Thermal Model at RHIC: particle ratios and $p_\perp$ spectra

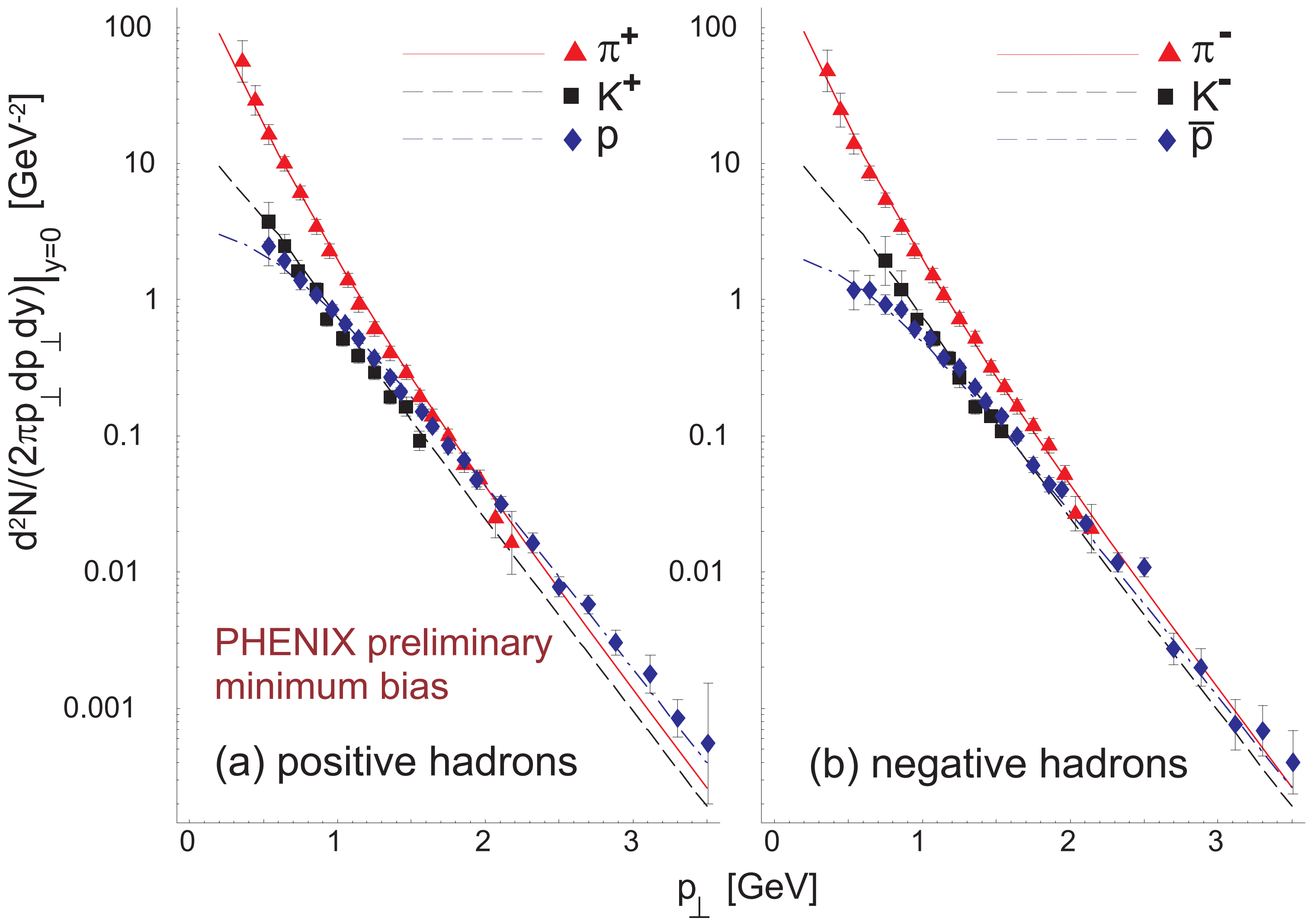
Wojciech's Broniowski and Florkowski

Hirschegg, January 2002

- WB & WF, Strange particle production at RHIC in a single-freeze-out model, nucl-th/0112043
- WB & WF, Description of the RHIC $p_\perp$ spectra in a thermal model with expansion, Phys. Rev. Lett. 87 (2001) 272302 — spectra!
- WF, WB, & M. Michalec, Thermal analysis of particle ratios and $p_\perp$ spectra at RHIC, nucl-th/0106009
- M. Michalec, WB, & WF, Scaling of hadron masses and widths in thermal models ... , Phys. Lett. B520 (2001) 213 — medium effects
- WF & WB, In-medium modifications of hadron masses and chemical freezeout ... , Phys. Lett. B477 (2000) 73
- WB & WF, Geometric relation between centrality and the impact parameter ... , nucl-th/0110020 — useful!
- M. Michalec, PhD Thesis, nucl-th/0112044 — uniform study
- WF, Epiphany 2002 talk, - ratios, + SPS

\+ Anna Baran, PhD student

Minimum-Bias Data from PHENIX

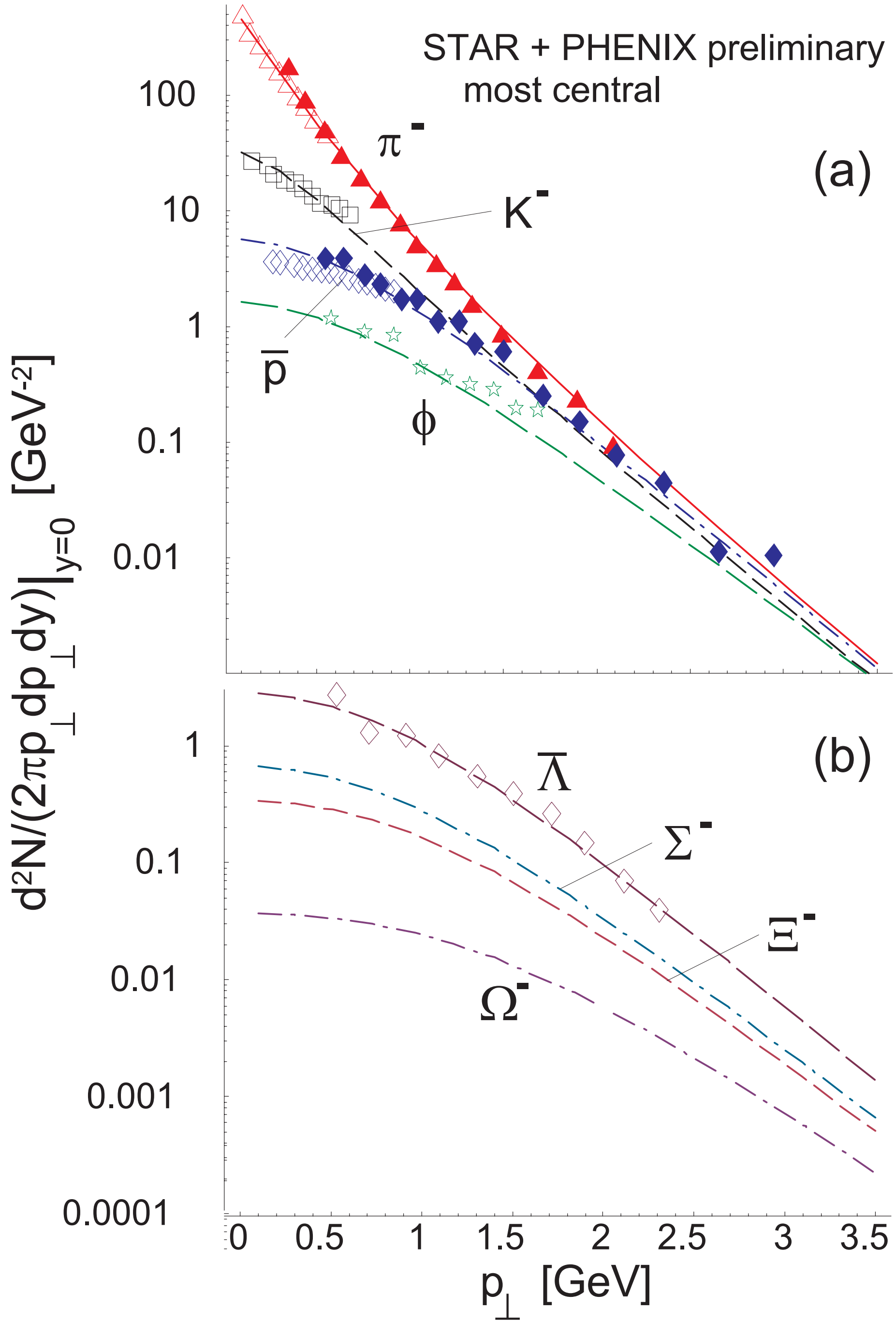


Au+Au collisions at $\sqrt{s} = 130$ GeV A

Data from Velkovska (PHENIX) nucl-ex/0105017, QM01

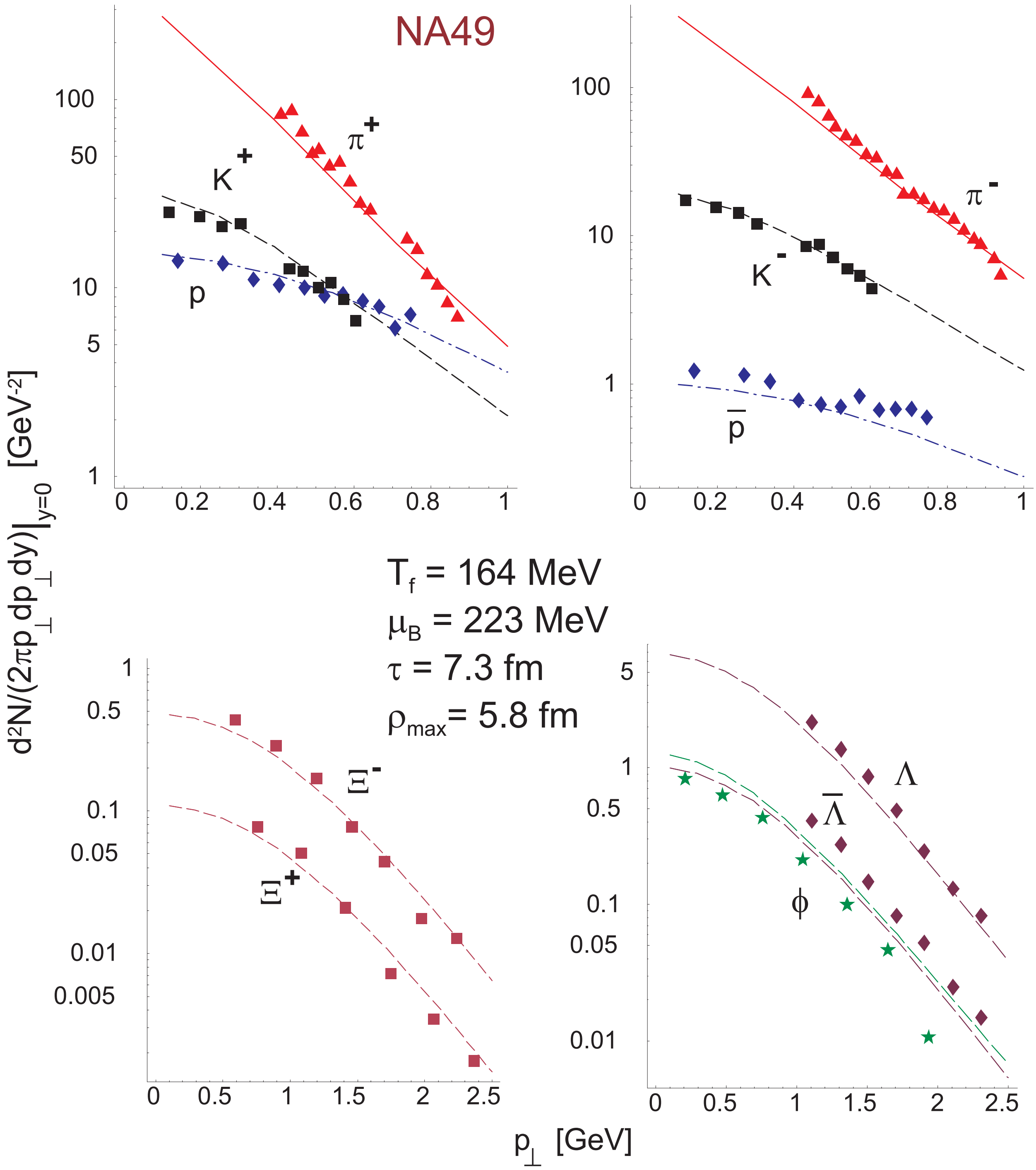
π^0 also agrees

Most Central Events from PHENIX and STAR



ϕ - Yamamoto (STAR) hep-ph/0112017, $\bar{\Lambda}$ - Snellings (STAR) hep-ph/0111437

Single-freezout works also for SPS



Data from NA49: NPA 610 (1996) 188c; PLB 491(2000) 59; PLB 444 (1998) 523

Comparison of the freeze-out parameters

	PHENIX: c=0-5%	c=15-30%	c=60-92%	NA49: c=0-5%
τ [fm]	8.2	6.3	2.3	7.3
$\rho_{\max}$ [fm]	6.9	5.3	2.0	5.8
$\rho_{\max}/\tau$	0.84	0.84	0.87	0.79
$\beta_\perp^{\max}$	0.64	0.64	0.66	0.62
$\langle\beta_\perp\rangle$	0.47	0.47	0.48	0.45
λ_∞ [MeV]	354	354	362	339

$$\beta_\perp^{\max} = \frac{\rho_{\max}}{\sqrt{\tau^2+\rho_{\max}^2}}$$

$$\langle\beta_\perp\rangle = \int_0^{\rho_{\max}} r dr \frac{r}{\sqrt{\tau^2+r^2}} / \int_0^{\rho_{\max}} r dr$$

Conclusions

- simple explanation of the $p_\perp$ spectra with a surprising accuracy with two universal and commonly accepted thermal parameters and two shape parameters (longitudinal and transverse flow)

- model also fits uniformly the particle ratios (T, μ_B)

- small sizes of the hadronic system, compatible with the order of the measured HBT radii

- the hydrodynamical evolution is omitted, the shape of the freeze-out surface is the guessed input – other choices possible

- the inclusion of the cascade decays of resonances is crucial for the success of the model, semi-analytic approach, no need for Monte-Carlo methods (effective cooling via decays)

- other observables can be calculated (rapidity dependence, eliptic flow, correlations)

- first calculations show that the model also works reasonably well for SPS

- medium modifications of masses are possible within a reasonable (10-20%) range

- widths of resonances do not spoil the fit!

- universal temperature – a signal of the phase transition or a feature of the hadronization process?