Update on Kaon Yield Estimates

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Introduction

- Target: verify model estimates of charged and neutral kaon yield from proton heavy nucleus interaction at 8 – 24 GeV/c
- There is no solid theoretical basis to create model of low-energy kaon production from heavy nuclei
- Three different estimates were presented at first workshop

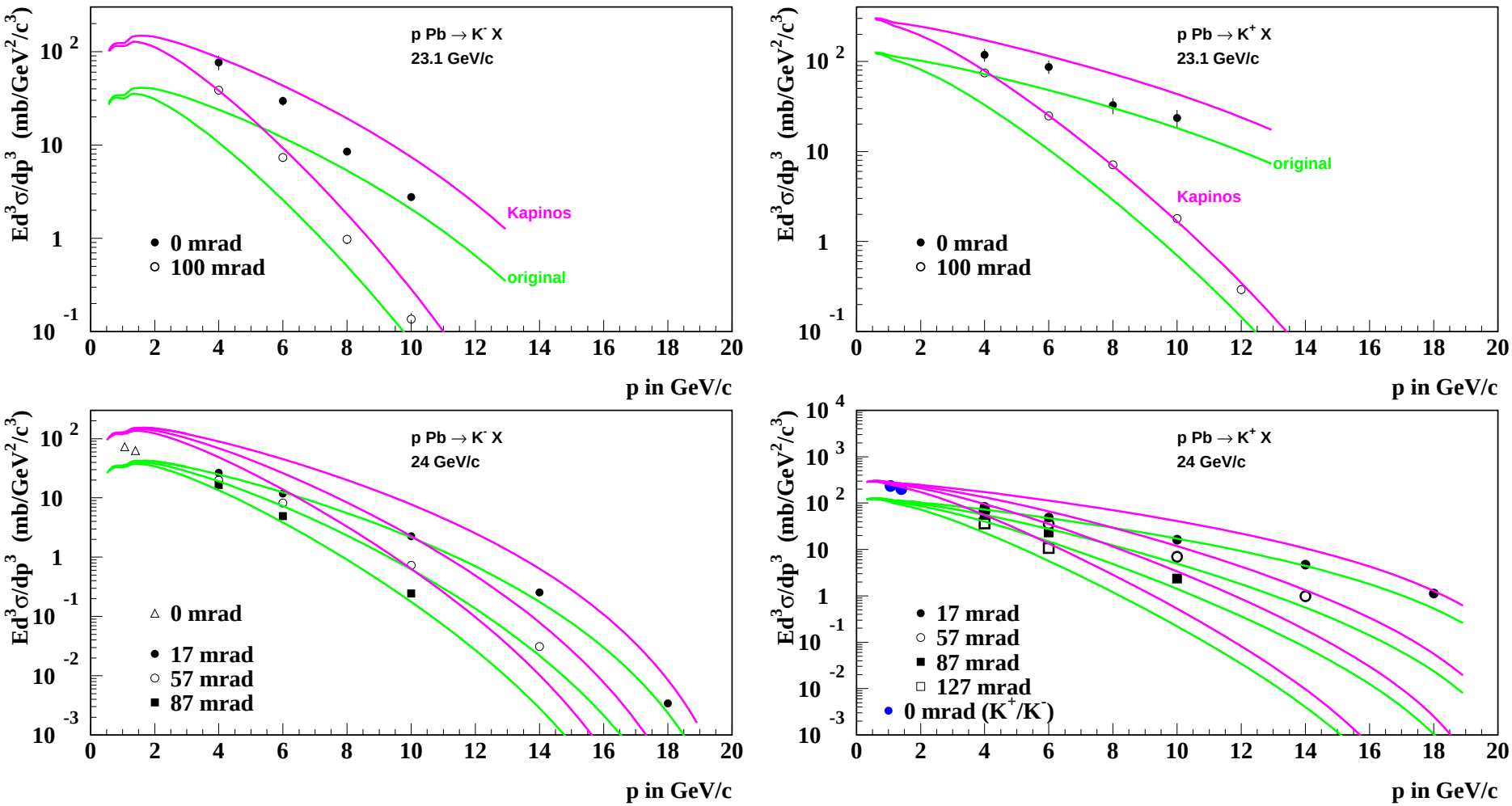
✓ More experimental data are needed

Models

- LAQGSM is Los Alamos version of the Quark-Gluon String Model
- LAQGSM is implemented into MARS code system. It is possible to simulate thick target production.
- All LAQGSM results in this presentation were obtained using MARS-LAQGSM, not with the original LAQGSM!

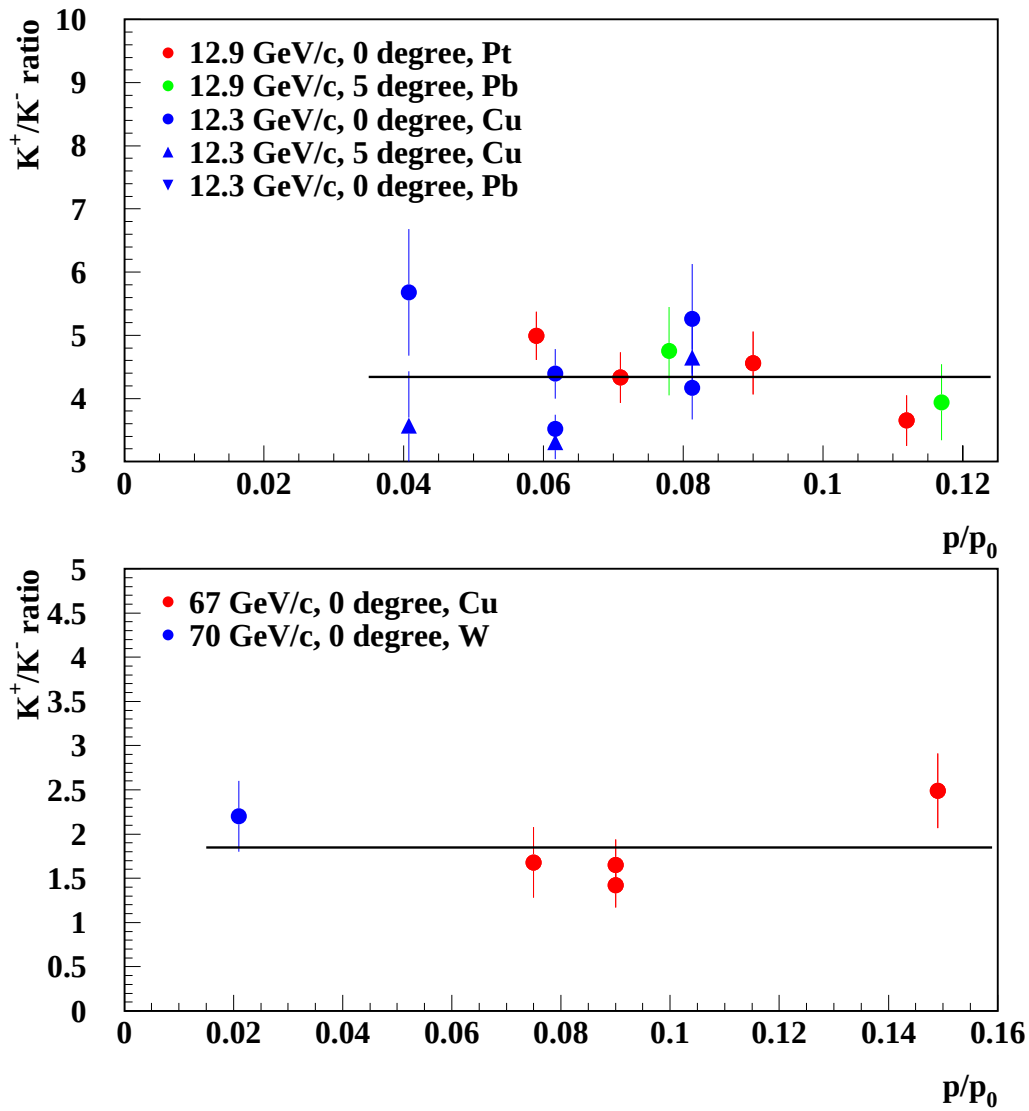
- Kapinos model is based on the phenomenological analysis of Efremov, Kazarnovsky, Paryev
- EKP developed closed analytical expressions for inclusive cross section for K^+ and K^- production in proton-proton and proton-nucleus collisions based on experimental data
- There are measurements of kaon production on heavy nuclei which were not used in EKP analysis
- Kapinos renormalized EKP model using such data

Kapinos “calibrates” EKP model using 23.1 GeV/c data

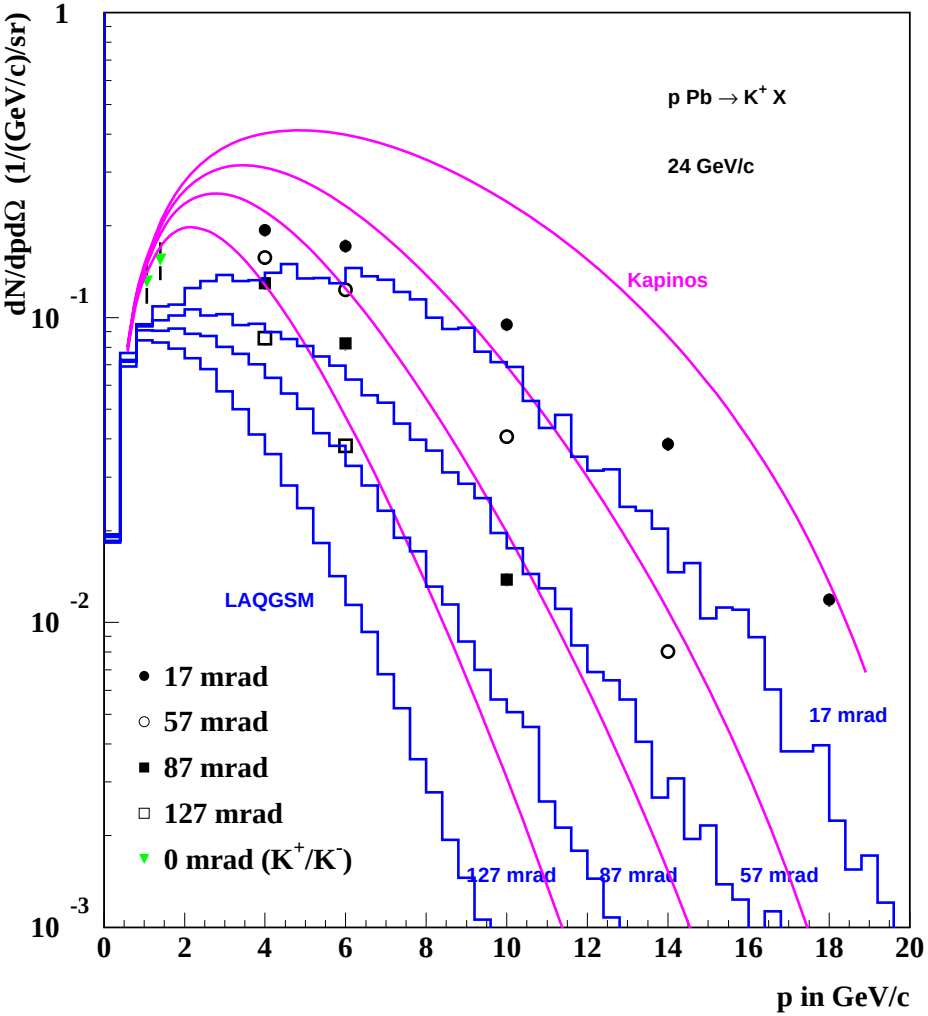


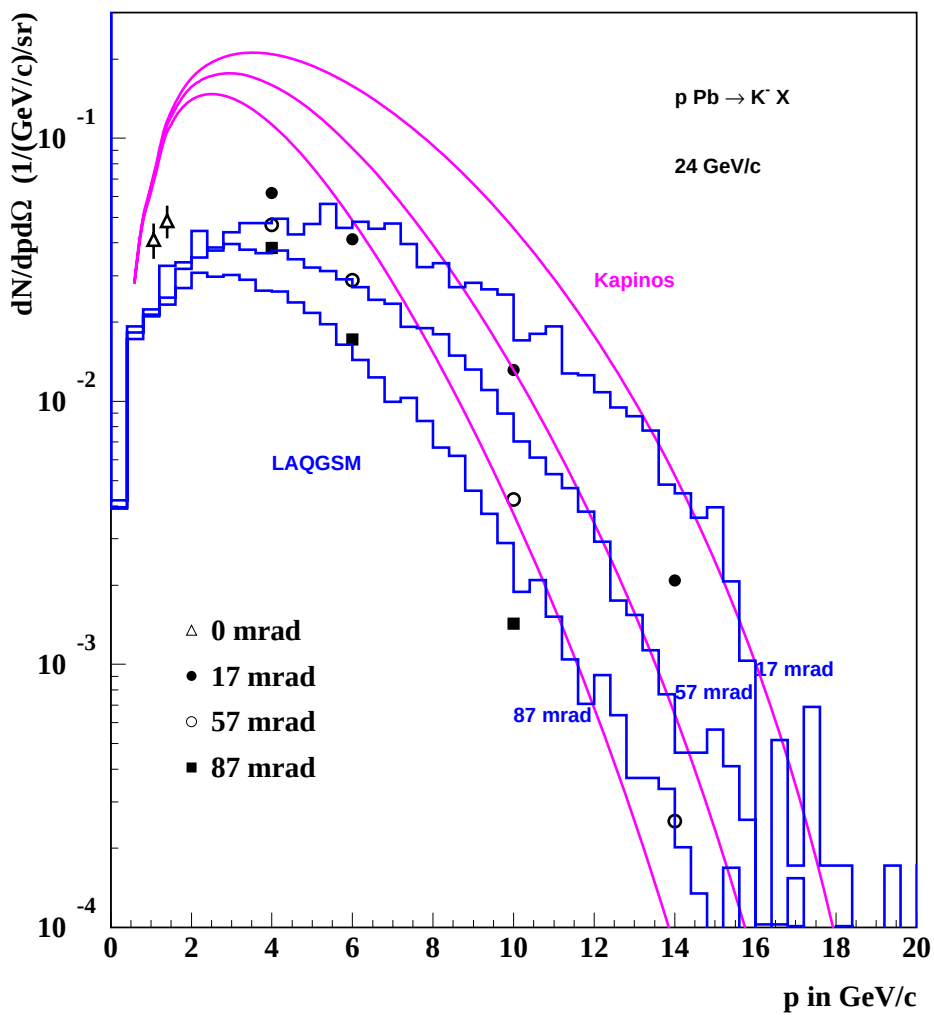
Charged kaon ratio at 24 GeV/c

- K^+/K^- ratio at small kaon momenta and angles depends on primary proton energy
- Ratio falls as $s^{-.5}$ between 8 and 70 GeV/c (s is center-of-mass energy)
- At 24 GeV/c $K^+/K^- \sim 3.2$

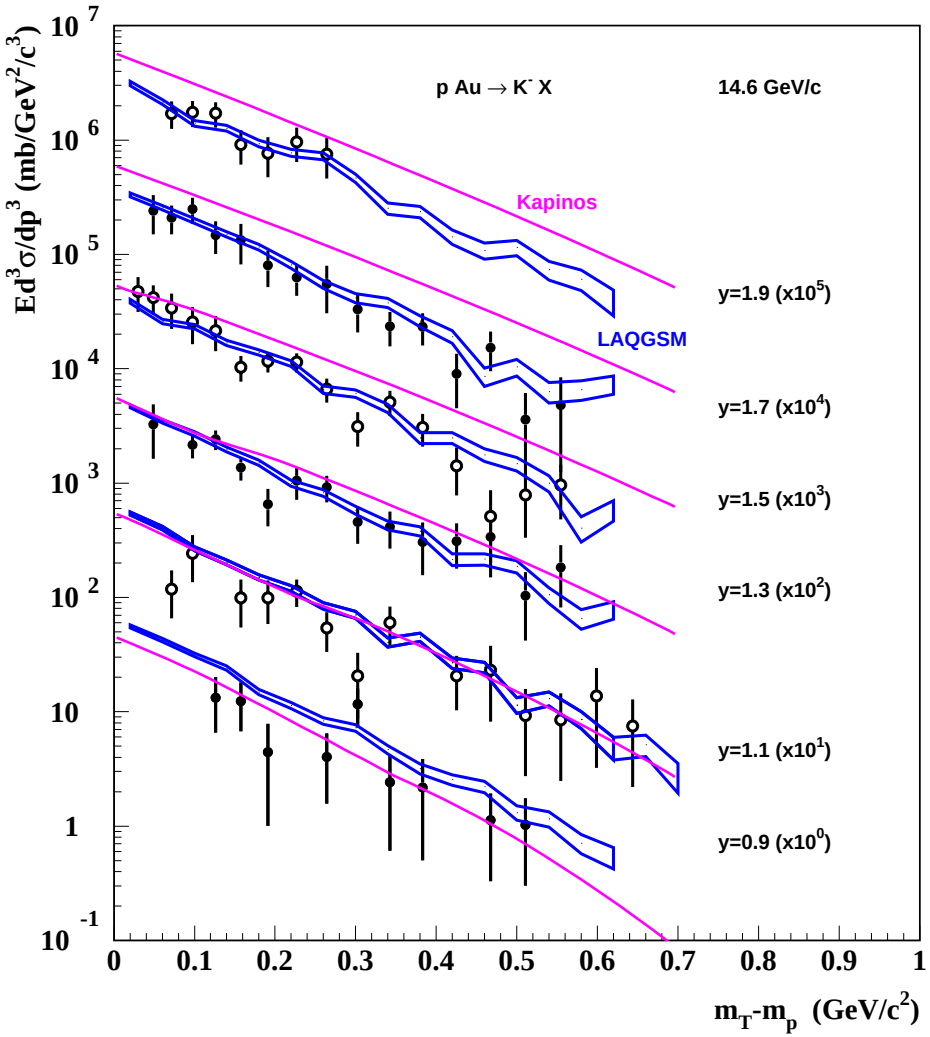


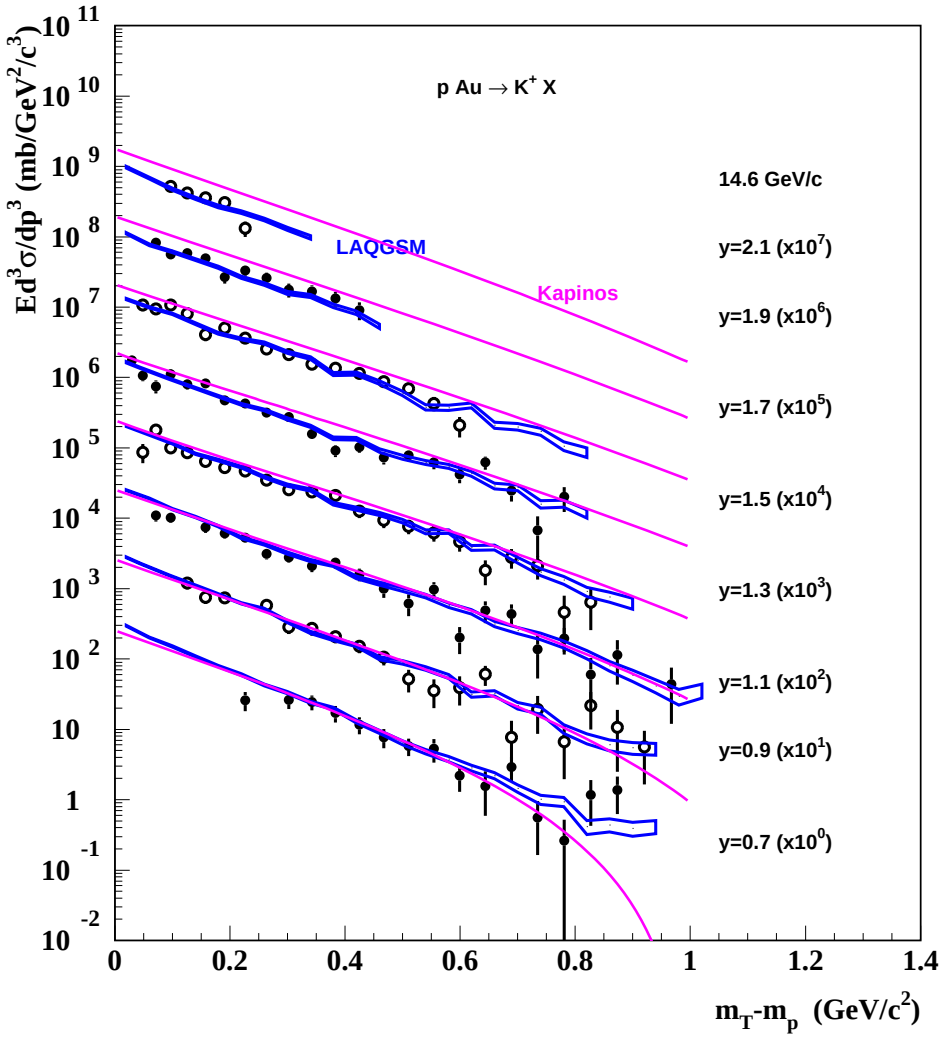
Charged kaon production at 24 GeV/c





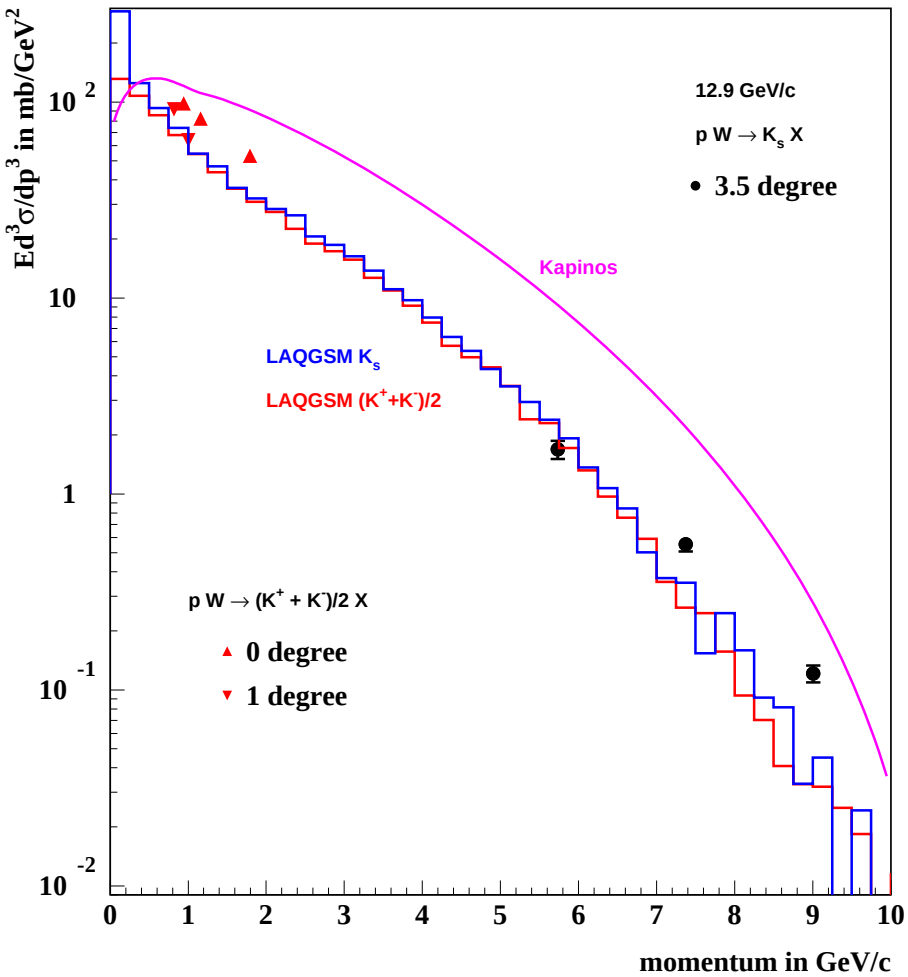
E802 data and models

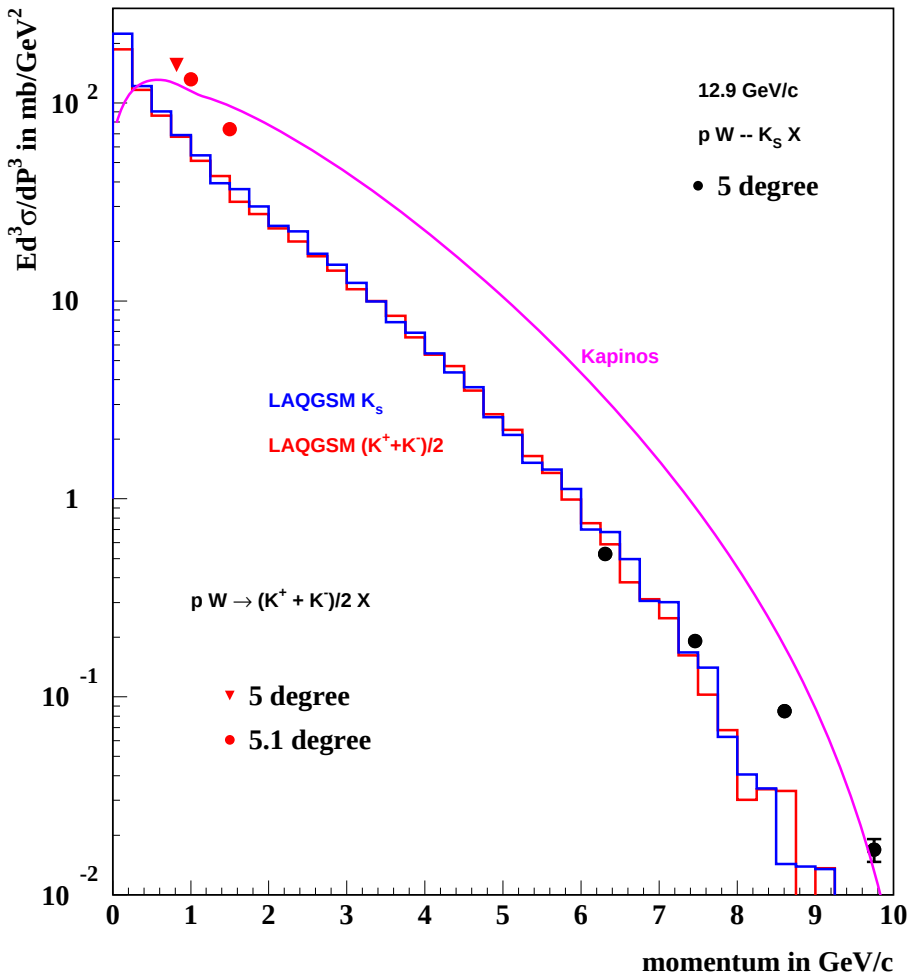




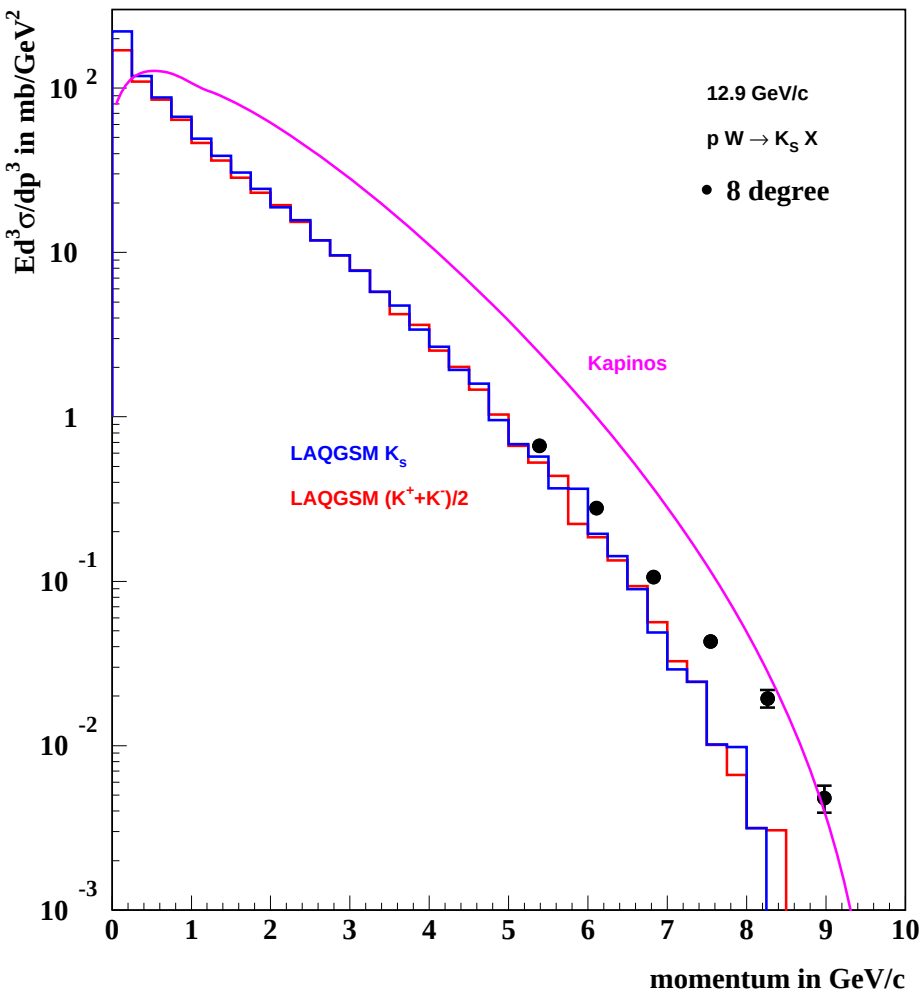
y=0.7 and m_T-m_p=0.26 GeV ↔ p=0.81 GeV/c and θ=45^0

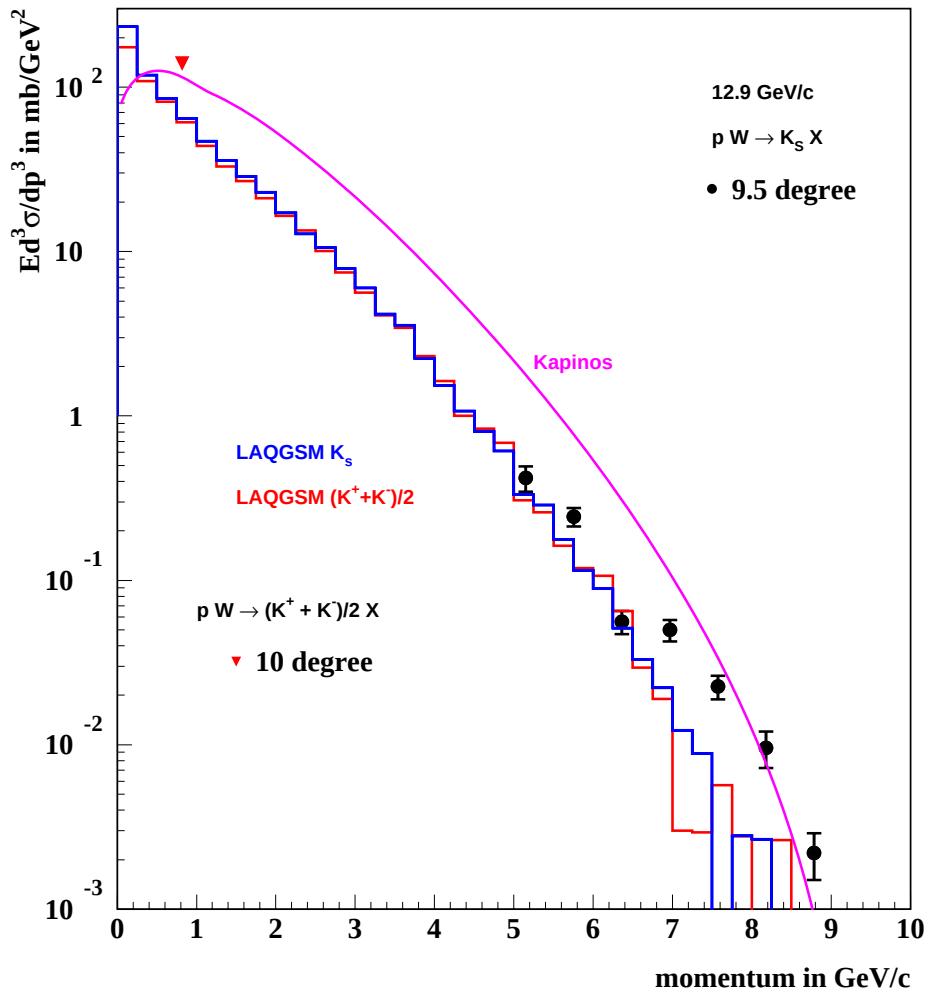
Models and data at 12.9 GeV/c





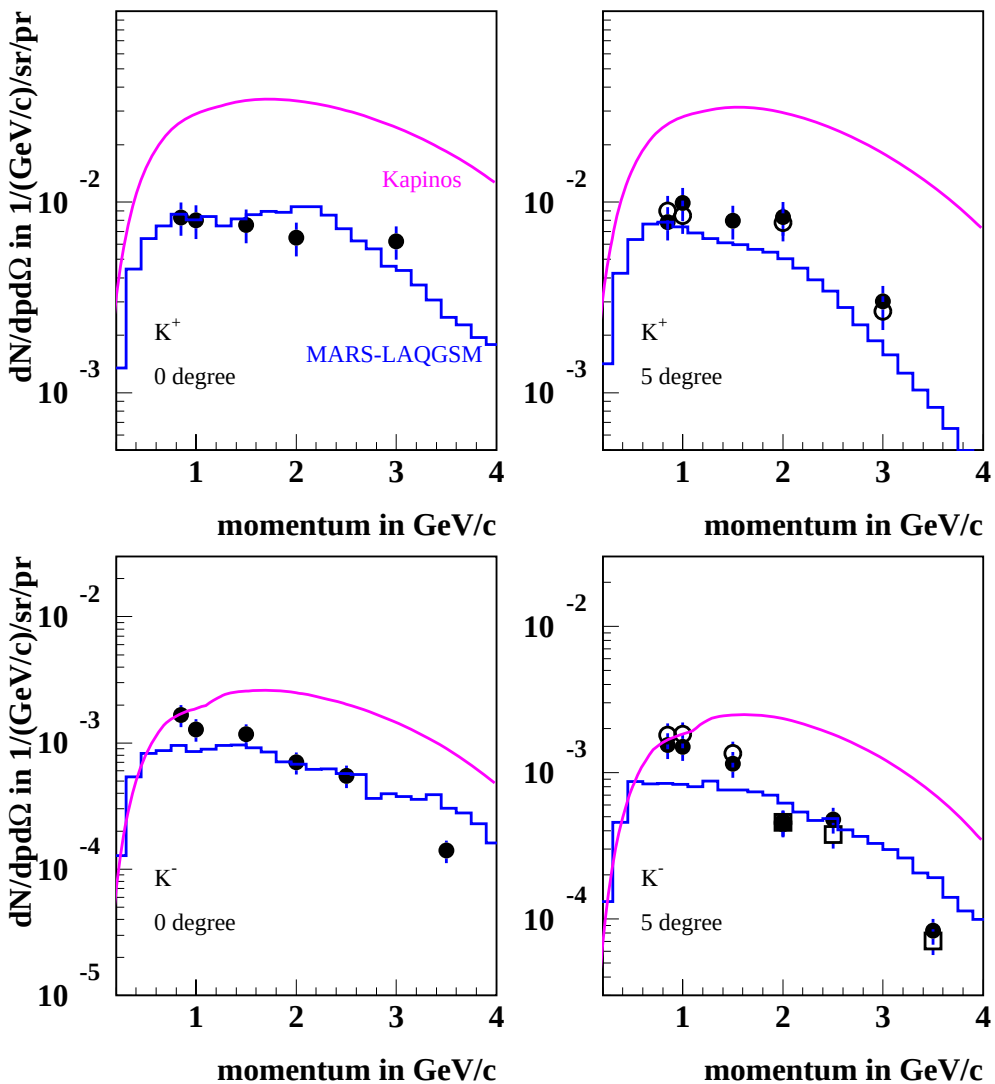
Models and data at 12.9 GeV/c





Models and data

- Kapinos model (and original BKP model) can not reproduce data at large x ($p/p_0 > 0.1$) & small angle, and small x &large angles simultaneously (p is kaon and and p_0 is proton momentum)
- With Kapinos scale BKP model describes well data at p~1 GeV/c and $p_0 > 12$ GeV/c, with original scale BKP reproduces well high-x and low-angle experimental data
- LAQGSM systematically underestimates low-x measurements
- Both models reproduce well large angle e802 results at 14.6 GeV/c



Charged kaon production from 10 cm lead target at 8 GeV/c

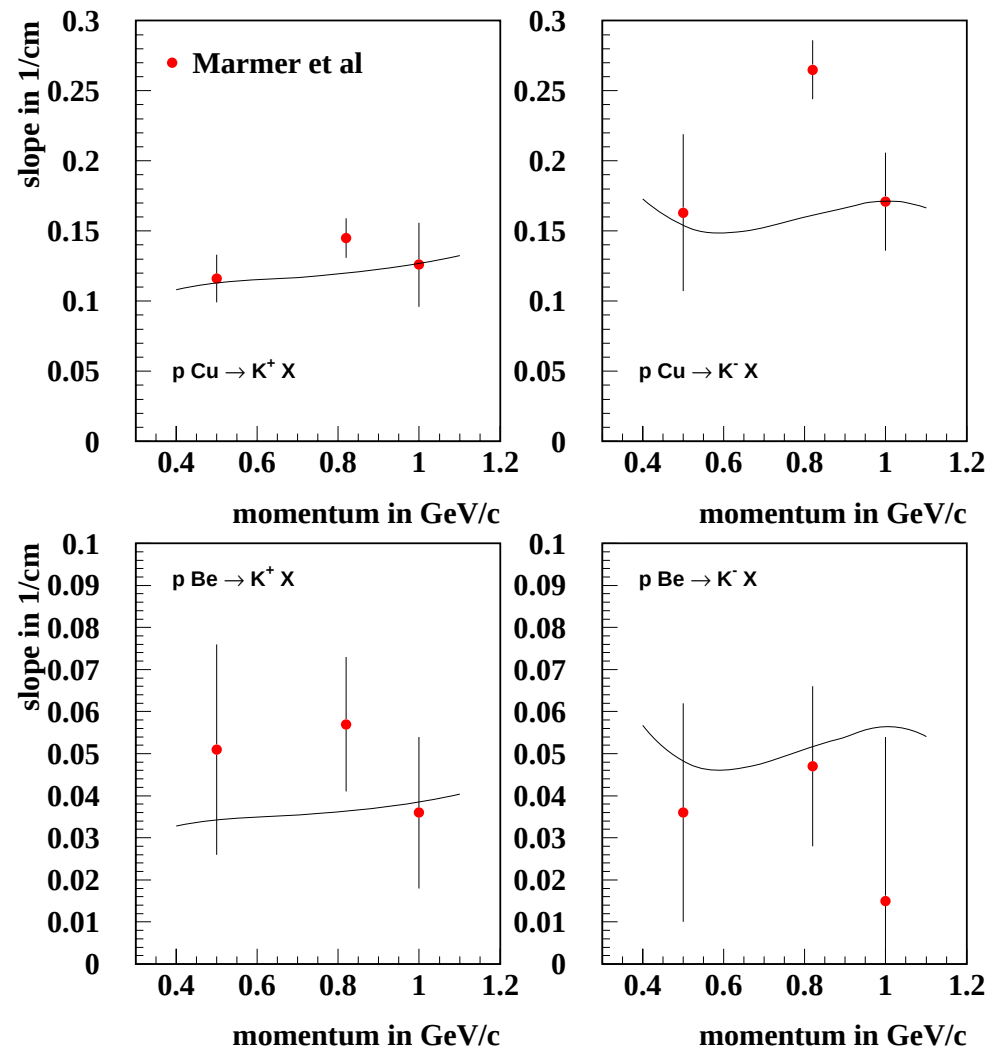
From thin to thick target

- Simple linear dependence on target thickness is used in Kapinos model
- MARS-LAQGSM simulates kaon production in hadronic shower
- Simplest model – kaon production and absorption:

  $\theta \sim 0 \quad \Sigma_{in} (\exp(-\Sigma_{in} x) - \exp(-\Sigma_{out} x))/(\Sigma_{out} - \Sigma_{in})$

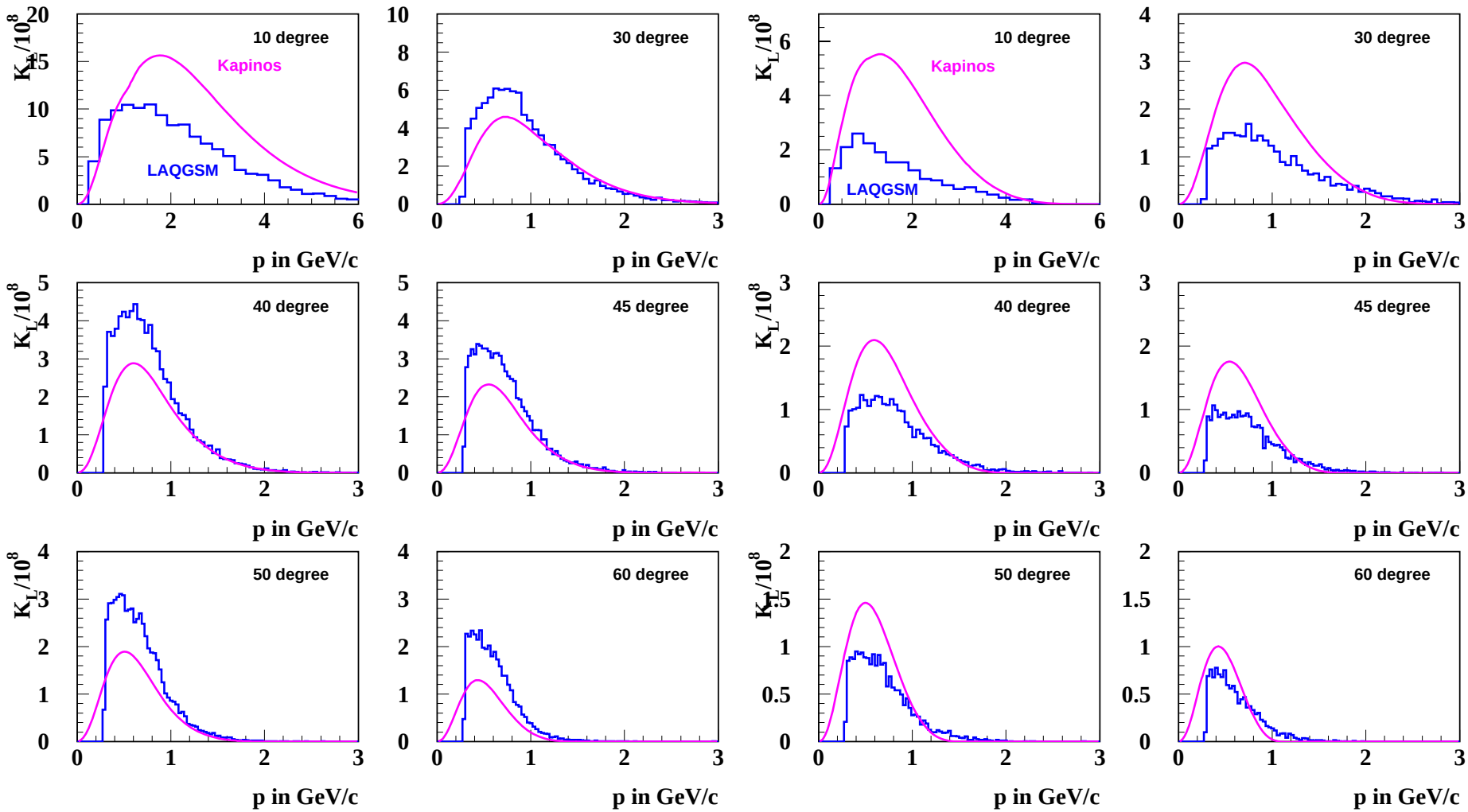
  $\sim \Sigma_{in} x \exp(-(\Sigma_{in} + \Sigma_{out})x/2)$

  $\theta \sim 1 \quad 1-\exp(-\Sigma_{in} x)$
- Kaon production in secondary interactions is not important at least in 8-12 GeV/c momentum range



Charged kaon production from thick target at 12.3 GeV/c

LAQGSM vs Kapinos-I

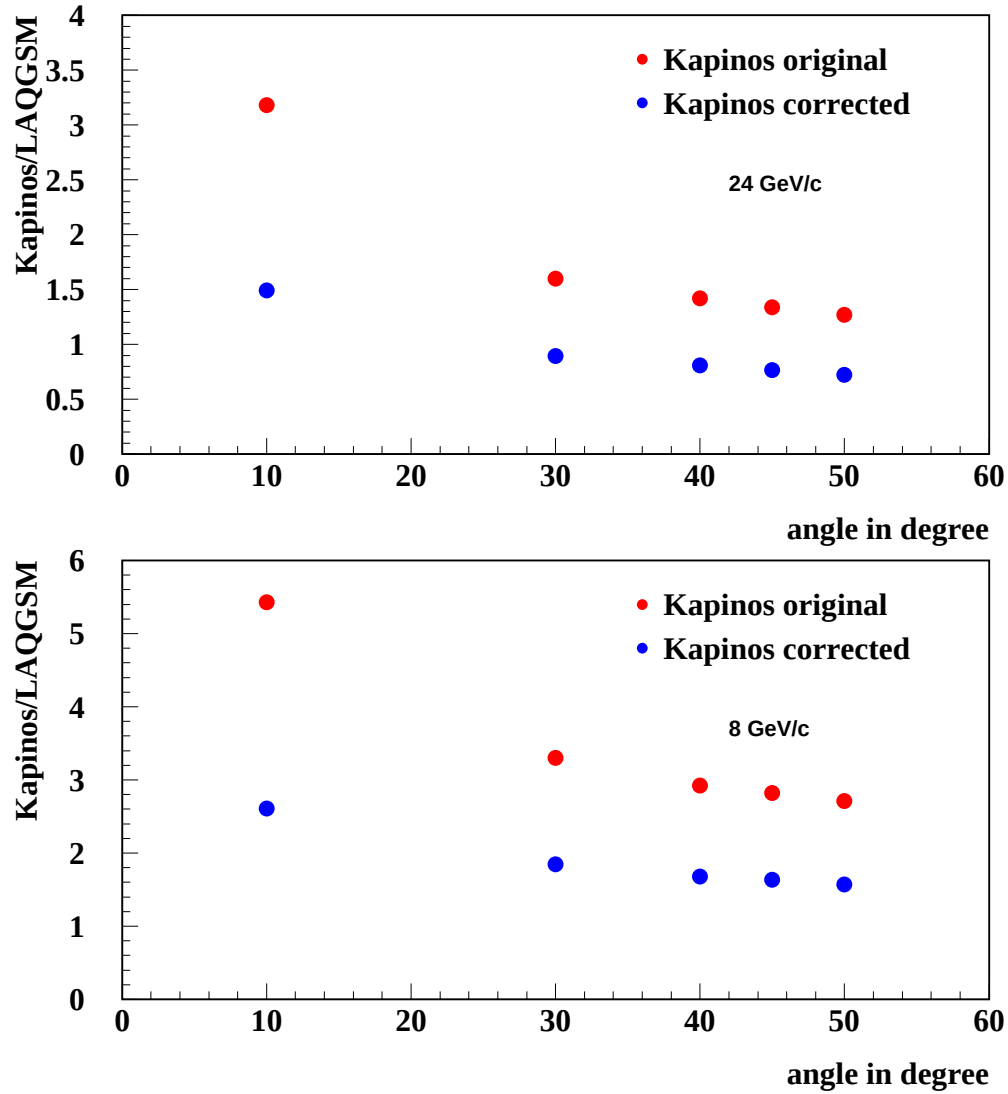


K_L into 500 μsr by 5×10^{13} protons on 10 cm platinum target at 24 GeV/c

K_L into 500 μsr by 5×10^{13} protons on 10 cm platinum target at 8 GeV/c

LAQGSM vs Kapinos-II

- LAQGSM and Kapinos fluxes agree within 50% at 24 GeV/c
- Kapinos model is in close agreement with thin target data at small angle and small momentum at 24 GeV/c. LAQGSM underestimates this measurement on ~ 40%
- Kapinos model predicts much larger number of neutral kaons than LAQGSM at 8 GeV/c, especially at small angles
- Kapinos model overestimates experimental yield at 8 GeV/c and small angles. LAQGSM agrees well with this data
- Both models reproduce well ONLY large angles and low momentum data at 14.6 GeV/c



K_L production 10 cm platinum target

Conclusions

- New experimental data on kaon production at small angles and low kaon momenta were included to verification
- LAQGSM is in good agreement with data on neutral/charged kaon production at 8 and 14.6 GeV/c, but underestimates kaon yield at $x < 0.1$
- Kapinos model is in acceptable agreement with $x < 0.1$ data, but overestimates experimental data at larger x
- Both models agree with each other and experiment at large angles and low momenta at 14.6 GeV/c. Kapinos model yield (45 degree) is 20% lower than LAQGSM at 24 GeV/c, but ~60% larger at 8 GeV/c
- Comparison with another codes (FLUKA, FRITIOF, UrRQMD …) is needed to verify large-angle yield
- Comparison with data on large-angle production from light nuclei could be useful in model tuning/verification