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Nuclear Physics Working Group Report

**CLAS Collaboration Meeting
Jefferson Lab**

October 23rd, 2015

**Lamiaa El Fassi
(on behalf of Kawtar Hafidi)**

Analyses Under Review: Update

Neutral pion electroproduction ratios off C, Fe, and Pb

By T. Mineeva, University of Connecticut

First round

Review committee: L. Weinstein (Chair), Y. Ilieva and M. Wood

Measurements of the Fifth Structure Function of the Deuteron

By G. Gilfoyle, University of Richmond

First round

Review committee: S. Kuhn (Chair), A. El Alaoui and S. Gilad

Differential cross sections for reactions $\gamma + d \rightarrow \pi^- p$ p_spec

N. Pivnyuk, ITEP

Second round

Review committee: S. Strauch (Chair), B. McKinnon and M. Mirazita

Analyses Under Review: **New**

Deeply Virtual Compton Scattering off 4He

By Mohammad Hattawy et al., IPN Orsay

First round

Review committee: Michel Garçon (Chair), Sebastian Kuhn & Zein-Eddine Meziani

Analyses Under Review: New

Deeply Virtual Compton Scattering off 4He

By Mohammad Hattawy et al., Orsay

First round

Review committee: Michel Garçon (Chair), Sebastian Kuhn & Zein-Eddine Meziani

Stay tuned for the next set of SRC analyses led by Or Hen, Erez Cohen et al., as part of Data-Mining project

NPWG Agenda for Thursday October 22nd, 2015

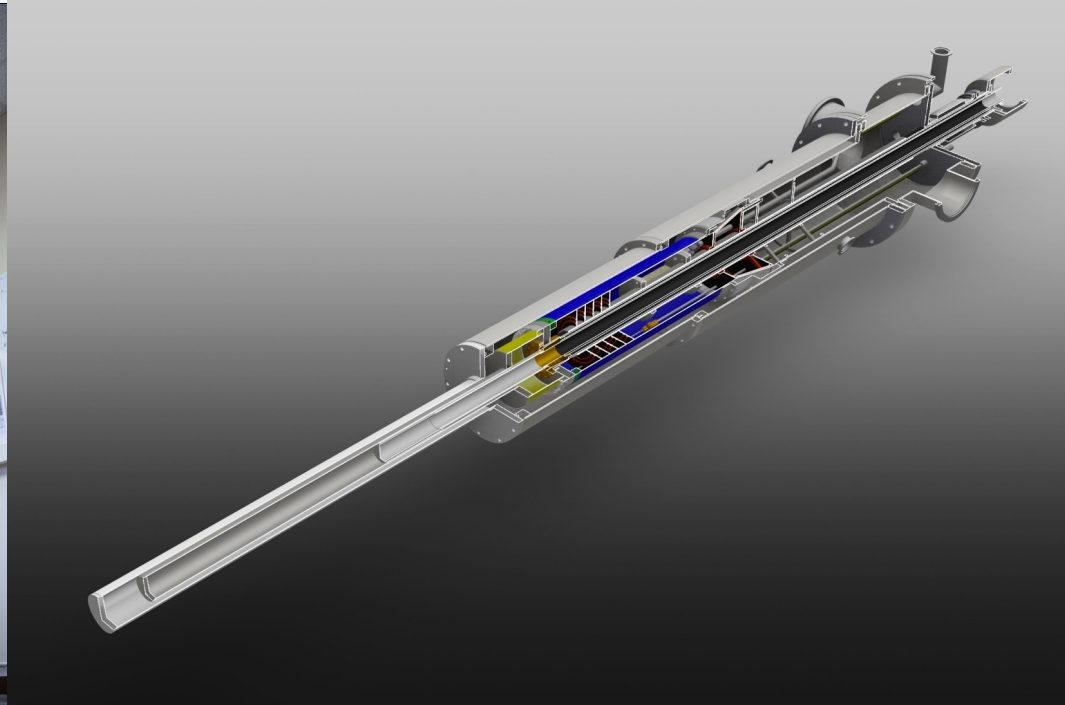
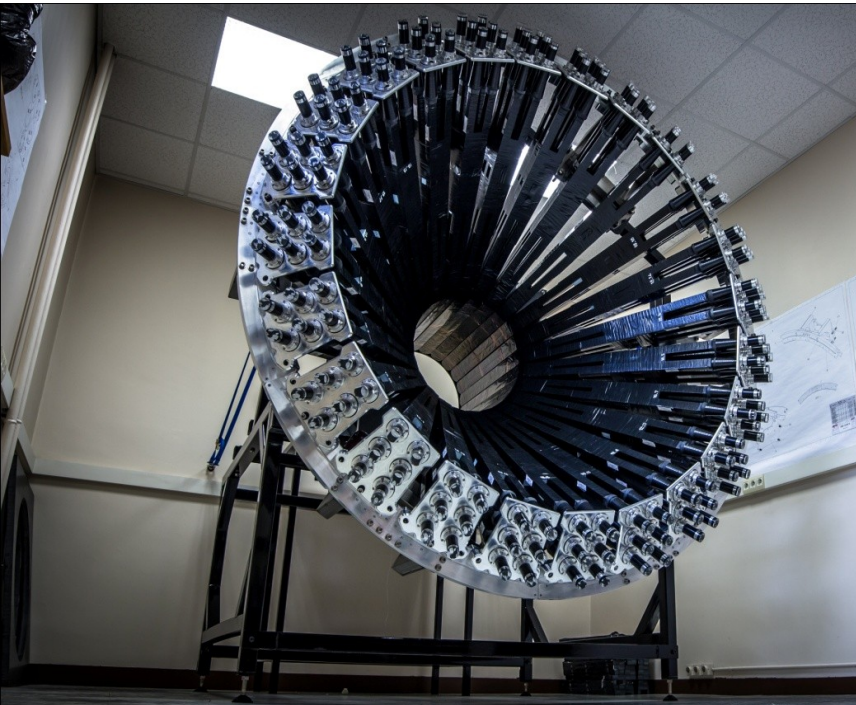
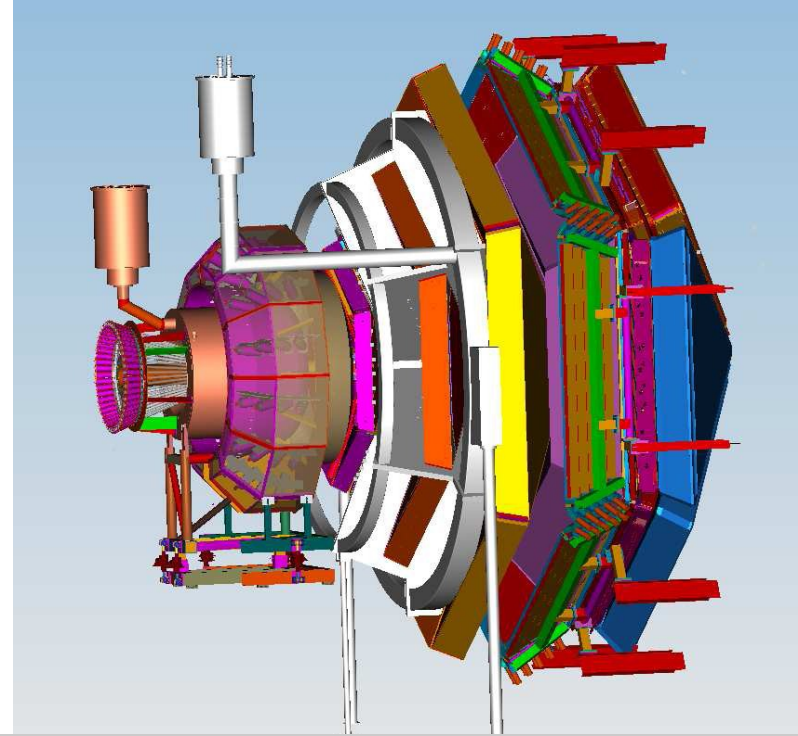
14:00	Nuclear Physics Working Group status	L. El Fassi (for K. Hafidi)	10'
14:10	Extension of ND3 run group	Silvia Niccolai	40'
14:50	Update on the analysis of YN interaction	Nick Zachariou	15' + 5'
15:10	Coffee Break		20'
15:30	Progress on Measurement of the double polarization observables Cx and Cz for final-state interactions in $\text{pol}(\gamma) + d \rightarrow K^+ \text{pol}(\lambda) n$	Tongtong Cao	20' + 5'
15:55	Status of eg2 single pion production analysis	Steve Manly & Hyupwoo Lee	20' + 5'
16:20	Tagged EMC from eg2 data	Barak Schmookler	20' + 5'

Minisession on the extension of the polarized ND3 CLAS12 run group

Silvia Niccolai



CLAS Collaboration meeting, 10/22/2015



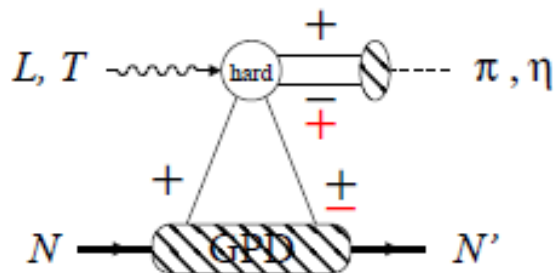
Reasons and purpose of this session

PR12-15-004: Deeply Virtual Compton Scattering on the neutron with a longitudinally polarized deuterium target (A. Biselli, C. Keith, S. Niccolai, S. Pisano, D. Sokhan):

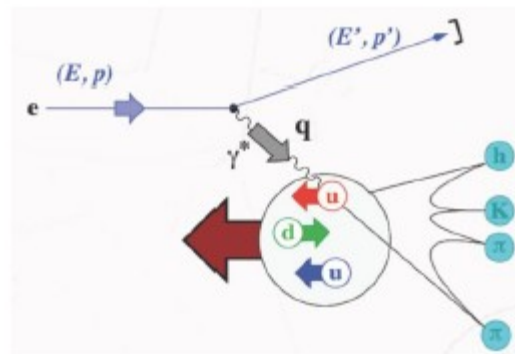
- Presented at **PAC43**, requesting **100 days (plus overhead)** of running time on **ND3**, 50 shared with the existing run group (RG-Cb), plus **50 days of new beam time**
- **Setup:** CLAS12 (including CND), longitudinally polarized ND3 target
- **Goals:** TSA, DSA for nDVCS ($ed \rightarrow en\gamma(p)$), sensitive to the $\text{Im}(\mathbf{H}_n)$ and $\text{Re}(\mathbf{H}_n)$ CFFs
→ Extraction of neutron GPDs → **quark-flavor separation of GPDs**
- **Conditionally approved (C2)** by the PAC, must come back to the next PAC, broken into TWO proposals: a « parasitic » one for the already-approved 50 days (needing only CLAS approval), and a new proposal, requesting new beam time, that will go through the PAC
- For the new proposal, it was asked to **add other physics channels** to better support and motivate the need to extend the existing run group

Other reaction channels

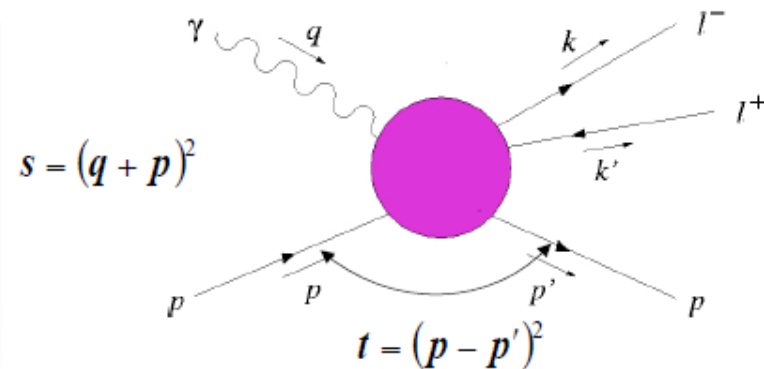
- **DVMP** (for GPDs): π^0 , $\pi^\pm$, η (ρ^0 , $\rho^\pm$, ω) **Christian Weiss**
- **nSIDIS** (for TMDs): **Silvia Pisano**, **Harut Avakian**, **Aurore Courtoy**, **Marco Contalbrigo**
- **Baryon resonances**: **Viktor Mokeev**, **Volker Burkert**, **Ralph Gothe**
- **nTCS**: **Pawel N. Turonsky**
- **Inclusive**: is more data necessary/pleasant to have? **Sebastian** (couldn't make it)
- Nuclear physics folks?



Pseudoscalar DVMP:
Transversity GPDs
Flavor separation



SIDIS (pions, kaons, di-hadrons)
TMDs: Flavor separation



Timelike Compton Scattering
Universality of GPDs
Flavor separation

Progress Report on $\vec{\gamma} d \rightarrow K^+ \vec{\Lambda} n$ Analysis Development of a Realistic Event Generator

Tongtong Cao

Advisor: Yordanka Ilieva

CLAS Collaboration Meeting, Oct 2015



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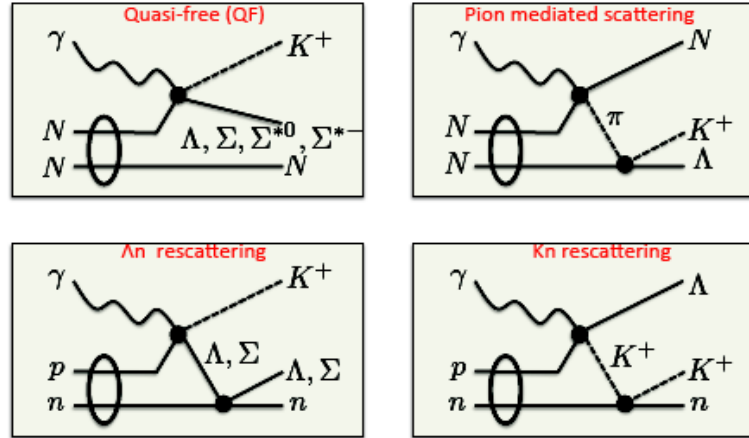


National Science Foundation
WHERE DISCOVERIES BEGIN



Generator for $\vec{\gamma} d \rightarrow K^+ \vec{\Lambda} n$

- Reaction mechanisms and background channels in the experimental data.



- Channels in the generator.

Channel Number	Channel Name	First step	Second step
1	π^0 mediated for signal	$\gamma n \rightarrow \pi^0 n$	$\pi^0 p \rightarrow K^+ \Lambda$
2	Kn re-scattering for signal	$\gamma p \rightarrow K^+ \Lambda$	$K^+ n \rightarrow K^+ n$
3	Λn re-scattering for signal	$\gamma p \rightarrow K^+ \Lambda$	$\Lambda n \rightarrow \Lambda n$
4	Σn re-scattering for Σ production	$\gamma p \rightarrow K^+ \Sigma$	$\Sigma n \rightarrow \Sigma n$
5	π^+ mediated for signal	$\gamma p \rightarrow \pi^+ n$	$\pi^+ n \rightarrow K^+ \Lambda$
6	Quasi-free for Σ^{*0} production	$\gamma p \rightarrow K^+ \Sigma^{*0}$	$\Sigma^{*0} \rightarrow \Lambda \pi$
7	Quasi-free for Σ^{*-} production	$\gamma n \rightarrow K^+ \Sigma^{*-}$	$\Sigma^{*-} \rightarrow \Lambda \pi^-$

Additionally, two channels for quasi-free of Λ and Σ productions are processed in the next process of conversion from root-file to BOS-file.

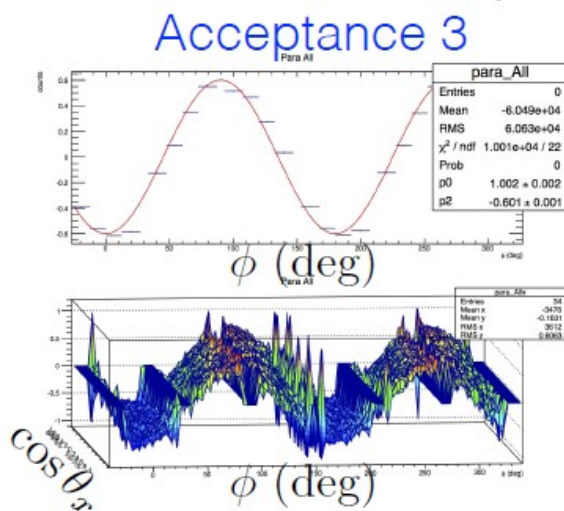
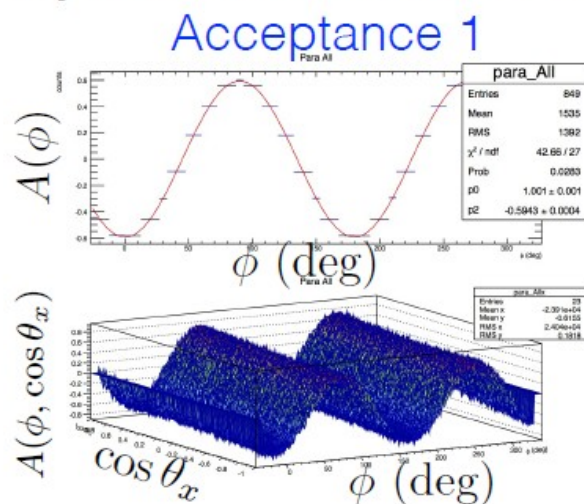
Technique of Isospin Couplings

- The technique of isospin couplings is used to calculate unpolarized cross section of the second-step channels in our generator by published results of the closest channels.
- For $\pi N \rightarrow K\Lambda$, we considered three channels: a) $\pi^- p \rightarrow K^0 \Lambda$, b) $\pi^0 p \rightarrow K^+ \Lambda$, and c) $\pi^+ p \rightarrow K^+ \Lambda$, and obtained the ratio of cross section for these three channels $\sigma_a : \sigma_b : \sigma_c = 2 : 1 : 2$ using the technique. Through published cross section of the channel a, we can obtain cross section of the channels b and c.
- For $\pi N \rightarrow K\Sigma$, we considered five channels: a) $\pi^- p \rightarrow K^0 \Sigma^0$, b) $\pi^- p \rightarrow K^+ \Sigma^-$, c) $\pi^+ p \rightarrow K^+ \Sigma^+$, d) $\pi^+ n \rightarrow K^+ \Sigma^0$, and e) $\pi^0 p \rightarrow K^+ \Sigma^0$. Through published cross section of channels a, b, and c, we can obtain cross section of channels d and e.

Study of the Hyperon-Nucleon (YN) Interaction in Exclusive Λ Photoproduction off the Deuteron

Systematic Studies of method for extracting observables

- Goal: Extract single and double polarisation observables for FSI in $\gamma d \rightarrow K^+ \Lambda n$
- Systematic studies of binned technique (fitting asymmetries)



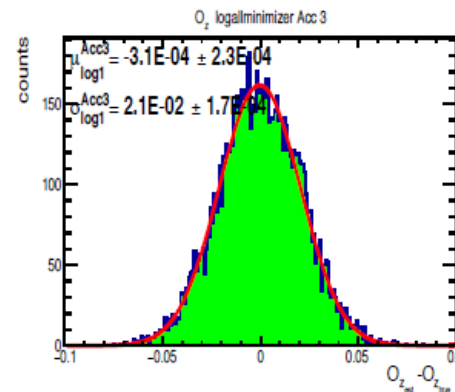
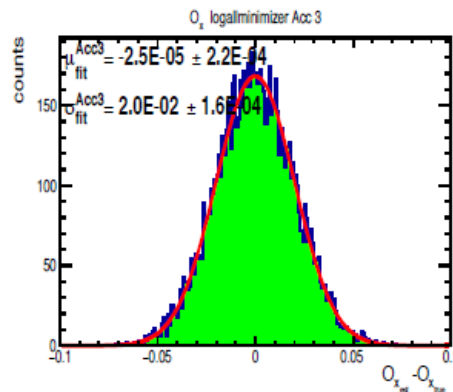
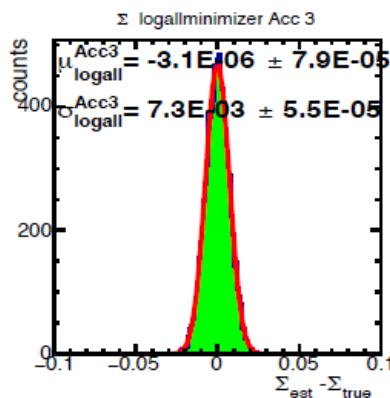
Generated 10^4 samples each with 10^6 events

- 1D binned technique produces reliable results
- 2D binned techniques produces strongly biased results

Study of the Hyperon-Nucleon (YN) Interaction in Exclusive Λ Photoproduction off the Deuteron

Systematic Studies of method for extracting observables

- Different log likelihood (LL) techniques were developed based on various assumptions
 - Allows the simultaneous determination of single and double polarisation observables
 - LL technique has been extensively studied using generated data
 - Systematic bias due to acceptance assumptions is $\mathcal{O}(10^{-3})$ (order of magnitude smaller than stat. uncertainty)



- LL method is more robust for low statistic bins compared to the binned techniques

Nicholas Zachariou

Status of eg2 Single Pion Production Analysis

Error Analysis

Hyupwoo Lee, Steve Manly

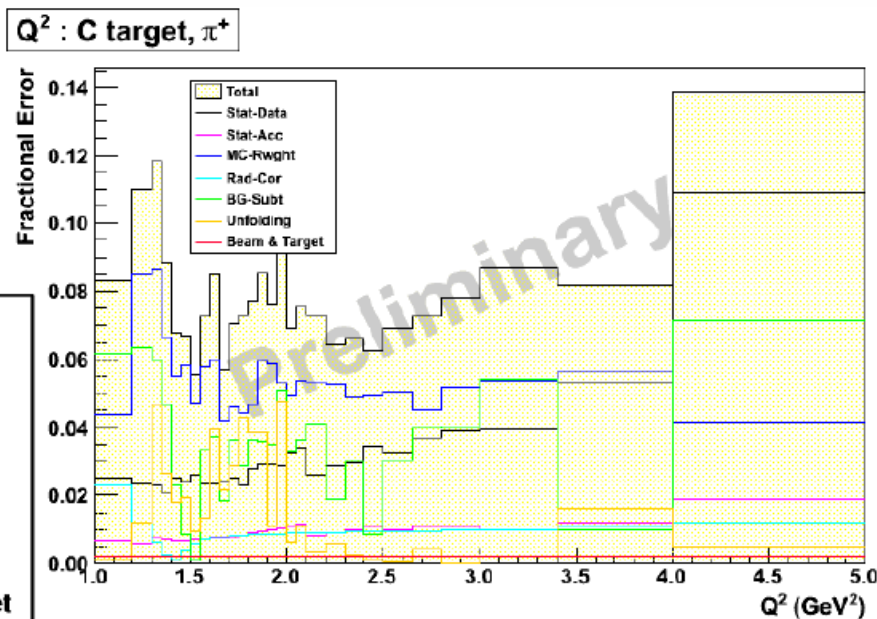
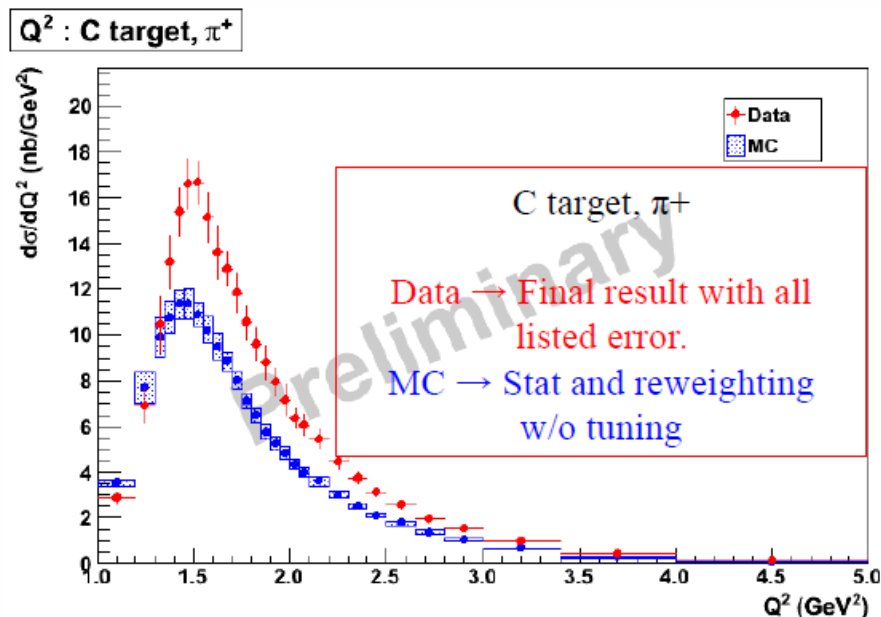
University of Rochester

CLAS nuclear physics working group meeting

Oct, 21, 2015

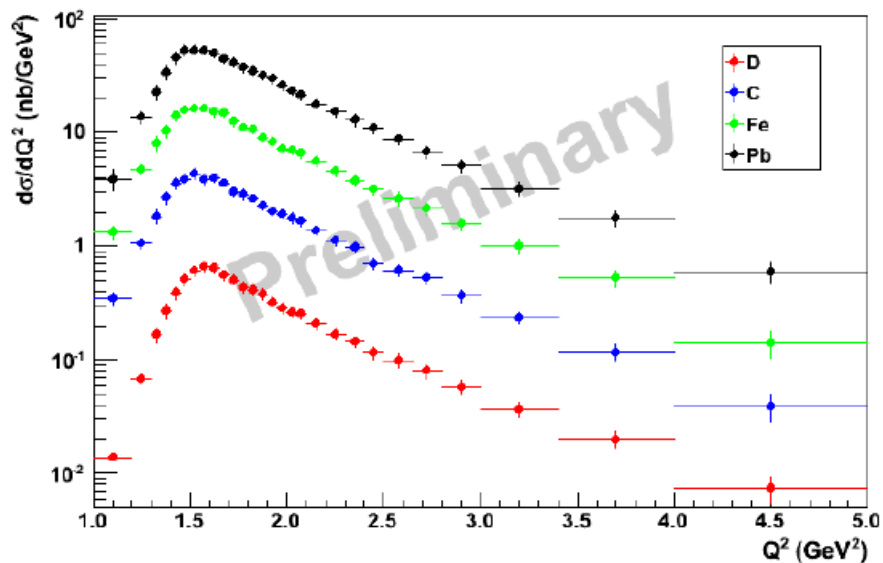
Error List

- Statistical error
 - Data : $\sim 5\%$
 - Acceptance : $\sim 1\%$
- Systematic error - Global
 - Total Q : $< 1\%$
 - Target properties : Area density : $0.2 \sim 1.0\%$
 - Stability
- Systematic error - Local
 - MC : GENIE reweighting : $\sim 8\%$
 - Background subtraction : $\sim 3.5\%$
 - Radiative Correction : $\sim 1\%$
 - Unfolding : $\sim 2.5\%$
- Total Error
 - $\sim 11\%$ fractional error

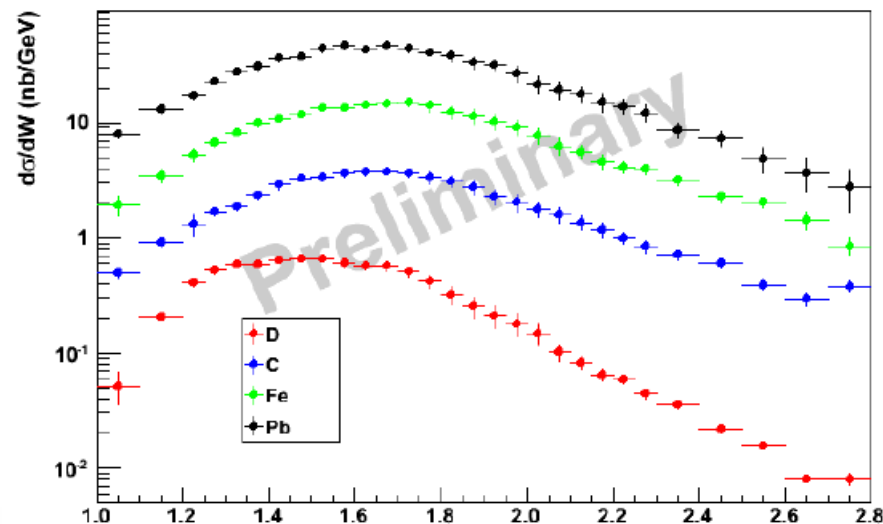


X-section pim

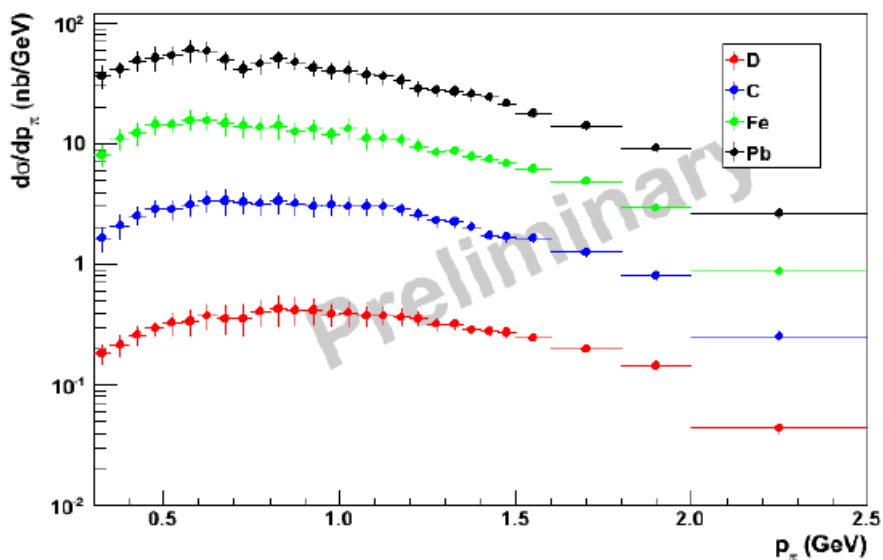
$Q^2 : \pi^-$



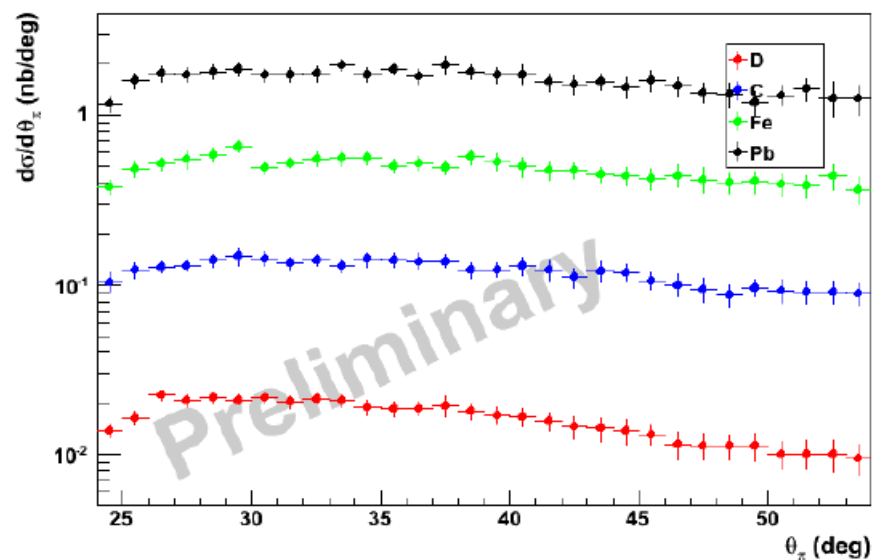
$W : \pi^-$



$P_\pi : \pi^-$

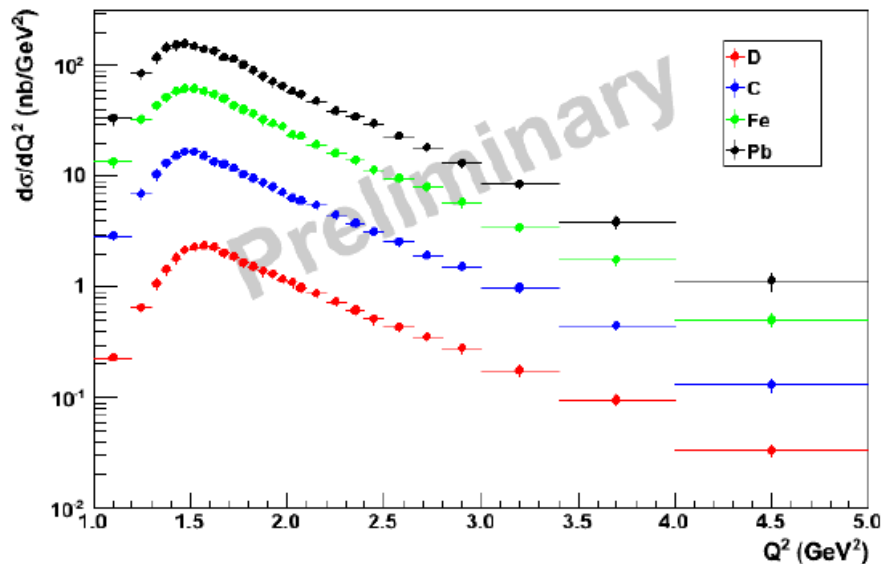


$\theta_\pi : \pi^-$

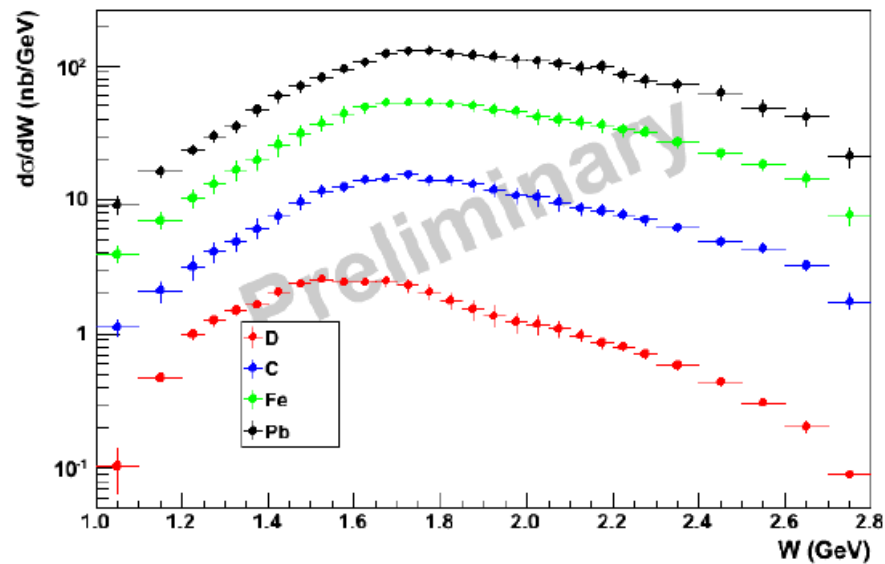


X-section pip

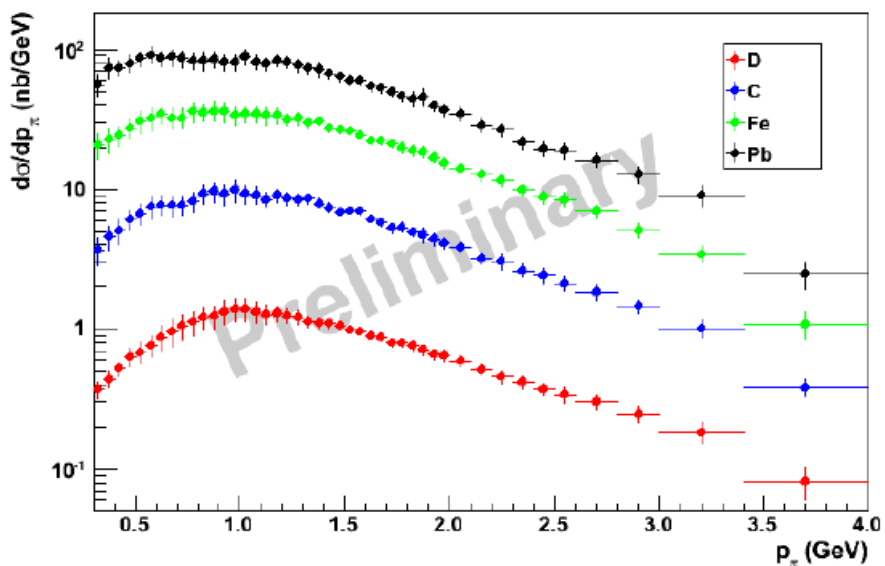
$Q^2 : \pi^+$



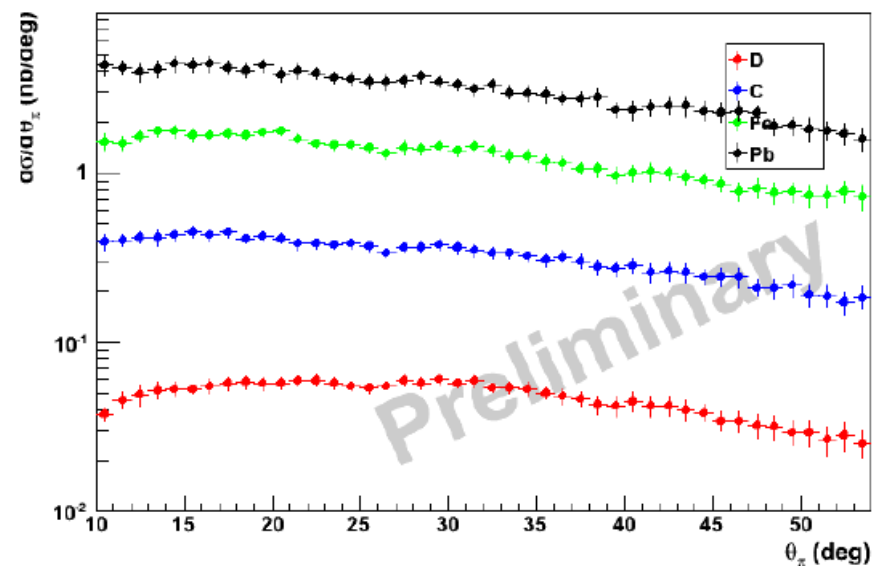
$W : \pi^+$



$P_\pi : \pi^+$



$\theta_\pi : \pi^+$



An Update on the “Tagged” EMC Effect Analysis

Barak Schmookler

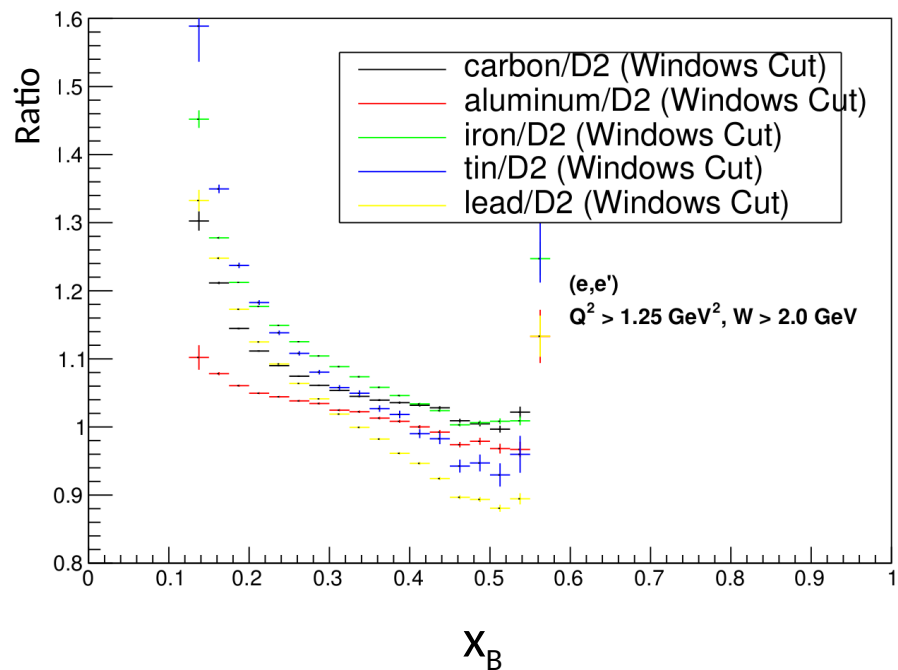
MIT

Analysis Status

- Analyzing data from Eg2c run period
- We choose events with EMC Kinematics
- We study EMC events with backwards-recoiling (with respect to the momentum transfer) proton with $k > k_F$
- Naïve Expectation if EMC effect arises from SRC pairs:
Flat $[\sigma(A)/A]/[\sigma(d)/2] \approx a_2(A/d)$
- Current Status: We have preliminary results and are working on applying needed corrections

Preliminary Results

Inclusive Per-Nucleon Cross Section Ratios



Semi-inclusive Per-Nucleon Cross Section Ratios

