P_t Spectra of Identified Hadrons Measured with the PHENIX experiment at RHIC

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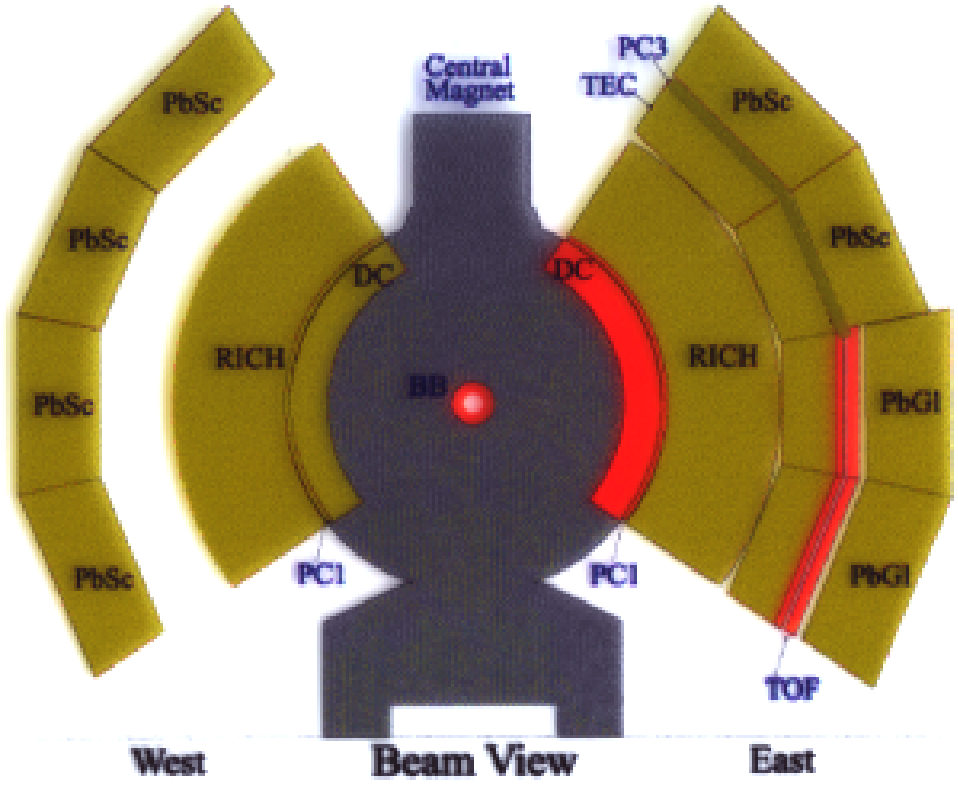
for the PHENIX collaboration

- **The detector**
- **Hadron identification**
- **Corrections to raw distributions**
- **M_t and P_t distributions - minimum bias and as a function of centrality**
- **T_{eff} and $< p_t >$ versus N_{part}**

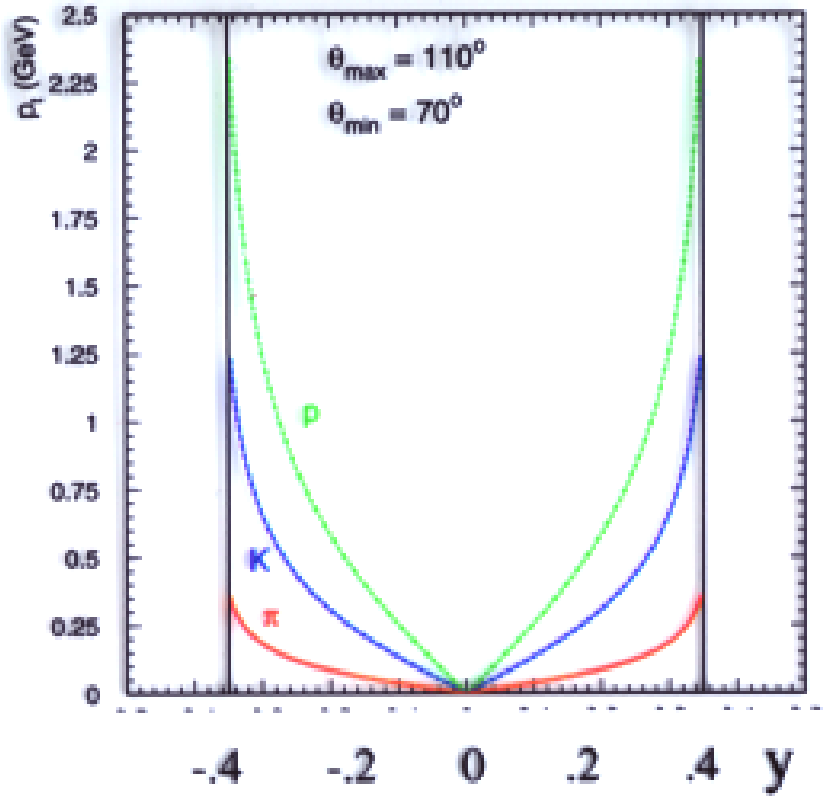
The PHENIX detector



Hadron identification

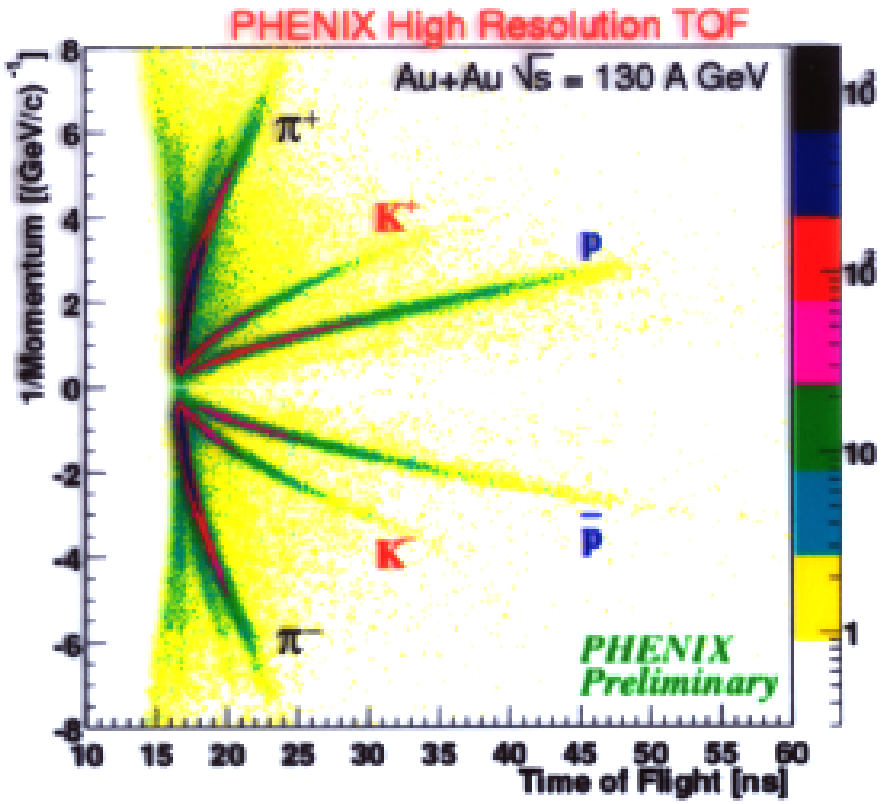
- drift chamber (DC)
- Pad chamber 1 (PC1)
- Time-of-flight (TOF)
- Beam-beam counters (BBC)

PHENIX acceptance



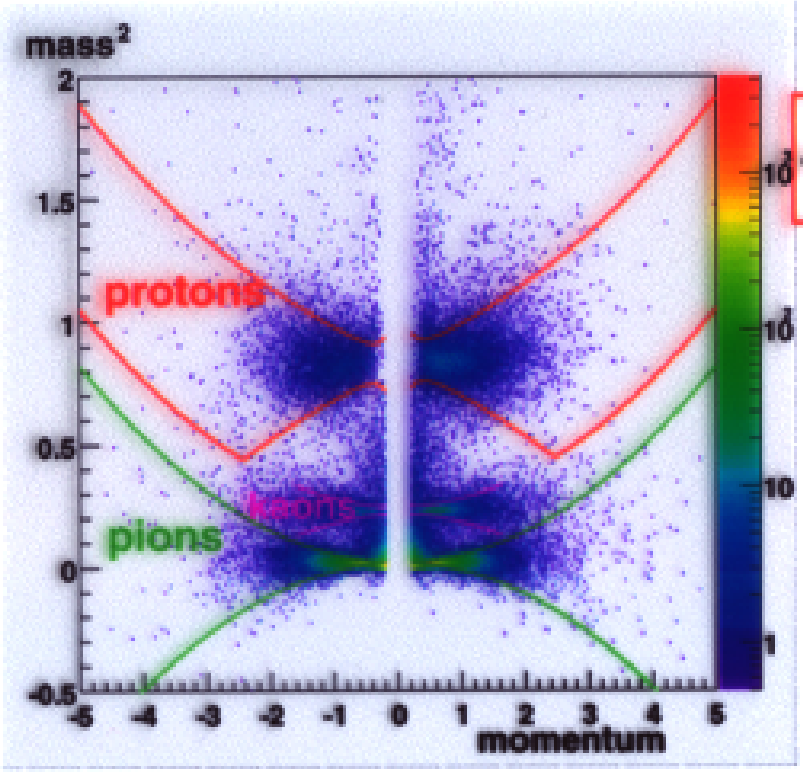
- **Tracking**
  - $\Delta\eta = 0.8$
  - $\Delta\phi = 180$ **deg**
- **Time-of-flight**
  - $\Delta\eta = 0.7$
  - $\Delta\phi = 45$ **deg**

Hadron Identification



- **Tracking system: drift chamber , Pad chamber**
  - **momentum measurement**
  - **path length to TOF detector**
- **Timing system**
  - **beam-beam counters - start time**
  - **Time-of-flight counters - stop time**

Particle Id Cuts



- **PID bands defined in mass² vs momentum space**

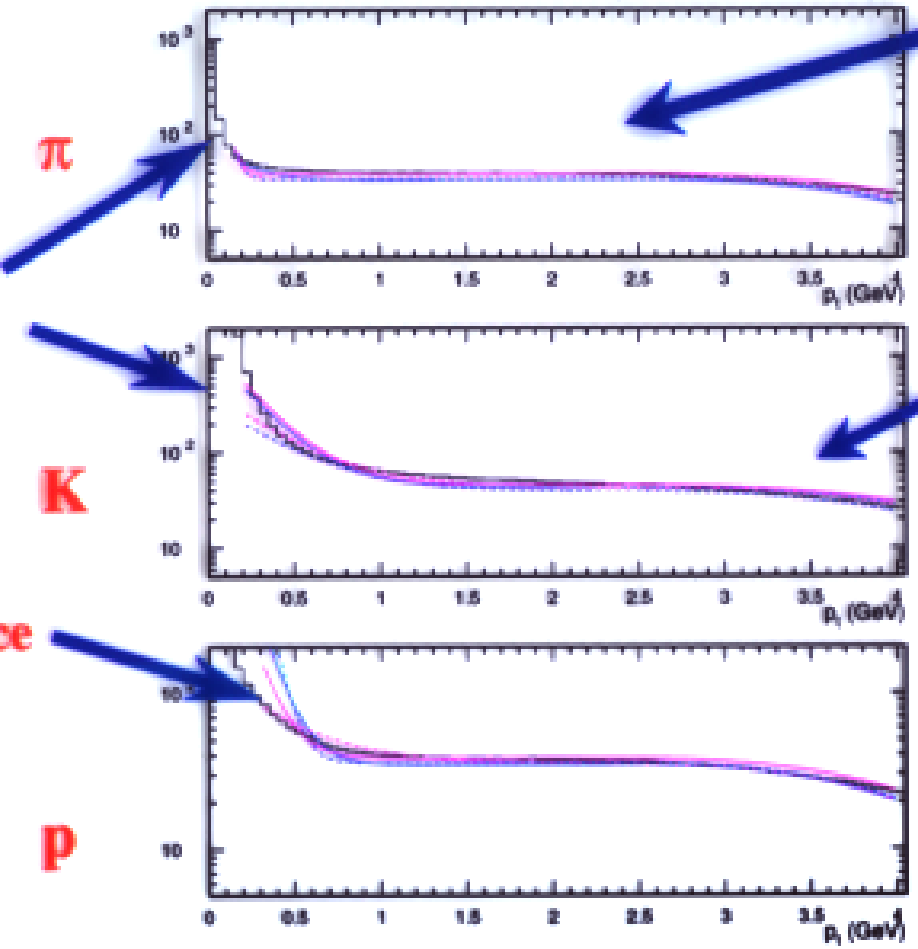
$$\sigma^2_{m^2} = \frac{\sigma_\alpha^2}{K_1^2}\left(4m^4p^2\right) + \frac{\sigma_{ms}^2}{K_1^2}\left(4m^4\left(1+\frac{m^2}{p^2}\right)\right) + \frac{\sigma_t^2c^2}{K_1^2}\left(4p^2\left(m^2+p^2\right)\right)$$

σ_t = 120±5 ps, σ_α=2.8±0.2 mrad,

σ_{ms}=0.6±0.1 mrad

- **K cut off at 1.6 GeV/c**
- **π cut off at 2.2 GeV/c**
- **protons - up to 5 GeV/c**

Corrections
based on single particle Monte Carlo



Overall scale

- acceptance
- dead areas
- tracking efficiency

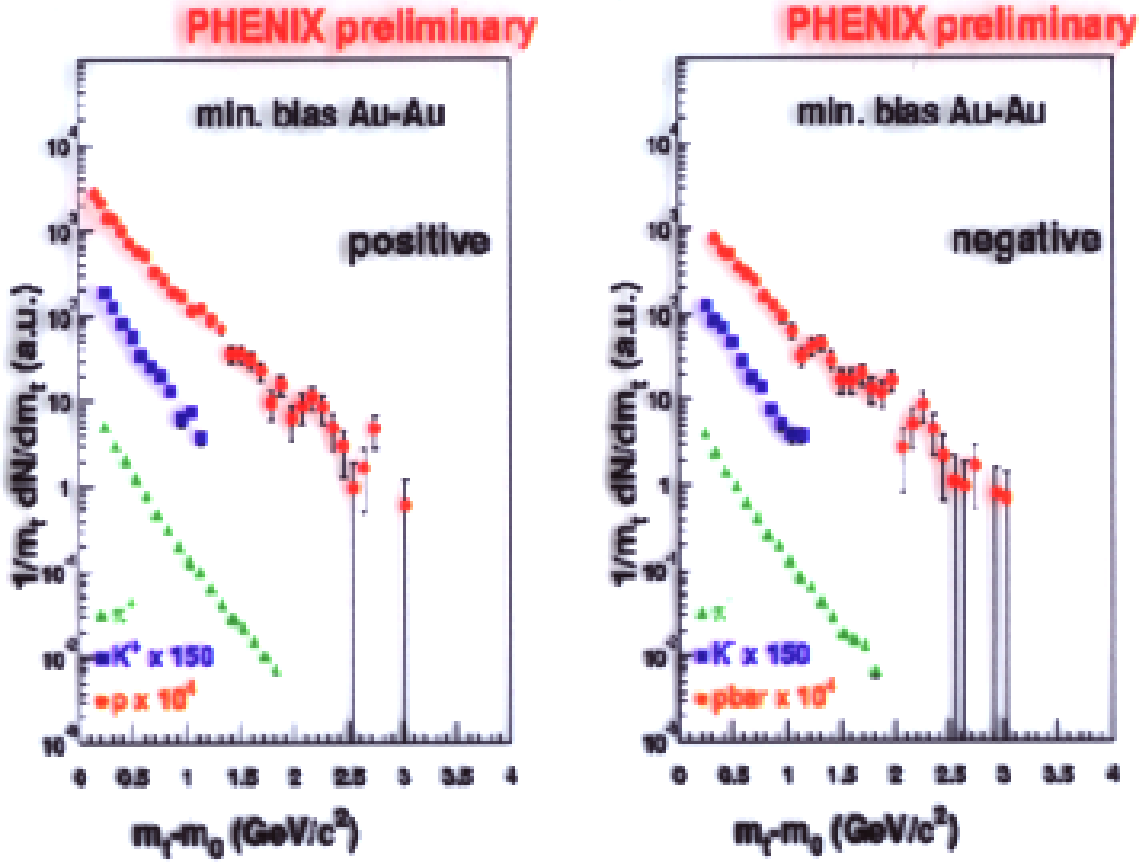
Momentum resolution

Multiplicity dependence- small:

studied by track embedding into real events

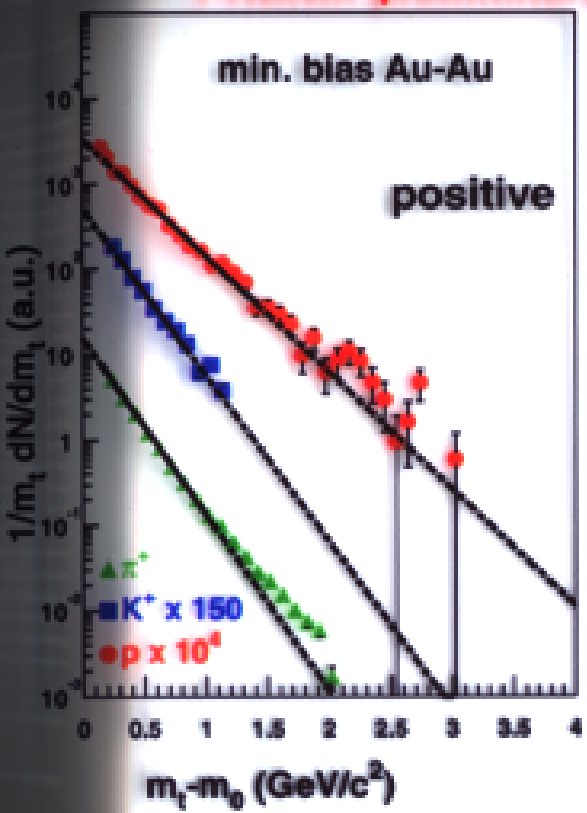
PHENIX

Minimum Bias m_t distributions

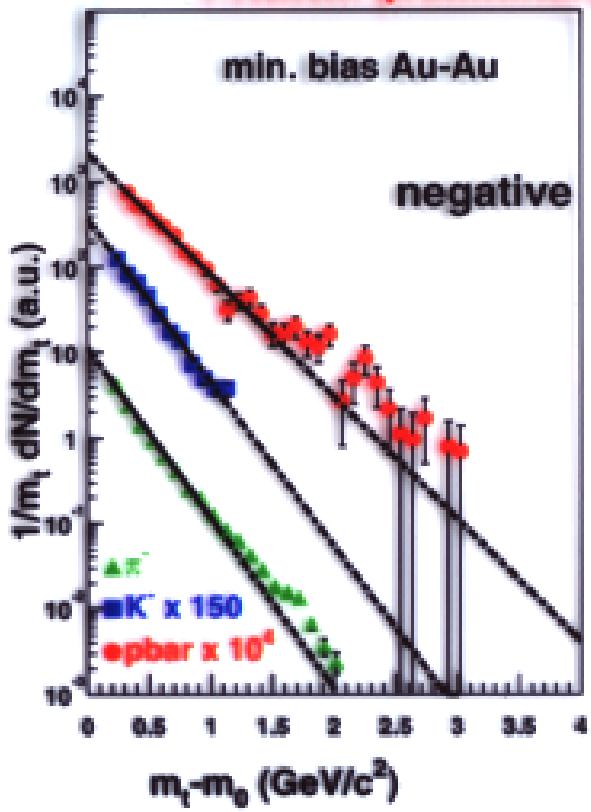


Minimum Bias m_t distributions

PHENIX preliminary



PHENIX preliminary



Fit ranges in pt :

pions:

$0.3 < p_t < 1.0$(GeV/c)

kaons:

$0.6 < p_t < 1.0$ (GeV/c)

protons:

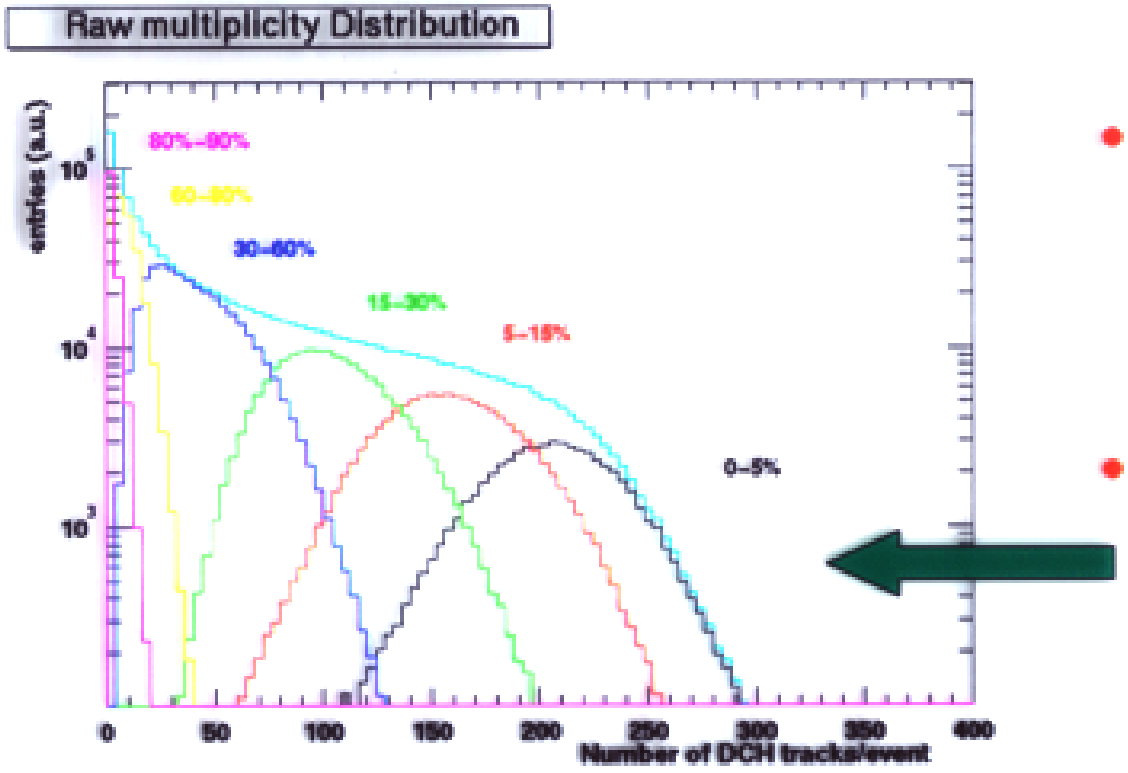
$0.8 < p_t < 2.2$ (GeV/c)

$0.8 < p_t < 3$ (GeV/c)

anti-protons:

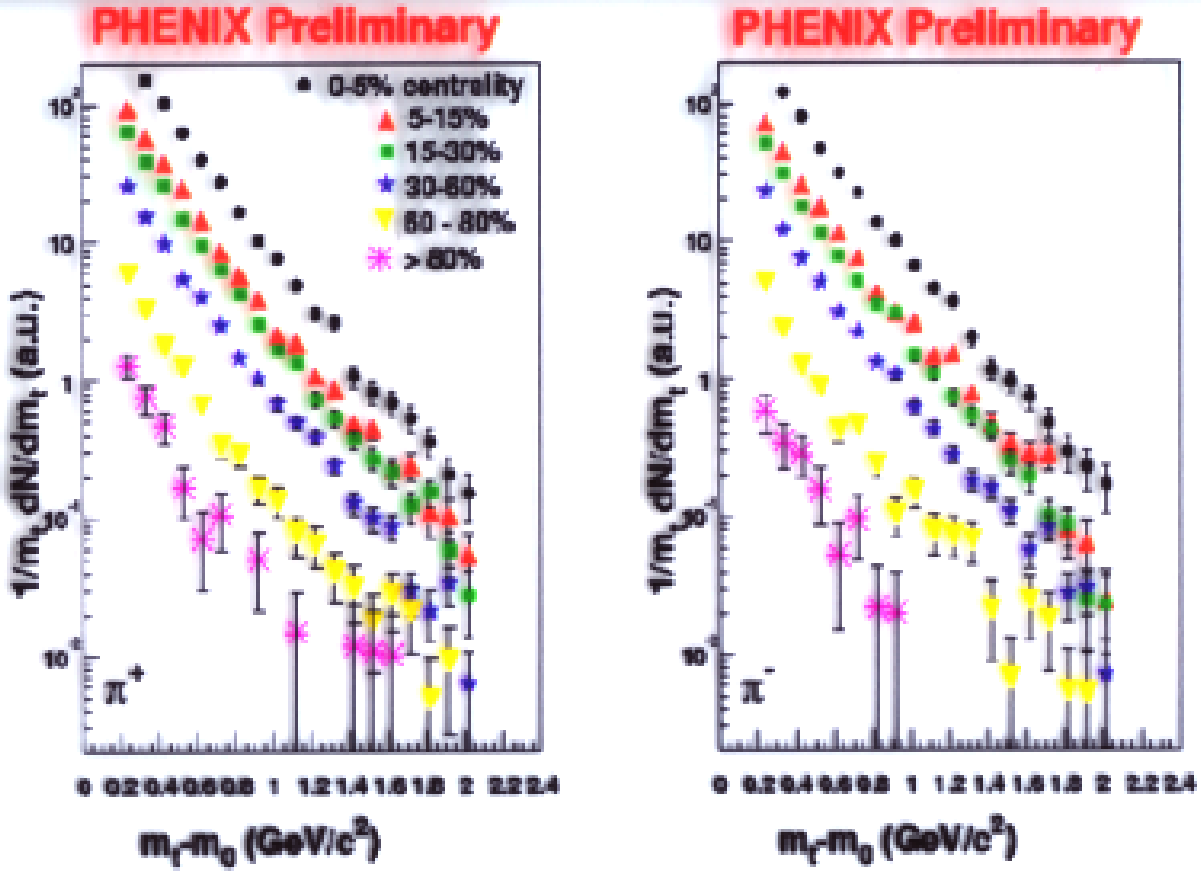
$0.8 < p_t < 2.2$ (GeV/c)

Centrality Selection

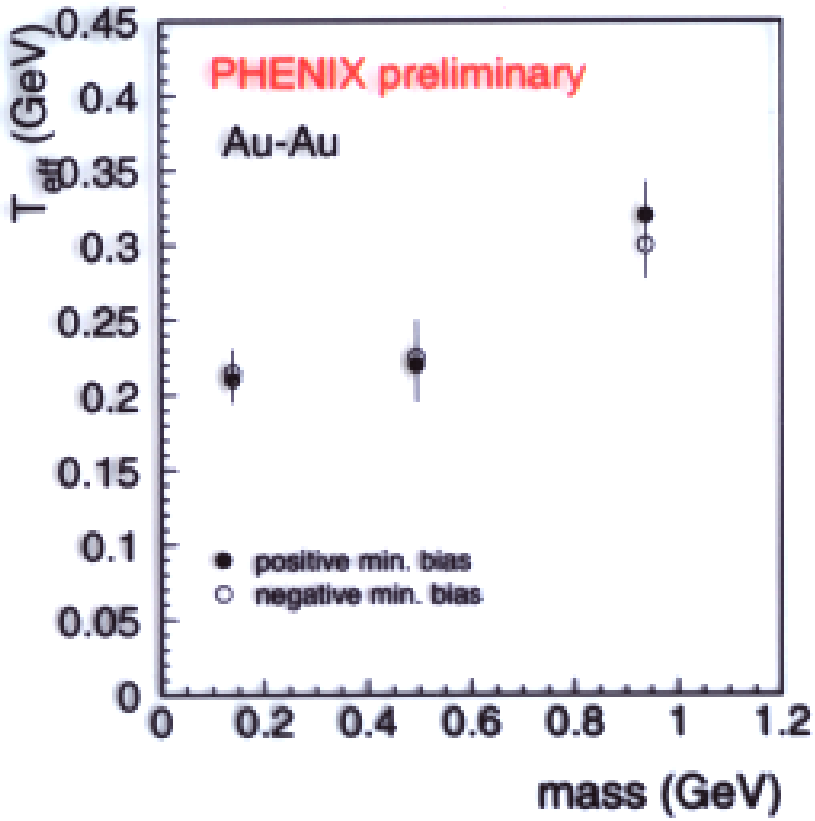


- Centrality selection based on the correlation between beam-beam counters and ZDC counters
- Number of tracks/event with these selections

Pion mt-distributions as a function of centrality

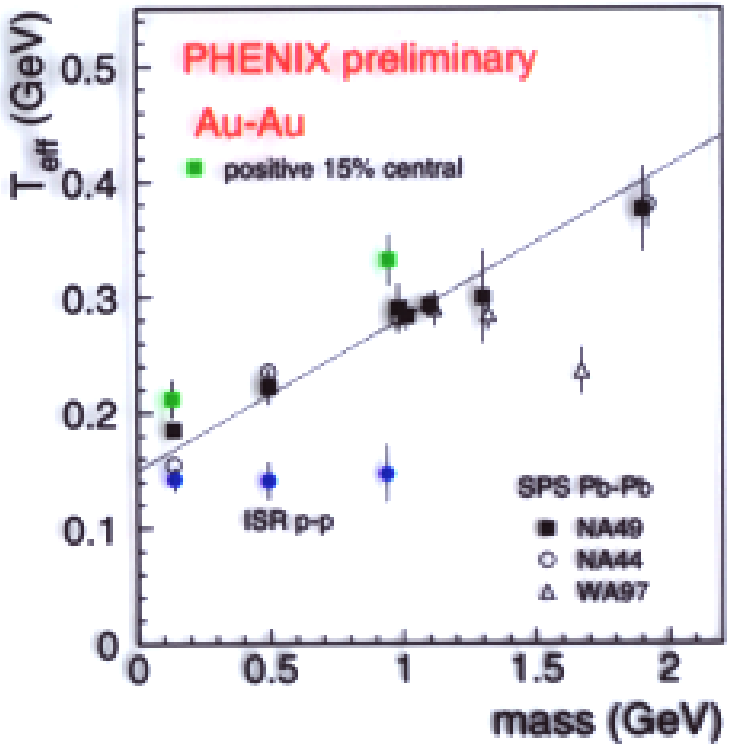


Particle inverse slopes in minimum bias events



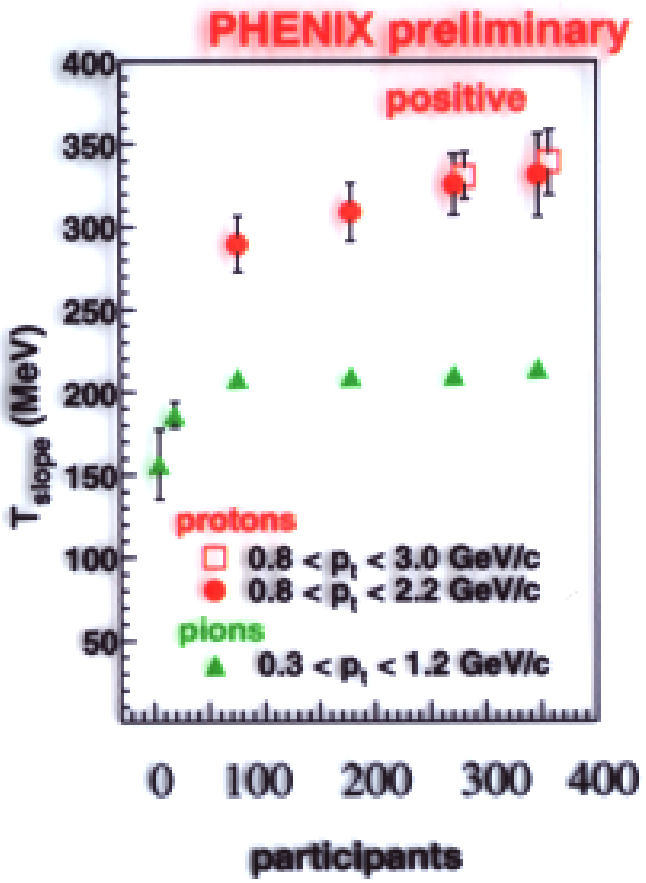
- **negative**
  - pions 215 +/- 3 +/- 15 MeV
  - kaons 225 +/- 15 +/- 20 MeV
  - antiprotons 300 +/- 10 +/- 20 MeV
- **positive**
  - pions 210 +/- 3 +/- 15 MeV
  - kaons 220 +/- 15 +/- 20 MeV
  - protons 320 +/- 10 +/- 20 MeV
- $T_{eff} = T_{fo} + m_0 \langle\beta_T\rangle^2$

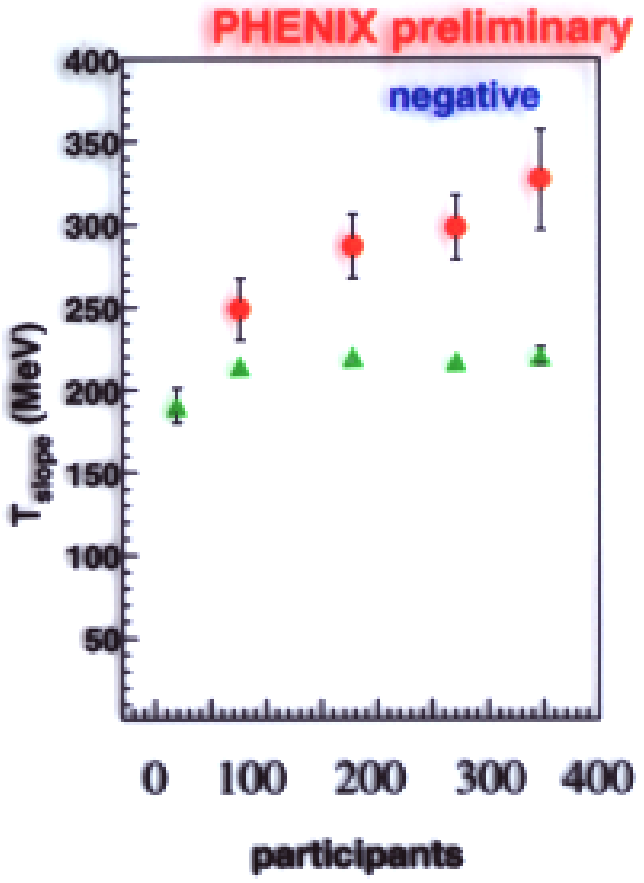
Flow at RHIC and SPS in central events



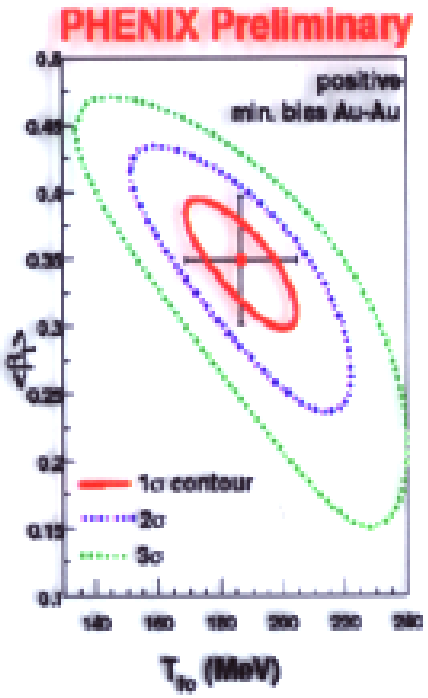
- **PHENIX 15% CENTRAL**
  - π^+ 212 +/-5 +/- 15 MeV
  - p 332 +/-10 +/- 20 MeV
- **protons at SPS**
  <(NA44+NA49)>
  290 +/- 10 MeV

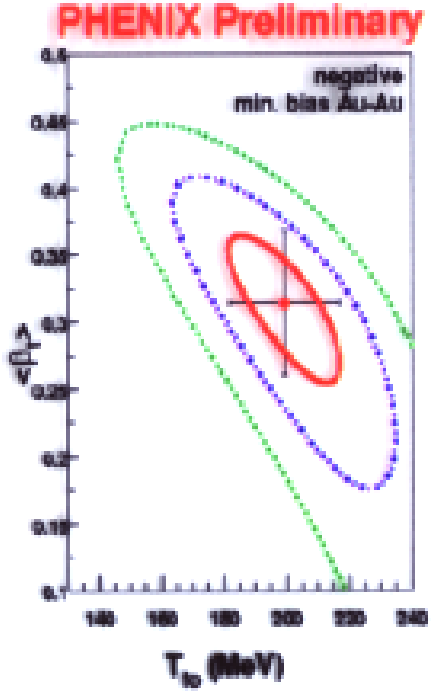
Inverse slope versus N_{part}





Freeze-out T and flow velocity

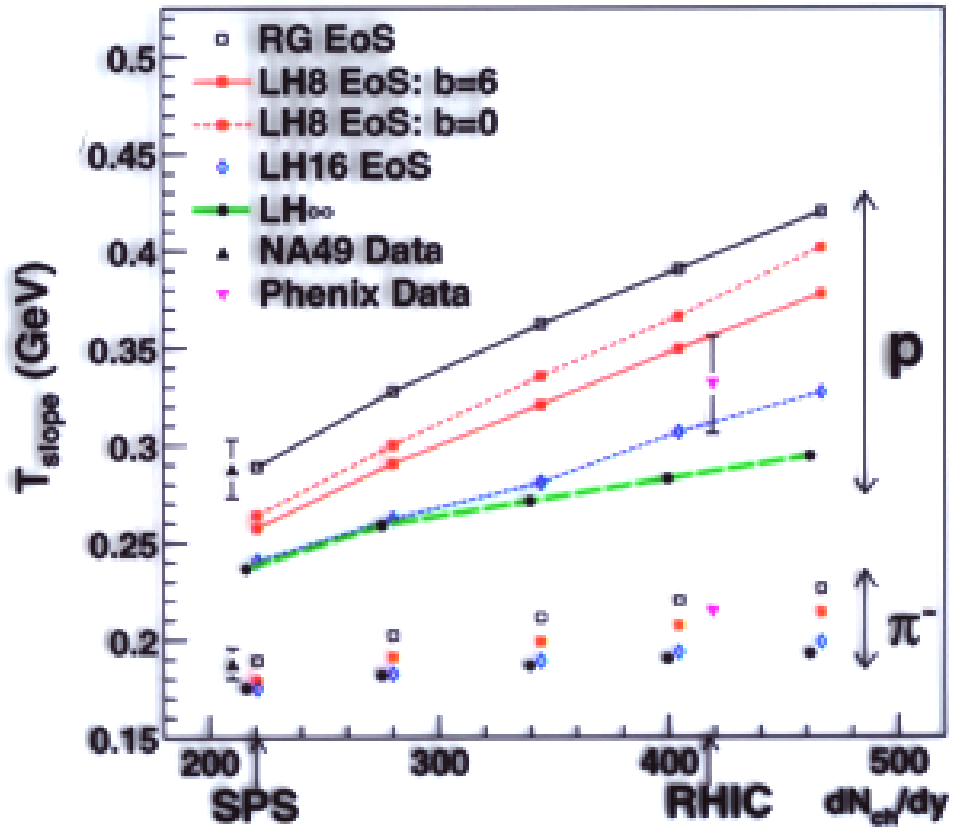




- **RHIC Au+Au**
  - T_{fo} = 186 +/- 18 MeV
  - $\langle\beta_t\rangle$ = 0.36 +/- 0.05
- **SPS Pb+Pb**
  - T_{fo} = 149 +/- 22 MeV
  - $\langle\beta_t\rangle$ = 0.39 +/- 0.04

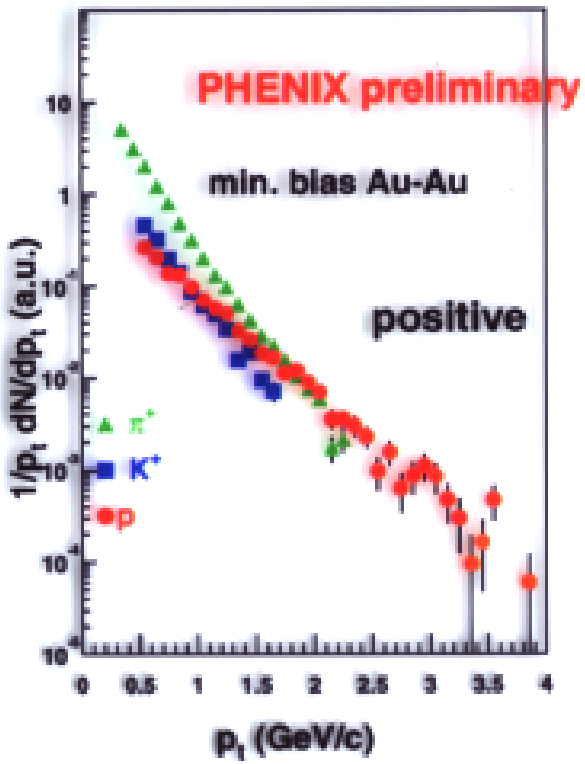
Comparison to theory : hydro + cascade

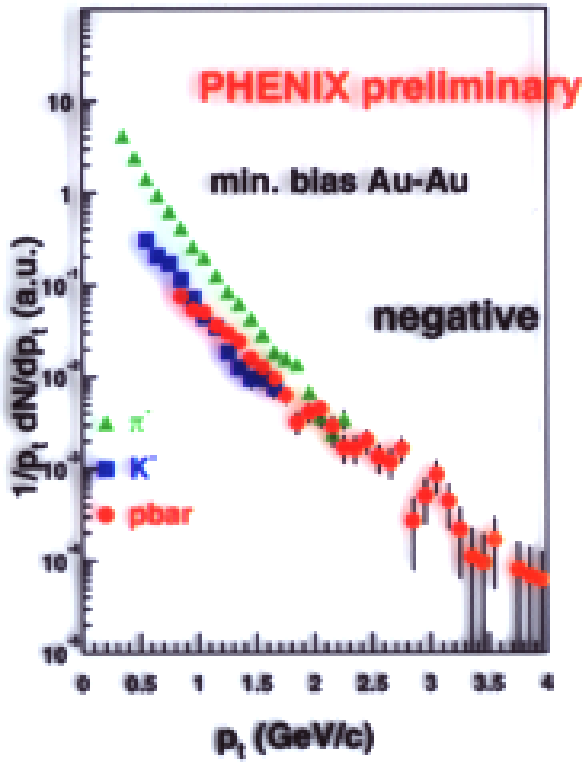
Derek Teaney



- **Proton slopes are sensitive to the EOS**
- **The PHENIX measurement has discriminatory power against various model assumptions**

Transverse momentum distributions in minimum bias events





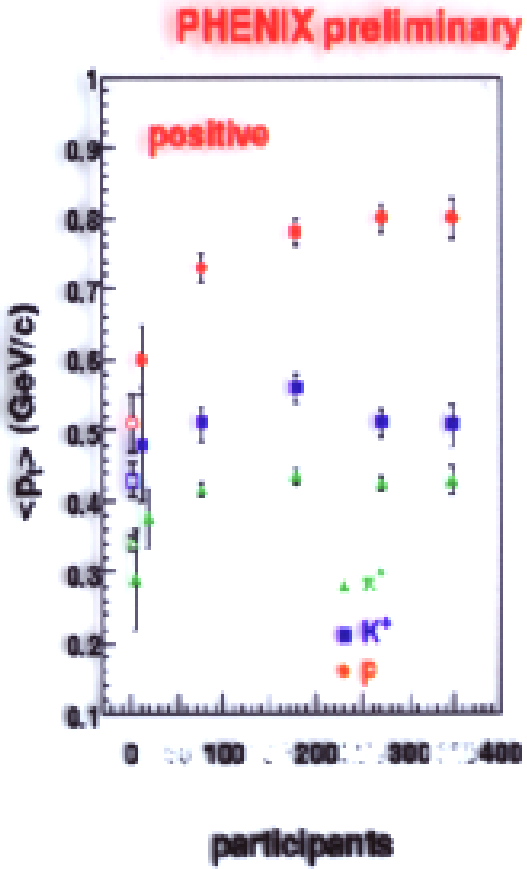
- **Large proton and anti-proton yield at high p_t**
- ***Sort in centrality classes***
- ***In the entire p_t range fit:***

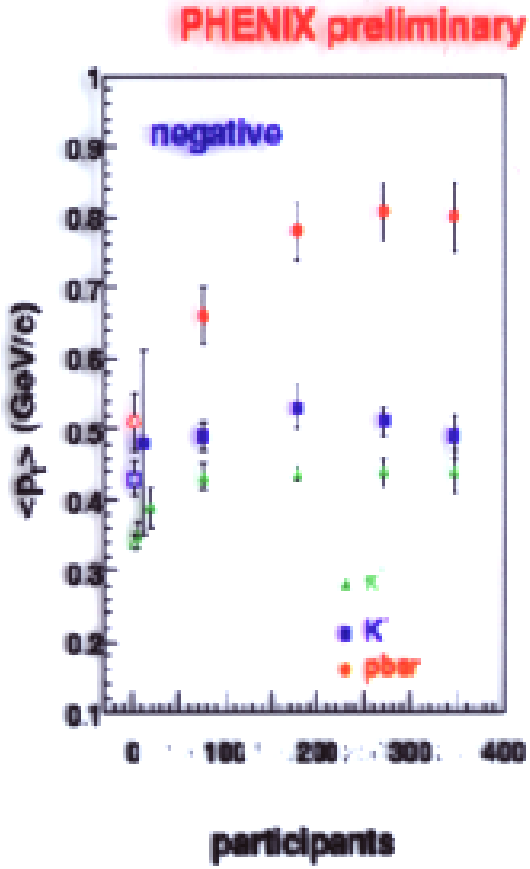
power law function to π

exponential - K and p

- ***extract <p_t> from the fit***

Mean p_t versus number of participants





- **Pions**

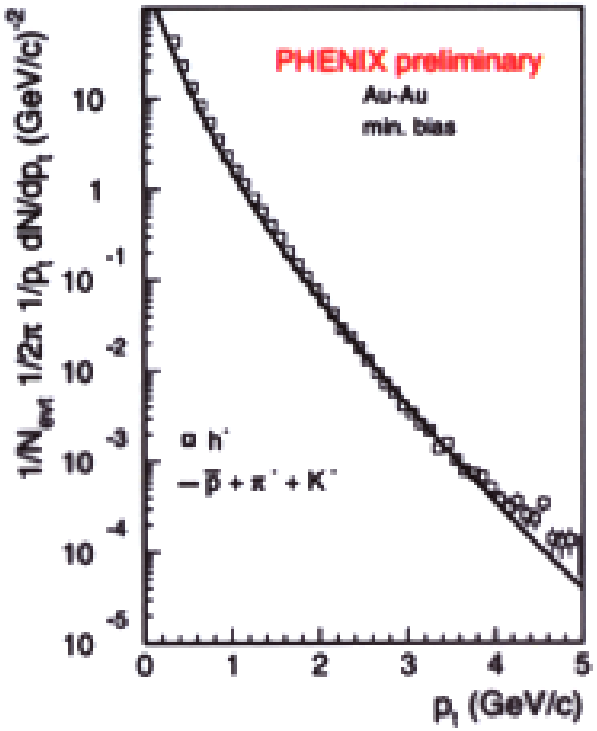
  steep rise and plateau
- **Protons**

  gradual rise and higher $\langle p_t \rangle$

Conclusions

- Measured π, K, p up to 2.2/1.6/3.5 GeV/c in p_t
- Pion spectra nearly independent of N_{part} beyond the very peripheral collisions
- Kaon inverse slopes are rather similar to those of pions
- Protons/anti-protons inverse slopes rising with N_{part}
- Proton inverse slopes higher than at SPS.
- High p_t hadron yields dominated by protons/anti-protons

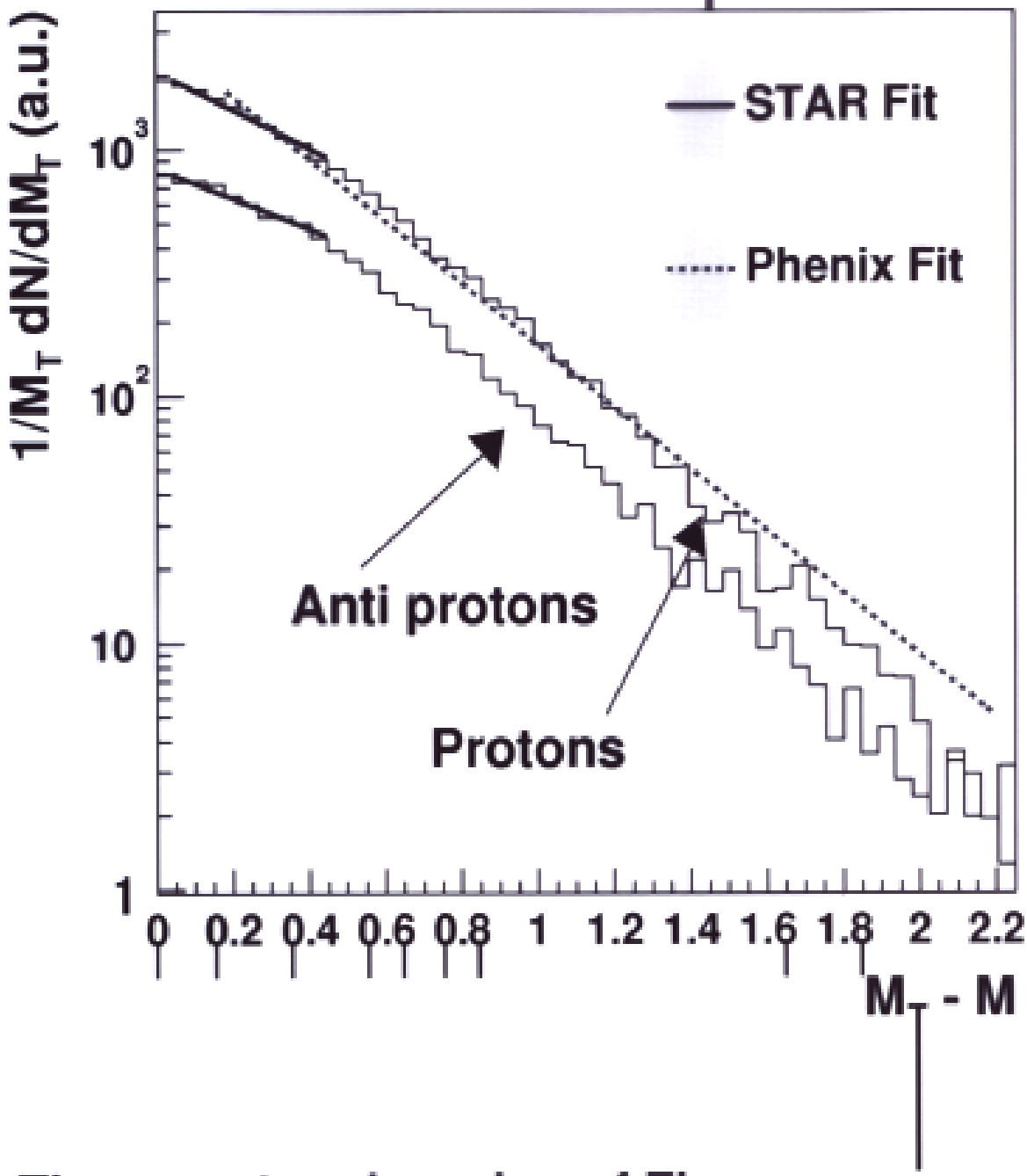
Charged hadron spectra



- **After normalizing the π^- yield to π^0 yield - sum all identified negative hadron spectra**
- **Compare to non-identified h^- spectra - very good agreement observed**
- **Significant contribution of anti-protons above**

  p_t = 2 GeV/c

RHIC Radial Flow comparisons



The curvature is a sign of Flow