Progress and Outlook of the STAR Fixed-Target Program

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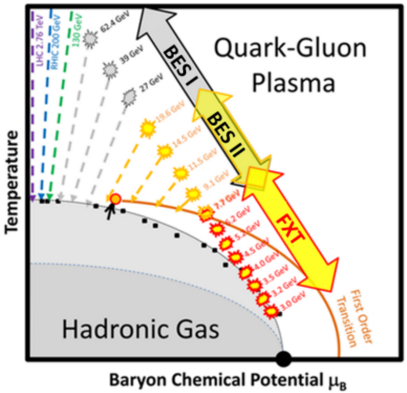
Outline

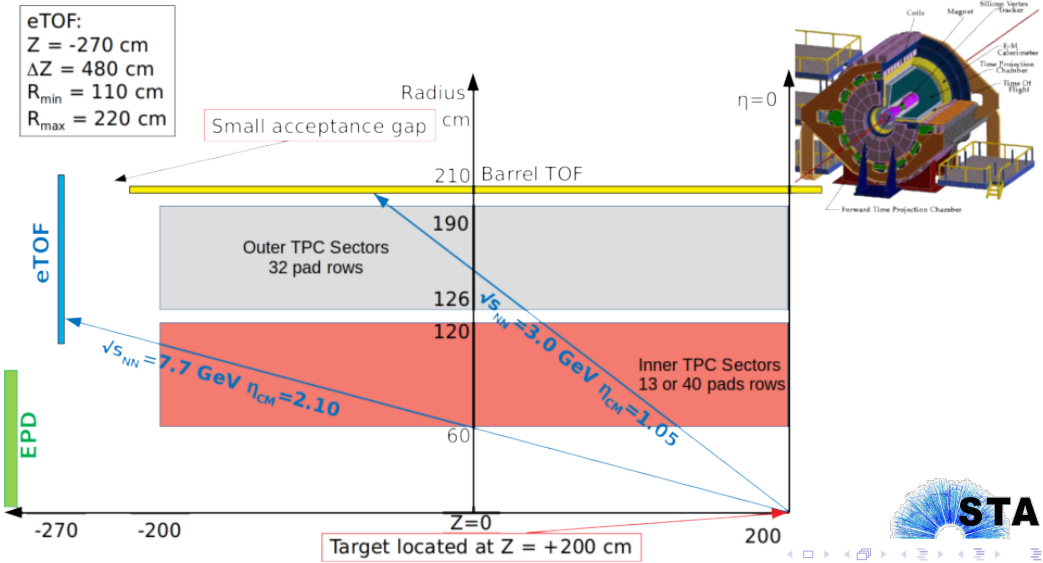
Motivation

- In BES-I, STAR observed fluctuations that could be indicative of a critical point
- Theory predicts that critical fluctuations should return to the baseline as the energy drops but 7.7 GeV is the lowest realistic collider energy at RHIC
- The STAR Fixed-Target program (FXT) allows lower energies to be probed to provide coverage below the hinted critical point
- FXT also allows high statistics measurements of strange baryon momentum spectra and rapidity density distributions which have never been published at many of these energies



Outline

STAR Fixed-Target Geometry



The STAR Fixed-Target

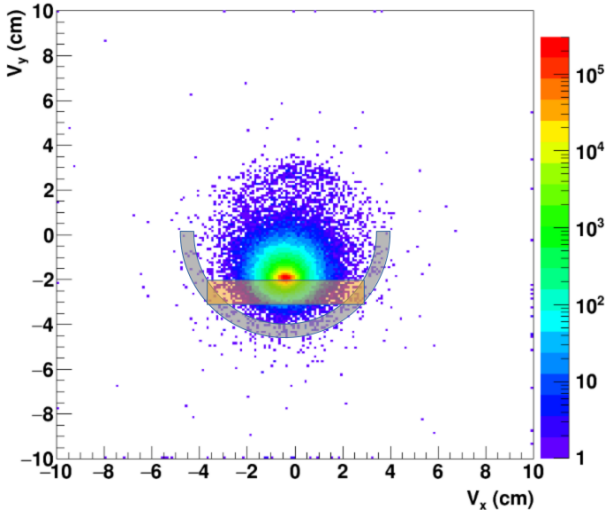
- Target located at $z = 200$ cm (in 2015, located at $z = 210$ cm)
- Target is 0.25 mm thick - 1% interaction probability (in 2015, was 1mm thick)
- Target is held 2 cm below center of beam axis
- Collider filled with 12 bunches

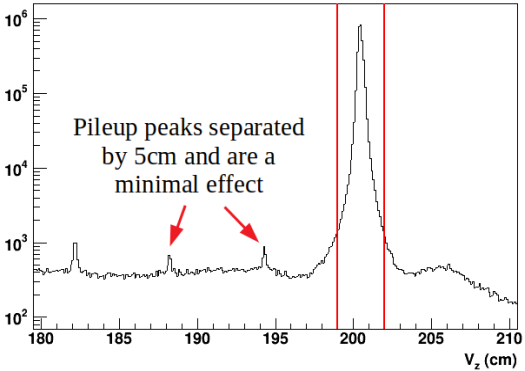
STAR Fixed-Target Data Sets

$\sqrt{s_{NN}}$ (GeV)	E_{beam} (GeV)	y_{CM}	Year Collected	Number of Good Triggers (Millions)
3.0	3.85	1.05	2018	360
3.0	3.85	1.05	2019	3.7
3.2	4.59	1.14	2019	200
3.9	7.3	1.37	2019	53
4.5	9.8	1.52	2015	1.3
7.7	31.2	2.10	2019	50

- Data will be collected at $\sqrt{s_{NN}} = 3.5$, 4.5, 5.2, 6.2, and 7.7 GeV in 2020

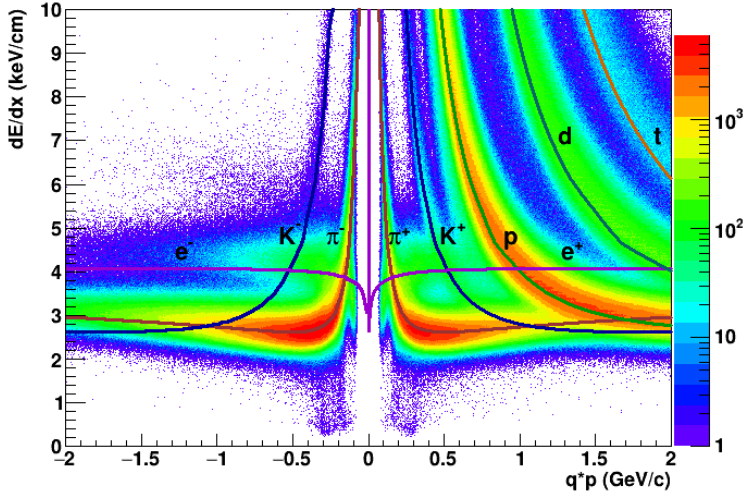
Au+Au $\sqrt{s_{NN}} = 3.2$ GeV Vertex Location





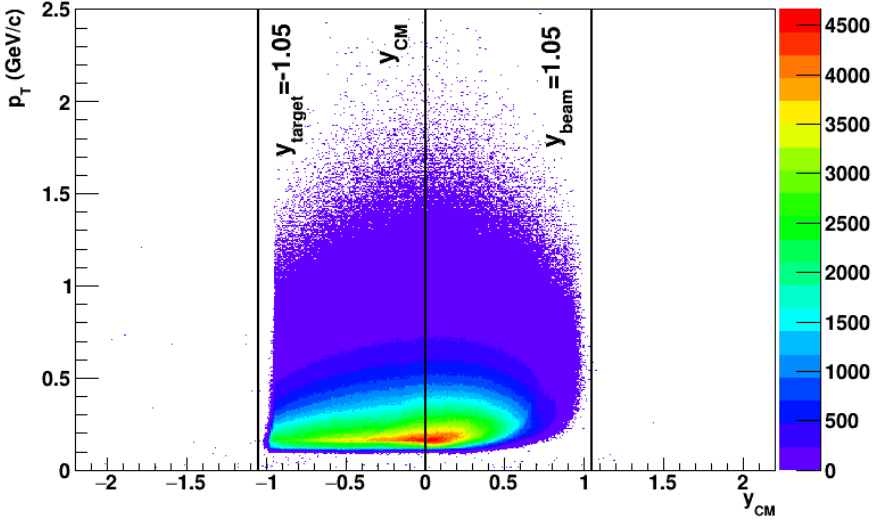
Outline

Au+Au $\sqrt{s_{NN}} = 3.2$ GeV dE/dx



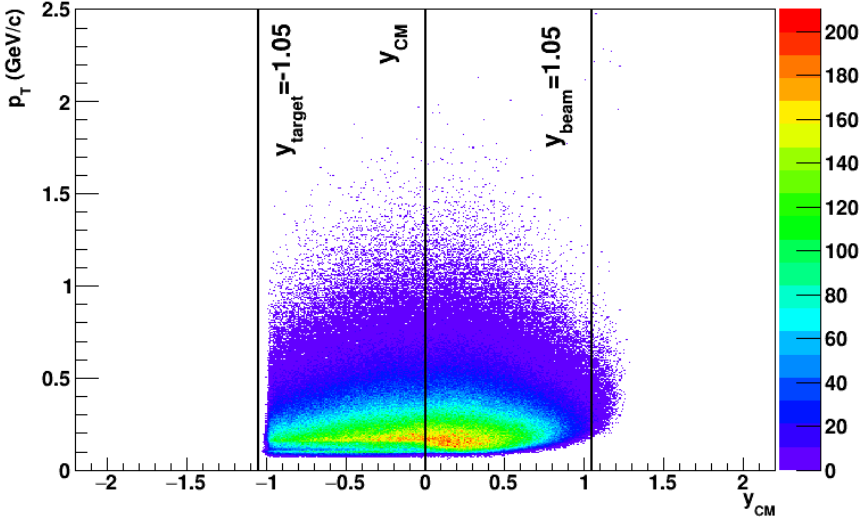
- Very good separation between particles
- Low energy means little contamination between particle species
- π^- dominate negatively charged particles

Au+Au $\sqrt{s_{NN}} = 3.0$ GeV Fixed-Target 2018 π^- Acceptance



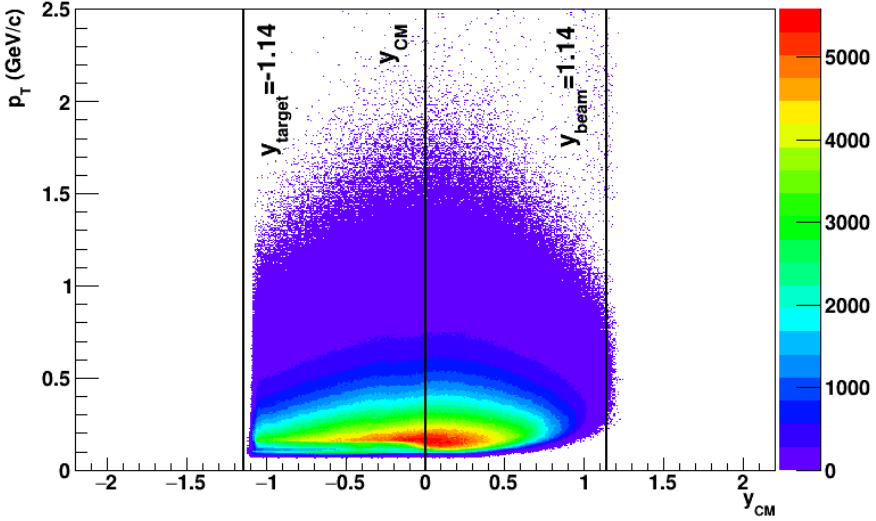
- Good midrapidity acceptance

Au+Au $\sqrt{s_{NN}} = 3.0$ GeV Fixed-Target 2019 π^- Acceptance



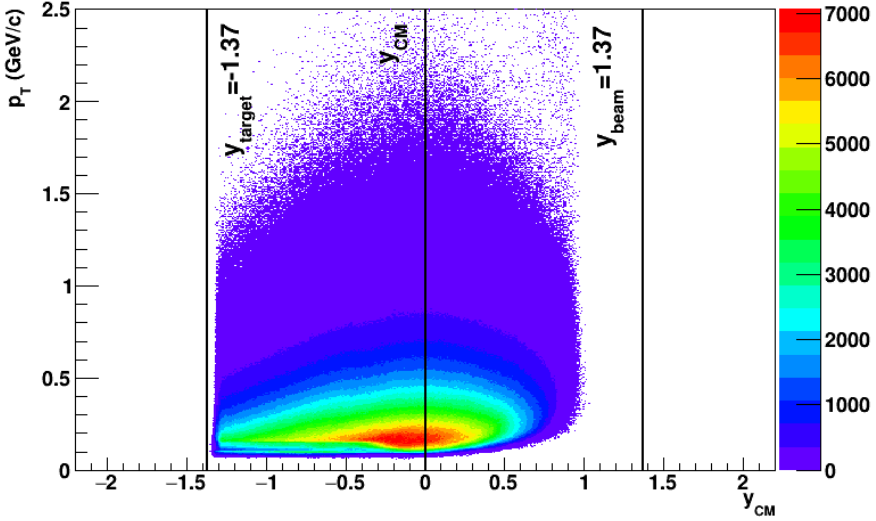
- Improved forward rapidity coverage due to iTPC

Au+Au $\sqrt{s_{NN}} = 3.2$ GeV Fixed-Target 2019 π^- Acceptance



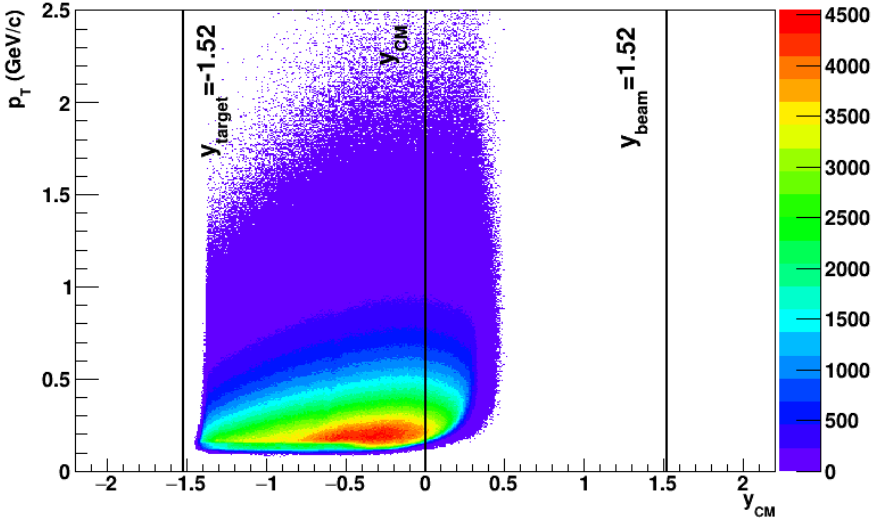
- Good midrapidity acceptance

Au+Au $\sqrt{s_{NN}} = 3.9$ GeV Fixed-Target 2019 π^- Acceptance



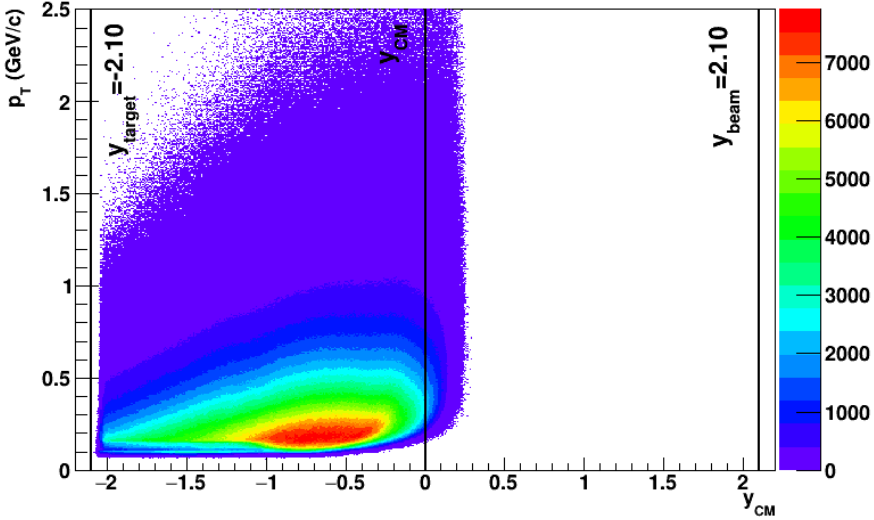
- Good midrapidity acceptance

Au+Au $\sqrt{s_{NN}} = 4.5$ GeV Fixed-Target 2015 π^- Acceptance



- Okay midrapidity coverage, will improve with iTPC

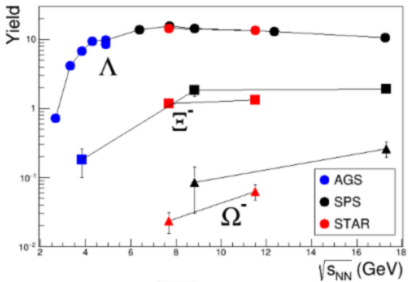
Au+Au $\sqrt{s_{NN}} = 7.7$ GeV Fixed-Target 2019 π^- Acceptance

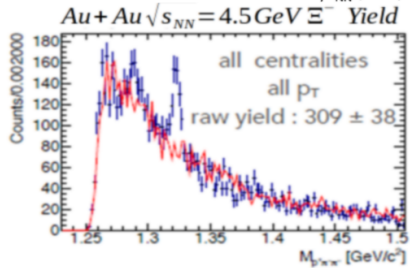


- Coverage extends to midrapidity

Outline

Strange Baryon Measurements





- The high statistics Fixed-Target data sets already collected and those planned in the rest of BES-II will allow for a high precision measurements of the Λ and Ξ^- (Ω^-?) rapidity density distributions at these energies, many of which were never published by the AGS experiments
- These data along with statistical models[1] are used to predict the yield of the strange baryons at the STAR Fixed-Target energies

[1] P. Braun-Munzinger et al. - Nucl. Phys. A 697, p. 902
[2] E895 - Nucl. Phys. A 698, p. 495
[3] E877 - Phys. Rev. C 63, 014902
[4] E891 - Phys. Lett. B 386, p. 496
[5] NA49 - Phys. Rev. Lett. 93, 022302
[6] STAR - arXiv:1906.03732 [nucl-ex]

Strange Baryon Yield Estimates

$\sqrt{s_{NN}}$ (GeV)	Number of Top 5% Centrality Events	Estimate of Particle Count for Top 5% Centrality		
		Λ	Ξ^-	Ω^-
3	18M	1.4M	7k	35
3.2	10M	1.5M	10.5k	80
3.9	2.5M	1.5M	4k	200
4.5	200k	36k	52	< 10
7.7	2.5M	2.1M	17k	850

- π, K, and p efficiencies estimated using ratio of the measured yield to published data
- Expected Λ, Ξ^-, and Ω^- yields estimated from published data or statistical models using the main charged decay channels and daughter PID efficiencies
- Estimated yield multiplied by number of top 5% centrality events expected assuming minimum-bias trigger

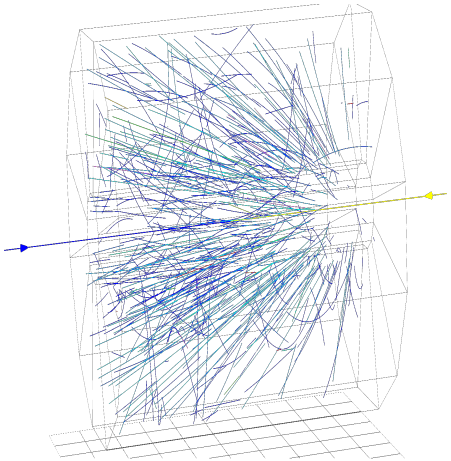
Outline

Conclusions

- The STAR Fixed-Target program has started successfully and has already collected large amounts of data
- The acceptance of the STAR detector for Fixed-Target data is well understood and will allow us to achieve our physics goals
- We expect to perform high-statistics measurements of strange baryons and produce spectra and rapidity density distributions for Λ and Ξ^-, which have never been published at many of these energies

Backup

Event and Track Selection Cuts



- Event selection
  - Select on minimum-bias events (using mixture of EPD, BBC, and VPD triggers)
  - $199 < V_z < 202$ cm
- Track selection
  - Track projects back to the primary vertex (at target location)
  - Distance of Closest Approach (DCA) ≤ 3