S_{11} Resonance Electroproduction at High Q^2

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- study baryon resonance **$S_{11}(1535)$** through reaction p(e,e'p)η;
- get high statistics differential cross section;
- extract helicity amplitude $A_{1/2}$;
- do this at highest Q^2 thus far.

$S_{11}(1535)$ Resonance

Spin ½, isospin ½, negative parity;

Strongly excited over all Q^2;

Well isolated in ep -> e'ηp channel:

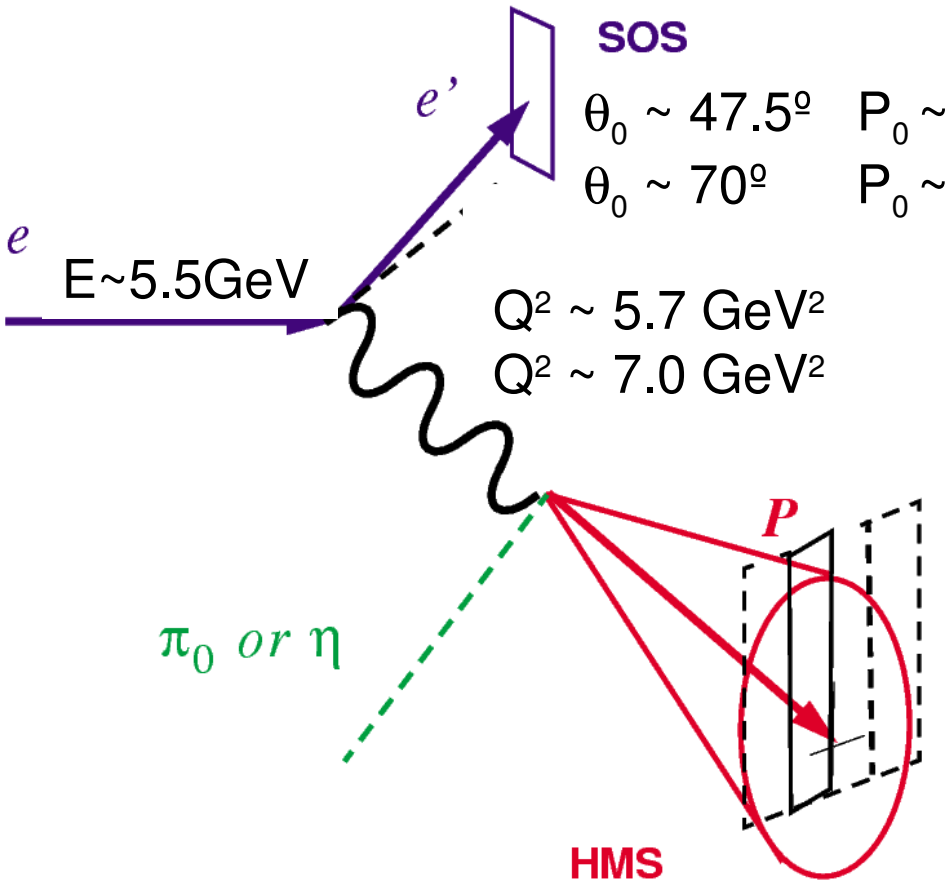
- only isospin ½ contribute;
- large branching fraction to η (45%-60%) c.f. few percent for others;

Strong energy dependence at threshold since
$W_{thr} = m_p + m_\eta = 1486$ MeV;

strong S-wave character (η photoproduction)

Experiment

Data taken at Jlab in Hall C
Two spectrometer coincidence configuration



θ_0 ~ 47.5º P_0 ~ 1.7 GeV/c
θ_0 ~ 70º P_0 ~ 1.0 GeV/c

Q^2 ~ 5.7 GeV^2
Q^2 ~ 7.0 GeV^2

$\theta_0 > 11.2º$ $P_0 < 5$ GeV/c

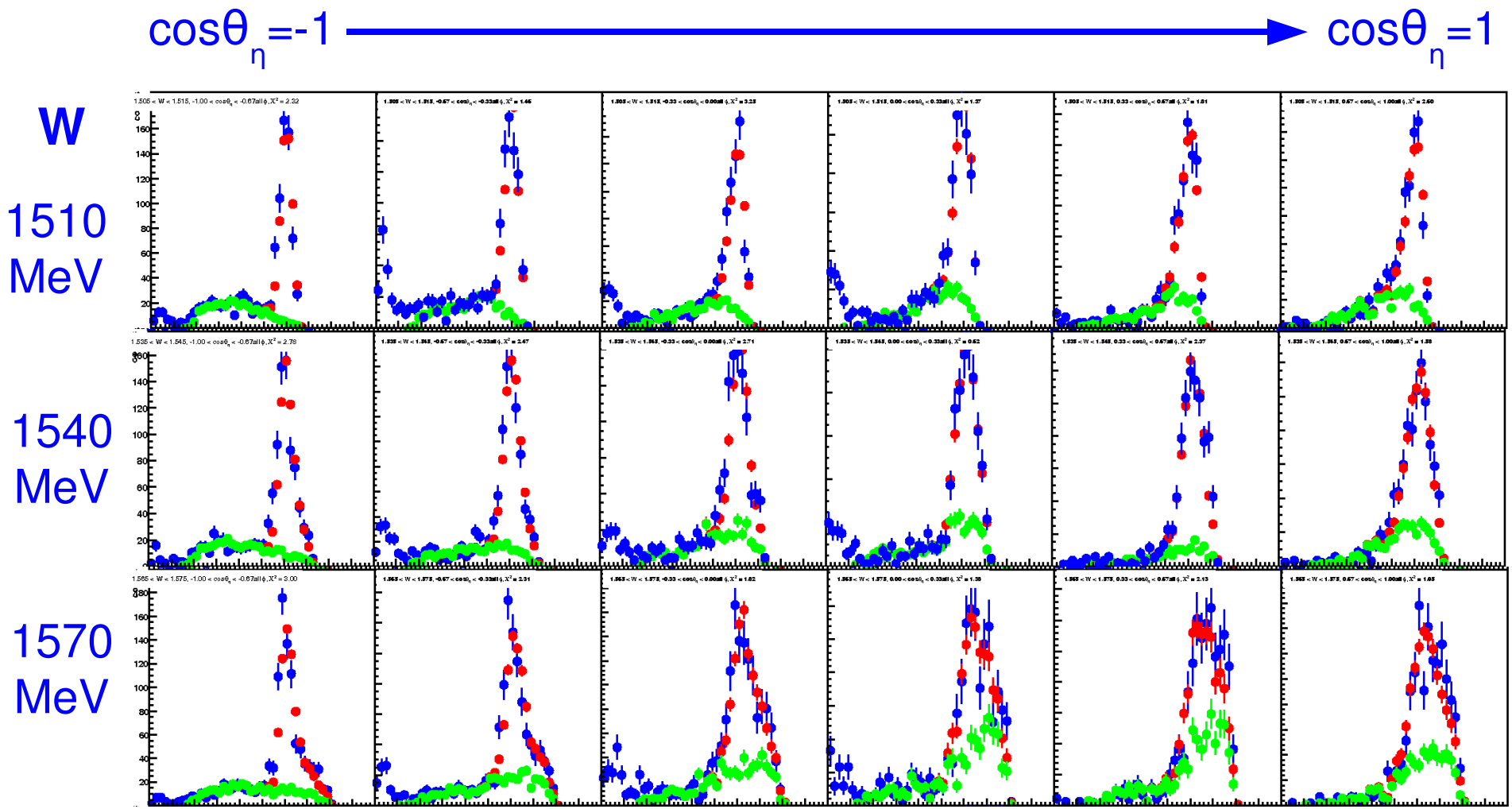
2 points in Q^2 measured

Undetected η identified by missing mass reconstruction.

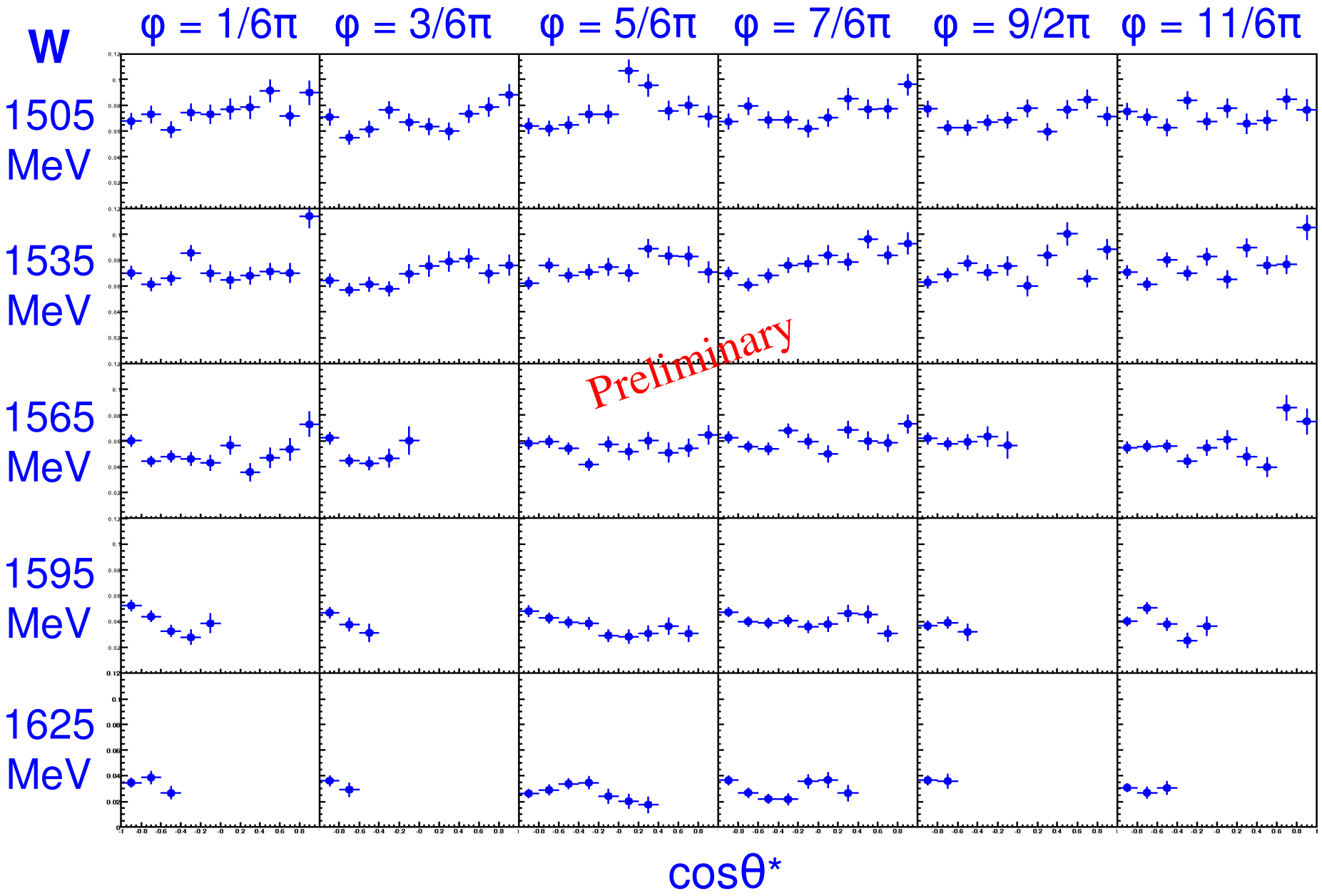
kinematic focusing at higher Q^2 – proton recoils in narrow cone allowing detection of full centre of mass angles for W < 1550 MeV.

η Identified from Missing Mass

multipion background and η signal well modelled by Monte Carlo simulation



Differential Cross Section e(p,e'p)η

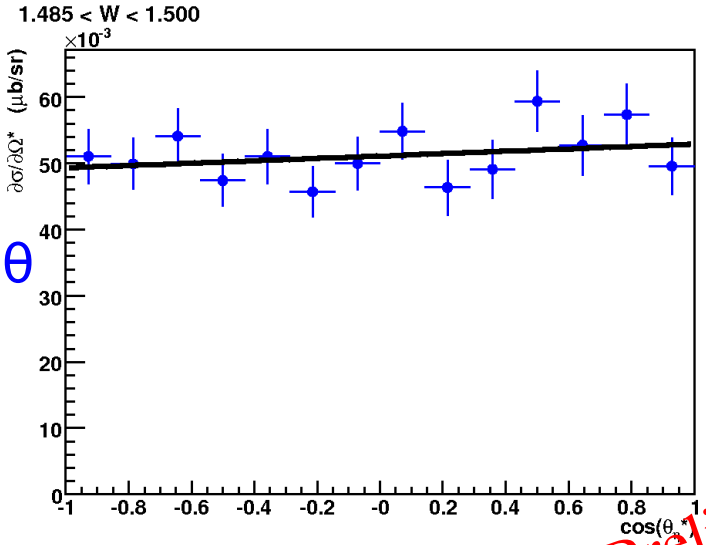


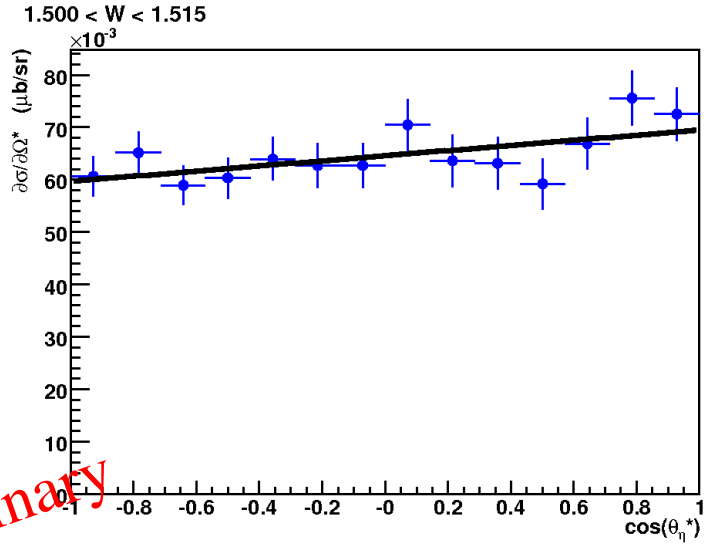
Shape of Angular Distribution

Fits of $A_0 + A_1 \cos\theta$

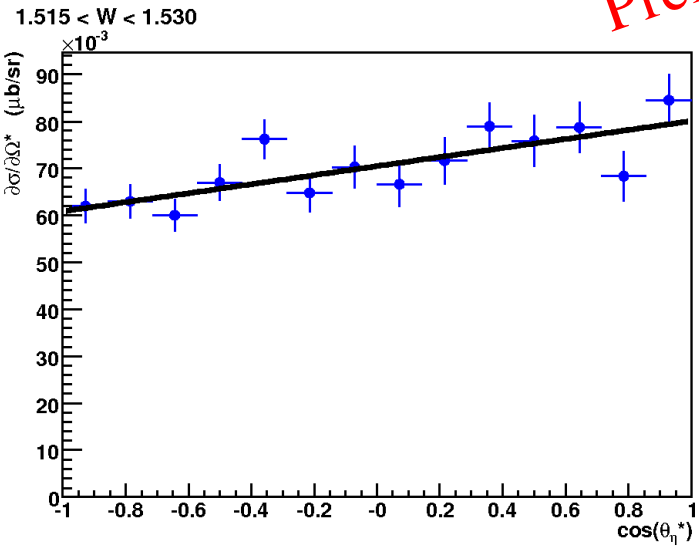
Non-zero A_1 due to interference with P-wave.

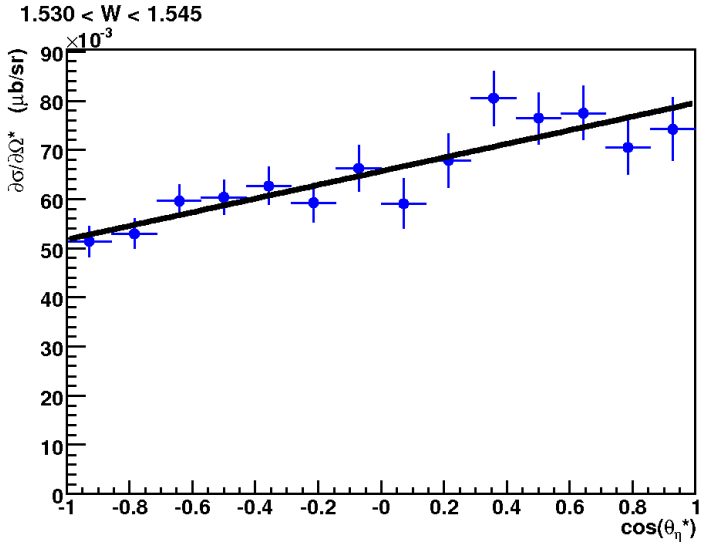
A_1/A_0 gives size of effect.





Preliminary

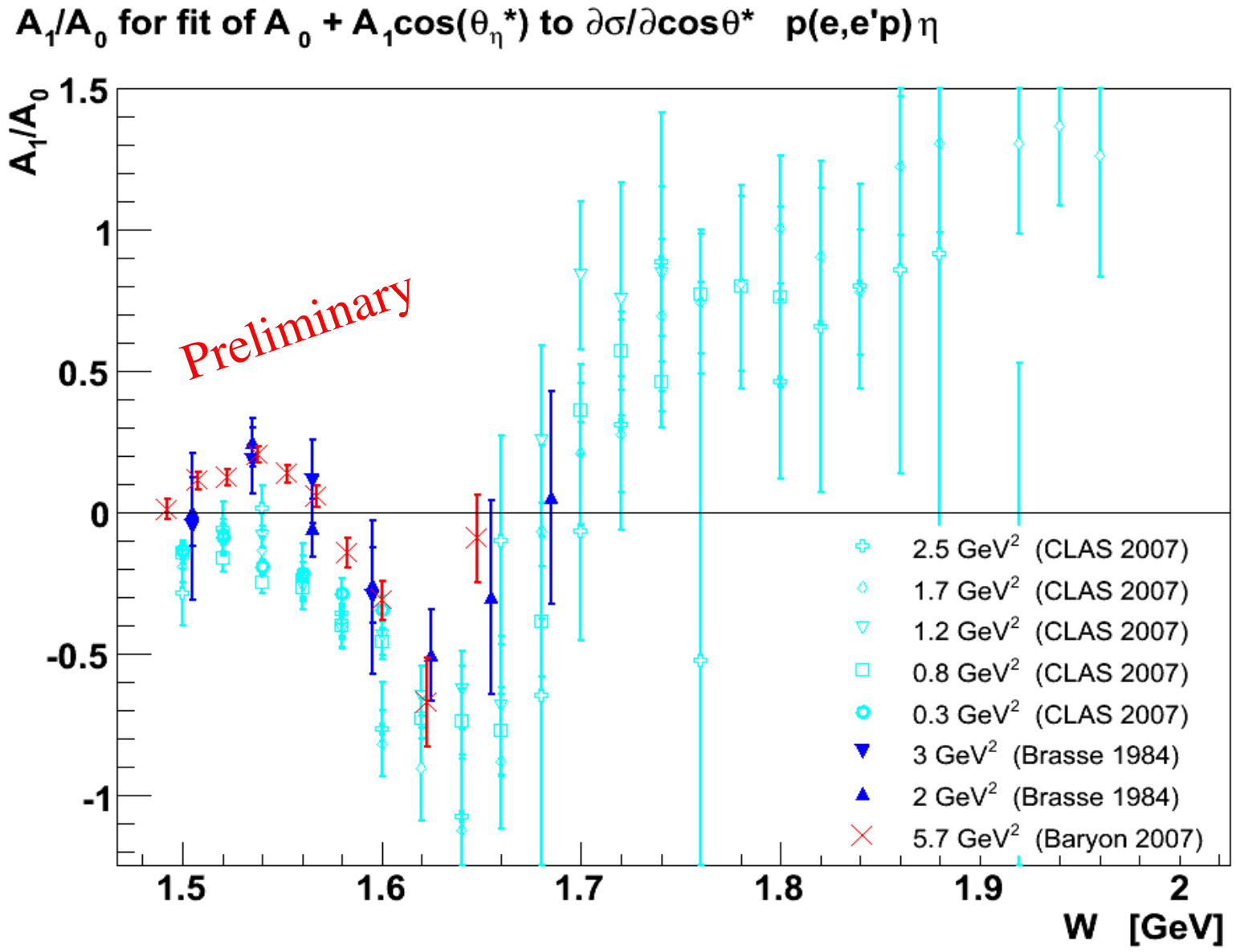




Data is independent of φ and higher orders in cosθ to within statistics.

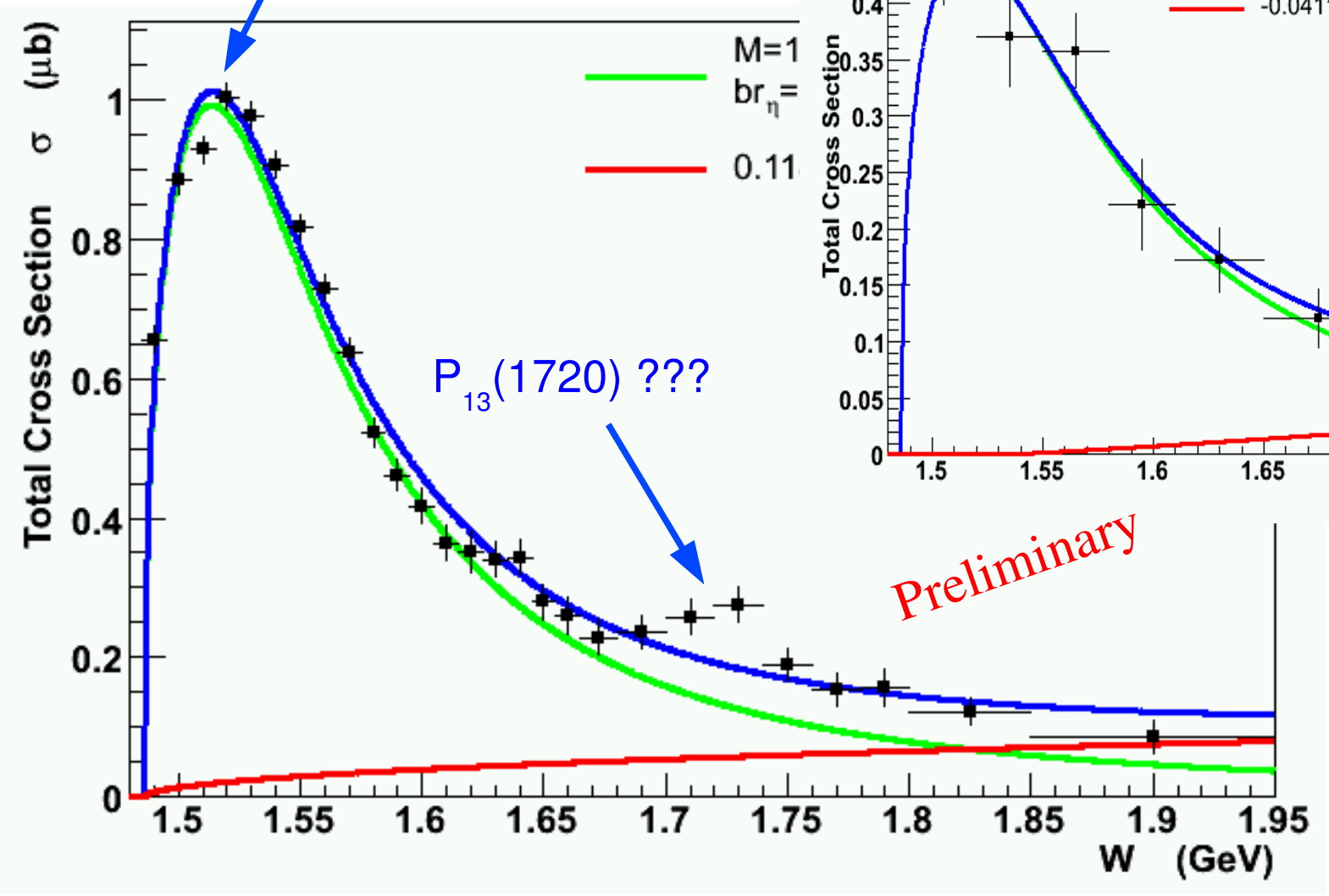
W Dependence of cosθ*

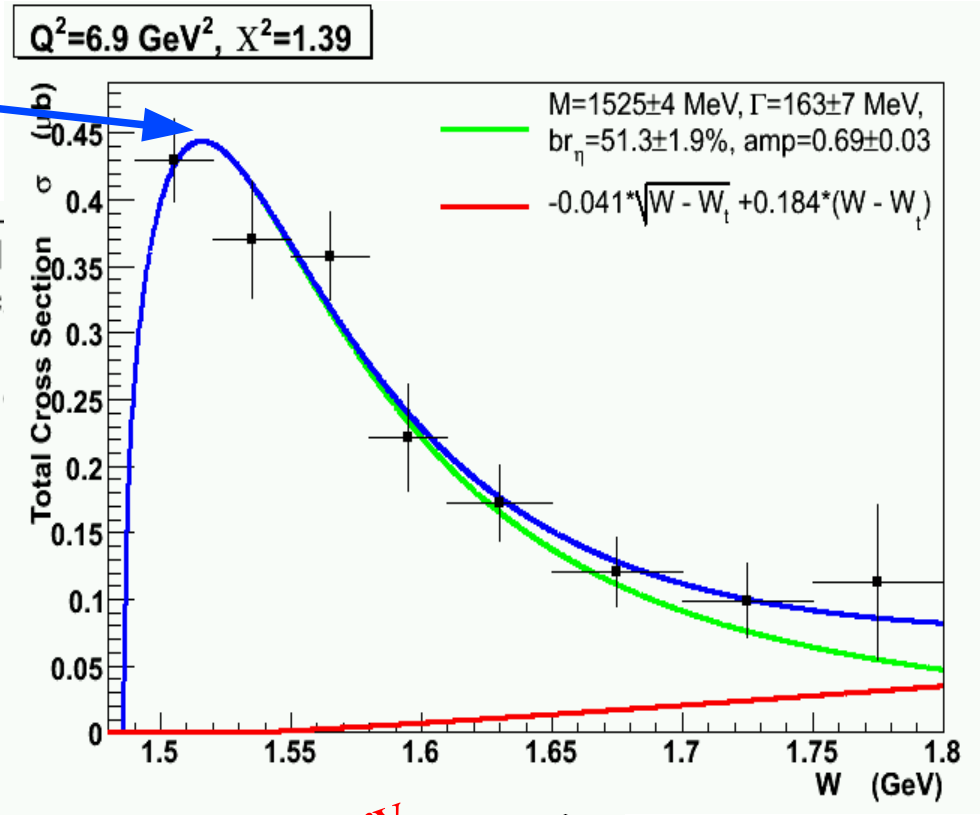
Plot shows data for $0.3 < Q^2 < 5.7$ GeV^2



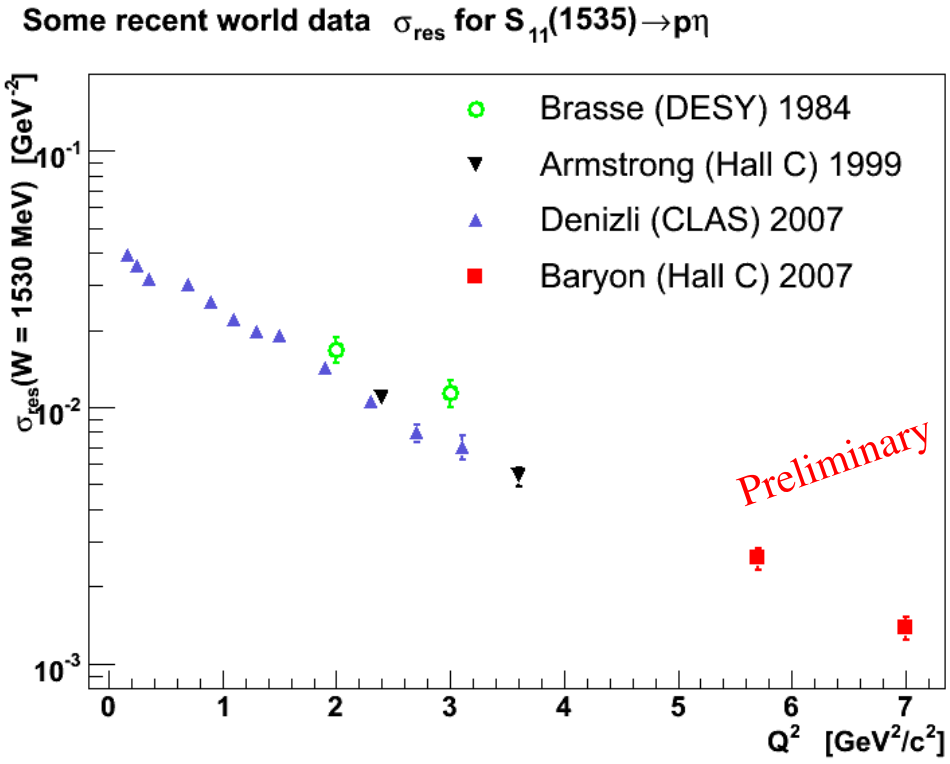
W dependence (angle integrated)

$\sigma_{res} = \sigma(W = W_{res})$ needed for $A_{1/2}$



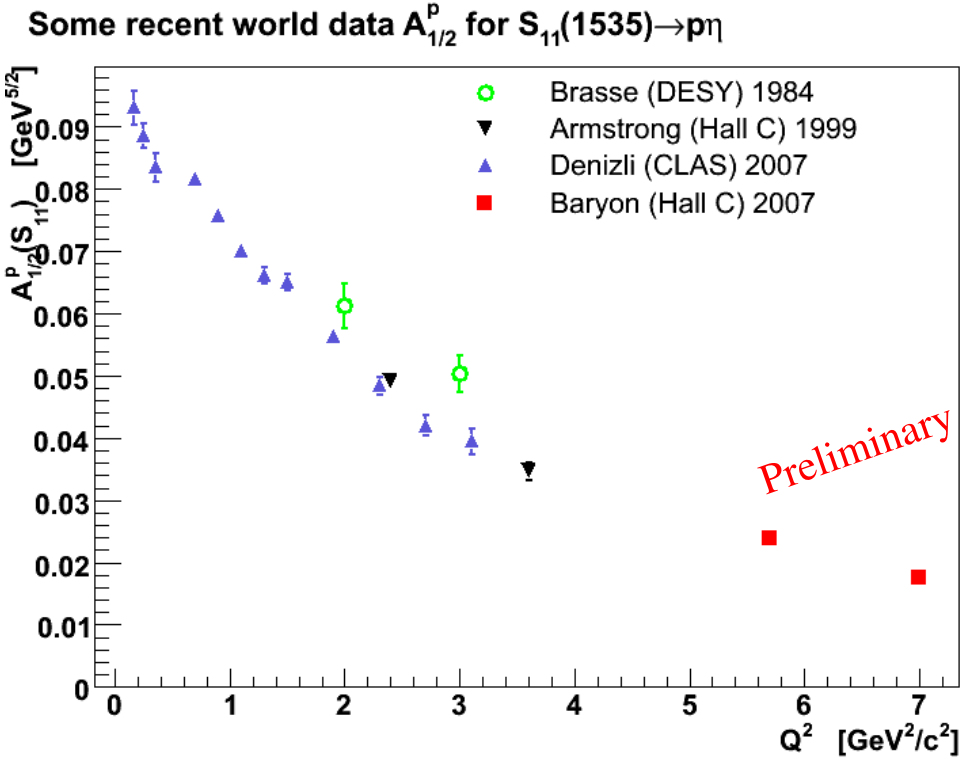


σ_{res} and Helicity Amplitude $A_{1/2}$



$$A_{\frac{1}{2}}(Q^2) = \left[\frac{W_R\Gamma_R}{2m_p b_\eta}\sigma(W_R, Q^2)\right]^{1/2}$$

Assuming S_{11} dominance and $S_{1/2}$ negligible



$A_{1/2}$ extracted consistently for all data sets:

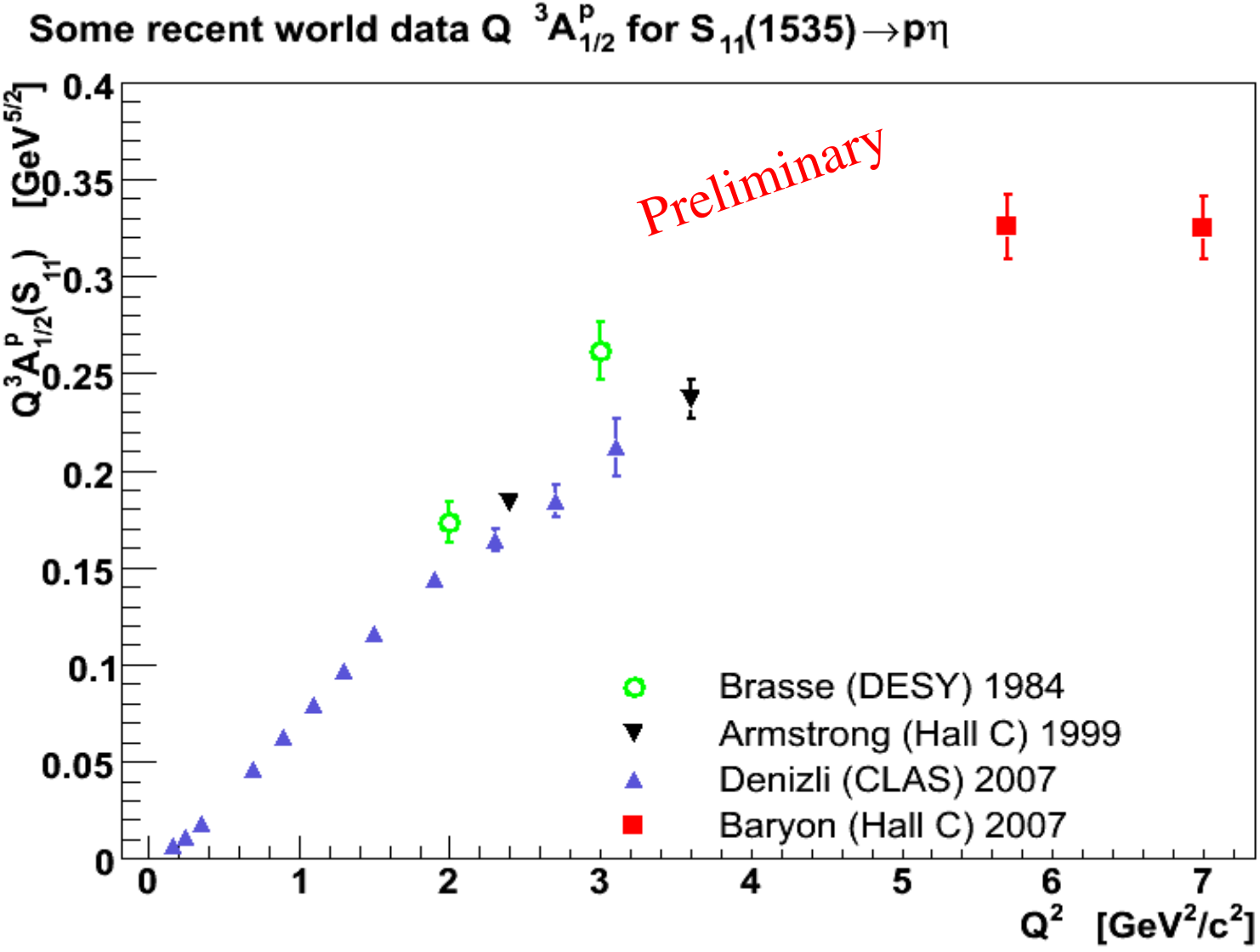
W_{res} = 1530 MeV

Γ_{res} = 150 MeV

b_η = 0.55

Possible Onset of Scaling

The quantity Q^3S_{11} seems to flatten from about $Q^2 \sim 5\ GeV^2$ – as expected from pQCD[1], but may be caused by other 'soft' effects.[2]



[1] Carlson 1986

[2] Isgur 1984
Radyushkin 1991

Conclusion

Measured the differential and sections for $^{1}H(e,e'p)\eta$ from threshold to third resonance region for Q^2 of 5.7 and 7.0 GeV^2;

Extracted helicity amplitude $A_{1/2}$ for S_{11};

Observed possible resonance and interference at W ~ 1.7 GeV;

Observed scaling in $Q^3A_{1/2}$ for S_{11} which may indicates the onset of pQCD.

CLAS Data Fits