Experiment 97-101

$\Delta(1232)$ and $S_{11}(1535)$

Electroproduction

at High Momentum Transfer

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Spokespersons-V. Frolov, J.Price, P.Stoler, V.P. Kouberovski

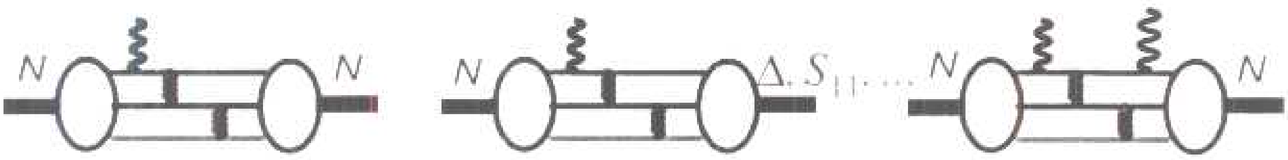
A. Afanasev, R.Davidson and A. Radyushkin will serve as theory support.

Common Physics Approach

The study of *soft* and *hard* processes in QCD

Asymptotically PQCD

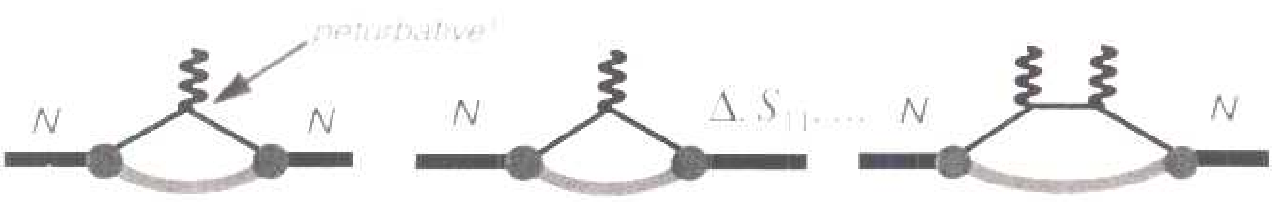
Hard: Leading order Fock states.
Valence pQCD.



elastic *resonance transition* *Compton scattering*

Pre -asymptotically GPD

Soft: Fully complex Fock states states.
Feynman mechanism.



elastic *resonance transition* *Compton scattering*

Form Factors and GPD's ?

-GPD's are the best hope for modeling parton distributions at accessible kinematic regions

-Form factors are simply related to GPD moments

-Form factors are related to parton k_perp distributions

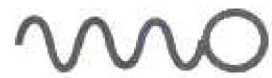
Nucleon Elastic scattering:
Wide angle Compton scattering:

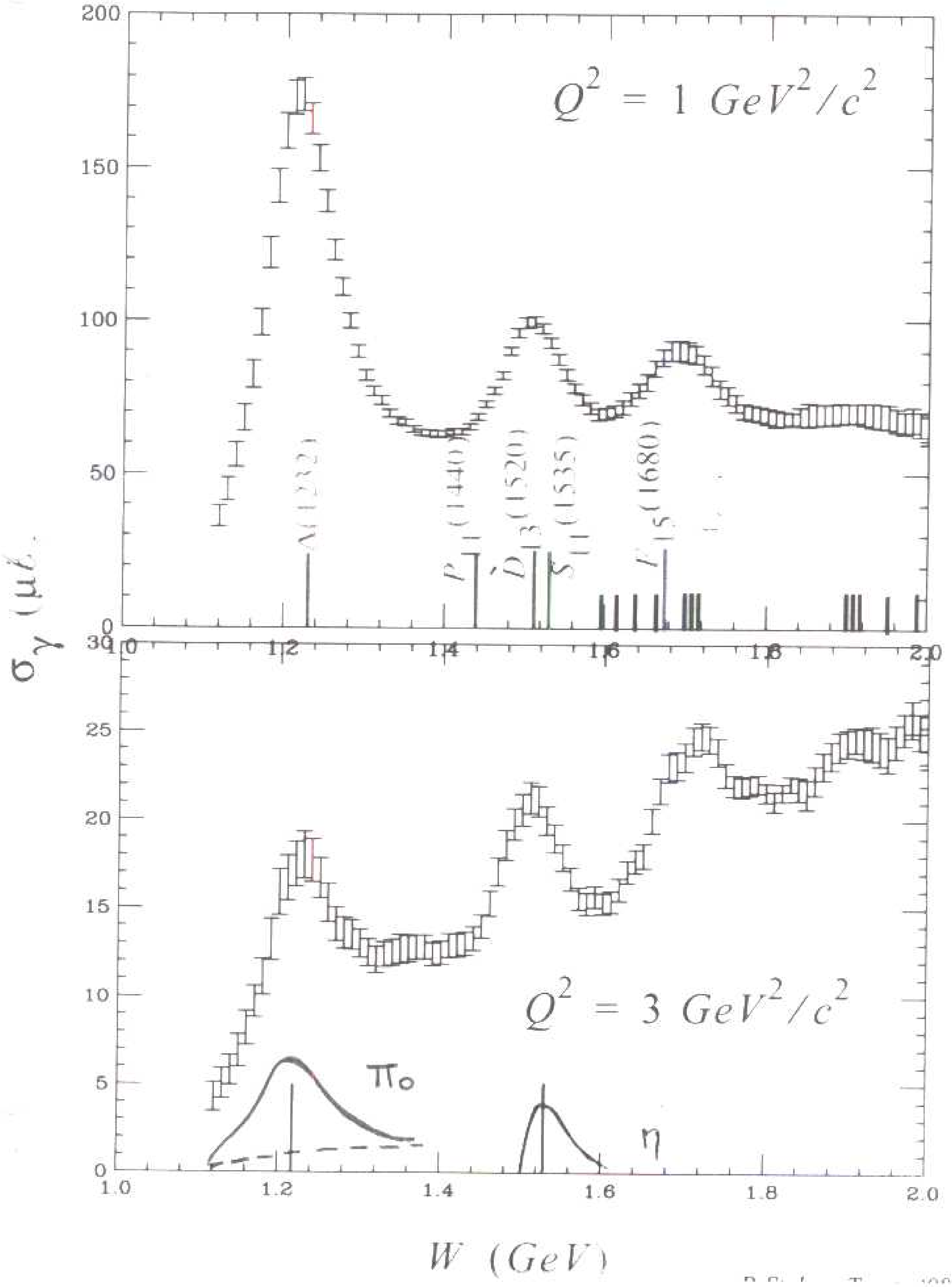
$$F_1, F_2 \text{ or } G_M, G_E \longleftrightarrow H, E$$

Delta Resonance:

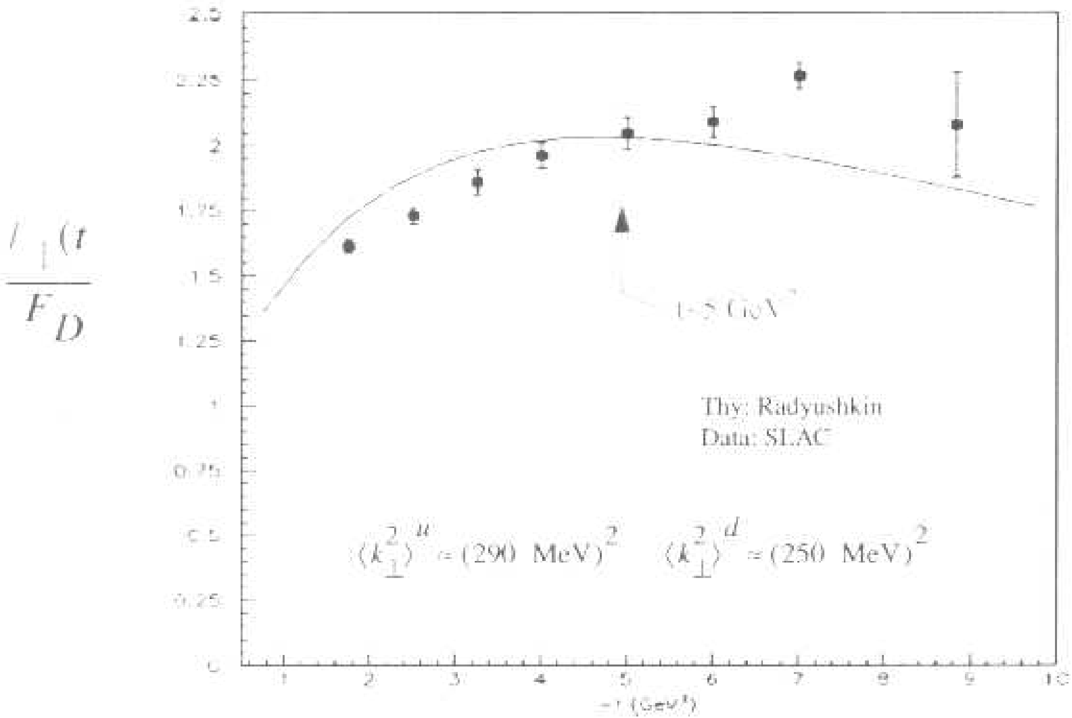
(isovector components)

$$G^*_M, G^*_E \longleftrightarrow H_1, E_1$$

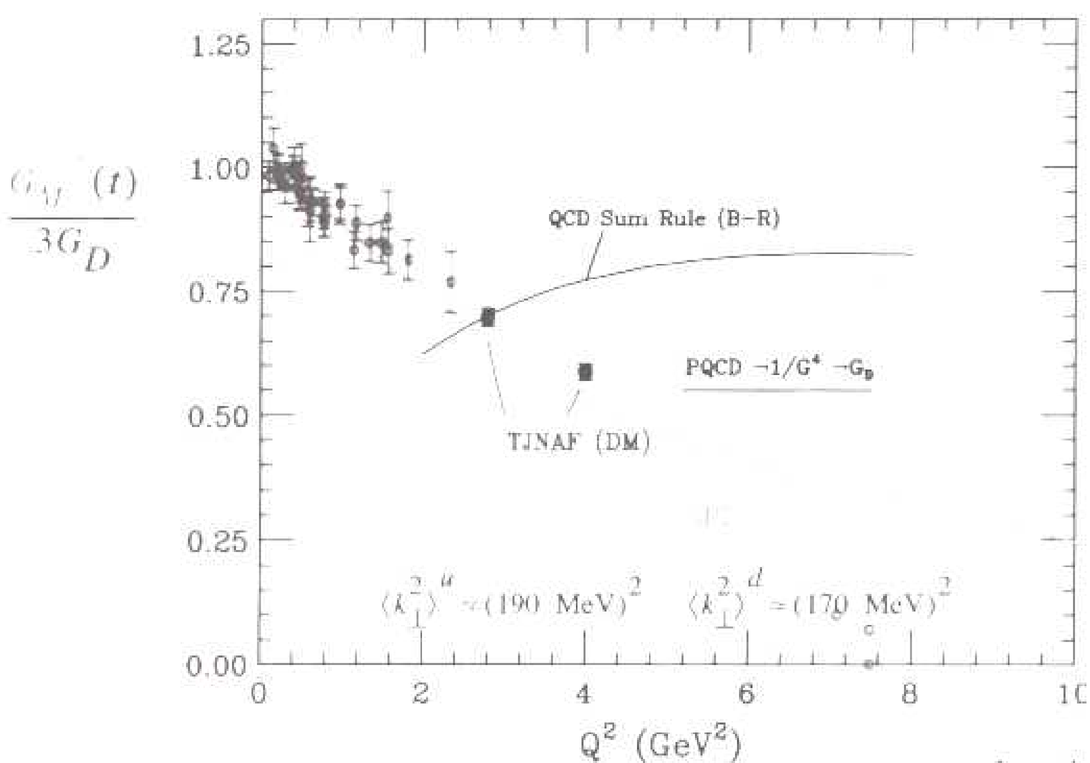
Inclusive (e, e') γ_v 



Proton Dirac Form Factor



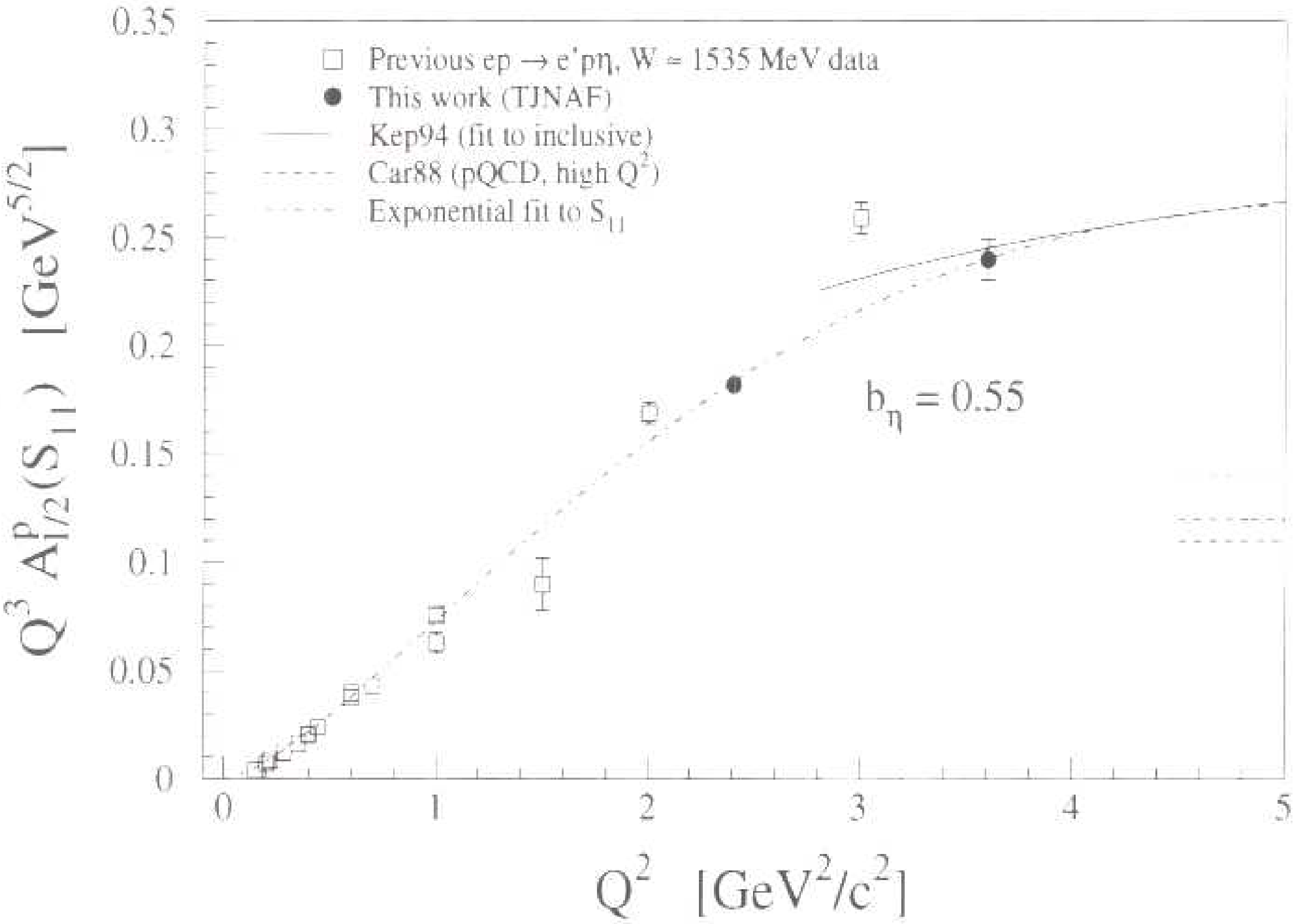
Delta Magnetic Form Factor



law (hard)

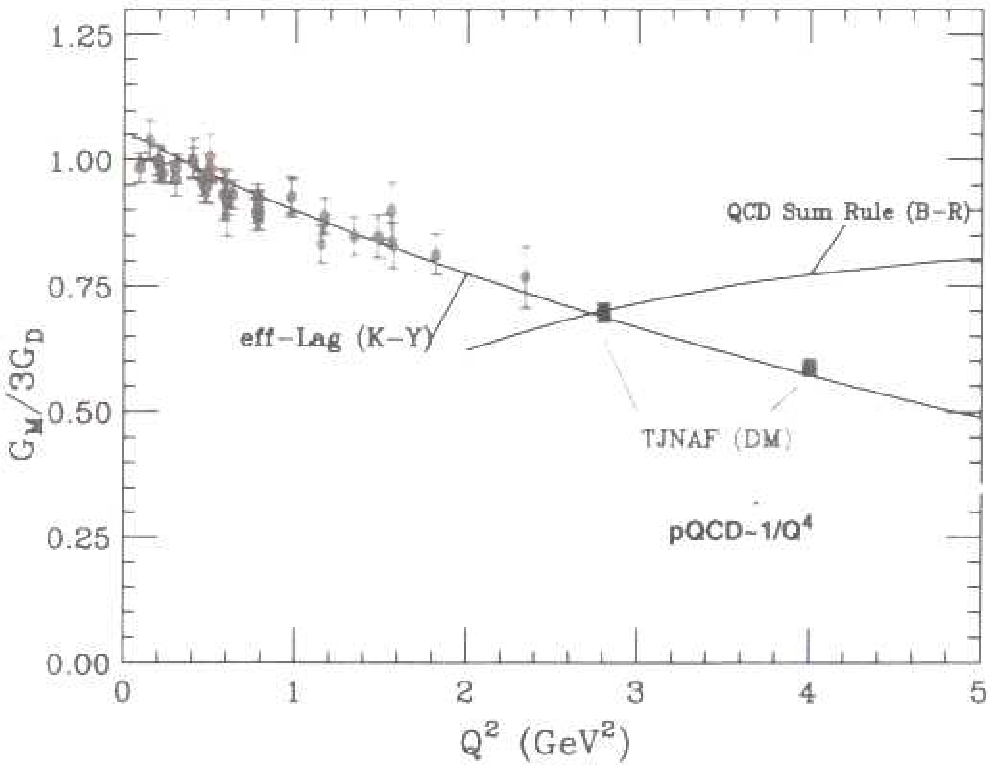
$$e + p \rightarrow S_{11}(1535) \rightarrow \eta + p$$

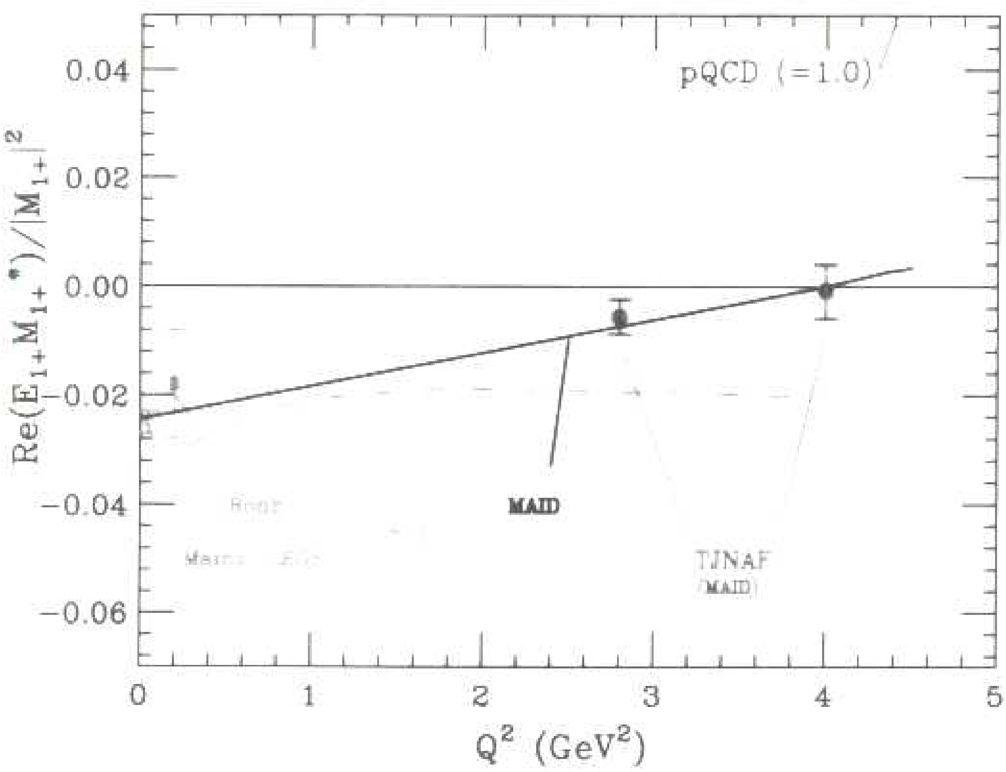
JLAB experiment 94-014 (C. Armstrong thesis)



JLAB Exp. 94-014

$$e + p \rightarrow e' + \Delta(1232) \rightarrow p + \pi^0$$



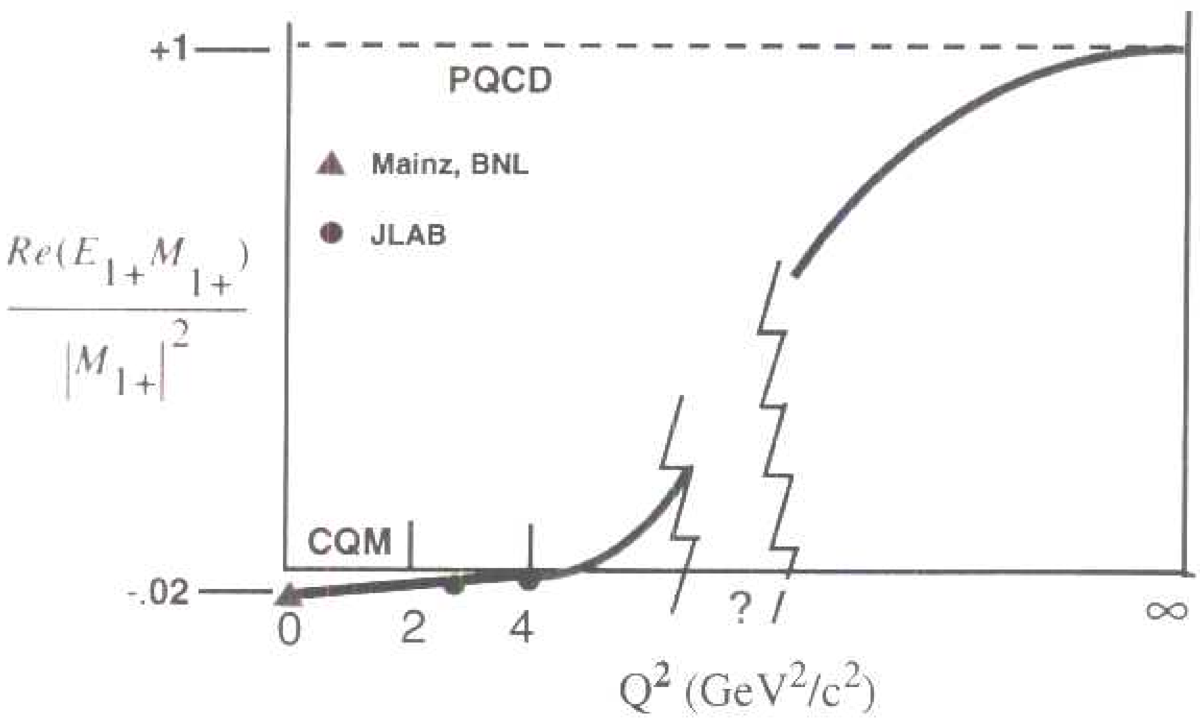


$$e + p \rightarrow \Delta(1232) \rightarrow \pi^0 + p$$

CQM ⟶ GPD ⟶ PQCD

$$A_{1/2} \propto 1/Q^3 \qquad Q^4 G_M^* \rightarrow const$$

$$E_2/M_1 \rightarrow 1$$



$\Delta(1232)$ via $p(e, e'p)\pi^0$

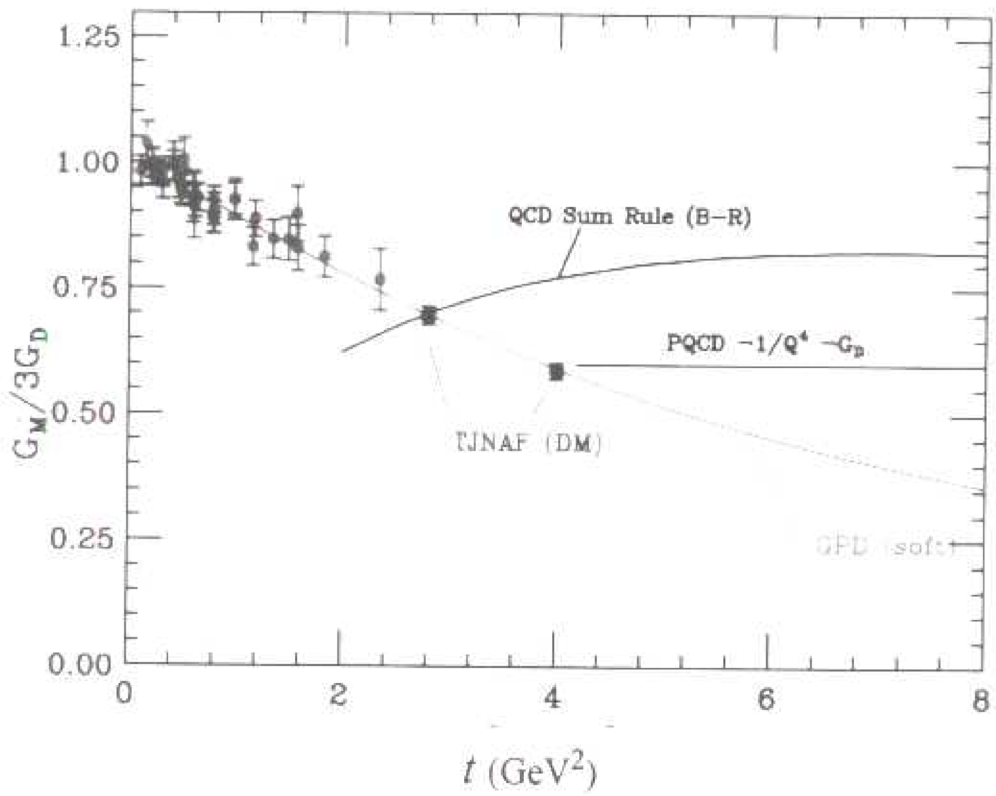
$S_{11}(1535)$ via $p(e, e'p)\eta$,

$Q^2 \sim 7.5$ GeV^2/c^2

E_{beam}	I_{max}	Target	beam time	proton detector	electron detector
~5.75 GeV	~90 μA	4cm LH	25 days	HMS	SOS

Number of events: ~25 k for each resonance.

$$G^*{}_M(N-\Delta)$$



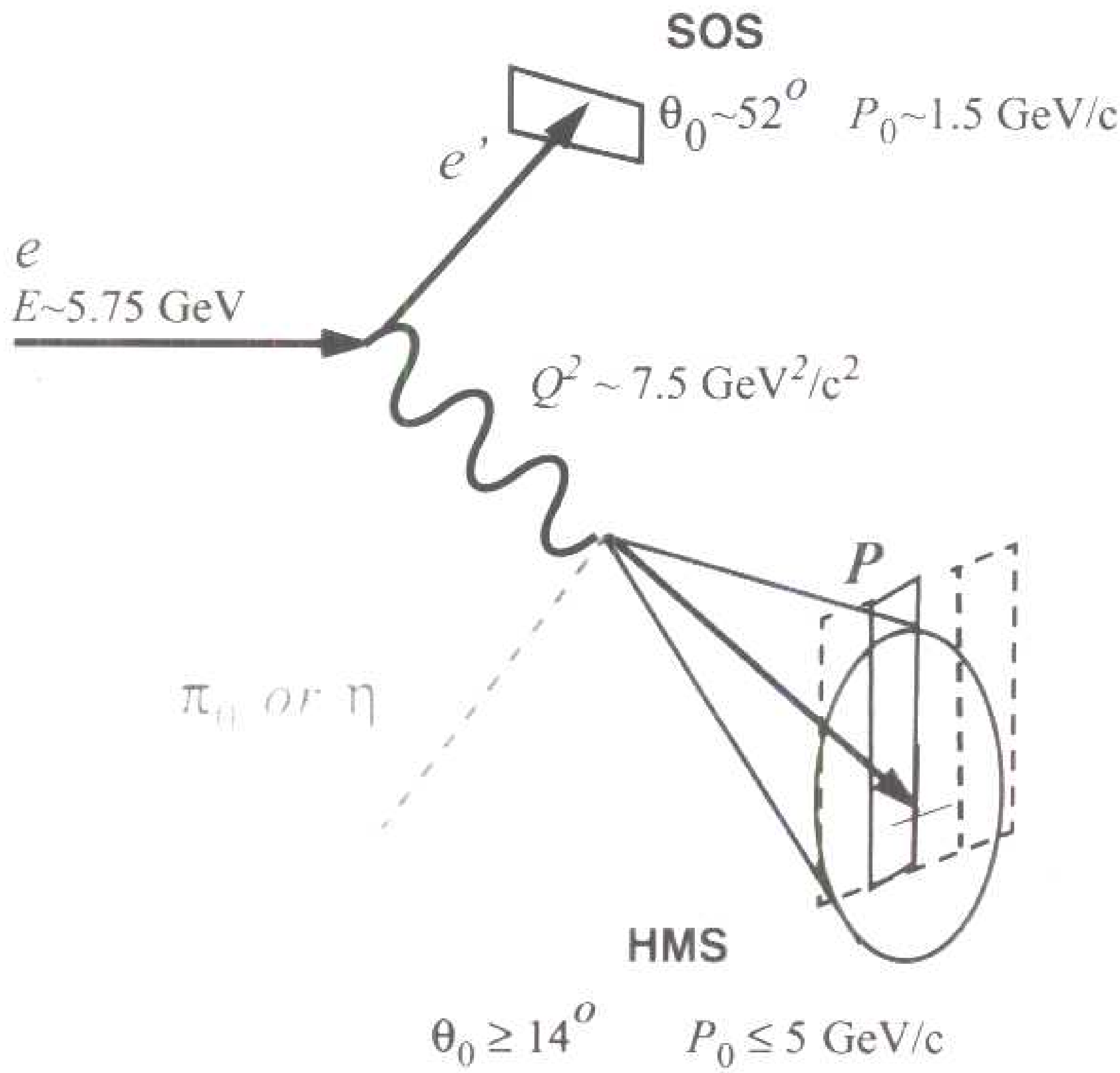
$$F_{n\Delta}(t) = \sum_q e_q \int_0^1 H^3_{n\Delta}(\xi, x, t)dx$$

$$\Psi_p(x, k_\perp) = \Phi_p(x)e^{-k_\perp{}^2/2x\bar{x}\lambda_p^2} \qquad \Psi_\Delta(x, k_\perp) = \Phi_\Delta(x)e^{-k_\perp{}^2/2x\bar{x}\lambda_\Delta^2}$$

$$H^3_{n\Delta}(x, t) \sim \int \Psi_p(x, k_\perp)\Psi_\Delta(x, k_\perp)dk_\perp = F_{n\Delta}(x)e^{-\bar{x}t^2/4x\lambda_{n\Delta}^2}$$

$$\lambda_{n\Delta}^2 = \lambda_n^2 + \lambda_\Delta^2 \approx 0.4 \text{ GeV2} \Rightarrow (k_{\perp n\Delta})_{RMS} \approx 180 \text{ MeV}$$

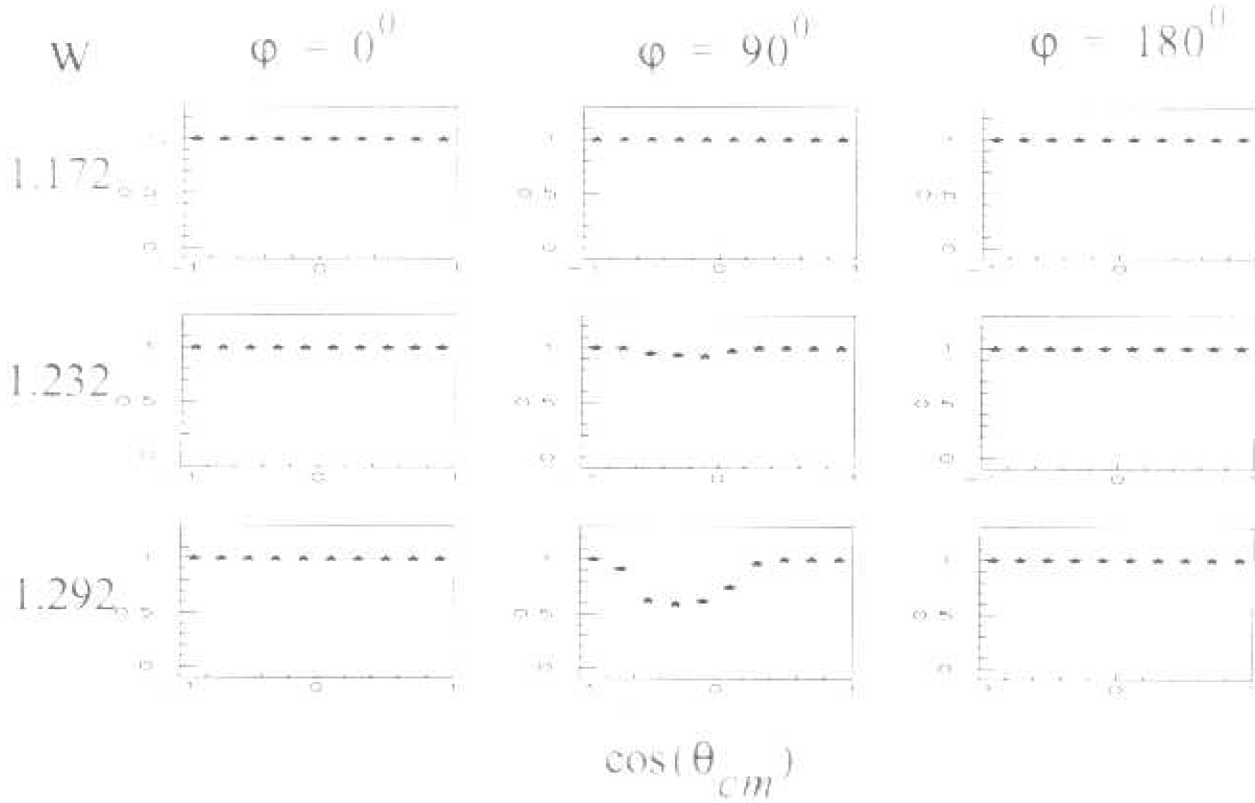
power law (hard)



SOS
θ_0~52^o P_0~1.5 GeV/c
e'
e
E~5.75 GeV
Q^2 ~ 7.5 GeV^2/c^2
P
π_0 or η
HMS
$\theta_0 \geq 14^o$ $P_0 \leq 5$ GeV/c

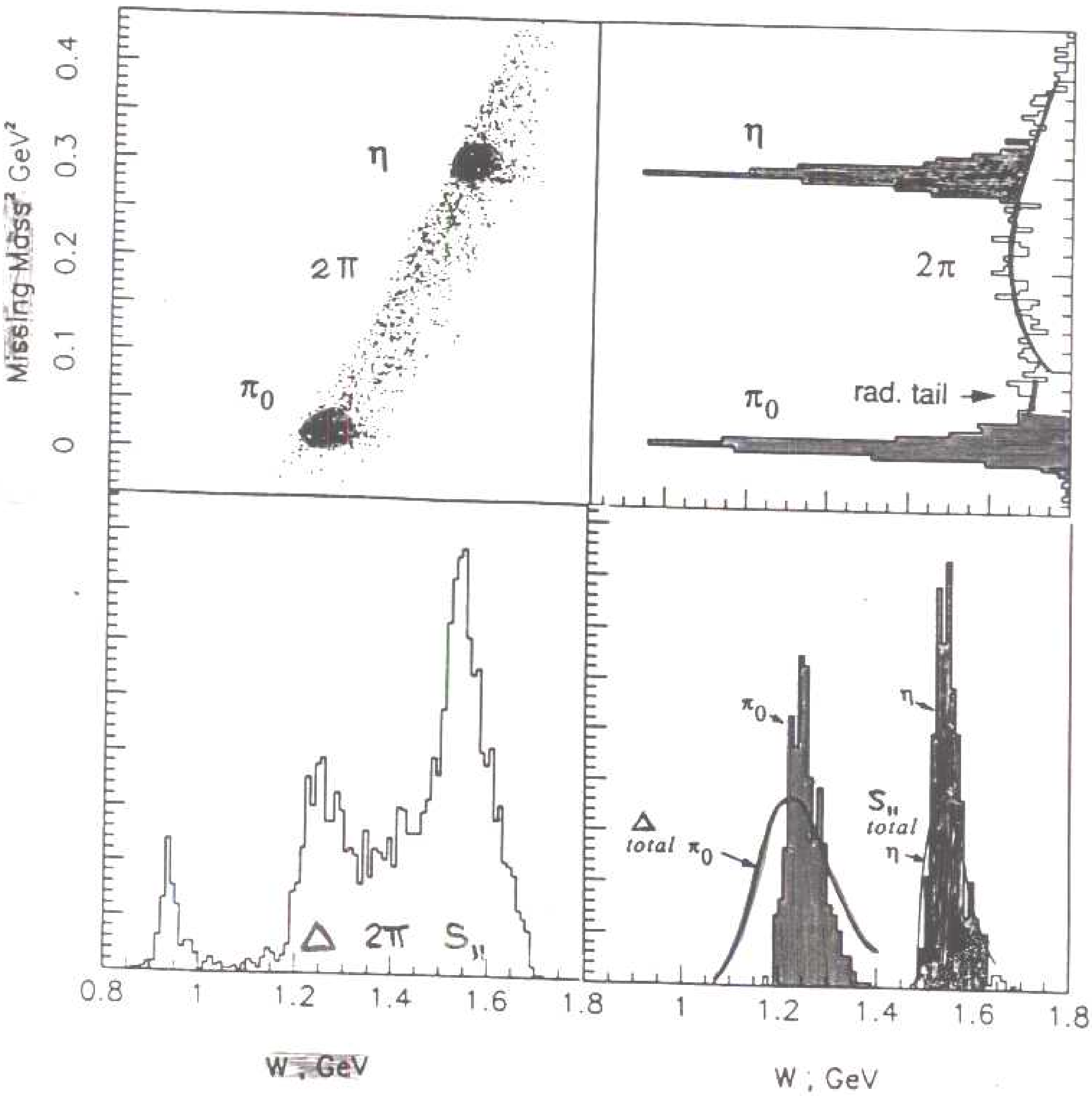
Acceptances for $p(e, e'p)\pi^\circ$ at $Q^2 = 7.5\ GeV^2/c^2$

Out-of-plane angles $\varphi = 0, 90, 180^0$



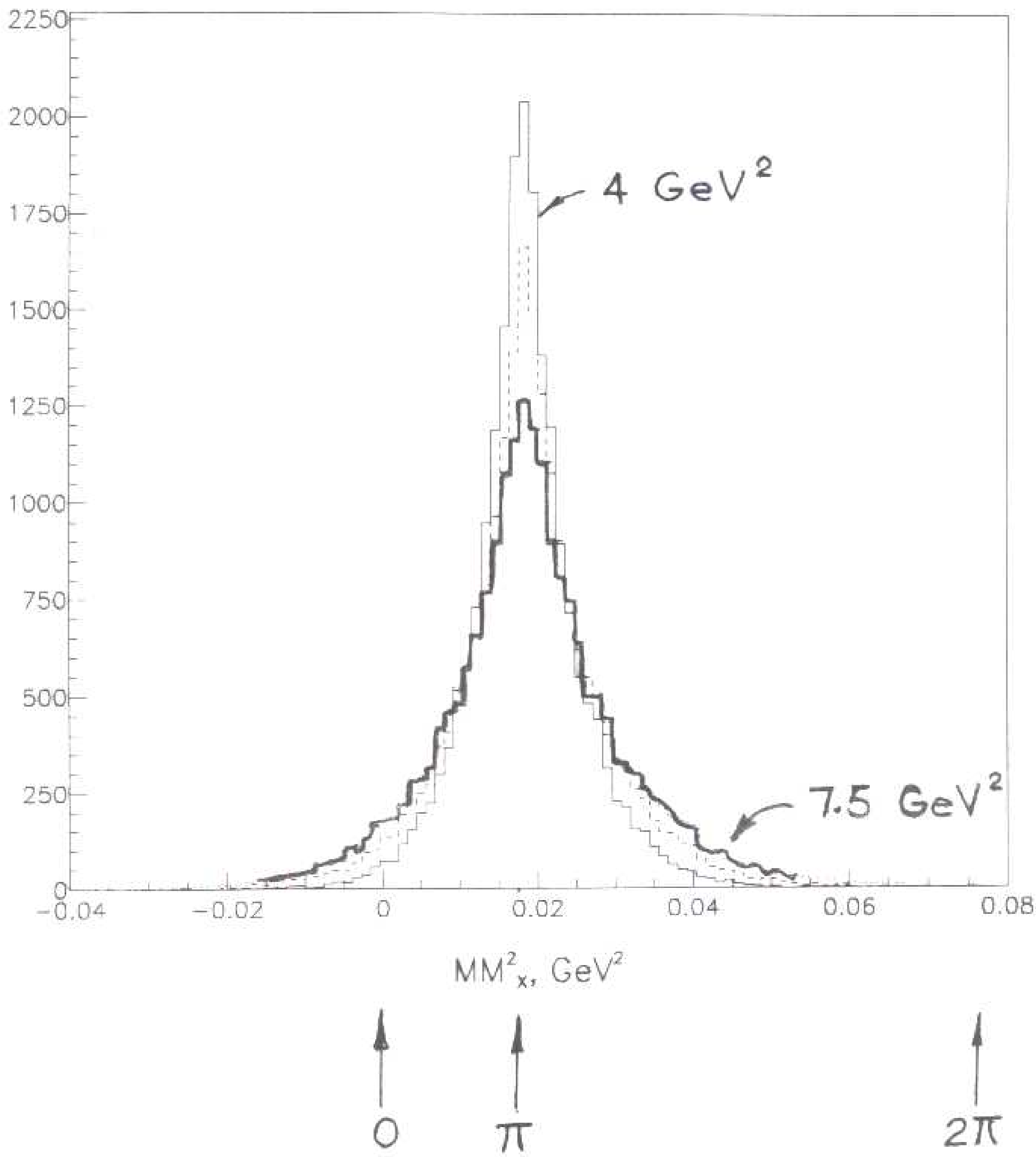
e - p coincidence at $Q^2 = 3\ GeV^2/c^2$

(missing mass)^2 vs W



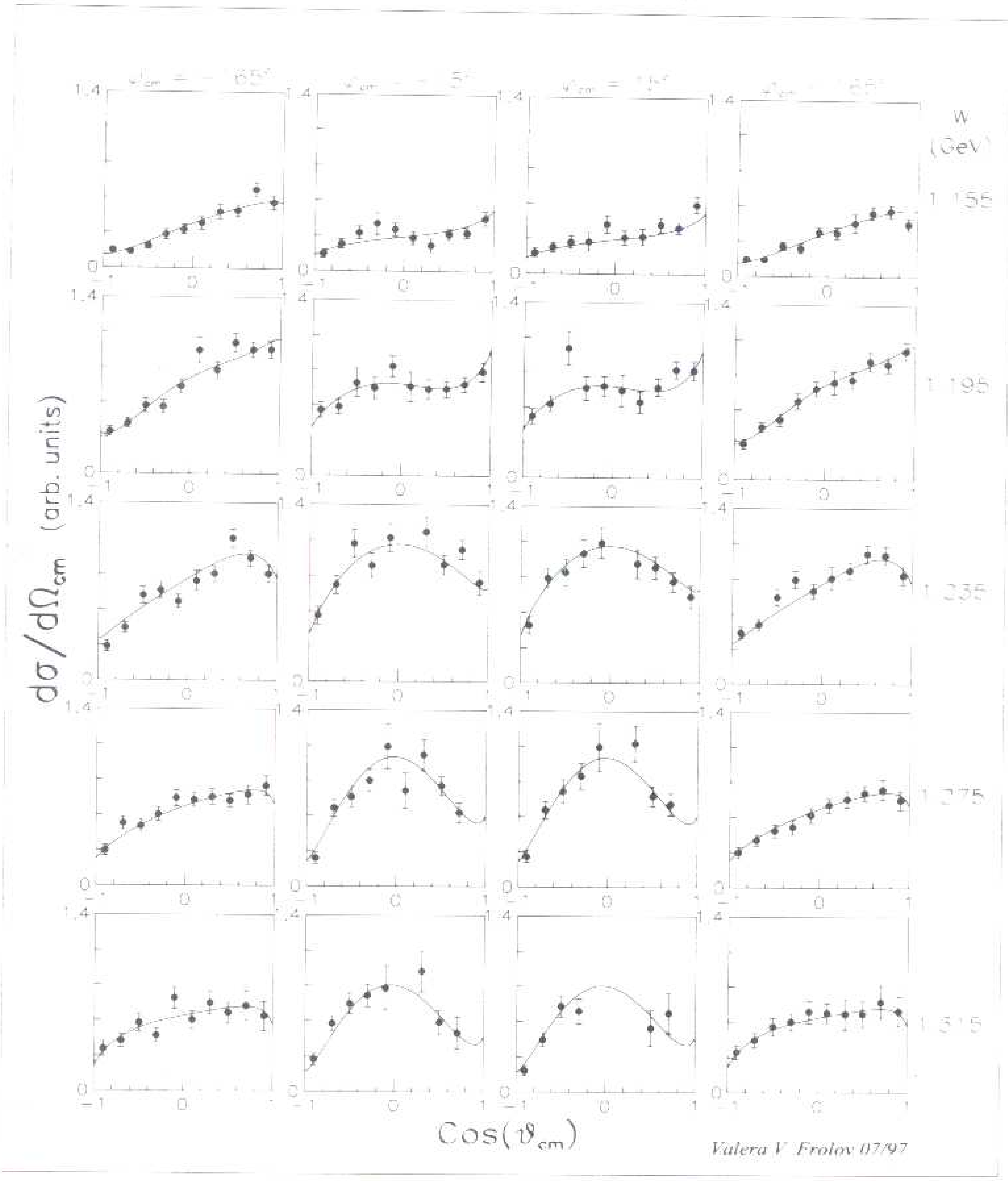
Note: above data from 1 kin. setting.

Monte Carlo simulation for the MM^2_x



E94-014: Selected Angular Distributions at $Q^2 = 2.8\ GeV^2$

(20% of available kinematic intervals)



Angular distributions for each W in the barycentric frame fit by:

$$\frac{d\sigma}{d\Omega_e dE_e d\Omega_m'} = \Gamma_v \frac{d\sigma}{d\Omega' m}$$

$$\frac{d\sigma}{d\Omega m} = A(\theta') + \varepsilon B(\theta') + \varepsilon C(\theta')\cos 2\varphi' + \sqrt{\varepsilon(\varepsilon+1)}D(\theta')\cos\varphi'$$

The functions A, B, C, D are expanded up to cubic in $\cos(\theta')$

The functions A, B, C, D are expanded in terms of the contributing ***multipole amplitudes***. $E_{l+,-}$, $M_{l+,-}$, $S_{l+,-}$

Fit assumes M_{1+} dominance at resonance.