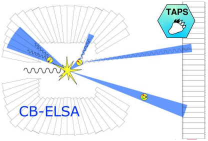
ω Photoproduction at the CBELSA/TAPS Experiment

Andrew Wilson
For the CBELSA/TAPS Collaboration

Florida State University

May 17-20, 2011
NStar 2011 Jefferson Lab Newport News, VA



Outline

1. Motivation
2. CBELSA/TAPS Experimental Setup
3. $\gamma p \to p\omega$
   - Reconstruction
   - Differential Cross Sections
4. CLAS/CBELSA η Disagreement
5. Summary and Outlook

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Motivations for Studying ω Photoproduction

- Find resonances that couple to ω mesons.
- Improve on the forward angle scattering cross sections.
- Help resolve the CLAS/CBELSA η photoproduction discrepancy.

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The PDG(2010) currently lists 4 N^* resonances that couple to the ω meson.

$$N(1710)^{***} \quad N(1900)^{**} \quad N(2080)^{**} \quad N(2190)^{****}$$

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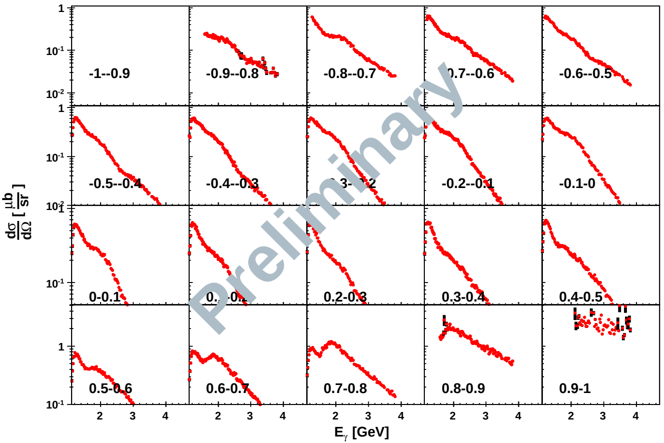
Motivations for Studying ω Photoproduction

CLAS ω Photoproduction Cross Section

M. Williams et al. Phys.Rev.C80:065209,2009.



Forward and backward angles $\rightarrow$ background processes and high spin resonances.

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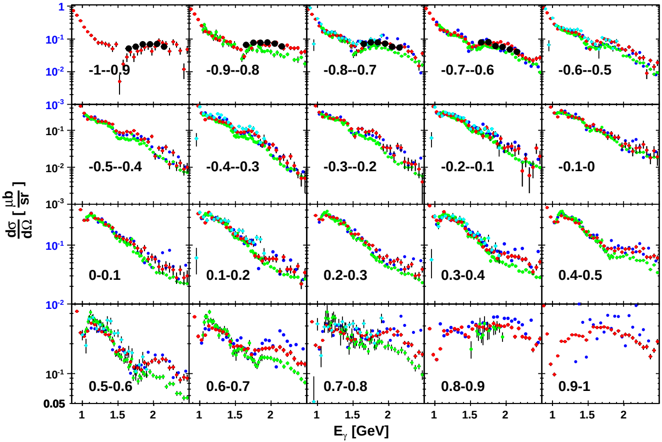
Motivations for Studying ω Photoproduction

Single η Photoproduction Cross Section

CBELSA/TAPS(09) CBELSA(05) CLAS(09) CLAS(02) LEPS(09)



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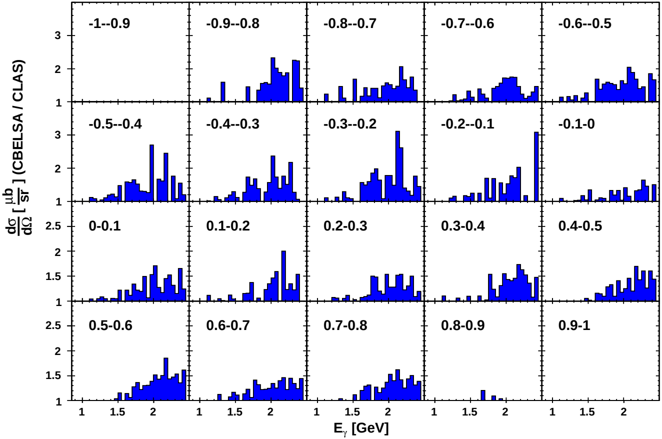
Motivations for Studying ω Photoproduction

Single η Photoproduction Cross Section Ratio



Normalization?

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At CBELSA/TAPS, the same photon flux is used for reactions π^0,η and ω.
Can use π^0 and ω cross sections study differences in normalization.

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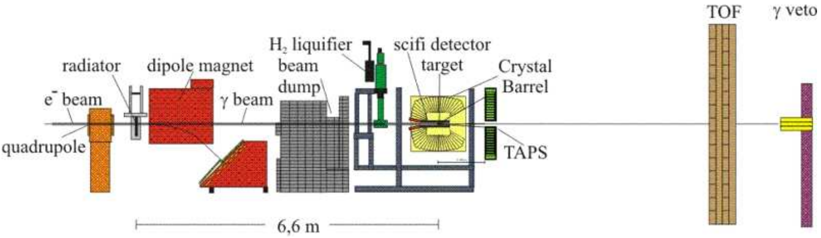
CBELSA/TAPS Experiment (2002)



- Located in Bonn, Germany at the ELSA facility.
- Nearly a 4π detector optimized to detect photons.
- Has scintillators to detect the presence of charged particles.
- CB (1290 *CsI* Crystals) TAPS (528 BaF_2 Crystals)

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Data Set

- Data taken October 2002 - November 2002
- Unpolarized photon beam up to 3.2 GeV
- Unpolarized liquid hydrogen target

Kinematic Cuts

$$p\omega \quad \to \quad p(\pi^0\gamma) \quad \to \quad p(\gamma\gamma)\gamma \quad \to \quad \text{3/4 particles}$$

- Transverse momentum cut $\pm 30\,\text{deg}$
- timing cuts (relative to the timing calibration)
  - Uncharged time $\pm$ 3 ns
  - Charged time {-5,+15} ns

Kinematic Fitting

ω meson

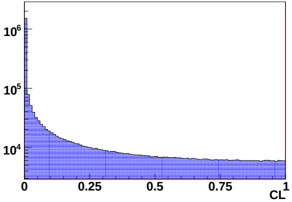
m = 782.65 MeV, Γ = 8.49 MeV

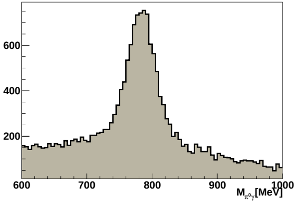
$\rightarrow$ Cannot kinematically fit to $p\omega$

Fit to $p_{missing}\pi^0\gamma$

Confidence Level Cut

$CL_{p\pi^0\gamma} > 0.01$





$\sim 440,000$ events left

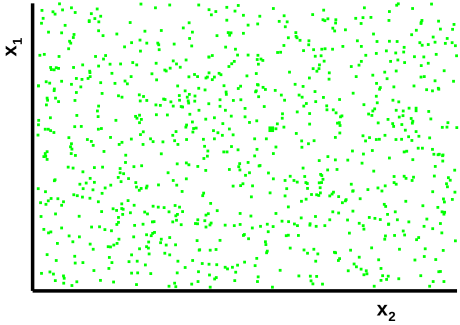
Qvalue Background Subtraction

Idea: Weight each event with its probability to be a true $p\omega$ event.

(M. Williams, M. Bellis, C.A. Meyer,JINST 4:P10003,2009.)

Events in $p\omega$ Phase Space

$(E_\gamma, \cos\theta_p^{cms})$



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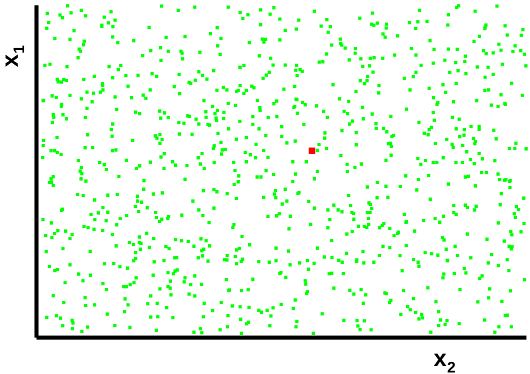

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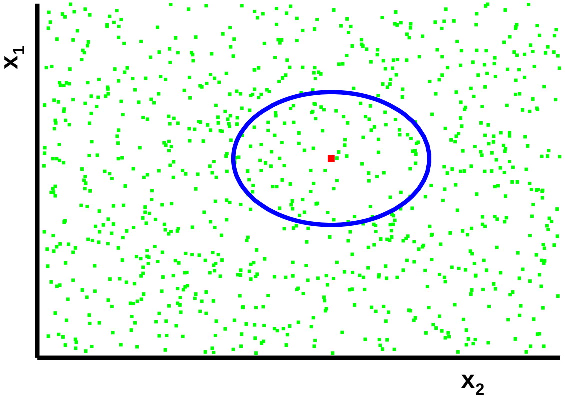
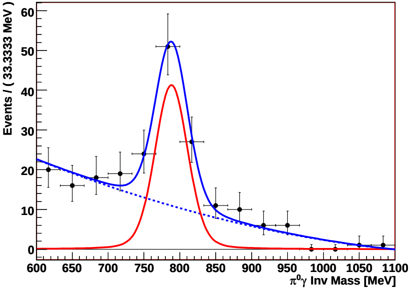
Nearest Neighbor Events



Qvalue Background Subtraction

Idea: Weight each event with its probability to be a true $p\omega$ event.

Plot and Fit of Nearest Neighbor Events



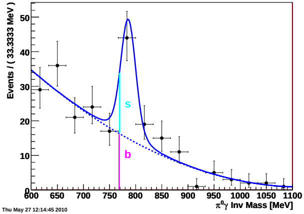
Voigt function (peak) with 2nd degree chebychev polynomial (background)

Unbinned maximum likelihood fit

Qvalue Background Subtraction

Idea: Weight each event with its probability to be a true $p\omega$ event.

$$\text{probability fraction (Qvalue)} = \frac{s}{s+b}$$



Repeat for each event

Advantage: Only have to fit once to produce different distributions of the data.
Disadvantage: Huge amounts of processing time. (one fit per event in analysis)

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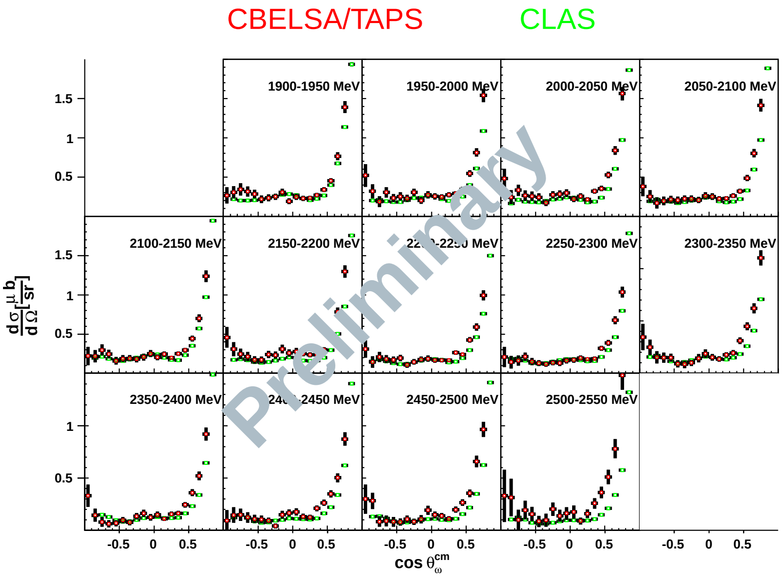
ω Photoproduction Differential Cross Sections



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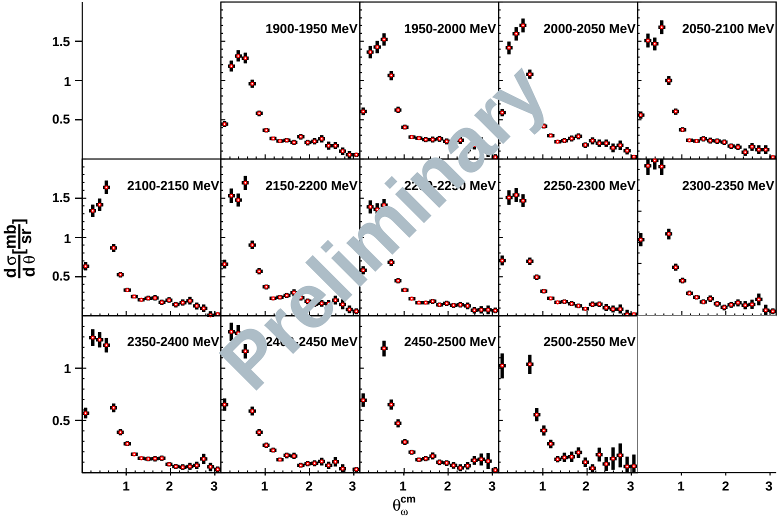

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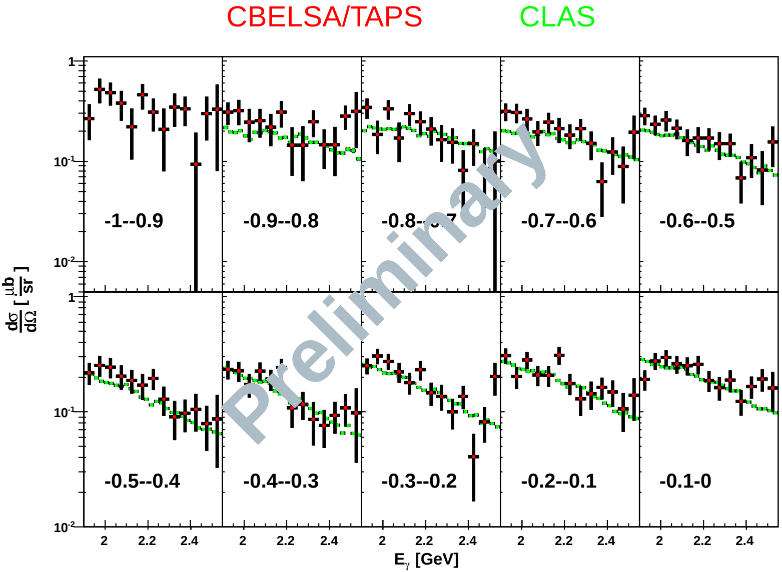

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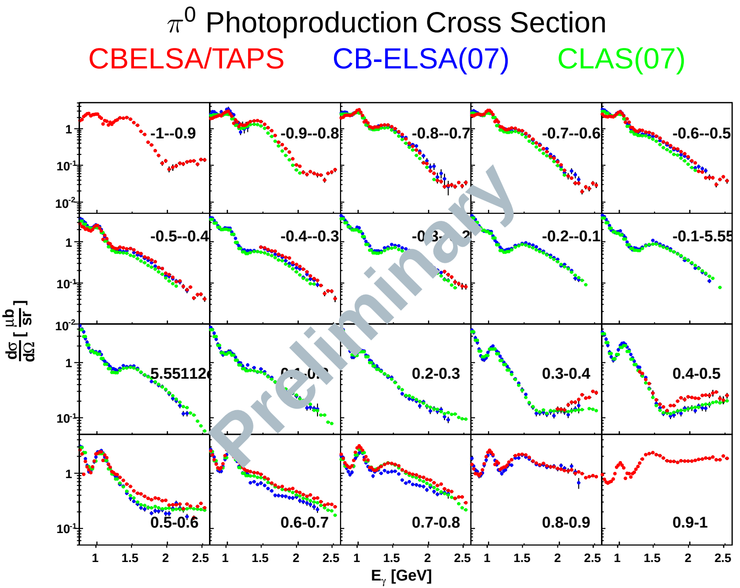
Reaction by Reaction Comparison

- π^0 Photoproduction
- ω Photoproduction
- η Photoproduction

Reaction by Reaction Comparison



N. Sparks Parallel session II-A (under collaboration review)

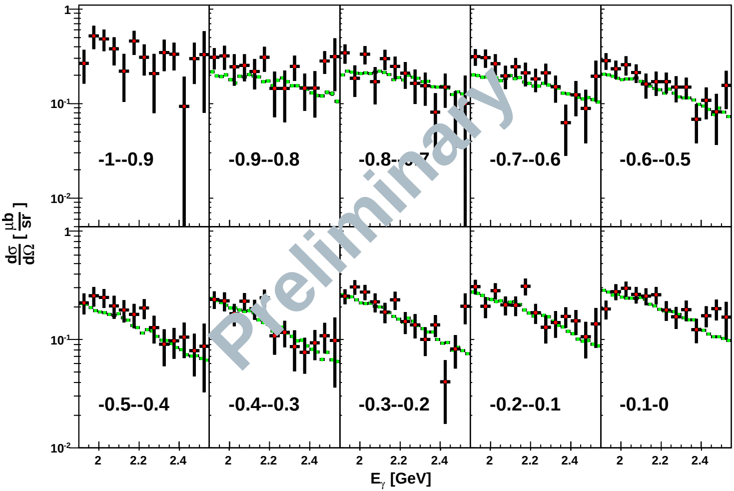
Reaction by Reaction Comparison

- π^0 Photoproduction
- ω Photoproduction
- η Photoproduction

Reaction by Reaction Comparison

ω Photoproduction Cross Section

CBELSA/TAPS CLAS



Reaction by Reaction Comparison

- π^0 Photoproduction
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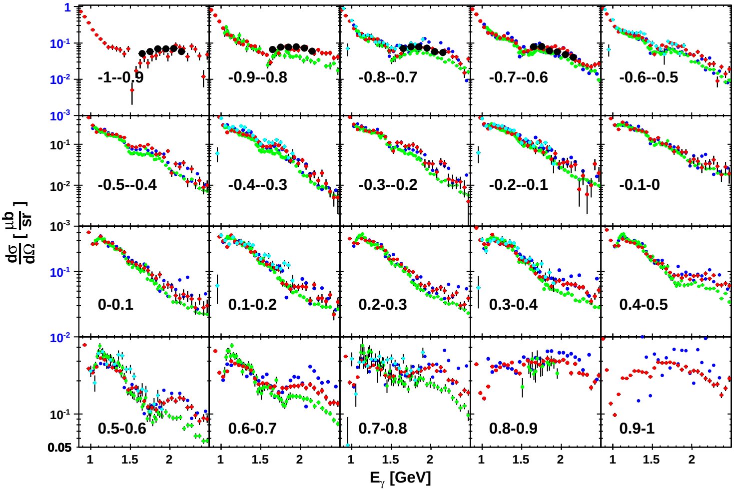
- η Photoproduction

Reaction by Reaction Comparison

η Photoproduction Cross Section

CBELSA/TAPS(09) CB-ELSA(05) CLAS(09) LEPS(09)



Reaction by Reaction Comparison

- π^0 Photoproduction
- ω Photoproduction
- η Photoproduction

- Could be normalization.
- The η photoproduction discrepancy is present above 1.8 GeV photon energy and occurs at all angles.
- Corresponds to about a factor of $\sim$2 difference at 2.5 GeV photon energy.

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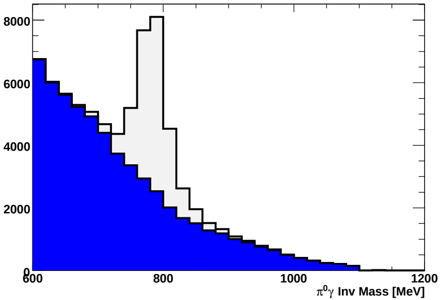
Summary

- Showed the reconstruction and differential cross sections for ω photoproduction.
- Analyzed the CBELSA/CLAS η differential cross section disagreement.

Outlook

- Finalize the ω photoproduction analysis.
- Continue with the analysis of $\pi^0\omega$ photoproduction.
- Continue work on a phenominological model to describe ω and $\pi^0\omega$ photoproduction.

$\pi^0\omega$ Analysis: $\pi^0\gamma$ Invariant Mass



$\sim$ 17,000 $p\pi^0\omega$ events.