

Physics of the Heavy Flavor Tracker at STAR

- Responses to the CD1 review comments

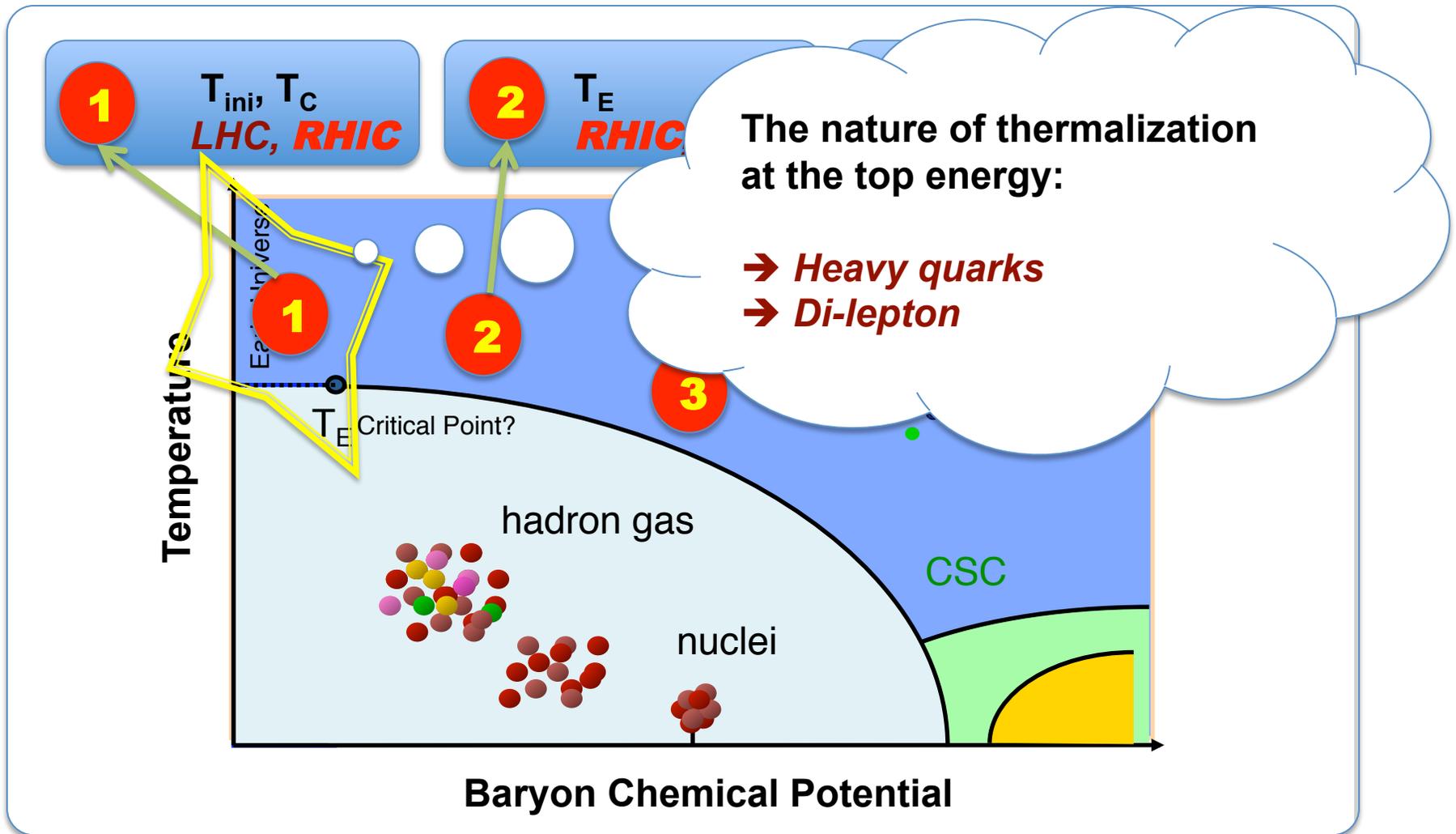
Nu Xu (for STAR Collaboration)

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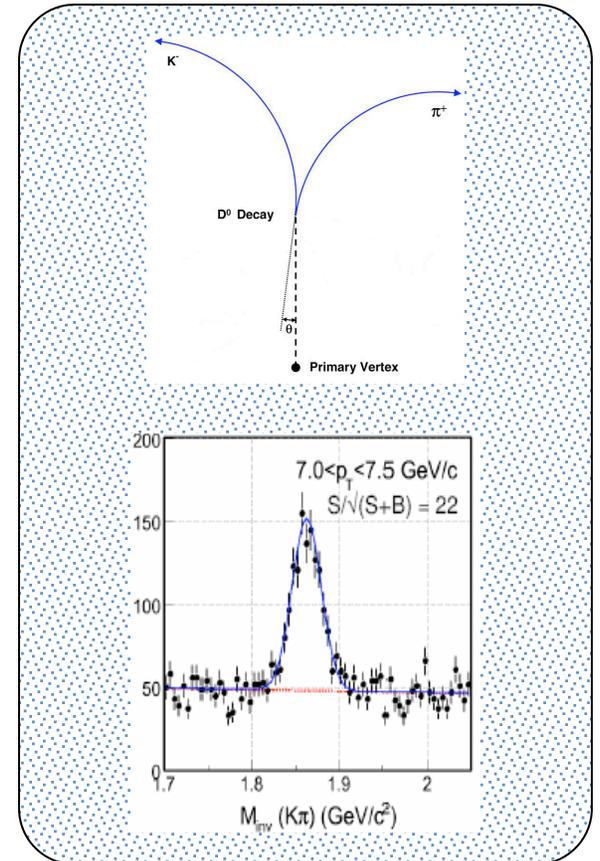
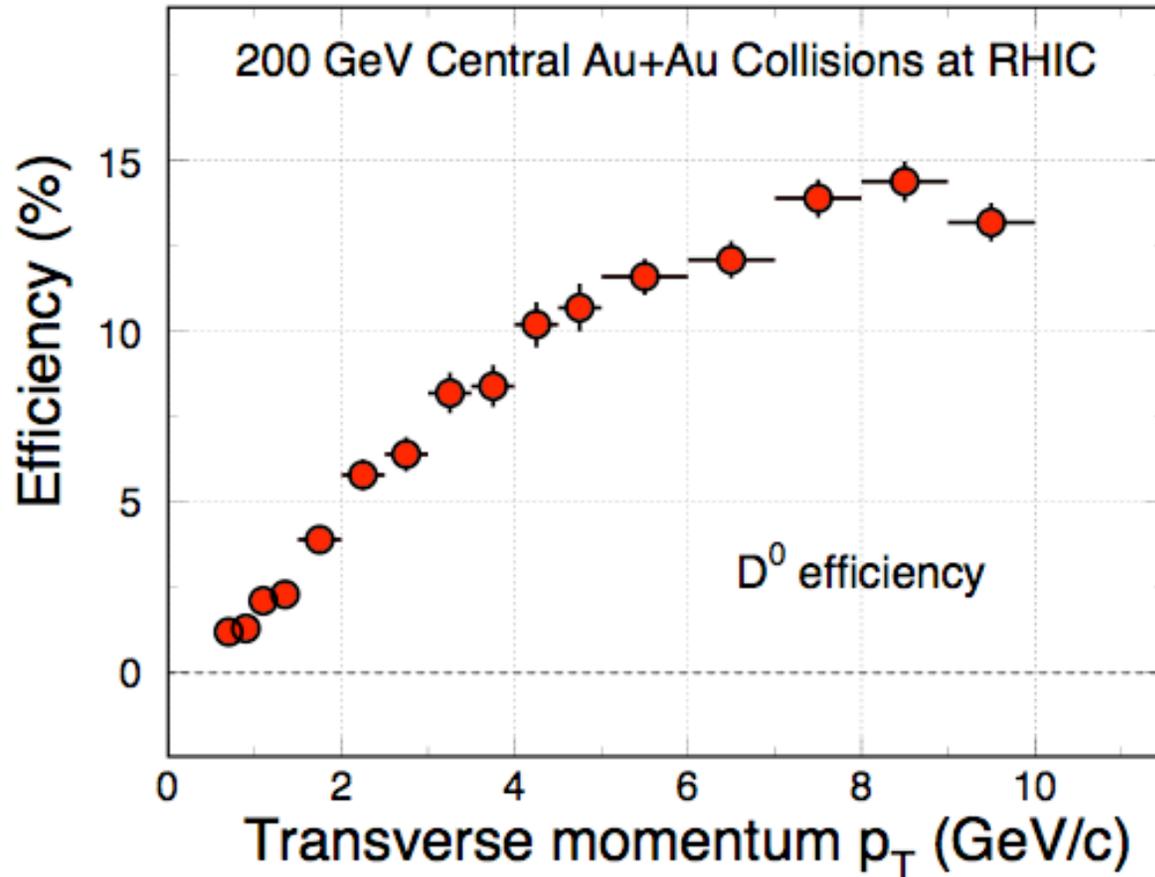




The QCD Phase Diagram and High-Energy Nuclear Collisions



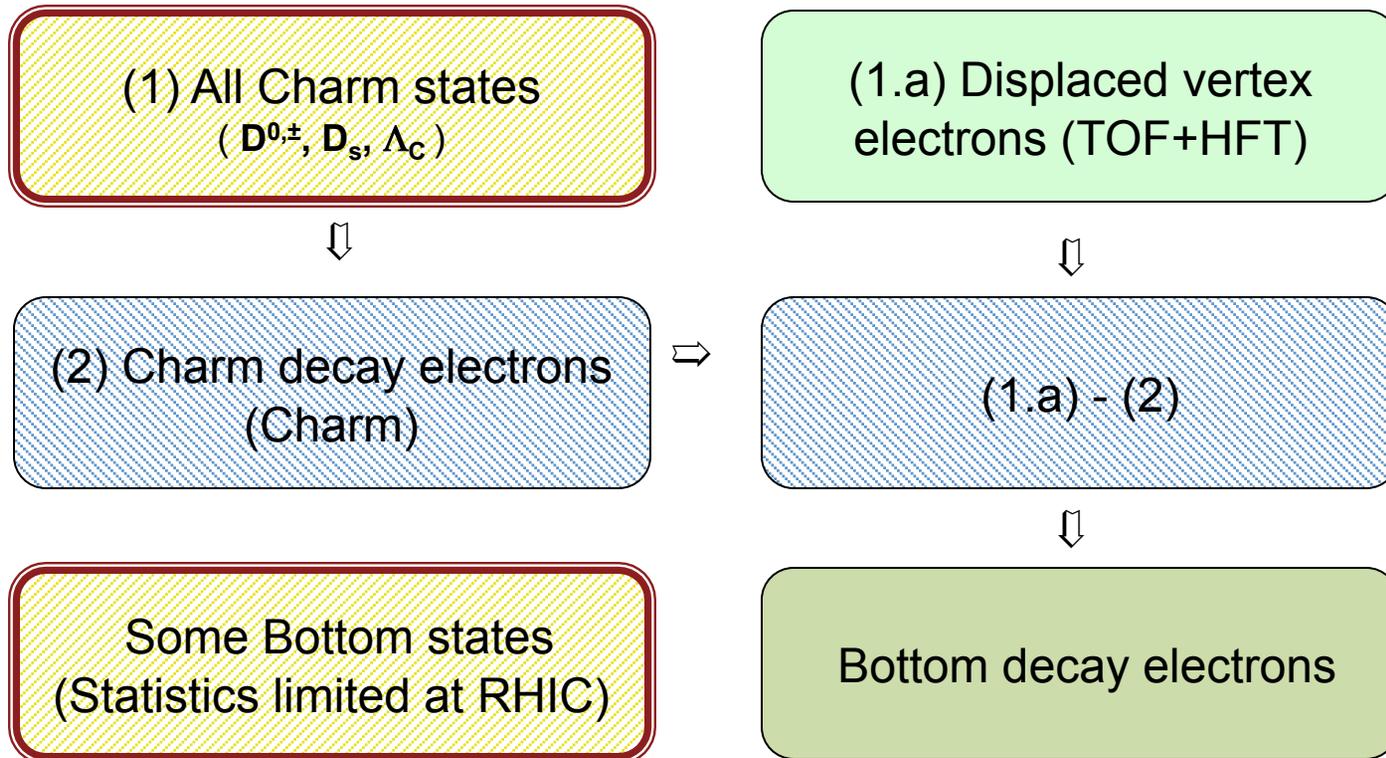
D⁰ Reconstruction Efficiency



- Central Au+Au collisions: top 10% events.
- The thin detector allows measurements down to $p_T \sim 0.5$ GeV/c.
- Essential and unique!



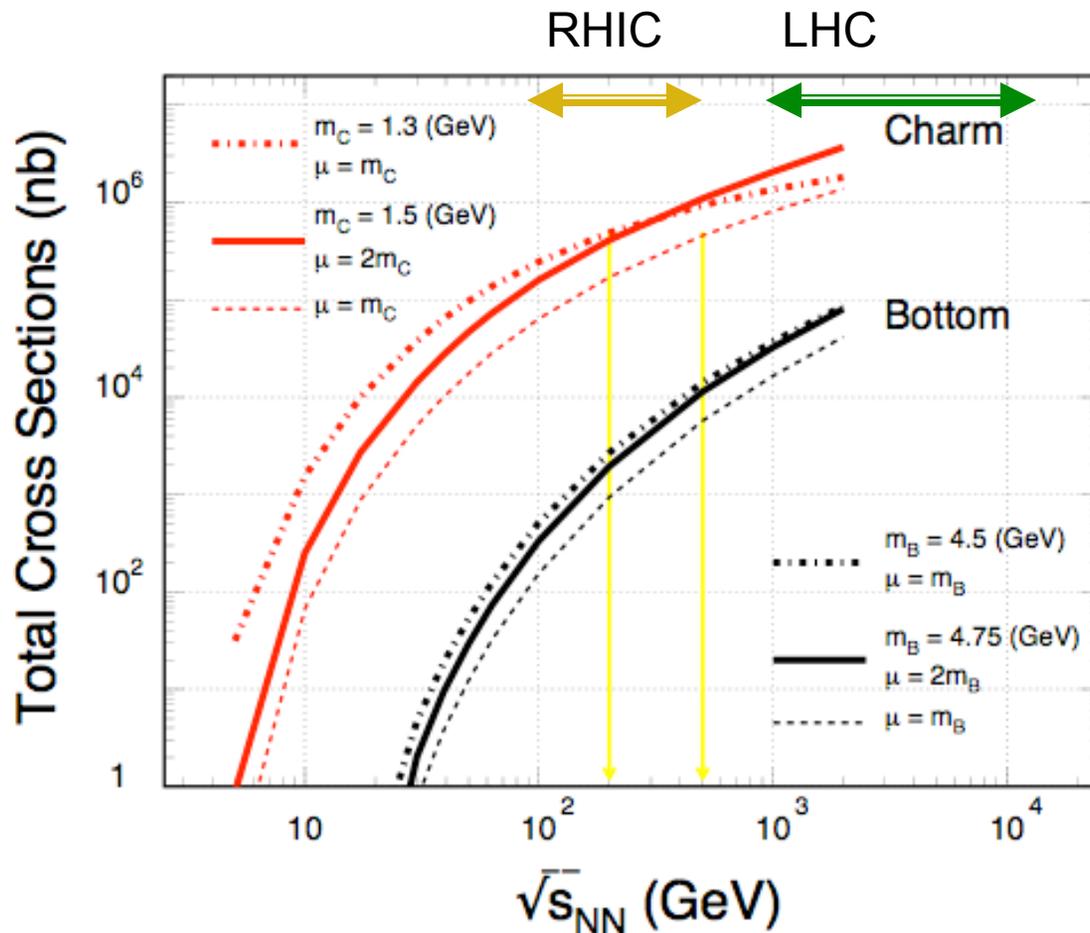
Strategies for Bottom Measurement



Measure **Charm** and **Bottom** hadron:
Cross sections, Spectra and v_2



Heavy Quark in p+p Collisions



NLO pQCD predictions of charm and bottom for the total p+p hadro-production cross sections.

Renormalization scale and factorization scale were chosen to be equal.

RHIC: 200, 500 GeV

LHC: 900, 7000, 14000 GeV

Ideal energy range for studying pQCD predictions for heavy quark production.

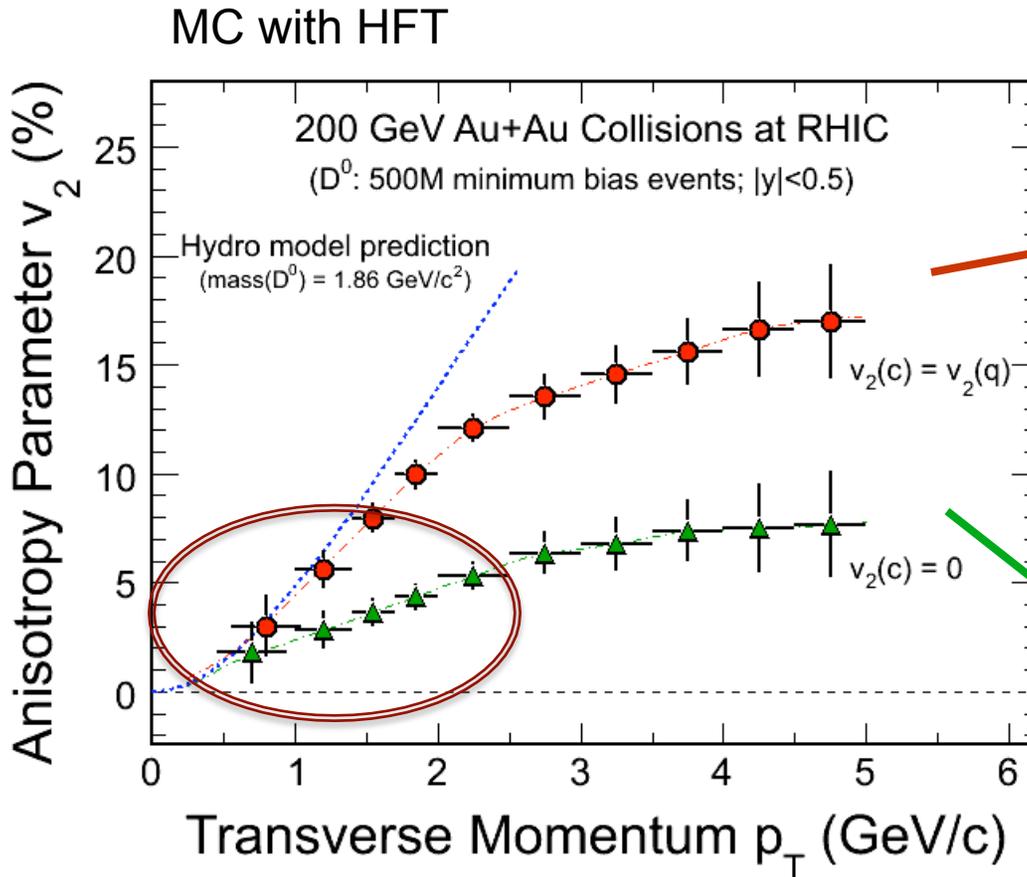
Necessary reference for both, heavy ion and spin programs at RHIC.

Plan for p+p collisions:

200 GeV

500 GeV for σ , not in with full luminosity

Charm Hadron v_2



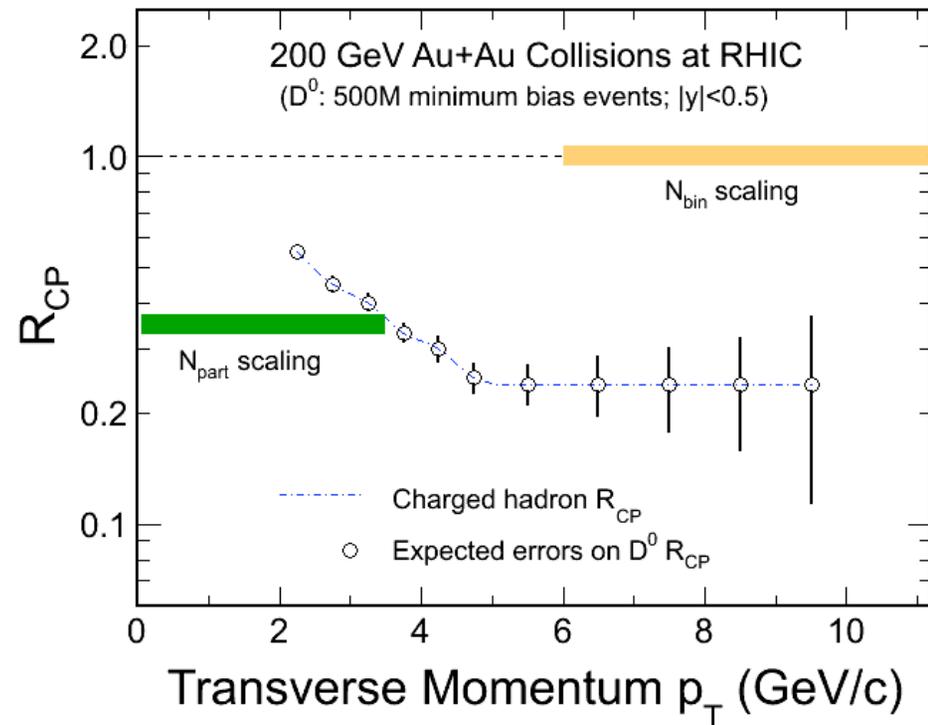
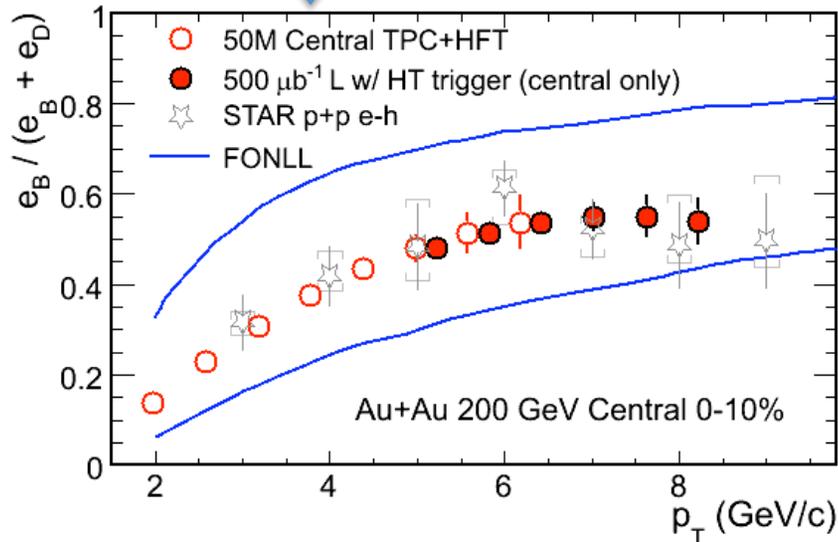
Charm-quark flow
 Thermalization of light-quarks!

Charm-quark does not flow
 Drag coefficients

- 200 GeV Au+Au minimum bias collisions (500M events).
- Charm collectivity \Rightarrow drag/diffusion constants \Rightarrow **medium properties!**



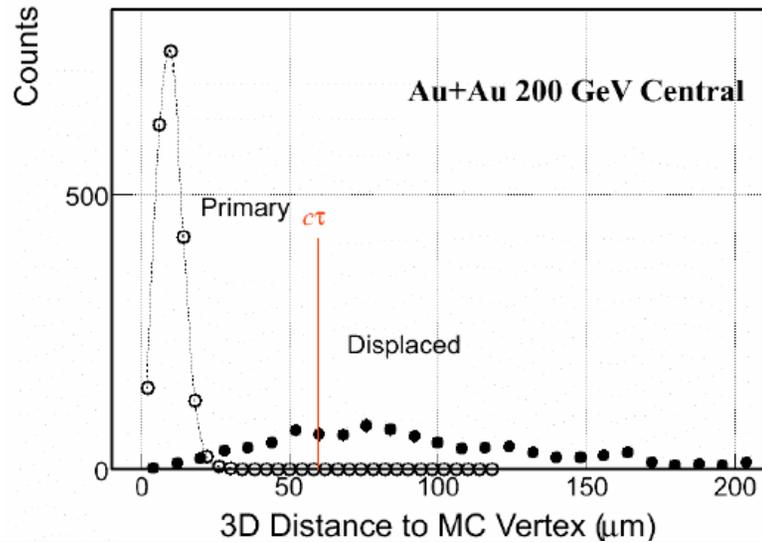
Charm Hadron R_{CP}



$$R_{CP} = a \cdot N^{10\%} / N^{(60-80)\%}$$

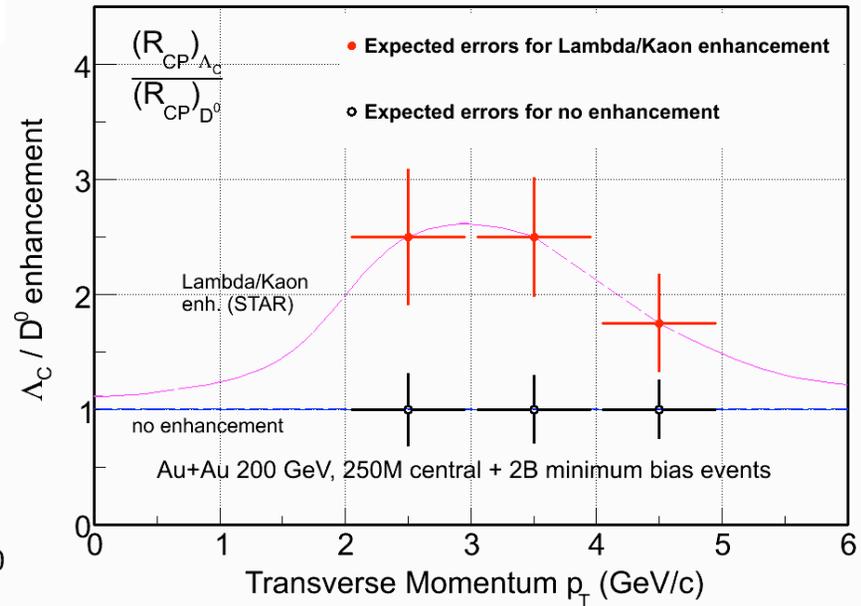
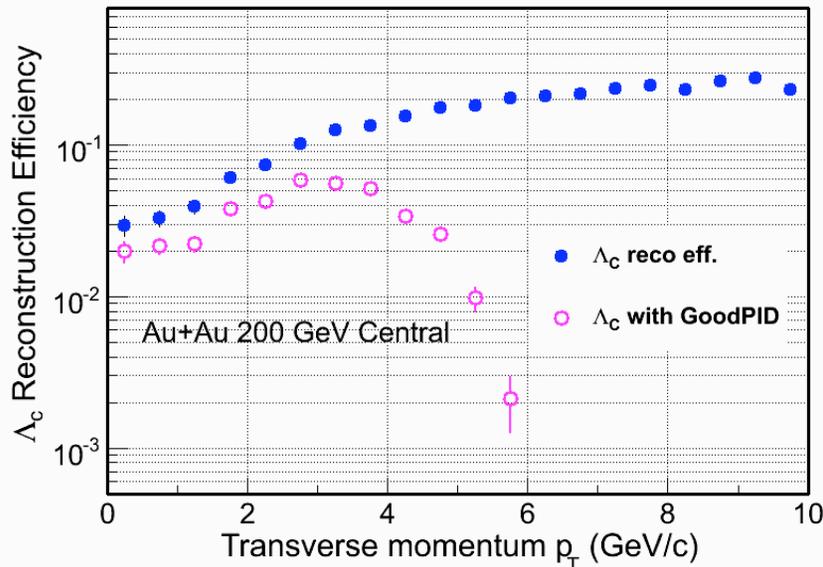
- Significant Bottom contributions in HQ decay electrons.
- 200 GeV Au+Au minimum bias collisions ($|y| < 0.5$ 500M events).
- Charm $R_{AA} \Rightarrow$ **energy loss mechanism!**

Λ_c Measurements



$\Lambda_c (\rightarrow \rho + K + \pi)$:

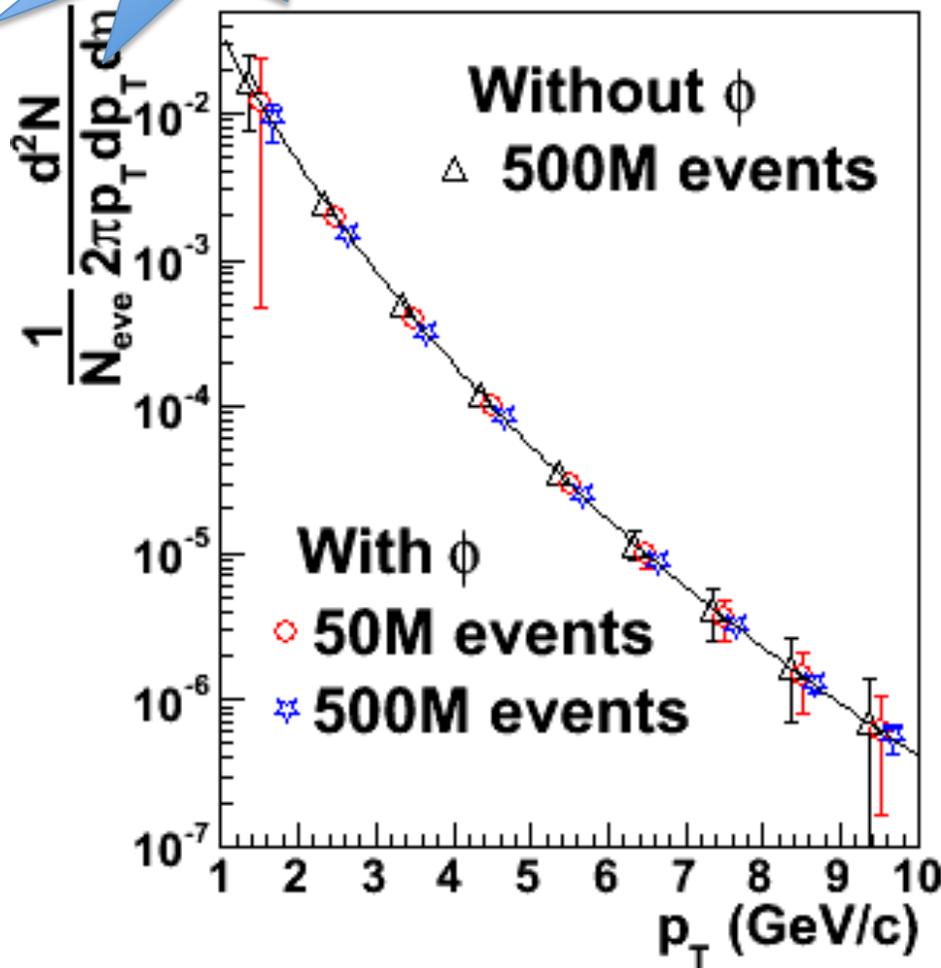
- 1) Lowest mass charm baryon
- 2) Total yield and Λ_c/D^0 ratios can be measured.





D_s Reconstruction

200 GeV Central Au+Au Collisions at RHIC



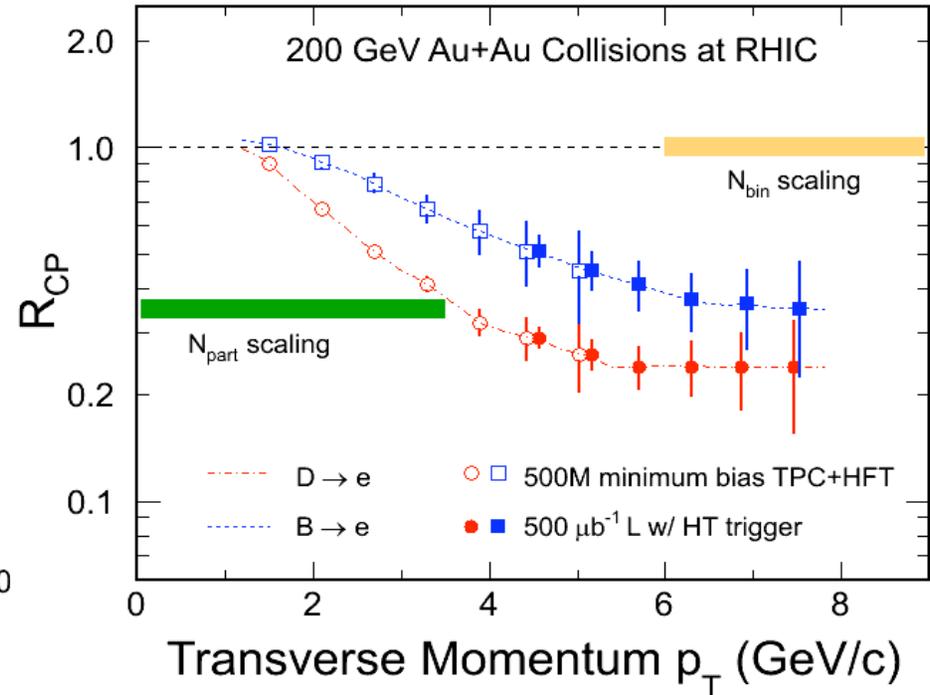
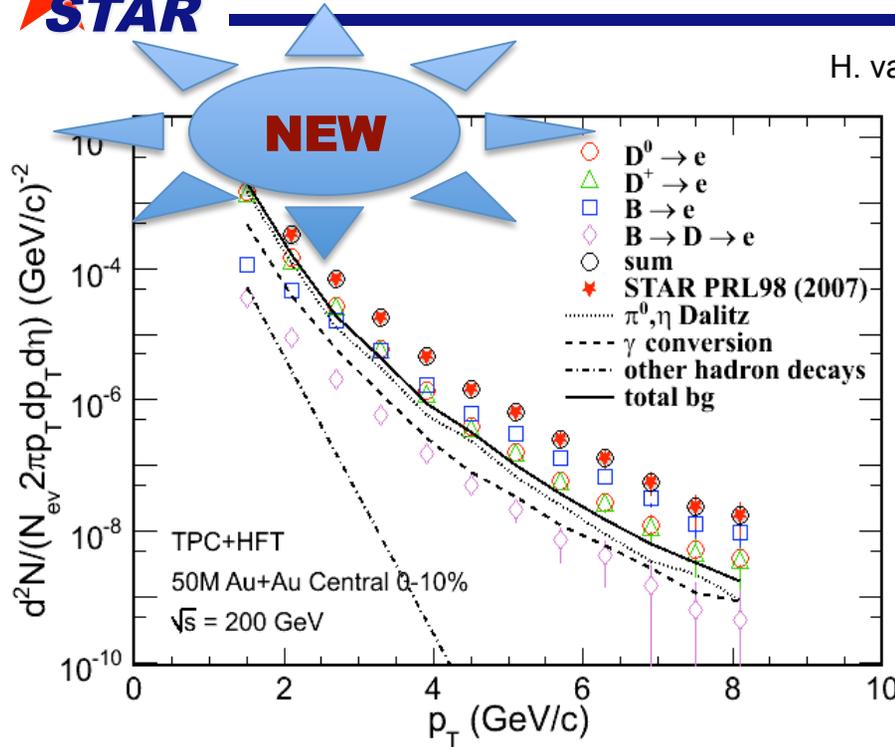
- $D_s \rightarrow K^+ K^- \pi$ (BR 5.5%)
- $D_s \rightarrow \phi \pi \rightarrow K^+ K^- \pi$ (BR 2.2%)
- mass = 1968.49 ± 0.34 MeV
- **decay length** $\sim 150 \mu m$

- Work in progress ...
- 200 GeV central Au+Au
- Ideal PID
- Power-law spectrum with:
 $n = 11, \langle p_T \rangle = 1$ GeV/c

0.5B events will work!

c- and b-decay Electrons

H. van Hees et al. Eur. Phys. J. **C61**, 799(2009). (arXiv: 0808.3710)



$$R_{CP} = a \cdot N^{10\%} / N^{(60-80)\%}$$

- DCA cuts \Rightarrow **c- and b-decay electron distributions and R_{CP}**
- 200 GeV Au+Au minimum biased collisions ($|y| < 0.5$ 500M events)

Physics of the Heavy Flavor Tracker at STAR

1) The STAR HFT measurements (p+p and Au+Au)

- (1) Heavy-quark cross sections: $D^{0,\pm,*}$, D_S , Λ_C , B ...
- (2) Both spectra (R_{AA} , R_{CP}) and v_2 in a wide p_T region: 0.5 - 10 GeV/c
- (3) Charm hadron correlation functions
- (4) Full spectrum of the heavy quark hadron decay electrons

2) Physics

- (1) Measure heavy-quark hadron v_2 , heavy-quark collectivity, to study the medium properties ***e.g. light-quark thermalization***
- (2) Measure heavy-quark energy loss to study pQCD in hot/dense medium ***e.g. energy loss mechanism***
- (3) Measure di-leptons to study the ***direct radiation*** from the hot/dense medium
- (4) Analyze ***hadro-chemistry including heavy flavors***



To Do List

	issue	slide #	name	deadline
(1)	D ⁰ efficiency for both (i) Cu- and (ii) Al-cables	3		
(2)	Detailed description of the cross section measurements		Nu	
(3)	Total cross section results: Charm and Bottom. It should be done with 500 M M.B. events and both cases.	5	Yifei	
(4)	Rescale the statistical error bars with CU-cable scenario, keep 500 M M.B. events.	6	Yifei, Xin	
(5)	Similar to (4) but for R _{AA}	7		
(6)	Beam time in terms of weeks for 500M, 1B and 2B M.B. events. How many weeks do we need to have a measurement of the cross section for Λ_C ?	8	Xin	
(7)	Measurements in p+p collisions:			
(8)	Measurements in d+Au collisions: D₀, D_S, D⁺, Λ_C, total NPe, Bottom, Charm.			
(9)	Measurements in Au+Au collisions: D₀, D_S, D⁺, Λ_C, total NPe, Bottom, Charm. Low p_T.			
(10)	Measurements in polarized p+p collisions?		Xin	
(11)	What does PHENIX measure in their VTX?		Xin, Nu	