

# *Production of charged pions off nuclei at HARP within the GiBUU model*

K. Gallmeister, U. Mosel

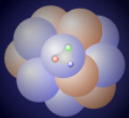
- HARP

CERN PS, proton/pion beam 3-13 GeV/c

- GiBUU:

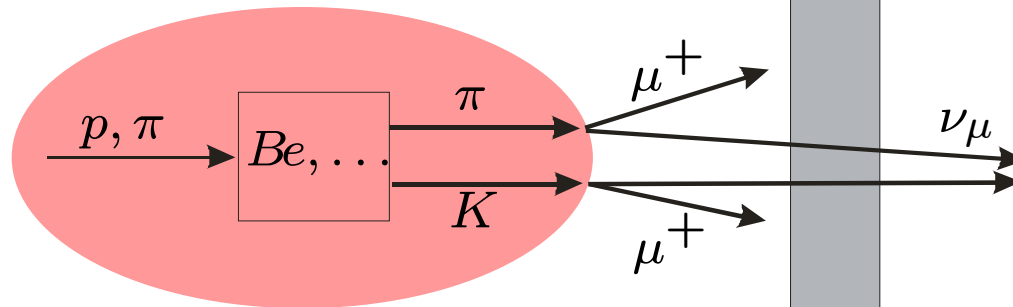
semiclassical coupled channel transport model  
from some MeV to tens of GeV

multi purpose:  $p$ ,  $\pi$ ,  $\gamma^*$ ,  $\nu$  – induced reactions, HIC



# Introduction

## ■ HARP, NA61/Shine



understand hadronic FSI

aim: adjust flux for ...

- MiniBooNE
- SciBooNE
- K2K

## ■ GiBUU

■  $pN, \pi N \rightarrow X$  using PYTHIA

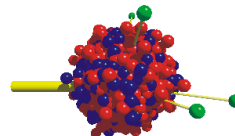
■ propagation of final state  $X$  within GiBUU transport model

*additional:*

- binding energies
- Fermi motion
- Pauli blocking
- formation times / CT

- elastic/inelastic scatterings (coupled channels)
- experimental acceptance

<http://gibuu.physik.uni-giessen.de>



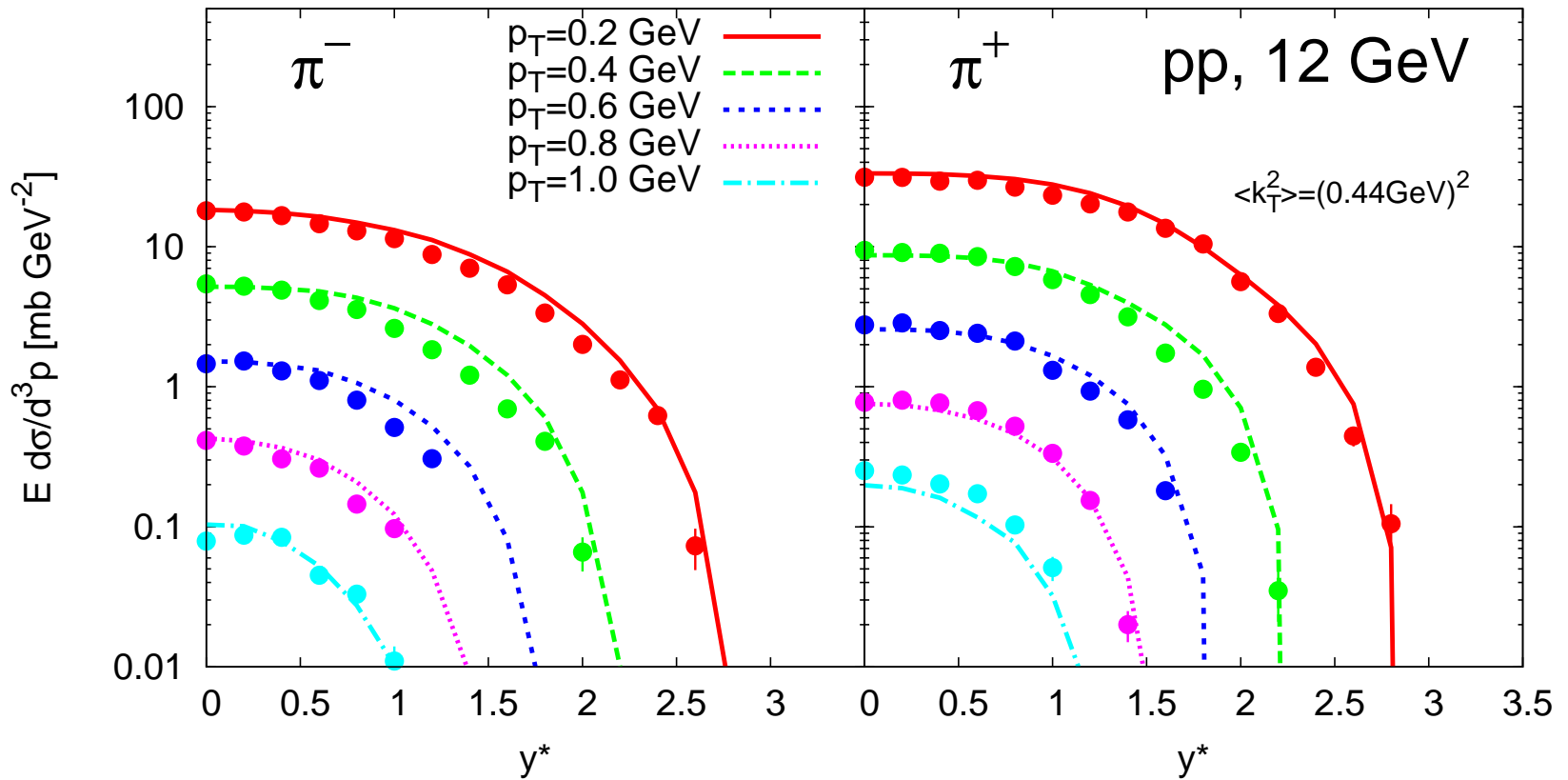
Institut für Theoretische Physik, JLU Giessen

**GiBUU**

The Giessen Boltzmann-Uehling-Uhlenbeck Project

# elementary: $pp \rightarrow \pi^\pm X$

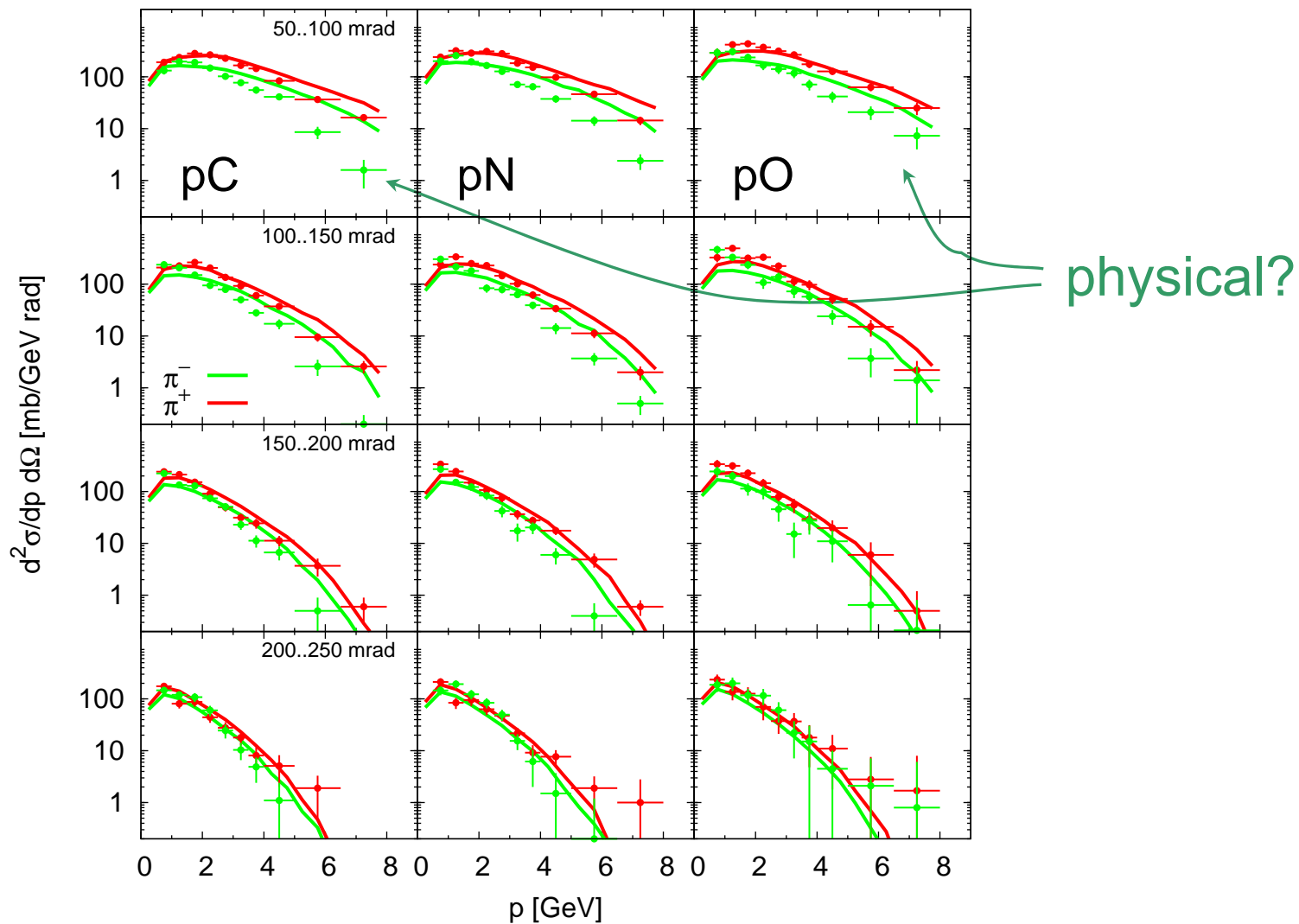
data: V. Blobel et al., Nucl. Phys. B69 (1974) 454



■ Pythia v6.4 describes elementary data very well

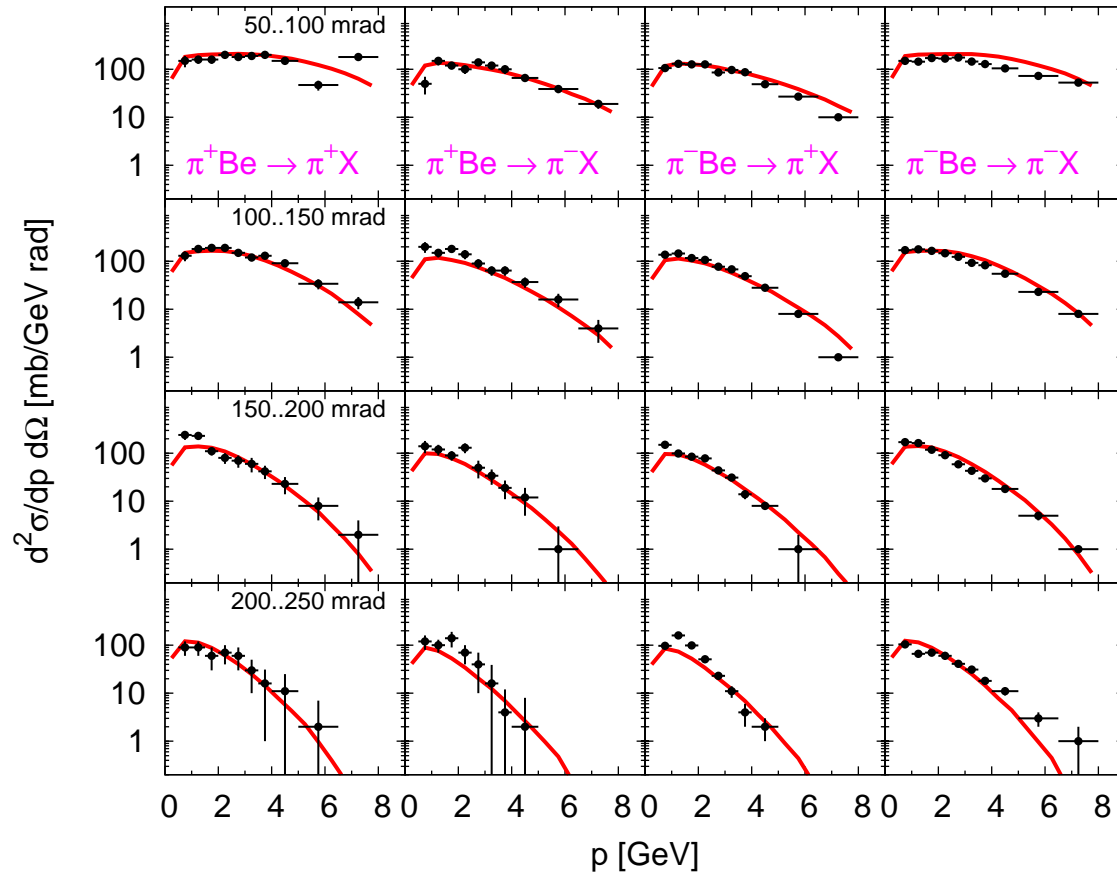
# $pA \rightarrow \pi^\pm X$ (forward, 12 GeV/c)

data: M.G. Catanesi et al. (HARP), Astropart. Phys. 30 (2008) 124



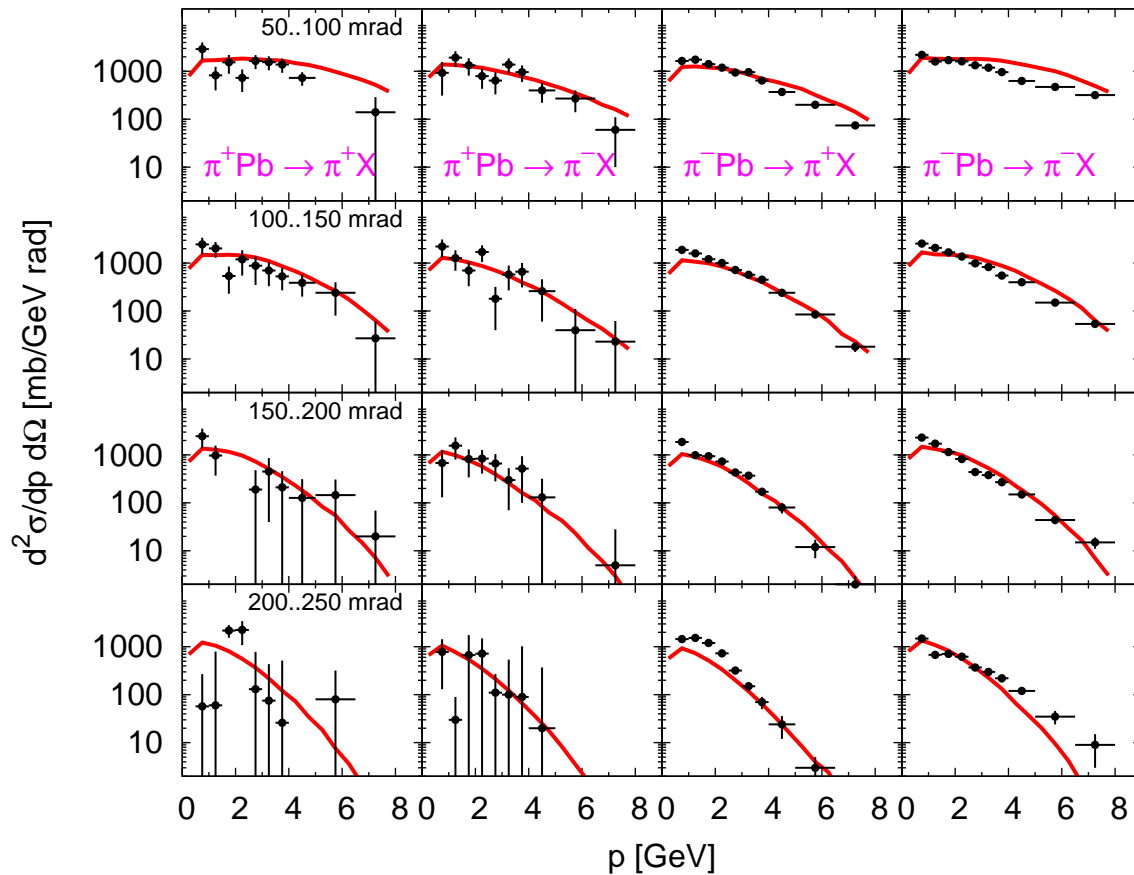
# $\pi^\pm \text{Be} \rightarrow \pi^\pm X$ (forward, 12 GeV/c)

data: M.G. Catanesi et al. (HARP), arXiv:0902.2105 [hep-ex]



# $\pi^\pm Pb \rightarrow \pi^\pm X$ (forward, 12 GeV/c)

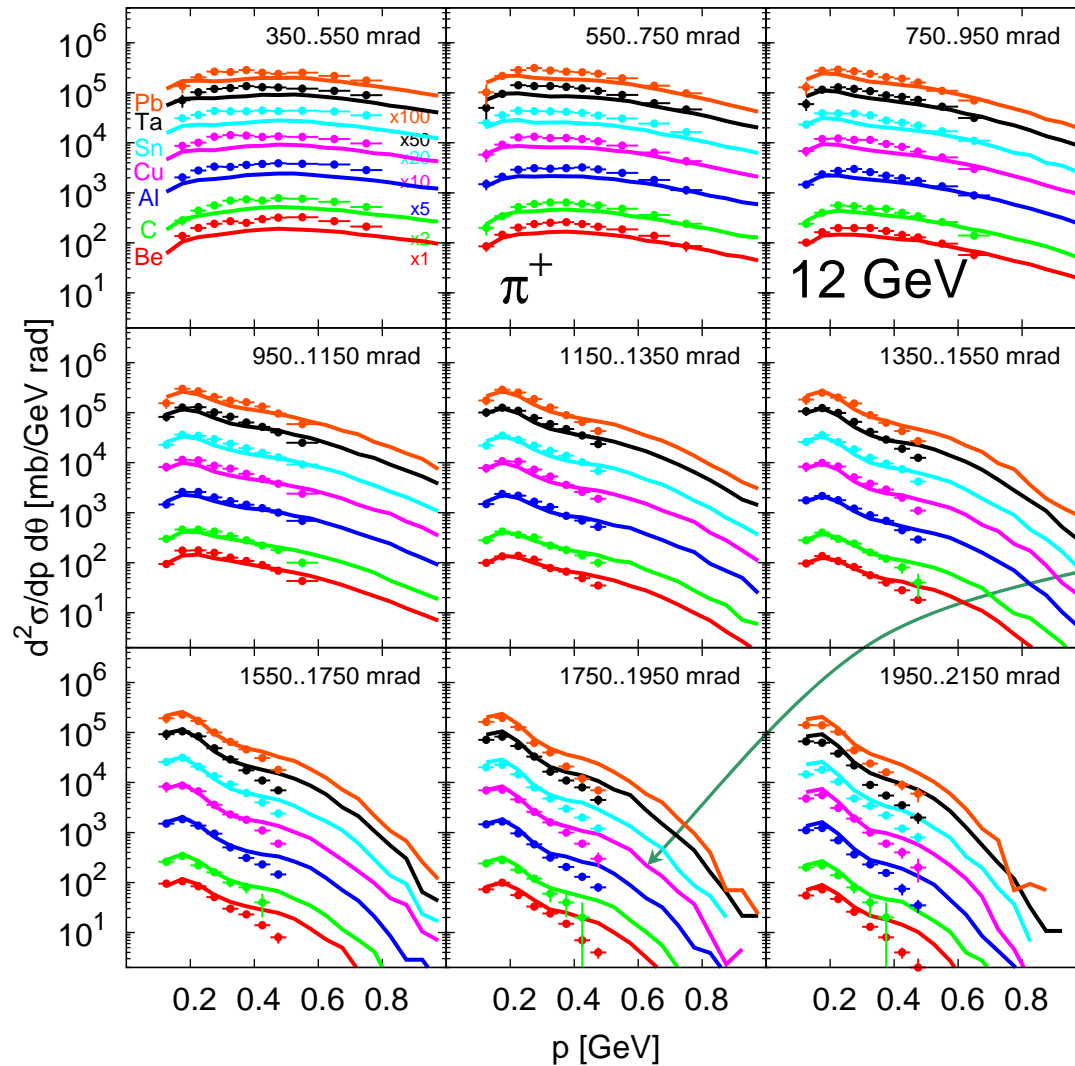
data: M.G. Catanesi et al. (HARP), arXiv:0902.2105 [hep-ex]



- forward production described very well
- pion beam slightly better described than proton beam

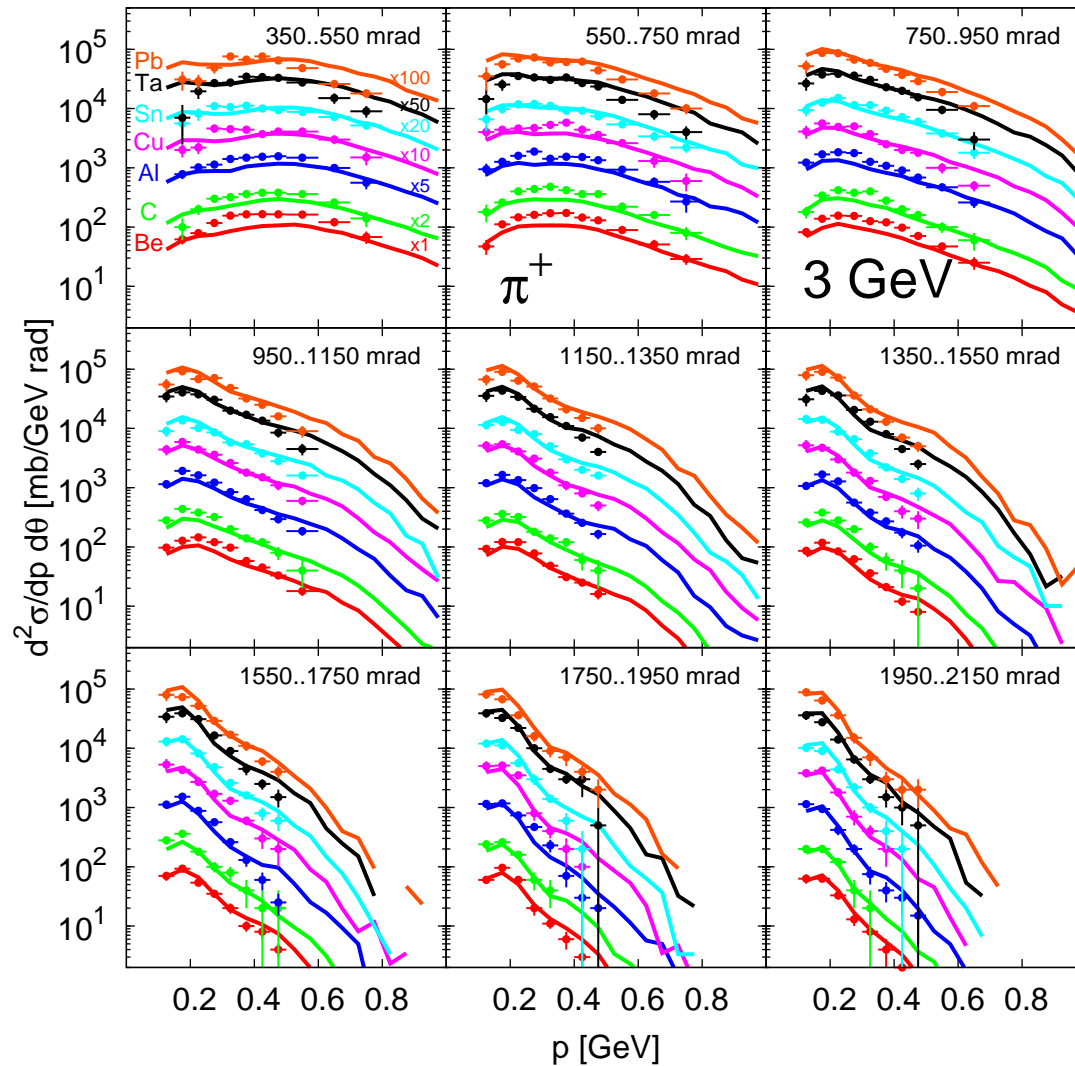
# $pA \rightarrow \pi^+ X$ (backward, 12 GeV/c)

data: M.G. Catanesi et al. (HARP), Phys. Rev. C 77 (2008) 055207



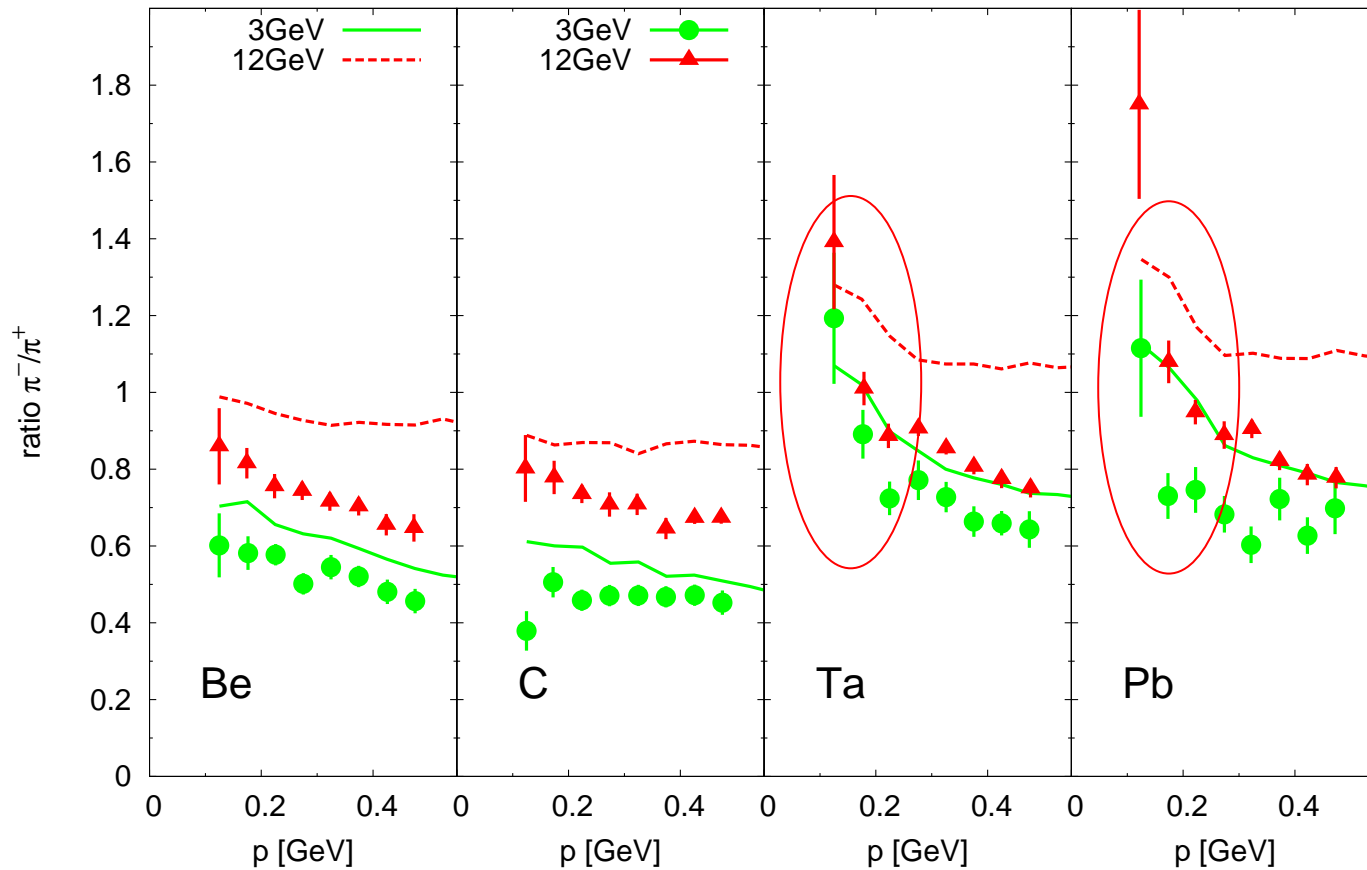
# $pA \rightarrow \pi^+ X$ (backward, 3 GeV/c)

data: M.G. Catanesi et al. (HARP), Phys. Rev. C 77 (2008) 055207





# Ratio $\pi^-/\pi^+$ (backward, 350..1550mrad)



- $\pi$  from  $\Delta$  at rest (long collision histories)
- neutron over proton excess

# Summary

## ■ GiBUU:

- coupled channel transport code (semi classical)
- from some MeV to tens of GeV  
(Pythia v6.4 for high energy)
- multi purpose:  $\rho$ ,  $\pi$ ,  $\gamma^*$ ,  $\nu$  – induced reactions  
Heavy Ion Collisions

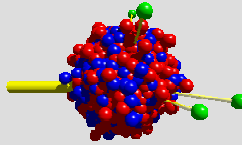
## ■ HARP:

- calibrate flux for neutrino experiments
- pion, proton beam
- critical test for hadronic FSI

■ GiBUU describes HARP data very well

■ predictions for NA61/Shine (30 GeV/c): pions, kaons

# Backup slides



GiBUU

The Giessen Boltzmann-Uehling-Uhlenbeck Project

Institut für Theoretische Physik, JLU Giessen

$$\frac{df^X}{dt} = \frac{\partial f^X}{\partial t} + \frac{\partial H}{\partial \vec{p}} \frac{\partial f^X}{\partial \vec{r}} - \frac{\partial H}{\partial \vec{r}} \frac{\partial f^X}{\partial \vec{p}} = I_{\text{coll}}(f^X, f^a, f^b, \dots)$$

*1 particle phase space densities*

full coupled channel

■ Hamiltonian  $H = H(f^X, f^a, f^b, \dots)$

hadronic mean fields + potentials

■ Solved with „testparticle ansatz“

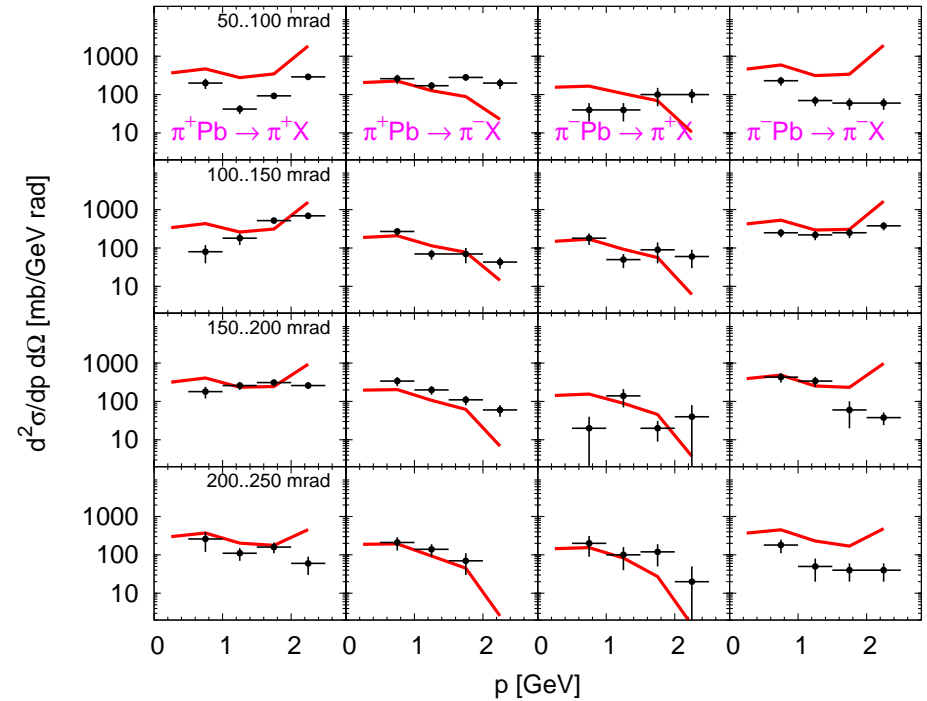
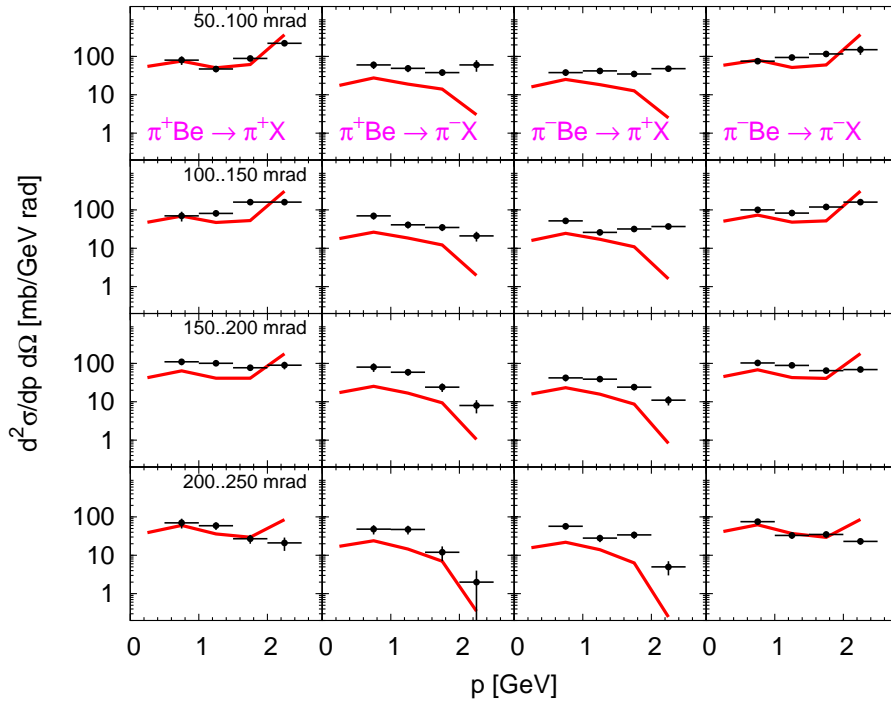
$$f^X = \sum_{i=1}^{n \times N^X} \delta(\vec{r} - \vec{r}_i) \delta(p - p_i)$$

local ensemble method  
= local collisions

■ 61 baryons, 21 mesons

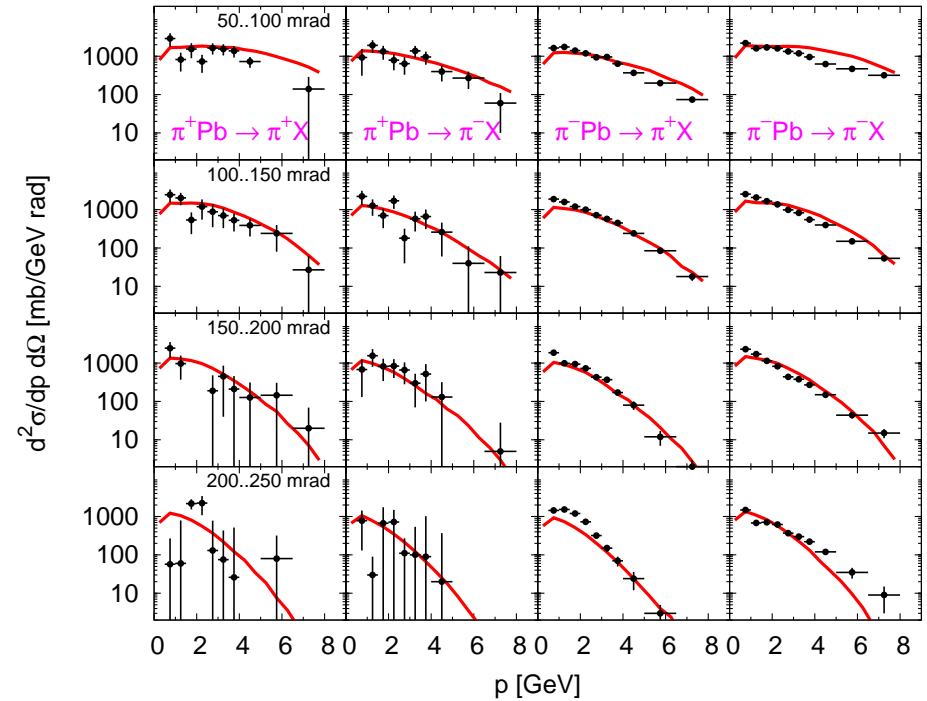
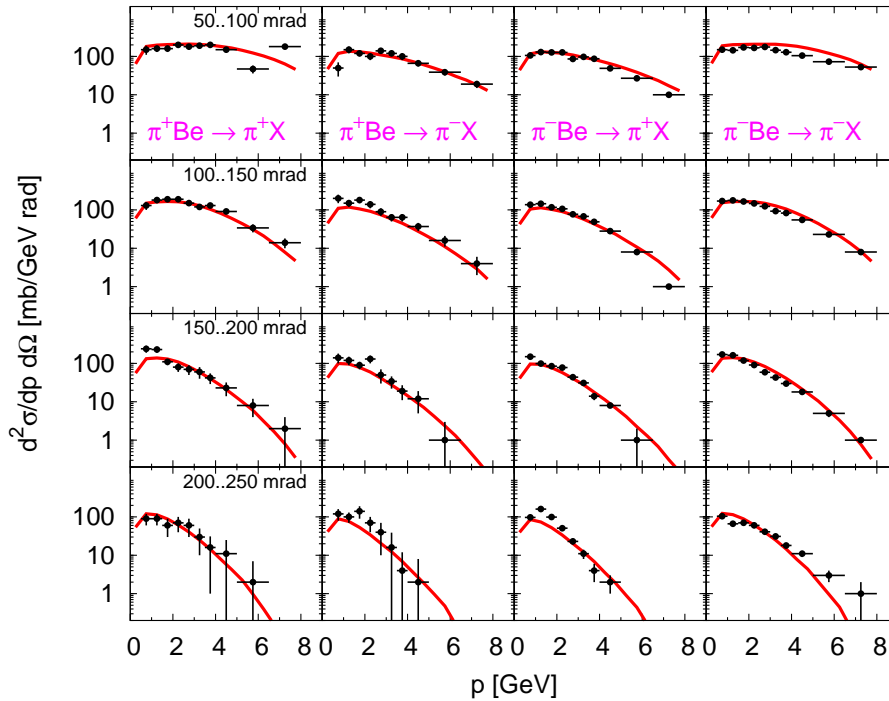
# $\pi^\pm A \rightarrow \pi^\pm X$ (forward, 3 GeV/c)

data: M.G. Catanesi et al. (HARP), arXiv:0902.2105 [hep-ex]



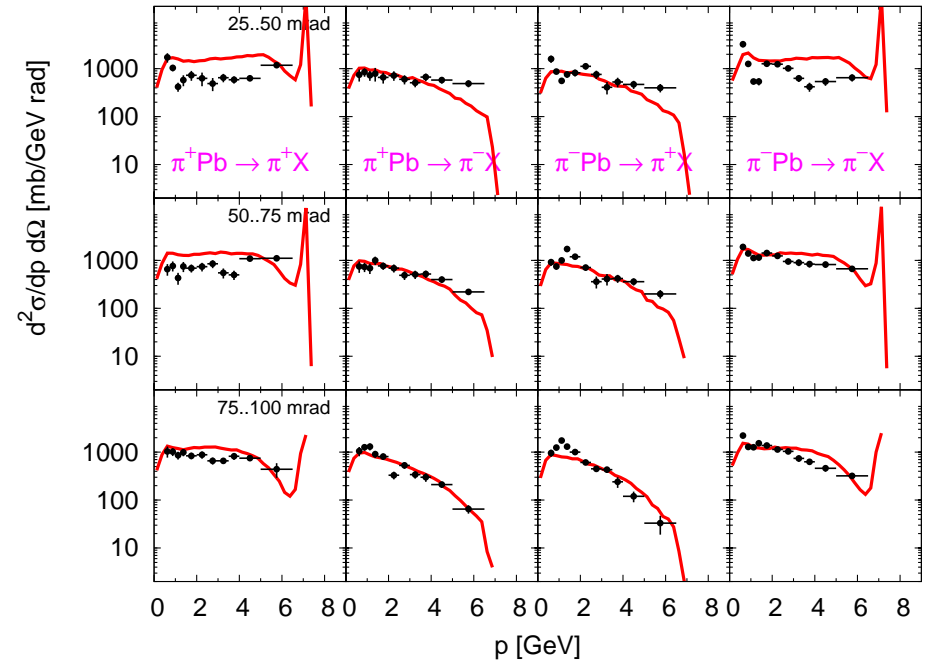
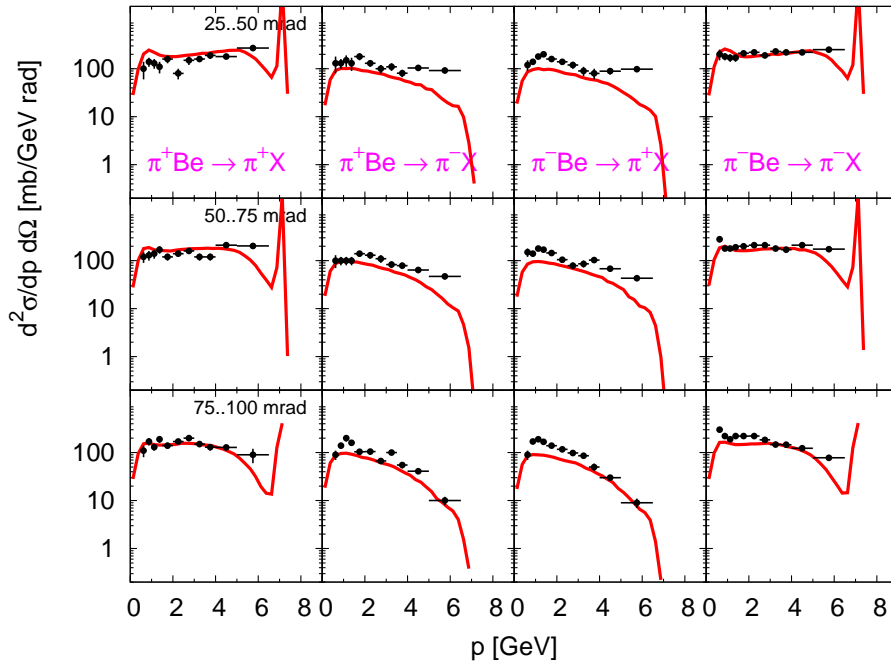
# $\pi^\pm A \rightarrow \pi^\pm X$ (forward, 12 GeV/c)

data: M.G. Catanesi et al. (HARP), arXiv:0902.2105 [hep-ex]



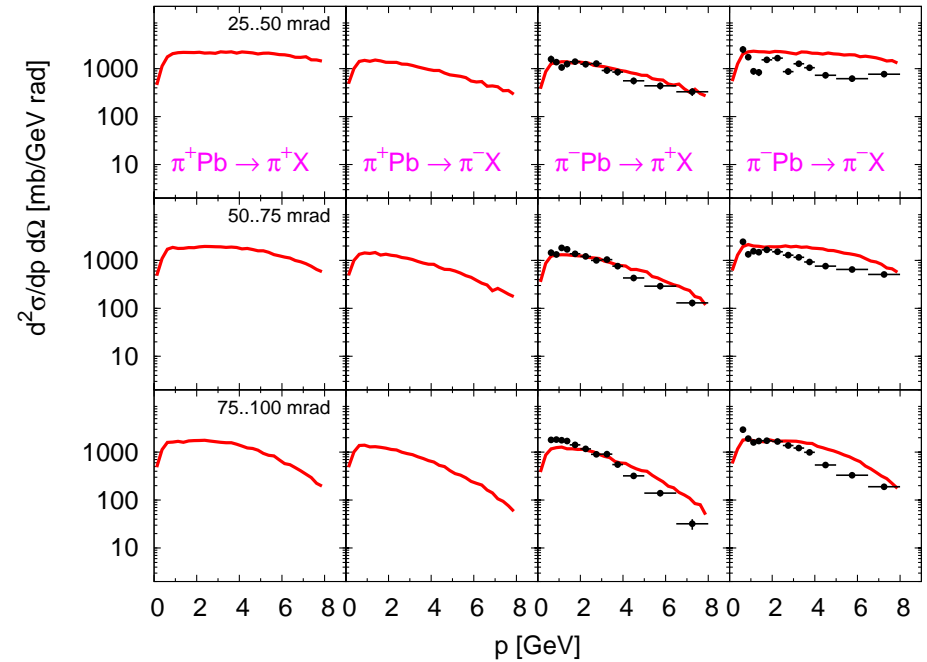
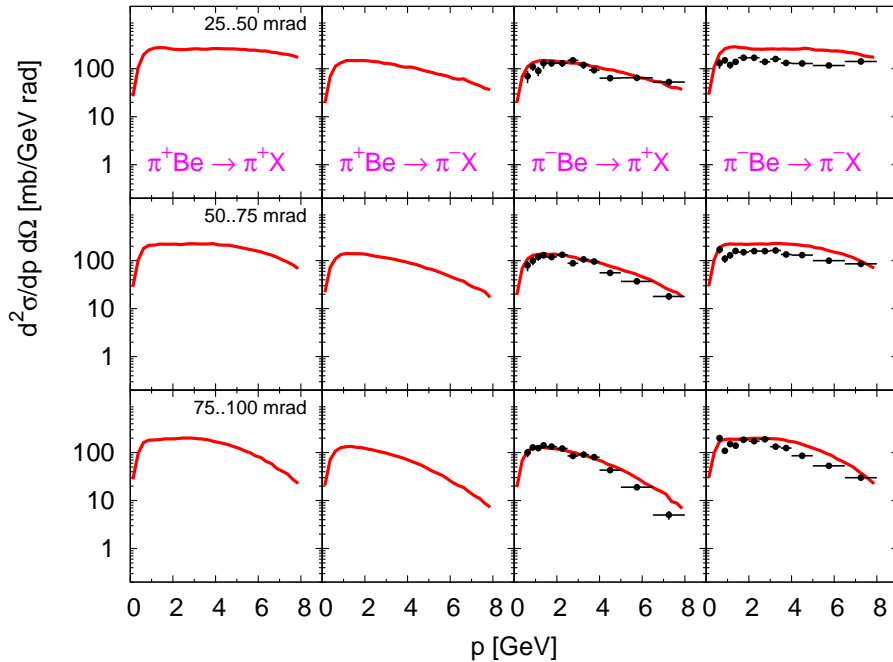
# $\pi^\pm A \rightarrow \pi^\pm X$ (very forward, 8 GeV/c)

data: M.G. Catanesi et al. (HARP), arXiv:0902.2105 [hep-ex]



# $\pi^\pm A \rightarrow \pi^\pm X$ (very forward, 12 GeV/c)

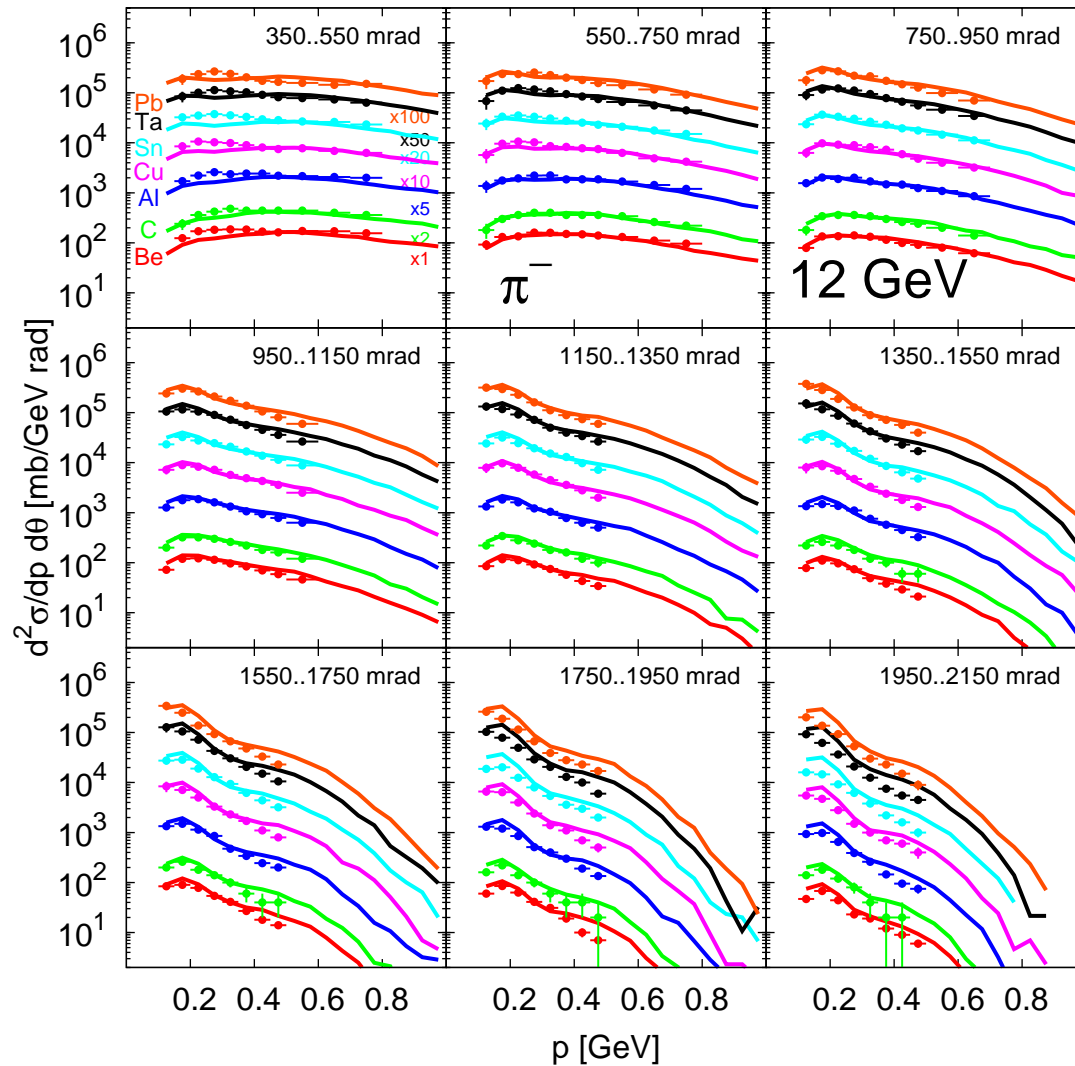
data: M.G. Catanesi et al. (HARP), arXiv:0902.2105 [hep-ex]





# $pA \rightarrow \pi^- X$ (backward, 12 GeV/c)

data: M.G. Catanesi et al. (HARP), Phys. Rev. C 77 (2008) 055207



# $pA \rightarrow \pi^- X$ (backward, 3 GeV/c)

data: M.G. Catanesi et al. (HARP), Phys. Rev. C 77 (2008) 055207

