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

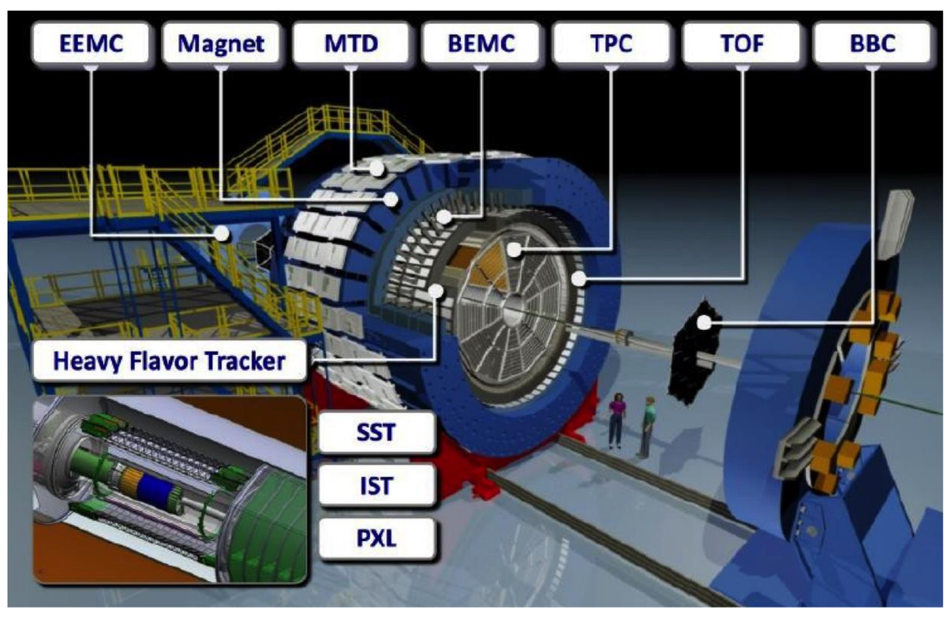
Decay Mode:	
$K^{*\pm}(892) \rightarrow K_S^0\pi^\pm$	~100%
$K_S^0 \rightarrow \pi^+\pi^-$	(69.20±0.05)%

$K^{*\pm}(892)$ candidate is reconstructed by inverting 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.

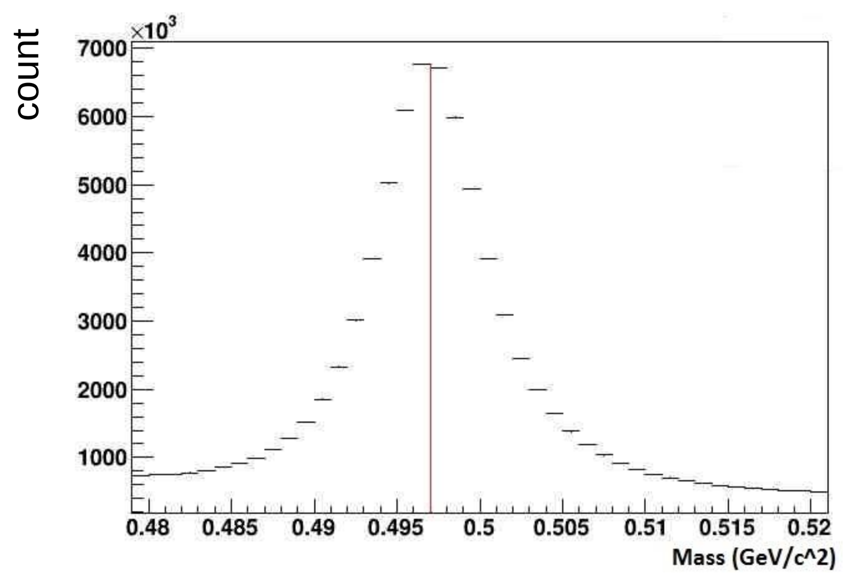


- The data used in this analysis were minimum bias trigger Au+Au collisions at 200 GeV collected in the Run 2011 from the STAR experiment.
- Particle Identification: TPC (Time Projection Chamber) dE/dx and TOF (Time of Flight) are used for pion identification.

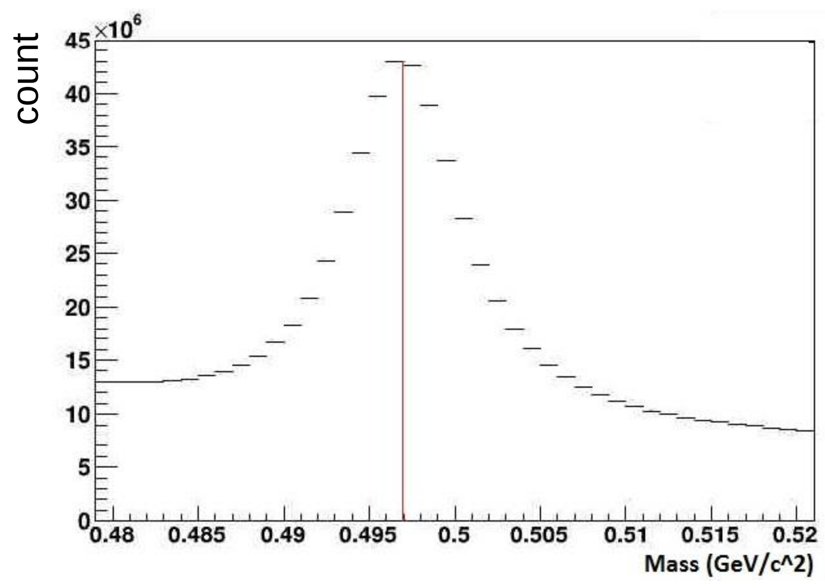
- **K_S^0 signals**

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

K_S^0 signals for centrality 50%~80%



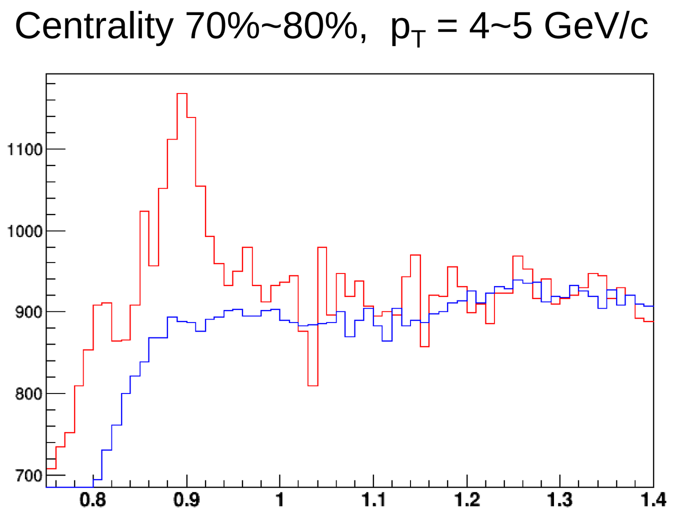
K_S^0 signals for centrality 20%~50%



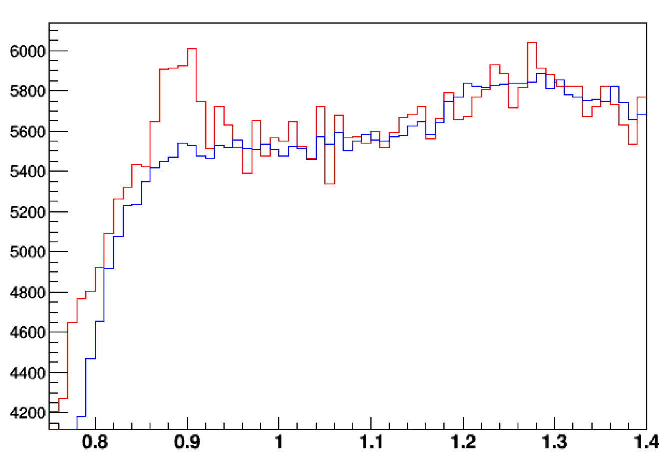
PDG value: 497.614±0.024 MeV

Examples of foreground (red) and event mixing background (blue):

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



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



Track Cuts, Event Cuts and Particle Identification

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)

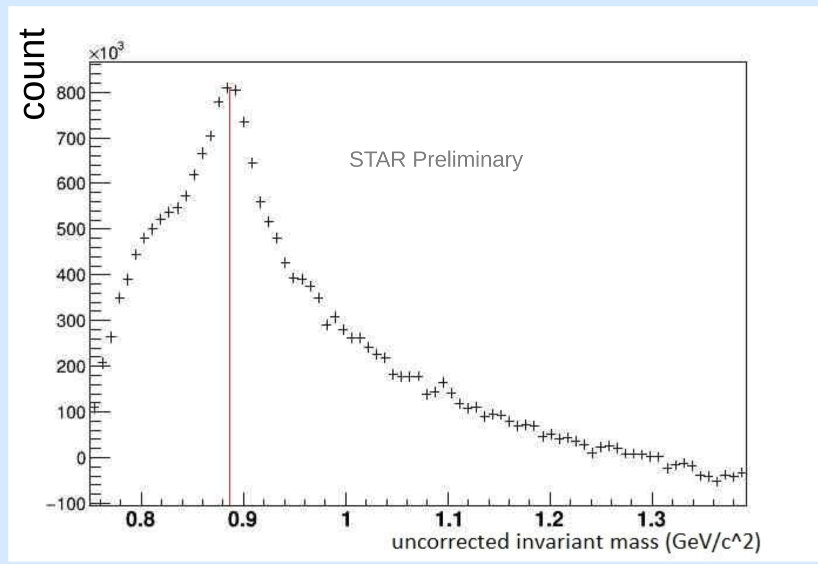
Track cuts for K0 reconstruction:
nHitsFit > 15
p > 0.2 GeV/c
TOF flag > 0
|β-βπ| < 0.04
|nσπ|< 3.0
dca_π+_π- < 0.8 cm
decay length > 4.0 cm
dca_to_vtx (for K0) < 0.85 cm
dca_to_π+ & dca_to_π- > 0.5 cm
mass of K0 = (0.48, 0.51) GeV/c^2

Track cuts for pion:
|nσπ| < 2.0
0.2 < pT < 10.0 GeV/c
p < 10.0 GeV/c
|η| < 0.8
dca < 3.0 cm
NFitPnts > 15
NTpcHits > 15
nHitsFit/nHitsTotal > 0.55

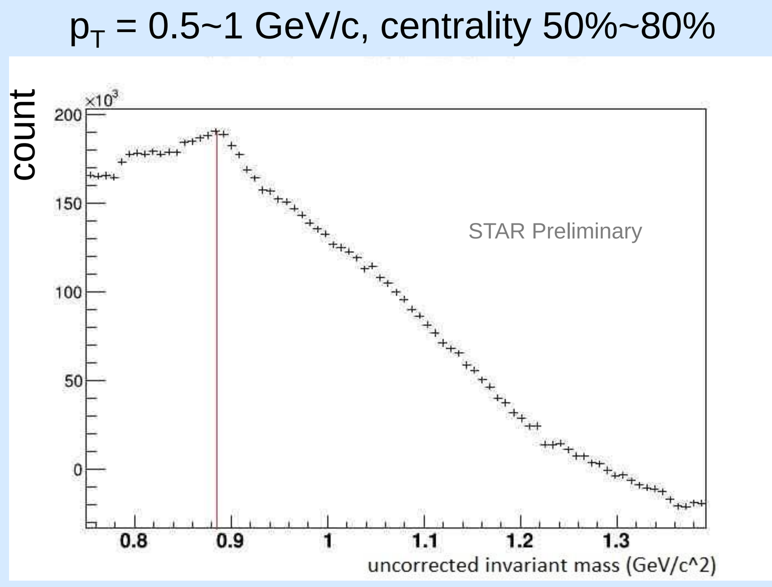
Results

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

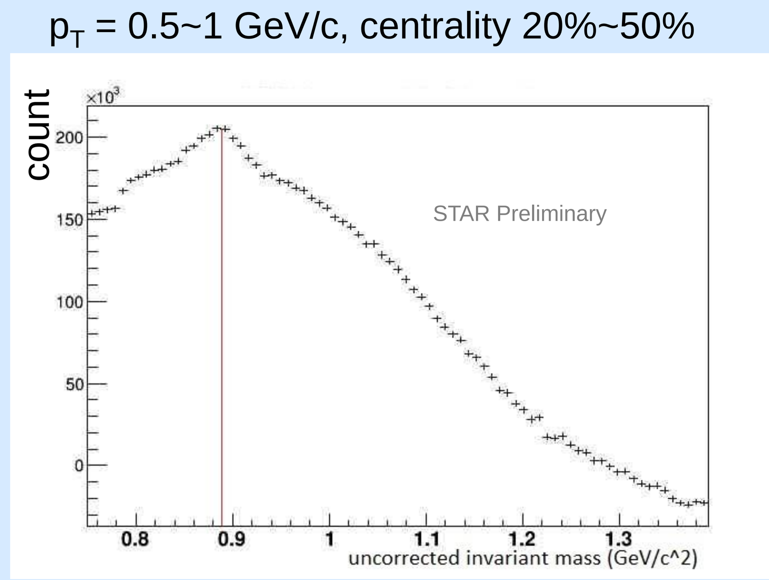
$K^{*\pm}$ signals for p_T = 0.5~3 GeV/c, all centrality combined



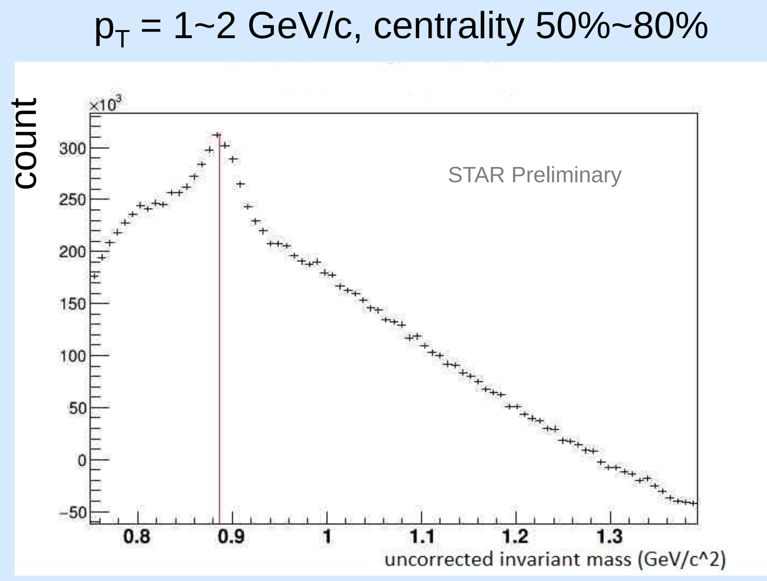
p_T = 0.5~1 GeV/c, centrality 50%~80%



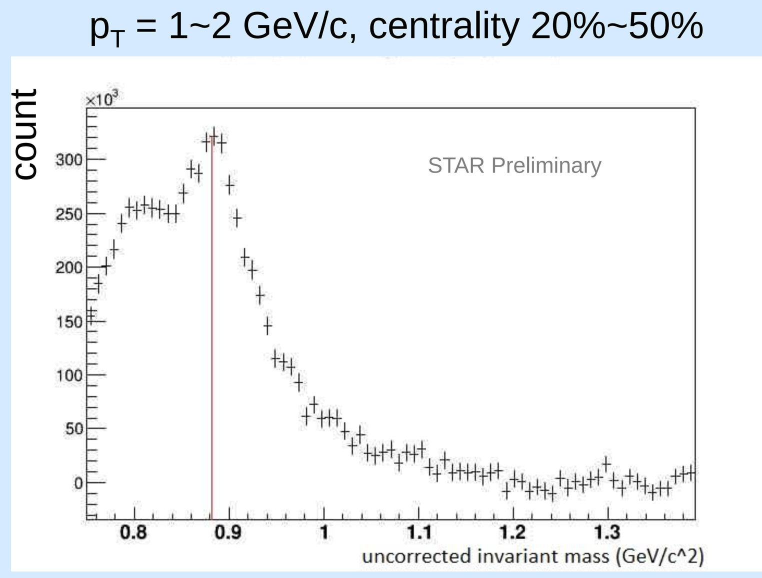
p_T = 0.5~1 GeV/c, centrality 20%~50%



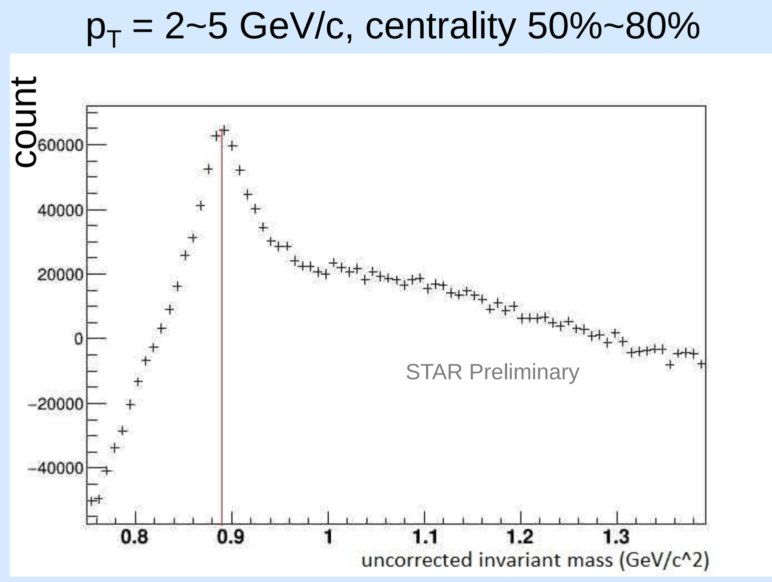
p_T = 1~2 GeV/c, centrality 50%~80%



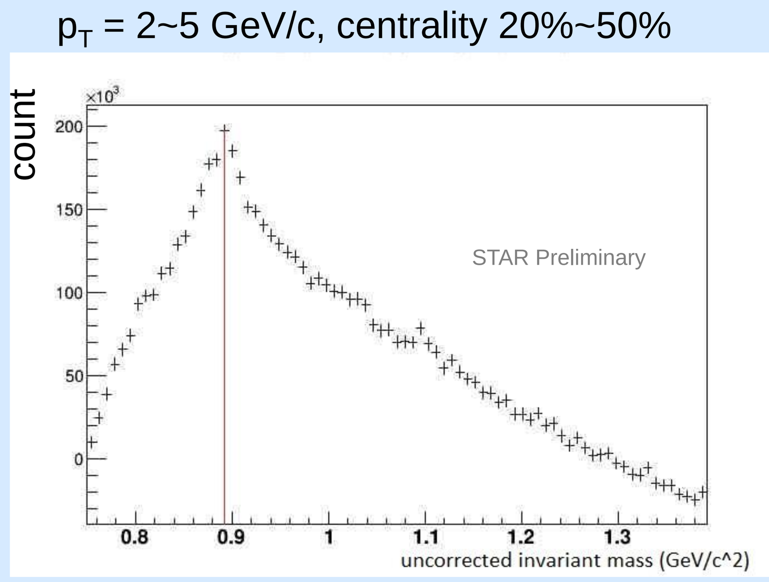
p_T = 1~2 GeV/c, centrality 20%~50%



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

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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