Nuclear Physics Working Group Meeting
March 19, 2010 A110

Agenda

13:30-13:40 'Update on reviews', Jerry Gilfoyle,
13:40-14:05 'Studies of final-state interactions in meson photoproduction off
        the deuteron' - Yordanka Ileava
14:05-14:30 'Update on K0 hadronization analysis' - Aji Daniel
14:30-14:55 'Update on the EG6 RTPC Calibration' - Raphael Dupre
14:55-15:15 Break
15:15-15:40 'Update on EG2 pion analysis' - Steve Manly/Hyupwoo Lee
15:40-16:05 'Coherent pi+ photoproduction on 3He' - Rakhsha Nasseripour
16:05-16:30 'gd->pi-pp, g10 analysis status report' - Nikolai Pivnyuk
16:30-16:55 'Analysis of inclusive A(e,e') scattering at x_b>1 for D, 12C,
        56Fe, and 208Pb using eg2 data' - Natasha Dashyan/Stepan
        Stepanyan.
16:55-17:15 'Update on analysis of EG1 data to extract polarization
        observables in D(e,e'p)n' - Michael Mayer.

Current and Recent Reviews*

Dan Protopopescu - Multipole Analysis of the Delta0(1232) in 3He
Committee:Kyungseon Joo (Chair), Mike Vineyard, ;Mike Wood
Ongoing – DP will complete data analysis; no recent changes.

Alex Vlasov – CAN: Source size measurements in the eHe -> e'pΛ X reaction.
Committee: Larry Weinstein (chair), Pavel Degtyarenko, Yordanka Ilieva
Ongoing – Last exchange was in October. Committee awaiting the next round of changes.

K. Hafidi et al. - CAN:Color Transparency in eg2
Committee: Hovanes Egiyan (chair), Mike Wood, Stepan Stepanyan
Ongoing – 'mostly converged'; authors have some final comments to address. No recent changes.

Aji Daniel and Ken Hicks – CAN: A measurement of the nuclear dependence of hadronization of neutral kaons (using EG2 data set)
Commitee: Reinhard Schumacher (chair), Steve Manly, Lamiaa Elfassi
Ongoing – Several exchanges between authors and committee. Meeting on Nov 20.

R. Nasseripour and Barry Berman - CAN - pi+ Photoproduction on 3He
Committee: Ken Hicks (chair), Raffaella Devita, Carlos Salgado.
Ongoing – Committee responded to second round of changes in mid-February.

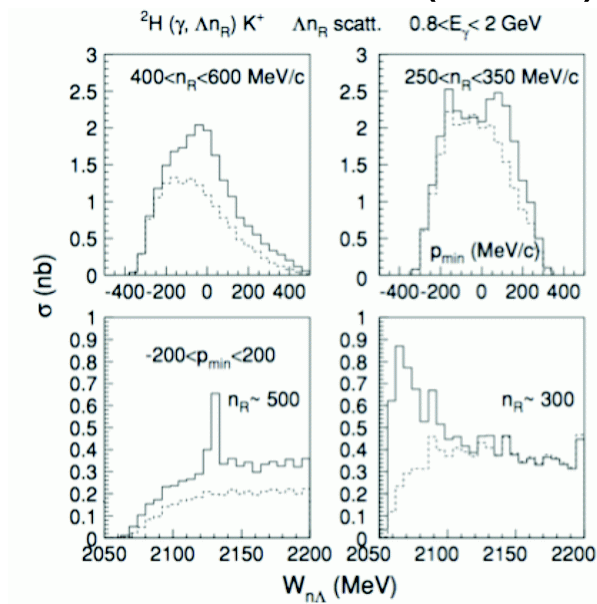* If you want to modify this list send email to gilfoyle@jlab.org

Study of FSI in Meson Photoproduction off the Deuteron (g13 data)
Yordanka Ilieva

πN and KN final-state interactions can be signature for color transparency (J.M.Laget, PRC 73, 044003 (2006)).

Limited data for YN.

Use $\gamma D \rightarrow K^+ \Lambda n$. ⟶

- differential cross section
- comparison with g10 (N. Pivnyuk's results)
- combined data g13, eg3
- helicity asymmetries
- might be possible to extend to eg3 data   ⟵   Use $\gamma D \rightarrow pp\pi^-$
• Linearly polarized photons
- beam-spin asymmetry

Suppression at larger t and s signals CT

Analyzing g13 data set.

- Observables emphasizing ΛN rescattering
- Circularly polarized photon beam E_γ = 0.8 - 2.0 GeV
- ~5% of data PID based on reconstructed mass

Use $\gamma D \rightarrow K^+ \Lambda n$. $\longrightarrow$
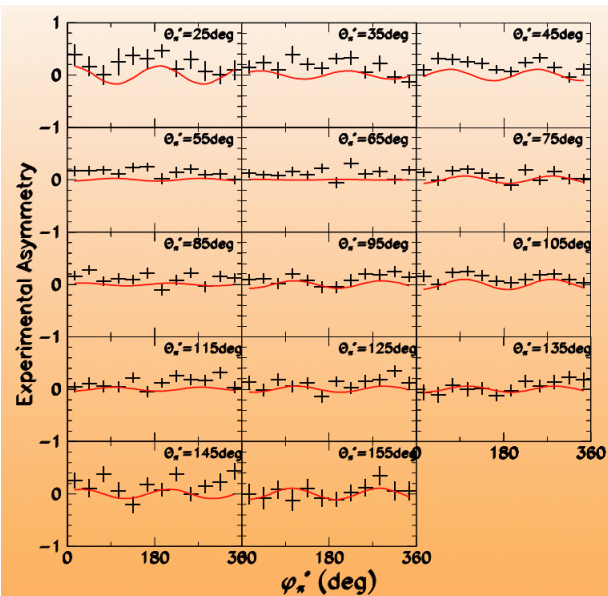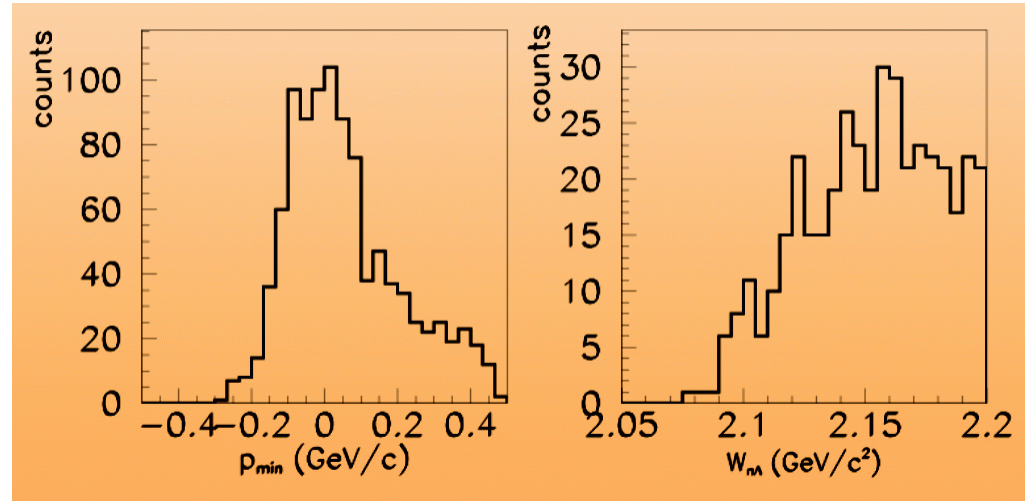
Use $\gamma D \rightarrow pp\pi^-$ $\longleftarrow$

Good start on the analysis. More to come from two students.

Investigations on the flavor dependence of the EMC effect from EG2 data

Aji Daniel

- EMC Effect – quarks are different in nuclei.

- Theory – wide range from conventional nuclear physics to exotic models.

- Predictions of significant flavor dependence.

  - From the nuclear PDFs and fragmentation functions one can form the yield of charged pions from SIDIS.

  - Super-ratio $\longrightarrow \dfrac{Y_{Au}^{\pi^+}/Y_{Au}^{\pi^-}}{Y_{D}^{\pi^+}/Y_{D}^{\pi^-}}$

  - Significant dependence on x_B
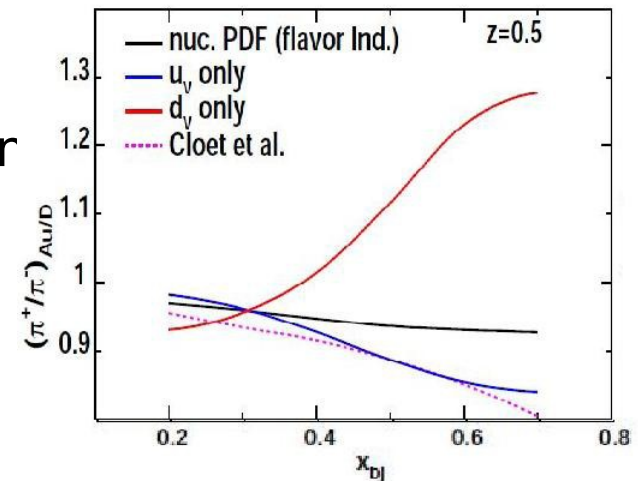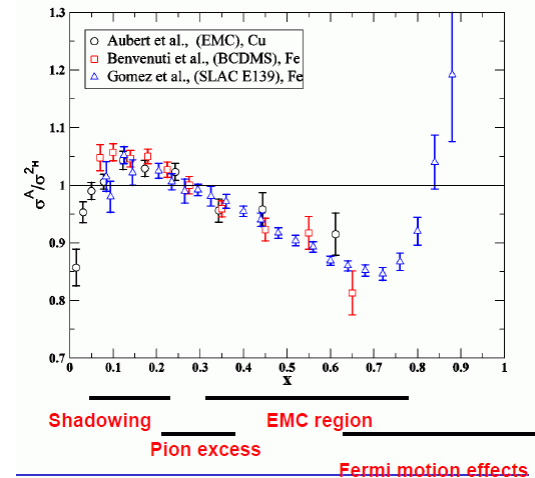
EG2 experiment

- **Primary Goal: Measure the space-time properties of hadron formation**

- **Ran during 2003 and 2004 in Hall B**

- **Beam energy 5.014 GeV**

- **Targets ^2H, ^{12}C, ^{56}Fe, ^{208}Pb**

- **^2H was simultaneously in the beam with nuclear targets**

Applied kinematic cuts (W >2 GeV, y <0.85, Q2>1 GeV2)

Expect hadron attenuation to be reduced in super-ratio.

Nuclear target used is Fe

- **Data shown are integrated over 03<z<0.7 region**

- **Kumano et al (Nuc. PDF includes EMC effect, but assume the effect is flavor independent)**

- **Cloet et al (medium modifications different for different flavors)**

Super Ratio

Very Preliminary

Legend:
— Cloet et al.
— Nuc. PDF (Kumano et al.)

$[Y(\pi^+)/Y(\pi^-)]_{Fe/D}$ vs x_{bj}
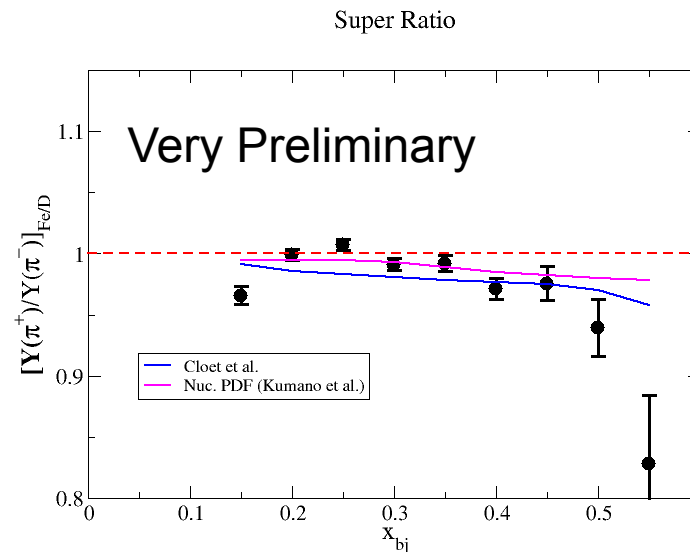
To do:
  -Optimize the kinematics.
  -Backgrounds
  -Acceptance corrections
  -Radiative corrections.
 -Other available targets.

EG6 RTPC Calibration Update
Raphael Dupre

EG6 Experiment

- Produce exotic meson resonances with quasi real photons (07-009)

- Study EMC effect with coherent and incoherent DVCS on Helium (08-024)

- Detect hadron (proton or 4He) with

Radial Time Projection Chamber (RTPC)

Calibration of RTPC

- Use low-energy (large cross section) beam energ.

- Elastic scattering from hydrogen and helium.
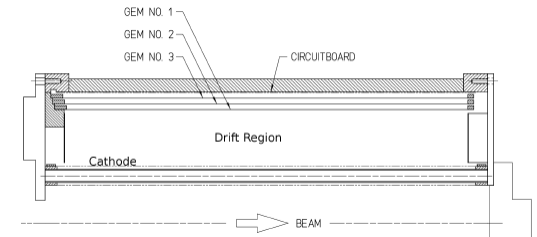
Calibrations

RTPC Drift Paths
1. Determination of the paths followed by the electrons in the drift region is the key to determine the particles trajectory.
2. Main issue of the calibration; direct link to the accuracy of momentum and angles determination.
3. Methods being pursued.
    1. Calculation with MAGBOLTZ – Uncertainties are: (a) magnetic field determination, (b) global position of the detector, (c) electric field determination, (d) gas composition.
    2. Determination from data: good simulation of the trajectory of nuclei needed (Geant4).

Gain Calibration
1. Difficulties: (a) energy is often diffused on 2 or more pads, (b) evaluation of baseline a problem for some noisy channels
2. Possible solutions: (a) gain calculated by comparing data and simulation, (b) relative gain measured by comparing pads on one track.

Electronic Noise
• Noise from electronics large and rapidly time varying.
• Temporary hot pads determined event-by-event -> Cuts noise by 2, but quality needs to be assessed.

eA for neutrinos project update - Acceptance study
Steve Manly/Hyupwoo Lee

High precision accelerator neutrino experiments are taking place in 0.5-2 GeV region on nuclei.

Systematic uncertainties will become comparable to statistical ones.
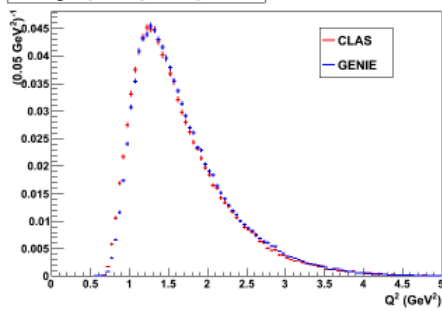
Need to tune Monte Carlo used to calculate backgrounds.

Using eg2 data to determine differential x-sections for single charged pion production as first step.

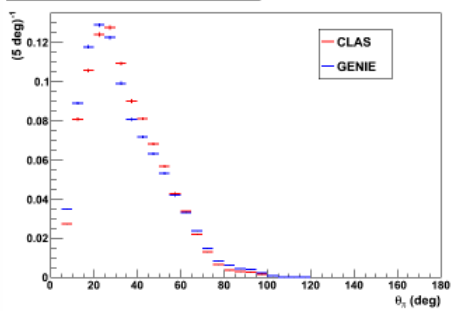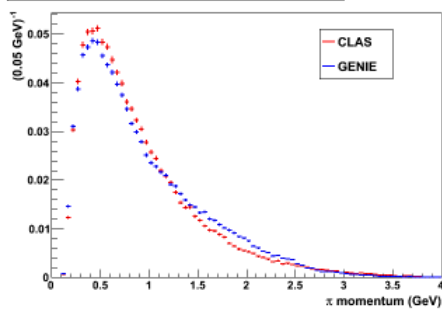GENIE - Generates Events for Neutrino Interaction Experiments

Comparison of EG2 data (red) and GENIE calculation (blue) for single π+ production from D2 target.

GENIE: 10M events generated and run through simulation chain(GSIM, GPP, and User_ana).
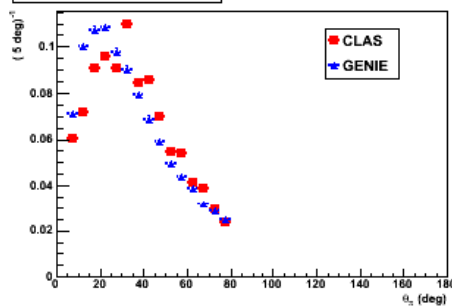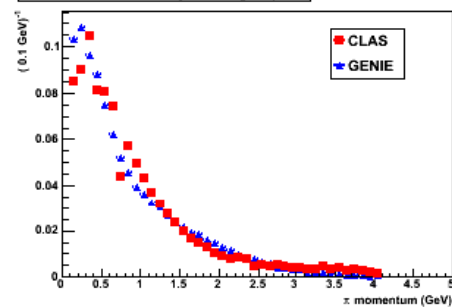
Similar results for carbon.
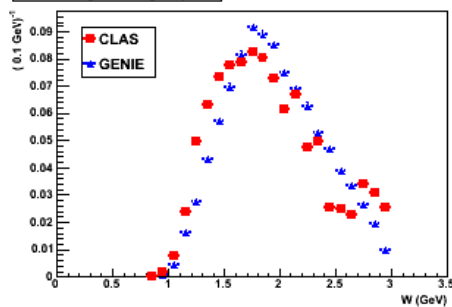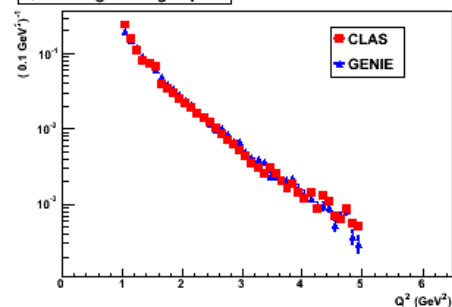
π+, D2 target

CLAS: eg2 Run #42011 (12C+D2target, ~10M events) was used.

Comparison of acceptance-corrected CLAS data in red (corrected with GENIE calculation) and GENIE in blue. Many other spectra in hand.

GENIE shows impressive agreement with CLAS data 'out of the box'.

π^+ Coherent Photoproduction on ^{3}He

Rakhsha Nasseripour and Barry Berman, GWU

Measure $A(\gamma,\pi^+)A'$ where A' has the same mass number as the target.

g3a Experiment with CLAS

Motivation:
1. Medium modifications
2. Long-range part of NN interaction.
3. Pion cloud and mesonic degrees of freedom.

Electron beam	1.645 GeV
Tagged photon beam	0.34 - 1.55 GeV
Target	18-cm liquid ^{3}He target
Target density	0.0675+/-0.0004 gcm^{-3}
Torus field	1920 A
Trigger	L2, Tagger, Start Counter, TOF
Runs	22095 - 22402

- Only one π and one t
- Vertex cuts
- Time cut
- Fiducial cuts
  Energy-loss corrections
- Use of two-body kinematics to select the background-free πt channel.

mt^2: ~7.88 $(GeV/c^2)^2$

$m(\pi^+)^2$: ~0.02 $(GeV/c^2)^2$

Constant   969.8
Mean   0.2030E-01
Sigma   0.2517E-01
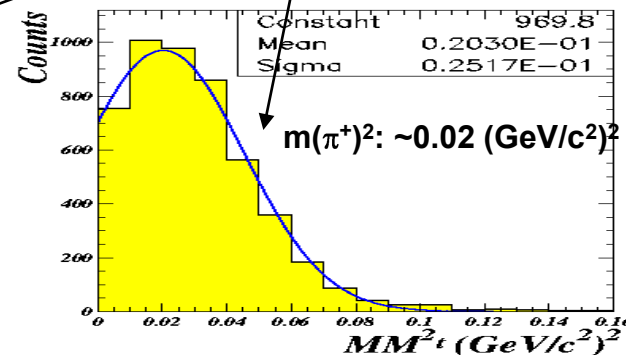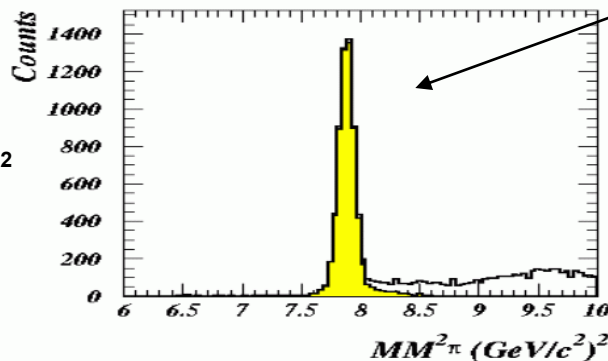
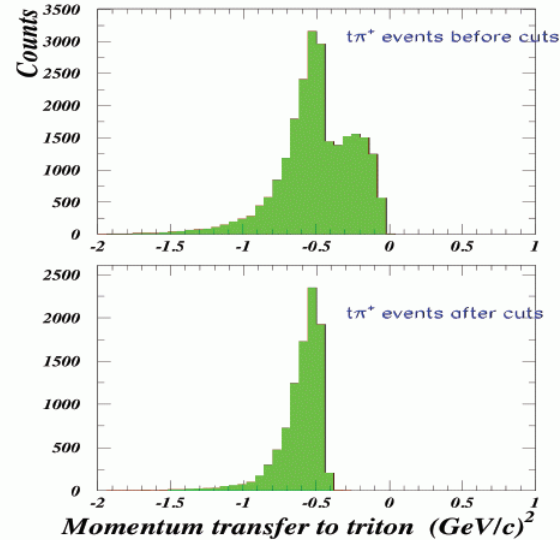Analysis note complete and under working group review.

New result: Momentum transfer dependence (Q^2 in red).

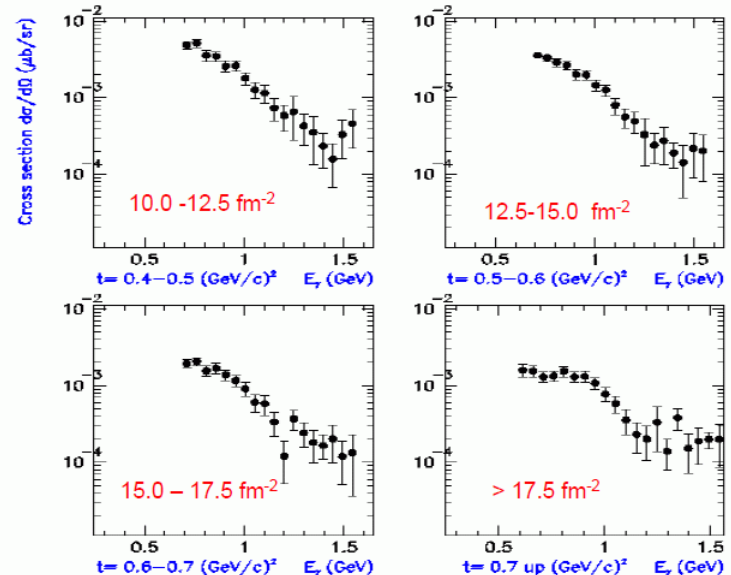Concern about rapid changes in the photon flux correction.

No Q^2 overlaps with previous measurements.

New calculations underway by Tiator and Kamalov.

Momentum transferred to the nucleus
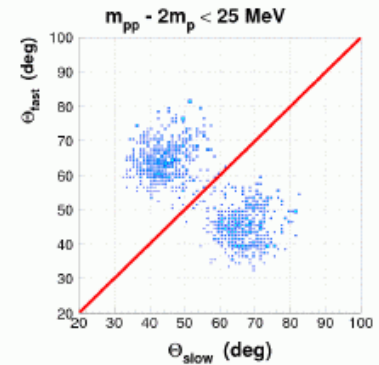
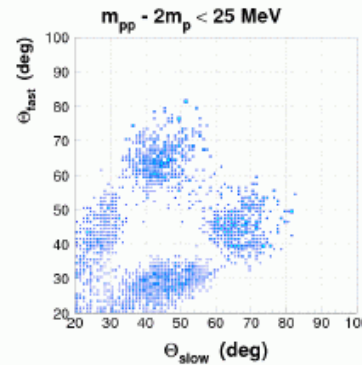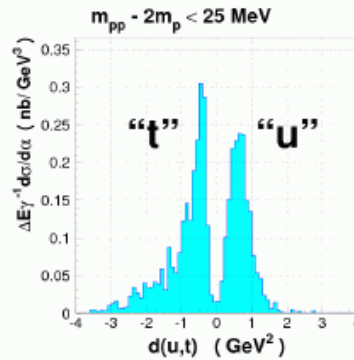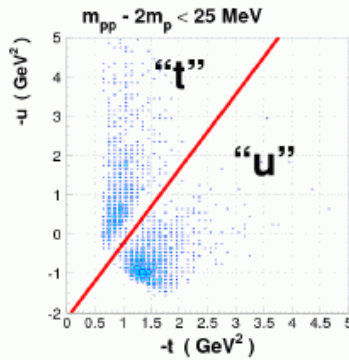$t\pi^+$ events before cuts

$t\pi^+$ events after cuts

Momentum transfer to triton (GeV/c)^2

Momentum Transferred Dependence

Cross section $d\sigma/d\Omega$ (μb/sr)

10.0 -12.5 fm^{-2}
t= 0.4−0.5 (GeV/c)^2 E$_\gamma$ (GeV)

12.5-15.0 fm^{-2}
t= 0.5−0.6 (GeV/c)^2 E$_\gamma$ (GeV)

15.0 − 17.5 fm^{-2}
t= 0.6−0.7 (GeV/c)^2 E$_\gamma$ (GeV)

> 17.5 fm^{-2}
t= 0.7 up (GeV/c)^2 E$_\gamma$ (GeV)

π⁻ - production off Deuterium in γ D → π⁻ p p
Nikolai Pivnyuk
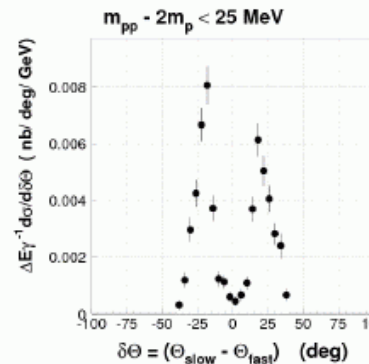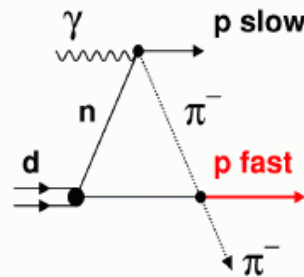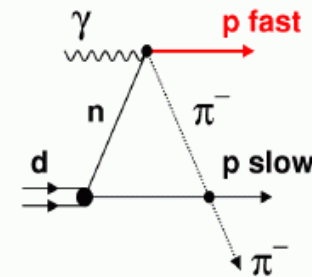
QF sector . Eγ < 1.8 GeV . dσ/dt (2) .

V.Tarasov & SAID vs data. Preliminary.

N.A. Pivnyuk, ITEP @ NPWG.
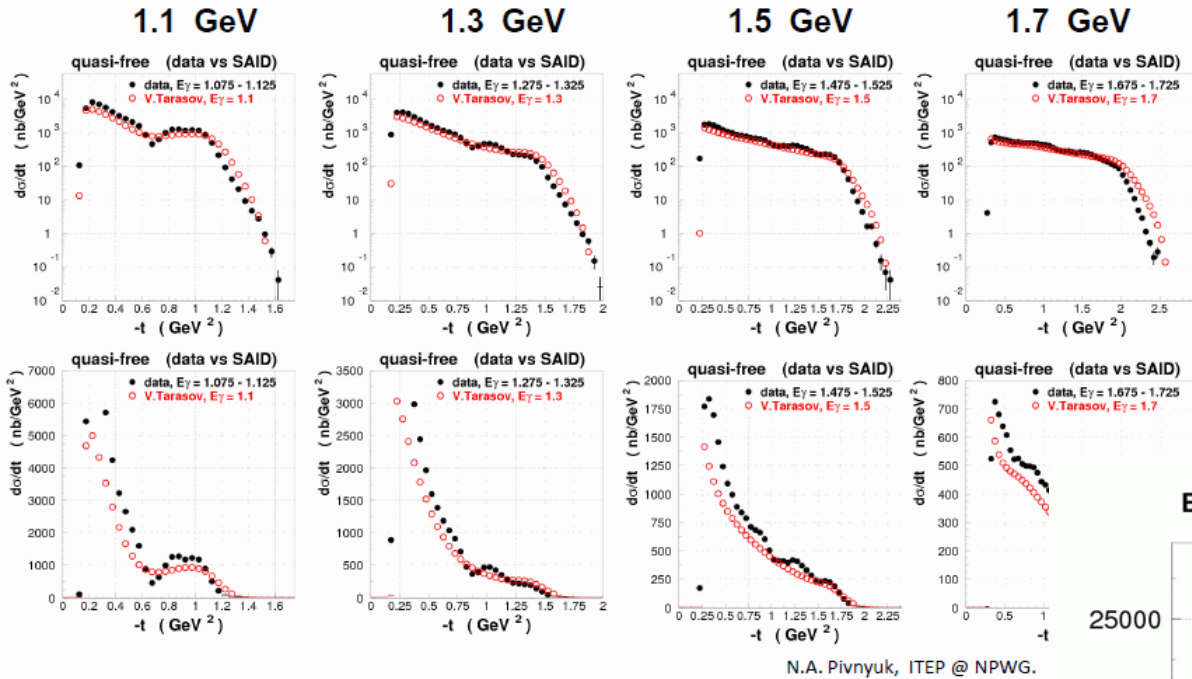
Comparison with SAID database at GWU.

Excellent agreement!

$\pi^-p \to \pi^-p$, 'u,t' all E_γ = 1.8-3.5 GeV ⟶

?

E_γ = 1.8 - 3.5 GeV. pure pion resc.

— Model
— SMC
• Data

Θ_{rec} (20 < Θ_{pass} < 40)
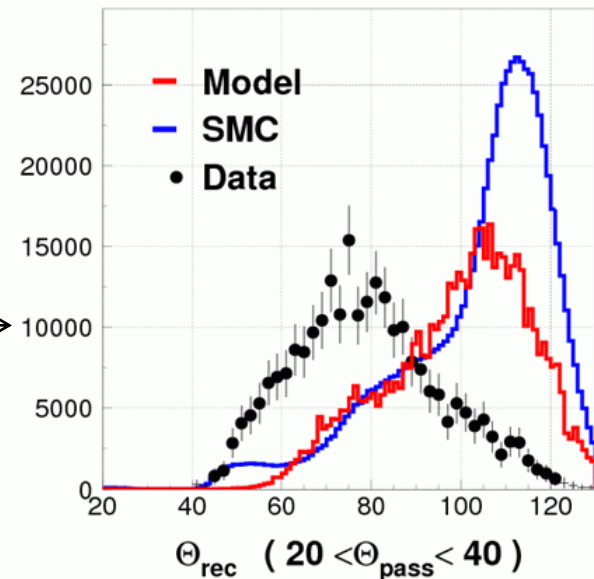
Scaling of A(e,e')/D(e,e') at $x_B > 1.5$ with eg2 data
S. Stepanyan for N. Dashyan

- Short range correlations (SRC) in nuclei:
  - ➢ High momentum part of nuclear wave function dominated by SRC and:
    - ▪ shape of the momentum distribution for different nuclei should be the same.
    - ▪ ratios of quasi-elastic scattering cross sections for different nuclei should scale.
- Extract the probability of 2N nucleon correlations in nucleus A, a2N(A), was extracted from the ratio:

$$r(A, {}^3He) = \frac{(2\sigma_p + \sigma_n)\sigma_A(Q^2, xB)}{(Z\sigma_p + N\sigma_n)\sigma_{He}(Q^2, xB)}$$
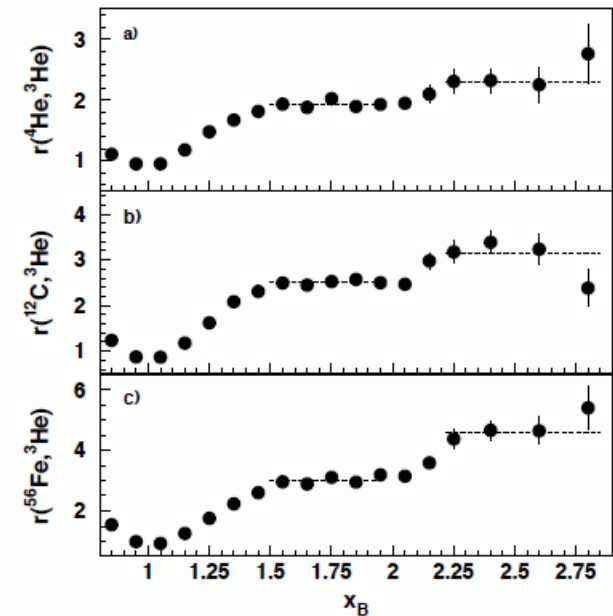
1. using theoretical value for probability of 2N correlations in deuterium a2N(^{2}H) and
2. theoretical/experimental estimate of relative probability a2(^{3}He/^{2}H)

Eg2 data set and analysis

Simultaneous running with LD_2 and solid targets (^{12}C, ^{27}Al, ^{56}F, and ^{208}Pb).

Analysis goal is study scaling effect in the ratio of cross sections of inclusive reaction A(e,e') to D_2(e,e') at $x_B > 1.5$ Region.
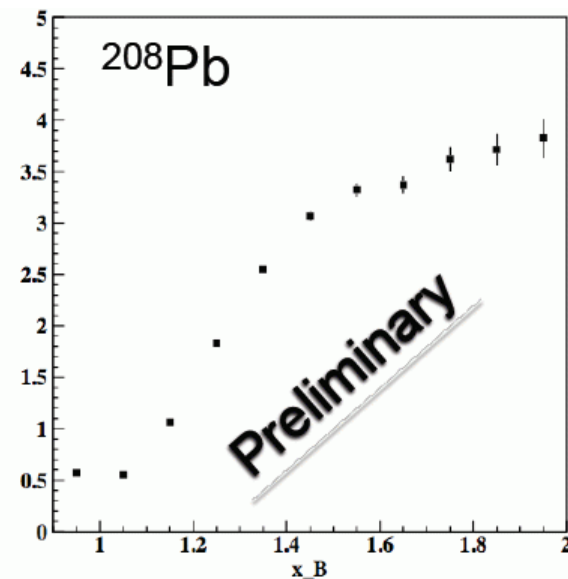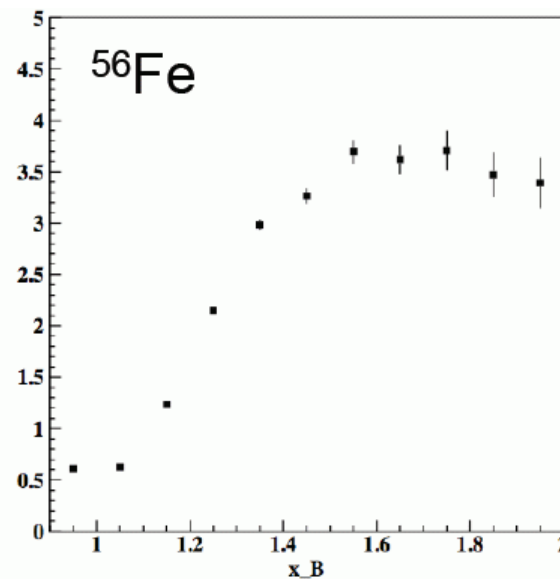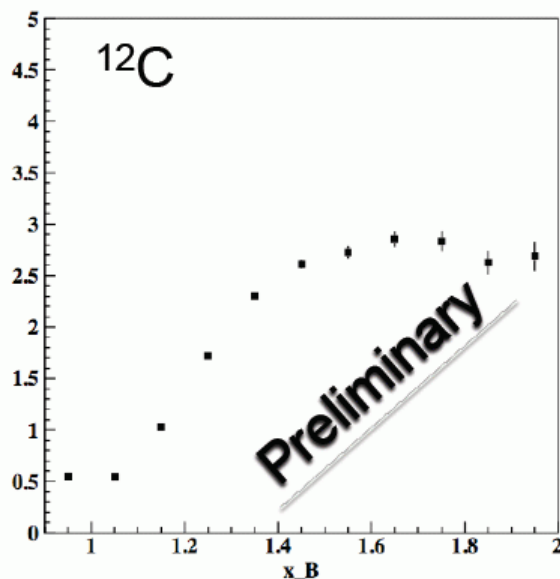
Dual target configuration will reduce systematical errors in the ratio of yields from different targets.
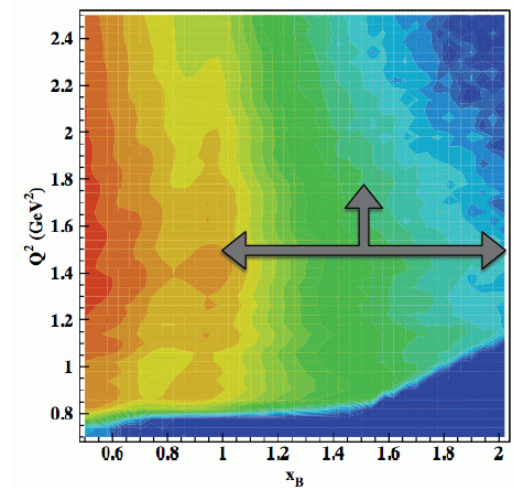
Kinematic Region

Need to get full statistics, refine cuts for PID and event selection, study Q^2 effects.

The plateaus plateau!

Update on analysis of EG1 data to Extract Polarization Observables in D(e,e'p)n
## *Michael Mayer*

Data mining analysis

1. Longitudinally polarized electrons at energies 1.6, 2.5, 4.2 and 5.7 GeV were scattered from longitudinally polarized NH_3 and ND_3 targets.
2. Additional targets were ^{12}C, ^4He and ^{15}N.
3. Main analysis of inclusive spin structure functions Completed.
4. Goal here is to extract polarization observables (e.g. double spin asymmetry $A_{||}$) for quasielastic scattering off proton.

Motivated by new calculations from Jeschonnek and van Orden (PRC 80, 054001 (2009).

Relativistic calculation of various asymmetries accessible with a polarized deuteron target.
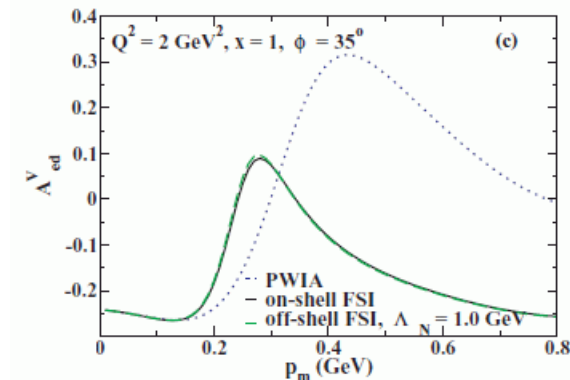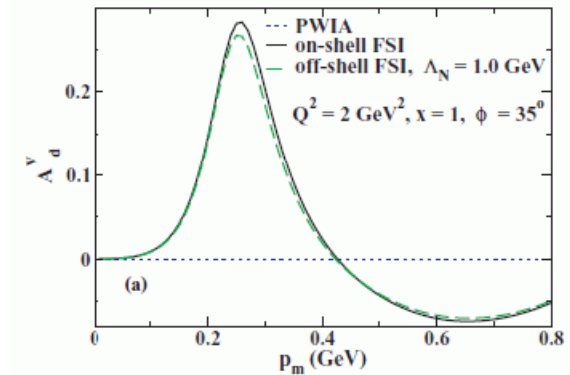
Event Selection.

Use the missing mass spectrum of D(e,e'p)n reaction.

Dilution factor

-Fraction of events scattered from polarized deuteron target.
-Scale carbon data to ND3 data in low missing mass region and subtract.
-Gives a dilution factor of 10% which is well below the expected result.

Improve Cuts

1. Added Geometric and Timing Cuts to the CC.
   ☐   - Δt_{proton} cuts
   ☐   - fiducial cuts on proton/electron
2. Missing Energy Cuts<1.15
3. Missing momentum cuts <0.5
4. p_{proton}> 0.3 GeV/c

Ultimately will correct for beam and target polarizations in asymmetry. $A_{raw} = \dfrac{n^+ - n^-}{n^+ + n^-}$

E6

1. 5.765 GeV polarized electron beam on Deuterium.
2. Look for backwards scattered protons
3. Use spectator tagging to study electron scattering from high momentum neutrons in deuteron
4. Study the bound nucleon structure function