Nuclear Physics Working Group Summary Report

M. H. Wood, Canisius College

July 13, 2018

Conferences

Since March 2018 meeting, there were 21 presentations.
Invited – 3 (3 approved), Contributed 6 (5 notified), General – 9 (8 notified), Poster – 3 (3 notified)

Upcoming Conferences

Conference	Speaker	Type
EICUGM18	Lamiaa El Fassi	Invited
Gordon Conference	Mariana Khachatryan	Invited
DNP	Lamiaa El Fassi	Contributed
	Nicholas Zachariou	Contributed
	Sereres Johnston	Contributed
	Meytal Duer	Contributed
	Adi Ashkenazi	Contributed

Active Reviews

- **PROBING 2N-SRC in 12C, 27Al, 56Fe, and 208Pb using the A(e,e'n) and A(e,e'p) reactions,** M. Duer et al. (Ad hoc review)
- **Measurement of Transparency Ratios for Protons and Neutrons**, M. Duer et al. (Analysis review)
- **The center of mass motion of short-range correlated nucleon pairs studied via the A(e, e'pp) reaction**, E. Cohen et al. (Submitted)
- **Neutral pion electroproduction ratios off C, Fe, and Pb to D**, T. Mineeva et al. (Analysis review restarting very soon)

PAC46 Reviews

- **Electrons for Neutrinos, Addressing Critical Neutrino-Nucleus Issues**, L. Weinstein et al.
- **Short Range Correlations in Nuclei and the EMC Effect**, O. Hen et al.

SRC Studies using Triple Coincidence A(e,e'pp) & A(e,e'np) reactions

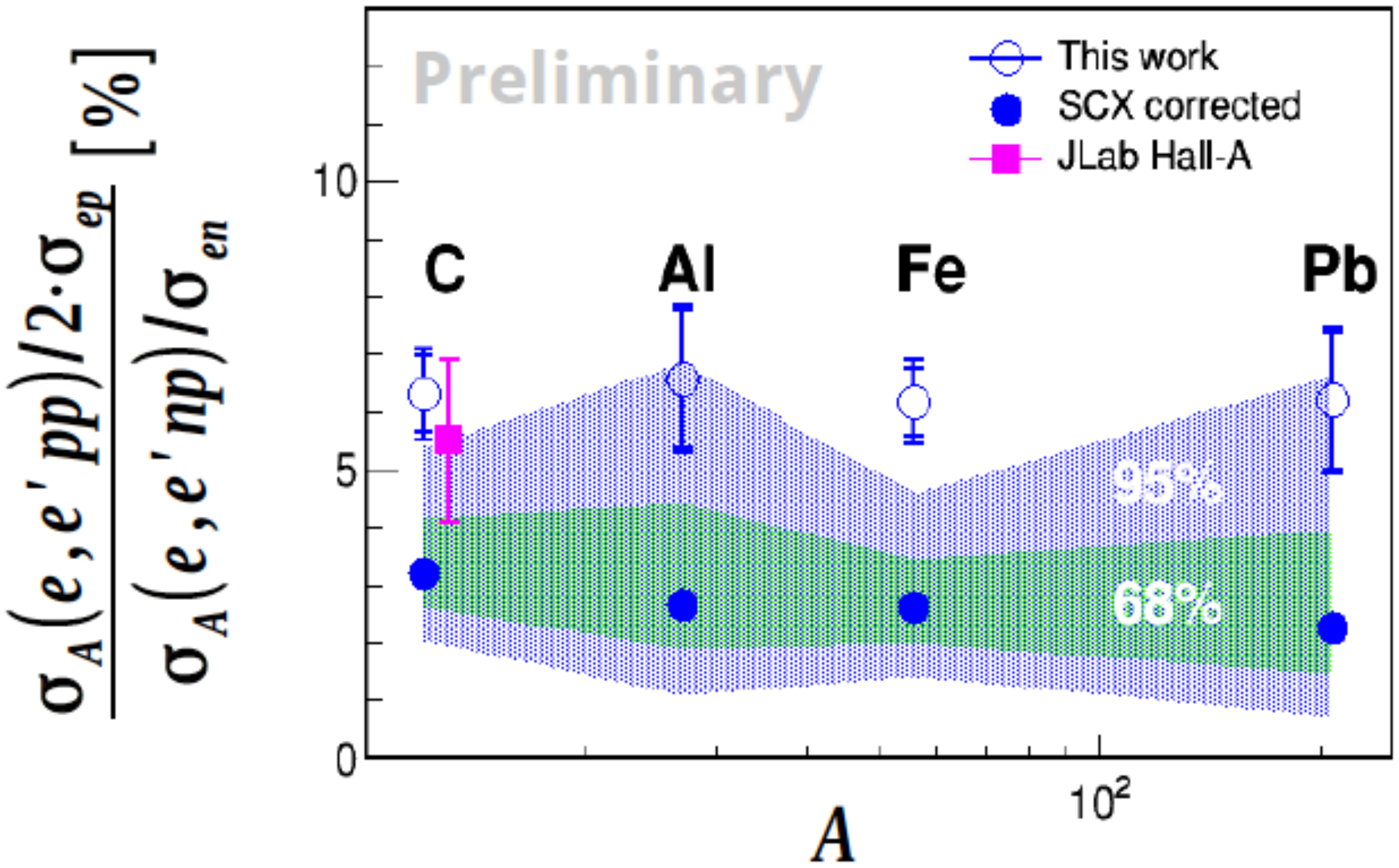
A data-mining project using CLAS EG2 data

Meytal Duer

Tel-Aviv University

Direct Observation of np-Dominance

A(e,e'pp)/A(e,e'np) ratios



Subedi, Science 320 (2008)

SCX correction: C. Colle, W. Cosyn, Phys. Rev. C 93, 034608 (2016).

Direct Observation of np-Dominance

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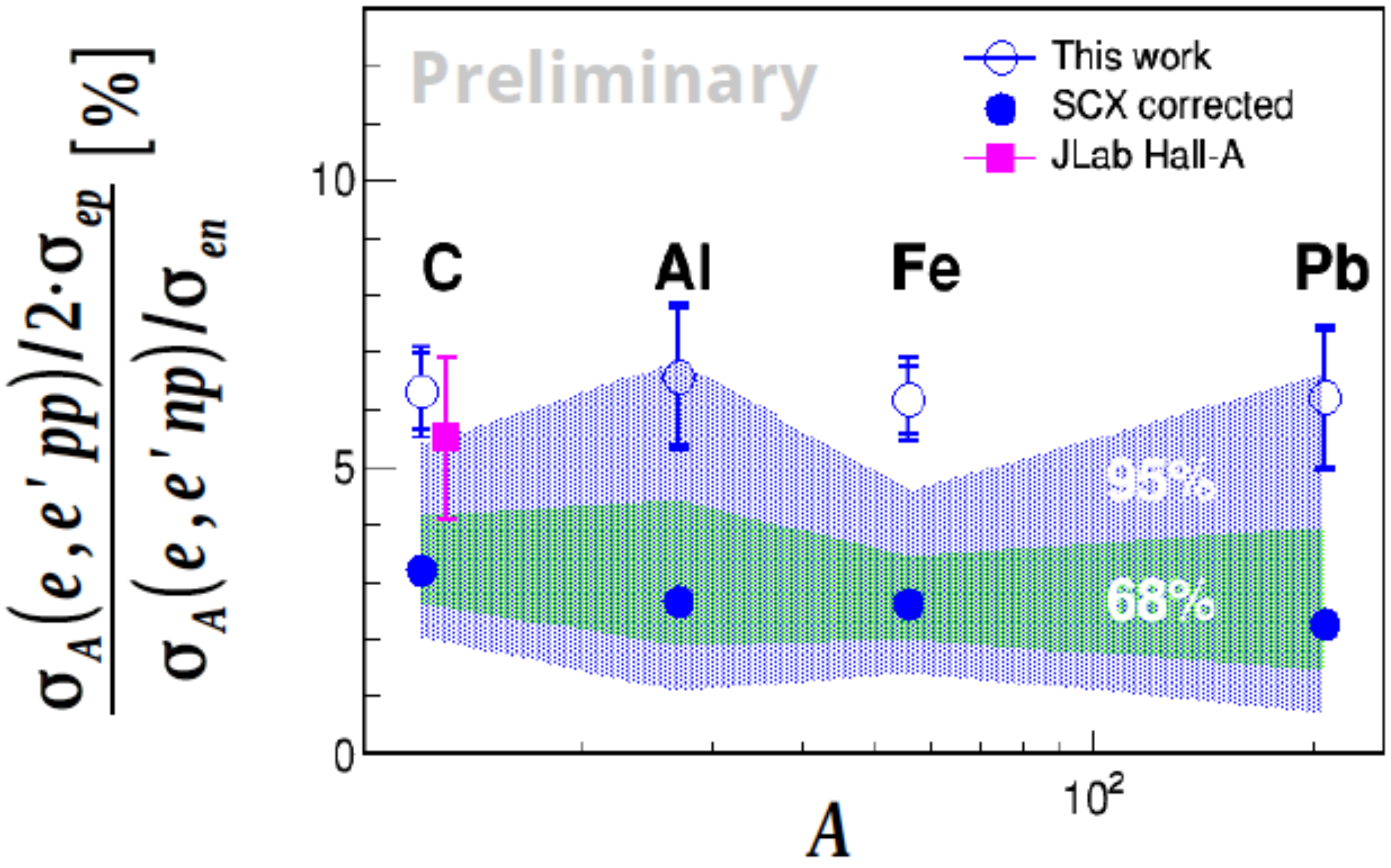

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SCX correction: C. Colle, W. Cosyn, Phys. Rev. C 93, 034608 (2016).

Transparency Studies using A(e,e'p) & A(e,e'n) reactions

A data-mining project using CLAS EG2 data

Meytal Duer

Tel-Aviv University

Formal Definition

$$T_N(A) = \frac{\sigma_{\exp} A(e,e'N)}{\sigma_{PWIA} A(e,e'N)} \qquad N = p/n$$

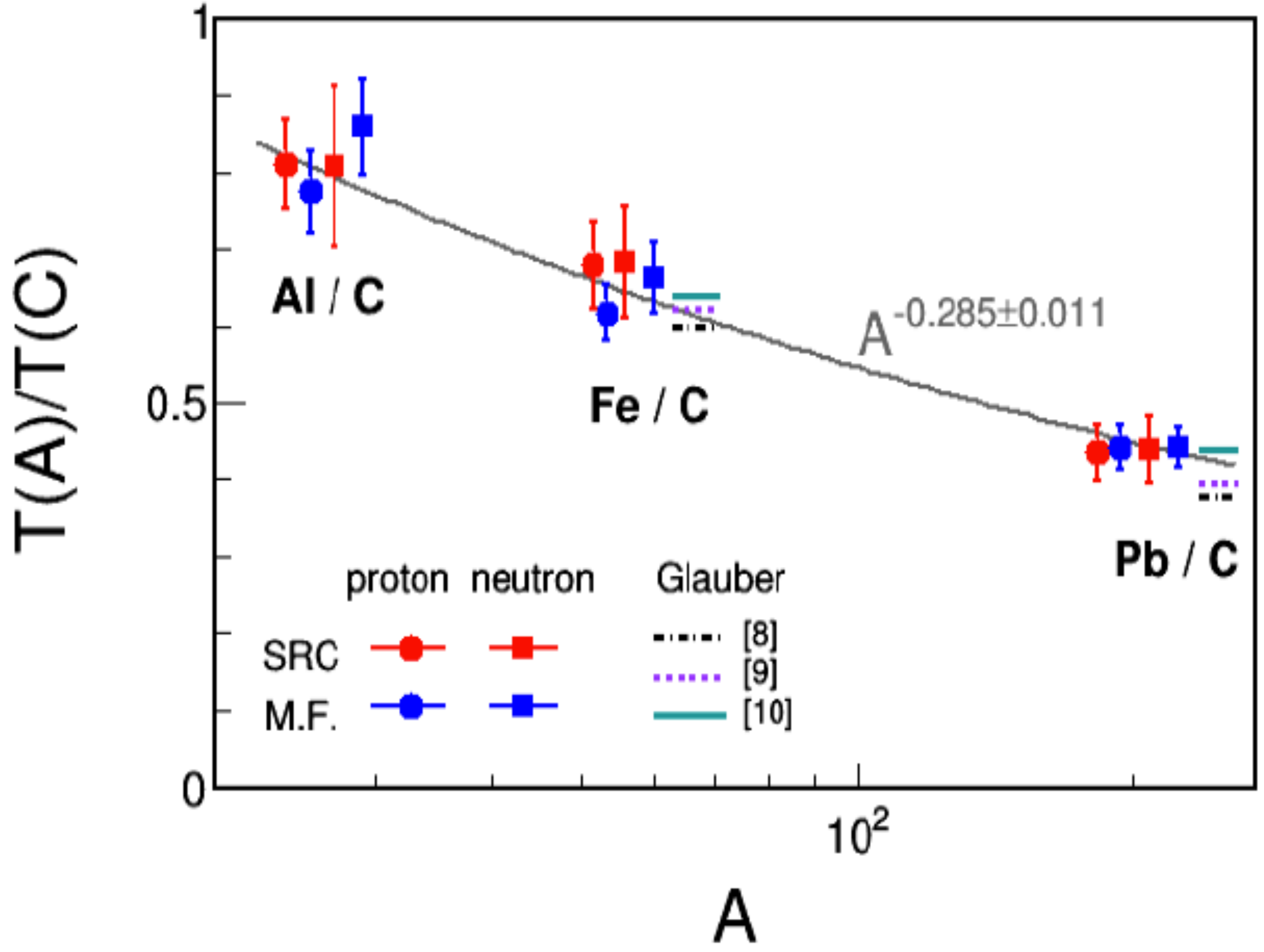
Following Ref. [1] using factorized approximation for large Q²:

$$\sigma_{PWIA} = \frac{K}{\# N} \cdot E_N \cdot \sigma_{eN} \cdot \oint S_A(E, p_i)$$

Moving to ratios:

$$\frac{T_N(A)}{T_N(C)} = \frac{\sigma_{\exp} A(e,e'N) / \oint S_A(E,p_i)}{\sigma_{\exp} C(e,e'N) / \oint S_C(E,p_i)}$$

[1] De Forest, Nucl. Phys. A 392, 232 (1983)



[8] C. Colle, W. Cosyn, Phys. Rev. C 93, 034608 (2016).
[9] L. L. Frankfurt, M. I. Strikman, and M. Zhalov, Phys. Lett. B. 503, 73 (2000).
[10] V. J. Pandharipande, and S. C. Pieper, Phys. Rev. C 45, 791 (1992)

By: Igor Korover

Tel Aviv University and NRCN

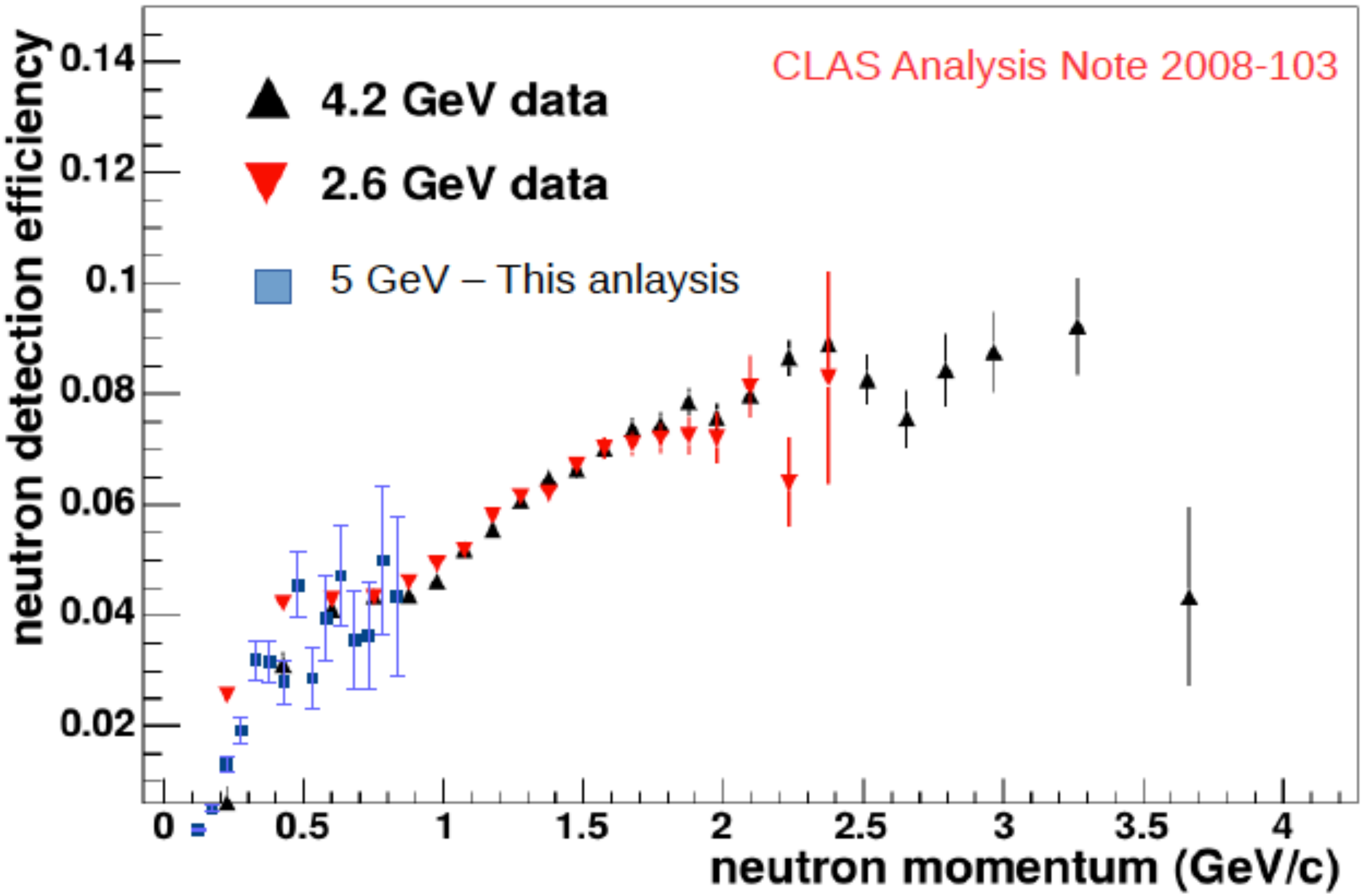
July 12, 2018

Study of SRC with recoil neutron detection in CLAS6

On going Data Mining analysis

Hall B, NPWG – Jefferson Lab, Newport News

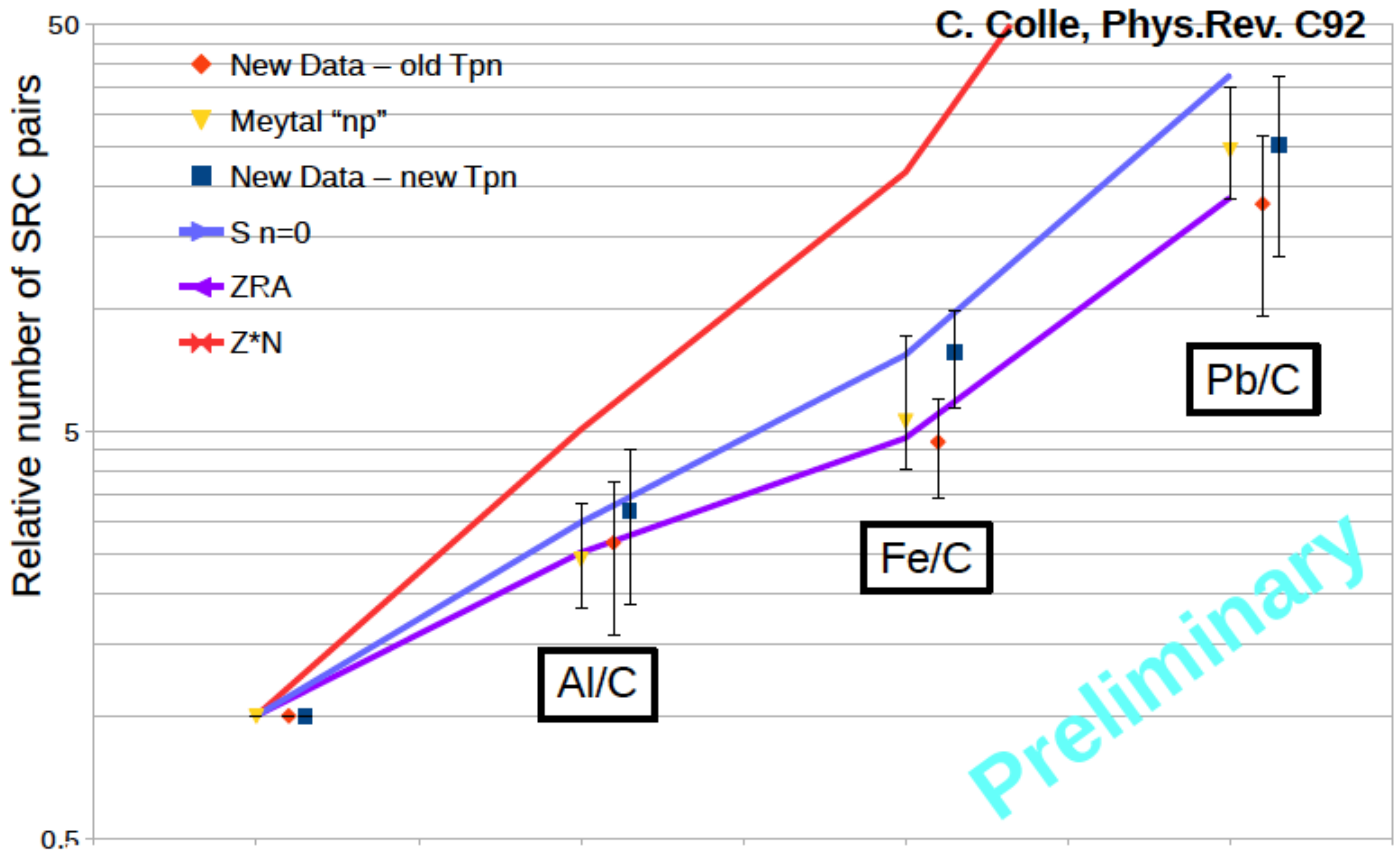
Efficiency comparison



Gn Analysis

$ep \rightarrow e\pi^{+}(n)$

A(e,e'pn) / C(e,e'pn)



C. Colle, Phys.Rev. C92
50
5
0.5
Relative number of SRC pairs
New Data – old Tpn
Meytal "np"
New Data – new Tpn
S n=0
ZRA
Z*N
Al/C
Fe/C
Pb/C
Preliminary

Going Beyond the Tensor Limit Using $\frac{(e,e'pp)}{(e,e'p)}$ Data

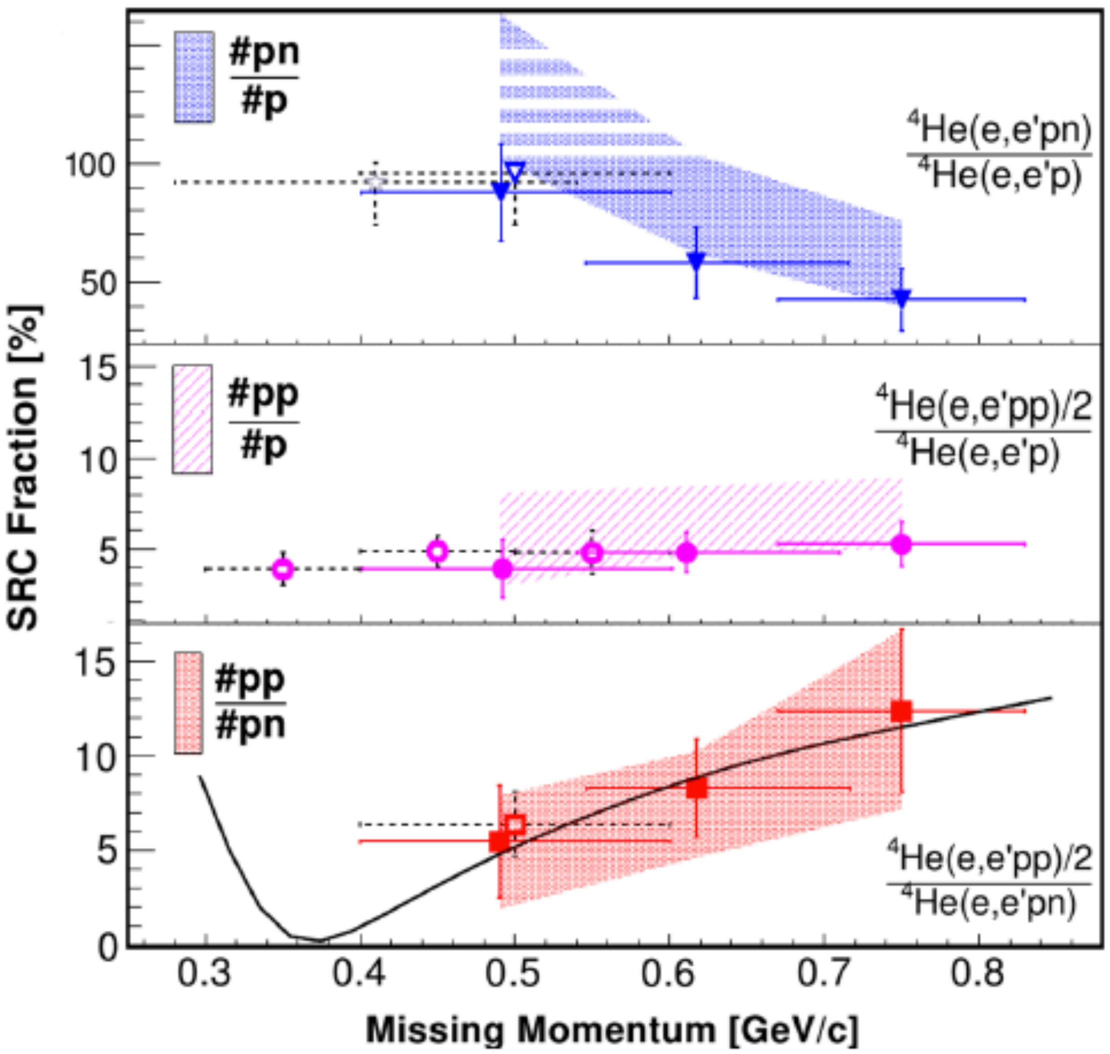
CLAS Nuclear Physics Working Group Meeting

Axel Schmidt

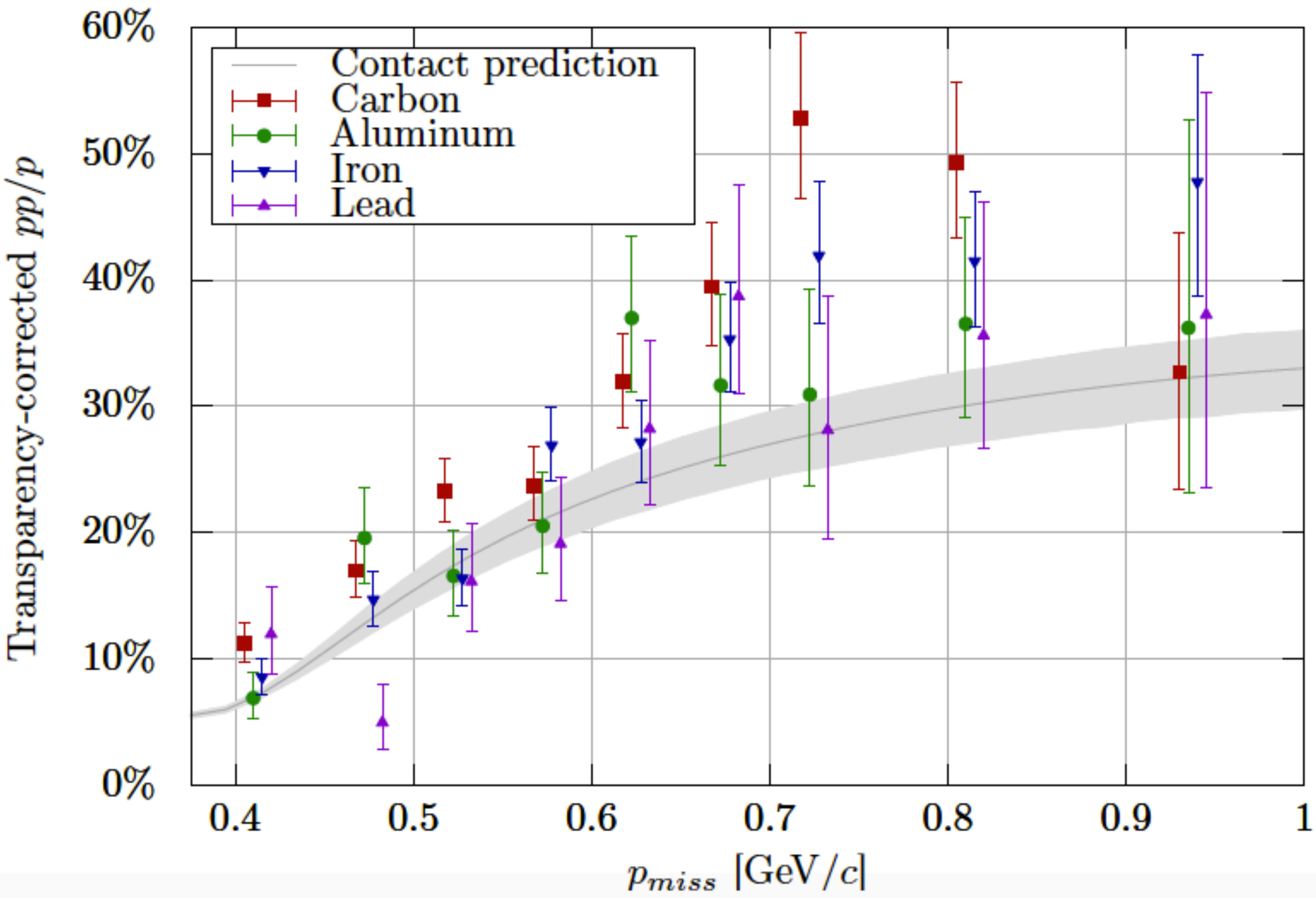
MIT

July 12, 2018

How does *np*-dominance evolve with momentum?



Transparency corrected pp/p



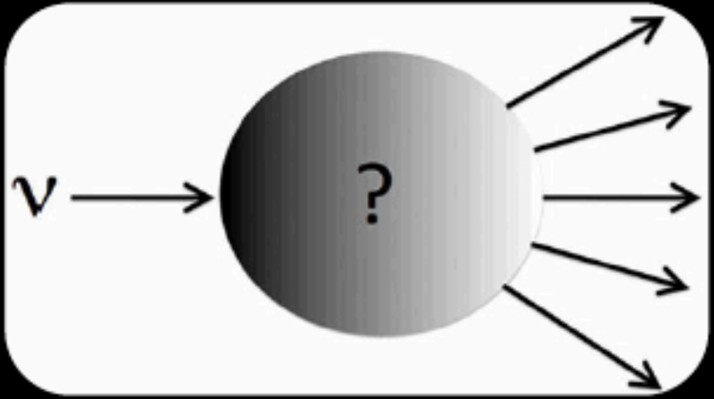
Jefferson Lab
Thomas Jefferson National Accelerator Facility

MIT · OLD DOMINION UNIVERSITY · MICHIGAN STATE UNIVERSITY · TEL AVIV UNIVERSITY

Electrons for Neutrinos: Addressing Critical Neutrino-Nucleus Issue

Proposal C12-17-006

Spokespersons:
O. Hen (MIT), K. Mahn (MSU),
E. Piasetzky (TAU), S. Stepanyan (JLab)
and L.B. Weinstein (ODU).

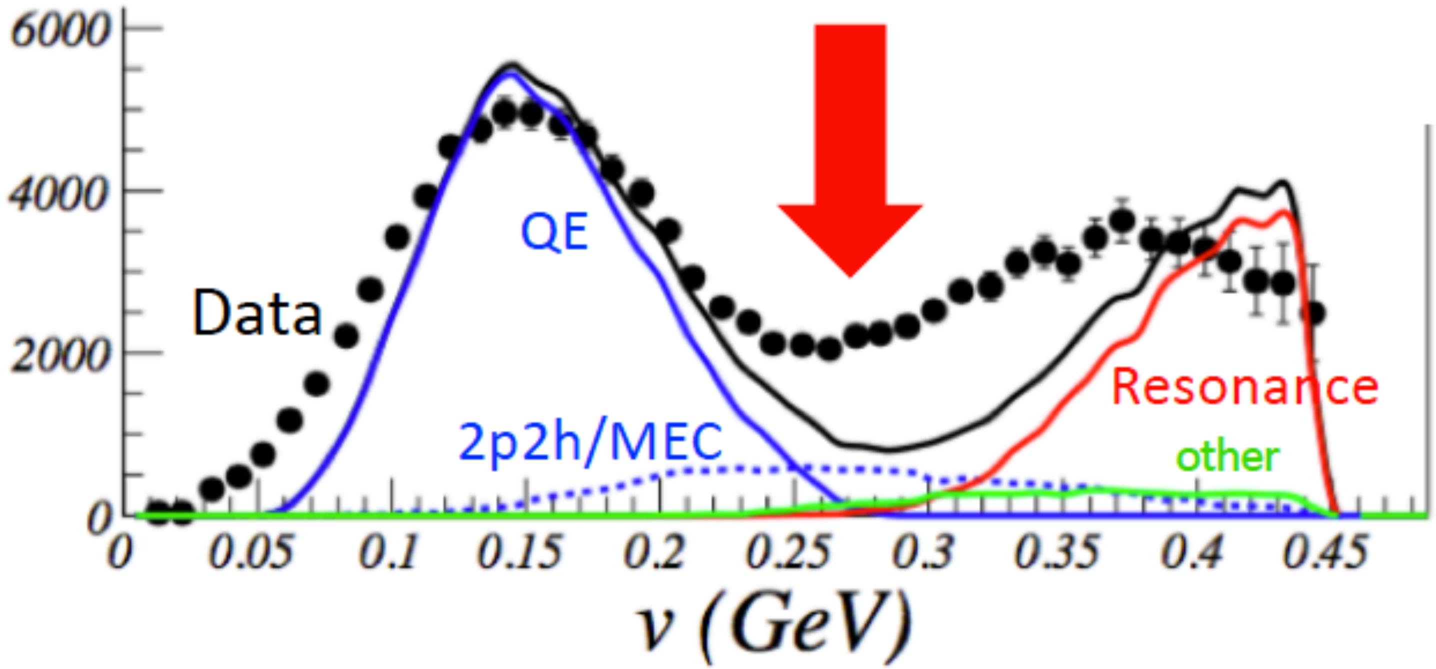


Jefferson Lab PAC-46, July 17th, 2018

Example I: 2p2h Effects

2p2h is a phenomenological model intended to include Meson Exchange Currents, short range correlations, pion production and reabsorption, and any other process (except rescattering) leading to two nucleons in the final state

C(e,e') 560 MeV $\theta = 60^o$



Still large issues with Genie, even in inclusive (e,e')

Beam Time Rationale

CLAS6

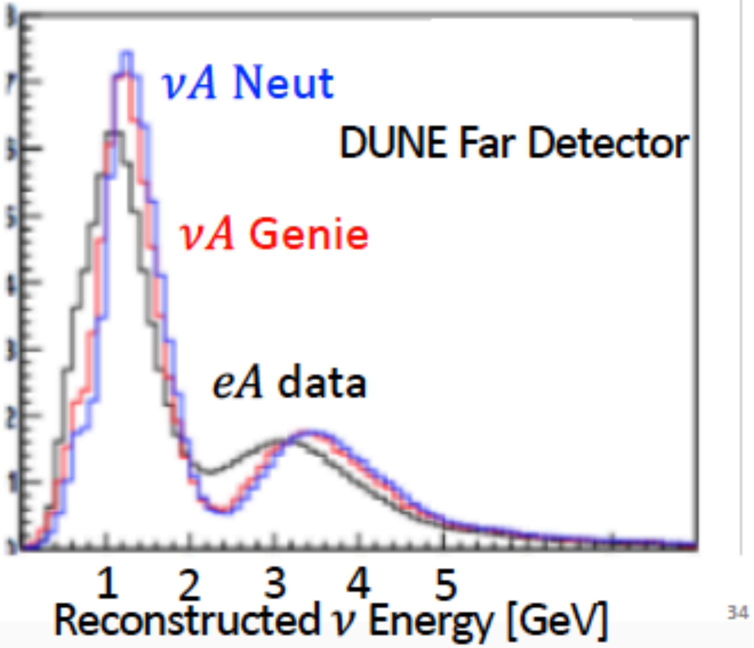
E_{rec}(%)	^{56}Fe 4.46 GeV	
	Fraction	Error
80—90	0.18	0.01
70—80	0.16	0.01
60—70	0.08	0.01
50—60	0.01	0.01

$p_\perp > 0.2$ GeV/c

4—6% error per 10% bin in reconstructed energy

Error feeds directly into energy reconstruction plot and oscillation parameters

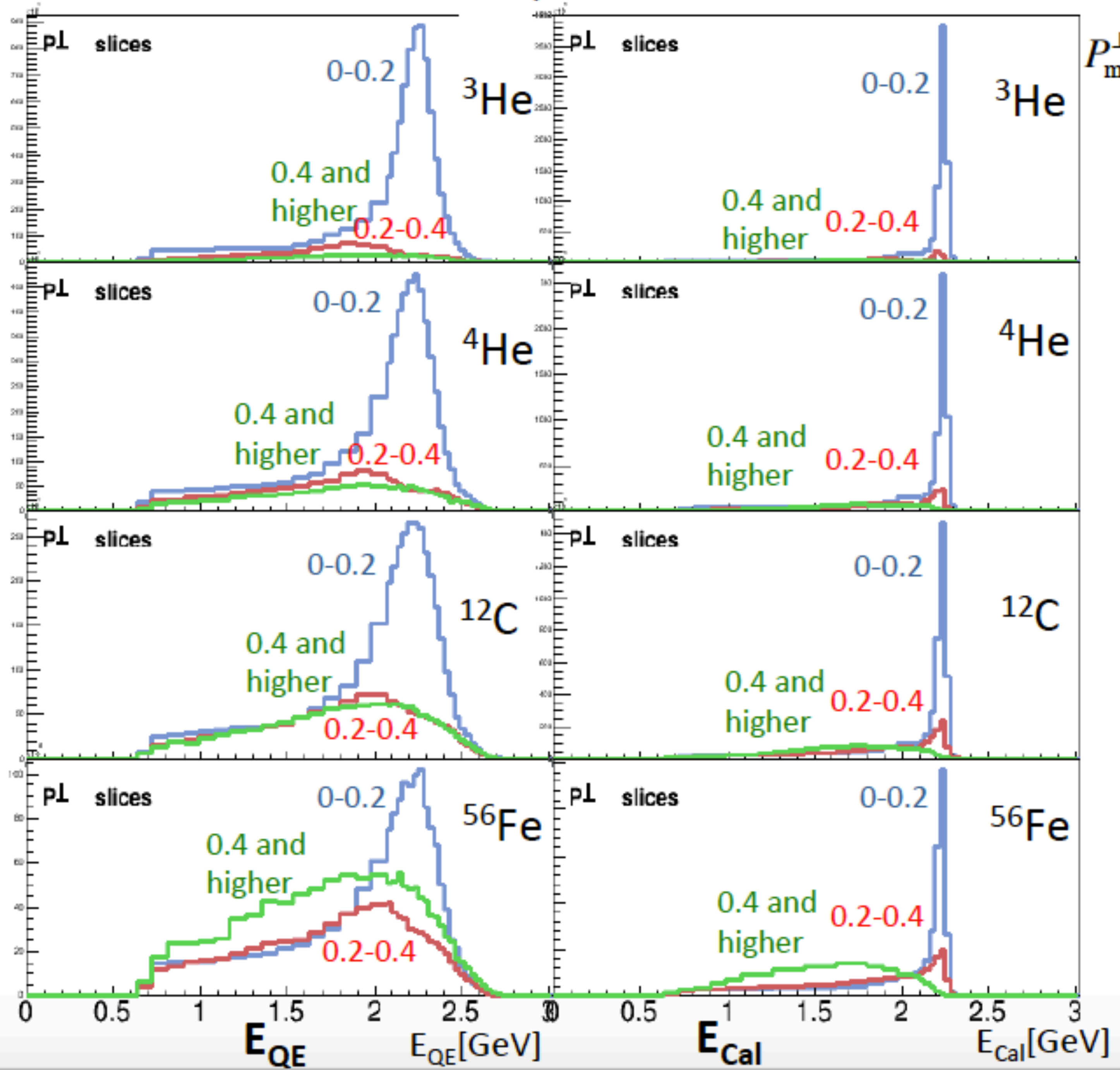
Ten times more statistics
→1.5% error per 10% E bin
<or>
→5% error per 3% E bin



Validation of neutrino energy estimation using electron scattering data

Student
Mariana Khachatryan
Supervisor
Lawrence Weinstein

E_{Cal} and E_{QE} for all targets at 2.261 GeV in $P_{\rm miss}^{\perp}$ slices

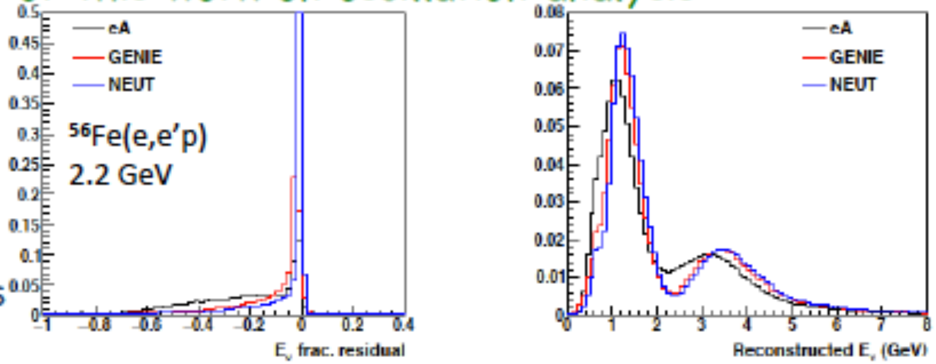


$$P_{\rm miss}^{\perp} = P_{e^-}^{\perp} + P_{p}^{\perp} = P_{\rm init}^{\perp}$$

1. Worse peak resolution for E_{QE}
2. $E_{Reconstructed}$ worse for heavier targets
3. Large $P_{\rm miss}^{\perp}$->bad reconstruction

Summary

1. The first use of electron data to test neutrino energy reconstruction algorithms
   - select zero-pion events to enhance quasi-elastic signal
     - Subtract for undetected few protons
     - Subtract for undetected 1 pion events
   - just using scattered lepton (E_{QE})
     - used in Cherenkov-type neutrino detectors
   - total energy of electron plus proton (E_{Cal})
     - used in calorimetric neutrino detectors
2. Only 0.1-0.56 of events reconstruct to within 5% of the beam energy
   - better for lighter nuclei
   - improved by a transverse momentum cut
3. First preliminary attempt to quantify the impact of this work on oscillation analysis presented by L. Weinstein (previous talk).
4. Comparison to models to be presented by Afroditi (next talk).
5. Work to be done before submitting the analysis note
   - Need to subtract for undetected few pion events
   - Finalize error calculations
6. Work in progress
   - extend analysis to other types of events
   - more targets and energies
   - Proposal "Electrons for Neutrinos" conditionally approve by PAC 45.



Fractional Energy feed down spectra

Chris Marshal (LBL)

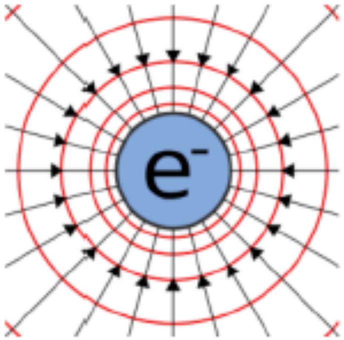
Afroditi Papadopoulou (MIT@FNAL)

Adi Ashkenazi (MIT@FNAL)

Electrons for Neutrinos Simulation

Hen Lab

Laboratory for Nuclear Science @ MIT



Afroditi Papadopoulou

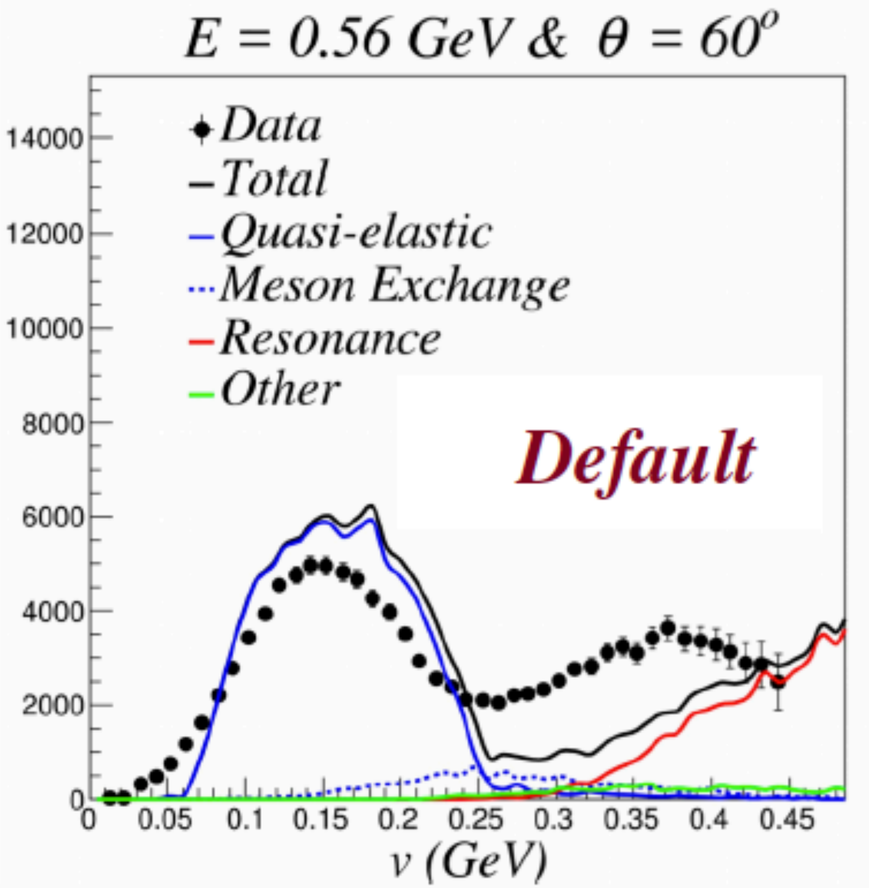
CLAS Summer Collaboration Meeting

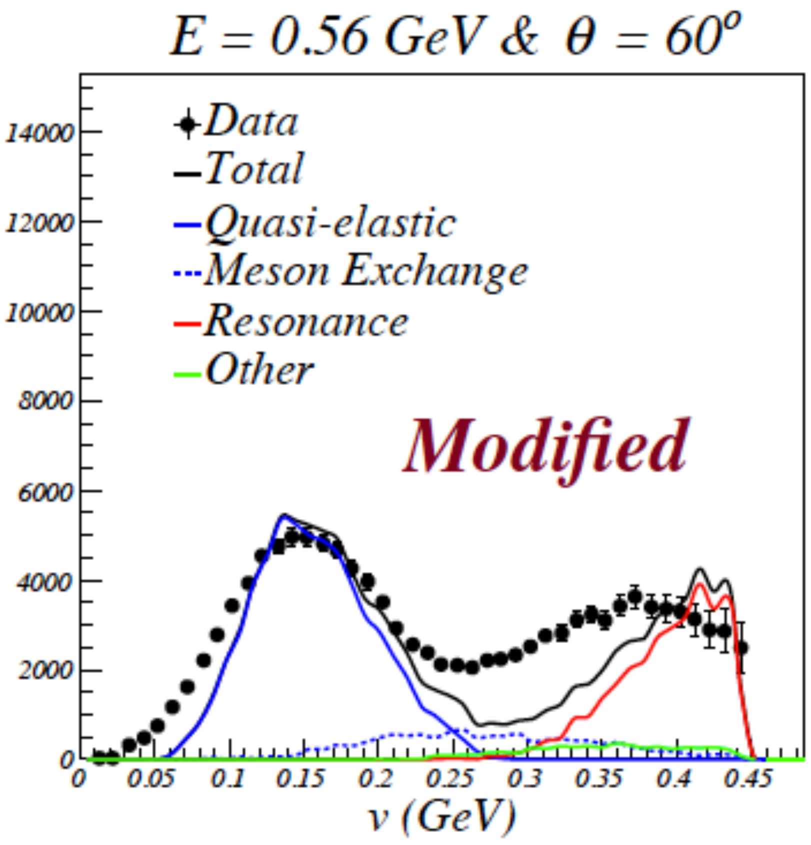
July 12, 2018

Future Plans

GENIE Event Generator Development

Standard Candle → Inclusive Analysis On ^{12}C





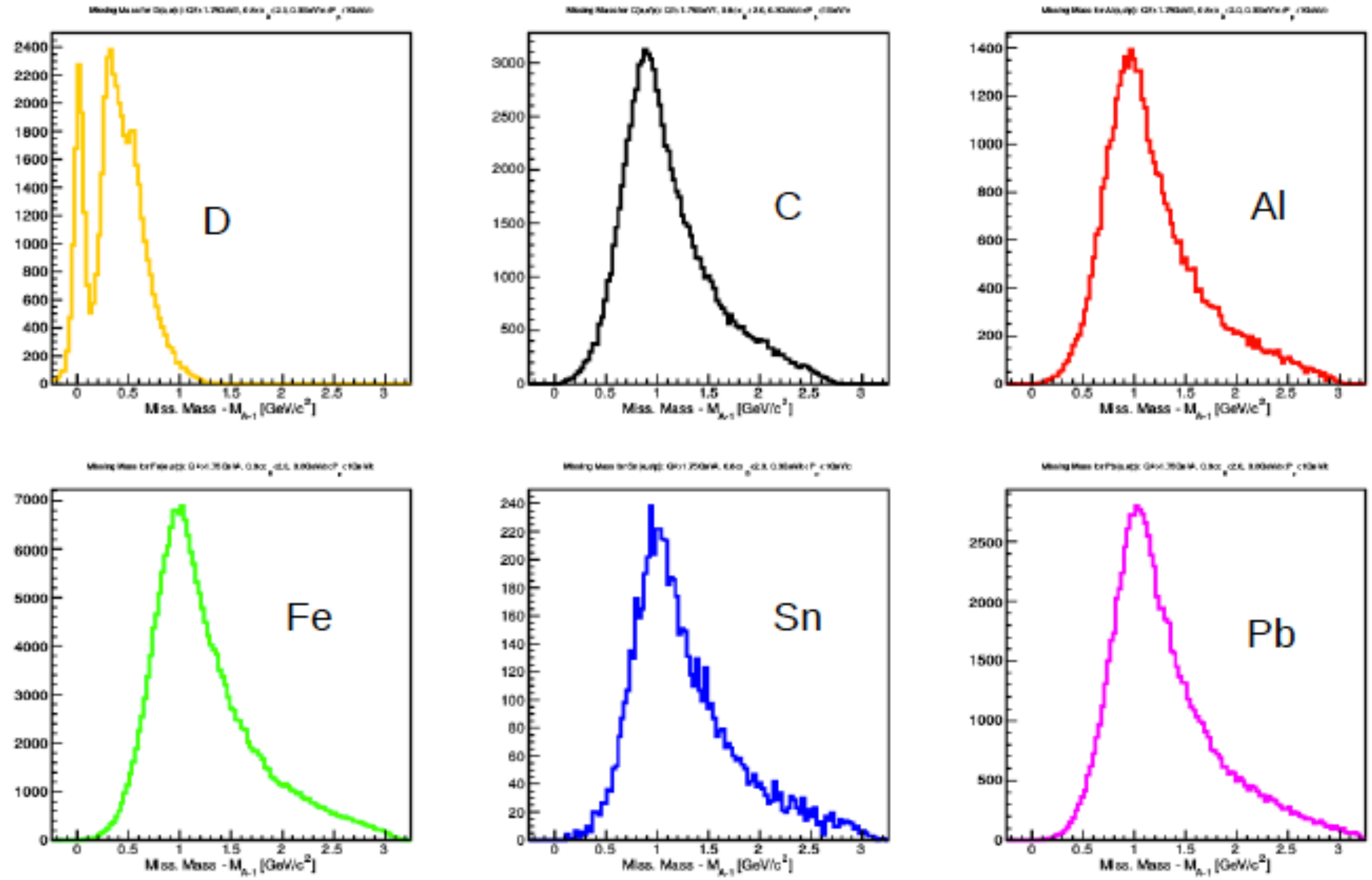
Analysis of $(e,e'p_{Recoil})$ Reactions from ^{2}D, ^{12}C, ^{27}Al, ^{56}Fe, and ^{208}Pb using the EG2c Dataset

Barak Schmookler

Selecting (e,e'p$_{Recoil}$) Events

- In QE D(e,e'p) events, the missing mass reconstructs to the neutron mass. This is true whether the detected proton is the struck or the spectator nucleon. (See section 3.3.2 of my inclusive analysis note.)
- For these QE events with low proton momentum, we compare the proton momentum vector to the q-vector.
- From here, we determine a consistent set of cuts to apply to all targets.

Missing Mass: (e,e'p) Events, $Q^2>1.75$ GeV^2, $0.8<x_B<2.0$, $|\mathbf{P}_p|<1GeV/c$



But Does it Matter?

- We need to compare the deuterium spectrum for our recoil events to plane-wave cross-sections with and without the missing mass cut.
- We need to include radiative effects (and there is a jacobian for going from cross-sections to yield).
- We can use the Hall A/C code *SIMC* to do all this. In progress...

Status update of analysis note on "Hadronization studies via pi0 electroproduction"

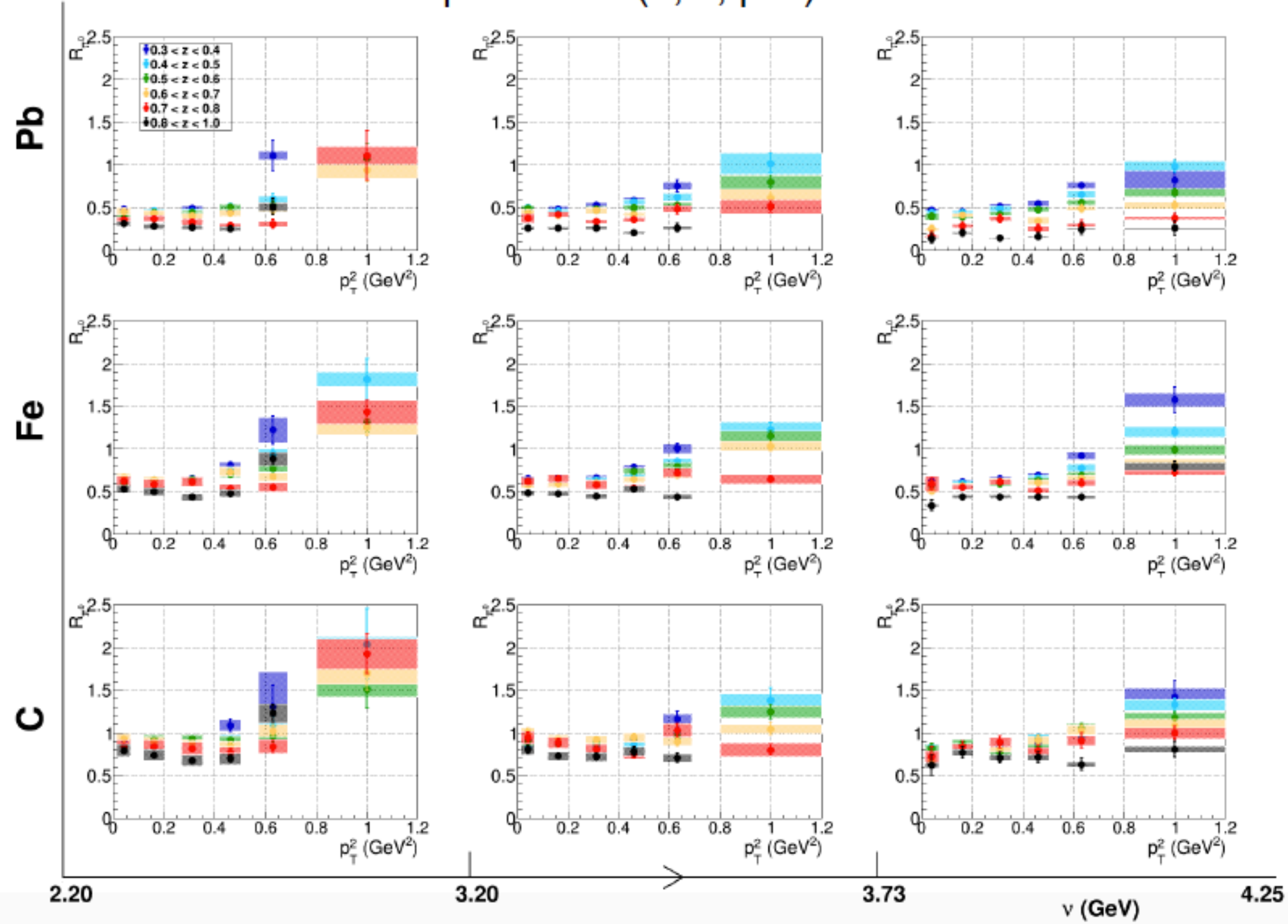
Taisiya Mineeva

Universidad Técnica Federico Santa María

CLAS collaboration meeting July 12th, 2018

FONDECYT
Fondo Nacional de Desarrollo
Científico y Tecnológico

Multiplicities in (ν, z, pT²) bins



Data corrected for Acc, and RC effects on e. No SIDIS pi0 RC corrections here (few %)

Total erros in (v, z, pT2) bins

Systematic uncertainty	$\Delta^{C}_{RMS}(\%)$	Δ^{Fe}_{RMS} (%)	Δ^{Pb}_{RMS} (%)
Normalization type			
Target vertex cut	0.5	0.5	0.5
Target leakage	0.9	0.9	0.9
Sampling fraction cut	0.4	0.4	0.4
Photon energy cutoff	2.1	2.1	2.2
EC time (beta) cut	0.6	0.6	0.6
DC fiducial cuts	1.3	1.3	1.3
Electron radiative corrections	3.3	3.3	3.3
SIDIS radiative corrections	1.5	1.5	1.5
Total normalization	4.6	4.6	4.6
Bin-by-bin basis			
Background shape	0.6	0.5	0.8
Signal shape	2.1	2.1	4.5
Acceptance in finite bin width	2.8	2.8	2.8
Average Systematics (ν, z, p_T^2)	6.4	6.6	7.2
Average Statistics (ν, z, p_T^2)	6.0	4.7	9.4
Total Error (ν, z, p_T^2)	8.7	8.1	11.8