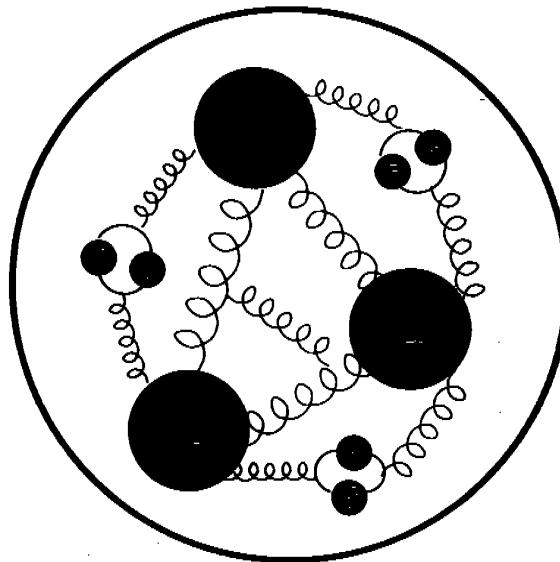


# Experimental Approach to the Nuclear Gluon Distribution

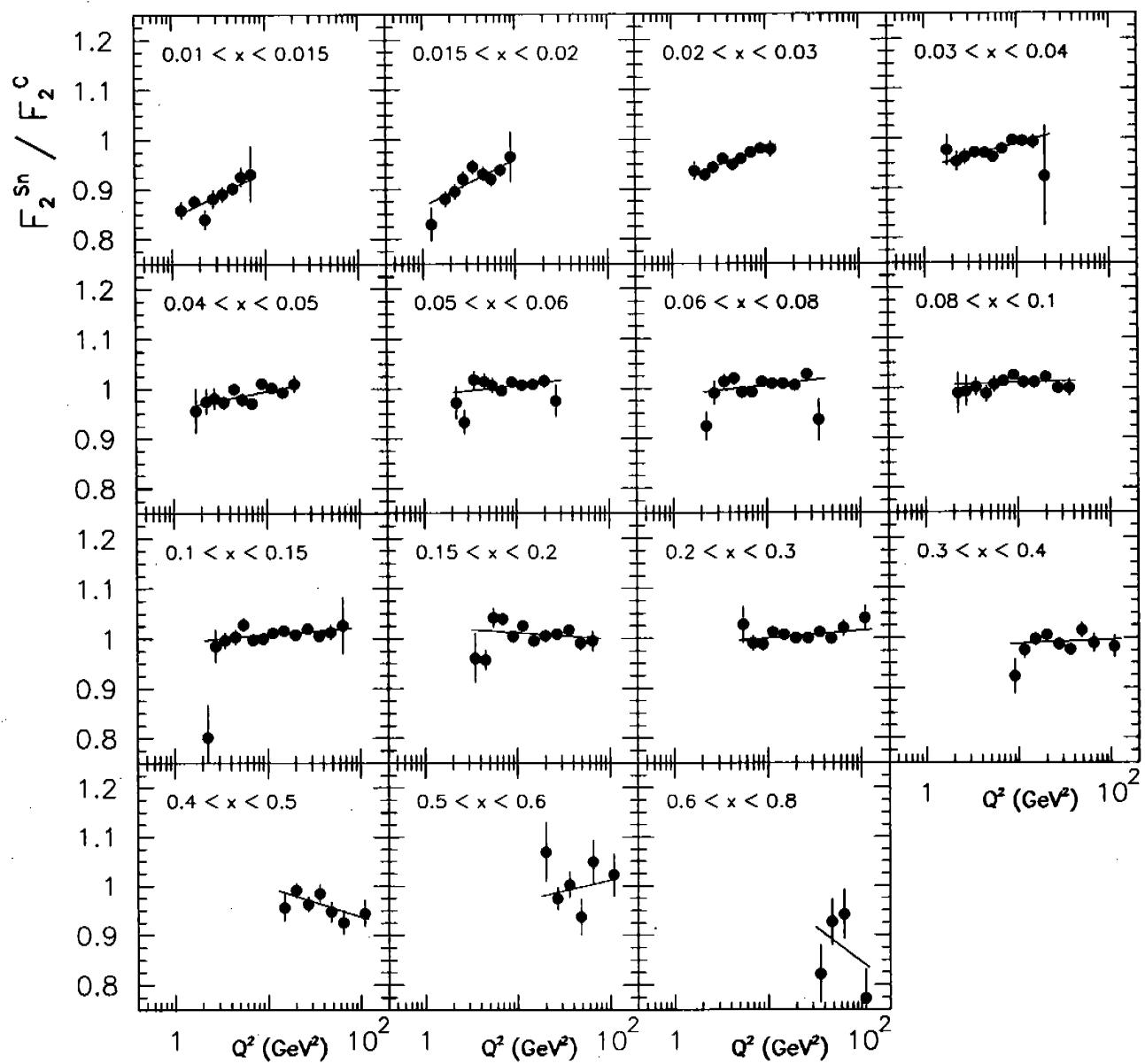
Antje Bruell  
Jefferson Lab

2nd Electron Ion Collider Workshop  
Jefferson Lab, March 15 2004



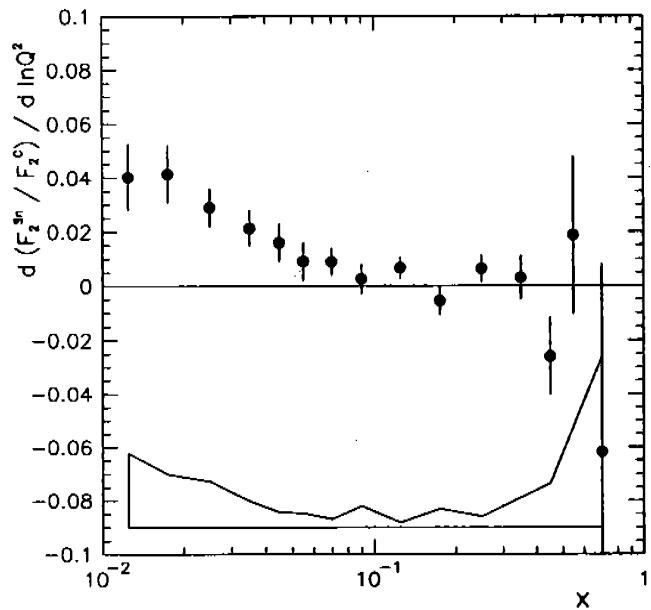
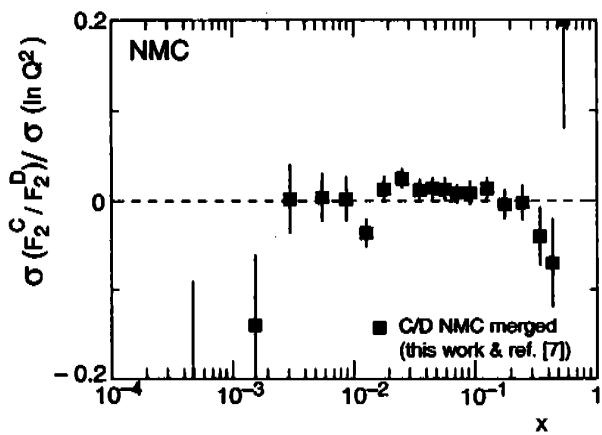
- Motivation
- Possible Measurements and systematic uncertainties
  - $Q^2$  dependence of  $F_2^A/F_2^D$
  - A dependence of  $F_L$
  - Dijet and high  $p_T$  hadron pair production
  - Open Charm production

## $Q^2$ dependence of the EMC effect



## $Q^2$ dependence of the EMC effect

- Precision data on  $F_2^C/F_2^D$  (NMC)
- Data on  $F_2^{Sn}/F_2^C$  collected at 3 different beam energies (NMC)

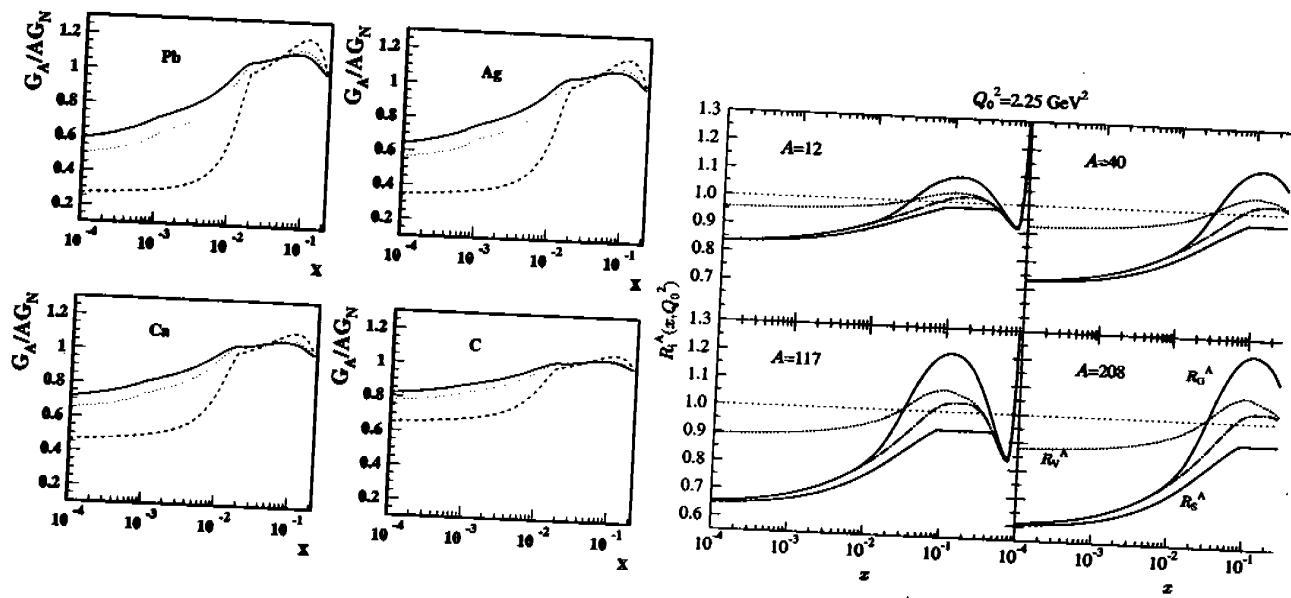


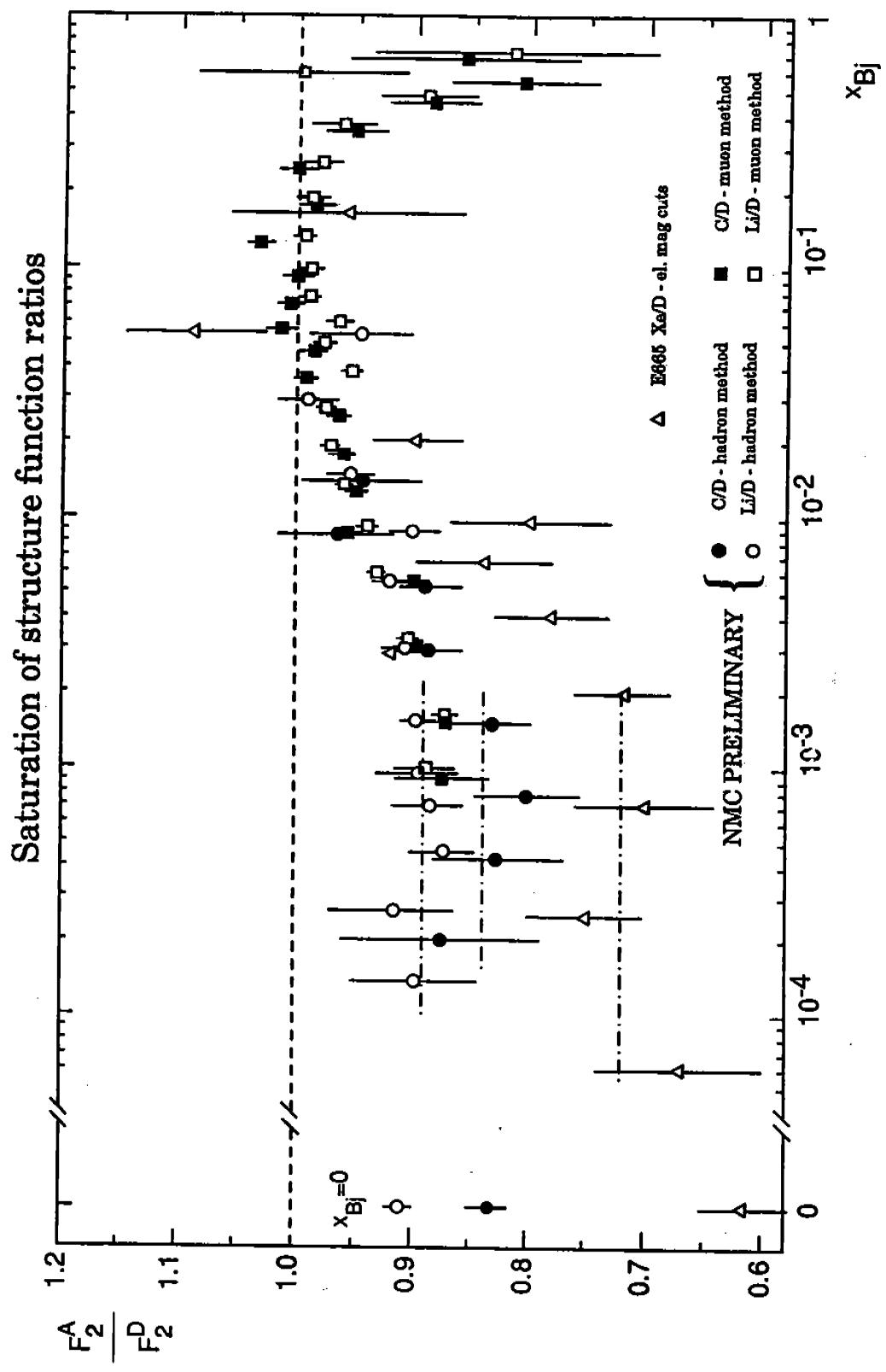
$F_2^C/F_2^D$ : no significant  $Q^2$  dependence

$F_2^{Sn}/F_2^C$ : small and positive  $Q^2$  dependence at low values of  $x$

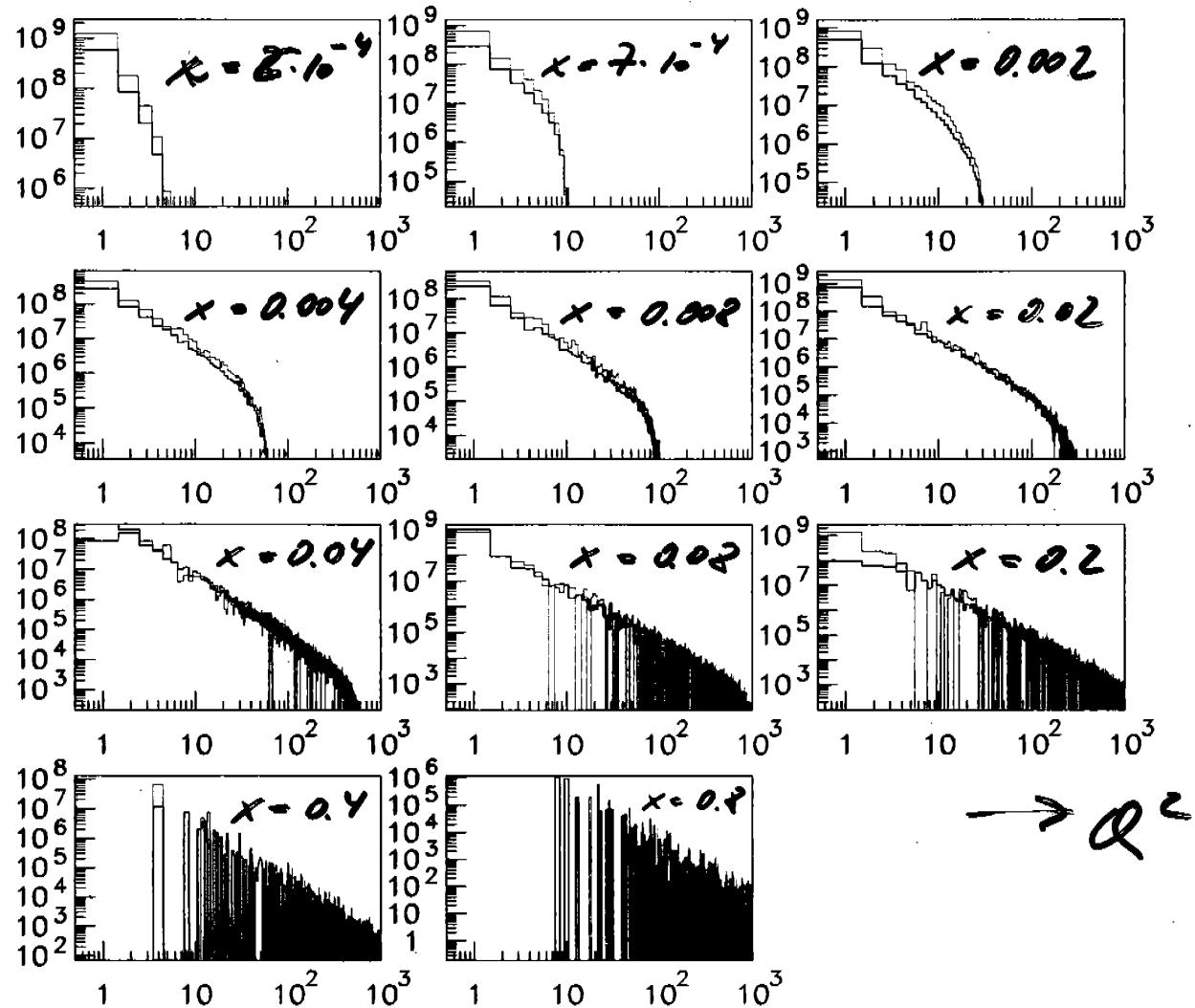
# Nuclear parton distributions

- Nuclear valence quark distributions well known
- Nuclear gluon distribution hardly constrained by data but extracted within certain model assumptions
- two examples:  
left: Frankfurt & Strikman (98)  
right: Eskola et al (98)





$\bar{E}_e = 10 \text{ GeV}$ ,  $\bar{E}_p = 250 \text{ GeV}$   
 100 days at  $\mathcal{L} = 10^{32} \text{ cm}^{-2} \text{s}^{-1}$   
 cross section vs  $Q^2$



$$\frac{\partial F_2^A/F_2^D}{\partial \ln Q^2} \text{ at EIC'}$$

- statistics no issue
- large  $Q^2$  range for  $x < 0.5$
- possibility to normalize to existing NMC measurements  
(norm. uncertainty  $< 0.5\%$ )
- possibility to exclude noisy  
(large) contributions to  
radiative corrections by  
requirement of additional  
particles

## Observable decay modes

- open charm

$$D^0 \rightarrow K^+ \pi^- + \text{c.c.}$$

$$D^0, D^+ \rightarrow K^+ \mu^- X + \text{c.c.}$$

- requires very good PID
- suffers from large combinatoric background
- $D^0 \rightarrow K^+ \pi^-$  is the only decay mode into 2 particles, i.e. has the best signal/background ratio
- $K$  and  $\mu$  from the vertex is a clear signature for charm

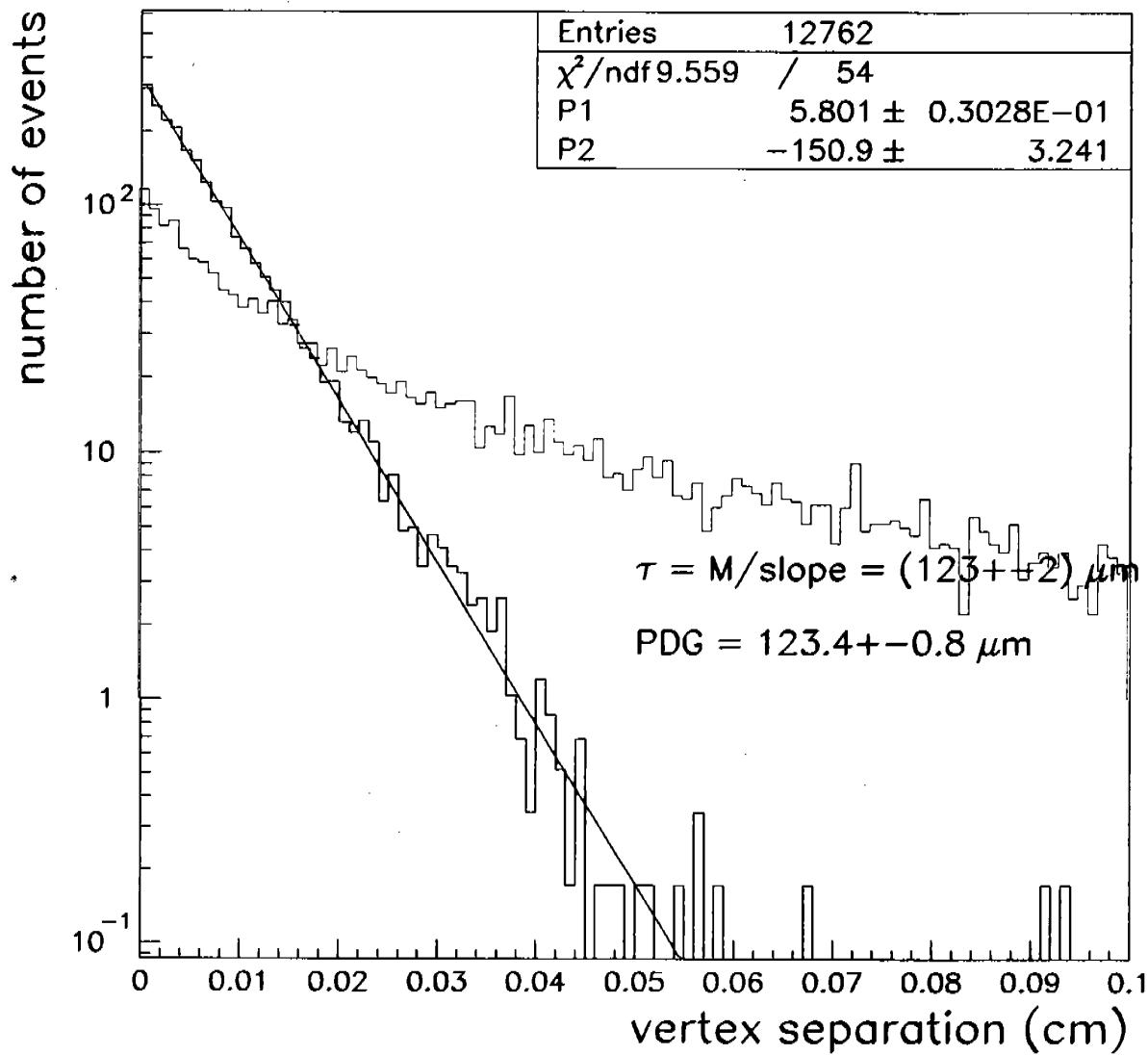
- $J/\psi$

$$J/\psi \rightarrow e^+ e^-$$

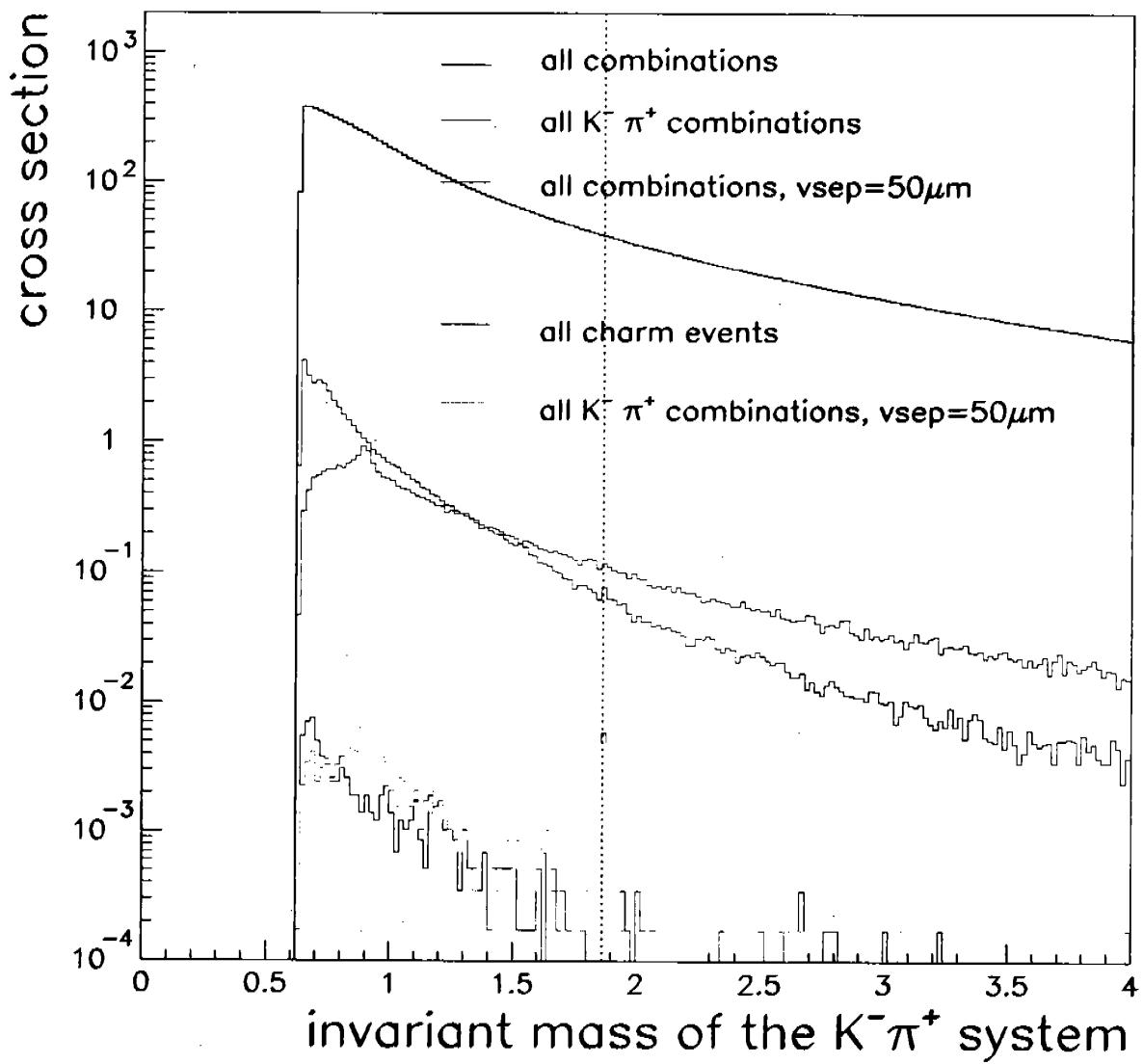
$$J/\psi \rightarrow \mu^+ \mu^-$$

- requires large acceptance
- suffers from low rates
- has almost no background

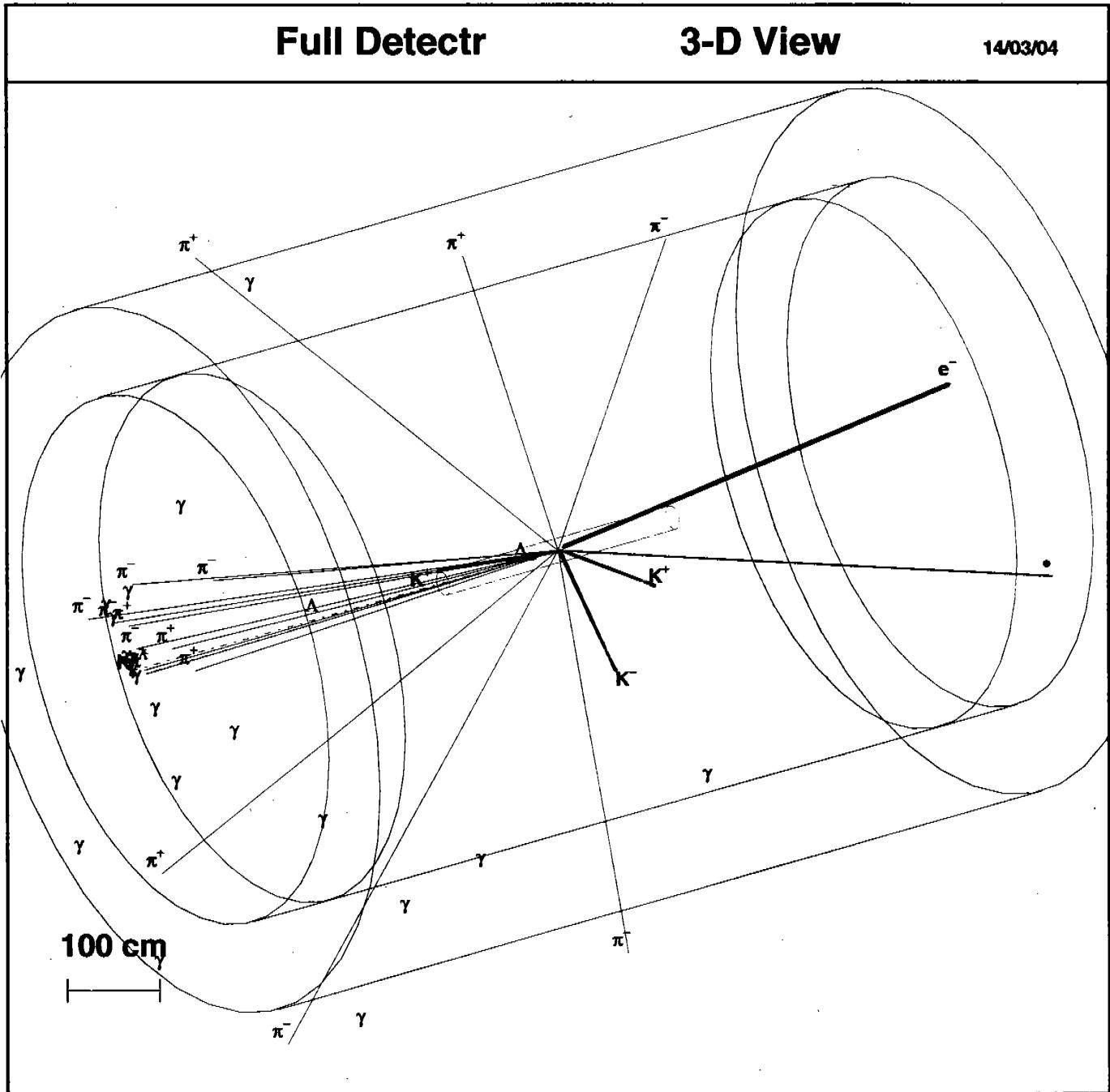
## $D^0$ mesons (black=divided by $p_0$ )



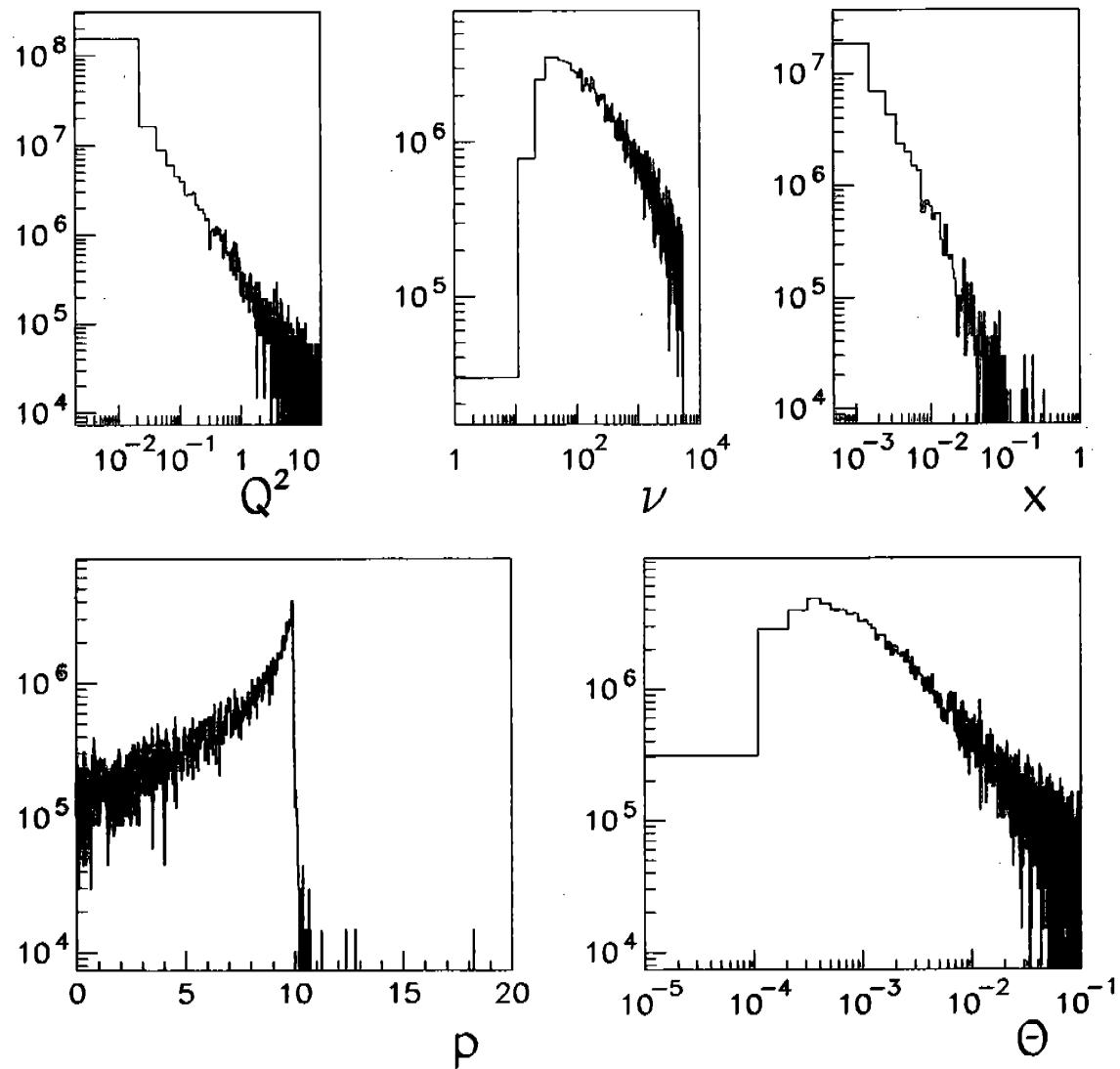
## PYTHIA – hadronic D0 decays



$c$   $\longrightarrow$   $\rho$

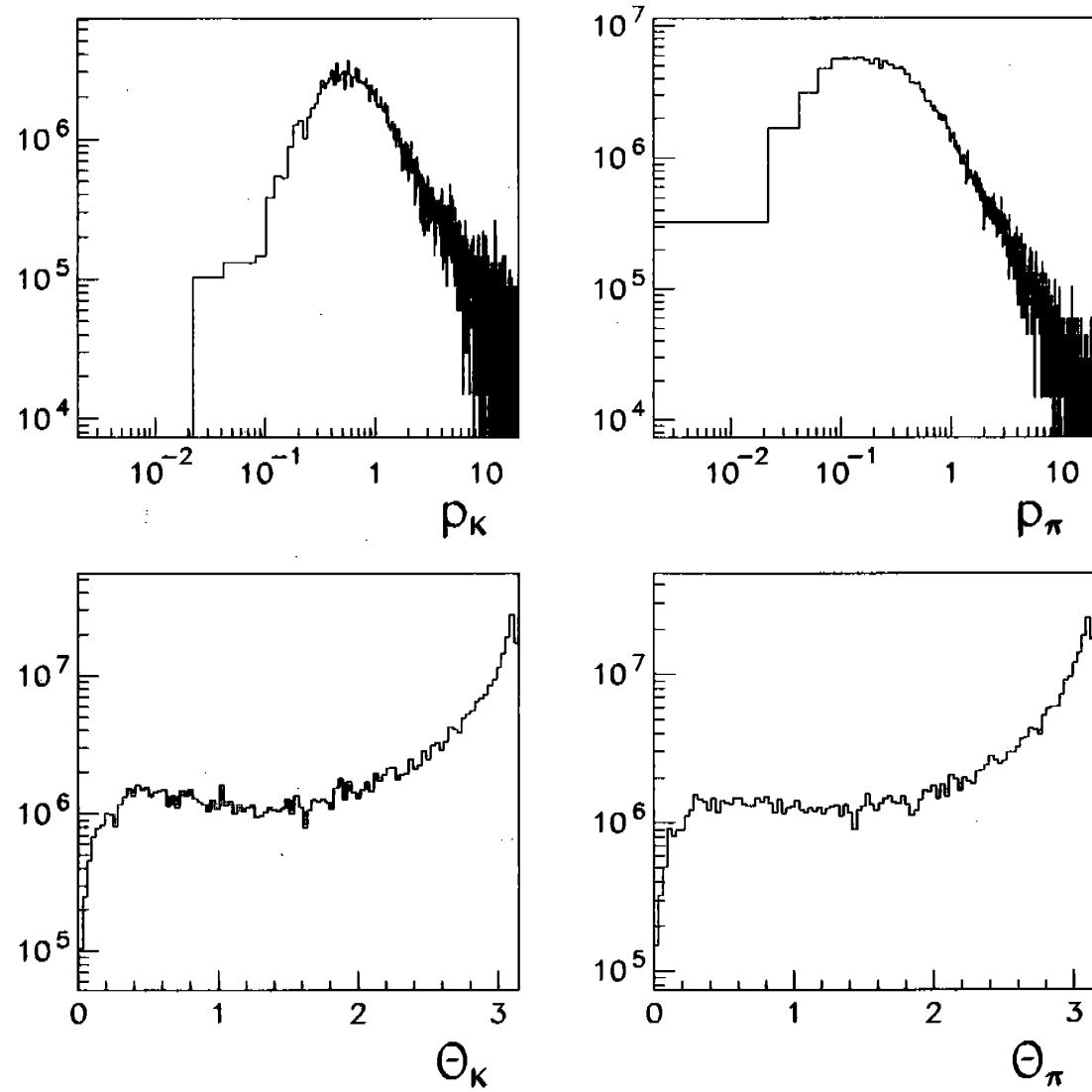


## AROMA – kinematics of scattered lepton



$\rightarrow Q^2$  small  $\rightarrow$  use  $m_c$  as hard scale  
 $\rightarrow \theta$  very small  $\rightarrow$  detection possibilities?

## AROMA – kinematics of decay particles

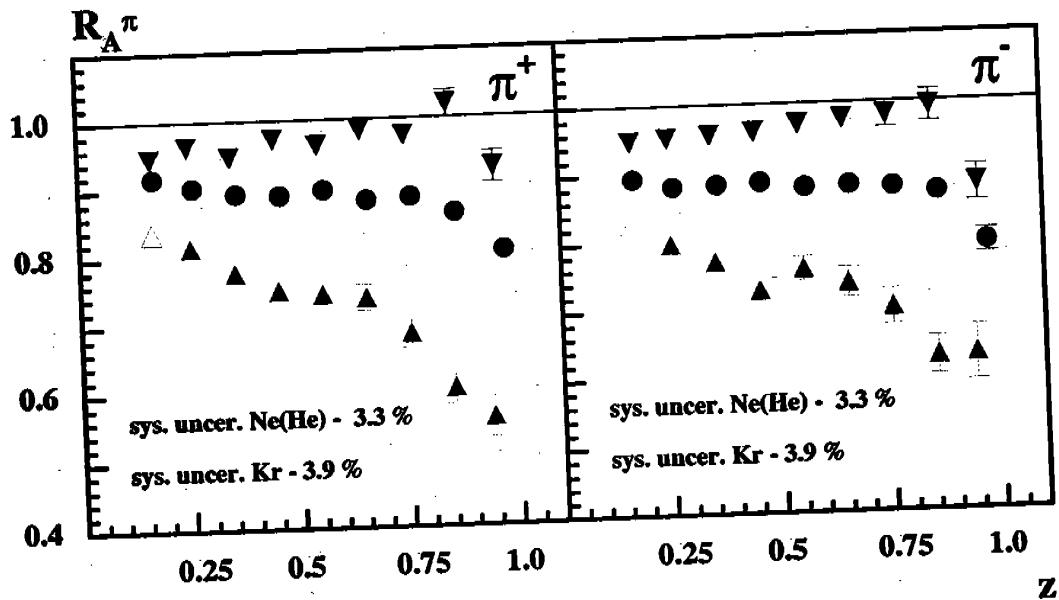
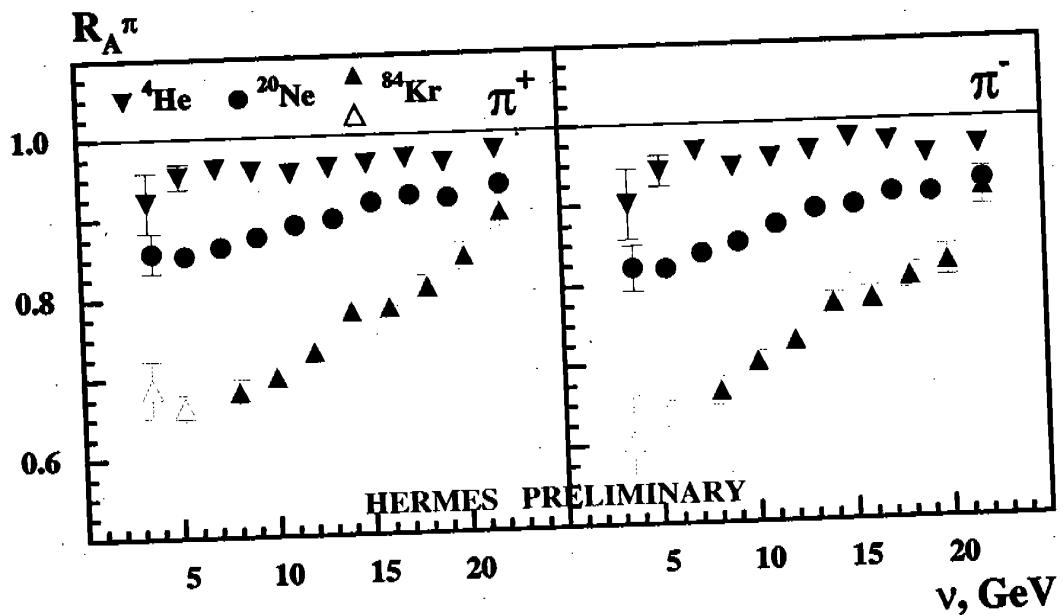


→ need  $\bar{\nu}/\nu$  separation  
for  $0.1 < p < 4 \text{ GeV}$

# Hadronisation in Nuclei



- Pions

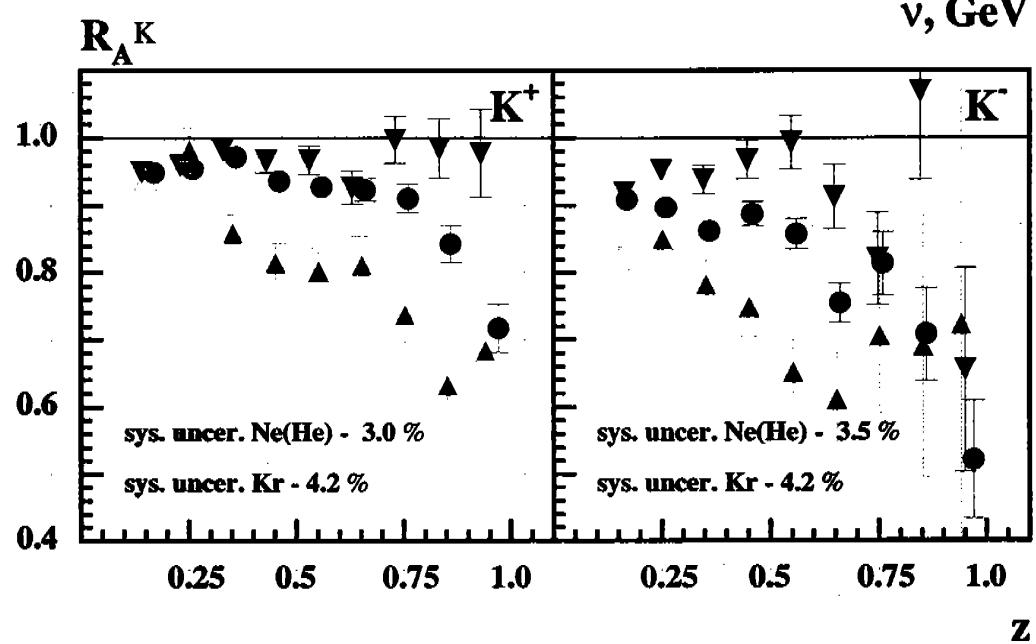
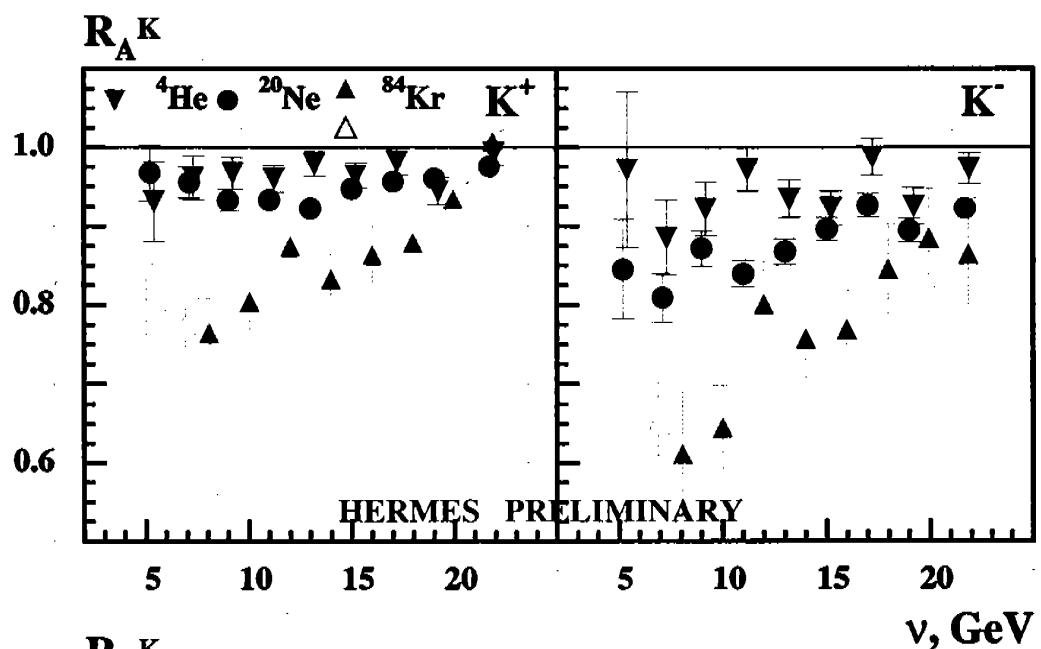


Strong  $\nu, z$  and A dependence

# Hadronisation in Nuclei



- Kaons



## Conclusions

- both  $\frac{\partial \Sigma^A}{\Sigma^A} / \partial \ln Q^2$  and charm production will allow a statistically very precise measurement of  $G^A/G^D$  for  $x > 10^{-3}$
- inclusive measurement is only indirectly sensitive to  $G(x)$
- open charm measurement requires PID + vertex separation + correction for nuclear attenuation