



Strangeness production in Au+Au collisions at $\sqrt{s_{NN}} = 19.6$ GeV with the STAR experiment



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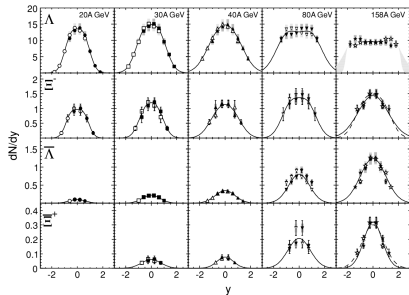


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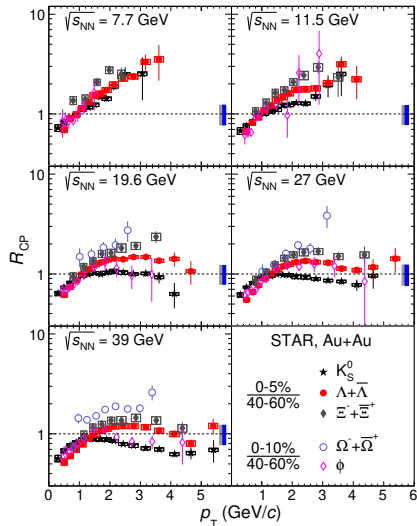


Motivation



NA49, PRC 78, 034918 (2008)

- ❑ Strange hadrons (K_s^0 , Λ , Ξ) are excellent probes for identifying the QCD phase boundary and the onset of deconfinement.
- ❑ Rapidity distribution of baryons (Λ , Ξ^-) shows wider distribution than that of anti-baryons ($\bar{\Lambda}$, $\bar{\Xi}^+$).



STAR, PRC 102, 034909 (2020)

RHIC Beam Energy Scan Program

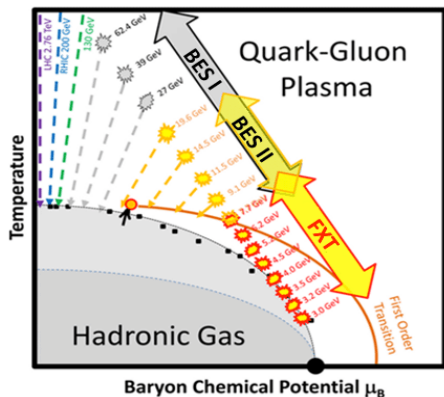
- Study of QCD phase diagram.
- Search for the first order phase transition.
- Search of QCD critical point.

BES-I

$$\sqrt{s_{NN}} = 62.4, 54.4, 39, 27, 19.6, 14.6, 11.5, 7.7 \text{ GeV}$$

BES-II

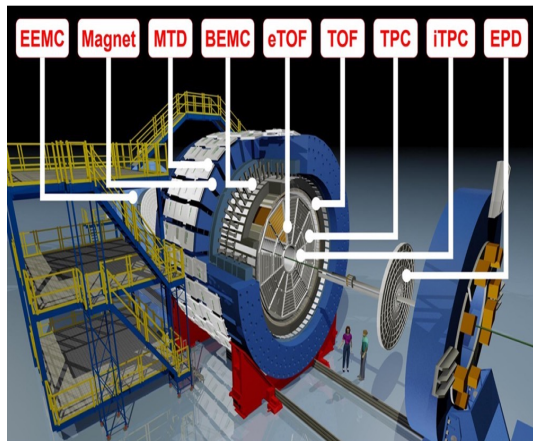
$$\sqrt{s_{NN}} = 19.6, 14.5, 11.4, 7.7 \text{ GeV (collider mode)}$$
$$\sqrt{s_{NN}} = 3.0, 3.2, 3.5, 3.9, 4.5, 5.2, 6.2, 7.7, 9.1 \text{ and } 17.3 \text{ GeV (FXT)}$$



Nuclear Physics A 967, 2017

- ❑ BES program control the temperature and chemical potential of collision system by varying the collision energy.

The STAR detector



Upgraded TPC: iTPC

Particle Identification:

- better momentum resolution
- better dE/dx resolution
- improved acceptance
 $|\eta| < 1.0 \rightarrow |\eta| < 1.5$

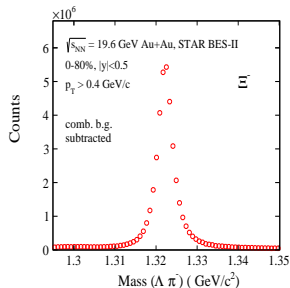
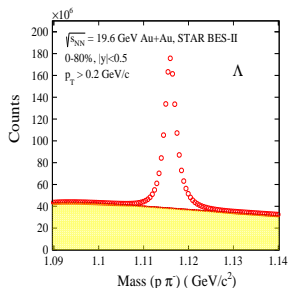
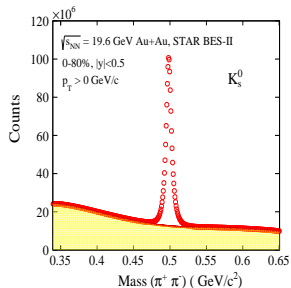
Strange hadrons reconstruction:

- lower p_T and broader rapidity acceptance

➤ **Tracking:** Time Projection Chamber (TPC)

➤ **Particle Identification:** Time Projection Chamber and Time Of Flight (TOF)

- For BES-II program, Au ions are collided.



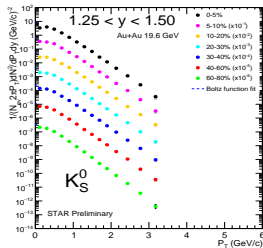
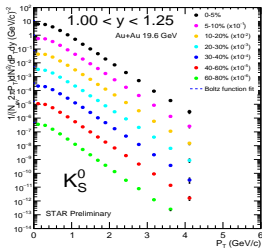
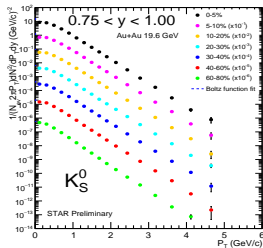
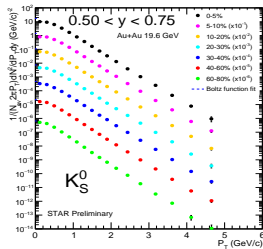
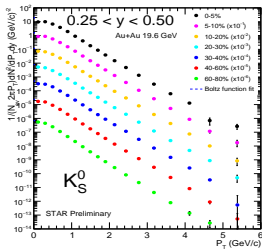
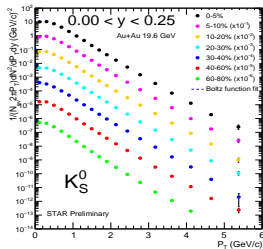
- Daughter particles such as p , π , K are used to reconstruct the decay vertex of multi-strange particles.
- Large number of strange particles allow multi-differential measurements.

$$K_s^0 \rightarrow \pi^+ + \pi^-, B = 69.2\%$$

$$\Lambda (\bar{\Lambda}) \rightarrow p (\bar{p}) + \pi^- (\pi^+), B = 63.9\%$$

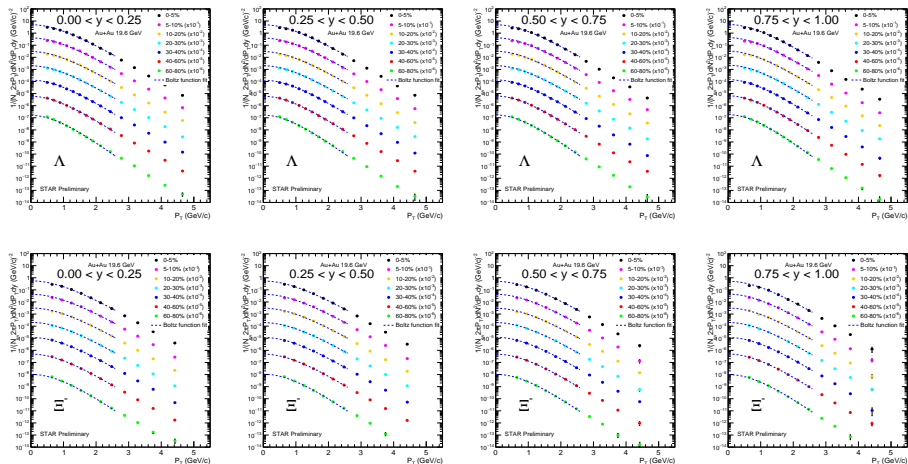
$$\Xi^- (\bar{\Xi}) \rightarrow \Lambda (\bar{\Lambda}) + \pi^- (\pi^+), B = 99.9\%$$

$K_S^0 p_T$ spectra



- K_S^0 can be measured down to zero p_T , no extrapolation is needed for the total yield.
- Rapidity: $|y| < 1.5$, $\Delta y = 0.25$

Λ , Ξ^- p_T spectra

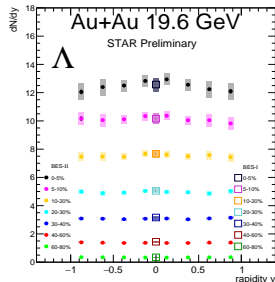
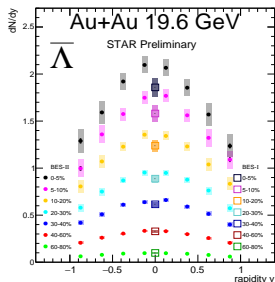
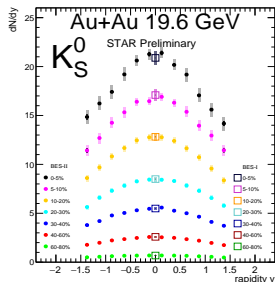


Low p_T extrapolation for Λ , Ξ^- : Boltzmann function

Rapidity: $|y| < 1.0$, $\Delta y = 0.25$

Λ yields corrected for feed-down from Ξ and Ξ^0

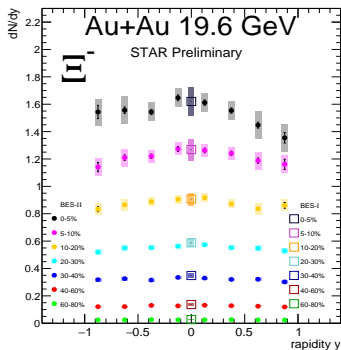
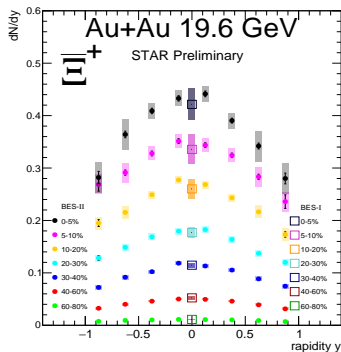
Rapidity distribution of K_s^0 , Λ , $\bar{\Lambda}$



- Rapidity distribution of meson K_s^0 and anti-baryon $\bar{\Lambda}$ shows Gaussian-like distributions.
- Rapidity distribution of baryon Λ shows wider distribution than that of anti-baryon $\bar{\Lambda}$.
 - Extra contributions from stopped baryons.
- NA49 results also show similar trends.

NA49, PRC 78, 034918 (2008)

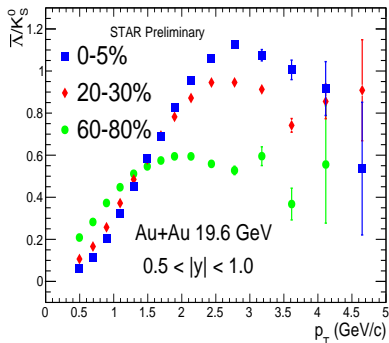
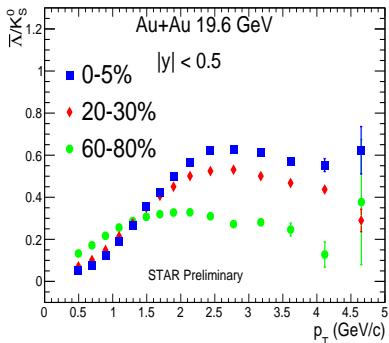
Rapidity distribution of Ξ^- , Ξ^+



- Rapidity distribution of anti-baryon Ξ^+ shows Gaussian-like distribution.
- Rapidity distribution of baryon Ξ^- shows wider distribution than that of anti-baryon Ξ^+ .
 - Extra contributions from stopped baryons.
- NA49 results also show similar trends.

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Baryon enhancement at intermediate p_T



- Ratios in central collisions are higher than that in peripheral collisions at intermediate p_T , indicating hadron formation through parton recombination and parton collectivity.
 - QGP is formed at early stage.
- Clear centrality and rapidity dependence of (anti-)baryon-to-meson ratio at intermediate p_T region.

- ❑ Rapidity dependence of strange and multi-strange particle production with extended p_T coverage at $\sqrt{s_{NN}} = 19.6$ GeV in BES-II.
- ❑ Rapidity density distribution of baryon is wider than that of anti-baryons at $\sqrt{s_{NN}} = 19.6$ GeV.
- ❑ Baryon enhancement at intermediate p_T in central collisions as compared to peripheral collisions is observed at $\sqrt{s_{NN}} = 19.6$ GeV \rightarrow Consistent with QGP formation.

Outlook

- ❖ Multi-strange particle Ω^- ($\bar{\Omega}^+$) will also be included in the analysis at $\sqrt{s_{NN}} = 19.6$ GeV.
- ❖ Strangeness measurements at lower energies from $\sqrt{s_{NN}} = 3.2$ to $\sqrt{s_{NN}} = 14.6$ GeV will probe the onset of deconfinement in BES-II program.

Thank You

Backup Slides

$\bar{\Lambda}$, Ξ^+ p_T spectra

