

Rapidity Density Distributions of Identified Protons from the RHIC BES at STAR

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Beam Energy Scan Motivation and Outline

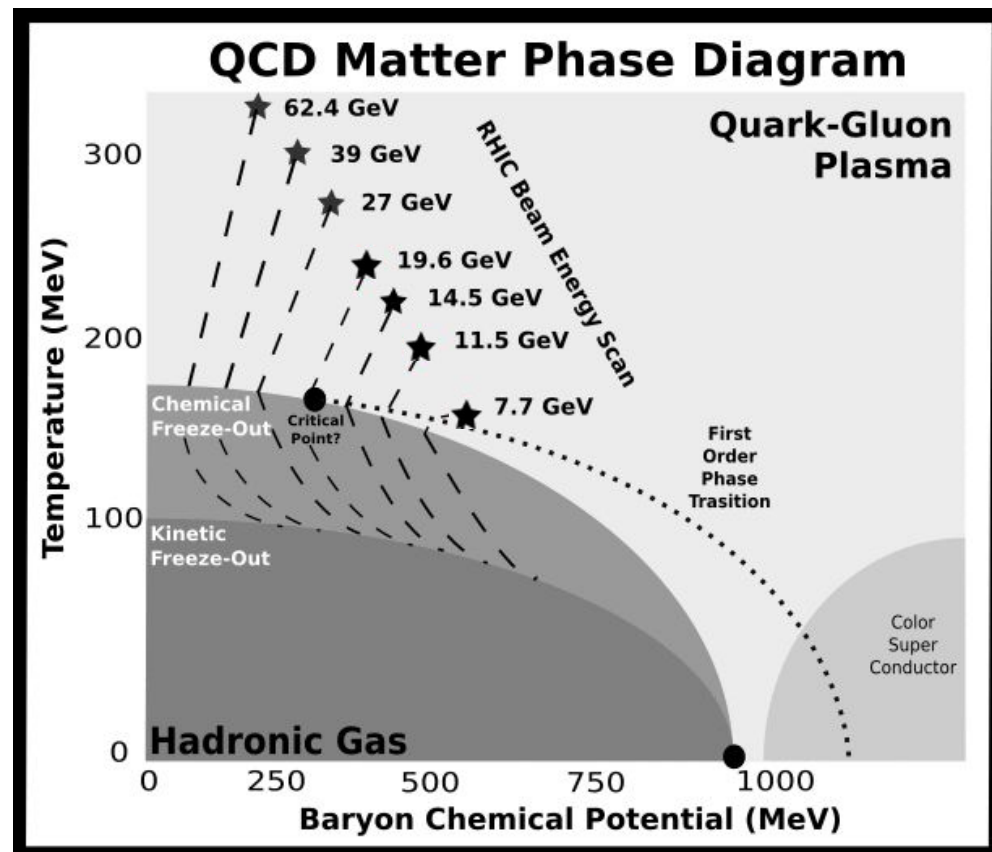


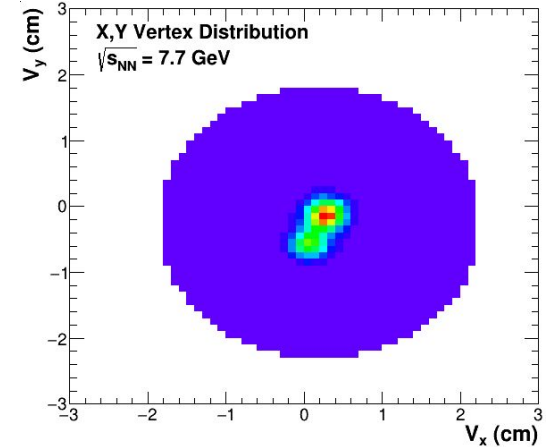
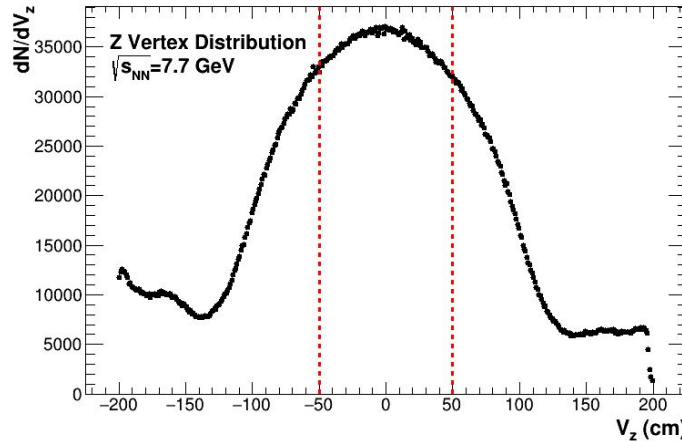
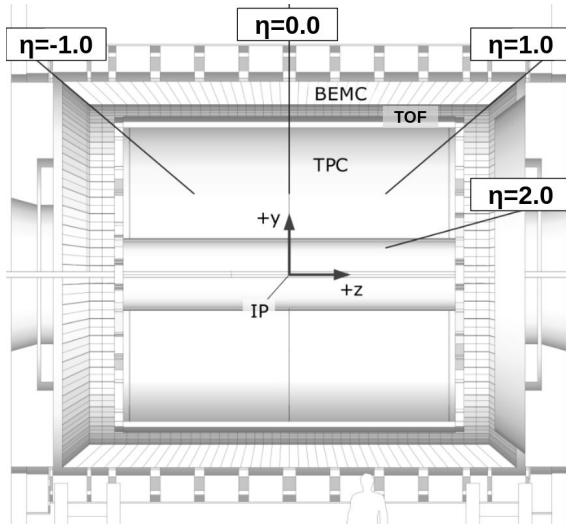
Study of the QCD Phase Diagram

- Search for Critical Point
- Search for Phase Transition Phenomena - Softening of EOS
- Baryon Stopping

In this Talk

- Event Selection
- Particle Identification
- Transverse Mass Spectra and dN/dy Extraction
- Rapidity Density Distributions
- Summary





Z-Vertex Selection:

- 7.7 GeV : $|V_z| < 50$ cm
- All Others: $|V_z| < 30$ cm

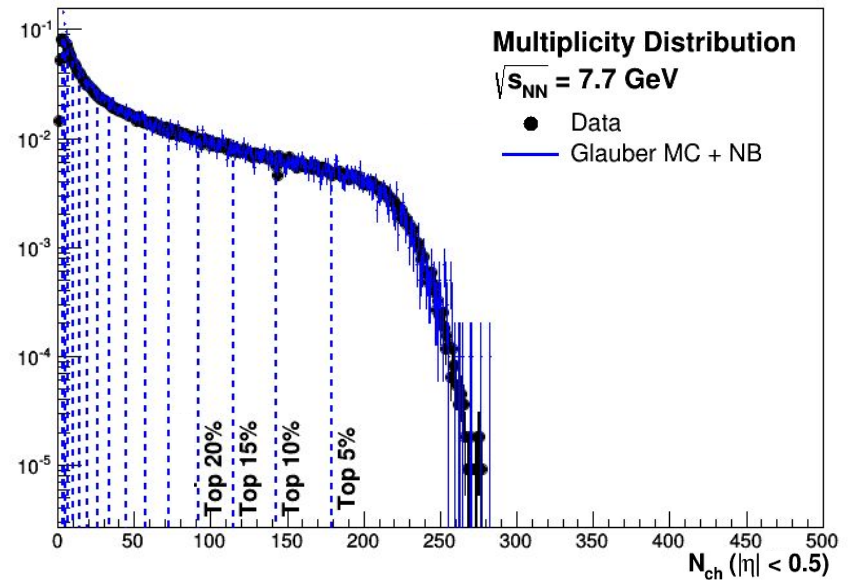
Radial Vertex Selection:

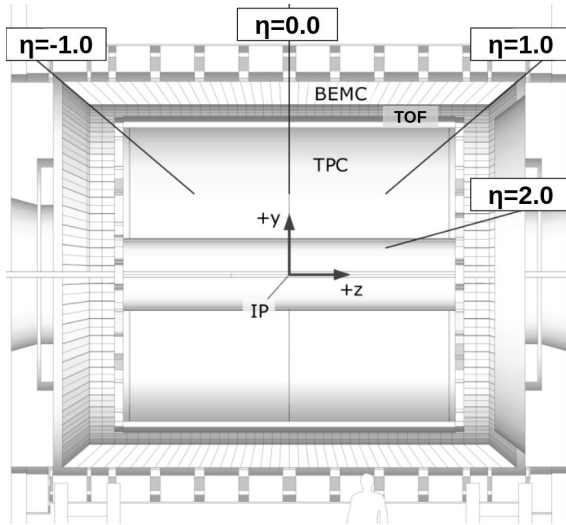
- 14.5 GeV: $|V_R| < 0.5$ cm
- All Others: $|V_R| < 2.0$ cm

Centrality:

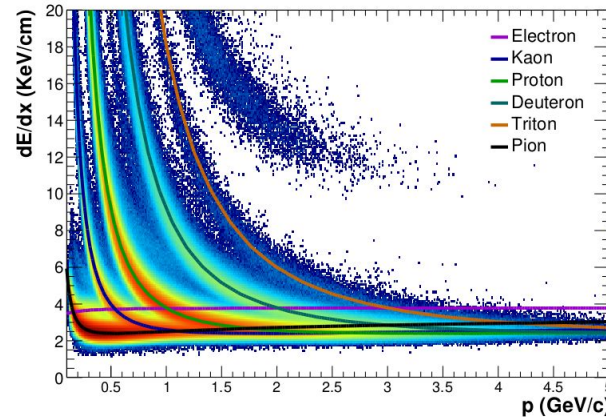
- Nine Bins
- Glauber MC + Neg. Bin. Particle Production Model

% Centrality Bins
00-05
05-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80

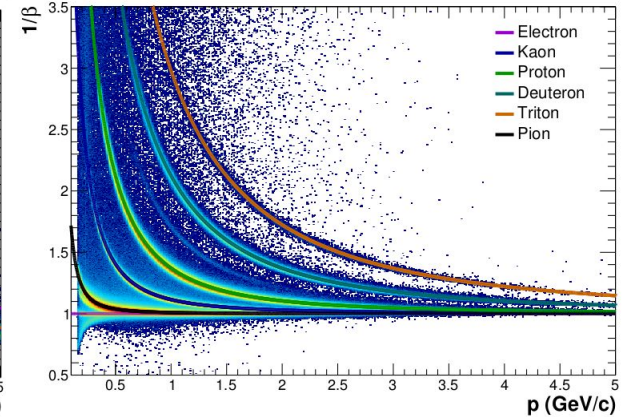




TPC



TOF

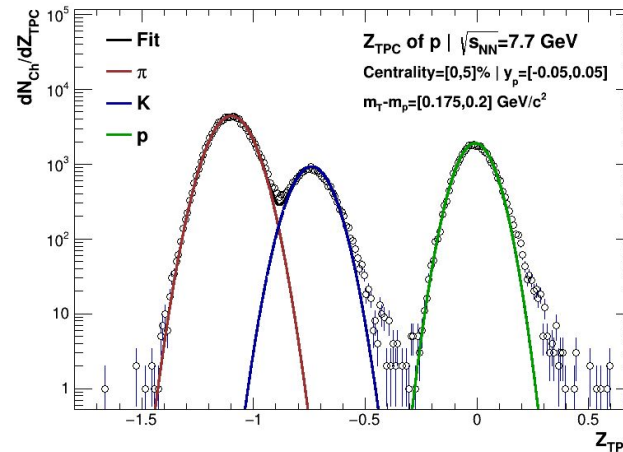


Particle Identification:

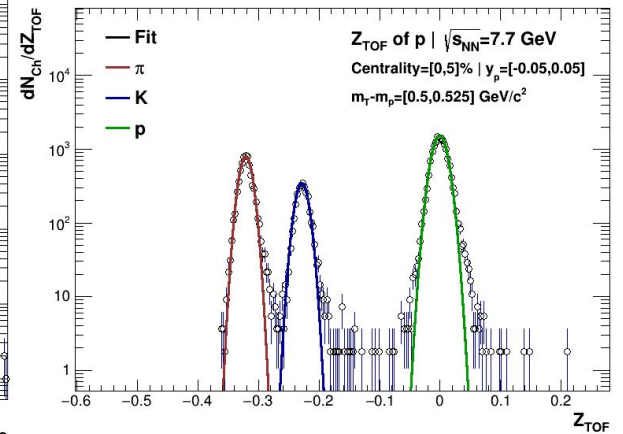
- Energy loss in TPC
- Time of flight in TOF
- Excellent PID throughout $y_p = [-0.65, 0.65]$

Tracks are binned by:

- Event centrality
- Rapidity | bin width = 0.1
- Transverse mass | bin width = 0.025 GeV/c²



$$Z_{TPC}(X) = \ln \frac{(dE/dx)_{meas}}{(dE/dx)_{exp,X}}$$



$$Z_{TOF}(X) = \left(\frac{1}{\beta}\right)_{meas} - \left(\frac{1}{\beta}\right)_{exp,X}$$

Proton Transverse Mass Spectra

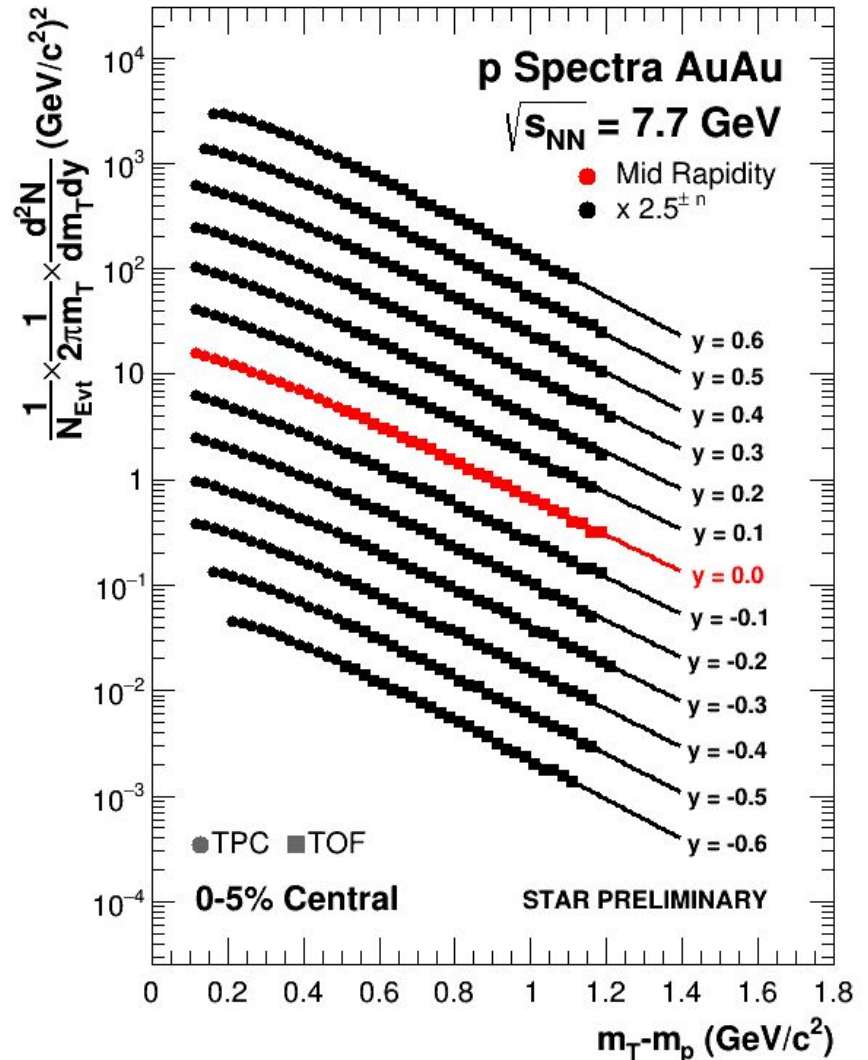


Spectra are Corrected for:

- Energy loss in the detector material
- Finite bin width
- Tracking efficiency
- “Knockout” proton background

Spectra are Fit with:

- Boltzmann function above $m_T - m_0 = 0.3 \text{ GeV}/c^2$
- Ignores radial flow effects
- More sophisticated Blast Wave model will be used in future

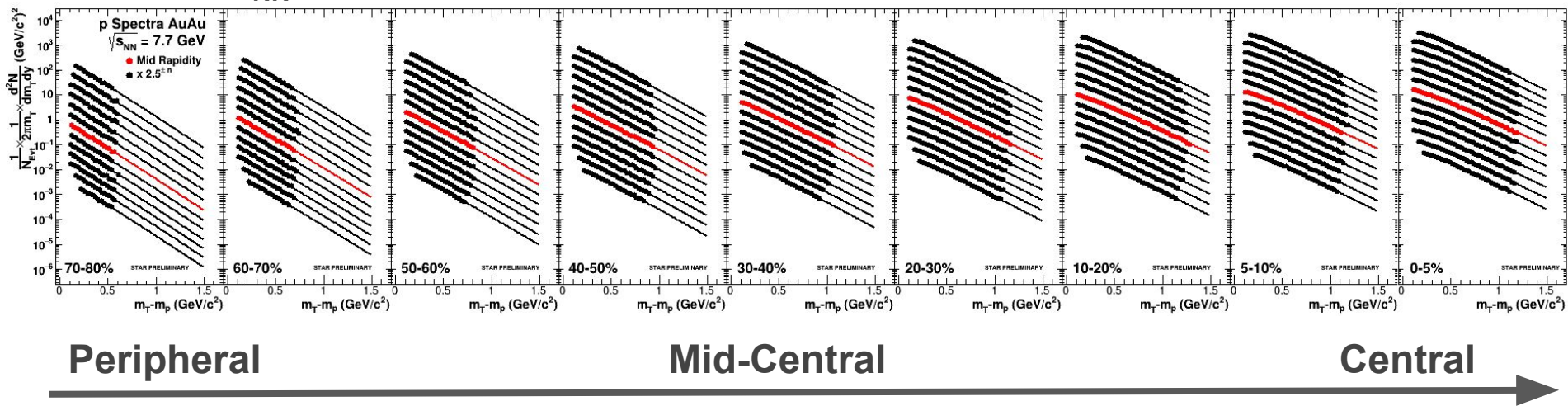


Proton Spectra | Au+Au at $\sqrt{s}_{NN} = 7.7$ GeV



Au+Au $\sqrt{s}_{NN} = 7.7$ GeV

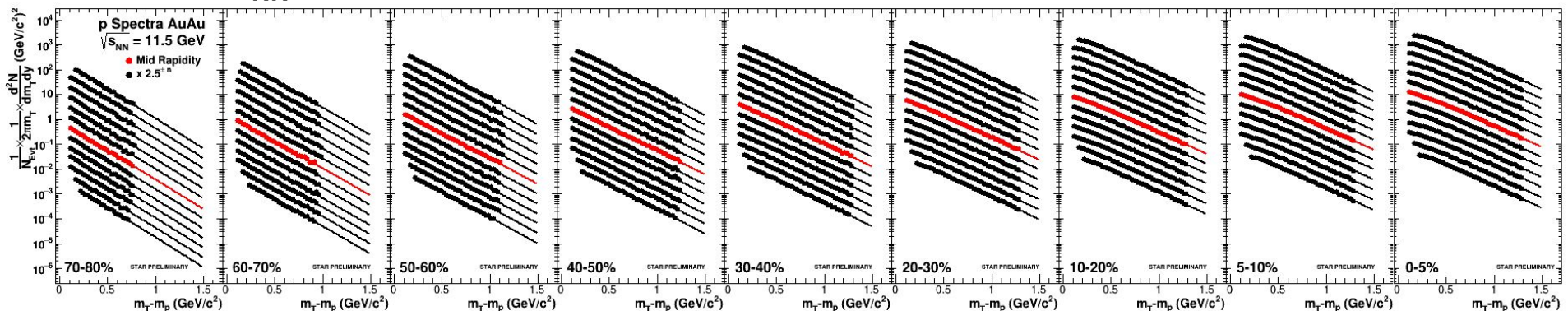
Mid Rapidity: $|y| < 0.05$ Rapidity Range: ± 0.65 (bin width: 0.1)



Proton Spectra | Au+Au at $\sqrt{s_{NN}} = 11.5$ & 14.5 GeV

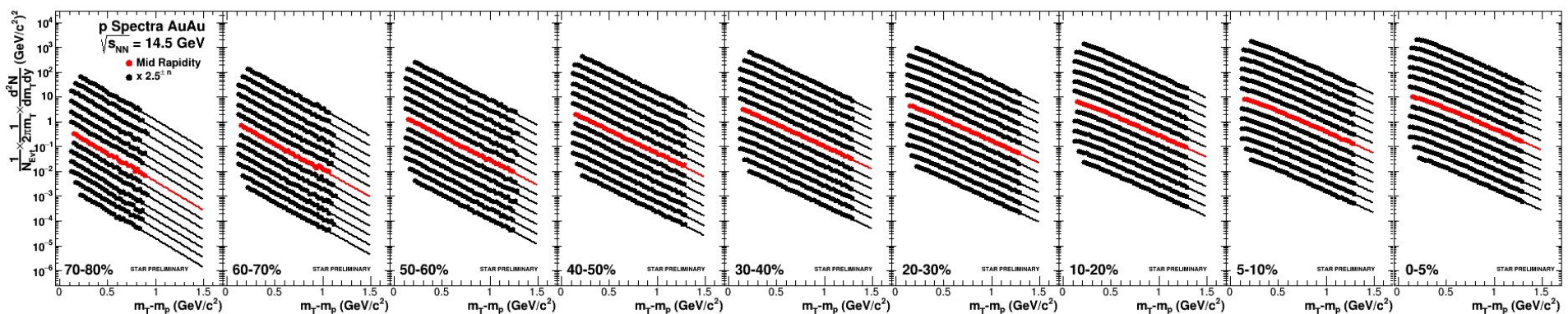


Au+Au $\sqrt{s_{NN}} = 11.5$ GeV



Au+Au $\sqrt{s_{NN}} = 14.5$ GeV

Mid Rapidity: $|y| < 0.05$ Rapidity Range: ± 0.65 (bin width: 0.1)



Peripheral

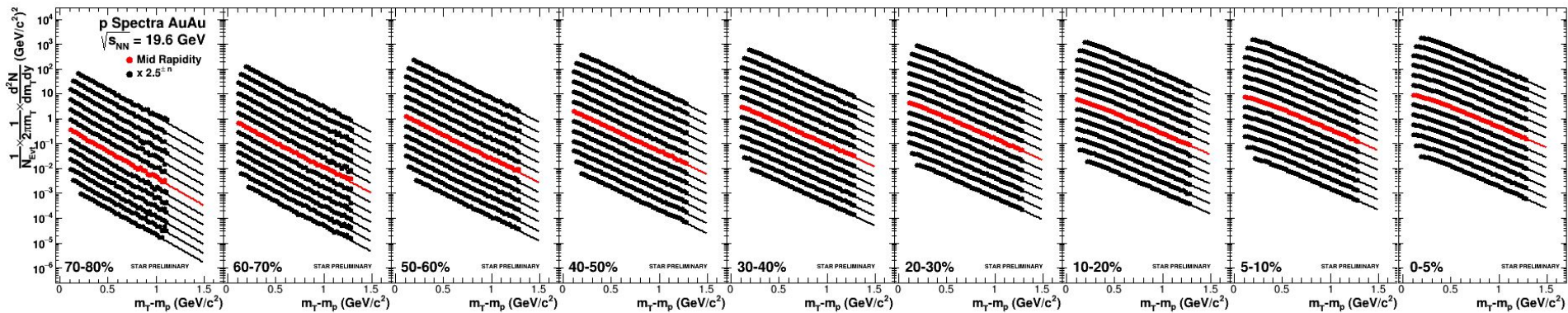
Mid-Central

Central

Proton Spectra | Au+Au at $\sqrt{s_{NN}} = 19.6$ & 27.0 GeV

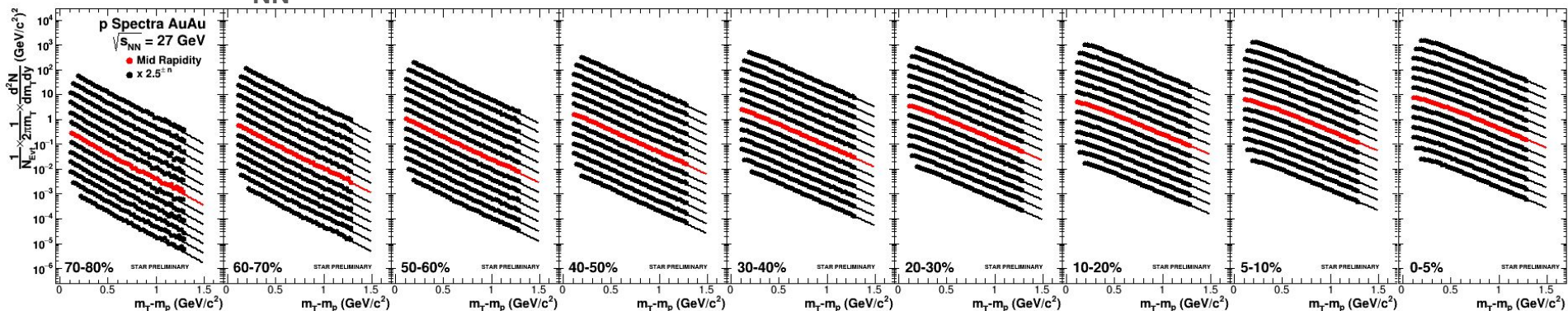


Au+Au $\sqrt{s_{NN}} = 19.6$ GeV



Au+Au $\sqrt{s_{NN}} = 27.0$ GeV

Mid Rapidity: $|y| < 0.05$ Rapidity Range: ± 0.65 (bin width: 0.1)



Peripheral

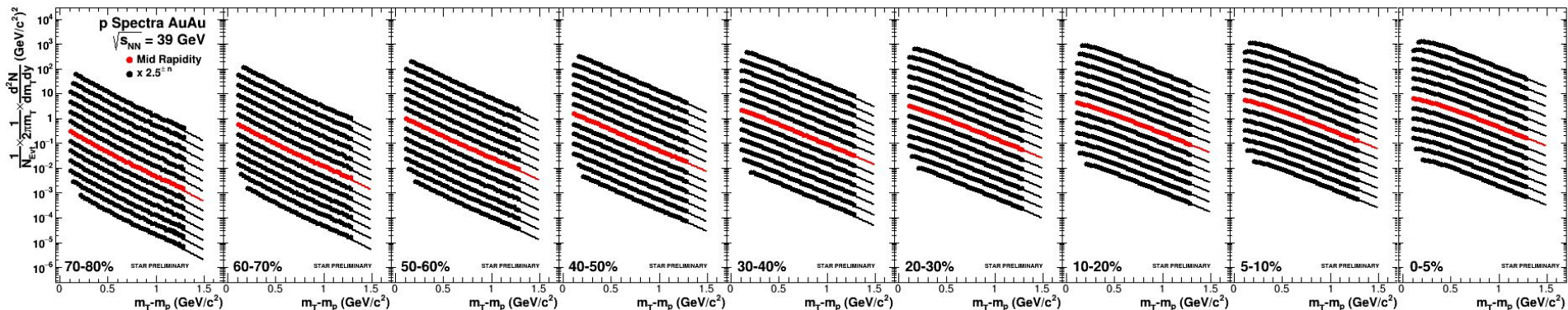
Mid-Central

Central

Proton Spectra | Au+Au at $\sqrt{s_{NN}} = 39.0$ & 62.4 GeV

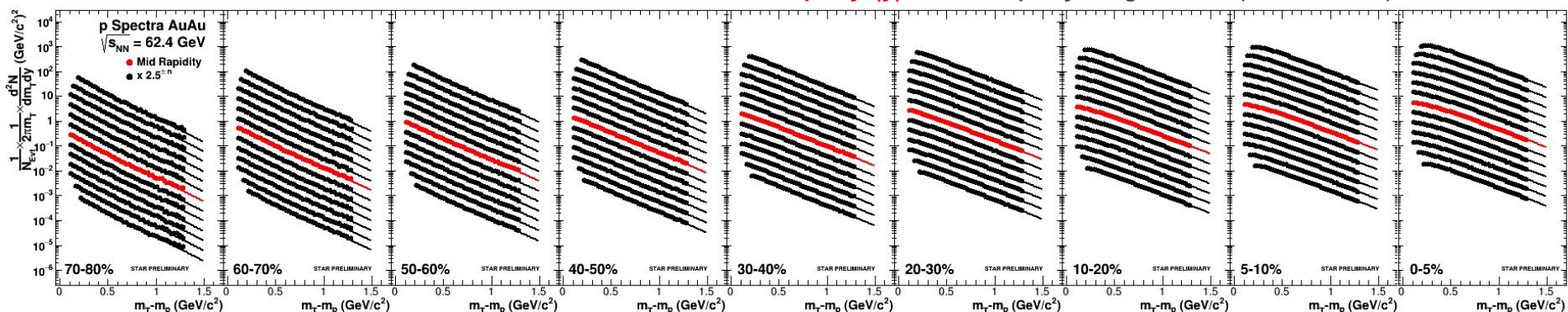


Au+Au $\sqrt{s_{NN}} = 39.0$ GeV



Au+Au $\sqrt{s_{NN}} = 62.4$ GeV

Mid Rapidity: $|y| < 0.05$ Rapidity Range: ± 0.65 (bin width: 0.1)

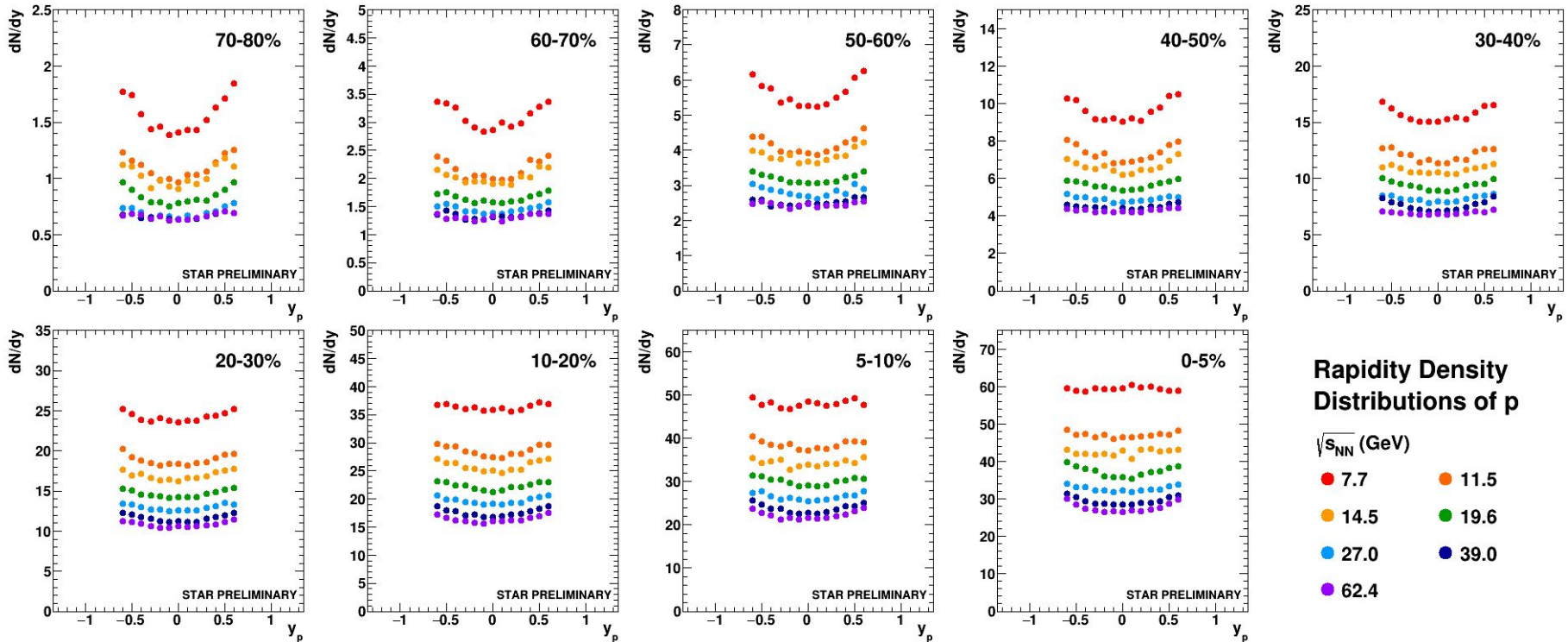


Peripheral

Mid-Central

Central

BES Proton Rapidity Density Distributions



- dN/dy obtained by integrating Boltzmann Fits in $m_T - m_0 = [0, 10]$ GeV/ c^2
- Errors are statistical only

- Large gap between 7.7 and 11.5 consistent with large difference in baryon chemical potential (μ_B)
- Evolution of 7.7 GeV structure with centrality suggests baryon deflection in peripheral collisions

$\sqrt{s_{NN}}$ (GeV)	7.7	11.5	14.5	19.6	27.0	39.0	62.4
μ_B (MeV)	420	315	260	205	155	115	70

Conclusions and Future Work



- STAR has extracted the transverse mass spectra of identified protons:
 - For Au+Au collisions at BES energies at $\sqrt{s_{NN}} = 7.7, 11.5, 14.5, 19.6, 27.0, 39.0,$ and 62.4 GeV
 - Differentially in about one unit of rapidity and in nine centrality bins
- The spectra have been used to obtain preliminary rapidity density distributions via a simple Boltzmann function model.
- A full blast wave model using simultaneous fits to $\pi^{+-}, k^{+-}, p,$ and \bar{p} spectra will be used in the future to extract the p and \bar{p} yields:
 - Will account for the effect of radial flow
 - Will result in net proton rapidity density distributions