Angular dependence of jet energy loss

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- Jet energy loss is barely understood *(B. Cole)*

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- Jet energy loss is barely understood *(B. Cole)*
- *Radiative* and *collisional* energy loss
- What is their ratio? Is any one of them dominant?
- Exploring the radiative phenomenon – in this talk

Introduction 2

- Various approaches to radiative jet energy loss:
  - time ordered pQCD — Baier–Dokshitzer–Mueller–Schiff,
  - QED-analogy — Gyulassy–Wang,
  - thin plasma: time ordered pQCD, kinetical limits, opacity expansion — Gyulassy–Lévai–Vitev.

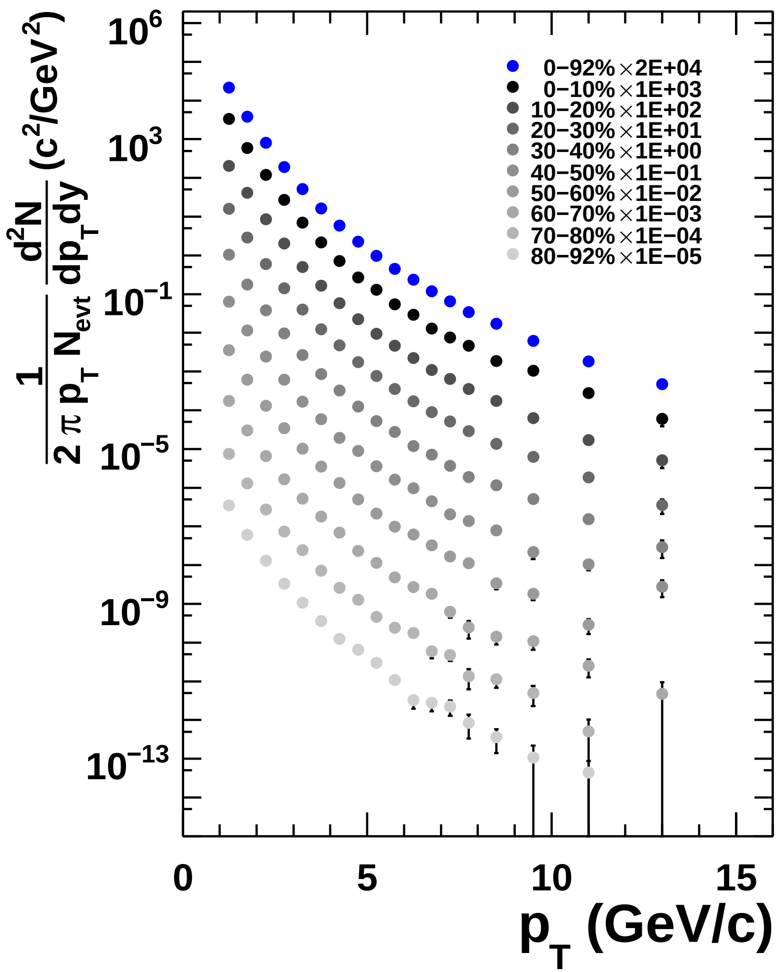
Experimental Results

Experimental Results

S. S. Adler *et al.* (PHENIX), Phys. Rev. C **72**, 034904 (2007)

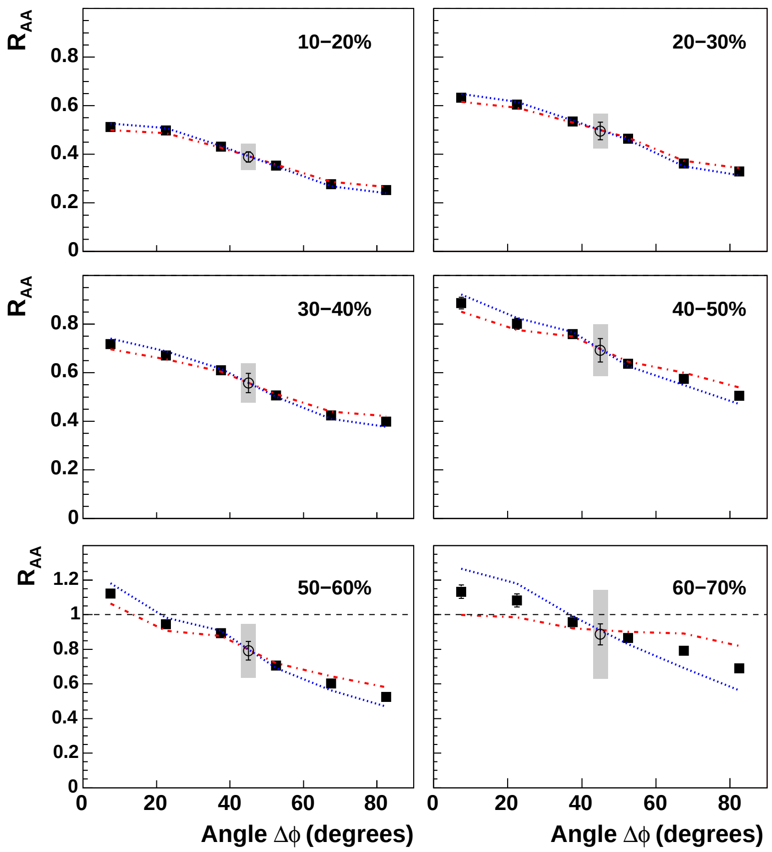
- Recent deep analysis of π^0 yields.
- $\sqrt{s_{NN}} = 200$ GeV Au-Au collisions at RHIC
- R_{AA} as a function of $\Delta\Phi$

Experimental Results 2



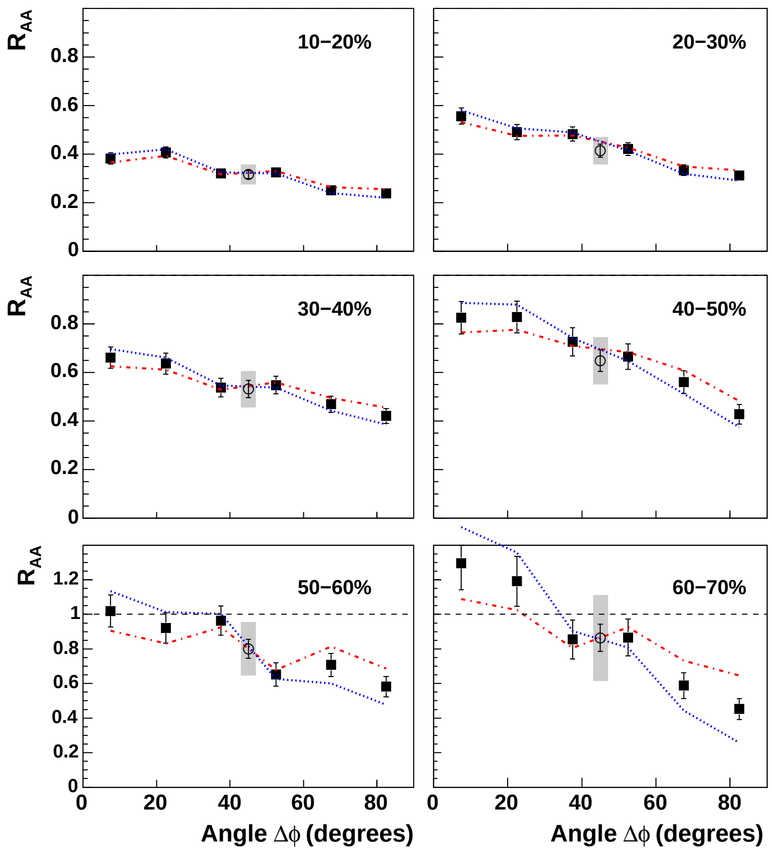
"conventional" form of results: invariant yields, function of p_{T}

Experimental Results 3



azimuthal angle dependence in centrality bins (p_{T} 3-5 GeV)

Experimental Results 4



azimuthal angle dependence in centrality bins (p_T 5-8 GeV)

Theory

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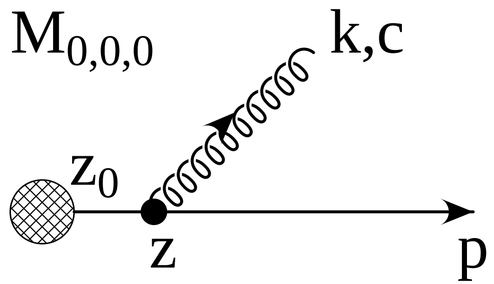
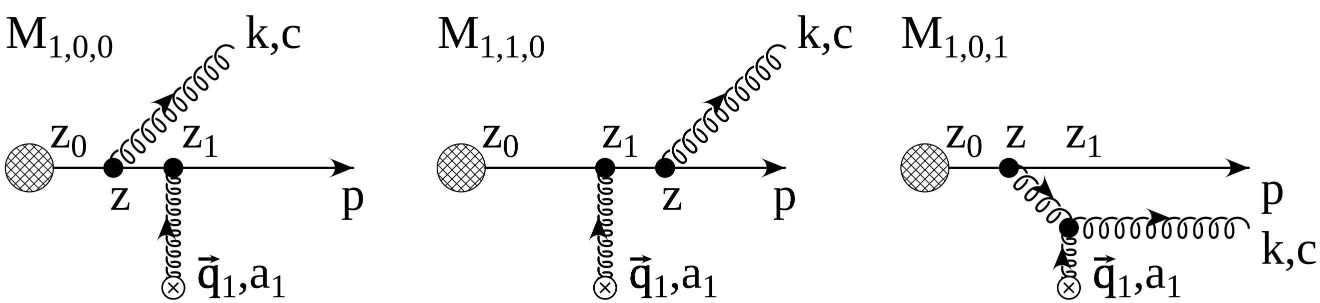
M. Gyulassy, P. Lévai, I. Vitev, Nucl. Phys. **B594** 371 (2001)



First order in opacity expansion:



Theory 2

$$\frac{\mathrm{d}I^{(1)}}{\mathrm{d}x} = \frac{C_R \alpha_s}{\pi} \left(1 - x + \frac{x^2}{2}\right) \frac{EL}{\lambda_g} \int\limits_{\mathbf{k}^2_{\mathrm{min}}}^{\mathbf{k}^2_{\mathrm{max}}} \frac{\mathrm{d}\mathbf{k}^2}{\mathbf{k}^2} \int\limits_0^{\mathbf{q}^2_{\mathrm{max}}} \mathrm{d}^2\mathbf{q} \frac{\mu^2_{\mathrm{eff}}}{\pi(\mathbf{q}^2 + \mu^2)^2} \times$$

$$\times \frac{2\mathbf{k}\cdot\mathbf{q}(\mathbf{k}-\mathbf{q})^2 L^2}{16x^2E^2 + (\mathbf{k}-\mathbf{q})^4 L^2}$$

Theory 3

Making it dimensionless:

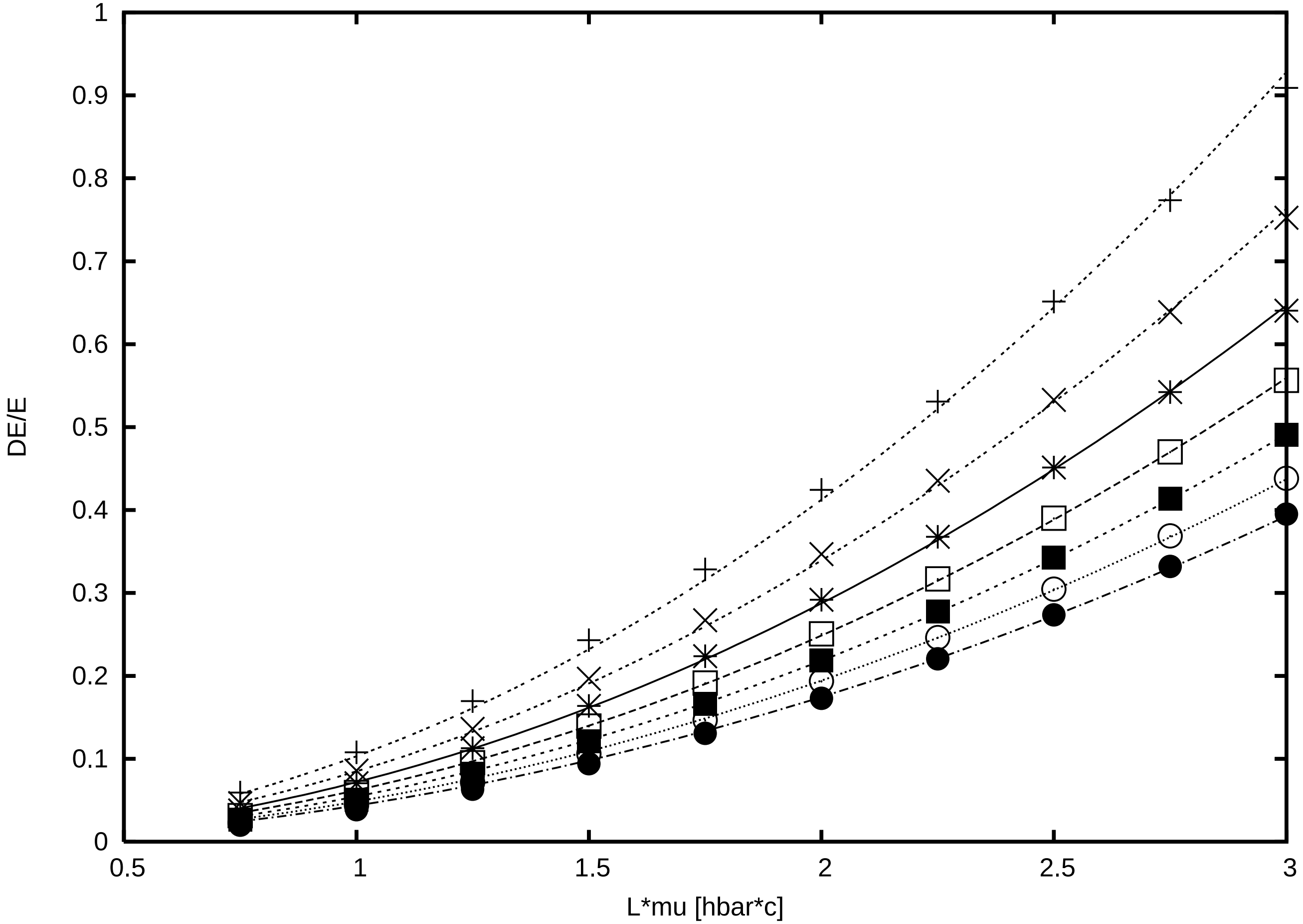
$$\frac{\Delta E}{E} = \frac{C_R \alpha_s}{\pi} \frac{L\mu}{\lambda_g \mu} \int_0^1 \mathrm{d}x \left(1 - x + \frac{x^2}{2}\right) \int_{\mathbf{k}^2_{\mathrm{min}}/\mu^2}^{\mathbf{k}^2_{\mathrm{max}}/\mu^2} \frac{\mathrm{d}\mathbf{k}^2/\mu^2}{\mathbf{k}^2/\mu^2} \times$$

$$\times \int_0^{\mathbf{q}^2_{\mathrm{max}}/\mu^2} \frac{\mathrm{d}^2\mathbf{q}}{\mu^2} \frac{\mu^2_{\mathrm{eff}}/\mu^2}{\pi(\mathbf{q}^2/\mu^2 + 1)^2} \frac{[(2\mathbf{kq}/\mu^2)(\mathbf{k}-\mathbf{q})^2/\mu^2] \cdot L^2\mu^2/(\hbar c)^2}{16x^2E^2/\mu^2 + (\mathbf{k}-\mathbf{q})^4/\mu^4 \cdot L^2\mu^2/(\hbar c)^2}$$

$$\mathbf{q}^2_{\mathrm{max}}/\mu^2 = 3E/\mu,\ (\mu^2_{eff})^{-1} = (\mu^2)^{-1} - (\mathbf{q}^2 + \mu^2)^{-1}$$

Numerical Results

Parametrization of energy loss



Parametrization of energy loss

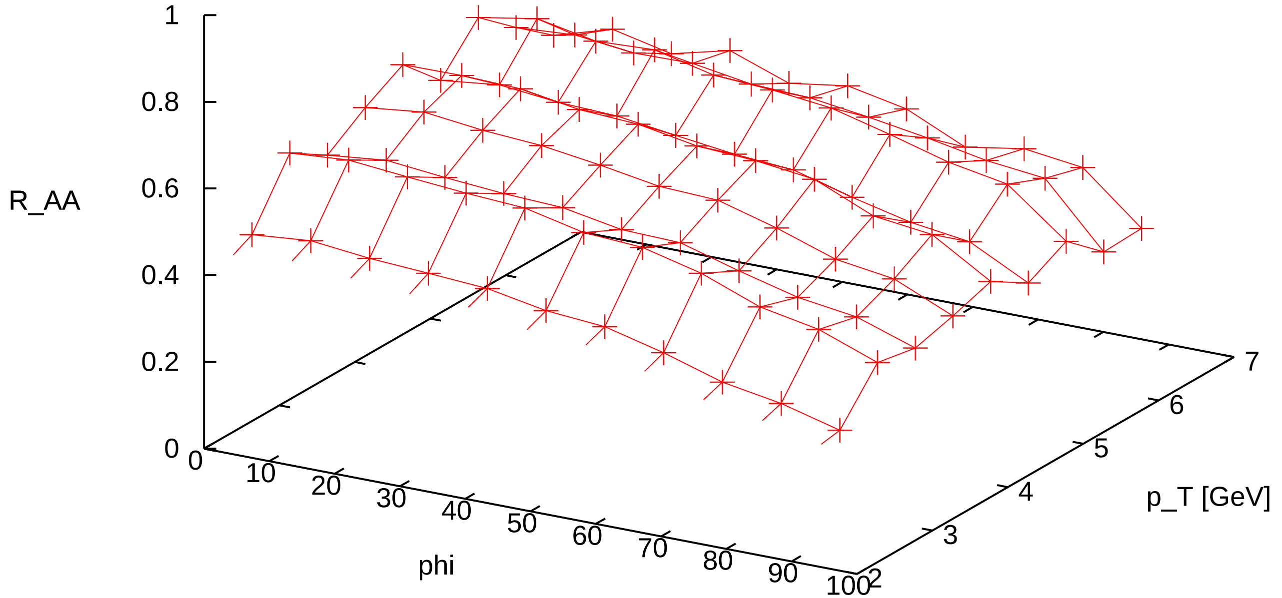
$$\frac{\Delta E}{E} \approx \frac{b}{E/\mu - b_0} \cdot (L\mu)^2$$

Simulation

- Monte Carlo calculation (any L dependence, density dep., ...)
- 2D simulation, almond shape
- individual 'jets' in random directions in an energy window
- R_{AA} is the ratio of yields with and without energy loss
- initial parton distribution (pQCD results)
- fragmentation into π^0 (KKP)

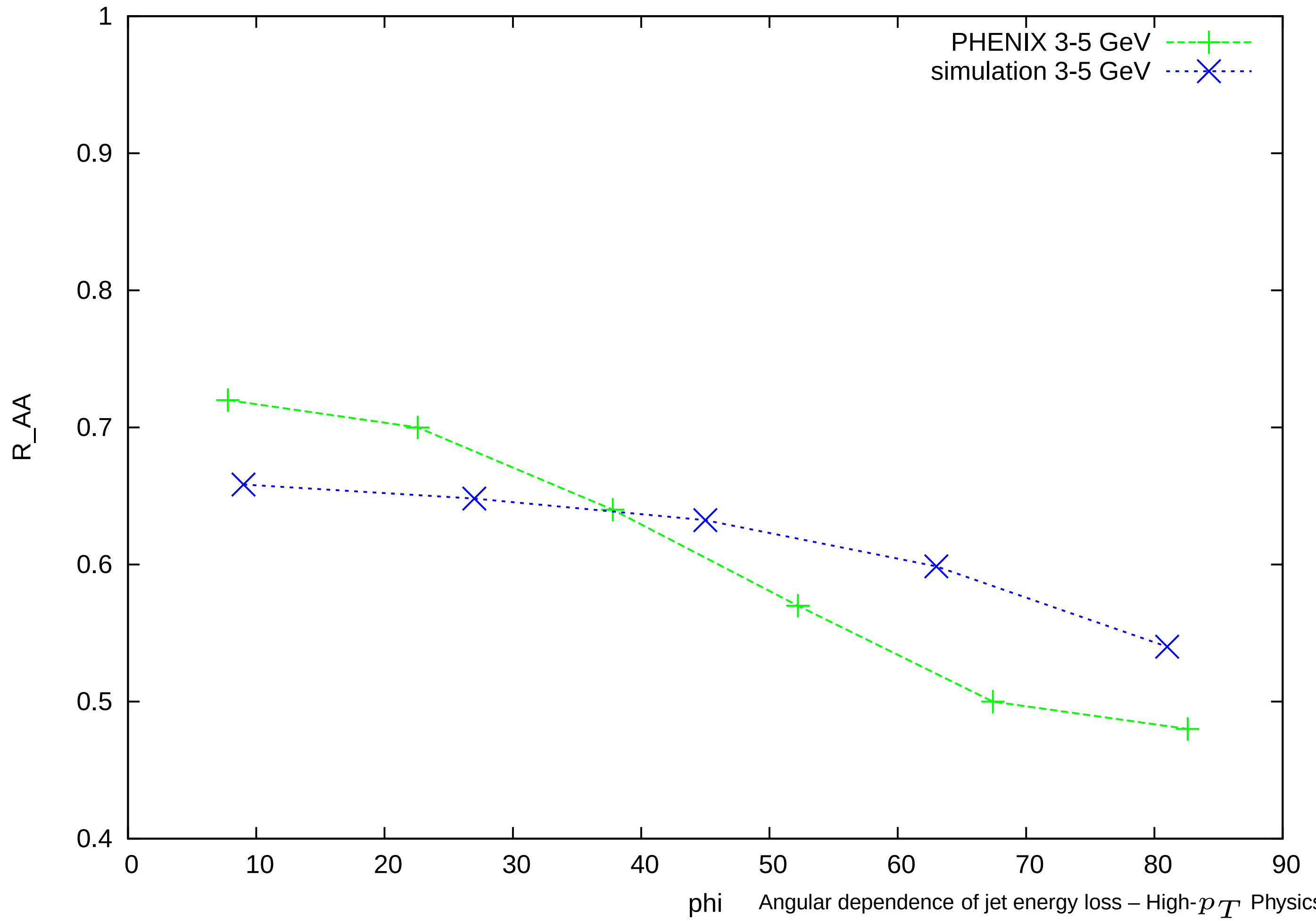
Results 1

central collision



Results 2

comparison of non central with experimental (30-40%)



Conclusions

- Radiative energy loss: order of magnitude O.K.
- but the azimuthal dependence is not correct
- possible solutions:
  - redefine shape of overlap area
  - reconsider L^2 dependence
  - introduce collisional energy loss (L dependence?)

References

- S. S. Adler *et al.* (PHENIX), Phys. Rev. C **72**, 034904 (2007)
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