Reconstruction of K*(892) Resonance in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV at STAR

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The Relativistic Heavy Ion Collider (RHIC) produces a hot, dense and de-confined medium, called the quark-gluon plasma (QGP), with Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV. The K*$^{\pm}$(892) resonance is a short-lived vector meson with a life-time of 4 fm/c, shorter than the expected life-time of the QGP. The decay of the K*$^{\pm}$ and its properties may provide an effective tool to probe the evolution of the QGP produced. Experimentally, K*$^{\pm}$ is not a well-studied particle at STAR previously because of its fast decay and large combinatorial background. In recent years, improvements in data sample statistics and particle identification capability promise better K*$^{\pm}$ measurements. In this poster, we report the reconstruction of invariant mass of K*$^{\pm}$ resonance via the hadronic decay channel K*$^{\pm}$(892) → $K_S^0\pi^{\pm}$ as a function of transverse momentum (p_T) up to 5 GeV/c for various collision centrality classes. Physics implications of our measurements will also be discussed.

Introduction

Decay Mode:	
K*$^{\pm}$(892) → $K_S^0\pi^{\pm}$	~100%
K_S^0 → $\pi^+\pi^-$	(69.20±0.05)%

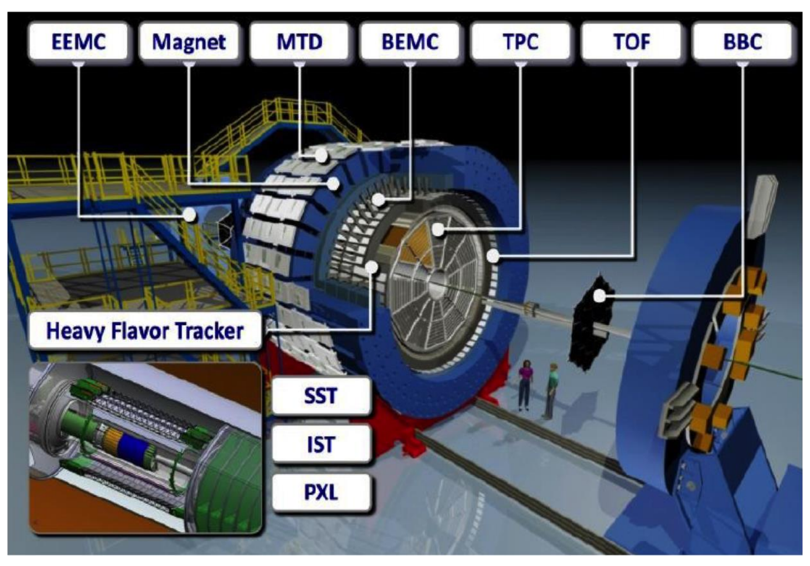
K*$^{\pm}$(892) candidates are reconstructed by calculating invariant mass of K* decay products.

By special relativity,

$$m_{K^*} = \sqrt{E_{K^*}^2 - \vec{p}_{K^*}^2} = \sqrt{\left(E_{K_S} + E_\pi\right)^2 - \left(\vec{p}_{K_S} + \vec{p}_\pi\right)^2} \qquad (c = 1)$$

So we should expect to observe a resonance peak around 0.892 GeV/c^2.

Background Method:
Mixed-Event Background –Build reference background distribution by pairing decay daughters from different collision events to eliminate possible correlation dependence.



The STAR Detector

- The data used in this analysis were minimum bias trigger Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV collected in the Run 2011 from the STAR experiment.
- Particle Identification: TPC (Time Projection Chamber) dE/dx and TOF (Time of Flight) are used for pion identification.
- The differences between this analysis and the previous result [1] are an increase in statistics of more than 100 times and the use of TOF for pion PID.

Track Cuts, Event Cuts and Particle Identification

NFitPnts is the number of fit points of a track in the TPC, NTpcHits is the number of hits of a track in the TPC, MaxPnts is the number of maximum possible points of a track in the TPC, and DCA is the distance of closest approach to the primary interaction point. Tof is the time of flight, pVtxz is the primary vertex Z, pVtxr is the primary vertex radial, vzVpd is the vertex position detector Z, β is the velocity, η is the pseudorapidity.

Event cuts:
|pVtxz| < 30 cm
|pVtxr| < 2 cm
|pVtxz – vzVpd|< 3 cm
Trigger = minimum bias

Cut for K*:
Dip angle > 0.04
(Dip angle is the angle between K0 and pion momentum vectors)

Track cuts for K0 reconstruction:
nHitsFit > 15
p > 0.2 GeV/c
TOF flag > 0
|β-βπ| < 0.04
|$n_{\sigma\pi}$|< 3.0
dca_π+_π- < 0.8 cm
decay length > 4.0 cm
dca_to_vtx (for K0) < 0.85 cm
dca_to_π+ & dca_to_π- > 0.5 cm
mass of K0 = (0.48, 0.51) GeV/c^2

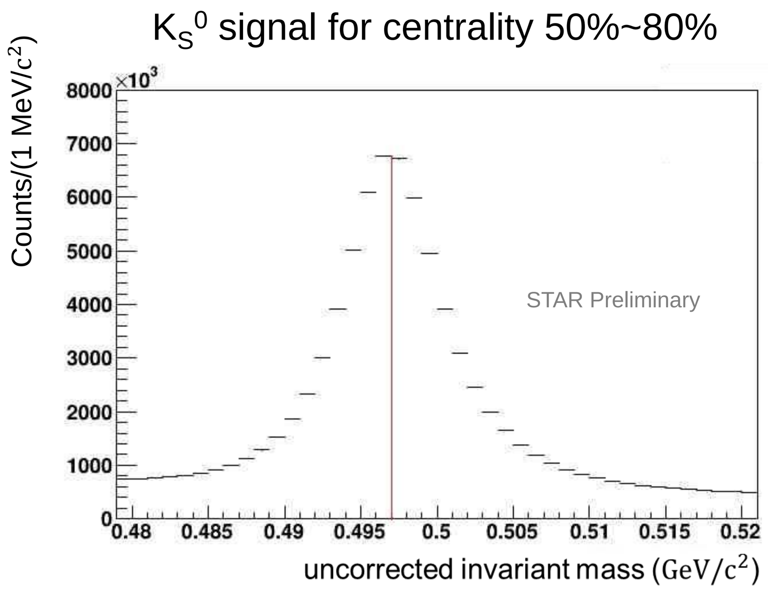
Track cuts for pion:
|$n_{\sigma\pi}$| < 2.0
0.2 < p_T < 10.0 GeV/c
p < 10.0 GeV/c
|η| < 0.8
dca < 3.0 cm
NFitPnts > 15
NTpcHits > 15
nHitsFit/nHitsTotal > 0.55

• K_S^0 signal

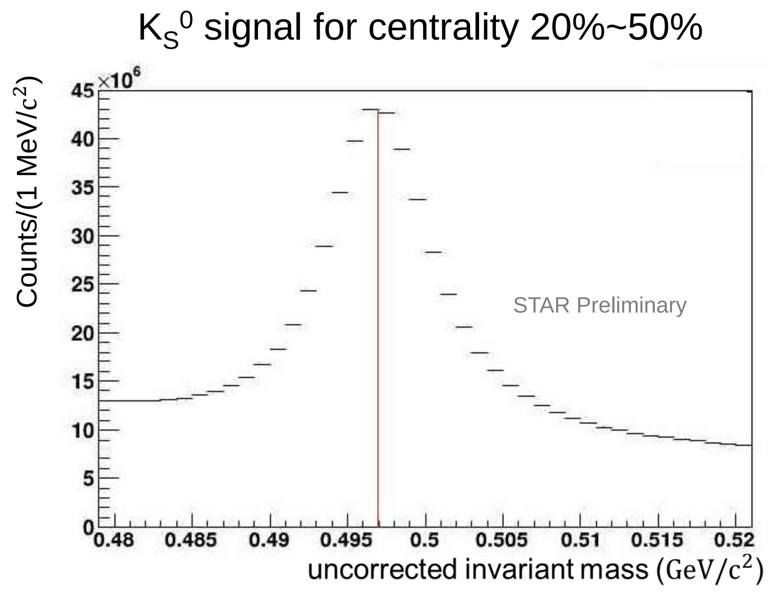
Observed in the $\pi^+\pi^-$ invariant mass distribution reconstructed from the decay topology method.

PDG value: 497.614 ± 0.024 MeV

K_S^0 signal for centrality 50%~80%

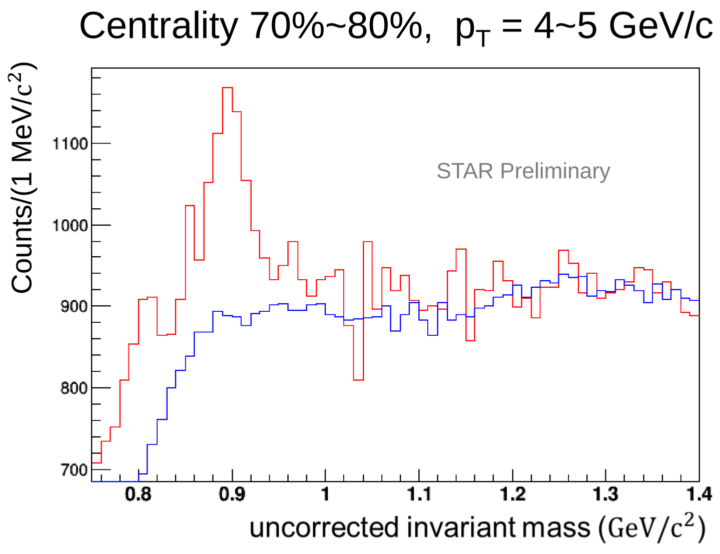


K_S^0 signal for centrality 20%~50%

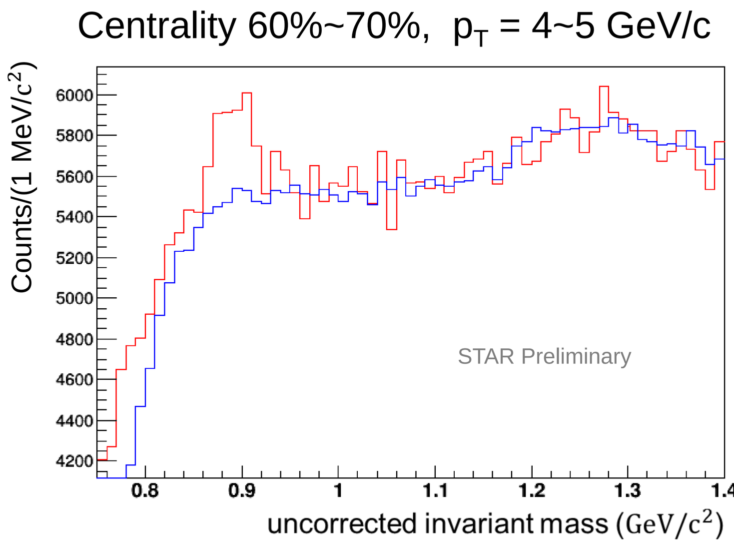


- **Examples of signal (red) and event mixing background (blue):**

Centrality 70%~80%, p_T = 4~5 GeV/c



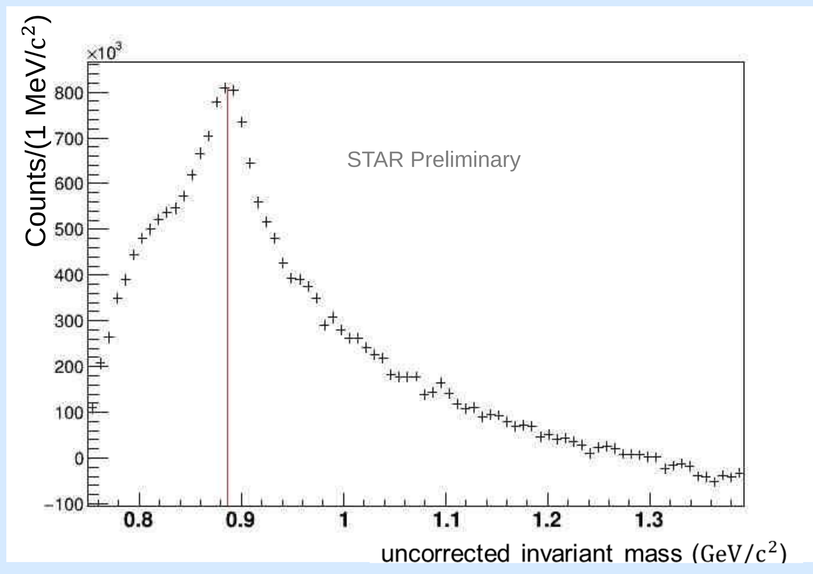
Centrality 60%~70%, p_T = 4~5 GeV/c



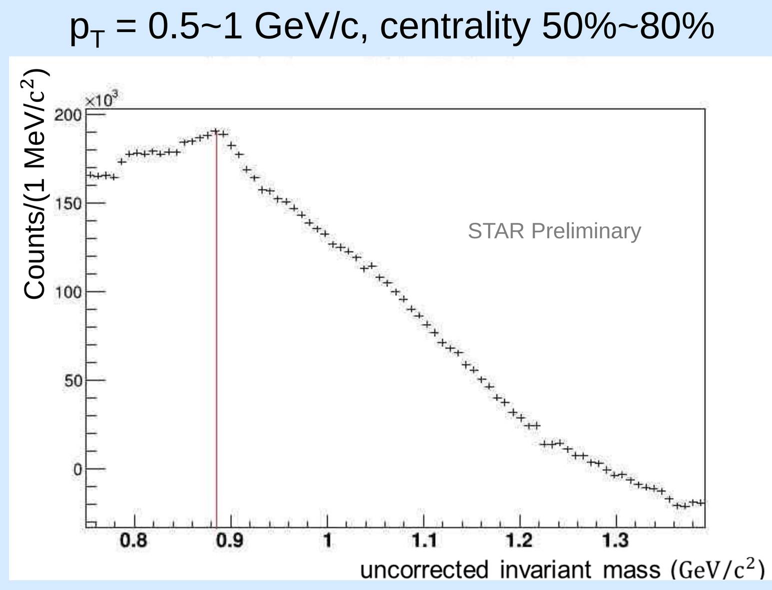
Results

- **K*$^{\pm}$(892) signal**: Mixed-event background has been subtracted.

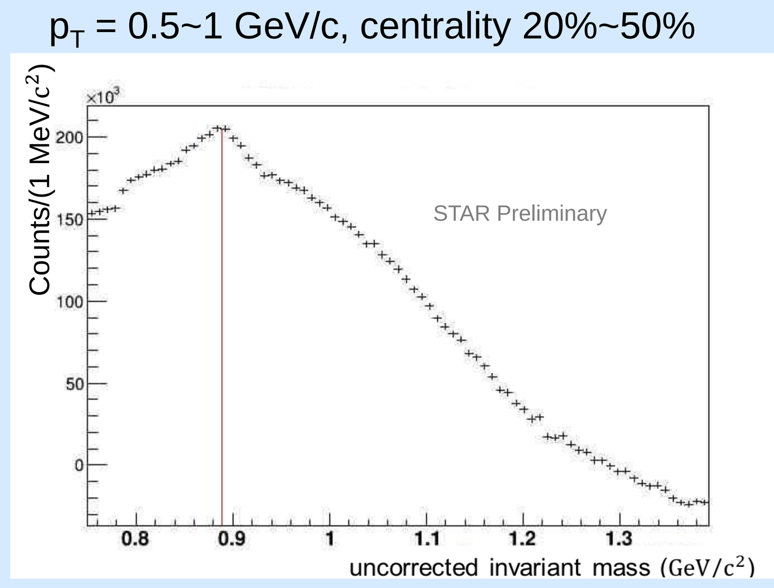
K*$^{\pm}$ signal for p_T = 0.5~3 GeV/c, all centrality combined



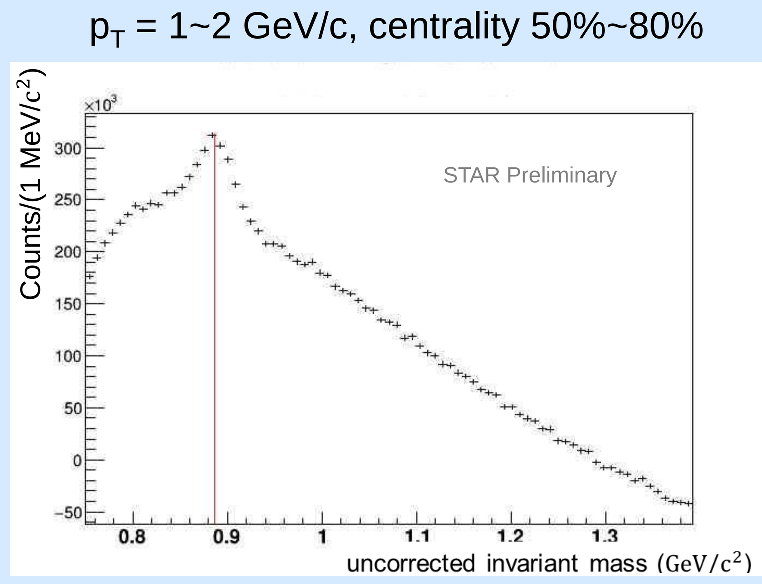
p_T = 0.5~1 GeV/c, centrality 50%~80%



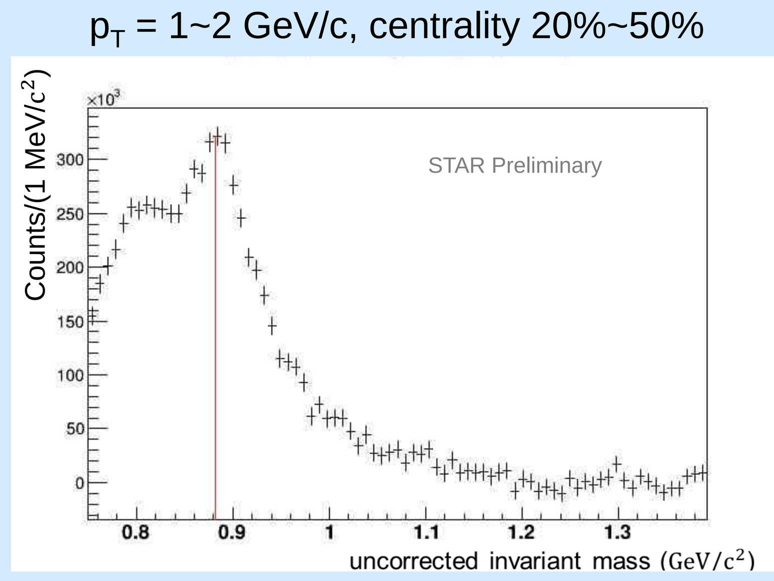
p_T = 0.5~1 GeV/c, centrality 20%~50%



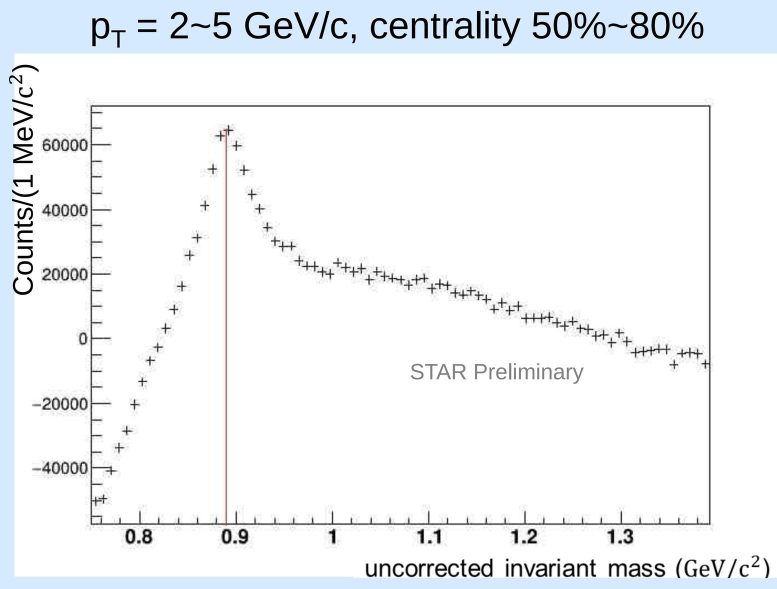
p_T = 1~2 GeV/c, centrality 50%~80%



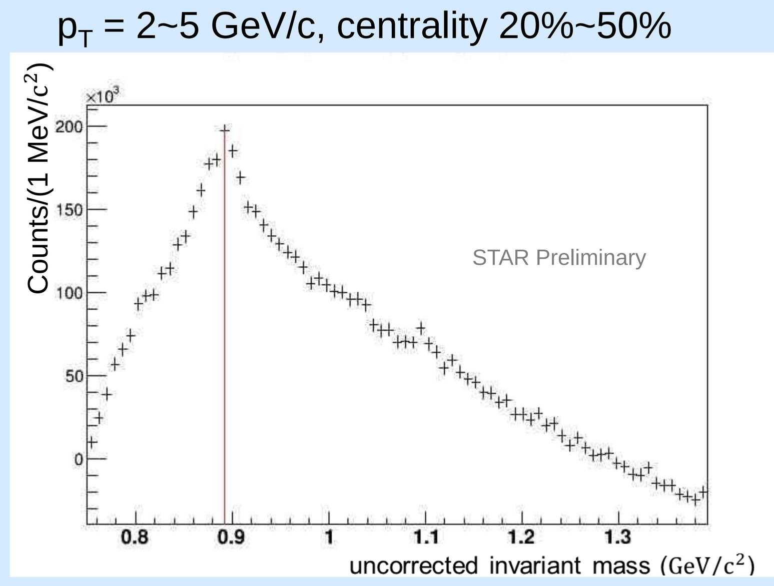
p_T = 1~2 GeV/c, centrality 20%~50%



p_T = 2~5 GeV/c, centrality 50%~80%



p_T = 2~5 GeV/c, centrality 20%~50%



PDG value: 891.66 ± 0.26 MeV

Summary and Outlook

➢ The signals for K*$^{\pm}$(892) resonance produced in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV at STAR are significant. The data analysis confirms the existence of a measurable amount of K*$^{\pm}$, which allows further study of its properties.

➢Possible future study of new physics includes resonance decays in strong magnetic field. For example, how K* mass changes with the magnetic field.

Acknowledgement

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Reference

[1]. STAR Collaboration, Phys.Rev.C71 064902 (2005).

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