Recent measurements on open heavy flavor at STAR

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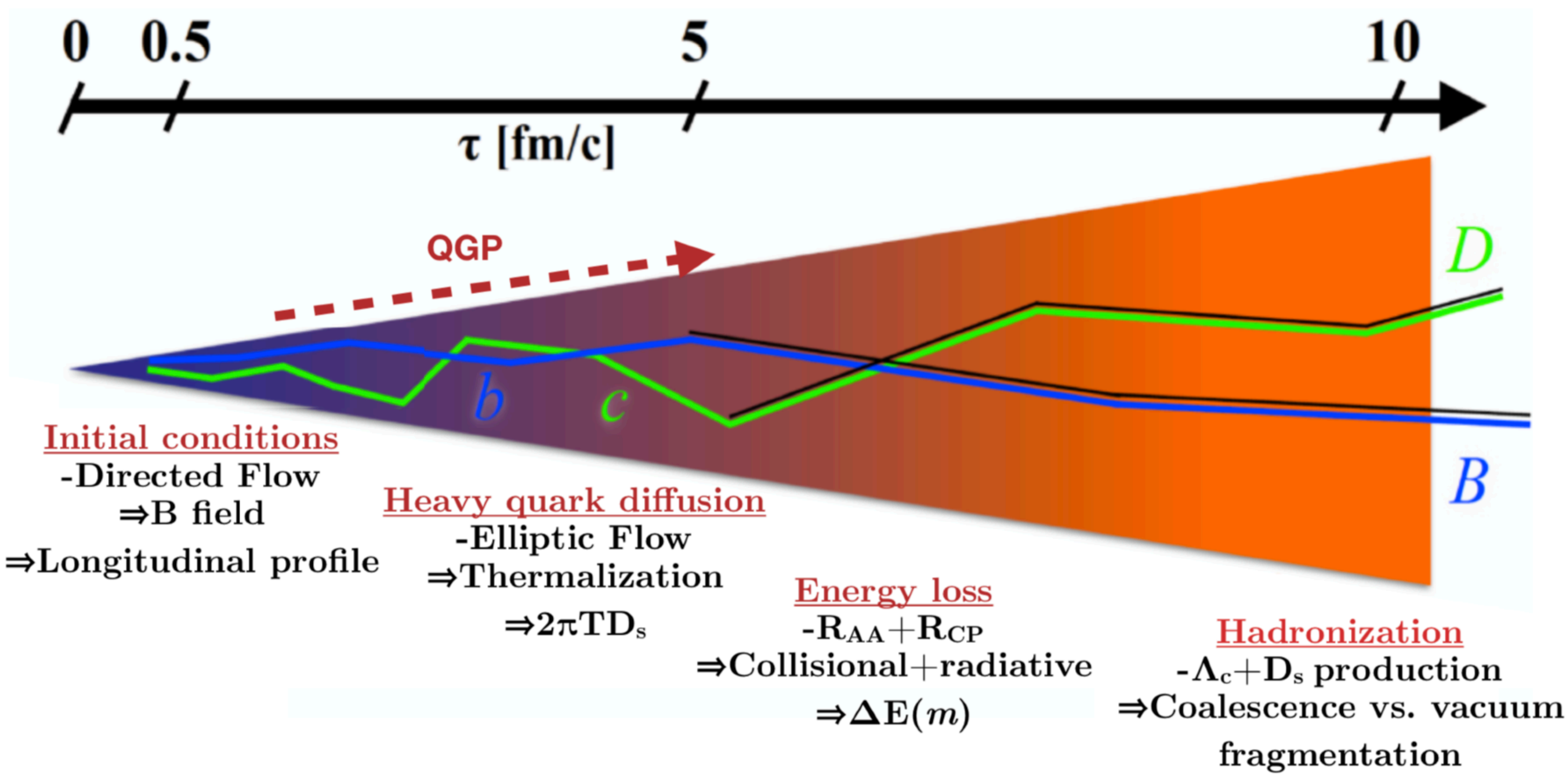
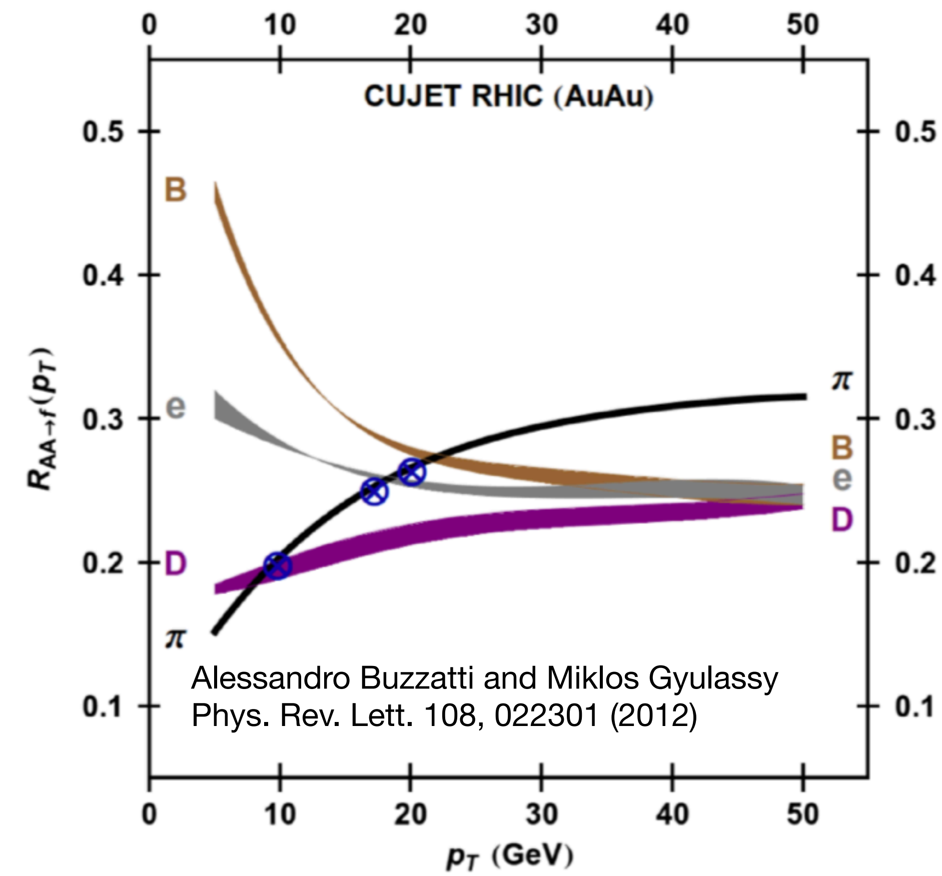
Why heavy flavor?

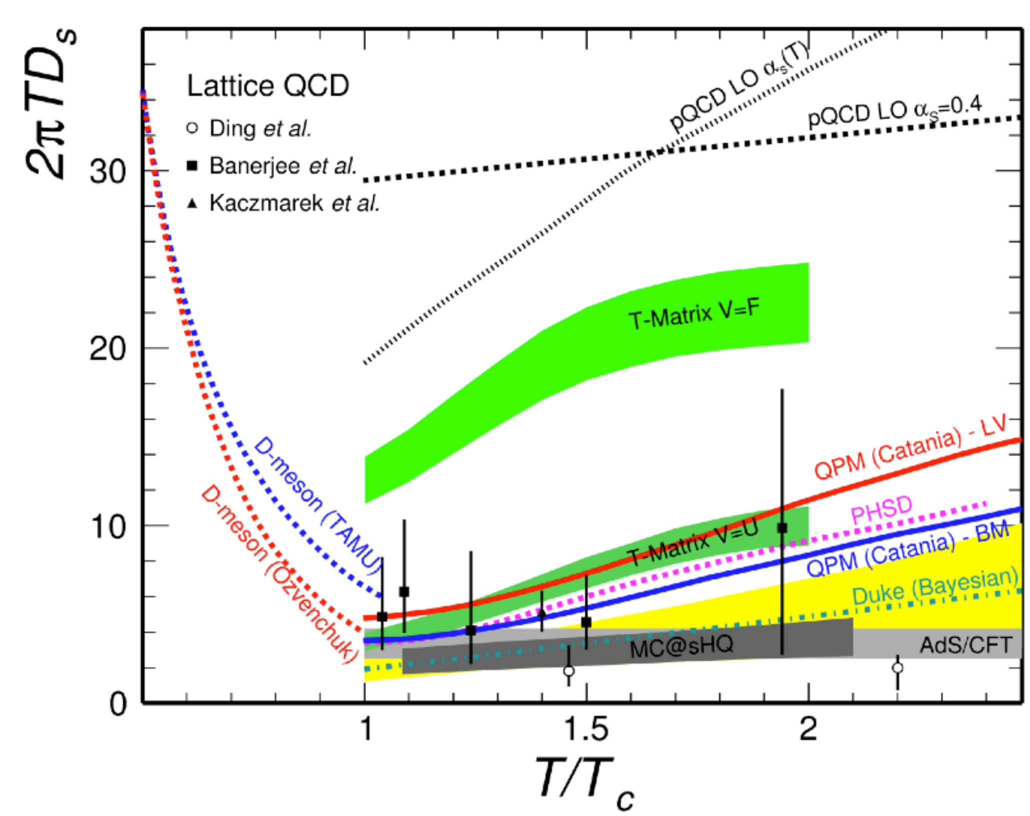
- $m_{c,b} >> T_{QGP}, \Lambda_{QCD}$
  - ➡ Produced early dominated through initial hard scatterings
  - ➡ Cross sections calculable with pQCD
- ➡ **Heavy quarks are ideal probes to study Quark-Gluon Plasma**



Outline of open heavy flavor measurements at STAR

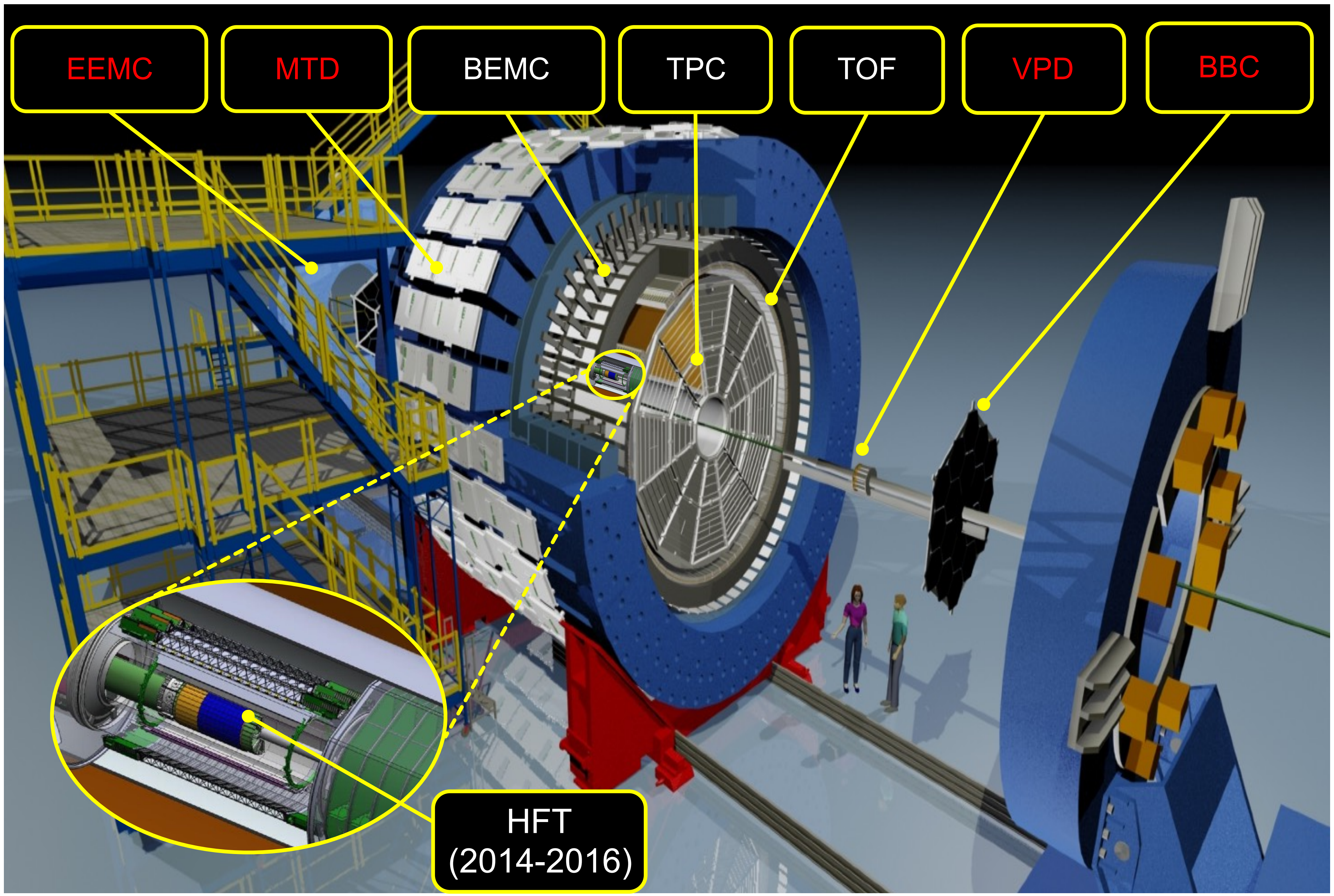
- ✦ Energy loss in QGP
  - ➡ D^0, D^+ R_{AA}/R_{CP}
- ✦ Hadronization
  - ➡ Λ_c/D^0, D_s/D^0
- ✦ Mass dependence of Energy loss
  - ➡ b/c→ electrons R_{AA}
- ✦ Transport coefficients
  - ➡ D^0 v_2
  - ➡ b/c→ electrons v_2





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:~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 rϕ and z directions: ~30 μm at p = 1.5 GeV/c

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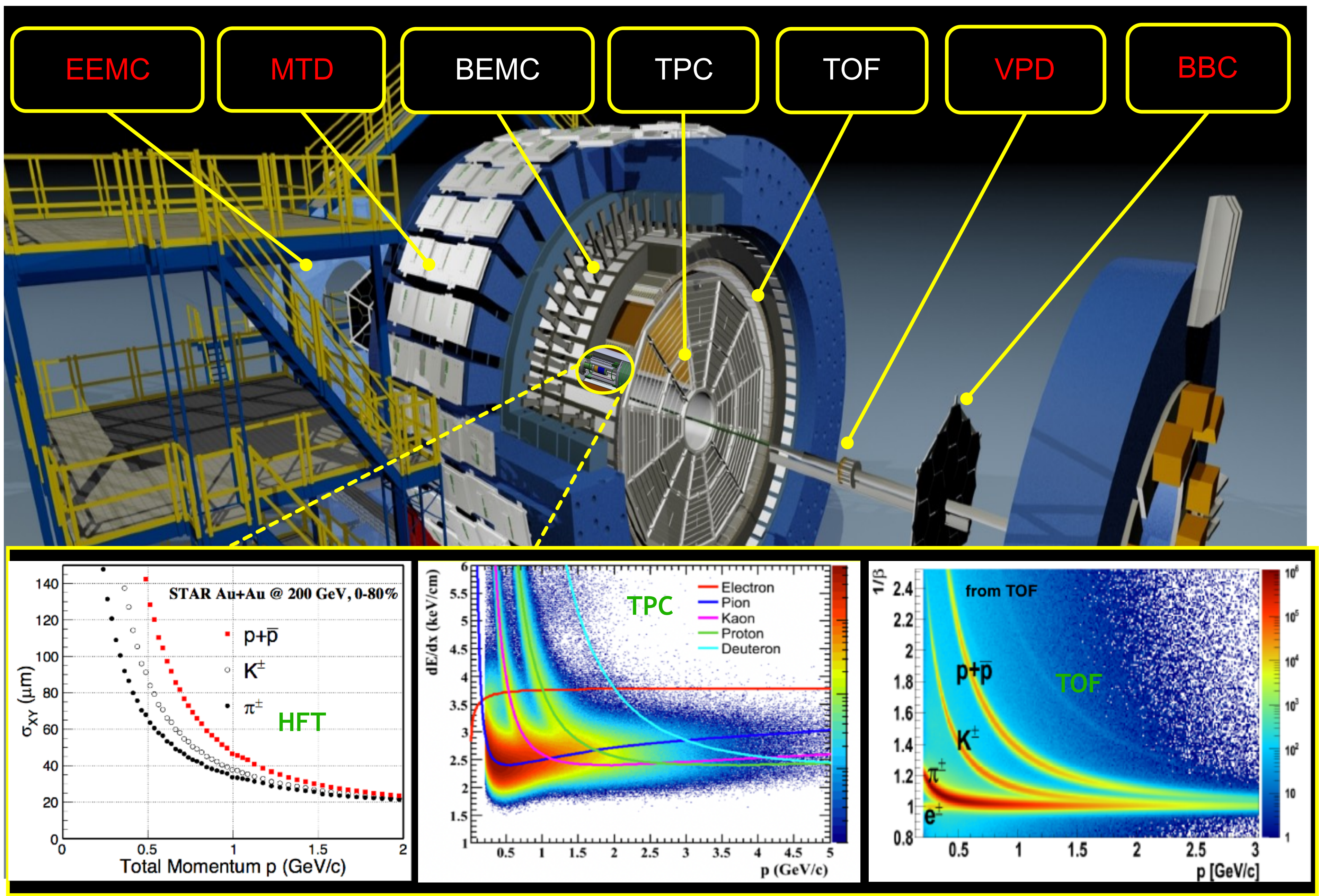

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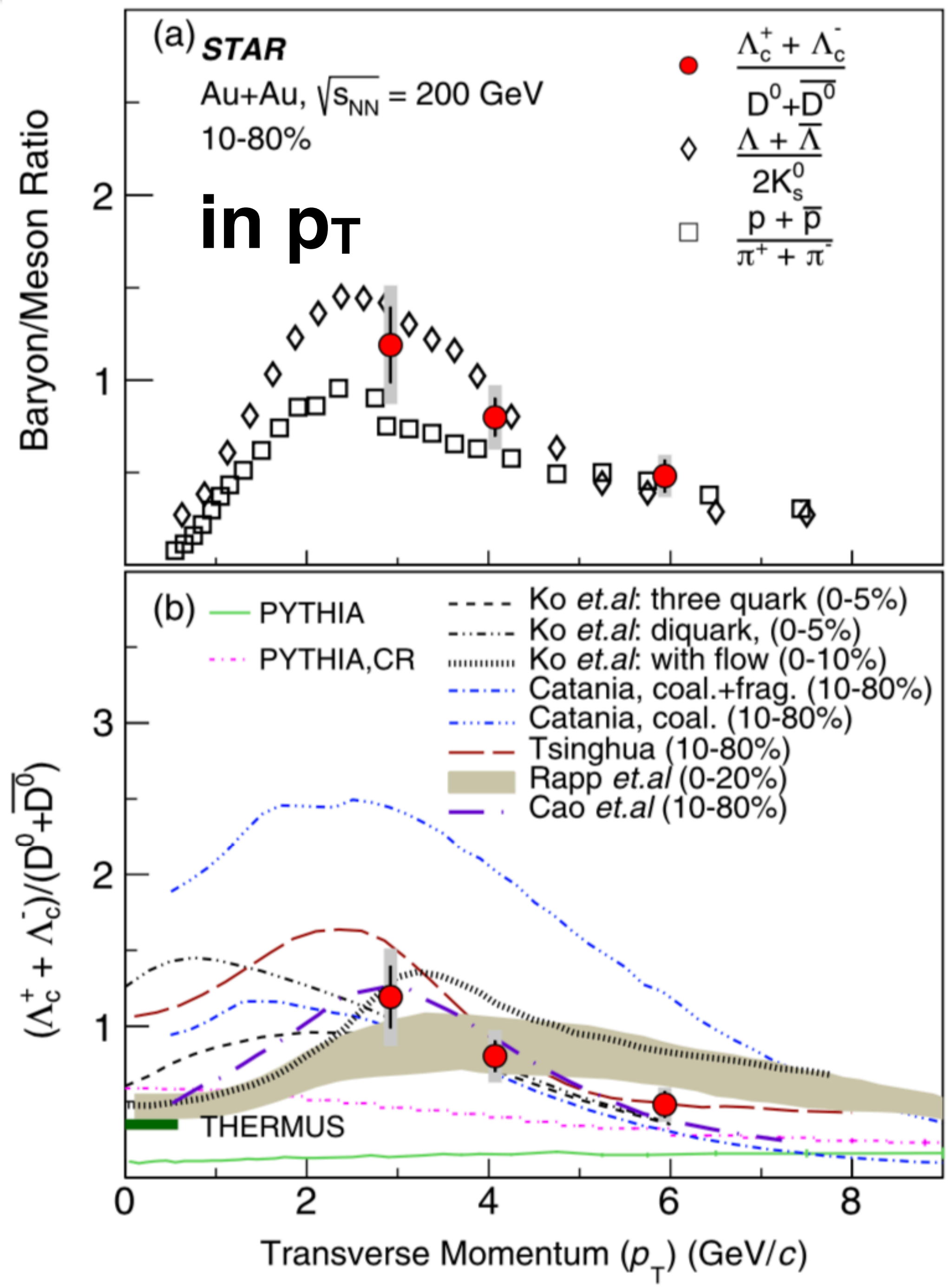
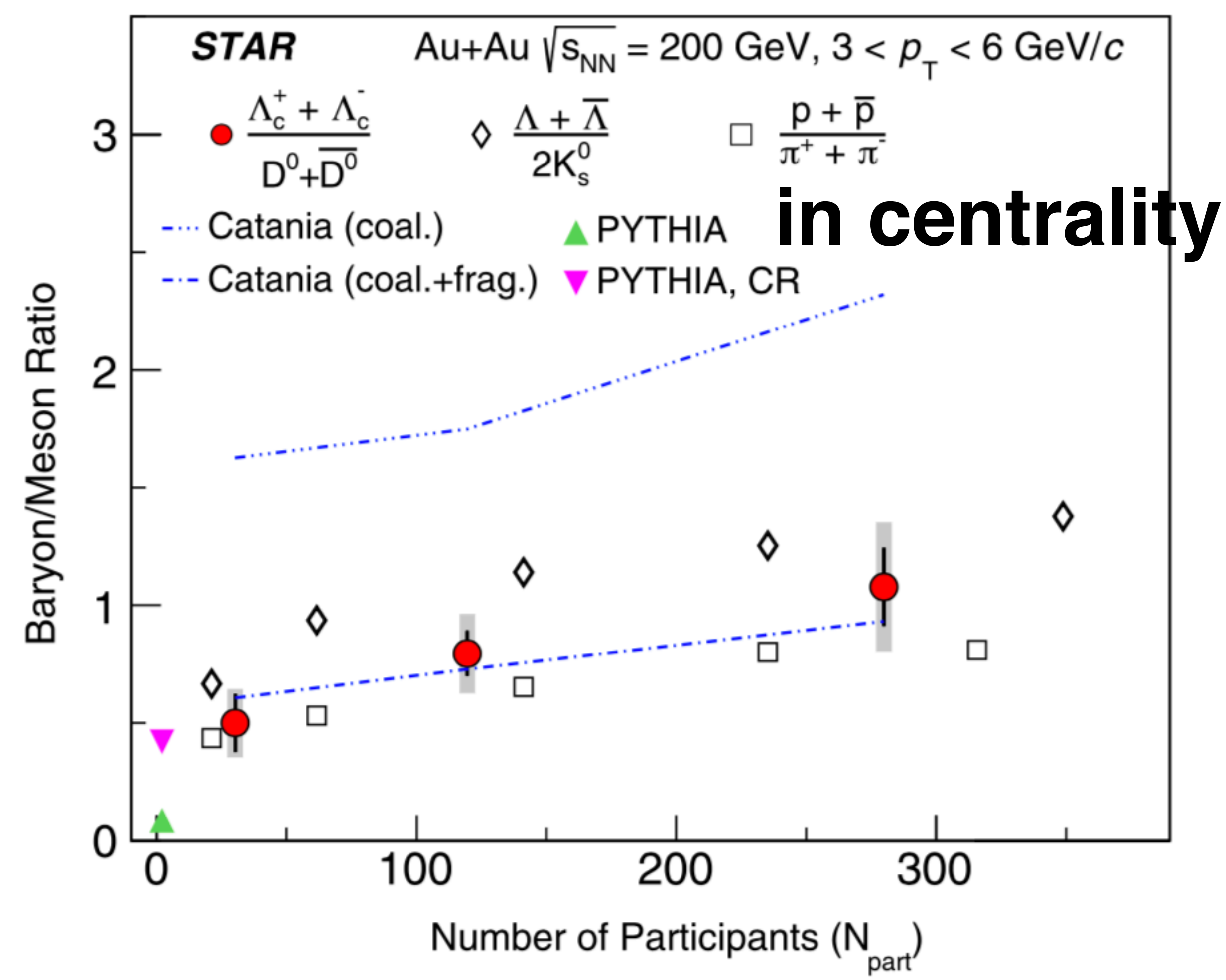
Λ_c/D^0 ratio

PRL 124, 172301(2020)





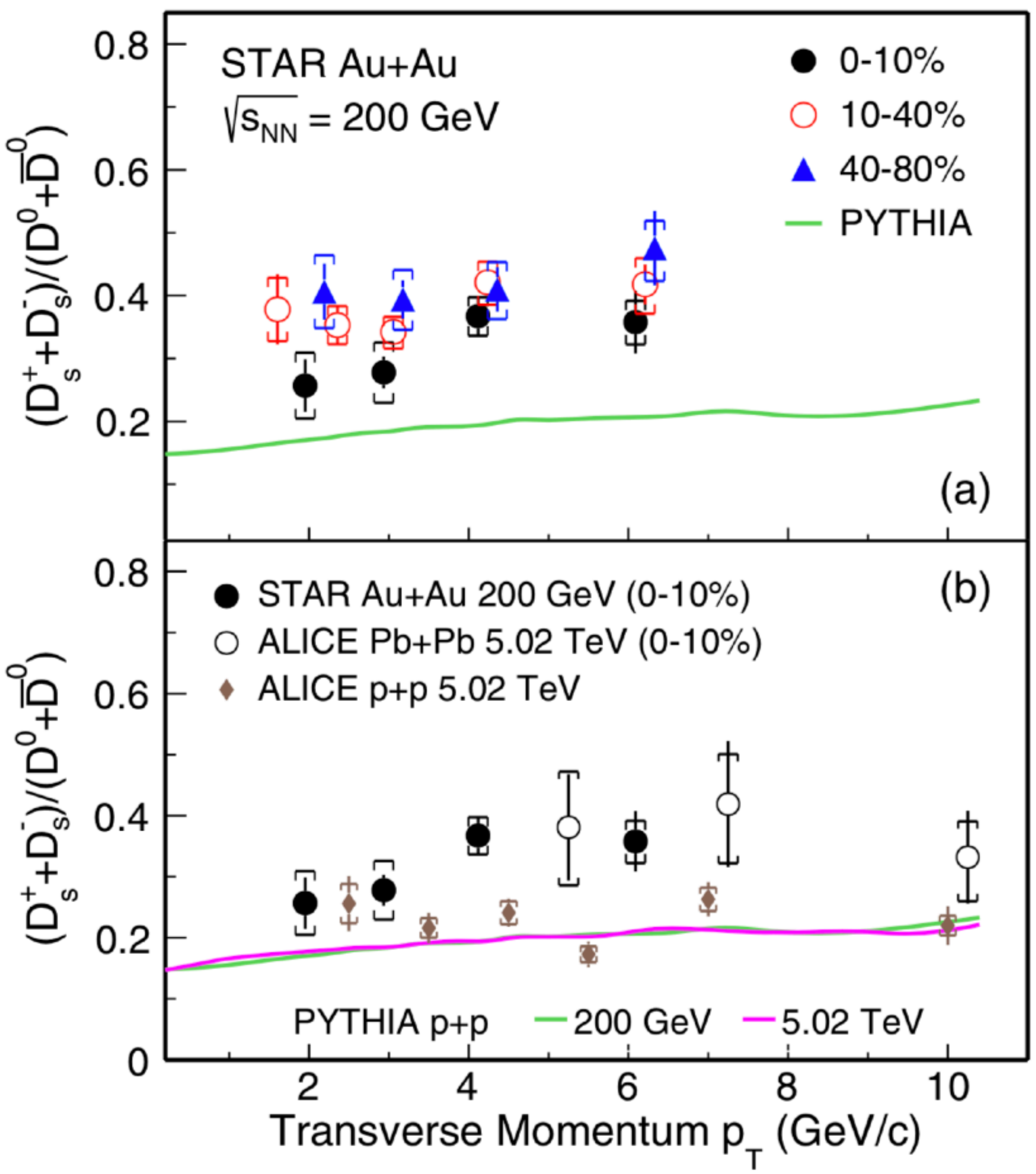
- Significant enhancement of Λ_c/D^0 compared to PYTHIA/fragmentation baseline
- The Λ_c/D^0 ratio is comparable with light flavor baryon-to-meson ratios
- Consistent with charm quark hadronization via coalescence

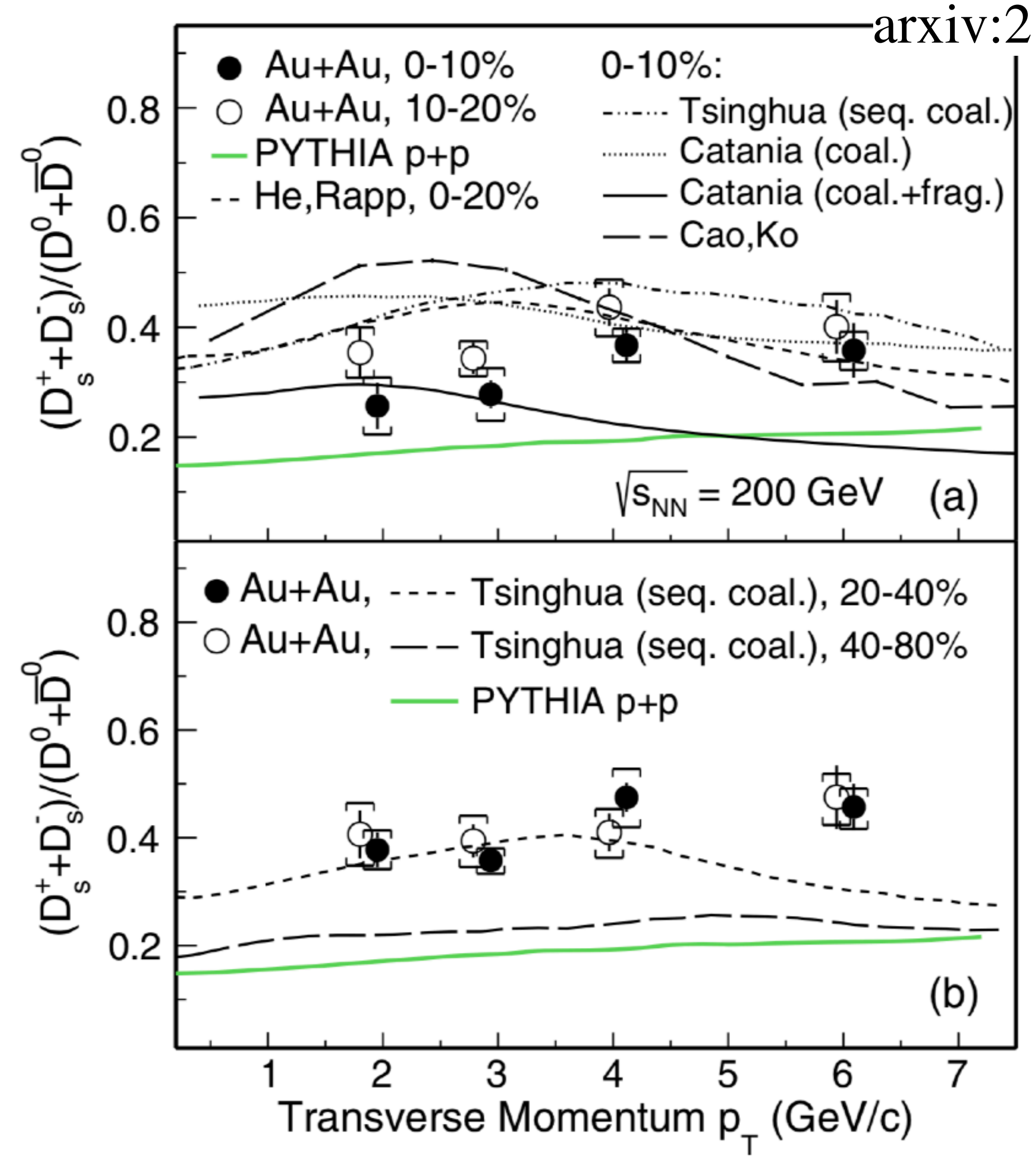
D_s/D^0 ratio

Accepted by PRL

arxiv:2101.11793

ALICE: EPJC 77, 550 (2017)
ALICE: JHEP 2018, 174 (2018)

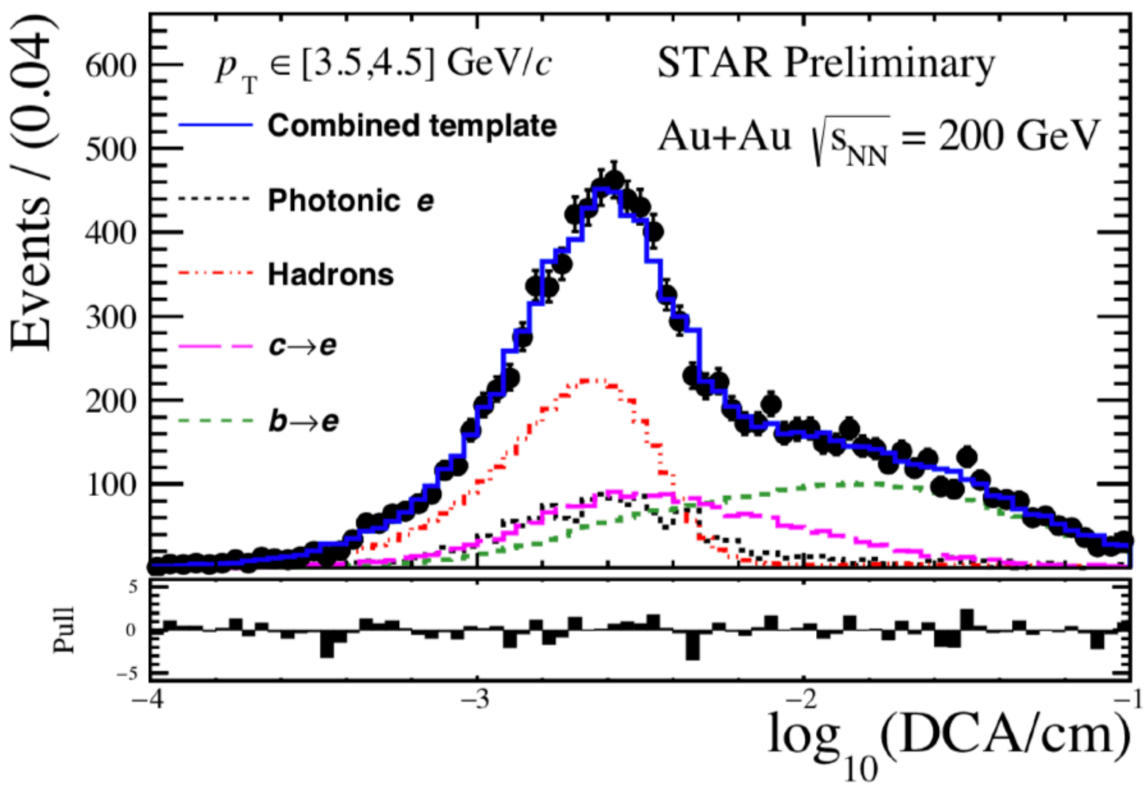


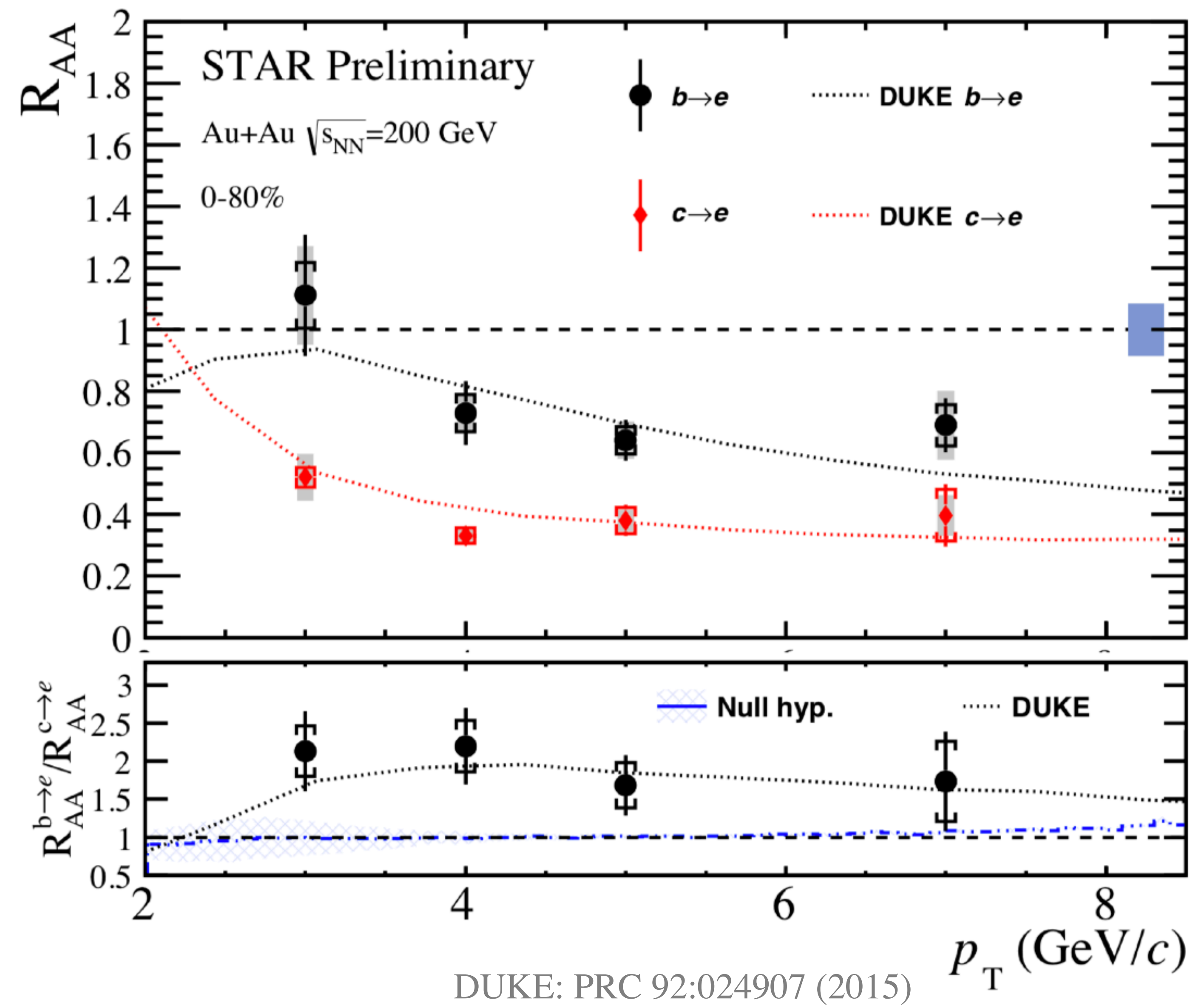


Tsinghua: arXiv:1805.10858 (2018)
Catania: EPJC 78, 348 (2018)
He/Rapp :PRL 124, 042301 (2020)
Cao,Ko: PLB 807, 135561 (2020)

- Significant enhancement of D_s/D^0 ratio compared to PYTHIA and p+p @ 7 TeV
- Comparable to Pb+Pb @ 5.02 TeV
- Models incorporating coalescence with enhanced strangeness production qualitatively describe data

b/c→ electrons R_{AA}



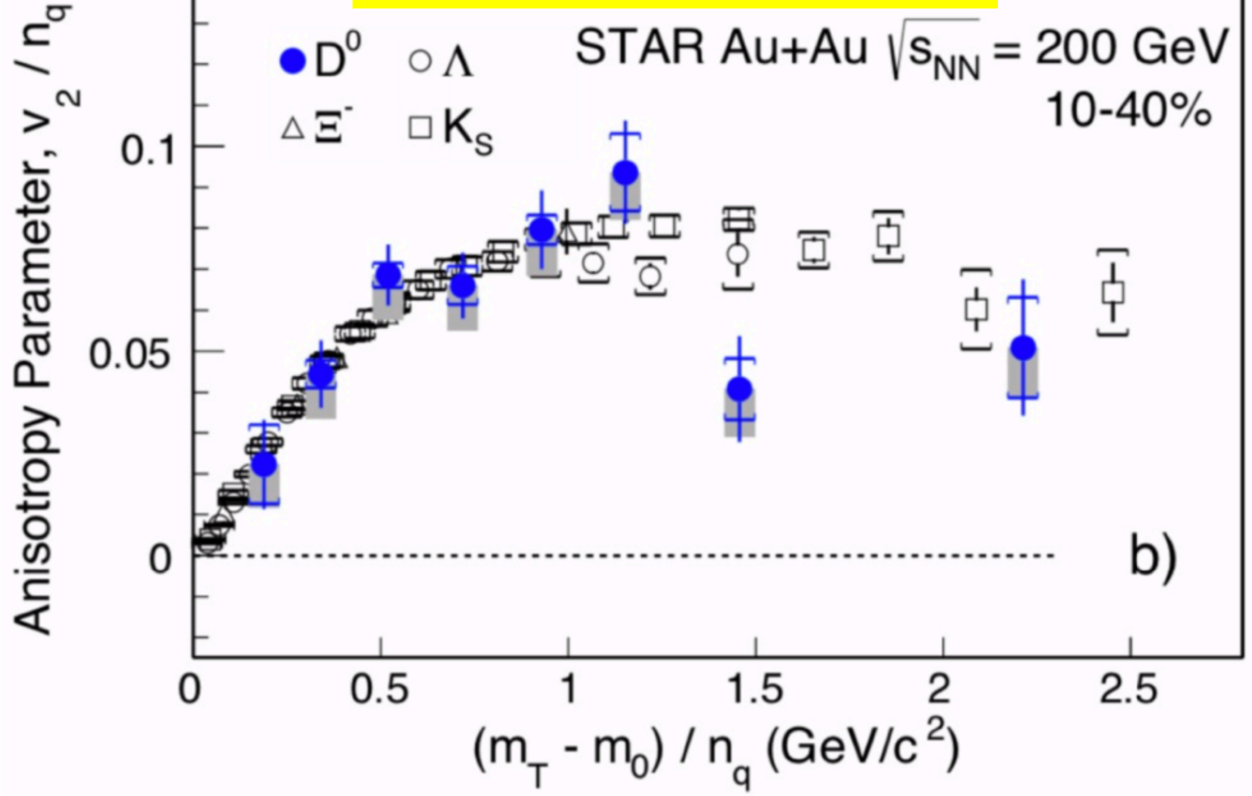


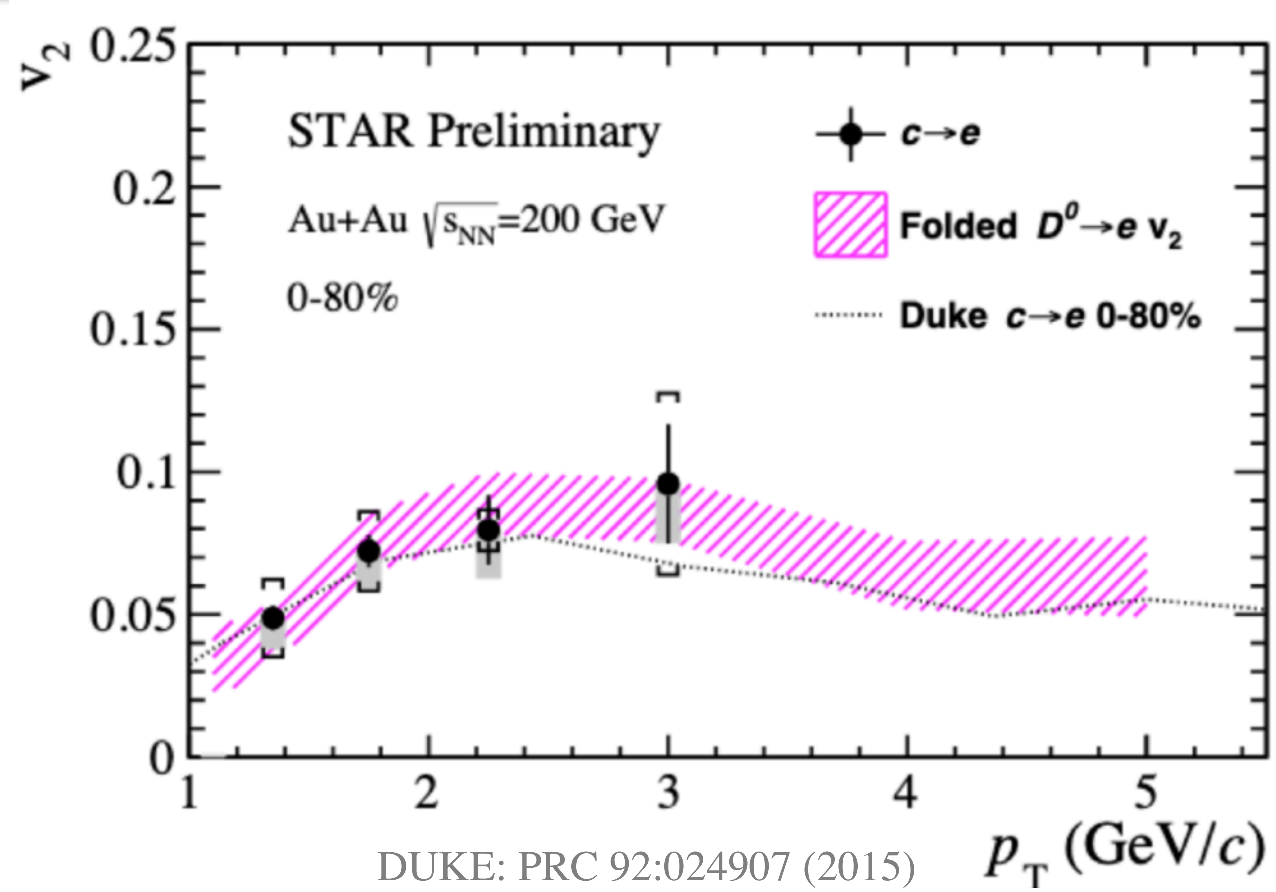
$$R_{AA}^{b\rightarrow e} = \frac{f_{Au+Au}^{b\rightarrow e}}{f_{p+p}^{b\rightarrow e}} R_{AA}^{HFe} \qquad R_{AA}^{c\rightarrow e} = \frac{f_{Au+Au}^{c\rightarrow e}}{f_{p+p}^{c\rightarrow e}} R_{AA}^{HFe}$$

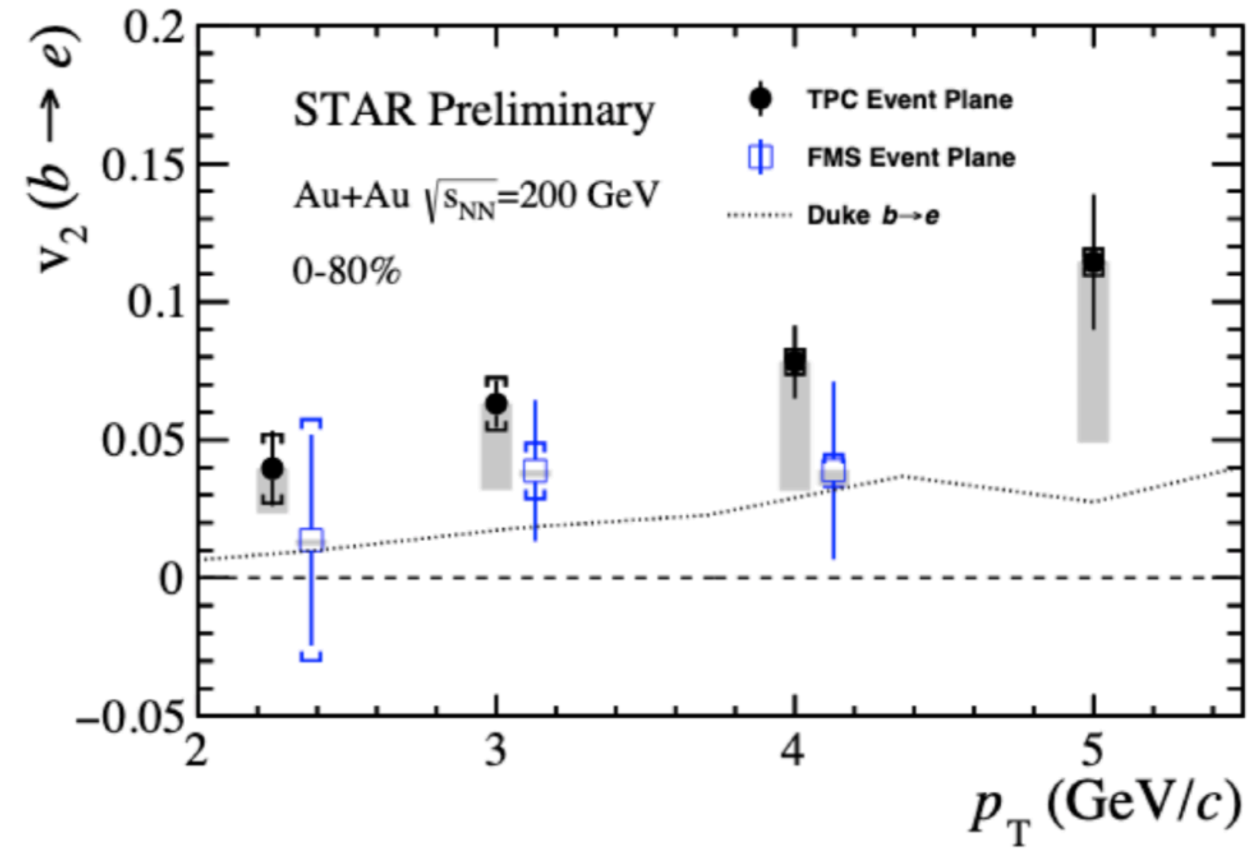
- ✦ R_{AA} ($c\rightarrow e$) < R_{AA} ($b\rightarrow e$) (~3σ at 3-7 GeV/c)
  - ➡ Consistent with mass hierarchy of parton energy loss

D^0 v_2 and b/c→ electrons v_2

PRL 118, 212301(2017)







- D^0 v_2 is similar to those of light hadrons
  - ➡ Charm quarks may be thermalized
- c→e v_2 consistent with D^0 measurement folded to decayed electrons
- Non-zero b→e v_2 with significance > 3σ
- Duke calculations are consistent with data considering non-flow

Summary

- Significant enhancements of Λ_c/D^0, D_s/D^0 ratios in Au+Au w.r.t. p+p
  - ➡ Important role of coalescence in charm hadronization
- Hierarchy of $b/c \rightarrow e$ R_{AA} in Au+Au 200 GeV
  - ➡ Mass dependence of parton energy loss ($\Delta E_c > \Delta E_b$) in the QGP
- D^0 v_2 is similar to those of light hadrons
  - ➡ Charm quarks may be thermalized
- Non-zero $b \rightarrow e$ v_2 with significance $> 3\sigma$