η cross section measurements with CLAS g12 data

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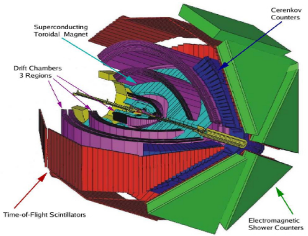
Outline

1. Introduction
   - Review of the CLAS g12 Experiments
2. $\gamma p \to p\eta$ Cross Section
   - Corrections and Cuts
   - Background Subtraction
   - Preliminary Results
   - Error Analysis
3. $\gamma p \to K^0\Sigma^+$ Cross Section
   - Current Progress
4. Summary

Outline

CLAS g12 Experiments



CLAS Detector

electron energy	5.7 GeV
tagged photon energy	1.1-5.45 GeV
target	liquid hydrogen
target position	$-110 < z < -70$ cm
target polarization	unpolarized
photon polarization	circular

g12 Run Conditions

Plan: cross section measurements based on the g12 data

$\gamma p \to p\eta$, $\gamma p \to K^0\Sigma^+$, $\gamma p \to p\omega$

Outline

Corrections

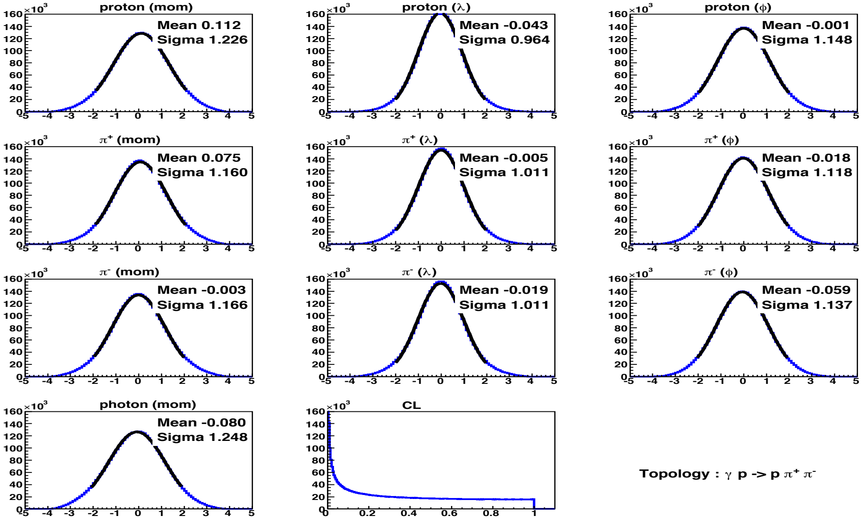
Why do we need these corrections?

	data	Momte Carlo
Eloss	yes	yes
MomC	no	no
BeamC	no	no
Kfit	yes	yes

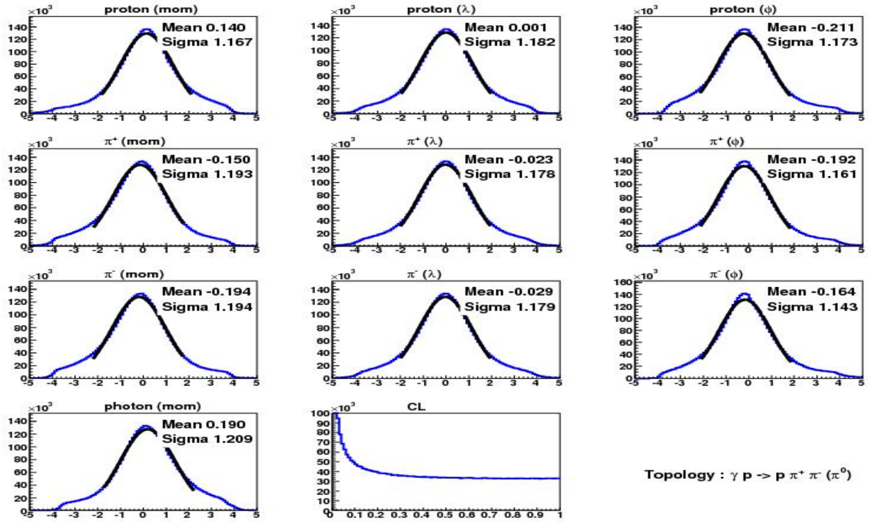
1. Eloss:particles lose energy when interacting with the detector
2. MomC:due to misalignment of the chambers and fluctuations of the B field
3. BeamC:caused by the tagger sag
4. Kfit:to fulfill energy and momentum conservation

Do we need all these corrections?

Pull Distributions of Two-pion Events



Pull Distributions of Three-pion Events

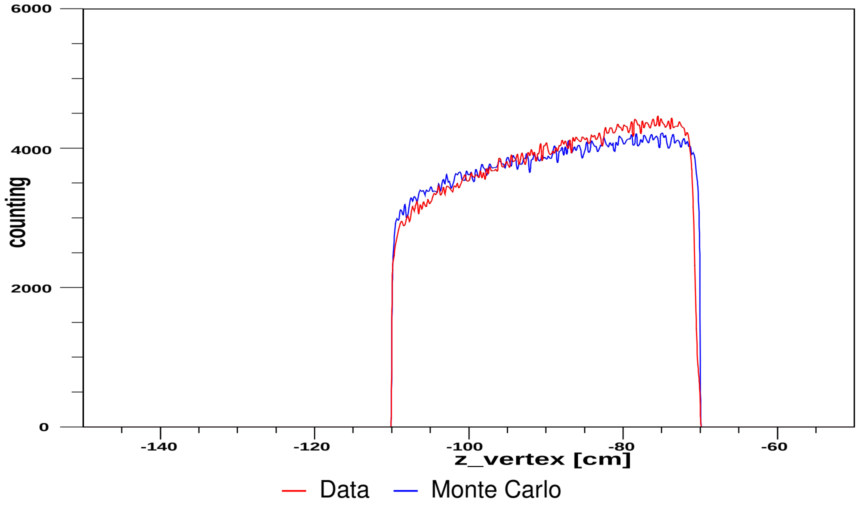


Cuts

	data & Monte Carlo
confidence level cut	1%
$\Delta\beta$ cut	3σ
vertex cut	$-110 < z < -72$ cm
forward π^0 cut	$\cos\theta_{\pi^0}<0.99$
fiducial cut	yes
trigger cut	yes
trigger simulation	only for MC
bad paddle knock out	yes

- Cuts mostly aims at removing background.
- All cuts must be equal to data and MC.

Vertex Distributions



Background Subtraction

Background subtraction is done by using a probability-based method.

- Resonance tends to be kinematically close to resonance, so for background.
- The proportion of the resonance components among the nearest neighbors of one events give the Bayesian probability of this event to be the resonance.
- This Bayesian probability is called the Q-factor.

If we choose M different kinematic observables $O_k(k = 1, 2, 3, \cdots, M)$ that are normalized by their ranges, the kinematic distance squared between two events that are labeled by i and j can be defined as

$$d_{ij}^2 = \sum_k (O_k^i - O_k^j)^2 \quad (1)$$

Background Subtraction

By computing the kinematic distance, we can find N events in one kinematic bin that are kinematically closest to a chosen event. These N nearest neighbors will be used to fill the $\pi^+\pi^-\pi^0$ invariant mass distribution. Then this mass distribution can be fit by a fit function as the sum of the resonance fit function and the background fit funtion

$$f(m) = r(m) + b(m) \tag{2}$$

where we denote m as the $\pi^+\pi^-\pi^0$ invariant mass for convenience and $r(m)$ and $b(m)$ as the resonance and the background fit functions respectively. The Q-factor of the chosen event is

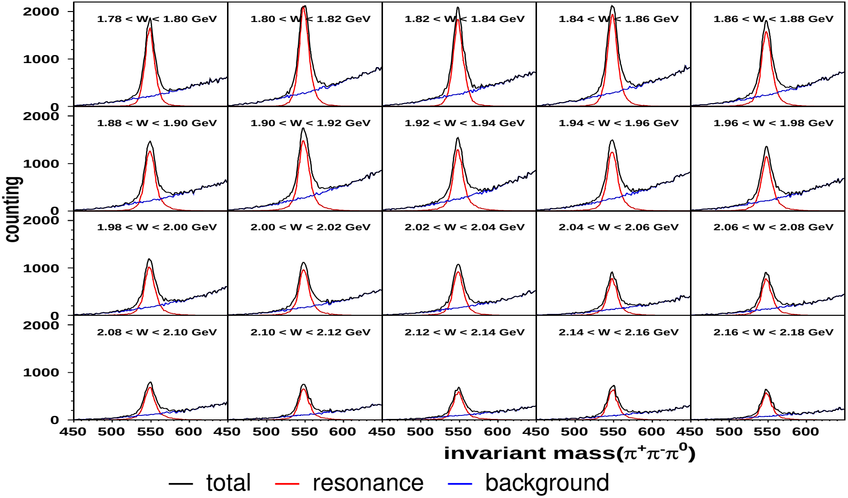
$$Q = \frac{\int r(m)dm}{N} \tag{3}$$

Kinematic Observables

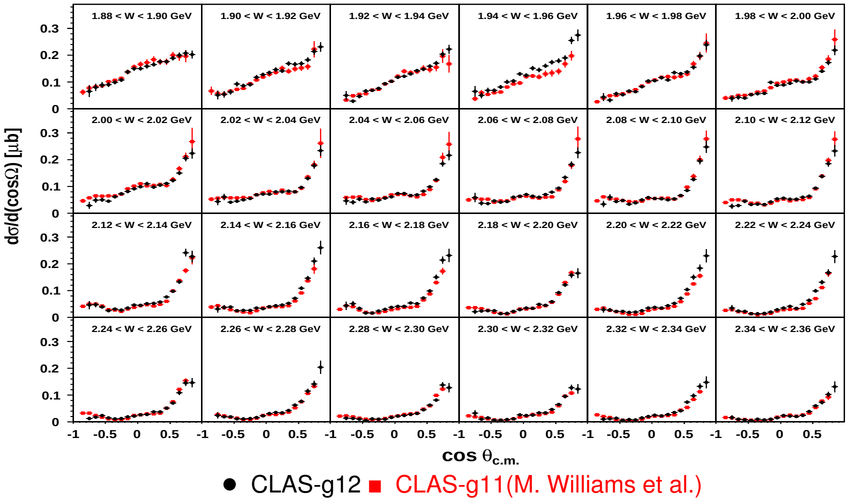
Table: Kinematic Observables

O^k	range of O^k
$cos\theta_{\eta}^{CM}$	2
$cos\theta_{\pi^+\pi^-}^{\eta}$	2
$\phi_{\pi^+\pi^-}^{\eta}$	2π
ϕ_{η}^{Lab}	2π
W	width of the binning of W
λ	1

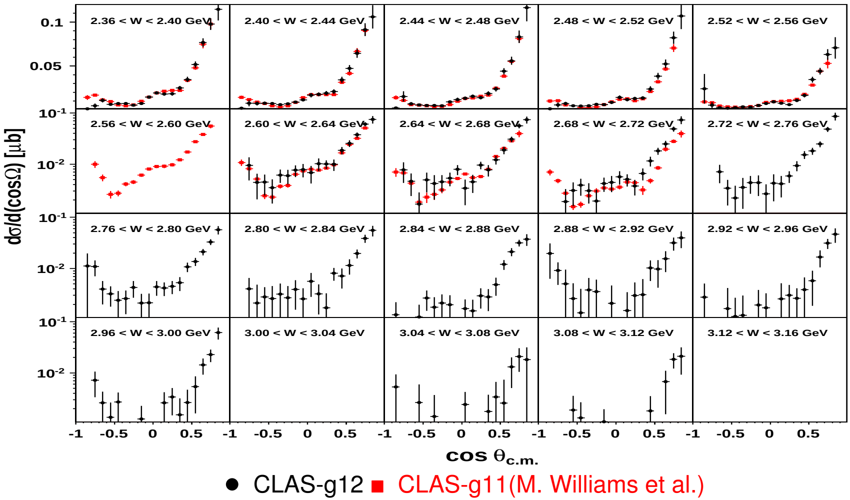
$\pi^+\pi^-\pi^0$ Invariant Mass Distributions



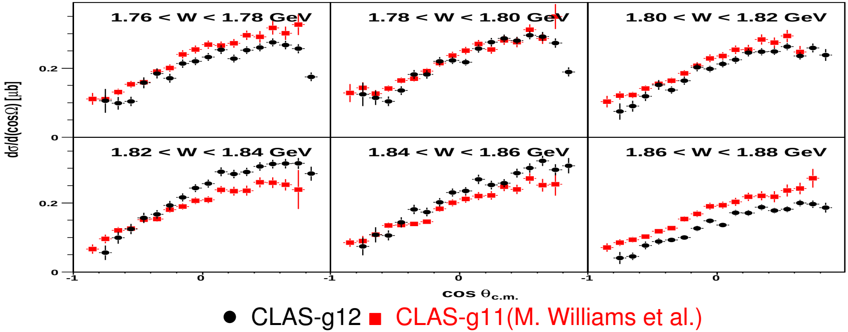
η Differential Cross Sections



η Differential Cross Sections



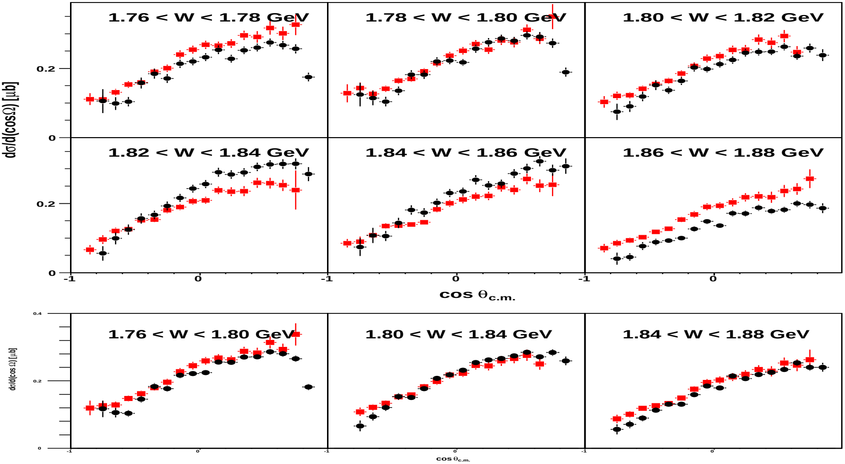
Fluctuations at Low Beam Energies



The only energy-dependent normalization factors are the photon flux and the MC efficiency.

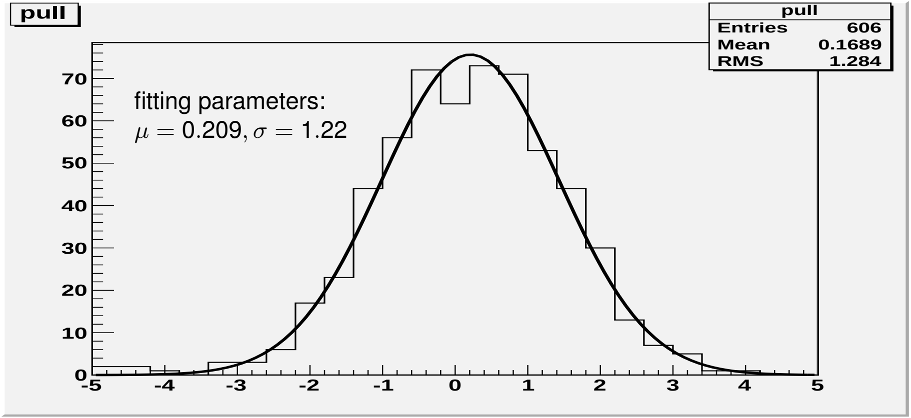
$$\frac{d\sigma}{d\Omega} = \frac{N}{\epsilon_{MC}\Phi\rho_{target}\Delta\Omega Br} \quad (4)$$

Solution for These Fluctuations



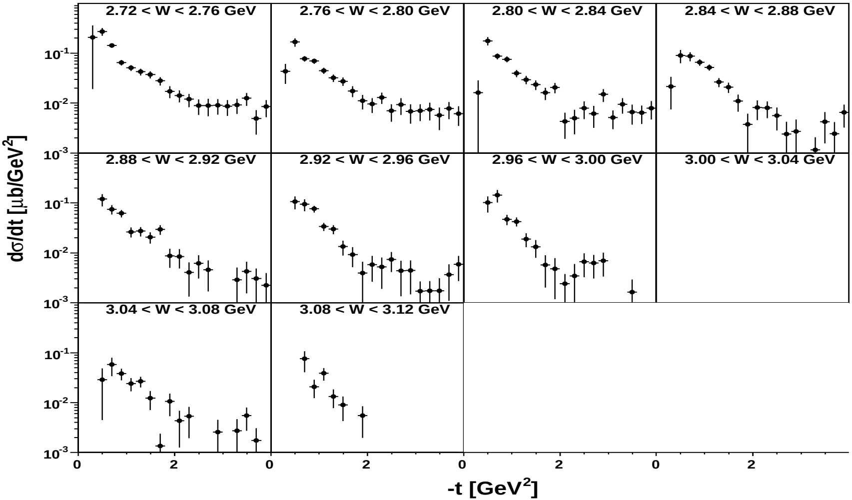
● CLAS-g12 ■ CLAS-g11(M. Williams et al.)

Pull Distribution with g11



$$\Delta S = \frac{S_1 - S_2}{\sqrt{\sigma_1^2 + \sigma_2^2}} \tag{5}$$

$d\sigma/dt$ Differential Cross Sections



Correlation Error of the Background Subtraction

The Q-factor method brings about a statistics-based uncertainty, called the correlation error.

- The more events in one kinematic bin, the smaller correlation error.
- The fewer events, the more repetitive nearest neighbors are used and the bigger correlation error there is.

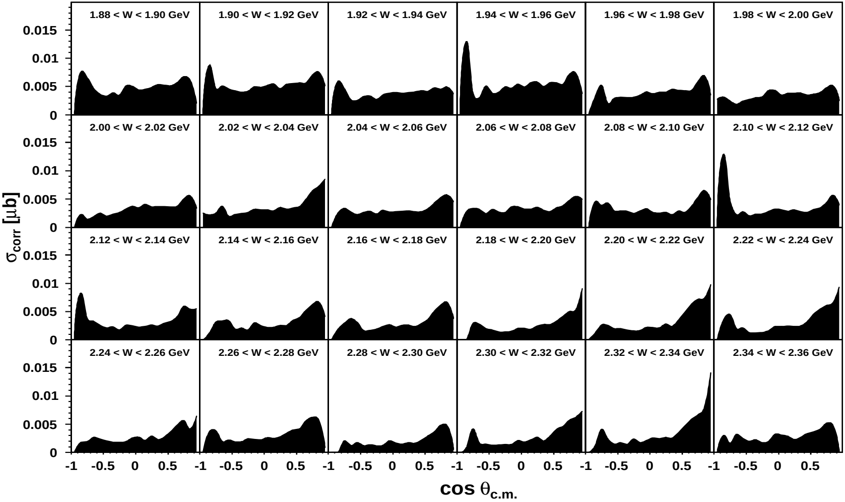
This error is formulated as

$$\sigma^2_{corr} = \sum_{i,j} \sigma^i_Q \rho_{ij} \sigma^j_Q \tag{6}$$

Then the total statistics-based uncertainty will be

$$\sigma^2 = \sigma^2_{corr} + \sigma^2_{stat} \tag{7}$$

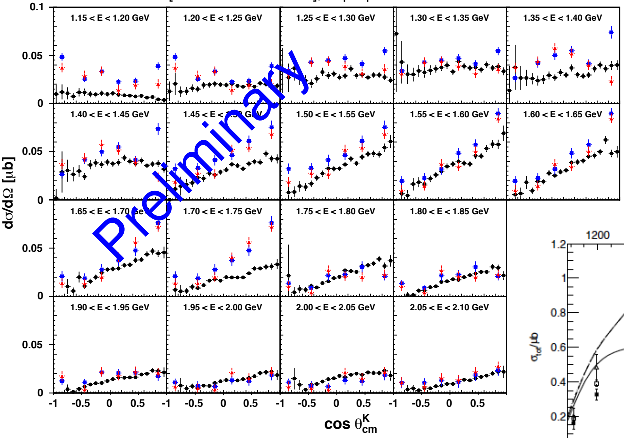
Correlation Error Band



Outline

$\gamma p \to K^0\Sigma^+$ Cross Section

Z. Akbar *et al.* [CLAS Collaboration], in preparation.

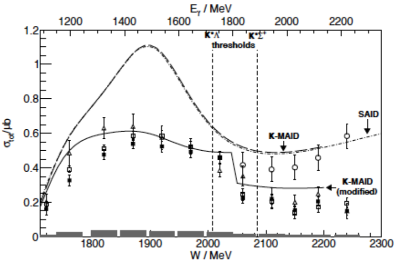


CLAS-g12 • CB-ELSA • CBELSA/TAPS •

New cross section results in 50-MeV-wide E_γ bins for

$$1.15 < E_\gamma < 3.0 \text{ GeV}$$

Phys. Lett. B **713**, 180 (2012)



➜ In preparation for $K^0\Sigma^+$: $E, \Sigma, T, C_x, C_z, O_x, O_z$

Outline

Summary

1. In this talk, we've mainly shown our η cross section measurement, which includes:
   - Corrections and Cuts
   - Background Subtraction
   - Preliminary Results
   - Error Analysis
2. Our plan of g12 cross section analysis:
   - $\gamma p \to p\eta$ Cross Section(to be concluded)
   - $\gamma p \to K^0\Sigma^+$ Cross Section
   - $\gamma p \to p\omega$ Cross Section
   - $\gamma p \to p\phi$ Cross Section