Distance of Closest Approach and Unfolding Study to Infer Bottom and Charm Quark Production in p+p Collisions at $\sqrt{s} = 200\text{GeV}$ in the PHENIX Experiment

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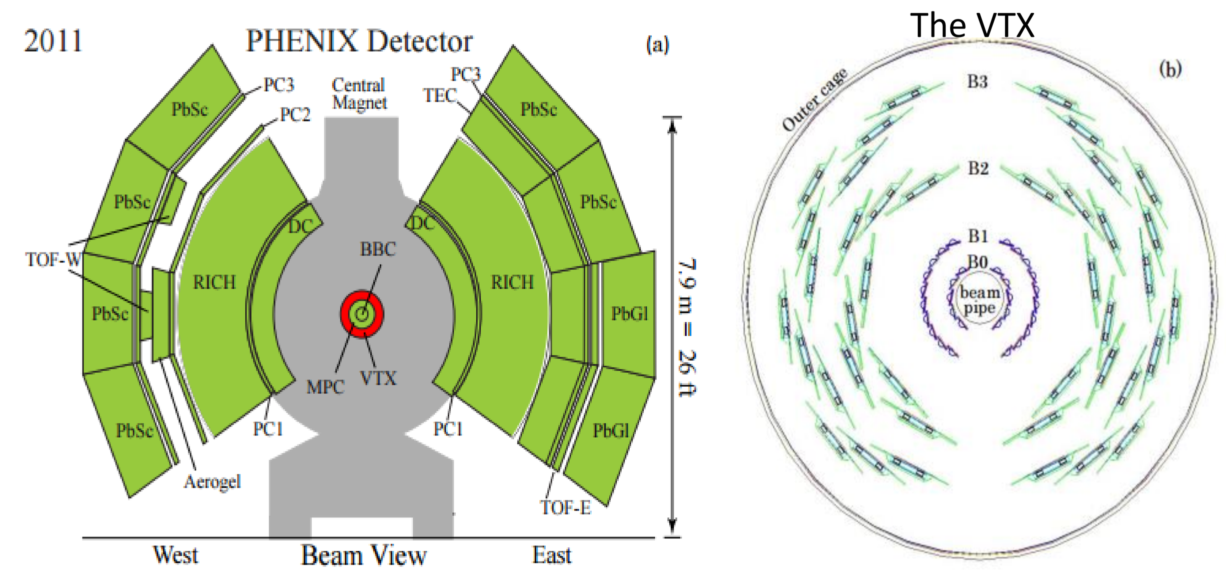
Motivation

- Heavy quarks produced in hard scattering processes are great probes of the Quark Gluon Plasma (QGP) produced in high energy heavy ion collisions
- Combining measured yields of bottom and charm hadrons in both Au+Au and p+p events we can make a measurement of the mass dependence of the energy loss in the QGP

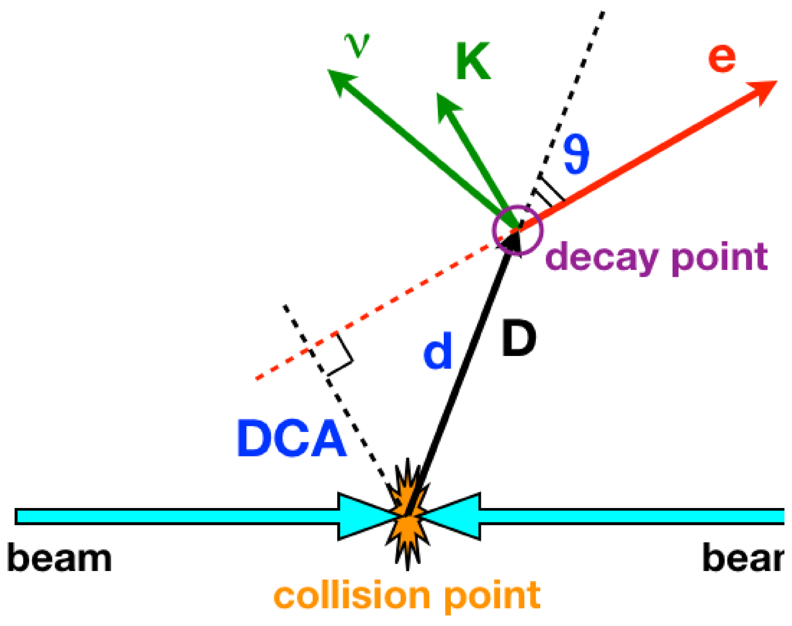
The PHENIX experiment

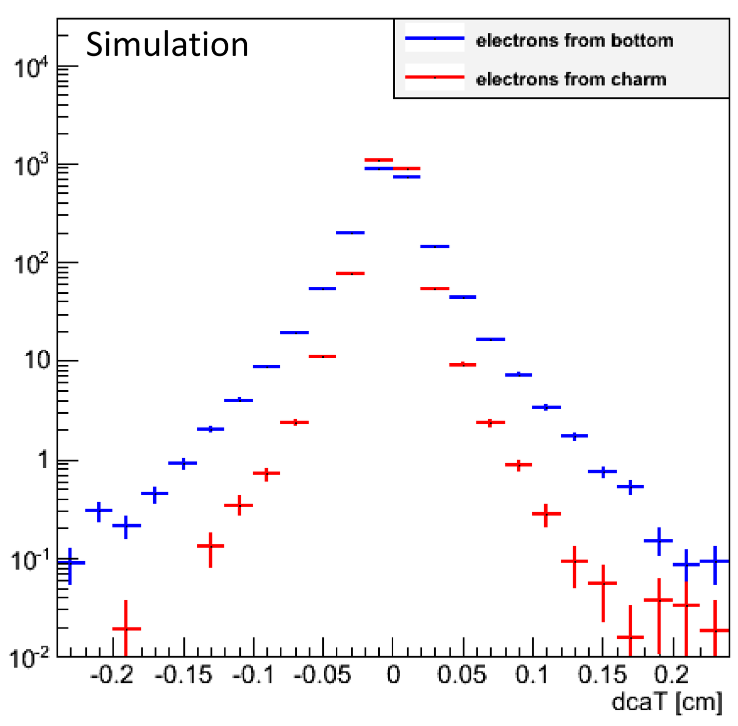
- PHENIX experiment comprises two central arms which provide $|\eta| < 0.35$ and a combined azimuthal angle coverage of $\Delta\phi = \pi$
- Silicon Vertex Detector (VTX) in PHENIX provides accurate vertex determination and high resolution tracking



Distance of Closest Approach

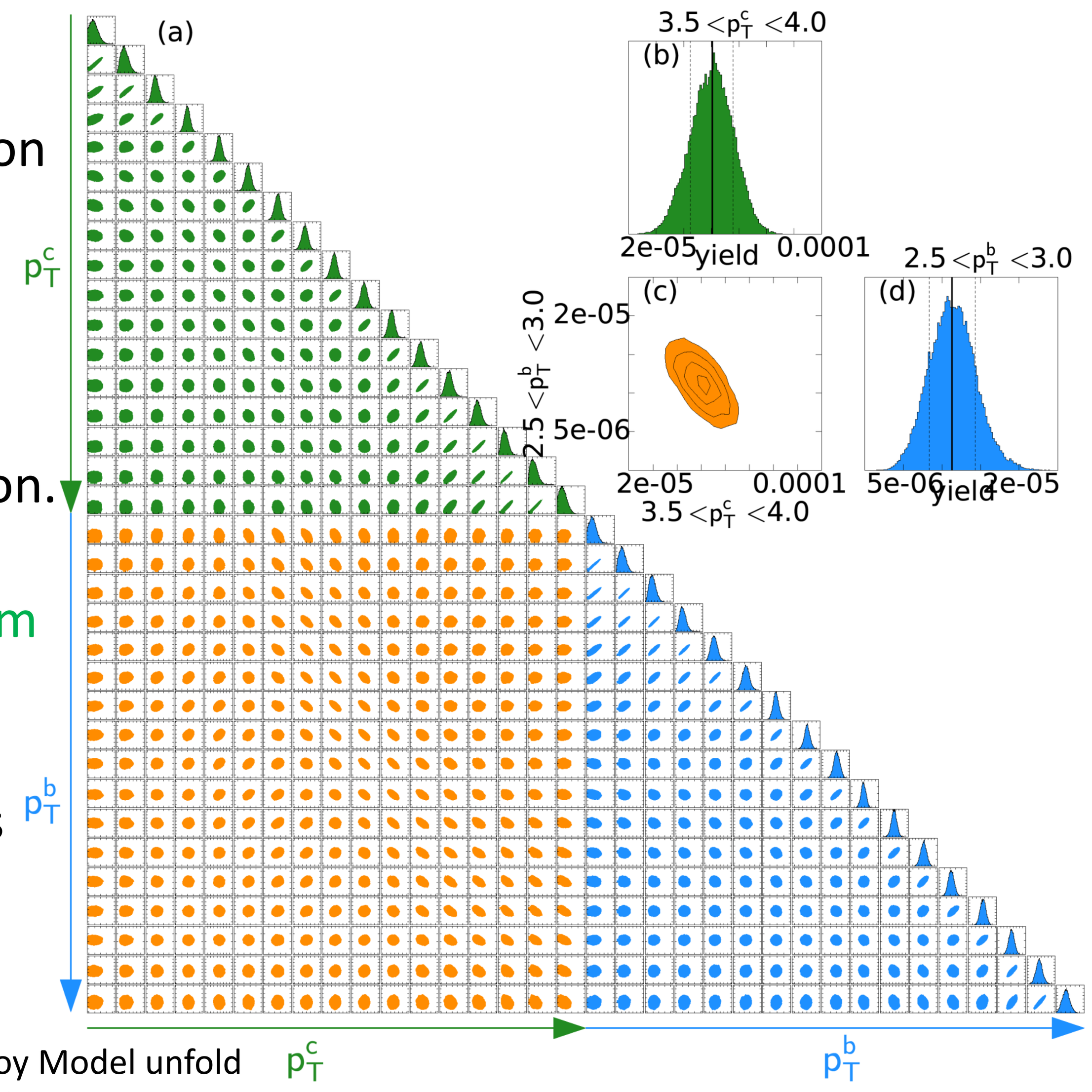
- VTX allows for calculation of distance of closest approach (DCA) of central arm tracks to the collision vertex
- Semileptonic decays of bottom and charm hadrons have distinguishable DCA distributions due to differences in life time and decay kinematics





Unfolding

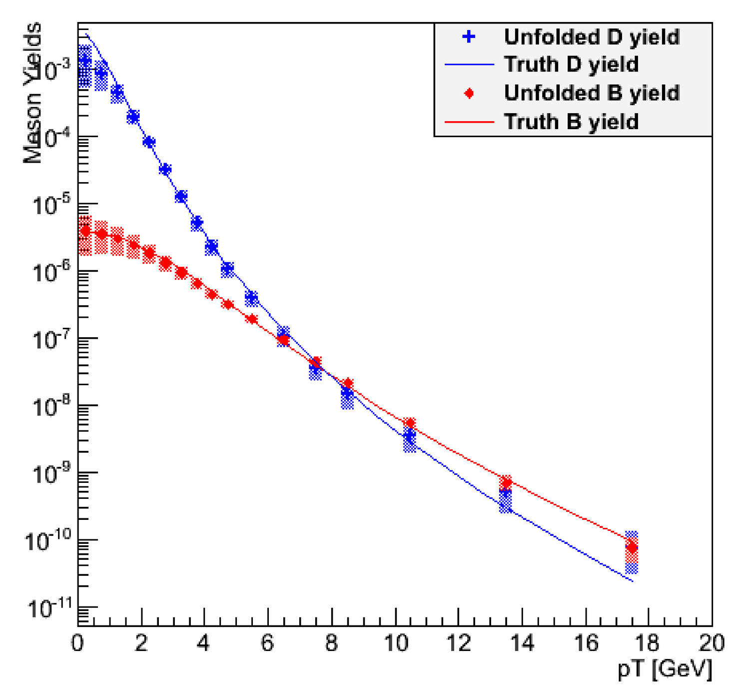
- Bayesian unfolding technique
- Takes both heavy flavor electron invariant yields, and electron DCA_T distributions as input
- Sampling method selects trial hadron yields and compares them using a likelihood function.
- Uses an *a-priori* model of the decay kinematics of both charm and bottom to extract joint probability distributions, and posterior probability functions
- Hadron yields of both bottom and charm hadrons are extracted from the posterior probability distributions

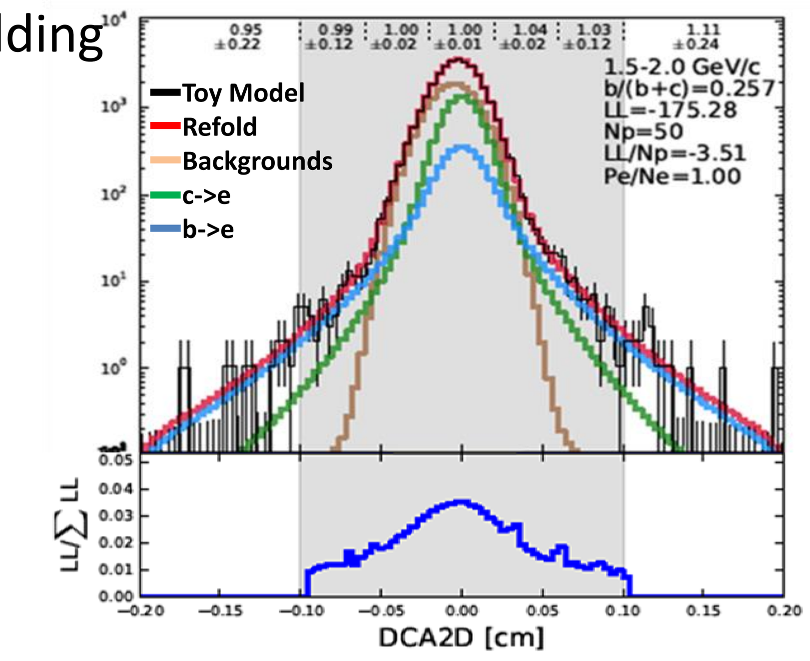


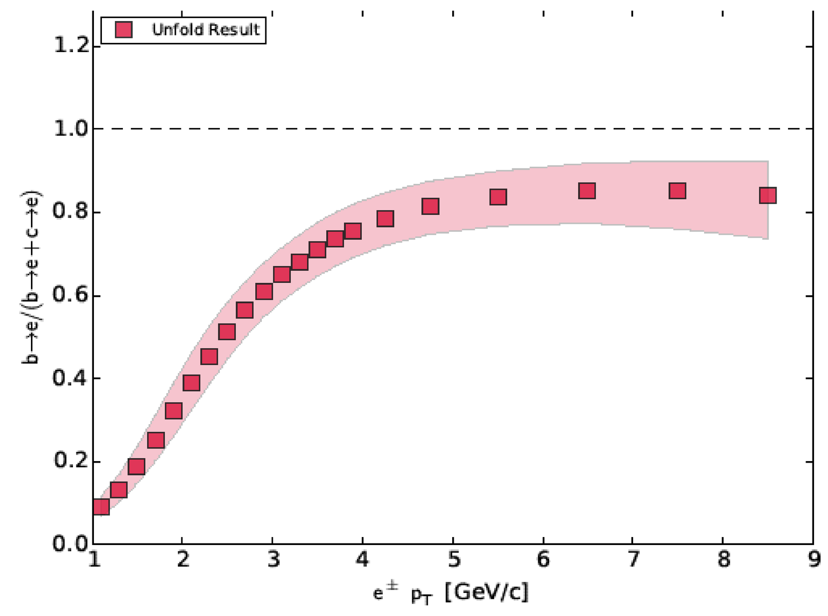
Toy Model unfold
a.) shows joint probability distributions of hadron yields, showing correlations between the parameters. Along the diagonal are the marginalized posterior probability distributions, from which the yields were extracted.
b.) and d.) highlight how the yield is determined and c.) shows an example of the anti-correlation between b and c hadron yields at mid p_T

Testing the Unfolding

- Unfolding provides full set of parent bottom and charm hadron yields
- Hadron yields are piped through decay matrices to extract results in electron space.
- Results shown are from a toy-model unfolding

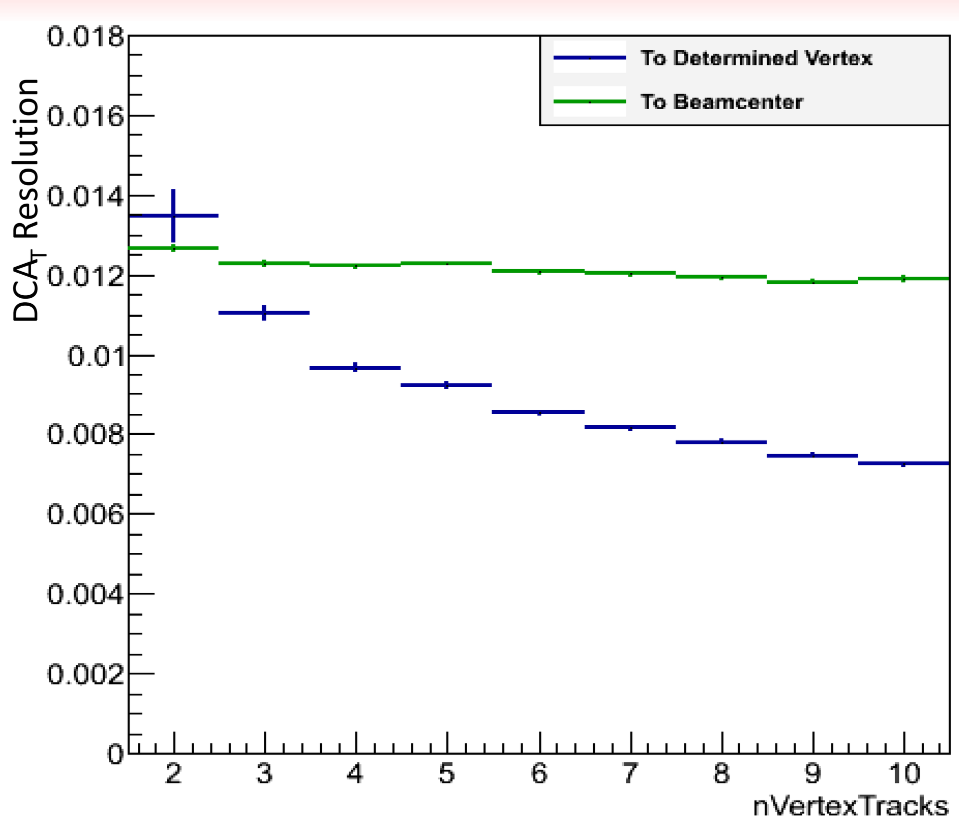






DCA resolution and Removing Bias

- Lower multiplicity in p+p compared to Au+Au
- In b->e and c->e events, on average 6 tracks used in vertex determination
- Remove bias in DCA measurement a recalibrator was written to recalculate vertex without electron tracks
- DCA resolution improved by using a weighted average of the vertex measured by the VTX with the beam center.



Outlook

- Using the unfolding technique with both the 2014 AuAu and 2015 pp datasets we will be able to provide an accurate measurement of both bottom and charm hadron R_{AA}
- Will allow for an accurate measurement of bottom and charm hadron energy loss due to the QGP with enough accuracy to help distinguish between various theoretical models of energy loss