D^{*+} production in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV measured by the STAR experiment

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Outline

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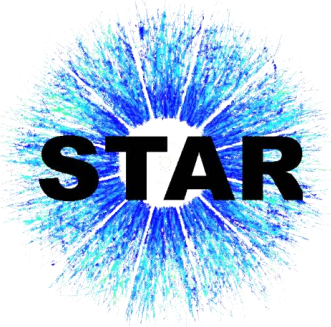
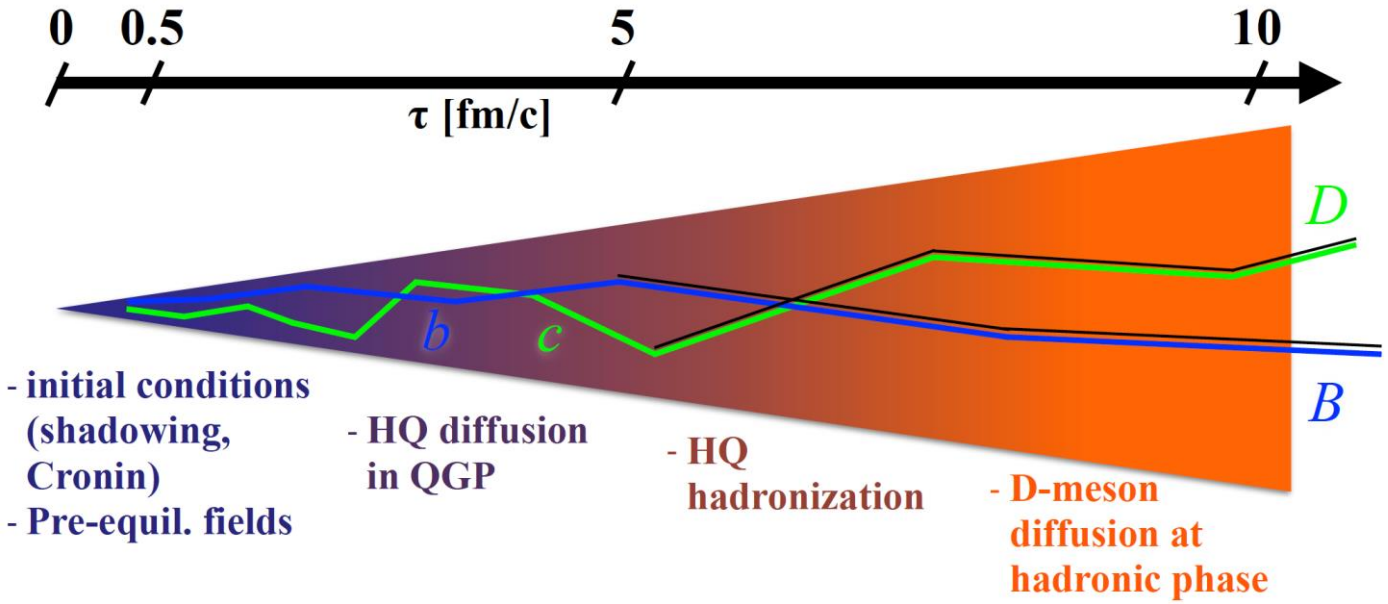
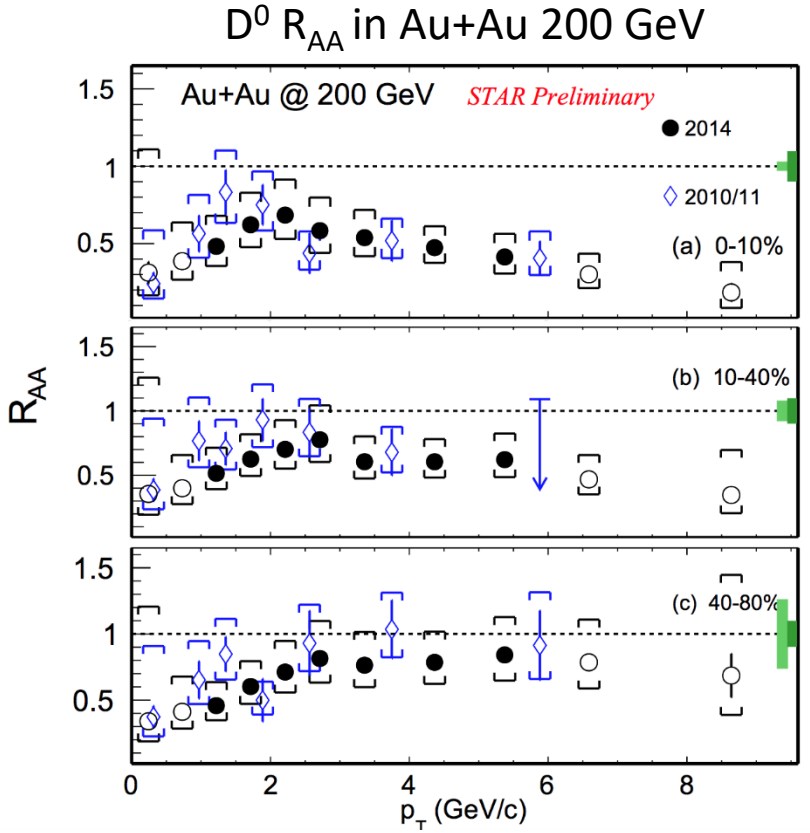
- Reconstruction and Efficiency
- Results
- Summary



Motivation

◊ Heavy flavor: Penetrating probe of QGP;





◊ Dominantly produced during hard partonic scatterings at the early stage

- calibrated probe calculable in pQCD
- experience the entire QGP evolution
- sensitive probes to the medium properties

Motivation

◊ Study the D^{*+}/D^0 ratio;

(1) D^{*+} feed-down contribution to D^0 yields;

$$D^{*+} \rightarrow D^0 \pi^+_{soft}$$

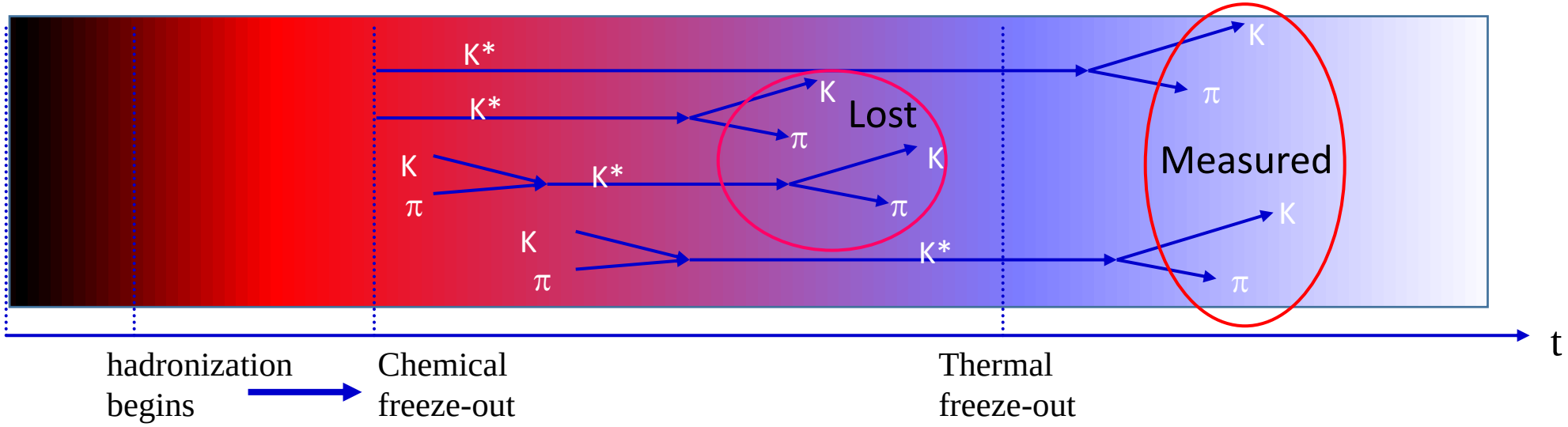
(2) Other effects:

-- D^{*+} spectral function predicted to broaden in hot medium [1];

-- Re-scattering which has already been seen in K^* [2].

Resonance	K*(892)	$D^{*+}(2010)$
Decay channel	K π	$D^0\pi$
Branching Ratio %	~100	67.7
Width	50.7 MeV	83.3 KeV
Life time	4 [fm/c]	~2[pm/c]

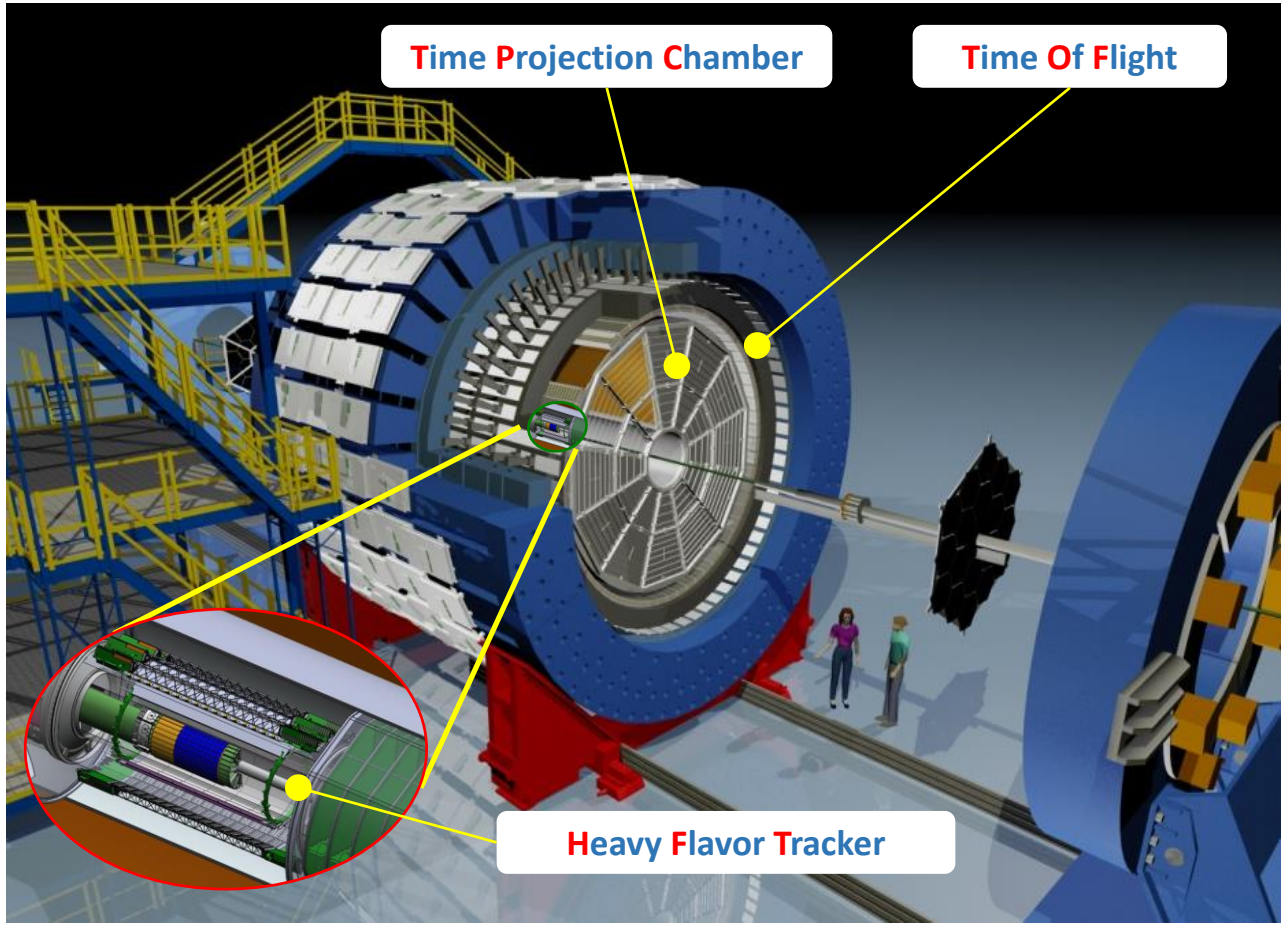
Shorter life time in the hot medium?



[1] Phys. Rev. C (2018)97, 034918

[2] Phys. Rev. C (2011)84, 034909

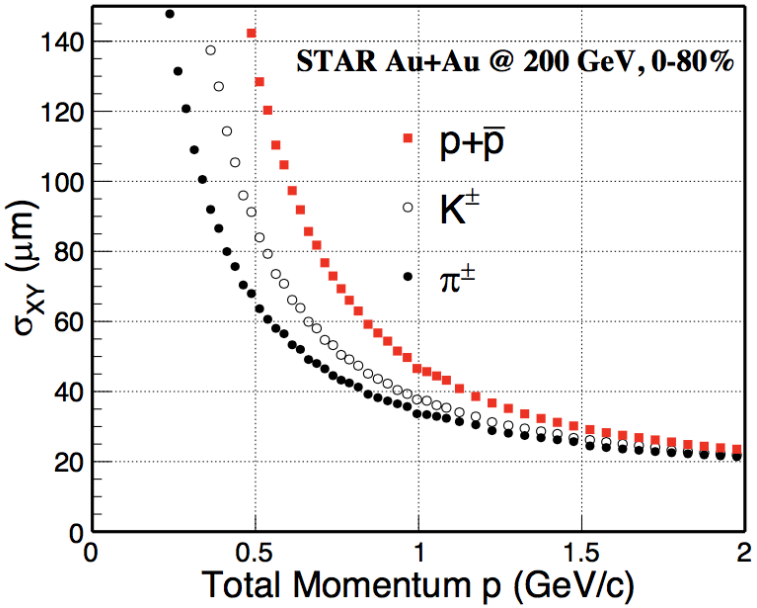
STAR Detector



STAR Heavy Flavor Tracker provides excellent vertex resolution and allows reconstruction of charm hadron decays.

Heavy Flavor Tracker (HFT)
Inner tracking system (2014-2016):

- Silicon Strip Detector: r ~22 cm
- Intermediate Silicon Tracker: r ~14 cm
- PIXEL detector: r ~2.8 & 8 cm, MAPS, 20.7x20.7 μm^2, 0.5%X_0 thick, air-cooled



HFT DCA_{XY} resolution

Phys. Rev. Lett. (2017) 118, 212301

Dataset and reconstruction method

◊ **Dataset:**

Au+Au @ 200 GeV recorded in 2014;

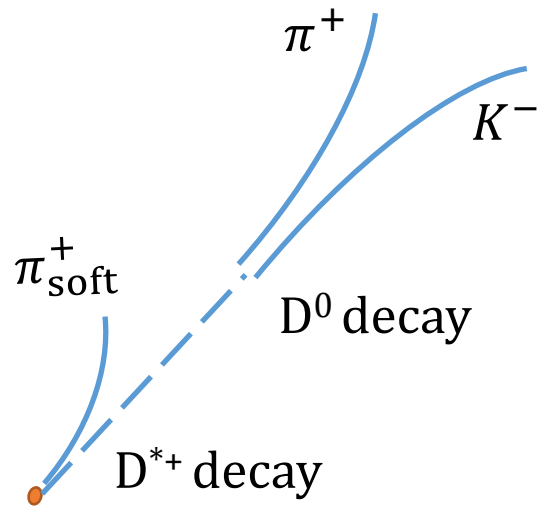
~ 900Million minimum-bias events.

◊ **Reconstruction method**

$$D^{*+} \rightarrow D^0 \pi^+_{soft} (B.R. = 67.7\%),$$

$$D^0 \rightarrow K^- \pi^+ (\text{B. R.} = 3.89\%),$$

and its charge conjugate channel.



◊ **D^0 reconstruction cuts:**

$|y|_{D^0} < 1$;

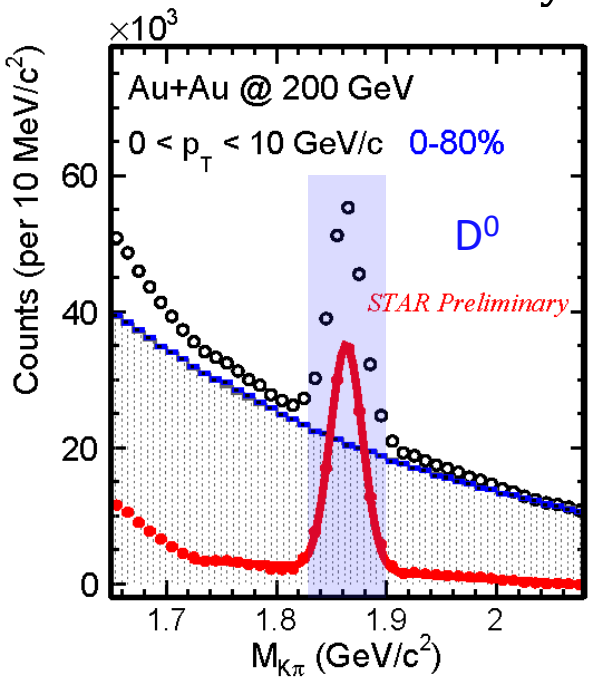
K/π : $p_T > 0.3$ GeV/c;

K/π : $|\eta| < 1$;

K/π : at least one hit in each layer of PXL and IST;

K/π PID : if TOF available, TOF && TPC;

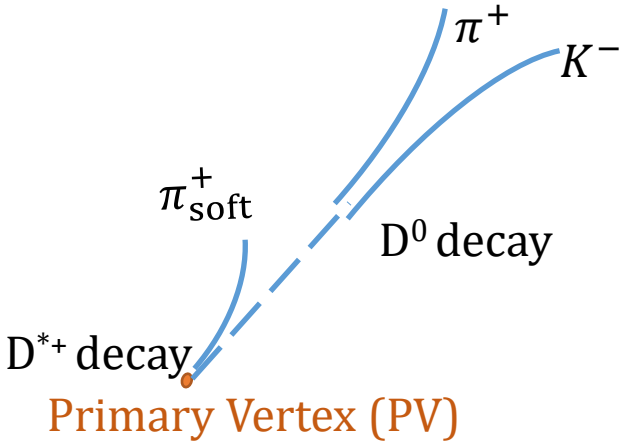
otherwise TPC only.

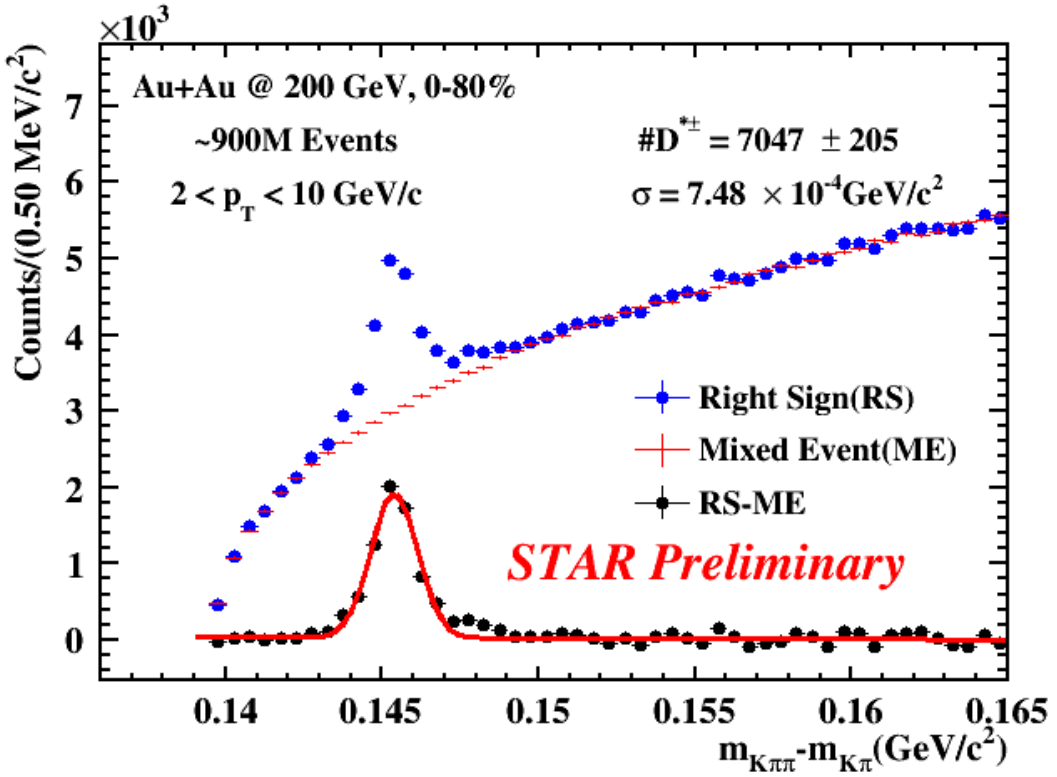


Signal extraction

◊ π_{soft} cuts:

$DCA_{PV} \leq 3$ cm, not refitted with the PV;
nHitsFit ≥ 20,
(no requirement to leave hits in HFT);
$p_T > 0.15$ GeV/c;
$|\eta| < 1$;
PID: TOF and TPC if TOF is available,
otherwise TPC only.





◊ Background is estimated by the mixed-event method.

Efficiency correction

- **D^{*+} efficiency**

  D^0 efficiency $\otimes$ π_{soft} efficiency;

  Vertex resolution correction;

- **D^0 efficiency**

  D^0 reconstruction efficiency ← Fast simulation with inputs from data and embedding;

  Mass cut efficiency ← Real data D^0 signal;

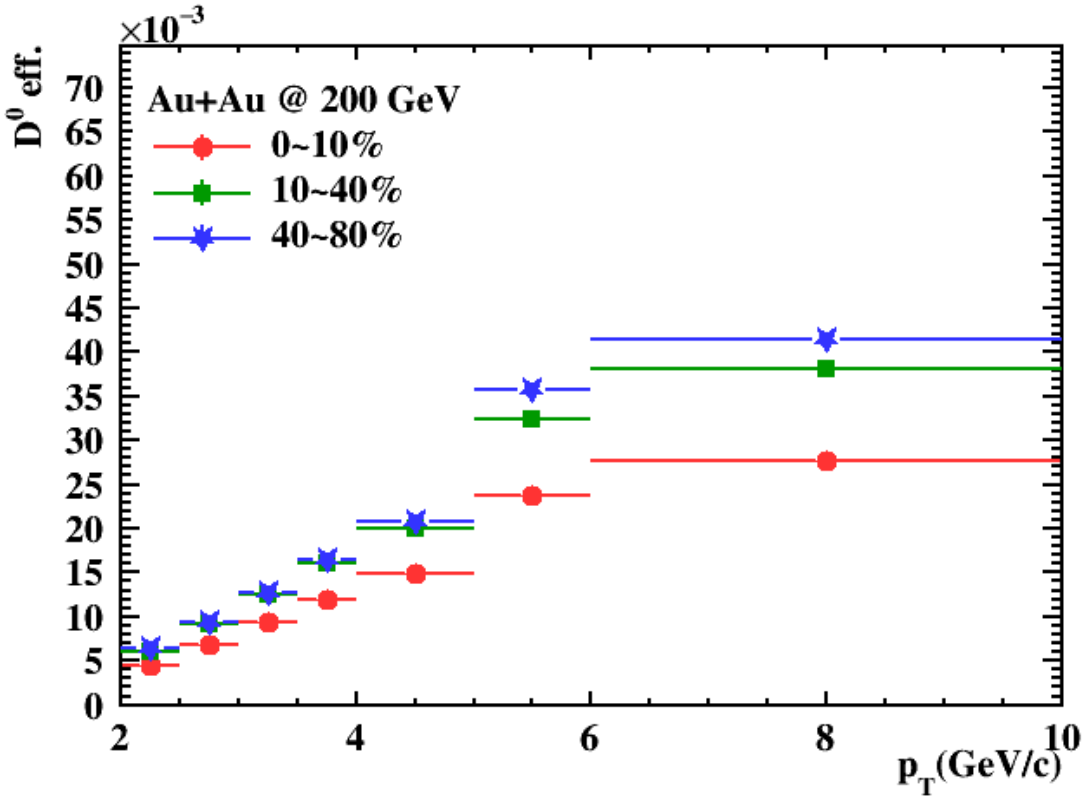
- **π_{soft} efficiency**

  TPC tracking efficiency ← TPC embedding;

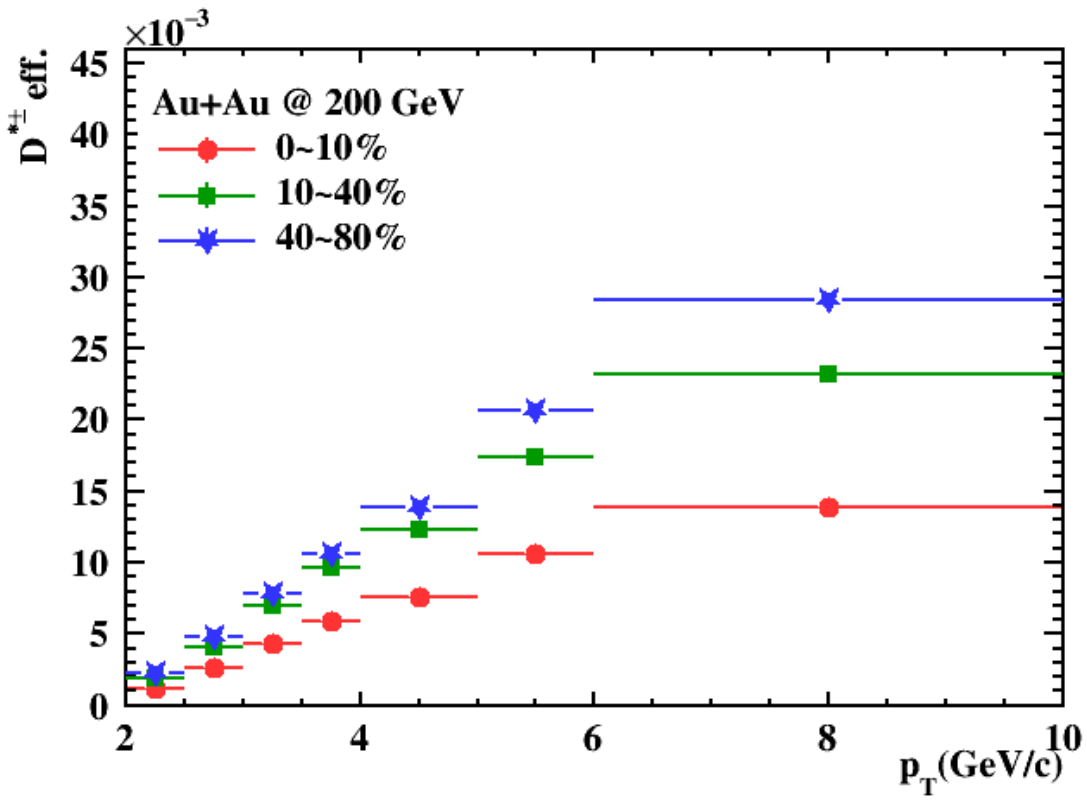
  TOF matching efficiency ← Real data;

  PID efficiency ← Extracted using the pure pion sample from ${K_s}^0$ decay.

Efficiency

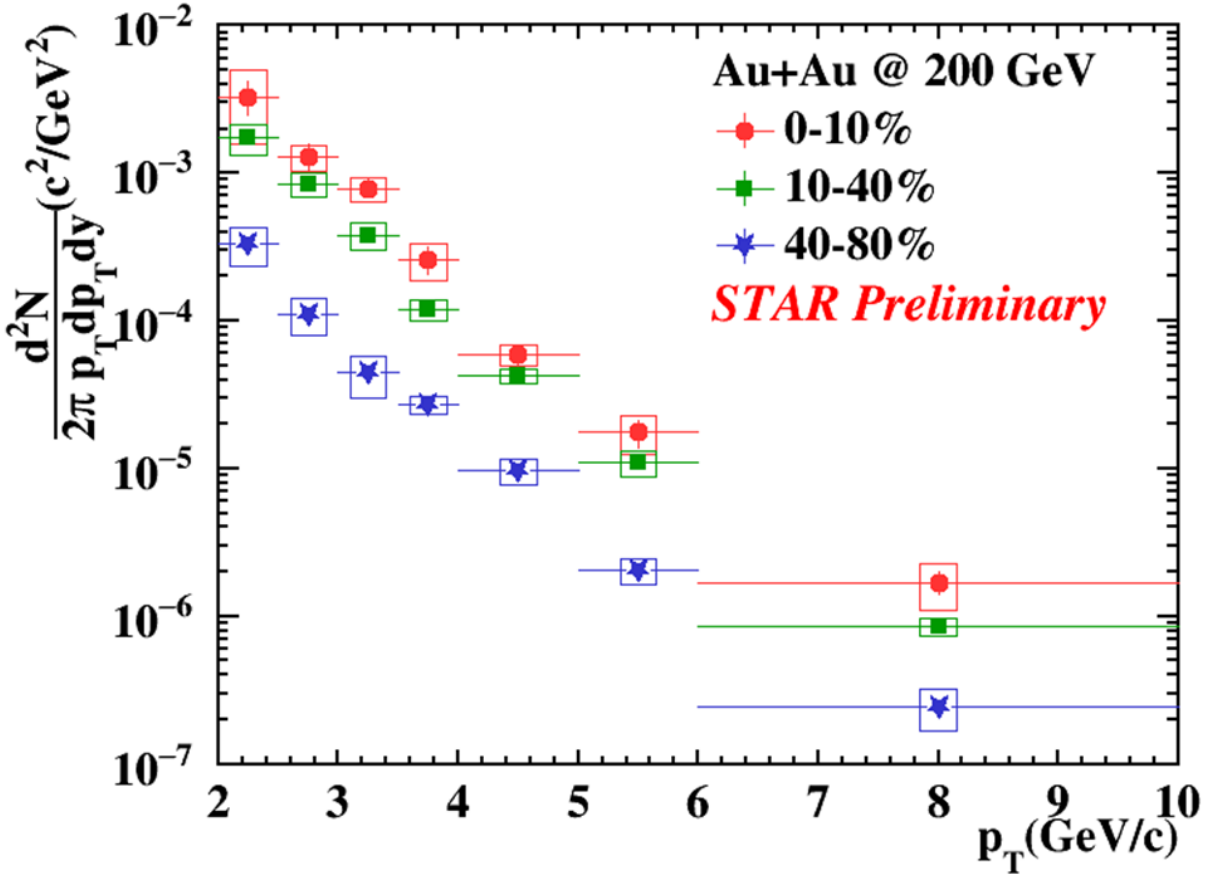


D^0 reconstruction efficiency



D^{*+} total efficiency

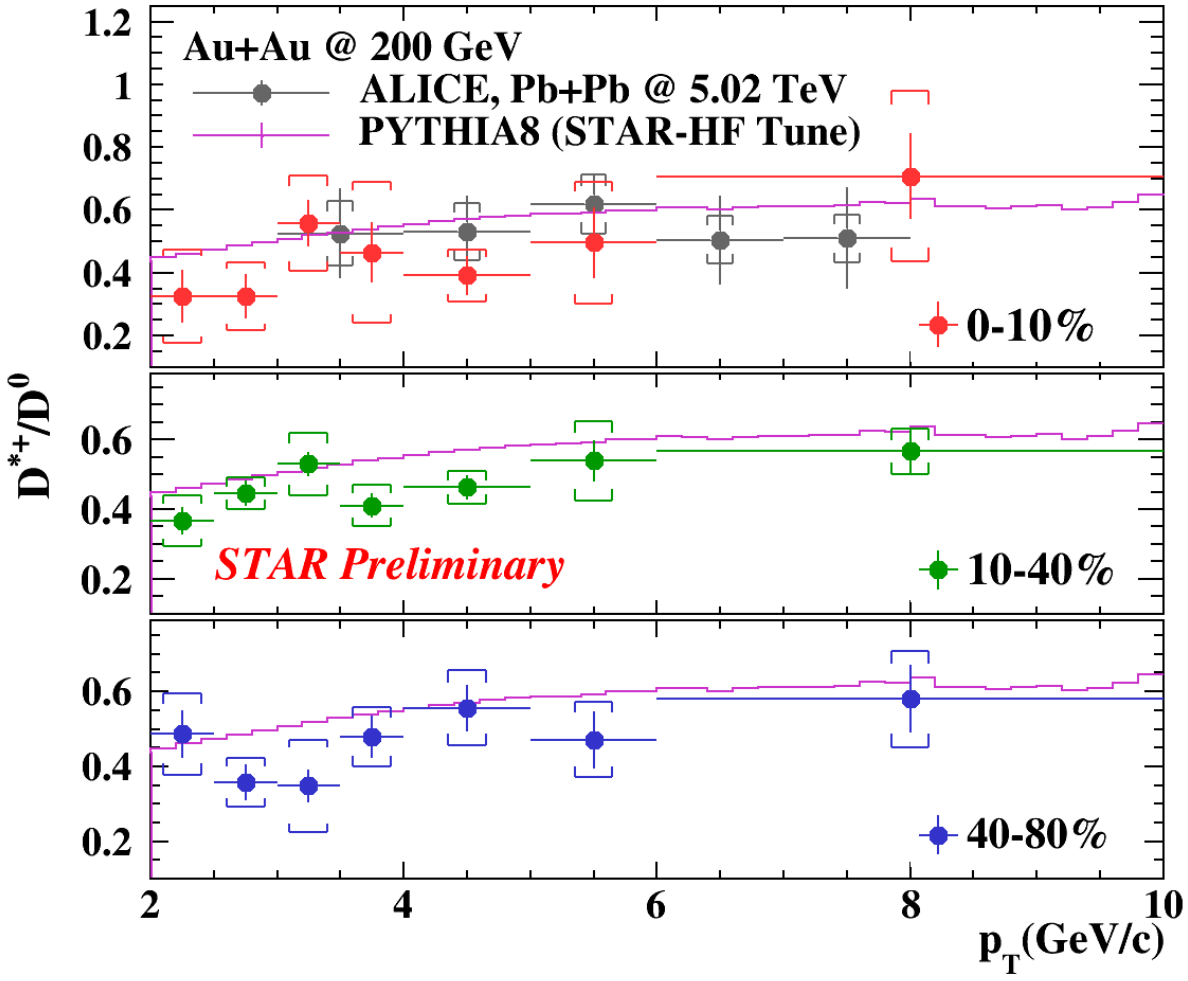
D^{*+} p_T spectra



Branching ratio = 67.7%*3.89%;

$$\frac{d^2N}{2\pi p_T dp_T dy} = \frac{\text{Raw } yield \,/\, Eff.}{2\pi p_T \Delta p_T \, \Delta y N_{events} \times B.R.}$$

D^{*+}/D^0 ratio vs. p_T

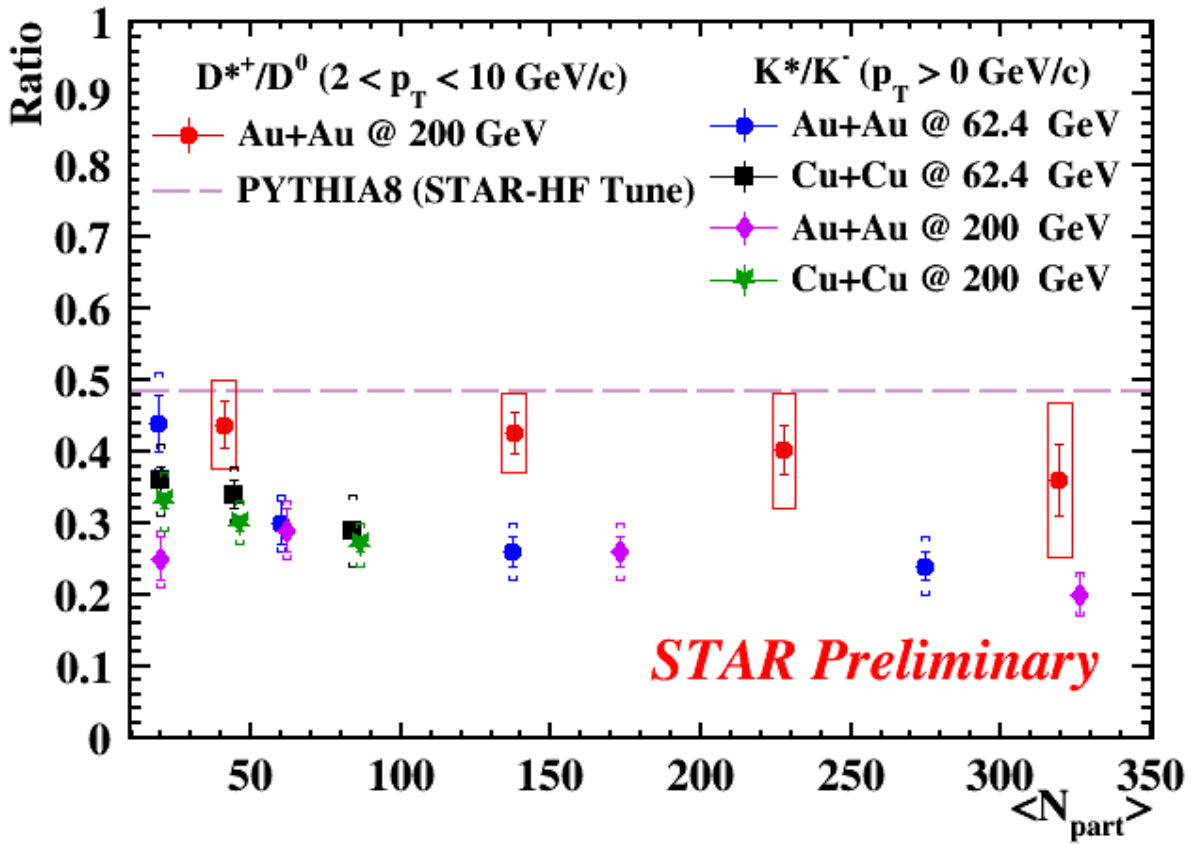


- D^{*+}/D^0 ratio shows a rising trend as p_T increases.
- D^{*+}/D^0 (Au+Au @ 200 GeV) ~ D^{*+}/D^0 (Pb+Pb @ 5.02 TeV) [1].
- PYTHIA8 (STAR-HF Tune) consistent with data;

  -- D^{*+} and D^0 has similar suppression.

[1] ALICE Collaboration. arXiv:1804.09083.

D^{*+}/D^0 ratio vs. centrality



D^{*+}/D^0 and K^*/K^- [1] integrated yield ratios

◊ No strong centrality dependence;
-- No significant hot medium effect on the D^{*+} life time.

[1] Phys. Rev. C (2011)84, 034909

Summary

- D^{*+} p_T spectra and D^{*+}/D^0 ratio have been measured for different centrality classes of Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV.
- The p_T dependence of D^{*+}/D^0 ratio is similar in different centrality bins, and is comparable to PYTHIA8.
- Ratio of integrated yields ($2 < p_T < 10$ GeV/c) of D^{*+} to D^0 shows no strong centrality dependence. No significant effect from hot medium on the D^{*+} life time.

Outlook

- Combine STAR Run 2014 data with Run 2016 data to improve statistical precision.