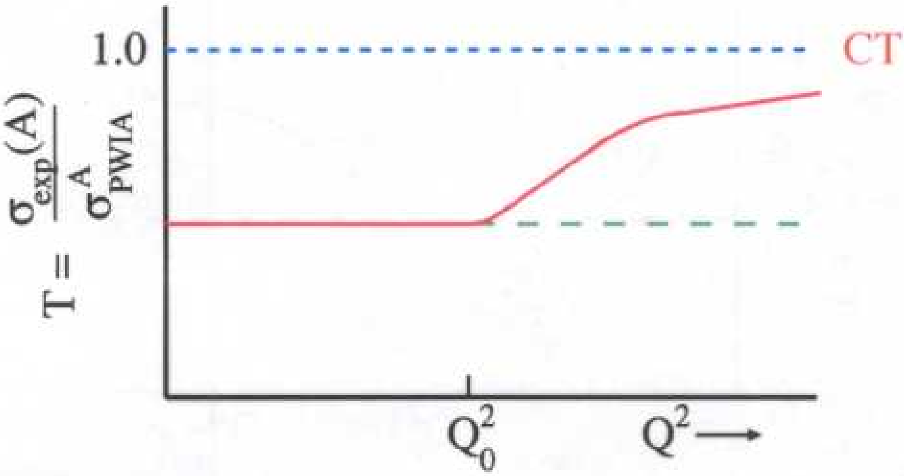
JLab E94-139 Results

E94-139 Search for Color Transparency in Quasifree A(e,e′p) Scattering

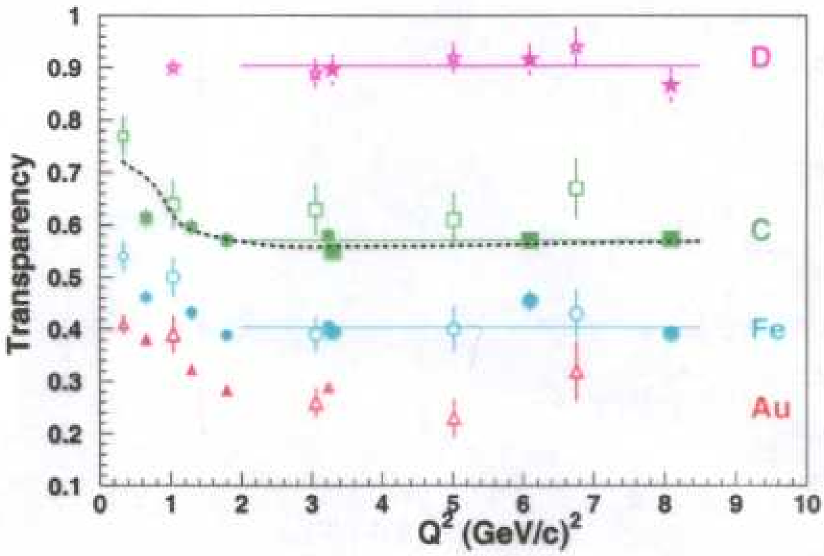
From fundamental considerations (quantum mechanics, relativity, nature of strong interaction) it is predicted (Brodsky, Mueller) that **fast** protons scattered from the nucleus will have **decreased** final state interactions



E94-139 Results (Submitted to Phys. Rev.)

C o n s t a n t Value fits for $Q^2 > 2$ (GeV/c)^2 $\rightarrow$ $\chi^2/df \approx 1$

Dashed line is correlated Glauber calculation (Pandharipande et al)



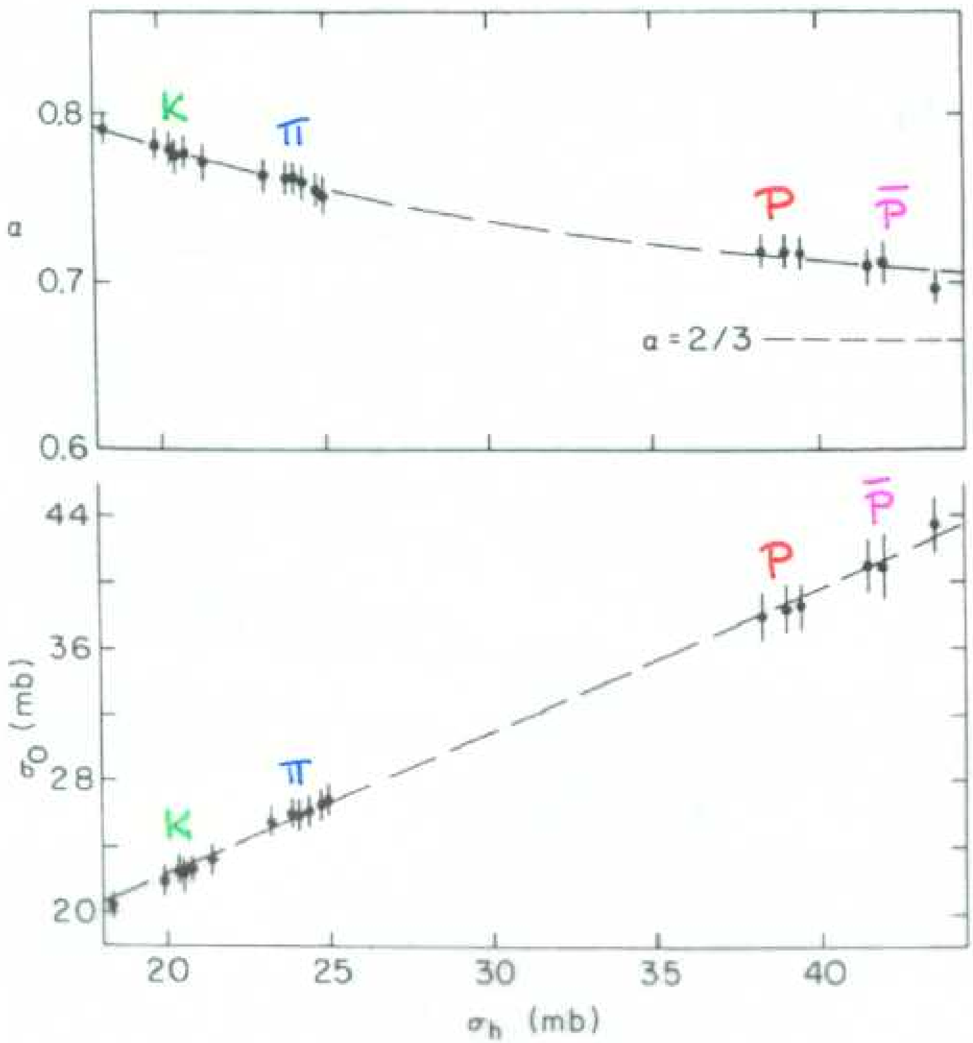
Q^2 dependence consistent with standard Glauber

Hadron-Nucleus and Hadron-Proton Total Cross Sections

A.S. Carroll et al., Phys. Lett. 80B, 319 (1979)

Hadron momentum = 60, 200, 280 GeV/c

Two plots show $\sigma(A) = \sigma_0 A^\alpha$ and $\sigma_0 = \sigma_{hN}$



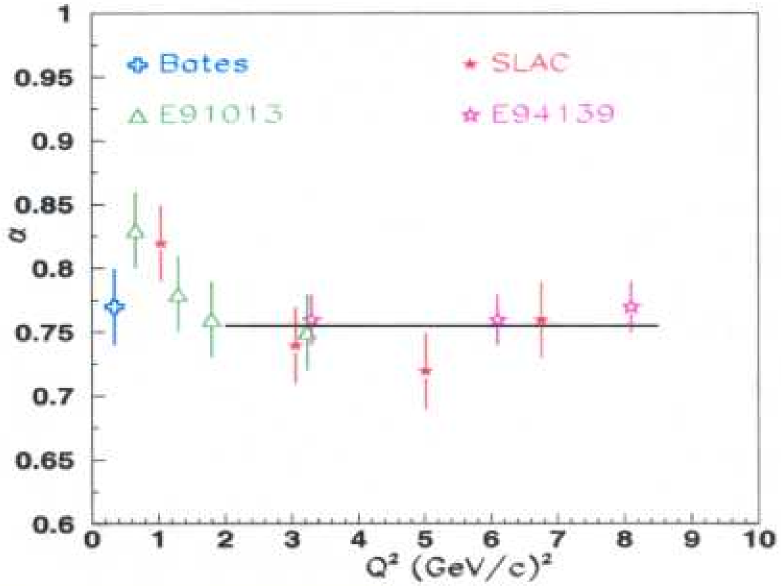
Results
$\alpha \sim$ **0.78 for Kaons**
$\alpha \sim$ **0.76 for Pions**
$\alpha \sim$ **0.72 for Protons**
$\alpha \sim$ **0.71 for Anti-Protons**

Quasifree scattering off A nucleons within the nucleus where $\alpha < 1$ can be interpreted as due to the strong interaction nature of the probe

E94-139 Results - A Dependence

I. T = $A^{\alpha'}$ fits at fixed Q^2

Normally, $\sigma(A) = \sigma(N)A^{\alpha}$ and thus $\alpha = \alpha' + 1$

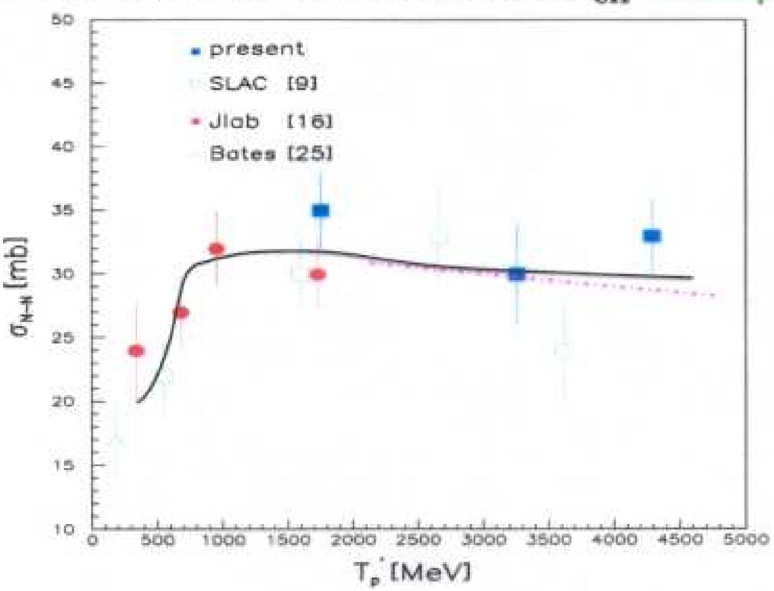


α = constant = 0.76 for $Q^2 > 2$ (GeV/c)^2

II. Simple Geometric Model

$$T_{\rm class} = \frac{1}{Z}\int d^3r\,\rho_Z(\mathbf{r})\exp\left[-\int dz'\,\sigma_{\rm eff}\rho_{A-1}(\mathbf{r}')\right] .$$

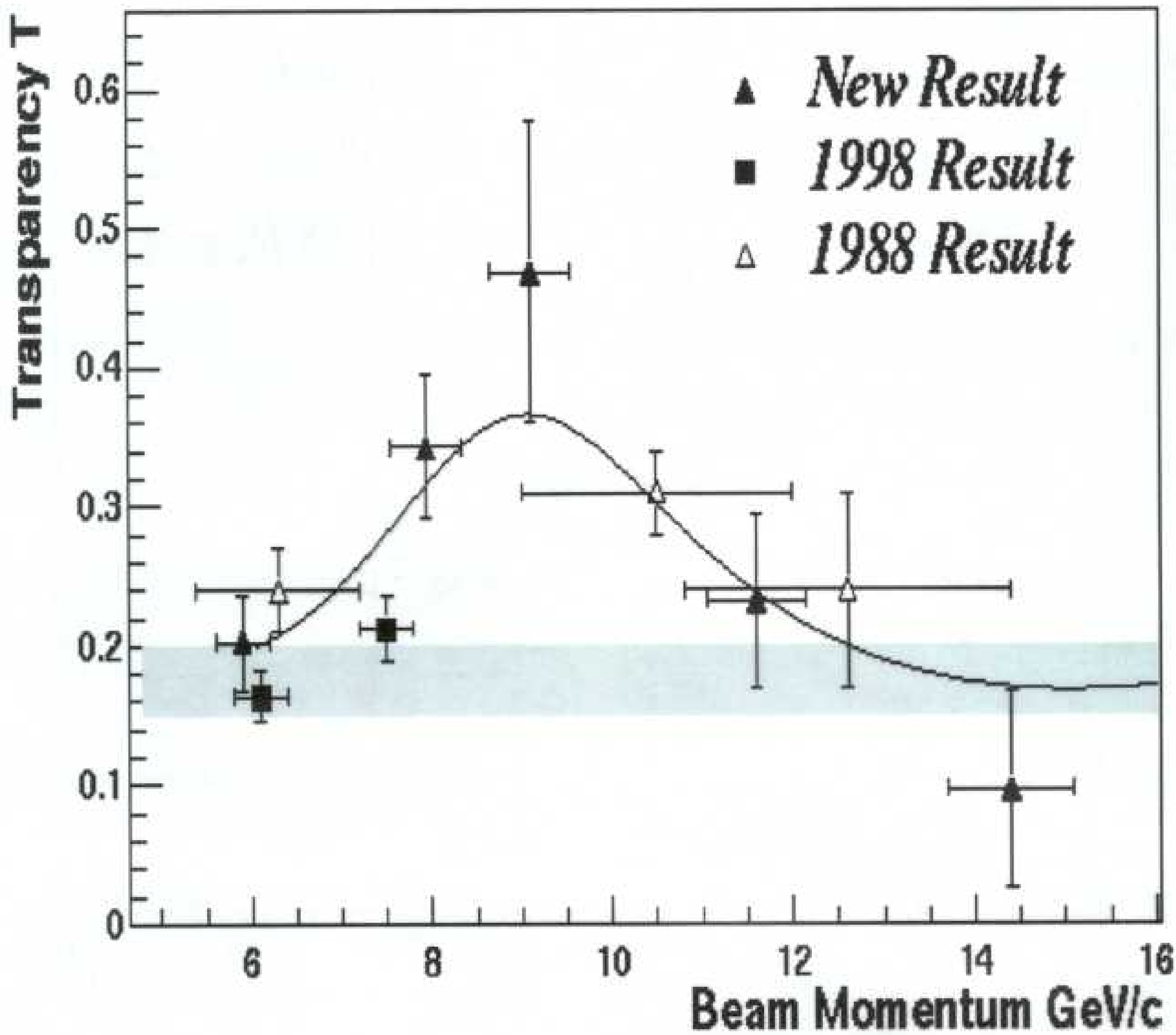
with an effective proton-nucleon cross section $\sigma_{\rm eff}$ independent of density



Solid curve shows energy dependence of free p-N cross section!

Color Transparency in A(p,2p) – BNL Results

$Q^2 \approx$ 3 6 8 10



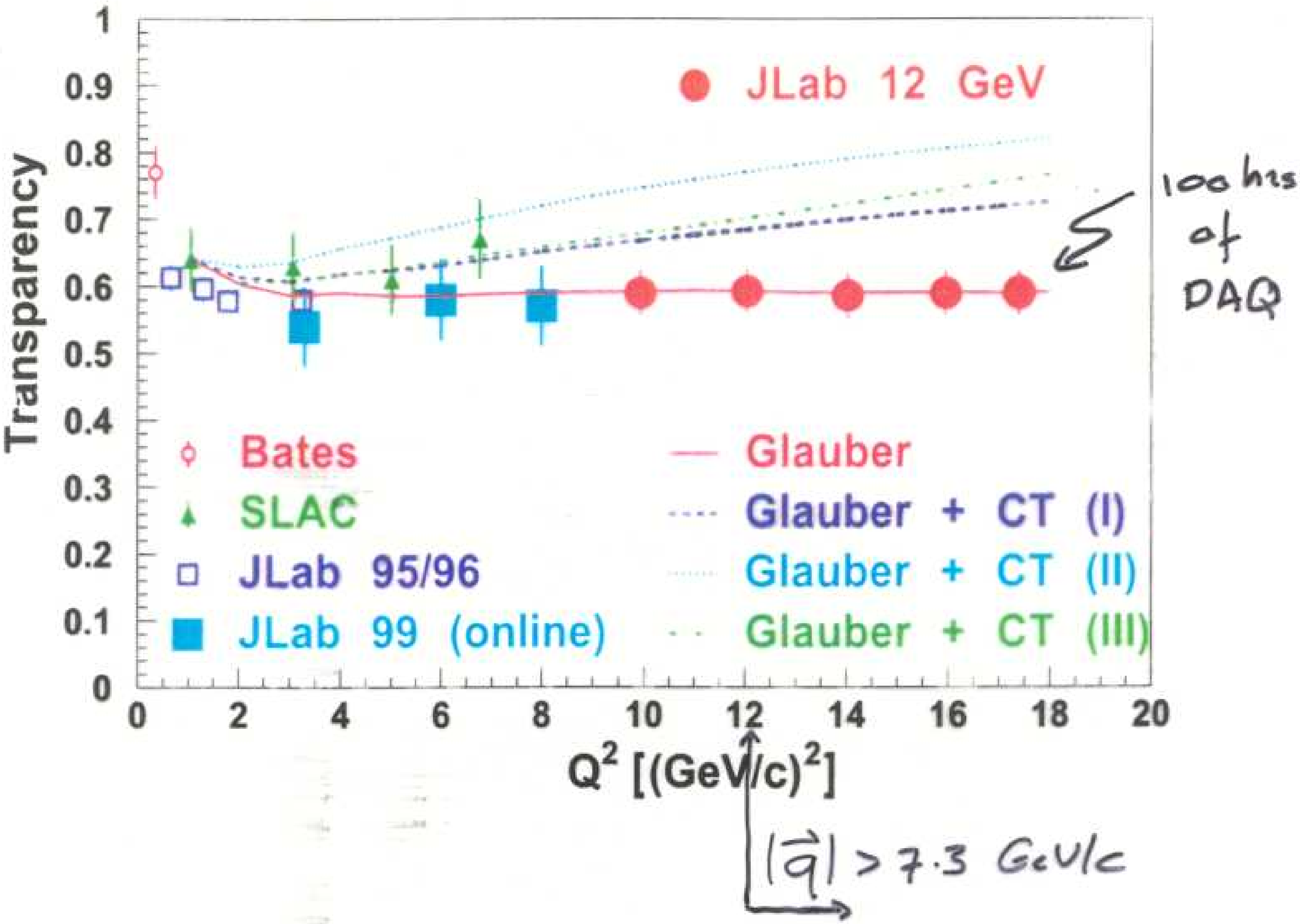
Shaded area is Glauber calculation, solid line is 1/oscillation in p-p scattering

A(p,2p) may remove long-distance component in p-p scattering

(Nuclear Filtering)

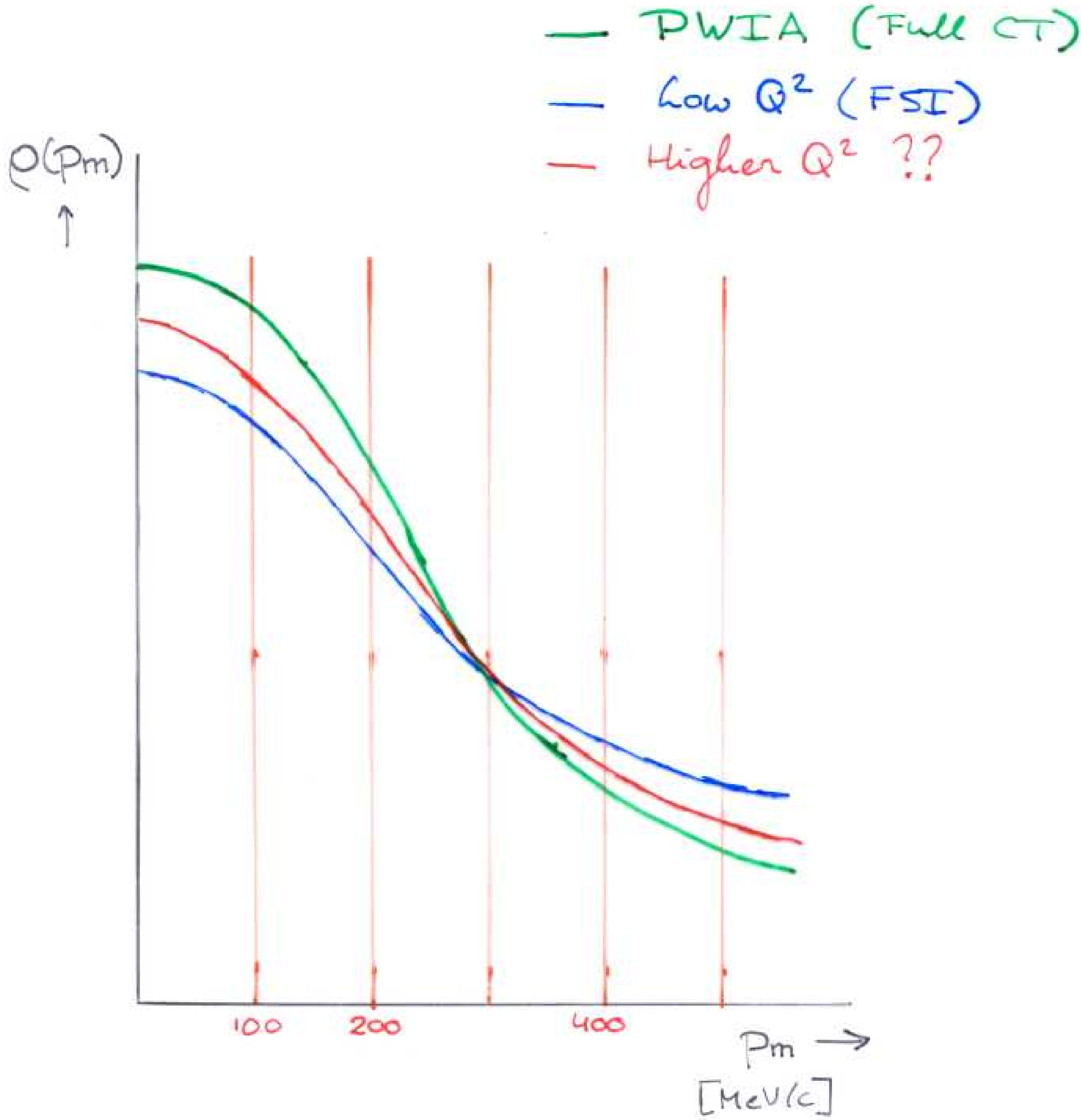
A(e,e′p) does NOT select small-size configuration at Q^2 = 8 (GeV/c)^2

$^{12}C\ (e,e'p)$



$$\text{Transparency} = \frac{\sigma_{\text{expt}}}{\sigma_{\text{PWIA}}}$$

$^2H(e,e'p)$

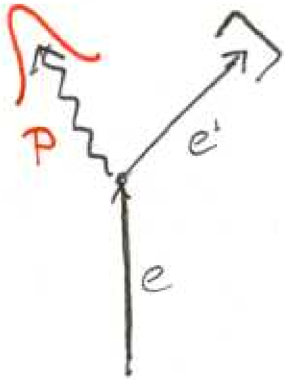


→ $\sigma(p_m = 400) / \sigma(p_m = 200)$

$\sigma(p_m = 200) / \sigma(p_m = 100)$

I] Spectrometers

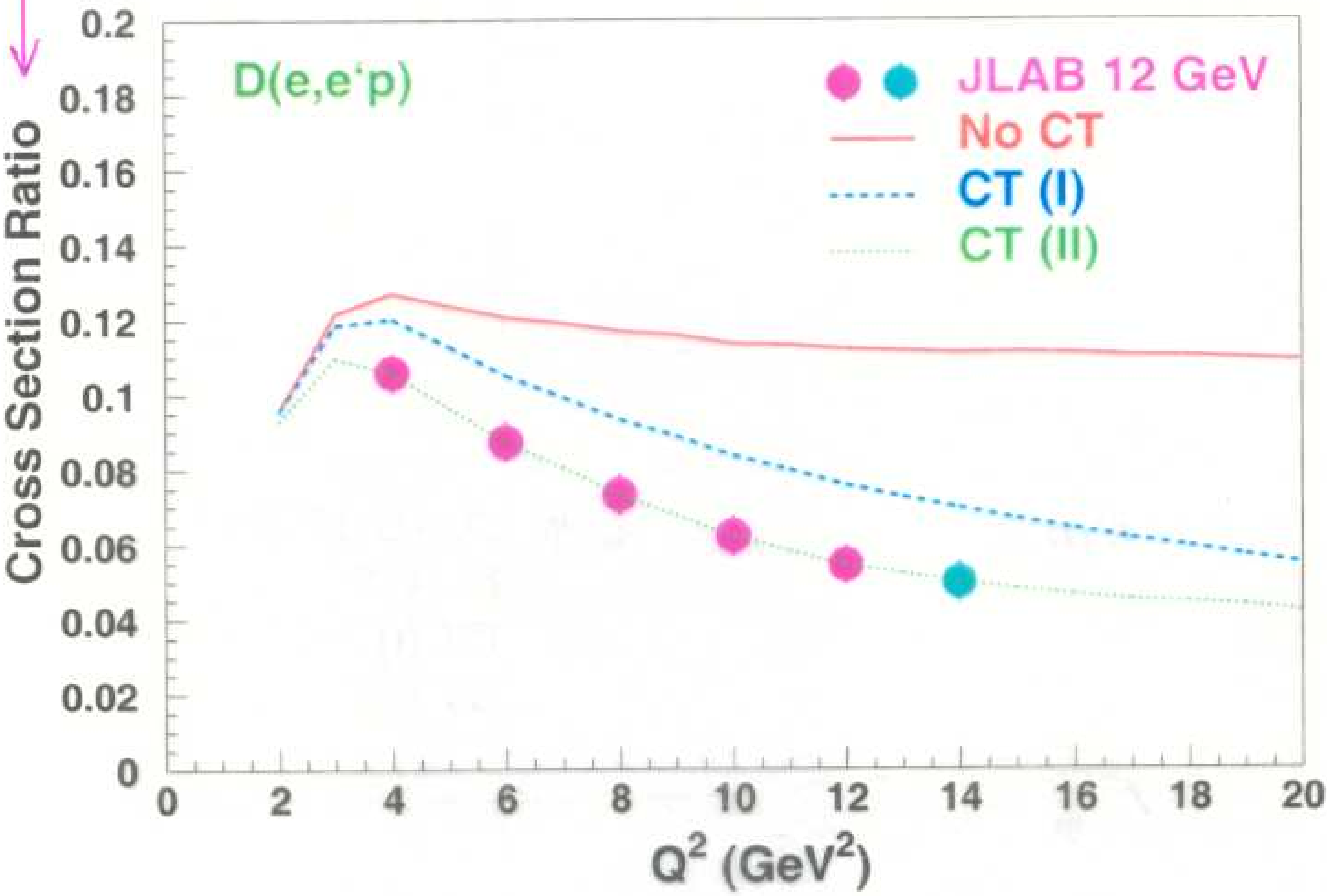
II] CLAS



$(\vec{e}, \vec{e}', \vec{p}) \longrightarrow (\vec{q}, E_m, \vec{p}_m)$

p_m large
but $\vec{q}$ large } Spectrometer O.K.

$\sigma(p_m = 400\ \mathrm{MeV/c}) / \sigma(p_m = 200\ \mathrm{MeV/c})$



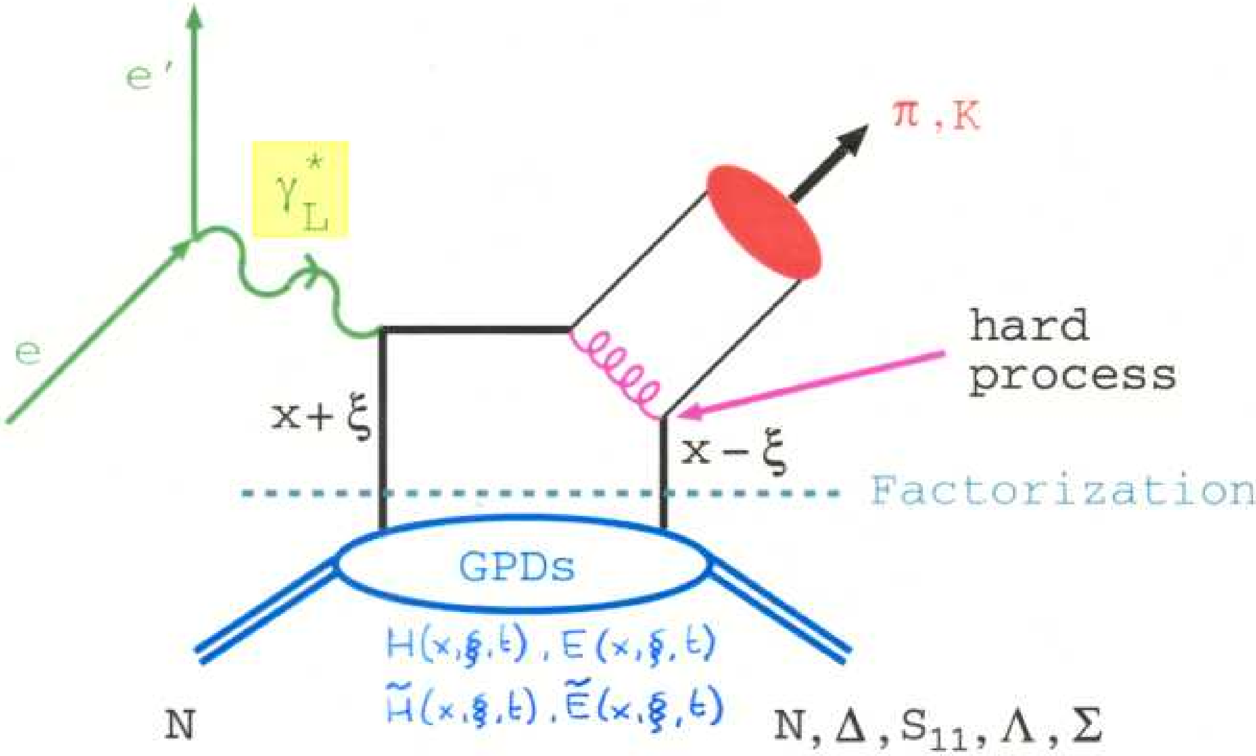
● HMS + SHMS, 1 month

● " , 1 month

CLAS : $Q^2 \leq 10\ (\mathrm{GeV/c})^2$ (Griffioen, Kuhn)

But <u>all</u> $p_m \leq 400$ MeV/c!

Deep Exclusive Meson Production



For factorization to be strictly valid

$$\sigma_L \sim Q^{-6}, \sigma_T \sim Q^{-8}$$

and

Onset of Color Transparency

Support and Problems

- $\sigma_L/\sigma_T \sim Q^2$ for (e,e$'\pi^+$) and ($\mu, \mu'\rho^\circ$) at $Q^2 \sim$ few (GeV/c)^2
- Pion Form Factor predicted to be soft to $Q^2 \sim 10$ (GeV/c)^2
- FNAL A($\mu, \mu'\rho^\circ$) data show some hint of CT at $Q^2 \geq 3$ (GeV/c)^2
- FNAL Di-jet data seem to see full CT at $Q^2 \simeq 10$ (GeV/c)^2

Color Transparency - Pion Electroproduction

Status	No evidence for CT in A(e,e′p) up to $Q^2 = 8.1$
	FNAL A($\mu, \mu' \rho^0$) data show some hint of CT at $Q^2 \geq 3$
	A(π,dijet) data claim full CT at $Q^2 > 7$

However, no unambiguous, **model-independent** , evidence for the **onset of CT** exists.

- Just looking at Q^2-dependence of reaction is dangerous
  (coherence vs. formation length effects)
- Similarly, just looking at A-dependence of reaction dangerous

Need reliable baseline calculations to conclusively look for the onset of CT!

A(e,e′π) next best case, beyond A(e,e′p)

- **Baseline calculations doable**
- **Onset of CT expected at lower Q^2 ($q\bar{q}$ vs qqq)**
- **Formation lengths easily $\sim$ 10 fm**

Measurable effects predicted for $Q^2 \leq 5$ (GeV/c)^2 – E01-107

General expectation: CT should be there at $Q^2 \sim 10$ (GeV/c)^2

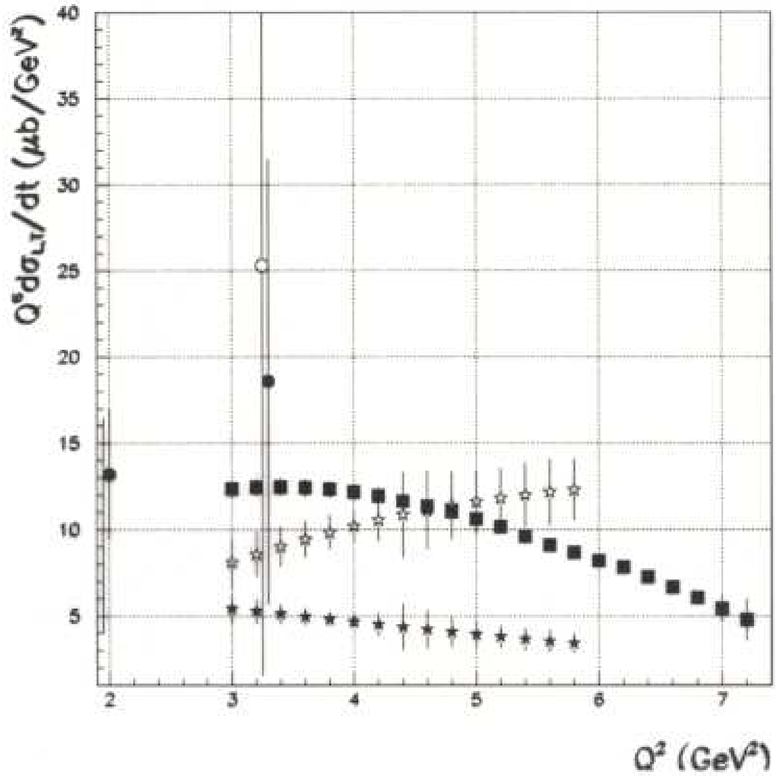
Meson Electroproduction at 12 GeV

CLAS benefit [I]: large range of (e,e′m) reactions

CLAS benefit [II]: large range of (x, Q^2) at same time

Typical Q^2 range: **6 $(GeV/c)^2$ for L/T separations**

9 $(GeV/c)^2$ for cross sections



For correlated kinematics e.g. A(e,e′$\pi^{\pm}$), A(e,e′K$^+$)

Hall C benefit: high luminosity, forward-angle spectrometers

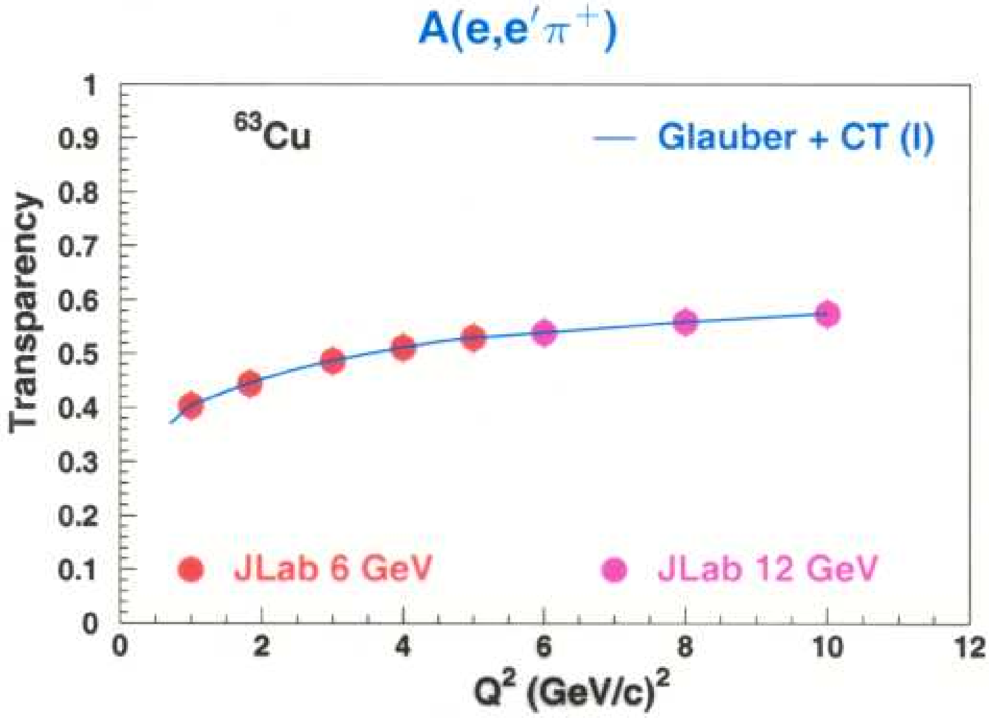
Typical Q^2 range: **10 $(GeV/c)^2$ for L/T separations**

14 $(GeV/c)^2$ for cross sections

Could be important to reach factorization region!

Future Color Transparency Searches

JLab at 12 GeV, HMS + SHMS



Higher Q^2 ($\approx$ 14 (GeV/c)^2) IF one releases the demand $t \leq 0.5$ GeV^2