



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 medium, called the quark-gluon plasma (QGP), with Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. The $K^*(892)$ 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^* and its properties may provide an effective tool to probe the evolution of the QGP produced. Experimentally, K^* 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^* measurements. In this poster, we report the reconstruction of invariant mass of K^* resonance via the hadronic decay channel $K^*(892) \rightarrow K_S^0 \pi^\pm$ 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

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

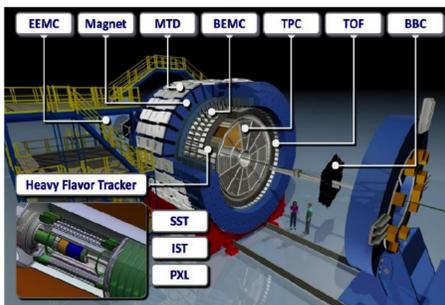
By special relativity,

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

So we should expect to observe a resonance peak around 0.892 GeV/c².

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.

Decay Mode:

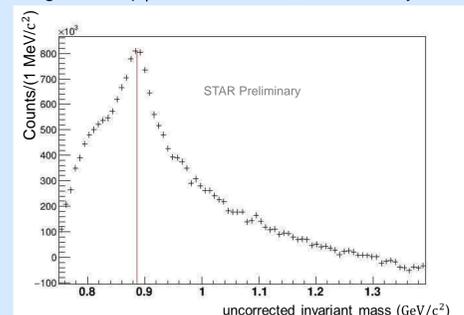
$$K^*(892) \rightarrow K_S^0 \pi^\pm \quad \sim 100\%$$

$$K_S^0 \rightarrow \pi^+ \pi^- \quad (69.20 \pm 0.05)\%$$

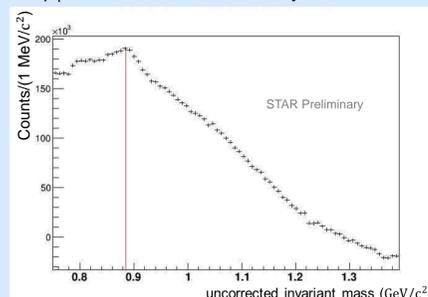
Results

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

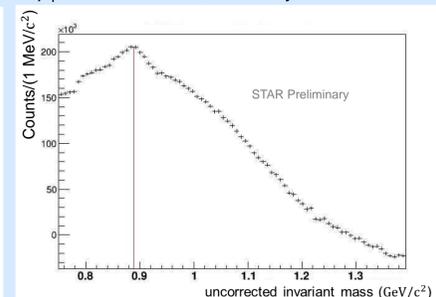
K^* signals for $p_T = 0.5-3$ GeV/c, all centrality combined



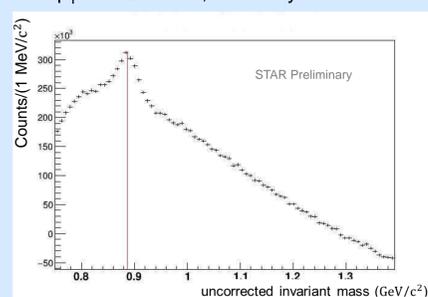
$p_T = 0.5-1$ GeV/c, centrality 50%~80%



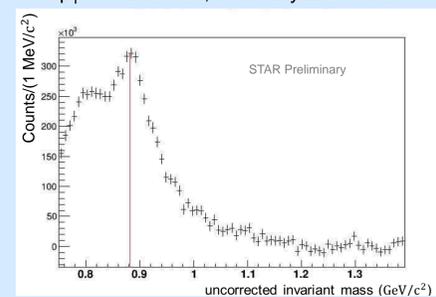
$p_T = 0.5-1$ GeV/c, centrality 20%~50%



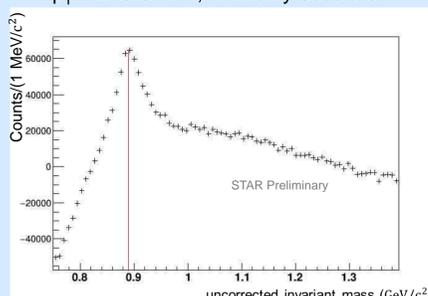
$p_T = 1-2$ GeV/c, centrality 50%~80%



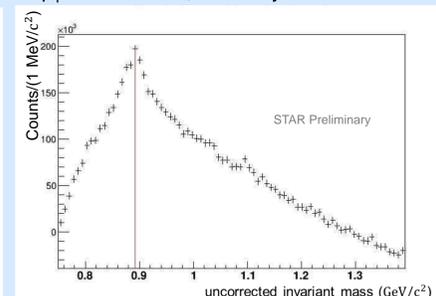
$p_T = 1-2$ GeV/c, centrality 20%~50%



$p_T = 2-5$ 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 $K^*(892)$ 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^* , 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

Thanks to Prof. Huan Z. Huang for mentorship and to Dr. Gang Wang and the STAR collaboration for guidance. Thanks to Roli Esha, Liwen Wen for valuable help on my coding.

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 K_0 and pion momentum vectors)

Track cuts for K_0 reconstruction:

- nHitsFit > 15
- $p > 0.2$ GeV/c
- TOF flag > 0
- $|\beta - \beta_\pi| < 0.04$
- $|n_{\sigma\pi}| < 3.0$
- $dca_{\pi^+ \pi^-} < 0.8$ cm
- decay length > 4.0 cm
- dca_{to_vtx} (for K_0) < 0.85 cm
- $dca_{to_ \pi^+}$ & $dca_{to_ \pi^-} > 0.5$ cm
- mass of $K_0 = (0.48, 0.51)$ GeV/c²

Track cuts for pion:

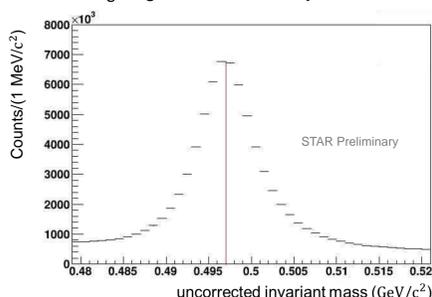
- $|n_{\sigma\pi}| < 2.0$
- $0.2 < p_T < 10.0$ GeV/c
- $p < 10.0$ GeV/c
- $|\eta| < 0.8$
- dca < 3.0 cm
- NFitPnts > 15
- NTpcHits > 15
- nHitsFit/nHitsTotal > 0.55

K_S^0 signals

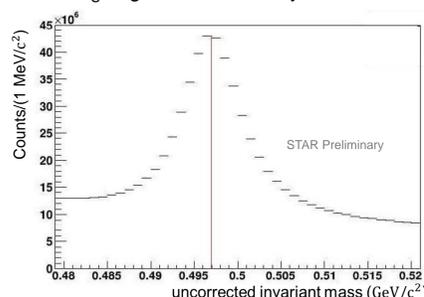
Observed in the $\pi^+ \pi^-$ invariant mass distribution reconstructed from the decay topology method.

PDG value: 497.614 ± 0.024 MeV

K_S^0 signals for centrality 50%~80%

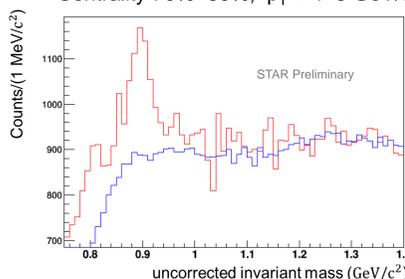


K_S^0 signals for centrality 20%~50%

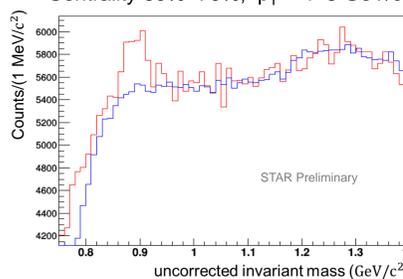


Examples of signal (red) and event mixing background (blue):

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



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



Reference

[1]. STAR Collaboration, arXiv:nucl-ex/0412019v2, 22 Apr 2005

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