Rapidity Dependent Transverse Flow at RHIC

- π,K,p spectra vs y for central Au+Au at 200 GeV
- mean p_T vs y (0<y<3.5)
- Blast-Wave Fits vs y (y~0,1,2,3)
- Summary

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Characterizing "Thermal" Source with Transverse Flow

- Curvature and Slope of m_T spectra increase with particle mass
  - measure inverse slope parameter (T_{obs}), $\langle p_T \rangle$ of identified particles
  - $T_{obs} = T_{fo} + \text{mass} * \beta^2$
- Hydro-inspired Blast-Wave fits to deduce freeze-out parameters
  - o Local thermal equilibrated source or boosted system
  - o parameterization with Flow velocity (β), freeze-out Temperature (T_{fo}) and System Geometry (size and profile)
  - o Schnedermann et al. PRC48(1993)

$$\frac{dn}{m_T dm_T} \propto \int_0^R r\, dr\, m_T K_1 \left(\frac{m_T \cosh \rho}{T_{th}} \right) I_0 \left(\frac{p_T \sinh \rho}{T_{th}} \right)$$

-Thermal Freeze-out Temperature: T

- boost angle: $\rho = \tanh^{-1}\beta$

-Transverse velocity: $\beta(r) = \beta_s (r/R_{max})^{\alpha}$

How does Transverse Flow develop with rapidity?

- $\langle p_T \rangle$ vs y

- BW Fit with T, β, α vs y

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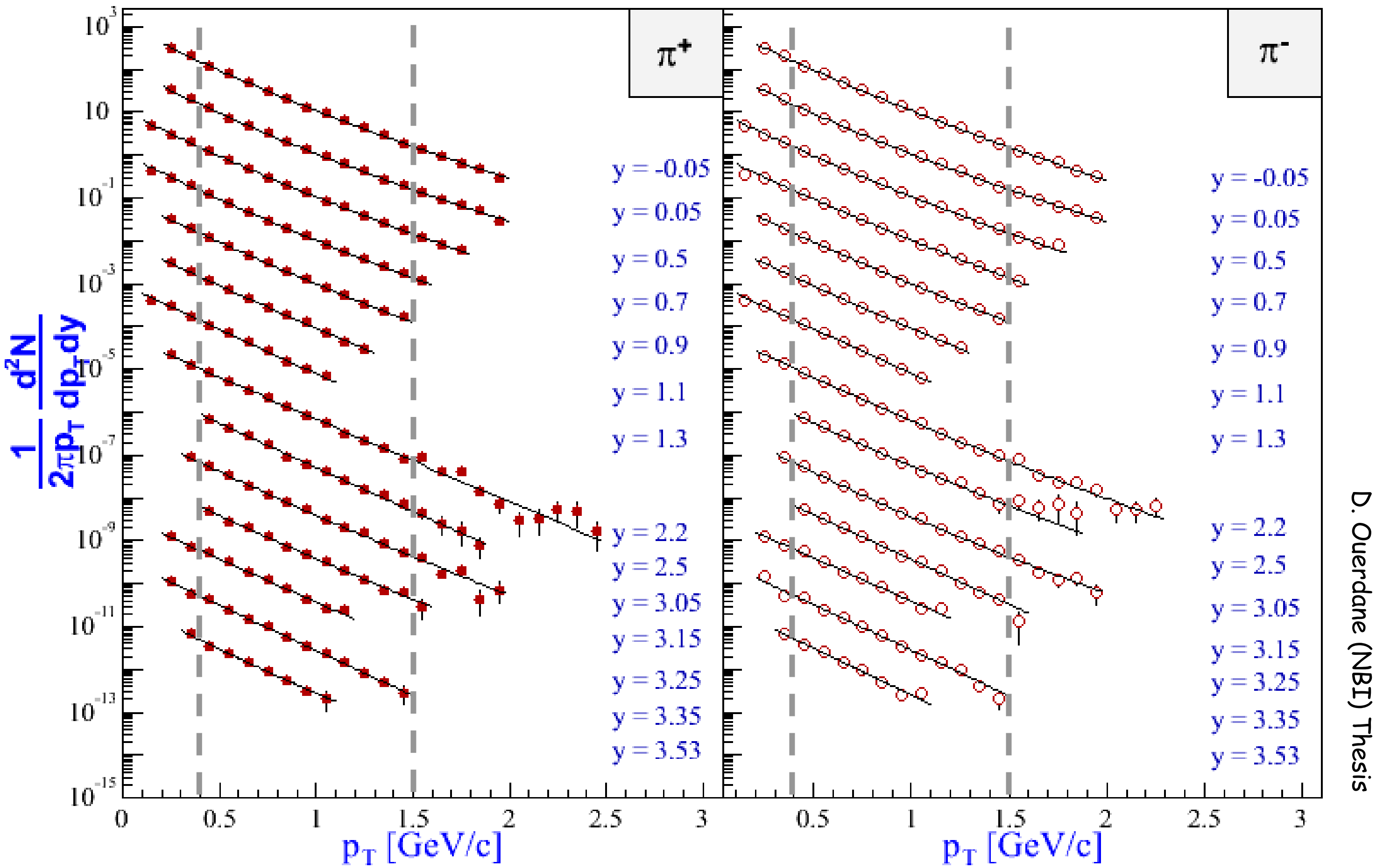
π^+ and π^- (0-5% Au+Au at $\sqrt{s_{NN}}$ = 200 GeV) ($0 \leq y \leq 3.5$)

BRAHMS Preliminary



- pion spectra shown with power-law fits (Divided by 10 successively from top)
- Fitting ranges for BW fits shown with dashed lines (-resonance, -"hard" part)
- "Inverse Slope" (from 0.3-1.0GeV): slowly decrease with rapidity (~220MeV -> ~200MeV)
- dN/dy shape: close to a Gaussian with $\sigma(\pi^+) \sim \sigma(\pi^-) \sim 2.3$

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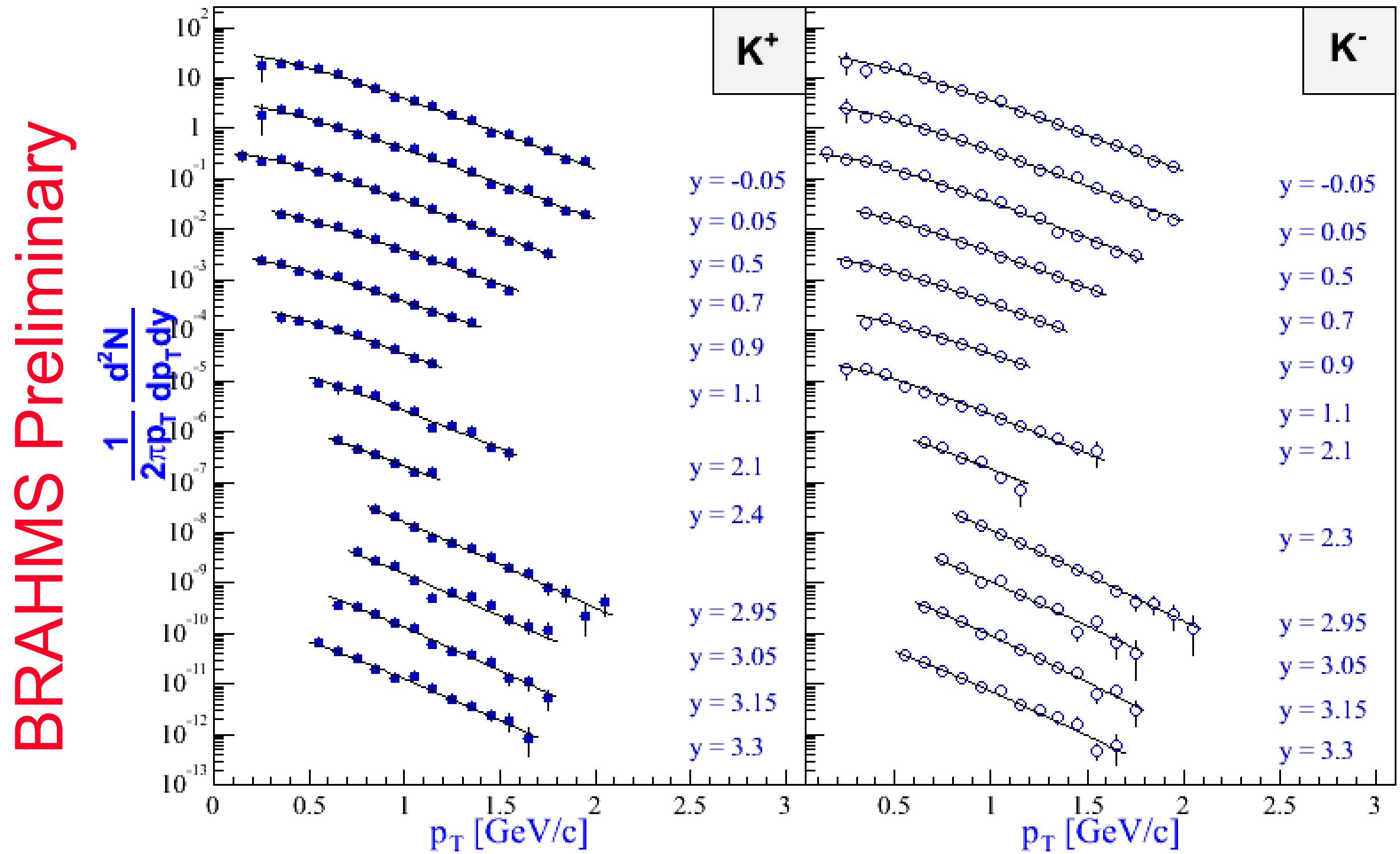
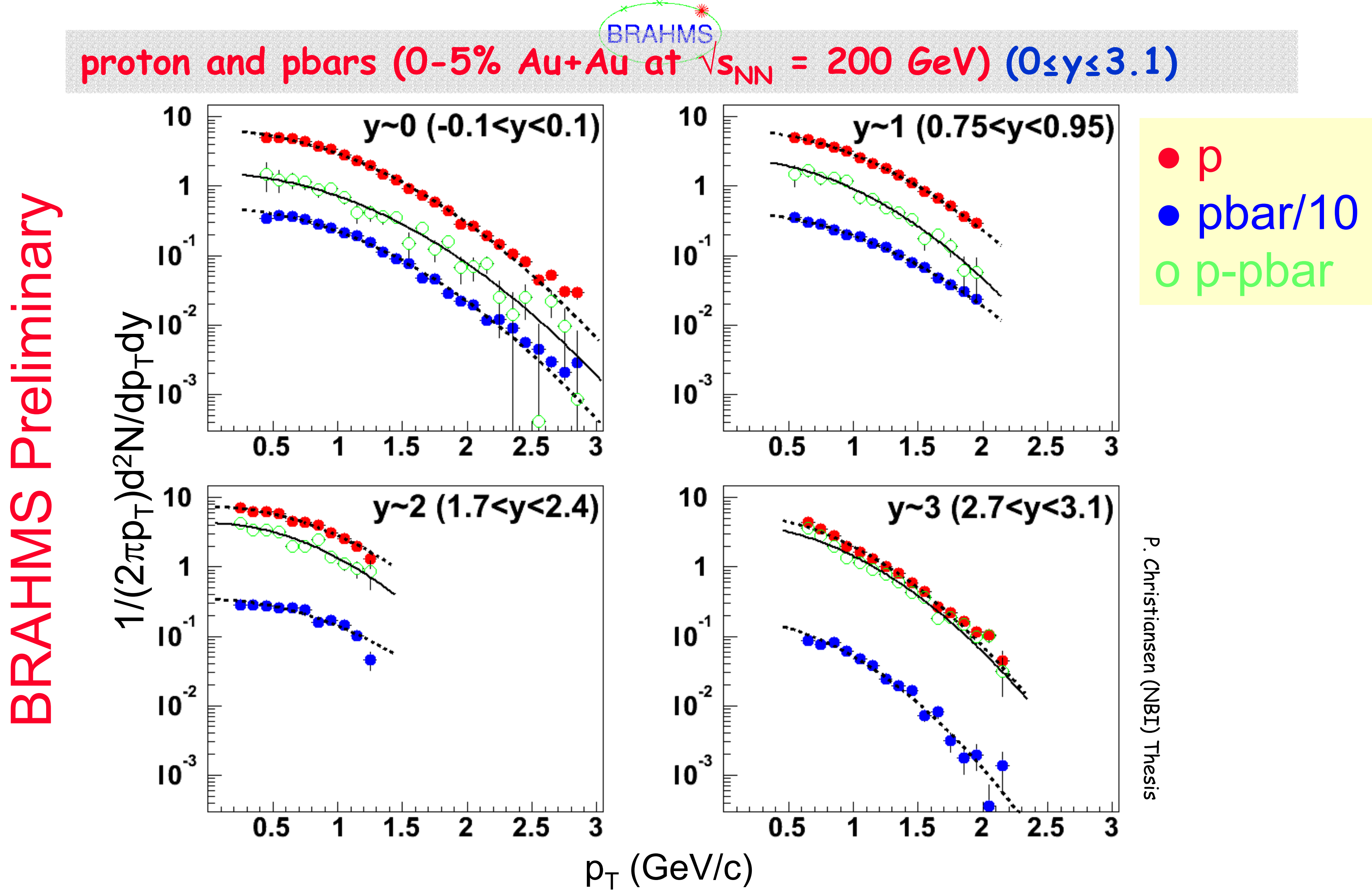
K^+ and K^-(0-5% Au+Au at $\sqrt{s_{NN}}$ = 200 GeV) (0≤y≤3.3)



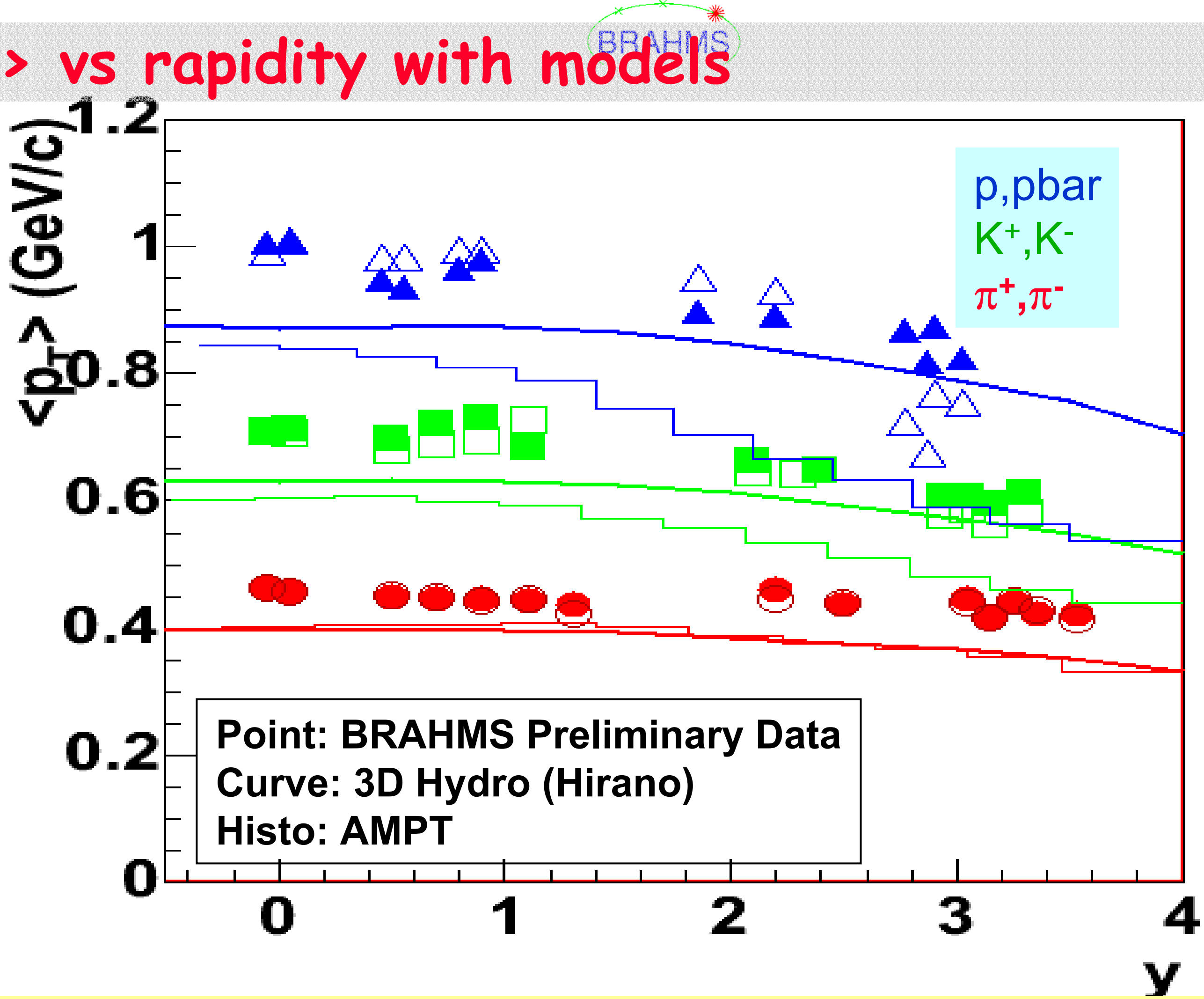
- Kaon spectra shown with m_T exponential fits (Divided by 10 successively from top)
- Inverse Slope: smoothly decrease with rapidity (~300MeV -> ~230MeV)
- dN/dy shape: close to a Gaussian with $\sigma(K^+)$~2.4 $\sigma(K^-)$~2.1

proton and pbars (0-5% Au+Au at $\sqrt{s_{NN}}$ = 200 GeV) ($0 \leq y \leq 3.1$)



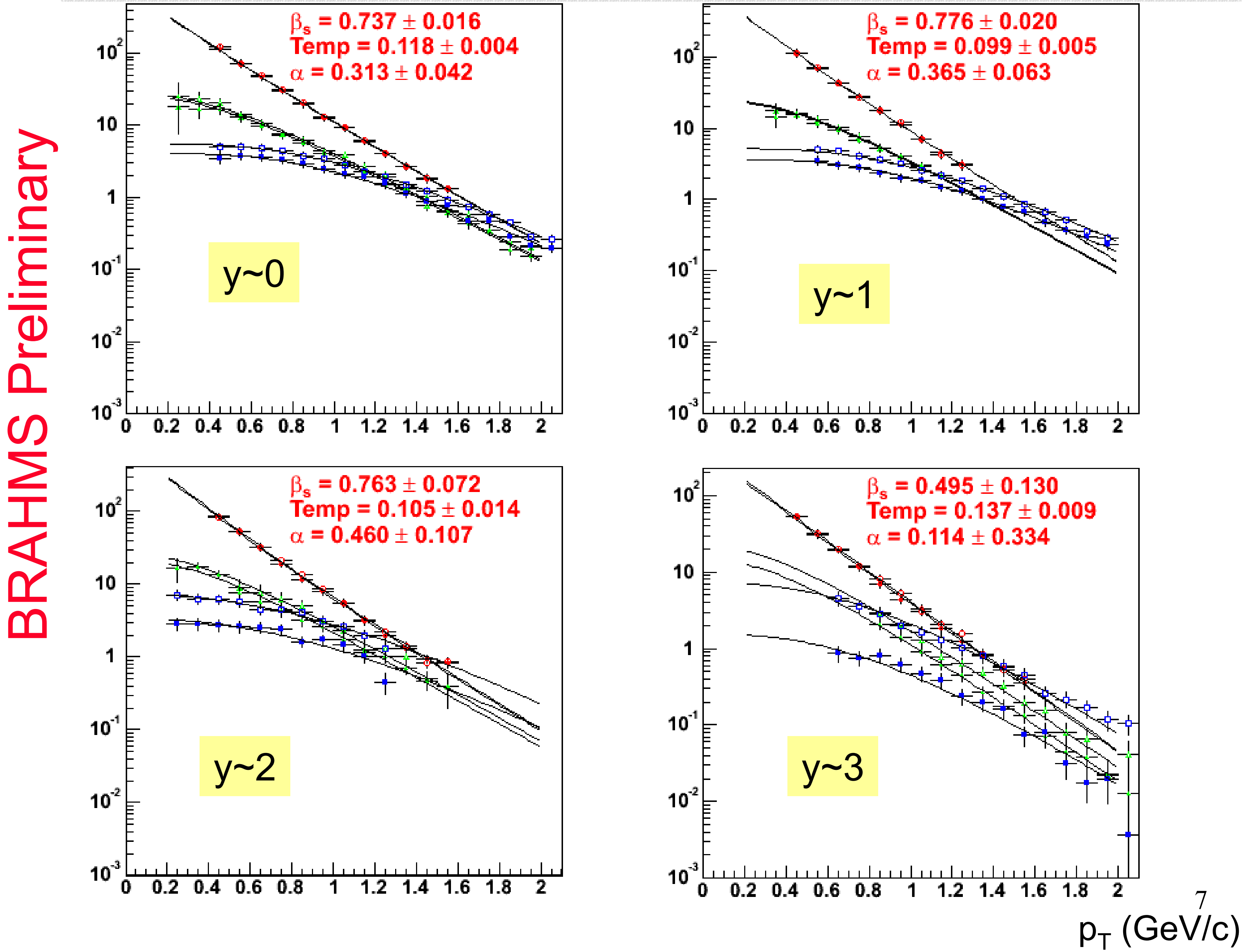
- proton and pbar spectra shown with Gaussian fits
- Spectra are summed over rapidity ranges of δy=0.4-0.6 due to statistics+acceptance
- Λ feed-down corrections are not applied

$\langle p_T \rangle$ vs rapidity with models

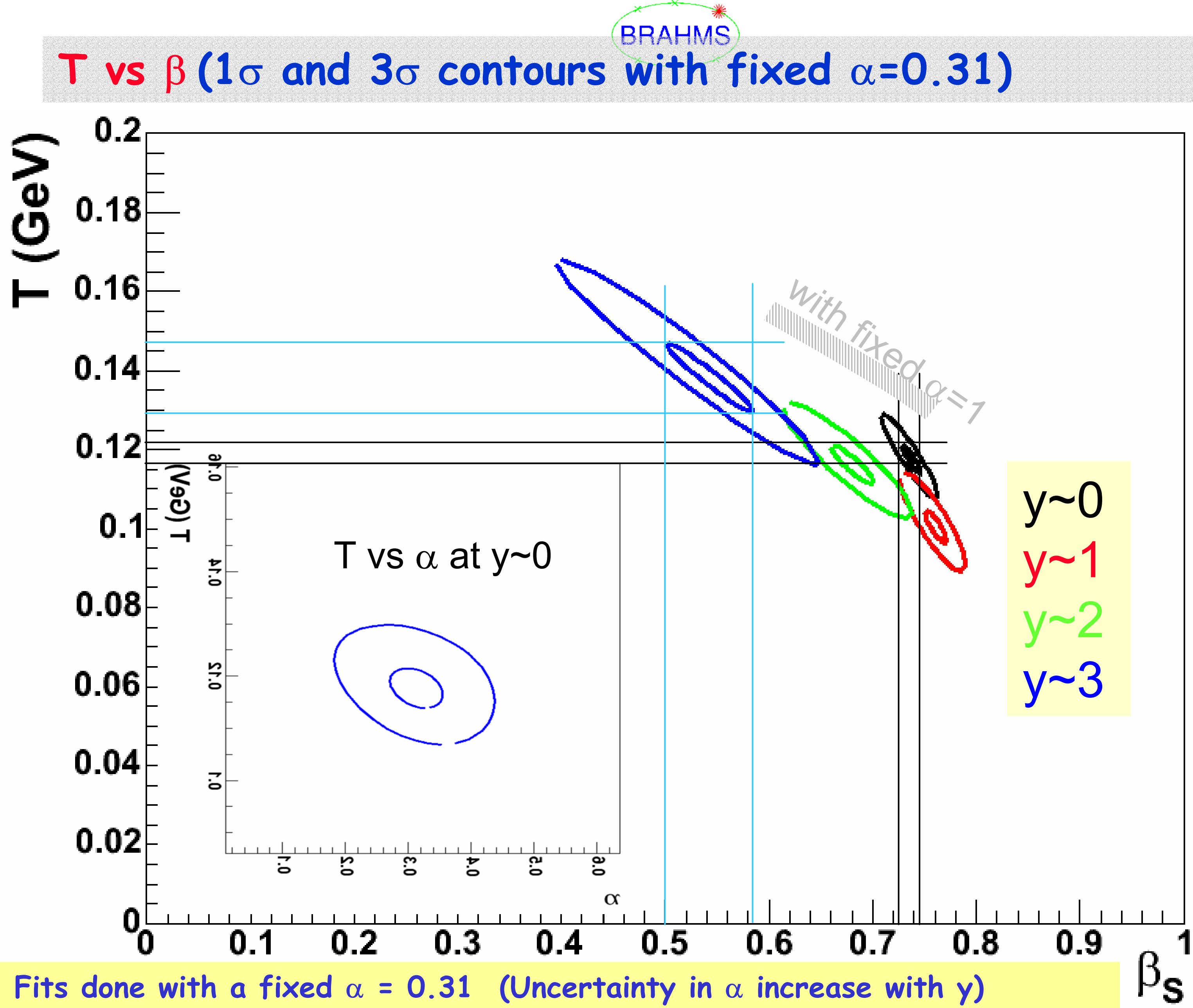


- Calculated from fitting spectra
- $\langle p_T \rangle$ decrease with y: π ~10% K and p ~15-20% drop from y=0 to y~3
- AMPT and 3D-Hydro model under-predict $\langle p_T \rangle$
- 3D-Hydro describe y-dependence qualitatively with a single T_{th} value (T_{th} = 100 MeV, T_{ch} = 170 MeV)

Spectra with BW Fits at y~0,1,2,3 (T,β_s,α in the fit R_{max}=13fm)

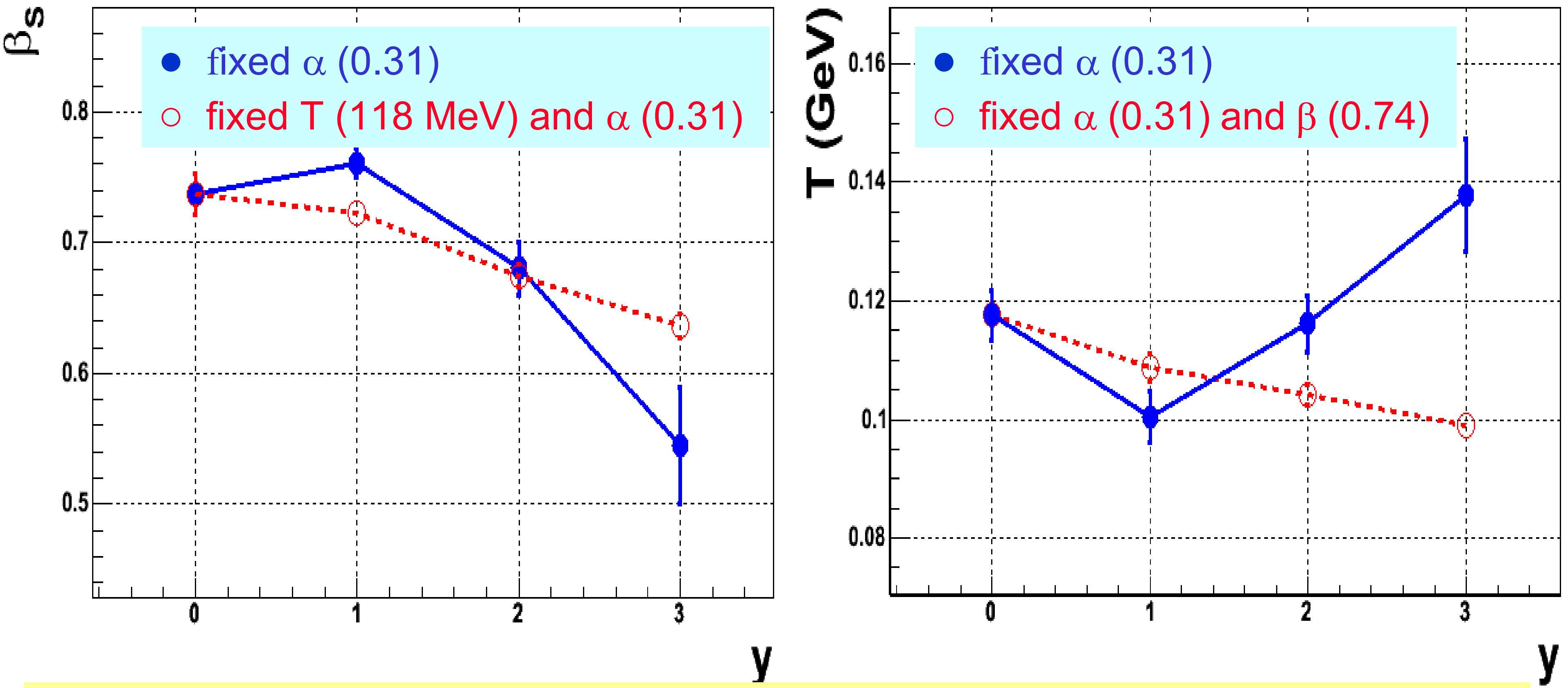


T vs β (1σ and 3σ contours with fixed α=0.31)



- Fits done with a fixed α = 0.31 (Uncertainty in α increase with y)
- T increases as β decreases with rapidity
- BW parameters better defined for smaller y

β_s vs y and T vs y



- Fits done with a fixed α (y=0 value) and T (or β_s)
- β_s decrease with y :~25% decrease from y~0 to y~3
- β_s =0.74-0.54 ($\langle\beta\rangle$=0.64-0.47), T=100-138 MeV
- Naïve picture: lower particle density->easier/faster to be frozen->higher temperature

Summary

- BRAHMS measured identified hadron spectra in $0 \leq y \leq 3.5$ in Au+Au at $\sqrt{s_{NN}}$ = 200 GeV
- $\langle p_T \rangle$ increase with particle mass and decrease with rapidity
- Blast-Wave parameterization describes data with T and β

- Hydro-dynamical behavior/re-scattering in a wide rapidity range at RHIC
  - Strong collective transverse flow: $\langle\beta\rangle \sim 0.64 - 0.47$
  - Thermal Freeze-out temperature: T~ 100 – 137 MeV
  - Transverse flow decrease (~25%) with rapidity from y=0 to y~3 while temperature tends to increase
  - Consistent with Hydro calculations, especially at y≠0? Constraint for models.