Measurements of strange hadrons K^0_S, Λ and Ξ from Au+Au collisions at 14.5 GeV in STAR

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For the STAR Collaboration

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Strangeness in Quark Matter SQM 2015
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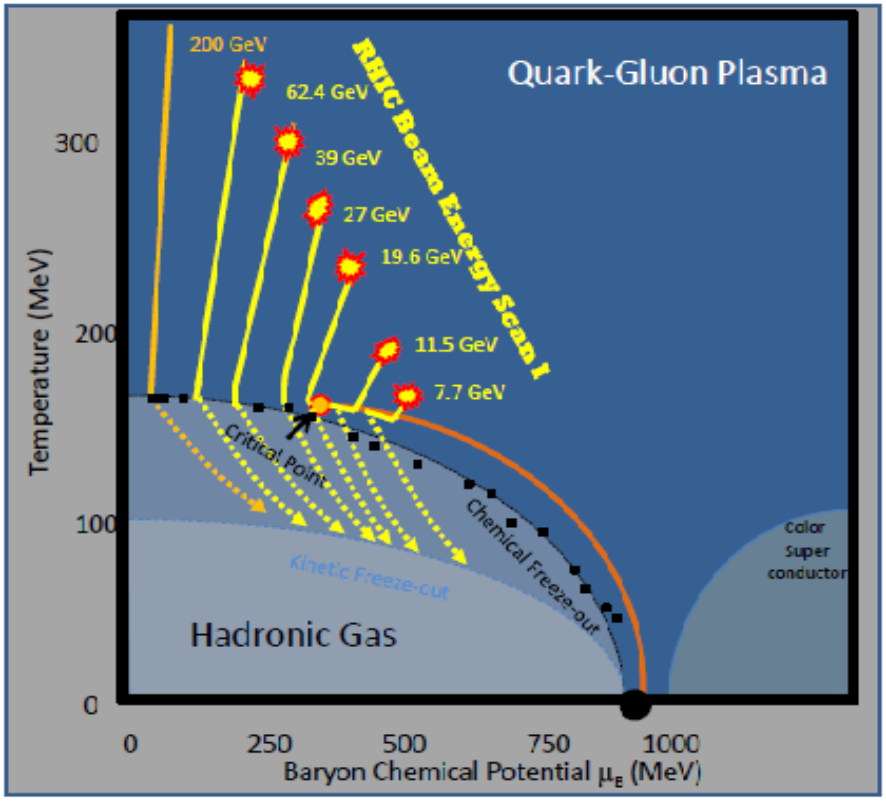
Outline

- Motivation for RHIC beam energy scan
- STAR detector and K^0_S, Λ, Ξ reconstruction
- mid-rapidity K^0_S, Λ, Ξ production in Au+Au 14.5 GeV
  - p_T spectra
  - Particle yields
  - Anti-baryon to baryon ratios
  - Nuclear modification factor: R_{CP}
  - Baryon enhancement: $\bar{\Lambda} / K^0_S$
- Summary

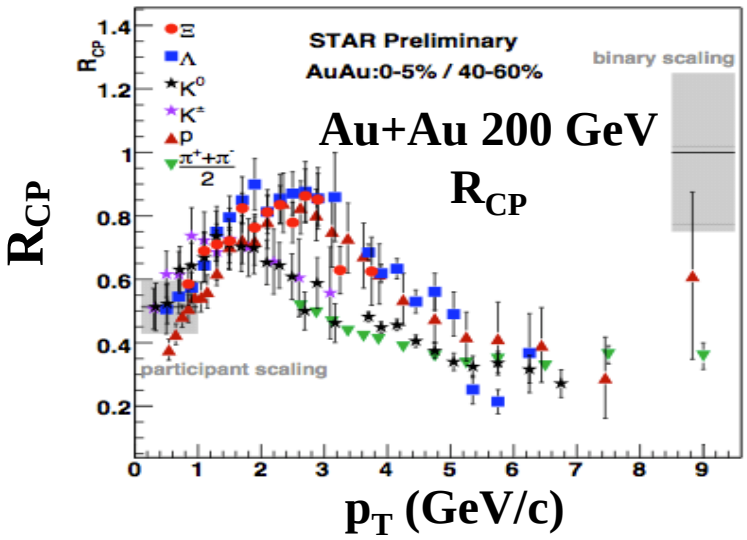
RHIC BES: study QCD phase diagram

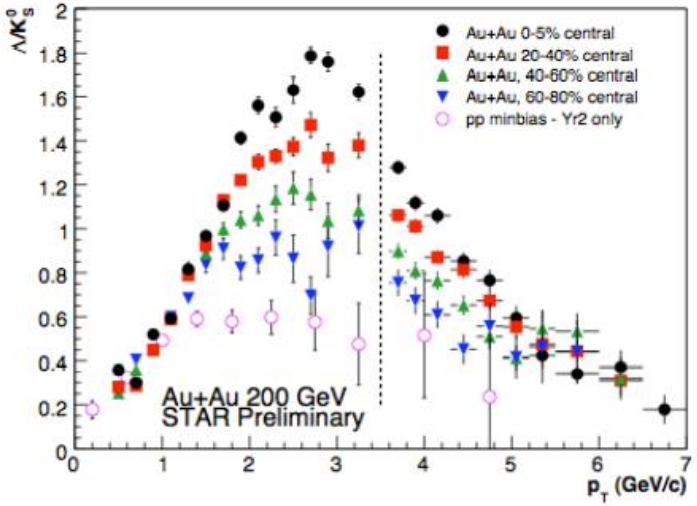


STAR, arXiv:1007.2613

- Beam Energy Scan at RHIC
  - To study the **onset of de-confinement** and **phase boundary**
  - To search for the **QCD critical point**
- Systematic study of Au+Au collisions at 7.7, 11.5, **14.5**, 19.6, 27, 39 GeV (BES Phase-I)

Strangeness is sensitive probe





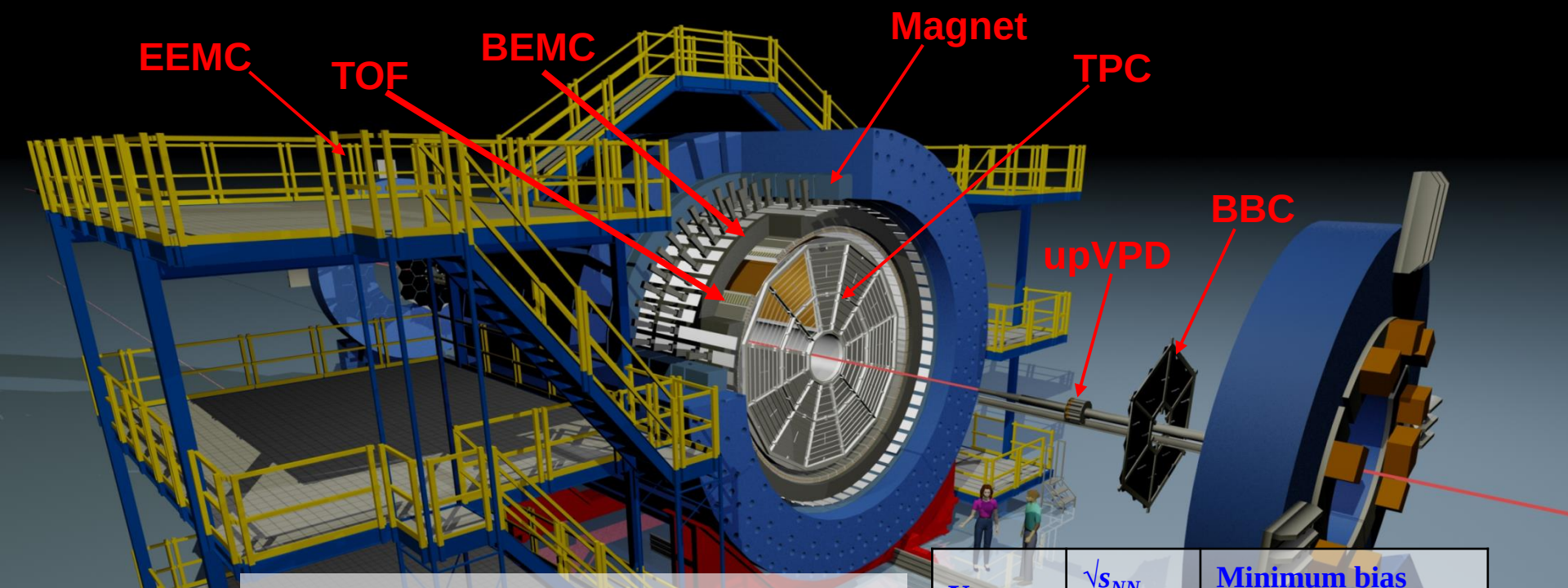
- Nuclear modification factors at Au+Au 200 GeV
  - less than unity at high p_T
  - Baryon/meson follow different trends

  → **Partonic energy loss & recombination**
- Baryon/meson ratio at Au+Au 200 GeV
  - baryon enhancement at intermediate p_T in central collisions

  → **Parton recombination**

STAR, arXiv:1007.2613

The Solenoidal Tracker At RHIC (STAR)



TPC

- full azimuthal coverage at mid-rapidity ($|\eta|<1.0$)
- π ,K, p identified with dE/dx and TOF
- secondary vertex reconstruction

Year	$\sqrt{s_{NN}}$ (GeV)	Minimum bias events in Million
2010	7.7	~ 4 M
2010	11.5	~ 12 M
2011	19.6	~ 36 M
2011	27	~ 70 M
2010	39	~ 130 M
2014*	14.5	~ 18 M

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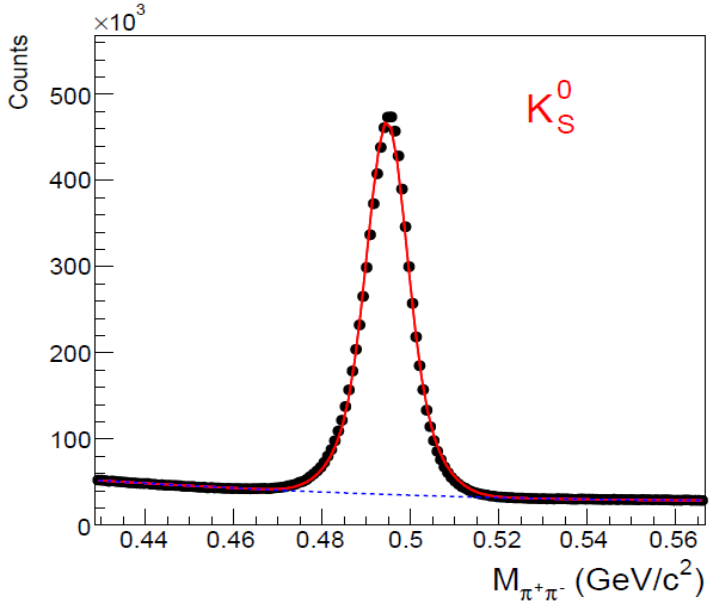
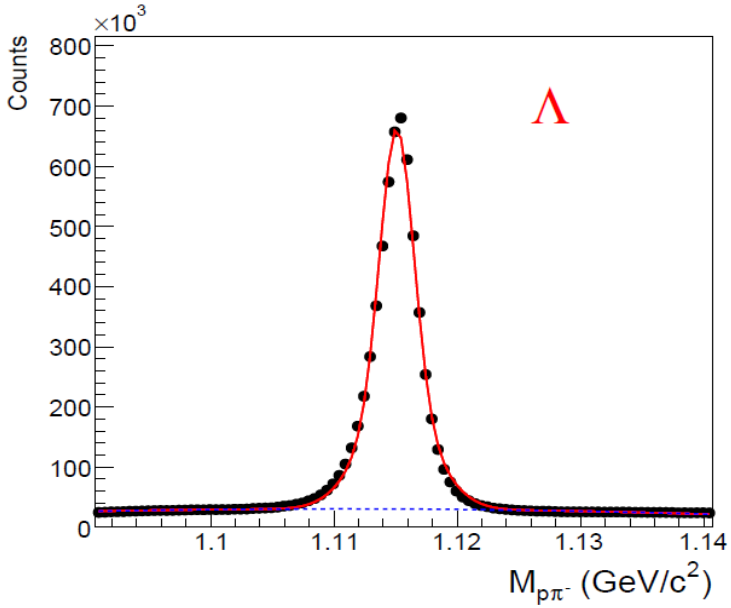
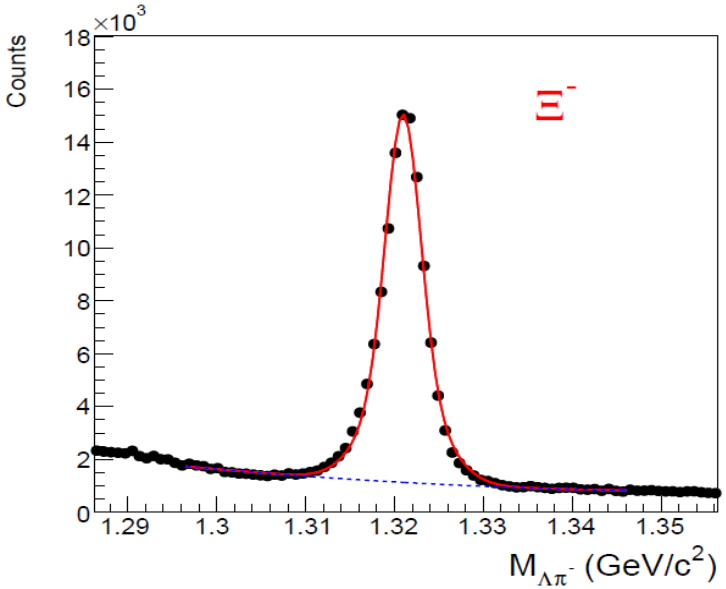
Particle identification and reconstruction



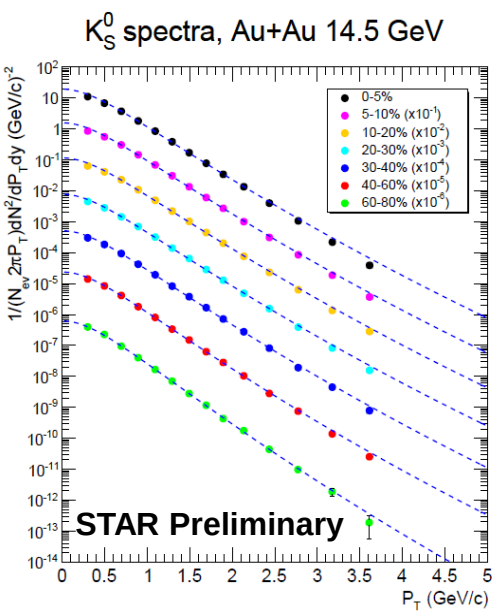


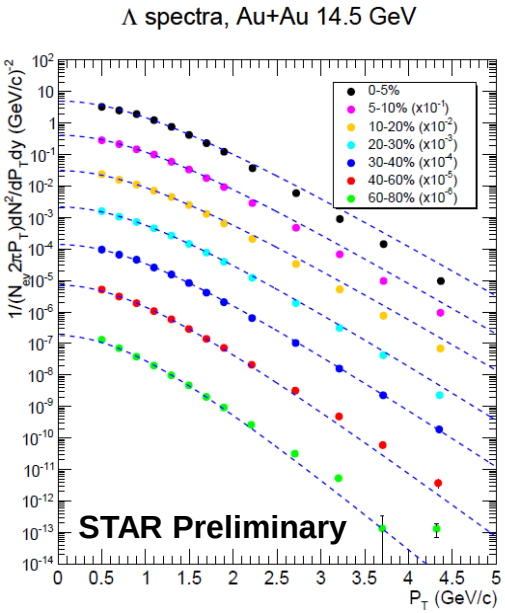


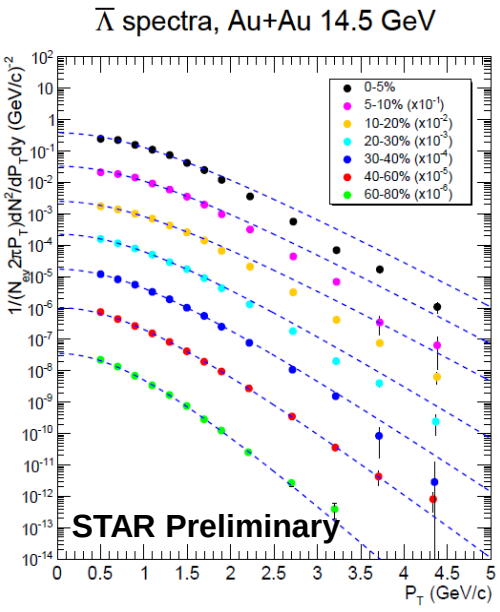
Au+Au 14.5 GeV, 0-80%, full p_T range

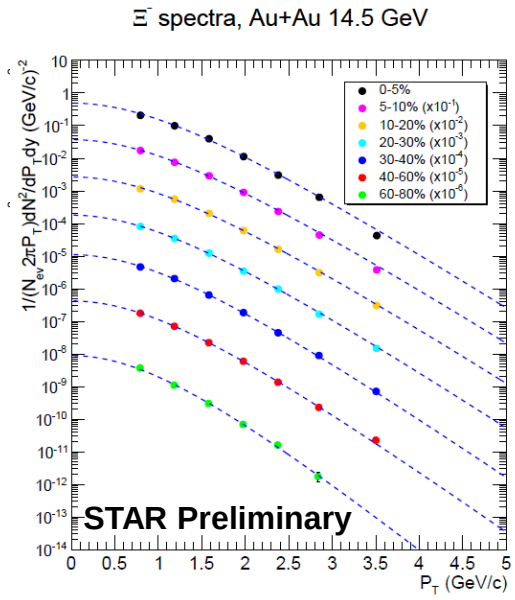
- $K^0_S \rightarrow \pi^+ + \pi^-$
- $\Lambda \rightarrow p + \pi$
- $\Xi \rightarrow \Lambda + \pi \rightarrow (p + \pi) + \pi$
- π ,K, p are identified with TPC dE/dx
- reconstruct the secondary vertex

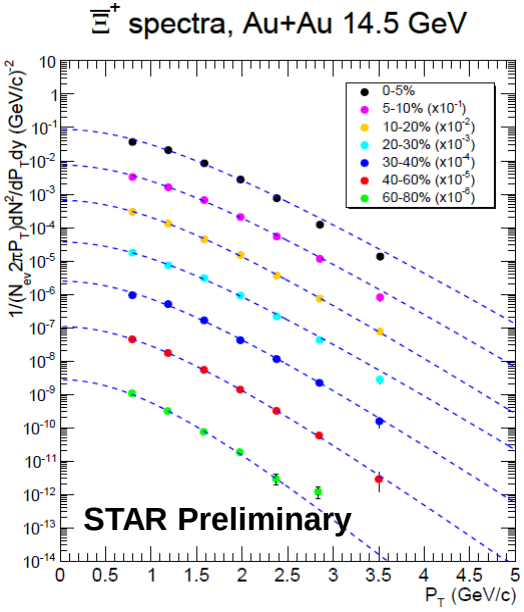
p_T spectra





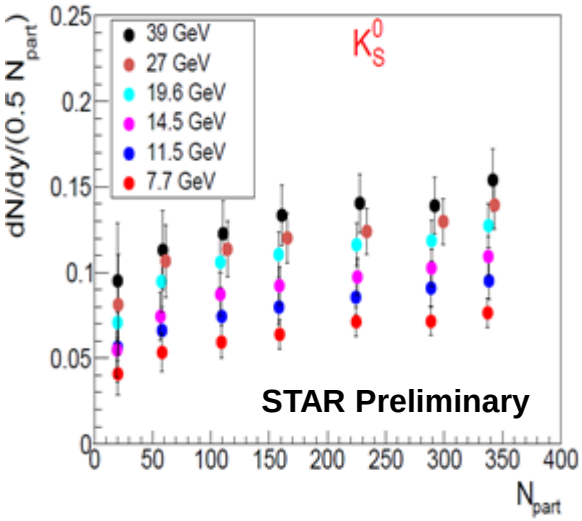


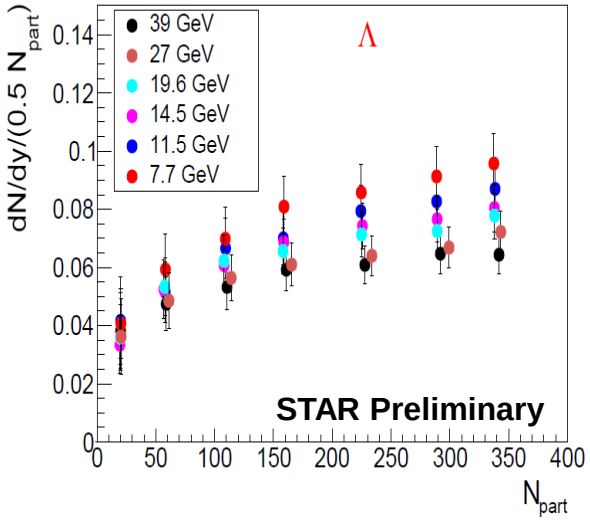


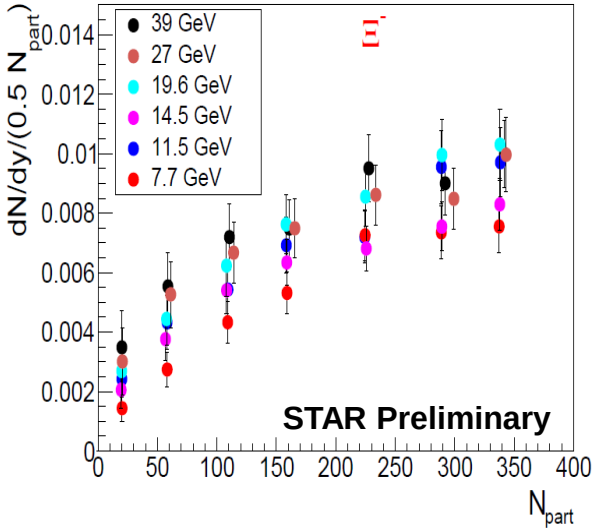


- *$|y|<0.5$, statistical error only*
- *Λ spectra are weak decay feed-down corrected*
- *Spectra are extrapolated to low p_T with fitting functions*

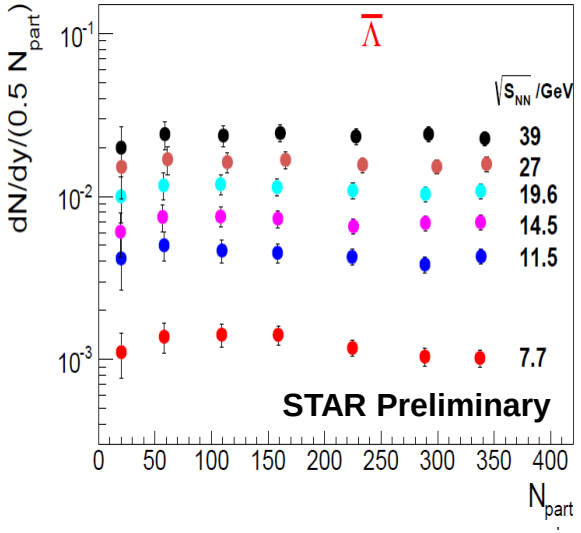
Particle yields

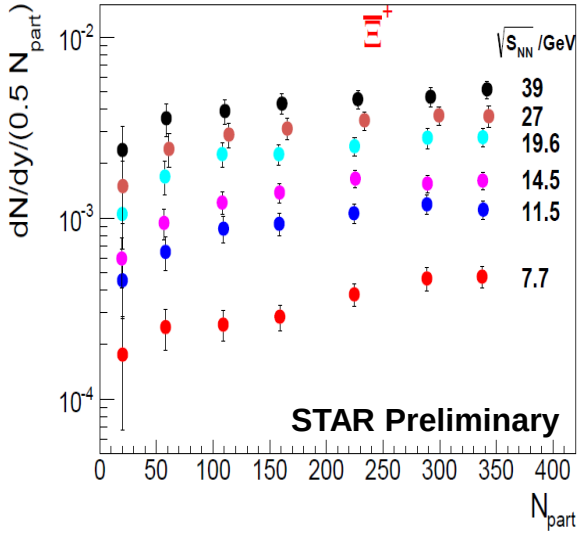






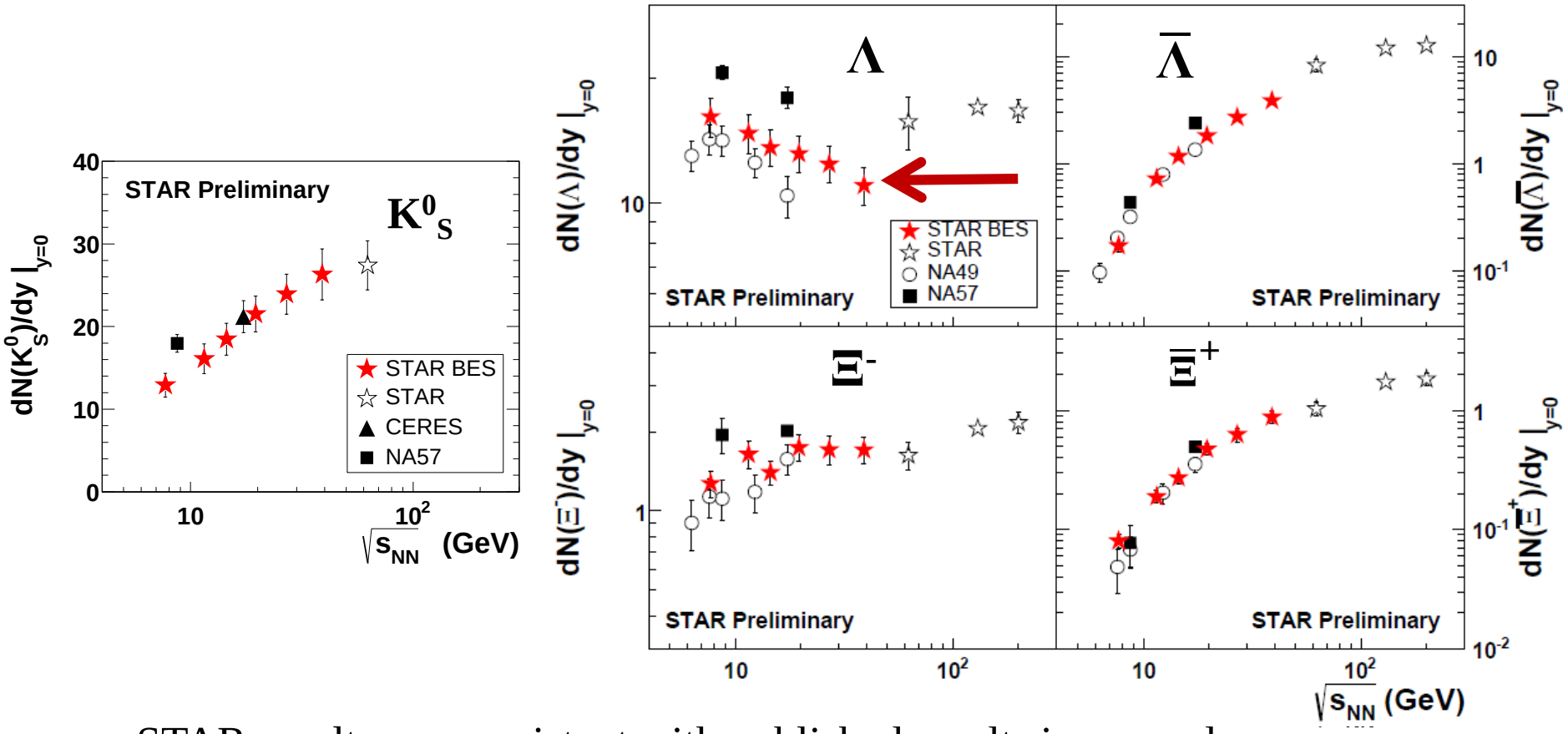
- K^0_S, Λ, Ξ⁻ and $\bar{\Xi}^+$ yield per participant increase with the increase of centrality
- $\bar{\Lambda}$ yield per participant does not show centrality dependence at all energies





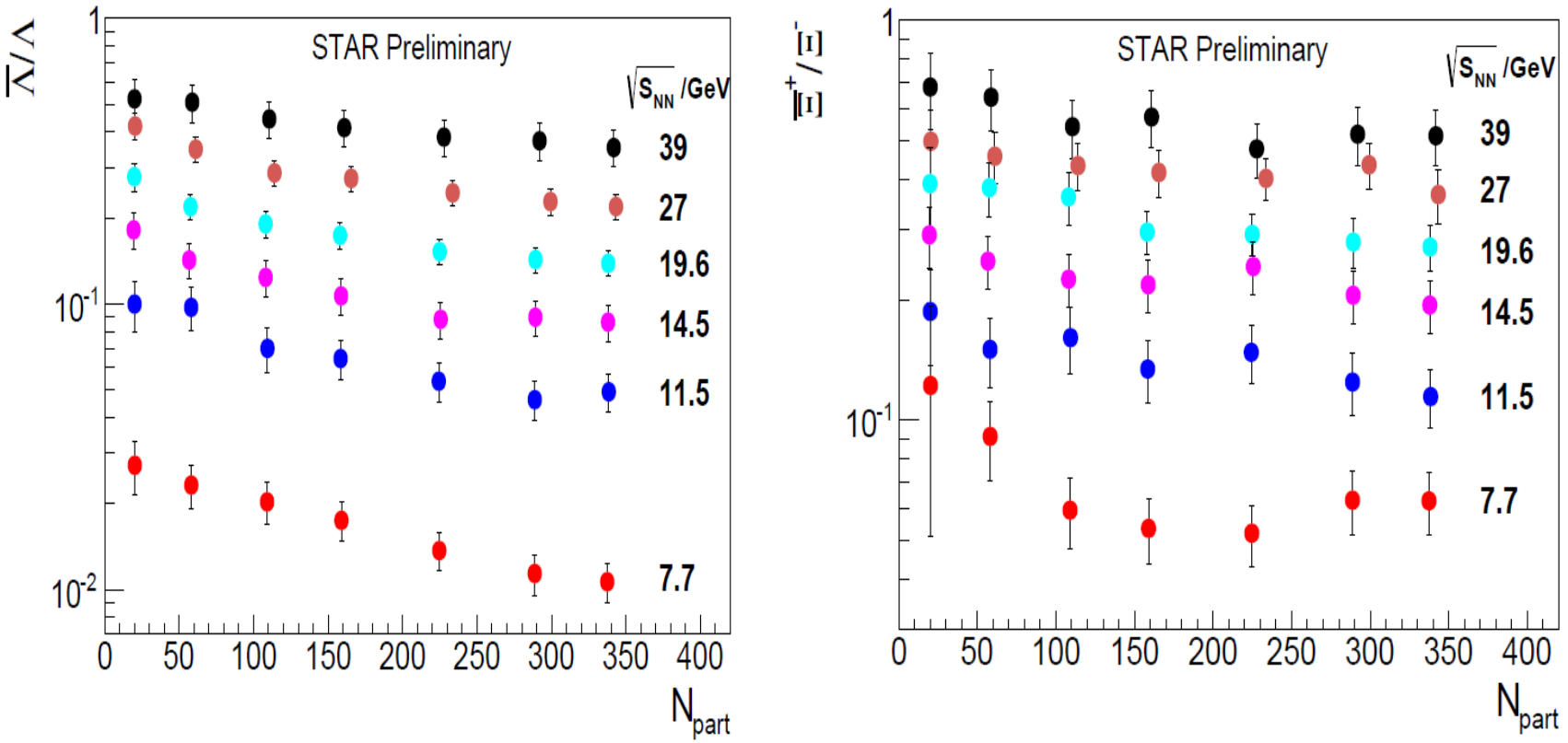
Particle yields

mid-rapidity, most central collisions (0-5%)



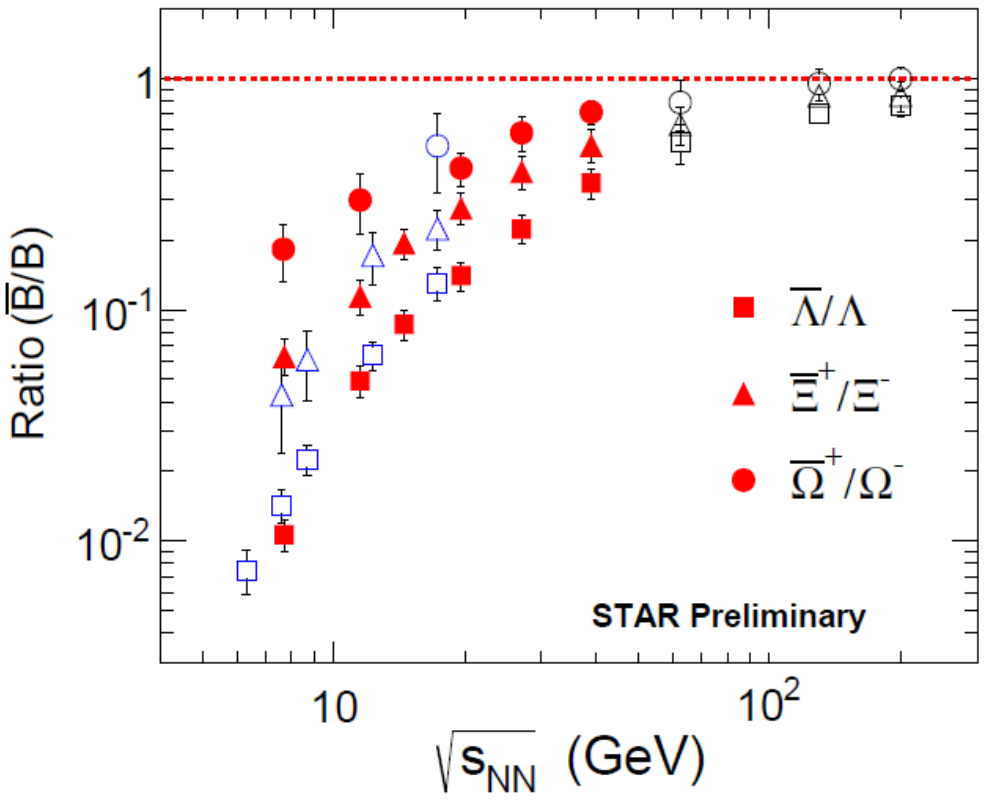
- STAR results are consistent with published results in general.
- **Λ yields seems to show dip around 39 GeV. Why? the baryon stopping at mid-rapidity decrease with increasing energy**

Anti-baryon to baryon ratio



- Anti-baryon to baryon ratios decrease with the increase of centrality at all energies
- The effect is more prominent at lower energies, anti-baryon absorption?

Anti-baryon to baryon ratio (excitation function)



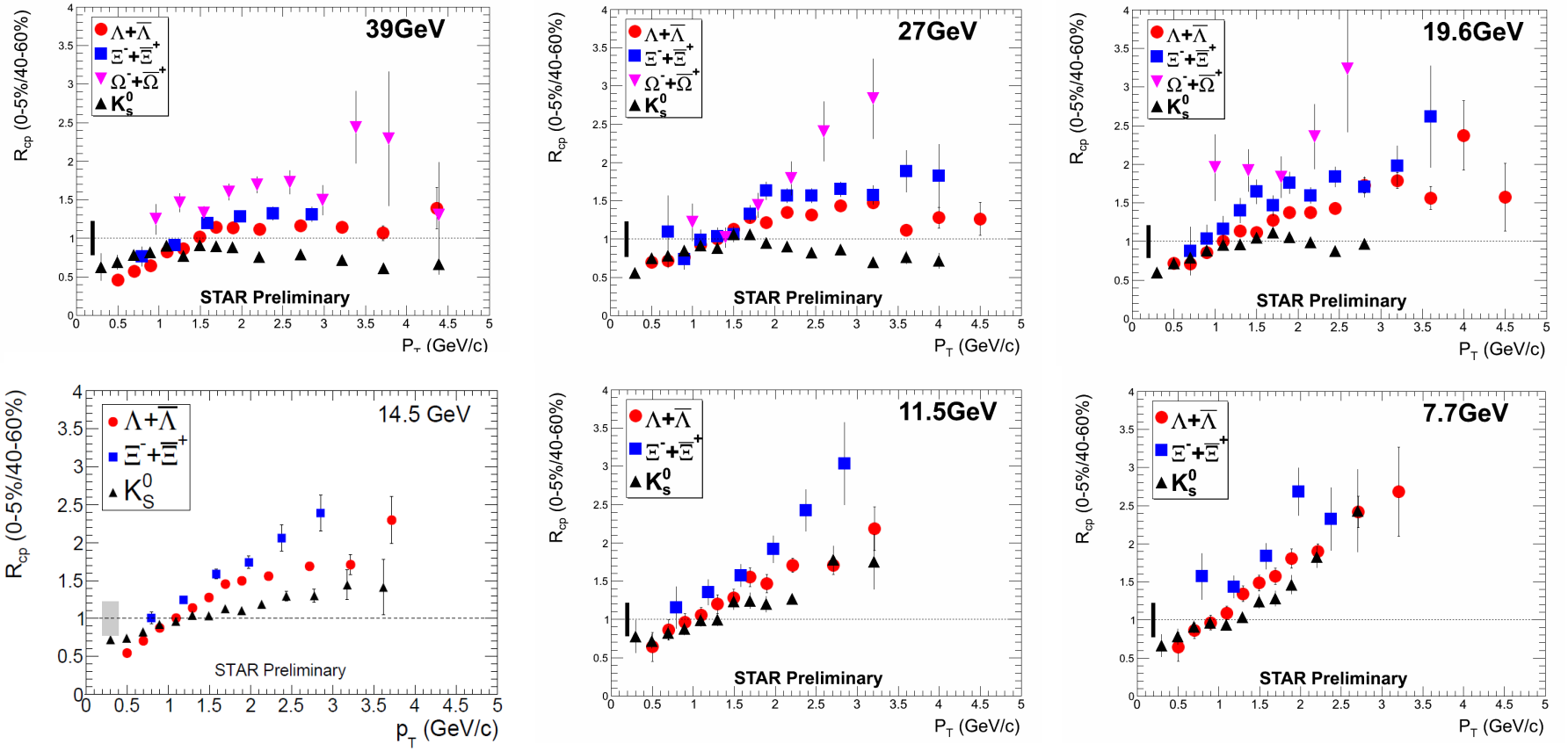
Solid red: STAR BES;
Open black: STAR published;
Open blue: NA49

central collisions (0-5%)

- STAR BES data stay on a trend with existing data at SPS and RHIC
- Anti-baryon to baryon ratio increase with number of strange quarks at lower energies

$$\bar{\Omega}^+/\Omega^- > \bar{\Xi}^+/\Xi^- > \bar{\Lambda}/\Lambda$$

Nuclear modification factors R_{CP}



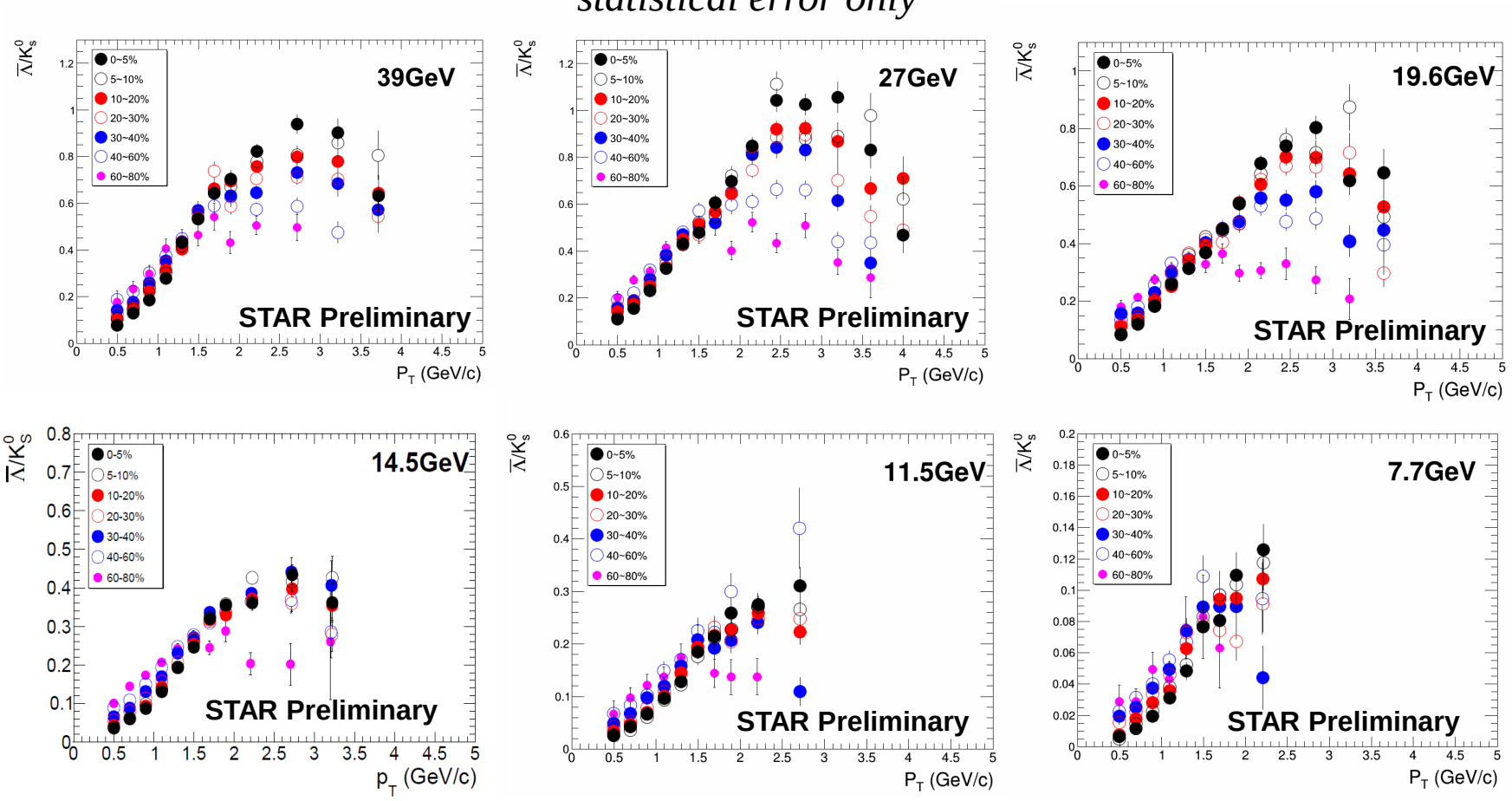
Statistical error only
Ω R_{CP} in 19.6 and 27 GeV : (0~10%)/(40~60%)

$\sqrt{s_{NN}} \leq$ **14.5 GeV,**

- K^0_S R_{CP} larger than unity for $p_T > 1.5$ GeV/c
- R_{CP} particle type (baryon/meson) difference at intermediate p_T (2~3 GeV/c) becomes less obvious

$\bar{\Lambda}$ / K^0_S ratio

statistical error only



$\sqrt{s_{NN}} \leq$ **14.5 GeV**, at $p_T \sim 2$GeV/c, the separation of central (0-5%) and peripheral (40-60%) collisions in $\bar{\Lambda}$ /K^0_S become less obvious

Summary

- Measured K^0_S, Λ, Ξ production in Au+Au collisions at 14.5 GeV, to complete the BES phase-I
- The new 14.5 GeV yields and ratios are in line with other STAR BES data and SPS data
- For $\sqrt{s_{NN}} \leq$ **14.5 GeV**,
  - K^0_S R_{CP} larger than unity for $p_T > 1.5$ GeV/c
  - $\bar{\Lambda}/K^0_S$ show much less separation between central and peripheral collisions

  → possible change of collision dynamics between 14.5 and 19.6 GeV