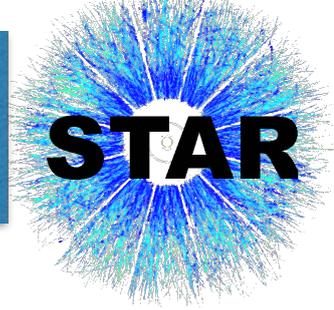


Measurements of open bottom hadron  
production via displaced  $J/\psi$ ,  $D^0$  and electrons  
in Au+Au collisions at  $\sqrt{s_{NN}} = 200$  GeV  
at STAR

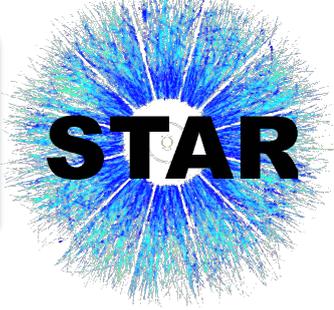
Xiaolong Chen (for the STAR Collaboration)

State Key Laboratory of Particle Detection and Electronics  
University of Science and Technology of China



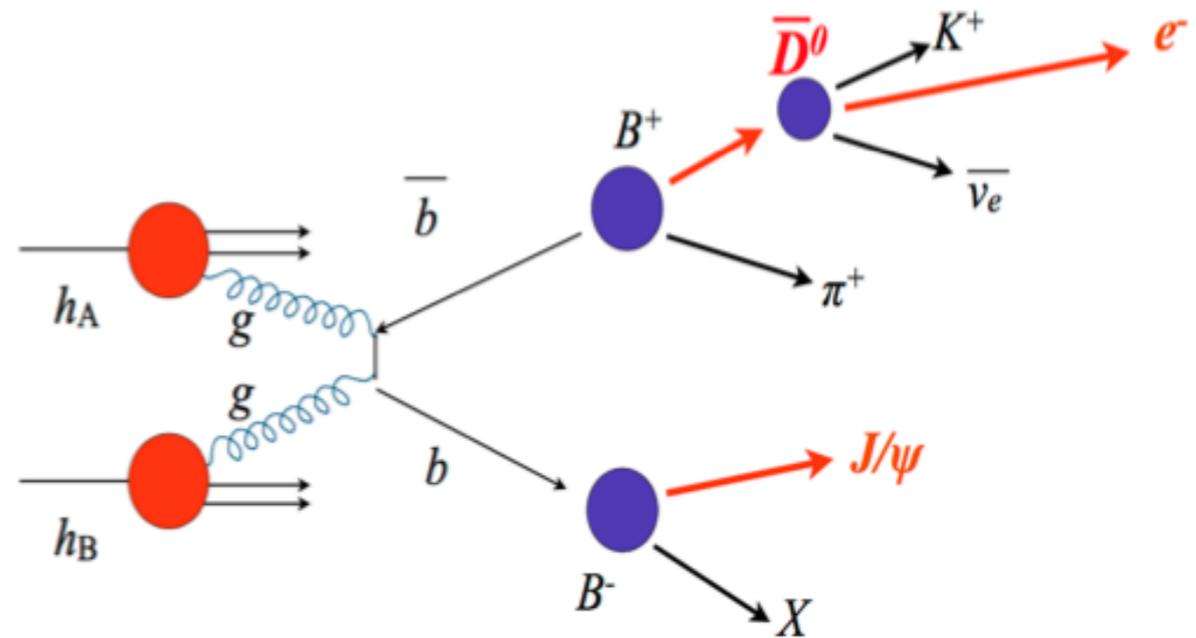
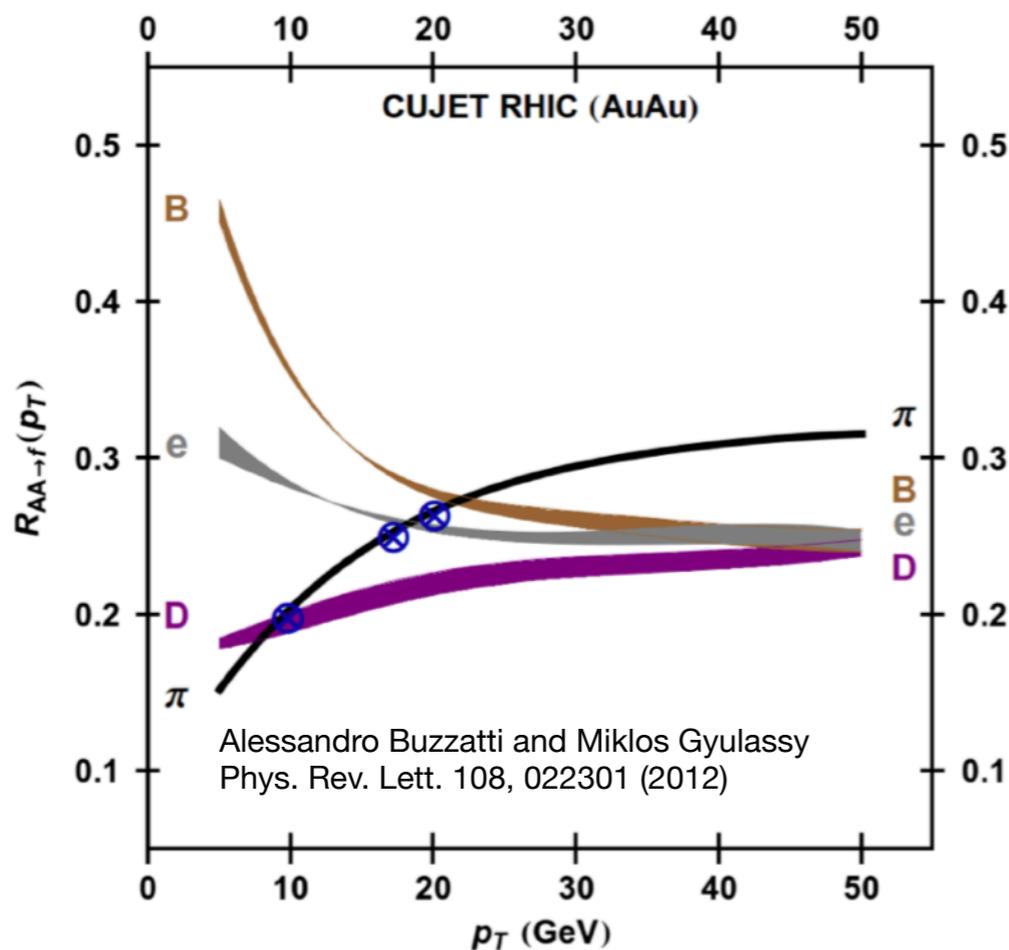
- ✓ Introduction
- ✓ STAR experiment
- ✓ Bottom measurements in 200 GeV Au+Au collisions
  - ✓  $B \rightarrow J/\psi$
  - ✓  $B \rightarrow D^0$
  - ✓  $B/D \rightarrow$  electrons
- ✓ Summary and outlook

# Introduction

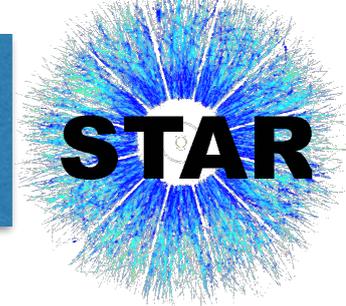


- ✓ Heavy quarks in A+A collisions
  - ✓ Produced early dominated through initial hard scatterings
  - ✓ Experience the entire evolution of the hot and dense medium
- ✓ Theoretical prediction for  $\Delta E$  in medium:  $\Delta E(u,d,s) > \Delta E(\mathbf{c}) > \Delta E(\mathbf{b})$

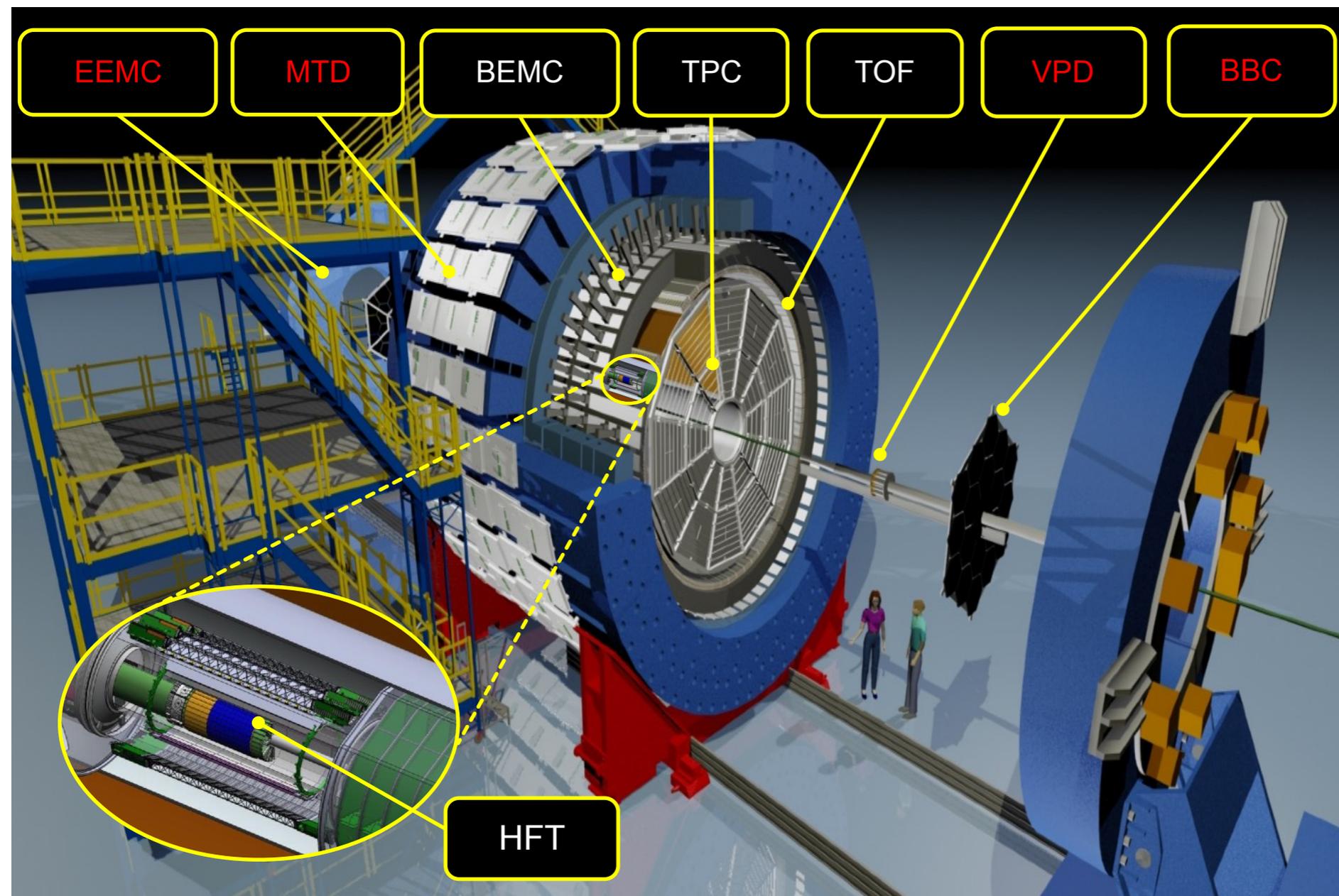
*R. Baier et al., Ann. Rev. Nucl. Part. Sci. 50, 37 (2000); M. Gyulassy et al., nucl-th/0302077*



# STAR detector



$|\eta| < 1$  with full azimuthal coverage



## Time Projection Chamber (TPC)

- ➔ Momentum determination
- ➔ PID through  $dE/dx$

## Time of Flight (TOF)

- ➔ PID through  $1/\beta$
- ➔ Timing resolution:  $\sim 85$  ps

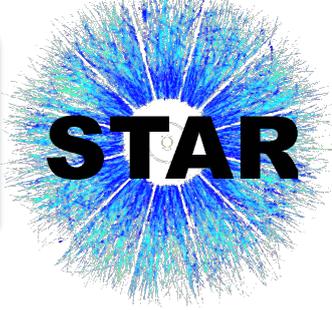
## Barrel Electromagnetic Calorimeter (BEMC)

- ➔ electron PID through  $p/E$
- ➔ Triggering on high- $p_T$  electrons

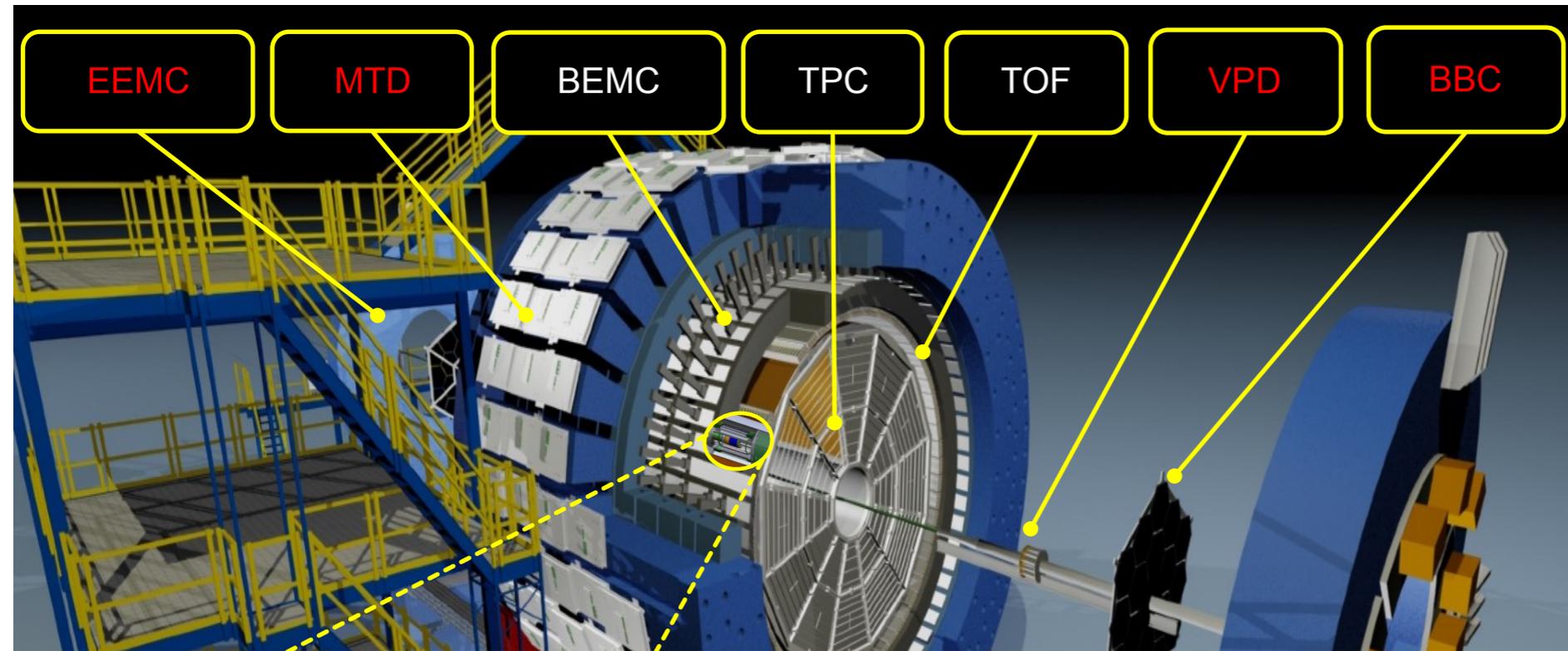
## Heavy Flavor Tracker (HFT)

- ➔ Excellent DCA resolution in both  $r\phi$  and  $z$  directions:  $\sim 30$   $\mu\text{m}$  at  $p = 1.5$  GeV/c

# STAR detector



$|\eta| < 1$  with full azimuthal coverage



## Time Projection Chamber (TPC)

- ➔ Momentum determination
- ➔ PID through  $dE/dx$

## Time of Flight (TOF)

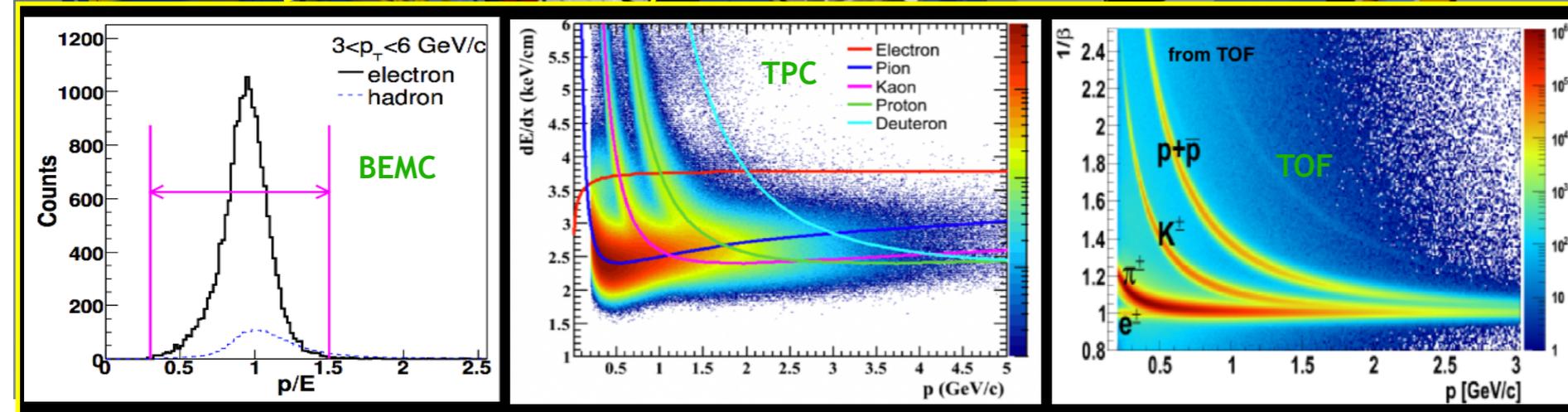
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# STAR detector



EEMC

MTD

BEMC

TPC

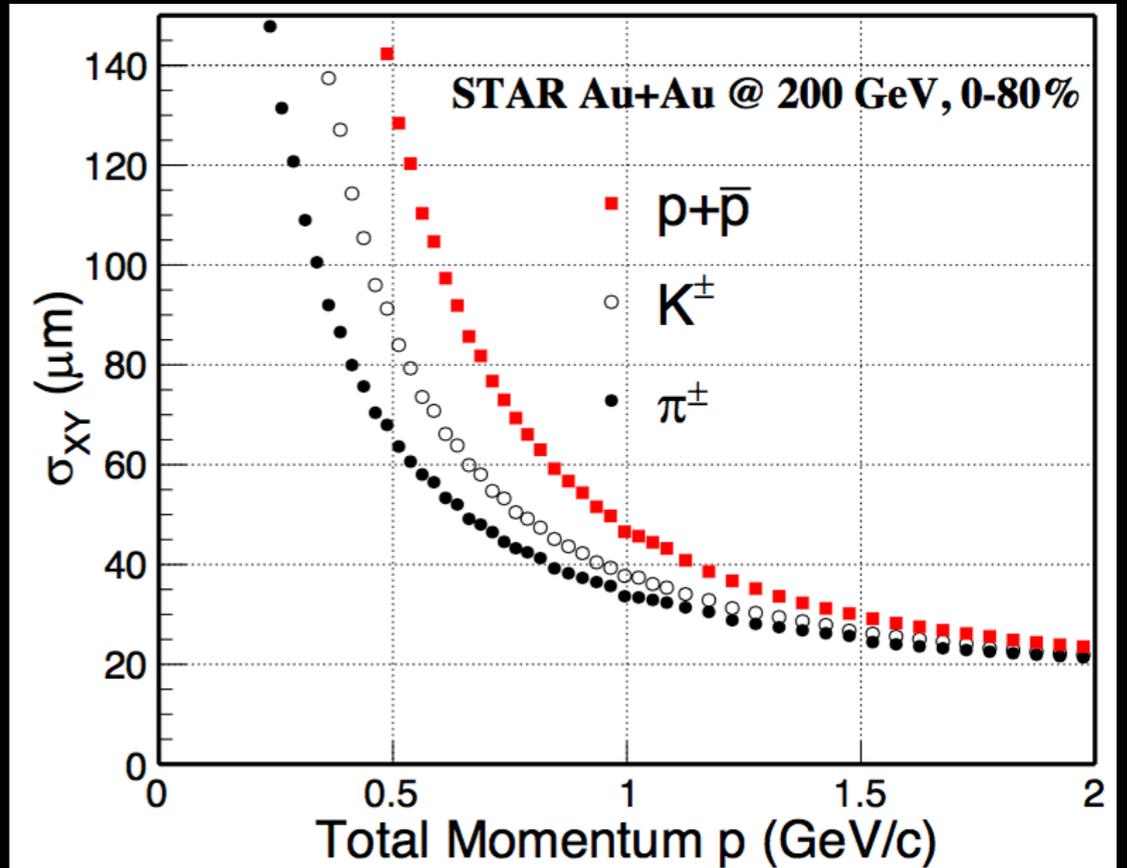
TOF

VPD

BBC

## HFT (2014-2016):

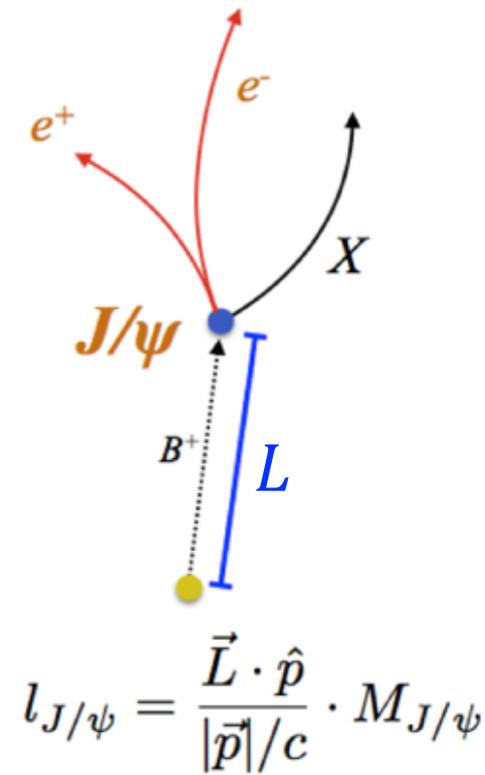
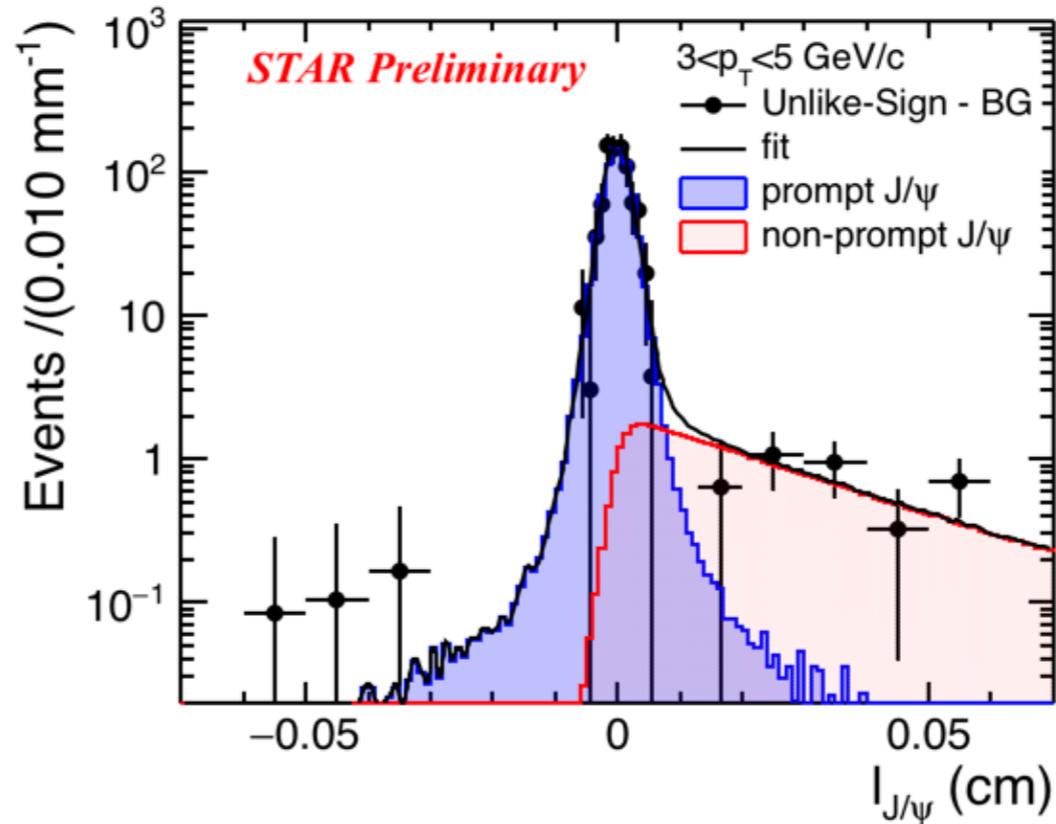
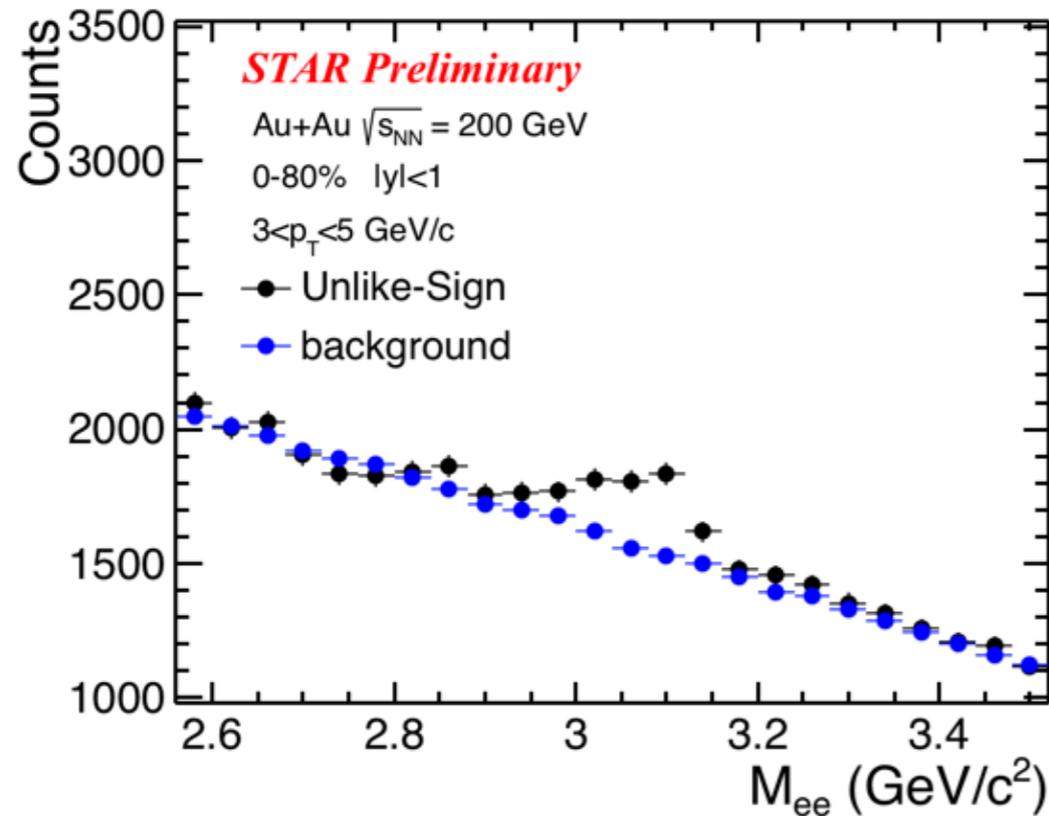
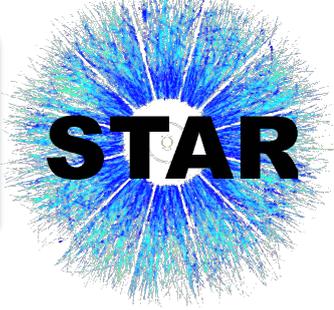
- ★ Silicon Strip Detector:  $r \sim 22$  cm
- ★ Intermediate Silicon Tracker:  $r \sim 14$  cm
- ★ PIXEL detector:  $r \sim 2.8$  &  $8$  cm, MAPS,  $20.7 \times 20.7 \mu\text{m}^2$ ,  $0.5\%X_0$  (2014)  $0.4\%X_0$  (2016), air-cooled



★ Precise reconstruction of displaced decay vertices.

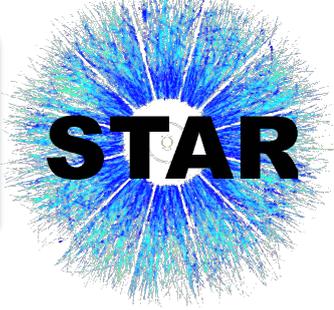
HFT

# Extract $B \rightarrow J/\psi$

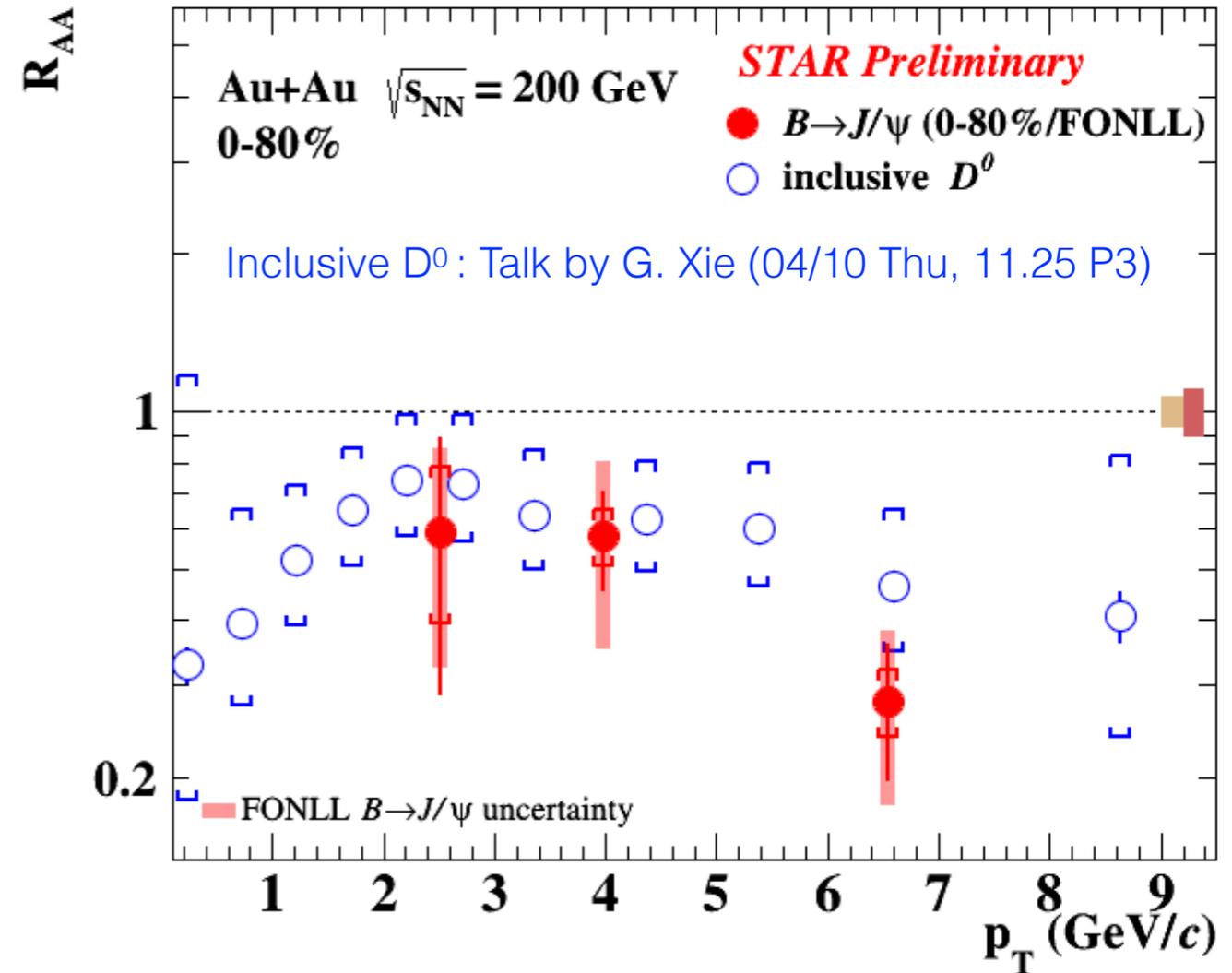
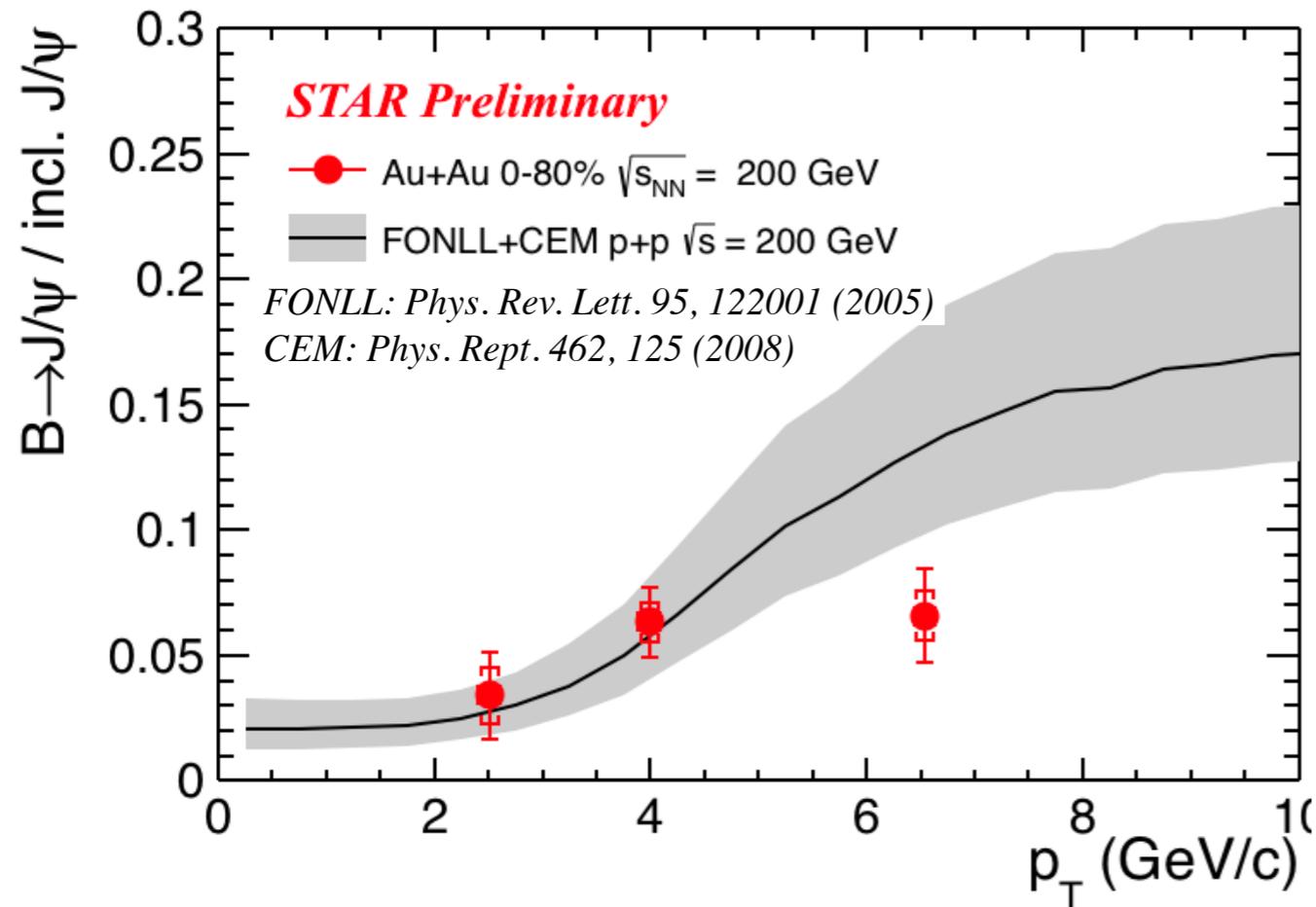


- ✓  $\sim 900$ M MB (2014) +  $\sim 1.2$  nb $^{-1}$  BEMC triggered events (2014+2016)
- ✓ Background is estimated using event mixing method
- ✓ Extract contribution of non-prompt J/ $\psi$  from pseudo-proper decay length ( $l_{J/\psi}$ ) distribution

# B → J/ψ fraction and R<sub>AA</sub>

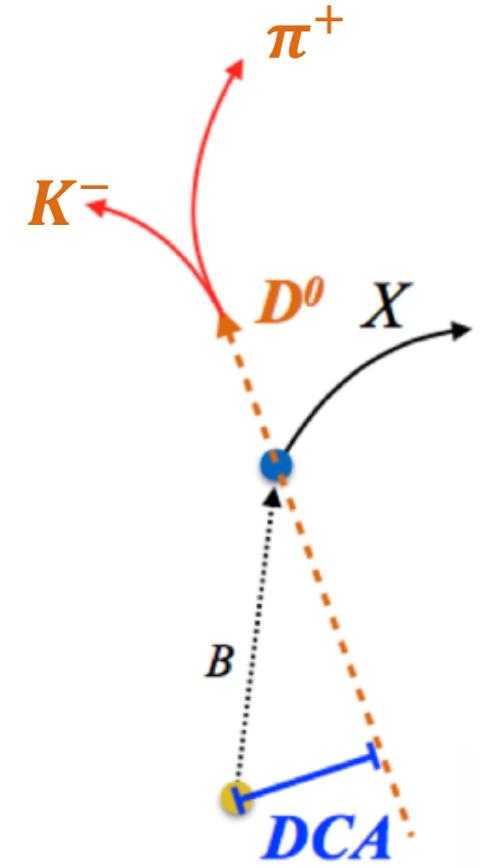
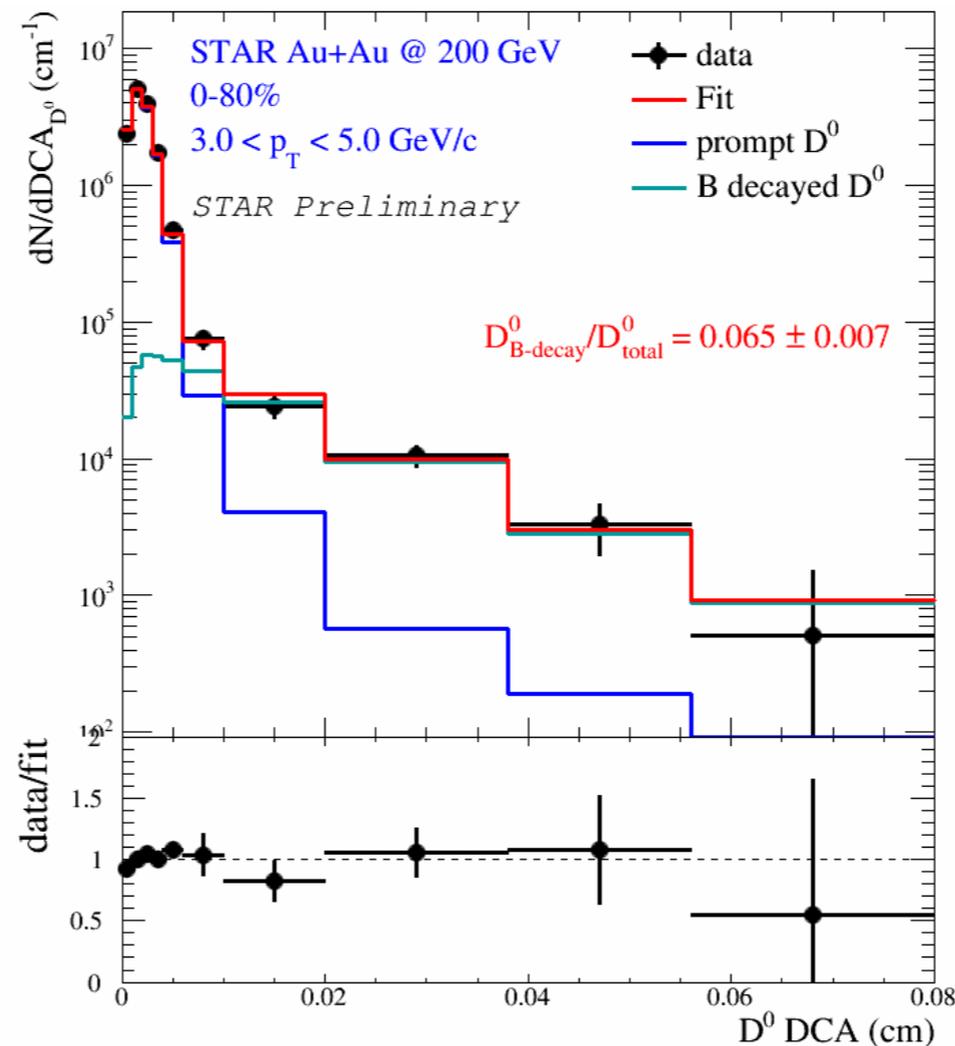
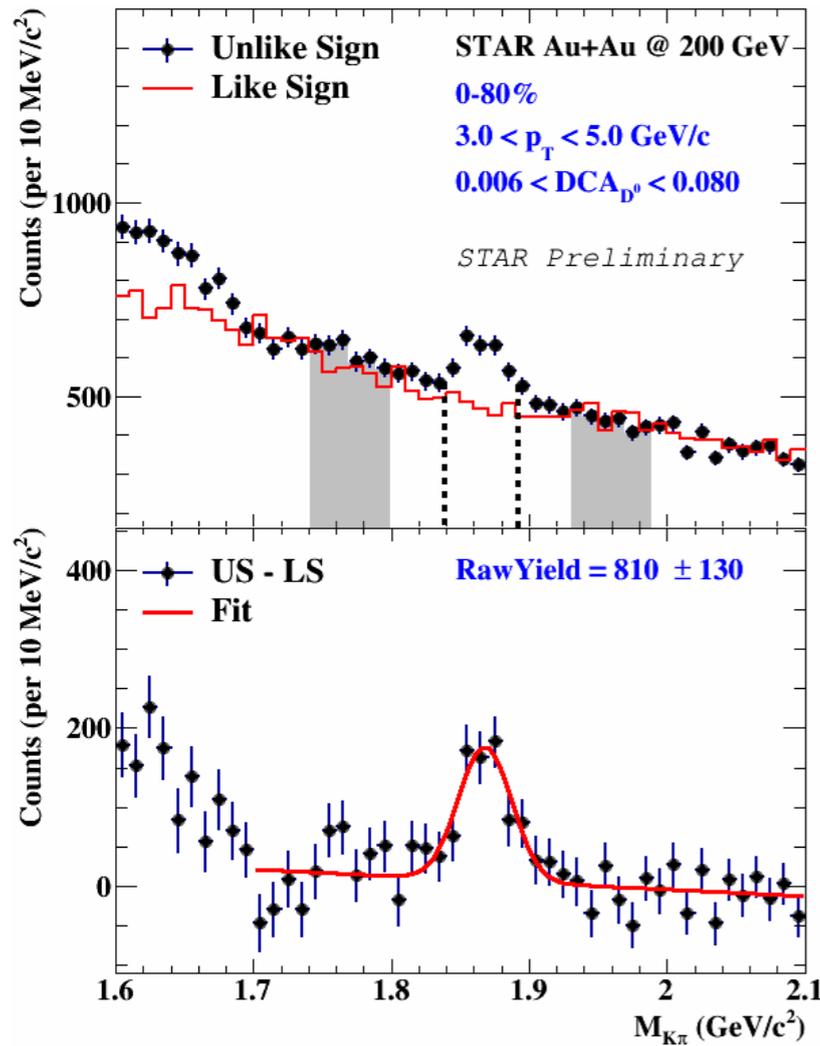
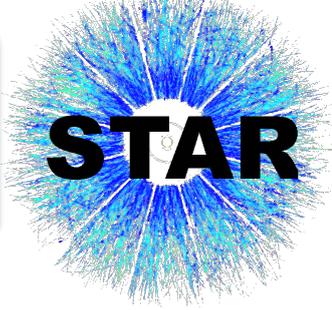


$$R_{AA}^{B \rightarrow J/\psi} = \frac{f_{Au+Au}^{B \rightarrow J/\psi}(\text{data})}{f_{p+p}^{B \rightarrow J/\psi}(\text{theory})} R_{AA}^{\text{incl. } J/\psi}(\text{data})$$



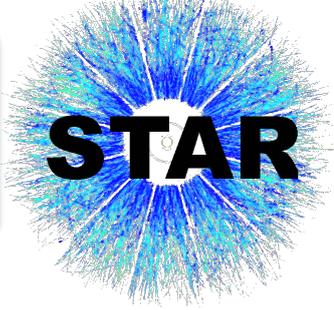
➔ **Strong suppression** is observed for non-prompt J/ψ at high  $p_T$  and is similar to that of  $D^0$  mesons.

# Extract $B \rightarrow D^0$

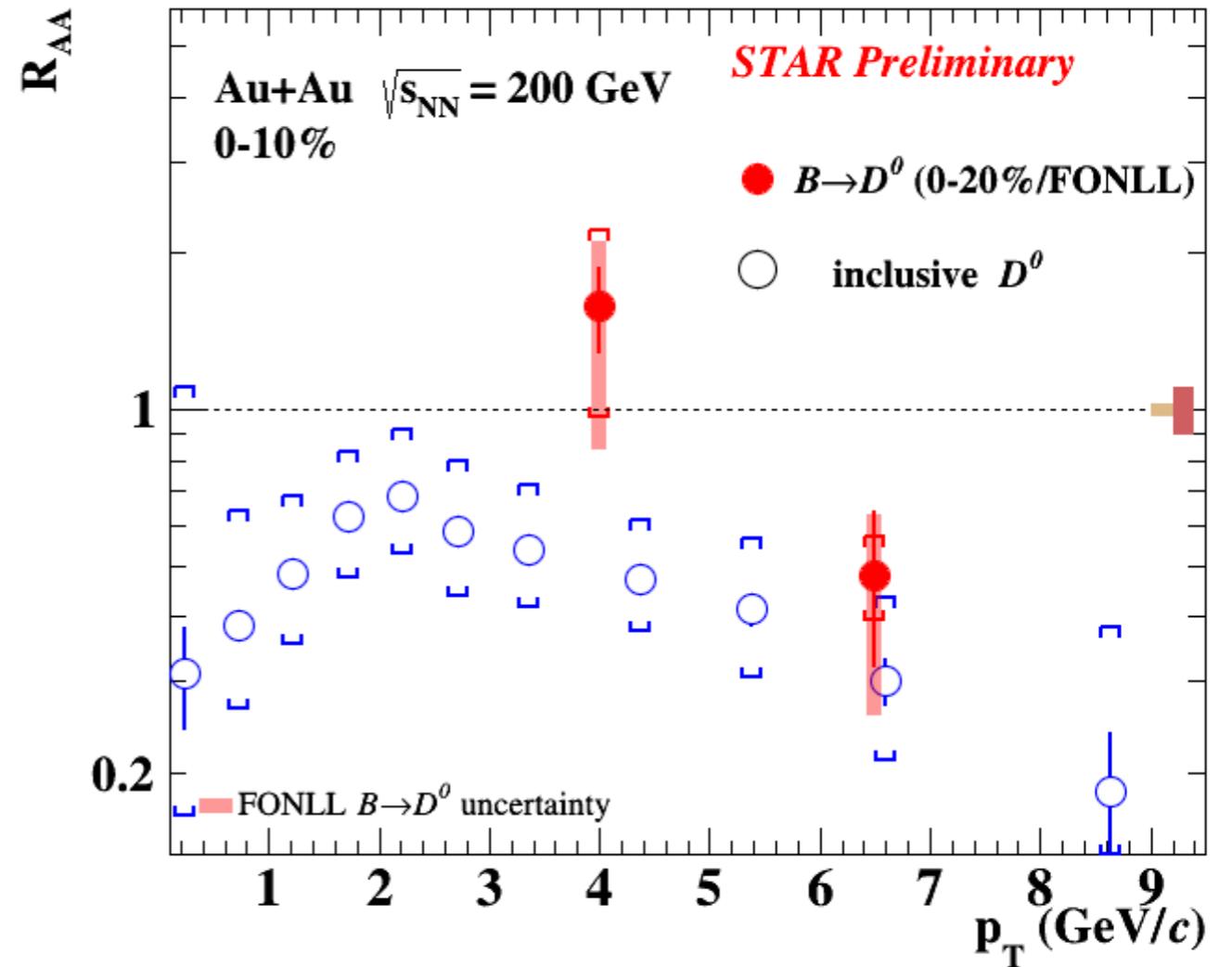
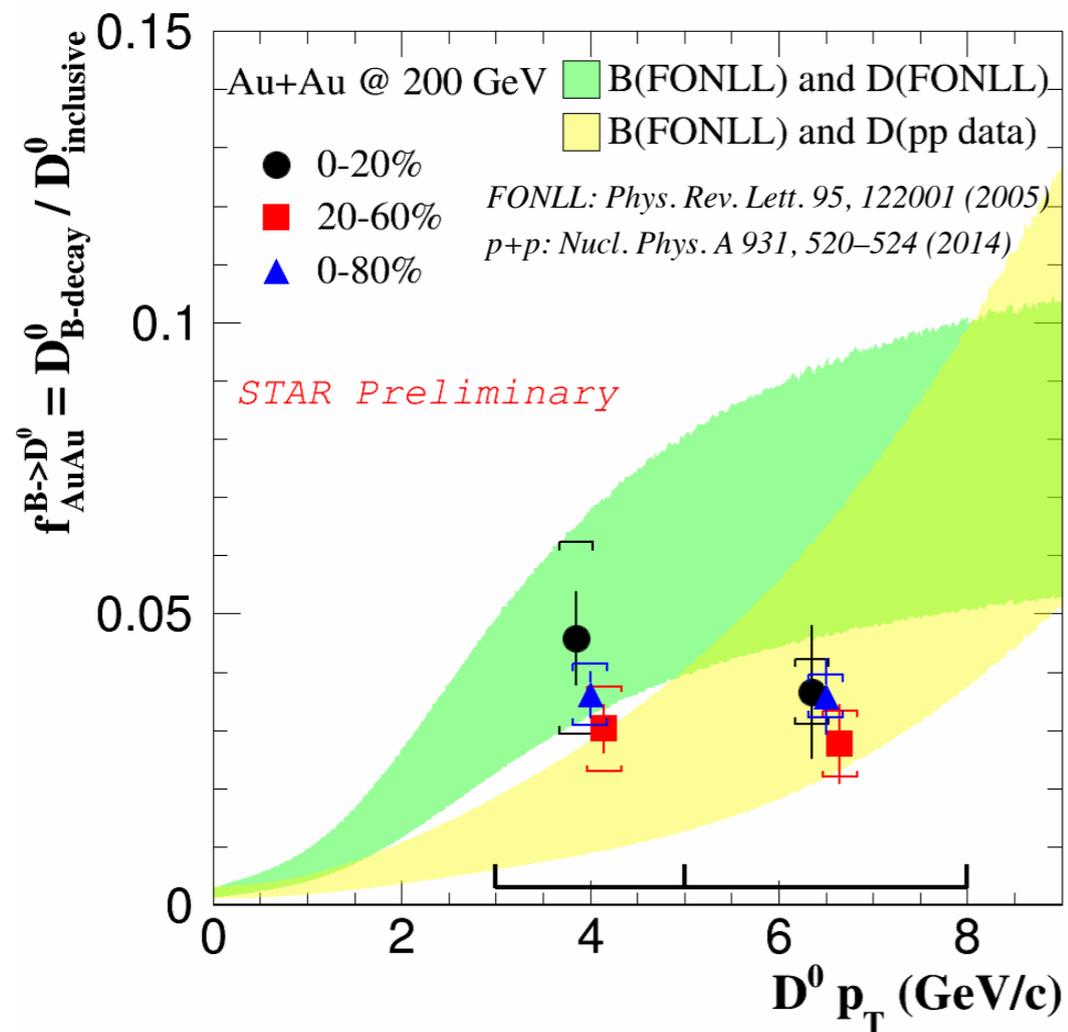


- ✓ ~900M MB events in 2014
- ✓ Background is estimated using side bands
- ✓ Extract contribution of non-prompt  $D^0$  from  $D^0$  DCA distribution

# B $\rightarrow$ D<sup>0</sup> fraction and R<sub>AA</sub>

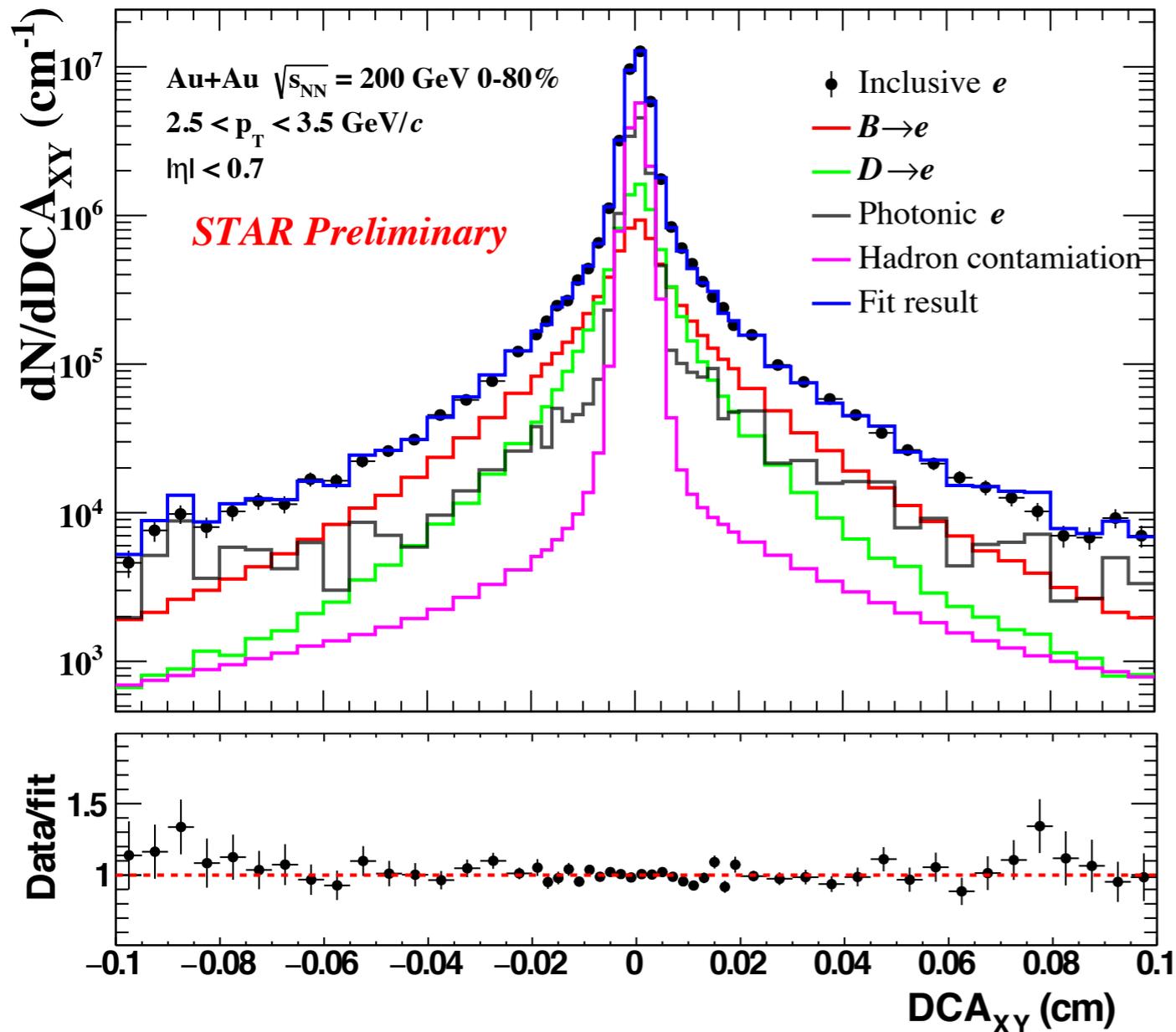
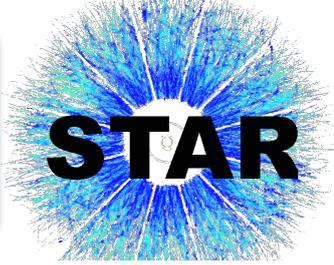


$$R_{AA}^{B \rightarrow D^0} = \frac{1}{\langle N_{coll} \rangle} \frac{f_{Au+Au}^{B \rightarrow D^0} \times dN_{Au+Au}^{inc. D^0} / dp_T}{dN_{FONLL}^{B \rightarrow D^0} / dp_T}$$



- ➔ **Strong suppression** of non-prompt D<sup>0</sup> is observed at D<sup>0</sup> p<sub>T</sub> range 5-8 GeV/c
- ➔ A hint of **less suppression** for non-prompt D<sup>0</sup> compared to prompt D<sup>0</sup> at 3 < p<sub>T</sub> < 5 GeV/c.

# Extract $B/D \rightarrow e$



## ✓ Signal

- ✓ Broader  $\text{DCA}_{XY}$  distribution for **bottom-** than **charm-decayed** electrons

- ✓ Signal template: Data-driven simulation + EvtGen decayer ( $D^0$ ,  $D^\pm$ ,  $B^0$ ,  $B^\pm$ )

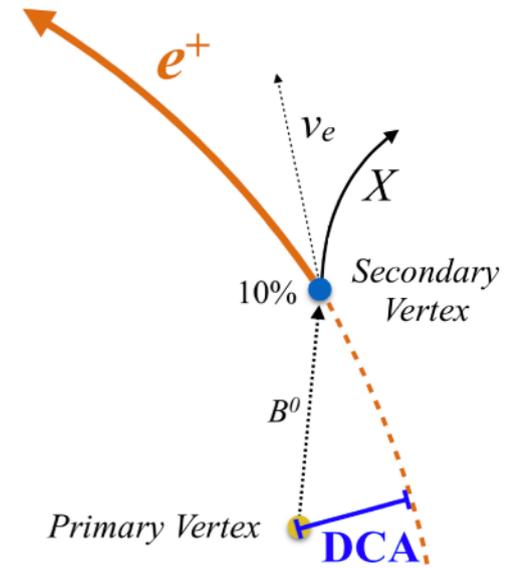
## ✓ Background

- ✓ **Hadron contamination**

Template: inclusive hadron distribution from data and contribution constrained using inclusive electron purity

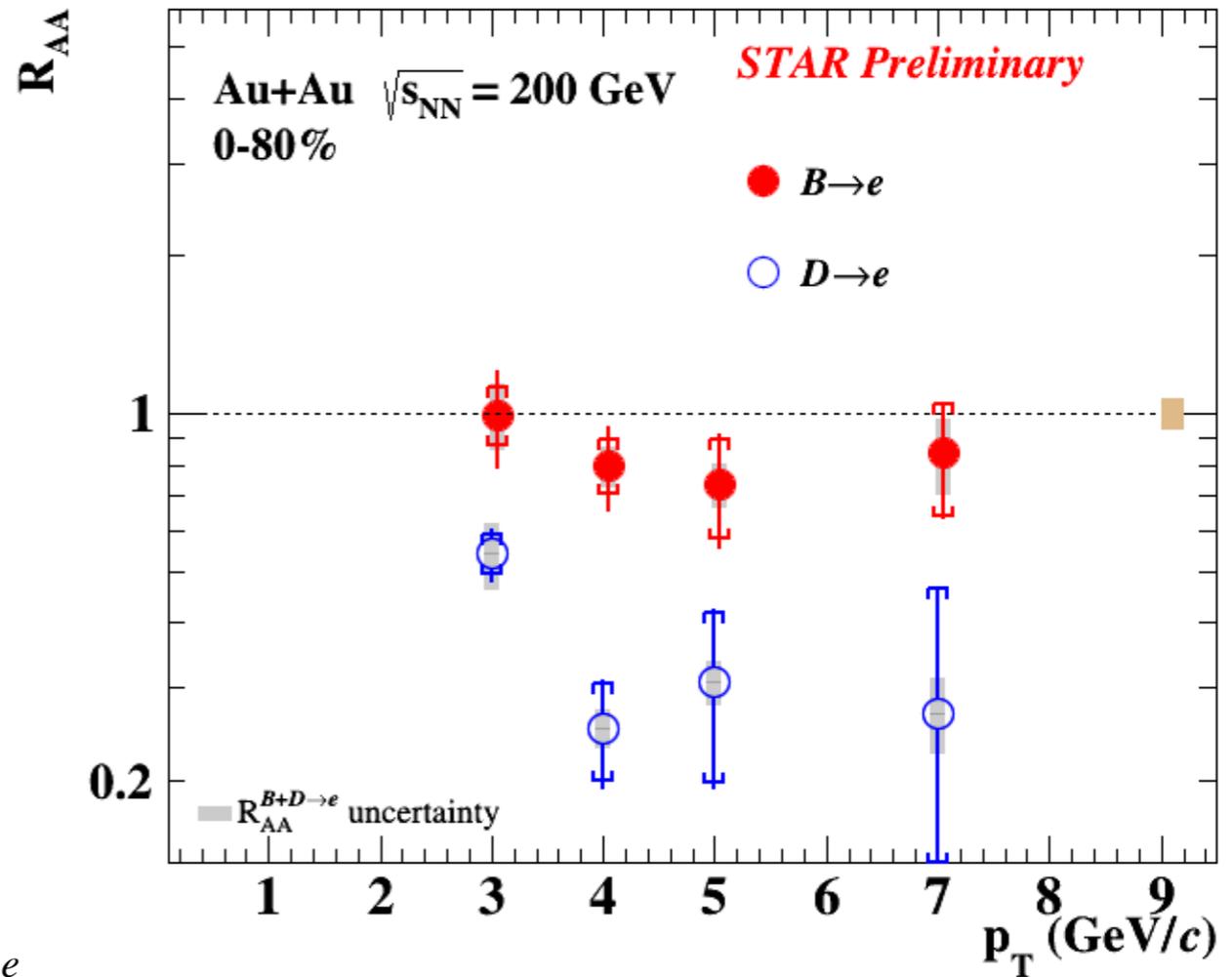
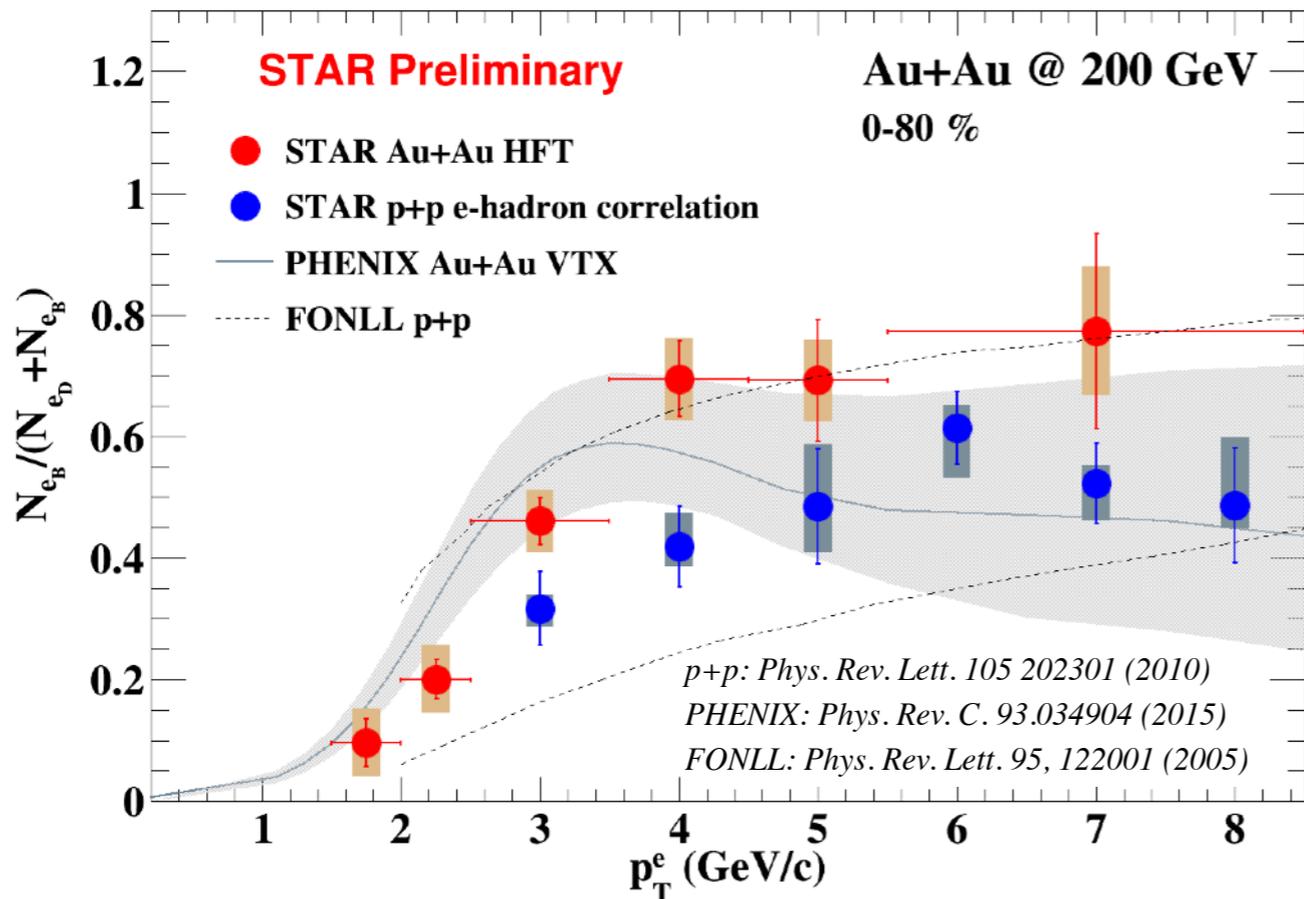
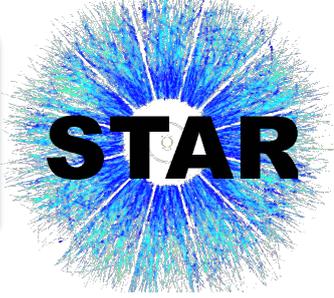
- ✓ **Photonic electron**

Template: from data with correction factors extracted from Hijing simulations



$\sim 900\text{M MB} + \sim 0.2 \text{ nb}^{-1}$  BEMC triggered (HT) events in 2014

# B/D $\rightarrow$ e fraction and $R_{AA}$

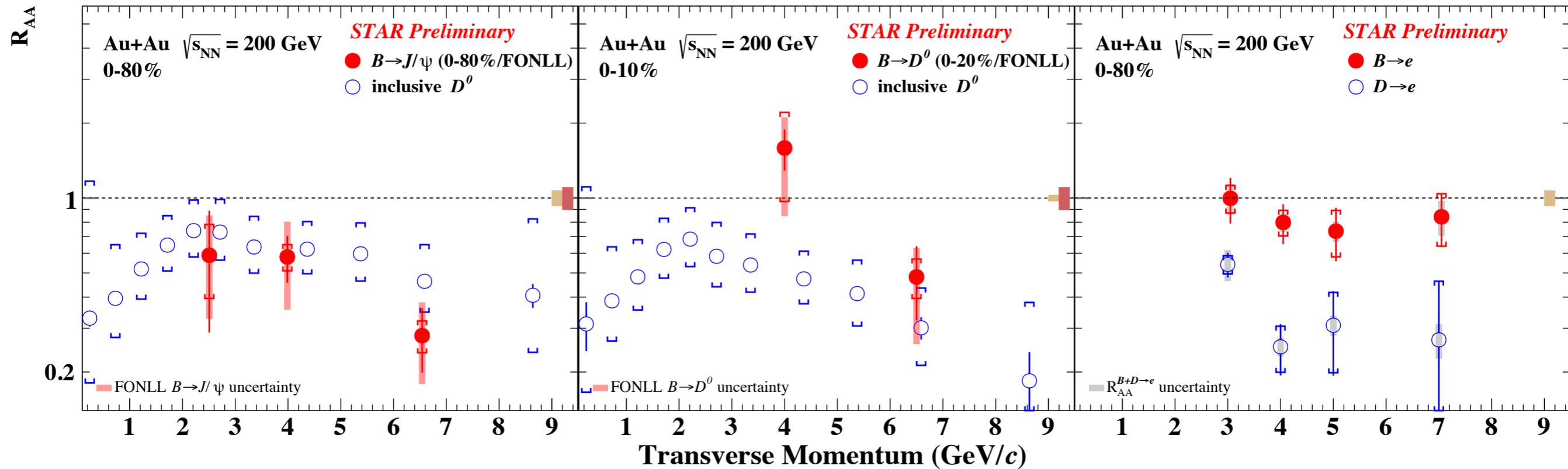
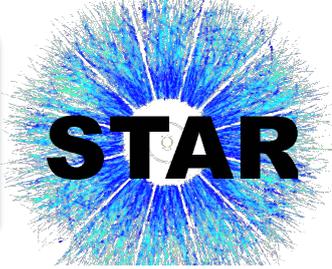


$$R_{AA}^{B \rightarrow e} = \frac{\int_{Au+Au}^{B \rightarrow e}}{\int_{p+p}^{B \rightarrow e}} R_{AA}^{inc.e}, \quad R_{AA}^{D \rightarrow e} = \frac{1 - \int_{Au+Au}^{B \rightarrow e}}{1 - \int_{p+p}^{B \rightarrow e}} R_{AA}^{inc.e}$$

Nuclear modification factor calculated with inclusive non-photon electron  $R_{AA}$ , and bottom-decayed electron fractions measured in p+p and Au+Au

- ➔  $R_{AA}(e_D) < R_{AA}(e_B)$  ( $\sim 2\sigma$  at 3-8 GeV/c)
- ➔ Consistent with mass hierarchy of parton energy loss ( $\Delta E_c > \Delta E_b$ )

# Summary



- ✓ **Measured open bottom hadron production via displaced  $J/\psi$ ,  $D^0$  and electron decay channels in 200 GeV Au+Au collisions**
  - ✓ Strong suppression for  $B \rightarrow J/\psi$  and  $B \rightarrow D^0$  at high  $p_T$
  - ✓ Indication of less suppression for  $B \rightarrow e$  than  $D \rightarrow e$  ( $\sim 2\sigma$ ): consistent with  $\Delta E_c > \Delta E_b$
- ✓ **Outlook**
  - ✓ A factor of  $\sim 1.5$  more MB and  $\sim 5$  more HT Au+Au events recorded in 2016 for  $D^0$  and electron decay channels