
Hadrochemistry of jet quenching at the LHC

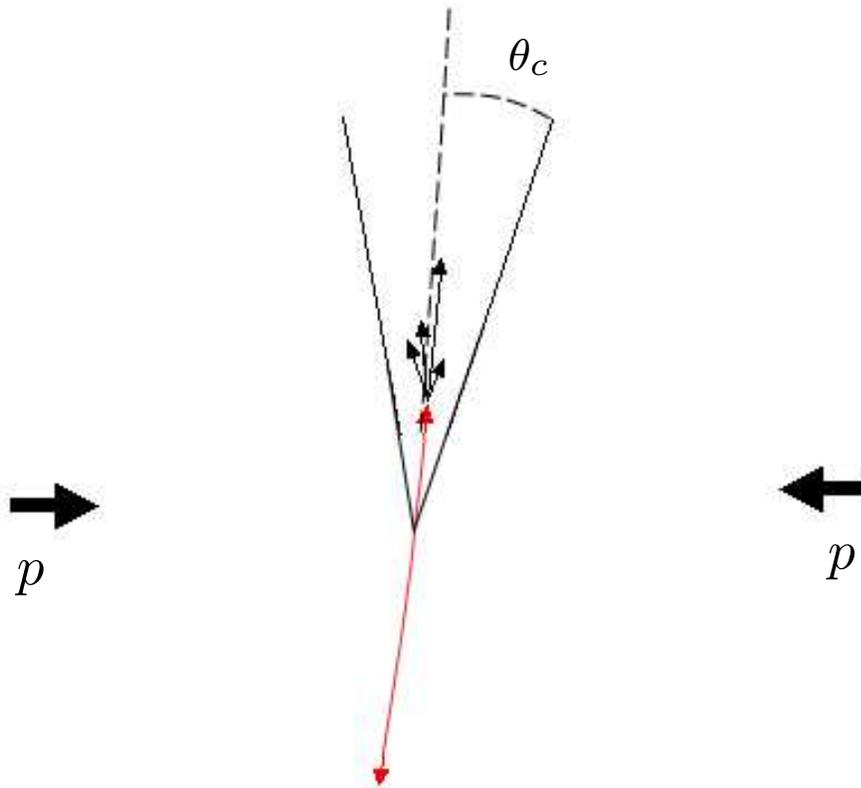
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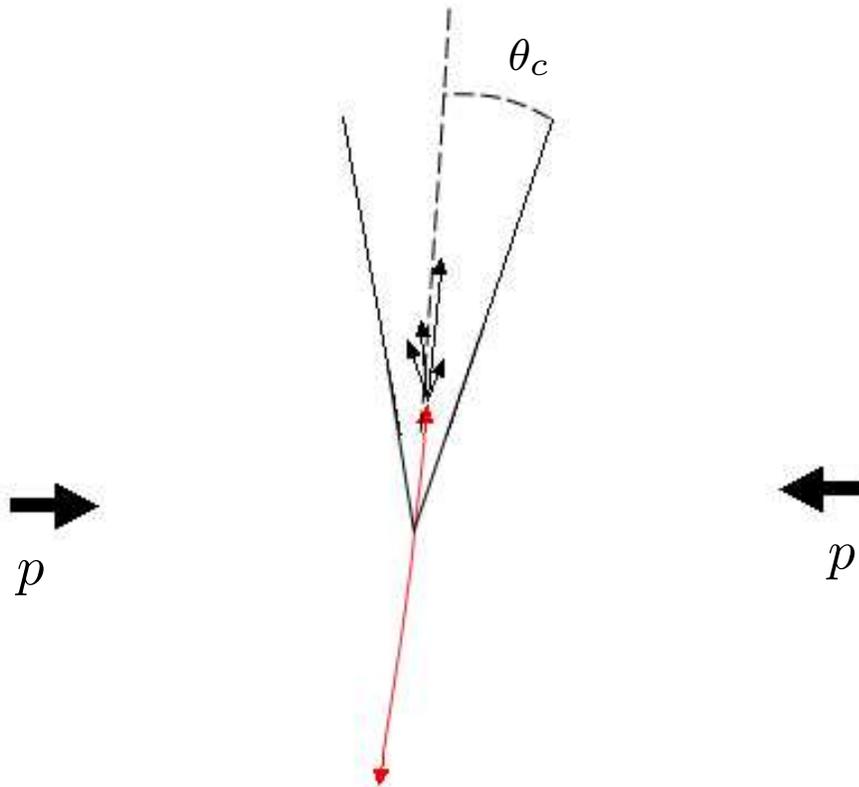
in collaboration with **Urs Achim Wiedemann**

School on QCD, low x Physics, Saturation and Diffraction, Copanello, Calabria, Italy, July 1-14 2007

JETS AT SMALL x



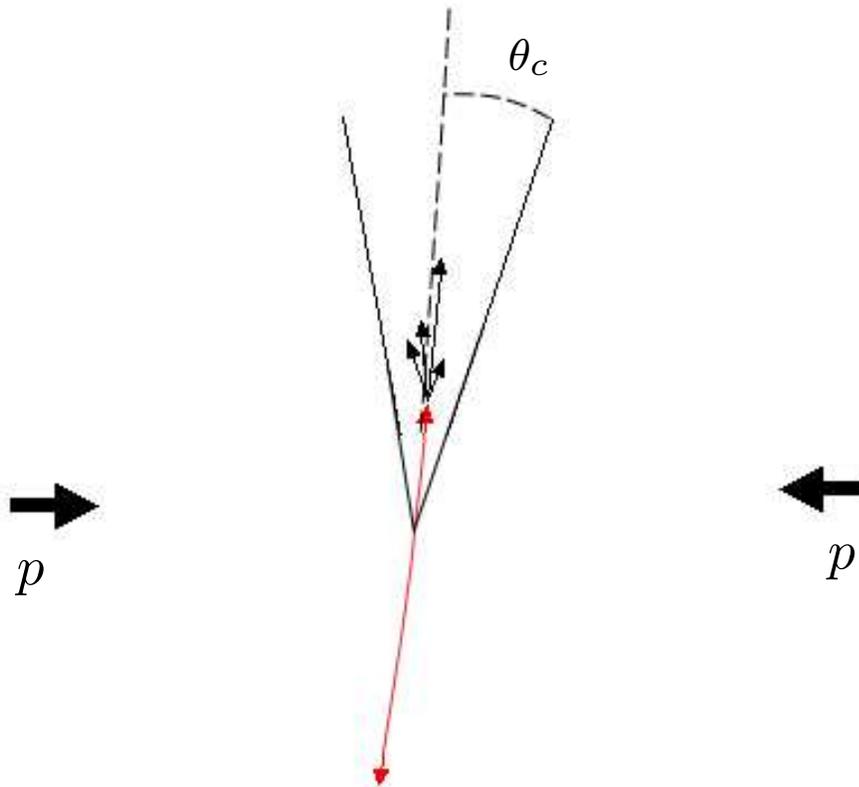
JETS AT SMALL x



● $x = \frac{p}{E_{\text{jet}}}$

fraction of jet energy
carried by the hadron

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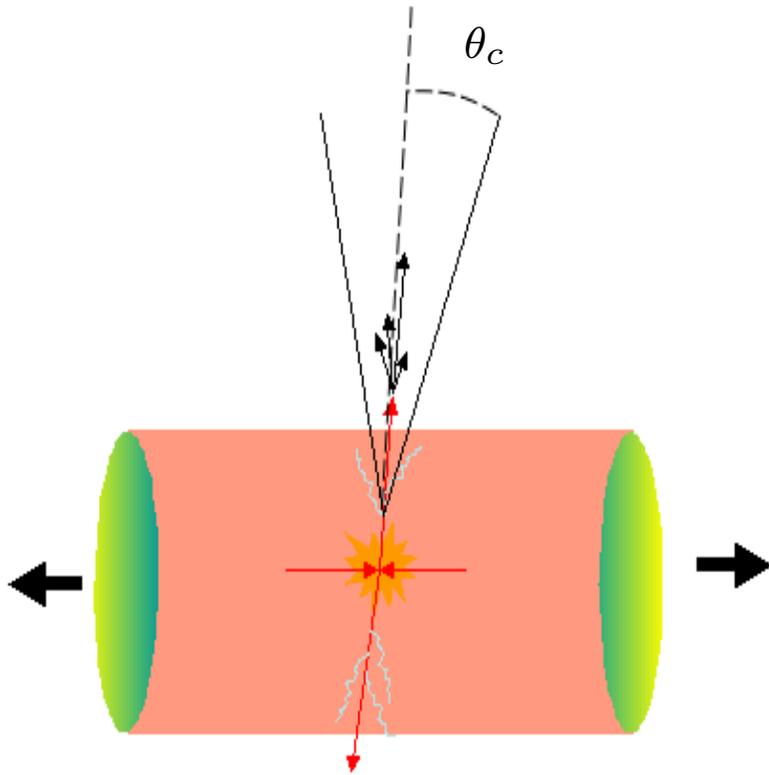


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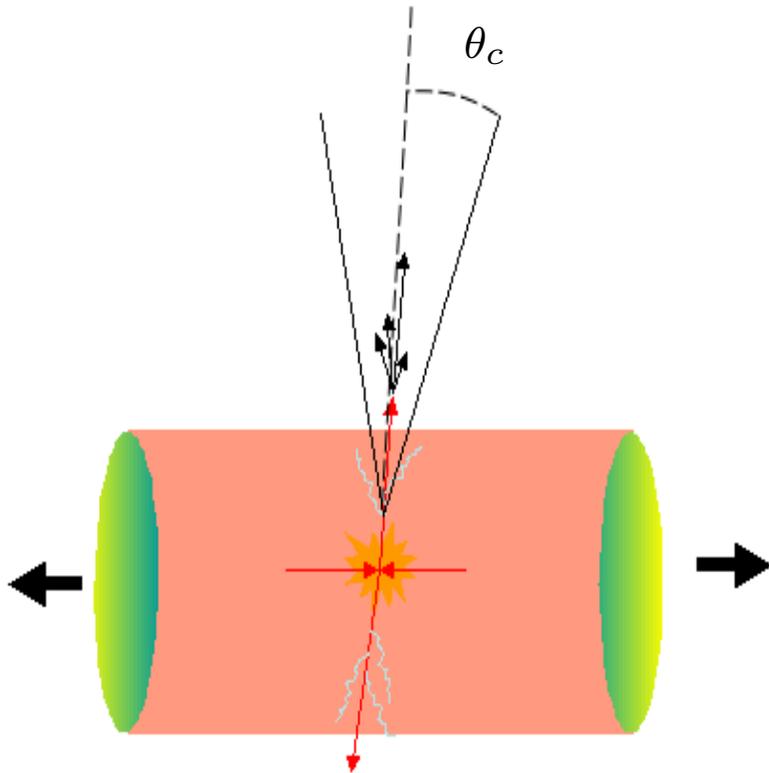
fraction of jet energy
carried by the hadron

- perturbative approach of Modified Leading Logarithmic Approximation (MLLA)
- hypothesis of Local Hadron-Parton Duality (LPHD)

THE PROCESS

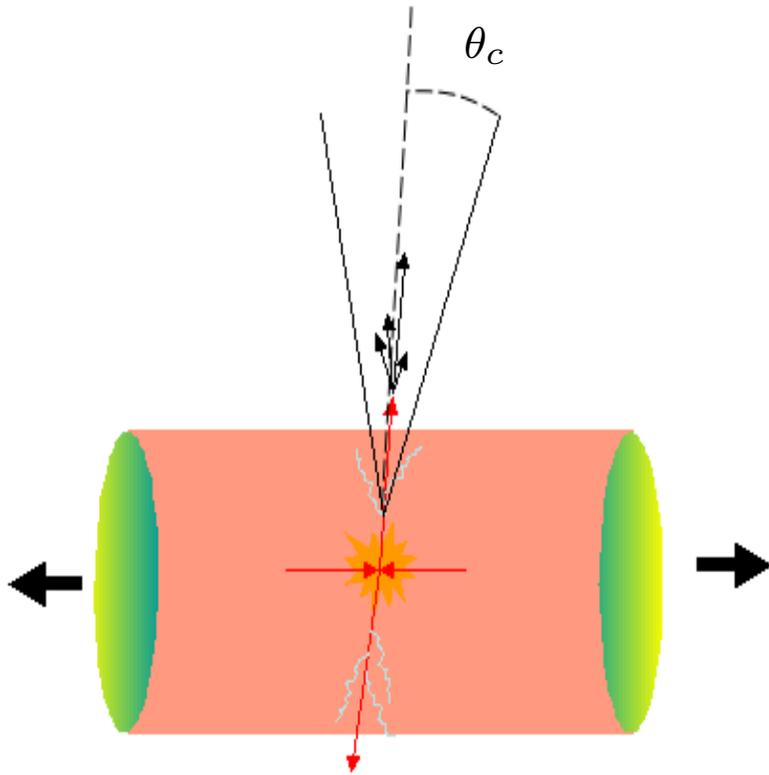


THE PROCESS



- a lot is known about jets in e^+e^- and $pp/p\bar{p}$ as well as in e^-p
- we have successful models for spectra at intermediate momenta

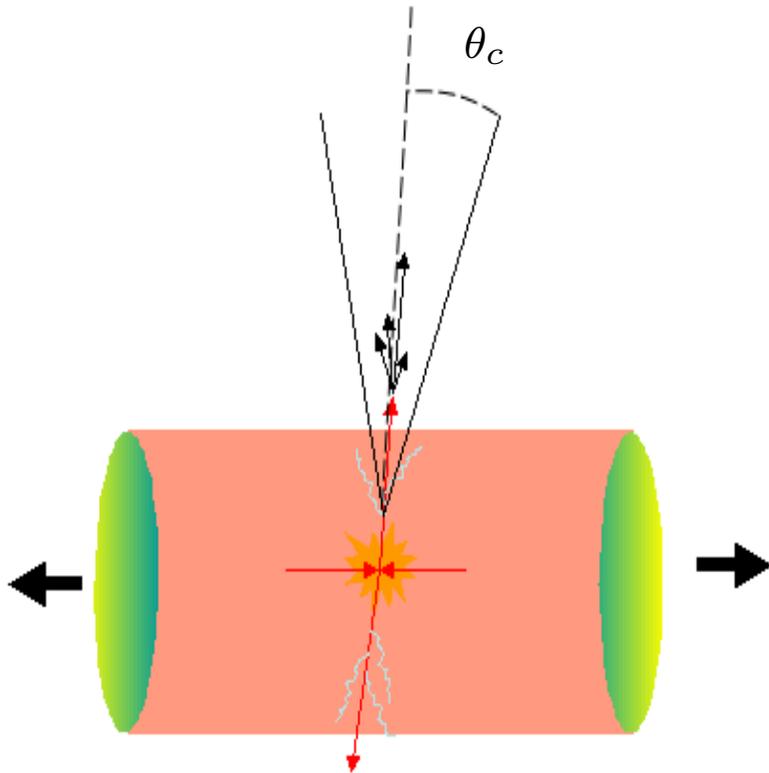
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Highly energetic jet superimposed on the top of the heavy ion background

THE PROCESS



⇒ central collisions

⇒ we choose $\theta_c = 0.28$

⇒ underlying event particles
which end up in the cone
added

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Highly energetic jet superimposed on the top of the heavy ion background

Possible mechanisms medium affects hadrochemistry:

- color transfer effects
- flavor and baryon number exchange between medium and projectile
- recombination of partons from jet and medium
- recoil effects - medium components kicked into the jet cone
- momentum exchange between medium and projectile

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- **momentum exchange between medium and projectile**

This is likely to underestimate the medium-modifications of jet hadrochemistry. However, it may serve as a baseline on top of which other signatures of hadrochemical modifications can be established.

MLLA + LPHD

[Yu.L.Dokshitzer, S.I.Troyan, Ya.I.Azimov, V.A.Khoze; 1984-1992]

- resummation in leading $\log Q^2$ and $\log(1/x)$ + angular ordering
- non-leading single logs of $1/x$ taken into account
- energy-momentum conservation

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$$D(\xi = \ln \frac{1}{x}, E_{\text{jet}}, \theta_c, M_h, \Lambda)$$

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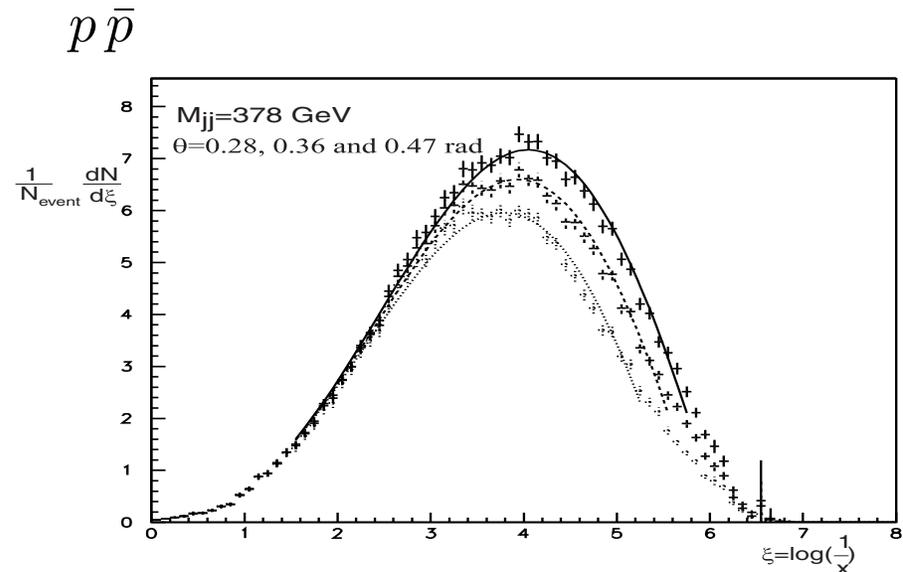
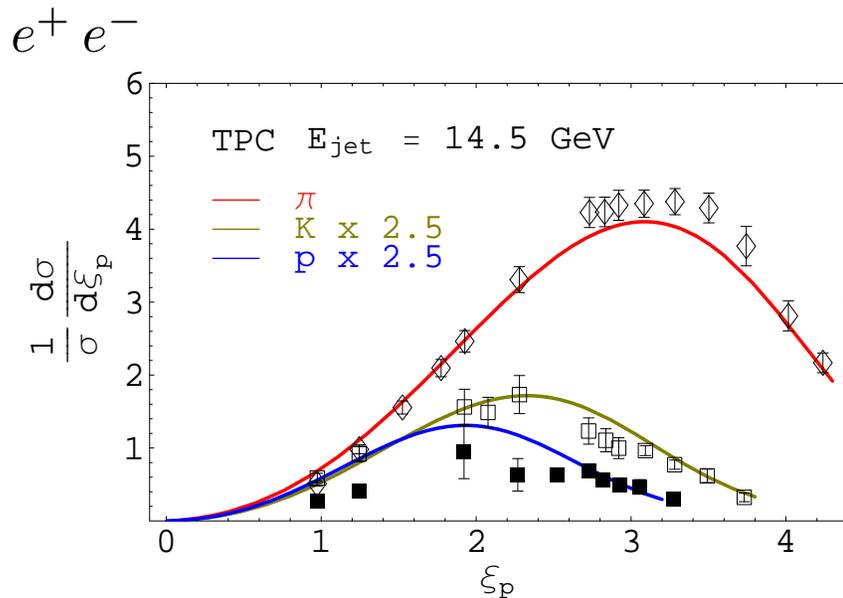
$$\frac{dN^h}{d\xi} = K_{\text{LPHD}} \gamma_h D\left(\xi = \ln \frac{1}{x}, E_{\text{jet}}, \theta_c, M_h, \Lambda\right)$$

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THE MODEL OF MEDIUM MODIFICATION

[N.Borghini, U.A.Wiedemann; 2005]

- medium enhances parton splitting by factor, e.g.

$$P_{qq}(z) = C_F \left\{ \frac{2(1+f_{\text{med}})}{(1-z)_+} - (1+z) \right\}$$

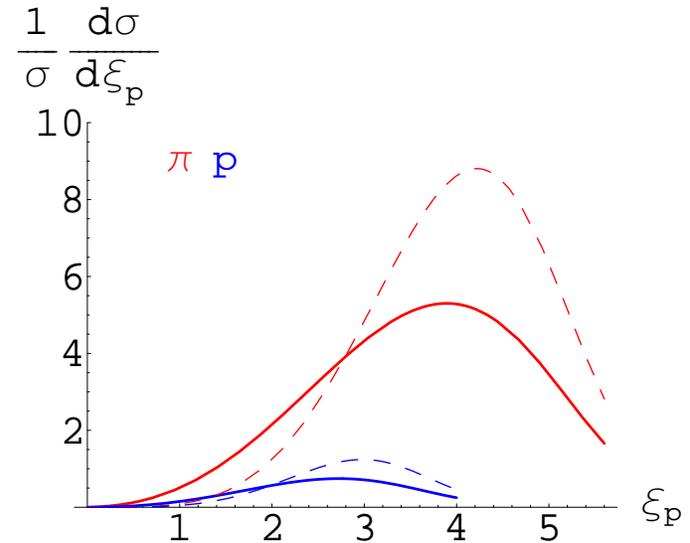
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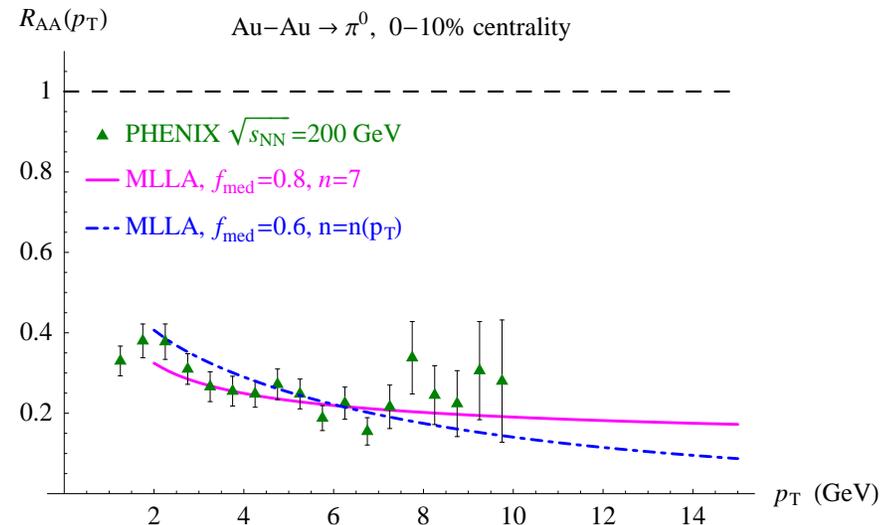
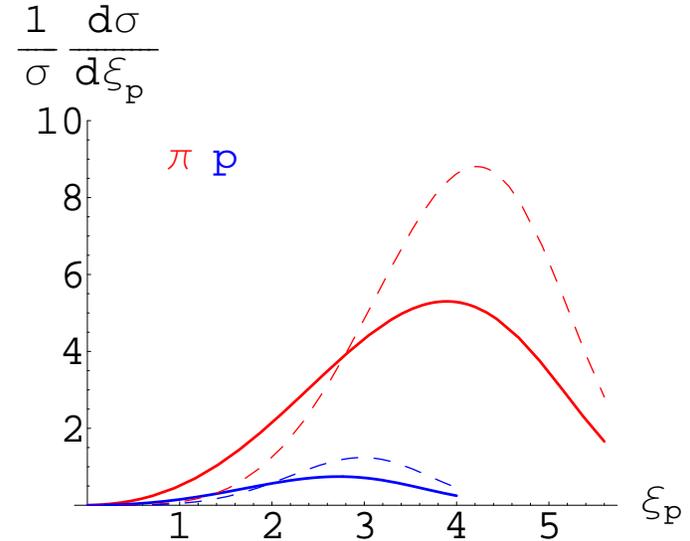
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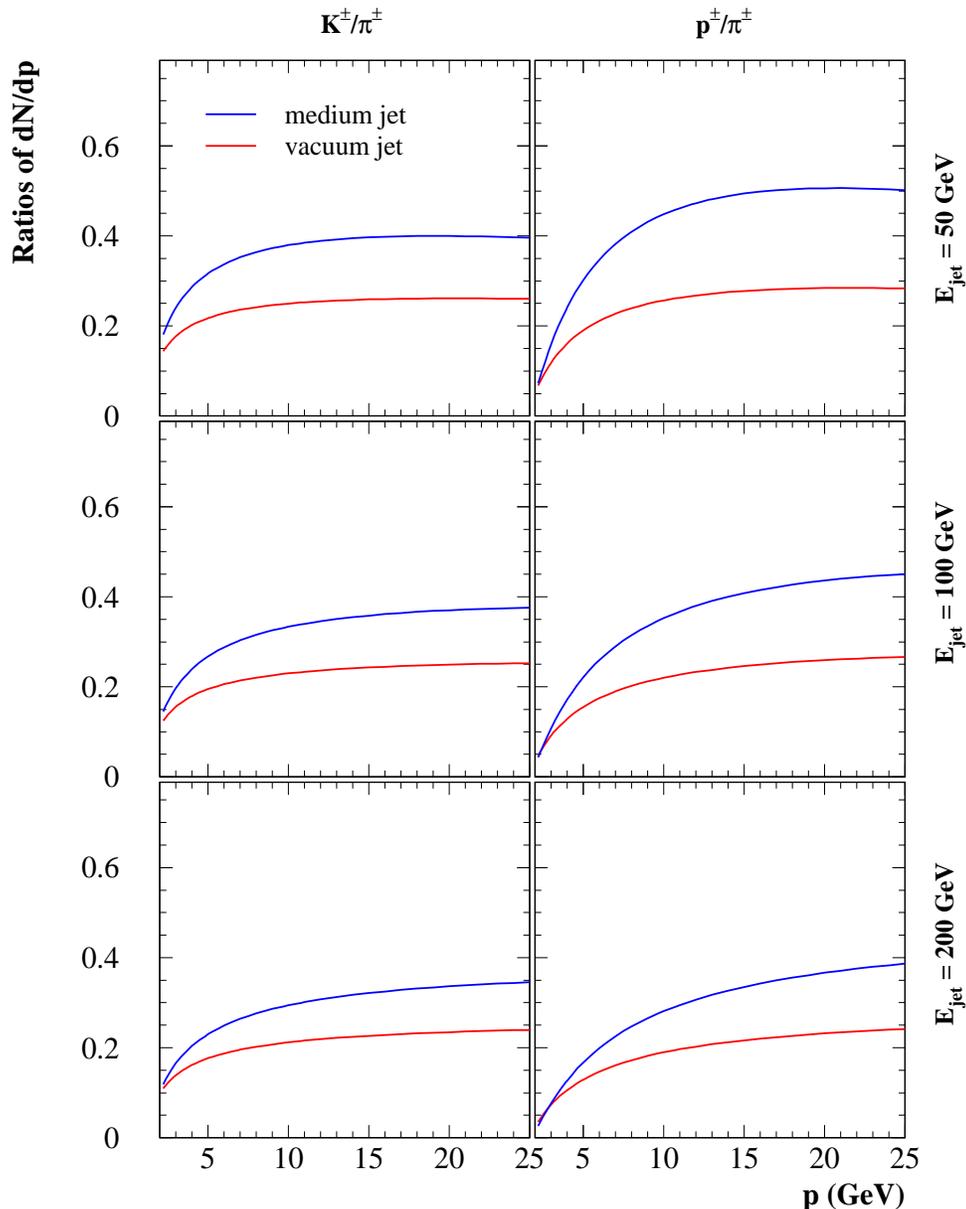
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- jet multiplicity distribution softens
- enough to account for the observed suppression of single inclusive spectra



HADRON RATIOS



jet cone size: $\theta_c = 0.28$

factor 0.7 for kaons from jet

K_{LPHD} assumed to be unchanged

Pure jets

- significant difference of hadron ratios for medium modified and unmodified jets at high momenta
- ratios in medium jets are larger since the suppression of the light hadron spectra is stronger

THE MODEL OF UNDERLYING EVENT

[R.J.Fries, B.Müller, C.Nonaka, S.A.Bass; 2003]

[L.Maiani, A.D.Polosa, V.Riquer, C.A.Salgado; 2003]

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● **recombination** of constituent quarks

$v_{\perp} = 0.55$ (RHIC), $v_{\perp} \approx 0.7$ (LHC),

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KKP parametrization, suppression of particles with
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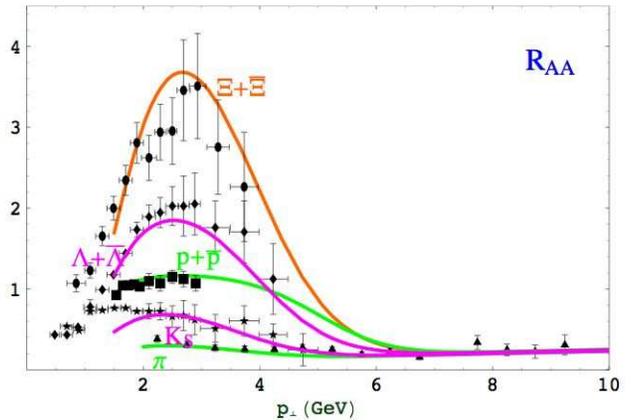
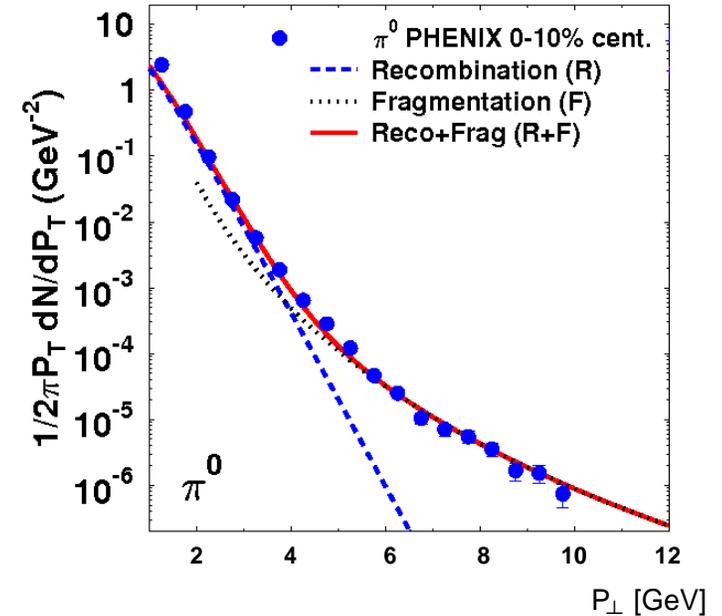
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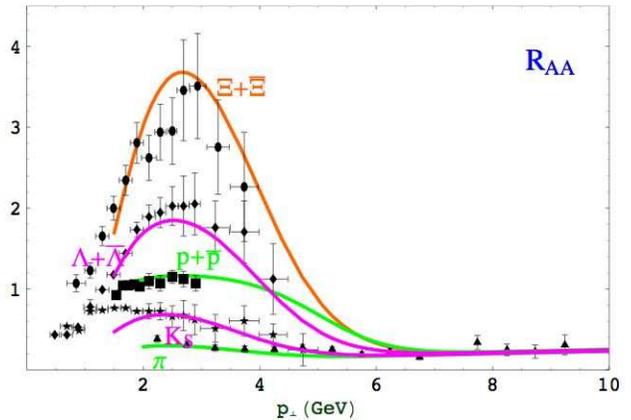
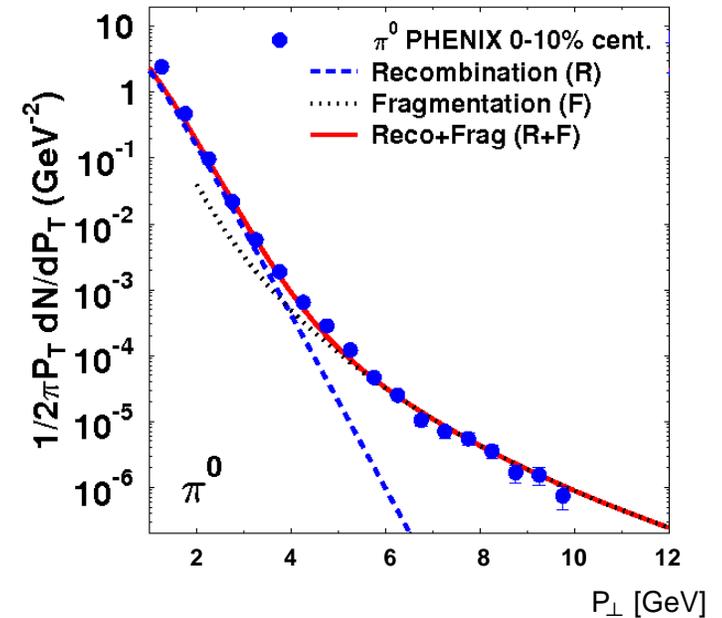
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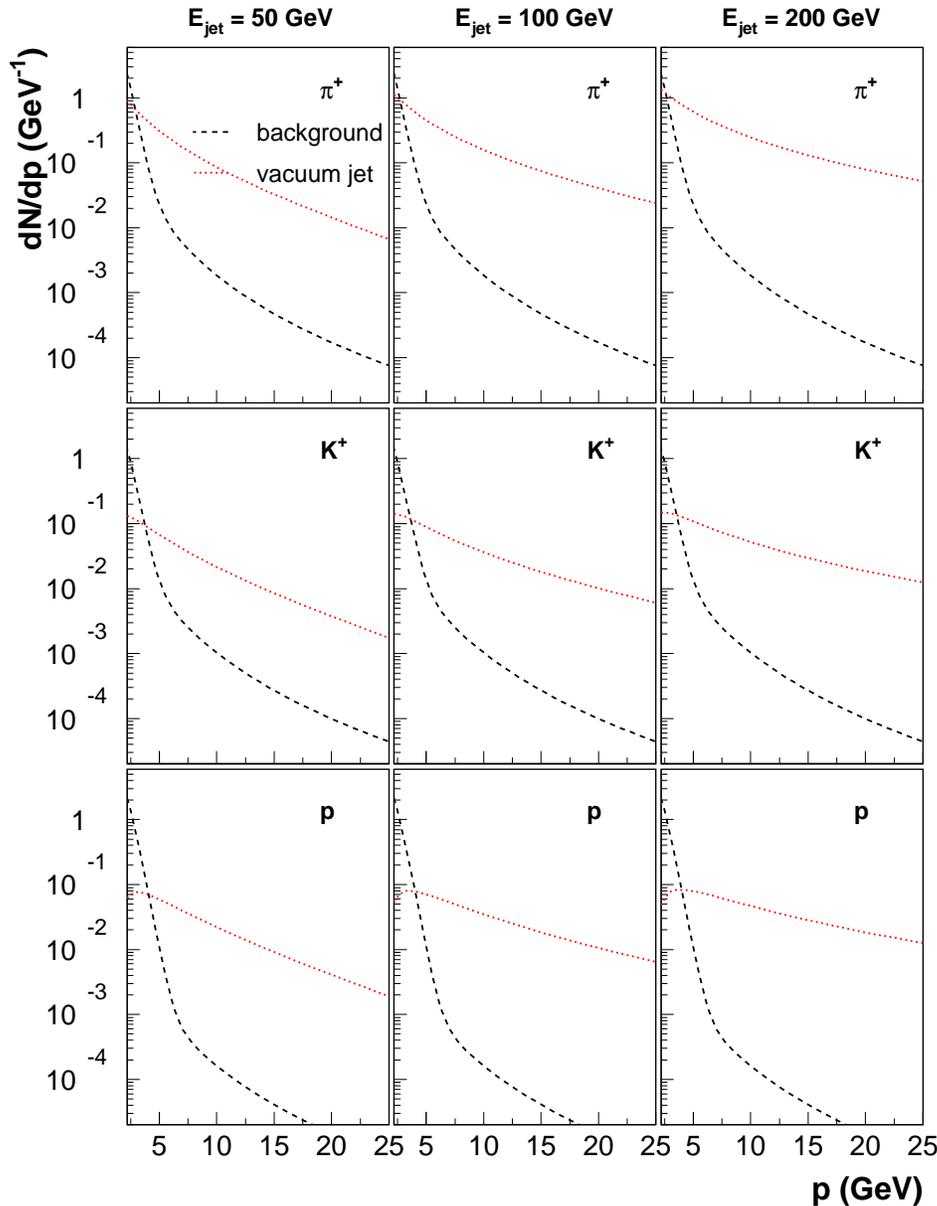
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LHC spectra expected to be dominated by recombination component up to the momenta higher by 2 GeV w.r.t. RHIC spectra



HADRON SPECTRA

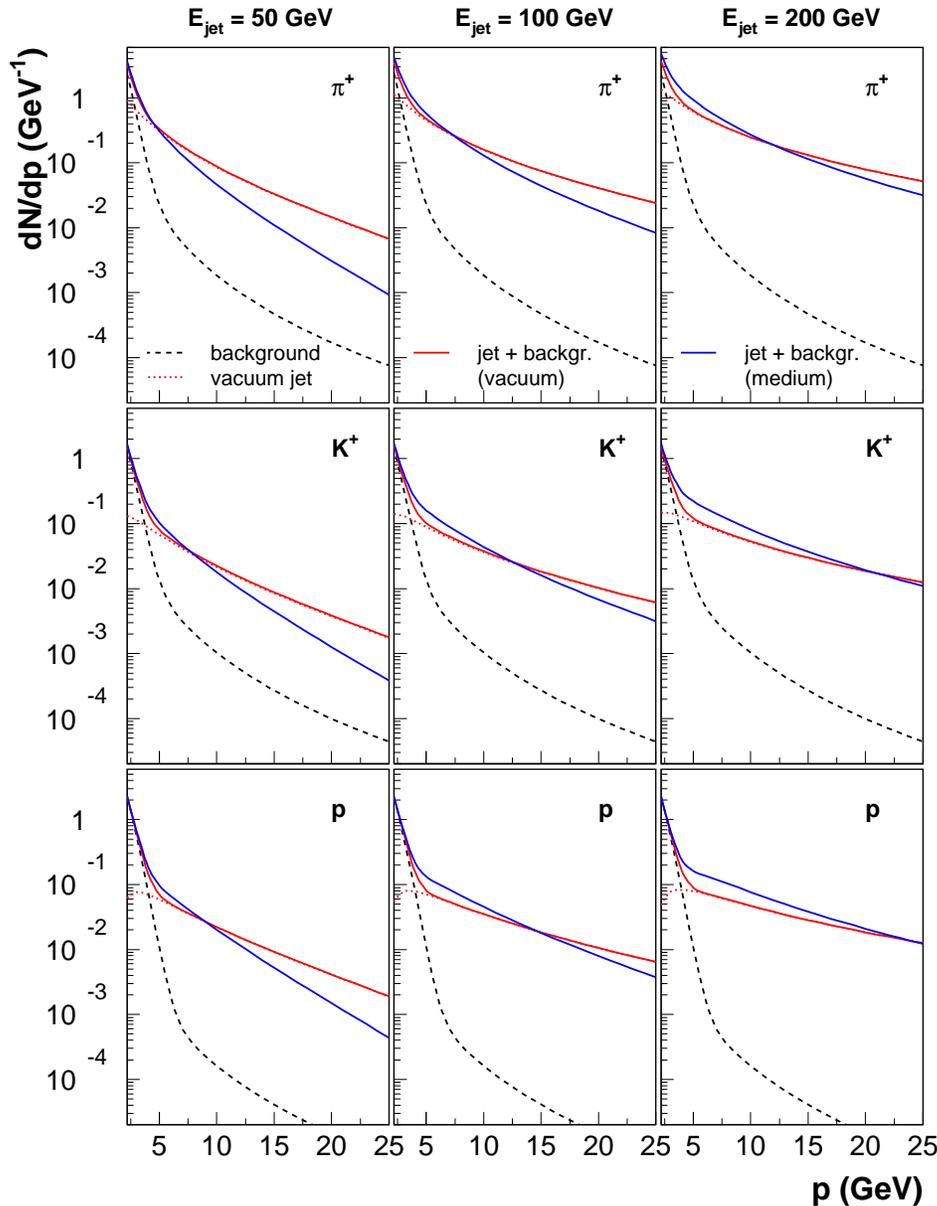


jet cone size: $\theta_c = 0.28$

factor 0.7 for kaons from jet

- characteristically different spectra for the soft background and jets
- the larger jet energy the stronger the effect
- proton spectra particularly well separated

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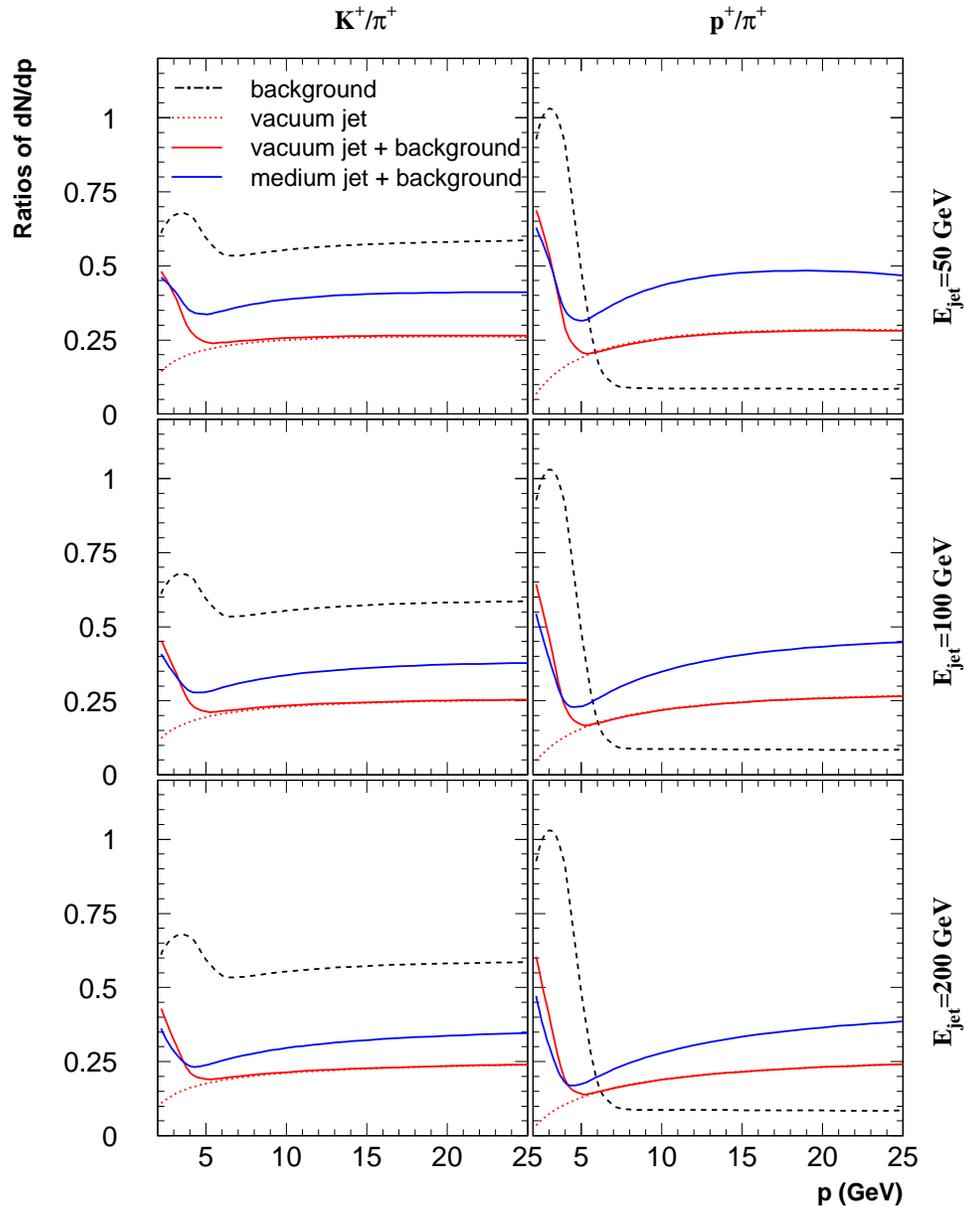


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- medium affects hadrochemistry within the jet cone
- medium modification varies with hadron species and jet energy
- modified spectra well separated from the background

HADRON RATIOS



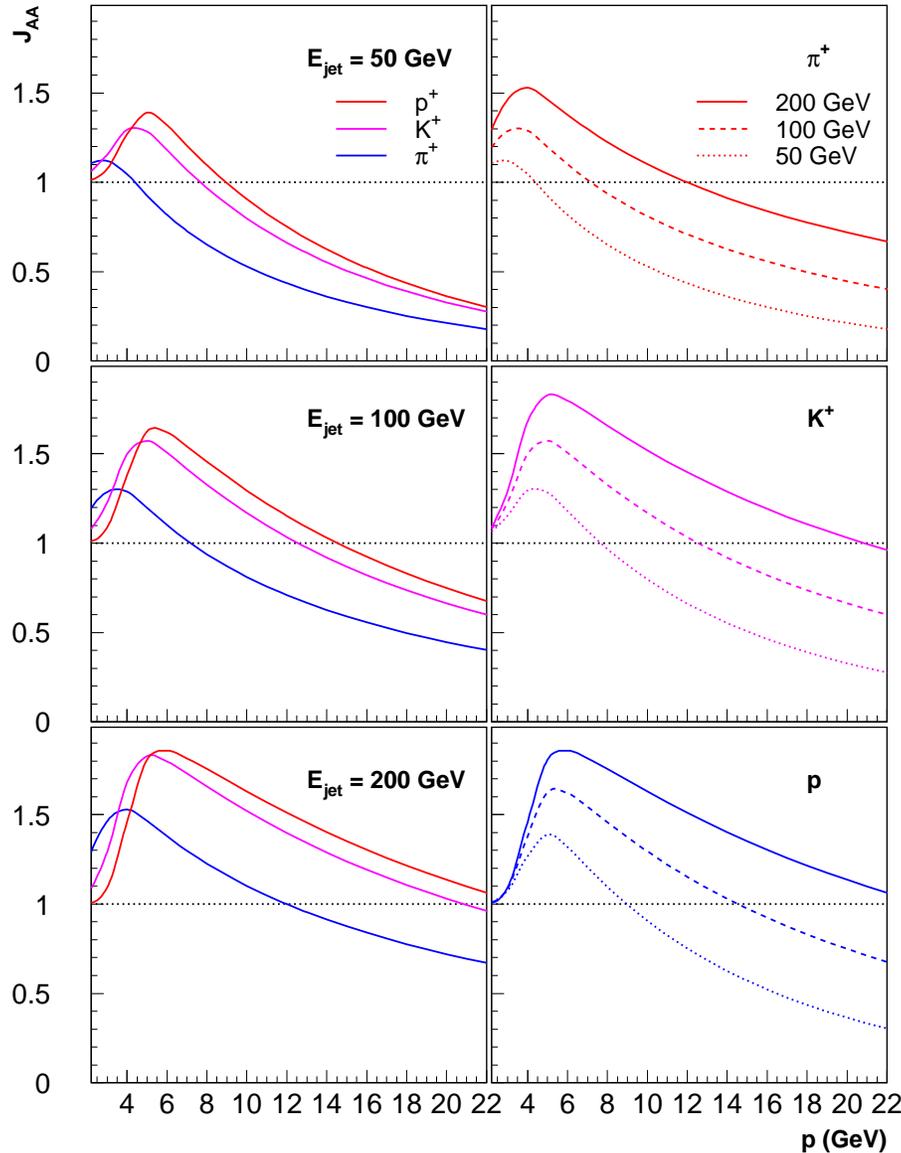
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Jets + background

- difference of hadron ratios persists
- mild dependence on energy for E_{jet} for certain p-range
- at high momenta hadrons from background dominate over hadrons from modified jet

MODIFICATION FACTORS



jet cone size: $\theta_c = 0.28$

factor 0.7 for kaons from jet

Jets + background

$$J_{AA} \equiv \frac{\left. \frac{dN}{dp} \right|_{\text{med}}}{\left. \frac{dN}{dp} \right|_{\text{vac}}}$$

- critical momentum varies significantly both with hadron species and with energy
- protons the least sensitive to the background

SUMMARY

- Jet quenching can leave signatures in the hadrochemical composition of jets
- Modifications of spectra and ratios vary with hadron species and jet energies
- Because of characteristically different hadrochemistry of jets and the soft background this signature persists even if one does not separate the two
- Measurement of the underlying event in Pb-Pb collisions at LHC will reduce uncertainties of our predictions