Transverse Energy and Particle Production in $\sqrt{s_{NN}} = 130$ GeV Au + Au Collisions measured by the PHENIX −Experiment

Nuclear Physics Spring Meeting

Münster 2002

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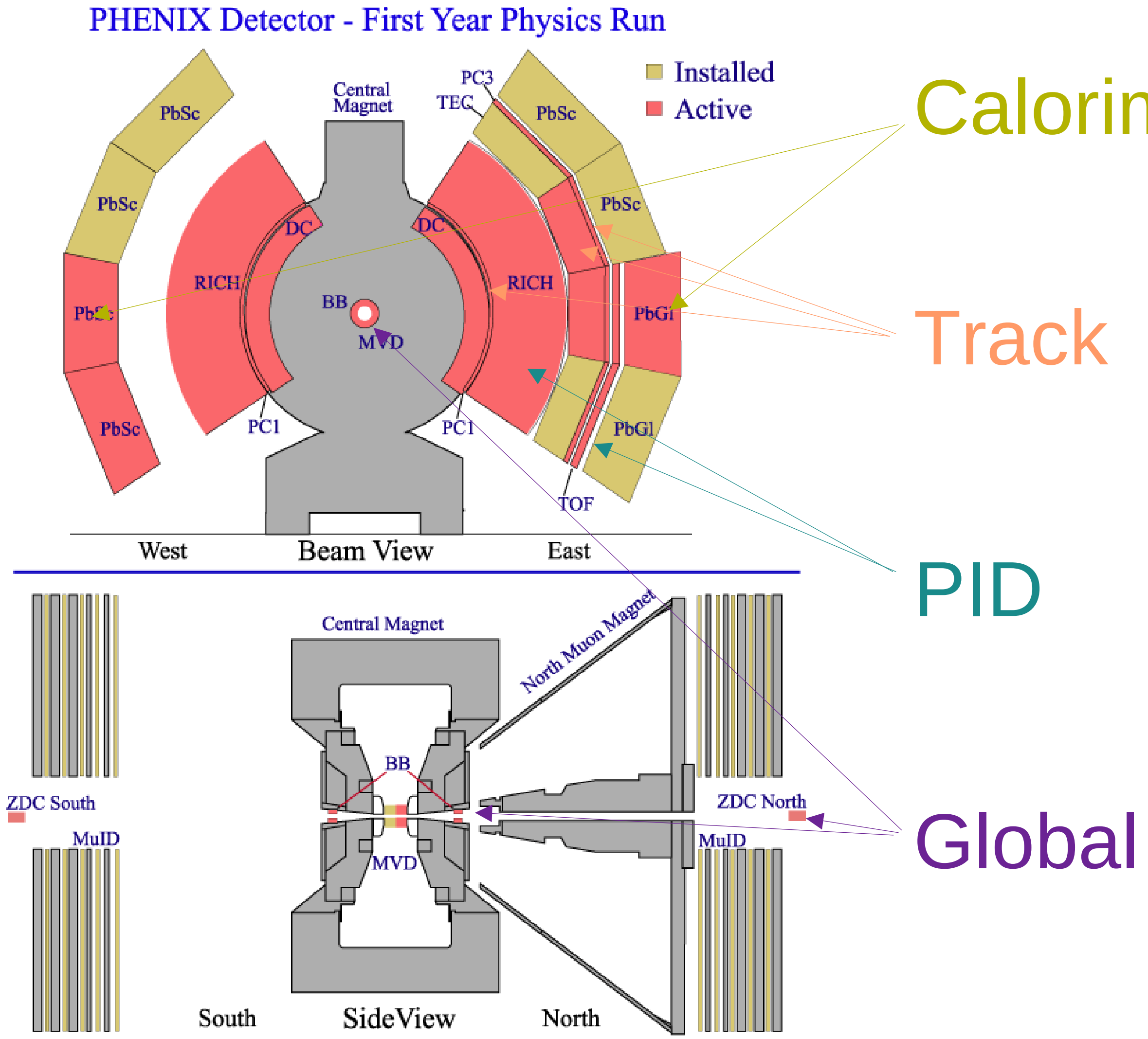
Transverse Energy

- Definition $E_T := \sum_i E_i \sin(\theta_i)$
- Global event characterization
- Information about initial state :
  - Energy density:

$$\epsilon_{Bj} = \frac{dE_T}{dy} \frac{1}{\tau_0 \pi R^2} \xrightarrow{\text{experimentally}} \epsilon_{Bj} \tau_0 = \frac{dE_T}{dy} \frac{1}{\pi R^2}$$

- Collision dynamics:
  - Centrality dependence
  - Scaling with √s

Experimental Setup



First Year Collisions at RHIC: $\sqrt{s_{NN}} = 130$ GeV

E_T Measurement

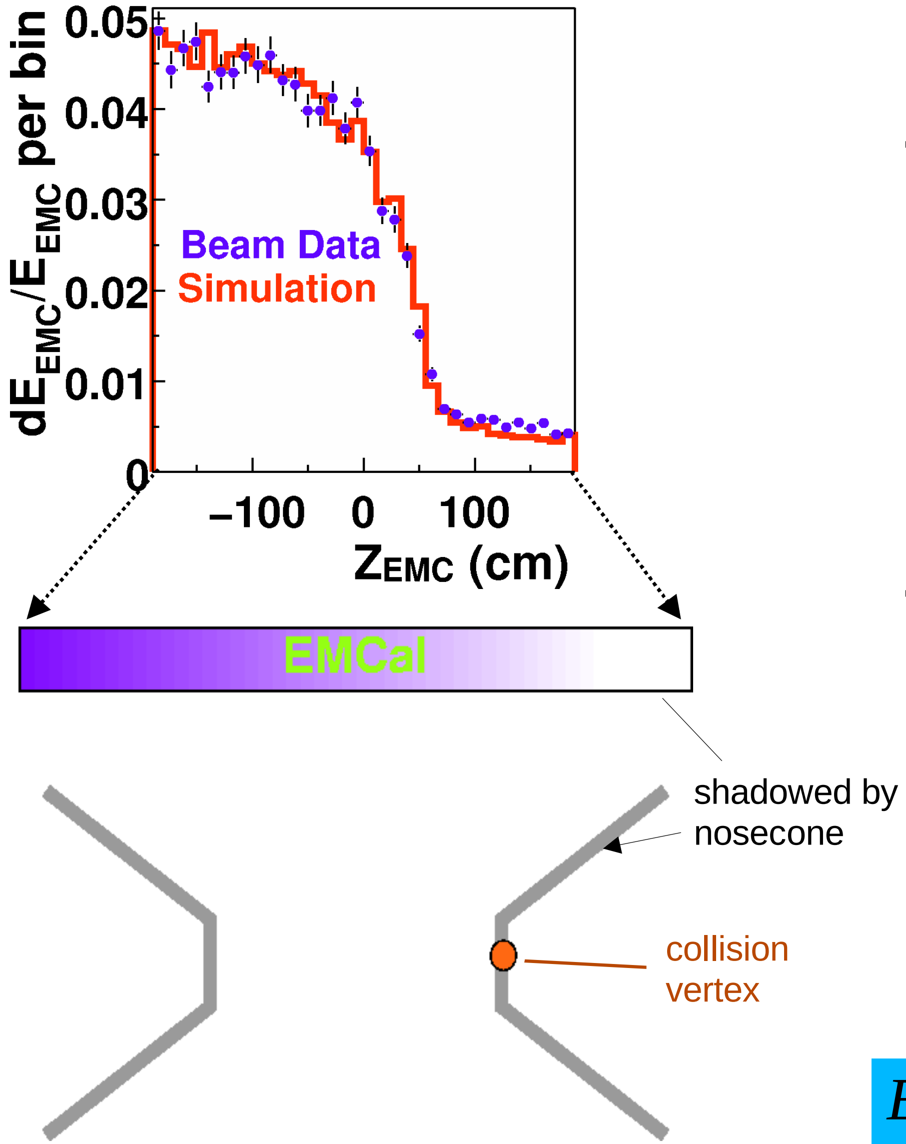
- 2 Sectors Lead−Scintillator sandwich calorimeter
  - $|\eta| \leq 0.38$
  - $\Delta\phi = 44.4°$
- Convention
  - $E_T := \sum_i E_i \sin(\theta_i)$
    - $E_i = E_{kin}$ for nucleons
    - $E_i = E_{total}$ else

important for comparisons

- Corrections needed for
  - Geometrical acceptance
  - Detector response
  - Background
  - Other sources of energy loss

$\Rightarrow$ Detailed simulation (HIJING + GEANT)

Simulation of the EMCal



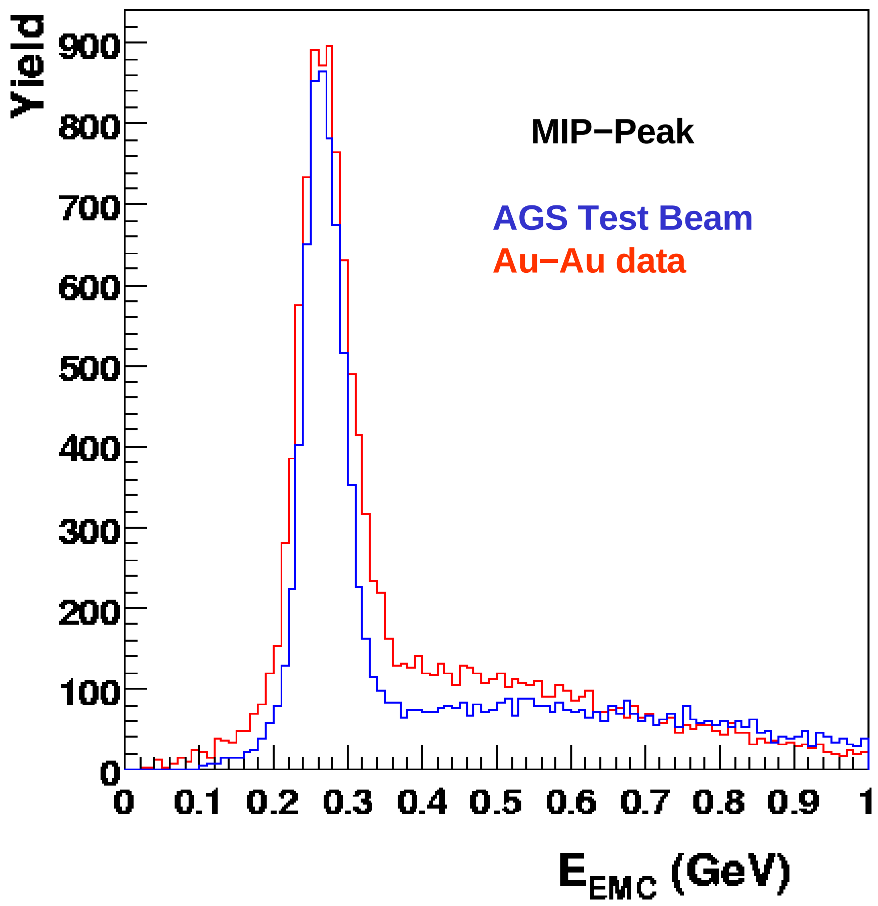
- One test for simulation:
  - Reconstruction of shadowed collisions
  - Good agreement with real data
- Correction factors
  - Detector response etc.

  $\Rightarrow$ k = 1.17 $\pm$ 0.01
  - Geometrical acceptance

  $\Rightarrow$ α_{geo} = 10.6

$$E_T(\Delta\eta=1, \Delta\phi=2\pi)=\alpha_{geo}\, k\, E_T(Raw)$$

Systematical Errors

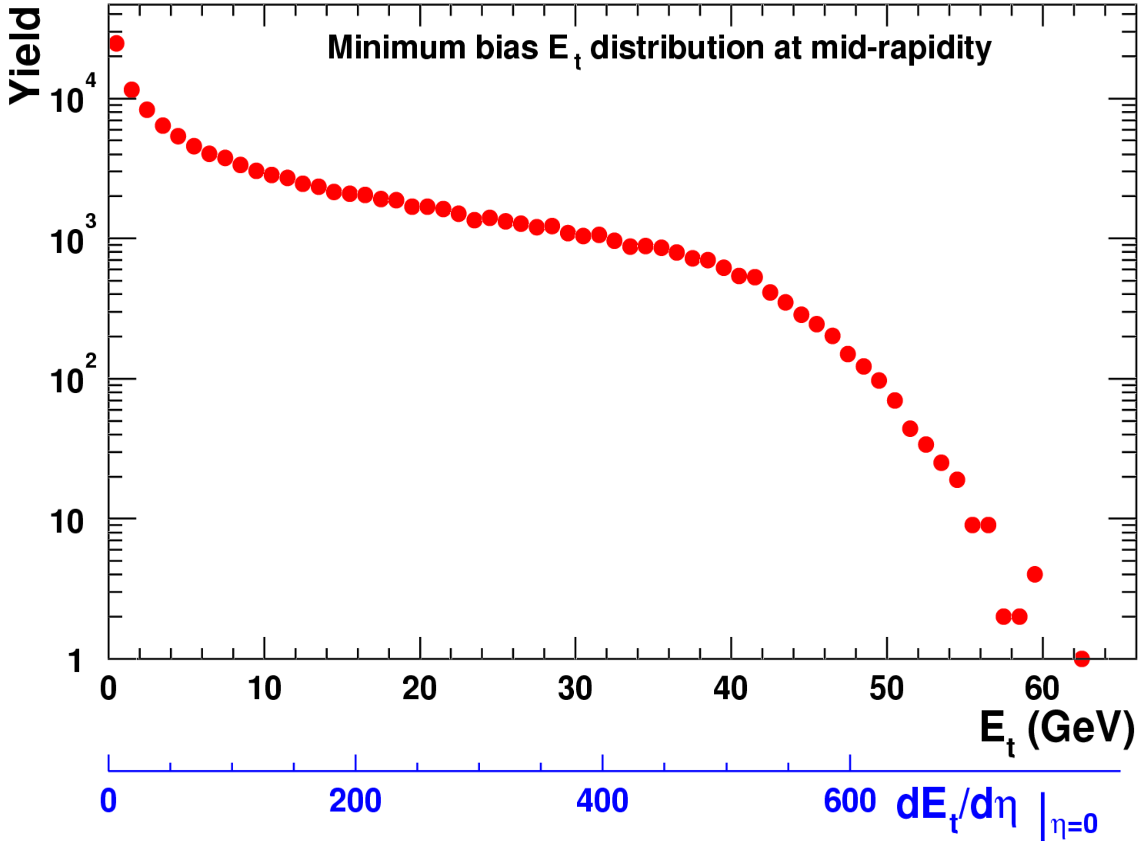


- Check Calibration with
  - MIP peak
  - Reconstructed π^0 mass
  - E/p matching (RICH)

  $\Rightarrow$ Error < 1.5 %
- Check Simulation with
  - Different particle compositions
  - Different p_T−slope parameters

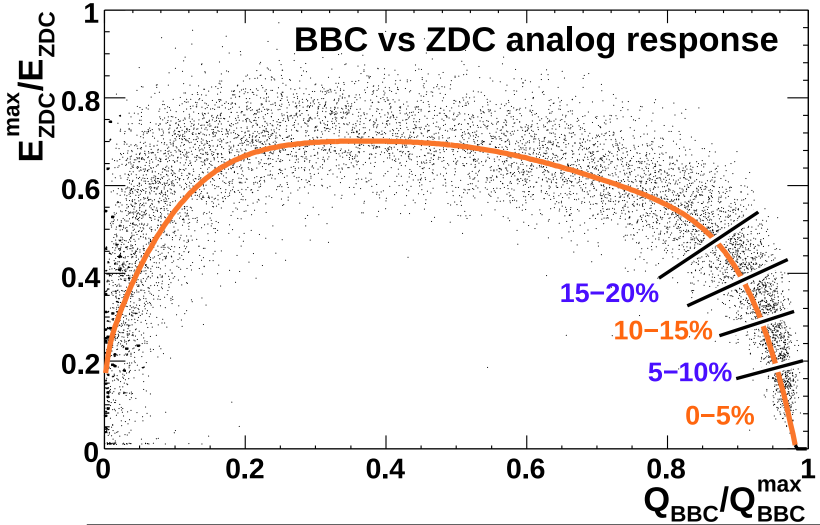
  $\Rightarrow$ Error < 3 %

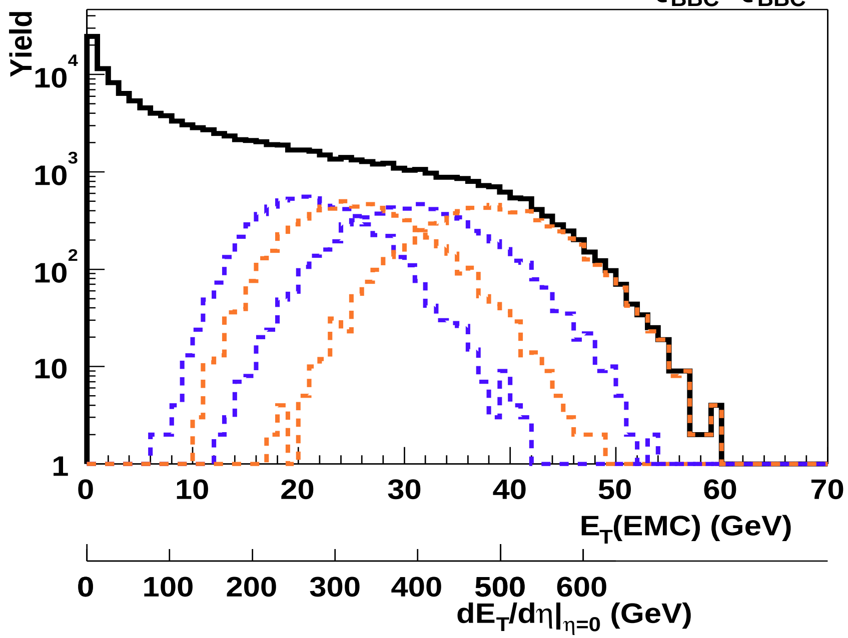
Minimum −Bias E_T−Distribution



$$E_T(\Delta\eta=1,\Delta\phi=2\pi)=\alpha_{geo}\,k\,E_T(Raw)$$

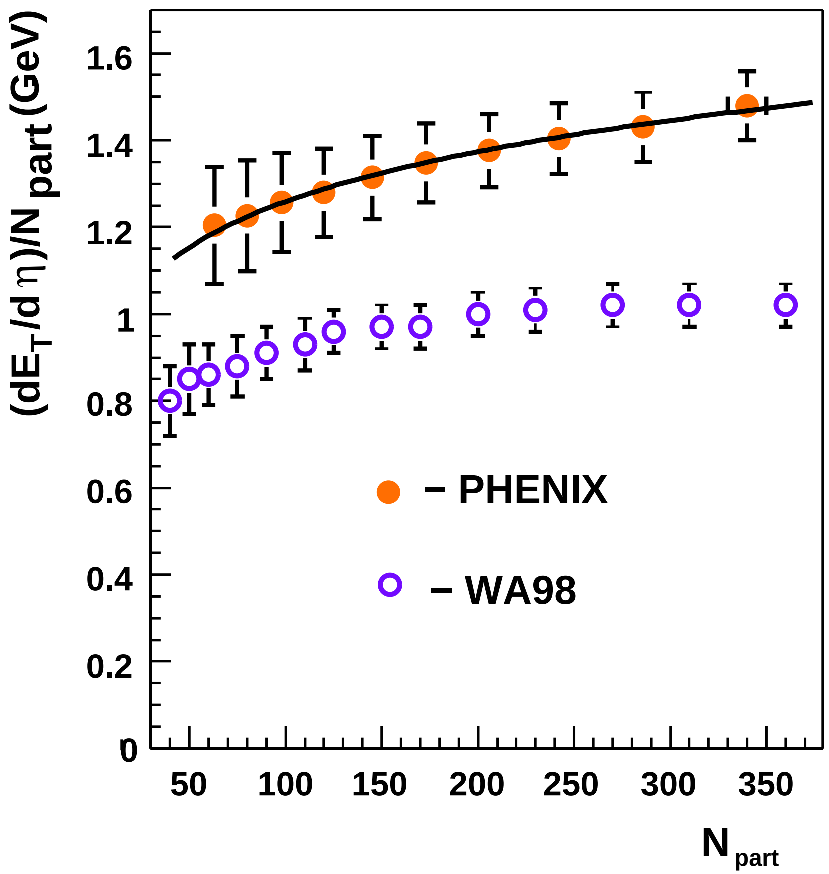
Centrality Selection in PHENIX





- BBC Trigger
  - Multiplicity
  - $\eta = 3 - 3.9$
  - (92 ± 2) % of $\sigma_{Au-Au} = 7.2$ b
- ZDC Trigger
  - Nuclear interaction and Coulomb dissociation
  - $|\eta| > 6$
  - 97.8% of BBC satisfy ZDC

Scaling with N_{part}



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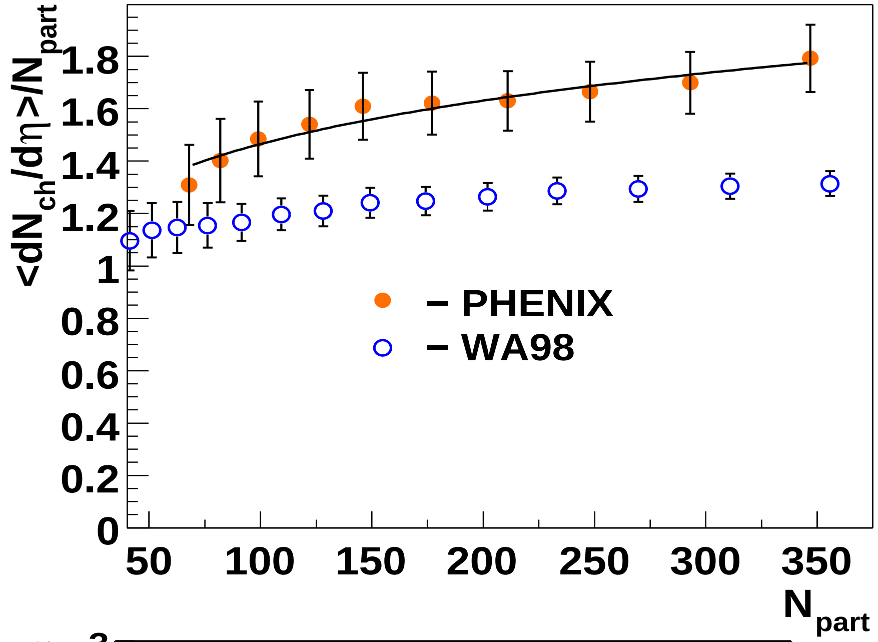
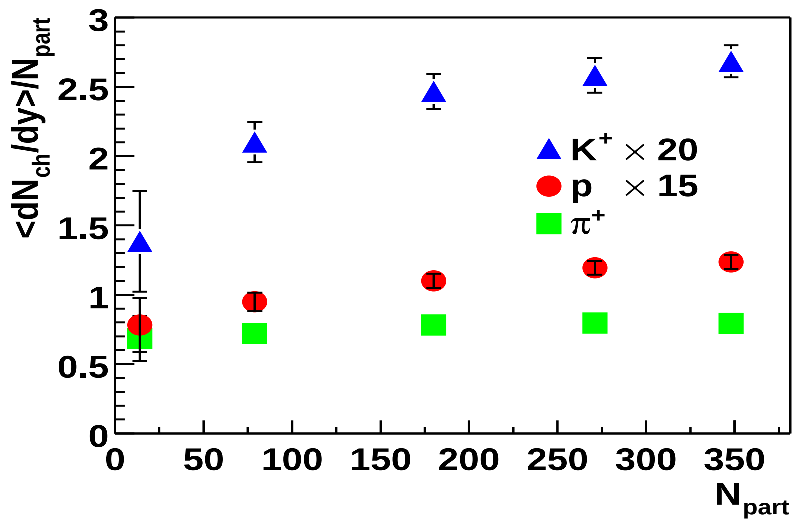
- N_{part} from Glauber Modell
- $\langle dE_T/d\eta \rangle \propto N^{\alpha}_{part}$
  - PHENIX: $\alpha = 1.13 \pm 0.05$
  - Compare WA98:
    - $\sqrt{s_{NN}} = 17.2$ GeV
    - $\alpha = 1.08 \pm 0.06$
- E_T−density @ $\eta \approx 0$:
  - ~ 40 % larger than at SPS
- Energy−density (2 % most central):
  - $\varepsilon_{Bj}\tau \approx 4.6$ GeV/fm^2
  - ~ 60 % larger than at SPS

Scaling of Particle Production with N_{part}





- $<dN_{ch}/d\eta> \propto N^{\alpha}_{part}$
- Shows similar scaling with N_{part} as $<dE_T/d\eta>$
  - PHENIX: $\alpha = 1.16 \pm 0.04$
  - WA98:
    - $\alpha = 1.07 \pm 0.04$
- Identified hadrons:
  - Enhancement of p and K compared to π

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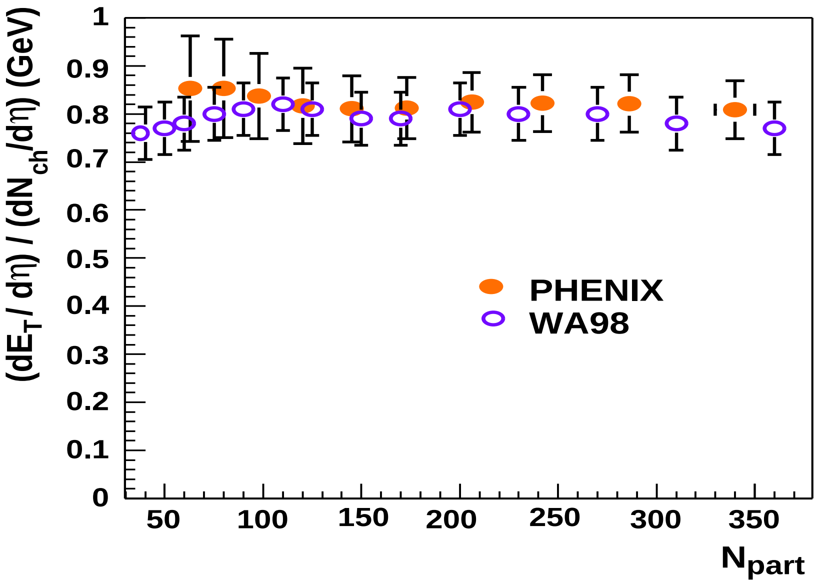
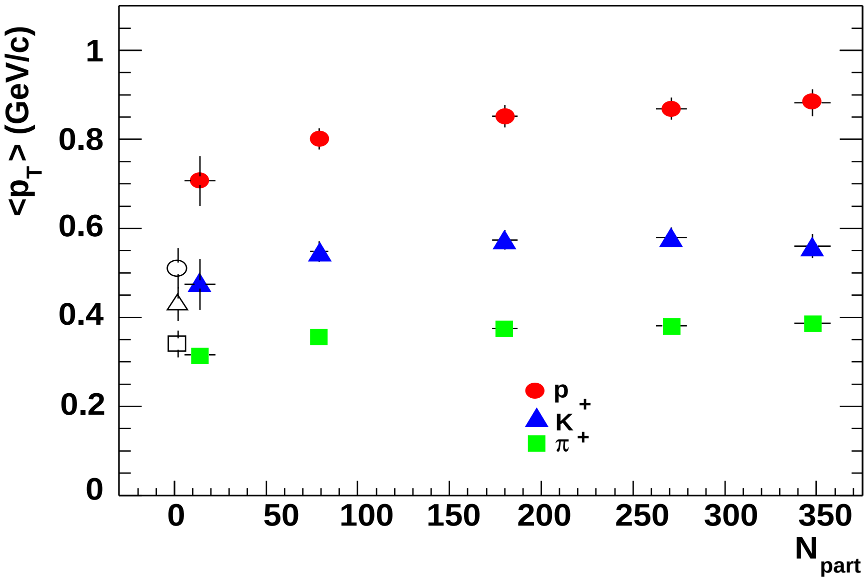
Mean Particle Energies





- E_T per charged particle:
  - No obvious centrality dependence
  - RHIC comparable to SPS

  ⇒ Higher energy density due to higher multiplicity
- $<p_T>$:
  - Rise from peripheral
  - Proton (and antiproton) larger than in p+p

  ⇒ Nuclear effects important even at small N_{part}

Summary

- Measurement of E_T at midrapidity for $\sqrt{s_{NN}} = 130$ GeV
  - ~ 40 % increase in $\langle dE_T/d\eta \rangle$ compared to SPS
  - Increase with centrality of $\langle dE_T/d\eta \rangle$ stronger than at SPS
  - Centrality independence of dE_T/dN_{ch} and similar for SPS and RHIC energies
- Identified Hadrons
  - Yield for kaons and protons show larger increase with centralitiy than pions
  - $\langle p_T \rangle$ rises from most peripheral to central