Detailed study of parton energy loss via measurement of fractional momentum loss of high p_T hadrons in d+A and A+A collisions

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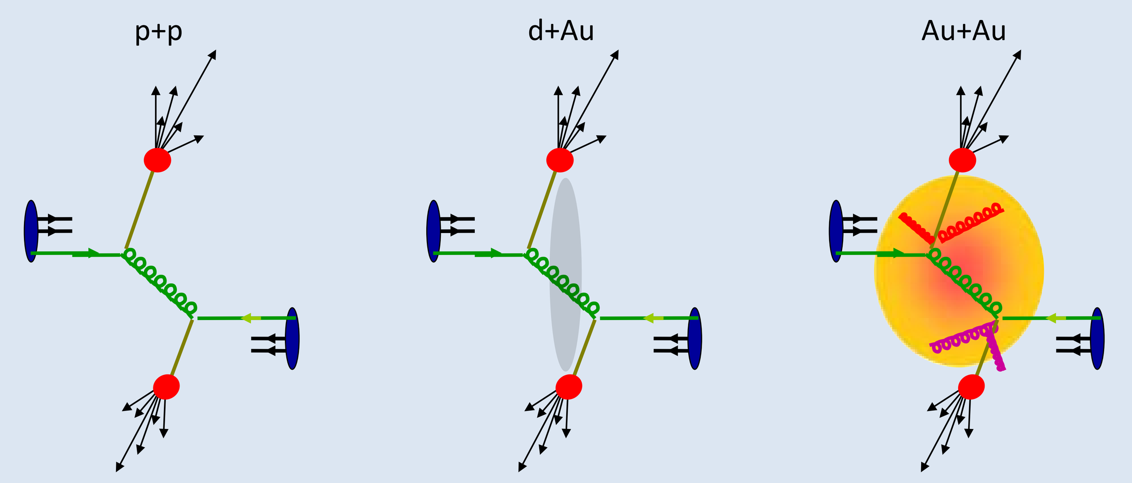
Hard scattering as densimeter of medium

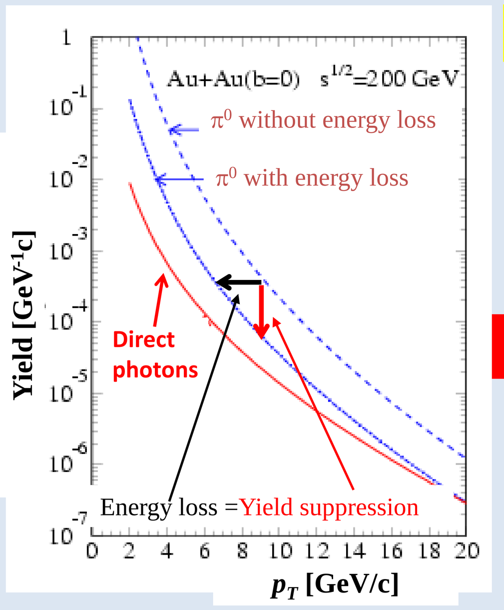
•Parton may change its momentum in hot dense medium.
→Energy loss through Gluon radiation, etc.

•Effect may be path-length and system dependent ~a densimeter~.

•Look at leading particles of jet as a measure of jet energy.

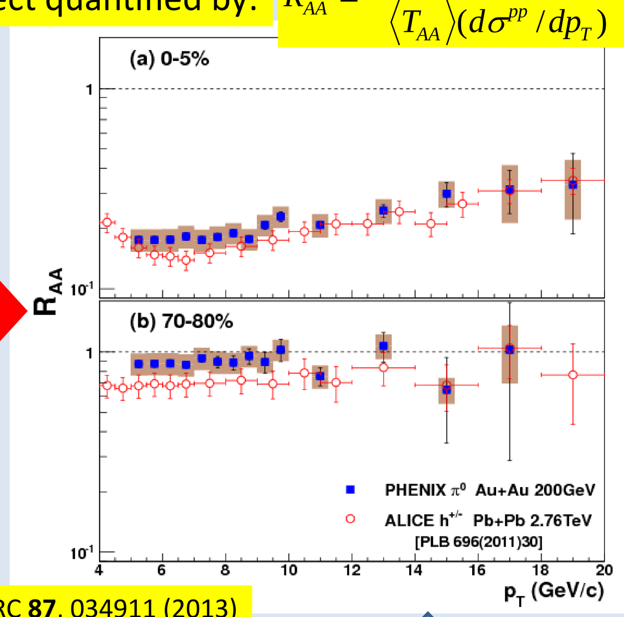
Cross section of A+B collisions ∝ AB × p+p collisions





X.-N., Wang, PRC **58** (1998)2321

Effect quantified by: $R_{AA} = \frac{(1/N_{evt}^{AA})(dN^{AA}/dp_T)}{\langle T_{AA}\rangle (d\sigma^{pp}/dp_T)}$

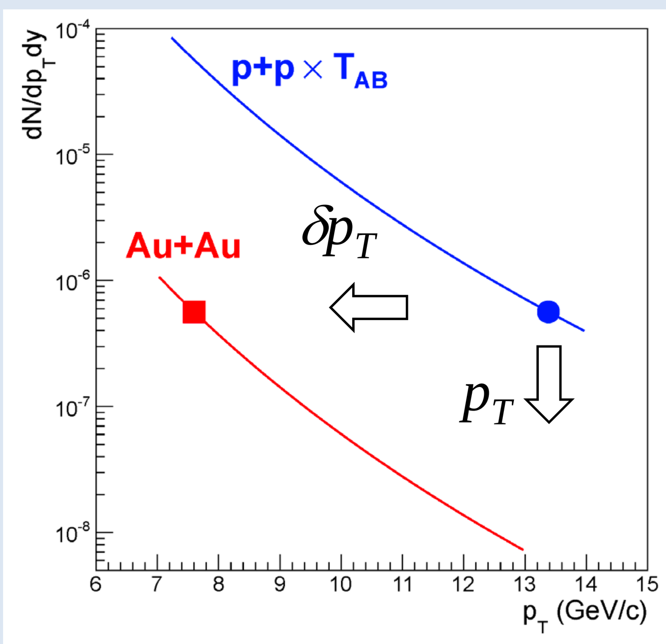


PRC **87**, 034911 (2013)

Surprising similar R_{AA} between RHIC and LHC, meaning energy loss is also same?

No! Then how to quantify?

Fractional momentum loss ($\delta p_T/p_T$)

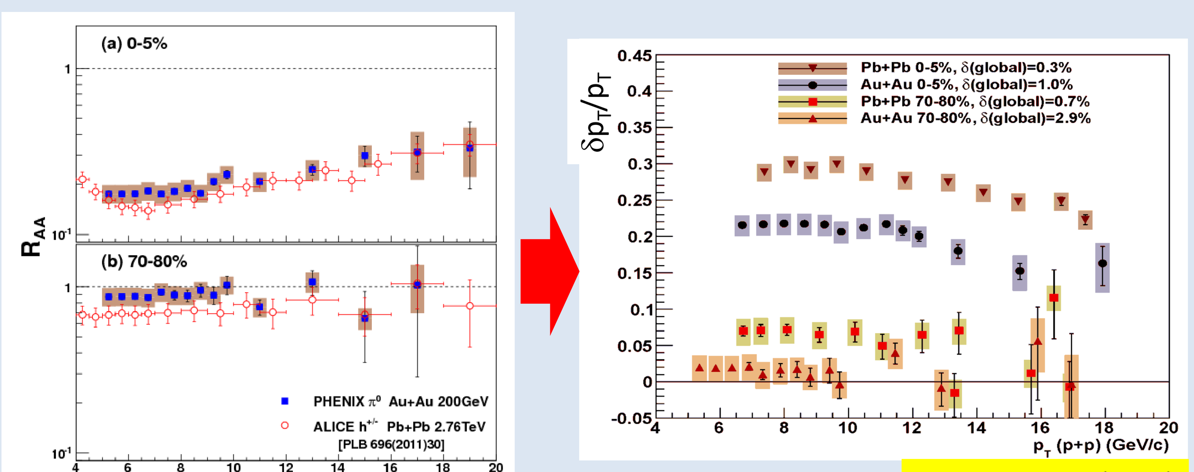


Measuring fractional momentum loss ($\delta p_T/p_T$) of high p_T hadrons in place of R_{AA} in A+A collisions.

$$p_T : p_T(p+p)$$
$$\delta p_T = p_T(p+p) - p_T(A+A)$$

•(p+p) denotes p+p yield scaled by number of binary nucleon-nucleon collisions (N_{coll}).

$\delta p_T/p_T$ from 200GeV to 2.76TeV: a factor of 1.5 increase at LHC!



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Number of quark participants (N_{qp})?

See posters by J. Mitchell (B-10) and M. Tannenbaum (C-20) for detail

•Number of quark participants, N_{qp}, is estimated using a Glauber model.

•Nucleons are distributed using a Woods-Saxon distribution.

•Quarks are distributed about the nucleon centers with random azimuth and radially sampled from $\rho(r) = \rho_0^{proton} e^{-ar}$, where a = 4.27 fm^{-1}.

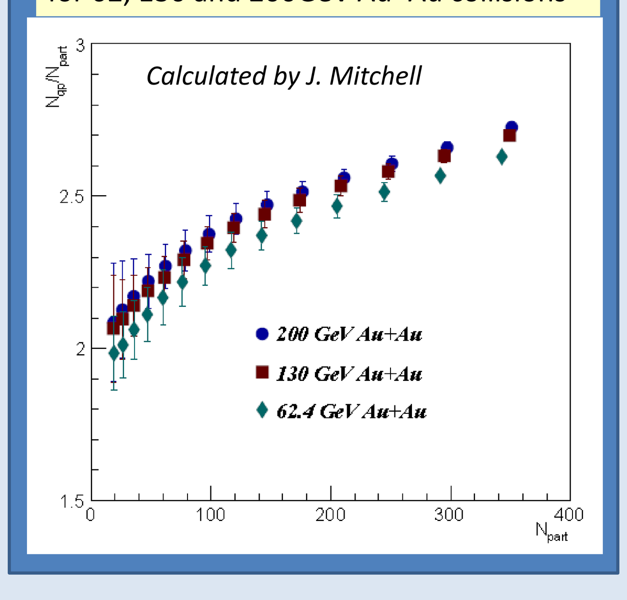
•Quarks interact when their separation, *d*, satisfies the condition of:

$$d < \sqrt{\frac{\sigma_{qq}^{inel}}{\pi}}$$

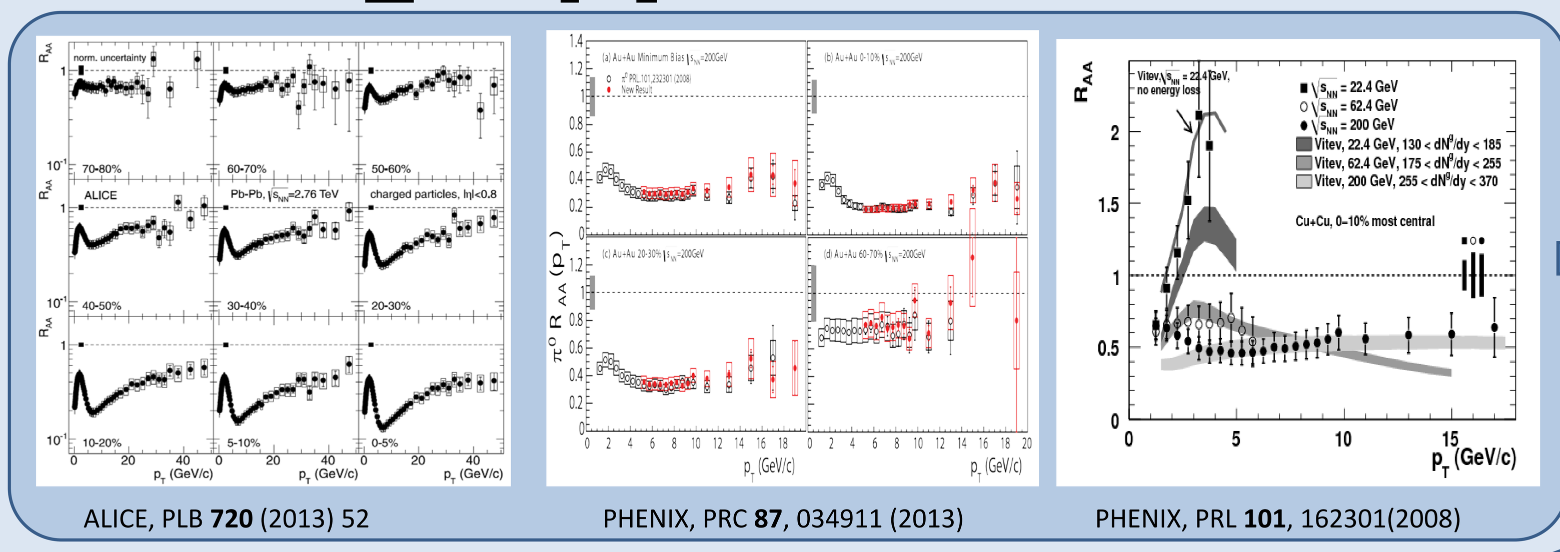
The quark-quark inelastic cross section (σ_{qq}^{inel}) is estimated by reproducing the n-n inelastic cross section for nucleon-nucleon collisions as follows:

$\sqrt{s_{NN}}$[GeV]	$\sigma_{nn}^{inel.}$	$\sigma_{qq}^{inel.}$
2700	64.0	18.4
200	42.3	9.36

Ratios of N_{qp}/N_{part} as a function of N_{part} for 62, 130 and 200GeV Au+Au collisions



Rewrite R_{AA} to $\delta p_T/p_T$



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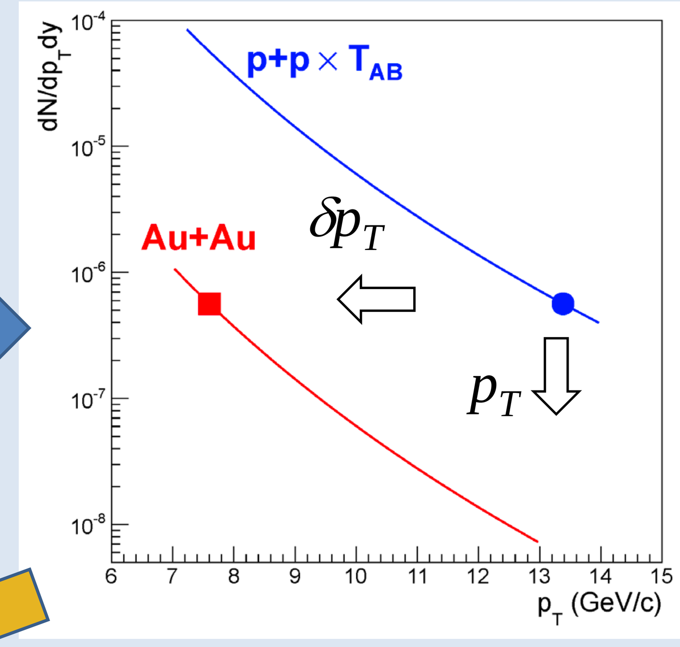
PHENIX, PRC **87**, 034911 (2013)

PHENIX, PRL **101**, 162301(2008)



Results and discussion

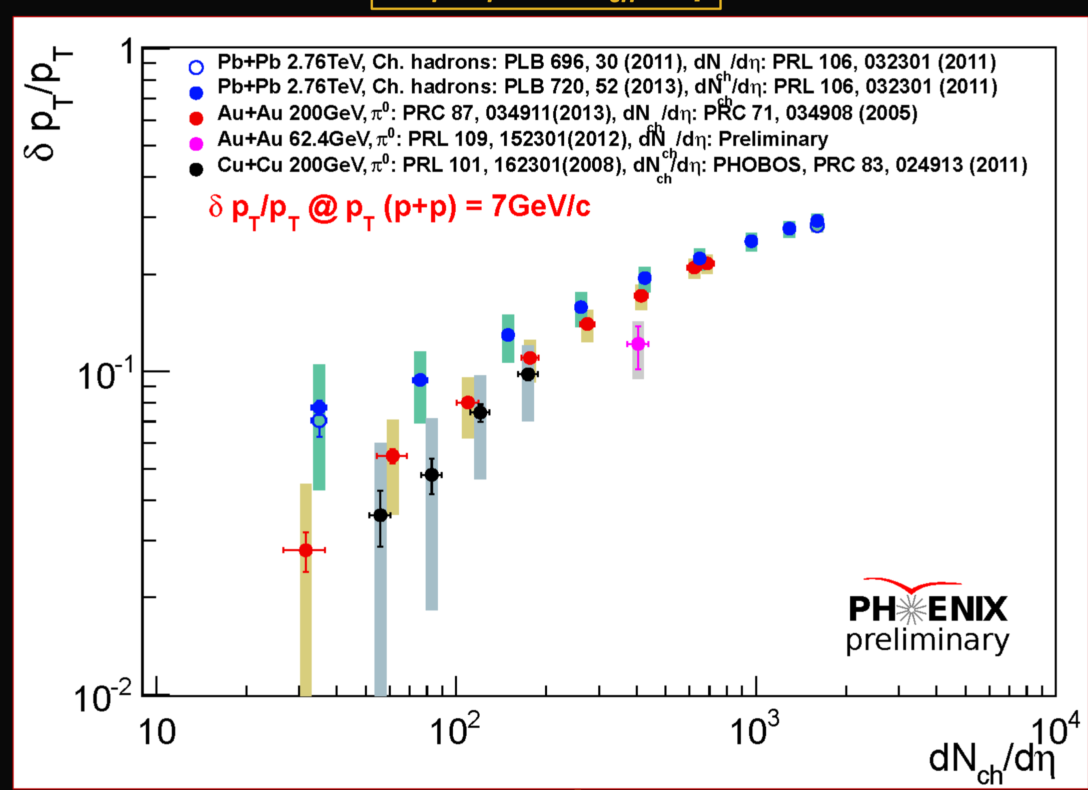
Plotting $\delta p_T/p_T$ as a function of $dN_{ch}/d\eta$, N_{part}, and N_{qp}

•The p_T(p+p) selection is limited to 7GeV/c this time.
→ **We will perform the same analysis for broader p_T(p+p) range in near future**

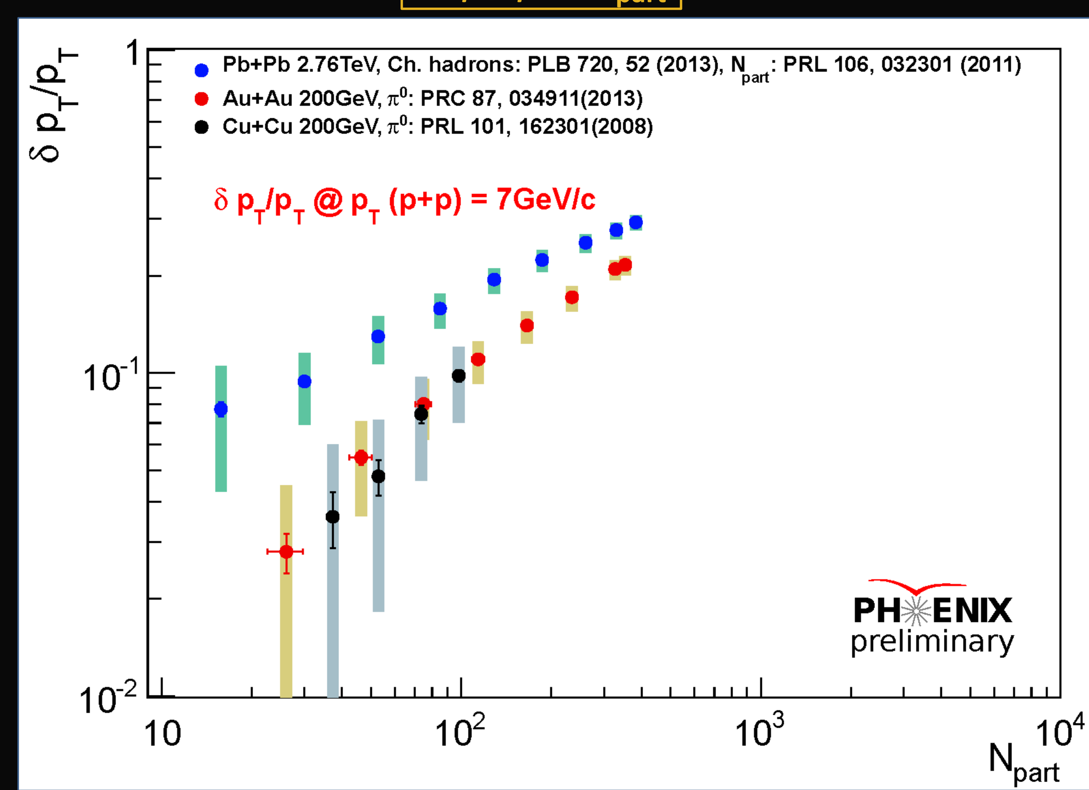
•$dN_{ch}/d\eta$ is used as a measure of the energy density.

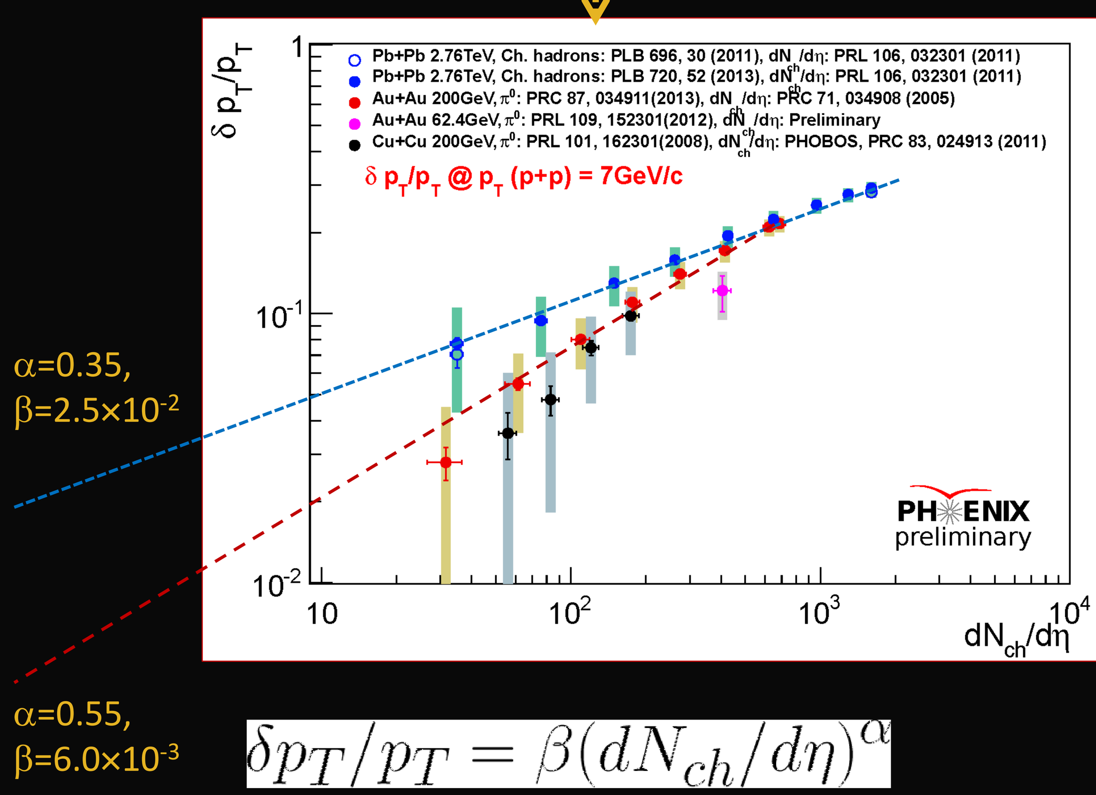
•N_{qp} is the number of quark participants. ($N_{qp} \cong (2\text{-}3) \times N_{part}$, depending on energies and centralities)
→ ***See the left bottom section of this poster.***

$\delta p_T/p_T$ vs $dN_{ch}/d\eta$



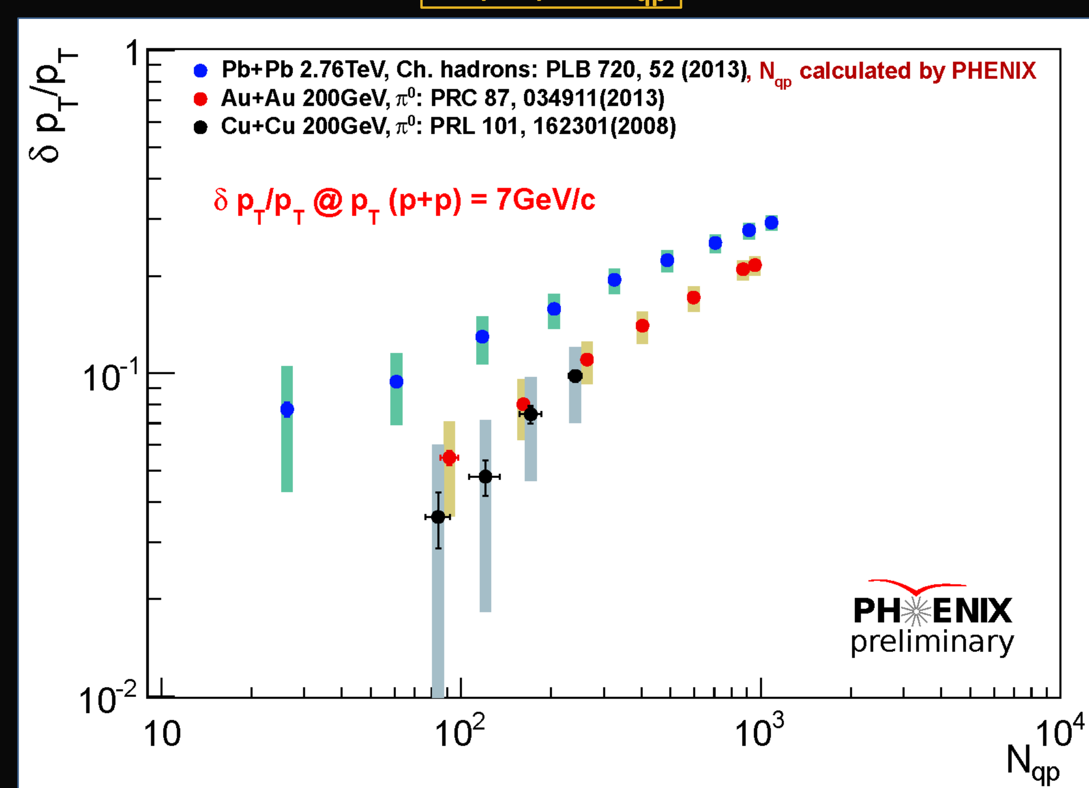
$\delta p_T/p_T$ vs N_{part}





$$\delta p_T/p_T = \beta (dN_{ch}/d\eta)^{\alpha}$$

$\delta p_T/p_T$ vs N_{qp}



•$\delta p_T/p_T$ vs $dN_{ch}/d\eta$ for 200GeV Au+Au and Cu+Cu collisions tend to merge into the one for 2.76TeV Pb+Pb collisions at larger $dN_{ch}/d\eta$, independent of $\sqrt{s_{NN}}$.

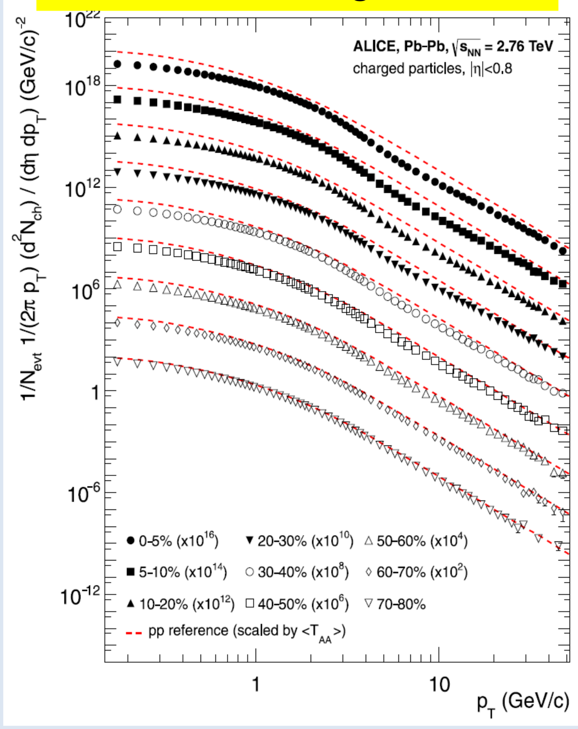
•Within same $\sqrt{s_{NN}}$, both N_{part} and N_{qp} scaling work very well.

•It would be interesting to look where *p*+A and *d*+A points will be located. (future plan)
(Recently, *p*(*d*)+A collisions are said to produce hot dense matter.)

Ingredients (Dataset used for this analysis)

These spectra + $dN_{ch}/d\eta$ + N_{part} + N_{qp}

Pb+Pb 2.76TeV charged hadrons



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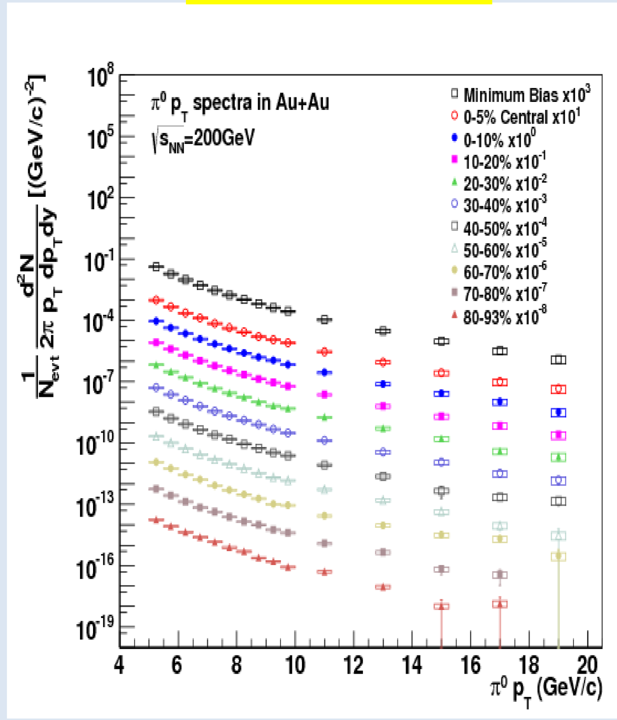
Au+Au 200GeV π^0



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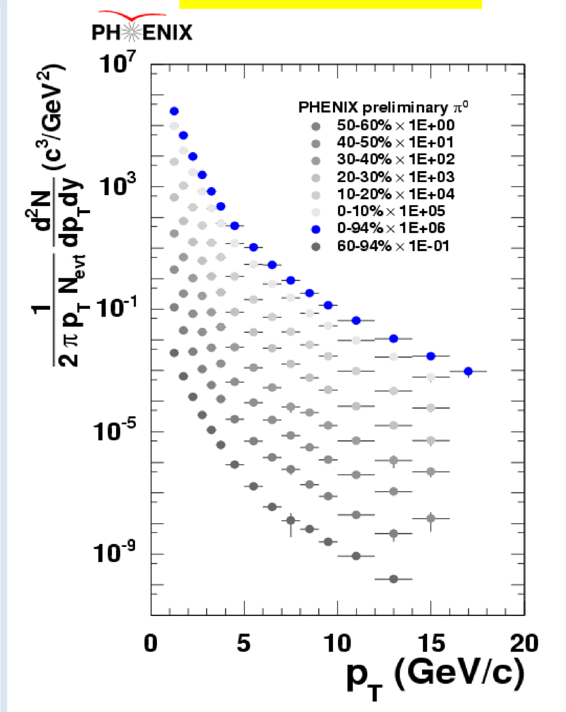
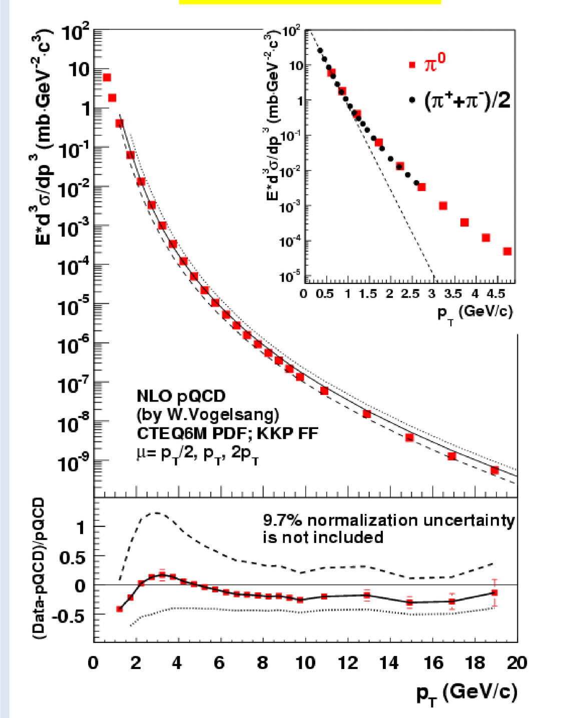
Cu+Cu 200GeV π^0



PHENIX, PRL **101**, 162301(2008)

p+p 200GeV π^0



PHENIX, PRD **76**, 051106 (2007)

Poster presented on May 20, 2014, for XXIV QUARK MATTER DARMSTADT 2014