# Measurements of Open Heavy Flavor in STAR Experiment

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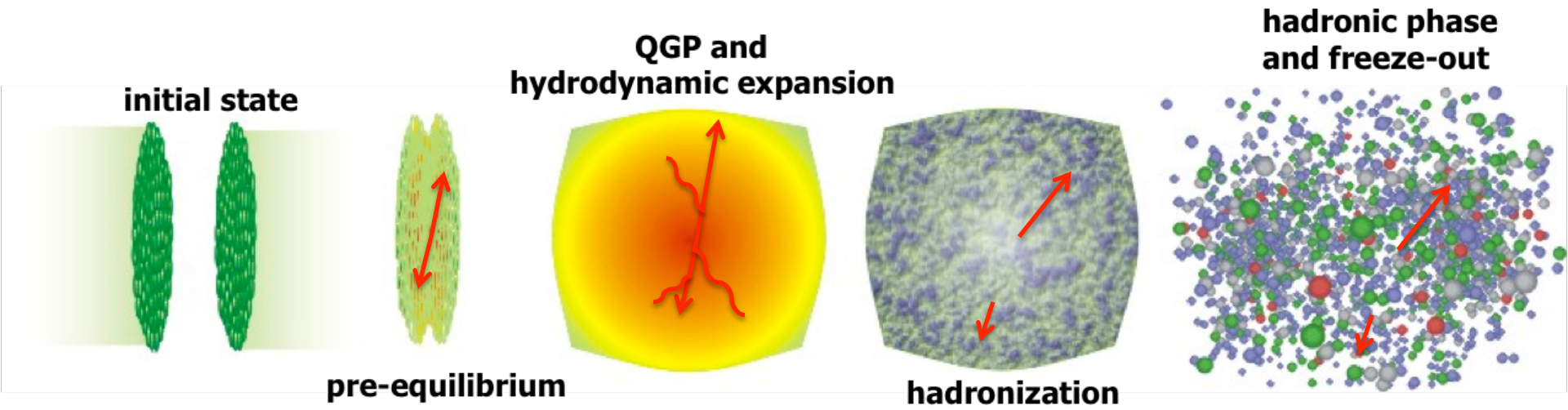
UIC UNIVERSITY OF ILLINOIS AT CHICAGO

# Why Heavy Flavor?

- HF quarks are produced primarily in initial hard scattering, and are exposed to the evolution of the hot nuclear matter created at RHIC.
- **Au+Au, Cu+Cu, U+U, …**
  - How does a parton lose its energy in the QGP? $\Delta E_g > \Delta E_q > \Delta E_c > \Delta E_b$?
  - Using the HF as a probe to study properties of the QGP and their dependence on system size, energy, …



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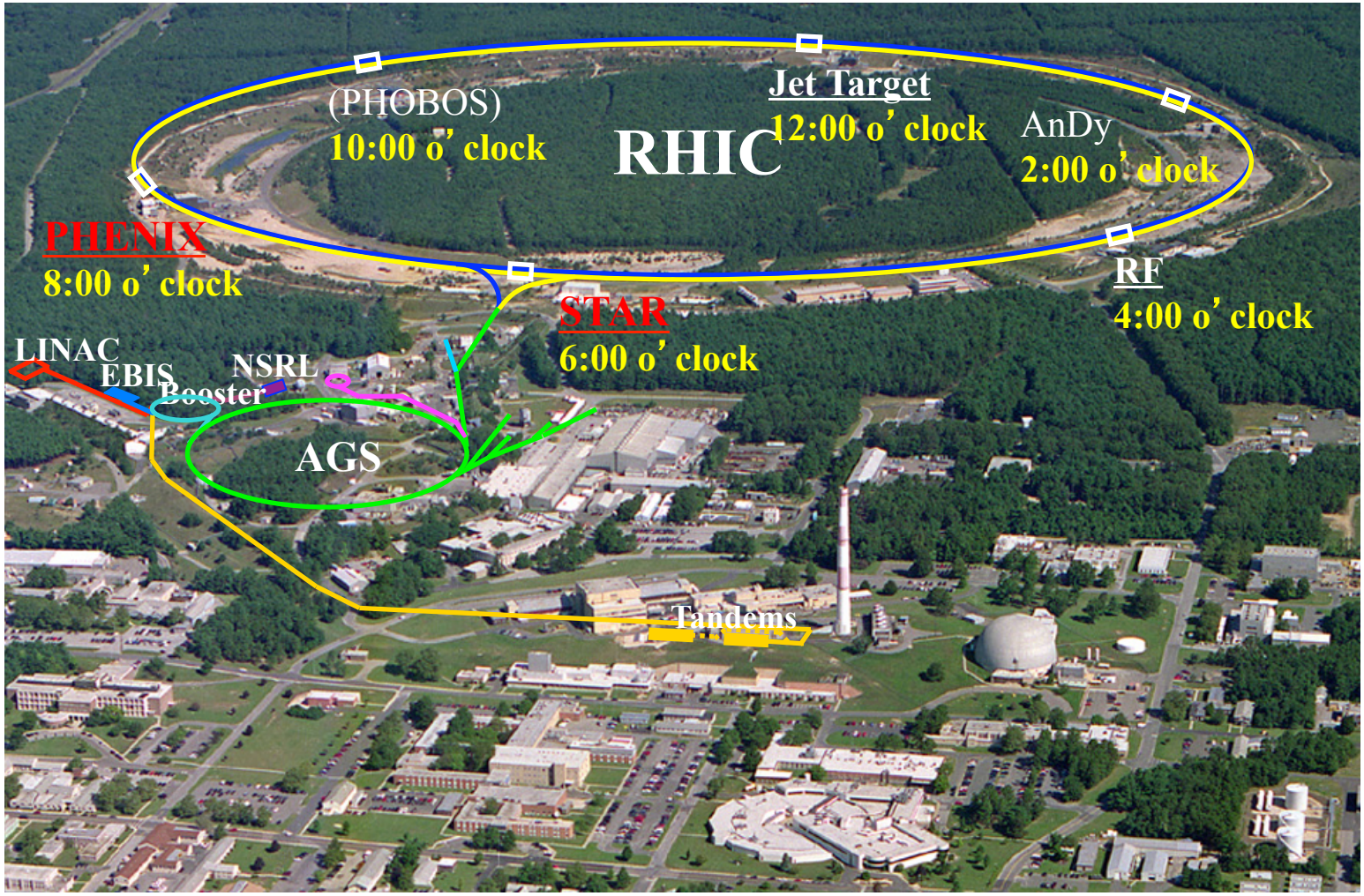
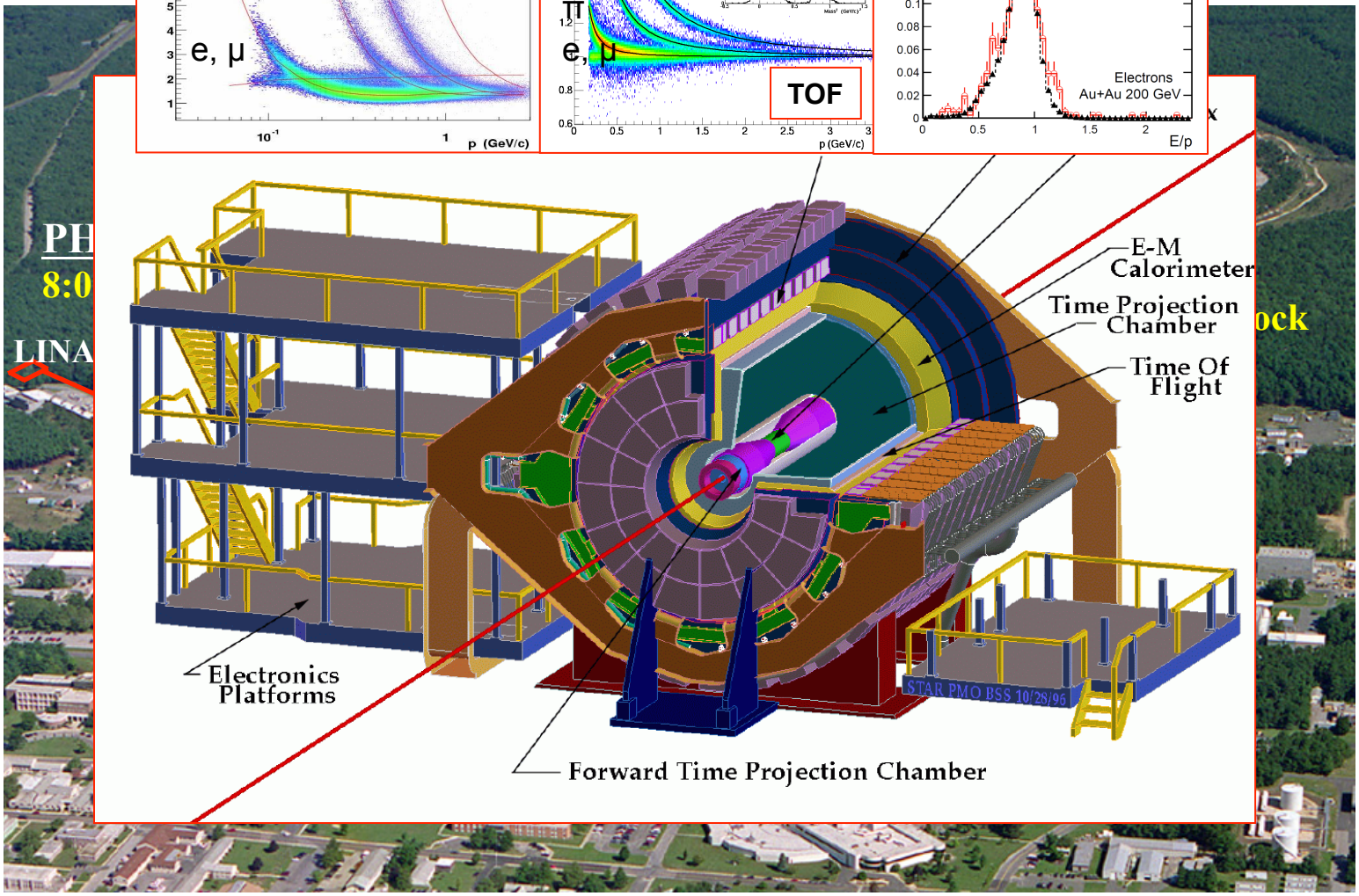
  - Using the HF as a probe to study properties of the QGP and their dependence on system size, energy, …
- **p+p**
  - Test of pQCD and Reference for studies of the QGP
- **p+Au, d+Au**
  - Cold Nuclear Matter effects (shadowing, CGC, Cronin effect, …)

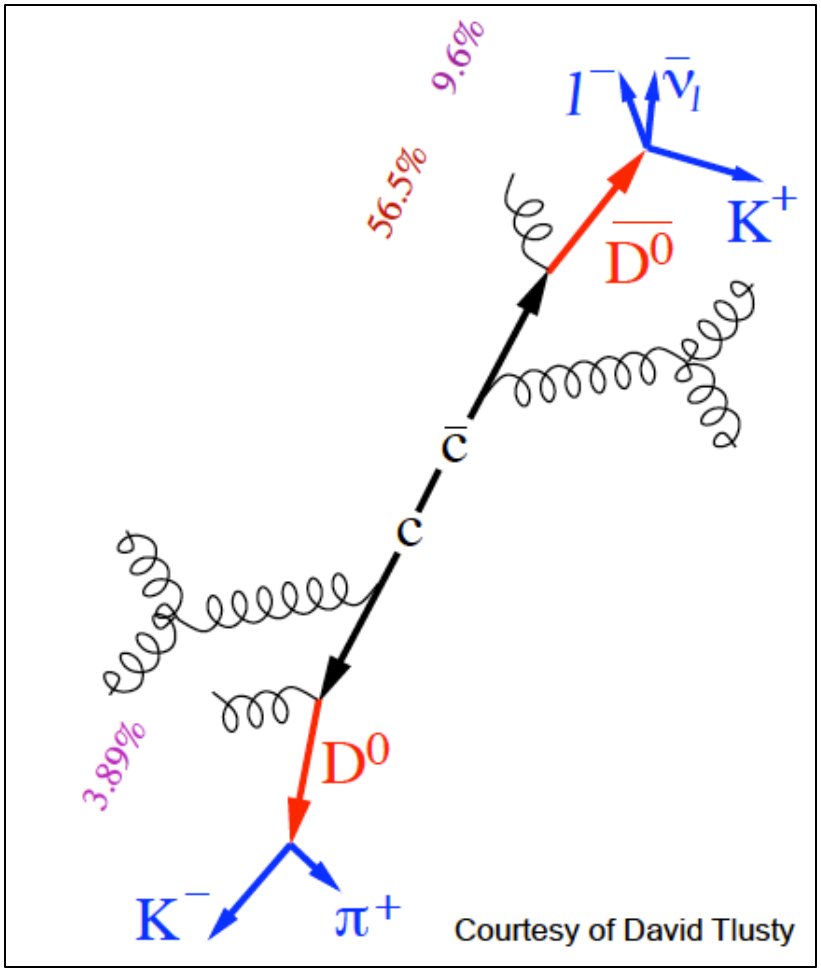
# Relativistic Heavy Ion Collider



# STAR Experiment



# Open Heavy Flavor Production



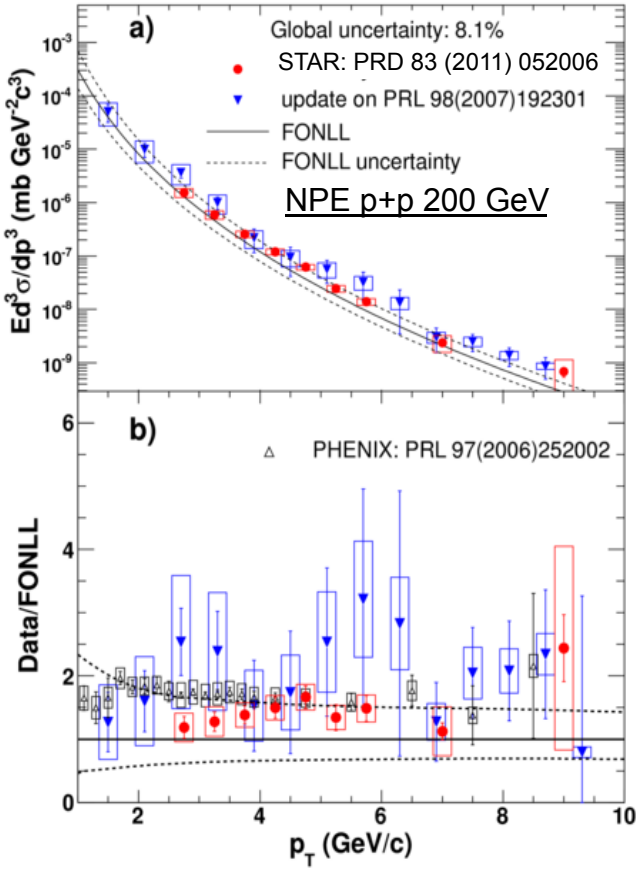

**Semi-leptonic channel:**

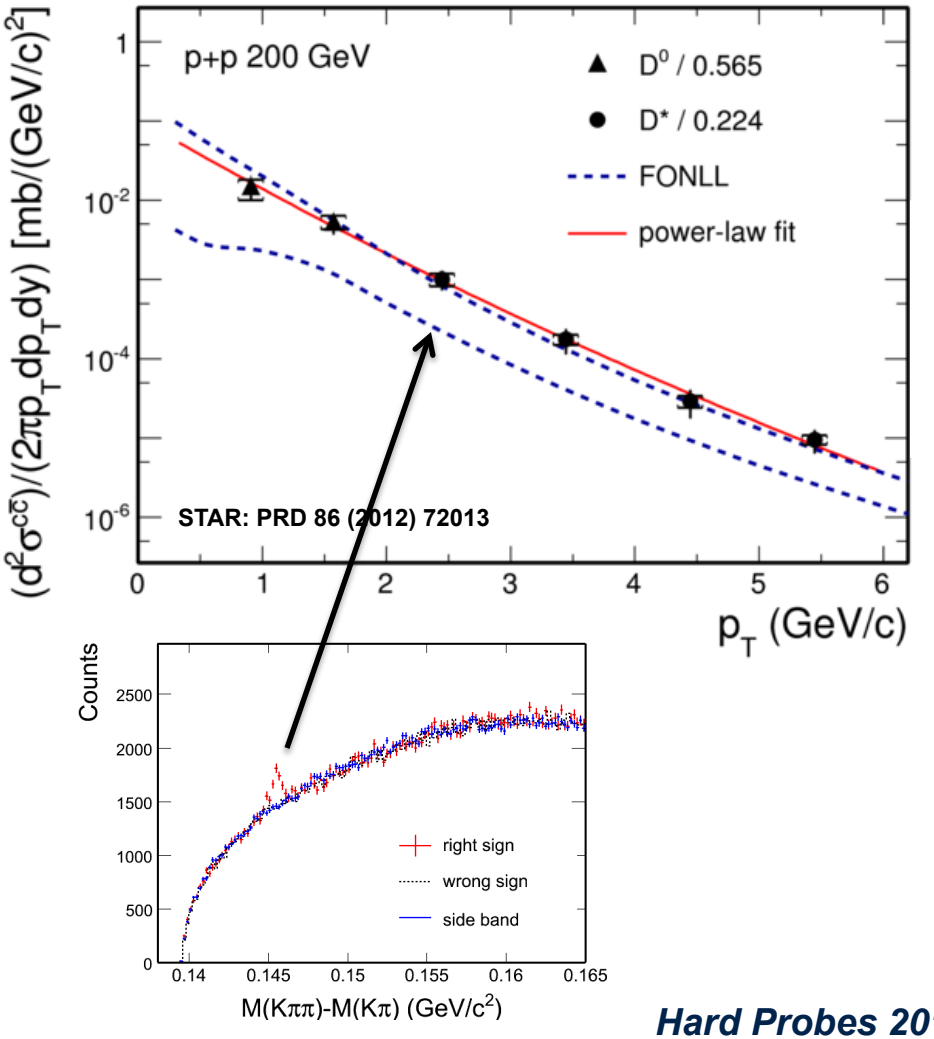
- Single e± with background subtraction estimated from MC+data
- Larger branching ratio; online trigger on high $p_T$ charged leptons
- No direct access to the kinematics of the original charm hadrons; Contribution from charm and bottom

**Hadronic channel**:

- Fully reconstructed open charm hadrons with background estimated from data
- Smaller branching ratio; no direct trigger online; large background contribution w/o good vertex measurement

# Open Charm Production – p+p –



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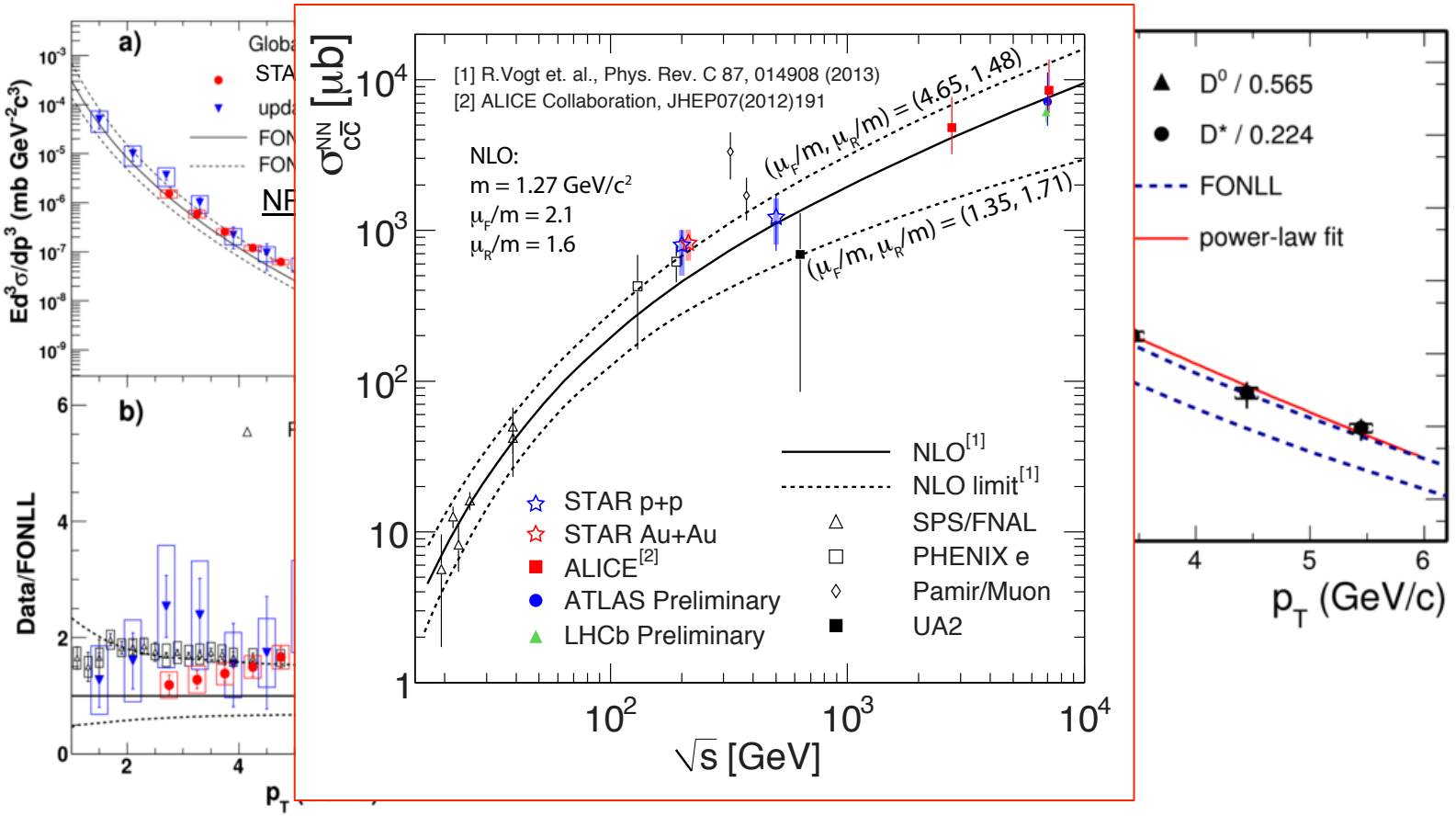
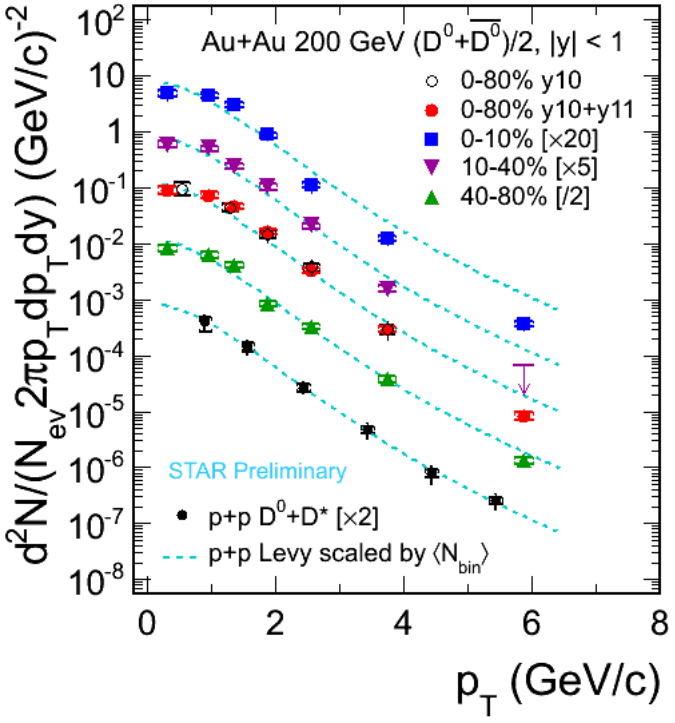
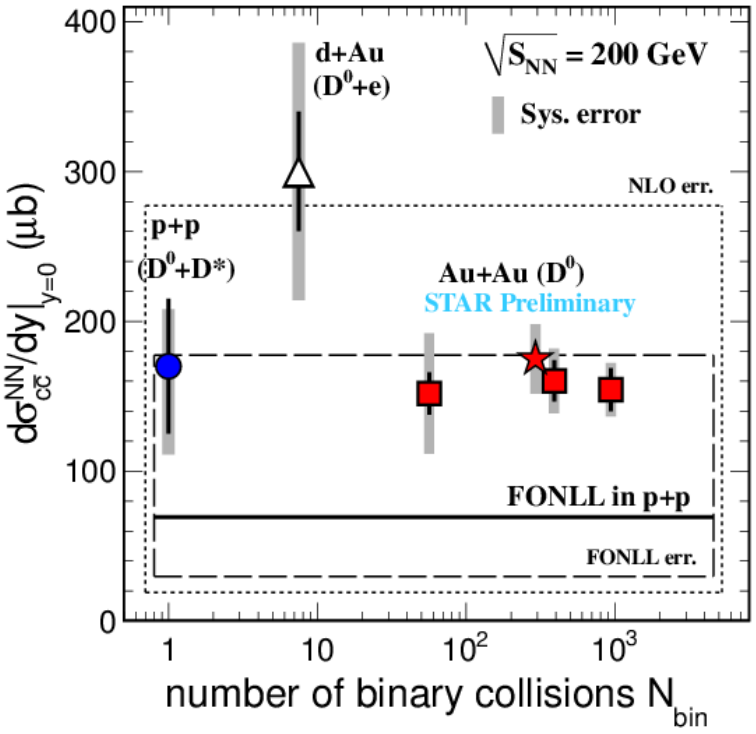
# Open Charm Production – p+p –




Measurements of total charm production cross-section can be described by NLO-NLL calculation within uncertainties.

# Open Charm Hadronic Channel – Au+Au –




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



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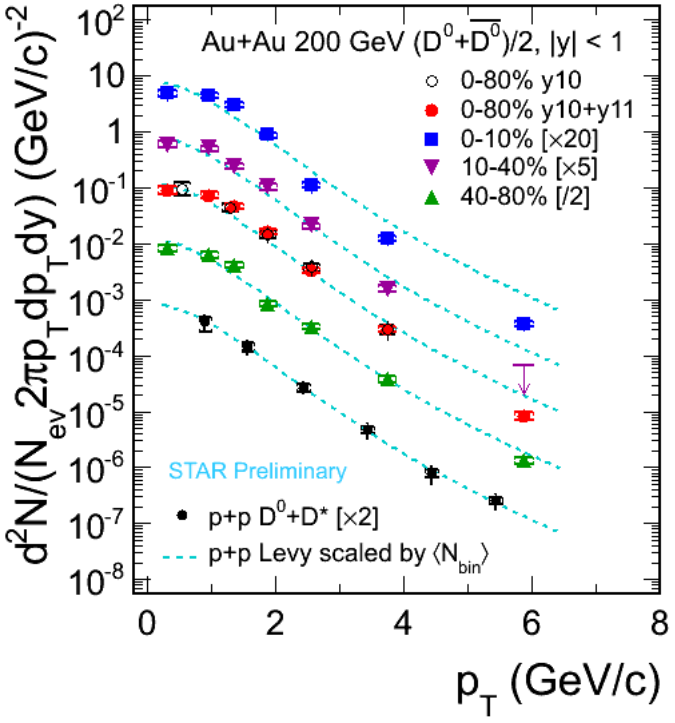


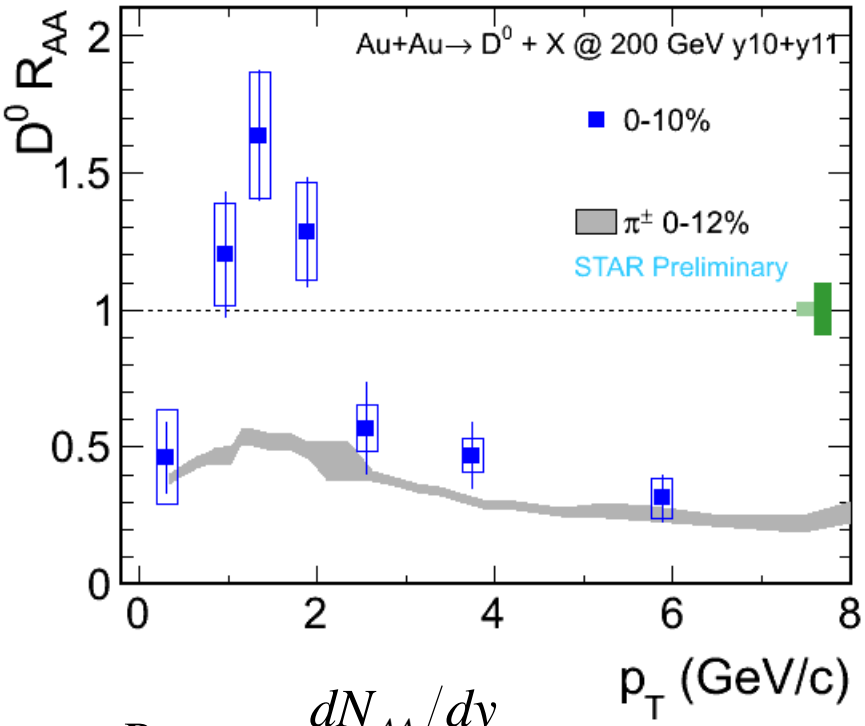


$$R_{AA} = \frac{dN_{AA}/dy}{N_{coll} \cdot dN_{pp}/dy}$$

Suppression at high $p_T$ in central collisions is similar to that of pions.



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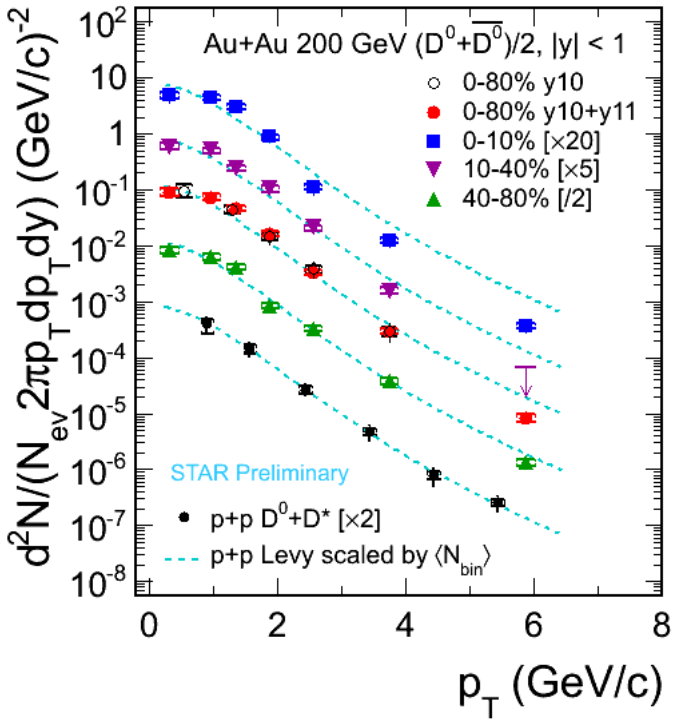
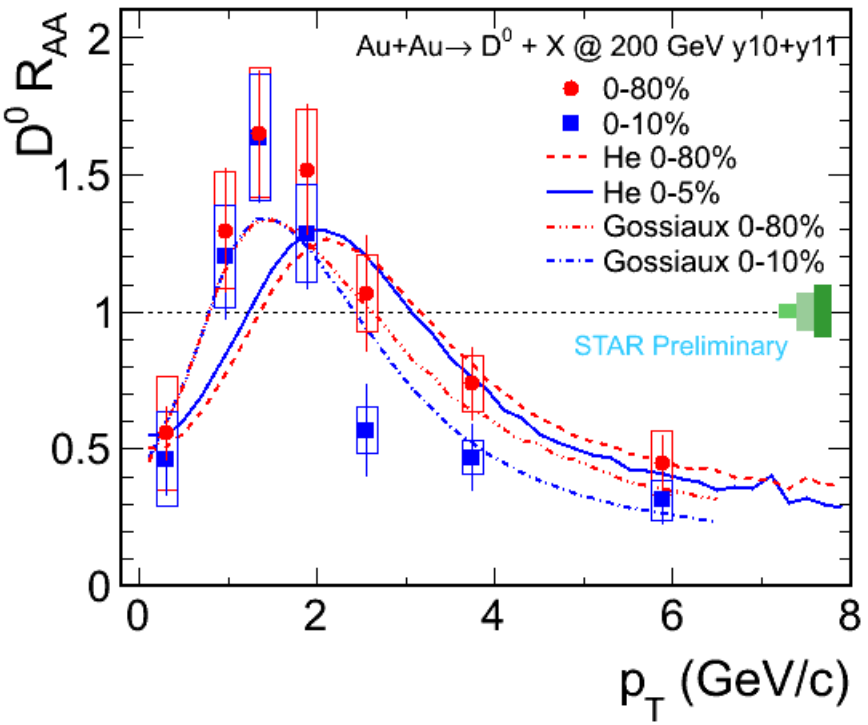
# Open Charm Hadronic Channel – Au+Au –




low $p_T$ enhancement described by models with light quarks coalescence with charm.



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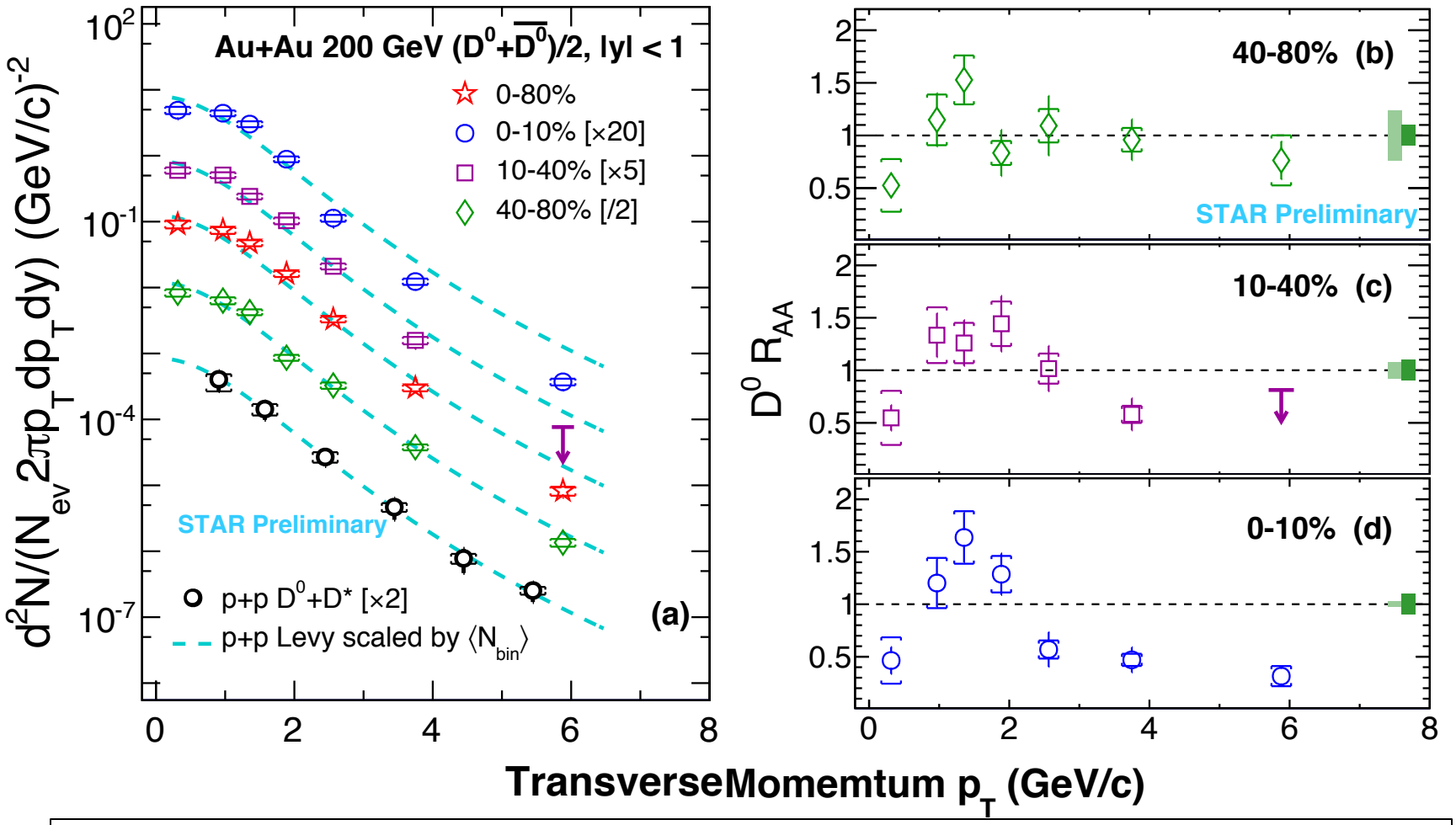
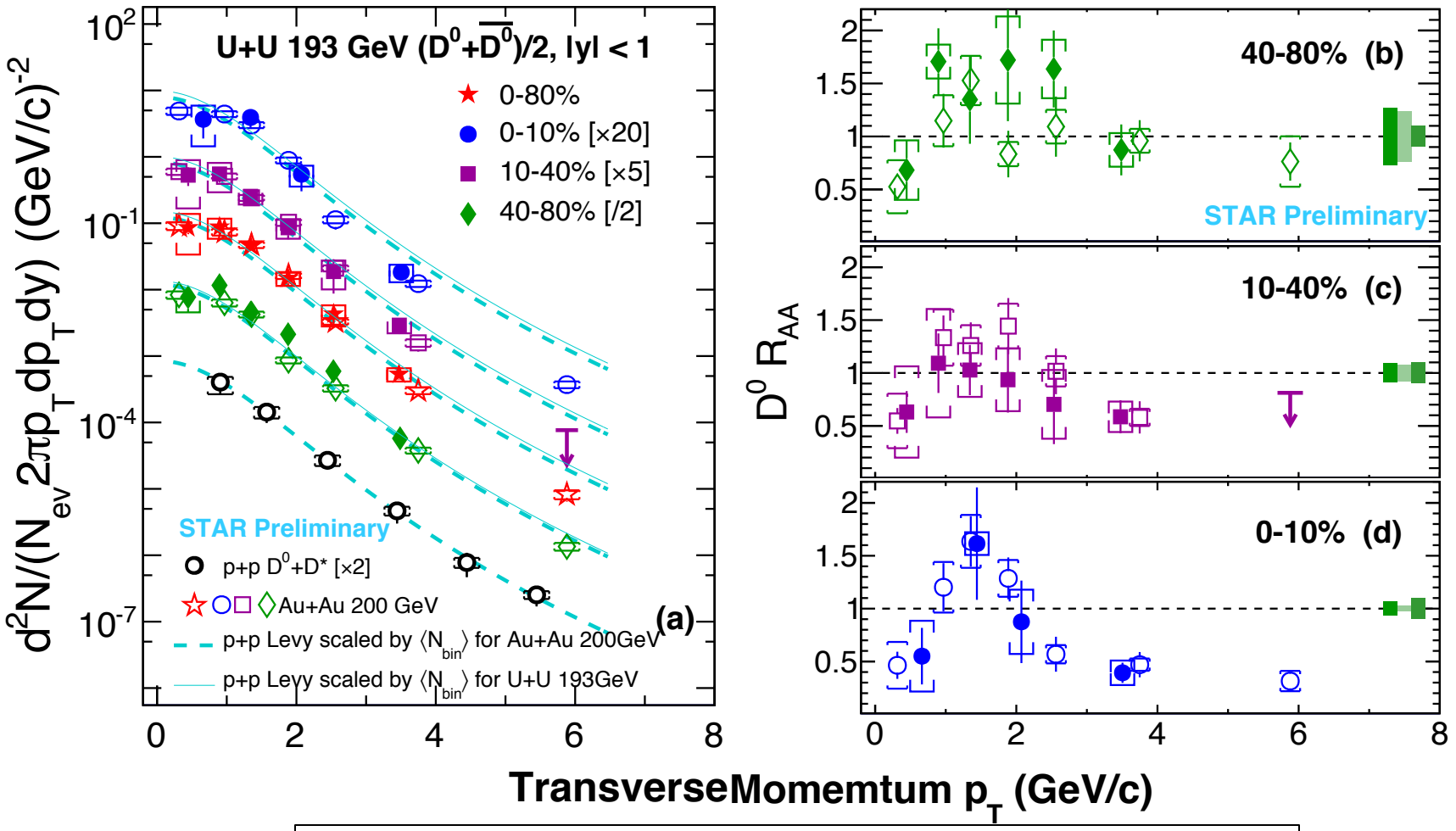
# Open Charm Hadronic Channel – Au+Au –




PRC 84, 054907: U+U collisions has 20% higher energy density than Au+Au

# Open Charm Hadronic Channel – U+U –




Similar behavior in U+U collisions as Au+Au collisions



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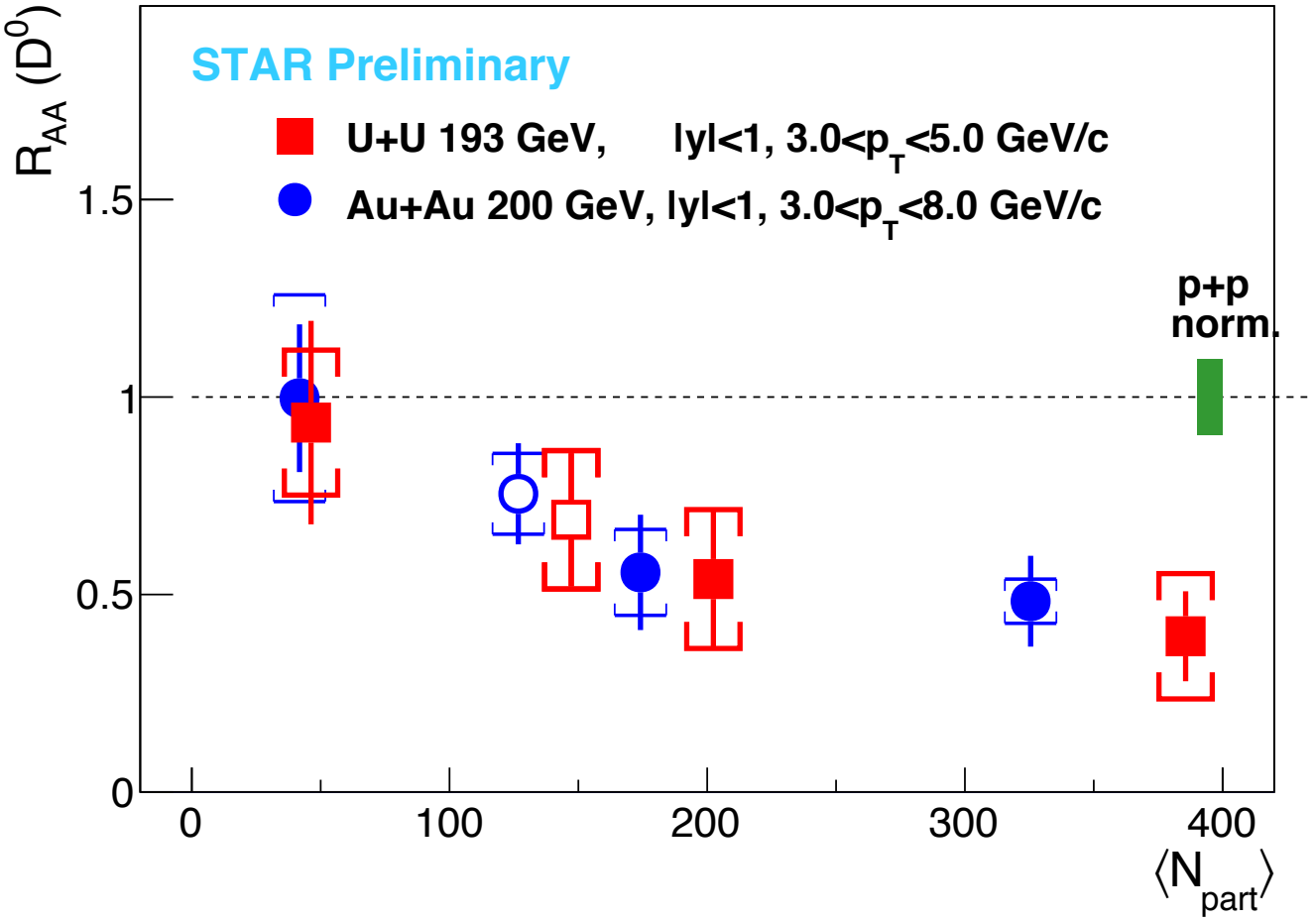
# Open Charm Hadronic Channel – Au+Au and U+U –



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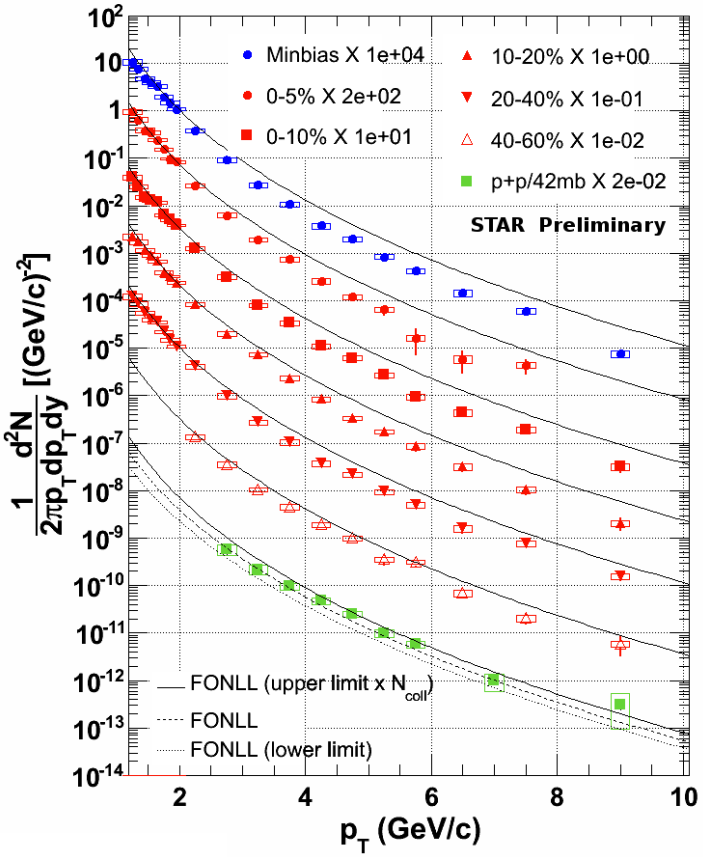
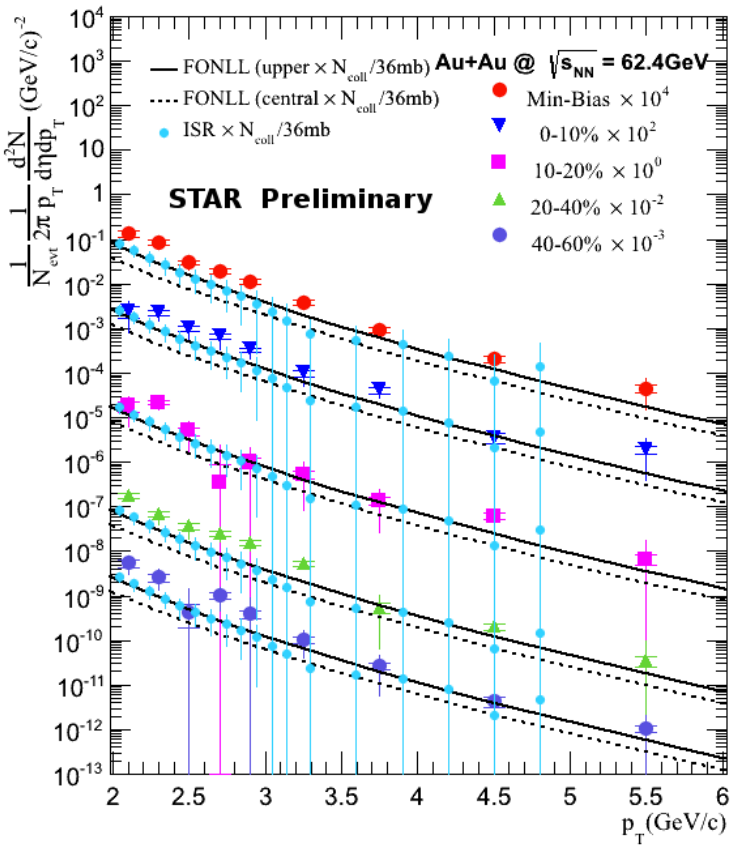
# Non-Photonic Electron – Au+Au –




Strong suppression of NPE at 200 GeV, but no suppression at 62 GeV (62 GeV not corrected yet for J/psi or Drell-Yan, can be ~20% at high $p_T$).



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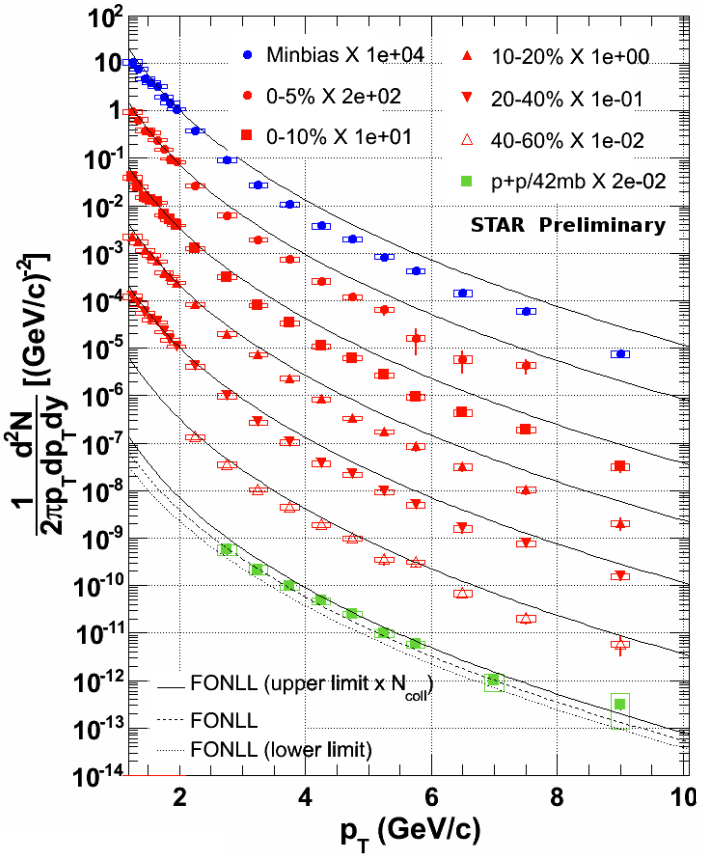


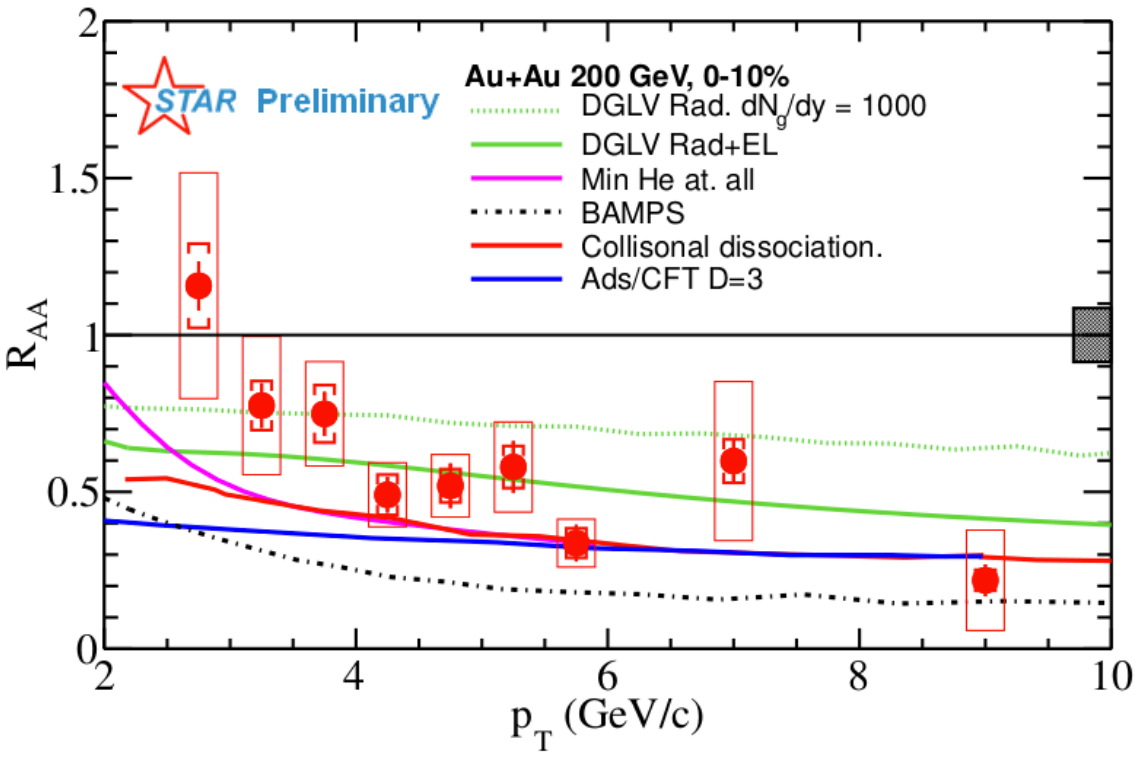


Data tends to disfavor model with radiative energy loss only.
Need better precision p+p measurements to further constrain models.



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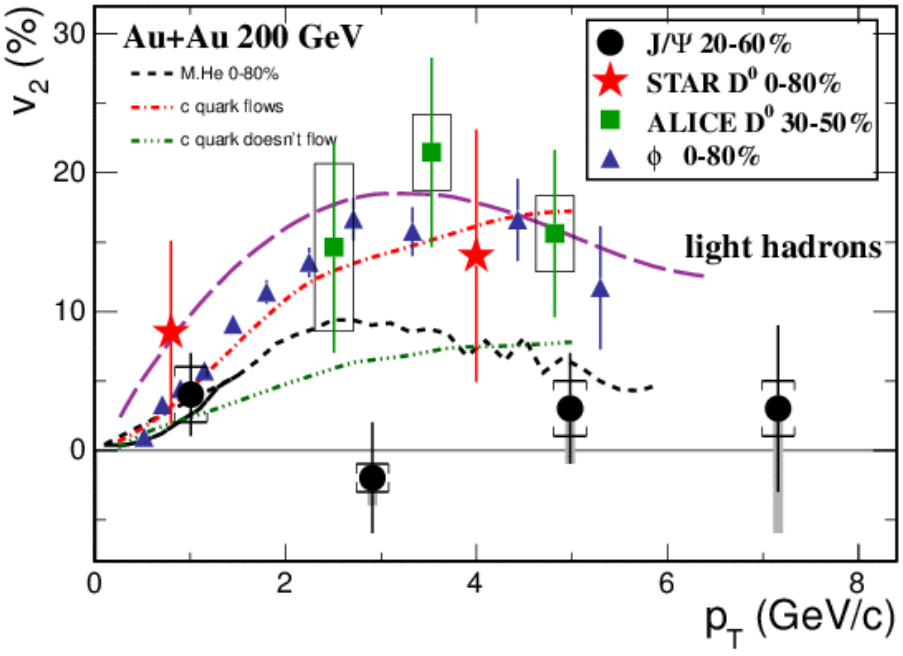
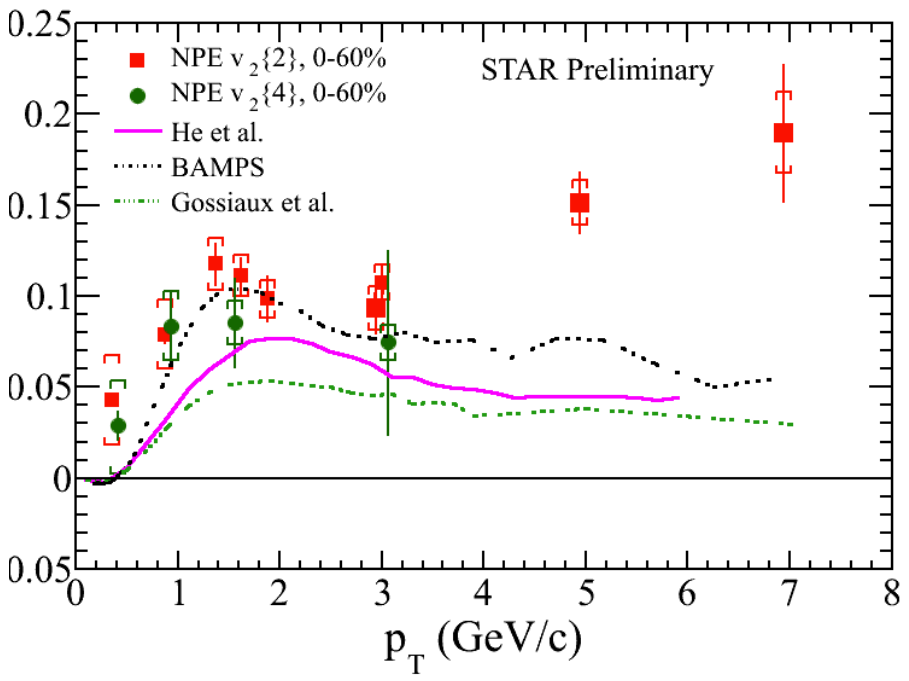
# Open Heavy Flavor Flow – Au+Au –




Significant non-zero NPE $v_2$ at low $p_T$:
is it from coalescence with light quark and/or charm quark flow?



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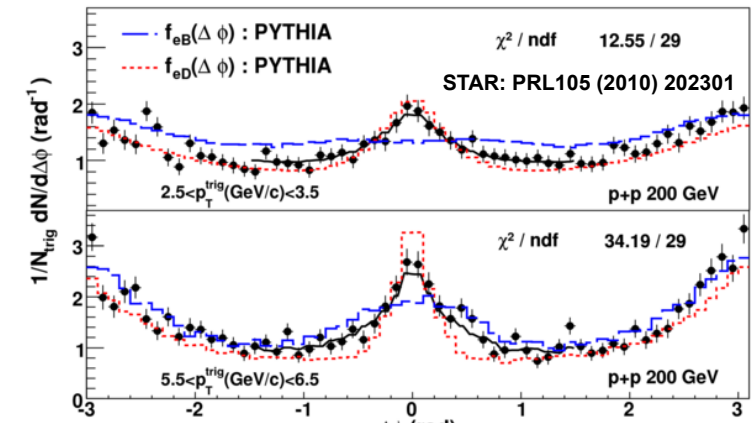
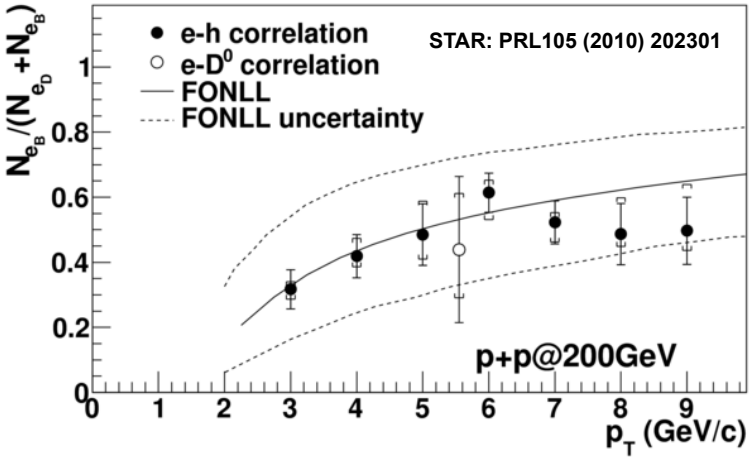
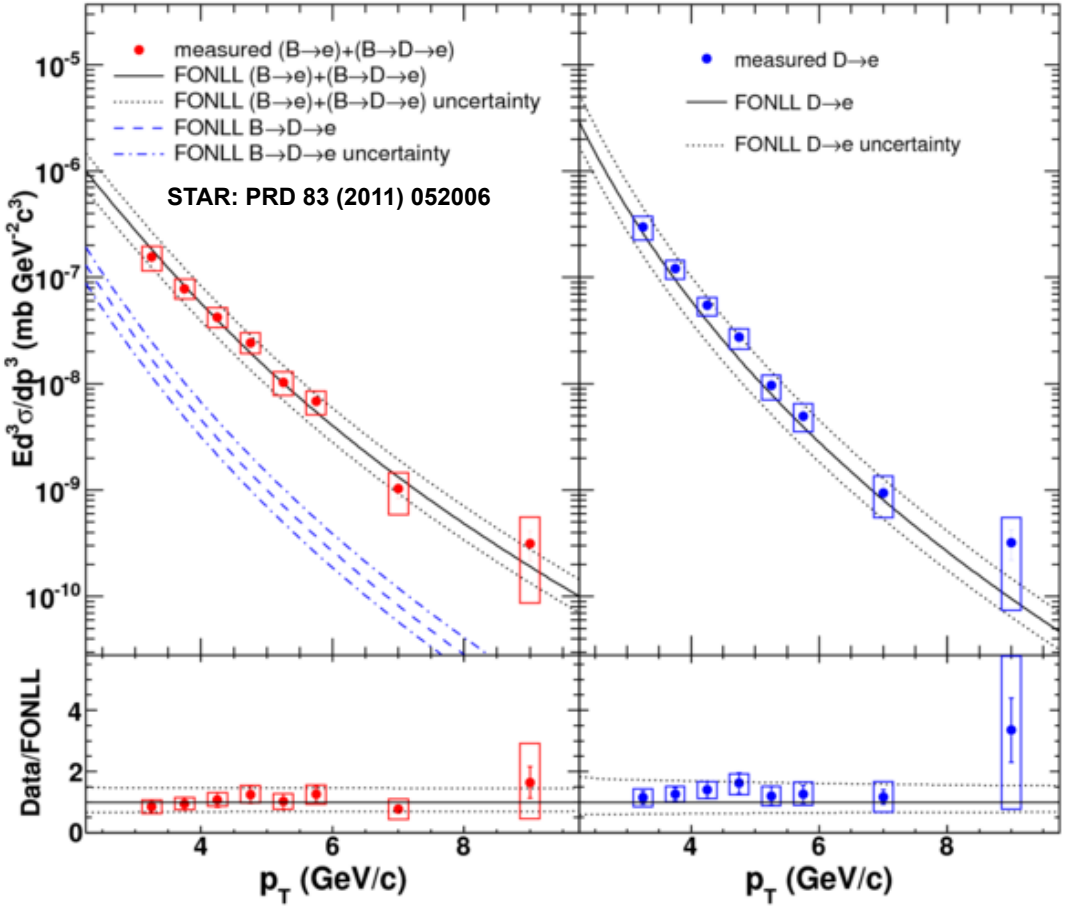
# Open Bottom Production – p+p –

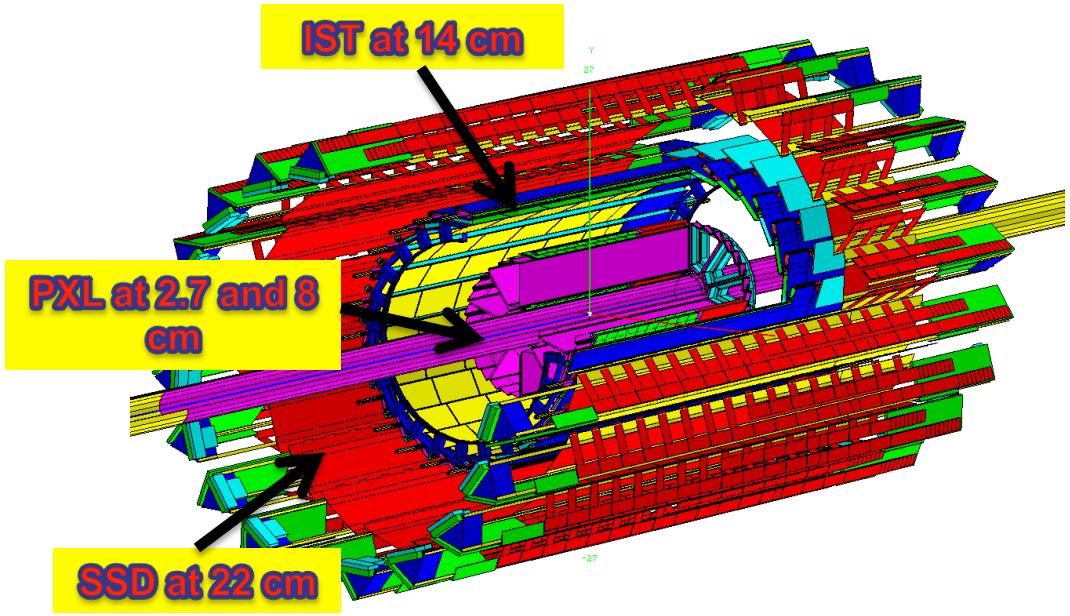


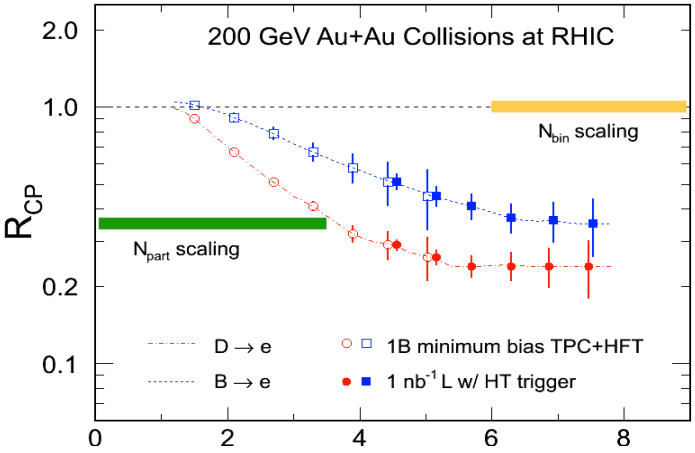

B->e and D->e extracted from e-h correlation and consistent with FONLL.

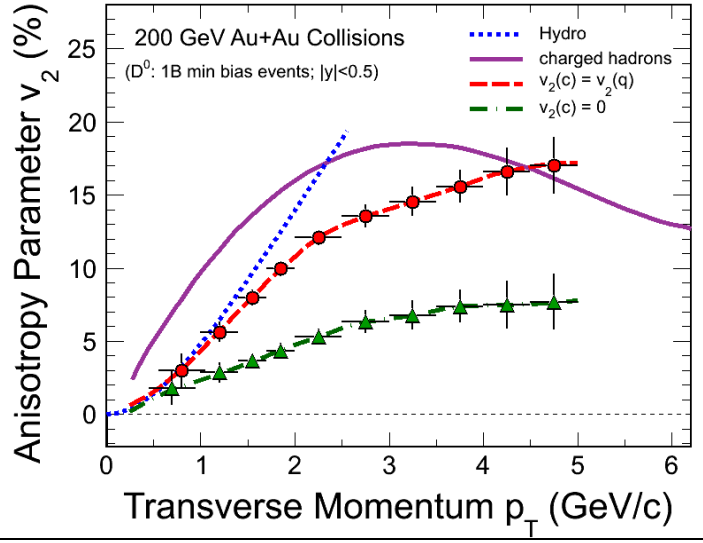
# Heavy Flavor Tracker for 2014




- 2 layers of thin silicon pixel (MAPS): 0.5%$X_0$/layer, 12x12μm resolution, 360M pixels

- 2 layers of silicon strip detectors: fast readout, bridging TPC and PXL




unique high precision at low $p_T$ -> medium thermalization, total charm production



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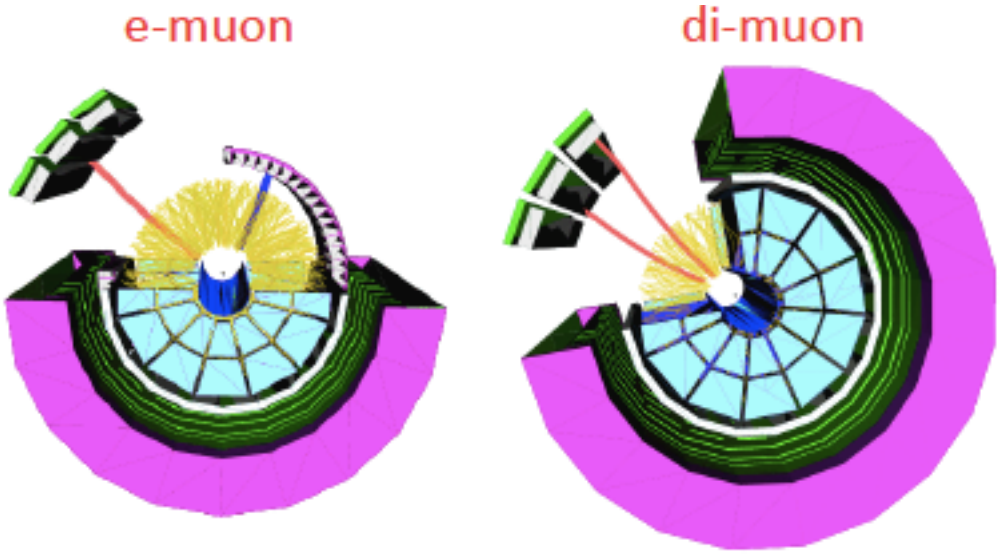
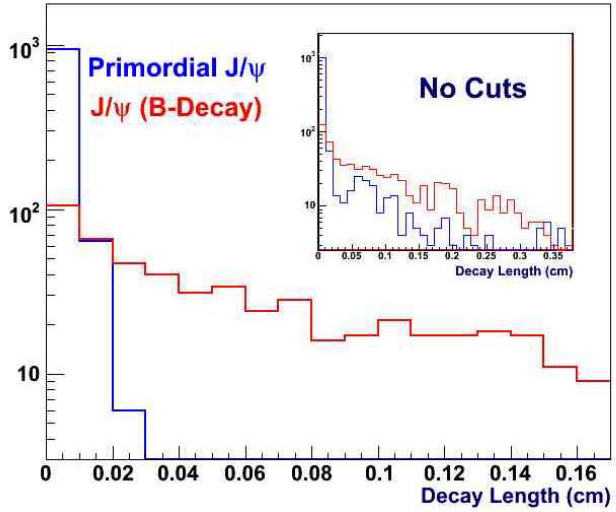
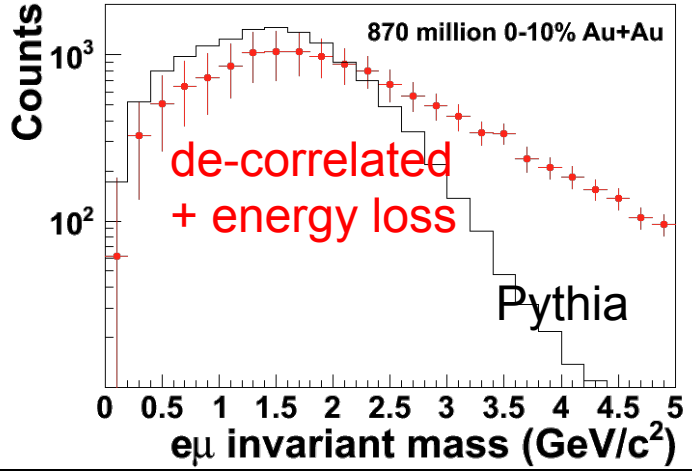
# Muon Telescope Detector for 2014




- Multi-gap Resistive Plate Chamber:
  - Gas detector, avalanche mode
- Electronics same as STAR-TOF
- Acceptance: 45% at $|\eta|<0.5$
  - Covers the magnet iron bars with gaps in-between uncovered




(together with HFT) displaced J/psi from B hadron decay; e-mu correlations



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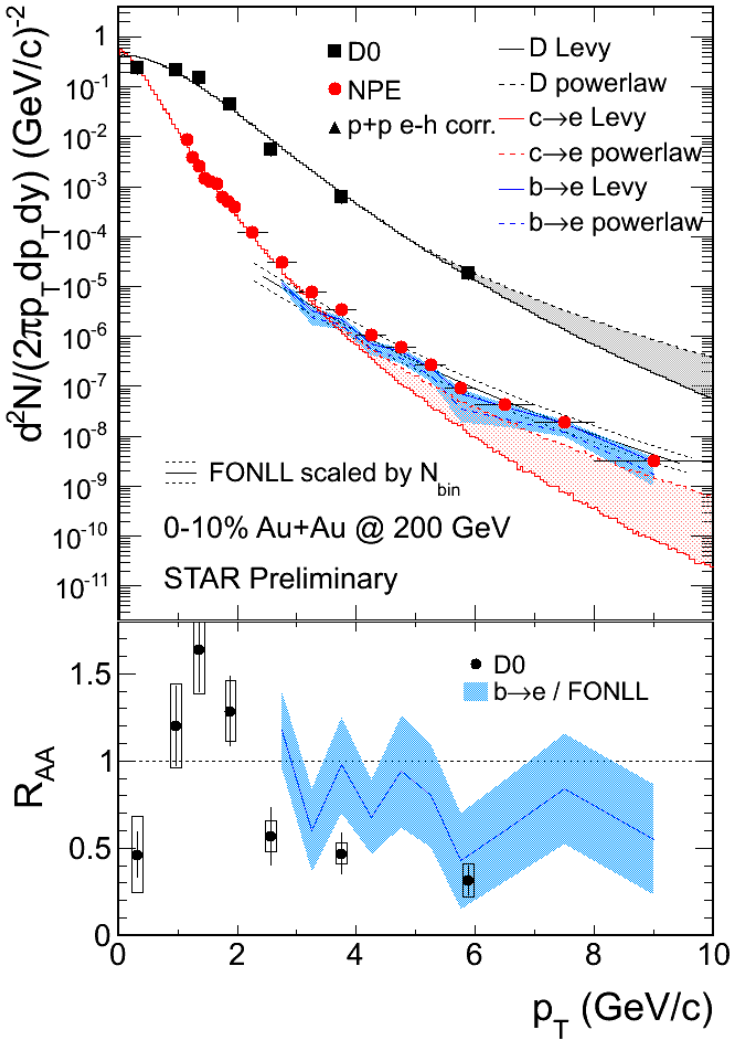
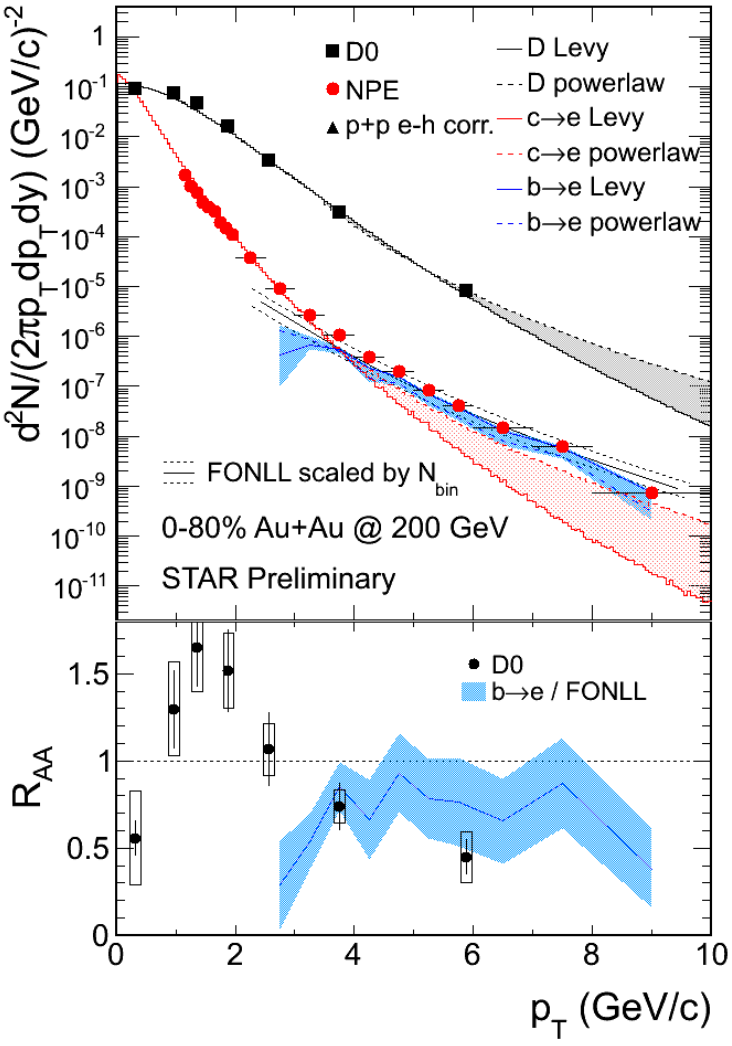
# Summary and Outlook

- Open charm and bottom production measured in 200 GeV p+p collisions consistent with FONLL calculations within uncertainties.
- Strong suppression observed for $D^0$ at high $p_T$ in 200 GeV Au+Au and 193 GeV U+U collisions, while enhancement structure at low $p_T$.
- Strong suppression observed for NPE in 200 GeV Au+Au collisions but not in 62 GeV Au+Au collisions(?). Significant $v_2$ observed for NPE in 200 GeV Au+Au collisions.
- New detectors take data starting in 2014 for HF physics: precise measurements down to low $p_T$ to study how heavy flavor quarks interact with the hot nuclear medium, and the medium properties.

# Open Bottom Production – Au+Au



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