Strange Hadron Production in Small System Using the STAR Detector

Ishu Aggarwal (for the STAR Collaboration)

Panjab University Chandigarh, India

Email : iaggarwal@rcf.rhic.bnl.gov

I. Motivation

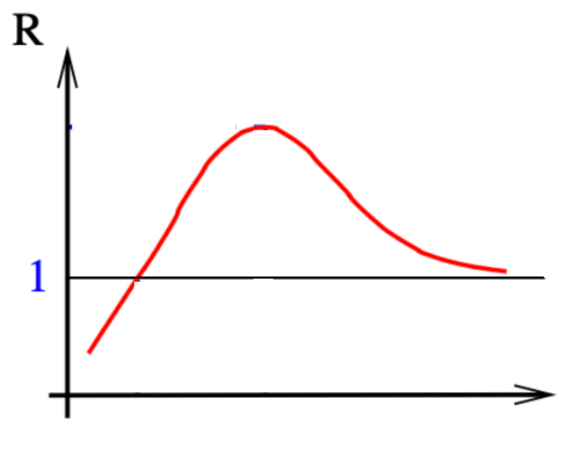
Motivation I : Strangeness as a Probe for Deconfinement

- Strangeness enhancement in A+A collisions w.r.t. $p+p \rightarrow$ a signature of QGP formation.
- Strangeness measurement in d+Au can bridge the multiplicity gap between peripheral A+A and $p+p$.

Motivation II : Probing Cold Nuclear Matter Effects

Nuclear modification factor R_{dAu}

•Cronin effect is seen with nuclear modification factor R



Measurements of particle type and centrality dependence of R_{dAu} (p_T) may help us to understand the mechanism behind Cronin Effect.

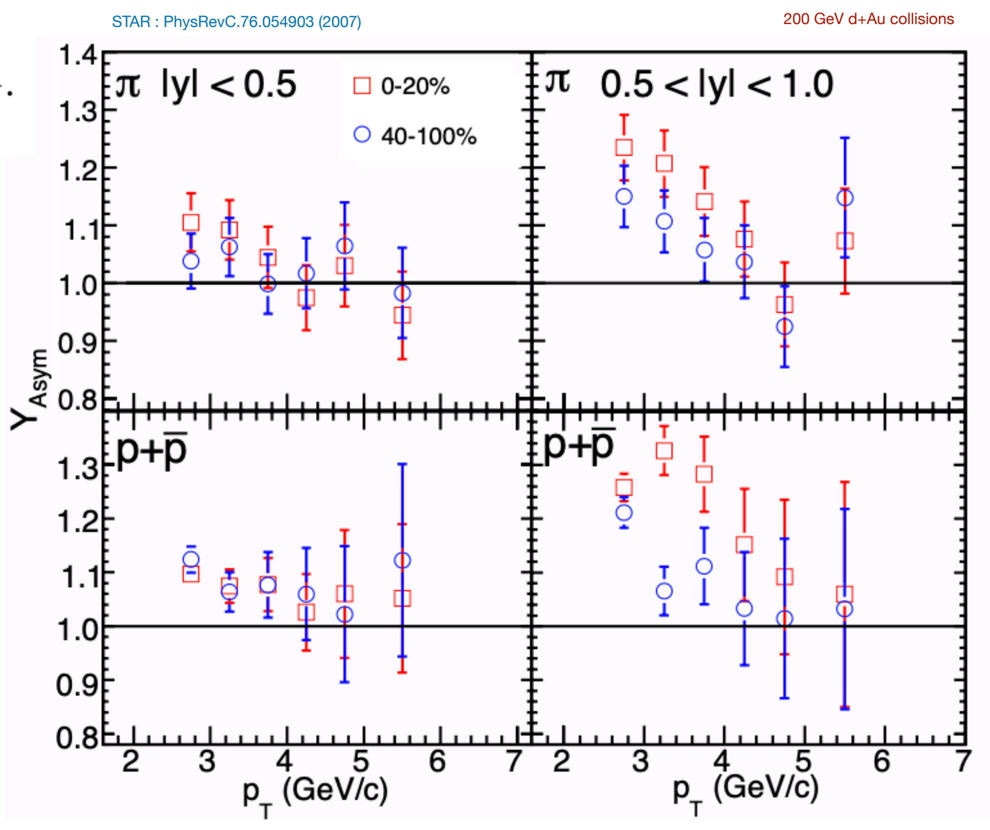
Rapidity Asymmetry

$$Y_{asym}(p_T) = \frac{d^2N(p_T)/dy_{CM}dp_T|_{y_{CM}\in[-b,-a]}}{d^2N(p_T)/dy_{CM}dp_T|_{y_{CM}\in[a,b]}}$$

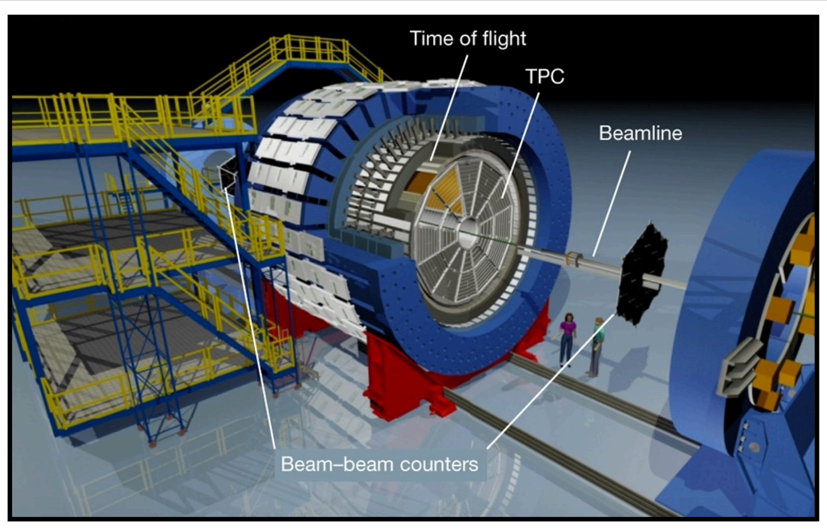
Au going side - backward rapidity

d going side - forward rapidity

- Rapidity Asymmetry provides unique tool to study contributions from nuclear effects (nuclear shadowing, multiple scattering etc.) to particle production.



II. Overview of the STAR Detector



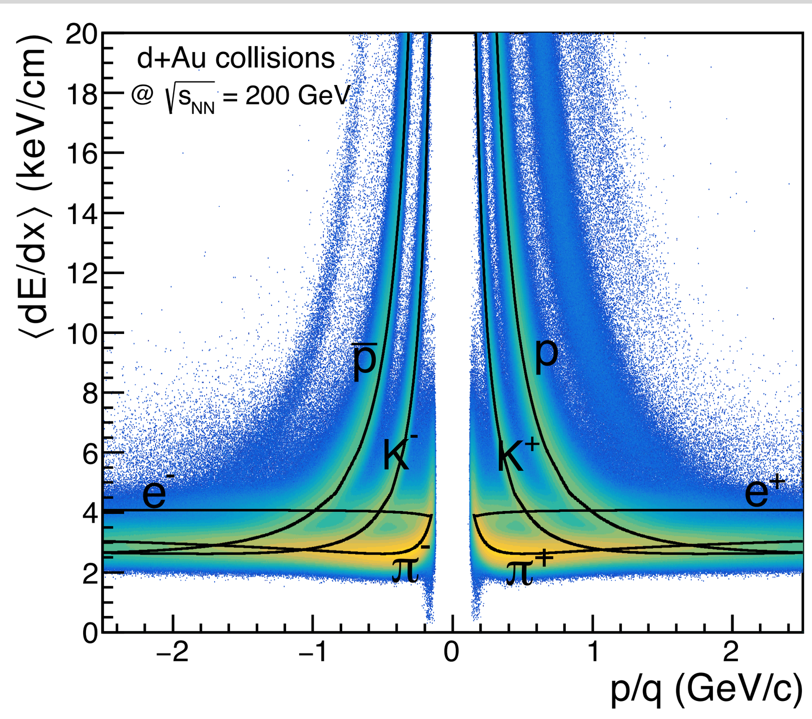
- The Solenoidal Tracker At RHIC, known as STAR, tracks the thousands of particles produced by heavy-ion collisions at RHIC.
- STAR detector is used to study the signatures of the Quark Gluon Plasma (QGP) formation.
- Time Projection Chamber (TPC) is the main detector used for the analysis.

III. Data Set and Particle Identification

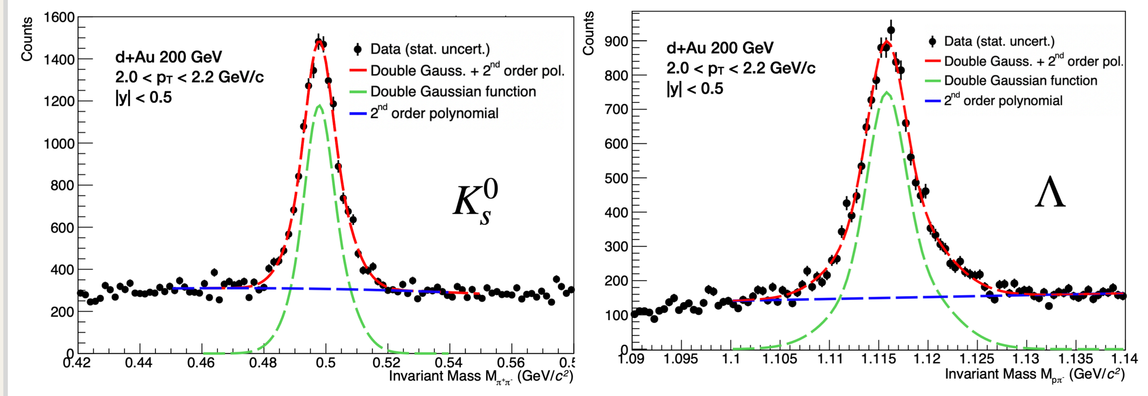
- d+Au collisions @ $\sqrt{s_{NN}}$ = 200 GeV
- Year : 2016
- Events : ~100M

Particle identification is done via $\langle dE/dx \rangle$ measured in TPC

$Z = log\frac{\langle dE/dx \rangle_{measure}}{\langle dE/dx \rangle_{Bichsel}}$, $n\sigma_p = \frac{Z}{\sigma_p}$, where σ_p is the $\langle dE/dx \rangle$ resolution of TPC



IV. K^0_S and Λ Signal Reconstruction



K^0_s, Λ are reconstructed via their hadronic decay channels :

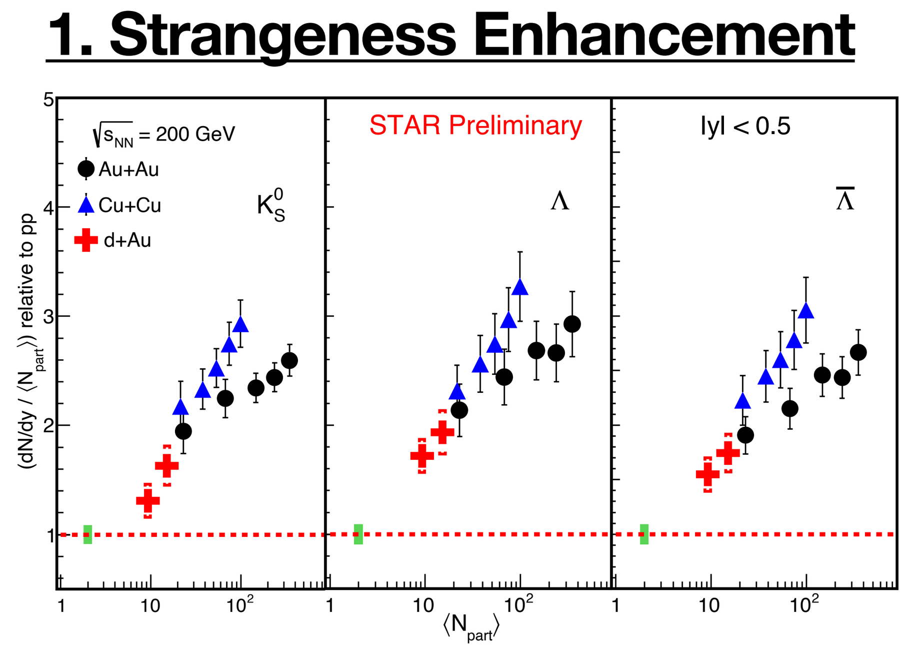
$K^0_s \rightarrow \pi^+ + \pi^-$ (B.R. 69.2%)

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

Raw yields are extracted and corrected for efficiency and acceptance.

V. Results

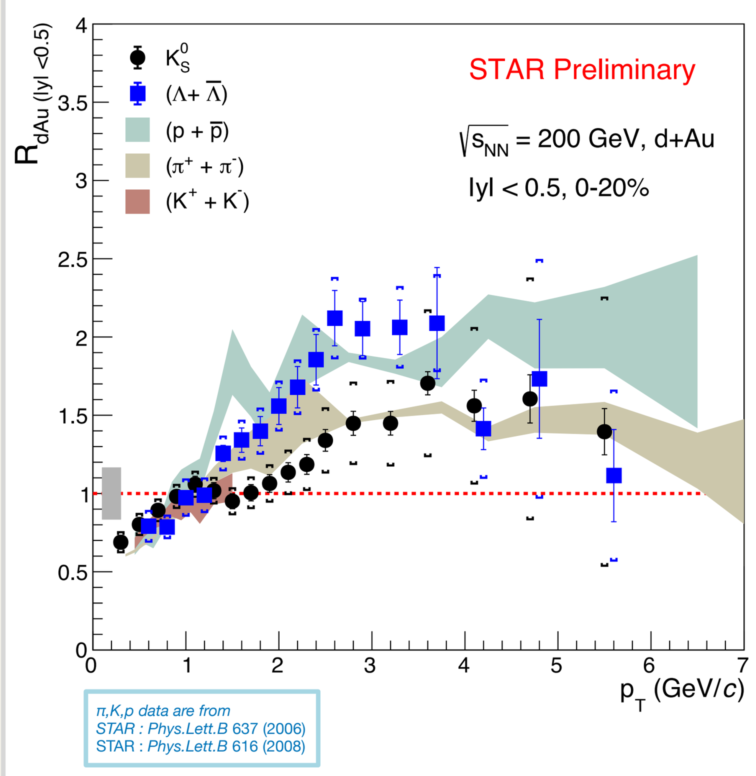
1. Strangeness Enhancement



- $\Lambda(\bar{\Lambda})$ and K^0_s yields in d+Au 200 GeV are enhanced as compared to $p+p$ collisions.
- d+Au fill the gap between $p+p$ and peripheral Cu+Cu & Au+Au collisions.
- Strange particle yields increases as a function of $\langle N_{part} \rangle$.

STAR : Phys. Rev. C 75, 064901 (2007)
STAR : Phys. Rev. Lett. 108, 072301 (2012)
STAR : Phys. Rev. C 79, 034909 (2009)

2. Nuclear Modification Factor

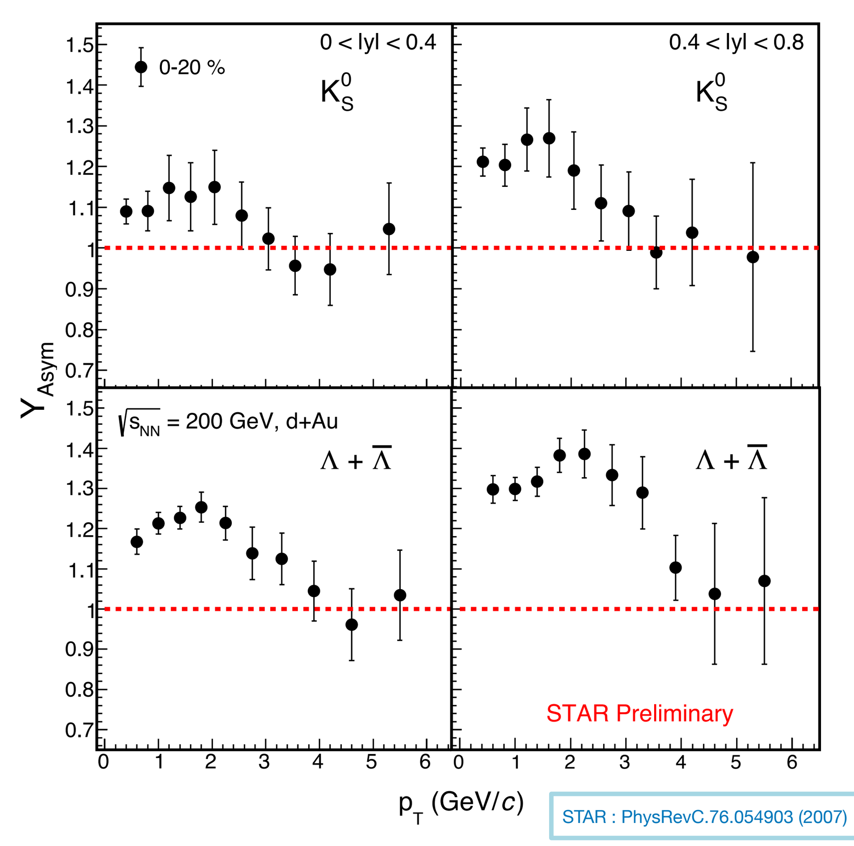


$$R_{dAu}(p_T) = \frac{d^2N/(dp_T dy)}{T_{dAu}d^2\sigma^{pp}/(dp_T dy)}$$

$$T_{dAu} = \langle N_{bin} \rangle / \sigma^{pp}_{inel.}$$

- Cronin-like enhancement is observed for K^0_s & Λ at intermediate p_T.
- R_{dAu} of K^0_s is consistent with charged kaons.
- Enhancement in d+Au compared to p+p for p_T in 2-4 GeV/c is stronger for baryons (Λ, p) compared to mesons (K^0_s, π).

3. Rapidity Asymmetry



$$Y_{asym}(p_T) = \frac{d^2N(p_T)/dy_{CM}dp_T|_{y_{CM}\in[-b,-a]}}{d^2N(p_T)/dy_{CM}dp_T|_{y_{CM}\in[a,b]}}$$

- Y_{asym} > 1 is observed at low p_T
  - Signifies the presence of nuclear effects.
- Consistent with unity at high p_T.
- Hint of more prominent effect towards higher rapidity (0.4 < |y| < 0.8).

VI. Summary

- Yields of K^0_s & $\Lambda(\bar{\Lambda})$ in d+Au collisions are observed to be enhanced w.r.t. $p+p$ collisions : **Strangeness enhancement.**
- **Nuclear modification factor (R_{dAu})** for K^0_s & Λ show Cronin-like enhancement.
- **Rapidity asymmetry** for K^0_s & Λ is observed
  - At low p_T : indicating presence of nuclear effects and is more pronounced at more forward rapidity regions.
  - Asymmetry is more pronounced for Λ compared to K^0_s.

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