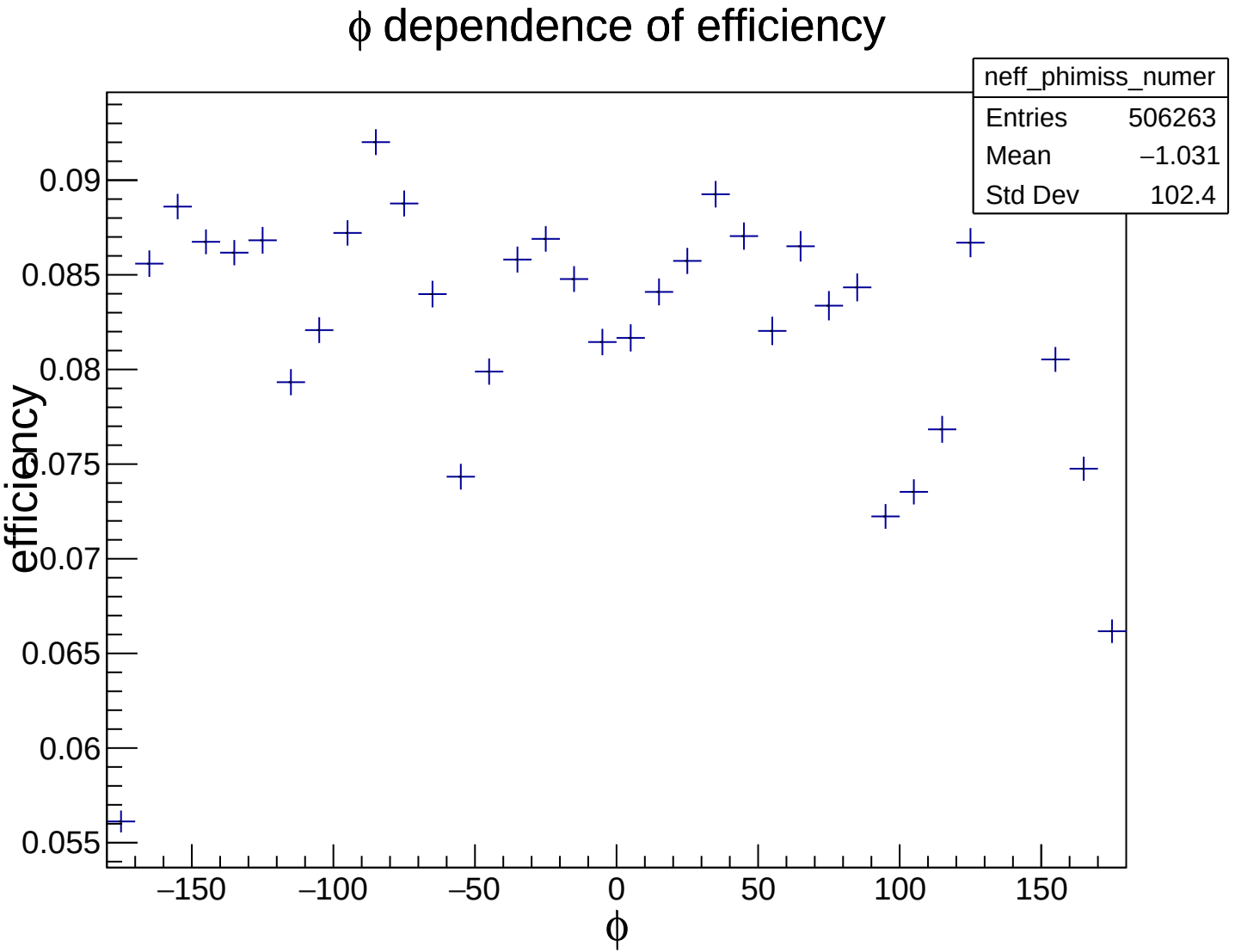

Missing Mass vs θmiss (numerator)
Entries 15950
Mean 0.904
Std Dev 0.03539
Missing Mass (GeV/c2)


Missing Mass vs θmiss (numerator)
Entries 11098
Mean 0.895
Std Dev 0.03941
Missing Mass (GeV/c2)

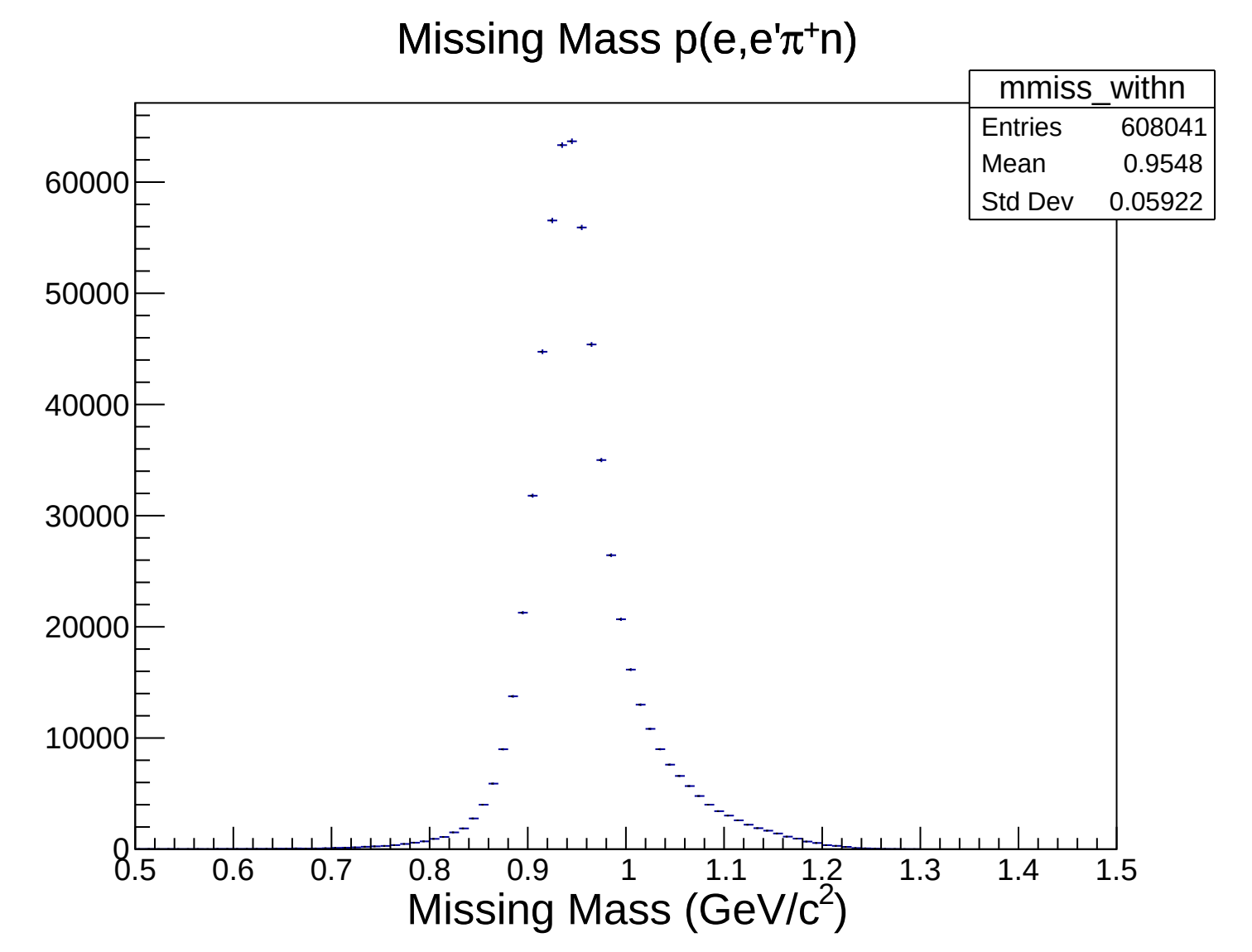

Missing Mass vs θmiss (numerator)
Entries 8333
Mean 0.8845
Std Dev 0.04237
Missing Mass (GeV/c2)

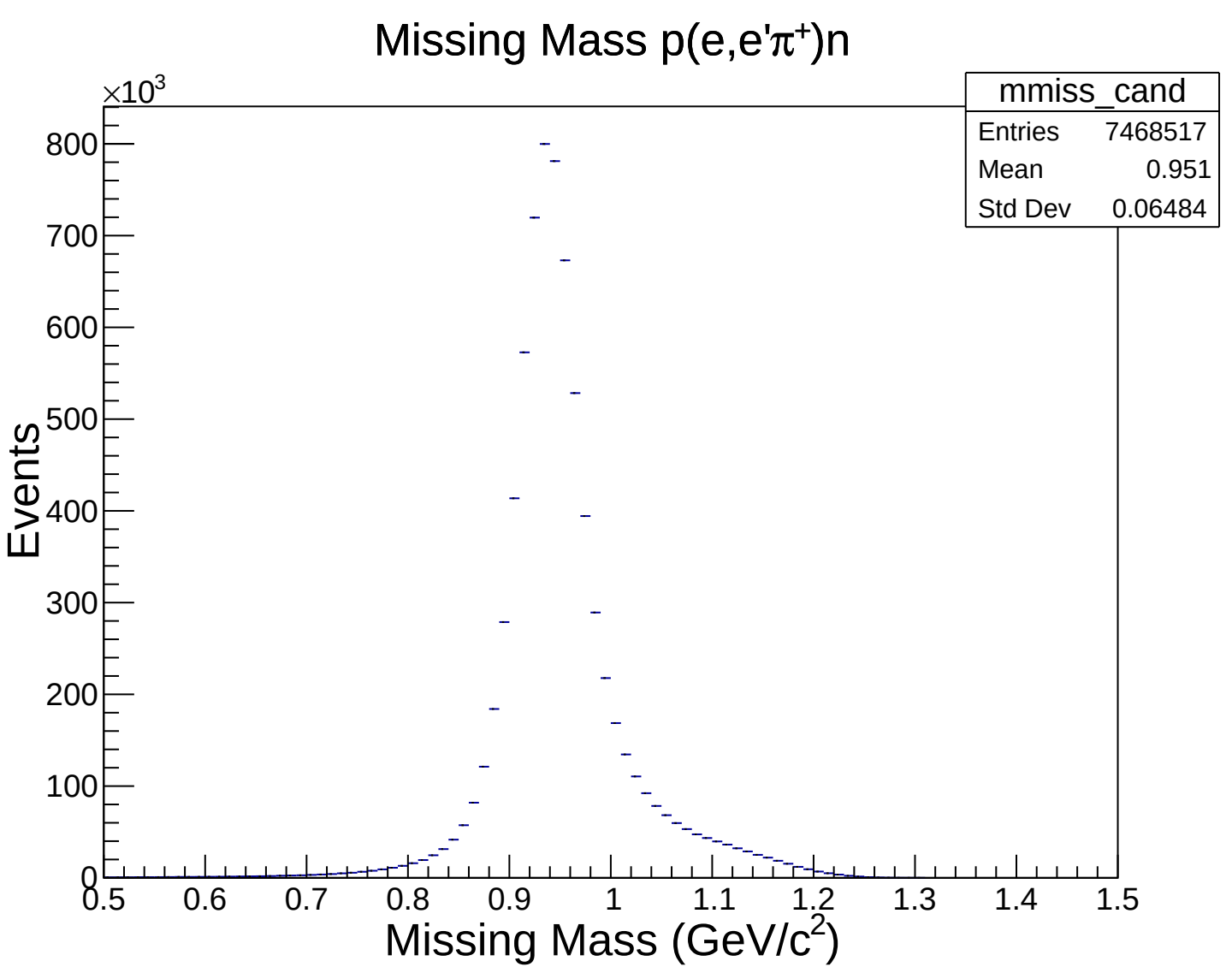

ϕ dependence of efficiency
neff_phimiss_denom
Entries 6697424
Mean −4.744
Std Dev 104.6
×10^3
efficiency
ϕ


ϕ dependence of efficiency
neff_phimiss_numer
Entries 554004
Mean −6.093
Std Dev 103.1
efficiency
ϕ

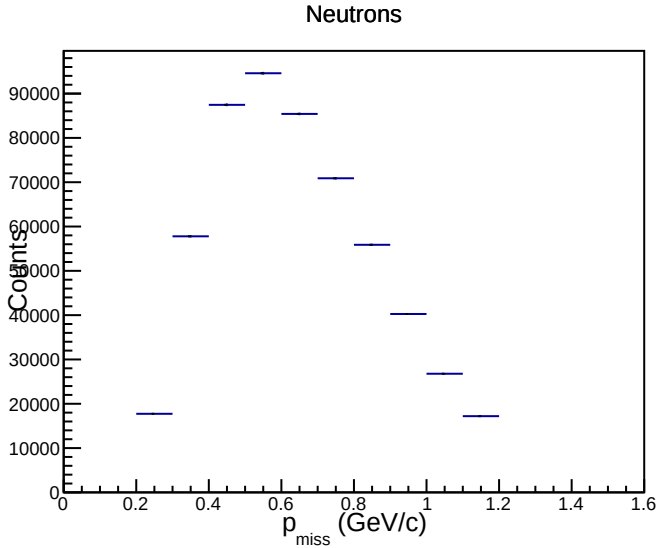

ϕ dependence of efficiency
neff_phimiss_numer
Entries 506263
Mean −1.031
Std Dev 102.4
efficiency
0.09
0.085
0.08
0.075
0.07
0.065
0.06
0.055
−150
−100
−50
0
50
100
150
ϕ

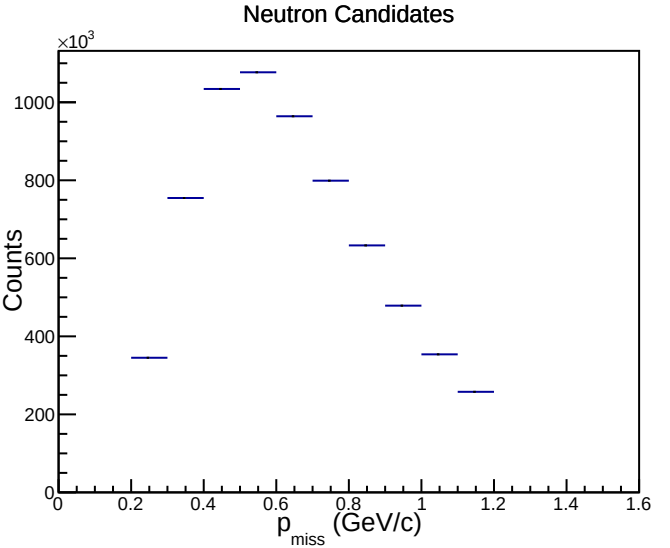
Denominator and numerator missing mass

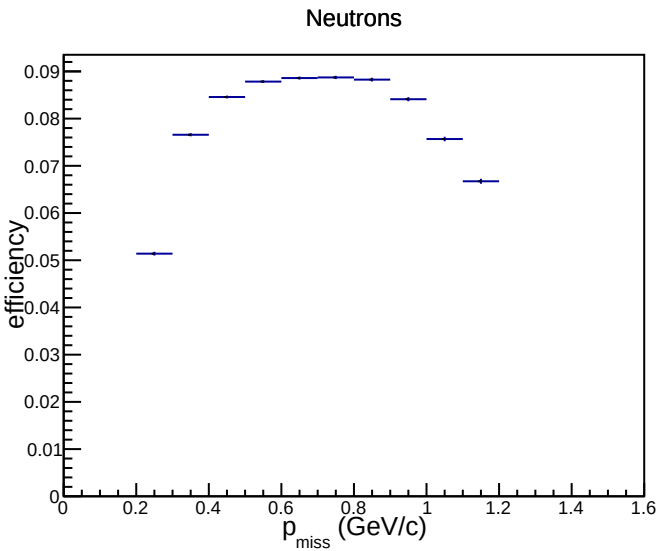

Missing Mass p(e,e'π+n)
mmiss_withn
Entries 608041
Mean 0.9548
Std Dev 0.05922
60000
50000
40000
30000
20000
10000
0
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
Missing Mass (GeV/c2)

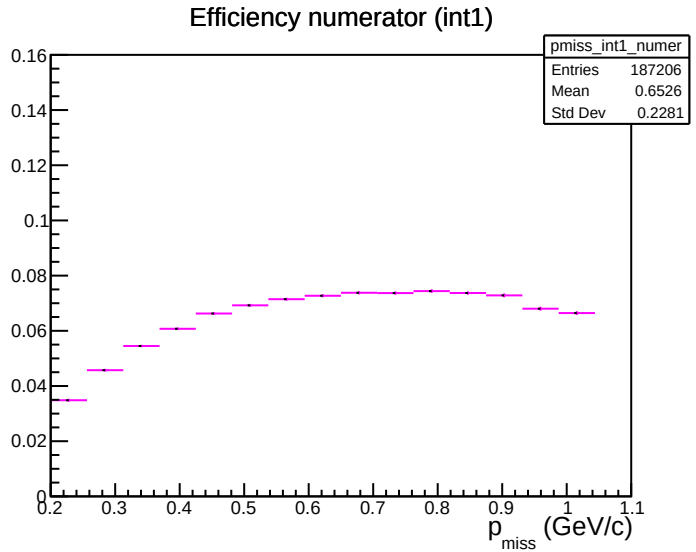

Missing Mass p(e,e'π+)n
mmiss_cand
Entries 7468517
Mean 0.951
Std Dev 0.06484
×10^3
800
700
600
500
400
300
200
100
0
Events
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
Missing Mass (GeV/c^2)

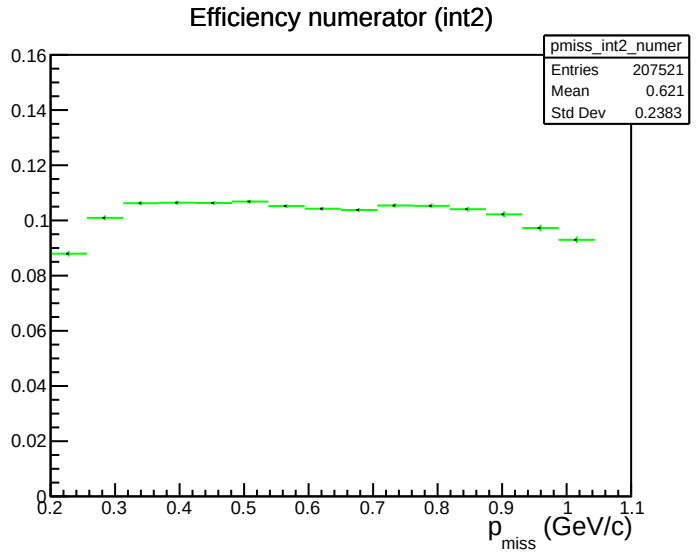
Efficiency results

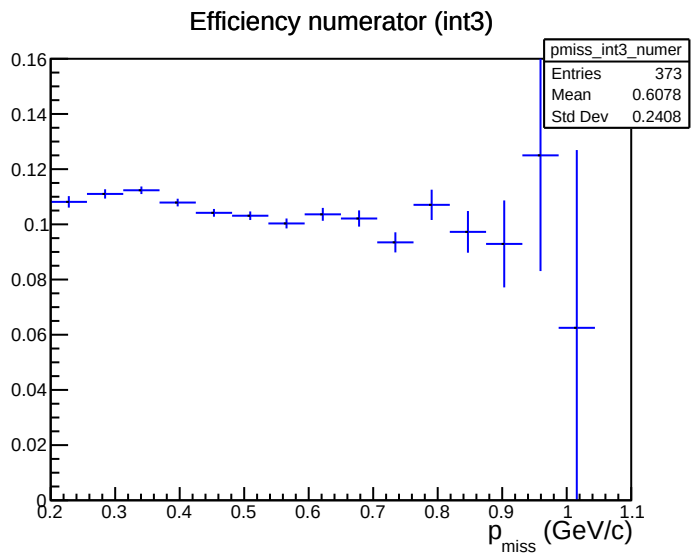

Neutrons
Counts
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
p miss (GeV/c)

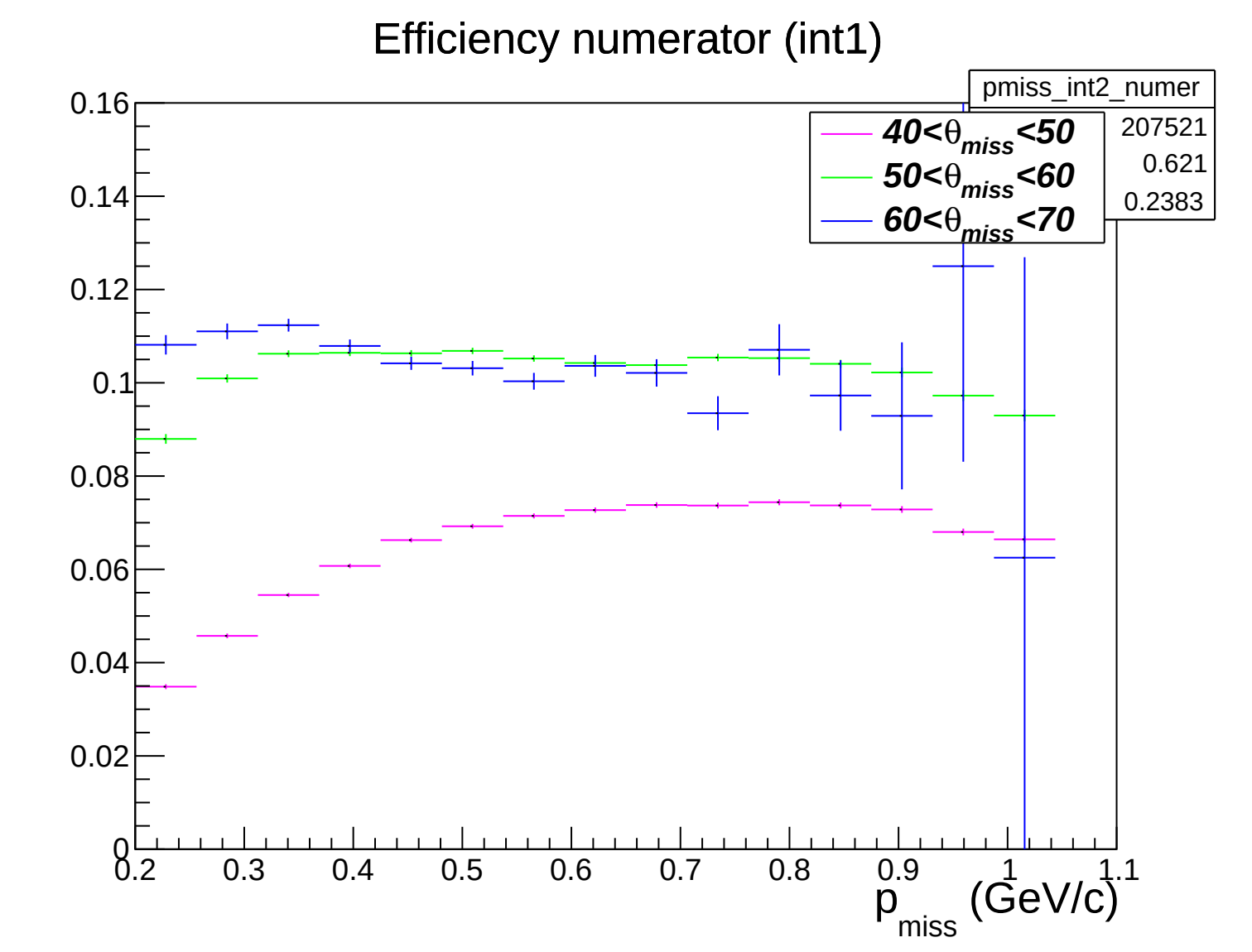

Neutron Candidates
×10^3
Counts
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
p miss (GeV/c)

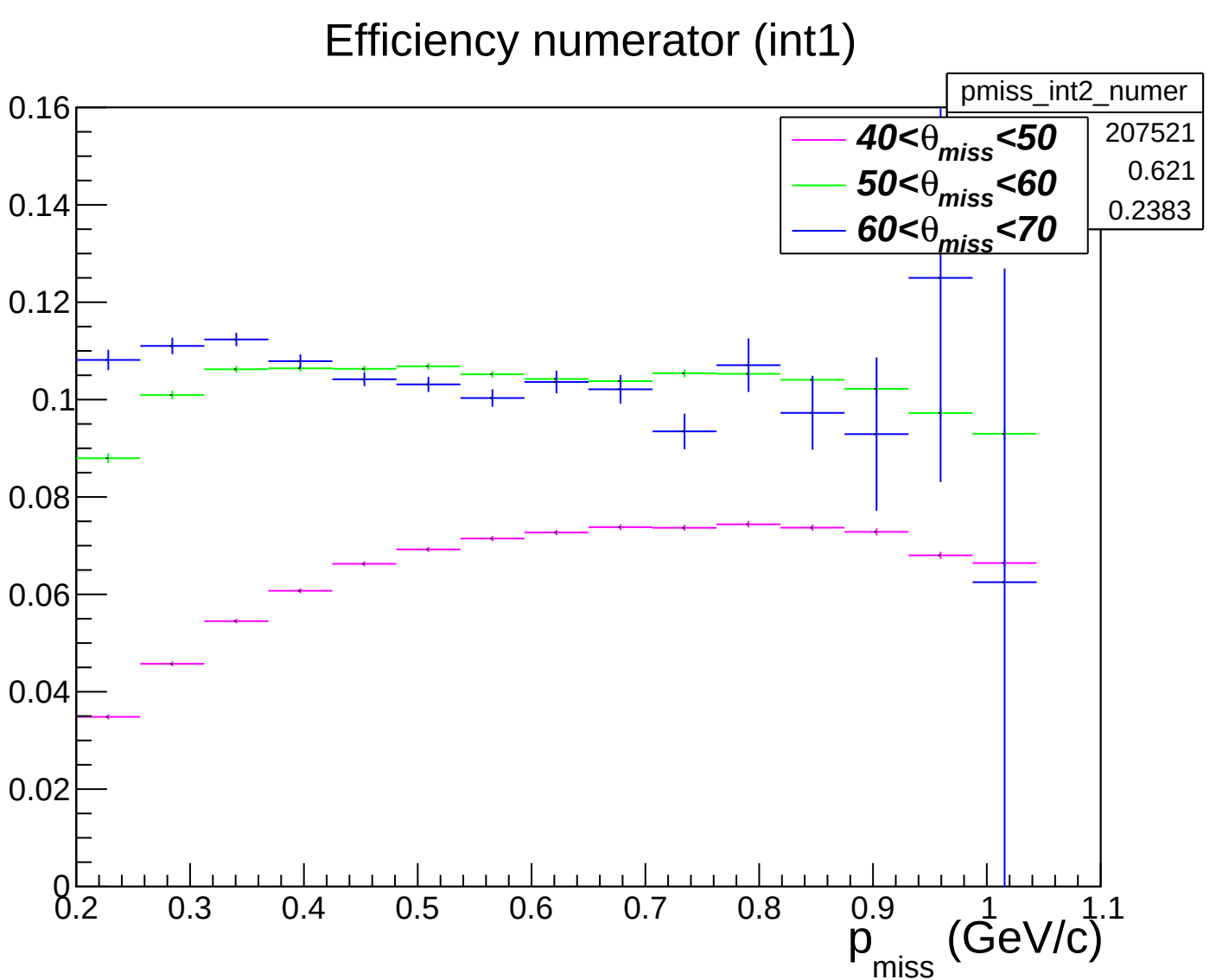

Neutrons
efficiency
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
p miss (GeV/c)

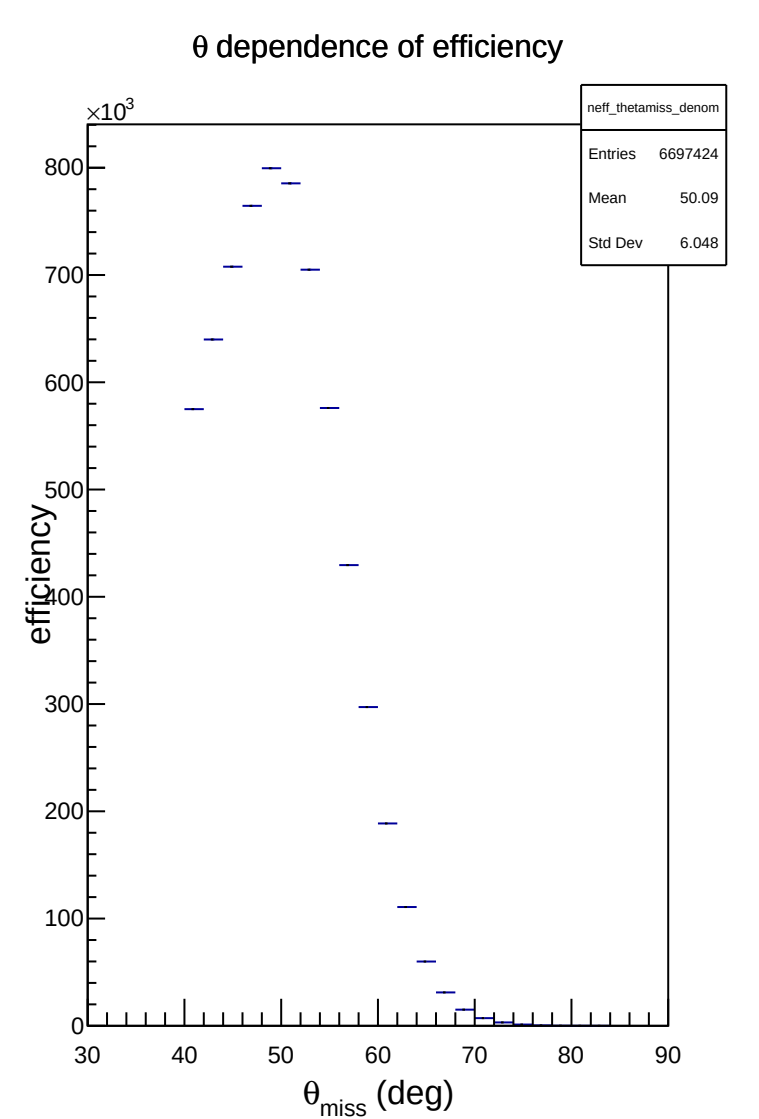

Efficiency numerator (int1)
pmiss_int1_numer
Entries 187206
Mean 0.6526
Std Dev 0.2281
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1
p_miss (GeV/c)

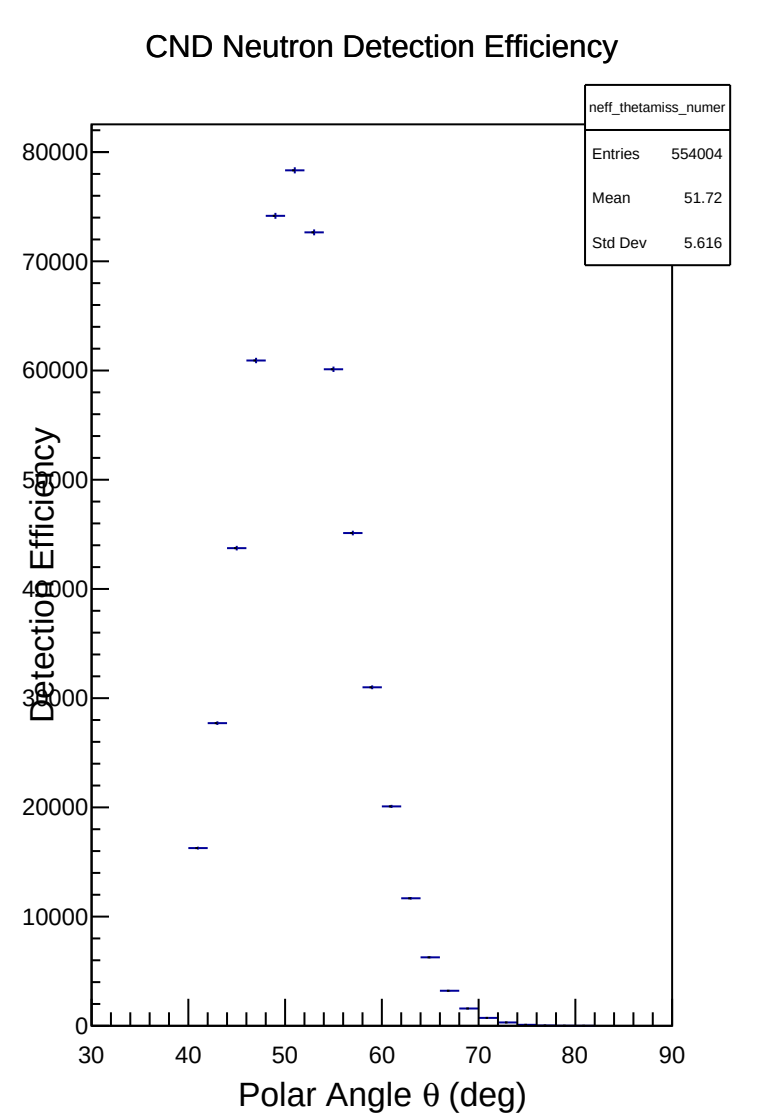

Efficiency numerator (int2)
pmiss_int2_numer
Entries 207521
Mean 0.621
Std Dev 0.2383
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1
p_miss (GeV/c)

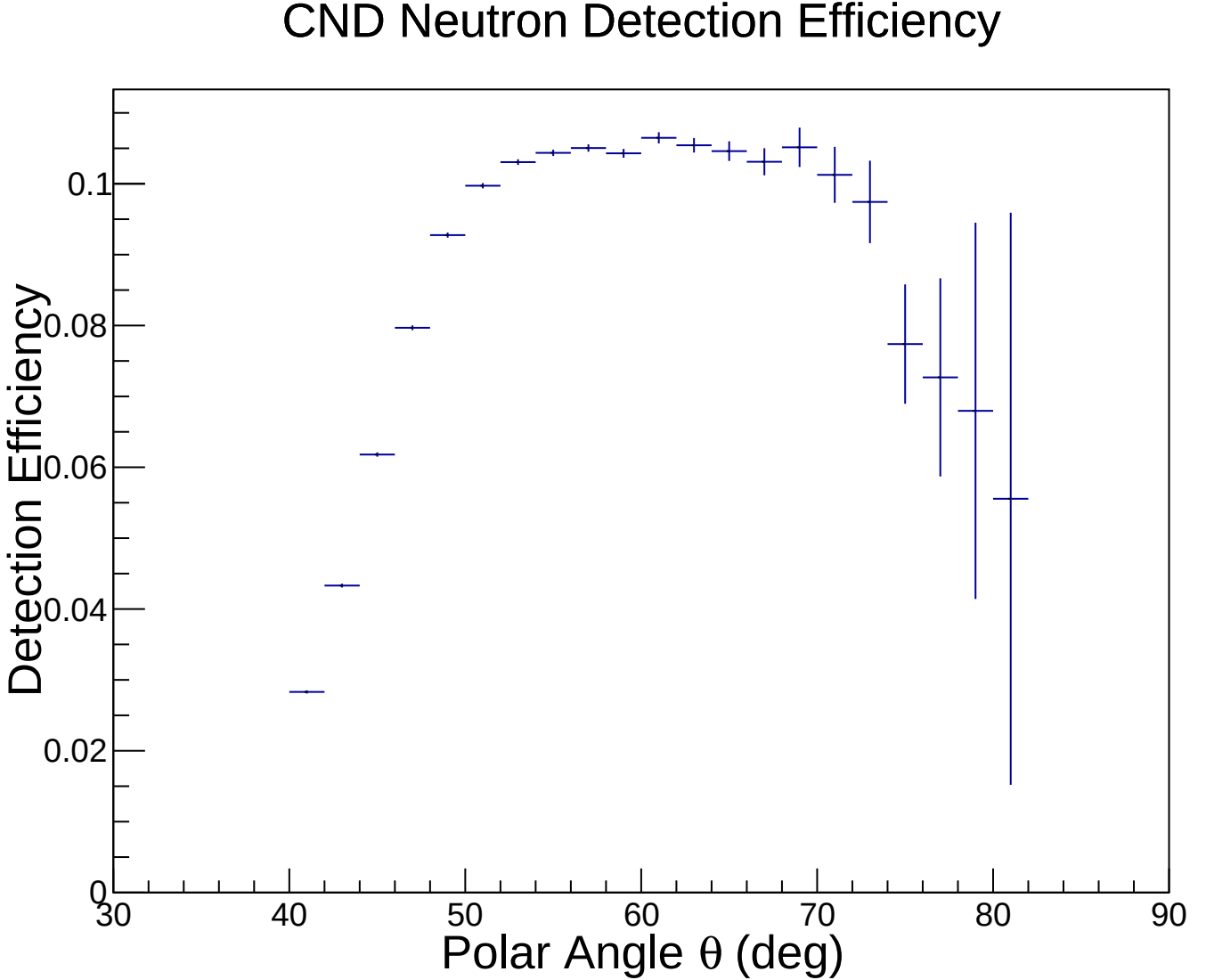

Efficiency numerator (int3)
pmiss_int3_numer
Entries 373
Mean 0.6078
Std Dev 0.2408
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1
p_miss (GeV/c)

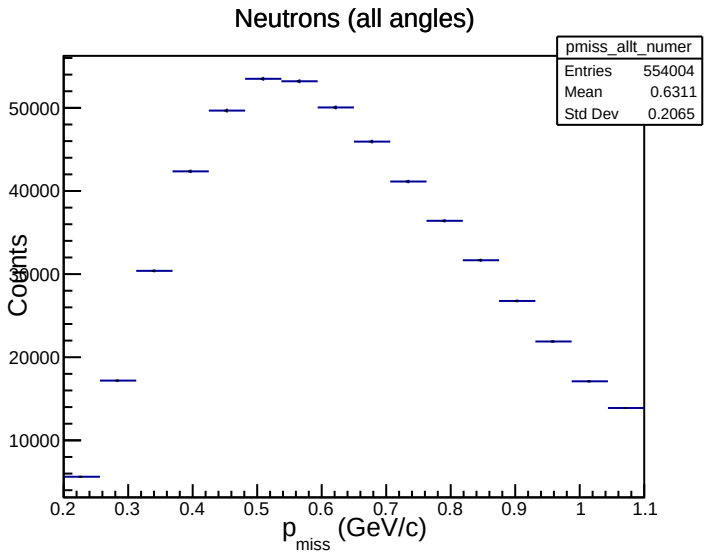

Efficiency numerator (int1)
pmiss_int2_numer
207521
0.621
0.2383
40<θmiss<50
50<θmiss<60
60<θmiss<70
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
pmiss (GeV/c)

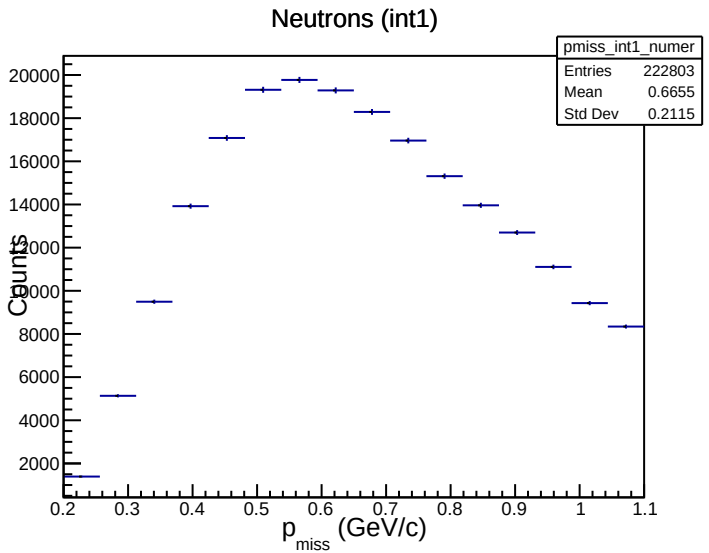

Efficiency numerator (int1)
pmiss_int2_numer
207521
0.621
0.2383
40<θmiss<50
50<θmiss<60
60<θmiss<70
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
pmiss (GeV/c)

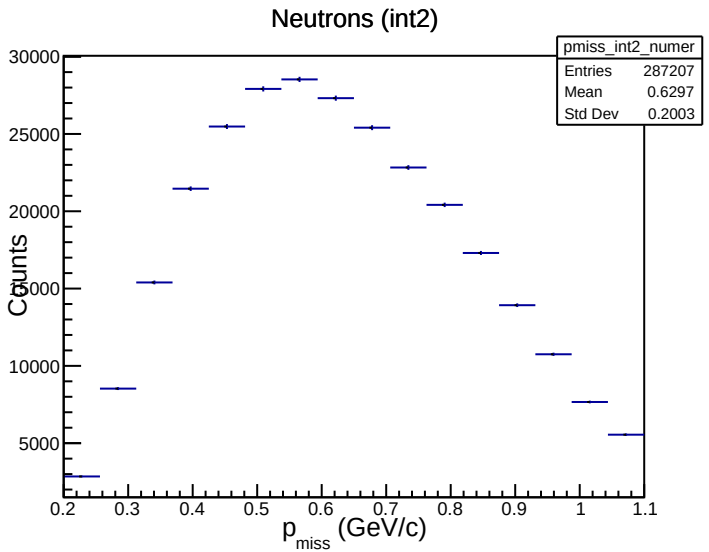

θ dependence of efficiency
neff_thetamiss_denom
Entries 6697424
Mean 50.09
Std Dev 6.048
×10^3
efficiency
θ_miss (deg)

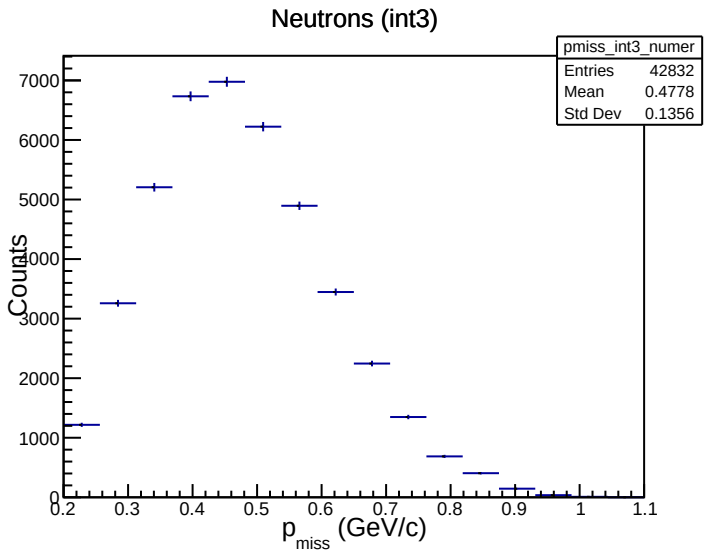

CND Neutron Detection Efficiency
neff_thetamiss_numer
Entries 554004
Mean 51.72
Std Dev 5.616
Detection Efficiency
Polar Angle θ (deg)

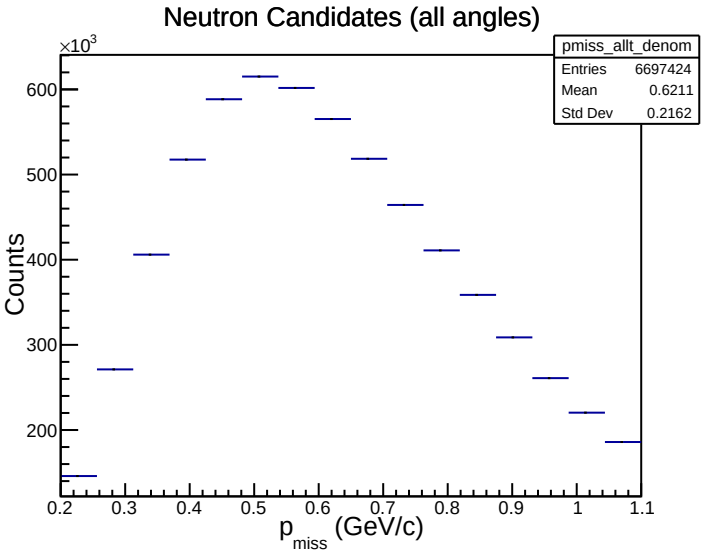

CND Neutron Detection Efficiency
Detection Efficiency
0
0.02
0.04
0.06
0.08
0.1
30
40
50
60
70
80
90
Polar Angle θ (deg)

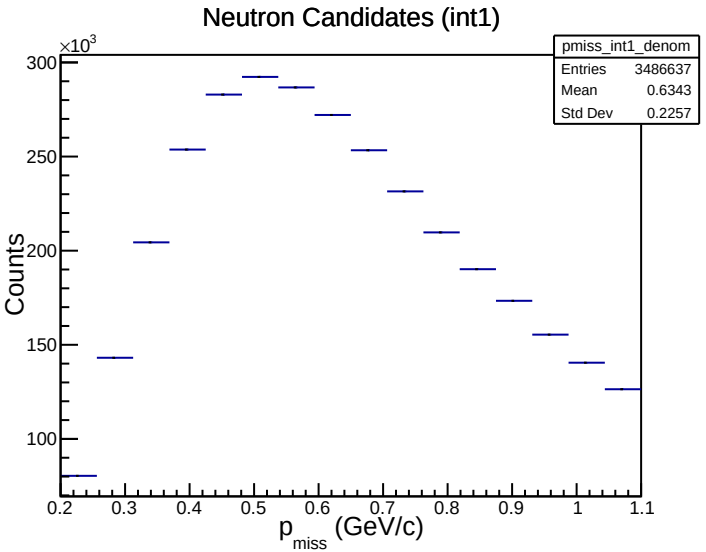

Neutrons (all angles)
pmiss_allt_numer
Entries 554004
Mean 0.6311
Std Dev 0.2065
Counts
p miss (GeV/c)

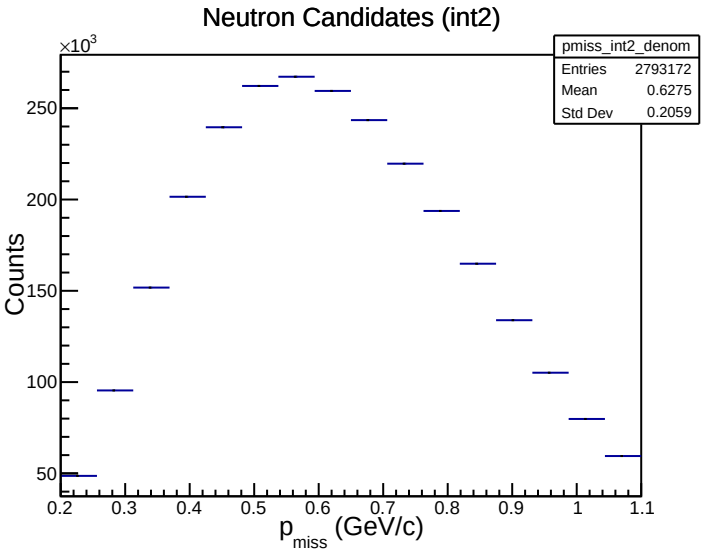

Neutrons (int1)
pmiss_int1_numer
Entries 222803
Mean 0.6655
Std Dev 0.2115
Counts
p miss (GeV/c)

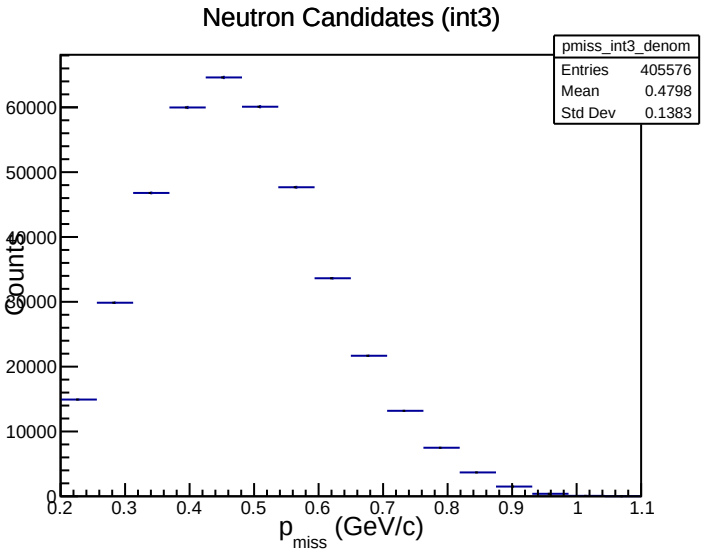

Neutrons (int2)
pmiss_int2_numer
Entries 287207
Mean 0.6297
Std Dev 0.2003
Counts
p miss (GeV/c)

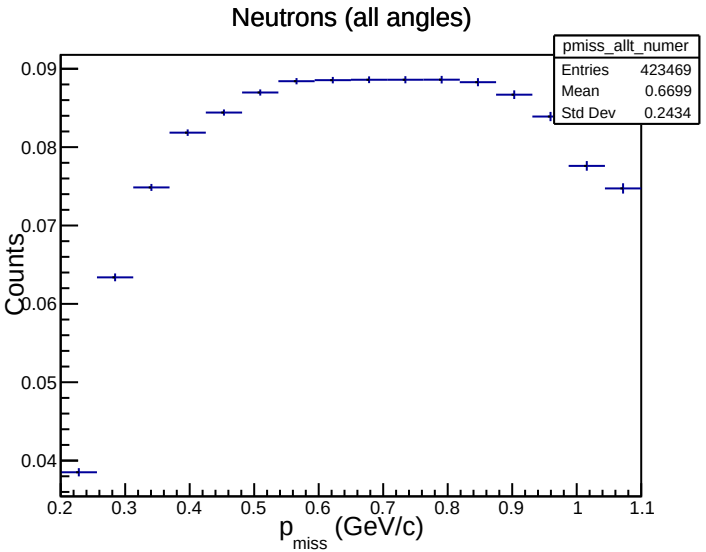

Neutrons (int3)
pmiss_int3_numer
Entries 42832
Mean 0.4778
Std Dev 0.1356
Counts
p miss (GeV/c)

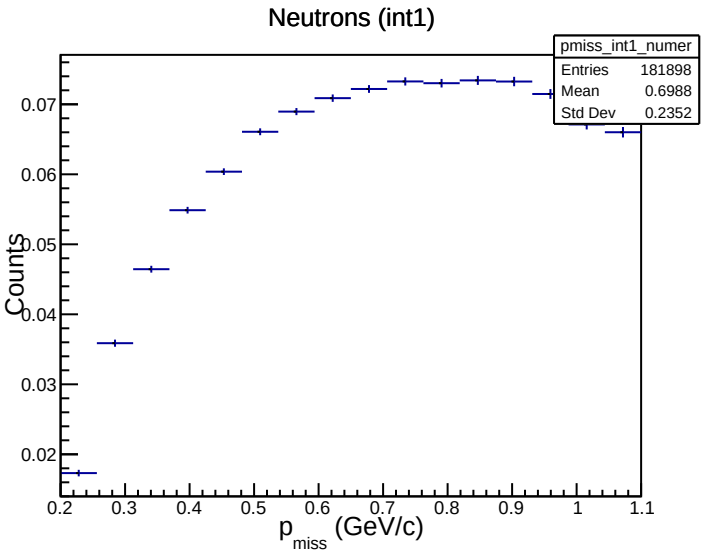

Neutron Candidates (all angles)
×10^3
pmiss_allt_denom
Entries 6697424
Mean 0.6211
Std Dev 0.2162
Counts
p_miss (GeV/c)

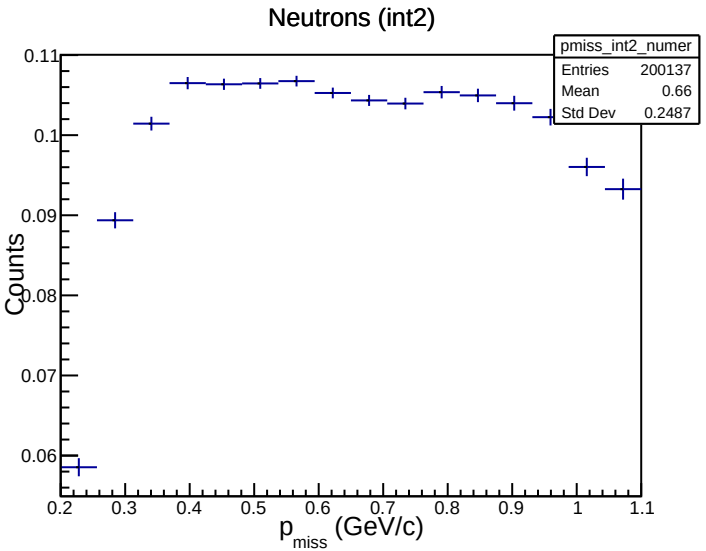

Neutron Candidates (int1)
×10^3
pmiss_int1_denom
Entries 3486637
Mean 0.6343
Std Dev 0.2257
Counts
p_miss (GeV/c)

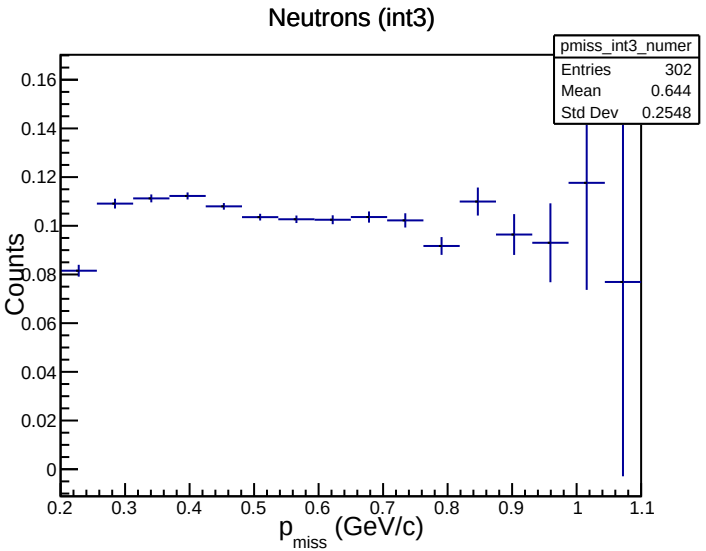

Neutron Candidates (int2)
×10^3
pmiss_int2_denom
Entries 2793172
Mean 0.6275
Std Dev 0.2059
Counts
p_miss (GeV/c)

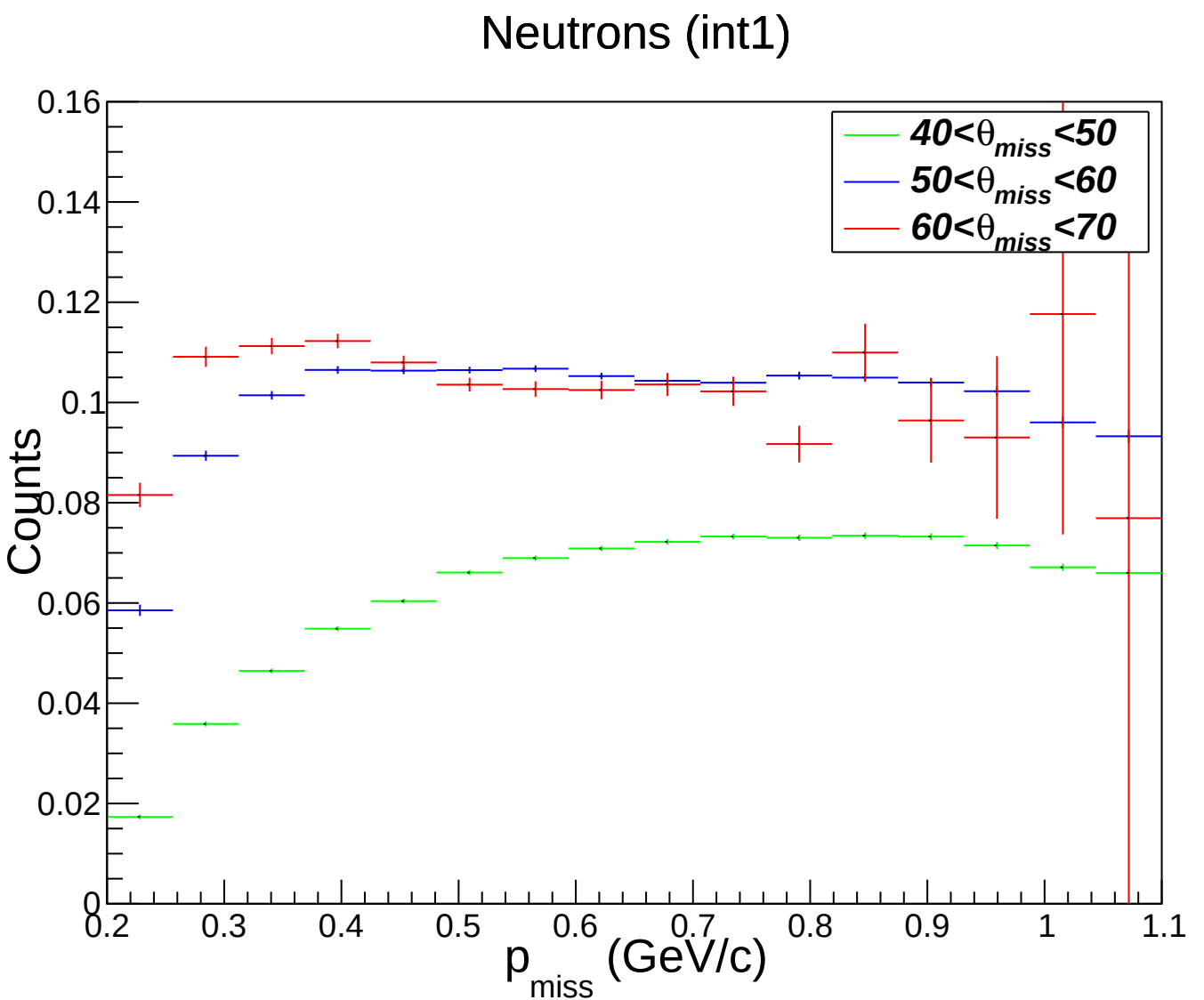

Neutron Candidates (int3)
pmiss_int3_denom
Entries 405576
Mean 0.4798
Std Dev 0.1383
Counts
p_miss (GeV/c)


Neutrons (all angles)
pmiss_allt_numer
Entries 423469
Mean 0.6699
Std Dev 0.2434
Counts
p miss (GeV/c)


Neutrons (int1)
pmiss_int1_numer
Entries 181898
Mean 0.6988
Std Dev 0.2352
Counts
p miss (GeV/c)


Neutrons (int2)
pmiss_int2_numer
Entries 200137
Mean 0.66
Std Dev 0.2487
Counts
p miss (GeV/c)


Neutrons (int3)
pmiss_int3_numer
Entries 302
Mean 0.644
Std Dev 0.2548
Counts
p miss (GeV/c)


Neutrons (int1)
40<θmiss<50
50<θmiss<60
60<θmiss<70
Counts
pmiss (GeV/c)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1