SIMULATION STUDY OF BACKGROUND PARTICLES IN THE MUON TELESCOPE DETECTOR AT THE STAR EXPERIMENT

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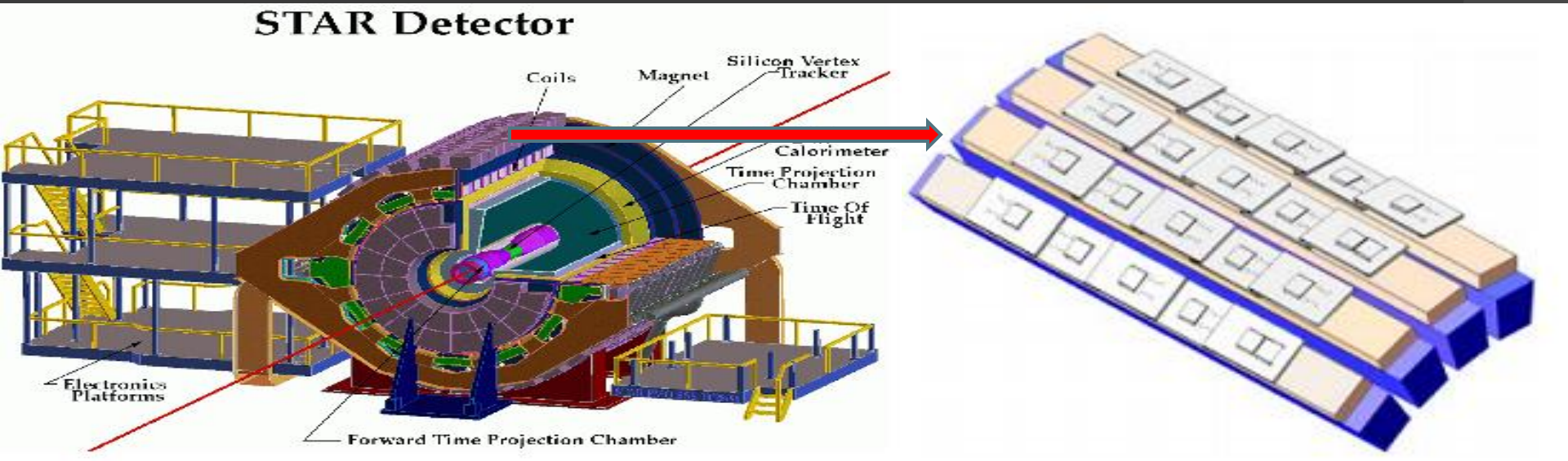
Thanks to Dr. Mioduszewski and Yanfang Liu

Overview

- Background
- Simulation data
- Cuts
- Survival Probabilities (pions, kaons, protons, and muons)
- p_T Distributions
- Delta Z distributions

Background

- The newly built Muon Telescope Detector probes the QGP through the detection of :
  - di-muon pairs from QGP thermal radiation, quarkonia, light vector mesons, resonances in QGP, and Drell-Yan production
  - single muons from the semi-leptonic decays of heavy flavor hadrons.
- The MTD is located on the outside of the time projection chamber (TPC)
  - The TPC is the main tracking detector for STAR
- Non-muon particles are intercepted by the barrel-electromagnetic calorimeter (BEMC) and the steel from the magnet; **however not all of the background particles are filtered**



Simulation Data

- Run 14: 14.5 GeV Au+Au collision
- Omega production
  - $\Omega^- \rightarrow \Lambda + K^-$
    - $\Lambda \rightarrow p + \pi^-$
    - $K^- \rightarrow \mu^- + \nu^-_\mu$
  - # K: 141866
  - # π: 138300
  - # p: 172865
  - # μ: 16564
- Phi production
  - $\varphi \rightarrow K^- + K^+$
    - $K^\pm \rightarrow \pi^\pm + \pi^\pm + \pi^\mp$
  - # K: 309034
  - # π: 11912
  - # p: 4790
  - # μ: 15882

Cut Numbers

1. p_T cut: 1.2 GeV/c < p_T < 30 GeV/c
2. NHitsFit cut: NHitsFit > 20
3. NHitsDedx cut: NHitsDedx > 15
4. Pseudorapidity cut: |eta| <= .65
5. Tracks associated with MTD hit
6. Dedx (ionization energy loss the in TPC) cut: -1 < NSigmaPion < 3

Track quality cuts

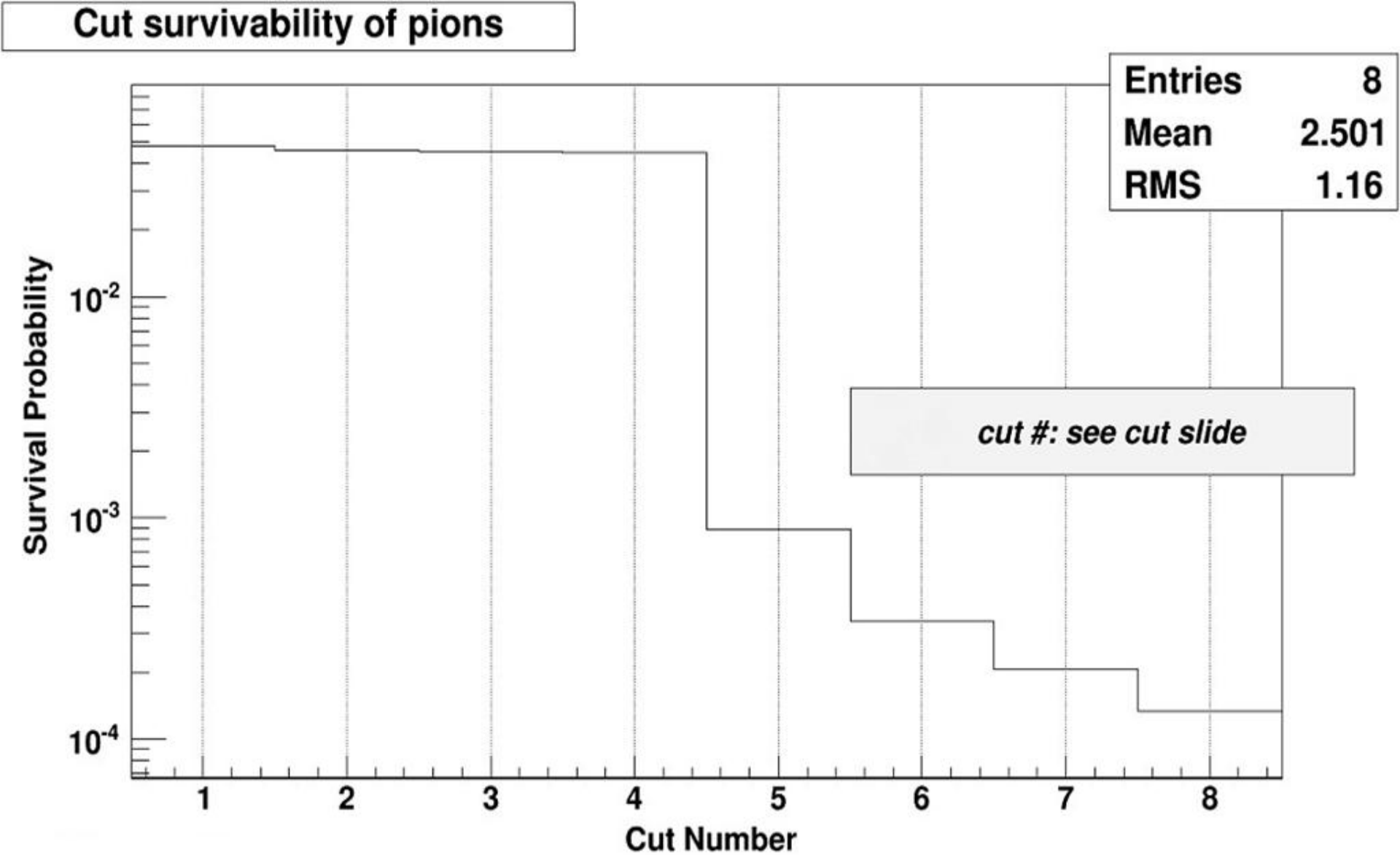
Cuts on the distance between track projection and MTD hits for:

1. Y coordinate: $|\Delta Y| < 20$
2. Z coordinate: $|\Delta Z| < 20$

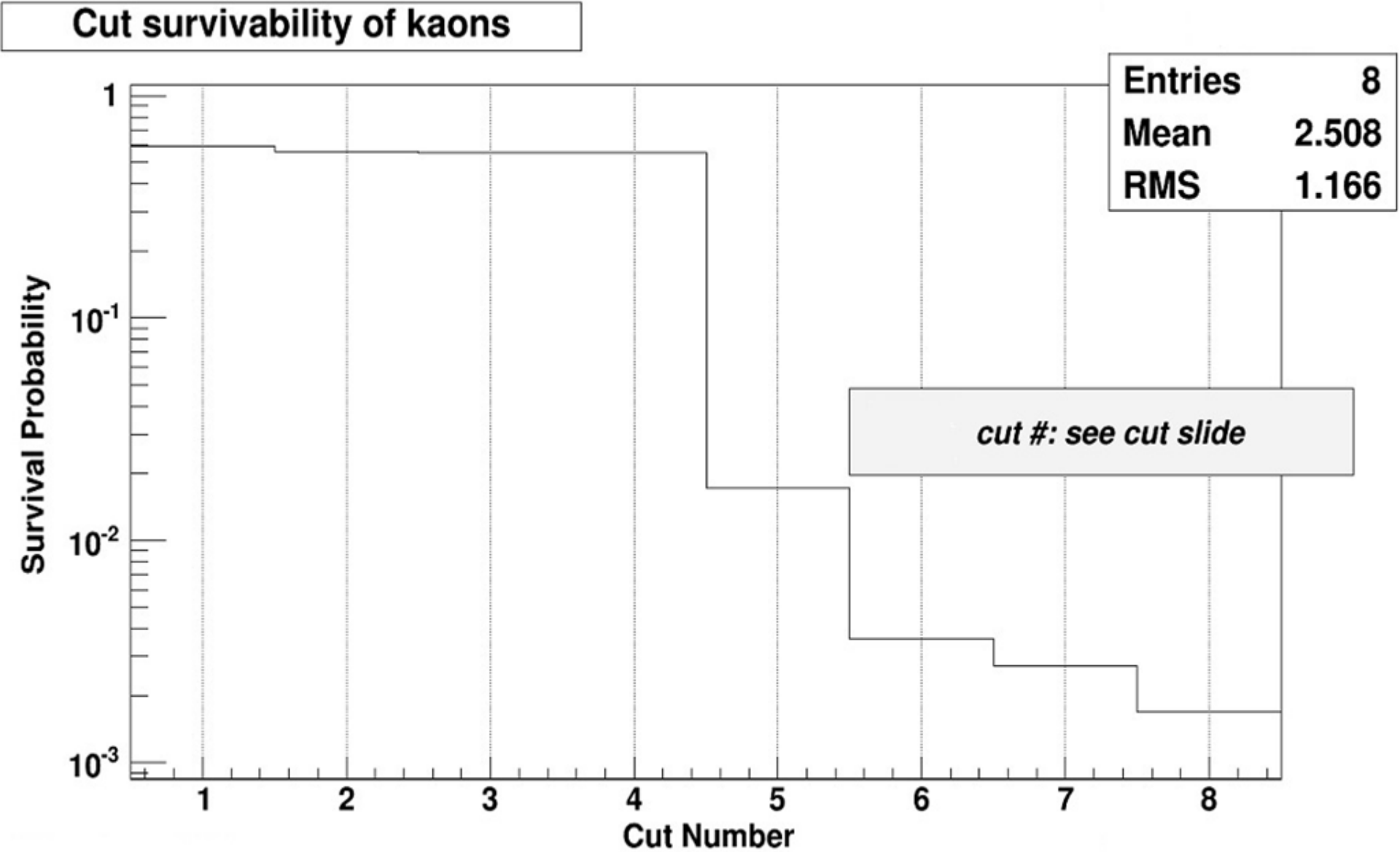
Particle identification cuts

Analysis

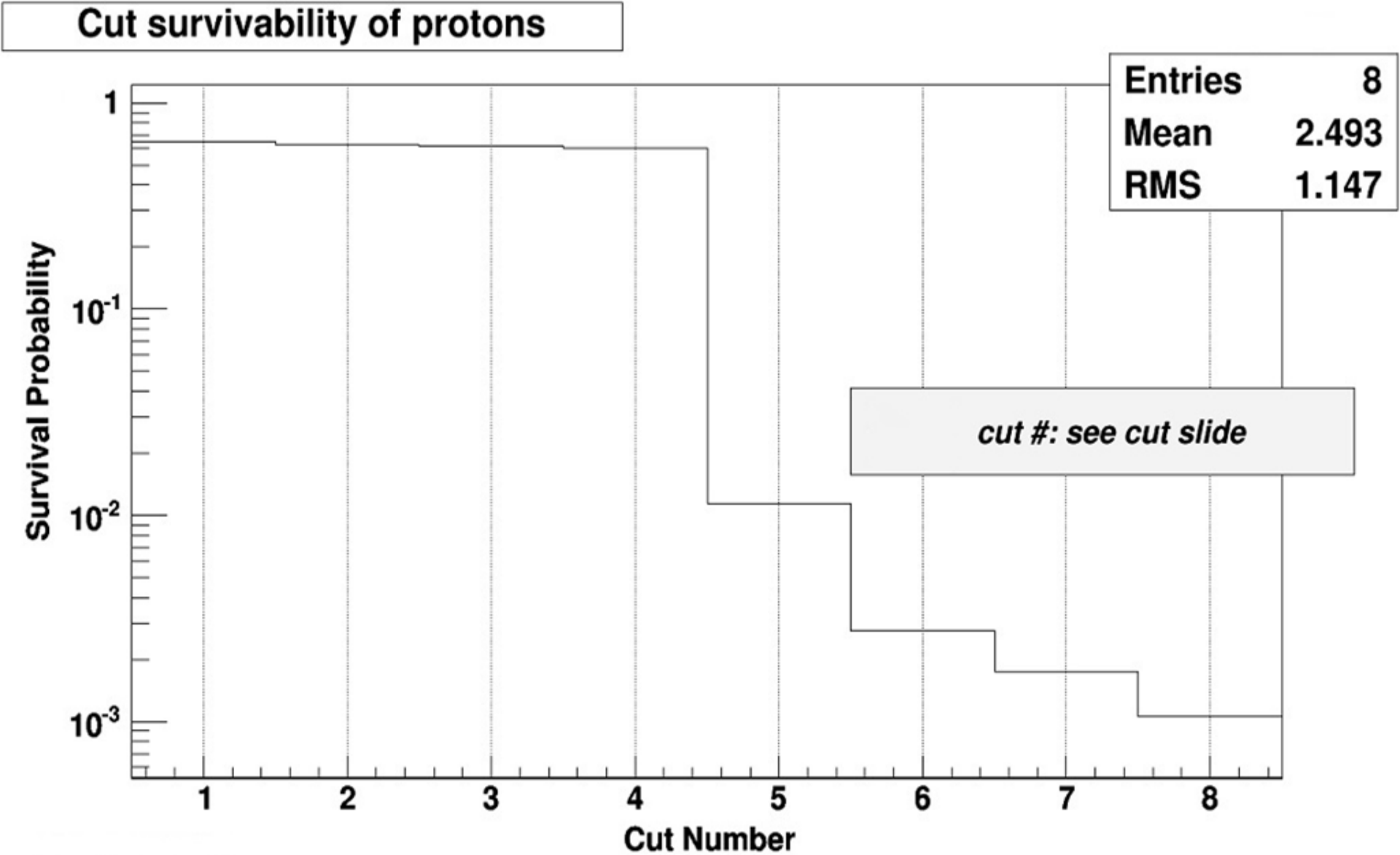
- Investigate the survivability of background particles
  - what percent survive all the cuts
- The shape of Delta Z distribution to estimate the number of background particles that survive these cuts in the real data



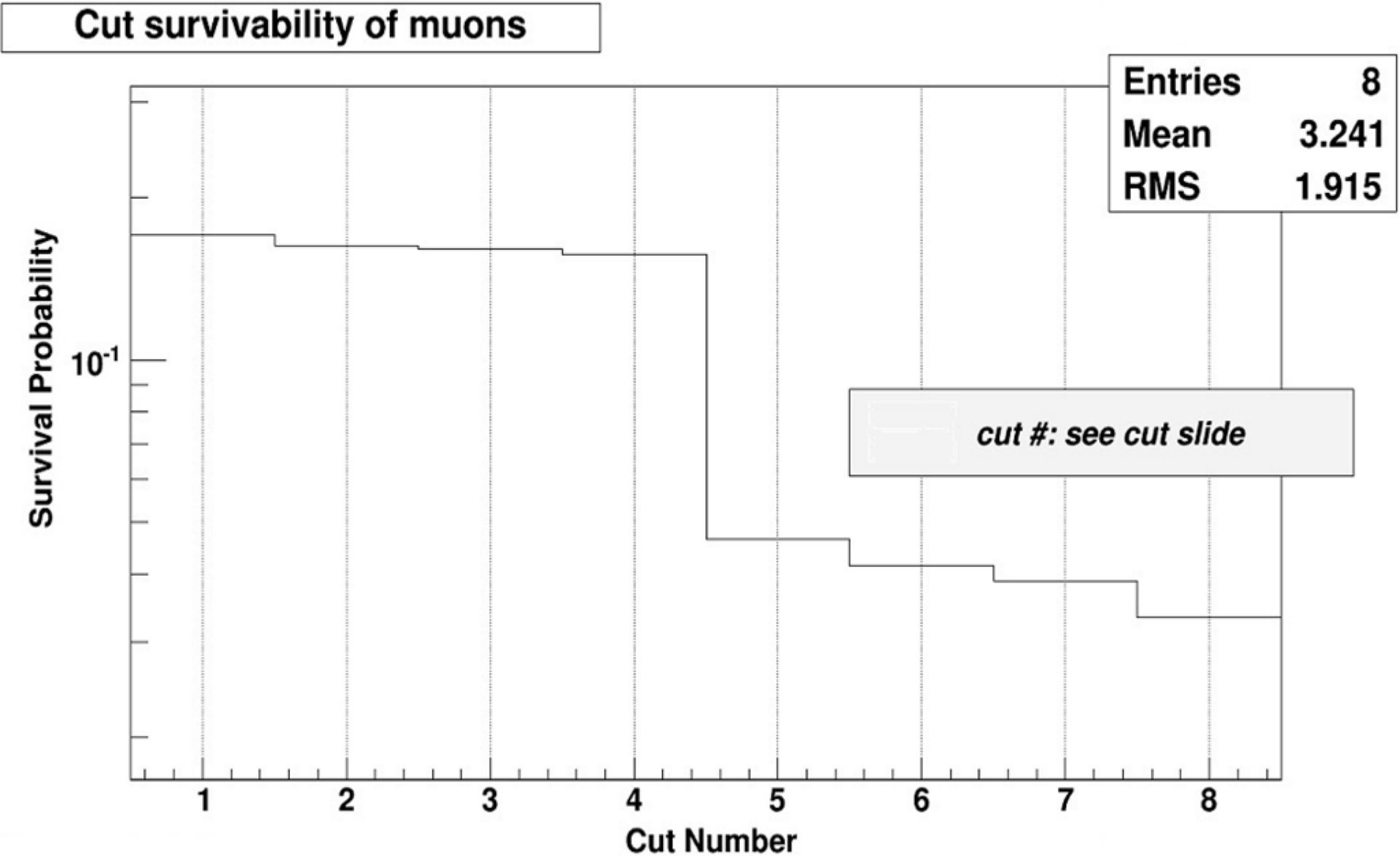
0.28% of the pions, that have a $p_T > 1.2$ GeV, survive the cuts



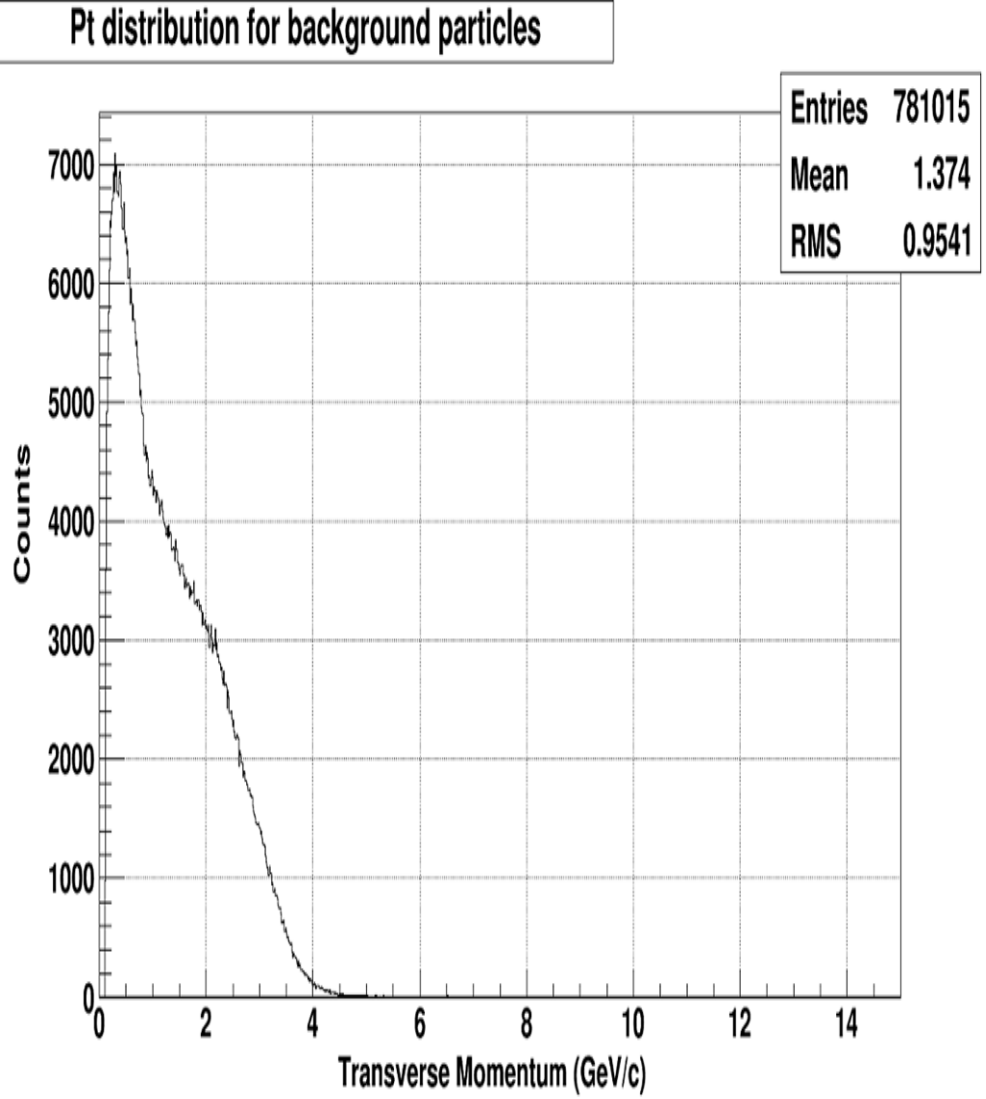
0.29% of the kaons, that have a $p_T > 1.2$ GeV, survive the cuts

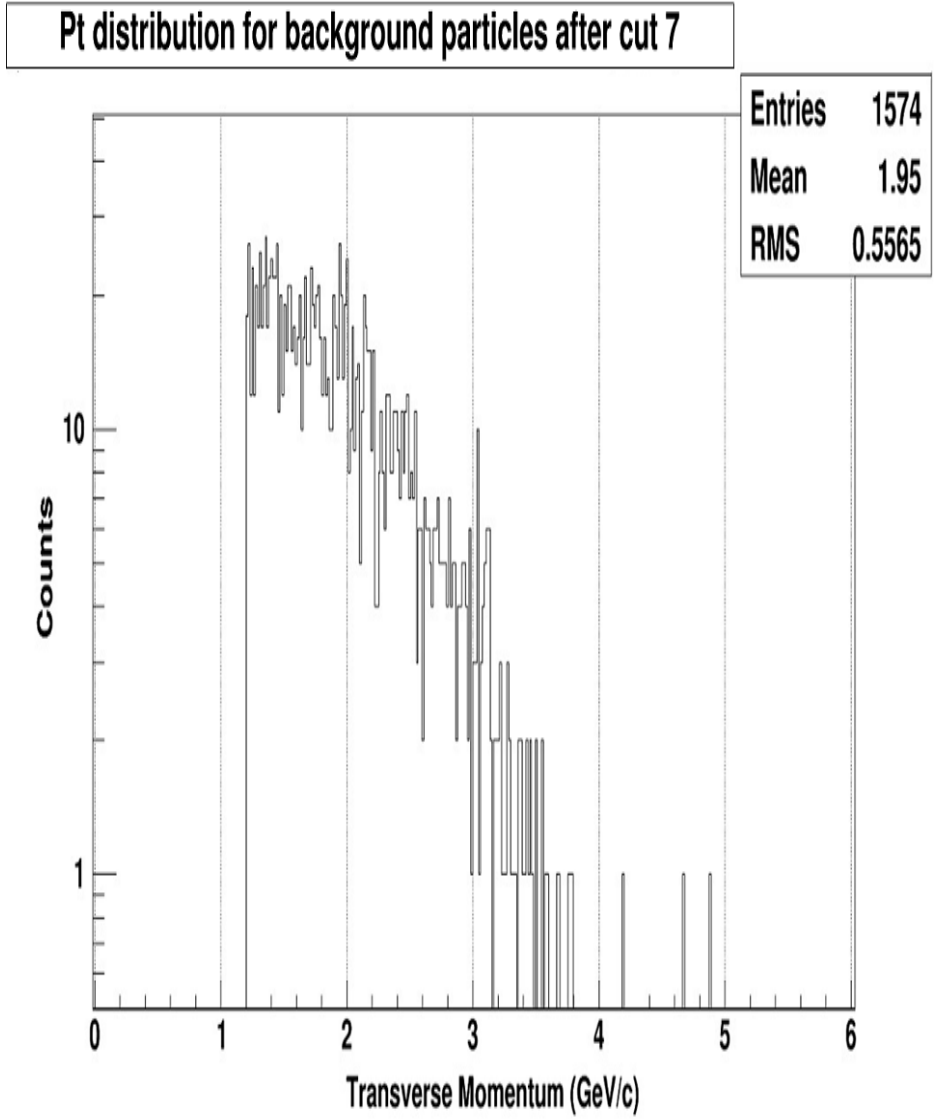


0.16% of the protons, that have a $p_T > 1.2$ GeV, survive the cuts



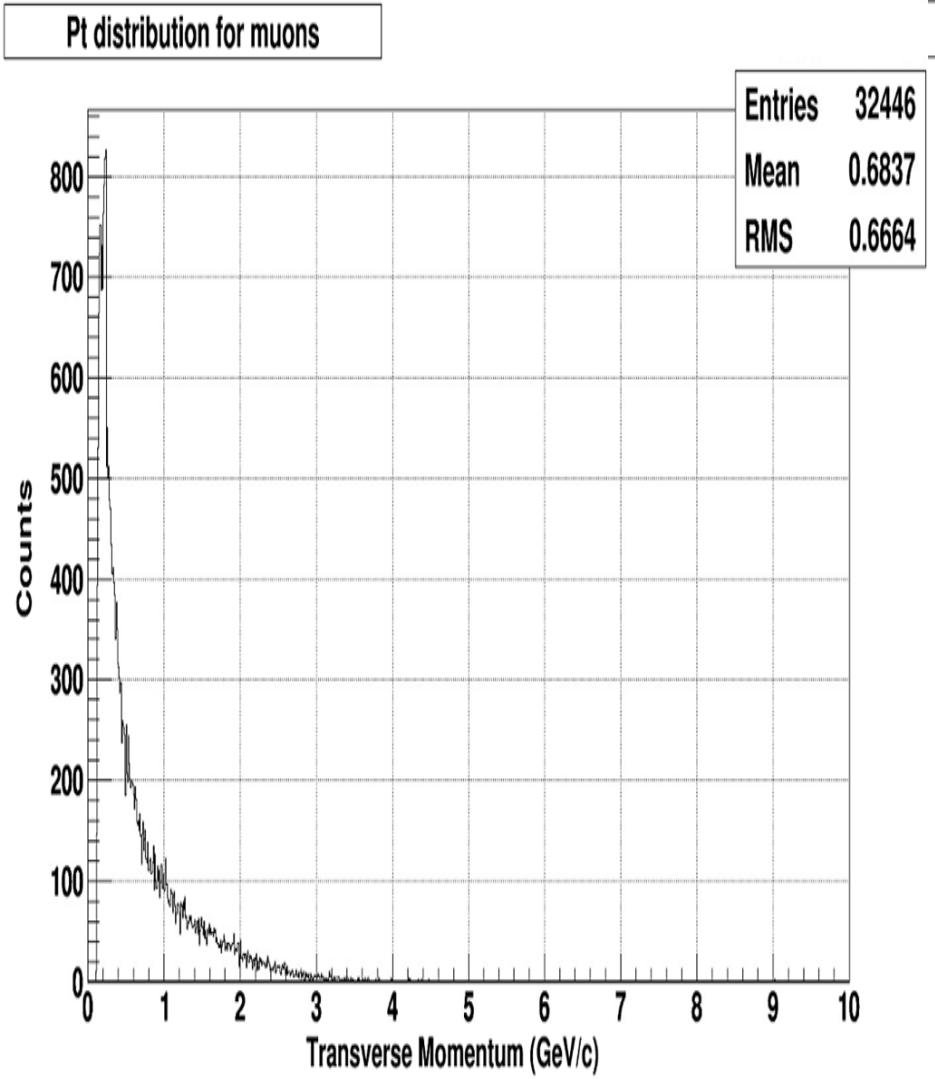
20% of the muons, that have a $p_T > 1.2$ GeV, survive the cuts .

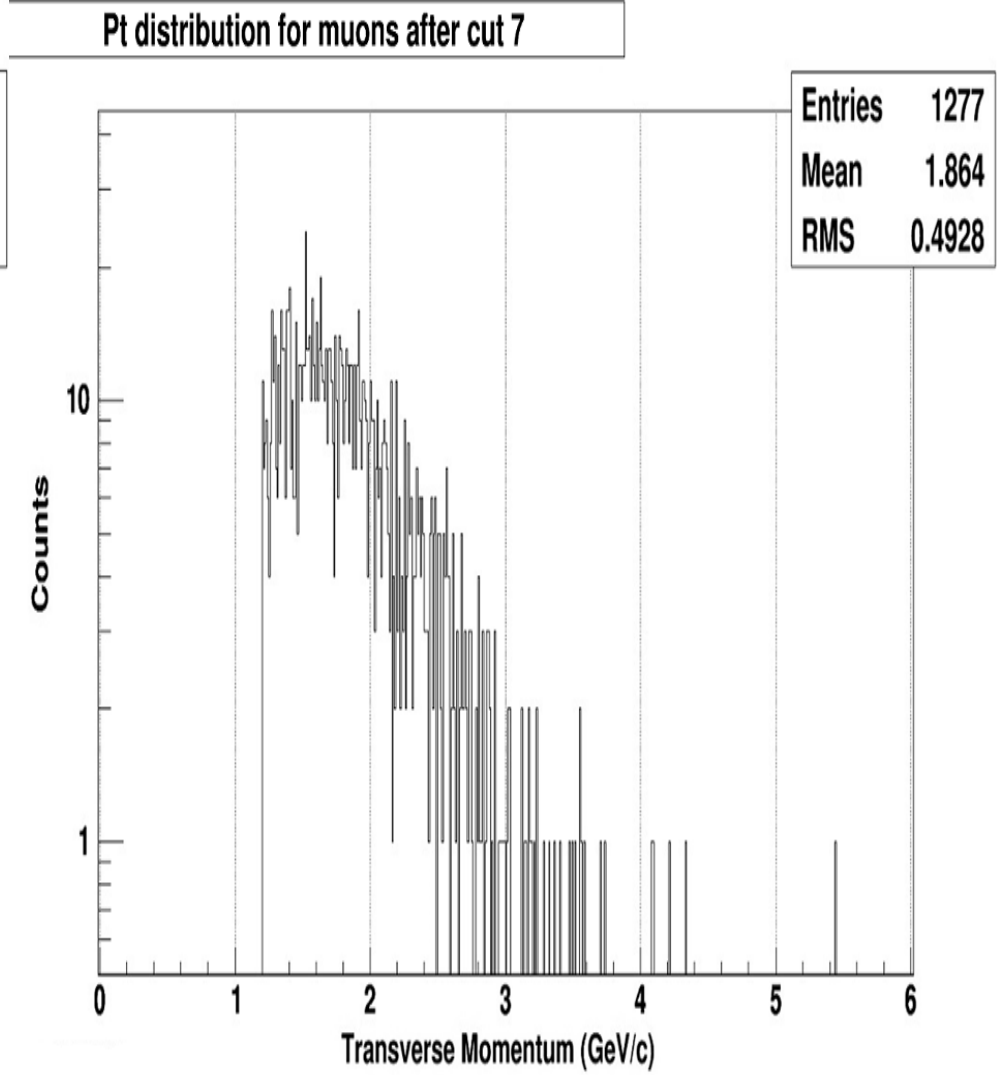




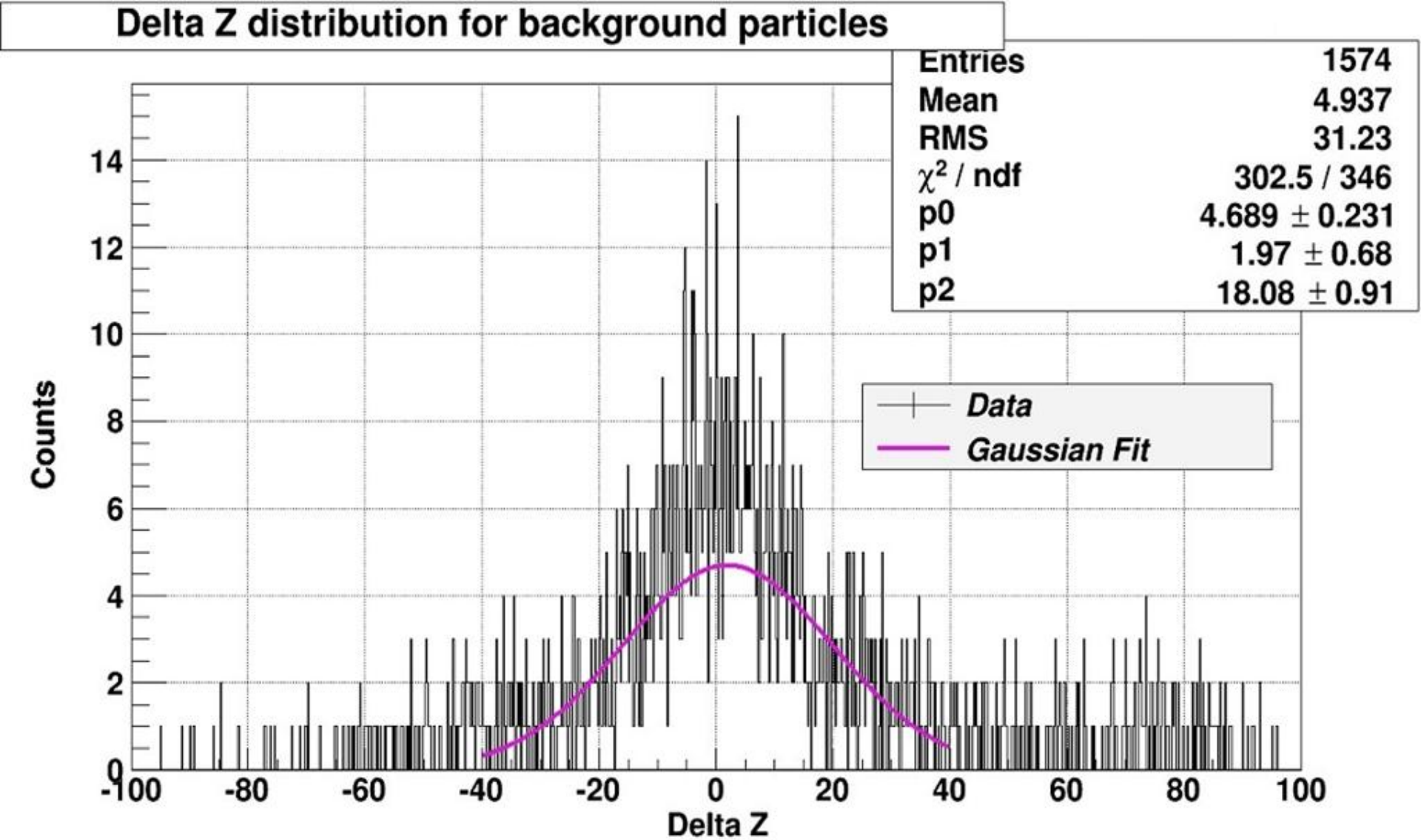
After cut 7

- 31 pions survive out of the original 150212
- 1225 kaons survive out of the original 141866
- 309 protons survive out of the original 177665

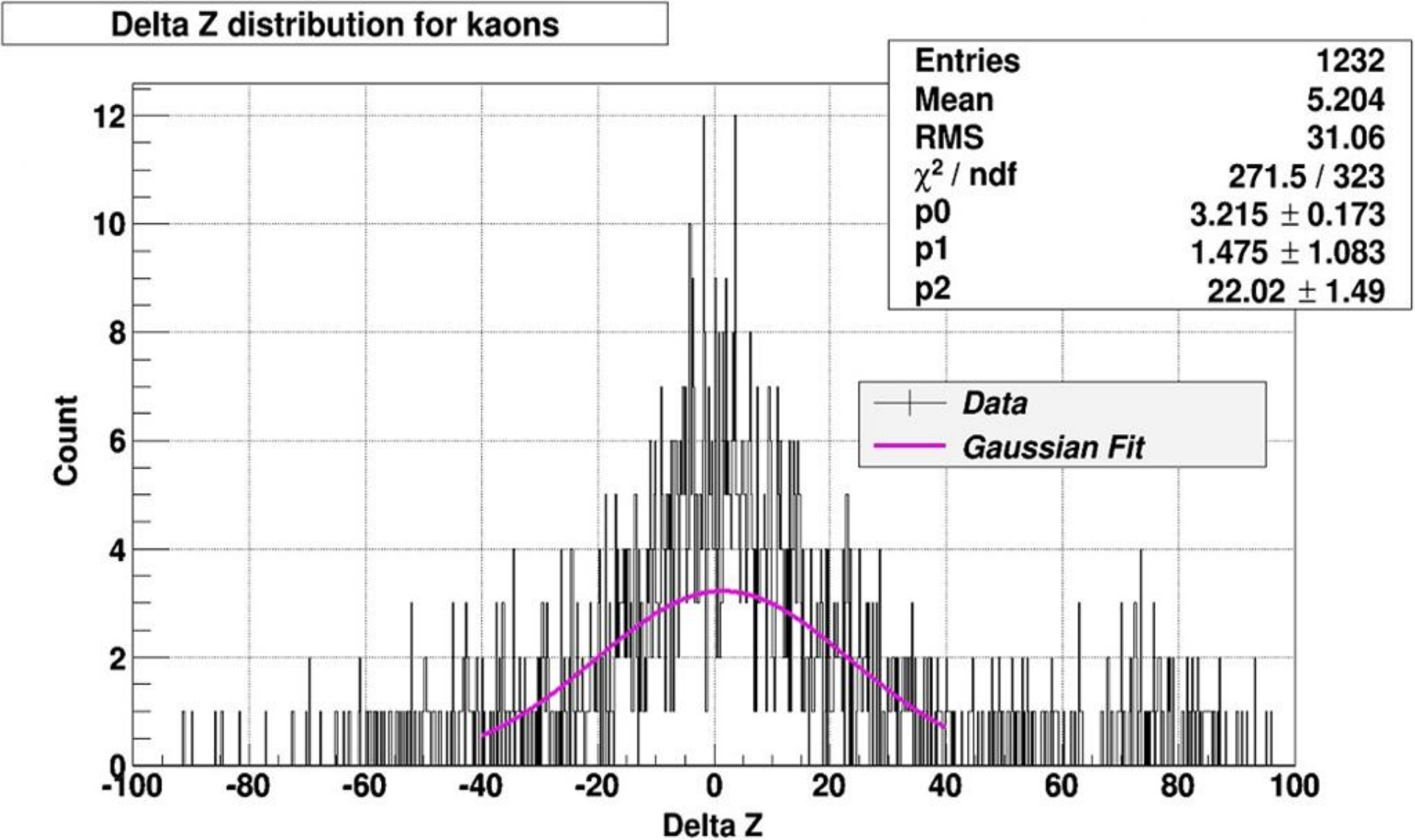




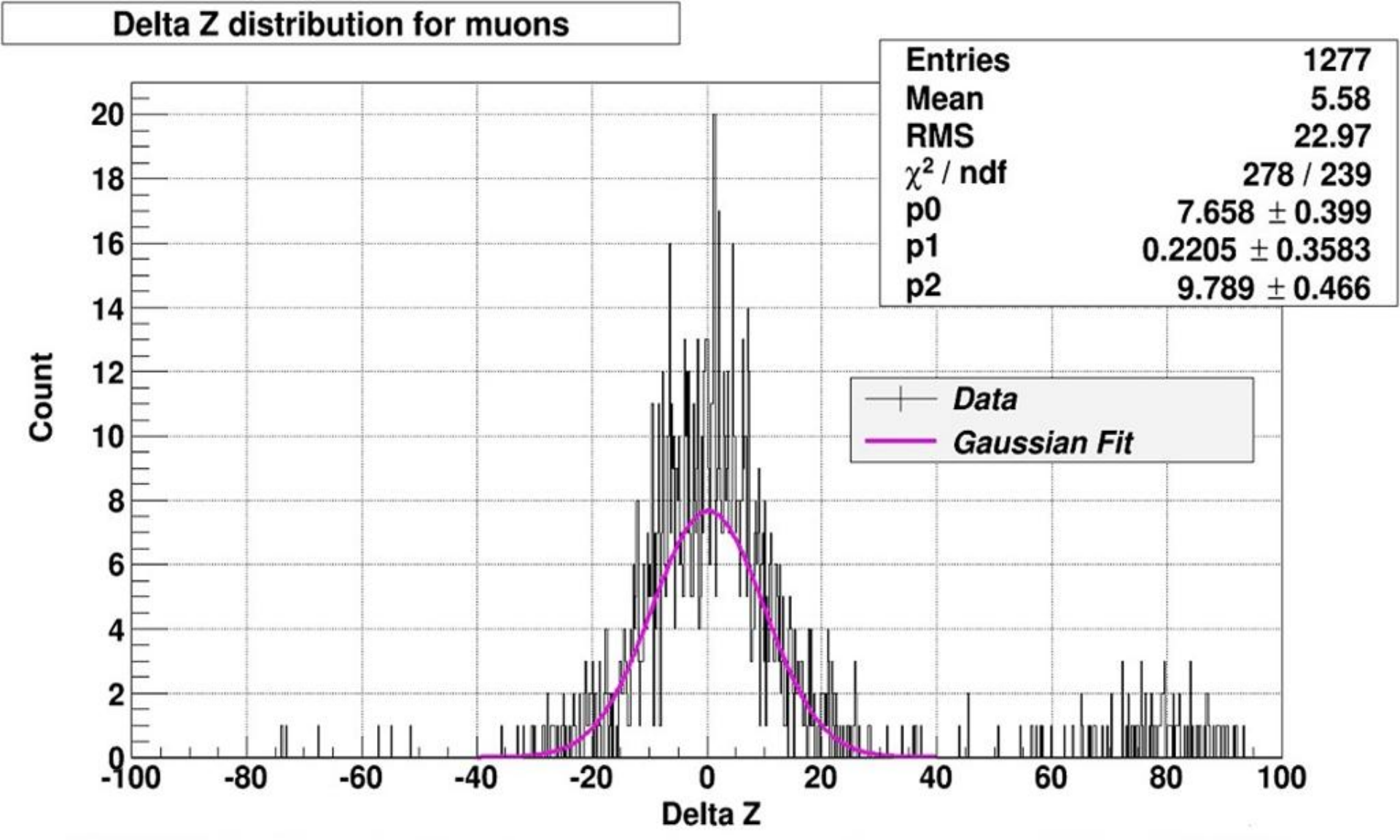
After cut 7, 1277 muons survive out of the original 32446



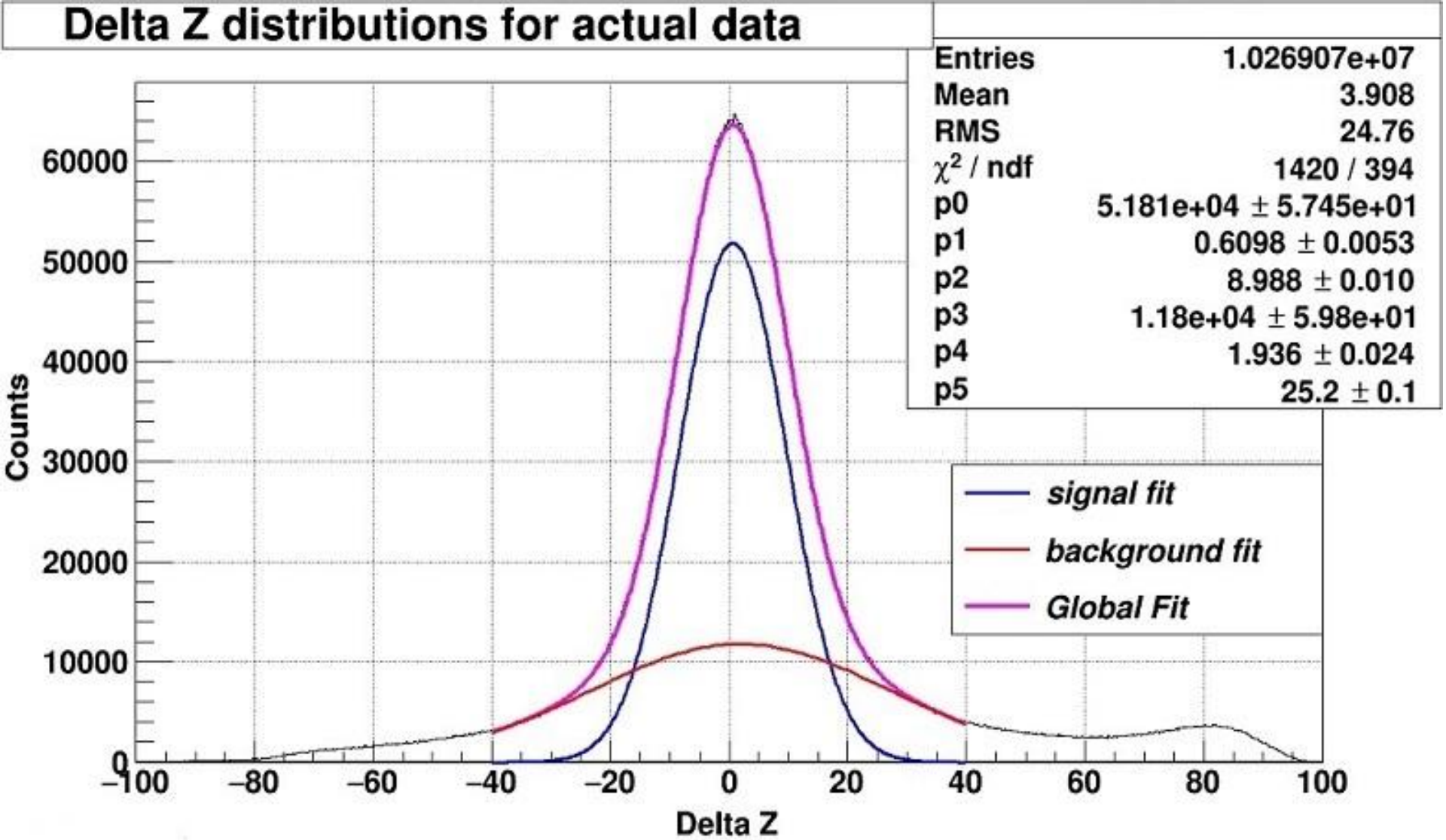
The background particles have a width of 18.08 ± .91



Kaons have a width of 22.02 ± 1.49



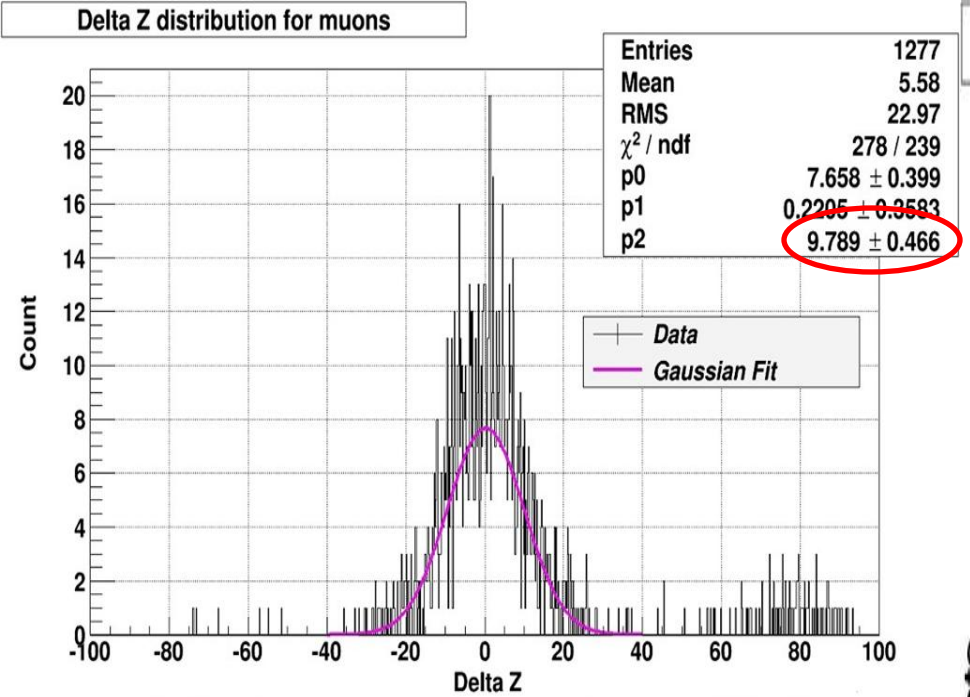
Muons have a width of 9.789 ± .466

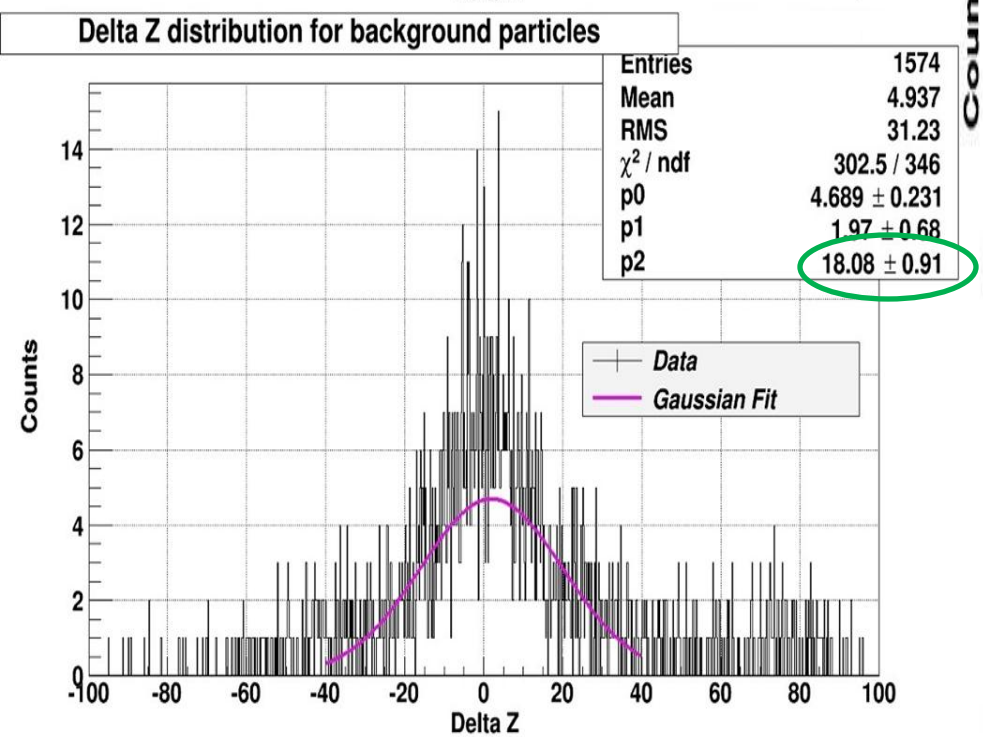


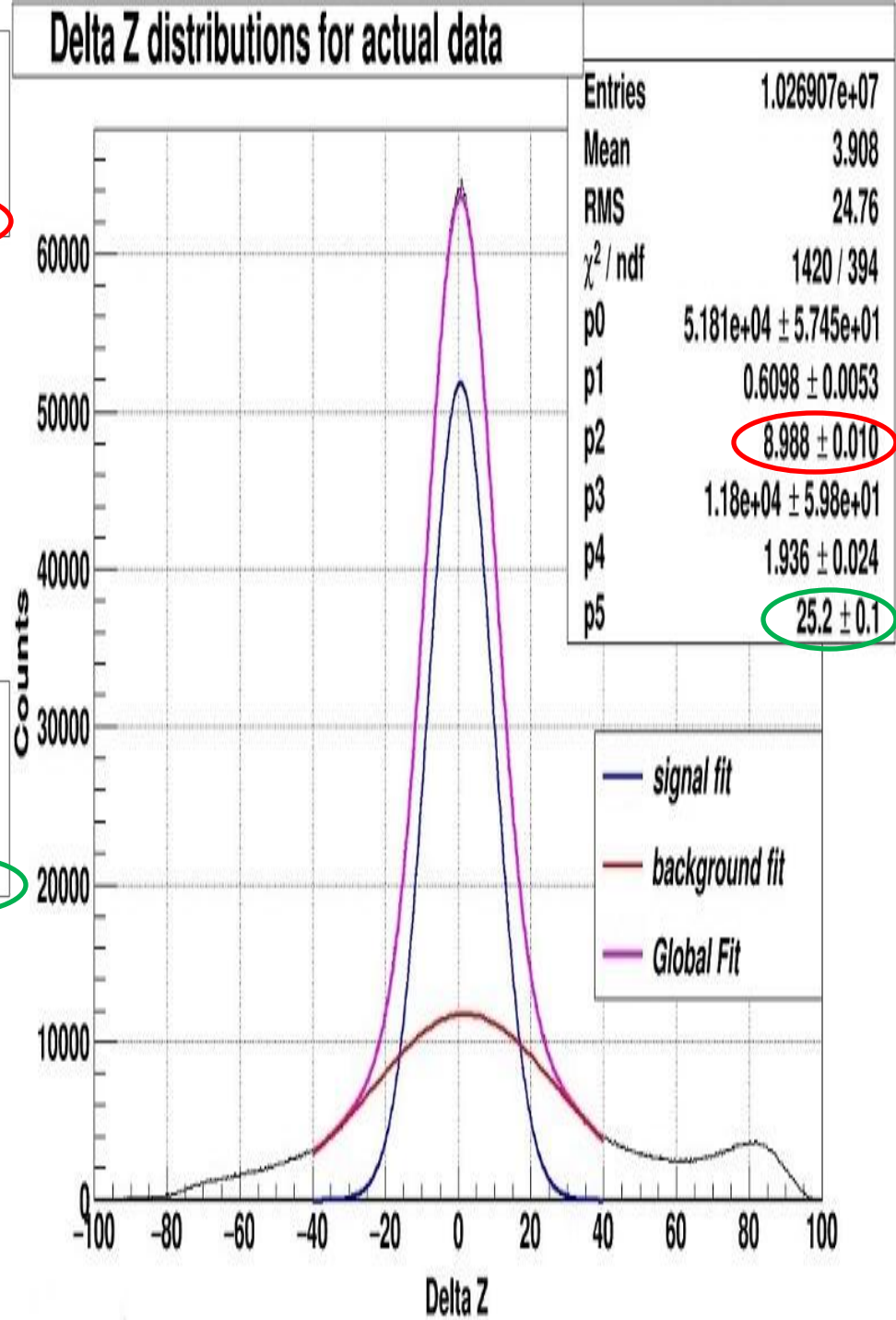
The signal fit (suspected muons) has a width of 8.988 ± 0.010

The background fit has a width of 25.2 ± 0.1

Background particles make up about 38% of the data


Delta Z distribution for muons
Entries 1277
Mean 5.58
RMS 22.97
χ² / ndf 278 / 239
p0 7.658 ± 0.399
p1 0.2205 ± 0.3583
p2 9.789 ± 0.466
Data
Gaussian Fit
Count
Delta Z


Delta Z distribution for background particles
Entries 1574
Mean 4.937
RMS 31.23
χ² / ndf 302.5 / 346
p0 4.689 ± 0.231
p1 1.97 ± 0.68
p2 18.08 ± 0.91
Data
Gaussian Fit
Counts
Delta Z

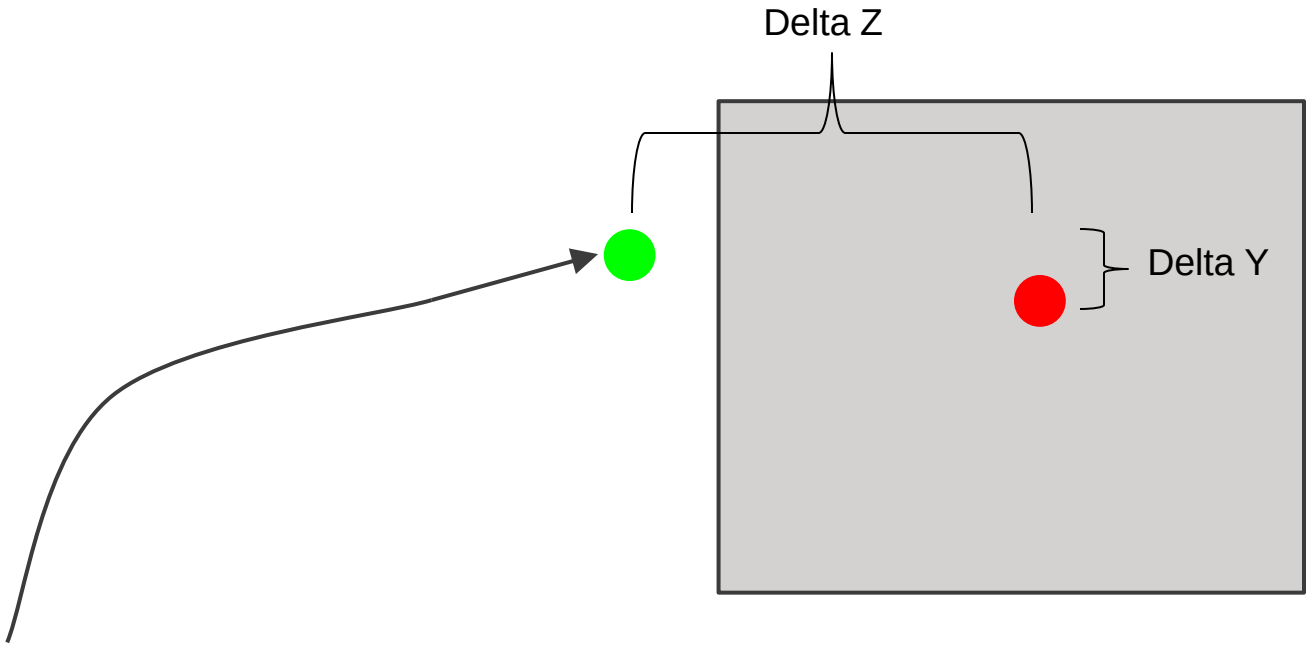

Delta Z distributions for actual data
Entries 1.026907e+07
Mean 3.908
RMS 24.76
χ² / ndf 1420 / 394
p0 5.181e+04 ± 5.745e+01
p1 0.6098 ± 0.0053
p2 8.988 ± 0.010
p3 1.18e+04 ± 5.98e+01
p4 1.936 ± 0.024
p5 25.2 ± 0.1
signal fit
background fit
Global Fit
Counts
Delta Z

Summary

- 0.28% of the pions, that have a $p_T > 1.2$ GeV, survive the cuts
- 0.29% of the kaons, that have a $p_T > 1.2$ GeV, survive the cuts
- 0.16% of the protons, that have a $p_T > 1.2$ GeV, survive the cuts
- 20% of the muons that have a $p_T > 1.2$ GeV survive the cuts , 100 X greater survivability than the background
- Background particles have a Delta Z width of 18.08 ± .91
- Kaons have a Delta Z width of 22.02 ± 1.49
- Muons have a Delta Z width of 9.789.08 ± .466
- The Delta Z widths agree well with the double Gaussian fit

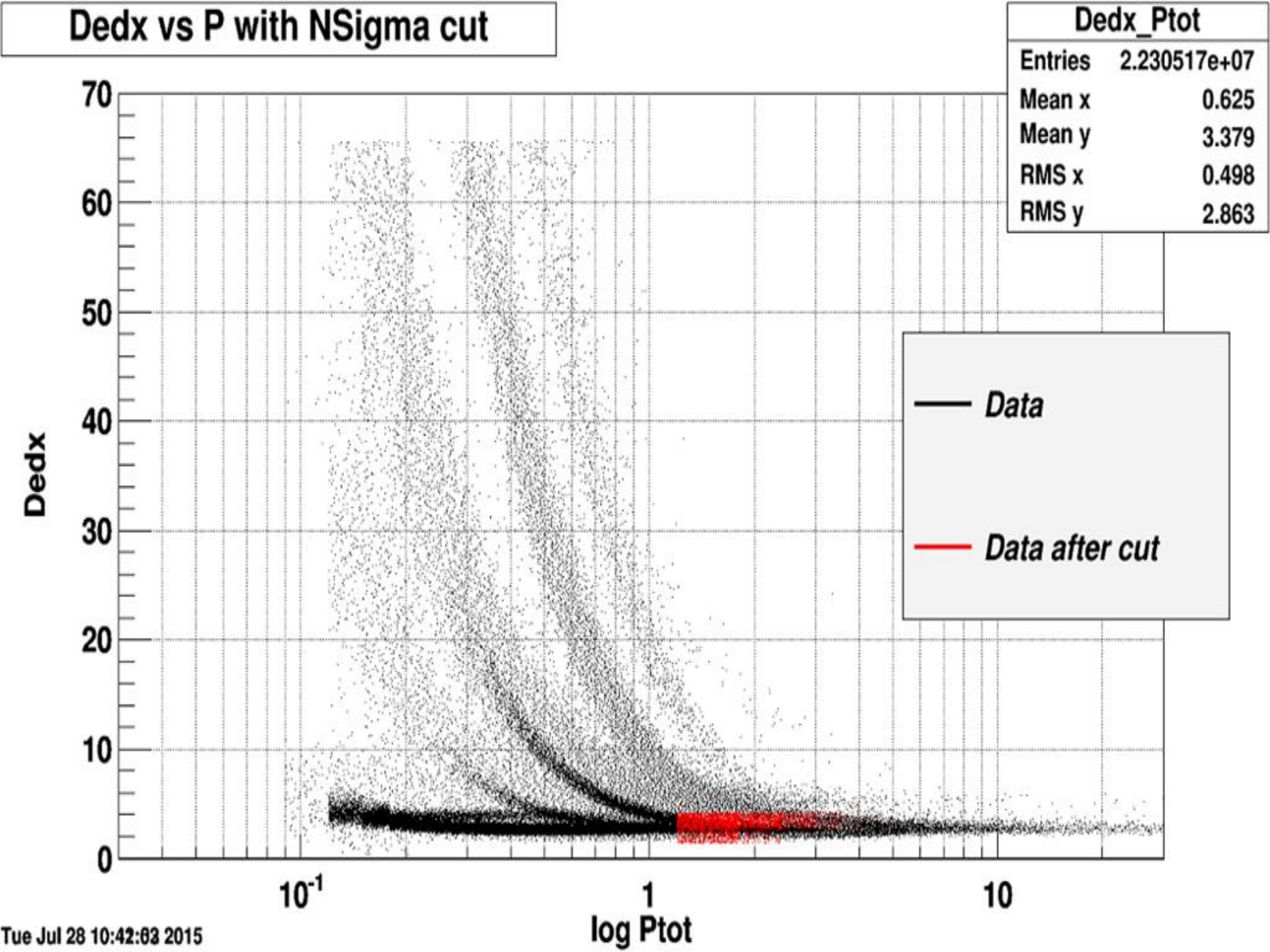
Backup slides

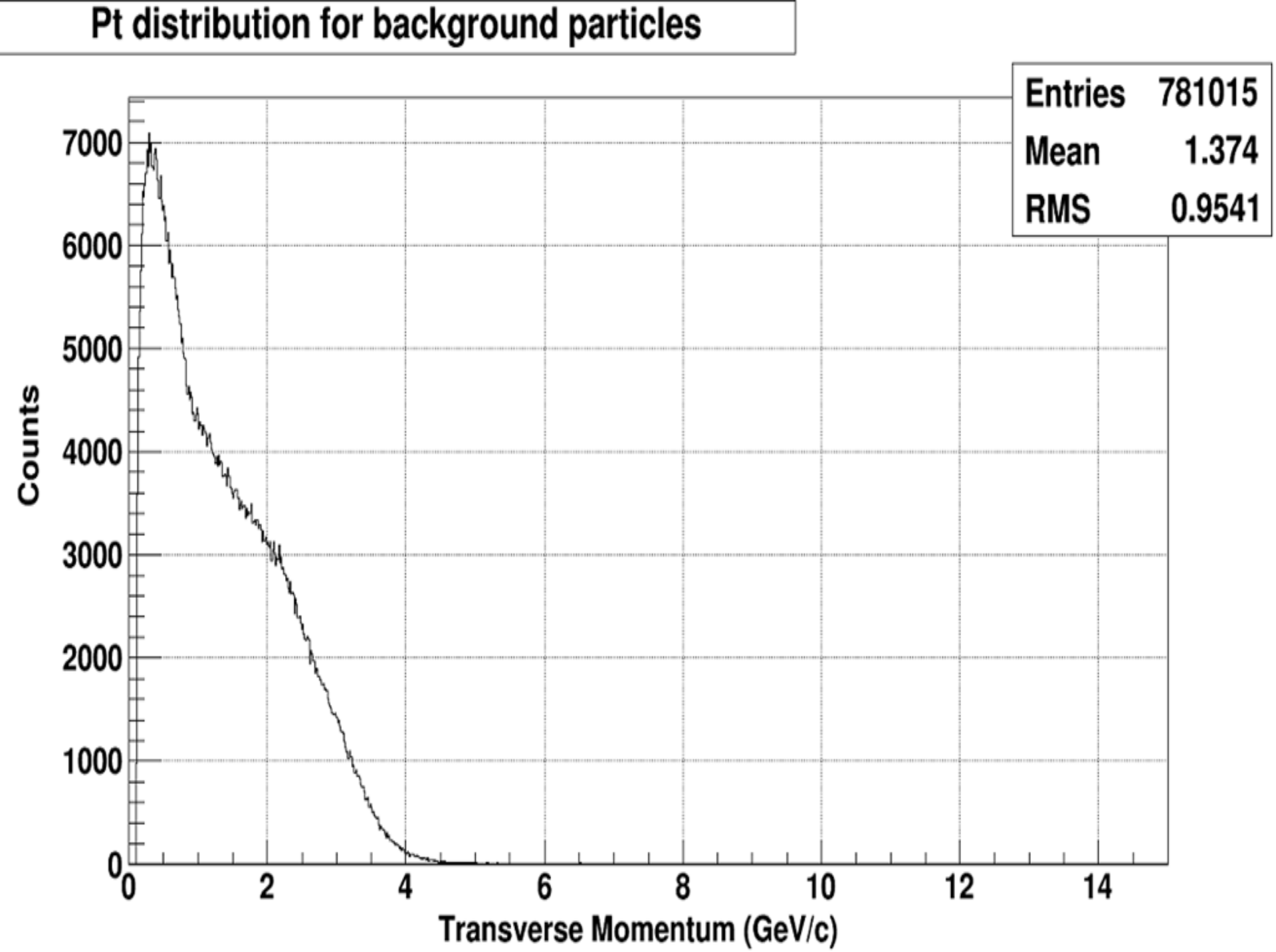
Track Matching to MTD hits

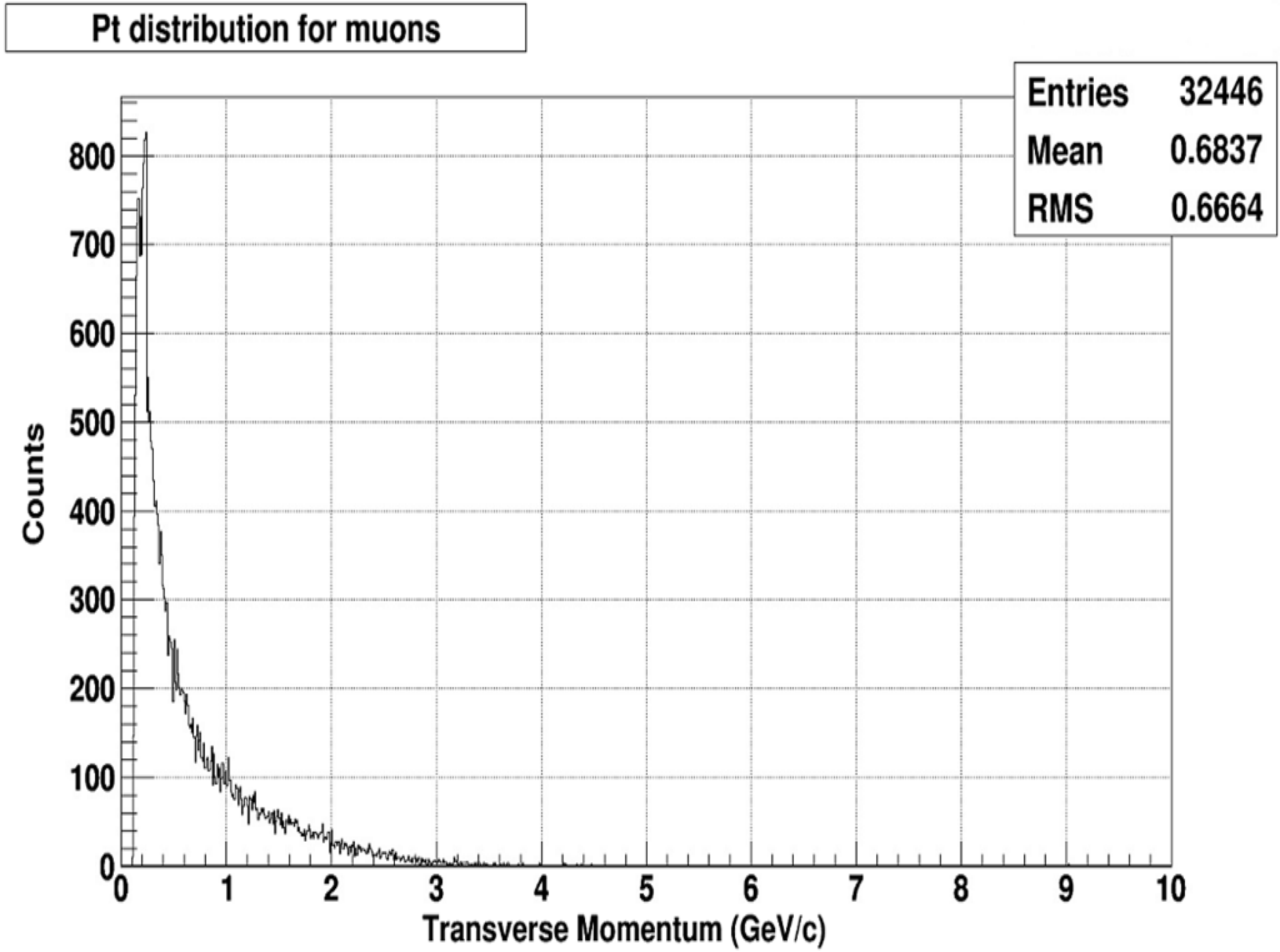


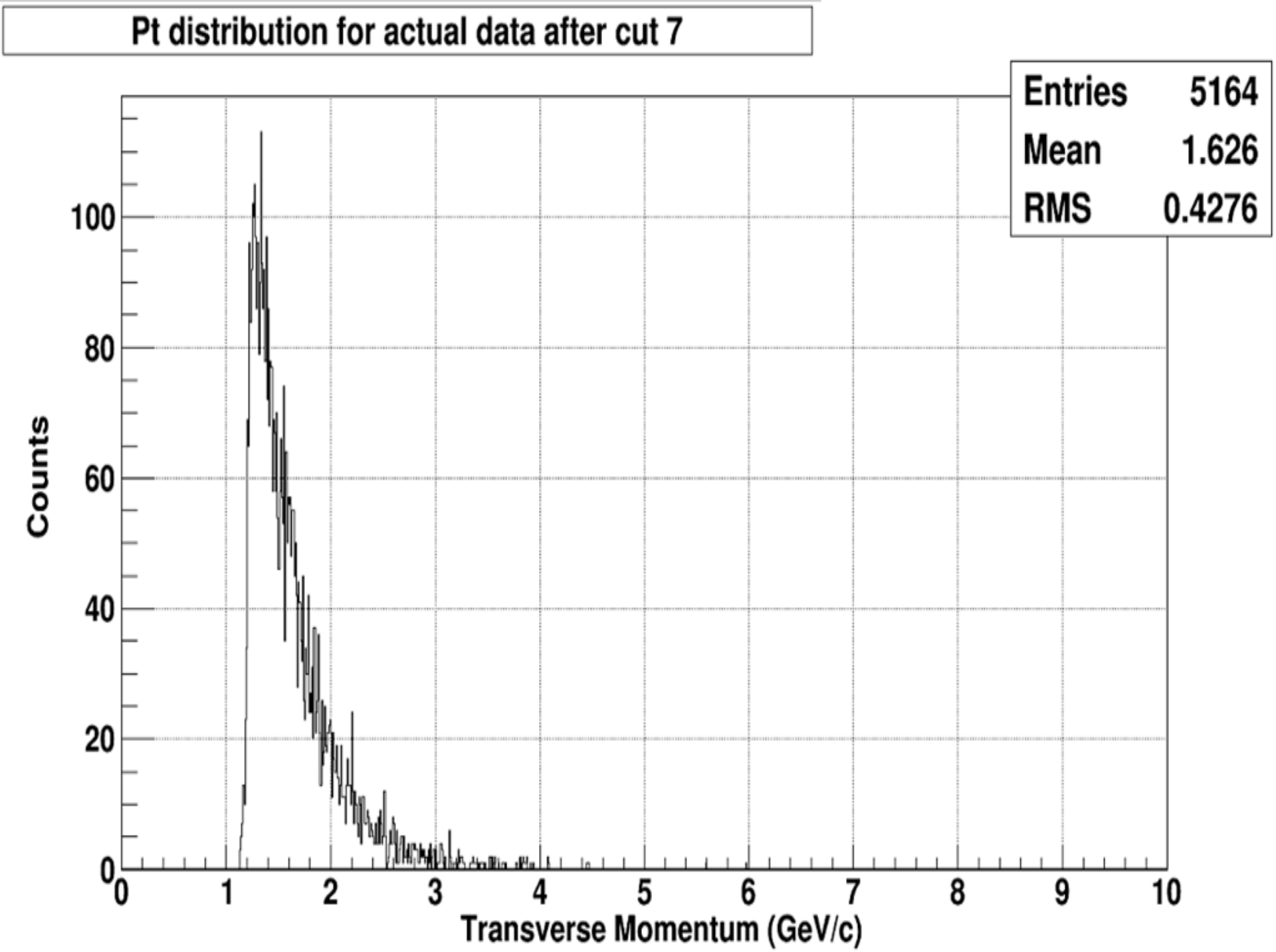
What's next?

- More Statistics
  - Simulate flat p_T and weight each entry with true p_T
- Time of flight cut (TOF)


Dedx vs P with NSigma cut
Dedx_Ptot
Entries 2.230517e+07
Mean x 0.625
Mean y 3.379
RMS x 0.498
RMS y 2.863
Data
Data after cut
Dedx
log Ptot
70
60
50
40
30
20
10
0
10^{-1}
1
10
Tue Jul 28 10:42:03 2015


Pt distribution for background particles
Entries 781015
Mean 1.374
RMS 0.9541
Counts
7000
6000
5000
4000
3000
2000
1000
0
0
2
4
6
8
10
12
14
Transverse Momentum (GeV/c)


Pt distribution for muons
Entries 32446
Mean 0.6837
RMS 0.6664
Counts
0
100
200
300
400
500
600
700
800
0
1
2
3
4
5
6
7
8
9
10
Transverse Momentum (GeV/c)


Pt distribution for actual data after cut 7
Entries 5164
Mean 1.626
RMS 0.4276
Counts
0
20
40
60
80
100
0
1
2
3
4
5
6
7
8
9
10
Transverse Momentum (GeV/c)