HSWG

CLAS Collaboration Meeting
JLab, November 3 2016

Morning

08:30 **Hadron Spectroscopy Working Group Business** *20'*
Speaker: Marco Battaglieri (INFN-GE)

08:50 **An event generator for Npi and KY electroproduction at Q2 from 5.0 to 12 GeV2** *20'*
Speaker: Evgeny Golovach (MSU)

09:10 **Measuring Double Pion Electroproduction Cross-sections (remote)** *20'*
Speaker: Arjun Trivedi (USC)

09:30 **Investigation of exclusive π+π- electroproduction off the proton bound in the deuteron in the resonance region with CLAS** *20'*
Speaker: Iulia Skorodumina (USC)

09:50 **High Q2 π0 Electroproduction in the Resonance Region** *20'*
Speaker: Maurizio Ungaro (Jefferson Lab)

10:10 **Status report on the beam asymmetry for the omega meson off bounded proton** *20'*
Speaker: Olga Cortes (Idaho State University)

10:30 **Coffee Break** *30'*

11:00 **Box anomaly in eta'->pi+pi- gamma with clas g12 data (remote)** *10'*
Speaker: Xinying Song (Forschungszentrum Juelich)

11:10 **An update on the Radiative decay of Eta' from g11 data set** *20'*
Speaker: Georgie Mbianda (ODU)

11:30 **Status of the Analysis of eta->pi+pi-pi0 with the CLAS g12 data set**
Speaker: Danie Lersch (Juelich Research Center)

11:50 **An update on eta->pi+pi-\gamma from g11 data** *20'*
Speaker: Torri Roark (ODU)

12:10 **K0 Lambda Cross Sections with g13 Data** *20'*
Speaker: Nicholas Compton (OHIO U)

12:30 **Study of Coherent Deuteron Scattering using g10 Data** *20'*
Speaker: Taya Chetry (Ohio U)

Afternoon

14:30 **Analysis review status** *30'*

15:00 **The HSWG in the CLAS12 era (HSWG 2.0)** *20'*
Speaker: Marco Battaglieri (INFN-GE)

15:20 **The common tools for HSWG 2.0** *20'*
Speaker: Raffaella De Vita (INFN - Genova)

15:40 **The HSWG 2.0 analysis framework** *20'*
Speaker: Derek Glazier (University of Glasgow)

16:00 **Coffee break** *30'*

16:30 **Discussion** *1h0'*

Agenda

- ✳ Status of ongoing analysis
- ✳ Status of analysis review
- ✳ HSWG in CLAS12 era: HSWG 2.0

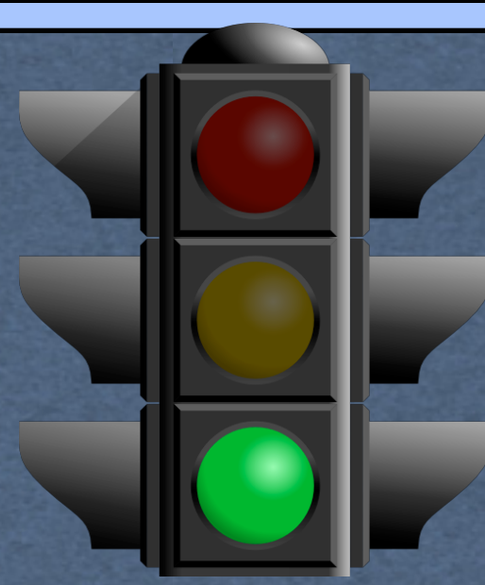
Activities

- ✳ Regular report at HSWG on JPAC activity to strengthen exp/the connection
- ✳ JPAC plenary talk at the Collaboration meeting
- ✳ Analysis ready for a plenary presentation?

Talks

- ✳ Over all CLAS contributions, HSWG-related are 36%
- ✳ Strong interaction with the CSC
- ✳ List of possible topics/speakers on the latest CLAS results
- ✳REMINDER: Communicate talks and proceedings to the CSC
- ✳ JSA-TFC funds $20k allocated for 2016

WG Reviews status



K0Λ Photoproduction on the Neutron within the Resonance Region
PI: Nick Compton
RC: L.Zana, E.Isupov, S.Schadmand
Started Jan 2016
Status:II round, progresssing

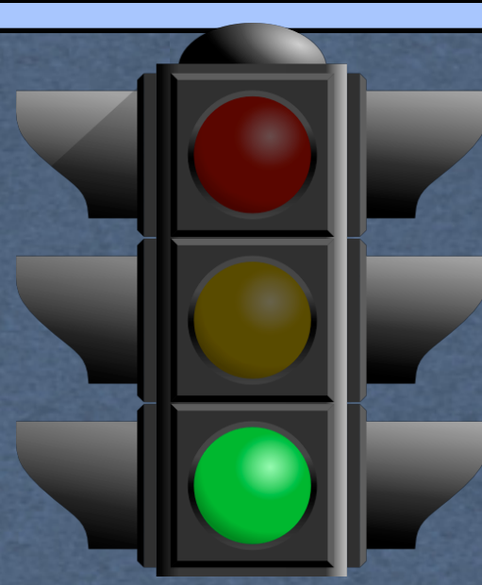
2pi photoproduction from g11
PI: Evgheny Golovach et al.
Ralf Gothe (Chair), Lei Guo , Alessandro Rizzo
Status: progressing

DONE!

Pol OBSERVABLES IN g(pol) d to K+Lambda n FSI
PI: Nick Zachariou et al.
Steffen Strauch (Chair), Mikhail Bashkanov , Kenneth Hicks
Status: progressing

Less than 4 months!

WG Reviews status



Cascade polarization in photoproduction

PI: J.Bono et al.
RC: A. D'Angelo (Chair), M.Kunkel, E Pasyuk
Status: just started

Polarization Observables T and F in the $\vec{p}(\vec{\gamma},\pi 0)p$ Reaction

PI:H.Jiang
RC: Barry Ritchie (Chair), Volker Crede , Bryan McKinnon
Status: just started

Measurement of Cross-Sections of exclusive pi^{0} Photo-production on Hydrogen from 1.1 GeV - 5.45 GeV using e +e-gamma

PI: Michael Kunkel
RC: Carlos Salgado (Chair), Lei Guo , Yordanka Ilieva
Status: just started

New since last meeting

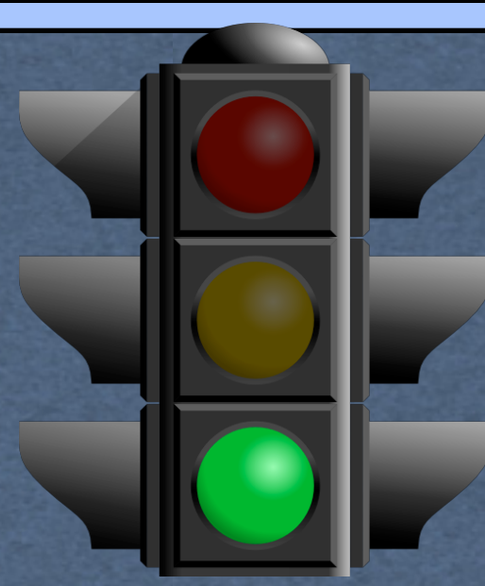
Analysis report on the ep \to e'p pi+ pi- reaction in the CLAS detector with a 2.039 GeV beam

PI: Gleb Fedotov
RC: Nikolay Markov (Chair), Evgeny Golovach , Daniel Carman
Status: just started

Measurement of the g d o p pi- (p) Quasi-free xsec

PI: Paul Mattione
RC: Eugene Pasyuk (Chair), Nicholas Compton , Nicholas Zachariou
Status: just started

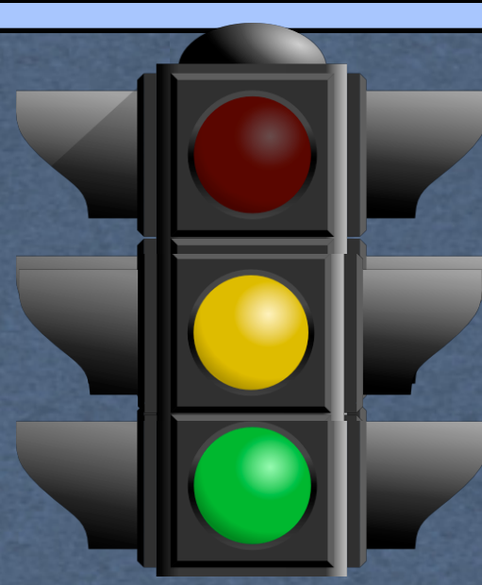
WG Reviews status



Measurement of Sigma in pi- photoproduction on the neutron from the g13b dataseta
PI: D.Sokhan (GlasgowU) et al.
RC: Eugene Pasyuk (Chair), Nicholas Zachariou , Paul Mattione
Timeline: jun 2016
Status: just started

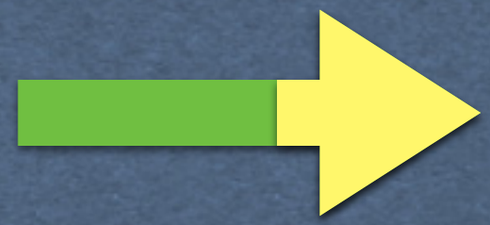
In progress

WG Reviews status

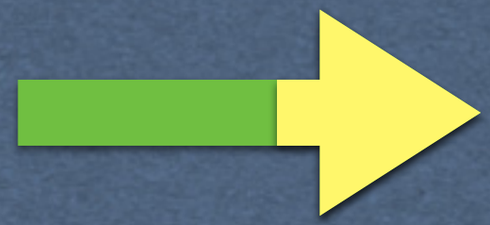


KLambda and KSigma from FROST
PI: N.Walforf et al.
RC: S.Strauch, M.Holtrop, P.Mattione,
1 round of comments in May 2015, waiting for a revised
Status: stalled

Spin observables in omega production
PI: Brian Vernarsky
RC: F.Klein, A.Filippi, S.Strauch
Started Sept 2014
Status: resumed connection with CMU, Committee
Status: progressing

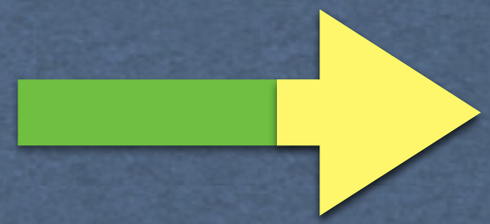


Pentaquark search in g10 by using the MMSA method
PI: Kenneth Hicks et al.
RC: Stepan Stepanyan (Chair), Lei Guo , Bryan McKinnon
Status: III round



Gamma p to K0K0 from the g12 Data Set
PI: Kenneth Hicks and Shloka Chandavar
RC: Carlos Salgado (Chair), Derek Glazier , Lorenzo Zana
Status: II round

E asymmetry for g n -> pi^- p from g14 (HDice) data
PI: F.Klein
RC: B.Briscoe, P.Cole, M.Dugger
Status:?????



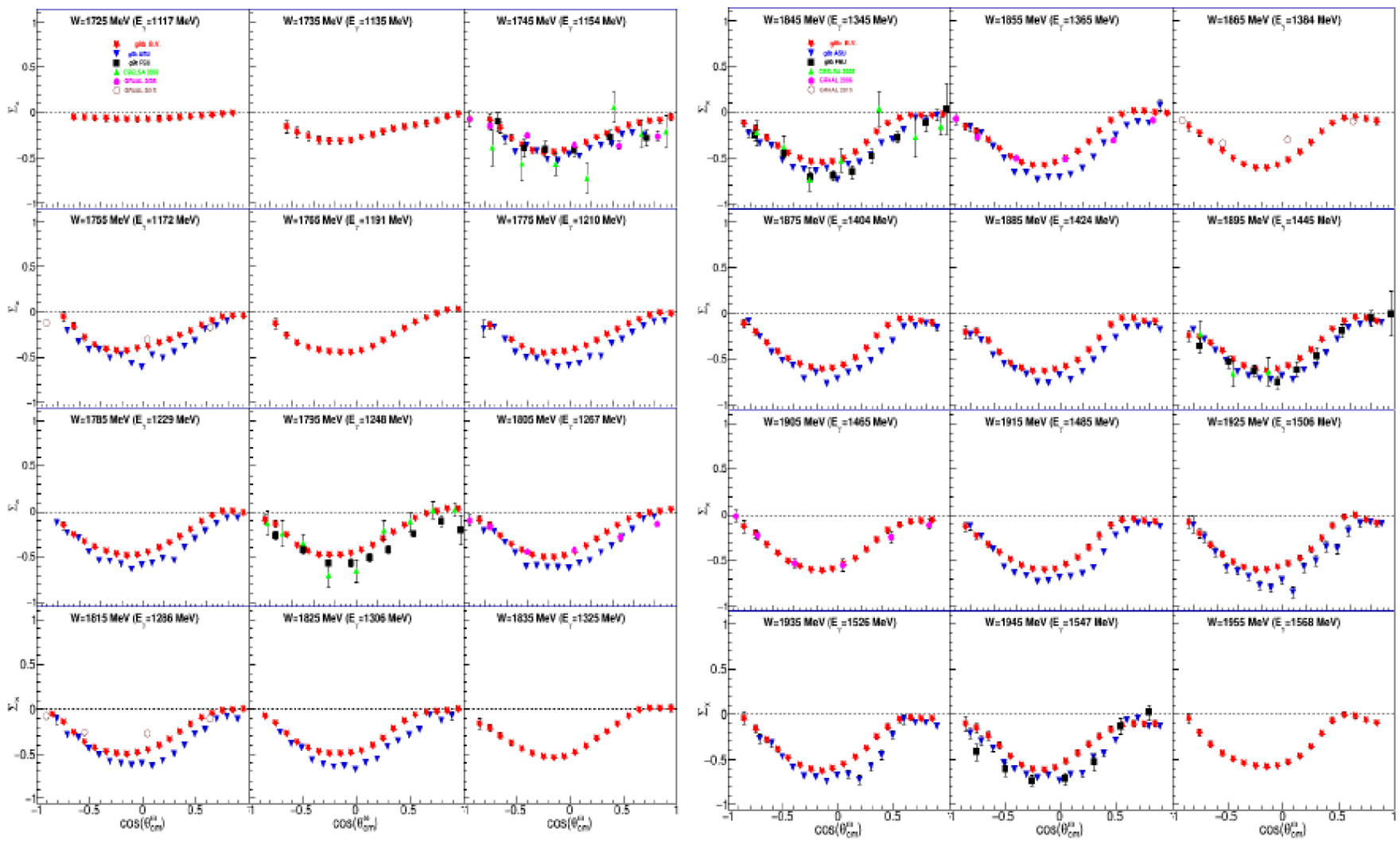
Spin observables in omega production

PI: Brian Vernarsky
RC: F.Klein, A.Filippi, S.Strauch
Started Sept 2014
Status: resumed connection with CMU, Committee
Status: progressing

At this point the committee cannot recommend to go forward with a publication!

Aug/Sept. 2016: re-analyzed ASU and FSU data

Red: CMU (g8b from SDMEs)
Blue: 'new' ASU (g8b)
Black: 'new' FSU (g9b)



ASU and FSU data fully consistent, both off by ~30% compared to B.V.'s data

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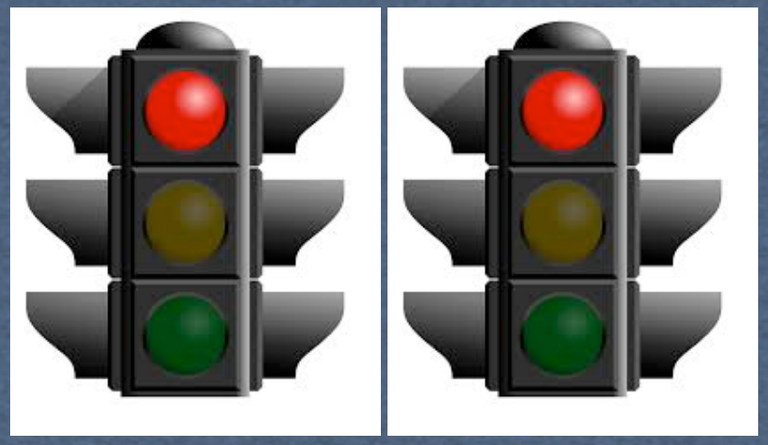
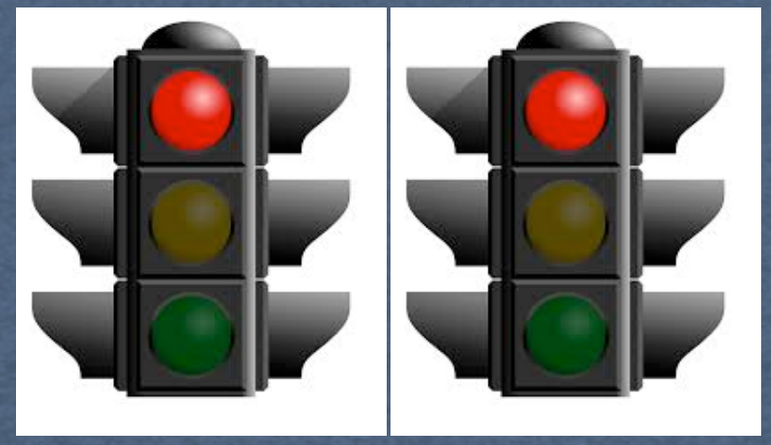


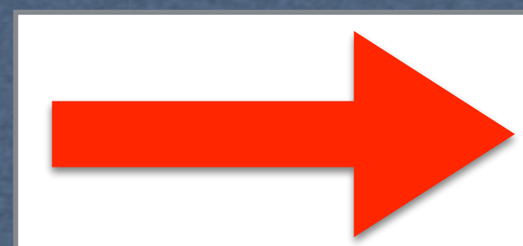
WG Reviews status



Spin observables in eta meson photoproduction on the proton from FROST data
PI: R.Tucker (ArizonaU) et al.
RC: K.Livingston, J.Price, Xiangdong Wei
Timeline: jun 2016
Status: just started

Polarized structure function sigmaLT from the single pi0 electroproducion on the proton in the resonance region
PI: Nick Markov
RC: V.Crede, Ralf Goethe, Yelena Prok
Started Sept 2014
Status: new Pid documented as addendum

Exclusive Photo-Production Measurement of K +Sigma*- off Quasi-Free Neutrons in Deuterium
PI: H.Lu (SCU) et al.
RC: N.Zachariou, M.Dugger, D.MacGregor
Status: resumed with reshuffled committee, still waiting …



Action required!

Event generator for the $p\pi^0$, $n\pi^+$, $K^+\Lambda$, and $K^+\Sigma^0$ electroproduction channels at Q^2 from 5 to 12 GeV^2

V. Klimenko[1], E. Golovach[1], V. Mokeev[2]
[1]Moscow State University
[2]JLAB

Using CLAS6 data to be ready for the CLAS12 challenges

Event generator for the $p\pi^0$, $n\pi^+$, $K^+\Lambda$, and $K^+\Sigma^0$ electroproduction channels at Q^2 from 5 to 12 GeV^2

V. Klimenko[1], E. Golovach[1], V. Mokeev[2]
[1]Moscow State University
[2]JLAB

CLAS data provided cross sections for a number of exclusive at Q^2 below ≈ 5-6 GeV^2. An attempt was performed to extrapolate the integrated cross sections up to Q^2 ≈ 12 GeV^2.

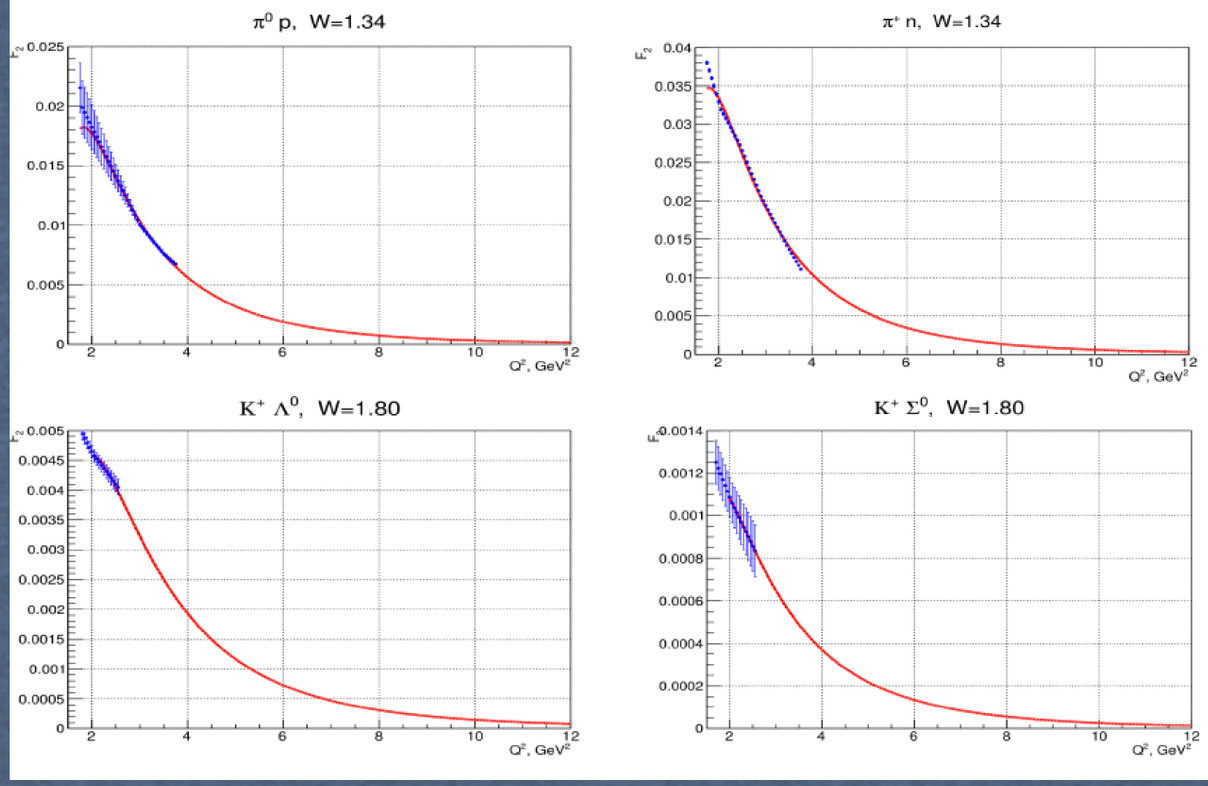
Contribution from the exclusive channels into inclusive structure functions were extracted from the available data. In the spirit of the operator product expansion we assumed:

$$F_{1,2,channel}(W,Q^2) = \sum_{n=0,1,2} \frac{C_n}{(Q^2)^n}$$

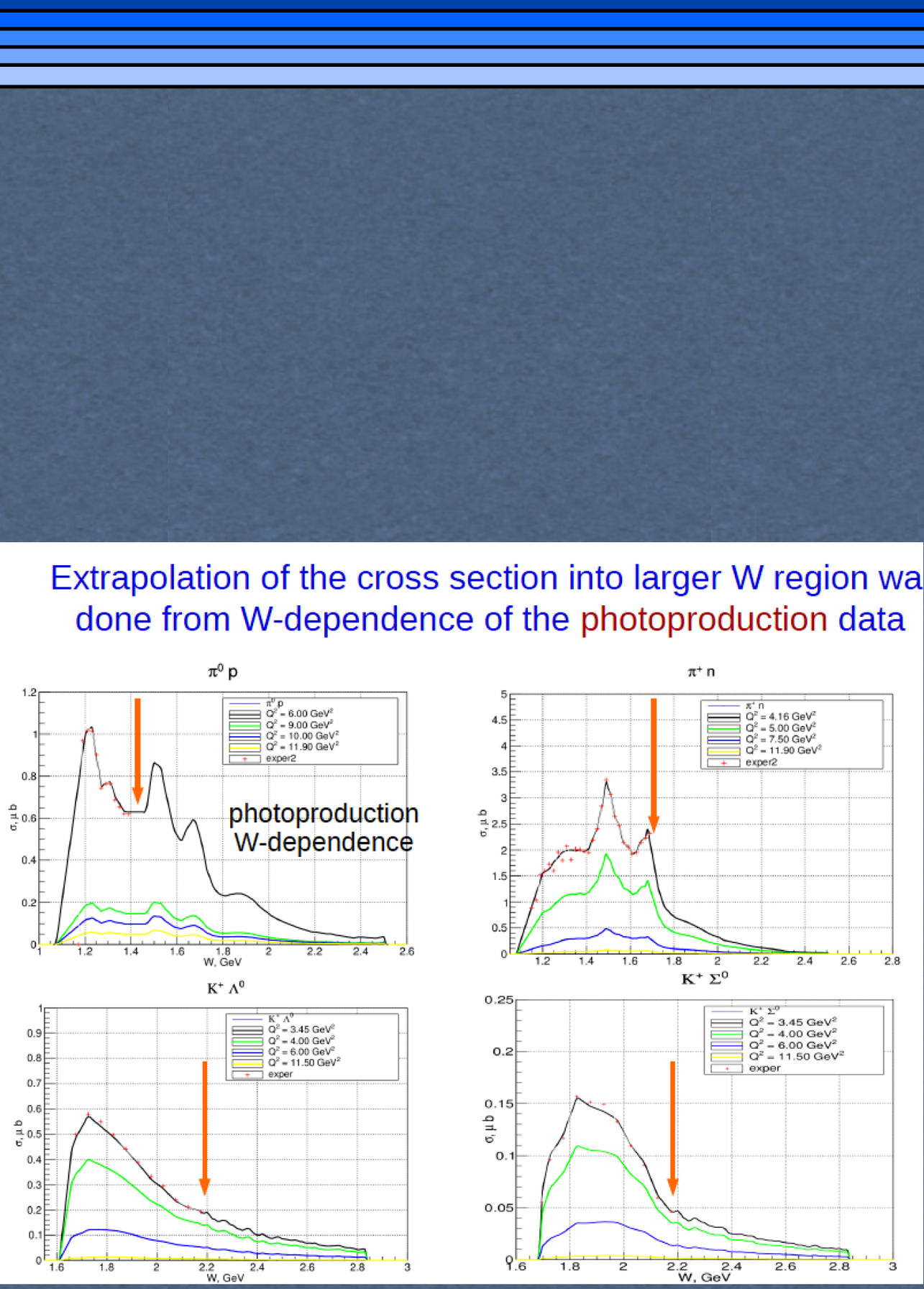
$F_{1,channel}$ and $F_{2,channel}$ were fit at each W, in the Q^2 range, where data are available, letting C_n to be the fit parameters.

Then $F_{1,channel}$ and $F_{2,channel}$ were extrapolated to higher Q^2. The extrapolated cross section was then calculated.

Fit and Extrapolation of the contribution of the exclusive channels into the structure function F_2



Extrapolation of the cross section into larger W region was done from W-dependence of the photoproduction data



Measurement of Double Pion Electroproduction Cross-sections

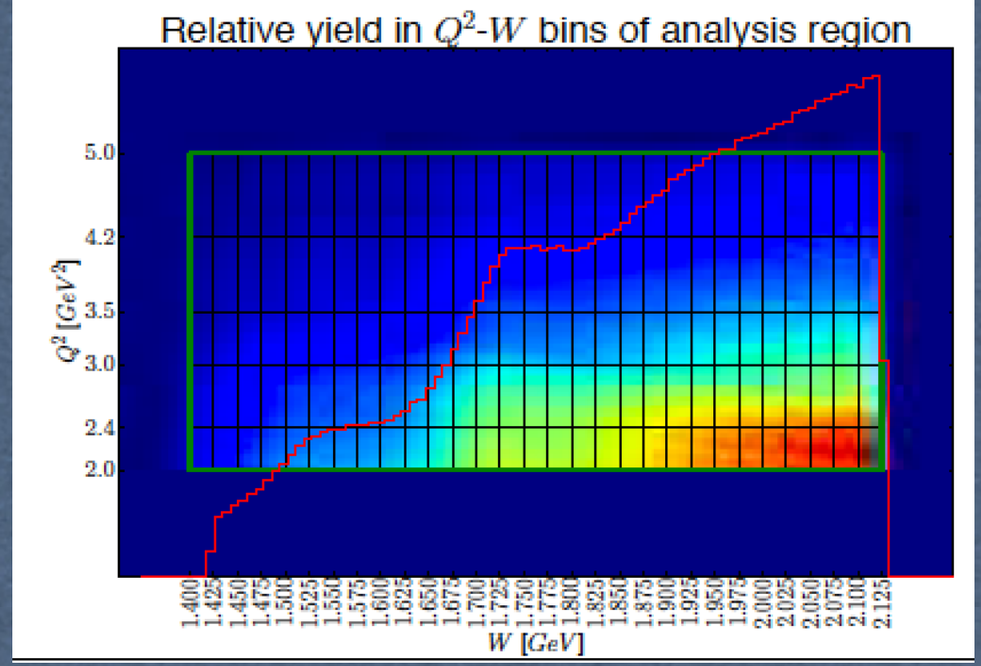
Reaction: $ep \rightarrow e'p'\pi^+\pi^-$

$Q^2 = [2.0, 5.0] GeV^2$

$W = [1.400, 2.125] GeV$

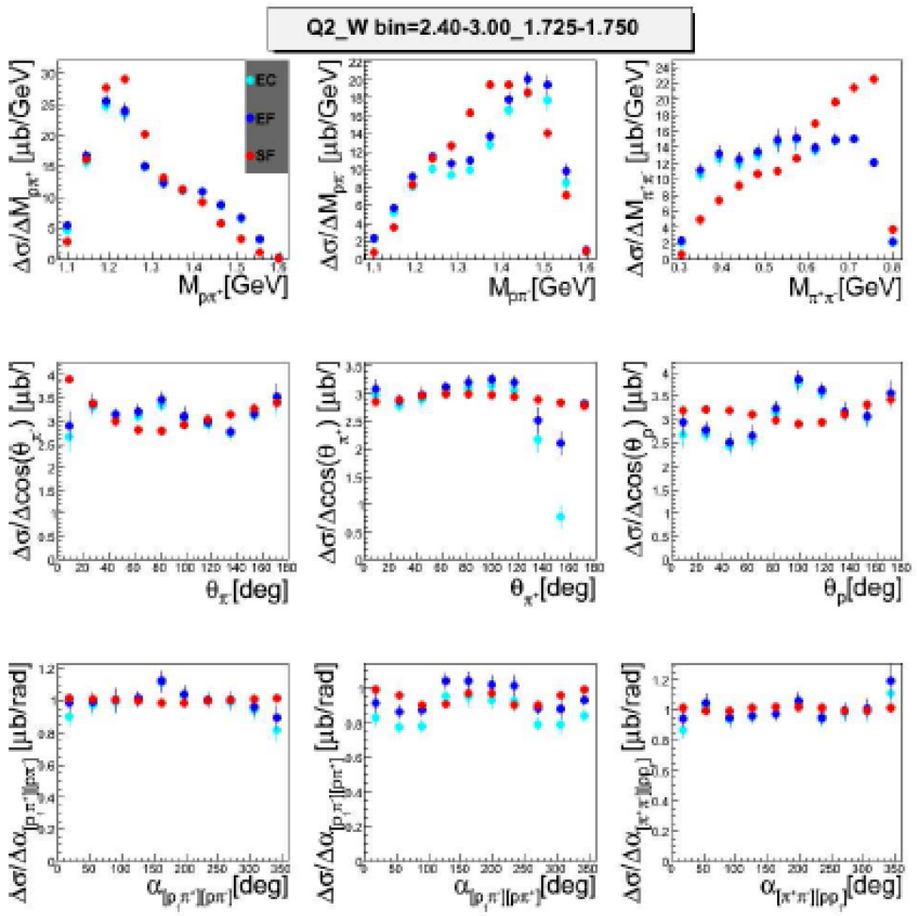
Arjun Trivedi

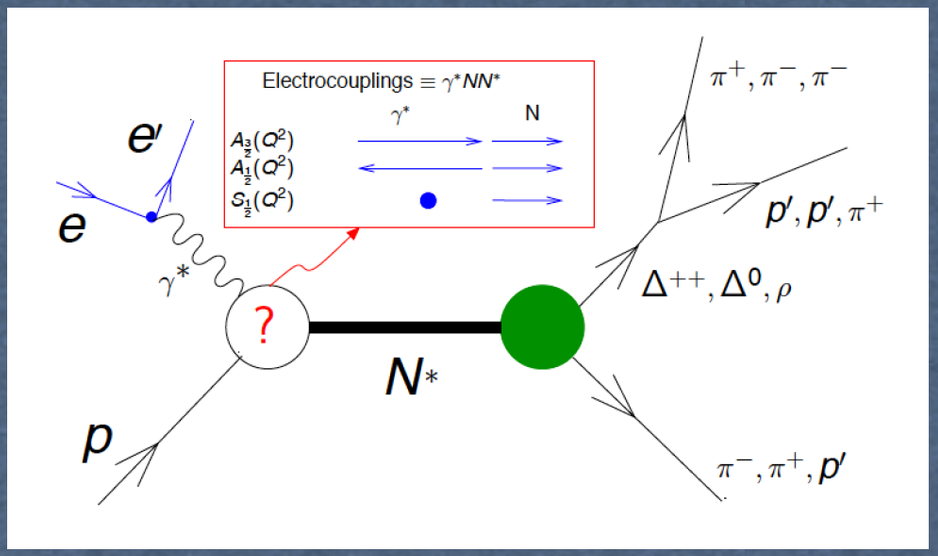
E16 experiment conducted in Hall B



Single-differential cross-sections

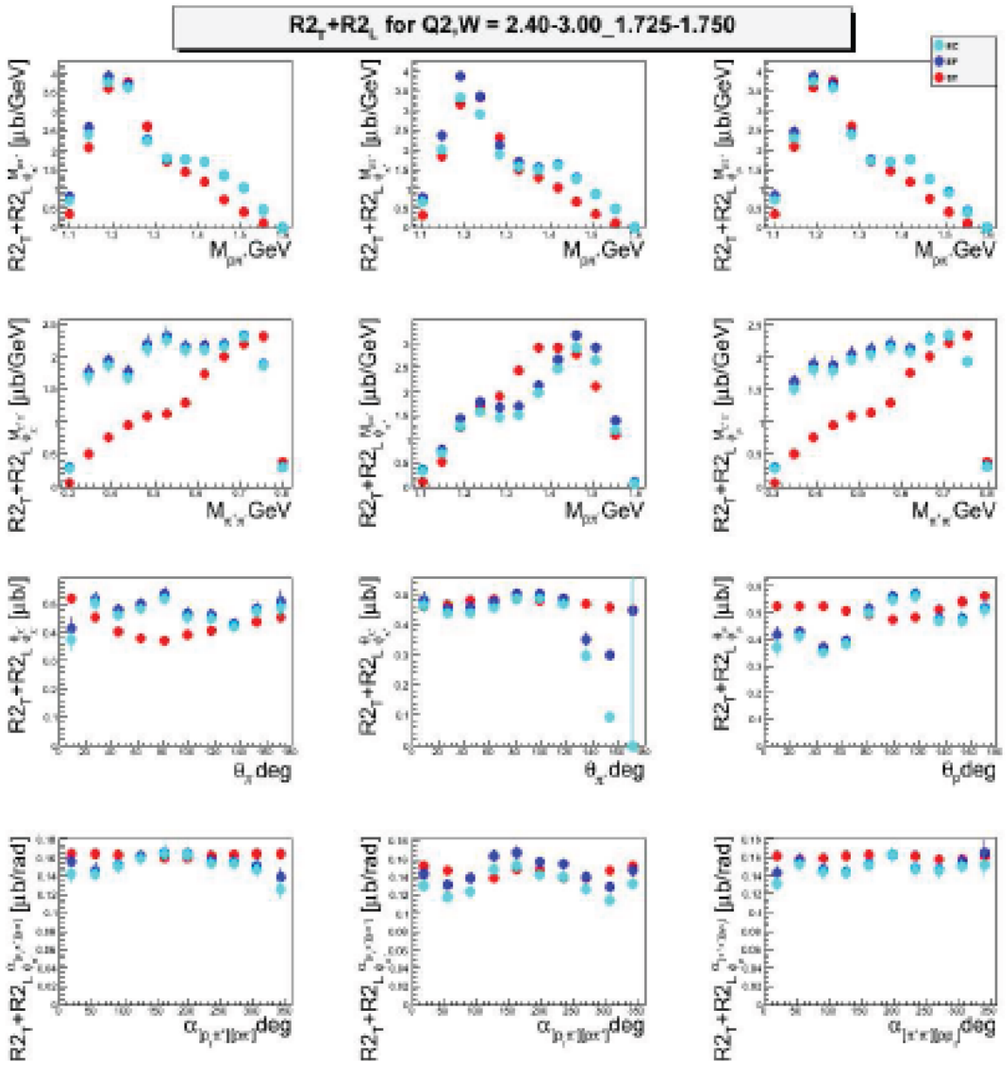
Q^2, W bin $= [2.4, 3.0) GeV^2, [1.725, 1.750) GeV$

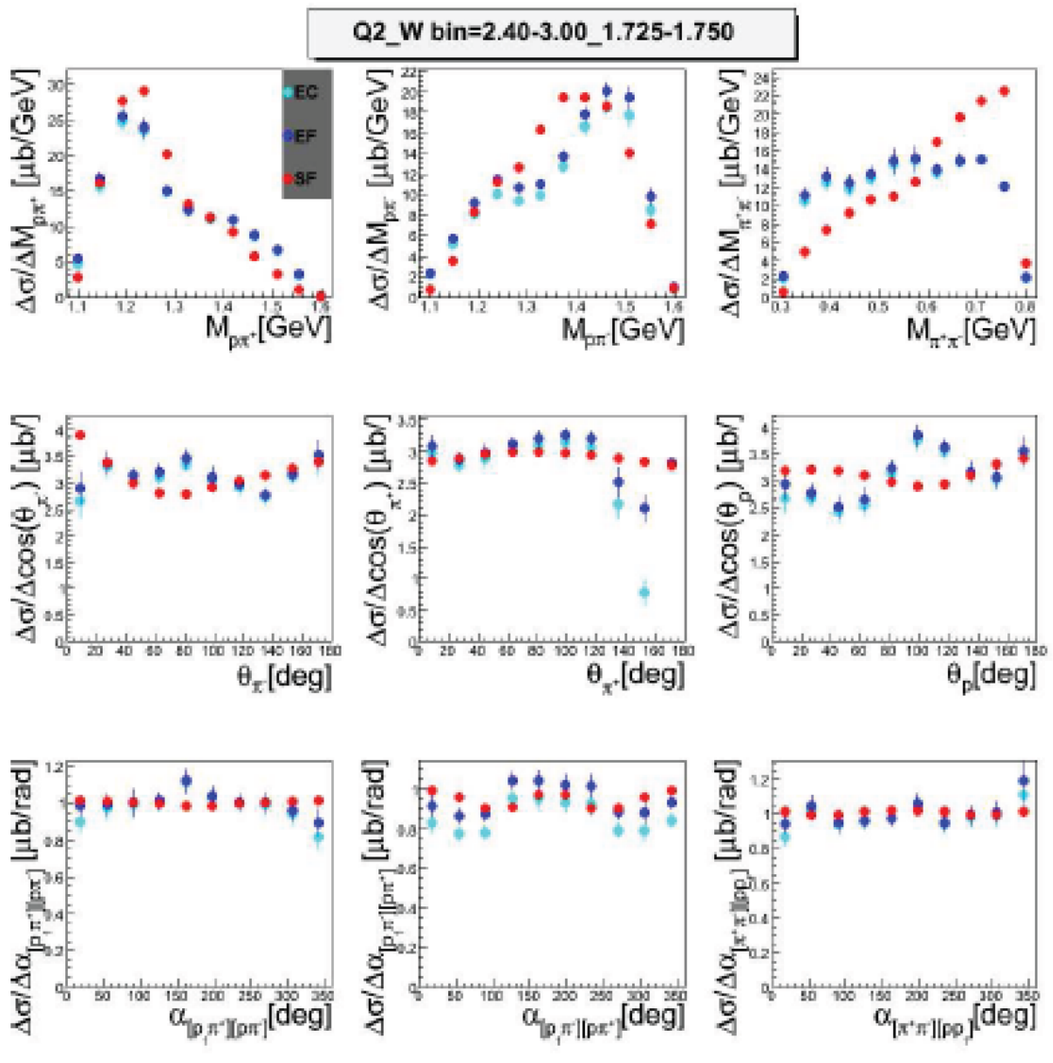




γ^* polarization dependent cross-sections

Q^2, W bin $= [2.4, 3.0)GeV^2, [1.725, 1.750)GeV$





$$\left(\frac{d^2\sigma}{dX_{ij}d\phi_i}\right) = \underline{R2_T{}^{X_{ij}} + R2_L{}^{X_{ij}}} + R2_{LT}{}^{c,X_{ij}}\cos\phi_i + R2_{TT}{}^{c,X_{ij}}\cos 2\phi_i + \delta_{X_{ij}\alpha_i}\left(R2_{LT}{}^{s,\alpha_i}\sin\phi_i + R2_{TT}{}^{s,\alpha_i}\sin 2\phi_i\right)$$

Electroproduction of π^0 in the resonance region at high Q^2 with CLAS

Analysis Overview
Preliminary Results

Maurizio Ungaro

Volker Burkert, Kyungseon Joo, Cole Smith, Paul Stoler

June / July 2016:

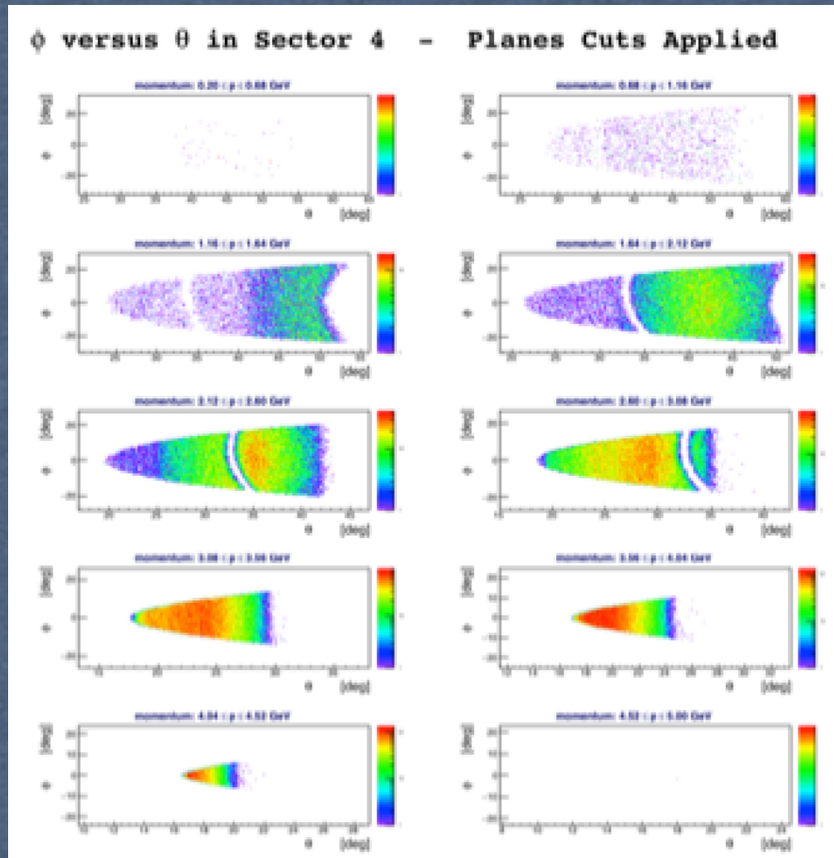
- Refurbishing software to re-cook e1-6 data

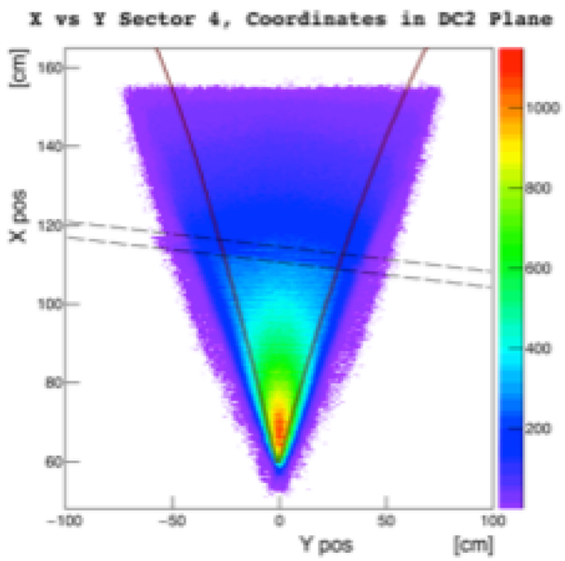
Aug 2016:

- E1-6 data processed

Sept / Oct / Nov 2016:

- Refurbishing generator (aao)/GSIM/analysis software
- Acceptance Calculation
- Data analysis



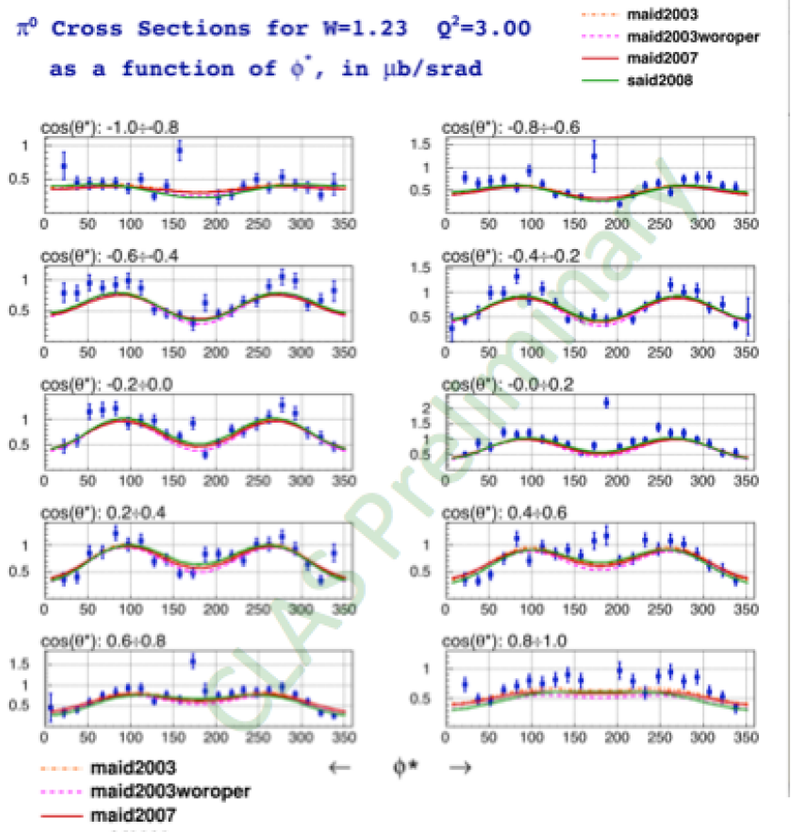


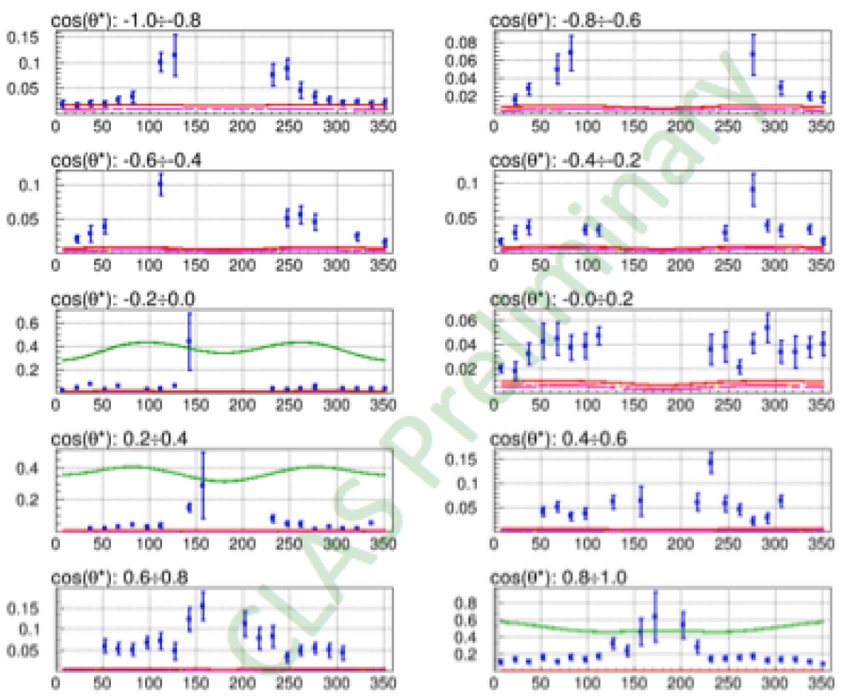
$$d\sigma/d\Omega^* = \sigma_T + \varepsilon\sigma_L + \varepsilon\sigma_{TT}\cos 2\phi + \sqrt{2\varepsilon(\varepsilon+1)}\sigma_{LT}\cos\phi$$

$$\sigma_L + \varepsilon\sigma_T = a$$

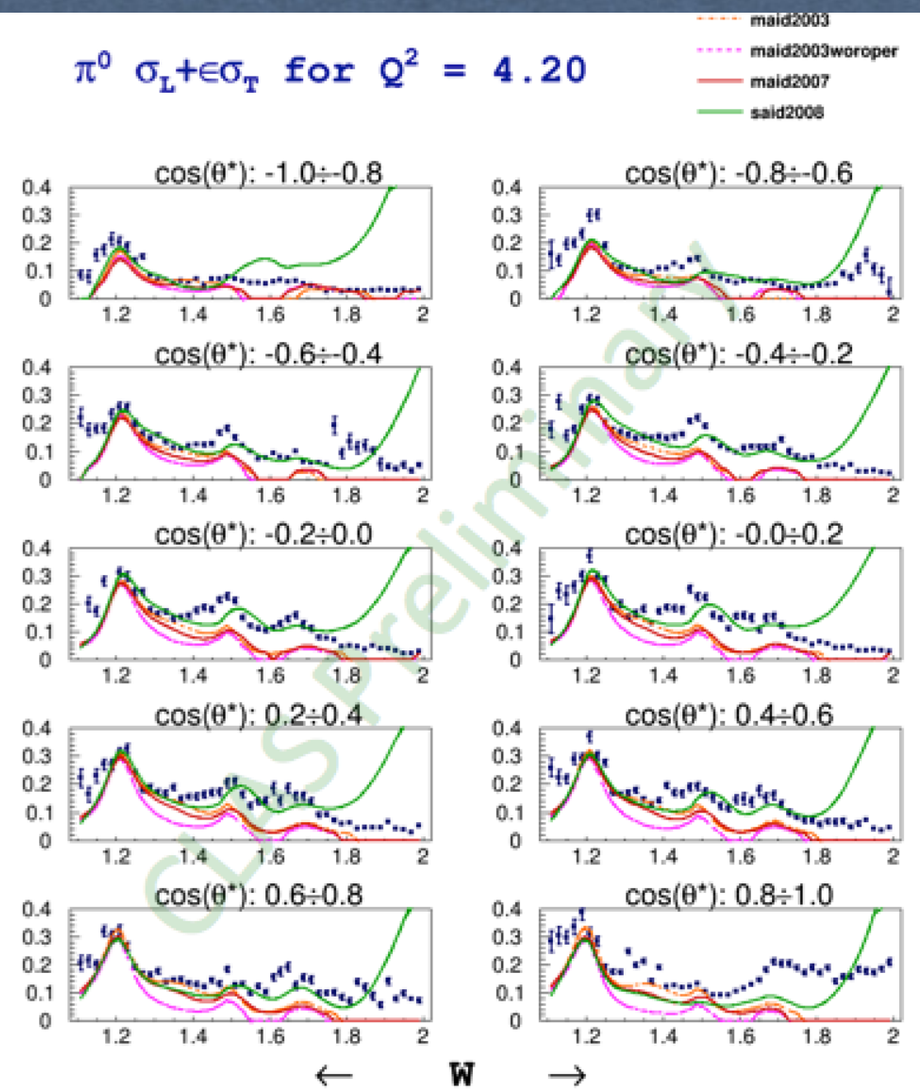
$$\sigma_{LT} = \frac{b}{\sin\theta\sqrt{2\varepsilon(\varepsilon+1)}}$$

$$\sigma_{TT} = \frac{c}{\sin^2\theta\,\varepsilon_T}$$





$$d\sigma/d\Omega^* = \sigma_T + \varepsilon\sigma_L + \varepsilon\sigma_{TT}\cos 2\phi + \sqrt{2\varepsilon(\varepsilon+1)}\sigma_{LT}\cos\phi$$



Investigation of Exclusive π+π- Electroproduction off the Proton Bound in the Deuteron in the Resonance Region with CLAS

Speaker: Iuliia Skorodumina
(University of South Carolina)

What is different from the free proton target experiment?

1) Fermi motion of the target proton which leads to:

- *W*-smearing if not all final particles are registered
- Different procedure of lab-to-cms transformation

2) Considerably more complex effects of initial and final state interactions due to the presence of spectator neutron

3) Off-shellness of the target proton

4) Possible modification of reaction amplitudes

Final Goals

- To extract fully integrated and single differential cross sections of the reaction $\gamma_v\, p(n) \rightarrow p'(n')\pi^+\,\pi^-$ in the resonance region 1.3 GeV < *W*< 1.825 GeV, 0.45 GeV^2 < Q^2 < 1 GeV^2

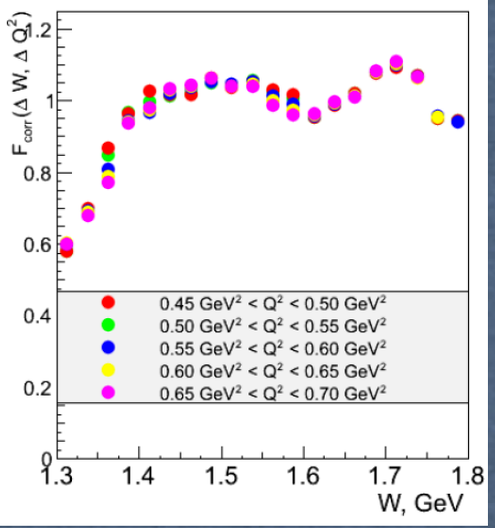
- To compare them with the cross sections of the analogous reaction off the free proton

Correcting the Effects of Fermi Motion on the Cross Sections

$$\frac{d\sigma}{dW_{true}dQ^2d\tau} = \frac{d\sigma}{dW_{fsm}dQ^2d\tau}F_{corr}(\Delta W, \Delta Q^2, \Delta\tau)$$

$$F_{corr}(\Delta W, \Delta Q^2, \Delta\tau) =$$

$$\frac{N_{nofermi}(\Delta W, \Delta Q^2, \Delta\tau)}{N_{fermi}(\Delta W, \Delta Q^2, \Delta\tau)}$$



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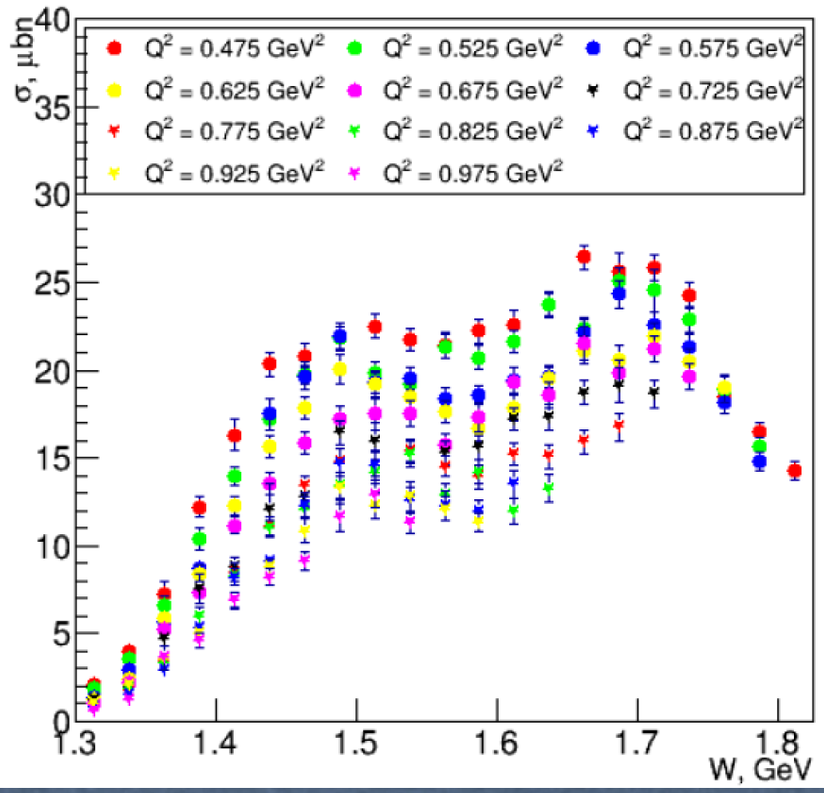
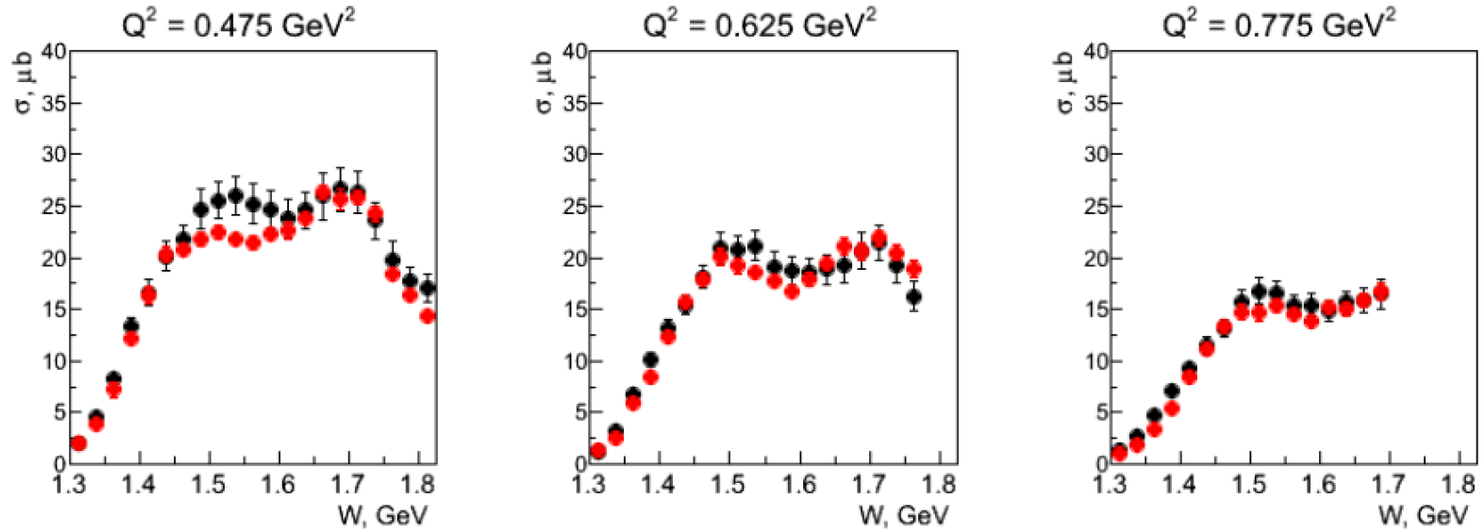




Black symbols – free proton cross sections (e1e, E_{beam} = 2.039 GeV)
error bars show both statistical and systematical uncertainties
G. Fedotov analysis note under review

Red symbols – bound proton cross sections (e1e, E_{beam} = 2.039 GeV)
error bars show statistical uncertainty only

Status report on the beam asymmetry for the omega meson off bound proton

Olga María Cortés

ω photoproduction off bound proton in previous experiments

- The study of bound proton can be studied in comparison with free proton data. (CLAS g8b and g9FROST)
- The way we handle bound proton will provide information on how to analyze bound neutrons

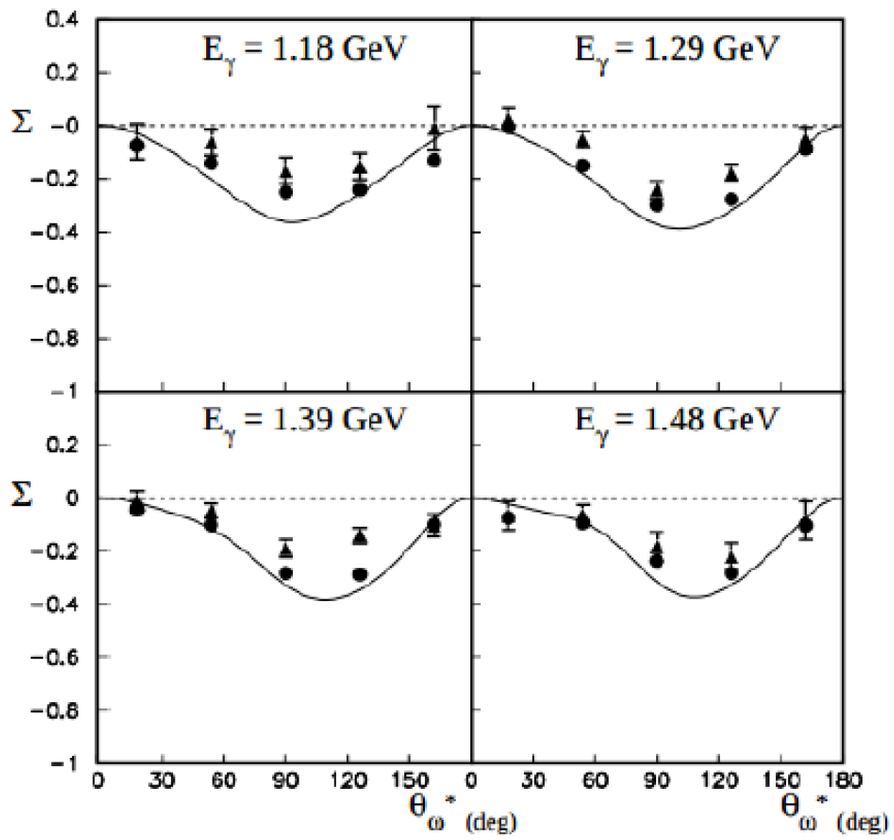


Figure: Data GRAAL 2015: Full circles, free proton. Full triangles, quasifree. (V. Vegna et al. PhysRevC.91.065207 (2015))

$\vec{\gamma}p(n) \to \omega p(n)$ with $\omega \to \pi^+\pi^-\pi^0$ and $\pi^0 \to \gamma\gamma$

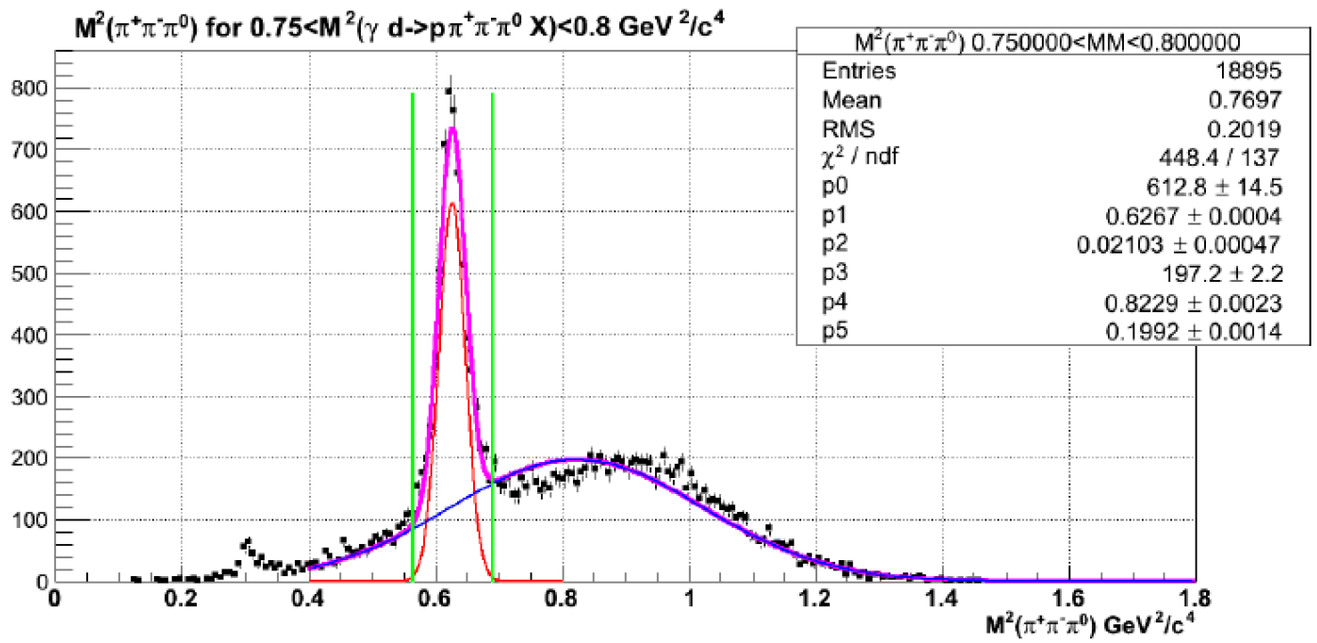
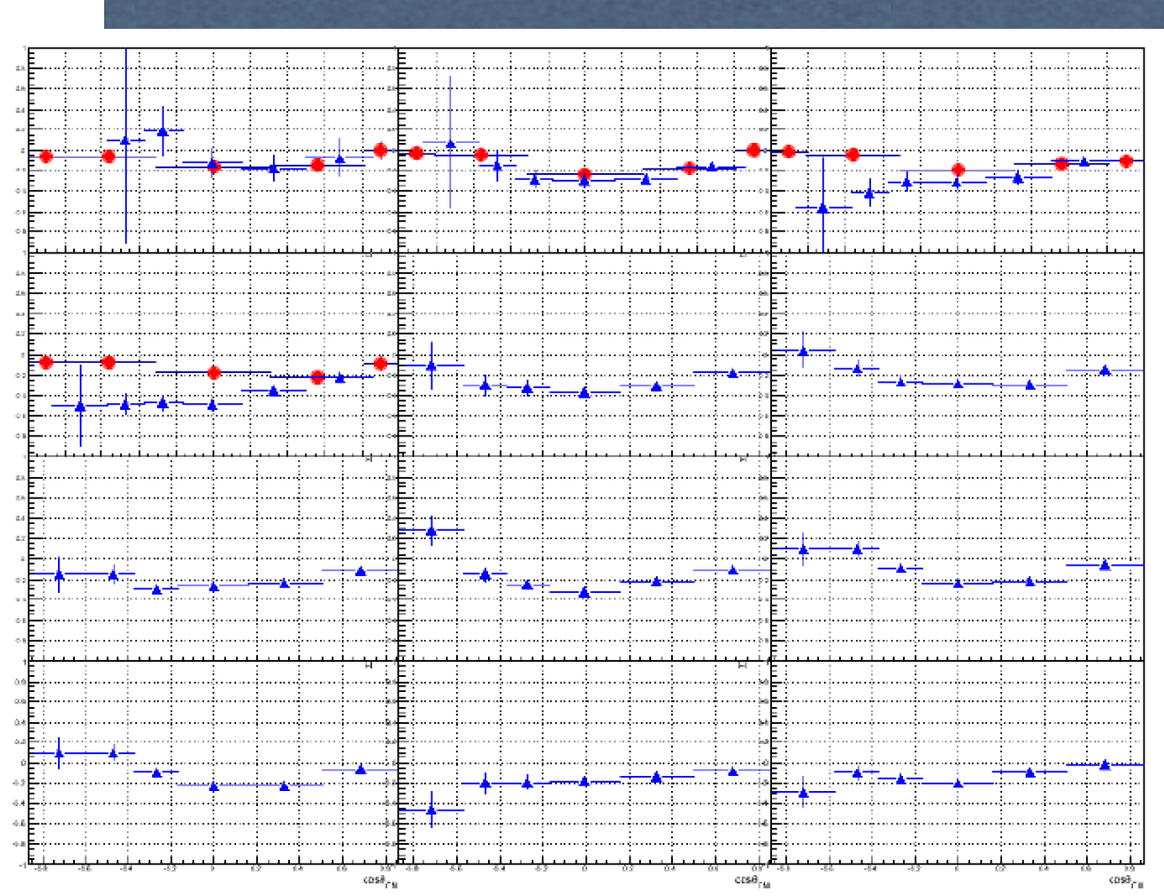


Figure: Example. Invariant mass squared of the three pions for missing mass squared $0.75 < M_X^2(\vec{\gamma}d \to p\pi^+\pi^-\pi^0 X) < 0.8\text{GeV}^2/c^4$. 3σ cut around the ω peak for missing mass squared. Shift in the peak due to calorimeter resolution and was reproduced via Toy Monte Carlo

$$F = \frac{\sum_i (A_{tot} - A_{bkg})_i}{\sum_i (A_{bkg})_i}$$

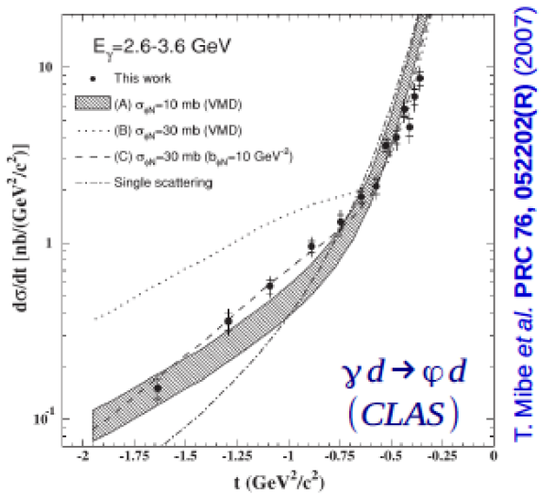
$$\left(\frac{dN}{d\phi}\right)^{\parallel(\perp)}_{signal} = F^{\parallel(\perp)} \left(\frac{dN}{d\phi}\right)^{\parallel(\perp)}_{peak}$$



Coherent Deuteron Scattering
(g10 Data)

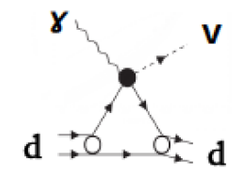
Taya Chetry
Kenneth Hicks
Ohio University

- γ d $\rightarrow$ ρd $\rightarrow$ $\pi^+\pi^- d$
  - Global Spectrum
  - Acceptance
  - Yield Extraction
  - Preliminary Results
- γ d $\rightarrow$ ωd $\rightarrow$ $\pi^+\pi^- d$ (π^0)
  - Global Spectrum
  - Acceptance
  - Yield Extraction
  - Preliminary Results
- γ d $\rightarrow$ πd* $\rightarrow$ $\pi^+\pi^- d$
  - Global Spectra
  - Acceptance
  - Yield Extraction
  - VERY Preliminary Results

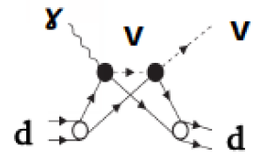


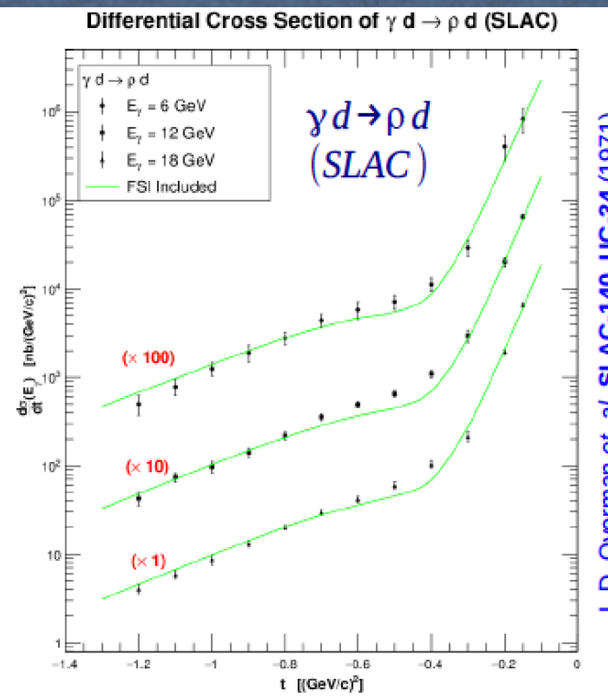
T. Mibe *et al.* PRC 76, 052202(R) (2007)

Single scattering



Double scattering





I. D. Overman *et. al.* SLAC-140, UC-34 (1971)

- Vector Meson beams cannot be produced in a lab.
- These studies will allow to test models of hadronic scattering of ρ and ω-mesons from the nucleon.
- Limited world data for these channels.

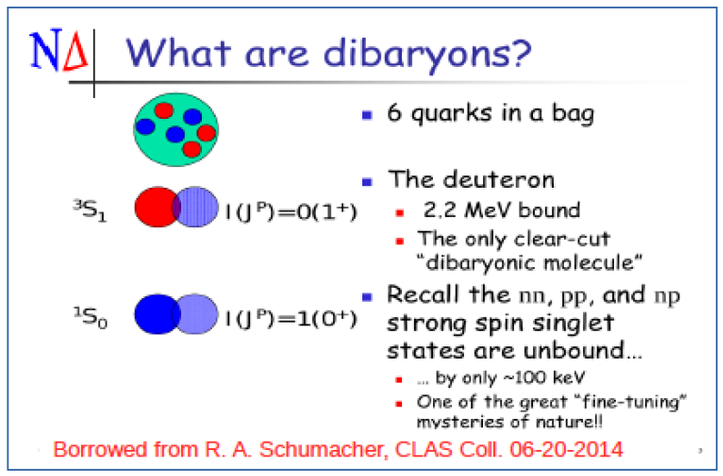
Mandelstam *t* :

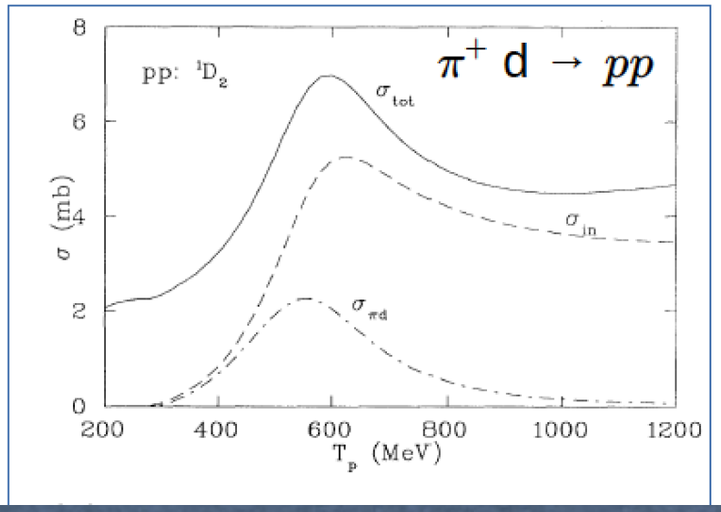
$$t=(P_\gamma - P_V)^2=(P_{d_i} - P_{d_o})^2$$

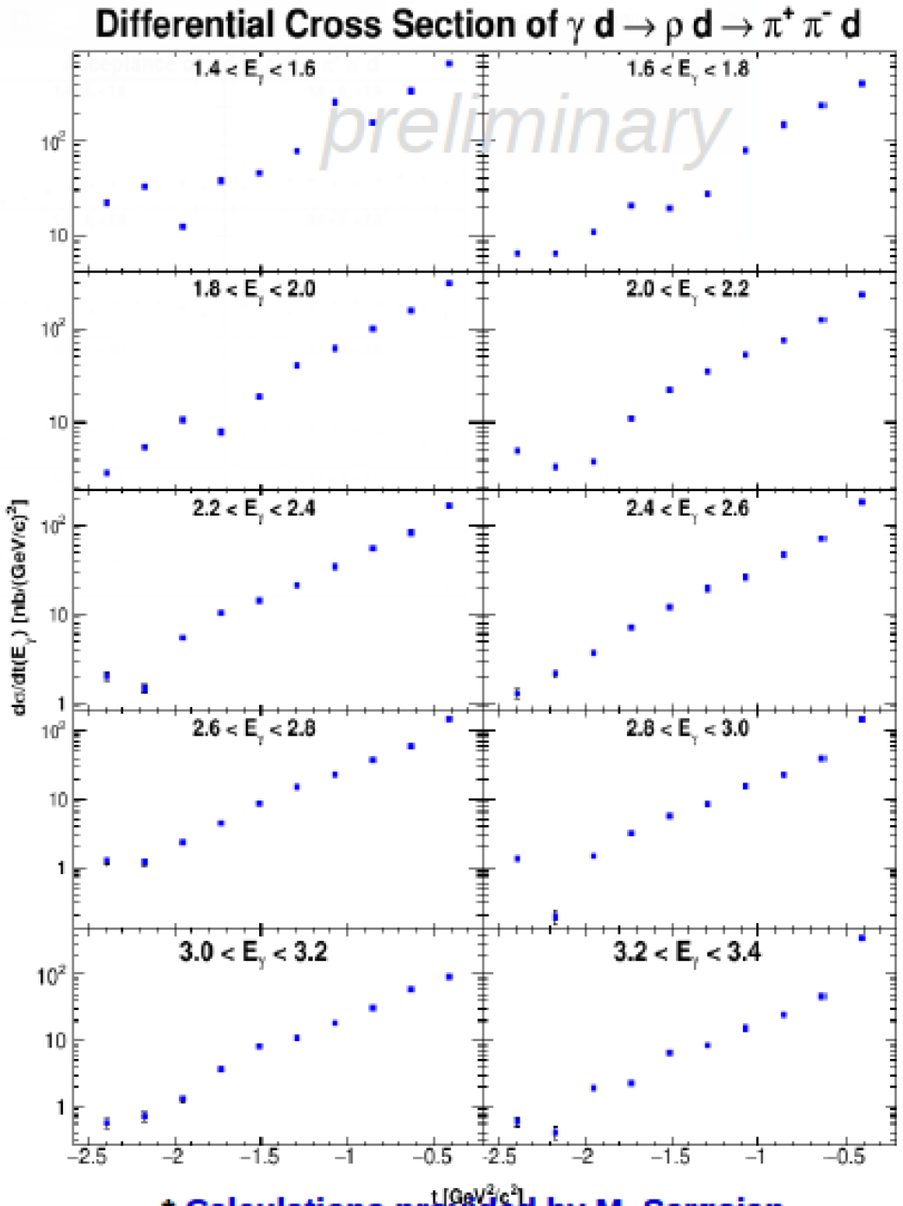
Reactions in interest

$\gamma d \rightarrow \rho d$ $\gamma d \rightarrow \omega d$

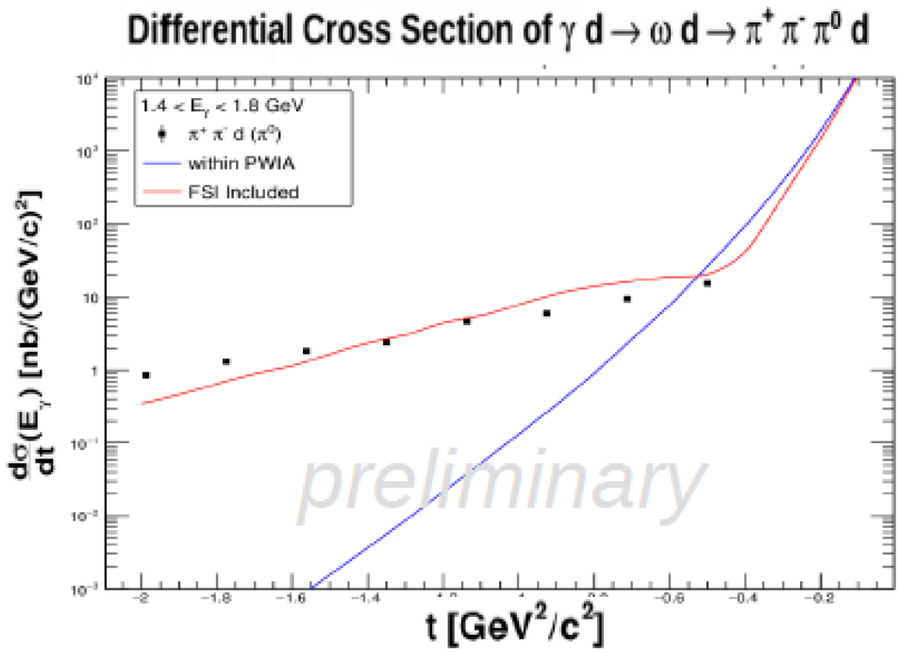
DIBARYON
g10 results



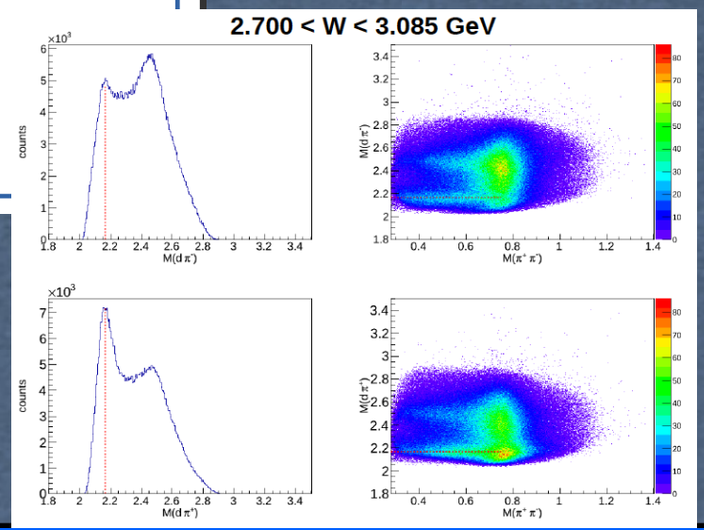




*** Calculations provided by M. Sargsian**



- Preliminary Differential Cross Section results for $\gamma d \rightarrow \rho d$ and $\gamma d \rightarrow \omega d$ are presented.
- These are diffractive scattering processes as expected.
- Understanding these reaction channels will help understand their interference in the d* resonance
  - $\gamma\, d \rightarrow \pi d^{*} \rightarrow \pi^{+}\pi^{-} d$

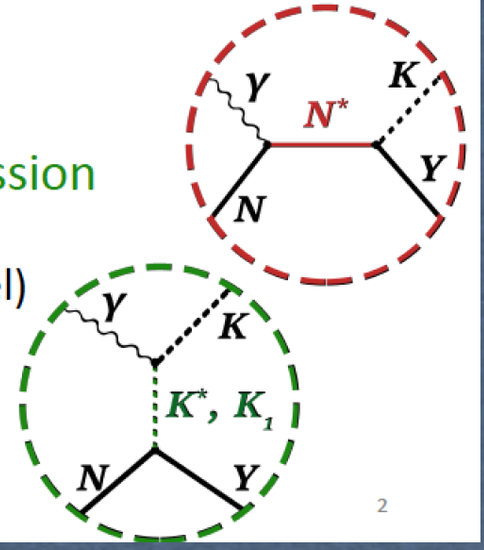


Cross Sections of $\gamma d \rightarrow K^0\Lambda(p)$ with g13 Data

N. Compton, C.E. Taylor, K. Hicks, P. Cole, and others

Motivation

- A complete experiment in several reaction channels will improve our understanding of nucleon resonances
- $K^0\Lambda$ provides constraint on resonances found in $K^+\Lambda$ channels through PWA
- This reaction has t-channel suppression
  - Neutrality and spin of the K^0
  - Ideal for resonance studies (s-channel)
  - Cross section is likely lower than $K^+\Lambda$



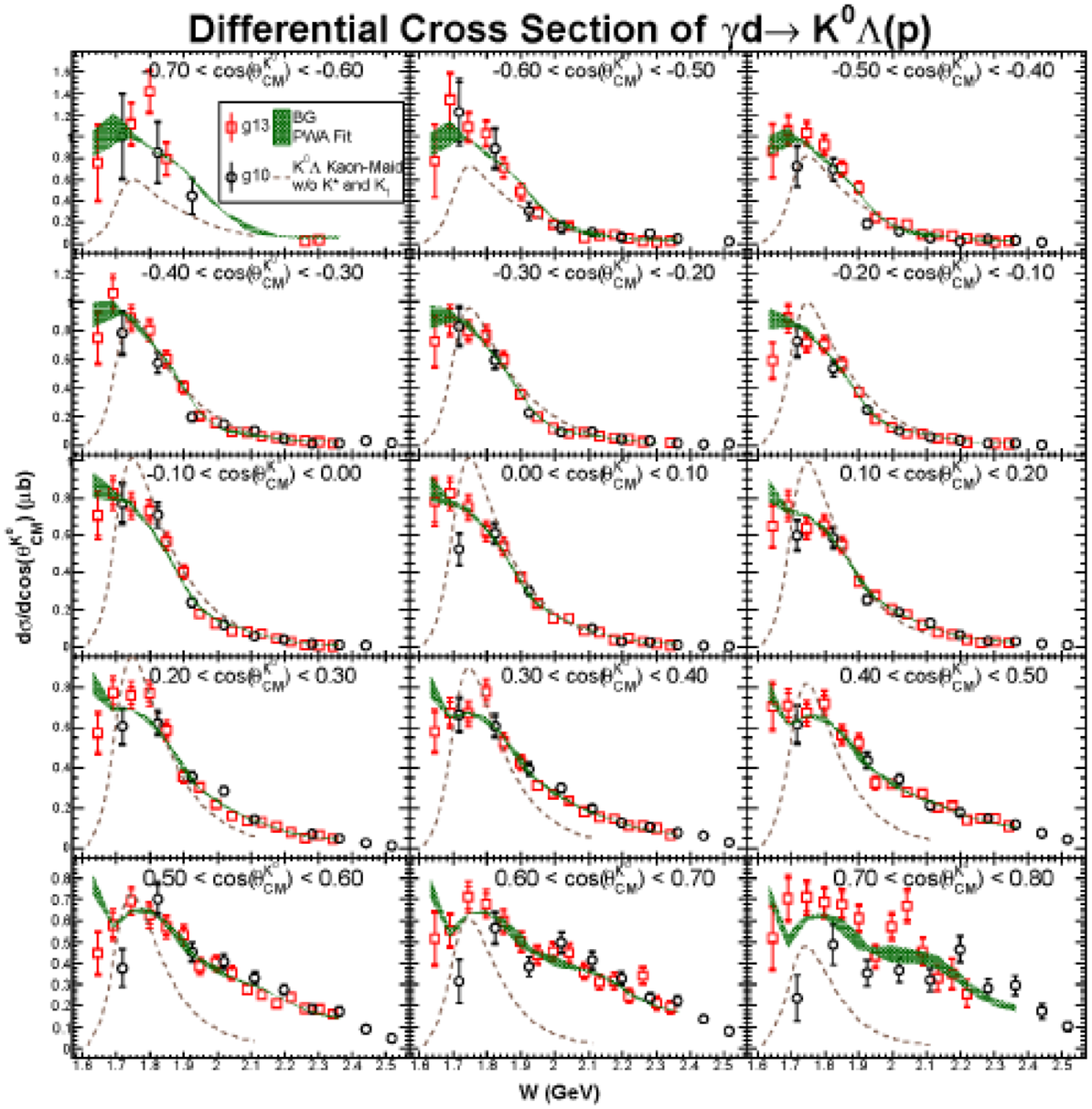
/2016 2

$\gamma d \rightarrow K^0\Lambda(p)$

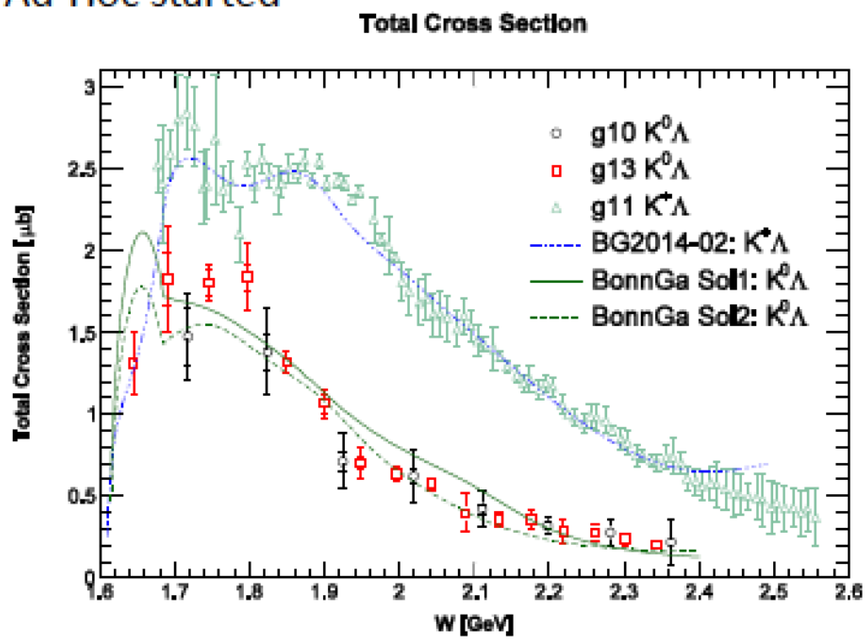
- Detected with the topology:
  - $\gamma d \rightarrow K^0\Lambda p \rightarrow K_S^0\Lambda p \rightarrow \pi^-\pi^+\pi^- p(p)$
- Backgrounds contributing to this topology:
  - $\gamma d \rightarrow X \rightarrow \pi^-\pi^+\pi^- p(p)$
    - $X \neq K^0\Lambda$, *but could be* $\rho\Delta$
    - *Minimized, but not excluded with invariant mass cuts*
  - $\gamma d \rightarrow K^0\Sigma^0 p \rightarrow K_S^0\Lambda\gamma p \rightarrow \pi^-\pi^+\pi^- p(\gamma p)$

Cross Sections of $\gamma d \rightarrow K^0 \Lambda(p)$ with g13 Data

N. Compton, C.E. Taylor, K. Hicks, P. Cole, and others



- $K^0\Lambda$ provides constraint on resonances found in $K^+\Lambda$ channels through PWA
- This reaction has t-channel suppression
  - Ideal for resonance studies (s-channel)
  - Cross section is likely lower than $K+\Lambda$
- These data agree with previous g10 measurements
- These cross sections appear to be missing a "bump" at 1900 MeV
- Preliminary PWA fits were provided by BoGa
- These fits are very close to a "predicted" value
- Analysis review is complete
- Ad-Hoc started



Search for Box Anomaly in $\eta' \to \pi^+ \pi^- \gamma$

Dr. Xinying Song

On behalf of Juelich group

Radiative Decay of η' in CLAS

$$\gamma p \to p(\eta' \to \pi^+\pi^-\gamma)$$

Georgie Mbianda Njencheu

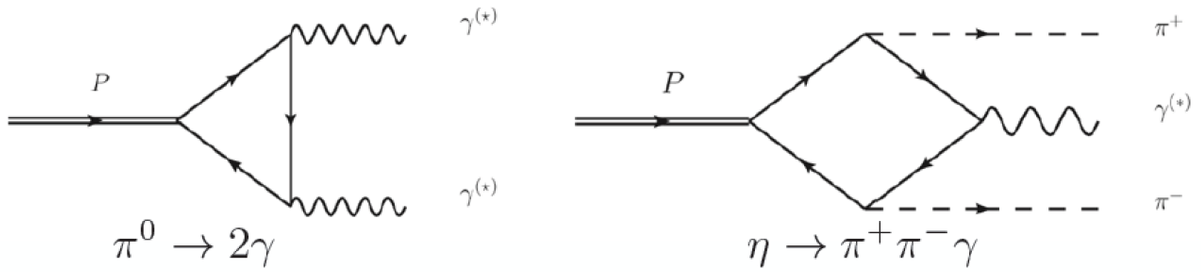
Update on

$$\eta \to \pi^+\pi^-\gamma$$

from g11 data

Torri Roark
Moskov Amaryan
Georgie Mbianda Njencheu
Ilya Larin

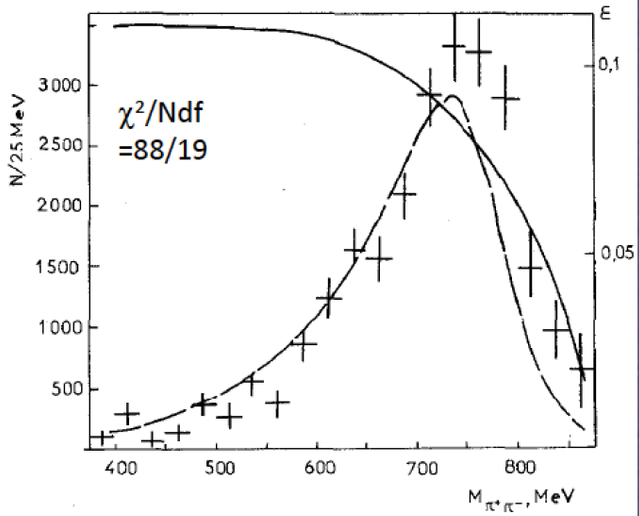
Wess-Zumino-Witten Lagrangian



- anomalies correspond to some higher order terms in WZW Lagrangian
- fit two pion invariant mass distribution with free parameter alpha

Preliminary Experiments results

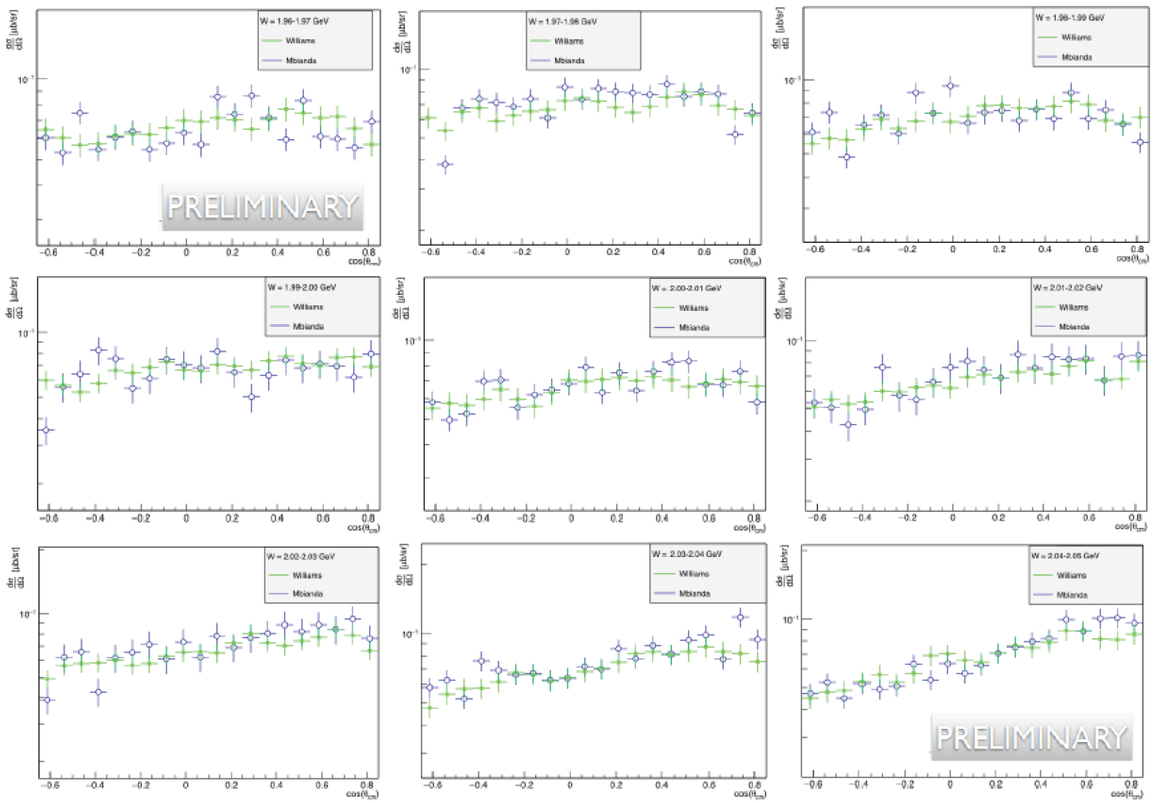
- Observations of ρ_0 mass measurement Via $\eta' \to \gamma\pi^+\pi^-$ in $\pi N \to \eta' N$ shows that:
  - Mass shift is as large as 20 to 30 MeV;
  - A fully mediated by ρ_0 mass: incomplete;
  - A non-resonance contribution $\eta' \to \gamma\pi^+\pi^-$.



Z. Phys. C - Particles and Fields 50, 451-454 (1991)

Differential cross section for $\gamma p \rightarrow p\eta'$ compared

g11



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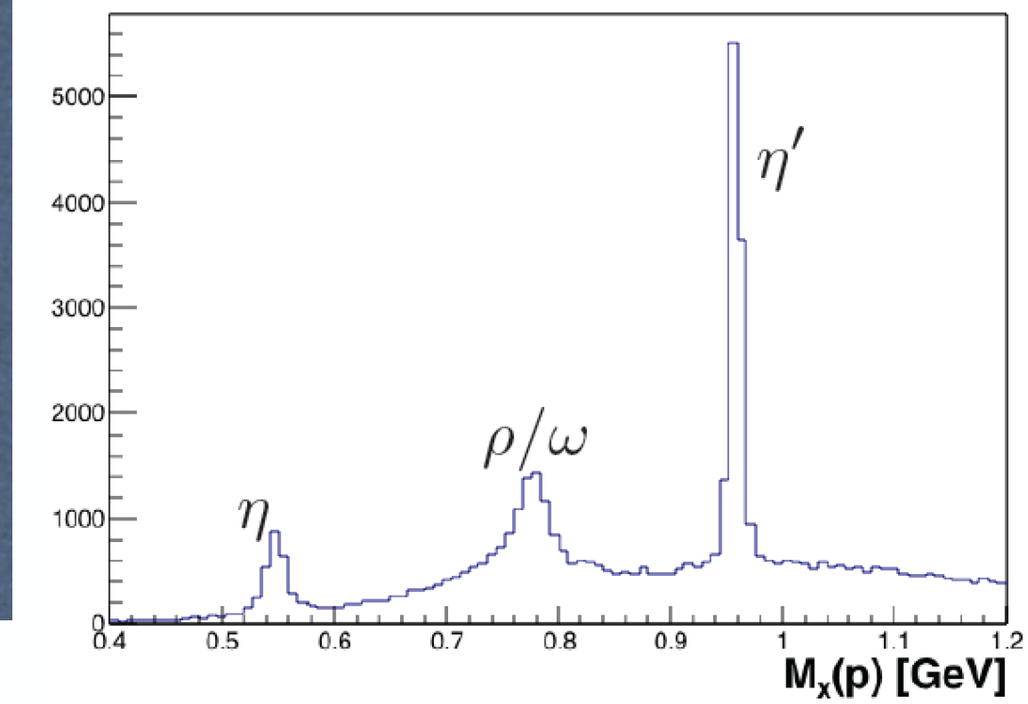


$\alpha = (1.17 \pm 0.40)\ GeV^{-2}$

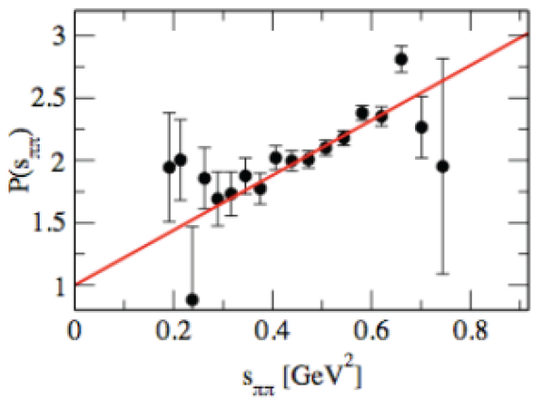
$\beta = (-1.44 \pm 0.41)\ GeV^{-4}$

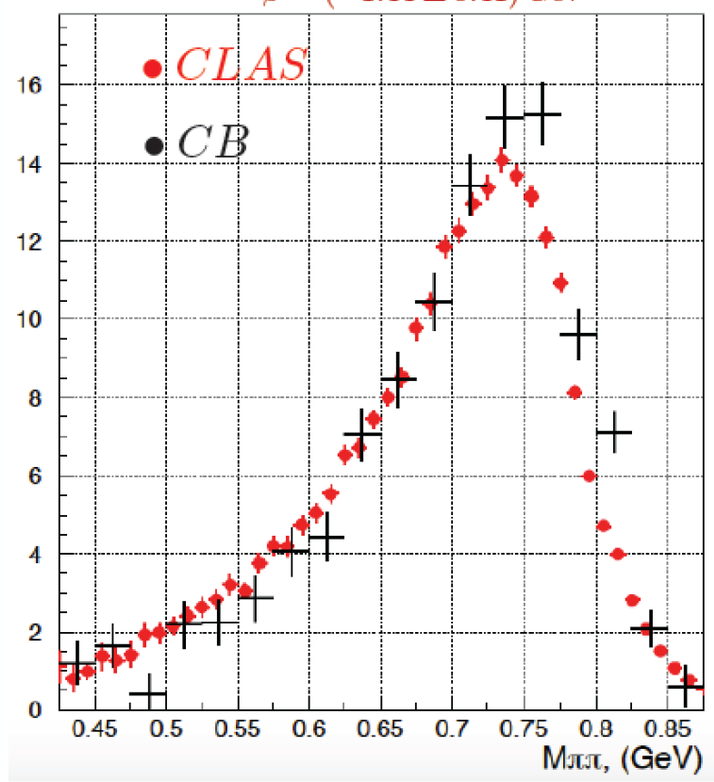
- The radiative decay matrix element can be written as:

$$|M|^2 \approx |F_V(m^2_{\pi\pi})|^2(1 + \alpha m^2_{\pi\pi} + \beta m^4_{\pi\pi})^2 E^2_\gamma q^2 sin^2(\theta)$$

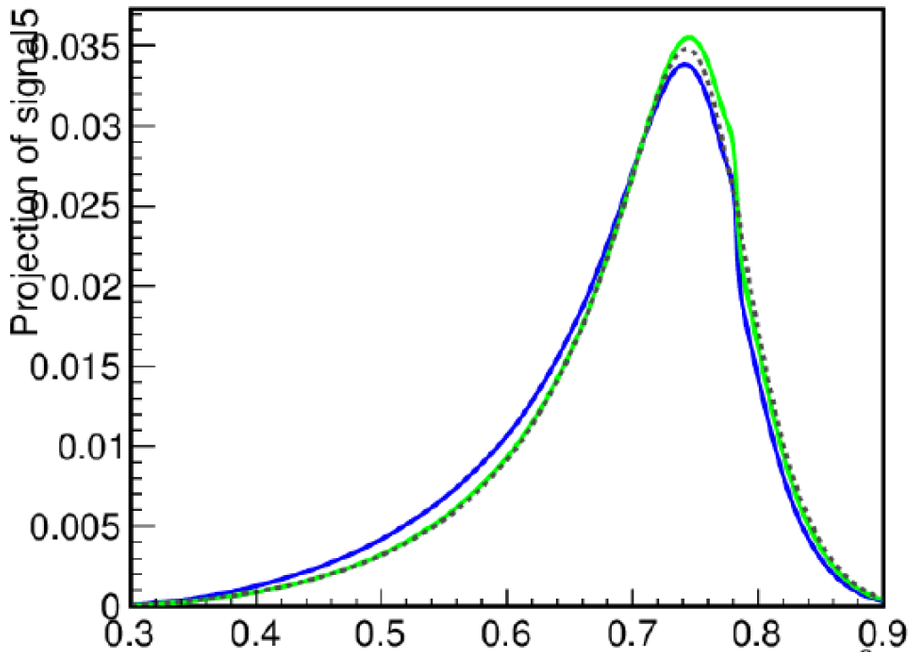
Experiment	α [GeV^{-2}]	β [GeV^{-4}]
CRYTAL BARREL (1997)	$1.80 \pm 0.49 \pm 0.04$	$0.04 \pm 0.36 \pm 0.03$
GAMS-2000	2.7 ± 1.0	
CLAS(g11) Preliminary	$1.17 \pm 0.40 \pm 0.12$	$-1.44 \pm 0.41 \pm 0.14$
Theory		
Kubis (2015)	1.4 ± 0.4	-1.0 ± 0.1

$\alpha' = (1.80 \pm 0.49 \pm 0.04)$ GeV^{-2} **(1997)**



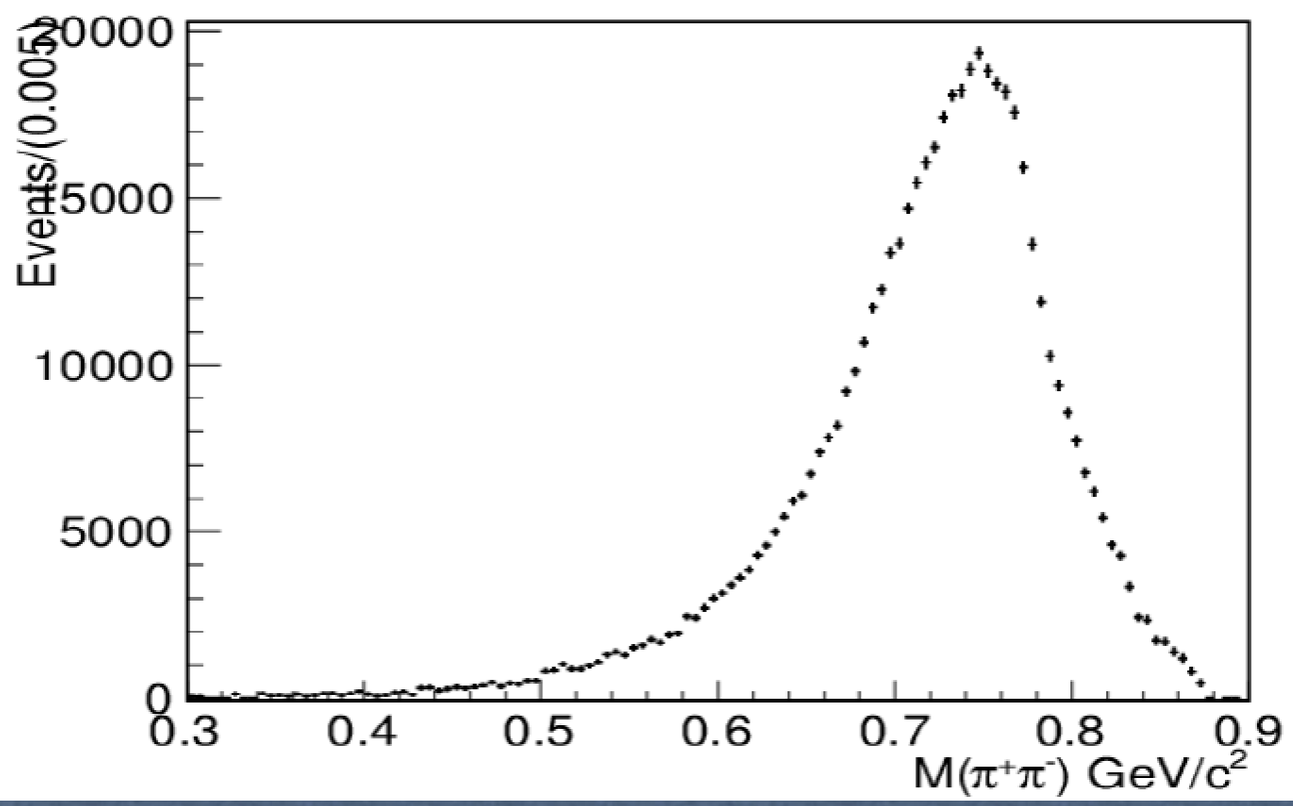


The models to be used



- ρ-ω mixing
- ρ-ω mixing with box anomaly
- Model independent approach with ω interference

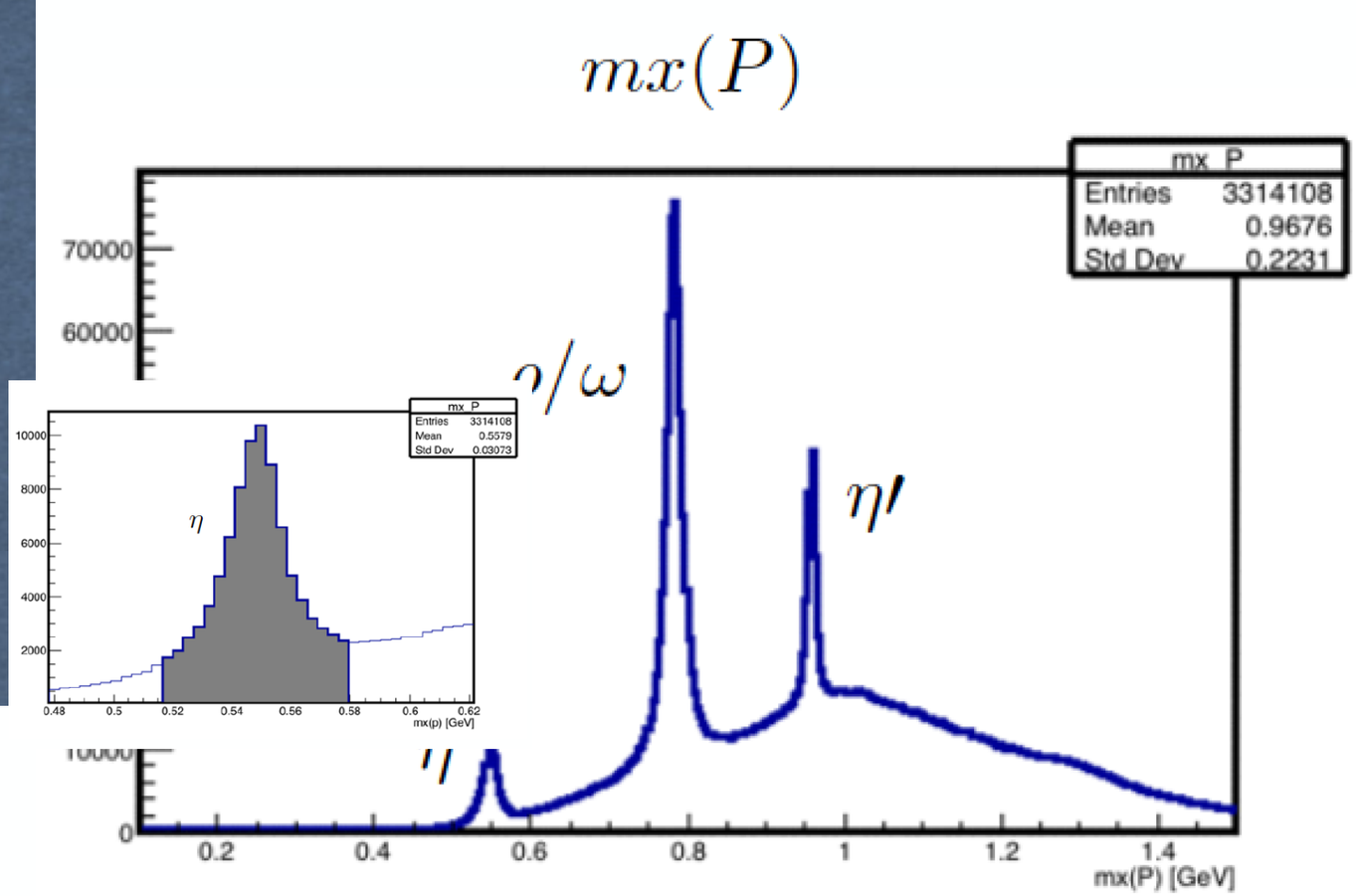
G12 data taken by CLAS

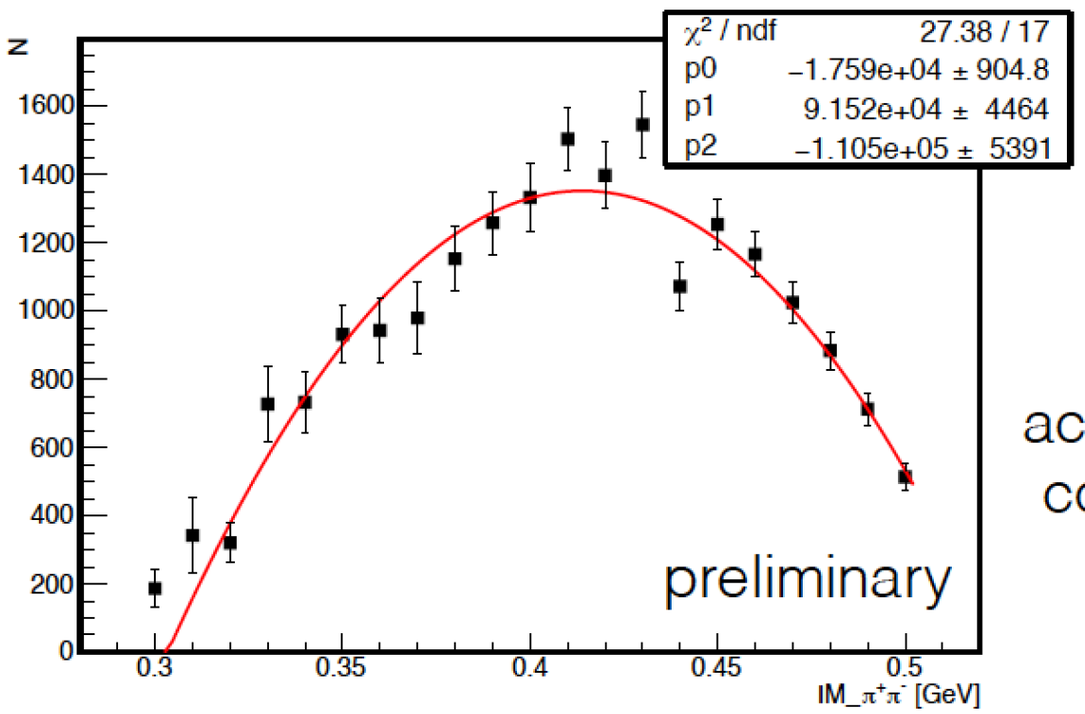


Missing mass of the proton

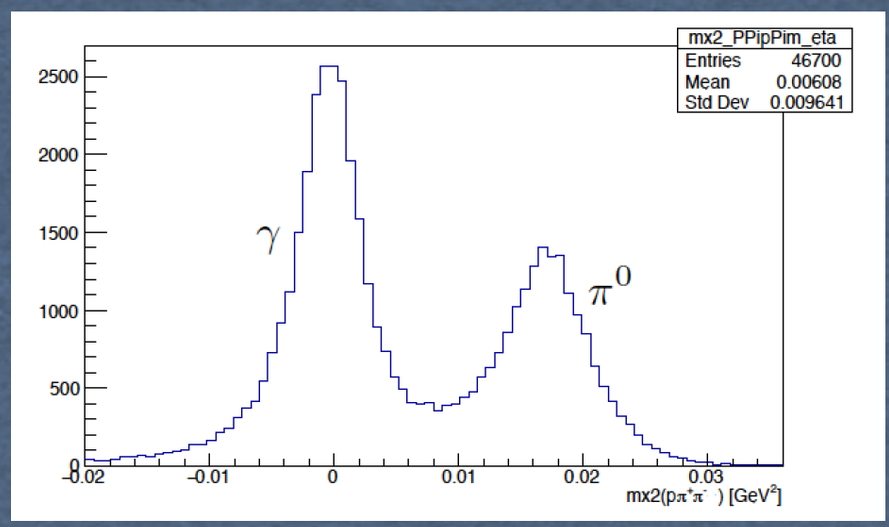
$$\frac{d\Gamma}{ds_{\pi\pi}} = |AP(s_{\pi\pi})F_v(s_{\pi\pi})|^2\,\Gamma_0(s_{\pi\pi})$$

$$P(s_{\pi\pi}) = 1 + \alpha s_{\pi\pi} + O(s_{\pi\pi}^2)$$



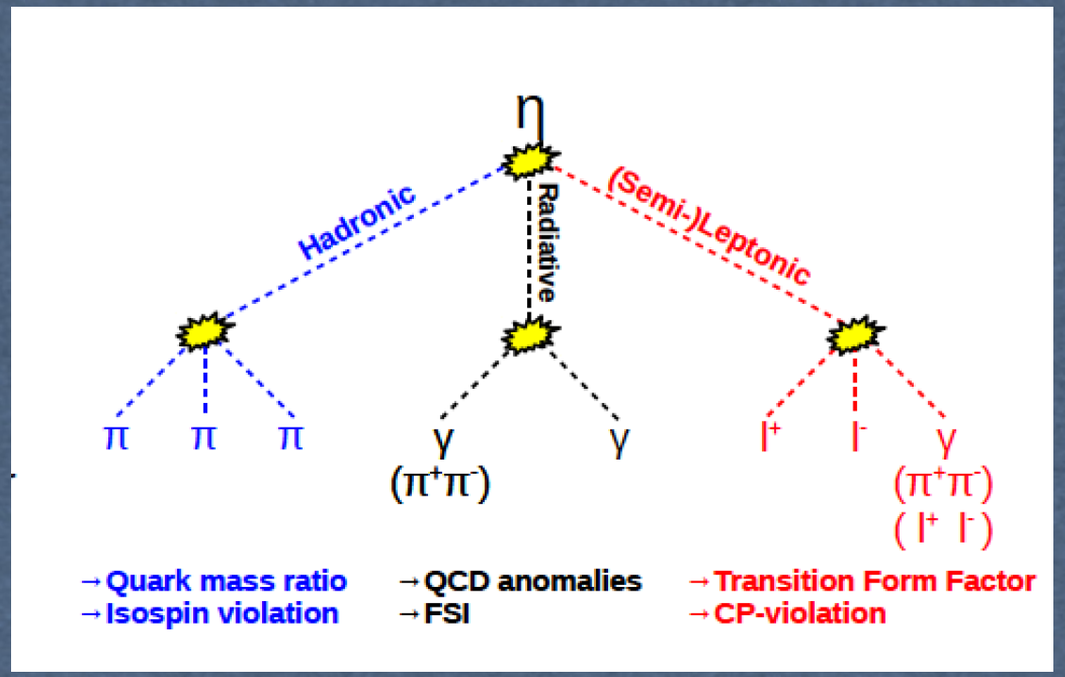


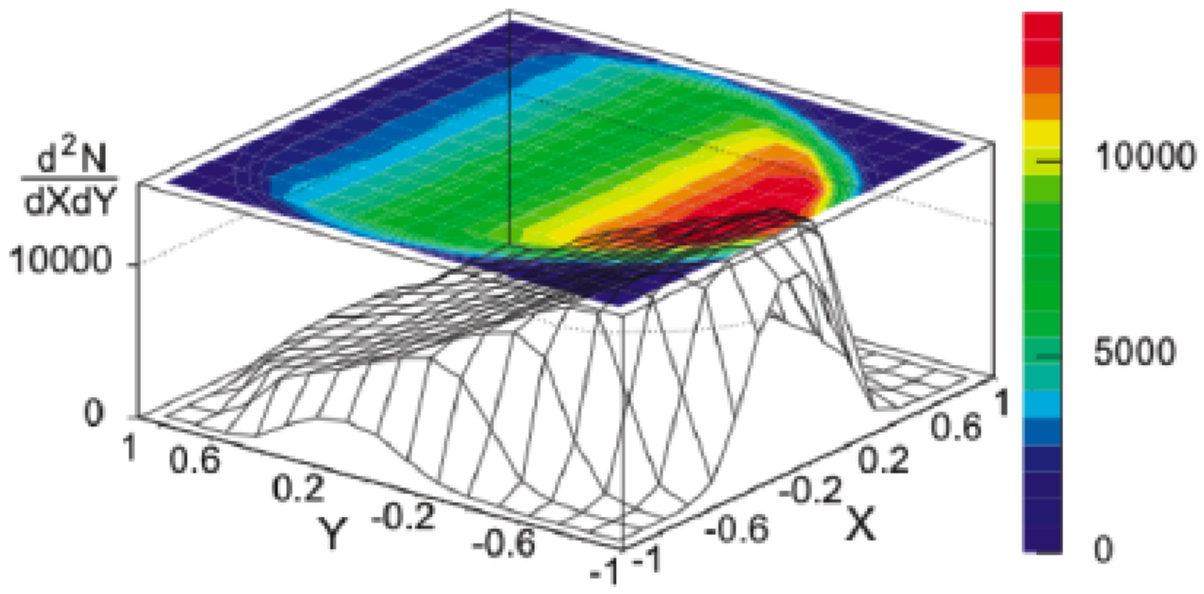
not acceptance corrected!



Status of the Analysis of $\eta \to \pi^+\pi^-\pi^0$ with the CLAS g12 Data Set - Vol. II

Daniel Lersch





Dimensionless Dalitz plot variables:

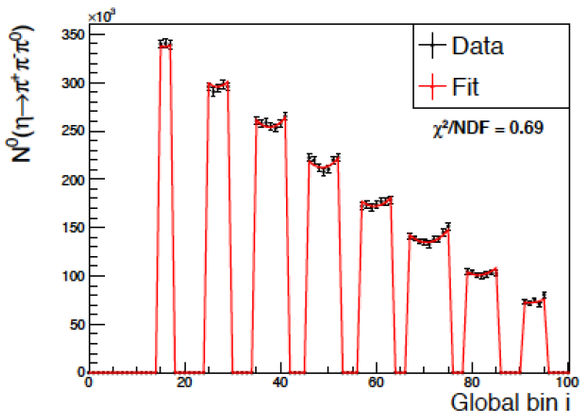
$$X = \sqrt{3}\frac{T_{\pi^+} - T_{\pi^-}}{T_{\pi^+} + T_{\pi^-} + T_{\pi^0}}$$

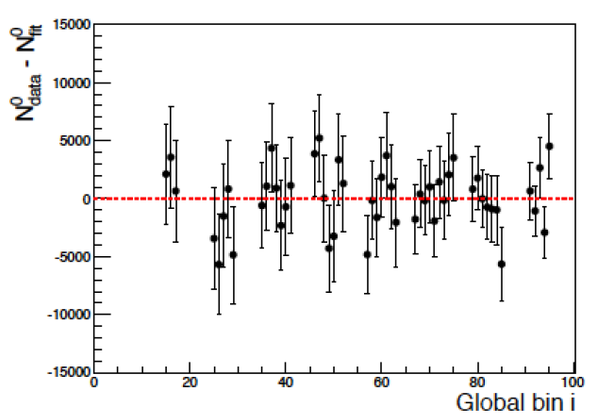
$$Y = \frac{3T_{\pi^0}}{T_{\pi^+} + T_{\pi^-} + T_{\pi^0}}$$

- Dalitz plot analysis: $\frac{d^2\Gamma_{meas}}{dXdY} \propto (1 + aY + bY^2 + dX^2 + fY^3 + gX^2Y + ...)$
  $\to$ c, e and h would imply C-violation

Calculation of the Dalitz Plot Parameters

- Define: $\chi^2 \equiv \sum_{i=0}^{120} \left(\frac{N_i^0(\eta \to \pi^+\pi^-\pi^0) - N_i^{fit}(a,b,c,d,e,f)}{\Delta N_i^0(\eta \to \pi^+\pi^-\pi^0)} \right)^2$
- With:
  - $N_i^0(\eta \to \pi^+\pi^-\pi^0) \equiv N_i^{rec}(\eta \to \pi^+\pi^-\pi^0) \times A(i) \times \frac{1}{\text{Efficiency}(i)}$
  - $\Delta N_i^0(\eta \to \pi^+\pi^-\pi^0) \equiv$ well, the corresponding error
  - $N_i^{fit}(a,b,c,d,e,f) \equiv$ norm $\times [aY(i) + bY^2(i) + cX(i) + dX^2(i) + eX(i)Y(i) + fY^3(i) + ...]$
- Minimise χ^2 and leave all parameters as free





Parameter:		−a	b	d	f
Theor.	ChPT (NNLO)[a]	1.271(75)	0.394(102)	0.055(57)	0.025(160)
	NREFT[b]	1.213(14)	0.308(23)	0.050(3)	0.083(19)
	PWA[c]	1.116(32)	0.188(12)	0.063(4)	0.091(3)
Exp.	KLOE (08)[d]	$1.090(5)(^{+8}_{-19})$	0.124(6)(10)	$0.057(6)(^{+7}_{-16})$	0.14(1)(2)
	WASA[e]	1.144(18)	0.219(19)(47)	0.086(18)(15)	0.115(37)
	KLOE (16)[f]	$1.095(3)(^{3}_{-2})$	0.145(3)(5)	$0.081(3)(^{+6}_{-5})$	$0.141(7)(^{+7}_{-8})$
	CLAS G12	1.130(22)	0.195(29)	0.109(21)	0.139(49)

- Calculation from JPAC* group using the WASA-at-COSY result: $Q = 21.4 \pm 0.4^{(c)}$

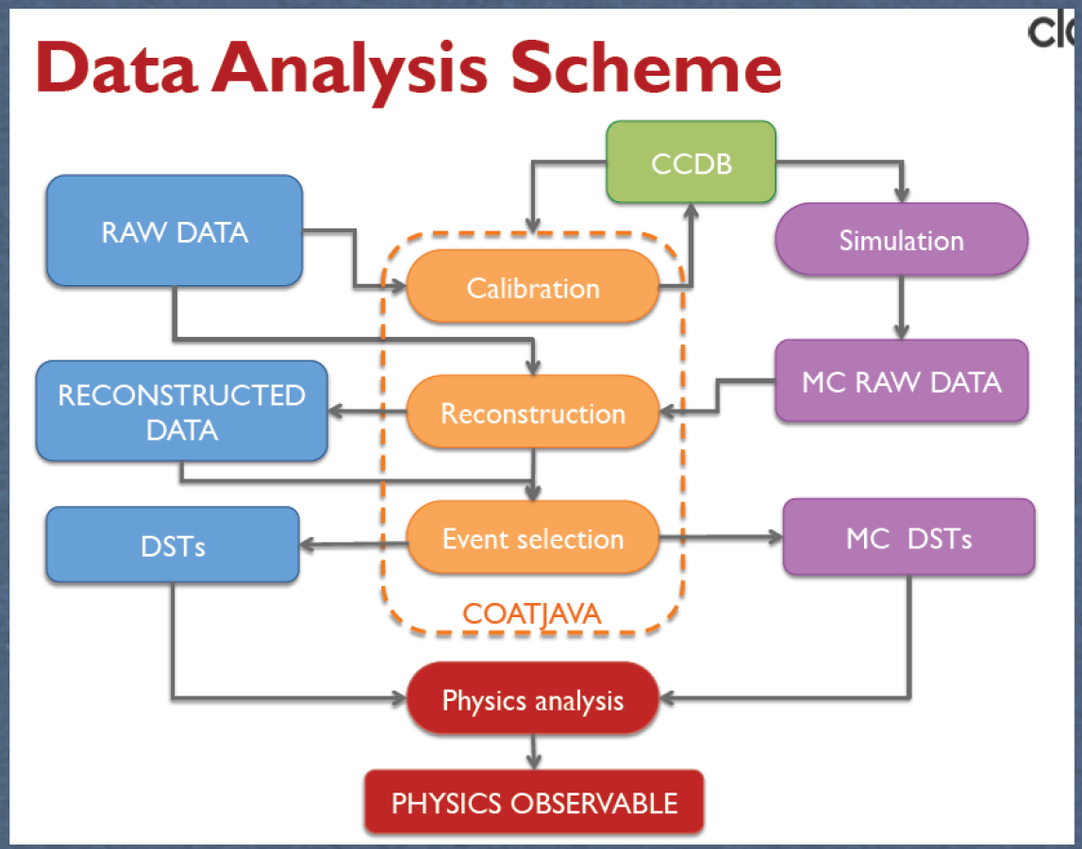
  ⋆ Interactive web page: http://www.indiana.edu/ jpac/index.html
- **Dalitz Plot Analysis for $\gamma p \to p\eta[\eta \to \pi^+\pi^-\pi^0]$ with CLAS**
  - i) **Extract Dalitz Plot parameter** (so close!)
  - ii) **Calculate Q via PWA**
- Results are shown with statistical errors
- Major issue: $c = 0.018 \pm 0.008 \neq 0 \Rightarrow$ Systematic tests

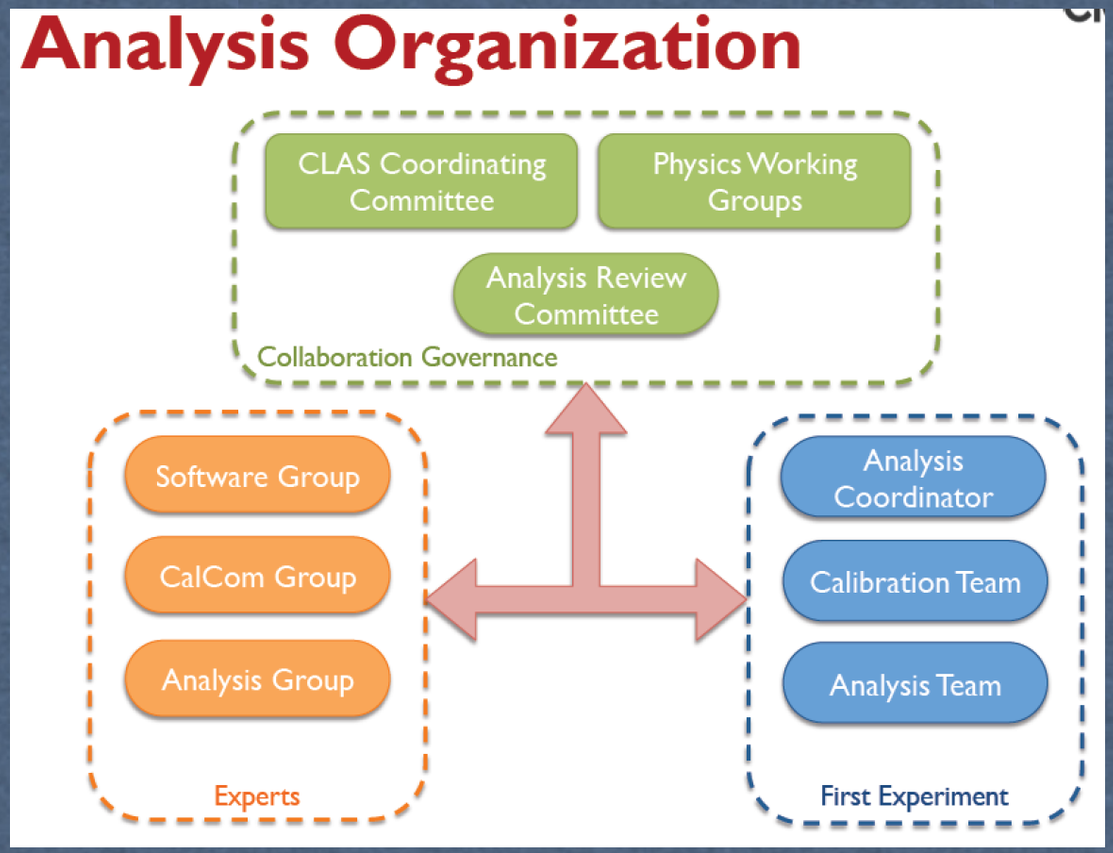
The HSWG in the CLAS12 era (HSWG 2.0)

Why?

- ✳ Feb/March 2017 CLAS12 Commissioning run (KPP)
- ✳ Fall 2017 CLAS12 engineering run
- ✳ RG-A (12 GeV on H2 target) will be the major player of CLAS12 First Experiment

- ✳ Outcome of the Common Tools Committee includes suggestions to reorganise the PWG in CLAS12 era



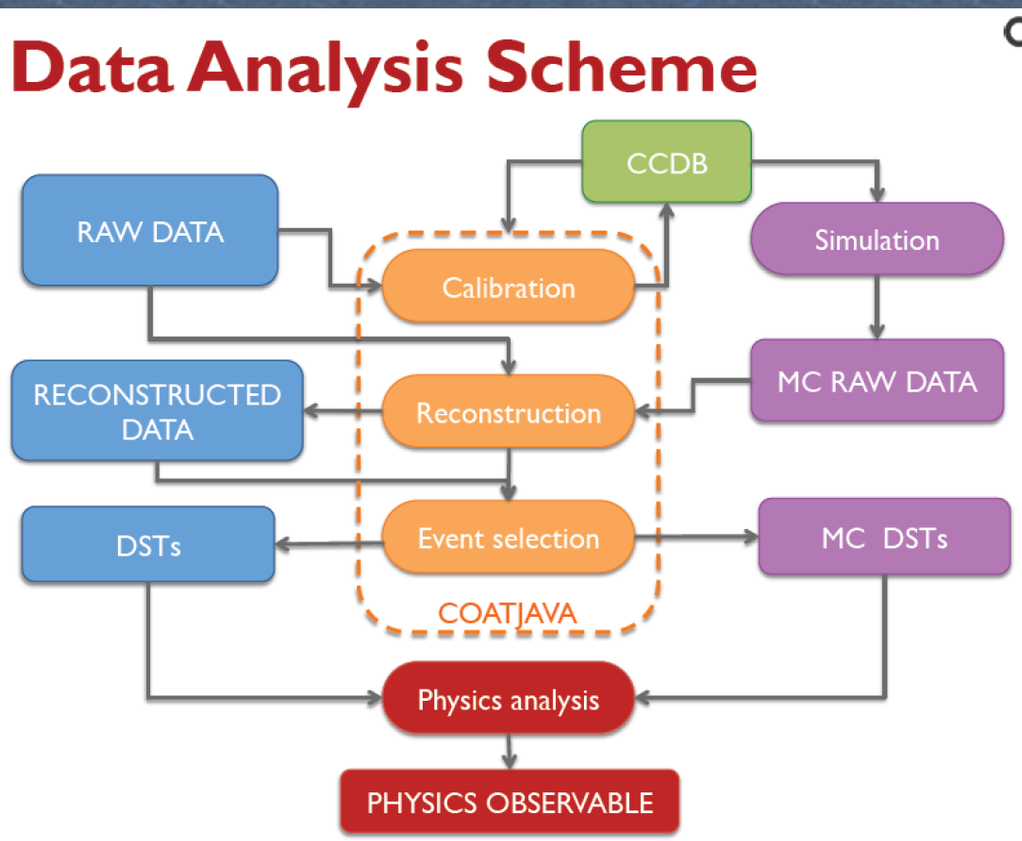


Report of the Ad-Hoc Committee on Common Tools

Committee Members

R. De Vita (Chair)
D. Glazier
S. Kuhn
C. Smith
V. Ziegler

Data Analysis Scheme



Actions

1. Complete the COATJAVA reconstruction and calibration tools. This must be done keeping future code developments backward compatible with the present version 3.0.

2. Extend COATJAVA to incorporate Event Selection, as per our definition.

3. Create a new group of "wise experts" (Analysis Group) who will guide the development of algorithms for momentum corrections, PID, background subtraction, fiducial cuts and other corrections, exploiting the expertise accumulated with analysis of CLAS data. Algorithms developed by this group should be reviewed by an analysis review committee (see 4). Upon approval they should be considered "standard", requiring no further review when applied to specific analysis and only a short reference in future analysis notes.

4. Create a "First experiment analysis review committee" drawn from the relevant PWGs before the experiment even begins, and have that committee review each individual tool/algorithm/method used to arrive at Physics results, as they are being developed (by the RG A collaborators or the "experts" in 3). If this approach will prove to be effective for the First Experiment, it should be extended to any future CLAS12 experiment.

5. Set up a work plan defined by Run Group A to determine the optimal run conditions and be ready for data analysis prior the beginning of the first experiment. This includes:
   - setting up event generators,
   - running full simulation and reconstruction of a benchmark reaction for each Run Group A proposal,
   - becoming familiar with COATJAVA, GEMC and CED or other COMMON TOOLS that may become available,
   - determining the optimal detector, target, magnets, trigger configuration for data taking,
   - define a clear management structure, internal to the group, and distribute tasks of common interest with a clear timeline and milestones.
6. Utilize the CLAS12 software discussion forum for the exchange of information between software users; encourage the use of the clas12-software mailing list; organize software workshops during Collaboration meetings, and identify collaborators who will update documentation and tutorials on the software wiki.

The HSWG in the CLAS12 era (HSWG 2.0)

How?

- Significant impact on HSWG_2.0 duties
  - Nominate representatives in the Analysis Review Committee: permanent/temporary?
  - contribute to the Analysis/Calibration team: define 'experts' and 'workers'
  - Identify specific procedures relevant for the HSWG only: PWA, Kinematic-fit?

- Significant impact in the Analysis review Process
  - Define standard procedures and extra (to be specifically review)
  - run-group review from the very beginning (e.g. g11/g12)

- Significant impact in the Analysis review Process
  - Define standard procedures and extra (to be specifically review)
  - run-group review from the very beginning

The HSWG in the CLAS12 era (HSWG 2.0)

When?

★ **Consider the first experiment a Collaboration and HSWG priority**

✳ HSWG members should contribute :

- to the CLAS12 Common Analysis framework
- to the CLAS12 Detector Calibration
- to the CLAS12 Detector reconstruction

✳ HSWG member should specifically:

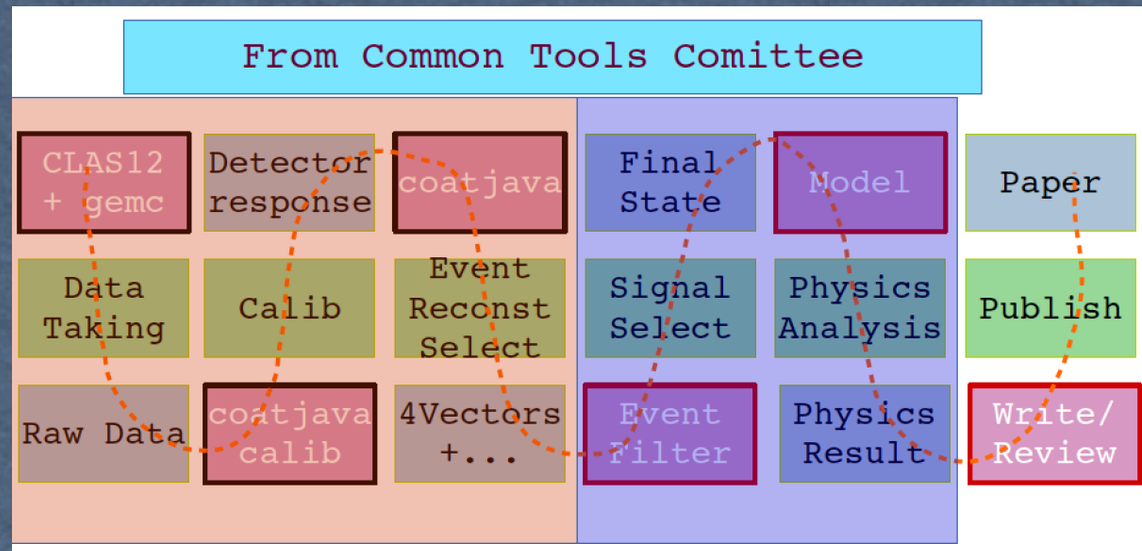
- Focus on a specific reaction easy to analyse to get results quickly
- Define known/measured benchmark reference to compare to
- Identify critical issues in detector calibration
- Contribute to the calibration and taking care of specific HSWG procedures
- Identify procedures to insure high quality data
- Run simulation in advance
- Develop and test the full analysis chain (test on simulation)
- Test the new procedure for an efficient and timely analysis review

★ **If this scheme will be successful we should extend to all HSWG_2.0 analyses**

Signal Selection and Physics Analysis Tools

Hadron Spectroscopy Working Group

Derek Glazier
University of Glasgow
(HASPECT working group)



CLAS Collaboration
Run Group

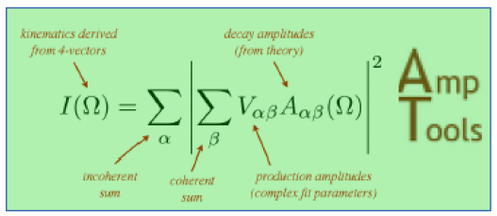
Open
Individual?
Experiment?
Working Group?
…
But with "guidance"

What types of analysis are we performing?

Model Dependent : We must interface to these tools

The PyPWA Project

$$I(\tau) = \sum_{i,j} \sum_{b,b'} {}^{i}A_b(\tau)\ {}^{i,j}\rho_{b,b'}\ {}^{j}A^*_{b'}(\tau).$$

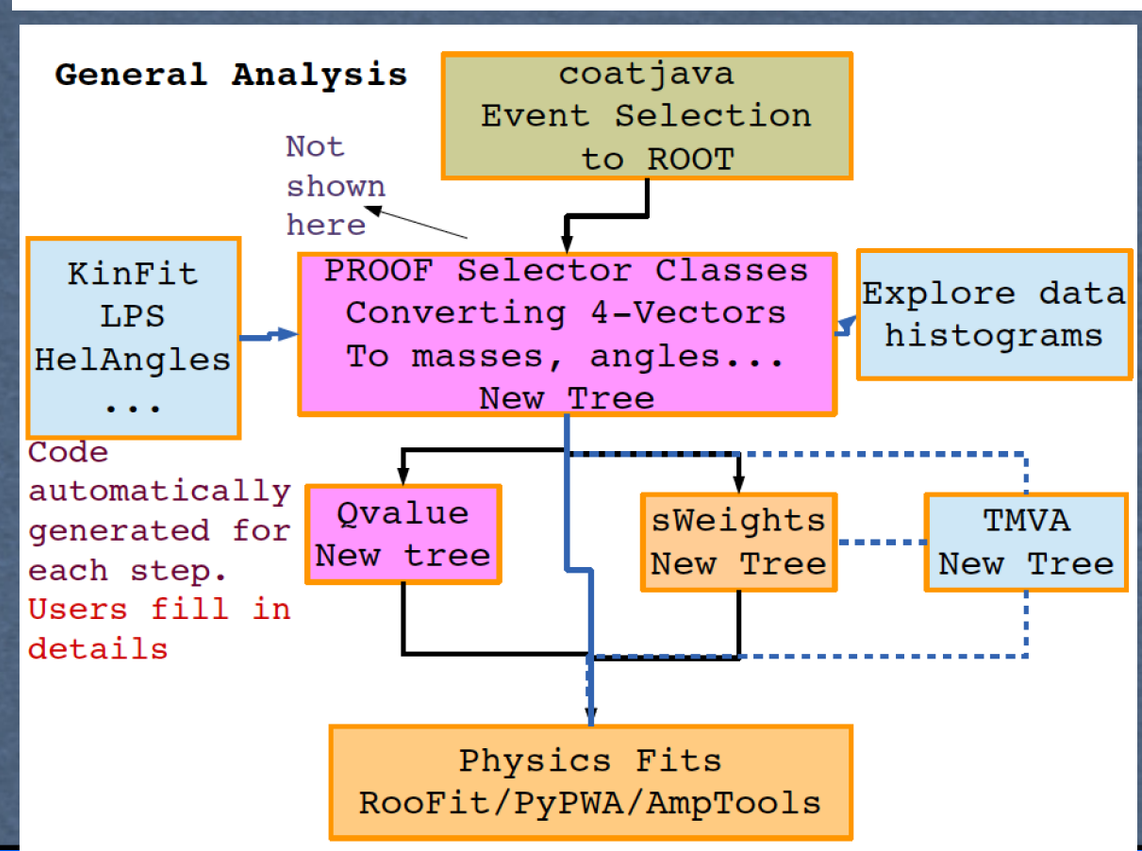


Model Independent :

Peak Hunting
Cross Sections
Spin Density Matrix Elements
Polarisation Observables

Signal Selection :

Q-Factor
sPlots
Sideband Subtraction
TMVA Cut
Missing Mass Cut



The HSWG in the CLAS12 era (HSWG 2.0)

★ **If we agree, we need to define a workplan and coordinate the effort from different groups**

★ **HSWG should play a major role in CLAS12 data analysis**

Collaboration - wise

- ✳ Identify Institution interested in contributing
- ✳ Identify an Analysis coordinator per each institution
- ✳ choose areas where you want to contribute

Common tools analysis framework

Common tools calibration framework

HSWG Tools

- evgen
- helicity info
- sg/bg separation
- kin fitter
- normalization
- efficiency/acceptance

HSWG Analysis

- angular distributions
- asymmetries
- DME
- trigger efficiency
- xsec
- (PWA)