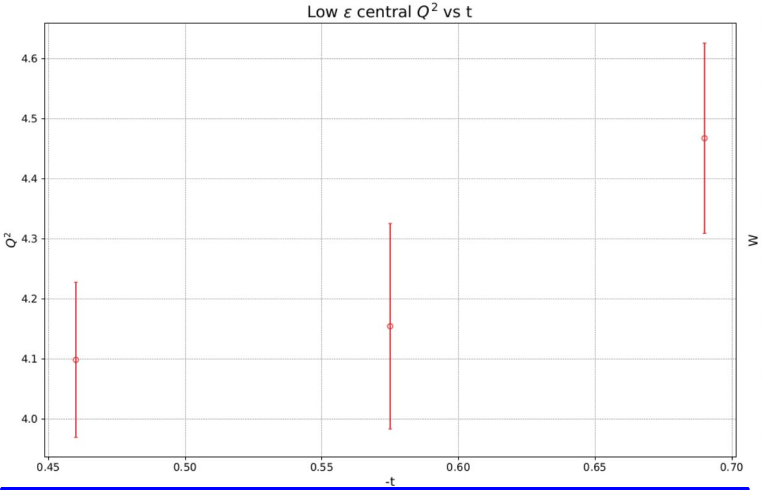
KaonLT Meeting

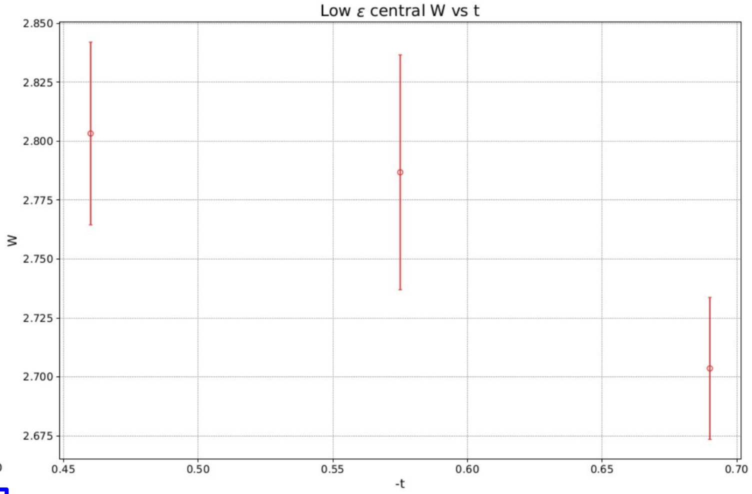
February 26-27th, 2025

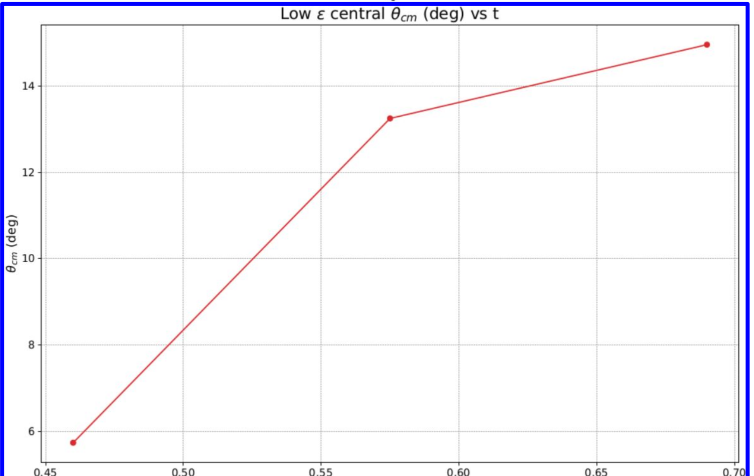
Richard L. Trotta

Small |t| θ_{cm} behavior

Low Epsilon







Q^2=4.4, W=2.74

Missing Mass Shifts

- Center MM_shift = -0.001672
- Left MM_shift = +0.001519

-t Shifts

- Center t_shift = +0.002647
- Left t_shift = -0.002398

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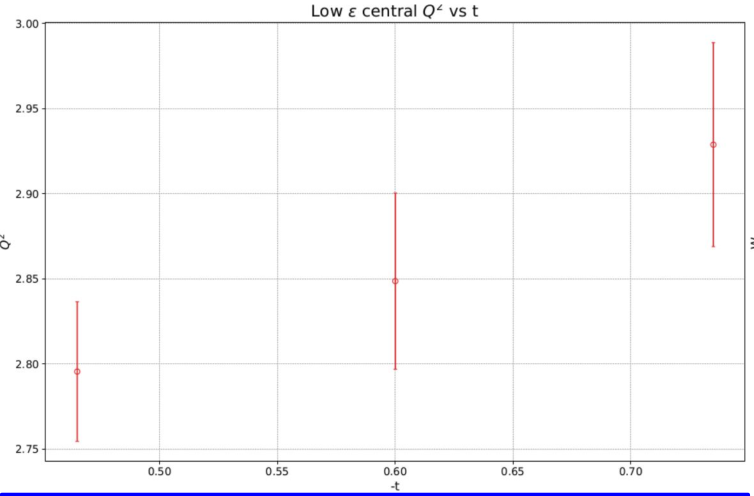
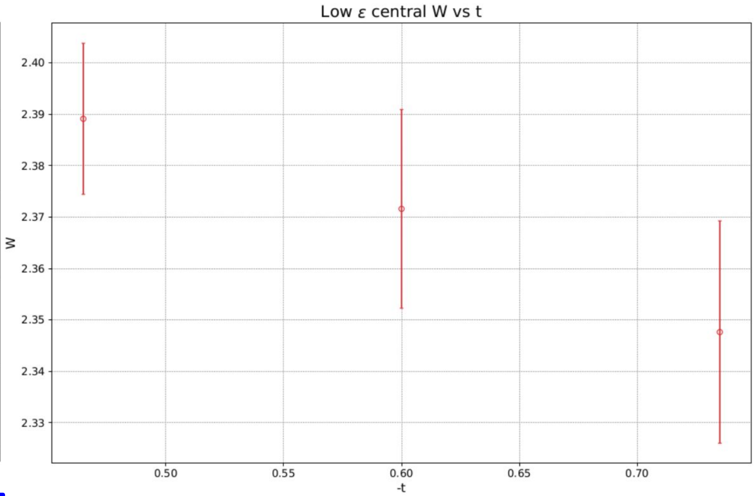
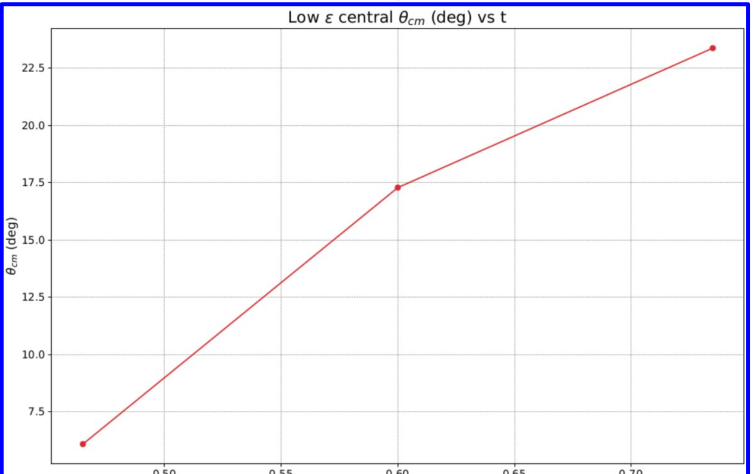






Q^2=3.0, W=2.32

Missing Mass Shifts

- Center MM_shift = -0.001918
- Left MM_shift = -0.000941

-t Shifts

- Center t_shift = +0.003220
- Left t_shift = +0.001576

Calculated θ_{cm} distribution

- Using the histogram distributions (instead of central values), I calculated the θ_{cm} distribution
  - Same calculation as eps_n_theta.f

$$s = W^2$$
$$\omega = \frac{s + Q^2 - m_2^2}{2m_2}$$
$$q = \sqrt{Q^2 + \omega^2}$$
$$m_1^2 = -Q^2$$

$$m_3 = \begin{cases} m_K, & \text{if } \texttt{pid} = \text{"kaon"} \\ m_\pi, & \text{if } \texttt{pid} = \text{"pion"} \end{cases}$$

$$m_3^2 = \begin{cases} m_K^2, & \text{if } \texttt{pid} = \text{"kaon"} \\ m_\pi^2, & \text{if } \texttt{pid} = \text{"pion"} \end{cases}$$

$$(m_2, m_4) = \begin{cases} (m_p, m_\Lambda), & \text{if } n_{\text{pol}} > 0 \\ (m_n, m_p), & \text{if } n_{\text{pol}} \leq 0 \end{cases}$$

$$(m_2^2, m_4^2) = \begin{cases} (m_p^2, m_\Lambda^2), & \text{if } n_{\text{pol}} > 0 \\ (m_n^2, m_p^2), & \text{if } n_{\text{pol}} \leq 0 \end{cases}$$

$$E_1^{\text{cm}} = \frac{s + m_1^2 - m_2^2}{2W}$$
$$E_3^{\text{cm}} = \frac{s + m_3^2 - m_4^2}{2W}$$

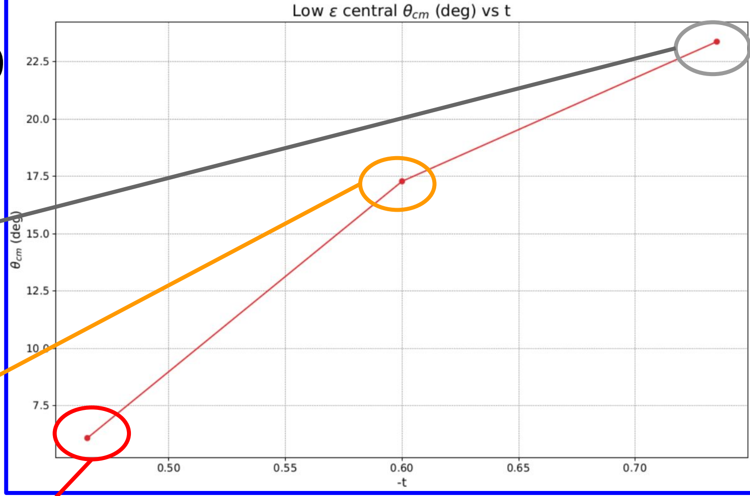
$$p_1^{\text{lab}} = q$$
$$p_1^{\text{cm}} = \frac{p_1^{\text{lab}} m_2}{W}$$
$$p_3^{\text{cm}} = \sqrt{(E_3^{\text{cm}})^2 - m_3^2}$$

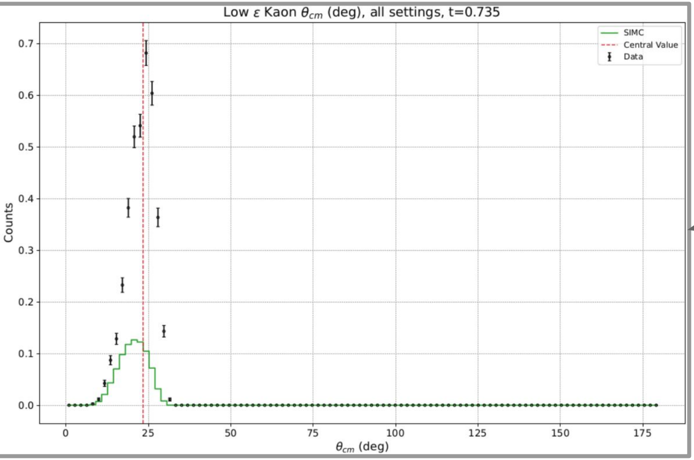
$$t_{\min} = -\left[(E_1^{\text{cm}} - E_3^{\text{cm}})^2 - (p_1^{\text{cm}} - p_3^{\text{cm}})^2\right]$$

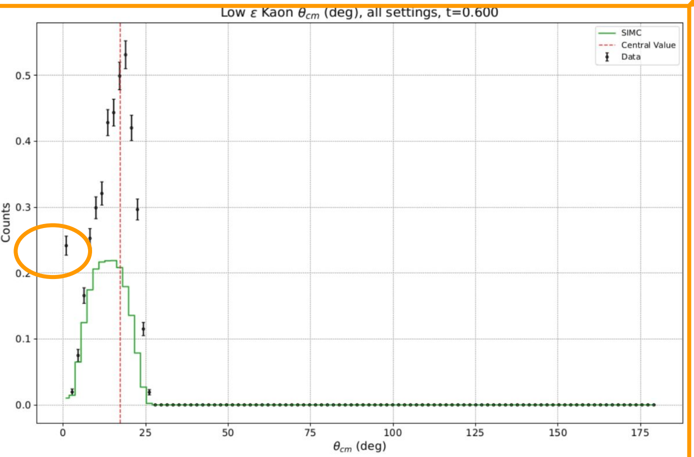
$$\theta_{\text{cm}} = 2\sin^{-1}\left(\sqrt{\frac{t - t_{\min}}{4\,p_1^{\text{cm}}\,p_3^{\text{cm}}}}\right), \qquad \text{for } t \geq t_{\min}$$

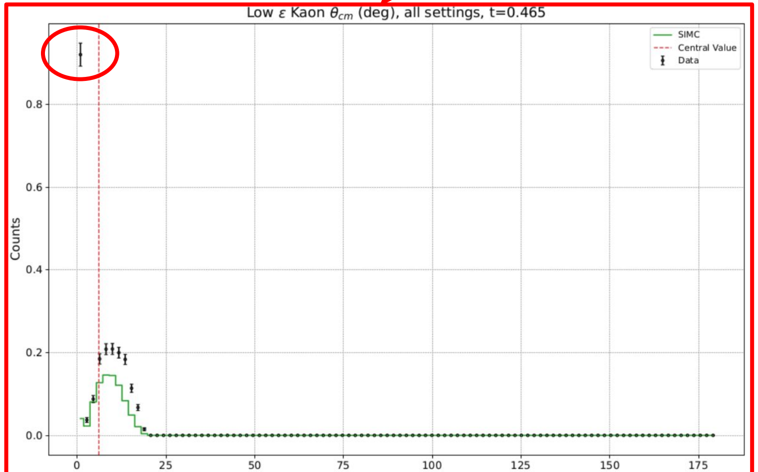
$$\epsilon = \left[1 + 2\,\frac{Q^2 + \omega^2}{4E_b(E_b - \omega) - Q^2}\right]^{-1}$$

θ_{cm} blows up as it approaches zero









Ignore simc/data scale issue (bug)

Calculated θ_{cm} distribution

- Using the histogram distributions (instead of central values), I calculated the theta_cm distribution
  - Same calculation as eps_n_theta.f

$$p_1^{\text{lab}} = q$$
$$p_1^{\text{cm}} = \frac{p_1^{\text{lab}}\, m_2}{W}$$
$$p_3^{\text{cm}} = \sqrt{(E_3^{\text{cm}})^2 - m_3^2}$$

$$t_{\min} = -\left[(E_1^{\text{cm}} - E_3^{\text{cm}})^2 - (p_1^{\text{cm}} - p_3^{\text{cm}})^2\right]$$

$$\theta_{\text{cm}} = 2\sin^{-1}\left(\sqrt{\frac{t - t_{\min}}{4\, p_1^{\text{cm}}\, p_3^{\text{cm}}}}\right), \qquad \text{for } t \geq t_{\min}$$

$$\epsilon = \left[1 + 2\,\frac{Q^2 + \omega^2}{4E_b(E_b - \omega) - Q^2}\right]^{-1}$$

$$s = W^2$$
$$\omega = \frac{s + Q^2 - m_2^2}{2m_2}$$
$$q = \sqrt{Q^2 + \omega^2}$$
$$m_1^2 = -Q^2$$

$$m_3 = \begin{cases} m_K, & \text{if } \texttt{pid} = \text{“kaon”} \\ m_\pi, & \text{if } \texttt{pid} = \text{“pion”} \end{cases}$$

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$$(m_2,\, m_4) = \begin{cases} (m_p,\, m_\Lambda), & \text{if } n_{\text{pol}} > 0 \\ (m_n,\, m_p), & \text{if } n_{\text{pol}} \leq 0 \end{cases}$$

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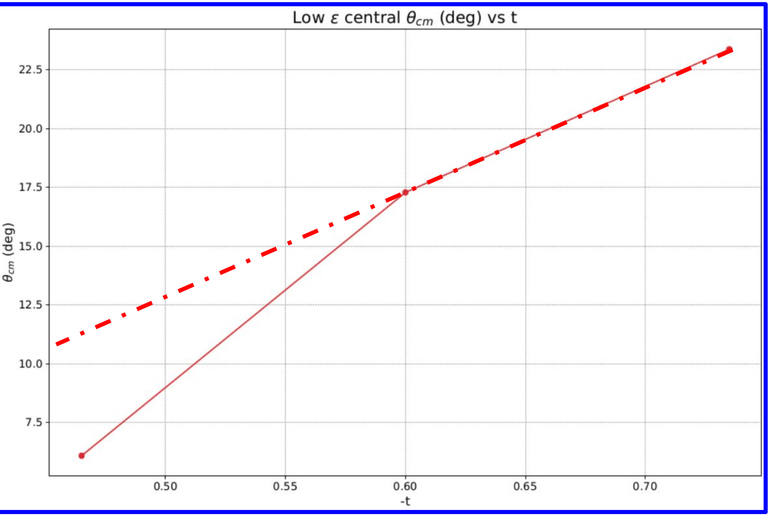
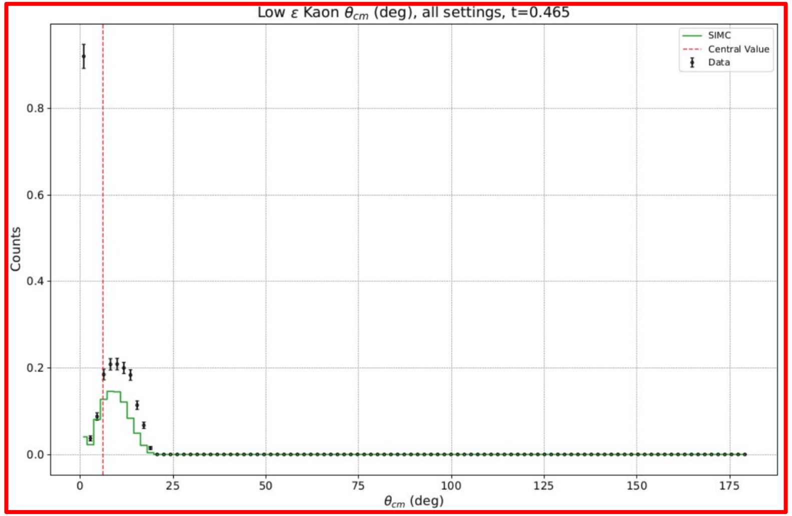
$$E_1^{\text{cm}} = \frac{s + m_1^2 - m_2^2}{2W}$$
$$E_3^{\text{cm}} = \frac{s + m_3^2 - m_4^2}{2W}$$

Possible Solution



- Linear fit the higher |t| θ_{cm} values
- Maximal theta value and find t-shift here
  - Range of t-shift values
- Needs physical explanation
  - Offset related?
  - **Resolution related?**

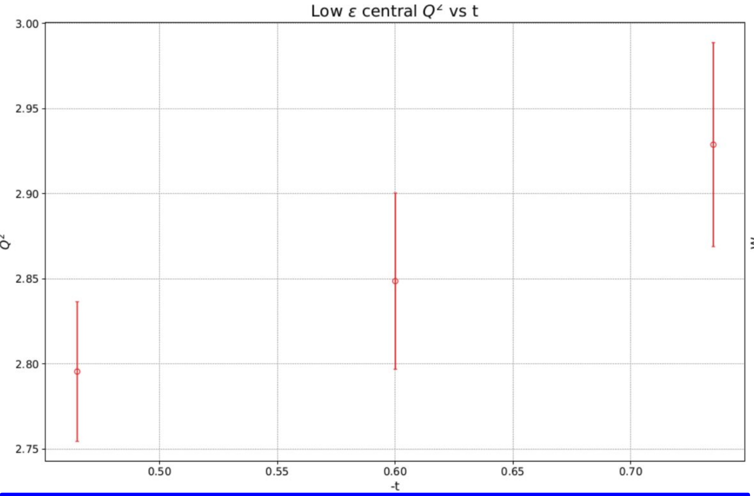
$$\Delta(t - t_{\mathrm{min}}) > \delta_{\mathrm{res}}$$

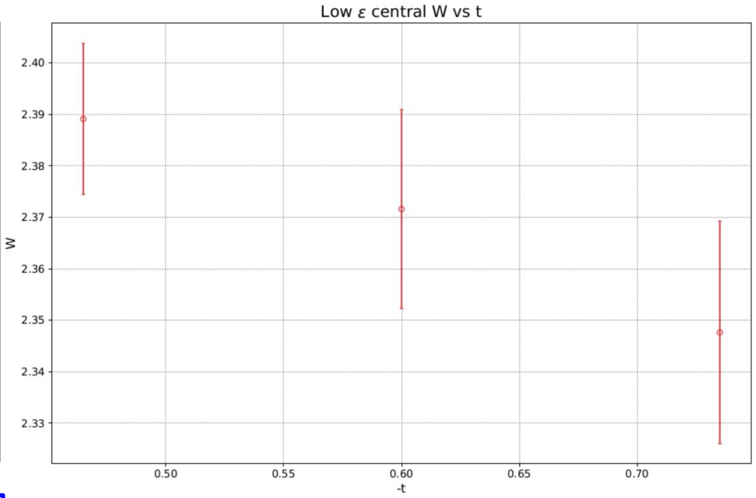


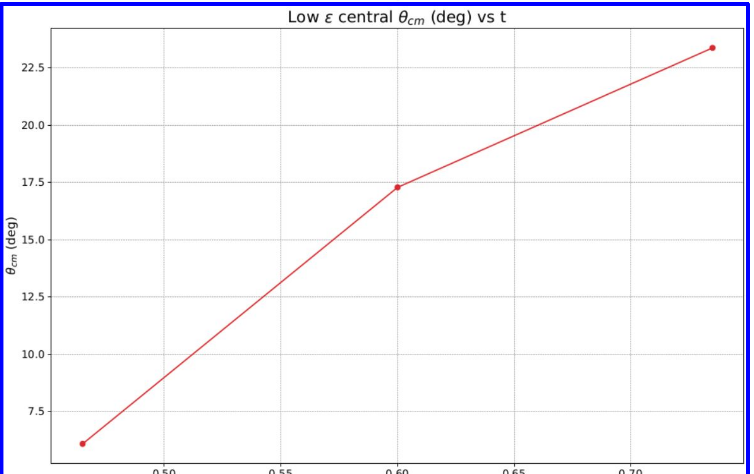
EXTRA

Small |t| θ_{cm} behavior

Low Epsilon







Q^2=3.0, W=2.32

- Side note:
  - I need to check with no t-shift and same binning
- With similar bins…
  - (2026-03-20) t=0.479 θ_{cm}=6.08
  - (2026-01-13) t=0.471 θ_{cm}=9.80
- Regardless, this trend is the same