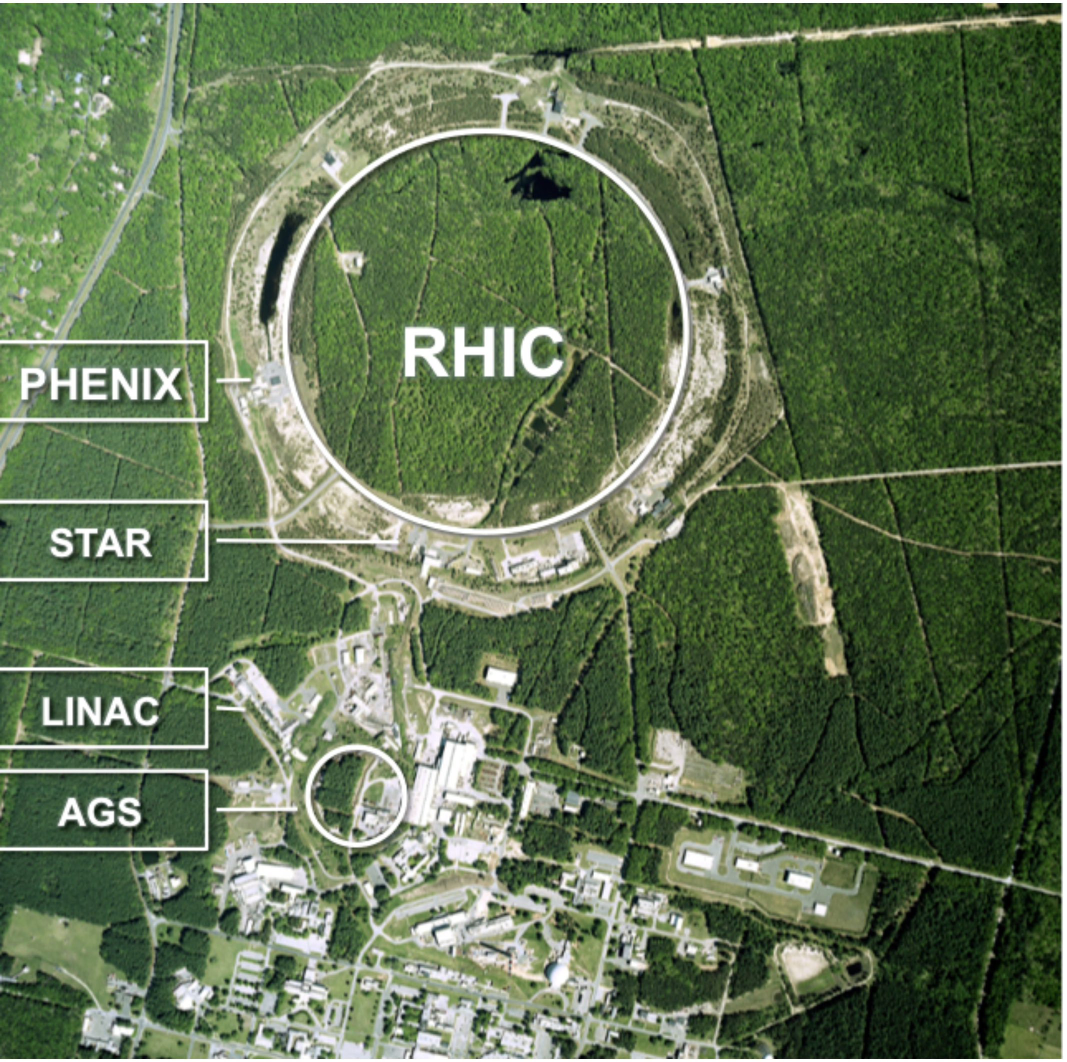
Lake Louise Winter Institute 2016

Results on reconstructed jets with the PHENIX detector at RHIC

Arbin Timilsina (Iowa State University)
for the PHENIX Collaboration

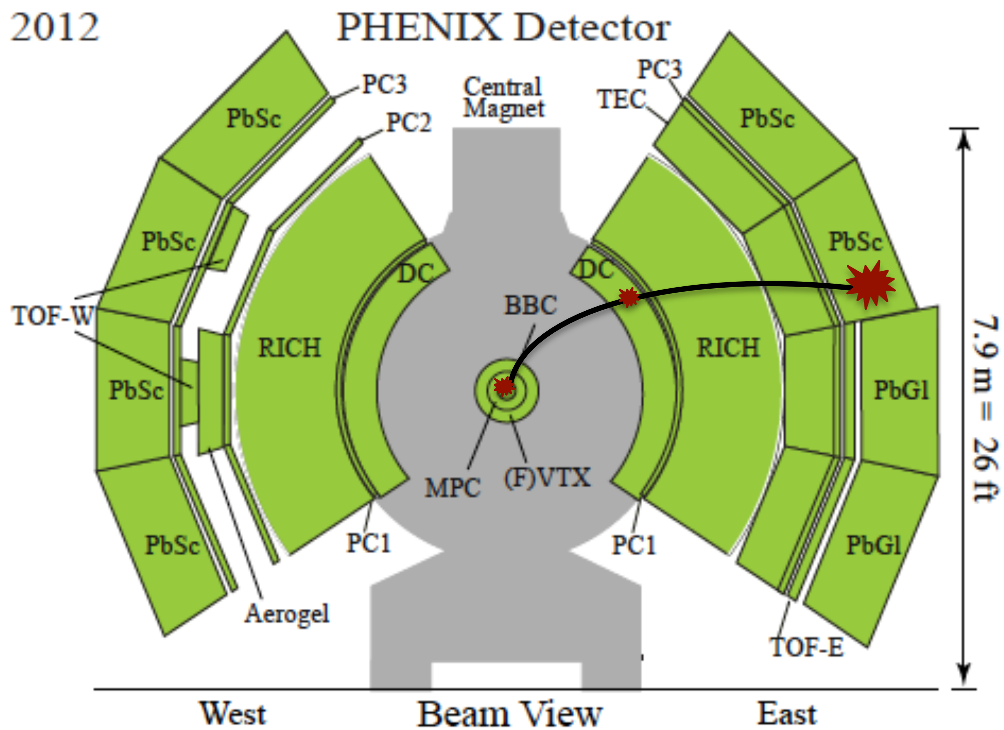
February 13, 2016

Relativistic Heavy Ion Collider (RHIC)



- Two independent intersecting storage rings, 3.8 km circumference
- Accelerates **polarized** *p* up to 250 GeV
- Accelerates *d*, ^{3}He, Cu, Al, Au, U up to 100 GeV

The PHENIX Detector

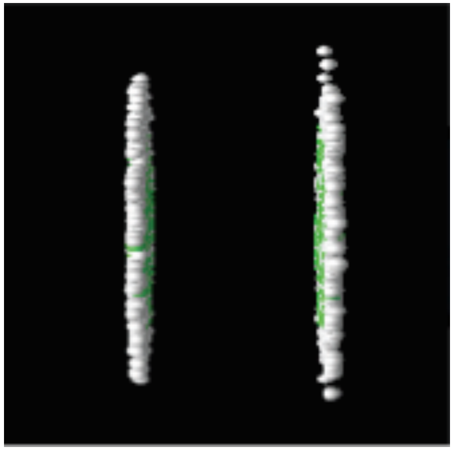


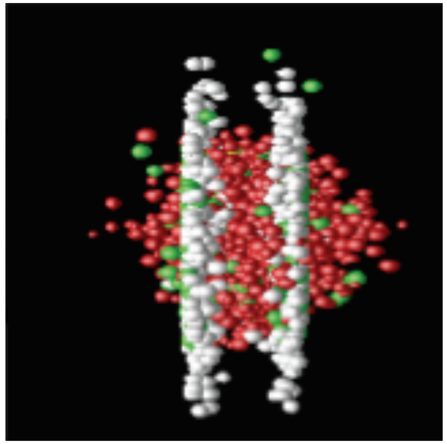
PHENIX central arms: $|\eta| < 0.35$, $\Delta\phi = \pi$

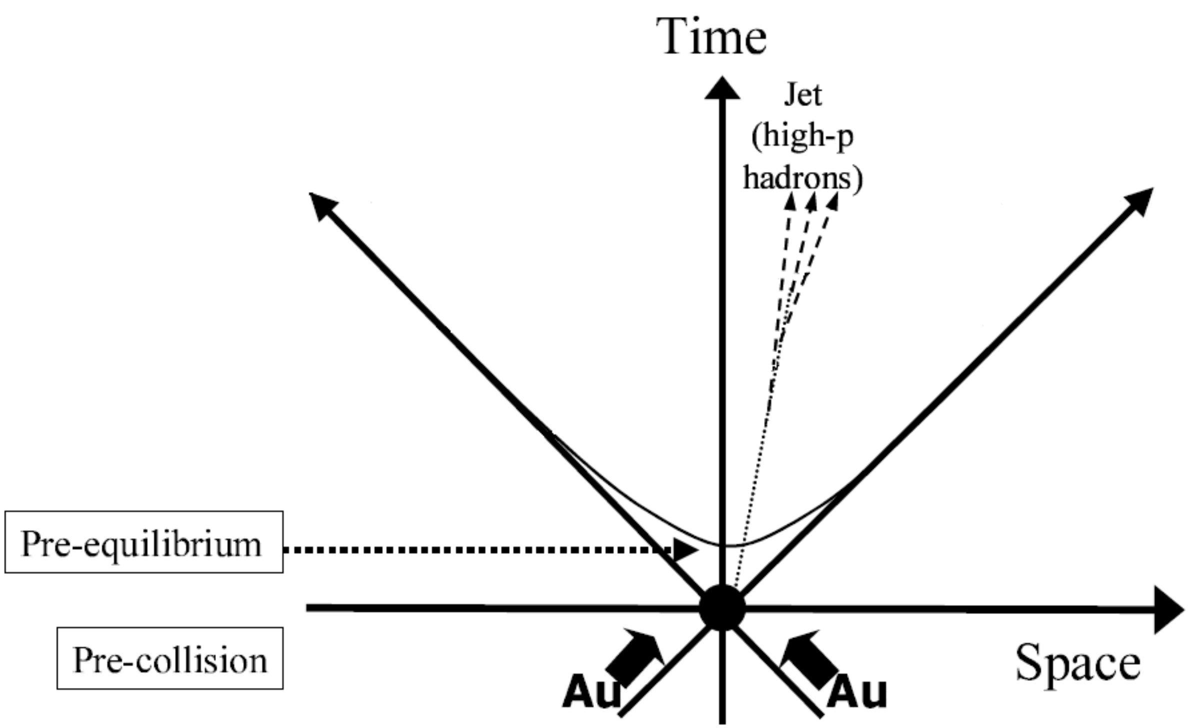
- Charged particle tracks are reconstructed using the Drift Chamber (DC), the Pad Chamber (PC), and the collision point.

- Neutral clusters are measured in the Electromagnetic Calorimeter (EMCal). EMCals (PbSc & PbGl) measures π^0, γ, and some hadrons (with lower efficiency).

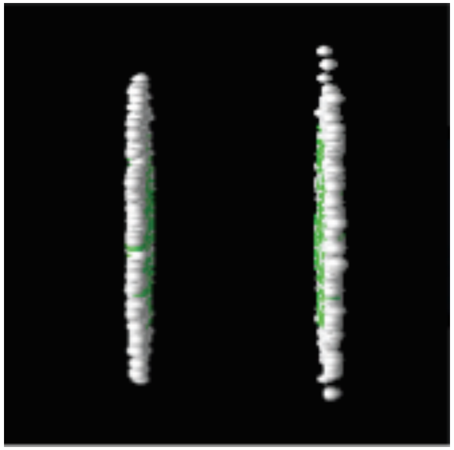
Ultra-relativistic Heavy Ion Collisions

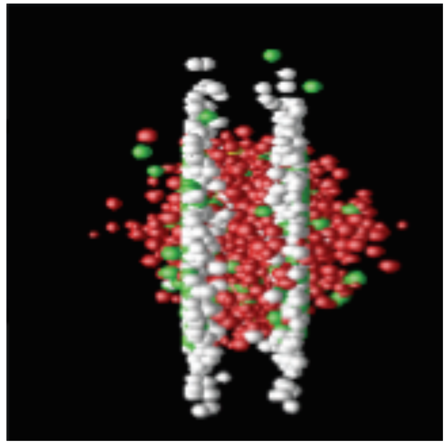


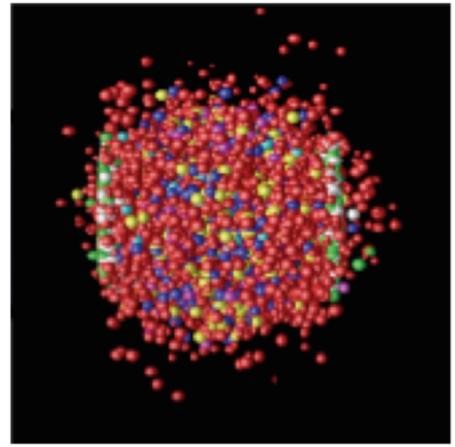


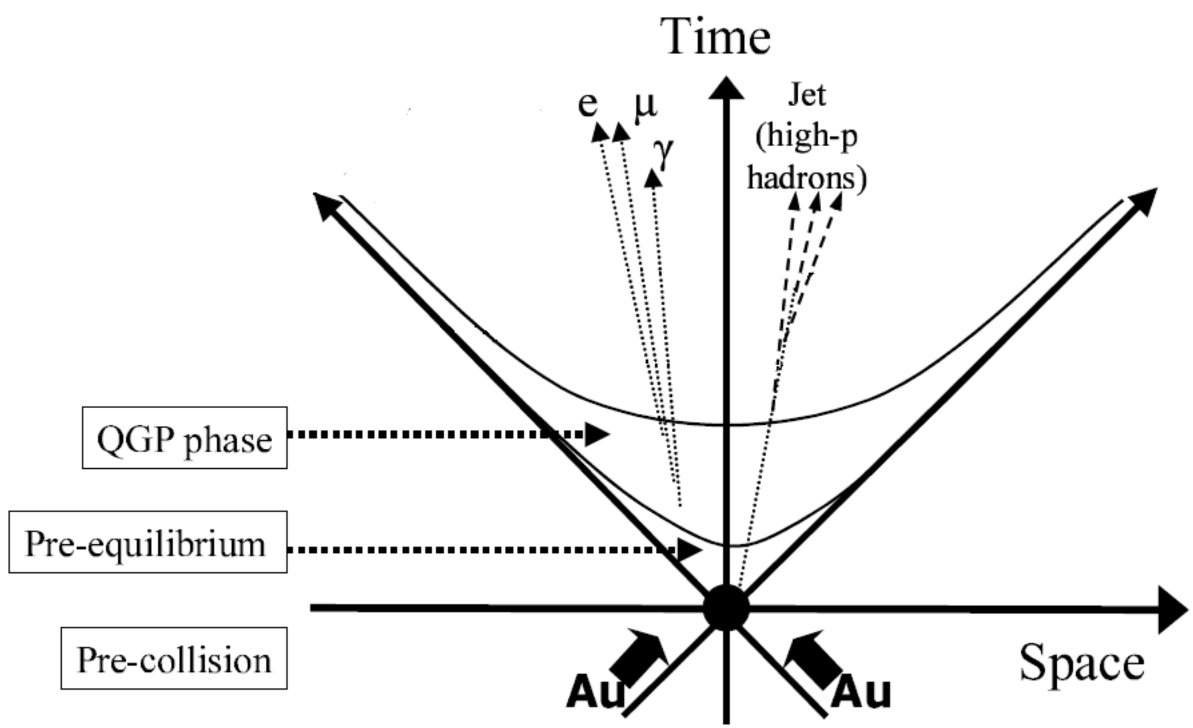


Ultra-relativistic Heavy Ion Collisions

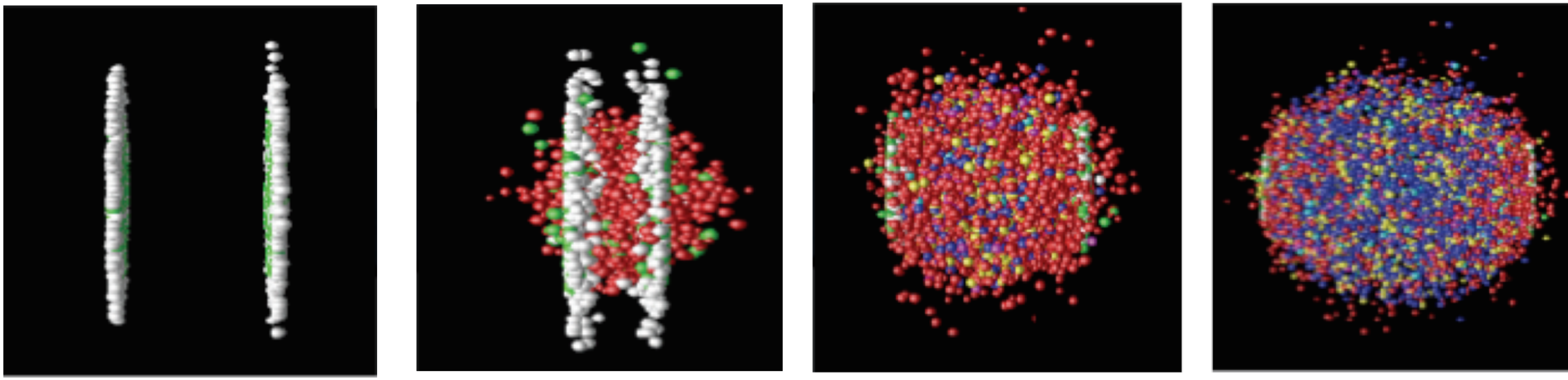


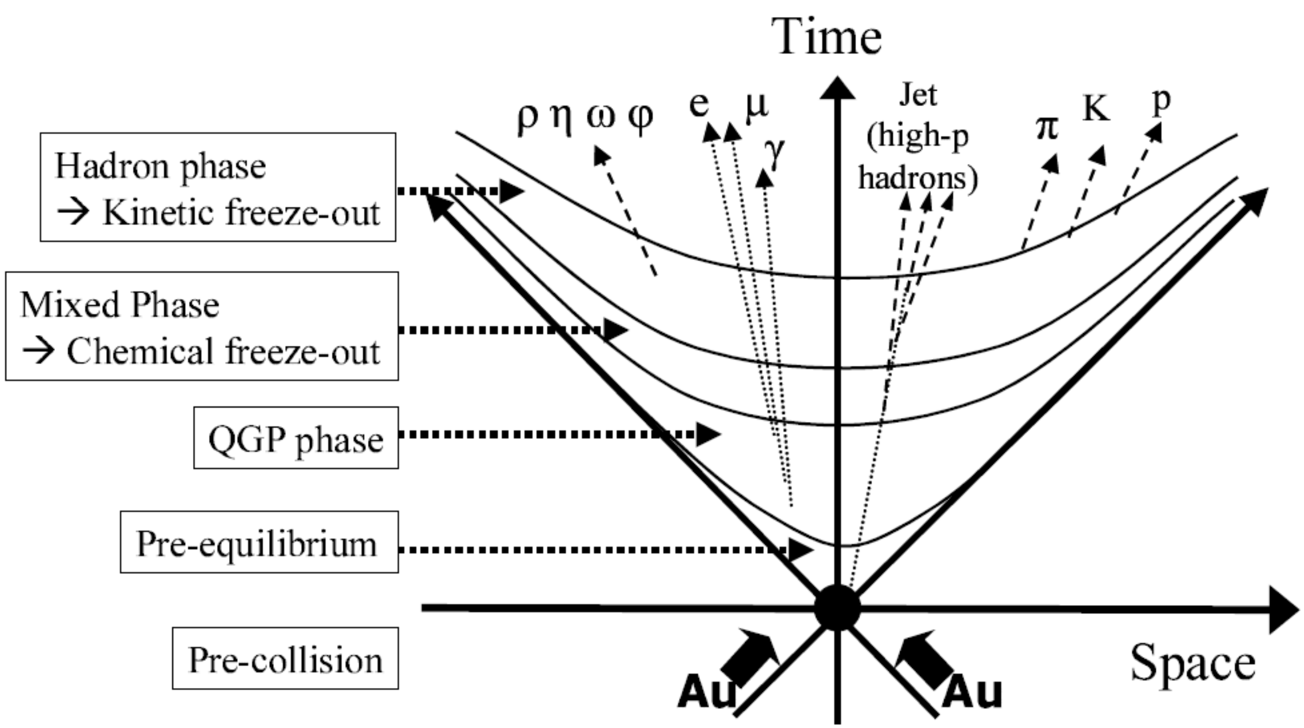




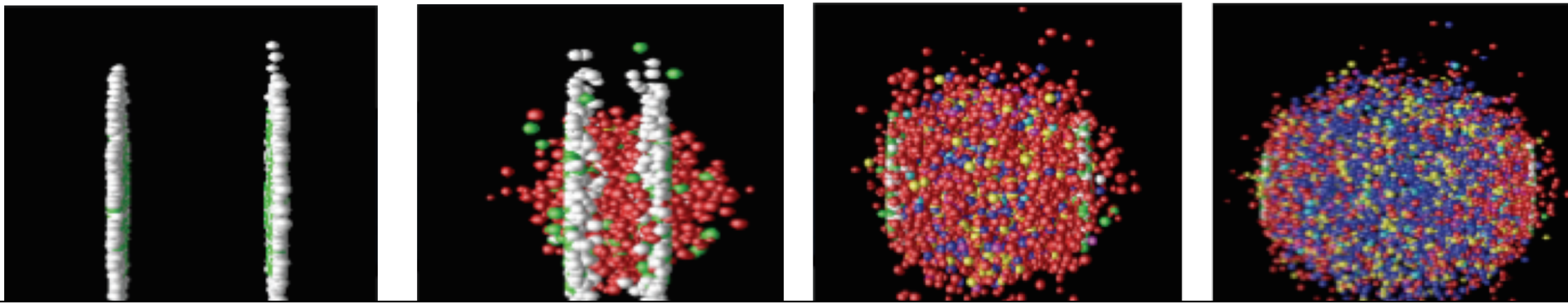


Ultra-relativistic Heavy Ion Collisions

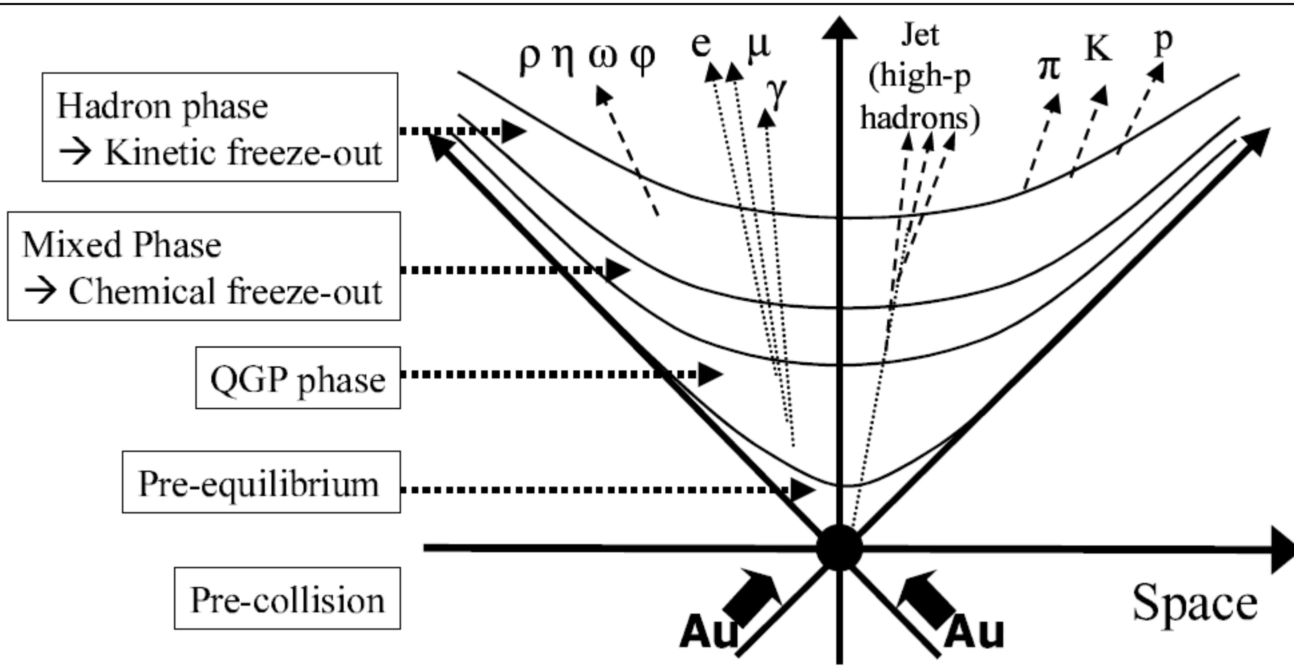




Ultra-relativistic Heavy Ion Collisions



Jet measurements in heavy ion collisions -> quantify the energy loss of hard-scattered partons



Jets in PHENIX

- Jets reconstructed using the anti-k_t algorithm
  - EMCal cluster energy + charged particle tracks

- Jet-level requirements
  - number of constituents ≥ 3
  - restriction on contribution of charged constituents
  - jet axis required to be away from detector edge

- Centrality-dependent response matrices generated by embedding PYTHIA *p+p* jets into real heavy ion events
  - Due to missing neutral hadronic energy and tracking inefficiency, on average, PHENIX gets ≈ 70% of the true jet energy
  - Spectra corrected for detector effects and underlying event fluctuations with unfolding procedure

Jet results from PHENIX

Cu+Au and *p*+*p* jet spectra (2012 data)

- Preliminary measurement, R=0.2 anti-k_t algorithm, stronger underlying event contribution -> choice of smaller cone size

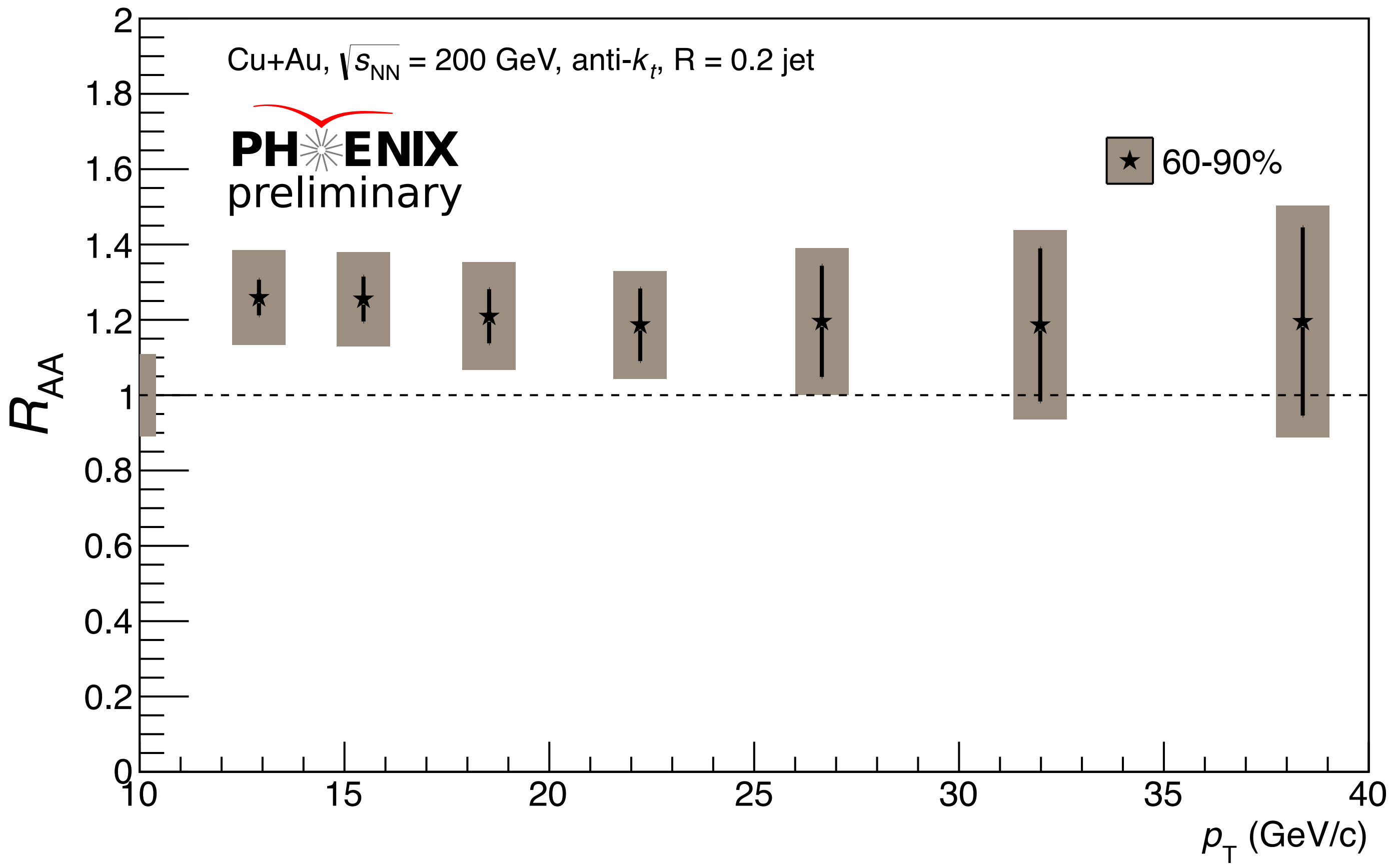
***d*+Au and *p*+*p* jet spectra (2008 data)**

- R=0.3 anti-k_t algorithm
- Submitted to PRL, nucl-ex/1509.04657

Cu+Au collisions

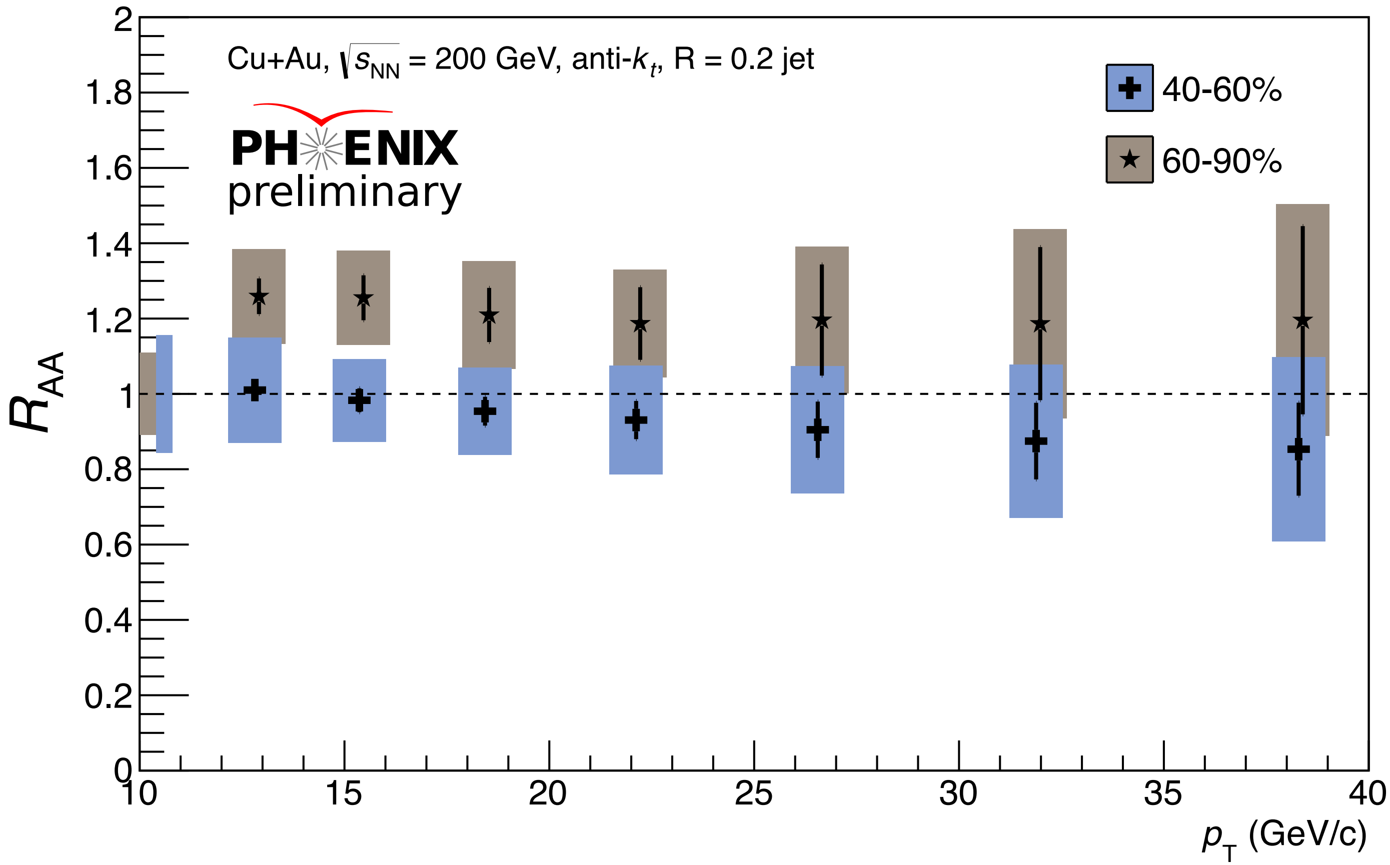
Jet suppression: R_{AA} vs. p_T

$$R_{AA}^{cent} = \frac{\left(\frac{1}{N_{evts}^{cent}} \frac{dN}{dp_T}^{cent}\right)_{CuAu}}{T_{AB}^{cent} \times \frac{d\sigma}{dp_T}}$$



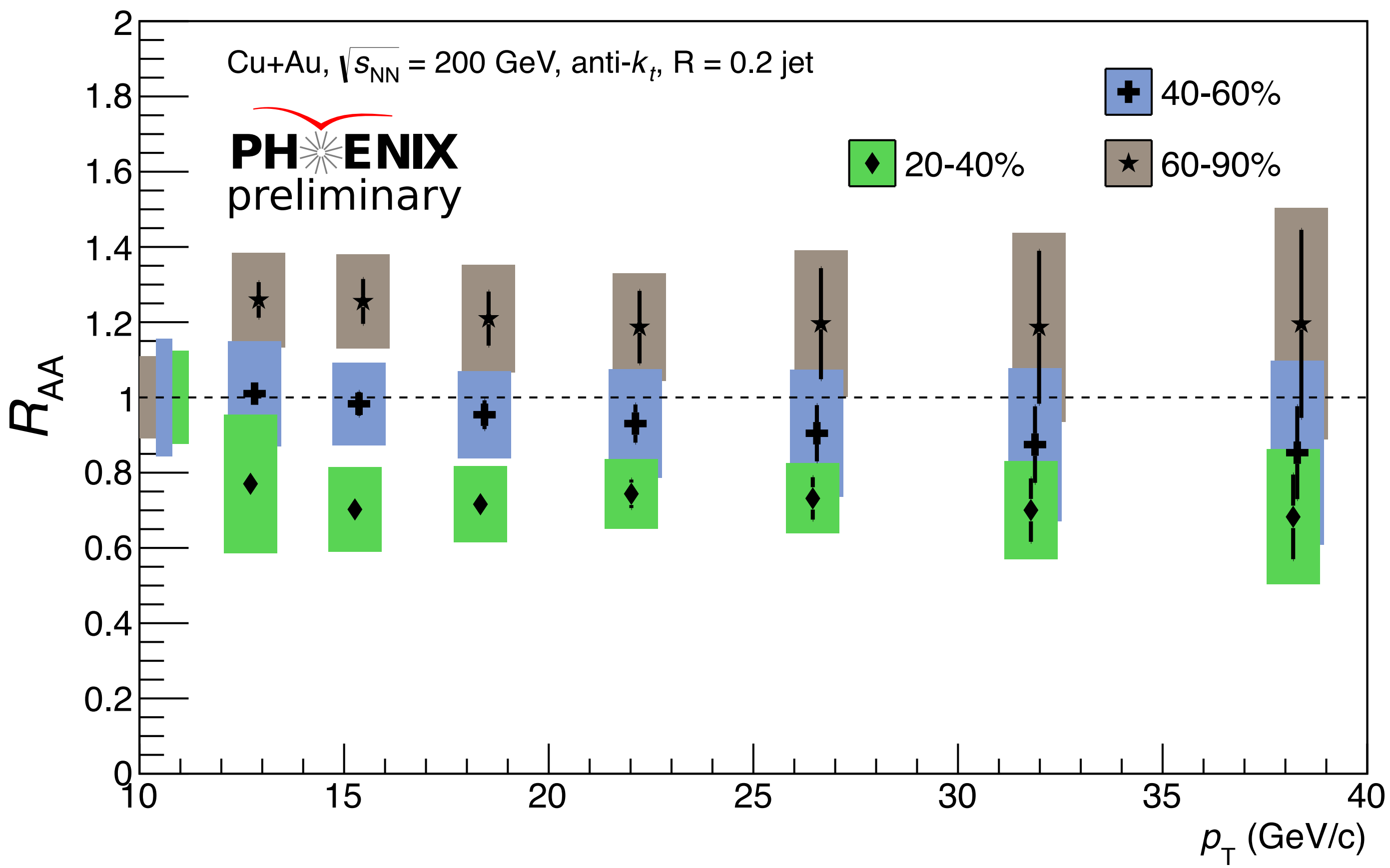
At high p_T, consistent with 1 within the uncertainties

Jet suppression: R_{AA} vs. p_T



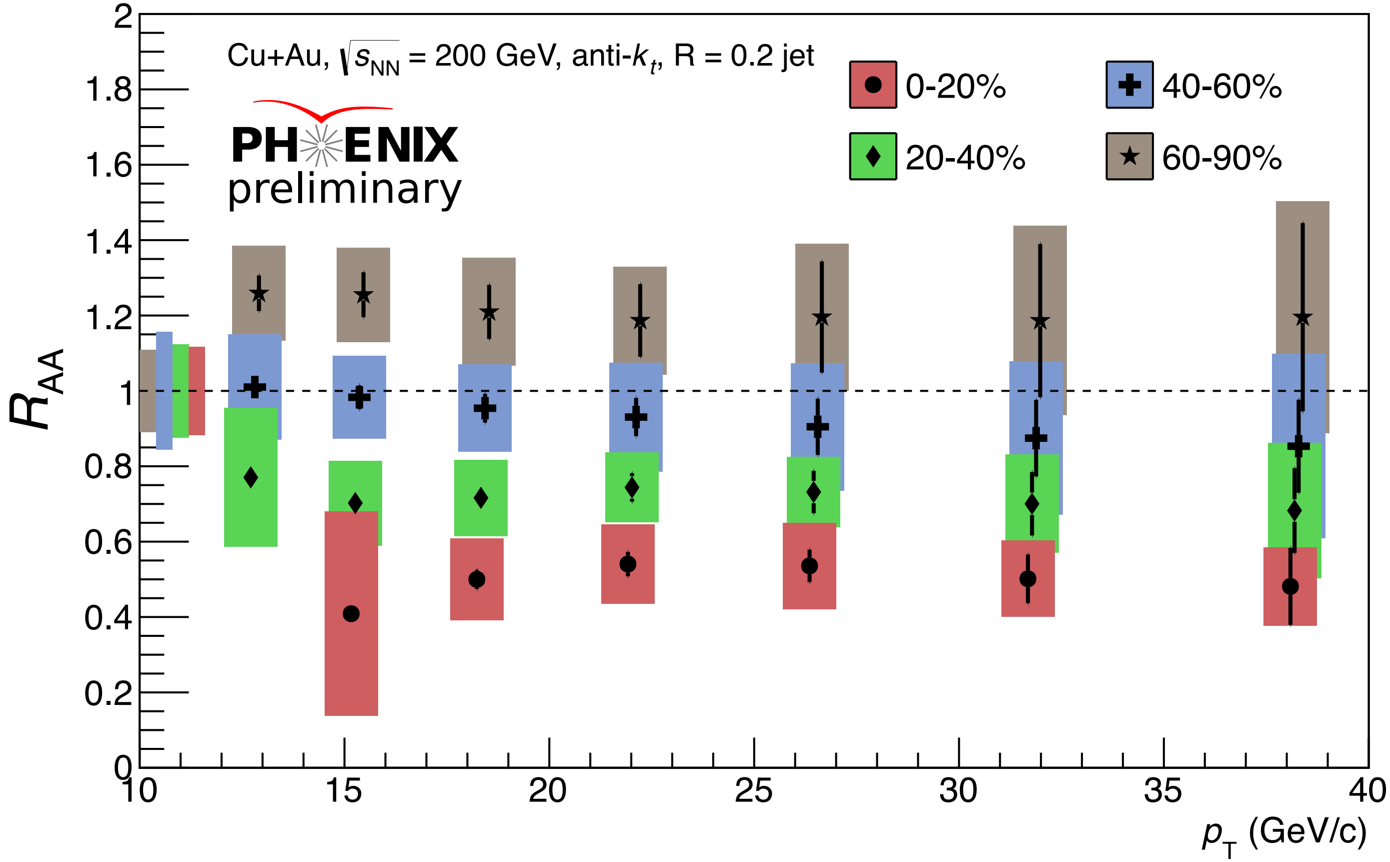
- Suppression shows centrality dependence

Jet suppression: R_{AA} vs. p_T



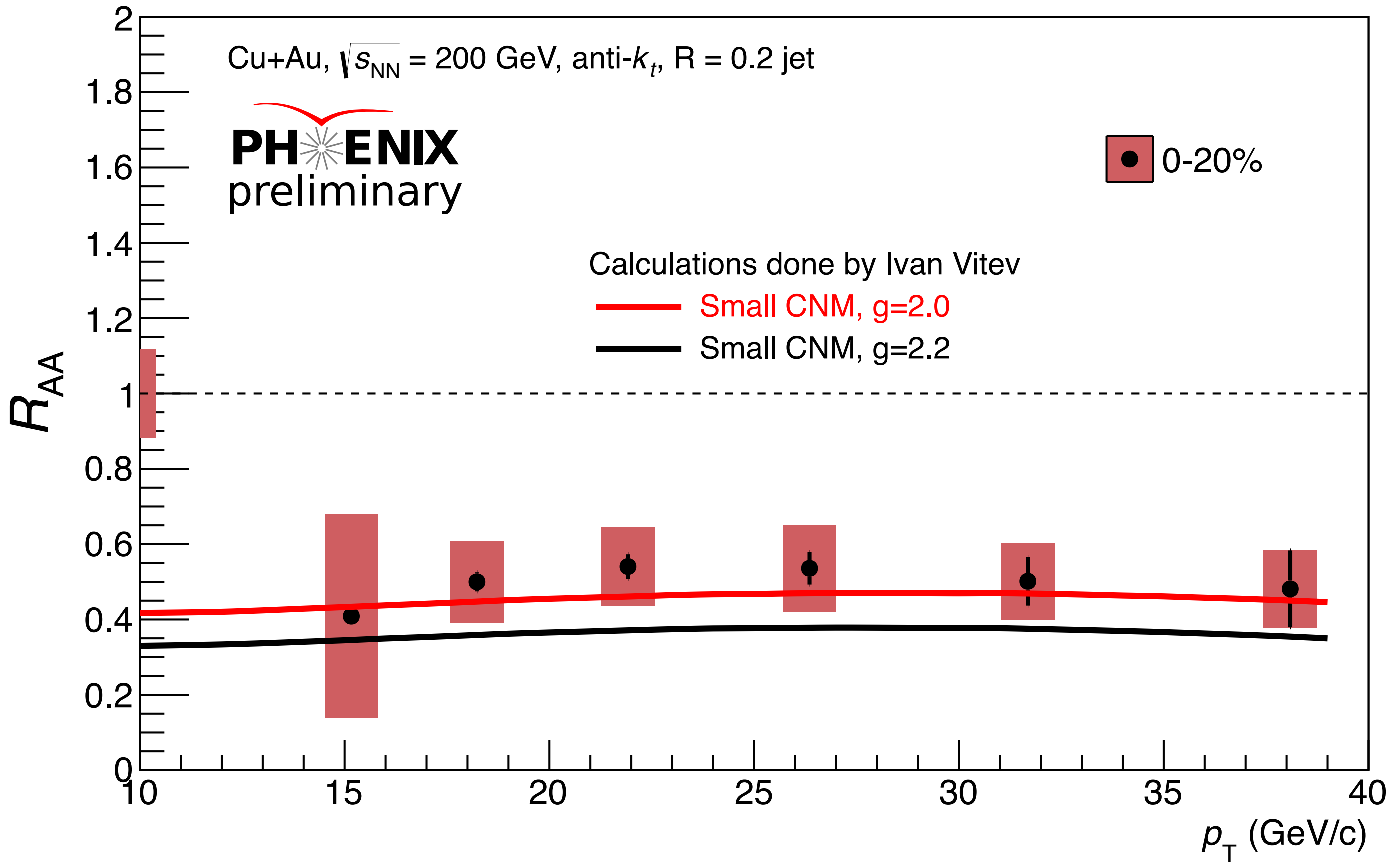
- Suppression shows centrality dependence
- No p_T dependence

Jet suppression: R_{AA} vs. p_T



- For central collisions, jets are suppressed by approximately a factor of two

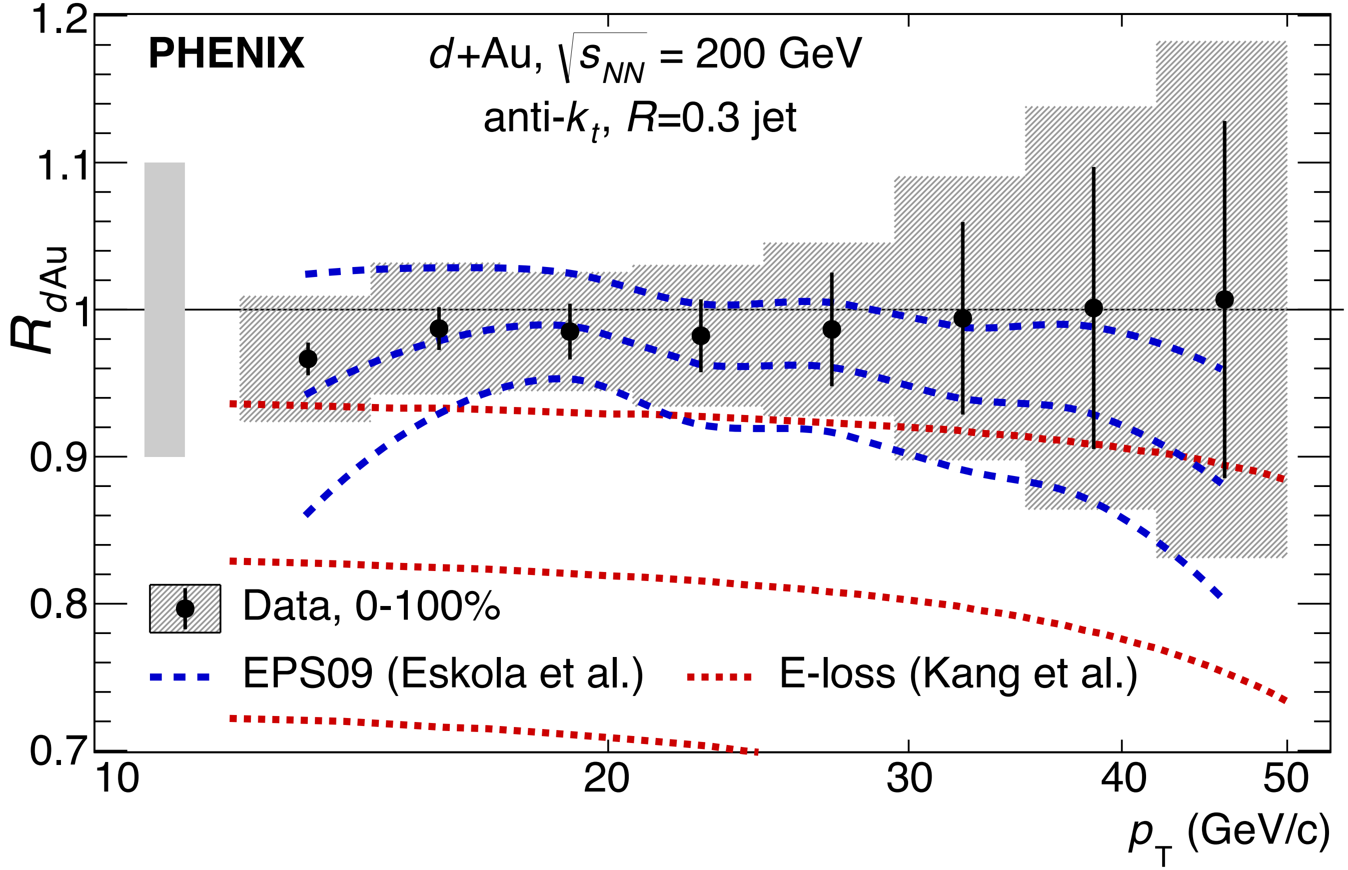
Comparison to theory



- Quantitatively in line with jet quenching calculations
- Calculations done for 2 different couplings between the jet and the medium (g=2.0 and g=2.2). arXiv:1509.07257 [hep-ph], arXiv:1509.02936 [hep-ph]

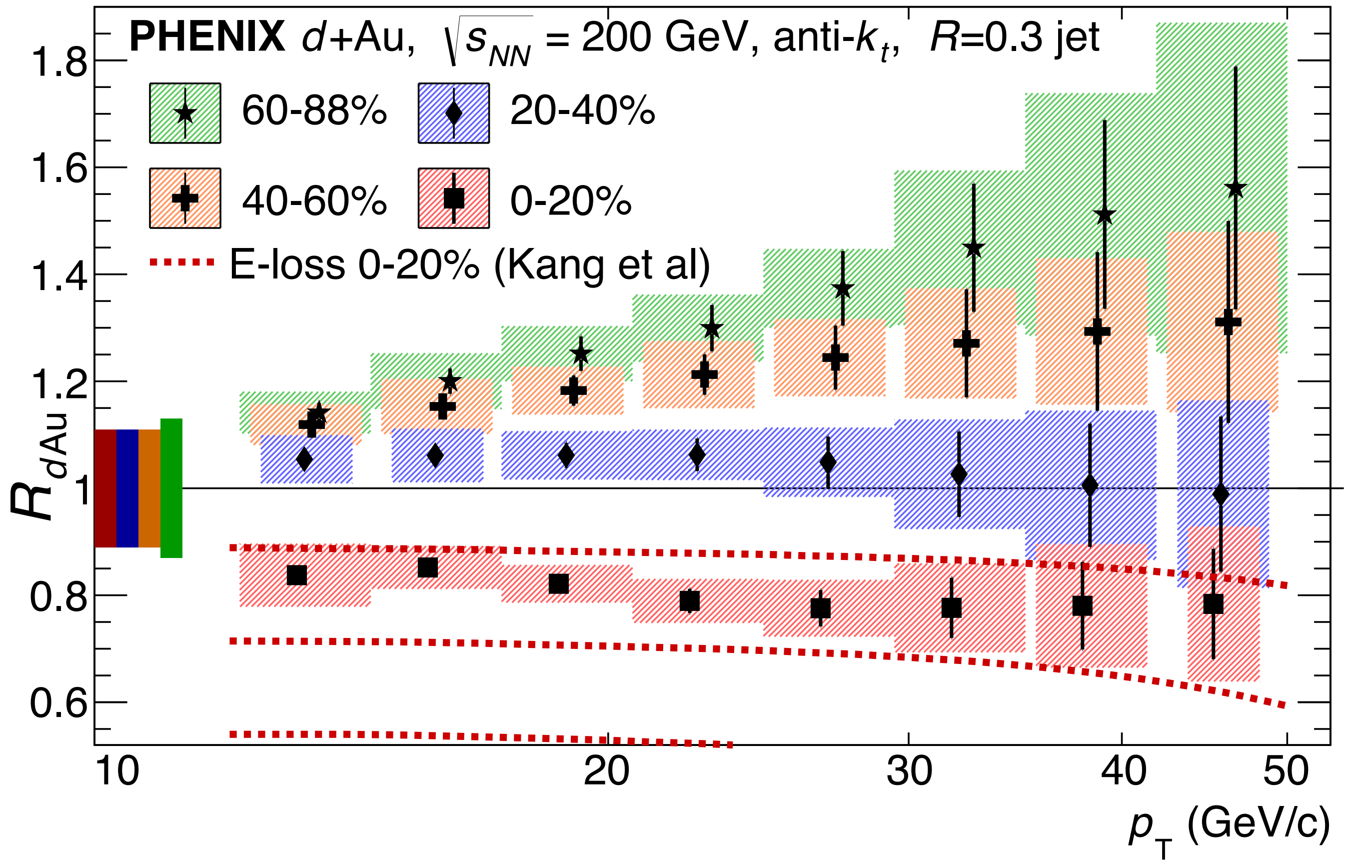
d+Au collisions

Minimum bias jet rate



- In centrality-integrated collisions, R_{dAu} = 1
- Compares favorably to nuclear PDF analyses (EPS09)

Centrality-selected jet rate



- Suppression of jet rate in central 0-20% events, enhancement in 40-60% and 60-88% events
- Suppression in the most central case is comparable to models including initial-state energy loss effects, but enhancement in peripheral is very challenging to understand within these models

Summary

- Progress on jet measurements with PHENIX detector in both large and small systems

- Jets are found to be suppressed by approximately a factor of two in central Cu+Au collisions as compared to *p*+*p* collisions. Suppression shows no p_T dependence.

- Surprising, unexpected centrality dependence in *d*+Au collisions