The $d(e, e'p_s)$ (DEEPS) Experiment at JLab

(CLAS E6 Run Group).

Keith Griffioen

email: griff@nikhef.nl, tel: +31-20-592-2122

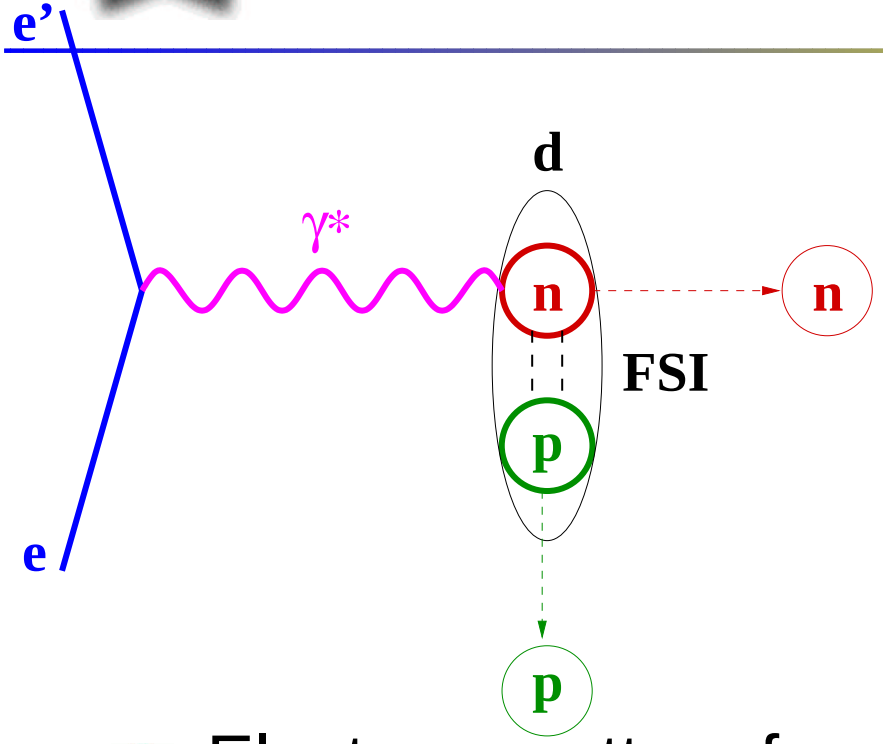
Nationaal Instituut voor Kernfysica en Hoge Energie Fysica (NIKHEF)

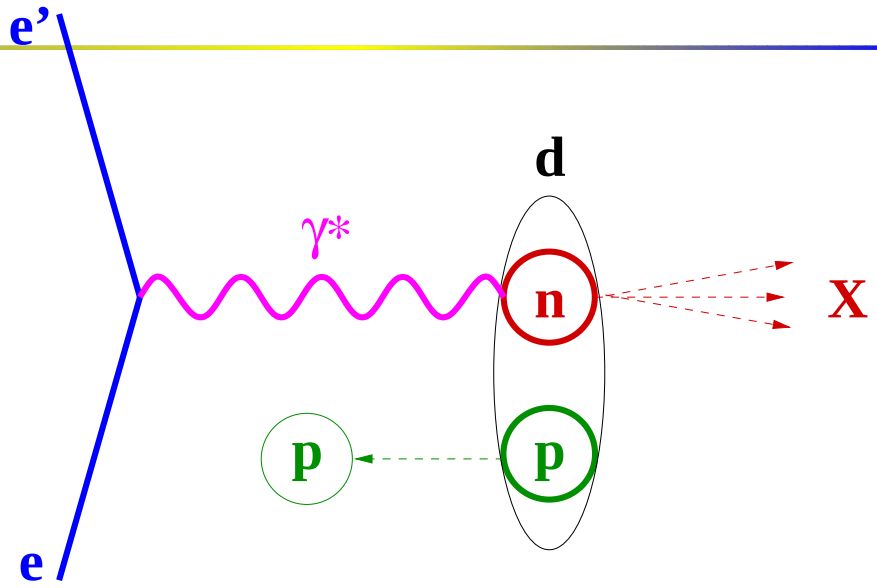
College of William & Mary, Williamsburg, VA

CLAS e6 Run Period

- Data collected from 30 January to 16 March 2002
- $E_{\mathrm{beam}} = 5.77$ GeV
- Beam current: 7 nA
- Liquid deuterium target
- Luminosity: 10^{34} cm^{-2}s^{-1}
- Integrated luminosity: 14.4 fb^{-1}
- CLAS field: 2250 A inbending
- Trigger: good electron
- Trigger rate: 3000 per second
- Events: 3.5 billion

$d(e, e'p_s)$ Reaction





- Electron scatters from a neutron in deuterium
- The spectator proton is detected along with the scattered electron
- One wishes to minimize final-state interactions with the proton
- CLAS can detect protons down to about 250 MeV/c from 40–140°

Spectator Model

$Q^2 \equiv -q^2 = -(e - e')^2 = \vec{q}^2 - \nu^2$ $\quad x = Q^2/2p \cdot q$

$\vec{p}$ is spectator momentum $\quad y = p \cdot q / p \cdot e$

$E_s = \sqrt{m^2 + \vec{p}^2}$ $\quad \alpha = (E_s + p_{||})/m$

$E^* = \sqrt{m^{*2} + \vec{p}^2}$

$E_s + E^* = 2m$

$p \cdot q = (2m - E_s)\nu - p_{||} q = m\nu(2 - [E_s + p_{||}(q/\nu)]/m)$

$x \approx x_{\mathrm{Bj}}/(2 - \alpha)$

$\frac{d\sigma_{2\mathrm{N}}}{dx dQ^2 d\alpha d^2 p_\perp} =$

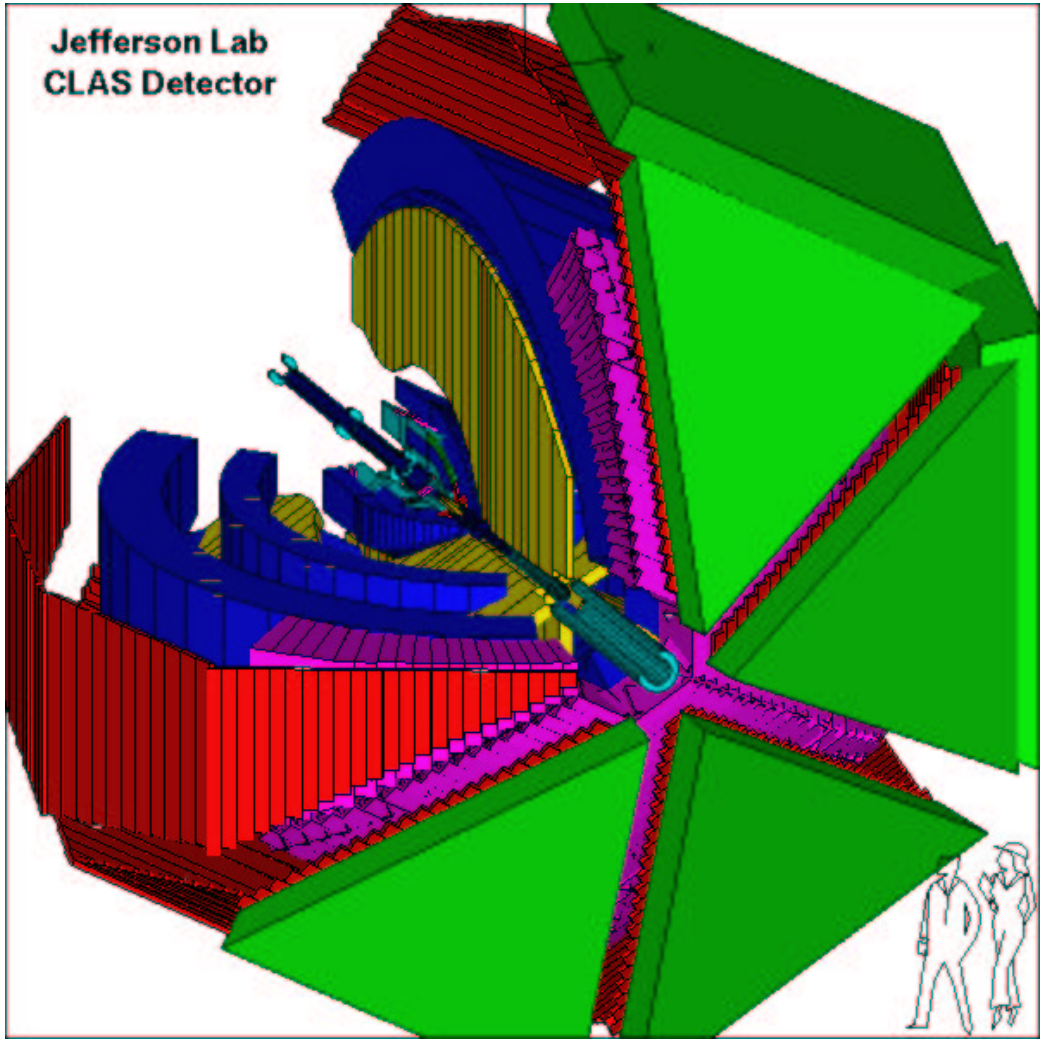
$\frac{4\pi\alpha_{\mathrm{EM}}^2}{Q^4}\left[y^2 F_1(x, Q^2) + (1 - y - \frac{m^2 y^2 x^2}{Q^2})\frac{F_2(x,Q^2)}{x}\right] |\psi_{LC}(\alpha, p_\perp)|^2$

$|\psi_{LC}(\alpha, p_\perp)|^2 d\alpha d^2 p_\perp = |\psi_{NR}(|\vec{k}|^2)|^2 d^3k$

$\vec{p}_\perp = \vec{k}_\perp$

$\alpha = \frac{k_{||}}{\sqrt{m^2 + \vec{k}^{\,2}}} + 1$

CLAS spectrometer



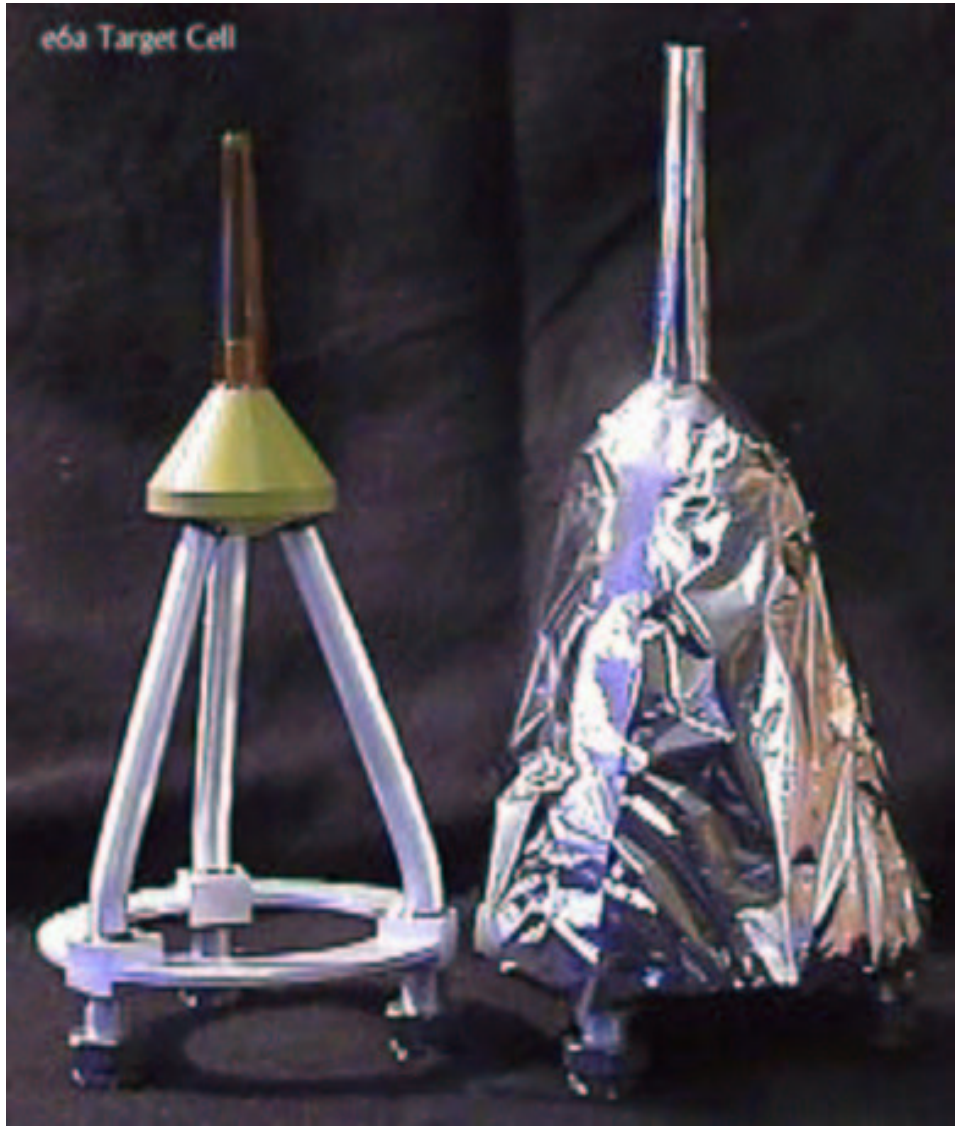
$E_e = 5.8, 4.2, 2.6$ GeV
LD target
Luminosity: 10^{34}/cm^{2}s
green: EM calorimeter
magenta: Cherenkov
red: TOF scintillators
blue: drift chambers
yellow: SC magnet

E6 Deuteron Target

- 5cm long cell
- conically shaped

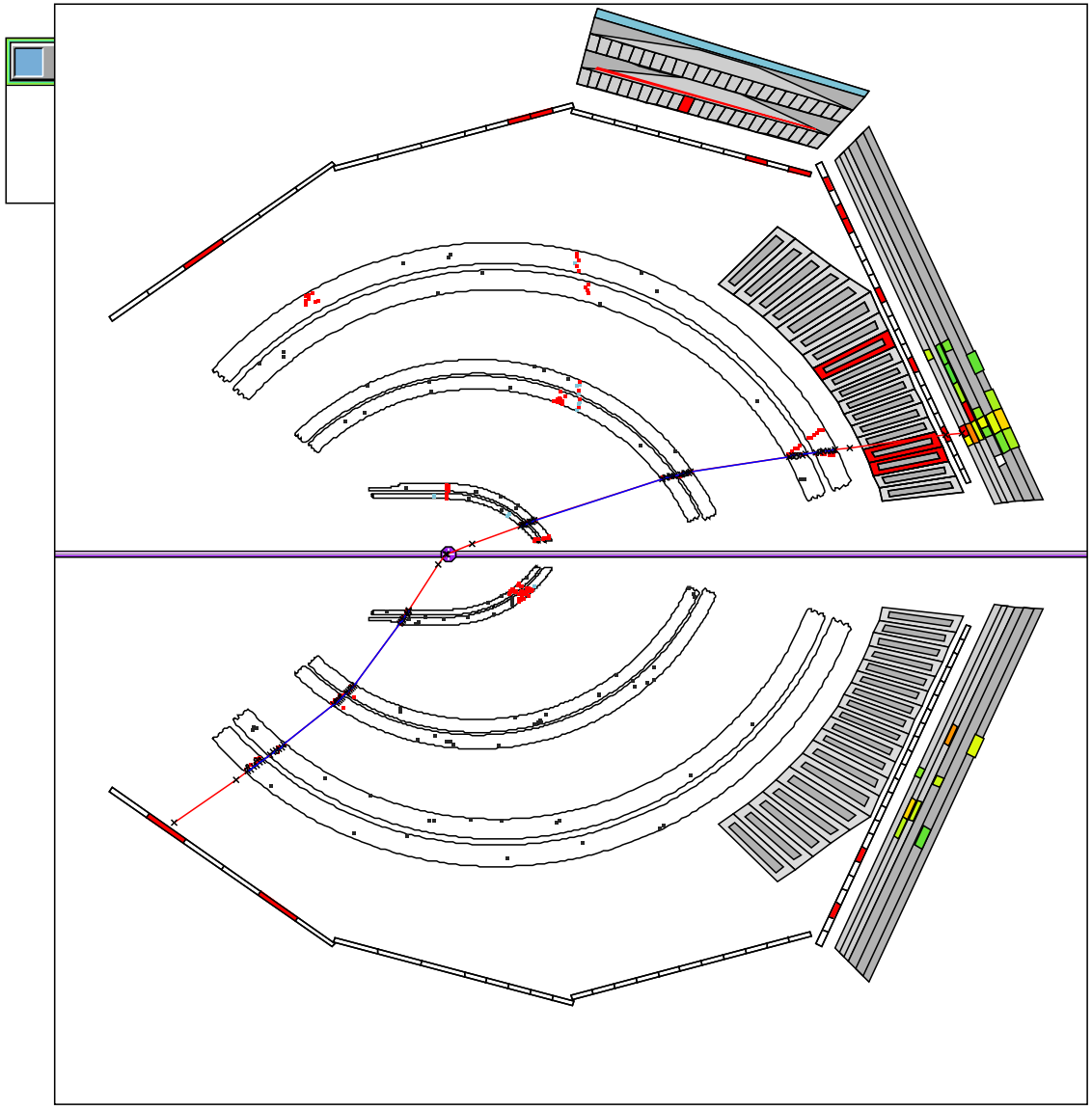
0.7–1.2 cm diameter maximizes flow while minimizing material the slow protons encounter

- right side shows super insulation around target

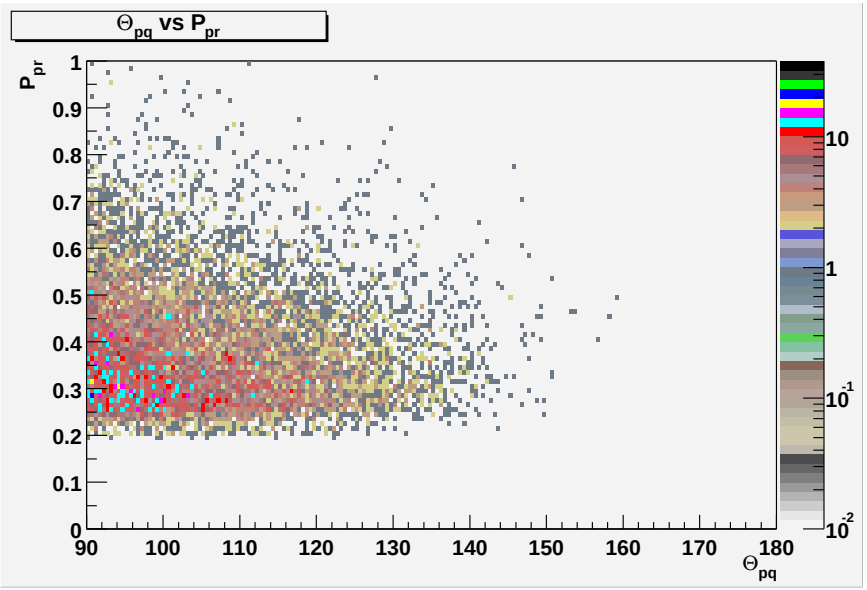


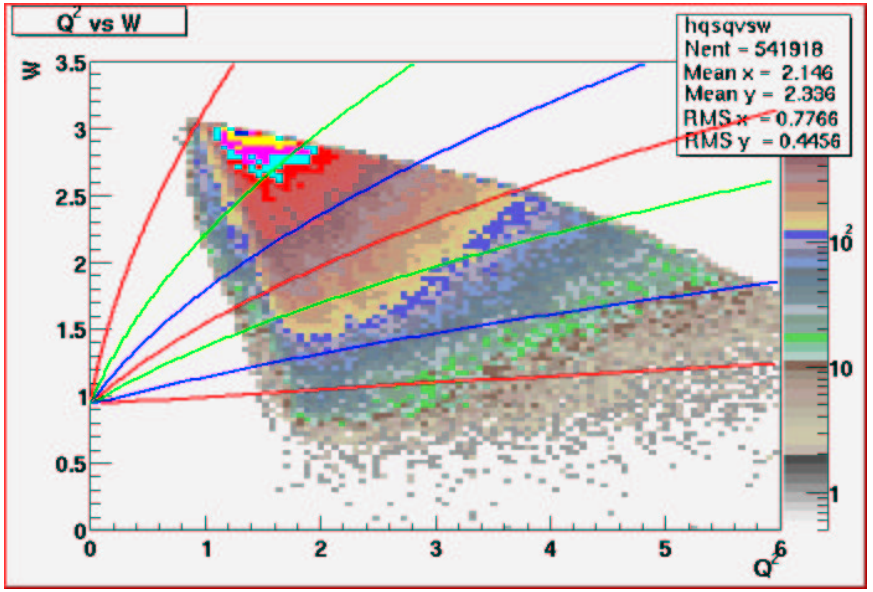
Tagged Electron Scattering Event

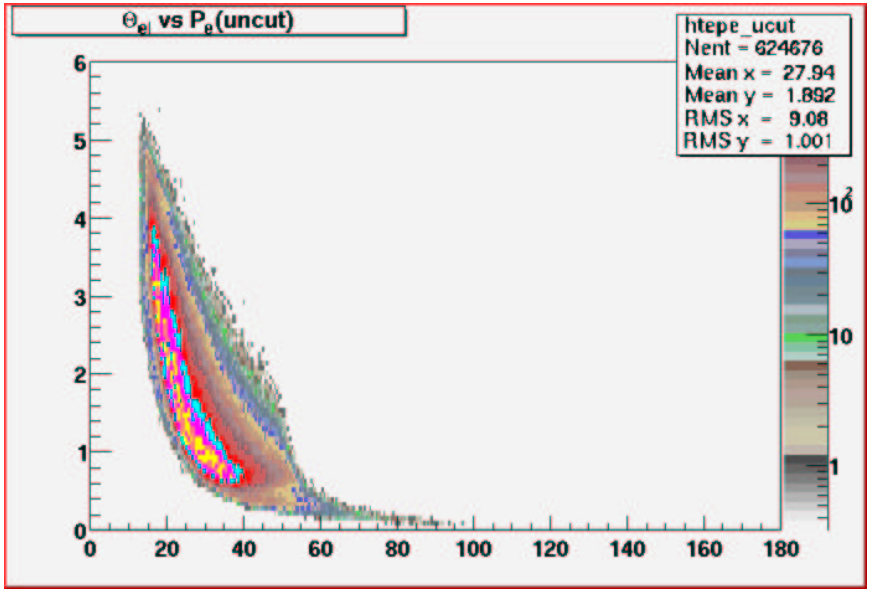
Actual CLAS quasi-elastic scattering event with inbending electron and backward-going spectator proton

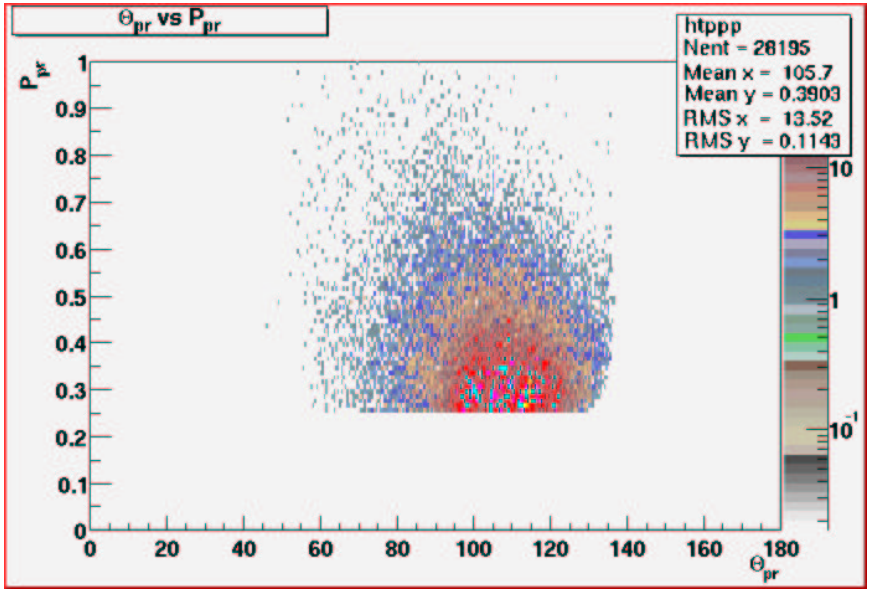


CLAS Kinematics









Spectator Momentum Dependence

Spectator momentum distribution p_s for:

left: $\cos\theta_{pq} < -0.3$

right: $-0.3 < \cos\theta_{pq} < 0.3$

and for:

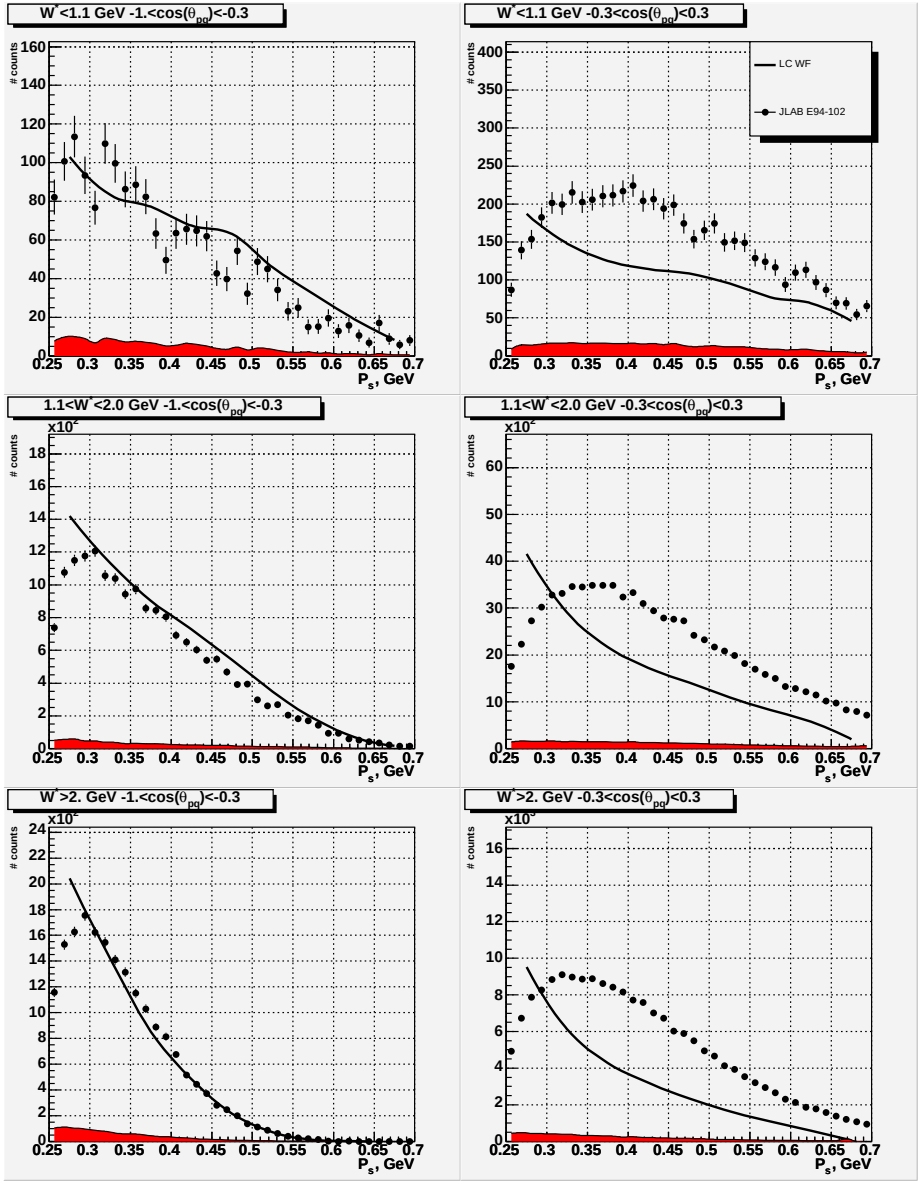
top: $W^* < 1.1$ GeV

middle: $1.1 < W^* < 2.0$ GeV

bottom: $W^* > 2.0$ GeV

with:

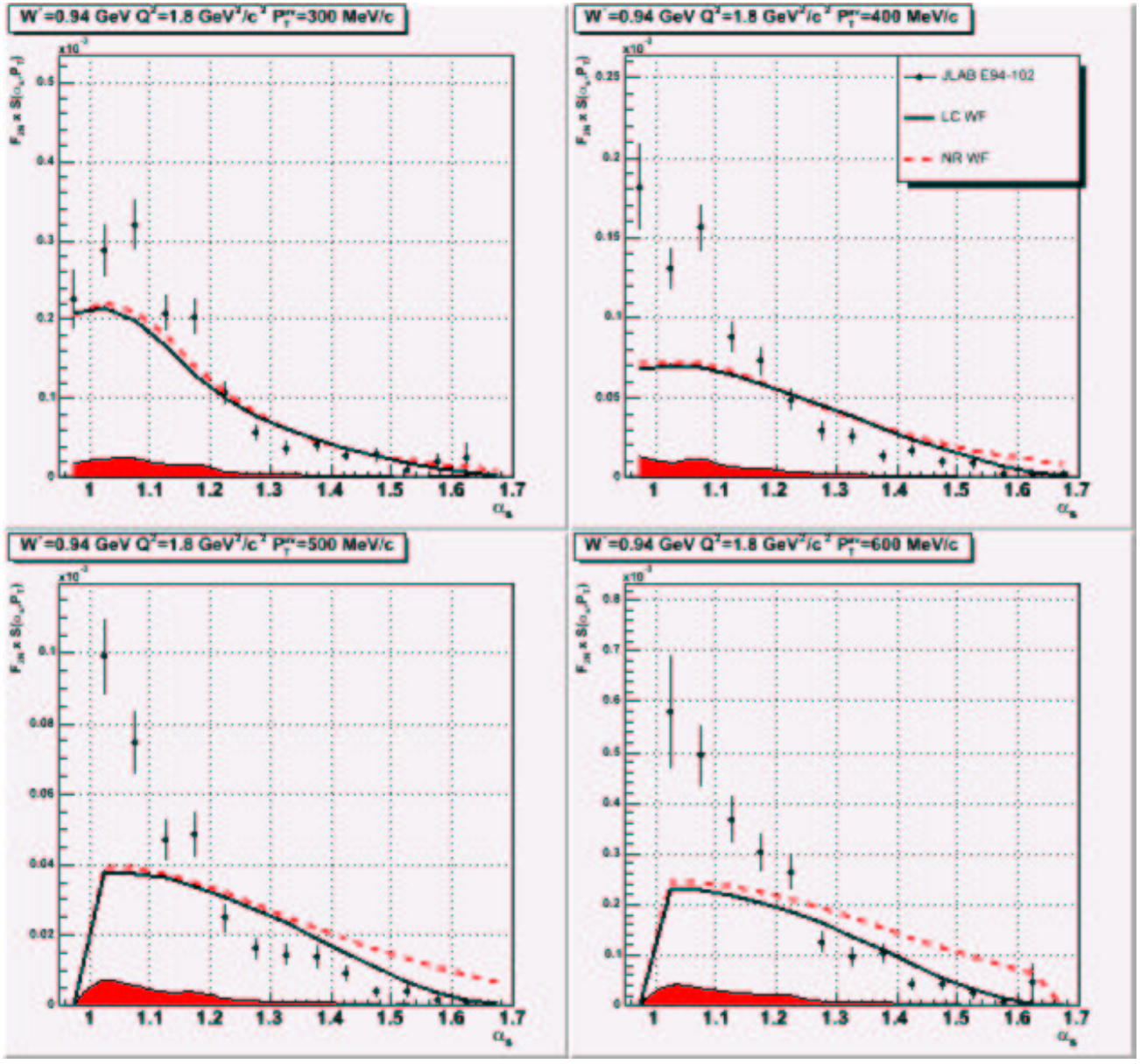
curves: spectator model



Quasi-Elastic Scattering

$F_2^n(x, Q^2)S(\alpha_s, p_T)$

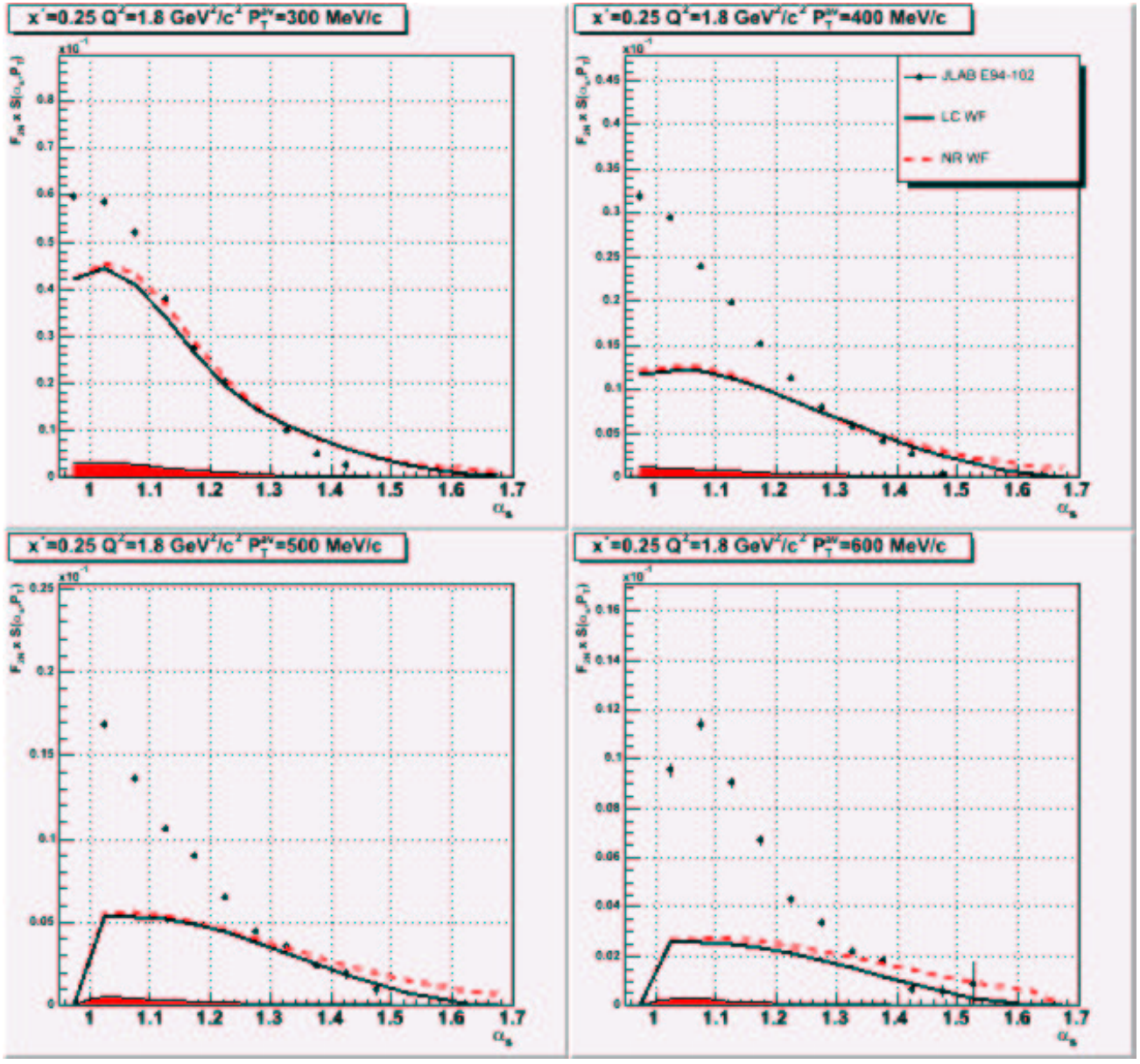
- $Q^2 = 1.8$ GeV^2
- $W^* = 0.94$ GeV
- p_T = 0.3, 0.4, 0.5, 0.6 GeV/c
- solid black: spectator model with light-cone wave function
- dashed red: spectator model with non-relativistic wave function



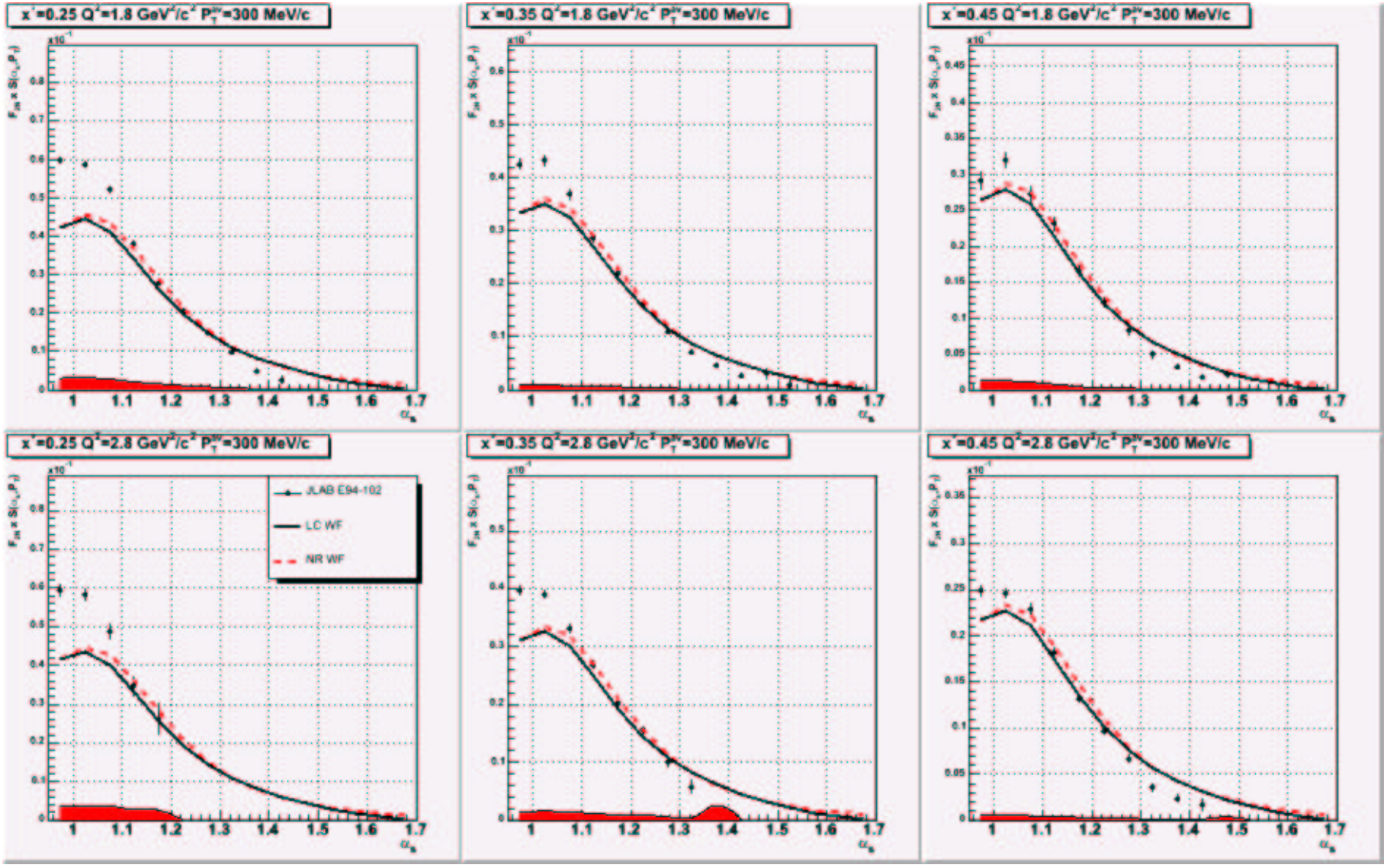
α_s Dependence

$F_2^n(x, Q^2)S(\alpha_s, p_T)$

- $Q^2 = 1.8$ GeV^2
- $x^* = 0.25$ GeV
- clockwise: p_T = 0.3, 0.4, 0.5, 0.6 GeV/c
- solid black: spectator model with light-cone wave function
- dashed red: spectator model with non-relativistic wave function



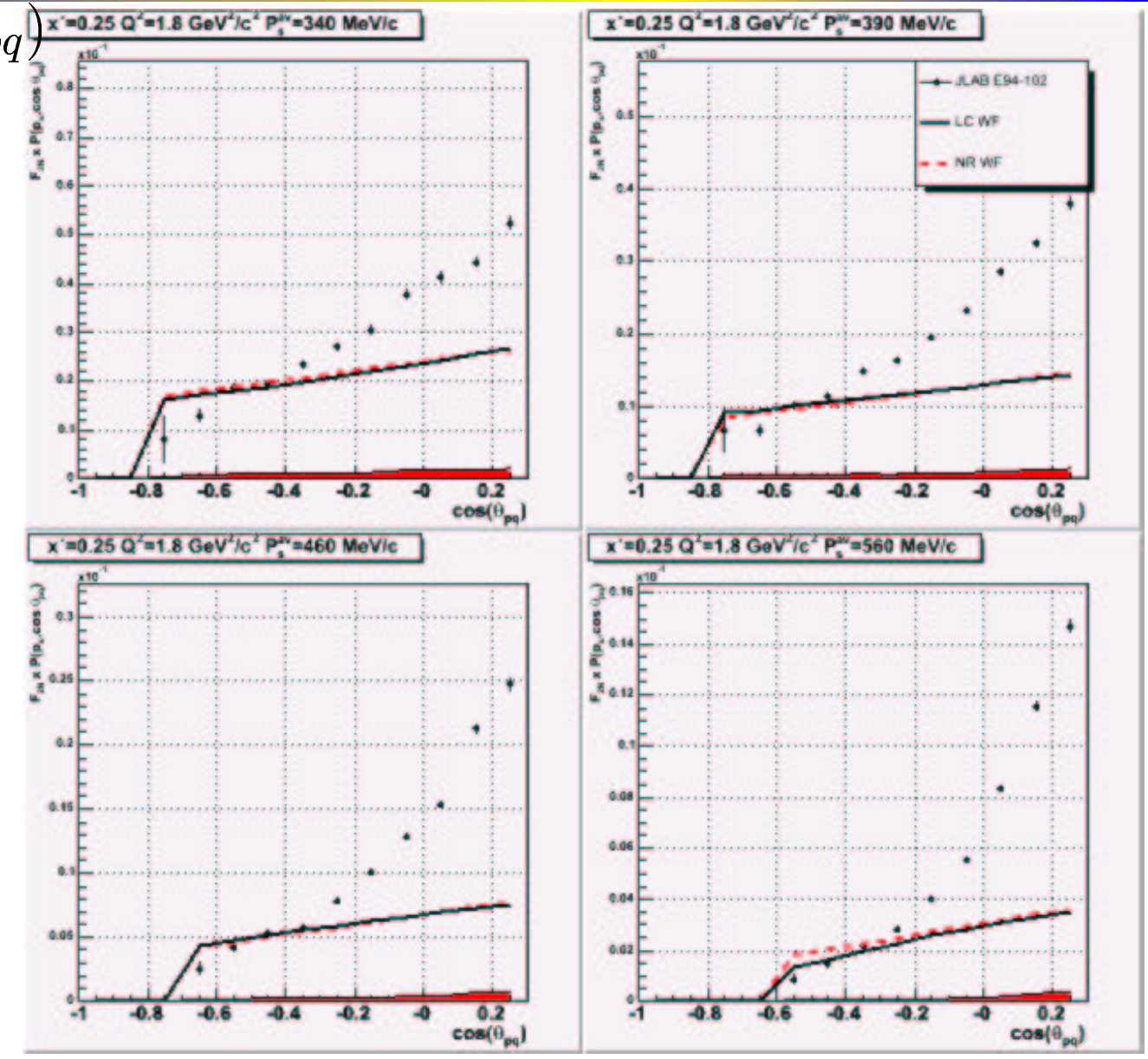
α_s Dependence



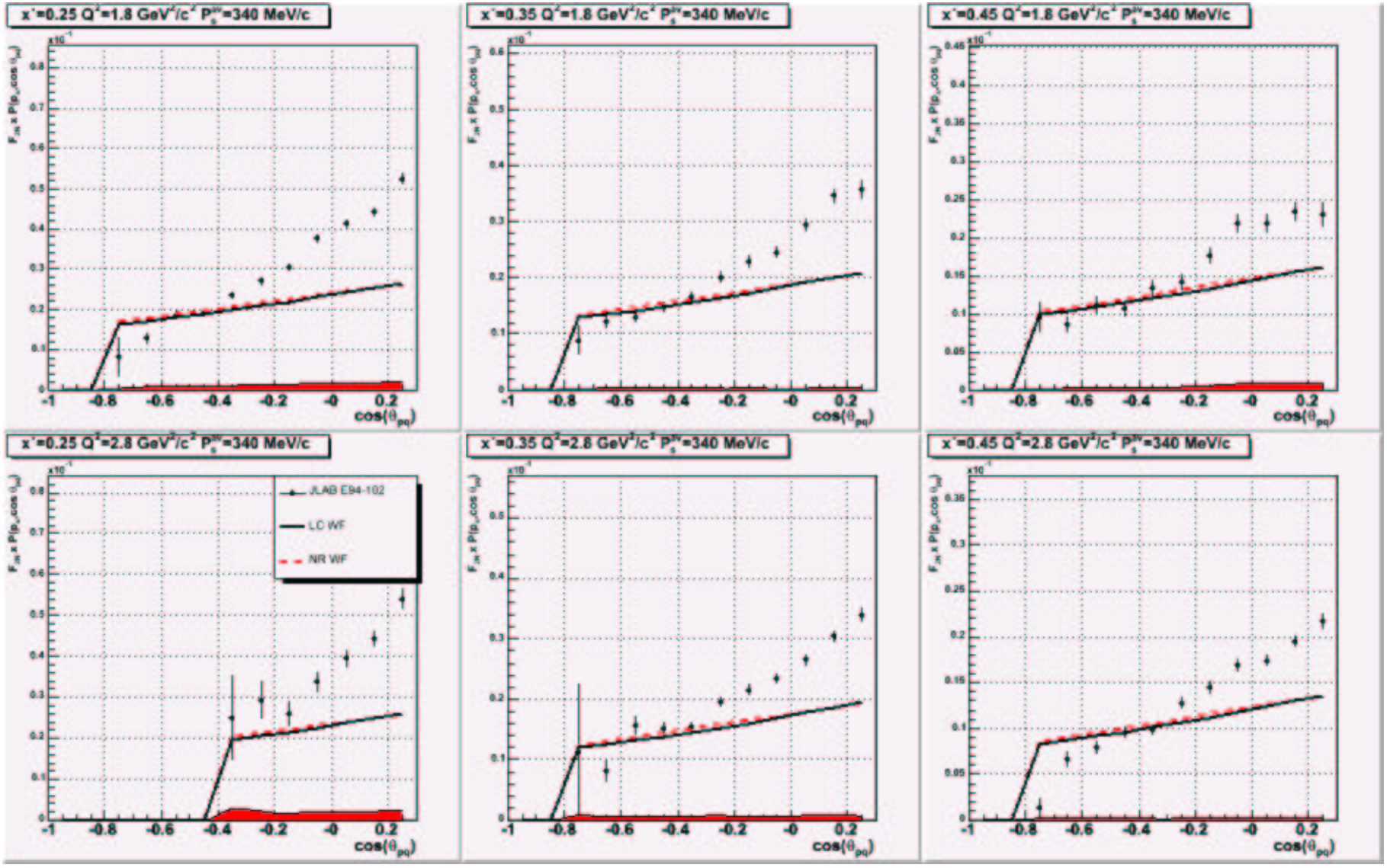
$\cos\theta_{pq}$ Dependence

$F_2^n(x, Q^2)P(p_T, \cos\theta_{pq})$

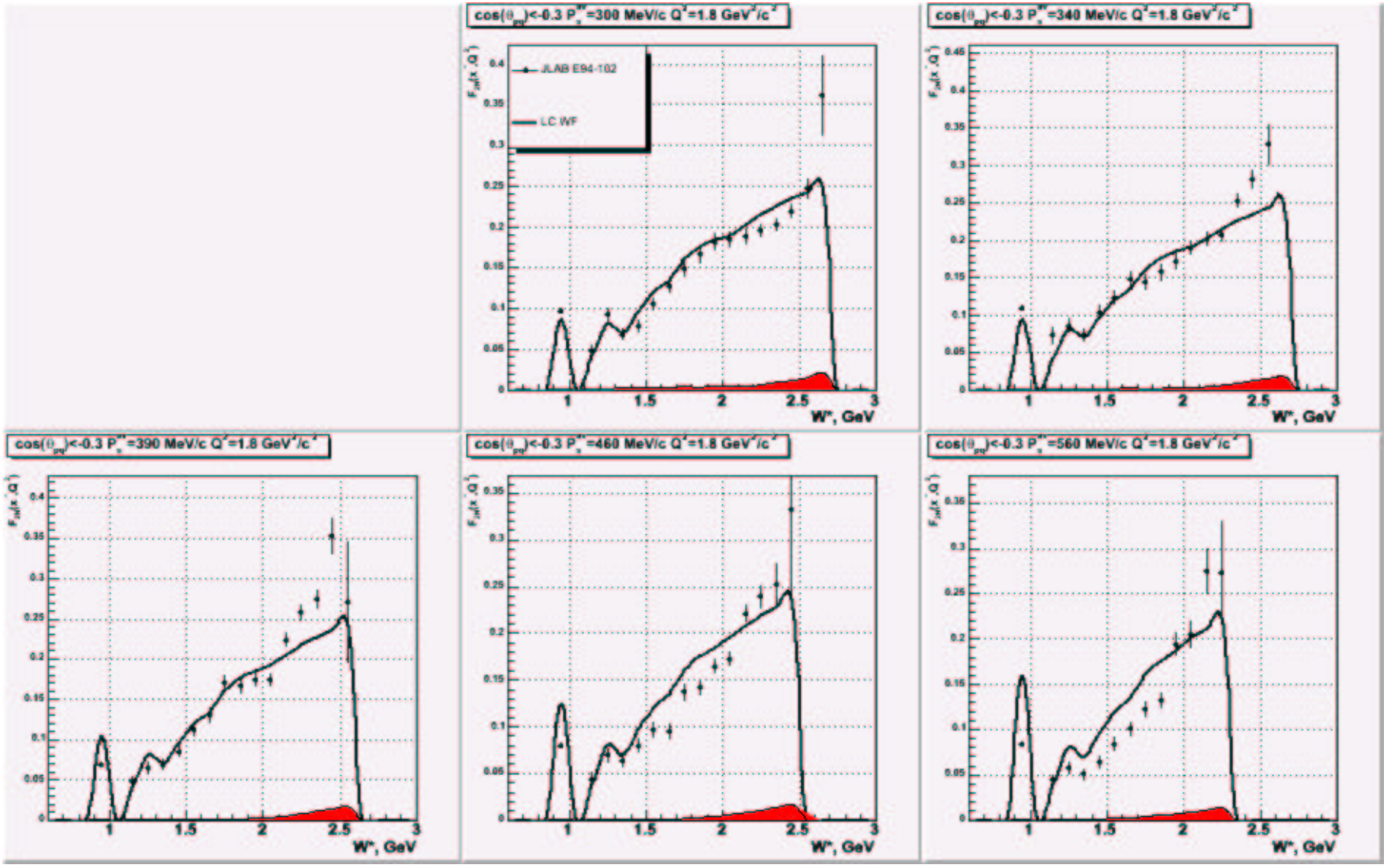
- $Q^2 = 1.8$ GeV^2
- $x^* = 0.25$ GeV
- clockwise: p_T = 0.34, 0.39, 0.46, 0.56 GeV/c
- solid black: spectator model with light-cone wave function
- dashed red: spectator model with non-relativistic wave function



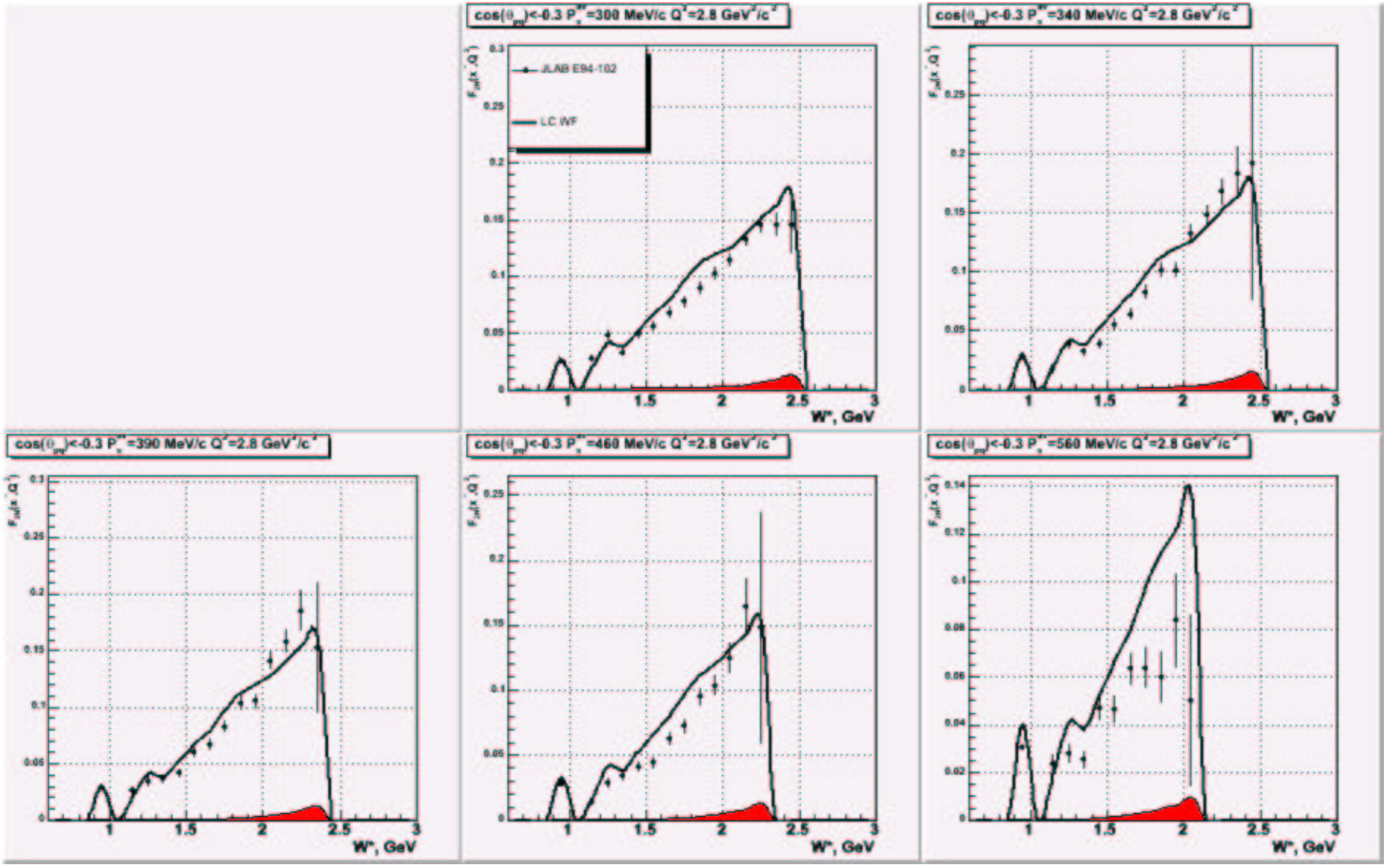
$\cos\theta_{pq}$ Dependence



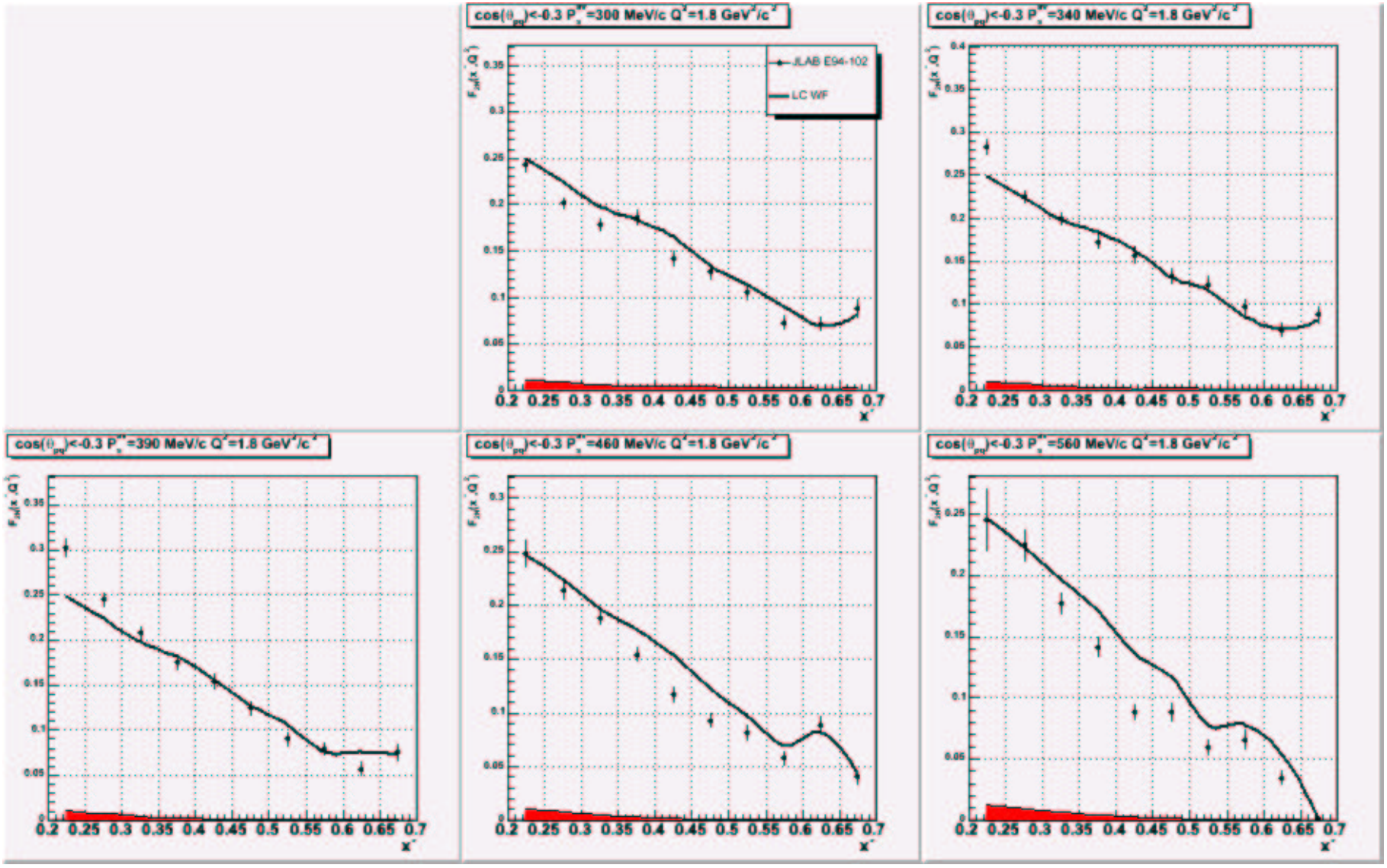
W^* Dependence



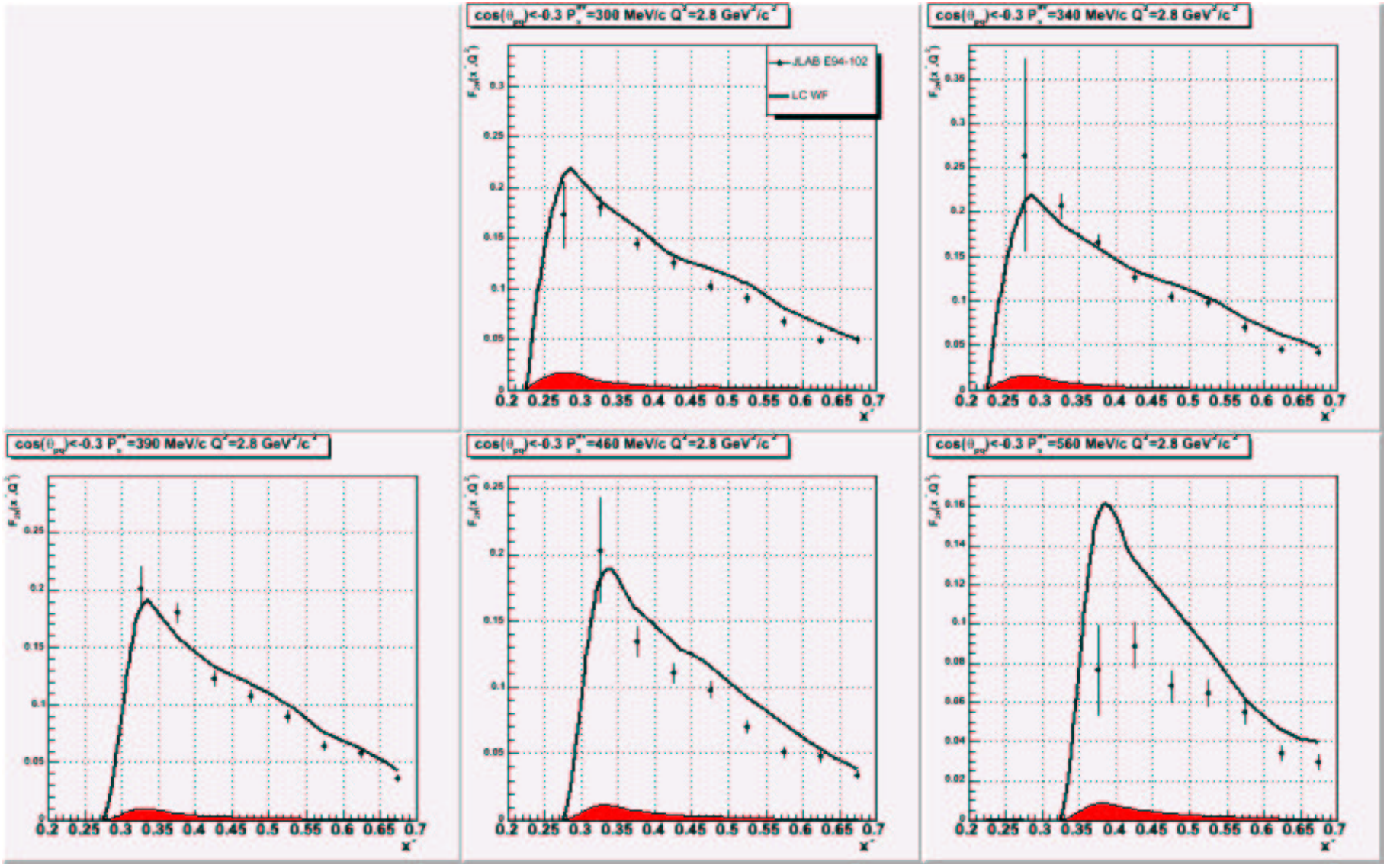
W^* Dependence



x^* Dependence



x^* Dependence



Conclusions

- CLAS has extensive data on tagged structure functions
- Final state interactions dominate at forward angles θ_{pq}
- The data follow the spectator model reasonably well
- Some hints of interesting deviations are apparent for extreme kinematics