Non-prompt D^0 measurement in Au+Au collisions at 200 GeV

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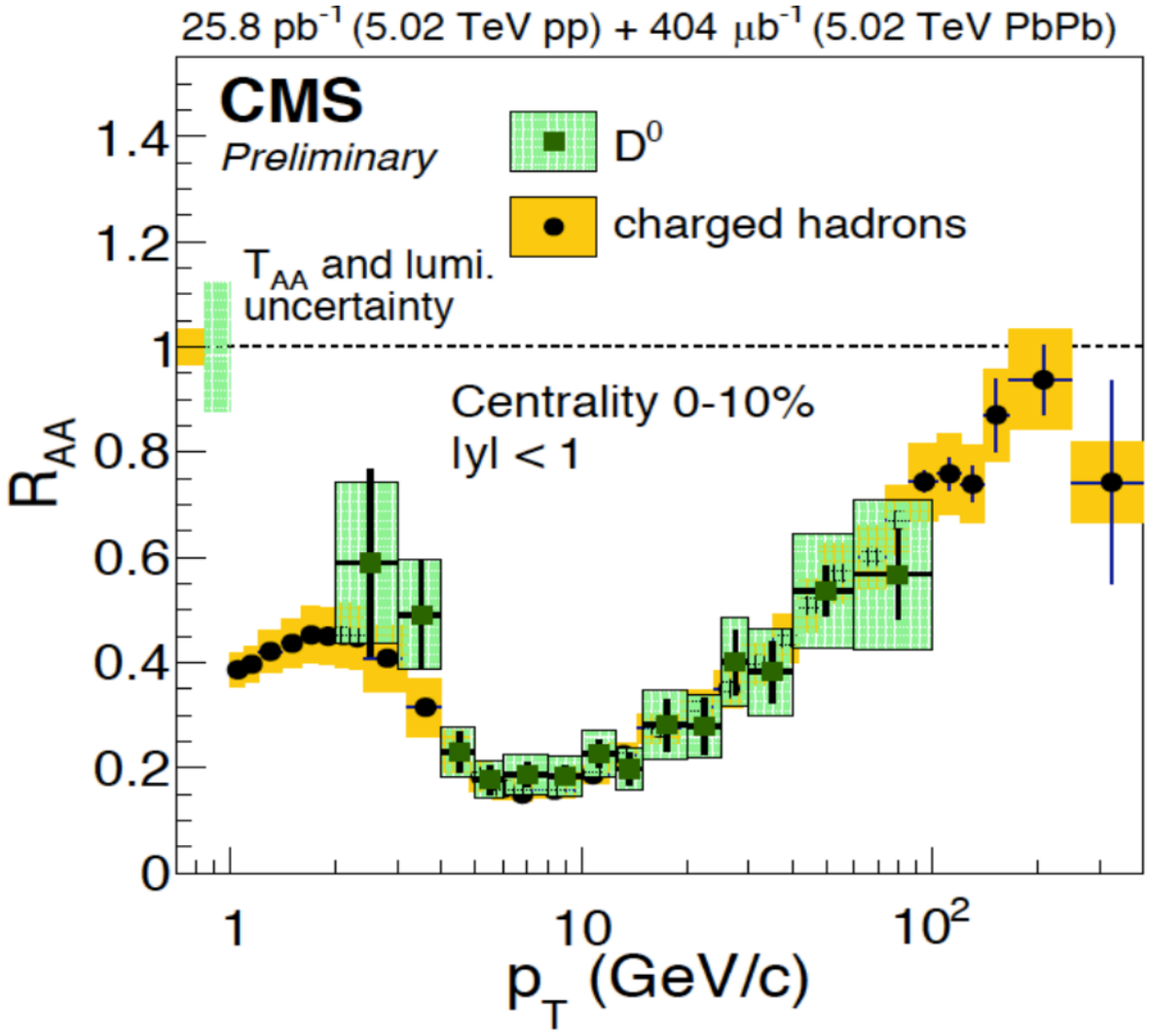
Outline

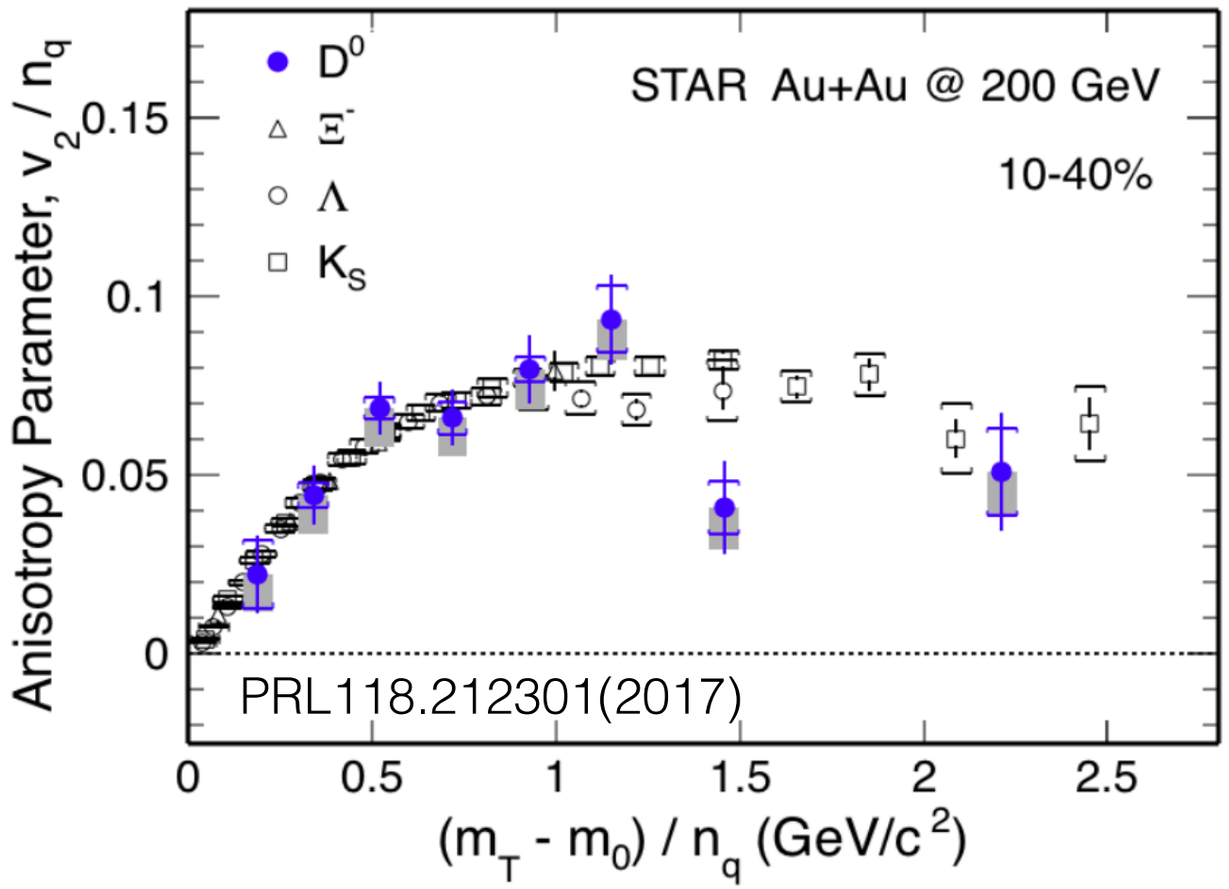
- Motivation
- STAR detector
- Analysis strategy
  - Particle identification and D^0 reconstruction
  - Prompt and non-prompt D^0 separation
- Results and discuss
- Summary and outlook

D^0 R_{AA} and v_2

$$R_{AA} = \frac{yield\ in\ AA}{N_{bin} \times yield\ in\ pp}$$

$$\frac{dN}{d(\phi - \Psi_r)} \propto 1 + 2v_2 \cos[2(\phi - \Psi_r)]$$

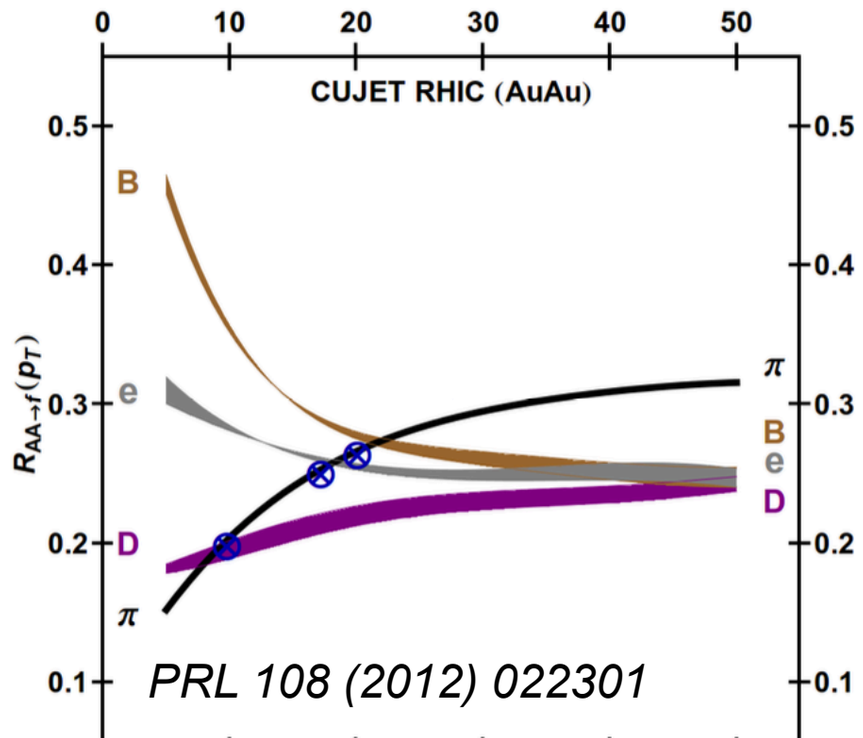




- Similar energy loss for light partons and charm quarks at high p_T
- Evidence of charm quarks flowing as light quarks
- Charm quarks interact strongly with the Quark-Gluon Plasma (QGP)

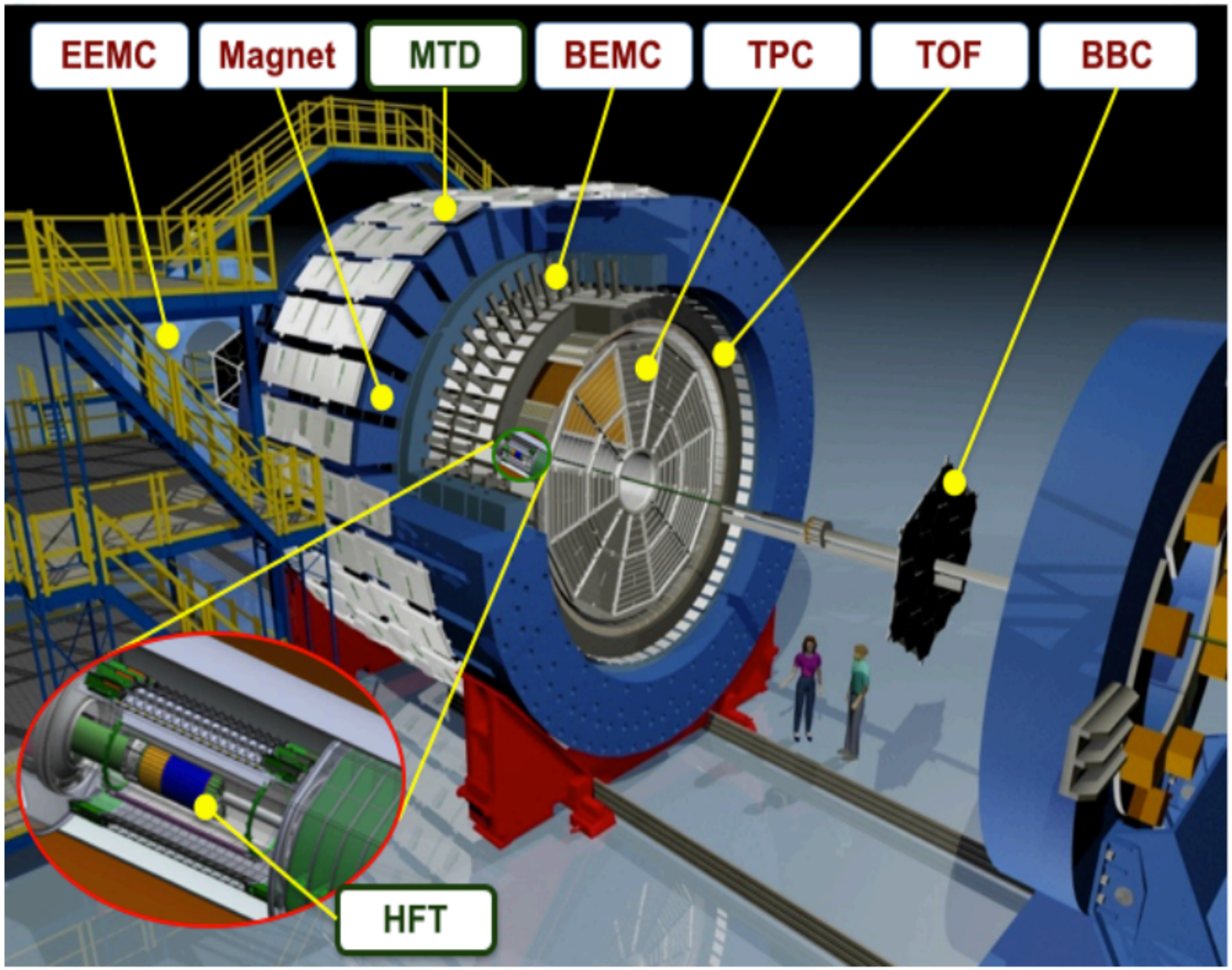
What about b-hadron

- Energy loss mechanisms in QGP
  - elastic collisions with the plasma constituents
  - gluon radiating
  - expected △E(c) > △E(b)

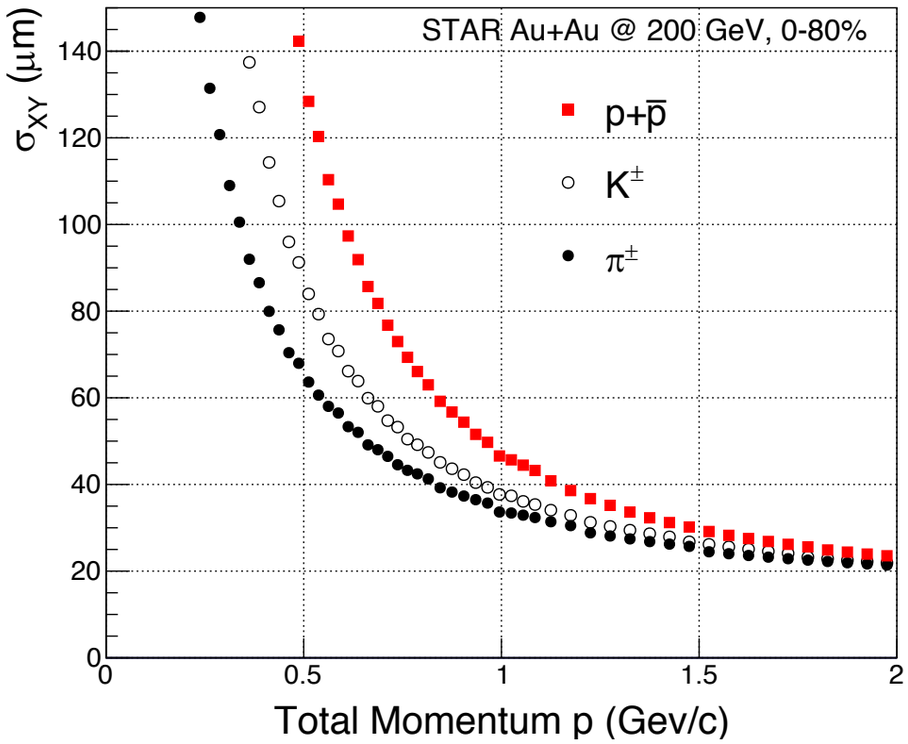


- b-hadron properties
  - $F(B^+) = 4.8\times10^{-3}(B^+ \to \overline{D^0}\pi^+)\times 0.0389(D^0 \to K^-\pi^+) = 1.87\times10^{-4}$
  - study the inclusive decays B->D (one example), others are B->J/psi, B->e etc
  - decay length: B^+~491μm, D^0~123μm

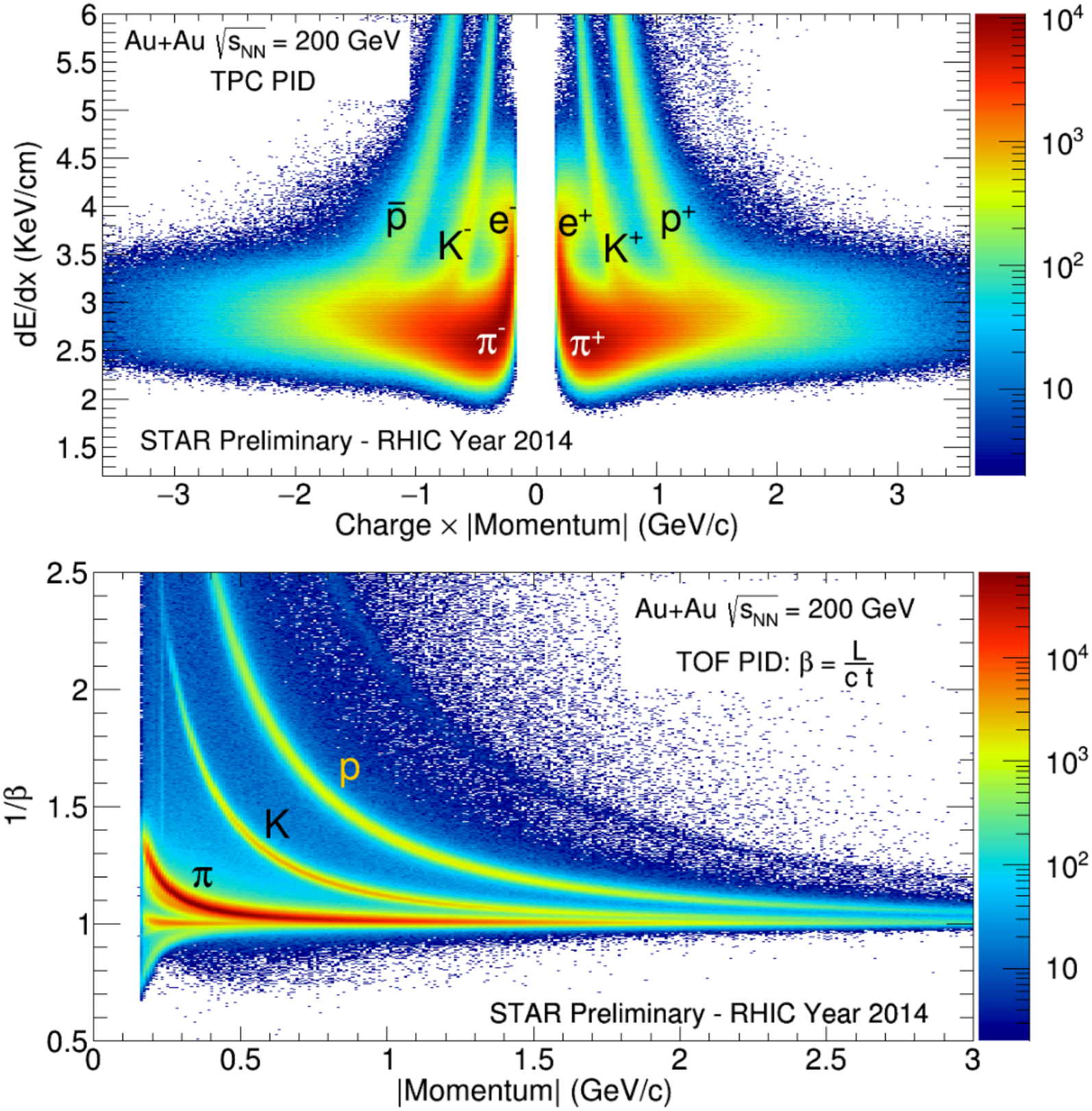
STAR detector



- TPC: tracking, PID through dE/dx
- TOF: PID through 1/β
- HFT: good DCA resolution ~ 35 μm @ 1 GeV/c (p)



Particle identification



TPC PID

$$n\sigma_X = \frac{1}{R_{dE/dx}} \ln \frac{\langle dE/dx \rangle^{Mea}}{\langle dE/dx \rangle_X^{Bichsel}}$$

$|n\sigma_\pi| < 3$

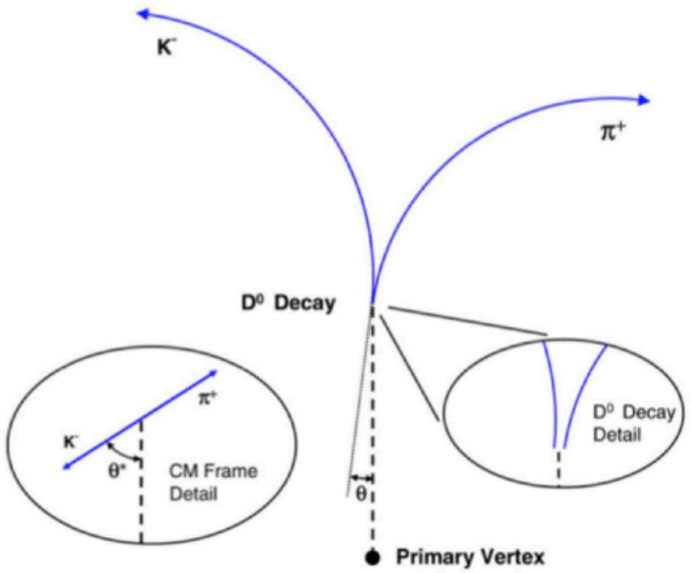
$|n\sigma_K| < 2$

TOF PID
Hybrid: use TOF when TOF available

$$\left| 1/\beta - \sqrt{m_\pi^2/p^2 + 1} \right| < 0.03$$

$$\left| 1/\beta - \sqrt{m_K^2/p^2 + 1} \right| < 0.03$$

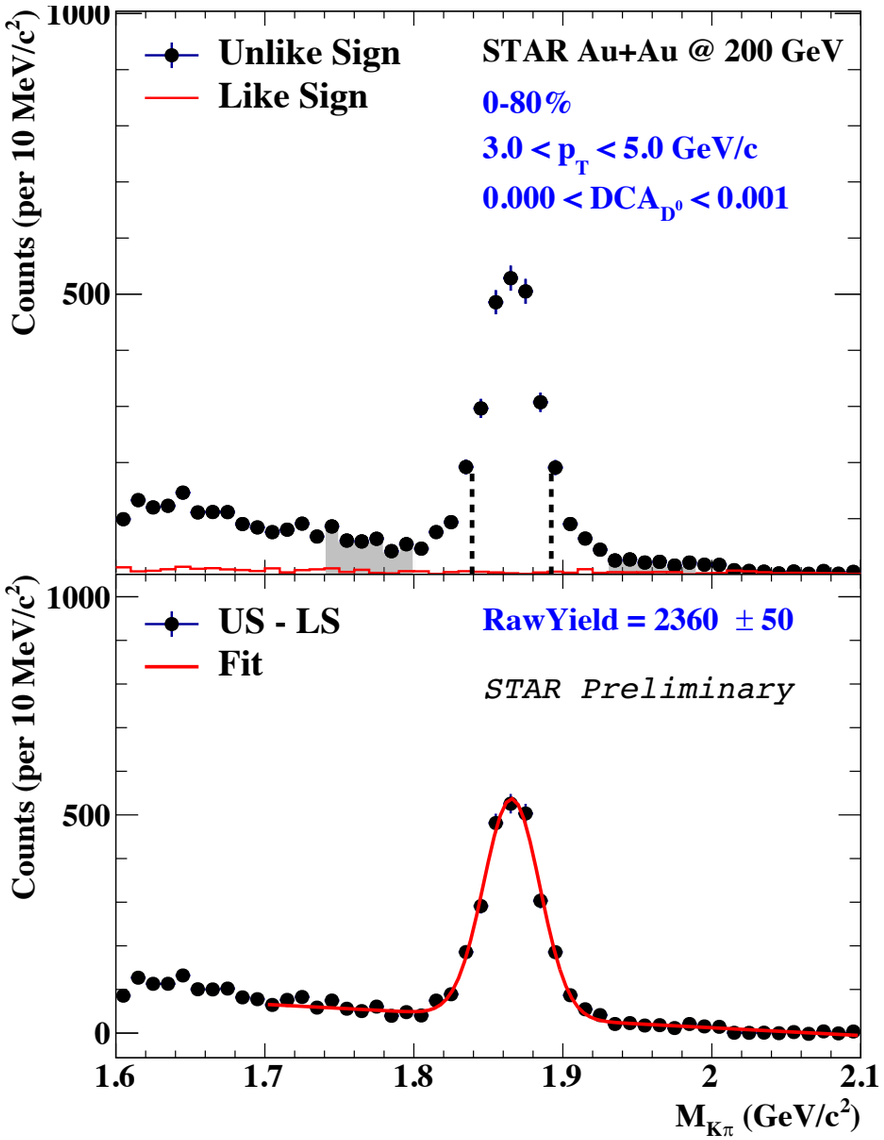
D^0 reconstruction

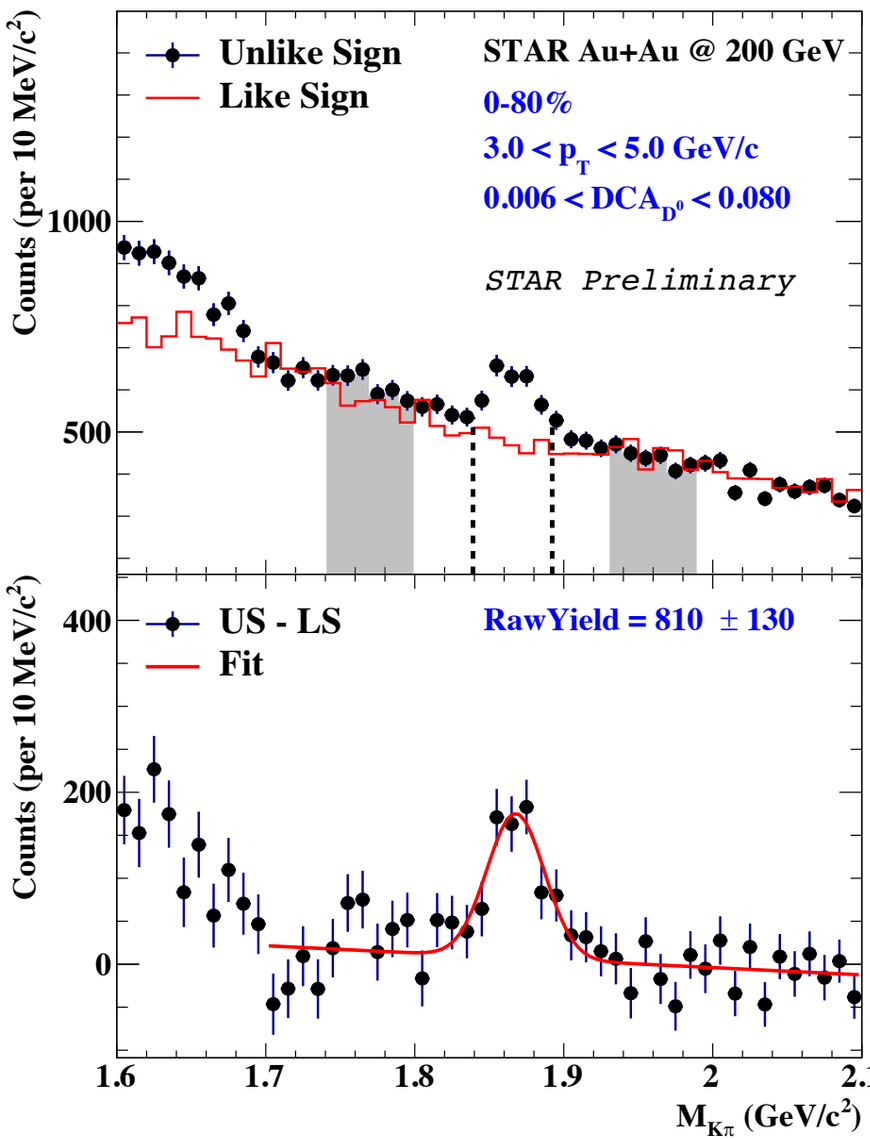


Topology cuts

p_T (Gev/c)	**3-5**	**5-8**
DecayL(μm)	>247	>259
cosθ	>0.95	>0.95
$DCA_{k\pi}$(μm)	<50	<60
DCA_k(μm)	>79	>58
DCA_π(μm)	>81	>62

STAR Run year 2014: ~ 900M



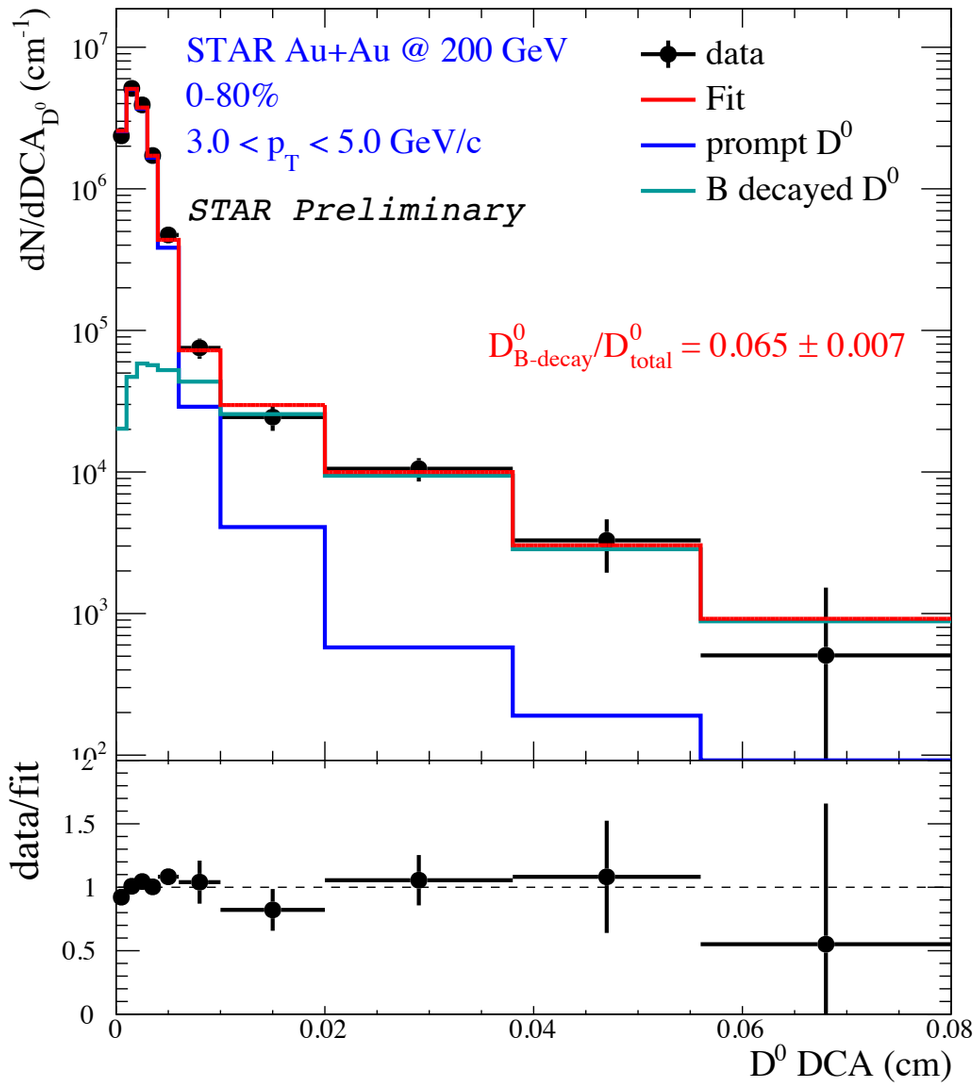


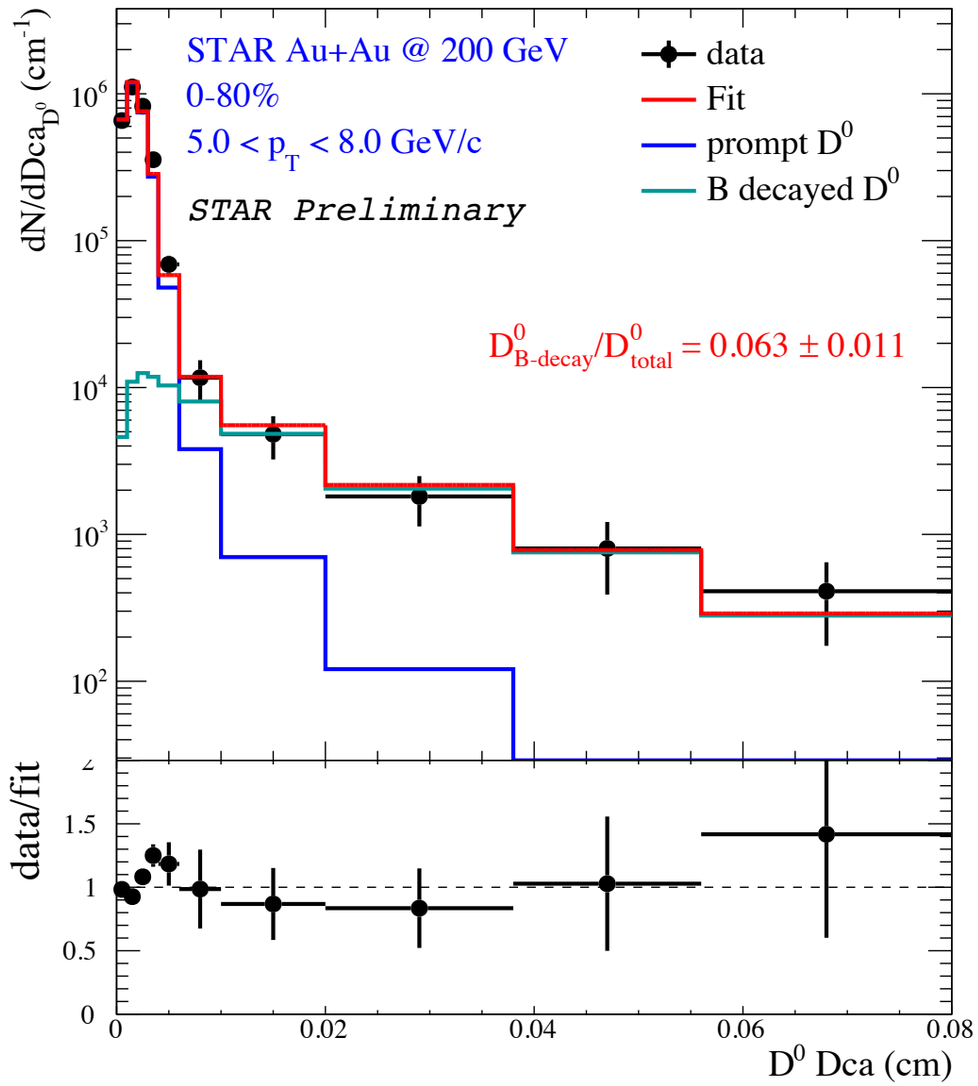
DCA template of prompt and non-prompt D^0

- Obtained from Data Driven Fast Simulation including detector effects: tracking efficiency, HFT matching ratio, DCA resolution, momentum resolution, etc
- B-meson and D^0-meson p_T shapes are from FONLL
- All decay channels to D^0 for B^0 and $B^{\pm}$ are included (PYTHIA version 6.416)
- Relative contributions of $B^{\pm}$, B^0 to non-prompt D^0 are fixed using fragmentation and branch ratio listed in the following table

Particle	$c\tau(\mu m)$	Mass(GeV/c^2)	$q(c,b) \rightarrow X(FR)$	$X \rightarrow D^0(\overline{D^0})$ (BR)
D^0	123	1.865	0.565	-
B^0	459	5.279	0.40	0.081(0.474)
B^+	491	5.279	0.40	0.086(0.790)

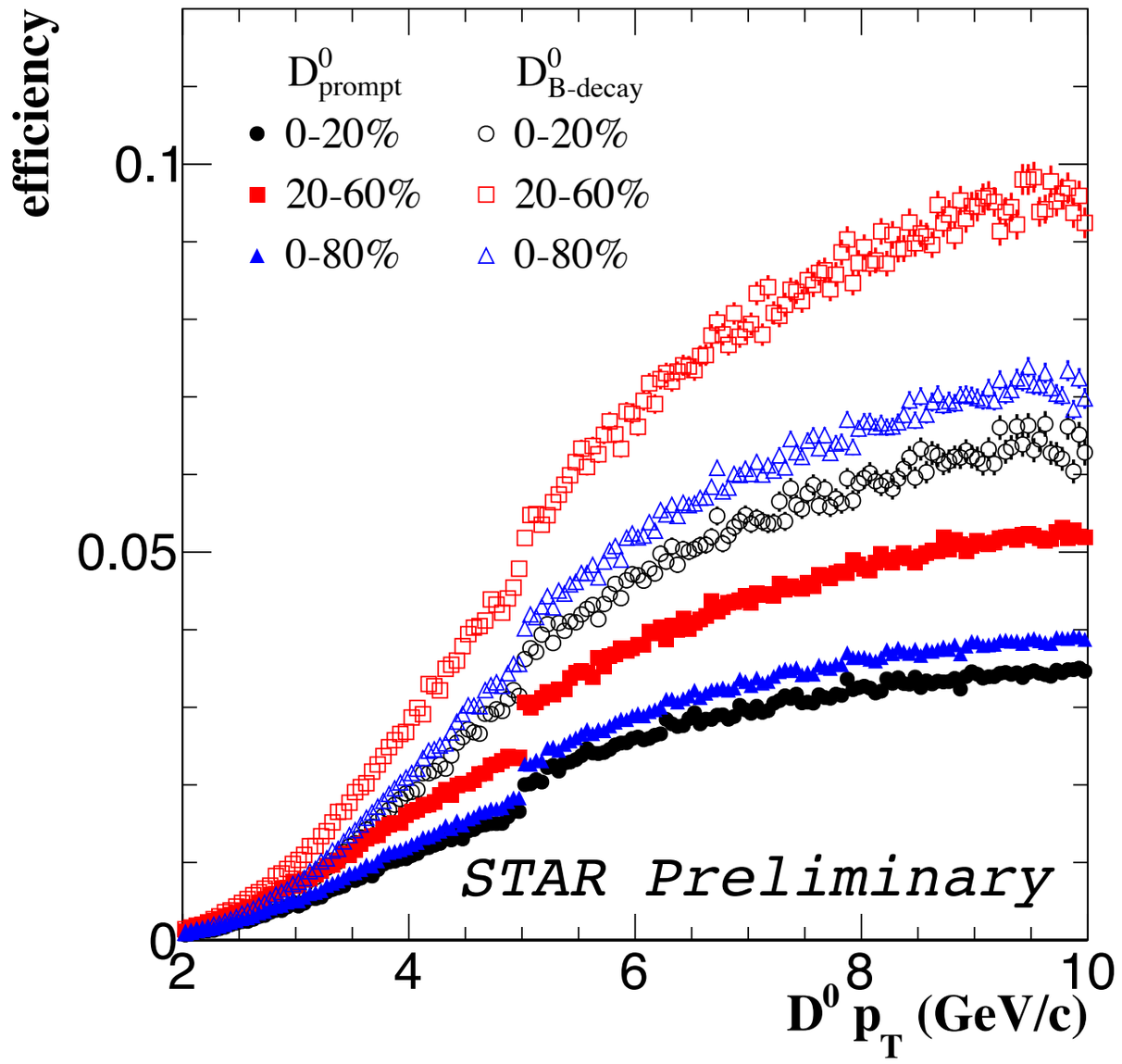
Template fitting





- DCA < 0.006 cm: raw yield from mass fitting
- DCA 0.006-0.08 cm: background estimated using unlike-sign distribution in the side band regions

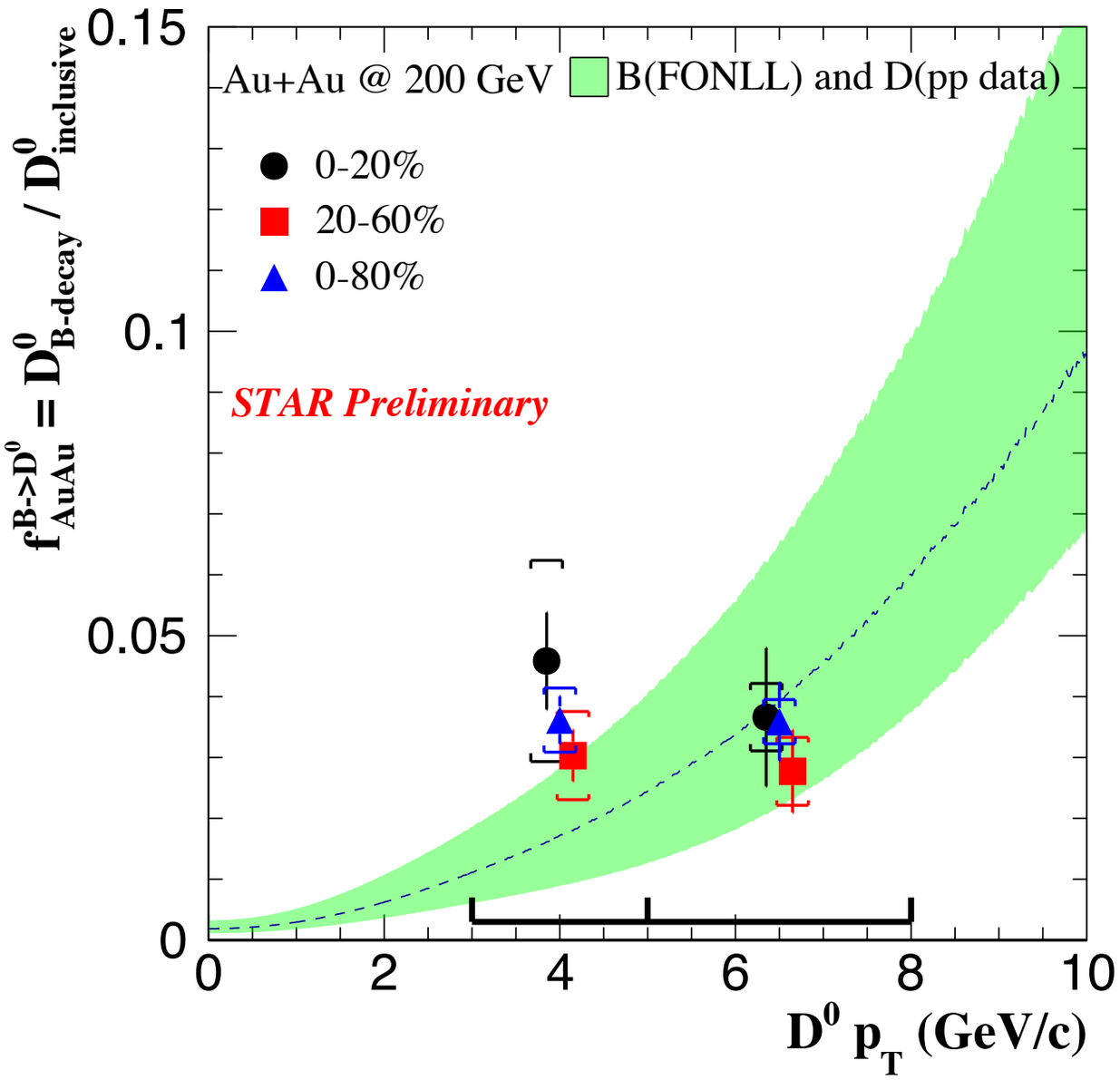
Efficiency correction

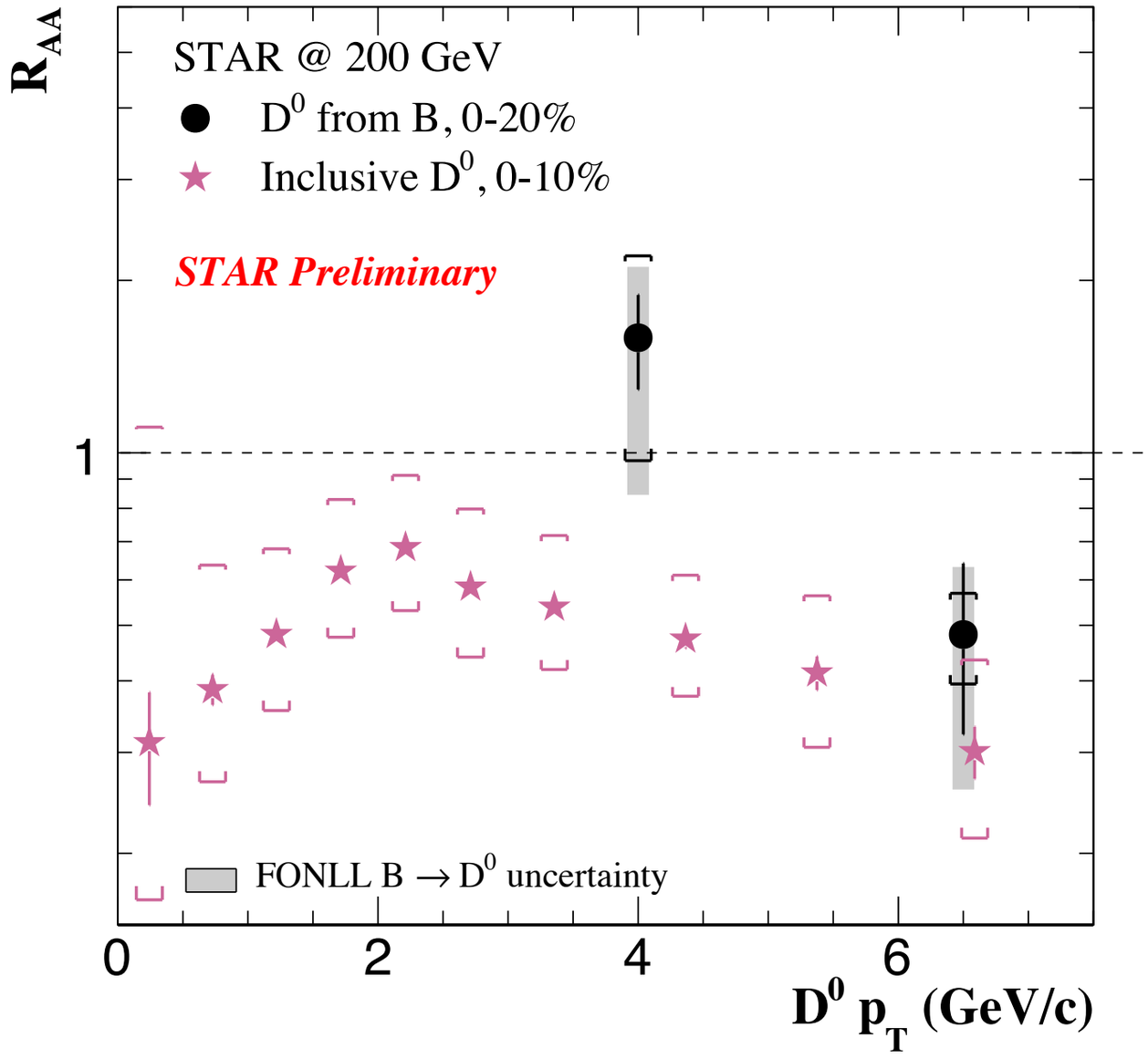


Jump at 5 GeV due to topological cuts changing

$$Ratio\_effCorr = \frac{Ratio(B)/eff(B)}{Ratio(B)/eff(B) + Ratio(D)/eff(D)}$$

Non-prompt D^0 fraction and R_{AA}



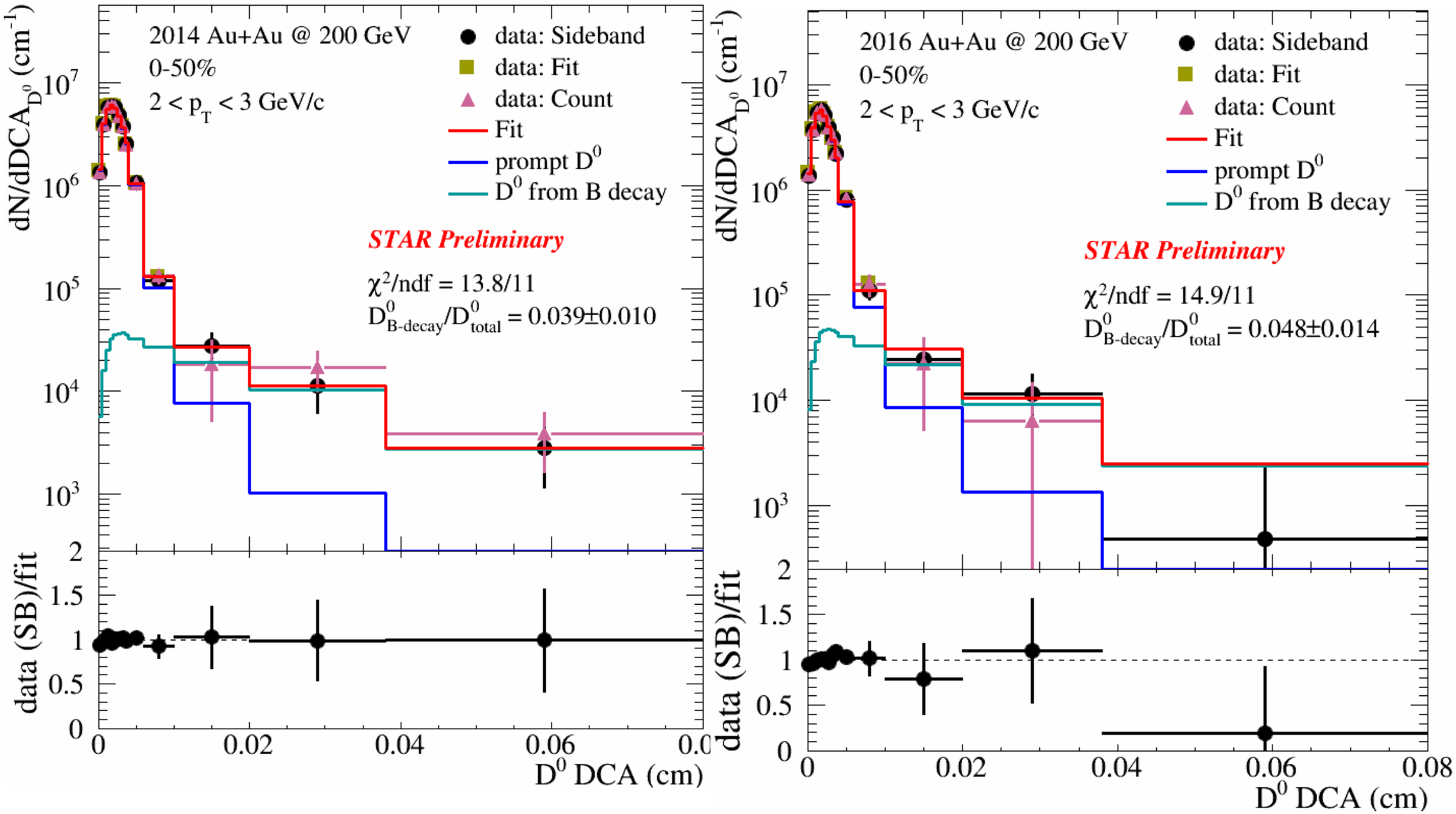


- Non-prompt D^0 R_{AA} : FONLL as the pp baseline
- Non-prompt D^0 production at $5 < p_T < 8$ GeV/c in Au+Au collisions is suppressed
- Hint of non-prompt D^0 is less suppressed

Summary

- Non-prompt D^0 fraction and R_{AA} are obtained at p_T range of 3-8 GeV/c with STAR run year 2014 data
- Non-prompt D^0 is suppressed at p_T range of 5-8 GeV/c
- Hint of non-prompt D^0 R_{AA} is less suppressed at lower p_T

Outlook



- Cuts tuning for non-prompt D^0 with TMVA::BDT method
- Run14 ~0.9B events + Run16 ~1.4B events
- Down to p_T range of 2-3 GeV/c