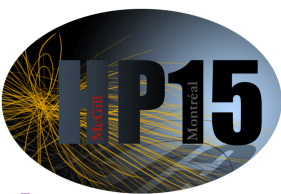


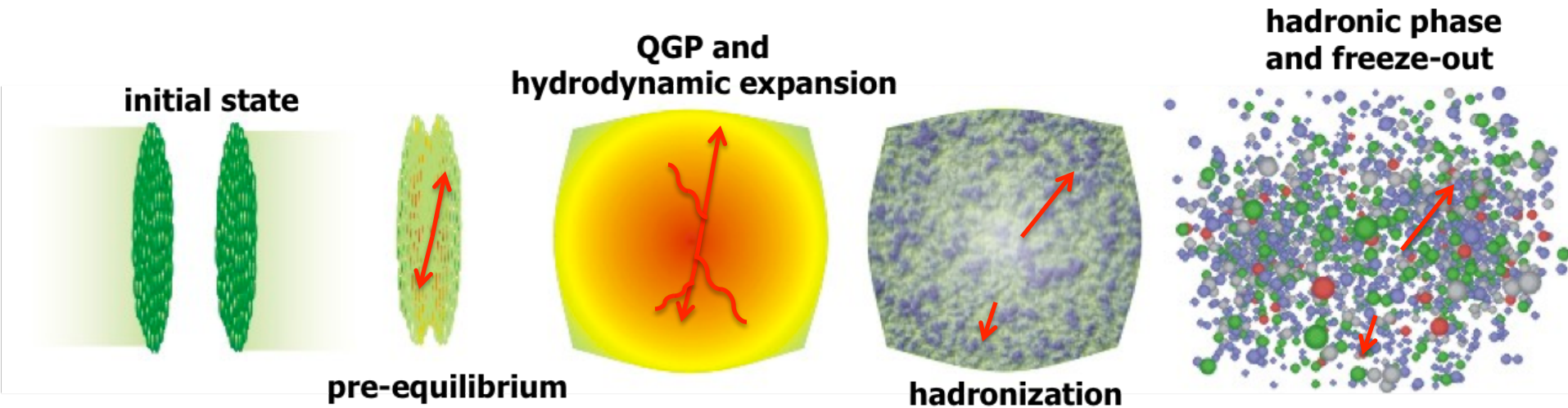
# Open charm hadron measurements at STAR

Qiu, Hao (LBNL)  
for the STAR Collaboration



# Why charm quark?

- $m_c \gg T_C, \Lambda_{\text{QCD}}, m_{u,d,s}$
- Produced early in initial hard scatterings at RHIC
- Experience the whole evolution of the medium
- Good probe to the properties of the medium

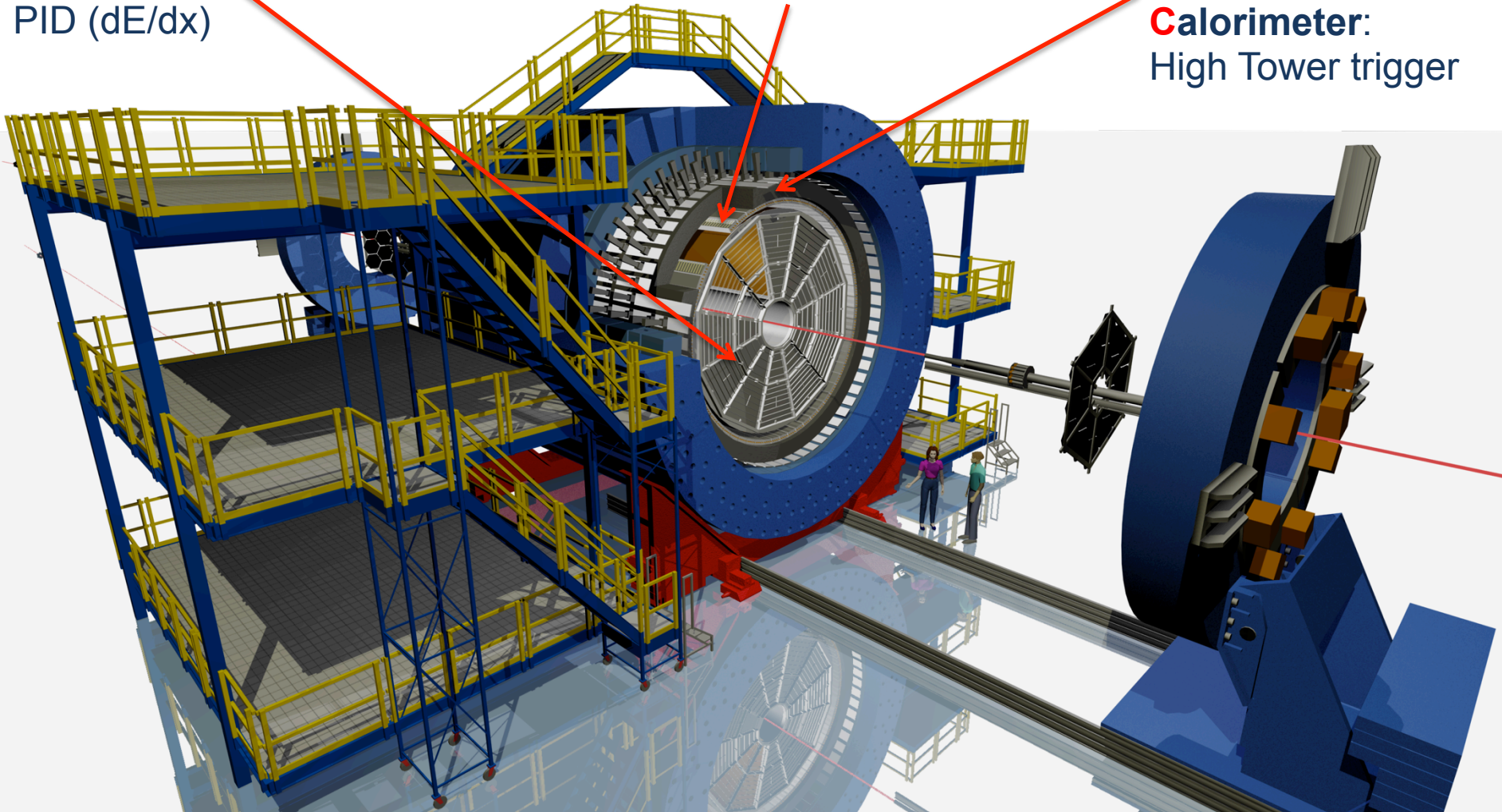


# STAR detectors (2012)

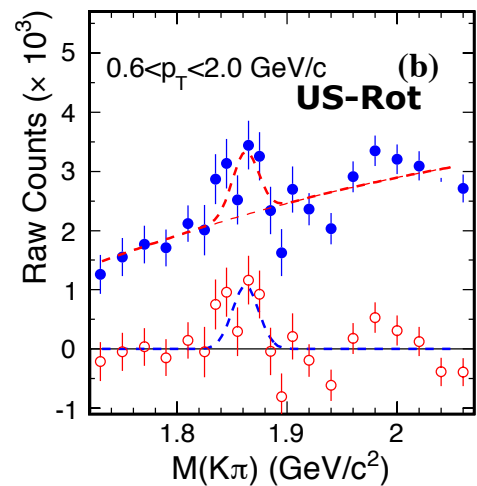
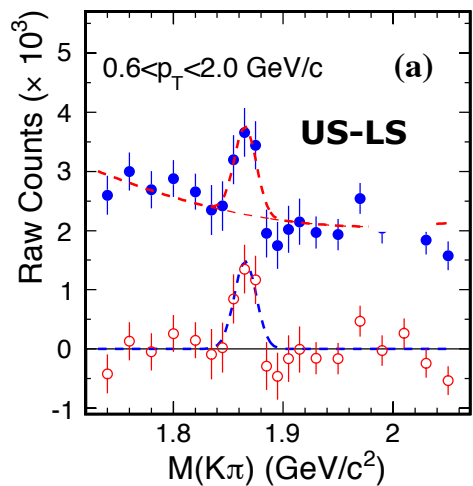
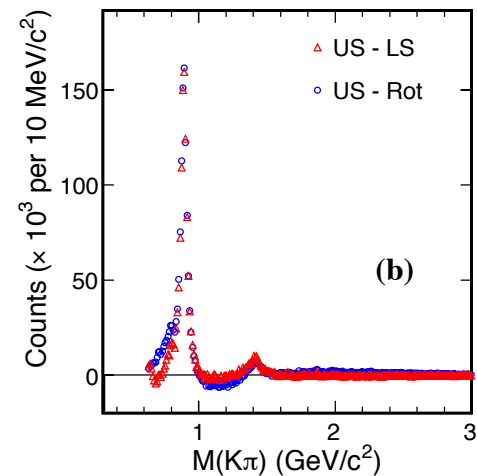
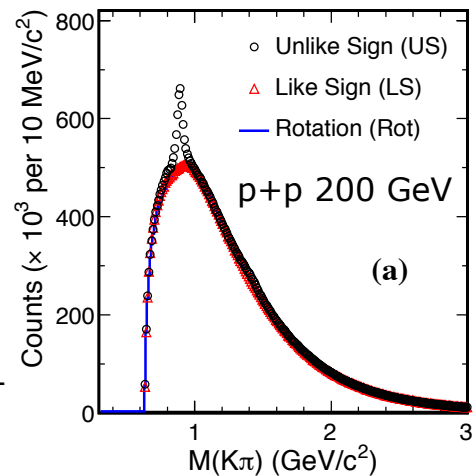
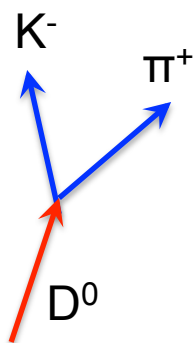
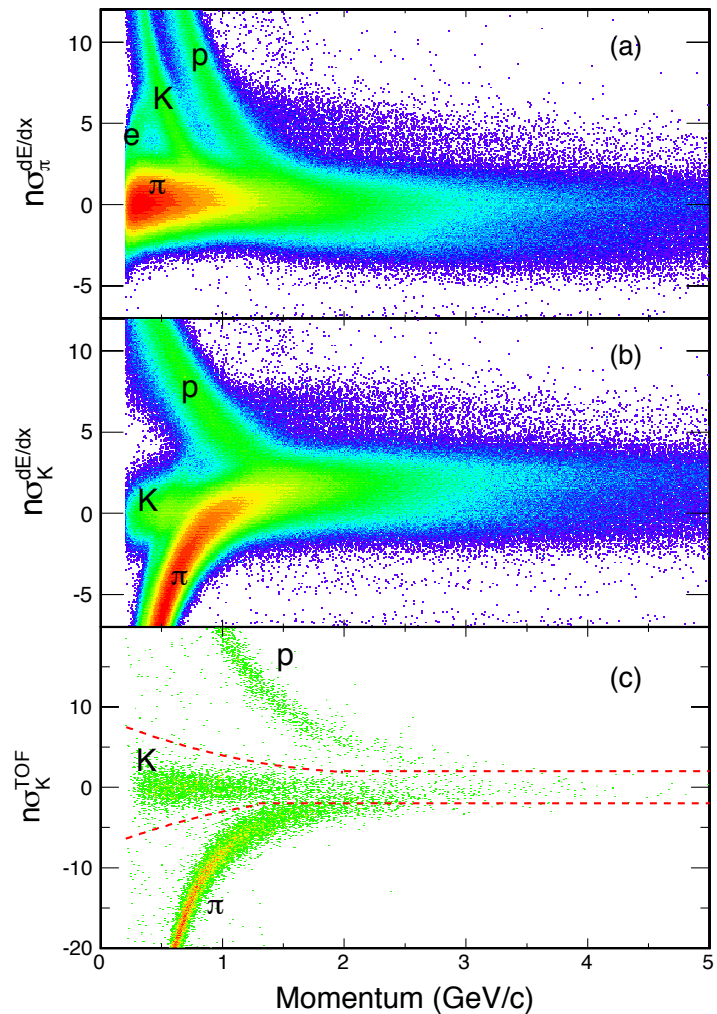
**Time Projection Chamber:**  
Tracking,  
PID ( $dE/dx$ )

**Time Of Flight detector:**  
PID ( $1/\beta$ )

**Barrel  
ElectroMagnetic  
Calorimeter:**  
High Tower trigger



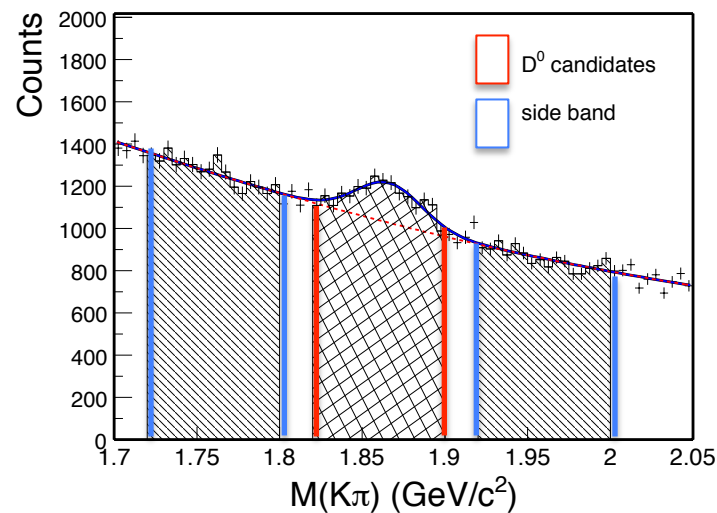
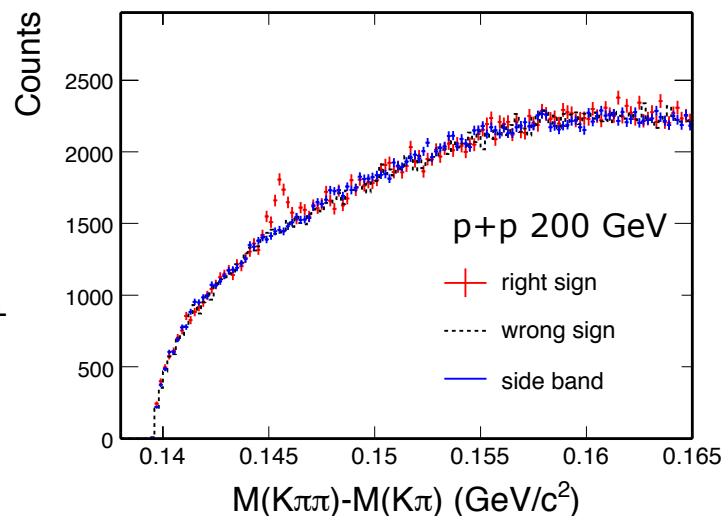
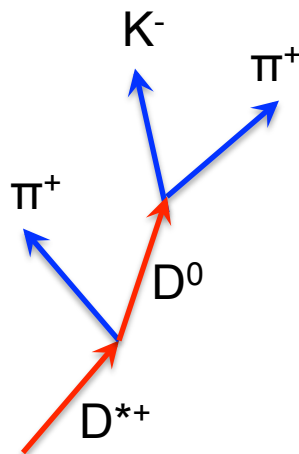
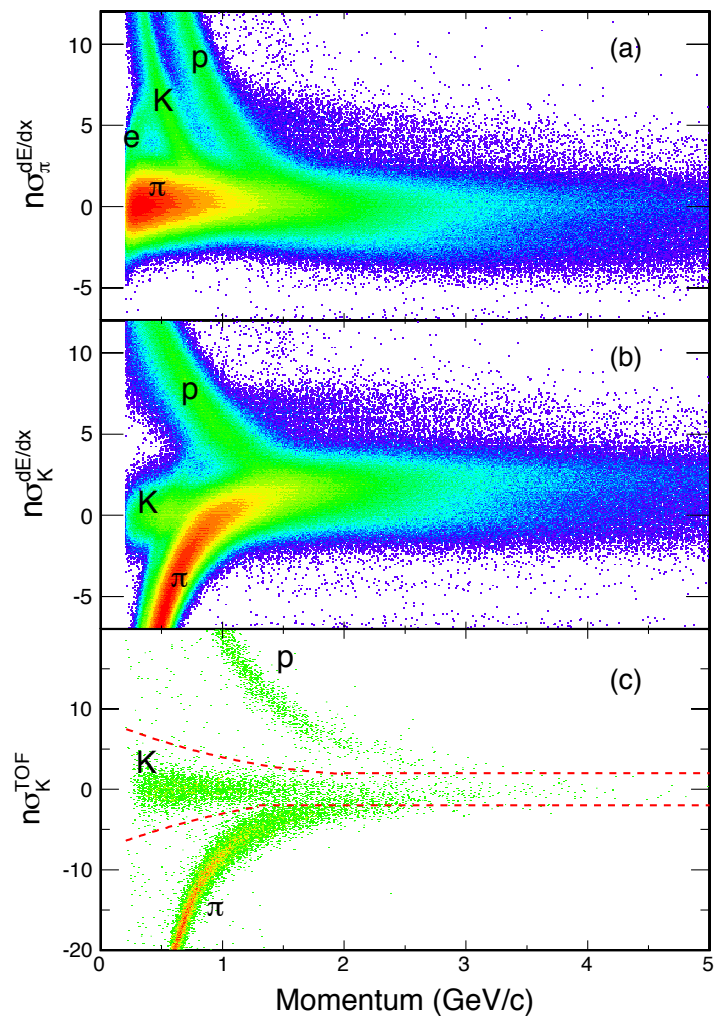
# Open charm hadron reconstruction



STAR: PRD 86, 072013 (2012)

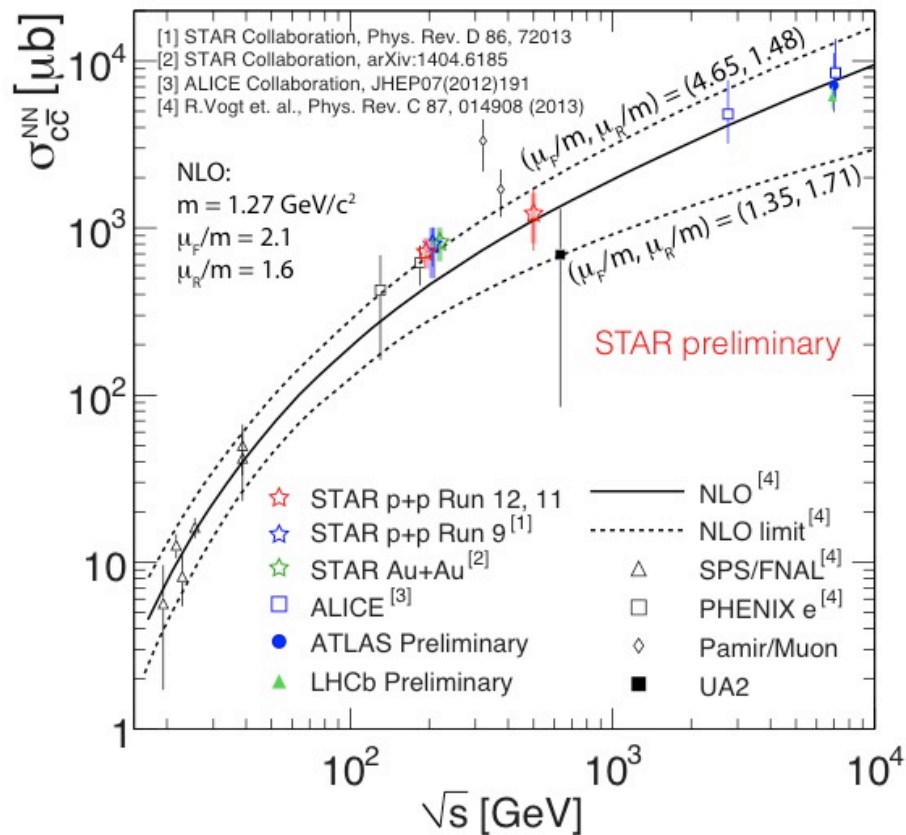
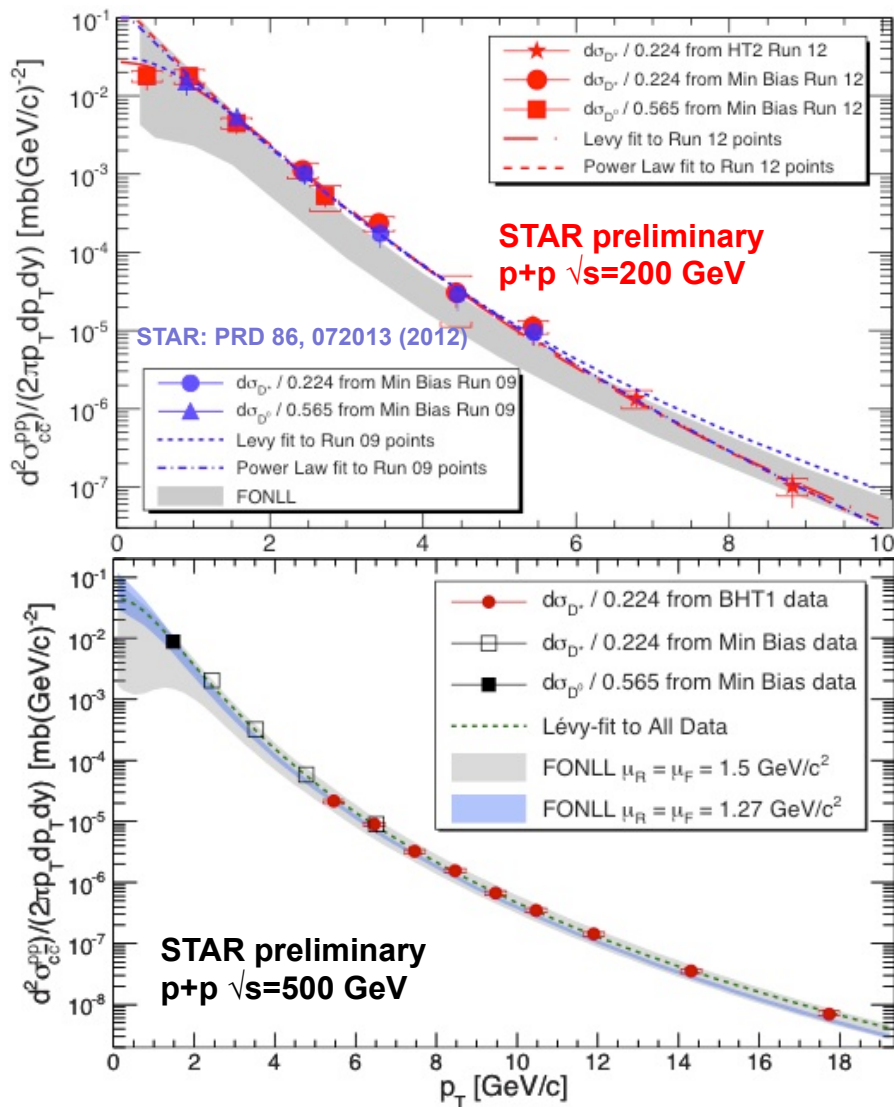


# Open charm hadron reconstruction



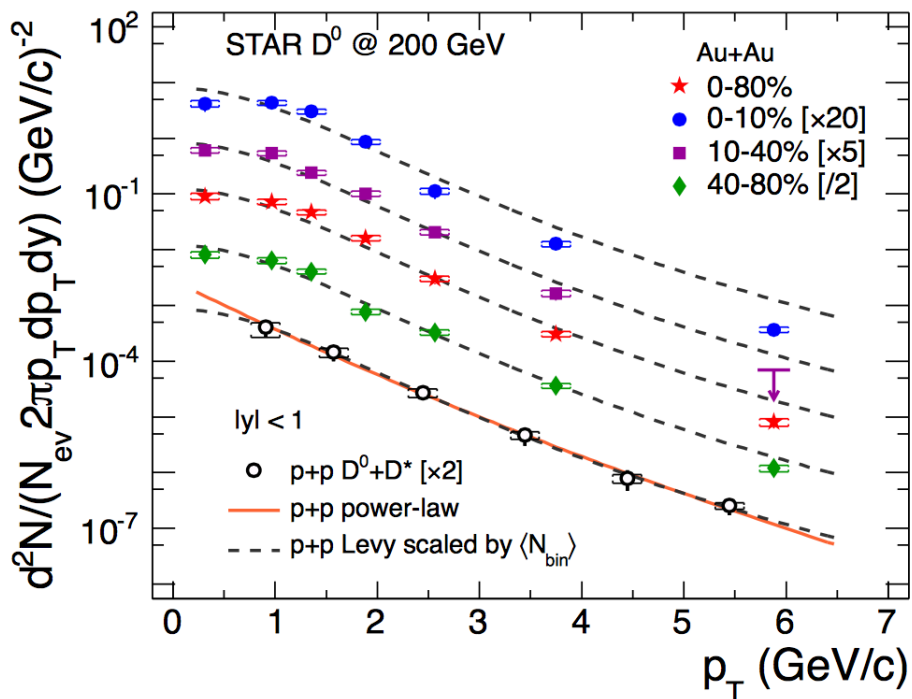
STAR: PRD 86, 072013 (2012)

# Open charm production in p+p

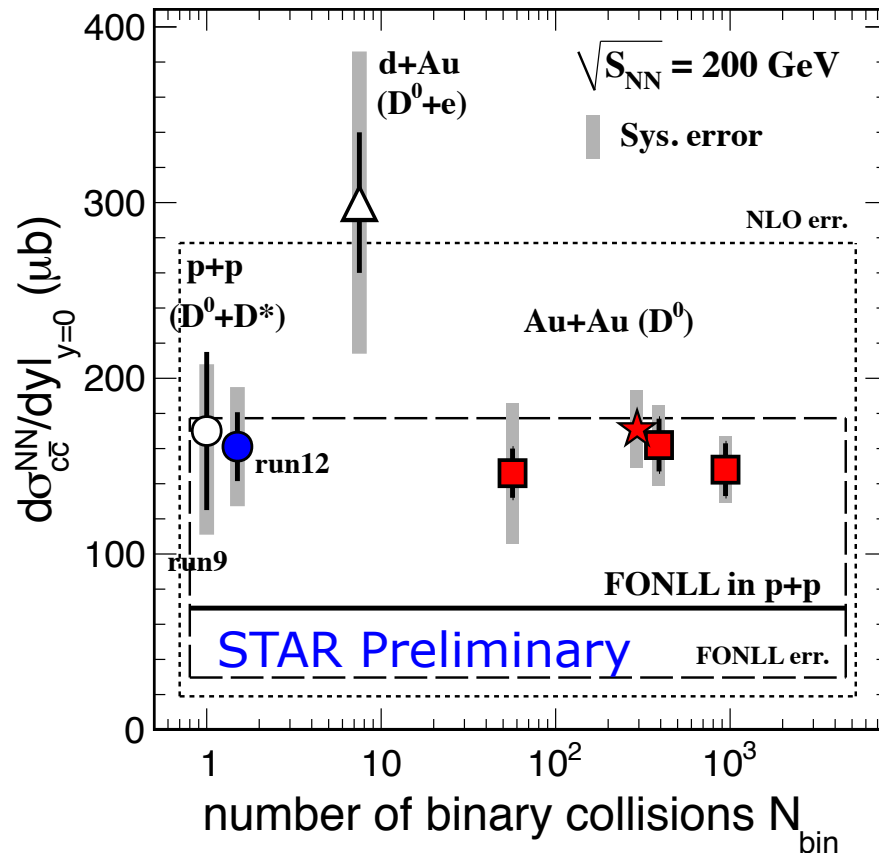


- Data consistent with Fix-Order Next-to-Leading Logarithm (FONLL) calculation within uncertainties

# Open charm production in Au+Au

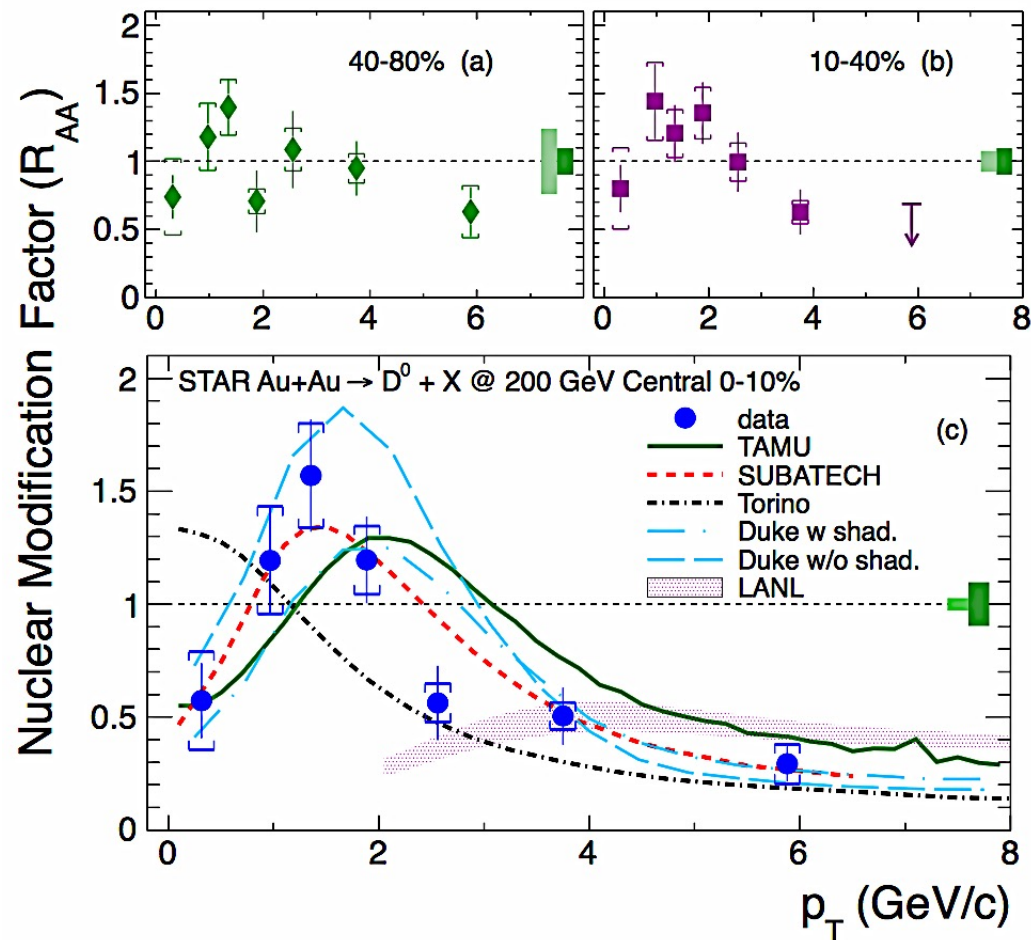


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- Total charm production scales with the number of binary collisions at RHIC

# Nuclear modification factor



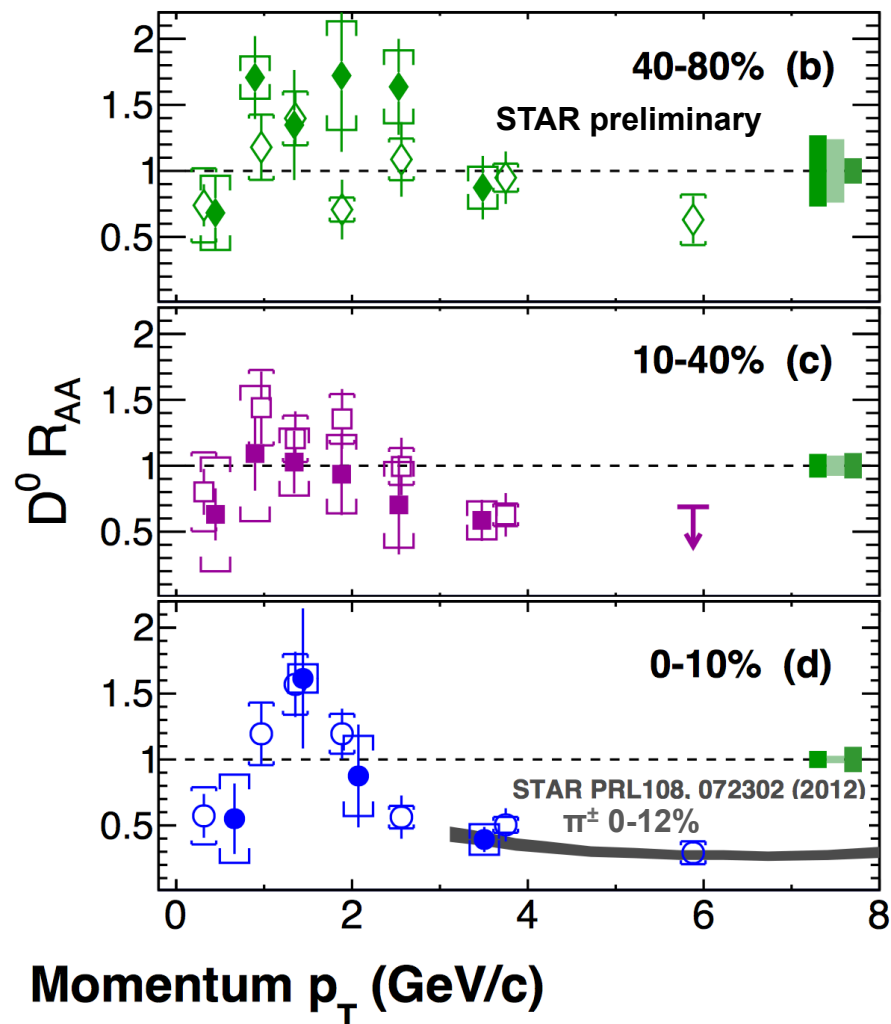
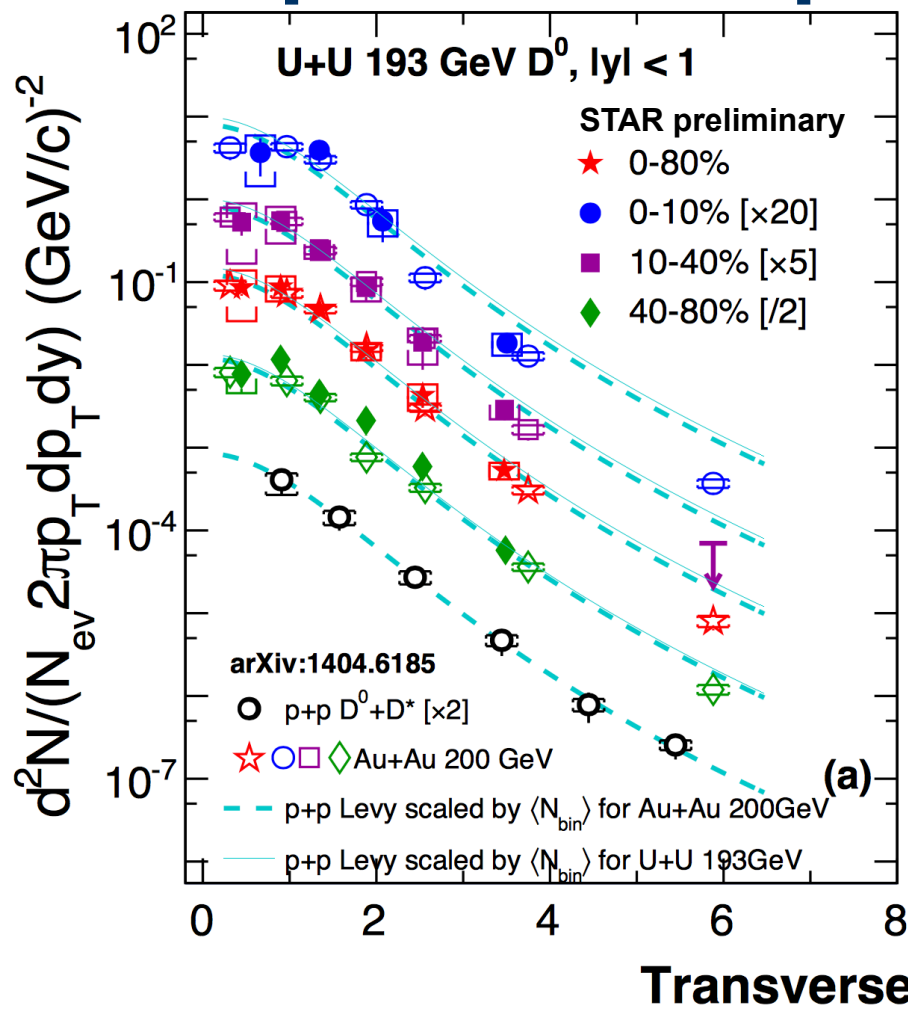
	TAMU	SUBATECH	Torino	Duke	LANL
HQ prod.	LO	FNOLL	NLO	LO	LO
QGP-Hydro	ideal	ideal	viscous	viscous	ideal
HQ eLoss	coll.	coll. +rad.	coll. +rad.	coll. +rad.	diss. +rad.
Coalescence	Yes	Yes	No	Yes	No
Cronin effect	Yes	Yes	No	No	Yes
Shadowing	No	No	Yes	Yes/No	Yes

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- Large suppression at high  $p_T$  points to strong charm-medium interaction
- Indication of enhancement  $p_T \sim 0.7-2 \text{ GeV}/c$ , described by models with coalescence of charm and light quarks
- Cold nuclear effects (Cronin, shadowing) could be important

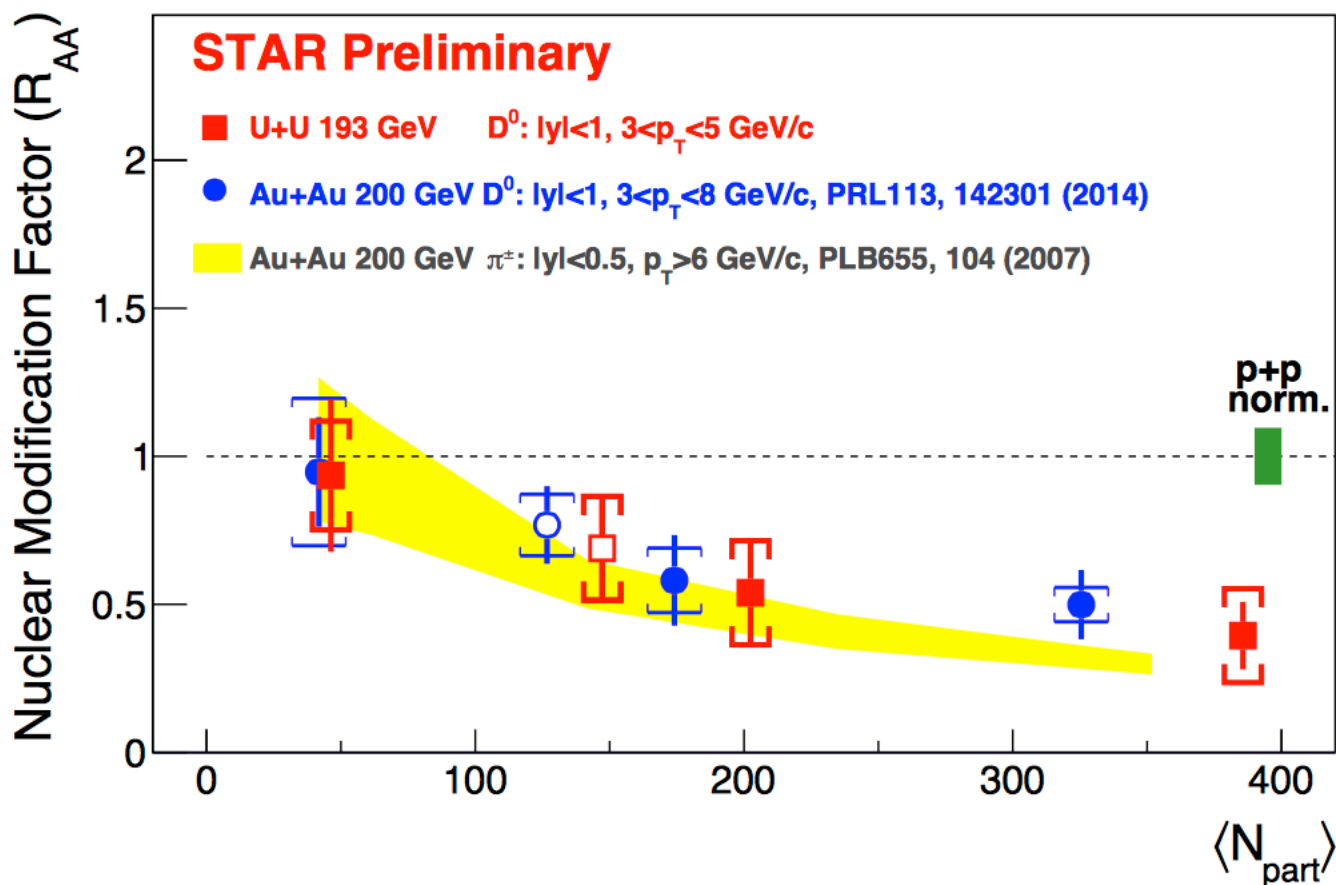


# Open charm production in U+U



- $R_{AA}$  similar trend in U+U collisions as in Au+Au collisions
- Both consistent with pion suppression at high  $p_T$

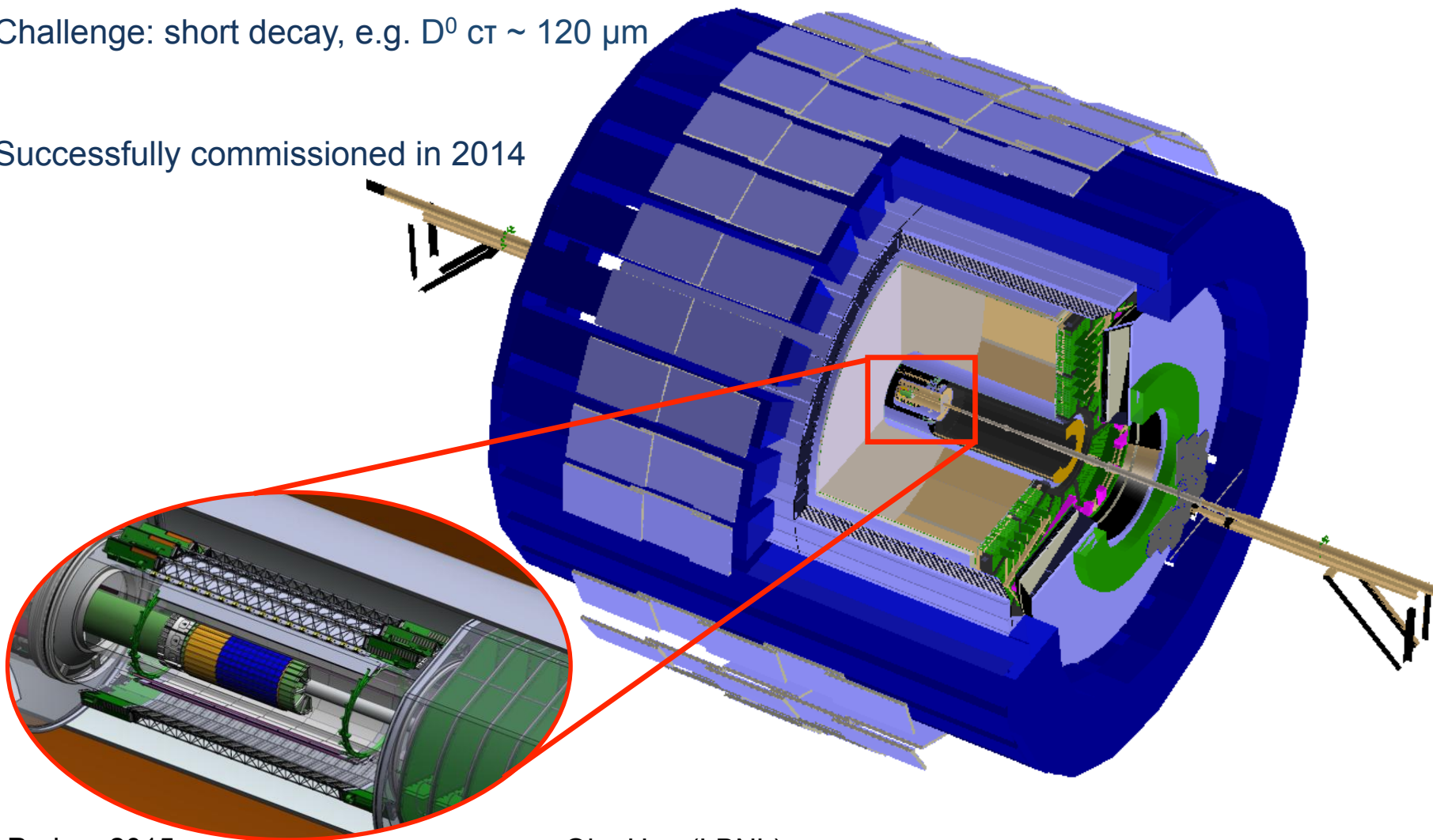
# Open charm production in U+U



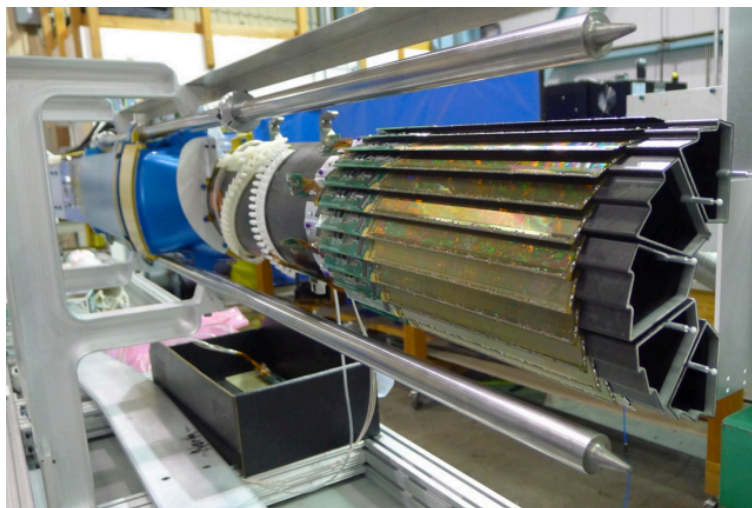
- Suppression of open charm at high  $p_T$  in U+U collisions is similar to and extends the trend as that of open charm and pions in Au+Au collisions.

# Heavy Flavor Tracker

- Reconstruct displaced decay vertices to greatly reduce combinatorial background
- Challenge: short decay, e.g.  $D^0$   $c\tau \sim 120 \mu\text{m}$
- Successfully commissioned in 2014



# HFT design and performance

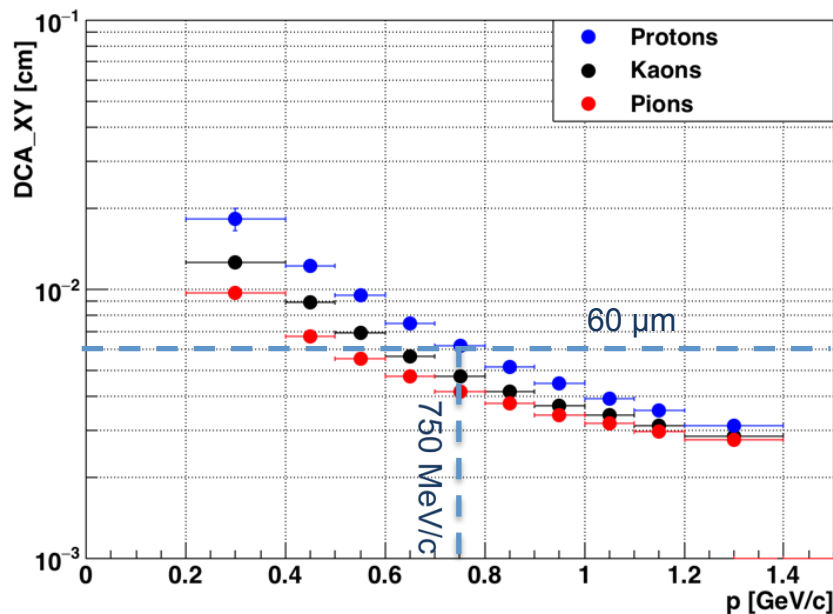


Silicon Strip Detector:  $r \sim 22$  cm

Intermediate Silicon Tracker:  $r \sim 14$  cm

PIXEL detector:  $r \sim 2.8$  &  $8.2$  cm

- **M**onolithic **A**ctive **P**ixel **S**ensors
    - used in a collider experiment for the first time
    - $20.7 \mu\text{m}$  pixel pitch  $\rightarrow \sigma = 7.8 \mu\text{m}$  considering vibration
    - thinned down to  $50 \mu\text{m}$
  - light carbon fiber support
  - air cooled
- $\rightarrow X/X_0: 0.4\% / \text{layer}$

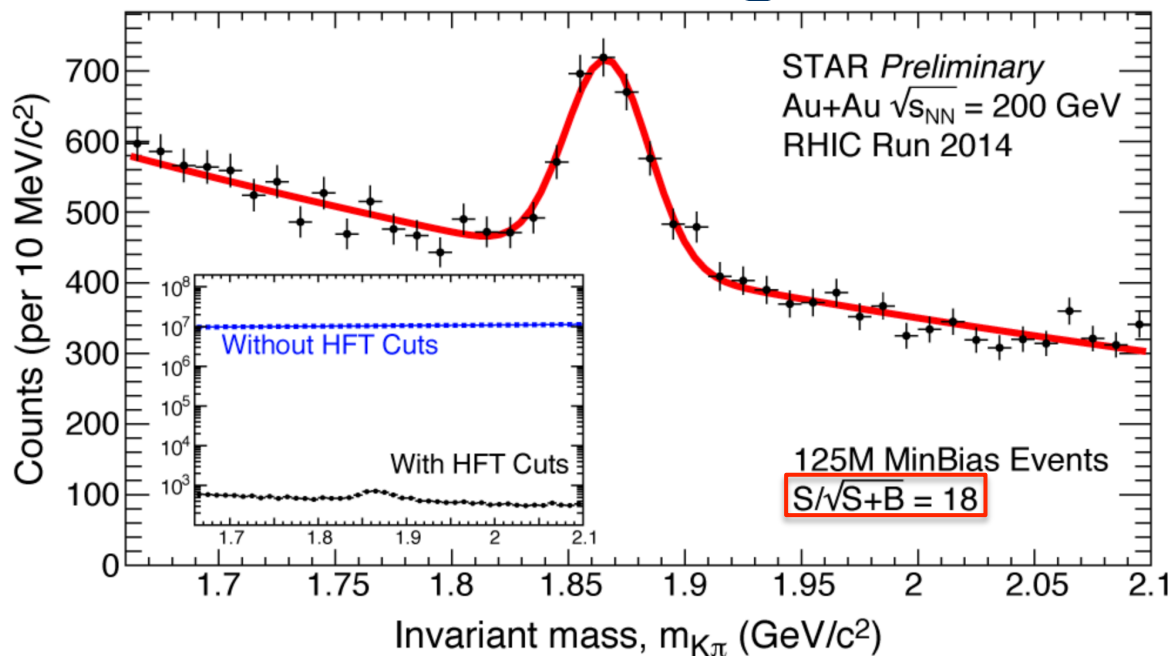


DCA resolution for tracks with TPC + HFT hits

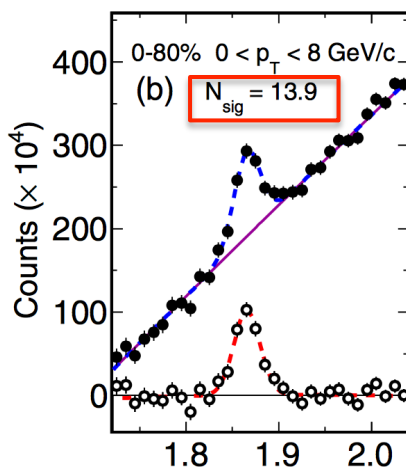
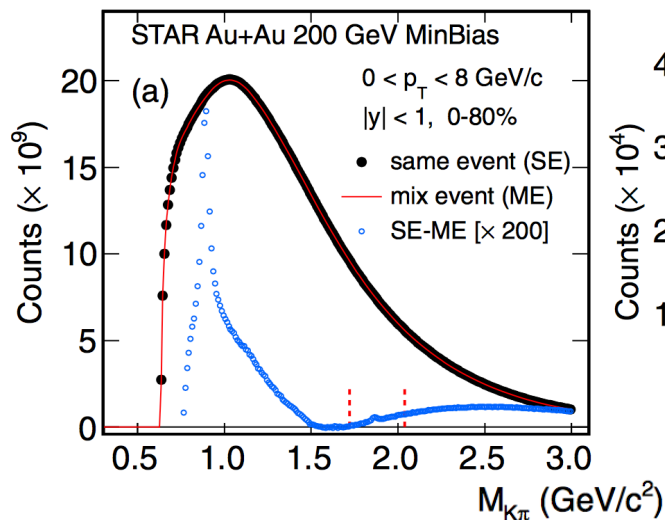
- $\sim 30 \mu\text{m}$  at high  $p_T$
- Better than the project goal:  $60 \mu\text{m}$  for kaon with  $p = 750 \text{ MeV}/c$



# D<sup>0</sup> signal with HFT



	Without HFT	With HFT
Year	2010+2011	2014
N <sub>events</sub>	1.1 B	10%*1.2B
significance	13.9	18



- Background greatly suppressed by topology cuts with HFT
- Significance greatly enhanced
- New physics results coming soon

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# Summary

- $D^0/D^*$  differential production cross-section in 200 and 500 GeV p+p collisions is consistent with FONLL calculations within uncertainties.
- Significant suppression at high  $p_T$  and indication of enhancement at  $p_T \sim 0.7-2$  GeV/c are observed for  $D^0$  production in both Au+Au and U+U collisions, which can be described by model calculations with strong charm-medium interaction and coalescence hadronization.
- STAR HFT has been commissioned successfully in Run14,  $D^0$  significance enhanced tremendously. Physics results on HF energy loss, collectivity and more will come soon.

**Thank you**

