Radiative Corrections for Cross Sections and Asymmetries

Analysis for d_2^n

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12/20/12

Outline

The ^{3}He Quasi-Elastic Tail

Fermi Smearing

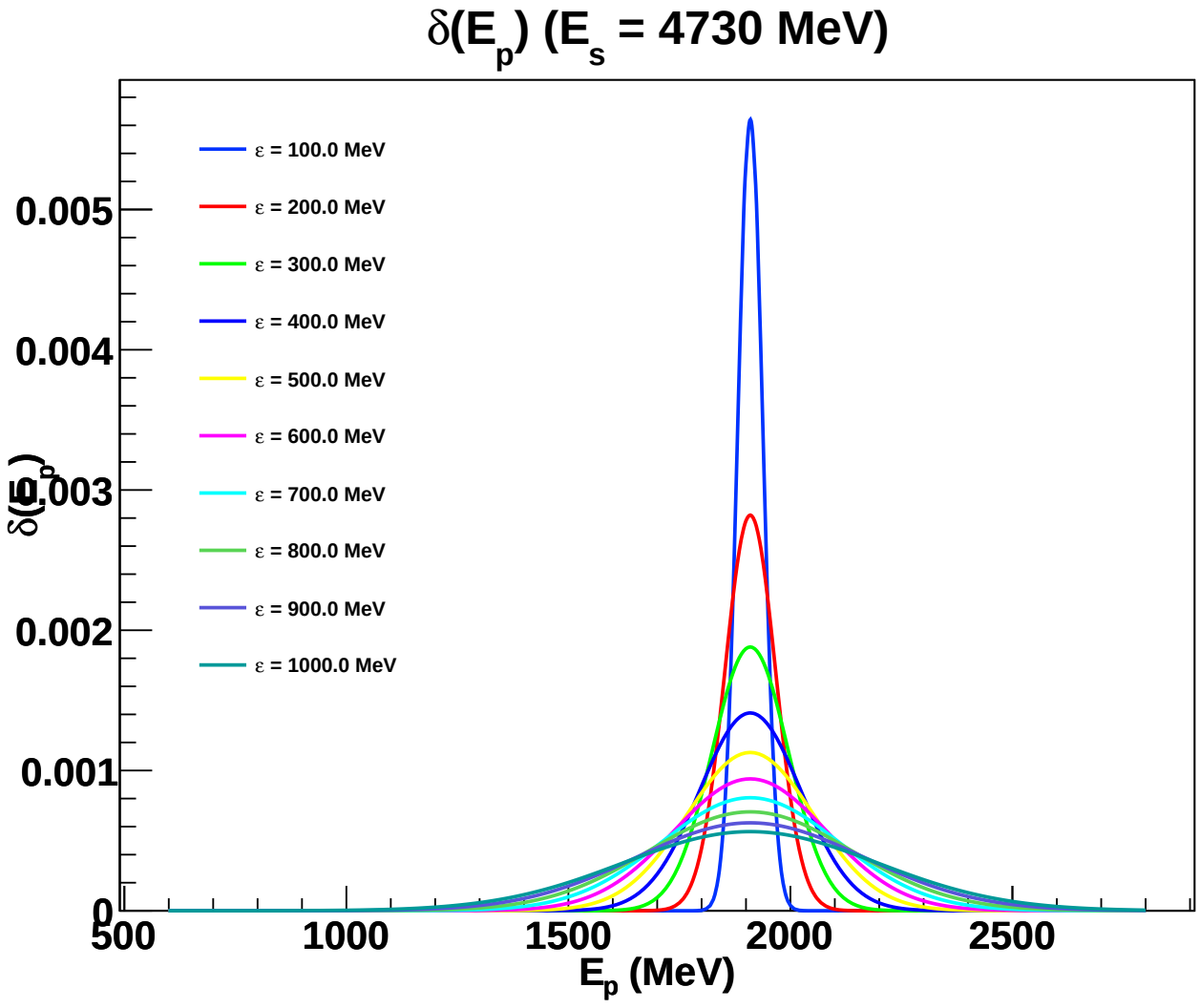
- To look into how Fermi smearing may affect the computed ^{3}He QE tail from ROSETAIL, we apply a smearing function to the form factors:

$$F_i\left(Q^2\right) \rightarrow S\left(\nu\right) F_i\left(Q^2\right)$$

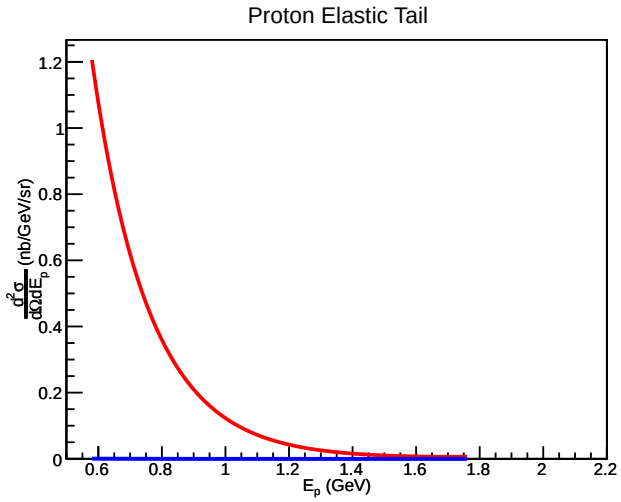
- $S\left(\nu\right)$ is of the form:

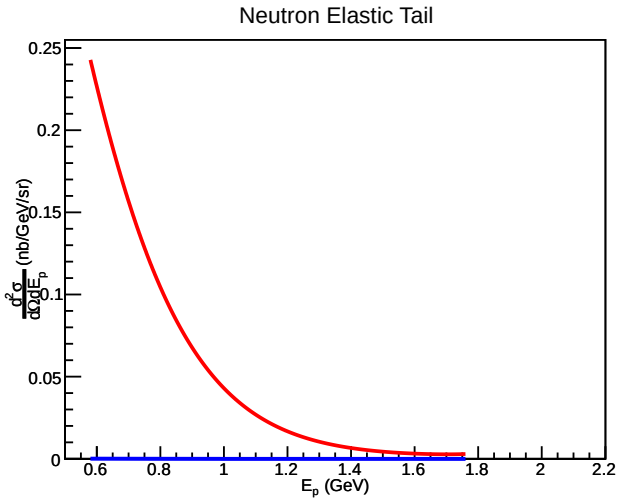
$$\begin{aligned} S\left(\nu\right) &= \frac{1}{\varepsilon\sqrt{\pi}} \exp\left[-\left(\frac{\nu_{\text{thr}} - \nu}{\varepsilon}\right)^2\right] \\ \nu &= E_s - E_p \\ \nu_{\text{thr}} &= \frac{Q^2}{2M_p} \\ \varepsilon &= \text{Variable parameter} \end{aligned}$$

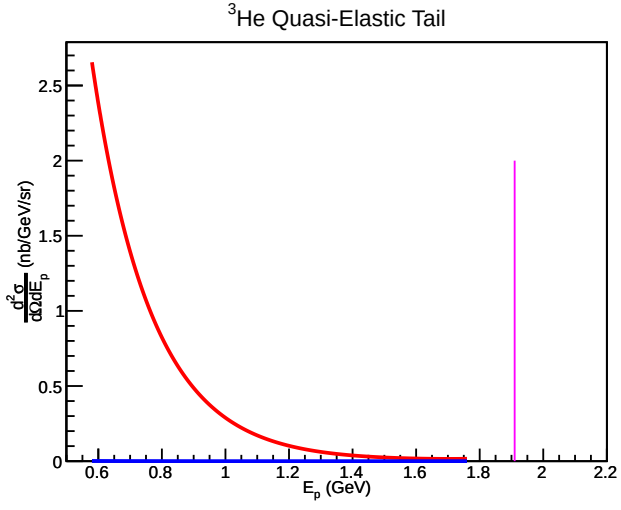
Smearing Function

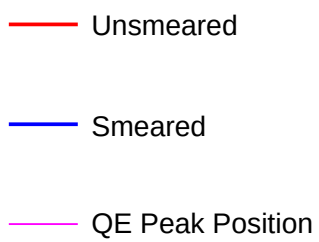


Application to the QE Tail









POLRAD

Updates

- Updated the code to remove outdated code (three-way arithmetic if-statements, etc.)
- New Makefile and Perl scripts to run the analysis from compilation to execution of program
- Addition of (more) current models:
  - $R = \sigma_L/\sigma_T$: R1990 or R1998 (R1990 was previously the default)
  - Unpolarized SFs: F1F209, NMC95
  - Polarized PDFs: DSSV, DNS2005, Bluemlein and Boettcher (BB) (leading-order option is used for each)
- For ^{3}He data, POLRAD would do the RCs and extract neutron quantities, so code was altered to extract the Born ^{3}He results only
  - Can still chose to extract neutron quantities by a switch in the configure file

POLRAD

Clarifications and Procedures

- After reading the manual (many times) and examining the code, it has become reasonably clear that the unfolding is necessarily done on the asymmetry $A_{1,2}$, not $A_{\parallel,\perp}$
  - Solution: Do the corrections on $A_{1,2}$, extract $A_{\parallel,\perp}$:

$$\begin{aligned} A_{\parallel} &= D\left(A_1 + \eta A_2\right) \\ A_{\perp} &= d\left(A_2 - \xi A_1\right) \end{aligned}$$

- The result of the unfolding goes one step further, in that it extracts A_1^n from ^{3}He data
  - An update was made to adjust the result to give ^{3}He results, see previous slide
- It appears that the code executes for one iteration
  - It seems that the only way to do multiple iterations is to insert the results back into POLRAD after each run (according to Xiaochao)

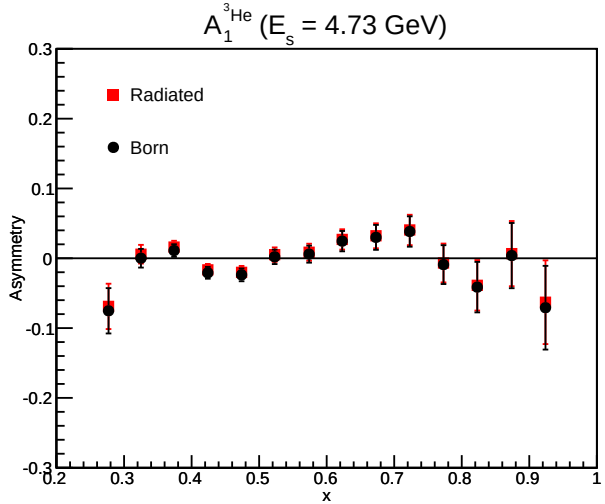
Preliminary Results (1)

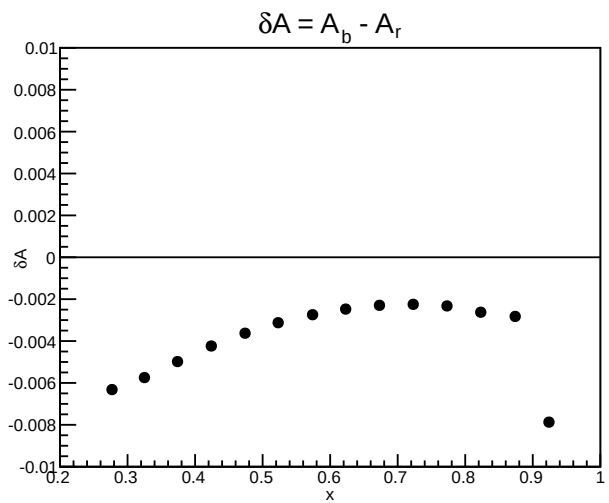
Details

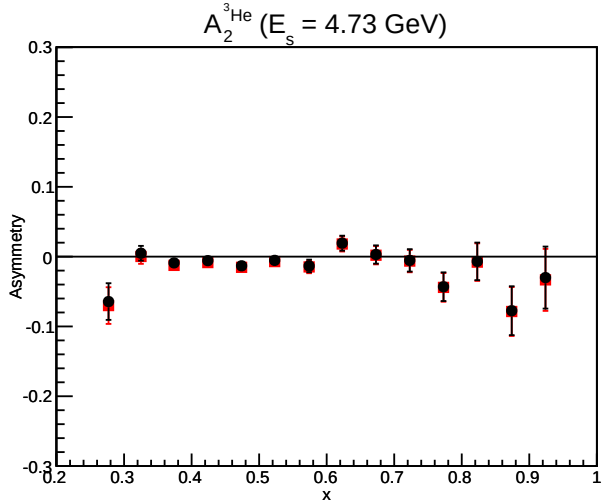
- The following plots show preliminary results for $A_{1,2}$ and $A_{\parallel,\perp}$ for 4- and 5-pass data using POLRAD
- Updated models were not used, because they do not cover the whole phase space in Q^2 (see talk from 11/15/12) and POLRAD runs indefinitely when using these models (to be fixed...)
- Models used:
  - Unpolarized SFs: NMC fit [Nucl. Phys. B **371**, 3 (1992)]
  - Polarized SFs: $g_1 = A_1 F_1$; $g_2 = g_2^{WW}$
  - R model: R1998
- Clearly the above calculation of g_1 is an approximation, but we are looking at a first run so as to see what POLRAD can give us
  - Remember that the g_2 contribution to A_1 is supressed because of kinematics

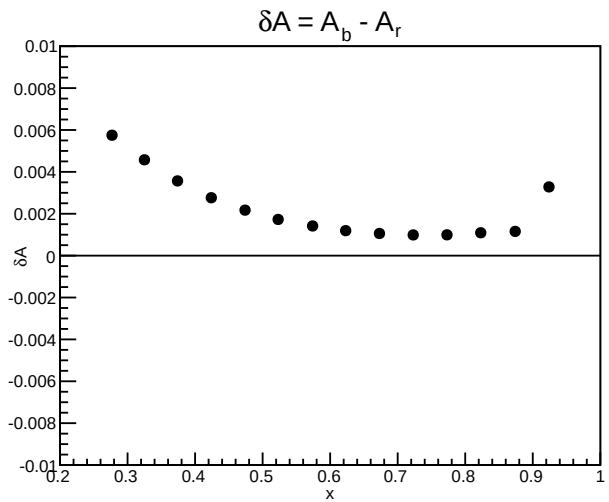
Preliminary Results (2)

$A_{1,2}$ (4-pass, one iteration)



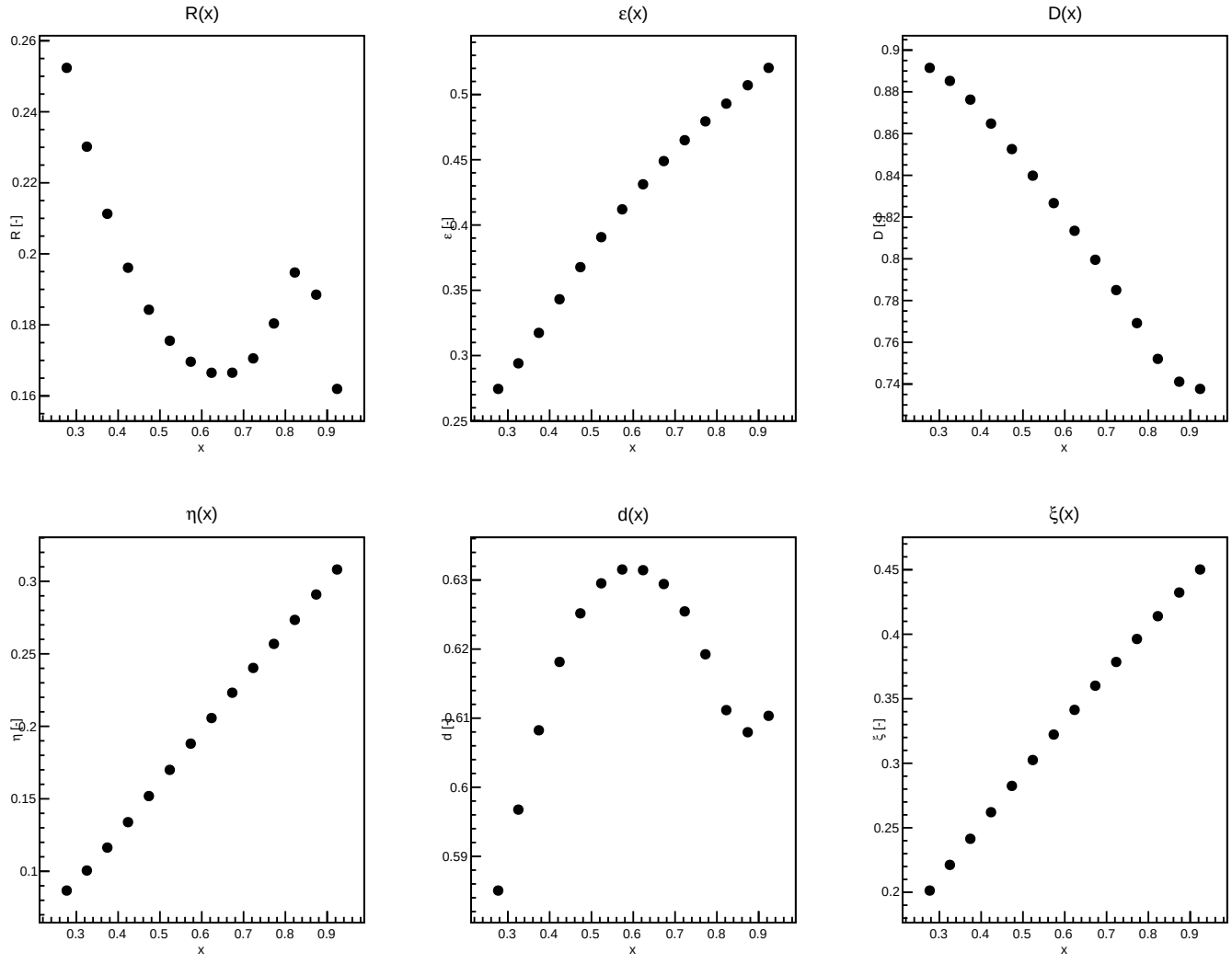






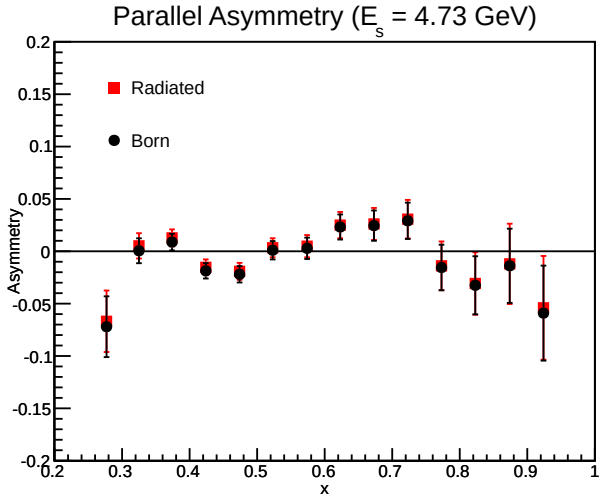
Preliminary Results (3)

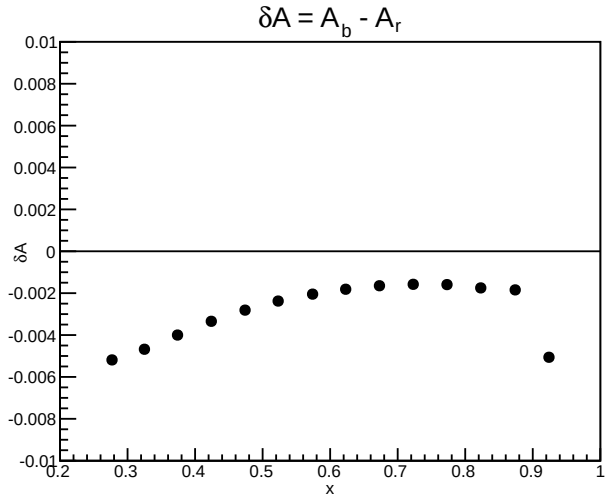
Kinematics at 4-pass

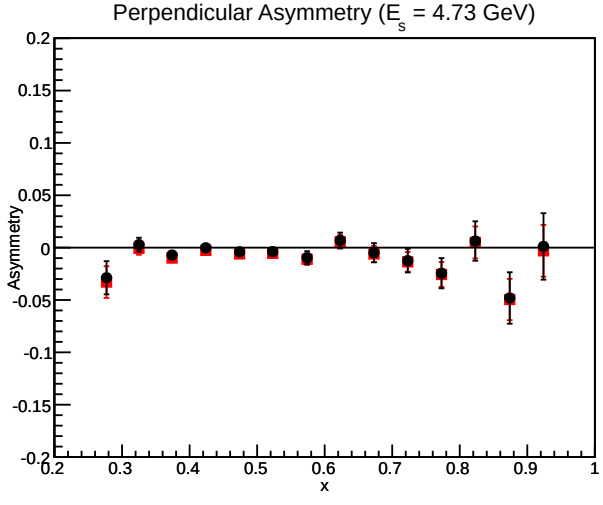


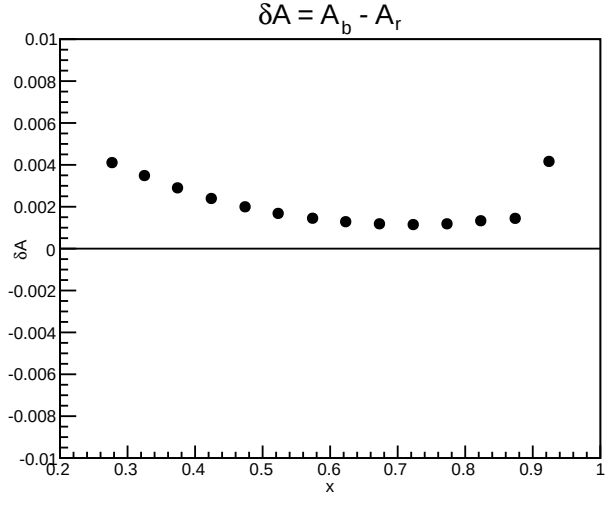
Preliminary Results (3)

$A_{\parallel,\perp}$ (4-pass, one iteration)



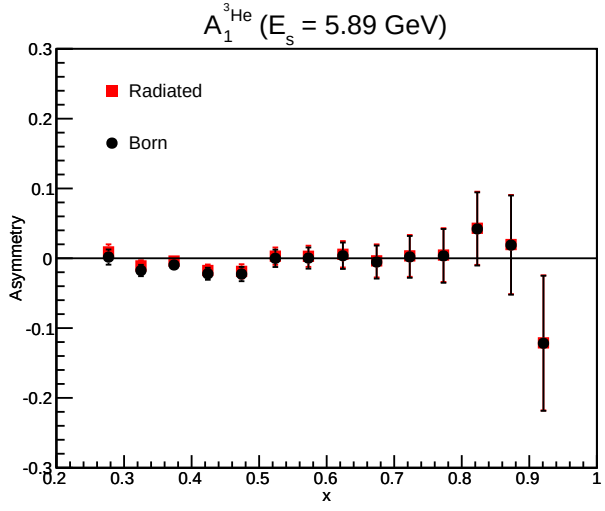


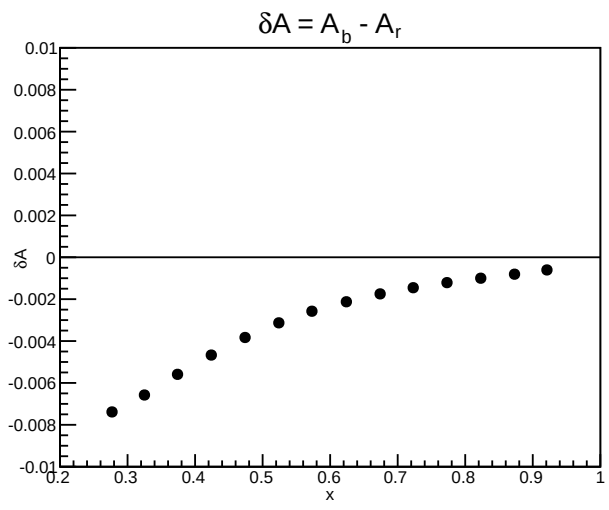


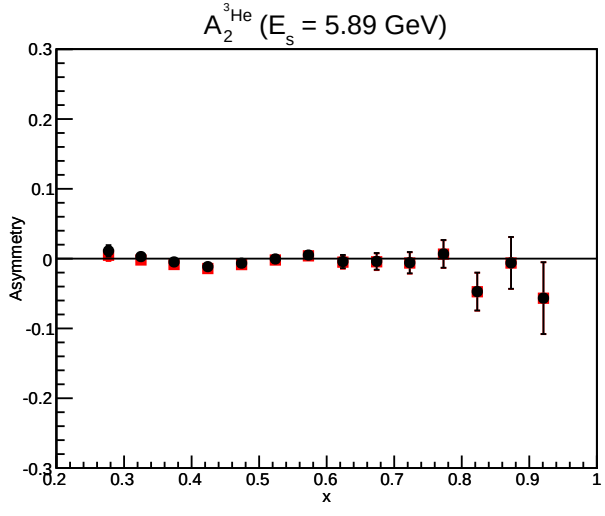


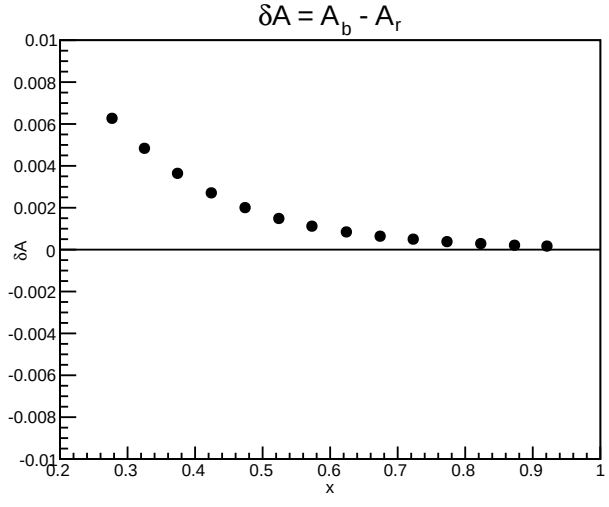
Preliminary Results (4)

$A_{1,2}$ (5-pass, one iteration)



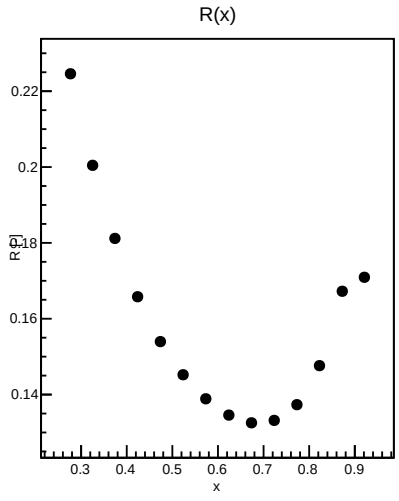


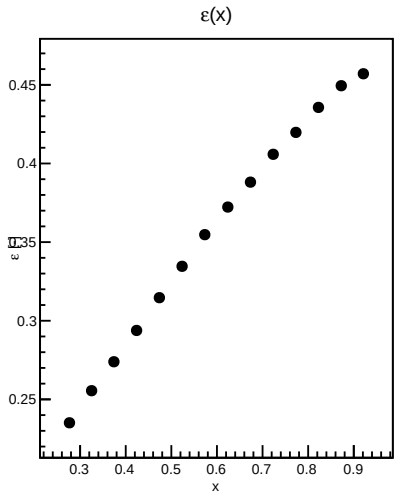


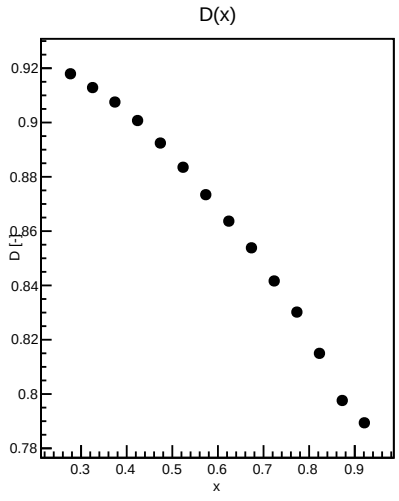


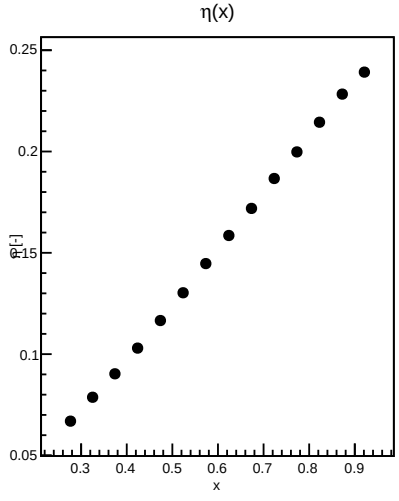
Preliminary Results (5)

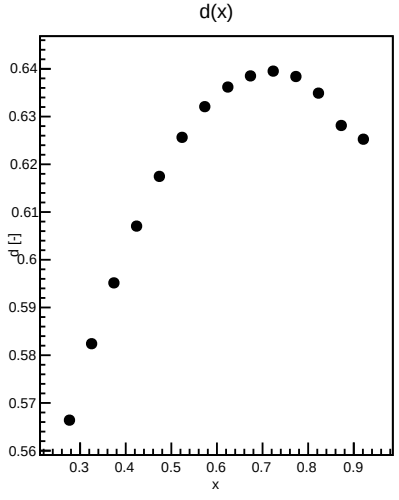
Kinematics at 5-pass

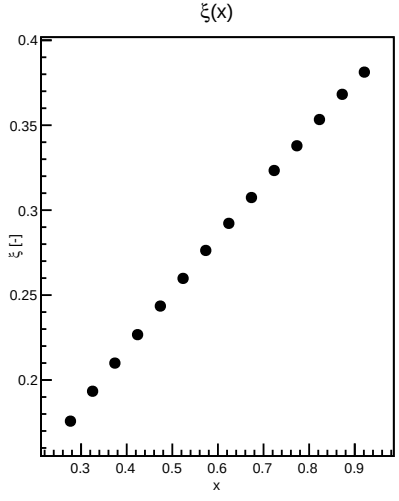






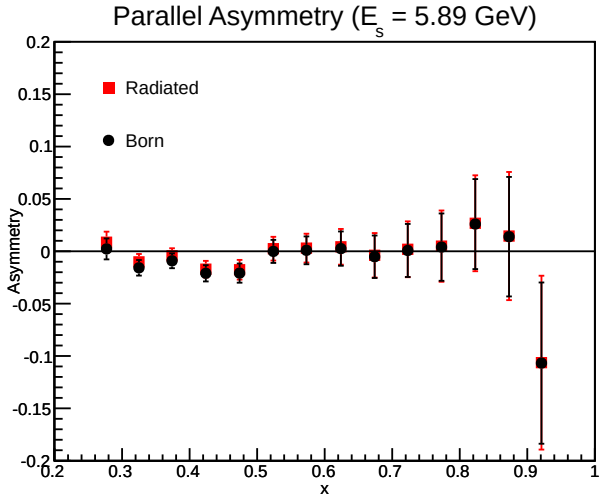


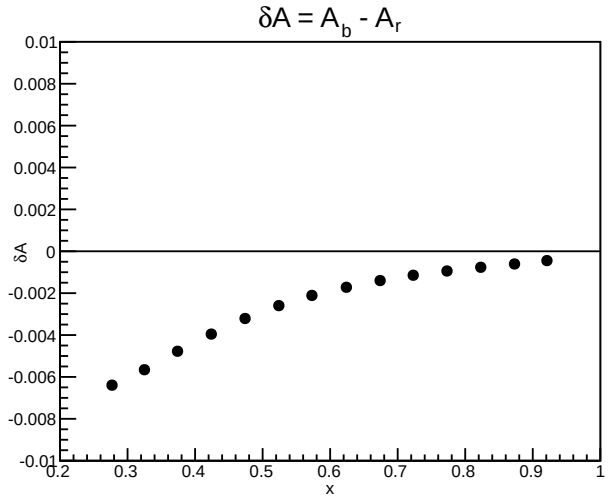


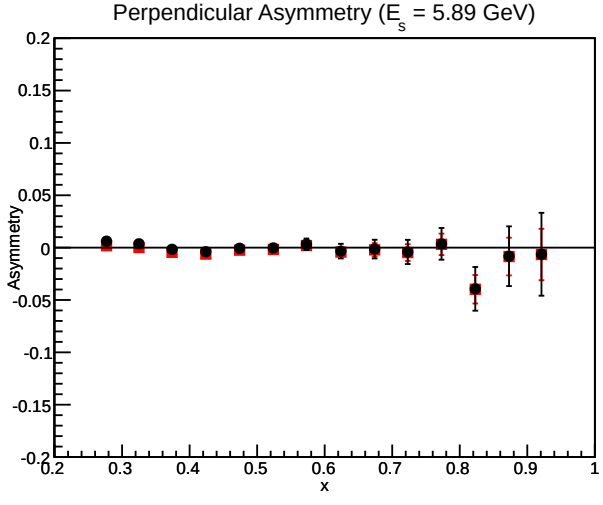


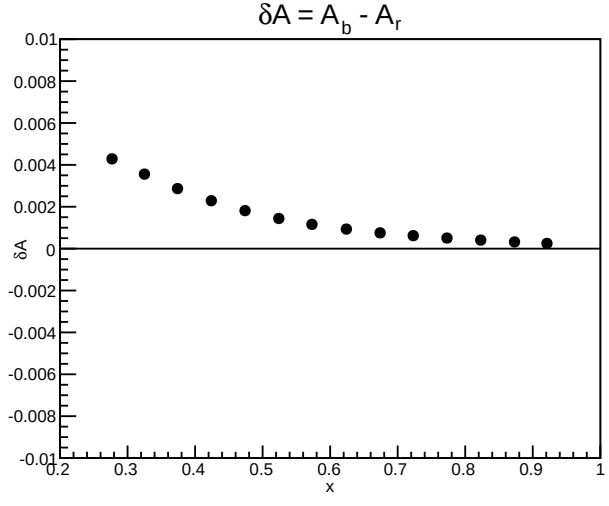
Preliminary Results (6)

$A_{\parallel,\perp}$ (5-pass, one iteration)



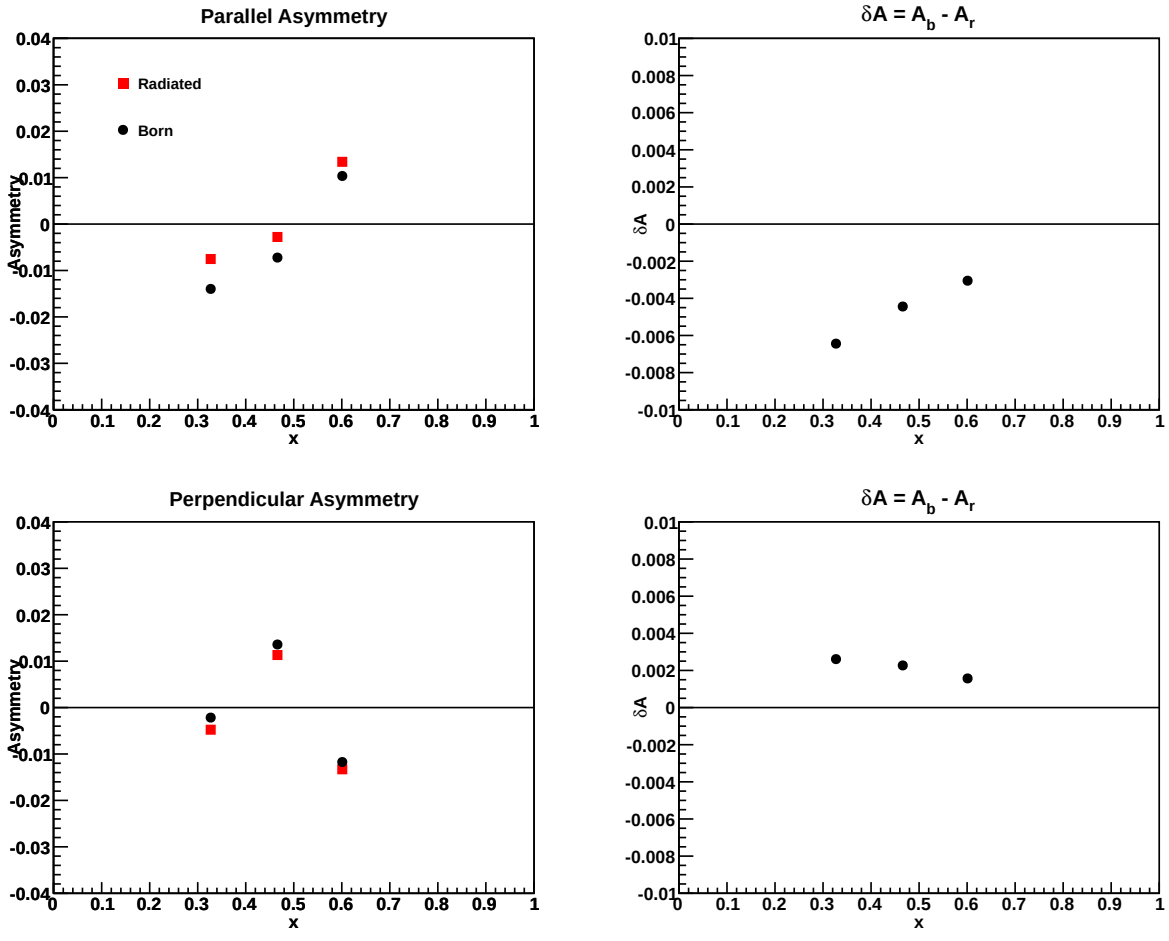






World Data

$A_{\parallel,\perp}$ (E99-117 data)



- Note: The radiative corrections here are the sum of internal and external effects

Summary

- Cross Sections
  - Fermi smearing framework is in place, just need to determine proper normalization of the function
- Asymmetries
  - Many updates to POLRAD
  - Preliminary results on $A_{1,2}$ and $A_{\parallel,\perp}$ have been obtained for 4- and 5-pass data
  - Sign and size of radiative corrections are consistent with E99-117
    - Unpolarized external effects have yet to be included for our data

To-Do

- Cross Sections
  - Proper normalization of smearing function
- Asymmetries
  1. Implement iterative procedure (in progress)
  2. Determine how to get updated models for $F_{1,2}$, $g_{1,2}$ to work properly
  3. Evaluate the unpolarized external radiative corrections in RADCOR