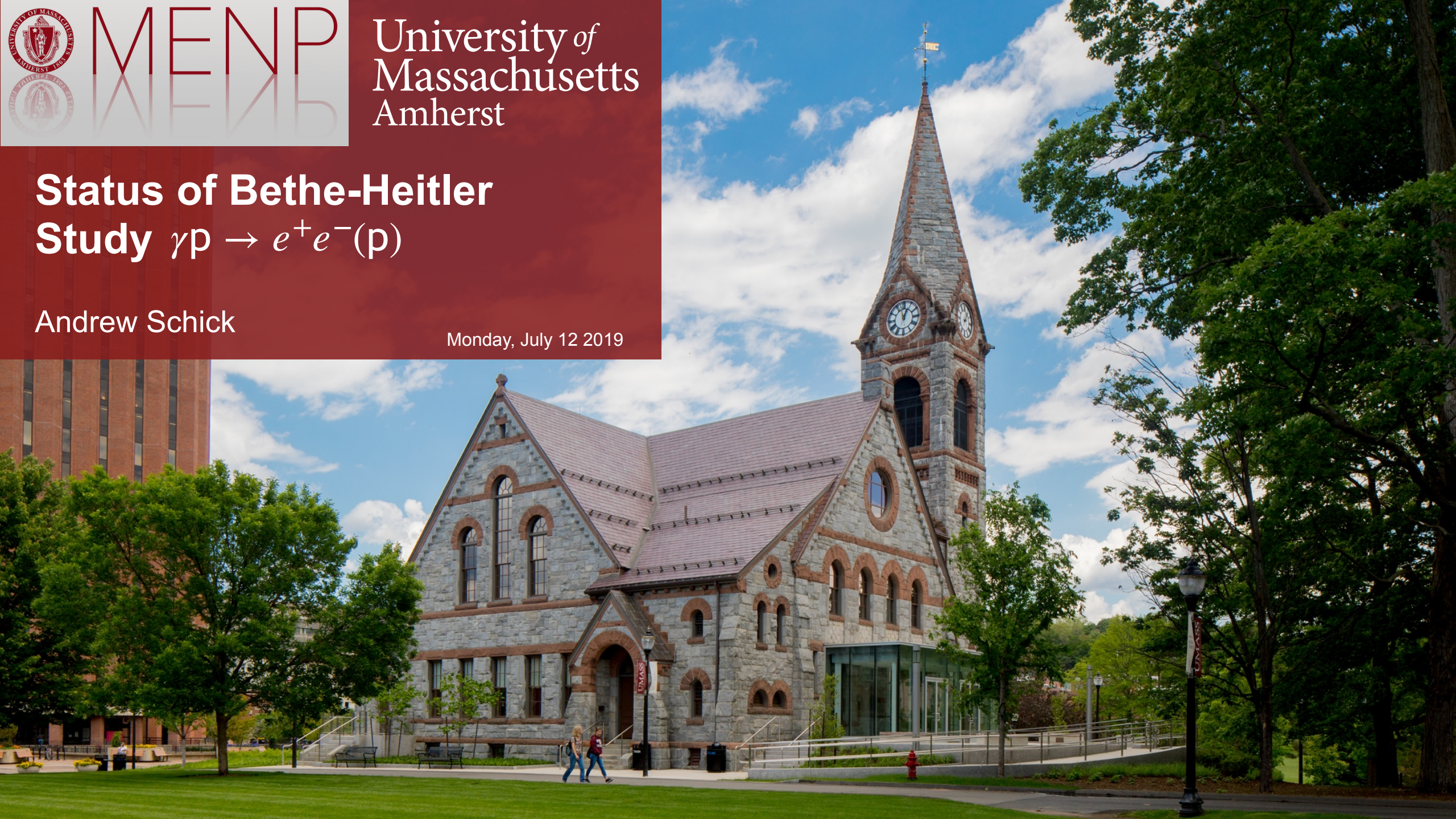


MENP

University of Massachusetts Amherst

Status of Bethe-Heitler Study $\gamma p \to e^+e^-(p)$

Andrew Schick

Monday, July 12 2019

Ground Level Cuts for $\gamma p \rightarrow e^+e^-(p)$

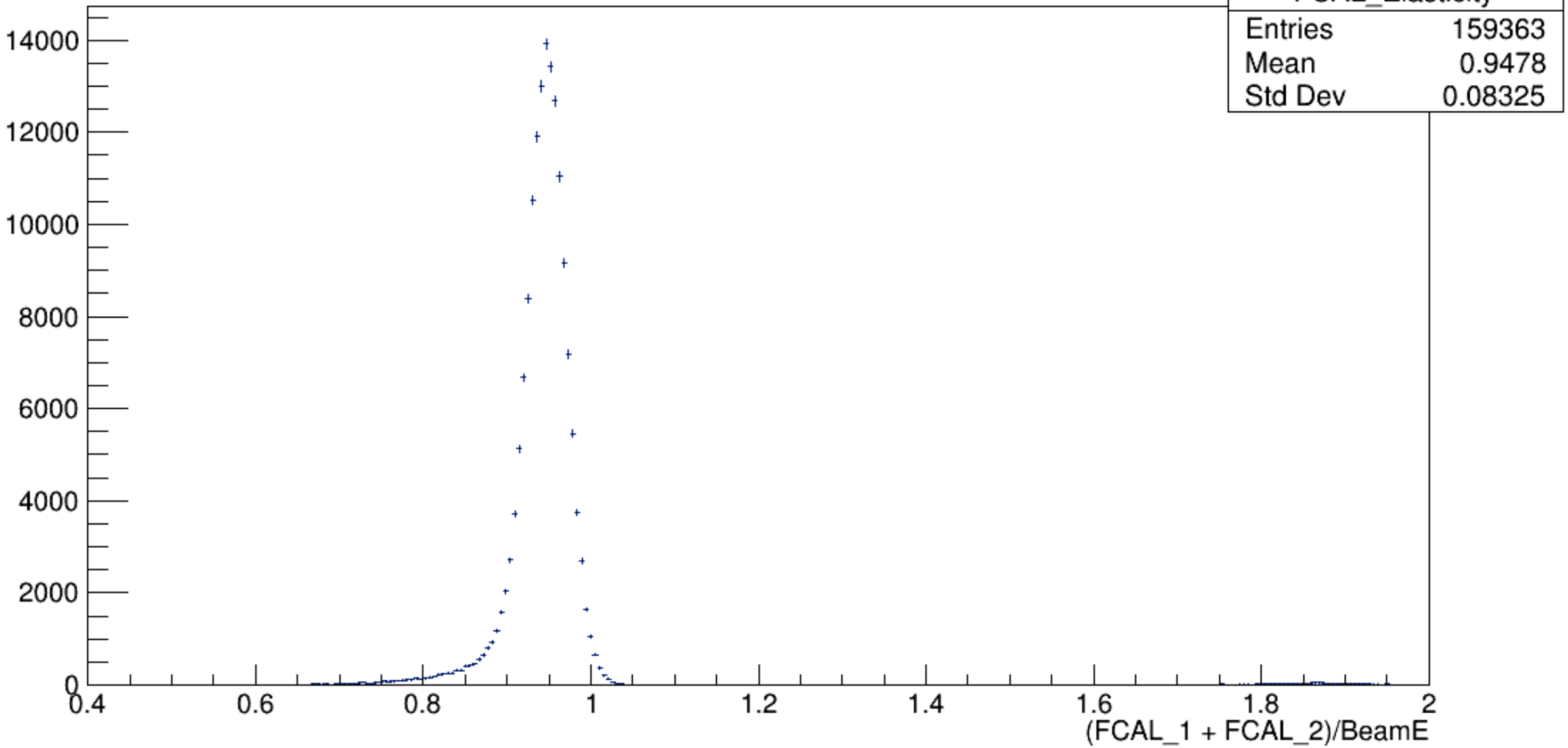
Preselection Cuts

1. Default GlueX cuts: https://halldweb.jlab.org/wiki/index.php/Spring_2017_Analysis_Launch_Cuts
2. Require E/p = 0.7 for electron and positron tracks in FCAL and BCAL

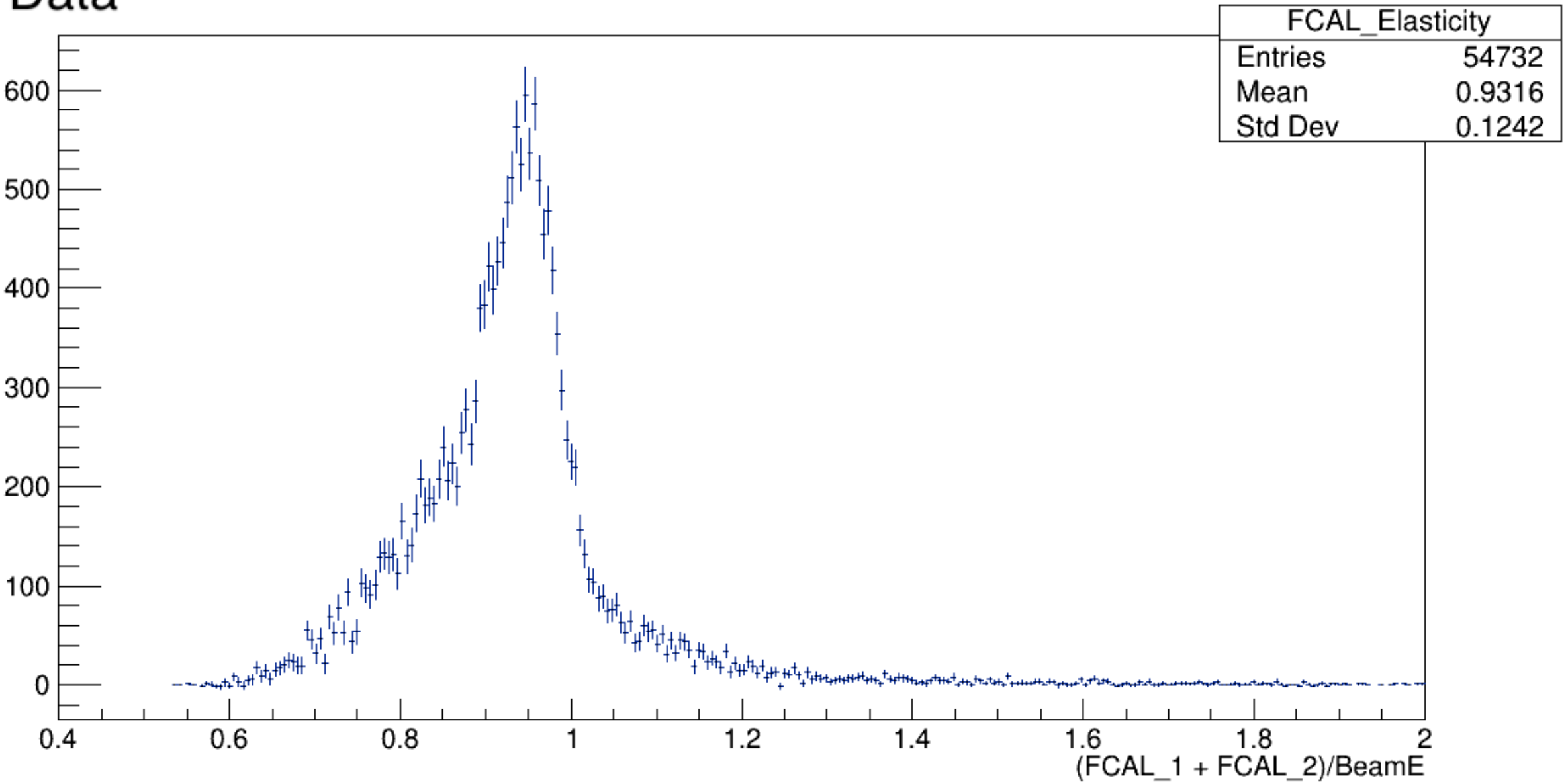
DSelector Cuts

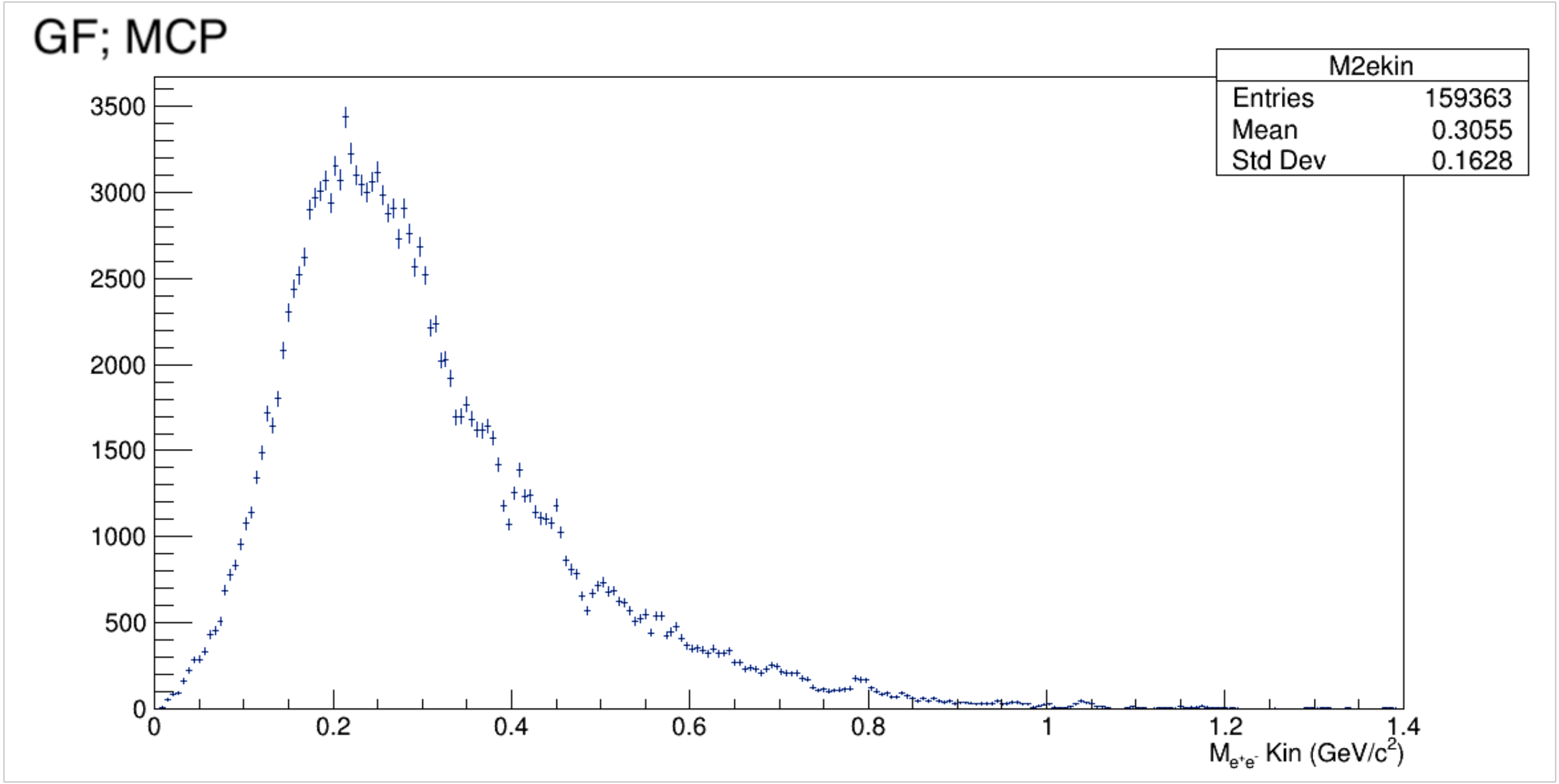
1. Cut on coherent peak: 8.12 < Eγ < 8.88
2. Require both electron and positron tracks have hit in FCAL
3. Require both electron and positron tracks have hit in TOF
4. Require dMinKinFitCL > 10E-6
5. Eliminate events with NumUnusedTracks ≥ 2
6. Eliminate events with Energy_UnusedShowers > 0

GF; MCP

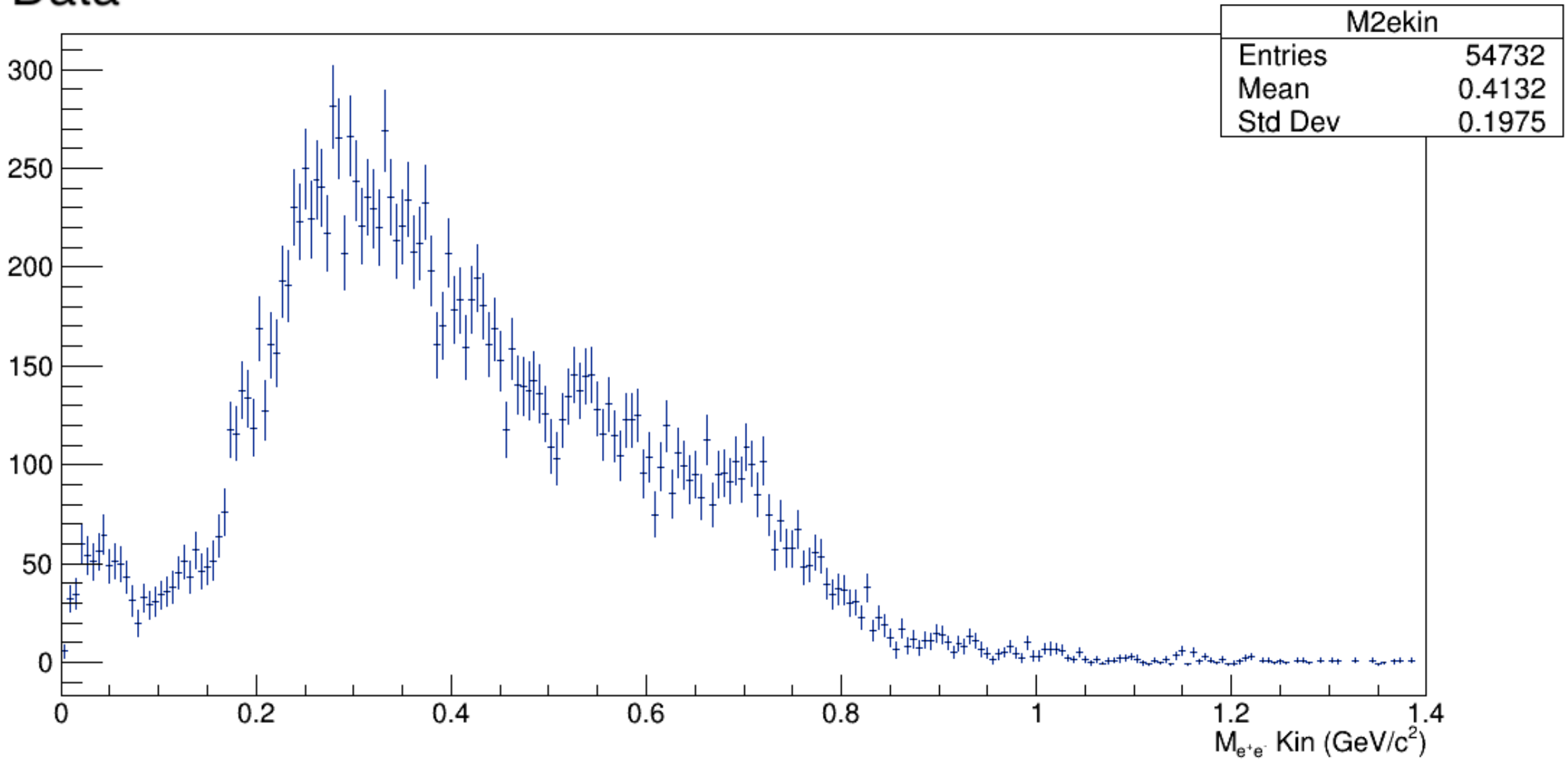

FCAL_Elasticity
Entries 159363
Mean 0.9478
Std Dev 0.08325
14000
12000
10000
8000
6000
4000
2000
0
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
(FCAL_1 + FCAL_2)/BeamE

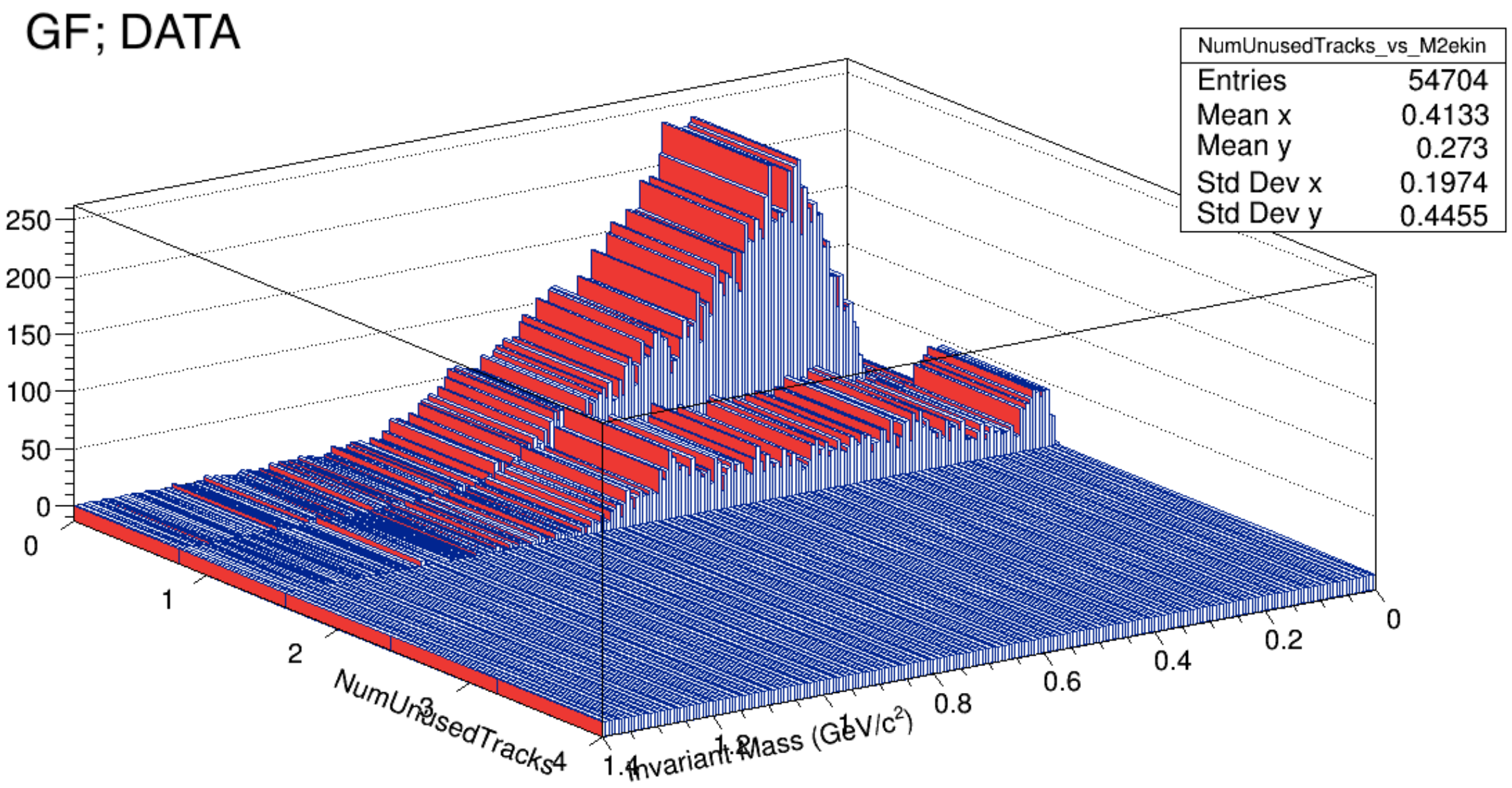
GF; Data


FCAL_Elasticity
Entries 54732
Mean 0.9316
Std Dev 0.1242
600
500
400
300
200
100
0
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
(FCAL_1 + FCAL_2)/BeamE


GF; MCP
M2ekin
Entries 159363
Mean 0.3055
Std Dev 0.1628
3500
3000
2500
2000
1500
1000
500
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
$M_{e^+e^-}$ Kin (GeV/c^2)

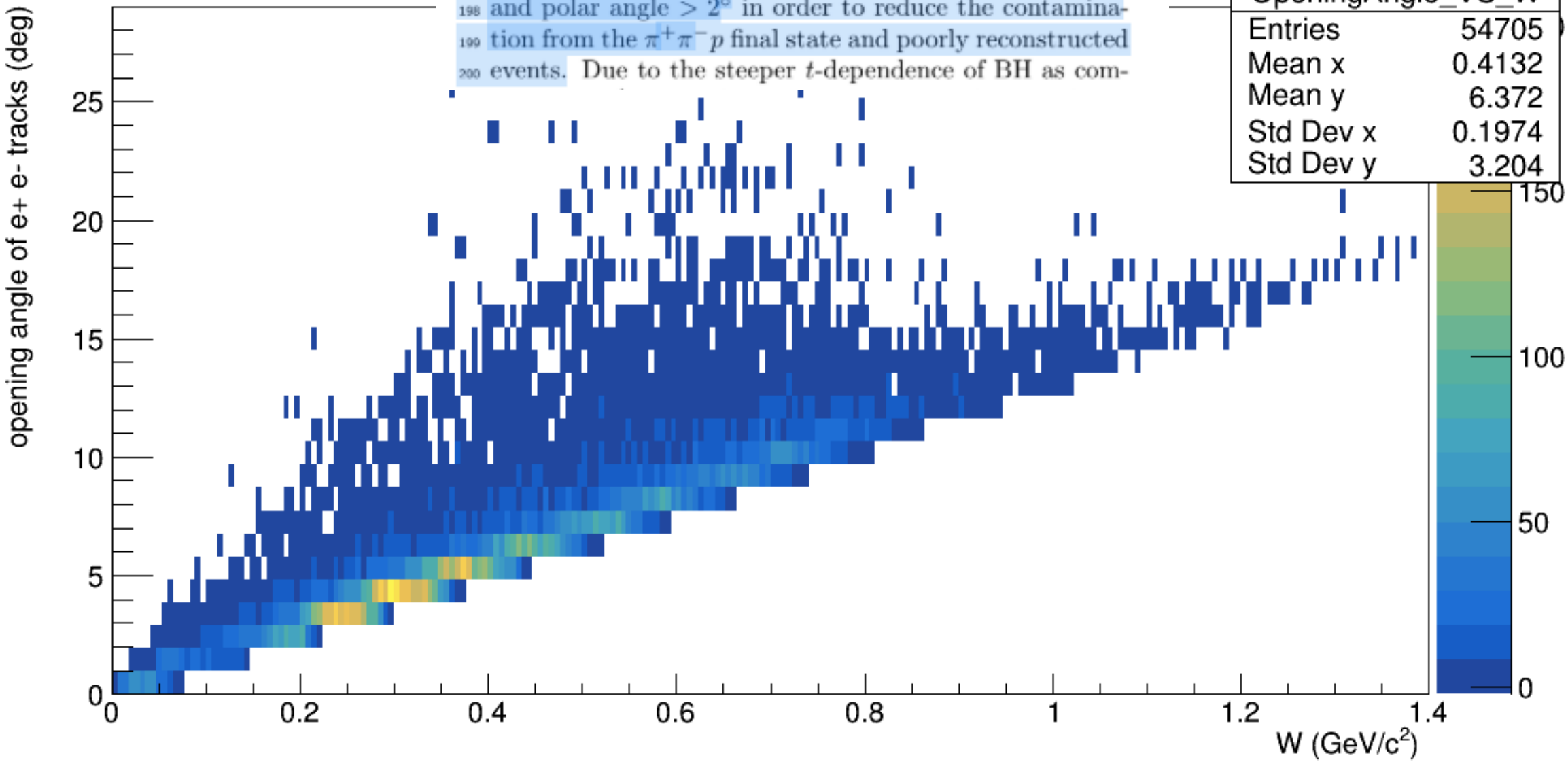
GF; Data

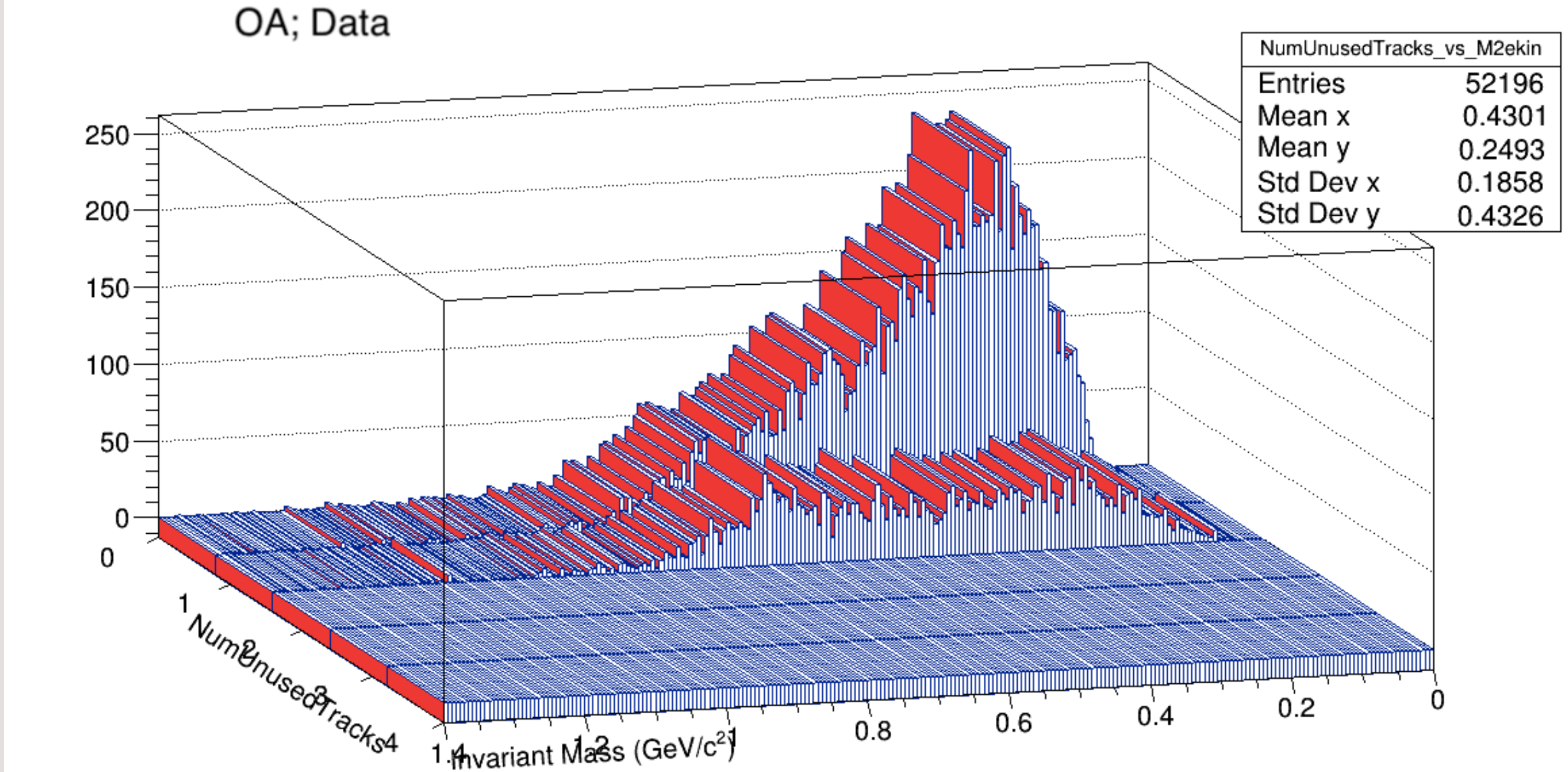

M2ekin
Entries 54732
Mean 0.4132
Std Dev 0.1975
300
250
200
150
100
50
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
$M_{e^+e^-}$ Kin (GeV/c^2)


GF; DATA
NumUnusedTracks_vs_M2ekin
Entries 54704
Mean x 0.4133
Mean y 0.273
Std Dev x 0.1974
Std Dev y 0.4455
250
200
150
100
50
0
0
1
2
3
4
NumUnusedTracks
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Invariant Mass (GeV/c²)

GF; Data

of energy in this layer compared to electrons. We require all charged particles to have momenta > 0.4 GeV and polar angle $> 2°$ in order to reduce the contamination from the $\pi^+\pi^- p$ final state and poorly reconstructed events. Due to the steeper t-dependence of BH as com-

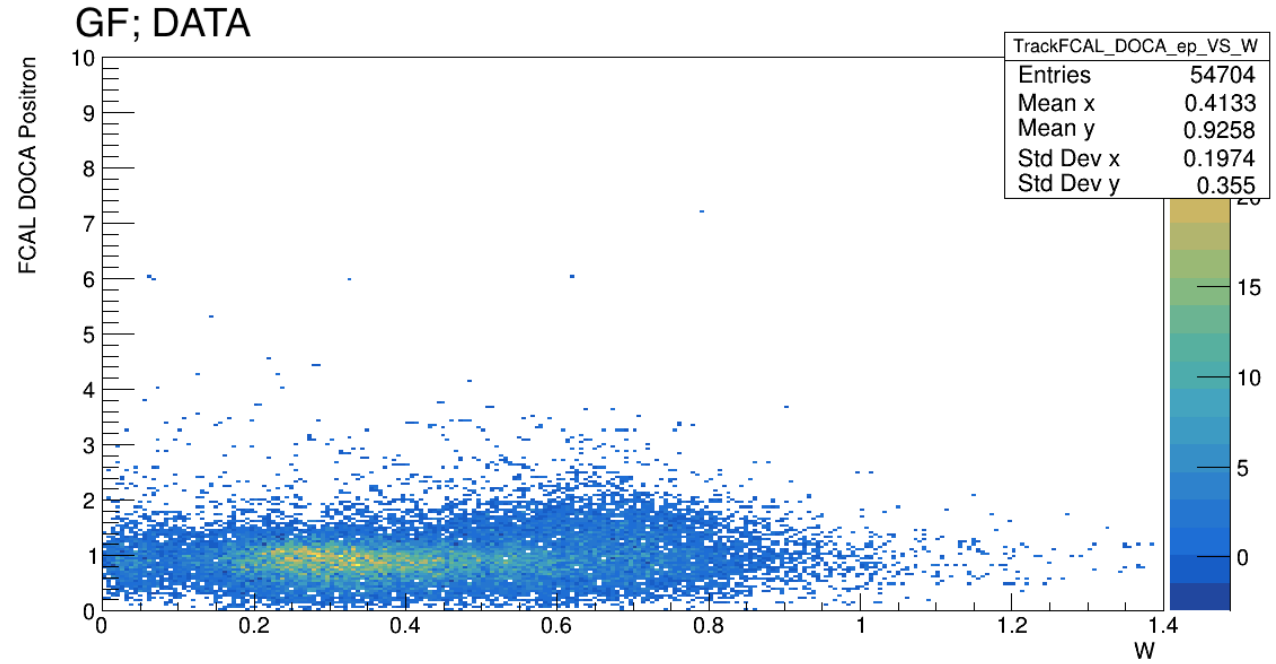


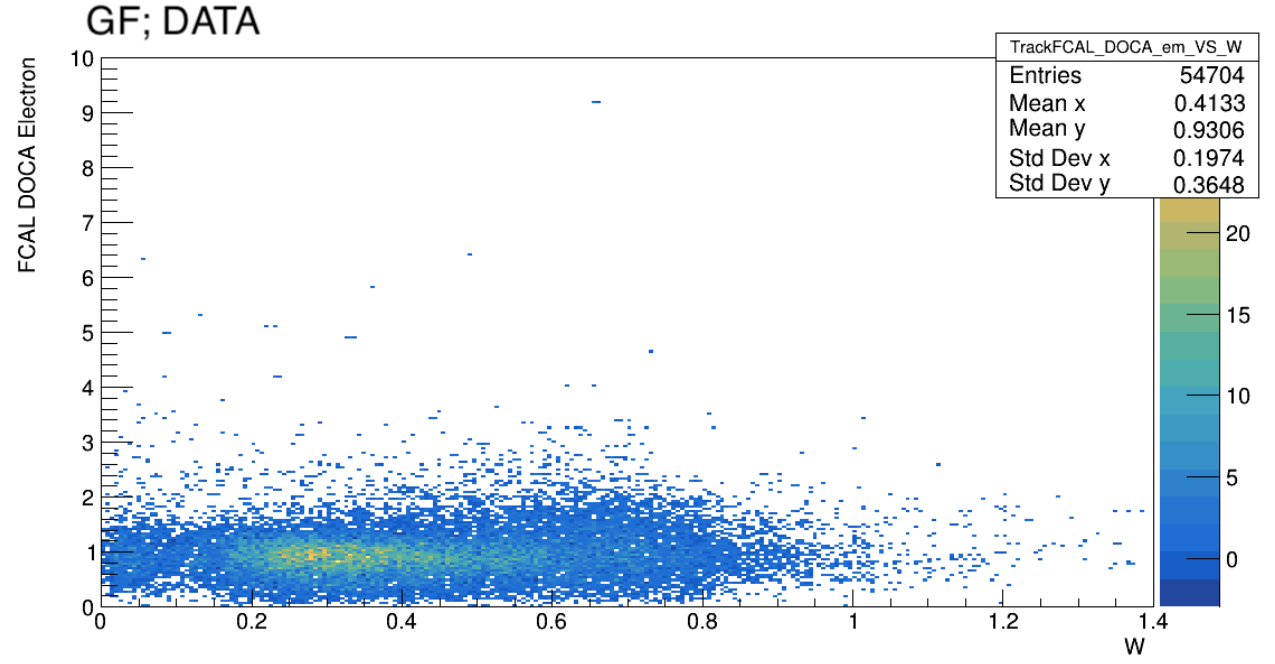

OA; Data
NumUnusedTracks_vs_M2ekin
Entries 52196
Mean x 0.4301
Mean y 0.2493
Std Dev x 0.1858
Std Dev y 0.4326
250
200
150
100
50
0
0
1
2
3
4
NumUnusedTracks
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Invariant Mass (GeV/c2)

Core Questions

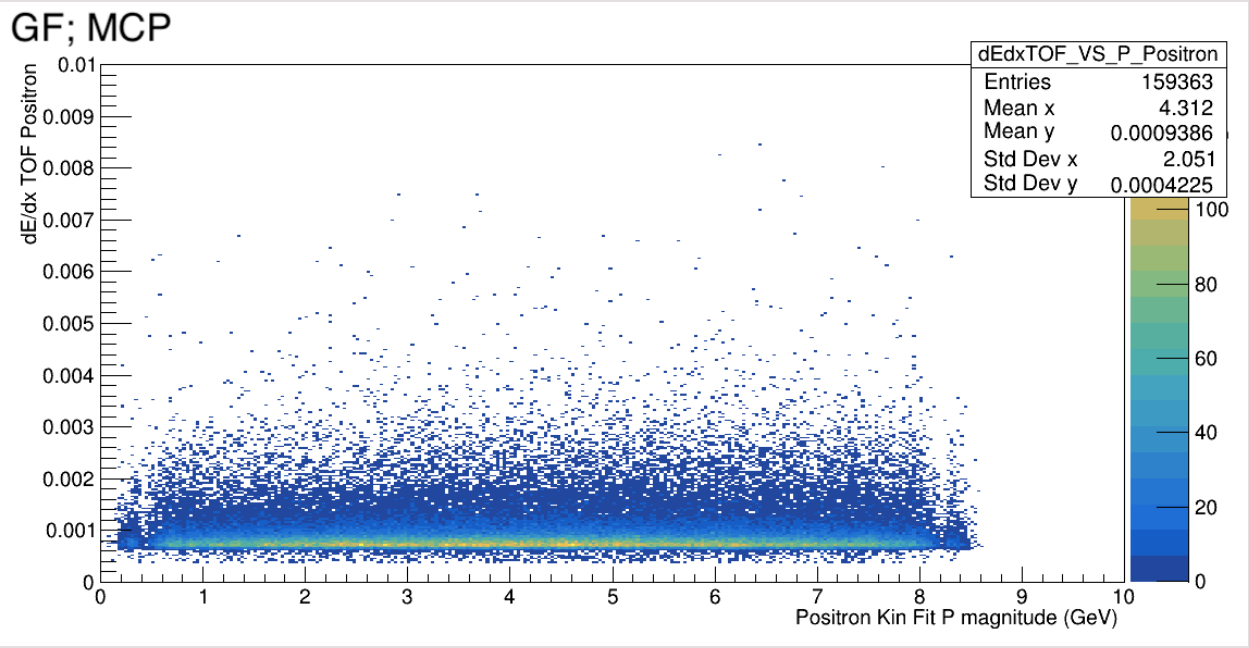
1. **Low invariant mass peak in the 1 unused track bin (solved)**
    i. FCAL Split offs? ***No***.
        - FCAL DOCA for tracks vs W
    ii. Proton/positron misidentification? ***No***.
        - TOF dE/dx cut
        - dE/dx plots
        - Unused tracks versus missing proton kin fit values
    iii. Poorly reconstructed tracks? ***Yes***.
2. **Cleaning up Elasticity and W plots: E over P cuts and fitting elasticity in bins of W**
    i. FCAL Elasticity vs $\frac{E_1}{p_1}+\frac{E_2}{p_2}$ and rotation onto one axis
    ii. Many bin fitting…

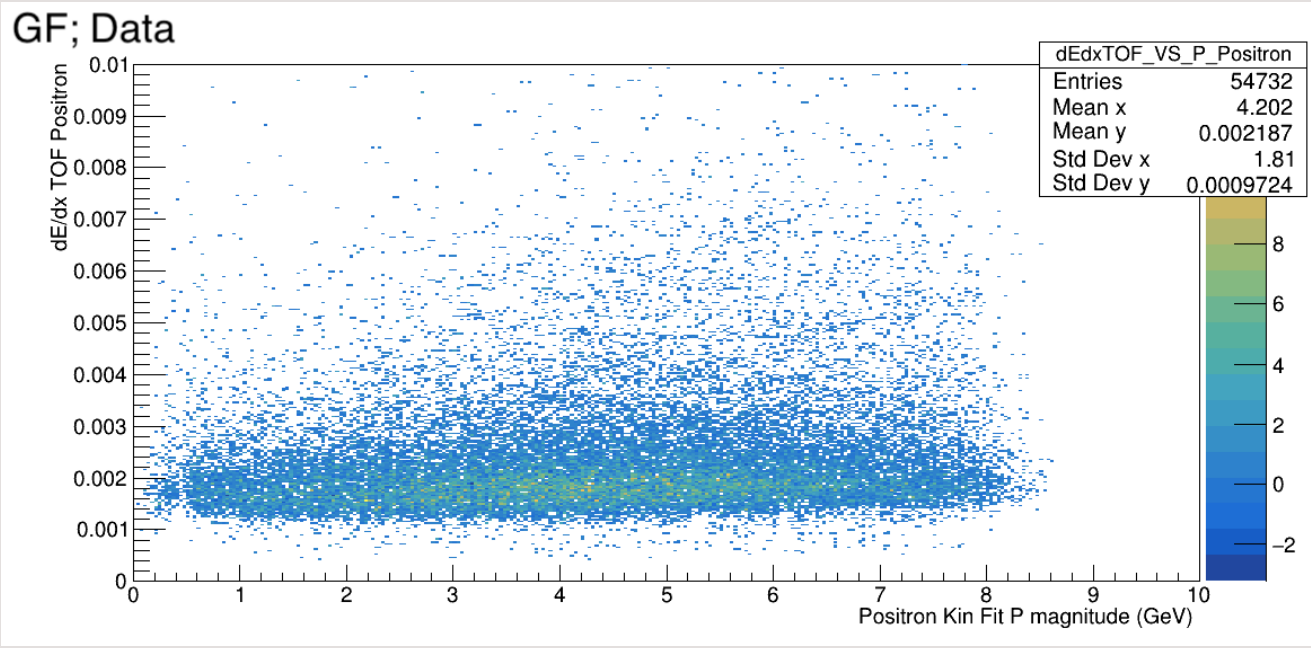
FCAL Split-offs?



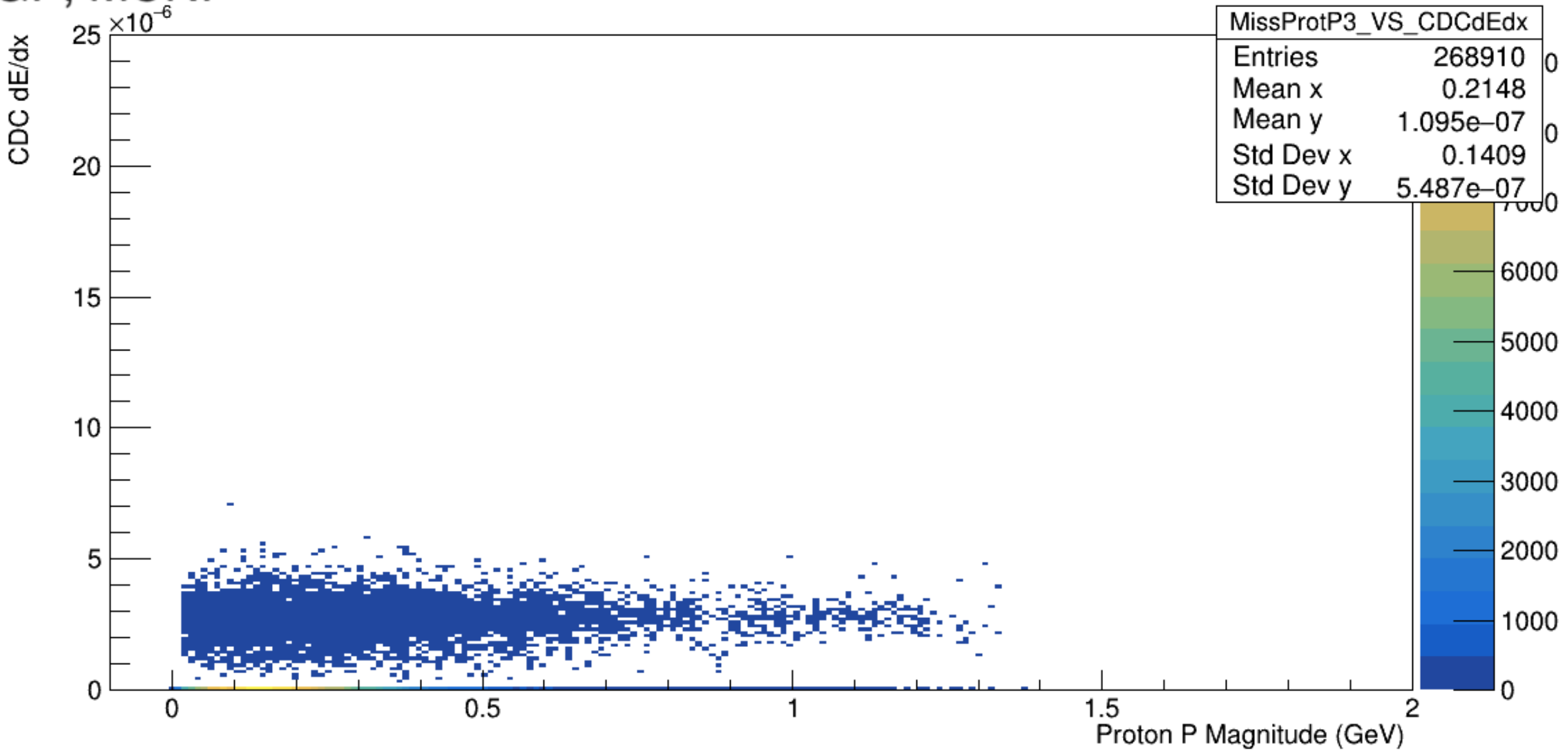


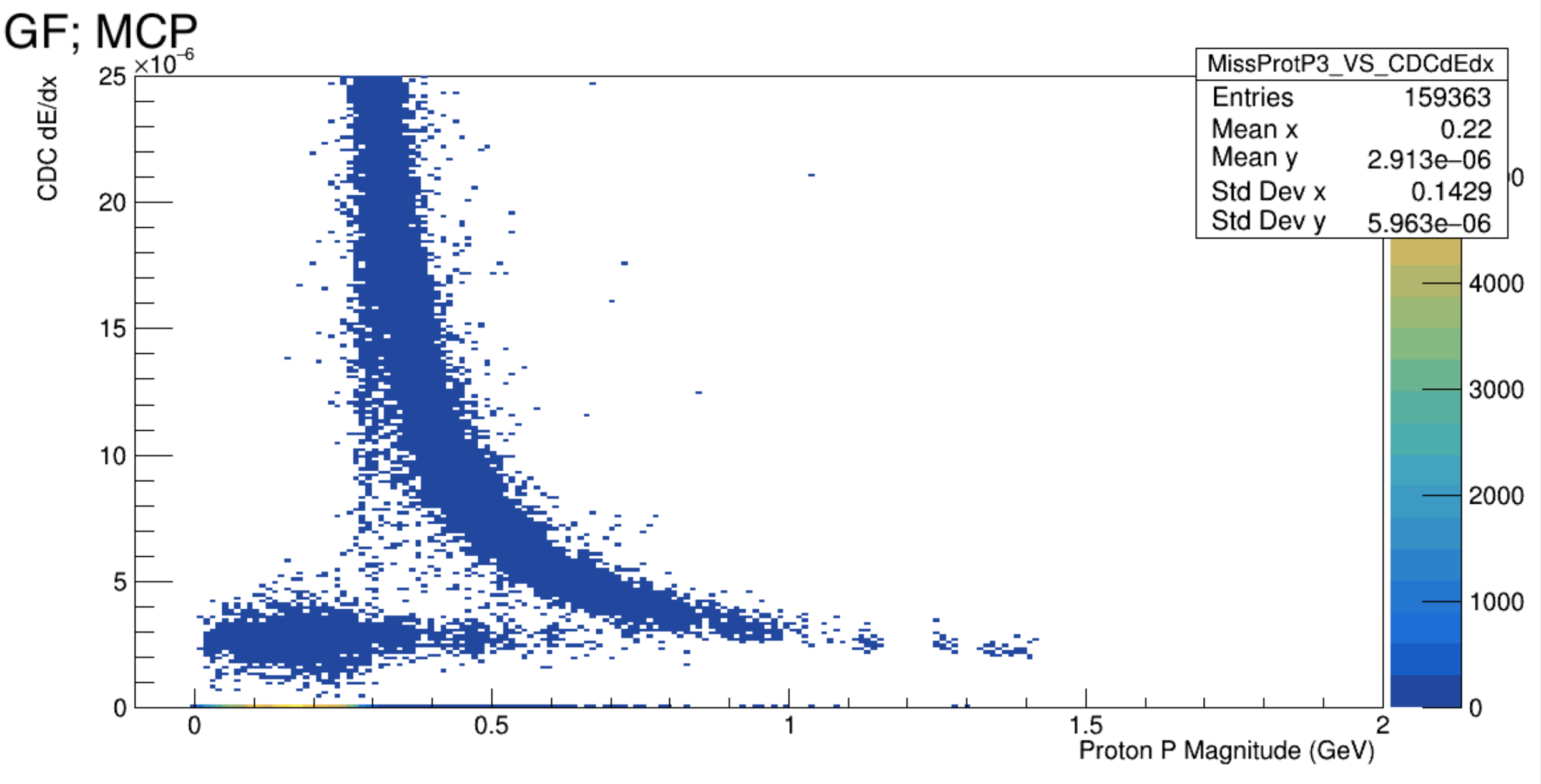
Proton/positron Mis-ID?

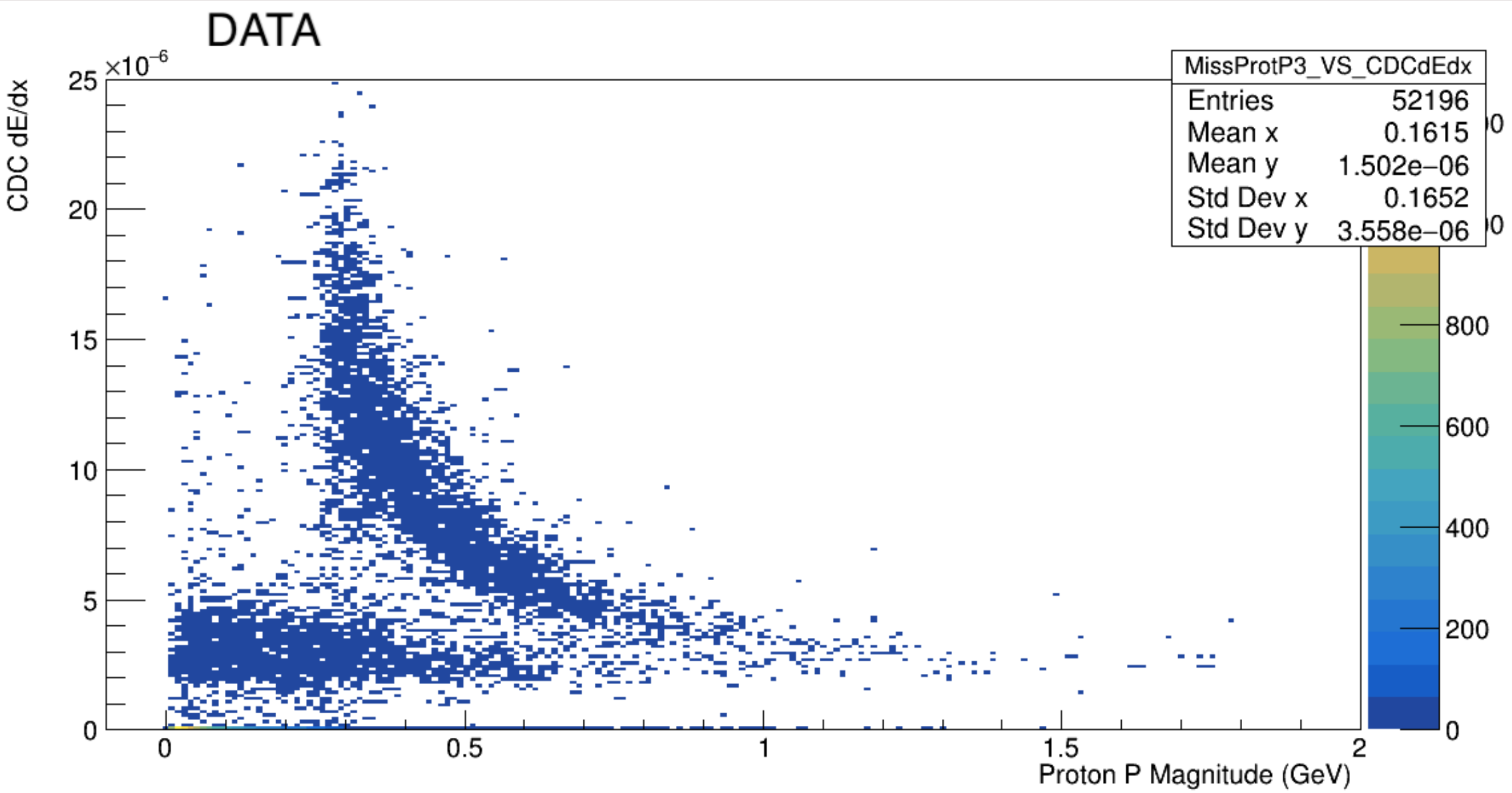


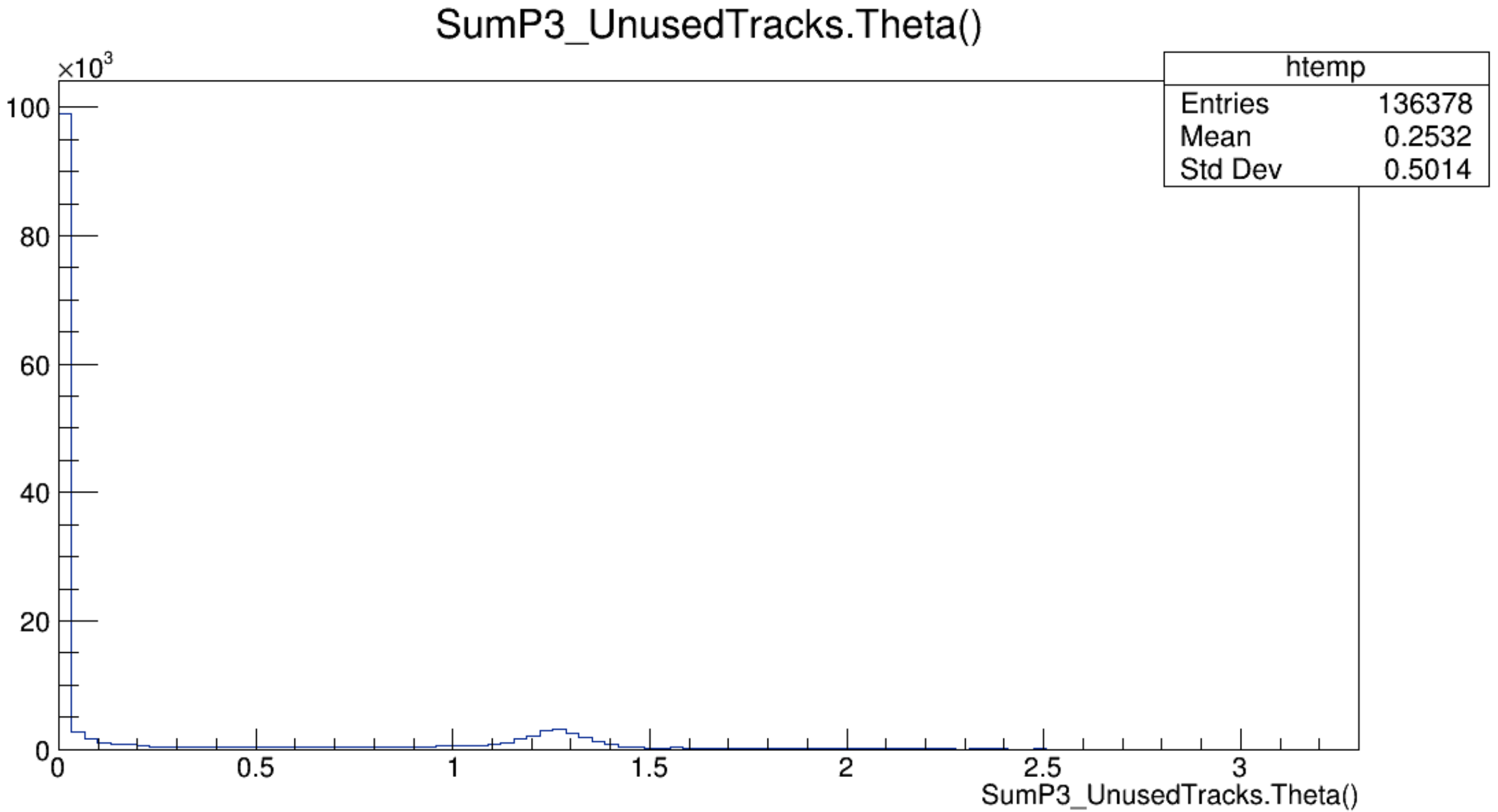


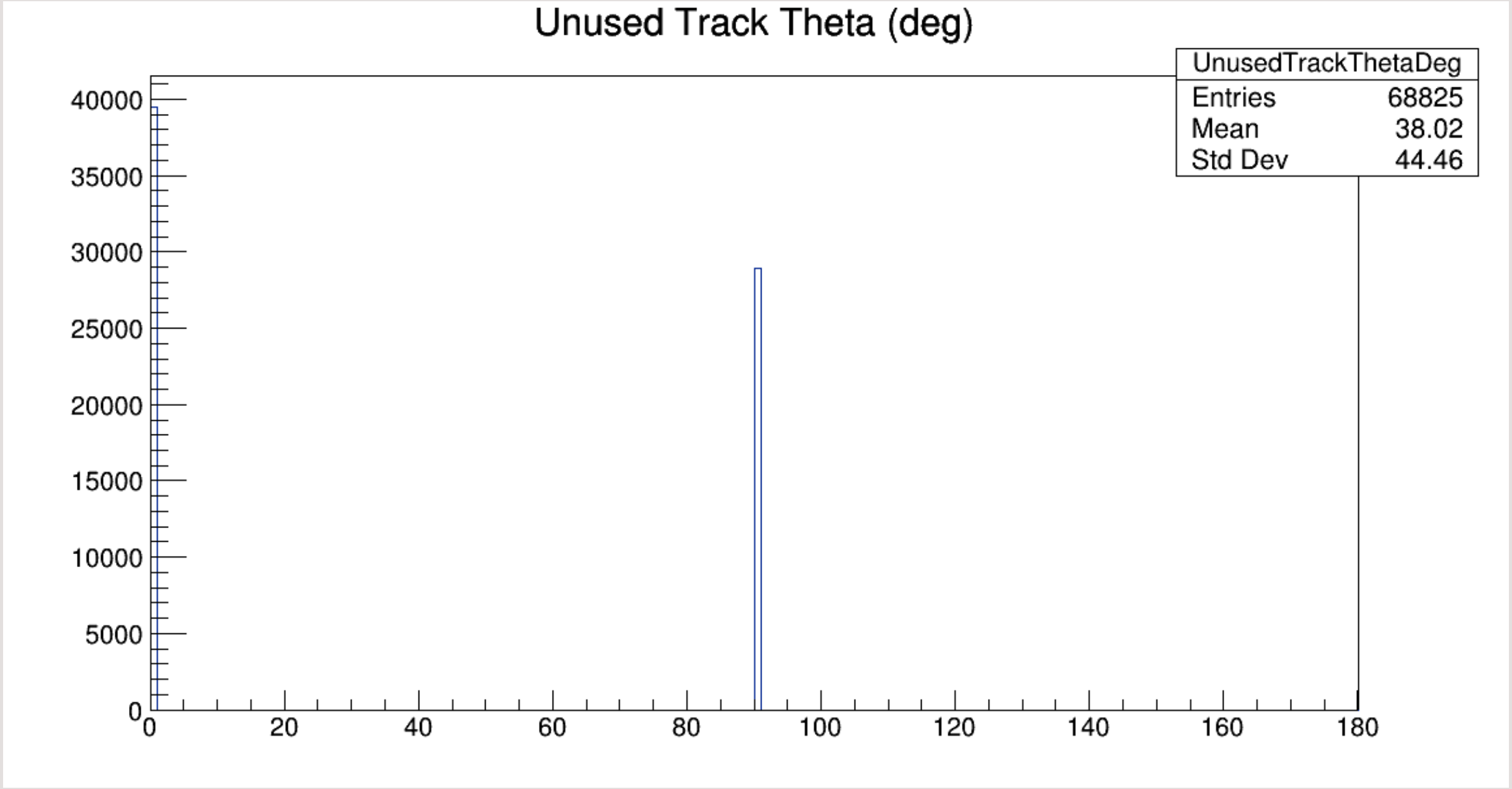
GF; MCNP

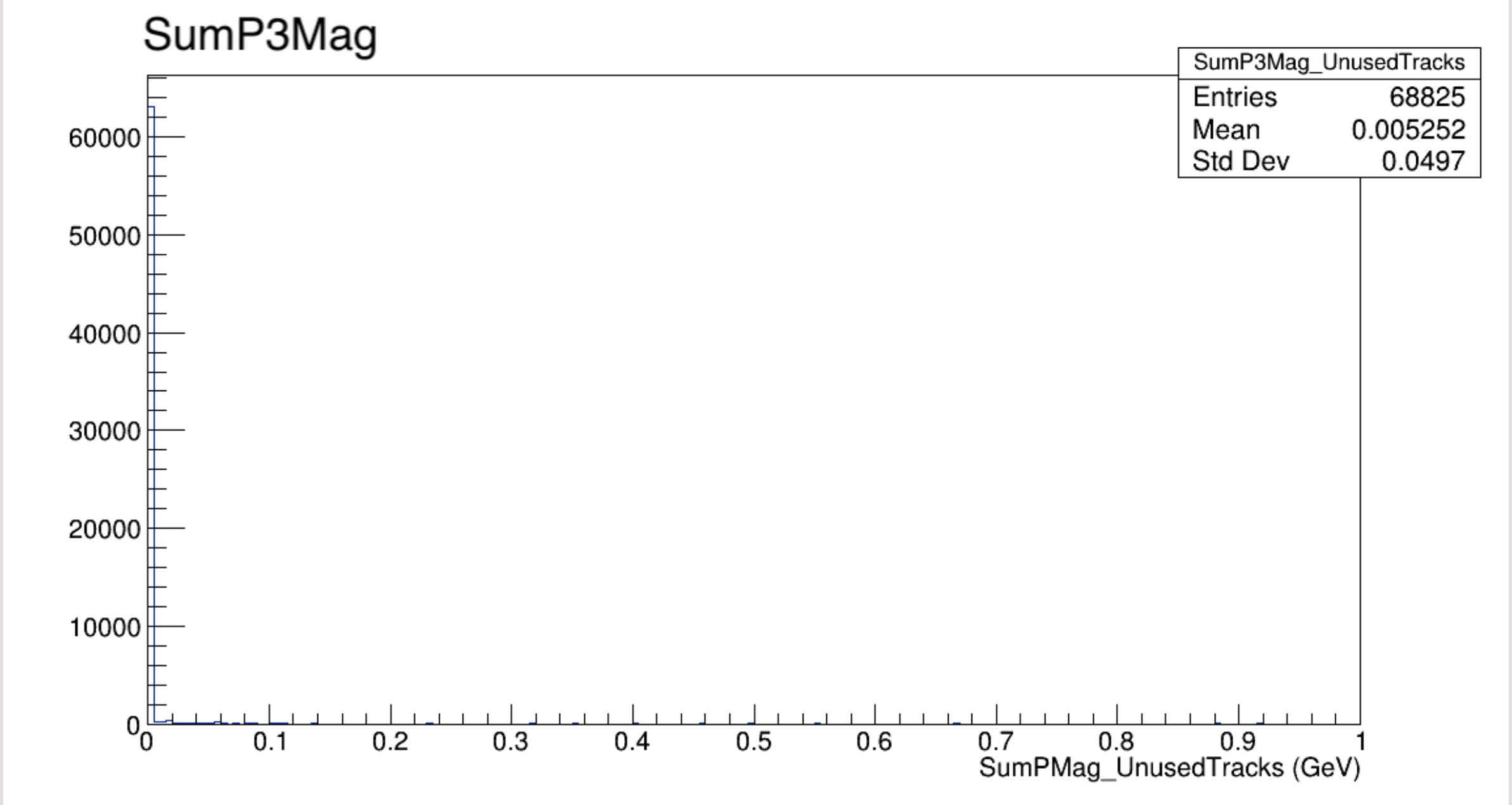

MissProtP3_VS_CDCdEdx
Entries 268910
Mean x 0.2148
Mean y 1.095e−07
Std Dev x 0.1409
Std Dev y 5.487e−07
CDC dE/dx
×10⁻⁶
25
20
15
10
5
0
0
0.5
1
1.5
2
Proton P Magnitude (GeV)
6000
5000
4000
3000
2000
1000
0

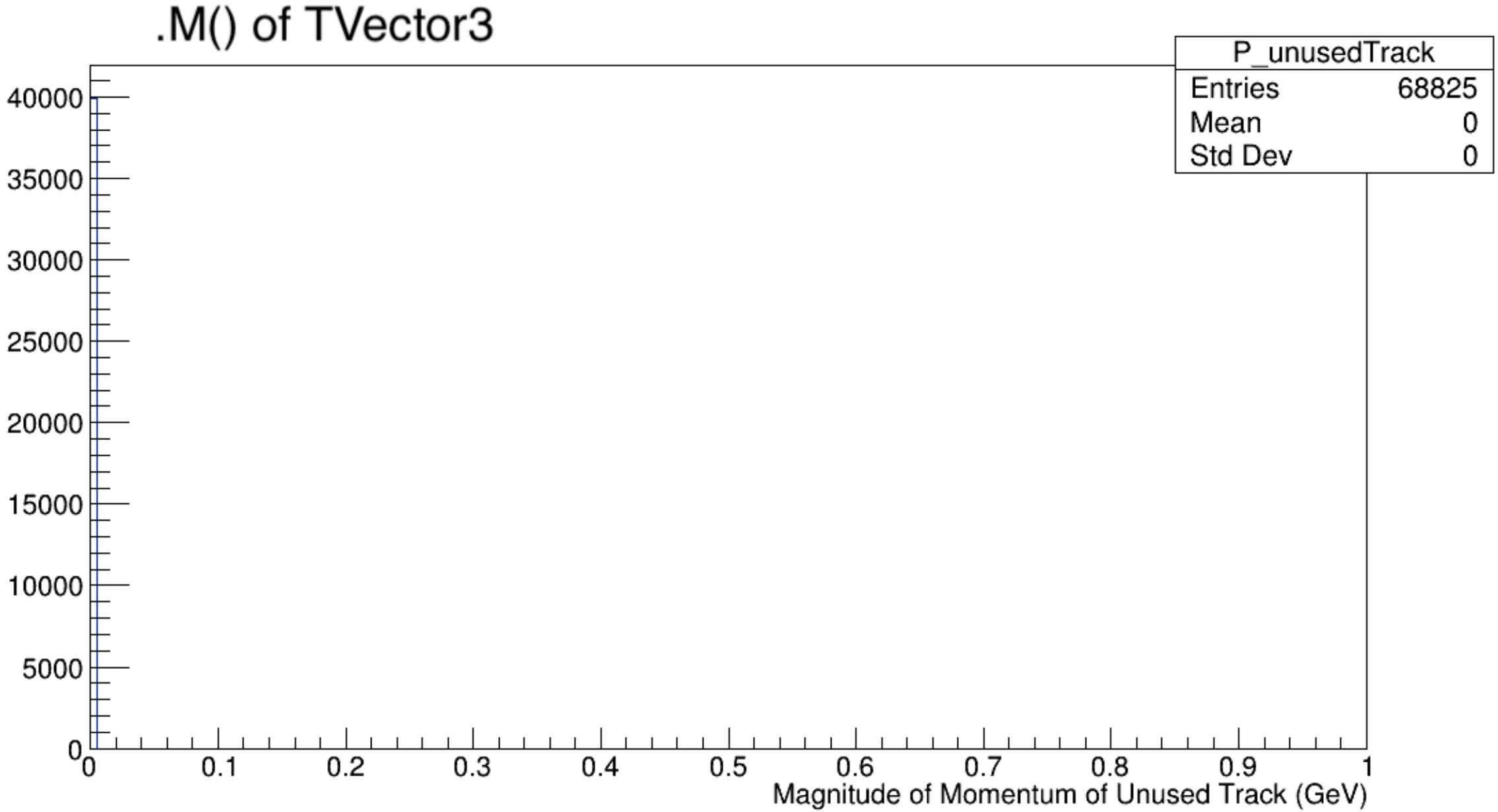

GF; MCP
MissProtP3_VS_CDCdEdx
Entries 159363
Mean x 0.22
Mean y 2.913e−06
Std Dev x 0.1429
Std Dev y 5.963e−06
CDC dE/dx
×10⁻⁶
25
20
15
10
5
0
0
0.5
1
1.5
2
Proton P Magnitude (GeV)
4000
3000
2000
1000
0


DATA
MissProtP3_VS_CDCdEdx
Entries 52196
Mean x 0.1615
Mean y 1.502e−06
Std Dev x 0.1652
Std Dev y 3.558e−06
CDC dE/dx
×10⁻⁶
25
20
15
10
5
0
0
0.5
1
1.5
2
Proton P Magnitude (GeV)
800
600
400
200
0

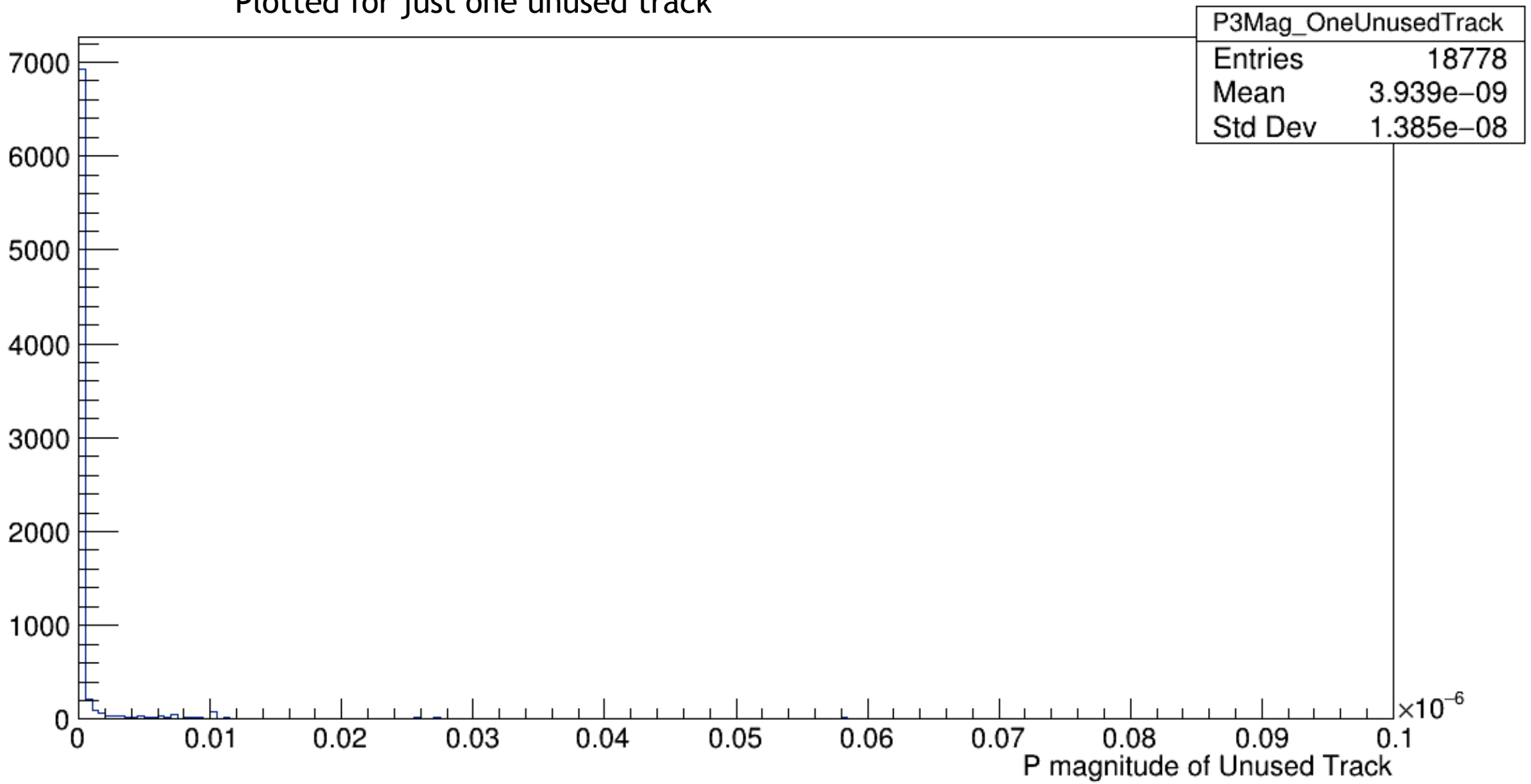

SumP3_UnusedTracks.Theta()
htemp
Entries 136378
Mean 0.2532
Std Dev 0.5014
×10^3
100
80
60
40
20
0
0
0.5
1
1.5
2
2.5
3
SumP3_UnusedTracks.Theta()

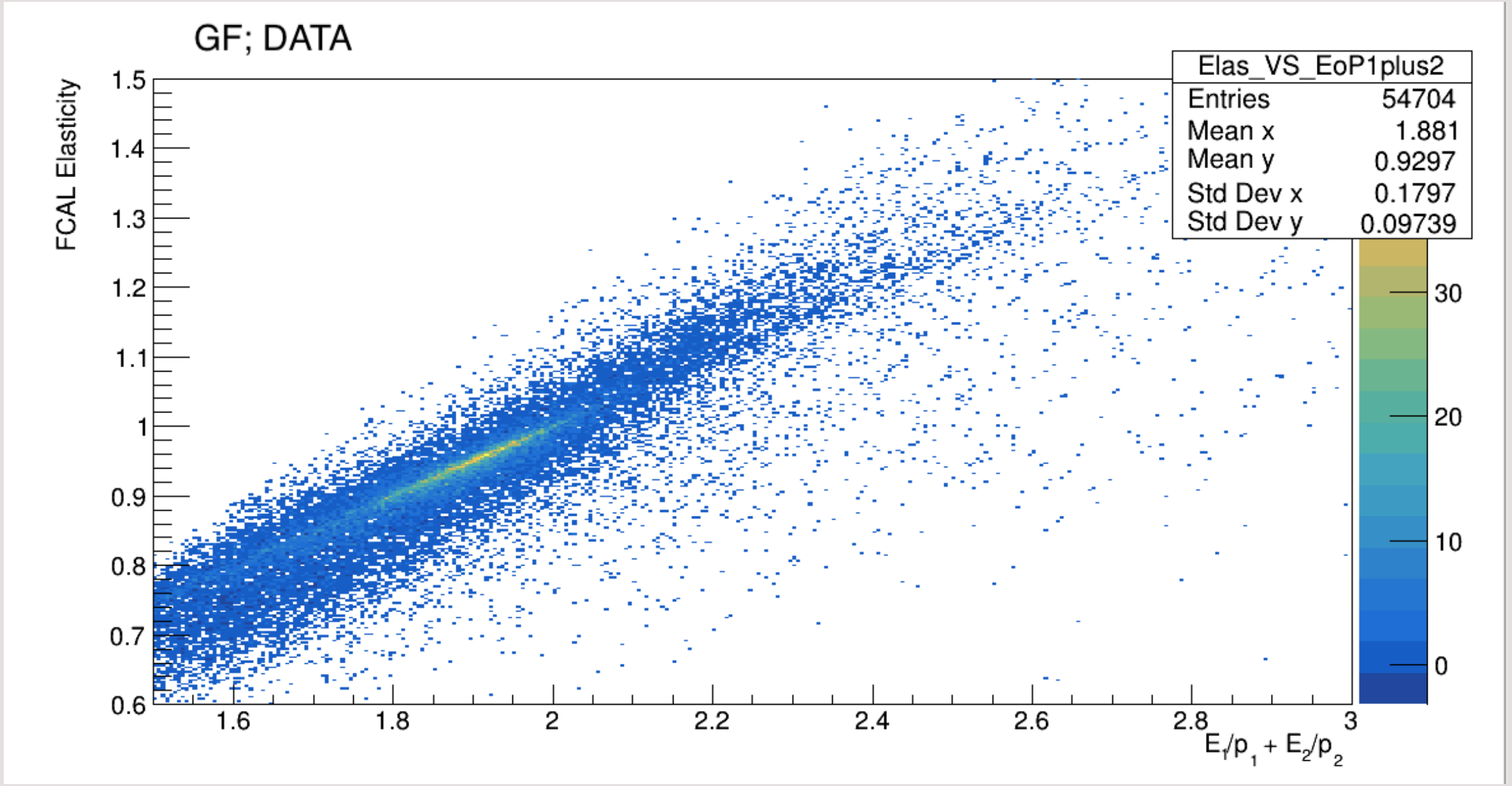

Unused Track Theta (deg)
UnusedTrackThetaDeg
Entries 68825
Mean 38.02
Std Dev 44.46
40000
35000
30000
25000
20000
15000
10000
5000
0
0
20
40
60
80
100
120
140
160
180

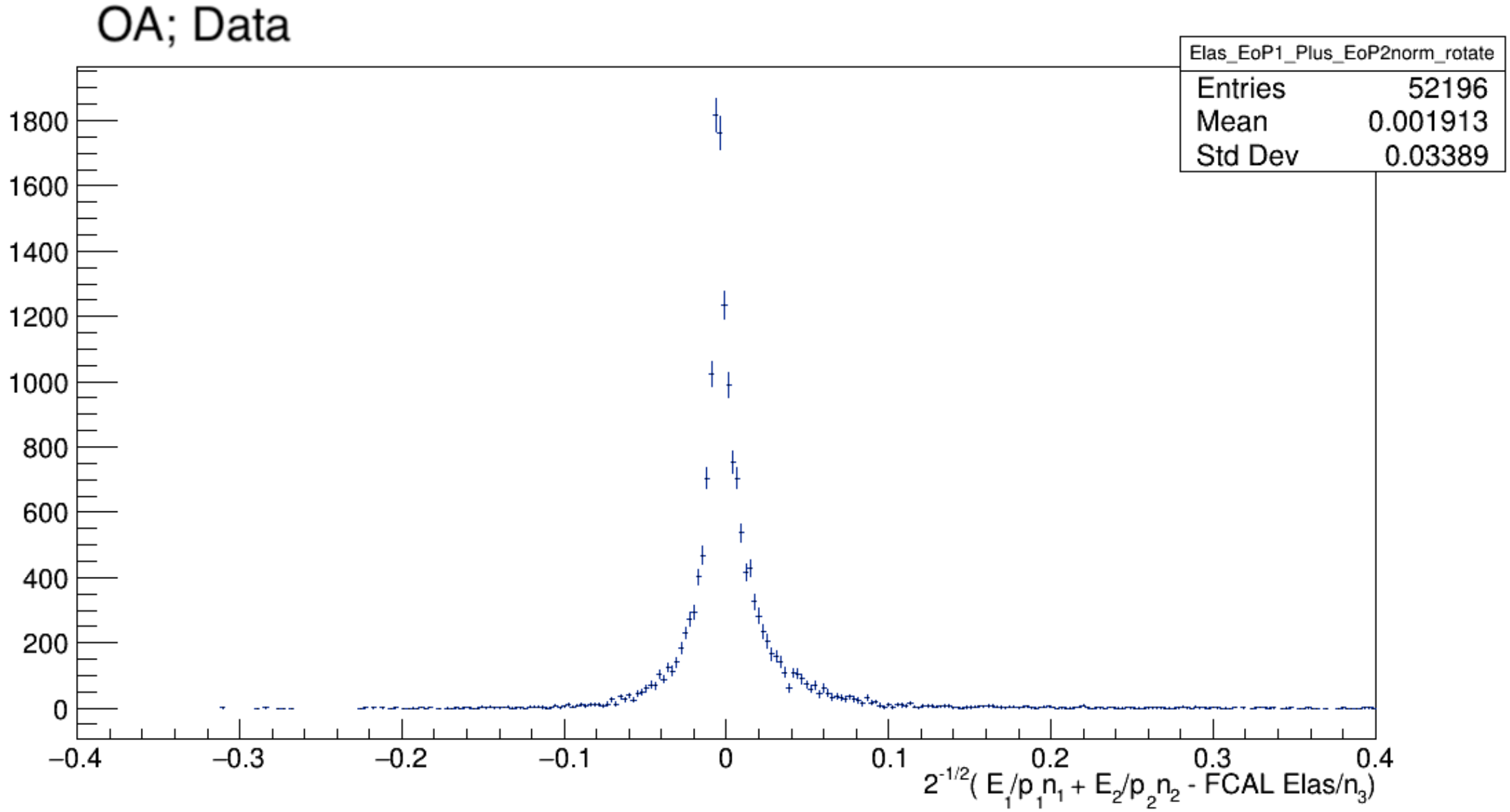

SumP3Mag
SumP3Mag_UnusedTracks
Entries 68825
Mean 0.005252
Std Dev 0.0497
60000
50000
40000
30000
20000
10000
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
SumPMag_UnusedTracks (GeV)


.M() of TVector3
P_unusedTrack
Entries 68825
Mean 0
Std Dev 0
40000
35000
30000
25000
20000
15000
10000
5000
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Magnitude of Momentum of Unused Track (GeV)

Plotted for just one unused track




GF; DATA
Elas_VS_EoP1plus2
Entries 54704
Mean x 1.881
Mean y 0.9297
Std Dev x 0.1797
Std Dev y 0.09739
FCAL Elasticity
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
1.6
1.8
2
2.2
2.4
2.6
2.8
3
$E_1/p_1 + E_2/p_2$
30
20
10
0


OA; Data
Elas_EoP1_Plus_EoP2norm_rotate
Entries 52196
Mean 0.001913
Std Dev 0.03389
1800
1600
1400
1200
1000
800
600
400
200
0
−0.4
−0.3
−0.2
−0.1
0
0.1
0.2
0.3
0.4
$2^{-1/2}(E_1/p_1 n_1 + E_2/p_2 n_2 - \text{FCAL Elas}/n_3)$