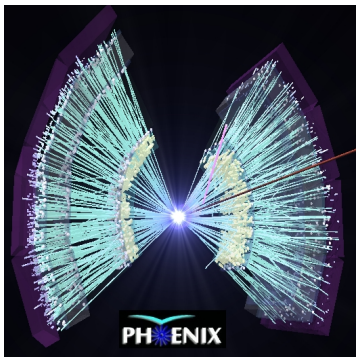
Why the formula

$$\left\langle \frac{dN_{ch}^{AA}}{d\eta} \right\rangle = \left\langle \frac{dN_{ch}^{pp}}{d\eta} \right\rangle \left[xN_{part}/2 + (1-x)N_{coll} \right]$$

should be deprecated

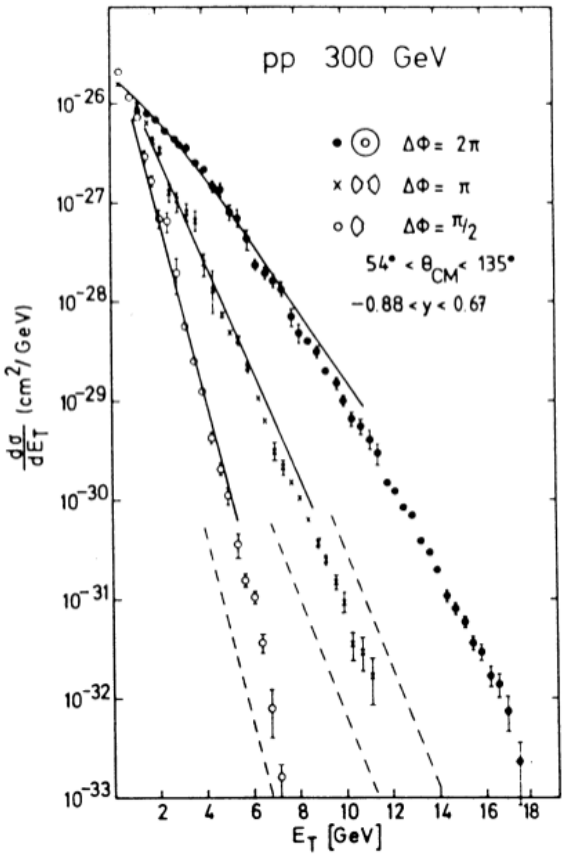
M. J. Tannenbaum
Brookhaven National Laboratory
Upton, NY 11973 USA

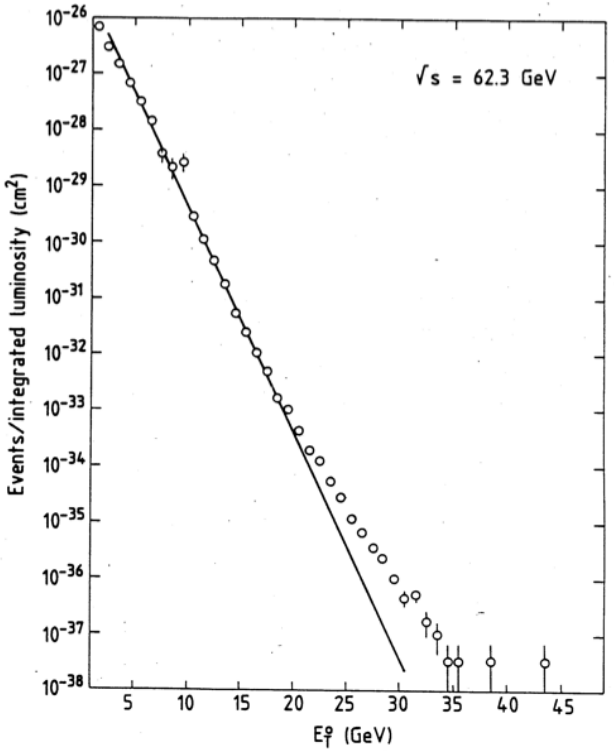


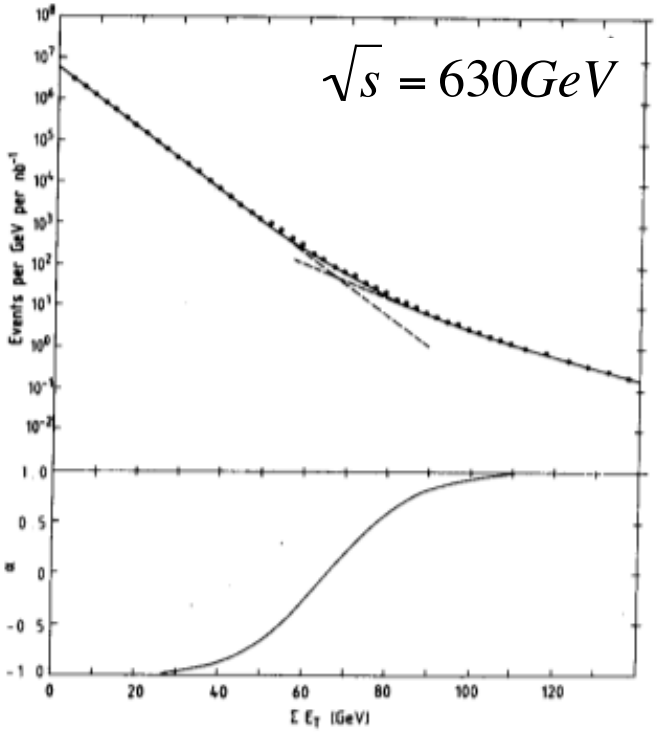
23rd International Conference on
Ultrarelativistic Nucleus-Nucleus Collisions
Quark Matter 2012
Washington, DC, USA
August 13-18, 2012

Since 1980 it has been known by all High Eenergy Physicists that E_T and multiplicity distributions are less sensitive to hard-scattering than single inclusive measurements

NA5, COR, UA2 CERN: E_T distributions





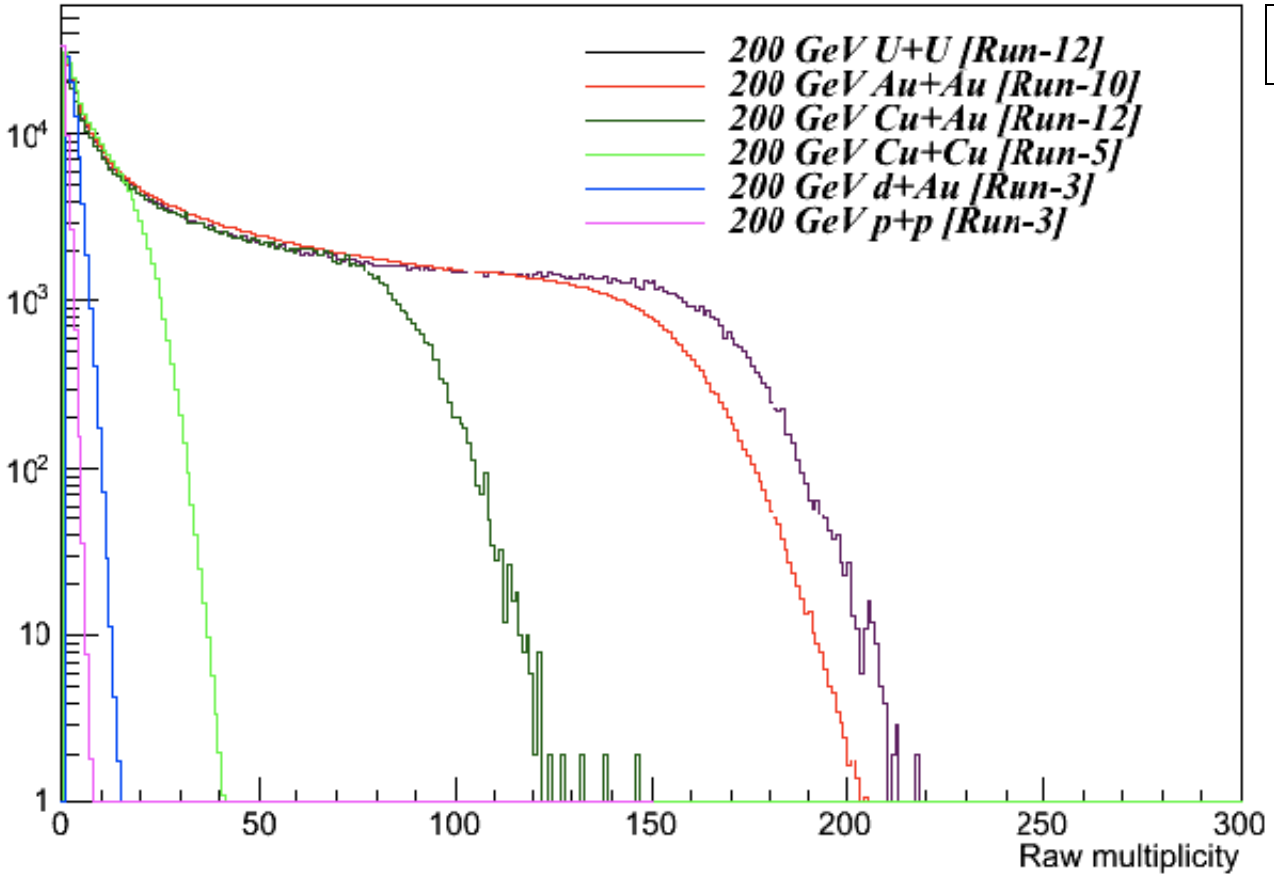


NA5 PLB112(1982)173: solid lines low p_T multi-particle production, dashes QCD hard scattering

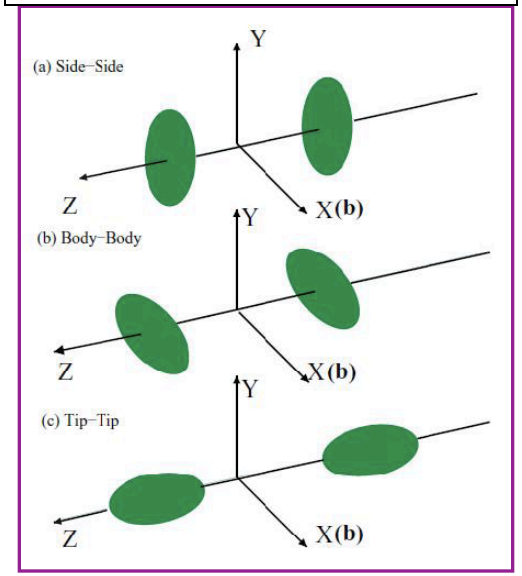
COR PLB126(1983)132: Hard scattering indicated by break in exponential is 7 orders of magnitude down

UA2 PLB165 (1985) 441: Break from hard scattering is 5-6 orders of magnitude down α=fraction hard-soft

All $dN_{ch}/d\eta$ distributions at $\sqrt{s_{NN}}$=200 GeV



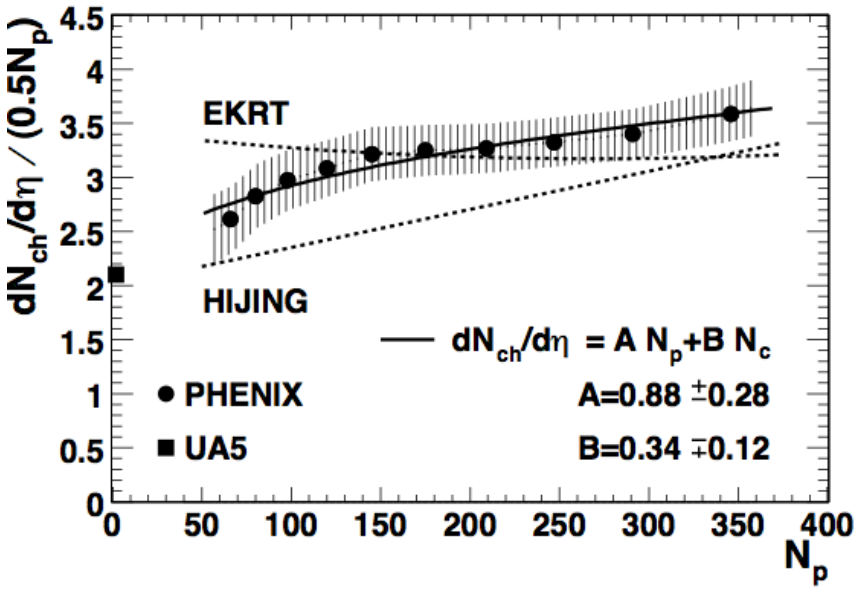
PRC 85 (2012) 034905



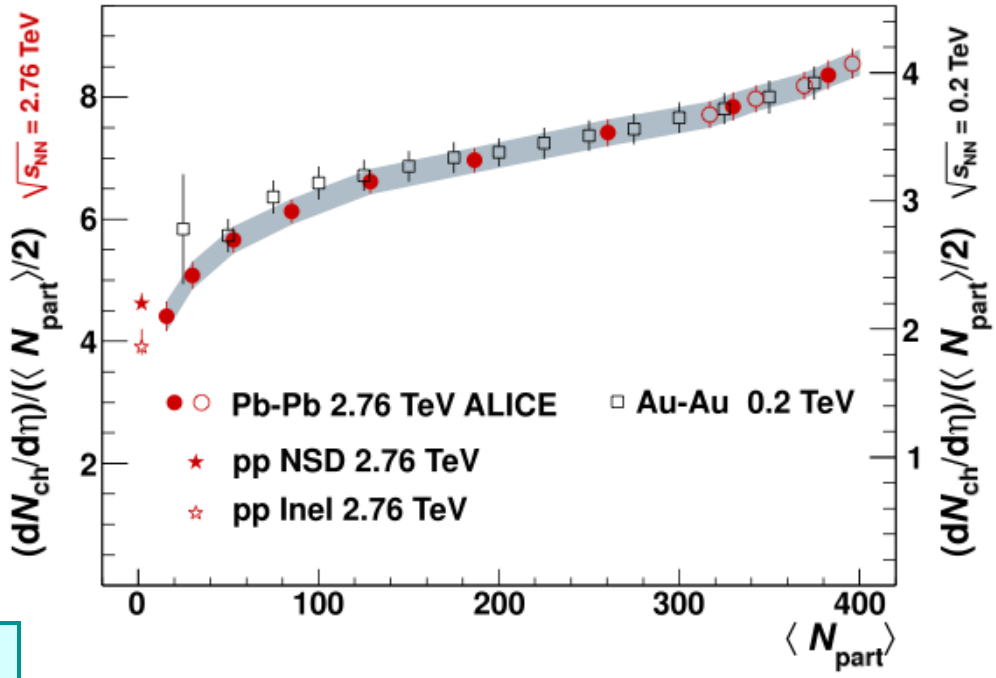
For U+U no obvious effect from different possible orientations

Raw values-performance plot; not corrected for response, efficiency, acceptance. All B+A show typical elongation with increasing A. No anomalous `noses' due to large Ncoll for tip-tip.

From RHIC to LHC to RHIC evolution of multiplicity with centrality, N_{part}



PHENIX $\sqrt{s_{NN}}$=130 GeV, PRL86 (2001)3500

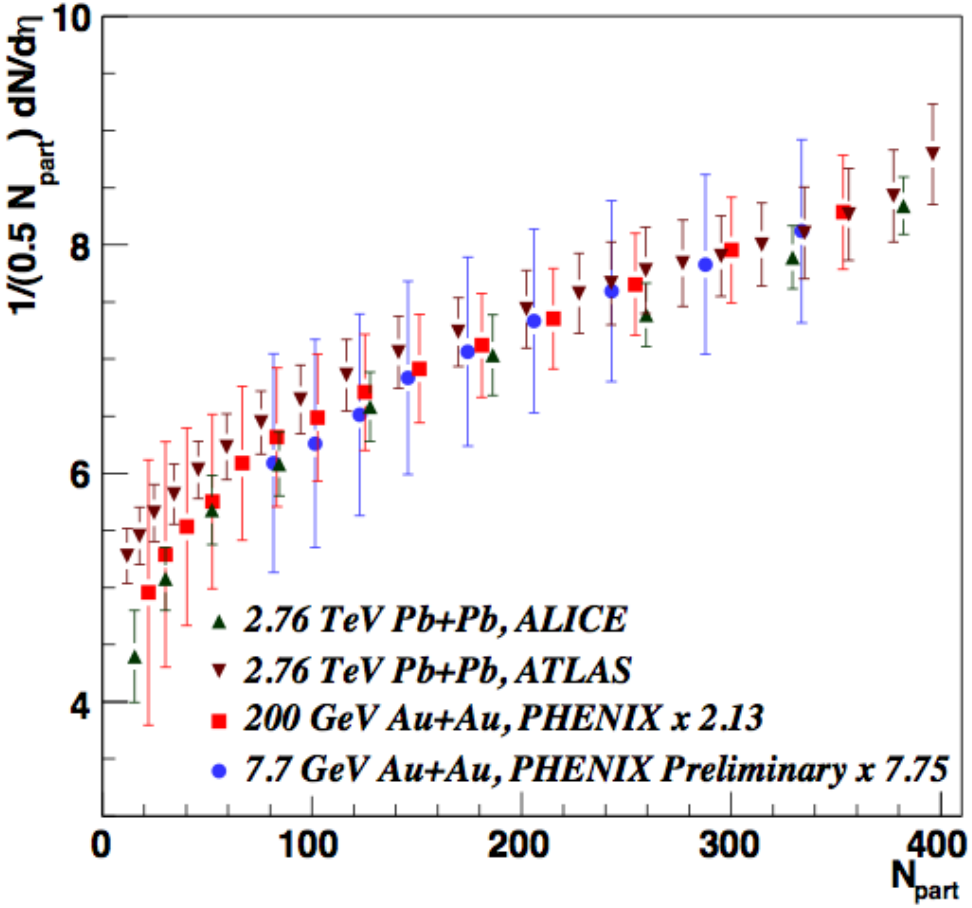


ALICE $\sqrt{s_{NN}}$=2.76 TeV PRL 106(2011)032301

For the LHC compared to RHIC, there is a minimal change in Npart with centrality due to pp cross section but Ncoll at ALICE/LHC is 1.5 larger than at RHIC since pp inelastic cross section is 64mb at 2.76 TeV(ALICE) compared to 42 mb at 200 GeV(RHIC). HOWEVER no effect seen in dNch/dη/(Npart/2) vs <Npart>

Identical shape of distributions indicates a nuclear-geometrical effect

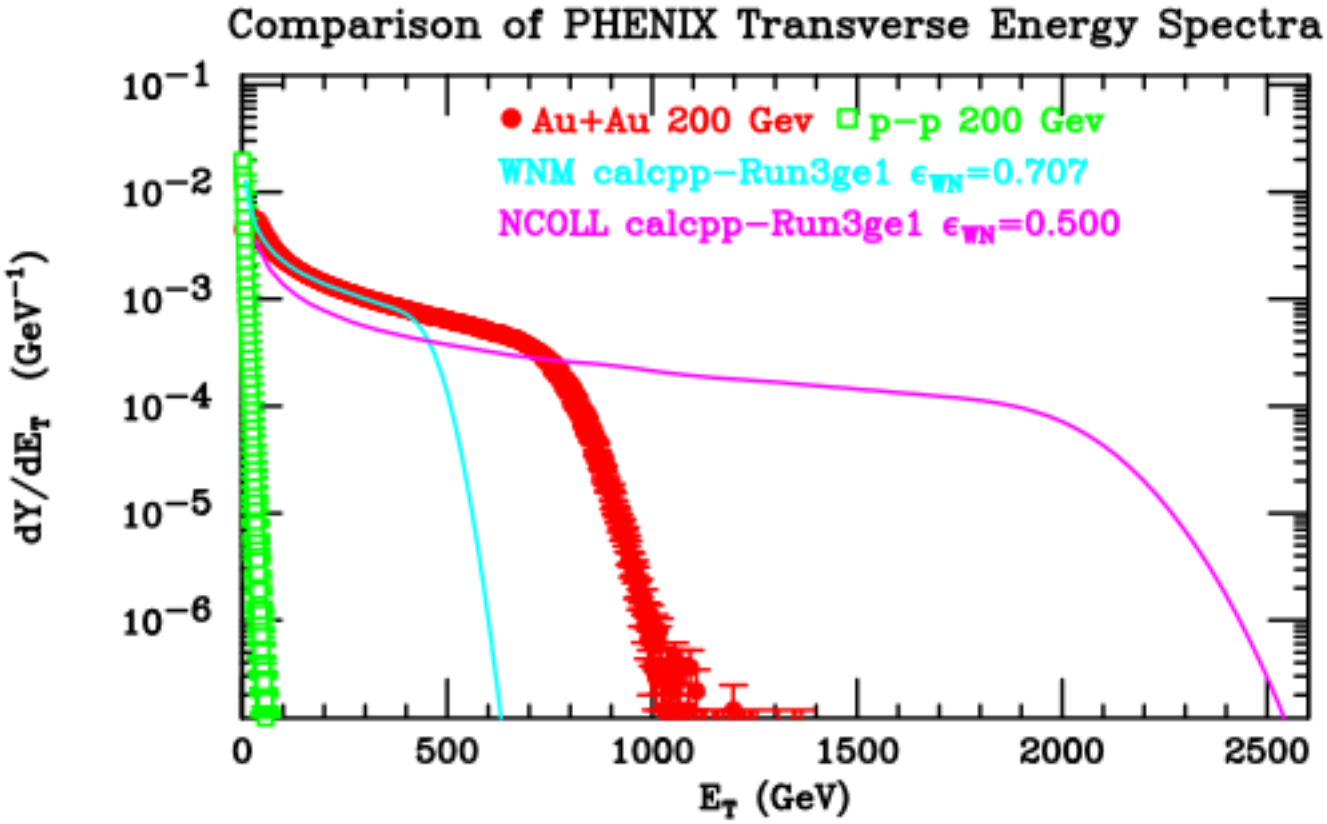
New RHIC data for Au+Au at $\sqrt{s_{NN}}$ =0.0077 TeV show the same evolution with centrality



The geometry is the number of quark participants/nucleon participant

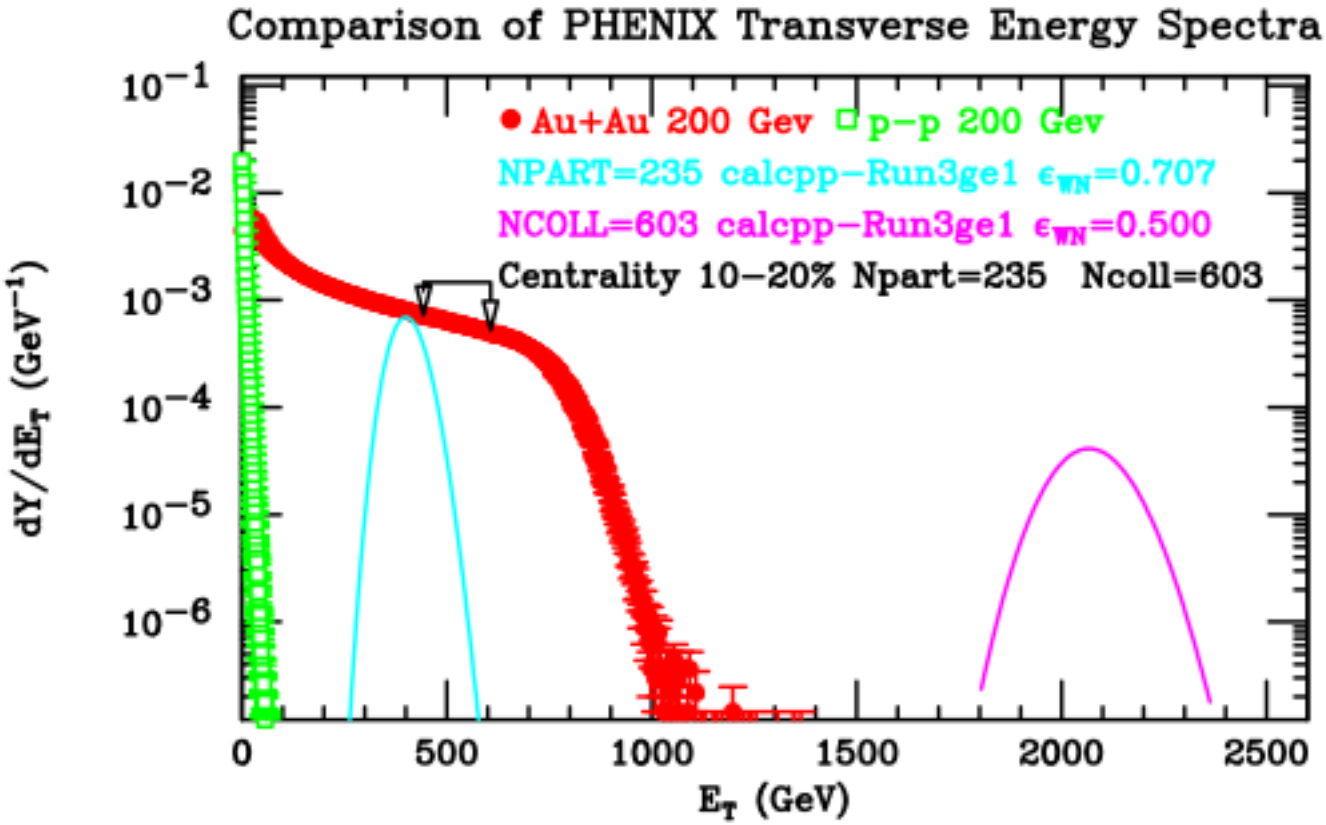
Eremin&Voloshin, PRC 67, 064905(2003) ; De&Bhattacharyya PRC 71; Nouicer EPJC 49, 281 (2007)

But first, given the p-p and Au+Au E_T distributions, it is easy to see why the formula makes no sense for the distribution



If you take the formula literally the red distribution should equal x/2 times the Npart (WNM) distribution + (1-x) times the Ncoll distribution, which looks nothing like it.

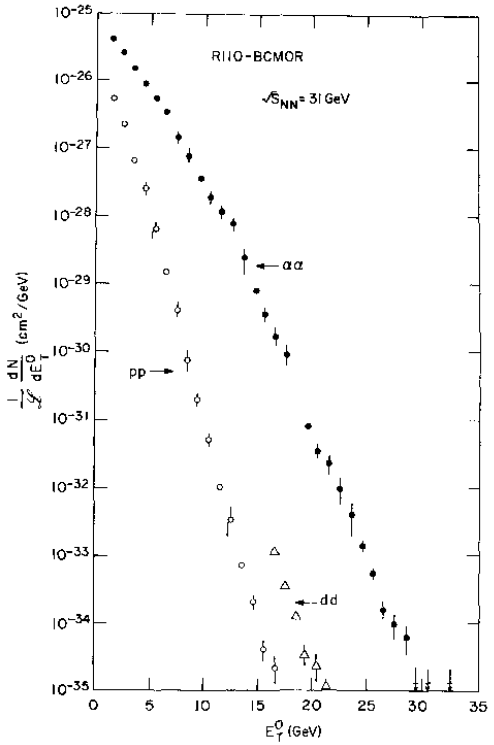
If you don't believe in distributions but like centrality cuts, here is 10-20%

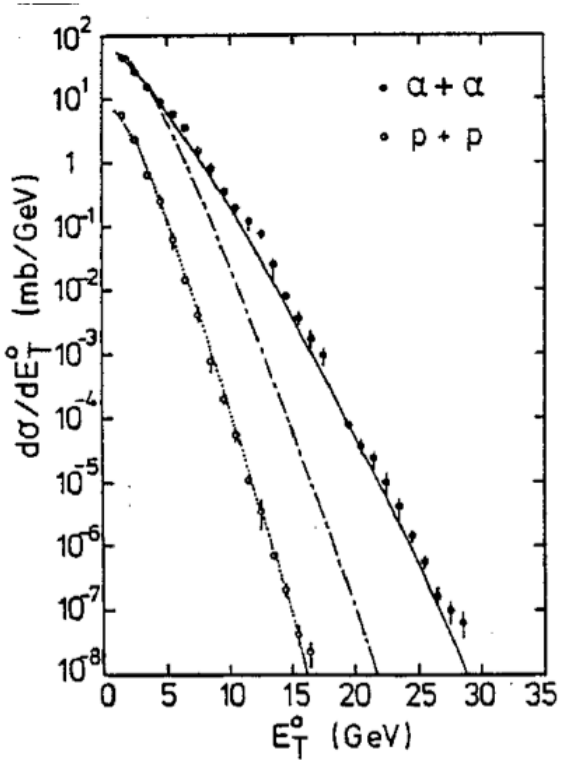


The average of the 10-20% region of red distribution does equal x/2 times the mean of the Npart (WNM) distribution + (1-x) times the mean of the Ncoll distribution; but there is no evidence of counts to average for E_T>1500 GeV as indicated by Ncoll convolutions of the p-p distribution .

Now that you are convinced what is wrong you probably want to see what is correct
Quark Participants

The first indication that the wounded nucleon model failed was given by the BCMOR experiment in α-α collisions at $\sqrt{s_{NN}}$=31 GeV at the CERN-ISR



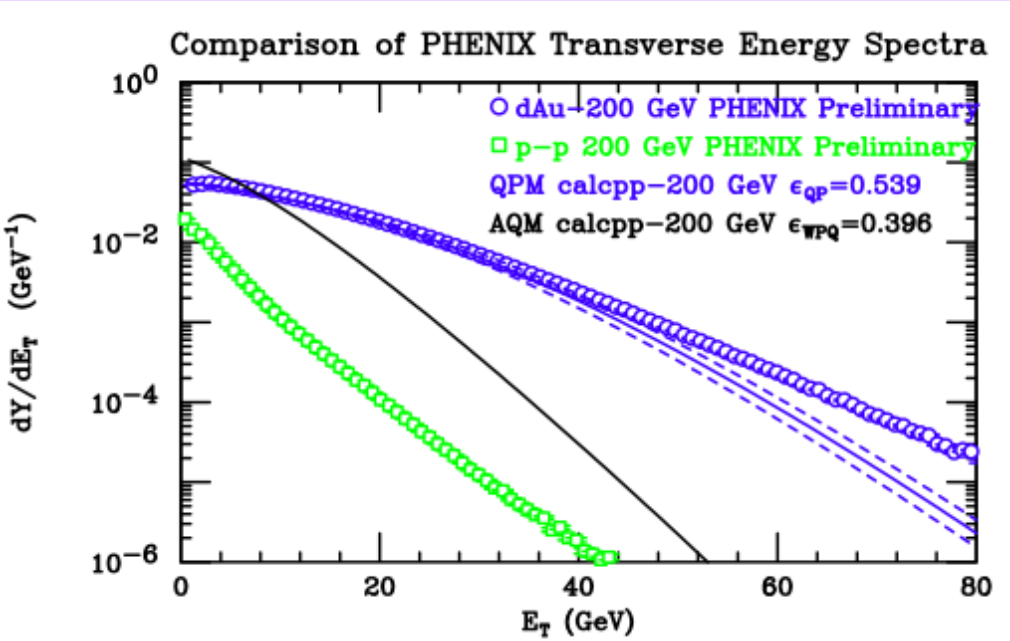


BCMOR $\sqrt{s_{NN}}$=31 GeV, PLB141(1984)140
also see MJT QM1984 !!!

T. Ochiai, ZPC35(1987)209: WNM dot-dash line vs. Additive Quark Model solid line

The Additive Quark Model and the Quark Participant Model are different

The Additive Quark Model (AQM), Bialas and Bialas PRD20(1979)2854 and Bialas, Czyz and Lesniak PRD25(1982)2328, is really a color string model. In the AQM model only one color string can be attached to a wounded quark. For symmetric systems, it is identical to the Quark Participant model. However for asymmetric systems such as d +Au it is a ``wounded projectile quark'' model since in this model, only 6 color strings can be attached to the d while the Au can have many more quark participants. PHENIX preliminary data shows that in fact it is the QPM not the color string model that works



Both STAR and PHOBOS have shown that Quark Participant Model works in Au+Au

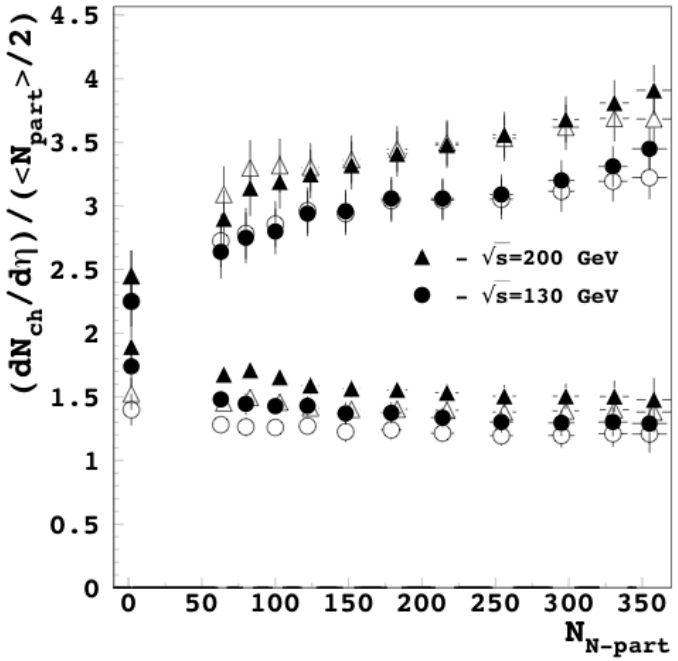
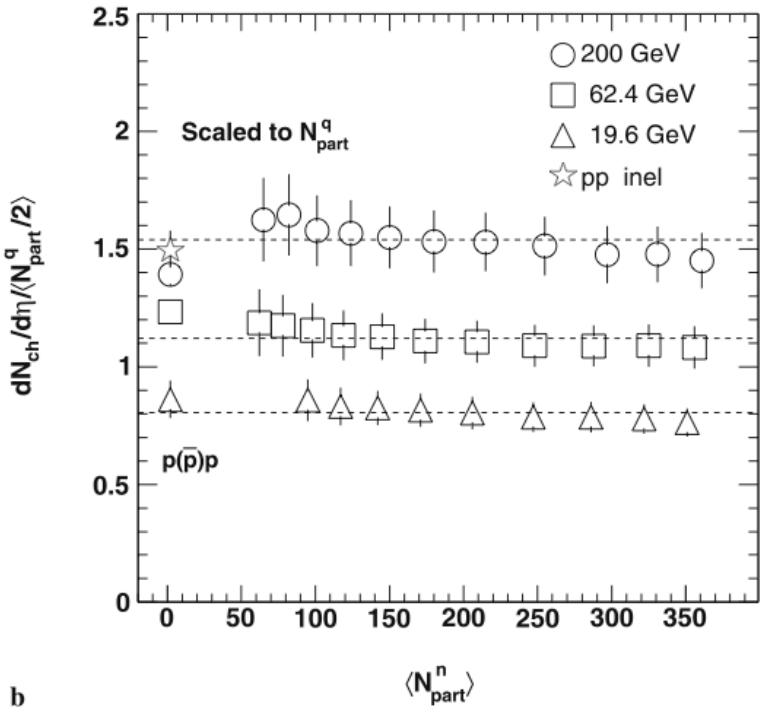


FIG. 3. (Color online) N_{ch} per nucleon and quark participant pair vs centrality. The results for quark participant pair are shown for $\sigma_{qq}=4.56$ mb (solid symbols) and $\sigma_{qq}=6$ mb (open symbols).

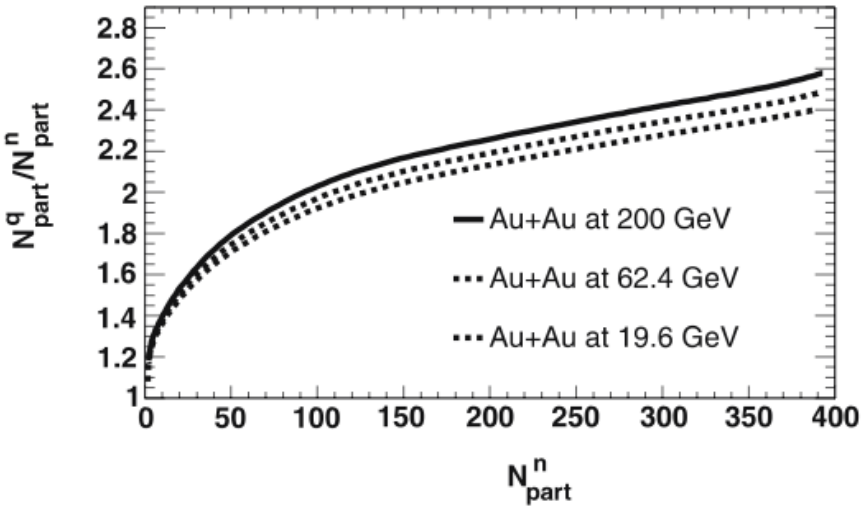
STAR: Eremin&Voloshin, PRC 67, 064905(2003)



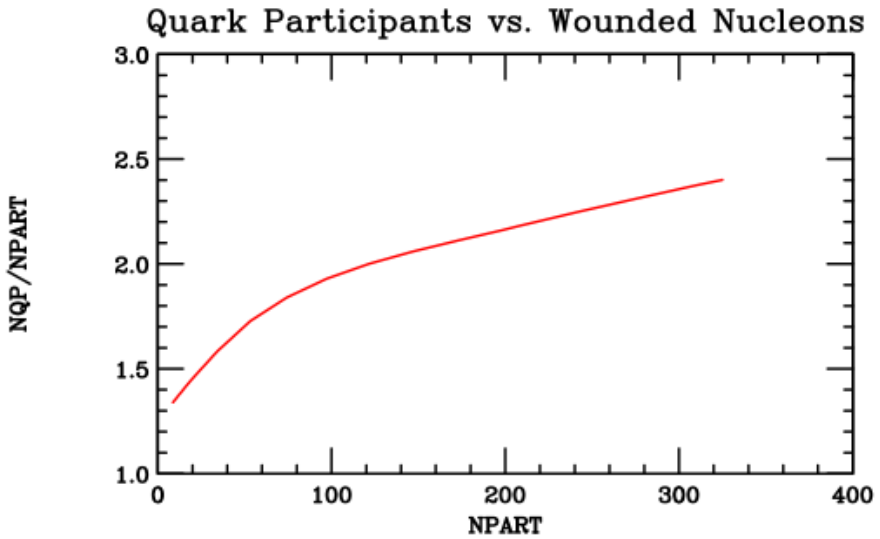
b

PHOBOS: Nouicer EPJC 49, 281 (2007)

The secret is the NQP/Npart nuclear geometry



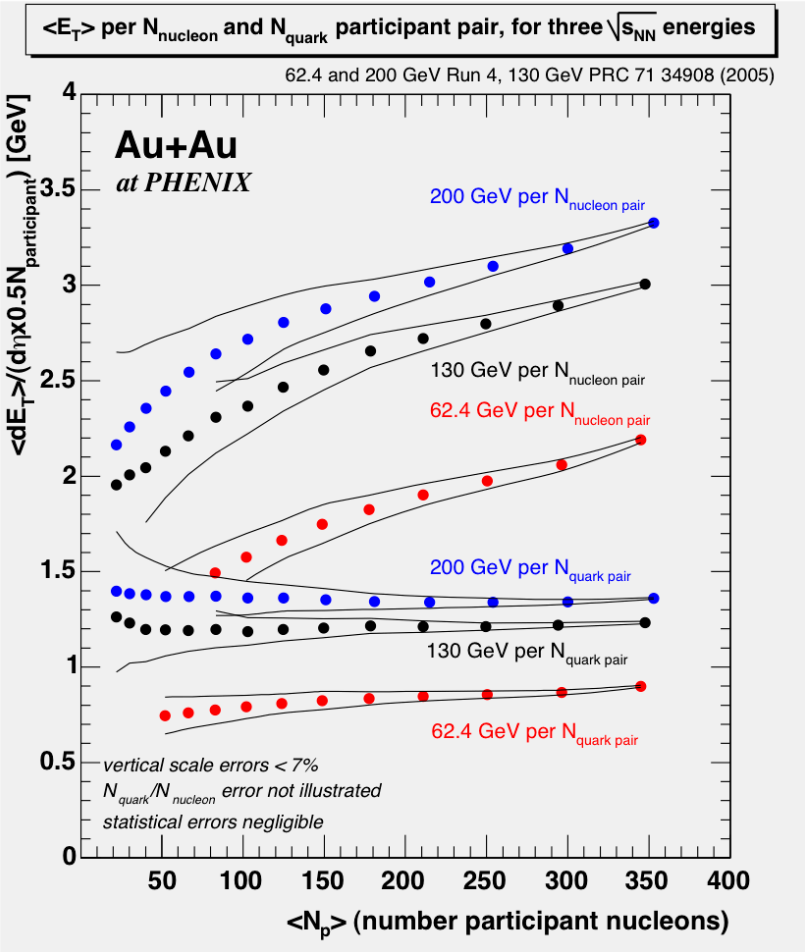
PHOBOS: Nouicer
EPJC 49, 281 (2007)



PHENIX: Glauber Model
calculation by Klaus Reygers

In the PHENIX Glauber calculation, the 3 quarks are distributed around the center of a nucleon according to the radial density distribution $\rho(r) = \rho(0)$ x exp(-ar) with $a = \sqrt{12}/R_{rms} = 4.27$ fm^{-1}, where $R_{rms} = 0.8$ fm. For application to NQP models based on quark participants, both nucleons are split into 3 quarks and the q+q cross section was first taken as 42 mb /9=4.7 mb but then adjusted to $\sigma = 9.36$ mb for q+q scattering in order to obtain a N+N $\sigma^{inel} = 42.0$ mb. In the NQP case the requirement for an inelastic collisions is to have at least one q+q collision, i.e. NQP≥ 2.

PHENIX also shows NQP model works for Au+Au from Raul Armendariz Thesis 2007



Result is presently unofficial for Nq-part but Nn-part plots agree with previous PHENIX results

Conclusion

Please accept what has been known since the mid 1980's that hard collisions contribute insignificantly to E_T and multiplicity distributions. All the data from p-p to U+U support this. The fundamental elements of particle production are quark participants as shown here. Ncoll is irrelevant

Au+Au E_T distribution for 10-15% centrality Raul Armendariz Thesis 2007