Hard Probes 2020

Heavy quark nuclear modification at forward rapidity in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV

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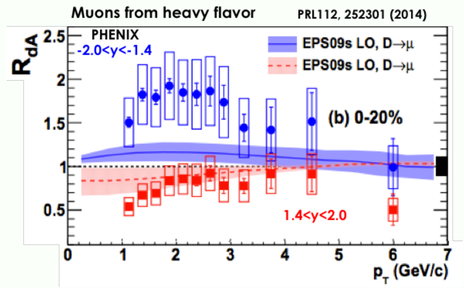
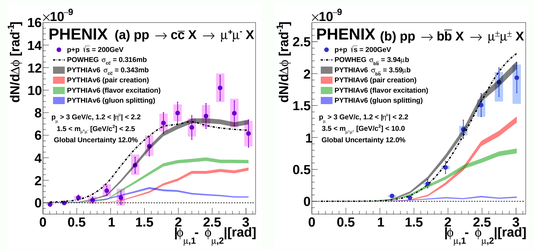
Forward Heavy Flavor in A+A collisions

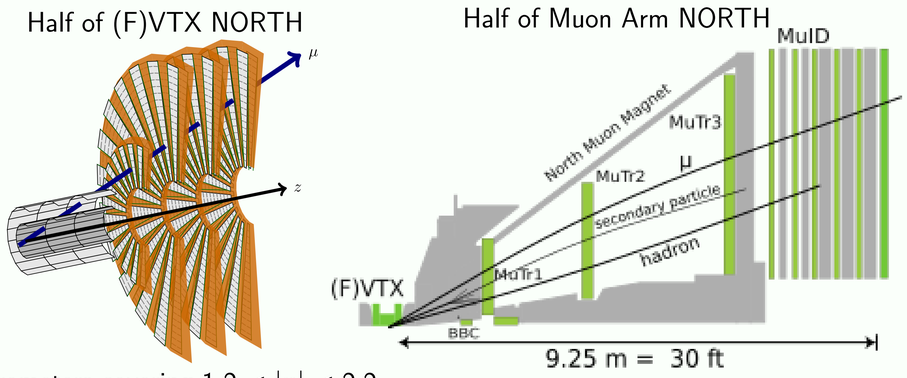


PRD99, 072003 (2019)



- explore a distinct kinematic region from mid-rapidity measurements
- large and unexpected initial state effects already observed in d+Au collisions
- main production mechanism is pair creation and flavor excitation, in contrast with LHC where gluon splitting dominates
- heavy flavor is expected to be largely affected by initial magnetic fields, effect is amplified at large rapidities

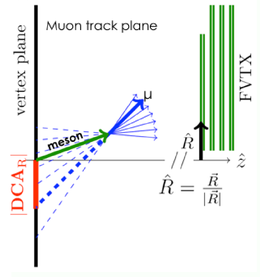
The PHENIX Muon Arms

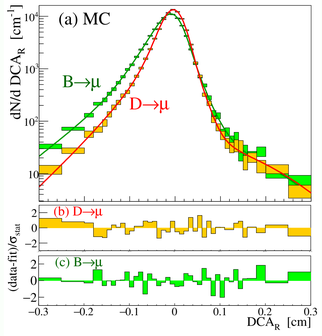


- two-arm spectrometers covering $1.2 < |\eta| < 2.2$
- from the Interaction Point
  - Central and Forward Vertex Detector (FVTX)
  - 7.2 nuclear interaction lengths hadron absorber and magnet between FVTX and MuTr
  - MuTr drift chambers inside $\int \mathbf{B} \cdot \mathbf{dl} = 0.72$ T·m magnetic field
  - MuID with Iarocci tube planes embedded in 4.8-5.4 nuclear interaction lengths hadron absorbers

Identifying hadrons from charm and bottom quarks

$DCA_R \equiv$ Radial Distance of the Closest Approach



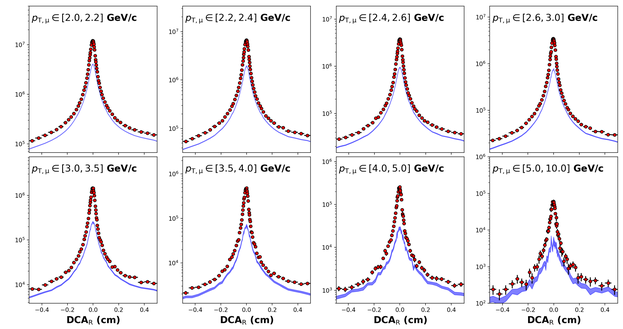


- charm and bottom yields obtained from single muon DCA_R distribution shapes
- lever arm of muon decay makes DCA_R asymmetric
- DCA_R resolution of ~ 150 μm is obtained in Au+Au collisions

Backgrounds

- nearly 70% of MuTr tracks w/ $p > 3$ GeV/c are from secondary particles produced inside the first absorber
  - removed with matching between MuTr track and FVTX track
- multiple MuTr-FVTX track matches caused by track projection uncertainties
  - measured with FVTX-MuTr track matches from different events
- up to 80% of muons are from light hadron decays
  - constrained from the difference of muon yields taken in collisions away (with more K,$\pi^{\pm}$ decay yields) and close from muon arm
  - measured in DCA_R fits
- prompt hadrons and muons
  - measured in DCA_R fits

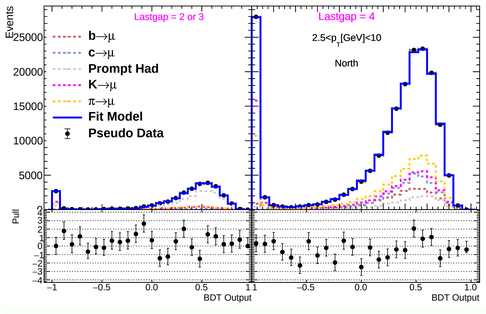
DCA_R distribution from 2014 Au+Au data.



muons penetrating all MuID gaps
MuTr-FVTX mismatch determination from mixed events

Signal/(mismatch background) ranges from 1/3.5 to 3 from low to high p_T muons.

Boosted Decision Tree Machine Learning



- DCA_R depends on:
  - event-by-event vertex resolution
  - distance between vertex and FVTX
  - momentum and rapidity of the particle
  - track and matching quality
  - decay length of the particle
- a Boosted Decision Tree [arXiv:physics/0703039] variable for particle promptness is trained with simulated prompt J/ψ and kaon decays
- shape scales are simultaneously fitted to the measure BDT for particles stopping in the MuID and muons which penetrate all MuID gaps
- validation checks found correct charm and bottom contribution in pseudo data with different compositions of charm, bottom, kaon, pion and prompt decays

Status of the Analysis and Perspectives

- waiting to accumulate statistics in detector simulations for light hadrons, these simulations are slow because of the large hadron rejection in the absorbers (a factor of $\sim 1/10$K)
- data driven techniques to validate DCA_R shapes from simulation have been studied
- expect R_{AA} of separated $c, b \to \mu$ covering at least $2 > p_T(\text{GeV}/c) > 5$
- smaller p_T B-mesons expected to be obtained from non-prompt J/ψs