

HSWG

CLAS Collaboration Meeting

JLab, Februrry 25 2015

Early Morning

- **08:45- 09:10** Opening remarks [↗](#) - *Marco Battaglieri*
- **09:10 - 09:30** The tools for evaluation of the gvNN* electrocouplings from the CLAS data [↗](#) - *Evgeni Isupov - remote*
- **09:30 - 09:50** Light Meson Decay working group activities [↗](#) - *S.Schadmand*
- **09:50-10:10** An update on the Electromagnetic Transition Form Factor of the eta' meson with g12 and CLAS12 [↗](#) - *Michael Kunkel - remote*
- **10:10 - 10:30** An update on Radiative Decay of eta' (from g11 data set). [↗](#) - *Georgie Mbianda Njencheu*

Coffee Break

Late Morning

- **11:00 - 11:20** JPAC activities [↗](#) - *Vladiylsav Pauk*
- **11:20 - 11:40** The HASPECT analysis framework [↗](#) - *Derek Glazier*
- **11:40 - 12:00** An update on omega cross section extraction [↗](#) - *Zulkaida Akbar*

Early afternoon

- **14:10 - 14:35** Coherent proton anti-proton pair production off deuterium from eg3 data [↗](#) - *Stepan Stepanyan*
- **14:35 - 14:55** Lambda-proton elastic scattering. [↗](#) - *John Price*

Coffee Break

Late afternoon

- **15:30 - 16:00** Analysis review status
 - K0Λ Photoproduction on the Neutron [↗](#) - *Lorenzo Zana*
 - Analysis of gamma p to K0K0 from the g12 Data Set [↗](#) (PI: K.Hicks/S.Chandavar)) - *Carlos Salgado*
 - Pentaquark search in g10 by using the MMSA method (PI: K.Hicks [↗](#)) - *Stepan Stepanyan*
 - 2pi from e1-6 (PI: E.Golovach) [↗](#) - *R.Gothe*
 - Exclusive Photo-Production Measurement of K+Sigma* - off Quasi-Free Neutrons in Deuterium (PI: H.Lu) [↗](#) - *Nick Zachariou*
 - KLambda and KSigma from FROST (PI: N.Waldorf [↗](#)) - *Steffen Strauch*
 - Polarized structure function sigmaLT from the single pi0 electroproduction on the proton in the resonance region (PI:N.Markov) [↗](#) - *Volker Crede*
 - Spin observables in omega photoproduction (PI: B.Vernarsky) [↗](#) - *Franz Klein*
 - Analysis of K+K photo-production from the g11 Data Set (PI: S.Lombardo) [↗](#) - *Paul Eugenio*
 - Polarization Observables in g(pol)p(pol)->ppi+pi-Using the g9a (FROST) Target and CLAS (PI: V. Crede) [↗](#) - *Ken Livingston*
 - gamma p -> eta p, gamma p -> eta' p and gamma p -> omega p beam asymmetries (PI: P.Collins - M.Dugger) [↗](#) - *Lei Guo*
- **16:00 - 17:00** g12 Run Group review
- **16:00 - 16:10** G12 Anayses Status [↗](#) - *Michael Kunkel*
- **16:10 - 16:20** Analysis Review status: g12 Run Group review [↗](#) - *Eugene Pasyuk*
- **16:20 - 17:00** Discussion

Agenda

- * Discussion about on-going / new-analysis
- * status of g12 analysis review

Activities

- * Regular report at HSWG on JPAC activity to strengthen exp/the connection
- * Selected talks on more advanced analysis on plenary session at the CLAS Collaboration
 - D.Ireland Photoproduction of Lambda and Sigma0 with linearly polarized photons
 - P.Roy Towards a Complete Experiment in Vector-Meson Photoproduction from FROST

Talks

- * Over all CLAS contribution, HSWG-related are 41% and 60% for proceedings
- * Friday is the last day for BARYON2016 conference submission
- * Contributions to conferences as HSWG and when talk is secured, assign speaker
- * REMINDER: Communicate talks and proceedings to the CSC
- * JSA-TFC funds \$20k allocated for 2016

Homework for the next Coll Meeting

- * Analysis framework for the first (and second) experiment(s)
- * Re-organization of the the HSWG in CLAS12 era:
 - development of a common analysis framework (high level analysis?)
 - role in raw data calibration and correction
 - analysis review : tutoring? run-grip analysis?

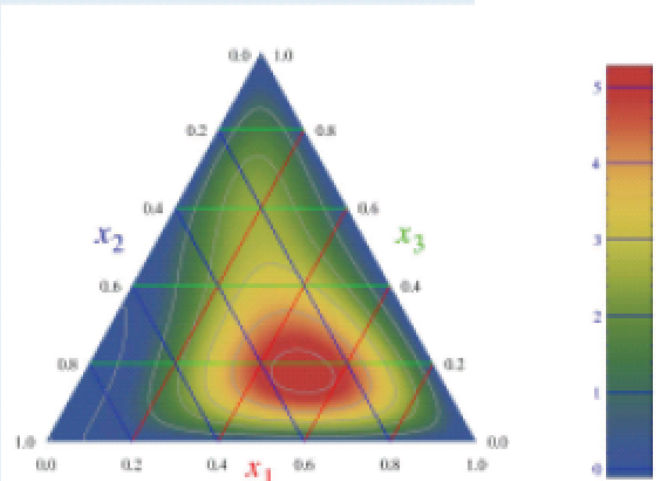
The tools for evaluation of the $\gamma_v NN^*$ electrocouplings from the CLAS data

E. Isupov, V. Burkert, K. Hicks, V. Mokeev

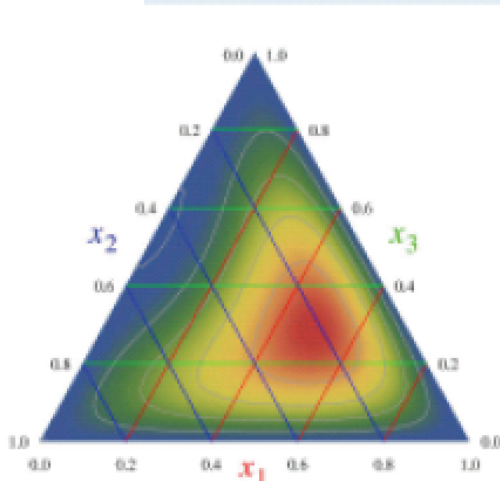
- N^* transition FF as a source of information about quark nucleon structure and dressing effect

Nucleon DA from LCSRs for comparison (N. Offen)

Nucleon



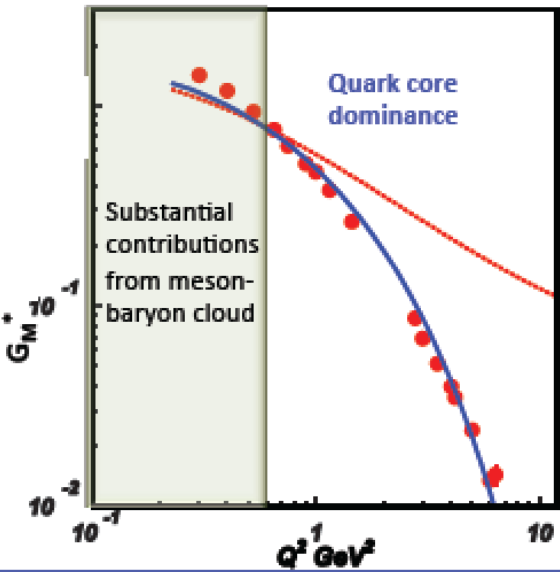
$N^*(1535?)$



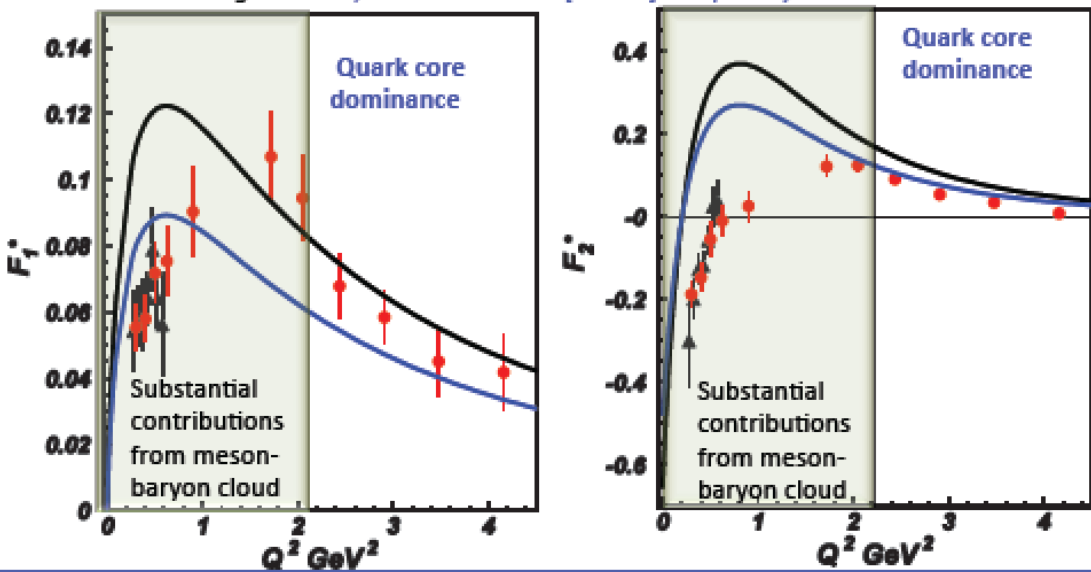
x_1, x_2, x_3 – momentum fraction of the valence quarks

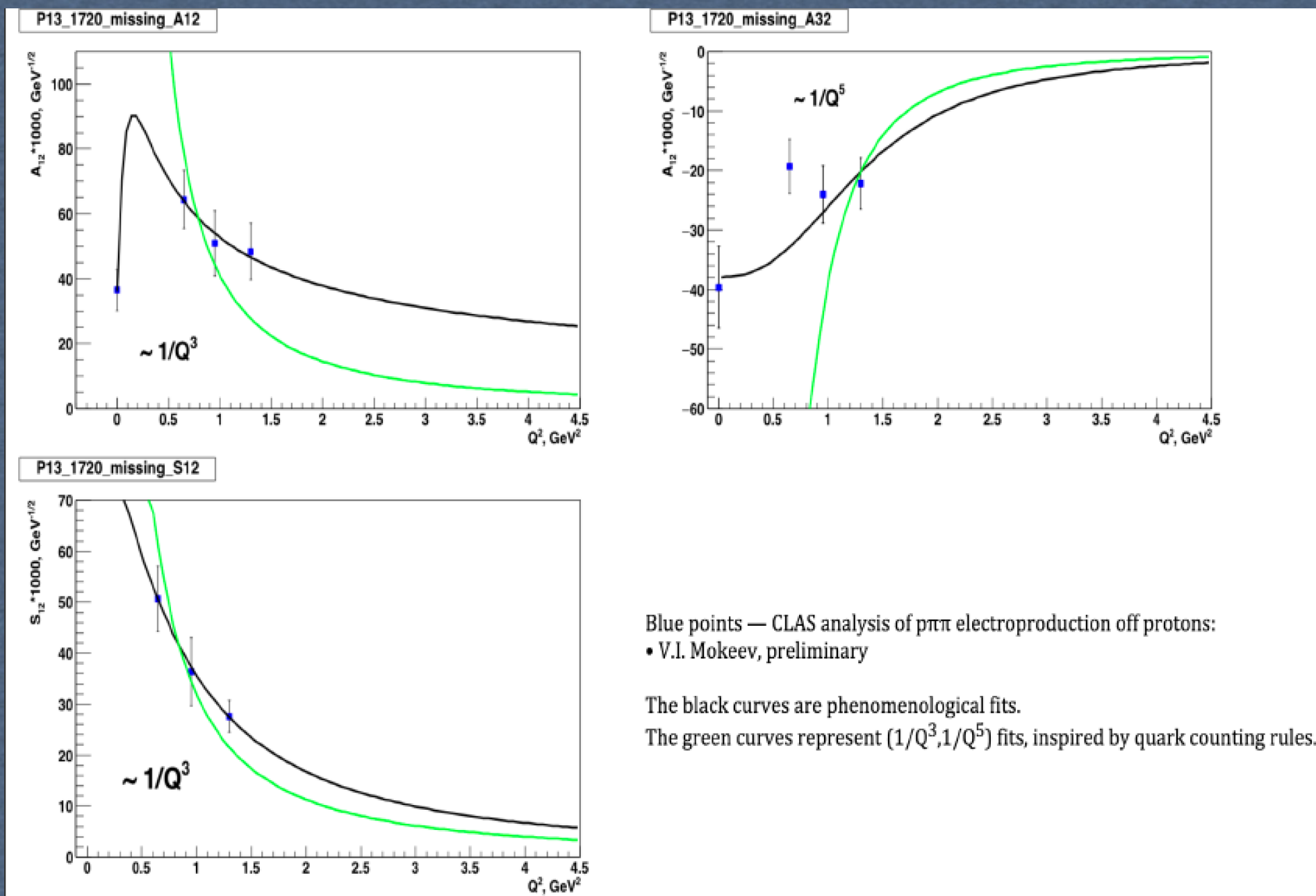
Access to the Dressed Quark Mass Function from the Data on the Transition $N \rightarrow N^*$ Form Factors

$D(1232)3/2^+$
Jones-Scadron convention
J. Segovia et al., Few Body Syst. 55,1185 (2014).



$N(1440)1/2^+$
Dirac F_1^* and Pauli F_2^*
 $N \rightarrow N(1440)1/2^+$ transition form factors
J. Segovia et al., arXiv: 1504.04386[nucl-th] accepted by PRL





- Abundant CLAS data from different final states (1pi, 2pi, VM, ...)
- Phenomenological fit of ALL N^* FF evolution in Q^2
- Comparison with QCD-inspired counting rules to assess the perturbative regime

- New data at large Q^2 are needed (and are coming!) to make any conclusions

Light Meson Decay working group activities



Susan Schadmand

List of Meson Decays

From Lmdwiki

meson decay	physics	people	data
$\pi \rightarrow \gamma e^+ e^-$	transition form factor, Me+e- (dark photon)	Michael Kunkel	g12
$\eta(\prime) \rightarrow \gamma e^+ e^-$	transition form factor	Susan Schadmand (Michaela Schever (master 2015))	g12
$\omega \rightarrow \pi^0 e^+ e^-$	transition form factor	Susan Schadmand +	g12
$\eta(\prime) \rightarrow \pi^0 e^+ e^-$	C violation	Haiyun Lu??	
$\eta(\prime) \rightarrow \pi^+ \pi^- e^+ e^-$	CP violation	Michael Kunkel	g12
$\eta(\prime), \omega \rightarrow \pi^+ \pi^- \gamma$	box anomaly upper limit branching ratio	Georgie Mbianda Njencheu	g11
$\eta' \rightarrow \pi^+ \pi^- \gamma$	box anomaly	Xinying Song	g12
$\eta, \omega, \phi \rightarrow \pi^0 \pi^+ \pi^-$	Dalitz plot analysis η ω ϕ	Daniel Lersch, (Diane Schott) Carlos Salgado + , Chris Pederson Haiyun Lu??	g11/g12
$\eta' \rightarrow \pi^+ \pi^- \gamma \gamma$ $\phi \rightarrow \pi^+ \pi^- \eta$	Dalitz plot analysis/meson mixing G-parity violation	Sudeep Ghosh	g12,(g11)
$\phi \rightarrow \omega \gamma$	C parity violation, ϕ rare decay	Haiyun Lu??	
NULL	invisible decay	Haiyun Lu??	
f_1	isospin symmetry breaking, f1 decay through rho	Haiyun Lu??	

g12 analyses follow procedure
common analysis for dilepton final states

paper(s) on pi0 cross section

planned paper

thesis
planned paper

planned papers

thesis

interested in taking part: Let us know!

- Extensive experimental program to study LMD using CLAS g12 data

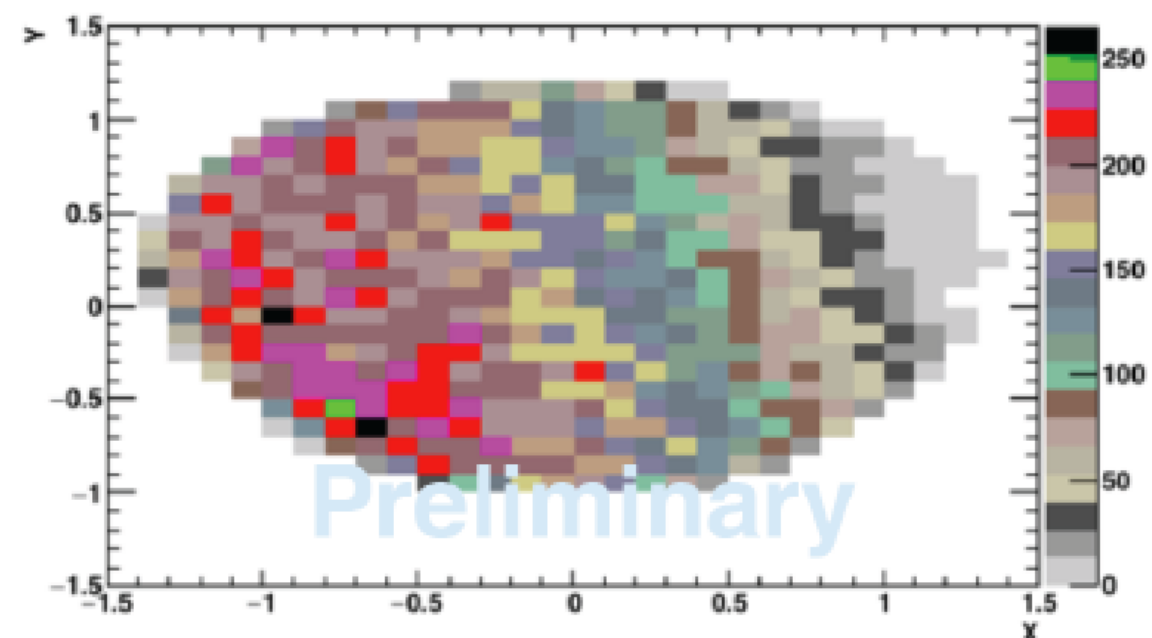
The Dalitz plot of $\eta' \rightarrow \eta\pi^+\pi^-$ decay from G12 dataset.

Sudeep Ghosh

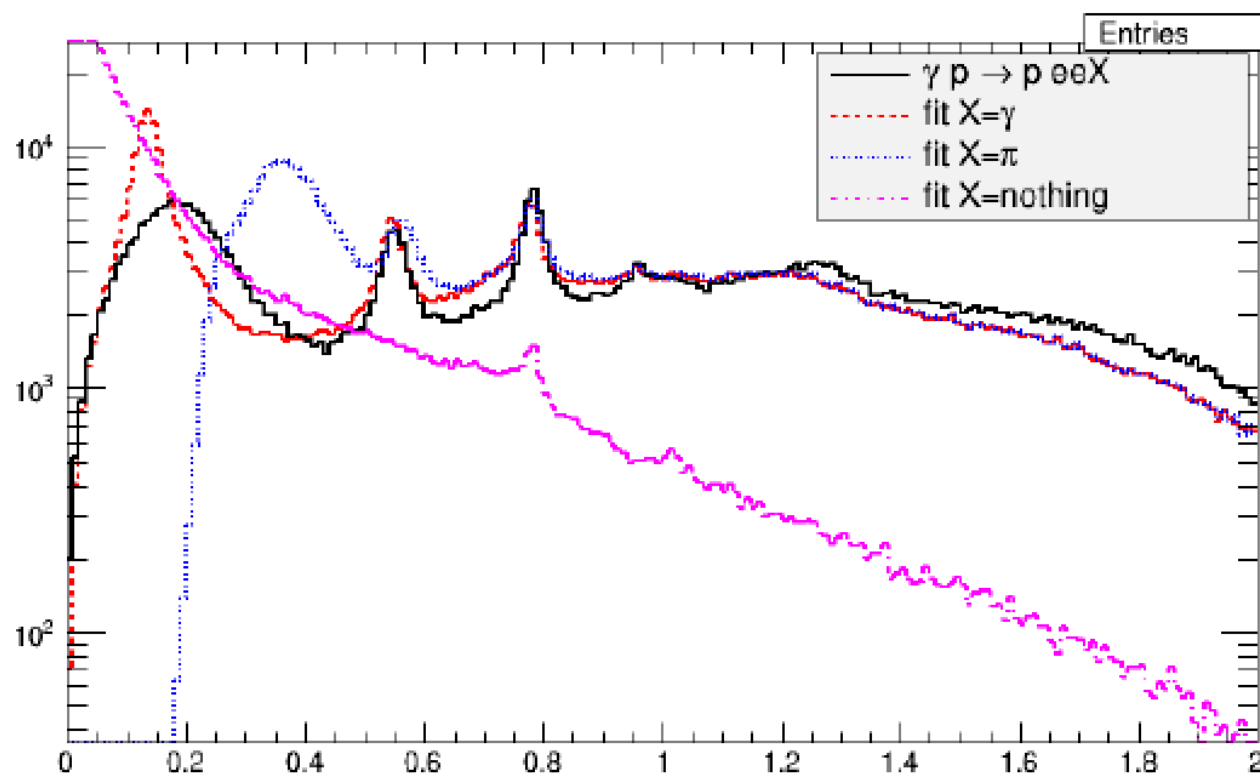
Discipline of Physics, School of Basic Science, Indian Institute of Technology Indore, Khandwa Road, Simrol, M.P. India- 462020

Motivation :

- Dalitz plot provides pure kinematic information of the decay, enabling the study of low-energy QCD dynamics.
- The decay of $\eta' \rightarrow \eta\pi^+\pi^-$ has a low Q-value, thus it will help to study effective chiral perturbation theory at a low Q limit.
- The study will report the Dalitz plot parameters in an independent measurement with different systematic errors.



Dalitz Plot distribution from G12 data

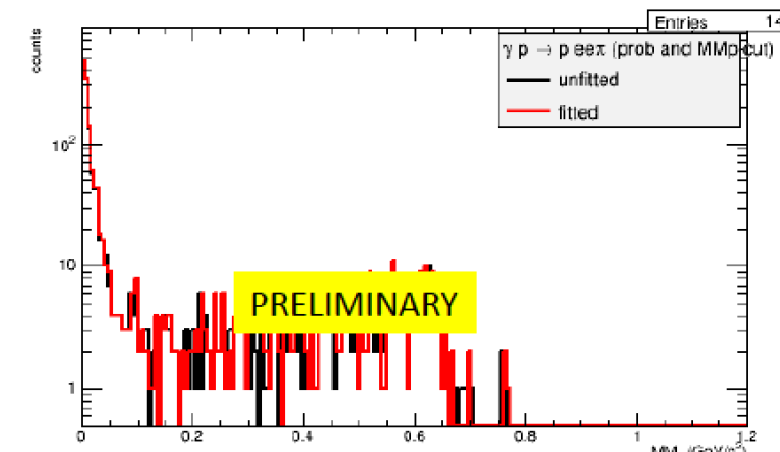
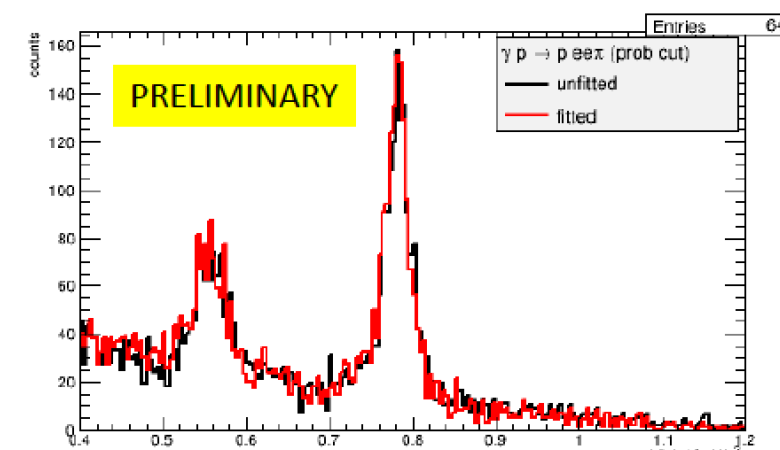


using

g12_corrections script

- Beam Corrections
- Momentum Corrections
- TOF knockouts
- EC Knockouts
- Geometric Fiducial Cuts

$\omega \rightarrow \pi e e$



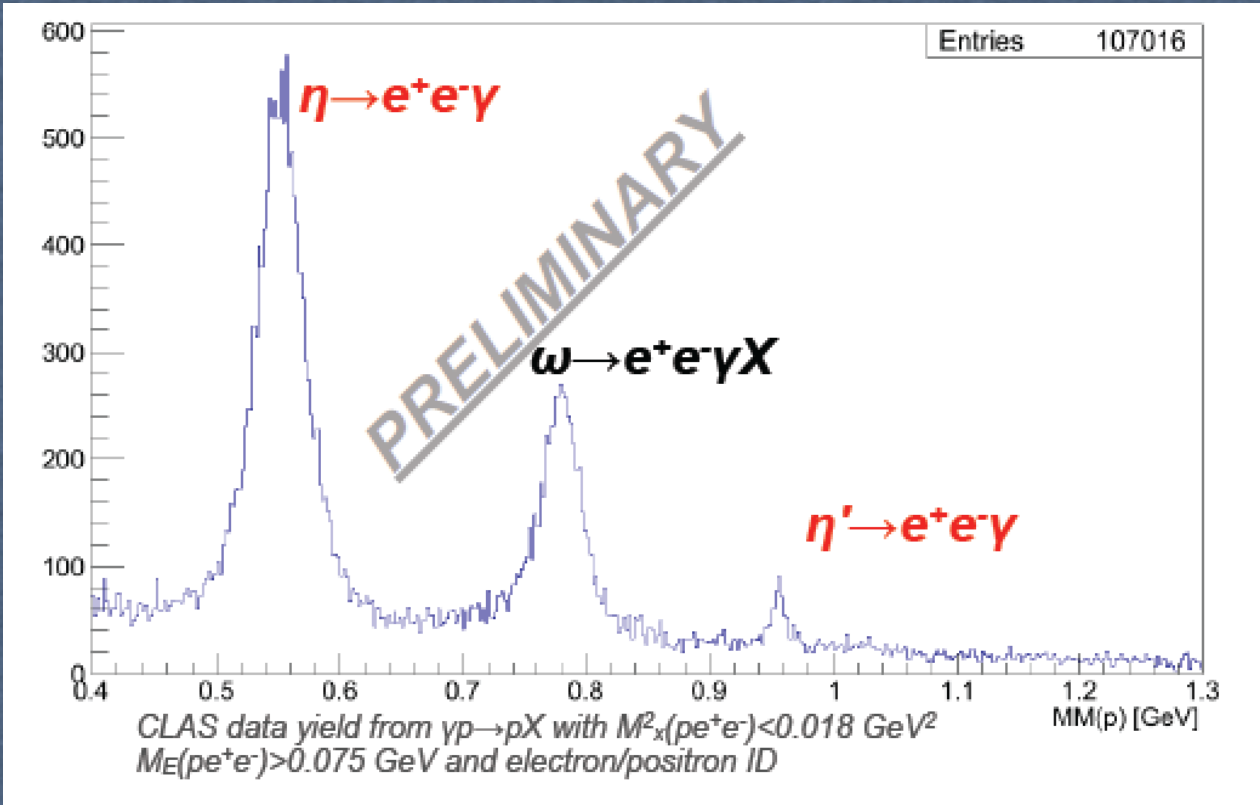
AN UPDATE ON THE ELECTROMAGNETIC TRANSITION FORM FACTOR OF THE ETA' MESON WITH G12 AND CLAS12

Michael C. Kunkel | IKP-1



Current BESIII and CLAS data sets do not have enough statistics to determine which theoretical model fits the $\eta' \rightarrow$ charge radius		
	$\langle r \rangle$	Number of events
BESIII ($\eta' \rightarrow \gamma e^+ e^-$)	$1.60 \pm 0.17(\text{stat}) \pm 0.08(\text{sys}) \text{ GeV}^{-2}$ [1]	894
CELLO ($\eta' \rightarrow \gamma \mu^+ \mu^-$)	$1.7 \pm 0.4 \text{ GeV}^{-2}$ [2]	75
CLAS ($\eta' \rightarrow \gamma e^+ e^-$)	TBD	89
Dispersion	$1.53^{+0.15}_{-0.08} \text{ GeV}^{-2}$	
ChPT	1.6 GeV^{-2}	
VMD	1.45 GeV^{-2}	

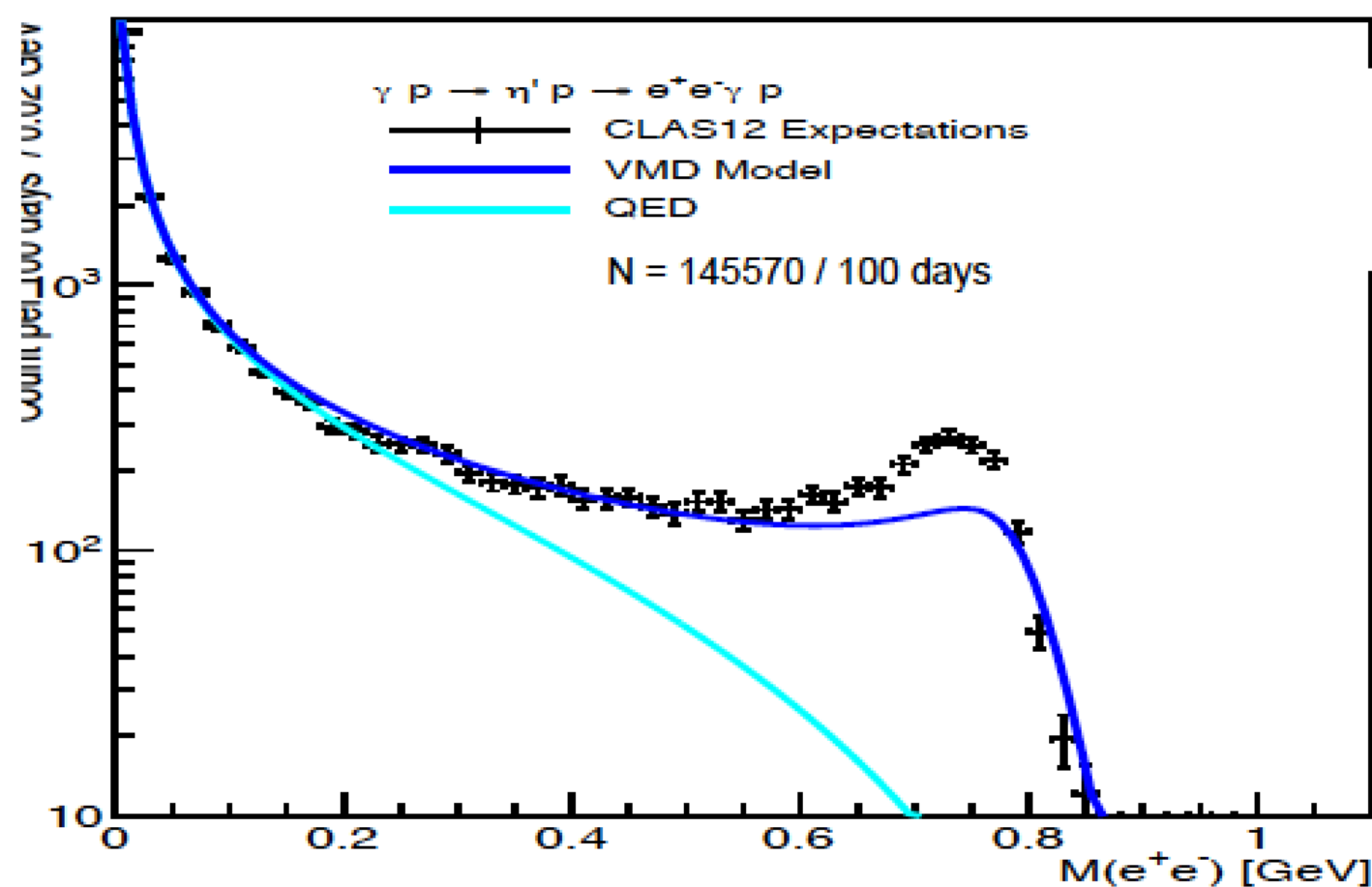
- Transition FF provides insight into the meson charge radius (via VMD) and mixing angle (relevant for g-2 physics)



- Limited statistics prevent a quantitative conclusion
- CLAS12 will be a competitive player in e^+e^- physics

CLAS η' Rates with electroproduction

Exclusive $\gamma p \rightarrow e^+e^- \gamma p$



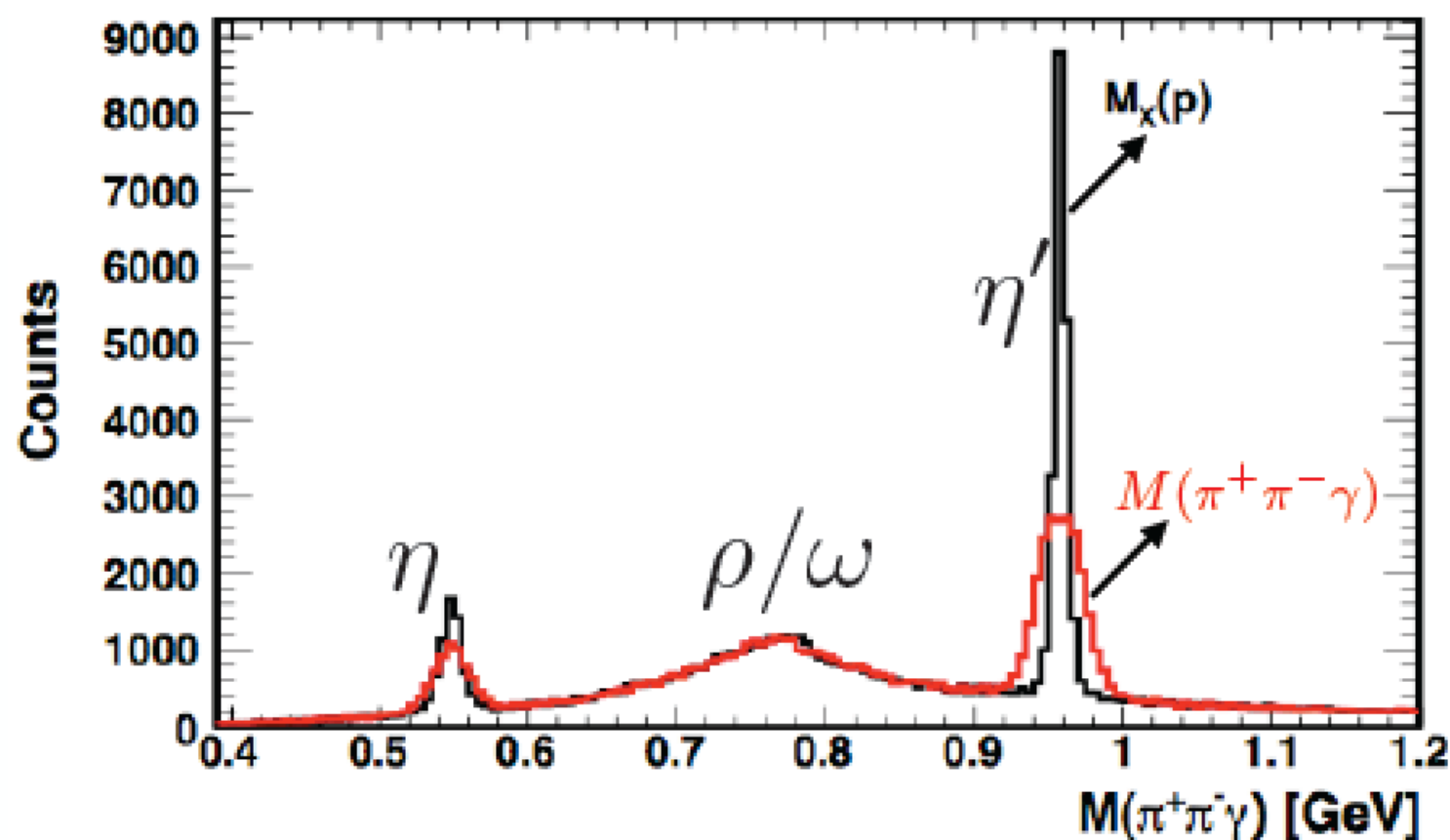
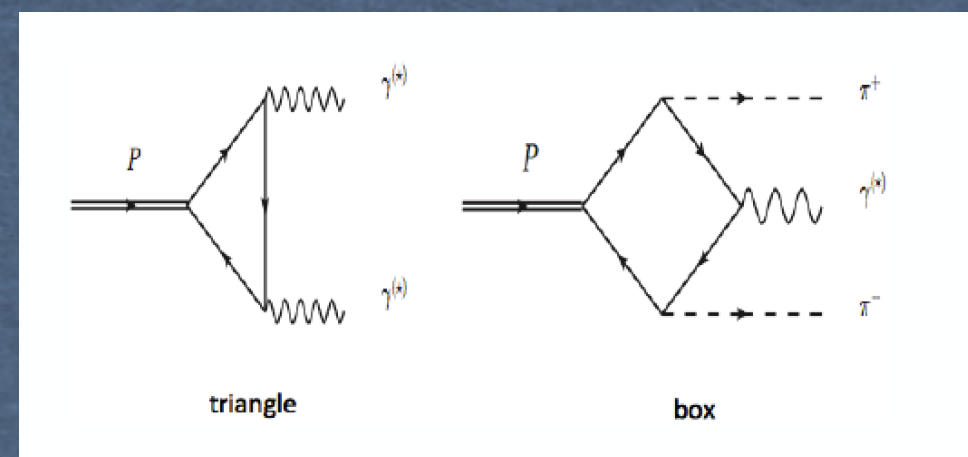
Within 100 days of beam-time CLAS can measure the η' transition form factor with a statistical uncertainty $\sim 1\%$

Radiative Decay of η' in CLAS

$$\gamma p \rightarrow p \{ \eta' \rightarrow \pi^+ \pi^- \gamma \}$$

Georgie Mbianda Njencheu, ODU
(LMD Group)

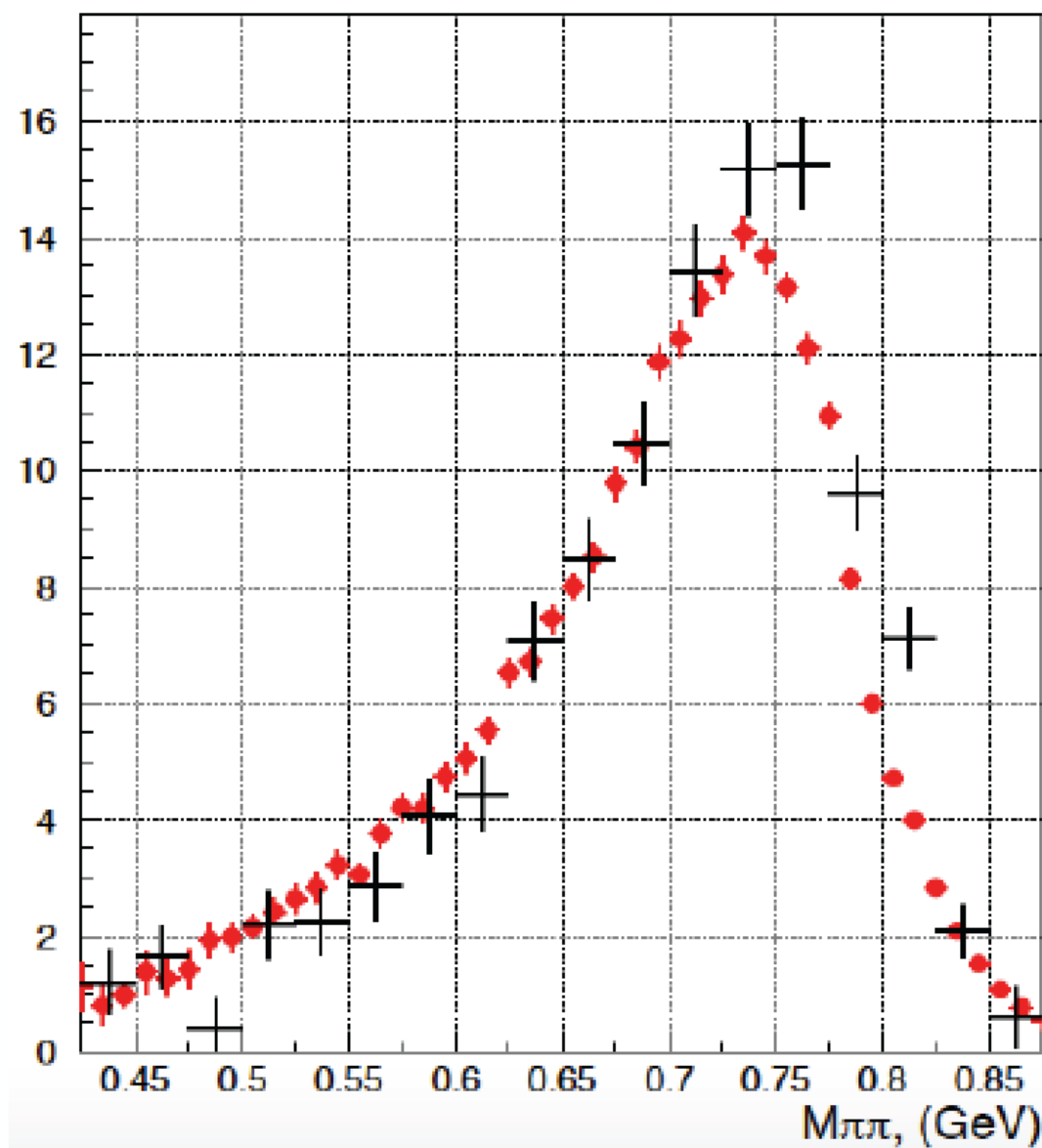
- EM U(1) and QCD SU(3) are formulated as perfect symmetry
- Anomaly arises when the symmetry is broken (e.g. Axial vector)
- It can be studied in rare meson decays



- Using XPT one parameter (alpha) used to describe the di-pion invariant mass encodes the information

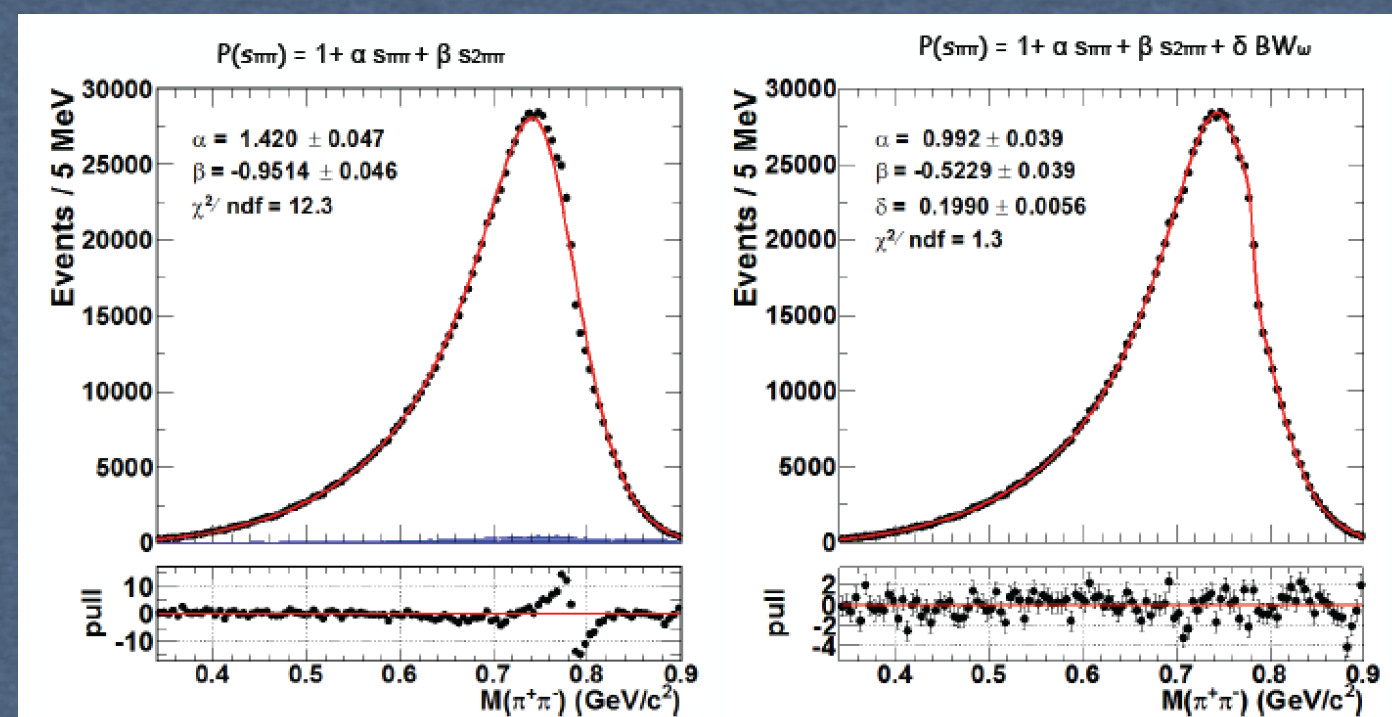
$$\alpha = 0.45 \pm 0.029 [GeV^{-2}]$$

$$\beta = -0.83 \pm 0.054 [GeV^{-4}]$$



- The spectrum includes CLAS acceptance and resolution effects

- Alpha from CLAS differs from BESIII and CRYSTAL BARREL results



JPAC activities

Vladyslav Pauk

hadron spectroscopy

lattice QCD

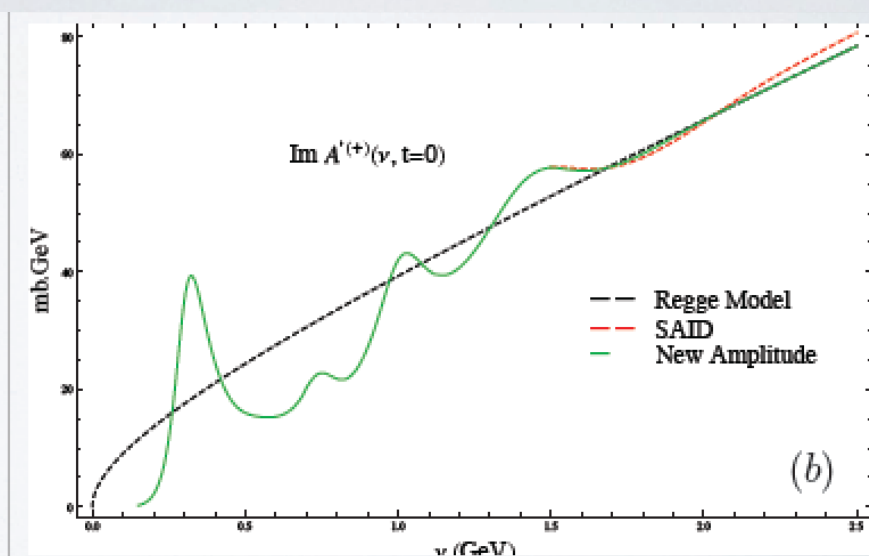
amplitude
analysis

spectrum of resonances

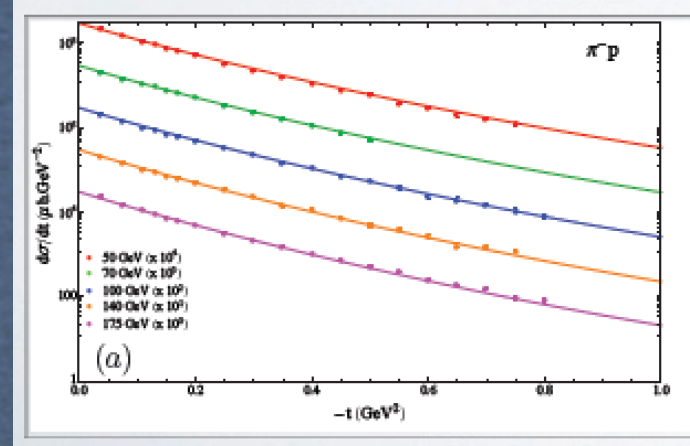
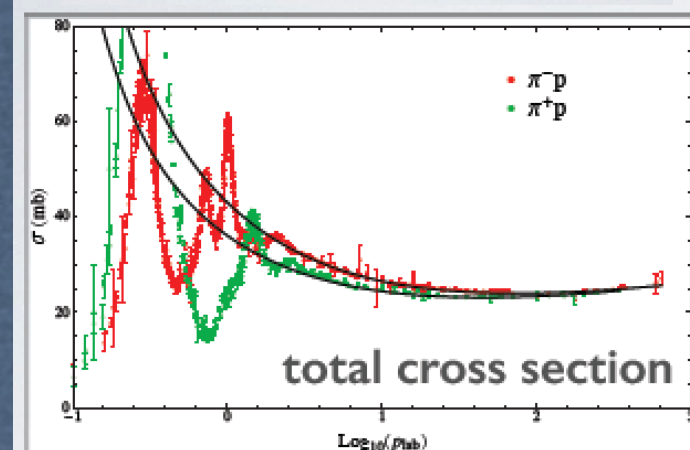
JPAC

matter

Finite Energy Sum Rules



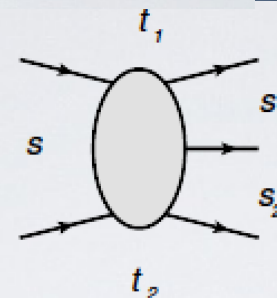
Pion-Nucleon Amplitudes



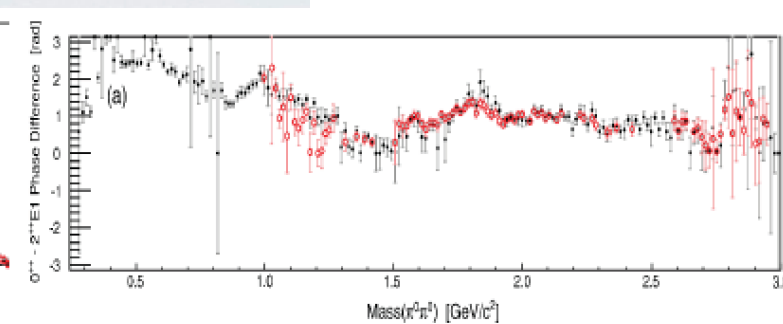
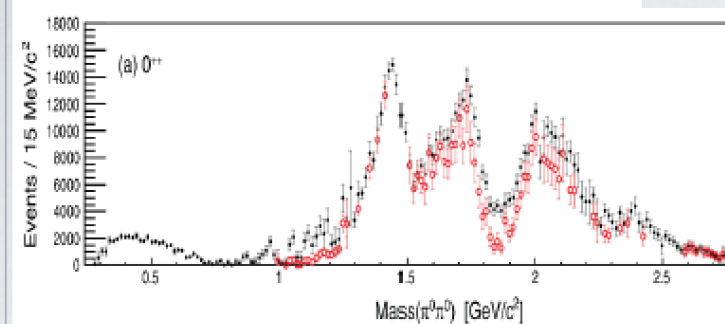
$\eta\pi$ production at COMPASS

$$\pi^- p \rightarrow \eta \pi^- p$$

$$\pi^- p \rightarrow \eta' \pi^- p$$



$J/\psi \rightarrow \gamma \pi \pi \pi$



Lepton pair production on a proton target =14=

Measure the ratio of the e vs μ cross sections

$$R_{\mu/e} \equiv \frac{d\sigma(\mu^-\mu^+ + e^-e^+)}{d\sigma(e^-e^+)} - 1$$

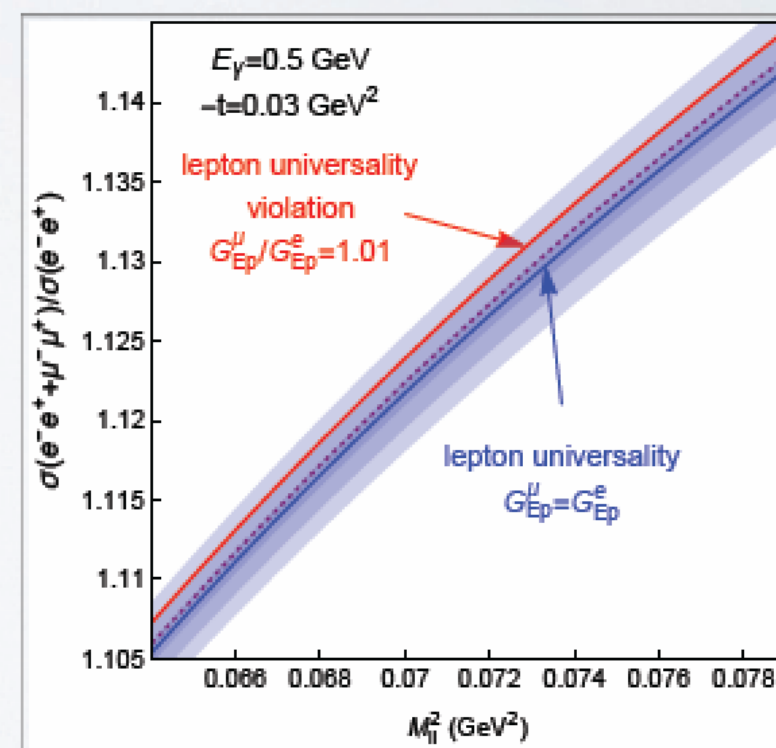
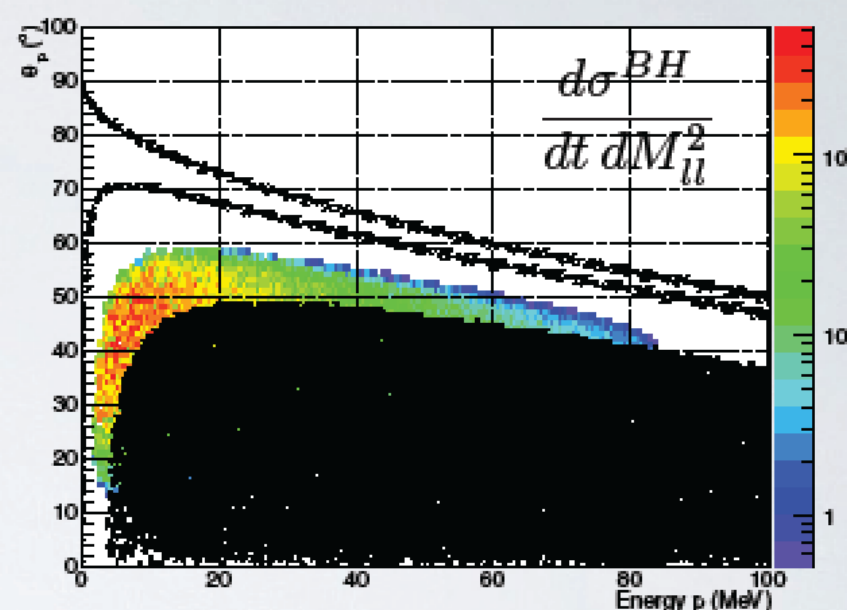
VP, Vanderhaeghen, Phys. Rev. Lett. 115, 221804

at small t the ratio $R_{\mu/e}$ gives **direct access** to the ratio of the **proton electric form factor** in the μp versus ep scattering

the deviation from the unity will be a sign of **violation of the lepton universality**

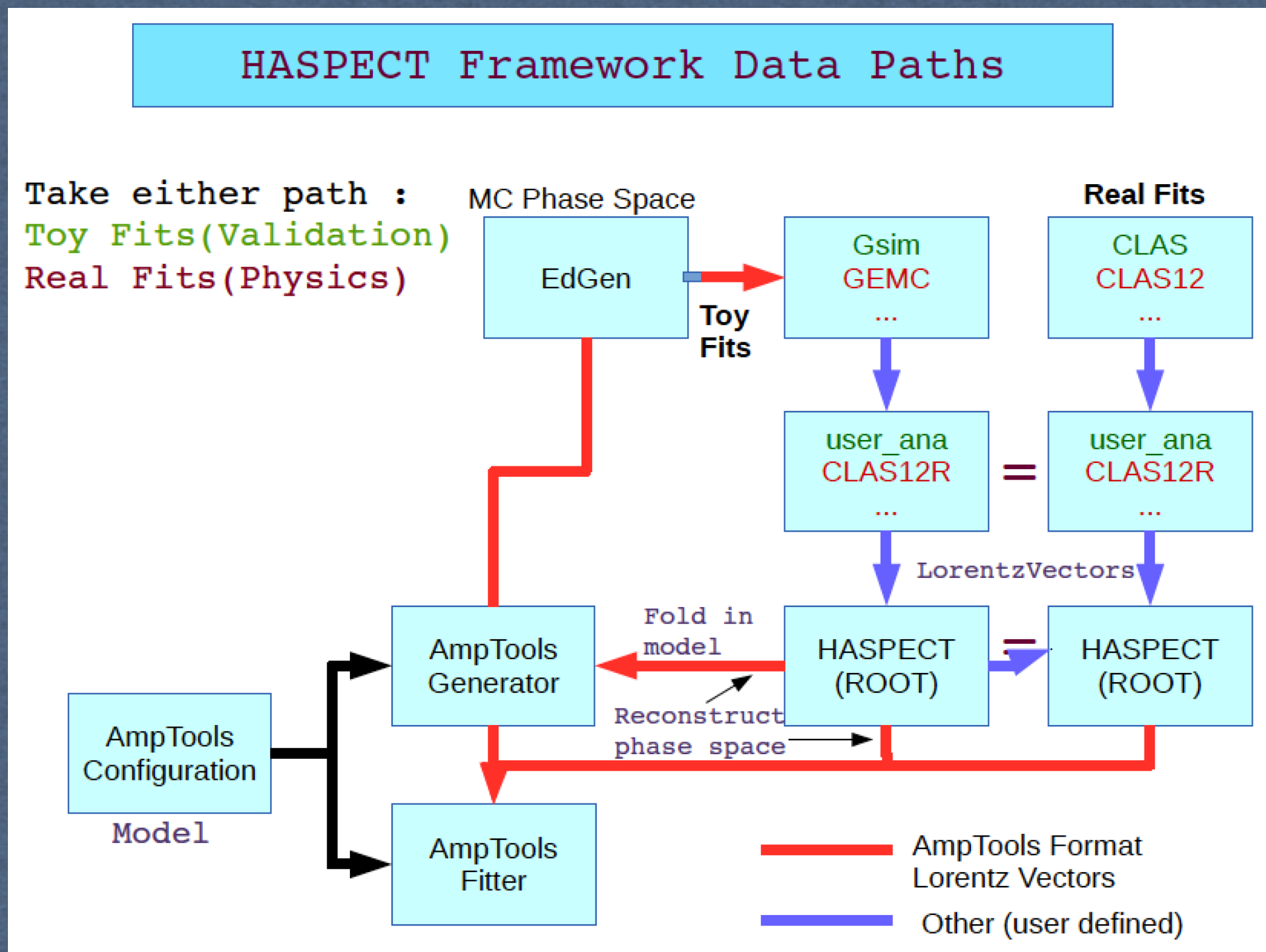
JLab

access the proton form factor by analyzing angular distributions of the lepton pairs



Derek Glazier
Glasgow University

- Possible framework for MesonEx high level analysis
- Possibility to extend to other WG
- Dedicated discussion at the next Collaboration meeting



Disentangle Signal and Background : $\pi^+\pi^-p$

g11 dataset, detect π^+ and p

Model from simulated $\pi^+\pi^-p$ and $\pi^+\pi^-\pi^0p$ events
Signal BG

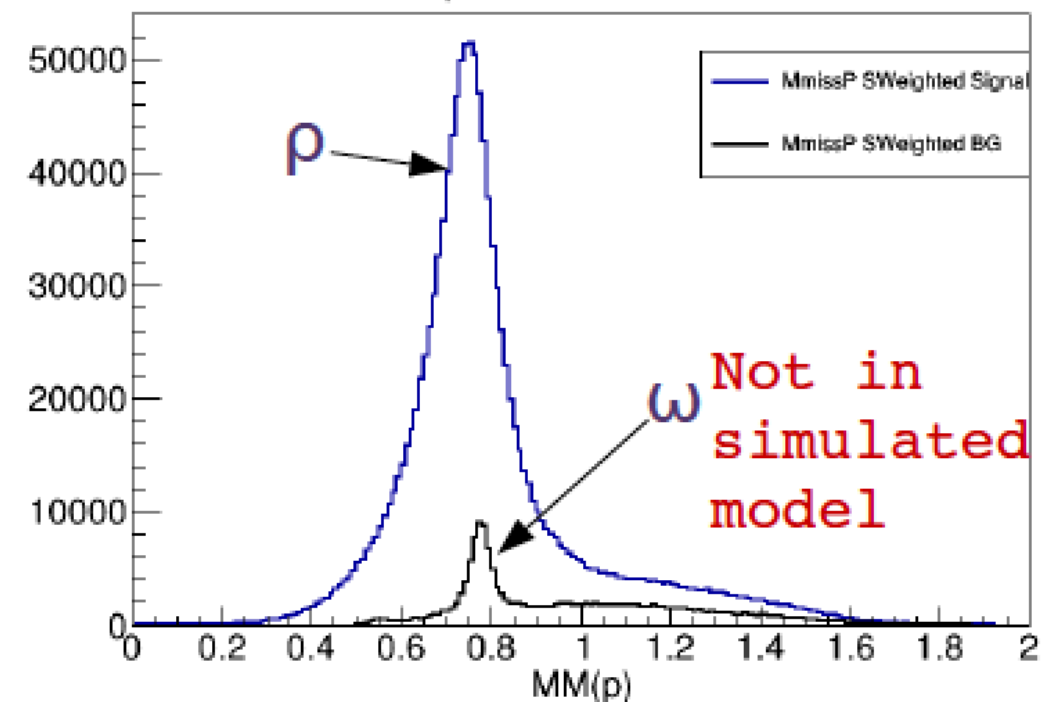
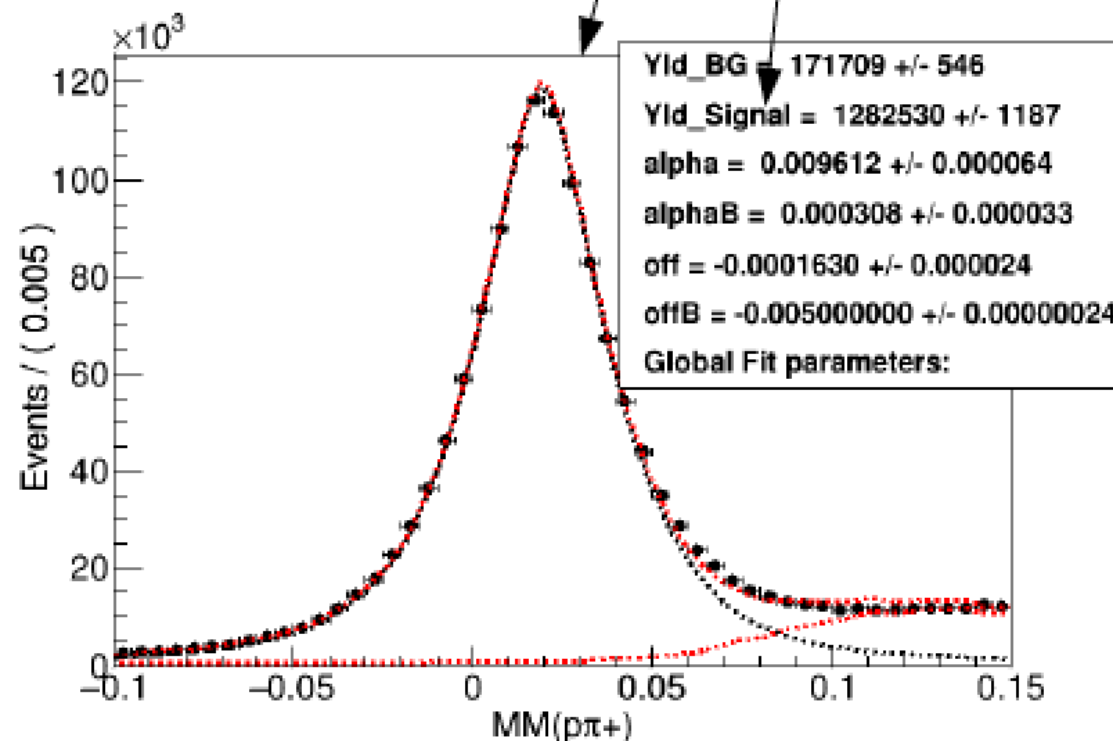
Just Phase Space

RooFit Extended Maximum likelihood fit

For
Cross section

RooStats sWeight calculation

⇒ Disentangle distributions
For amp analysis



Robust reaction separation method, works for many different reactions

"No decisions" to be made on modelling

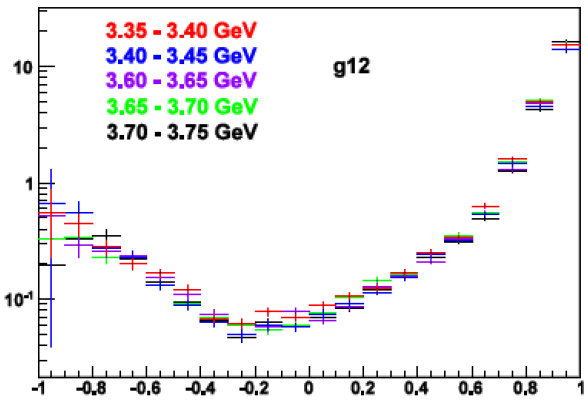
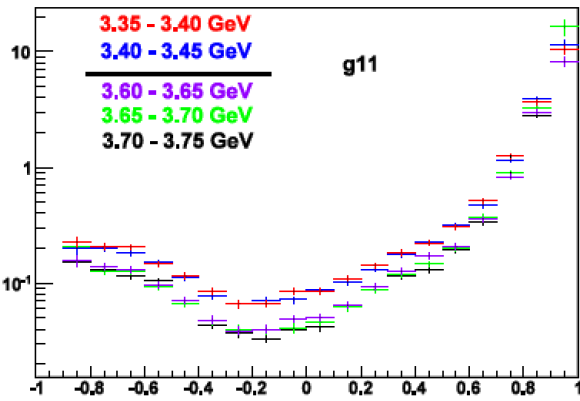
Provides weights for Amplitude Analysis, correct error propagation

"User friendly" software in preparation

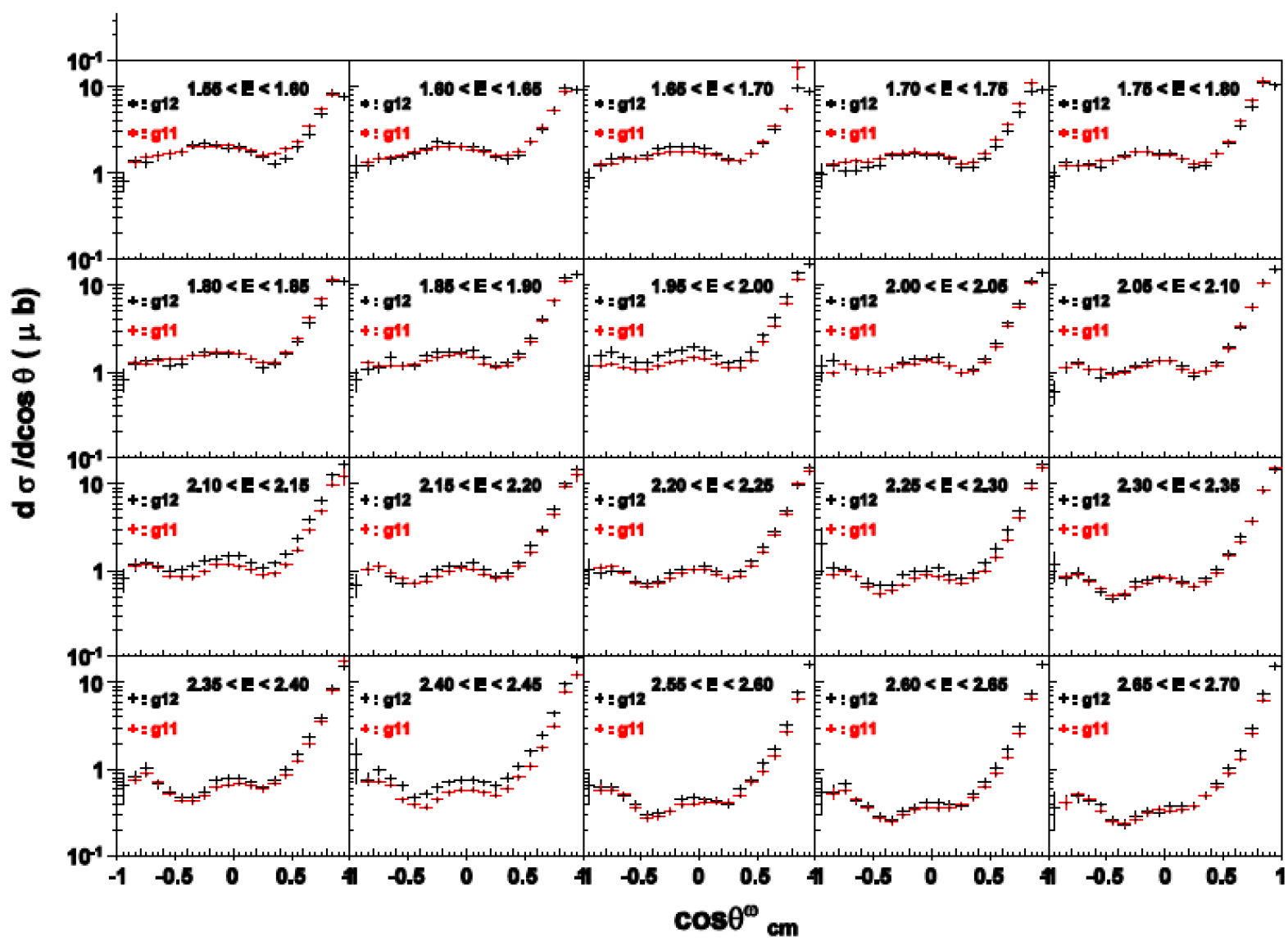
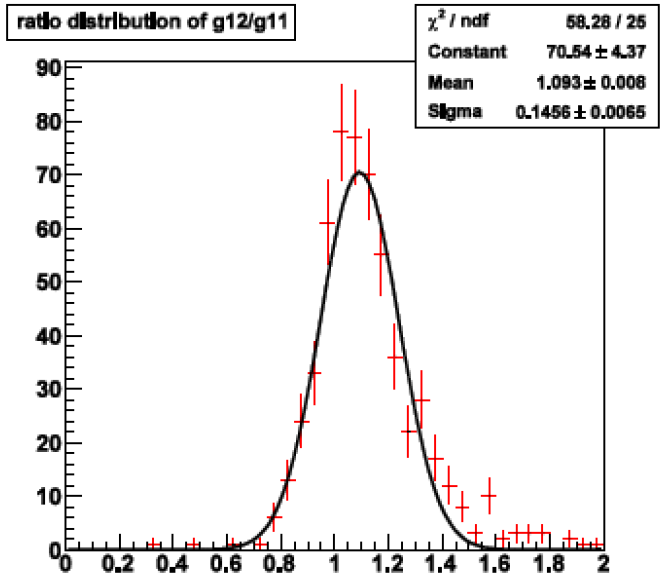
An update of $\gamma p \rightarrow p\omega$ Differential Cross Section From g12 and g8b

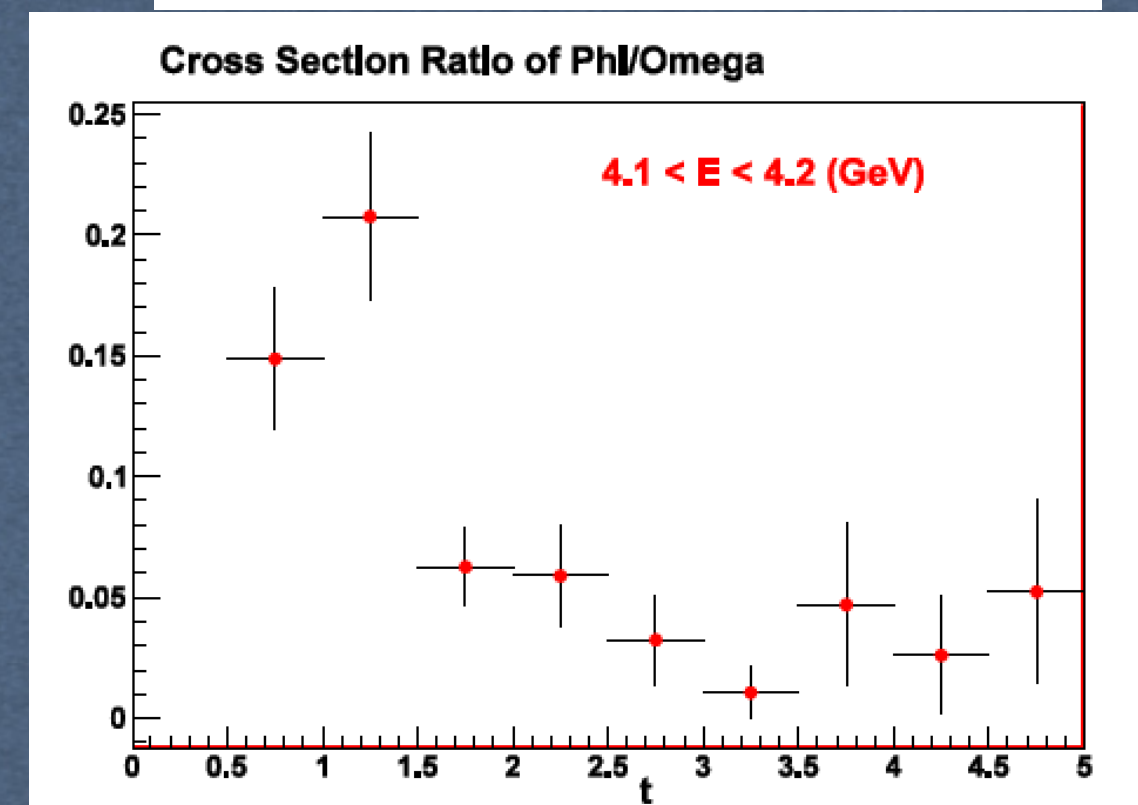
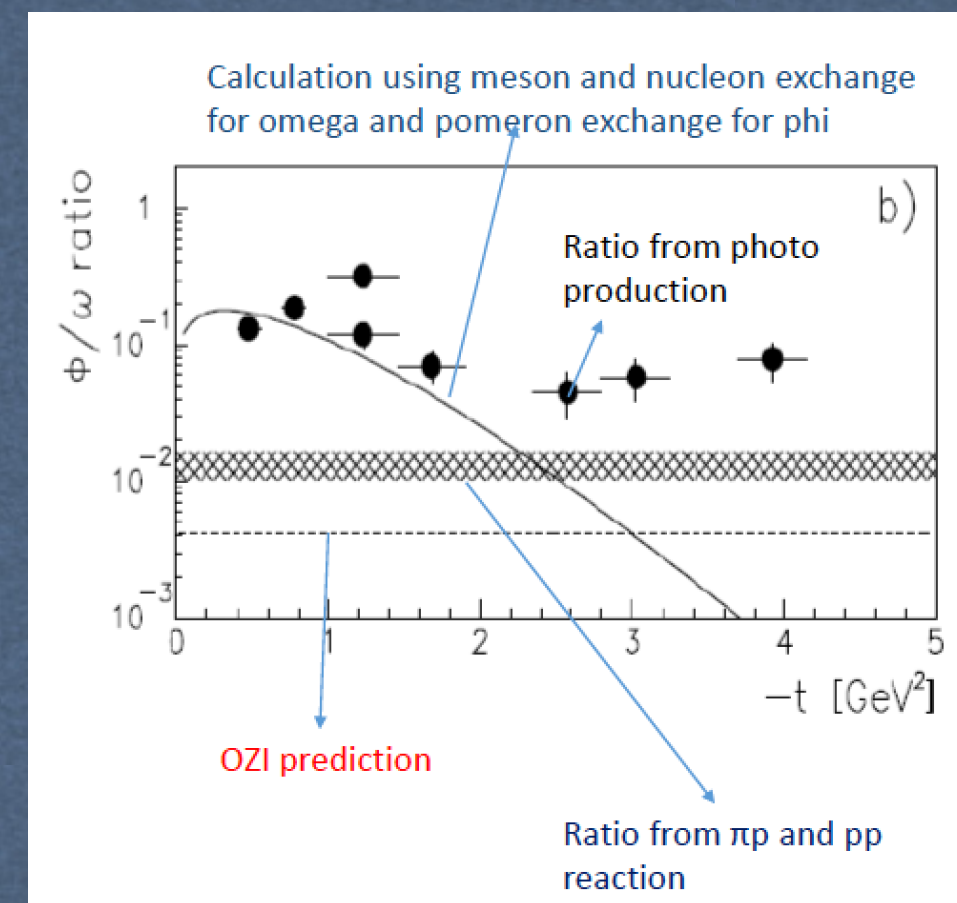
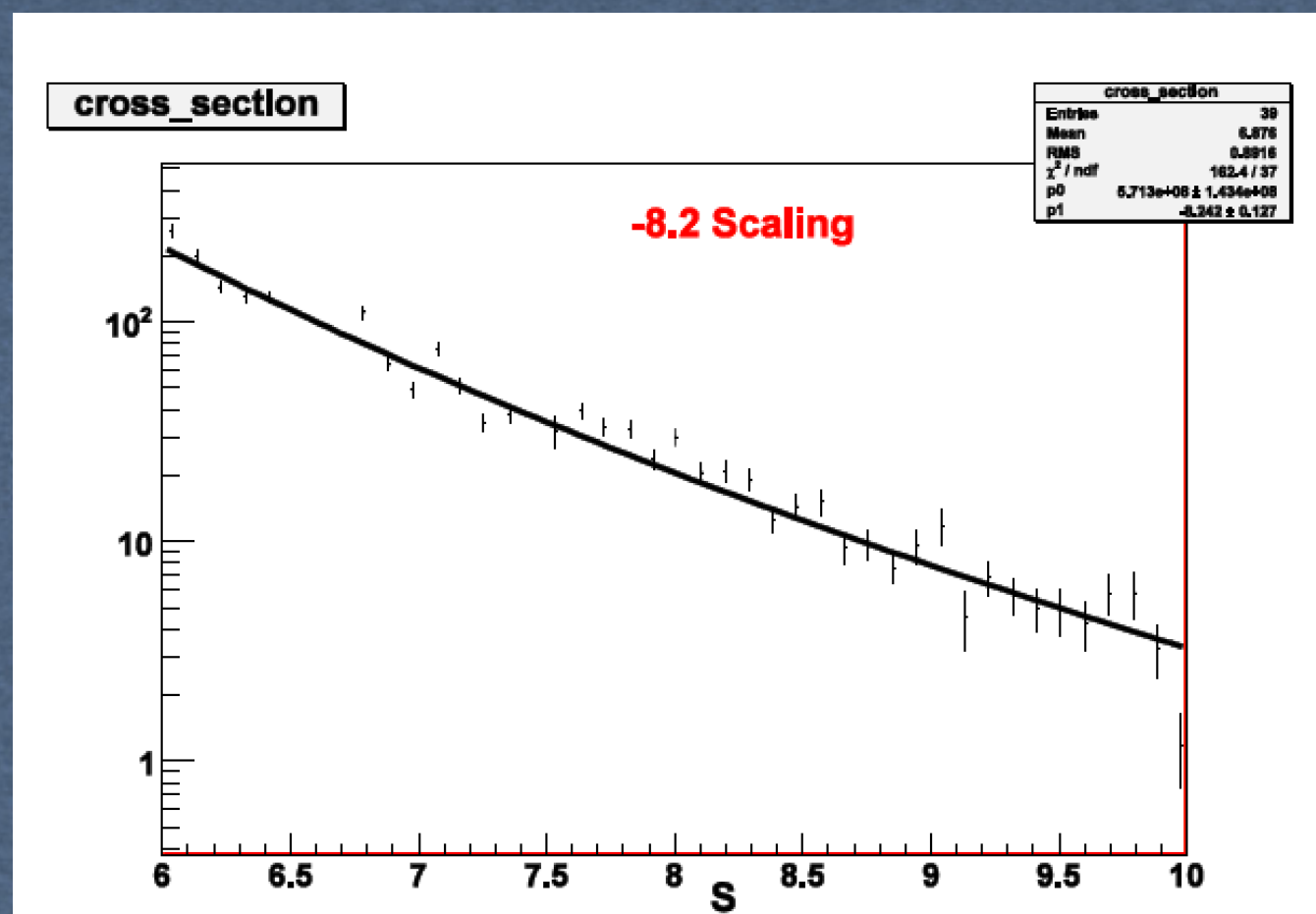
ZULKAIDA AKBAR
(FSU, TALLAHASSEE, FLORIDA)

CLAS COLLABORATION MEETING
02/25/2016



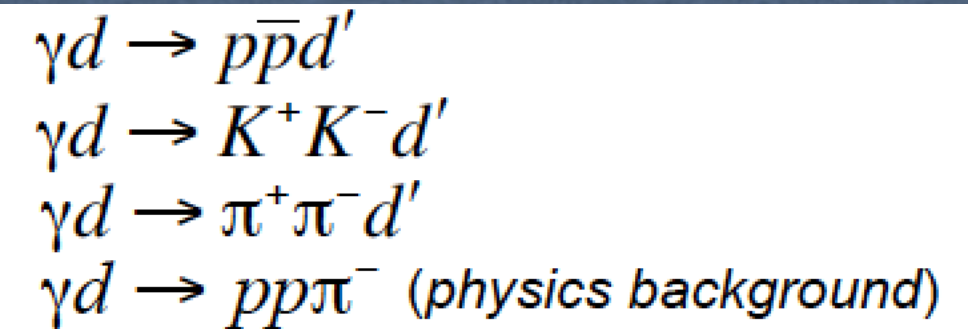
Ratio of g12/g11



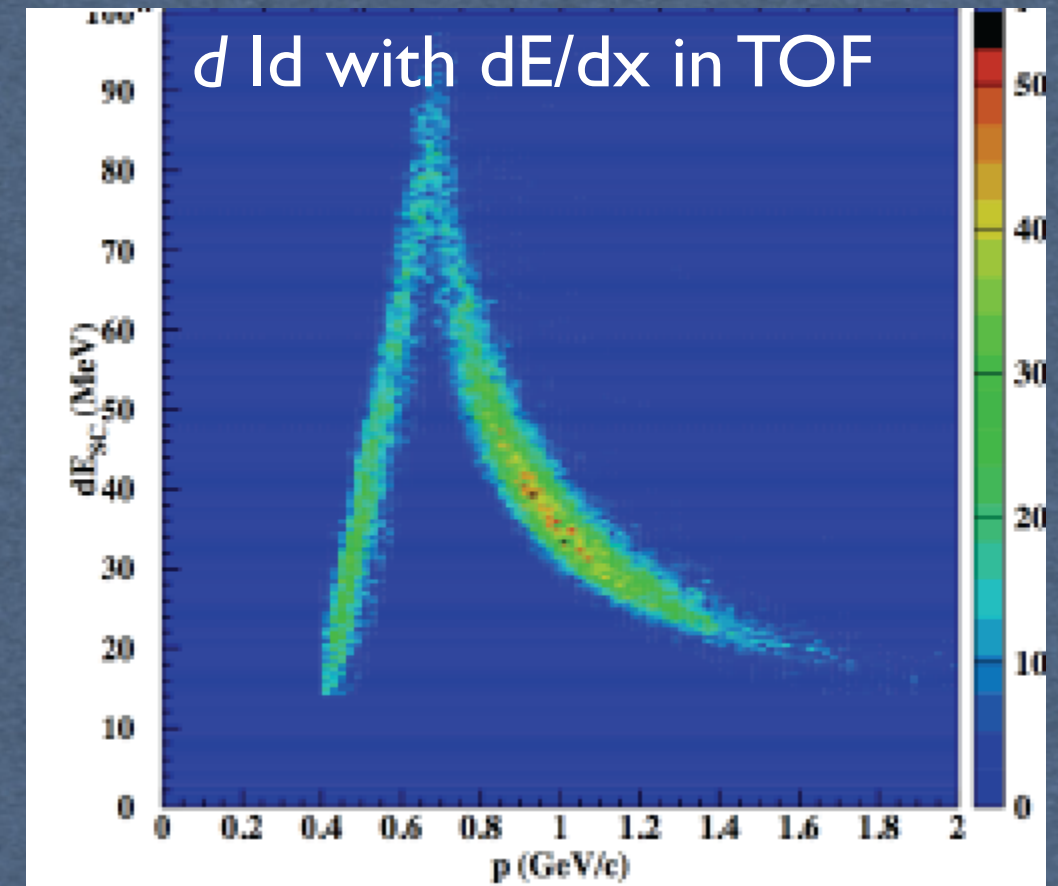
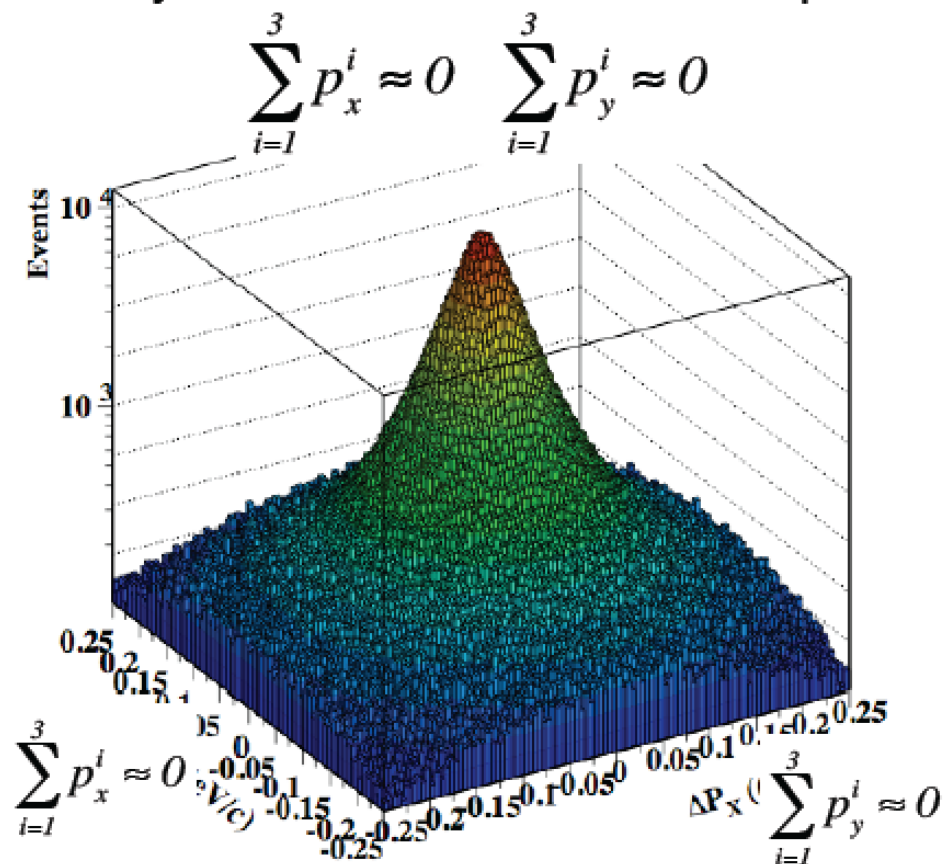


Coherent photoproduction of proton anti-proton pair on deuterium

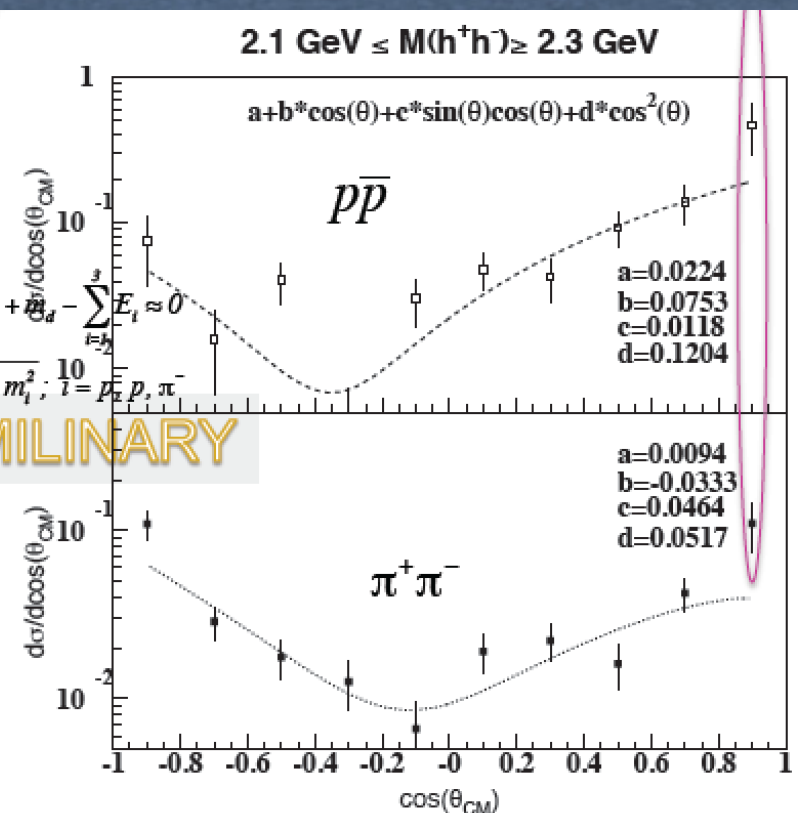
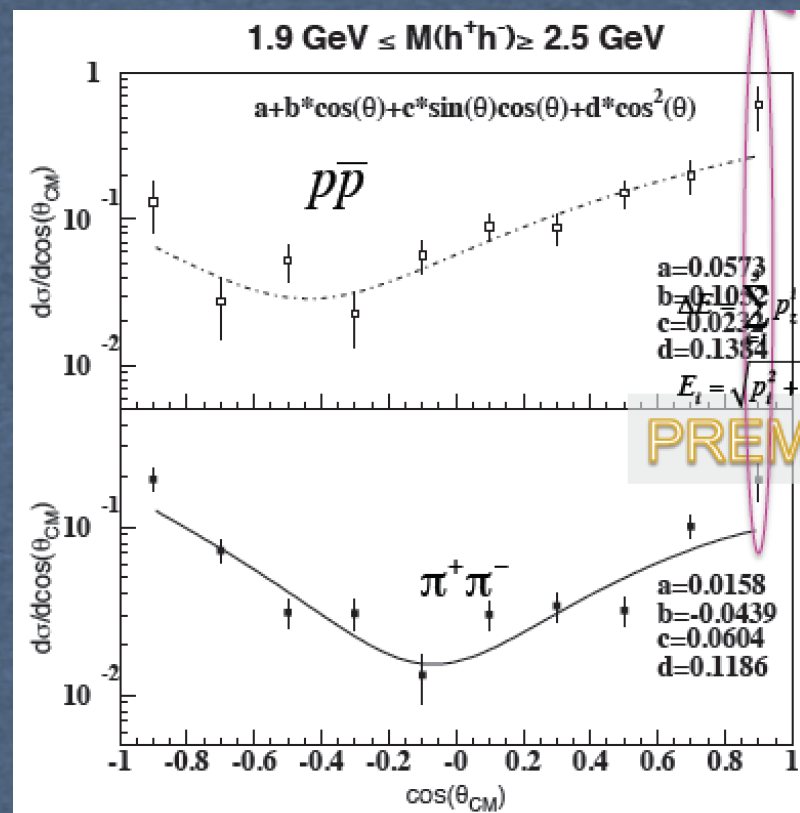
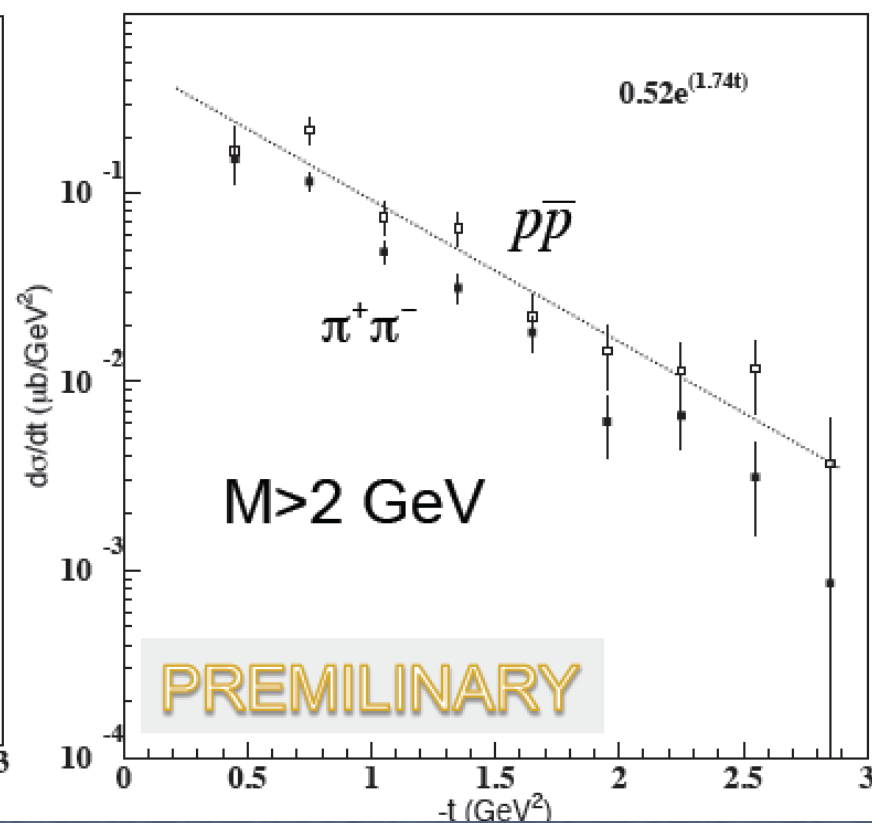
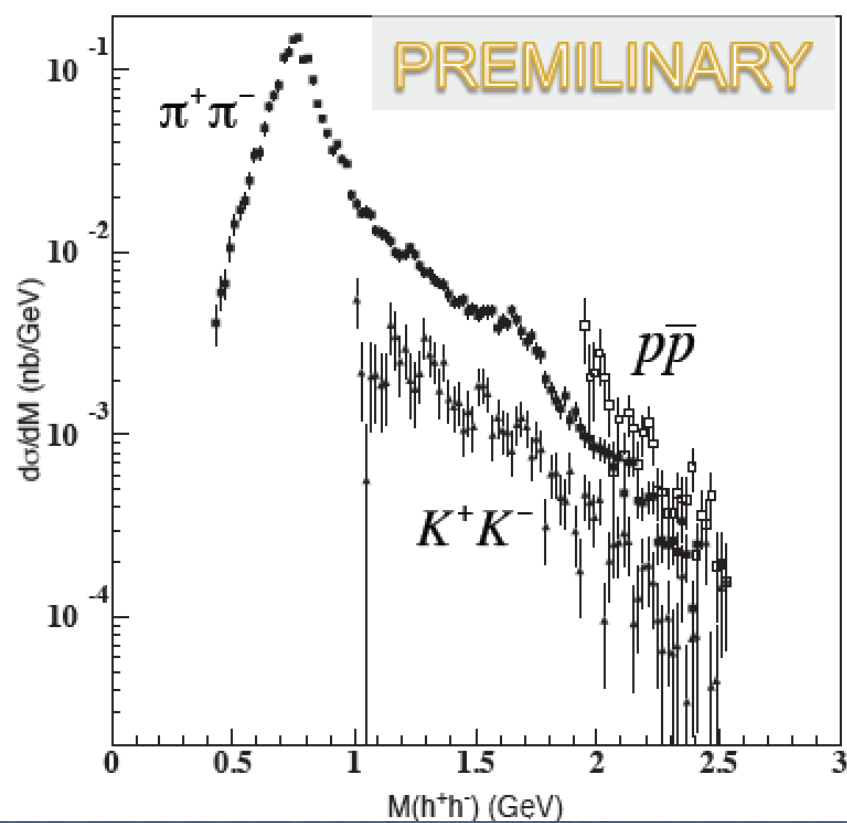
Y. Ghandilyan (grad.student, YerPhI), S. Stepanyan (JLAB)
CLAS Collaboration Meeting
February 24-26, 2016, Jefferson Lab, Newport News, VA



For fully exclusive final state with 3 particles:



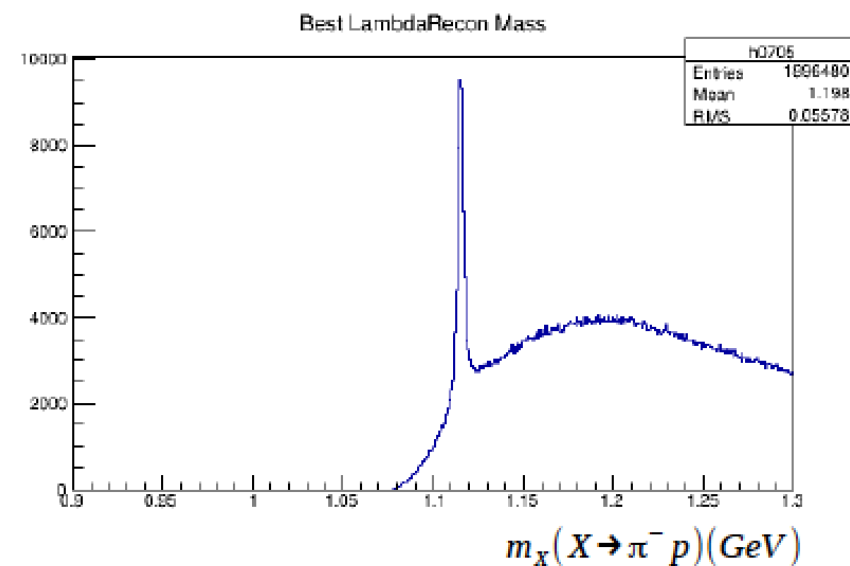
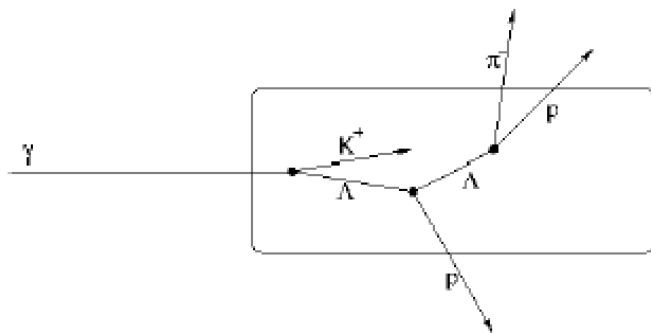
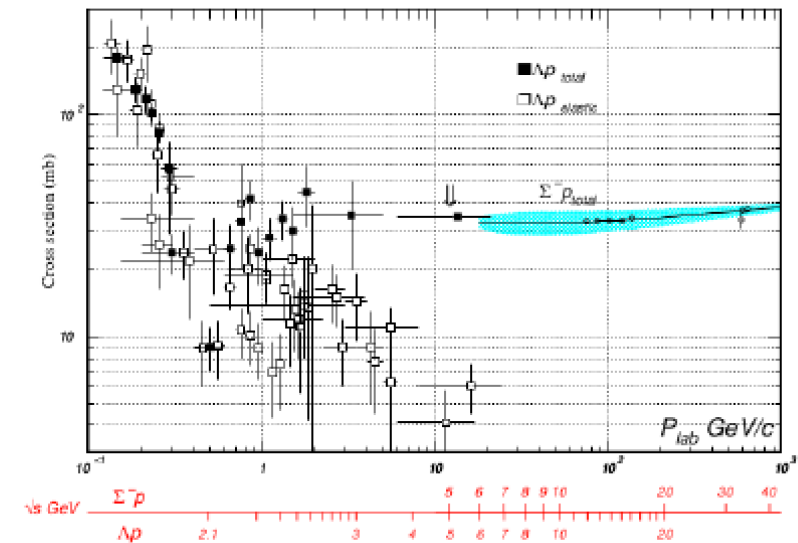
$$\gamma d \rightarrow h^+ h^- d'$$



Λp Elastic Scattering with CLAS

John Price
California State University, Dominguez Hills

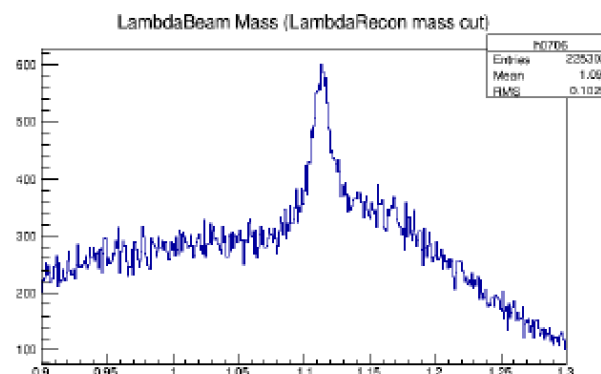
- Not much; all bubble chamber data
 - Taken from 1959 to 1975
 - About 1200 events total
 - ~50% error bars
- We can do better, right?
- **RIGHT?**



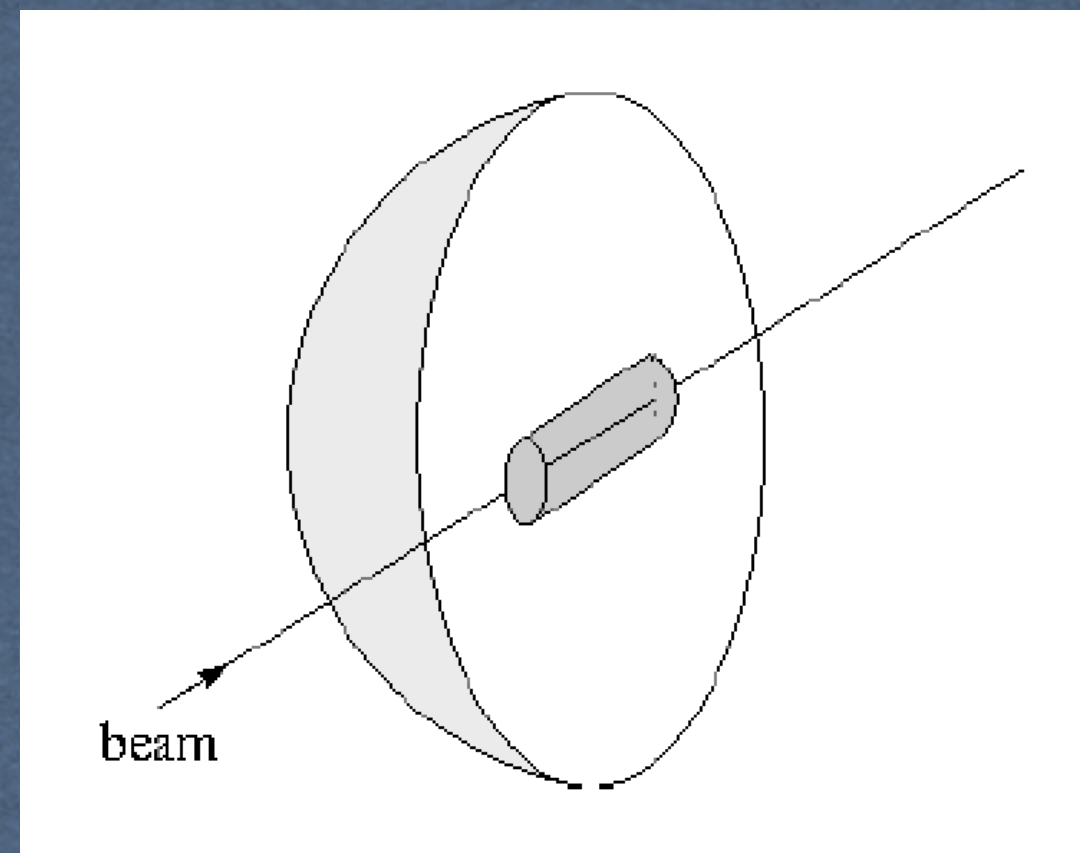
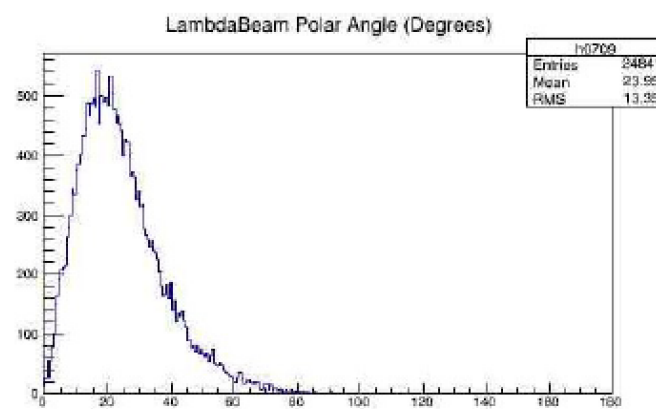
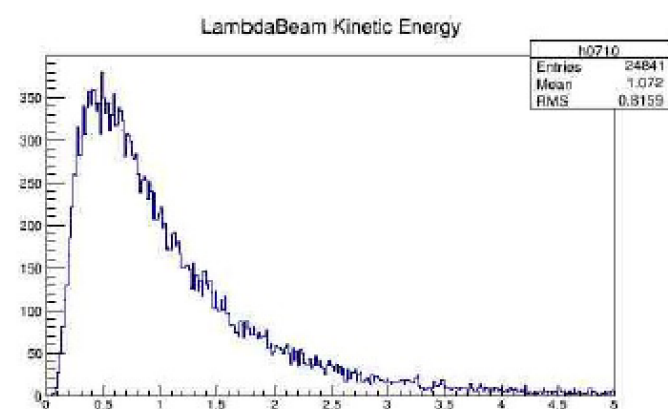
- Look for decay of outgoing Λ , **not** $K^+ X$
- Using reconstructed Λ , look for $m_X(Xp \rightarrow \Lambda p)$

Lambda “beam”

- Over 2000 events
- p range: ~750-2500 MeV
- θ range: $<45^\circ$



$m_X(Xp \rightarrow \Lambda p) (\text{GeV})$



- This represents a Λ “beam” in CLAS
- Lots of potential spectroscopy work
- Planning PAC proposal
 - Dedicated experiment to optimize flux, acceptance
 - Need special geometry for target

WG Reviews status

2pi electroproduction at large Q2 from E1-6 run

PI: E.Isupov et al.

RC: B.Briscoe, M.Guidal, M.Ripani



DONE!

E asymmetry for $g n \rightarrow \pi^- p$ from g14 (HDice) data

PI: F.Klein

RC: B.Briscoe, P.Cole, M.Dugger

Not started yet

K0⁺ Photoproduction on the Neutron within the Resonance Region

PI: Nick Compton

RC: L.Zana, E.Isupov, S.Schadmand

Status: I round

Gamma p to K0K0 from the g12 Data Set

PI: Kenneth Hicks and Shloka Chandavar

RC: Carlos Salgado (Chair), Derek Glazier, Lorenzo Zana

I round of comments completed

Pentaquark search in g10 by using the MMSA method

PI: Kenneth Hicks et al.

RC: Stepan Stepanyan (Chair), Lei Guo, Bryan McKinnon

II round of comments, waiting PI reply

2pi photoproduction from g11

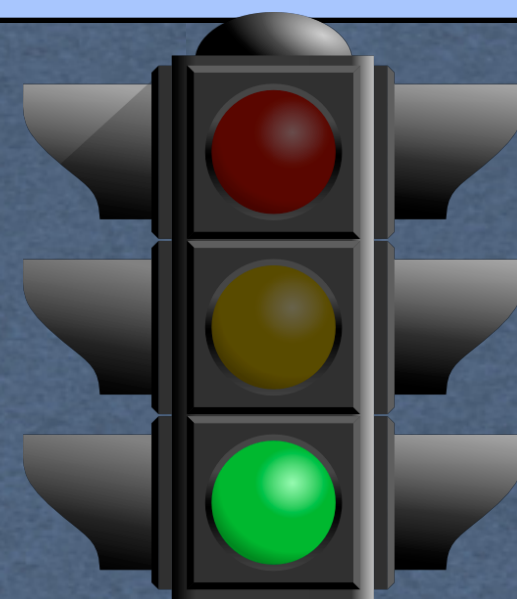
PI: Evgheny Golovach et al.

Ralf Gothe (Chair), Lei Guo, Alessandro RizzoStepan

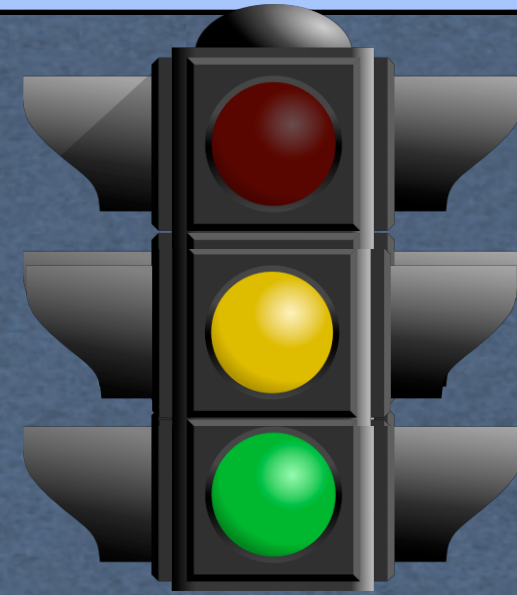
II round of comments, waiting for PI reply (close to the end)

New
since last meeting

In progress



WG Reviews status



KLambda and KSigma from FROST

PI: N.Walforf et al.

RC: S.Strauch, M.Holtrop, P.Mattione,

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 ...

Spin observables in omega production

PI: Brian Vernarsky

RC: F.Klein, A.Filippi, S.Strauch

Status: resumed connection with CMU, Committee needs to set up a final meeting

Polarization Observables in $g(\text{pol})p(\text{pol}) \rightarrow p\pi + \pi$ -Using the g9a (FROST) Target and CLAS

PI: V.Crede (FSU) et al.

RC: K.Livingston, V. Ziegler, E. Golovach

Status: new note received, in touch with the PI

$\gamma + p \rightarrow p K^+ K^-$ reaction

PI: S.Lombardo (Cornell)

RC: P.Eugenio, D. Schott, D. Carman

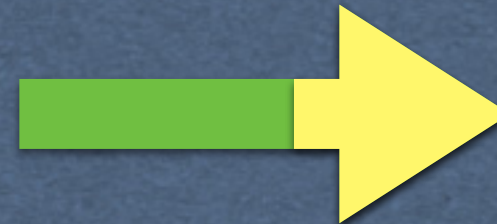
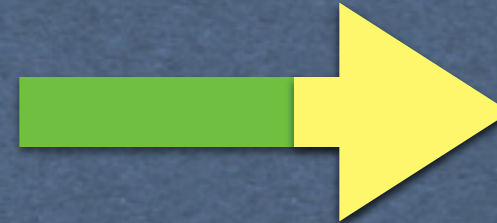
Status: almost done ????

Data analysis technique for obtaining $\gamma p \rightarrow \eta p$, $\gamma p \rightarrow \eta' p$ and $\gamma p \rightarrow \omega p$ beam asymmetries from the g8b running period

PI: Mike Dugger (Patrick Collins)

RC: L.Guo, D.Sober, E.Golovach

Status: ??? no feedback from the PI



Need
attention



Run Group Review

G12 SUMMARY



- The review committee: Raffaella De Vita, Michael Dugger, Yordanka Ilieva, Eugene Pasyuk (chair) received charge October 20, 2014. (7 years after the data were taken) 😞
- The goal: identify, review and approve common procedures relevant to most of the analyses of g12 data set. This would allow to streamline subsequent reviews of individual physycs analyses.

- Calibration quality is adequate
- Momentum corrections as described in the g12 note
- Beam energy correction as described in the g12 note
- Inclusive “Good” run list as described in table XX. Individual analysis may use a subset of it.
- Target density and its uncertainty as described in the g12 note
- Photon flux calculation procedure as described in the g12 note
- Lower limit for the systematic uncertainty of normalized yield: 5.7%
- Photon polarization calculation procedure as described in the g12 note
- Systematic uncertainty of the photon polarization as described in the g12 note.
- gsim parameters
- gpp smearing parameters
- Processing of MC data
- DC efficiency map
- EC knockout
- Minimal TOF knockout
- “Lepton ID” is approved as “Di-lepton ID”. For single lepton the cuts should be tighter.

- PID and event selection
- Kinematic fit
- Fiducial cuts
- Acceptance and efficiency calculations
- Accounting for multiple photons
- Anything else.....

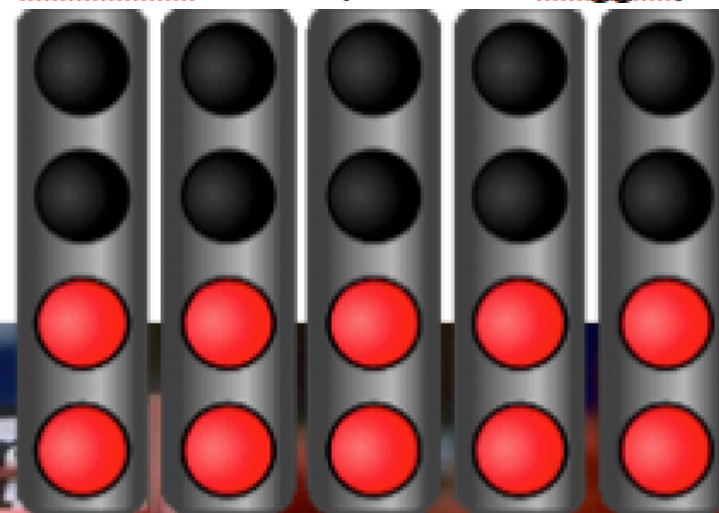
Approved

Analysis-dependent

Run Group Review

- The review committee: Raffaella De Vita, Michael Dugger,

Go!



...as fast as Ayrton Senna

G12 vs. G12

Round

- Calibration q
- Momentum
- Beam energy
- Inclusive "Gc subset of it.
- Target densit
- Photon flux c
- Lower limit f
- Photon polar
- Systematic u
- gsim parame
- gpp smearing
- Processing o
- DC efficiency
- EC knockout
- Minimal TOF
- "Lepton ID" i tighter.

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Run Group Review

Lesson learned

- * After 1.5 year of review HSWG has a better understanding of the run group review (RGR)
- * Not all has been approved but many procedures are common to different analysis
- * G12c analysis note will be used as a reference for future collaborators willing to analyse g12 (data mining)
- * Fast track for analysis relying on standards: reduced review committee made by 1 new + 1 supervisor from the RG review committee
- * Important lesson for CLAS12: not waiting for (9 years!) to set up the RG review!
- * We'll keep testing with FROST and g14 run groups
- * Major issues with students that leave the field: advisor responsibility?
- * Formal extended presentation at the HSWG before to assign a review committee
- * We are considering to assign a 'tutor' (nominated by HSWG and run group) to review the analysis from the very beginning (the same will serve in the final review committee)
- * Need to be discussed by the whole collaboration (next Coll Meeting?)