Erice School of Nuclear Physics
September 2016

Hadron Formation and the Statistical Model at low Energy (SPS, NICA, FAIR)

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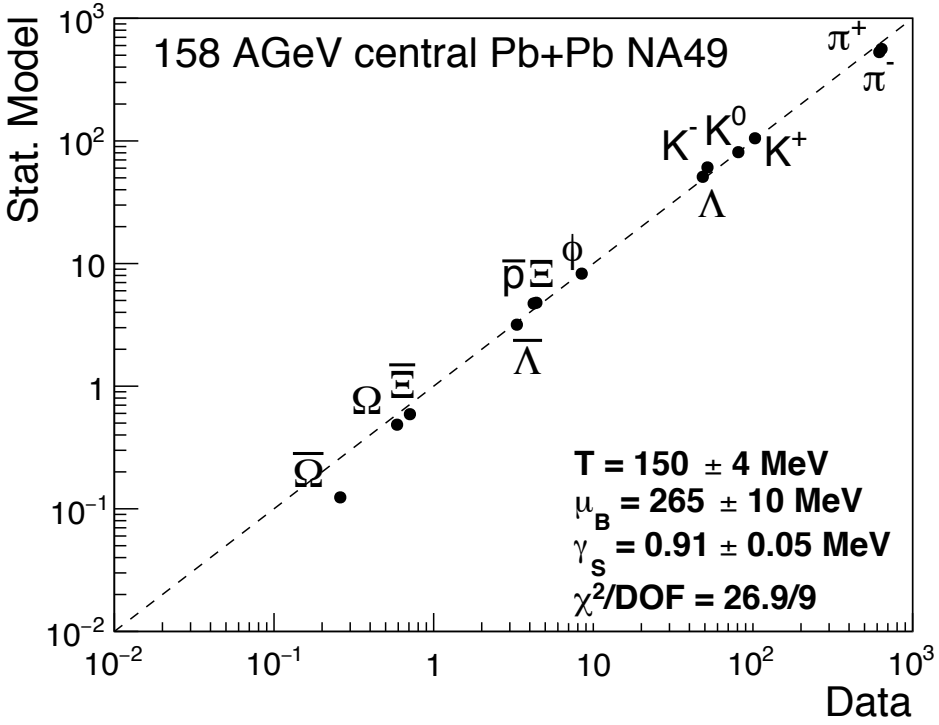
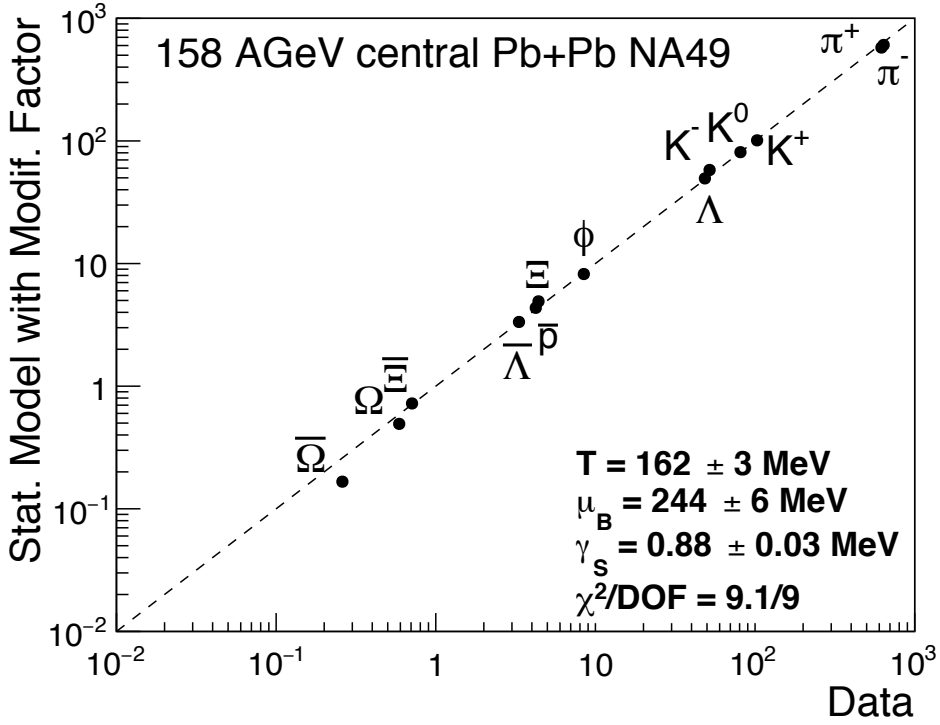
State of the art:
SHM Data Analysis with UrQMD Modification

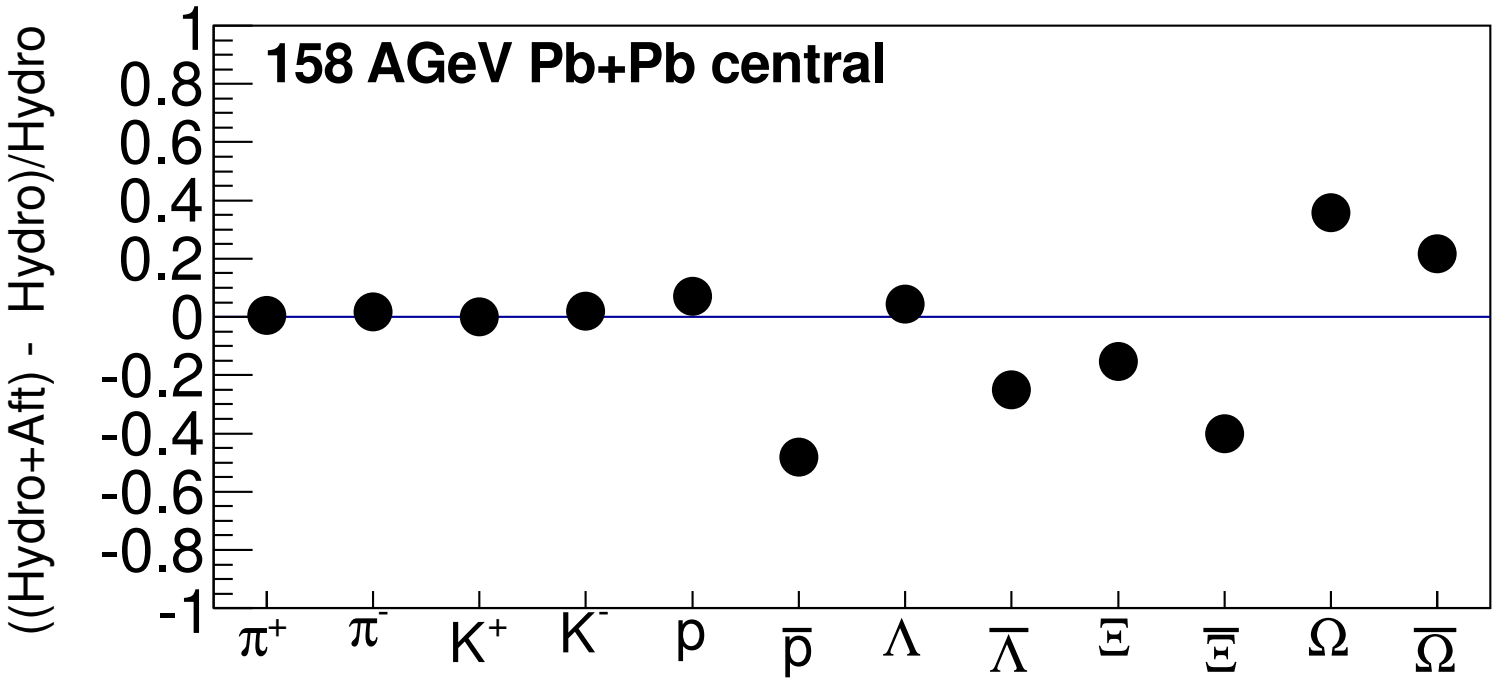
Example: Pb+Pb central NA49 at SPS
T increases by 12 MeV
chi^2/dof decreases





Corrections to SHM

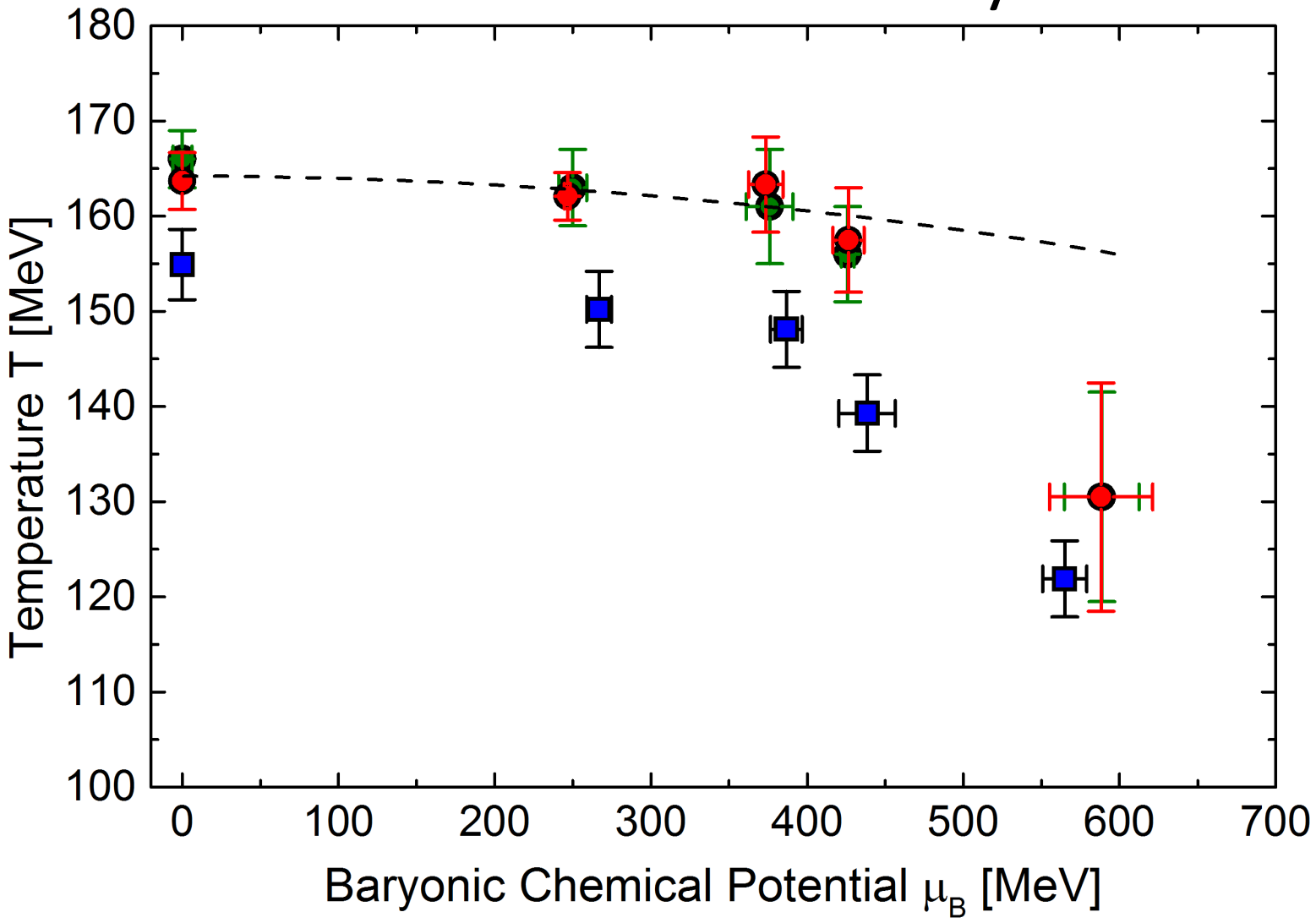
Revisit the hadronic-expansions stage:
UrQMD study of afterburner effects



Modification factors for hadronic Multiplicities
Baryon-Antibaryon annihilation effects

Bulk Hadrons nearly unaffected

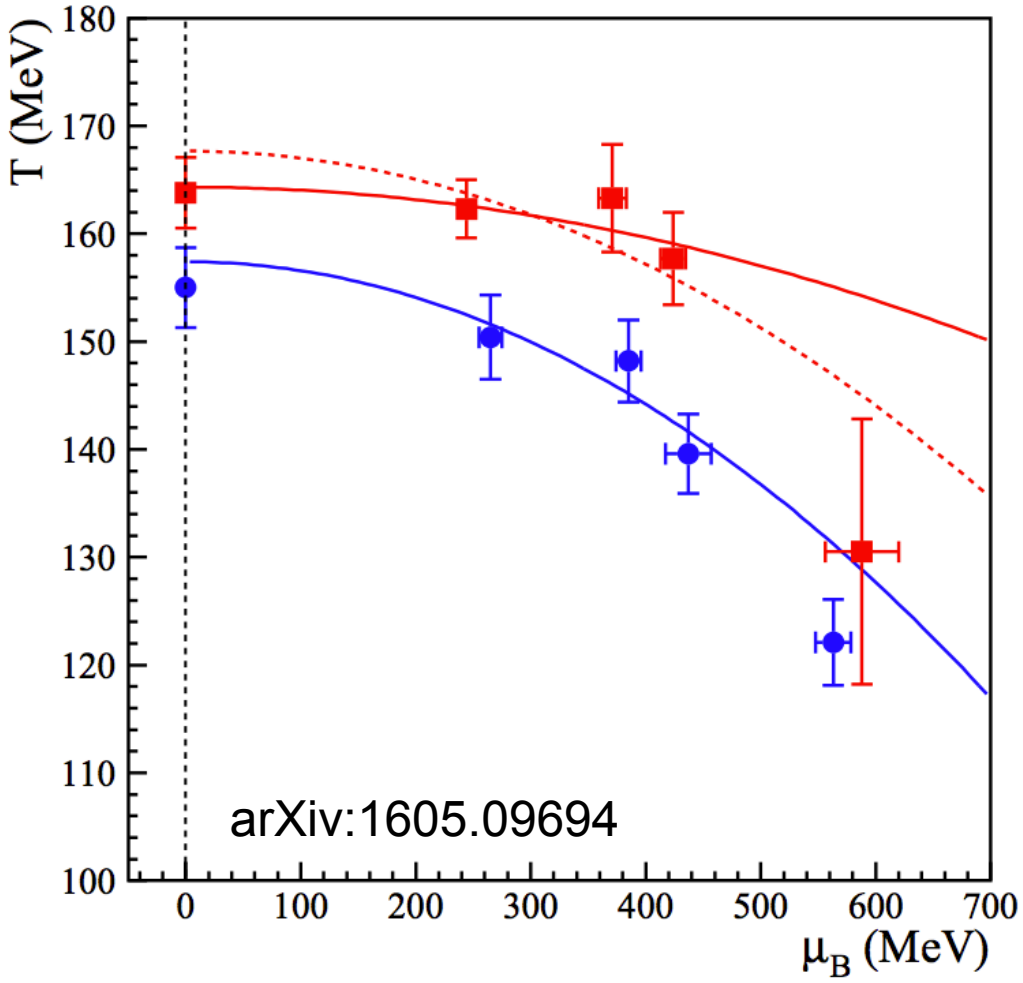
The Phase Boundary from Statistical Model Analysis



State of the art.

F. Becattini et al. arXiv: 1605.09694

The QCD Phase Boundary : AGS, SPS, LHC

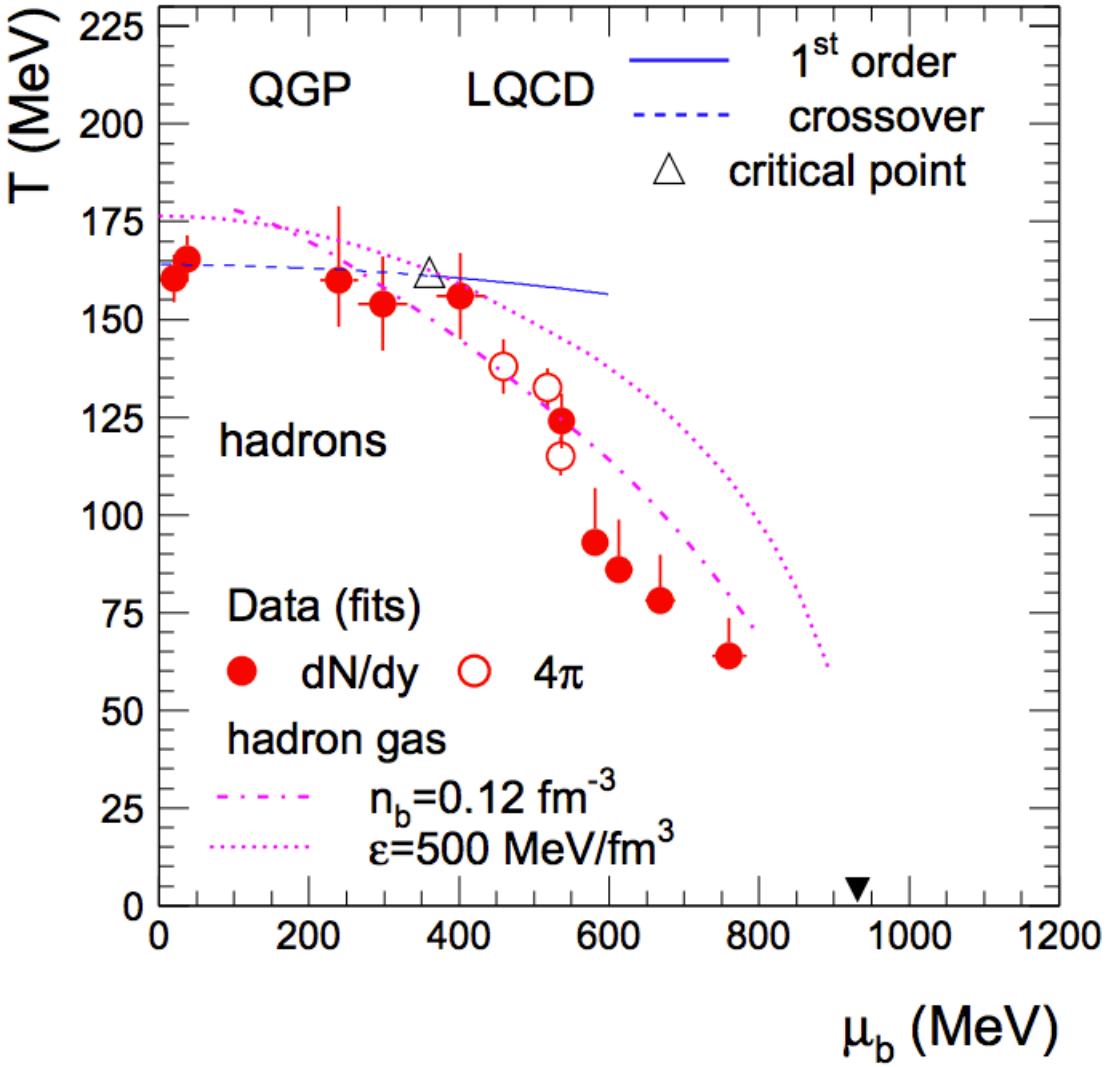


- low curvature up to mu(B)= 400MeV
- in agreement with lattice predictions

O. Kaczmarek et al. , PRD 83 (2011)
P. Hedge et al. , arXiv: 1511.03378
G. Enrodi et al. , JHEP 1104 (2011)

Abrupt drop-off beyond mu(B)=400MeV
see also A.Andronic et al. , Nucl. Phys. A772 (2006)

Statistical Model Results down to SIS



• not compatible with smooth interpolations

Abrupt drop-off beyond mu(B)=400MeV

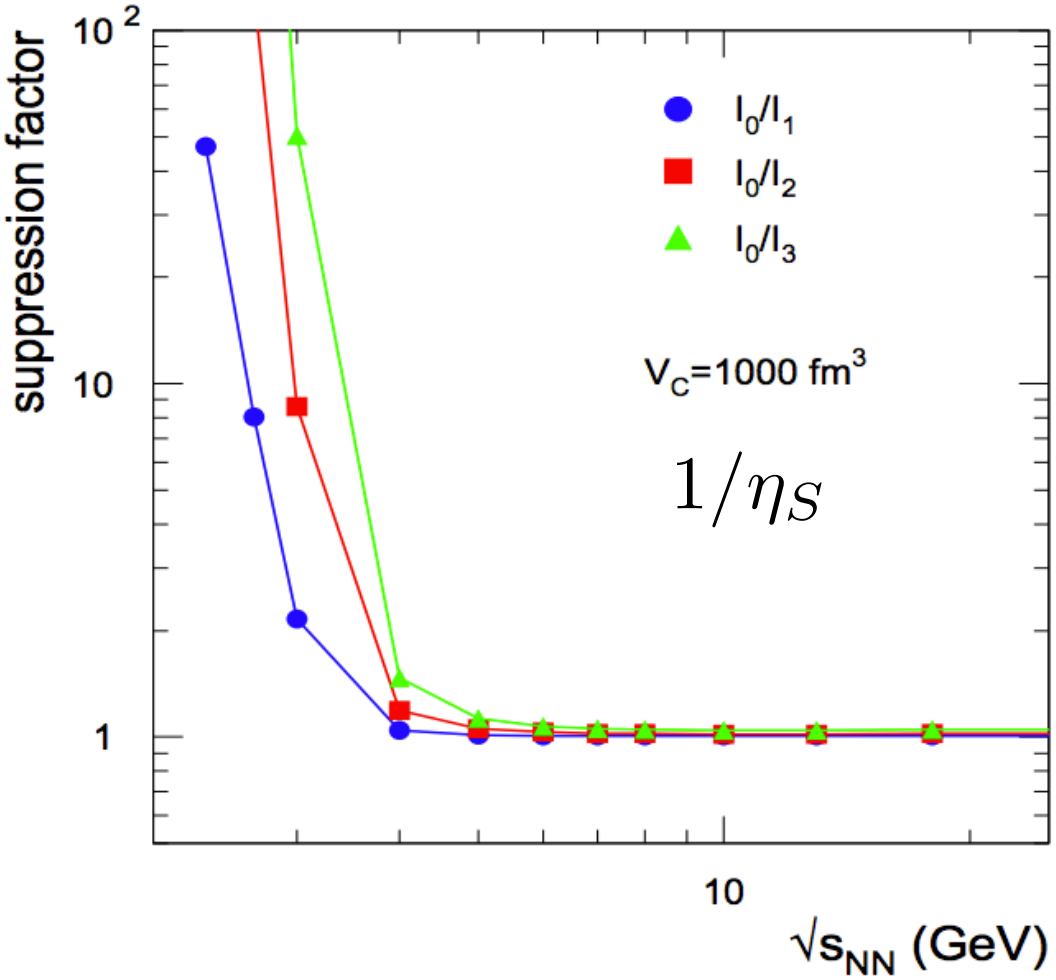
A.Andronic et al. , Nucl. Phys. A772 (2006)

High Baryochemical Potential

Specific high μ_B phenomena:

- canonical strangeness suppression
- critical point
- purely hadronic dynamics below „onset of deconfinement“

Canonical Suppression of Strangeness



$$n_{iS}^{can} = n_{iS}^{GC} \cdot \eta_{iS}$$

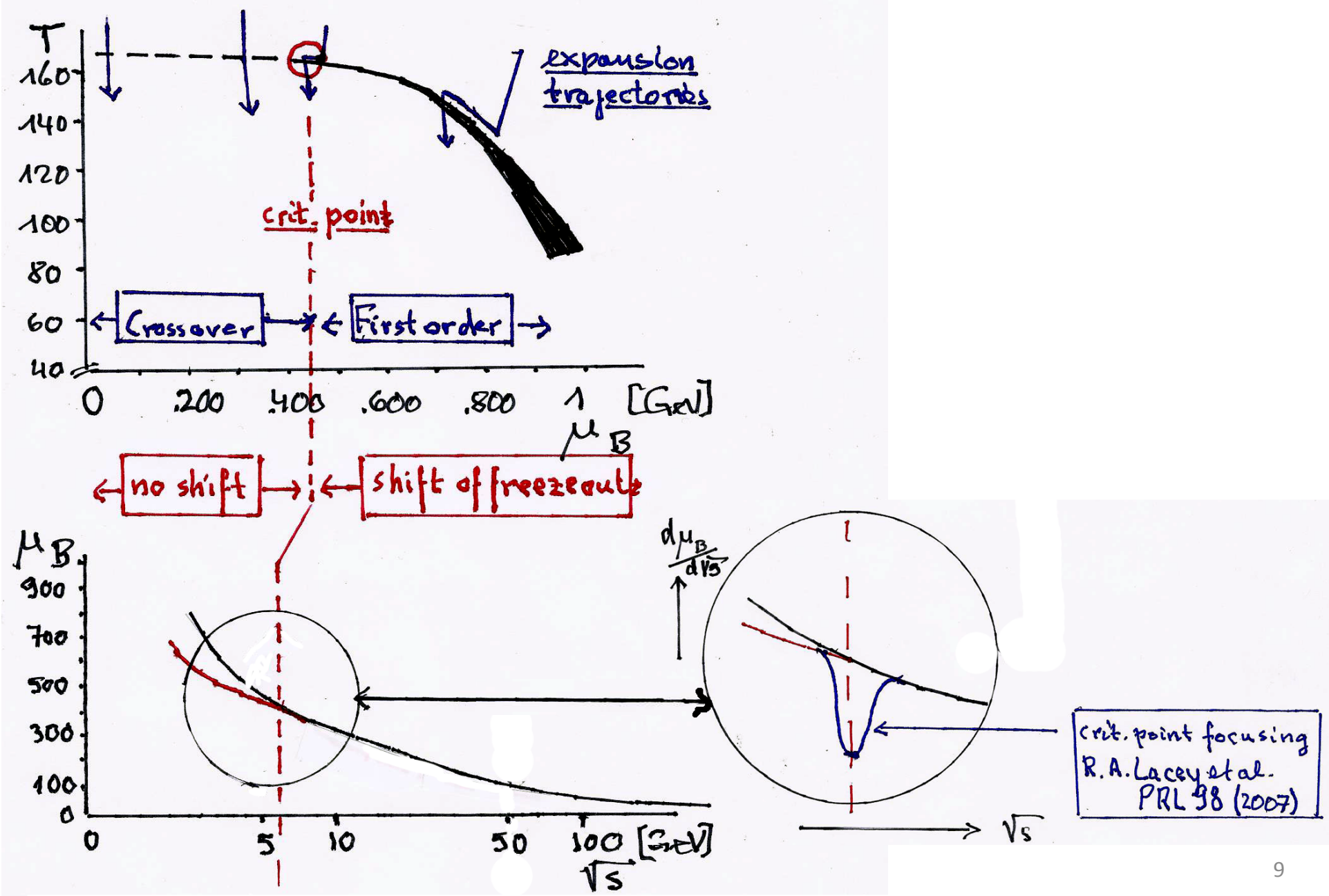
$$s = \pm 1, \pm 2, \pm 3$$

$$\eta_{iS} \approx \frac{I_s(x_i)}{I_0(x_i)} \rightarrow 1 \text{ for large } x_i$$

A. Tounsi and K. Redlich
J. Phys. G28 (2002) 2095

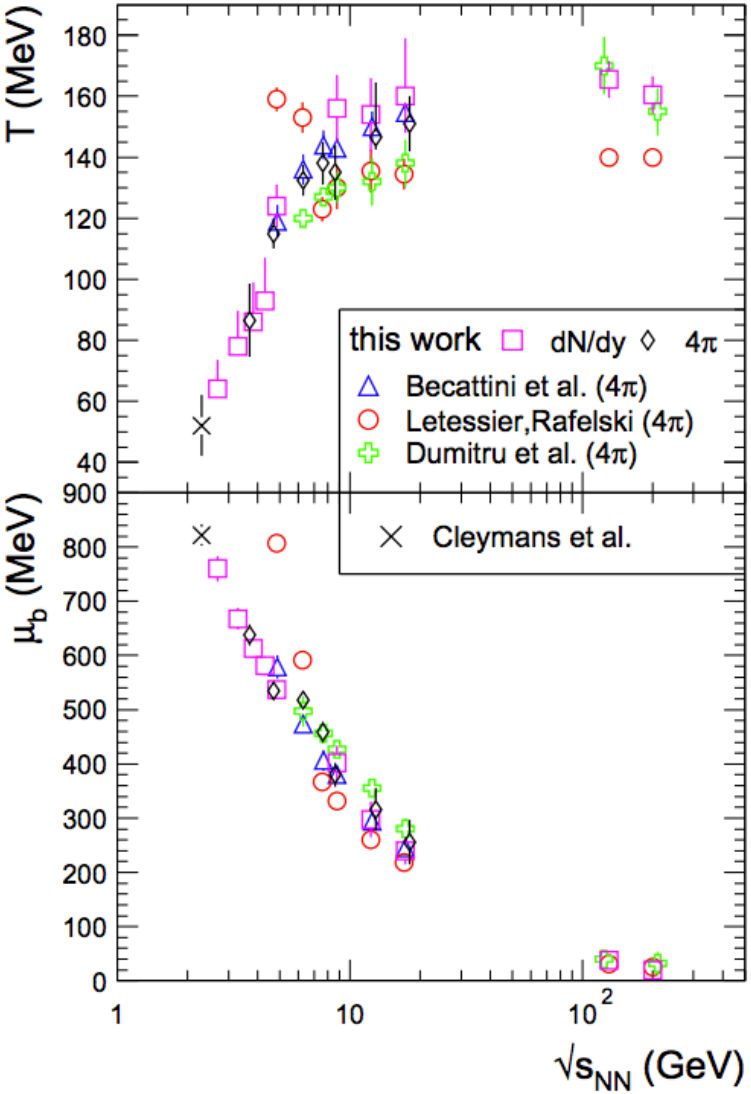
A.Andronic et al. , Nucl. Phys. A772 (2006)

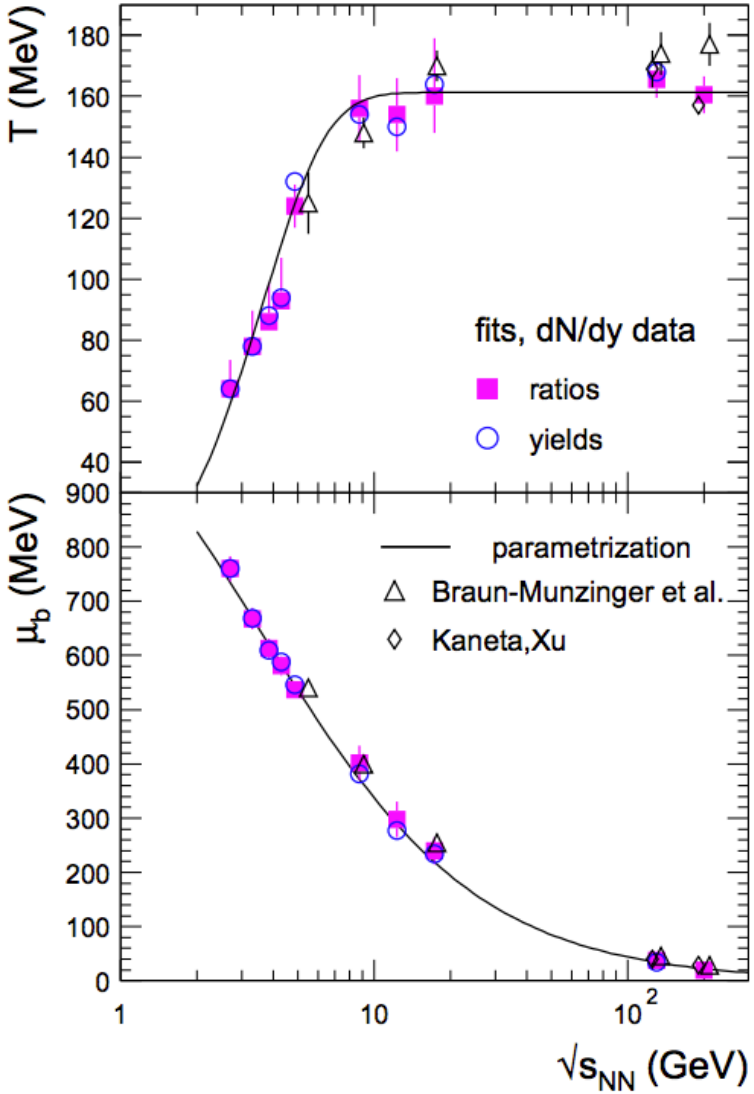
Search for the Critical Point of QCD



State of the art: μ_B vs. $\sqrt{s}$

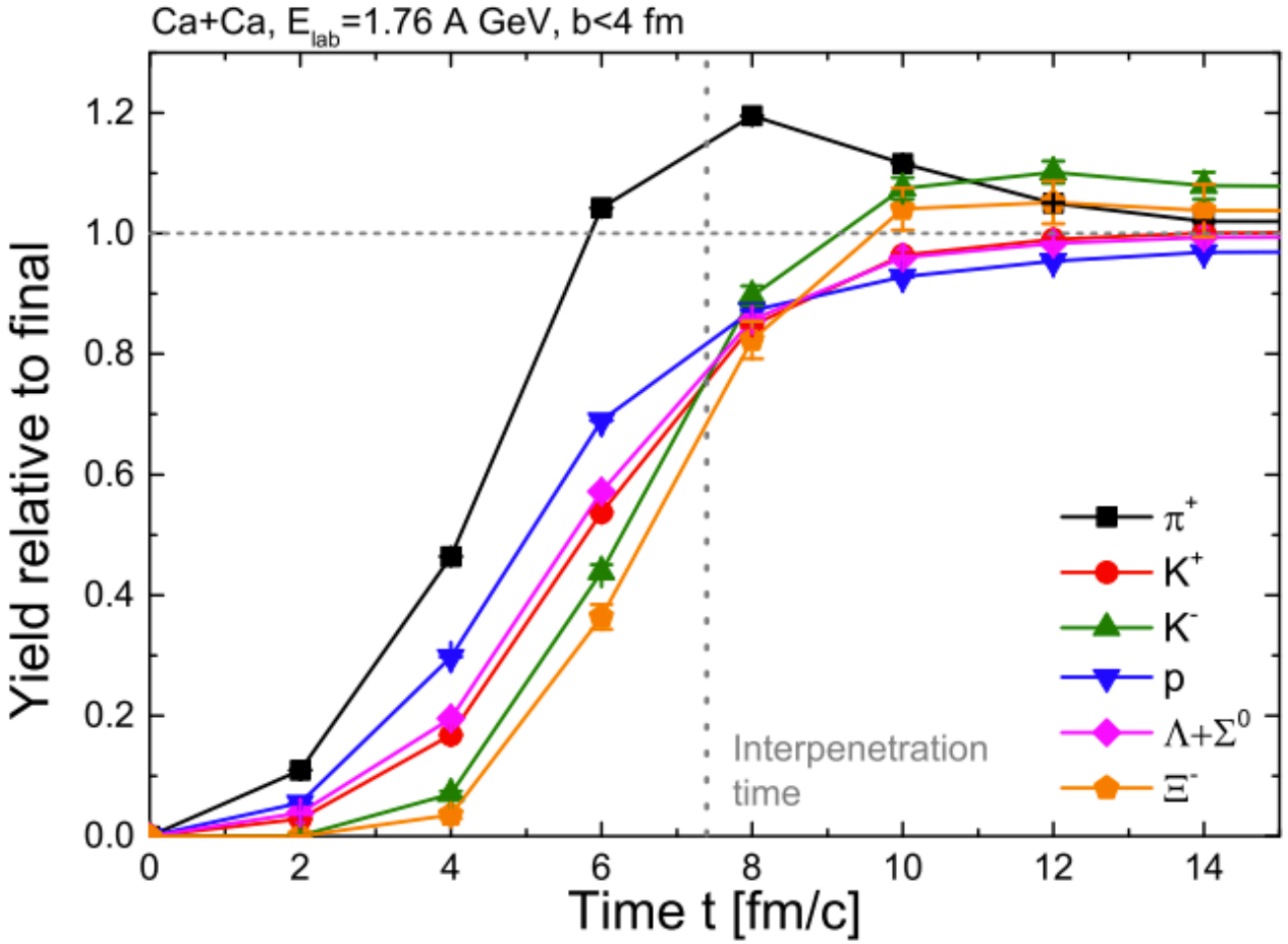
A.Andronic et al. , Nucl. Phys. A772 (2006)





Inadequate for our purpose!

Dynamics below the „onset of deconfinement“

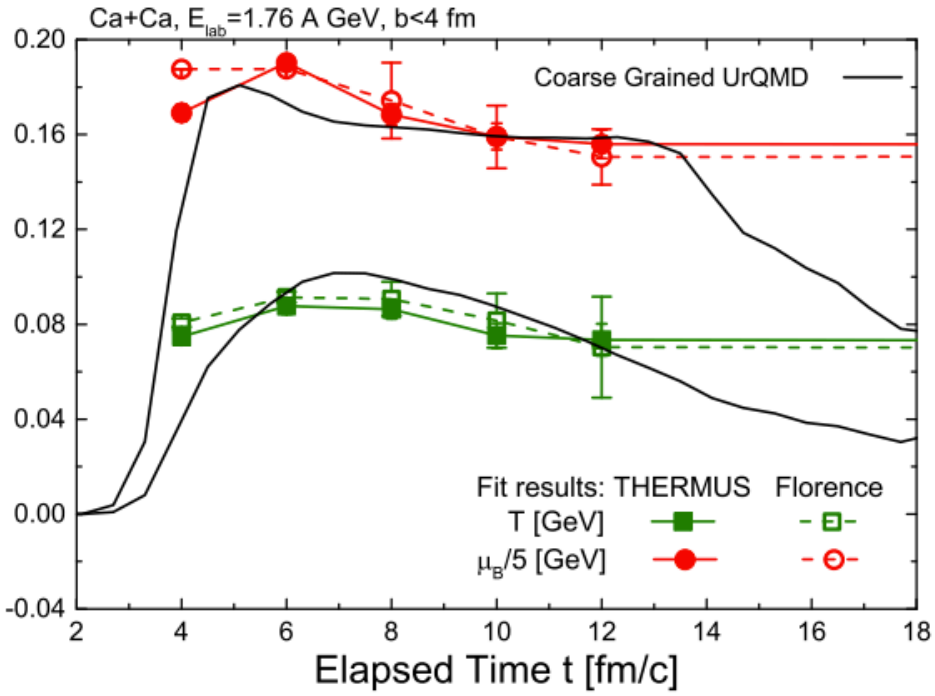


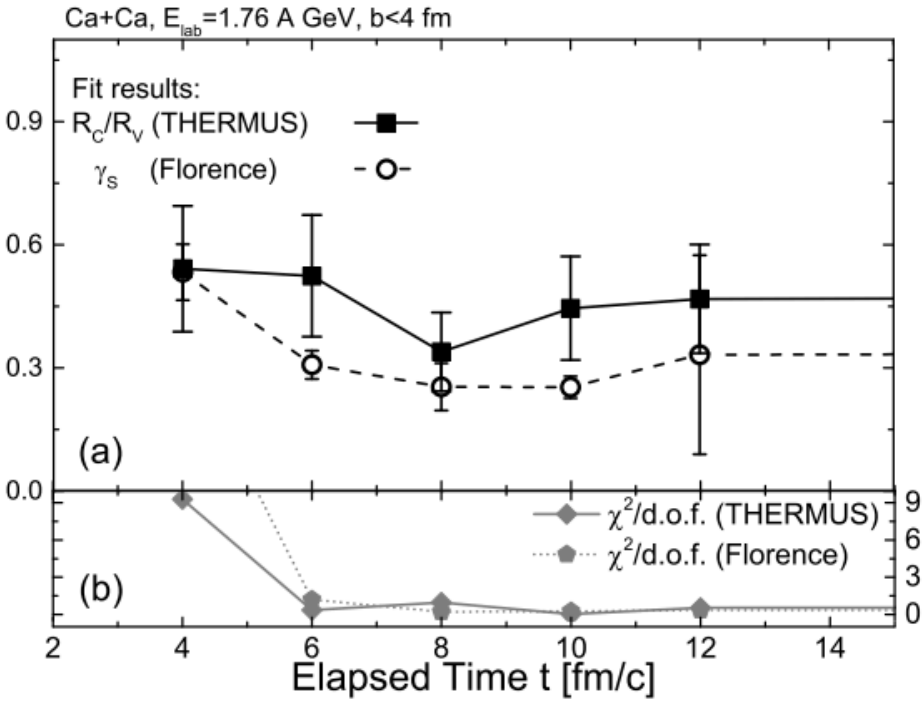
J. Steinheimer et al.
arXiv: 1603.02051

- subthreshold for all strange particles!
- all yields are essentially resonance decays
- recall hadronization theory!

SHM Analysis of SIS Data

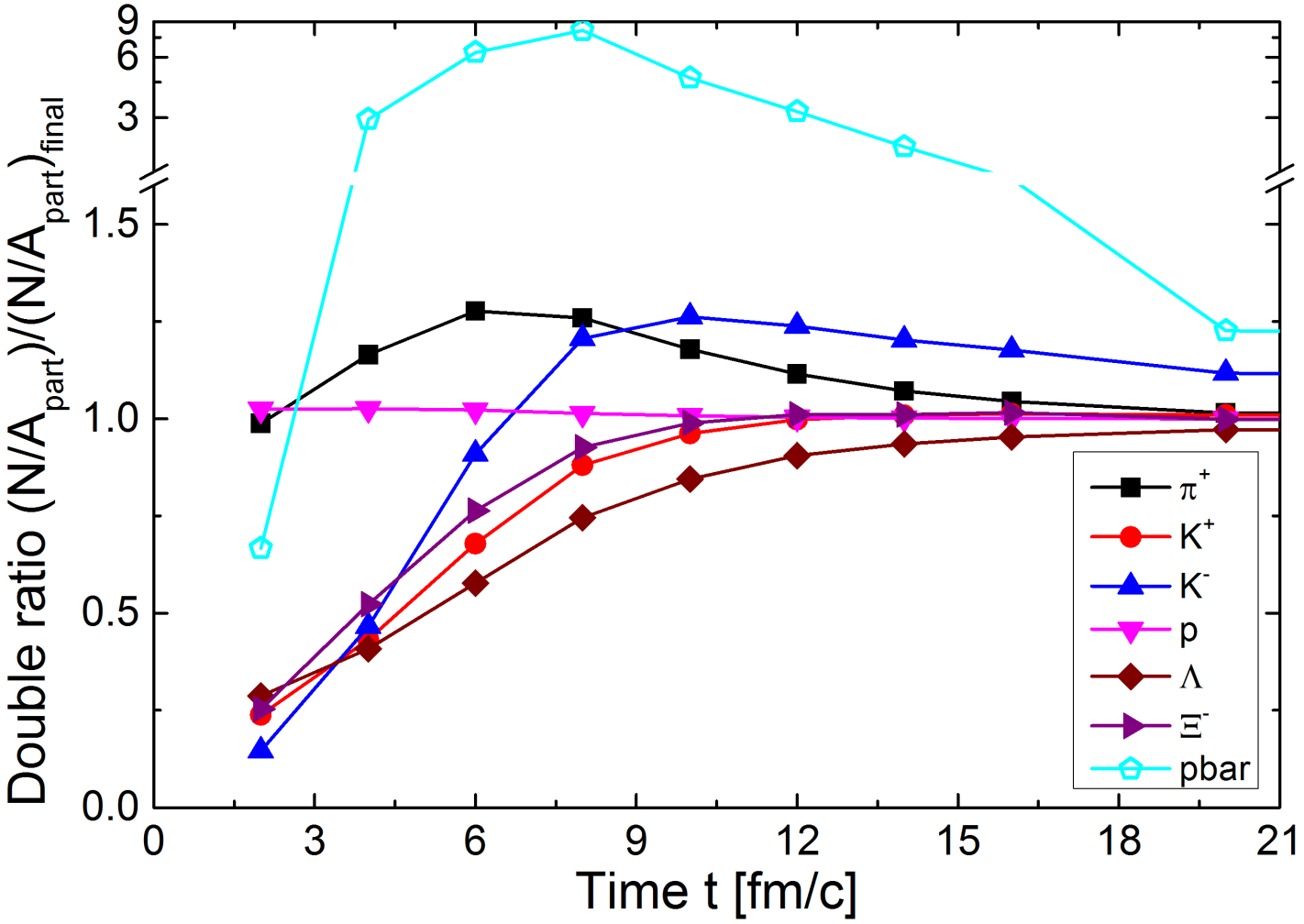
J. Steinheimer et al. arXiv: 1603.02051





- T, γ_S, and μ_B constant after interpenetration time
- are the data canonic or grand canonic?

UrQMD at 6 AGeV

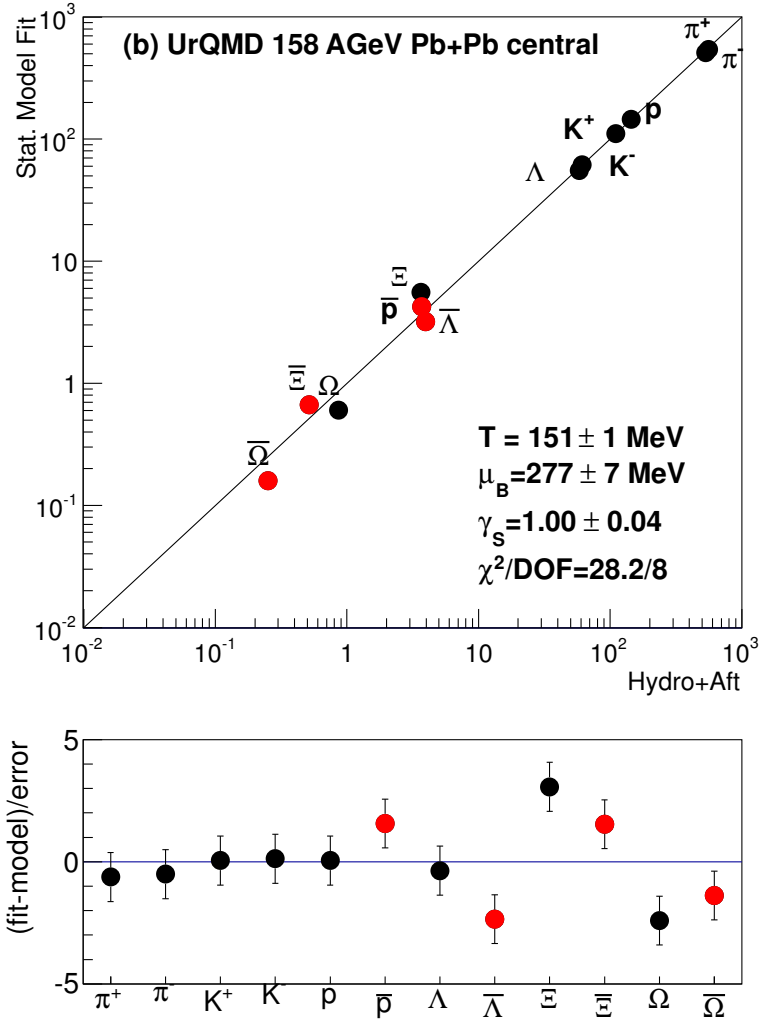


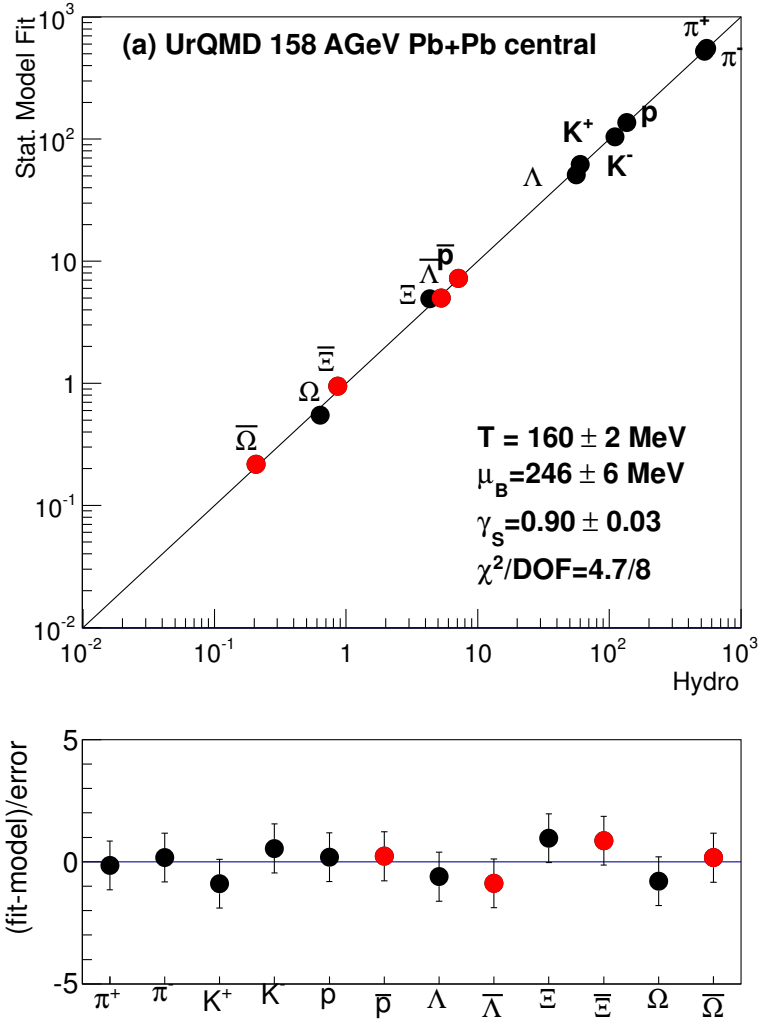
- similar pattern above thresholds
- wait for FAIR and NICA

Backup

Combining UrQMD with the Stat. Model

- drastic chi^2/dof improvement
- T rises above traditional SHM



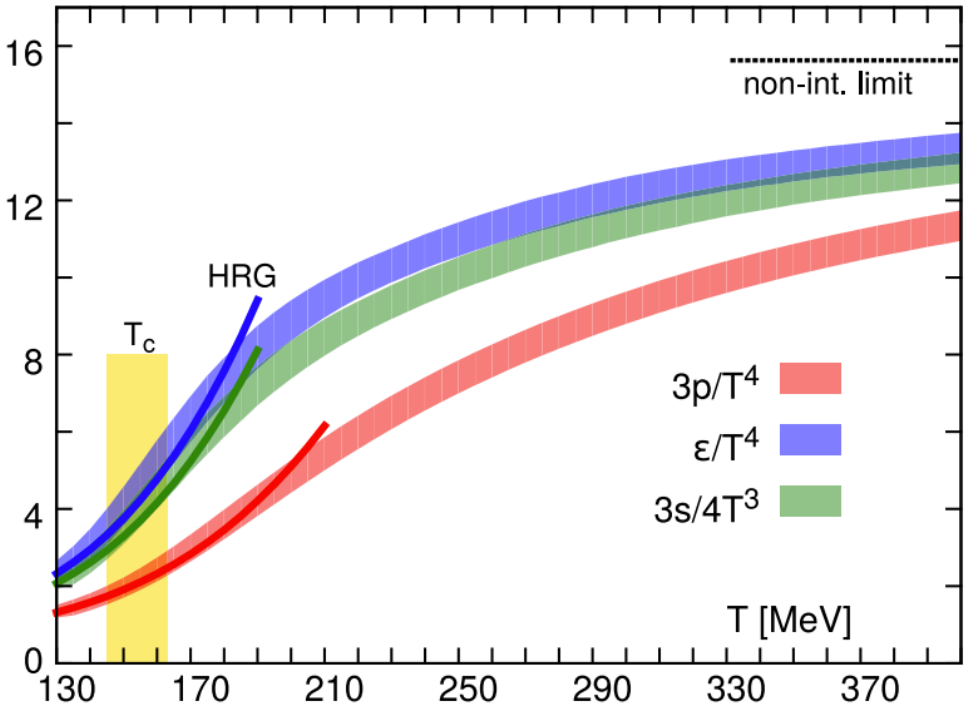


Tensions concerning T_c

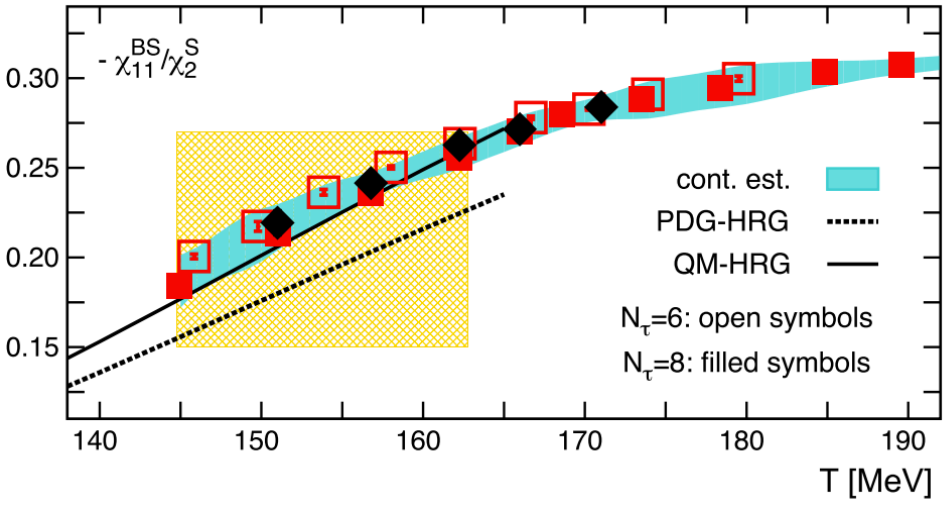
- We report T(c)=163MeV, similar to e+e- -> hadrons

- Lattice matching to Hadron Gas (HRG) reports T(c)=150MeV

A. Bazavov et al. , PRD 90 (2014)



A. Bazavov et al. , PRL 113 (2014)



Open Question!