KaonLT Meeting

May 15th, 2025

Richard L. Trotta

$$\sigma_L = (p_1 \cdot f_t) \cdot e^{-p_2|t|}$$

$$\sigma_T = \frac{p_5}{|t|^{p_6}}$$

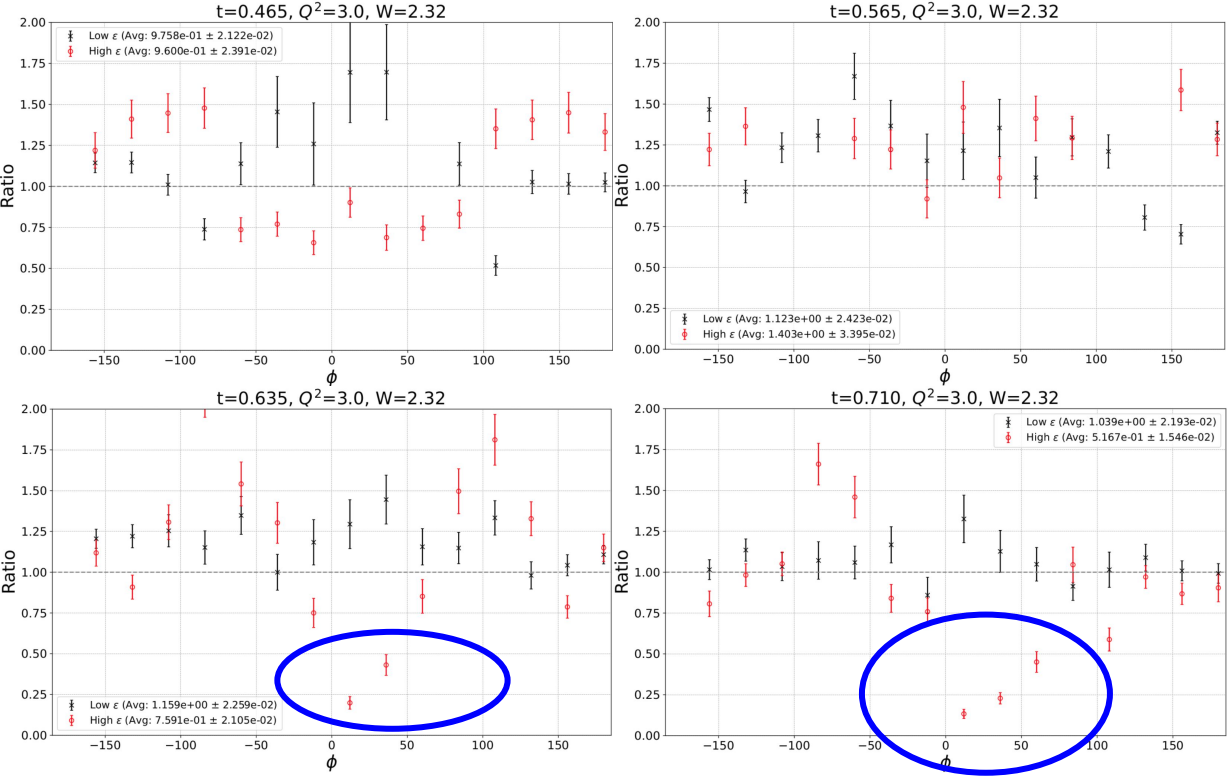
$$\sigma_{LT} = p_9 \cdot e^{-p_{10}|t|} \sin\theta$$

$$\sigma_{TT} = \frac{p_{13}}{|t|^{p_{14}}} \sin^2\theta$$

$$\omega(W) = \frac{1}{(W^2 - M^2)^{0.85 \cdot W_c^2 - 5.97 \cdot W_c + 12.68}}$$

Q^2=3.0, W=2.32, t=(0.40-0.75), 4t, 15φ

i=5



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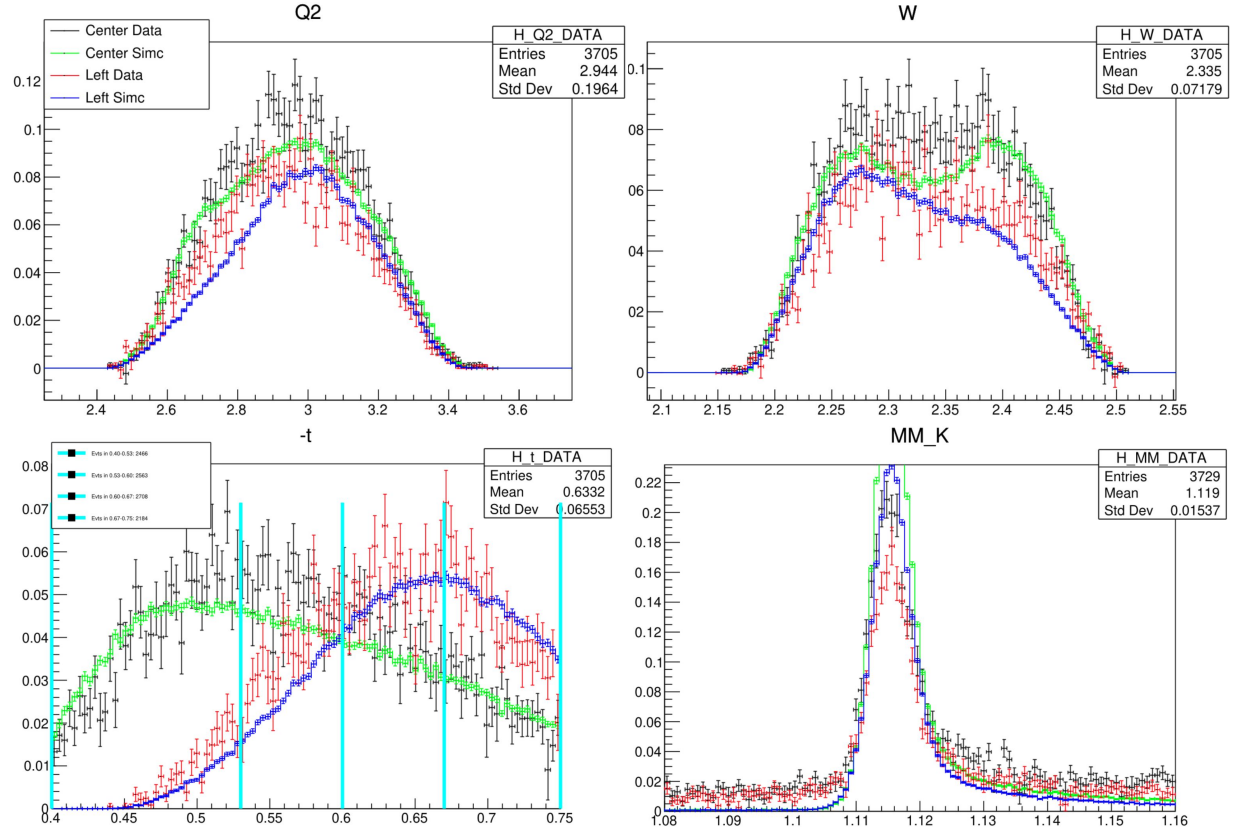

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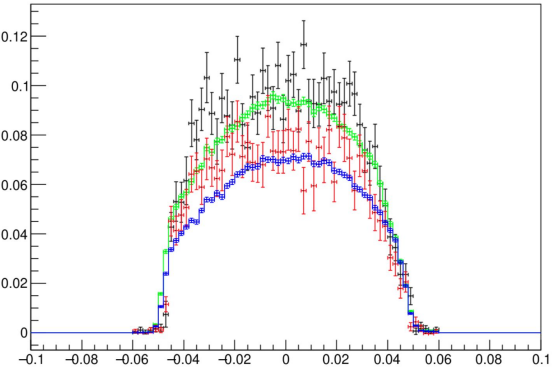
SHMS xptar



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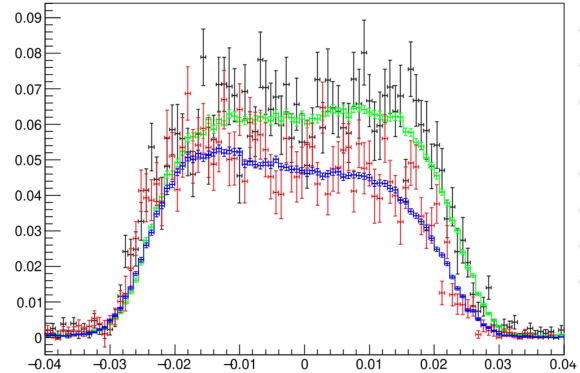
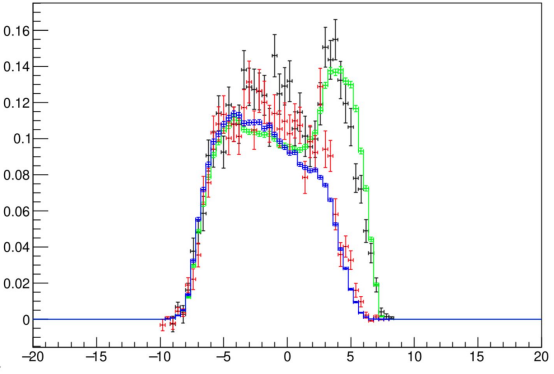
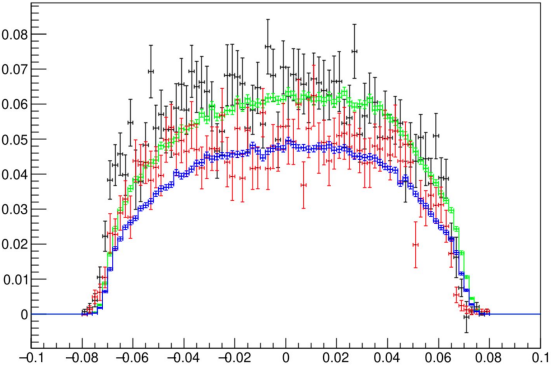


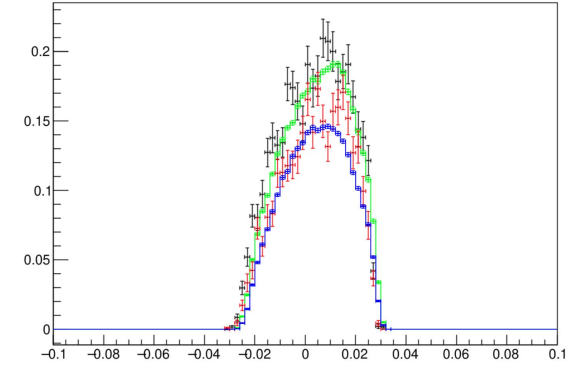
SHMS delta



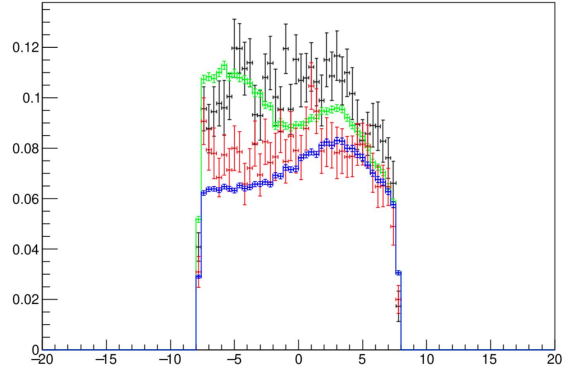
HMS xptar



HMS yptar



HMS Delta



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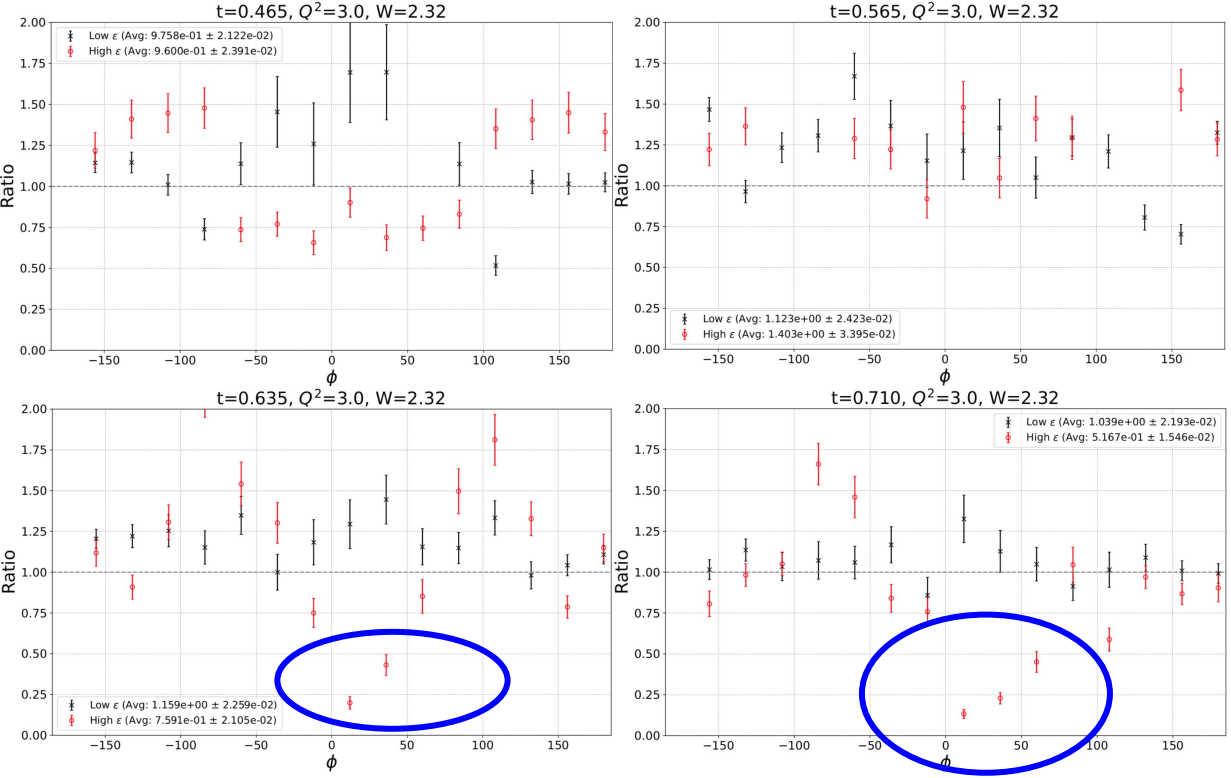

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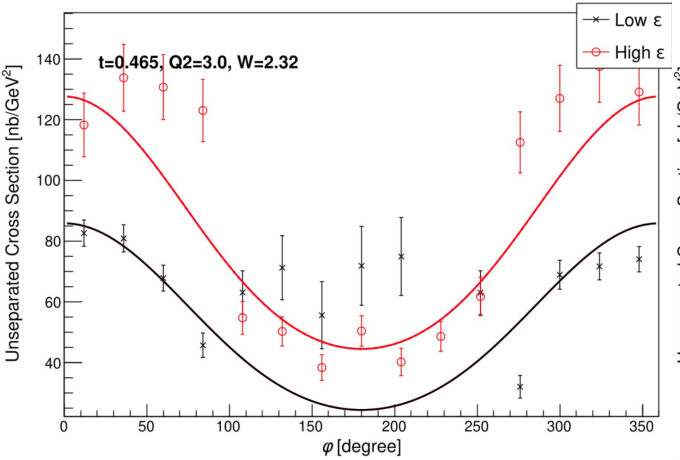

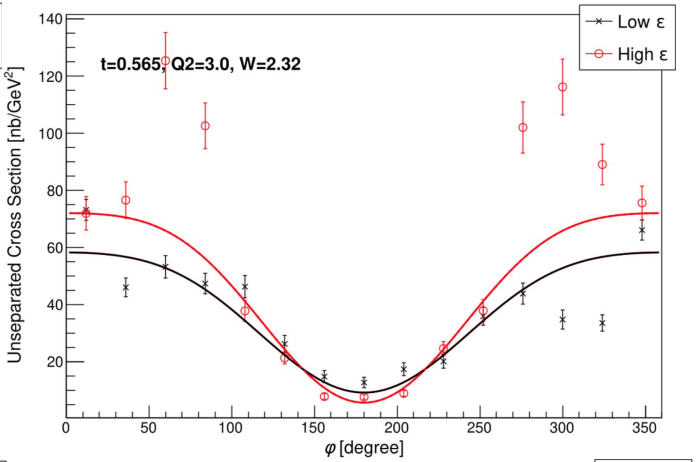

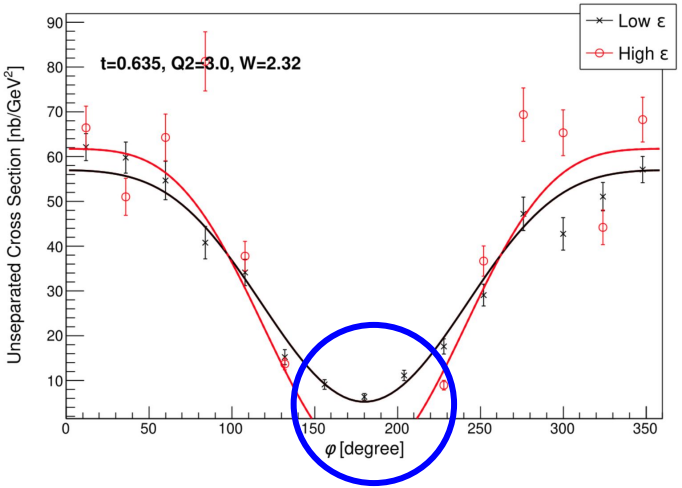

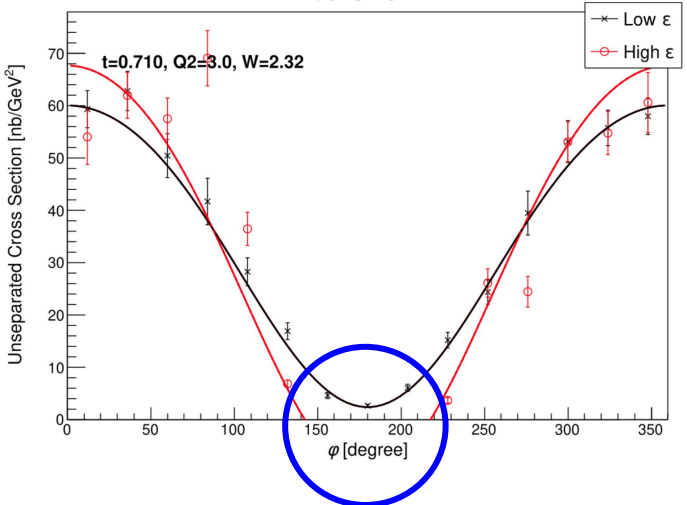

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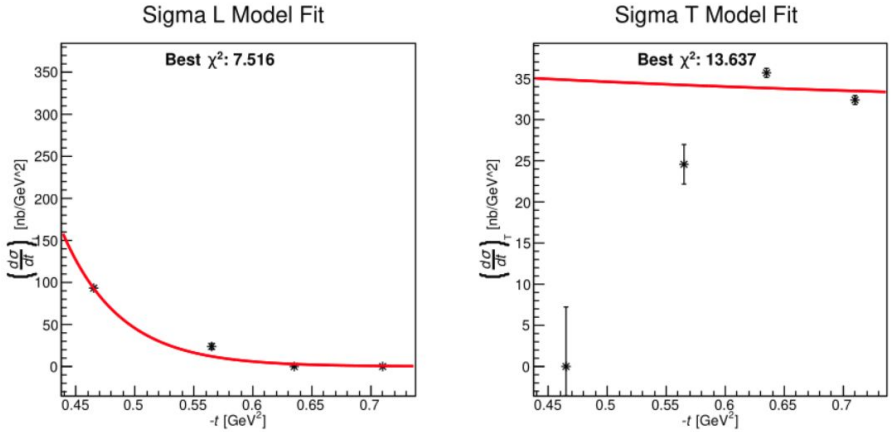
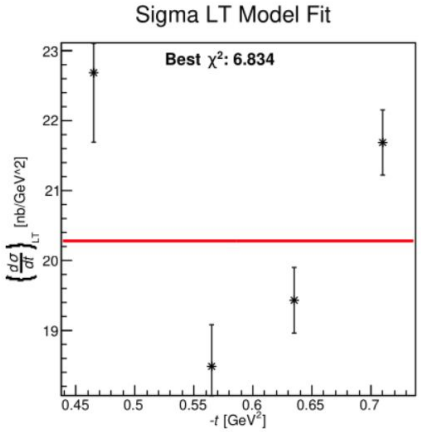
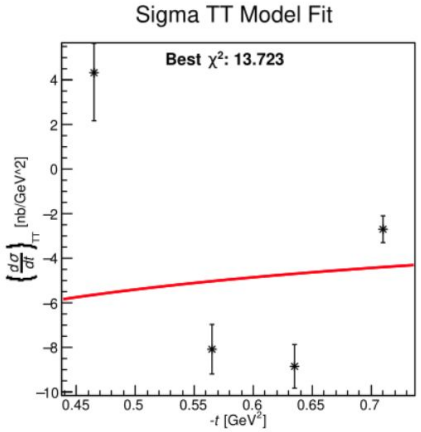
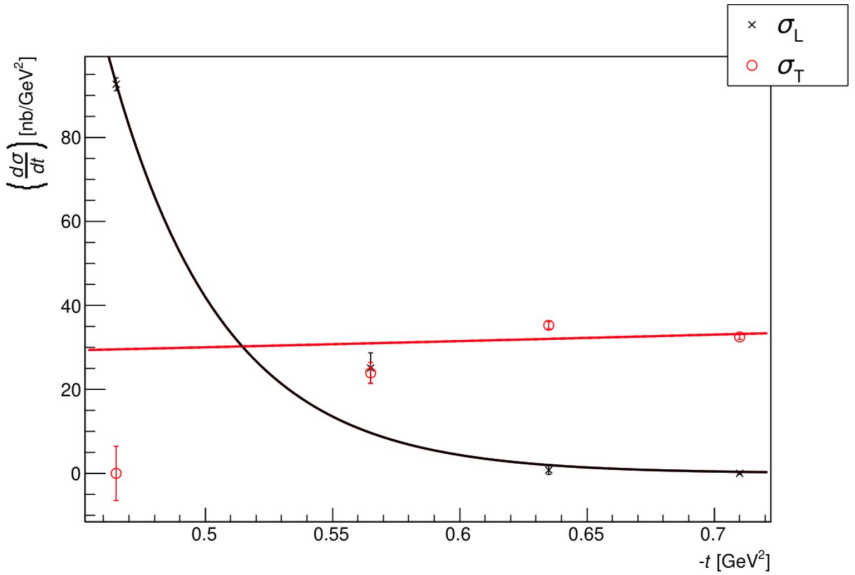


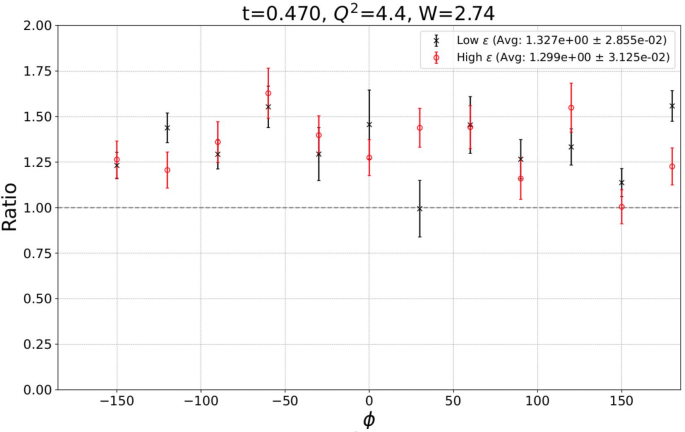


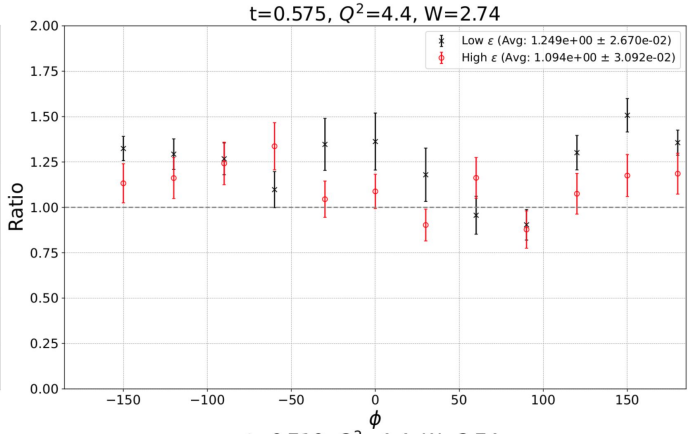


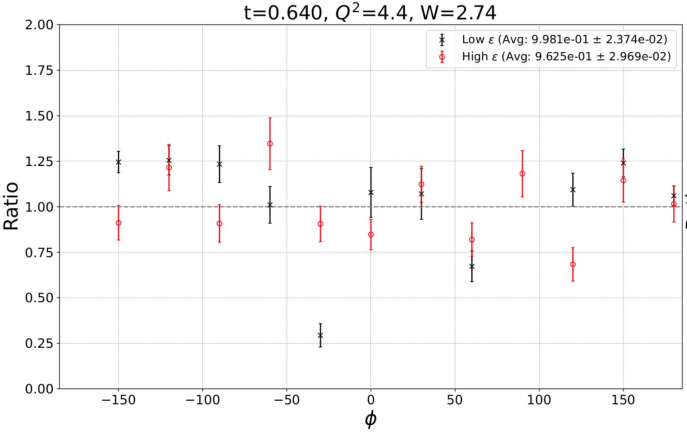


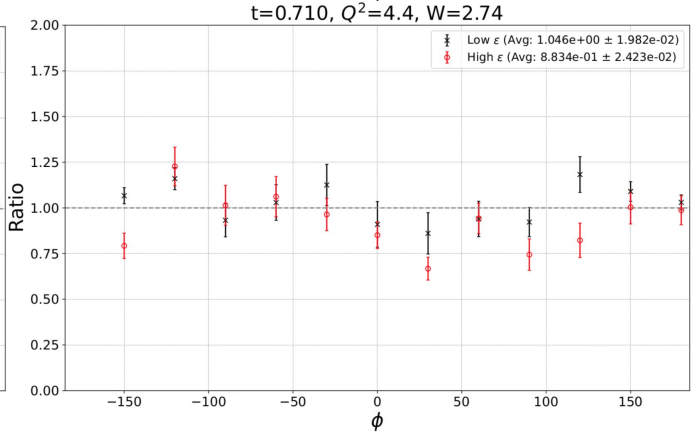
Q^2=4.4, W=2.74, t=(0.40-0.75), 4t, 12φ

i=10









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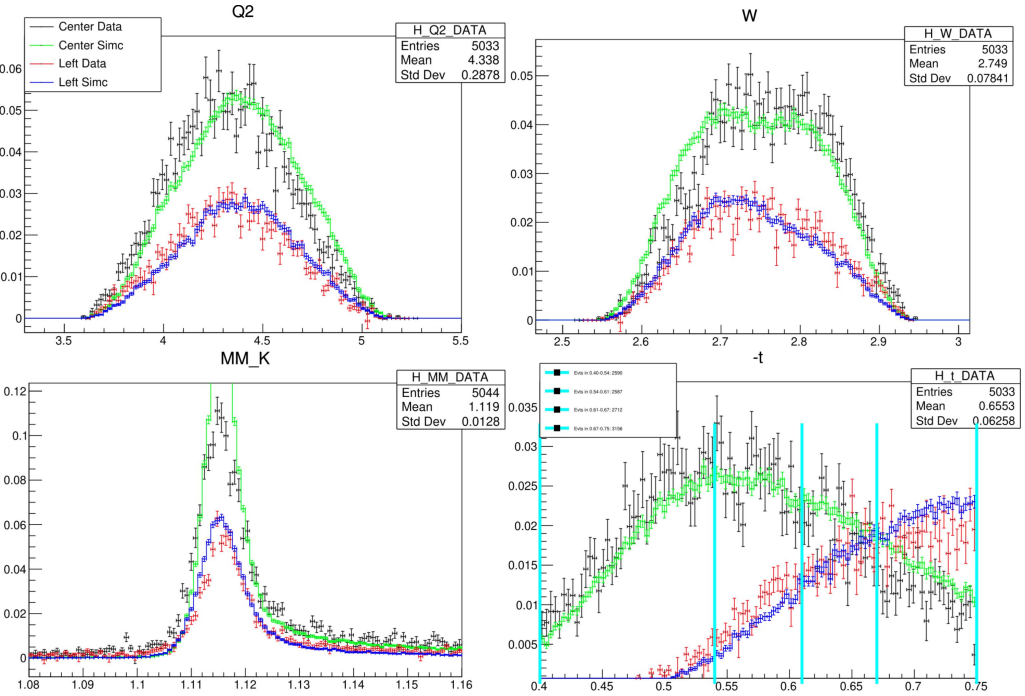

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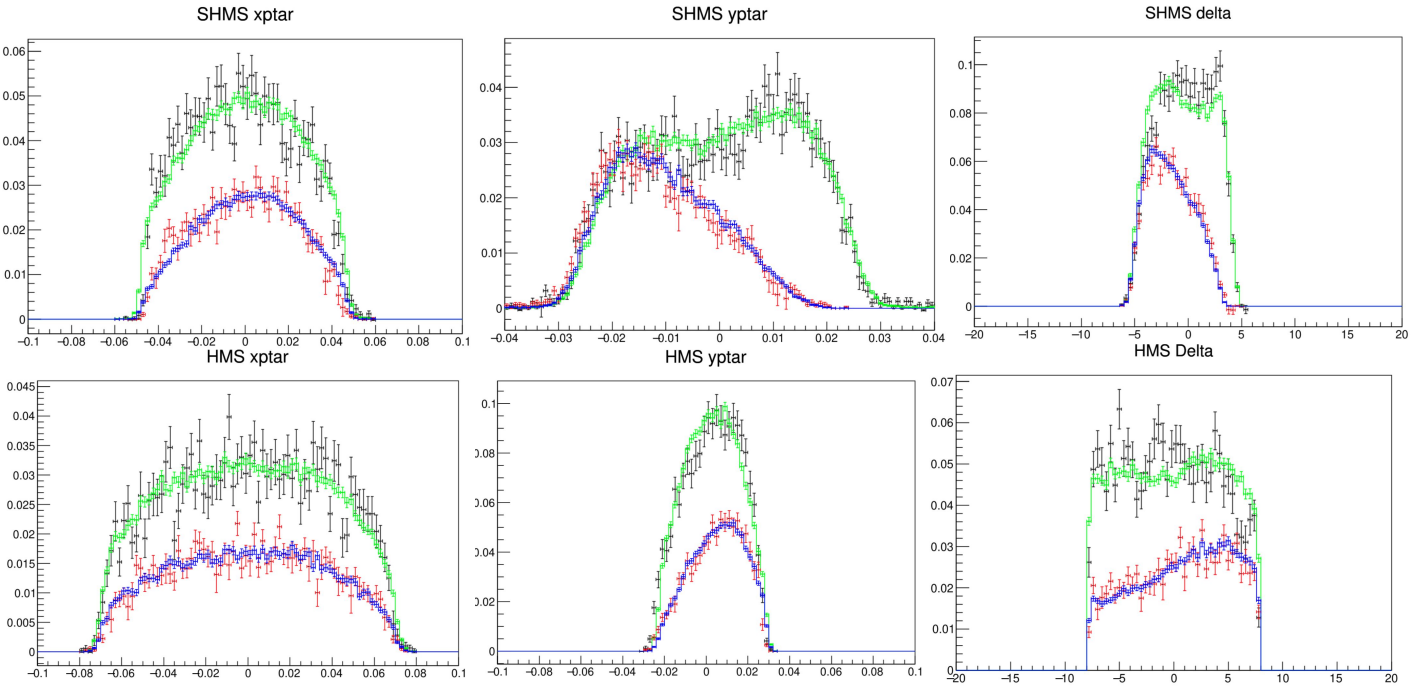

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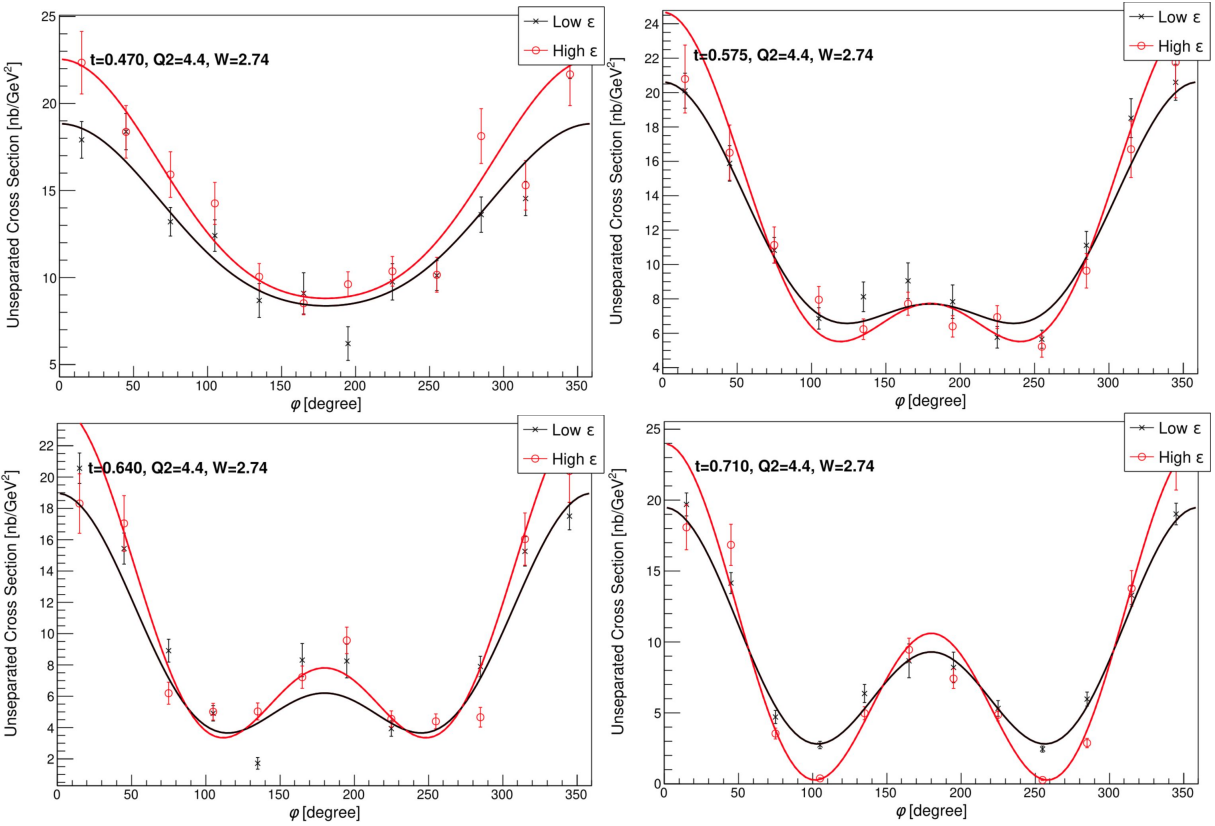

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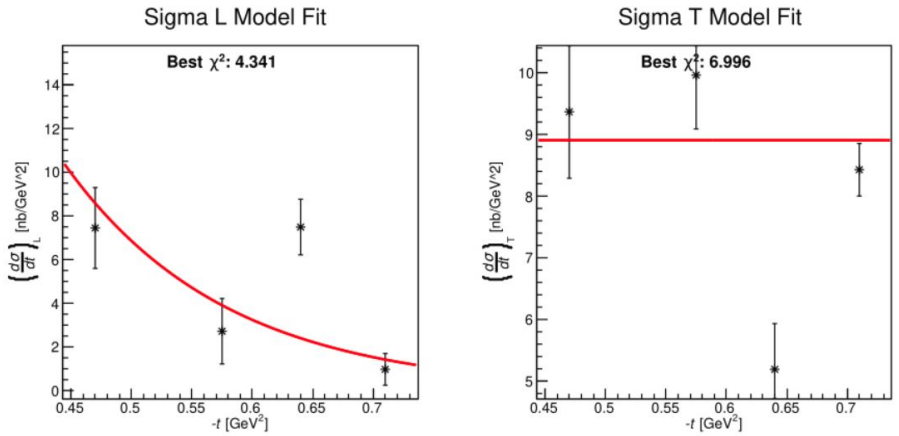

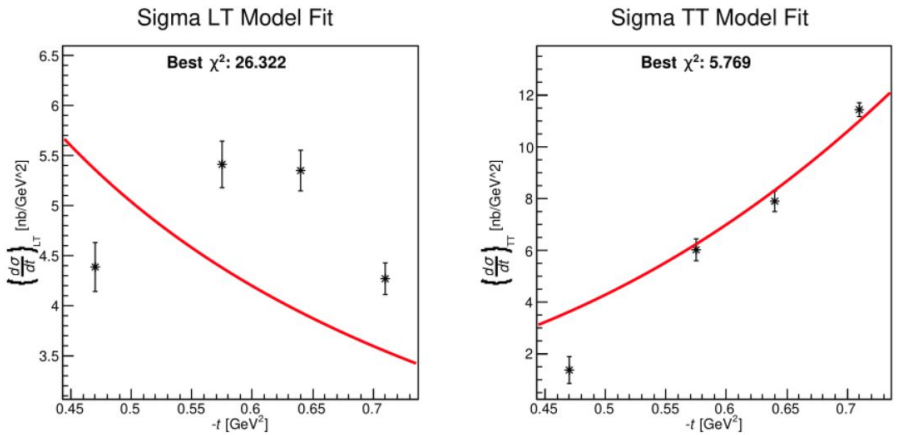

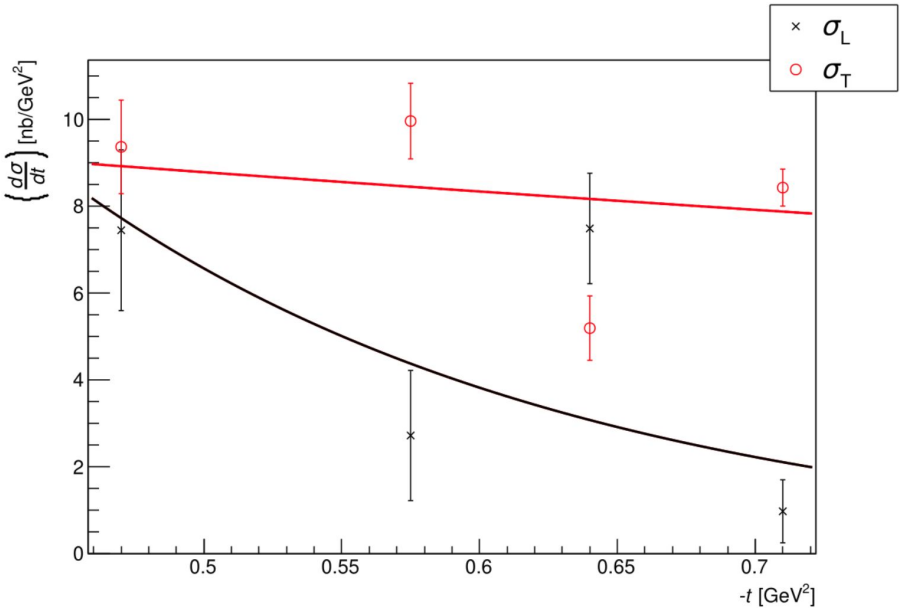

Outline of Systematic Studies

Source	pt-to-pt	t-correlated	scale (earlier)	scale (later)
Acceptance	0.4	0.4	2.0	1.0
PID		0.4	1.0	0.5
Coincidence Blocking		0.2		
Tracking efficiency	0.1	0.1	1.5	1.5
Charge		0.2	0.5	0.5
Target thickness		0.2	0.8	0.8
Kinematics	0.4	1.0		
Kaon Absorption		0.5	0.5	0.5
Kaon Decay		1.0	3.0	3.0
Radiative Corrections	0.1	0.4	2.0	2.0
Monte Carlo Model	0.2	1.0	0.5	0.5
Total	0.6	2.0	4.7	4.2

Systematic Type	Definition	Amplified in σ_L by $1/\Delta\varepsilon$?	Correlation Structure
Point-to-Point	Varies independently between high-ε and low-ε settings at fixed Q^2, W, and -t	Yes	Uncorrelated between ε-points at fixed -t
t-Correlated	Affects both ε-points equally within the same -t bin, but varies between different -t bins	Yes	Correlated within a -t bin, uncorrelated between bins
Scale	Affects all measurements uniformly across all ε, t, and Q^2	No	Fully correlated across all measurements

Point-to-Point (ε-Dependent) Systematic Studies (1)

These systematics are quantified by repeating the LT separation analysis under varied conditions for each ε point at fixed kinematics, observing how the variations propagate into σL, σT, σLT, and σTT.

- **Acceptance (ε-Dependent)**
  - **Method**: Vary geometric and fiducial cuts in SIMC for each ε setting independently.
  - **Test**:
    - Modify SIMC inputs one ε setting at a time.
    - Compare variations in reconstructed yields and cross section ratios between ε points.
  - **Timeline**: ~1–2 days per Q^2 setting
- **PID (Particle Identification)**
  - **Method**: Vary kaon PID thresholds in SHMS (e.g., HGCer, aerogel, hodoscopes) independently at each ε point to test stability.
  - **Test**:
    - Tighten/loosen Cherenkov photoelectron cuts, aerogel thresholds, and coincidence time windows.
    - Re-extract yields with each cut configuration.
  - **Timeline**: ~2-3 days per Q^2 setting

Point-to-Point (ε-Dependent) Systematic Studies (2)

- **Tracking Efficiency**
  - **Method**: Investigate ε-dependent tracking biases via changes in reconstruction conditions.
  - **Test**:
    - Loosen number-of-hits requirement per plane.
    - Allow multi-track events, relax χ^2 cuts.
    - Measure tracking efficiency from data (scintillator-tagged tracks vs. chamber tracks).
- **Kinematic Offsets**
  - **Method**: Apply beam energy, spectrometer angle, and momentum shifts per ε setting.
  - **Test**:
    - Rerun SIMC for shifted settings.
    - Recalculate ε and recompute L/T separation with perturbed inputs.
  - **Timeline**: ~1-2 days per Q^2 setting

Point-to-Point (ε-Dependent) Systematic Studies (3)

- **Radiative Corrections**
  - **Method**: Evaluate ε-dependent variations due to radiative tail modeling.
  - **Test**:
    - Vary missing mass (MM) cut widths in data (hcana).
    - Re-run SIMC with radiative-on vs radiative-off
  - **Timeline**: ~2-3 days per Q^2 setting
- **Monte Carlo (Model Dependence)**
  - **Method**: Investigate sensitivity of ε-dependent yield corrections to cross section model shape.
  - **Test**:
    - Use alternative input models in `physics_iterate.f`
    - Rerun SIMC and track changes in ε separation (especially σL).
  - **Timeline**: ~2-3 days per Q^2 setting

t-Correlated Systematic Studies (1)

Affect all ε settings equally for a given t bin but vary between t bins

- **Acceptance (t-Correlated)**
  - **Method**: Vary spectrometer angle/momentum and collimator geometry across all t bins.
  - **Test**:
    - Apply ±0.5 mrad angle and ±0.2% momentum shifts in SIMC.
    - Compare σ vs. t slopes across tight/loose acceptance configurations.
  - **Timeline**: Overlap with pt-to-pt
- **PID**
  - **Method**: Assess consistency of PID performance across all t bins.
  - **Test**:
    - Apply same PID cut variations (HGCer, aerogel, TOF) as point-to-point but compare impact on σ(t).
  - **Timeline**: Overlap with pt-to-pt
- **Kinematic Offsets**
  - **Method**: Quantify effect of calibration shifts (angle, momentum) on t-reconstruction.
  - **Test**:
    - Apply fixed shifts to spectrometer configuration and recompute missing t-distribution.
  - **Timeline**: Overlap with pt-to-pt

t-Correlated Systematic Studies (2)

- **Radiative Corrections**
  - **Method**: Assess model sensitivity of radiative tails in t-binned yields.
  - **Test**:
    - Vary MM cut and re-calculate σ(t) with radiative-on/off in SIMC.
  - **Timeline**: Overlap with pt-to-pt
- **Monte Carlo Model**
  - **Method**: Check sensitivity of σ(t) trends to alternate physics models.
  - **Test**:
    - Run SIMC with at least two cross section models.
    - Extract structure functions and compare residuals across t.
  - **Timeline**: Overlap with pt-to-pt

t-Correlated Systematic Studies (3)

- **Kaon Decay**
  - **Method**: Quantify decay-in-flight loss across t.
  - **Test**:
    - Rerun SIMC with kaon decay disabled/enabled.
    - Compare survival fractions as function of kaon momentum (i.e., t).
  - **Timeline**: ~2–3 days per Q^2 setting
- **Coincidence Blocking**
  - **Method**: Examine rate-dependent coincidence loss in SHMS/HMS trigger logic.
  - **Test**:
    - Compare blocked vs. unblocked event samples.
    - Shift timing window and evaluate event yield stability.
  - **Timeline**: ~10-12 days total
- **Kaon Absorption**
  - **Method**: Determine t-dependence of nuclear absorption losses. Likely a scale factor per Q^2 setting
  - **Test**:
    - Vary absorption coefficients or material models
    - GEANT to cross-check absorption by detector materials.
  - **Timeline**: ~2-3 days per Q^2 setting

Scale (Global Normalization) Systematics (1)

Affect all cross sections uniformly across all ε and t. These influence the absolute normalization of σL, σT, and thus any model-dependent extractions (e.g., F_K).

- **Radiative Corrections**
  - **Method**: Estimate total radiative yield correction model dependence.
  - **Test**:
    - Run SIMC with radiative-on/off.
    - Vary input cross section model and compare integrated correction factors.
  - **Timeline**: Overlap with pt-to-pt
- **Monte Carlo Model**
  - **Method**: Test sensitivity of global normalization to shape of input cross section model.
  - **Test**:
    - Run SIMC with different structure function inputs.
    - Compare global integrated yields.
  - **Timeline**: Overlap with pt-to-pt

Scale (Global Normalization) Systematics (1)

- **Kaon Decay**
  - **Method**: *Check with Peter B. and Dave G. to carefully check how things are implemented in SIMC*
  - **Test**:
    - Extract correction from SIMC decay module.
    - Assign decay uncertainty across all settings (SHMS momentum dependent).
  - **Timeline**: ???
- **Kaon Absorption**
  - **Method**: Estimate global kaon loss from GEANT or empirical scaling in SIMC.
  - **Test**:
    - Compare kaon yield loss in GEANT vs SIMC.
    - Apply uniform correction factor.
  - **Timeline**: ~2-3 days per Q^2 setting

To Do

1. Reanalyze…
   - Q^2=3.0/W=2.32
   - Q^2=4.4/W=2.74
   - Q^2=5.5/W=3.02
2. Re-parameterize…
   - Q^2=2.115/W=2.95
   - Q^2=3.0/W=3.14

MAY 2025

SUN	MON	TUE	WED	THU	FRI	SAT
27	28	29	30	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

JUNE 2025

SUN	MON	TUE	WED	THU	FRI	SAT
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	1	2	3	4	5

3. Full SIMC runs with new functions and parameters for all settings
4. Full Replay for all settings
5. Finalize systematics study **(~70-110 days)**

Finish up by Hall A/C meeting