Number of Quark Participant Scaling of $dN/d\eta$ and $dE_T/d\eta$ with Centrality from the RHIC Beam Energy Scan

Jeffery T. Mitchell for the PHENIX Collaboration

XXIV QUARK MATTER DARMSTADT 2014

PHENIX

BROOKHAVEN NATIONAL LABORATORY

Estimating the Number of Quark Participants

The number of quark participants, $N_{quark-part}$, is estimated using a Glauber model.

First, nucleons are distributed using a Woods-Saxon distribution.

Second, 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 following condition:

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

The quark-quark inelastic cross section is estimated by reproducing the nucleon-nucleon inelastic cross section for nucleon-nucleon collisions. The results are tabulated below.

sqrt(s_{NN}) [GeV]	$\sigma_{nn}^{inelastic}$ [mb]	$\sigma_{qq}^{inelastic}$ [mb]
2760	64.0	18.4
200	42.3	9.36
130	39.6	8.60
62	36.0	7.08
39	34.3	6.73
27	33.2	6.35
19.6	32.5	6.12
15	32.0	6.00
11.5	31.7	5.93
7.7	31.2	5.79

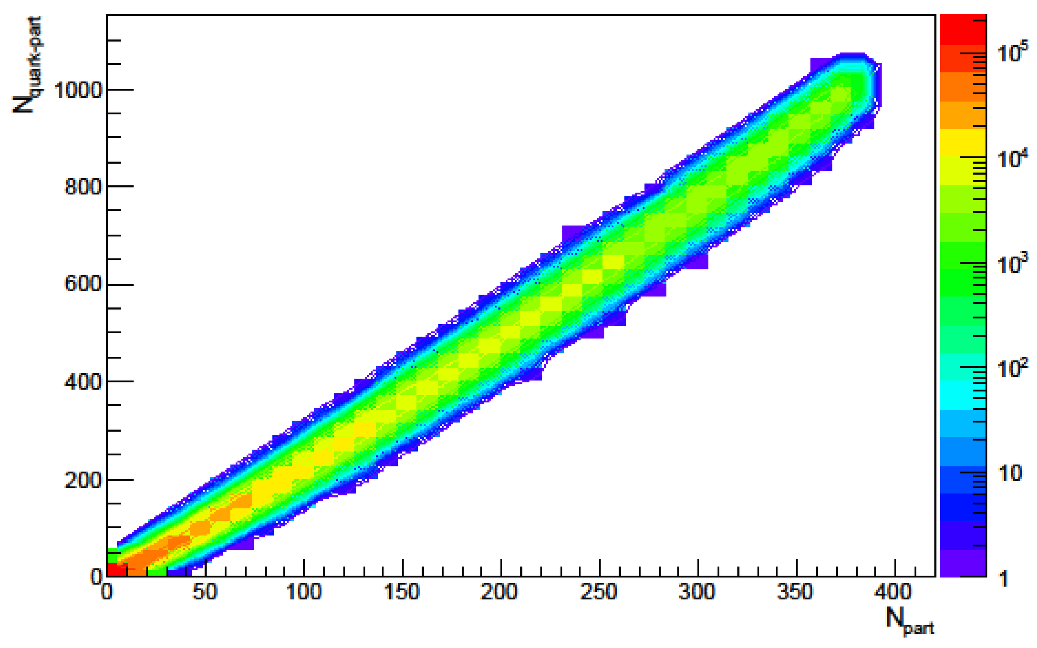


Fig. 1: The number of quark participants as a function of the number of nucleon participants from the Glauber model for 39 GeV Au+Au collisions.

Estimates of $N_{quark-part}$ and its systematic errors as a function of centrality are performed using the negative binomial distribution (NBD) sampling procedure outlined in M.L. Miller et al., Annu. Rev. Nucl. Part. Sci. 2007.57.205-243.

For ALICE estimates, the NBD parameters listed in B. Abelev et al., Phys. Rev. C88, 044909 (2013) were used. The N_{part} estimates provided by ALICE were reproduced before estimating $N_{quark-part}$.

Nucleon Participant Scaling

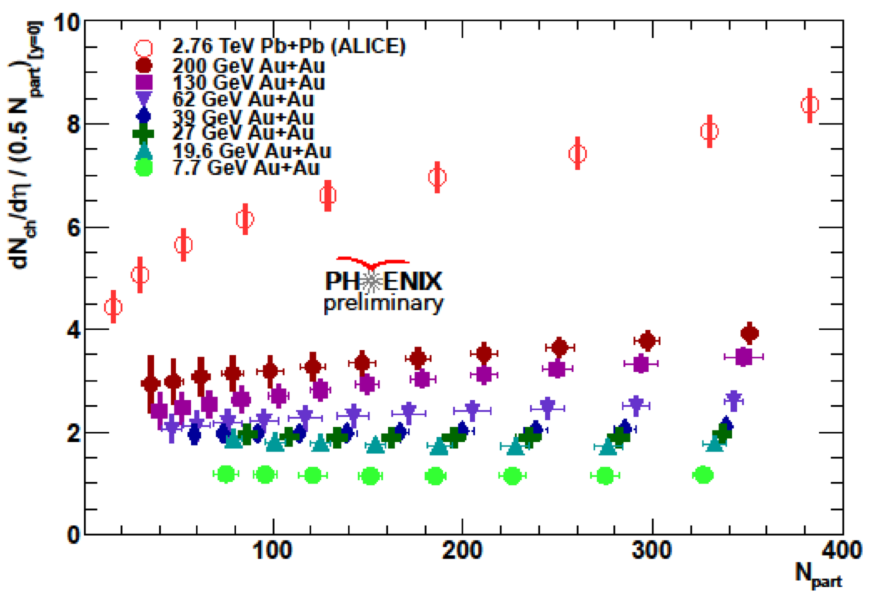


Fig. 2: $dN/d\eta$ at mid-rapidity normalized by the number of nucleon participant pairs as a function of N_{part}. The ALICE data are from K. Aamodt et al., Phys. Rev. Lett. 106, 032301 (2011).

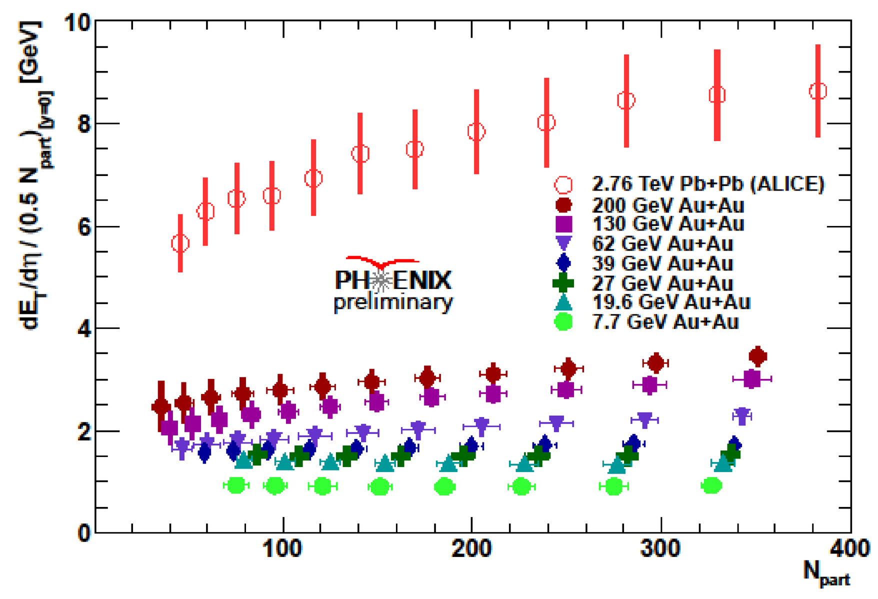


Fig. 3: $dE_T/d\eta$ at mid-rapidity normalized by the number of nucleon participant pairs as a function of N_{part}. The ALICE data are from C. Loizides et al., arXiv:1106.6324.

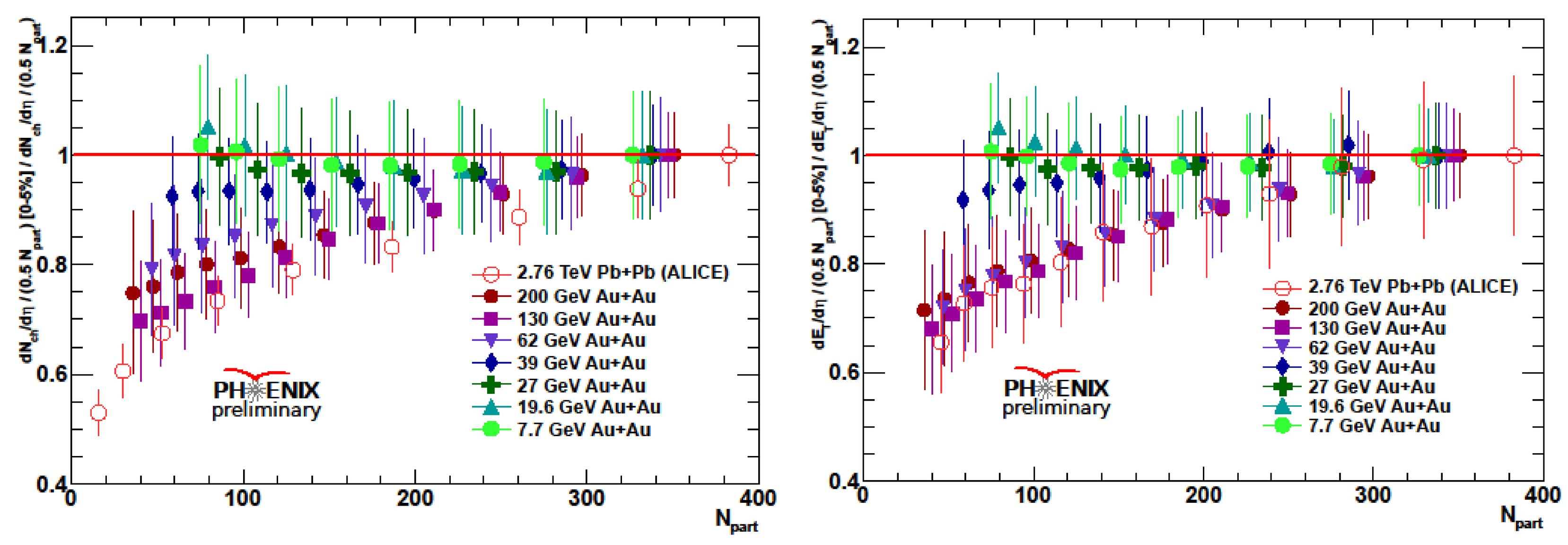


Fig. 4: The ratio of $dN/d\eta$ and $dE_T/d\eta$ at mid-rapidity normalized by the number of nucleon participant pairs to the most central value (0-5% centrality) as a function of N_{part}. The data are most consistent with nucleon participant scaling for sqrt(s_{NN}) at or below 39 GeV. The errors are the total statistical and systematic errors.

Quark Participant Scaling

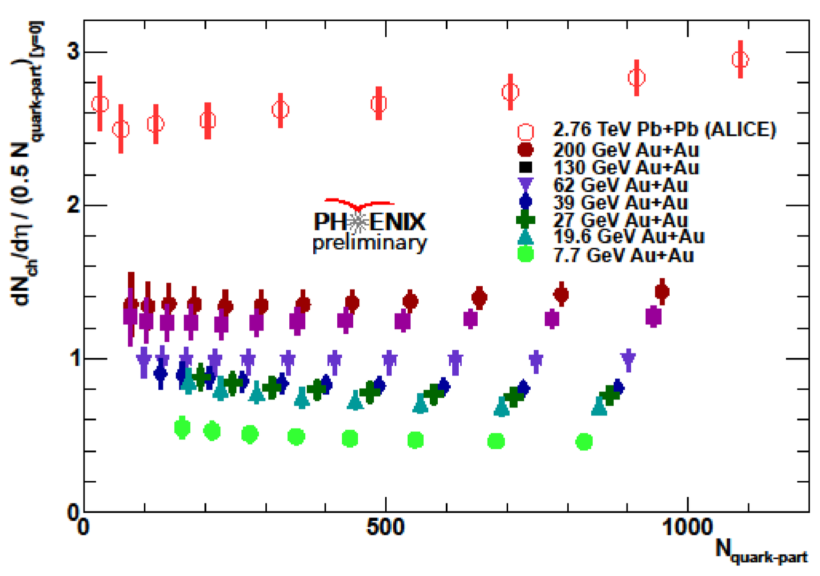


Fig. 5: $dN/d\eta$ at mid-rapidity normalized by the number of quark participant pairs as a function of N_{part}. The ALICE data are from K. Aamodt et al., Phys. Rev. Lett. 106, 032301 (2011).

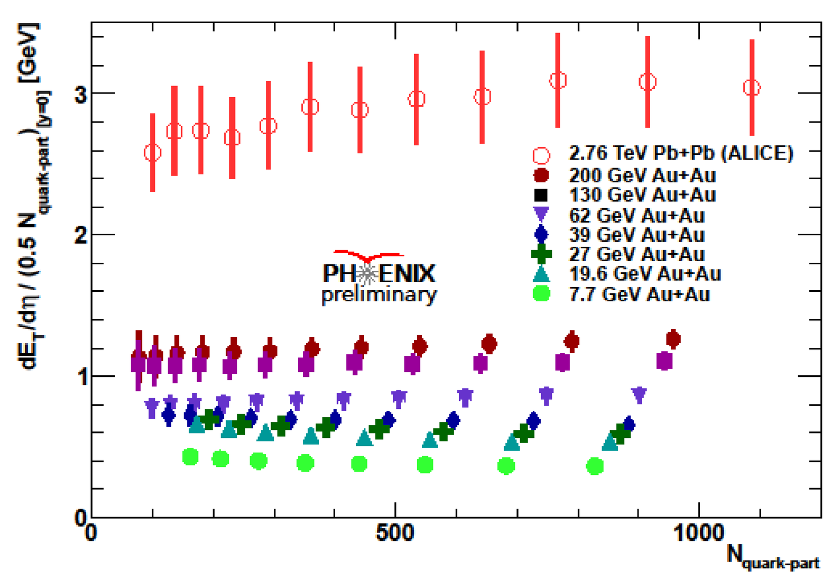


Fig. 6: $dE_T/d\eta$ at mid-rapidity normalized by the number of quark participant pairs as a function of N_{part}. The ALICE data are from C. Loizides et al., arXiv:1106.6324.

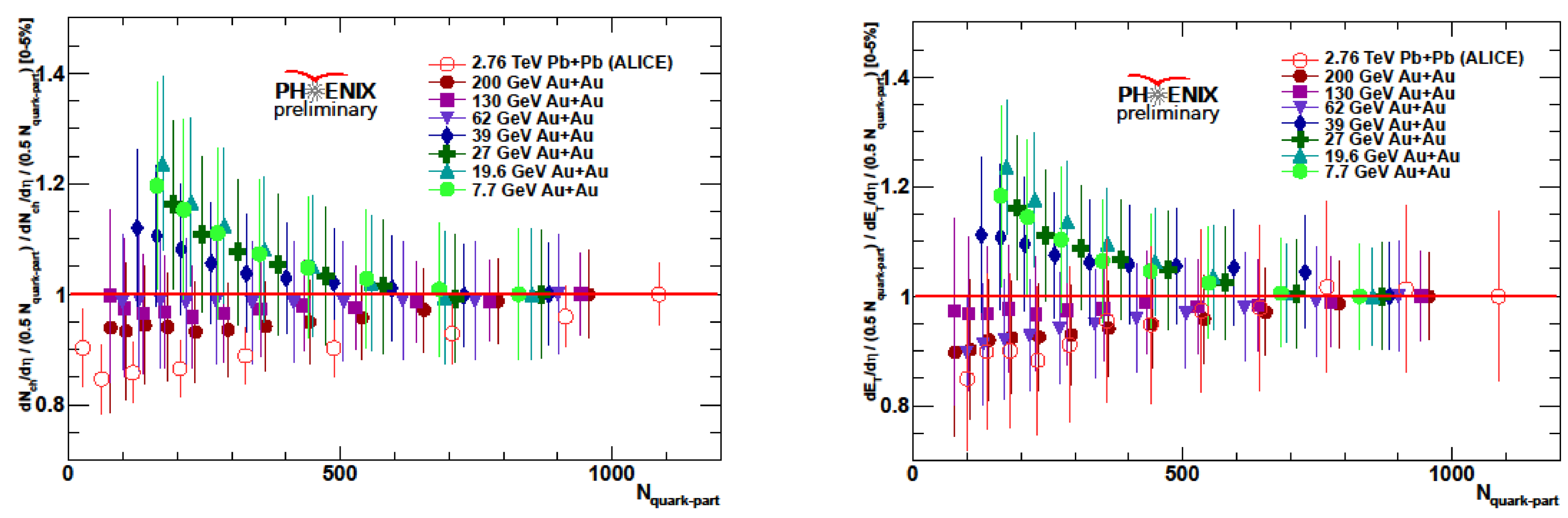
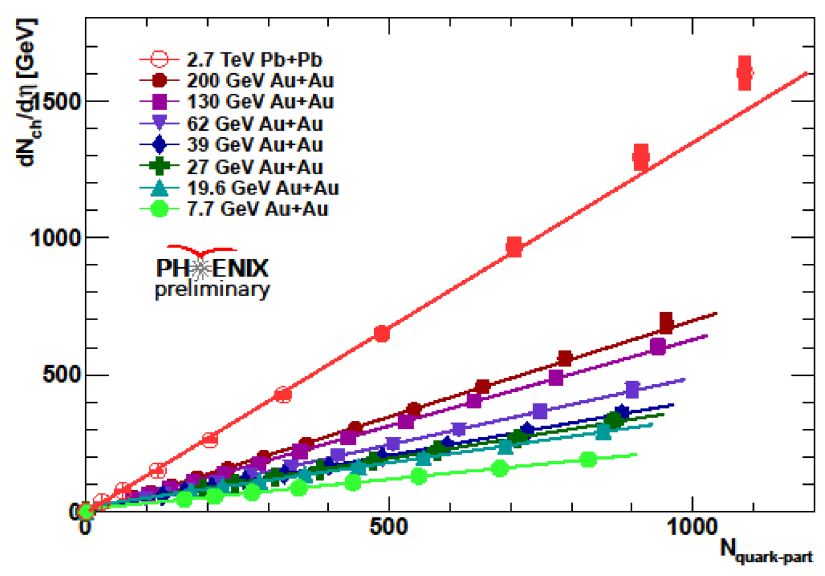


Fig. 7: The ratio of $dN/d\eta$ and $dE_T/d\eta$ at mid-rapidity normalized by the number of quark participant pairs to the most central value (0-5% centrality) as a function of N_{part}. The data are most consistent with quark participant scaling for sqrt(s_{NN}) between 39 and 200 GeV. The errors are the total statistical and systematic errors. Quark participant scaling is preferred for the ALICE data.



Fig, 8: $dN/d\eta$ at mid-rapidity as a function of N_{part}. The solid lines are linear fits to the data.

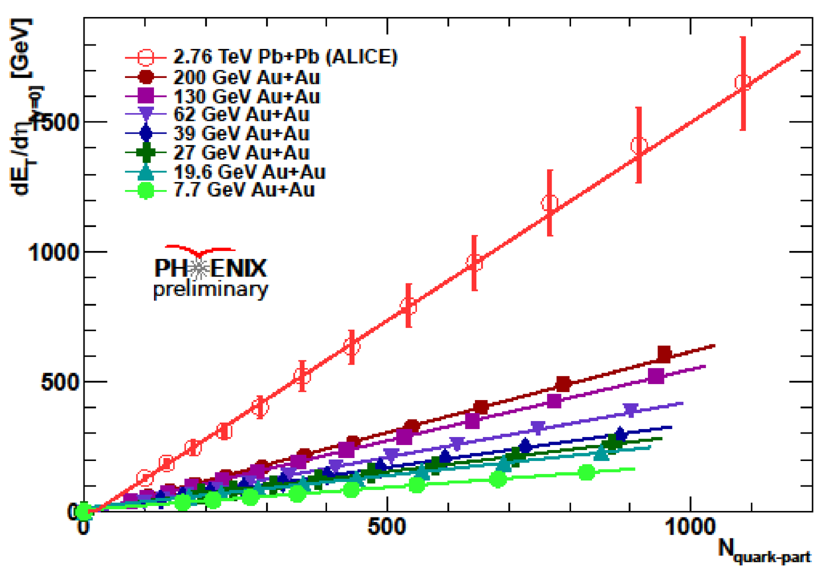


Fig. 9: $dE_T/d\eta$ at mid-rapidity as a function of N_{part}. The solid lines are linear fits to the data.

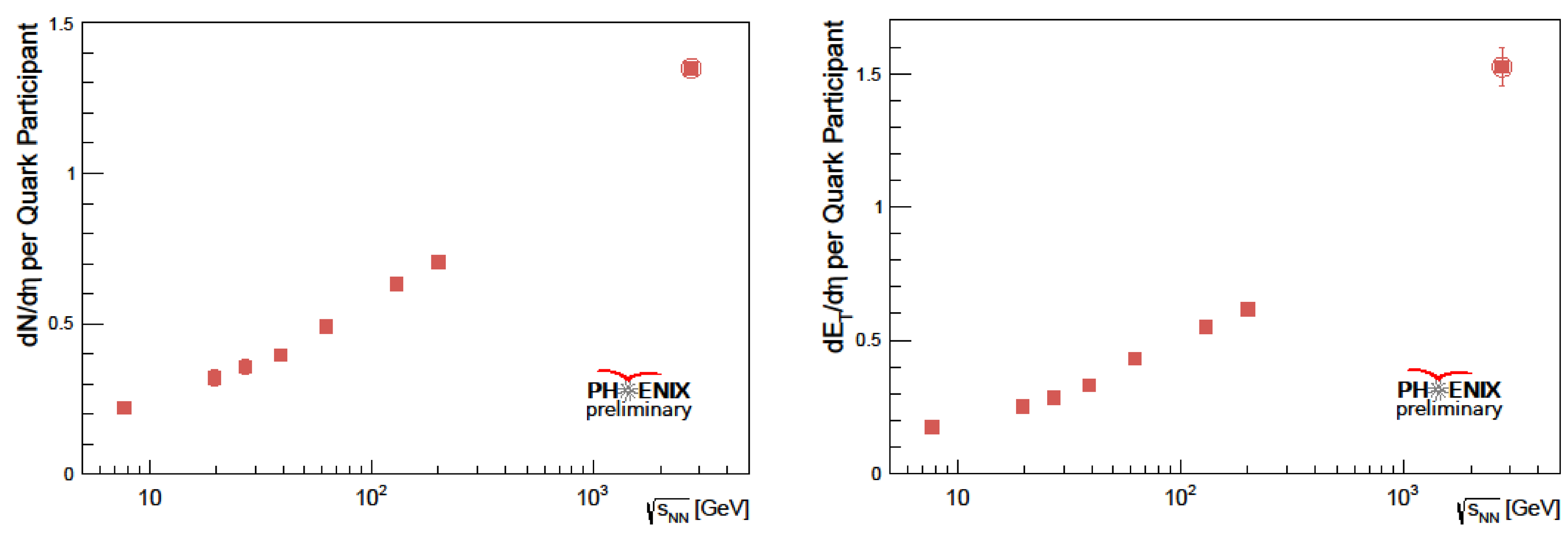


Fig. 10: $dN/d\eta$ and $dE_T/d\eta$ per quark participant as a function of sqrt(s_{NN}). The data points are the slopes of the linear fits on the plots to the left. Both sets of data are well described by a 2nd order polynomial as follows: $dN/d\eta/N_{quark-part} = 0.089 + 0.027x + 0.0167*x*x$ and $dE_T/d\eta/N_{quark-part} = 0.19 - 0.066*x + 0.029*x*x$, where $x = \ln \text{sqrt}(s_{NN})$.

Conclusions

Quark participant scaling has been previously demonstrated to work well for $dN/d\eta$ at 200 and 130 GeV (see S. Eremin and S. Voloshin, Phys. Rev. C67, 064905 (2003) and R. Nouicer, Eur. Phys. J. C49, 281 (2007)). This analysis investigates the onset of deconfinement by examining quark participant scaling for both $dN/d\eta$ and $dE_T/d\eta$ from the RHIC beam energy scan. Nucleon participant scaling holds best at or below sqrt(s_{NN}) = 39 GeV. Quark participant scaling holds best at or above sqrt(s_{NN})=39 GeV. ALICE data prefer quark participant scaling.