QUARK MATTER 2015

The XXVth International Conference on Ultrarelativistic Nucleus-Nucleus Collisions

Measurements of Open Heavy Flavor Production in Semi-leptonic Channels at STAR

Xiaozhi Bai[1,2] (for the STAR Collaboration)

1 Central China Normal University

2 University of Illinois at Chicago

U.S. DEPARTMENT OF ENERGY

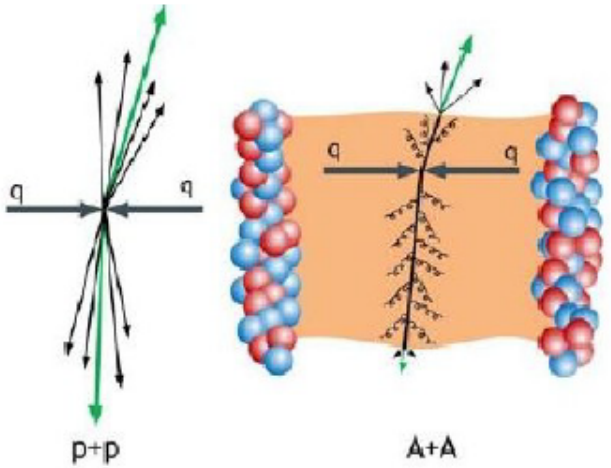
UIC UNIVERSITY OF ILLINOIS AT CHICAGO

Outline

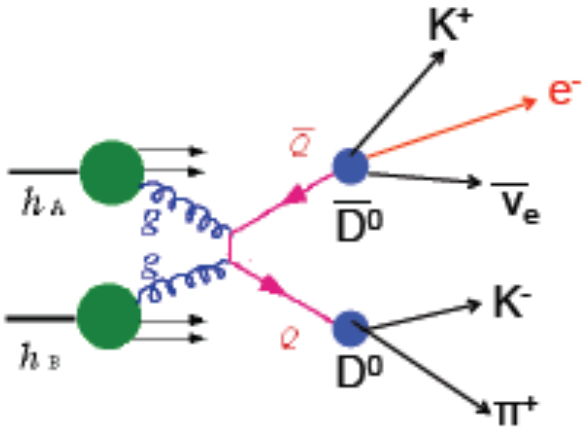
- Motivation
- STAR and Data Analysis
- Non-Photonic Electron (NPE) Results
  - NPE in p+p collisions at $\sqrt{s}$=200 GeV
  - R_{AA} in Au+Au and U+U collisions
  - Status of NPE analyses with the HFT
- Summary and Outlook

Motivation

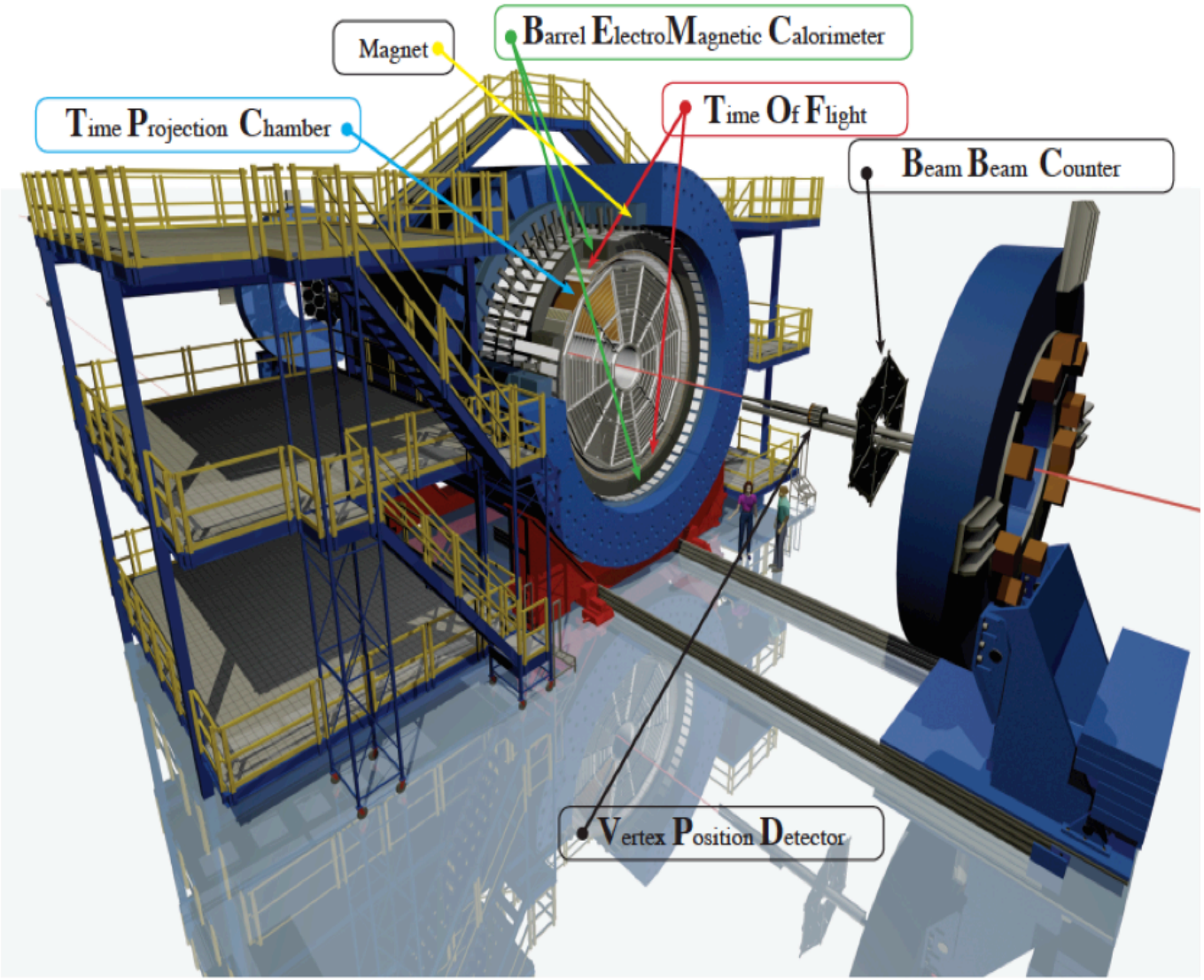
- **Heavy Flavor Quarks**
  - Large masses, dominantly produced in hard scatterings in the early stage
  - Excellent probe for studying the QGP



- **Non-Photonic Electrons (NPE)**
  - Produced from semi-leptonic decays of open heavy flavor hadrons
  - A good proxy to measure heavy flavor quark production
  - Can be triggered online with high eff.



STAR Detector (2012)



Time Projection Chamber
$|\eta|<1.1$, $0\leq\phi<2\pi$
tracking, momentum
electron ID through dE/dx

Time Of Flight
$|\eta|<0.9$, $0\leq\phi<2\pi$
electron ID for $p_T<1.5$ GeV/c

Barrel EM Calorimeter
$|\eta|<1$, $0\leq\phi<2\pi$
electron ID for $p_T>1.5$ GeV/c
high p_T electron online trigger

Vertex Position Detector
MinBias trigger

Data Analysis Procedure

Inclusive electrons after electron ID

- **Non-photonic electrons** from D/B hadron decays
- **Photonic electrons** Partially reconstructed though e^+e^- pairs
  - γ conversion $\gamma \rightarrow e^+e^-$
  - π^0 Dalitz decay $\pi^0 \rightarrow \gamma e^+e^-$
  - η Dalitz decay $\eta \rightarrow \gamma e^+e^-$
- **Hadron contamination** Statistically subtracted

NPE yield after background correction:

$$N_{npe} = N_{inclusive} * purity - N_{photonic} / \varepsilon_{photonic}$$

- purity: purity of inclusive electron sample
- $\varepsilon_{photonic}$: photonic electron reco. efficiency

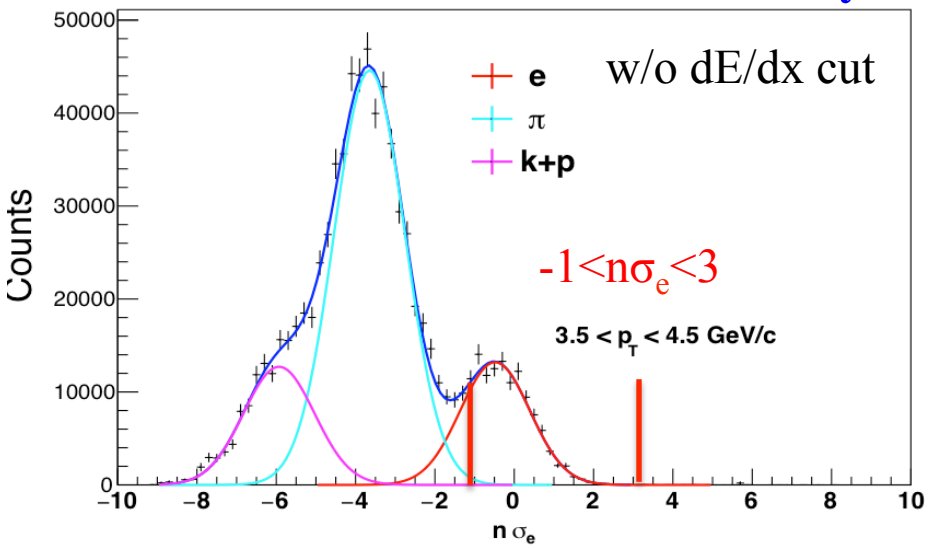
NPE invariant cross section:

$$E\frac{d^3\sigma}{dp^3} = \frac{1}{L}\frac{1}{2\pi p_T dp_T dy}\frac{N_{npe}}{\varepsilon_{Total}}$$

$$\varepsilon_{Total} = \begin{cases} \varepsilon_{dEdx}\varepsilon_{EMC}\varepsilon_{Trg}\varepsilon_{Trk} & p_T > 1.5 \text{ GeV/c} \\ \varepsilon_{dEdx}\varepsilon_{TOF}\varepsilon_{Trk} & p_T < 1.5 \text{ GeV/c} \end{cases}$$

Data Analysis Procedure

dE/dx Distribution Fit for Purity



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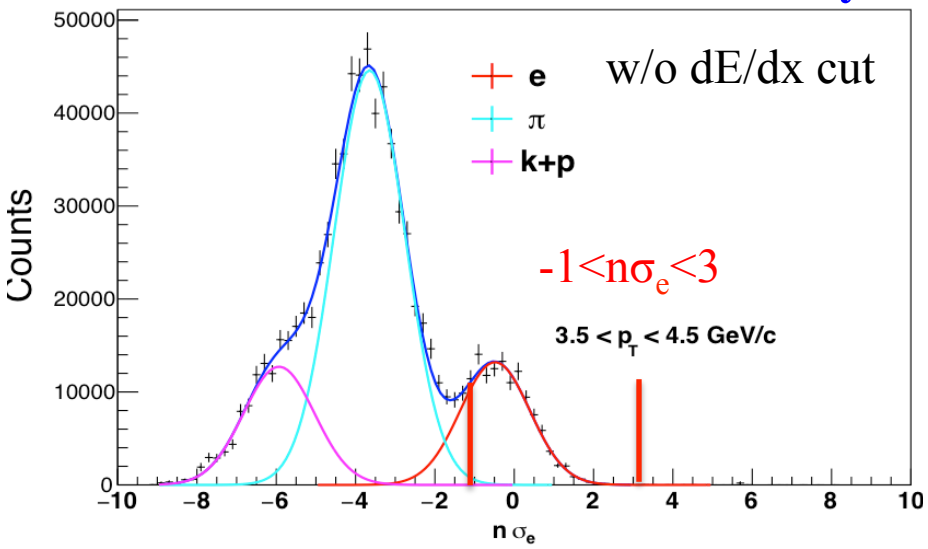
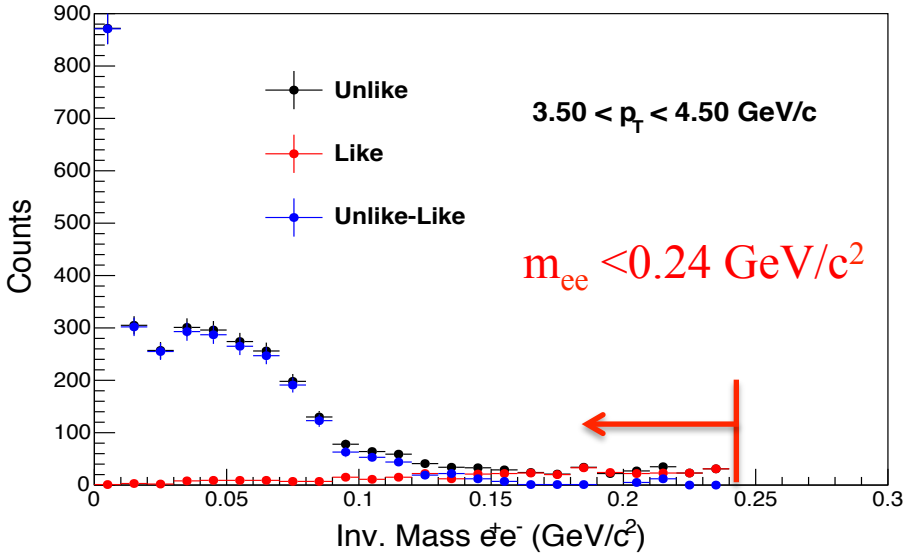


Photonic Electron Reconstruction



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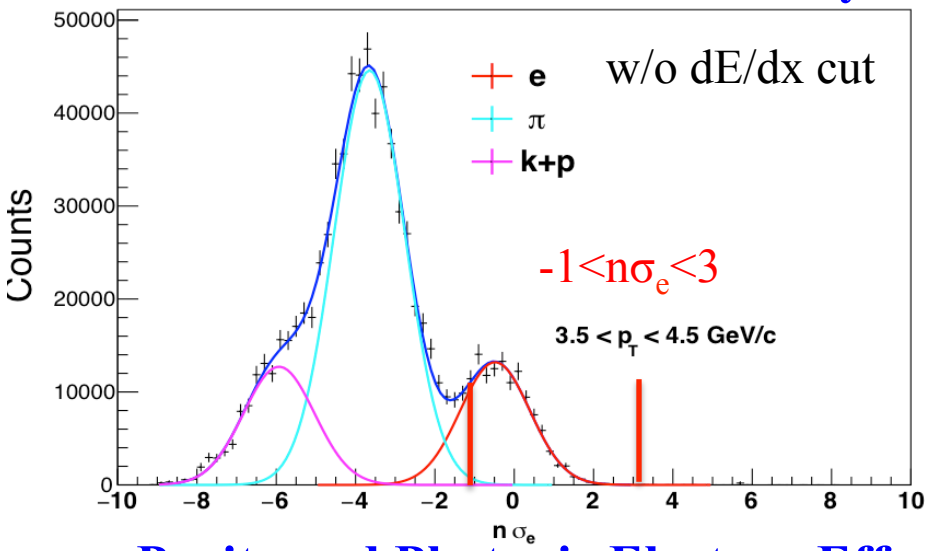

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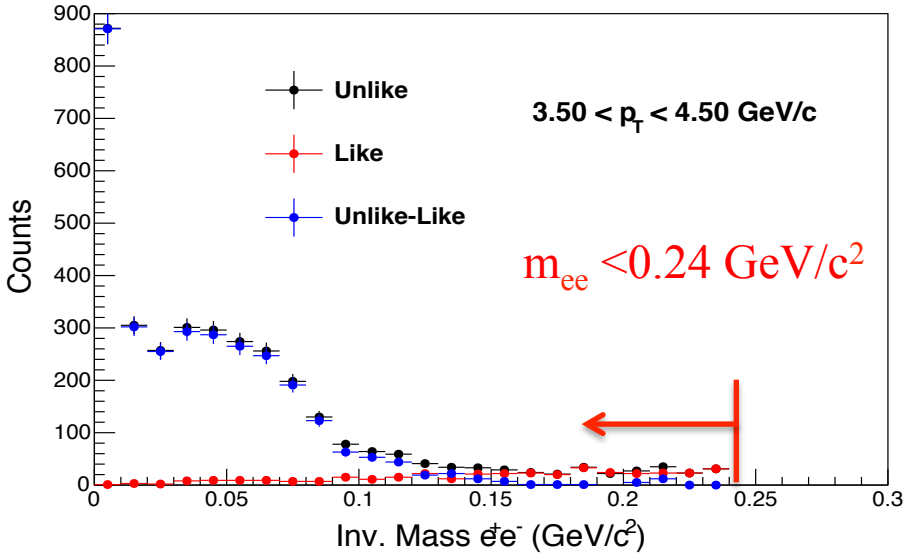
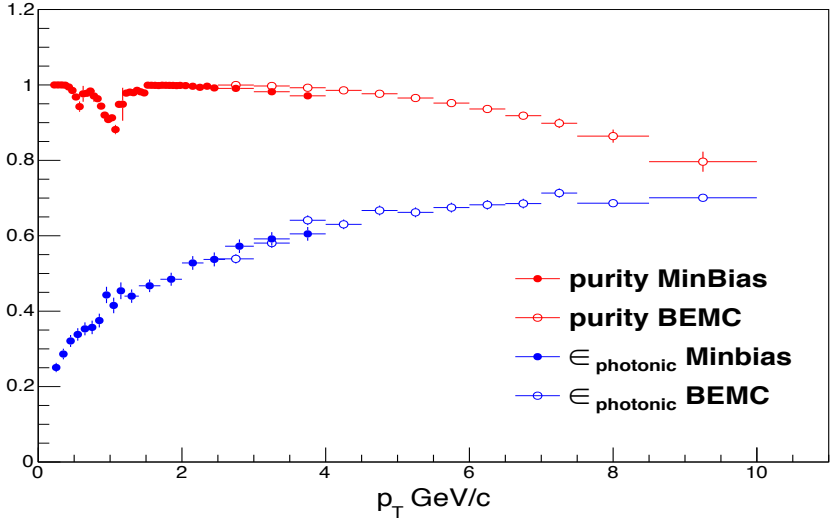


Purity and Photonic Electron Eff.



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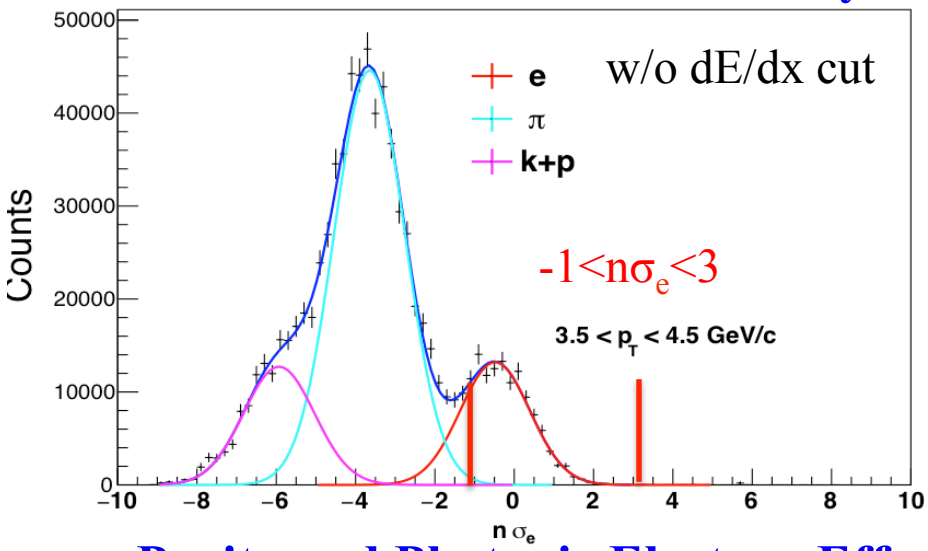

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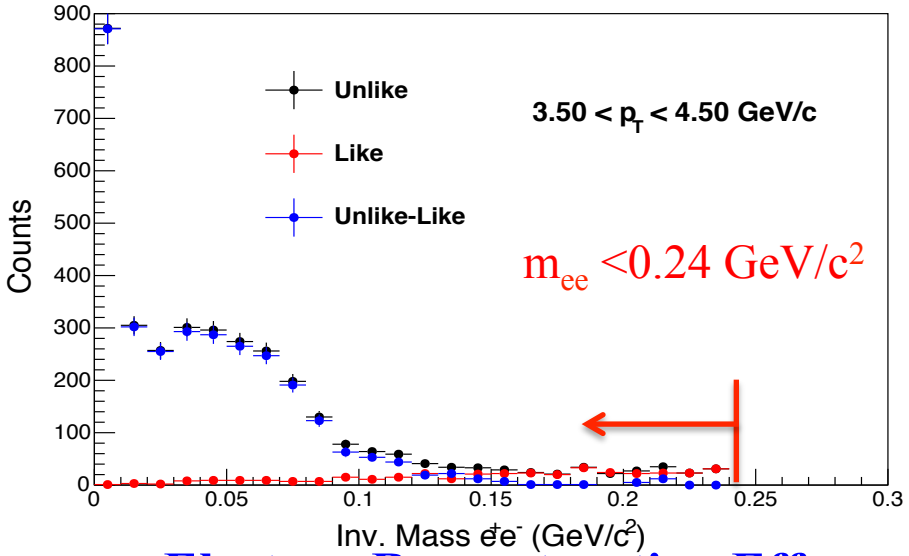

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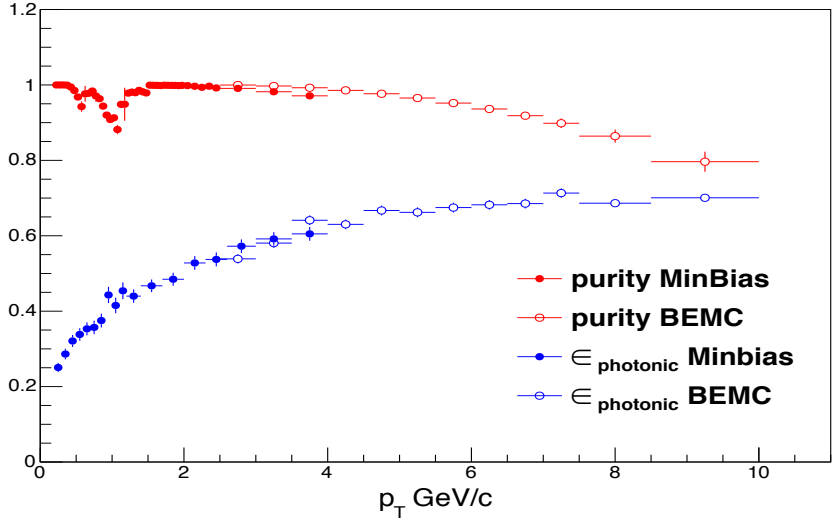
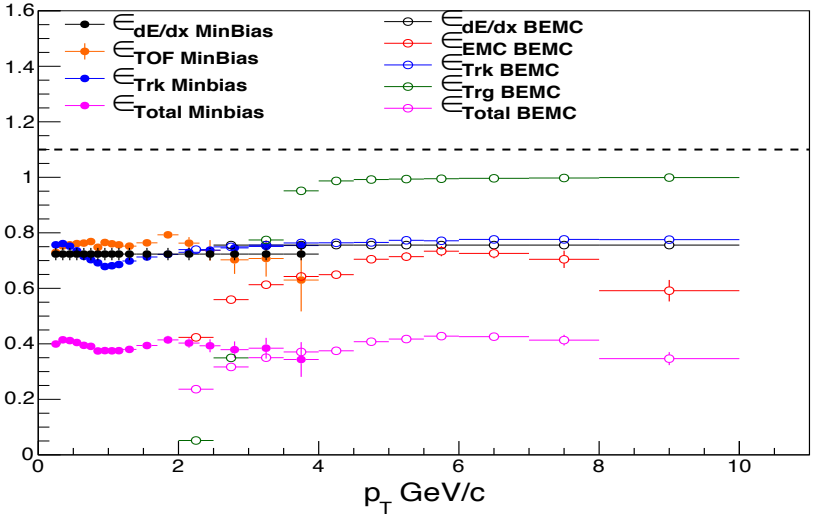
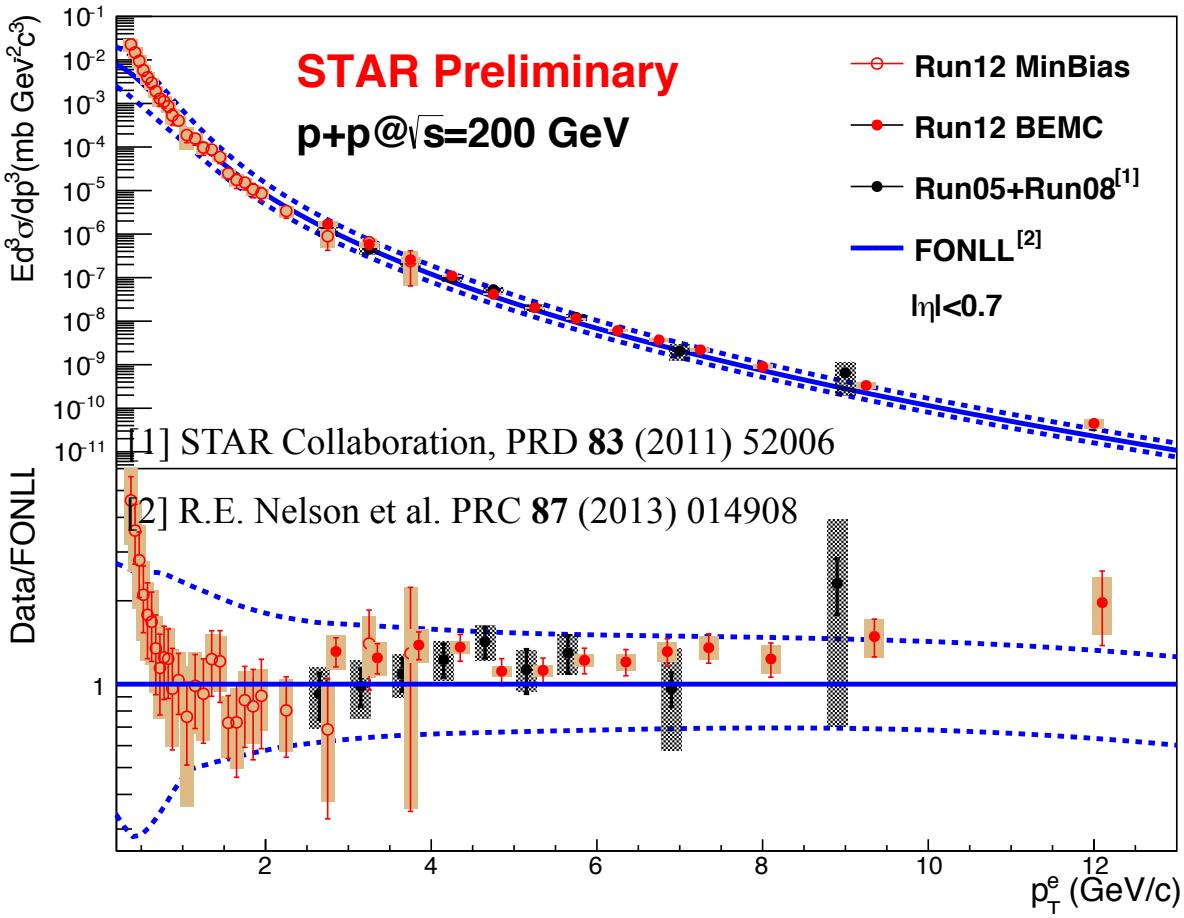


Electron Reconstruction Eff.



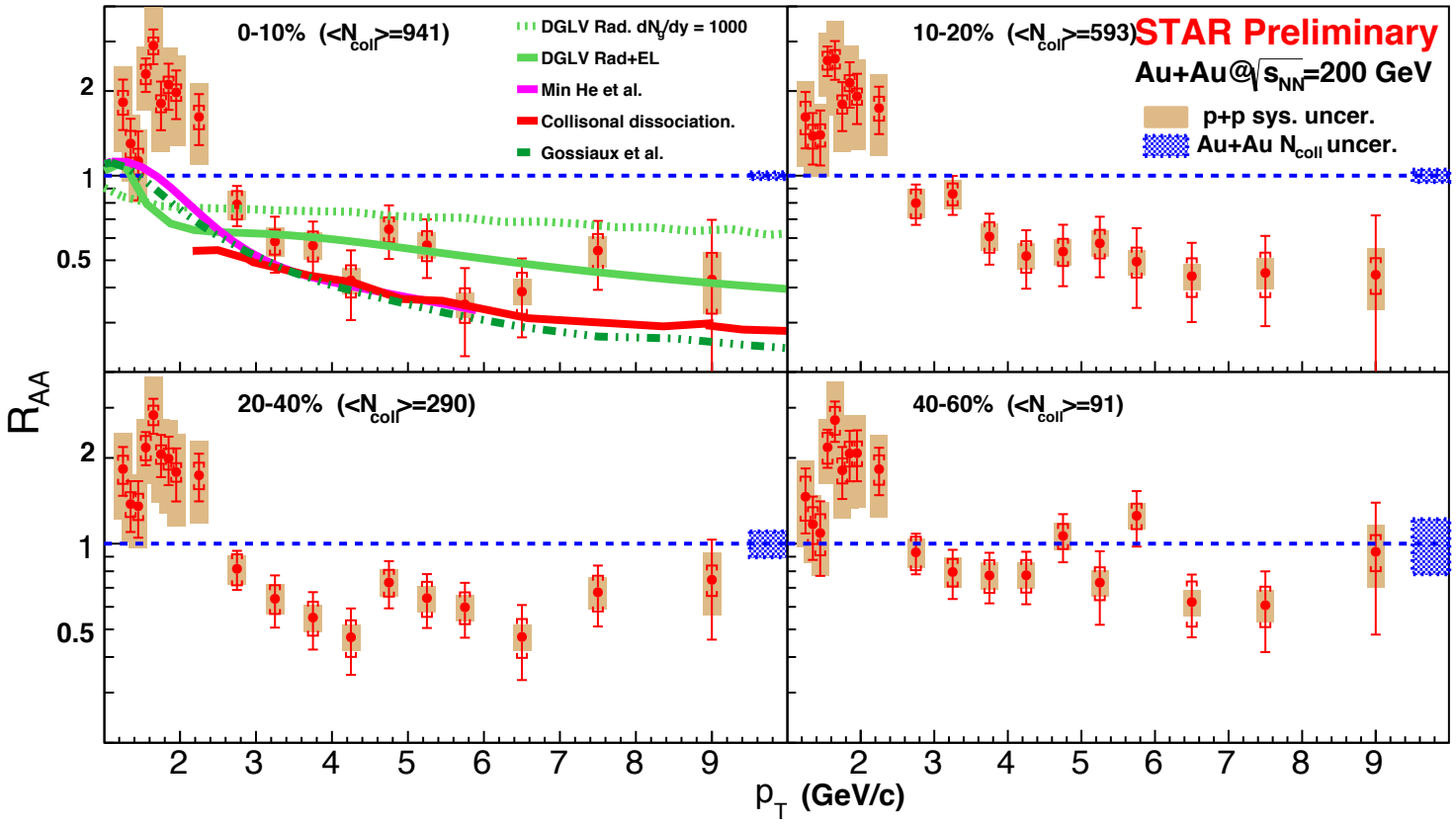
NPE in p+p@√s=200 GeV



Extend the p_T coverage to lower and higher values than previous STAR measurements with significantly better precision; Results confirm and constrain **FONLL** calculations!

Poster 0505 by X. Bai and 0567 by S. Zhang

R_{AA} in Au+Au@$\sqrt{s_{NN}}$=200 GeV

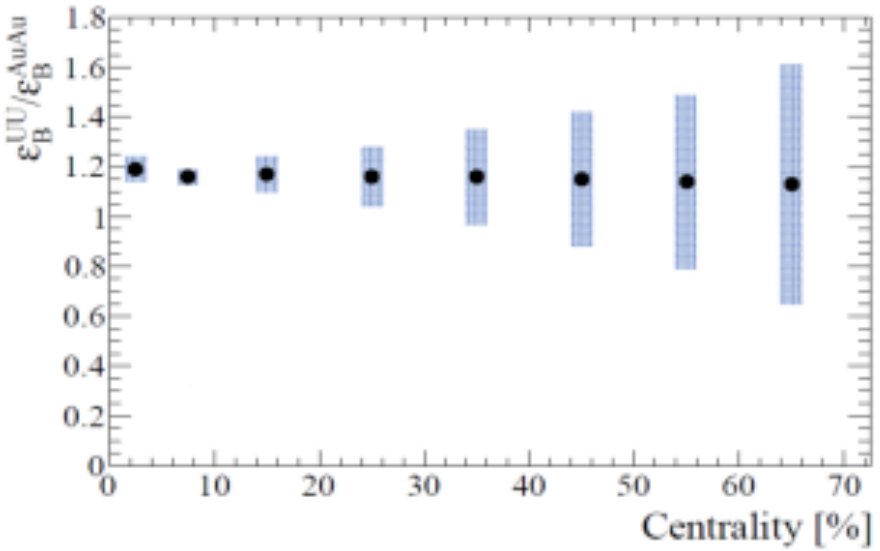


Significant suppression at p_T>4 GeV/c in the most central Au+Au collisions, and reduces gradually towards more peripheral collisions; Enhancement at low p_T across all centrality bins but with large systematic uncertainties.

Poster 0505 by X. Bai

R_{AA} in U+U@$\sqrt{s_{NN}}$=193 GeV

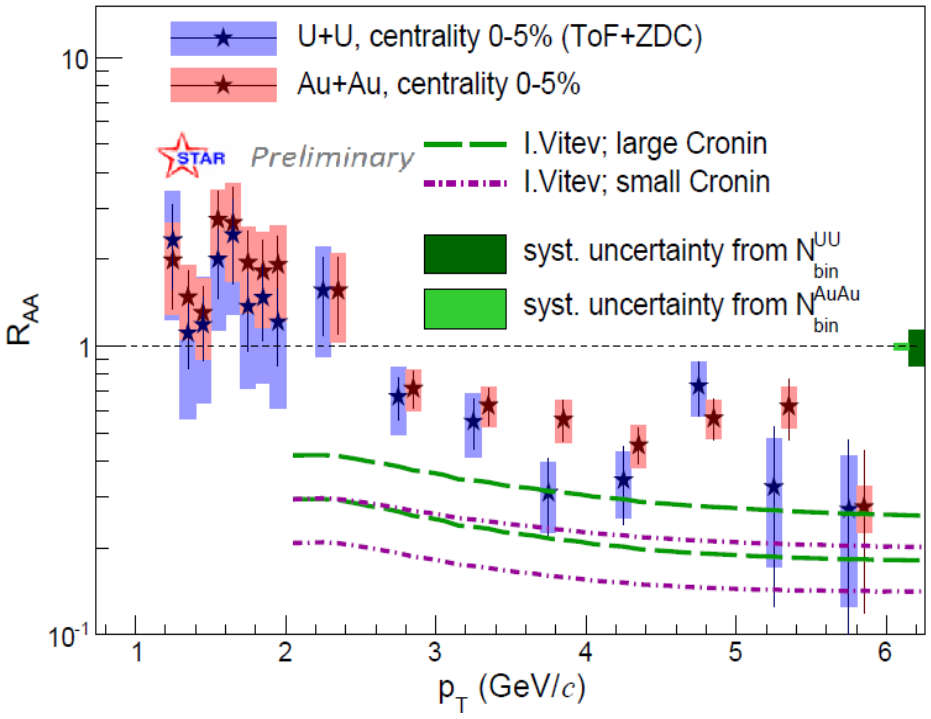
- Uranium nuclei have higher number of nucleons compared to gold nuclei.
- By colliding uranium nuclei it is possible to achieve up to 20% larger energy density than Au+Au collisions[1].

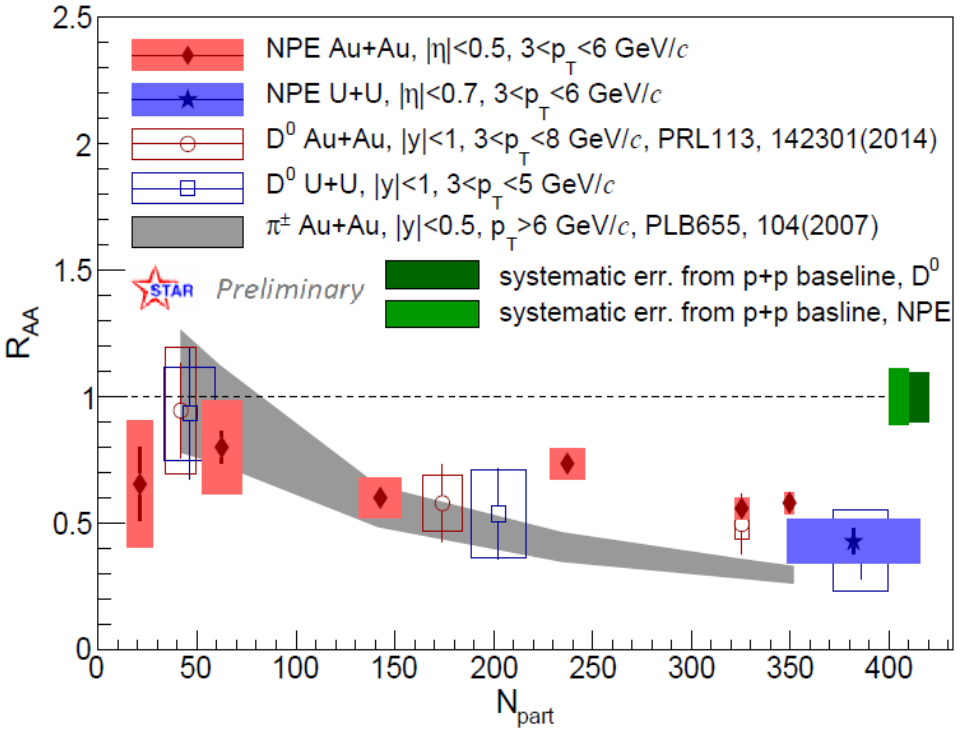


- Larger suppression of non-photonic electrons in uranium collisions is expected in comparison to gold nuclei at the same centrality class.

[1]D. Kikola, G. Odyniec, R. Vogt, Phys. Rev. C 84, 054907 (2011)

R_{AA} in U+U@$\sqrt{s_{NN}}$=193 GeV



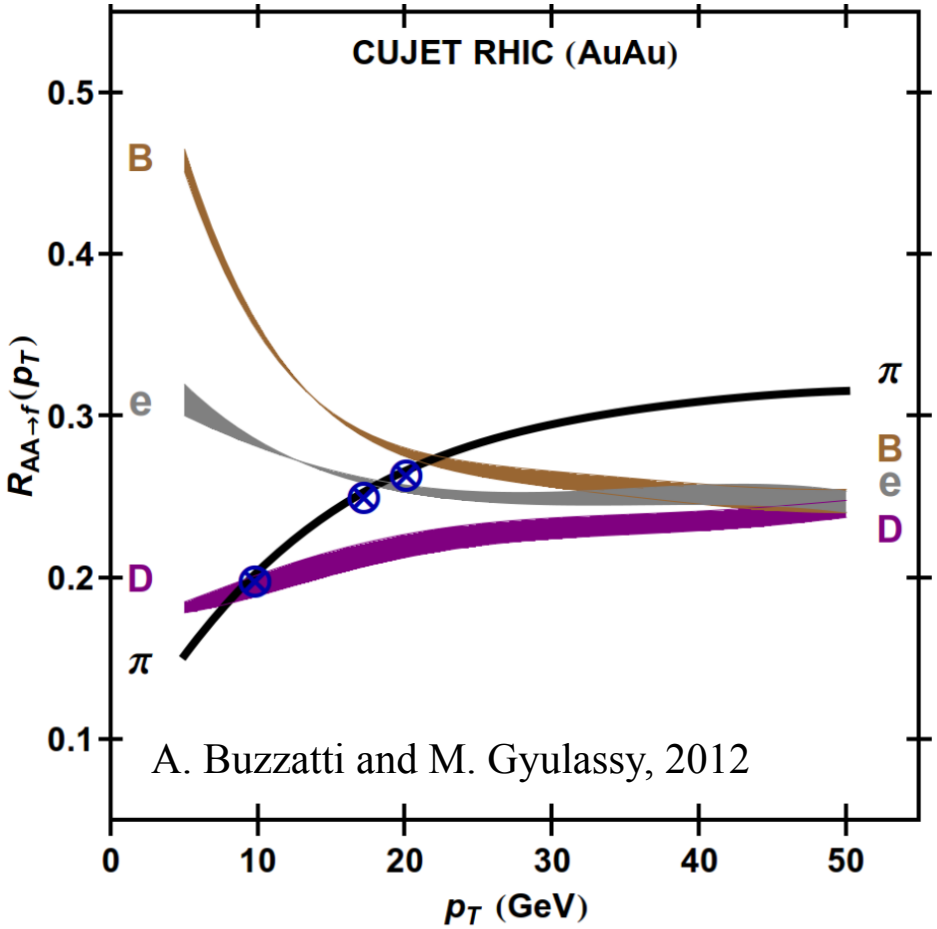


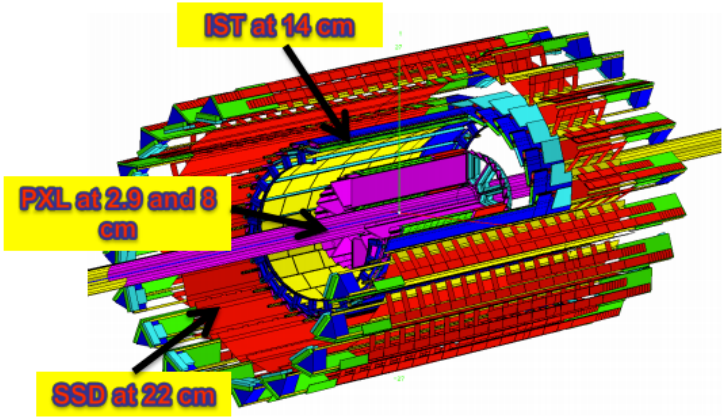
U+U and AuAu use the same improved p+p reference

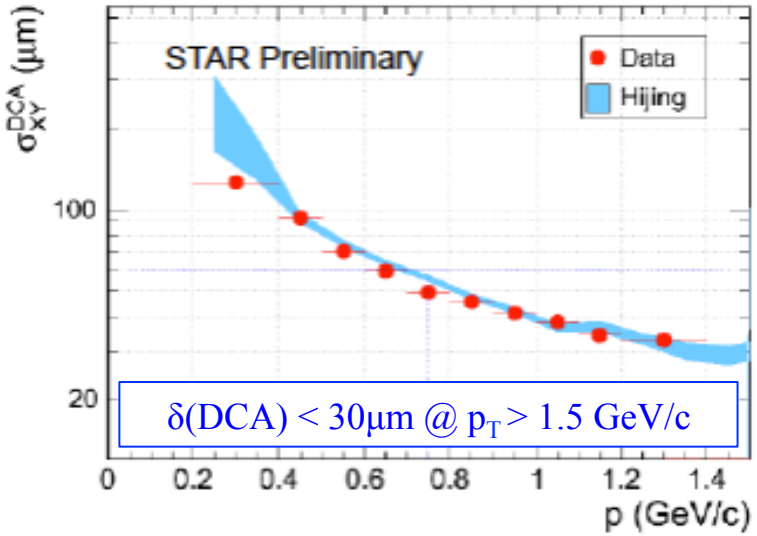
R_{AA} in the most central 0-5% U+U collisions systematically lower than that in 0-5% Au+Au collisions, but still consistent within uncertainties.

Poster 0517 by K. Gajdosova

Separate e_D and e_B with HFT

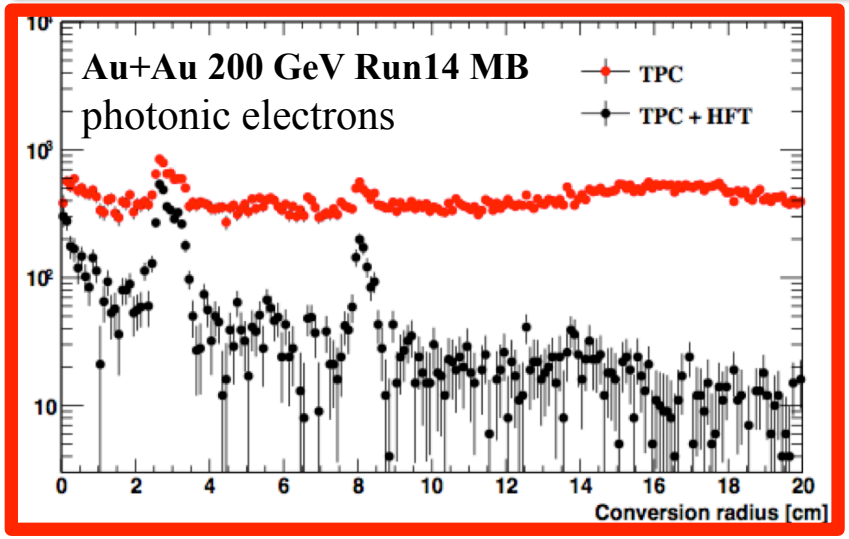


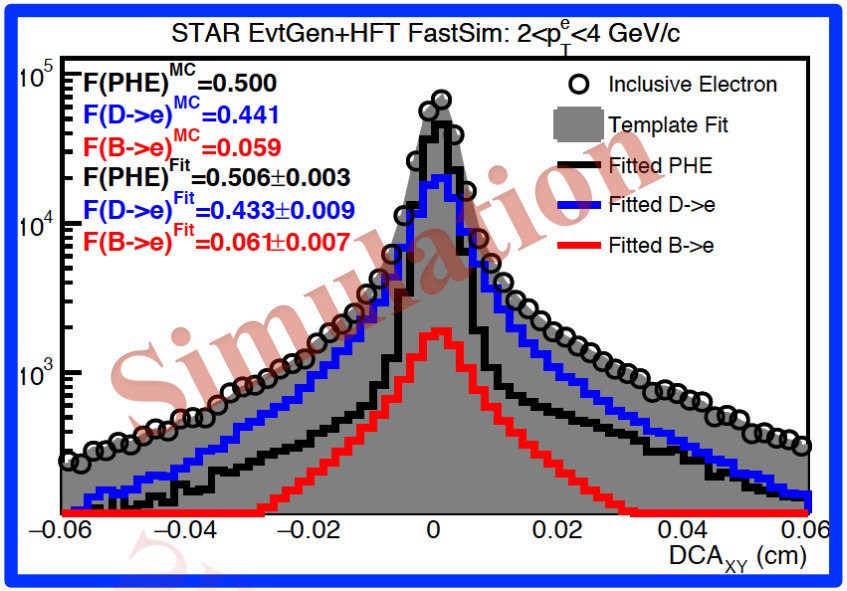




Precise measurements of charm and bottom quark production separately in heavy-ion collisions crucial for understanding parton energy loss mechanism. This becomes possible with the HFT.

Simulation of e_D and e_B with HFT





- Photon conversion background can be significantly suppressed by requiring hits in the the first HFT PXL layer.
- Simulation with HFT for electrons decayed from D and B hadrons:
  - DCA distributions for D and B decayed electrons, and photonic electrons (PHE) are obtained from fast simulation using real detector resolutions from data
  - Pseudo data generated and fitted to D/B/PHE MC templates, with stat. uncertainty at p_T=2-4 GeV/c:
    - δD/D~3%
    - δB/B~12%
- With full statistics of Run14+16 data, precise measurements are possible.

Poster 0542 by K. Oh

Summary and Outlook

- **Production cross section in 200 GeV p+p collisions**
  - measured as a function of p_T over a broad p_T range 0.3-12 GeV/c with significantly improved precision than previous measurements
  - confirm and constrain pQCD FONLL calculations
- **R_{AA} in 200 GeV Au+Au collisions**
  - strong suppression for p_T>4 GeV/c in central collisions, less towards more peripheral collisions.
  - Likely enhancement at low p_T in both central and peripheral collisions
- **R_{AA} in 193 GeV 0-5% central U+U collisions**
  - systematically lower than those in 0-5% central Au+Au collision but consistent within uncertainties.
- **Separate measurements for D and B decayed electrons**
  - become possible with the new HFT
  - analysis with Run14 Au+Au data in progress
  - precise results can be expected from STAR -> Stay tuned!