

Systematic Uncertainty Study (HMS delta) and finally Volume Systematic Uncertainty for $Q^2 = 0.38 \text{ GeV}^2$ analysis

(HMS delta)

Conducted from the Unseparated Cross-Section

$$\sigma_{\text{Exp}} = (Y_{\text{DATA}} / Y_{\text{SIMC}}) \times \sigma_{\text{Model}}$$

- **Standard Cut (-8.0 to +8.0)**
 - Calculated the yield ratio ($Y_{\text{DATA}}/Y_{\text{SIMC}}$) for each bin.
 - Performed an error-weighted average over 16 φ bins for each of the 7 t bins. This resulted in the final yield ratios for the 7 t bins under **the standard cut conditions**.

Conducted from the Unseparated Cross-Section

$$\sigma_{\text{Exp}} = (Y_{\text{DATA}} / Y_{\text{SIMC}}) \times \sigma_{\text{Model}}$$

- **Standard Cut Changed by -10%**
 - Calculated the yield ratio ($Y_{\text{DATA}}/Y_{\text{SIMC}}$) for each bin.
 - Performed an error-weighted average over 16 φ bins for each of the 7 t bins. This resulted in the final yield ratios for the 7 t bins under **the -10% standard cut changed conditions**.

Conducted from the Unseparated Cross-Section

$$\sigma_{\text{Exp}} = (Y_{\text{DATA}} / Y_{\text{SIMC}}) \times \sigma_{\text{Model}}$$

- Determined the difference in the yield ratio between the standard and modified cuts across 7 t-bins.

t bin	HMS delta -10% systematic Uncertainty (absolute)
t1	0.0108
t2	0.0386
t3	0.0520
t4	0.0500
t5	0.0575
t6	0.0489
t7	0.0505

Volume Systematic Uncertainty

- Determined **quadrature sum** of all variables (delta (-), xptar (\pm) and yptar (\pm)) for both spectrometers.

t bin	Volume systematic Uncertainty (absolute)
t1	0.012778
t2	0.039315
t3	0.060992
t4	0.052632
t5	0.065374
t6	0.051762
t7	0.051298