Preliminary Figures Request: Baryon to Meson Ratios in Jets from Au+Au and p+p colisions at 200 GeV

Gabriel Dale-Gau

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Contact Information:
PA name: Gabriel Dale-Gau
PA email address: gdaleg2@uic.edu
Supervisor email address:
evdolga@uic.edu

Data Set: Run 14 Au+Au sqrt{s_{NN}} = 200 GeV, Run 15 p+p sqrt{s_{NN}} = 200 GeV
Year: 2014, 2015
Production tag: AuAu: P18ih, pp: P16id
Triggers used: MB, HT2,HT3

Event Level Cuts:
0-20% Centrality
|vz| < 25
|vr| < 2.0
|vzz-vpd| < 3.0

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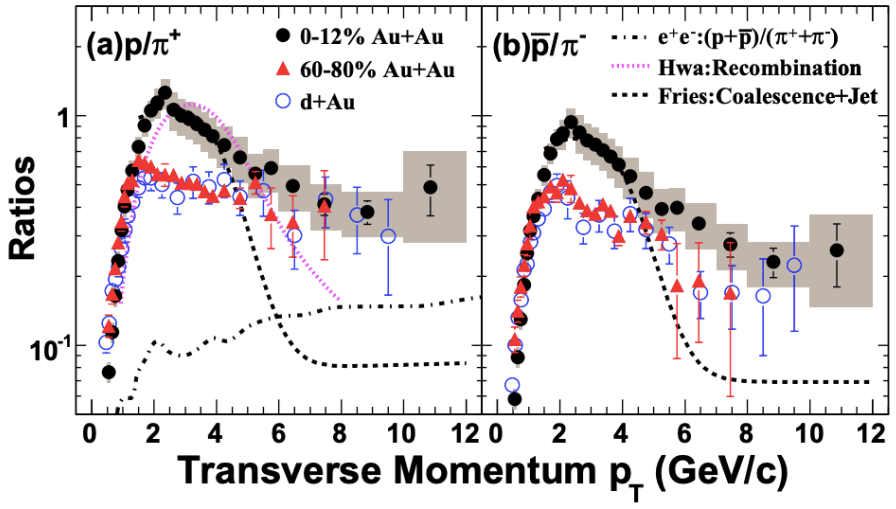
Motivation



[PRL97(2006)152301]

STAR

d+Au $\sqrt{s_{NN}} = 200$ GeV

Au+Au $\sqrt{s_{NN}} = 200$ GeV

$e^+ + e^-$ $\sqrt{s} = 91.2$ GeV

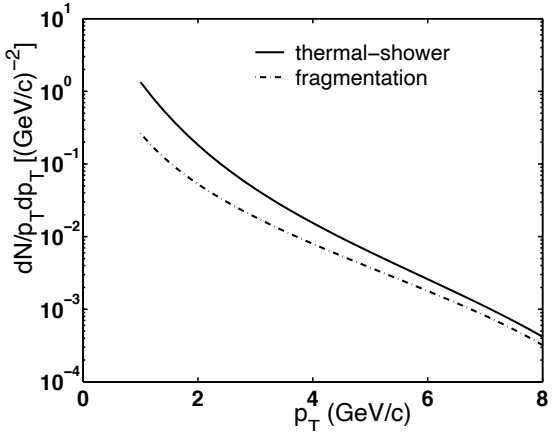
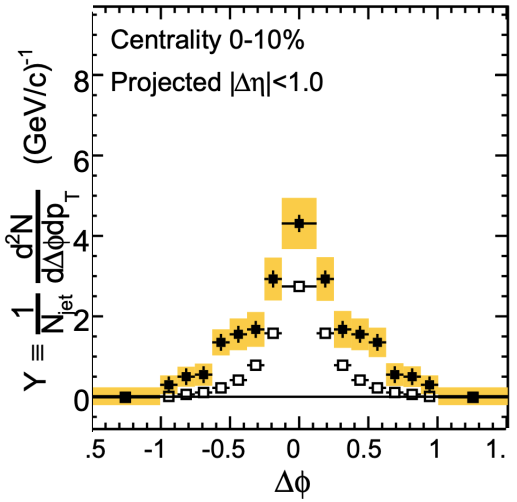


FIG. 4: Distributions of π^+ in p_T arising from thermal-shower recombination (solid line) and shower-shower recombination, i.e. fragmentation (dash-dot line).



[JHEP 11 (2016) 055]

CMS

Pb+Pb $\sqrt{s_{NN}} = 2.76$ TeV

p+p $\sqrt{s} = 2.76$ TeV

Jet $p_T > 120$ GeV/c

PbPb Leading Jets

pp Leading Jets

- Two prominent signatures of QGP:
  - Baryon enhancement
  - Jet quenching/Jet modification
- **Shower Parton Recombination** [PR(2004)0312271]
- AMPT simulations: baryon/meson is modified for jets in QGP [PLB(2022)137638]
- **Is jet fragmentation modified by QGP?**
- **How does QGP hadronize?**
- We measure **p/π in jets** using **jet-track correlations**

Quality Cuts

Jet Cuts:

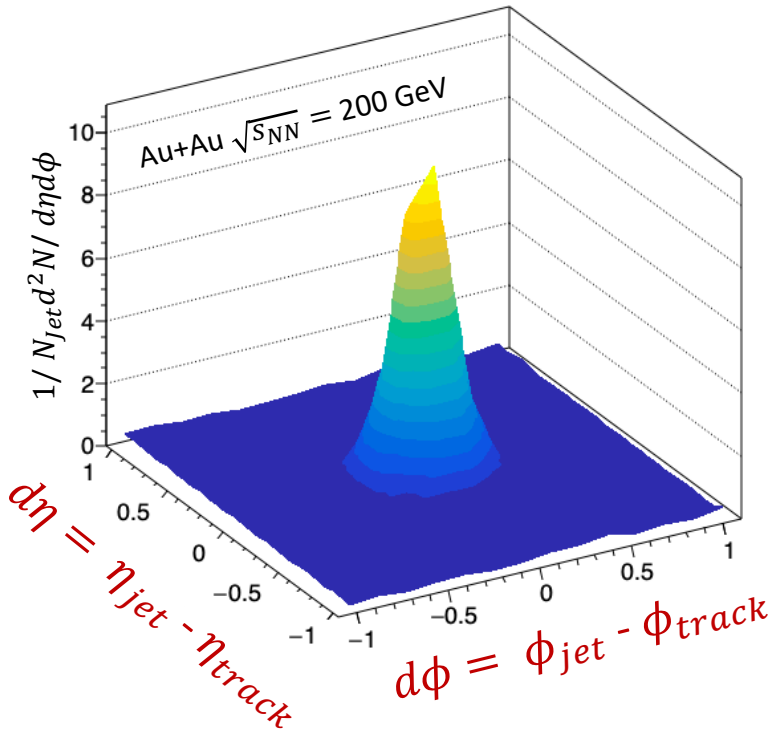
- $|\eta_{\mathrm{Jet}}| < 1.0 - R$
- Jet Radius R = 0.2, R = 0.3, R = 0.4
- Anti-k_{T} algorithm
- Inclusive Jets
- Jet $p_{\mathrm{T}} > 9$ GeV/c
- MB, HT2, HT3 data
- Constituent $p_{\mathrm{T}} > 2.0$ GeV/c

Track Cuts:

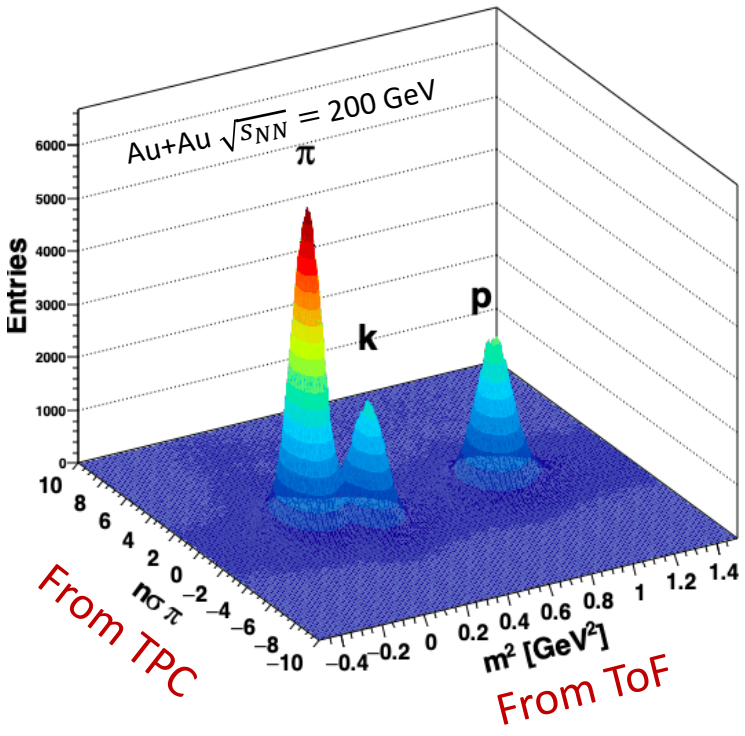
- nHits > 25
- $|\eta_{\mathrm{track}}| < 1.0$
- ToF matching cuts:
  $\beta > 0$
  $-0.5 < m^2 < 1.5$
- dE/dx matching cuts:
  $|n\sigma_{\pi}| < 10$
- $p_{\mathrm{T}} > 2.0$ GeV/c
- For jet-track correlation: $|\eta_{\mathrm{track}}| < 0.5$

Measurement Technique

2D jet-track correlation



Particle Identification



Fully reconstructed jets with tracks identified by **Time of Flight (ToF)** and **Time Projection Chamber** (**TPC**) information
=> **Particle Identification in jets**

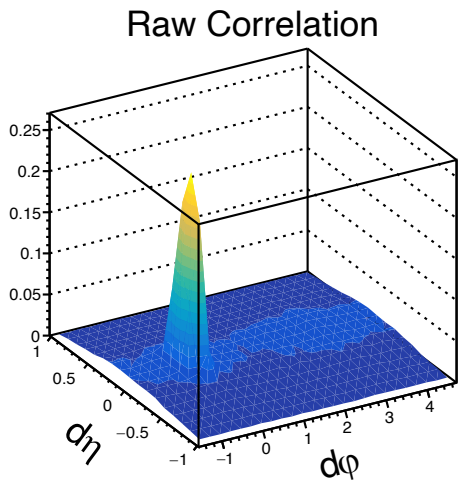
Data Samples

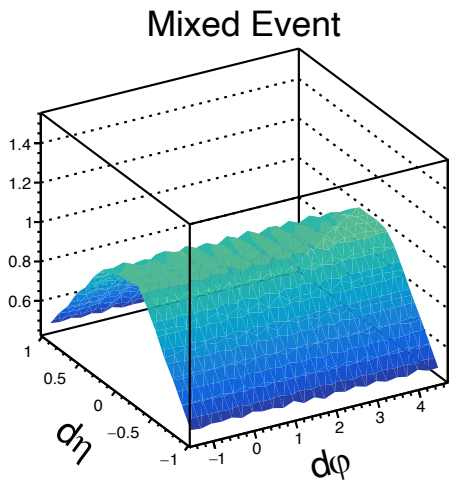
- p+p collisions at $\sqrt{s} = 200$ GeV (2015)
- 0-10% central Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV, (2014)

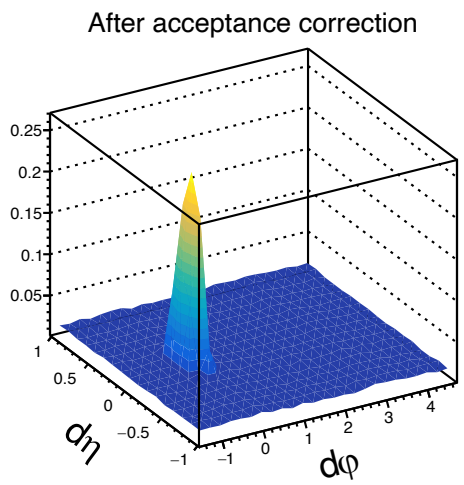
Jet Reconstruction

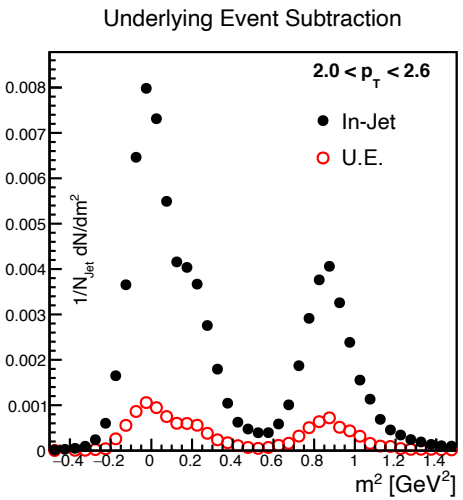
- **Anti- k_T**
- Jet R = 0.2, 0.3, 0.4
- Constituent selections
  - p_T^{const} > 2.0 GeV/c
  - p_T^{const} > 3.0 GeV/c
- **Jet p_T^{raw} > 9 GeV/c**
- **Inclusive Jets**

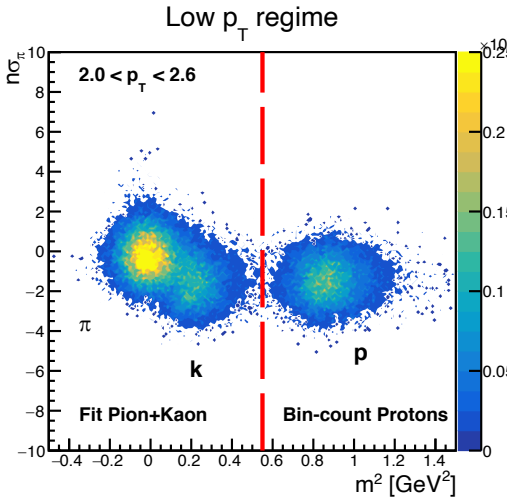
Analysis Overview

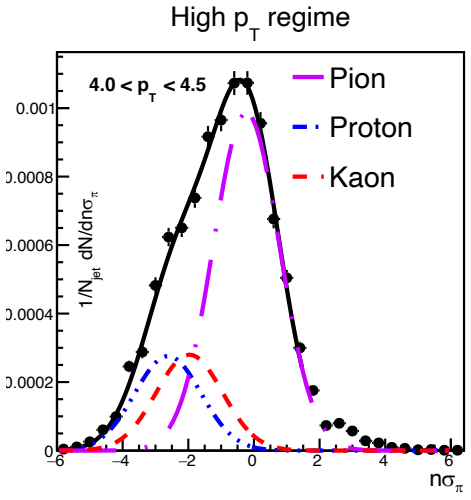








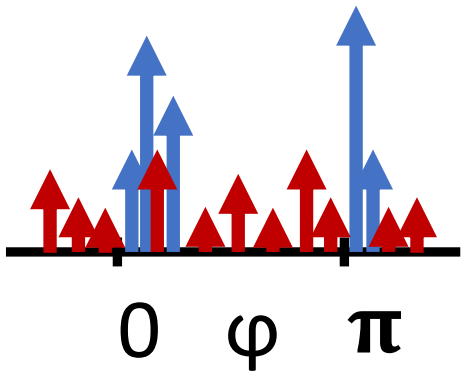




- Run Anti-k_{T} algorithm to identify Jet Axis
- Perform correlations with entire event
- Build Mixed event for pair acceptance correction
- Divide signal correlation by mixed event
- Select regions of equal area for jet and underlying event
- Subtract UE from Jet
- Identify Pion, Proton, Kaon yields from remaining Jet Signal
- Divide proton yield by pion yield to measure ratio

Correlated Background Removal: Embed into Mixed Constituent Event

p+p event
embedded in
Au+Au Mixed Event



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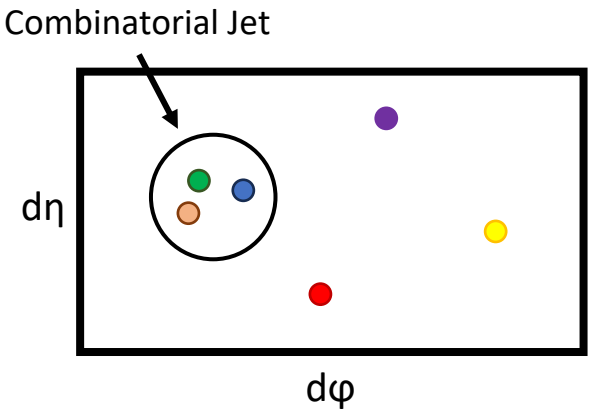


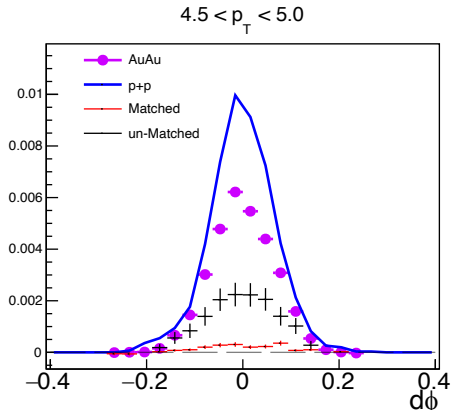
Procedure:

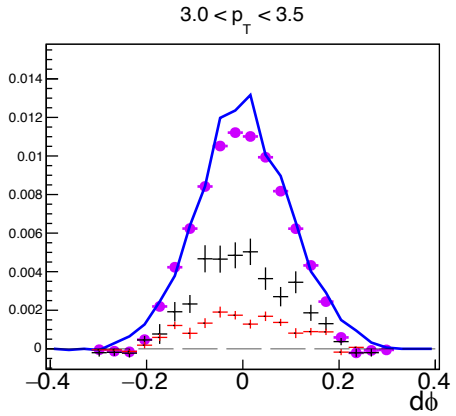
- Run Jetfinder on p+p event
- Create Mixed event by taking one track from different events until a reasonable nTrack value is reached
- Combine p+p event (with jet) and Mixed Event
- Run Jetfinder on resulting mixed event
- Perform correlations with mixed event

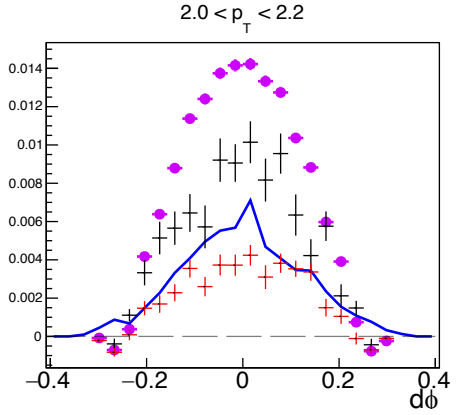
Pseudo-embedding → Matched Jets
Combinatorials → Unmatched jets

Fake Rate Determination:

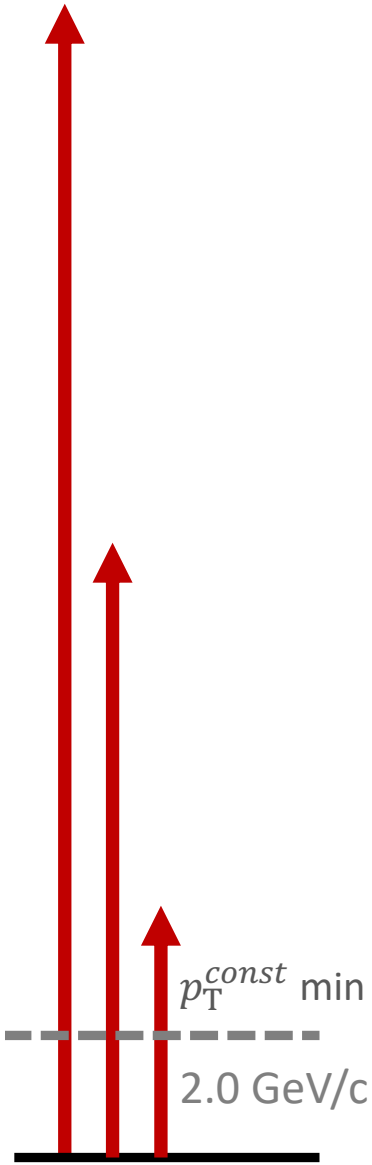
- Build Template fit using p+p and combinatorial jet spectra
- Fit to Au+Au Jet spectra
- Scale p+p and combinatorial n_{jet} values by fit parameters to determine fake rate





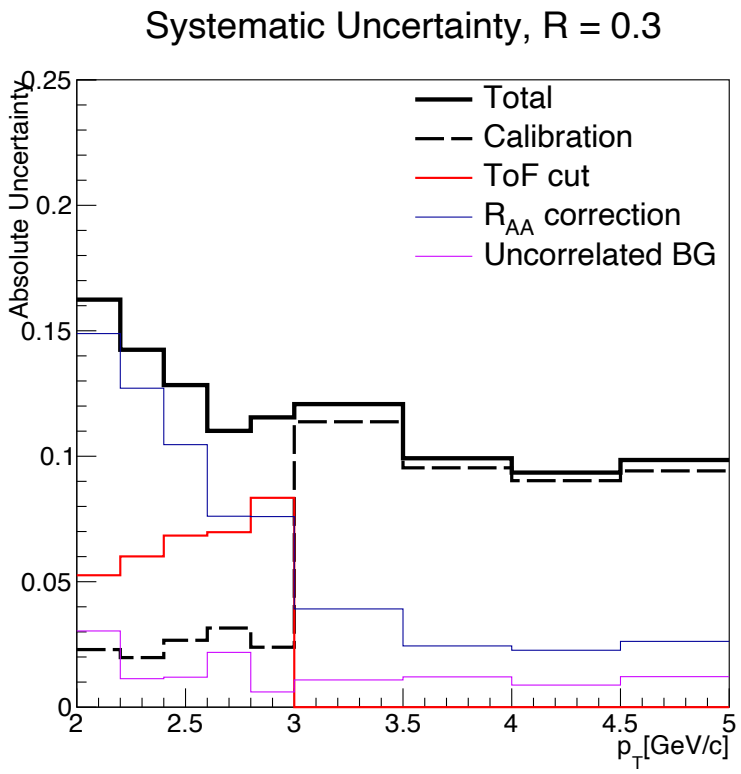


-- p+p
-- Au+Au
-- Matched
-- Unmatched

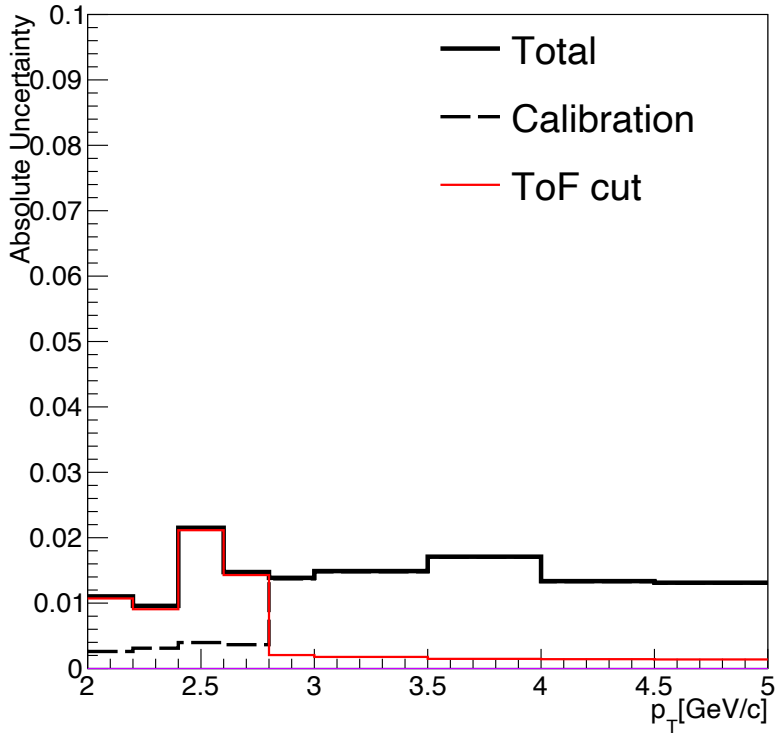


Systematic Uncertainty

Au+Au



p+p



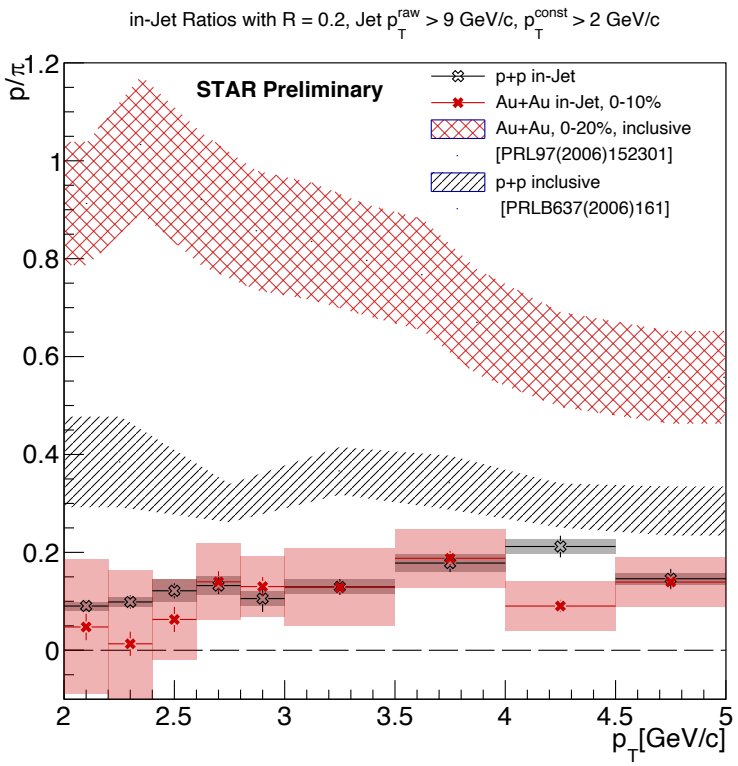
- One representative Jet R is shown here, all Systematics included in backup

Systematic Sources:

- dE/dx calibration, determined by varying each input parameter for gaussian fits
- ToF cut placement for proton identification below 3.0 GeV/*c*
- Uncorrelated background subtraction, determined by varying UE definition
- R_{AA} adjustment, determined by weighting spectra template fits with published STAR jet R_{AA}, and employing the extracted fake jet rate for correlated background subtraction

Results

R = 0.2



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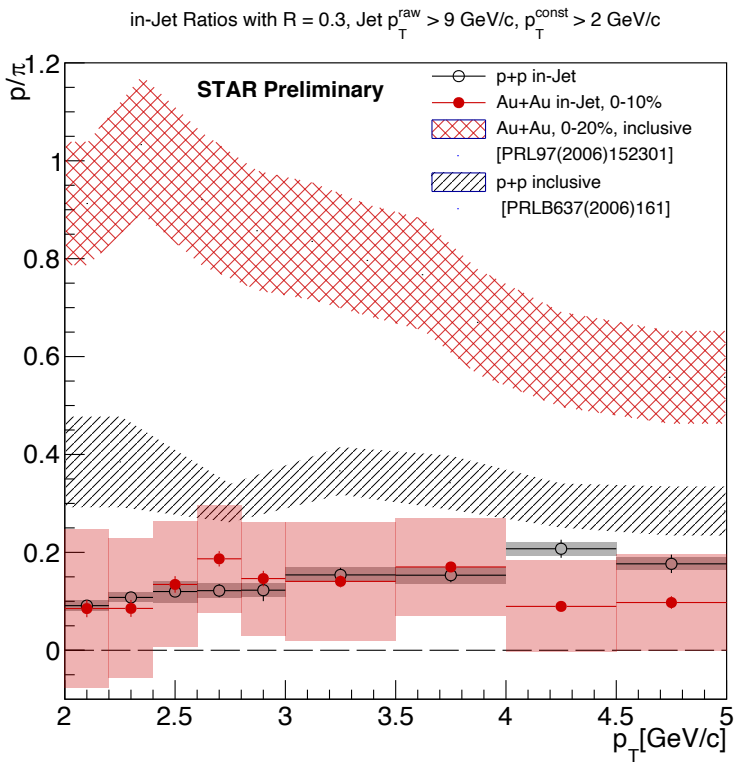

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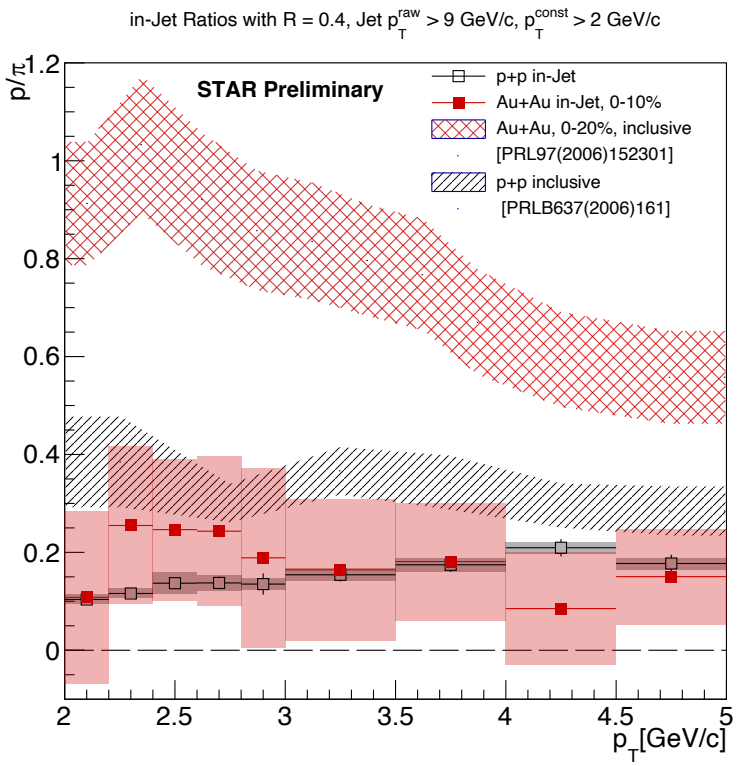


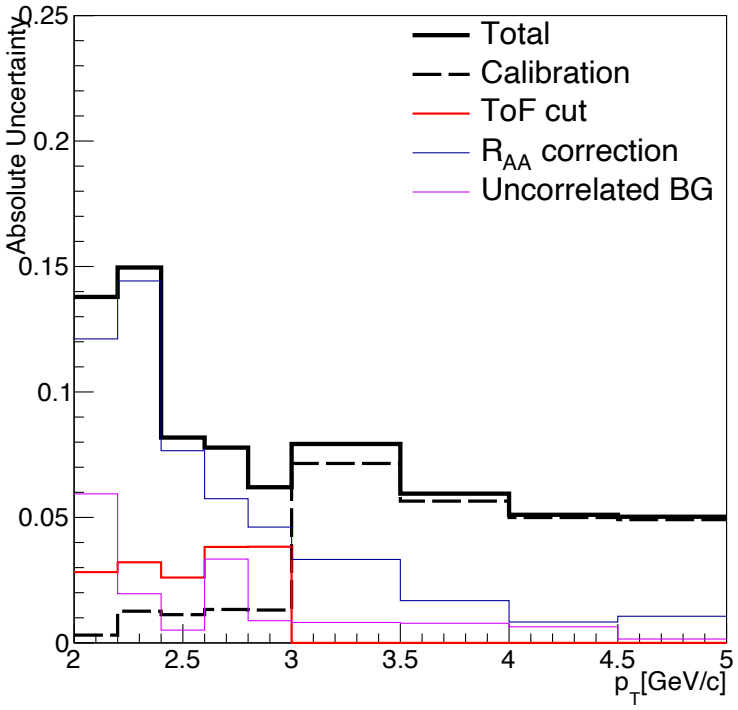
Physics Message

- Jet fragmentation for Jets with p_T > 9.0 GeV/*c* strongly prefers pion over proton production
- No enhancement between p+p and 0-10% central Au+Au collisions is observed
- No dependence on Jet R is observed

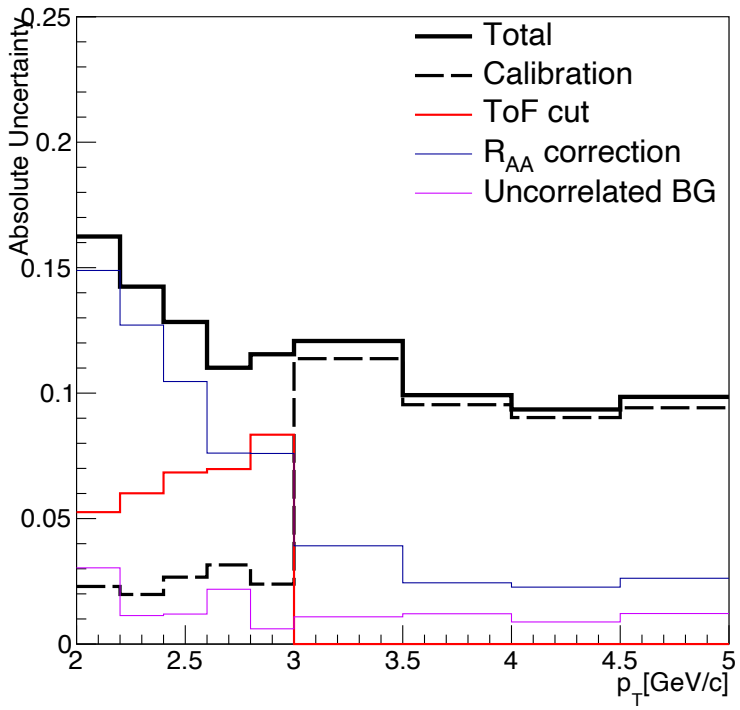
Backup

Au+Au Systematics

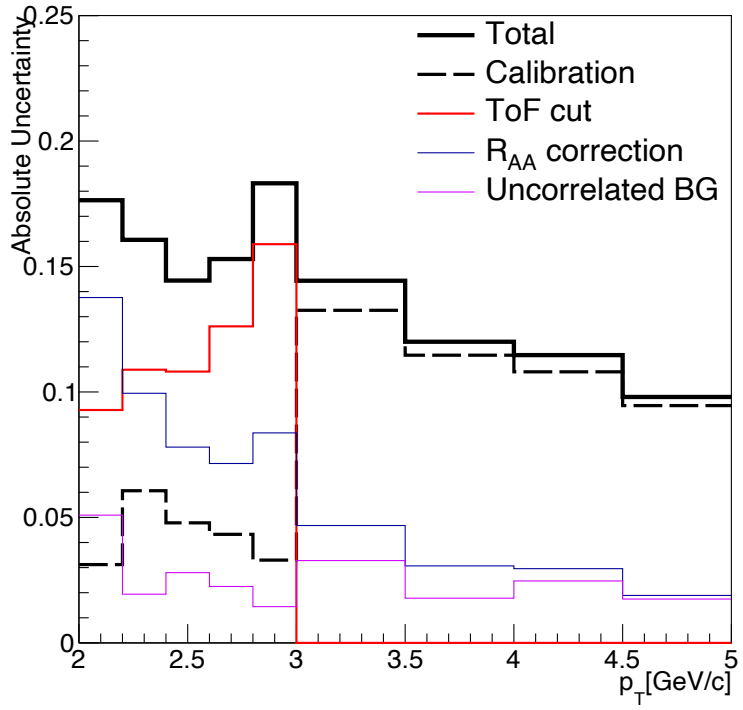
Systematic Uncertainty, R = 0.2



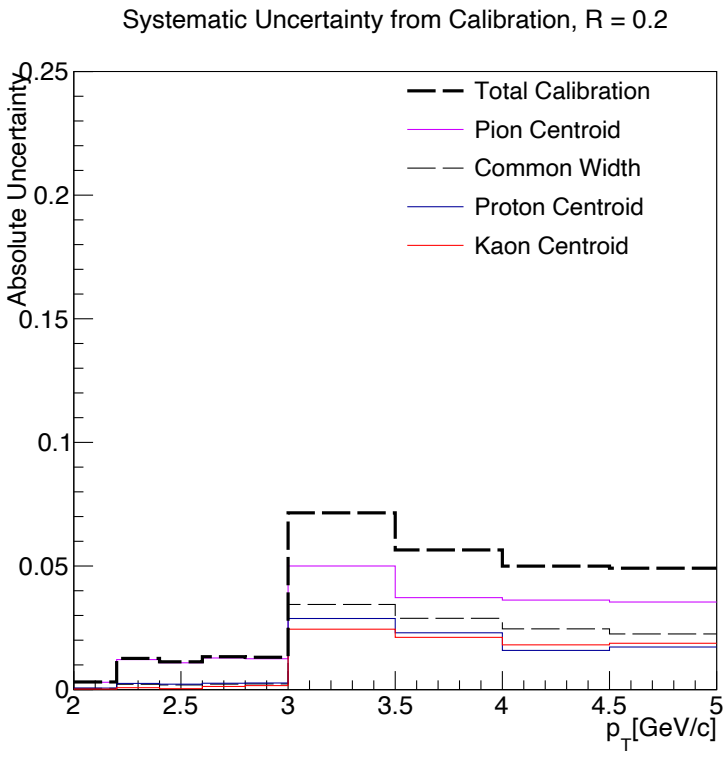
Systematic Uncertainty, R = 0.3

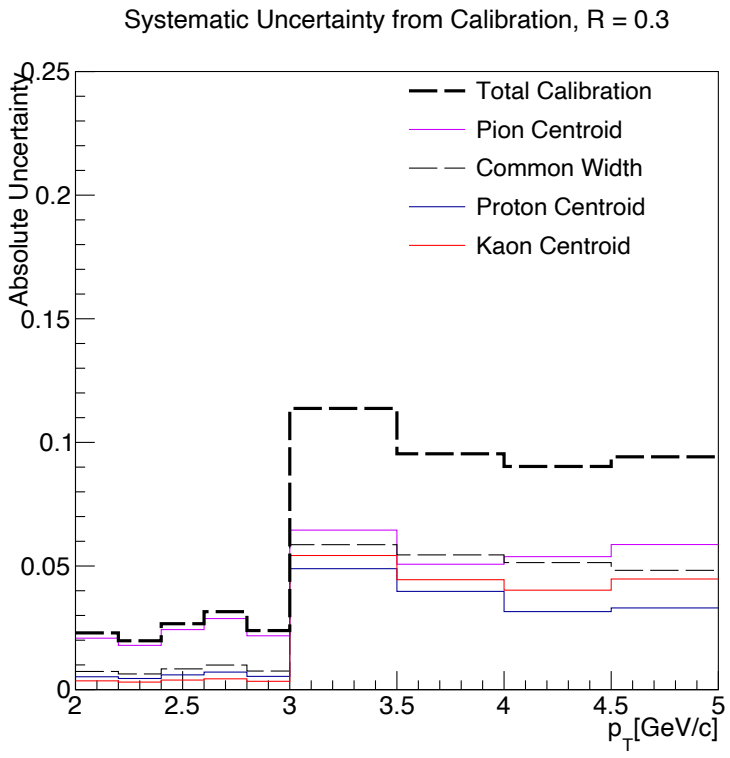


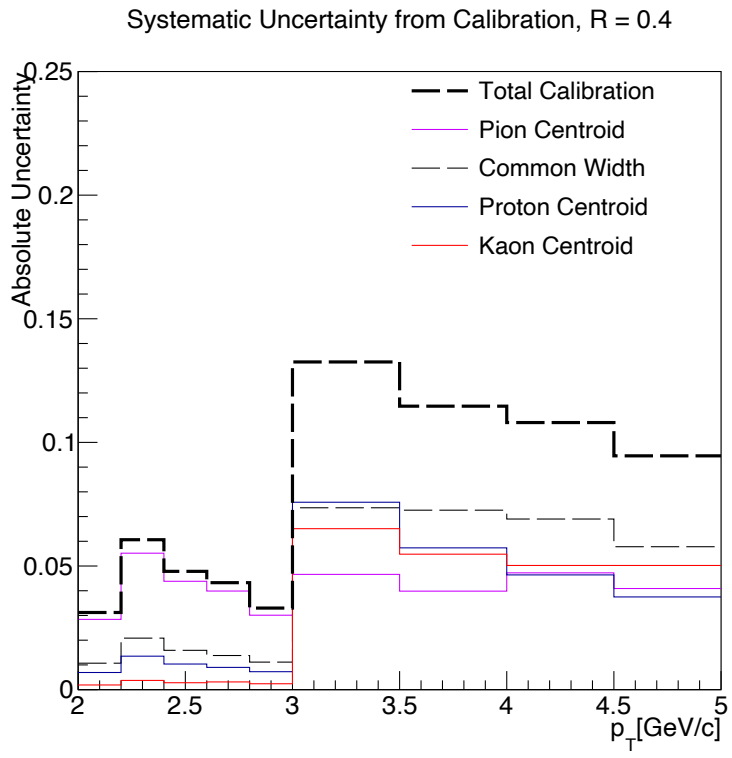
Systematic Uncertainty, R = 0.4



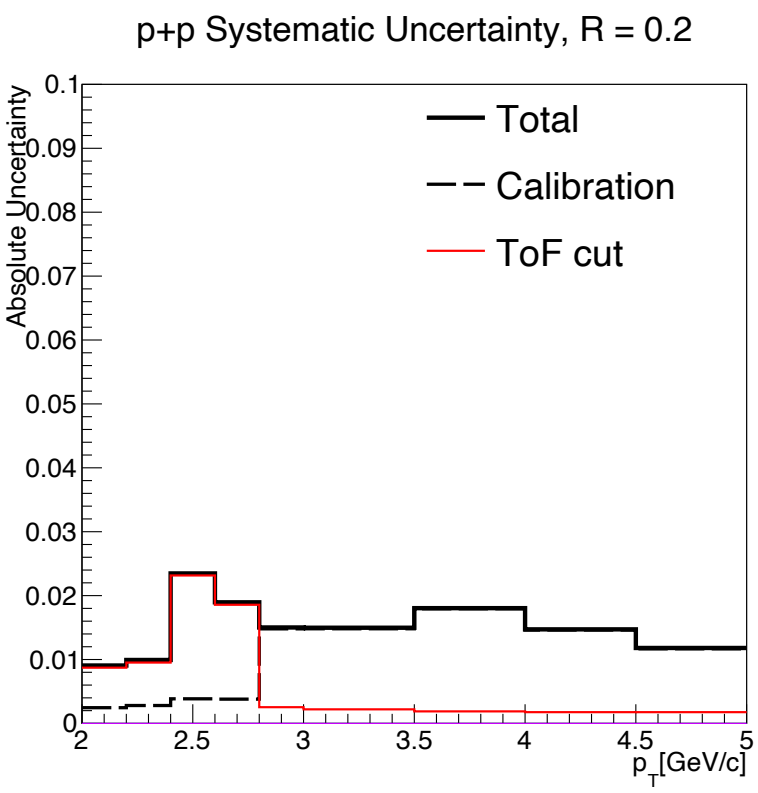
Au+Au, dE/dx Calibration Breakdown

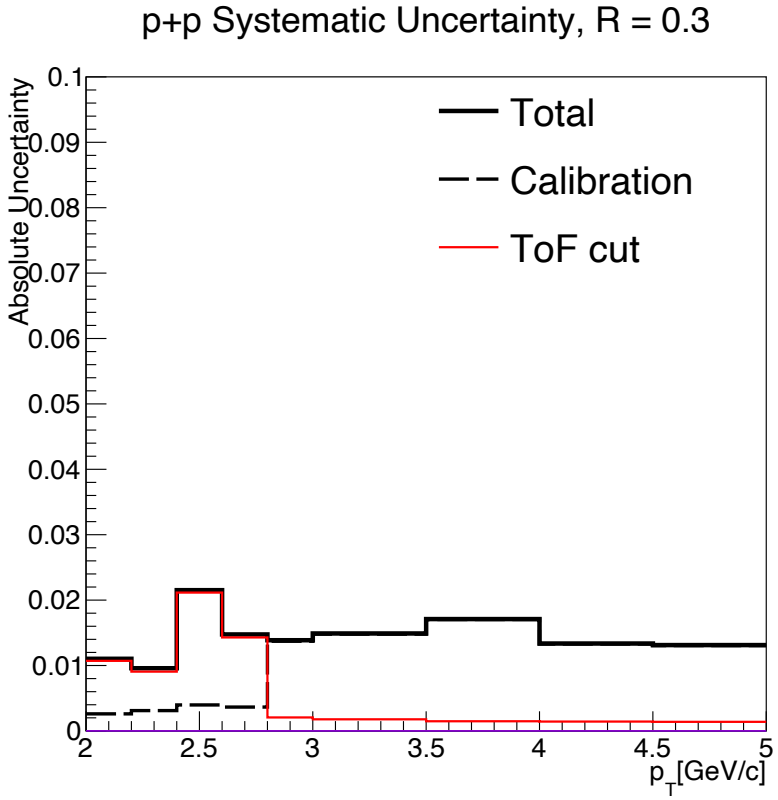


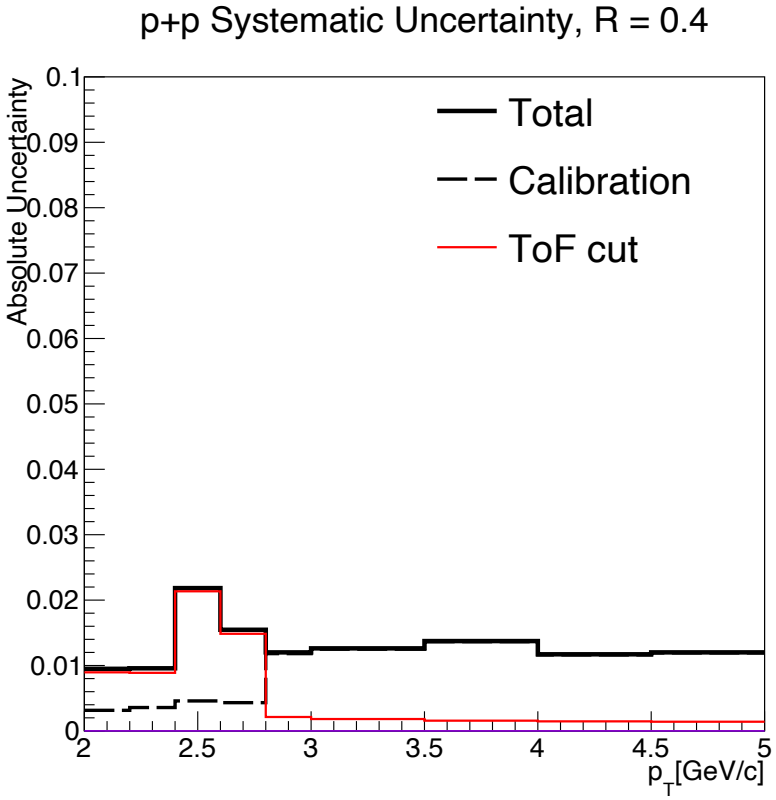




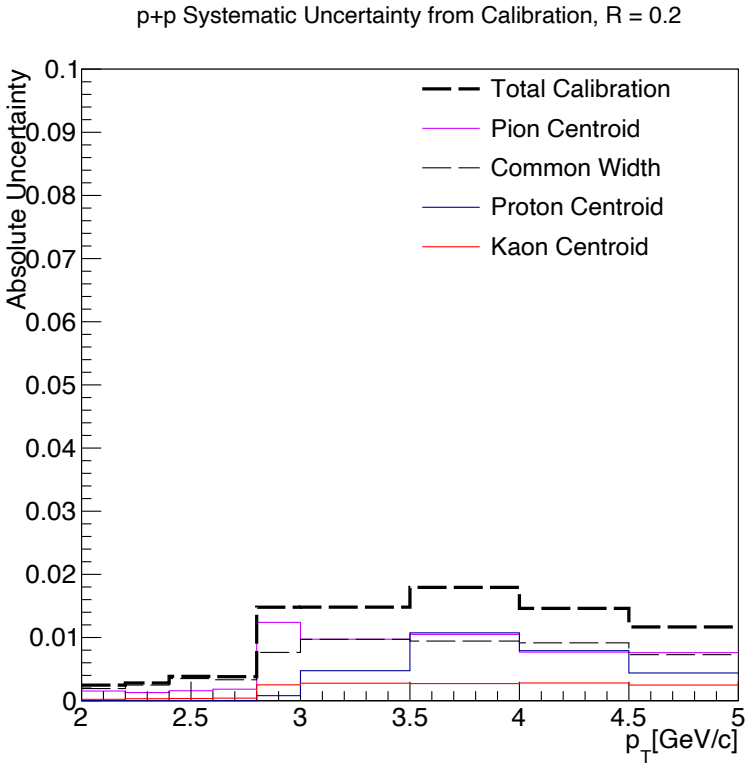
p+p Systematics

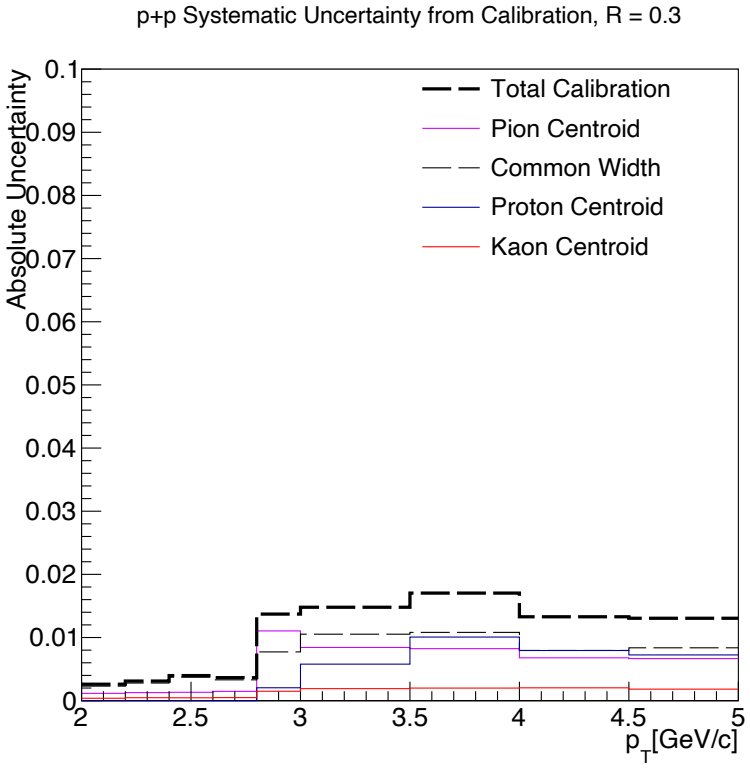


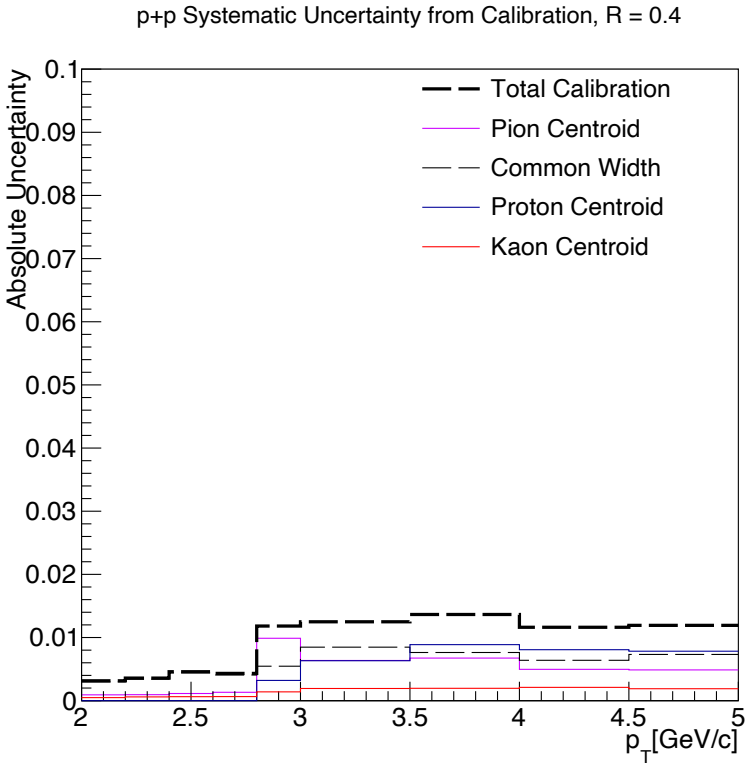




p+p, dE/dx Calibration Breakdown



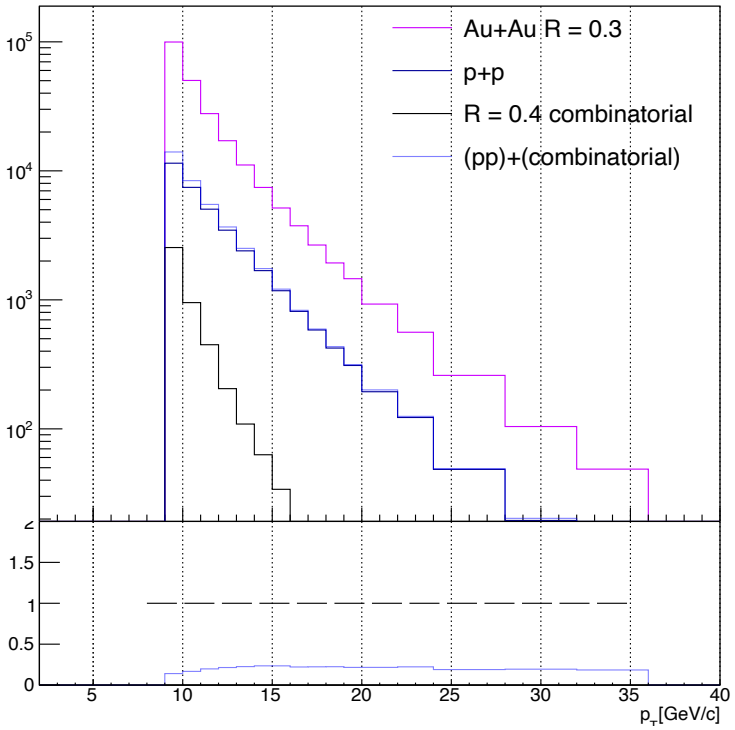




Determining Fake Rate: Spectra Template Fit

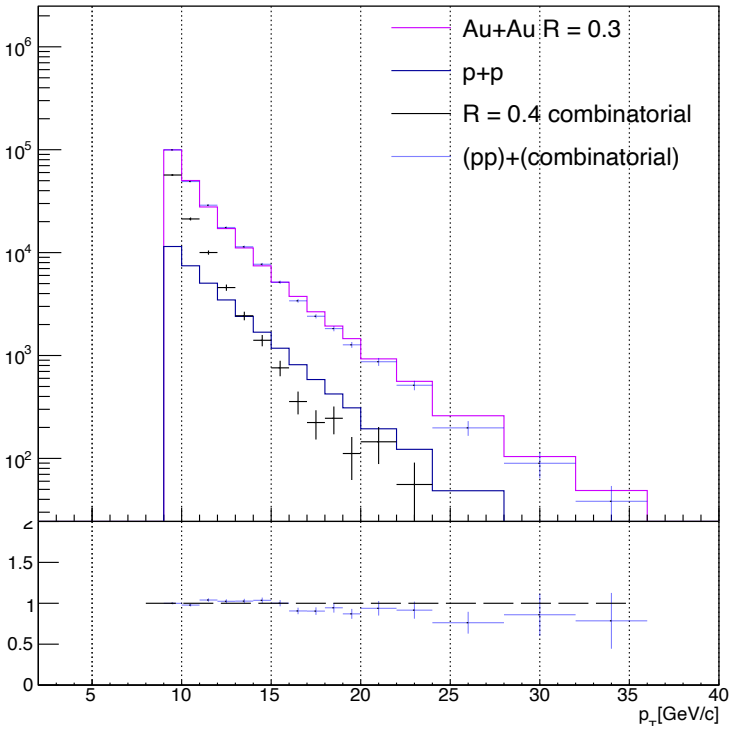
Raw Spectra → **Template Fit**

Rebuilding R = 0.3 Spectra



- Create a two-parameter template fit using the raw jet spectra from p+p and combinatorial jets
- Fit the raw Au+Au spectra
- Scale p+p and combinatorial Njet values by the resulting parameters to calculate fake rate

Rebuilding R = 0.3 Spectra

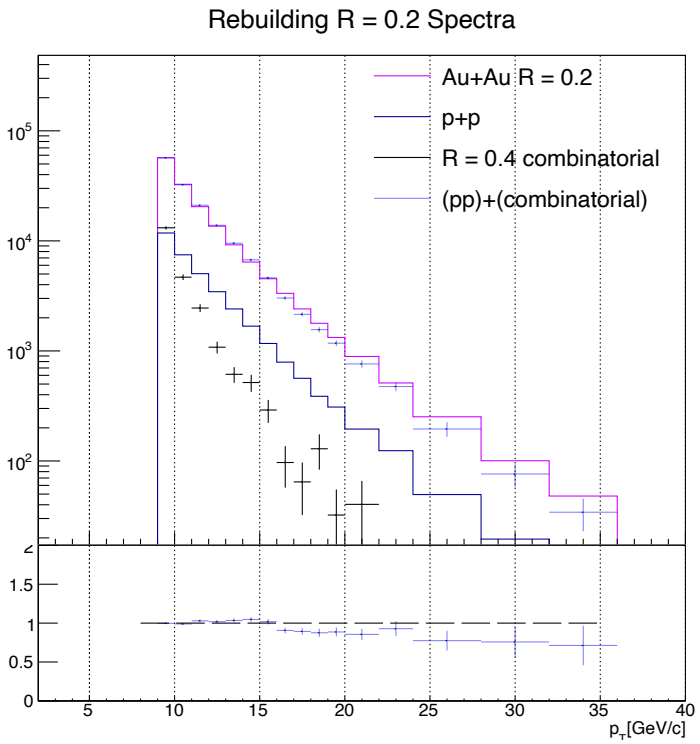


p+p	->	36,210 jets	*	3.7	=	133,977		
Combinatorial	->	4,475 jets	*	22.3	=	99,793	->	**42% Fake Rate**

Fit Parameters

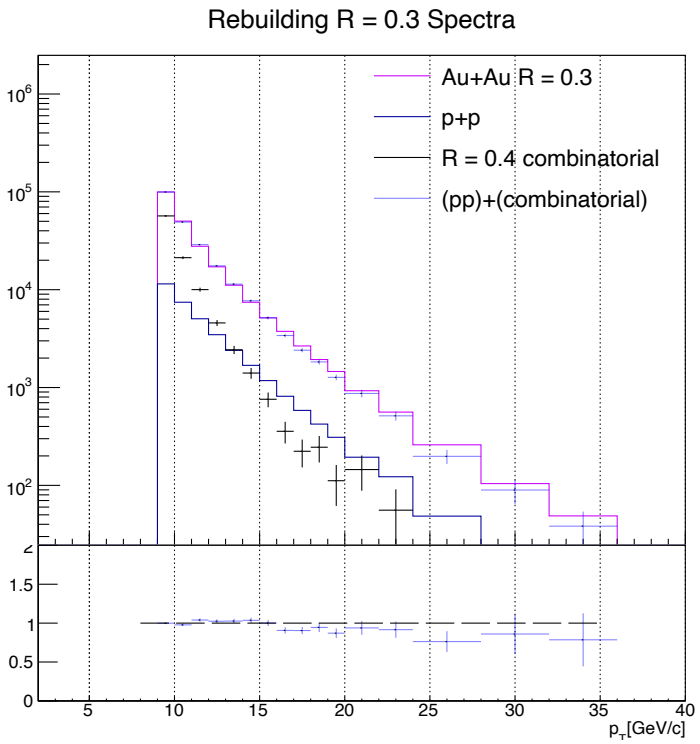
Determining Fake Rate: Spectra Template Fit

R = 0.2



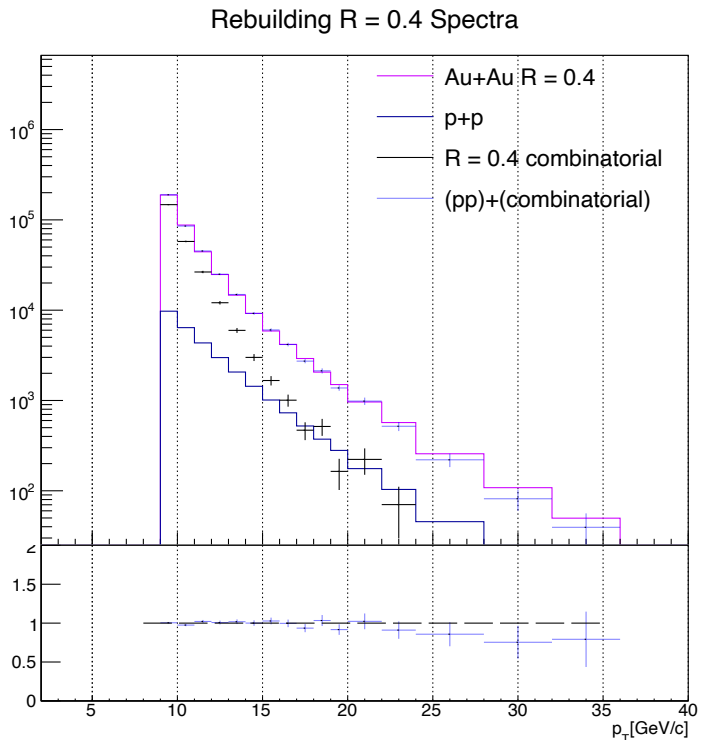
Fake Rate: 15%

R = 0.3



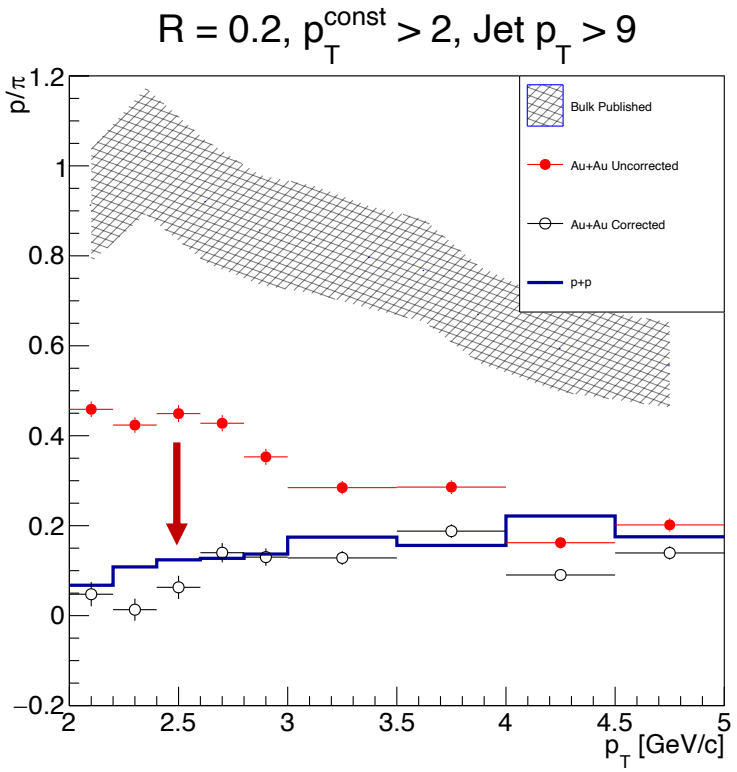
Fake Rate: 42%

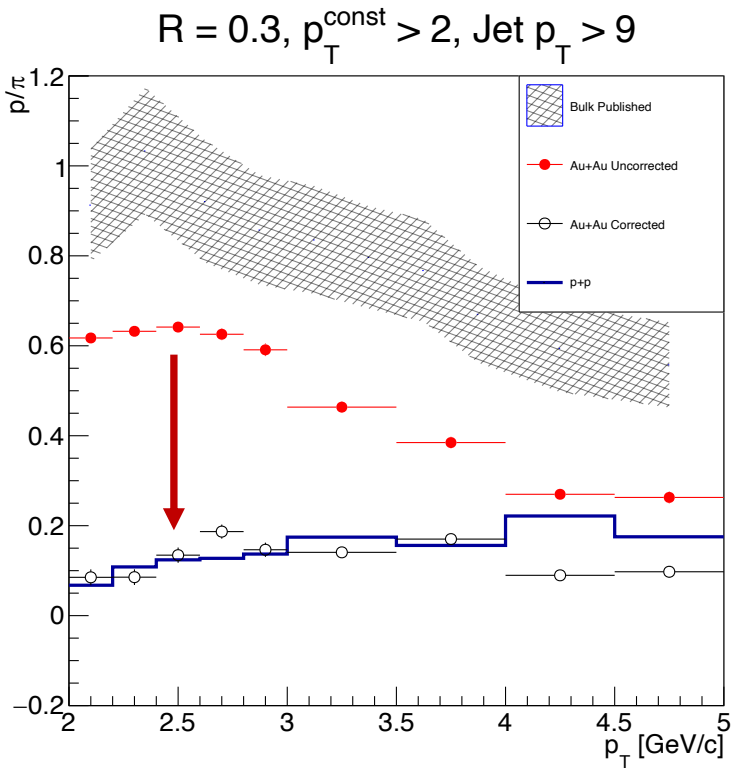
R = 0.4

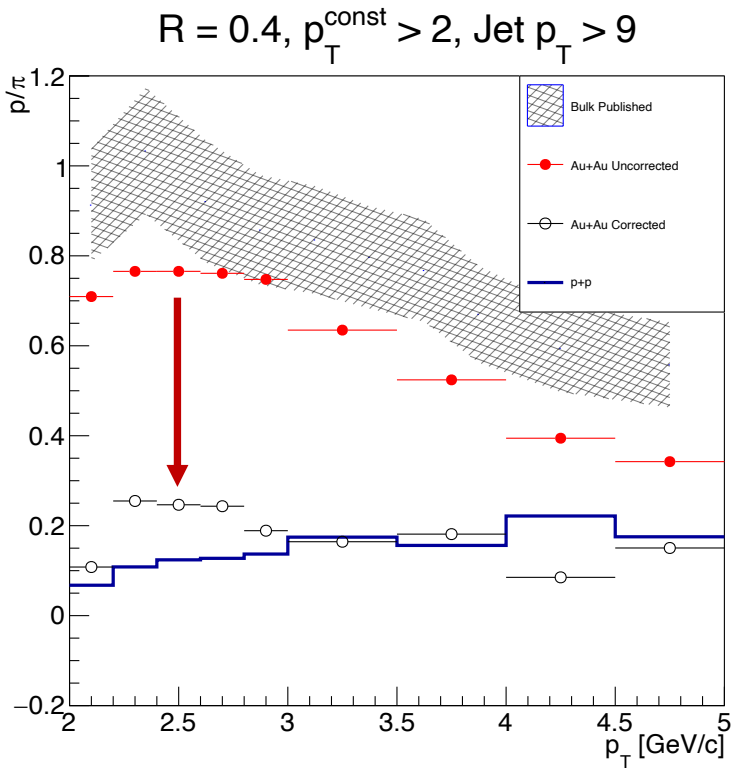


Fake Rate: 66%

Resulting Correction: Embed into MCE + Template Fit Fake Rate







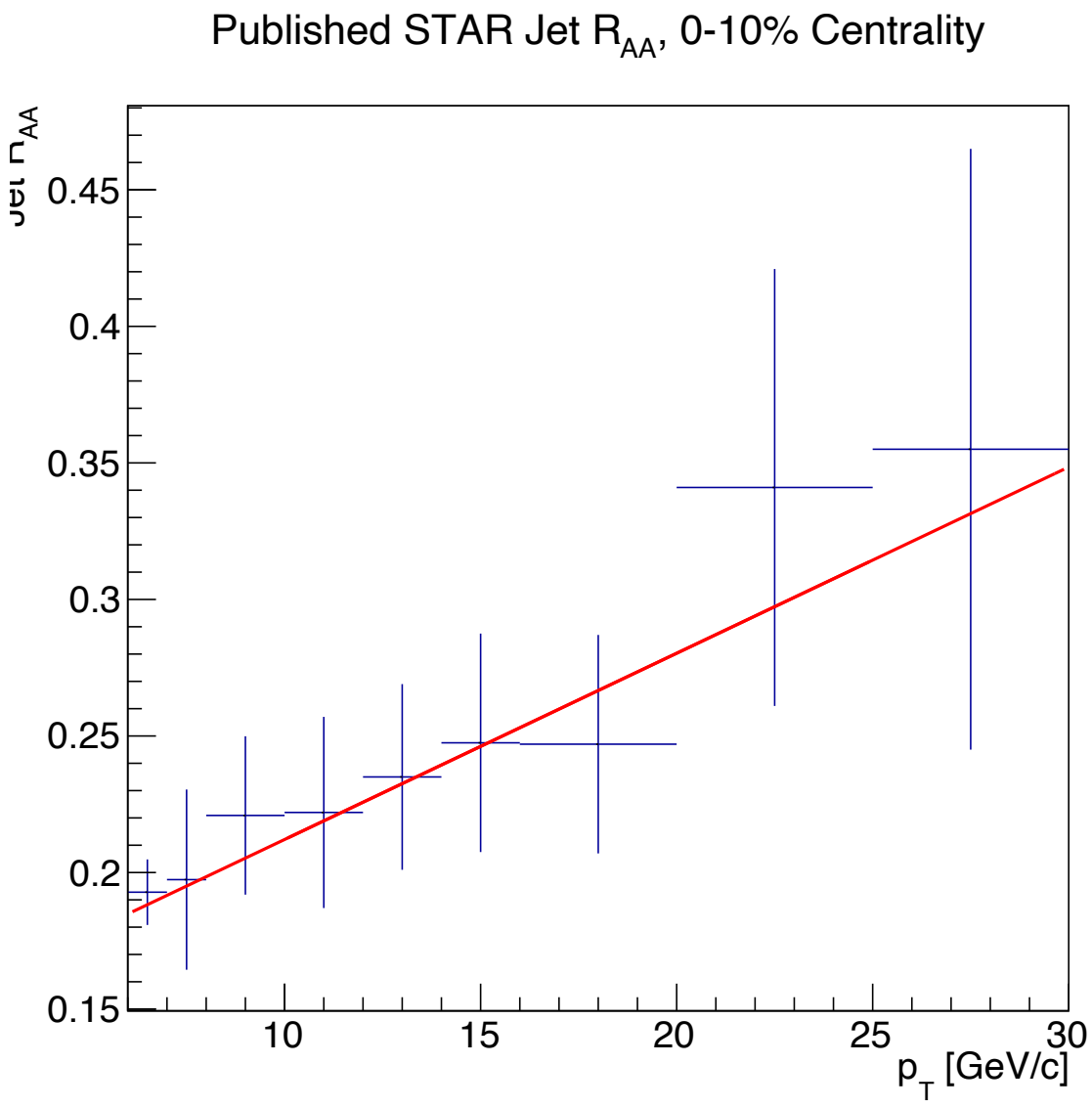
All Yields are per-jet:

$$Corrected\ Yield_{Pr} = \left(Yield_{Pr} - (FakeRate * Yield_{Pr}^{Combi})\right)/(1 - FakeRate) - Yield_{Pr}^{Pseudo}$$

Subtract Combinatorial

Scale Back to per-jet

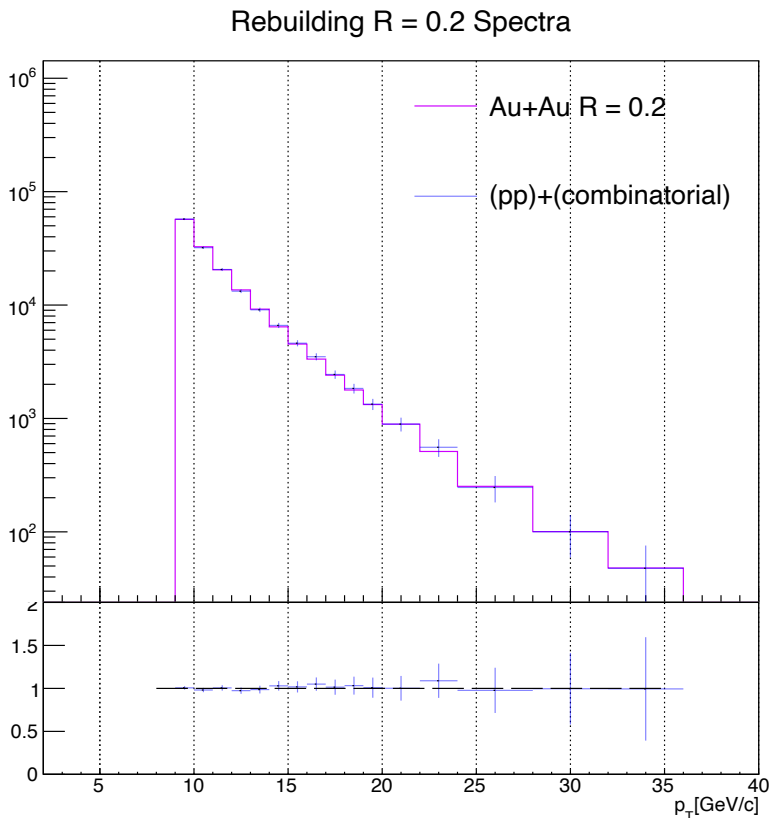
Subtract Upward Fluctuations

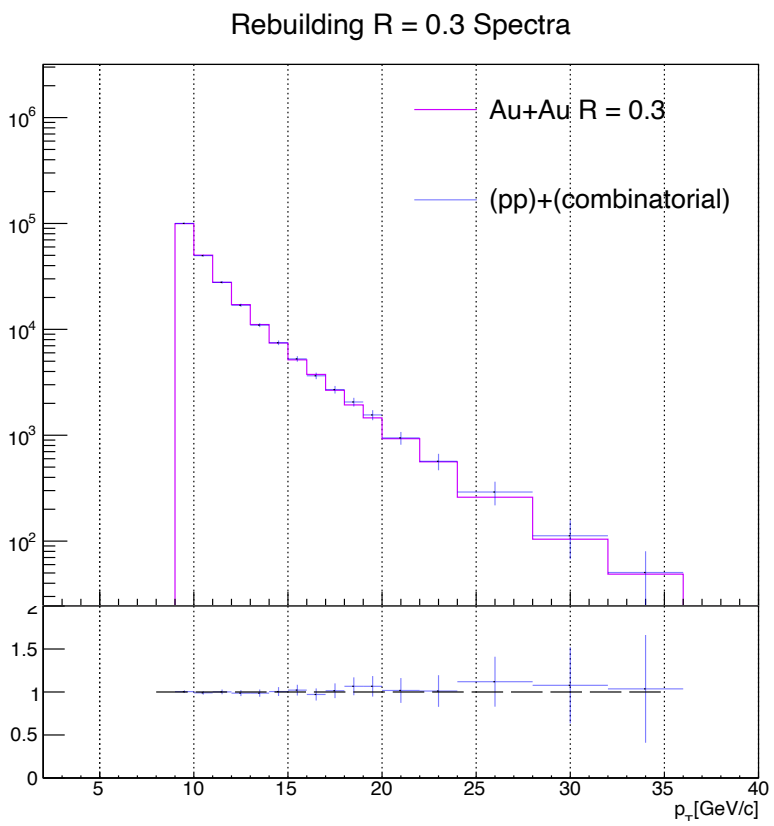


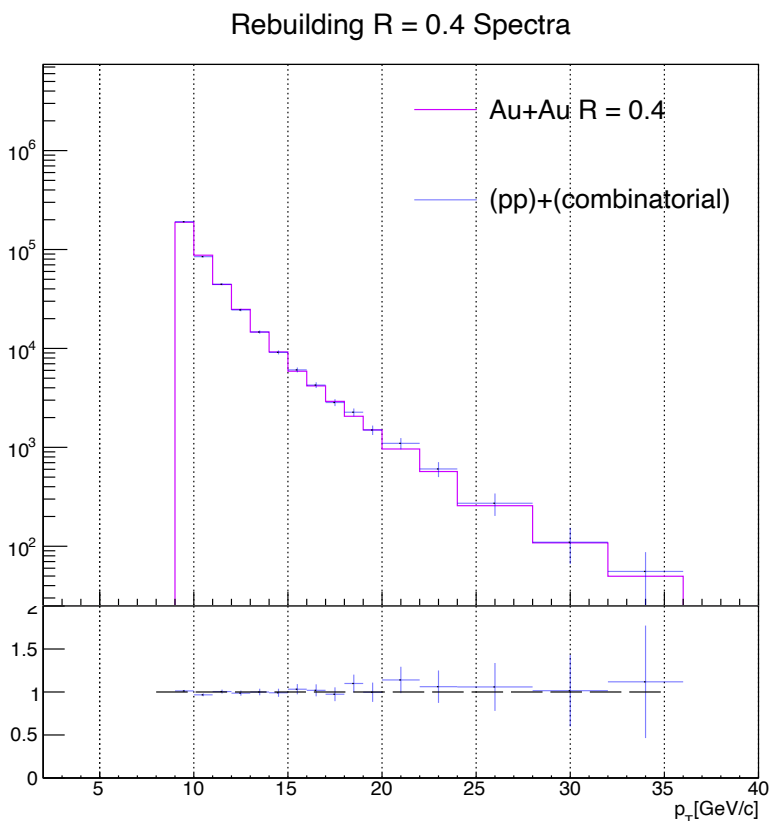
Systematics from Jet R_{AA}

- Our new template fit method of determining fake rate assumes flat R_{AA}
- As a futher systematic measure I extract the slope of published jet R_{AA}
- I weight the raw p+p spectra using this slope and re-run template fits to extract a variant fake rate
- The correction using this fake rate will be reported as systematics

Determining Fake Rate: Spectra Template Fit, Weighted by RAA





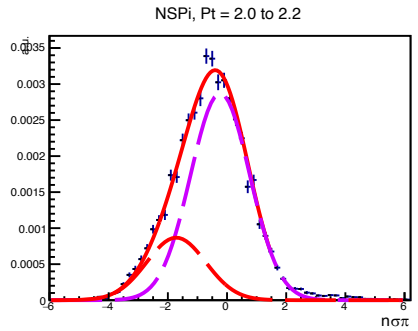


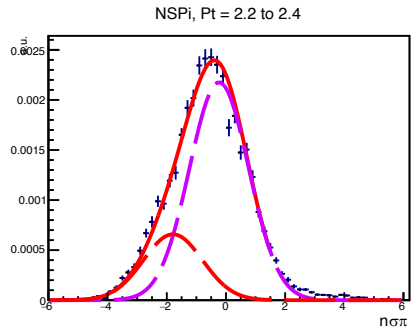
Fake Rate: 20%

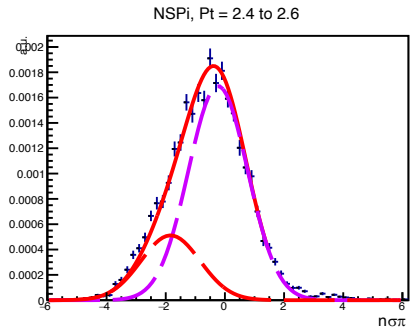
Fake Rate: 46%

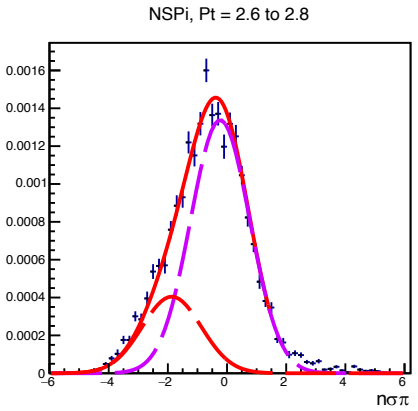
Fake Rate: 69%

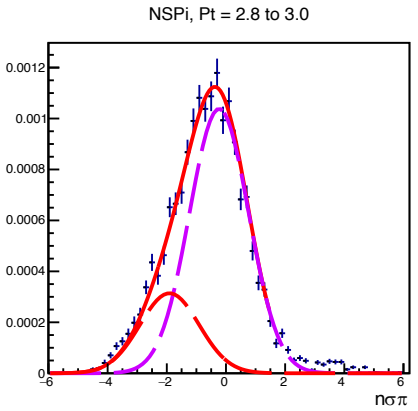
Double Fits for m^{2} < 0.5

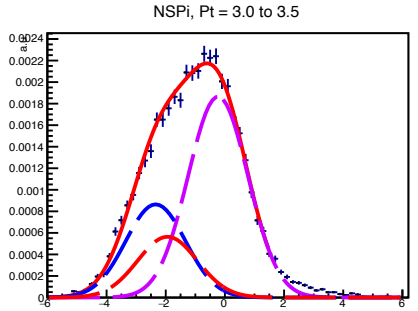




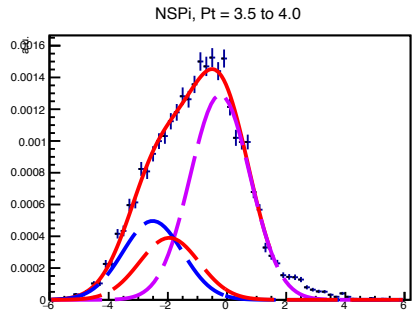


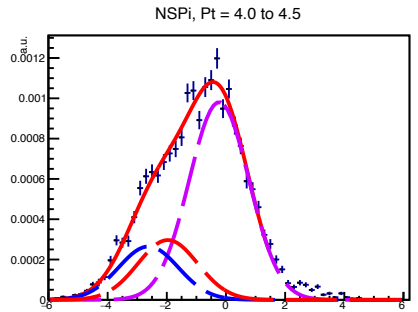


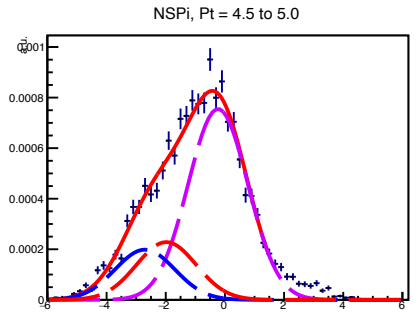




Triple Fits for full m^{2} Range







Gaussian Fits for R = 0.3