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Hadronic Freeze-Out in A+A Collisions

Effects of Inelasticity and Annihilation/Regeneration

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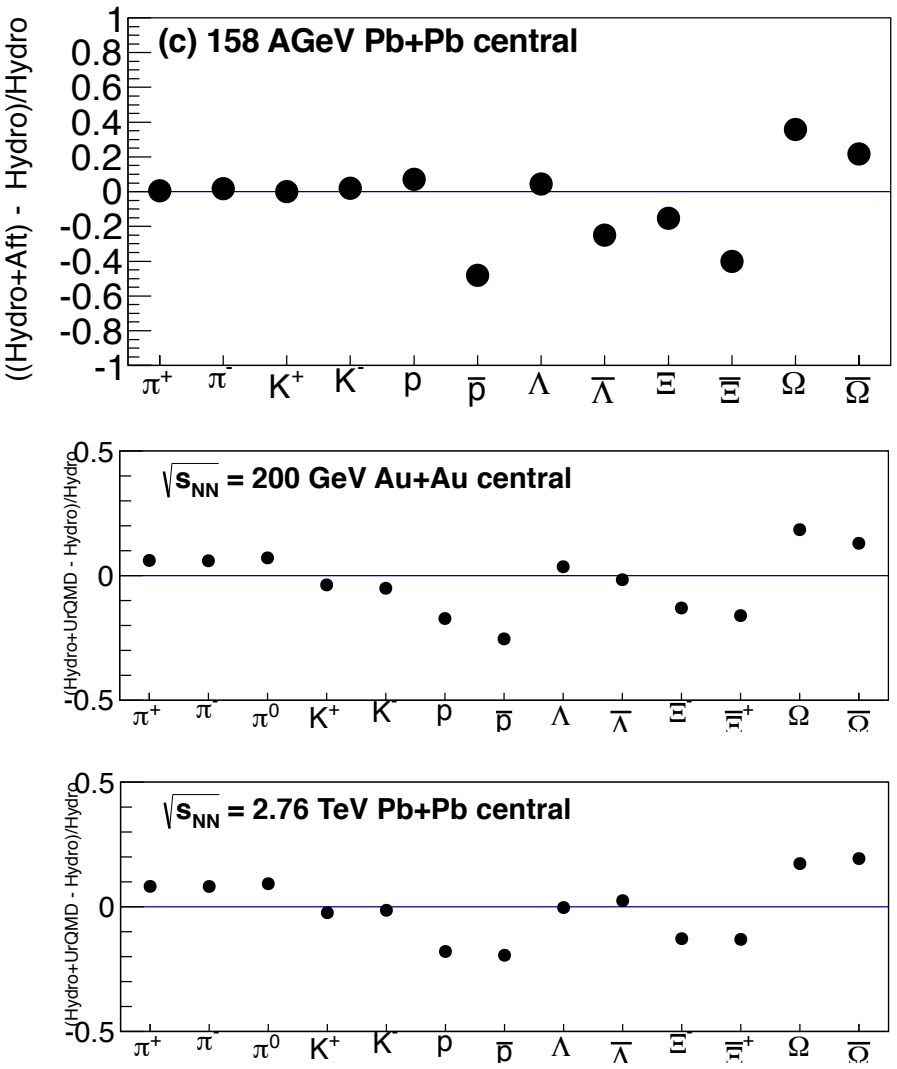
GOETHE UNIVERSITÄT FRANKFURT AM MAIN

UrQMD Study of Hadronic Expansion Effects on Hadron Yields



- Employ the recent hybrid version of UrQMD:
  - Hydrodynamic (3+1) phase until energy density < 1 GeV/fm3, plus hadronic emission à la Cooper-Frye.
  - Attach UrQMD hadronic expansion as an "afterburner" stage.

- Compare hadronic yields directly after Cooper-Frye with those after the "afterburner" stage.

SERIOUS ANNIHILATION EFFECTS in baryon and antibaryon sector!

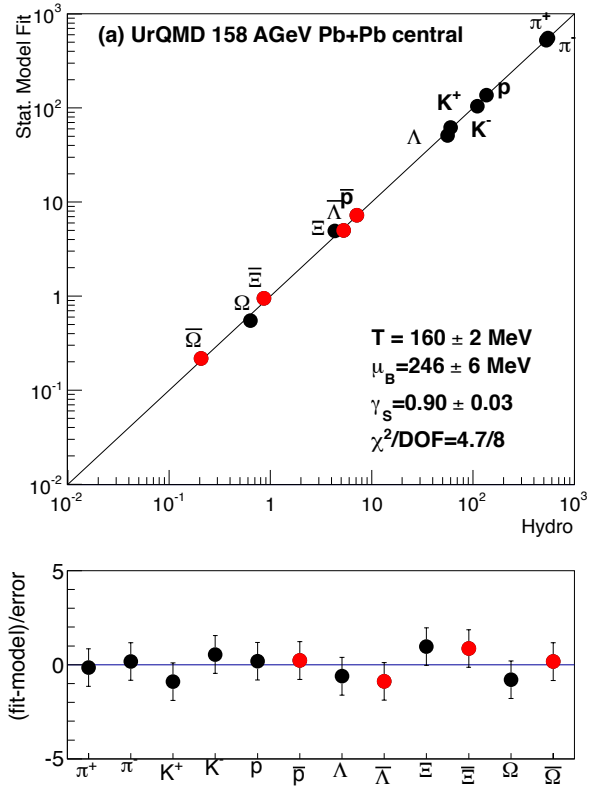
- At SPS: selective annihilation of $\bar{p}$, $\bar{\Lambda}$ and $\bar{\Xi}$. The rest essentially unaffected.

- At RHIC and LHC: annihilation tends to be symmetric for baryons and antibaryons; $\Lambda/\bar{\Lambda}$ unaffected, while Ω and $\bar{\Omega}$ are enhanced.

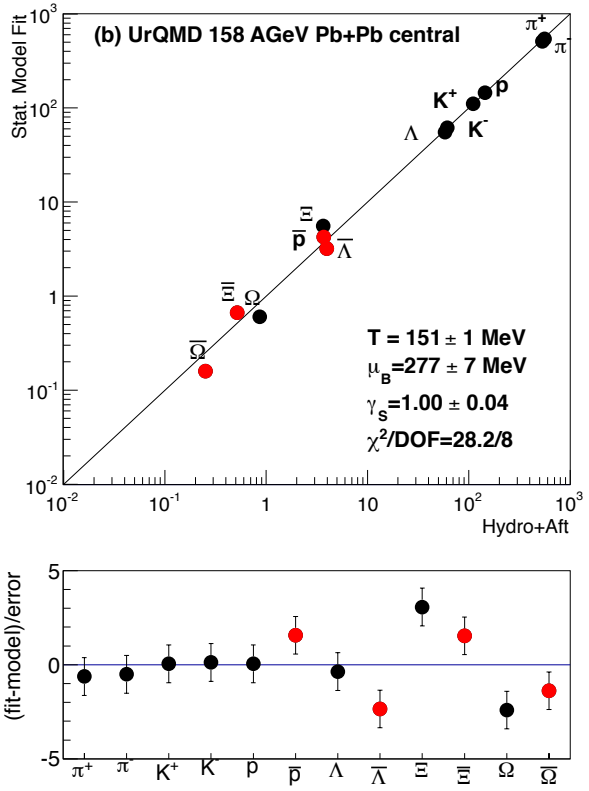
Statistical Model Analysis: UrQMD at SPS Energies

Approach: SM fit to UrQMD "Hydro only" vs. "Hydro plus afterburner"

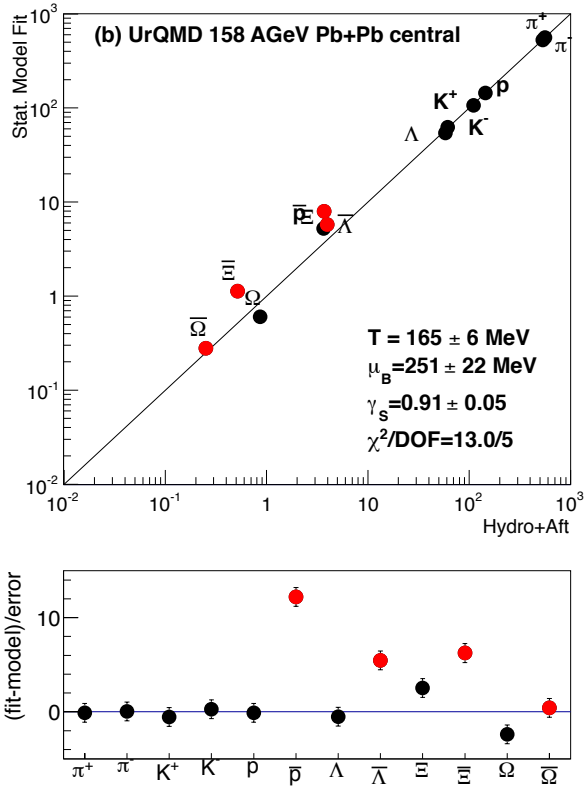
Hydro only



Hydro plus afterburner



Hydro plus afterburner restricted hadron set

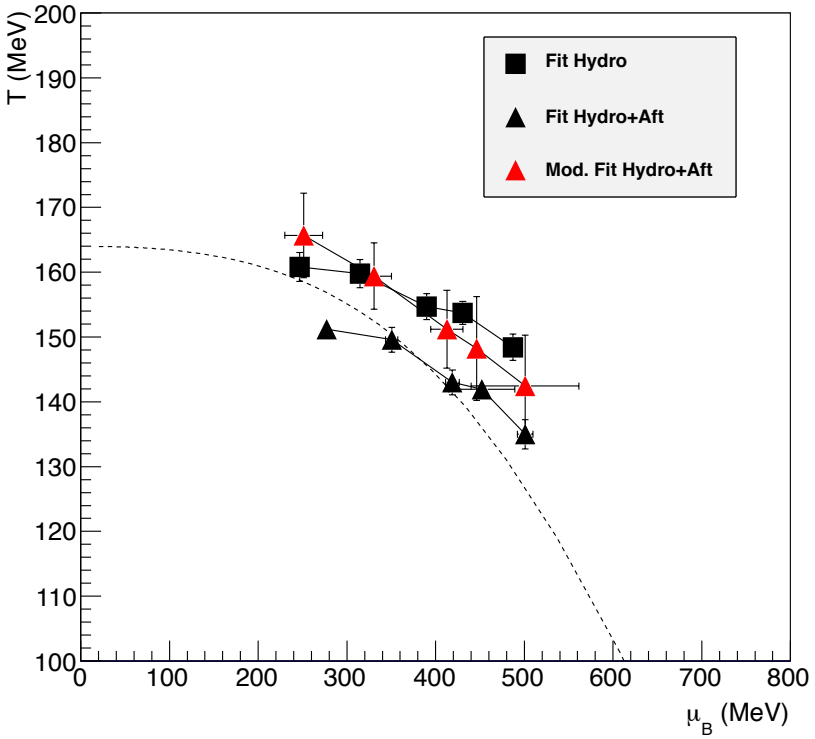


→ The empirical freeze-out curve needs revision!

Statistical Model Analysis: UrQMD at SPS Energies

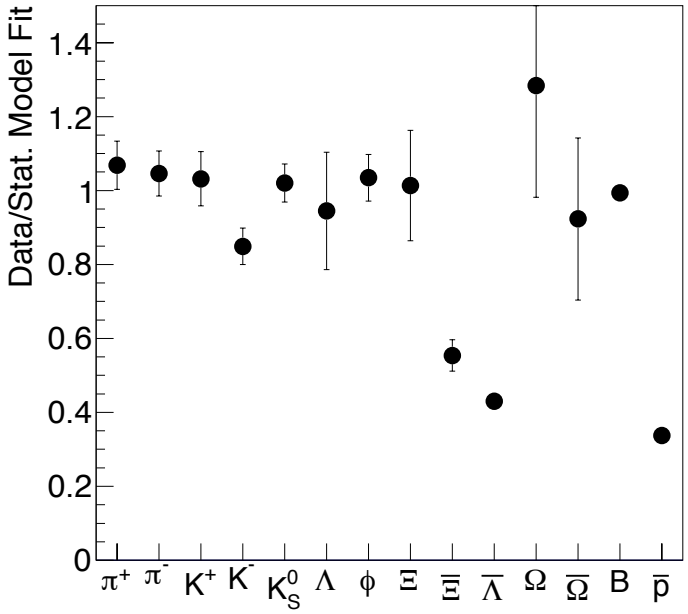
Approach:

- SM fit to UrQMD "Hydro only"
- SM fit to "Hydro plus afterburner"
- SM fit to "Hydro plus afterburner" with restricted hadron set

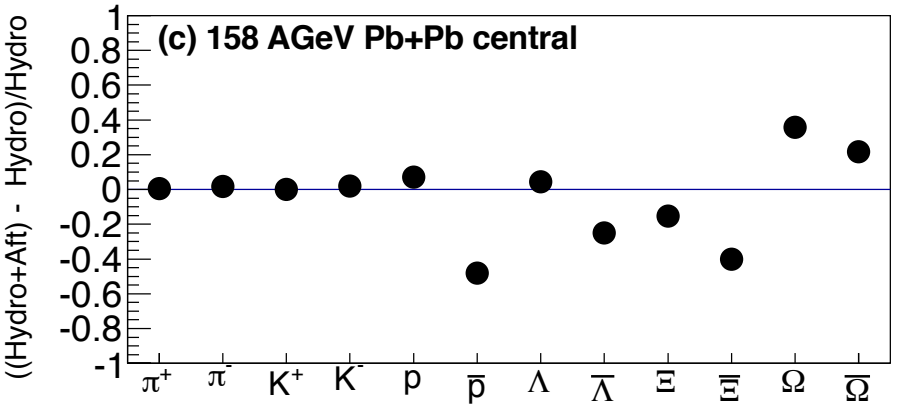


A modified SM fit recovers the original freeze-out curve, the empirical freeze-out curve will move up in *T*

Statistical Model Analysis: NA49 Data



SM fit to NA49 data in full acceptance central Pb+Pb 17.3 GeV OMITTING $\bar{p}$, $\bar{\Lambda}$ and $\bar{\Xi}$ from the fit

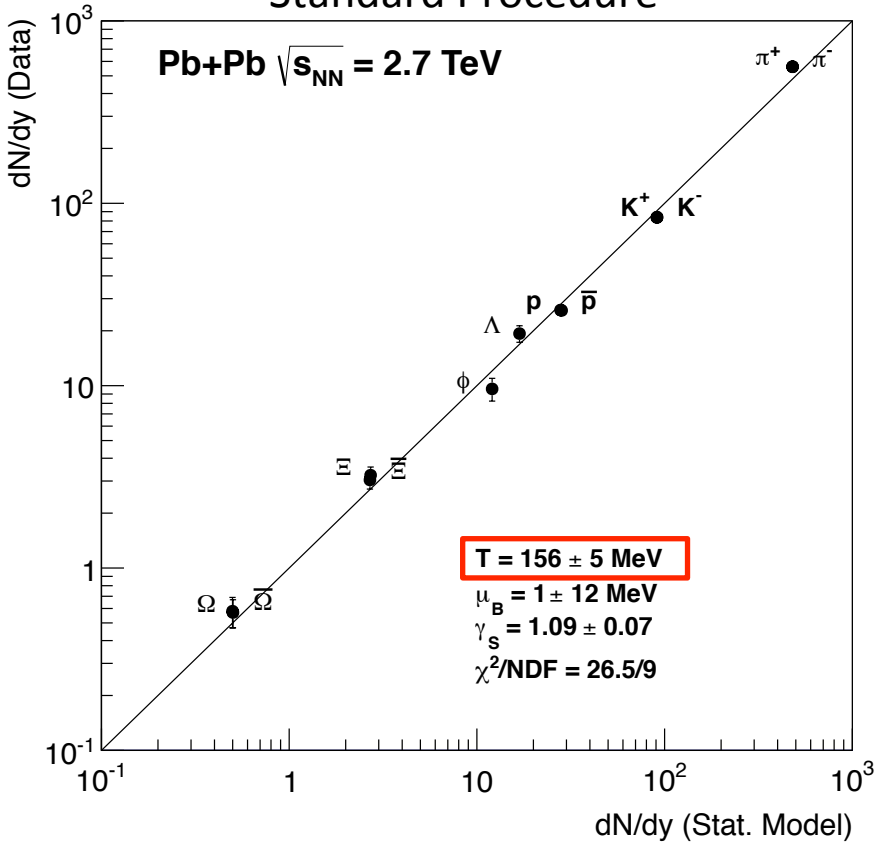


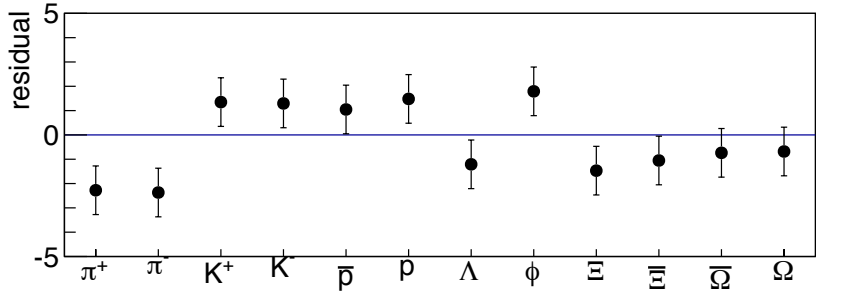
STRIKING SIMILARITY to UrQMD survival plot

Data shows similar selective antibaryon deficits as predicted by UrQMD

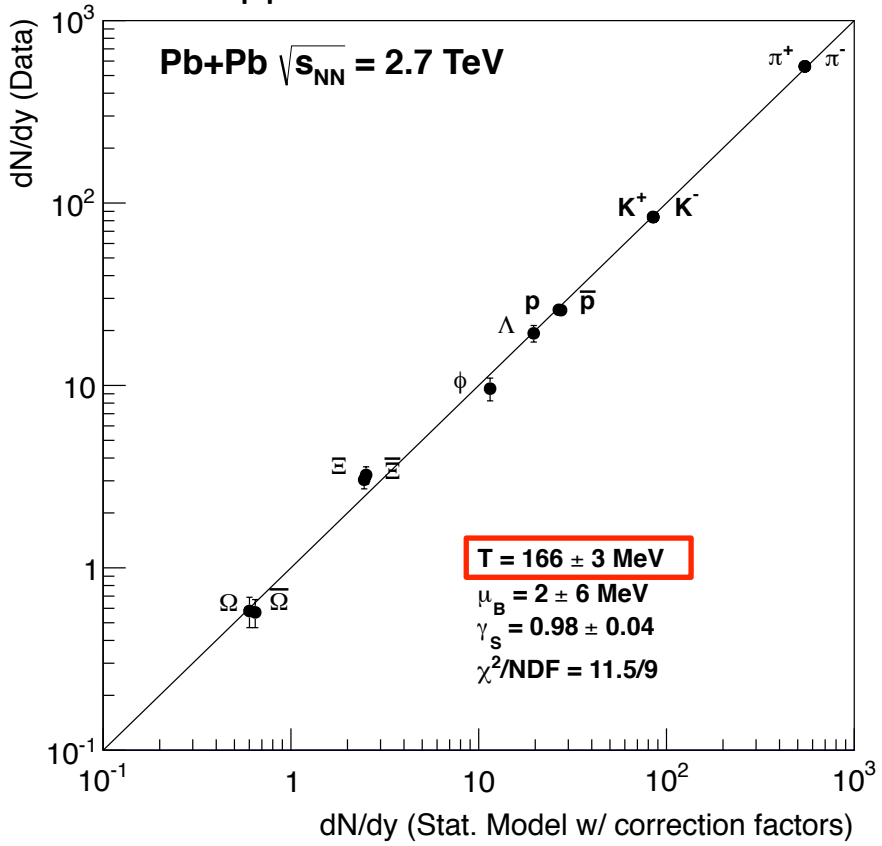
Statistical Model Analysis: ALICE Data

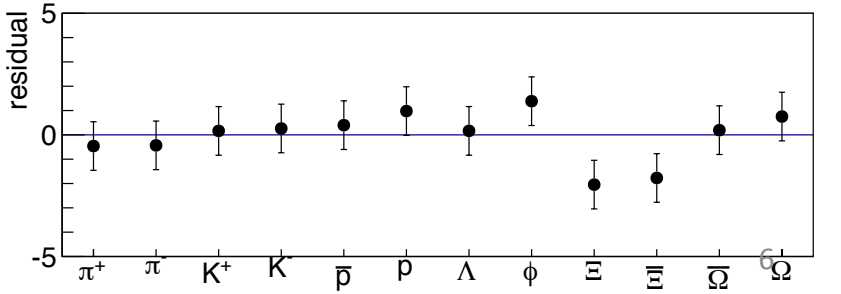
Standard Procedure





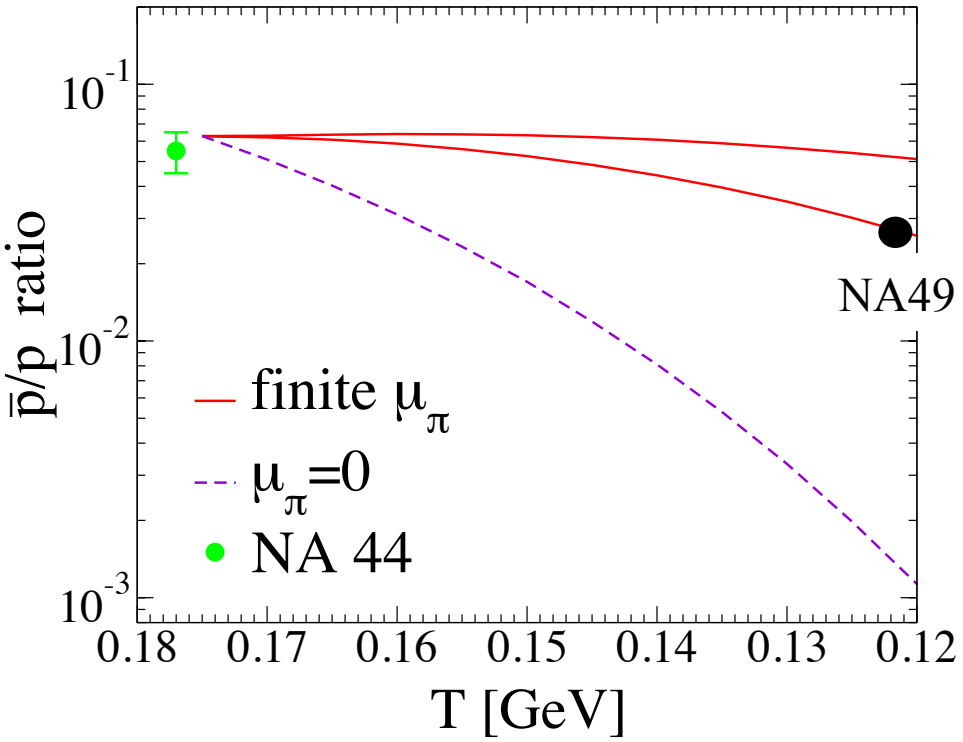
Applied UrQMD Corrections





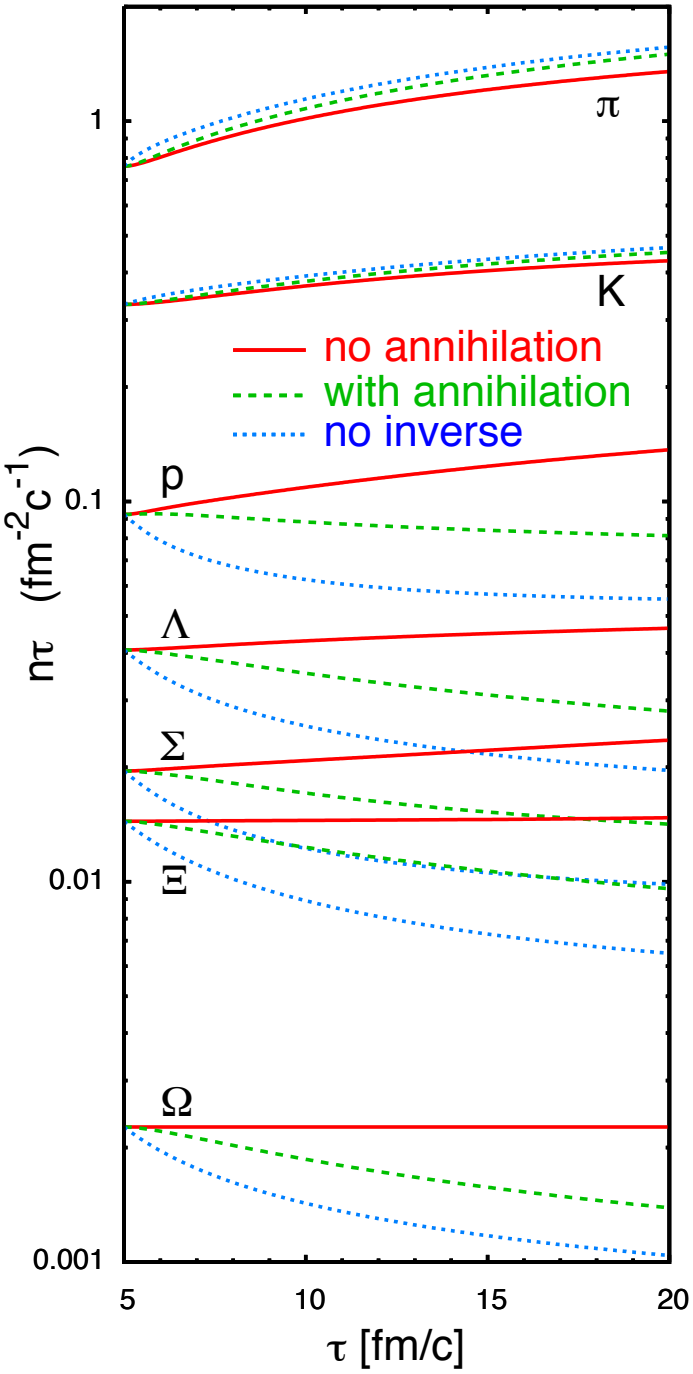
R.Rapp and E.Shuryak (arXiv 0008.326)

- Top SPS energy 17.3 GeV
- 3-dim. Blast-Wave-Model
- pbar regeneration by inverse annihilation



driven by substantial pion chemical potential due to pion oversaturation

overall 50% antiproton loss remaining



Y.Pan and S.Pratt (arXiv: 1210.1577)

- 1-dim. Bjorken expansion
- Rate equations
- Inverse reaction 5pions ➔ p pbar + X

All baryons/anti-baryons yields drop by about 40%

Freeze-out revisited: The Phase Diagram