Production of Multi-Strange Hyperons at FAIR Energies.

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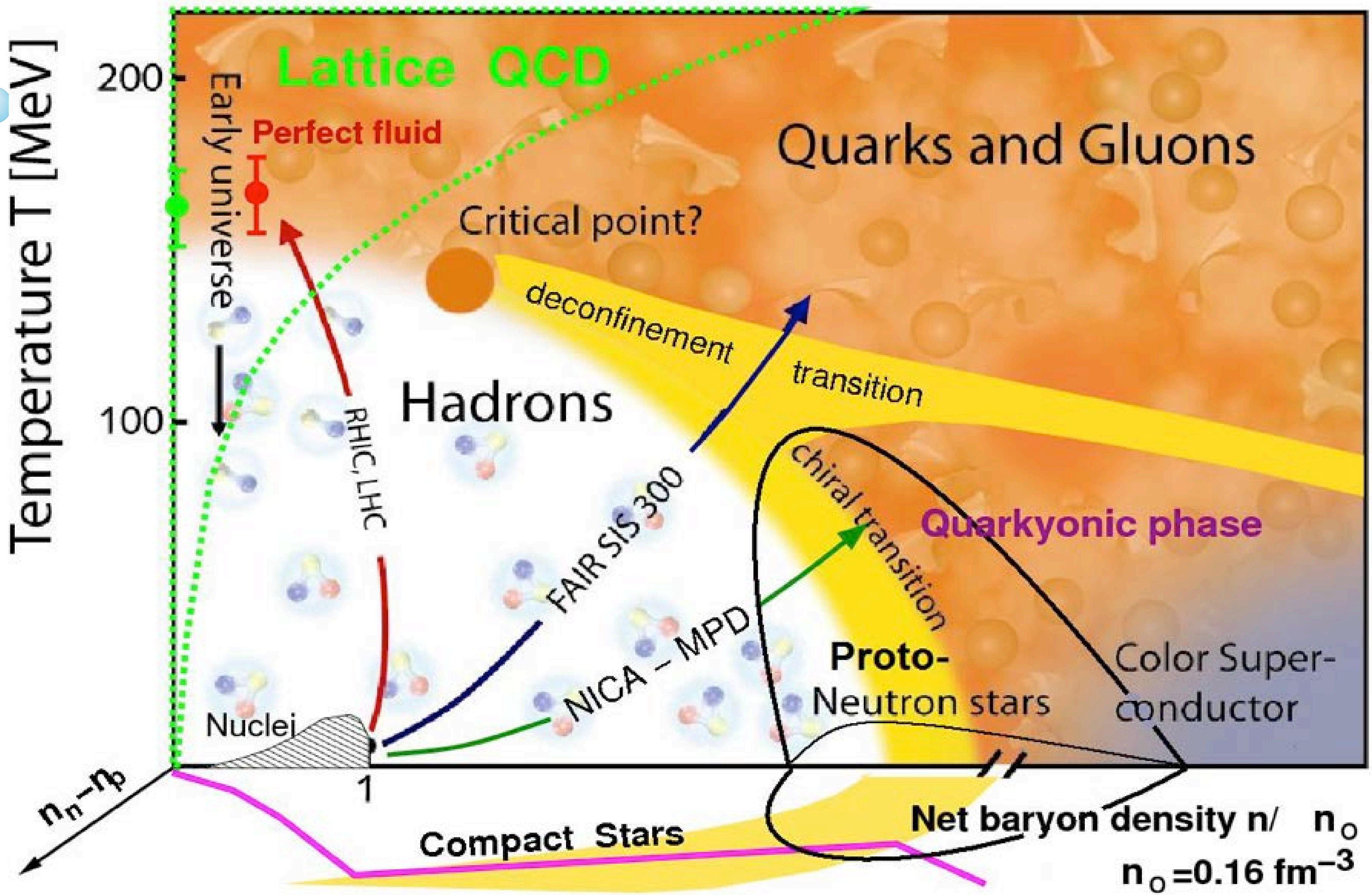
Outline

- ❑ Introduction
- ❑ Strangeness production mechanism
- ❑ Details of Input
- ❑ Results
- ❑ Summary

The Phase Diagram Of Strongly Interacting Matter

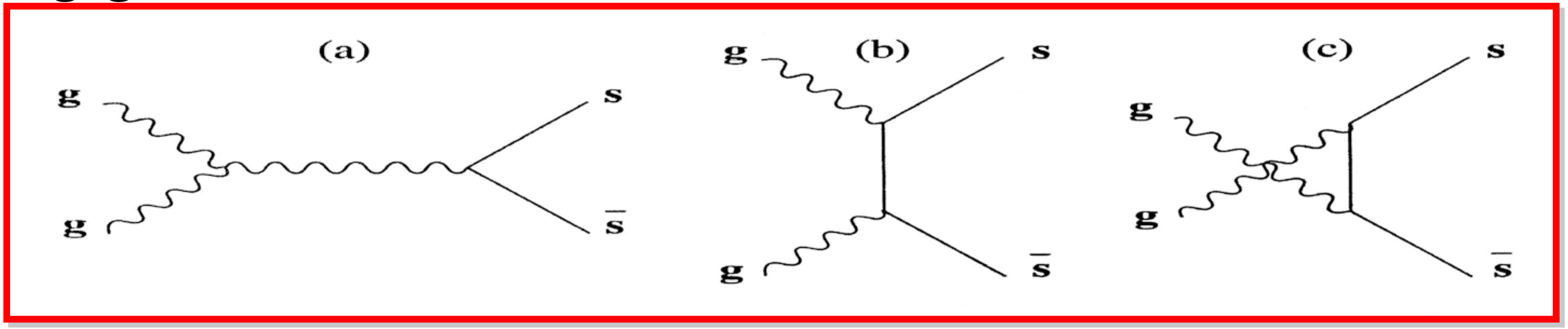


❑**Strangeness enhancement is one of the QGP signature**

❑**Strangeness has to be produced (no *s*-Quarks in nucleons)**

❑**Thresholds are high in hadronic reactions,**
e.g..: N + N → N + Λ+ K (E_{thres} ≈ 700 MeV)

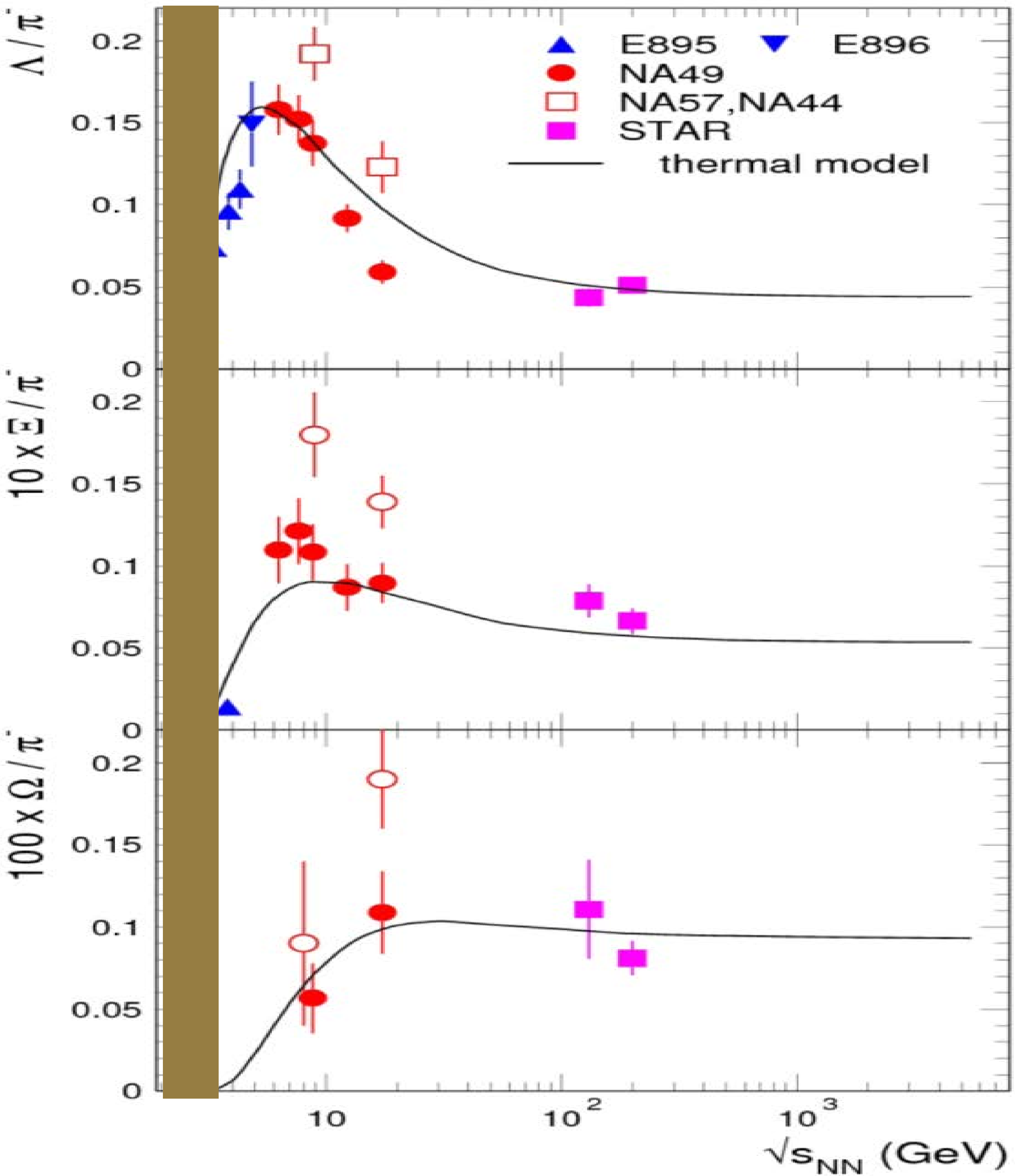
❑**Fast equilibration in a QGP via partonic processes,**
e.g. gluon-fusion



❑**more production of s-bars in dense baryonic matter → enhanced production of strange particle (having more than one strange quarks)**

⇒ **Enhancement of strange particle production in A+A relative to p+p expected (in particular multi-strange particles)**

Production of multi-strange baryons has the potential to probe the density and the EOS of the medium.



- ❑ 300 Ξ^- in Au+Au collisions at 6 AGeV and no Ω^- up to beam 30 AGeV .
- ❑ CBM experiment, capability of handling high interaction rate → detect particles with very low cross-section.
- ❑Performed a model based study of the production of strange particle with varying strangeness at FAIR energy.

Input Parameters

- Energy range = 5-90 AGeV
- Central Au+Au collision
- No of Events = 1 Million
- Rapidity cut = $-0.5 < y < 0.5$
- Model Used

Transport Model: UrQMD and AMPT (both default and string melting mode)

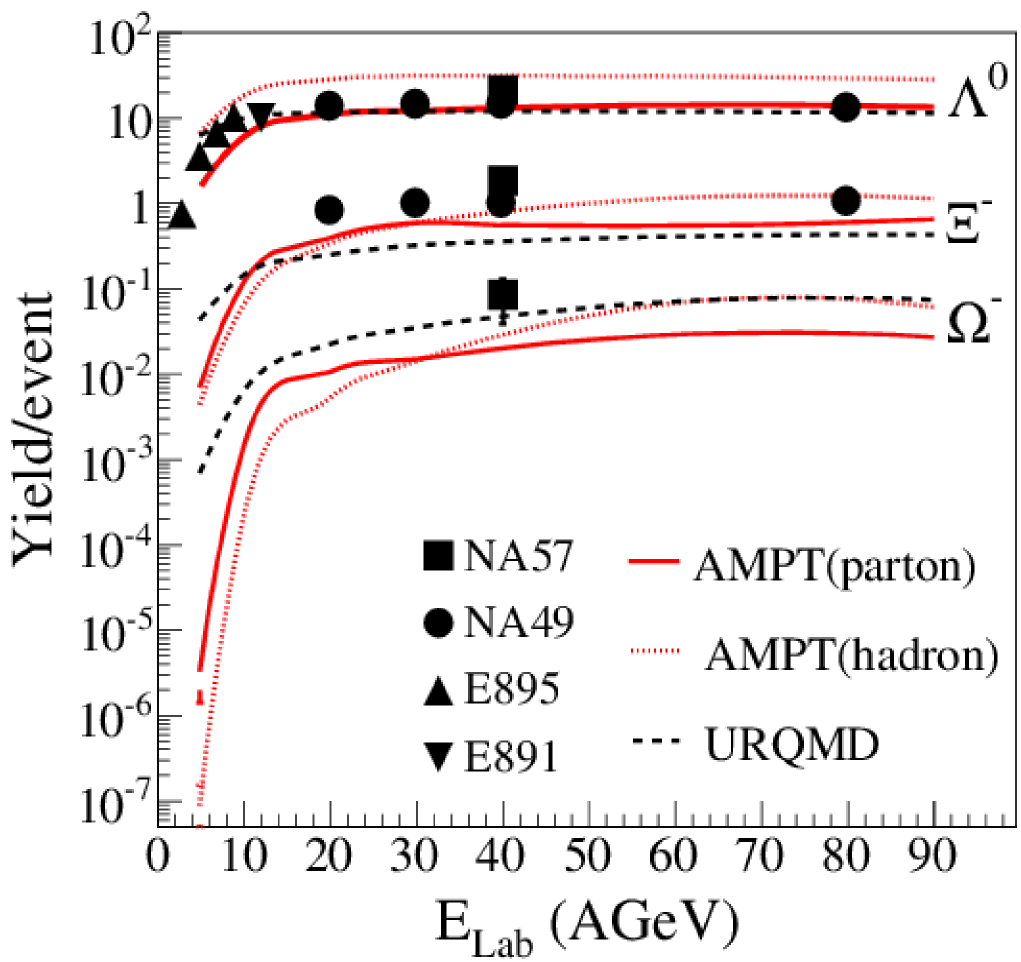
Input parameters for AMPT model

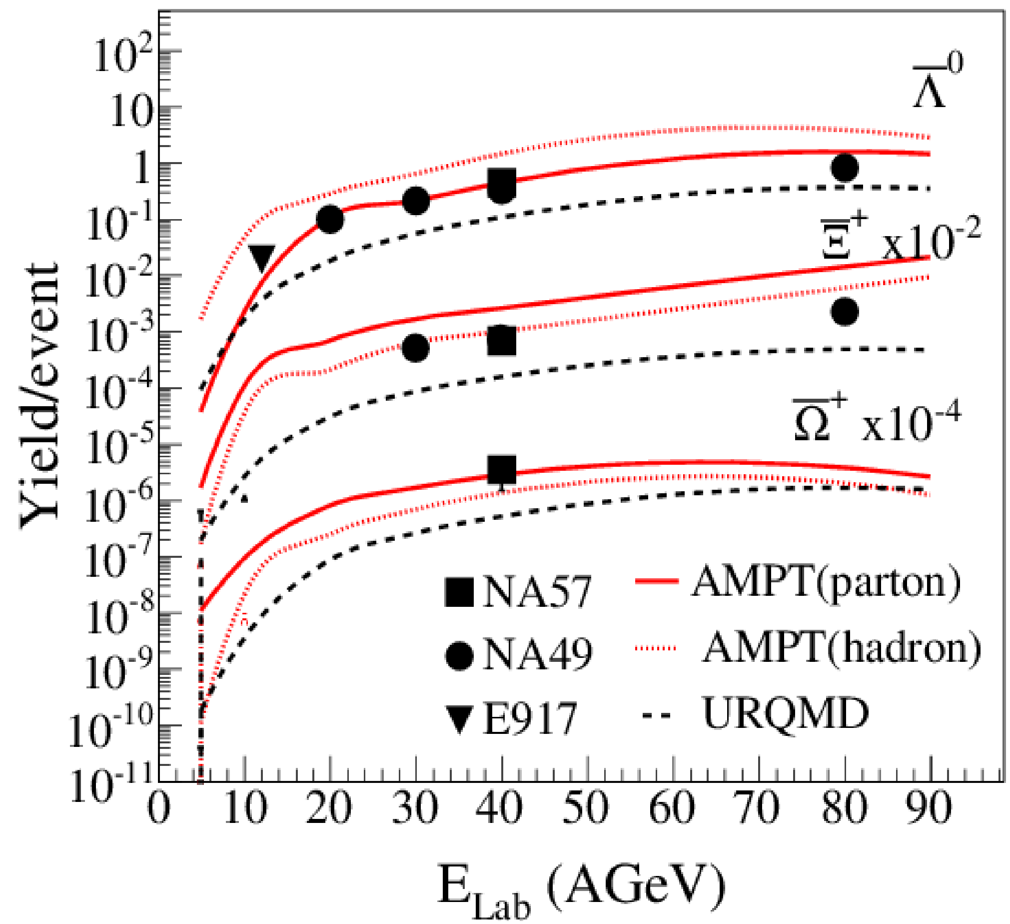
o Lund string parameters; a = 2.2 and b = 0.5 /GeV^2

o parton screening mass = 1.8 (1/fm) ~ cross section 10 mb

o strong coupling constant $\alpha_s = 0.47$

Energy Dependence: Yields

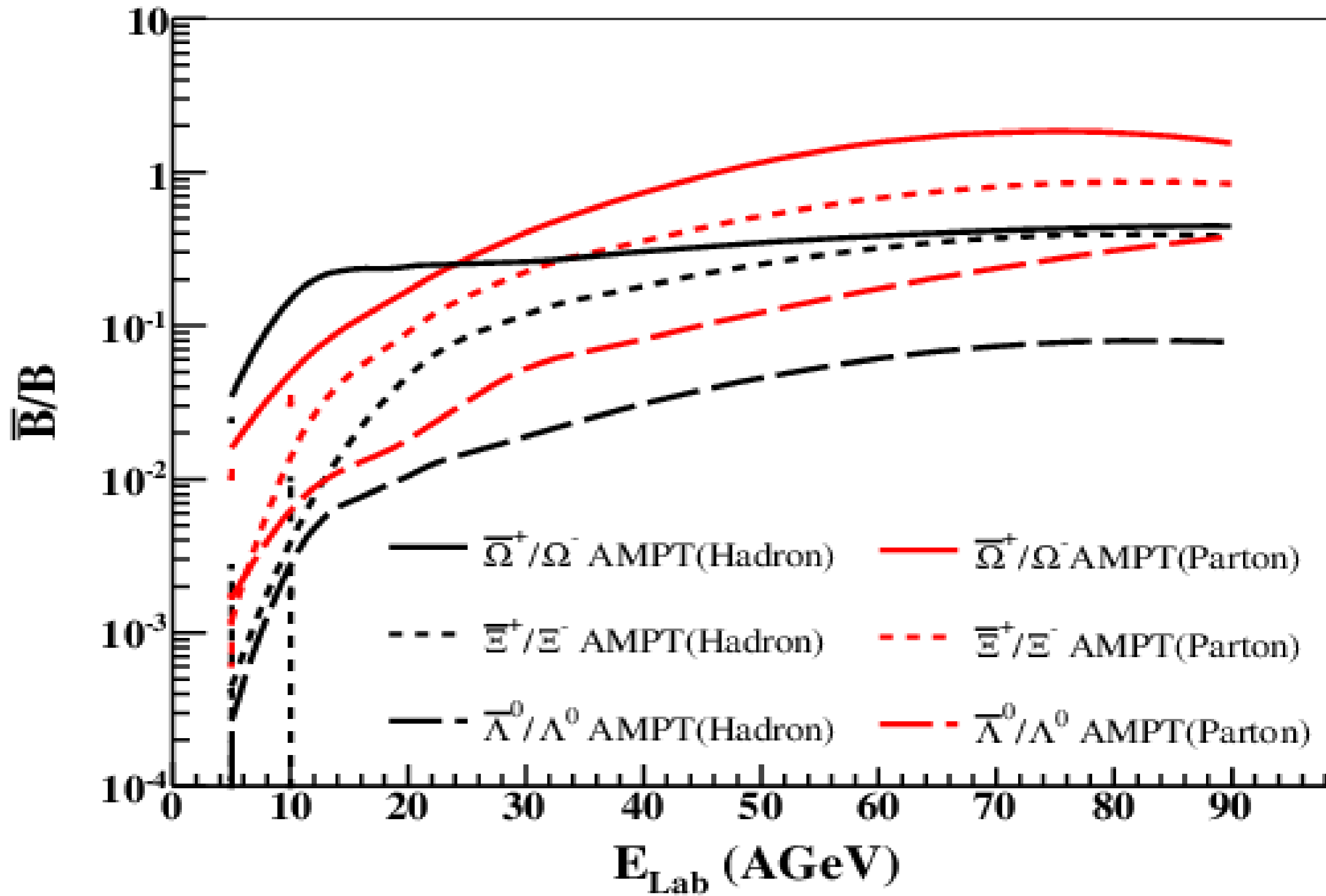




- UrQMD model reproduces reasonably well the average yields of Λ^0 hyperons.
- The anti-hyperon yields are underestimated by a factor of about 5.
- AMPT (hadronic) overestimate Λ^0 hyperons and underestimate the multi-strange hyperons.
- Over estimate anti- Λ^0 and reproduce other data point.

AMPT (parton) underestimate the hyperons but overestimate the anti – Ξ^+ hyperons and matches well with anti-Ω+.

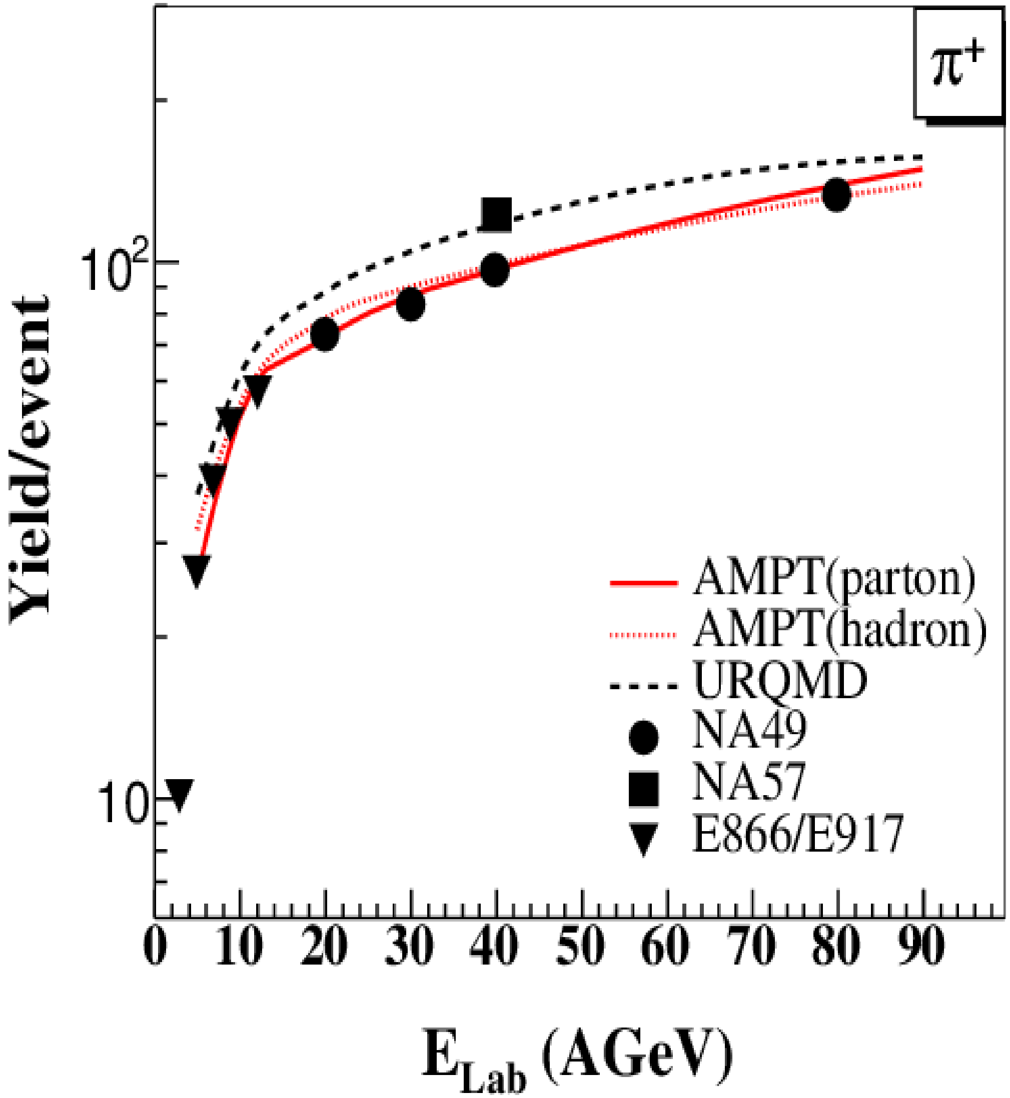
Energy Dependence: Ratio

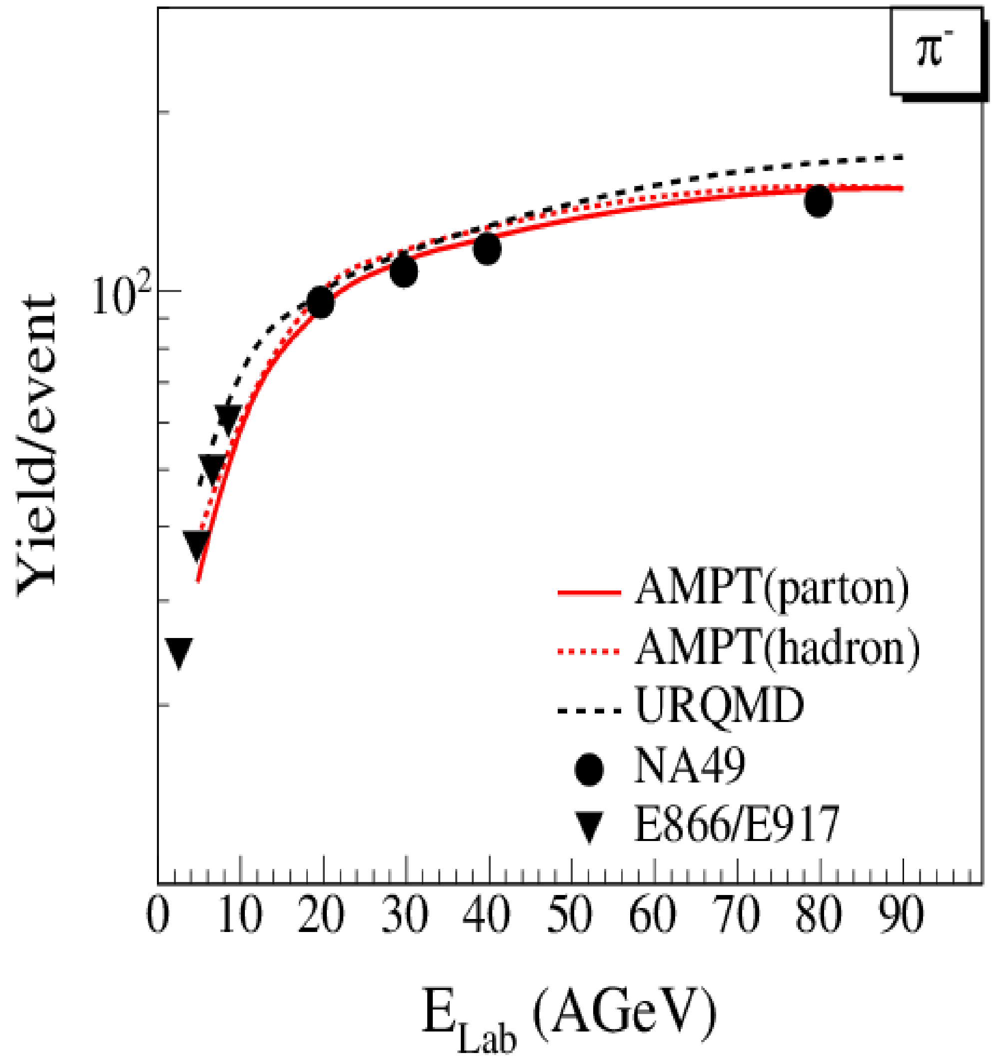


- Increase of the particle ratios up to 20 AGeV is significantly steeper for the partonic than hadronic mode.
- Anti-Ω^+/Ω^+ > anti-– Ξ^+/Ξ^- > anti-Λ^0/Λ^0 by factor of 10.
- At low energies, production of multi-strange antihyperons strongly depends on multiple collisions of partons or hadrons which are enhanced at high densities.

CBM

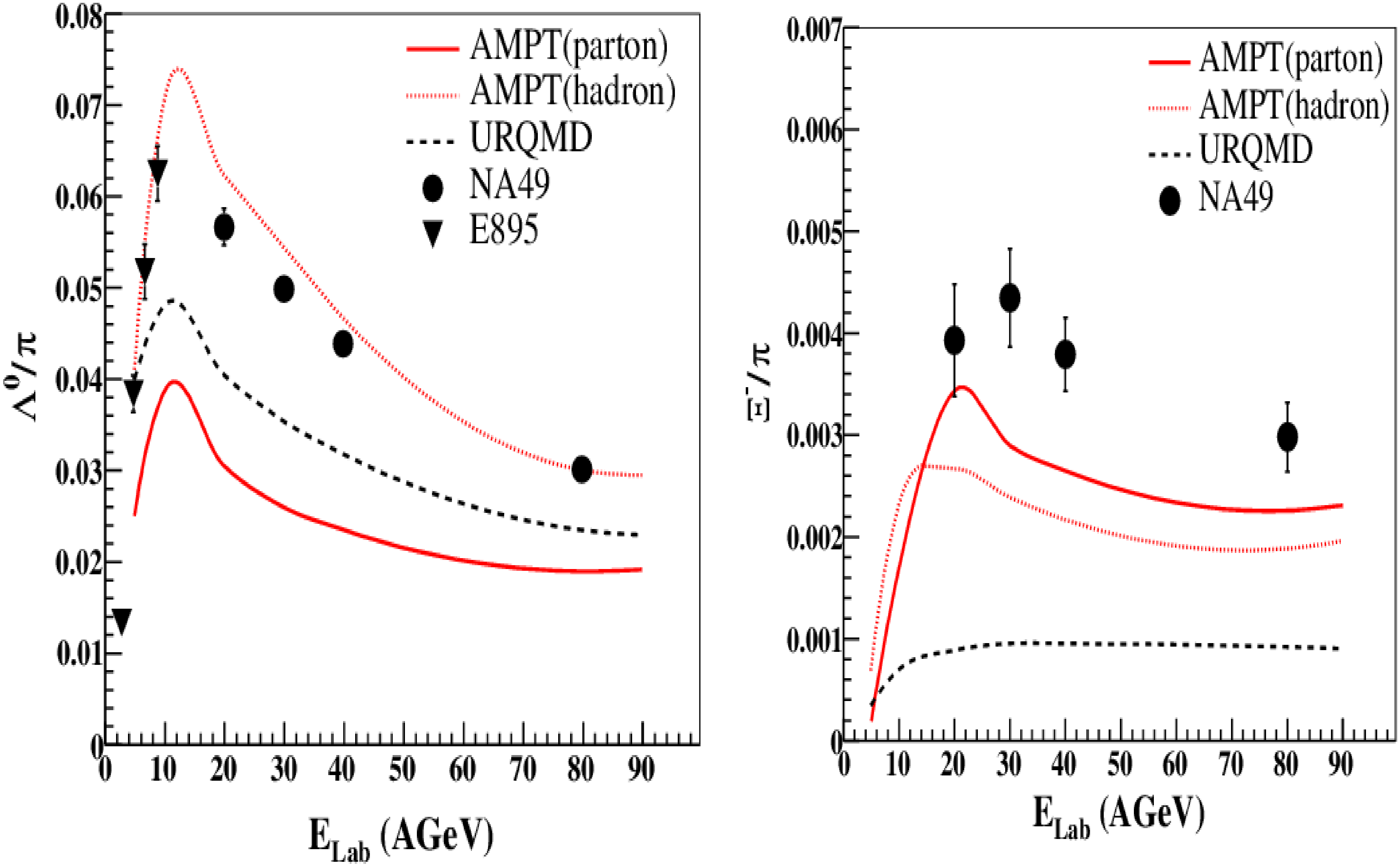
Energy Dependence: Yields



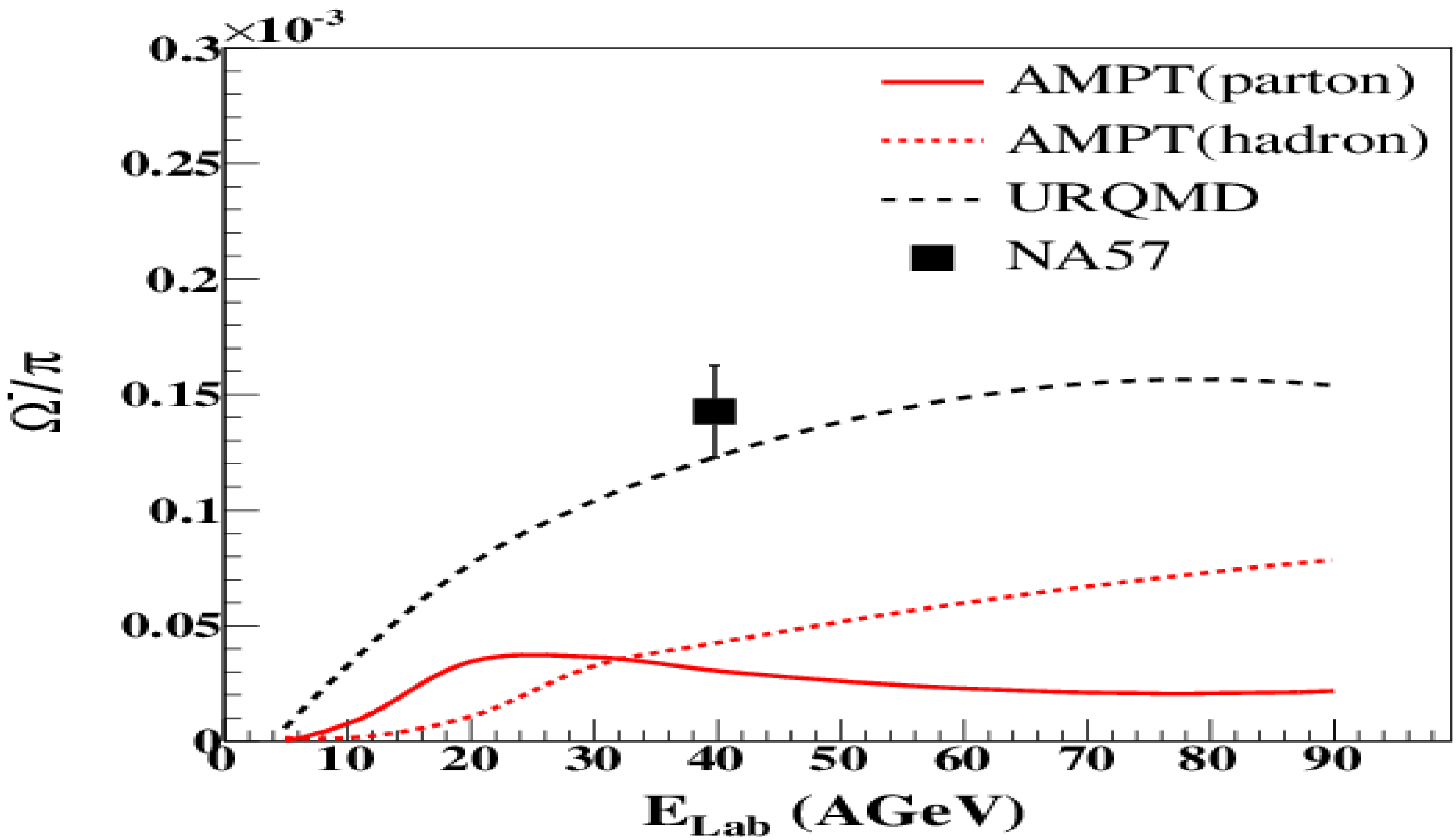


All the models reproduce the experimental data points within 20 - 30% difference but AMPT partonic approach leads to relatively better agreement

Energy Dependence: Ratio

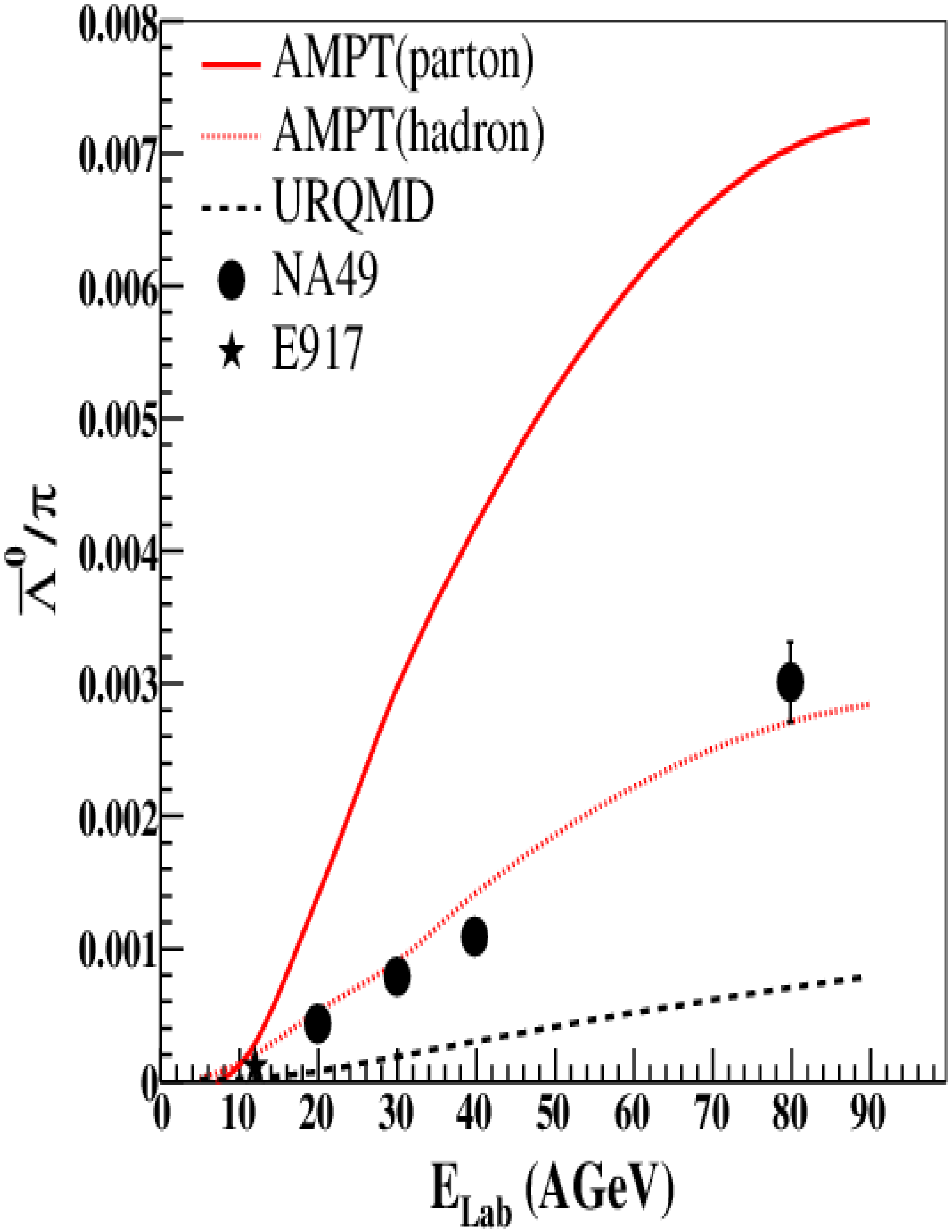


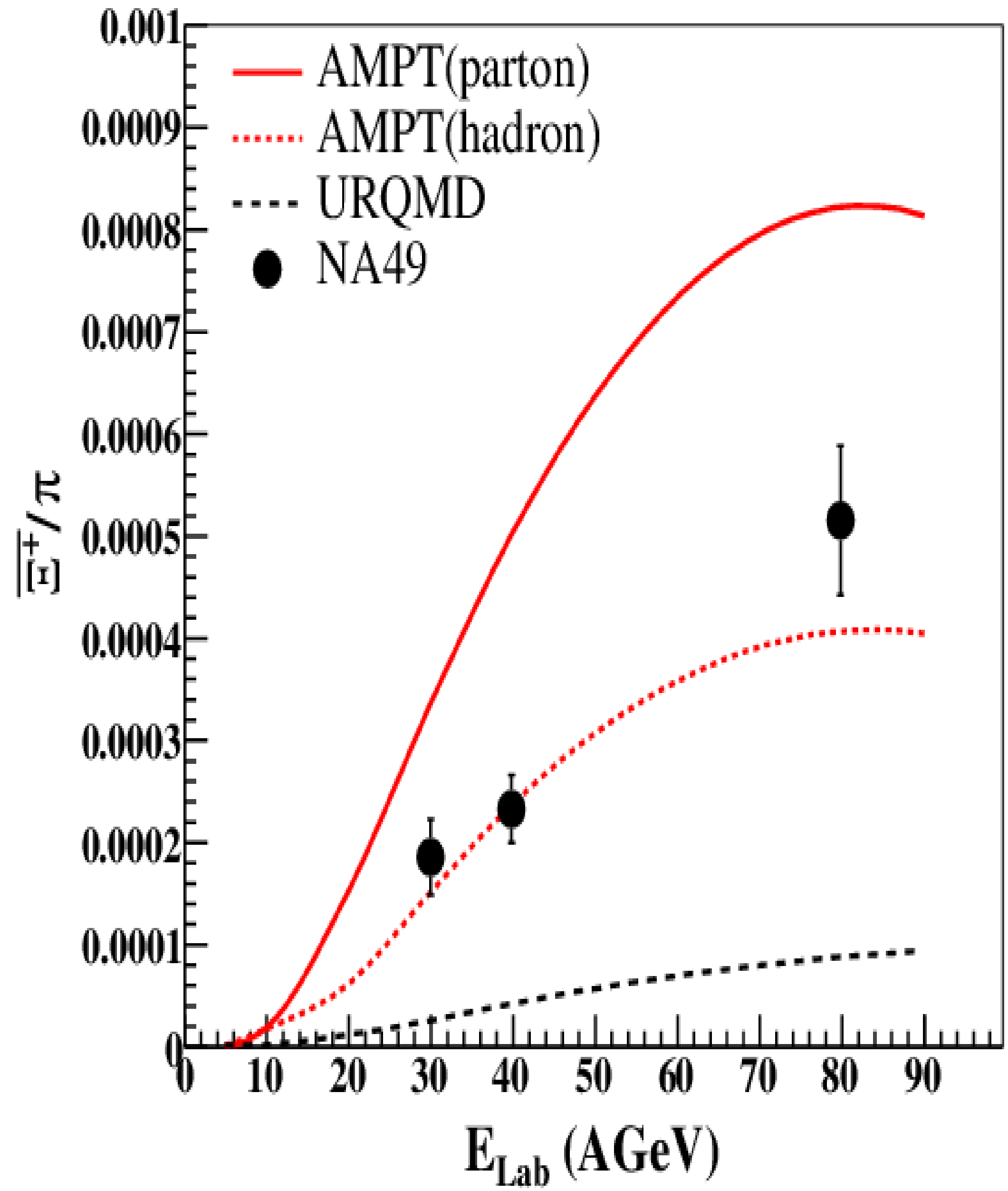
Energy Dependence: Ratio



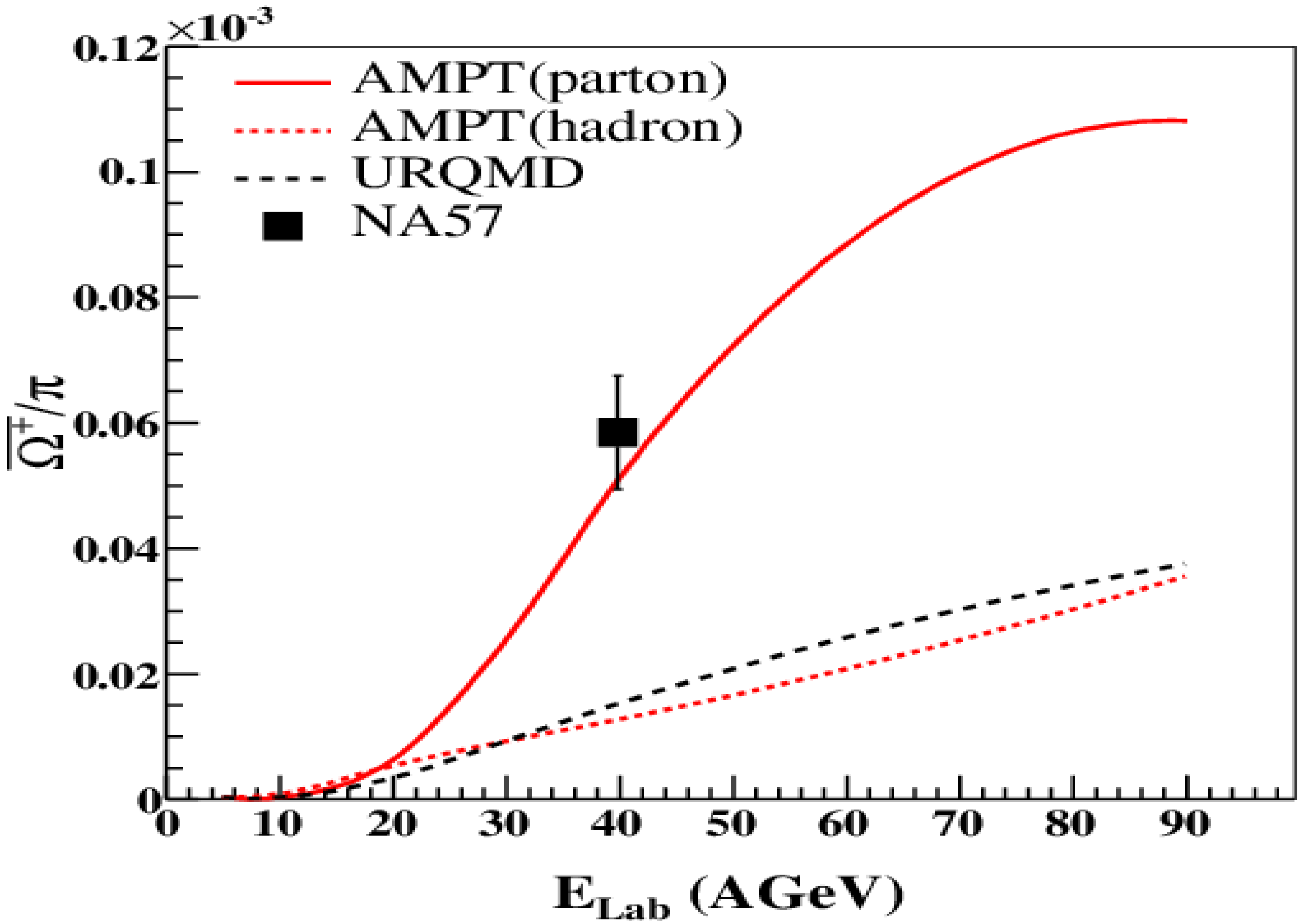
- ❑ All the ratios show a peak like structure around 11 AGeV (SIS100).
- ❑ UrQMD shows increase followed by saturation.
- ❑ Below 20 AGeV , the AMPT partonic mode predicts enhanced hyperon than hadronic mode; multi-strange particles are a sensitive probe of QCD matter at large baryon densities.

Energy Dependence: Ratio





Energy Dependence: Ratio



- No peak like structure for antihyperons to pion ratio.

Summary

❖ Production of antihyperons are more enhanced in the partonic mode as compared to the enhancement of hyperons, the trend is quite opposite in AMPT (hadronic) mode.

❖ AMPT code indicates more production of multi-strange hyperons in the partonic mode in comparison to hadronic scenario at beam energies up to 20 *AGeV.*

❖ Multi-strange hyperons are promising observables to study of degrees of freedom of QCD matter in neutron star core densities.

❖ CBM detector set-up is ideal for measurement of multi-strange hyperons; is designed and fabricated at FAIR.

Acknowledgment

1. Dr. Subhasis Chattopadhyay (VECC)
2. Prof. Peter Senger (GSI)
3. Shabir Ahmad (KU)

Thank You

Compressed Baryonic Matter Experiment
Technical Design Report for the CBM
Muon Chamber (MUCH)
The CBM Collaboration
December 2013