Jets in heavy-ion collisions at RHIC and LHC

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Summary from Lecture 2

- High-energy limit: Eikonal approximation
  - Particle propagates in a **straight line** without energy loss
  - Described by Wilson lines
- Non-eikonal corrections
  - Allow for changes in the transverse position
  - **Brownian motion** in transverse plane
- Medium-induced gluon radiation
  - Take parent as completely eikonal, and apply corrections to gluon
  - Energy loss by radiation

The final answer

$$k_+ \frac{dI}{dk_+ d^2\mathbf{k}_\perp} = \frac{\alpha_S C_R}{(2\pi)^2 k_+} 2\mathrm{Re} \int_{x_{0+}}^{L_+} dx_+ \int d^2\mathbf{x}\; e^{-i\mathbf{k}_\perp \cdot \mathbf{x}} \times$$

$$\times \left[\frac{1}{k_+} \int_{x_+}^{L_+} d\bar{x}_+ \; e^{-\frac{1}{2}\int_{x_+}^{L_+} d\xi n(\xi)\sigma(\mathbf{x})} \frac{\partial}{\partial \mathbf{y}} \cdot \frac{\partial}{\partial \mathbf{x}} \mathcal{K}(\mathbf{y}=0, x_+; \mathbf{x}, \bar{x}_+) - \right.$$

$$\left. -2 \frac{\mathbf{k}_\perp}{\mathbf{k}_\perp^2} \cdot \frac{\partial}{\partial \mathbf{y}} \mathcal{K}(\mathbf{y}=0, x_+; \mathbf{x}, L_+) \right] + \frac{\alpha_S C_R}{\pi^2} \frac{1}{\mathbf{k}_\perp^2}$$

where...

$$\mathcal{K}\left(\mathbf{r}(x_+), x_+; \mathbf{r}(\bar{x}_+), \bar{x}_+\right) = \int \mathcal{D}\mathbf{r} \exp \left[\int_{x_+}^{\bar{x}_+} d\xi \left(i \frac{p_+}{2} \dot{\mathbf{r}}^2 - \frac{1}{2} n(\xi) \sigma(\mathbf{r}) \right) \right]$$

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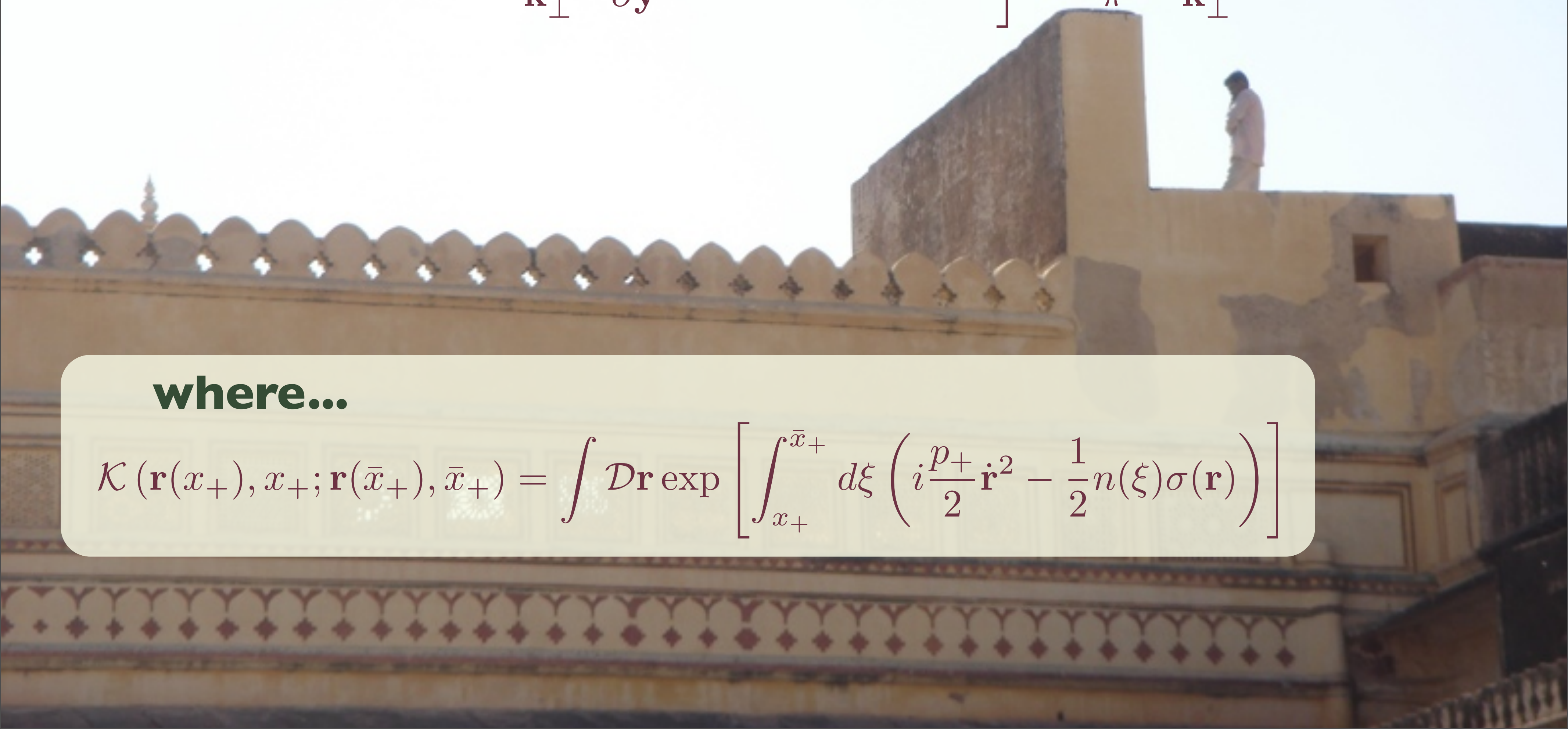

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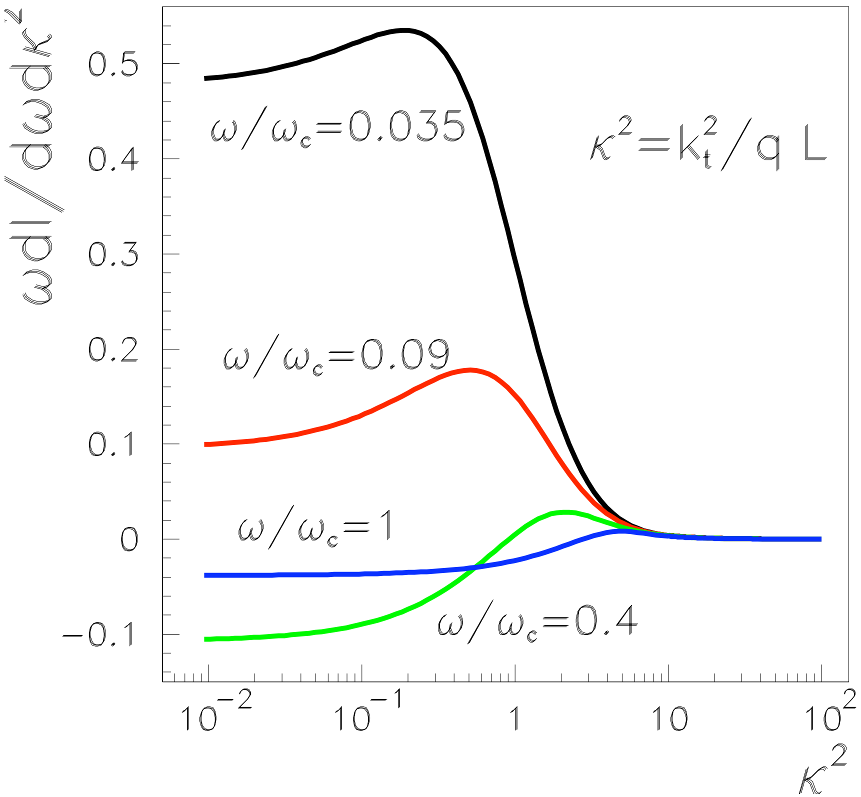
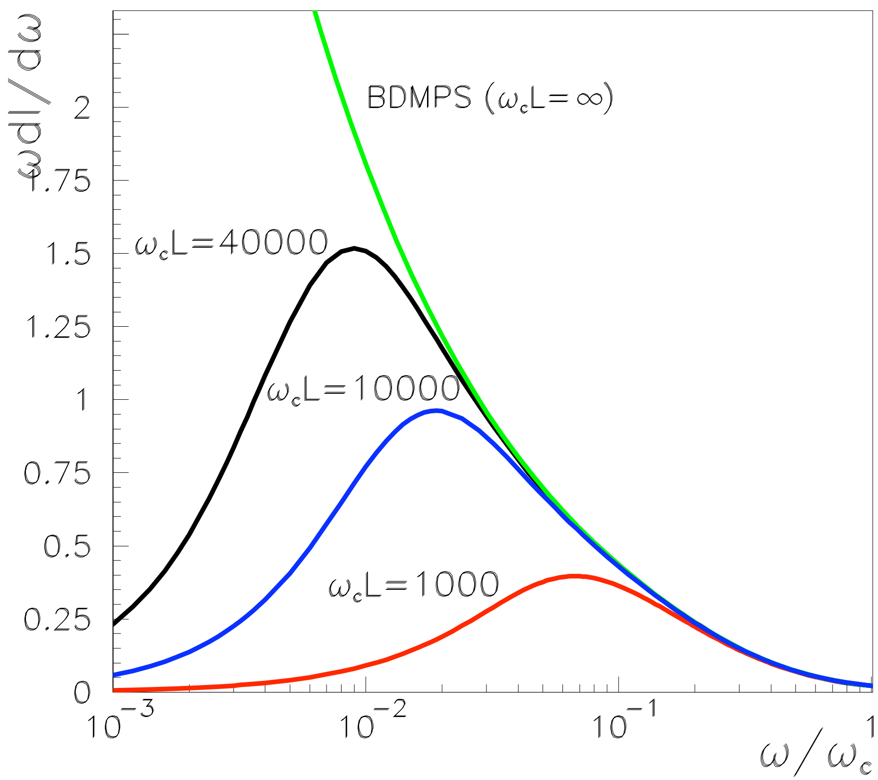
The medium-induced gluon radiation

⇛ **Numerical results**

$$\omega \frac{dI^{\rm tot}}{d\omega dk_\perp^2} = \omega \frac{dI^{\rm vac}}{d\omega dk_\perp^2} + \omega \frac{dI^{\rm med}}{d\omega dk_\perp^2}$$





$$\kappa^2 = \frac{k_\perp^2}{\hat{q} L} \qquad \omega_c = \frac{1}{2}\,\hat{q}\,L^2$$

$$\omega \frac{dI^{\rm med}}{d\omega} \equiv \int_0^{\omega^2} dk_\perp^2\, \omega \frac{dI^{\rm med}}{d\omega dk_\perp^2}$$

Medium-induced radiation (sketch of calculation)

⇛ We work in the approximation of a very highly energetic quark which radiates a soft gluon

$$E_q \gg \omega \gg k_\perp$$

- Eikonal propagators for quarks
- Non-eikonal corrections for gluons

⇛ "Recipe": write

- Quark propagation $W(\mathbf{x}_\perp, x_+, y_+)$
- Gluon propagation $G(\mathbf{x}_\perp, x_+; \mathbf{y}_\perp, y_+)$
- Quark-gluon hard vertex

$$\frac{i}{k_+}\epsilon_\perp \cdot \frac{\partial}{\partial \mathbf{y}_\perp}$$

- Then include Fourier transforms, integrals, color traces, factors....

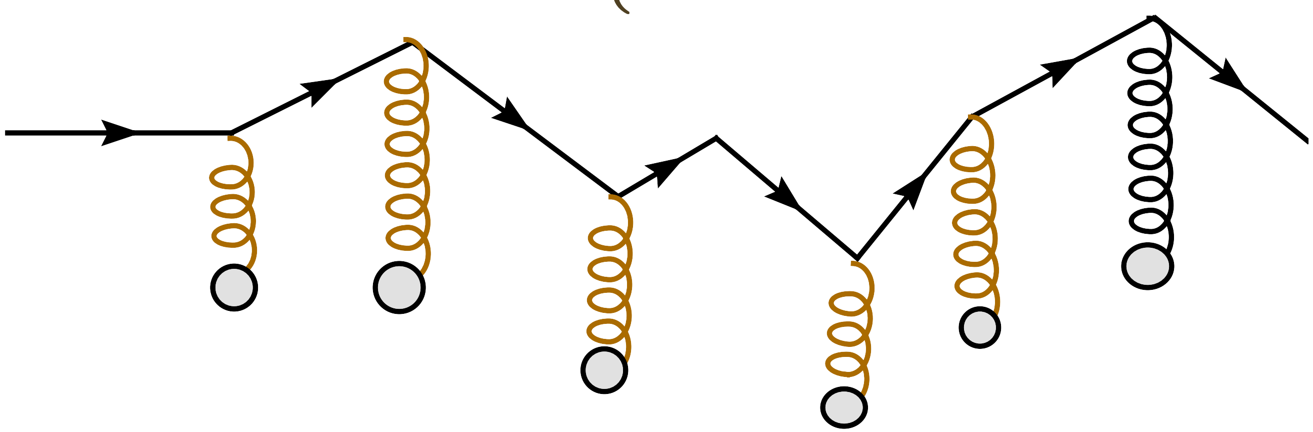
Non-eikonal terms

⇛ To compute the medium-induced gluon radiation, we will take into account small departure from a straight line for the gluon

$$\int dp_- \frac{e^{ip_-(x_{i+}-x_{(i+1)+})}}{2p_+p_- - p_\perp^2 + i\epsilon} = -i\frac{2\pi}{2p_+}\Theta(x_{(i+1)+} - x_{i+})e^{i\frac{p_\perp^2}{2p_+}((x_{i+}-x_{(i+1)+})}$$

⇛ In this case, instead of the Wilson line we obtain a path integral

$$G(a,b) = \int \mathcal{D}\mathbf{r}(x_+) \exp\left\{ i\frac{p_+}{2}\int dx_+ \left[\frac{d\mathbf{r}}{dx^+}\right]^2 + ig\int dx_+ A_-(x_+, r(x_+))\right\}$$



Brownian motion in transverse plane

$$\hat{q} \sim \frac{\mu^2}{\lambda}$$

⇛ Notice that for $p_+ \to \infty$ the Wilson line is recovered

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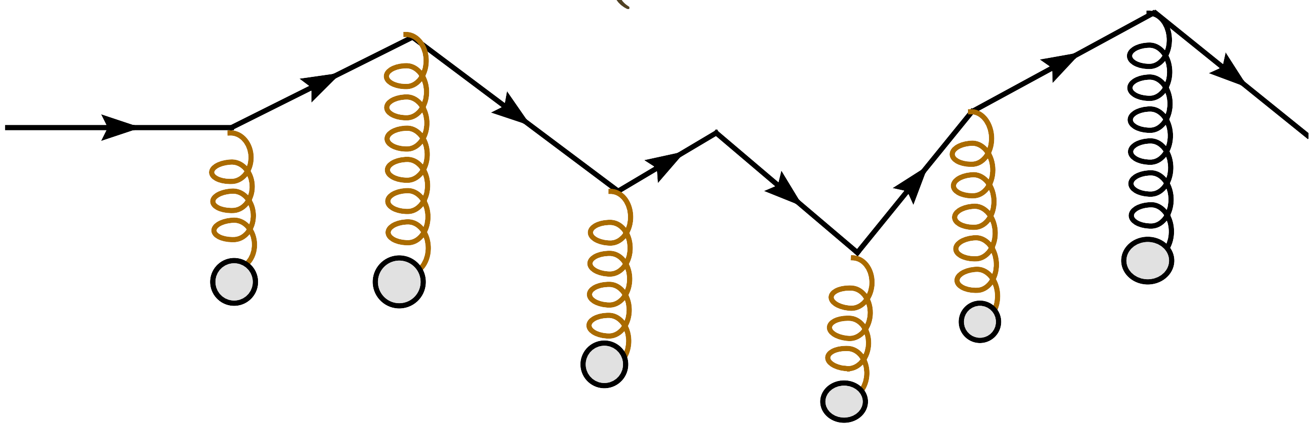

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Heuristic discussion I

- Recall the phases in the path integral

$$\exp\left\{ i\frac{k_\perp^2}{2\omega}(x_i - x_{i-1})\right\}$$

- The gluon decoheres from the quark when the phase is order 1
- So, we can define a gluon formation time $t_{\rm form} \sim \dfrac{\omega}{k_\perp^2}$
  - The radiation is suppressed when $t_{\rm form} > L$
  - Totally incoherent limit when $t_{\rm form} \ll L$
  - The accumulated transverse momentum

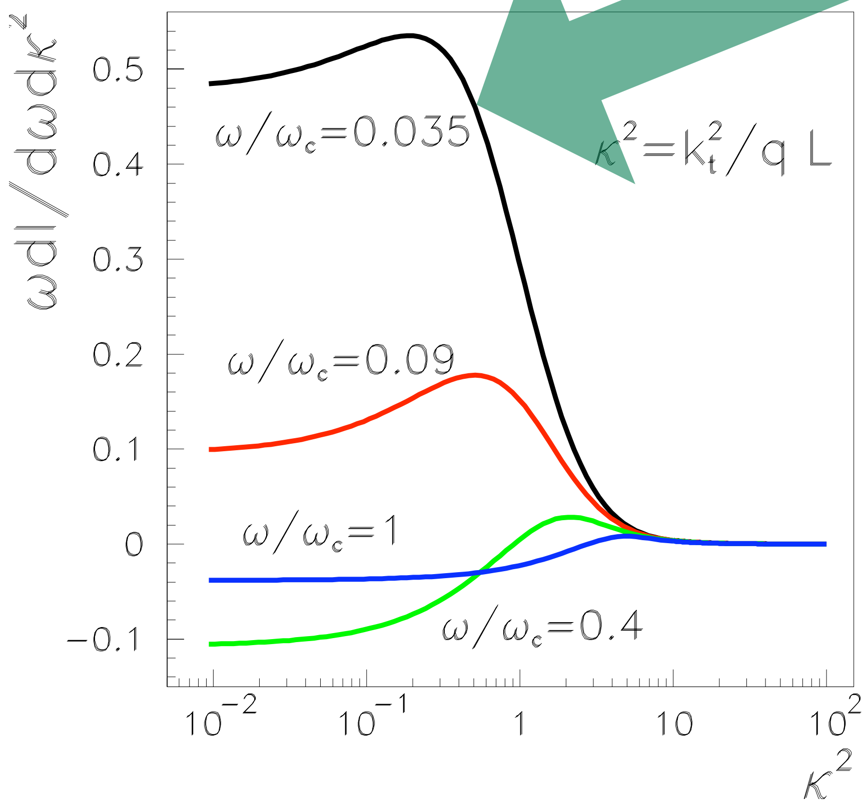
$\langle k_\perp^2 \rangle \sim \hat{q}\, t_{\rm form} \simeq \sqrt{\hat{q}\omega}$ [or $\langle k_\perp^2 \rangle \sim \hat{q}\, L$ for $t_{\rm form} > L$]

[For an extended discussion, see the review, S. Peigne and A.V. Smilga, arxiv:0810.5702]

The LPM suppression

$$\exp\left\{ i\frac{k_\perp^2}{2p_+}(x_{i+} - x_{(i+1)+}\right\}$$

$$t_{\rm form} \simeq \frac{2\omega}{k_\perp^2}$$



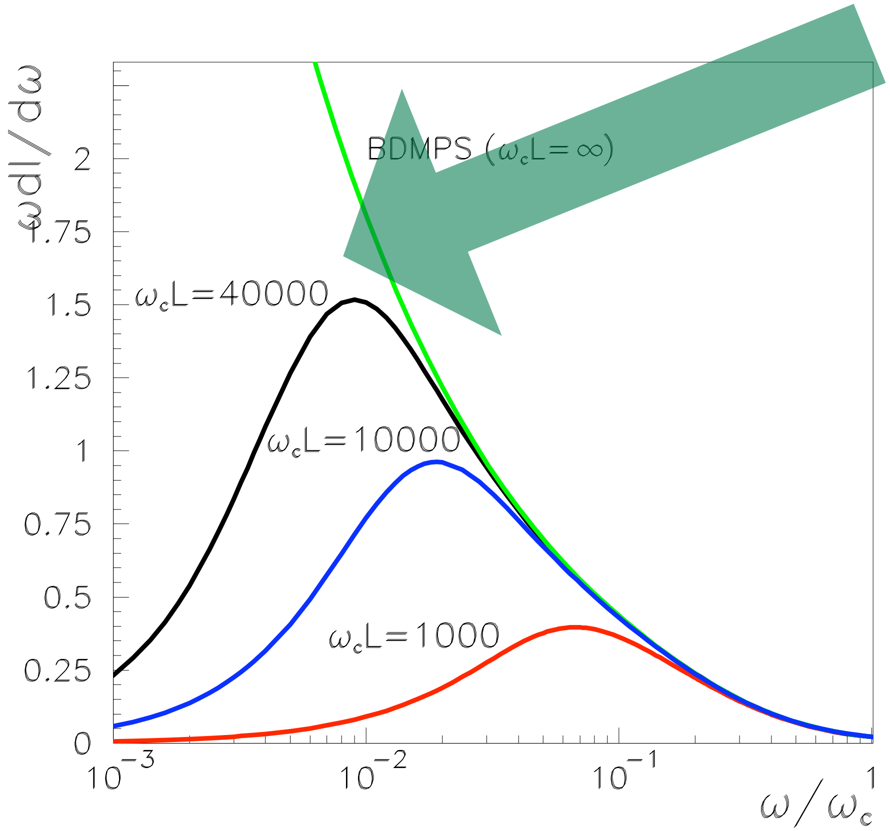
$$\langle k_\perp^2\rangle \simeq \hat{q}\, t_{\rm form} \simeq \hat{q}\,\frac{2\omega}{\langle k_\perp^2\rangle}$$

Radiation is suppressed due to formation time effects

$$\langle k_\perp^2\rangle \lesssim \sqrt{2\omega\hat{q}}$$

The LPM suppression II

$$\omega \frac{dI}{d\omega} = \int_0^{\omega} dk_\perp^2\, \omega \frac{dI}{d\omega dk_\perp^2} \simeq \int_{\hat{q}L}^{\omega} dk_\perp^2\, \omega \frac{dI}{d\omega dk_\perp^2}$$



⇛ **Medium-induced radiation is infrared and collinear finite**

Heuristic discussion II

⇛ For $t_{\rm form} \lesssim L$ the radiation is, using $\langle k_\perp^2\rangle \sim \hat{q}\,t_{\rm form} \simeq \sqrt{\hat{q}\omega}$

$$\omega\frac{dI}{d\omega} \simeq \alpha_s \frac{L}{t_{\rm form}} \simeq \alpha_s\sqrt{\frac{\hat{q}L^2}{\omega}} \simeq \alpha_s\sqrt{\frac{\omega_c}{\omega}}$$

⇛ More specifically

$$\omega\frac{dI}{d\omega} \simeq \frac{2\alpha_s C_R}{\pi}\begin{cases}\sqrt{\frac{\omega_c}{2\,\omega}} & \omega < \omega_c\,; \\ \frac{1}{12}\left(\frac{\omega_c}{\omega}\right)^2 & \omega > \omega_c\,.\end{cases}$$

⇛ So, the average energy loss

$$\langle\Delta E\rangle = \int_0^\infty d\omega\,\omega\frac{dI}{d\omega} \simeq \int_0^{\omega_c}\sqrt{\frac{\omega}{\omega_c}} \simeq \alpha_s\,C_R\,\omega_c \simeq \alpha_s\,C_R\,\hat{q}\,L^2$$

grows **quadratically** with the lenght

Main predictions of the formalism

- ***Energy loss*** $$\Delta E \simeq \frac{\alpha_s C_R}{2\pi}\hat{q}L^2$$

- ***Jet broadening*** $$k_\perp^2 \simeq \hat{q}L \propto \frac{\Delta E}{L}$$

Phenomenology I: Inclusive observables

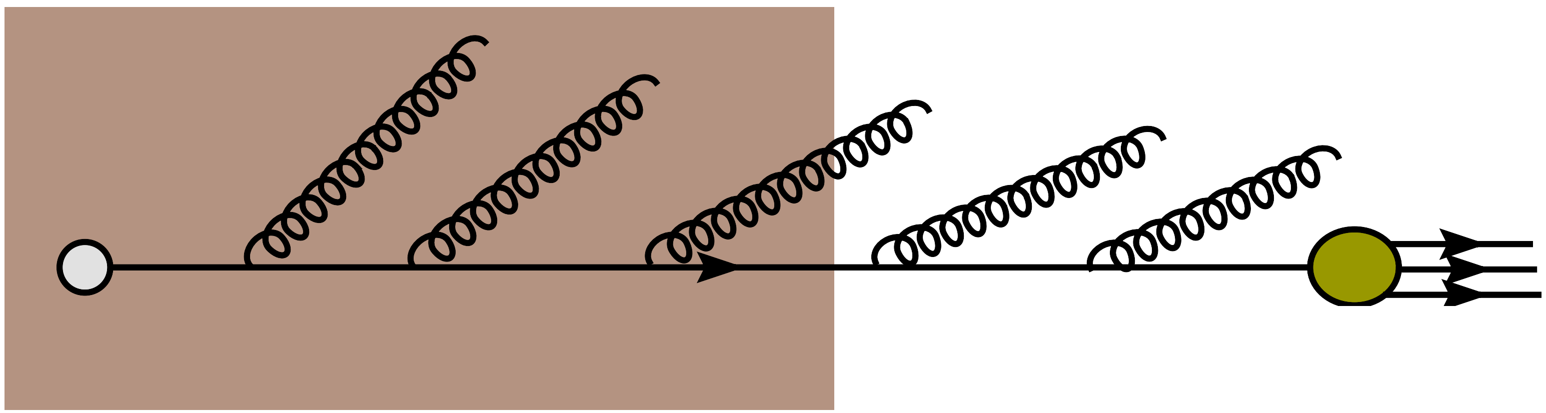
Implementation: Independent gluon emission

(Quenching Weights)

Independent gluon emision

- Vacuum and medum-induced gluon radiation treated separately
  - Medium-radiation first
  - Medium produces only energy loss

    (no modification of the evolution)
  - Independent gluon emission approximation - Poisson distribution



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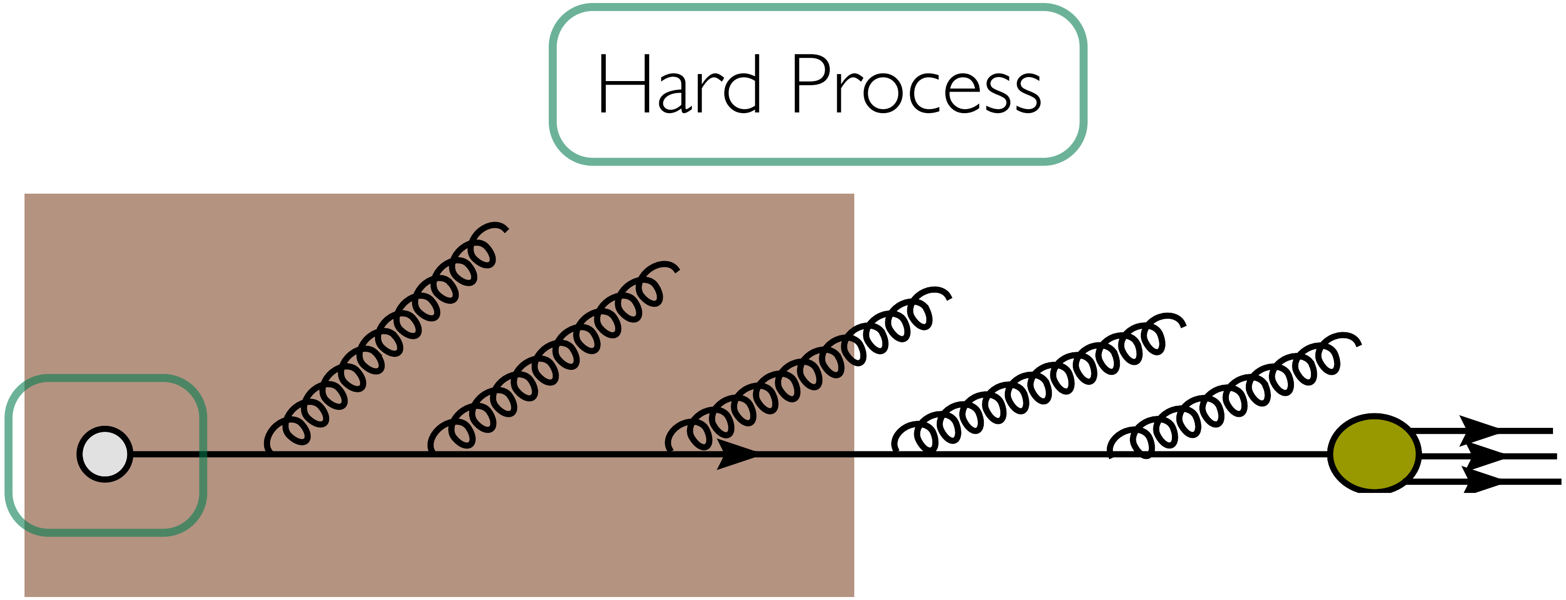

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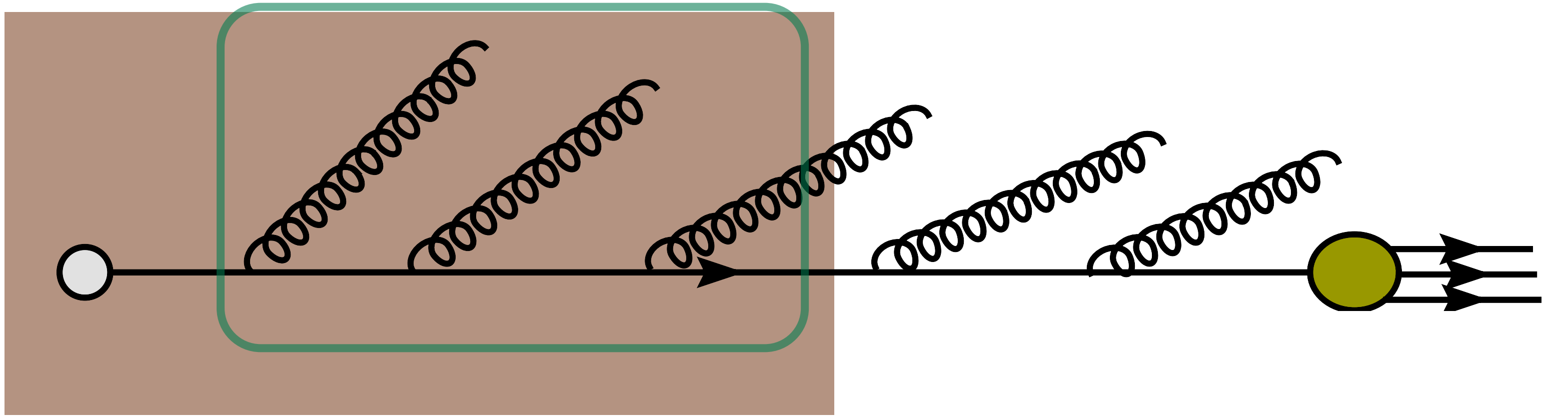
Medium-induced gluon radiation



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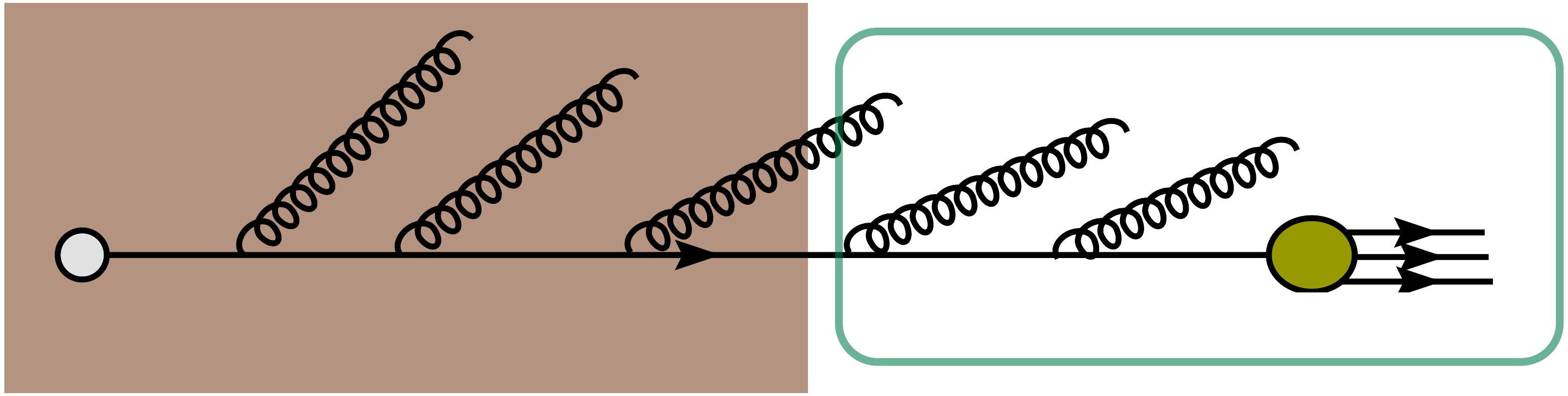
DGLAP vacuum evolution and hadronization



Poisson approximation

⇛ Probability that an arbitrary number of medium-induced gluons carry away a fraction of the energy ΔE of the fast quark/gluon

$$P(\Delta E) = \sum_{n=0}^{\infty} \frac{1}{n!} \left[\prod_{i=1}^{n} \int d\omega_i \frac{dI(\omega_i)}{d\omega} \right] \delta\left(\Delta E - \sum_{i=1}^{n} \omega_i \right) \exp\left[- \int_0^{\infty} d\omega \frac{dI}{d\omega} \right]$$

⇛ Contains the probability that nothing happens (no E-loss)

$$P(\Delta E) = p_0 \delta(\Delta E) - p(\Delta E) \longrightarrow p_0 = \exp\left[- \int_0^{\infty} d\omega \frac{dI}{d\omega} \right] = \mathrm{e}^{-\langle N_g \rangle}$$

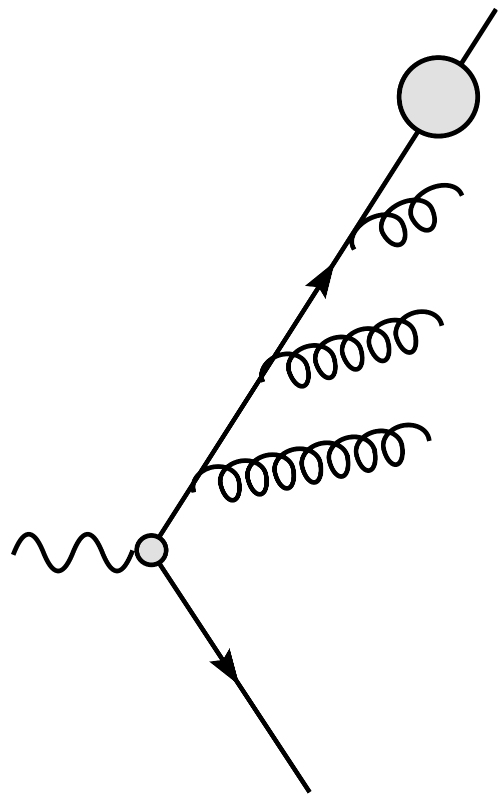
⇛ Notice that the formation-time effects (LPM suppression) leads to a non-zero value for $p_0 \iff \langle N_g \rangle < \infty$

⇛ This probability distribution is normally called Quenching Weights

[Baier, Dokshitzer, Mueller, Schiff 2001; Salgado, Wiedemann 2003]

Energy loss

⇛ Remember for the first day the fragmentation function



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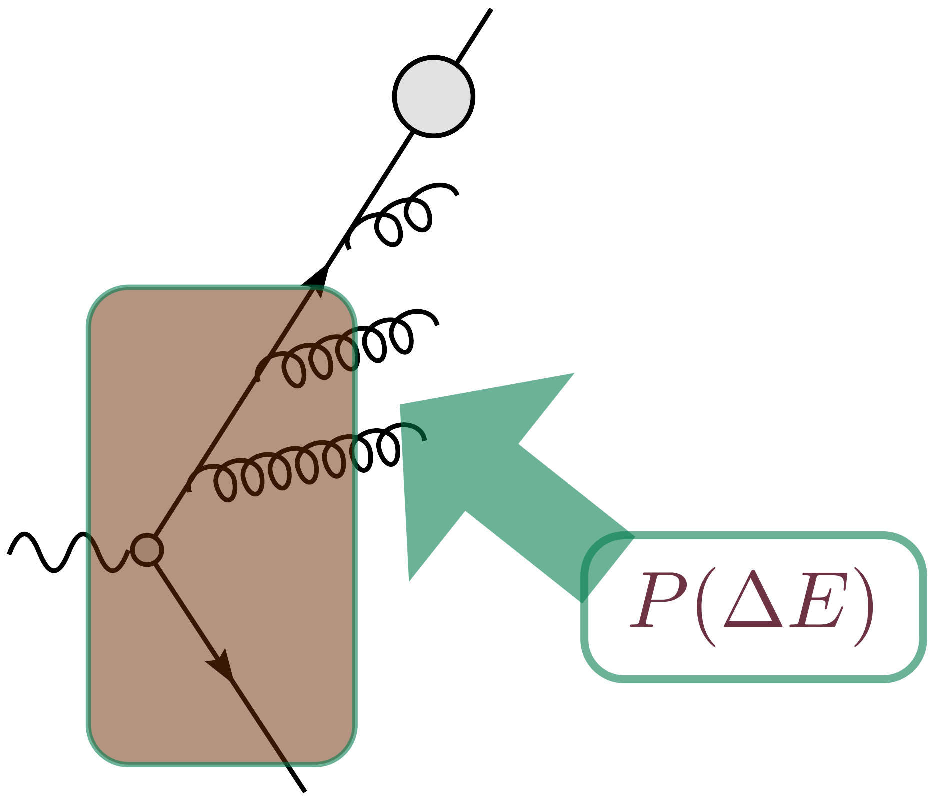


⇛ Medium-induced gluon radiation = energy loss

Medium modifies the fragmentation functions

Fragmentation functions

⇛ Let us assume that we know the FF in the vacuum

[de Florian, Sassot, Stratmann 2007; Albino, Kniehl, Kramer 2006; Hirai, Kumano, Nagai, Sudoh 2007..]

⇛ The one-particle inclusive cross section is

$$\frac{d\sigma}{dq_T} = \int dz \int d\epsilon \int dp_T\, f(p_T)\, P(\epsilon)\, D(z,Q^2)\, \delta(q_T - (1-\epsilon) z p_T)$$

$$= \int \frac{d\epsilon}{1-\epsilon} \int \frac{dz'}{z'} f\left(\frac{q_T}{z'}\right) P(\epsilon)\, D\left(\frac{z'}{1-\epsilon}, Q^2\right)$$

⇛ This allows to define a medium-modified fragmentation function as

$$D^{\rm med}(z,Q^2) = \int \frac{d\epsilon}{1-\epsilon} P(\epsilon)\, D\left(\frac{z}{1-\epsilon}, Q^2\right)$$

[First proposed by Wang, Huang, Sarcevic 1996]

⇛ Here only energy loss is taken into account, no modification of Q^2

Is this essential?

- First attempts: Use the average energy loss ΔE
- This is not good when distributions fall very fast (as in present case)
  - Let us study two "models" with $\Delta E = 1/2$

$$P_1(\epsilon) = \delta\left(\epsilon - \frac{1}{2}\right) \qquad P_2(\epsilon) = \frac{1}{2}\left[\delta\left(\epsilon - \frac{1}{4}\right) + \delta\left(\epsilon - \frac{3}{4}\right)\right]$$

- The distribution of perturbatively produced partons $f(p_T) \sim \frac{1}{p_T^7}$
  - Ignoring hadronization (FF)

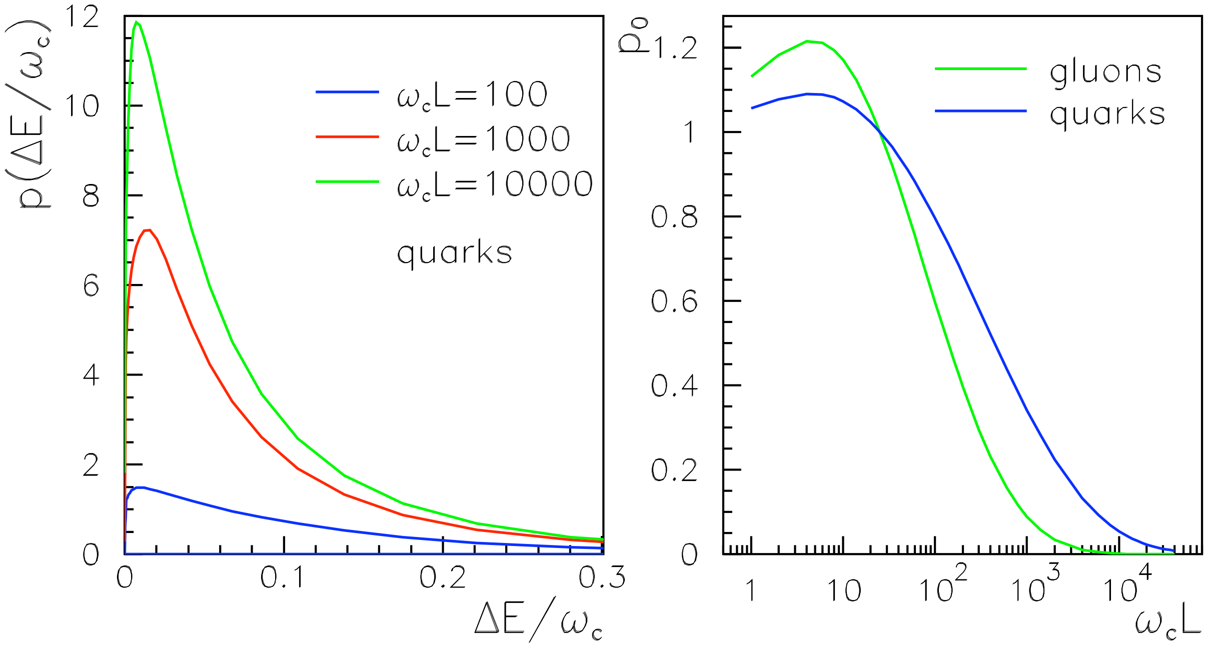
$$\frac{d\sigma}{dqT} = \int d\epsilon \int dp_T \, P(\epsilon)\, f(p_t)\, \delta(q_T - (1-\epsilon)p_T) \simeq \int d\epsilon \, P(\epsilon)(1-\epsilon)^6$$

  - This gives 0.015 for Model 1 and 0.09 for Model 2

- A good knowledge of the distribution of energy loss is essential

Numerical results

- Quenching weights in the multiple soft scattering approximation
  - Two variables:



[Salgado, Wiedemann, 2003]

- Energy loss for gluons is larger than for quarks due to color factor

The inclusive cross section

- So, everything together now

$$\frac{d\sigma^{AB\to h}}{dp_T^2 dy} = \sum_{i,j,k=q,\bar{q},g} \int \frac{dx_2}{x_2} \int \frac{dz}{z}\, x_1 f_i^A(x_1,Q^2) x_2 f_j^B(x_2,Q^2) \frac{d\sigma^{ij\to k}}{d\hat{t}} D_{k\to h}^{\rm med}(z,Q^2)$$

- Use **nuclear** PDFs $\quad f_i^A(x,Q^2) = R_i^A(x,Q^2) f_i^p(x,Q^2)$

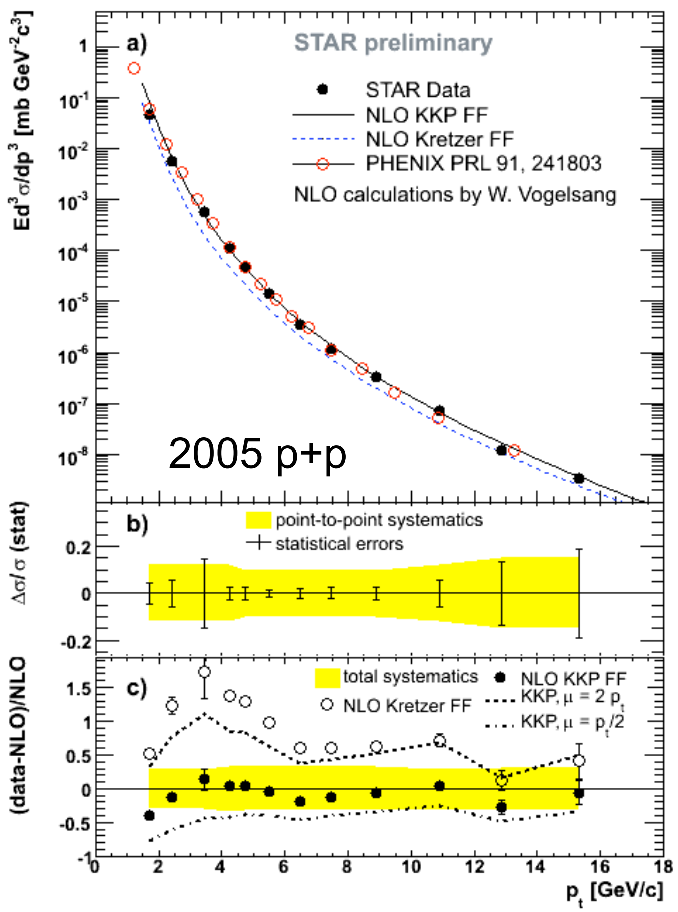
- With the medium-modified FF defined by

$$D^{\rm med}(z,Q^2) = \int \frac{d\epsilon}{1-\epsilon} P(\epsilon)\, D\left(\frac{z}{1-\epsilon}, Q^2\right)$$

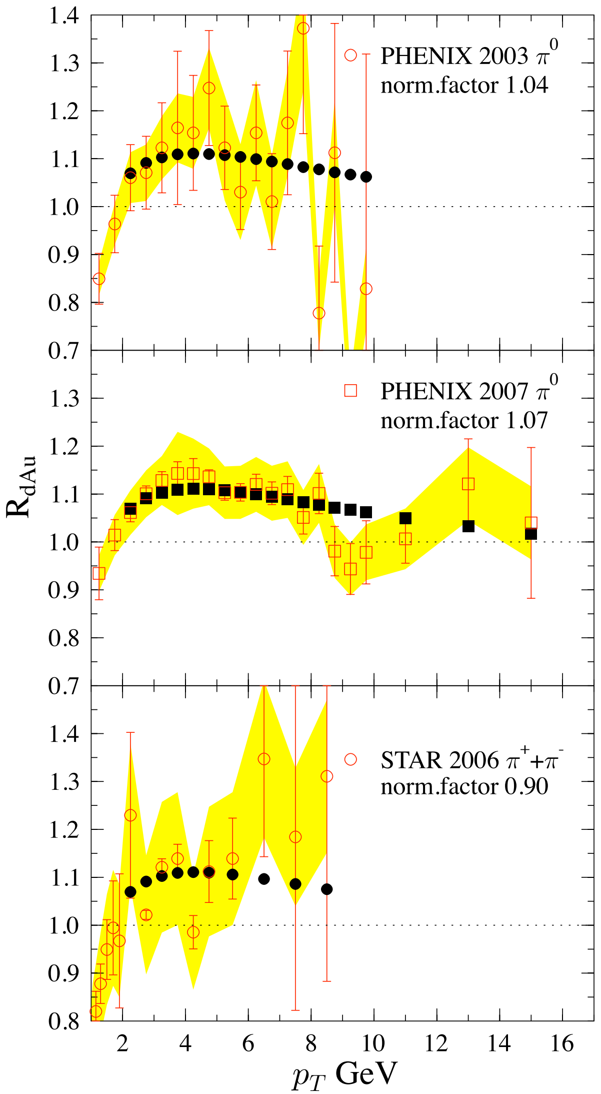
- QW depend on the in-medium length and the transport coefficient
  - Length given by geometry (not a free parameter)
  - Transport coefficient is the fitting parameter

The benchmark first!

proton-proton



d-Au from EPS08 nPDFs



Good agreement with NLO pQCD

The benchmark first!

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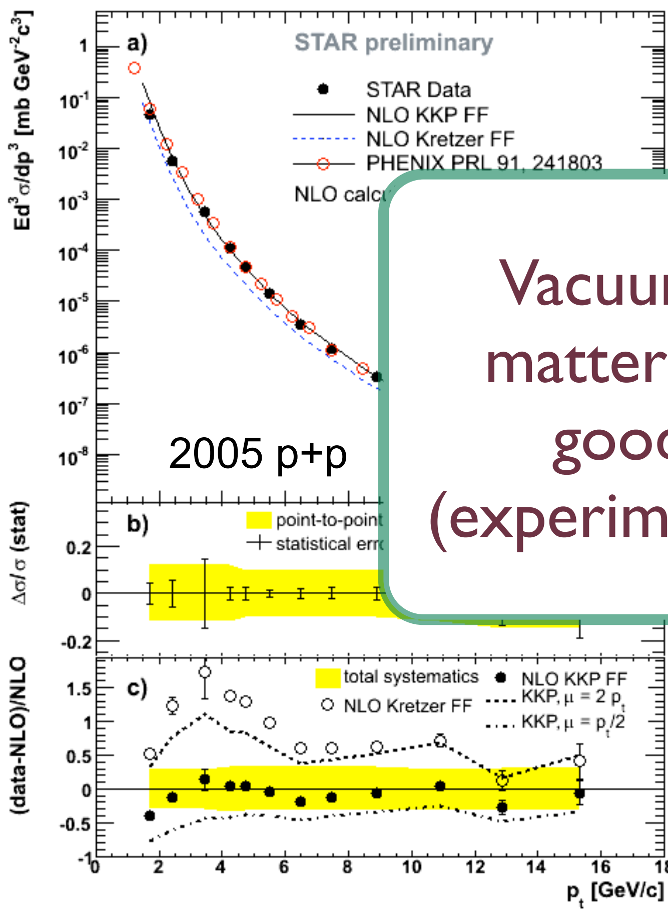

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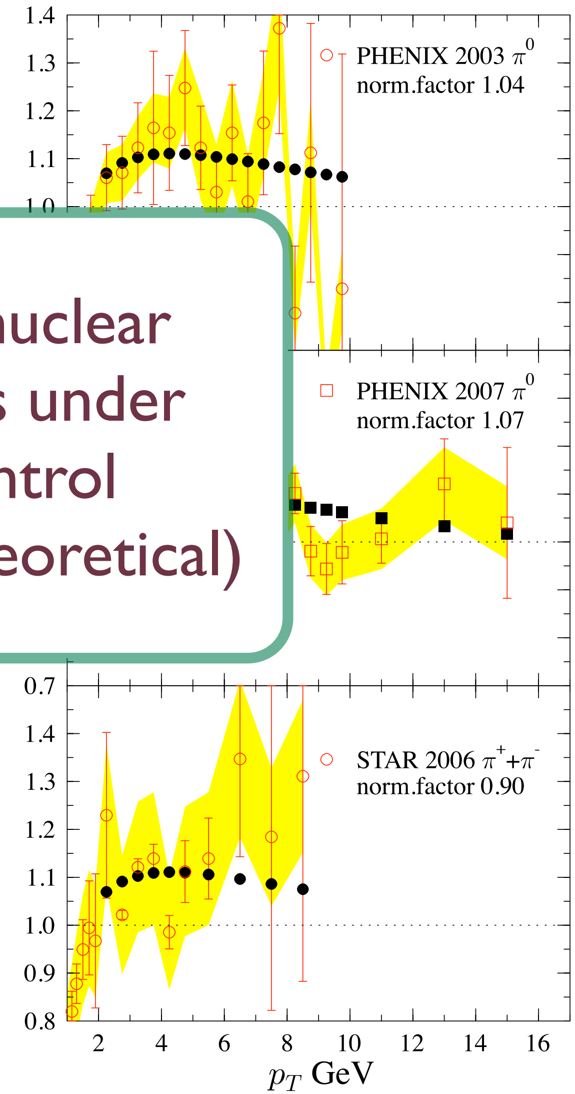


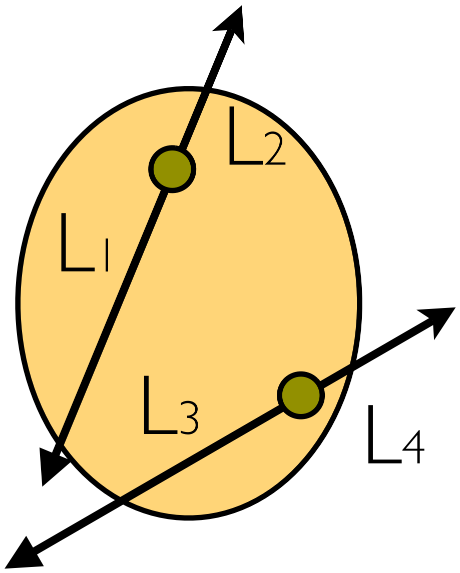
Vacuum and cold nuclear matter benchmarks under good enough control (experimental and theoretical)

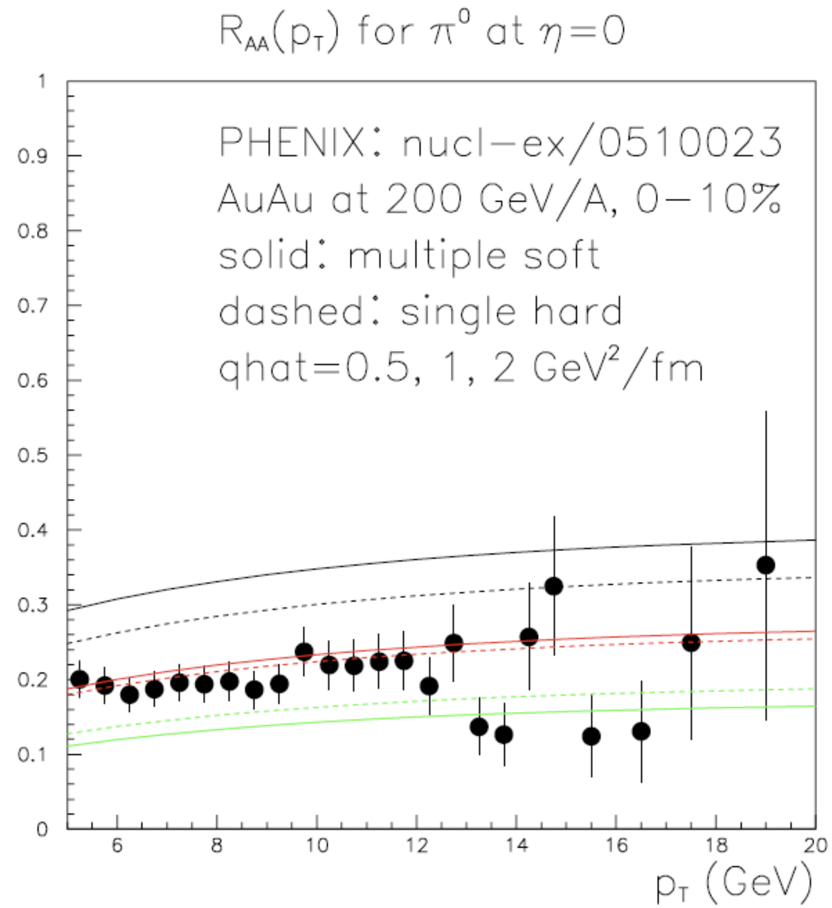
Good agreement with NLO pQCD

Fixed length

⇛ The hard process can be produced at any point inside the medium

Transverse plane:



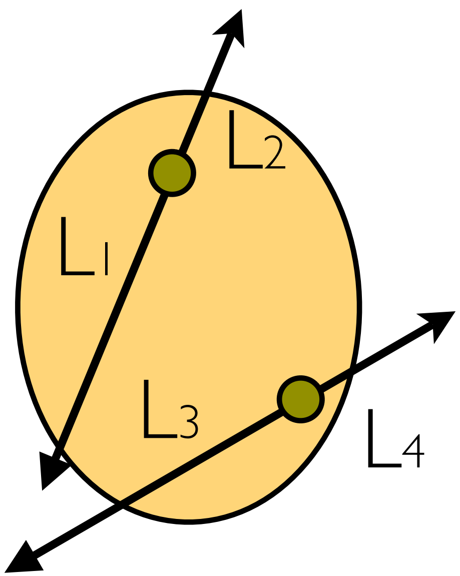


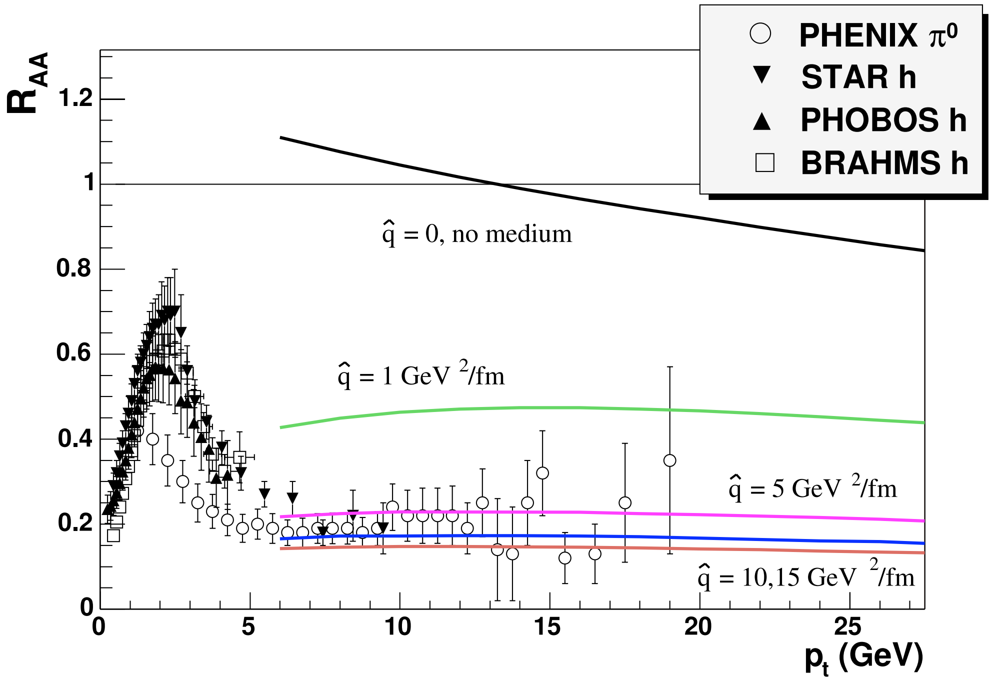
⇛ Average length for a cylinder of radius $R \simeq R_A \simeq A^{1/3} \simeq 6\text{fm}$

$$L \simeq 5.2\,\text{fm} \quad \Longrightarrow \quad \boxed{\hat{q} \simeq 1\,\text{GeV}^2/\text{fm}}$$

What if we do the other way round?

- Does the average of lengths commute with the suppression?
- Compute the effect for each path-length and then average





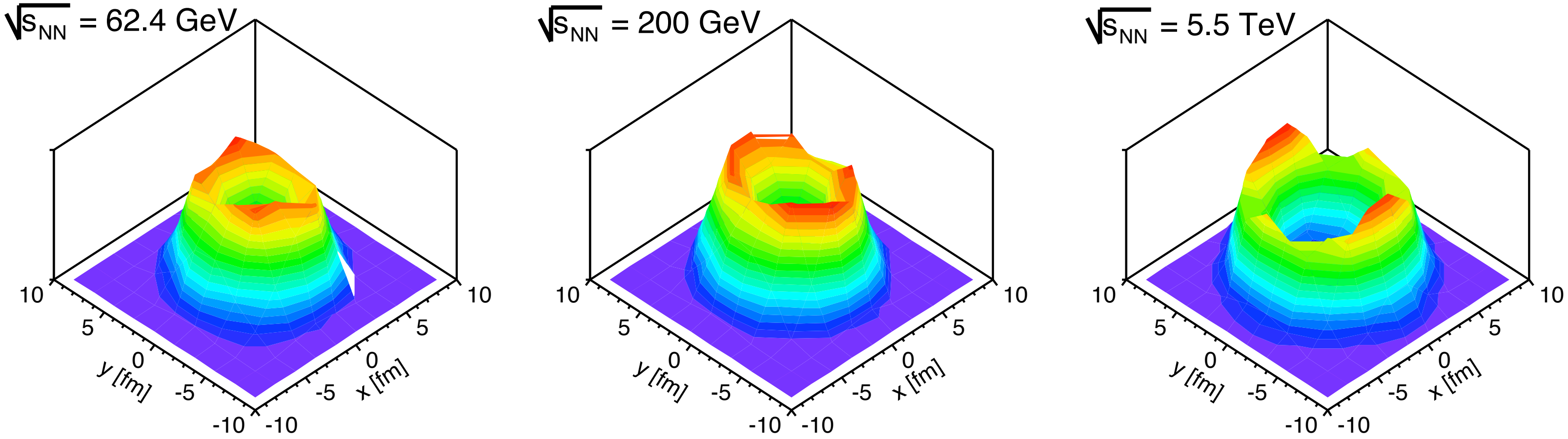
[Eskola, Honkanen, Salgado, Wiedemann, 2004]

- The obtained transport coefficient is much larger in this case

$$\hat{q} \simeq 4 \div 14\,\mathrm{GeV}^2/\mathrm{fm}$$

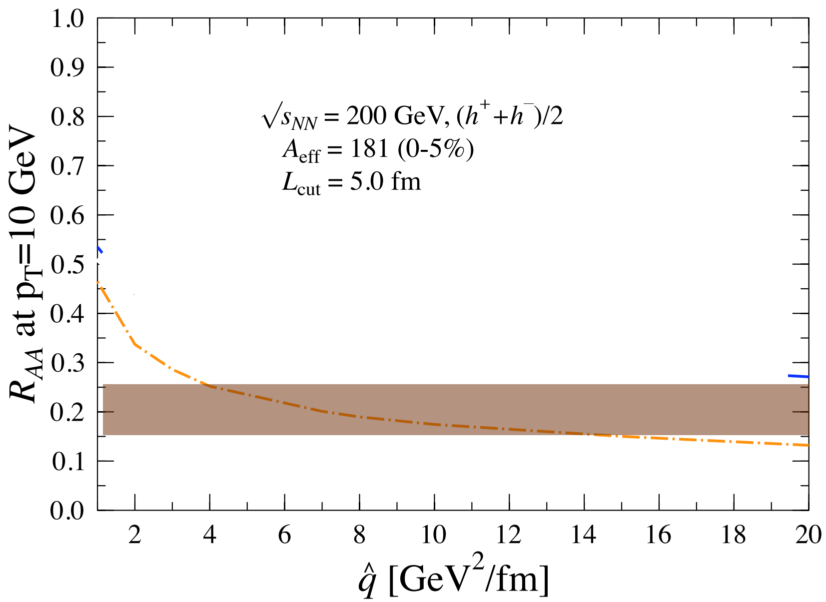
- Energy loss is very sensitive to implementation of the geometry

Inclusive high-pT hadrons are fragile



⇛ Surface bias effects reduce the sensitivity of RAA to changes in the medium parameters (transport coefficient)

$$\hat{q} \simeq 4 \div 14\,\mathrm{GeV}^2/\mathrm{fm}$$



[Muller 2002; Dainese, Loizides, Paic 2004; Eskola, Honkanen, Salgado, Wiedemann, 2004]

More realistic medium profiles?

Hydrodynamics

Expanding medium

⇛ The hydrodynamical description of HIC tells us that the medium is expanding longitudinally and transversely.

↘ The energy density and temperature decrease. Bjorken formula:

$$\epsilon(\tau) \sim \frac{\epsilon_0}{\tau^{4/3}} \qquad T(\tau) \sim \frac{T_0}{\tau^{1/3}} \qquad n(\tau) \sim \frac{n_0}{\tau^{1/3}}$$

⇛ So, the transport coefficient should also decrease with time

$$\hat{q} \sim \frac{\hat{q}_0}{\tau^\alpha},$$

$\alpha = 1$ for particle density scaling and Bjorken expansion

⇛ This can be implemented in the path integral

$$\mathcal{K}\left(\mathbf{r}(x), x; \mathbf{r}(\bar{x}), \bar{x}|\omega\right) = \int \mathcal{D}\mathbf{r} \exp\left[i\frac{\omega}{2}\int_x^{\bar{x}} d\xi \left(\dot{\mathbf{r}}^2 + i\frac{\hat{q}(\xi)}{2\omega}\mathbf{r}^2\right)\right]$$

2-dimensional harmonic oscillator with time-dependent frequency

Static-expanding scaling law

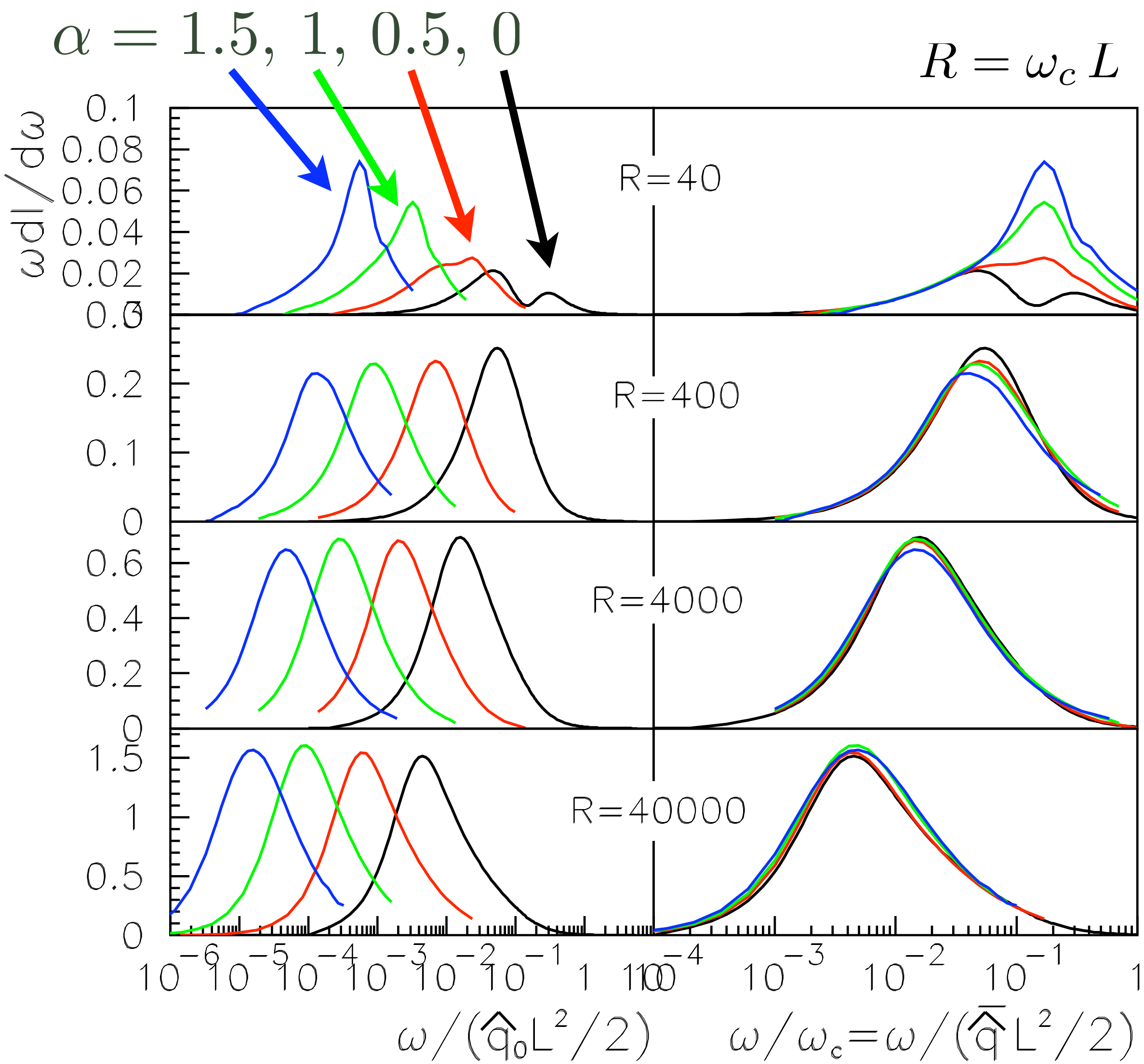
Expanding medium

$$\hat{q} \sim \frac{\hat{q}_0}{\tau^\alpha}$$

Scaling for the spectra

$$\langle \hat{q} \rangle = \frac{2}{L^2} \int d\xi \, (\xi - \xi_0) \, \frac{\hat{q}_0}{\xi^\alpha}$$

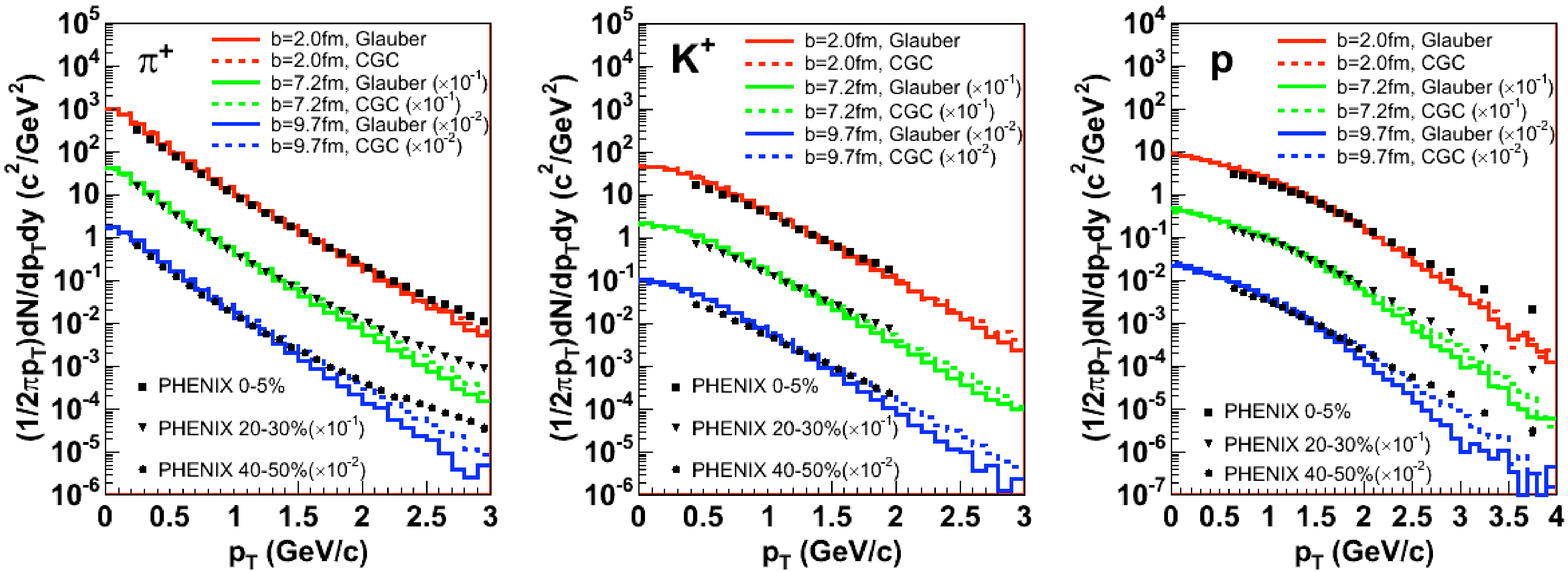
Allows to perform calculations in an equivalent static scenario



[Salgado, Wiedemann, 2003]

Hydrodynamical model

- Hydro calculations one of the main activity in HICs
  - We use the hydrodynamical fits by T. Hirano (code available)



Provides fields of energy density, T, etc... as a function of transverse position ant time

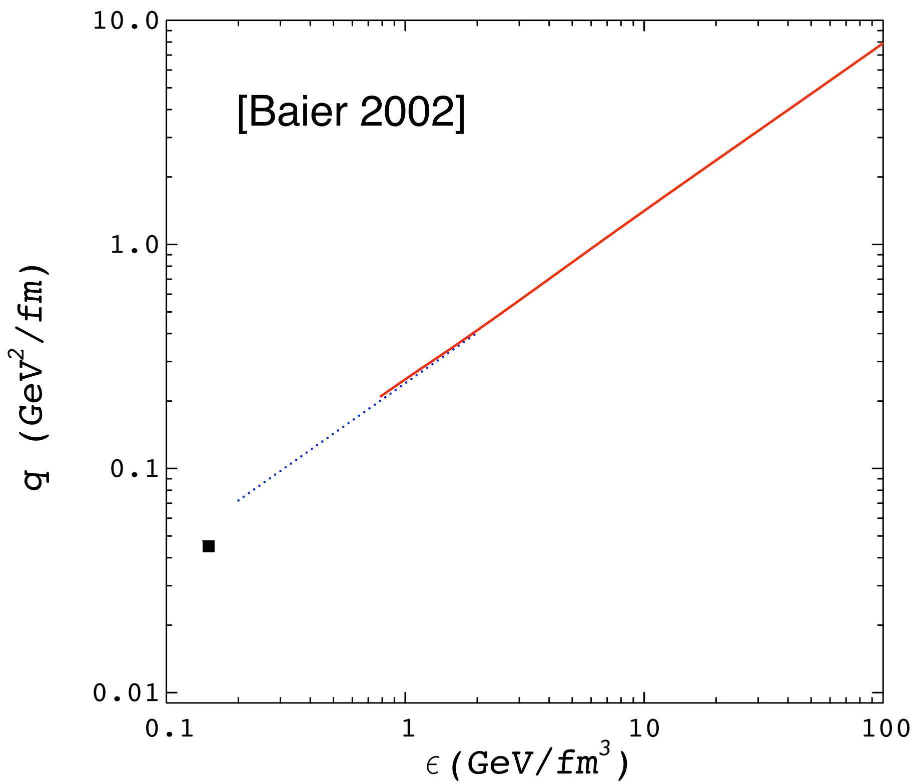
Hydro meets jet quenching

- Defining the length in a realistic medium is not trivial.
  - We can use instead the scaling law and write

$$\langle\omega_c\rangle(r,\phi) = \frac{1}{2}\langle\hat{q}\rangle L_{\rm eff}^2 = \int_0^\infty d\xi\,\xi\,\hat{q}(\xi); \qquad \langle\hat{q}\rangle L_{\rm eff} = \int_0^\infty d\xi\,\hat{q}(\xi)$$

- With the transport coefficient defined by the hydrodynamical variables. Ex.:

$$\hat{q}(\tau) = 2K\,\epsilon^{3/4}(\tau)$$

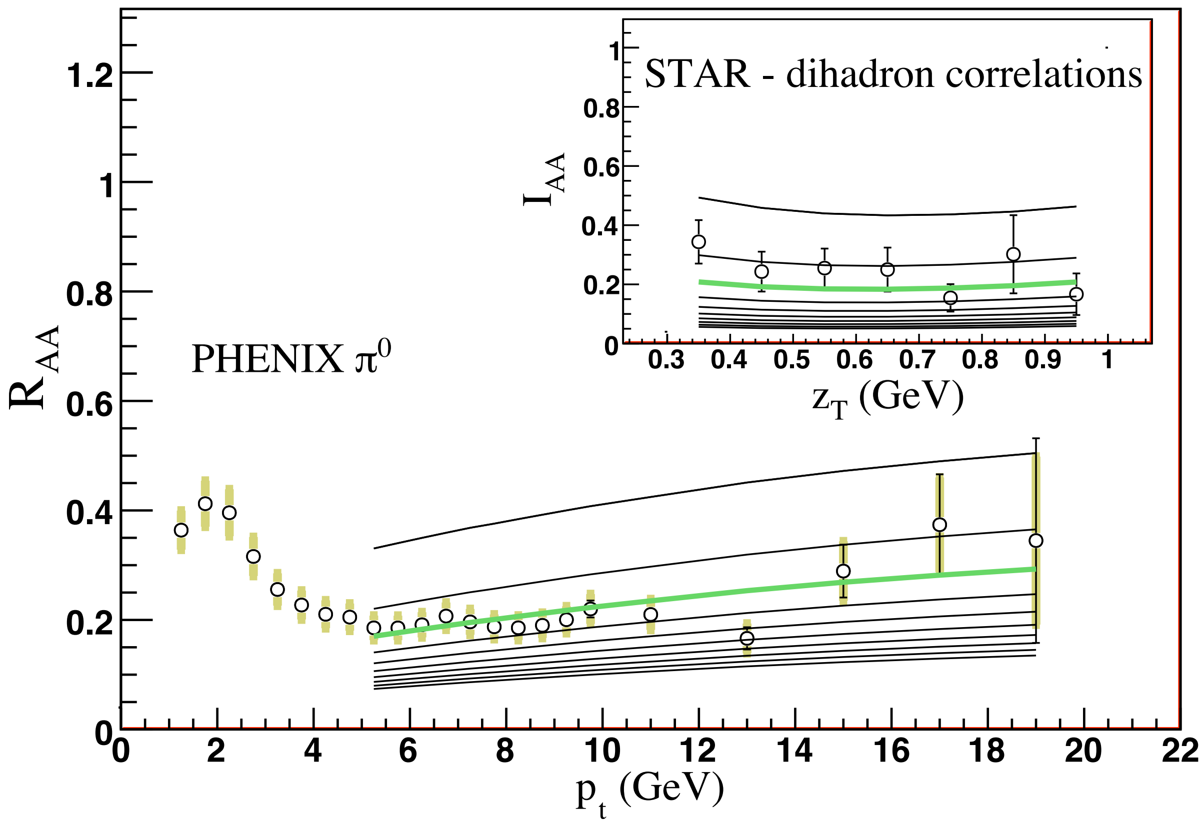


- and c a free parameter to be fitted to experimental data
  - Estimate from a free QGP gas

$$K = 1$$

Global fit to data using a hydrodynamical medium

⇛ A common fit of several observables to obtain the value of $\hat{q}$

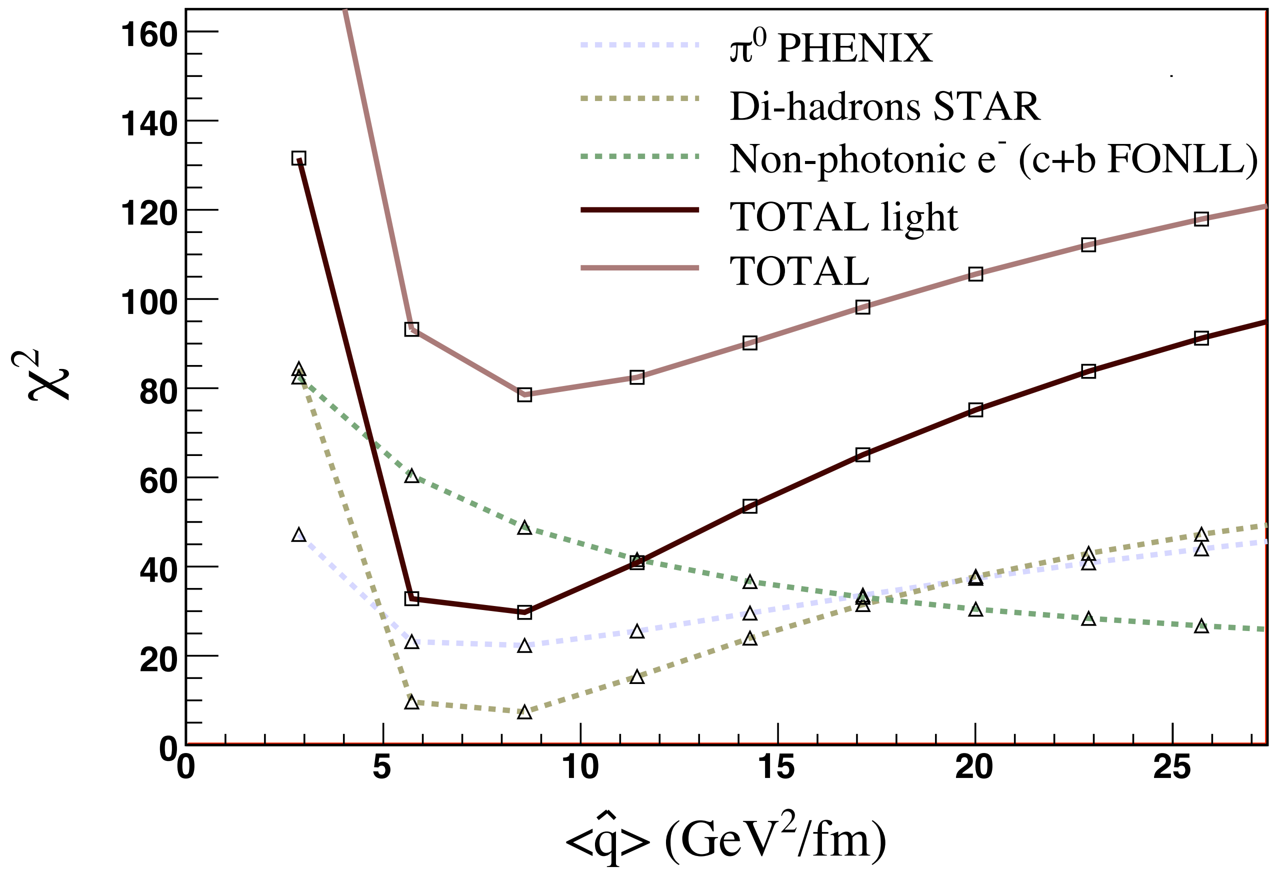


$K = 2,\ 3,\ 4 \ldots.$

[Armesto, Cacciari, Hirano, Salgado, in preparation]

Global fit to data using a hydrodynamical medium

[Armesto, Cacciari, Hirano, Salgado, in preparation]



Preliminary

Pions from PHENIX

$$K = 4.5 \pm 1.5$$

Di-hadrons STAR

$$K = 3.0 \pm 0.5$$

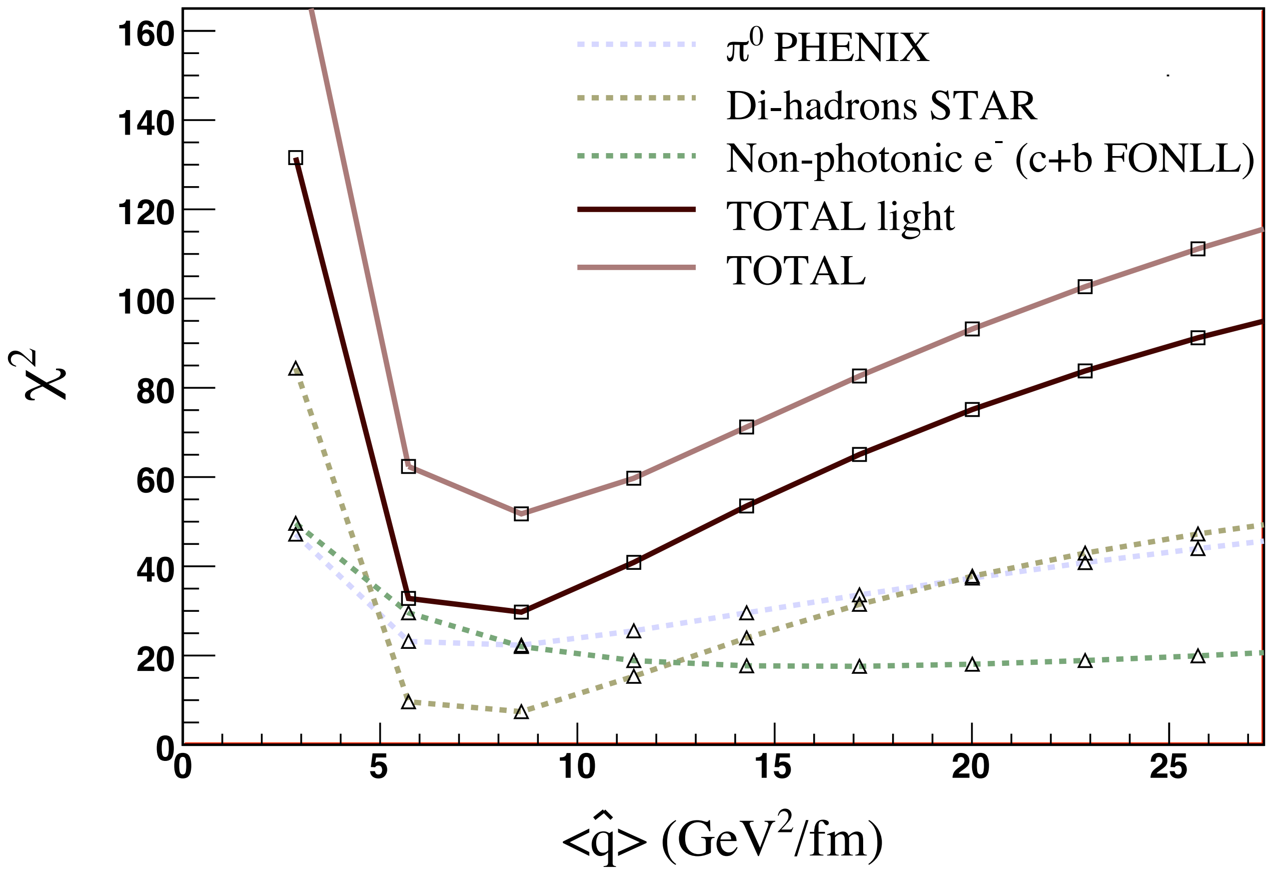
Total light

$$K = 3.5 \pm 0.5$$

Preliminary

Global fit to data using a hydrodynamical medium

[Armesto, Cacciari, Hirano, Salgado, in preparation]



Preliminary

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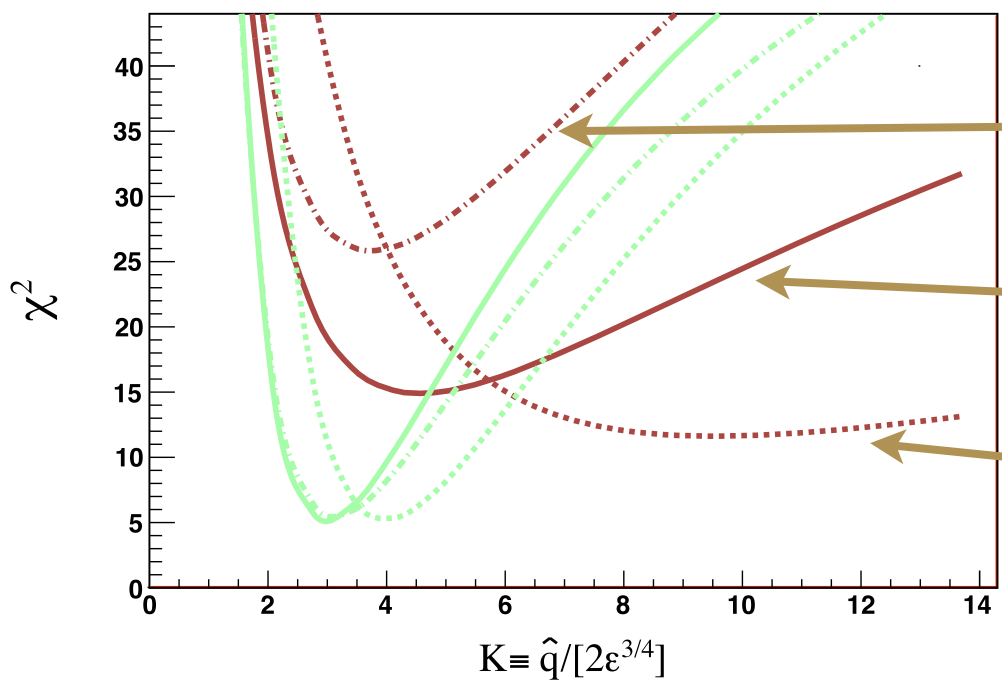
Preliminary

Global fit to data using a hydrodynamical medium

- The hydro calculation provides the medium profiles for $\xi > \tau_0$

Use different extrapolations for times smaller than thermalization



$$\hat{q}(\xi) = \frac{\hat{q}(\tau_0)}{\xi^{3/4}} \quad \text{for} \quad \xi < \tau_0$$

$$\hat{q}(\xi) = \hat{q}(\tau_0) \quad \text{for} \quad \xi < \tau_0$$

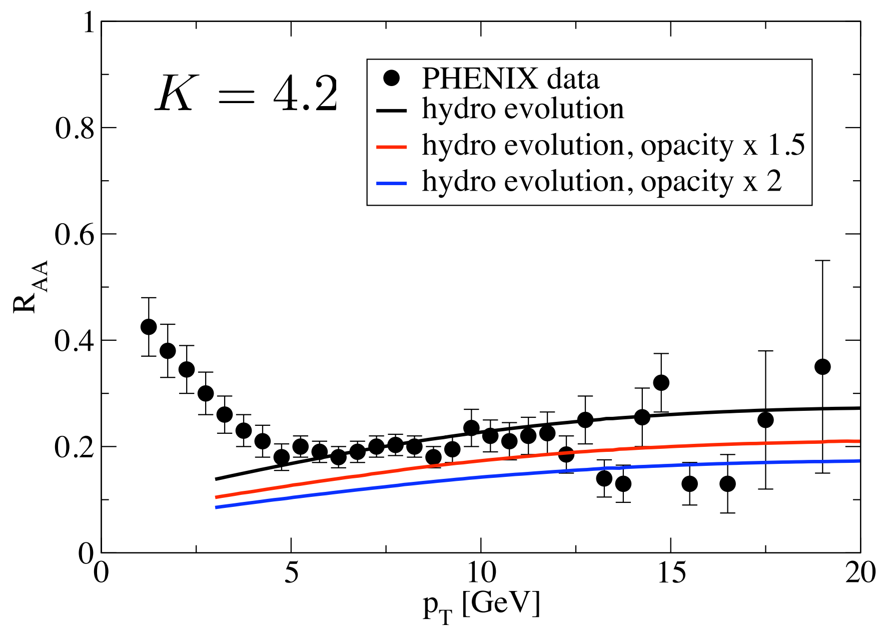
$$\hat{q}(\xi) = 0 \quad \text{for} \quad \xi < \tau_0$$

[Armesto, Cacciari, Hirano, Salgado, in preparation]

- Some sensitivity appears. Main features unchanged.

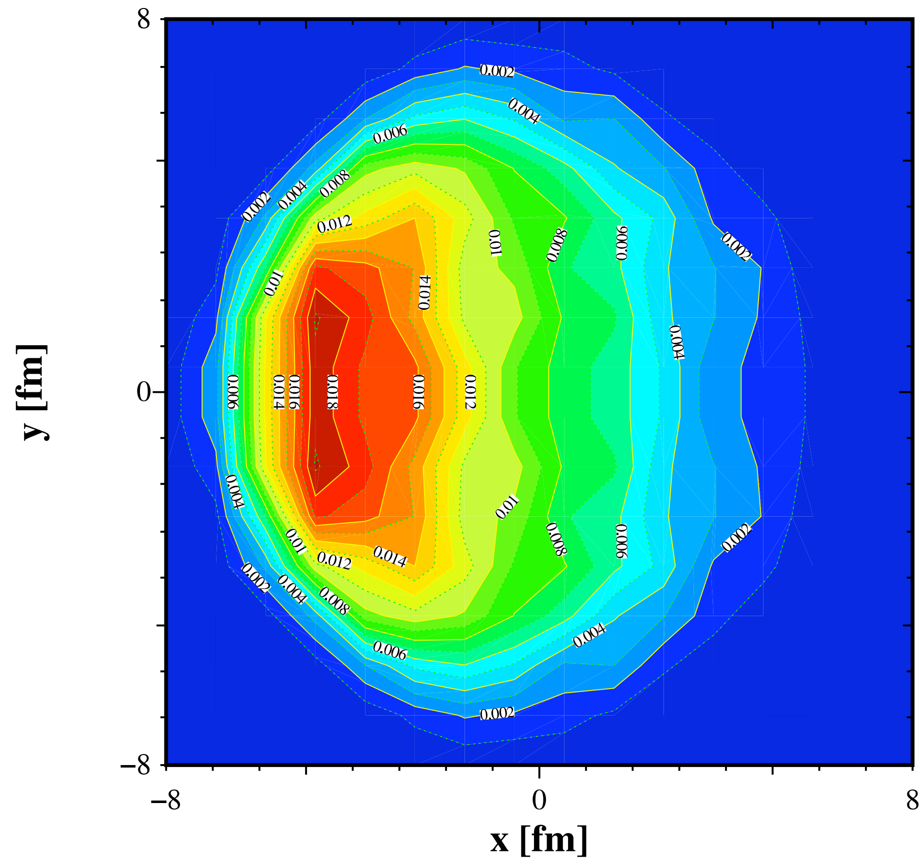
The medium profiles probed

[Eskola, Renk 2006; also Bass, Gale, Nonaka, Qin, Ruppert, Turbide...]



Sensitivity increases:
Surface bias less important

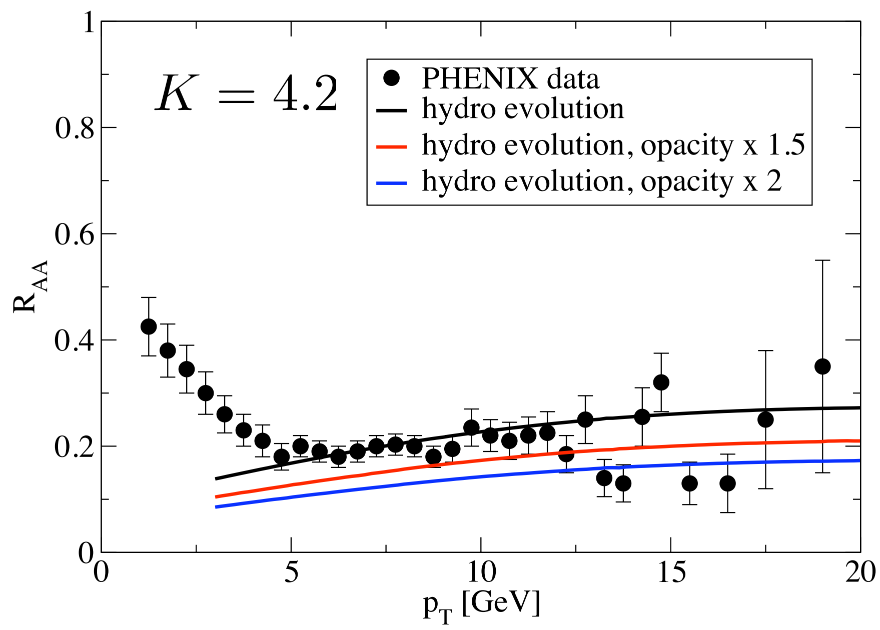
Hydrodynamics



Different hydrodynamical profiles give different values of $K = 2.3 \div 4.5$

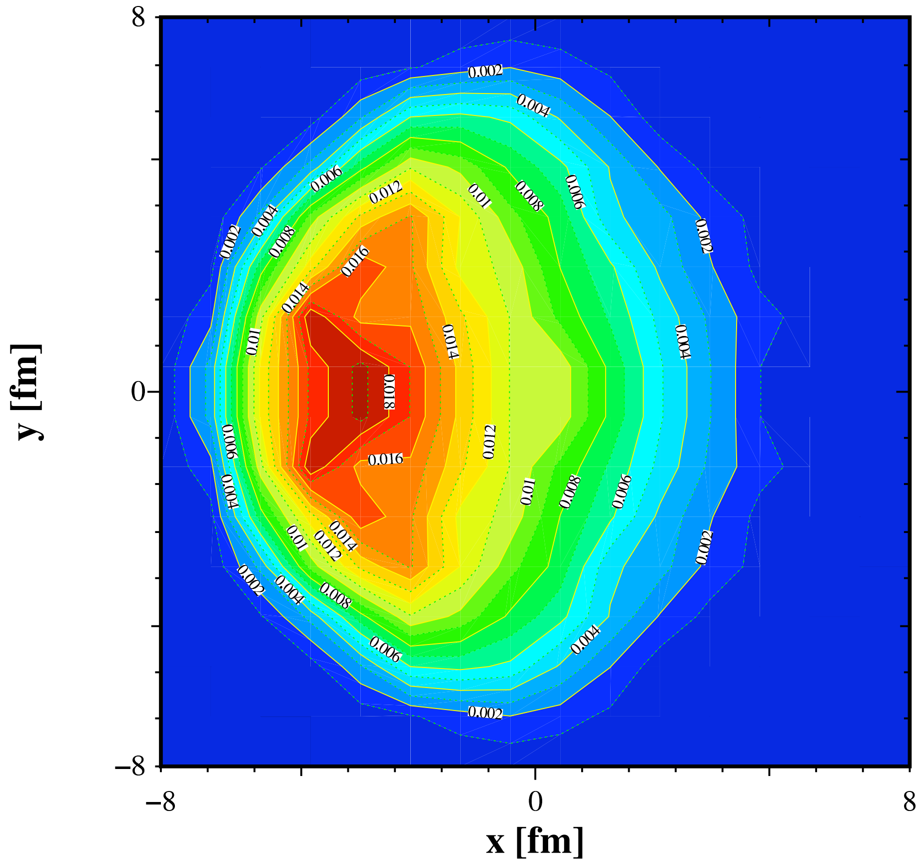
The medium profiles probed

[Eskola, Renk 2006; also Bass, Gale, Nonaka, Qin, Ruppert, Turbide...]



Sensitivity increases:
Surface bias less important

Box density



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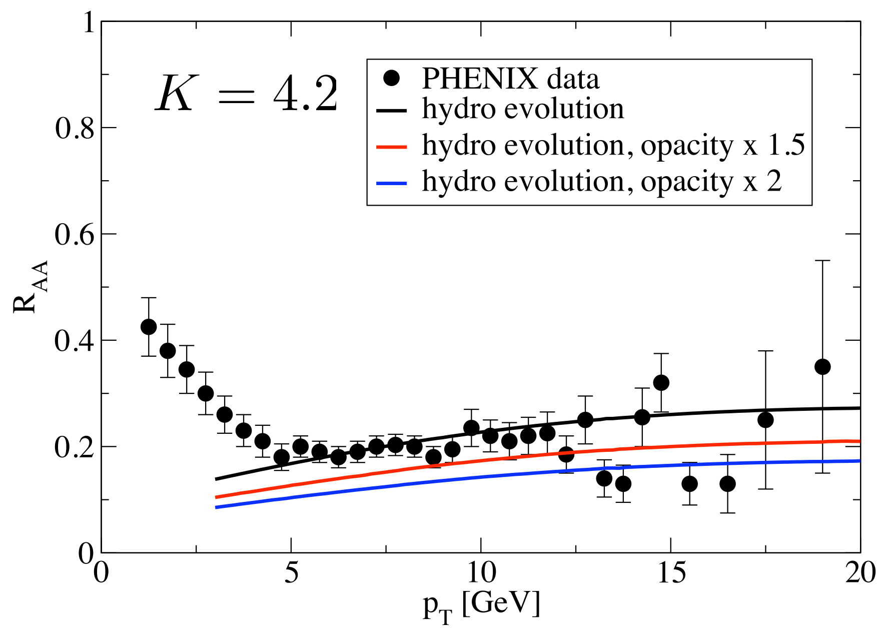
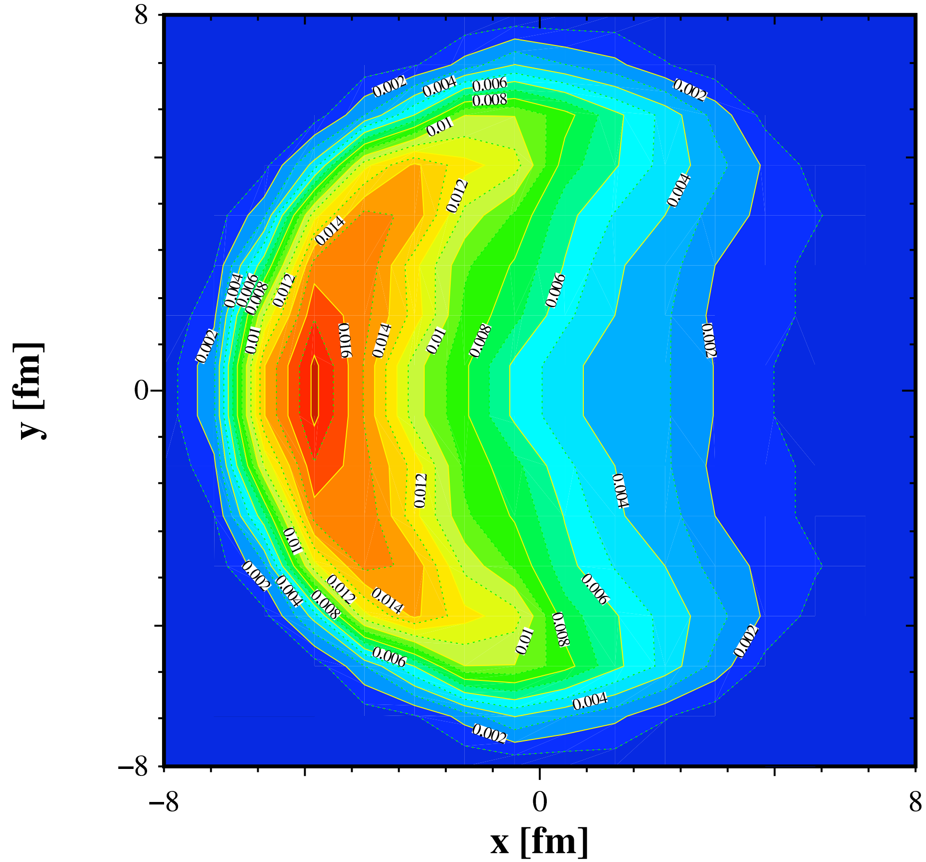


Hydrodynamics – black core



Sensitivity increases:
Surface bias less important

Different hydrodynamical profiles give different values of $K = 2.3 \div 4.5$

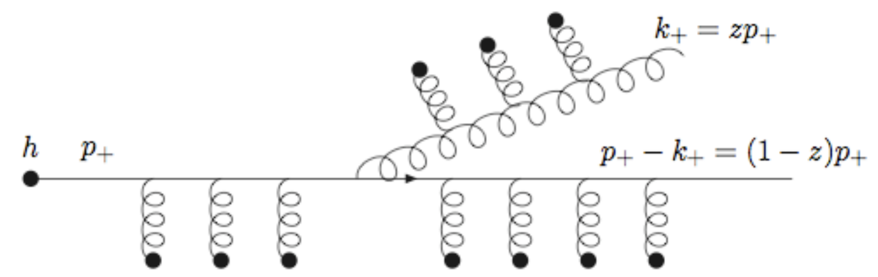
Partial summary

- Energy loss distribution important (QW)
- Different medium profiles give different determinations of the medium properties
- Other observables
  - Heavy quarks
  - Jets (and particle correlations)

Massive quarks

- Gluon radiation is suppressed by mass terms in the heavy quark propagator.
- Also true for the vacuum:
  - Dead cone effect

$$z\frac{dI}{dzdk_\perp^2} \simeq \frac{2\alpha_s C_F}{\pi}\frac{k_\perp^2}{(k_\perp^2 - M^2)^2}$$



- For the medium case, we need to modify the quark Wilson line

$$\int dp_- \frac{e^{i(x_{1+}-x_{2+})k_-}}{p^2 - M^2 + i\epsilon} = -\Theta(x_{2+} - x_{1+})\frac{2\pi i}{2p_+}\exp\left\{i\frac{M^2}{p_+}(x_{1+} - x_{2+})\right\}$$

- These exponents recombine: only change, multiply the integrand by

$$\exp\left\{i\frac{x^2M^2}{k_+}(x_+ - \bar{x}_+)\right\}$$

[Exercise: check this]

Massive quarks

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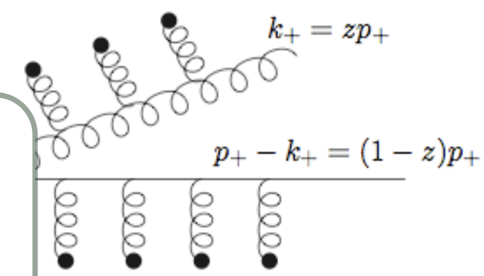
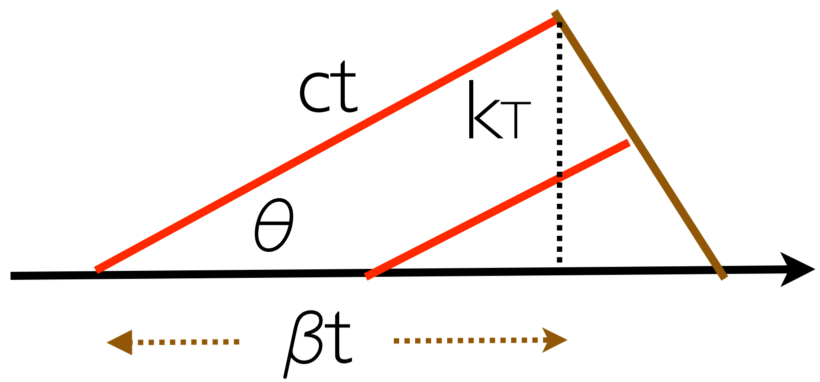
⇛ Also true for t

↘ Dead cone e

$$z\frac{dI}{dzdk_\perp^2} \simeq \frac{2\alpha_s C}{\pi}$$



Dead cone in vacuum



$$\sin\theta_{DC} = 1-\beta^2 = \left(\frac{M}{E}\right)^2$$

⇛ For the medi … Wilson line

$$\int dp_- \frac{e^{i(x_{1+}}}{p^2 - } \quad x_{1+} - x_{2+})\}$$

⇛ These exponents recombine: only change, multiply the integrand by

$$\exp\left\{i\frac{x^2M^2}{k_+}(x_+ - \bar{x}_+)\right\}$$

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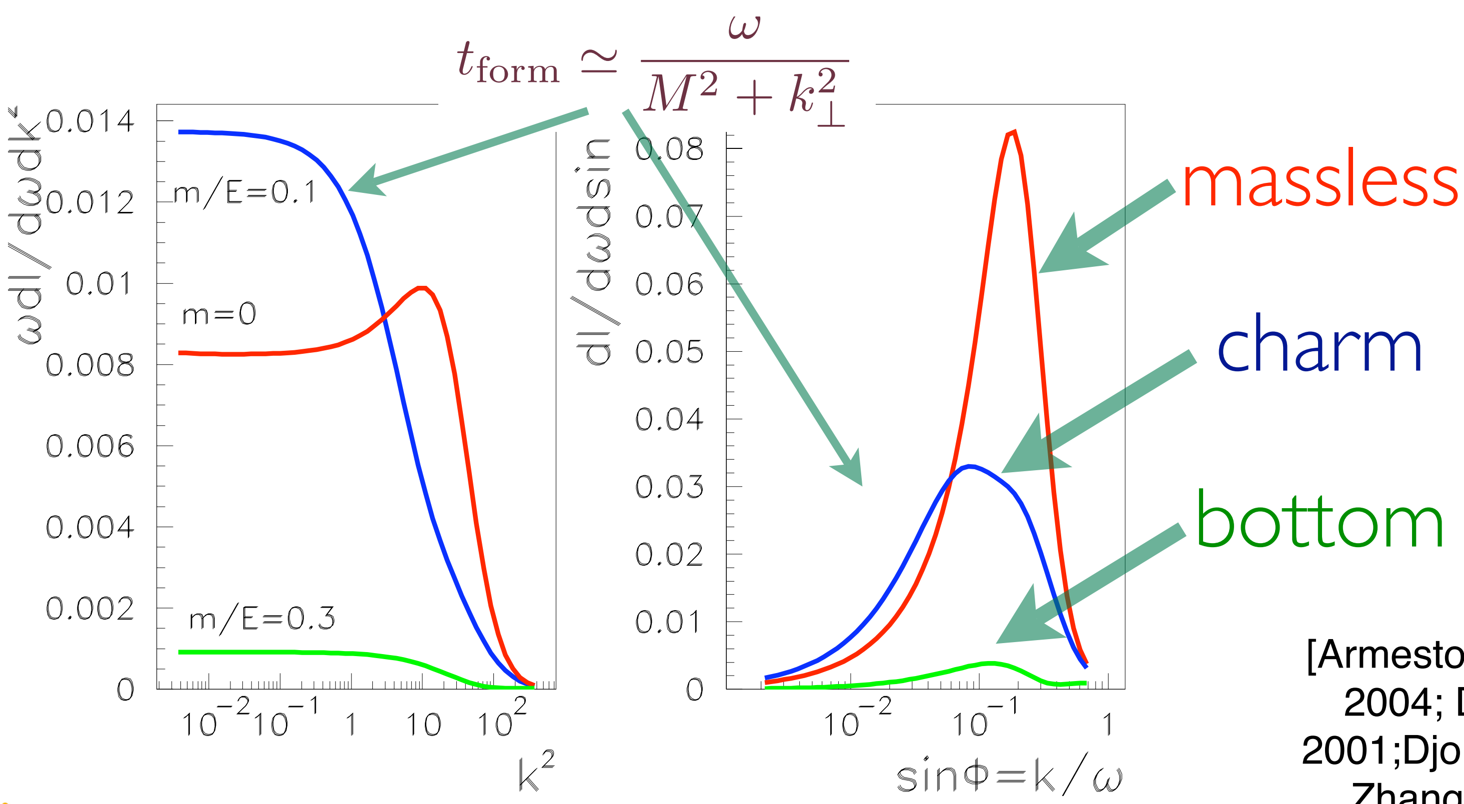
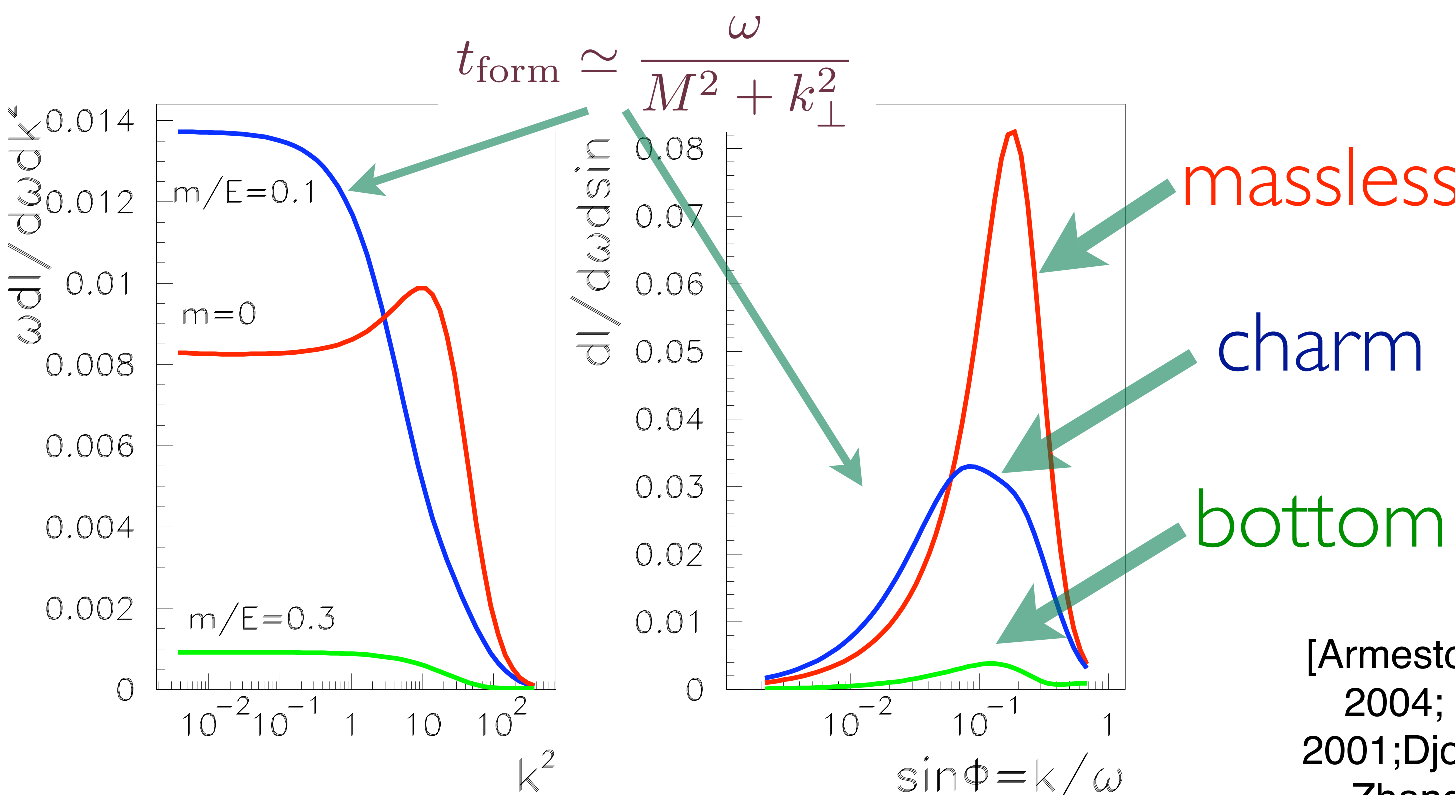
Numerical results



[Armesto, Salgado, Wiedemann 2004; Dokshitzer, Kharzeev 2001;Djordjevic, Gyulassy 2004; Zhang, Wang, Wang 2004]

- ⇛ Two opposite effects:
  - Mass terms in the propagators suppress the radiation
  - Formation time smaller for larger mass LPM less effective
- ⇛ Net effect: less energy lost by massive quarks in the medium
  - Less suppression of particles from heavy quarks

Numerical results



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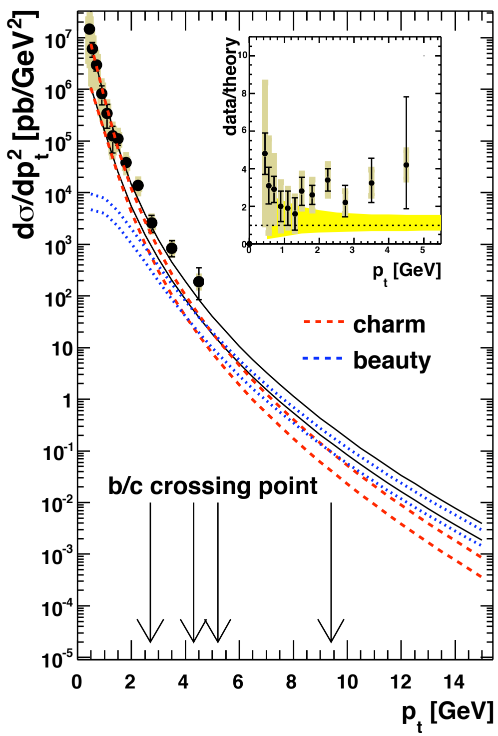
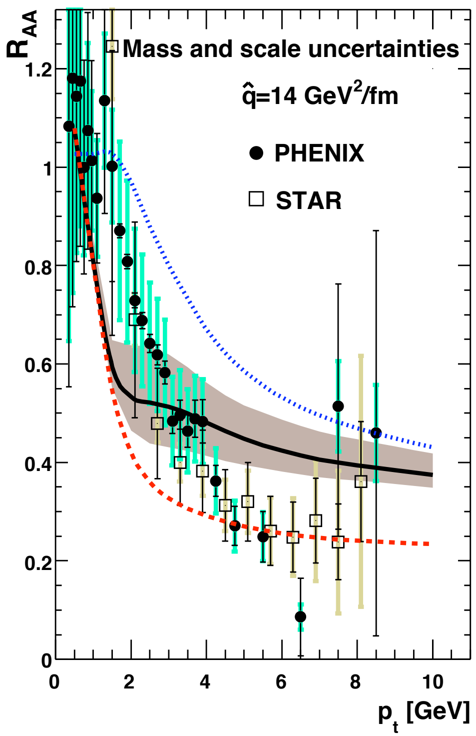
The single electron puzzle at RHIC

⇒ Suppression of charm and bottom at RHIC





[Armesto, Cacciari, Dainese, Salgado, Wiedemann 2005]

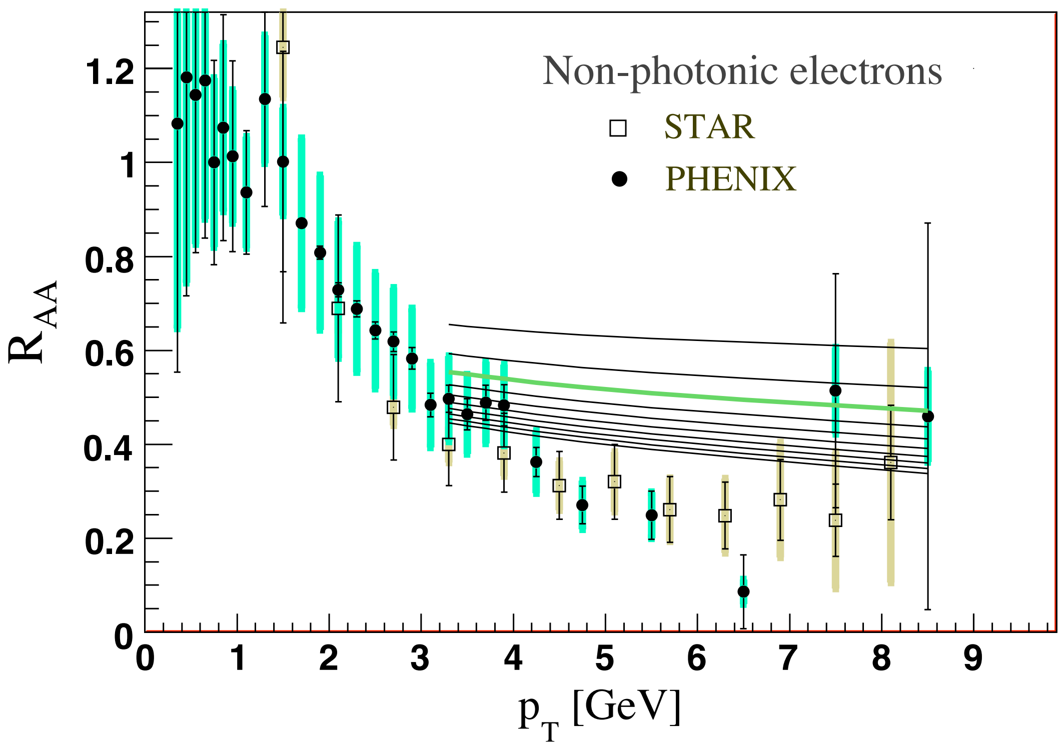
⇒ Only non-photonic electrons measured

- Do not distinguish between charm and bottom
- Large theoretical uncertainty in the c/b ratio

⇒ Measure charm and bottom separately

The single electrons in a hydro medium

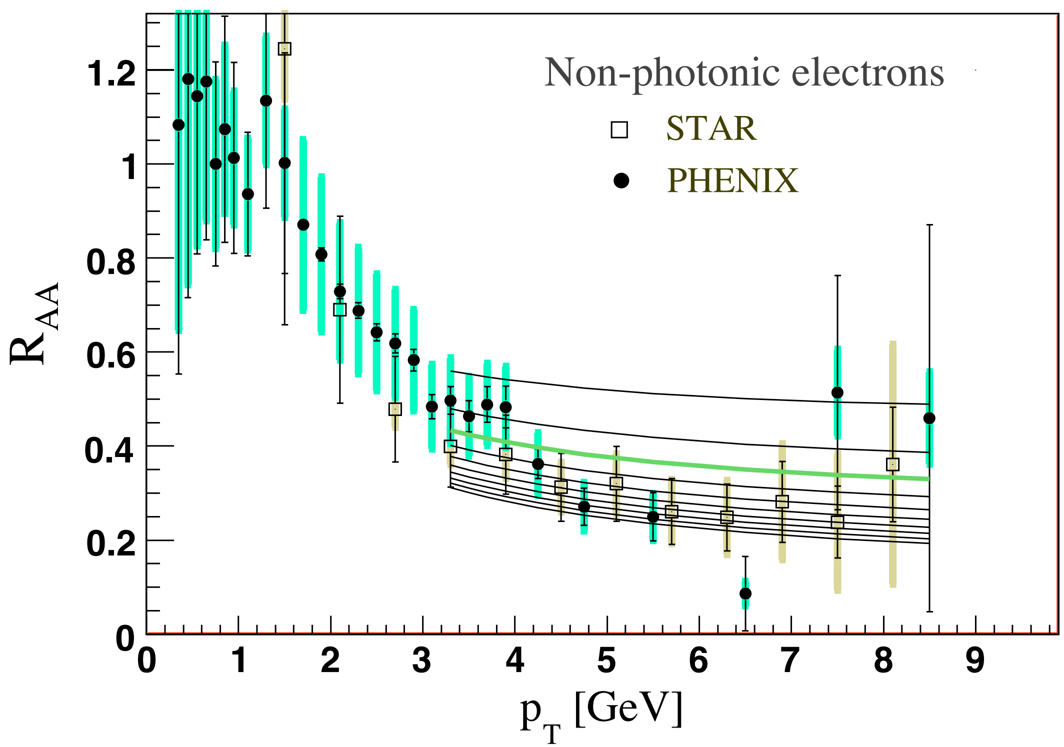
[Armesto, Cacciari, Hirano, Salgado, in preparation]



Charm + bottom contributions as given by FONLL

The single electrons in a hydro medium

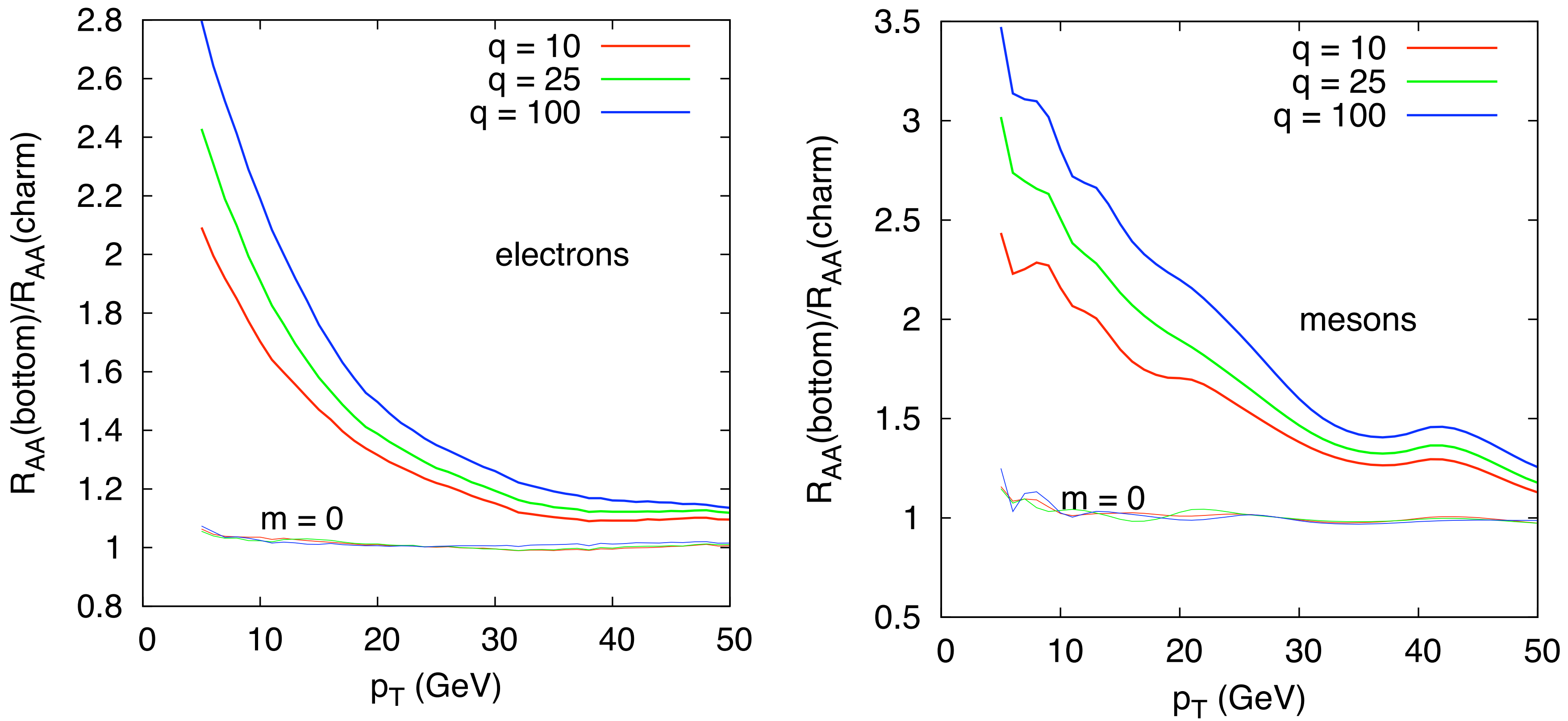
[Armesto, Cacciari, Hirano, Salgado, in preparation]



Suppression with only charm contribution to non-photonic electrons

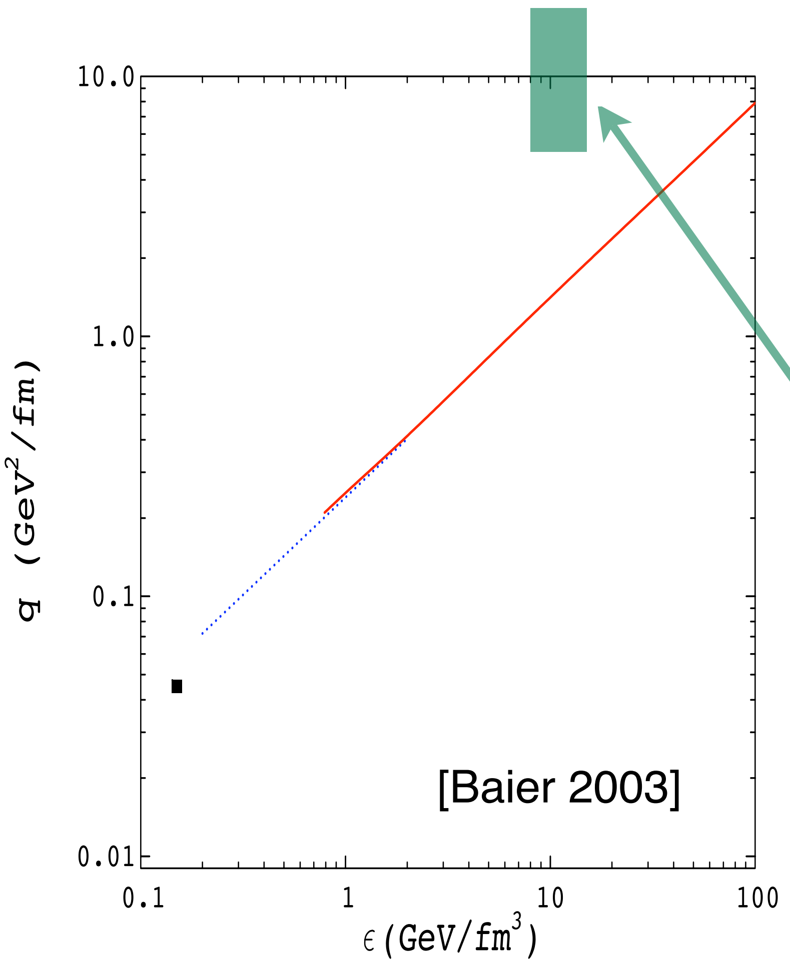
HQ at the LHC

- At the LHC charm and bottom separation will be possible
  - Double ratio sensitive to mass effects



Determination of qhat

Interpretation of the value of $\hat{q}$



- Transport coefficient for an ideal quark-gluon gas

$$\hat{q}_{\rm ideal\ gas} \simeq \frac{72}{\pi}\xi(3)\alpha_s^2 T^3 \simeq 2\epsilon^{3/4}$$

[Baier and Schiff 2006]

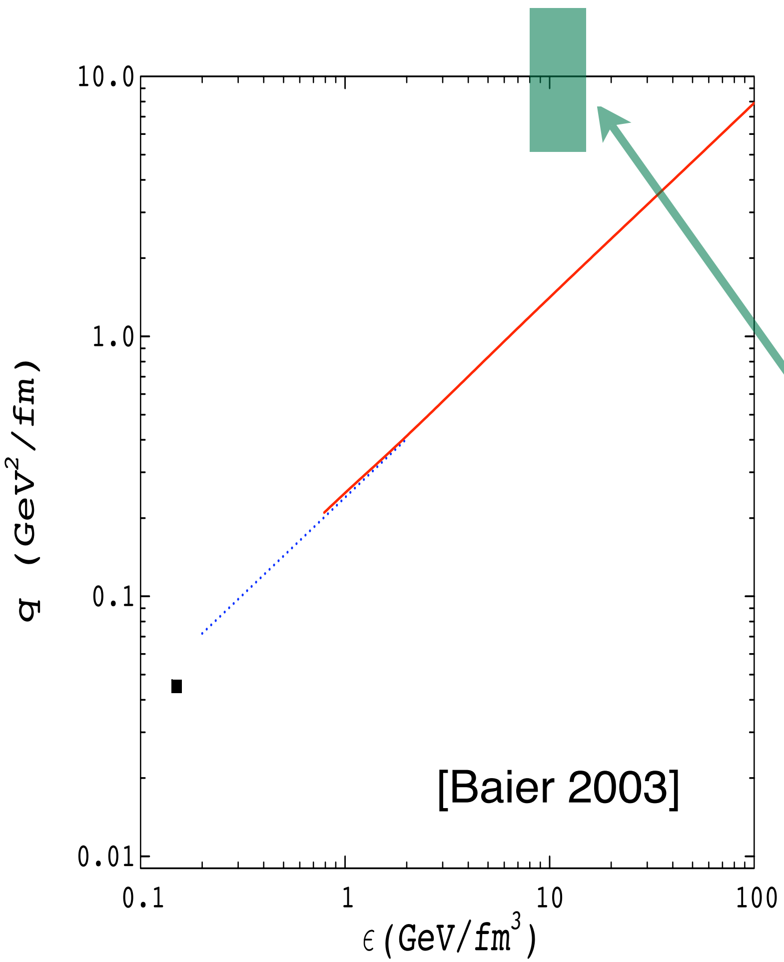
- Fits to the data

$\hat{q} > 5\ \hat{q}_{\rm ideal\ gas}$ [Eskola et al. 2004]

$\hat{q} \simeq 4.2\ \hat{q}_{\rm ideal\ gas}$ [Renk et al. 2007; Armesto et al 2008]

- Geometry plays a crucial role
- Very large uncertainties in the perturbative estimate

Interpretation of the value of $\hat{q}$



⇛ Transport coefficient for an ideal quark-gluon gas

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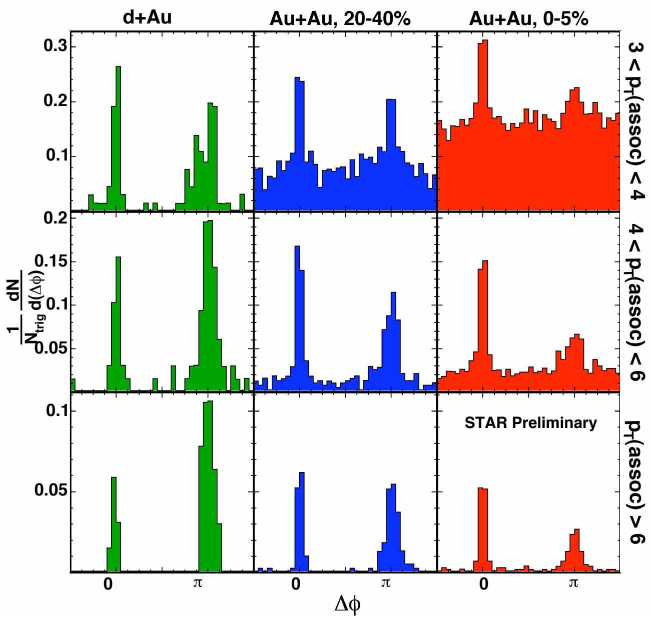
⇛ Geometry plays a crucial role

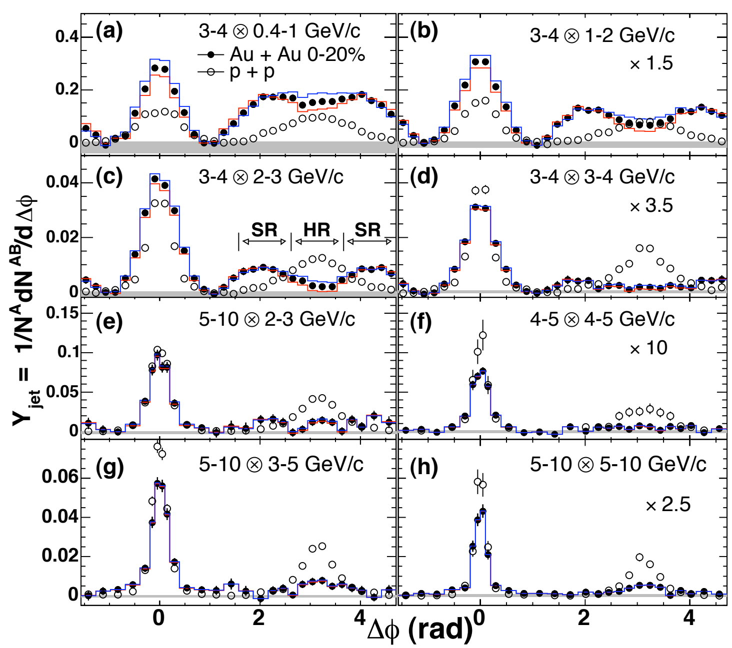
⇛ Very large uncertainties in the perturbative estimate

Signals large cross sections (much larger than perturbative ones?)

Jet studies in HIC

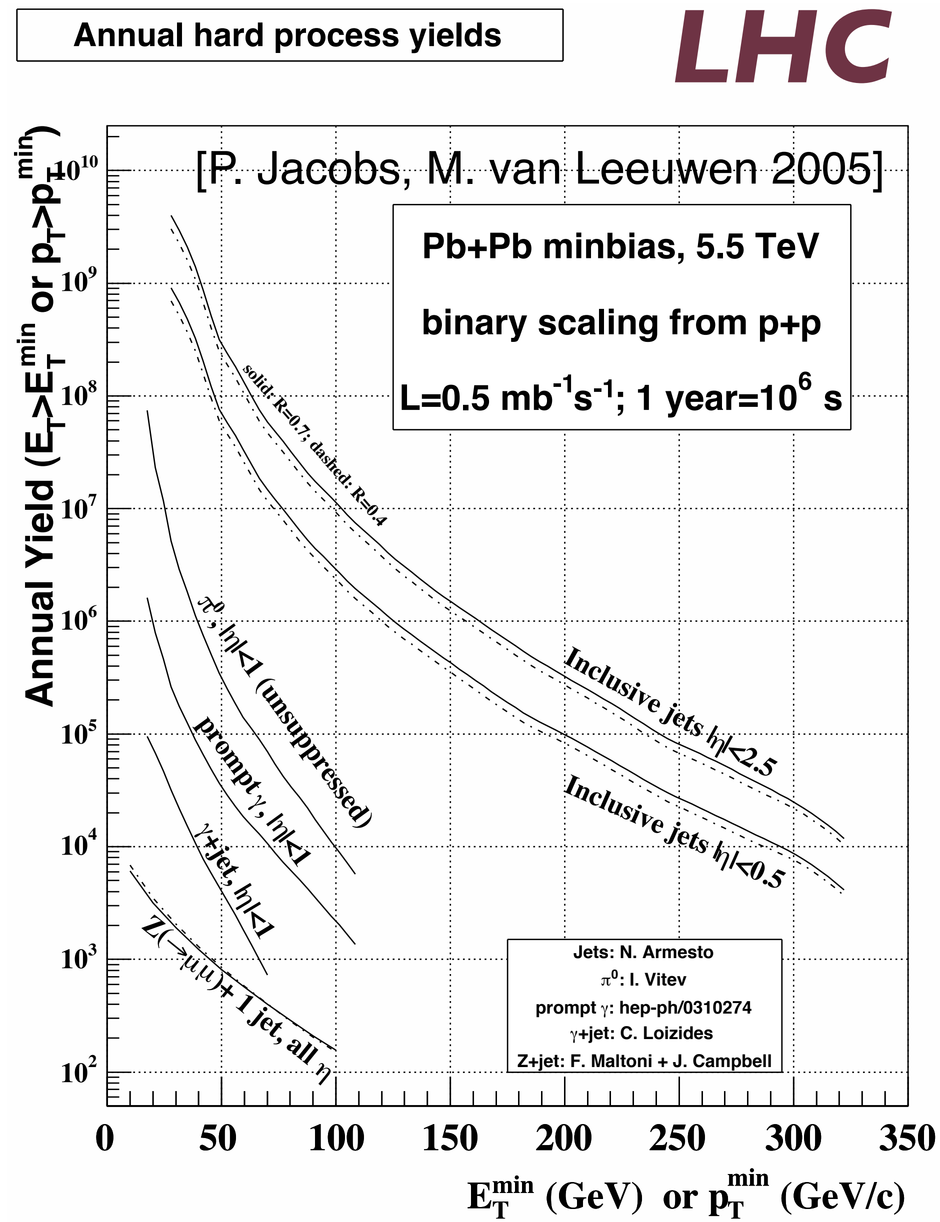


[STAR]

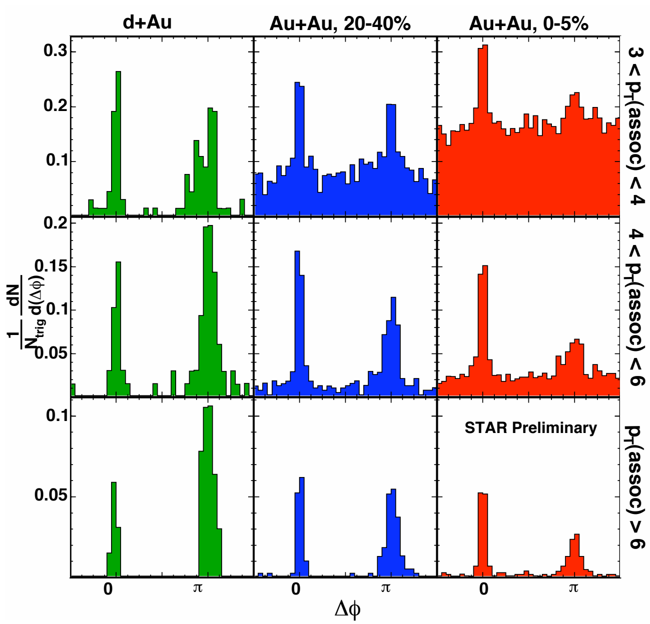


[PHENIX]

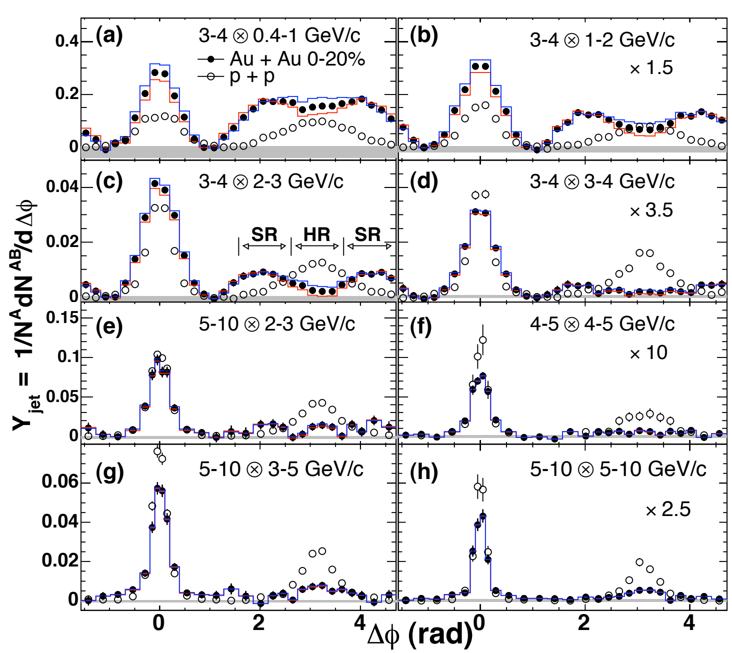
LHC



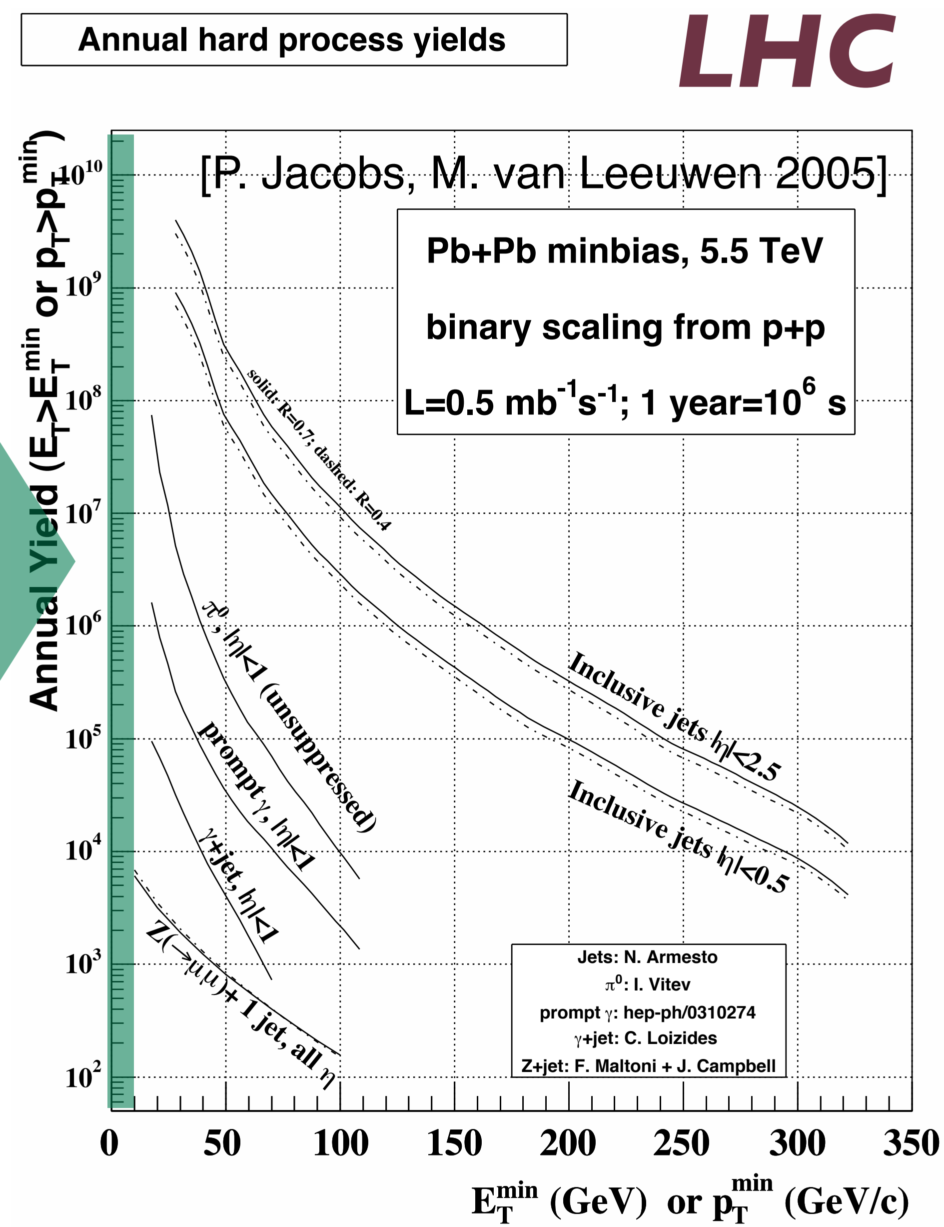
Jet studies in HIC



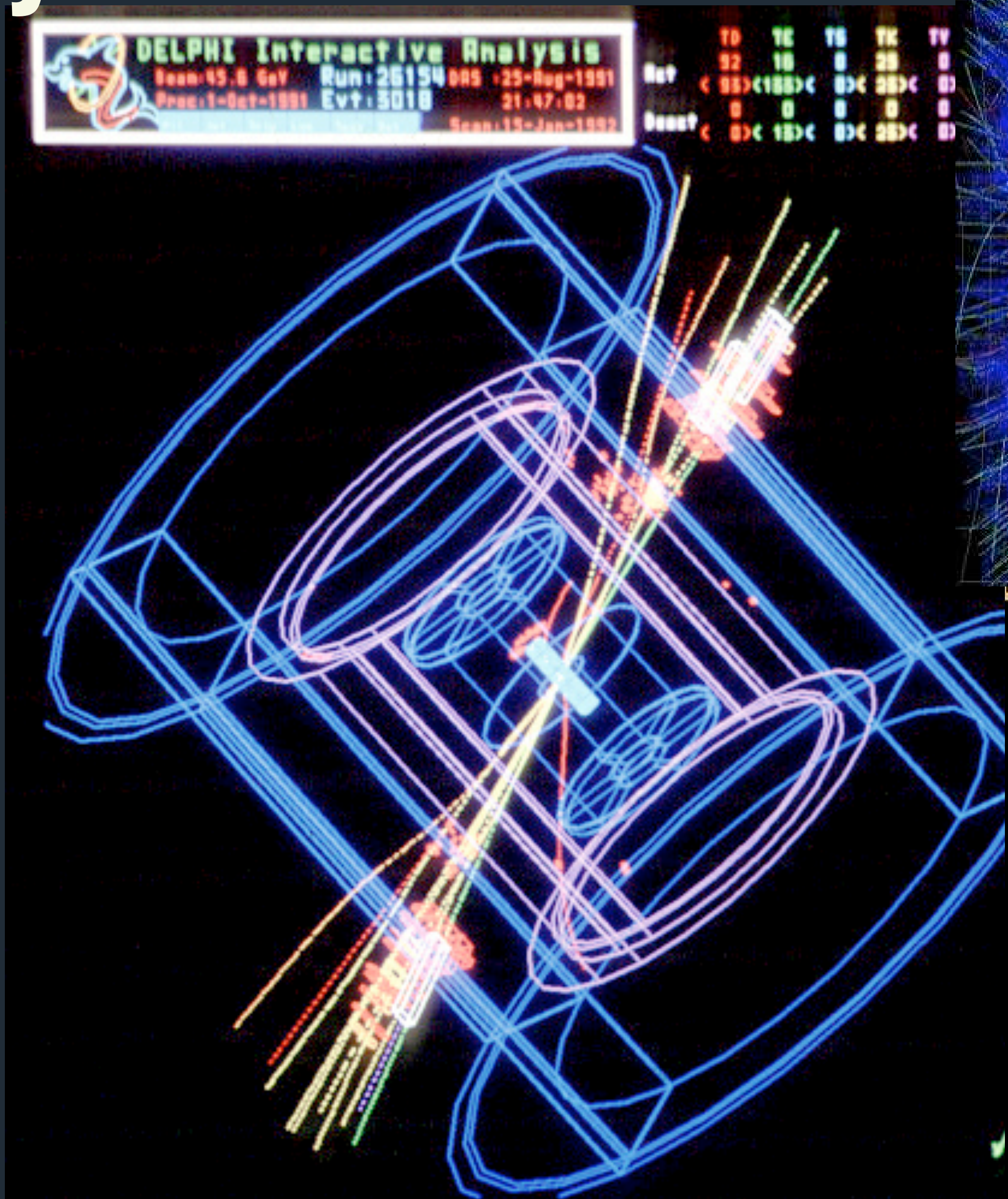
[STAR]

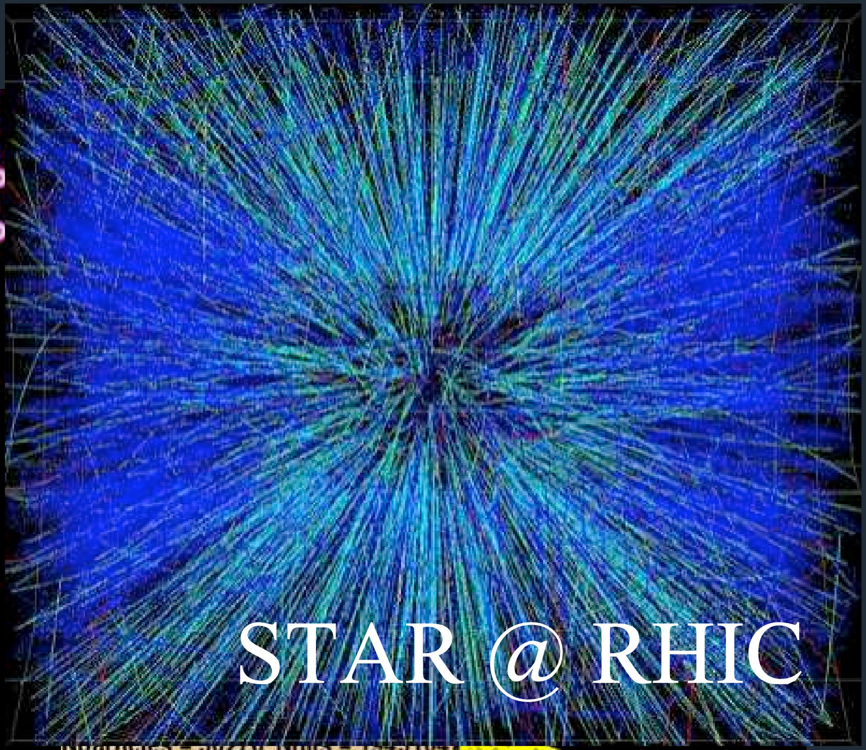


[PHENIX]



Jets in HIC

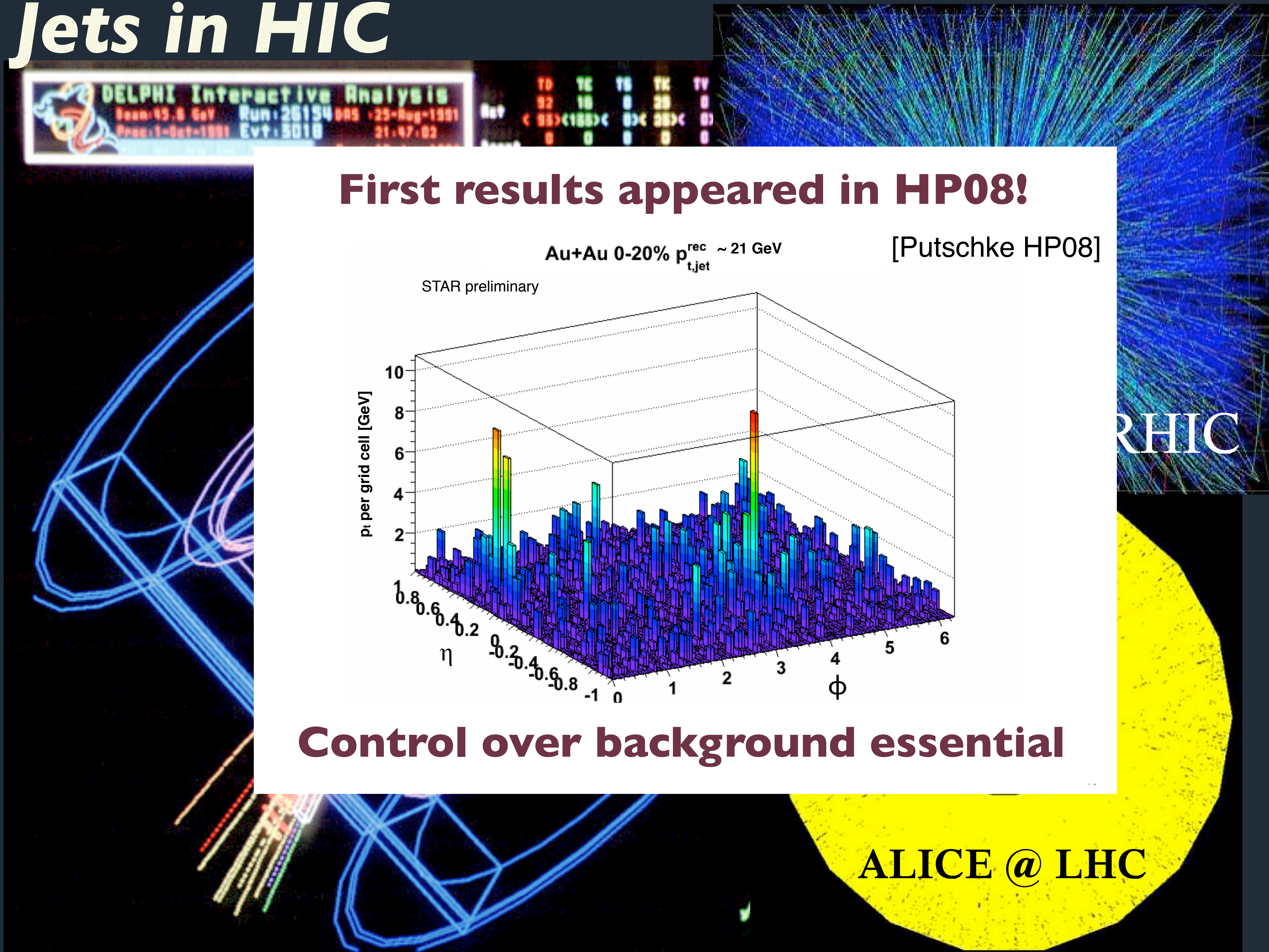

DELPHI Interactive Analysis
Run: 26154
Evt: 5018


STAR @ RHIC


ALICE @ LHC

Jets in HIC

First results appeared in HP08!



Control over background essential

Summary for jet quenching

- ⇛ The implementation of the medium-induced gluon radiation needs of a treatment of the energy carried by an arbitrary number of gluons
  - Not solved from first principles, independent gluon emission approximation used: Quenching weights
  - Only one-gluon **inclusive** distribution computed
- ⇛ Inclusive suppressions very well reproduced
  - Perturbative benchmark (pp) under good control
  - A correct implementation of the geometry plays a crucial role
  - Results with a hydro profile presented $K = 3.5 \pm 0.5$
- ⇛ Mass effects predict less suppression for heavy quarks
  - Benchmark needs to be improved
  - Other effects could appear (specially for beauty)