JLab @ 12 GeV

The Nature of Hadron-Hadron Interaction

JLab @ 12 GeV

- Extend 6 GeV: Energy
- Beyond HERMES: Luminosity
- Charm (J/Ψ) and Strange Sectors
  - Link with Lattice QCD
- Propagation of Vector Mesons
  - Coherence and Formation Lengths
- Exclusive reactions in Few Body Systems
  - Quasi-Free: On-shell Rescattering of Hadrons (σ_{hN})
  - Disintegration at high $p_\perp$: quarks ($\gamma NN \rightarrow NN$)
- Two scales: Q^2 and t *(mesons/quarks in hadrons)*

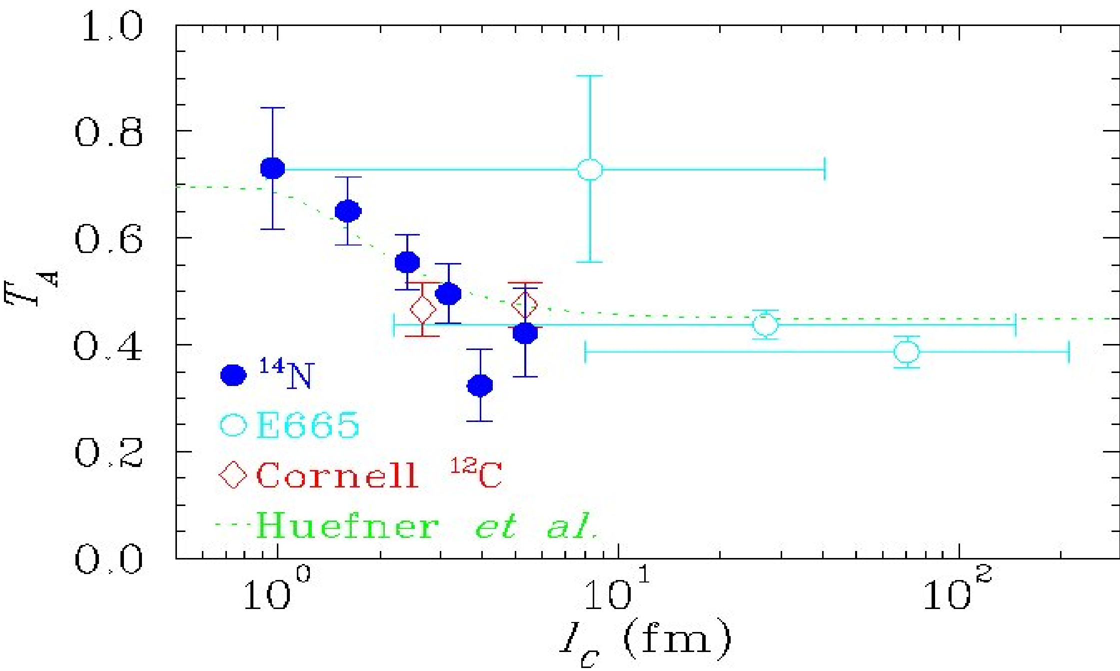
ρ^0 electroproduction (II)

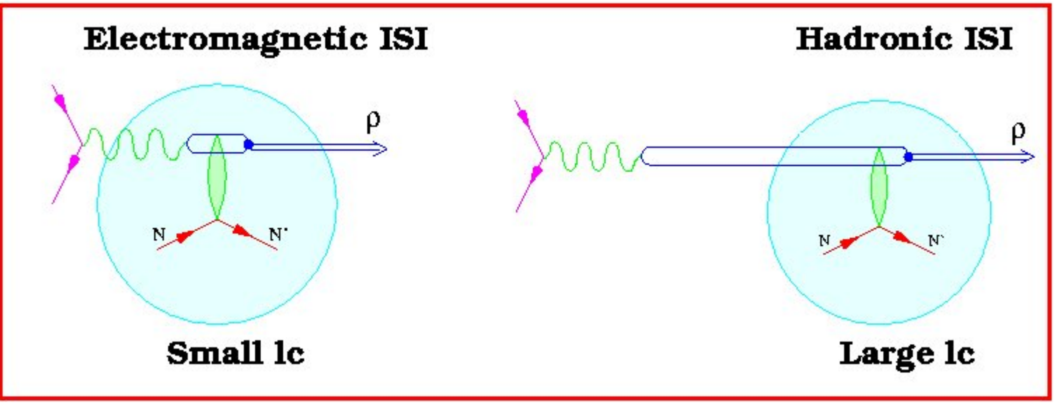
$lc = 2\nu/(2M^2 + Q2)$

The nuclear transparency depends strongly on the coherence length for l_c below 10 fm

$\Rightarrow$ Coherence length effect (CL)

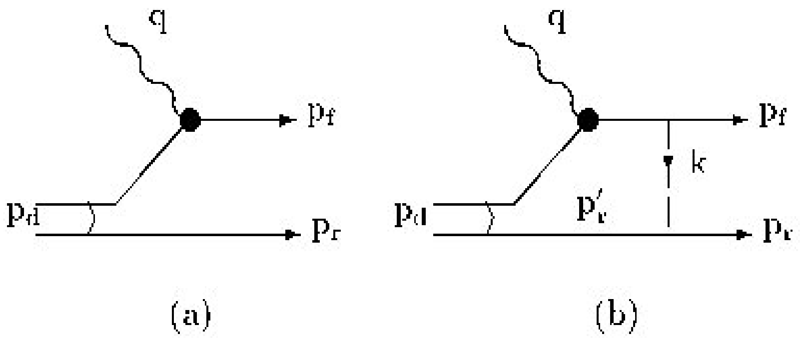
Q^2 increases $\Rightarrow$ T_A increases



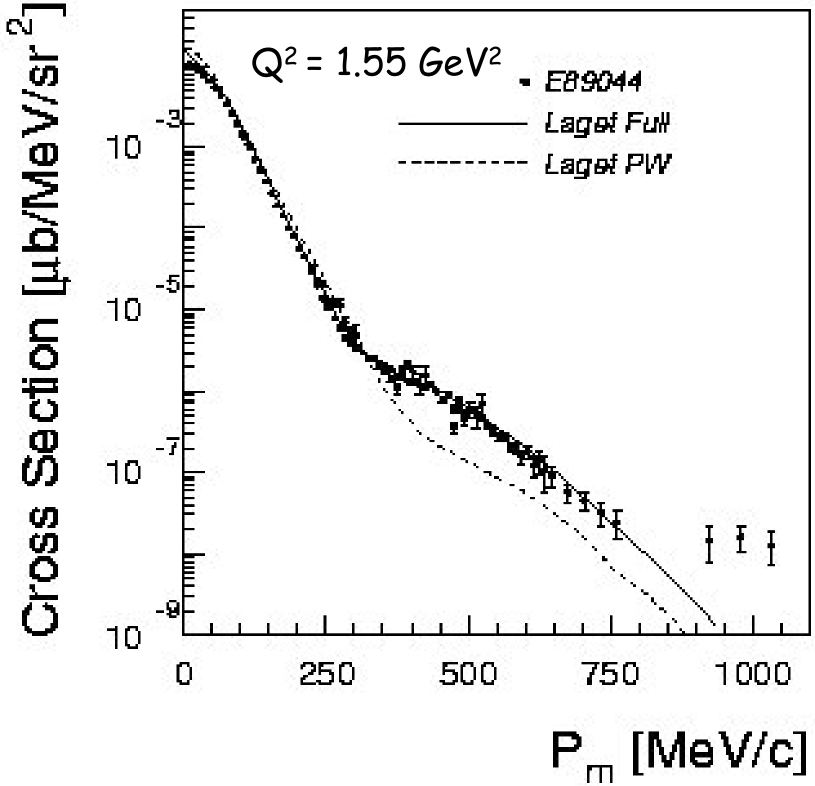


- Coherence Length effect can mimic CT signal
- To be safe, one should keep l_c fixed and measures the Q^2 dependence of T_A

CT in few-body system : Rescattering



Hall A : $^3He(e,e'p)d$ experiment



- E94-019 CLAS experiment : (e,e'N) and (e,e'NN) on ^2H, ^3He and ^4He

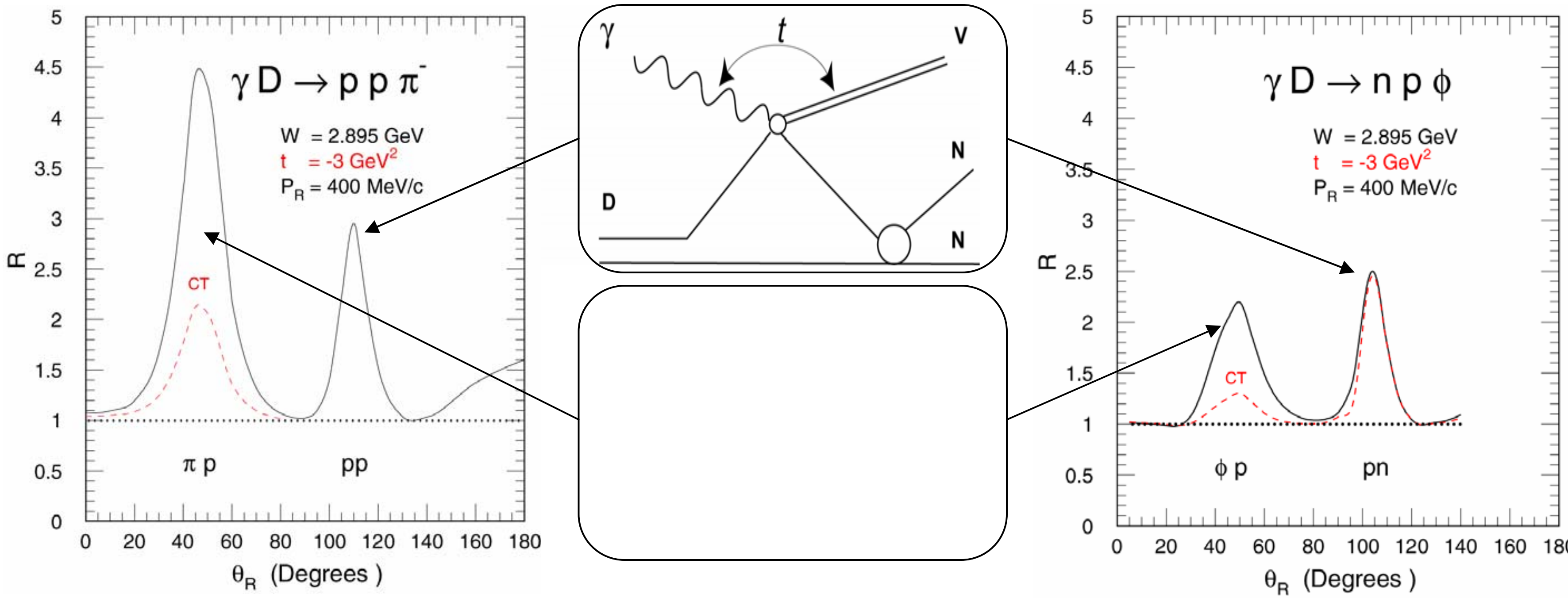
- Probability for the projectile to re-interact will be achieved by selecting double scattering kinematics.

- Hadronic picture on solid grounds

- Meson rescattering

X=1: quasi-free kinematics

Meson Production in Few Body Systems



- High *t* selects small transverse size
- Large P_R suppresses quasi-free mechanisms
- Evolution of unitary peaks with *t*: scattering of small objects
- R= Full / quasi-free; P_R = nucleon recoil momentum

Meson Production in Few Body Systems

- High t: selects small transverse size
- Expansion time ~ NN distance
- Exclusive experiments select on-shell scattering:
  - Unitary peak
  - On-shell elementary matrix elements
  - Low momentum components of the nuclear wave function
- Small counting rate ⇒ JLab!
- Already on solid grounds for ^{3}He,D(e,e'p) (Hall A, Hall B @ 6 GeV)
- JLab @ 12 GeV ⇒ $\sigma_{hN}(Q^2,t,..)$

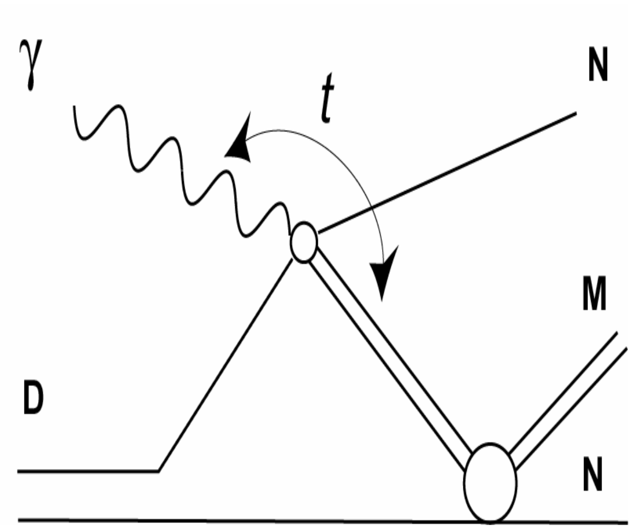


Photo- vs Electro-production

- Hadronic component of the photon
  - $\Delta\tau \approx 2\nu/(Q^2 + m_V^2)$
  - $\approx$ 3.2 fm for a 5 GeV real γ
  - High t $\Rightarrow$ small impact parameter
- $\Delta\tau$ decreases as soon as $Q^2 >> m_V^2$
  - Point like coupling takes over
  - See the “flow” of partons
- 2 hard scales: High t and High Q^2 (count rate)

$\Rightarrow$ From JLab6 to JLab12

ω Meson Electroproproduction (CLAS)
π^0 Regge Trajectory Exchange

- Low t: hadronic Form Factor

$$\frac{d\sigma}{dt} \propto \frac{1}{(Q^2 + \Lambda_0^2)^2}$$

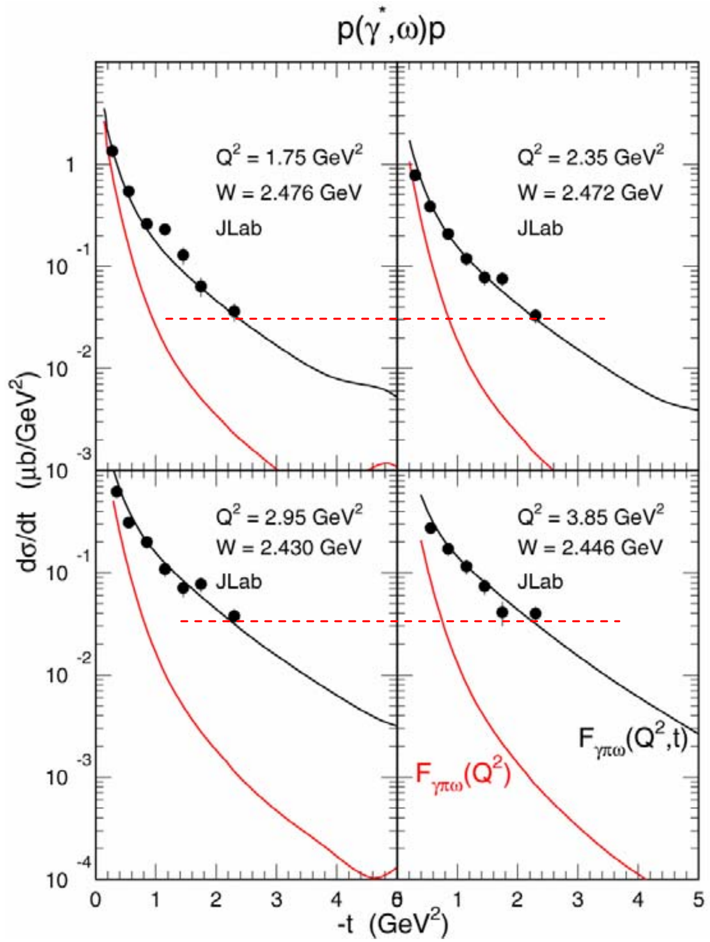
- High t: coupling to partons

$$\frac{d\sigma}{dt} \propto flat$$

- Data speak for themselves

- Model: $F(Q^2, t) = 1/(1 + \frac{Q^2}{\Lambda^2(t)})$

$$\Lambda(t) = \Lambda_0 \frac{1 + \alpha_\pi(0)}{1 + \alpha_\pi(t)}$$



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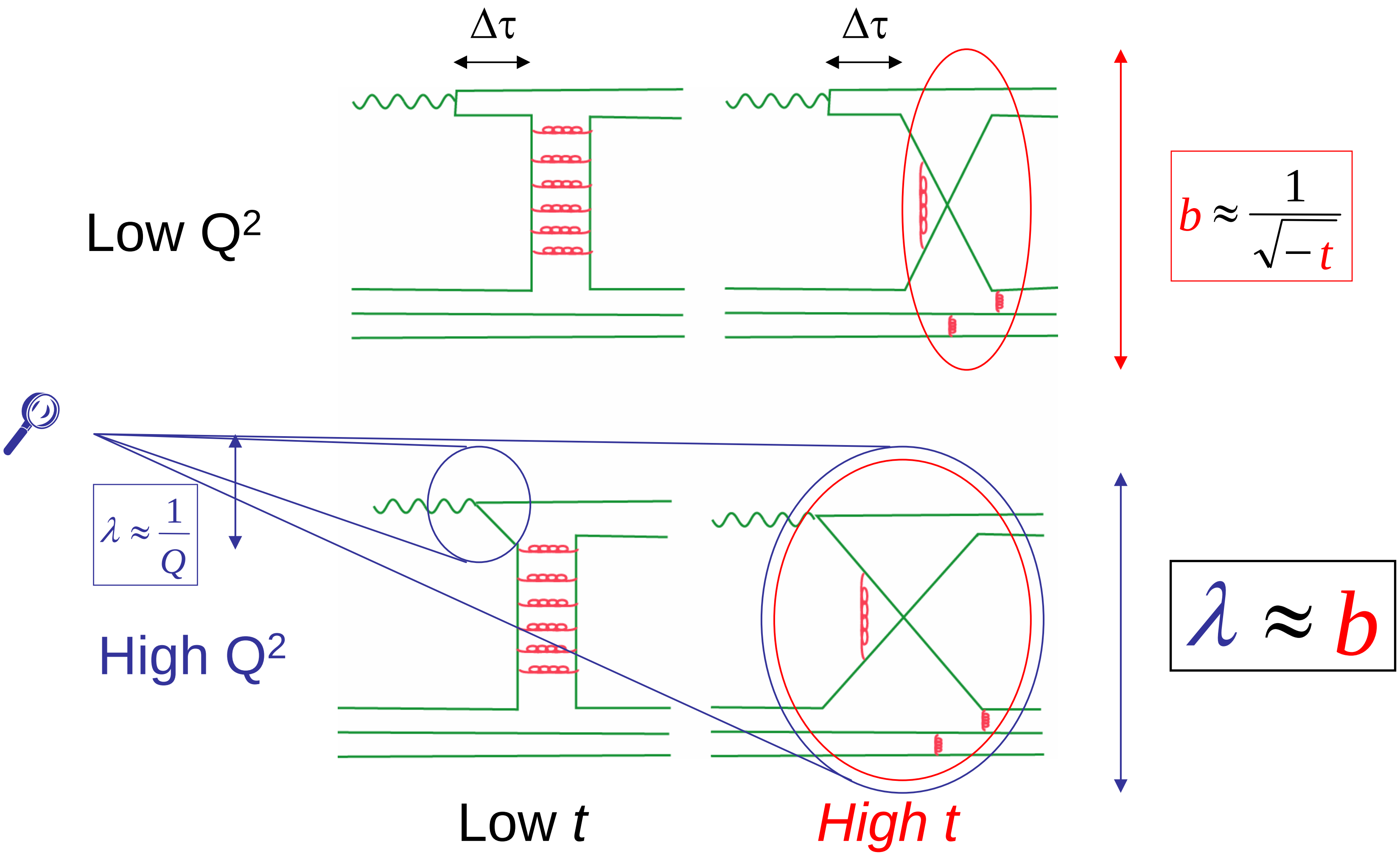
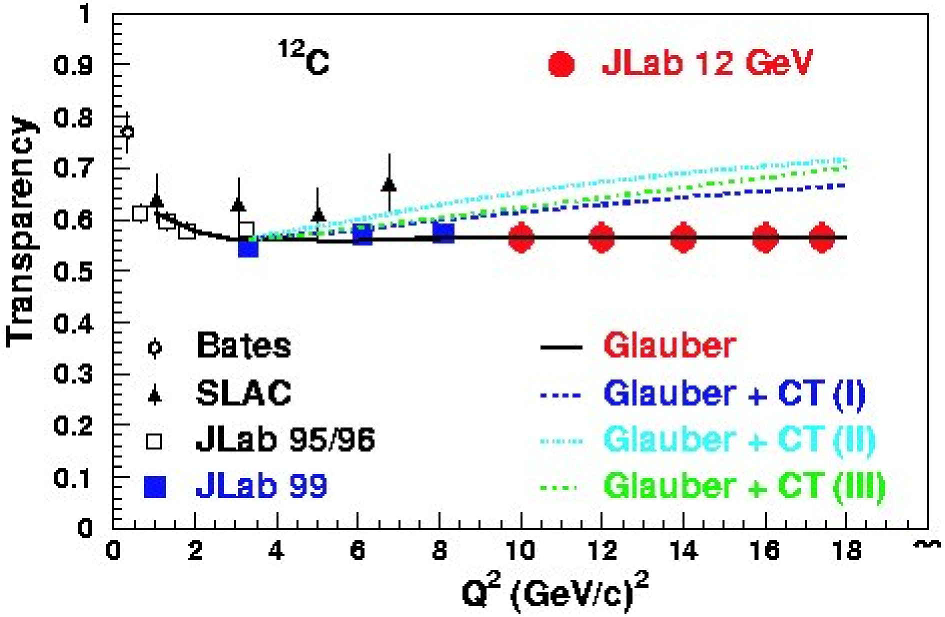
Open problems

- π in Nuclei?
  - What beyond π content of the nucleon?
  - Two hard scales: Q^2 and t
- Data base for other studies:
  - Already a lot at 6 GeV
  - Modeling with an accuracy of 5% !!!
  - 12 GeV?

The Space-Time Structure of Hard Scattering Processes

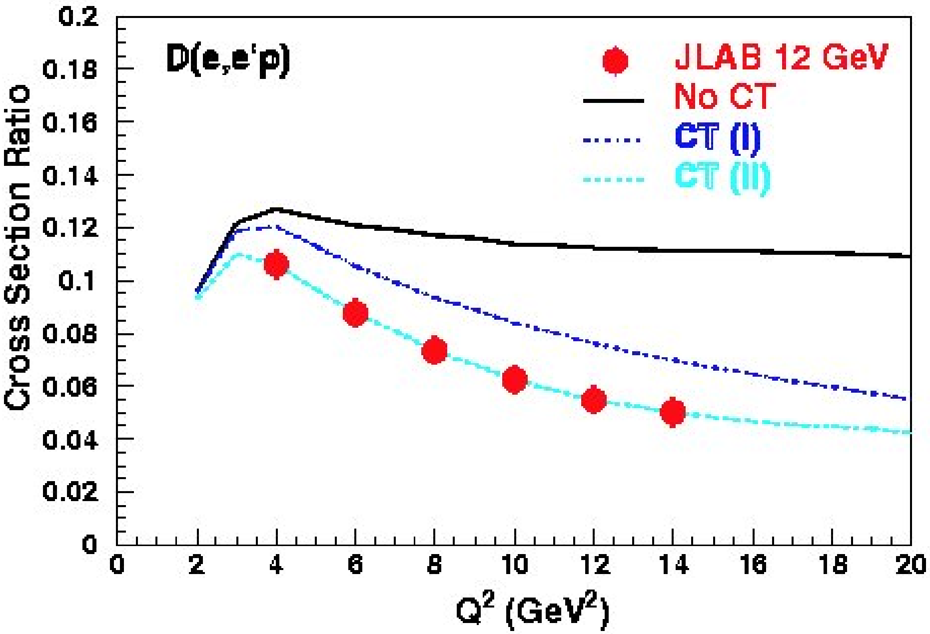


What could be done at 12 GeV ?



Quasi-free A(e,e'p):
Extend the Q^2 range up to 18 GeV^2

Is any increase of T_A considered as a non-ambiguous signal of CT ??

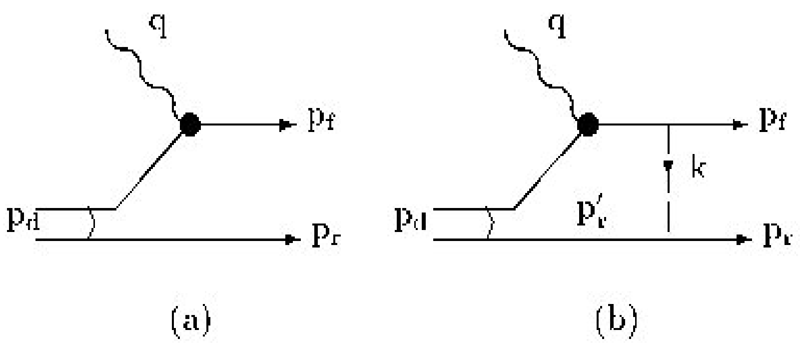


$R=\sigma(p_m=400MeV/c)/\sigma(p_m=200MeV/c)$

CT(I) : Calculation with ΔM^2 = 0.7 GeV^2
Farrar, Liu, Frankfurt and Strikman (1988)

CT(II) : Calculation with ΔM^2 = 1.1GeV^2
Sargsian, Private communication

CT in few-body system : Rescattering



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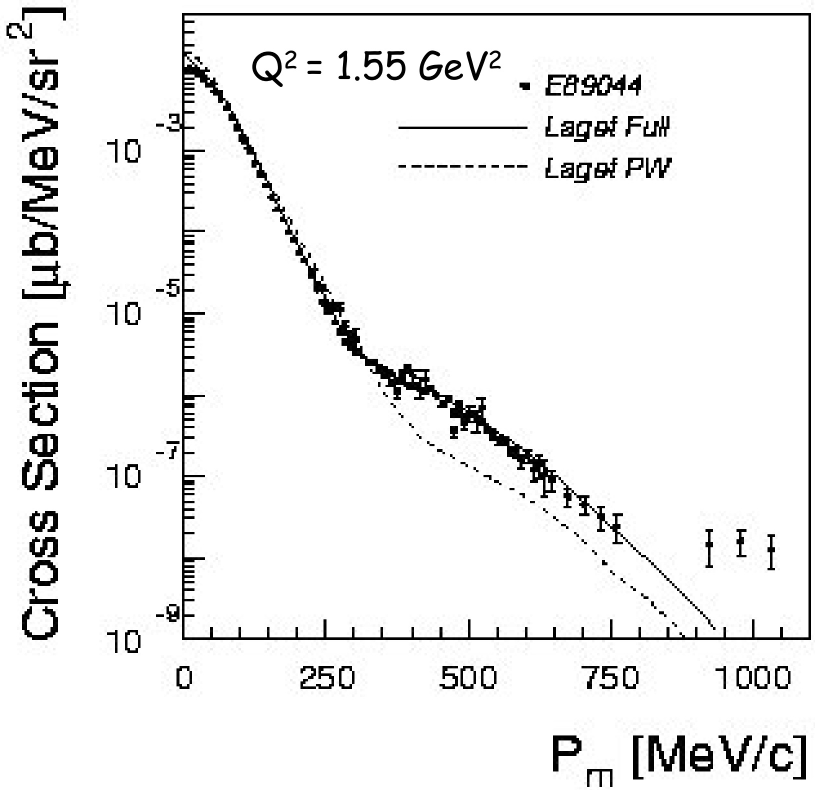


- E94-019 CLAS experiment : (e,e'N) and (e,e'NN) on ^2H, ^3He and ^4He
- Probability for the projectile to re-interact will be achieved by selecting double scattering kinematics.
- The measured ratios are : $T=\sigma(e,e'p)^{exp}/\sigma(e,e'p)^{PWIA}$

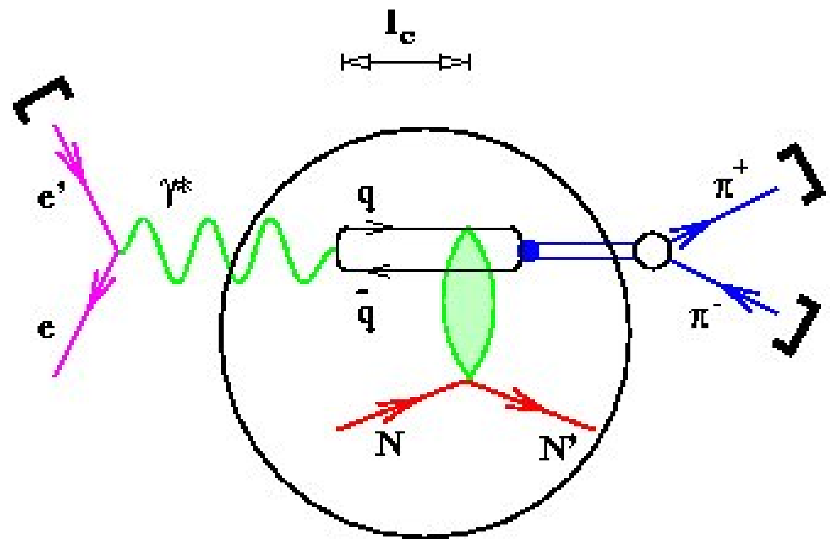
$T^{double}=\sigma(e,e'NN)^{exp}/\sigma(e,e'NN)^{PWIA}$

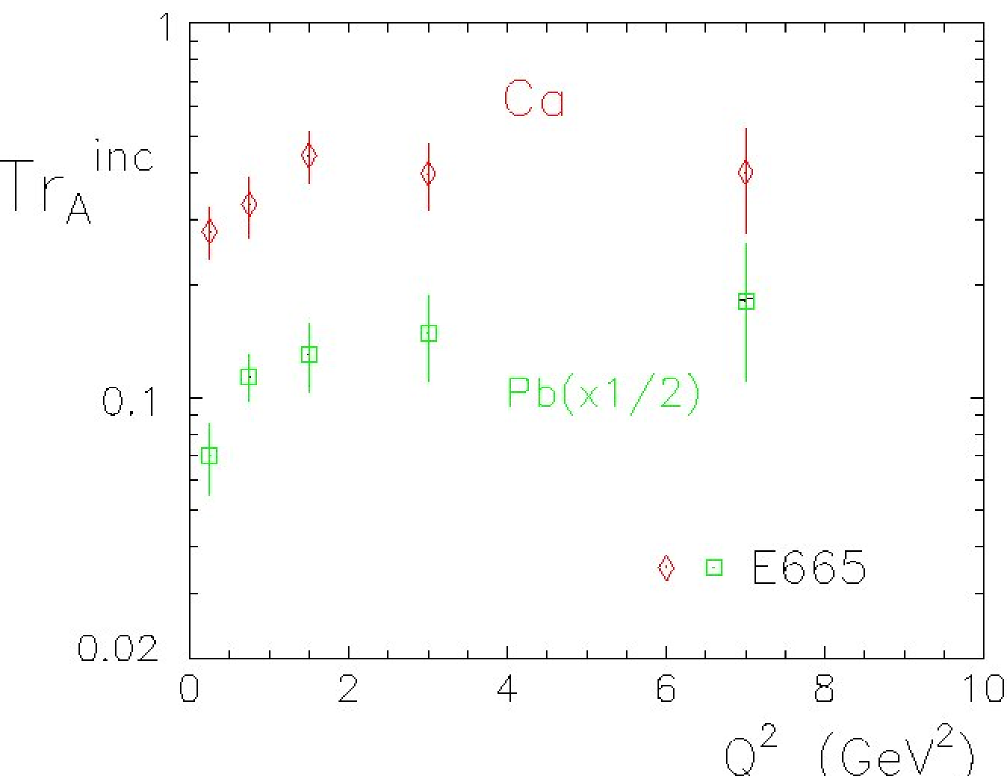
$R=\sigma^{double}/\sigma^{single}$

ρ^0 electroproduction (I)

Incoherent ρ^0 electroproduction on nuclei

Detected particles are :
Scattered electron and the π^+ and π^- from ρ^0 decay





Finite propagation distance (lifetime) l_c for the qqbar virtual state

$l_c = 2\nu/(2M^2 + Q^2)$

M is the mass of qqbar
For experimentalist M is the mass of the vector meson produced