Bottom and Charm production in p+p collisions at $\sqrt{s}$ =200 GeV measured by PHENIX

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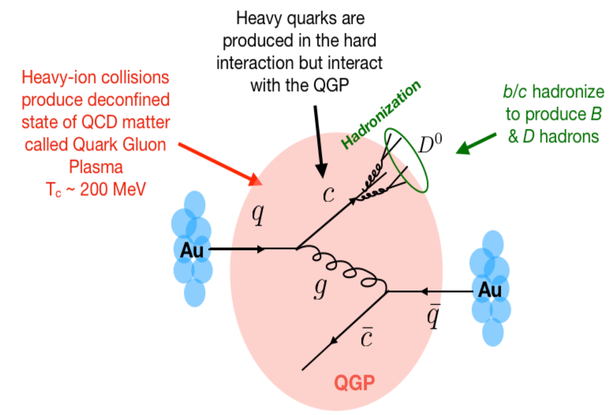
Motivation

Heavy quarks (b and c) produced in heavy ion collisions at RHIC are excellent probes of the Quark Gluon Plasma (QGP) since:

- ❖they cannot be produced thermally in the QGP
- ❖they interact via the strong force with the colored QGP medium
- ❖their yields can probe the parton energy loss mechanism in QGP and its mass dependence

Measurements of separated charm and beauty in p+p collisions provide a baseline for heavy ion collisions, and test pQCD calculations.

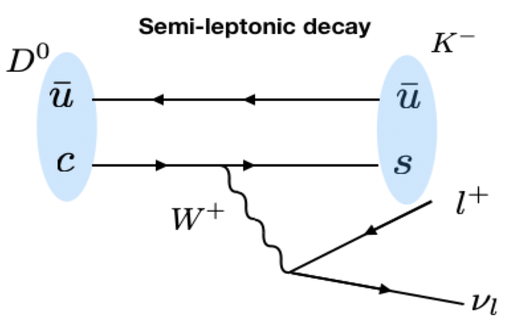


$m_b > m_c > \Lambda_{QCD}, T_c$

4.2 GeV 1.3 GeV 0.2 GeV

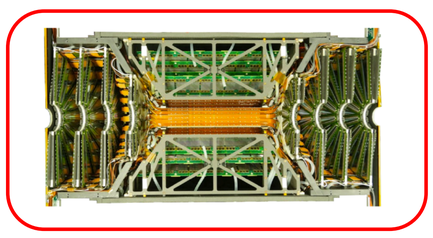
Expected energy loss in QGP: $E(u,d) > E(c) > E(b)$

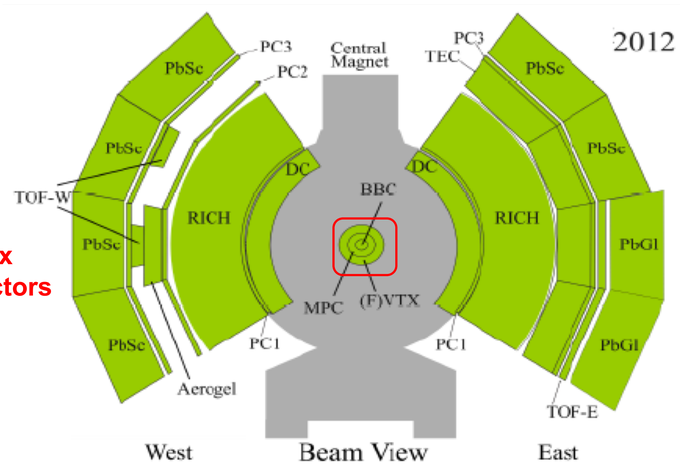
Experimental Methods



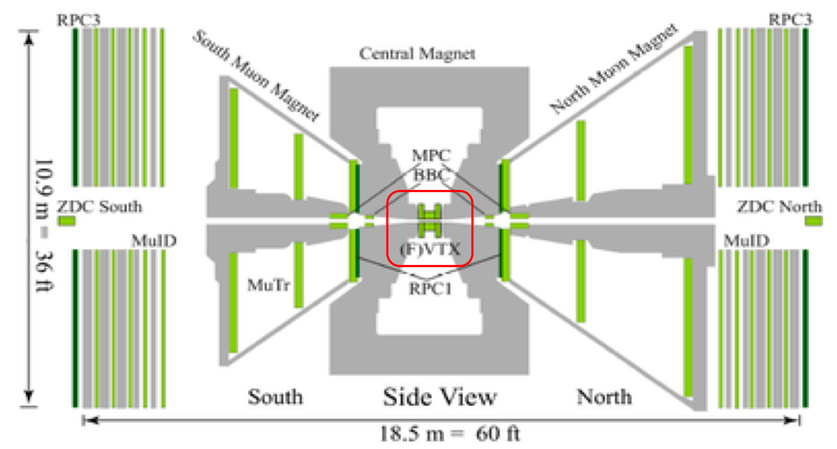
Particle	Lifetime $c\tau_0$
D^0	129.9 μm
D^+	311.8 μm
B^0	457.2 μm
B^+	491.1 μm

long lifetime → displaced decay vertex
Reconstructed in Silicon Vertex Detectors



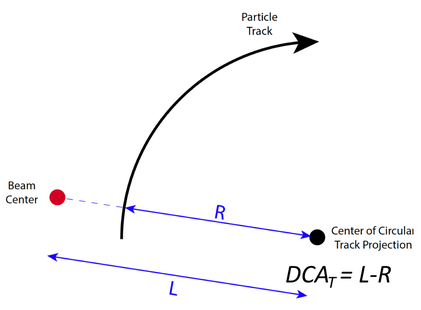


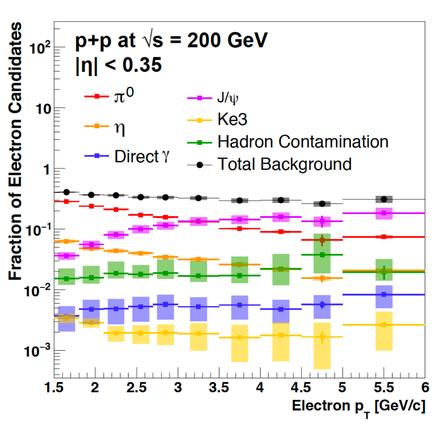
Mid rapidity (|η|<0.35) : electron id detectors

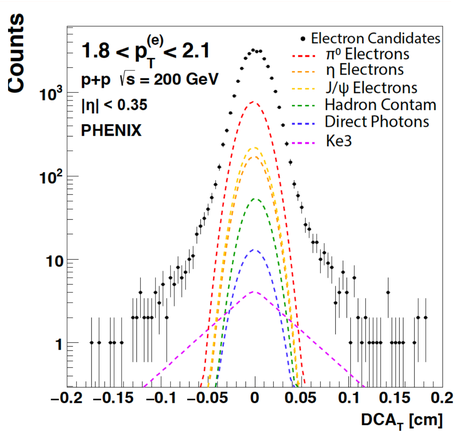


Forward rapidity(1.2<|η|<2.2): muon id detectors

Signal extraction: D/B-> e

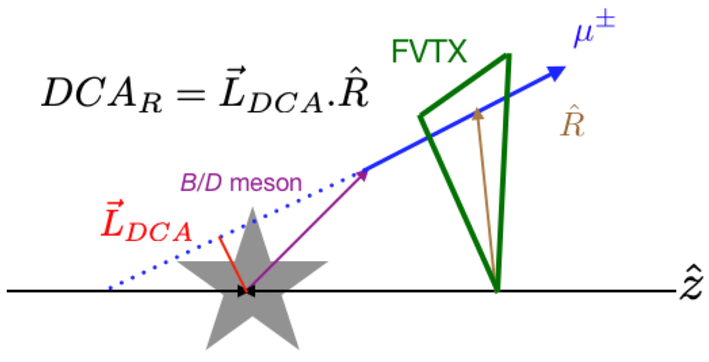




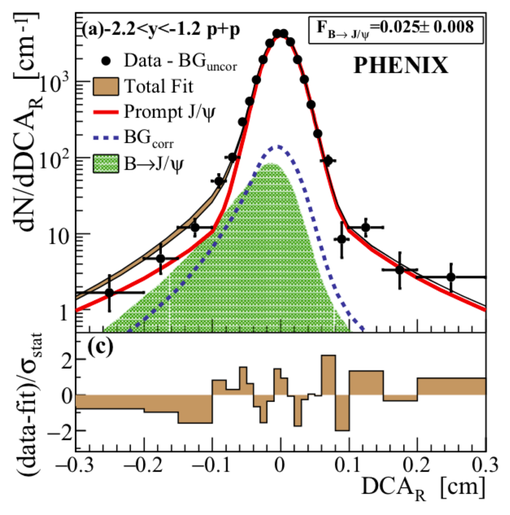


1. Measure the *DCA$_T$ dis*tribution of hadrons and electrons candidate tracks in data
2. Model the *DCA$_T$* distribution of non-heavy-flavor electrons: π^0, η, direct γ, J/ψ, K0, $K^{+/-}$
3. Determine the fraction of electrons attributable to each of the background sources considered
4. Bayesian unfolding to extract D/B hadron spectra based on DCA$_T$ distributions, and the invariant yield of inclusive heavy-flavor electrons.
5. Refold to get the electron spectra from charm and beauty

Signal extraction: B-> J/ψ

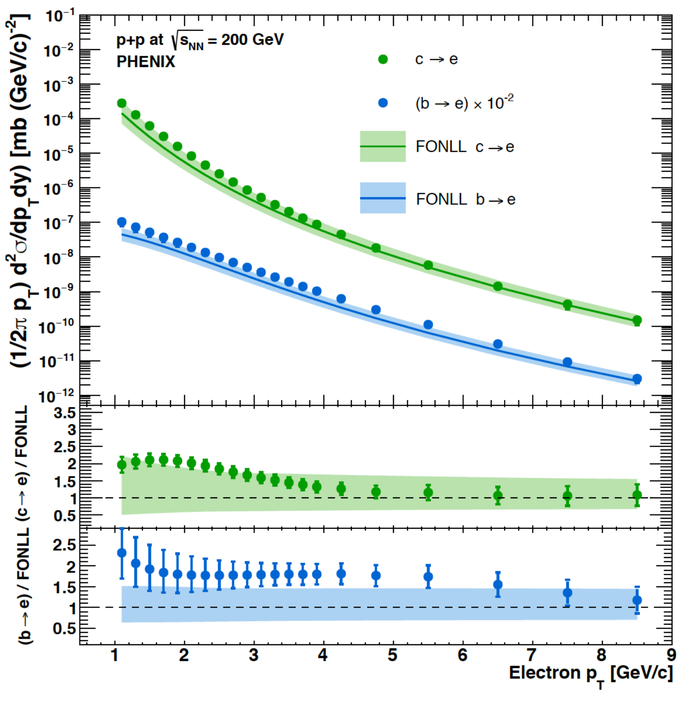


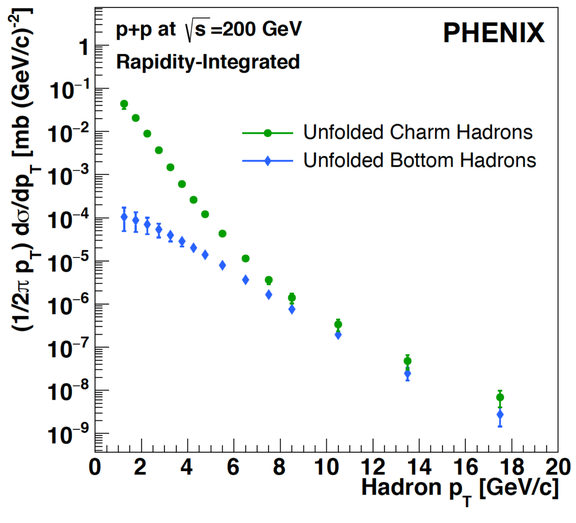
DCA$_R$ (DCA along the radial projection of tracks) proportional to the decay length can be precisely determined using FVTX+VTX.

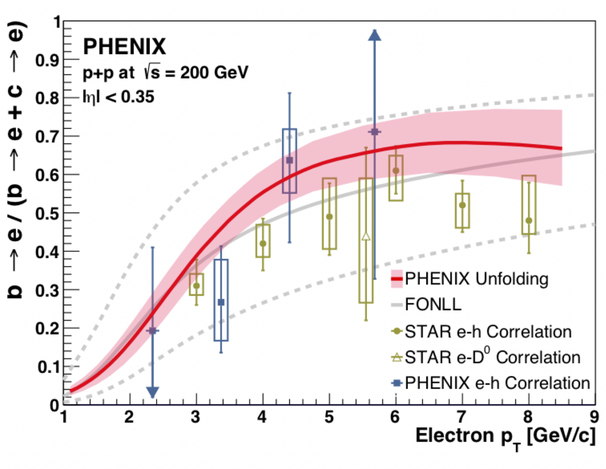


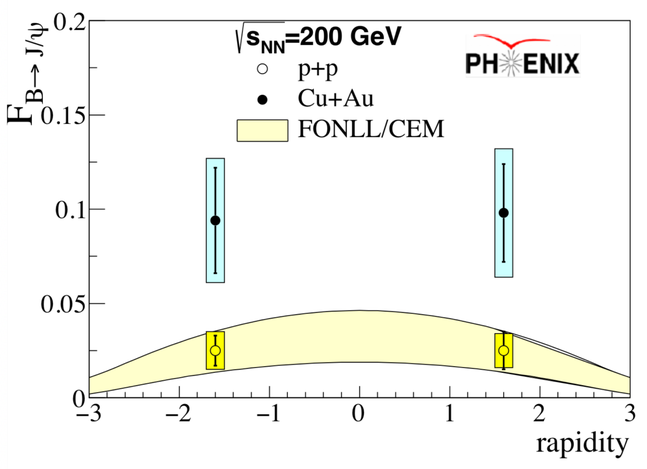
DCA$_R$ distributions can be fitted using signal and background templates to extract fraction of events B→ J/ψ in the inclusive J/ψ yield.

Results









- ❖ Heavy flavor electron spectra from D and B decays measured in p+p collisions at $\sqrt{s}$ =200 GeV at mid-rapidity
- ❖ D and B hadron spectra extracted via Bayesian unfolding
- ❖ The non-prompt J/ψ contribution (from B→ J/ψ) to the inclusive J/ψ yield measured in forward rapidities
- ❖ Results consistent with FONLL calculations given the large theoretical uncertainties [3]
- ❖ Experimental results provide a more precise reference to assess heavy-flavor modifications in heavy ion collisions

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References

1. Measurement of charm and bottom production from semi-leptonic hadron decays in p+p collisions at √s=200 GeV, PHENIX, Phys. Rev. D 99, 092003 (2019)
2. B-meson production at forward and backward rapidity in p + p and Cu + Au collisions at $\sqrt{s_{NN}}$ =200 GeV, PHENIX, Phys. Rev. C 96, 064901 (2017)
3. Theoretical predictions for charm and bottom production at the LHC, Cacciari, M., Frixione, S., Houdeau, N. et al. , J. High Energ. Phys. (2012) 2012: 137