Forward rapidity open heavy flavor measurements at PHENIX in p+p and Au+Au collisions

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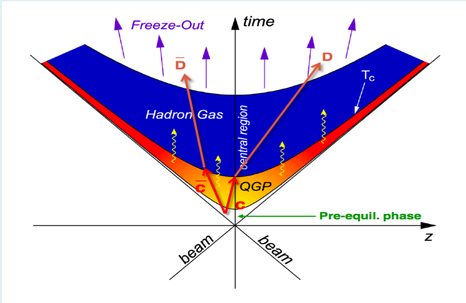
presented by Cesar Da Silva

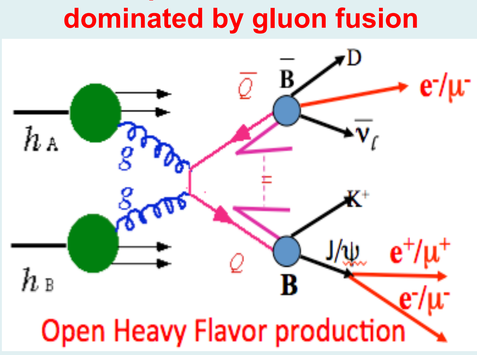
Motivation

Unlike light quarks, heavy flavor quarks (charm and bottom quarks) can be created before the formation of Quark Gluon Plasma (QGP) in heavy ion collisions. Therefore, heavy quarks are ideal probes to study the formation of QGP and its property.



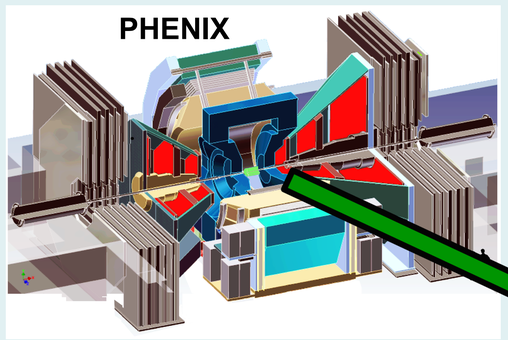
Bottom production at RHIC is dominated by gluon fusion

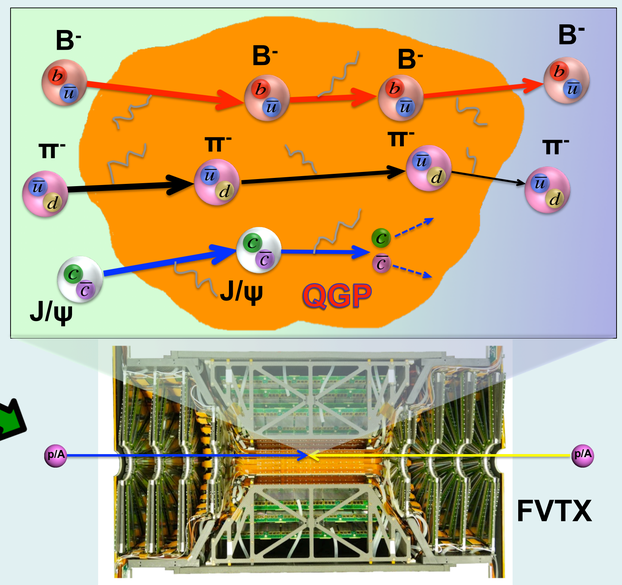
The production mechanism of heavy flavor is different at the Relativistic Heavy Ion Collider (RHIC) and at the LHC[1]. In addition to this, heavy flavor measurement such as non-prompt J/ψ from B-hadron decay and charm/bottom decays to single muon at RHIC allow to study the QGP over an extended kinematic region.



PHENIX FVTX Detector

The PHENIX experiment at the 8 o'clock interaction position of RHIC installed the Forward silicon vertex detector (FVTX) to enhance the capability to measure the heavy flavor production in the forward and backward rapidity region (1.2<|y|<2.2).





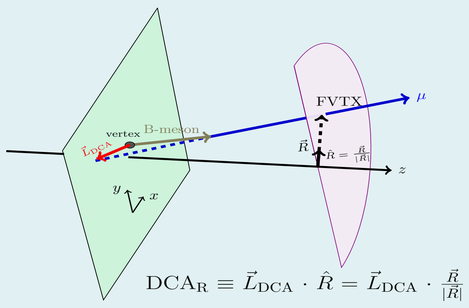
FVTX:

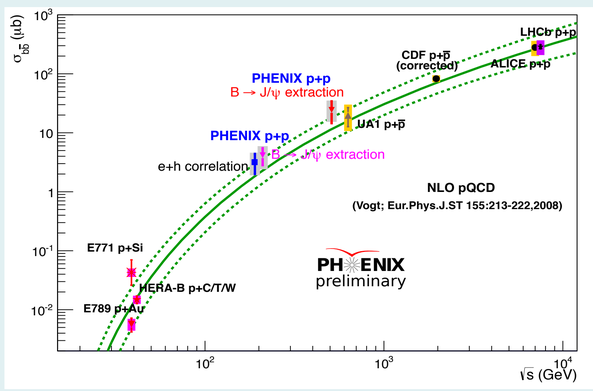
- Consist of 8 disks with 75 pitch silicon strips.
- With 1.2<|y|<2.2 and φ=2π coverage.
- provides precise vertex, tracking and DCA measurements for B→J/ψ and D, B separation.
- Better resolution along the radial direction.

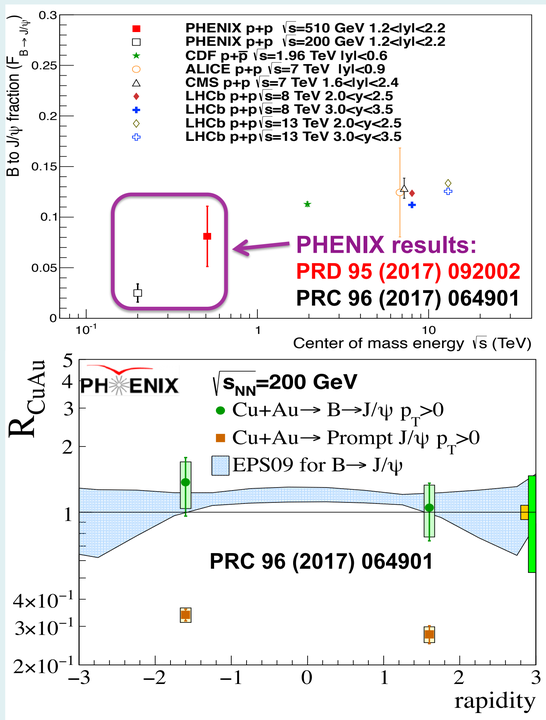
DOE Nuclear Physics Highlight

PHENIX FVTX published heavy flavor results

PHENIX has measured the B → J/ψ fraction in 510 GeV p+p, 200 GeV p+p and Cu+Au collisions using the radial projection of distance of closet approach (DCA_R) in the transverse plane of the primary vertex of muons from di-muon pairs. The extrapolated total bottom cross section is consistent with NLO pQCD calculations. Unlike prompt J/ψ, bottom production in Cu+Au collisions obeys p+p scaling behavior.

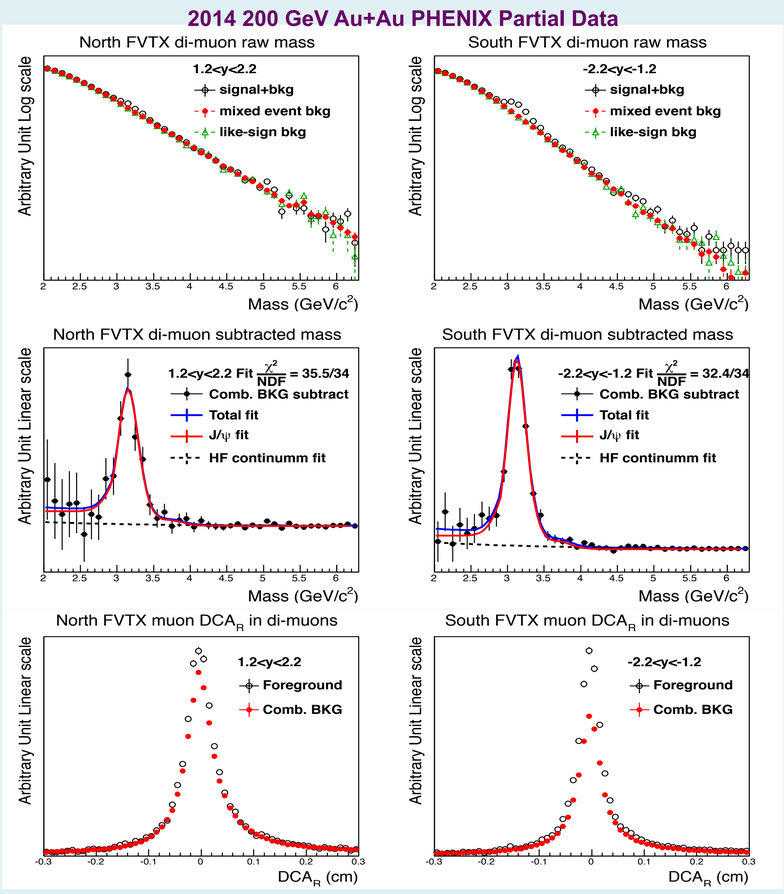






Ongoing B → J/ψ analysis in Au+Au collisions

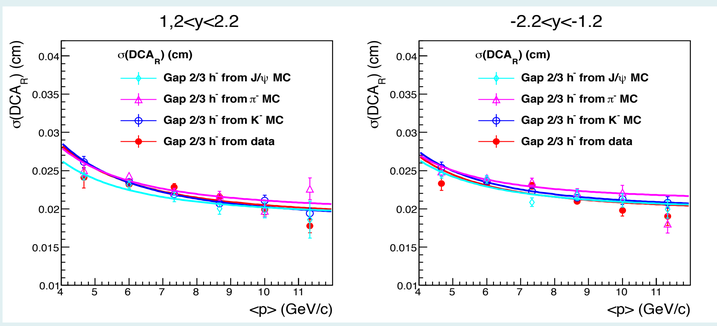
- The 2014 200 GeV Au +Au data production of the PHENIX experiment is ongoing.
- From partial 200 GeV Au +Au data, clear J/ψ signal has been found in the 1.2<|y|<2.2 region after subtracting huge combinatorial background determined by the mixed events.
- The DCA_R of muon from di-muon pairs has been determined in the foreground and combinatorial background.
- Analysis procedure has been developed.
- Studies including the embedding, detector mis-matching background determination, unfolding etc. are underway.



Analysis procedure for charm and bottom separated single muons

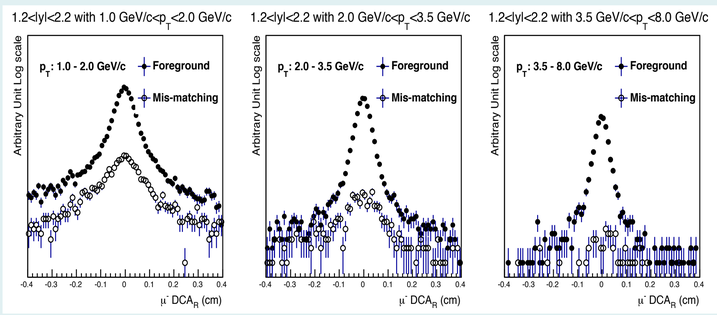
Resolution verification between data and MC:

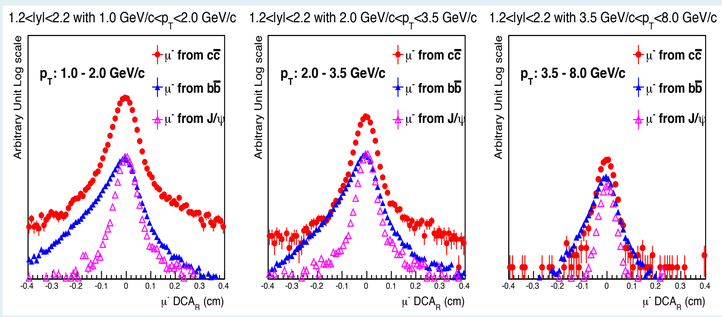
First characterize the DCA_R resolution in simulation by comparing data and simulation. A real data hadron sample ($K^{\pm}$, $\pi^{\pm}$) is obtained by requiring tracks passing through the 3rd and 4th gap of MuID that match to FVTX tracks. Muon tracks from J/ψ are produced through simulation, with the same MuID and FVTX requirements.



Analysis Procedure:

1) Select good muon candidates which reach the last gap of MuID and pass quality cuts.
2) Evaluations of various background contributions:
   (i) FVTX-MuTr mis-matching (done).
   (ii) hadron decayed muons (ongoing).
   (iii) punch through hadrons (ongoing).
3) Determination of the D → μ± and B → μ± momentum corresponds matrixes is ongoing.
4) Iterative fit (or unfolding) to get bottom over charm fraction (under development).
5) Apply the acceptance*efficiency corrections.
6) Evaluate systematic uncertainties.



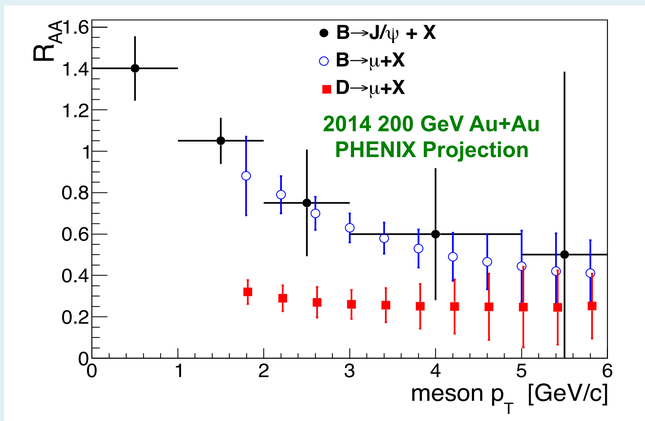


Analysis Status:

The analysis of charm and bottom separated single muon is ongoing. Normalized distributions of μ^- DCA_R from foreground, the FVTX-MuTr mis-matching, charm, bottom and J/ψ decays from the full simulation in 510 GeV p+p collisions in 3 p_T bins. The μ^+ DCA_R looks like the μ^- DCA_R distributions.

Summary & Outlook

Projection of B to J/ψ, B to $\mu^{\pm}$ and D to $\mu^{\pm}$ R_{AA} in 2014 200 GeV Au+Au data



Coming soon!

- PHENIX has measured the first forward B → J/ψ fraction in 510 GeV p+p, 200 GeV p+p and Cu+Au collisions with the J/ψ kinematics of p_T >0 GeV/c and rapidity 1.2<|y|<2.2, which extends the previous measurements to lower energy.
- Clear J/ψ signal has been found in partial 200 GeV Au+Au data at PHENIX. Analysis of B → J/ψ production in Au+Au collisions as a function of J/ψ p_T, event centrality and etc. is ongoing.
- The charm and bottom separated single muon analysis in p+p and Au+Au collisions is ongoing, this study together with the B→ J/ψ measurement will help us understand the heavy flavor mass/flavor dependent energy loss in the Quark Gluon plasma (QGP).

Reference

[1] T. Sjostrand, EPJC17 (2000) 137
[2] C. Aidala et al. (PHENIX Collaboration), arXiv:1701.01342, Phys. Rev. D **95** (2017) 092002
[3] C. Aidala et al. (PHENIX Collaboration), arXiv:1702.01085, Phys. Rev. C **96** (2017) 064901

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