PARTICLE RATIOS AT HIGH-p_T AT LHC ENERGIES

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Heavy ion Collisions at the LHC – Last Call for Predictions
CERN TH Dept. – Geneva
14^{th} May – 8^{th} June 2007

OUTLINE

'OLD': Predictions for pp and dA (since QM'06)

- Relevance of intrinsic-k_T in pp at LHC
- Spectra in pp based on KKP and AKK FFs
- Prediction based on KKP for pp and dA at LHC

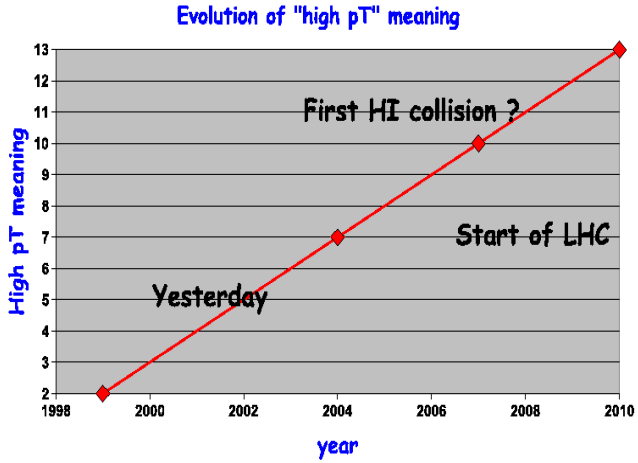
'NEW': Ratios in pp, dA and AA beyond RHIC

- KKP ratios vs. AKK ratios
- Intrinsic-k_T: modifications for $\pi^{\pm}/K^{\pm}$
- Jet-Quenching: differences in suppression pattern of $\pi^{\pm}/K^{\pm}$

MOTIVATION

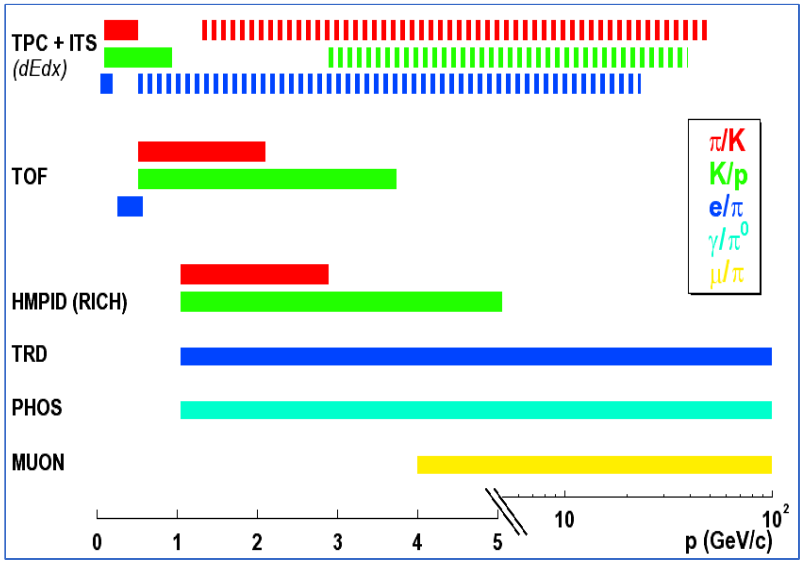
Time evolution of high-p_T

– Linear extrapolation form 2004:
Meaning of "high-p_T" has
changed for last 10 years.



HMPID in the ALICE

– ALICE has a unique capability
for high-p_T PID: π/K and K/p
up to 3 and 5 GeV/c respectively.



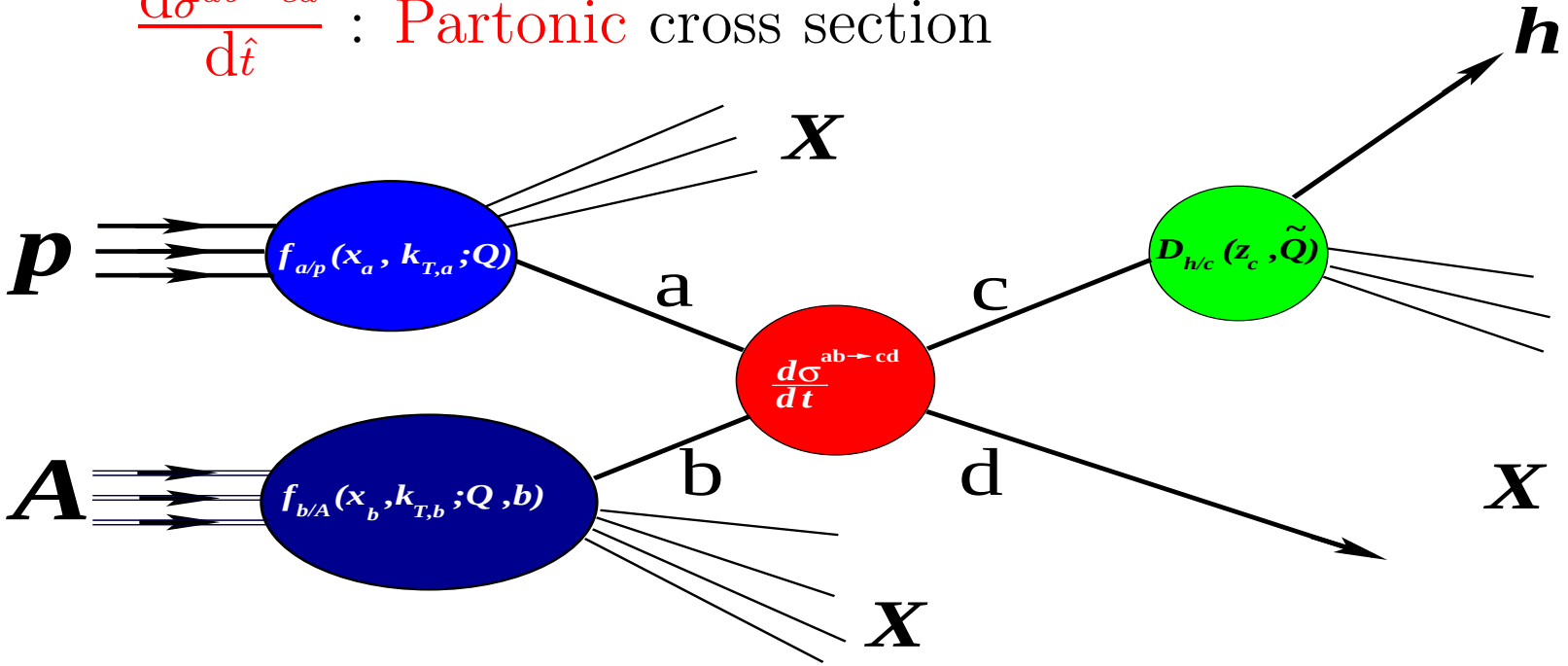
The pQCD Improved Parton Model for pp Collisions

$$E_\pi \frac{\mathrm{d}\sigma_\pi^{pA}}{\mathrm{d}^3 p_\pi} \sim f_{a/p}(x_a, Q^2; k_T) \otimes f_{b/A}(x_b, Q^2; k_T, b) \otimes \frac{\mathrm{d}\sigma^{ab\to cd}}{\mathrm{d}\hat{t}} \otimes \frac{D_{\pi/c}(z_c, \widehat{Q}^2)}{\pi z_c^2}.$$

$f_{b/A}(x_a, Q^2; k_T, b)$: Parton Dist. Function (PDF), at scale Q^2

$D_{\pi/c}(z_c, \widehat{Q}^2)$: Fragmentation Function for π (FF), at scale $\widehat{Q}^2$

$\frac{\mathrm{d}\sigma^{ab\to cd}}{\mathrm{d}\hat{t}}$: Partonic cross section



Longitudinal 1-Dimensional PDFs and FFs

(a) Parton Distribution Functions (PDF) :

(LO case) GRV – Glück, Reya, Vogt

HKM and HKN – Hirai et al.

(NLO case) MRST-(c-g) – A.D. Martin et al.

CTEQ5M – H. L. Lai et al.

HKM and HKN – Hirai et al.

(b) Fragmentation Functions (FF) :

BKK – Binnewies, Kniehl, Kramer (v1, v2)

KKP – Kniehl, Kramer, Pötter.

AKK – Albino, Kniehl, Kramer, Pötter.

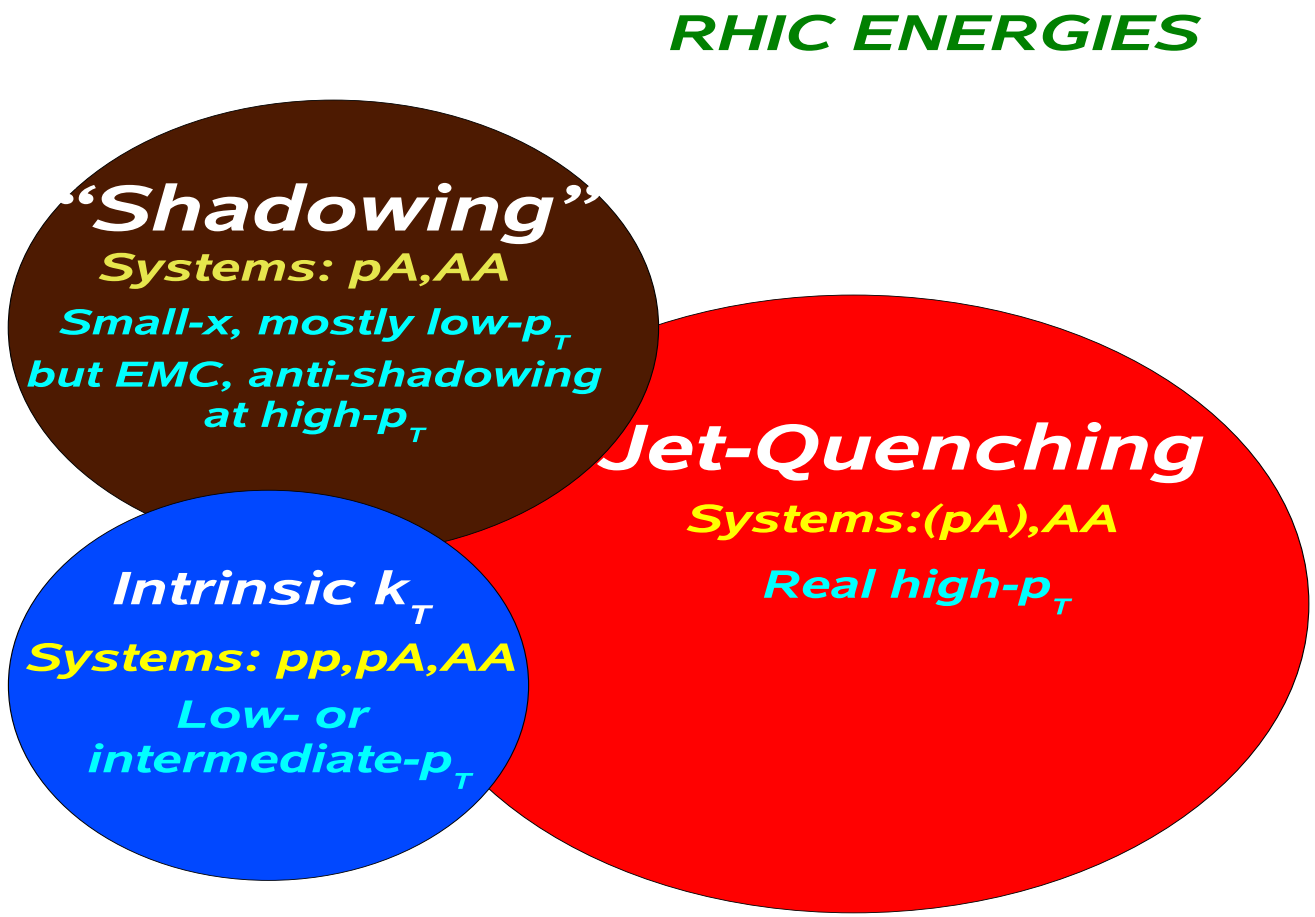
More: Kretzer, FGS, etc ...

(Nuclear) Effects in Our Model at:

CERN SPS ENERGIES

Old and new data from Fermilab, WA98, NA49 ...

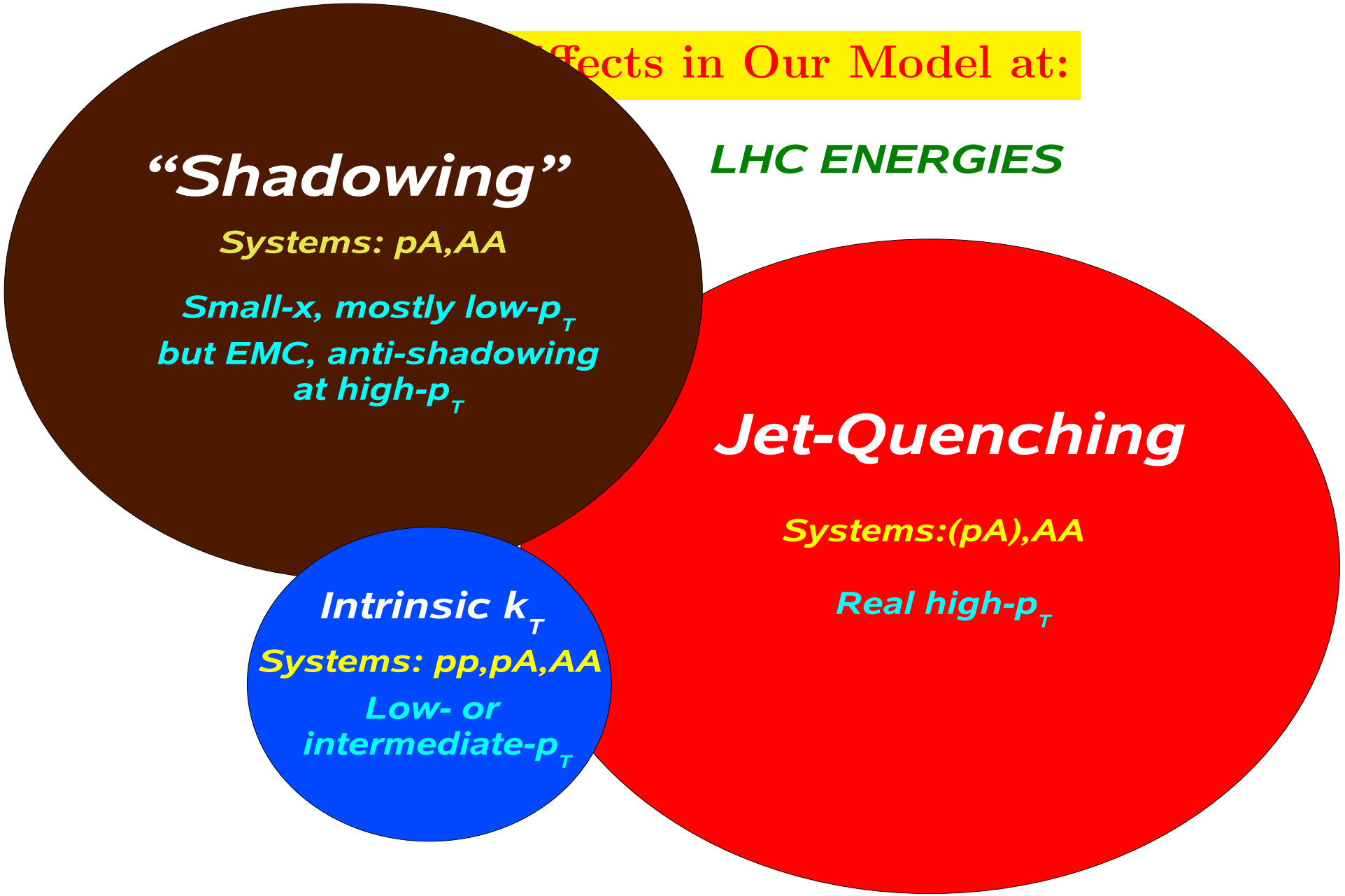
(Nuclear) Effects in Our Model at:



. . . high precision data by RHIC experiments . . .

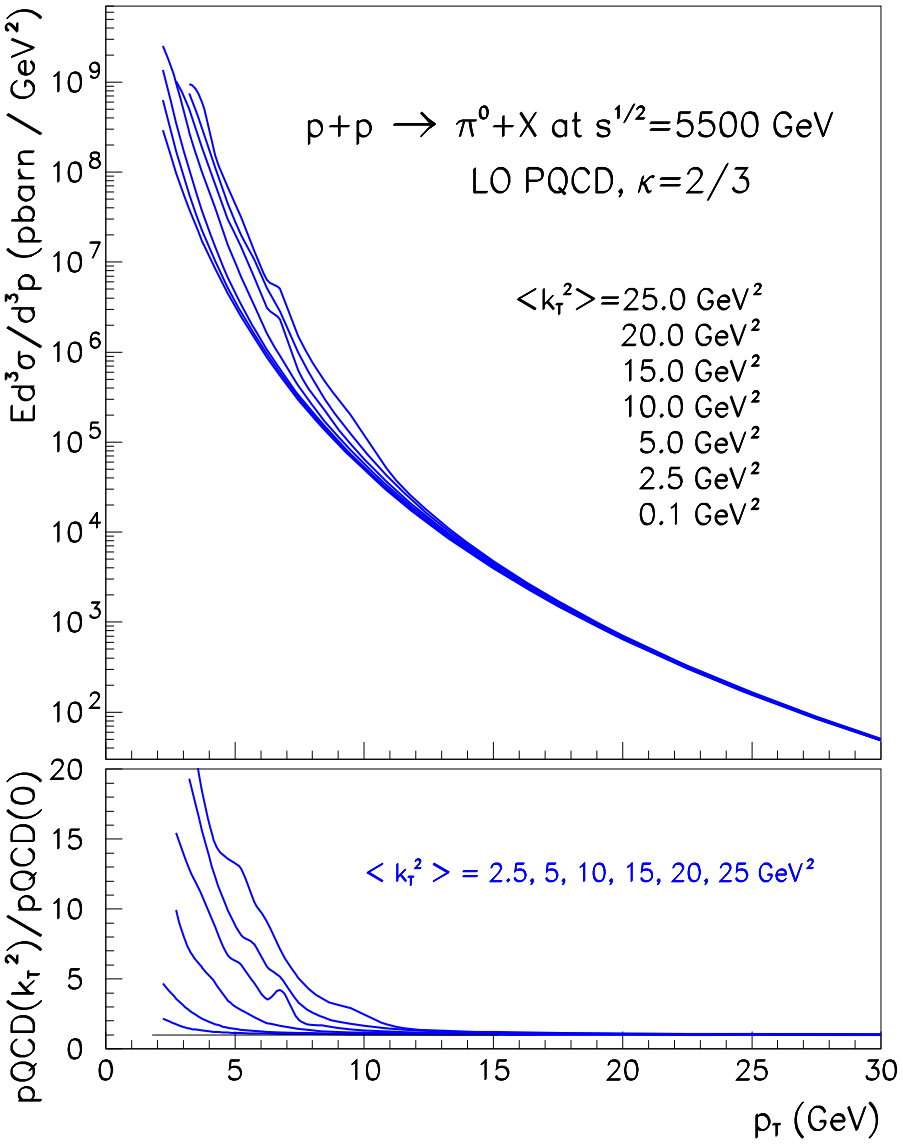
ffects in Our Model at:

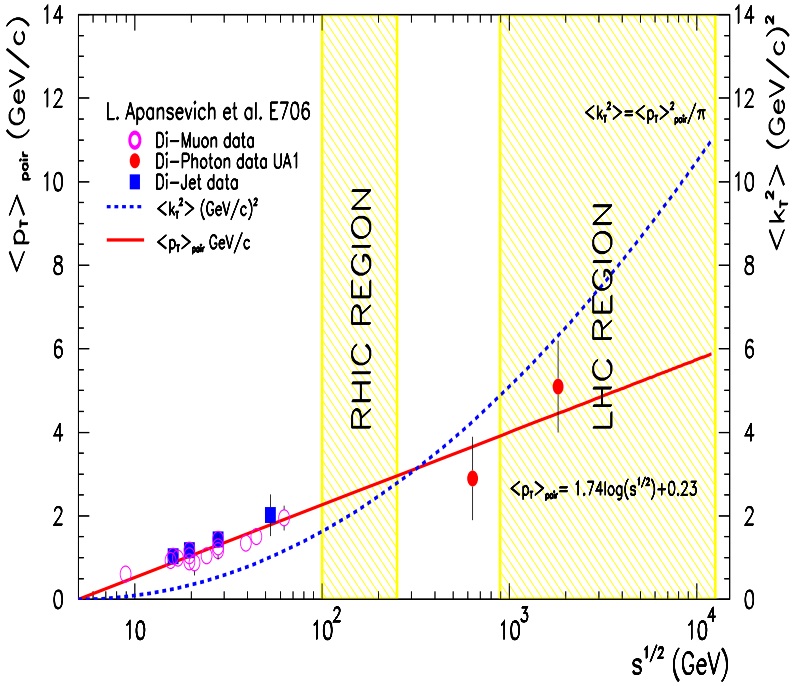
LHC ENERGIES



. . . and predictions for LHC energies!

Relevance of intrinsic-k_T in pp at LHC



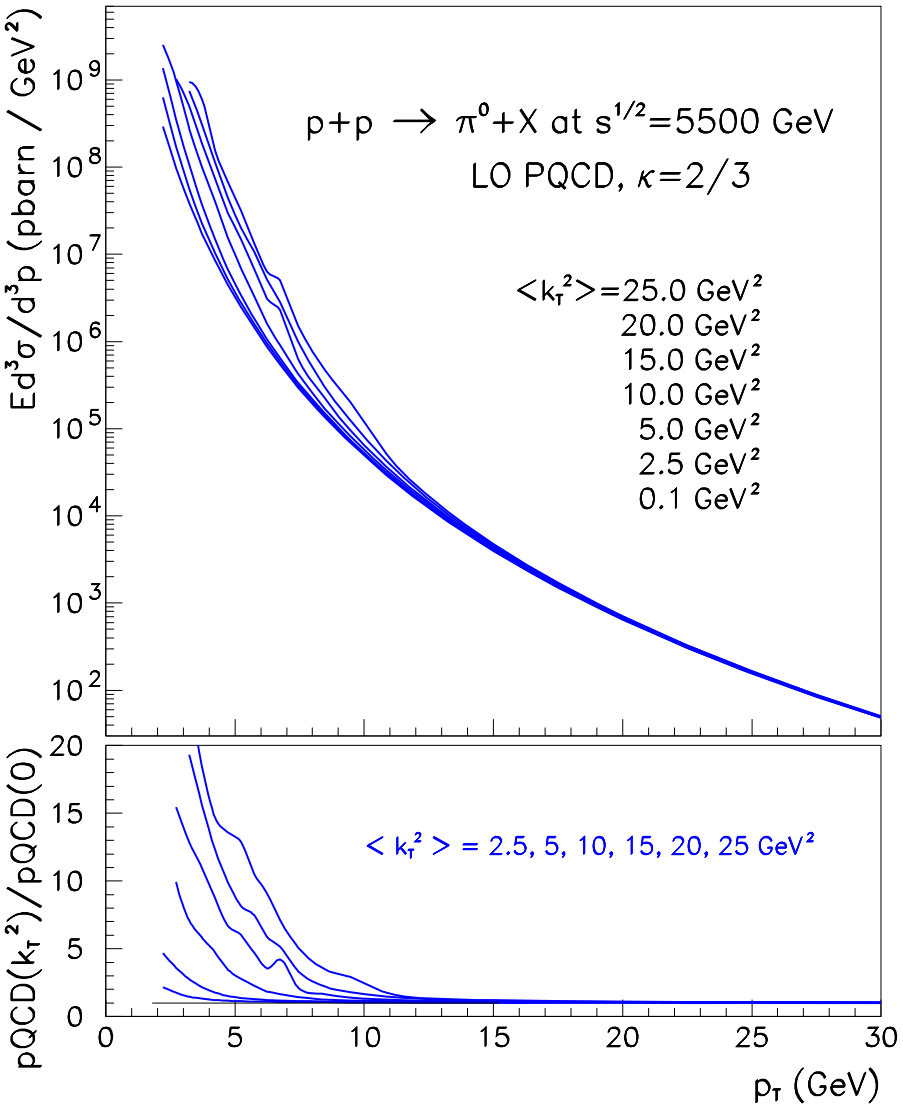


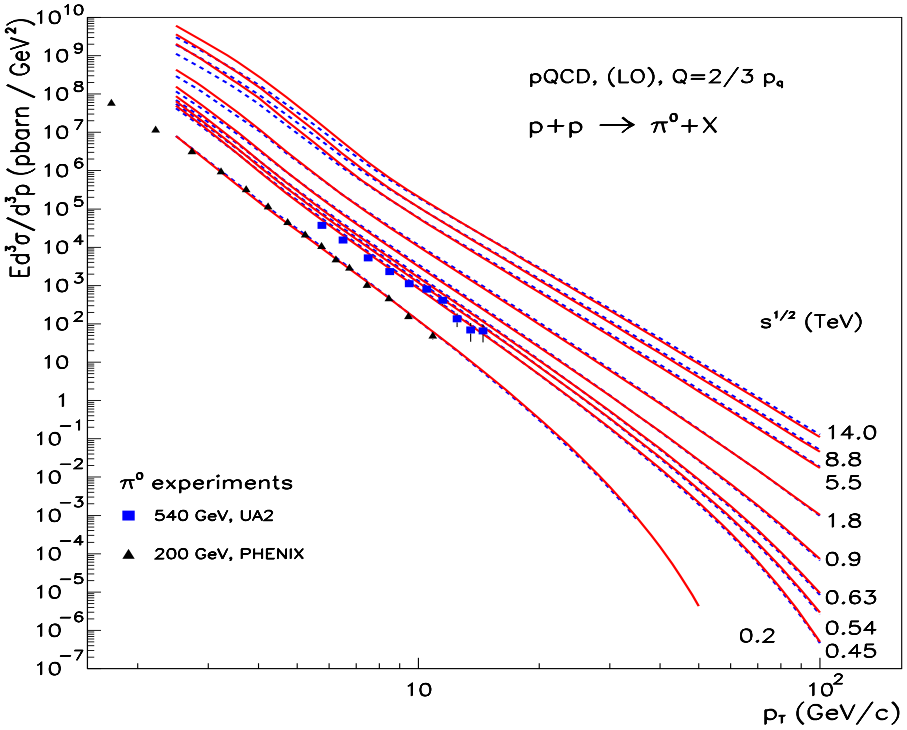
Experimental measurements on $\langle p_T \rangle_{pair}$ dependence on $\sqrt{s}$

L. Apanasevich et al. E706

Effect of $\langle k_T^2 \rangle$ can be seen in high-p_T hadron spectra at LHC

π production in pp collisions at different energies



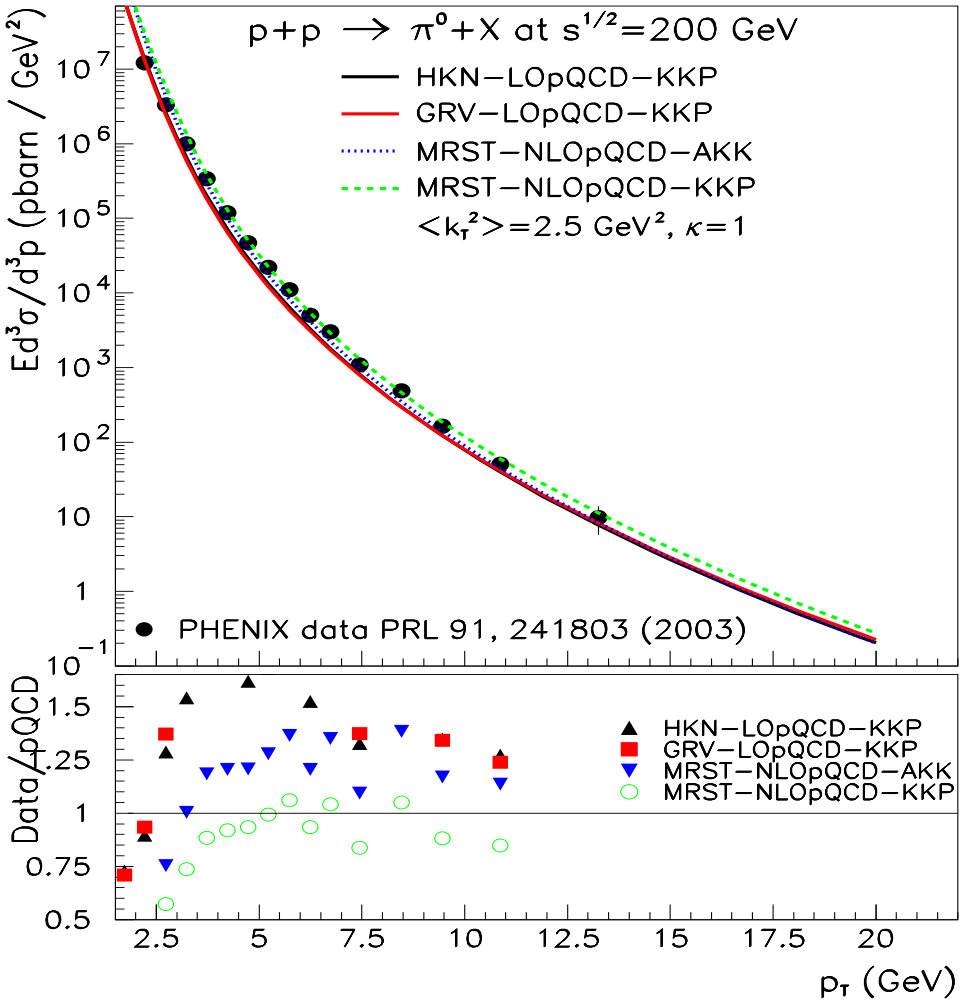


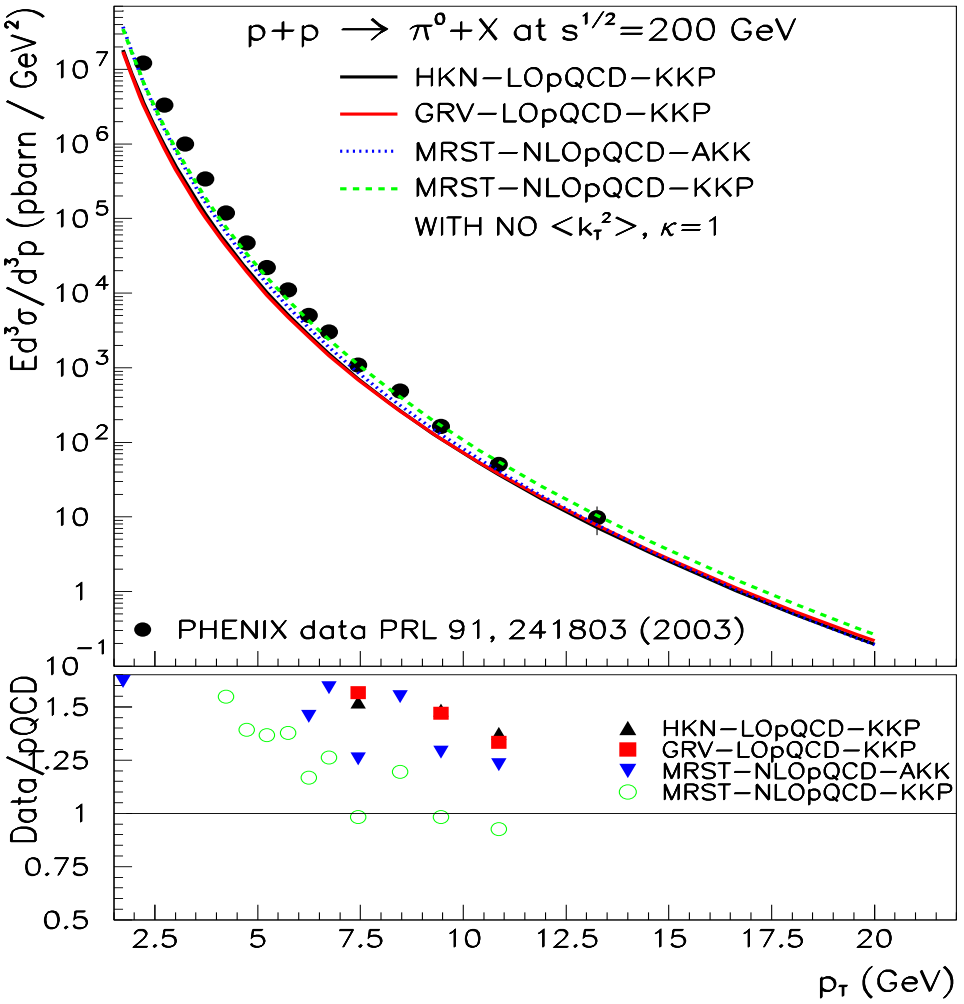
Can we see this modification in low-, and intermediate-p_T at LHC?

$\Longleftarrow$ non-exponential spectra

See: Phys. Rev C65 034903 (2002), and QM '07 Proc. hep-ph/0703059

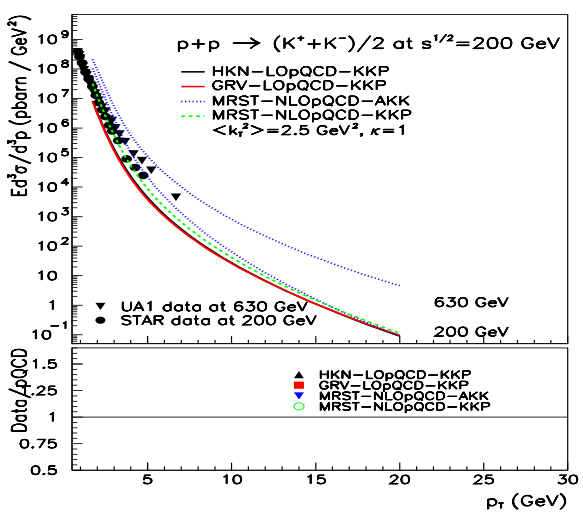
π^0 production in pp collisions

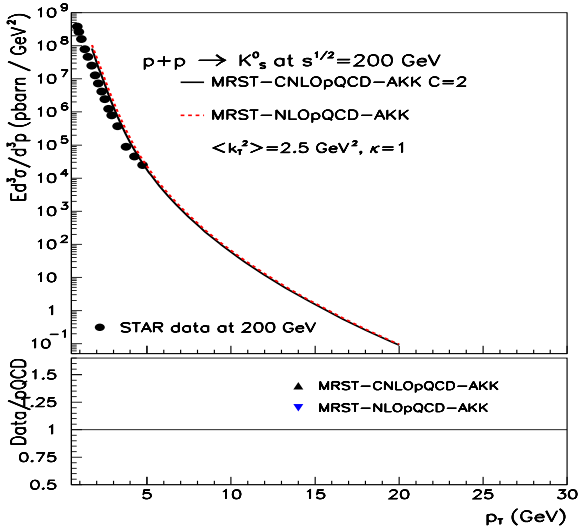


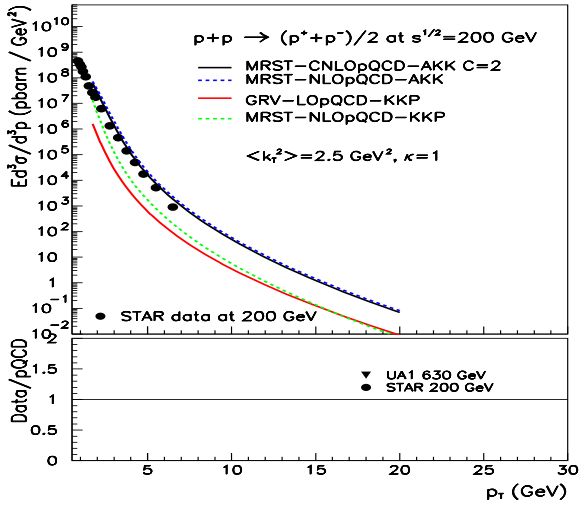


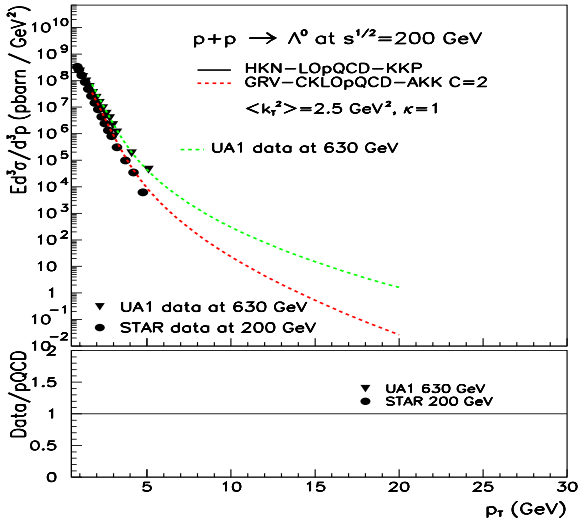
... and NOW for other hadron spectra in pp ...

K, K^0_s, Λ and p production in pp collisions



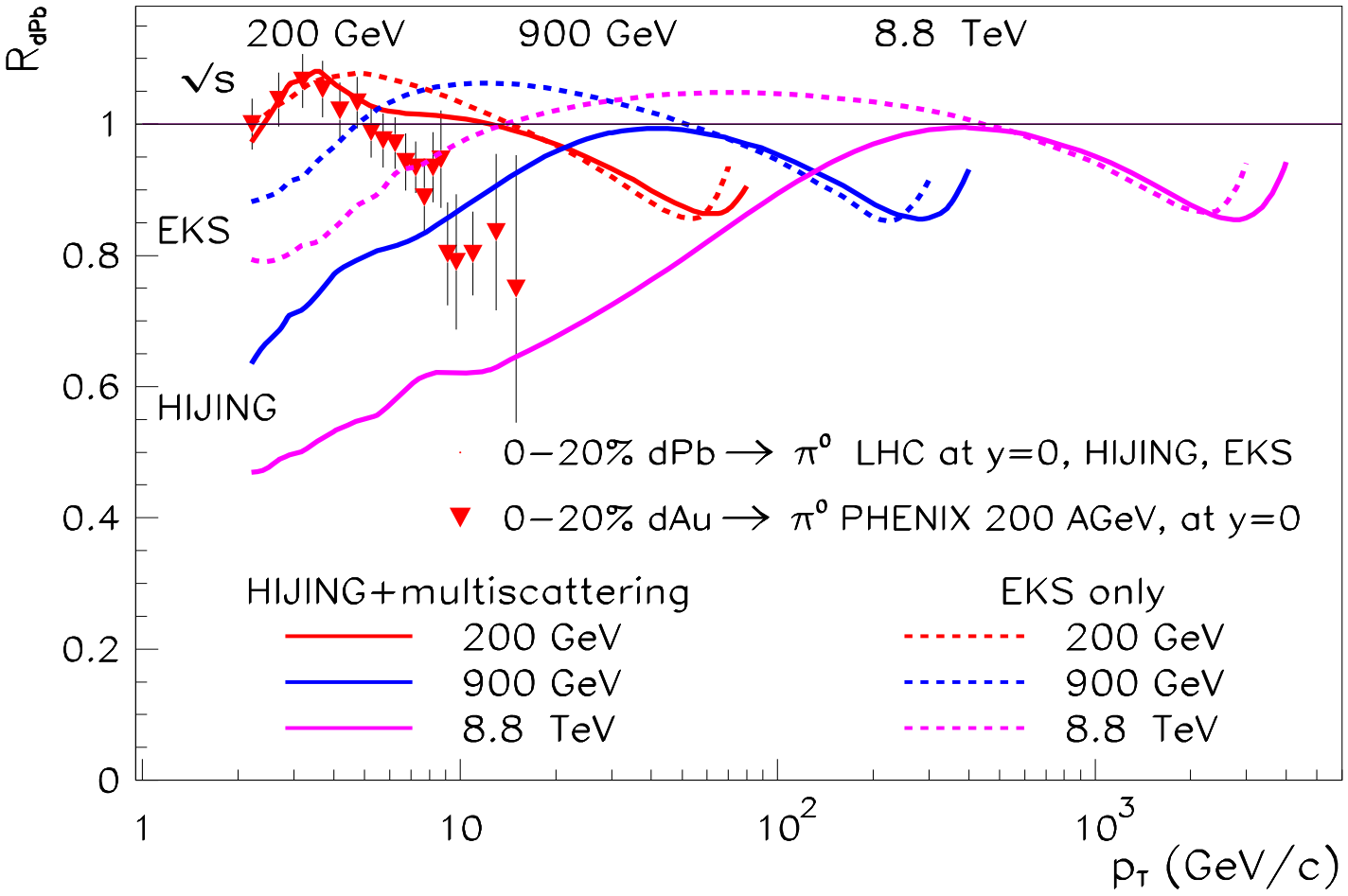


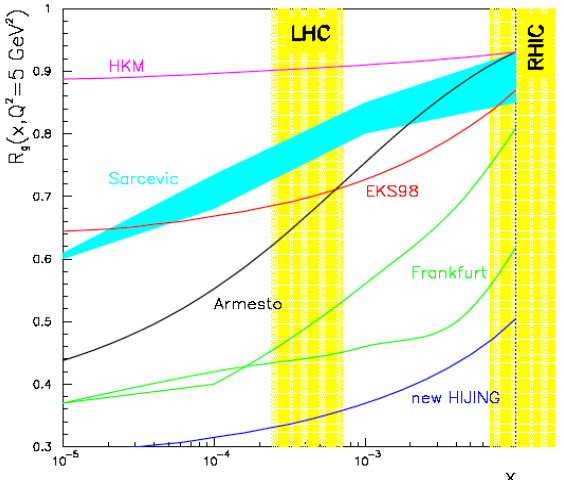




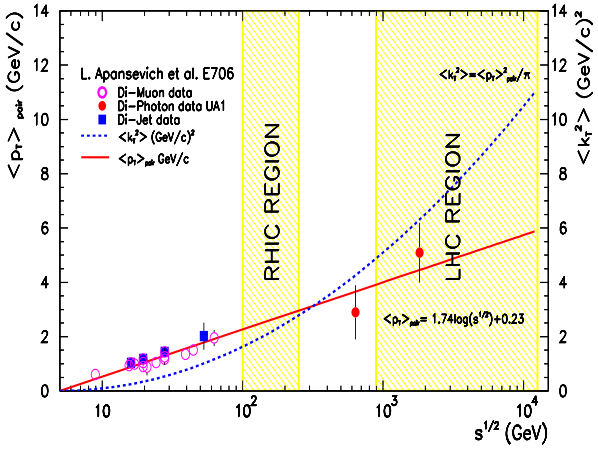
... Data/Theory coming soon ...

R_{dPb} at in dPb Collision at different energies beyond RHIC





CERN Yellow R. hep-ph/0308248

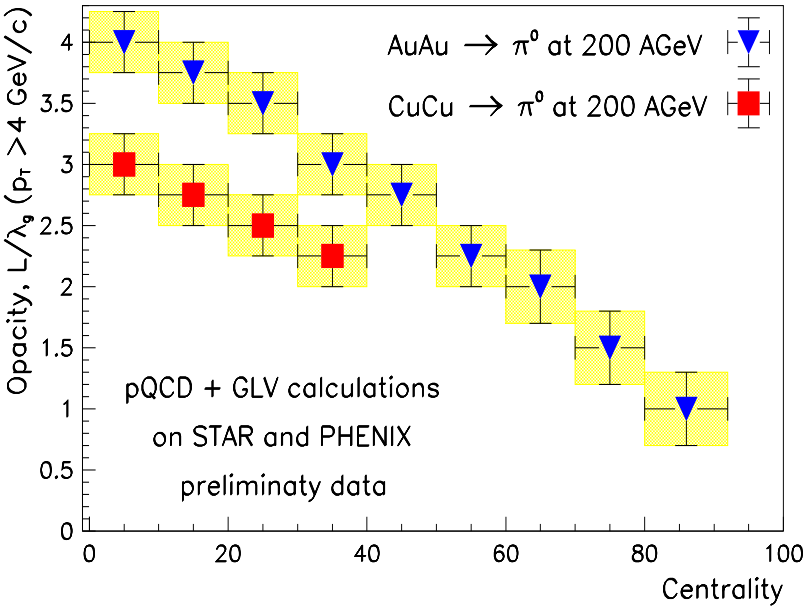


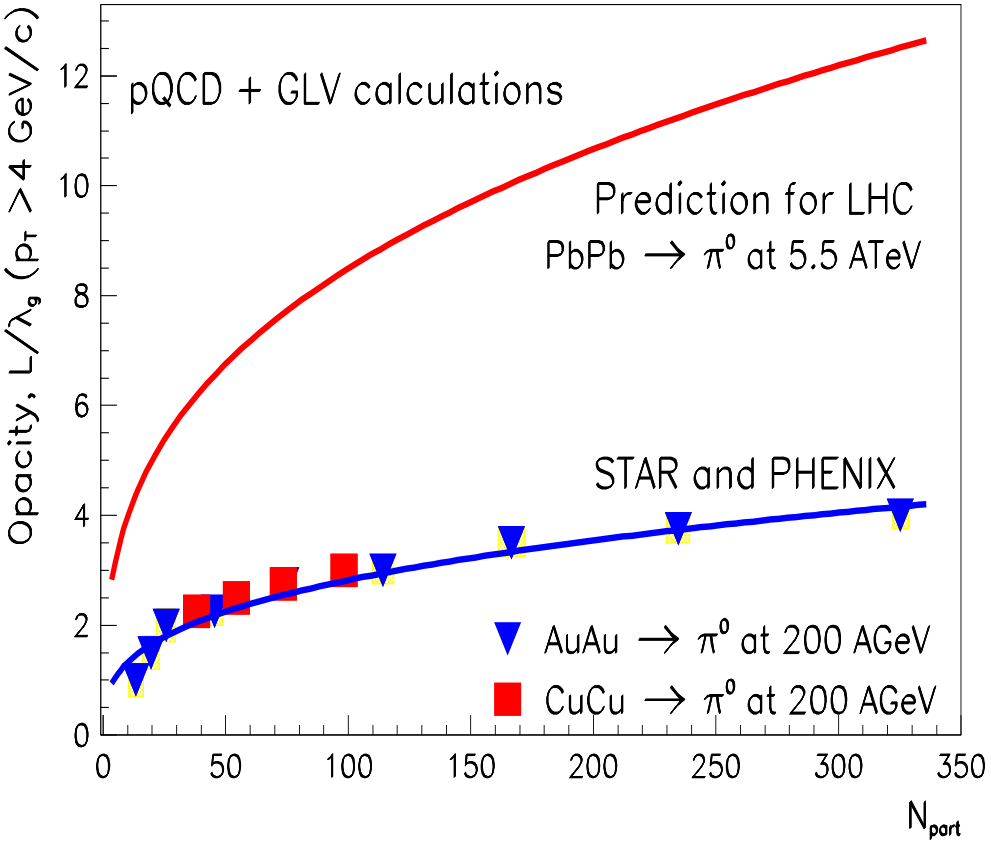
Two main initial state effects:

Suppression can be strong at high-p_T at the LHC energies.

Cronin peak is slightly moving towards higher-p_T values.

Opacity Prediction for *PbPb* collisions at LHC





$$L \propto A^{1/3} \propto N_{part}^{1/3}$$

$$\varepsilon = \Delta E/E \propto L^2 \propto N_{part}^{2/3}$$

L/λ will NOT disappear in very peripheral collisions $\Longrightarrow$

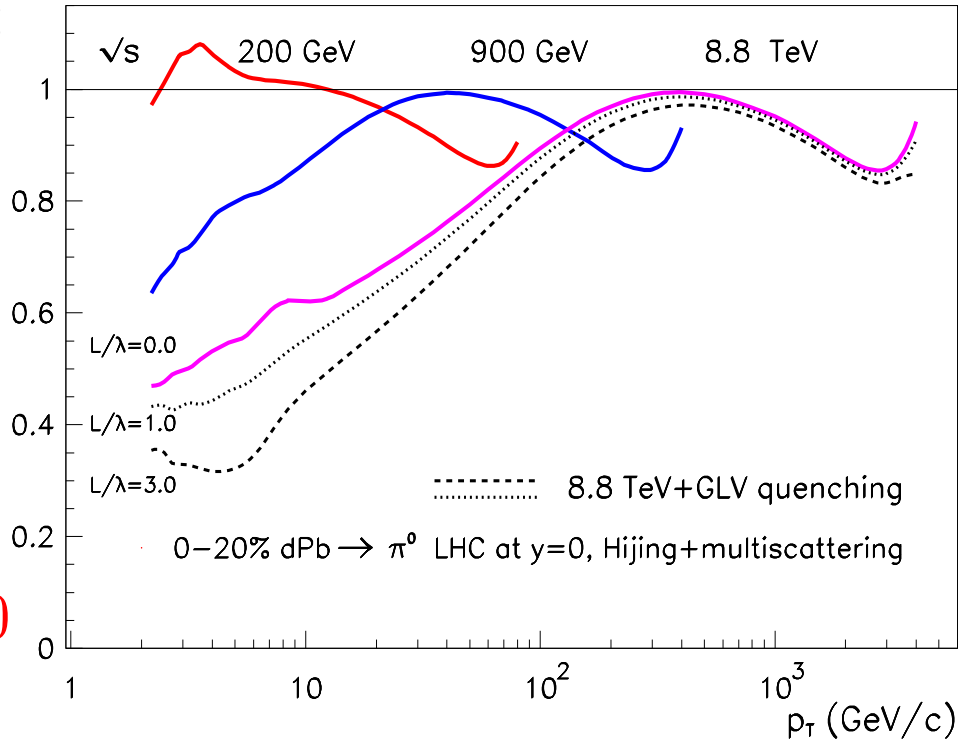
WHAT DOES THIS MEAN?

More Suppression at LHC ?

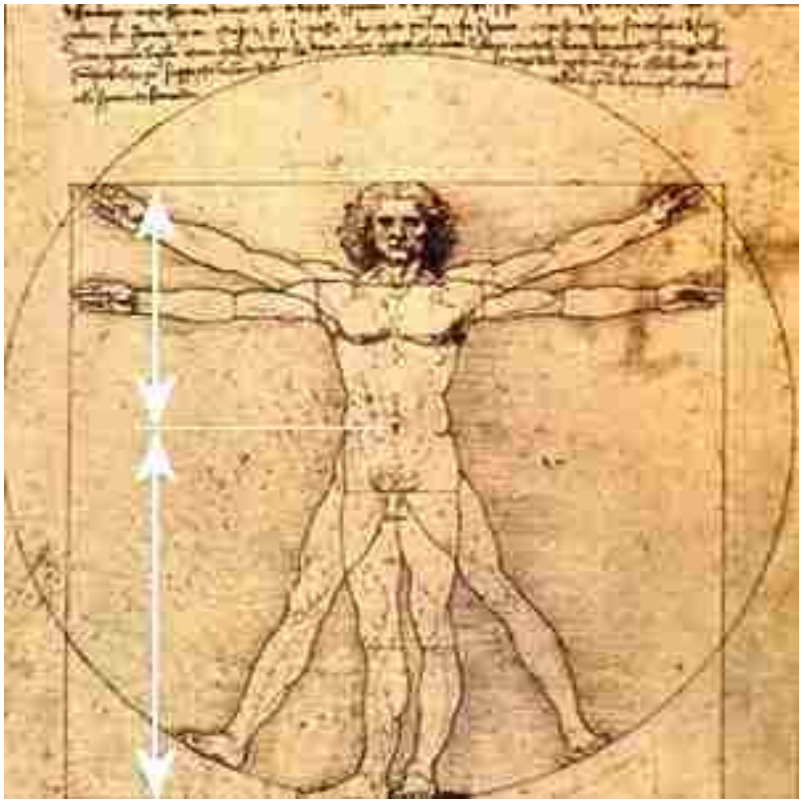
C.M. Energy dependence of GLV jet energy loss

$$\Delta E_{GLV} \approx \frac{C_R \alpha_s}{N(E)} \frac{L^2 \mu^2}{\lambda_g} \log \frac{E}{\mu} = \frac{C_R \alpha_s}{N(E)} \frac{1}{A_\perp} \frac{dN}{dy} \langle L \rangle \log \frac{E}{\langle \mu \rangle}$$

- $AuAu$ at RHIC $\frac{1}{A_\perp}\frac{dN}{dy} \approx \frac{680}{\pi R^2_{AuAu}} = 5.1$
- dAu at RHIC $\frac{1}{A_\perp}\frac{dN}{dy} \approx \frac{18}{\pi R^2_{dAu}} = 2.54$
- Without suppression $\frac{dN}{dy} \sim \ln \sqrt{s}$
- At LHC this $\frac{dN}{dy}$ will be $\sim 1500 - 2000$

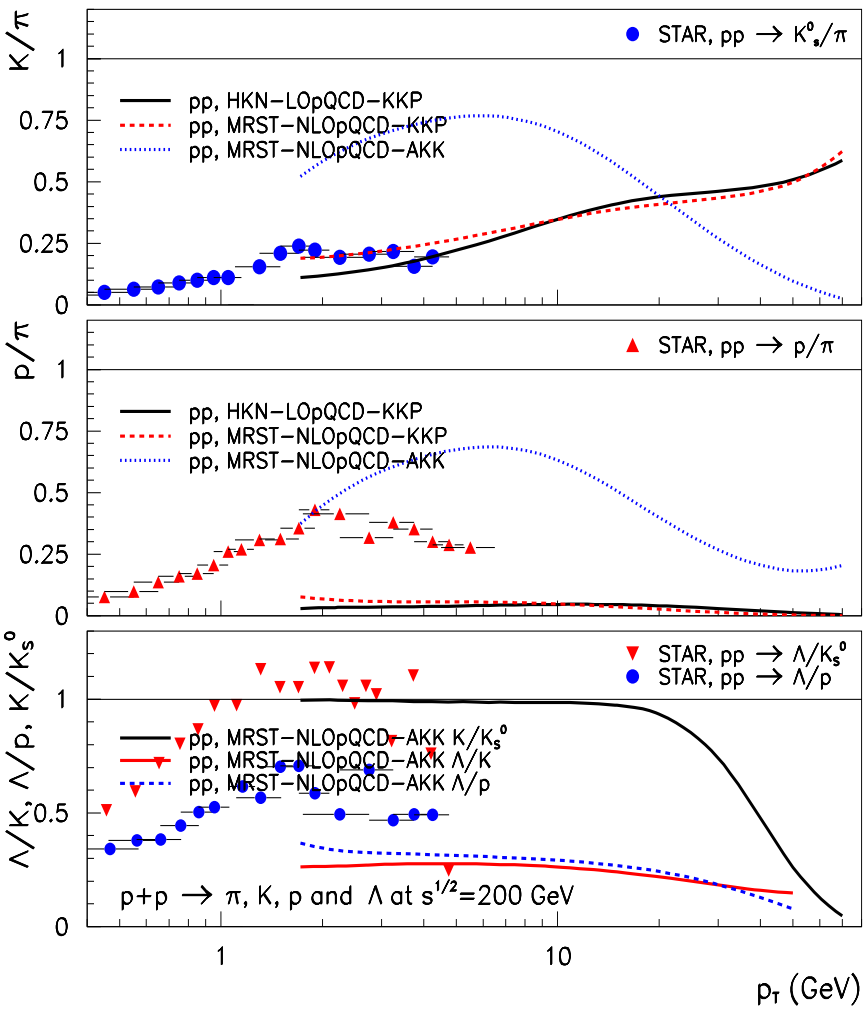


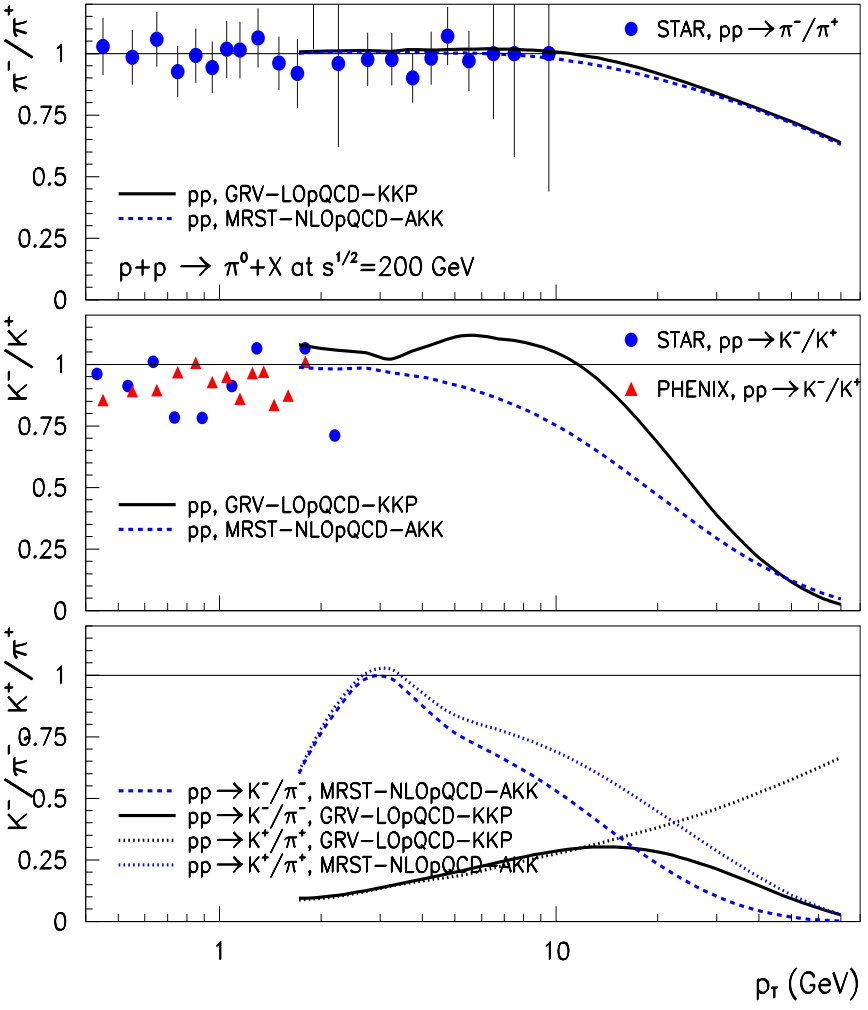
'NEW': Comparing KKP and AKK FFs



in pp, dA and AA collisions via ratios

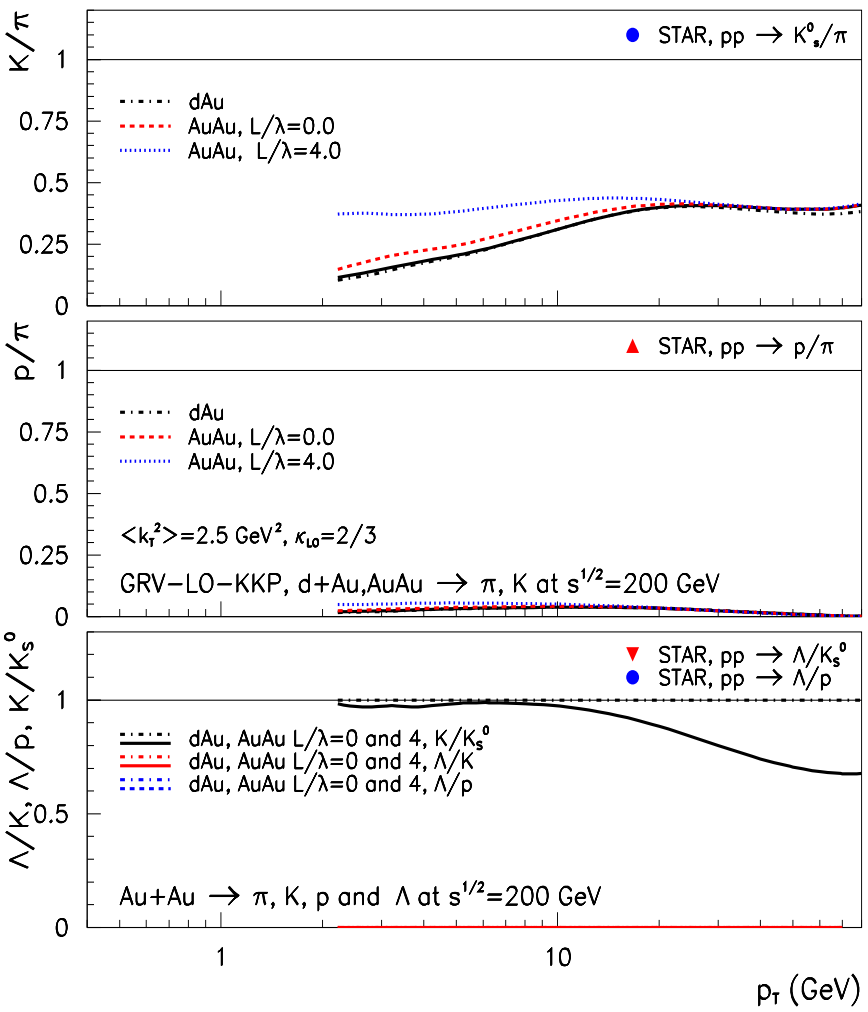
High p_T Hadron Ratios in pp at RHIC

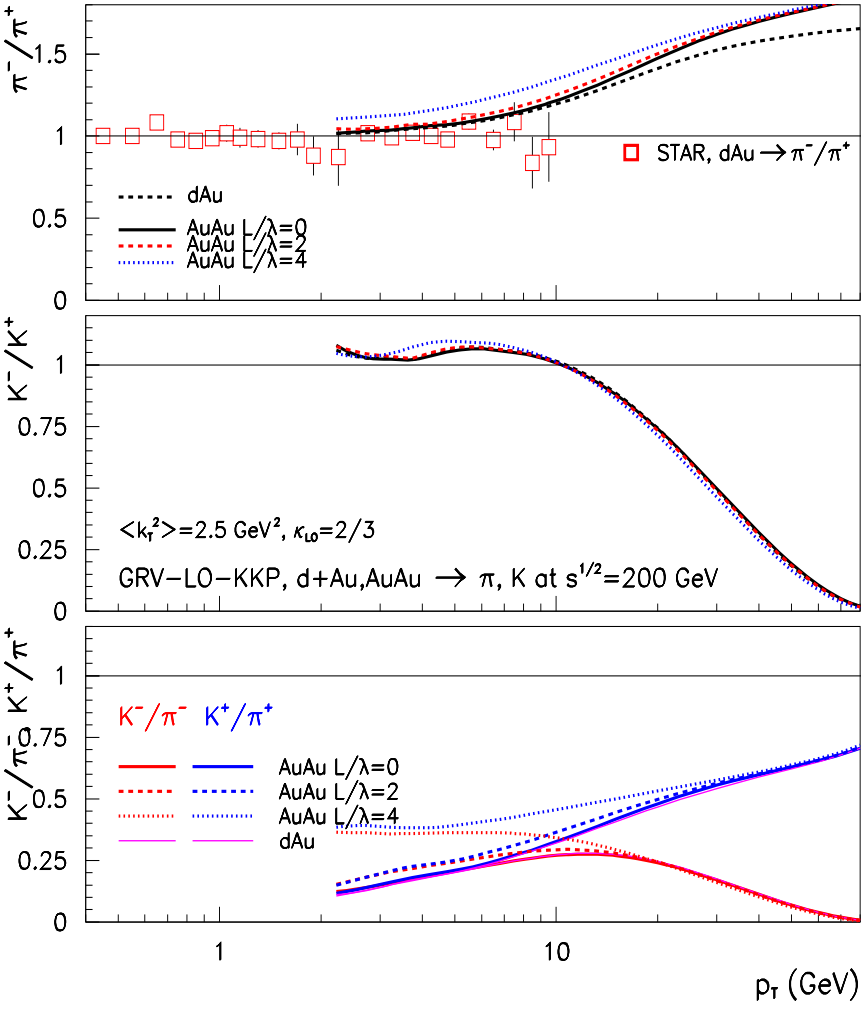




- LO and NLO calculations agree to each other
- AKK and KKP result differ and not only π/p

High p_T Ratios in dAu and $AuAu$ with KKP at RHIC

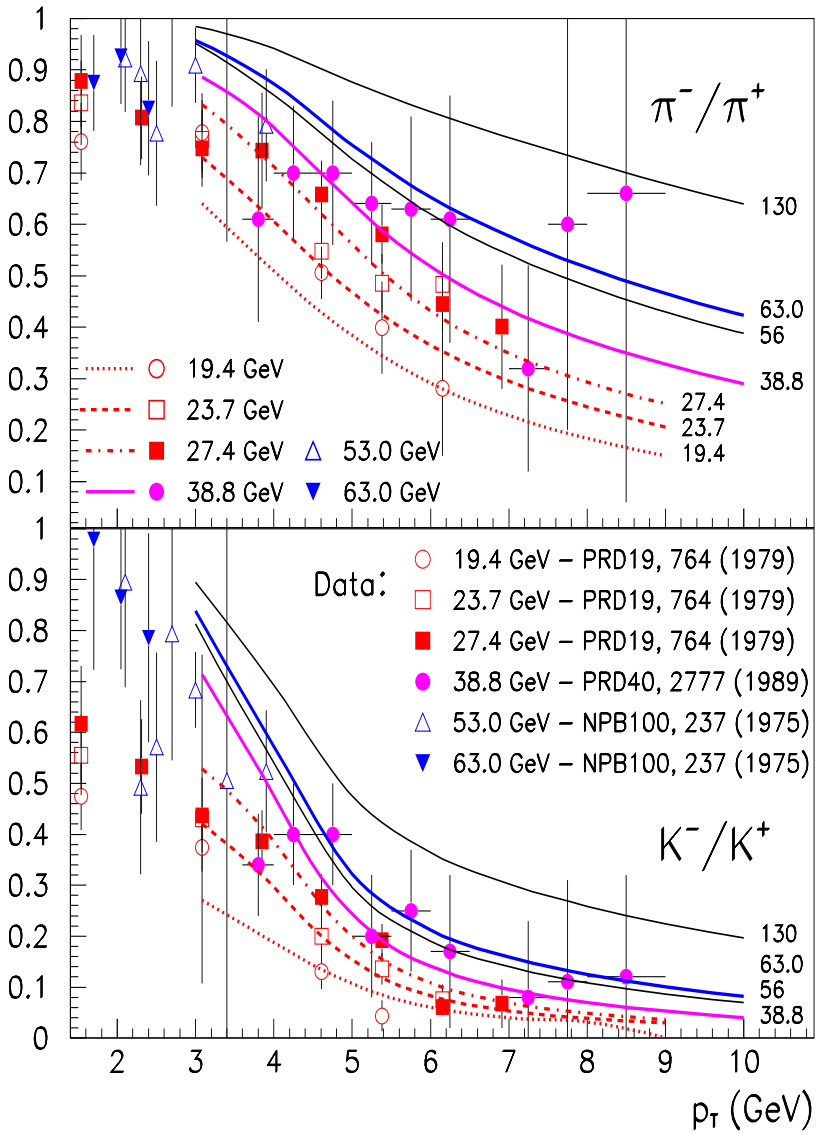


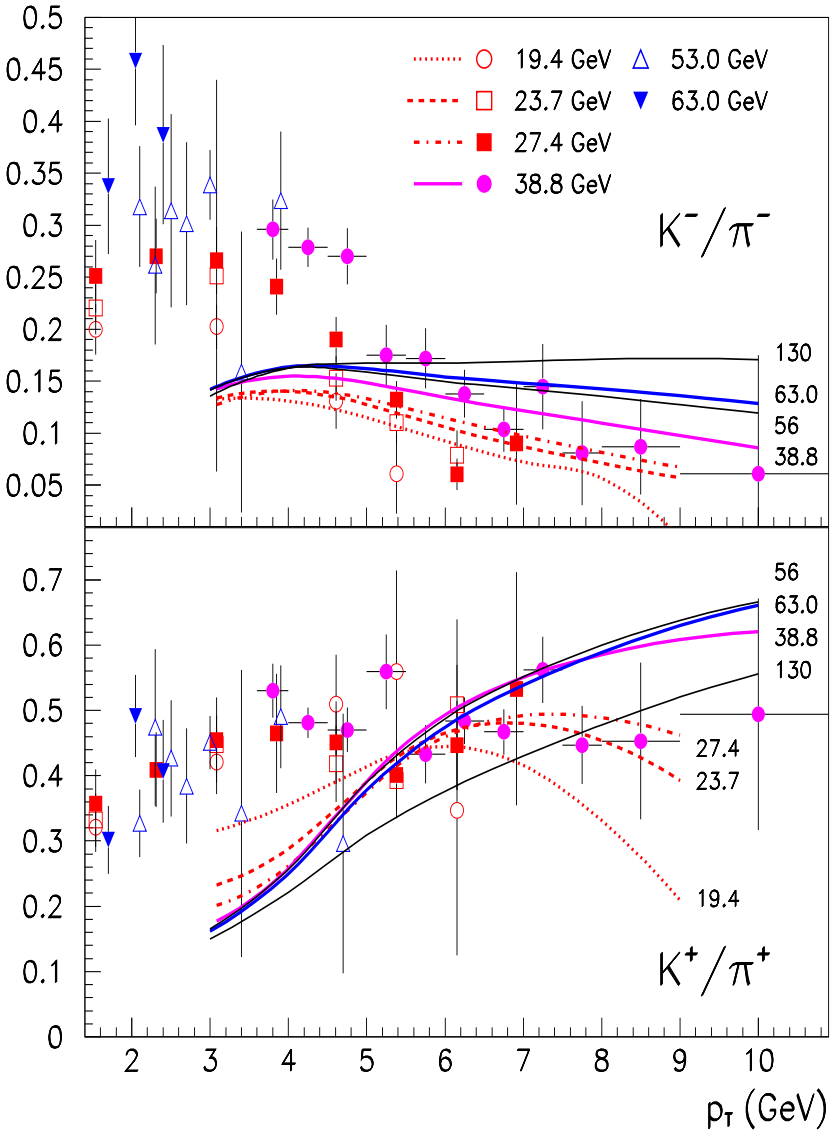


Applied KKP Fragmentation Function

- **Flavor dependence: jet-quenching is stronger for the g**

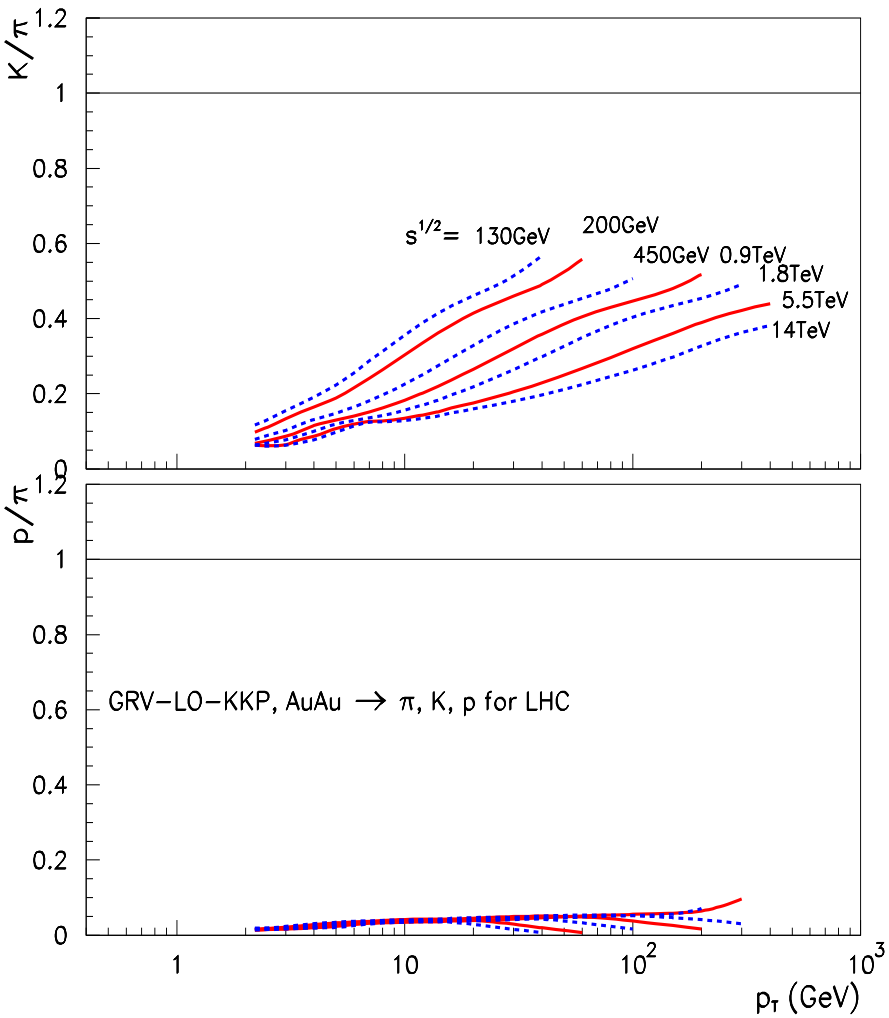
Ratio calculations in pp up to RHIC energies

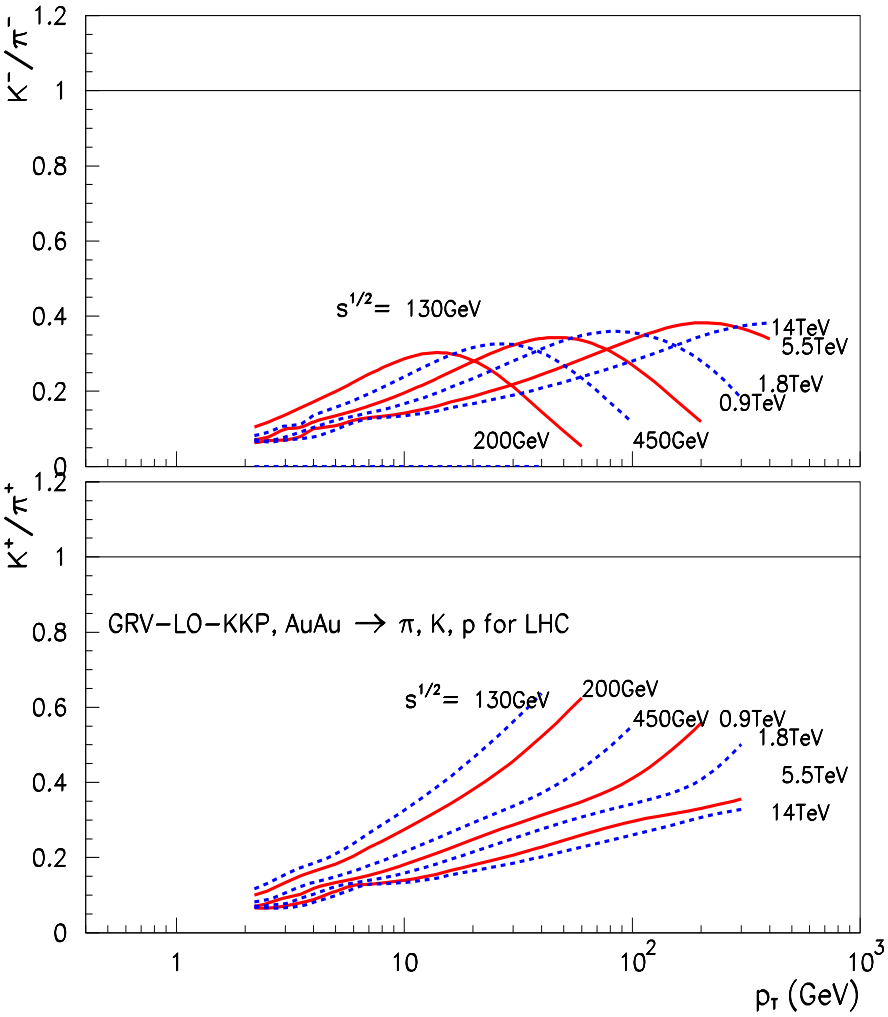




P. Levai, G. Fai, M. Gyulassy: nucl-th/0012017

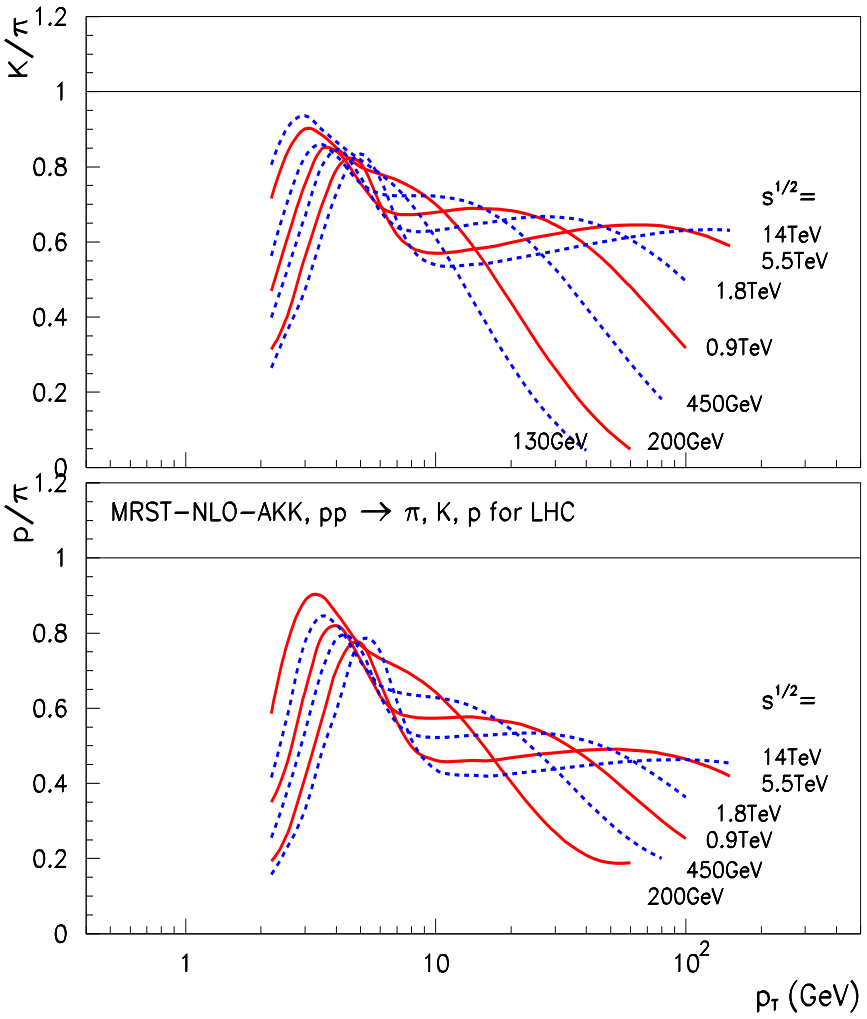
Ratio calculations in pp beyond RHIC energies

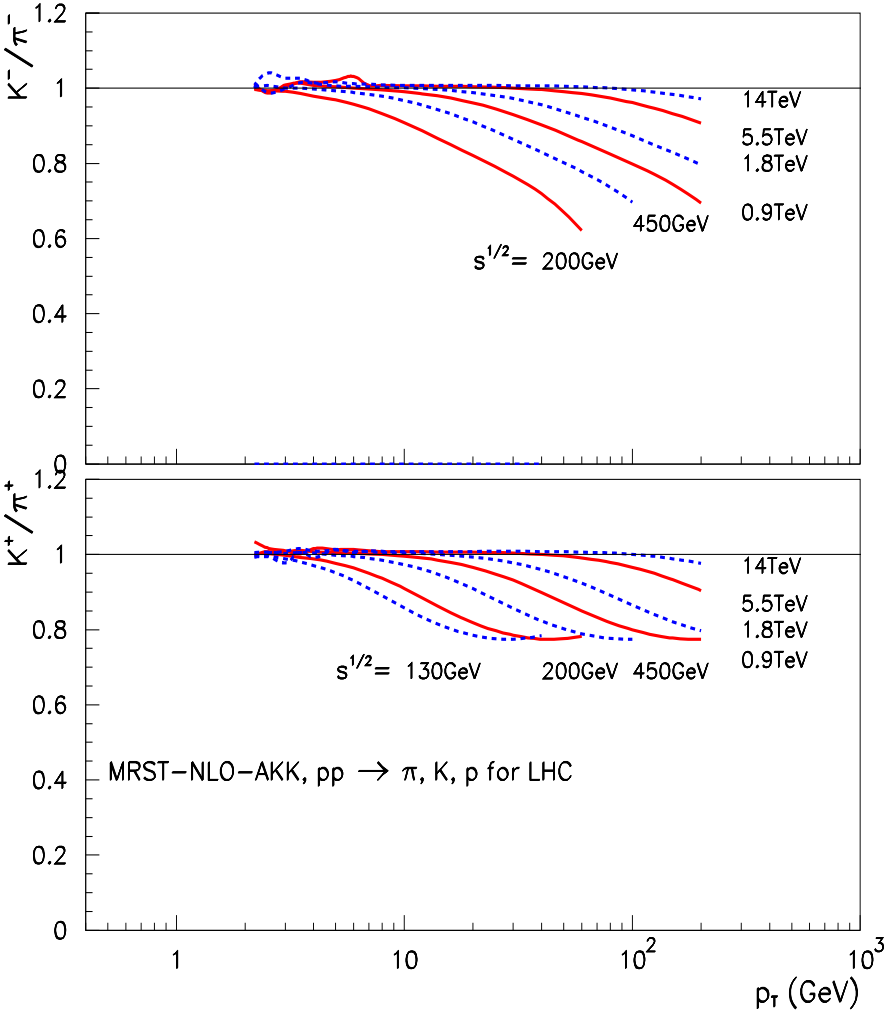




Calculations with KKP – it seem not all good...

Ratio calculations in pp beyond RHIC energies





Predictions with AKK ...

SUMMARY without CONCLUSIONS

Hadron Spectra and R_{dA}

$\Longrightarrow$ Relevance of intrinsic-k_T at low- and intermediate-p_T

$\Longrightarrow$ Strong shadowing effect up to intermediate-p_Ts

$\Longrightarrow$ dPb may 'need' cold-quenching beyond RHIC?

Effects on Particle Ratios in pp, dA and AA

$\Longrightarrow$ Ratios: some cases KKP and AKK disagree

$\Longrightarrow$ Differences in jet quenching: flavor dependence?

$\Longrightarrow$ Different $\langle k_T^2 \rangle$ for different hadrons?

Mearuring ratios are important . . .

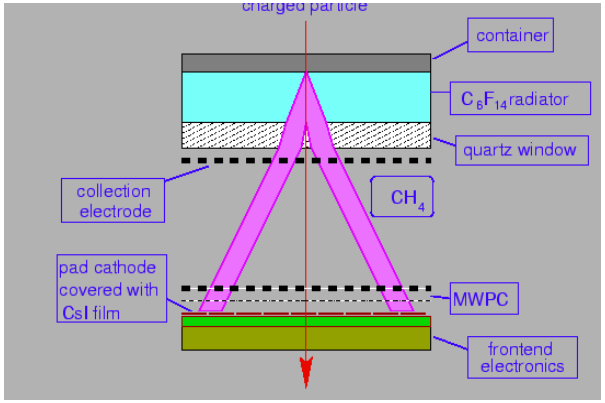
. . . but descriptions might be dangerous!

. . . and if the ALICE HMPID not enough . . .

Bari, INFN, RMKI, UNAM

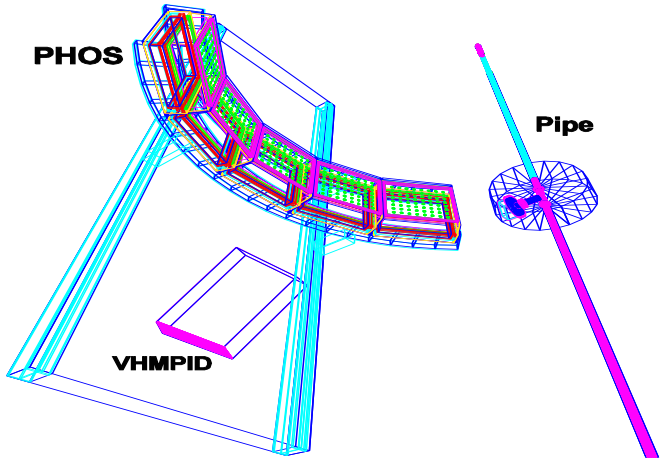
High Momentum Particle IDentification detector

– HMPID is for extend the range for the ID of π/K and K/p, on a track-by-track basis, up to 3 and 5 GeV/c respectively.



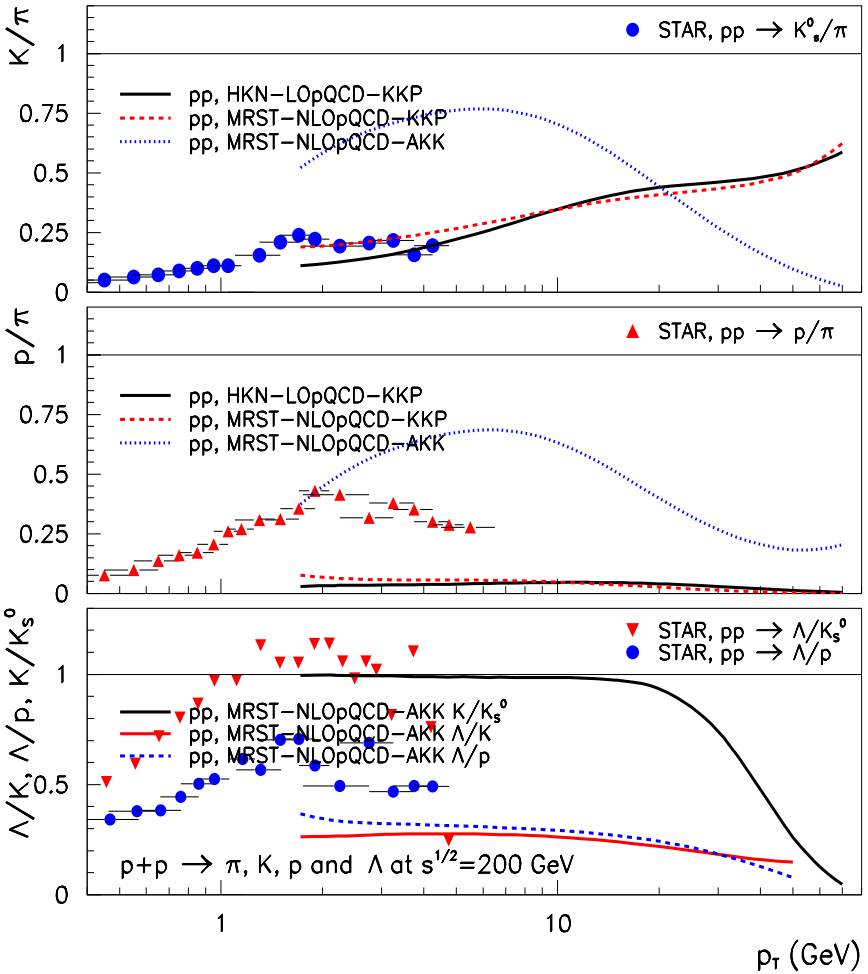
VERY HMPID (VHMPID)

– Higher momentum particle ID and track-by-track is available up to 15 GeV/c. (G. Volpe)

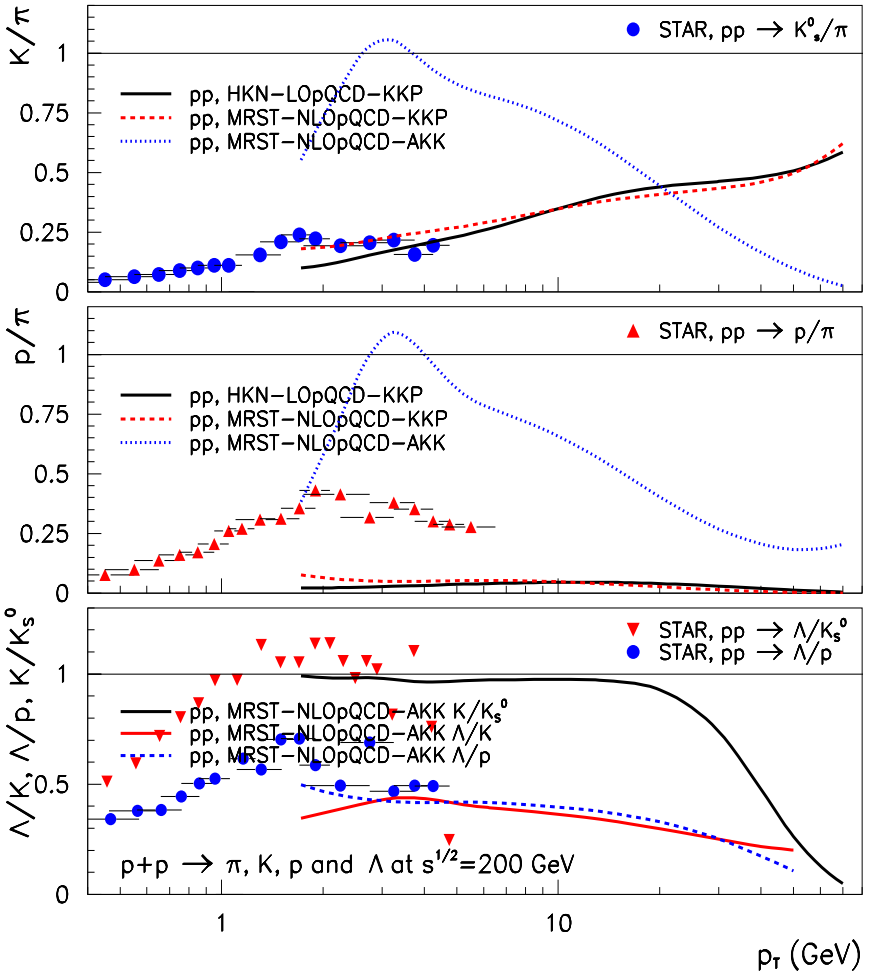


Effect of intrinsic-k_T on the ratios in pp at RHIC

Left: NO intrinsic-k_T



Right: with intrinsic-k_T



- Multiscattering at parton level: only for the q contribution
- Parton level multiscattering vs. different intrinsic-k_T?