Deep Sub-threshold Hyperon Production in the UrQMD Transport Model

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Transport Meeting
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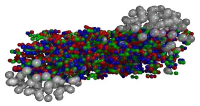
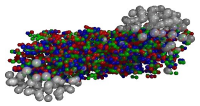
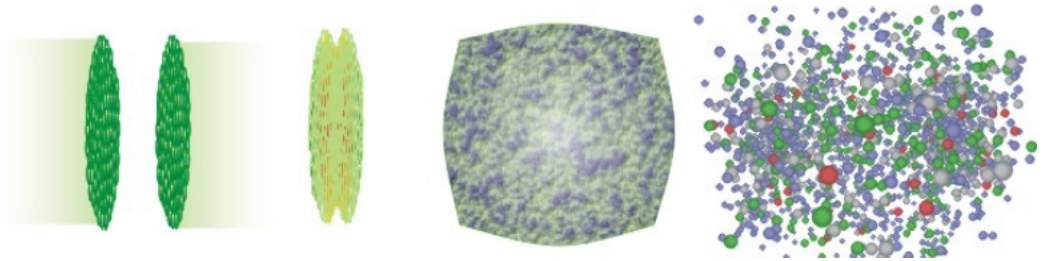


Outline

- Introduction
  - UrQMD
  - Low energy strangeness production
- Implementation + Results
  - Kaon + Baryon strangeness exchange
  - Hyperon + Hyperon strangeness exchange



The UrQMD model



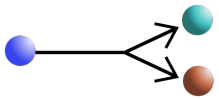
UrQMD = Ultrarelativistic Quantum Molecular Dynamics

Microscopic transport model with full phase space information

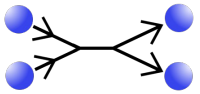
$$\frac{\partial x}{\partial t}\frac{\partial f(x,p)}{\partial x} + \frac{\partial p}{\partial t}\frac{\partial f(x,p)}{\partial p} + \frac{\partial f(x,p)}{\partial t} = I$$

I = Collision term for baryons and mesons

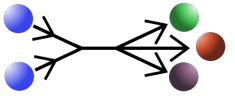
- Decay



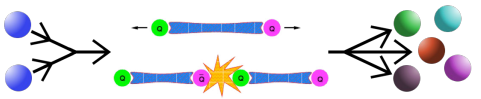
- Elastic collisions

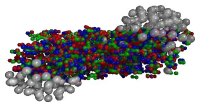


- Inelastic collisions



- String fragmentation





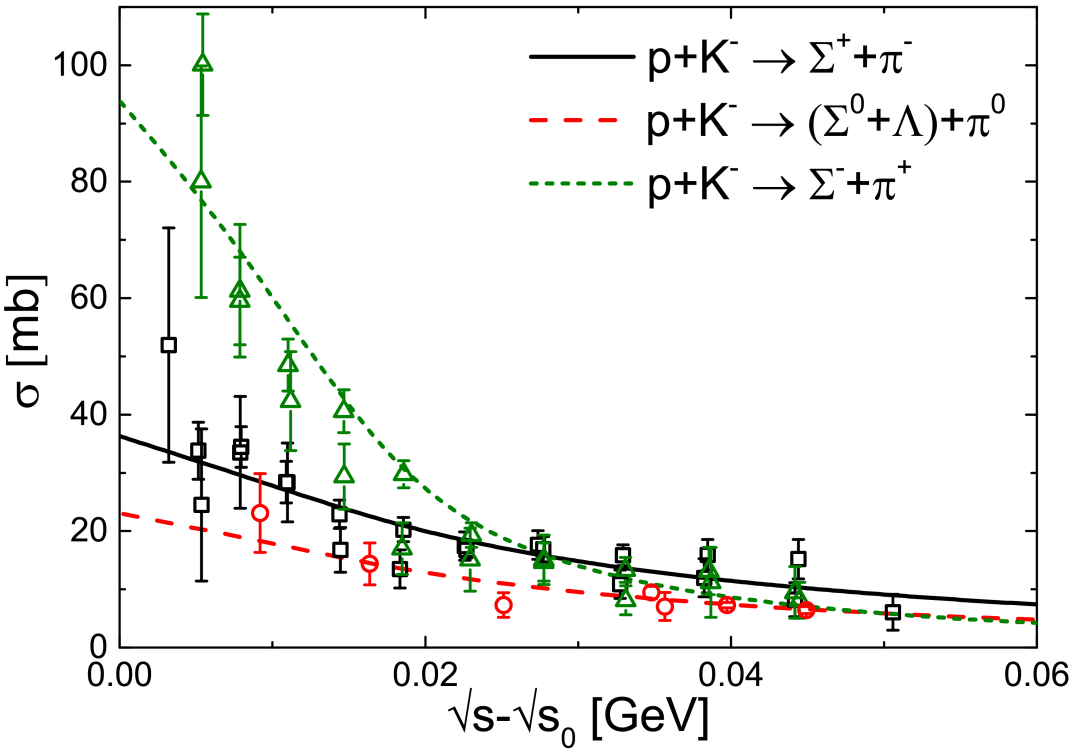
Low energy s-production

Process	Energy [MeV]
$N + \bar{N}$	1876
$K + \bar{K}$	988
$N + N \rightarrow N + K^-/\bar{K}^0 + \Sigma$	748
$N + N \rightarrow N + K^-/\bar{K}^0 + \Lambda$	672
$N + \bar{N} \rightarrow \Lambda + \bar{\Lambda}$	508
$K + \Xi \rightarrow \pi + \Omega$	1
$\Lambda + K^+/K^0 \rightarrow \pi + \Xi$	-157
$\Sigma + K^+/K^0 \rightarrow \pi + \Xi$	-233

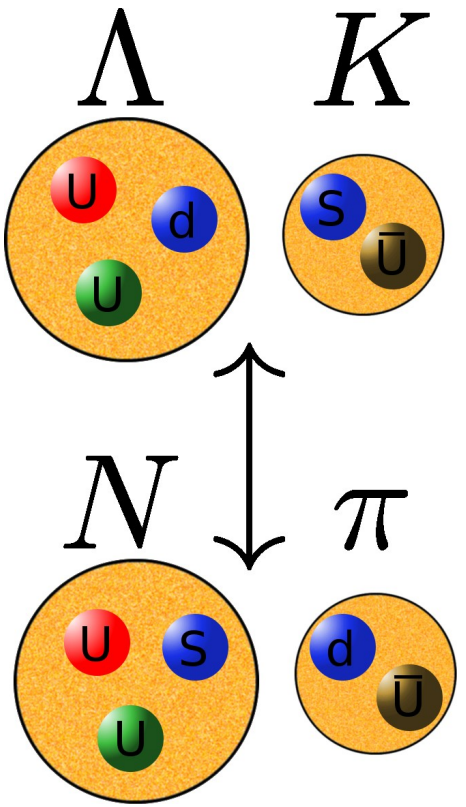
Implemented as
$N^* \rightarrow K^-/\bar{K}^0 + \Lambda/\Sigma$

K+B strangeness exchange

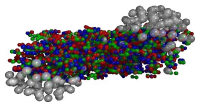
$$K + N \leftrightarrow \pi + \Lambda/\Sigma$$



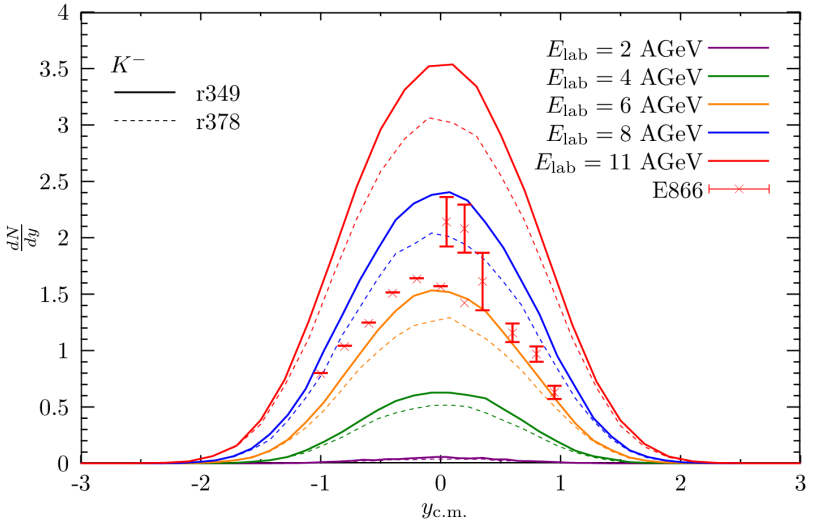
[Compilation of Cross-sections II: V. Flaminio et al.]

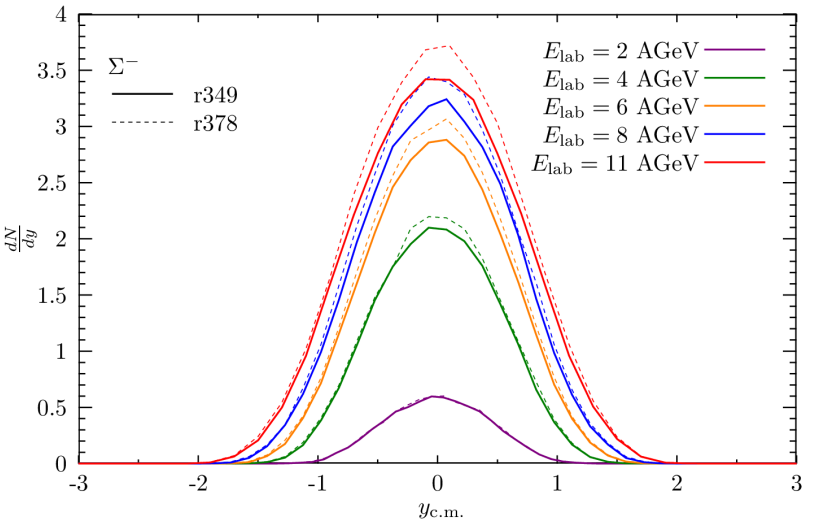


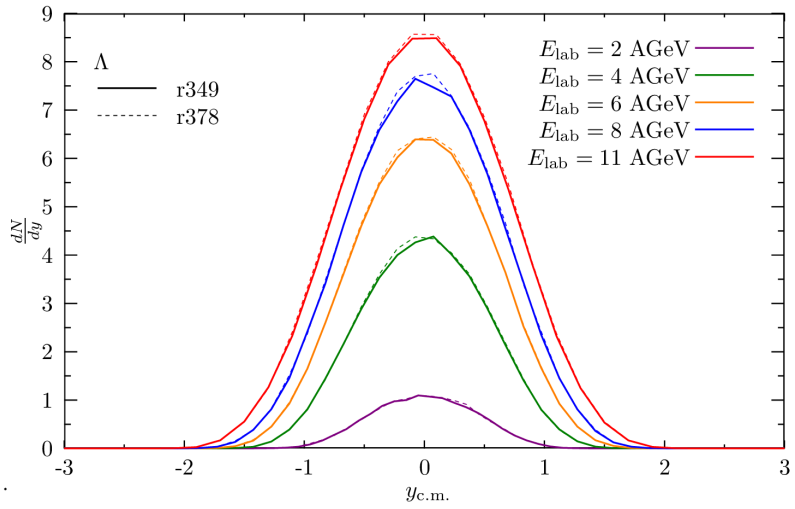
Isospin symmetry, isospin averaging or detailed balance for other processes.

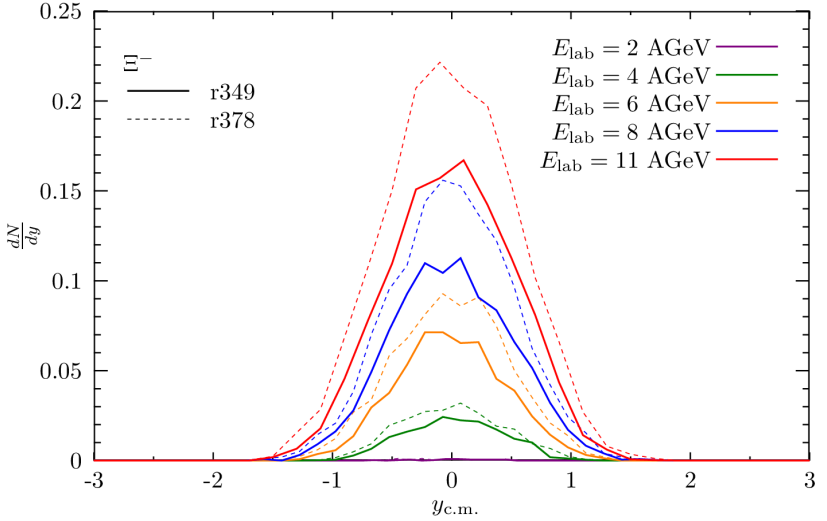


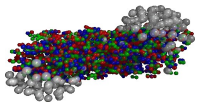
AGS Energies



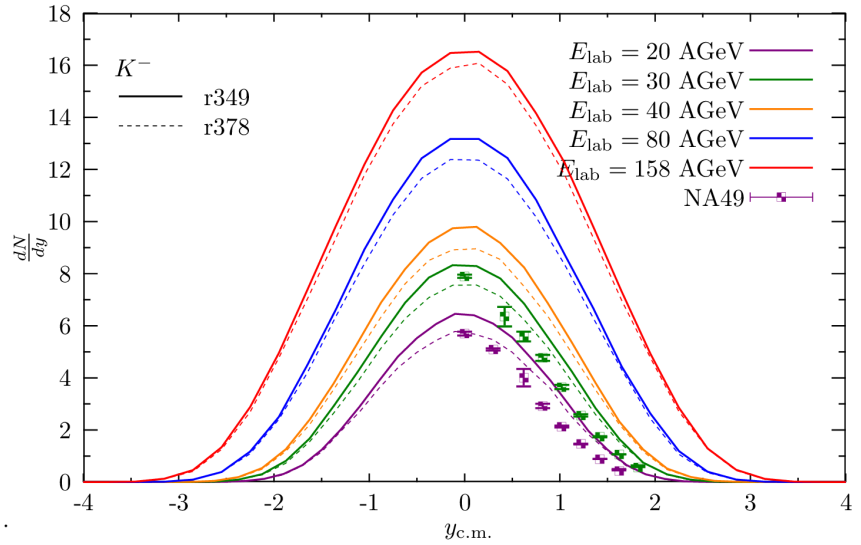


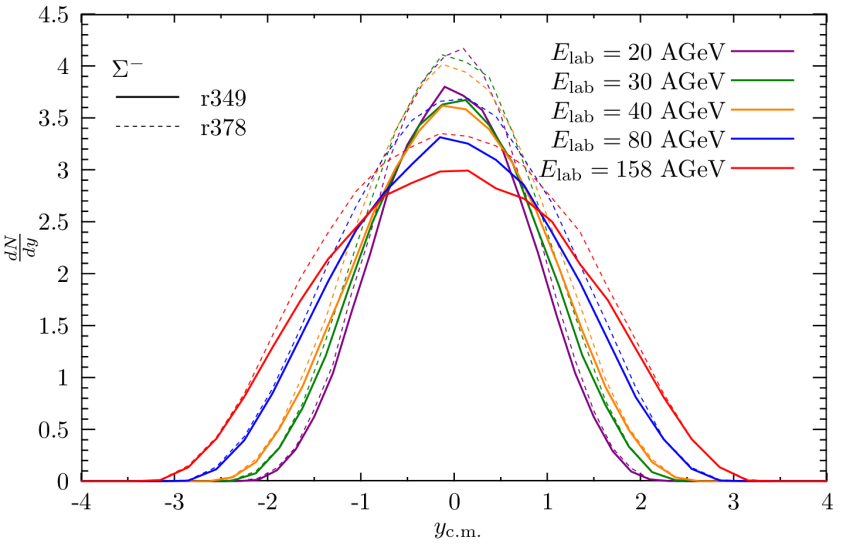


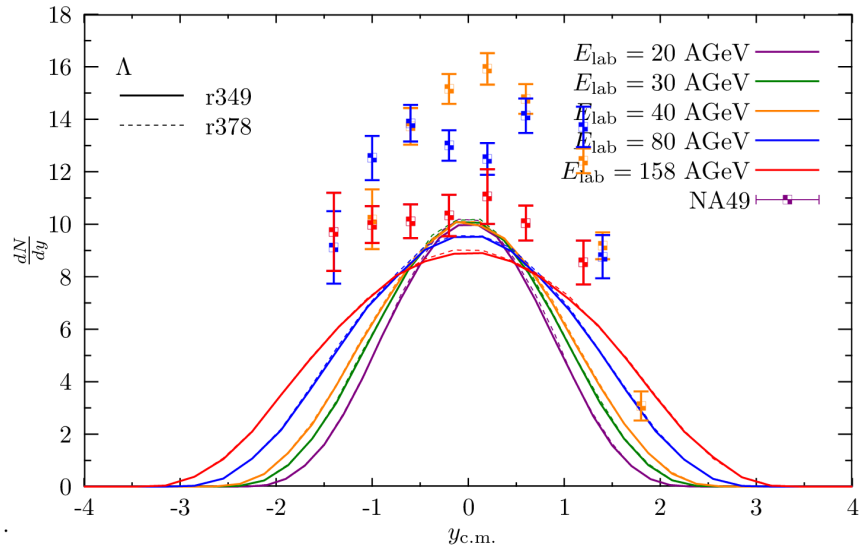


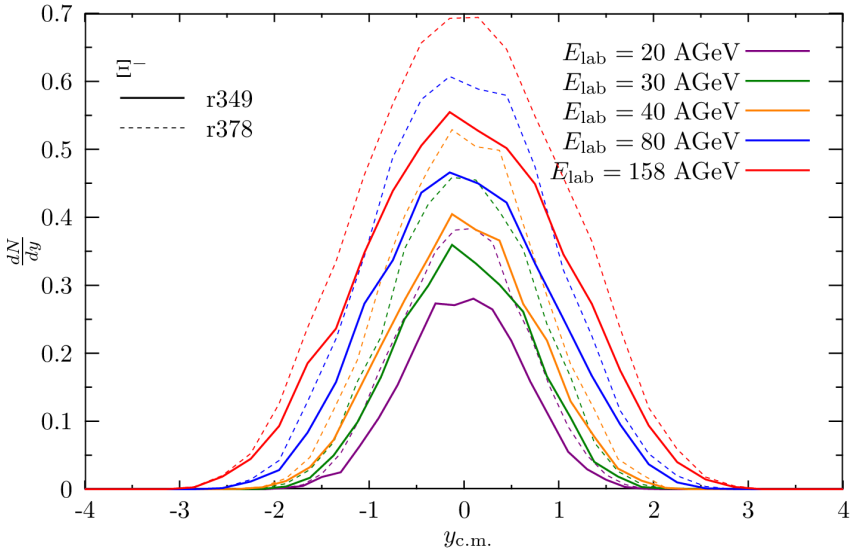


SPS Energies

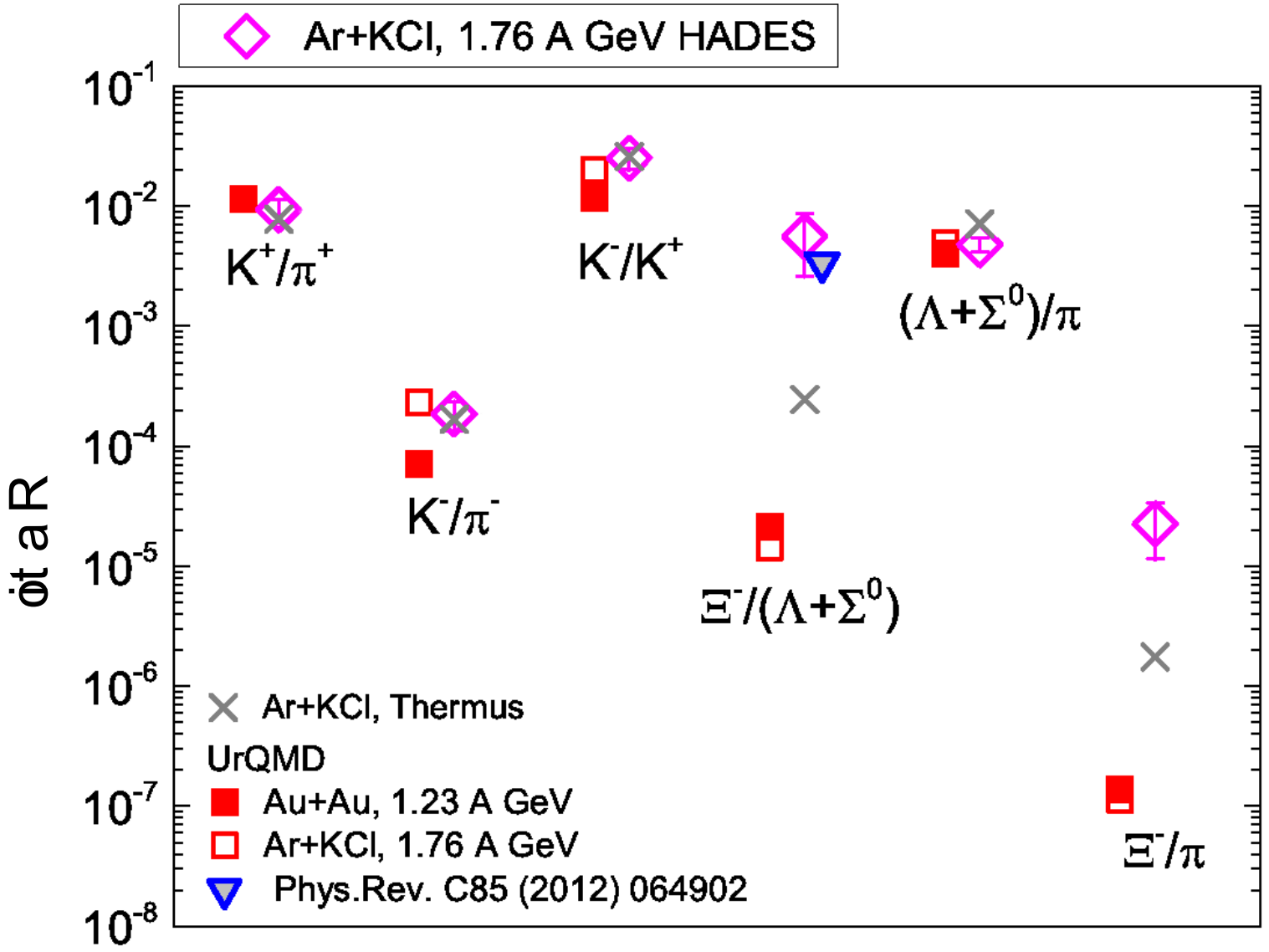


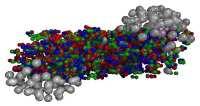




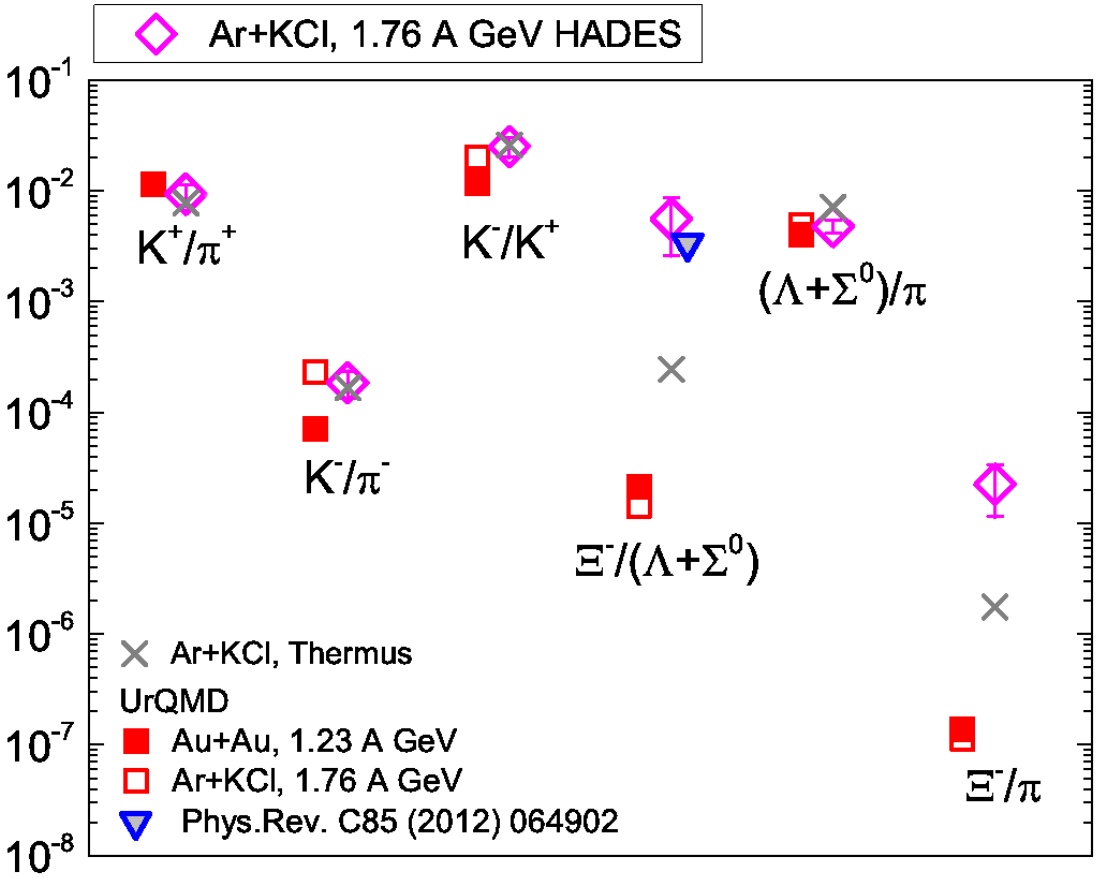


Particle Ratios





Y+Y exchange reactions



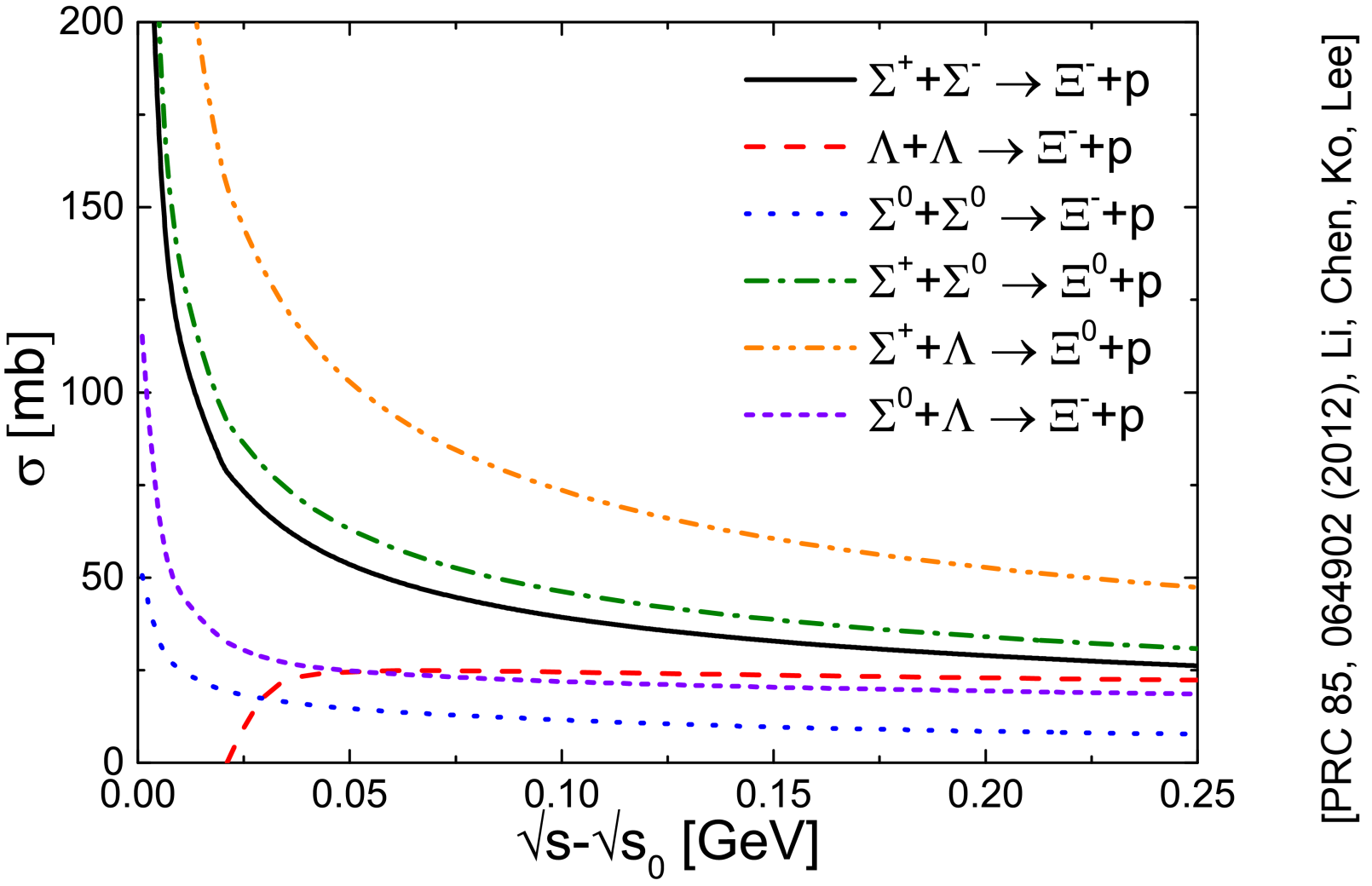
Less than 30 MeV needed

$$\Lambda + \Lambda \leftrightarrow N + \Xi$$

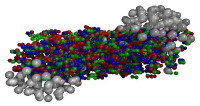
$$\Sigma + \Sigma \leftrightarrow N + \Xi$$

$$\Lambda + \Sigma \leftrightarrow N + \Xi$$

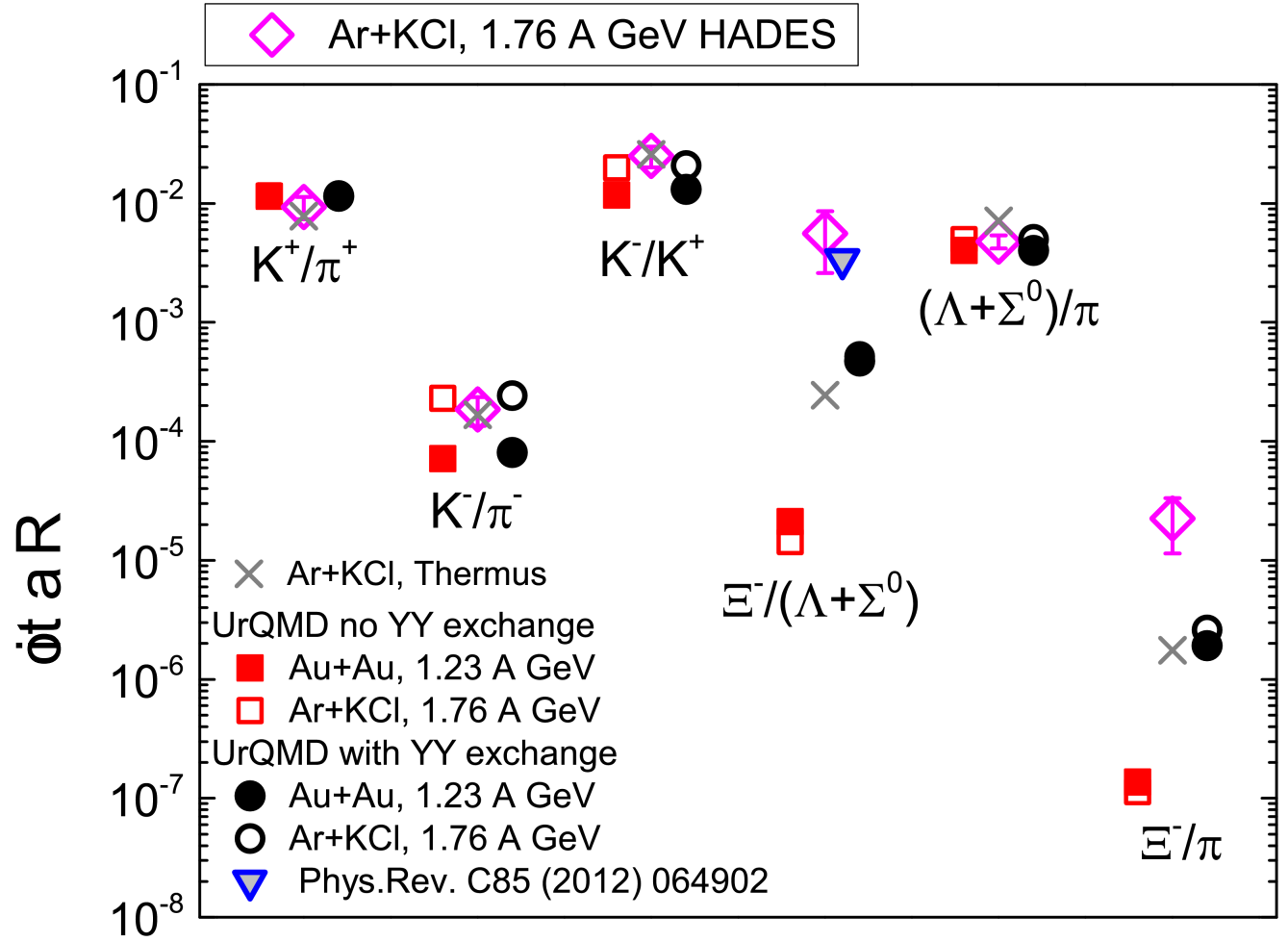
Y+Y exchange cross-section



Other channels: Same for neutrons & Detailed balance

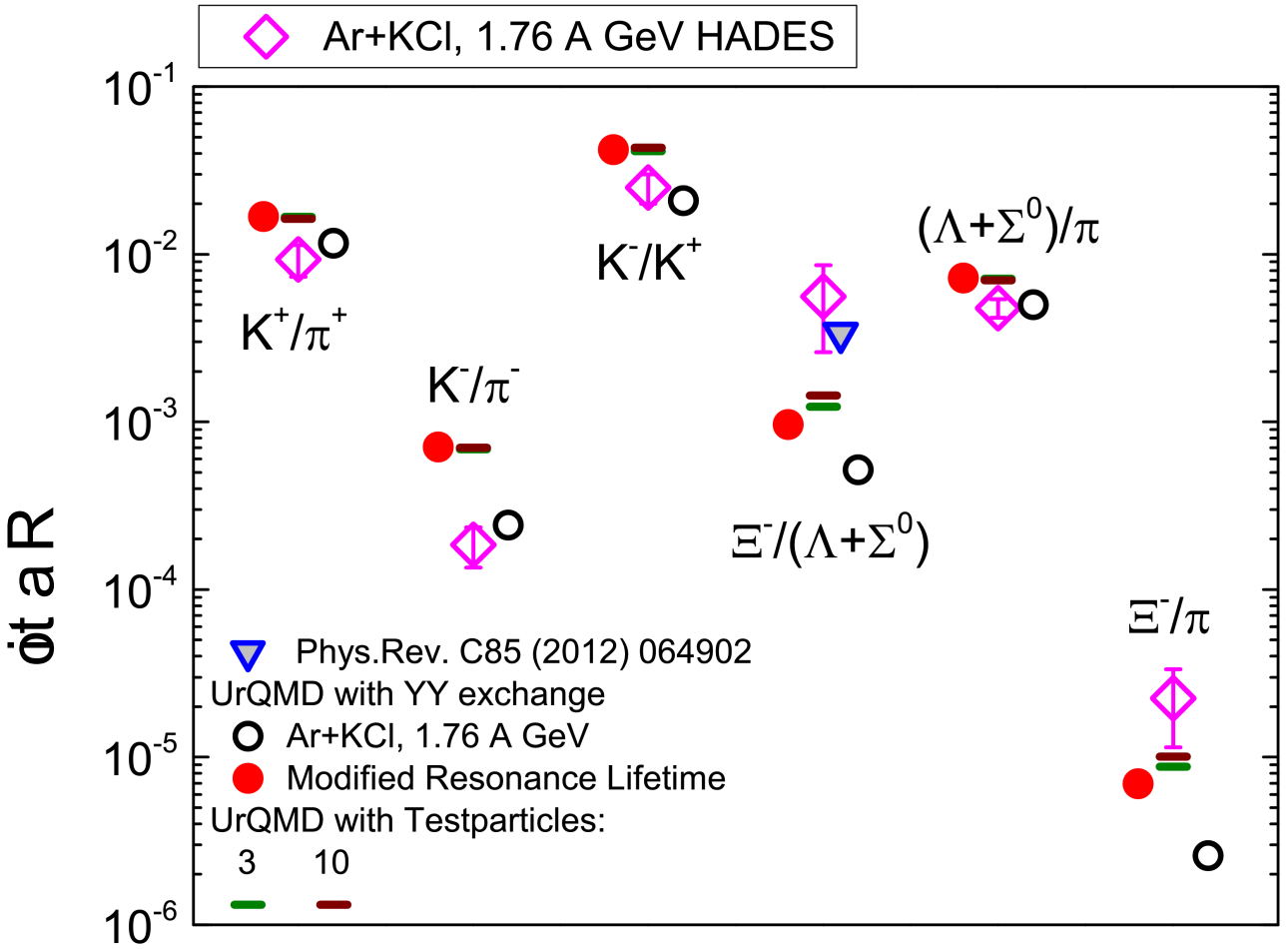


Ratios with YY exchange



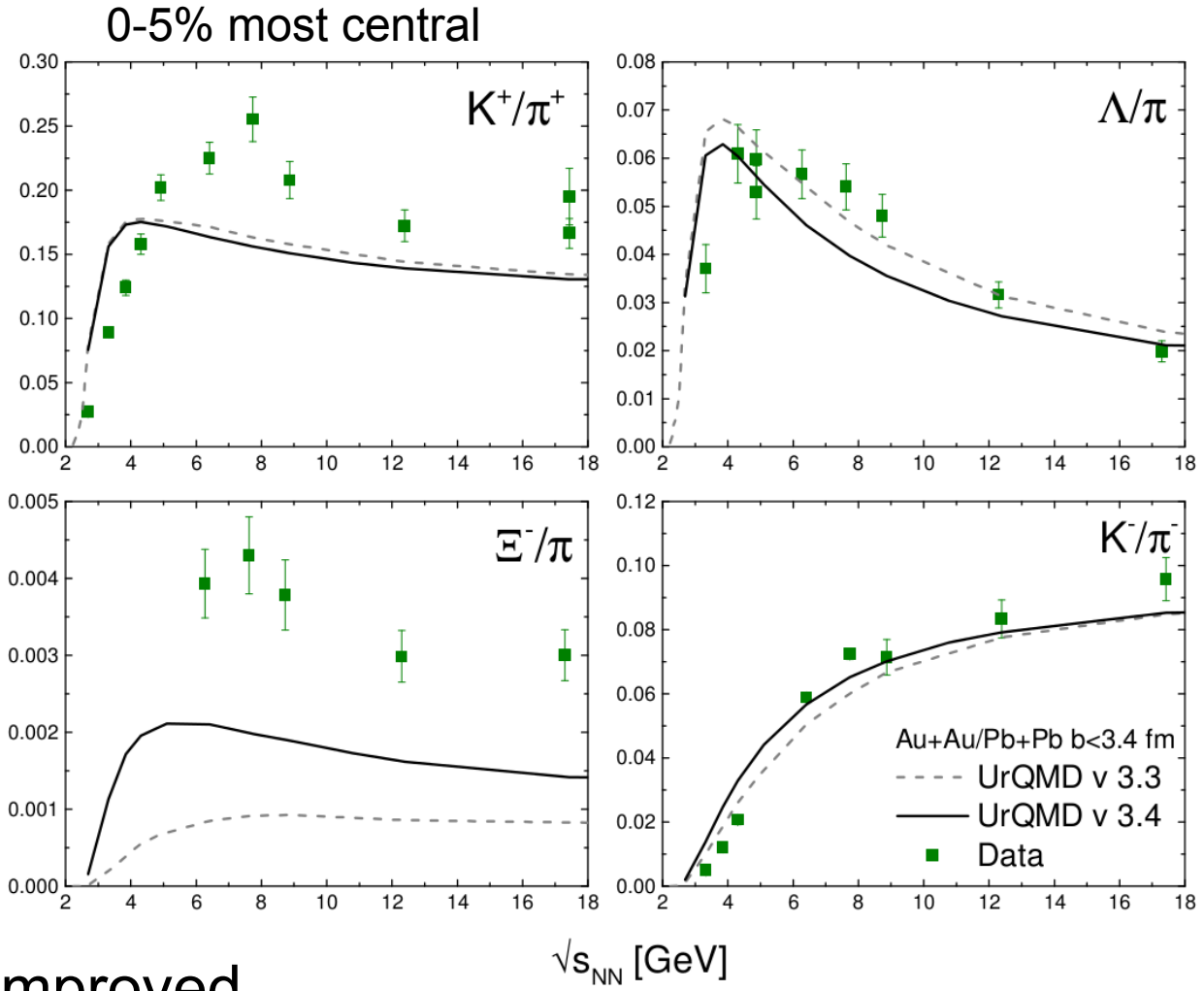
- Improved Ξ production
- Other yields unchanged

The difference

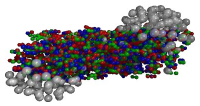


- Set N* and Δ lifetime close to zero to mimic direct Λ production
- Testparticles → self-interaction

Ratios excitation function



- Ξ/π ratio improved
- Stronger associated $K^+ + \Lambda$ production → enhanced Ξ production



Conclusion

- Strangeness exchange has been included into UrQMD
- Description of multi-strange baryons improved
- Test particles introduce self-interactions

- Investigate ways to enhance associated $K^+ + \Lambda$ production at low energies