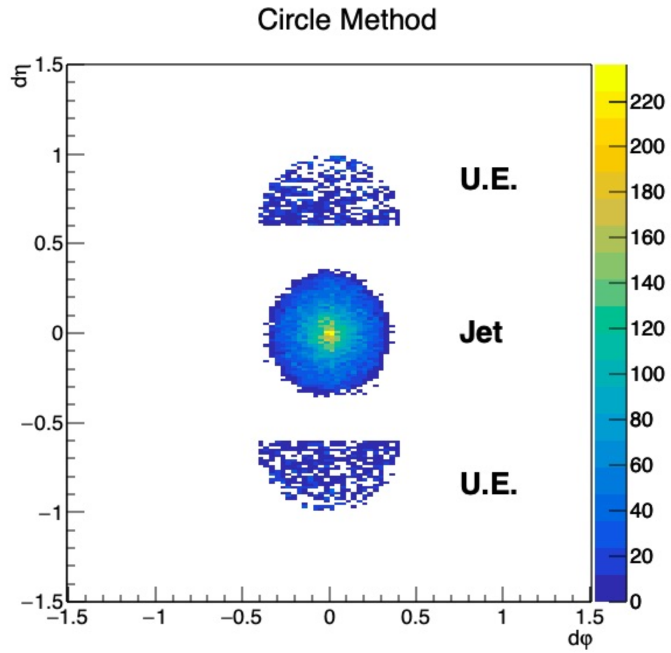
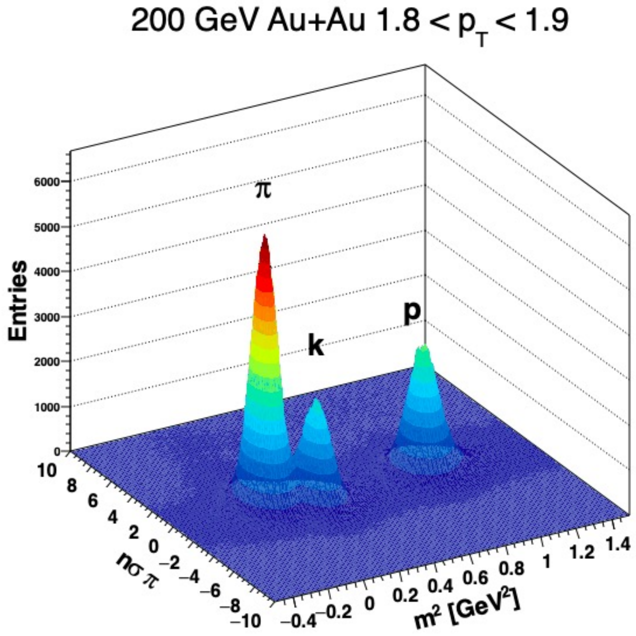
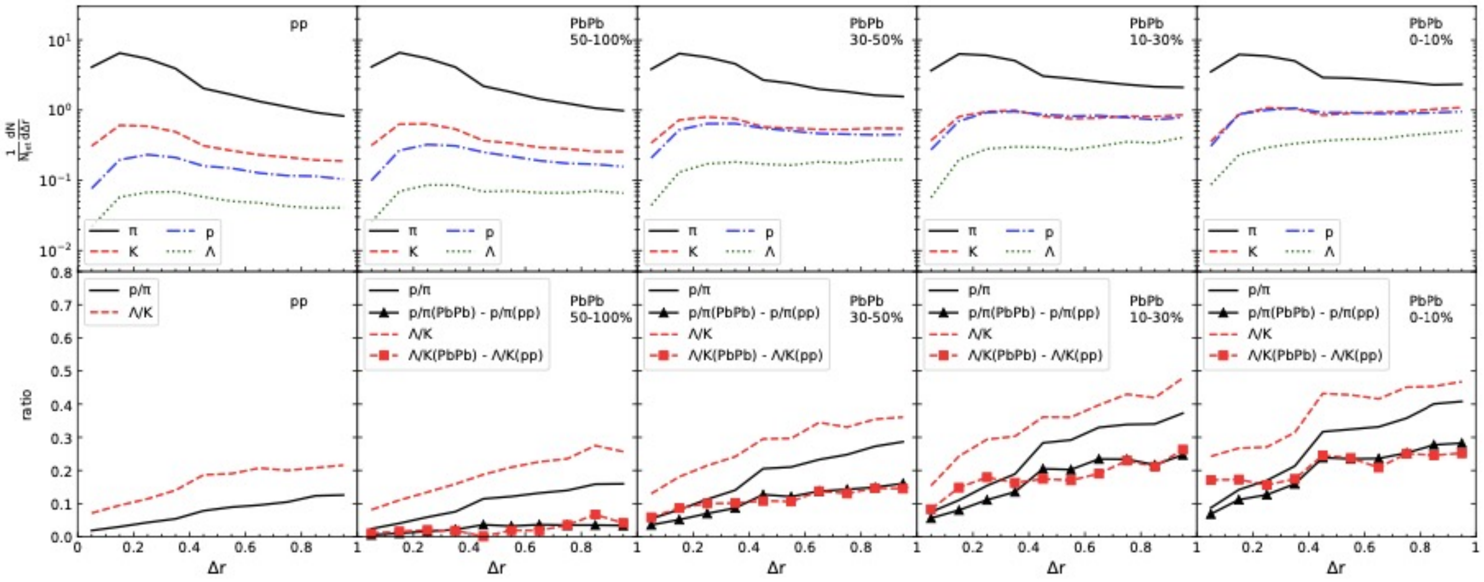
Baryon and Meson Ratios in Jets from Au+Au Collisions at 200 GeV

Gabriel Dale-Gau

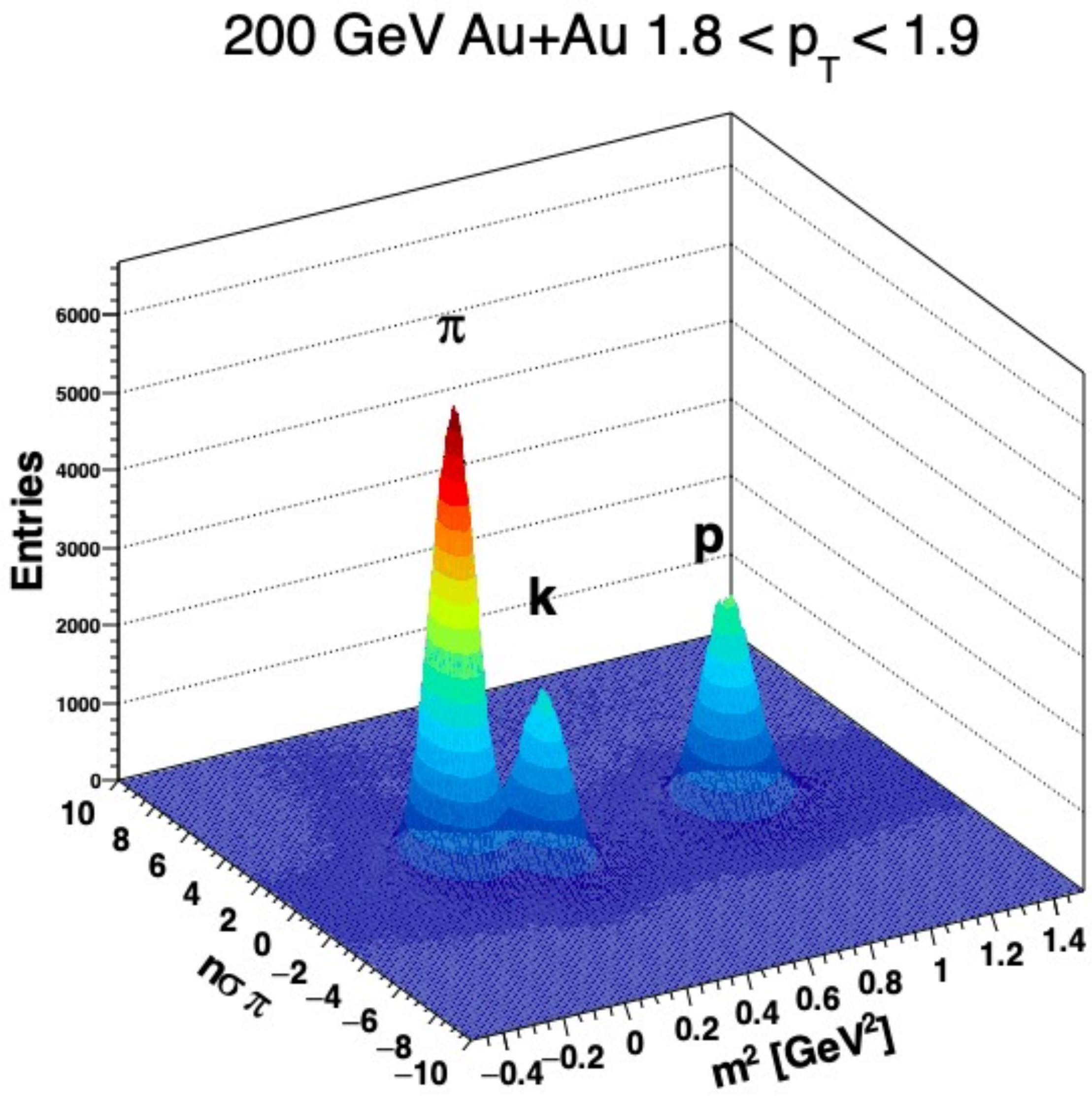






Introduction:

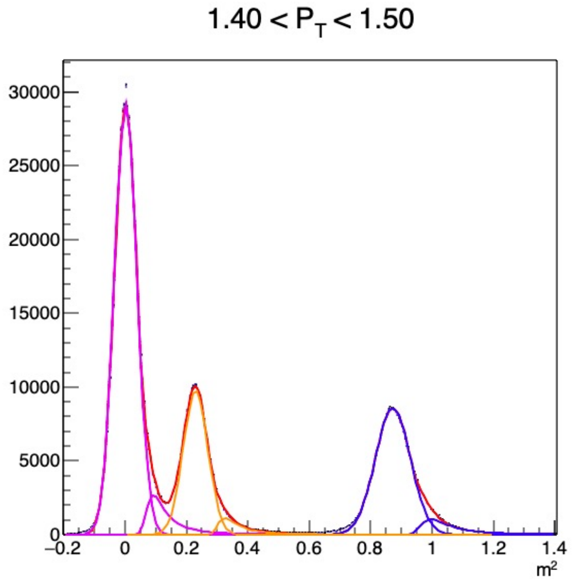
- Is hadronization/fragmentation modified by QGP?
- It is known that relative baryon to meson ratios differ between heavy ion and pp collisions arXiv:nucl-ex/0606003 [nucl-ex]
- Recent simulations lead us to suspect baryon and meson content in jets differs from that of the bulk arXiv:2109.14314v1 [hep-ph]
- In this study we will combine jet-track correlation with PID to examine baryon and meson content as a function of distance from jet axis, r



Overview:

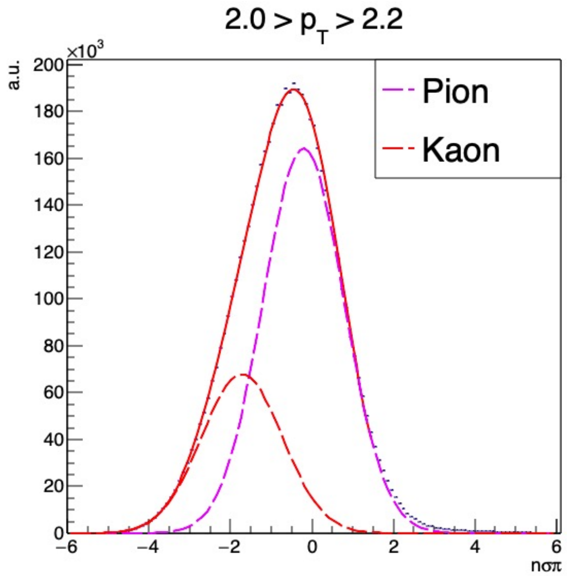
- Identify pion, kaon, and proton yields by employing both TOF and TPC information
- Combine particle identification with jet reconstruction
- Perform this same procedure for many p_T bins
- All data shown in this presentation is from Run 14 Au+Au at sqrt(s) = 200 GeV, 0-20% Centrality

Particle Identification



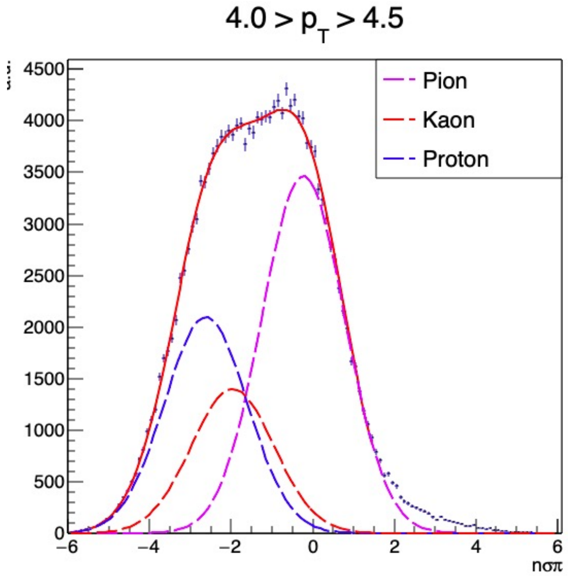
Low, p_T < 2.0

- ToF has clean separation between all three particle species and can be fit directly or bin counted in the case of protons. dE/dX is also fit as a cross check



Mid, 2.0 < p_{T} < 3.5

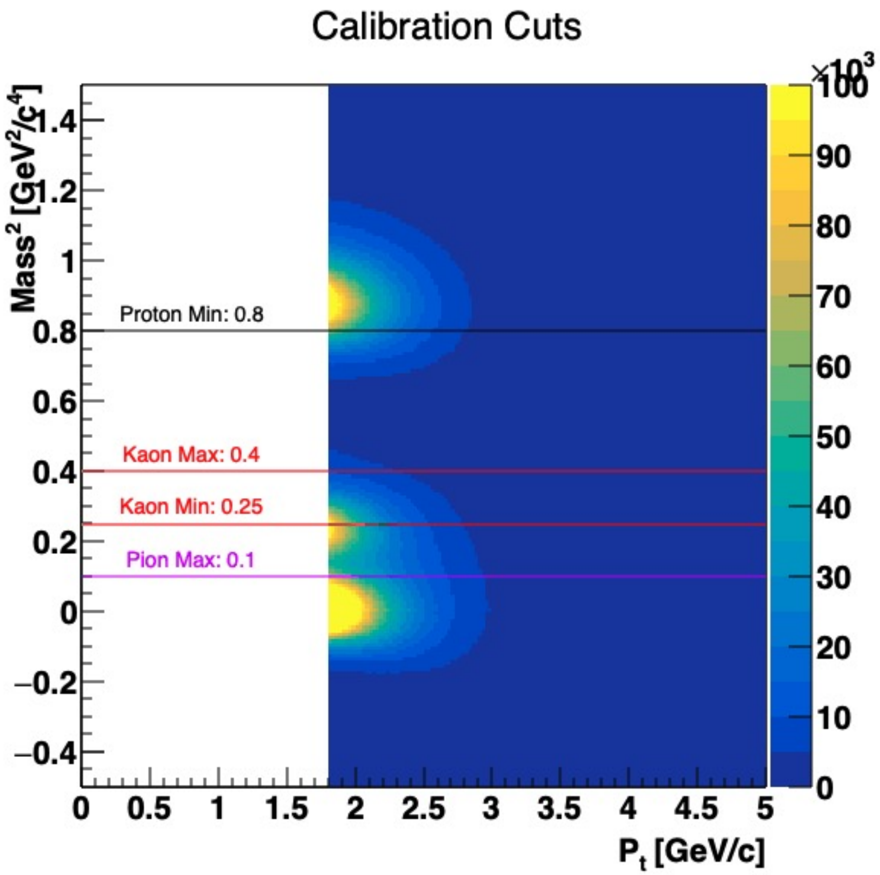
- Protons can still be directly counted from ToF, then cut away
- dE/dX is then fit with a double gaussian to identify Pion and Kaon yields

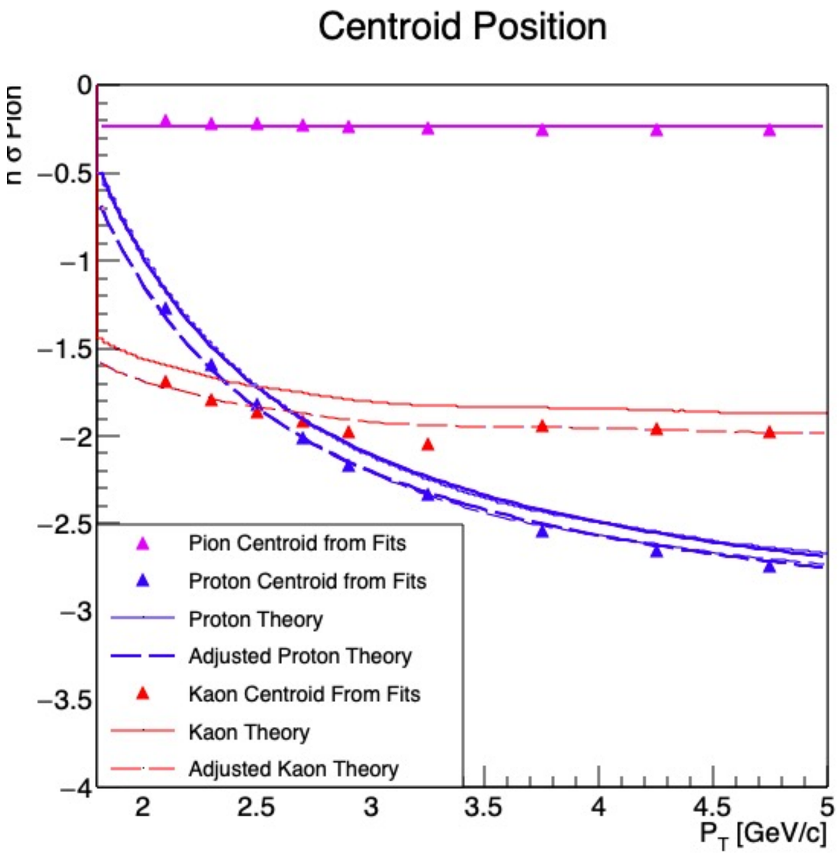


High, 3.5 < p_T

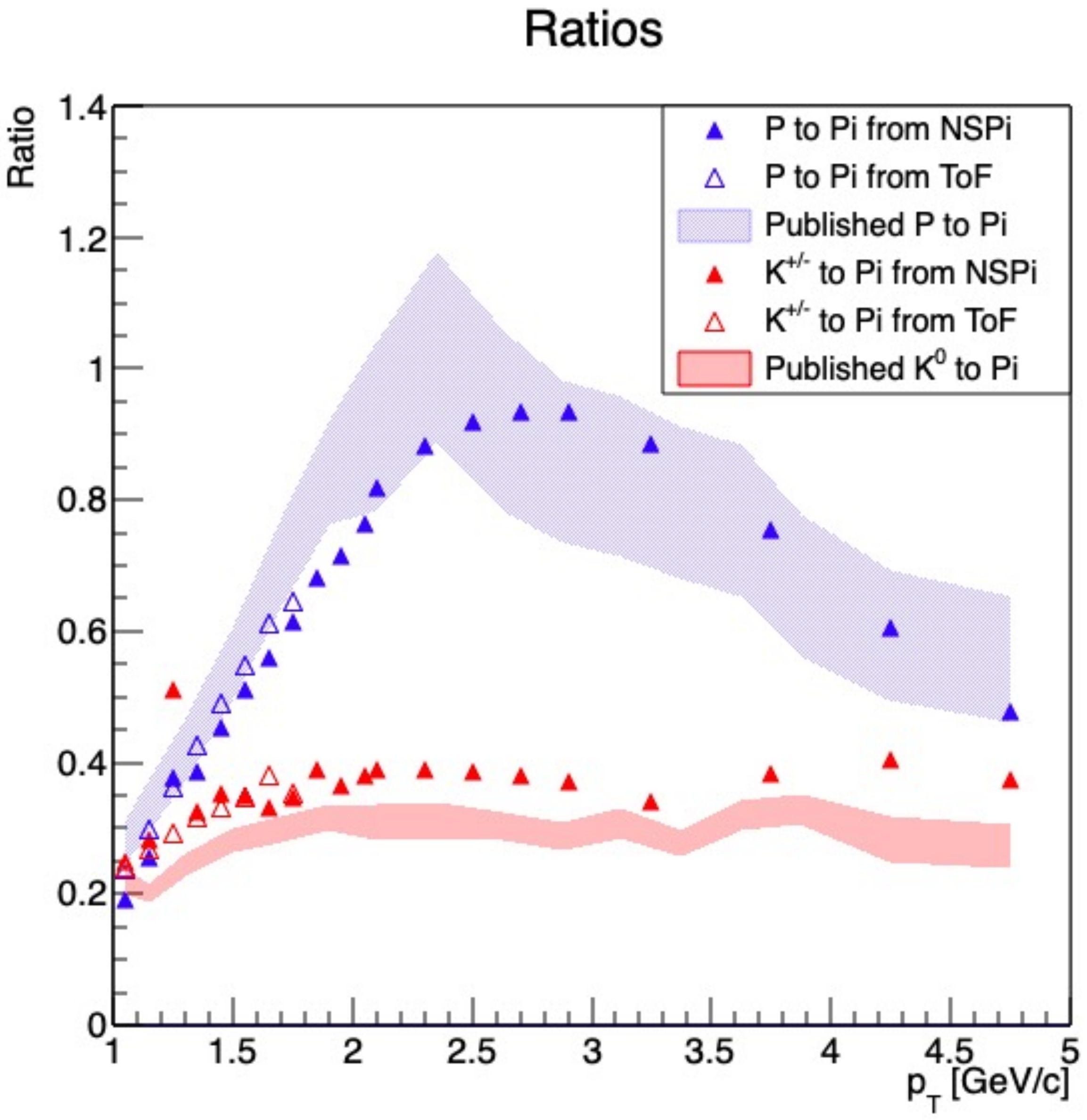
- ToF resolution deteriorates greatly
- dE/dX is fit with a triple gaussian
- Centroid location is determined through calibration outlined on the next slide

Particle Identification





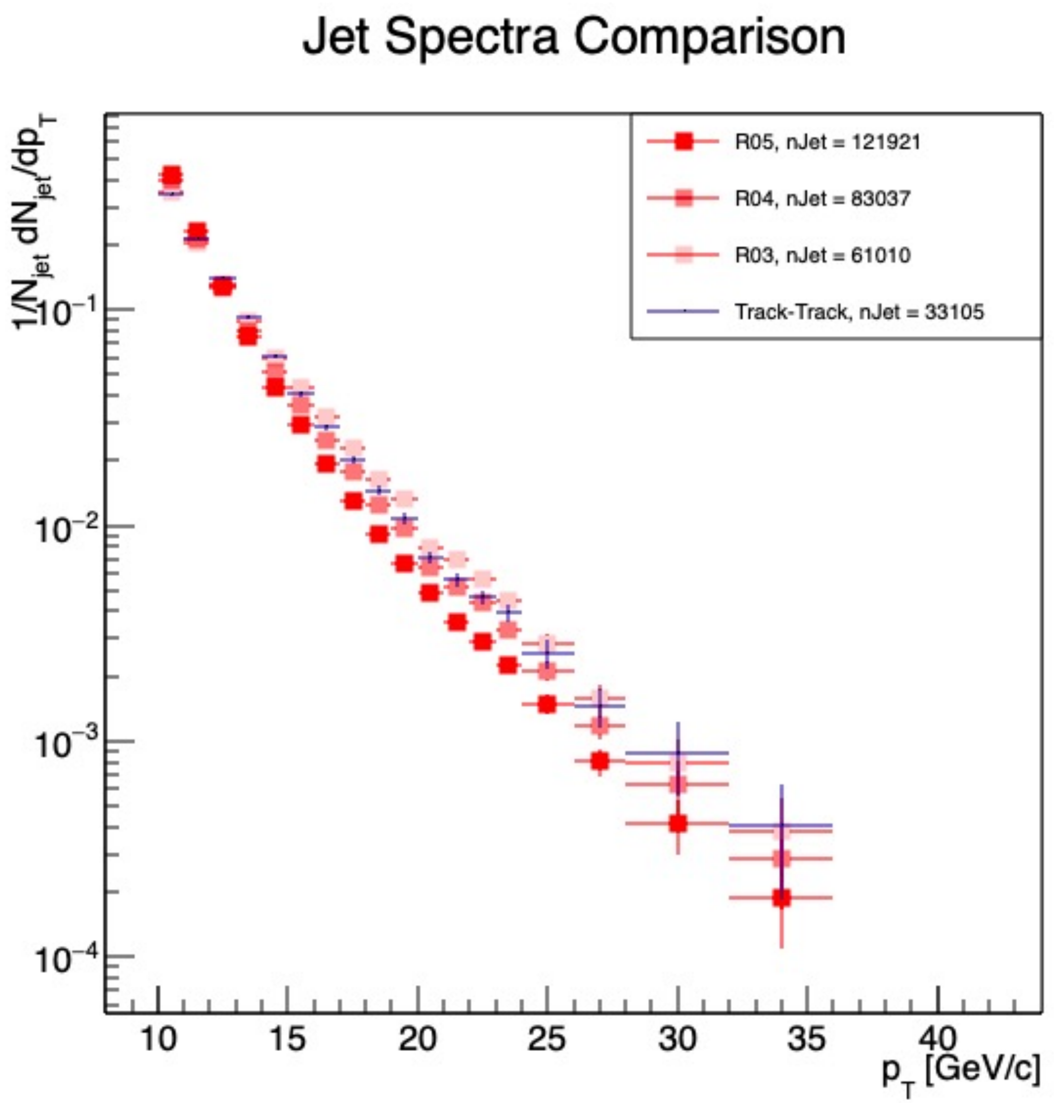
- Placing stringent cuts in ToF allows us to isolate clean samples of each particle species and fit them with a single gaussian to determine centroid location.
- Shifted dE/dX calibration is expected and has been observed in past work



Inclusive Results

- Constraining Centroids from calibration allows us to return to the full data and measure Pion, Kaon, and Proton yields
- Note that for all points below p_{T} = 3.5, Protons are counted directly from ToF, and Pions and Kaons are fit with a double gaussian in NSPi
- We are considering extending this study to low P_{T}, < 2.0, as ToF resolution is much better, giving us increased confidence in PID results. However, the abundance of statistics in this regime is more challenging for Jet correlation and underlying event subtraction

Jet Correlations

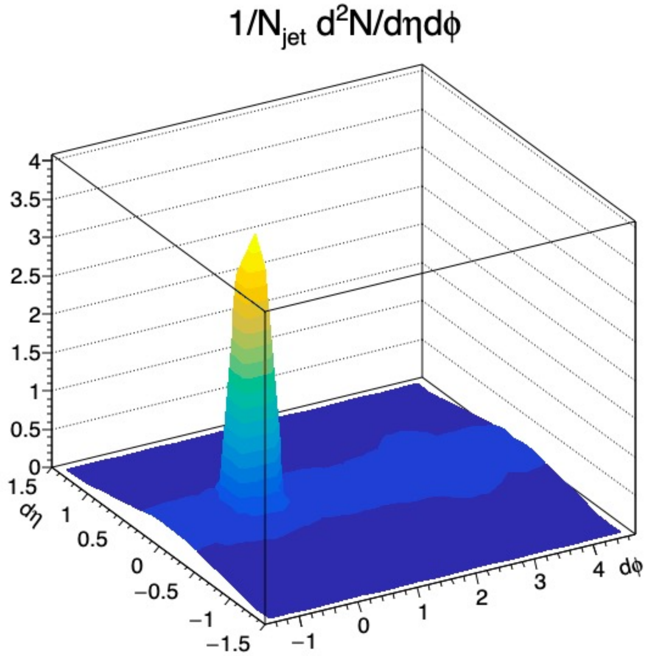


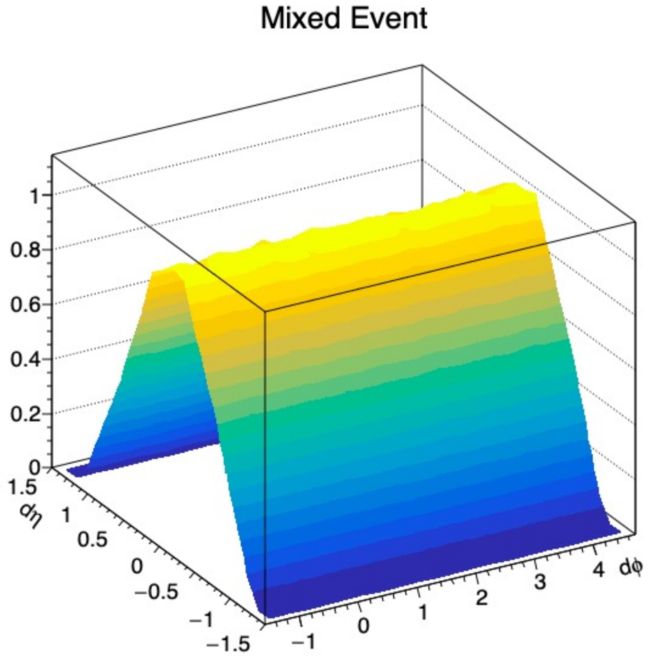
Jet Cuts:

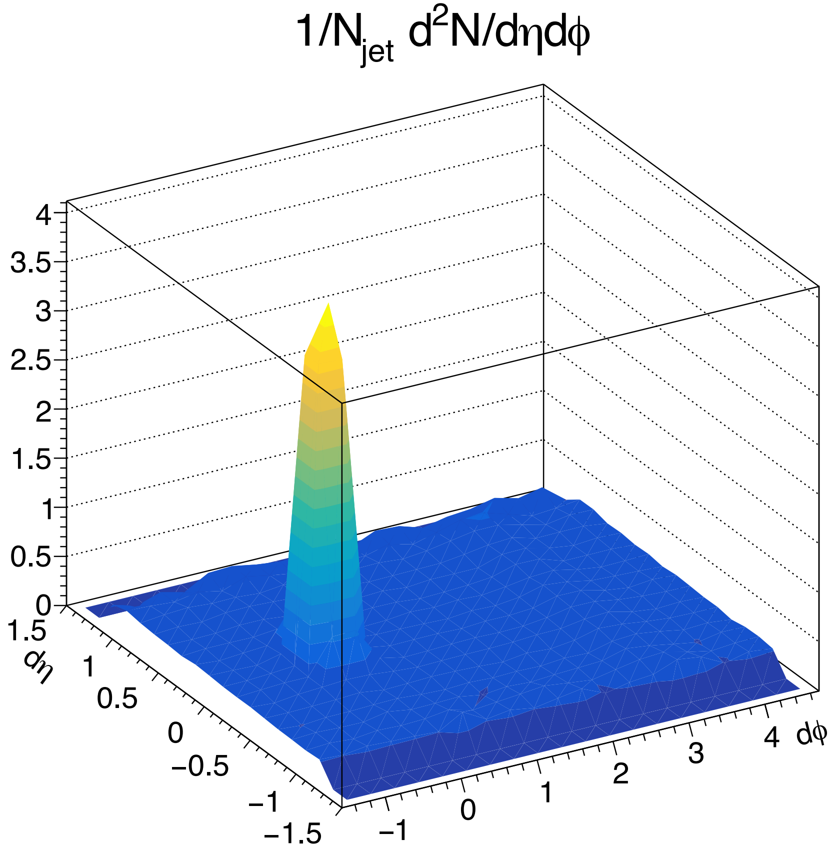
- |Jet eta| < 1.0 – R
- Jet Radius R = 0.3, R = 0.4, R = 0.5
- Anti-k_{T} algorithm
- Leading trigger Jets only
- Jet p_{T} > 10
- MB, HT2, HT3 data

Track Cuts:

- nHits > 25
- |eta| < 1.0
- ToF matching cuts:
  beta > 0
  -0.5 < m^{2} < 1.5
- dE/dx matching cuts:
  |nSigmaPion| < 10
- For jet reconstruction:
  p_{T} > 2.0
- For jet-track correlation: |track eta| < 0.5

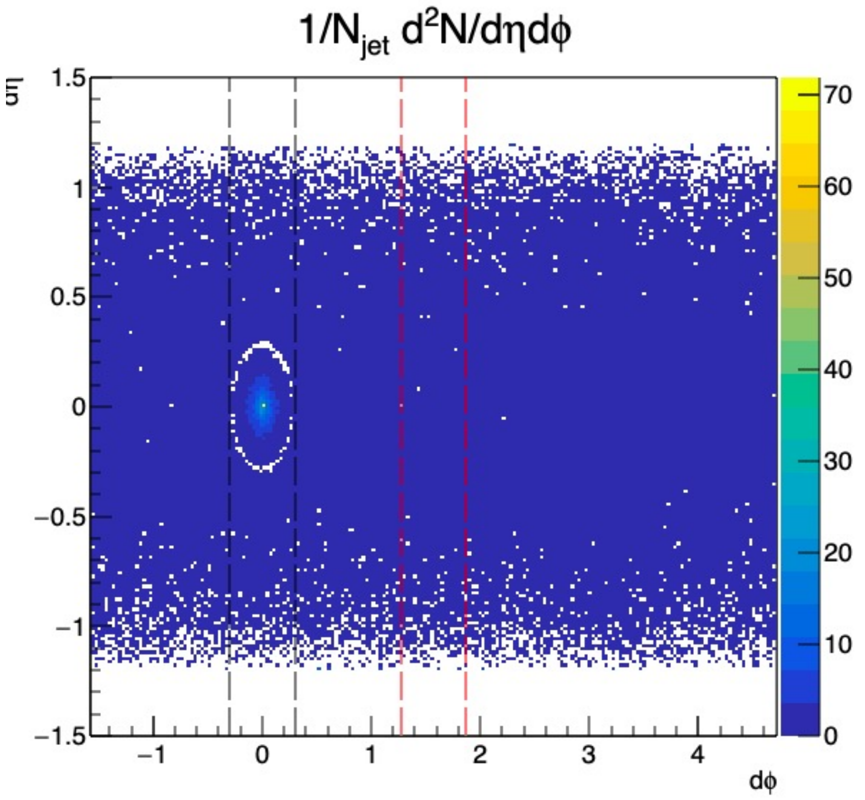


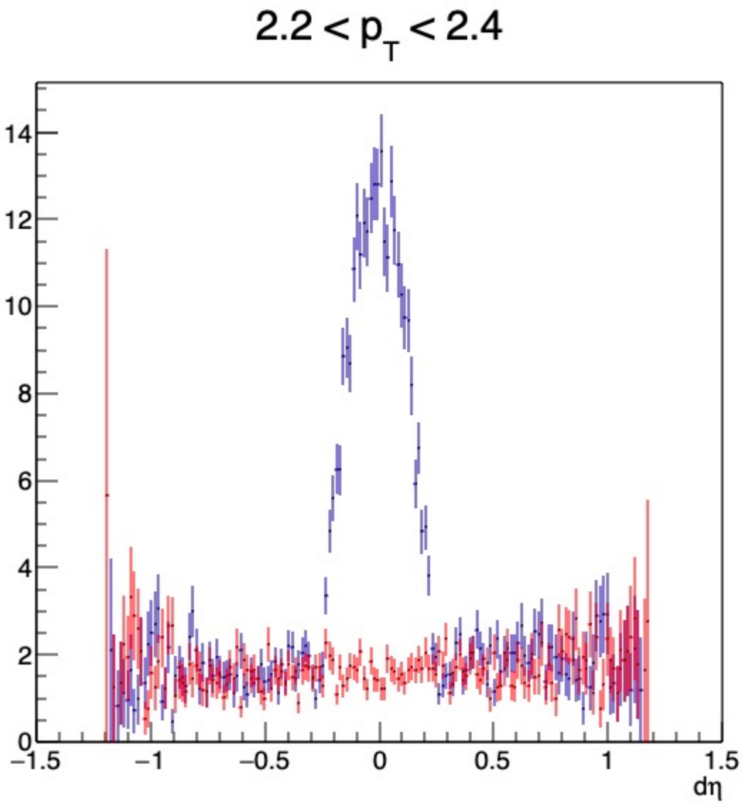




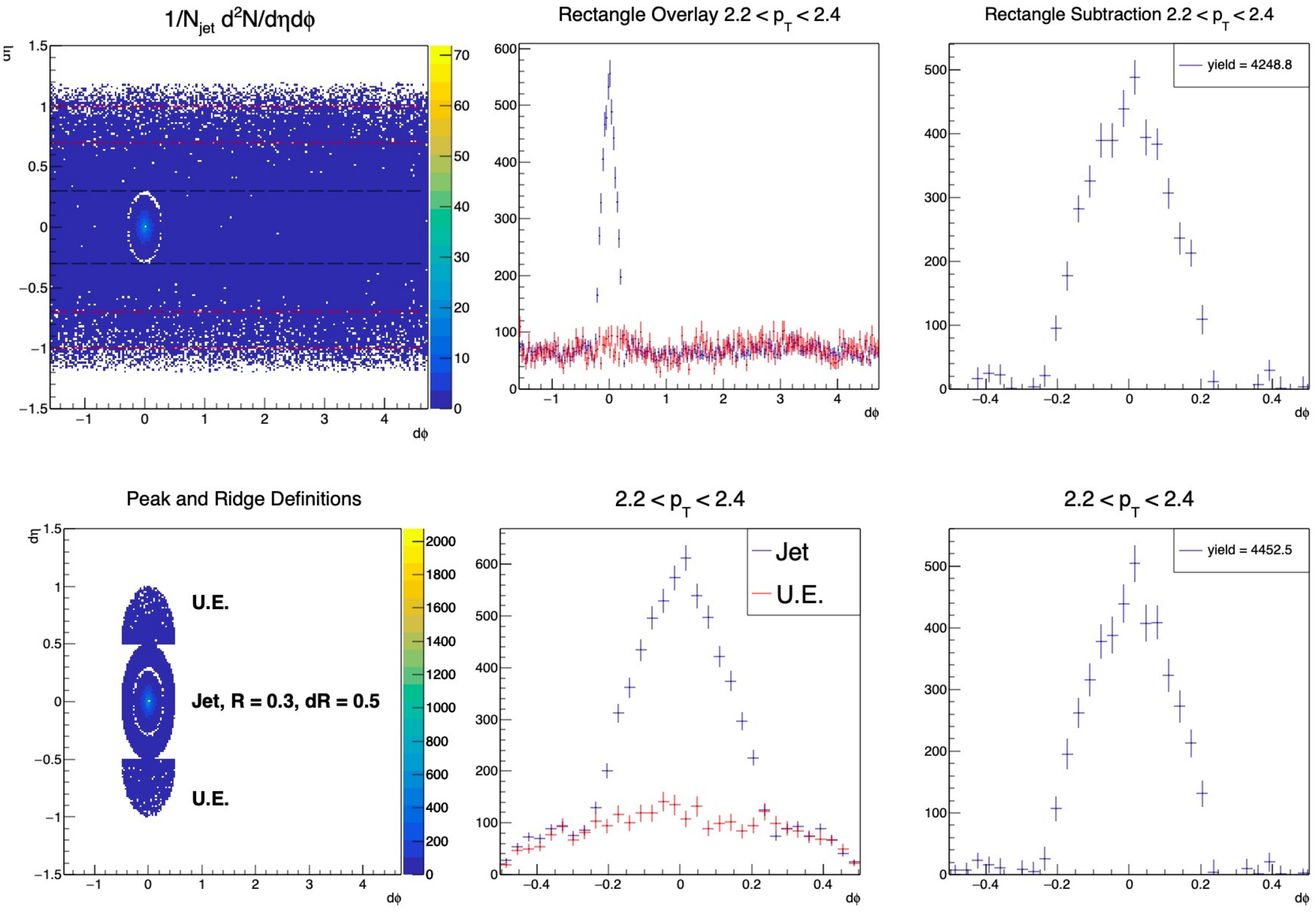
- Mixed event is employed to weight all distributions evenly in dη
- This achieves a uniform underlying event, which must be subtracted from our signal in order to obtain a clean sample of jet constituents

Side Band Flatness Check



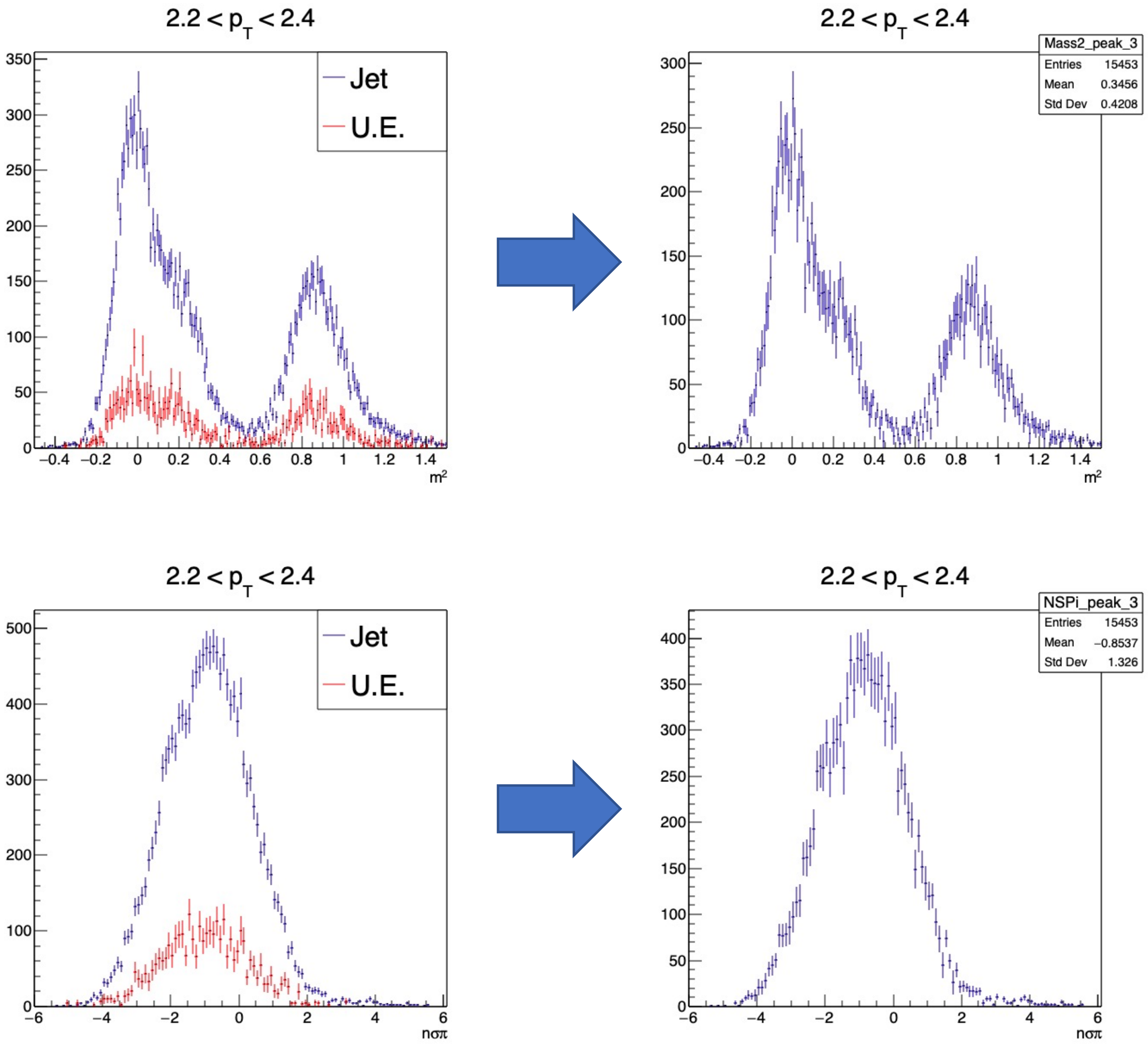


A check is performed by projecting a strip of the signal and a strip of the underlying event onto dη to confirm successful application of the mixed event



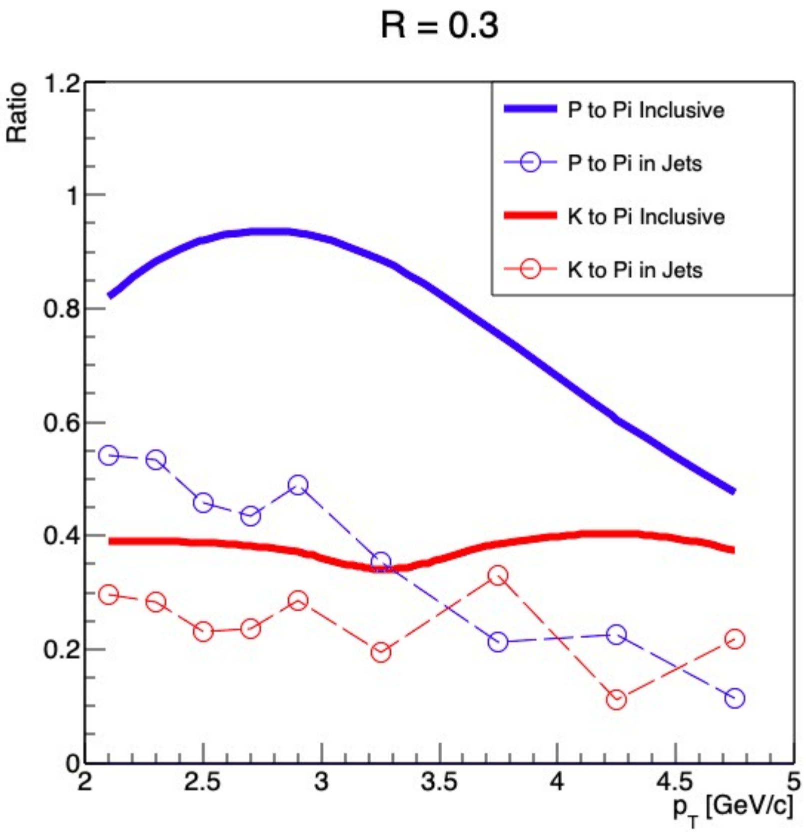
- The upper three graphs demonstrate U.E. subtraction using a rectangular cut.
- This also shows flatness in the dφ projection
- The lower three graphs show the same process for our circular subtraction technique
- The resulting yieldsfor this example pt bin differ by 4.5%

Jet Correlations

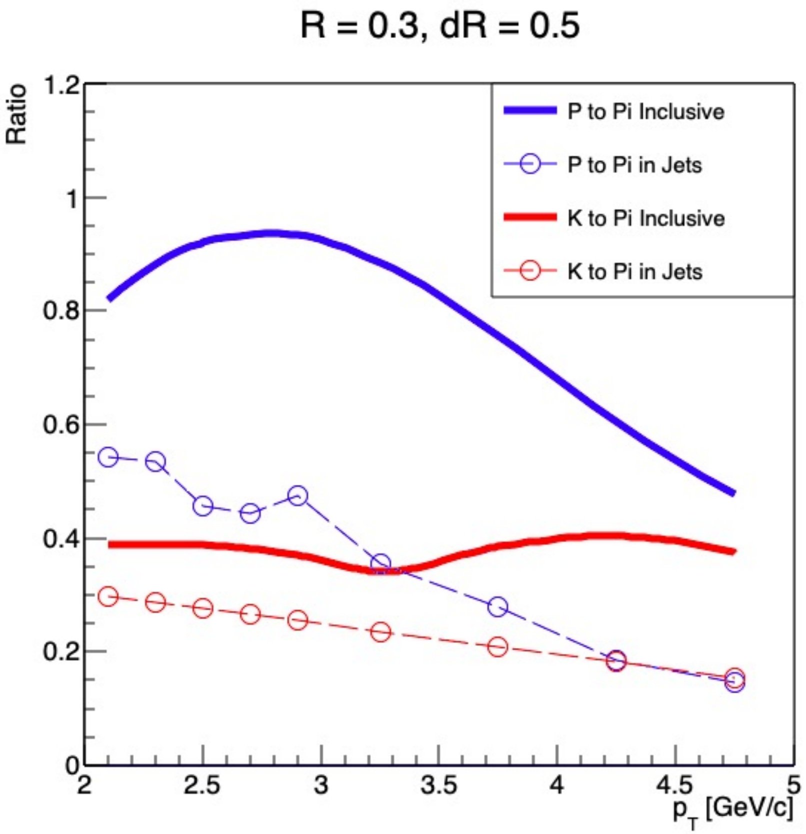


Subtraction is Performed in for both ToF and dE/dX data.
The resulting distributions are then fit with the same method used in our inclusive particle identification to measure the Baryon and meson ratios in the Jet region.

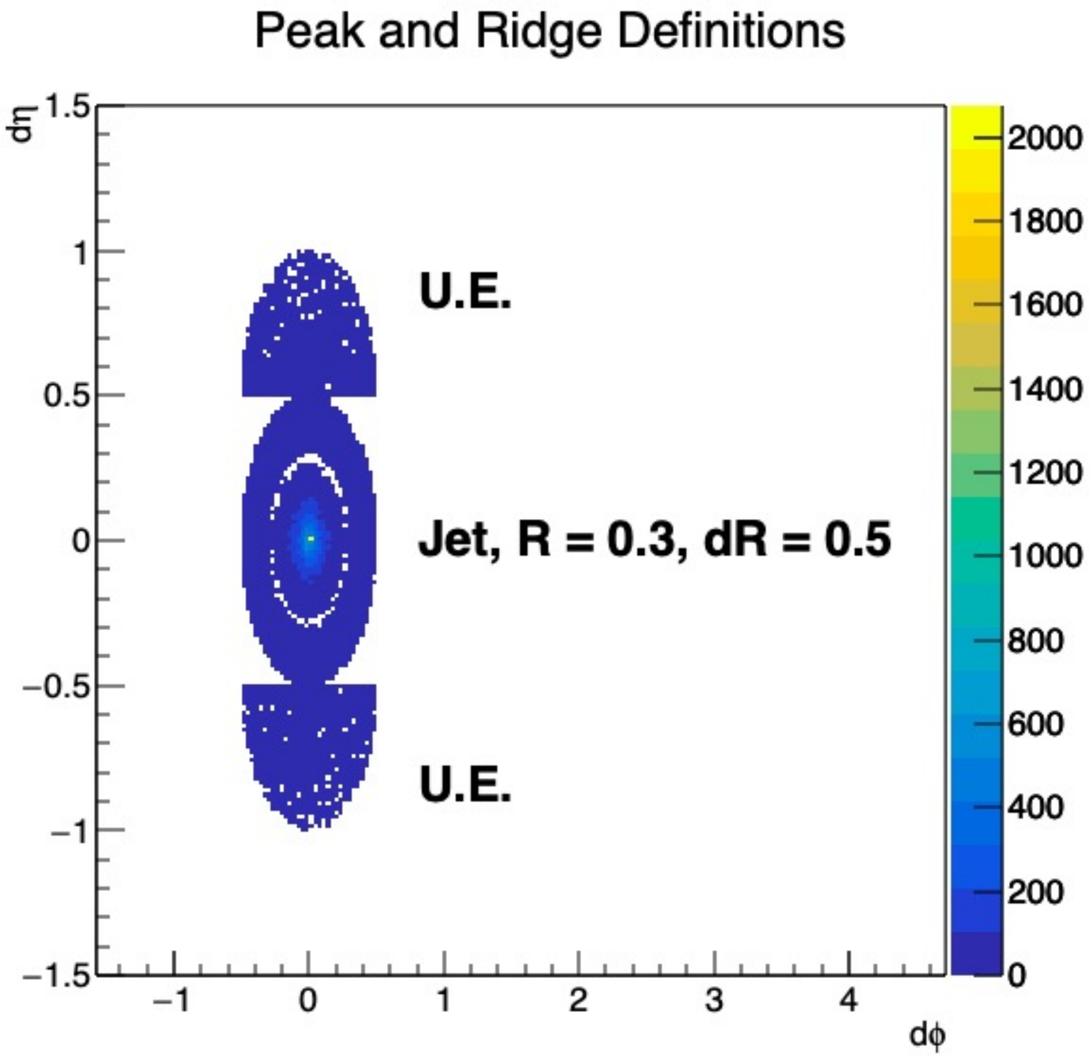
First Pass



Second pass



The subtracted distributions are fit twice, once with all three yields as free parameters, and then a second time with the k to pi ratio fixed based on a linear fit of k to pi from the first pass.

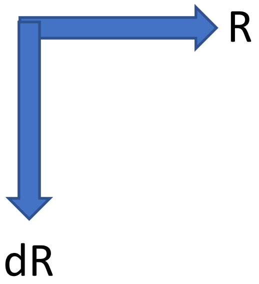


Radial Study

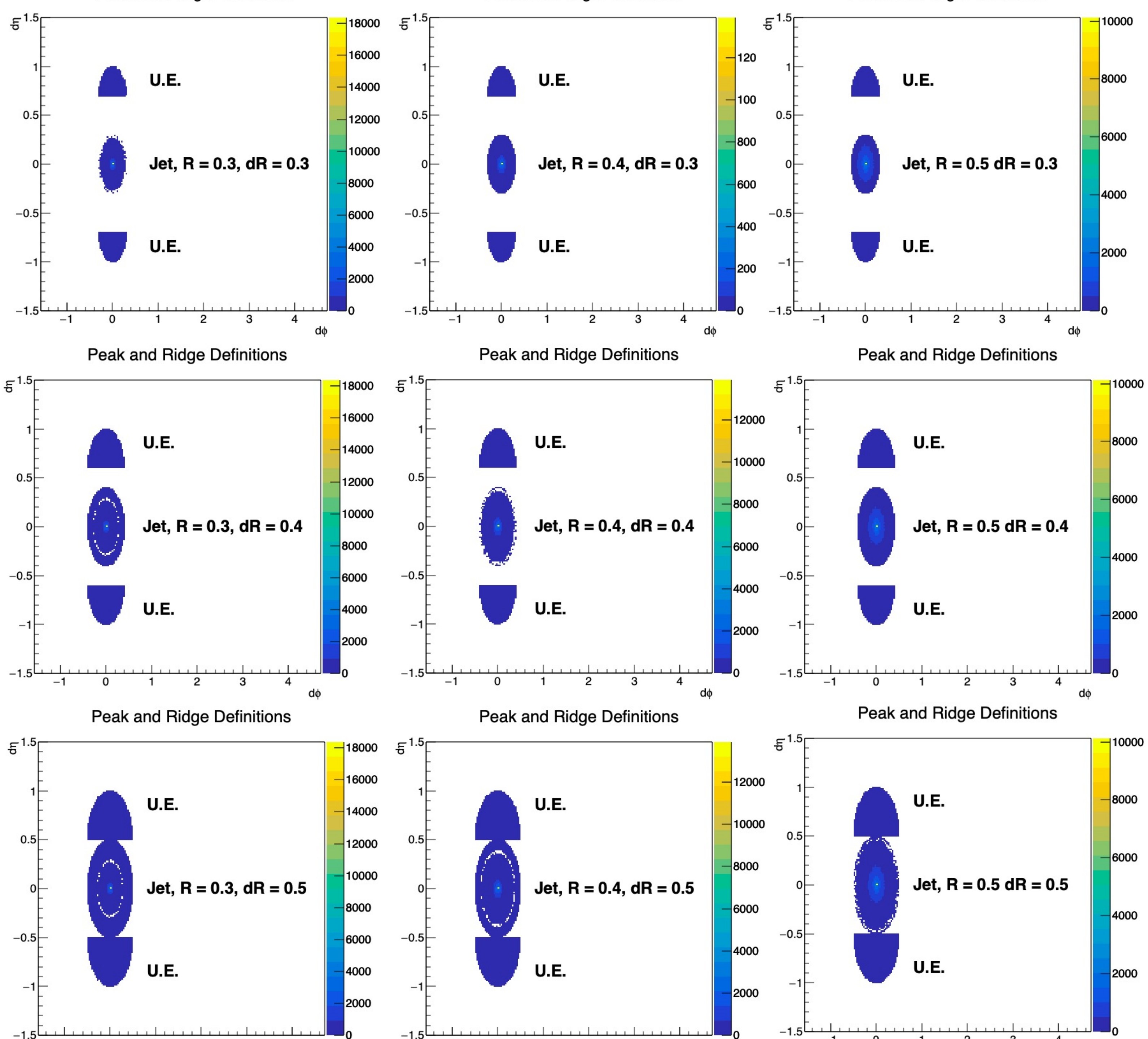
There are 2 distinct radial variables explored in this study:

- The Jet finder radius, R, employed in the anti-kt algorithm through fastjet
- The radius dR, used in subtraction to identify different portions of the jet region

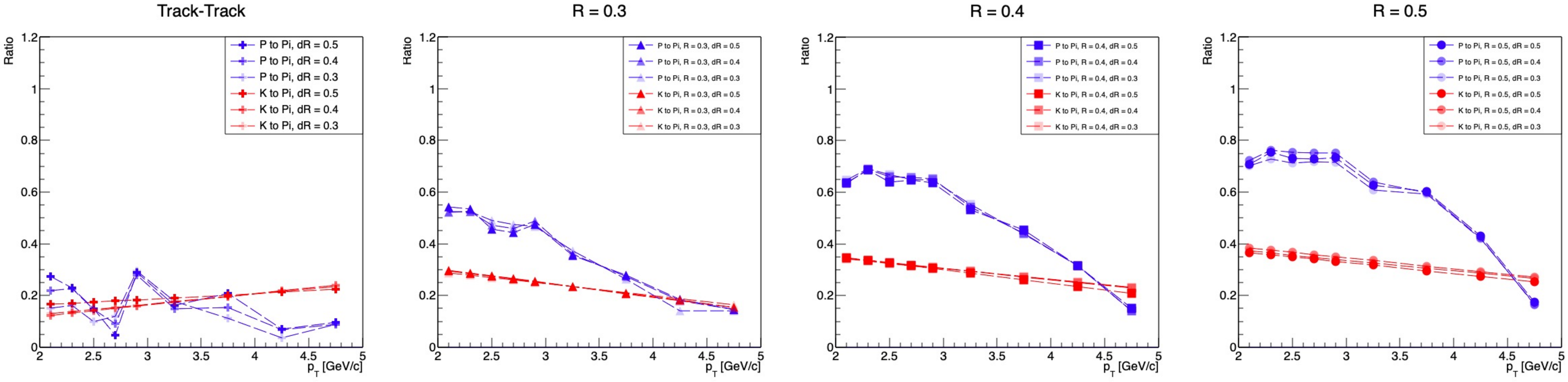
Both variables were given the values 0.3, 0.4, 0.5, and the study was run for all 9 combinations



All Combinations of R = 0.3, 0.4, 0.5 and dR = 0.3, 0.4, 0.5

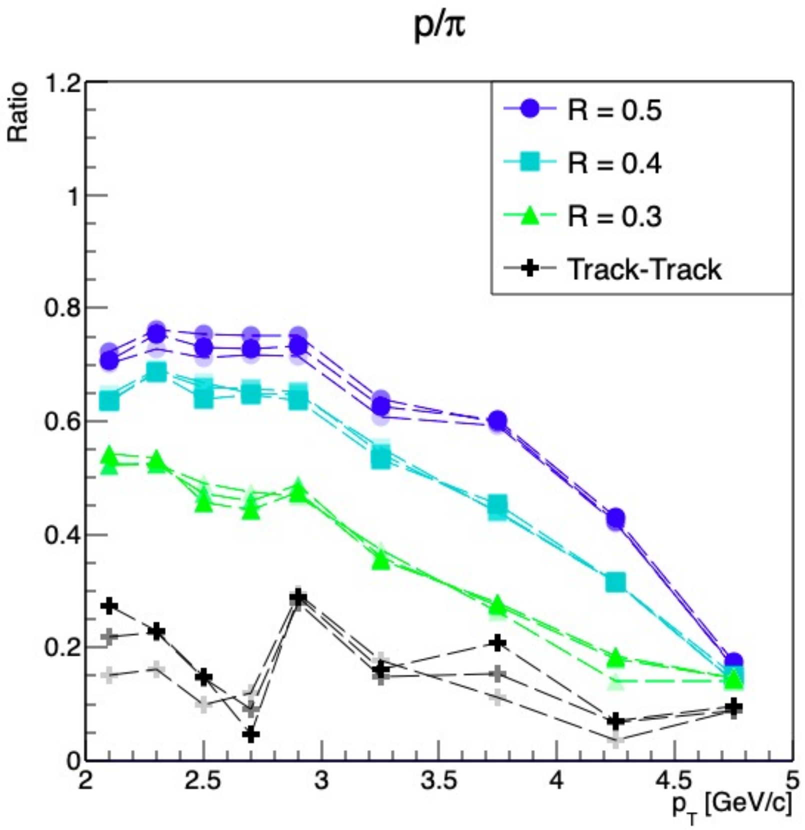


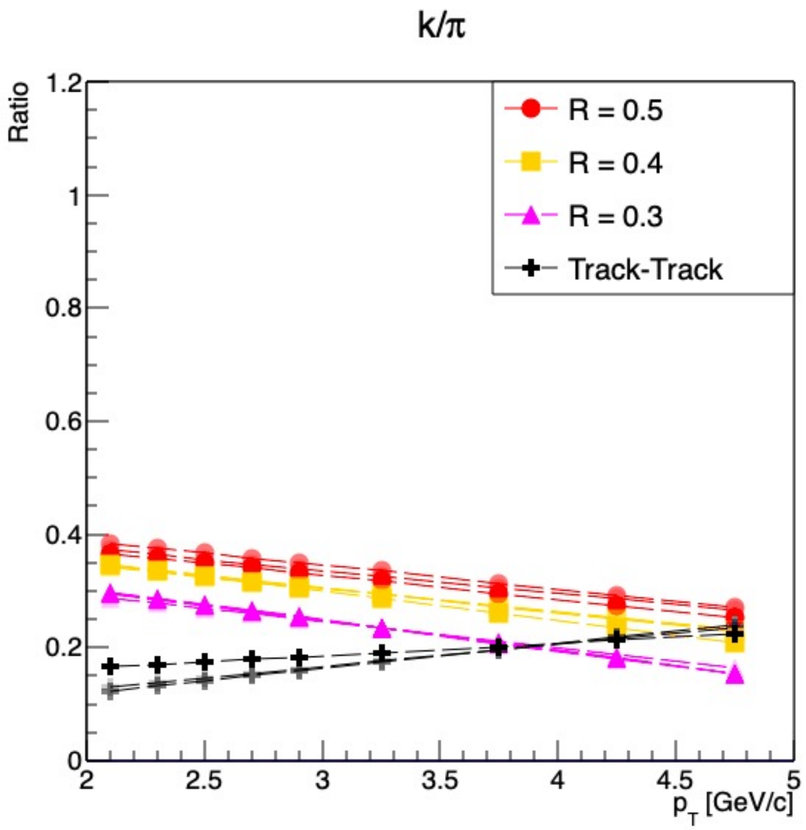
Preliminary Results



- The results show that PID has very little dependence on the area defined by dR, but shows a significant dependence on the jet finder radius R.
- A baseline measurement was also performed using a simple Track-Track correlation with no jetfinder, instead identifying jets using high pt particles above a threshold of 8 GeV
- Each of these jet selections posesss a similar average jet energy scale, as show in backup slides 31 and 32

Preliminary Results





Ongoing Work:

- Systematic uncertainty studies are in progress
- Extension to lower p_{T} Jet information is in progress
- PID for p+p 200 GeV run15 data is in progress
- We plan to try running this analysis on imbedded data sets to see if we can identify differences in jet content between different jet finder radius selections

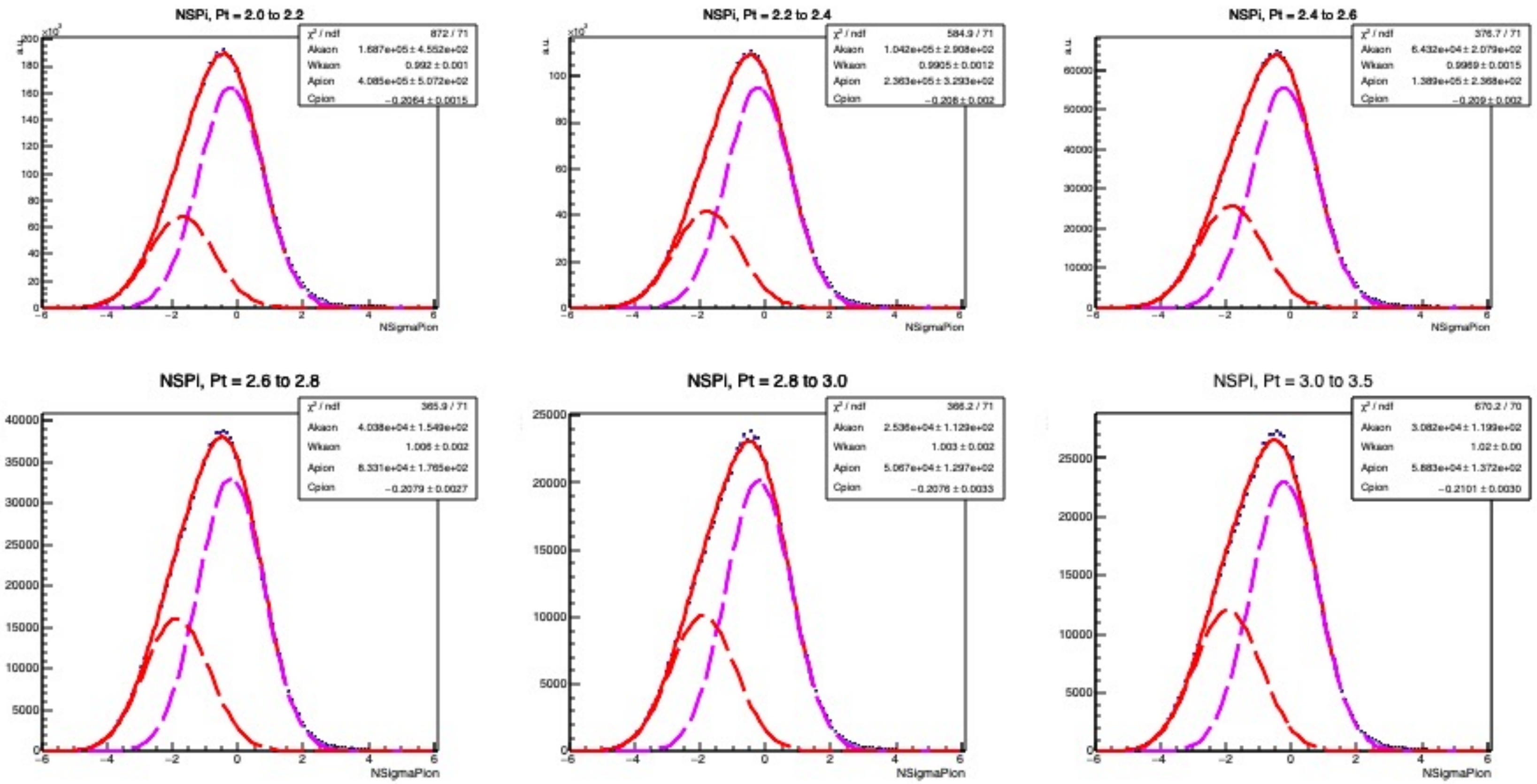
References

- Identified baryon and meson distributions at large transverse momenta from Au+Au collisions at √sNN = 200 GeV , arXiv:nucl-ex/0606003 [nucl-ex]
- Enhancement of baryon-to-meson ratios around jets as a signature of medium response, arXiv:2109.14314v1 [hep-ph] 29 Sep 2021
- Strangeness Enhancement in Cu+CU and Au+Au Collisions at √sNN = 200 GeV , arXiv:1107.2955 [nucl-ex]
- FastJet User Manual, arXiv:1111.6097 [hep-ph]
- Jet-Hadron Correlations in √sNN = 200 GeV p+p and Central Au+Au Collisions, arXiv:1302.6184v2 [nucl-ex]

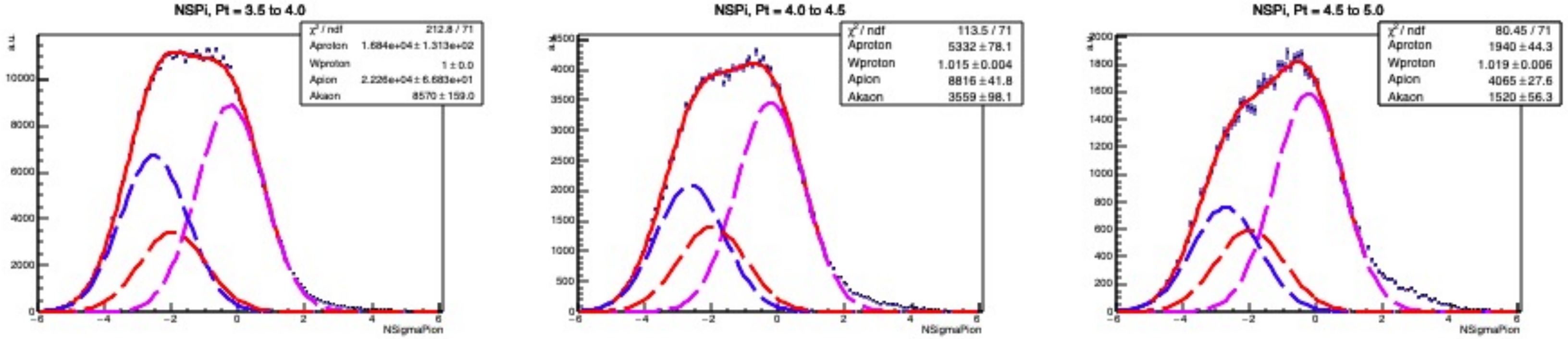
BACKUP

Double Fits for m^{2} < 0.5

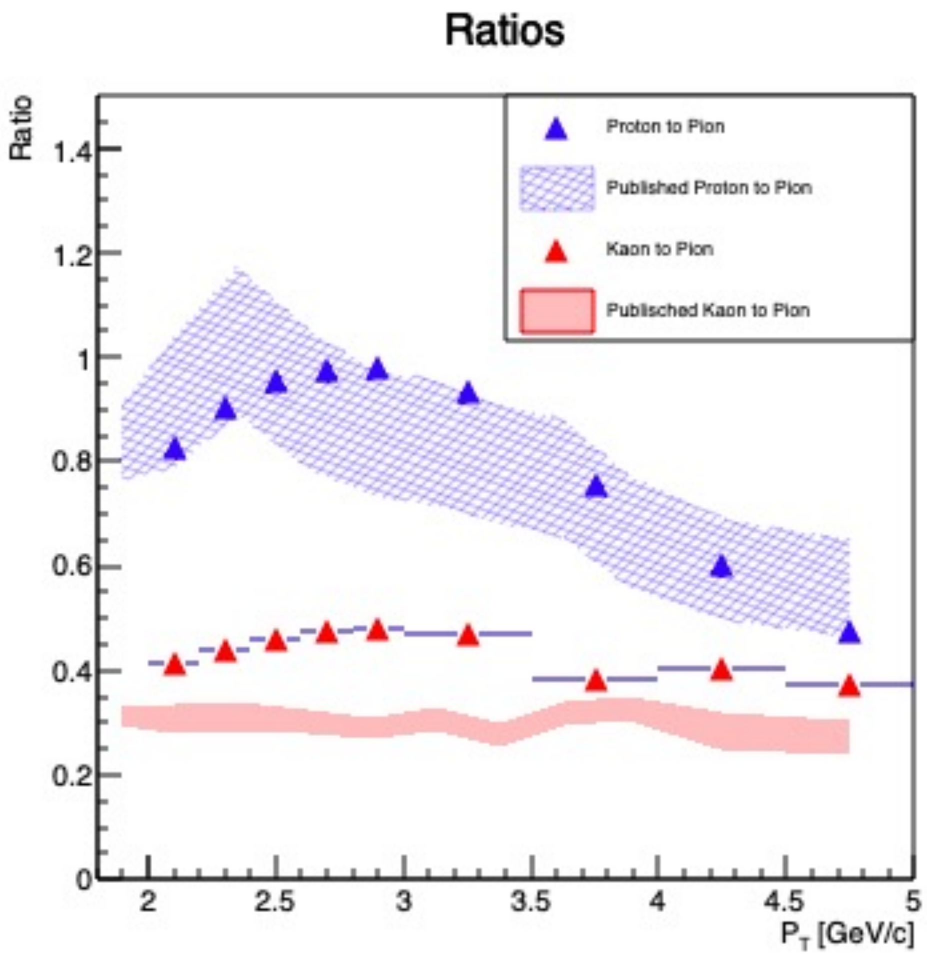
First
Pass
Inclusive
PID

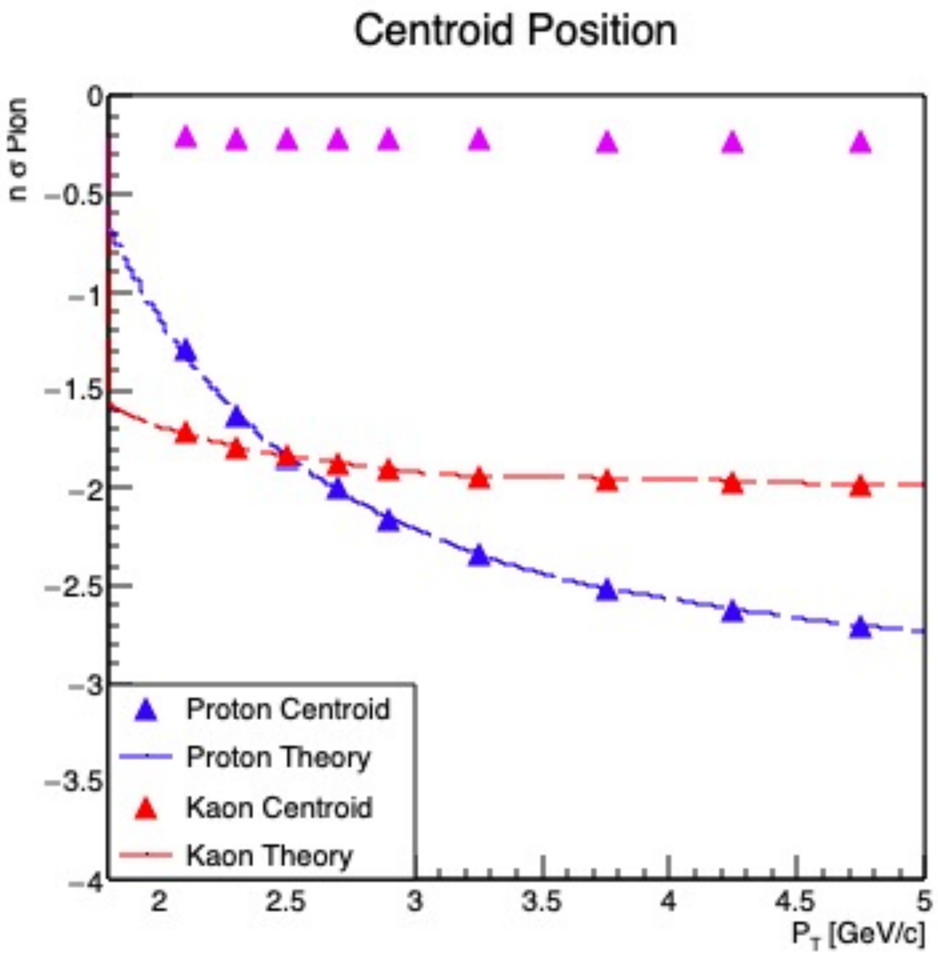


Triple Fits for full m^{2} Range

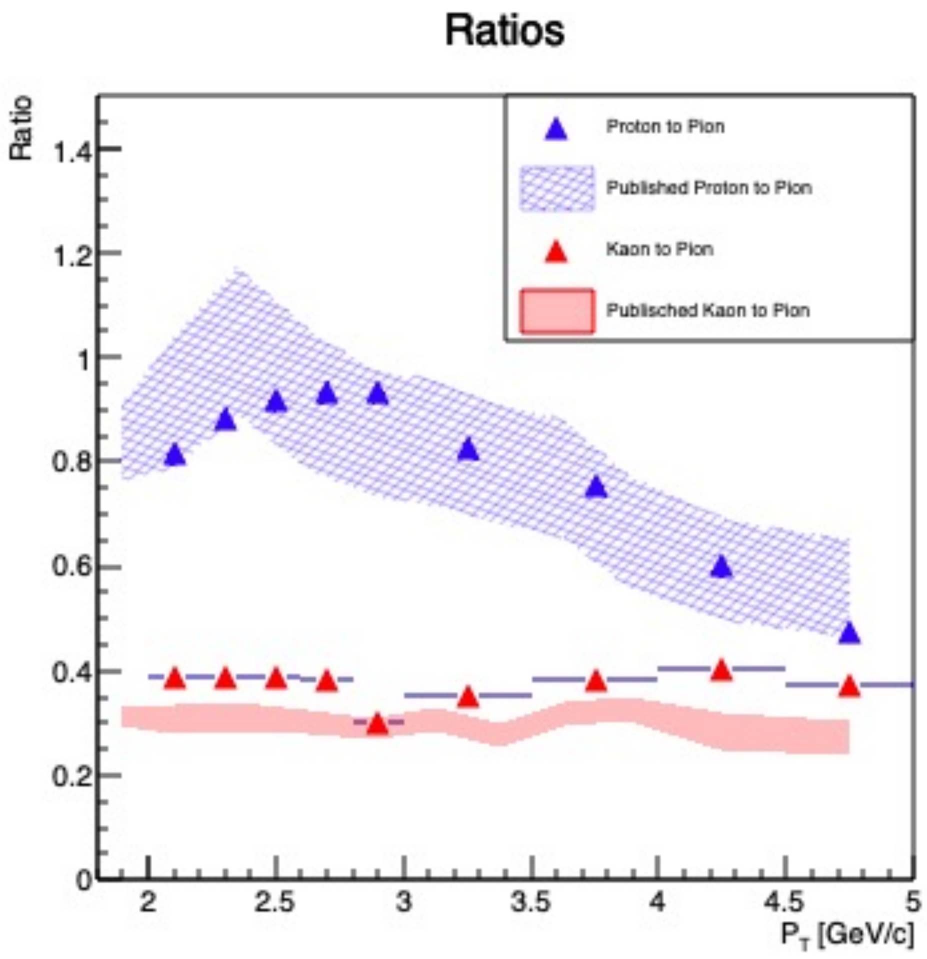


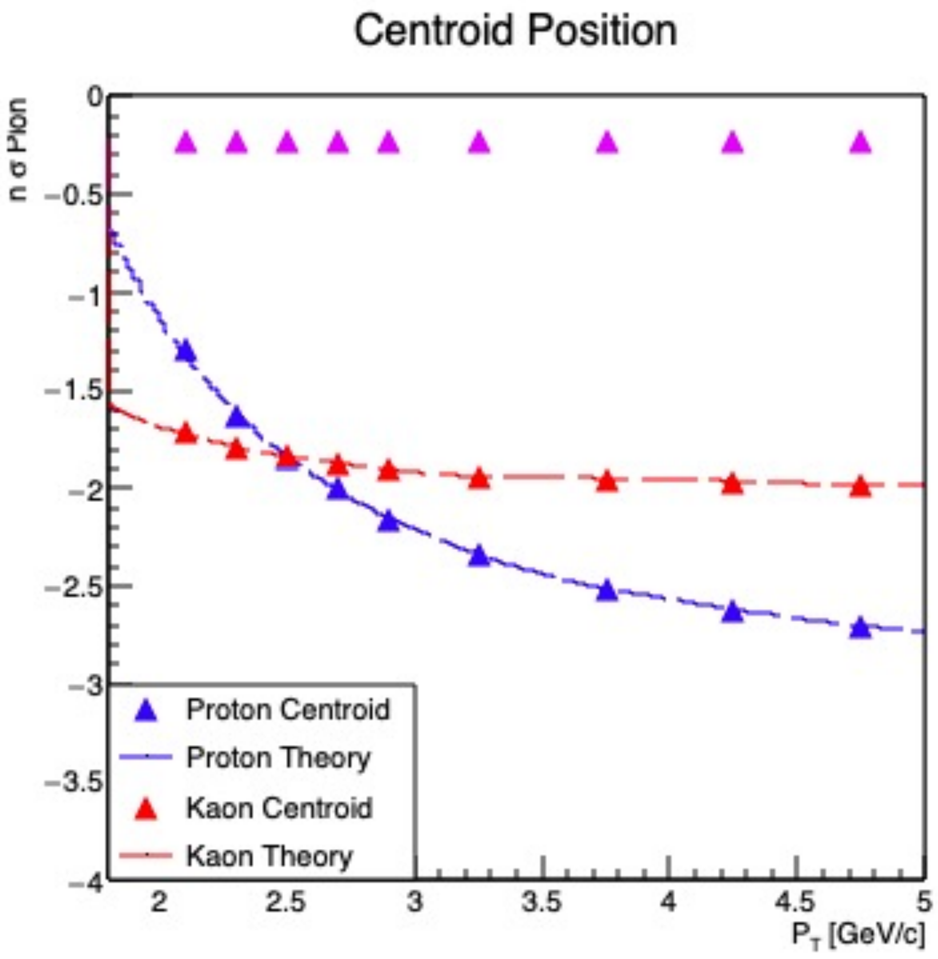
First Pass Inclusive



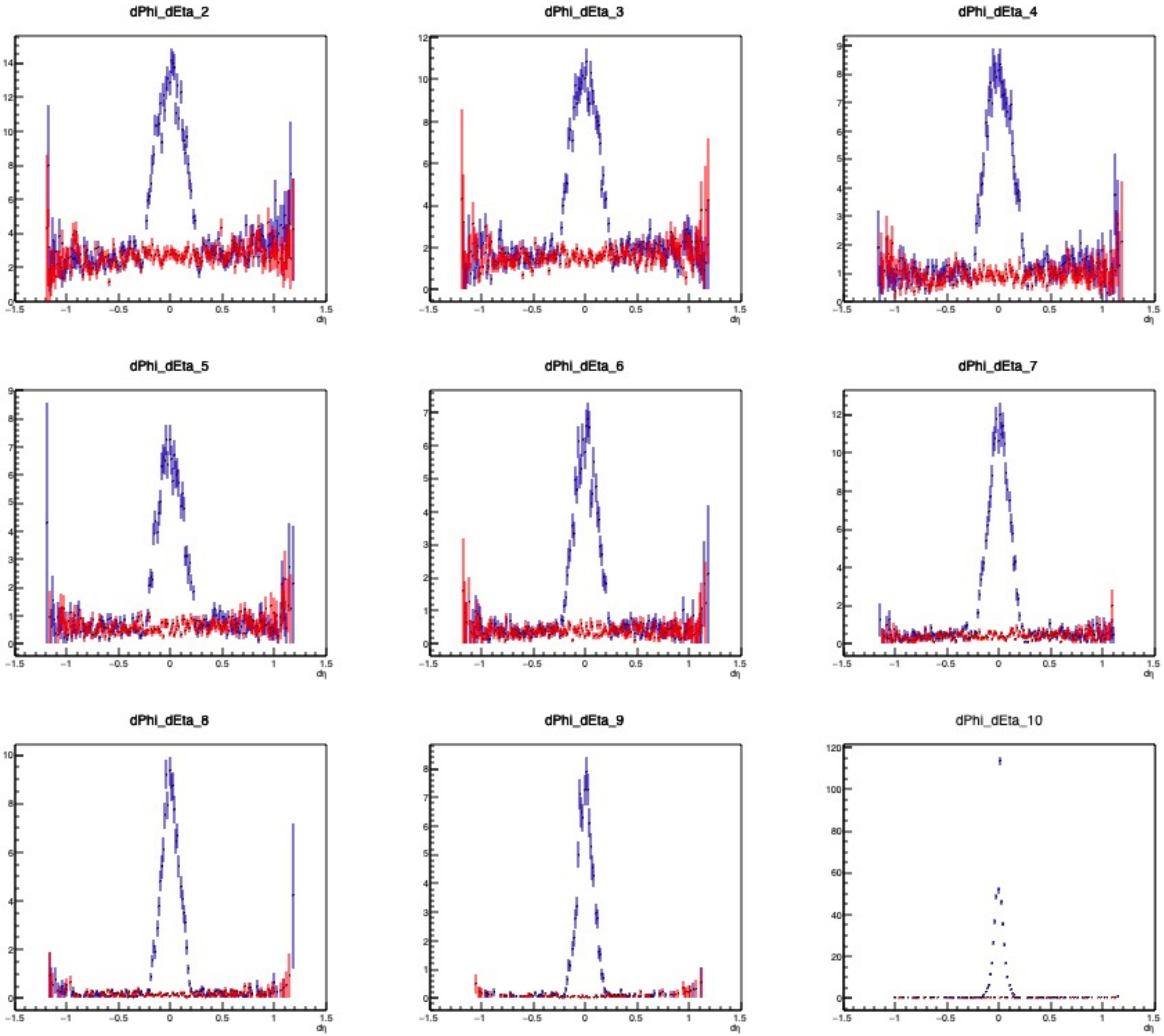


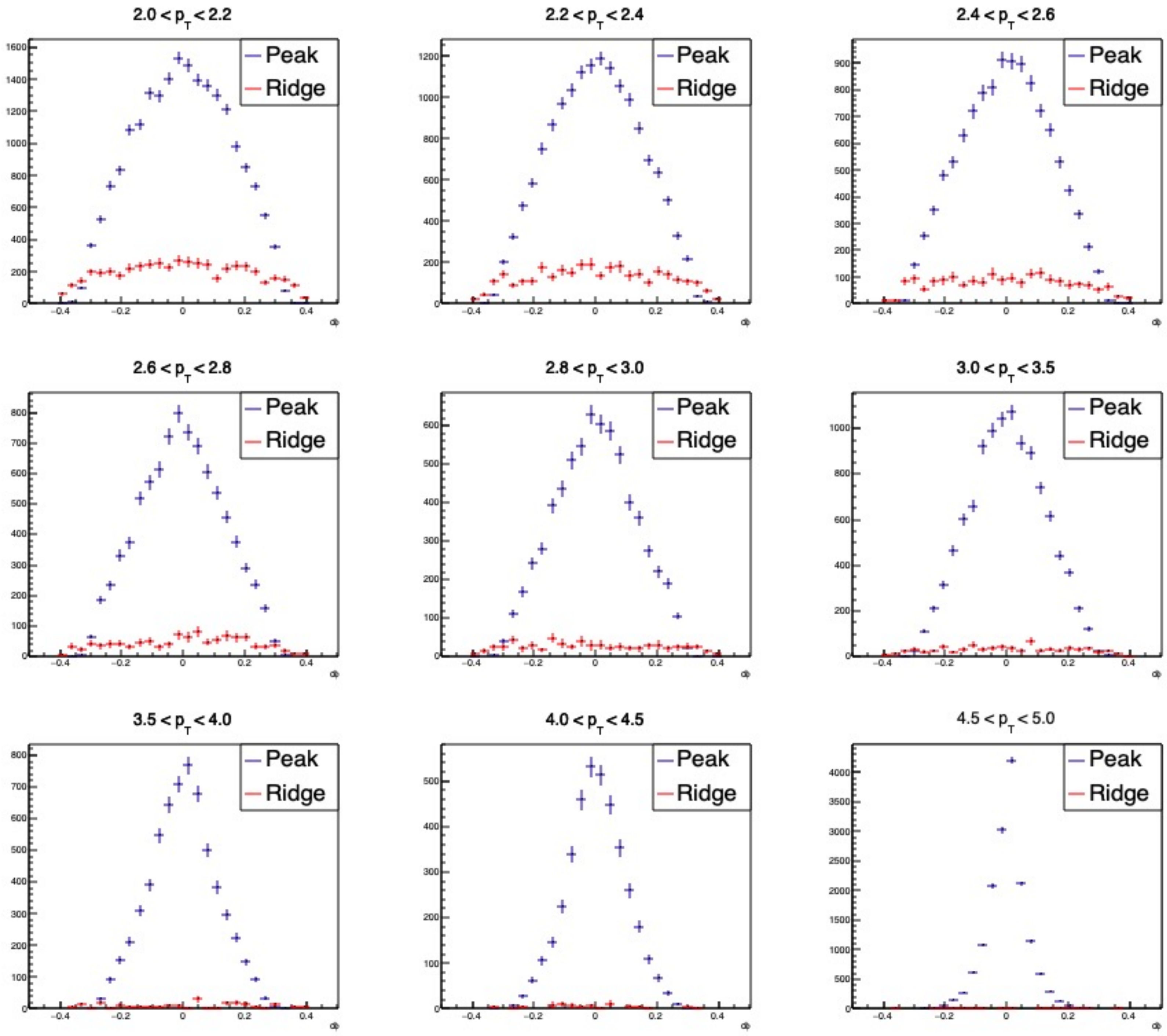
Second Pass Inclusive





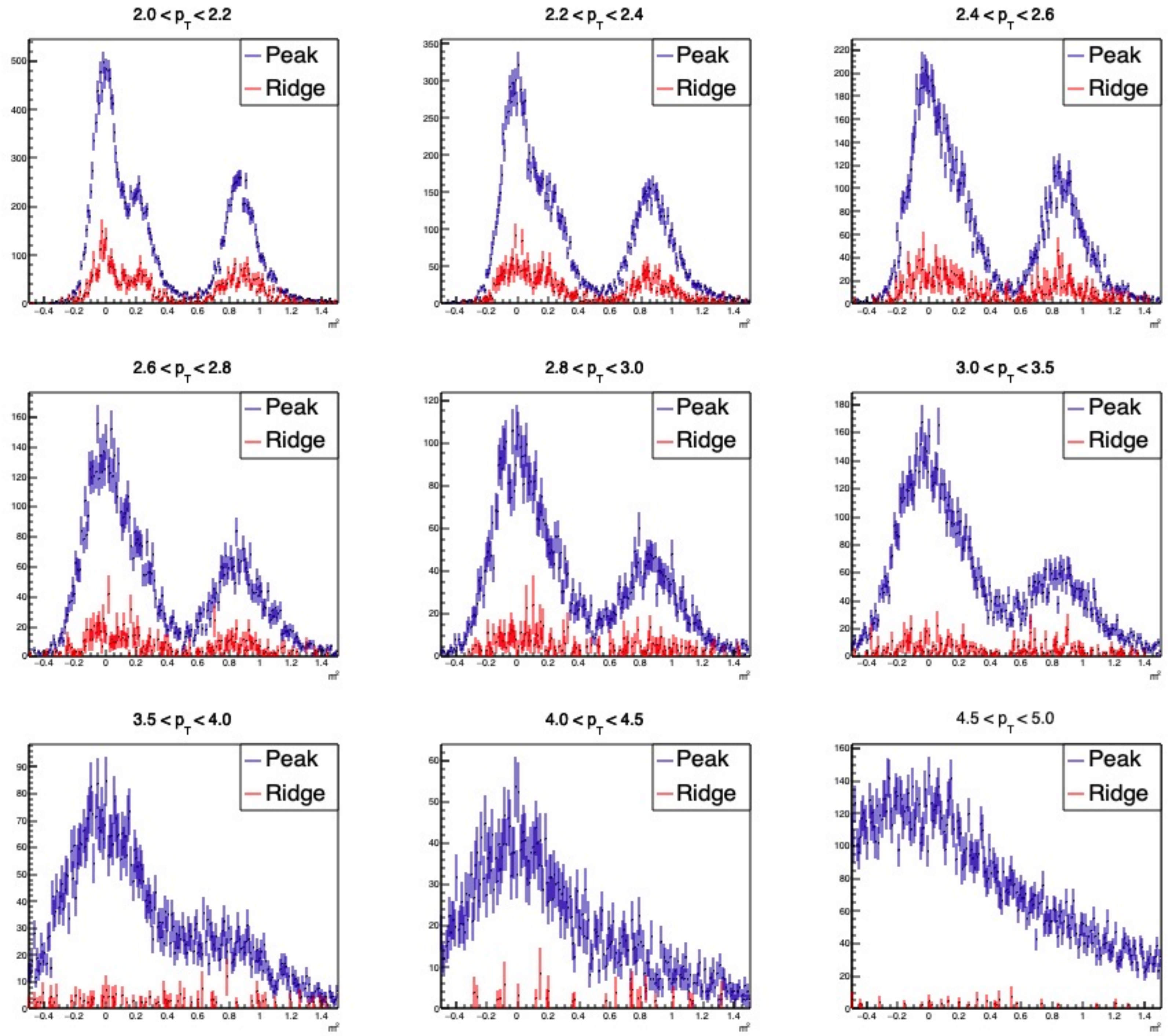
Sideband Overlays in dη
R = 0.3

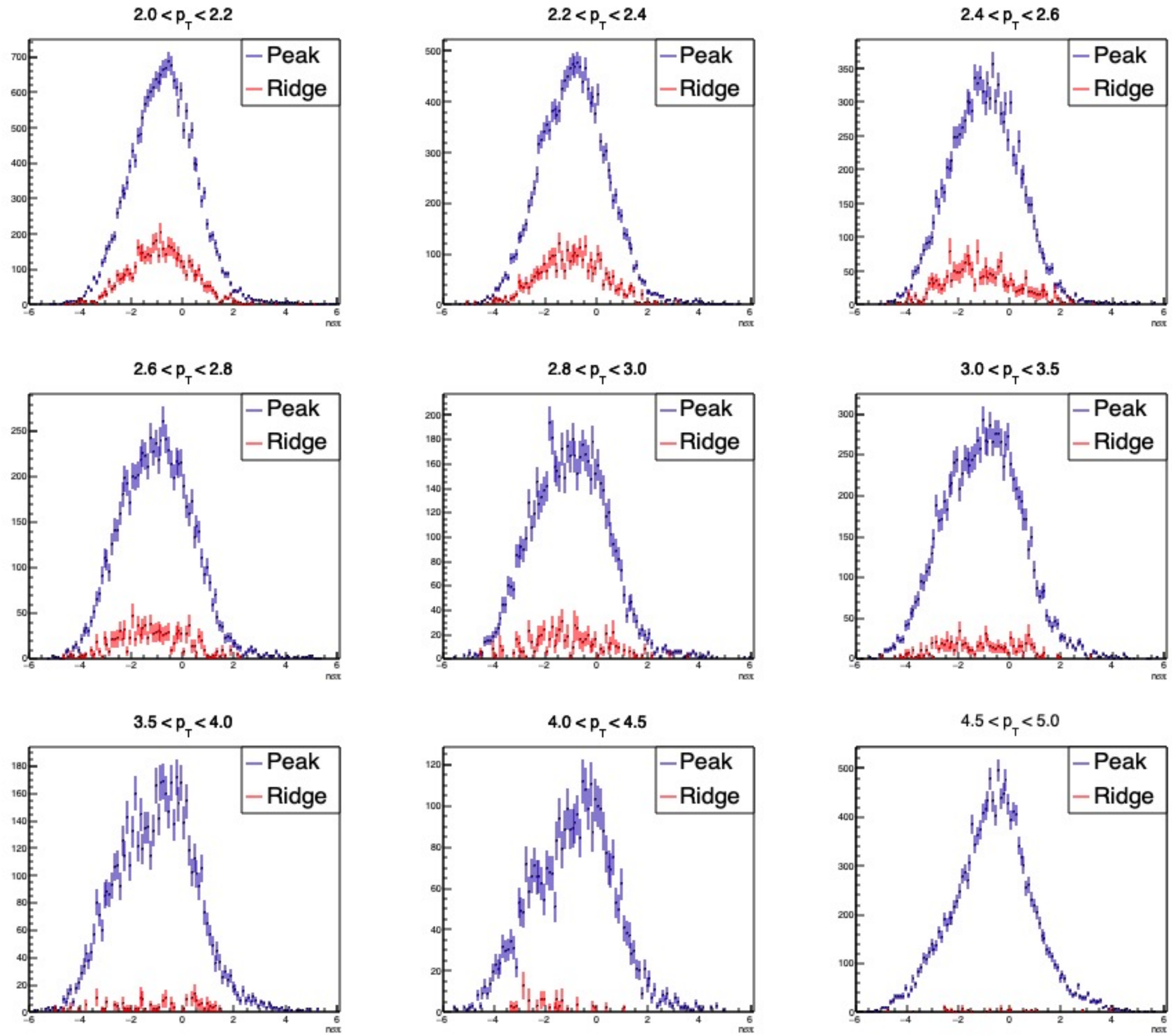




Example of dφ overlays, R = 0.4, dR = 0.4

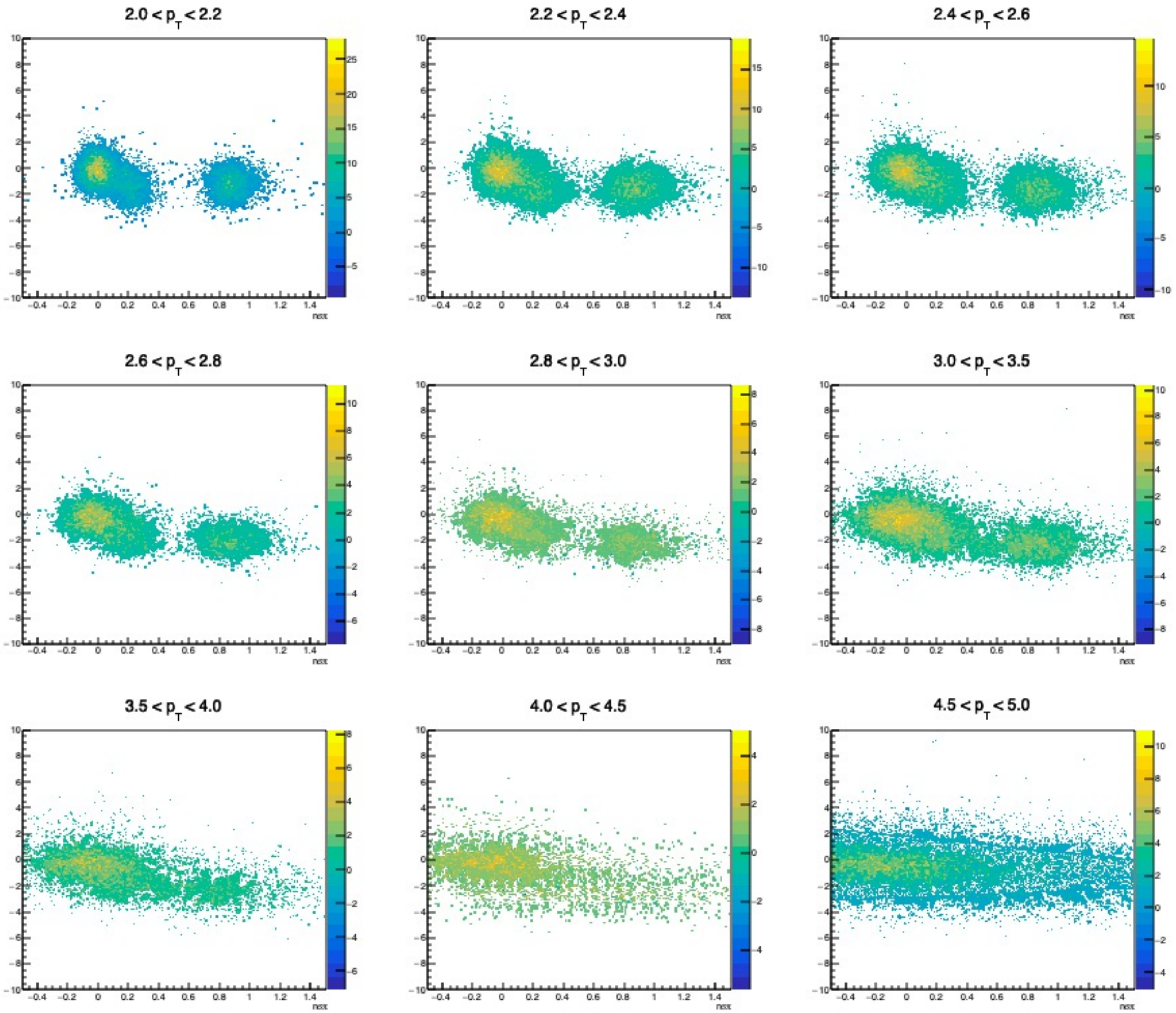
Example of mass squared overlays, R = 0.4, dR = 0.4



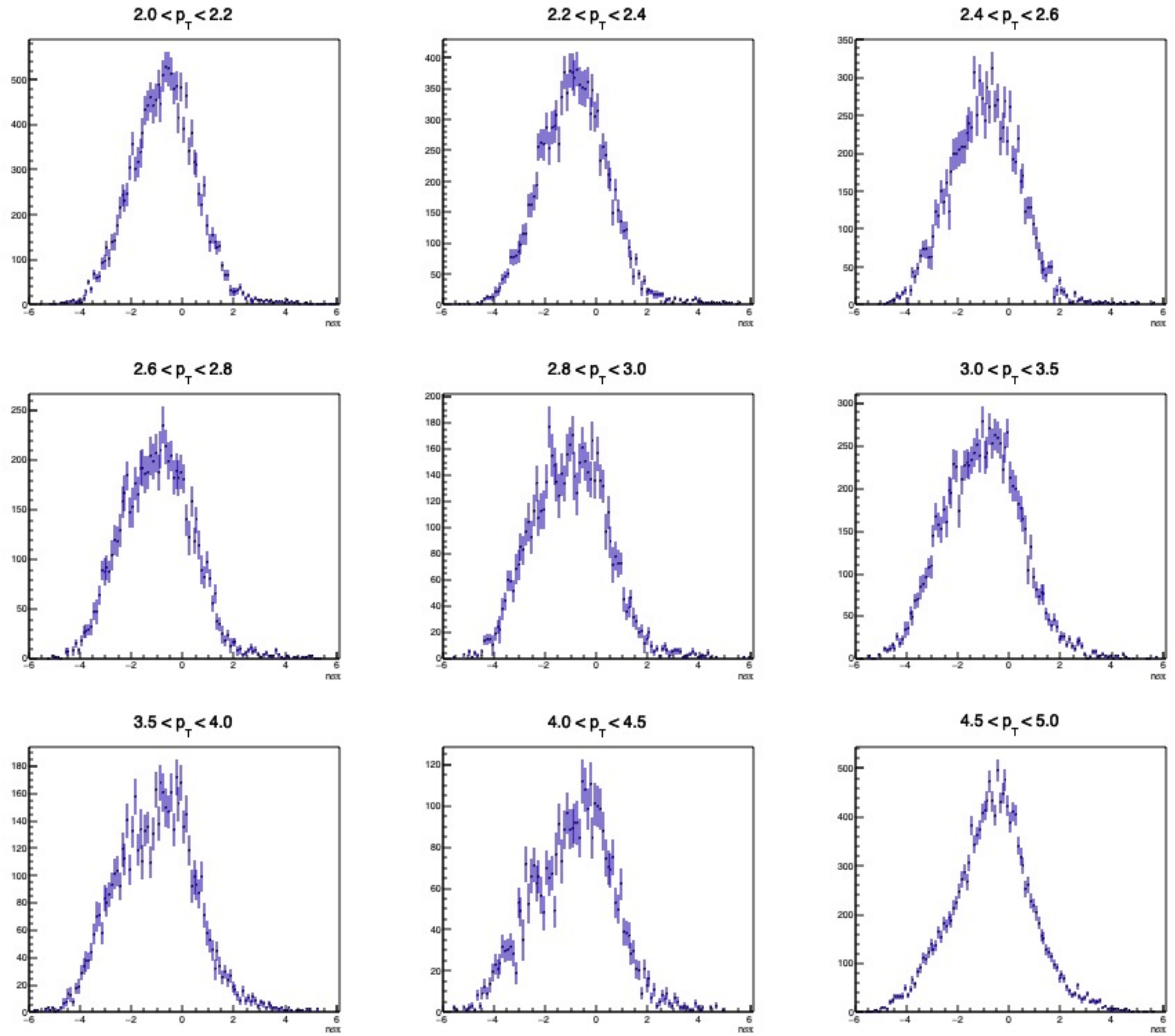


Example of nSigmaPion overlays, R = 0.4, dR = 0.4

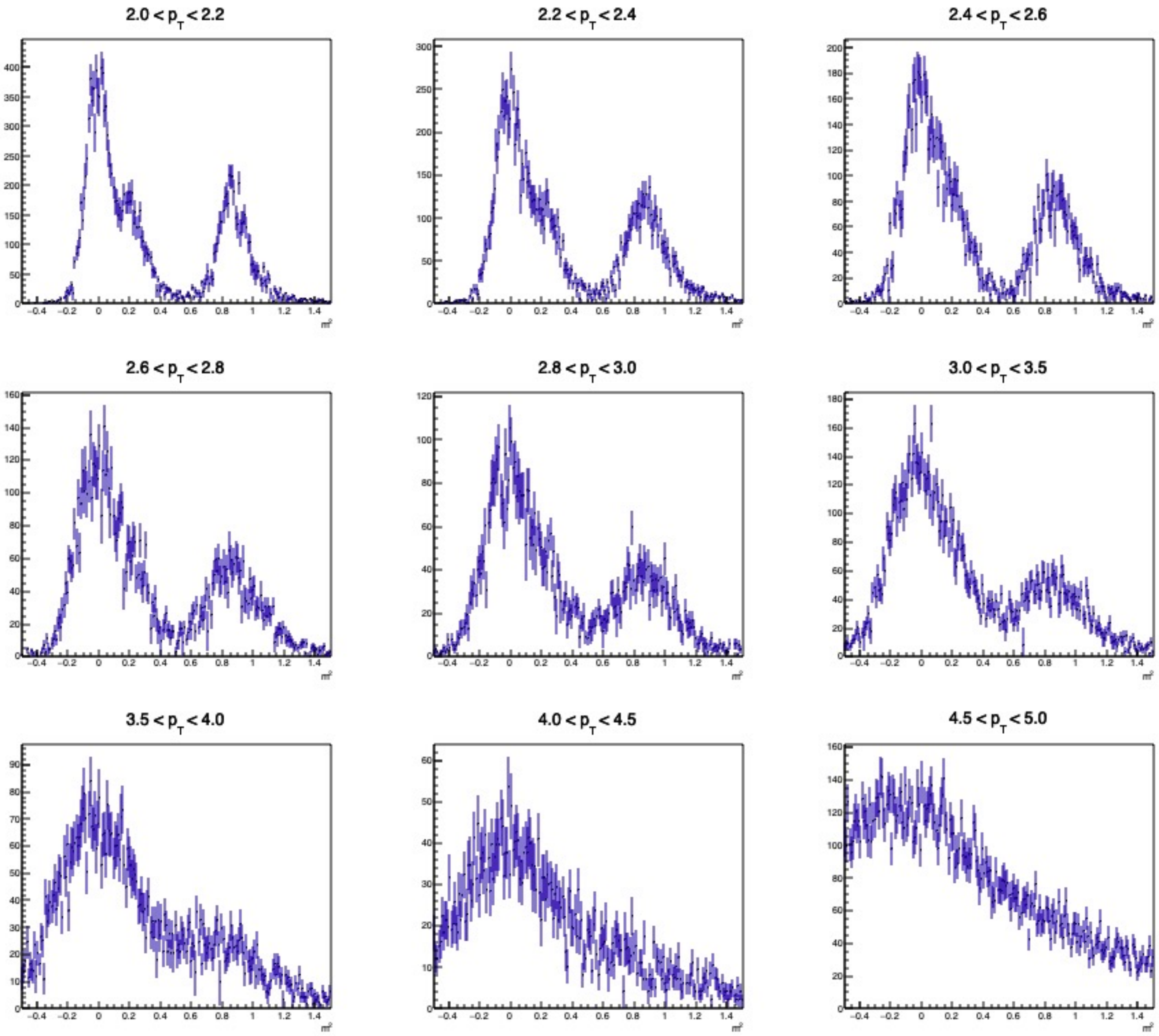
Example of 2D PID overlays, R = 0.4, dR = 0.4



Example of subtracted nSigmaPion distributions, R = 0.4, dR = 0.4

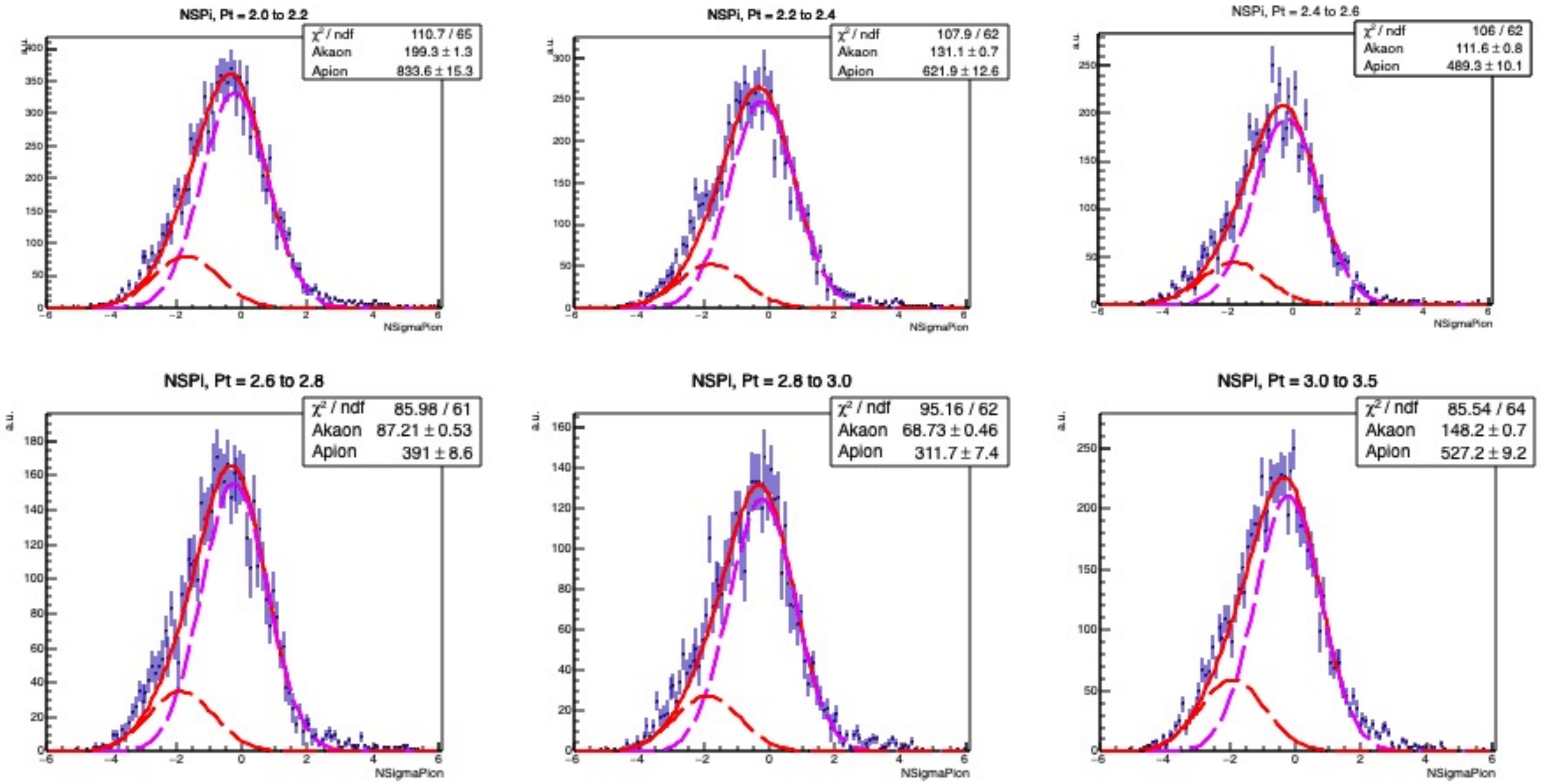


Example of subtracted mass squared distributions, R = 0.4, dR = 0.4

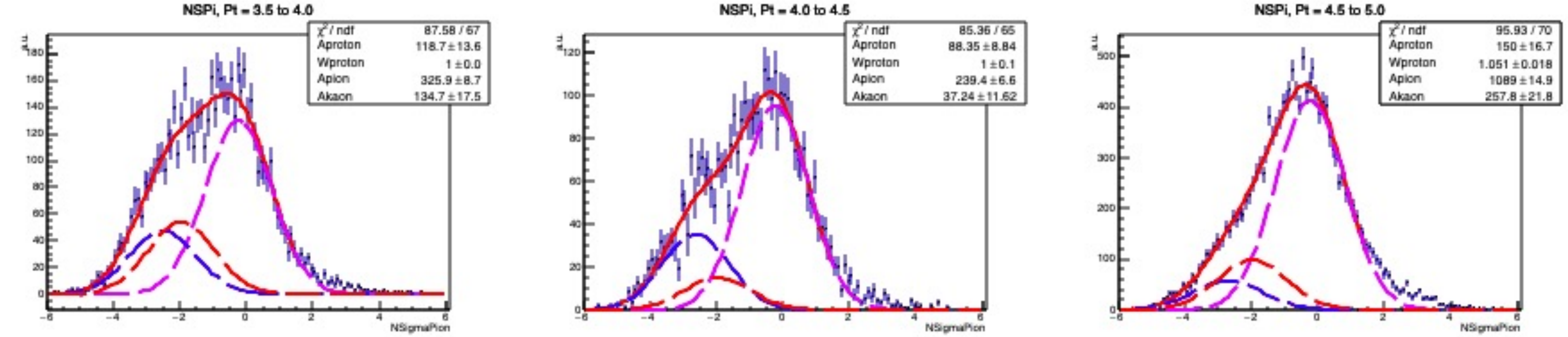


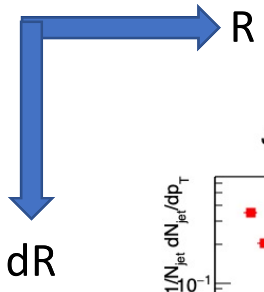
Double Fits for m^{2} < 0.5

PID fits for Signal
R = 0.4

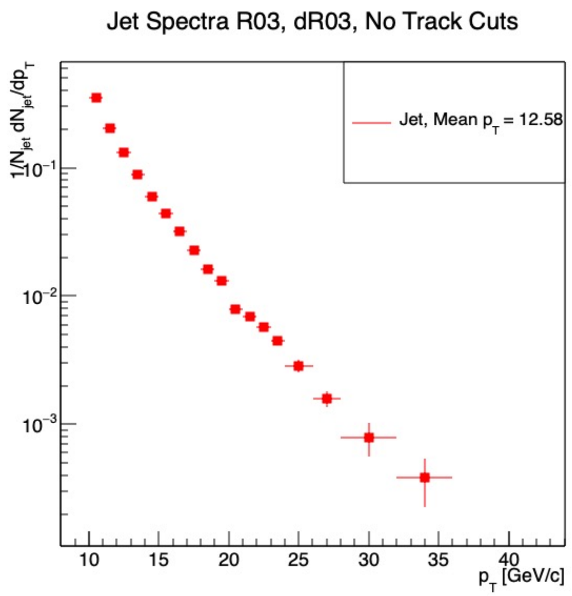


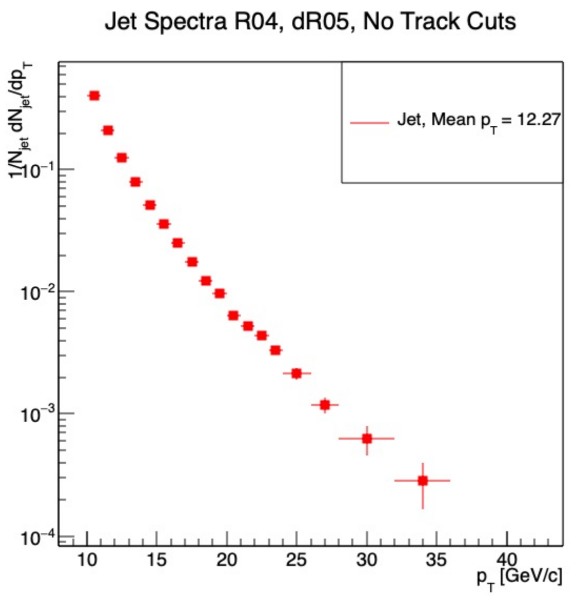
Triple Fits for full m^{2} Range

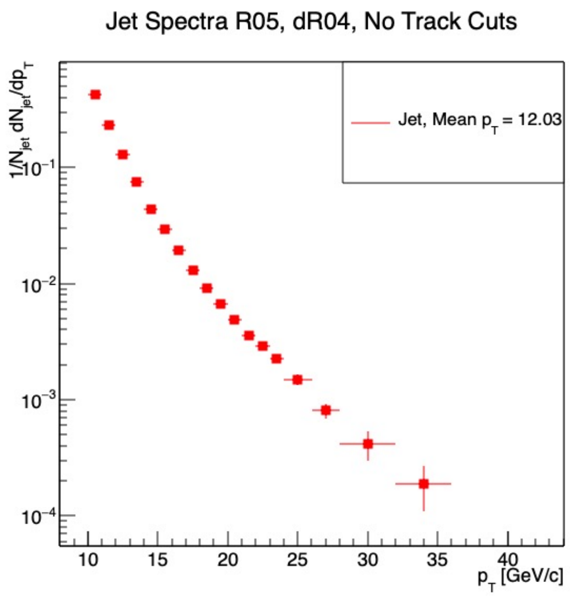




Jet Energy Consideration

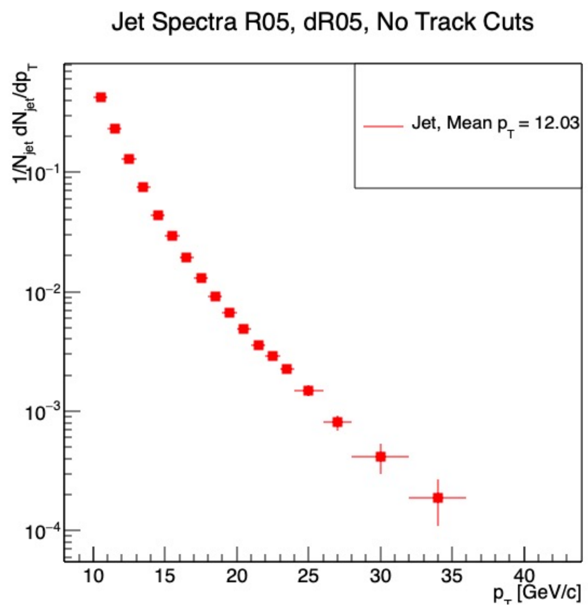


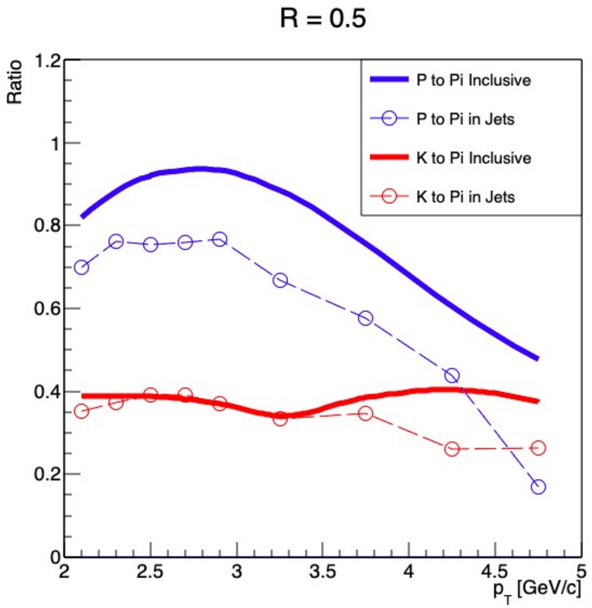




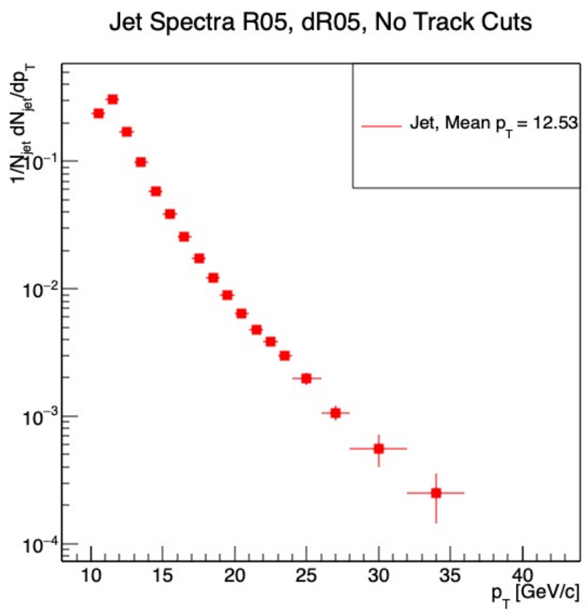
Energy	R03	R04	R05
Jet level	12.58	12.27	12.03
dR03	12.87	12.26	10.42
dR04	13.27	12.55	12.28
dR05	13.75	13.02	12.45

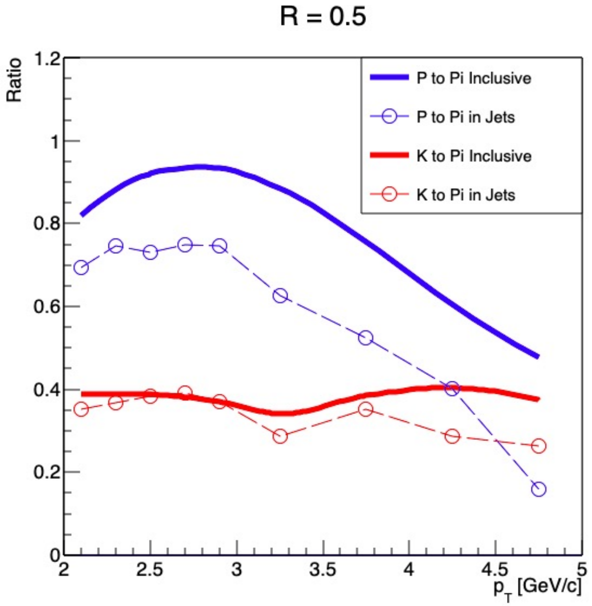
10.0 GeV cut



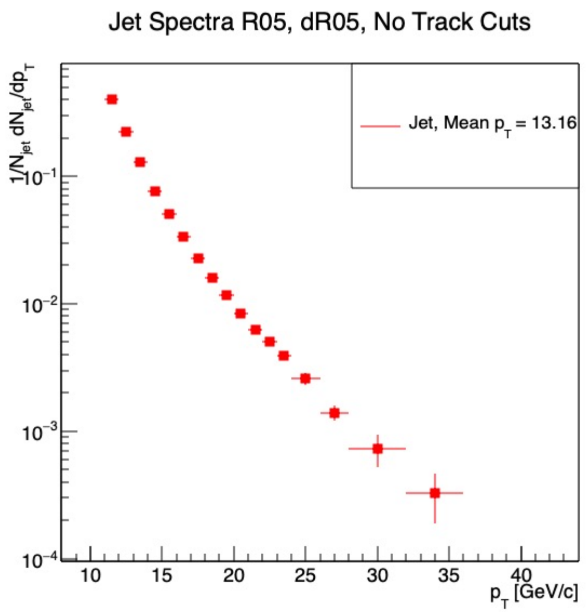


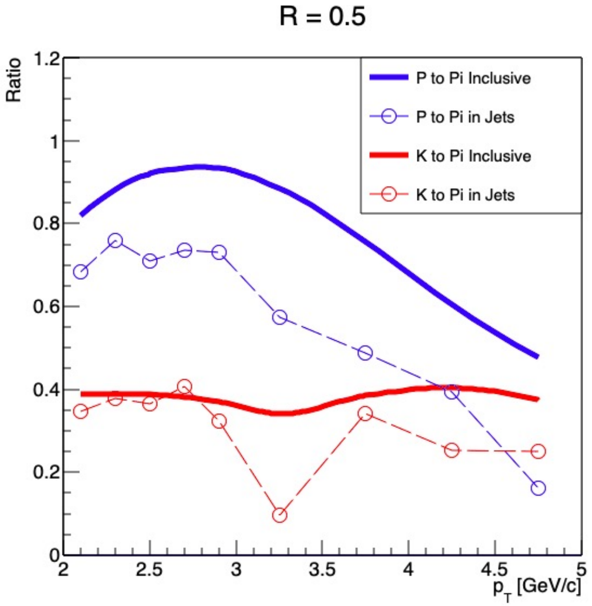
10.5 GeV cut

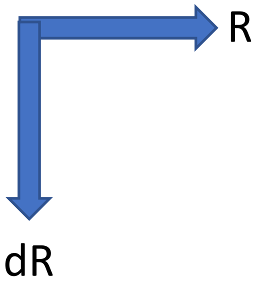




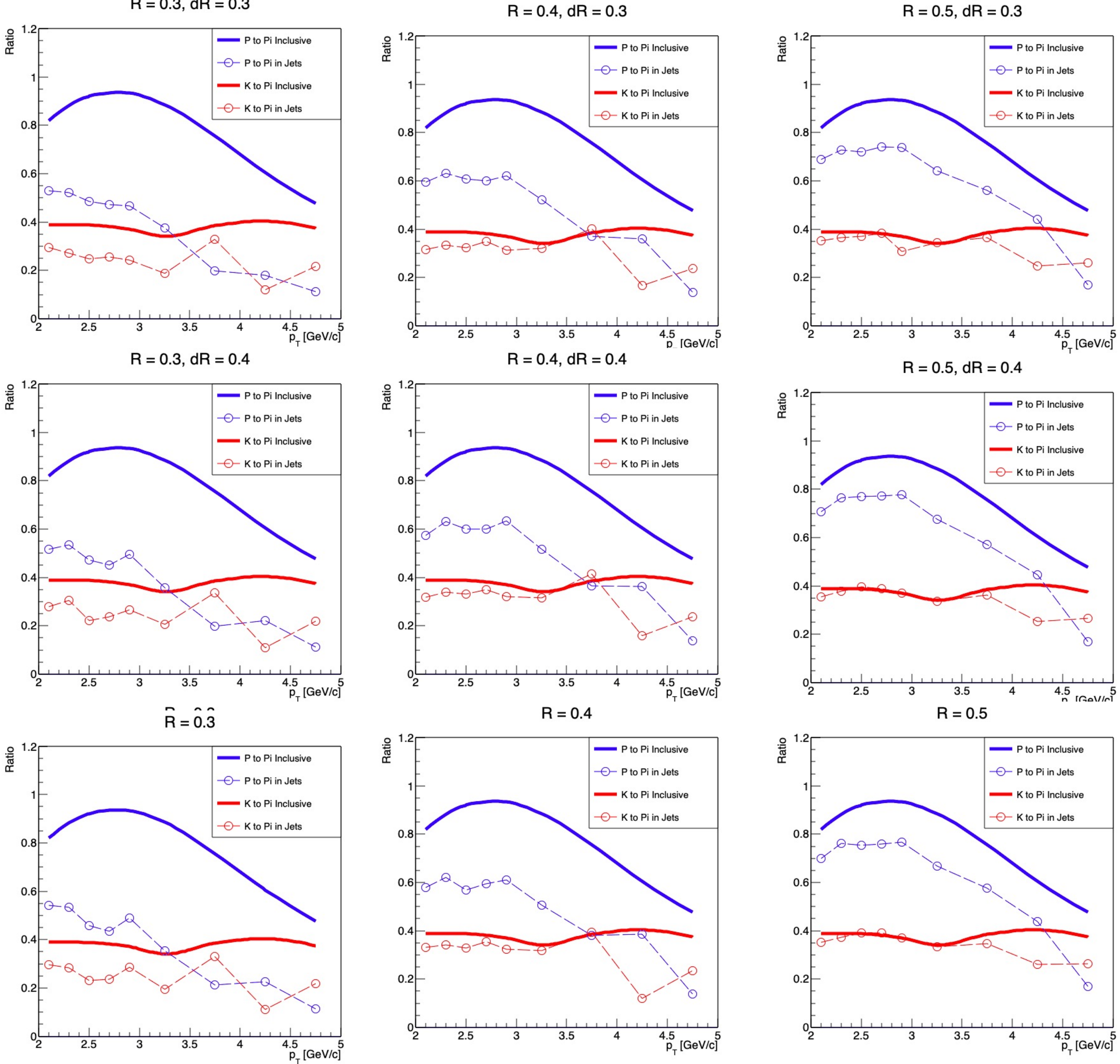
11.0 GeV cut

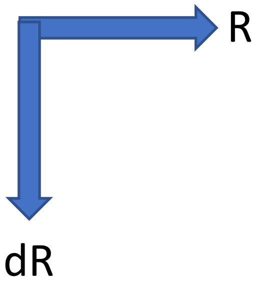






FIRST PASS
Radial Study PID





SECOND PASS
Radial Study PID