GDH Analysis

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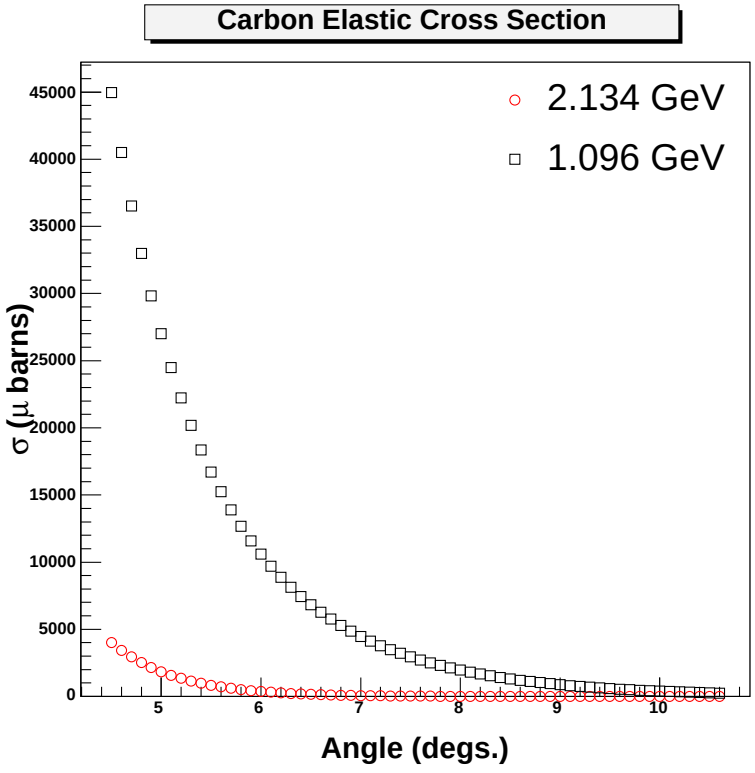
Pol. ^{3}He Collaboration Meeting

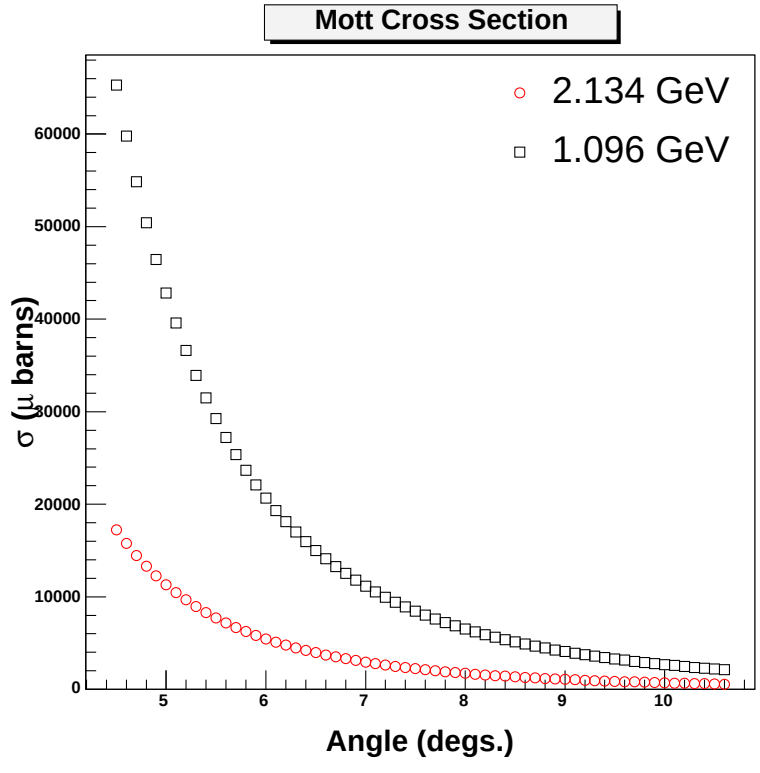
October 18^{th}, 2006

- Carbon Elastic Cross Section
- Systematic Studies
- Asymmetry Analysis
- Summary

Elastic ^{12}C Cross Section

- Calculated the cross section from the background subtracted yield.
- Data and simulation were different by $\sim$ 23%.
- Cross Section is extremely sensitive to the scattering angle.





Systematic Studies

- Radiative Corrections.
- Scattering angle from survey: $5.99 \pm 0.04^{\circ}$, (σ = 0.5 mm).
- Collimator positions.
- Acceptance cuts.
- VDC high rate (multi-track) efficiency.
- Background subtraction.
- Foil density.

Radiative Corrections.

- Rechecked material before and after scattering.
- Remeasured polystyrene from entrance and exit of septum.
- Found a mistake in MC by using 1.5 cm instead of 5 cm.
- Cross section agreement improved by $\sim$ 6% to 17.2%.

$$\rho = 0.03151 \pm 0.00036 \ \mathrm{g/cm^2}$$

$$\rho = 0.03220 \ \mathrm{g/cm^2} \ (\mathrm{A.Deur})$$

Radiative Corrections.

Before Scattering

Material	Thickness (cm)	RL Uncertainty (%)	RL (X_0)
Be	0.0127	10.0	3.60 x 10^{-4}
^4He	23.9	2.1	4.53 x 10^{-5}
^{12}C	0.0254	5.0	1.35 x 10^{-3}
^4He	20.0	0.5	3.79 x 10^{-5}
^{12}C	0.0127	5.0	6.76 x 10^{-4}
Total	43.951	5.6	2.47 x 10^{-3}

Radiative Corrections.

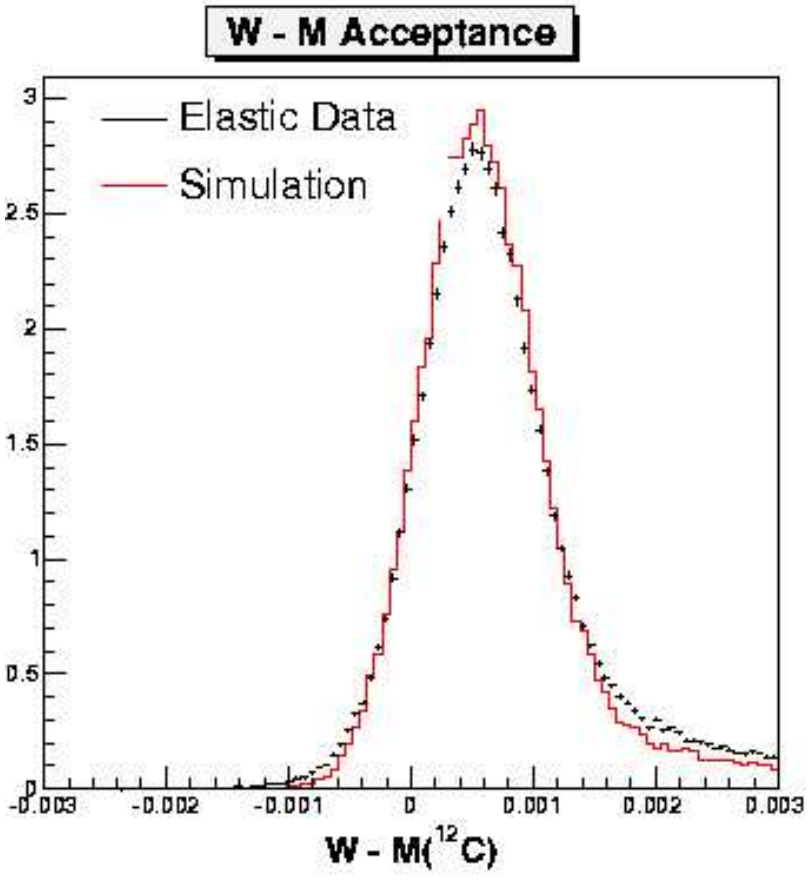
After Scattering

Material	Thickness (cm)	RL Uncertainty (%)	RL (X_0)
^{12}C	0.0128	5.0	6.79 x 10^{-4}
^4He	101.2	5.0	1.92 x 10^{-4}
Polystrene	5.04	0.4	3.63 x 10^{-3}
^4He	78.9	5.6	1.49 x 10^{-4}
Polystrene	5.04	0.4	3.63 x 10^{-3}
^4He	20.32	15.0	3.85 x 10^{-5}
Kapton	0.0178	2.8	8.88 x 10^{-4}
Total	210.5	2.8	9.20 x 10^{-3}

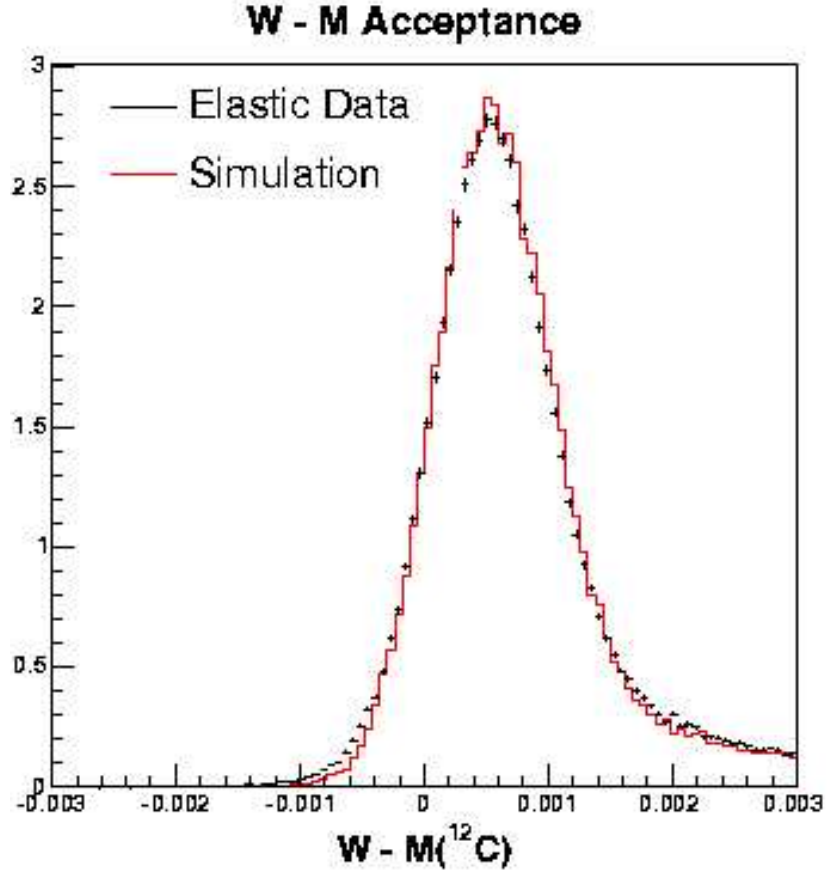
Missing Material?

- Studied possibility of additional material (ice?).
- Adjusted raditation lengths and resolution to match elastic tail.
- About 2 times (4 mm of ice) RL gives good agreement.
- Cross section then agrees within 5%.

Missing Material?



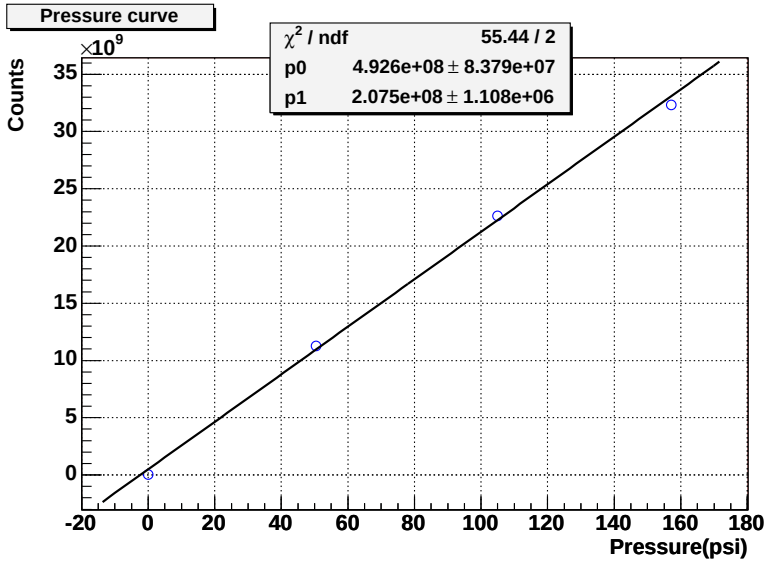
Nominal RL

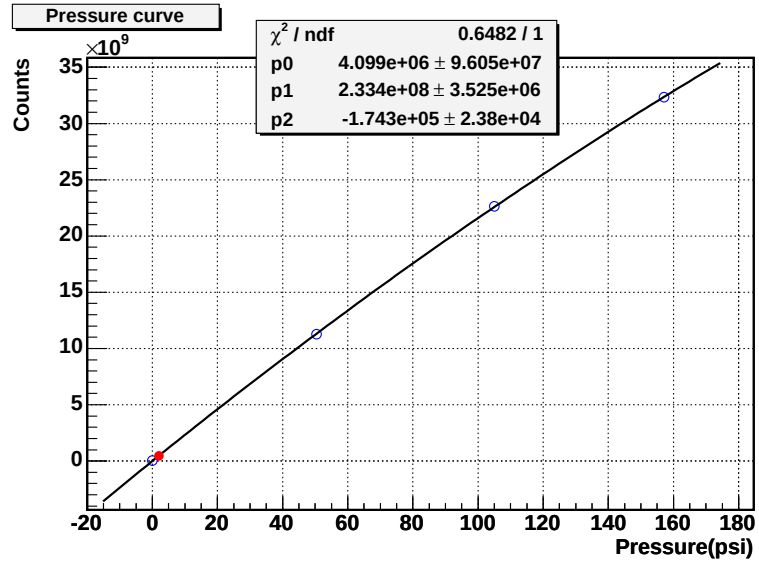


Added RL

VDC high rate (multi-track) efficiency

- Used N_2 pressure curve data to determine inefficiency of cutting multi-track events.
- Obtained yields of Nitrogen and carbon runs with acceptance and PID cuts.



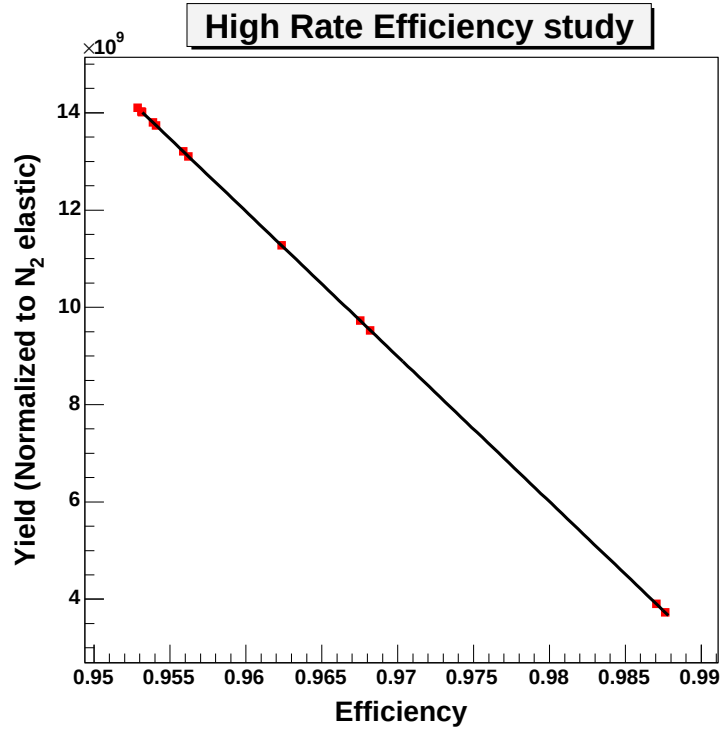


from Xiaohui Zhan

VDC high rate (multi-track) efficiency

- Efficiency is deviation of pressure curve from a straight line.
- Improved cross section agreement by $\sim$ 2%.

$$\epsilon_{1-\mathrm{track}} = \frac{p_0+p_1x+p_2x^2}{p_0+p_1x}$$



VDC high rate (multi-track) efficiency

Target	δ (%)	Run	ϵ_{VDC} (Data)	ϵ_{VDC} (N_2)
Carbon	+2	2391	0.9457	0.9682
Carbon	+2	2392	0.9534	0.9675
Carbon	0	2393	0.9562	0.9559
Carbon	0	2394	0.9552	0.9562
Carbon	-2	2401	0.9095	0.9532
Carbon	-2	2402	0.9117	0.9529
Carbon	-2	2403	0.9141	0.9531
Empty	-2	2408	0.9697	0.9870
Carbon	-4	2410	0.9078	0.9541
Carbon	-4	2411	0.9086	0.9539
Empty	-4	2412	0.9687	0.9876
Nitrogen (35 psig)	Elastic	2465	0.9240	0.9623

Systematic Uncertainties

Simulation

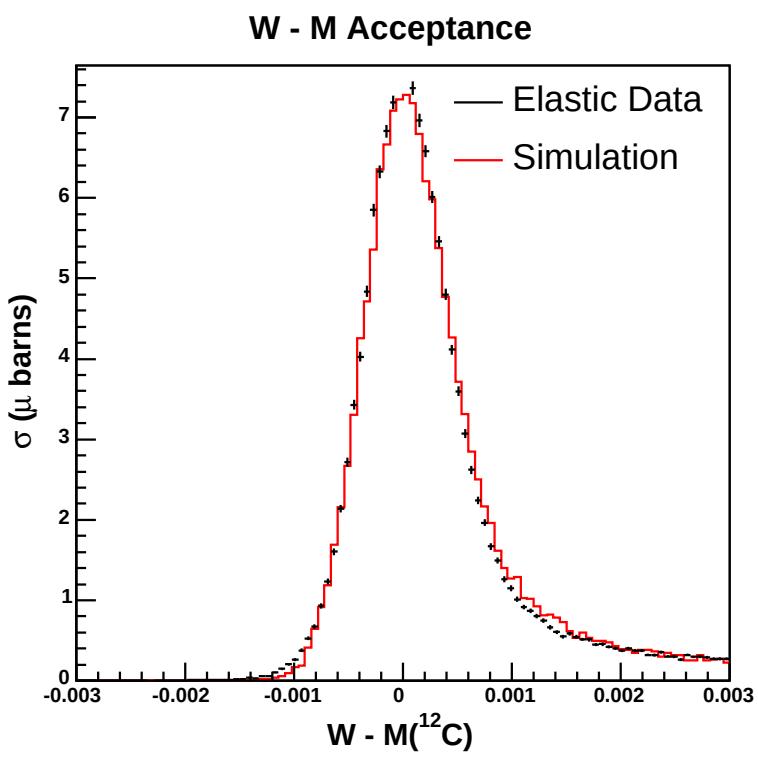
Source	δ	$\delta\sigma$	Comments
Statistics		negligible	
Form Factors	$\pm$ 1%	$\pm$ 2%	
Acceptance		$\pm$ 7%	$\phi_{\rm tg}$ cut study
Radiative Corrections	$\pm$ 5.6% and $\pm$ 2.8%	$\pm$ 0.6%	incident and scattered
Total		$\pm$ 7.3%	

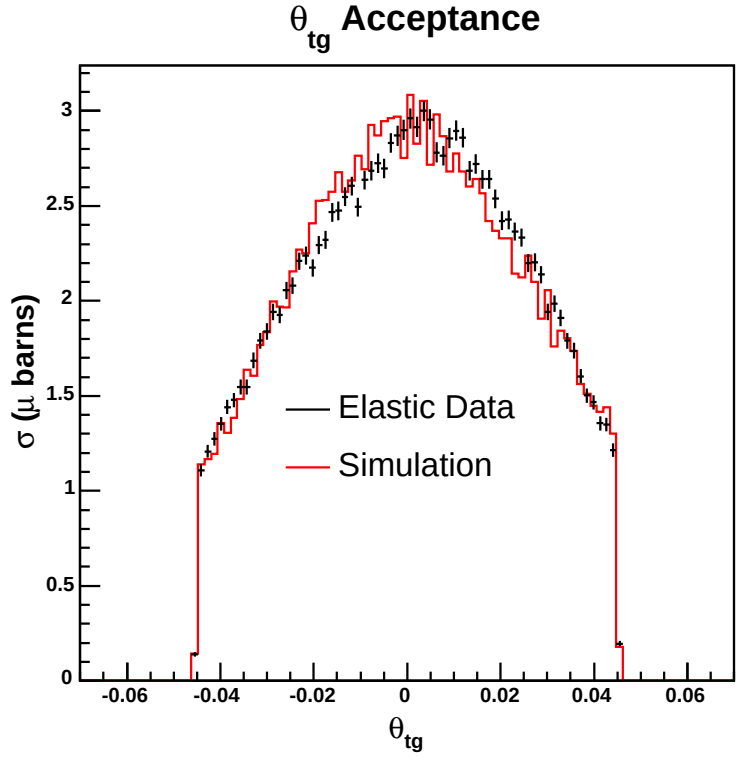
Systematic Uncertainties

Experimental

Source	δ	$\delta\sigma$	Comments
Statistics		$< 0.5\%$	
Beam Current	$\pm$ 1%	$\pm$ 1%	
Foil Density	$\pm$ 1%	$\pm$ 1%	Preliminary
Tracking Effi ciency	$\pm$ 1.8%	$\pm$ 2.2%	using N_2 pressure curve
Background Subtraction	$\pm$ 0.9%	$\pm$ 0.2%	from tracking effi ciency
Background Subtraction		$< \pm$ 2%	from using -2% data for 0 %
Energy	$\pm$ 1 MeV	$< \pm$ 0.5%	
Scattering Angle	$\pm$ 0.7%	$\pm$ 6.6%	0.5 mm uncertainty from survey
Collimator Positions	$\pm$ 250 microns	$\pm$ 5.8%	Should be rechecked
Total		$\pm$ 9.4%	

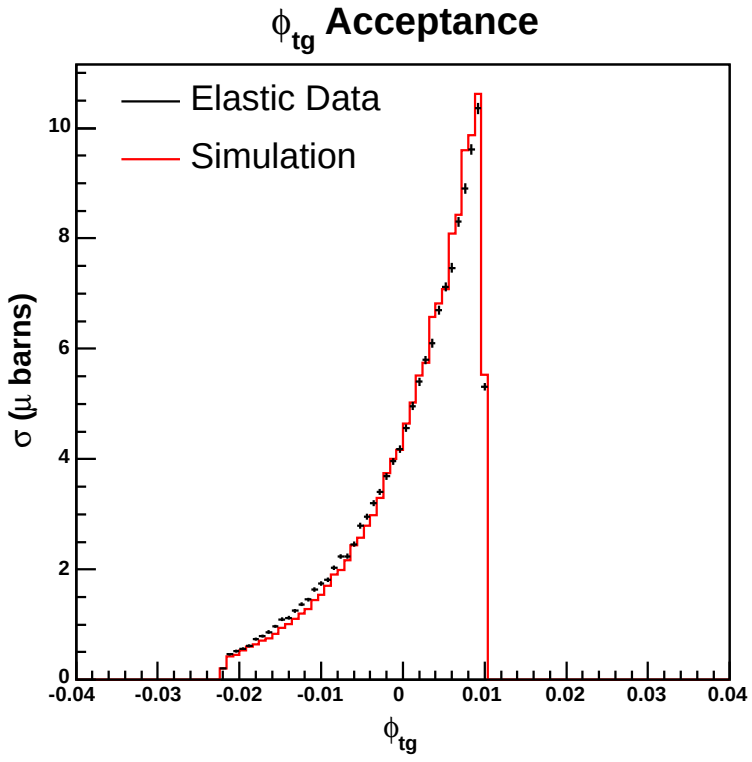
Data and MC Comparison

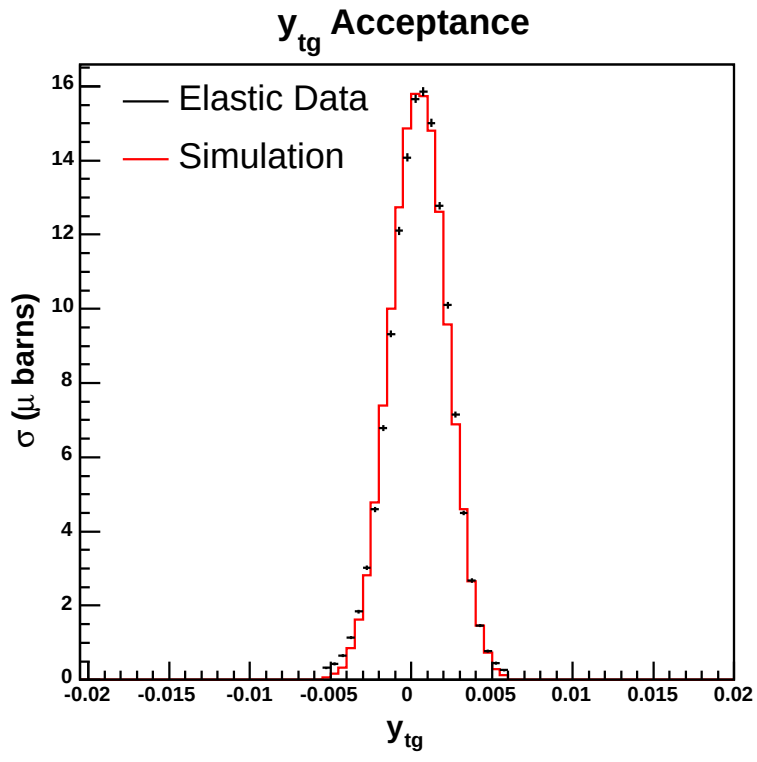




Absolute Comparison!

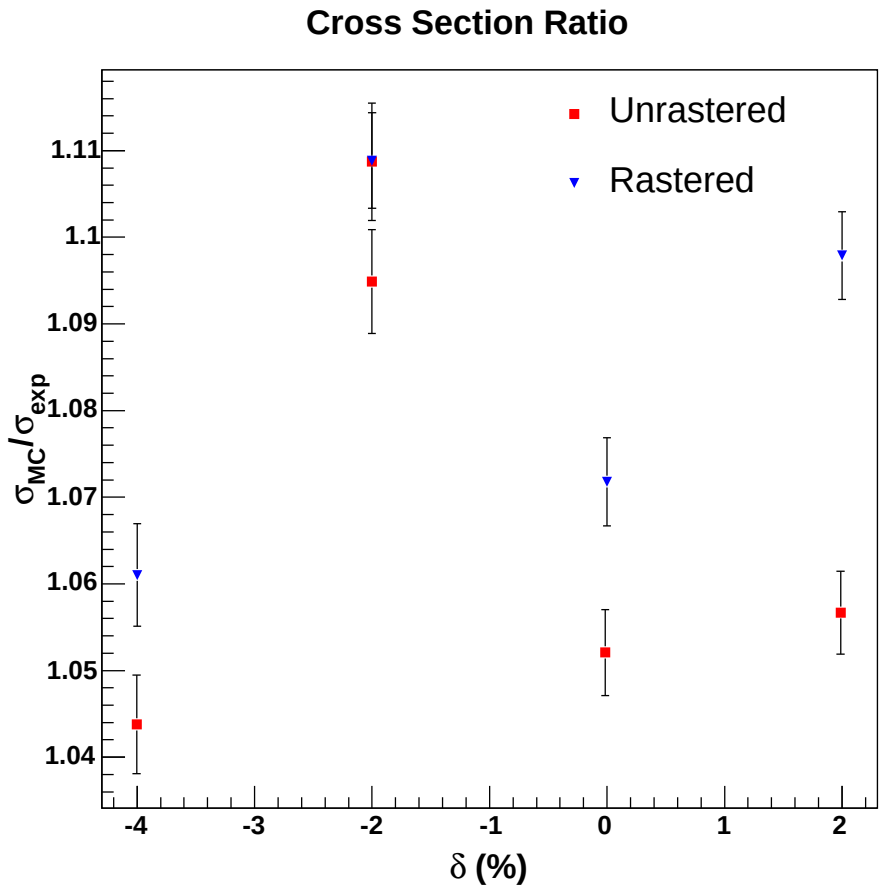
Data and MC Comparison





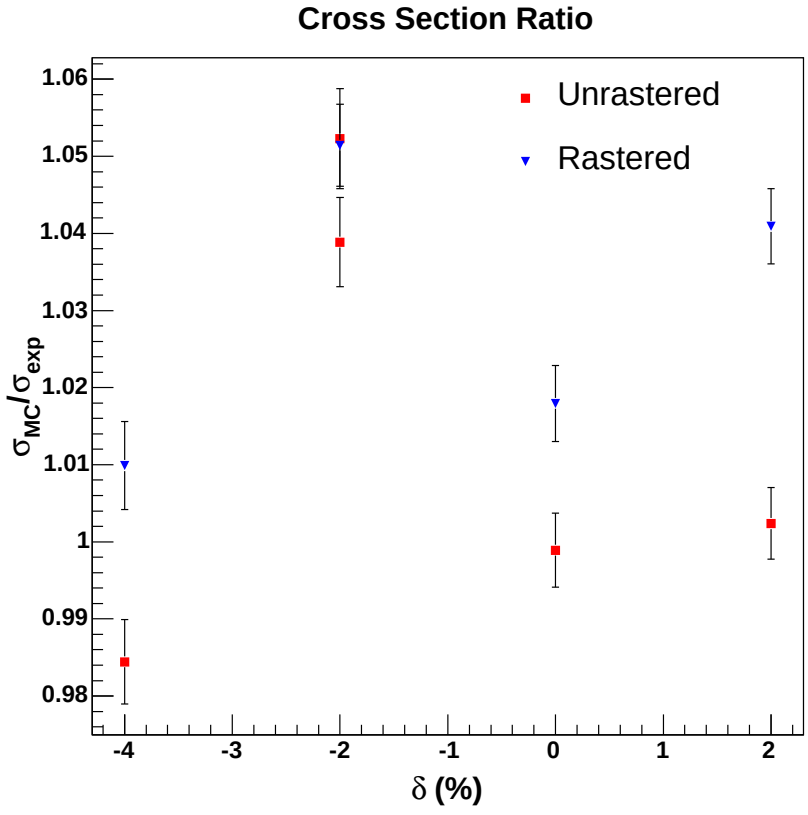
Absolute Comparison!

δ Comparison of $\sigma_{\mathrm{MC}}/\sigma_{\mathrm{exp}}$



Scattering Angle

- Matched simulation to data at 0% (6.022°).
- Possible overall angle offset, but witin uncertainity (0.04°).



Other Systematics

- Beam position cut (rastered runs): Small difference $<$ 0.5%.
- Added vertical and horizontal beam angles to MC.
- Angles are $<<$ 0.01^{o} and have little effect.

Other Systematics

- $\theta_{\rm tg}$ cut study:
  - Looked at slices in $\theta_{\rm tg}$ to check elastic tail versus vertical acceptance (ice check).
  - Elastic tail is fairly uniform versus $\theta_{\rm tg}$.

Other Systematics

- $\theta_{\rm tg}$ cut study:
  - The cross section ratio is not and is significantly worse at negative $\theta_{\rm tg}$.

$\theta_{\rm tg}$ cut (mrads)	$\sigma_{\rm exp}$ (μbarns)	$\sigma_{\rm MC}$(μbarns)	Ratio
$\pm$ 55	115.86	129.97	1.1086
20 to 40	123.14	131.00	1.0512
0 to 20	169.85	182.41	1.0614
-20 to 0	161.85	180.68	1.1032
-35 to -20	116.92	134.73	1.1387
-55 to -35	60.10	64.38	1.0586

Issues

- Unknown radiation lengths (ice, etc.): $\sim$ 9.7%.
- Scattering angle, there are possible checks: $\sim$ 6.6%.
- Sensitivity to $\theta_{\rm tg}$ acceptance: $<$ 2% or $\sim$ 5%.
- Difference in unrastered versus rastered: $\sim$ 1–2%.
- The 1.096 GeV data is not useful due to background.

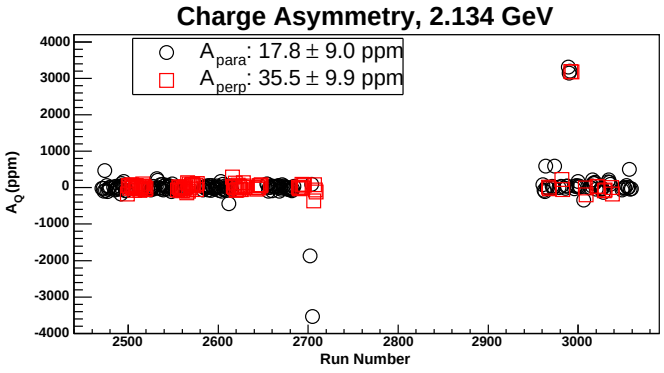
Still To Do

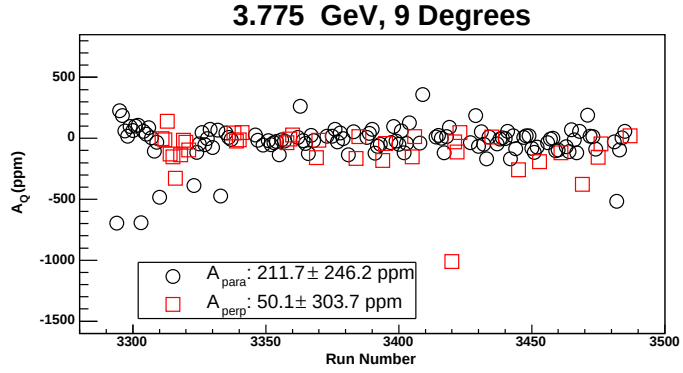
- ^{3}He and N_2 elastic analysis (Jaideep).
- Finalize systematics for ^{12}C elastic analysis.
- Acceptance study at 9°.

^{3}He Asymmetry Analysis

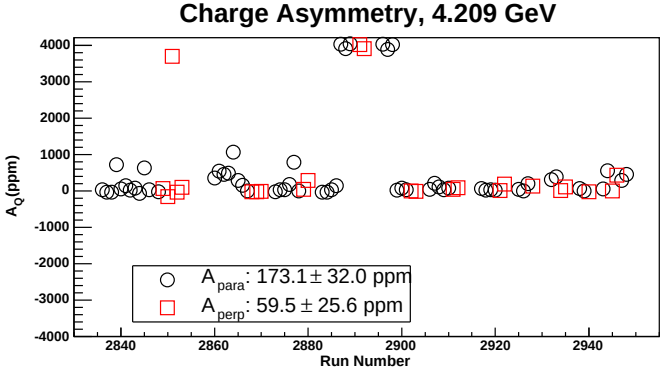
- Replayed all the second period data at 6° and 9°.
  - 6°: 276 GB.
  - 9°: 356 GB.
- Overview:
  - Began with tight PID cuts.
  - Checked A_{Q} and A_{LT}.
  - Removed short runs < 0.5 M events.
  - Used dilution factors from Xiaohui Zhan.
  - Obtained P_{t} and P_{b} from Jaideep.

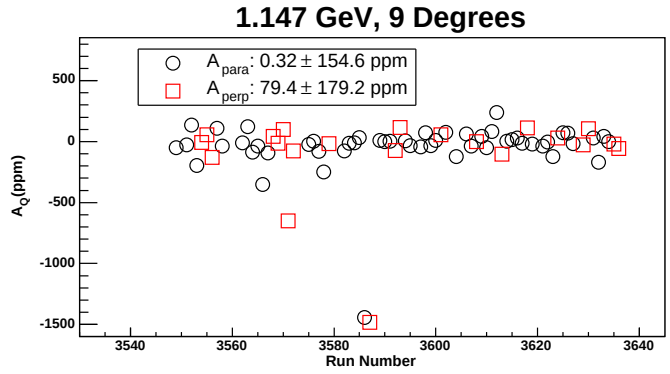
Charge Asymmetry

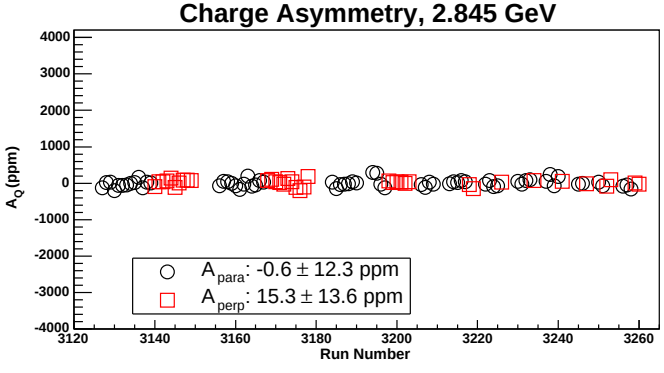


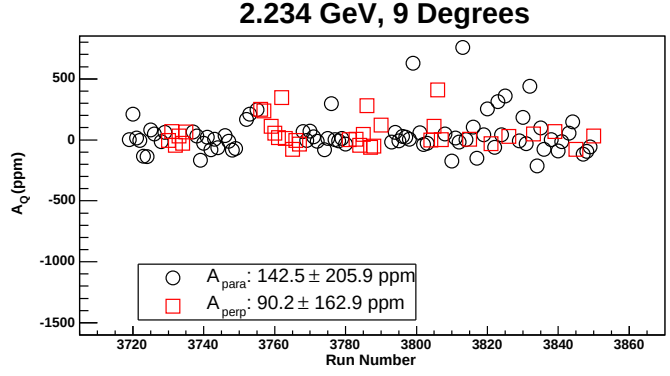


$A_Q < 500$ ppm!

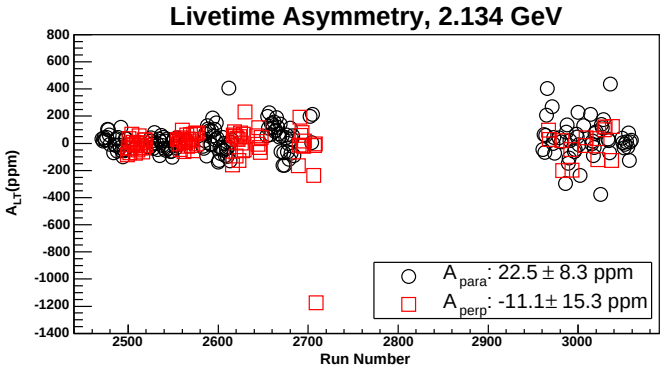


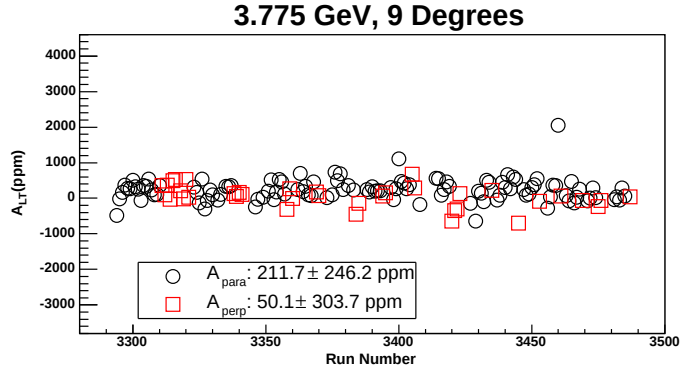




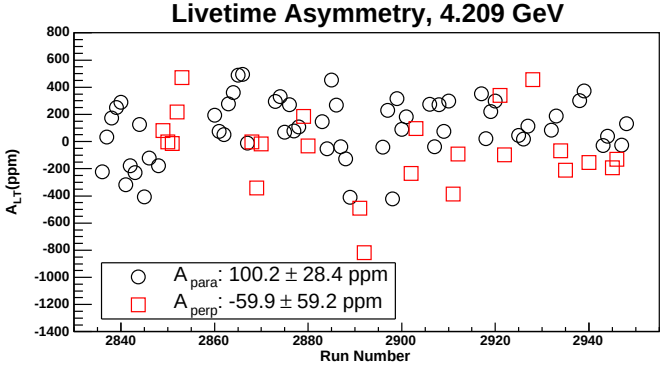


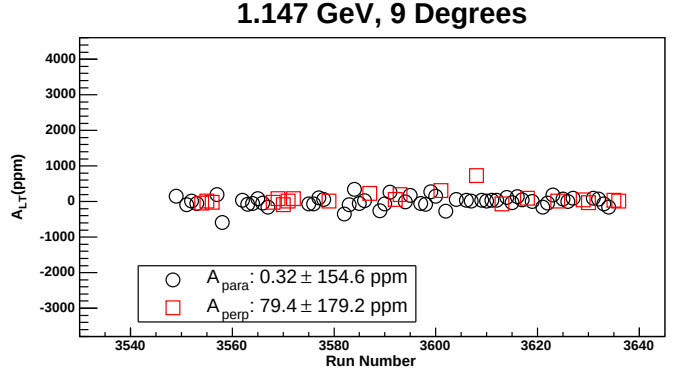
Livetime Asymmetry

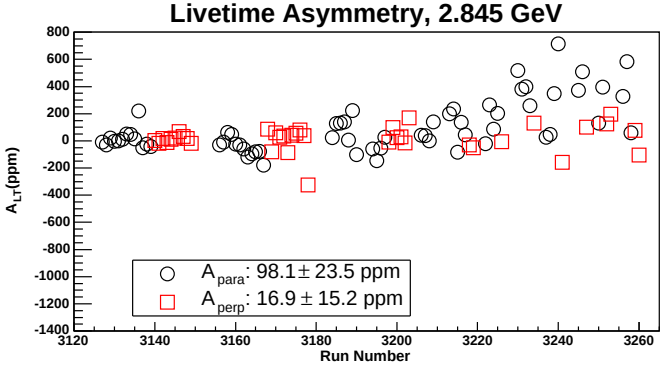


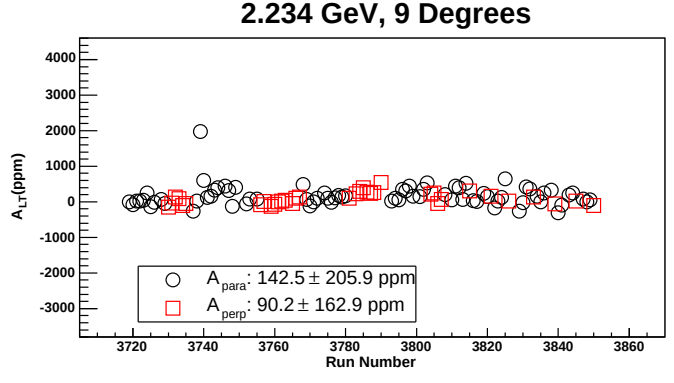


$A_{\mathrm{LT}} < 400$ ppm!

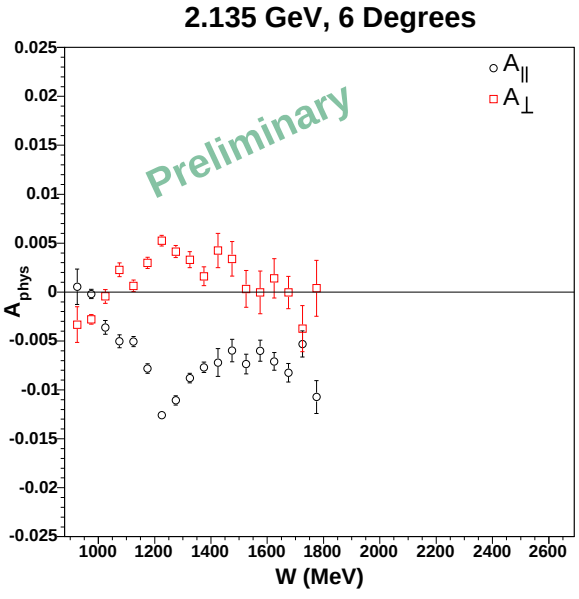


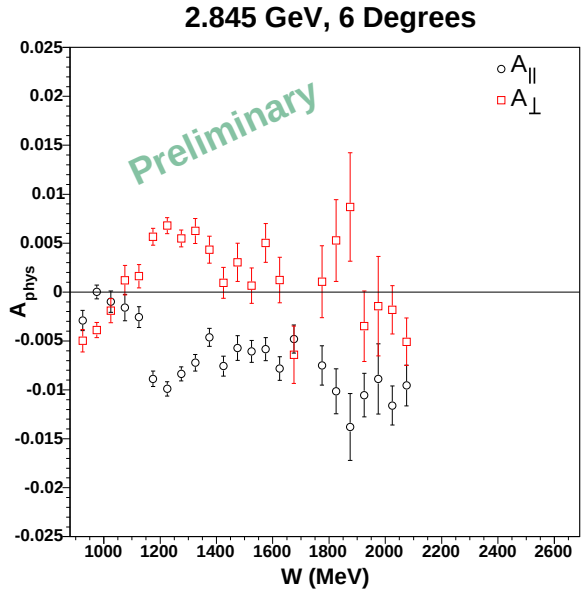


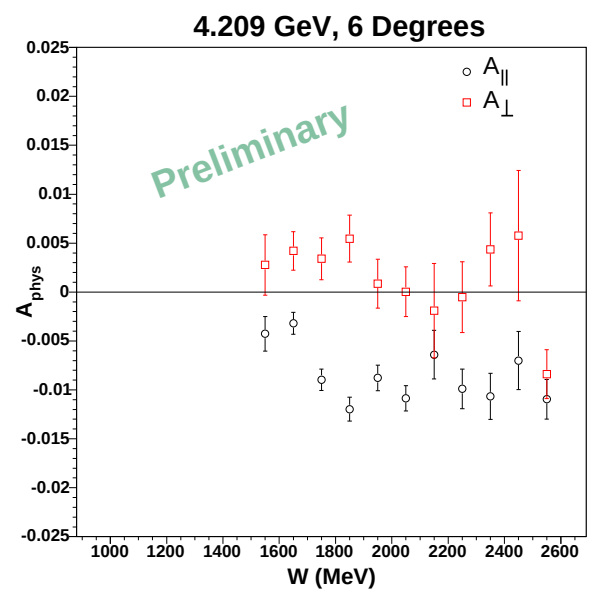




^{3}He Asymmetries

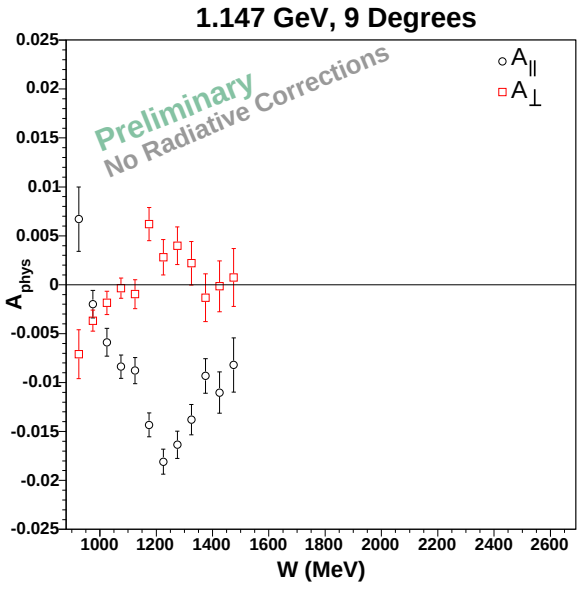


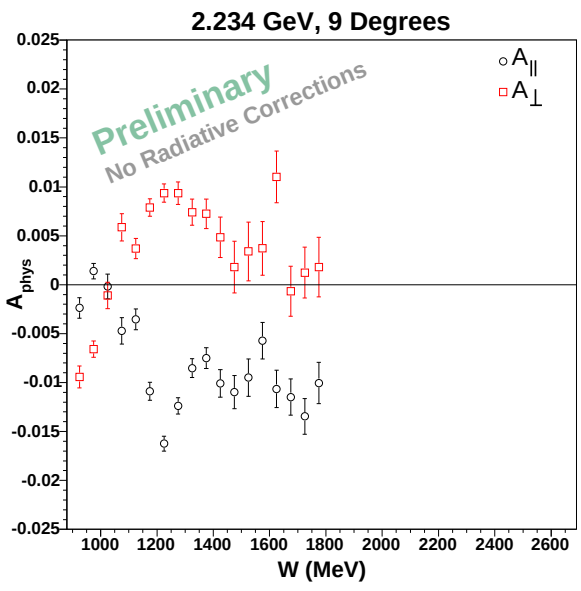


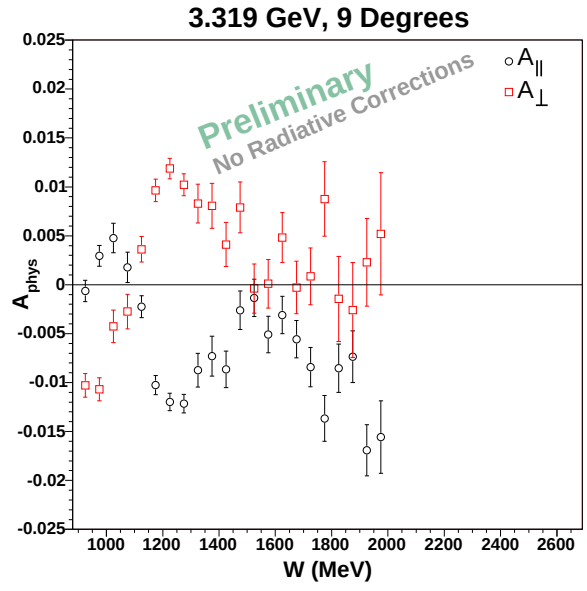


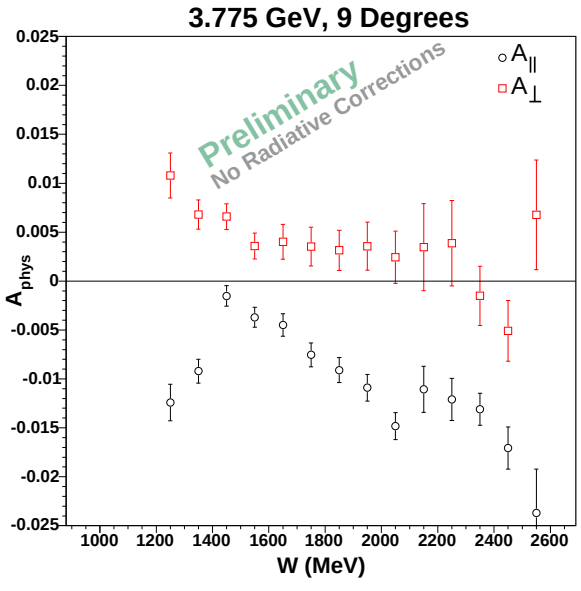
No Radiative Corrections!

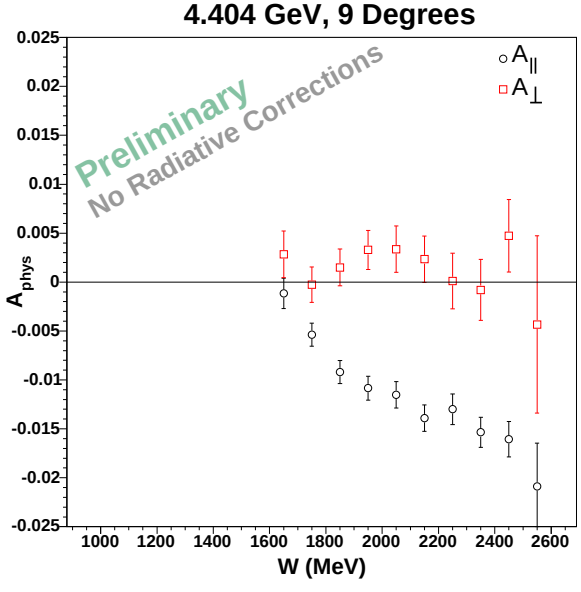
^{3}He Asymmetries



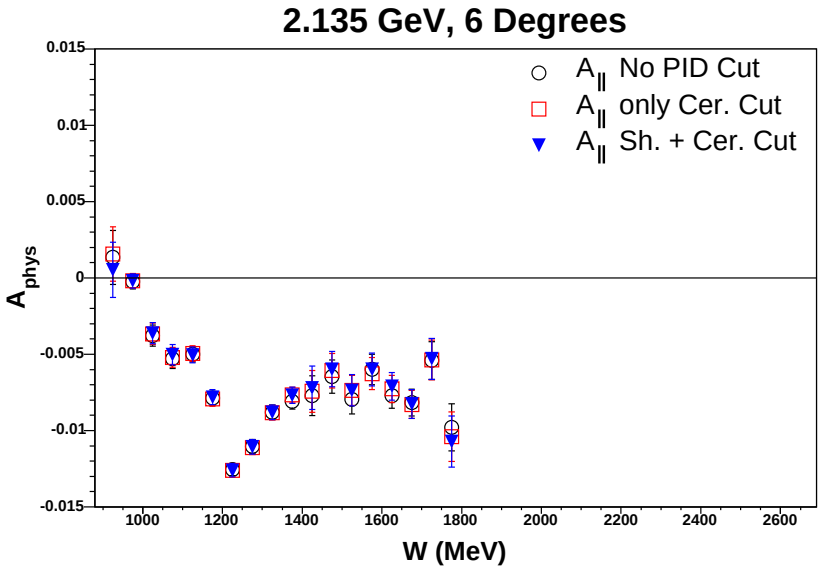


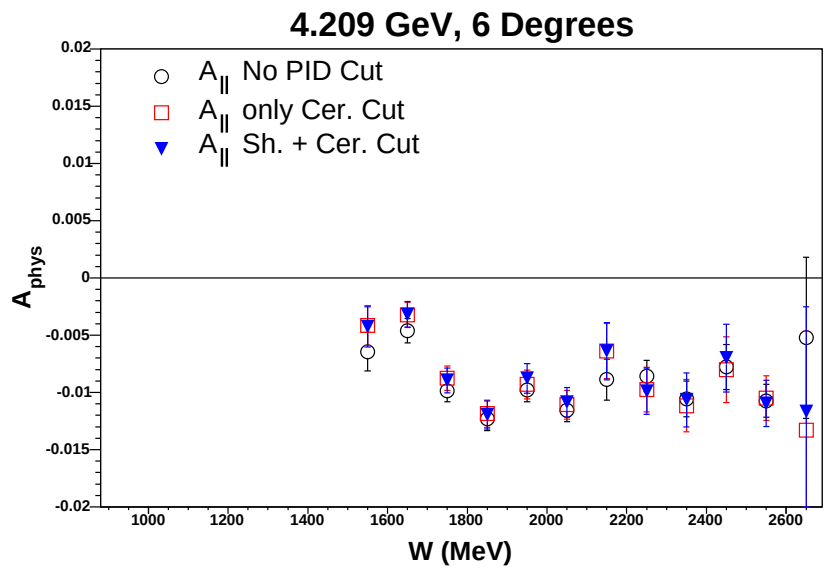


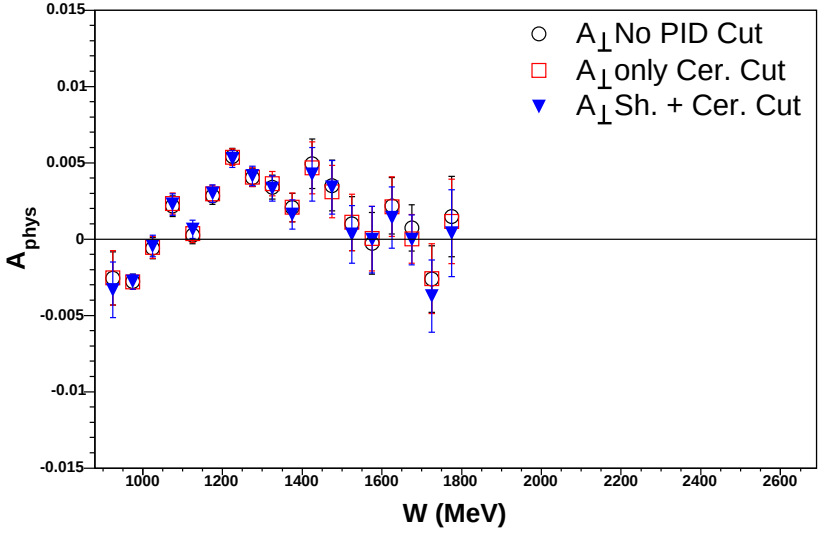


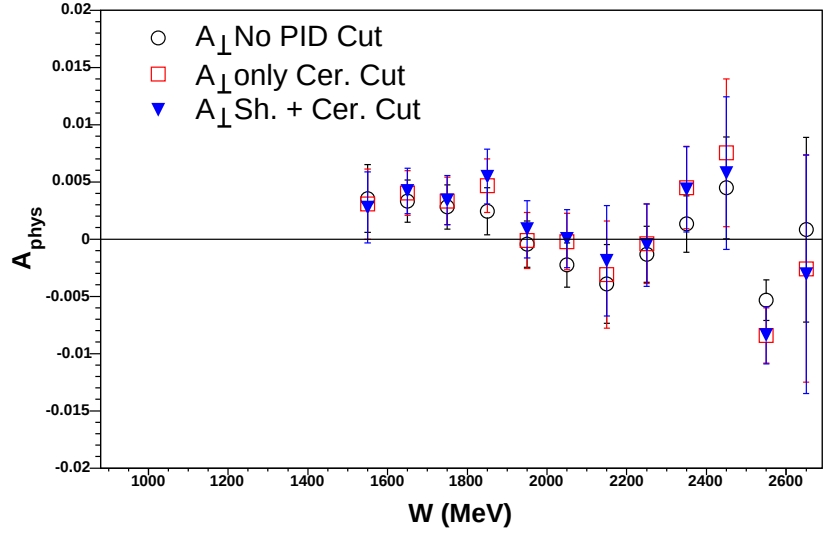


PID Cut Study









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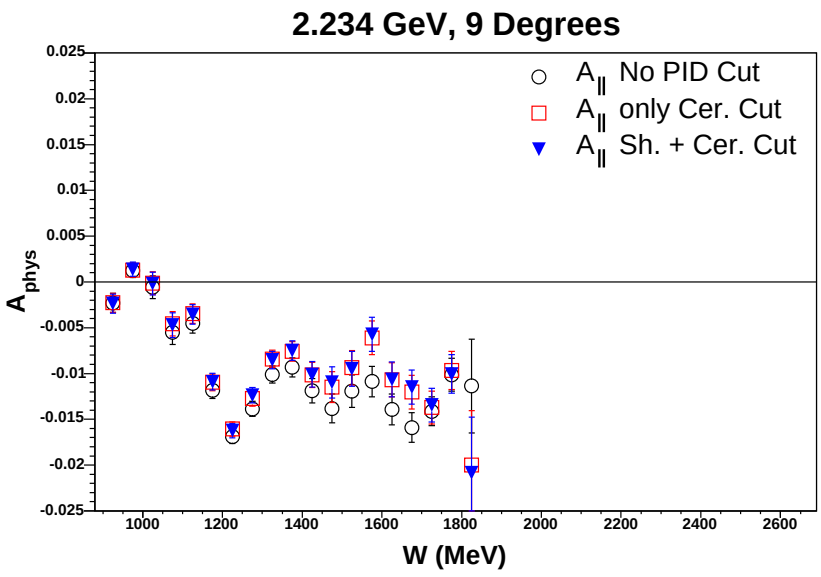
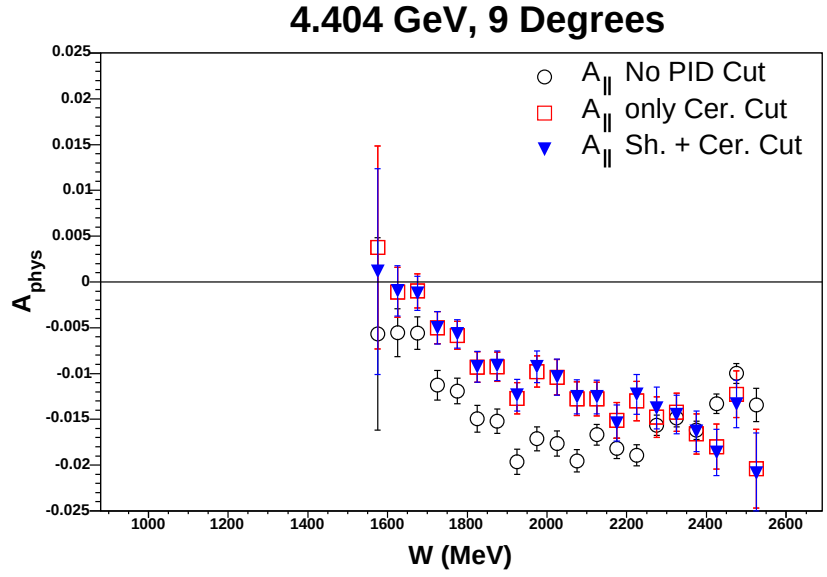
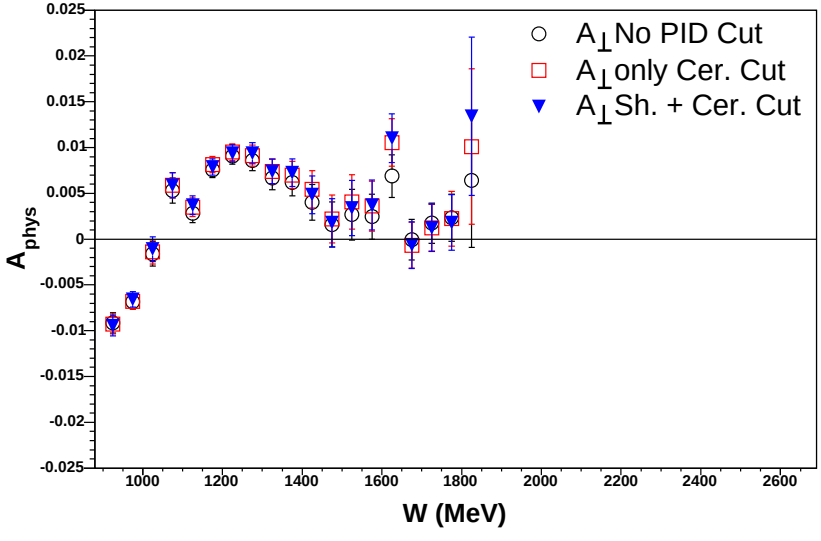
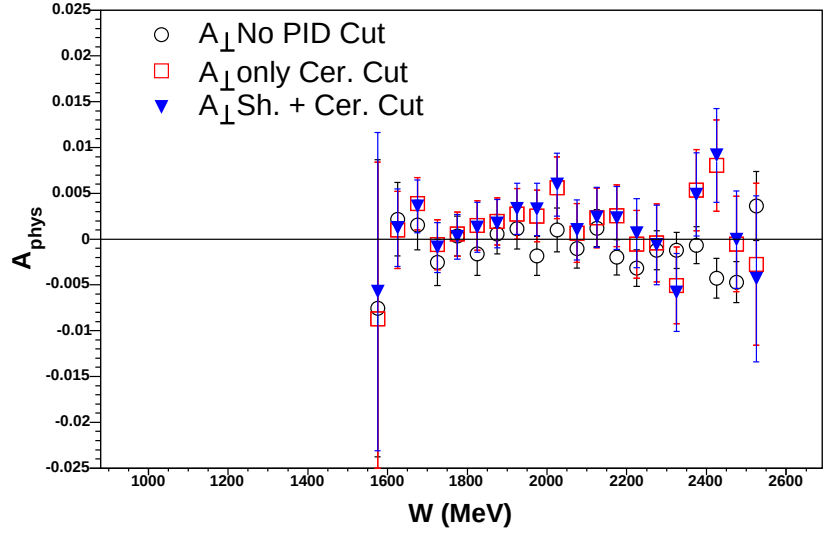
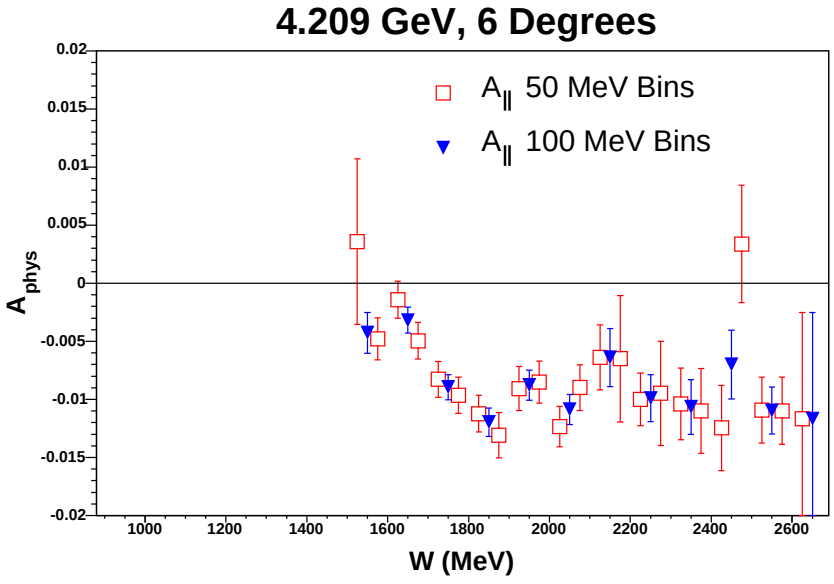


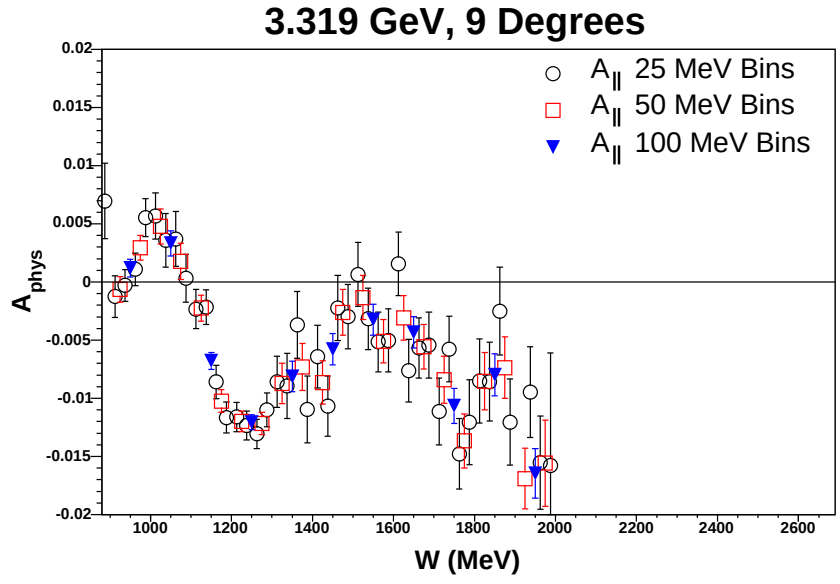


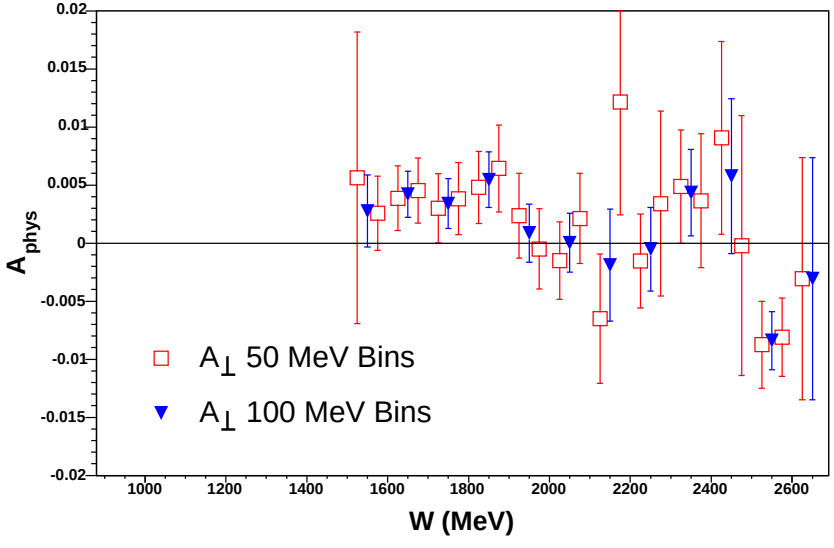


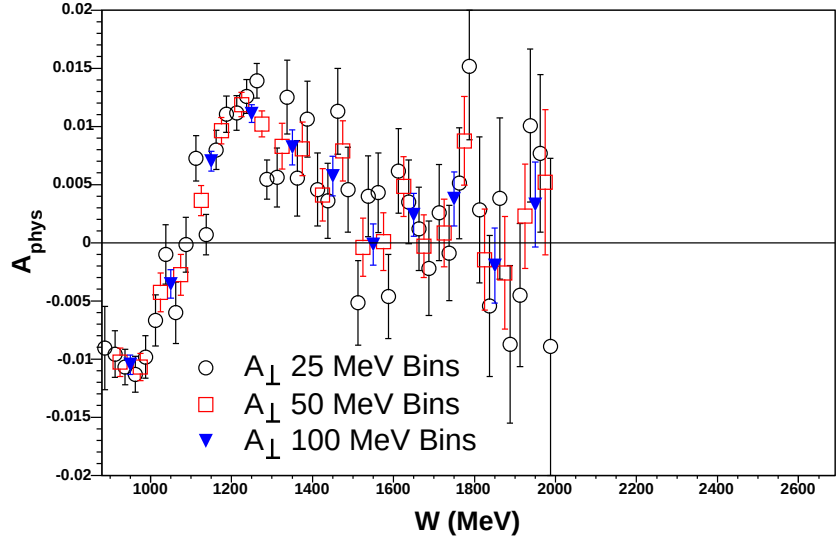


W Bin Size Comparison



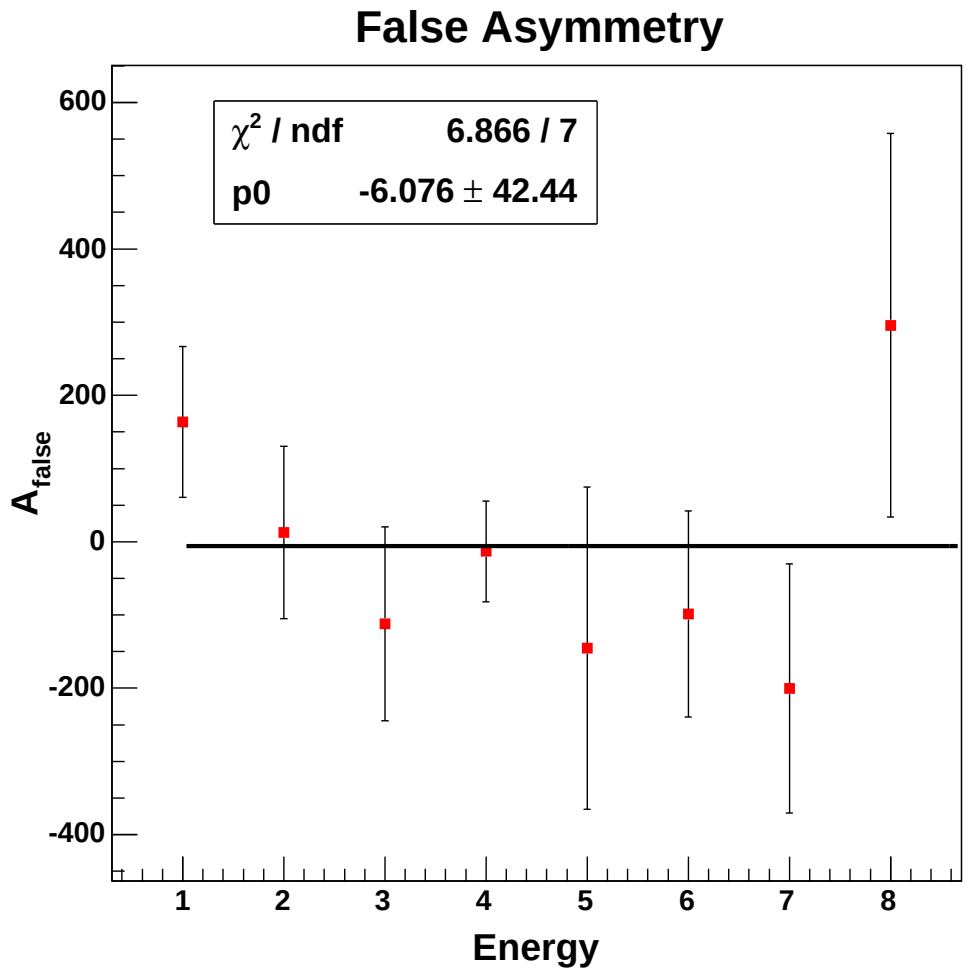




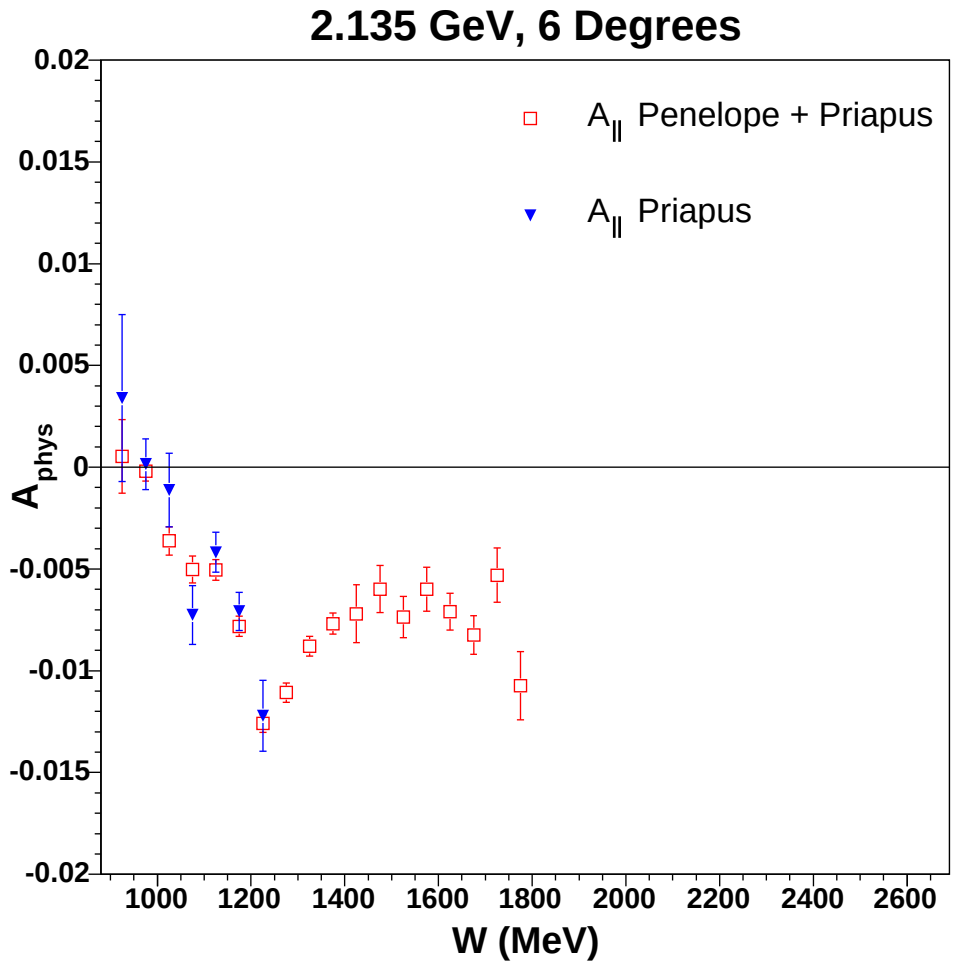


False Asymmetry

- From nitrogen and empty reference cell runs.



Cell Comparison



Remaining Items

- Check Pion Asymmetries.
- Resolve issue with prescale factors and uncertainties (T. Holmstrom).
- Write Asymmetry and BCM technotes.

Near Term Plan

- Acceptance study at 9°.
- PID cut effi ciency study.
- Collimator background study (T. Holmstrom).
- Unpolarized cross section analysis.
- Radiative Corrections (R. Feuerbach).