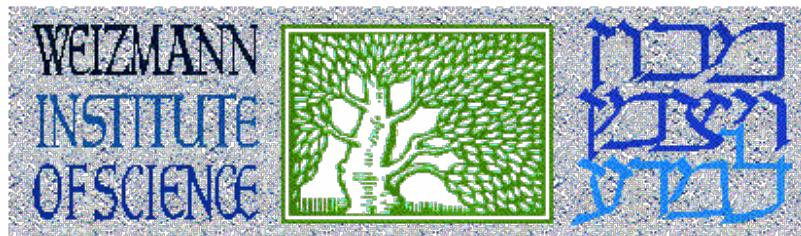


Using Tsallis function on heavy ion data.

Alexander Milov

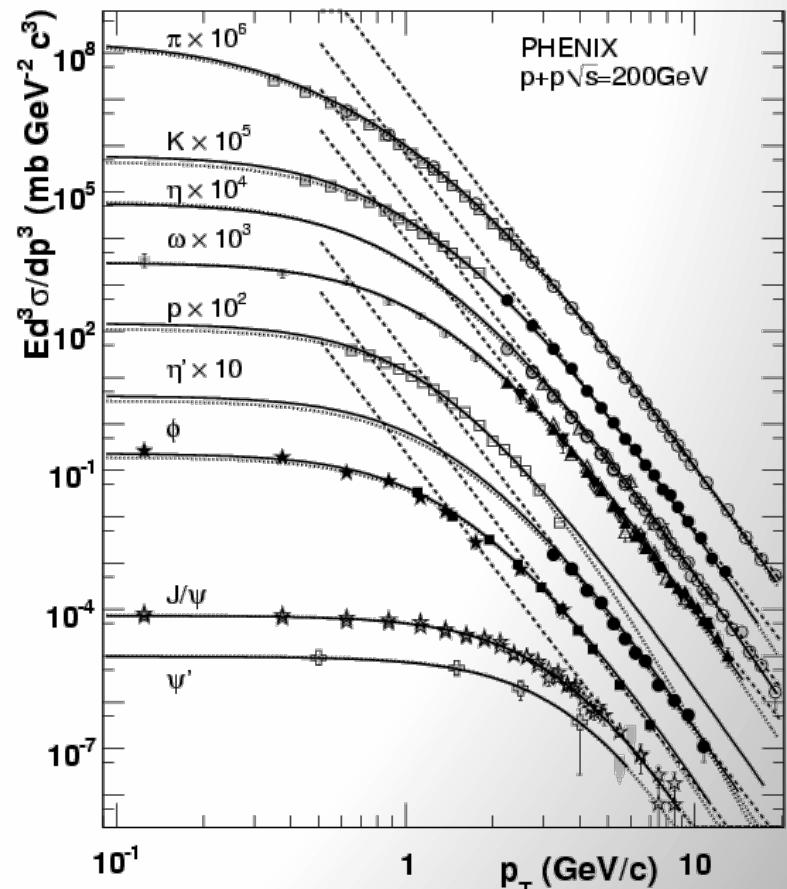
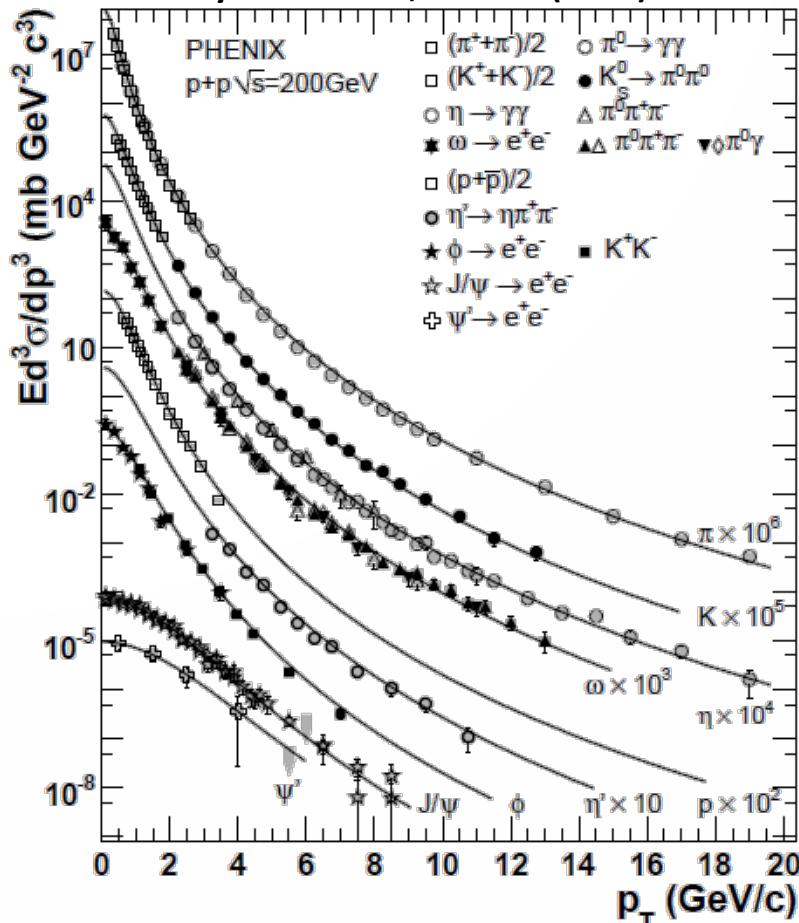


Weizmann Institute of Science



p+p at 200 GeV

Phys. Rev. D 83, 052004 (2011)



PHENIX produced a variety of identified particle spectra in pp

We tried to learn something from it using Tsallis distribution

Functional forms

Tsallis

$$G_q(E) = C_q \left(1 - (1-q) \frac{E}{T} \right)^{1/(1-q)}$$

Tsallis + normalization

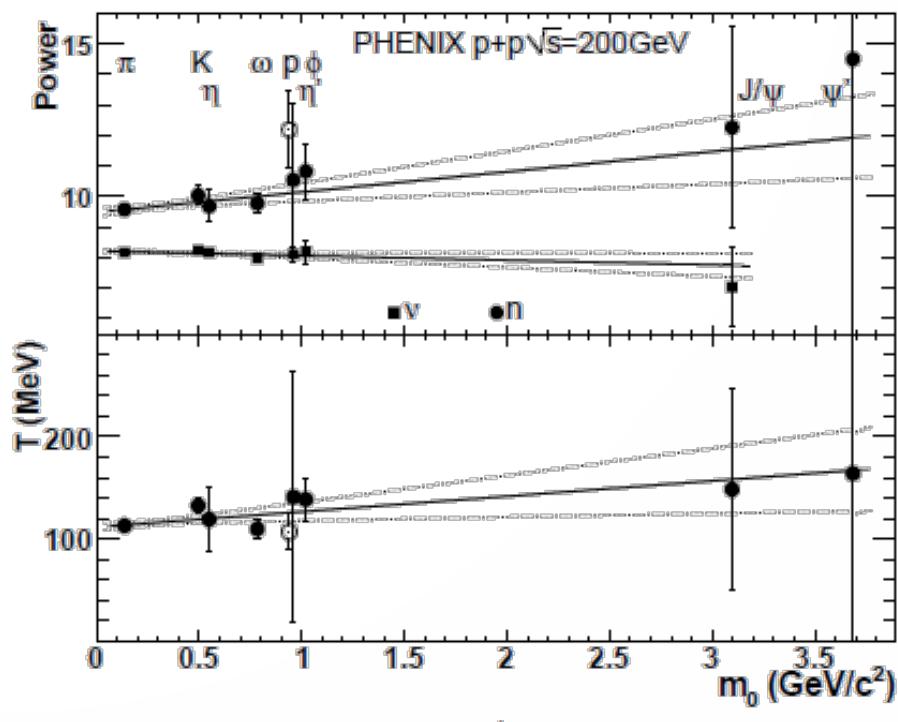
$$C_q = \frac{(2q-3)(q-2)}{T(T+m_0) - (q-1)(q-2)m_0^2} \quad n = -\frac{1}{1-q}$$
$$\times \frac{1}{\left(1 - (1-q)\frac{m_0}{T}\right)^{1/(1-q)}}.$$

$$E \frac{d^3\sigma}{dp^3} = \frac{1}{2\pi} \frac{d\sigma}{dy} \frac{(n-1)(n-2)}{(nT+m_0(n-1))(nT+m_0)} \times \left(\frac{nT+m_T}{nT+m_0} \right)^{-n}$$

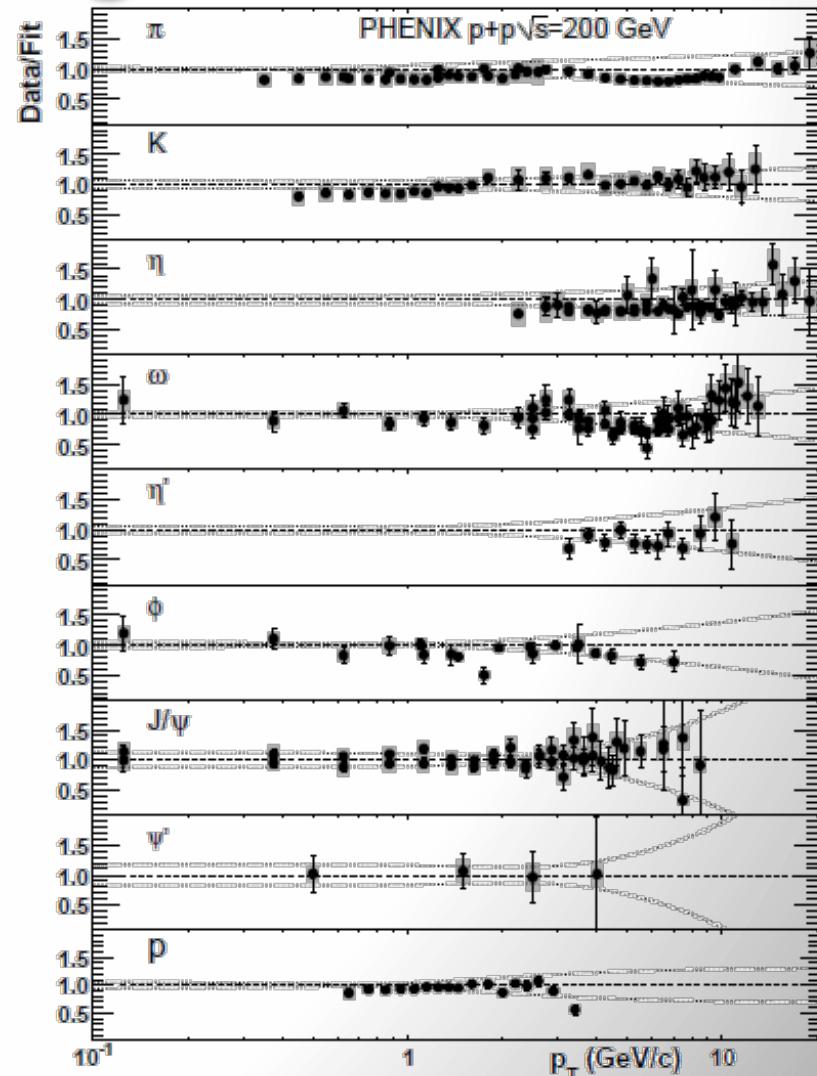
Hagedorn ($m \rightarrow 0 \rightarrow m_T = p_T$)

$$E \frac{d^3\sigma}{dp^3} = \frac{1}{2\pi} \frac{d\sigma}{dy} \frac{(n-1)(n-2)}{(nT)^2} \left(1 + \frac{m_T}{nT} \right)^{-n}$$

Fitting



Fit	Prob.
ν 8.154 ± 0.039	0.75
ν $(8.22 \pm 0.07) - (0.15 \pm 0.14)m_0 [\text{GeV}/c^2]$	0.79
n 9.656 ± 0.097	0.69
n $(9.48 \pm 0.14) + (0.66 \pm 0.39)m_0 [\text{GeV}/c^2]$	0.94
$T (\text{MeV})$ 115.3 ± 2.8	0.43
$T (\text{MeV})$ $(111.5 \pm 4.0) + (15 \pm 12)m_0 [\text{GeV}/c^2]$	0.51



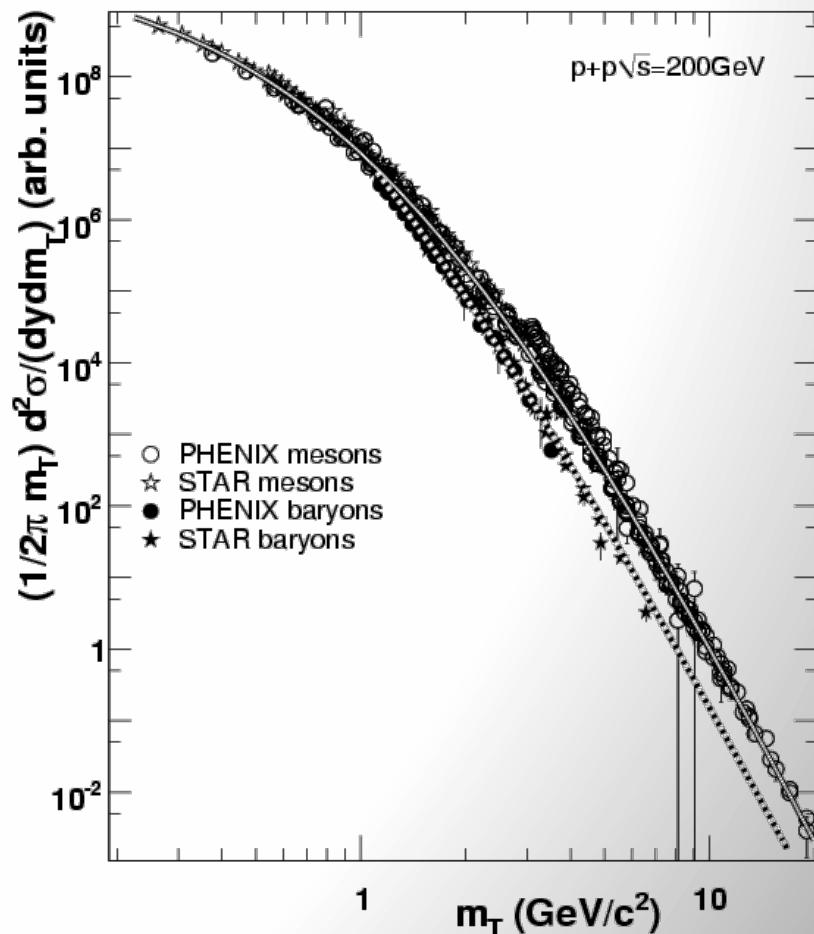
Fitting them shown something really interesting

Fit results

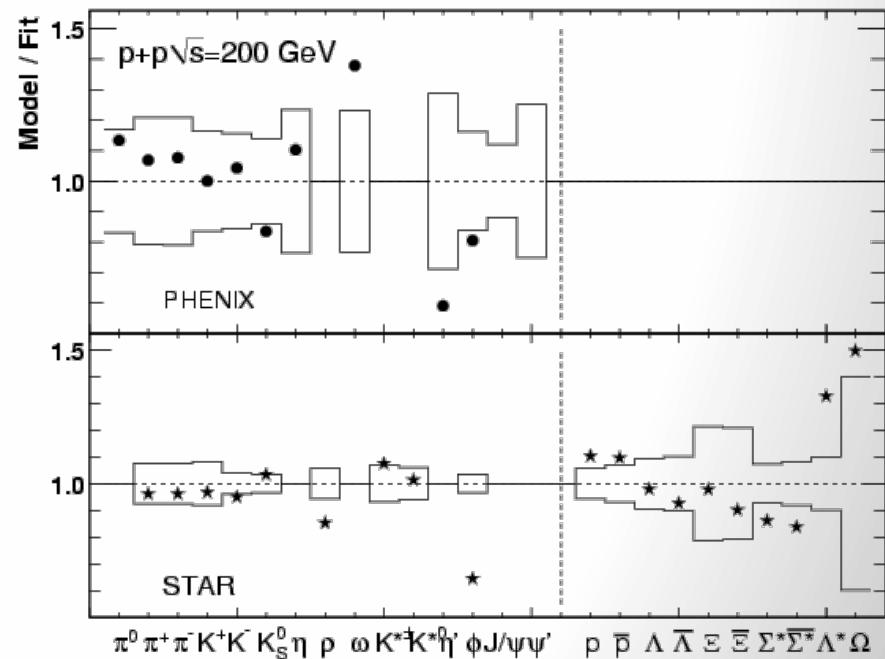
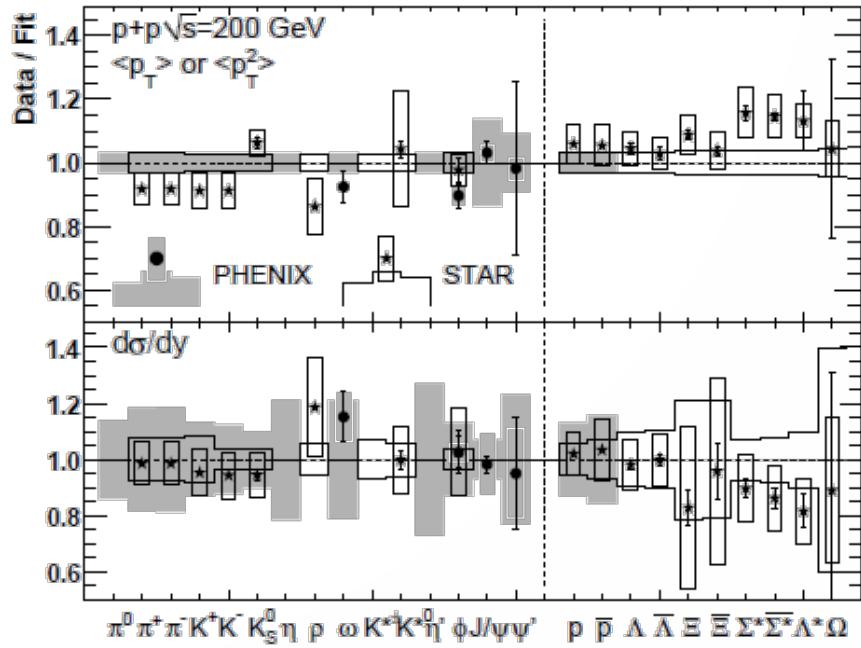
Fitting them shown something really interesting

	$d\sigma/dy$ (mb, μ b)	T (MeV)	$n = -1/(1 - q)$
π	$40.5 \pm 0.3 \pm 5.8$	114.2 ± 4.0	9.57 ± 0.10
K	$4.71 \pm 0.06 \pm 0.48$	118.4 ± 5.2	9.81 ± 0.13
η	$4.46 \pm 0.05 \pm 0.97$	119.0 ± 5.4	9.84 ± 0.14
ω	$3.64 \pm 0.07 \pm 0.77$	121.8 ± 6.7	10.00 ± 0.22
η'	$0.62 \pm 0.04 \pm 0.16$	123.8 ± 7.7	10.11 ± 0.28
ϕ	$0.421 \pm 0.009 \pm 0.054$	124.5 ± 8.1	10.15 ± 0.31
J/ψ	$0.761 \pm 0.013 \pm 0.060$	149 ± 22	11.5 ± 1.1
ψ'	$0.133 \pm 0.024 \pm 0.019$	156 ± 26	11.9 ± 1.3
p	$1.76 \pm 0.03 \pm 0.16$	58.8 ± 6.4	9.20 ± 0.28

All particles seemed consistent, except protons, we of course have had lot's of STAR data, and it show that mesons and baryons are different.



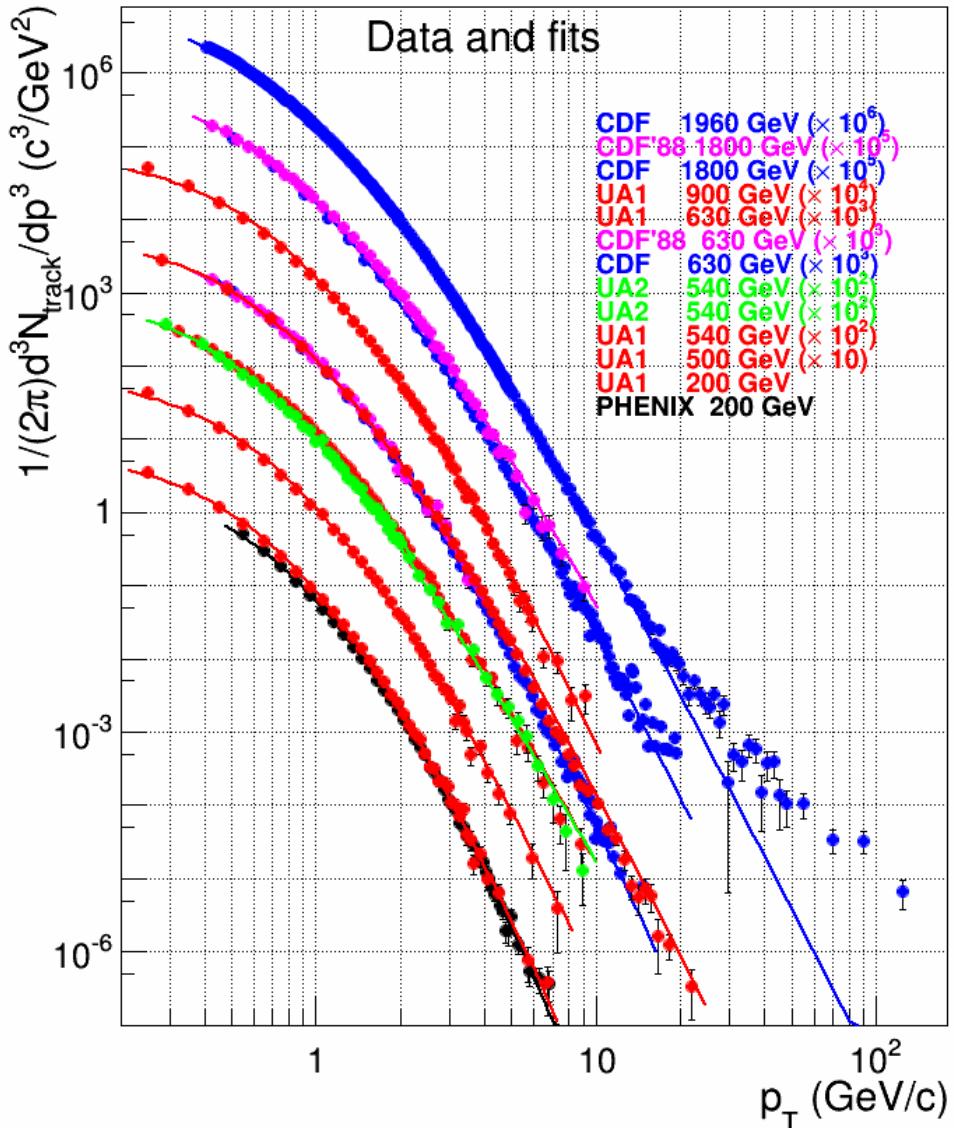
Abundances!



This was really interesting. We got some idea about abundances of particles which we could only measure above 2 GeV! But rather accurate because when we could measure at low pT the spectra integrals were very consistent.

So we compared them to stat model (F. Becattini et all).

Works at higher energies

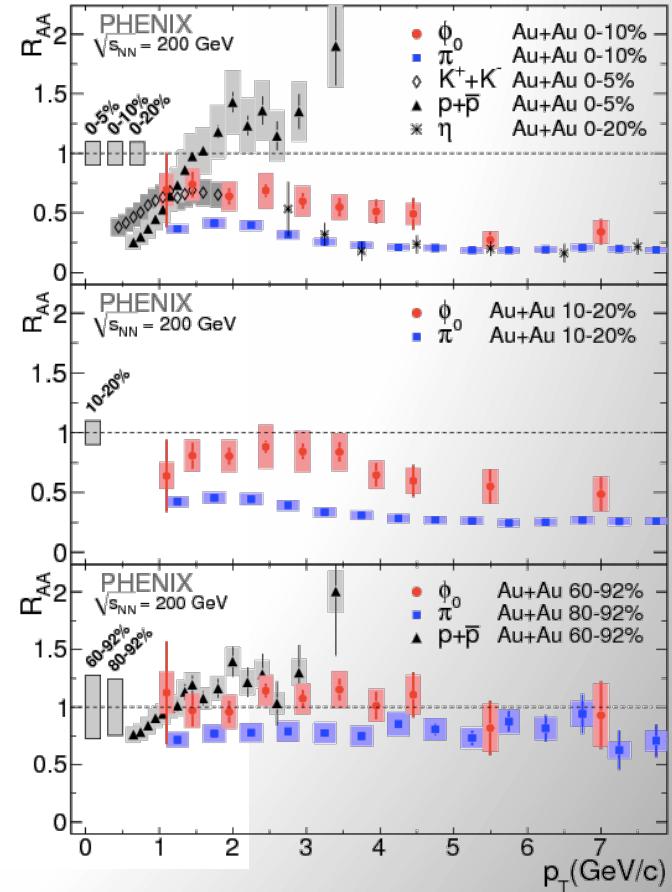
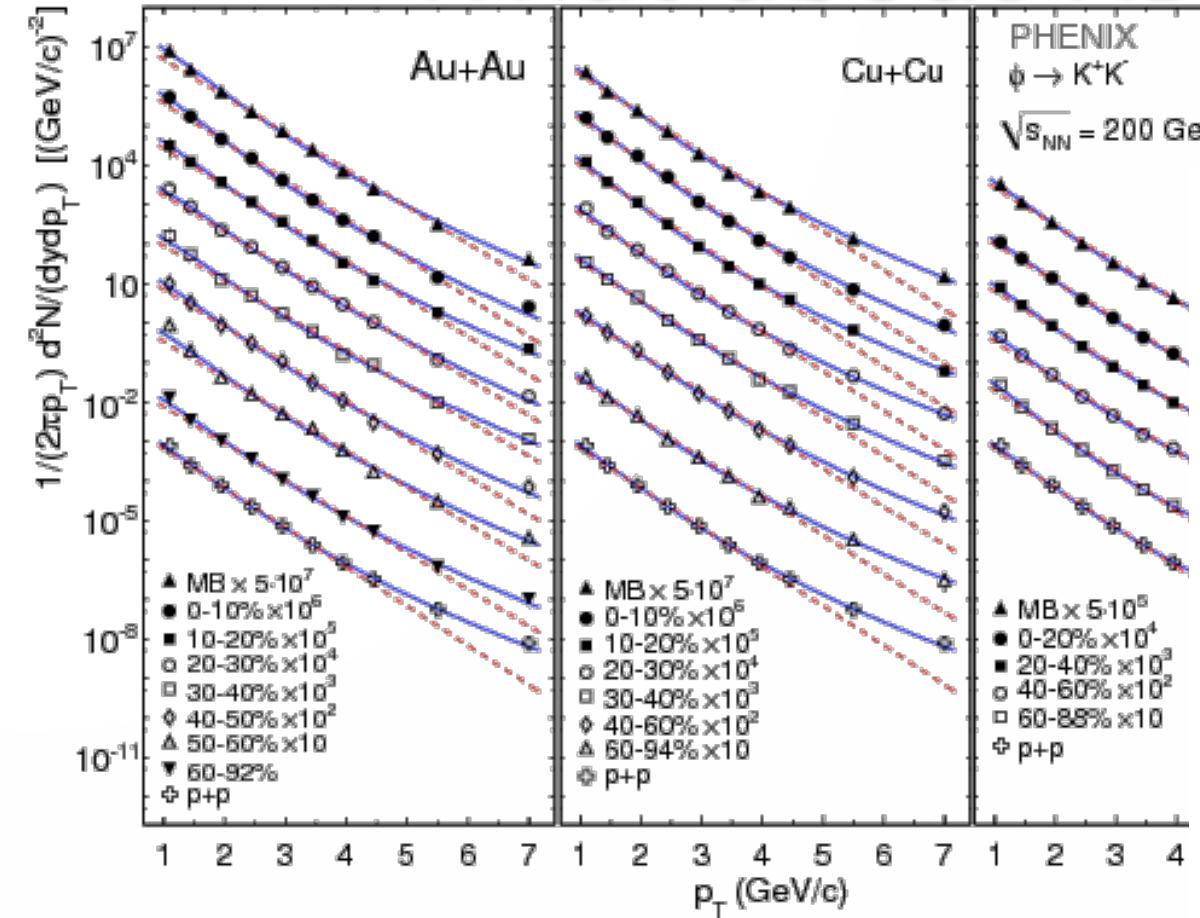


	nT (GeV)	n
CDF 1960GeV	0.917 (0.010)	7.555 (0.024)
UA1 900GeV	1.105 (0.044)	8.926 (0.145)
CDF 630GeV	0.977 (0.042)	8.618 (0.087)
UA1 630GeV	0.854 (0.002)	7.790 (0.007)
UA2 540GeV	0.500 (4.324)	6.504 (0.471)
UA1 540GeV	0.696 (0.015)	7.410 (0.070)
UA1 500GeV	0.940 (0.055)	8.682 (0.216)
UA1 200GeV	1.068 (0.061)	9.808 (0.256)
PHE 200GeV	1.389 (0.102)	10.636 (0.327)

Compilation by a.m. uncert. stat. only. If you want to use it, better check :(

ATLAS used Tsallis form for extrapolation at very low pT. Careful with dN/dy vs. dN/dη

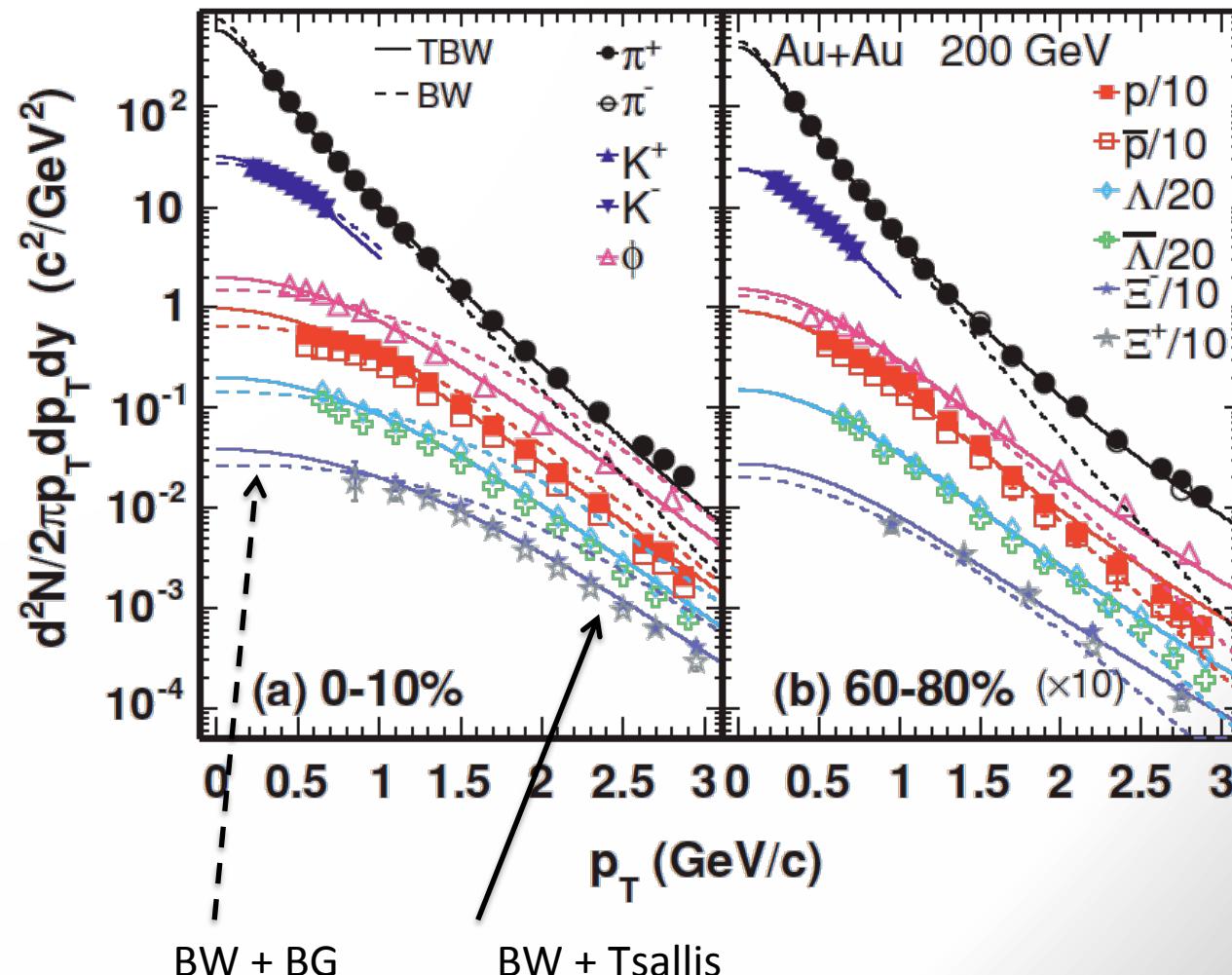
What about HI data?



It still fits very well, but in my opinion it should not

Tsallis Blast Wave Fit in AuAu

Phys. Rev. C 79:051901(R), 2009



Summary

In pp seems to work at all pT

Shows very consistent parameters for all particle species

Clearly different for mesons and baryons

In AA used for low pT mainly.

Improves Blast Wave fits

In p/dA ?

Many “technical” applications:

Extrapolation

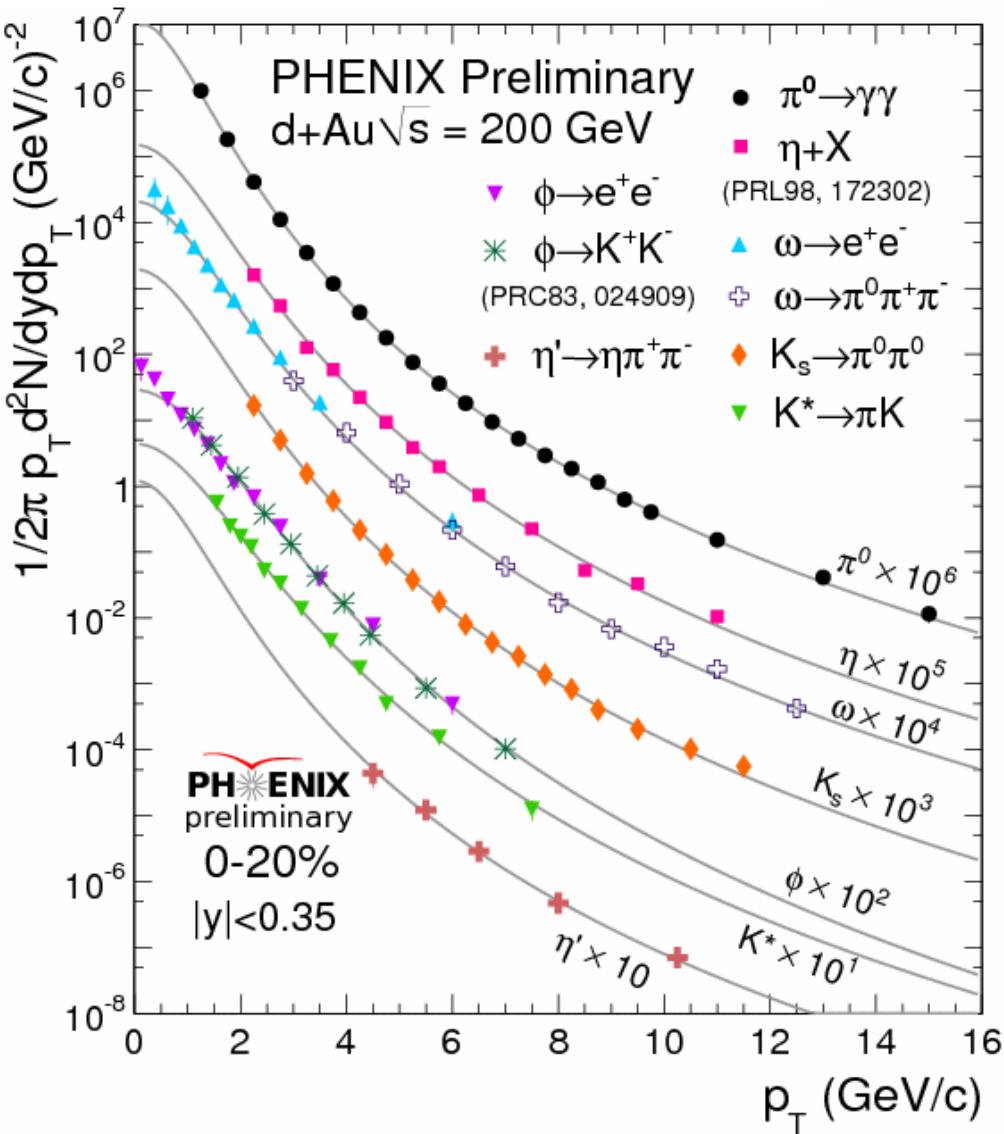
Integration at very low pT

Consistency checks

Systematics

backups

dAu



- ❖ Wide variety of hadrons
- ❖ Production spectra can be described with Tsallis function
- ❖ ToF + heavy hadrons can be added
- ❖ Potential for similar analysis of fit parameters