Reconstruction of K*(892) Resonance in Au+Au Collisions at 200 GeV at STAR

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The Relativistic Heavy Ion Collider (RHIC) produces a hot, dense and de-confined Quantum Chromodynamics (QCD) 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 presentation, we report the reconstruction of invariant mass of $K^{*\pm}$ resonance via the hadronic decay channel $K^{*\pm}(892) \rightarrow K_S^0\pi^\pm$ 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:	
$K^{*\pm}(892) \rightarrow K_S^0\pi^\pm$	~100%
$K_S^0 \rightarrow \pi^+ \pi^-$	(69.20±0.05)%

$K^{*\pm}(892)$ candidates are reconstructed by inverting the decay mode to obtain the distribution of invariant mass of the decay parent.

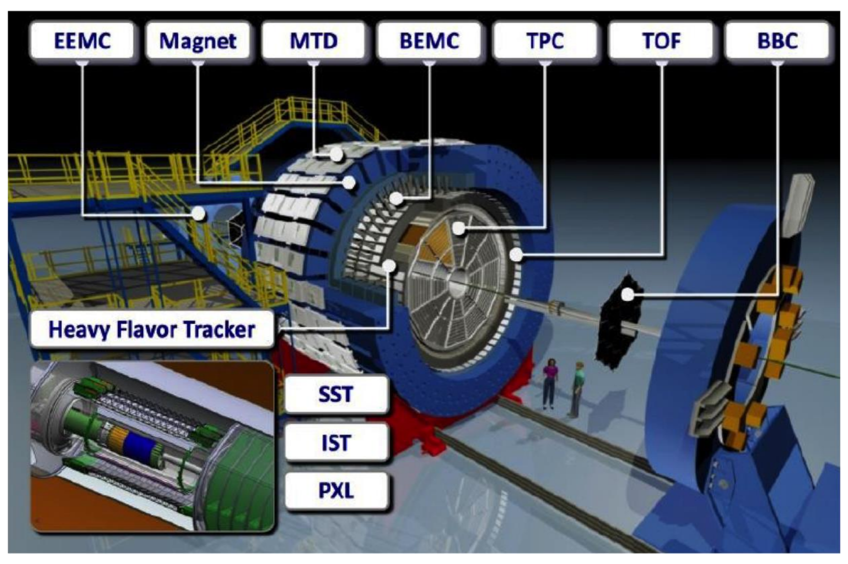
By special relativity,

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

So we should expect to observe a signal 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.



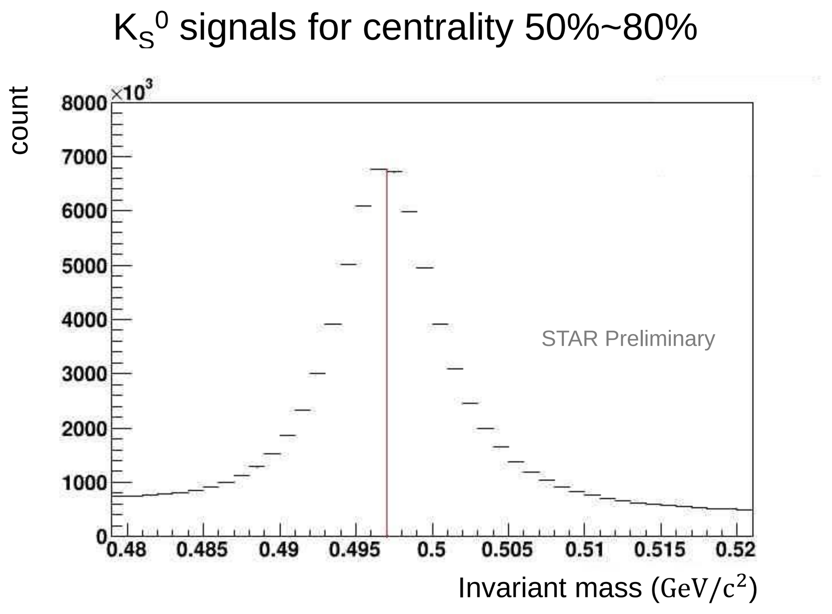
The STAR Detector

- The data used in this analysis were minimum bias trigger Au+Au collisions at 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.

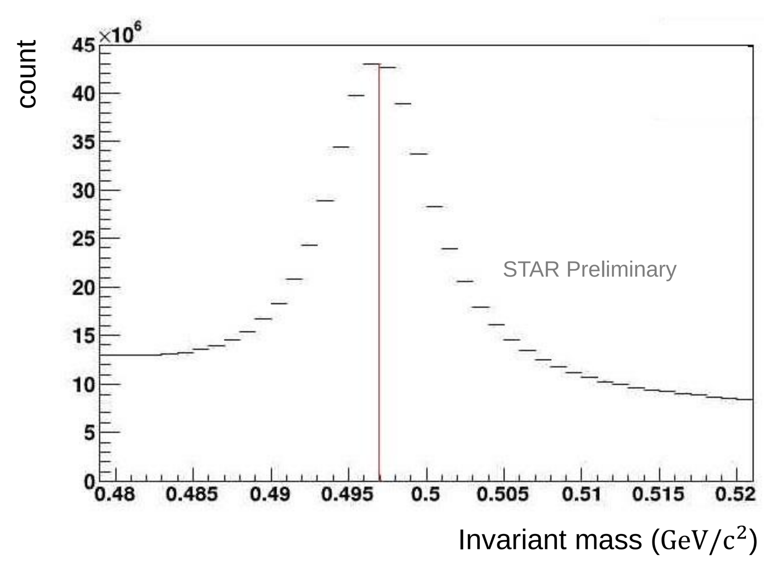
- **K_S^0 signals**

Observed in the π+π− invariant mass distribution reconstructed from the decay topology method.

K_S^0 signals for centrality 50%~80%



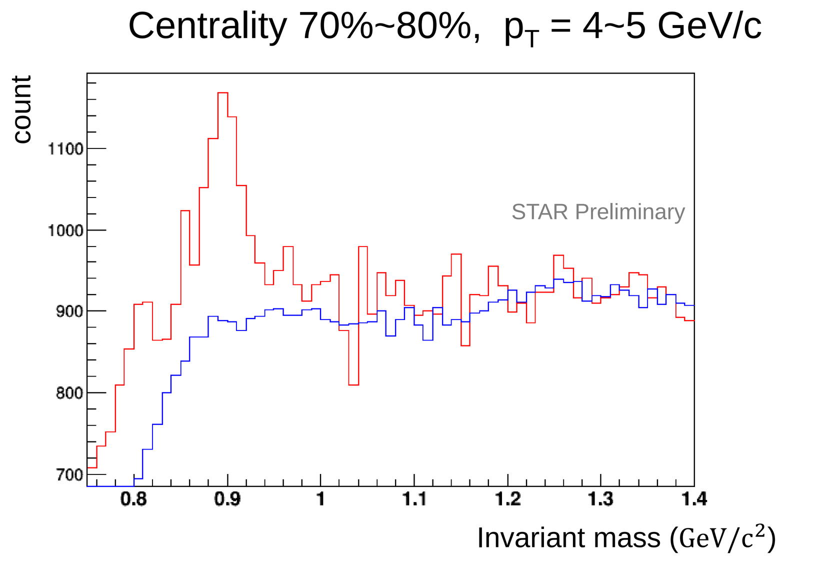
K_S^0 signals for centrality 20%~50%



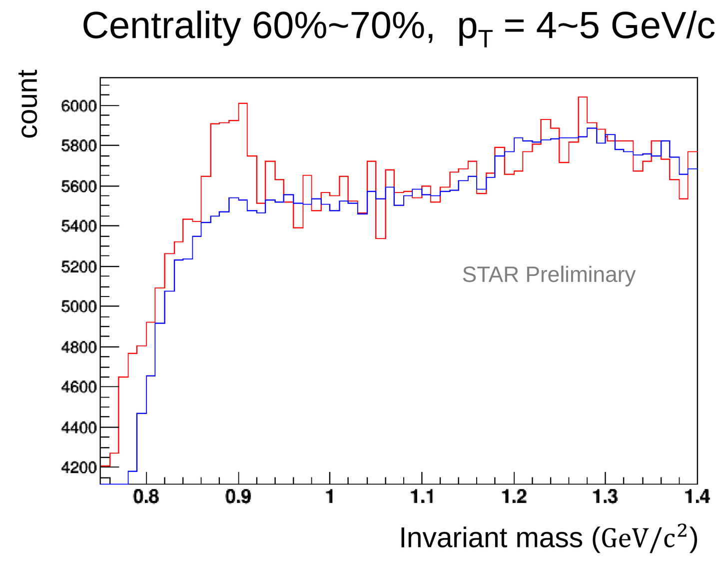
PDG value: 497.614±0.024 MeV

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

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



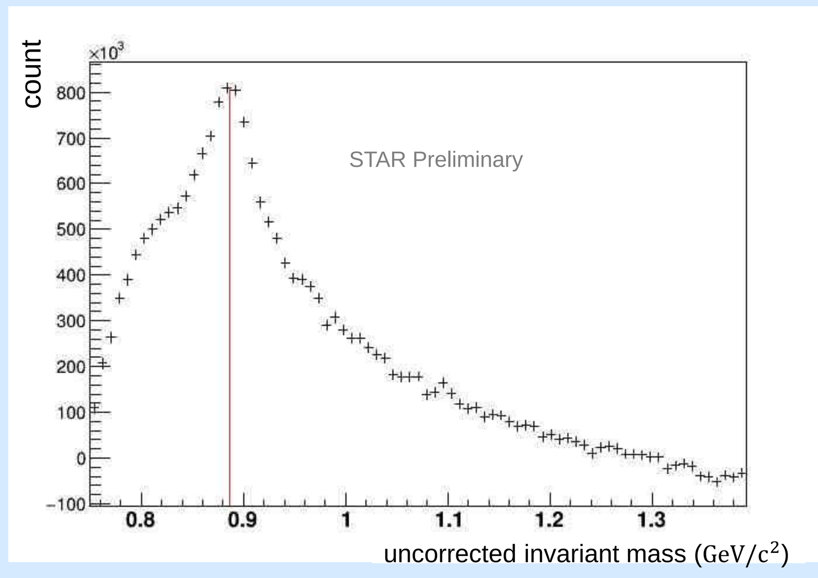
Centrality 60%~70%, p_T = 4~5 GeV/c



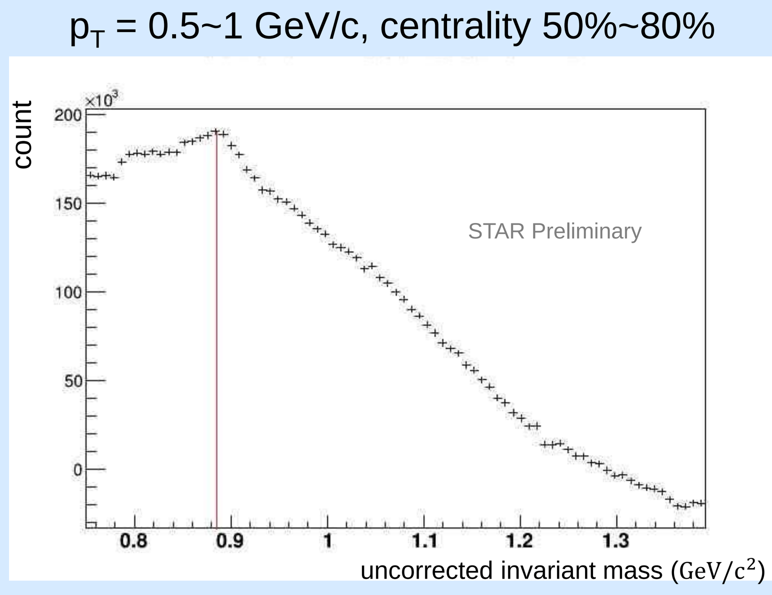
Results

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

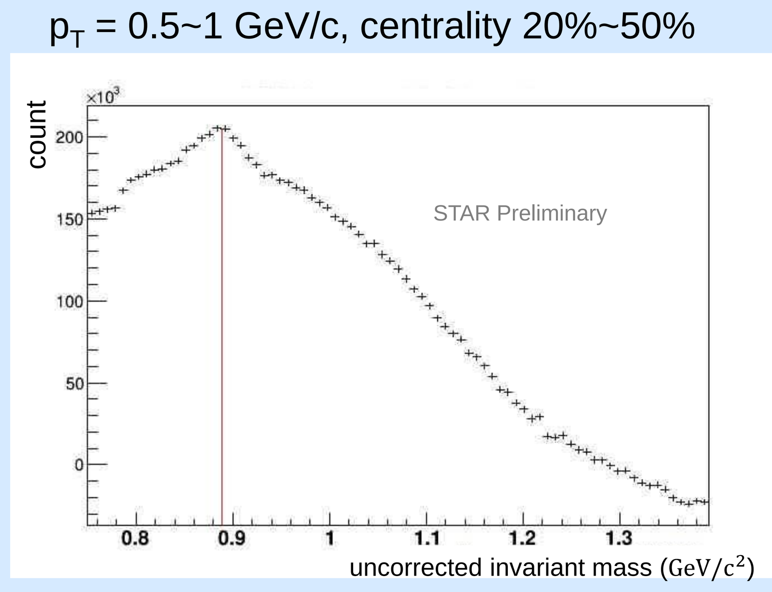
$K^{*\pm}$ signals for p_T = 0.5~3 GeV/c, all centrality combined



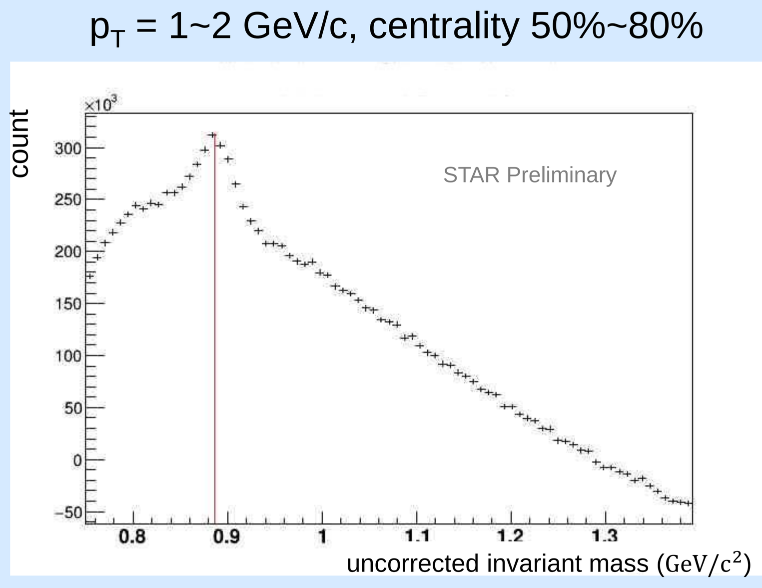
p_T = 0.5~1 GeV/c, centrality 50%~80%



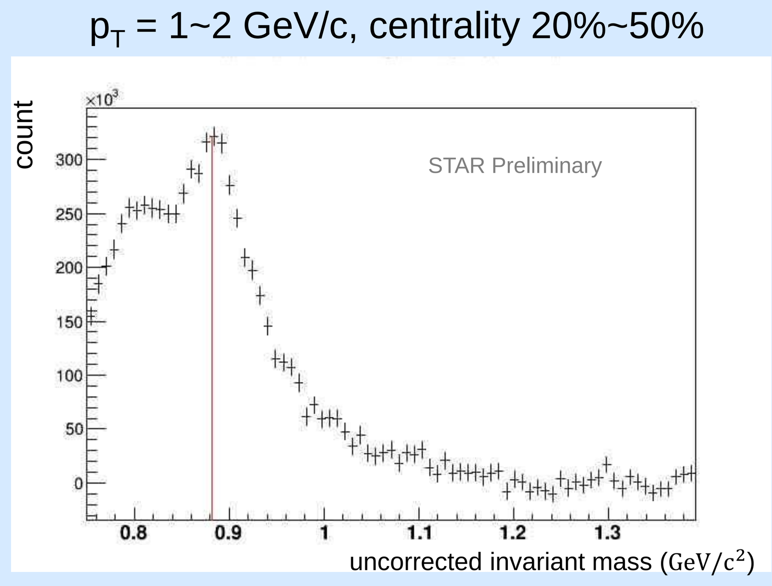
p_T = 0.5~1 GeV/c, centrality 20%~50%



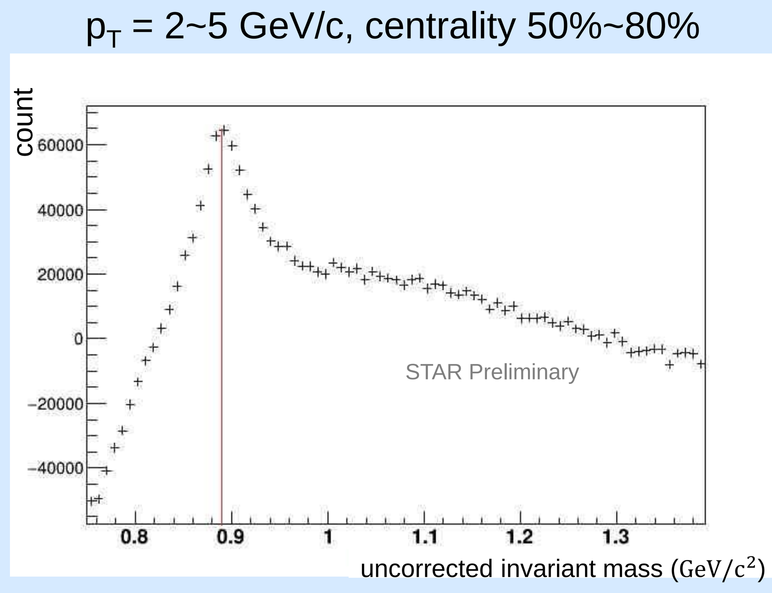
p_T = 1~2 GeV/c, centrality 50%~80%



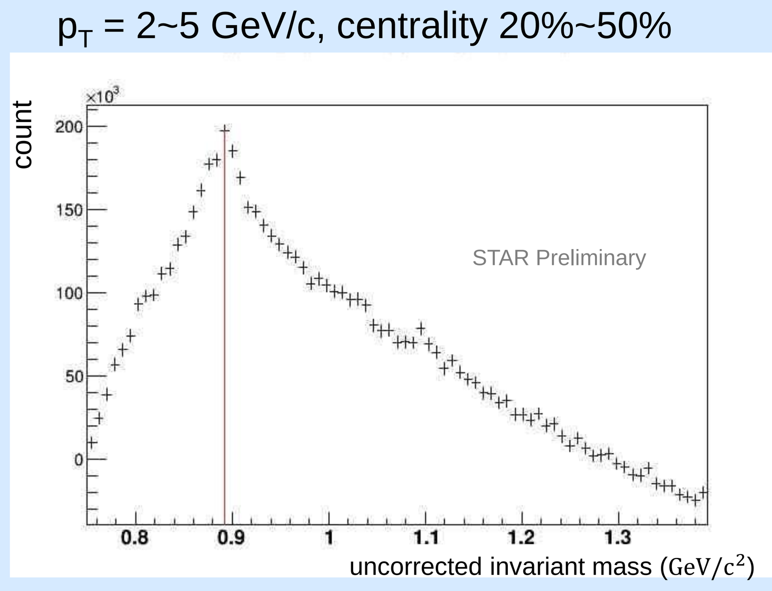
p_T = 1~2 GeV/c, centrality 20%~50%



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

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 < 30cm

pVtxr < 2cm

|pVtxz – vzVpd|< 3cm

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

$|\beta - \beta_\pi| < 0.04$

$|n_{\sigma\pi}| < 3.0$

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 < pT < 10.0 GeV/c

p < 10.0 GeV/c

$|\eta| < 0.8$

dca < 3.0 cm

NFitPnts > 15

NTpcHits > 15

nHitsFit/nHitsTotal > 0.55

Summary and Outlook

➢ The signals for $K^{*\pm}(892)$ resonance produced in Au+Au collisions at 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.

➢Future study of new physics if possible, 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, arXiv:nucl-ex/0412019v2, 22 Apr 2005

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