LHRS Analysis for d_2^n

SAMC and Acceptance Cut Study

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Outline

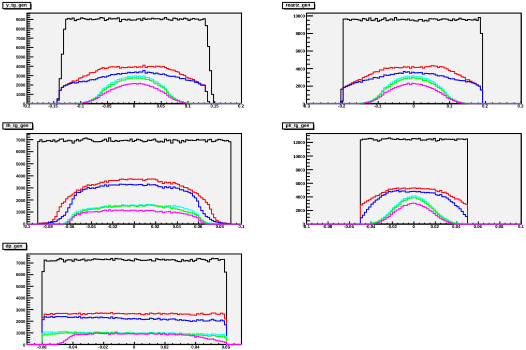
Adjustments (1)
Some Changes Made to SAMC

- Previously, the A_{eff} and Z_{eff} terms for the glass ^{3}He cell were wrong
  - Directly affects the radiation length of glass
- Found a bug in the way the scattering length in ^{3}He was calculated
- Found a bug in the Simpson integration method, used in calculating the radiative tails (for the cross section)
  - Problem partially solved: still crashes for $p_0 \neq 600\ \text{MeV}$...

Aperture Cut Study (1)

How Do the Distributions 'Evolve' as the Particle Traverses the LHRS?

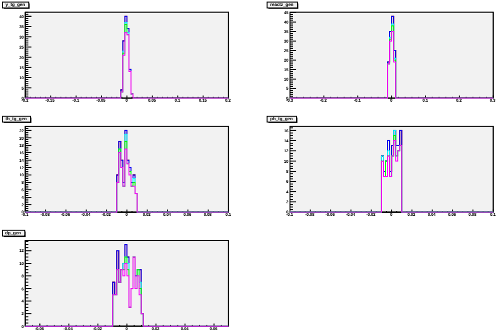
- Left to right, starting from the top: y_{tg}, Z_r, θ_{tg}, ϕ_{tg}, $\delta p/p$



- Black = No cuts
- Red = Passed Q1 exit
- Blue = Passed dipole entrance
- Cyan = Passed dipole exit
- Green = Passed Q3 entrance
- Magenta = Passed Q3 exit
- These cuts are cumulative as we go along!

Aperture Cut Study (2)

Narrow Bin Cut: What Percentage (w) Gets Through?



- $\Delta\theta = 20$ mrad
- $\Delta\phi = 20$ mrad
- $\Delta Z_r = 1.0$ cm
- $\Delta y_{tg} = 1.0$ cm
- $\Delta p/p = 1.0\%$
- $w = 0.8361 \pm 0.1122$

Aperture Cut Study (3)

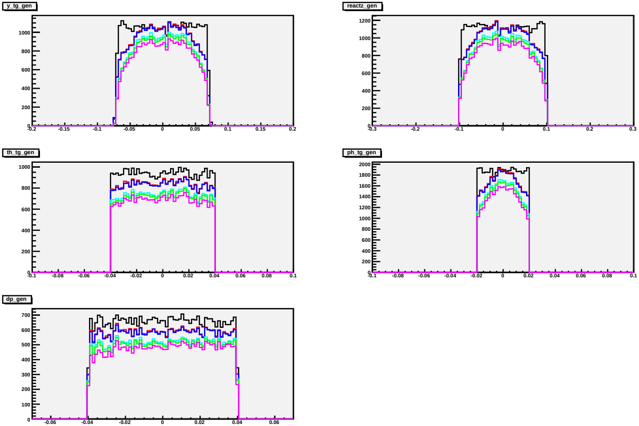
Narrow Bin Cut: A Closer Look by Aperture

Weight Factors by Aperture	
Aperture	w
Q1 (ex)	1.0000 ± 0.1280
D (en)	1.0000 ± 0.1280
D (ex)	0.9016 ± 0.1185
Q3 (en)	0.8770 ± 0.1162
Q3 (ex)	0.8361 ± 0.1122

- Remember we have chosen a central bin for this study – this is why everything passes through Q1
- 10% drop from entering Q1 to exiting D
- Lose another 7% upon exiting Q3 $\Rightarrow$ lose 17% total
- Within the statistical errors however, just about everything passes through

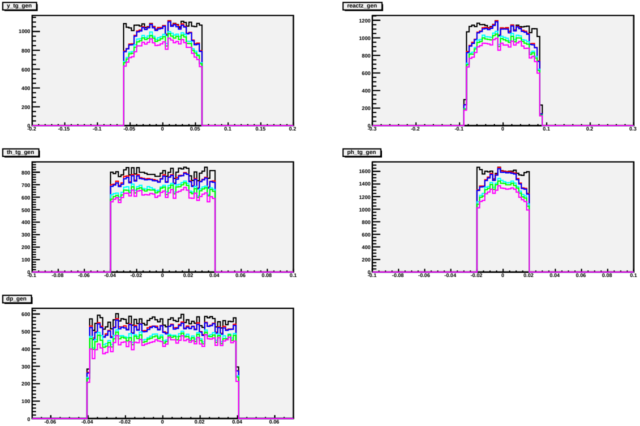
Target Cut Study (1)

Cut Set 1 (All Aperture Cuts are Shown in the Various Colors)

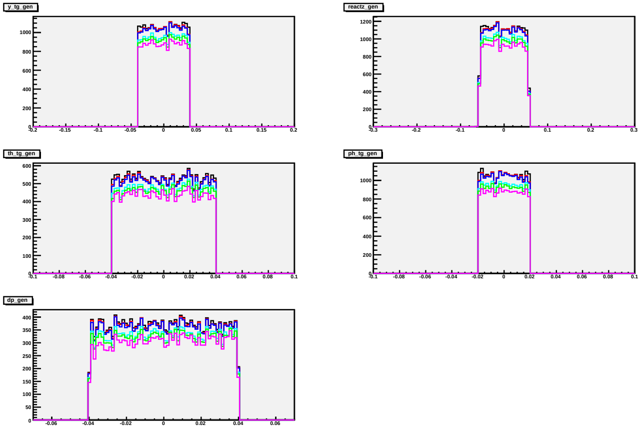


Target Cut Study (2)

Cut Set 2 (All Aperture Cuts are Shown in the Various Colors)



Target Cut Study (3)
Cut Set 3 (All Aperture Cuts are Shown in the Various Colors)



Target Cut Study (4)
Summary: A Few Different Cut Sets

Cut Sets for Acceptance Study [Full Widths]						
Set #	$\delta p/p$ (%)	θ_{tg} (mrad)	ϕ_{tg} (mrad)	y_{tg} (cm)	Z_r (cm)	w
1	7	80	40	16	20	0.7268 ± 0.0058
2	7	80	40	12	20	0.7764 ± 0.0066
3	7	80	40	9	20	0.8250 ± 0.0084

- Largest variation seen in y_{tg}
  - Cut choices for all other variables are chosen so as to avoid edge effects (especially in $\delta p/p$, θ_{tg})
  - Decided upon a cut of $\Delta\phi_{tg} = 40$ mrad: A wider cut includes the fall-off in ϕ_{tg}, $\Rightarrow y_{tg}$ shows variation (see the appendix)
- Note how ϕ_{tg} changes with the change in y_{tg}
  - Considering that the other target variable distributions do not change much in terms of shape, it seems that the best cut on y_{tg} is the one corresponding to cut set 3 because ϕ_{tg} tends to behave consistently across the chosen range of $\Delta\phi_{tg} = 40$ mrad (the widest acceptable range in ϕ_{tg})

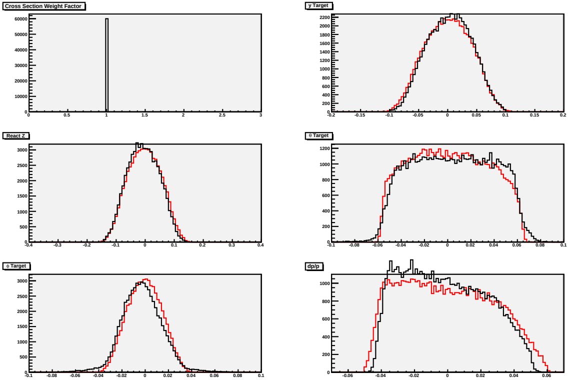
Cross Section-Weighted Distributions (1)

Method and Motivation

- While SAMC does include multiple scattering and energy loss effects, there is no direct application of the cross section to the reconstructed variables.
- We can add this effect in by weighting the reconstructed variables by the cross section:
  - For the i^{th} event, apply the weight factor $f_i = \sigma_i / \sigma_{\text{avg}}$
  - σ_i is the cross section for the i^{th} event
  - σ_{avg} is the average cross section from the SAMC run
- σ is calculated with contributions from:
  - Elastic tail
  - Quasi-elastic tail (utilizes the peaking approximation and accounts for Fermi Motion in the nucleus)
  - 'Dip' region (corresponding to $W_R = 1500, 1700\,\text{MeV}$)
  - DIS region
  - The tails are also corrected for soft photon radiation

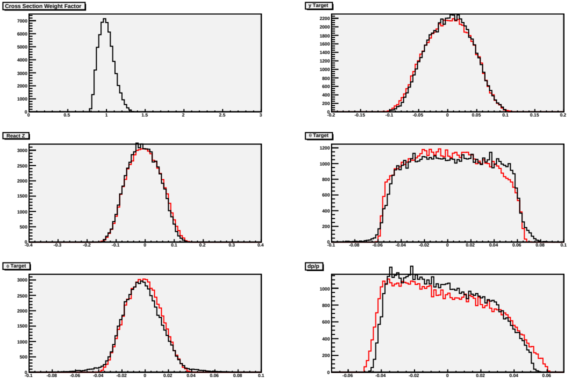
Cross Section-Weighted Distributions (2)

Comparison of Data to SAMC Before Cross Section Weighting: Target Variables



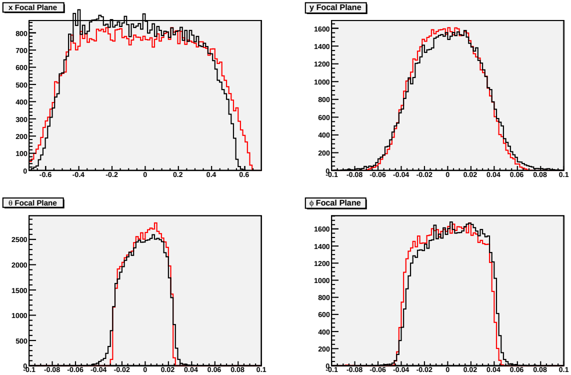
Cross Section-Weighted Distributions (3)

Comparison of Data to SAMC After Cross Section Weighting: Target Variables



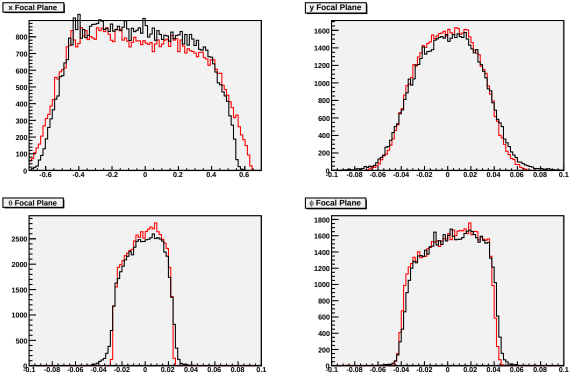
Cross Section-Weighted Distributions (4)

Comparison of Data to SAMC Before Cross Section Weighting: Focal Plane Variables



Cross Section-Weighted Distributions (5)

Comparison of Data to SAMC After Cross Section Weighting: Focal Plane Variables



Summary

- Aperture cuts:
  - It's clear from the plots that the dipole exit is the aperture that's doing the most in terms of defining the 'final' shape of our distributions in each variable (except for $\delta p/p$)
- Target cuts:
  - Changing the width in y_{tg} causes a variation in w up to 10% in this study
  - Cut set 3 shows that a cut on $\Delta y_{tg} = 9 \text{ cm}$ has little effect on the shape of all the other target variable distributions while maintaining a good weight factor (~ 0.82)
- Cross Section-Weighting:
  - SAMC should give another simulation (in addition to QFS) to check our cross sections against
  - Weighting the target variable (and focal plane) distributions by the cross section has little effect on most variables; however, one does see a change in ϕ_{tg}, ϕ_{fp}

What's Next?

- Debug SAMC concerning Simpson integration method
  - So we can plot the σ vs. p_0, ν, etc.
- Apply new acceptance cuts to the cross section calculation
- Get nitrogen cross section and dilution factor

Appendix (1)

Cut Set 4: Wide ϕ_{tg} Cut Study

- $\Delta\phi_{tg} = 50$ mrad
- All cuts on all variables are the same as cut set 3 (see next slide for plots)
- It was found that a variation of $\Delta\phi_{tg}$ from 20–40 mrad showed little to no change in the shape of the other target variable distributions. The weight factor $w \sim 0.82 \pm 0.01$ for such a study (the error bar is to show the range of w, and is not the statistical error bar as is assumed otherwise)
- Cut set 4 yields a weight factor of $w \sim 0.71$, a $\sim 10\%$ drop from the tighter ϕ_{tg} cuts

Appendix (2)

Cut Set 4: Wide ϕ_{tg} Cut Study