Light-Flavour Hadron Production at Fixed-Target Energies with STAR

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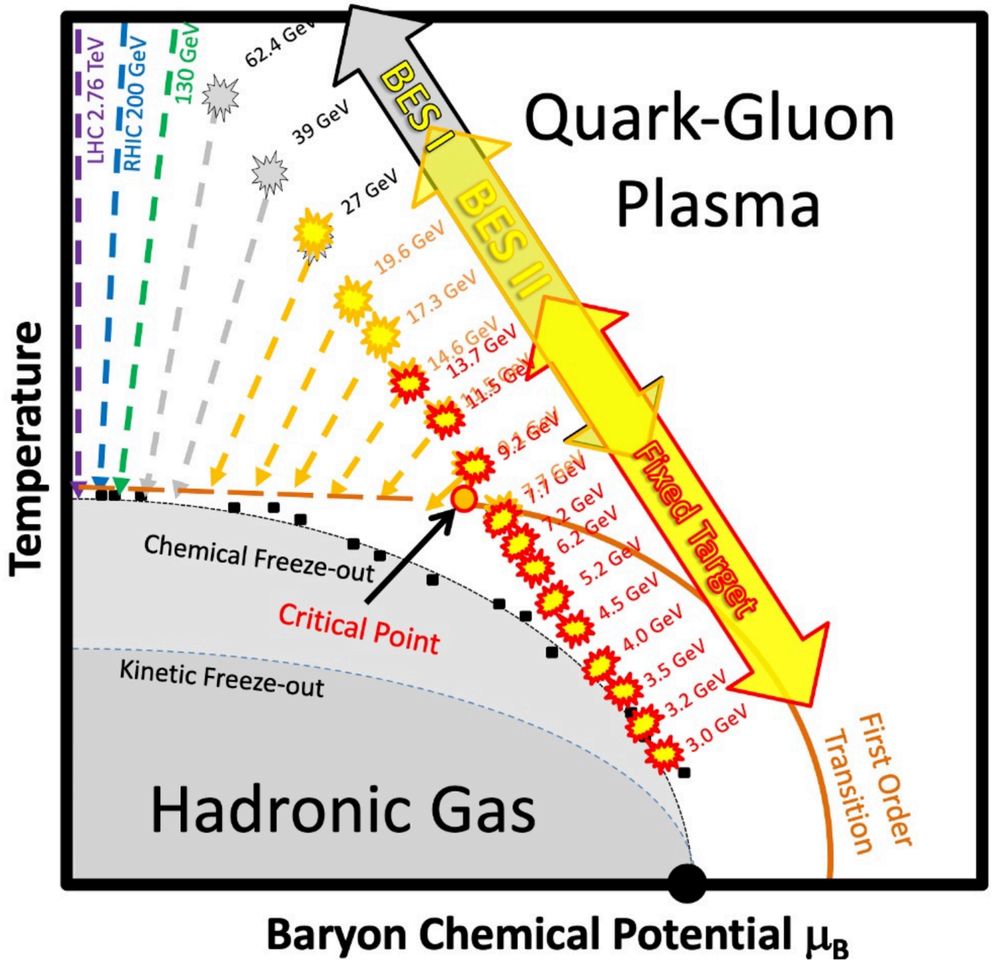
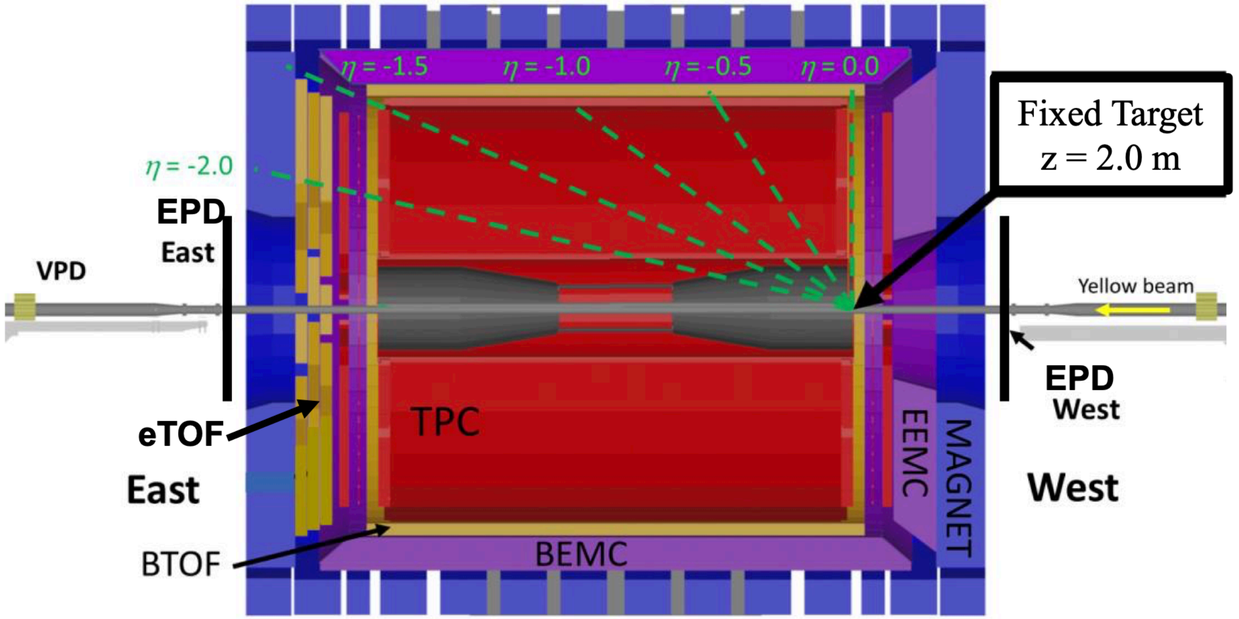
Light-flavour hadron production at STAR

- Hadron production is a key measurement in the search for a change of the QCD equation of state
- Light-flavor hadron [π,K,p] production measurements provide constraints to theoretical models
- This measurement gives unique a opportunity to test methodology of efficiency determination



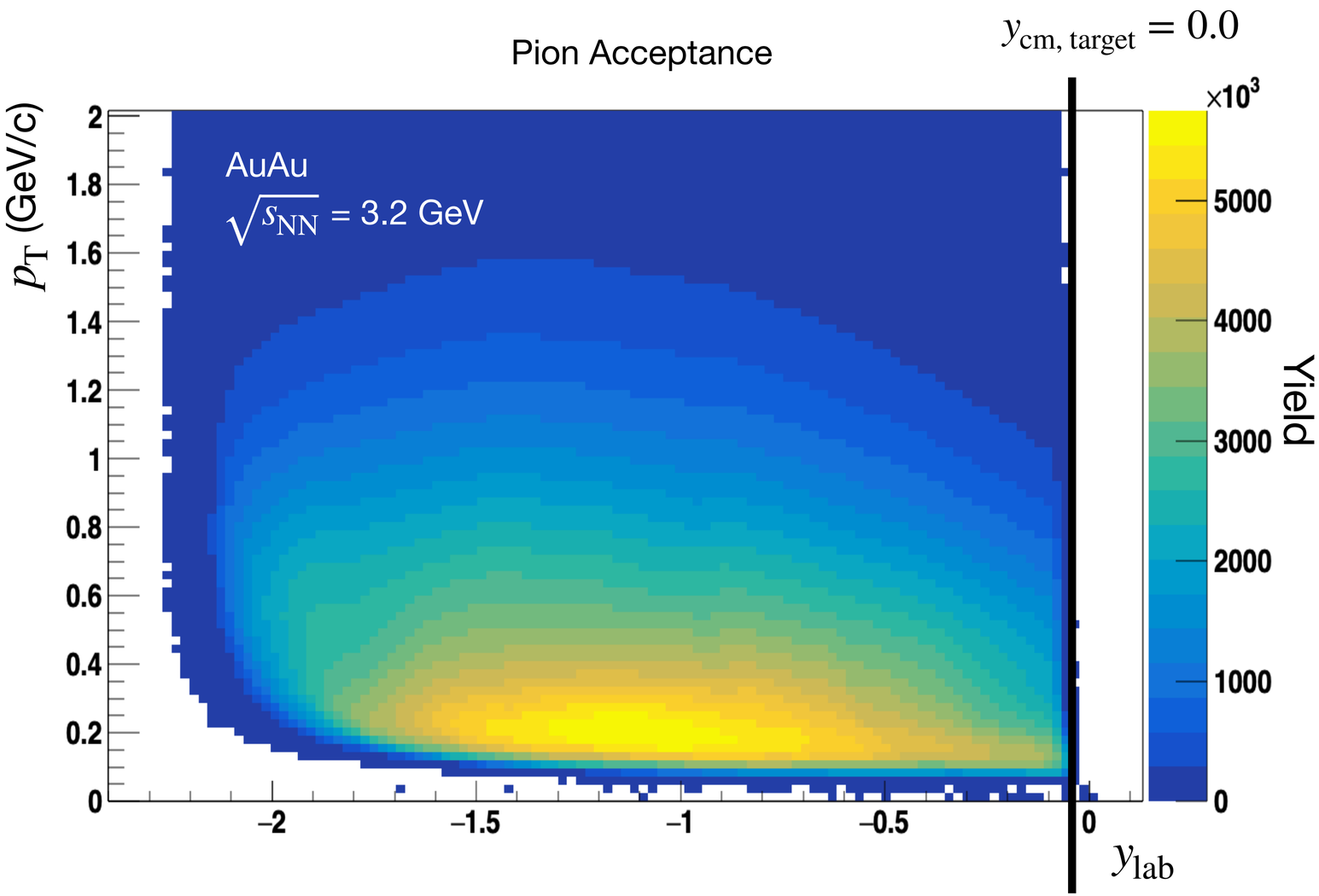
Fixed-target program (FXT)

- Program was mplemented to extend energy reach of BES-II
- New geometry allows for more extensive scanning of QCD phase diagram
- Turns STAR into a fixed-target experiment with a gold foil target at the west end of the detector
- As energy increases, Center of Mass rapidity (y_{cm}) moves into the endcap; eTOF becomes *critical*



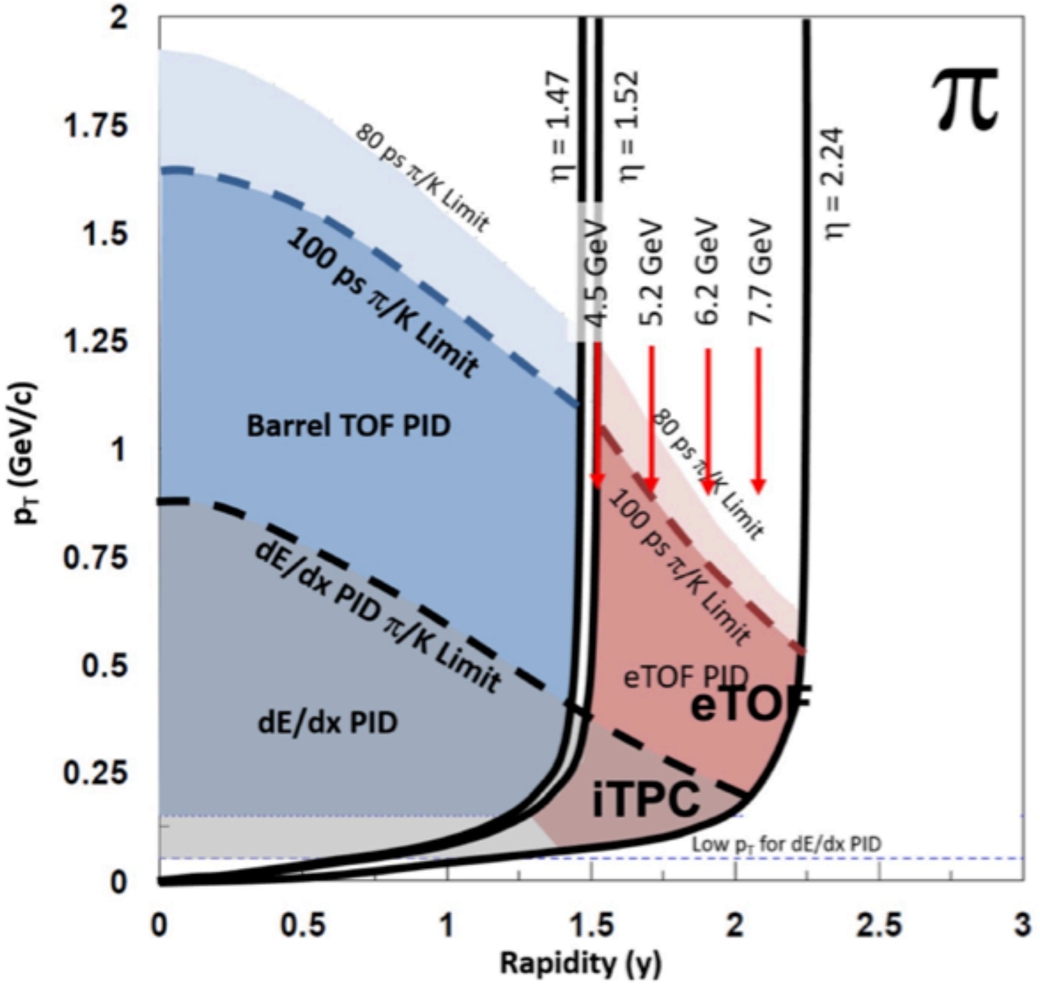
Time Projection Chamber (TPC)

- Recently upgraded (iTPC upgrade, 2019)
- Replaced inner pad rows (higher density of pad rows than before)
- Better dE/dx and momentum resolution.
- For FXT, -2.24 < η < 0
- With iTPC upgrade, a validation of the efficiency calculations is needed



Endcap Time-of-Flight (eTOF)

- Psuedorapidity coverage of: $-2.24 < \eta < -1.52$
- New detector for BES-II, implemented in 2019
- Extends available phase-space for STAR analyses
- When combined with collider data, will allow for large rapidity reach beyond center-of-mass rapidity, and extensive comparisons with collider data
- Center-of-mass rapidity moves into eTOF acceptance at higher FXT energies



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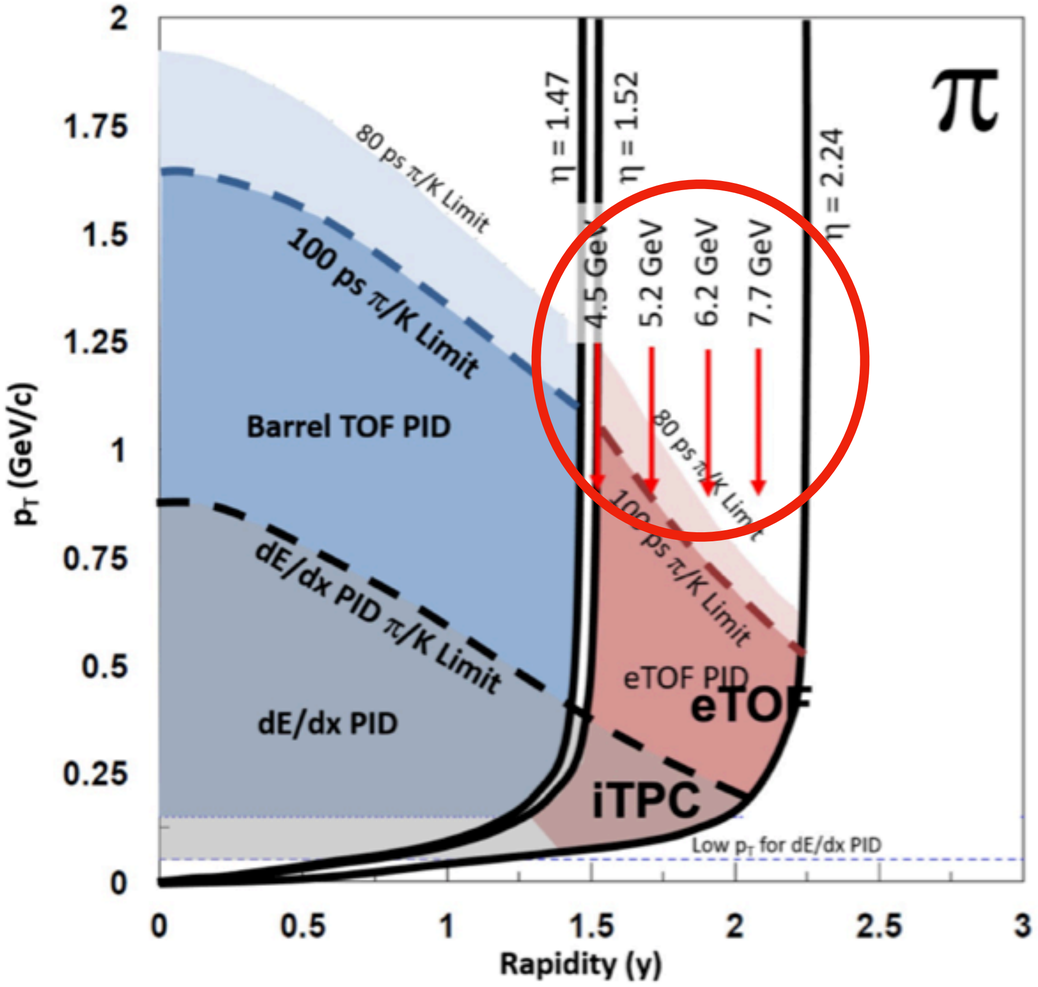
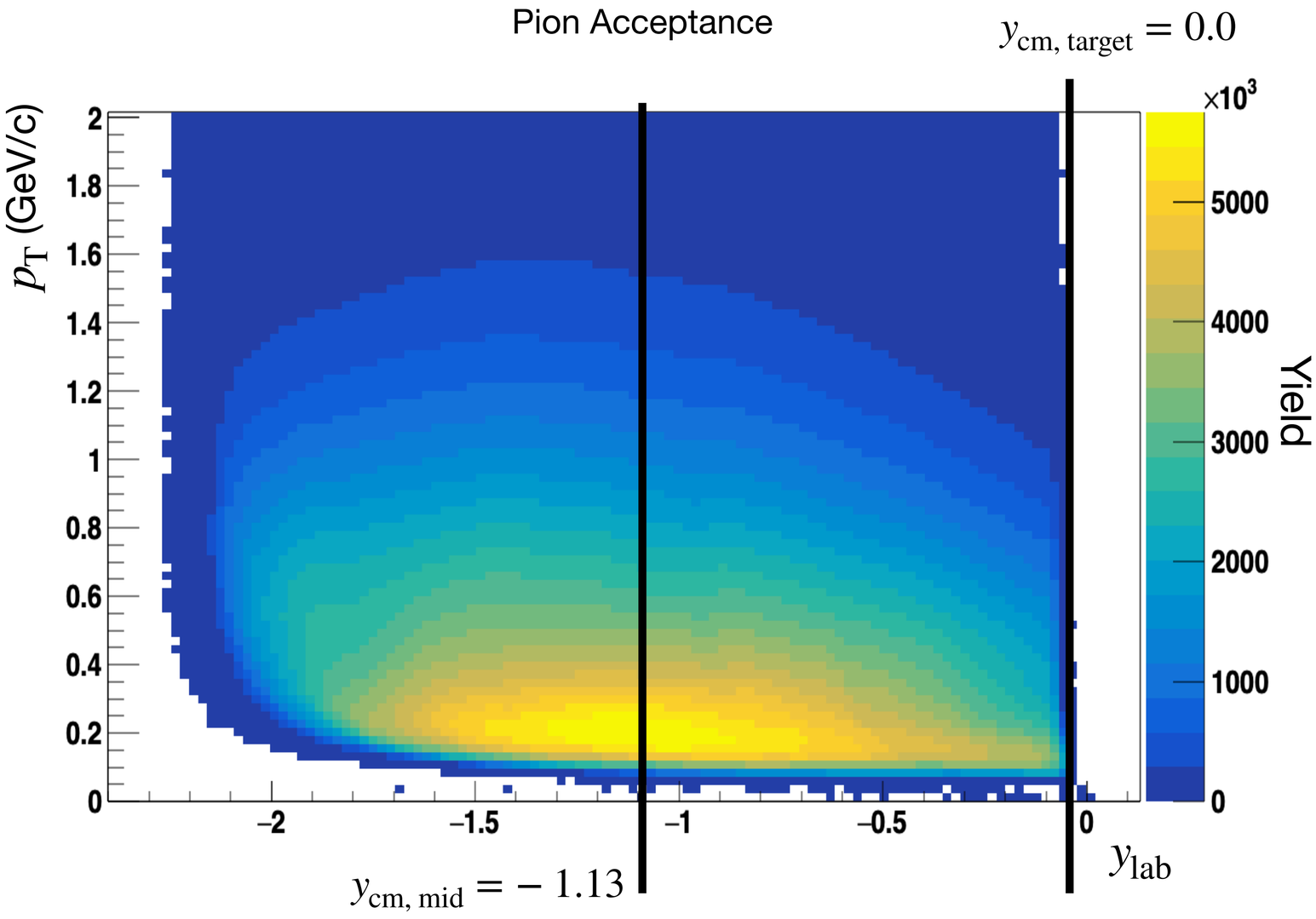


Key energy for validation: 3.2 GeV

- 3.2 GeV rapidity range reaches forward and backwards of center-of-mass rapidity

- Particle yields should be symmetric around mid-rapidity

- Provides a useful check of FXT spectra measurement methodology



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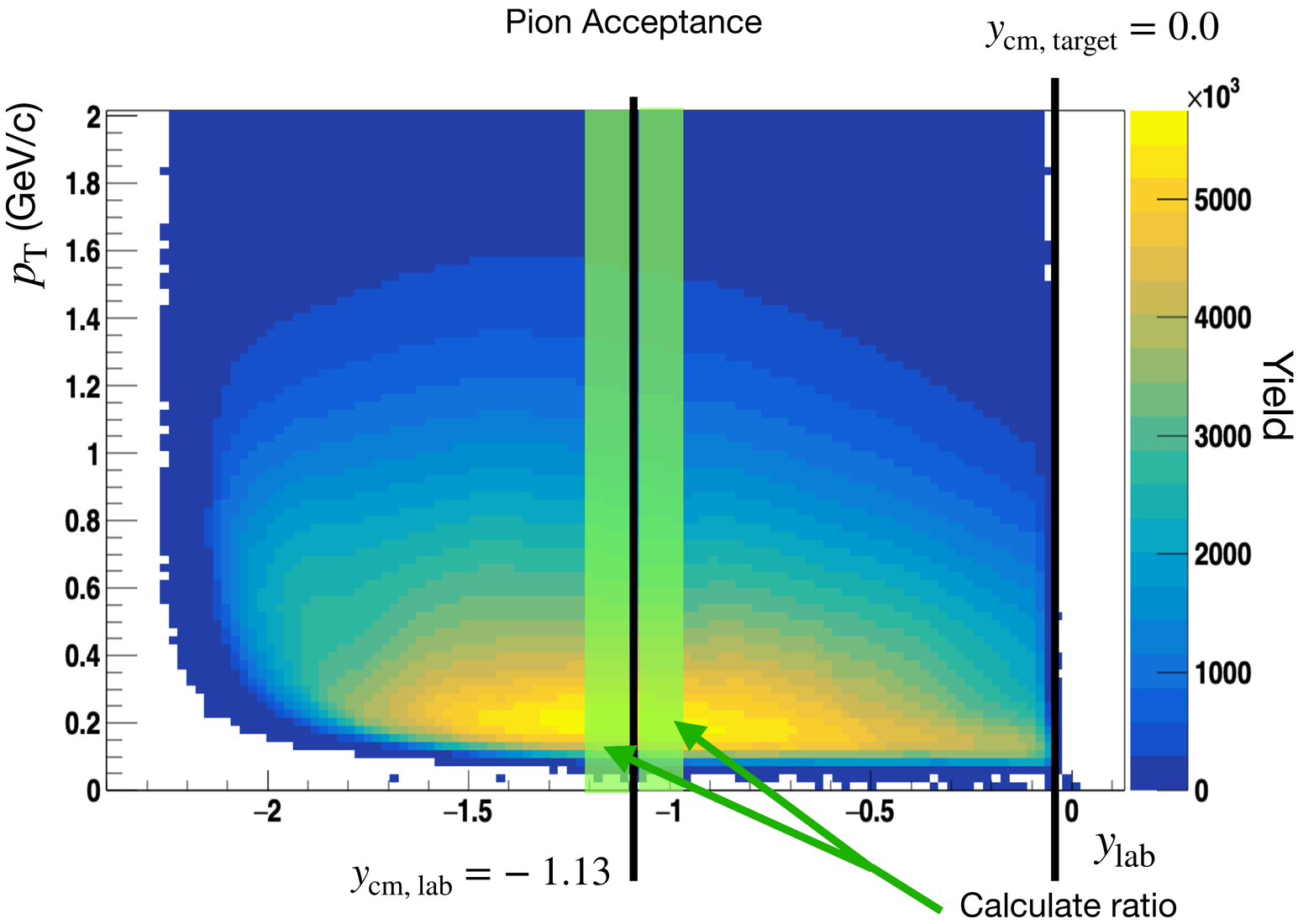

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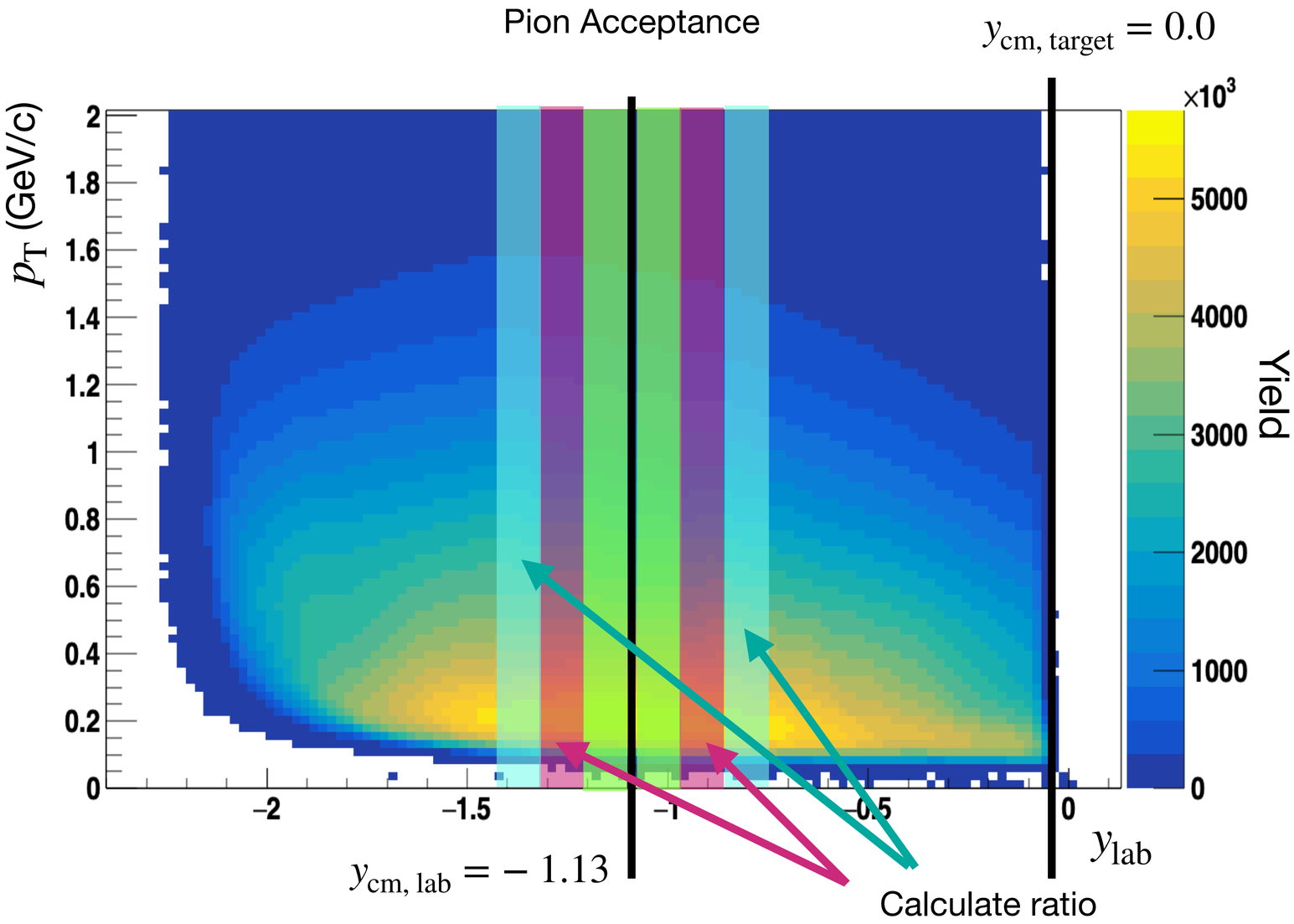

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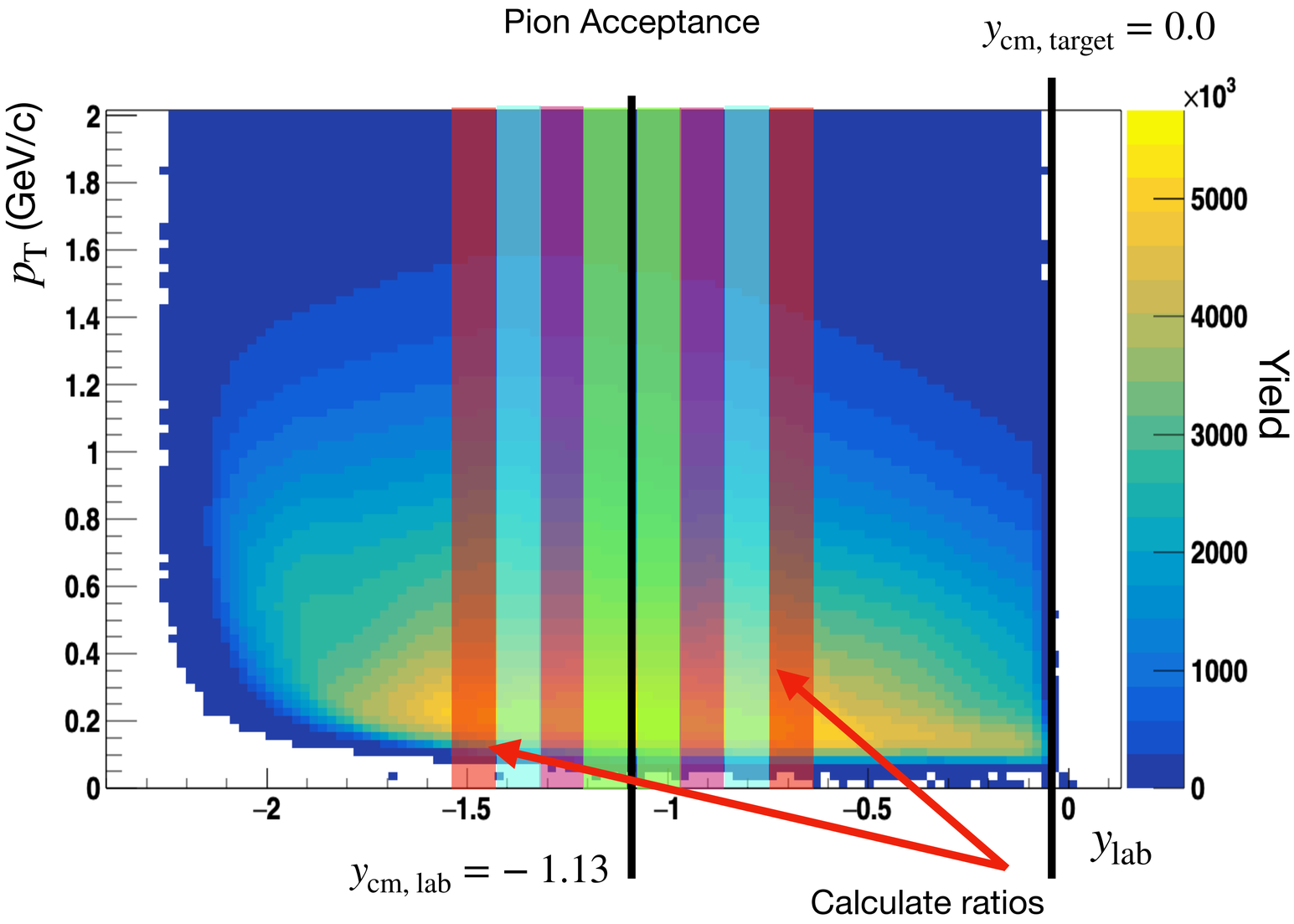
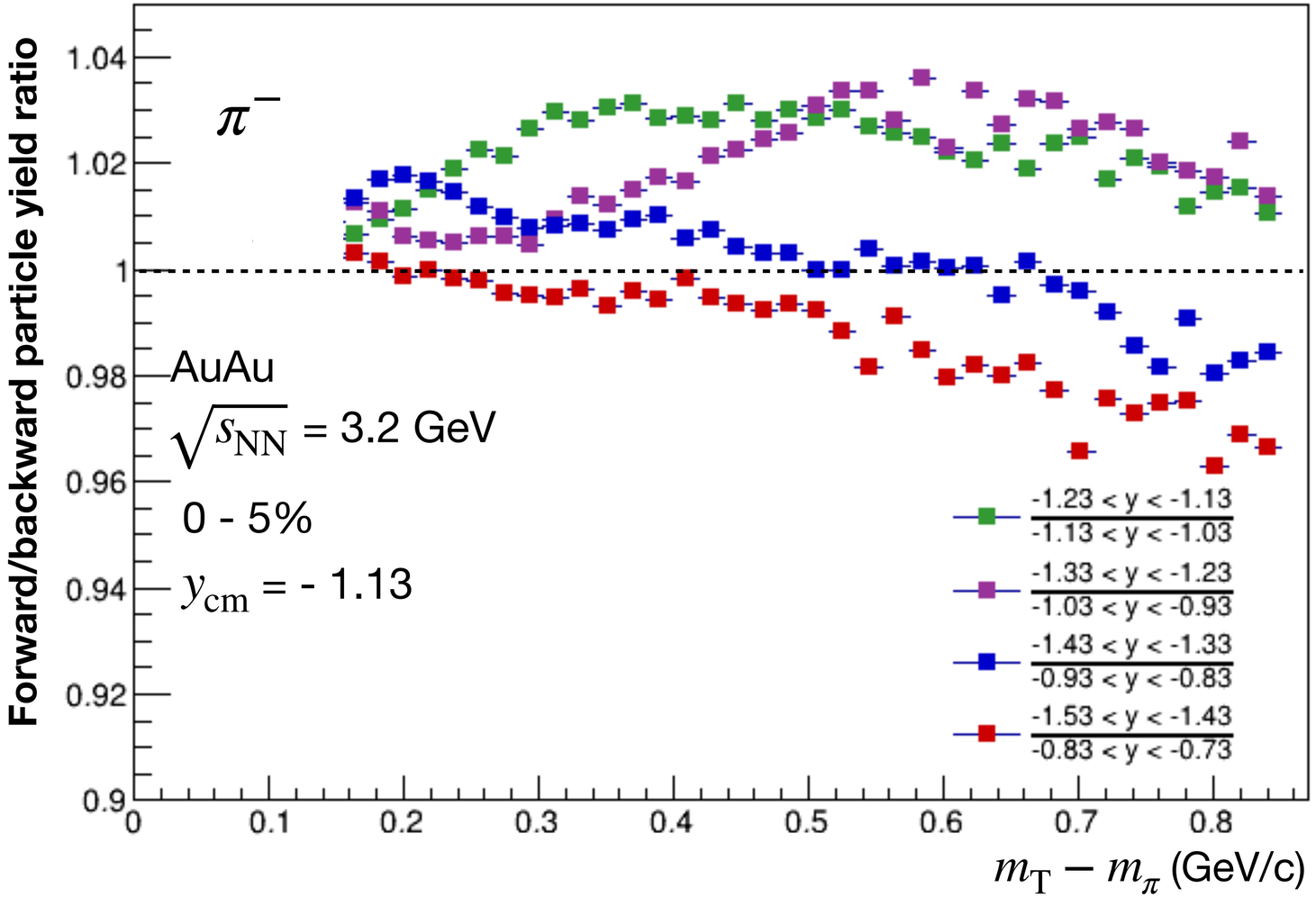


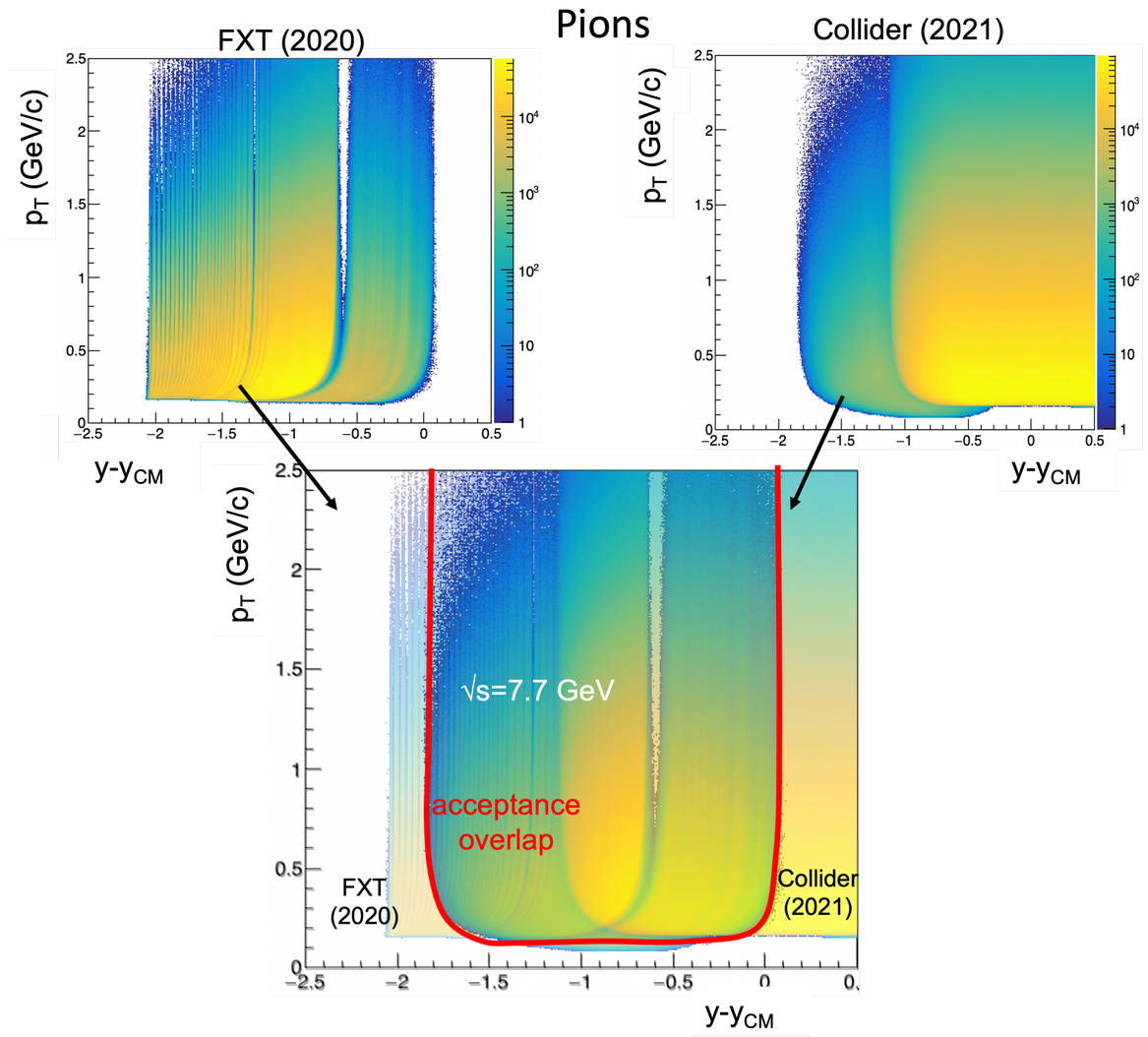
Forward/backward ratios at 3.2 GeV

- Points measured by TPC only
- Ratios shown deviate from unity up to 4%
- Differences in central value under investigation
- Can be used to empirically correct efficiency calculation, since this is the only correction applied to the measurement
- Further rapidity checks in other bins going
- No systematic errors included



Key energy for validation: 7.7 GeV

- 7.7 GeV – Overlap energy with collider mode.
- Allows for direct comparison of spectra to collider data.
- Most significant overlap in phase space at 7.7 GeV is with pions
- Important cross check between collider and FXT configurations



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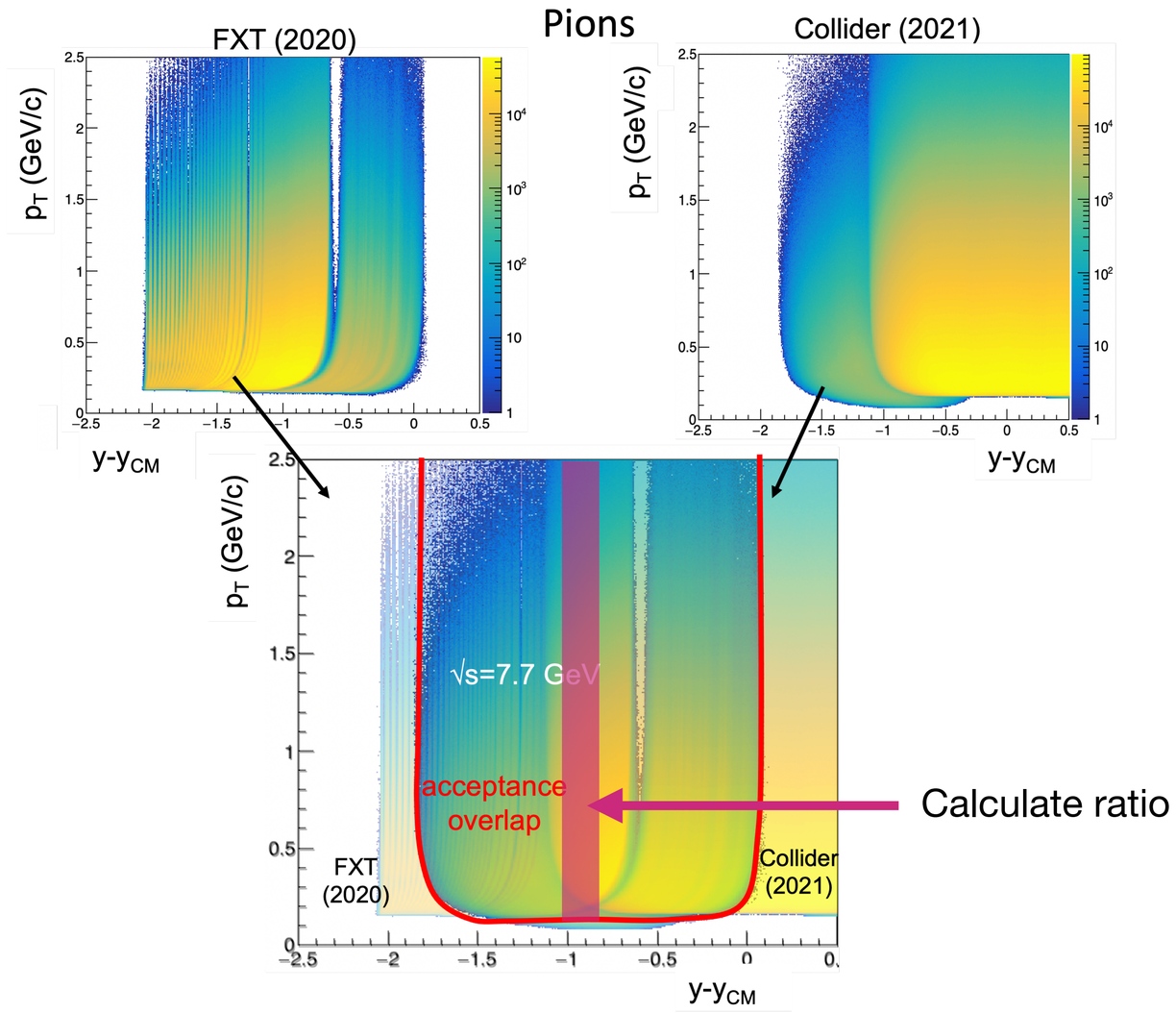
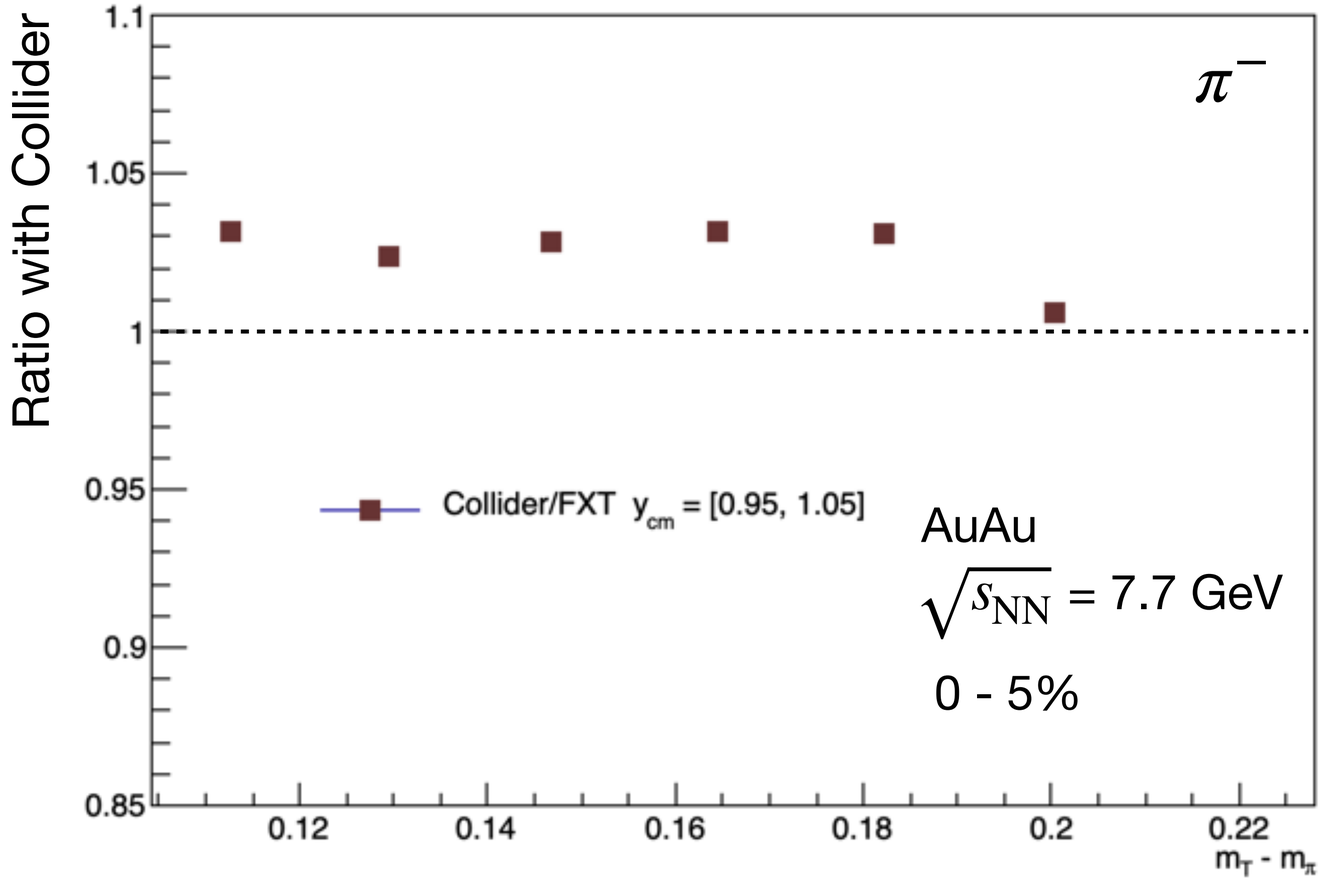


Comparison to collider at 7.7 GeV

- Although same rapidity, particles are produced in different regions of the detector
- Systematic difference in central value up to 3%
- Points measured by TPC only
- Deviations are under investigation
- Further rapidity checks going



Summary

- Measurements of [π,kp] spectra is ongoing for the produced fixed target energies:
  $\sqrt{s_{\mathrm{NN}}}$ = 3.2, 3.5, 3.9, 4.5, 5.2, 6.2, 7.2, 7.7 GeV

- New detector geometry and upgraded iTPC improve particle PID and acceptance, but a validation of our new efficiency calculations are needed

- eTOF expands the phase space available to STAR analyses, and will provide more overlap rapidities with collider at 7.7 GeV, and further checks around mid-rapidity at 3.2 GeV

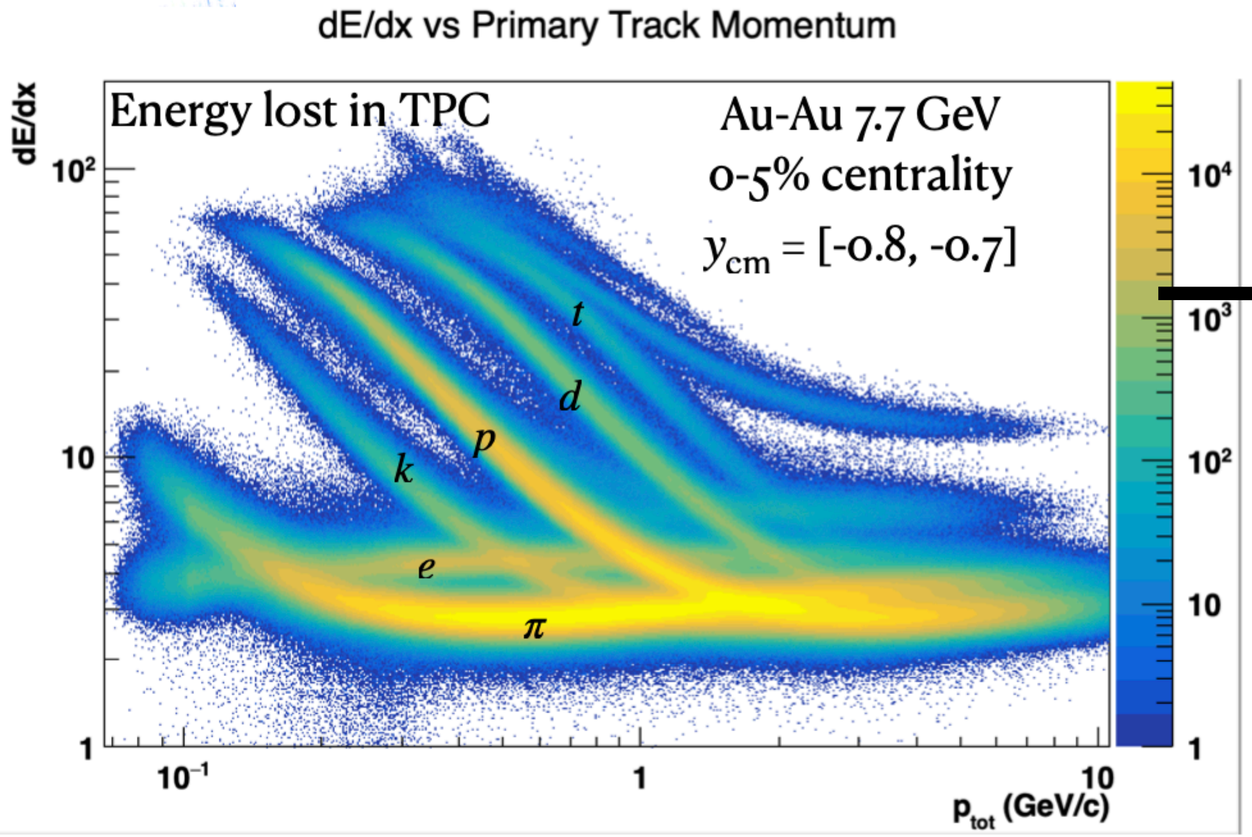
- Ratios forward and backward of mid-rapidity allow us to empirically evaluate the STAR efficiency methodology

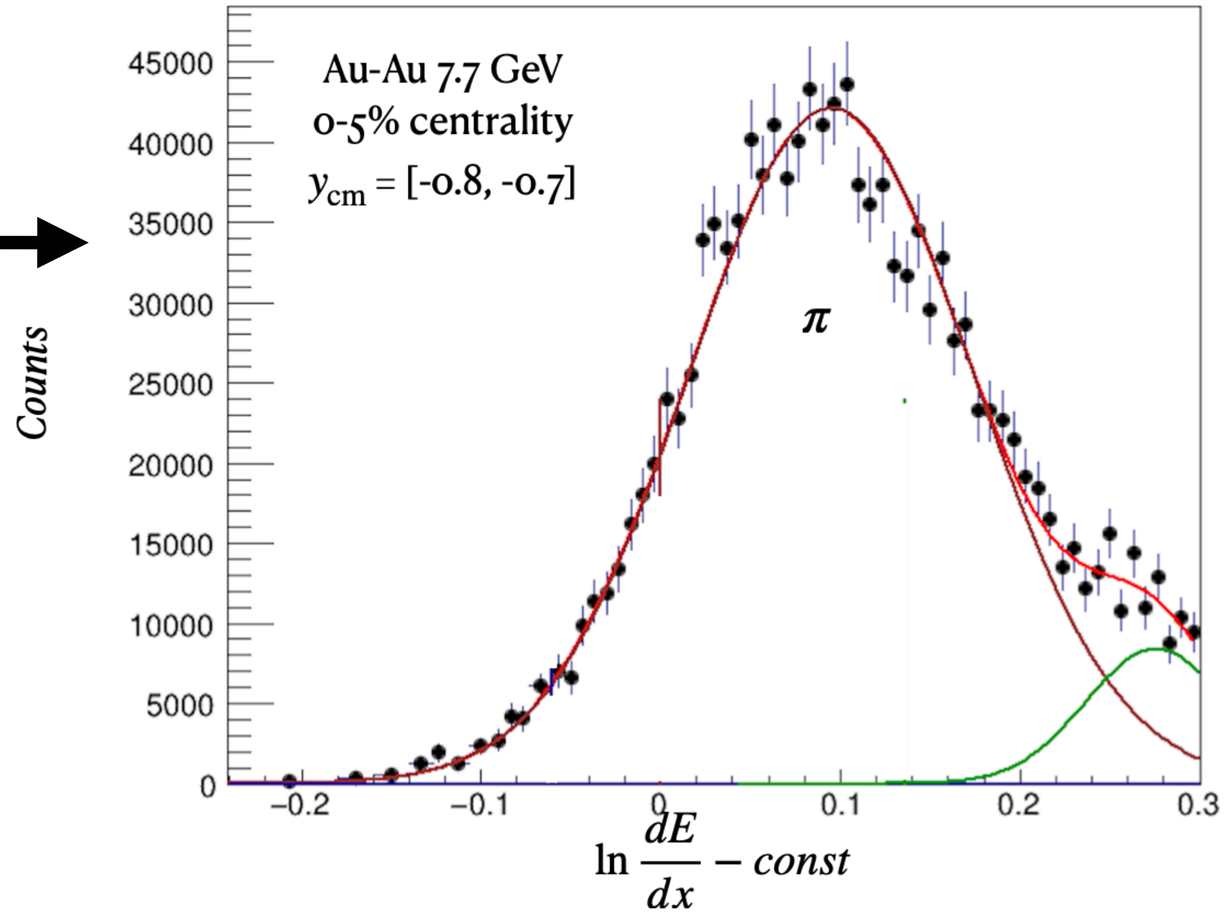
- Ratios shown for $y_{\mathrm{cm}} \pm 0.4$, where a discrepancy of up to 4% is observed

- Cross-checks with collider at $\sqrt{s_{\mathrm{NN}}}$ = 7.7 GeV show a deviation in central value up to 3%

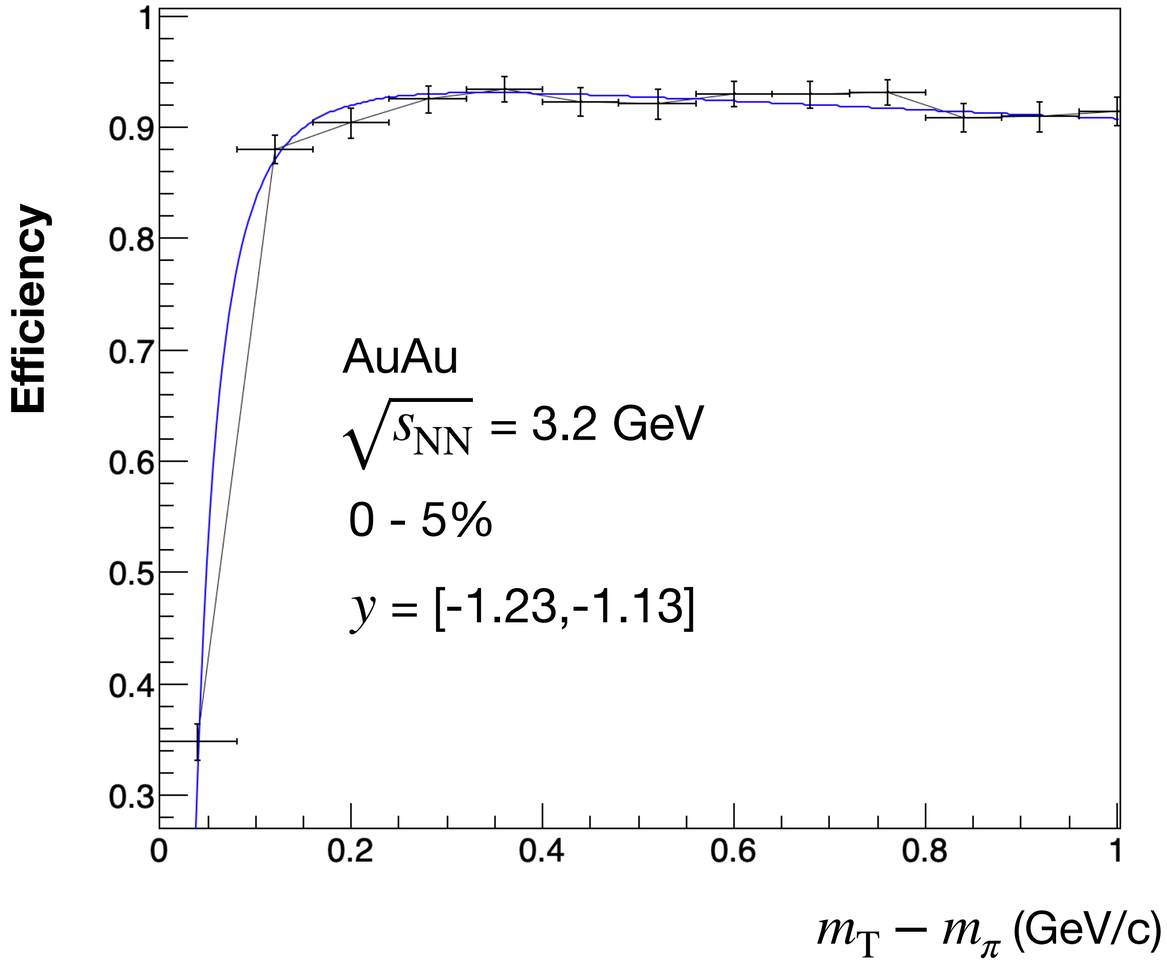
Backup

Methodology





Efficiency


Efficiency
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
0.2
0.4
0.6
0.8
1
AuAu
$\sqrt{s_{NN}}$ = 3.2 GeV
0 - 5%
y = [-1.23,-1.13]
$m_T - m_\pi$ (GeV/c)