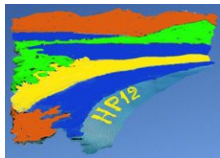


Reconstructed Jet Results in p+p, d+Au and Cu+Cu collisions at 200 GeV from PHENIX

Dennis V. Perepelitsa
Columbia University
for the PHENIX Collaboration

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Cagliari, Sardinia, Italy

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Introduction

Jets in PHENIX

Gaussian Filter

Analysis Techniques

p+p

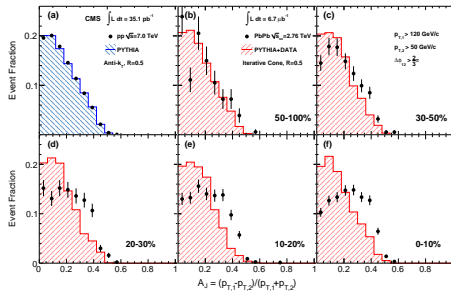
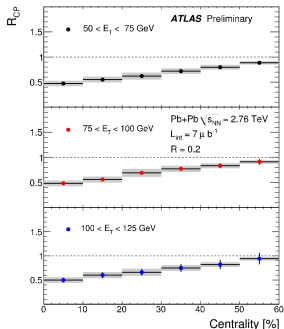
Cu+Cu

d+Au

nPDF effects

Outlook

Jets in Heavy Ion Collisions



▶ Jet reconstruction is being done in heavy ion collisions at RHIC and the LHC:

- ▶ Reconstruct full fragmenting parton kinematics at LO.
- ▶ Sensitive probe of suppression/quenching effects.

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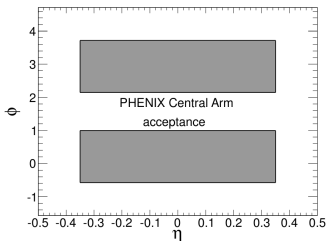
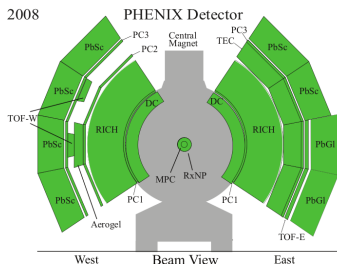
nPDF effects

Outlook

Why Jets at RHIC?

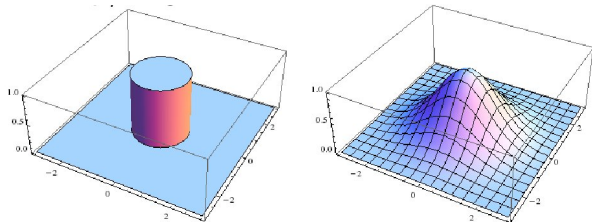
- ▶ Complementary set of measurements from two high statistics colliders!
 - ▶ Can measure jet modification at:
 - ▶ lower energies due to smaller underlying event
 - ▶ different x and Q^2 (different mixture of quark and gluon jets)
 - ▶ Versatility of collision species provides:
 - ▶ ability to vary system size, energy density, geometry
 - ▶ control against cold nuclear matter effects
- ⇒ hard probes analyses from $Cu+Au$ and $U+U$ in progress!

PHENIX detector



- ▶ Drift Chamber (DC), Pad Chambers (PC) and Ring Imaging Čerenkov Detector (RICH) measure charged hadrons and electrons
- ▶ Electromagnetic Calorimeter (EMCal) clusters photons, π^0 's, (some) neutral hadrons
- ▶ EMCal/RICH Trigger (ERT) and the high PHENIX DAQ rate allow complementary Minimum Bias and high- p_T triggered datasets

Gaussian Filter algorithm

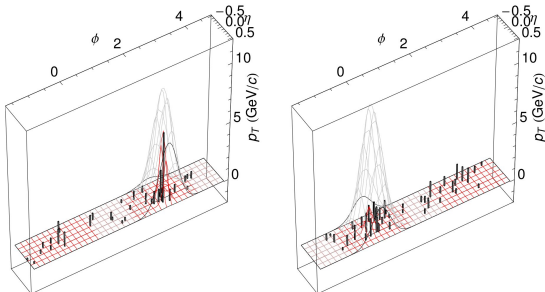


- ▶ Seedless, cone-like algorithm with a Gaussian angular weighting (nucl-ex/0806.1499)

$$p_T^{\text{jet}} \equiv \max \left\{ \int \int d\eta' d\phi' p_T(\eta', \phi') e^{-(\Delta\eta^2 + \Delta\phi^2)/2\sigma^2} \right\}$$

- ▶ Developed for use in heavy ion collisions.
- ▶ Focuses on the energetic core of the jet, optimizing S/B
- ▶ Stabilizes the jet axis in the presence of background

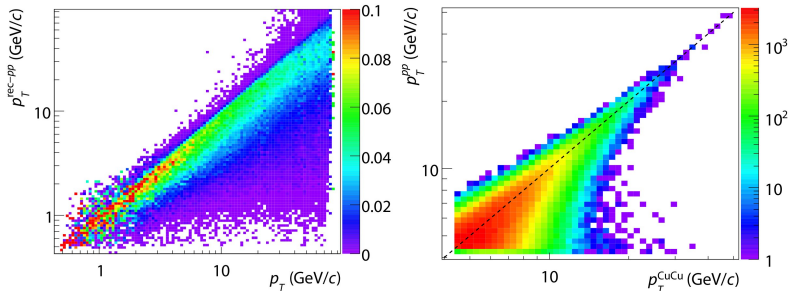
Fake jet rejection



9.6 GeV/c jet passing fake rejection Rejected 10.8 GeV/c background fluctuation

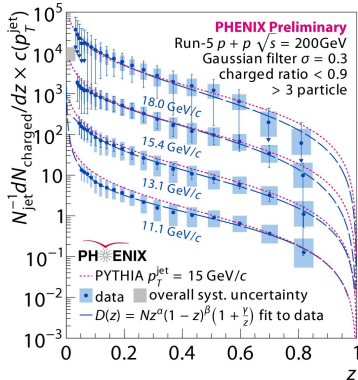
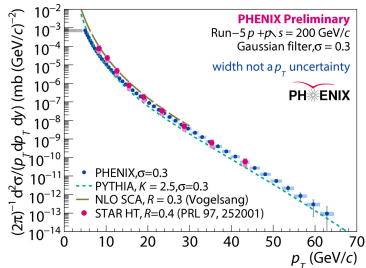
- ▶ Technique to separate low- p_T jets from underlying event fluctuations in HI collisions on a *jet by jet* basis.
- ▶ Similar to “angularly-weighted” p_T which rewards jets with a tight core of energy and punishes diffuse jets.
 - ⇒ efficient saturation with reconstructed p_T
 - ⇒ trade reconstruction efficiency for sample purity
 - ⇒ data-driven approaches set threshold

Energy Scale



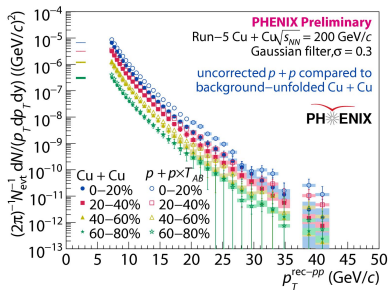
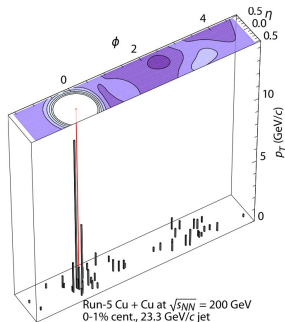
- ▶ In PHENIX, energy “resolution” driven by tracking inefficiency, loss of n, K_L^0 neutral energy, edge of acceptance effects.
- ▶ PYTHIA Tune A 2 \rightarrow 2 QCD events from $Q^2 = 0.5$ to 64 GeV.
 - \Rightarrow Cross-checks with HERWIG, other PYTHIA tunes
 - \Rightarrow Embedding into real heavy ion background.
- ▶ NLO calculation + hadronization correction in progress that will allow proper comparison to data.

Jets in $p+p$ at $\sqrt{s} = 200$ GeV



- ▶ Demonstration of PHENIX jet reconstruction and gaussian filter algorithm capability:
 - ▶ comparison with NLO pQCD across ten orders of magnitude.
- ▶ Fragmentation function ($z = p_{\parallel}^{\text{particle}}/p^{\text{jet}}$) measurement:
 - ▶ required development of n-dimensional generalization of SVD unfolding in GURU!

Jets in $Cu+Cu$ at $\sqrt{s} = 200$ GeV



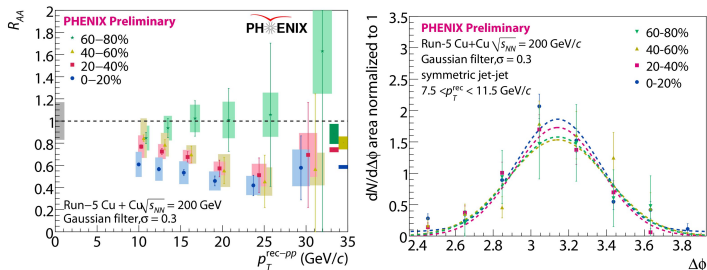
► p_T -feeding from underlying event:

- subtraction of centrality- and z-vtx parameterized average background

► p_T -smearing from UE fluctuations:

- evaluated through embedding $p+p$ jets into $Cu+Cu$ minimum bias events
- results shown here unfolded to $p+p$ reconstructed scale

Suppression without de-correlation in $Cu+Cu$



- ▶ Suppression of reconstructed jet R_{AA} :
 - ⇒ over a wide p_T range
 - ⇒ increasing suppression in more central collisions
- ▶ Reconstructed di-jet $\Delta\phi$ distributions unmodified:
 - ⇒ no angular de-correlation in central collisions!

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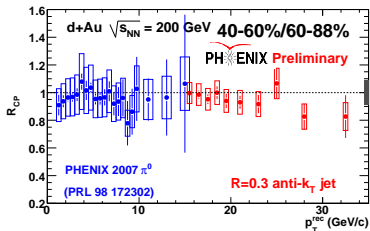
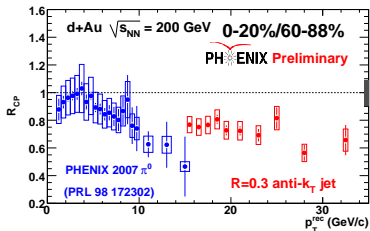
p+p

Cu+Cu

d+Au
nPDF effects

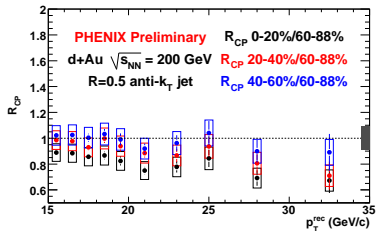
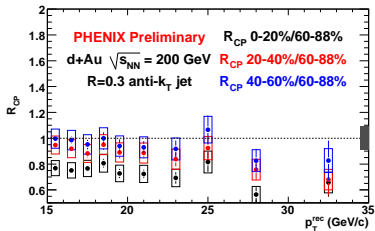
Outlook

Jets in $d+Au$ at $\sqrt{s} = 200$ GeV



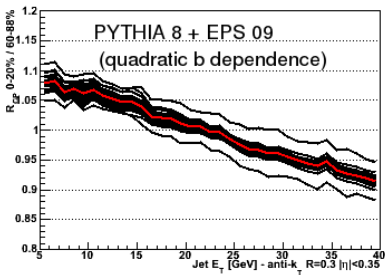
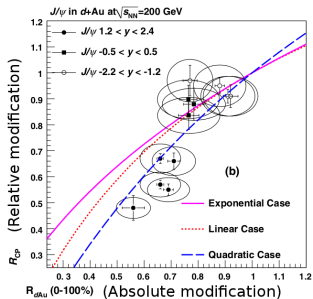
- ▶ anti- k_T jet reconstruction with $R = 0.3, 0.5$
- ▶ Reconstructed jet R_{CP} at the $p+p$ reconstructed scale.
 - ▶ relative to peripheral collision baseline
 - ▶ p_T -feeding from modest underlying event evaluated with embedding procedure and unfolded
- ▶ Suppression effect consistent with single-particle π^0 measurement.
 - ⇒ cold nuclear matter energy loss?
 - ⇒ impact parameter dependence of nPDFs?

Jets in $d+Au$ at $\sqrt{s} = 200$ GeV



- ▶ Multiple cone sizes provide additional control against effects of underlying event
- ▶ R_{CP} exhibits increasing suppression with decreasing impact parameter
- ▶ Ongoing improvements to analysis will produce:
 - ▶ R_{dA}
 - ▶ lower p_T behavior
 - ▶ results at p_T^{truth} scale

nPDF effects in $d+Au$ R_{CP}



- ▶ Nuclear PDF sets do not parameterize impact parameter dependence:

⇒ K. Eskola, Plenary 4B and I. Helenius, Parallel VC

- ▶ Leading-order toy study with EPS09 parameters (nucl-th/1011.4534):

⇒ quadratic b -dependence of Au nPDF from PHENIX J/ψ data, (PRL 107, 142301 (2011))

⇒ suppression from nPDF effects underpredicts data

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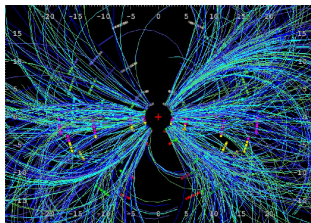
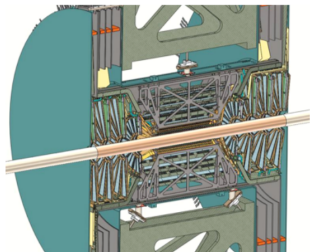
d+Au

nPDF effects

Outlook

Outlook

- ▶ Jet reconstruction efforts at PHENIX are ongoing.
- ▶ Preliminary results from $d+Au$ jet reconstruction:
 - ⇒ suppression effect at high- p_T
 - ⇒ consequences for interpretation of $A+A$ results!
- ▶ PHENIX capability for jet measurements improving:
 - ⇒ VTX (silicon vertex tracker) and FVTX (forward silicon vertex tracker)



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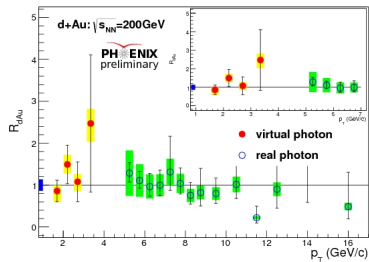
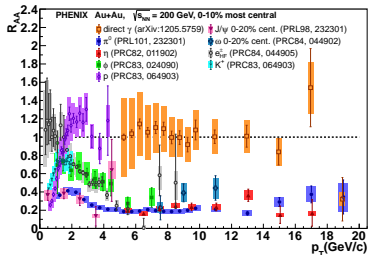
Cu+Cu

d+Au
nPDF effects

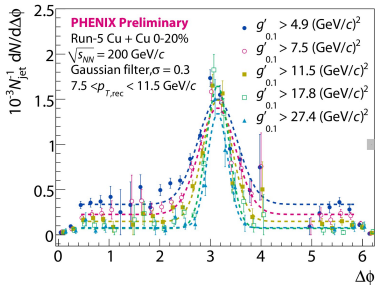
Outlook

BACKUP

Backup Plots I

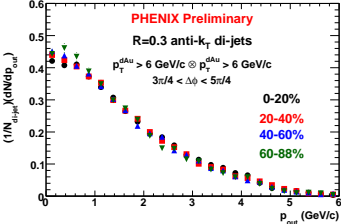
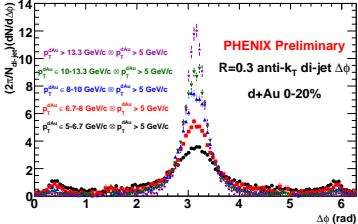


Backup Plots II



$$g_{\sigma_{dis}}(\eta, \phi) \equiv \sum_{i \in \text{fragment}} (p_T)_i^2 \exp\left(-(\Delta\eta^2 + \Delta\phi^2)/2\sigma_{dis}^2\right)$$

Backup Plots III



$$p_{\text{out}} (= \langle k_T \rangle) \equiv (p_T)_{\text{low}} \cdot \sin \Delta\phi$$

Backup Plots IV

PHENIX
Jet Results
(19/ 19)

D.V. Perepelitsa

Introduction

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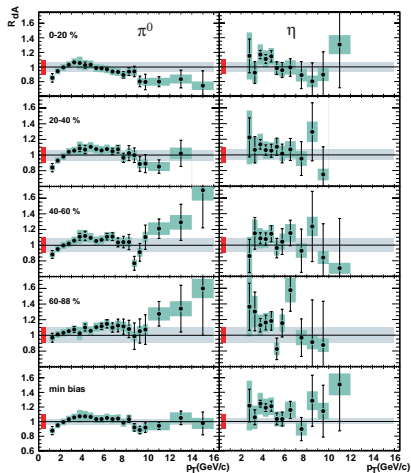
p+p

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Outlook



Phys. Rev. Lett. 98, 172302 (2007)