Strange Hadron Production in Au+Au Collisions at $\sqrt{s_{NN}} = 54.4\ GeV$

- Motivation
- STAR detector
- Results
  - ✓ p_T spectra
  - ✓ Particle yields
  - ✓ Nuclear modification factor R_{cp}
  - ✓ Strange particles/pions ratio
- Summary

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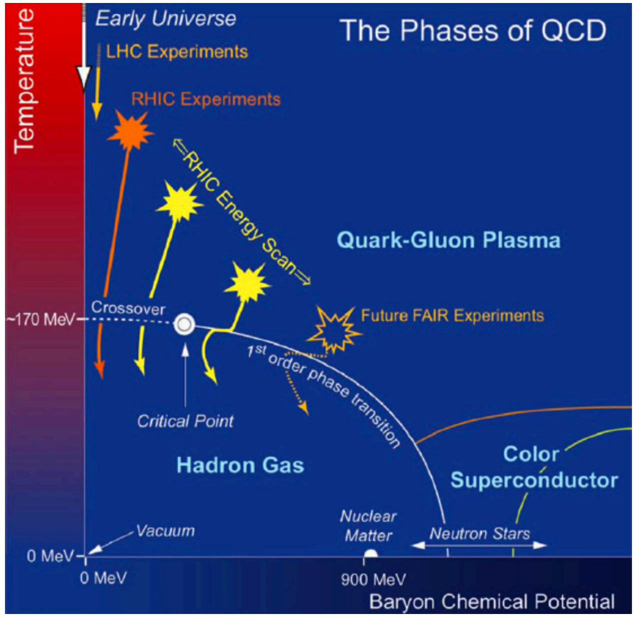
Motivation

Goal: Mapping the QCD Phase Diagram



- BES-I (completed) systematic study of Au+Au collisions at 7.7, 11.5, 14.5, 19.6, 27, 39, 54.4 and 62.4 GeV
- BES-II (ongoing) Au+Au = 7.7 – 19.6 GeV
- Fixed-Target (ongoing) Au+Au = 3.0 – 7.7 GeV, μ_B up to 720 MeV

https://drupal.star.bnl.gov/STAR/starnotes/public/sn0598

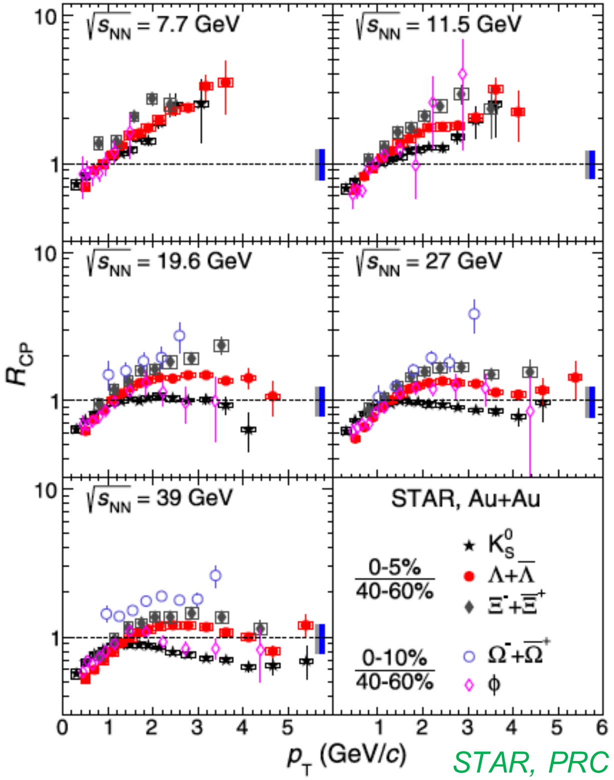
Multi-strange hadrons:

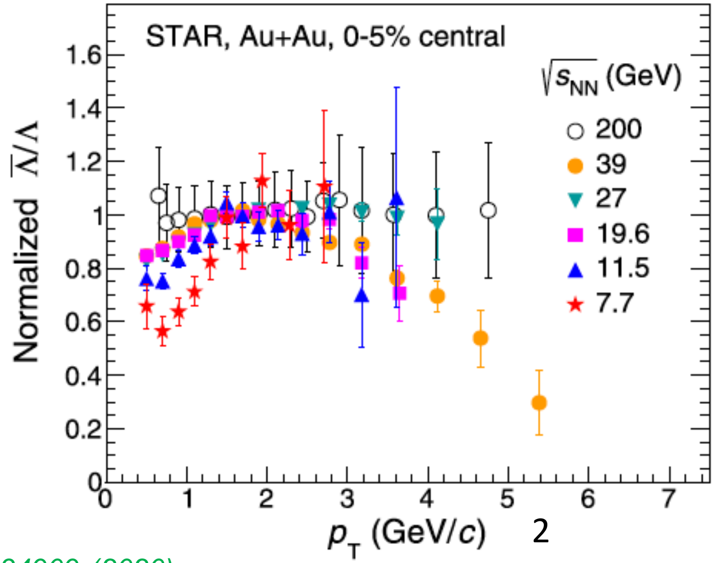
- Early freeze out
- Small hadronic interaction cross section

J. Rafelski and B. Muller, *PRL.56, 2334 (1986)*

STAR, NPA 757, 102(2005)

Sensitive probe to study the initial stage of the collision !





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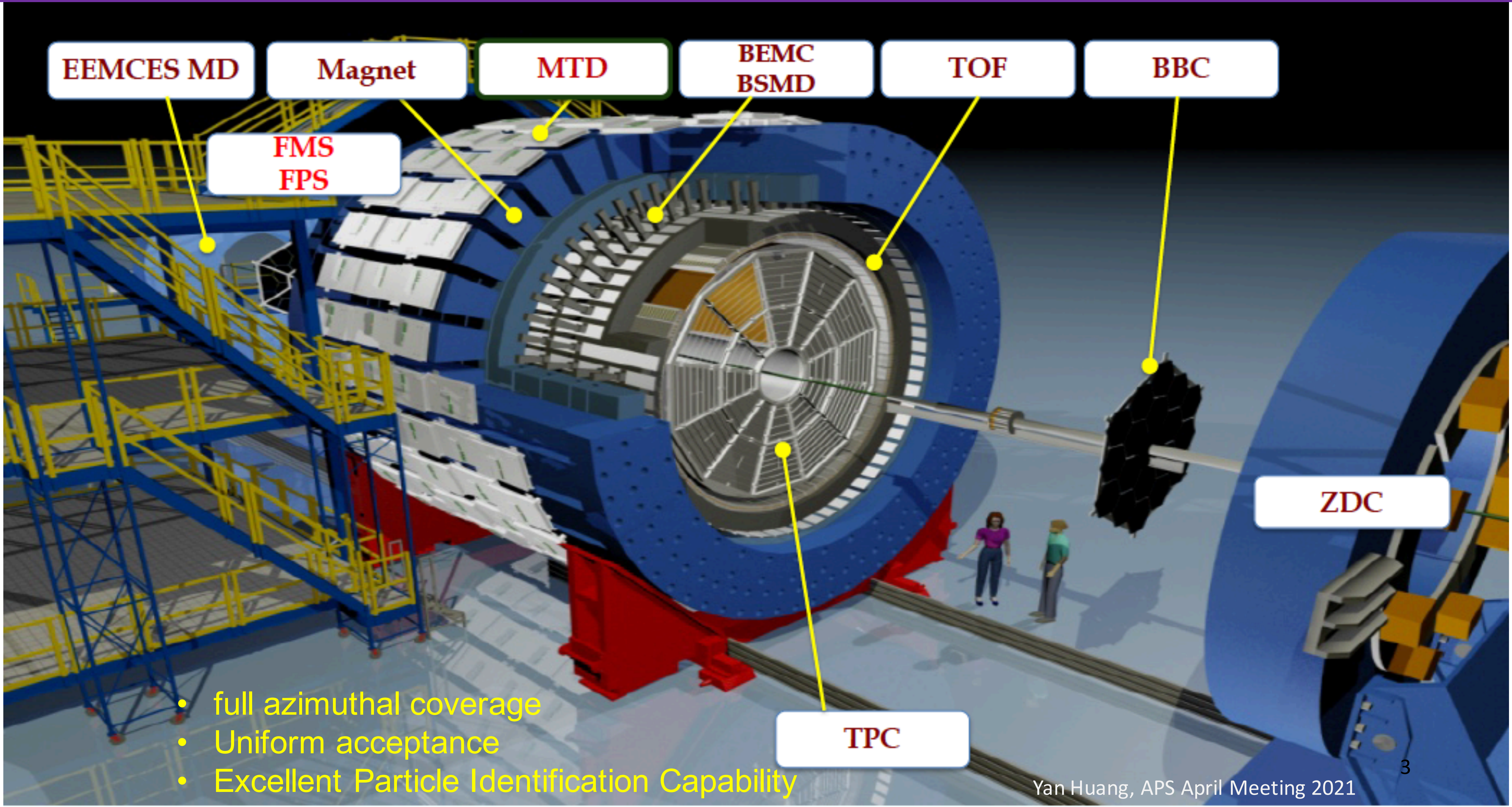
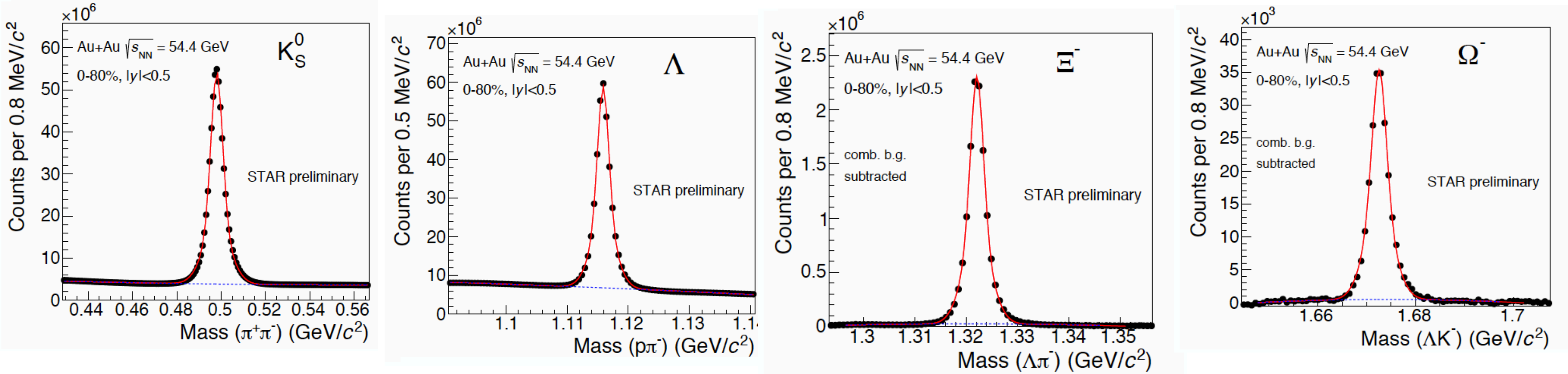
STAR detector



- full azimuthal coverage
- Uniform acceptance
- Excellent Particle Identification Capability

Particle identification and reconstruction



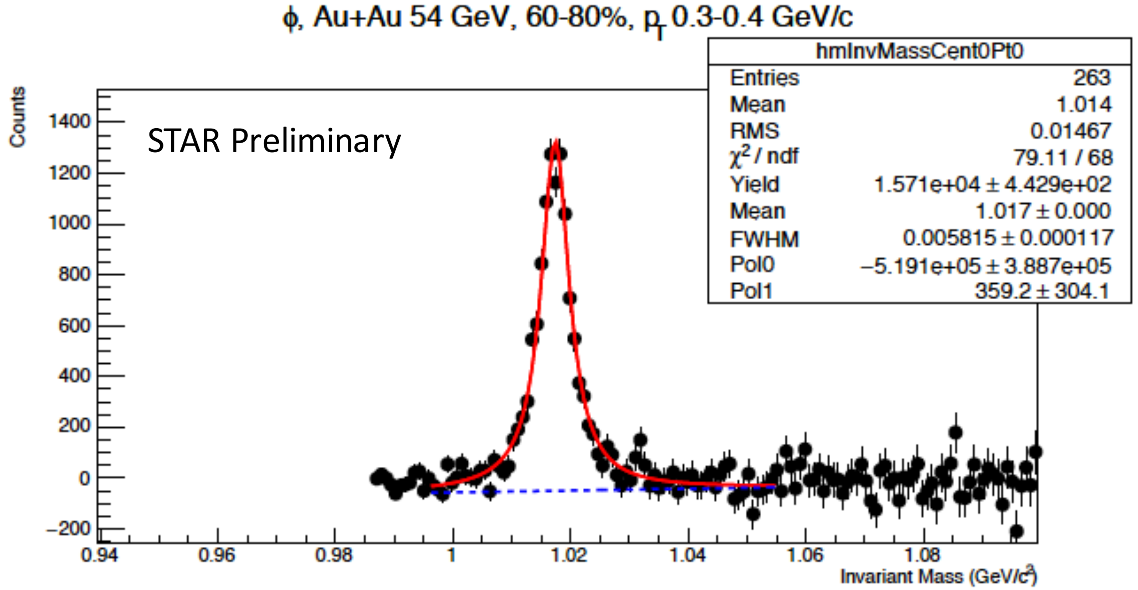
$$K^0_S \rightarrow \pi^+ + \pi^- \ (B.R.\ 69.20\%)$$

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

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

$$\Omega^-(\bar{\Omega}^+) \rightarrow \Lambda(\bar{\Lambda}) + K^-(K^+) \ (B.R.\ 67.8\%)$$

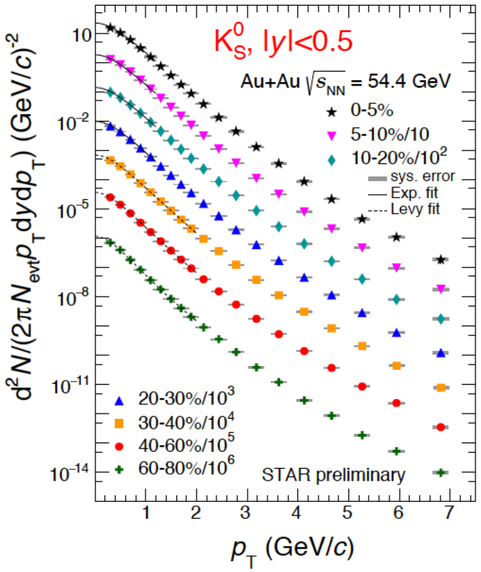
$$\phi \rightarrow K^+ + K^- (B.R.\ 49.2\%)$$

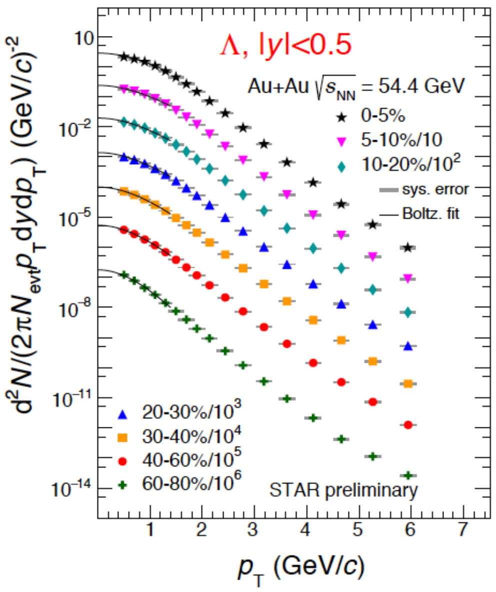


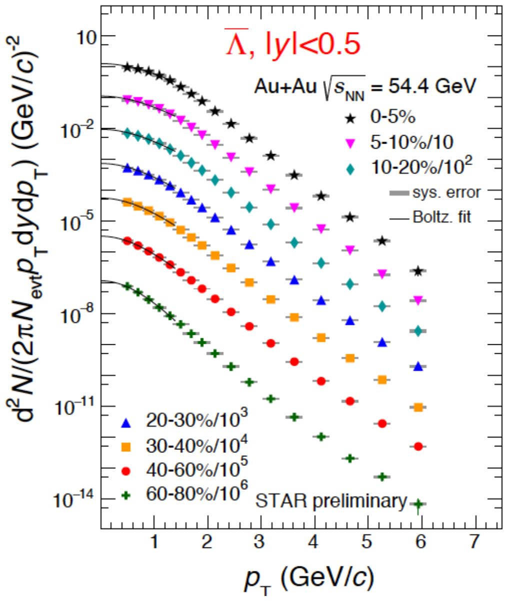
π, K, p are identified by dE/dx in TPC

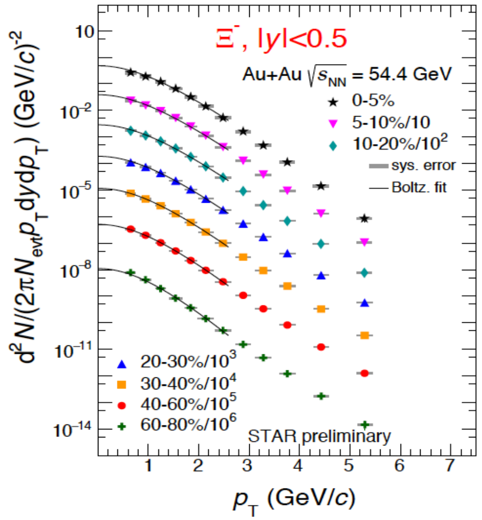
Reconstruct the secondary vertex

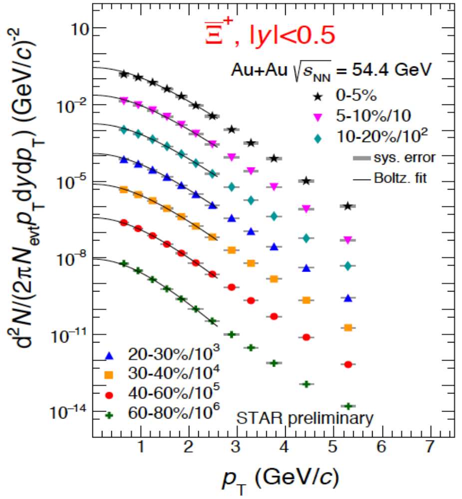
p_T spectra

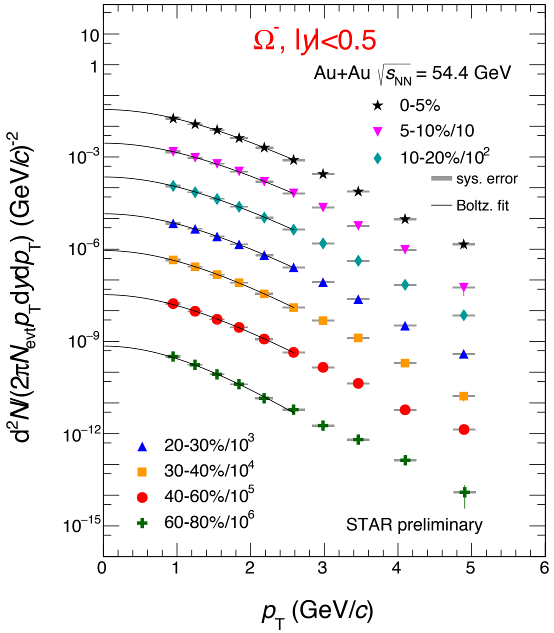


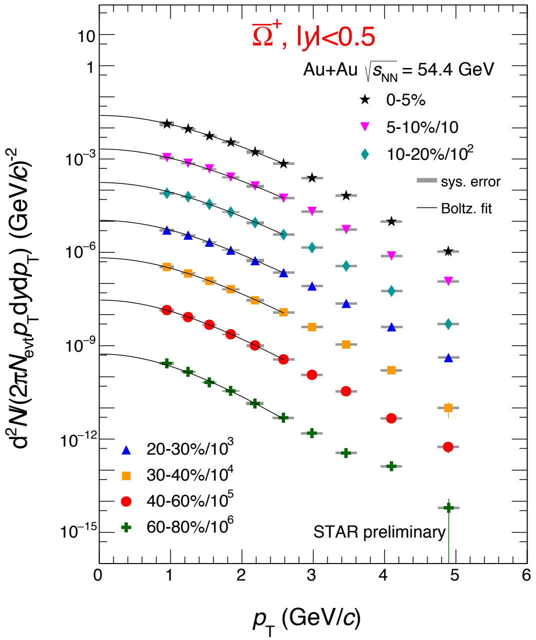


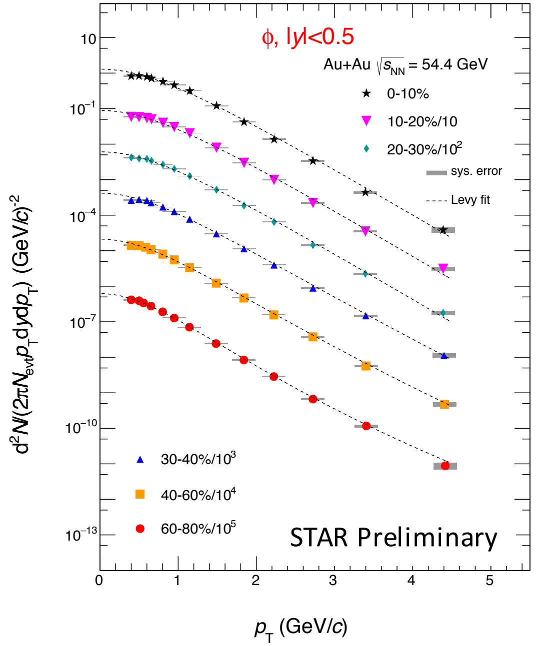








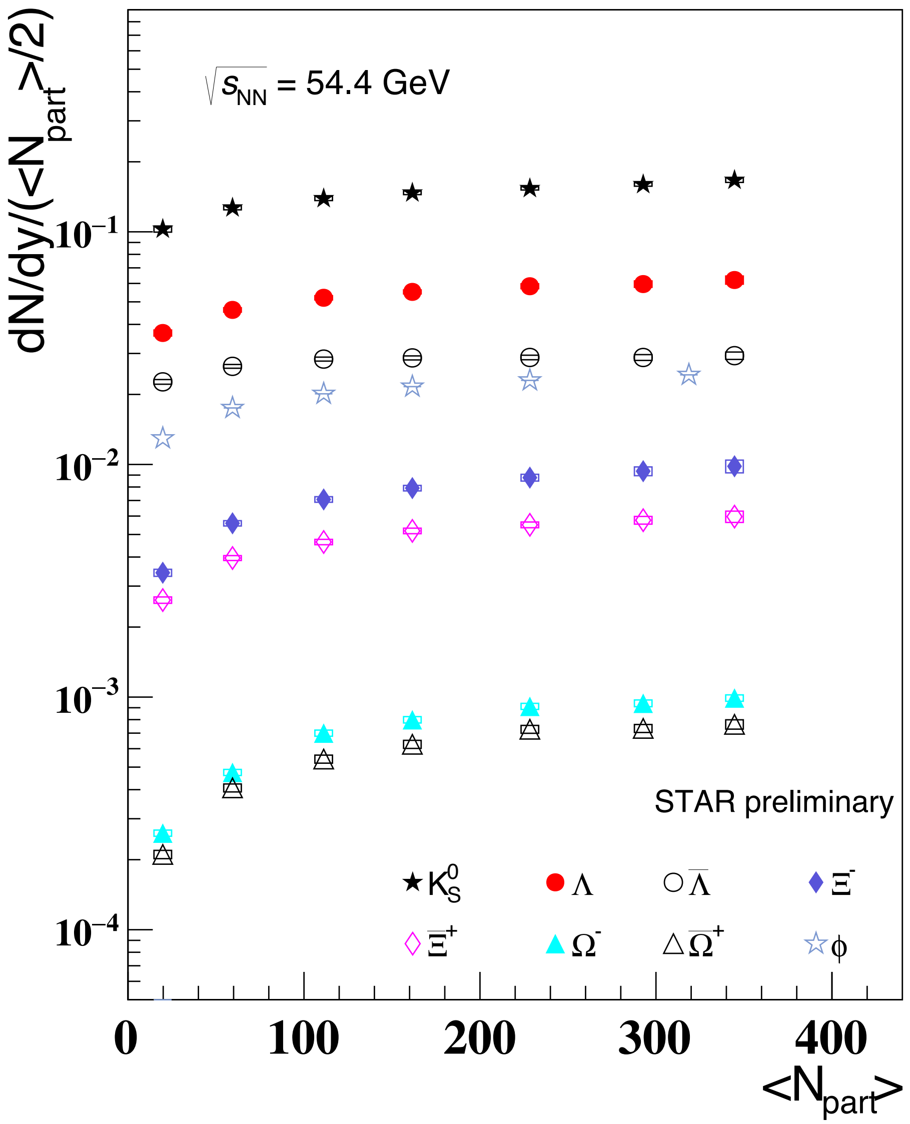


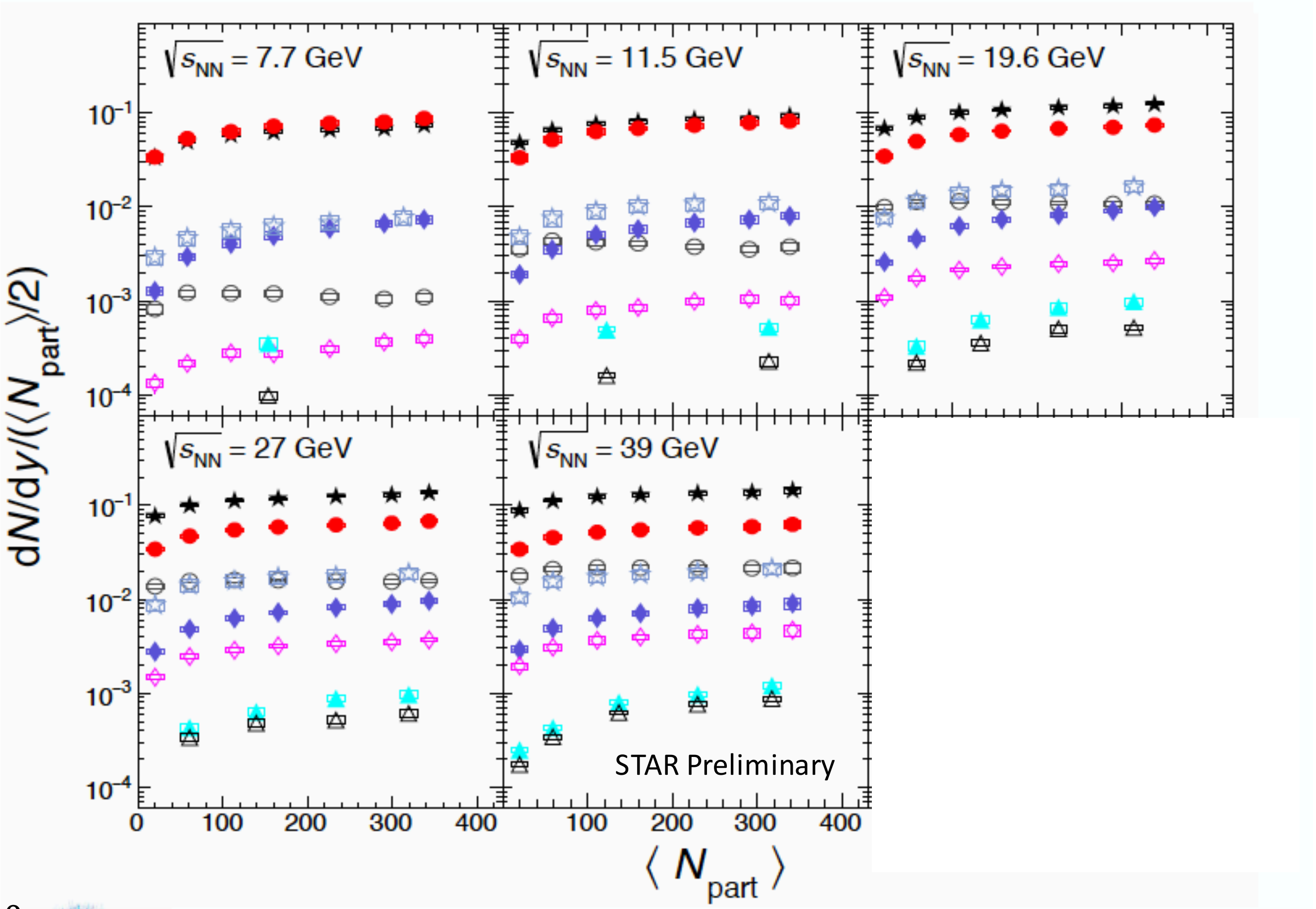


Low p_T extrapolation

- K_S^0, ϕ: m_T-exponential fit and Levy function
- Λ, Ξ, Ω: Boltzmann function

Particle Yields

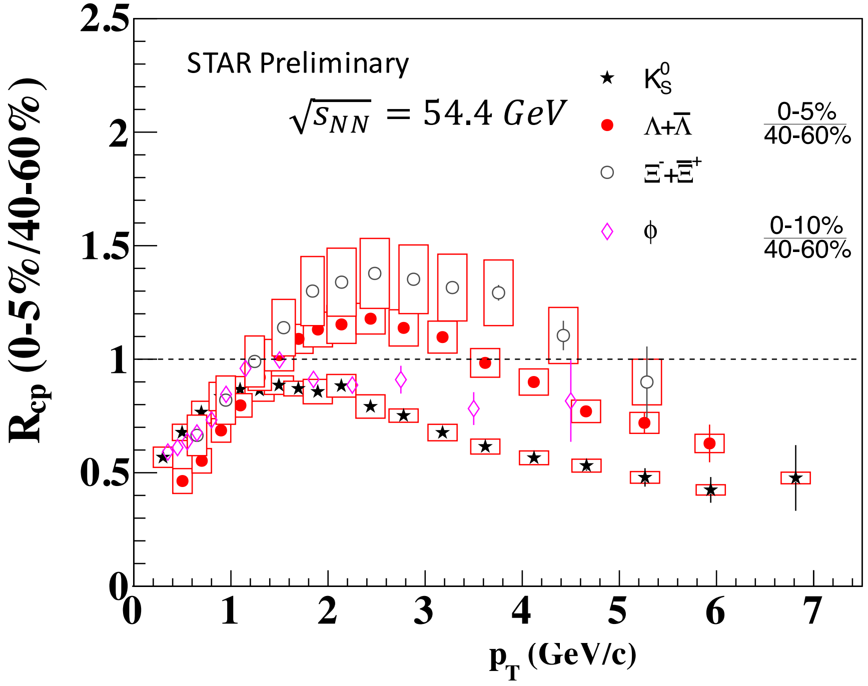




- K_S^0, Ξ, Ω, ϕ normalized yields: increase with average number of participant nucleons and energy
- Feed-down corrected $\bar{\Lambda}$ normalized yield: weak centrality dependence similar to other BES energies: possible annihilation processes on antibaryon production

Nuclear Modification Factor

$$R_{CP} = \frac{[(dN/dp_T)/\langle N_{coll}\rangle]_{central}}{[(dN/dp_T)/\langle N_{coll}\rangle]_{peripheral}}$$

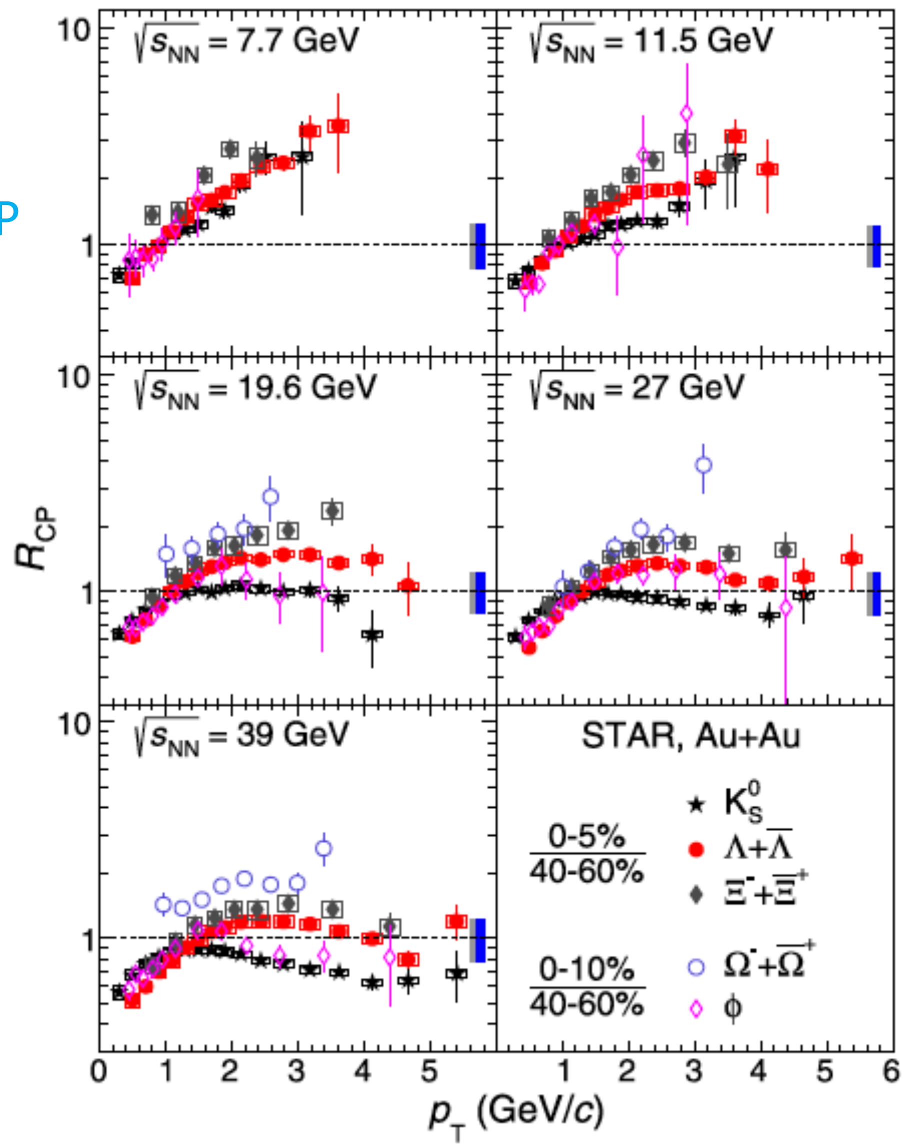


$\sqrt{s_{NN}} = 54.4~GeV$:

- Strong suppression at high p_T: energy loss of scattered partons in QGP
- Separation (baryon/meson) at intermediate p_T: parton recombination

$\sqrt{s_{NN}} \leq 11.5~GeV$:

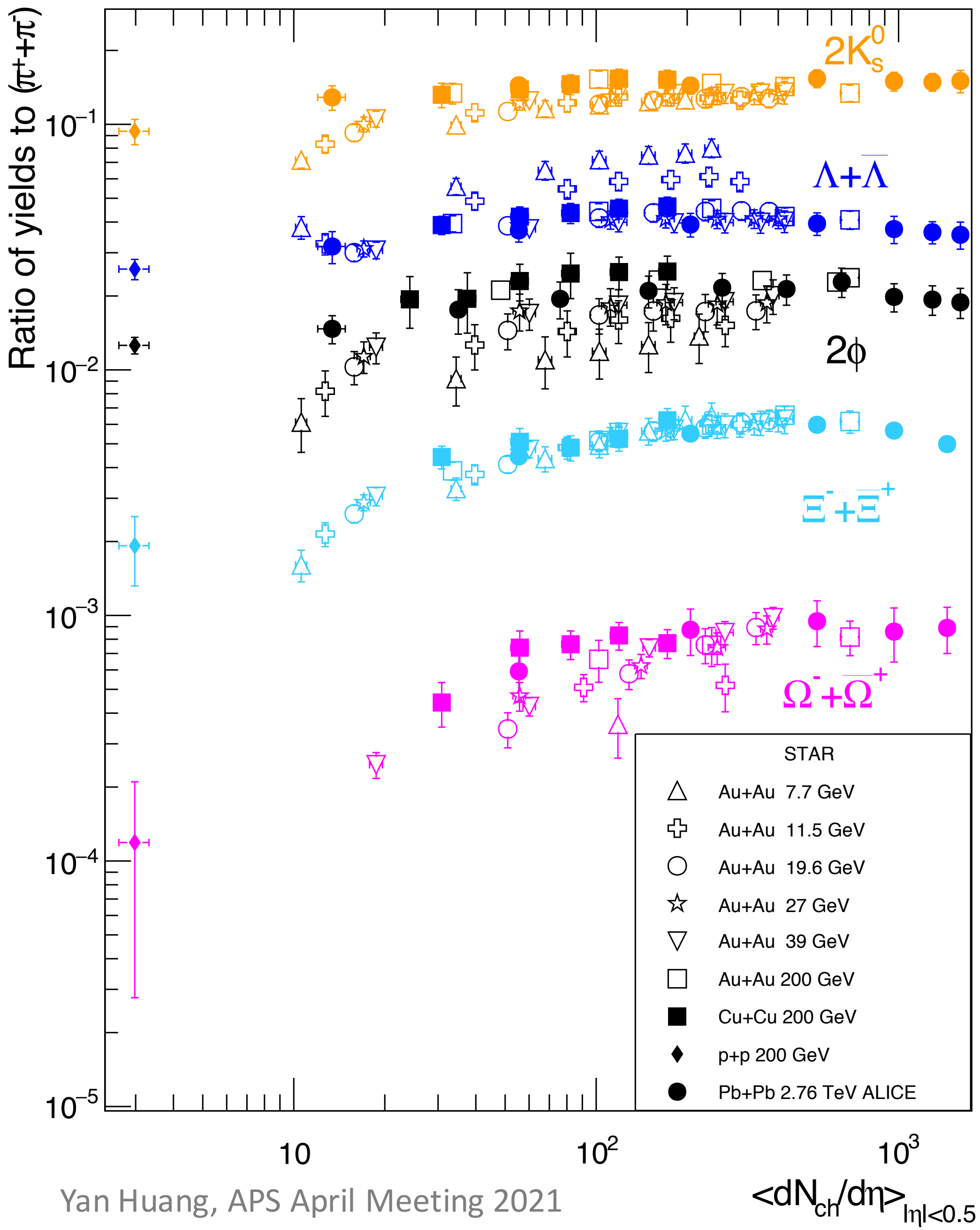
- No suppression
- Need more statistics for high p_T (BES II)



The energy evolution of strange hadron R_{cp} reflects the decreasing partonic effects with decreasing beam energies.

STAR, PRC 102, 034909 (2020)

Strange particles/pions ratio



$dN_{ch}/d\eta$ is a good scale independent of collision energies, except for Λ and ϕ

$$\frac{dn}{dy} = \frac{\sqrt{M(1+\sinh^2 y)}}{\sqrt{1+M\sinh^2 y}}\frac{dn}{d\eta},$$

where $M = 1 + m^2/p_t^2$

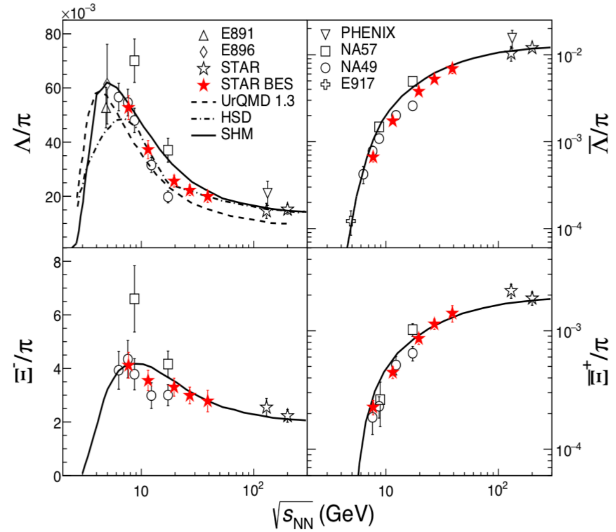
$$dN_{ch}/d\eta = \sum dN_{ch}/d\eta\,(k^{\pm},\pi^{\pm},p,\bar{p})$$

$$dN_{ch}/d\eta(\eta=0) \sim dN_{ch}/d\eta(|\eta|<0.5)$$

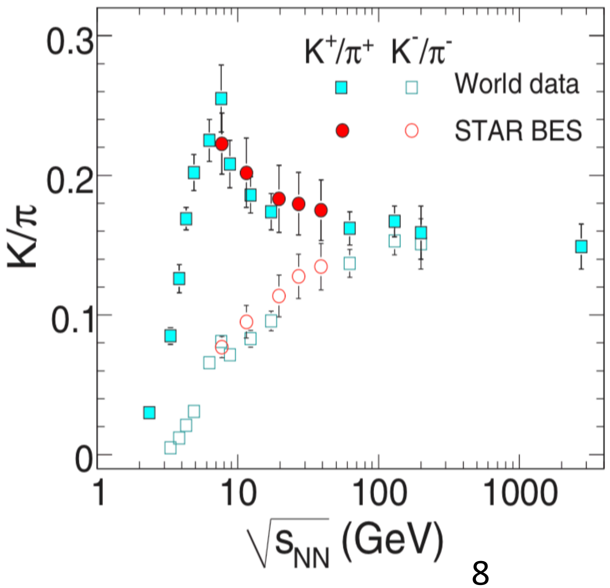
STAR, PRC 102, 034909 (2020)

STAR, PRC 96, 044904 (2017)

ALICE, PRC 88, 044910 (2013)



$NN^{-} \rightarrow N\Lambda K$



Summary

- K_S^0, Ξ, Ω, ϕ normalized yields: increase with average number of participant nucleons and energy
- $\bar{\Lambda}$ normalized yield: weak centrality dependence for Au+Au collisions at 54.4 GeV.

  → possible annihilation processes on antibaryon production

- Nuclear modification factors: Strong suppression at high p_T and Separation (baryon/meson) at intermediate p_T for 54.4 GeV.

  → Energy loss of partons in QGP and parton recombination

- $dN_{ch}/d\eta$ is a good scale independent of collision energies at different systems for K_S^0, Ξ and Ω.

Thanks for your attention!