Update on
$\gamma\, p \rightarrow p\, \phi\, \eta \rightarrow p\, K^{+} K^{-} \gamma\, \gamma$

08/24/2017

Bradford Cannon

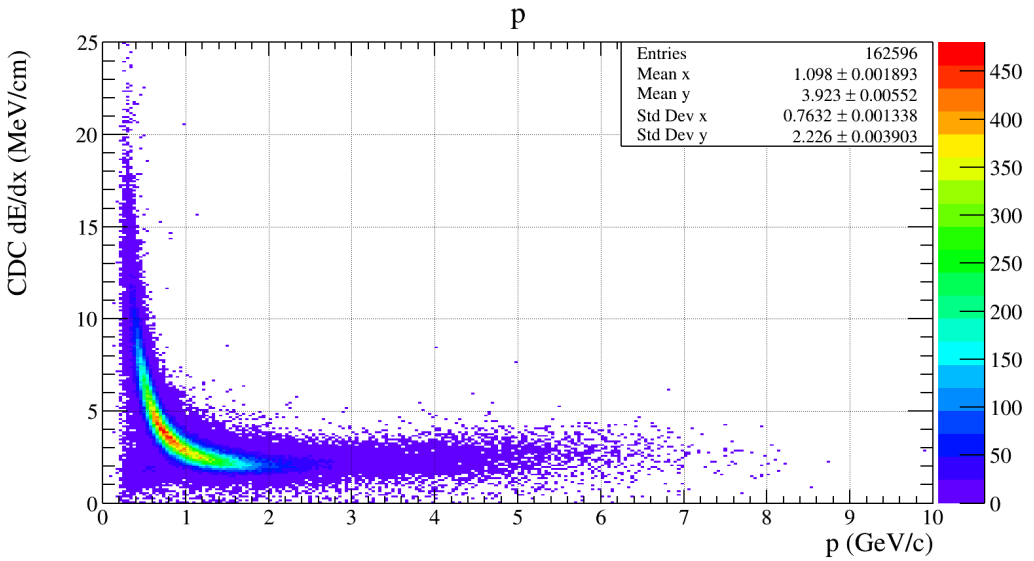
Purpose of This Talk:

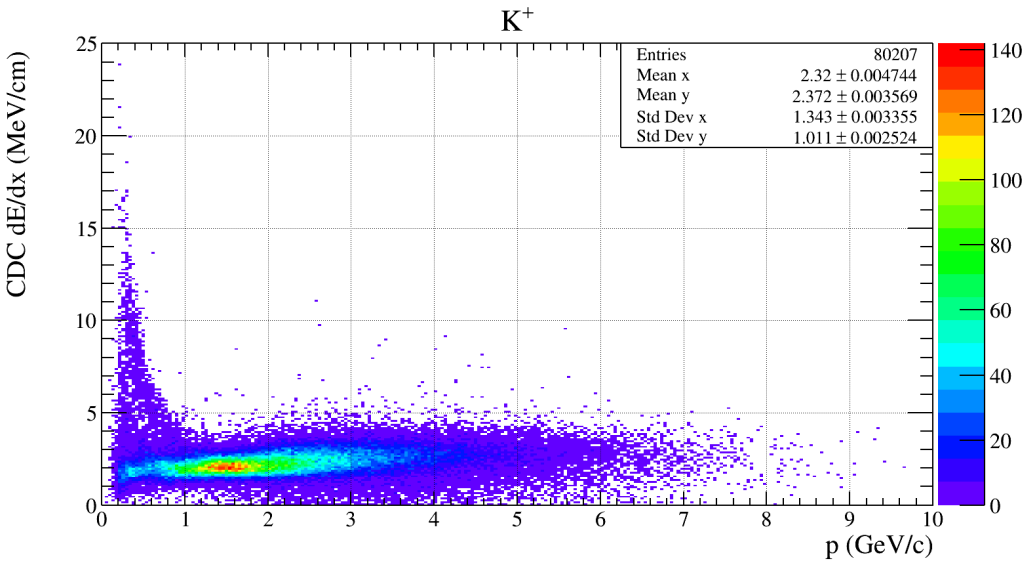
- To justify PID cuts that were made in the previous talk on 08/10/2017.
- Cuts to be justified:
  - dEdX Vs p (CDC/SC)
  - DeltaT Vs P (TOF)
  - Vertex Cuts (all charged tracks)
  - Number of Particles in final state

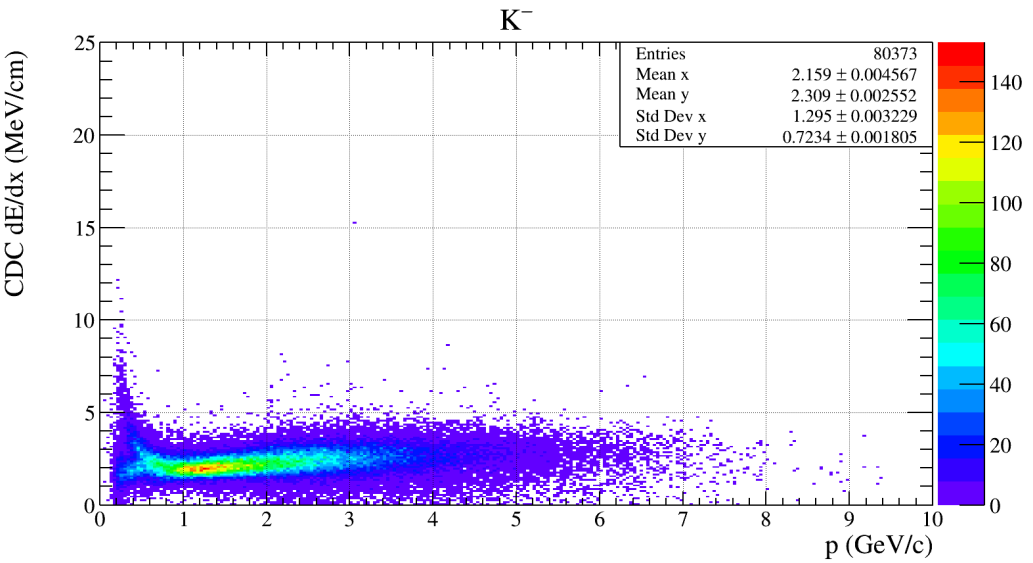
How dEdX study was performed:

- ~5% of the data from the Spring 2017 run was used.
- A 5% confidence level cut was done on all data before plots were made.
- Compare the K- distributions with the K+ distributions in order to establish a function that can effectively separate protons from K+
- Make cuts on same data without confidence level cut

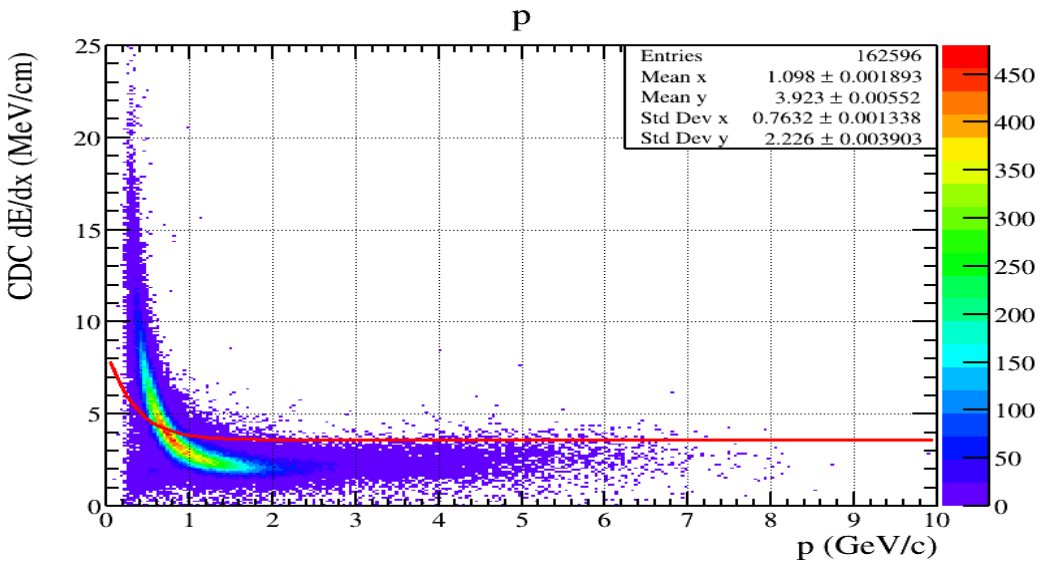
dEdX Vs P: CDC


p
CDC dE/dx (MeV/cm)
p (GeV/c)
Entries 162596
Mean x 1.098 ± 0.001893
Mean y 3.923 ± 0.00552
Std Dev x 0.7632 ± 0.001338
Std Dev y 2.226 ± 0.003903


K+
CDC dE/dx (MeV/cm)
p (GeV/c)
Entries 80207
Mean x 2.32 ± 0.004744
Mean y 2.372 ± 0.003569
Std Dev x 1.343 ± 0.003355
Std Dev y 1.011 ± 0.002524


K−
CDC dE/dx (MeV/cm)
p (GeV/c)
Entries 80373
Mean x 2.159 ± 0.004567
Mean y 2.309 ± 0.002552
Std Dev x 1.295 ± 0.003229
Std Dev y 0.7234 ± 0.001805

dEdX Vs P: CDC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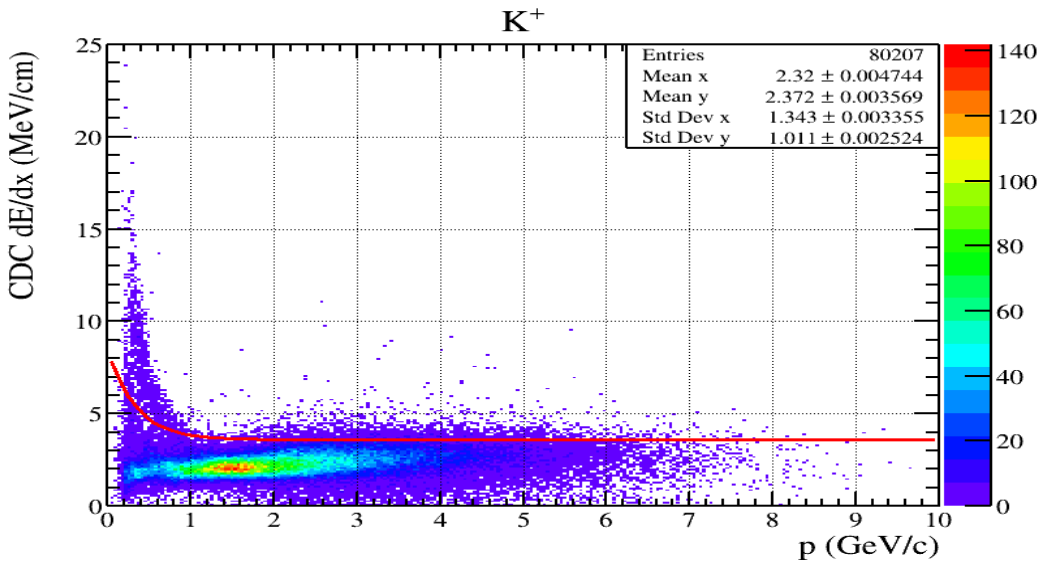
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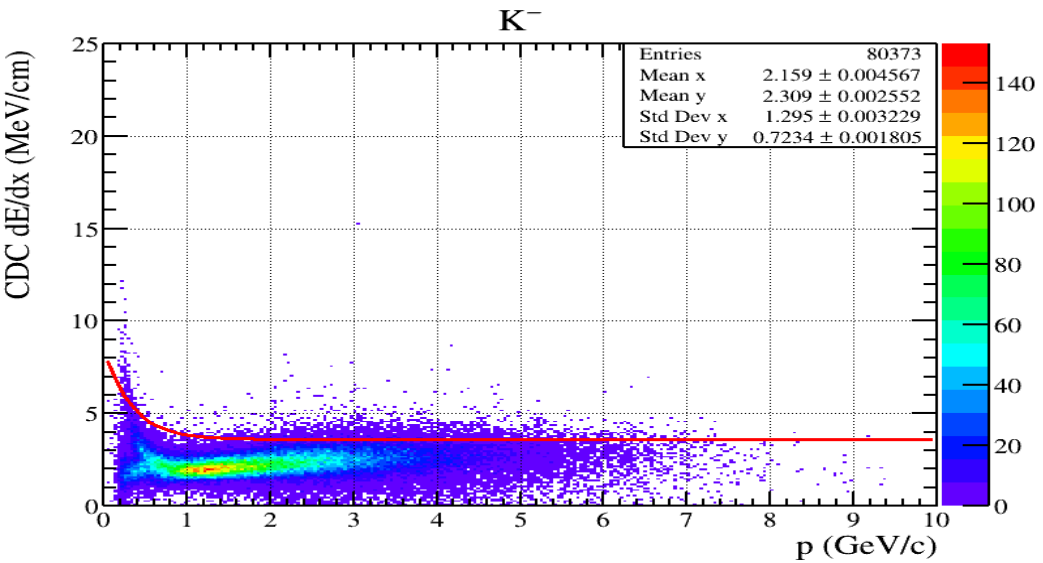
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Std Dev y 0.7234 ± 0.001805
CDC dE/dx (MeV/cm)
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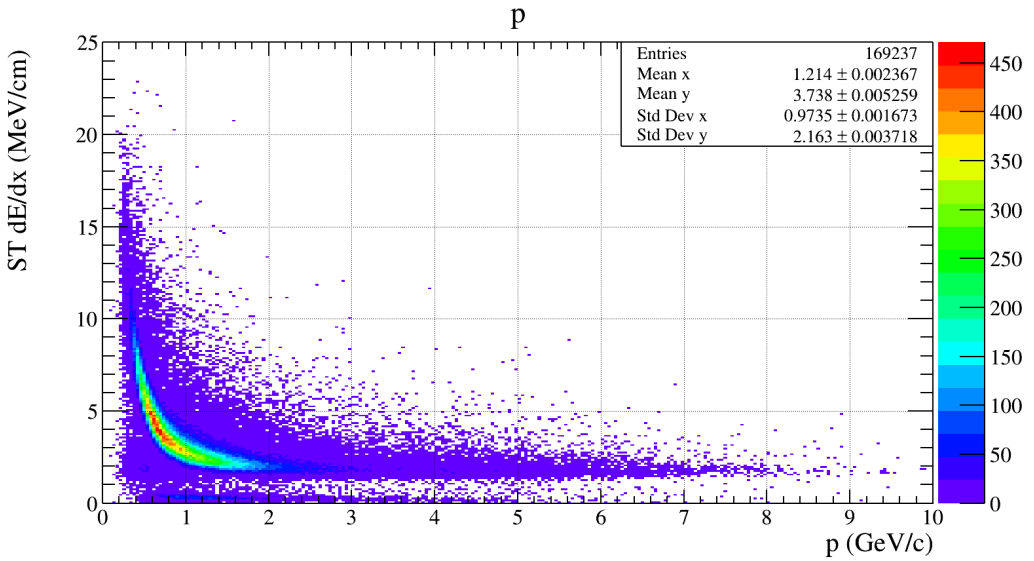
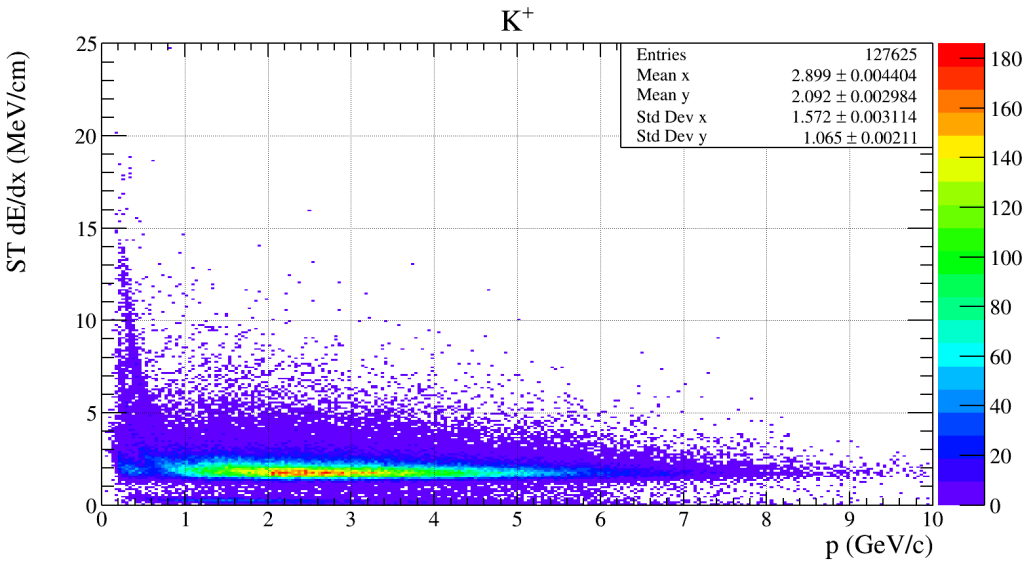
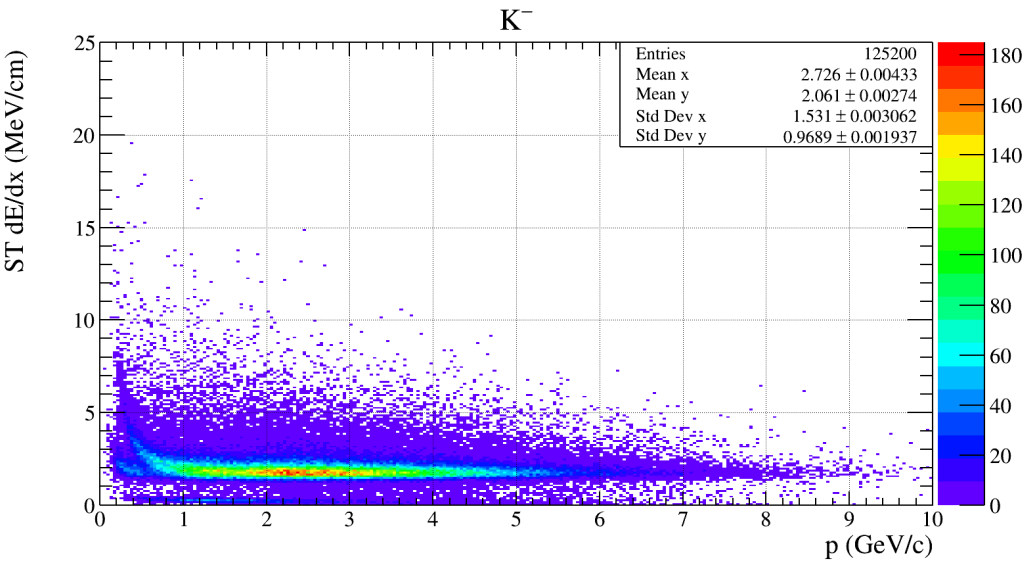
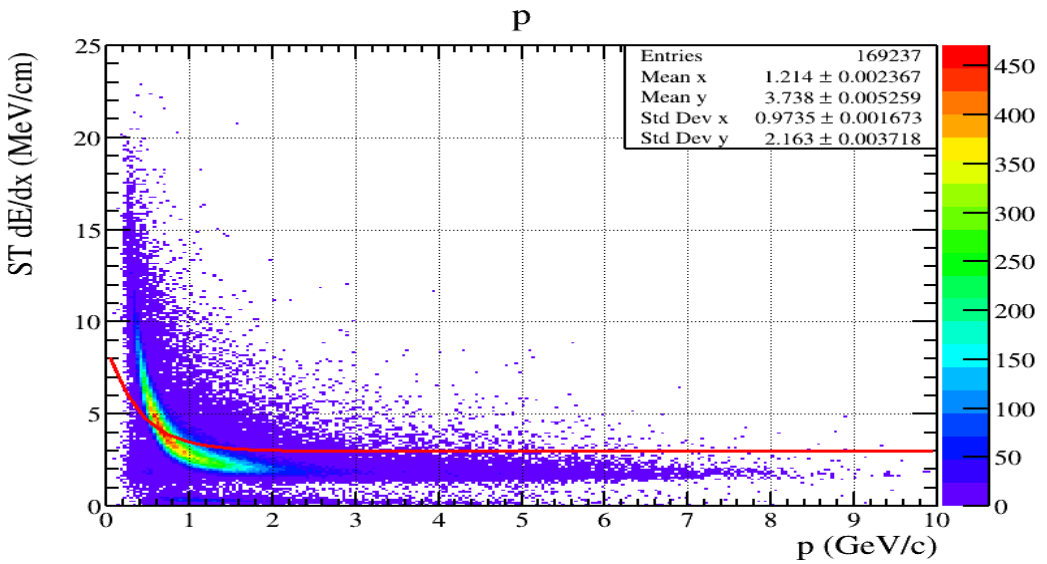
dEdX Vs P: SC


p
Entries 169237
Mean x 1.214 ± 0.002367
Mean y 3.738 ± 0.005259
Std Dev x 0.9735 ± 0.001673
Std Dev y 2.163 ± 0.003718
ST dE/dx (MeV/cm)
p (GeV/c)


K+
Entries 127625
Mean x 2.899 ± 0.004404
Mean y 2.092 ± 0.002984
Std Dev x 1.572 ± 0.003114
Std Dev y 1.065 ± 0.00211
ST dE/dx (MeV/cm)
p (GeV/c)


K−
Entries 125200
Mean x 2.726 ± 0.00433
Mean y 2.061 ± 0.00274
Std Dev x 1.531 ± 0.003062
Std Dev y 0.9689 ± 0.001937
ST dE/dx (MeV/cm)
p (GeV/c)

dEdX Vs P: SC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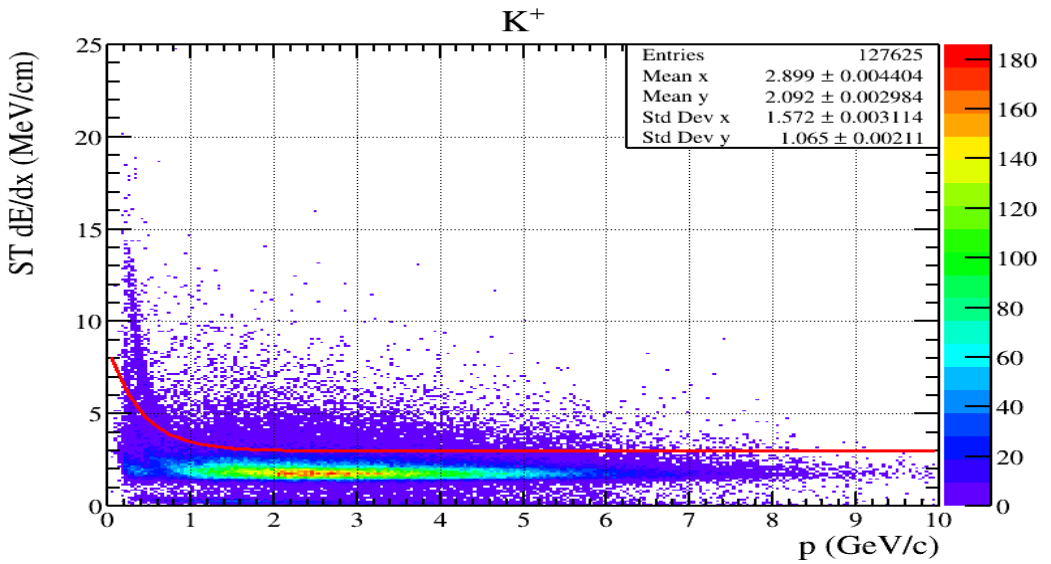
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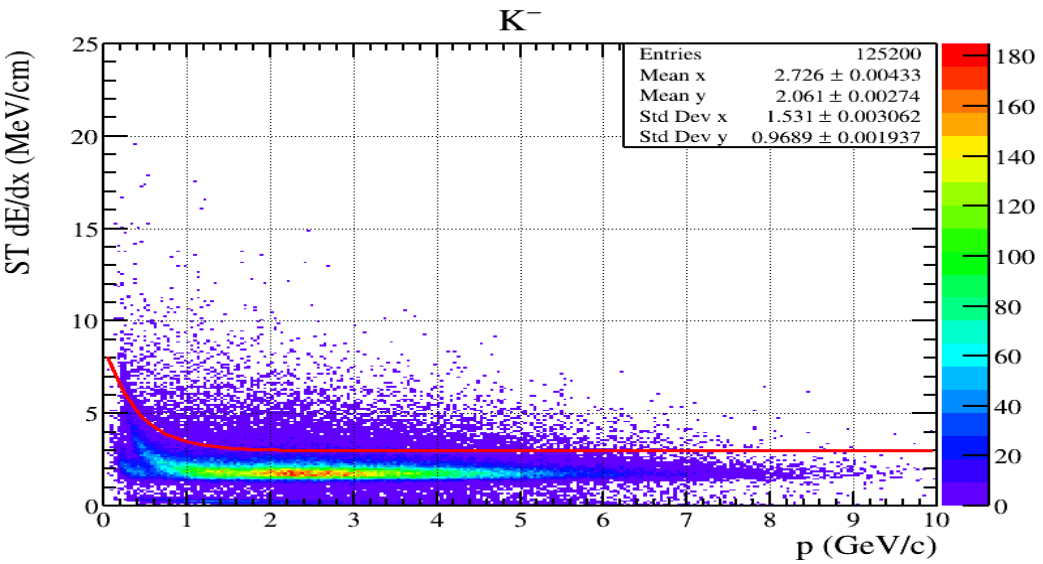
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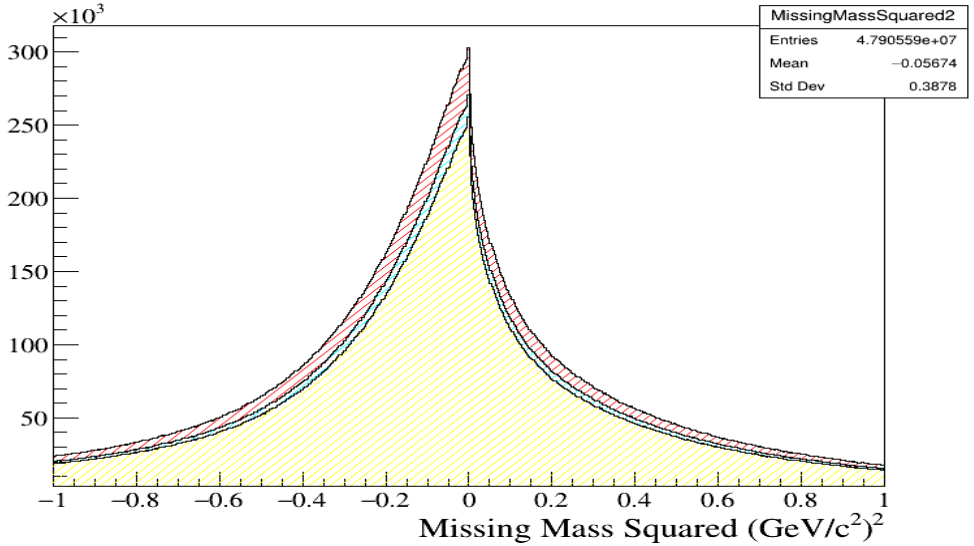
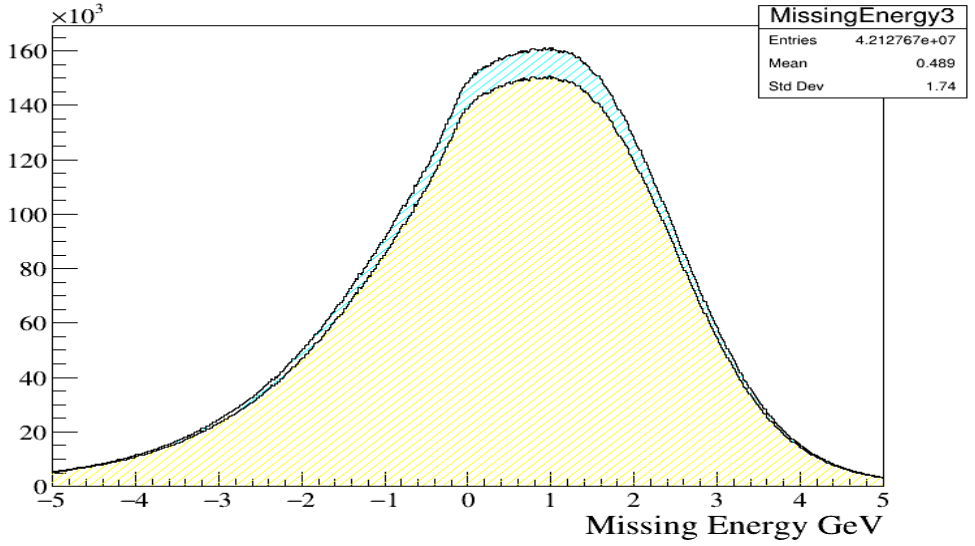
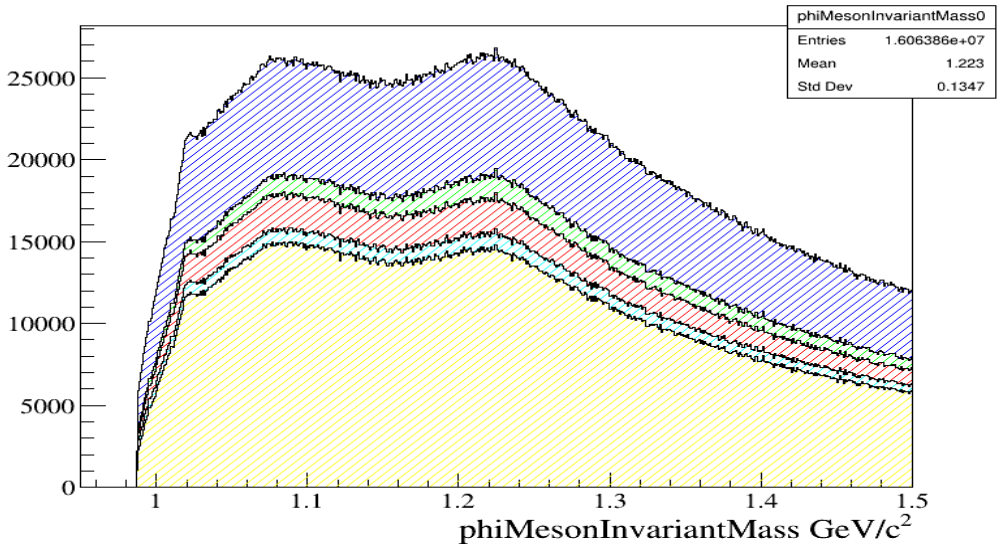
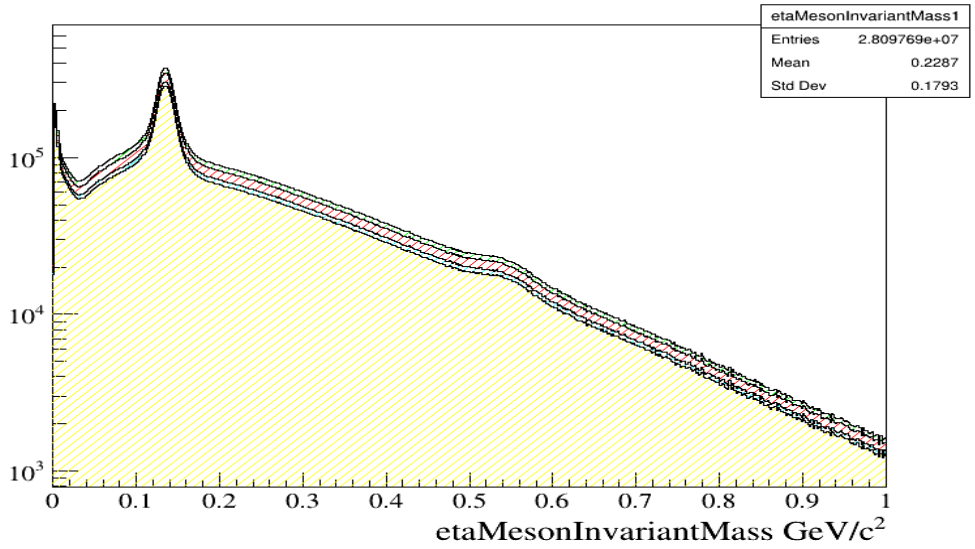
Std Dev x 1.531 ± 0.003062
Std Dev y 0.9689 ± 0.001937
ST dE/dx (MeV/cm)
p (GeV/c)

After dEdX Cuts:









Blue: No Cuts, Green: Proton dEdx CDC, Red: Kplus dEdX CDC
Cyan: Proton dEdX ST, Yellow: dEdX Kplus

How DeltaT study was performed:

- ~5% of the data from the Spring 2017 run was used.
- A 5% confidence level cut was done on all data before plots were made.
- Use the known distance to the time of flight from the target and simple physics to create a cut which matches the pion background for K+,K-, and Proton.
- Make cuts on same data without confidence level cut

Example: Subtracting pi+ from k+

- The amount of time it takes a charged particle to reach the TOF in the lab frame is given by:

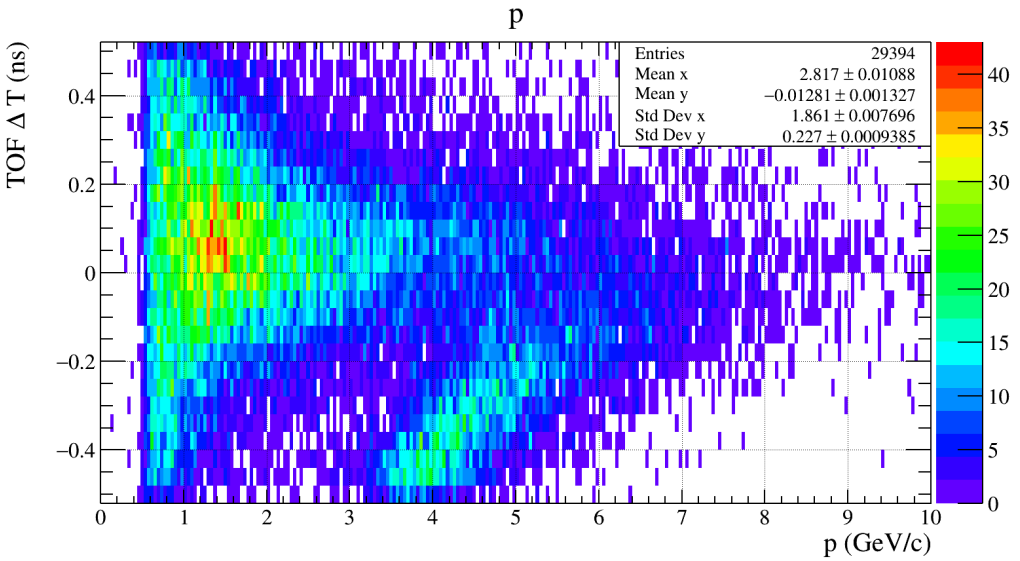
$$t = \frac{\delta X}{V} = \frac{\delta X}{\beta c}$$

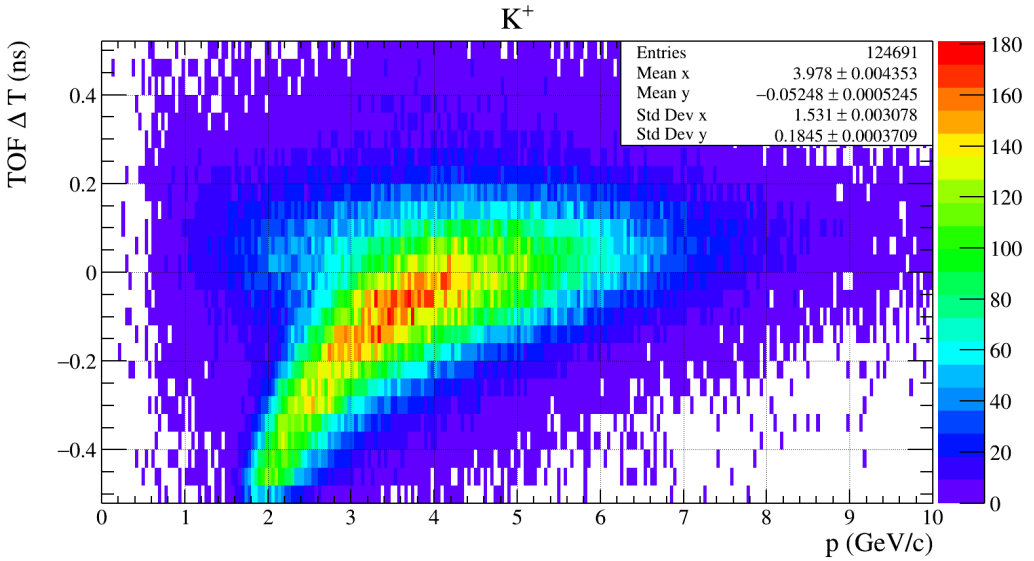
- The timing difference between a pion and a kaon is therefore given by:

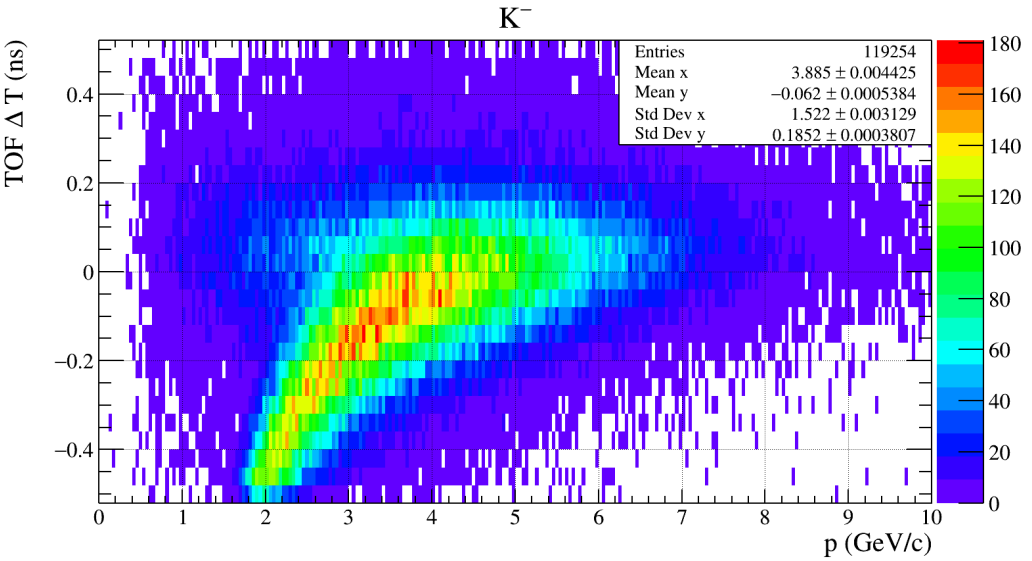
$$\delta t = \frac{\delta X}{c}\left[\frac{\sqrt{m_\pi{}^2 + P^2} - \sqrt{m_k{}^2 + P^2}}{P}\right]$$

- Since we know the observed momentum, P, and the masses of a pion and kaon, as well as the distance to the time of flight detector, we can use this function to separate pions from kaons.

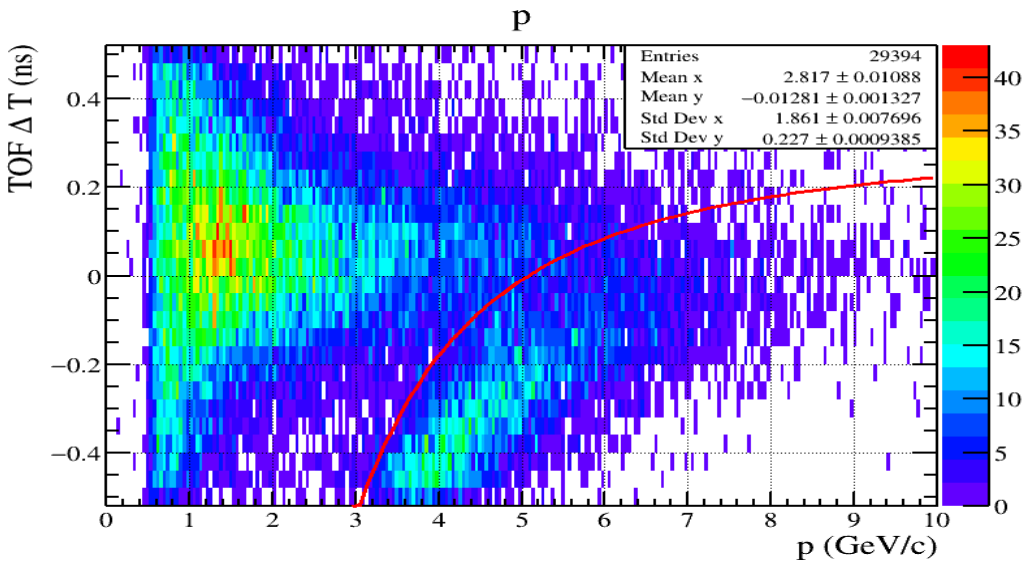
Delta T Vs P: TOF

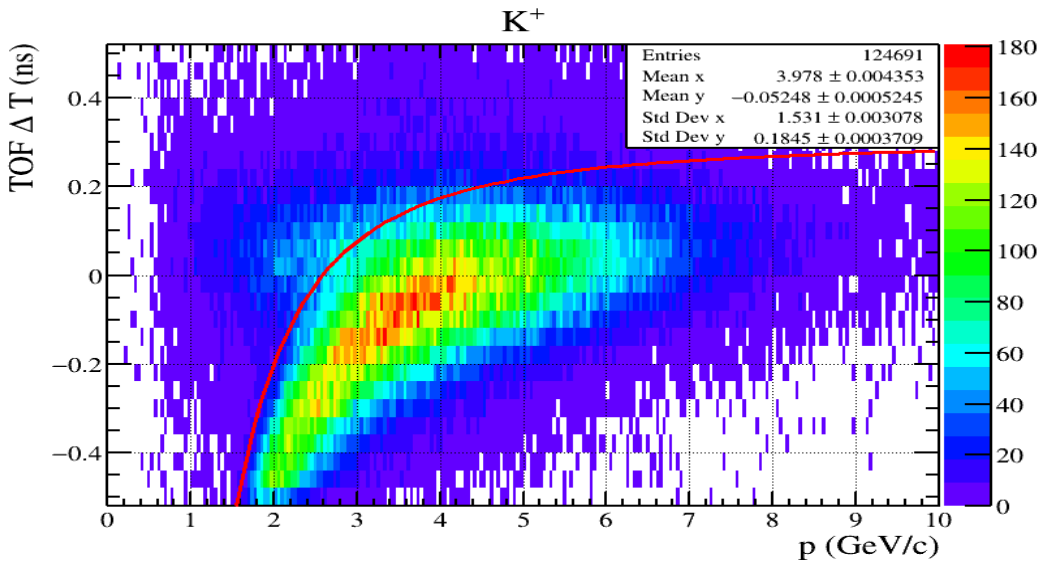


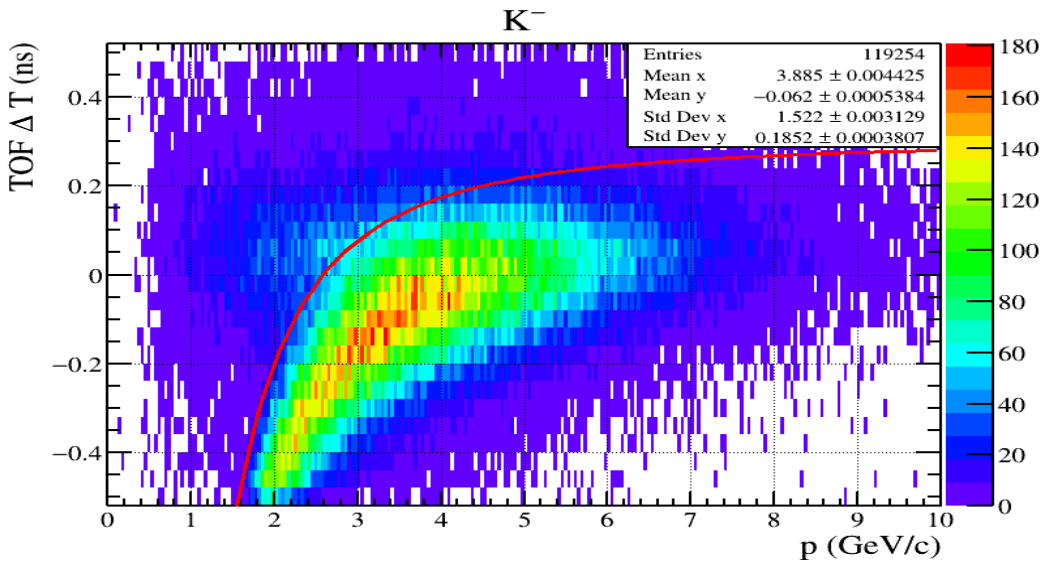




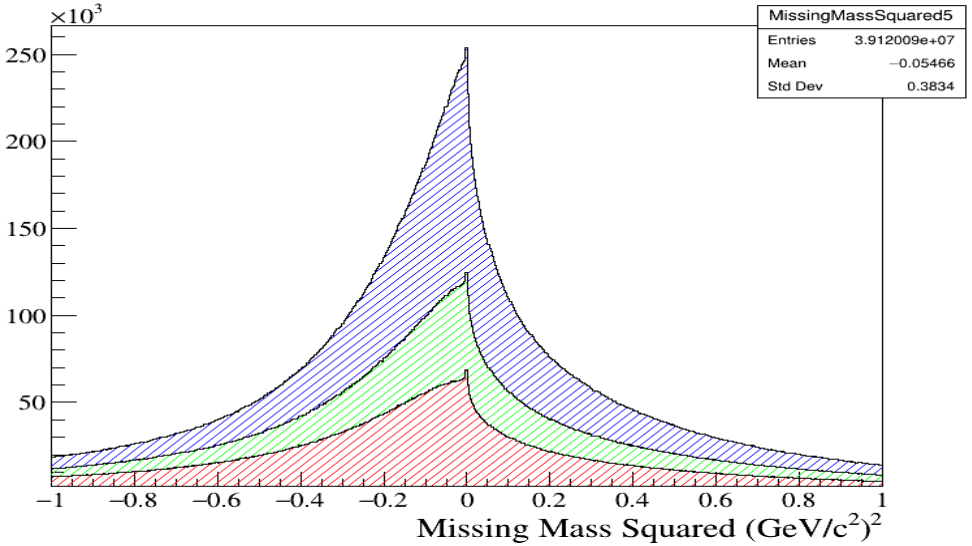
Delta T Vs P: TOF

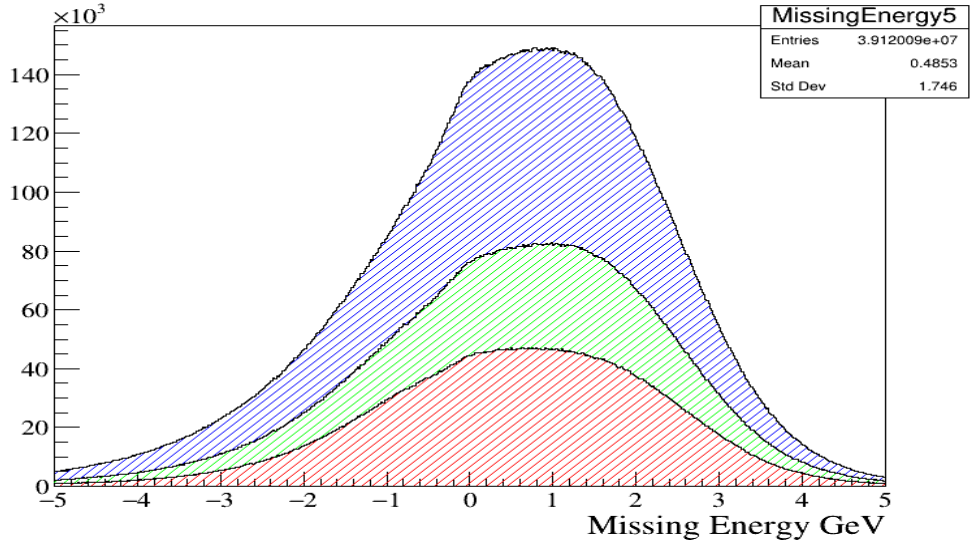


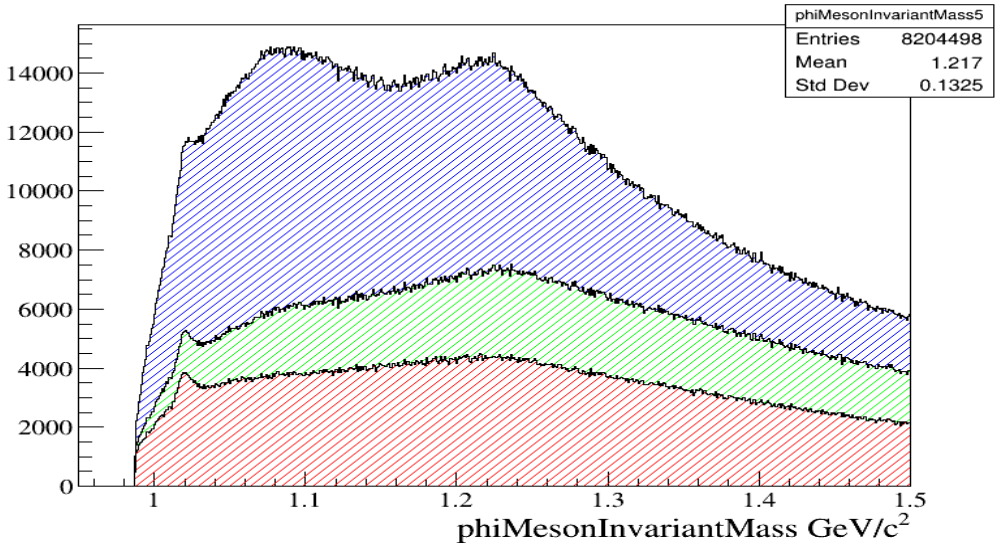


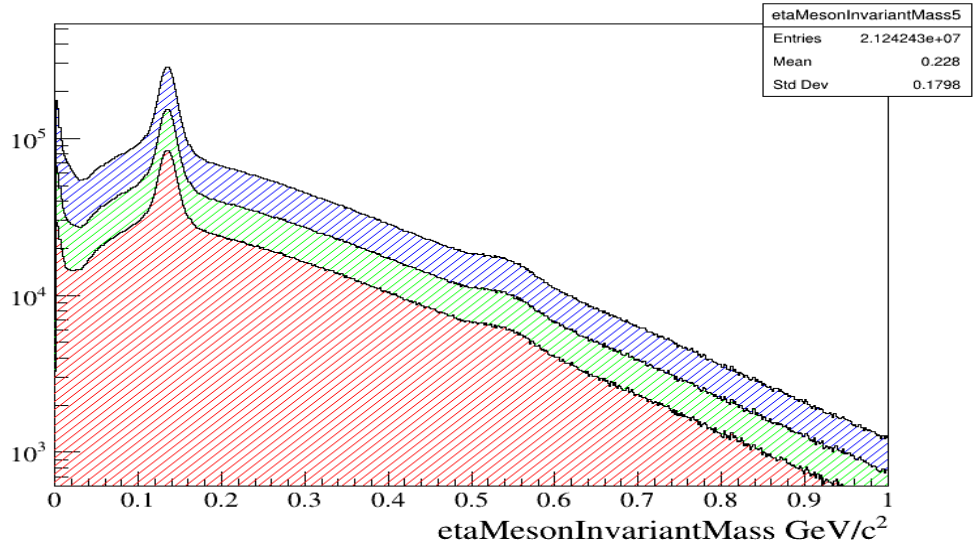


After DeltaT TOF Cuts:



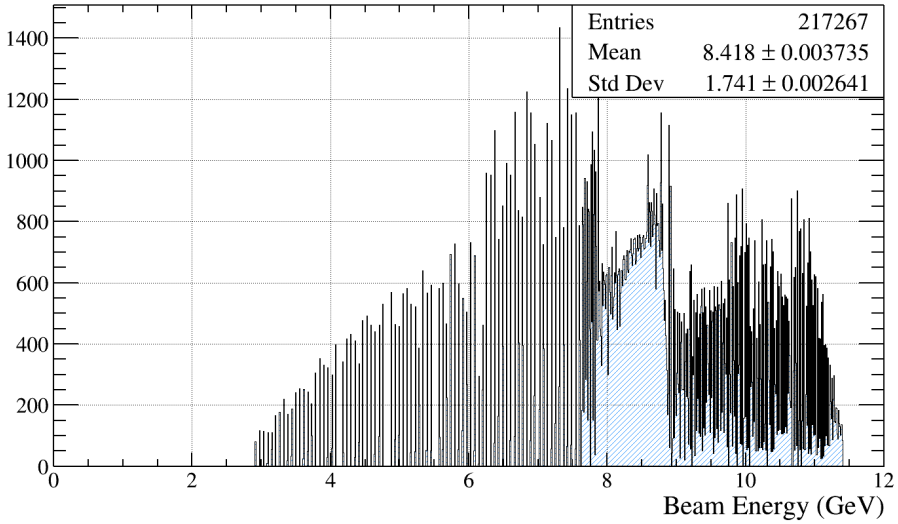


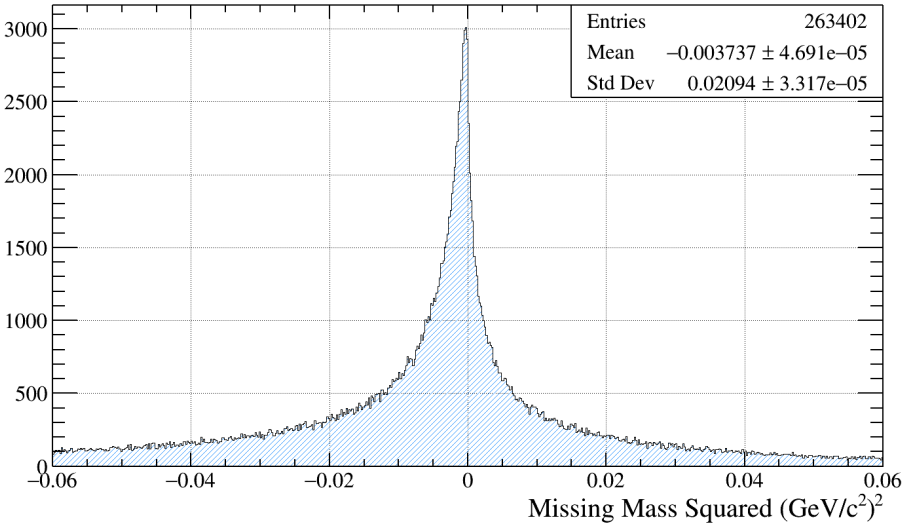


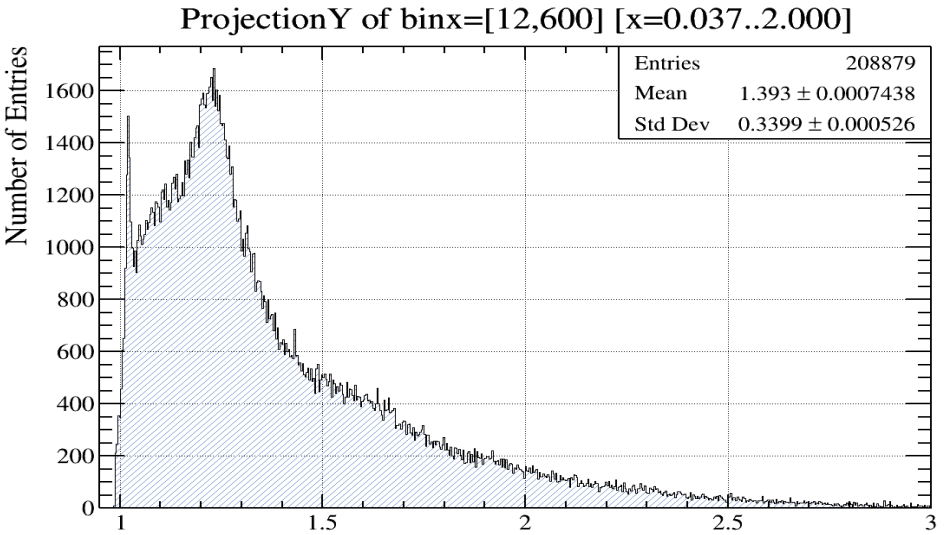


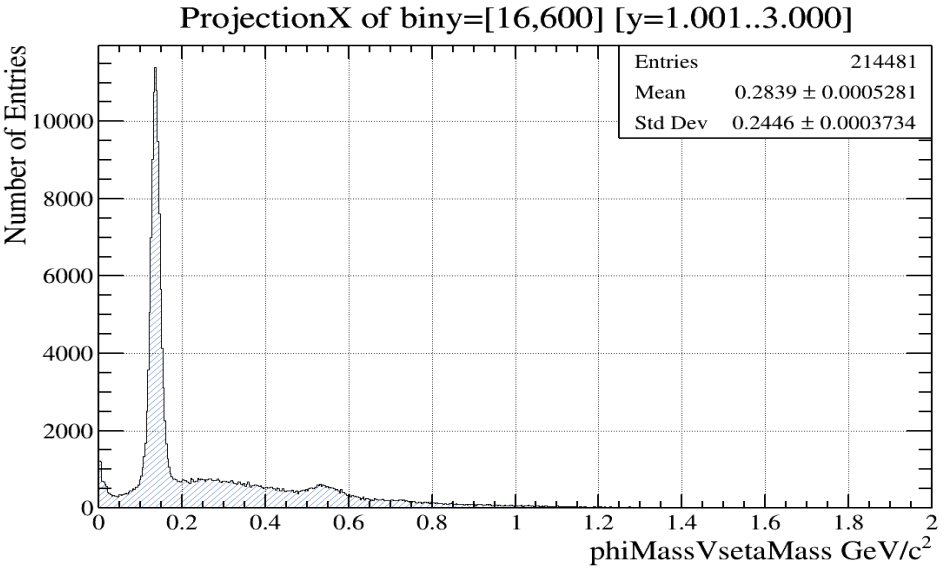
Blue: dT Proton TOF, Green: dT KPlus TOF, Red: dT KMinus TOF

Other plots @ 5% confidence level





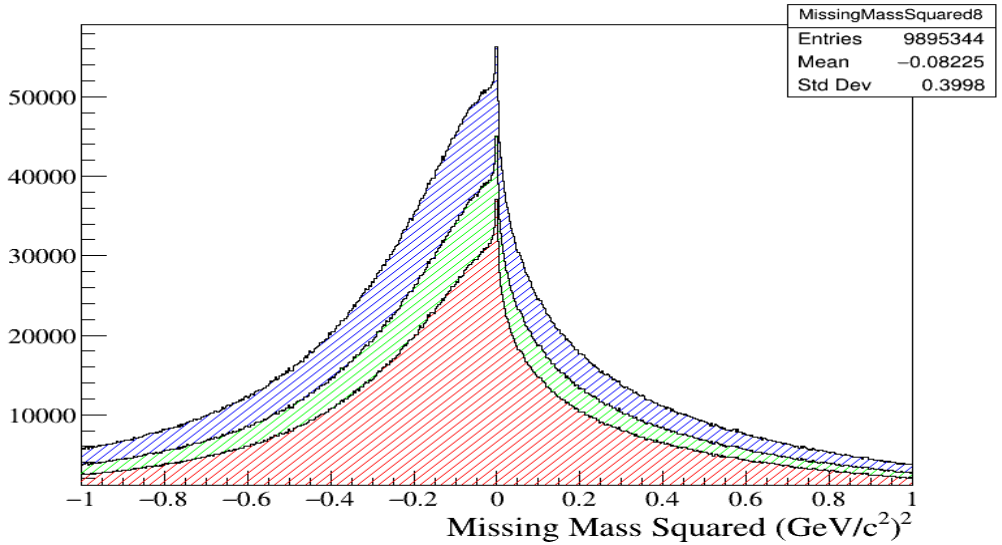


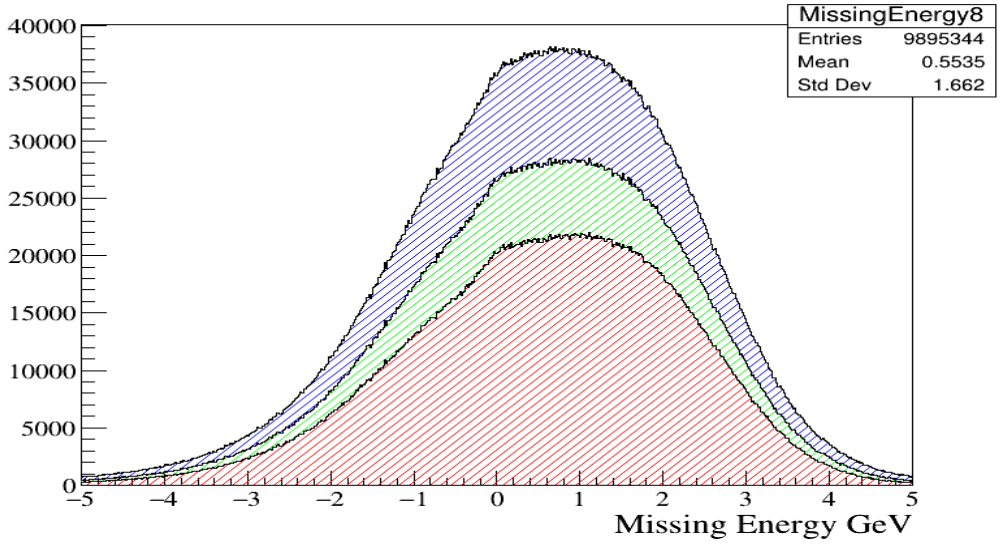


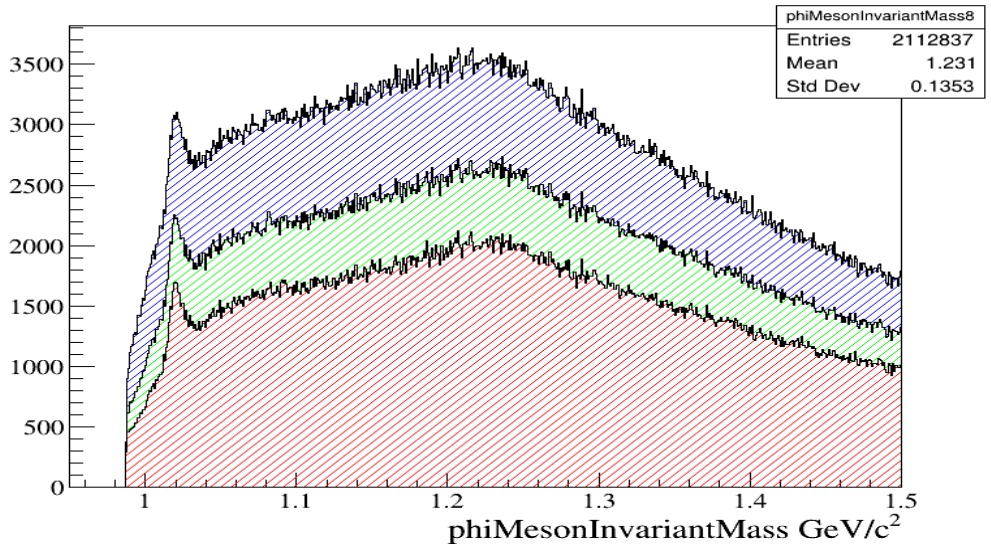
How Vertex study was performed:

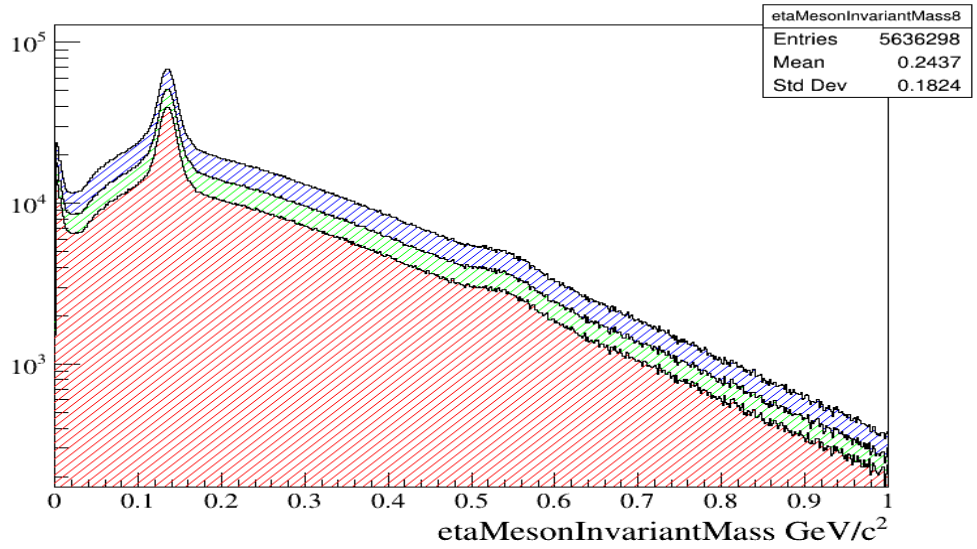
- ~5% of the data from the Spring 2017 run was used.
- Cut on Kinematic Fit Confidence level was taken away since it will bias the vertex distribution
- Compare distributions of Proton + (K+,K-,eta) before and after cut to see if excited baryons are cut.

After vertex Cuts:



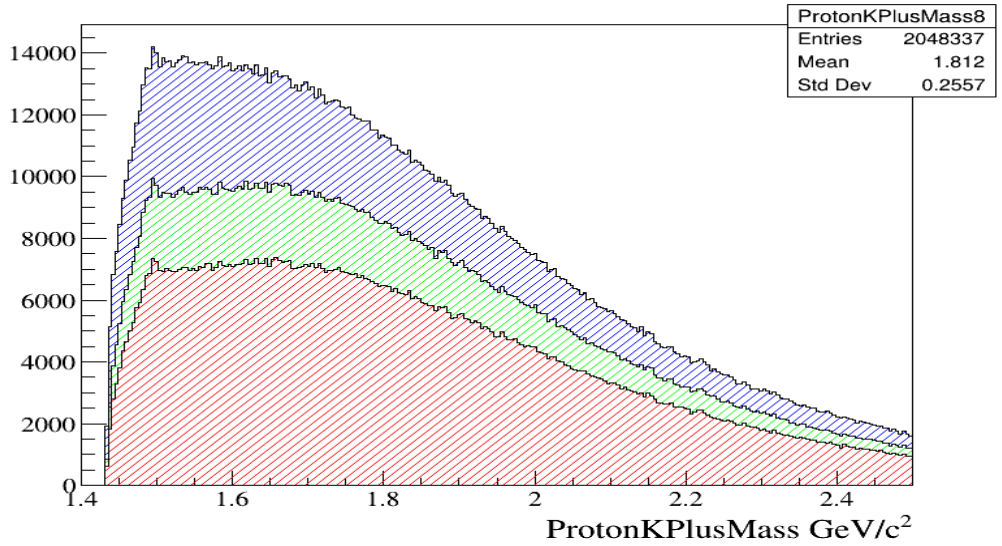


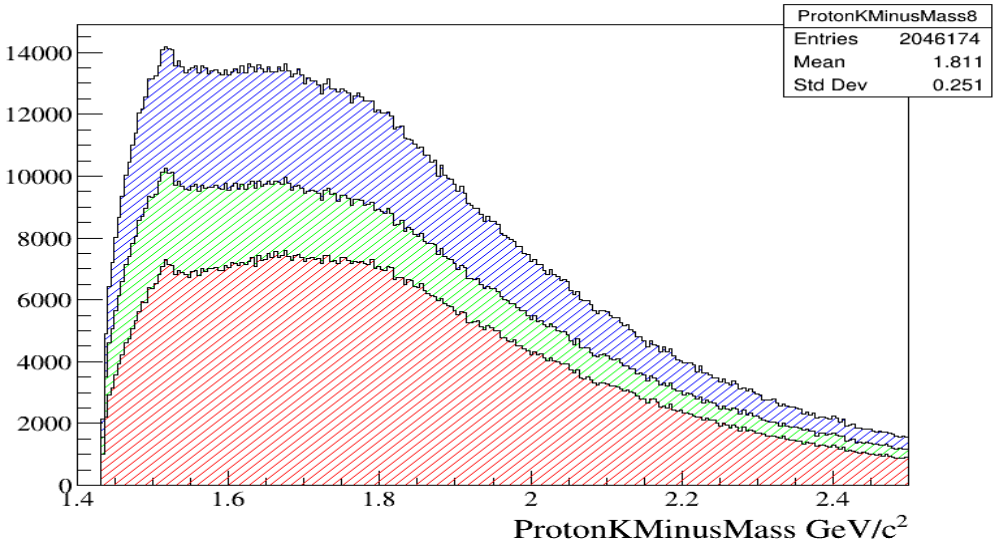


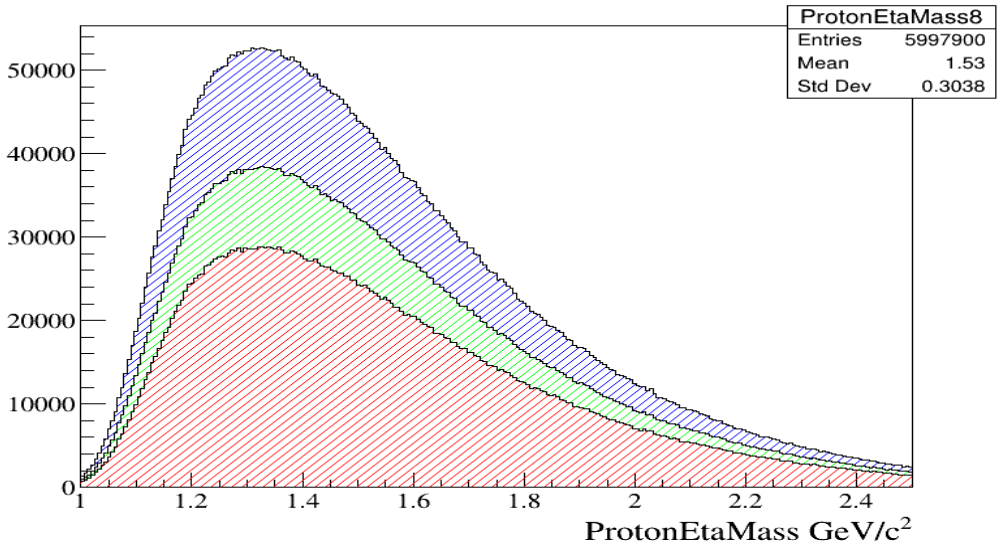


Blue: dT Proton TOF, Green: dT KPlus TOF, Red: dT KMinus TOF

After vertex Cuts:





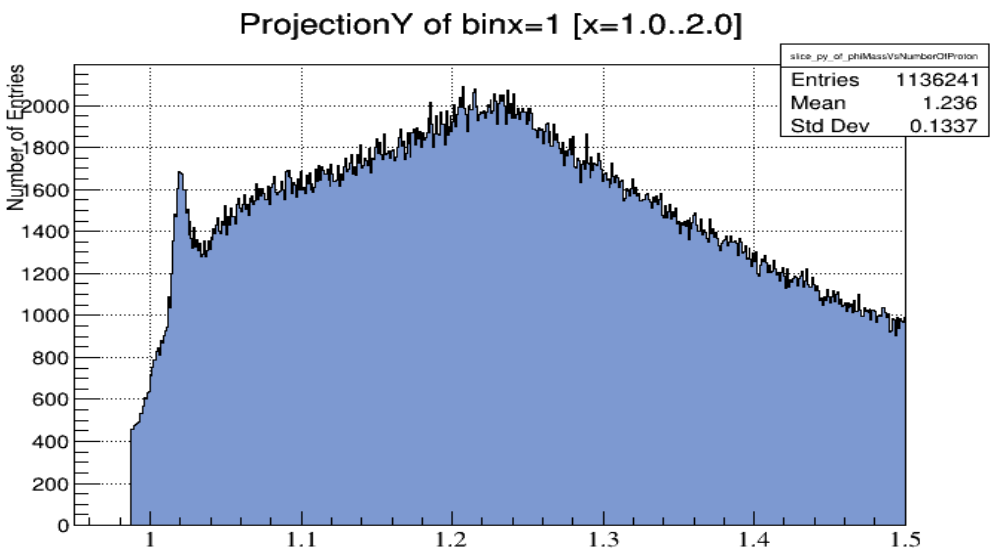


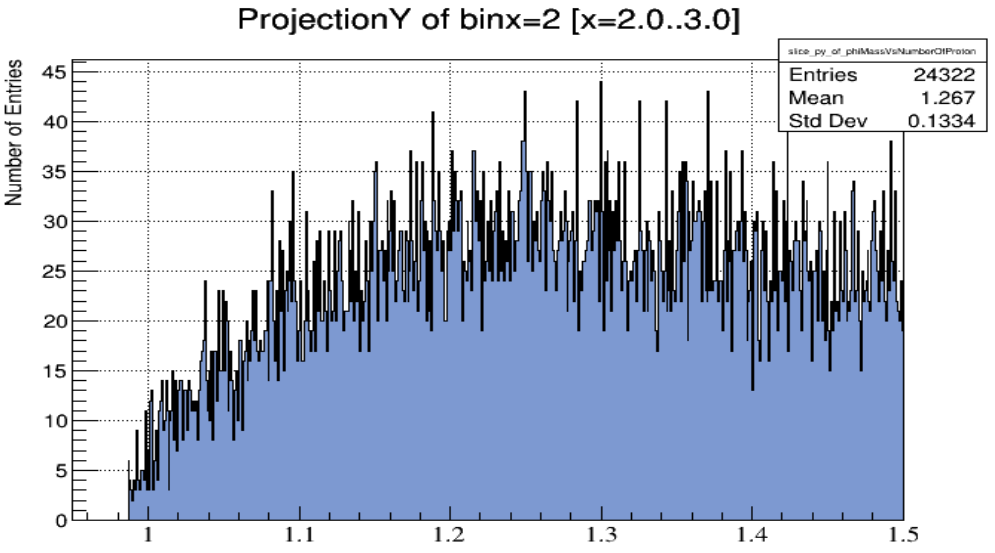
Blue: Proton vertex, Green: KPlus vertex, Red: KMinus vertex

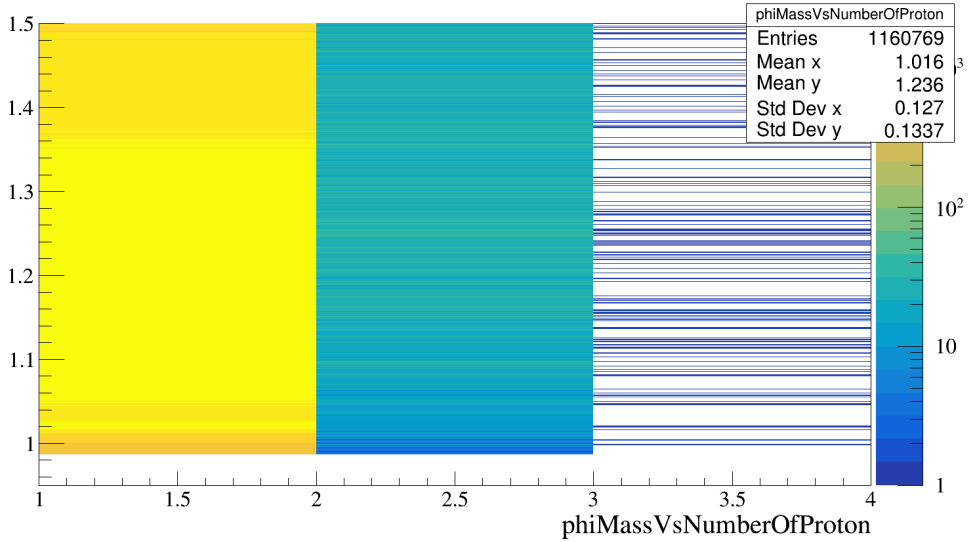
How Number of Particles study was performed:

- ~5% of the data from the Spring 2017 run was used.
- No cut on Kinematic Fit Confidence level
- Plot (phi/eta) Mass Vs Number of (proton,K+,K-, photons)
- Project onto invariant mass axis to study the loss of phi’s or eta’s

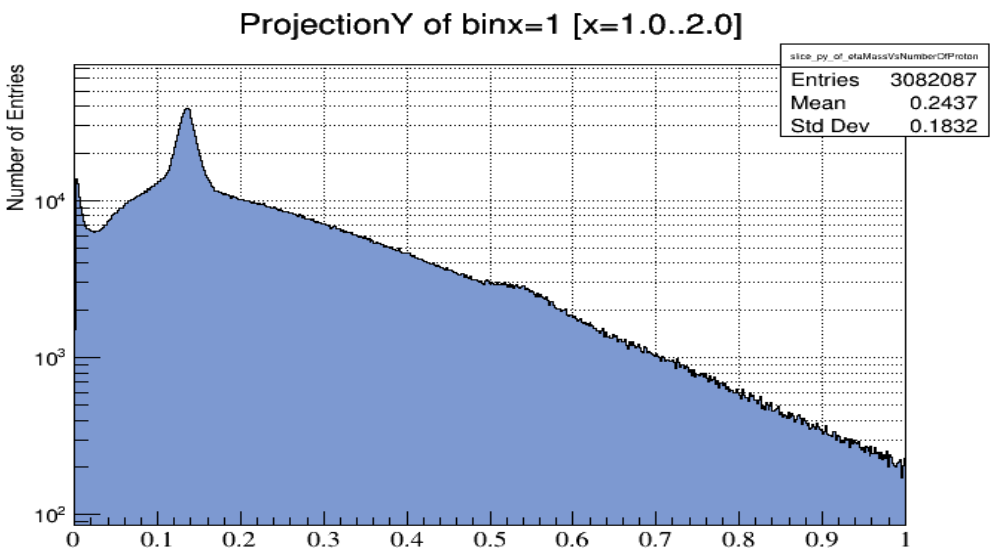
Number of Protons: phi Meson

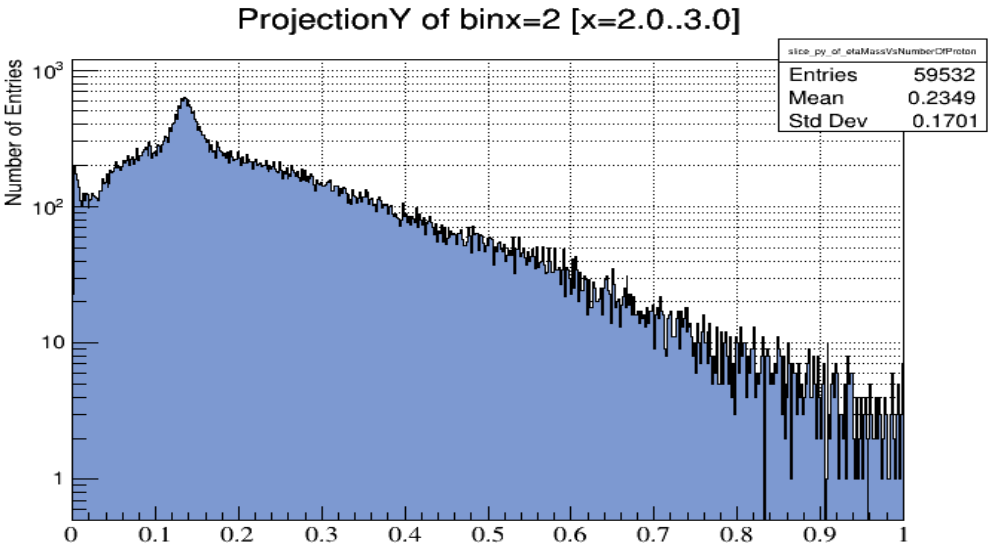


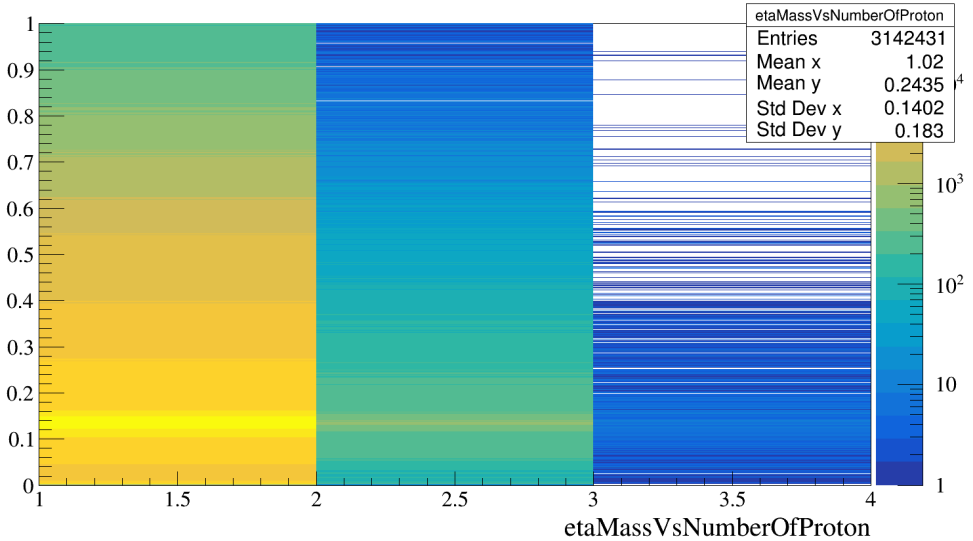




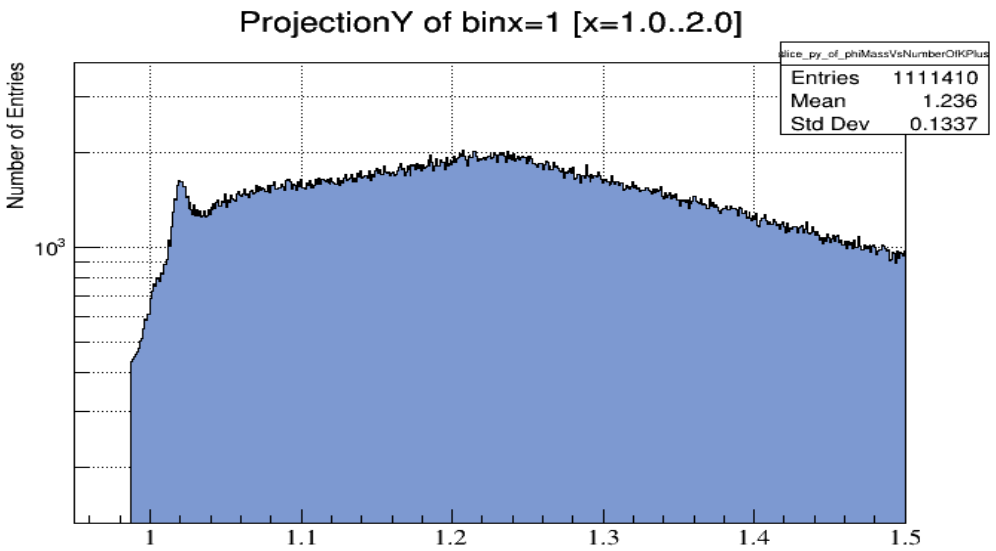
Number of Protons: eta Meson

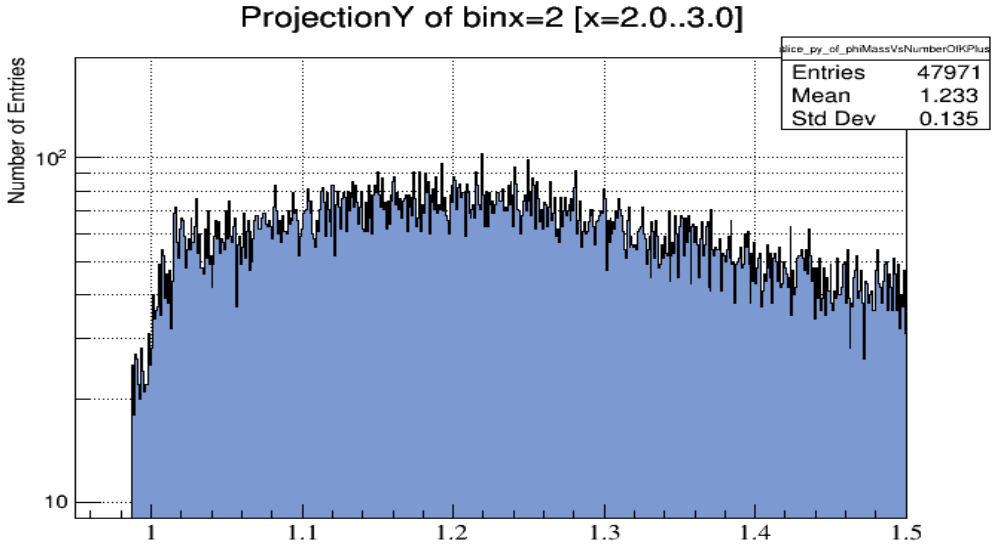


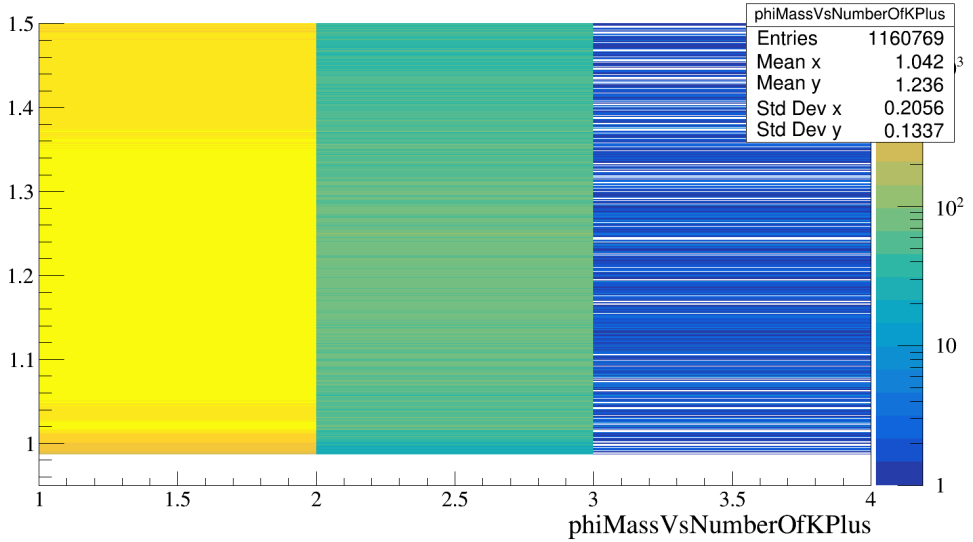




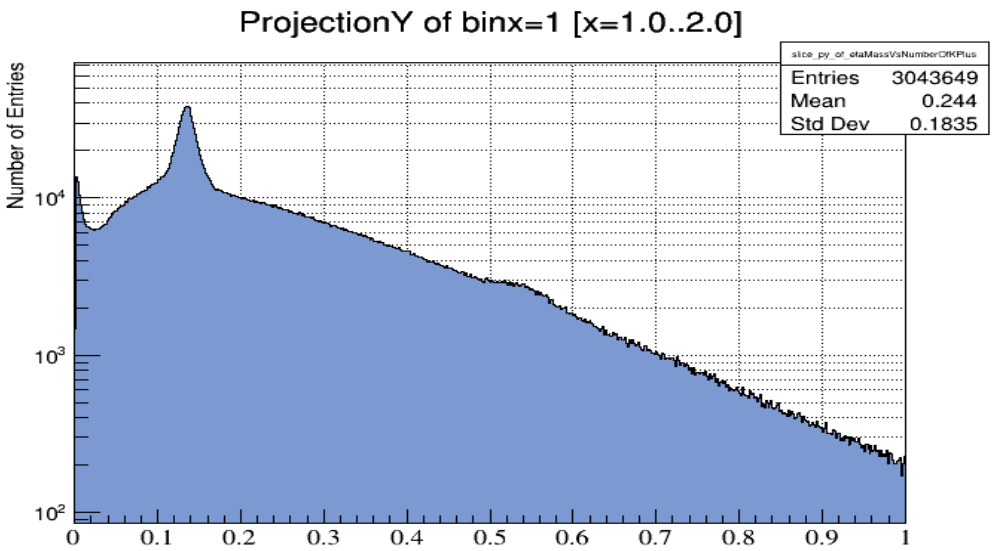
Number of KPlus: phi Meson

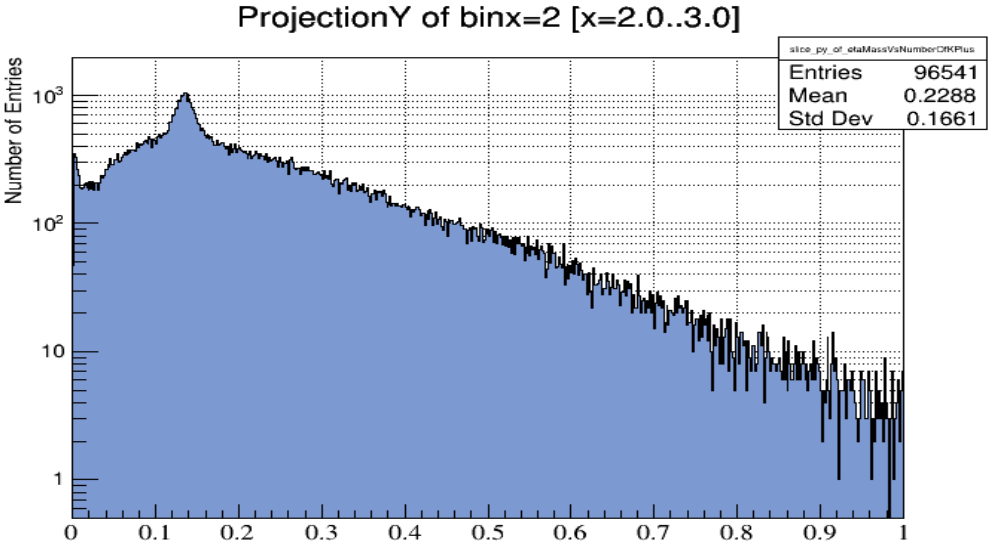


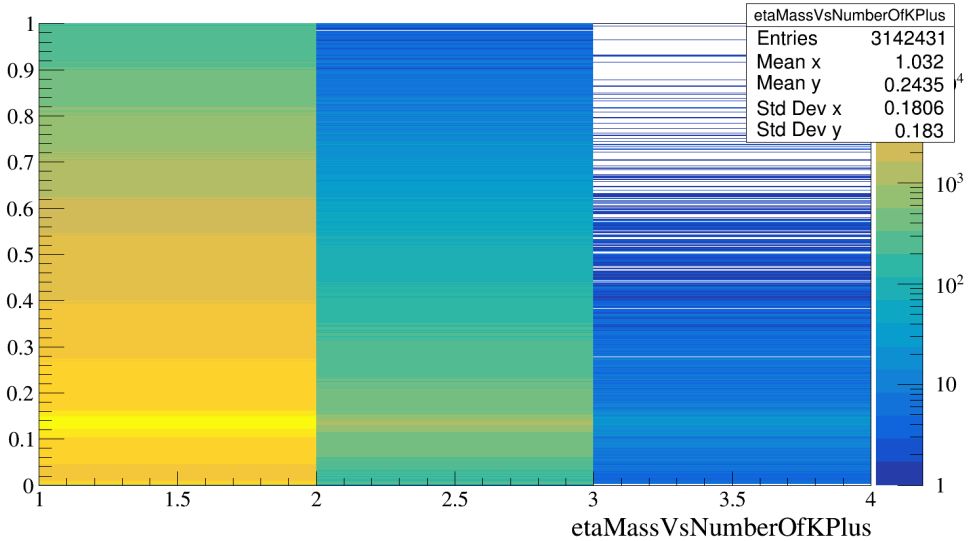




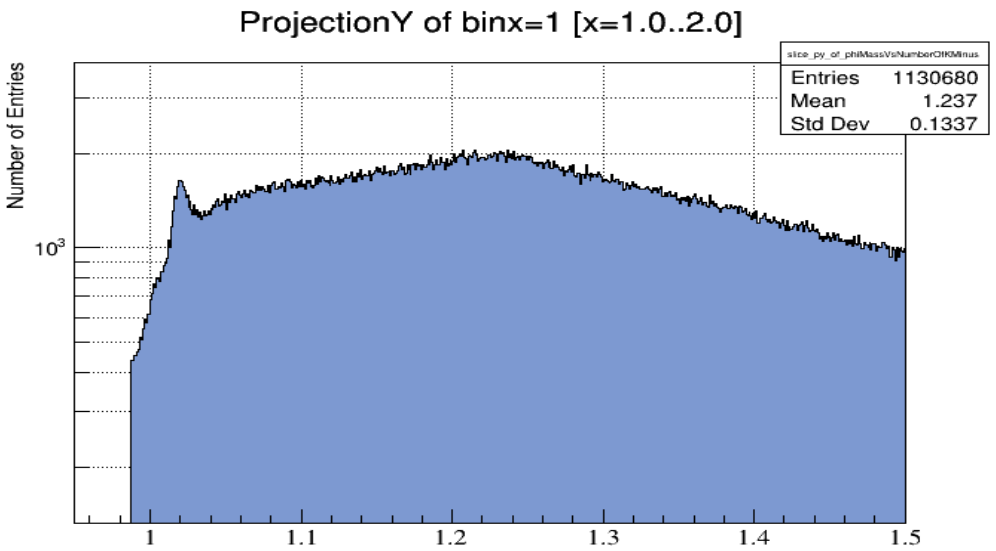
Number of KPlus: eta Meson

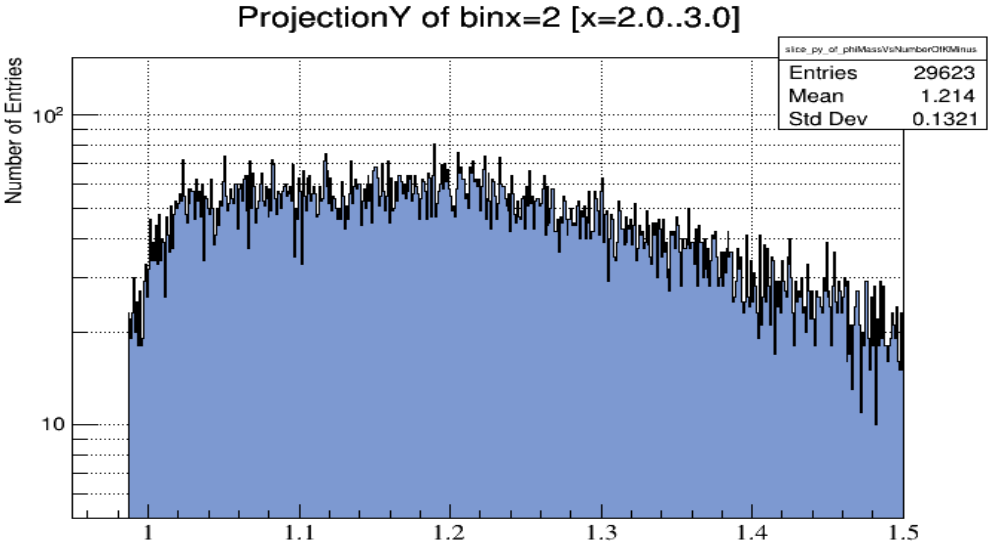


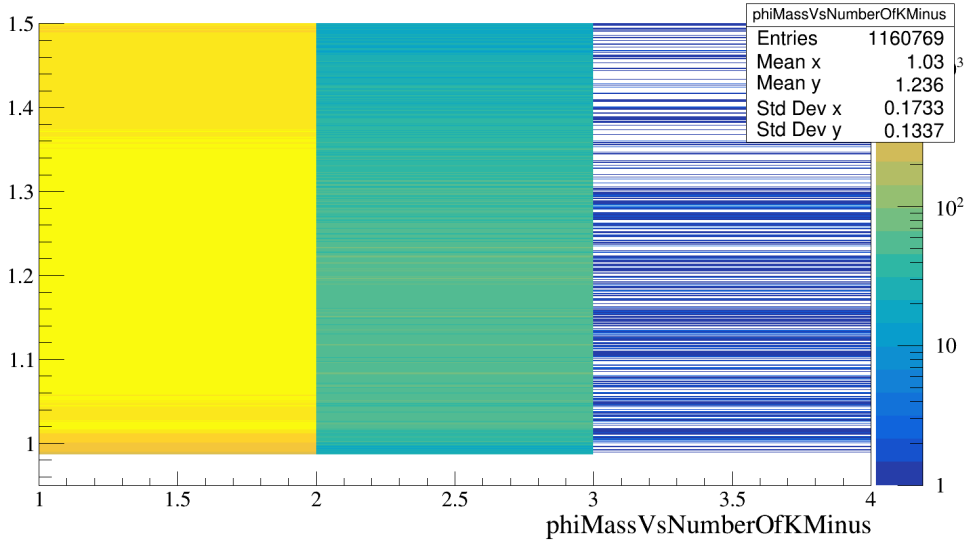




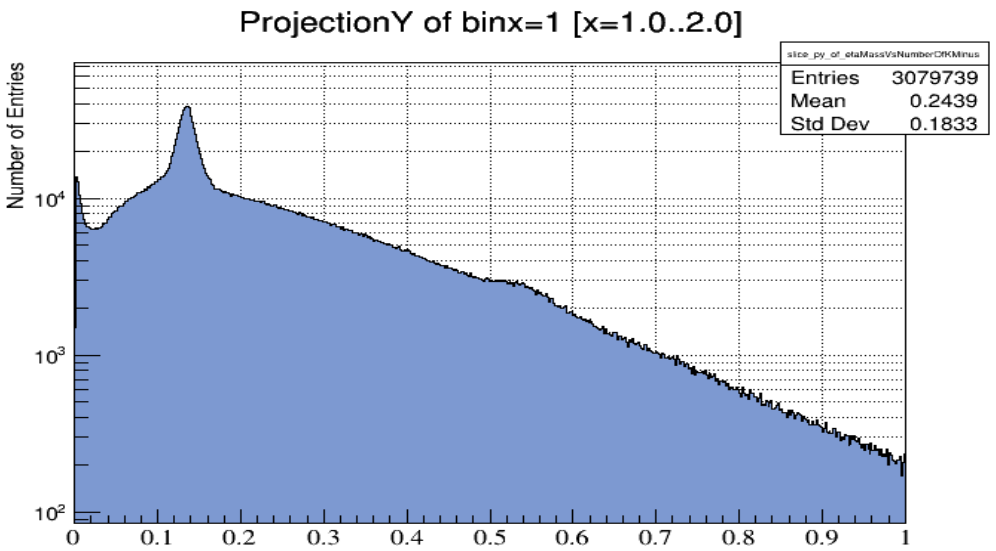
Number of KMinus: phi Meson

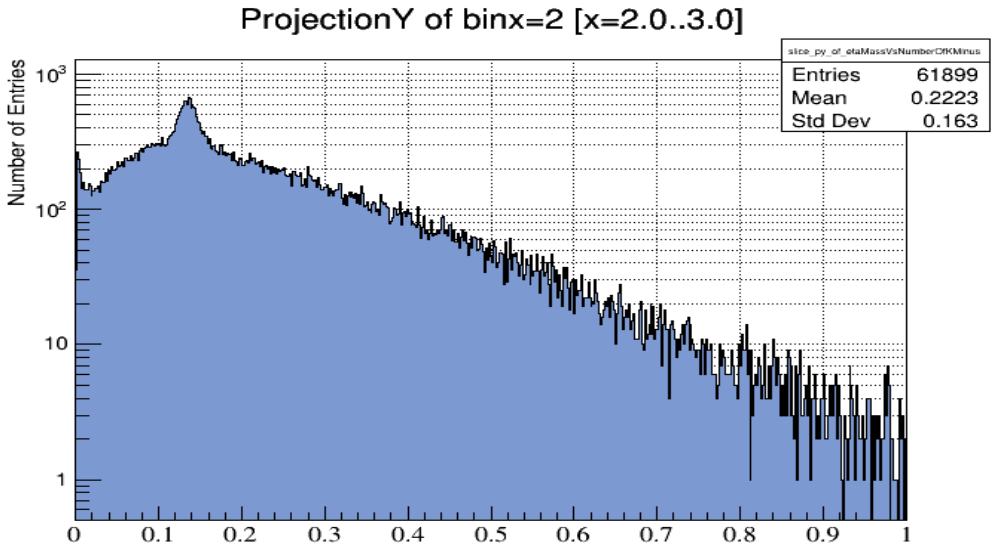


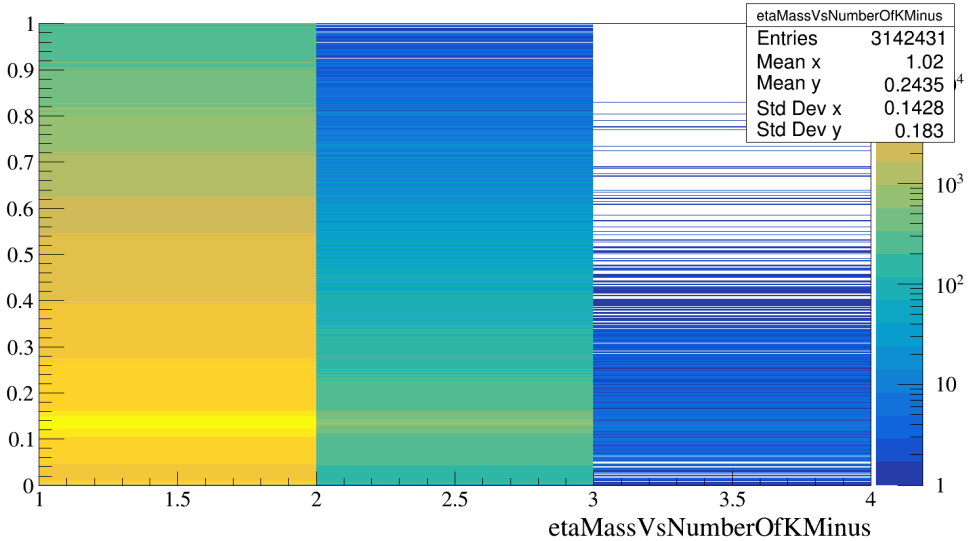




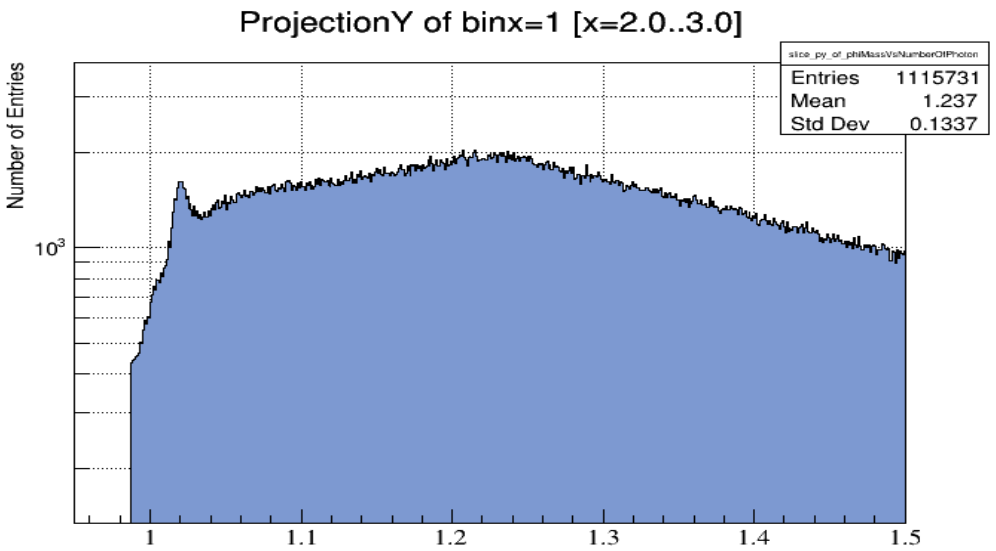
Number of Kminus: eta Meson

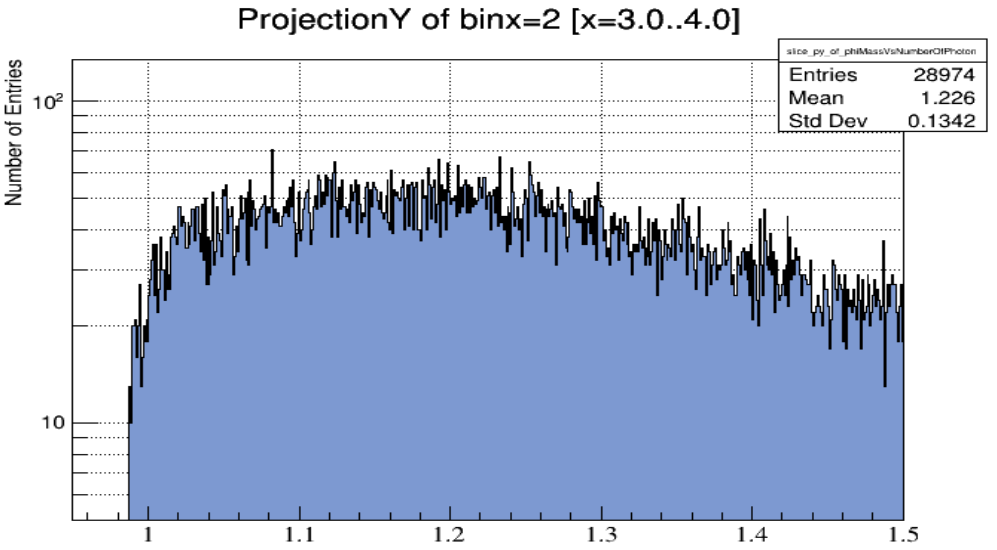


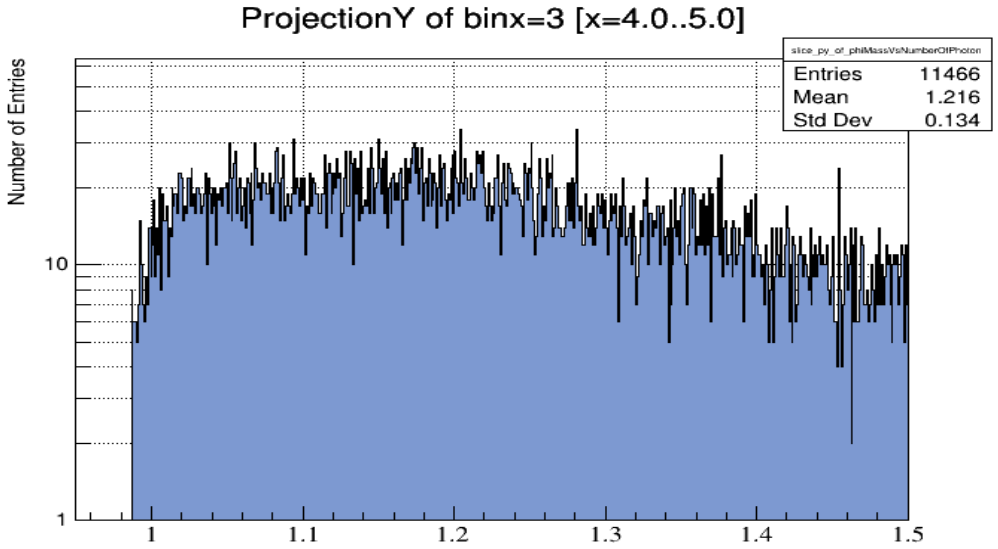


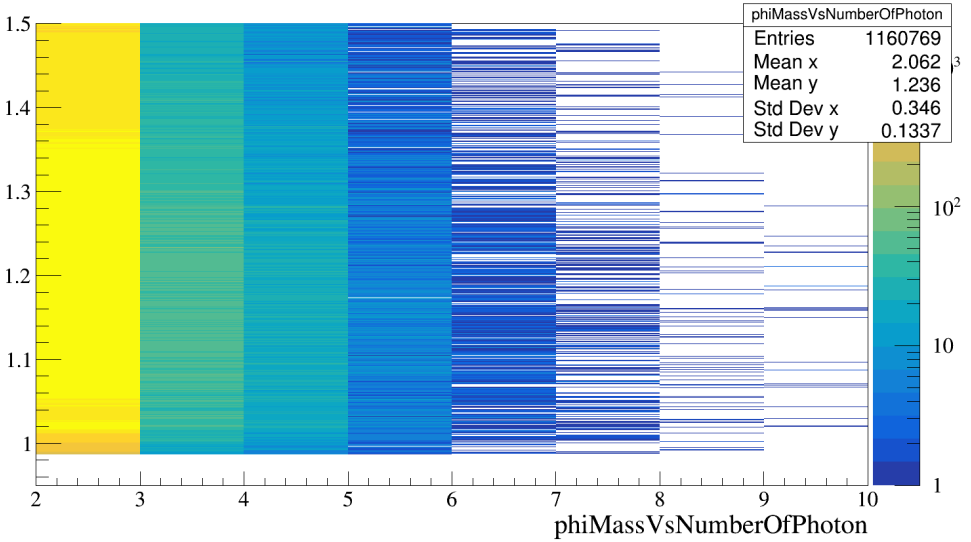


Number of Photon: phi Meson

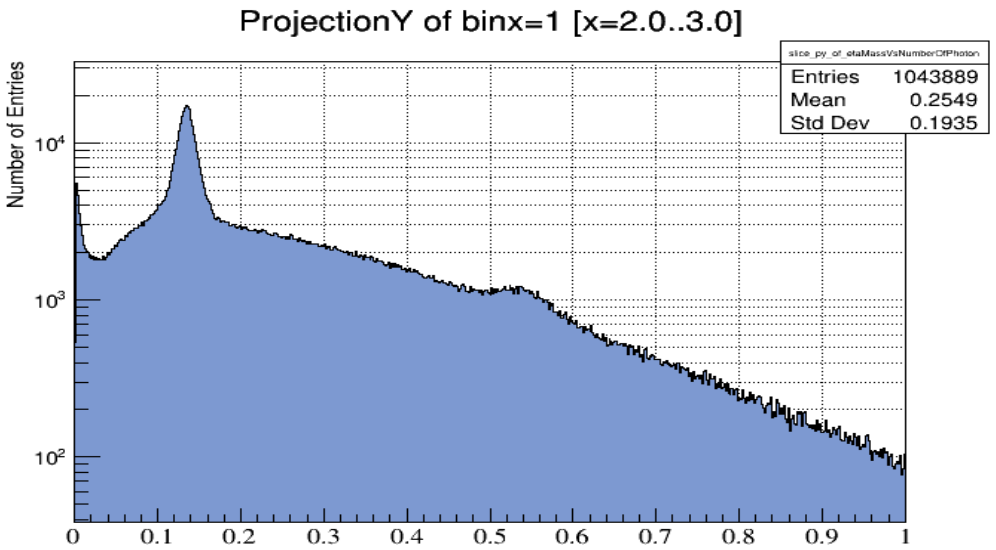


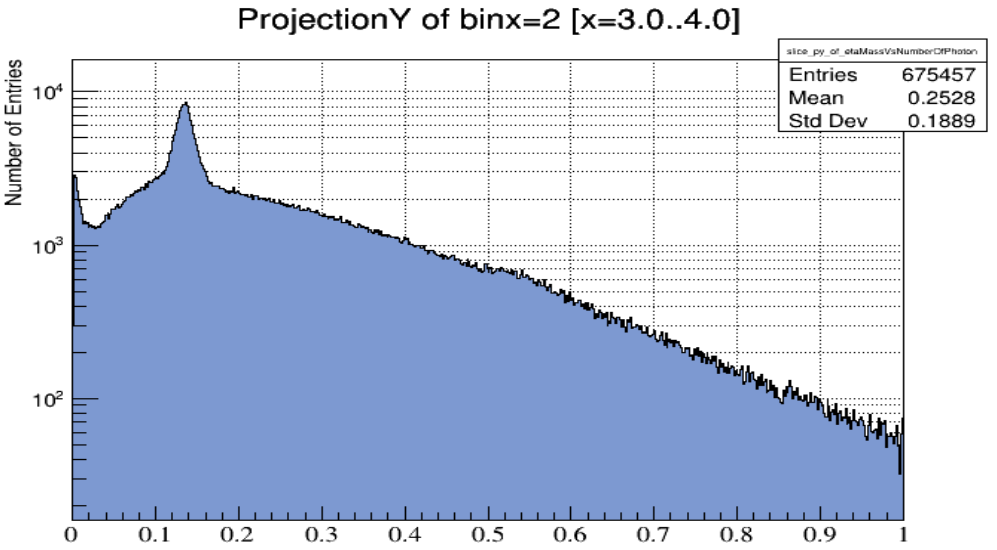


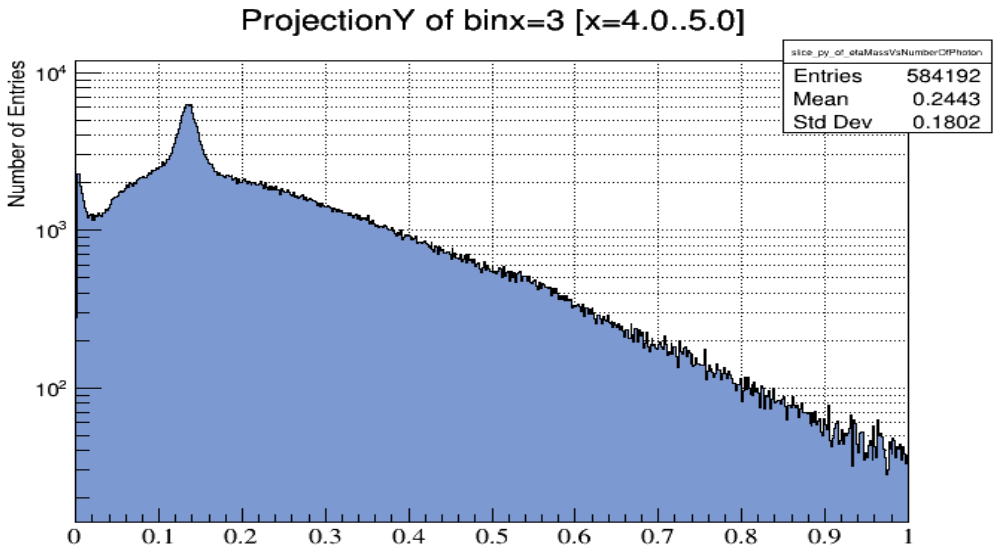


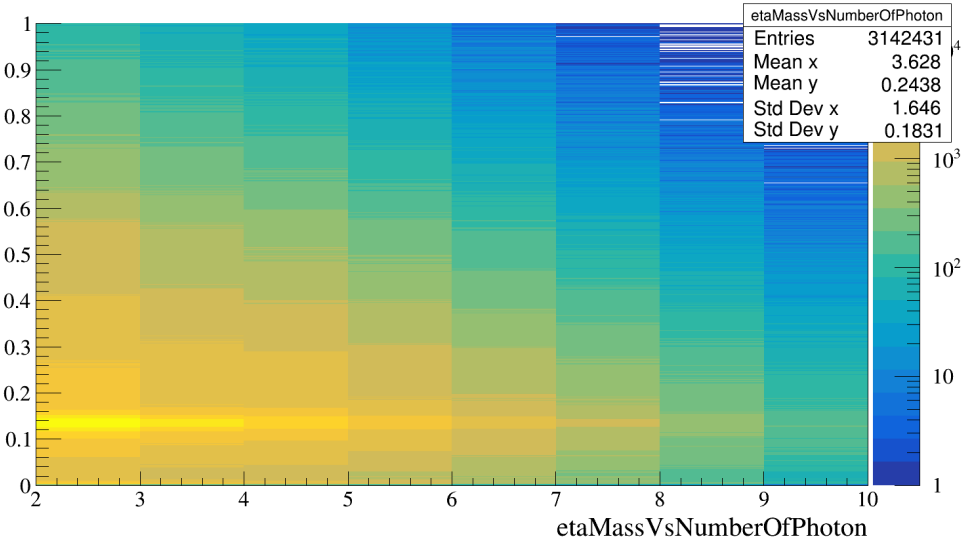


Number of Photon: eta Meson

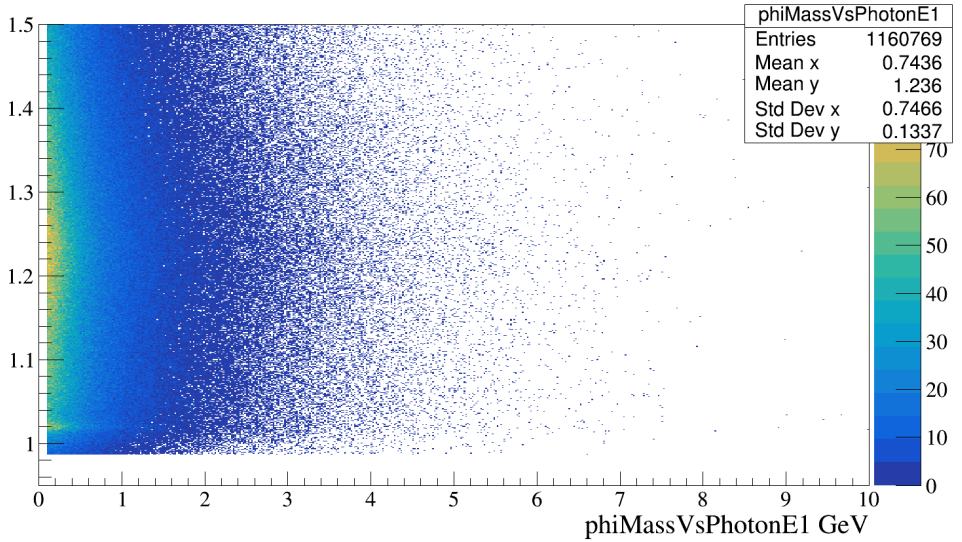


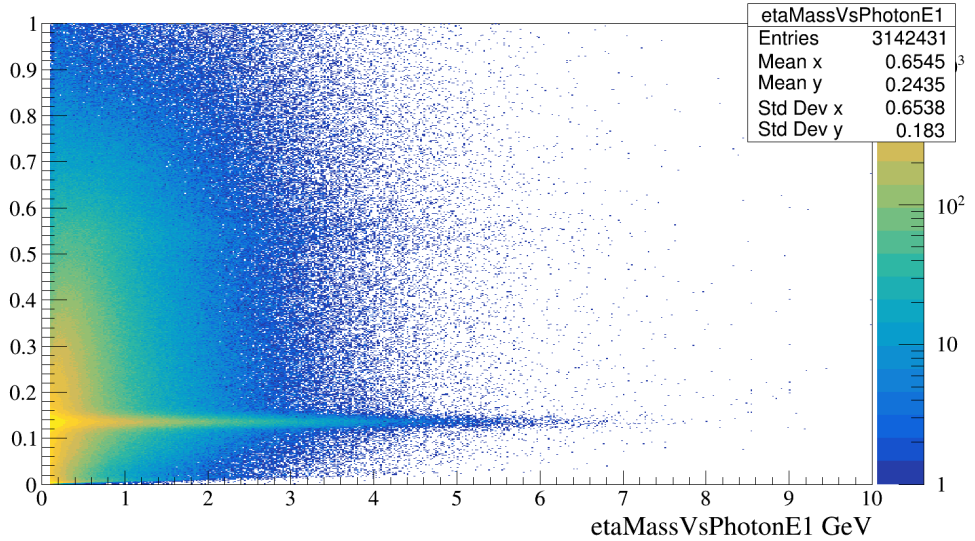






Photon Energy Vs phi/eta Meson

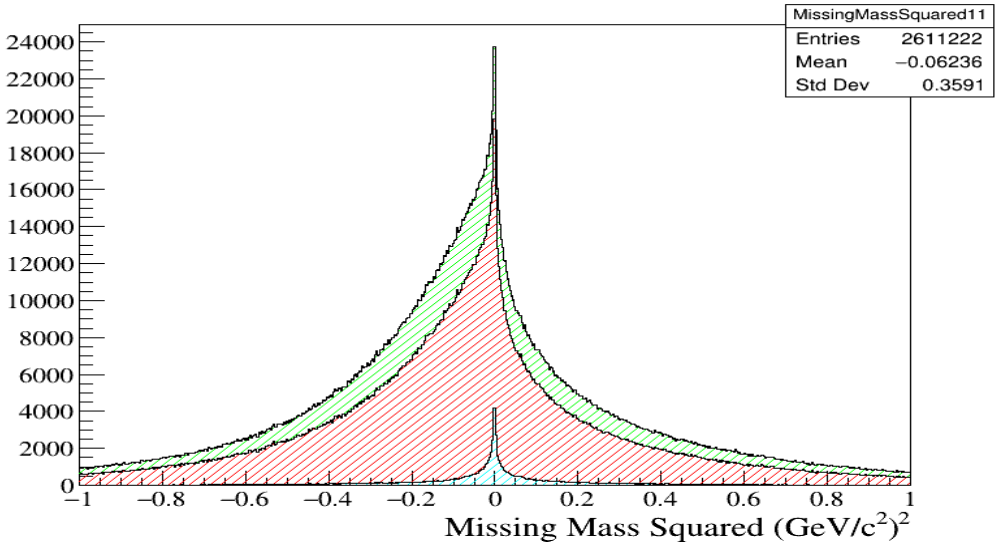


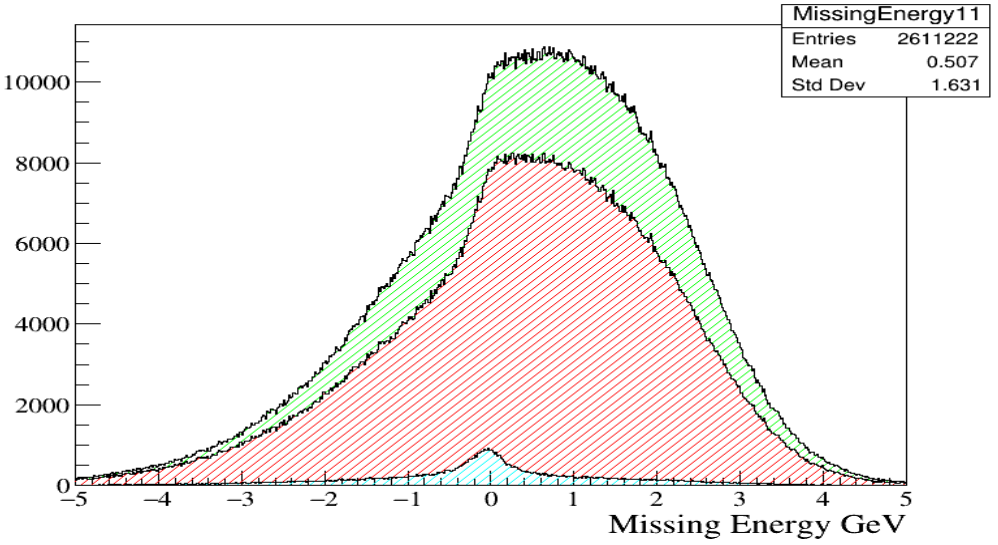


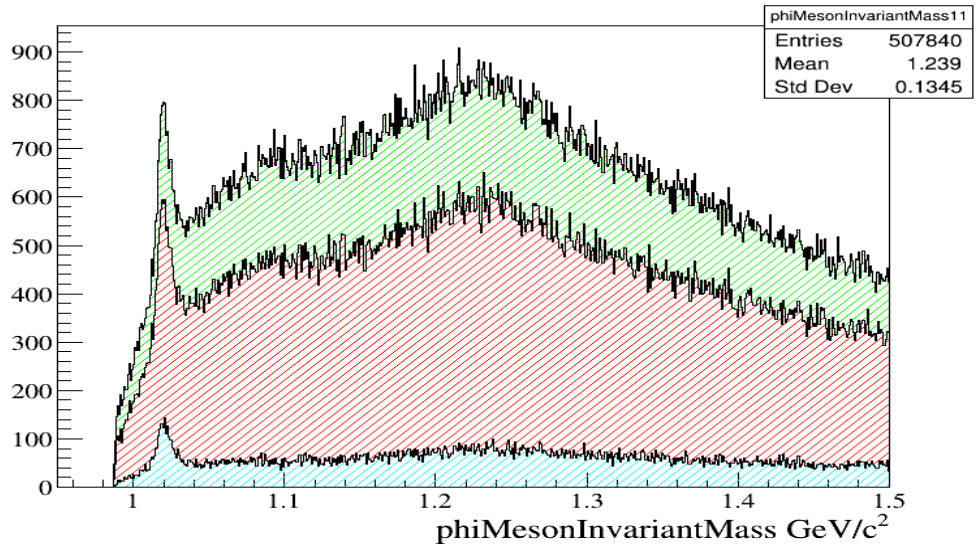
Number of Particle Cuts:

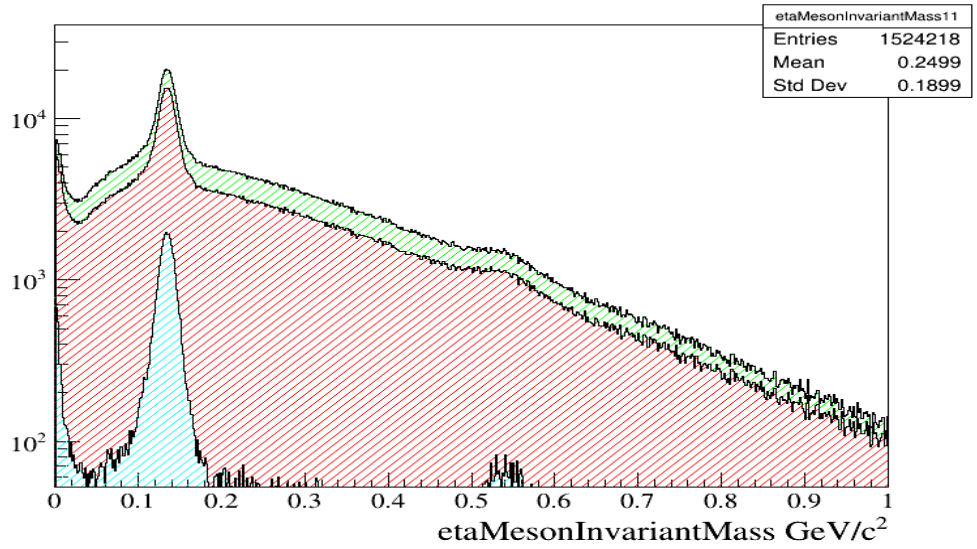
- Require exactly 2 photons
- Require exactly 1 Kminus (only one negative track)
- Require 1 or 2 protons (combination with K+)
- Require 1 or 2 K+ (combination with proton)

Number of Particle Cuts:



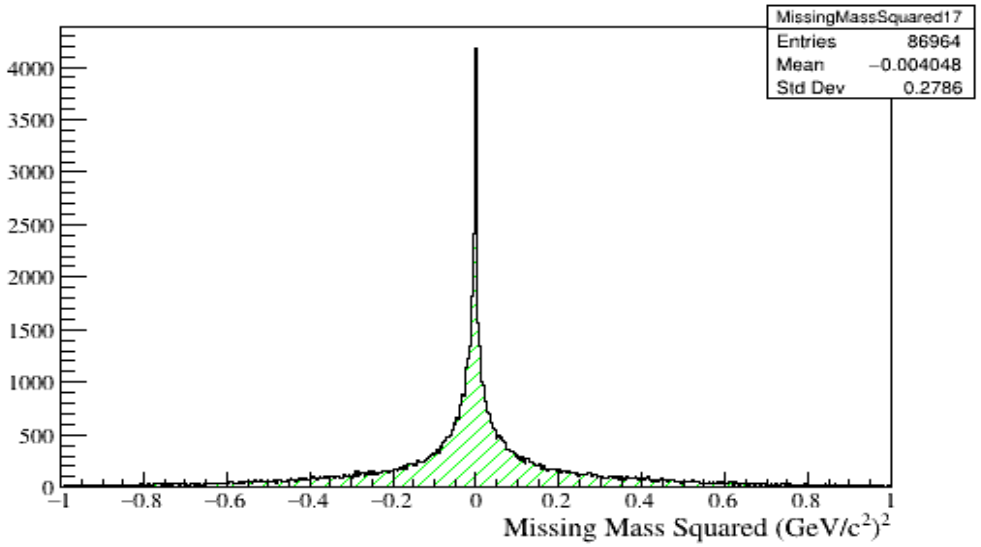


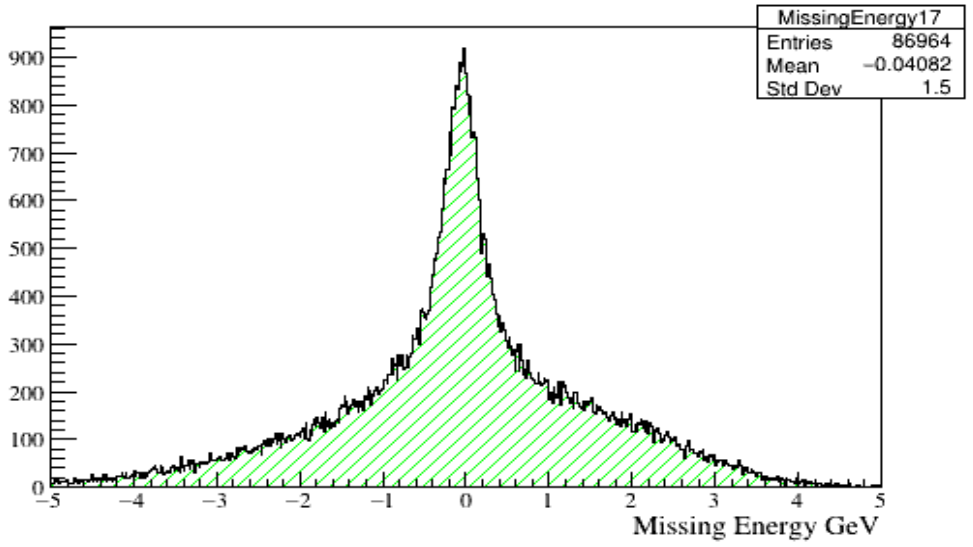


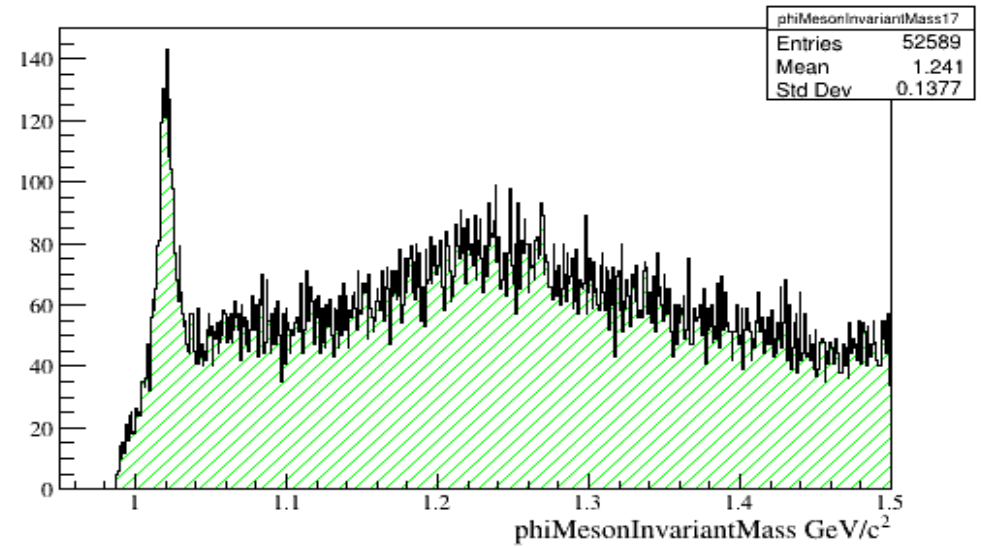


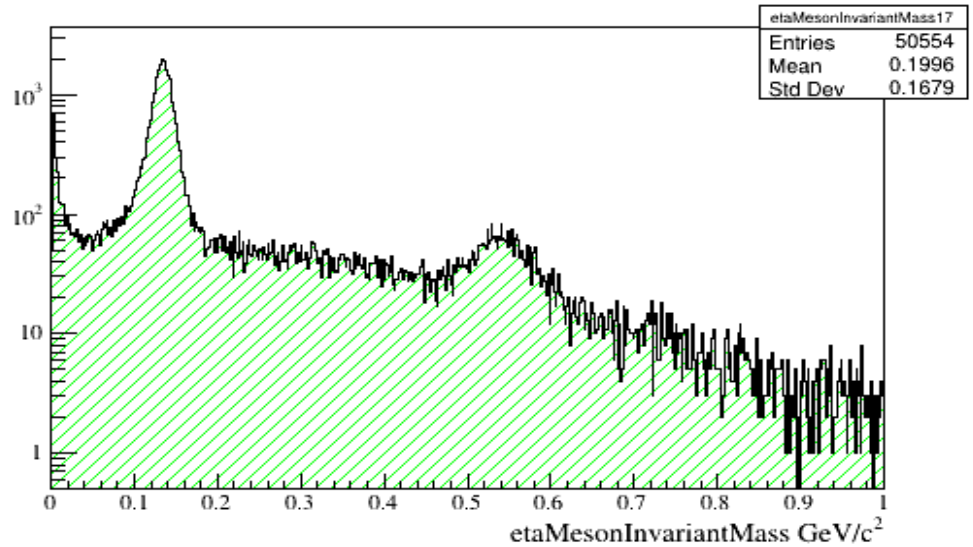
Blue: Proton Number, Green: Kplus Number,
Red: KMinus Number, Cyan: Photon Number

After All Cuts:

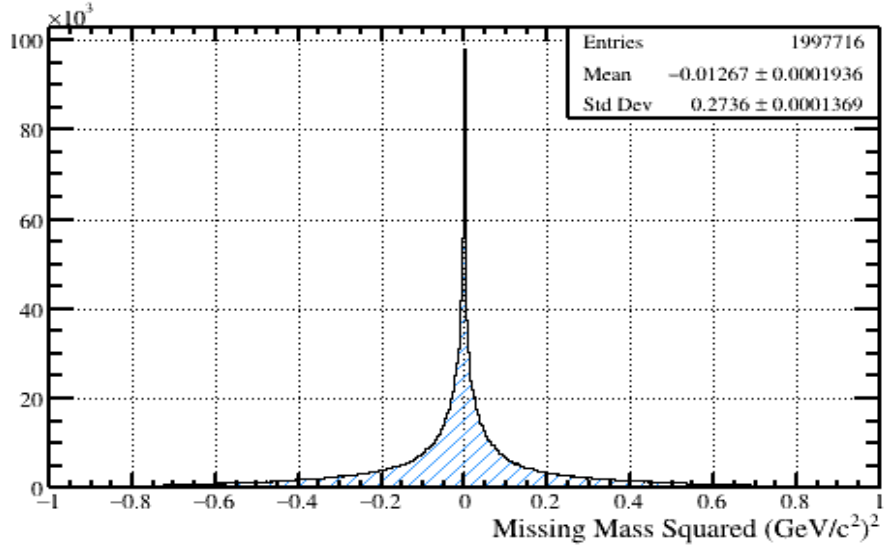


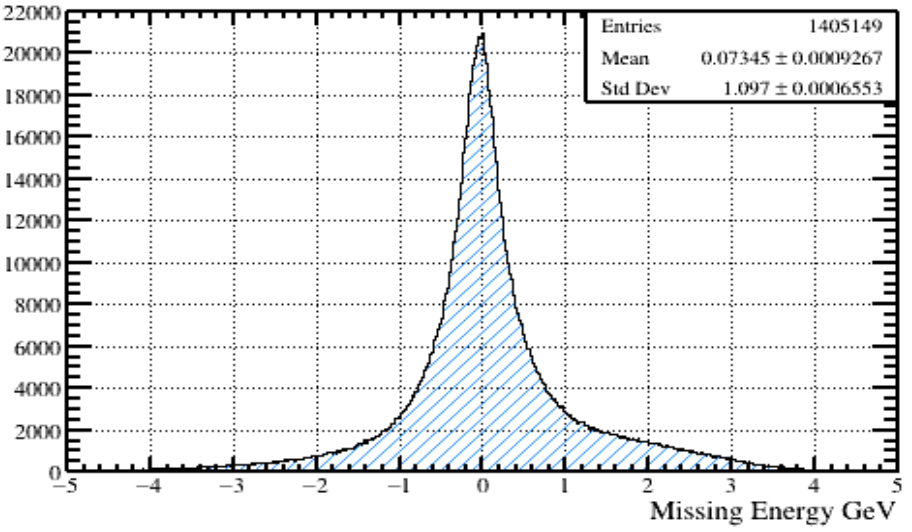


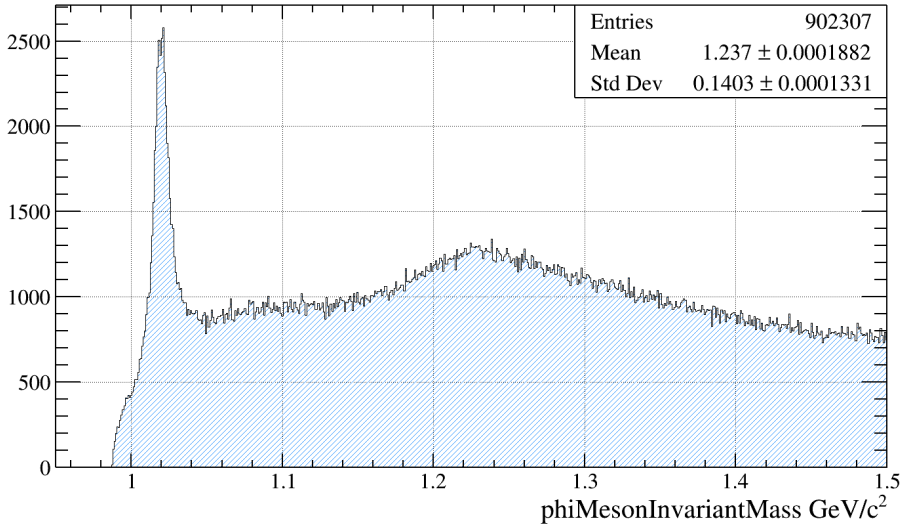


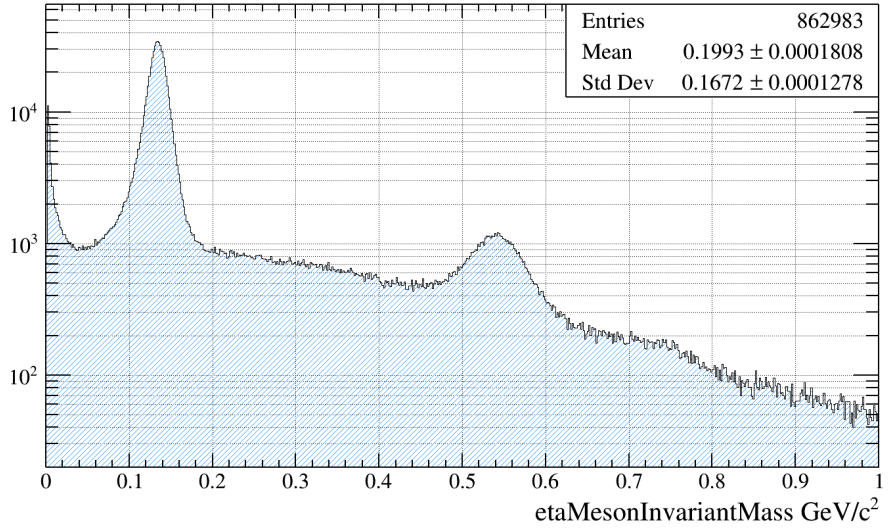


All Data/All Cuts:

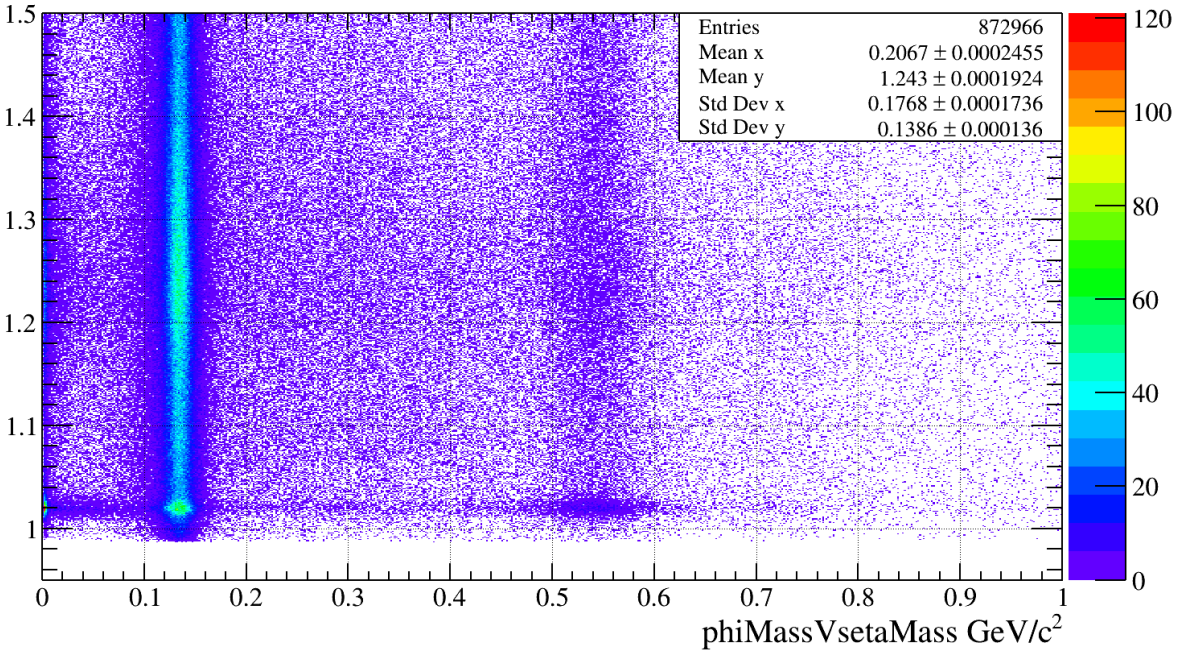


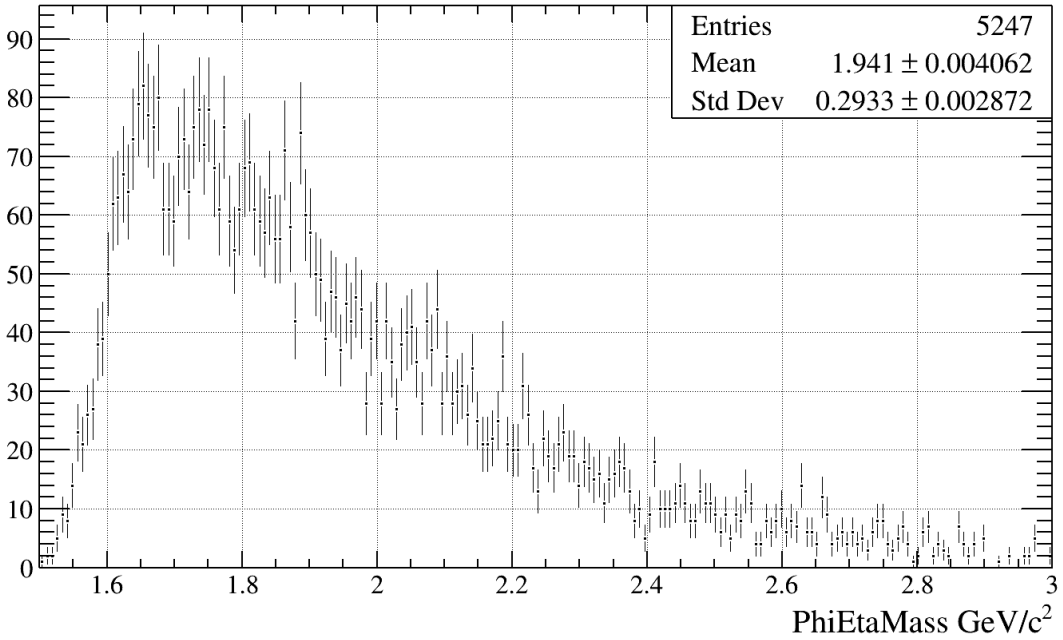




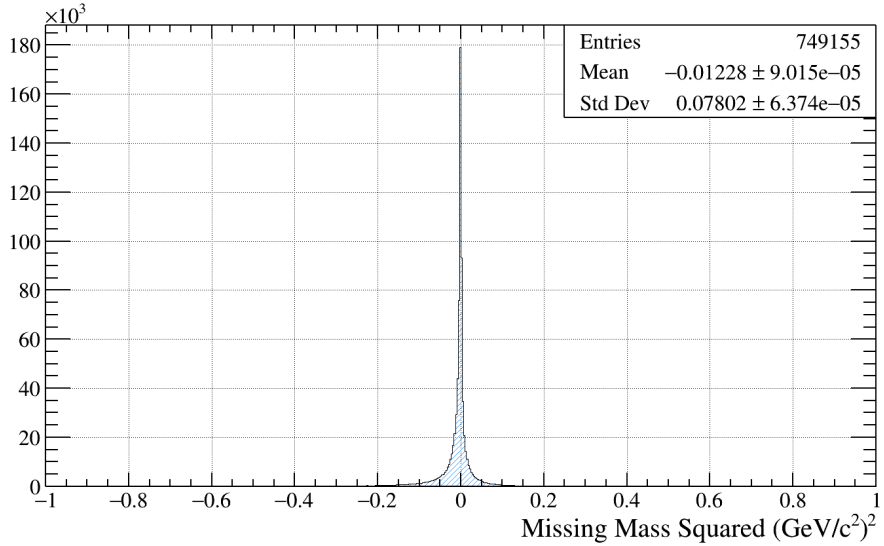


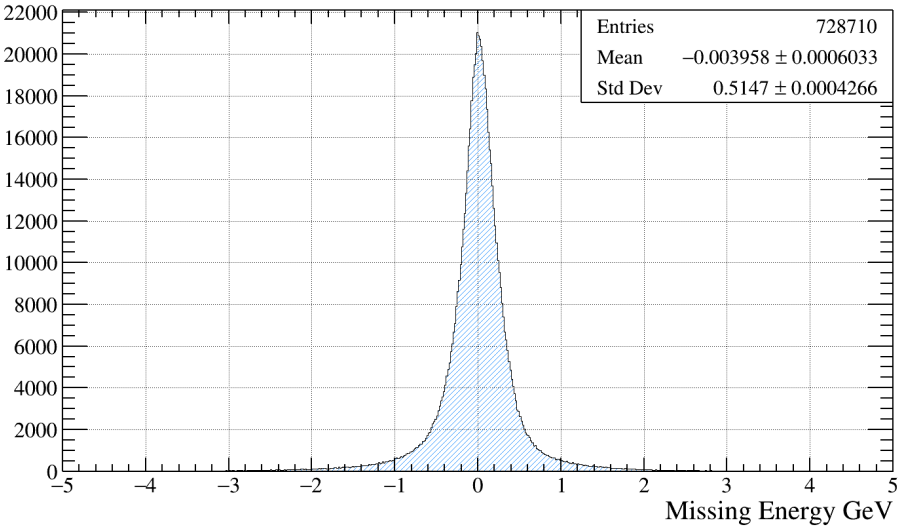
All Data/All Cuts:

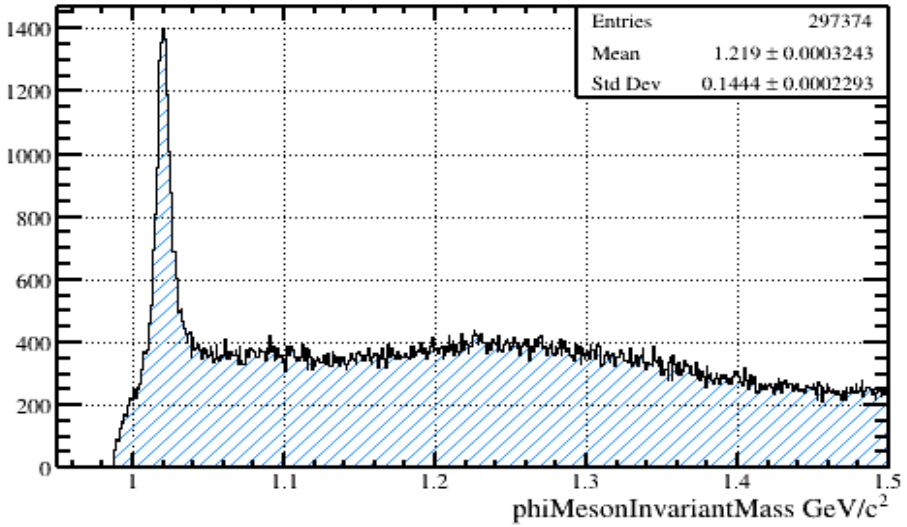


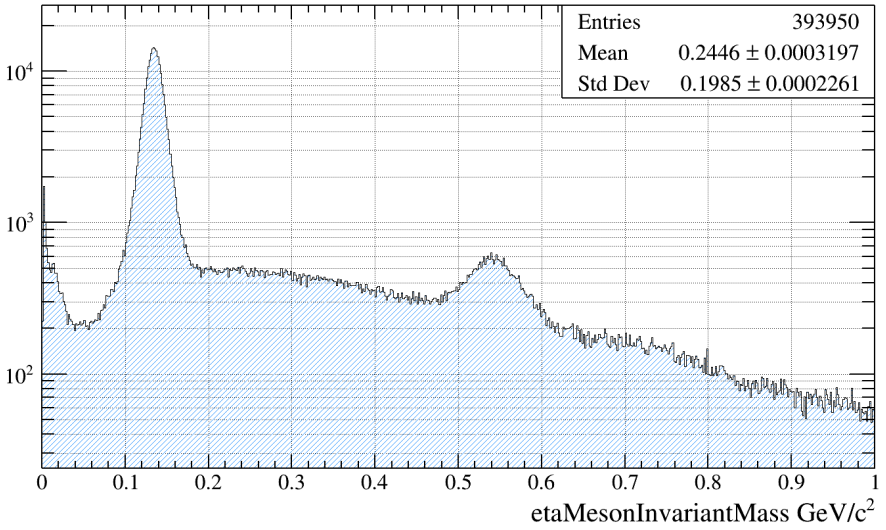


All Data/No Particle Cuts/1% KinFit:









All Data/No Particle Cuts/1% KinFit: