Thursday, 5 October 2017

08:50 - 10:30 Hadron Spectroscopy Working Group 1

Remote connection: https://bluejeans.com/758848750

Convener: Marco Battaglieri (INFN-GE)

Location: CEBAF Center (F113)

08:50 **Hadron Spectroscopy Working Group Business** *20'*
Speaker: Dr. Marco Battaglieri (INFN-GE)

09:10 **Analysis of Photoproduction Reactions** *20'*
Speaker: Dr. Vincent Mathieu

09:30 **First Measurement of Ξ− Polarization in Photoproduction.** *20'*
Speaker: Dr. Jason Bono (FNAL)

09:50 **Analysis of eta->pi+pi-pi0 with CLAS6** *20'*
Speaker: Mr. Daniel Lersch (Juelich Research Center)

10:10 **Vector Meson Photoproduction off of Deuterium using g10 Data** *20'*
Speaker: Mr. Taya chetry (Ohio University)

09:30 - 16:00 Hadron Spectroscopy Working Group 2

Remote connection: https://bluejeans.com/758848750

Convener: Dr. Marco Battaglieri (INFN-GE)

Location: CEBAF Center (F113)

14:30 **Photoproduction of K^0Sigma^+ from CLAS-g12** *20'*
Speaker: Mr. Zulkaida Akbar

14:50 **Analysis review status** *20'*

HSWG

CLAS Collaboration Meeting

JLab, October 5 2017

11:00 - 12:30 CLAS WGs Joint Session

Remote connection: https://bluejeans.com/758848750

Conveners: Dr. Marco Battaglieri (INFN-GE), Mr. Marco Contalbrigo (INFN Ferrara), Dr. Michael Wood (Canisius College)

Location: CEBAF Center (F113)

11:00 **Introduction** *10'*
Speakers: Dr. Marco Battaglieri (INFN-GE), Mr. Marco Contalbrigo (INFN Ferrara), Dr. Michael Wood (Canisius College)

11:10 **ACE report** *10'*
Speaker: Ken Hicks (Ohio University)

11:20 **The hadron spectroscopy analysis gframe** *15'*
Speaker: Dr. Derek Glazier (University of Glasgow)

11:35 **The DEEP analysis framework** *15'*
Speaker: Dr. Harut Avagyan (Jefferson Lab)

11:50 **Discussion on common analysis frameworks** *20'*

12:10 **How the WG can help in data analyses** *20'*

Agenda

- ✳ CLAS6 data analysis: Cascade
- ✳ Status of ongoing analysis (update from previous collaboration meeting)
- ✳ Dedicated (joint) session for CLAS12

Activities

- ✳ Push to get early results (from the director)
- ✳ Engineering run + RG-A preparation (before the next coll meeting!)
- ✳ Strengthen the collaboration with JPAC
- ✳ Any analysis ready for review has to give a presentation (sooner or later!) to the HSWG:
  - ✳ Taya's analysis about VM from deuterium
  - ✳ Jason's analysis about cascade polarisation
- ✳ Analysis ready for a plenary talk next time:
  - ✳ Mike's about pi0
  - ✳ Nick's about S_LT

Talks

- ✳ Over all CLAS contributions, HSWG-related are 35%
- ✳ Regular interactions with the CSC
- ✳ REMINDER: Communicate talks and proceedings to the CSC
- ✳ JSA-TFC funds $20k allocated for 2017 still available

WG Reviews status

New since last meeting

Gamma n --> K Y from g14
PI:R.Schumacher
RC:W.Briscoe (Chair), B.McKinnon ,A.DAngelo
Status: justified delay

Dalitz Plot Analysis of eta' to eta pi pi − from CLAS g12 Data Set
PI:S.Ghosh
RC:V.Crede (chair), A.Rizzo, E.Pasyuk
Status: first round of comments

In progress

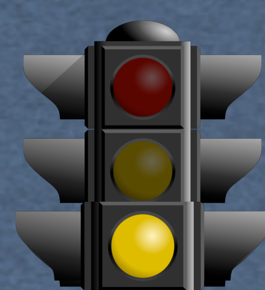
Photoproduction of the 3π mesons in the reaction $\gamma p \to \pi+\pi+\pi-n$ with CLAS detector at 6 GeV/$c2$
PI:P.Eugenio
RC: D.Glazier (chair), A.Filippi, M.Dugger
Status: 2nd round, waiting for response

Exclusive pi- Electroproduction off the Neutron in Deuterium in the Resonance Region
PI:Y.Tian
RC: Nikolay Markov (Chair), Mikhail Bashkanov , Eugene Isupov
Status: 1st round, waiting for response from PI

WG Reviews status

Radiative decay of eta' to pi+ pi- gamma from g11 data set
PI:G. Mbianda Njencheu
RC: R. Schumacher,S.Schadmand,A.Celentano
Status: no response in many months

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
Started Jul 2016
Status: waiting for comment from author



Pentaquark search in g10 by using the MMSA method
PI: Kenneth Hicks et al.
RC: Stepan Stepanyan (Chair), Lei Guo , Bryan McKinnon
Started Aug 2015
Status: NO progress

Polarization Observables T and F in the $\vec{p}(\vec{\gamma},\pi0)p$ Reaction
PI:H.Jiang
RC: Barry Ritchie (Chair), Volker Crede , Bryan McKinnon
Status: no info received from March

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
Sterted July 2016
Status: on-hold, still on-hold but authors are alive, paused for a while …

KLambda and KSigma from FROST
PI: N.Walforf et al.
RC: S.Strauch, M.Holtrop, P.Mattione,
Started May 2015
1 round of comments in May 2015, waiting for a revised
Status: stalled for a long while, now it seems to be resurrected, unfortunately NO, no news …

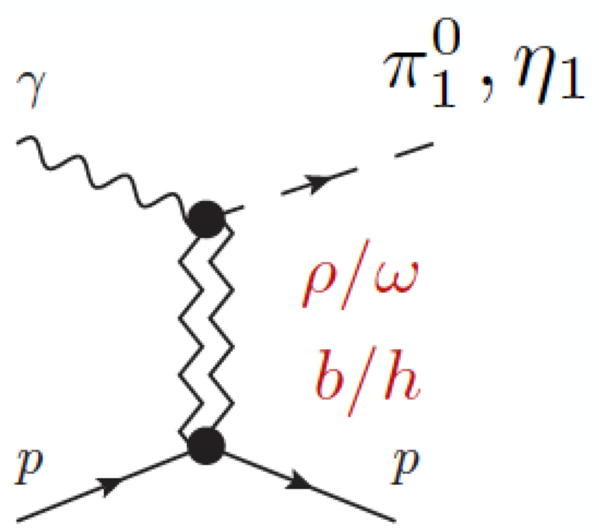
Exclusive Photo-Production Measurement of K+Sigma*- off Quasi-Free Neutrons in Deuterium
PI: H.Lu (SCU) et al.
RC: N.Zachariou, M.Dugger, D.MacGregor
Started in 2012 (!)
Status: ?????????????

Analysis of Photoproduction Reactions

Vincent MATHIEU

Jefferson Lab
-
Joint Physics Analysis Center

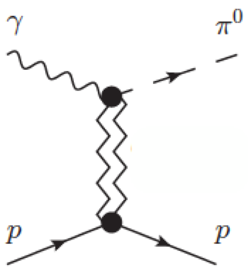
Does the target decouple at JLab energies ?



Factorization implies angular mom, conservation at each vertex:

$$A^{\lambda_\gamma \lambda_M}_{\lambda_p \lambda_{p'}} = \underbrace{\gamma(t)(\sqrt{-t})^{|\lambda_\gamma - \lambda_M|}}_{\text{top vertex}} \times \underbrace{(\sqrt{-t})^{|\lambda_p - \lambda_{p'}|}}_{\text{bottom vertex}} \times \frac{1 \pm e^{-i\pi\alpha(t)}}{2\sin\pi\alpha(t)} s^{\alpha(t)}$$

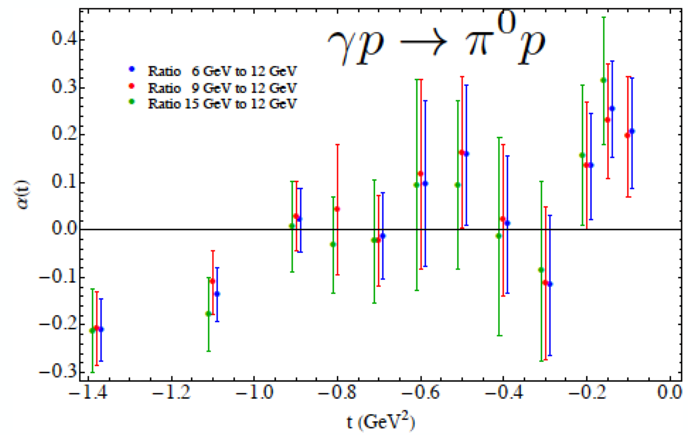
Effective Trajectory

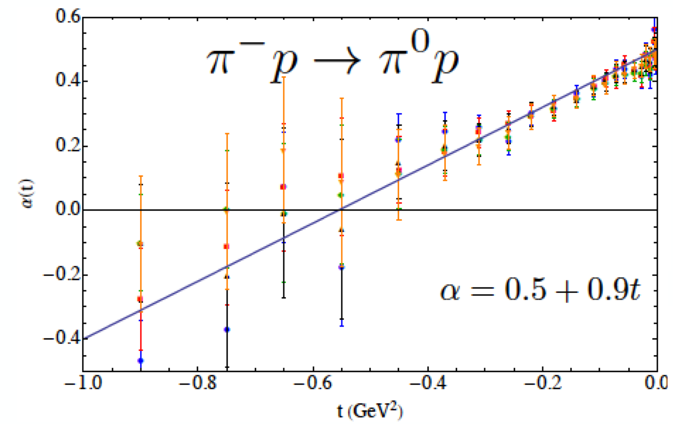


$$A \propto \beta(t) s^{\alpha(t)}$$

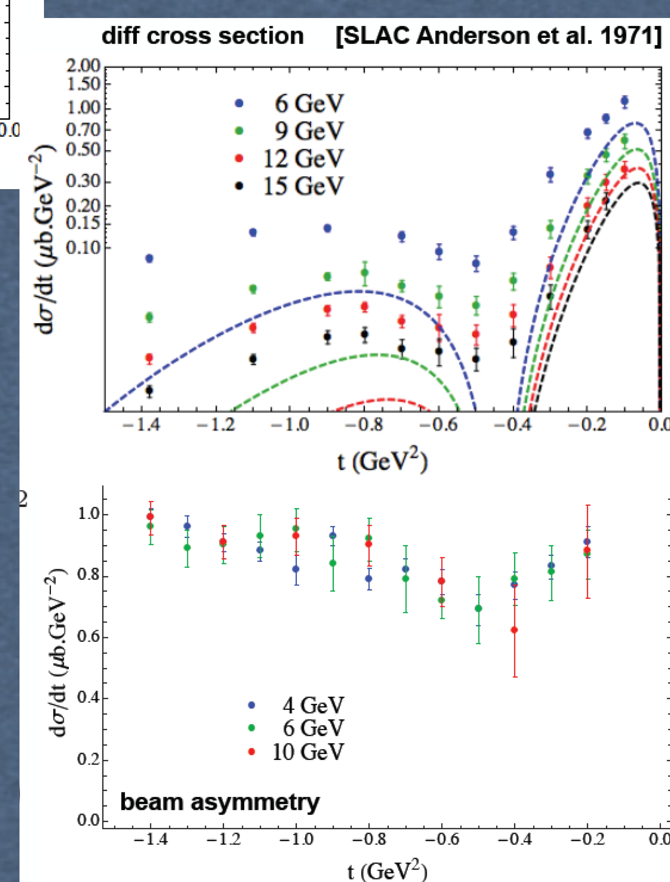
$$\frac{d\sigma}{dt} \propto \frac{1}{p^2}\beta^2(t) s^{2\alpha(t)}$$

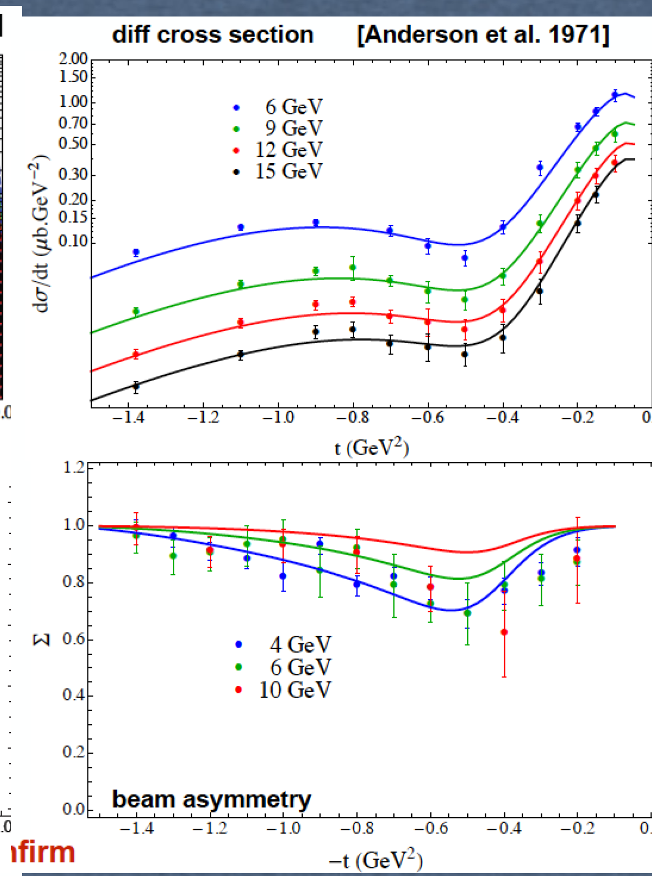
$$\alpha_{\text{eff}} = \frac{1}{2}\log\left(\frac{p^2\frac{d\sigma}{dt}}{p_0^2\frac{d\sigma_0}{dt}}\right)\log^{-1}\left(\frac{s}{s_0}\right)$$





Correct energy dependence
BUT
multiple contributions





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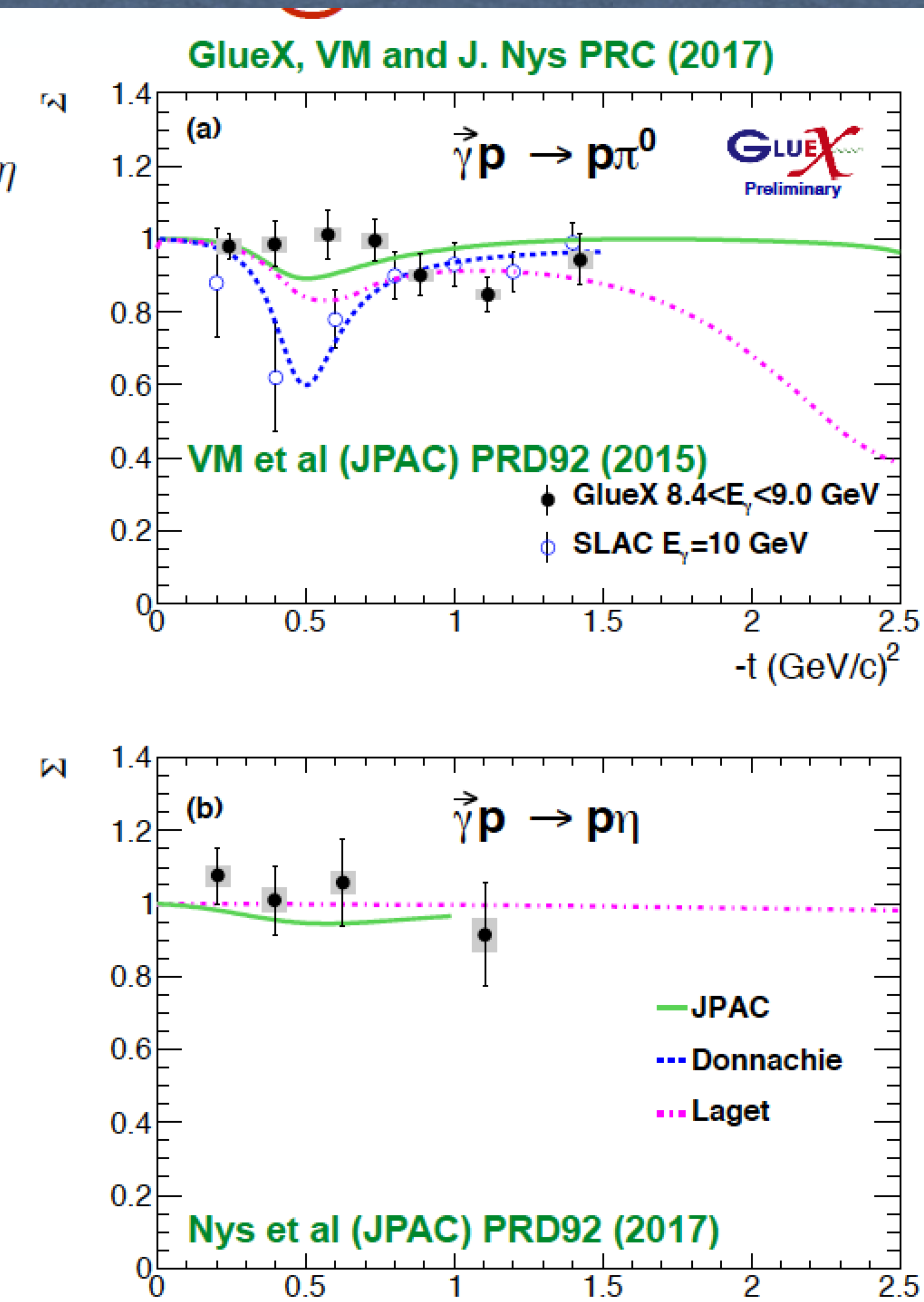
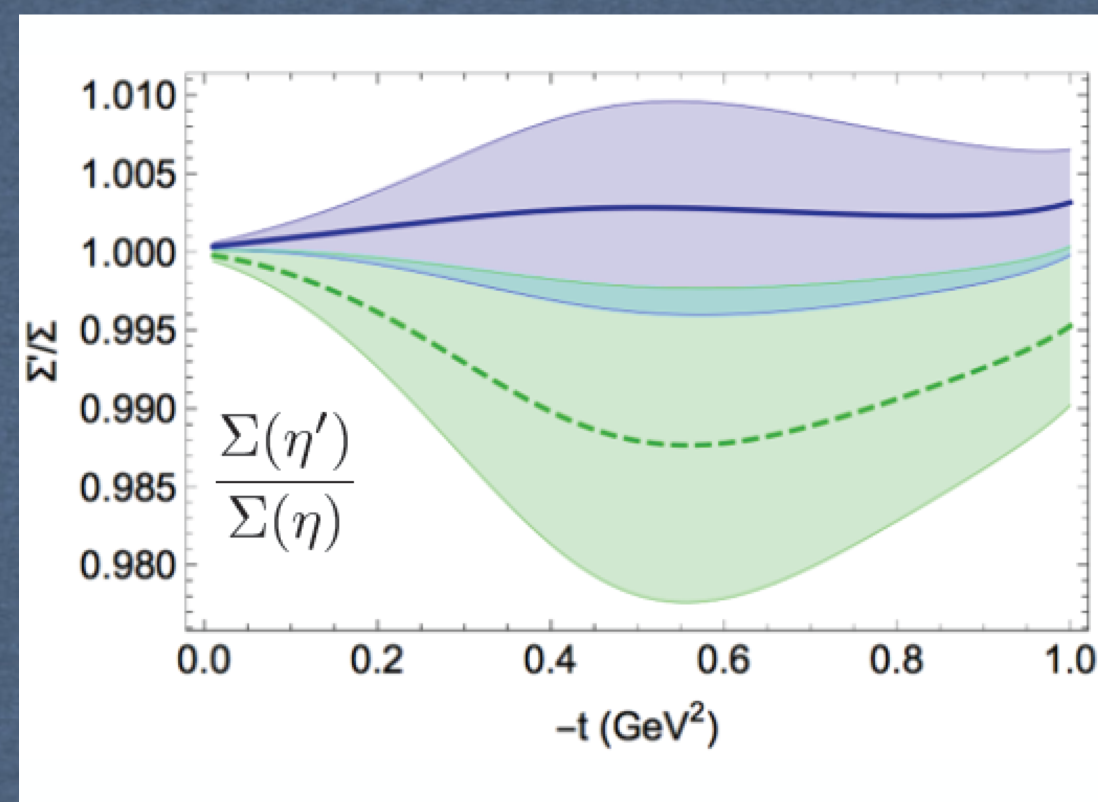


Beam asymmetry Difference probes strange exchanges contribution

blue and green models represent the estimation of systematic errors

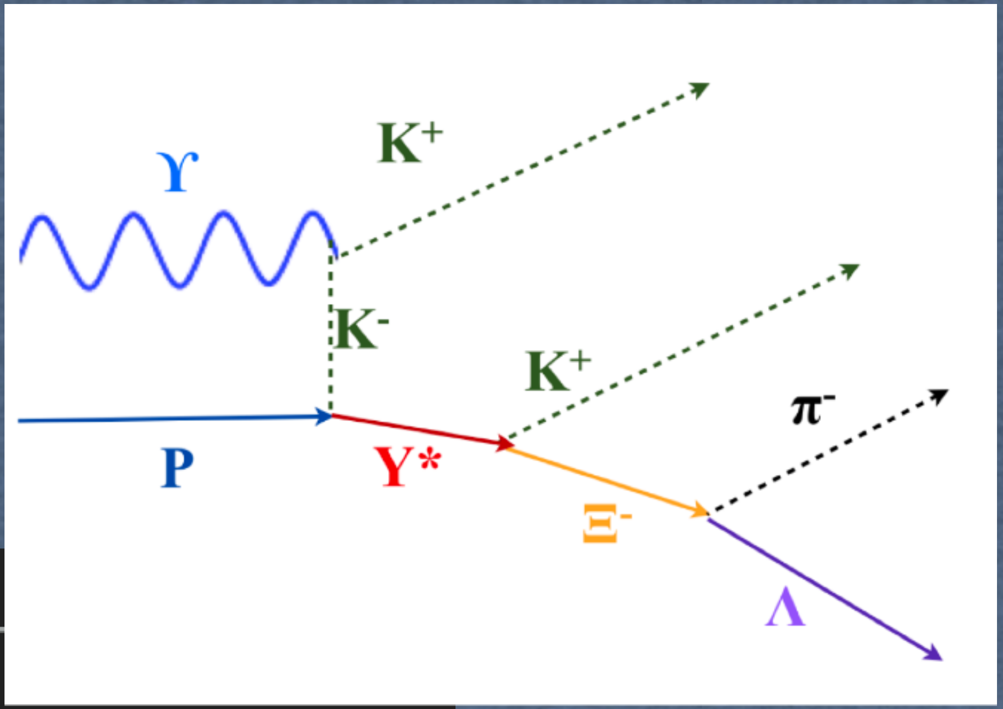
GlueX Preliminary results expected at the APS meeting (October 25-27th 2017)

VM et al. (JPAC) arXiv:1704.07684



Ξ- Polarization

Jason Bono, Fermilab

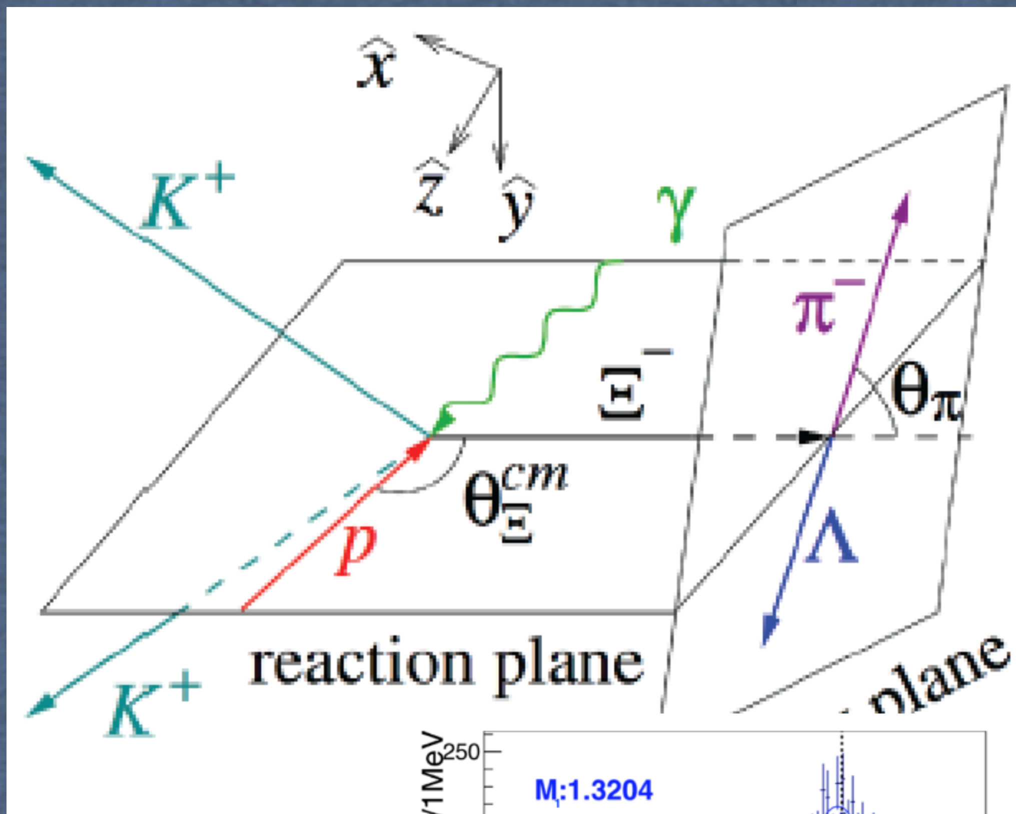


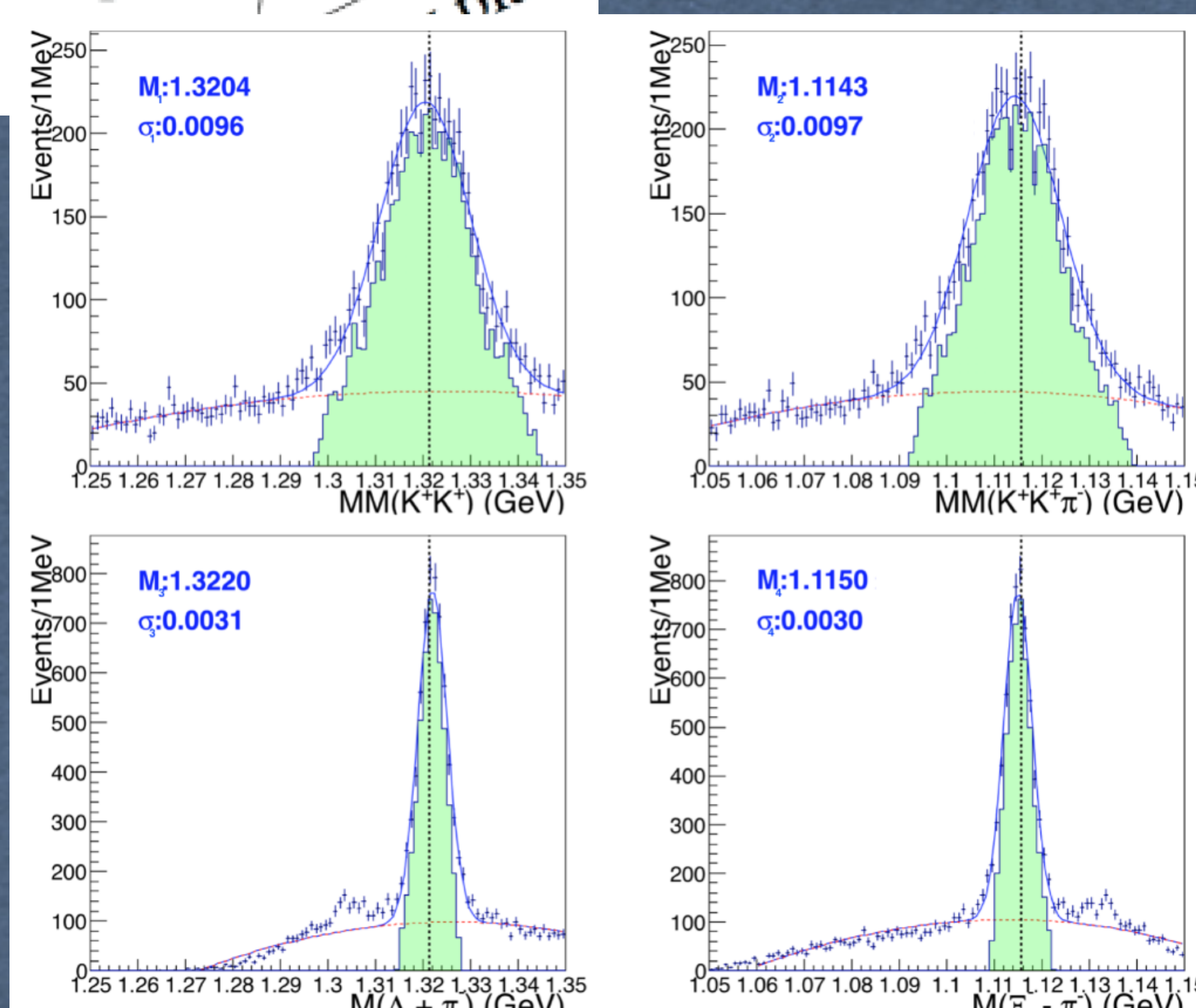
Intro

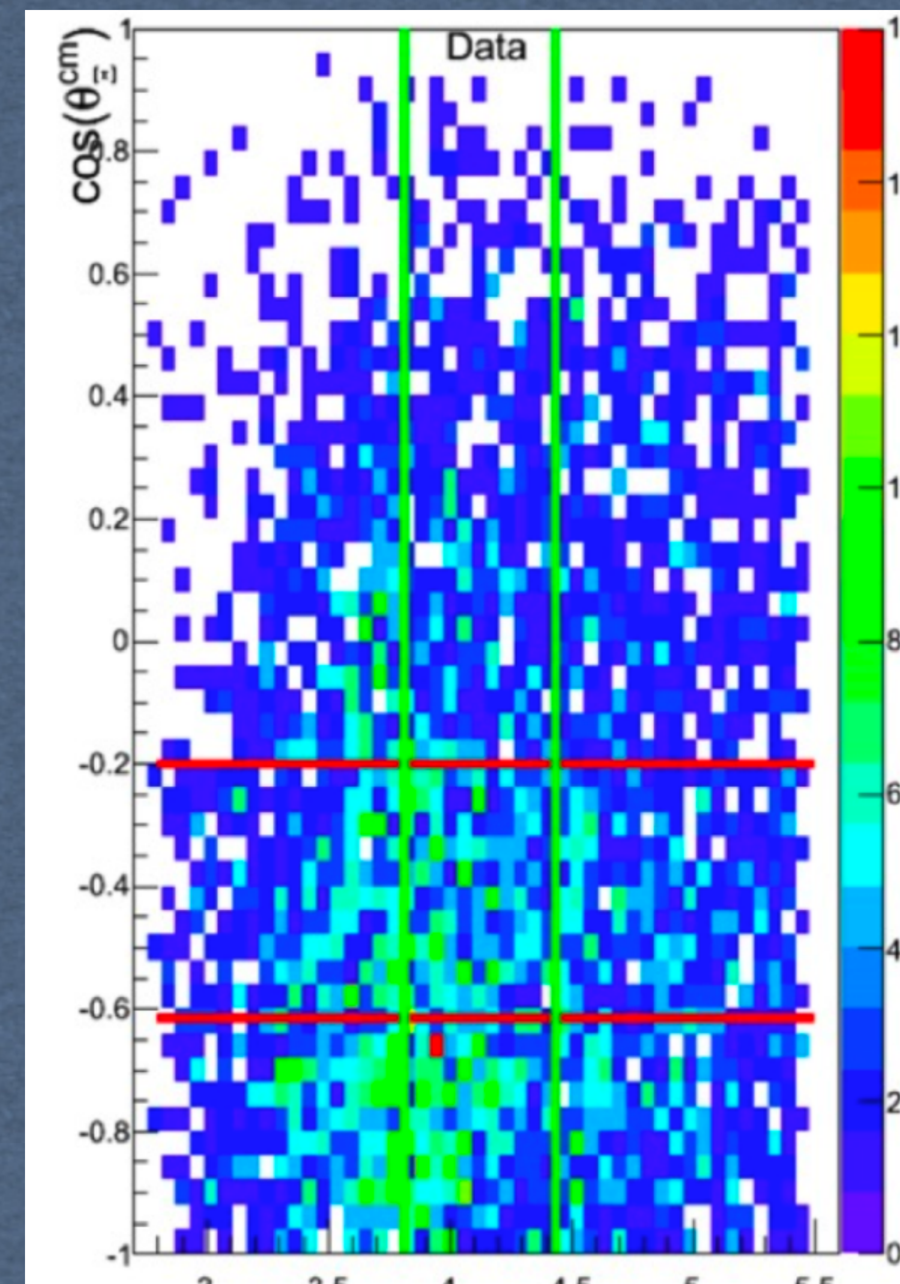
Ξ photoproduction

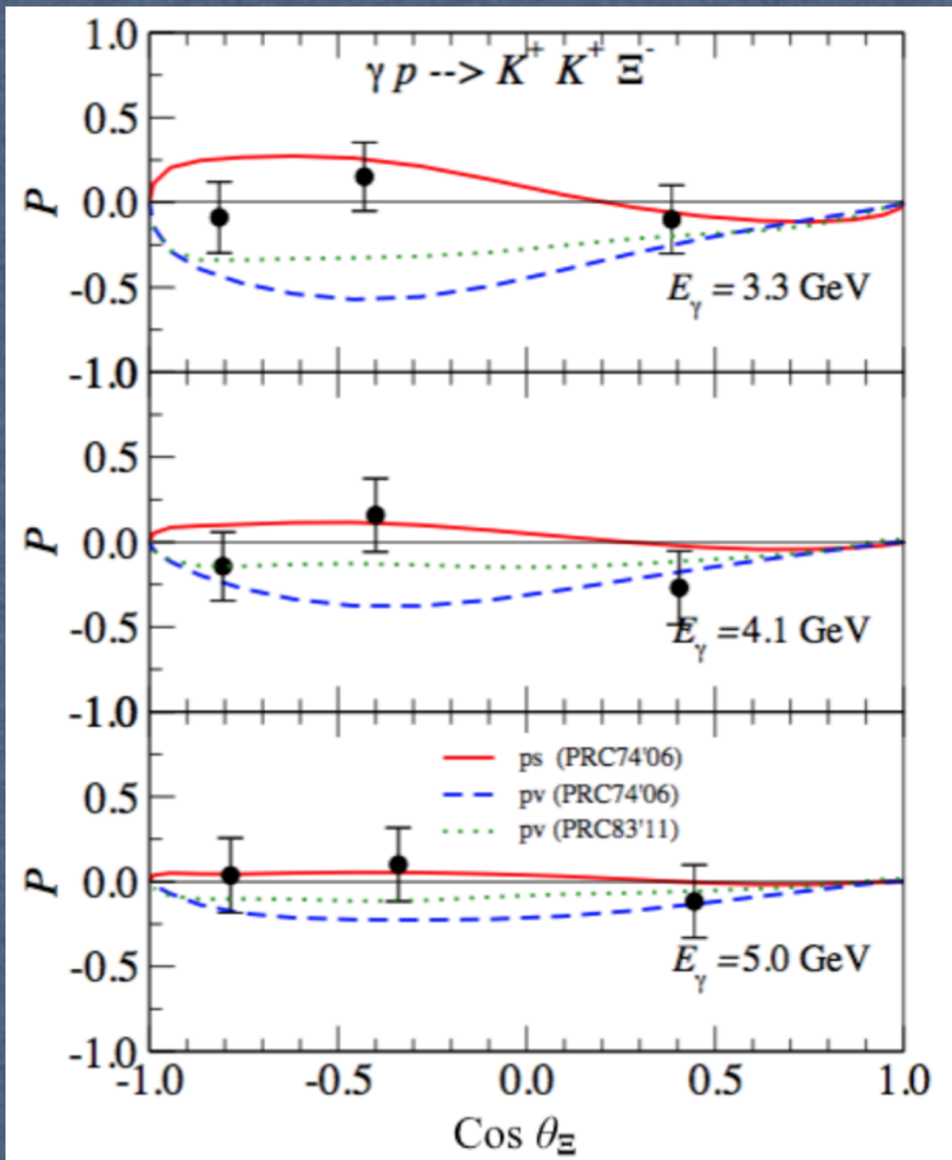
- Only one differential cross section measurement, L. Guo et al.
  - Measured $\delta\sigma/\delta\theta_{CM}$ and found that Ξ is produced backward
    - Indicative of t-channel
- Only one existing theoretical model, K. Nakayama et al.
  - Production proceeds through the excitation of S=-1 hyperons
  - Relativistic meson exchange, amplitudes calculated in the tree-level approximation from effective Lagrangians
  - Reproduced the L. Guo's $\delta\sigma/\delta\theta_{CM}$

5143 $\Xi^- \to \pi^- \Lambda$ events









P, Cx, and Cz in 3+3 Bins

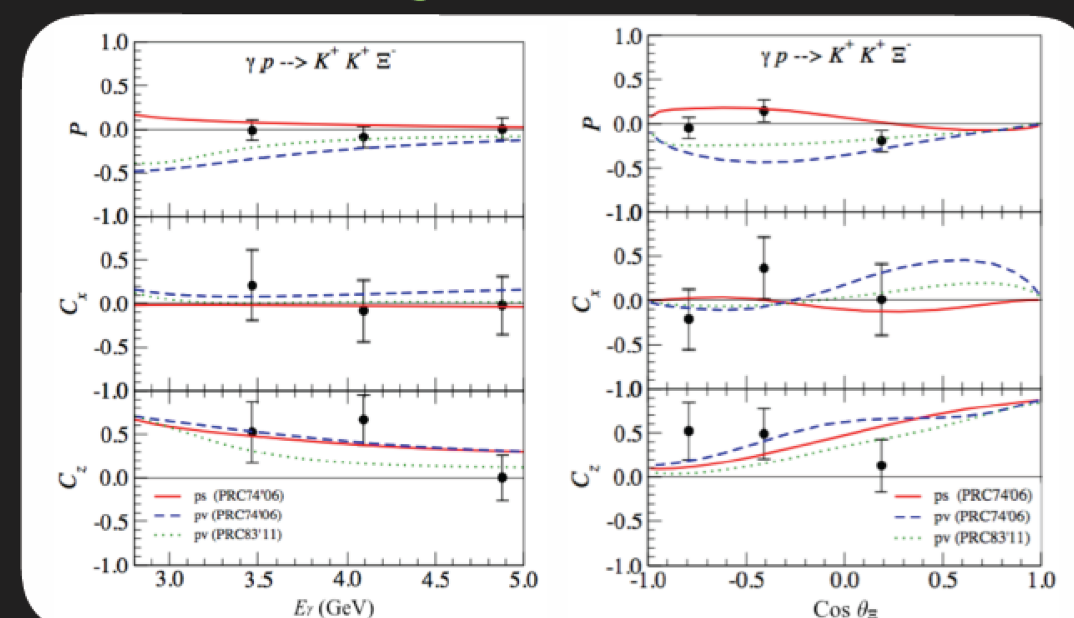
All bins consistent with P=0, Cx=0

Non-zero Cz

General agreement with model

Can not distinguish variants

Total integrated polarization = 0.3 ± 0.15



ps 06: Pseudoscalar coupling, resonances up to Λ(1890)

pv 06: Pseudovector coupling, resonances up to Λ(1890)

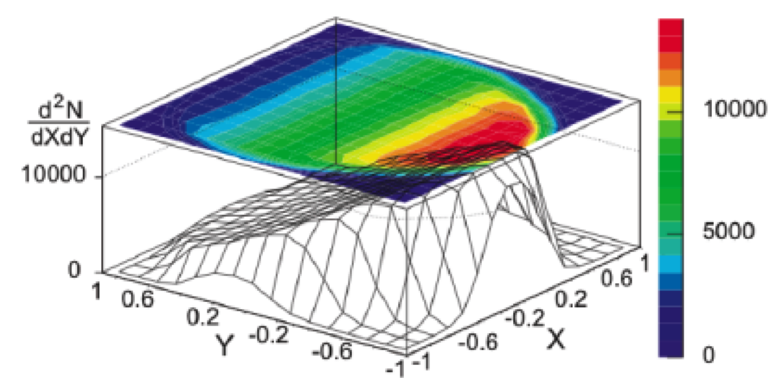
pv 11: Pseudovector coupling, resonances up to Σ(2030)

son Bono, jbono@fnal.gov 20

Update on the Dalitz Plot Analysis of: $\eta \rightarrow \pi^+\pi^-\pi^0$ with the CLAS6 g12 Data Set

Daniel Lersch

Dalitz Plot Analysis of $\eta \rightarrow \pi^+\pi^-\pi^0$



(a) KLOE coll., *JHEP*, 05, (2008)

Dimensionless Dalitz Plot Variables:

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

$$Y = 3\frac{T_{\pi^0}}{T_{\pi^+} + T_{\pi^-} + T_{\pi^0}} - 1$$

- Describe three body decay by two variables (here: X and Y)
- Complete information about decay dynamics
- Parameterise decay width Γ:
  $\frac{d^2\Gamma}{dXdY} \propto (1 + aY + bY^2 + cX + dX^2 + eXY + fY^3 + gX^2Y + ...)$
- $c \neq 0$ and $e \neq 0$:
  - i) Imply C-violation
  - ii) Cause asymmetries within the Dalitz Plot
- Compare Dalitz Plot parameters a,b,d,f from experiment and theory

Recent Measurements and Theoretical Predictions

	Parameter:	$-$ a	b	d	f
Exp.	KLOE (08)[a]	$1.090(5)(^{+8}_{-19})$	0.124(6)(10)	$0.057(6)(^{+7}_{-16})$	0.14(1)(2)
	WASA[d]	1.144(18)	0.219(19)(47)	0.086(18)(15)	0.115(37)
	KLOE (16)[f]	1.104(3)(2)	$0.142(3)(^{5}_{-4})$	$0.073(3)(^{+4}_{-3})$	$0.154(6)(^{+4}_{-5})$
Theor.	ChPT (NNLO)[b]	1.271(75)	0.394(102)	0.055(57)	0.025(160)
	NREFT[c]	1.213(14)	0.308(23)	0.050(3)	0.083(19)
	PWA[e]	1.116(32)	0.188(12)	0.063(4)	0.091(3)
	PWA[g]	1.077(29)	0.170(8)	0.060(2)	0.091(3)

(a) KLOE coll., *JHEP*, 05, (2008)

(b) J. Bijnens and K. Ghorbani., *JHEP*, 11, (2007)

(c) S- P. Schneider et al., *JHEP*, 028, (2011)

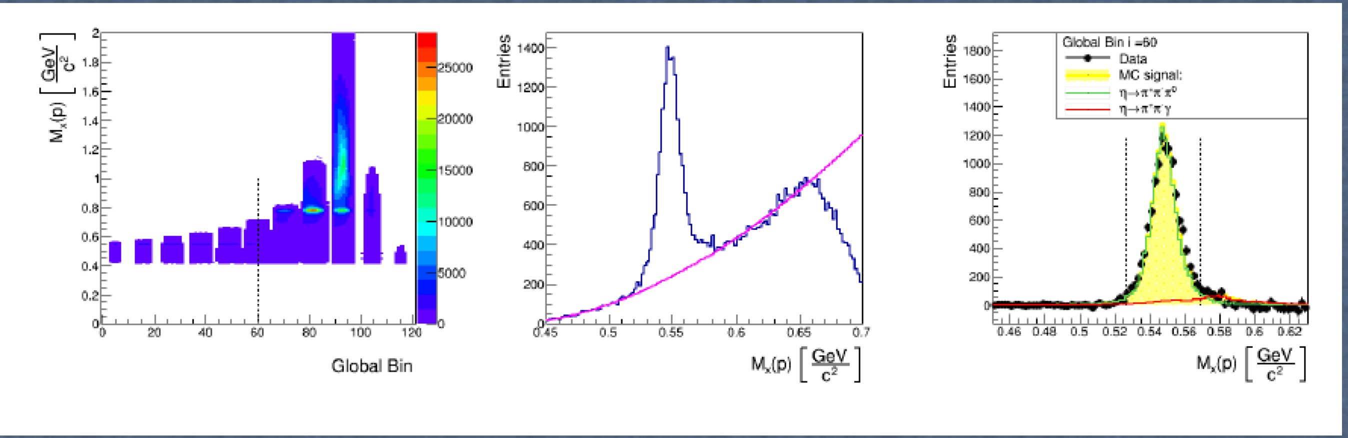
(d) WASA-at-COSY coll., *Phys. Rev.*, C90(045207), 2014

(e) Peng Guo et al., *Phys. Rev.*, D92(05016), (2015)

(f) KLOE coll., *JHEP*, 019, (2016)

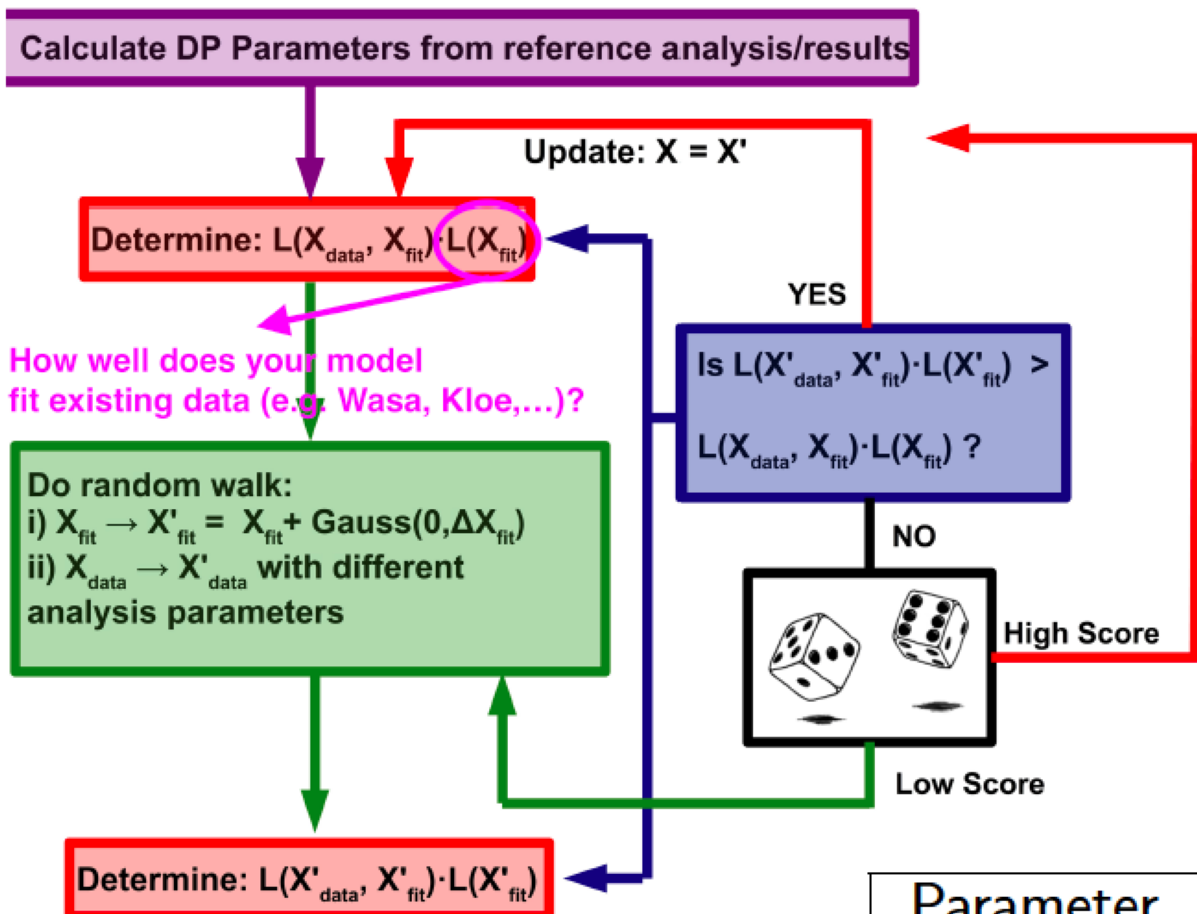
(g) Peng Guo et al., arXiv: 1608.01447v3, (2017)

- WASA-at-COSY: $Q = 21.4 \pm 1.1$[e]
- KLOE: $Q = 21.7 \pm 1.1$[g]
- **Dalitz Plot Analysis and determination of Q for $\gamma p \to p\eta[\eta \to \pi^+\pi^-\pi^0]$ with the CLAS G12 data set**



Towards Systematic Uncertainties: Random Walk Analysis

- Spend a lot of time in understanding systematics
- Had problems with estimating errors properly
- Try different approach: Random walk around reference result



Parameter	σ_{stat}	σ_{beam}	σ_{fit}	σ_{im}	σ_{π^0}	σ_{tot}
$a = -1.135$	± 0.021	$^{+0.042}_{-0.039}$	$^{+0.274}_{-0.159}$	$^{+0.046}_{-0.042}$	$^{0.016}_{0.060}$	$^{+0.281}_{-0.179}$
$b = 0.149$	± 0.020	$^{+0.3}_{-0.281}$	$^{+0.289}_{-0.322}$	$^{+0.118}_{-0.136}$	$^{0.045}_{-0.012}$	$^{+0.435}_{-0.449}$
$c = 0.013$	± 0.008	$^{+0.103}_{-0.115}$	$^{+0.008}_{0.007}$	$^{+0.004}_{-0.001}$	$^{+0.003}_{-0.018}$	$^{+0.103}_{-0.117}$
$d = 0.120$	± 0.020	$^{+0.004}_{-0.037}$	$^{+0.007}_{-0.032}$	$^{+0.008}_{-0.019}$	$^{+0.002}_{-0.003}$	$^{+0.011}_{-0.053}$
$e = 0.014$	± 0.021	$^{+0.004}_{-0.038}$	$^{+0.006}_{-0.040}$	$^{+0.019}_{-0.026}$	$^{+0.003}_{-0.002}$	$^{+0.021}_{-0.061}$
$f = 0.269$	± 0.048	$^{+0.057}_{-0.337}$	$^{+0.074}_{-0.030}$	$^{+0.095}_{-0.228}$	$^{+0.087}_{-0.052}$	$^{+0.159}_{-0.411}$
$g = -0.055$	± 0.068	$^{+0.038}_{-0.099}$	$^{+0.021}_{-0.118}$	$^{0.066}_{-0.004}$	$^{0.014}_{-0.006}$	$^{+0.038}_{-0.154}$

Summary and Outlook

- Refined error estimation $\Rightarrow$ Errors are in a more "reasonable" range
- Need to include into error-estimation:
  - Variation of photon beam energy range
  - Leaving out "sensitive" data points $\rightarrow$ Turned out to have an effect on f
  - Correlation of errors
- Statistical error depends on number of Dalitz Plot bins
  $\Leftrightarrow$ Finer binning?

Parameter	-a	b	c	d	f
KLOE(08)	$1.090(5)(^{+8}_{-19})$	0.124(6)(10)	0.0	$0.057(6)(^{+7}_{-16})$	0.14(1)(2)
WASA	1.144(18)	0.219(19)(47)	0.0	0.086(18)(15)	0.115(37)
KLOE(16)	1.104(5)(2)	$0.142(3)(^{+5}_{-4})$	0.0	$0.073(3)(^{+4}_{-3})$	$0.154(6)(^{+4}_{-5})$
G12	1.102(20)(13)	0.127(18)(5)	0.011(7)(7)	0.106(19)(5)	0.248(45)(10)

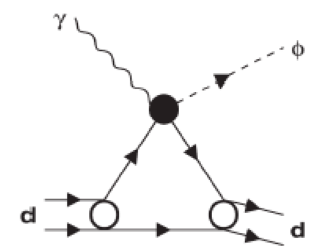
Coherent Vector -Meson Photoproduction off Deuterium: *g*10 Data

Taya Chetry
Ken Hicks
Ohio University

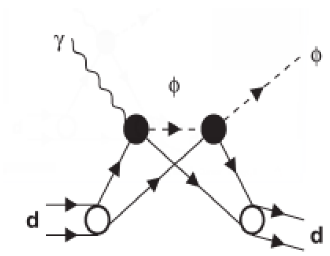
Motivation

$\gamma d \rightarrow \phi d$

Single scattering

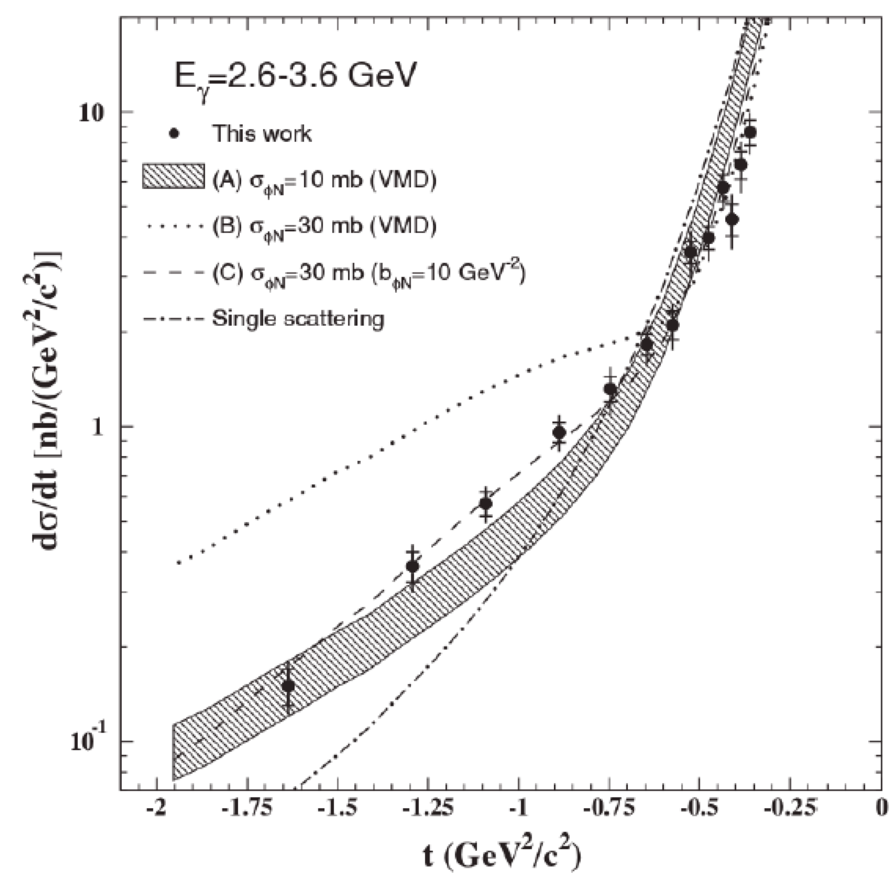


Double scattering



Mandelstam *t* :

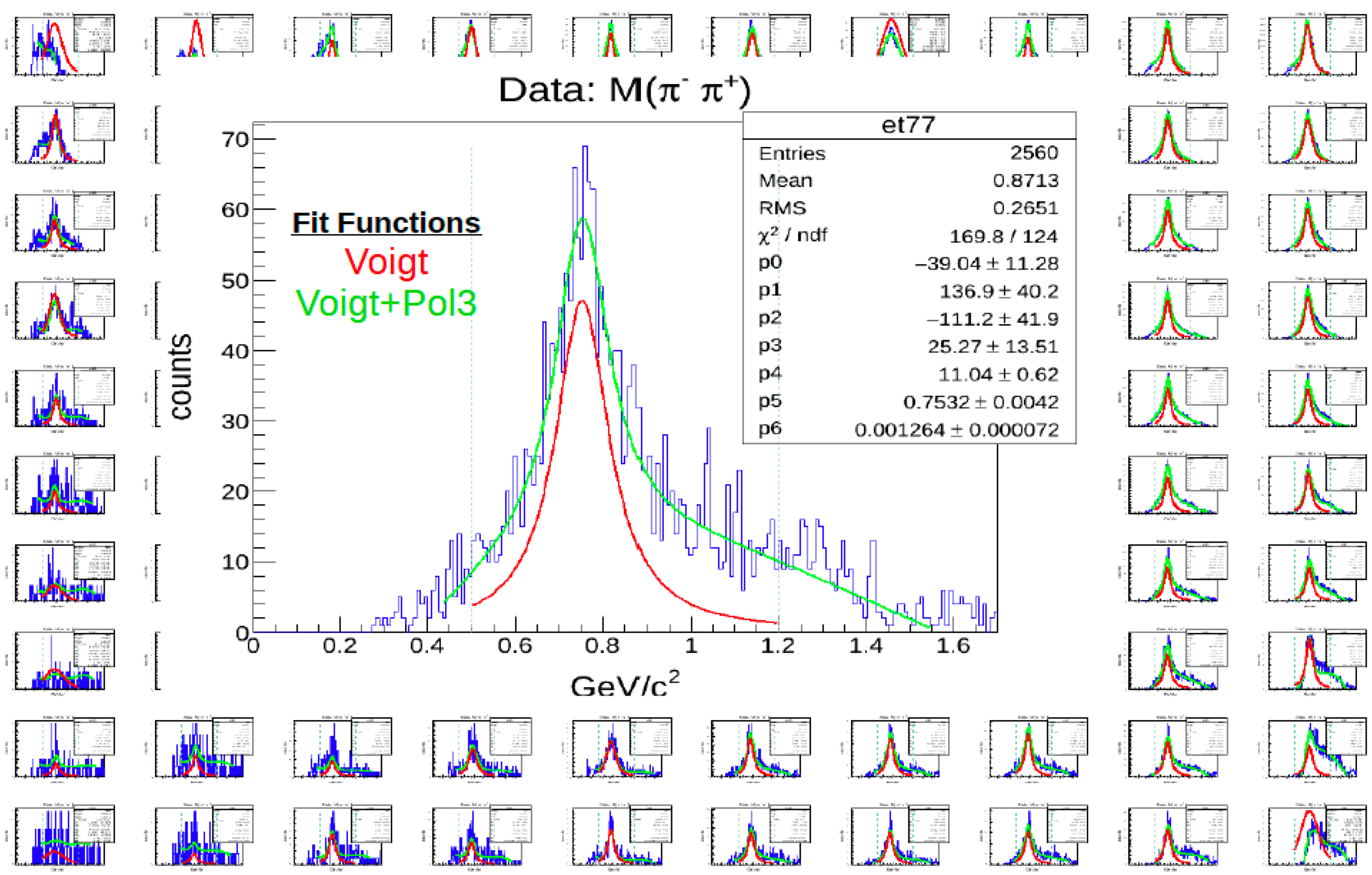
$$t=(P_{\gamma}-P_{\phi})^2=(P_{d_i}-P_{d_o})^2$$

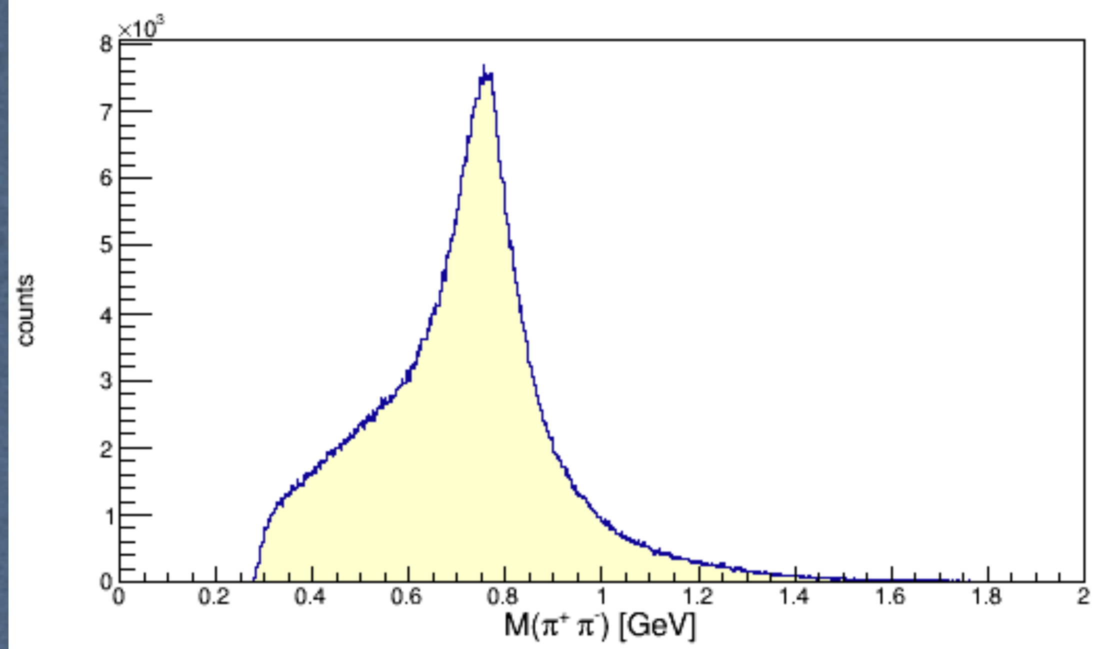


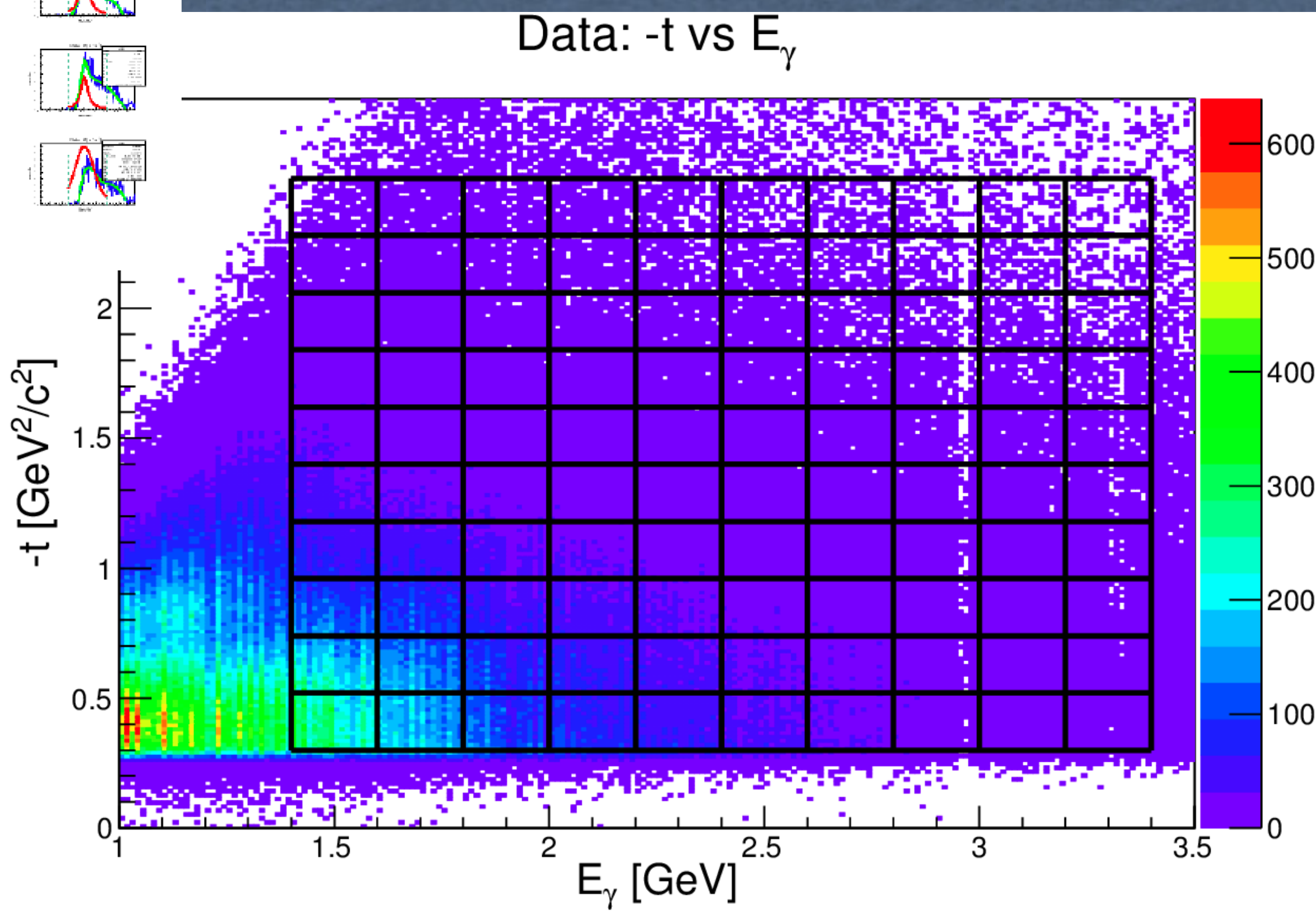
T. Mibe *et al.* PHYSICAL REVIEW C 76, 052202(R) (2007)

Yield Extraction

$\gamma\, d \rightarrow \rho\, d$







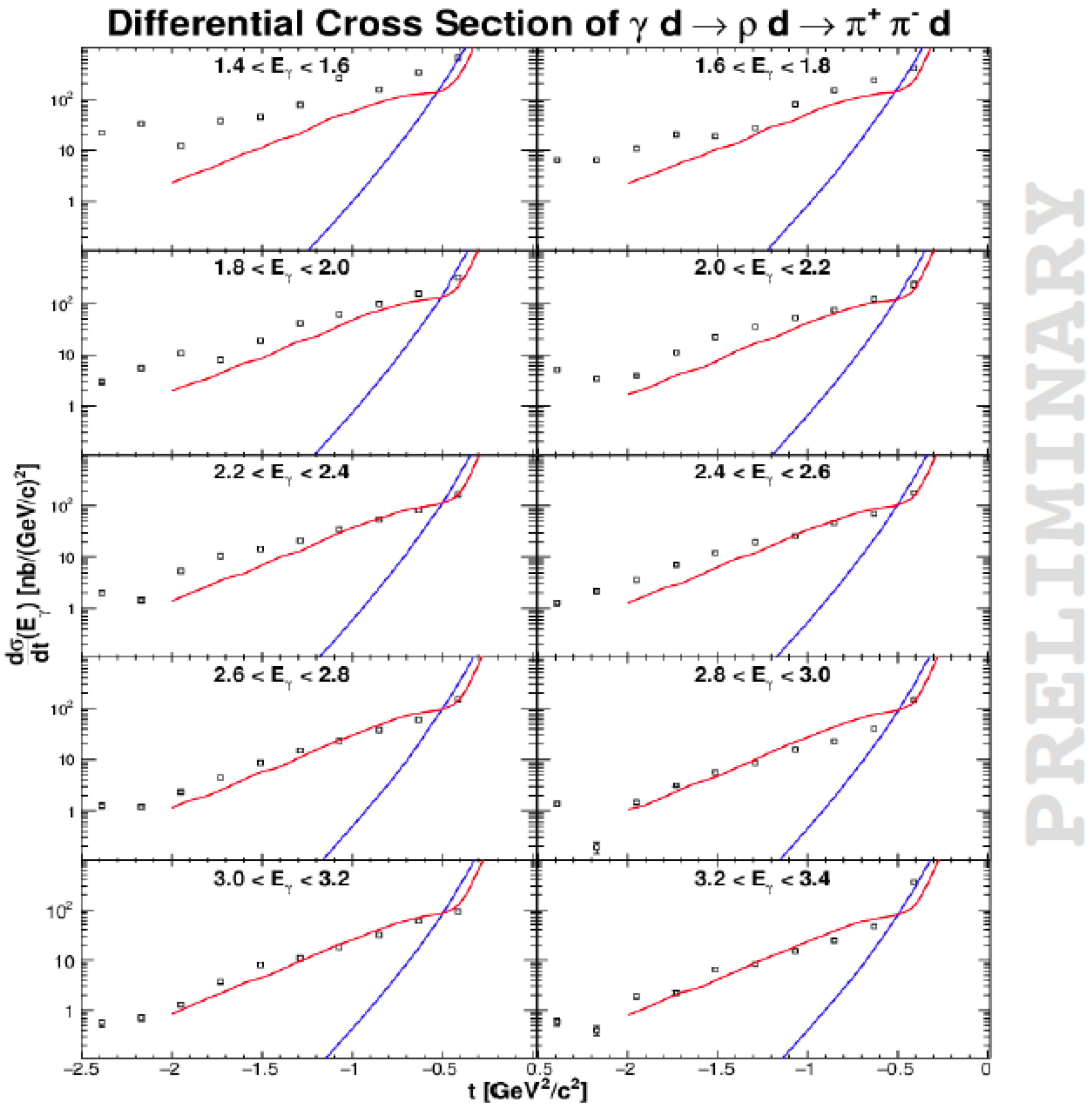
Yield is extracted by taking integral of the Voigt function

Differential Cross-section

Preliminary

- Calculations are provided by Dr. Sargsian (FIU)* .
- Production of ρ is within the Vector Dominance Model.
- Born Term Contribution: single scattering
- Final State Interaction included

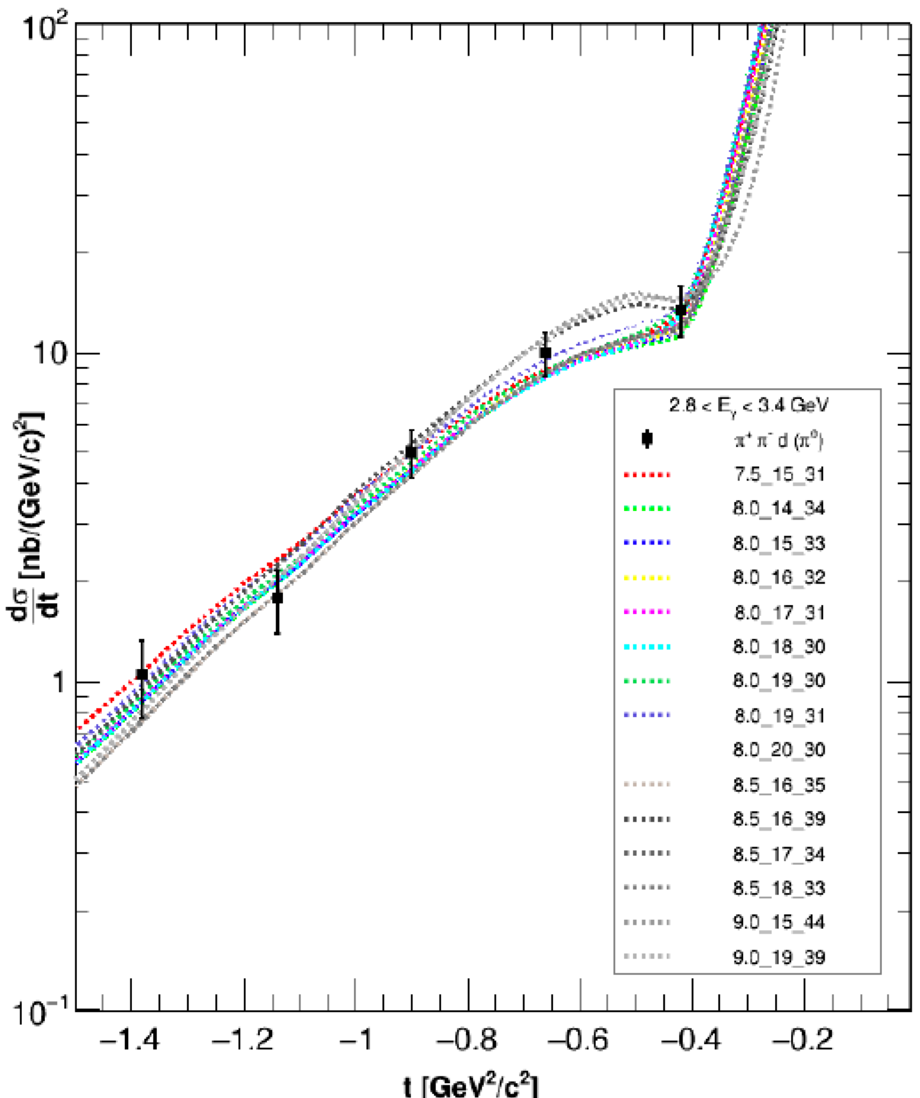
Work in Progress!



* *Coherent Photo- and Leptoproduction of Vector Mesons from Deuterium*, **Frankfurt et al**, Nucl.Phys. A622 (1997) 511-537

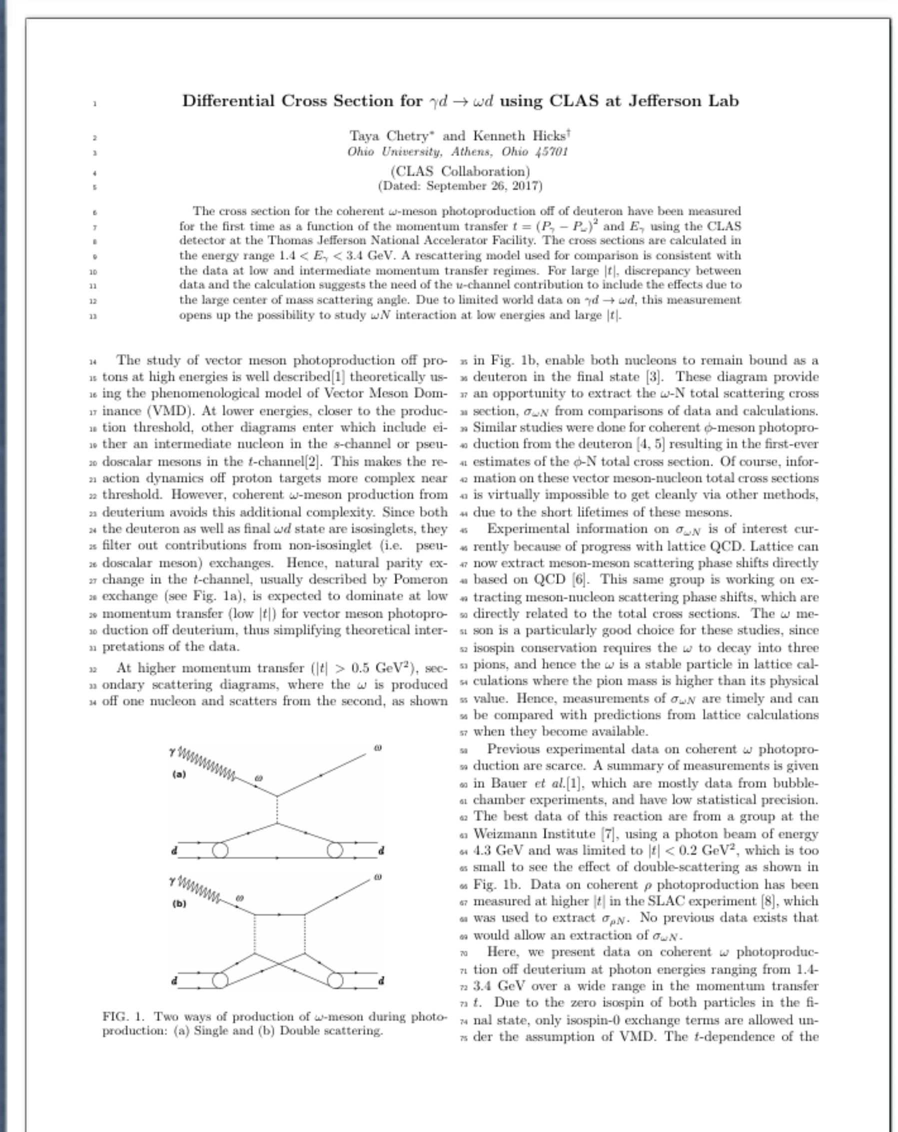
Comparison

$\gamma\, d \rightarrow \omega\, d$



$\alpha_{\gamma N} = \alpha_{\omega N} = -0.4$

$b_{\gamma N} = b_{\omega N}$ $[GeV^{-2}]$	$\frac{d\sigma}{dt}\big\vert_{t=0,\gamma N}$ $[\mu b/GeV^2]$	$\sigma_{\omega N}$ $[mb]$	χ^2/NDF
7.5	15	31	1.13
8.0	14	34	1.15
8.0	15	33	1.01
8.0	16	32	0.96
8.0	17	31	1.00
8.0	18	30	1.15
8.0	19	30	0.91
8.0	19	31	0.87
8.0	20	30	1.03
8.5	16	35	1.11
8.5	16	39	1.00
8.5	17	34	1.05
8.5	18	33	1.07
9.0	15	44	0.99
9.0	19	39	0.89
9.0	20	38	0.87



Differential Cross Section for $\gamma d \rightarrow \omega d$ using CLAS at Jefferson Lab

Taya Chetry* and Kenneth Hicks†
Ohio University, Athens, Ohio 45701
(CLAS Collaboration)
(Dated: September 26, 2017)

The cross section for the coherent ω-meson photoproduction off of deuteron have been measured for the first time as a function of the momentum transfer $t = (P_\gamma - P_\omega)^2$ and E_γ using the CLAS detector at the Thomas Jefferson National Accelerator Facility. The cross sections are calculated in the energy range $1.4 < E_\gamma < 3.4$ GeV. A rescattering model used for comparison is consistent with the data at low and intermediate momentum transfer regimes. For large $|t|$, discrepancy between data and the calculation suggests the need of the u-channel contribution to include the effects due to the large center of mass scattering angle. Due to limited world data on $\gamma d \rightarrow \omega d$, this measurement opens up the possibility to study ωN interaction at low energies and large $|t|$.

The study of vector meson photoproduction off protons at high energies is well described[1] theoretically using the phenomenological model of Vector Meson Dominance (VMD). At lower energies, closer to the production threshold, other diagrams enter which include either an intermediate nucleon in the s-channel or pseudoscalar mesons in the t-channel[2]. This makes the reaction dynamics off proton targets more complex near threshold. However, coherent ω-meson production from deuterium avoids this additional complexity. Since both the deuteron as well as final ωd state are isosinglets, they filter out contributions from non-isosinglet (i.e. pseudoscalar meson) exchanges. Hence, natural parity exchange in the t-channel, usually described by Pomeron exchange (see Fig. 1a), is expected to dominate at low momentum transfer (low $|t|$) for vector meson photoproduction off deuterium, thus simplifying theoretical interpretations of the data.

At higher momentum transfer ($|t| > 0.5$ GeV^2), secondary scattering diagrams, where the ω is produced off one nucleon and scatters from the second, as shown in Fig. 1b, enable both nucleons to remain bound as a deuteron in the final state [3]. These diagram provide an opportunity to extract the ω-N total scattering cross section, $\sigma_{\omega N}$ from comparisons of data and calculations. Similar studies were done for coherent ϕ-meson photoproduction from the deuteron [4, 5] resulting in the first-ever estimates of the ϕ-N total cross section. Of course, information on these vector meson-nucleon total cross sections is virtually impossible to get cleanly via other methods, due to the short lifetimes of these mesons.

Experimental information on $\sigma_{\omega N}$ is of interest currently because of progress with lattice QCD. Lattice can now extract meson-meson scattering phase shifts directly based on QCD [6]. This same group is working on extracting meson-nucleon scattering phase shifts, which are directly related to the total cross sections. The ω meson is a particularly good choice for these studies, since isospin conservation requires the ω to decay into three pions, and hence the ω is a stable particle in lattice calculations where the pion mass is higher than its physical value. Hence, measurements of $\sigma_{\omega N}$ are timely and can be compared with predictions from lattice calculations when they become available.

Previous experimental data on coherent ω photoproduction are scarce. A summary of measurements is given in Bauer *et al.*[1], which are mostly data from bubble-chamber experiments, and have low statistical precision. The best data of this reaction are from a group at the Weizmann Institute [7], using a photon beam of energy 4.3 GeV and was limited to $|t| < 0.2$ GeV^2, which is too small to see the effect of double-scattering as shown in Fig. 1b. Data on coherent ρ photoproduction has been measured at higher $|t|$ in the SLAC experiment [8], which was used to extract $\sigma_{\rho N}$. No previous data exists that would allow an extraction of $\sigma_{\omega N}$.

Here, we present data on coherent ω photoproduction off deuterium at photon energies ranging from 1.4-3.4 GeV over a wide range in the momentum transfer t. Due to the zero isospin of both particles in the final state, only isospin-0 exchange terms are allowed under the assumption of VMD. The t-dependence of the

FIG. 1. Two ways of production of ω-meson during photoproduction: (a) Single and (b) Double scattering.

Photoproduction of $K^0\Sigma^+$ From CLAS-g12

ZULKAIDA AKBAR

Status of N* in PDG 2016

KY channel are promising

- A set of 8 resonances claimed by BnGa-PWA from this chanel

But there are still plenty of room to explore

$\gamma p \to KY$

	Total	CLAS
$\gamma p \to K^+\Lambda$	9026	6046
$\gamma p \to K^+\Sigma^0$	6876	4343
$\gamma p \to K^0\Sigma^+$	304	48

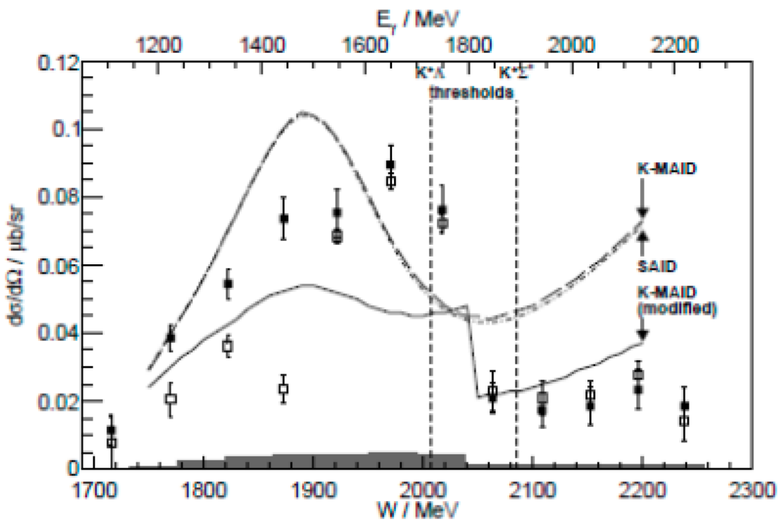
Courtesy of E. Pasyuk

			Status as seen in								
Particle	J^P	overall	$N\gamma$	$N\pi$	$N\eta$	$N\sigma$	$N\omega$	ΛK	ΣK	$N\rho$	$\Delta\pi$
N	$1/2^+$	****									
$N(1440)$	$1/2^+$	****	****	****		***				*	***
$N(1520)$	$3/2^-$	****	****	****	***					***	***
$N(1535)$	$1/2^-$	****	****	****	****					**	*
$N(1650)$	$1/2^-$	****	****	****	***			***	**	**	***
$N(1675)$	$5/2^-$	****	****	****	*			*		*	***
$N(1680)$	$5/2^+$	****	****	****	*	**				***	***
$N(1700)$	$3/2^-$	***	**	***	*			*	*	*	***
$N(1710)$	$1/2^+$	****	****	****	***		**	****	**	*	**
$N(1720)$	$3/2^+$	****	****	****	***			**	**	**	*
$N(1860)$	$5/2^+$	**		**						*	*
$N(1875)$	$3/2^-$	***	***	*			**	***	**		***
$N(1880)$	$1/2^+$	**	*	*		**		*			
$N(1895)$	$1/2^-$	**	**	*	**			**	*		
$N(1900)$	$3/2^+$	***	***	**	**		**	***	**	*	**
$N(1990)$	$7/2^+$	**	**	**					*		
$N(2000)$	$5/2^+$	**	**	*	**			**	*	**	
$N(2040)$	$3/2^+$	*		*							
$N(2060)$	$5/2^-$	**	**	**	*				**		
$N(2100)$	$1/2^+$	*		*							
$N(2120)$	$3/2^-$	**	**	**				*	*		
$N(2190)$	$7/2^-$	****	***	****			*	**		*	
$N(2220)$	$9/2^+$	****		****							
$N(2250)$	$9/2^-$	****		****							
$N(2300)$	$1/2^+$	**		**							
$N(2570)$	$5/2^-$	**		**							
$N(2600)$	$11/2^-$	***		***							
$N(2700)$	$13/2^+$	**		**							

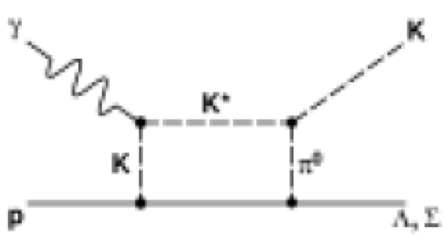
**** Existence is certain, and properties are at least fairly well explored.
*** Existence is very likely but further confirmation of decay modes is required.
** Evidence of existence is only fair.
* Evidence of existence is poor.

6

- Investigate the anomaly (sudden drop) seen on previous measurement

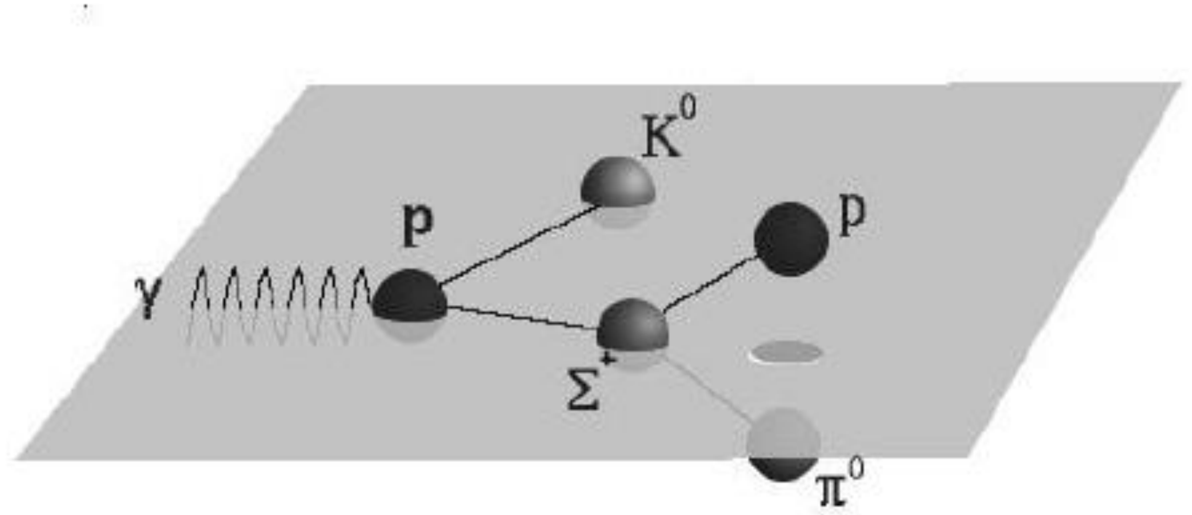


The anomaly seen in the total cross section of $\gamma p \to K^0\Sigma^+$ from CBELSA/TAPS



The diagram behind the anomaly

8

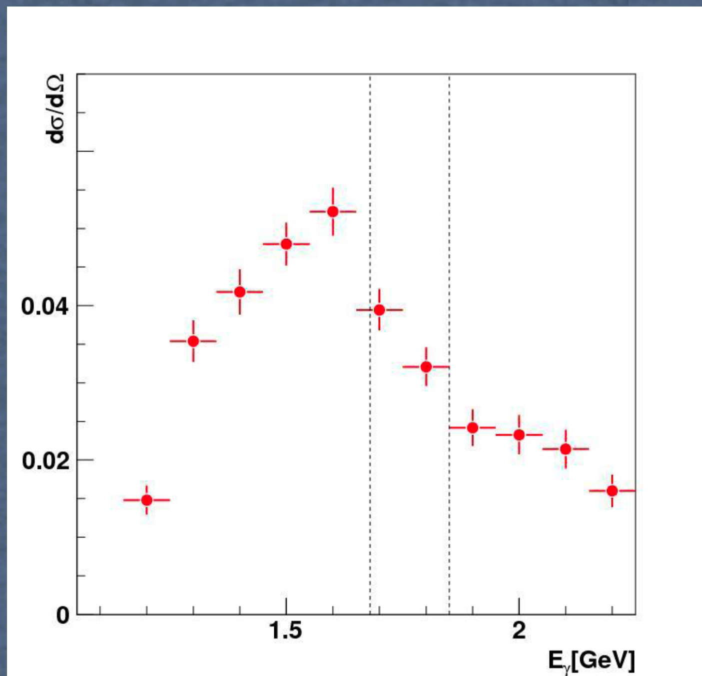


Data Analysis

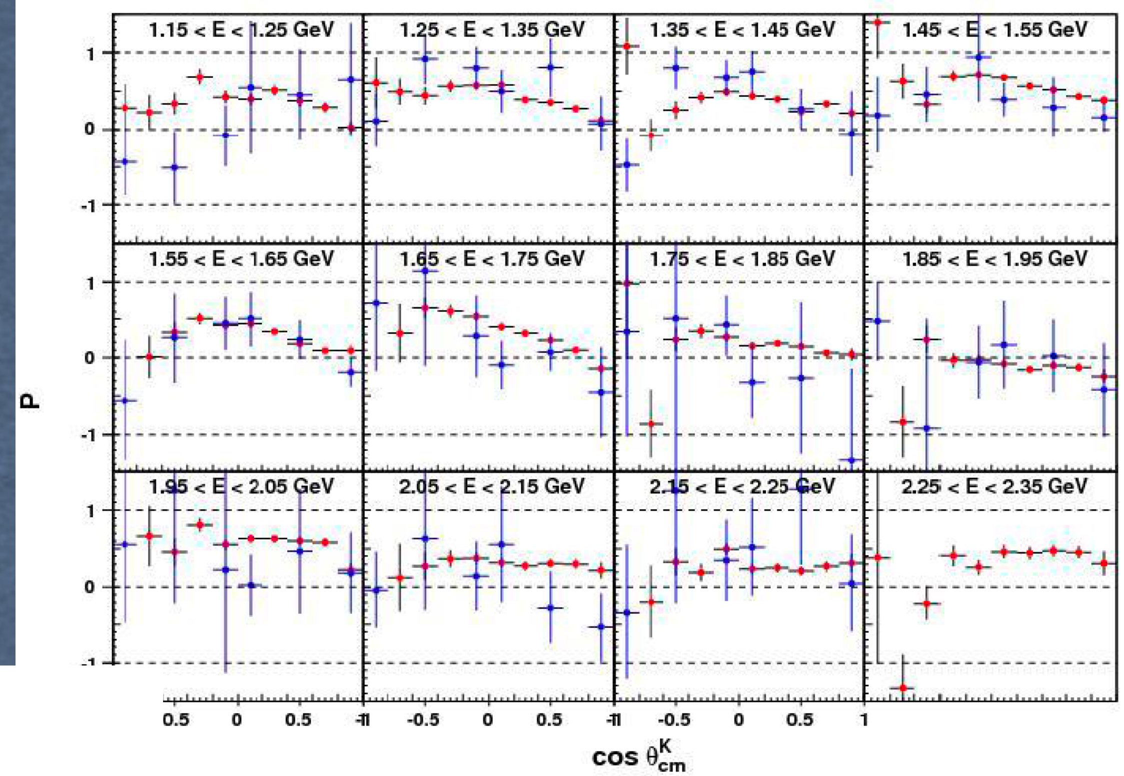
We have $\pi^+\pi^-\pi^0$ in the final state since :

$\gamma p \to K^0\Sigma^+$ → $\Sigma^+ \to p\,\pi^0$

→ $K^0 \to \pi^+\pi^-$



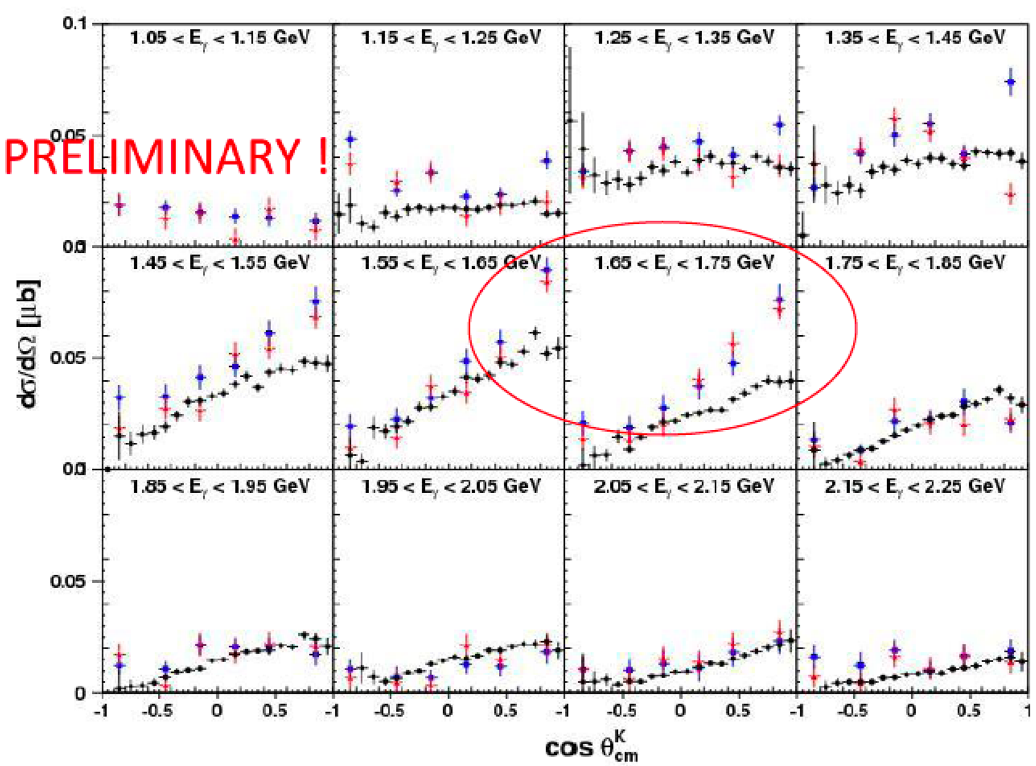
The Recoil Polarization of Σ^+



The figure shows the Recoil Polarization of Σ^+ from CLAS-g12 (**RED**) in comparison with the previous measurement from Cristal Barrel (**BLUE**)

PRELIMINARY !

Differential cross section of $\gamma p \rightarrow K^0\Sigma^+$

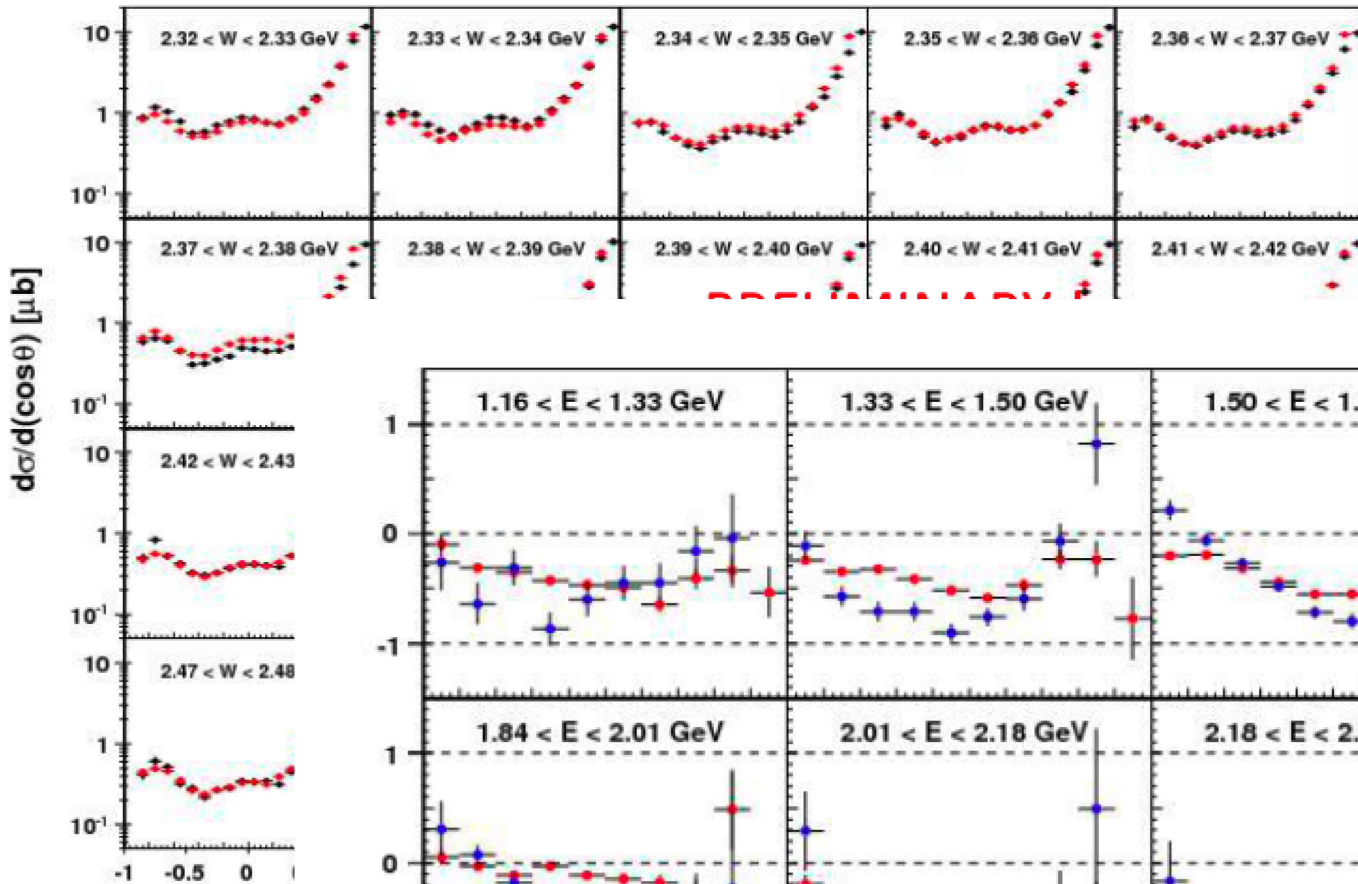


The figure shows the differential cross section of $\gamma p \rightarrow K^0\Sigma^+$ from CLAS-g comparison with the previous measurement from CBELSA/TAPS (**BLUE**)

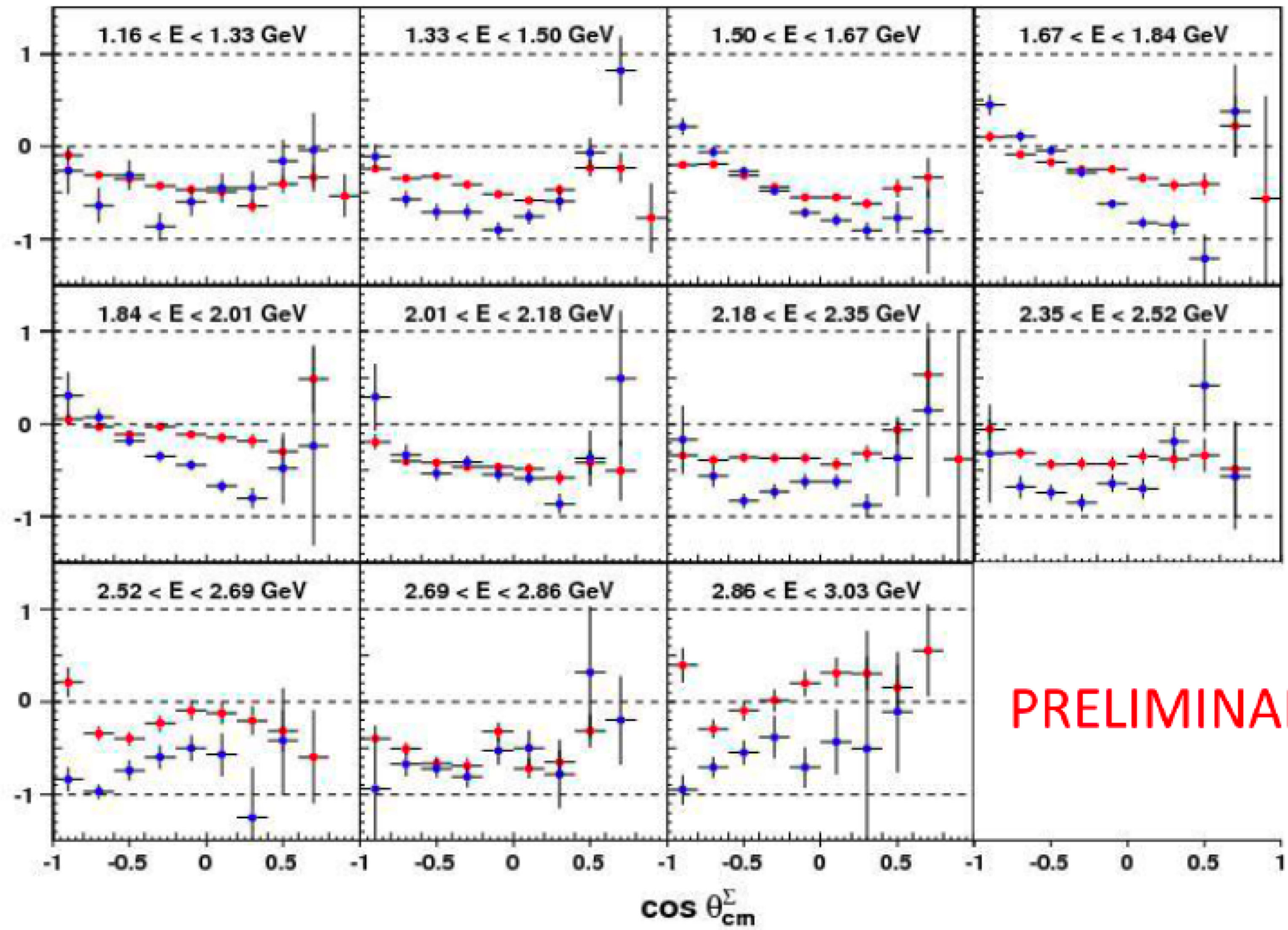
The CLAS-g12 data :

- Smooth transition between energy bin
- No indication of cusp-like structure (anomaly)
- In general has fair agreement with the previous CBELSA/TAPS and Cristal Barrel result except in the anomaly region

Differential cross section of γp ->pω



- The figure shows the Differential cross section of γp ->pω (**BLACK**) from CLAS-g12 in comparison with the previous measurement from CLAS-g11 (RED)



The figure shows the Recoil Polarization of γp -> $K^0\Sigma^+$ from CLAS-g12 (**RED**) in comparison with the previous measurement from CLAS-g11 (**BLUE**).

Disagreements are also seen!

PRELIMINARY !

CLAS Working Groups Joint Session

11:00 - 12:30 CLAS WGs Joint Session

Remote connection: https://bluejeans.com/758848750

Conveners: Dr. Marco Battaglieri (INFN-GE), Mr. Marco Contalbrigo (INFN Ferrara), Dr. Michael Wood (Canisius College)

Location: CEBAF Center (F113)

11:00 **Introduction** *10'*

Speakers: Dr. Marco Battaglieri (INFN-GE), Mr. Marco Contalbrigo (INFN Ferrara), Dr. Michael Wood (Canisius College)

11:10 **ACE report** *10'*

Speaker: Ken Hicks (Ohio University)

11:20 **The hadron spectroscopy analysis gframe** *15'*

Speaker: Dr. Derek Glazier (University of Glasgow)

11:35 **The DEEP analysis framework** *15'*

Speaker: Dr. Harut Avagyan (Jefferson Lab)

11:50 **Discussion on common analysis frameworks** *20'*

12:10 **How the WG can help in data analyses** *20'*

1) do we want a common analysis framework?
- pros: framework already set up, validated tools, simple procedure to incorporate new/better procedures, analysis review speed up
- cons: single framework, reduced freedom in developing the framework

2) can be the framework the same for the 3 WG?
- pros: see above
- cons: single framework, reduced freedom in developing the framework

3) How to implement it?

ACE Report:
"Ancient Council of Elders"

Ken Hicks
CLAS Collaboration Meeting
Oct. 5, 2017

The Real World

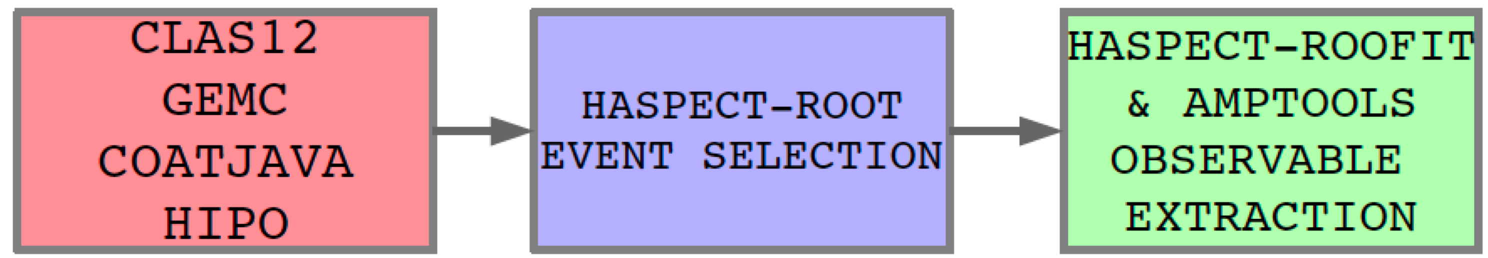
- Calibration routines are not written in a robust manner or are used in ways not expected.
- People have varying preferences in how they want to access the data.
- Each analysis is different and the guidelines may not have the necessary info.
- Each committee is different and has a different emphasis on how to do the review.

ACE recommendations (see our report)

- General Procedures: reconstruction -> HIPO file -> post-processing
- Analysis Review: 1) run group (in common) 2) individual final state
- Lessons Learned: standardize software, minimize mom. corrections
- Beam Information: data-taking procedures with redundant readouts
- Radiative corrections: standardize as best possible; common to all
- Higher-level analysis: explore machine learning, multi-variate analysis
  - Also develop guidelines for blinded analysis, partial-wave analysis, etc.
- Gather feedback from the collaboration: revise report as needed.

Preparing for CLAS12 Data Analysis
HASPECT Working group

Derek Glazier
University of Glasgow



- All observables extracted via Extended Maximum Likelihood fits
  - Polarisation Observables, Spin Density Matrix Elements, Angular Moments; Partial Waves;...
  - Simulated events used to correct for acceptance via normalisation integral
  - TOYMC method used to correct for detector distortions
  - Backgrounds accounted for using event weights
    - sWeights, Q-factor, sidebands,…
- Software based on RooFit or IU-AmpTools
  - Adding repository of standard observable fit functions or amplitudes

- Tested on simulated CLAS12 and real CLAS data
- Improving user interface, tutorials

The DEEP analysis framework

Harut Avakian(JLab)

SIDIS x-section

$$\frac{d\sigma}{dx\,dy\,d\psi\,dz\,d\phi_h\,dP_{h\perp}^2} = \frac{\alpha^2}{xyQ^2}\frac{y^2}{2(1-\varepsilon)}\left(1+\frac{\gamma^2}{2x}\right)\Big\{F_{UU,T} + \varepsilon F_{UU,L} + \sqrt{2\varepsilon(1+\varepsilon)}\cos\phi_h F_{UU}^{\cos\phi_h}$$

$$+\varepsilon\cos(2\phi_h)F_{UU}^{\cos 2\phi_h} + \lambda_e\sqrt{2\varepsilon(1-\varepsilon)}\sin\phi_h F_{LU}^{\sin\phi_h}$$

$$+S_\parallel\left[\sqrt{2\varepsilon(1+\varepsilon)}\sin\phi_h F_{UL}^{\sin\phi_h} + \varepsilon\sin(2\phi_h)F_{UL}^{\sin 2\phi_h}\right]$$

SIDIS $\ell($

$+S_\parallel\lambda_e\left[\sqrt{1-\right.$

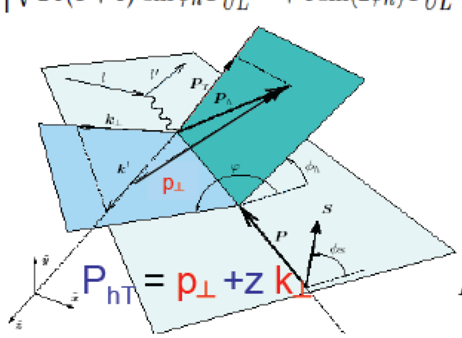
$+|S_\perp|\left[\sin(\phi\right.$

$+\varepsilon\sin(\phi$

$+\sqrt{2\varepsilon(1$

$+|S_\perp|\lambda_e\left[\sqrt{1\right.$

$+\sqrt{2\varepsilon(1$



$$F_{UU,T} = x\sum_q e_q^2\int d^2\mathbf{p}_\perp d^2\mathbf{k}_\perp\delta$$

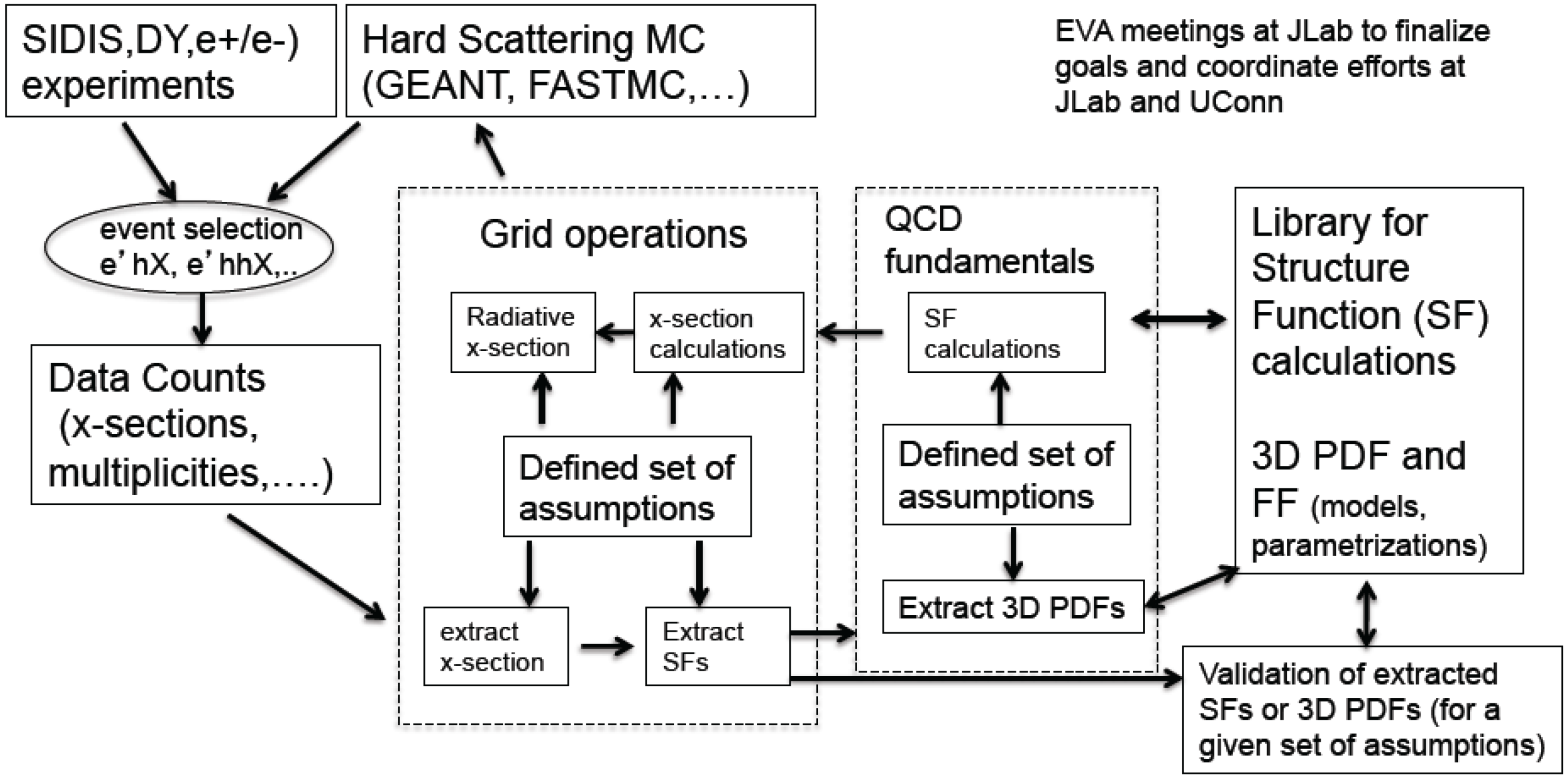
or

$$F_{UU,T}(x,z,P_{hT}^2,Q^2) = \sum_a \mathcal{H}_{UU,T}^a(Q^2;\mu^2)\int dk_\perp\,dP_\perp\,f_1^a(x,k_\perp^2;\mu^2)\,D_1^{a\to h}(z,P_\perp^2;\mu^2)\,\delta(zk_\perp - P_{hT} + P_\perp)$$
$$+Y_{UU,T}(Q^2,P_{hT}^2) + \mathcal{O}(M/Q).$$

or any representation of structure functions!!!

3D PDF Extraction and VAlidation (EVA) framework

EVA meetings at JLab to finalize goals and coordinate efforts at JLab and UConn



Development of a reliable techniques for the extraction of 3D PDFs and fragmentation functions from the multidimensional experimental observables with controlled systematics requires close collaboration of experiment, theory and computing

Jefferson Lab Avakian, JLab Oct 5 13

CLAS Working Groups Joint Session

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12:10 **How the WG can help in data analyses** *20'*

What is the role of the WG in CLAS12 era?

- role of the WG in the early stage of the run
- connection with other WG (CALCOM/OFF-LINE)
- replace/flank the run-grups?
- establish/maintain the analysis framework?
- how can we do better in analysis reviews:
  - adding a WG 'observer' from the beginning and then co-optate her/him in the analysis review committee
  - run-grup analysis (a la g12)