High p_T particle production in PHENIX

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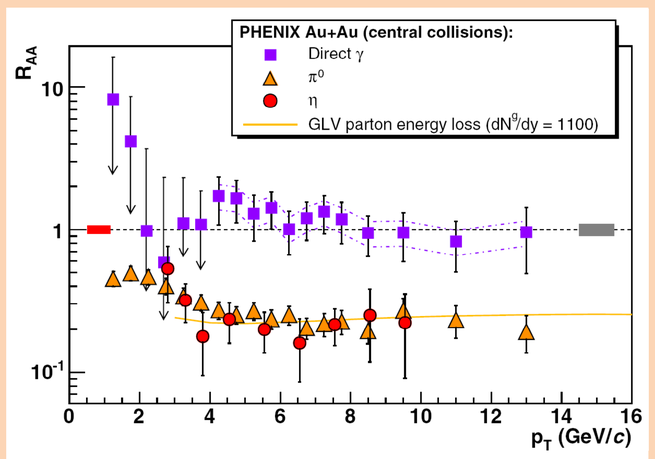
Introduction

Conclusions after first three years of RHIC

- Hadrons are suppressed, photons are not
- Evidence for parton energy loss
- R_{AA} constrains medium properties



PHENIX, Phys. Rev. Lett. 96, 202301 (2006)

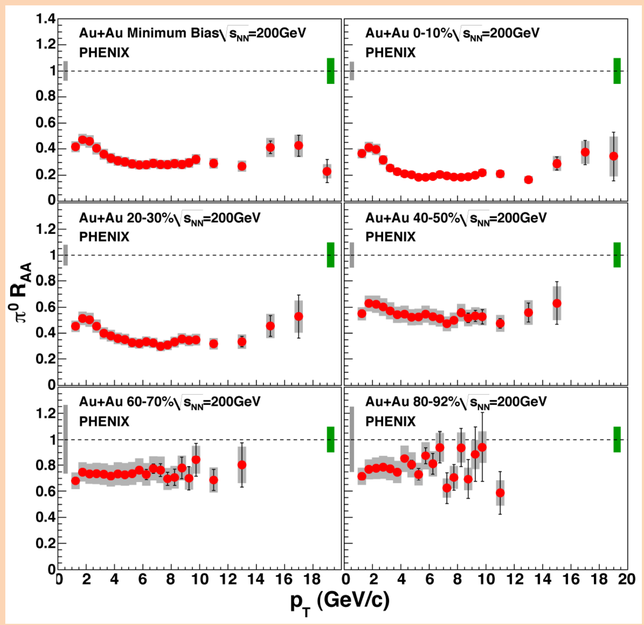
But is parton energy loss really the correct explanation?

Test as many predictions as possible

- p_T, N_{part}, $\sqrt{s_{NN}}$ dependence
- Quantitative model comparisons
- Comparison to direct photons

p_T dependence

π^0 in 200 GeV Au+Au from Run-4



PHENIX, arXiv:0801.4020 [nucl-ex]

- R_{AA} now measured up to 20 GeV/c
- R_{AA} constant (=0.2) up to highest p_T ($5 < p_T < 20$ GeV/c)
- Common power law behavior in p+p and Au+Au $\propto p_T^n$
- Motivates description in terms of fractional energy loss:

$$S_{loss} = 1 - R_{AA}^{1/(n-2)}$$

N_{part} dependence

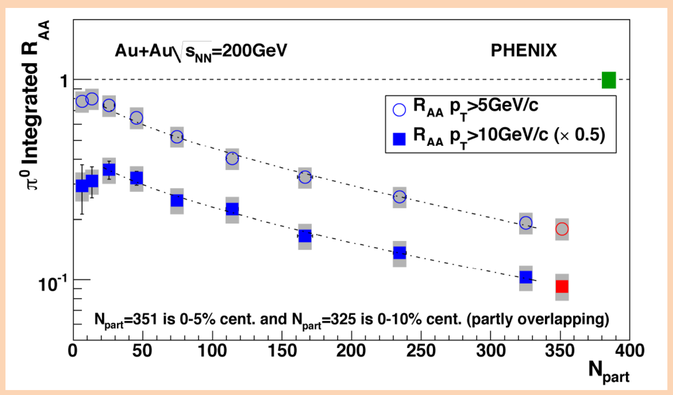
Models predict $N_{part}^{2/3}$ behavior of energy loss:

$$\varepsilon_{eff} \equiv \frac{\Delta E_{eff}}{E} \propto \frac{1}{A_T}\frac{dN_g}{dy} L \frac{1}{E} \propto N_{part}^{2/3}$$

transverse area : $A_T \propto N_{part}^{2/3}$

initial gluon density : $dN_g/dy \propto N_{part}$

path length : $L \propto N_{part}^{1/3}$



PHENIX, arXiv:0801.4020 [nucl-ex]

Fit with: $R_{AA} = (1 - S_0 N_{part}^{\alpha})^{n-2}$

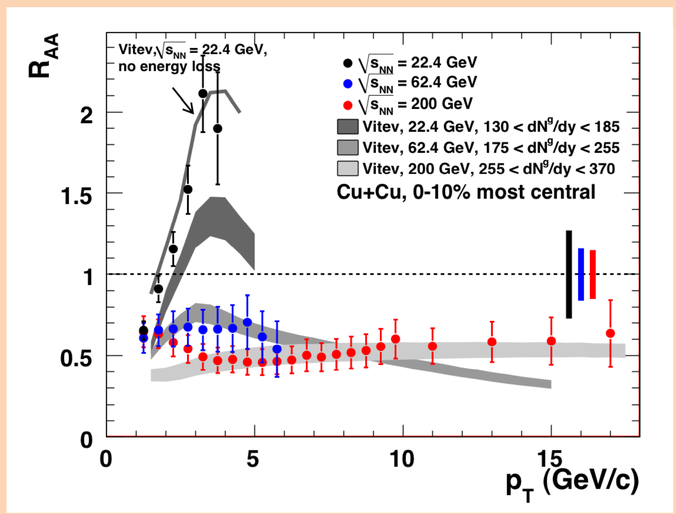
results in: $\alpha = 0.58 \pm 0.07$ for $p_T > 5$ GeV/c

$\alpha = 0.56 \pm 0.10$ for $p_T > 10$ GeV/c

- No saturation of energy loss with N_{part}
- Centrality dependence consistent with parton energy loss

$\sqrt{s_{NN}}$ dependence

π_0 spectra in Cu+Cu at 22.4, 62.4, and 200 GeV



PHENIX, arXiv:0801.4555 [nucl-ex]

62.4 and 200 GeV

- Suppression consistent with parton energy loss

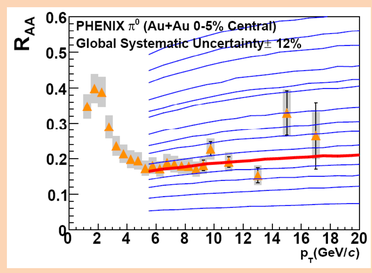
22.4 GeV

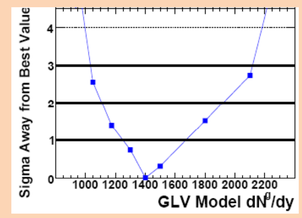
- No suppression
- Enhancement consistent with calculation that describes Cronin enhancement in p+A

Parton energy loss starts to prevail over Cronin enhancement between 22.4 and 62.4 GeV

Quantitative model comparisons

Fit of model to data taking experimental uncertainties correctly into account





PHENIX, arXiv:0801.1655 [nucl-ex]

- Type A: point-by-point
- Type B: p_T correlated
- Type C: normalization

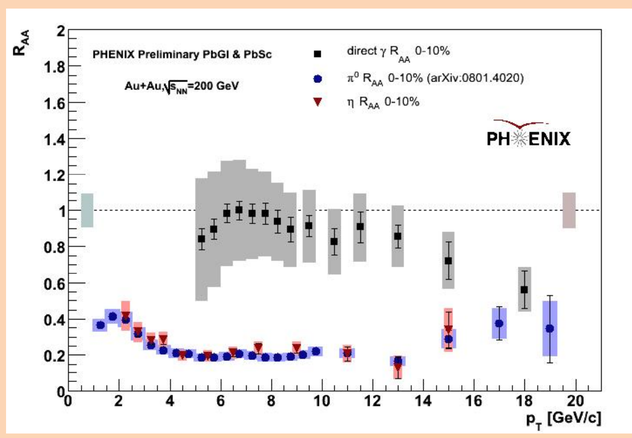
$$\tilde{\chi}^2 = \sum_{i=1}^{n} \frac{\left(y_i + \varepsilon_b \sigma_{b_i} + \varepsilon_c y_i \sigma_c - \mu_i\right)^2}{\tilde{\sigma}_i^2} + \varepsilon_b^2 + \varepsilon_c^2$$

PQM	GLV	WHDG	ZOWW
$\hat{q} = 13.2^{+2.1}_{-3.2}$ GeV^2/fm	$dN^g/dy = 1400^{+270}_{-150}$	$dN^g/dy = 1400^{+200}_{-540}$	$\varepsilon_0 = 1.9^{+0.2}_{-0.5}$ GeV/fm^3

- π^0 R_{AA} not fragile, but in fact quite sensitive to opacity
- Models uncertainties not considered though

Comparison to direct photons

π^0 and direct γ in Au+Au at 200 GeV



Same suppression pattern for π^0 and η

- Consistent with parton energy loss and vacuum fragmentation

Direct γ $R_{AA} < 1$ at highest p_T

- Caused by isospin, EMC effect, or suppression of fragmentation photons?
- Systematic study in high-statistics Run-7 data set forthcoming

Conclusions

Three new PHENIX precision high-p_T papers

- π^0 R_{AA} in 200 GeV Au+Au ~ constant up to 20 GeV
- No saturation of energy loss with N_{part}
- π^0 R_{AA} in 22.4 GeV Cu+Cu described without E_{loss}
- π^0 R_{AA} sensitive to opacity → model constraints
- Indication of modification of direct γ

Stay tuned for Run-7 results (better stat./sys., RxNP)