Overview of Meson Production Experiments at JLAB

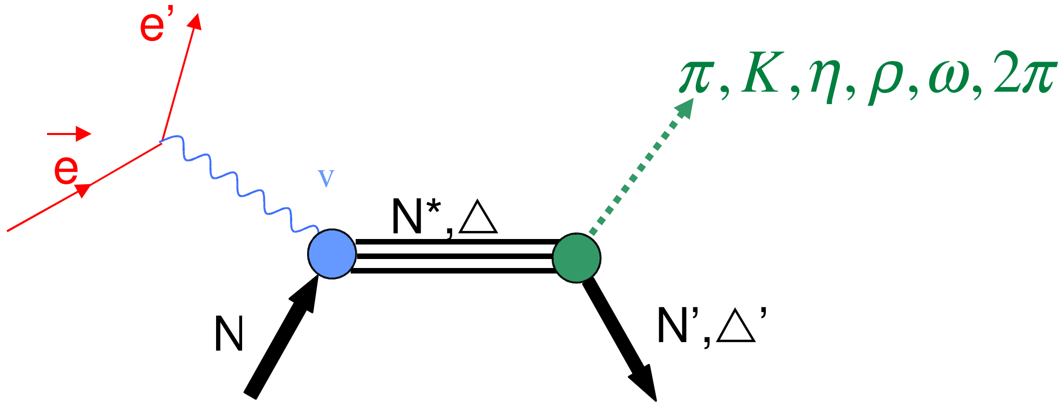
Cole Smith

University of Virginia

New Theoretical Tools for Nucleon Resonance Analysis Workshop

Argonne National Lab, Aug 29, 2005

$\mathcal{N}^*$ Program at JLAB



Physics Goals

- *Photocouplings $A_{3/2}$ $A_{1/2}$ $S_{1/2}$ vs Q^2 for known ,$\mathcal{N}^*$ resonances*
  - *Understand confinement and excitation mechanisms from QCD*
- *Search for missing resonances expected from SU(6)xO(3)*
  - *Details of quark wave functions (symmetric vs. di-quark)*

Theoretical Challenges

- *Partial wave, isospin and channel couplings of hadronic decay*
- *Interference between EM and strong interaction vertices*
- *Appropriate kinematic/dynamical d.o.f.: relativity, gluons vs. mesons*

Open questions

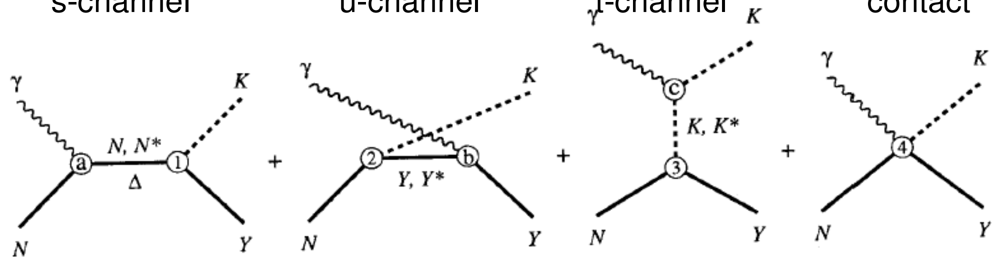
- Strangeness content of proton (G0, HAPPEX, SAMPLE, PVA4)
- What mechanism produces ss pair (sea quarks, flux tube breaking, gluon radiation) ?
- Which previously known resonances contribute to K , K final states?
- How significant are Born terms?
- Can missing resonances which couple to K , K channels be identified reliably?

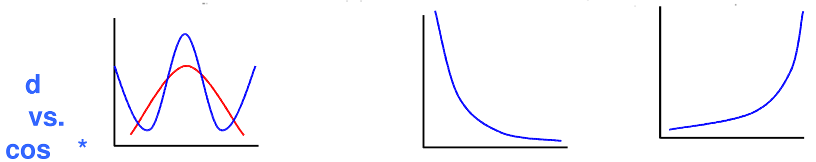
Advantages of K , K final states

- Easier to measure and analyze vs. N final states
- Resonance couplings to KY channels different from N
- K channel is an isospin filter (pure I=1/2)
- Weak decay → p - self analyzing
  - $W(\cos\theta)d\Omega = \frac{1}{2}(1+\alpha P_{\Lambda}\cos\theta)d\Omega$: measurement of W(cos) yields polarization.

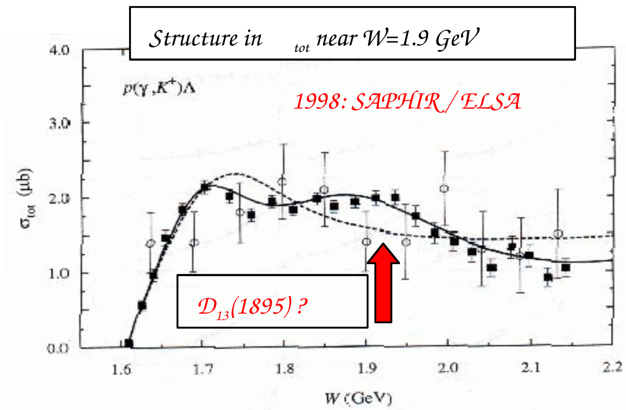
Kaon-Hyperon Electromagnetic Production: Hadrodynamic Models

s-channel u-channel t-channel contact



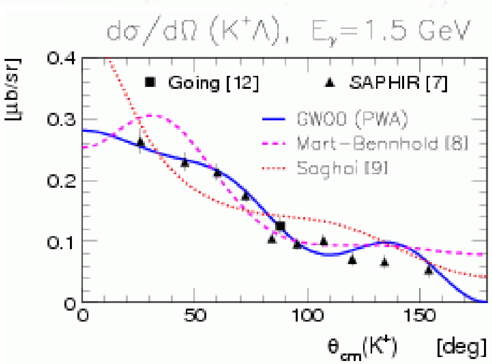


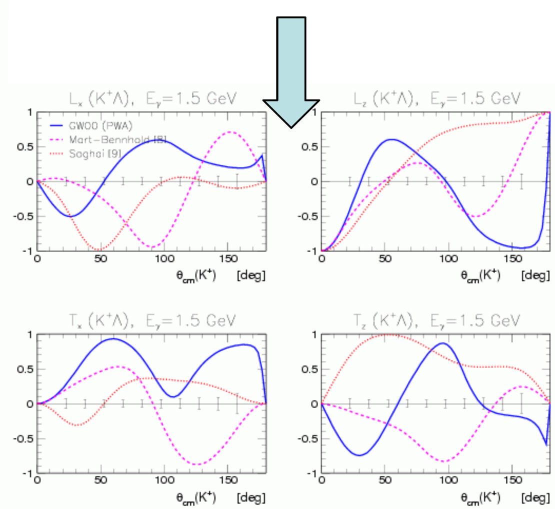
Resonance	Kaon-MAID $K^+\Lambda$	Kaon-MAID $K^+\Sigma^\circ$	Janssen-Ryckebusch $K^+\Lambda$	Janssen-Ryckebusch $K^+\Sigma^\circ$
s-channel diagrams				
$S_{11}(1650)$	X	X	X	X
$P_{11}(1710)$	X	X	X	X
$P_{13}(1720)$	X	X	X	X
$D_{13}(1895)$	X		X	
$S_{31}(1900)$		X		X
$P_{31}(1910)$		X		X
u-channel diagrams				
$S_{01}(1800)$			X	X
$P_{01}(1810)$			X	X
t-channel diagrams				
$K^*(893)$	X	X	X	X
$K_1(1270)$	X	X	X	X



More observables need to constrain models, especially polarization.

Experiment	Observable	Required Polarization: Beam	Target	Hyperon
	Single Polarization			
SAPHIR, CLAS	$\frac{d\sigma}{d\Omega}$	-	-	-
SPRING-8	Σ	linear	-	-
DESY	T	-	along y'	-
SAPHIR, CLAS	P	-	-	along y'
	Beam and Target Polarization			
	G	linear	along z	-
	H	linear	along x	-
	E	circular	along z	-
	F	circular	along x	-
	Beam and Hyperon Polarization			
	$O_{x'}$	linear	-	along x'
	$O_{z'}$	linear	-	along z'
CLAS	$C_{x'}$	circular	-	along x'
CLAS	$C_{z'}$	circular	-	along z'
	Target and Hyperon Polarization			
	$T_{x'}$	-	along x	along x'
	$T_{z'}$	-	along x	along z'
	$L_{x'}$	-	along z	along x'
	$L_{z'}$	-	along z	along z'

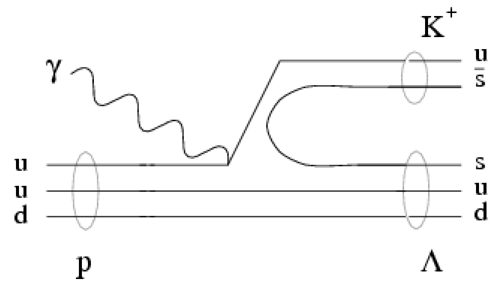




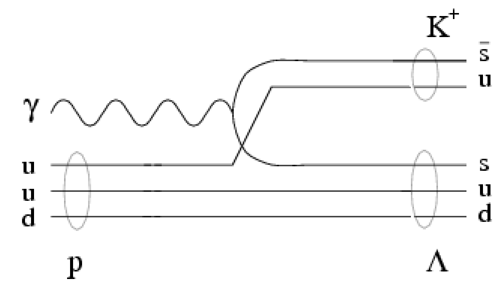
a) Direct knockout of u quark.
Flux tube breaks to create ss pair.

b) VMD: reaction probes
hadronic structure of photon

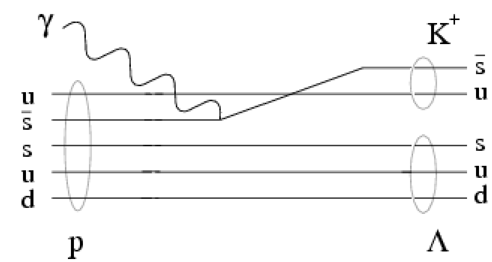
c) Photon probes virtual ss pairs in proton



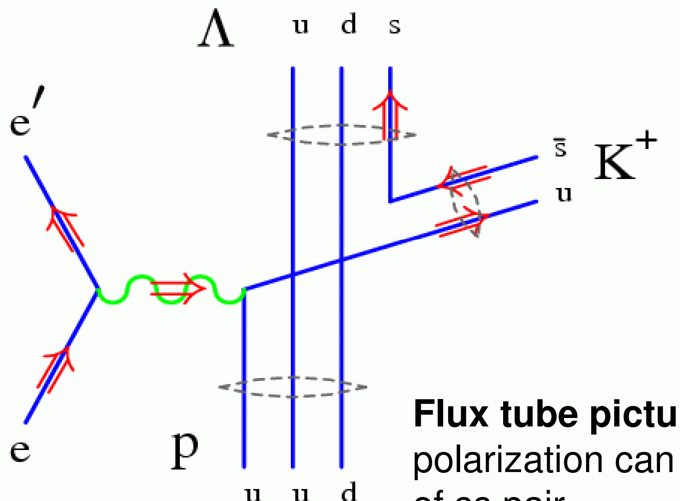
(a)



(b)



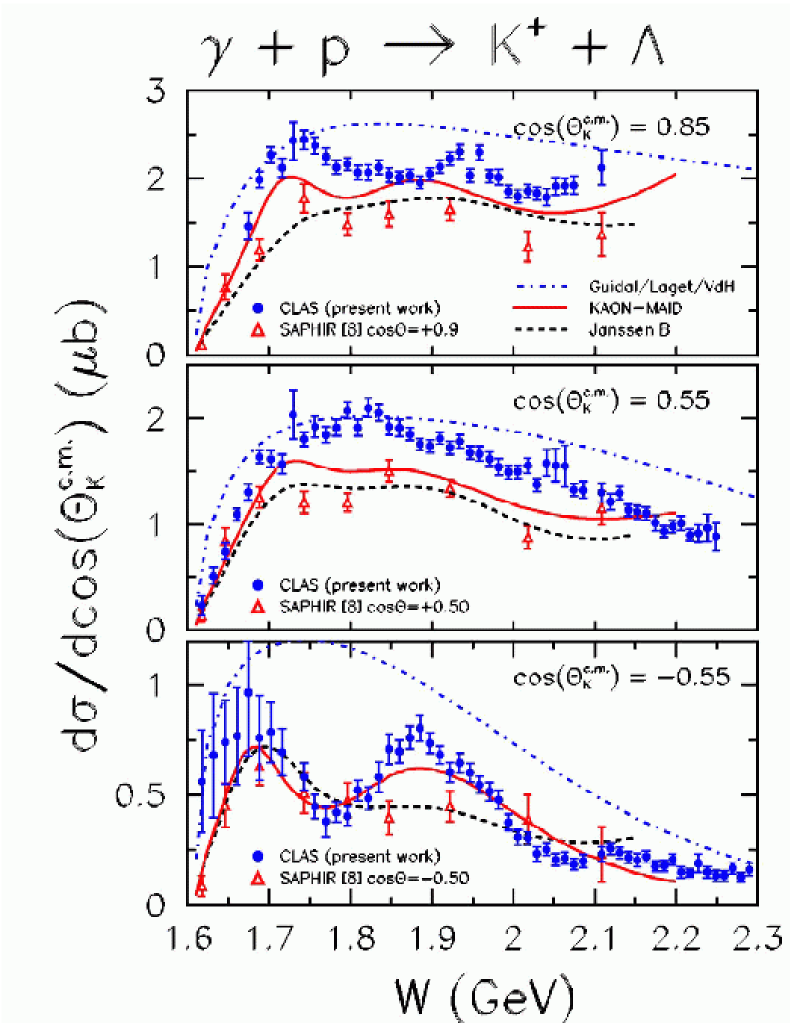
(c)



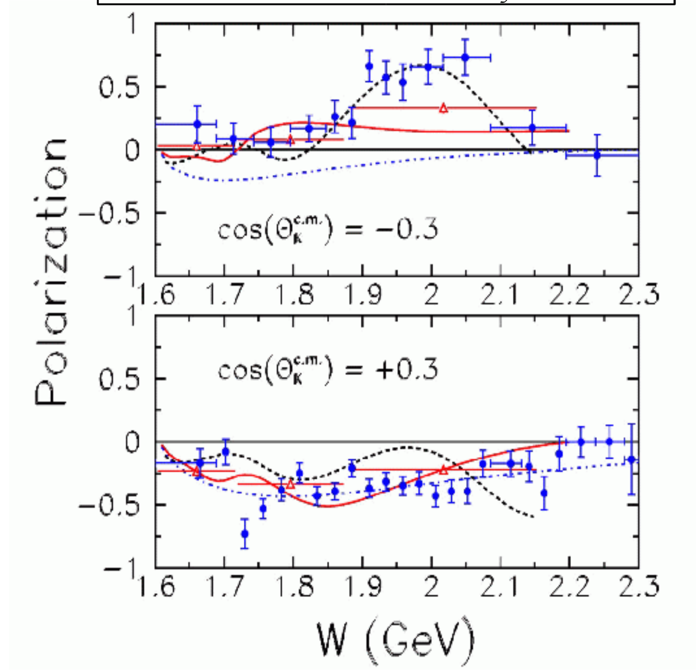
Flux tube picture: Measurement of polarization can be used to study spin alignment of ss pair

Review of CLAS K^+ ^{0} photoproduction experiments

CLAS/McNabb et al., PRC 69, 042201R (2004)



Induced recoil polarization P_y



Sensitive to interference between resonances and background

Bump at threshold from known $S_{11}(1650)$, $P_{11}(1710)$, $P_{13}(1720)$

Structure at higher W moves with C.M. angle – interfering resonances?

Summary of Recent Fits: Operator Product Expansion PWA

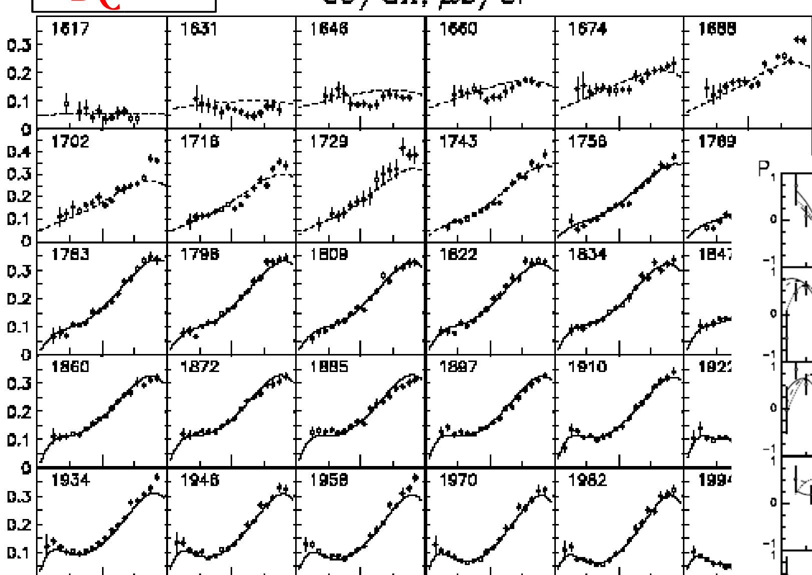
A.V. Sarantsev et al., hep-ex/0506011

Combined fit to KY, p ^{0},n $^+$,p CLAS, SAPHIR and LEPS data (d , P_y,).

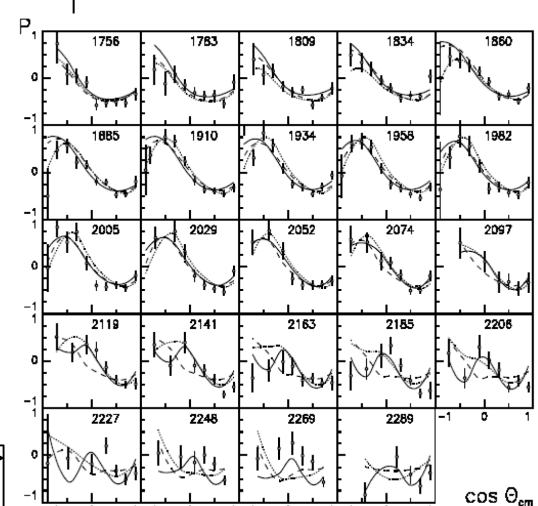
- *Analysis finds new P_{11} state at 1840 MeV, and = 140 MeV*
- *Fit also requires D_{13}(1870), D_{13}(2170)*

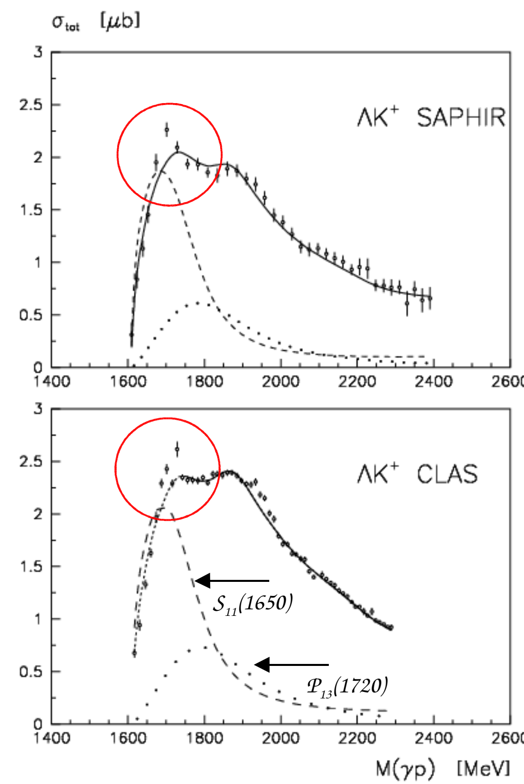
- *P_{11} state @ 1840 MeV consistent with SU(6) x O(3) symmetric quark model*
- *Inconsistent with diquark-quark symmetry*

K+ 0



Authors note sharp peak at W~1700 GeV cannot be fitted using conventional resonance parameters





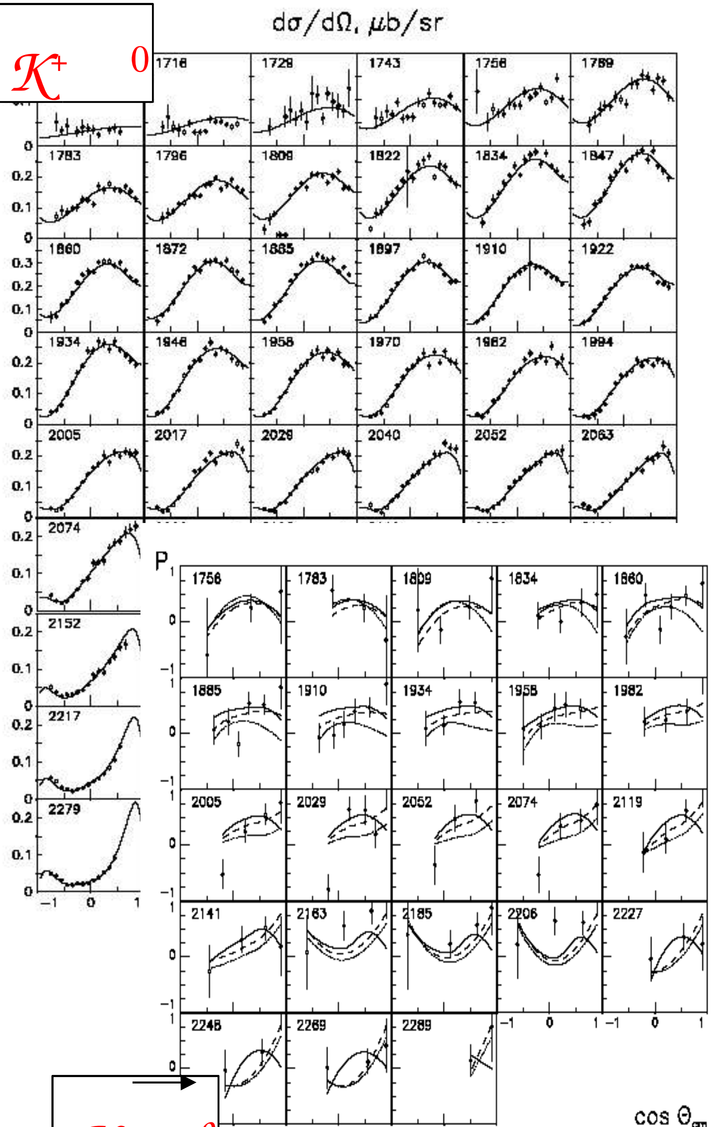
CLAS data

K+

Summary of Recent Fits: Operator Product Expansion PWA (cont'd)

A.V. Sarantsev et al., hep-ex/0506011

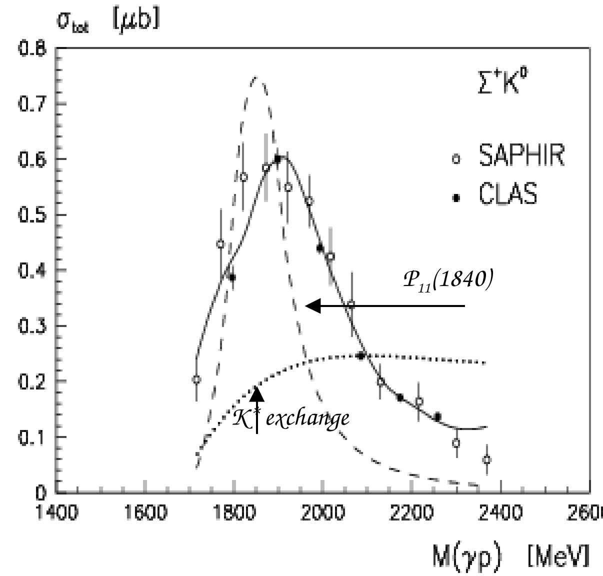
K^+ 0

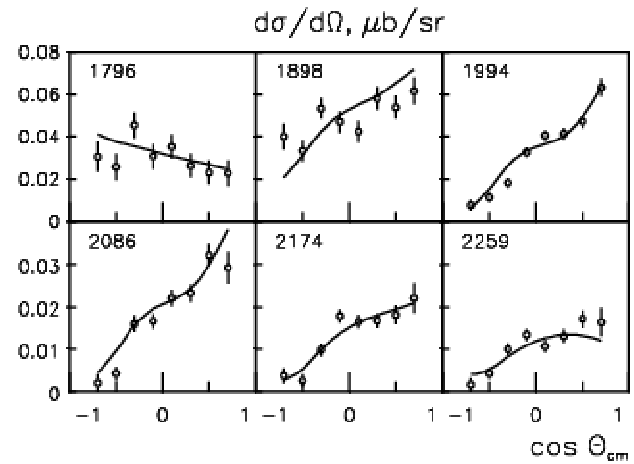


K^+ 0

K0 +

CLAS / E89-004 Bryan Carnahan (CUA)

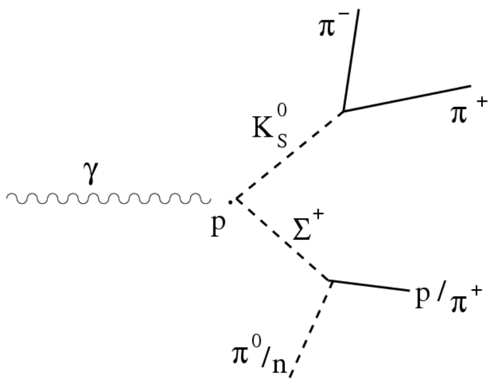




K^0 $^{+}$ photoproduction - Different isospin channel

CLAS / E89-004 Bryan Carnahan (CUA)

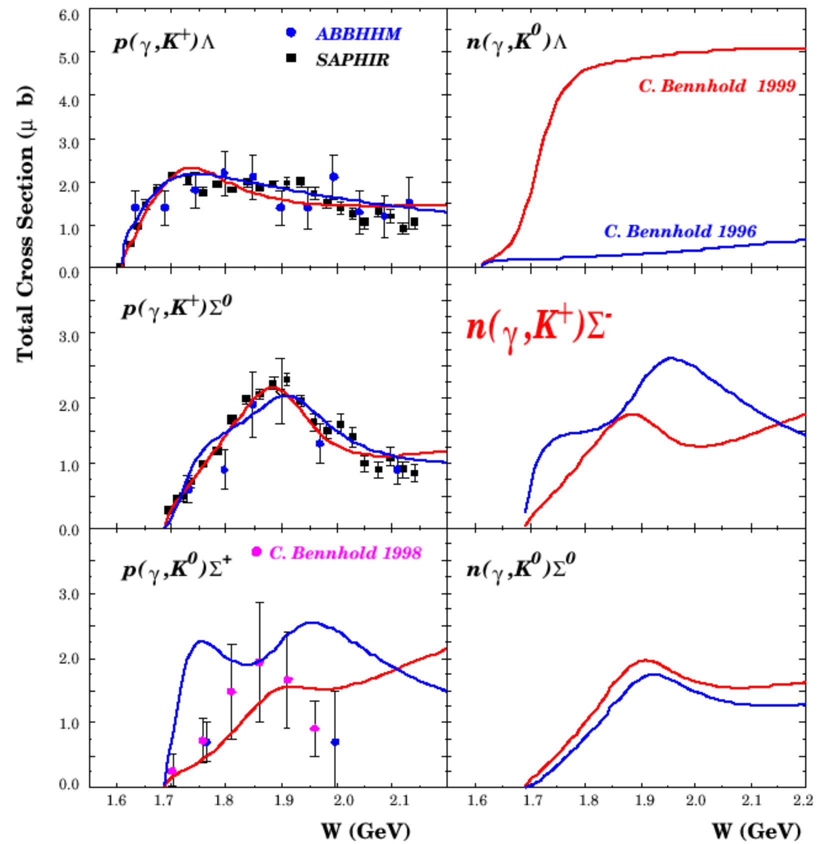
Requires measurement of 3 final state particles



Scarcity of previous measurements

	ABBHHM	SAPHIR	CLAS
Identified events	18	405	17500
Maximum photon energy	2.0 GeV	1.55 GeV	2.35 GeV

Resonances contribute with different Clebsch-Gordon weights.

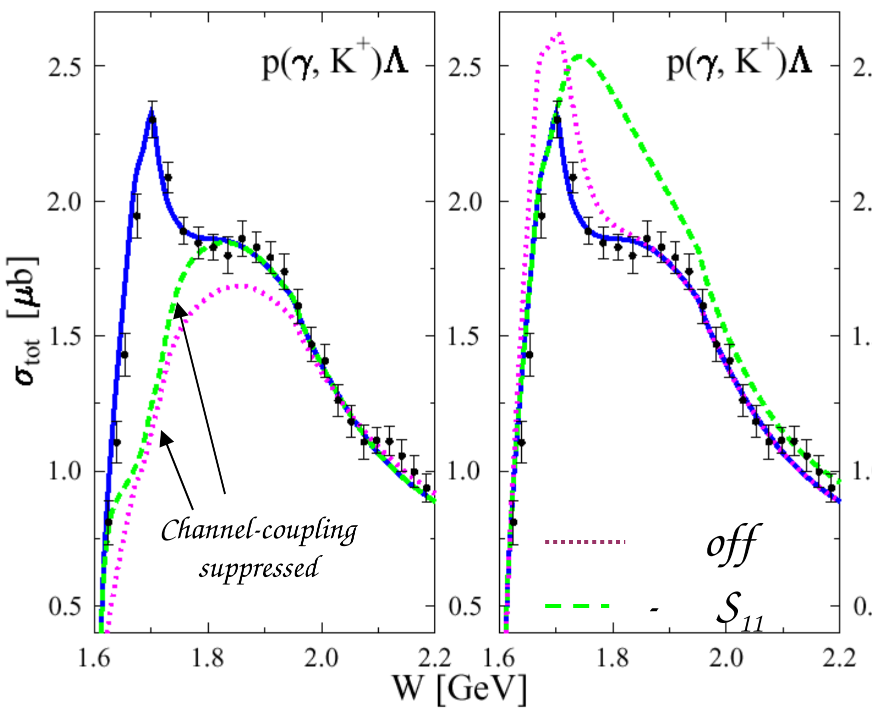


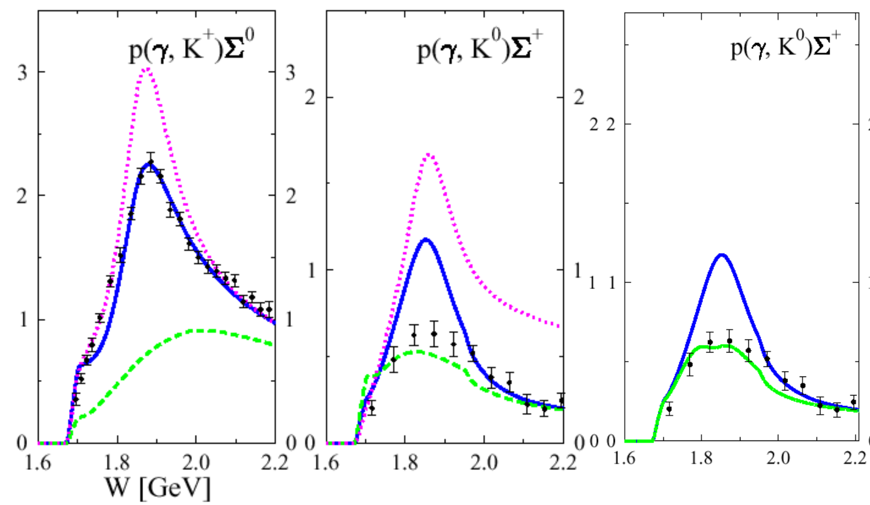
F.X. Lee, T. Mart, C. Bennhold, L.E. Wright
nucl-th/9907119 1999

Summary of Recent Fits: Coupled-Channel Analysis

A. Usov and O. Scholten, nucl-th/0503013

- *Rescattering contributions enhance cross section near threshold*
- *Cancellation from + p → + N → S_{11} → K+*
- *Peak near W=1700 dominated by + p → S_{11} → + N → K+*

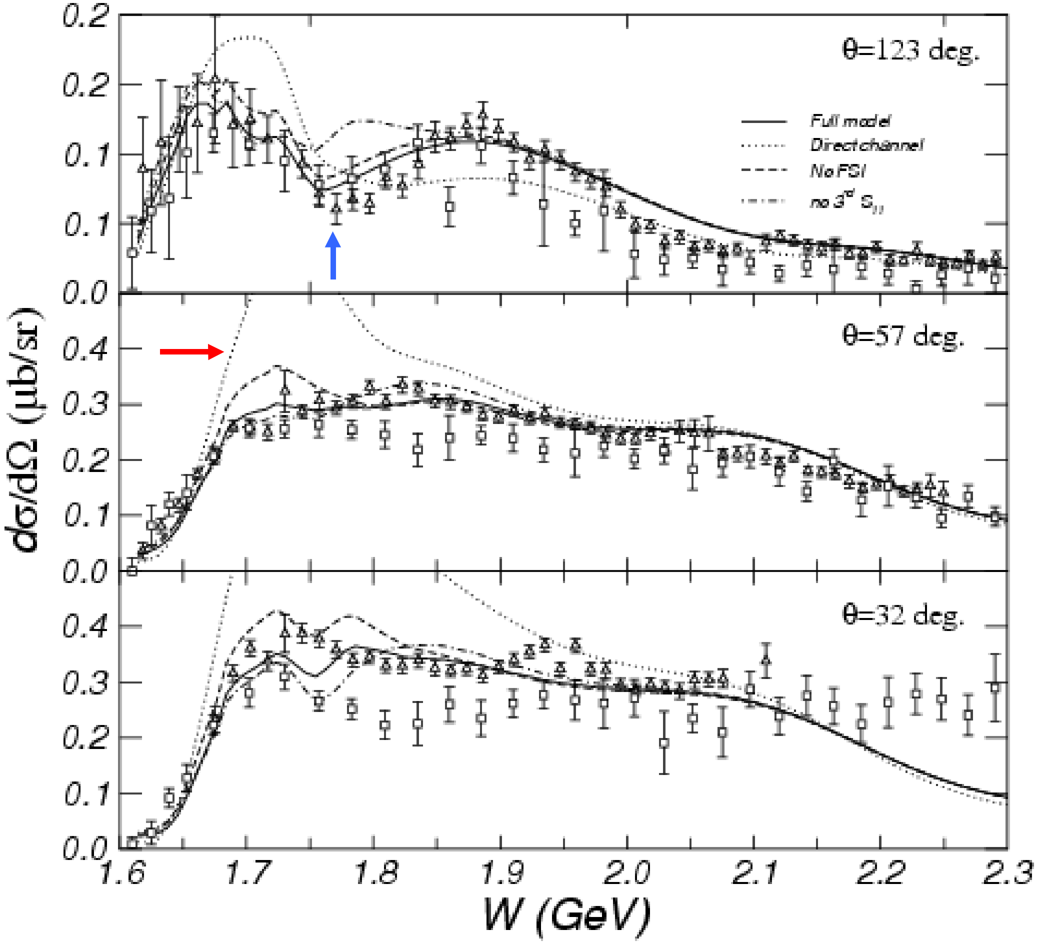




- *0/ + ratio sensitive to gauge prescription*
- *Isospin symmetry imposes strong contraints on resonance contributions*

Summary of Recent Fits: Dynamical Coupled-Channel Analysis

B. Julia-Diaz et al., nucl-th/0501005

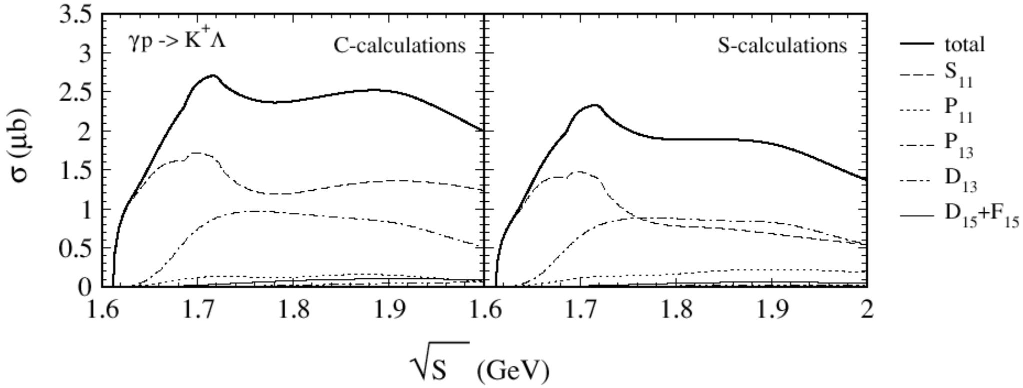


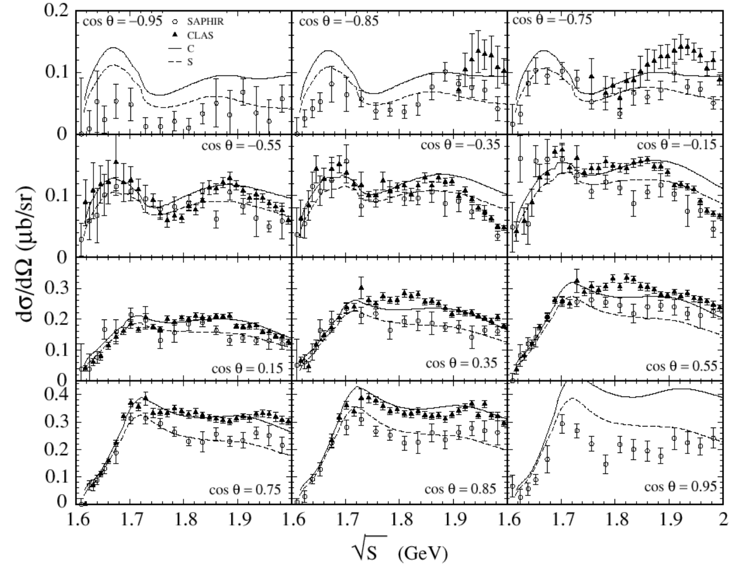
- *Coupled-channel effects from ^{0}p and ^{+}n intermediate states contribute strongly*
- *Forward angle cross section suppressed by CC near threshold*
- *Fit prefers third S_{11} state at W~1780 with ~100 MeV*

Summary of Recent Fits: Coupled-Channel Analysis

V. Shklyar et al., PRC 72, 015210 (2005)

- *Giessen model: previously fitted non-strange parameters held fixed.*
- *Separate fits to CLAS and SAPHIR K   data only*

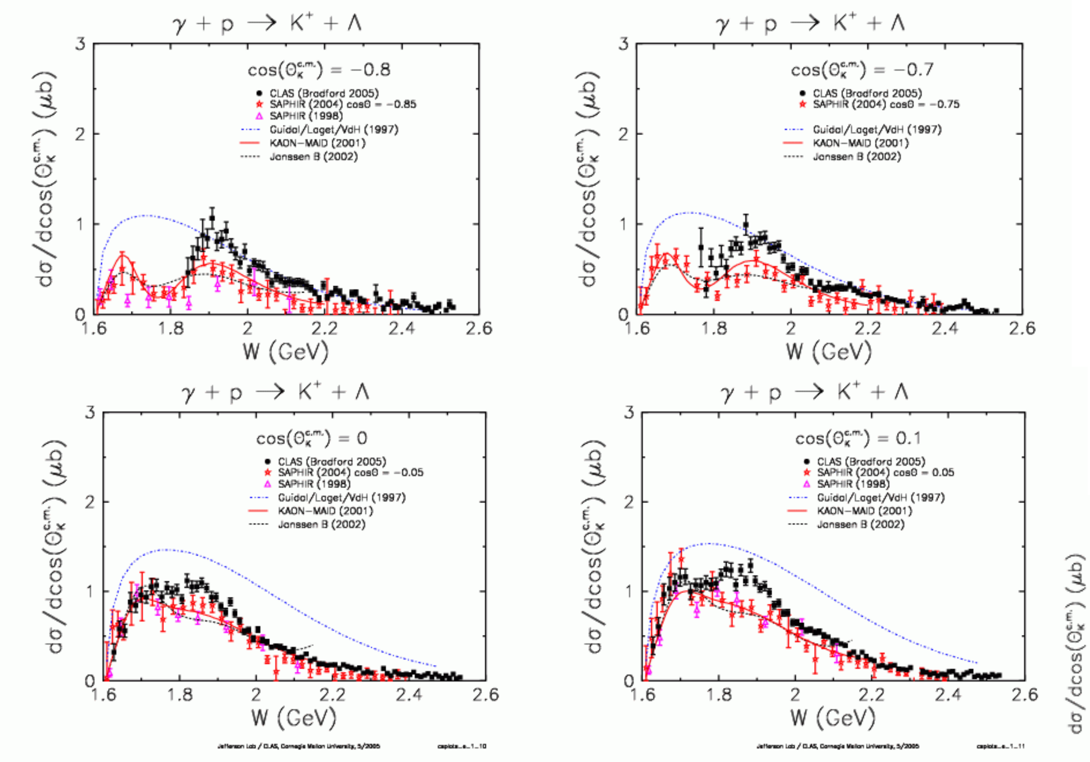




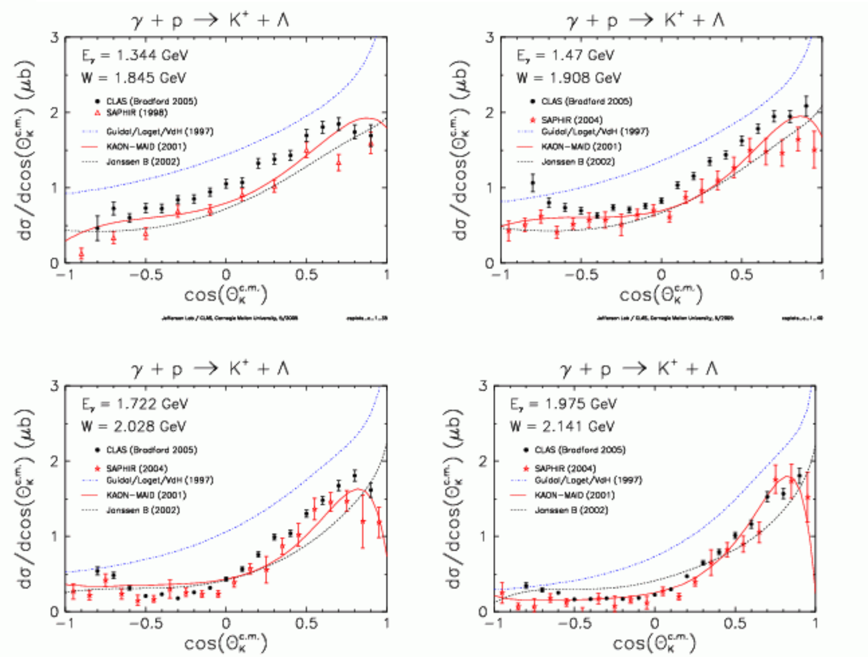
- *No effect from P_{11}(1710) , D_{13}(1890) or D_{13}(1950)*
- *CLAS fit requires more non-resonant strength in S_{11} channel*
- *P_{13} channel saturated by P_{13}(1720) and P_{13}(1900)*

K^{+} photoproduction – New CLAS 2005 data set

CLAS / E89-004 Robert K. Bradford (CMU) submitted to PRC



CLAS data more backward peaked compared to SAPHIR (u-channel contributions?)

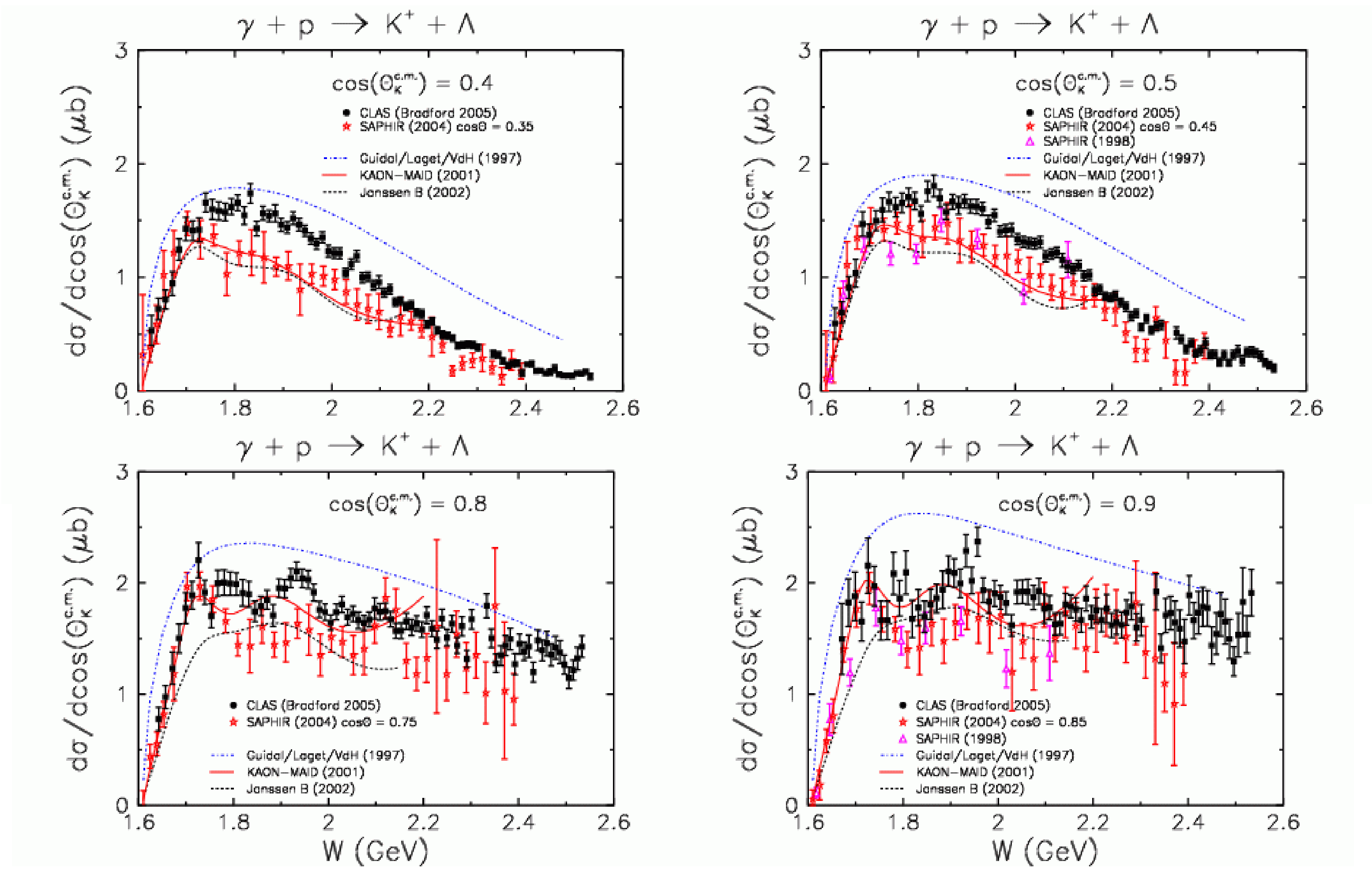


Prominent bumps around W=1.9 GeV visible at backward C.M. angles

K+ photoproduction – New CLAS 2005 data set

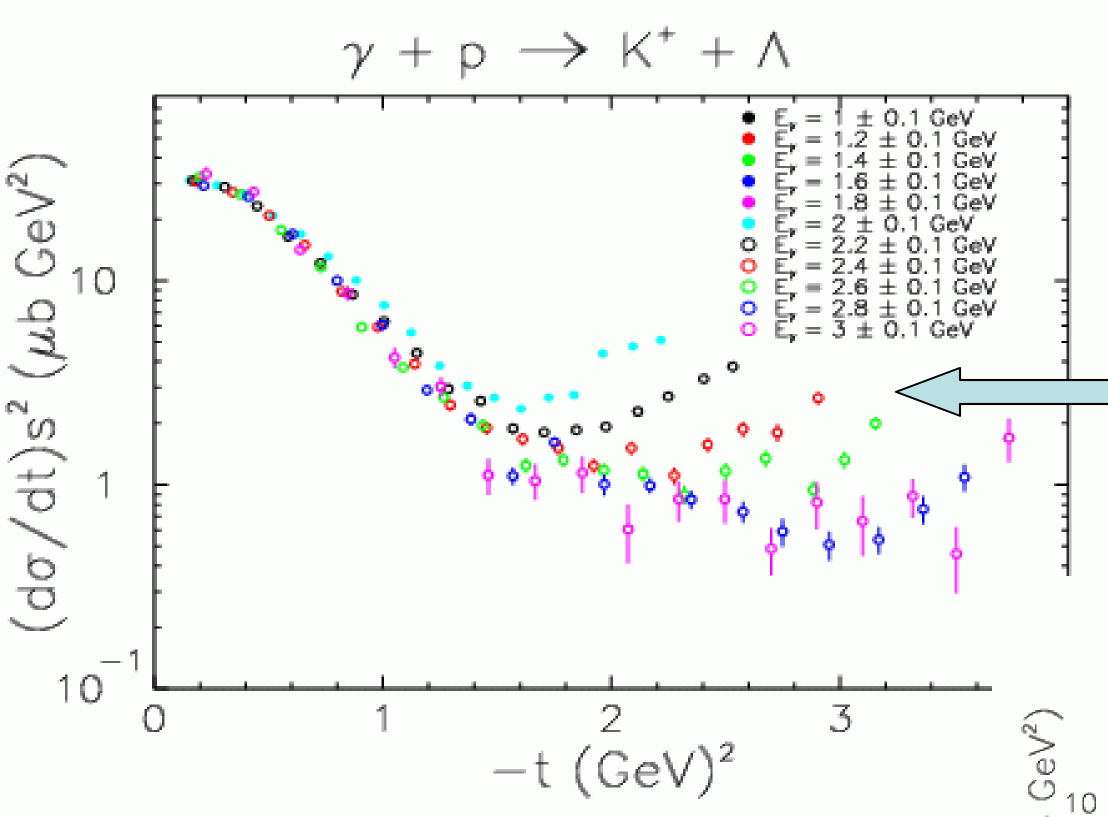
CLAS / E89-004 Robert K. Bradford (CMU)

Discrepancies between CLAS and SAPHIR K data persist.



K^+ photoproduction – New CLAS 2005 data set

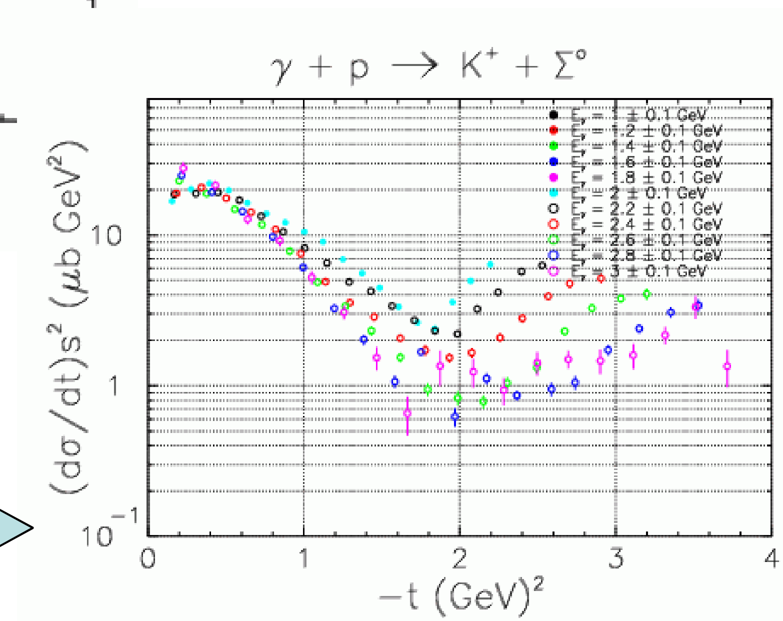
CLAS / E89-004 Robert K. Bradford (CMU)



$$\frac{d\sigma}{dt} = D(t)\left(\frac{s}{s_0}\right)^{2\alpha(t)-2}$$

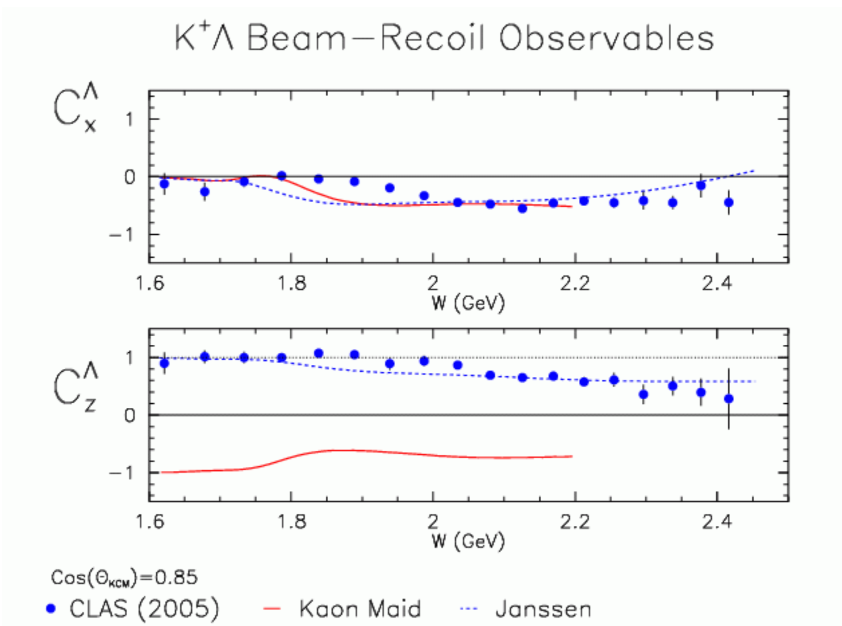
K^+ production exhibits Regge scaling up to –t~1.5

Some t-channel scaling evident for ^{0}, but isobars can contribute in s-channel

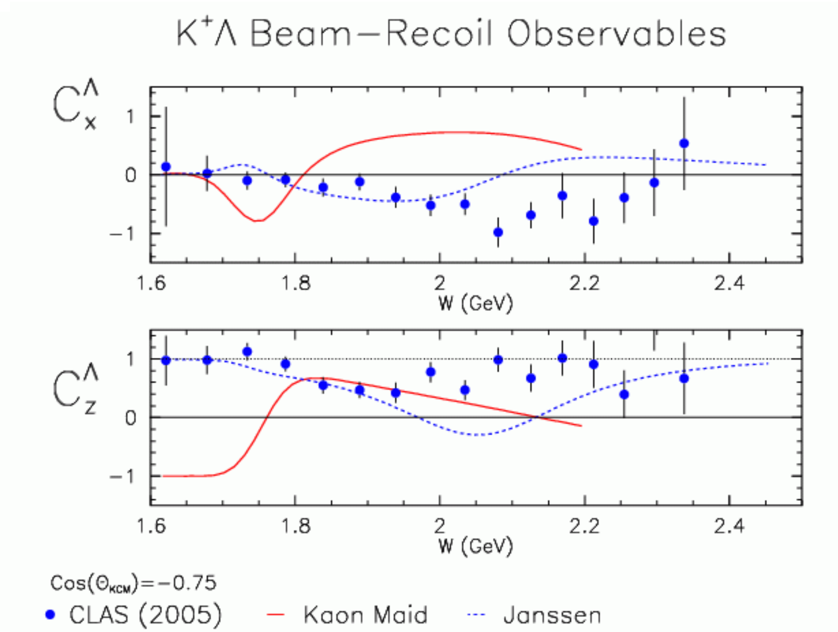


K^+ photoproduction – New CLAS 2005 data set

CLAS / E89-004 Robert K. Bradford (CMU)

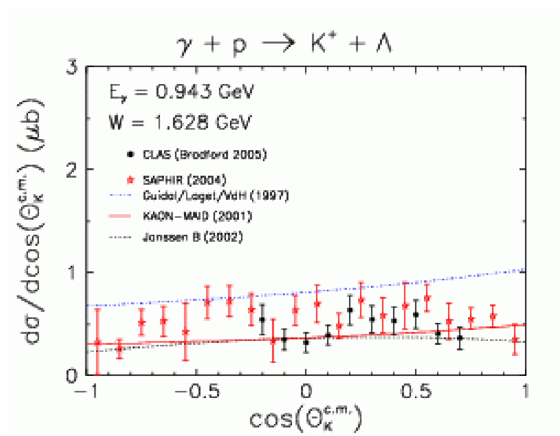


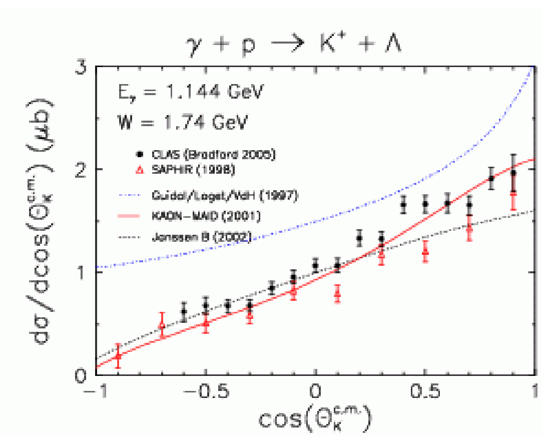
Forward c.m. angles



Backward c.m. angles

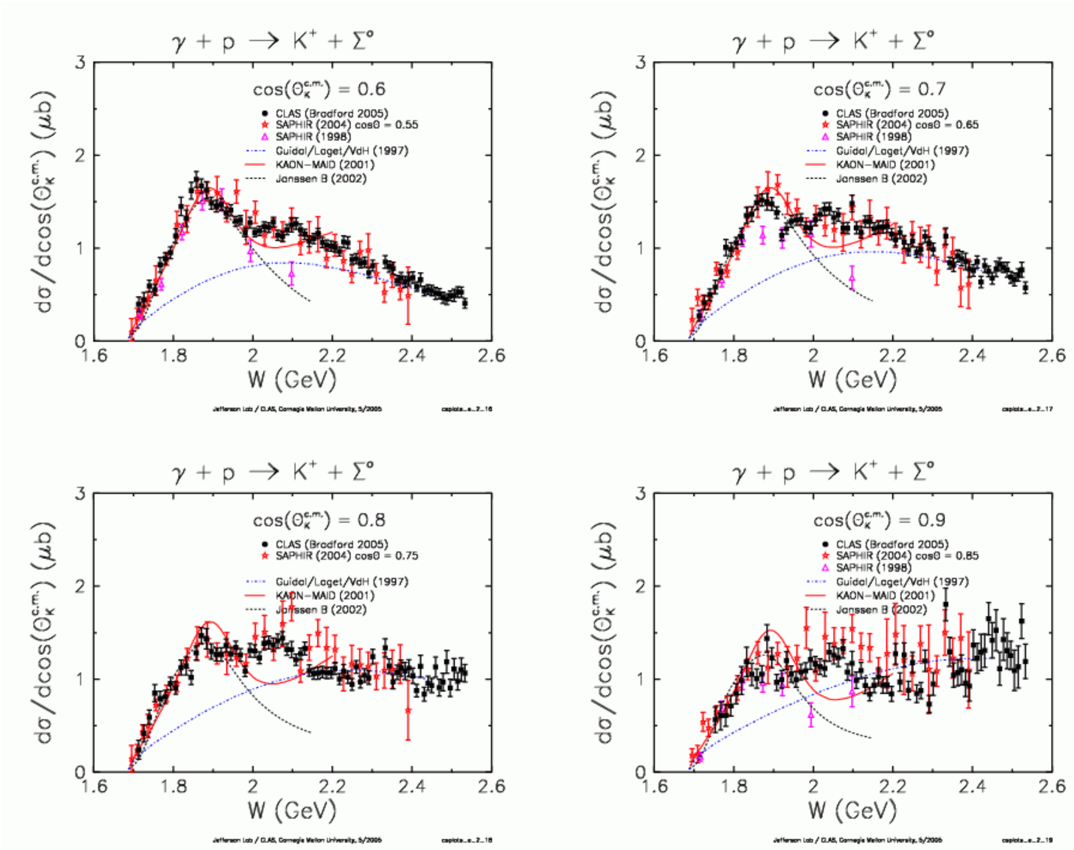
$C_z = +1$: maximally polarized along photon beam direction !

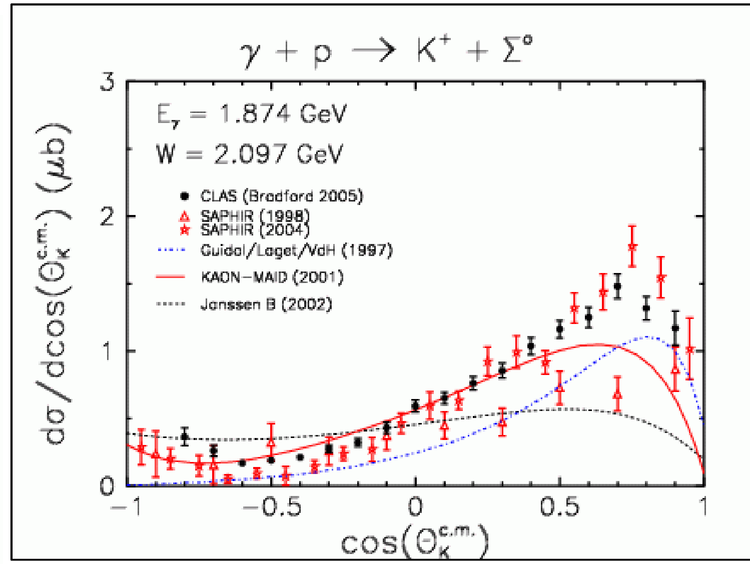


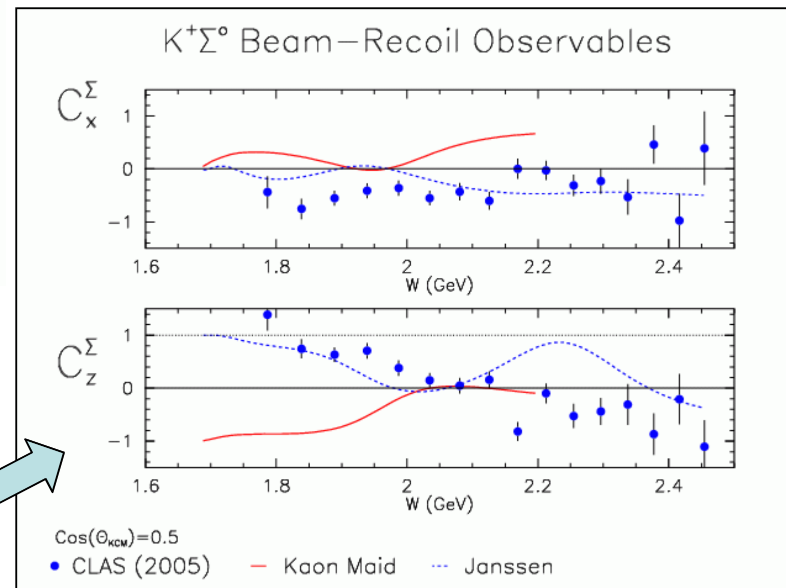


K^+ ^{0} photoproduction – New CLAS 2005 data set

CLAS / E89-004   Robert K. Bradford (CMU)







Possible bump near W=2 GeV

Zero crossing in C_z

Exp. E-02-112

Search for missing Nucleon Resonances

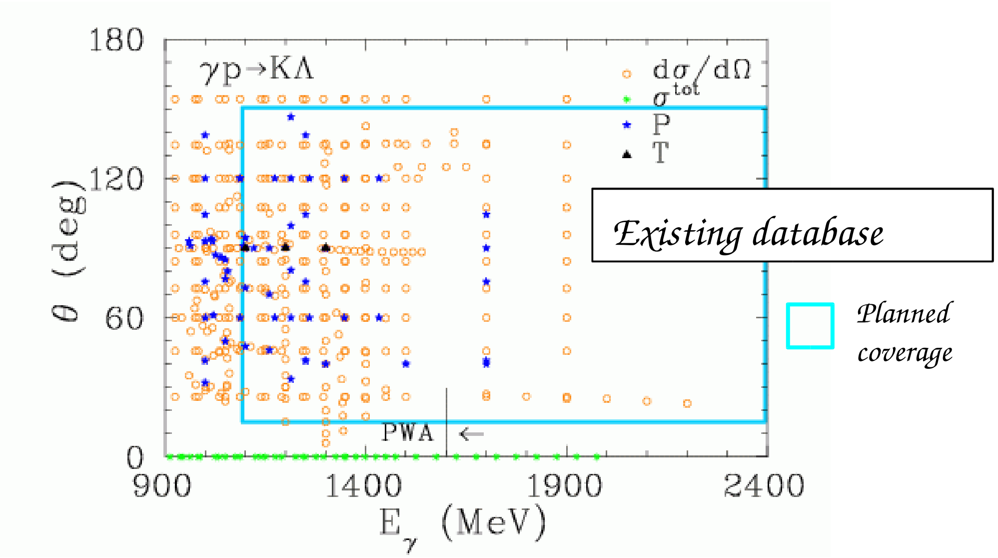
in the Photoproduction of Hyperons

using a Polarized Photon Beam

and a Polarized Target

F.J. Klein[1 2], H. Crannell, R. Hakobyan, D.I. Sober
The Catholic University of America, Washington, DC 20064
L. Todor[1], R. Schumacher
Carnegie Mellon University, Pittsburgh, PA 15213
P. Eugenio[1], S. McAleer, A. Ostrovidov
Florida State University, Tallahassee, FL 32306
W.J. Briscoe, I. Strakovsky, S. Strauch, R. Workman
The George Washington University, Washington, DC 20052
J.C. Sanabria
Universidad de los Andes, A.A. 4976, Santafé de Bogotá, Colombia
E. Pasyuk
Arizona State University, Tempe, AZ 85287
C. Djalali, A. Dzyubak, D. Tedeschi, M. Wood
University of South Carolina, Columbia, SC 29208
P.L. Cole
University of Texas at El Paso, El Paso, TX 79968
D. Jenkins
Virginia Polytechnic Institute, Blacksburg, VA 24061
D.G. Crabb
University of Virginia, Charlottesville, VA 22901
+
The CLAS Collaboration

[1]Co-Spokesperson
[2]Contact person



CLAS-g1: d /dΩ, P, C_x, C_z

CLAS-g8: , O_x, O_z

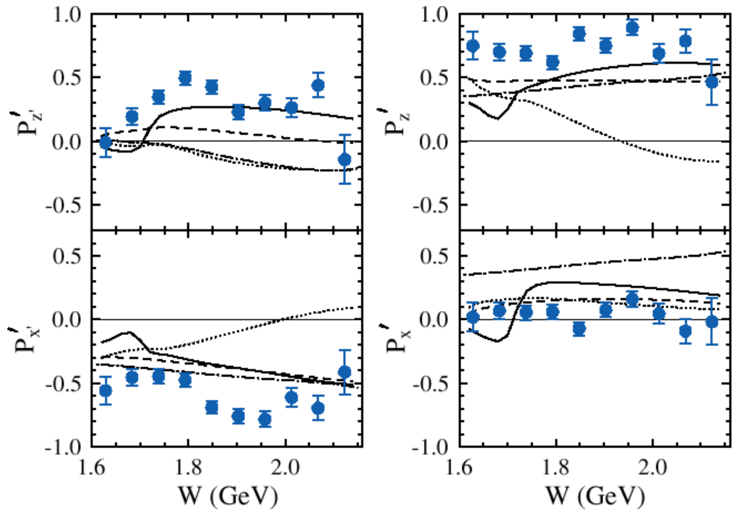
E-02-112: T, E, H, T_x, T_z, L_x, L_z

Full set of observables will be measured for first time, permitting model independent PWA.

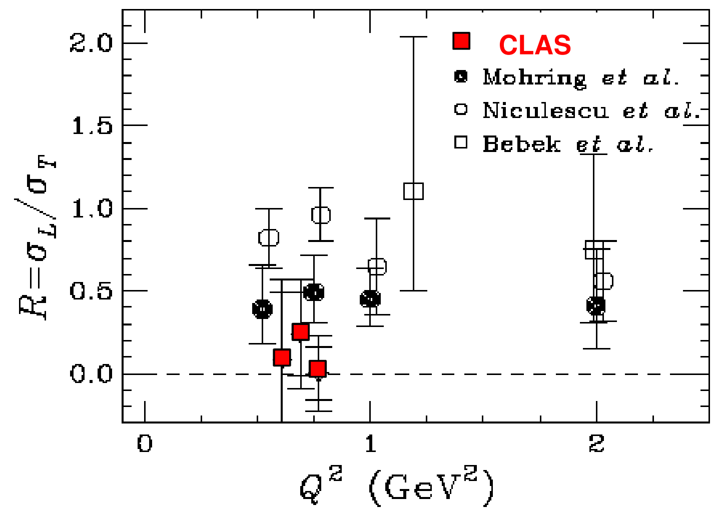
First experiments scheduled in 2007-2008

K^+ Electroproduction : Spin Polarization Transfer

Carman et al., PRL 90, 131804 (2003)

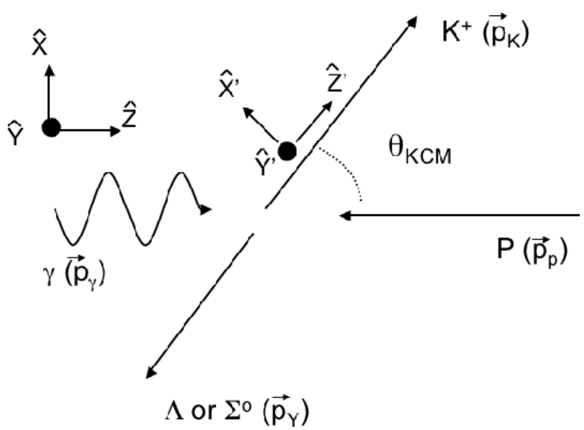


Raue and Carman, PRC 71, 065209 (2005)



Systematically smaller R compared to Hall C Rosenbluth separation

*polarized almost maximally along **



Parallel kinematics

$$R_\sigma = \frac{\sigma_L}{\sigma_T} = \frac{1}{\epsilon}\left(\frac{c_0}{\mathcal{P}'_{z'}} - 1\right)$$

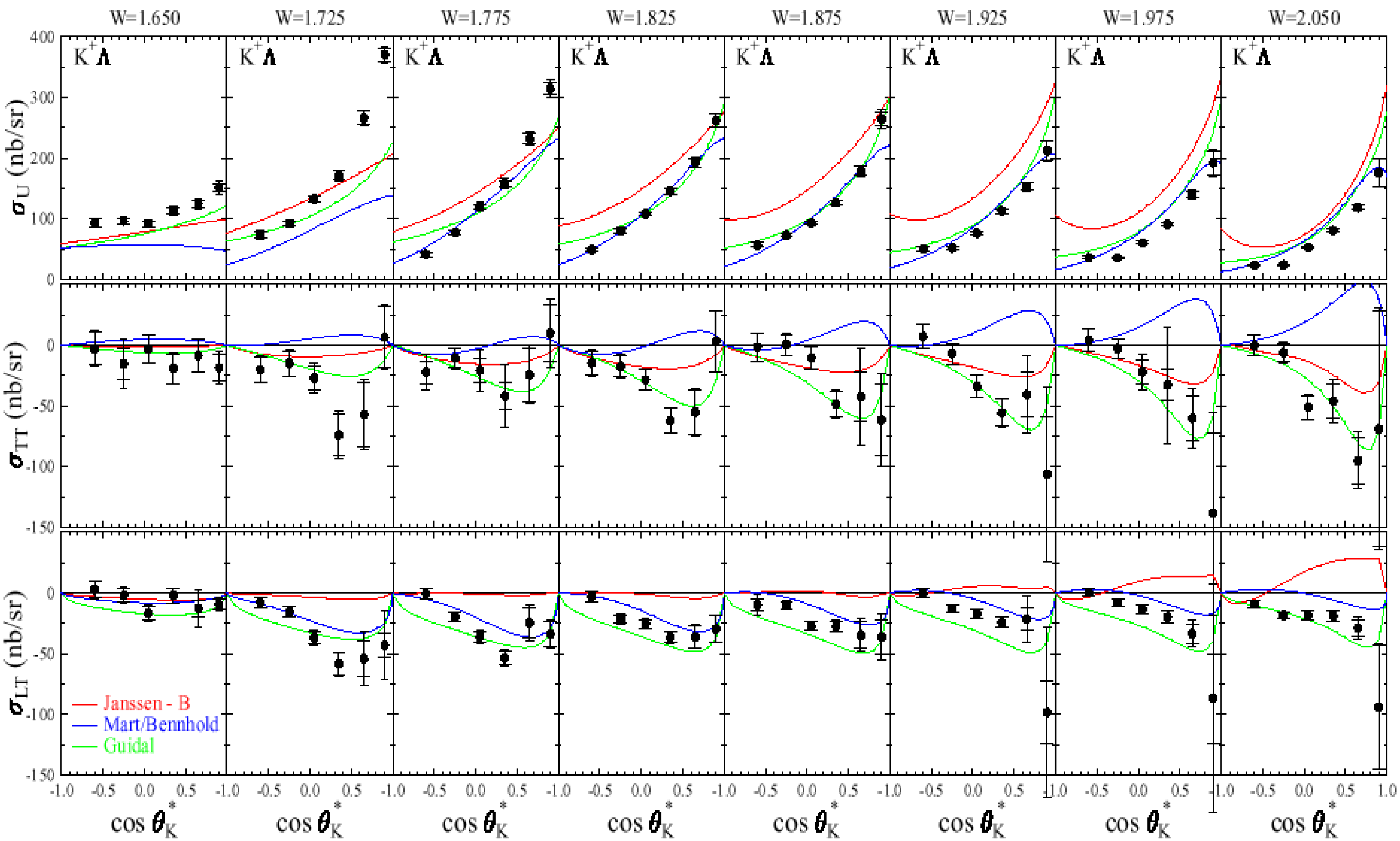
$$\mathcal{P}'_{x'} = \frac{c_0 R^{x'0}_{TT'}}{R^{00}_T + \epsilon_L R^{00}_L}, \qquad \mathcal{P}'_{z'} = \frac{c_0 R^{z'0}_{TT'}}{R^{00}_T + \epsilon_L R^{00}_L},$$

$$\mathcal{P}'_x = \frac{c_-\left({}^{c}R^{x'0}_{LT'}\cos\theta^*_K - R^{y'0}_{LT'} + {}^{s}R^{z'0}_{LT'}\sin\theta^*_K\right)}{R^{00}_T + \epsilon_L R^{00}_L},$$

$$\mathcal{P}'_z = \frac{c_0\left(-R^{x'0}_{TT'}\sin\theta^*_K + R^{z'0}_{TT'}\cos\theta^*_K\right)}{R^{00}_T + \epsilon_L R^{00}_L}.$$

K^+ electroproduction – Structure functions vs cos θ^* at Q^2=0.65

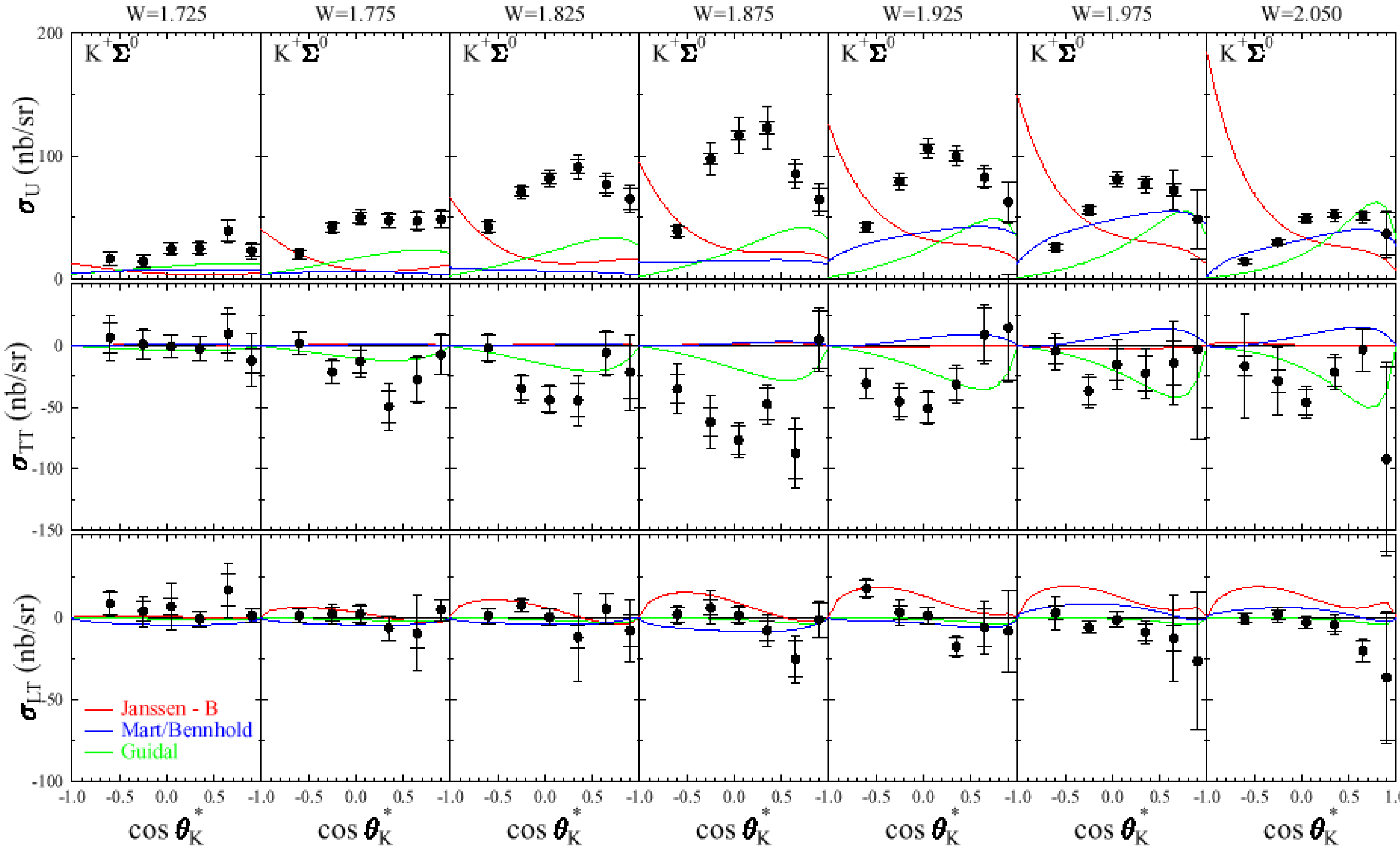
CLAS / E00-112 Pavel Ambrozewicz (CMU)



Strong forward peaking for $\sigma_{U'}$ σ_{TT} and σ_{LT}

*K+ 0 electroproduction – Structure functions vs cos * at Q^2=0.65*

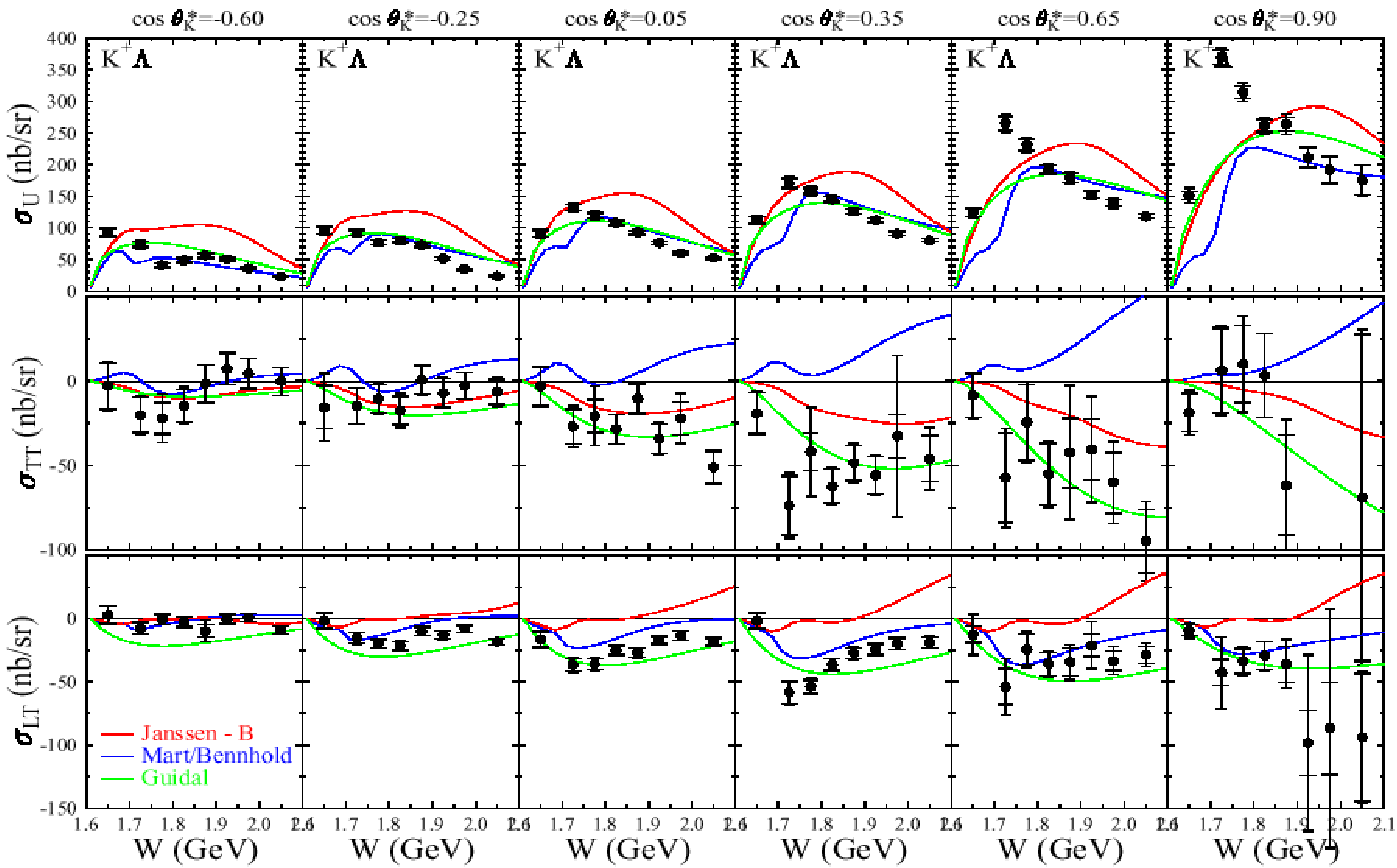
CLAS / E00-112 Pavel Ambrozewicz (CMU)



$_{LT}$ structure function for ^{0} production is consistent with zero.

K^+ electroproduction – Structure functions vs W at Q^2=0.65

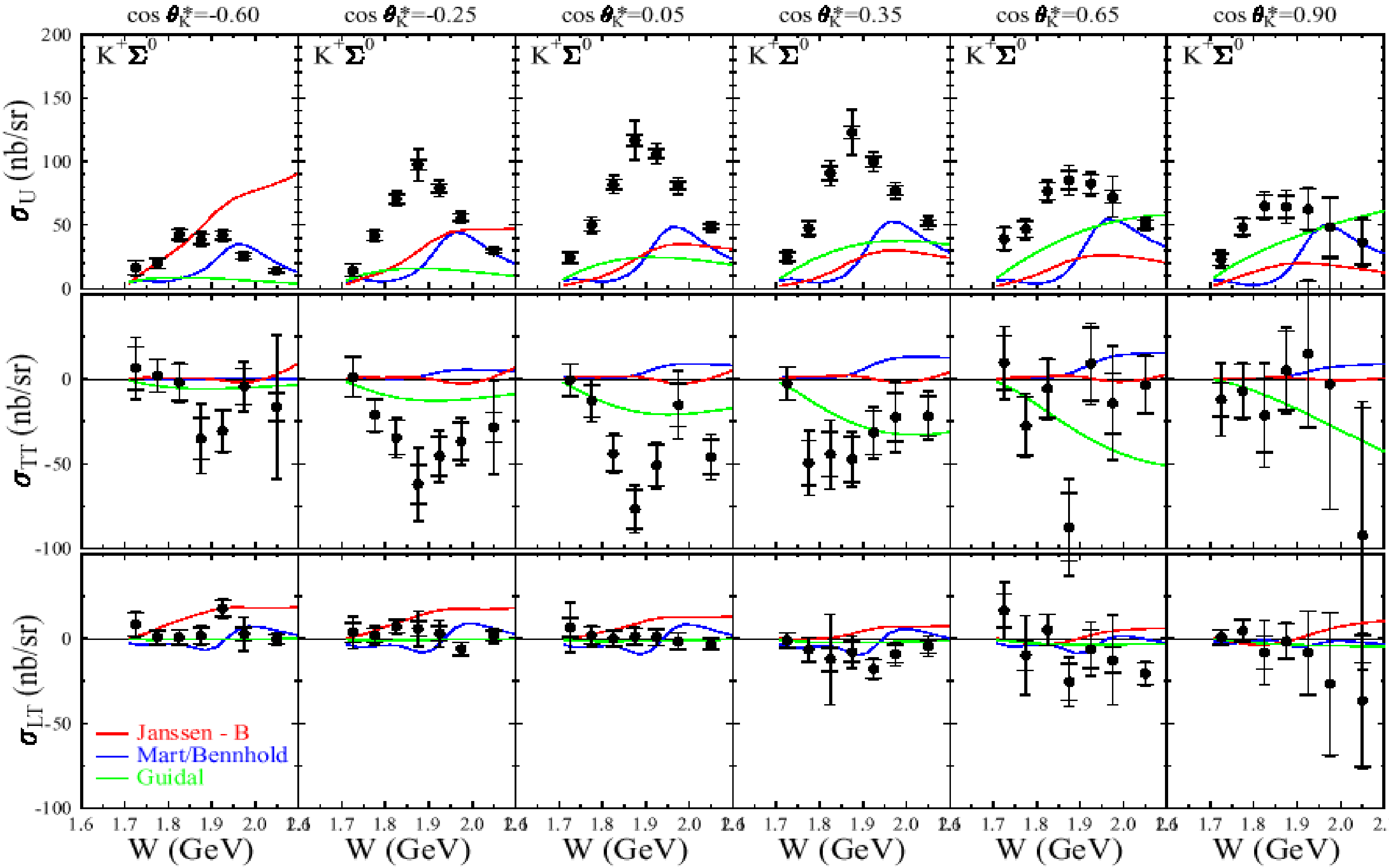
CLAS / E00-112 Pavel Ambrozewicz (CMU)



Strong enhancement in σ_U at forward angles around W=1.7 not seen in models

$K^+ \Sigma^0$ electroproduction – Structure functions vs W at Q^2=0.65

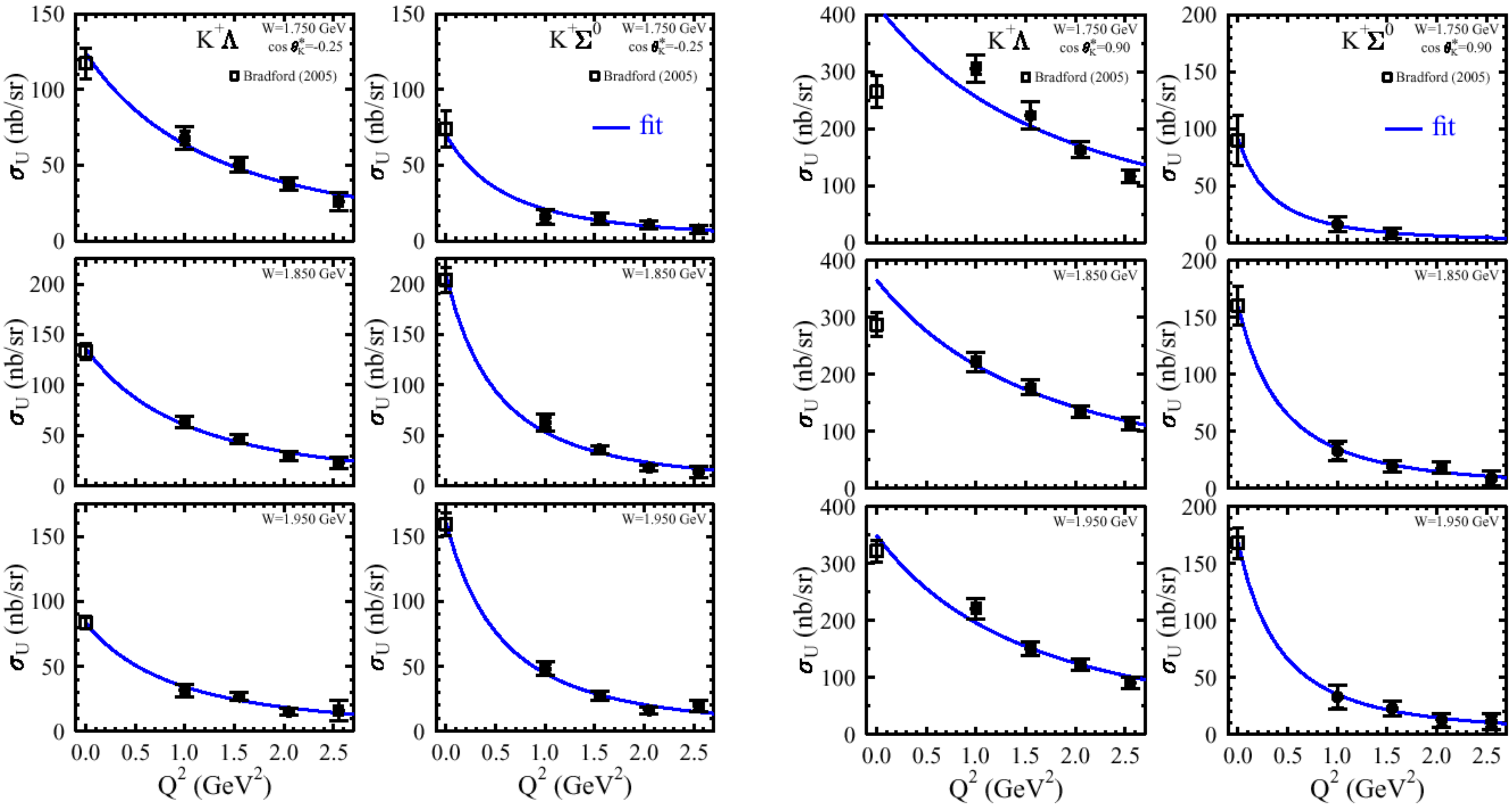
CLAS / E00-112 Pavel Ambrozewicz (CMU)



Models clearly should be refitted to these new data

K^+ , K^+ ^{0} electroproduction – Q^2 Dependence

CLAS / E00-112 Pavel Ambrozewicz (CMU)

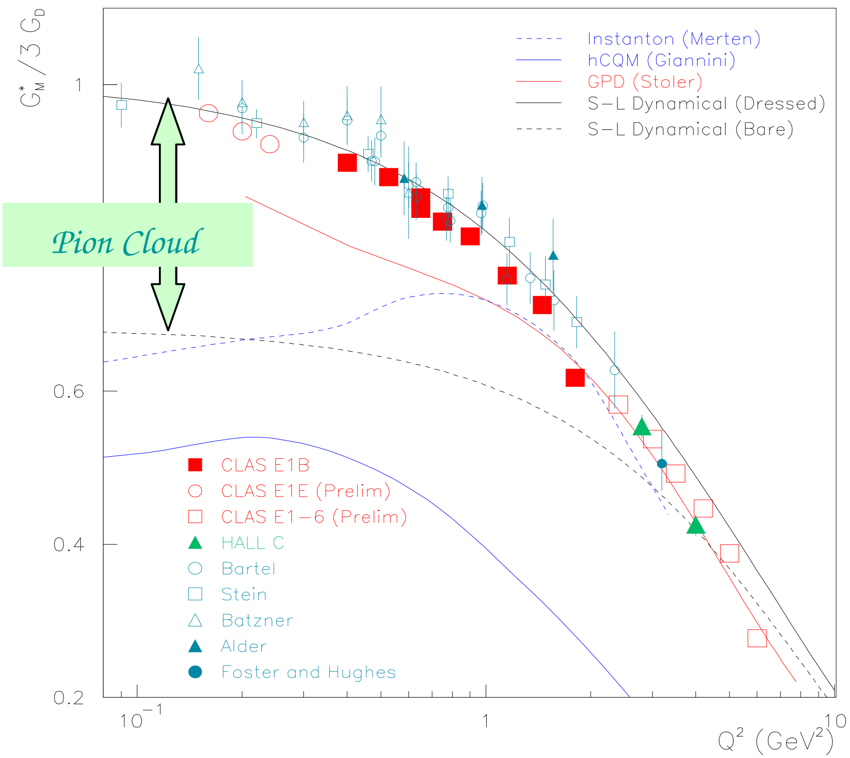


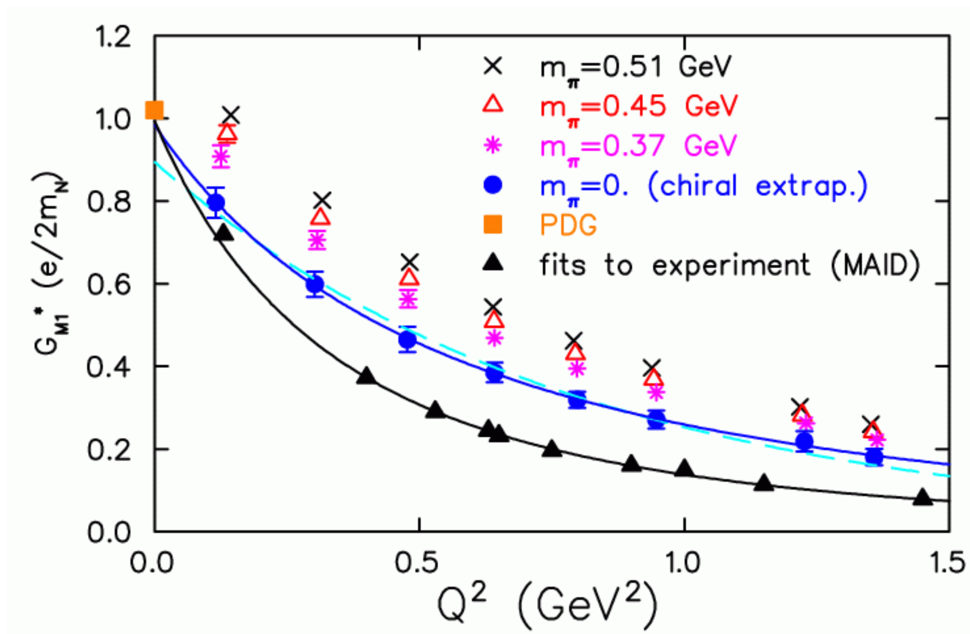
More rapid falloff for K^+ ^{0}

*p→ (1232) Magnetic Dipole Transition Form Factor

Sato,Lee PRC 63, 055201 (2001)

C. Alexandrou et al, PRL, 94, 021601 (2005)

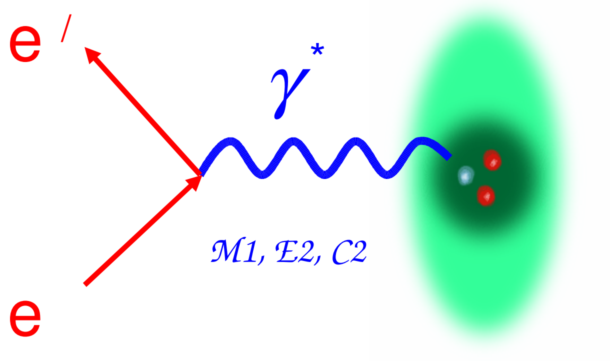


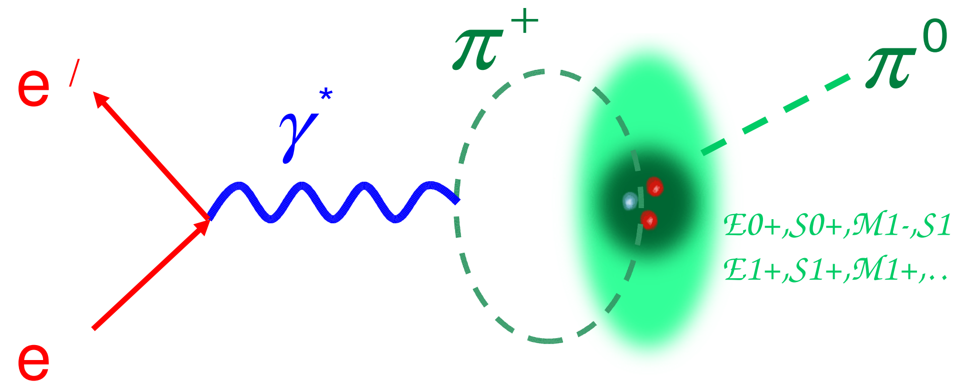


Dynamical models: Strong contribution from pion cloud rescattering at low Q^2.

Quenched Lattice: Agrees with data near Q^2=0, falls more slowly than data for Q^2 > 0

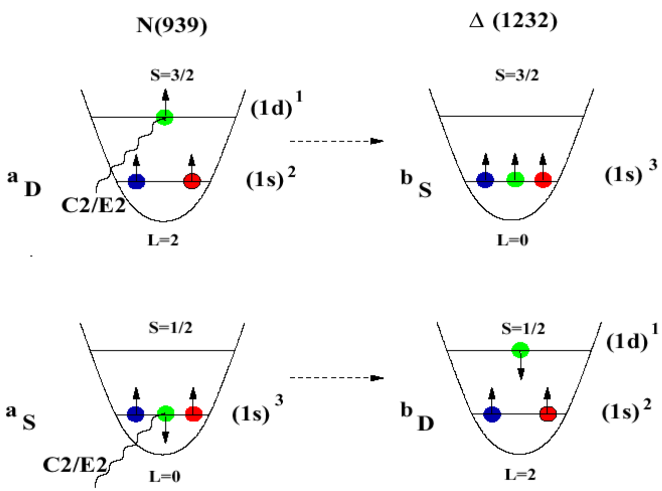
What are we probing at low Q^2 ?





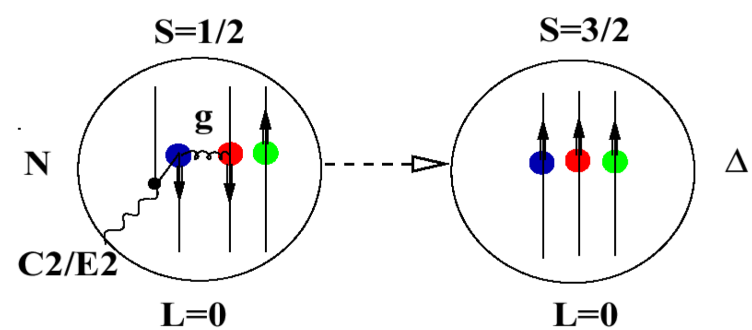
Short Range Physics?

- *Gluon exchange → D-state admixtures*
- *Deformation of N/*

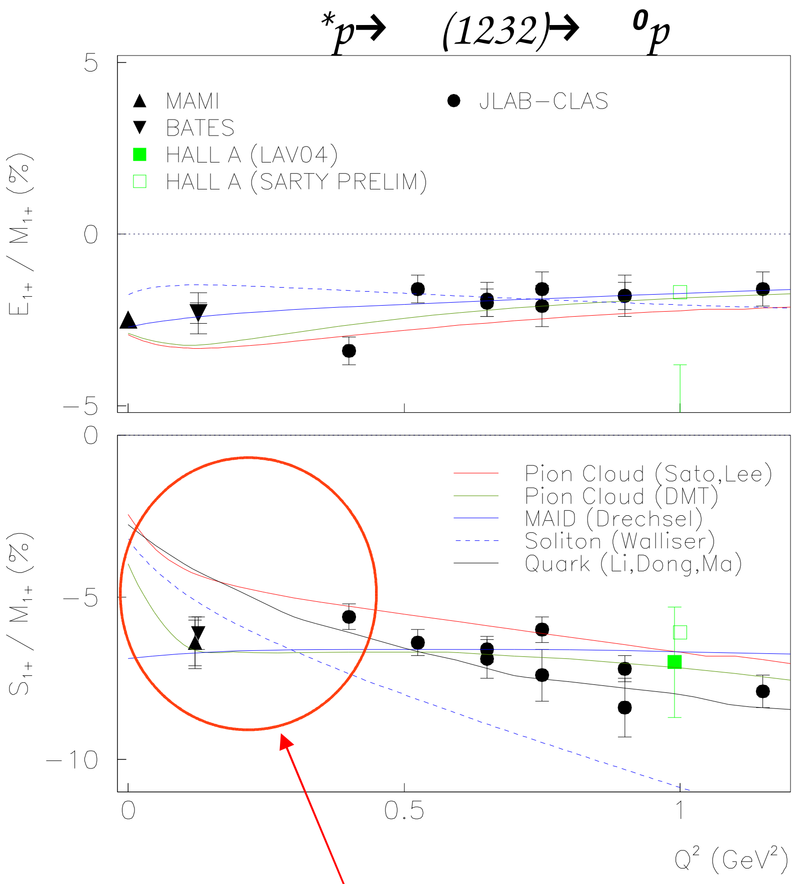


Long Range Physics?

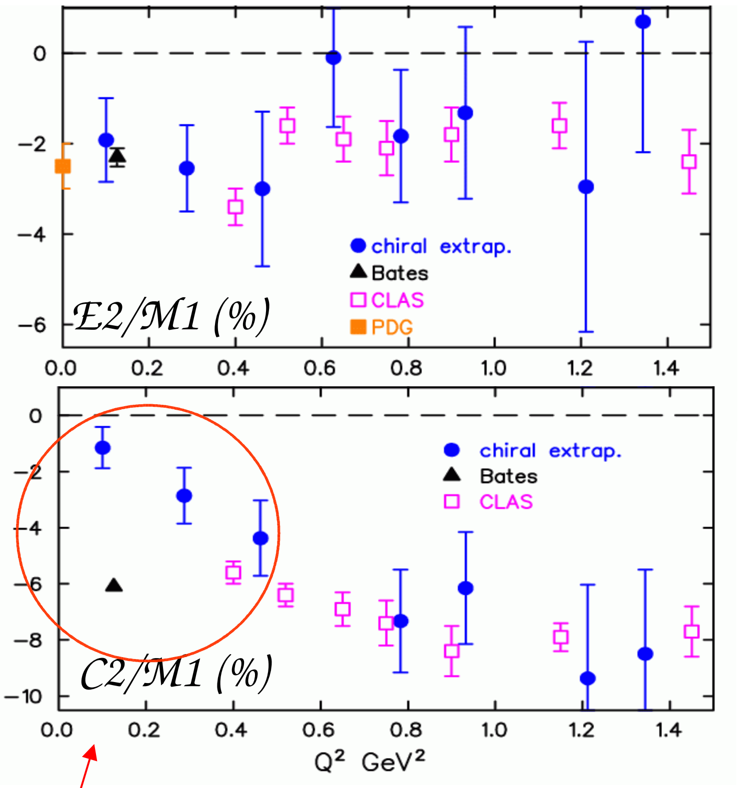
- *Coupling to pion cloud*
- *2-body currents*



Quadrupole Transition – Lattice QCD vs. Pion Cloud Models



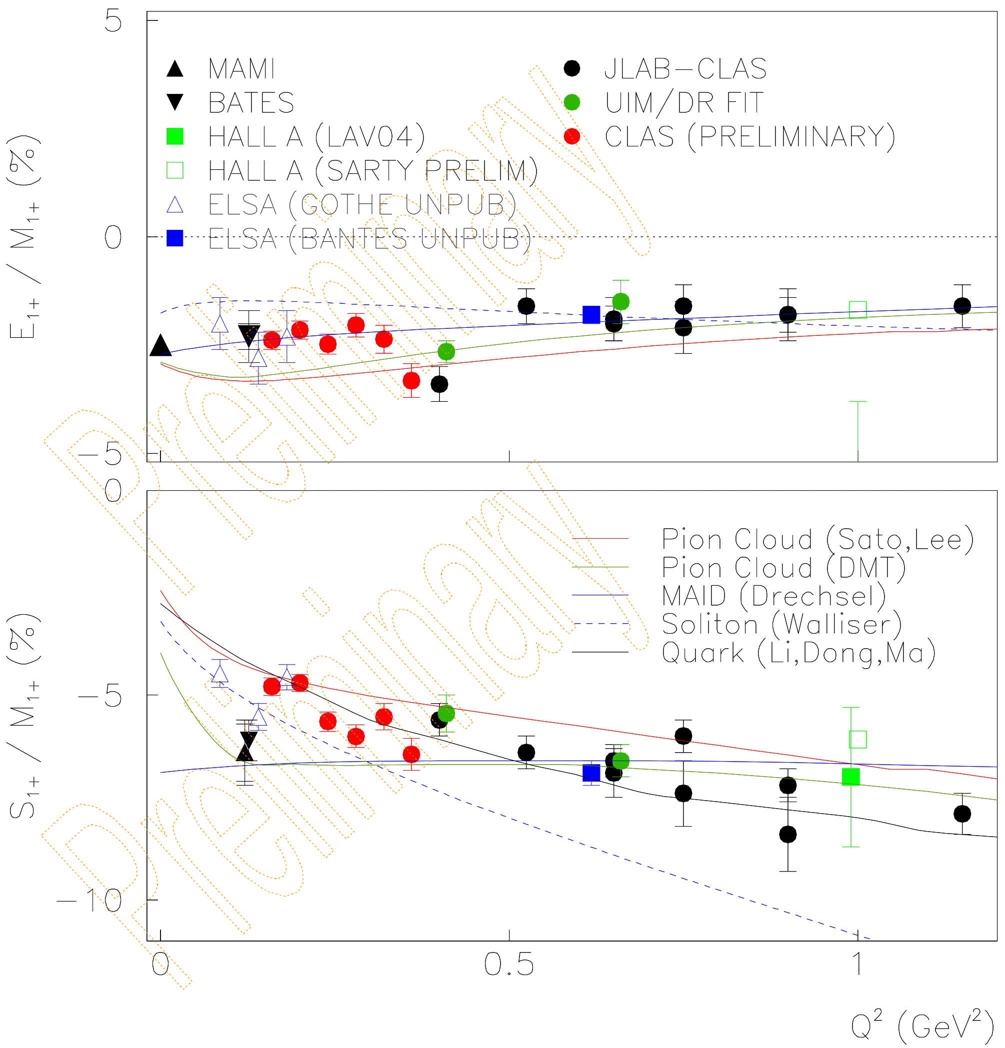
C. Alexandrou et al, PRL, 94, 021601 (2005)



Low Q^2 behavior of C2/M1 strong test of calculations !

Preliminary CLAS Results for REM and RSM

CLAS / E89-112   C. Smith (UVA)

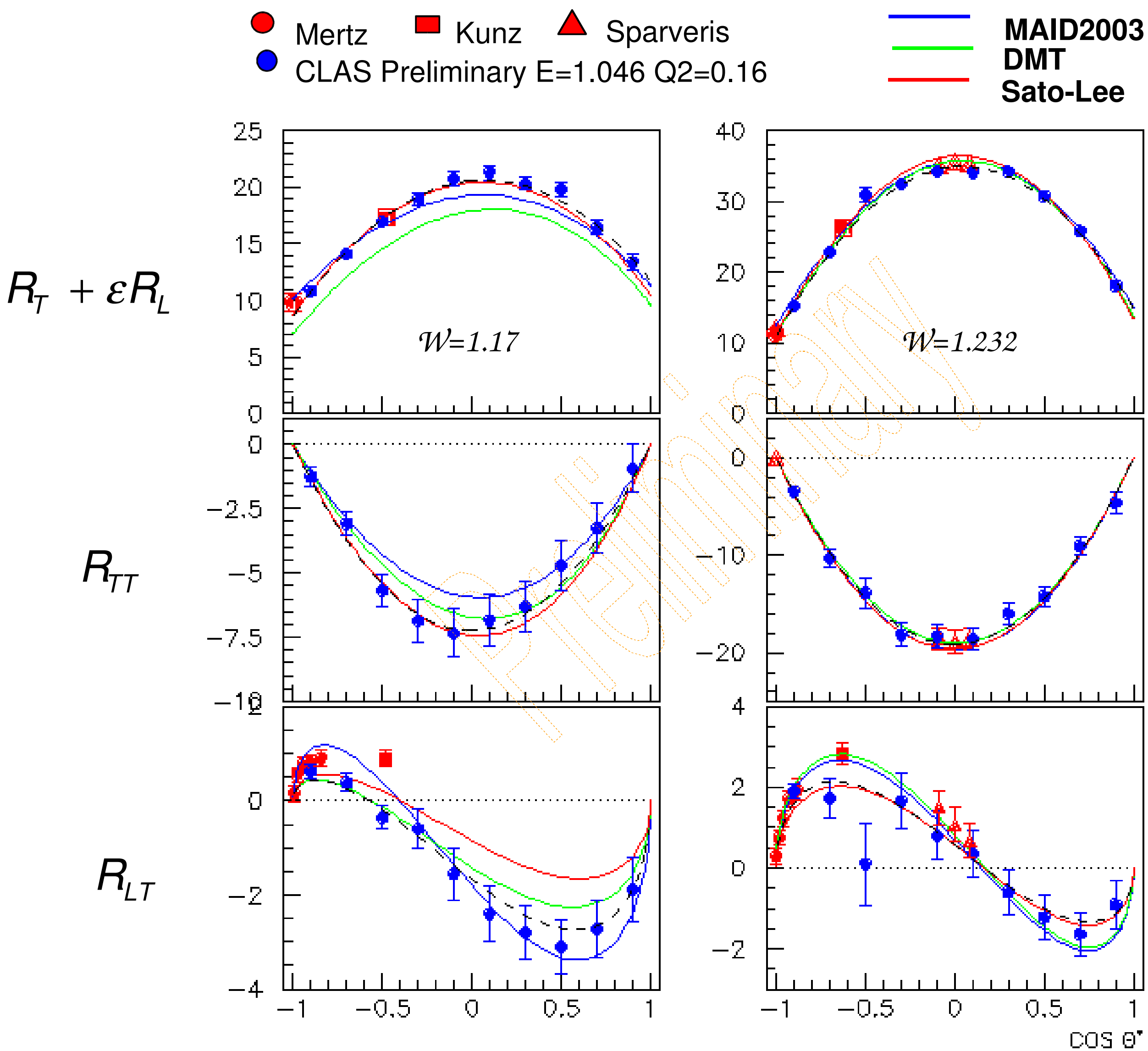


Still unclear whether apparent dip in S1+/M1+ at low Q^2 is real.

Reanalysis of ELSA low Q^2 points in progress.

(R. Gothe, private comm.)

Response at (1232) peak - Comparison to Bates at Q^2=0.127 GeV^2



Model variation negligible between Q^2=0.127 and 0.16.

Good agreement between Bates and CLAS for T+L and TT measurements.

Disagreement with Kunz point (■) for LT.

Global fit (-----) favors Sato-Lee model at W=1.232.

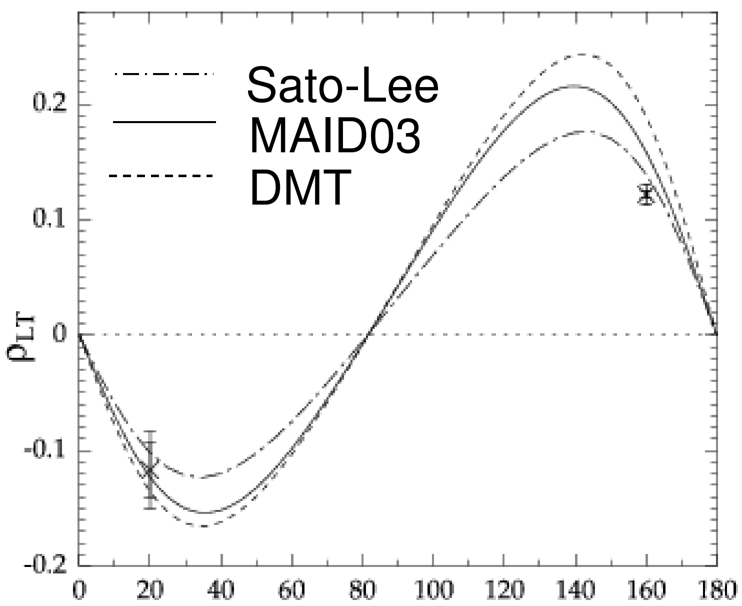
MAMI experiment: LT-asymmetry at Q^2=0.2 GeV^2

D. Elsner nucl-ex/05?

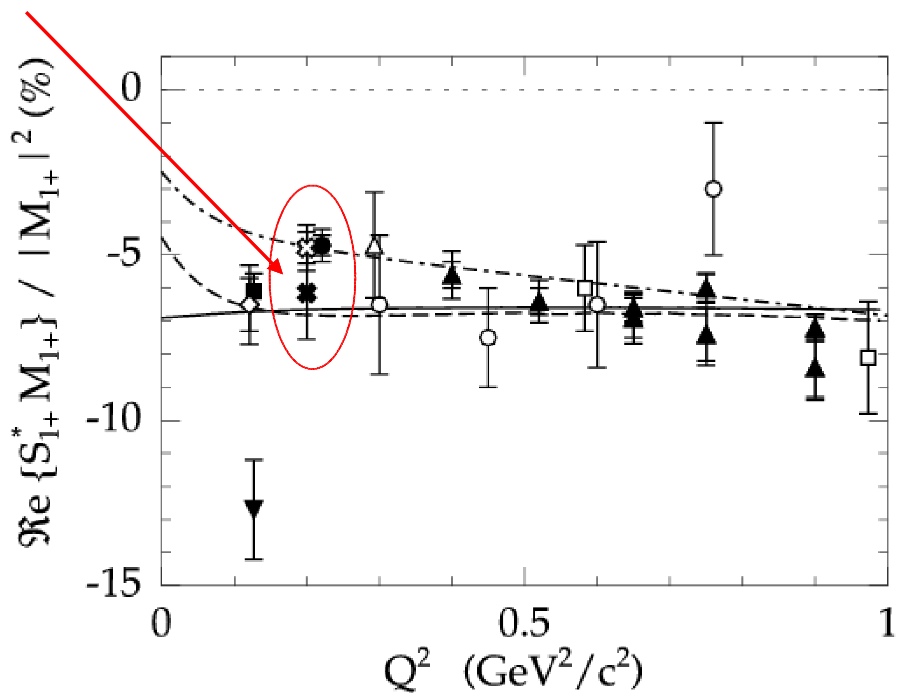
$$\rho_{LT}(\theta_{\pi^0}^{cm}) := \frac{\sigma_v(\phi=0^\circ) - \sigma_v(\phi=180^\circ)}{\sigma_v(\phi=0^\circ) + \sigma_v(\phi=180^\circ)} = \frac{\sqrt{2\epsilon_L(\epsilon+1)}\sigma_{LT}}{\sigma_T + \epsilon_L\sigma_L + \epsilon\sigma_{TT}}.$$

$$\simeq f(\theta_{\pi^0}^{cm}) \cdot \frac{\Re\{(S_{0+}^* + 6S_{1+}^* \cos\theta_{\pi^0}^{cm})M_{1+}\}}{|M_{1+}|^2}$$

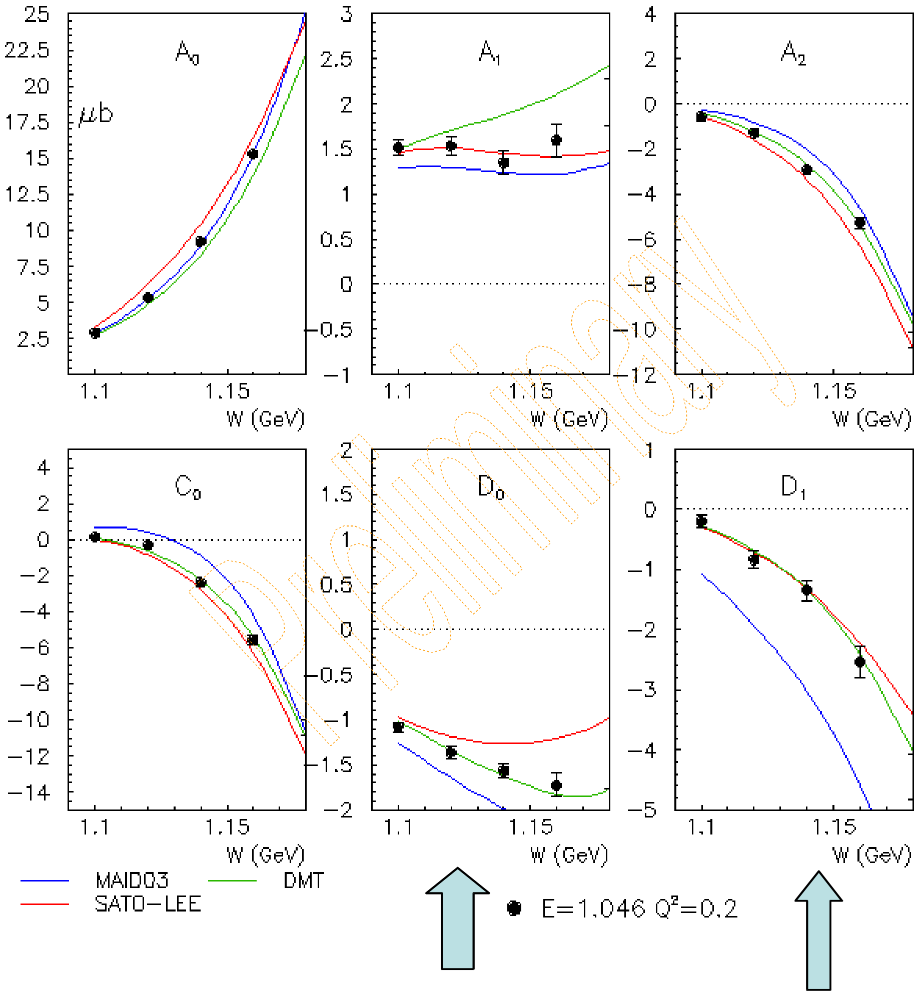
Raw asymmetry in agreement with CLAS data, however MAID03 fit yields larger RSM.



(deg)



Model Dependence most easily visible in Legendre coefficients



$$\bar{\sigma} = \nu_L R_L + \nu_T R_T + \nu_{LT} R_{LT} \cos\phi_\pi + \nu_{TT} R_{TT} \cos 2\phi_\pi$$

$$\nu_L R_L + \nu_T R_T = A_0 + A_1 P_1(\cos\theta_\pi^*) + A_2 P_2(\cos\theta_\pi^*)$$

$$R_{TT} = C_0 \sin^2\theta_\pi^*$$

$$R_{LT} = (D_0 + D_1 P_1(\cos\theta_\pi^*))\sin\theta_\pi^*$$

Leading order M1+ multipole terms

$$A_1 = 2Re(M_{1+}E_{0+}^*)$$

$$A_2 = -|M_{1+}|^2 + 6Re(M_{1+}E_{1+}^*) - 2Re(M_{1+}M_{1-}^*)$$

$$C_0 = -\frac{3}{2}|M_{1+}|^2 - 3Re(M_{1+}E_{1+}^*) - 3Re(M_{1+}M_{1-}^*)$$

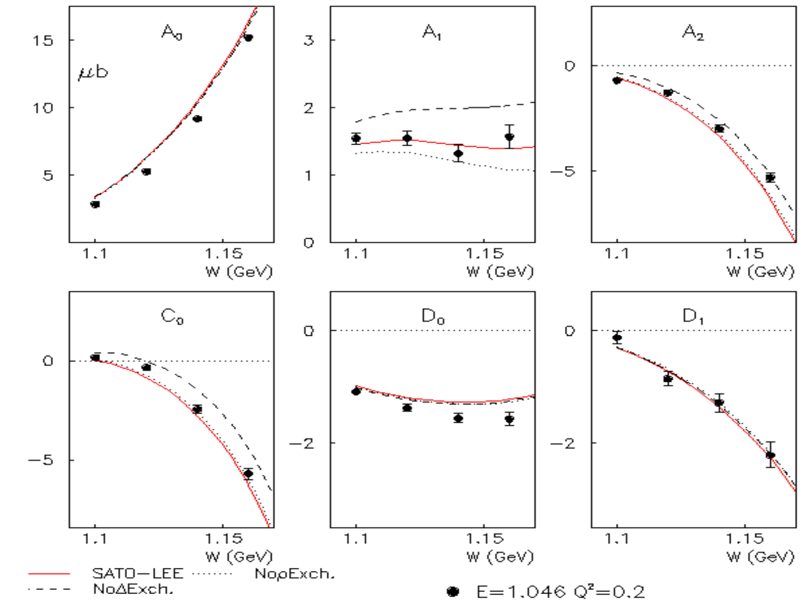
$$D_0 = Re(M_{1+}S_{0+}^*)$$

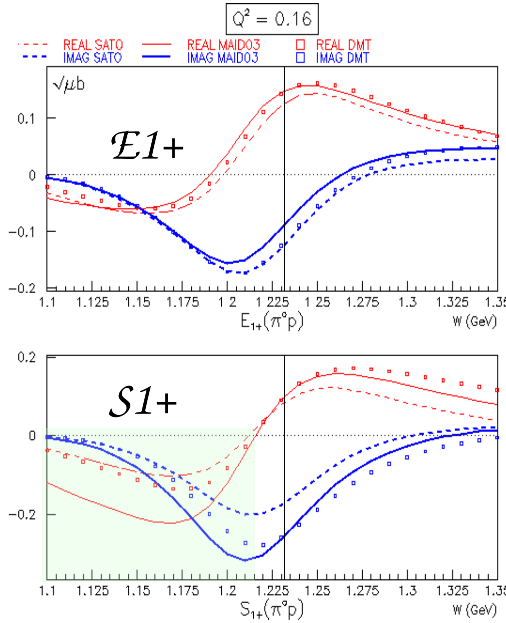
$$D_1 = 6Re(M_{1+}S_{1+}^*)$$

Large difference between dynamical models for A1 and D0.

Large difference between MAID and dynamical models for D1, which is dominated by Re(S_{1+})

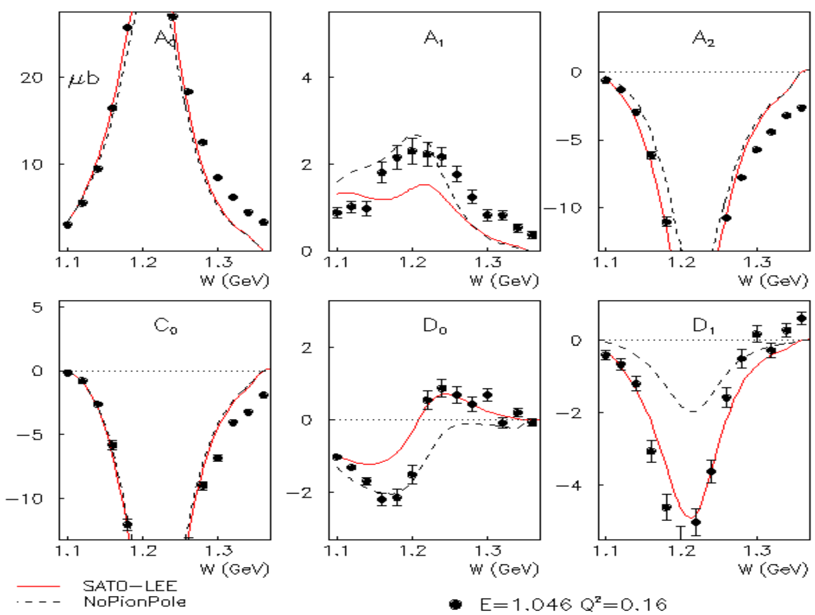
Sato-Lee Model: Sensitivity to details

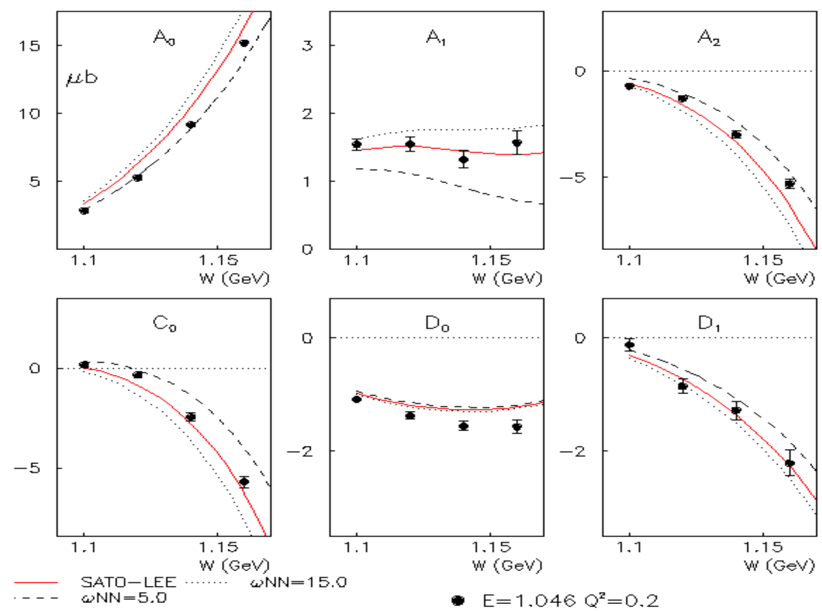




Models agree well

Strong disagreement away from   (1232) peak

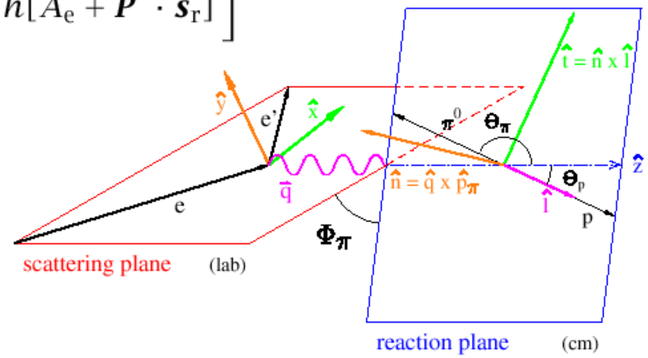




Recoil Polarization in p(e,e'p) π^0

Hall A / E91-011   J.J. Kelly (U.Md.)

$$\frac{d\sigma}{dE'_e\, d\Omega_e\, d\Omega_p^\star} = \frac{\sigma_0}{2}\left[1 + \boldsymbol{P}\cdot\hat{\boldsymbol{s}}_r + h[A_e + \boldsymbol{P}'\cdot\hat{\boldsymbol{s}}_r]\right]$$

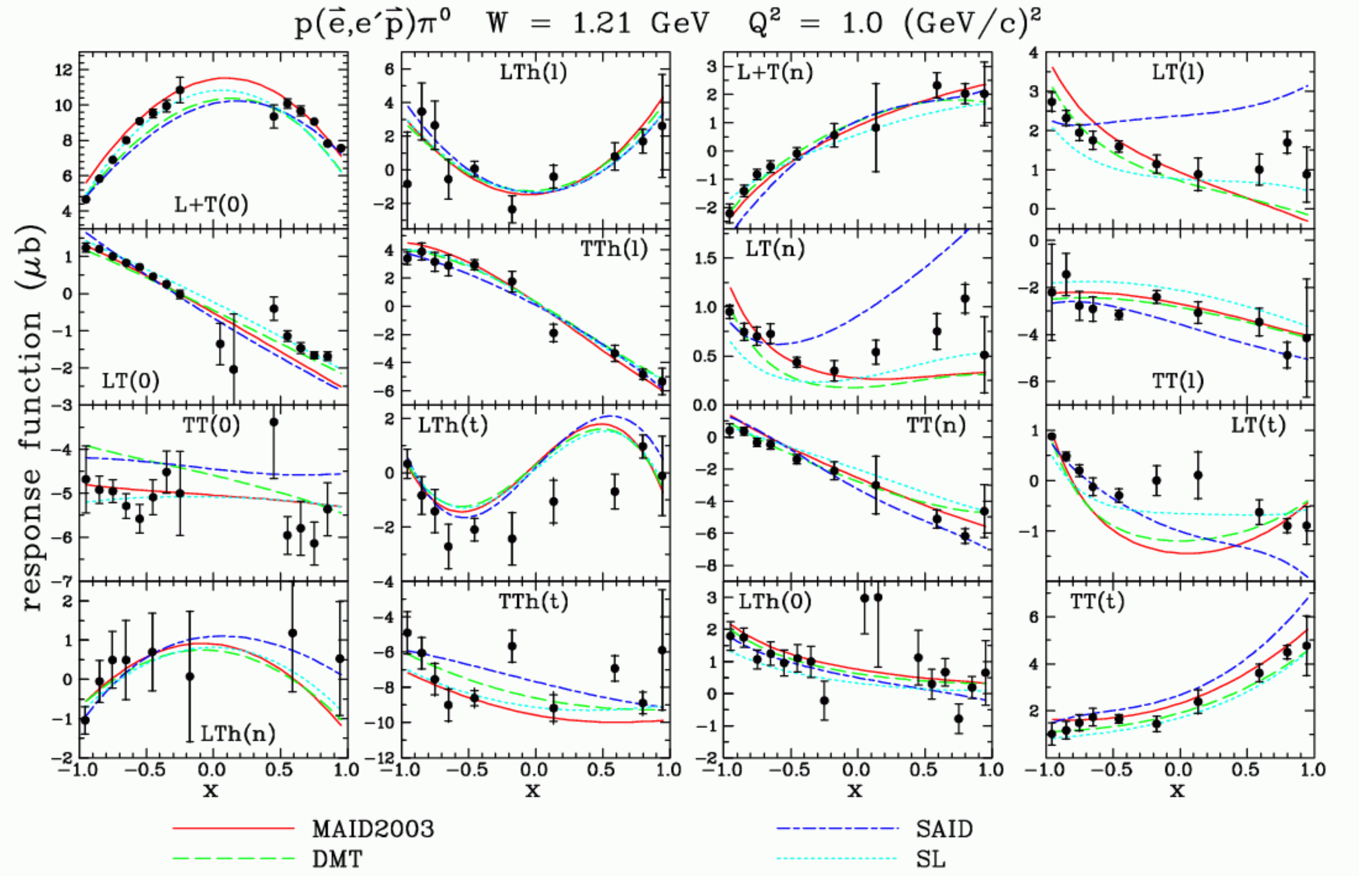


$$\frac{d\sigma}{dE'_e\, d\Omega_e\, d\Omega_p^\star} = \Gamma_v \frac{|\boldsymbol{p}_p^\star|\, W}{K_\gamma M_p}\Big[(R_T + R_T^n S_n) + 2\varepsilon_L^\star (R_L + R_L^n S_n)$$
$$+\sqrt{\varepsilon_L^\star(1+\varepsilon)}\,[(R_{LT} + R_{LT}^n S_n)\cos\phi + (R_{LT}^l S_l + R_{LT}^t S_t)\sin\phi]$$
$$+\varepsilon\,[(R_{TT} + R_{TT}^n S_n)\cos 2\phi + (R_{TT}^l S_l + R_{TT}^t S_t)\sin 2\phi]$$
$$+h\sqrt{\varepsilon_L^\star(1-\varepsilon)}\,[(R'_{LT} + R'^n_{LT} S_n)\sin\phi + (R'^l_{LT} S_l + R'^t_{LT} S_t)\cos\phi]$$
$$+h\sqrt{1-\varepsilon^2}\,[R'^l_{TT} S_l + R'^t_{TT} S_t]\Big]$$

- E_0=4.53 GeV Q^2=1.0 GeV^2 1.17 < W < 1.35 GeV
- Measured angular distributions for 16 response functions: 14 separated + 2 Rosenbluth combinations
- Both real and imaginary type responses → phase information for amplitude analyses
- EMR, SMR without sp truncation or M_{1+} dominance

Recoil Polarization : Separated Response Functions

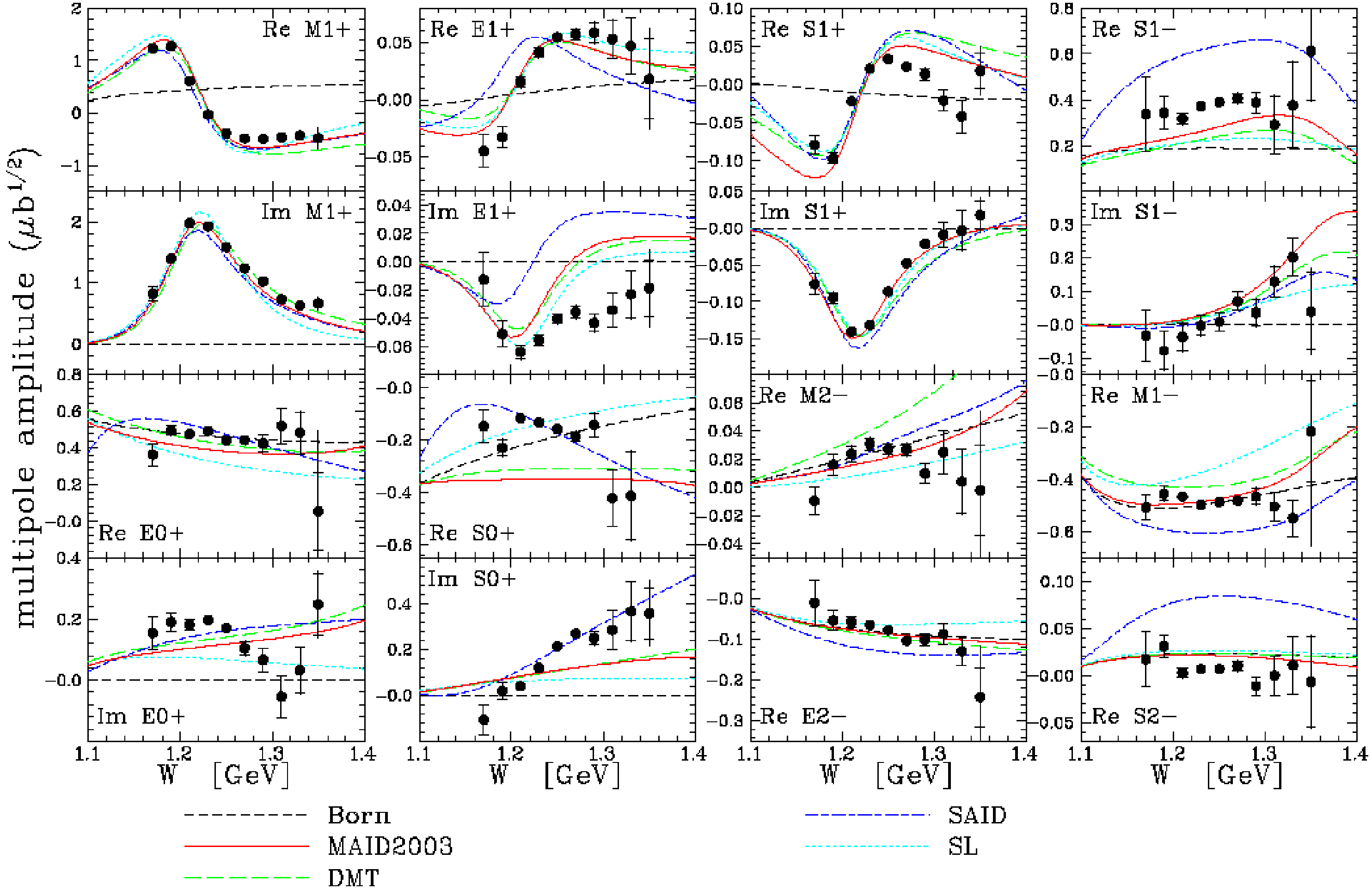
Hall A / E91-011 J.J. Kelly (U.Md.)



Some LT responses not well described by reaction models

Recoil Polarization: Extracted Multipoles

Hall A / E91-011   J.J. Kelly (U.Md.)

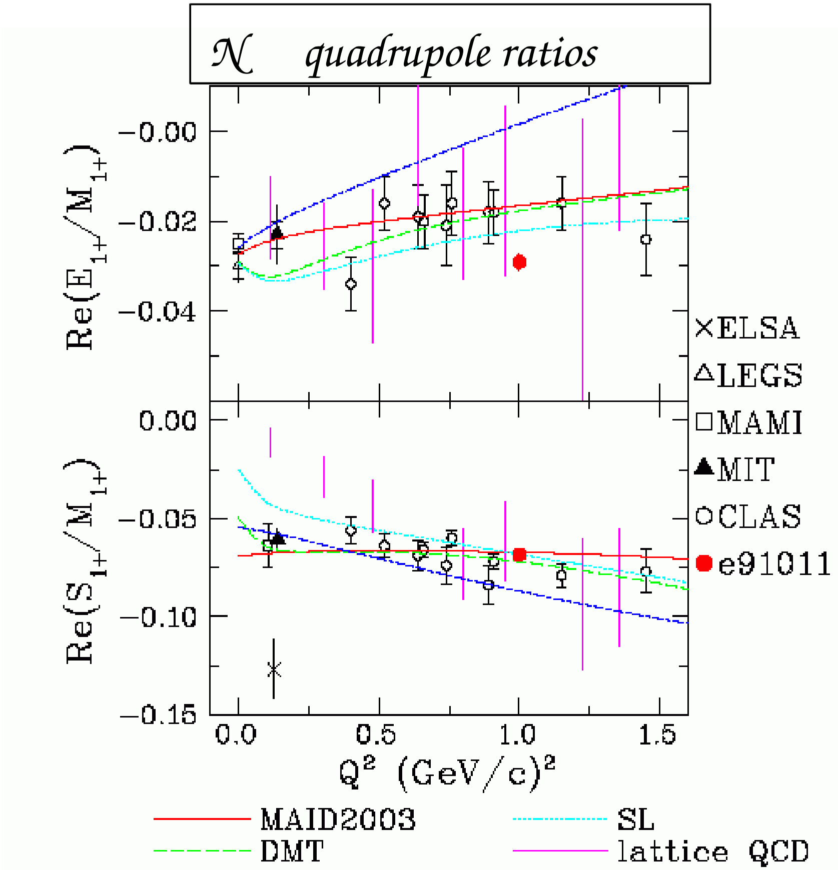


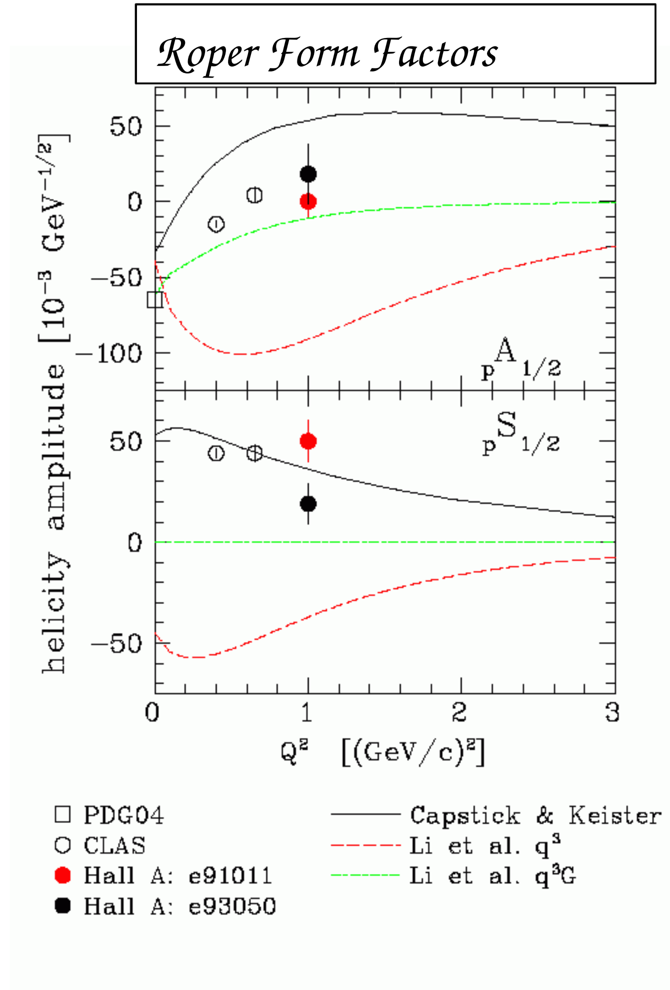
Multipoles extracted starting with Born baseline fit

First "model-independent" determination of multipole phases in electroproduction

Recoil Polarization: Results

Hall A / E91-011 J.J. Kelly (U.Md.)

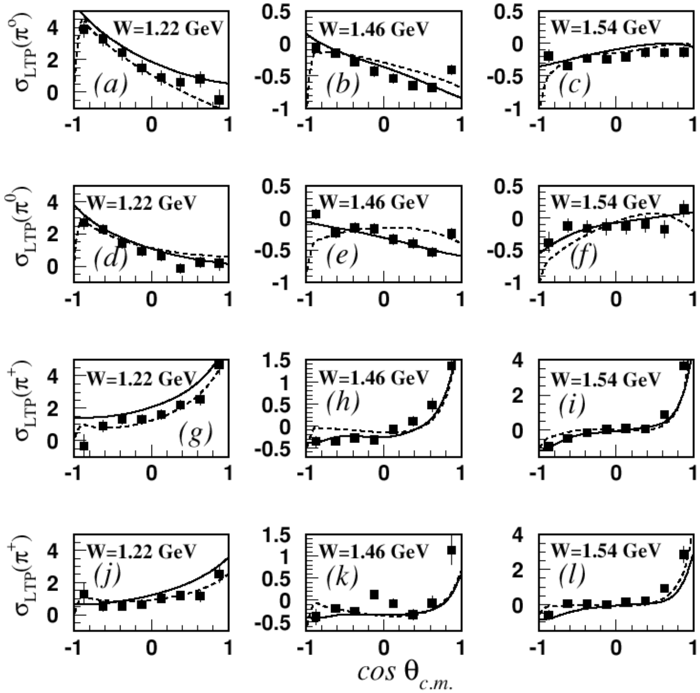




PHYSICAL REVIEW C 71, 015201 (2005)

Electroexcitation of the $P_{33}(1232)$, $P_{11}(1440)$, $D_{13}(1520)$, and $S_{11}(1535)$ at $Q^2 = 0.4$ and $0.65\,(\mathrm{GeV}/c)^2$

I. G. Aznauryan,[1] V. D. Burkert,[2] H. Egiyan,[2] K. Joo,[3] R. Minehart,[4] and L. C. Smith[4]
[1]Yerevan Physics Institute, 375036 Yerevan, Armenia
[2]Thomas Jefferson National Accelerator Facility, Newport News, Virginia 23606
[3]University of Connecticut, Storrs, Connecticut 06269
[4]University of Virginia, Charlottesville, Virginia 22901
(Received 8 July 2004; published 6 January 2005)



UIM

DR

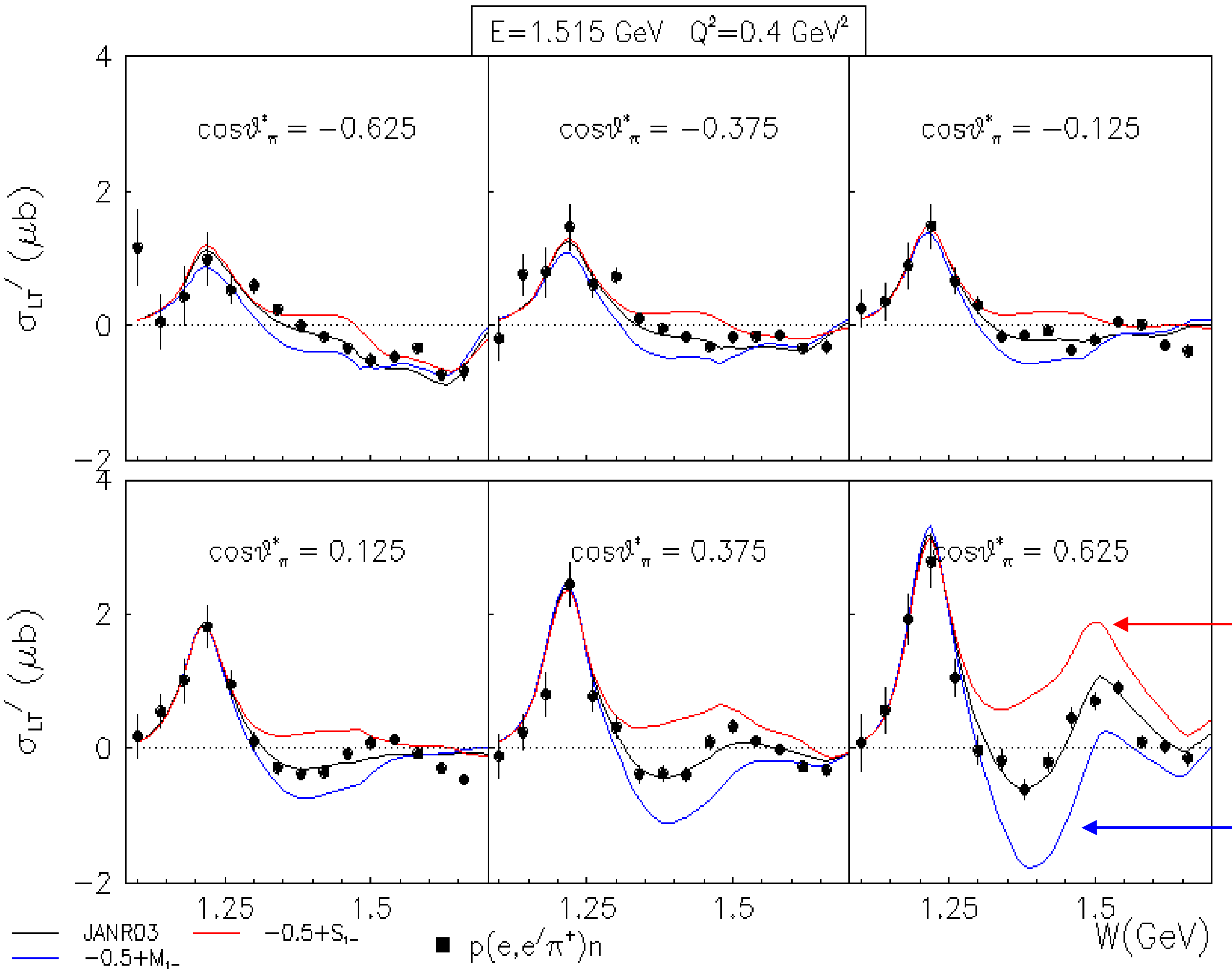
Observables used in global fit

Observable	Q^2	Number of data points	χ^2/data IM	χ^2/data DR
$\frac{d\sigma}{d\Omega}(\pi^0)$	0.4	3530	1.22	1.21
	0.6–0.65	6537	1.22	1.39
$\frac{d\sigma}{d\Omega}(\pi^+)$	0.4	2308	1.62	1.97
	0.6–0.65	1716	1.48	1.75
$A_{LT'}(\pi^0)$	0.4	956	1.14	1.25
	0.65	805	1.07	1.3
$A_{LT'}(\pi^+)$	0.4	918	1.18	1.63
	0.65	812	1.18	1.15
$\frac{d\sigma}{d\Omega}(\eta)$	0.375	172	1.32	1.33
	0.75	412	1.42	1.45

TABLE IV. Amplitudes of the $P_{11}(1440)$ and $D_{13}(1520)$ obtained in the analysis of π electroproduction. Multipole amplitudes are in $\mu b^{1/2}$ units; helicity amplitudes are in $10^{-3}\,\mathrm{GeV}^{-1/2}$ units. Helicity amplitudes for the $P_{11}(1440)$ electroexcitation are obtained using $M = 1440$ MeV, $\Gamma_{tot} = 350$ MeV, and $\beta_{\pi N} = 0.6$. Helicity amplitudes for the $D_{13}(1520)$ electroexcitation are obtained using $M = 1520$ MeV, $\Gamma_{tot} = 120$ MeV, and $\beta_{\pi N} = 0.5$.

Resonance	Q^2	${}_pM_{l-}^{1/2}$	${}_pE_{l-}^{1/2}$	${}_pS_{l-}^{1/2}$	${}_pA_{1/2}$	${}_pA_{3/2}$	${}_pS_{1/2}$	Approach
$P_{11}(1440)$	0.4	0.07 ± 0.01		0.31 ± 0.01	-15 ± 2		44 ± 2	IM
		0.02 ± 0.01		0.29 ± 0.01	-4 ± 2		41 ± 2	DR
	0.65	-0.02 ± 0.02		0.31 ± 0.02	4 ± 4		44 ± 4	IM
		-0.11 ± 0.02		0.26 ± 0.02	23 ± 4		37 ± 4	DR

Global Fit - Sensitivity to $P_{11}(1440)$



$$p(\vec{e},e'\pi^+)n$$

$$\sigma'_{LT} = \mathrm{Im}(L^*T)$$

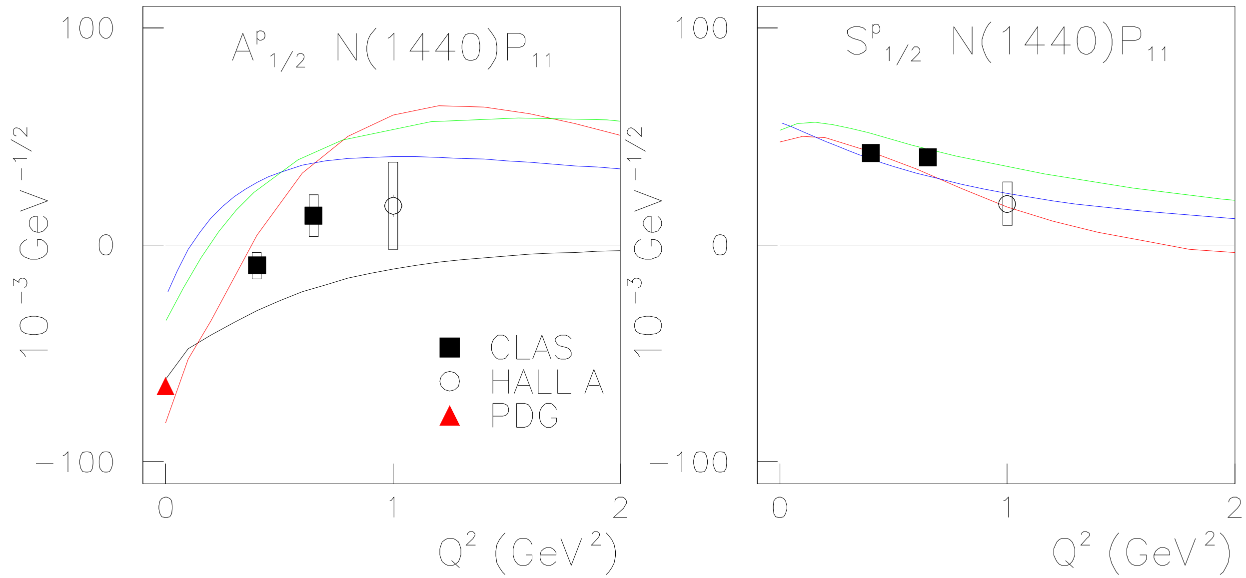
0.5 $b^{1/2}$ shift in $S_{1/2}$

0.5 $b^{1/2}$ shift in $A_{1/2}$

$_{LT}'$ sensitive to ***imaginary part*** *of $P_{11}(1440)$ through interference with real Born background. Forward peaking shows importance of pion pole.*

Global Fit to CLAS Data

$P_{11}(1440)$ Photocoupling Amplitudes



$A_{1/2}$ zero crossing ~ Q^2=0.5 GeV^2

Hybrid (q^3G) model excluded

Strong longitudinal strength.

Breathing mode or pion cloud?

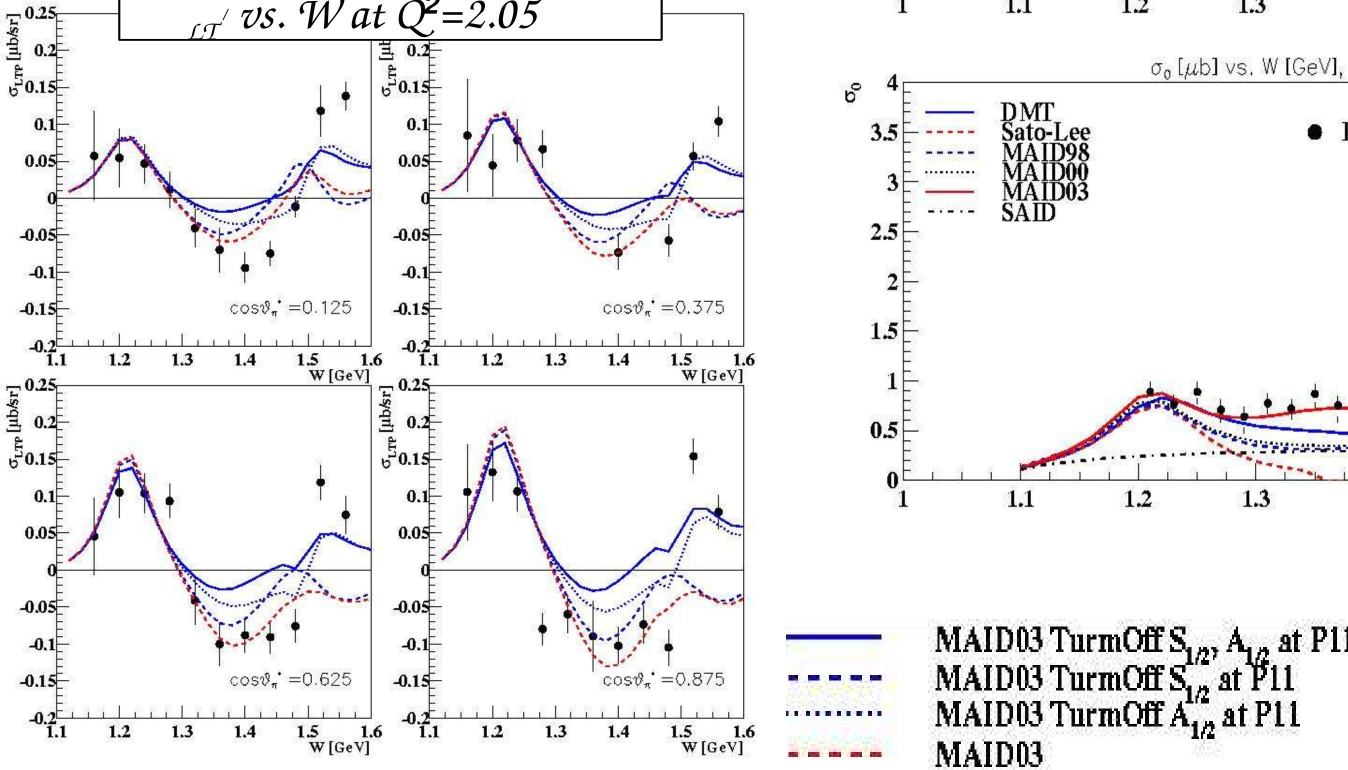
q^3G	*Li*	*RQM-Capstick*
$q^3\pi$	*Cano*	*RQM-Simula*

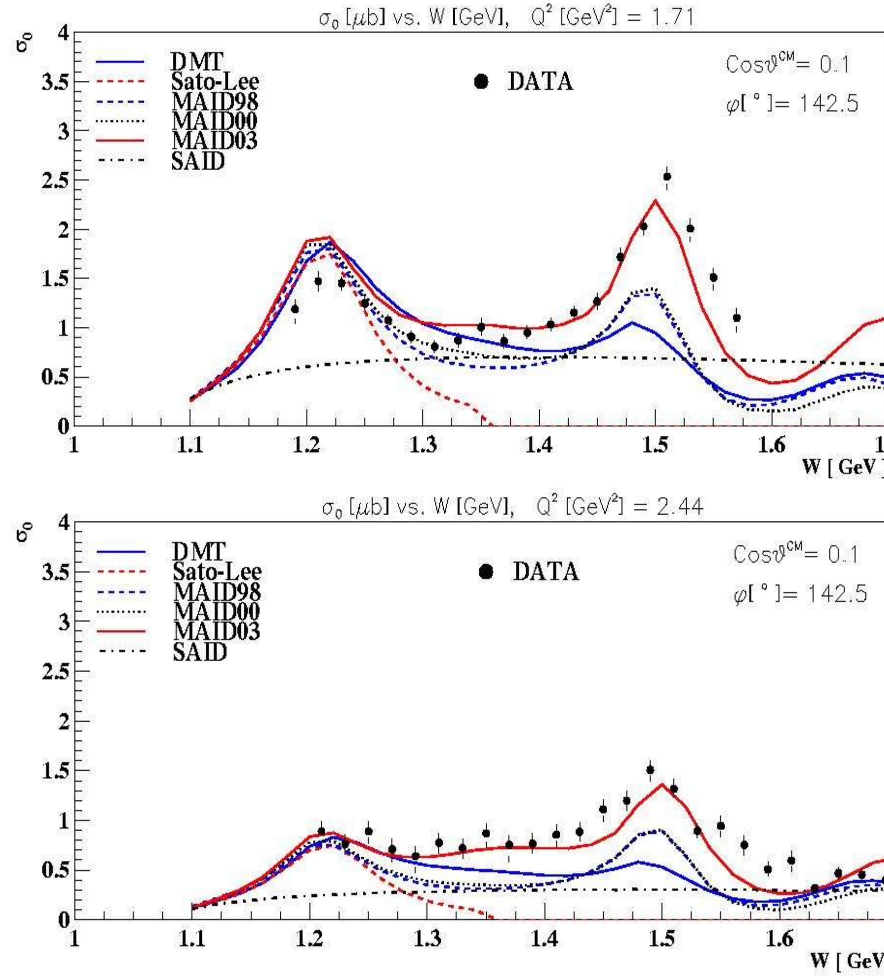
Exclusive $^{+}$ Electroproduction at High Q^2

Hall B / E99-107   K. Park (USC, Kyungpook)

W[GeV]	***1.1 - 1.8***	***0.02(35)***
Q^2[GeV^2]	***1.72 - 4.92***	***Variable(7)***
CSCM	***-1.0 - 1.0***	***0.2(10)***
PHICM	***0. - 360.°***	***15°(24)***

$_{LT'}$ vs. W at Q^2=2.05

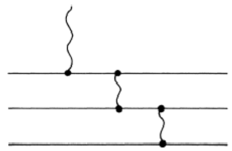




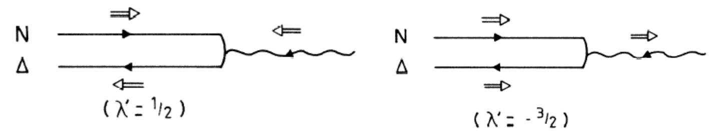
See I. Aznauryan's talk for preliminary fit results

Asymptotic behavior of p→ helicity amplitudes

pQCD scaling:



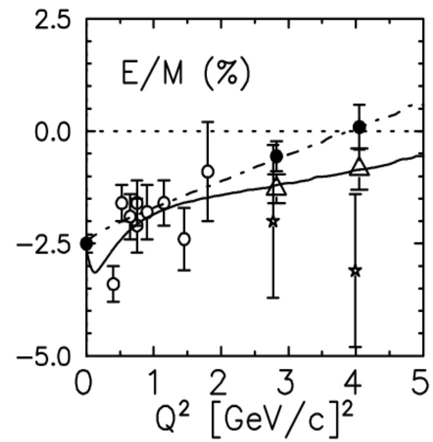
$$A^{\Delta}_{1/2} \;|\; \frac{1}{Q^3} \qquad A^{\Delta}_{3/2} \;\nleftarrow\; \frac{1}{Q^5}$$



$$E2 = -\frac{1}{2} A_{1/2} + \frac{1}{2\sqrt{3}} A_{3/2}$$

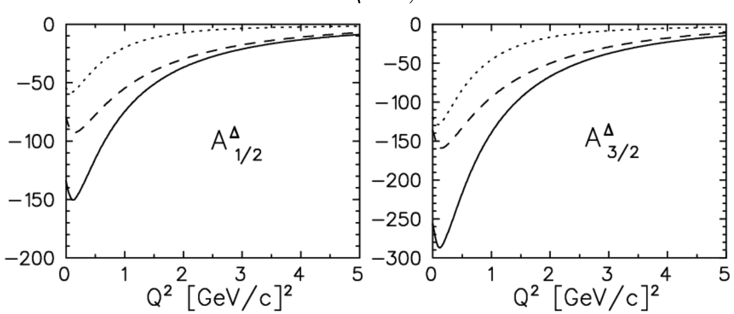
$$M1 = -\frac{1}{2} A_{1/2} - \frac{\sqrt{3}}{2} A_{3/2}$$

$$\frac{E2}{M1} \xrightarrow{Q^2 \; ? \; ?} 1$$

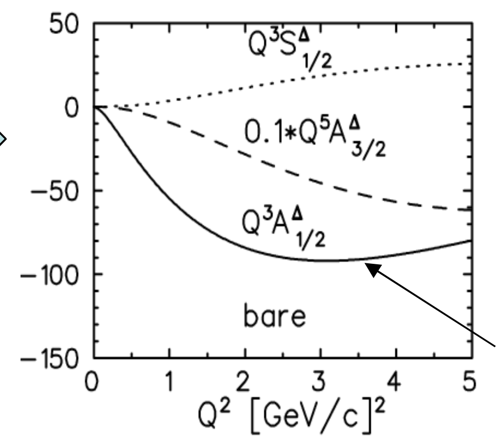


No pQCD scaling observed up to Q^2=4 GeV^2

Yang and Kamalov, Mod.Phys.Lett. A18 (2003) 248



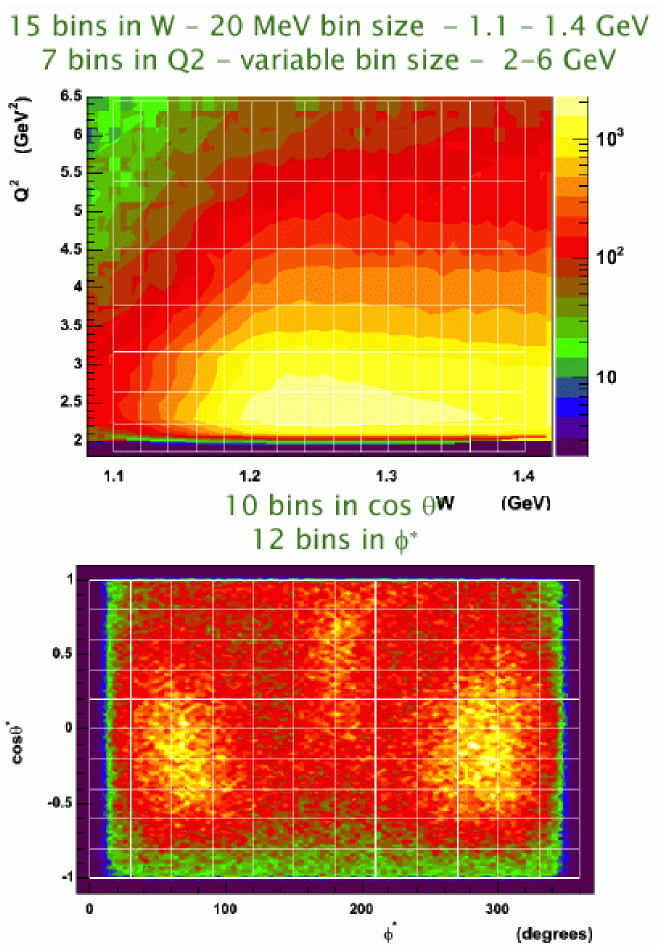
DMT model fits to JLAB 0 electroproduction data

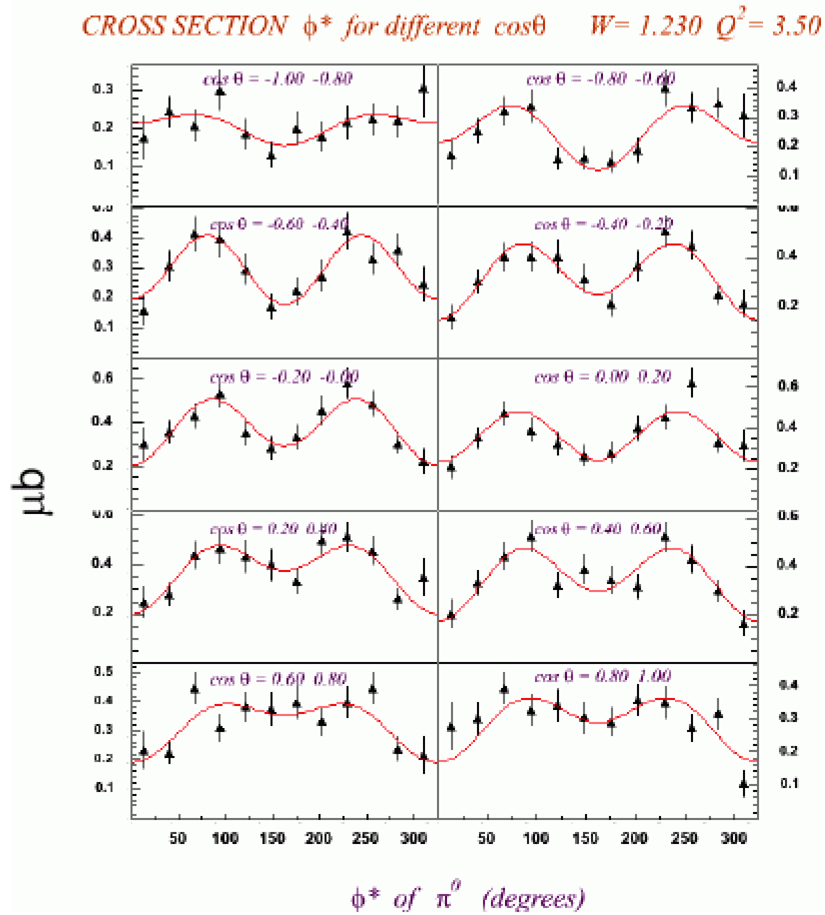


Helicity conserving $A_{1/2}$ scales as expected, but strongly supressed relative to $A_{3/2}$

Exclusive ^{0} Electroproduction at High Q^2

Hall B / E99-107   M. Ungaro (RPI,UConn)

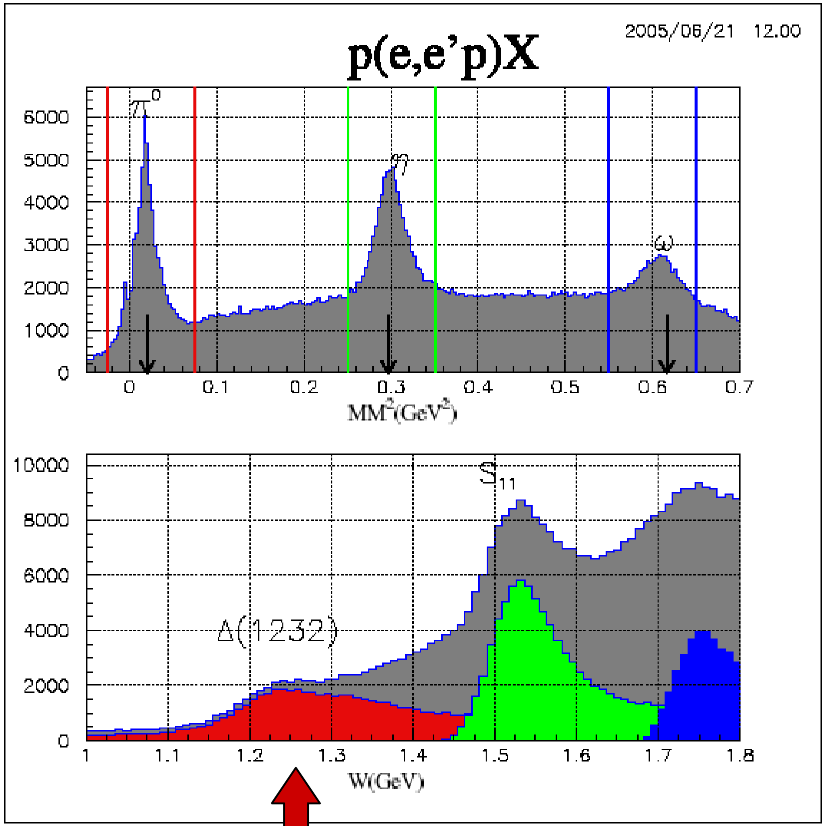




See talk by I. Aznauryan for preliminary fit results

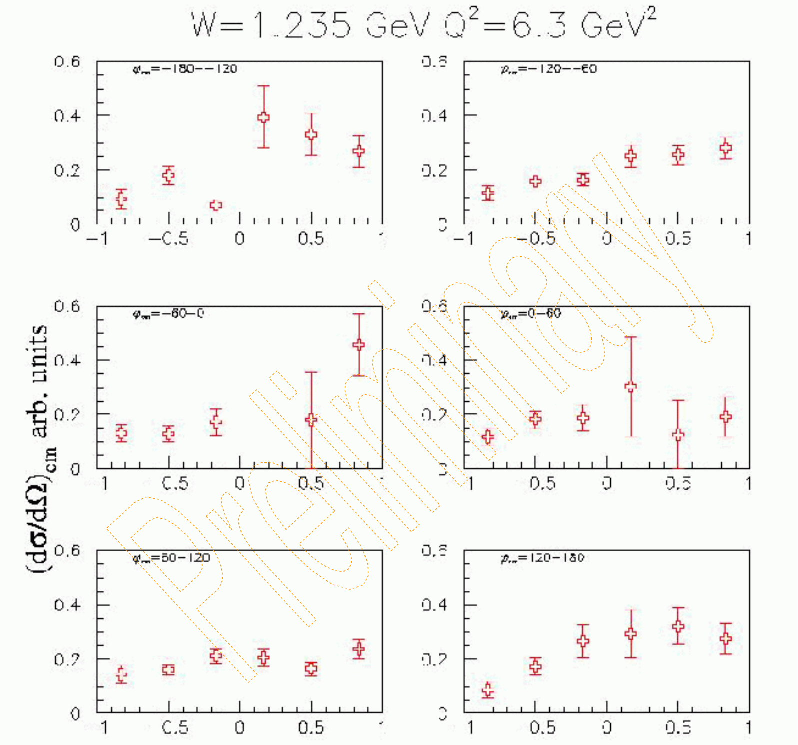
Exclusive Meson Electroproduction at High Q^2

Hall C / E01-002 A.N. Villano (RPI), M. Dalton (U. Witwatersrand)



Goal: Extend measurements of $P_{33}(1232)$ and $S_{11}(1535)$ transition form factors to Q^2=7.5 GeV^2

How reliable are reaction models at these Q^2 (e.g. - + form factor)?

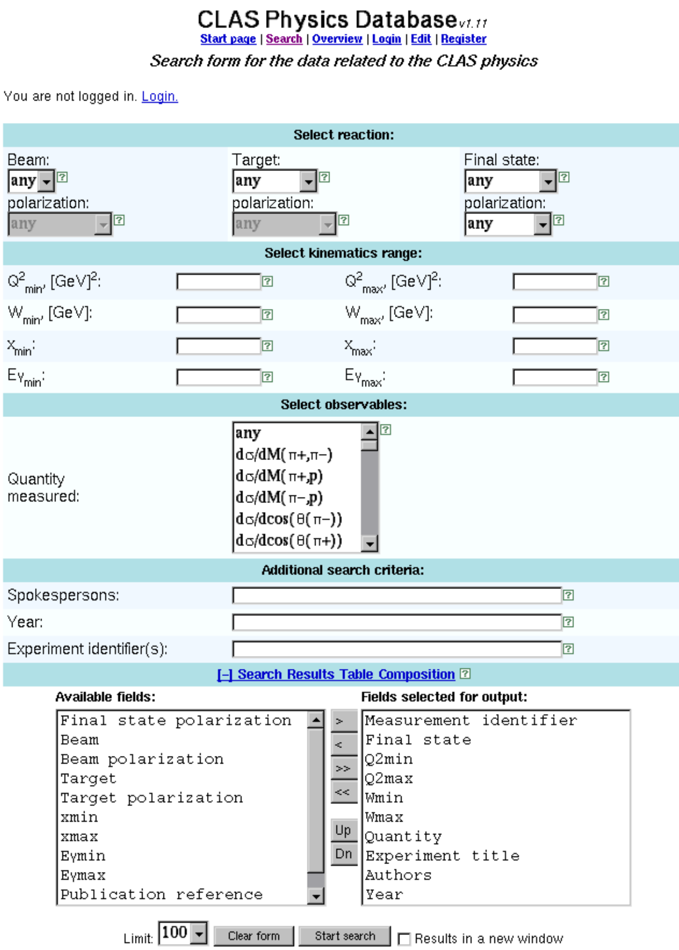


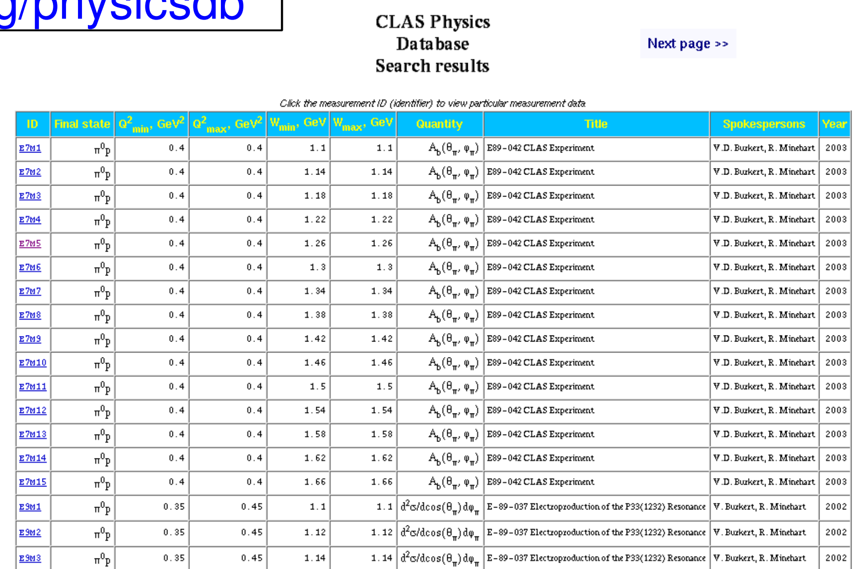
*Cos **

Background contributions may dominate response.

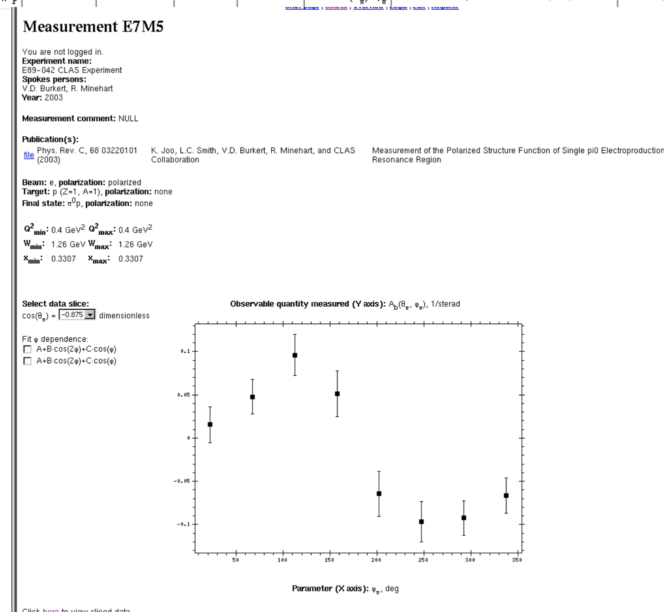
CPhysDB: CLAS Physics Database

clasweb.jlab.org/physicsdb





ID	Final state	Q^2_{min}, GeV^2	Q^2_{max}, GeV^2	W_{min}, GeV	W_{max}, GeV	Quantity	Title	Spokespersons	Year
E7M1	$\pi^0 p$	0.4	0.4	1.1	1.1	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E7M2	$\pi^0 p$	0.4	0.4	1.14	1.14	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E7M3	$\pi^0 p$	0.4	0.4	1.18	1.18	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E7M4	$\pi^0 p$	0.4	0.4	1.22	1.22	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E7M5	$\pi^0 p$	0.4	0.4	1.26	1.26	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E7M6	$\pi^0 p$	0.4	0.4	1.3	1.3	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E7M7	$\pi^0 p$	0.4	0.4	1.34	1.34	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E7M8	$\pi^0 p$	0.4	0.4	1.38	1.38	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E7M9	$\pi^0 p$	0.4	0.4	1.42	1.42	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E7M10	$\pi^0 p$	0.4	0.4	1.46	1.46	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E7M11	$\pi^0 p$	0.4	0.4	1.5	1.5	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E7M12	$\pi^0 p$	0.4	0.4	1.54	1.54	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E7M13	$\pi^0 p$	0.4	0.4	1.58	1.58	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E7M14	$\pi^0 p$	0.4	0.4	1.62	1.62	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E7M15	$\pi^0 p$	0.4	0.4	1.66	1.66	$A_b(\theta_\pi, \varphi_\pi)$	E89-042 CLAS Experiment	V.D. Burkert, R. Minehart	2003
E9M1	$\pi^0 p$	0.35	0.45	1.1	1.1	$d^2\sigma/d\cos(\theta_\pi)d\varphi_\pi$	E-89-037 Electroproduction of the P33(1232) Resonance	V. Burkert, R. Minehart	2002
E9M2	$\pi^0 p$	0.35	0.45	1.12	1.12	$d^2\sigma/d\cos(\theta_\pi)d\varphi_\pi$	E-89-037 Electroproduction of the P33(1232) Resonance	V. Burkert, R. Minehart	2002
E9M3	$\pi^0 p$	0.35	0.45	1.14	1.14	$d^2\sigma/d\cos(\theta_\pi)d\varphi_\pi$	E-89-037 Electroproduction of the P33(1232) Resonance	V. Burkert, R. Minehart	2002



Measurement E7M5

You are not logged in.
Experiment name:
E89-042 CLAS Experiment
Spokes persons:
V.D. Burkert, R. Minehart
Year: 2003

Measurement comment: NULL

Publication(s):
file Phys. Rev. C, 68 03220101 (2003) — K. Joo, L.C. Smith, V.D. Burkert, R. Minehart, and CLAS Collaboration — Measurement of the Polarized Structure Function of Single pi0 Electroproduction Resonance Region

Beam: e, **polarization:** polarized
Target: p (Z=1, A=1), **polarization:** none
Final state: $\pi^0 p$, **polarization:** none

Q^2_{min}: 0.4 GeV^2 Q^2_{max}: 0.4 GeV^2
W_{min}: 1.26 GeV W_{max}: 1.26 GeV
x_{min}: 0.3307 x_{max}: 0.3307

Select data slice:
$\cos(\theta_\pi)$ = -0.875 dimensionless

Fit φ dependence:
A+B·cos(2φ)+C·cos(φ)
A+B·cos(2φ)+C·cos(φ)

Click here to view sliced data.

Developed by Moscow State University

V. Mokeev, V. Sapunenko, M. Stepanov