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Argonne NATIONAL LABORATORY

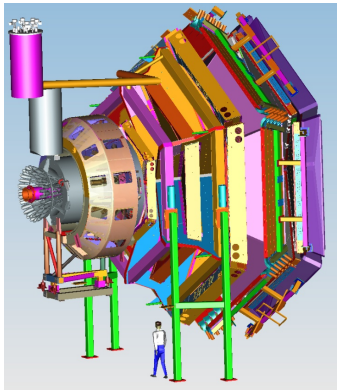
NUCLEAR PHYSICS WORKING GROUP

STATUS REPORT

CLAS COLLABORATION MEETING

KAWTAR HAFIDI

Friday February 26, 2016
Jefferson Lab, Newport News, VA



AGENDA

13:30 **NPWG status update** *10'*
Speaker: Dr. Kawtar Hafidi (Argonne National Laboratory)

13:40 **Tagged EMC and nuclear DVCS proposal** *25'*
Speaker: Raphael Dupre (IPN Orsay)
Material: **Slides**

14:05 **Update on DVCS off He4 analysis** *25'*
Speaker: Dr. Mohammad Hattawy (Argonne National Laboratory)
Material: **Slides**

14:30 **Update on the simulation for ALERT** *25'*
Speaker: Whitney Armstrong (Argonne National Laboratory)
Material: **Slides**

14:55 **Phi electroproduction off He4** *25'*
Speaker: Michael Paolone (Temple University)

15:20 **Coffee Break** *20'*

15:40 **Acceptance corrections for (e,e'pp) measurements and extraction of pp-SRC pairs c.m. motion and (e,e'pp)/(e,e'p) cross-section ratios** *25'*
Speaker: Or Hen (MIT)
Material: **Slides**

16:05 **Nucleon momentum distributions in He-3 using Large Angle Calorimeter** *25'*
Speaker: Mariana Khachatryan (ODU)
Material: **Slides**

16:30 **Study of A(e,e'n) reaction** *20'*
Speaker: Meytal Duer (Tel Aviv University)
Material: **Slides**

16:50 **Study of 2N-SRC via the A(e,e'np) reaction** *20'*
Speaker: Meytal Duer (Tel Aviv University)

17:10 **Status of g10a gd->pi-pp analysis** *25'*
Speaker: Nikolai Pivnyuk (ITEP)
Material: **Slides**

Deeply Virtual Compton Scattering off ^{4}He:

Update on the analysis

M. Hattawy

- Nuclear Physics Working Group -

CLAS Collaboration Meeting (23-26 February 2016)

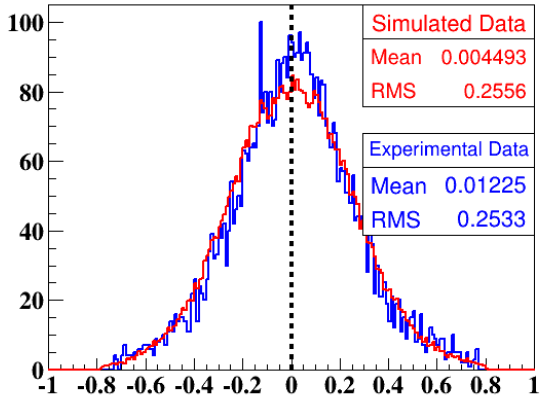
Coherent DVCS channel

◊ Only one e^-, at least 1γ and only one good ^{4}He.

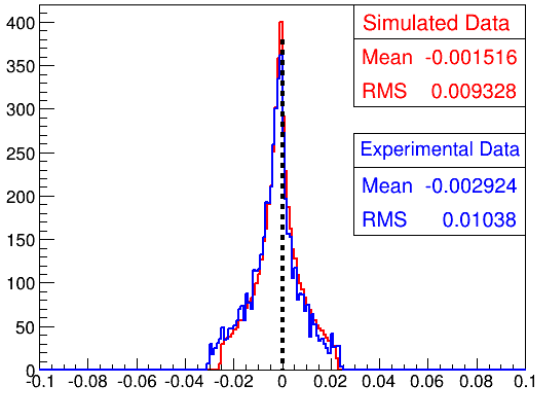
◊ Eγ > 2 GeV, W > 2 GeV/c^2 and Q^2 > 1 GeV².

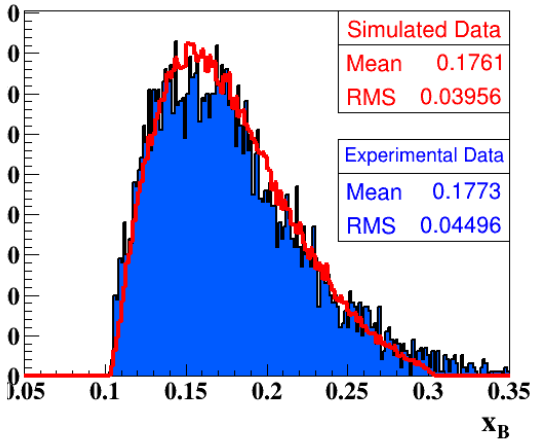
◊ Exclusivity cuts (3 sigmas).

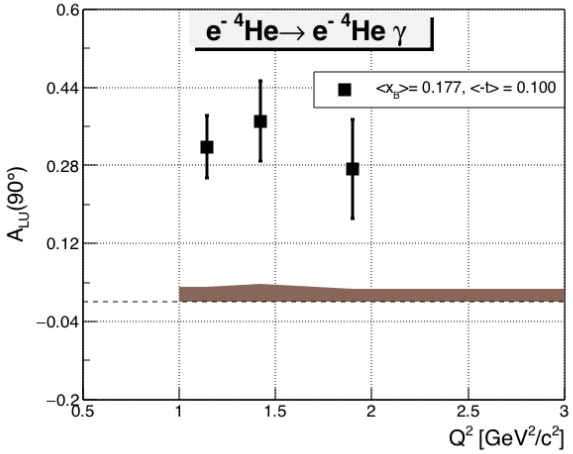
e^4He γ: Missing E [GeV]

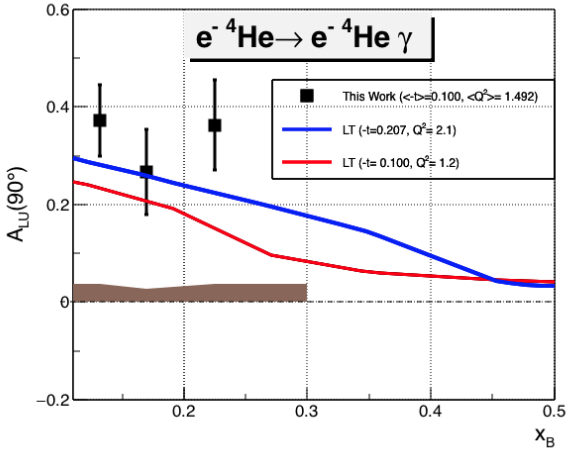


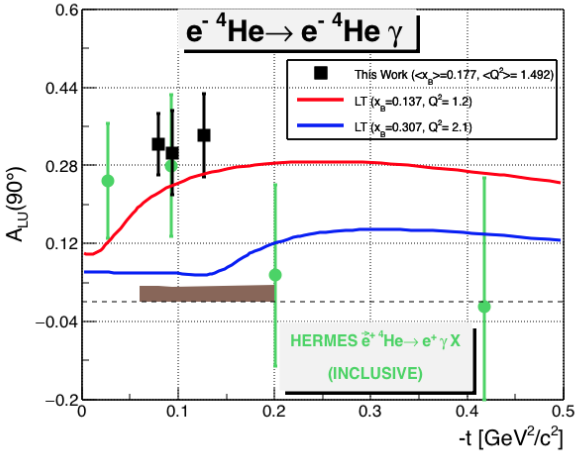
e^4Heγ: Missing M^2 [GeV^2/c^4]











LT: S. Liuti and S. K. Taneja, PRC 72 (2005) 034902.

HERMES: A. Airapetian, et al., Phys. Rev. C 81, 035202 (2010).

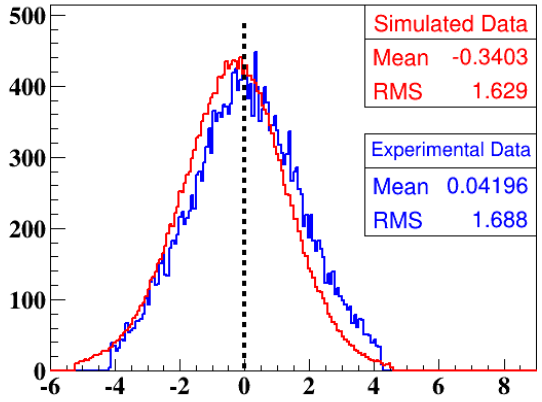
Incoherent DVCS channel

◊ Only one e^-, at least 1γ and only one good p.

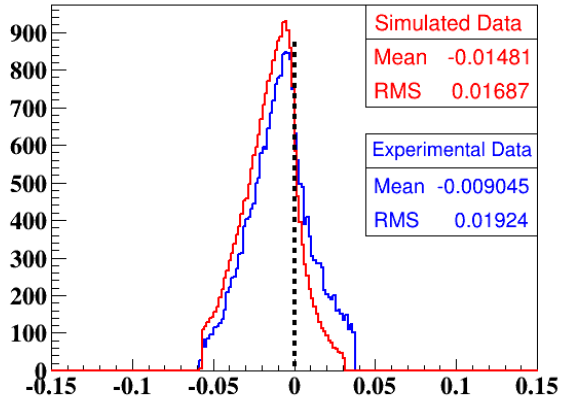
◊ Eγ > 2 GeV, W > 2 GeV/c^2 and Q^2 > 1 GeV².

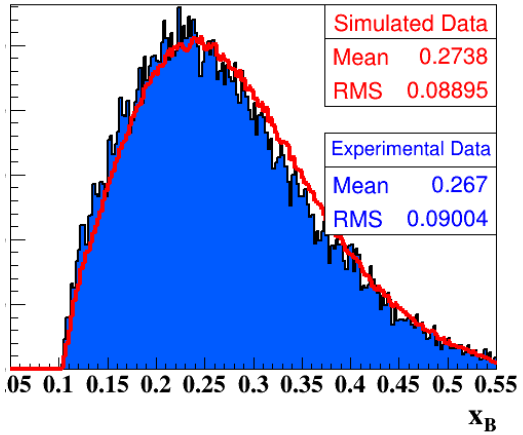
◊ Exclusivity cuts (3 sigmas).

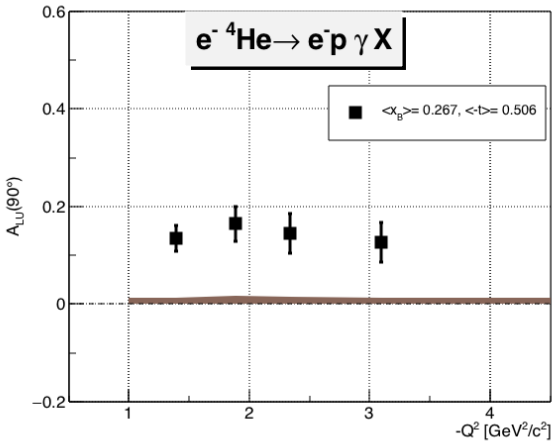
(γ ,γ*):(γ*,p) :: Δ ϕ [Deg.]

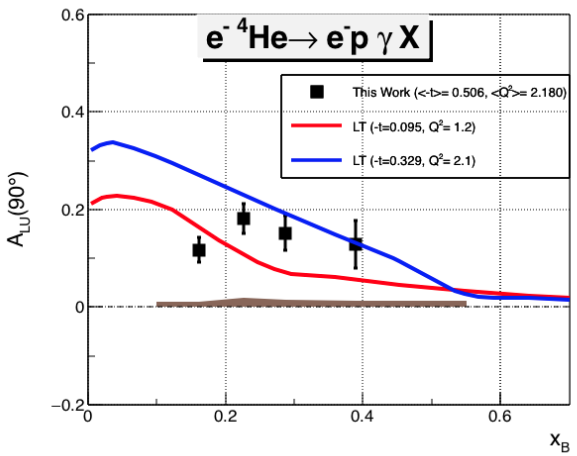


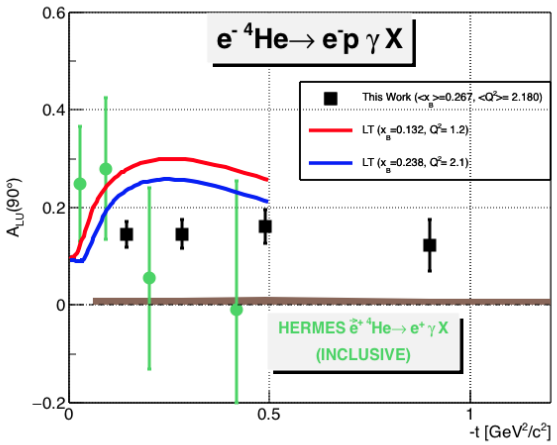
e'pγ: Missing M^2 [GeV/c]









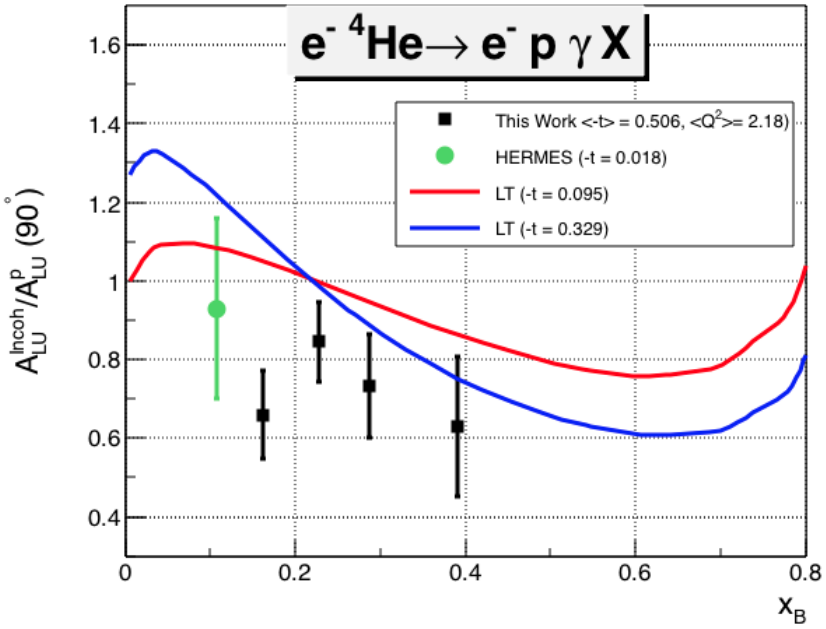


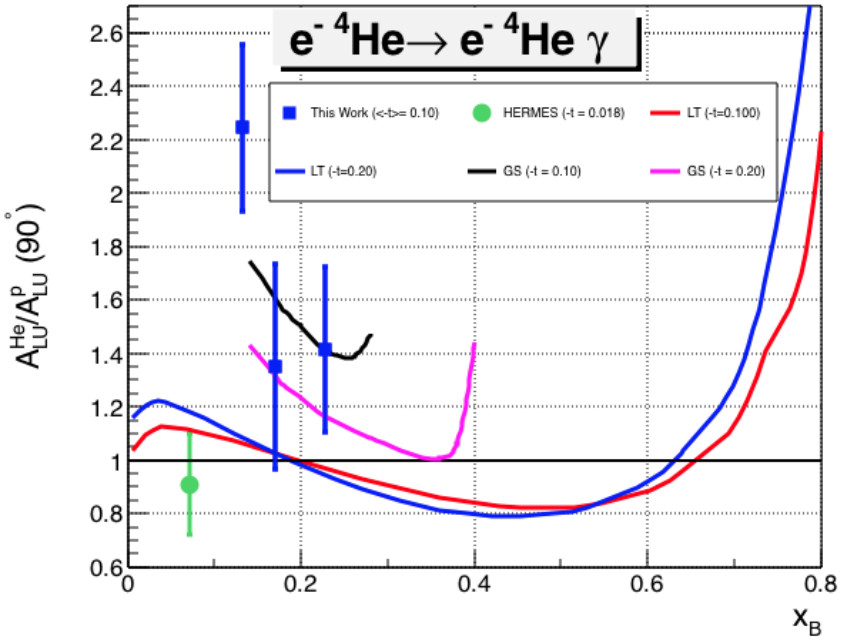
[1] LT: S. Liuti and S. K. Taneja.Phys. Rev., C72:032201, 2005.

[2] A. Airapetian, et al., Phys Rev. C 81, 035202 (2010).

EMC ratios

◊ Comparing our measured coherent and incoherent asymmetries with the asymmetries measured in CLAS DVCS experiment on the proton.





◊ The bound proton shows a lower asymmetry relative to the free one in the different bins in x_B.

◊ Consistent with the enhancement predicted by the Impulse approximation model [V. Guezy et al., PRC 78 (2008) 025211]

◊ Additional nuclear effects have to be taken into account in the nuclear spectral function calculations. [S. Liuti and K. Taneja. PRC 72 (2005) 032201]

ALERT Proposals:

Tagged EMC
Nuclear DVCS
(Φ production)
(others)

Raphaël Dupré

On behalf of the ALERT group

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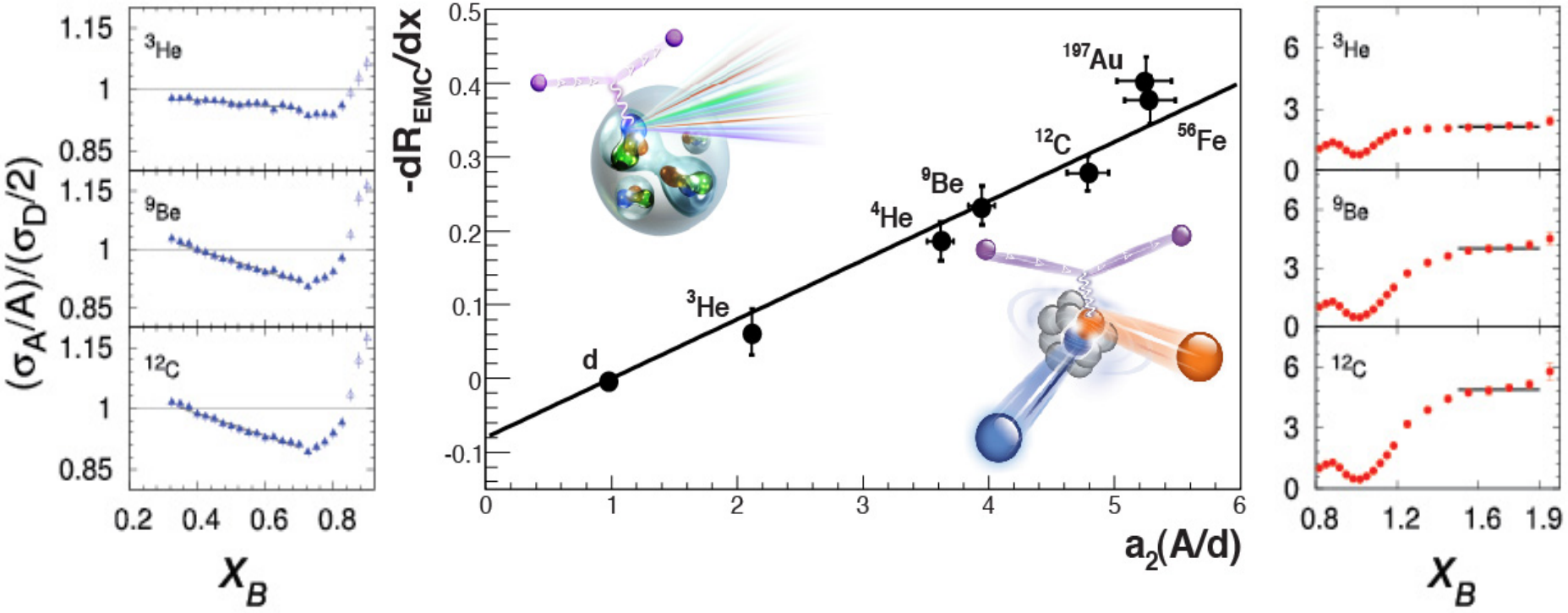
EMC - SHORT RANGE CORRELATION CONNECTION

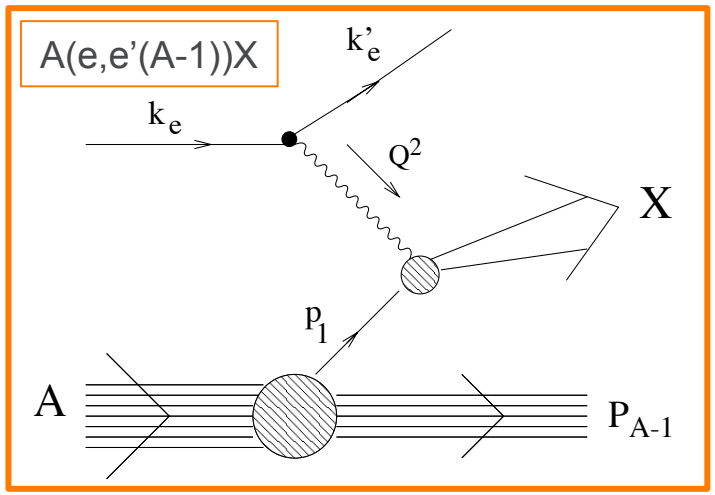
L. Weinstein et al. PRL 2011



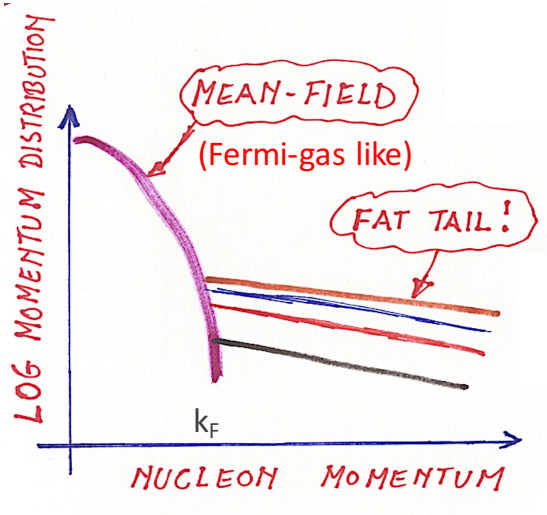
- The data show that EMC effect slopes are proportional to the SRC plateaus
- EMC effect and SRCs might be both a consequence of the **local QCD effects** within the nucleus

DO NUCLEONS WITH DIFFERENT BINDING ENERGIES CONTRIBUTE DIFFERENTLY TO THE EMC EFFECT?

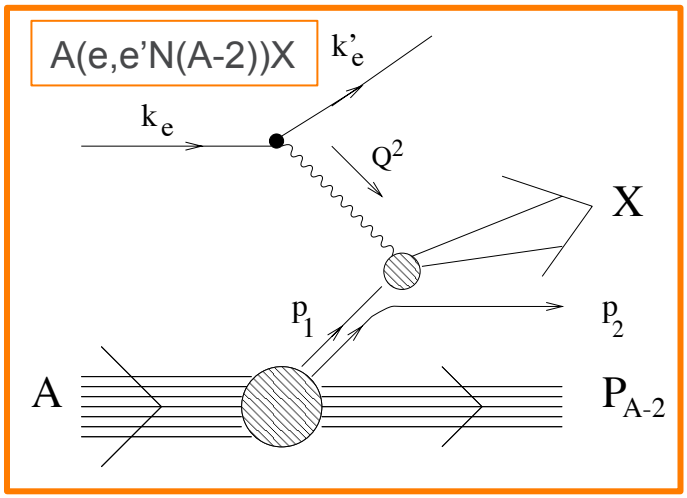
DIS on weakly bound nucleons



- DIS on low momentum nucleon
- Detect scattered electron and low momentum, low excitation energy (A-1) nucleus

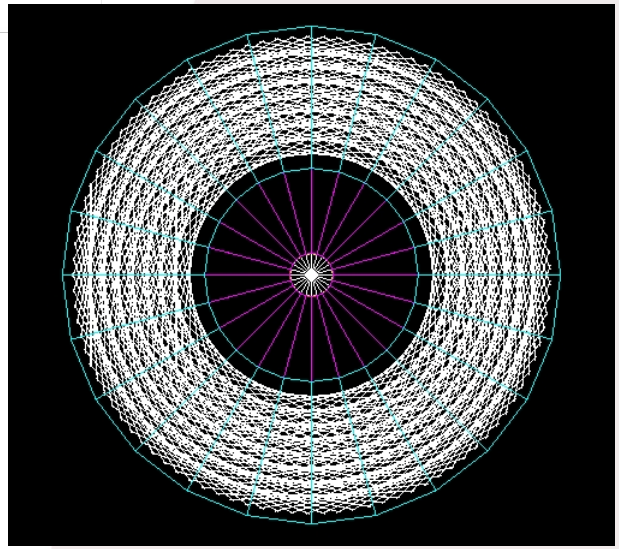


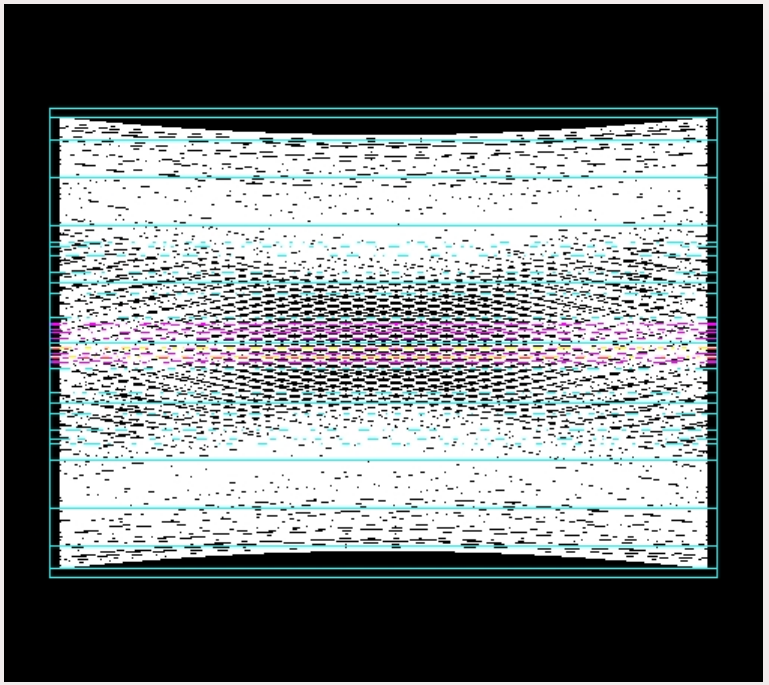
DIS on deeply bound nucleons



- DIS on high momentum nucleon
- Detect scattered electron, the high momentum nucleon from the pair and low momentum, low excitation energy (A-2) nucleus

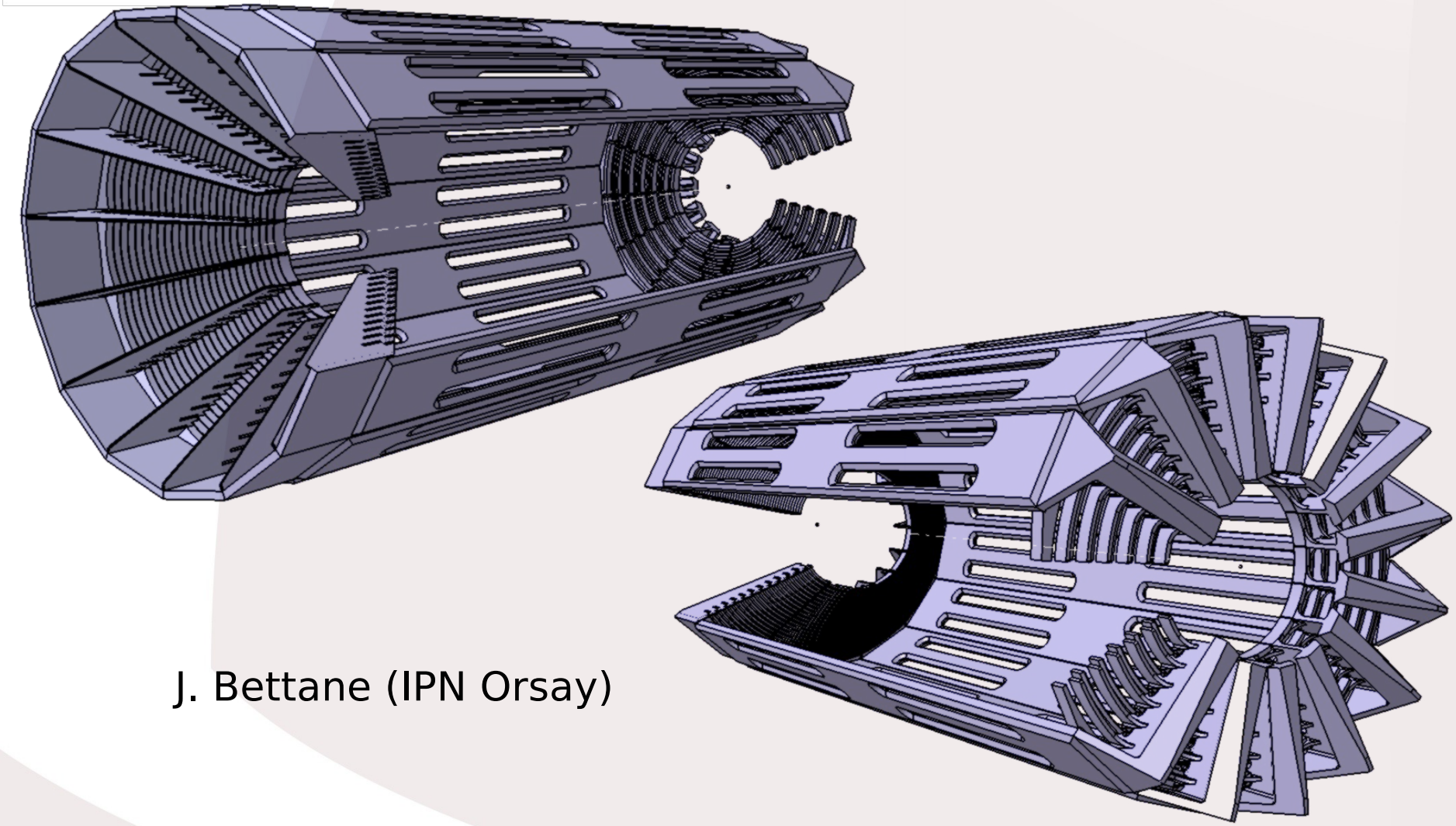
ALERT Detector





- **ALERT Detector**
  - Hyperbolic drift chamber
  - Scintillators for TOF and total energy measurement
- **GEANT 4 simulation**
  - To define the characteristics of the chamber
    (See Whitney's talk for recent progresses)
- **Still to be done**
  - TOF system geometry to be finalized
  - Electronics options to be evaluated
  - Mechanical integration on going

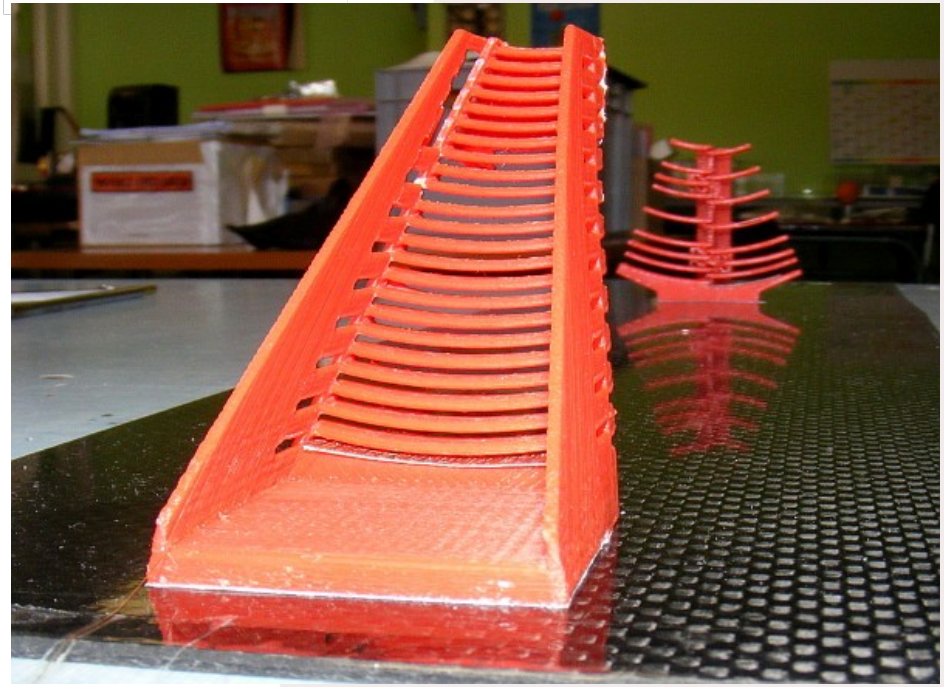
Design and Prototyping

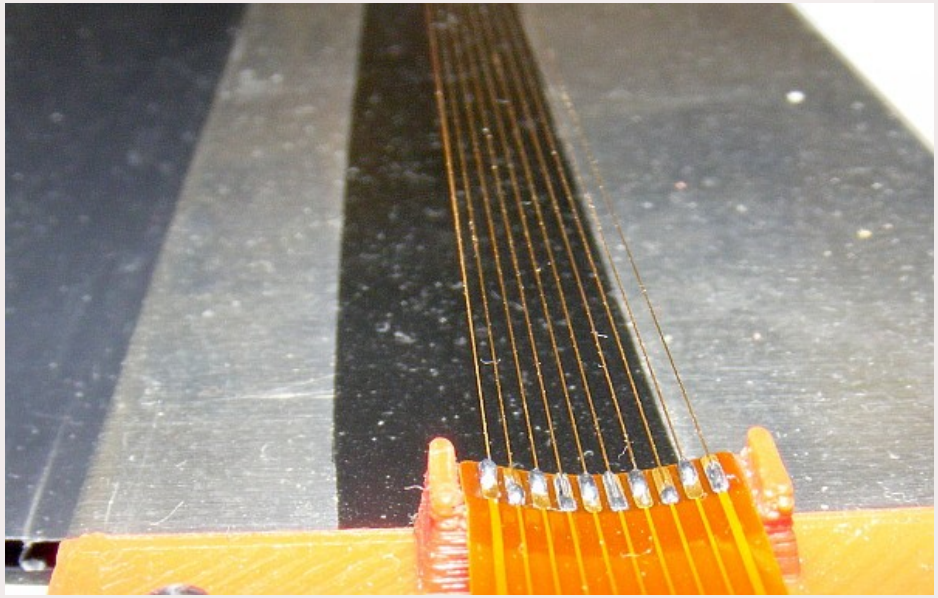


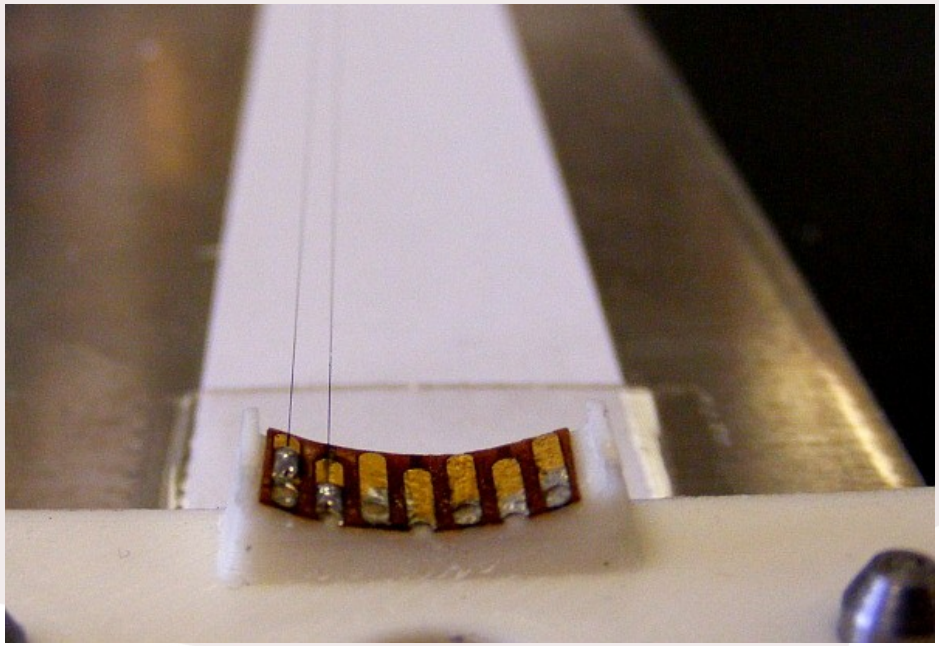
J. Bettane (IPN Orsay)

First prototype is designed and being ordered

Orsay Tests







Progress in Orsay:

- 3D printed tests
- Soldering wires on curved surface
- Gluing and soldering carbon wires

Summary

- **We will explore the dynamic properties of the EMC effect with a large program**
  - Test models for of inclusive EMC
  - Explore EMC in 3D and in the gluon sector
- **Run group is forming**
  - Tagged EMC
  - Nuclear DVCS
  - Φ production
  - Neutron DVCS
  - Tagged Form Factors
  - Others? (https://clasweb.jlab.org/wiki/index.php/ALERT_Collaboration)
- **Beam time request to be refined**
  - Estimated to ~50 days

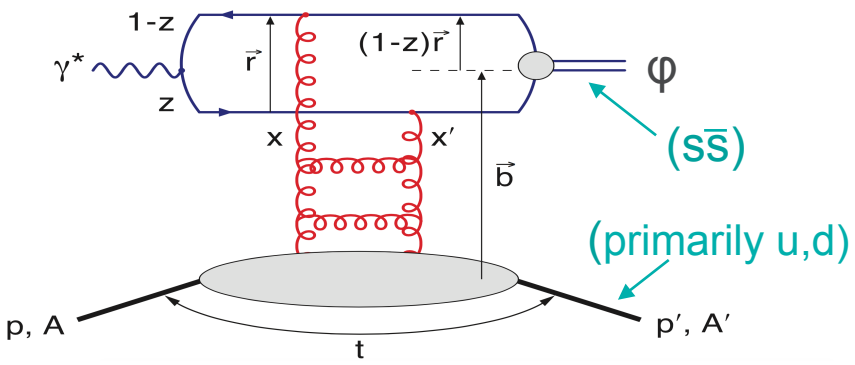
ELECTROPRODUCTION OF Φ MESONS OFF ^{4}HE

Michael Paolone
Temple University

CLAS Collaboration Meeting
February 25th 2016

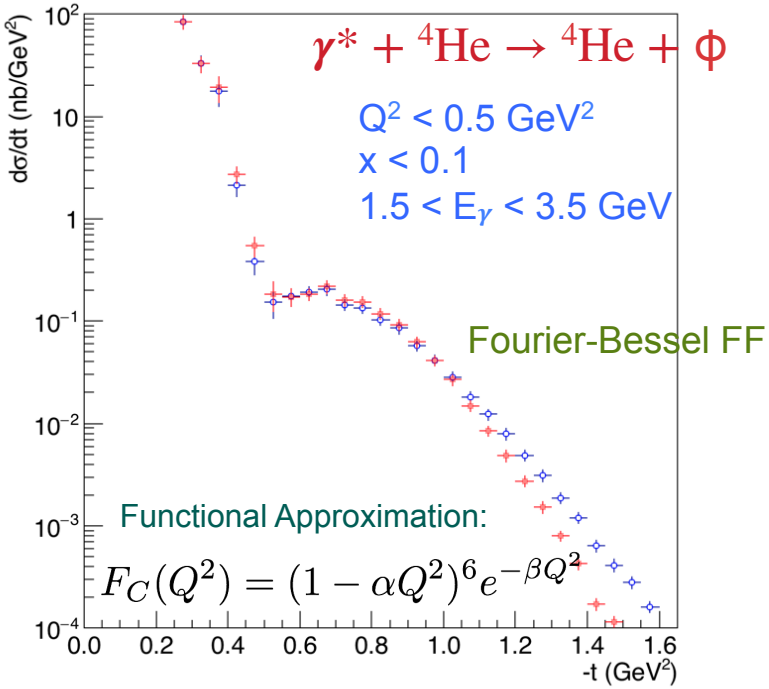
COHERENT ELECTROPRODUCTION OF Φ MESONS OFF ^{4}HE

- One can access gluon momentum distributions through coherent φ electroproduction.
- Coherent production off of nuclei can provide insight into gluon distributions in medium.
- Studies ongoing with CLAS6 experiment eg6.
- New experiment proposal being developed for CLAS12 and ALERT



Quark/meson exchange suppressed.
2+gluon exchange allows one to probe transverse gluon distributions of nucleons and nuclei

Nucl.Phys. B603 (2001) (arXiv:hep-ph/0102291)



Monte Carlo cross-section calculation

Update on the simulation for ALERT

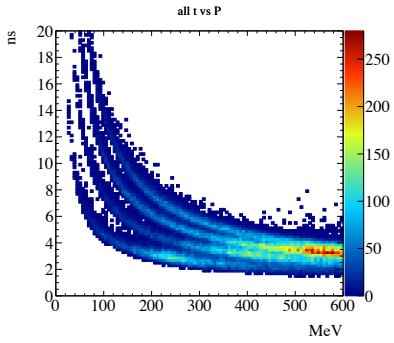
Whitney R. Armstrong

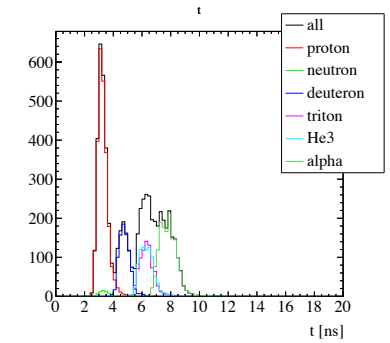
Argonne National Laboratory

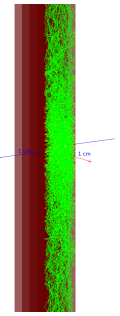
February 25, 2016

Various Scintillator Simulations

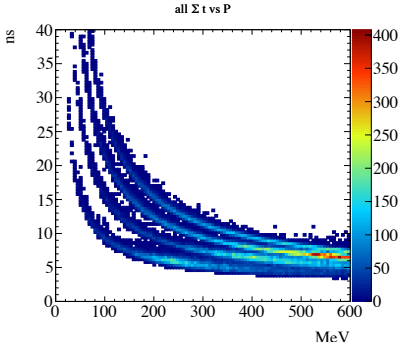
Bar 2×10×400 mm^3 single-end readout

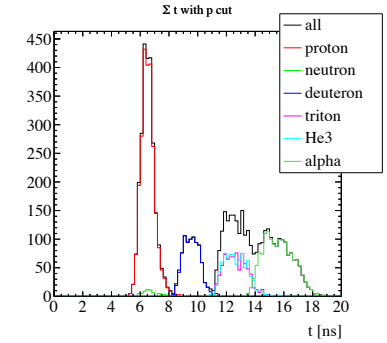


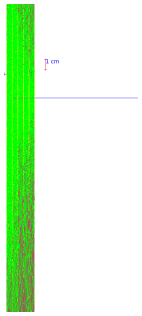




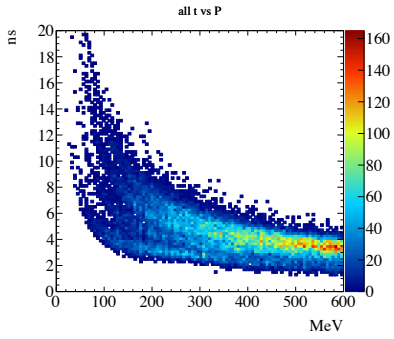
Bar 2×10×400 mm^3 dual-end readout

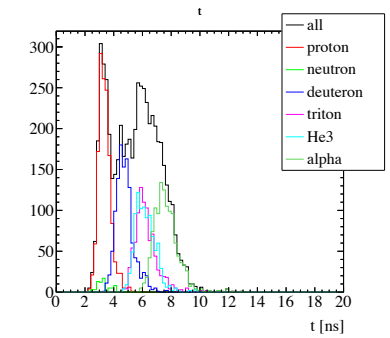


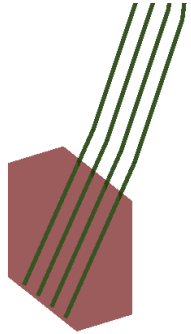




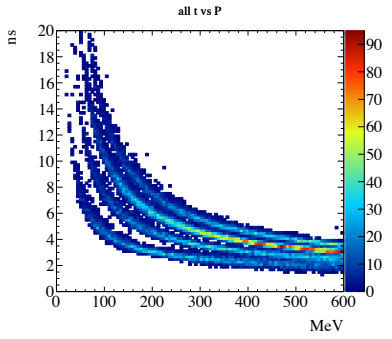
Tile: 30×30×15 mm^3 Sum readout at fiber ends

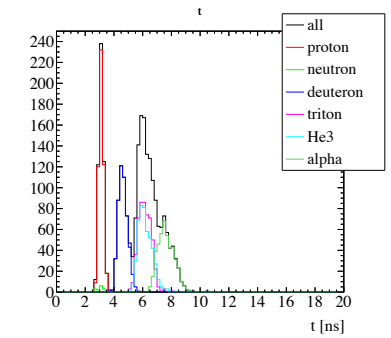


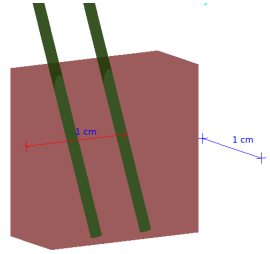




Tile: 15×15×7 mm^3 Sum readout at fiber ends

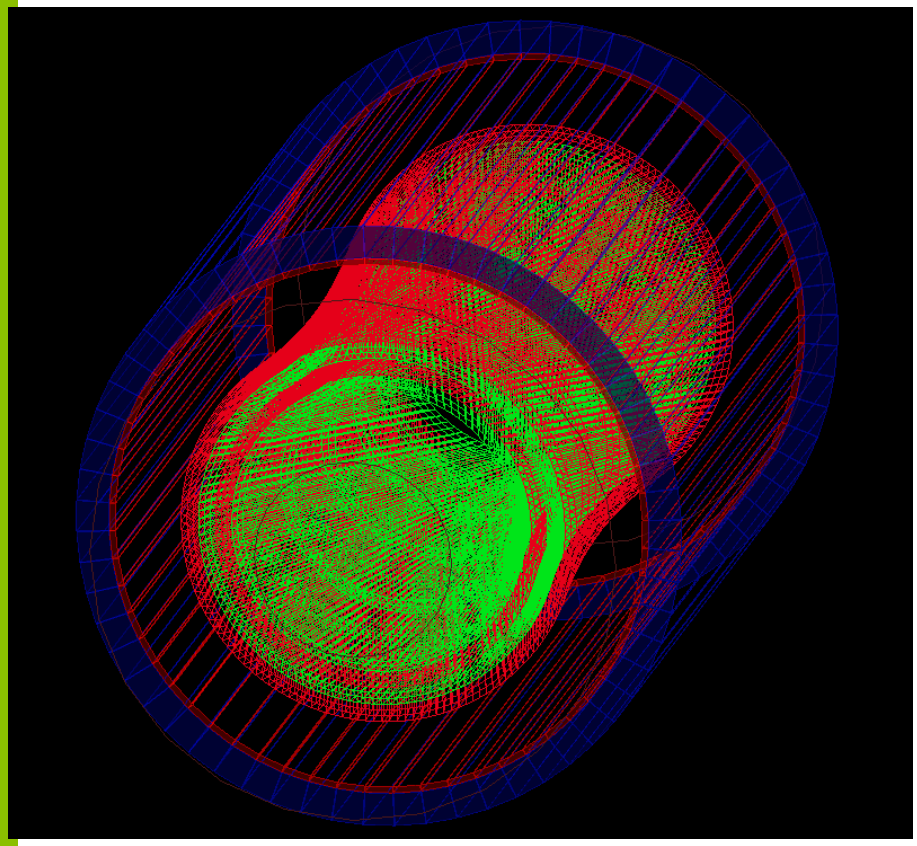






Dual ended readout or small tiles can work.

Preliminary Design

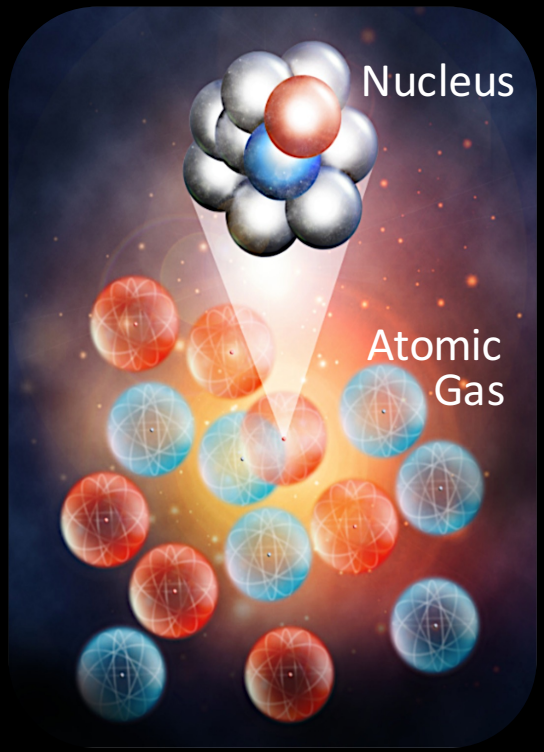


- Farm install documented: `https://clasweb.jlab.org/wiki/index.php/ALERT_Software`
- Everything is on gitlab
- Full Geant4 simulation for studying recoil detector completed
- Event generator available for producing realistic input

Future Work

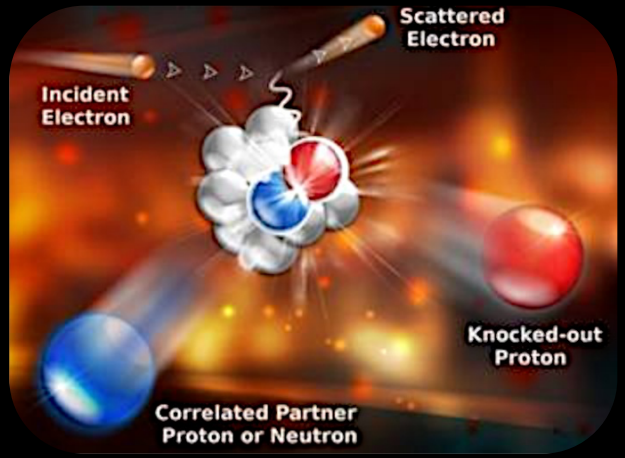
- Finish design of scintillator system
- Study different geometry/scintillator combinations
- Determine best way to detect photons: PMTs, SiPM, APDs, ...

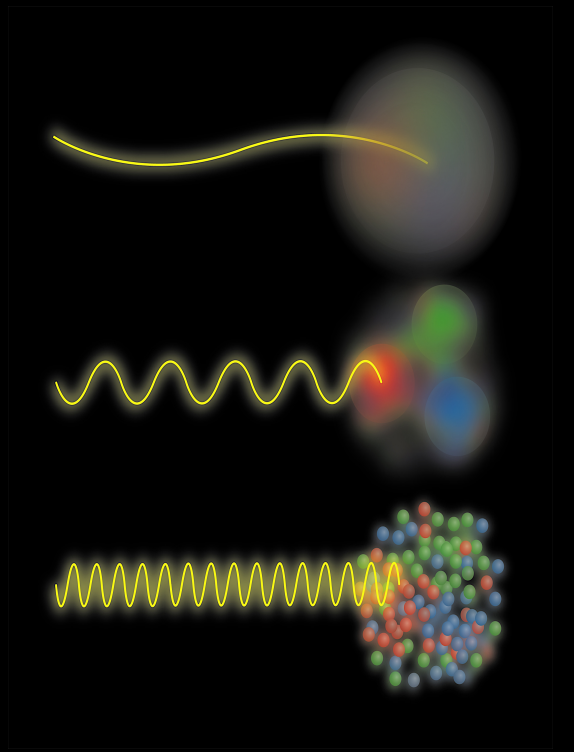
Acceptance Corrections for A(e,e'pp) Analysis



Or Hen

MIT

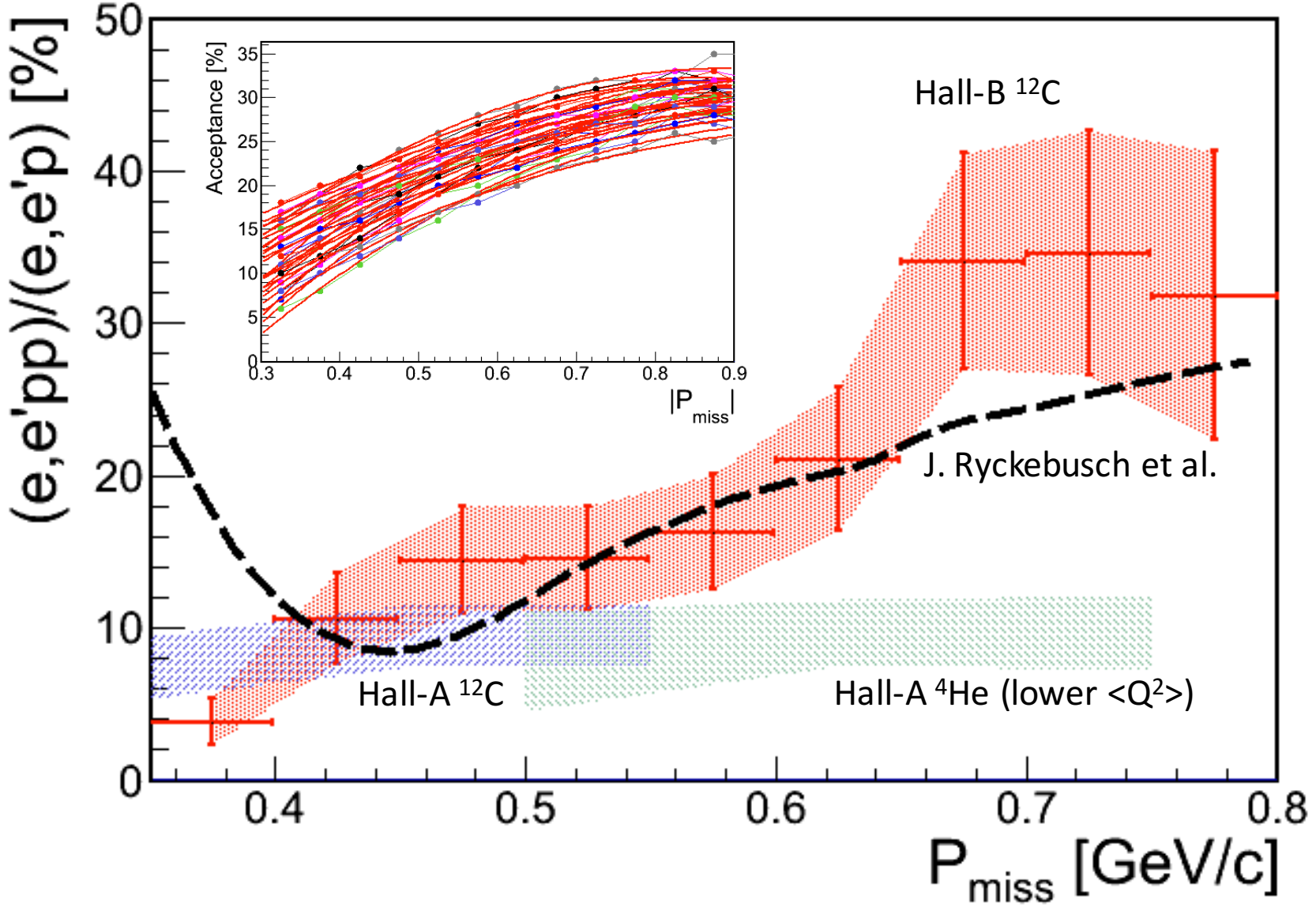




What Else? (e,e'pp)/(e,e'p)

- Previously published A(e,e'p)/^{12}C(e,e'p) and A(e,e'pp)/^{12}C(e,e'pp) cross-section ratios
- Still need to extract A(e,e'pp)/A(e,e'p) ratios, as a function of $|P_{miss}|$.
  - Relates to the fraction of pp-SRC pairs out of all high-momentum protons.
  - Expected to grow with $|P_{miss}|$, as we move from tensor dominated to the scalar (??) repulsive core.

Preliminary Results



OLD DOMINION UNIVERSITY
IDEA FUSION

Old Dominion University 2016

Comparing proton and neutron momentum distributions in ^{3}He using the Large Angle Calorimeter (LAC)

Student

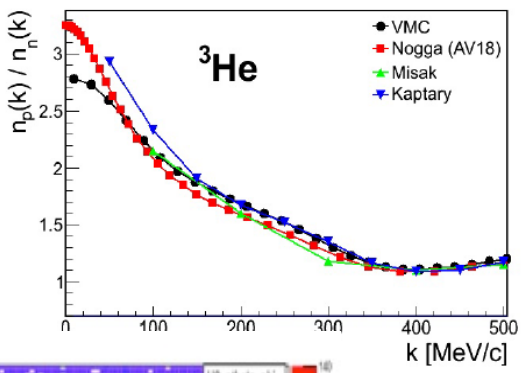
Mariana Khachatryan

Supervisor

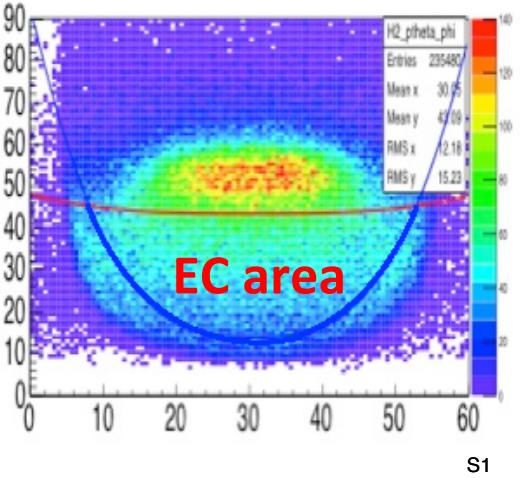
Lawrence Weinstein

Conclusions

- Want to measure $\frac{^3He(e,e'n)/^3He(e,e'p)}{^4He(e,e'n)/^4He(e,e'p)}$ using e2a and e2b

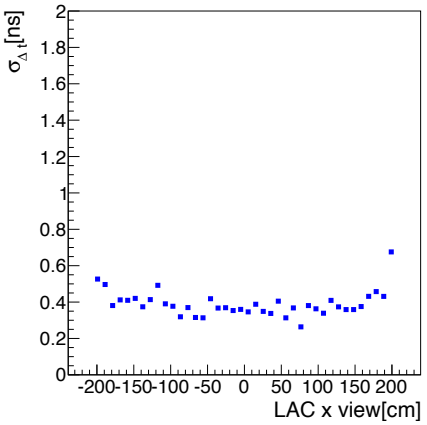


- Calibrated EC for e2b
  - Quasielastic neutrons at 2.2 and 4.7 Gev miss the EC



- Have studied LAC timing.
  - LAC timing is satisfying with calibration constants from e1c
  - Tof timing was poor calibrated, thus it was recalibrated.

S1



- Have recooked e2a experiment data

- e2a $\frac{^3He(e,e'n)/^3He(e,e'p)}{^4He(e,e'n)/^4He(e,e'p)}$ (2.26 GeV)
  - First glance looks good
  - Analysis ongoing [e2b to come]

Study of the A(e,e'n) reaction

A data-mining project using CLAS EG2 data

Meytal Duer

Tel-Aviv University

February 25, 2016

CLAS collaboration meeting

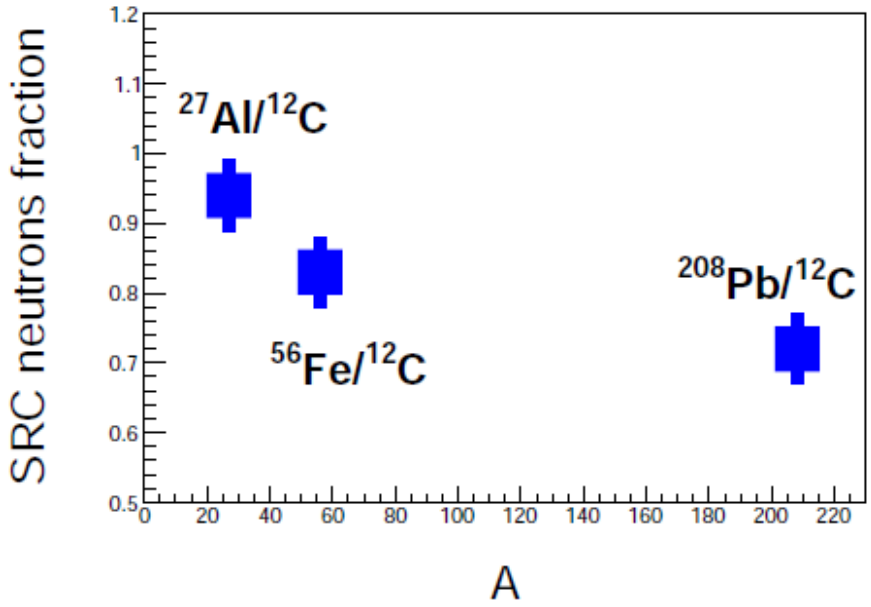
Calculation based on the np-dominance model

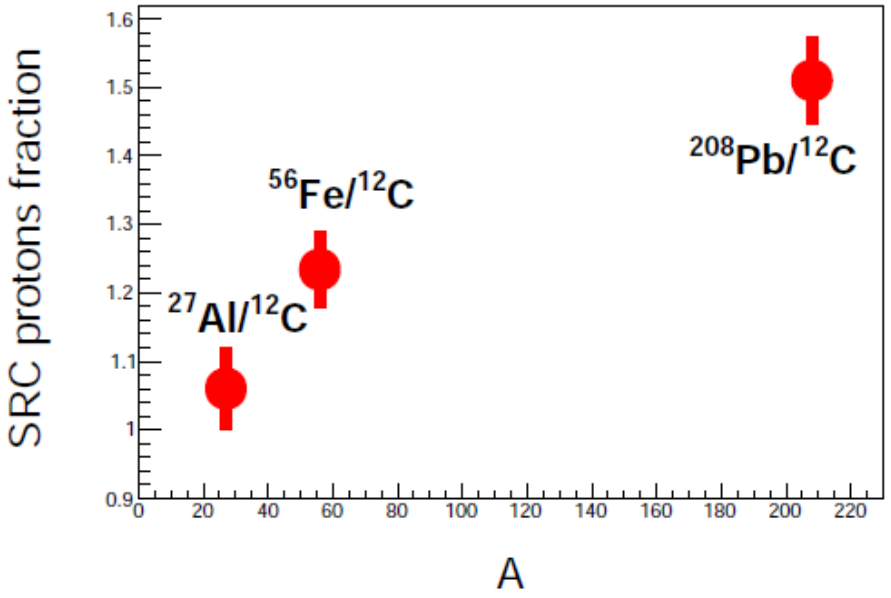
$$A(e,e'N)_{k<k_F} = \int_0^{k_0} n^{M.F.}(k)\,k\,dk$$

$$A(e,e'N)_{k>k_F} = \int_{k_0}^{\infty} n^{SRC}(k)\,k^2\,dk$$

$$\frac{A(e,e'n)/^{12}C(e,e'n)_{k>k_F}}{A(e,e'n)/^{12}C(e,e'n)_{k<k_F}}$$

$$\frac{A(e,e'p)/^{12}C(e,e'p)_{k>k_F}}{A(e,e'p)/^{12}C(e,e'p)_{k<k_F}}$$





Study of 2N-SRC via the A(e,e'np) reaction

A data-mining project using CLAS EG2 data

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The (e,e'np)/(e,e'pp) ratio

Expected ratio:

* np-dominance (#np/#pp~20)
* Leading n vs. leading p (2)
* Proton and neutron cross-sections ratio (~3)
* Neutron detection efficiency in the EC (~1/3)

$$\frac{A(e,e'np)}{A(e,e'pp)} \sim 1$$

Preliminary result

#(e,e'np) = 293

#(e,e'pp) = 365

Next step:

* Correct for cross sections ratio event-by-event
* Correct for neutron efficiency event-by-event
* Apply other corrections

π^- - production off Deuterium in

$\gamma\ d \rightarrow \pi^-\ p\ p_s$

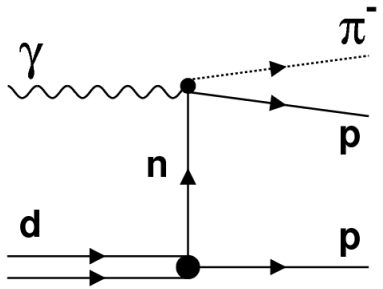
in Quasi-Free region

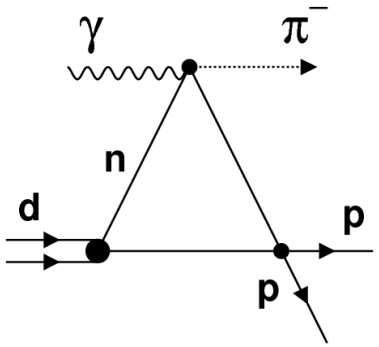
JLab CLAS, Experiment g10

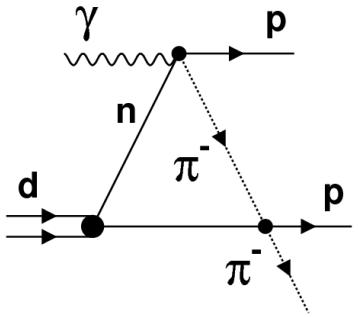
N.Pivnyuk, E.Pasyuk, J.-M. Laget, T.Mibe, V.Tarasov, V.Burkert, M.Dugger, B.Bobchenko, D.Weigand, J.Goetz, A.Kim, W.Chen

for CLAS Collaboration

TOPICS







Calculations :

J.-M. Laget. $1.0 < E_\gamma < 3.5$ GeV

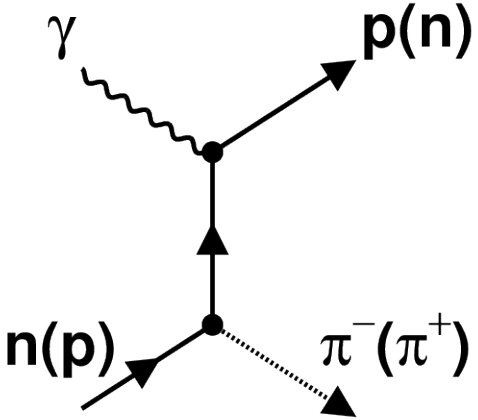
V. Tarasov. $1.0 < E_\gamma < 1.5$ GeV

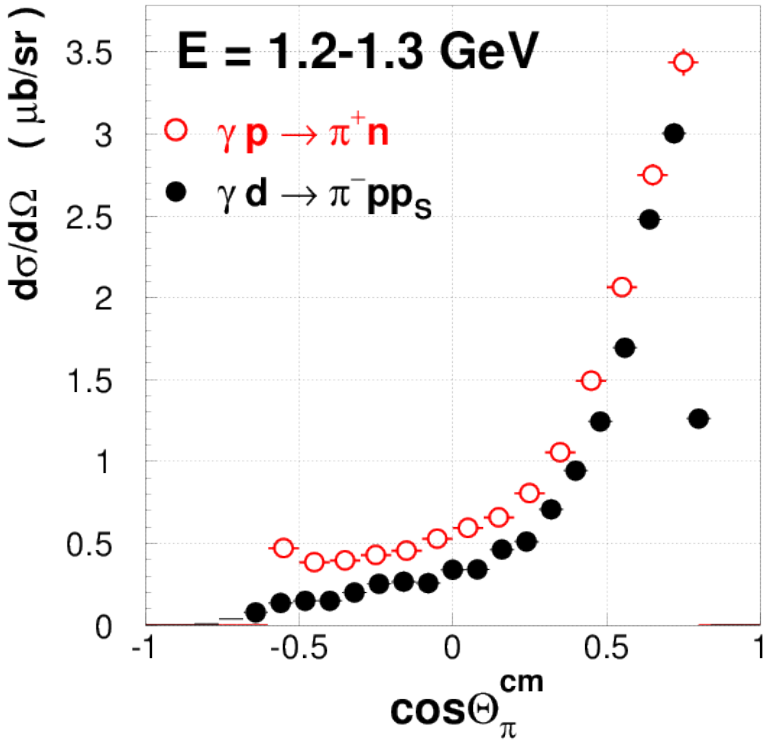
E_γ , $-t$, p_s , $\cos\theta_s$

$1.2 < E_\gamma < 1.3$

$\gamma p \rightarrow \pi^+ n$ (g1c) vs $\gamma d \rightarrow \pi^- p p_s$ (g10a)

u





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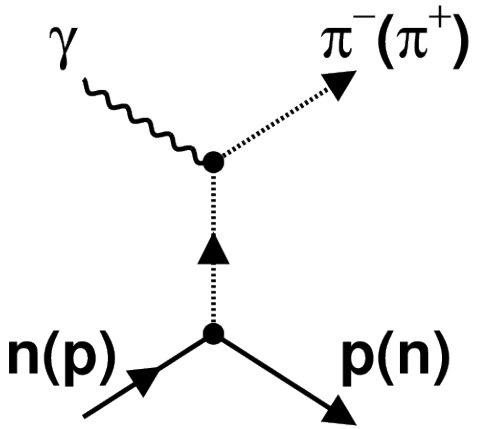

$2.2 < E_\gamma < 2.3$

$\gamma p \rightarrow \pi^+ n$ (g1c) vs $\gamma d \rightarrow \pi^- p p_s$ (g10a)

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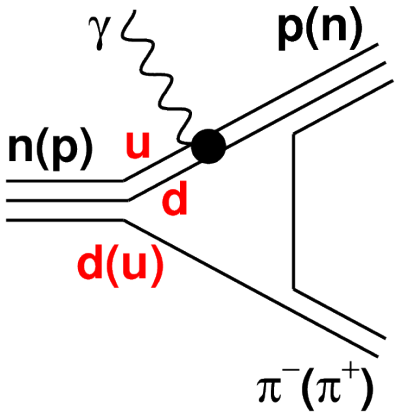

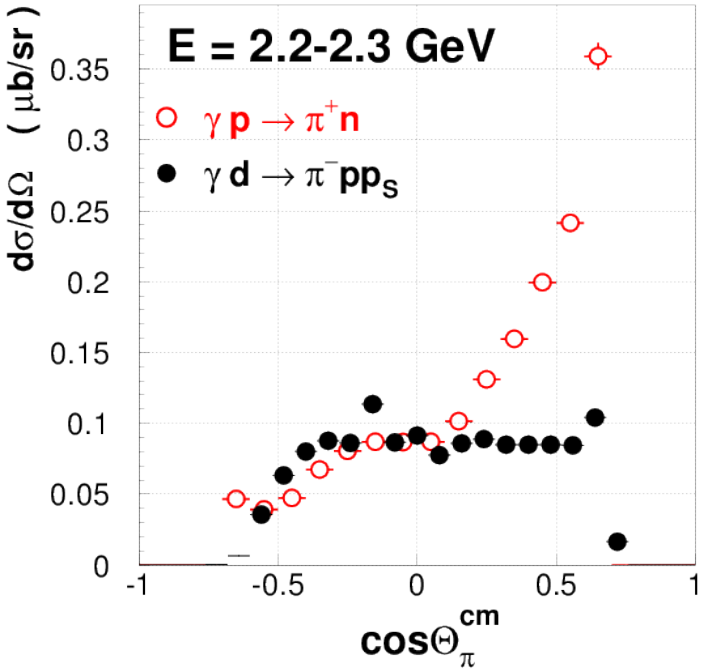

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