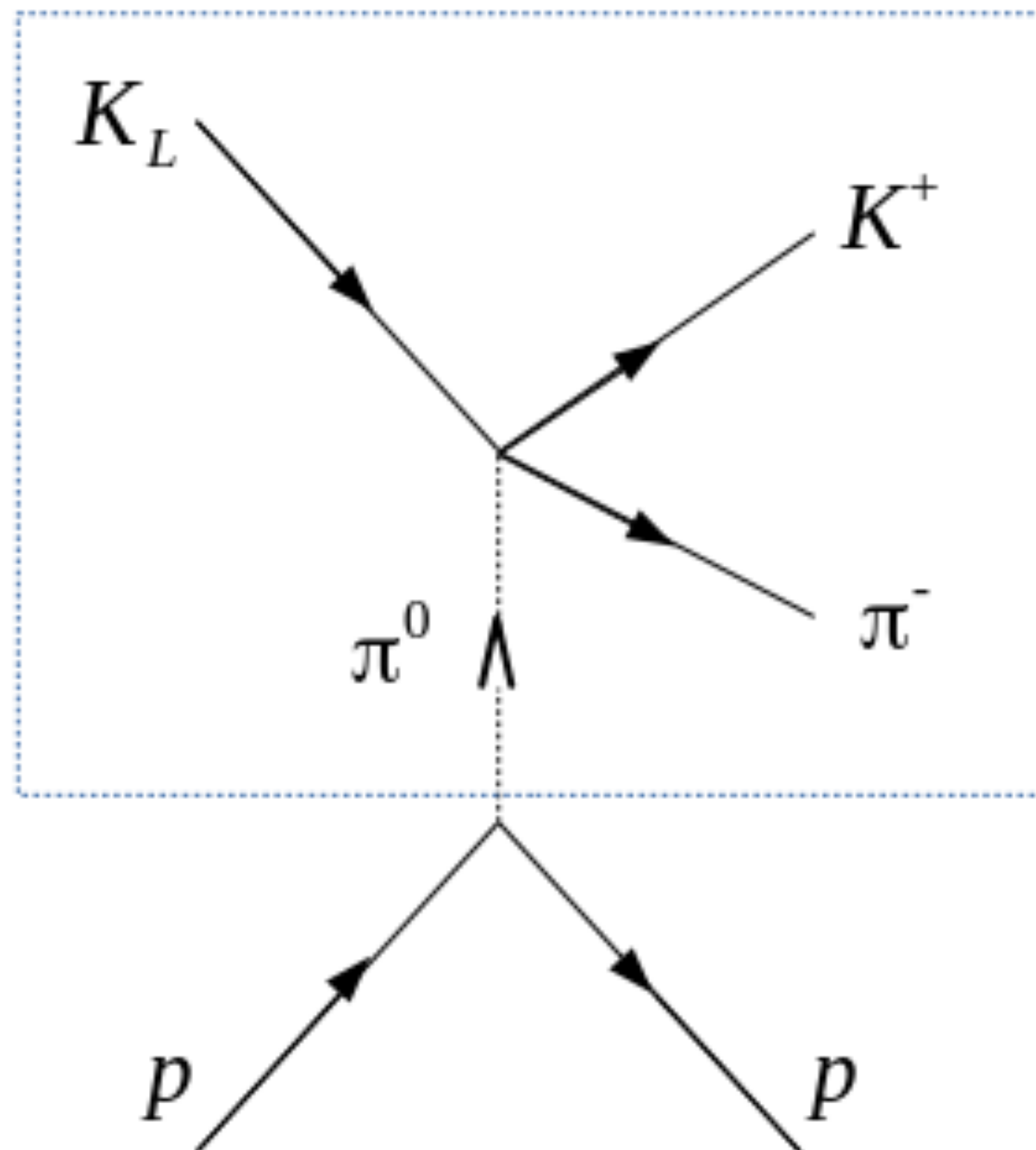


Status of the Forward $K\pi$ Analysis for $K_L p \rightarrow K^*(892)p \rightarrow K^+ \pi^- p$

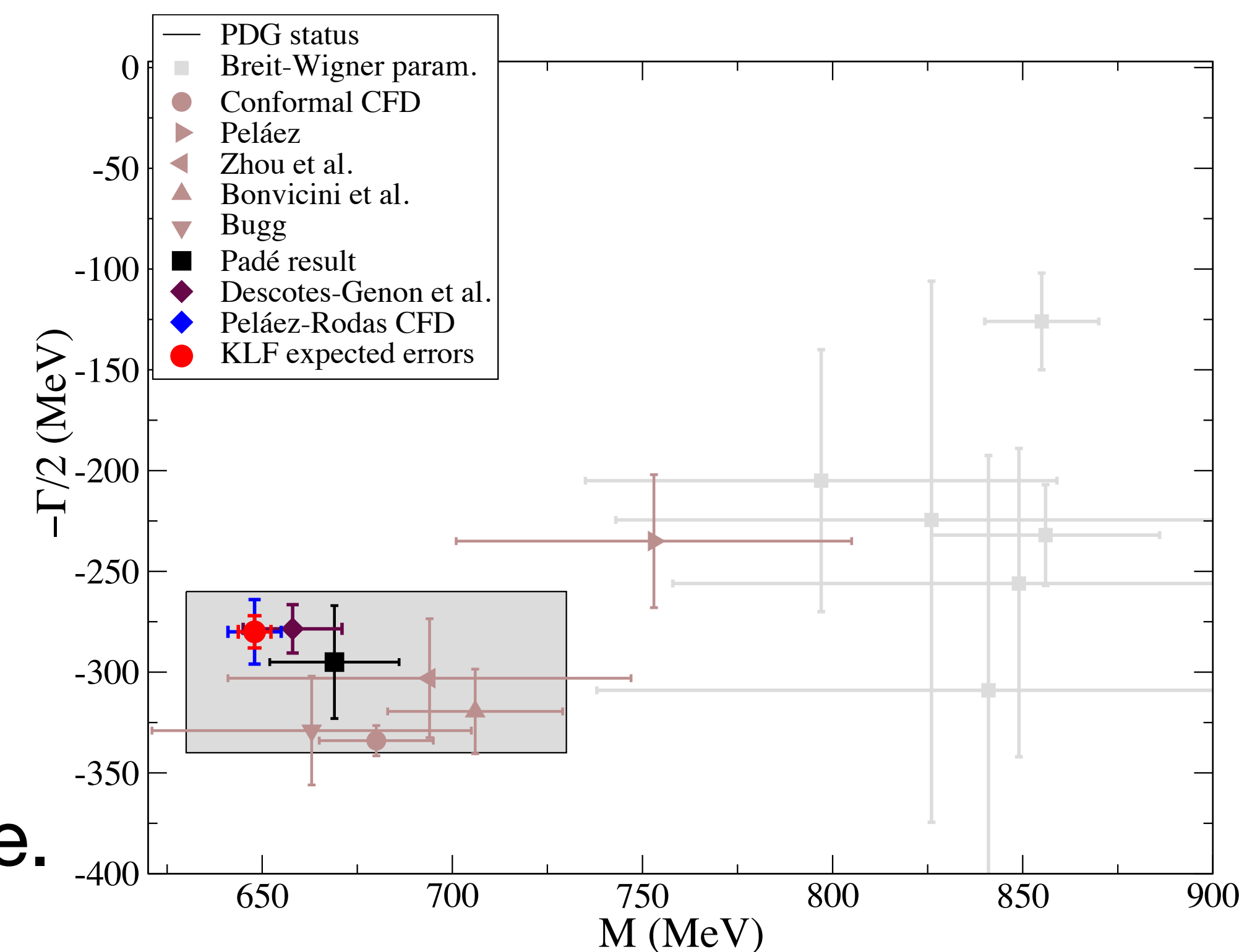
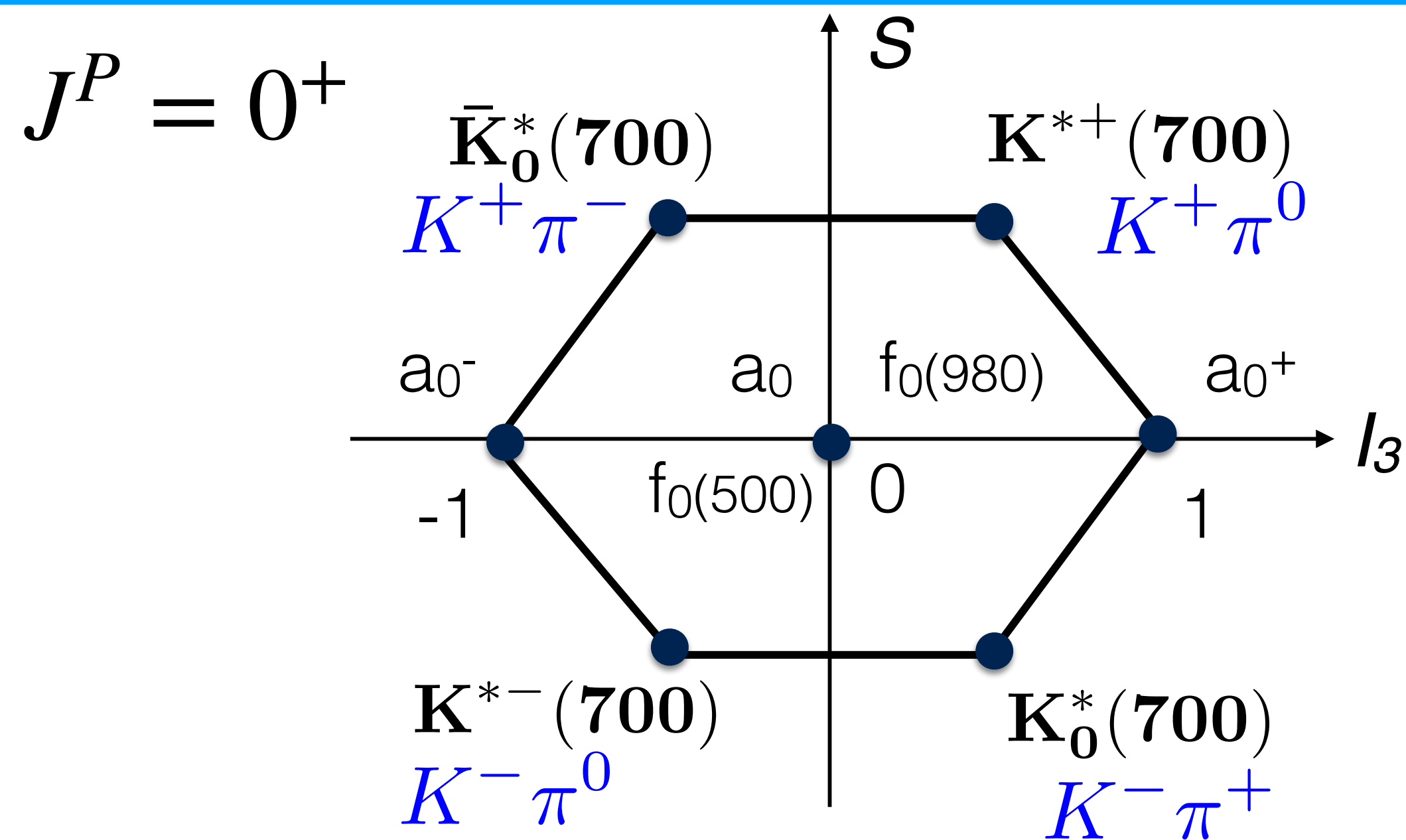
Keigo Mizutani
RCNP, The University of Osaka

8th KLF Collaboration Meeting
6-May-2026



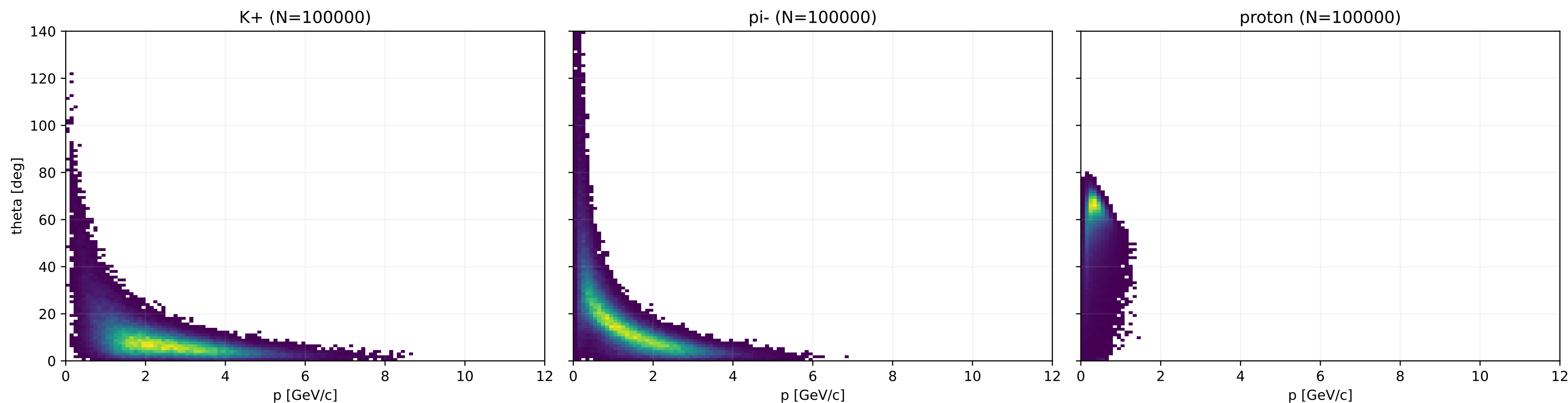
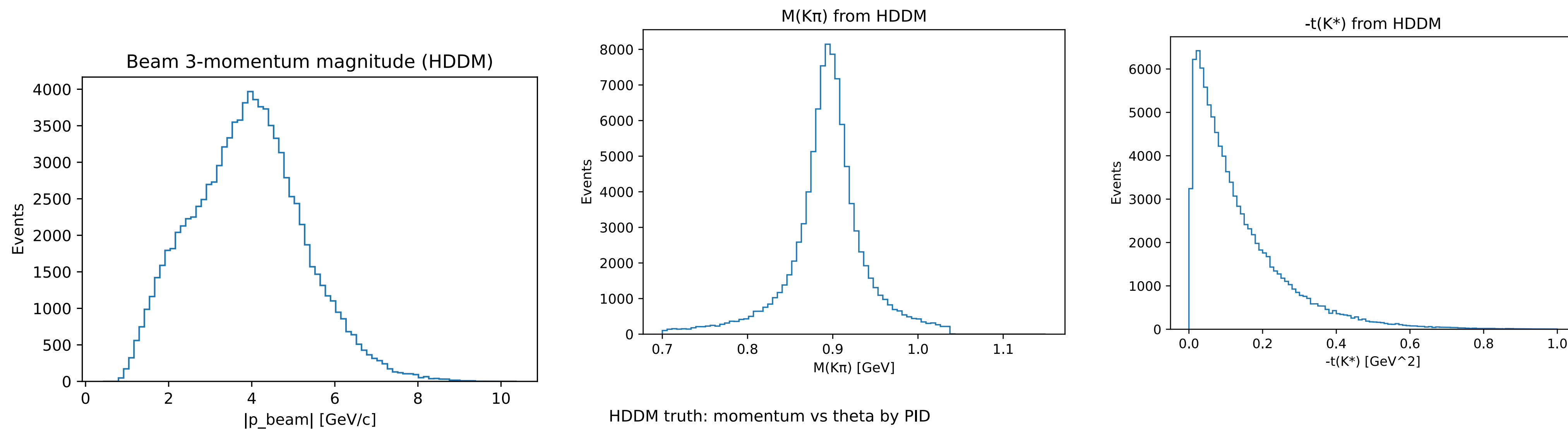


- $K\pi$ scattering is one of the simplest hadronic interactions involving strangeness.
- In the forward region, corresponding to small momentum transfer $-t$, the production amplitude is expected to be dominated by one-pion exchange.
- This provides access to elastic $K\pi \rightarrow K\pi$ scattering amplitudes and strange meson spectroscopy.
- Precise $K\pi$ amplitudes are important for the κ pole and may also provide input to dispersive studies of $K\pi$ form factors related to V_{us} .



- κ is now recognized as a light scalar resonance.
- It appears in the $I = 1/2$ $K\pi$ S -wave near threshold.
- Because it is very broad, it is difficult to determine from a simple mass peak.
- The key observable is the pole position of the $K\pi$ scattering amplitude.
- Improved low-energy $K\pi$ data from KLF can help constrain the κ pole.

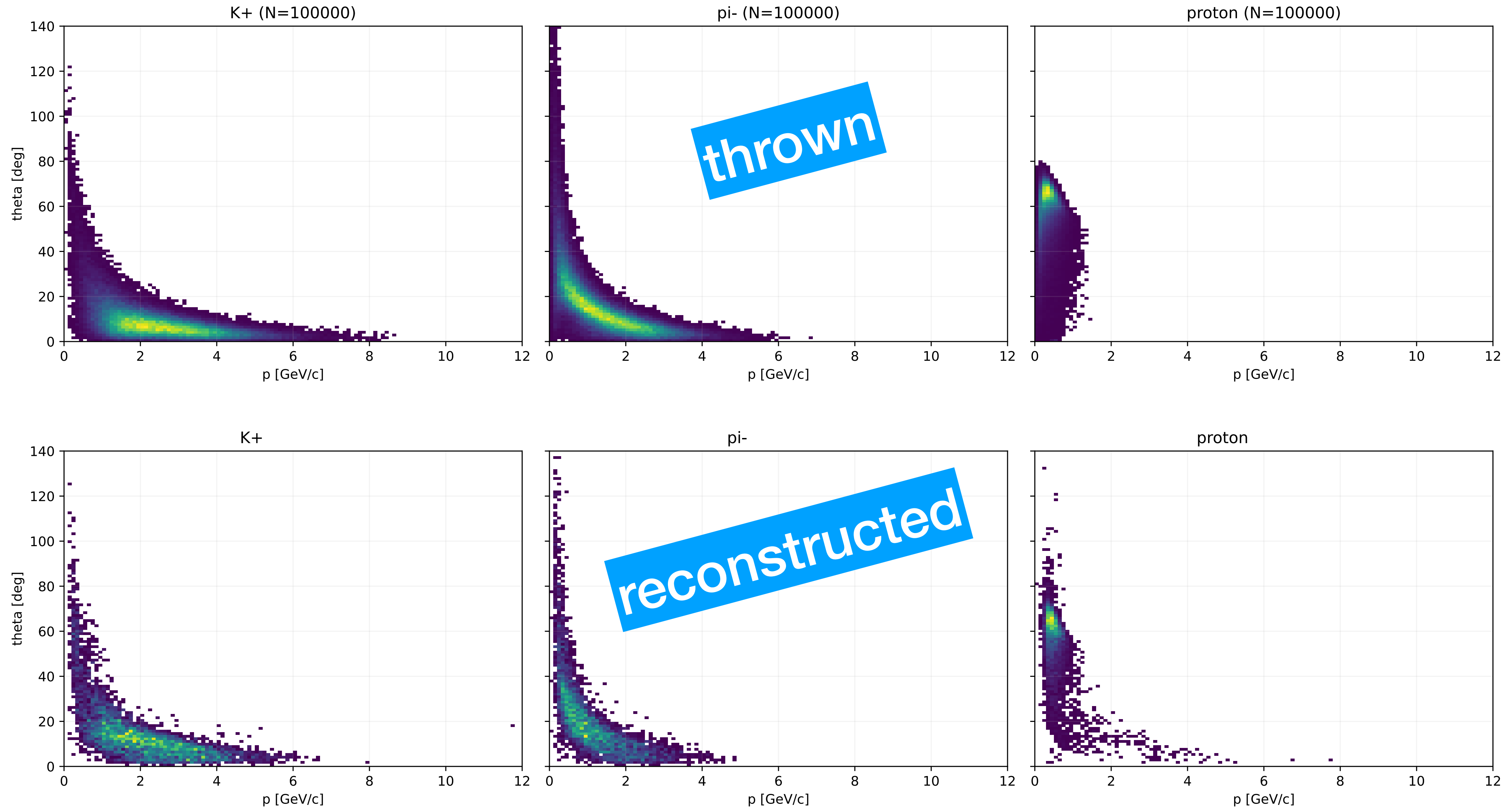
Regge-pole based generator: $K_L p \rightarrow K^*(892) p \rightarrow K^+ \pi^- p$, Dass & Froggatt, NPB8 (1968), B10 (1969)



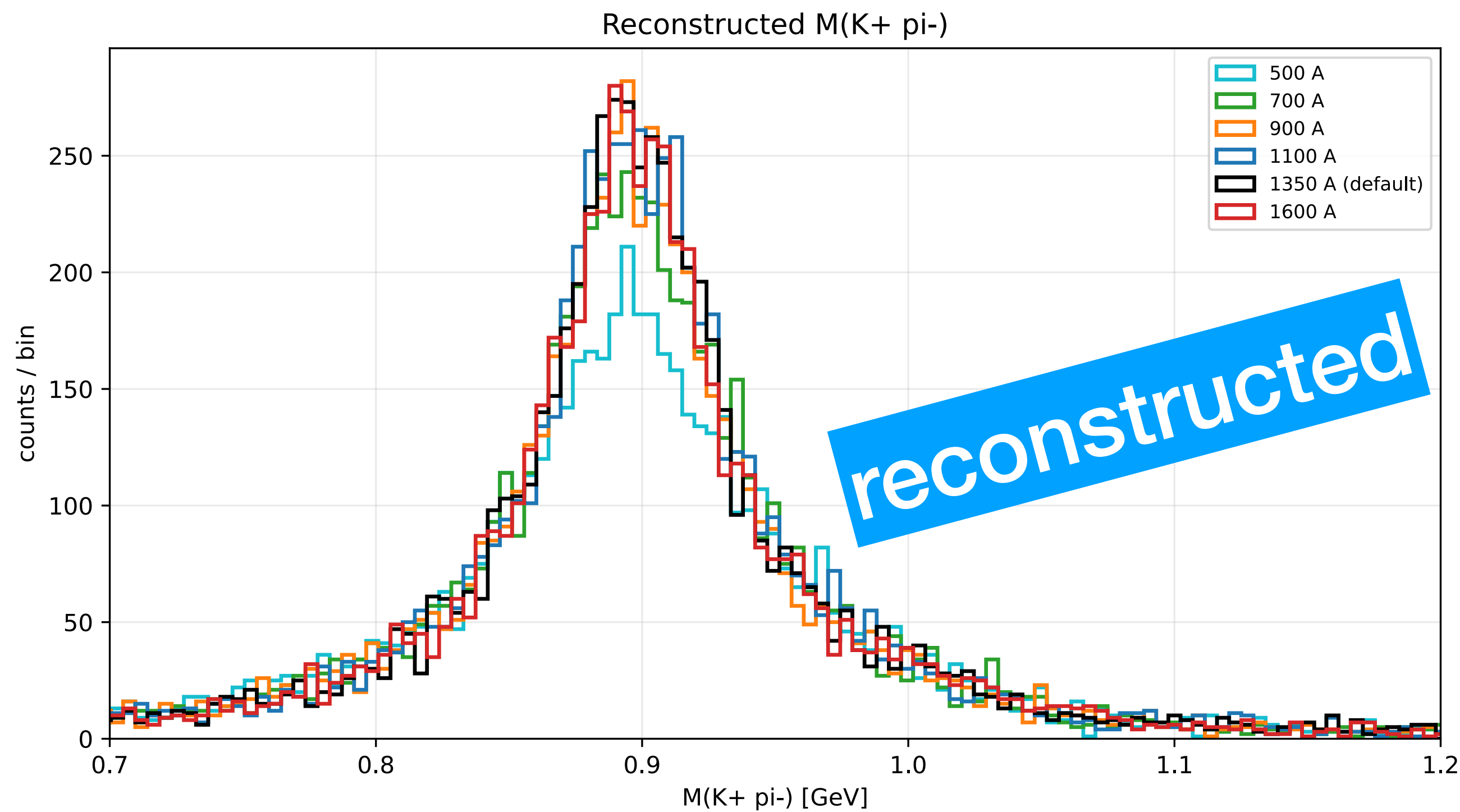
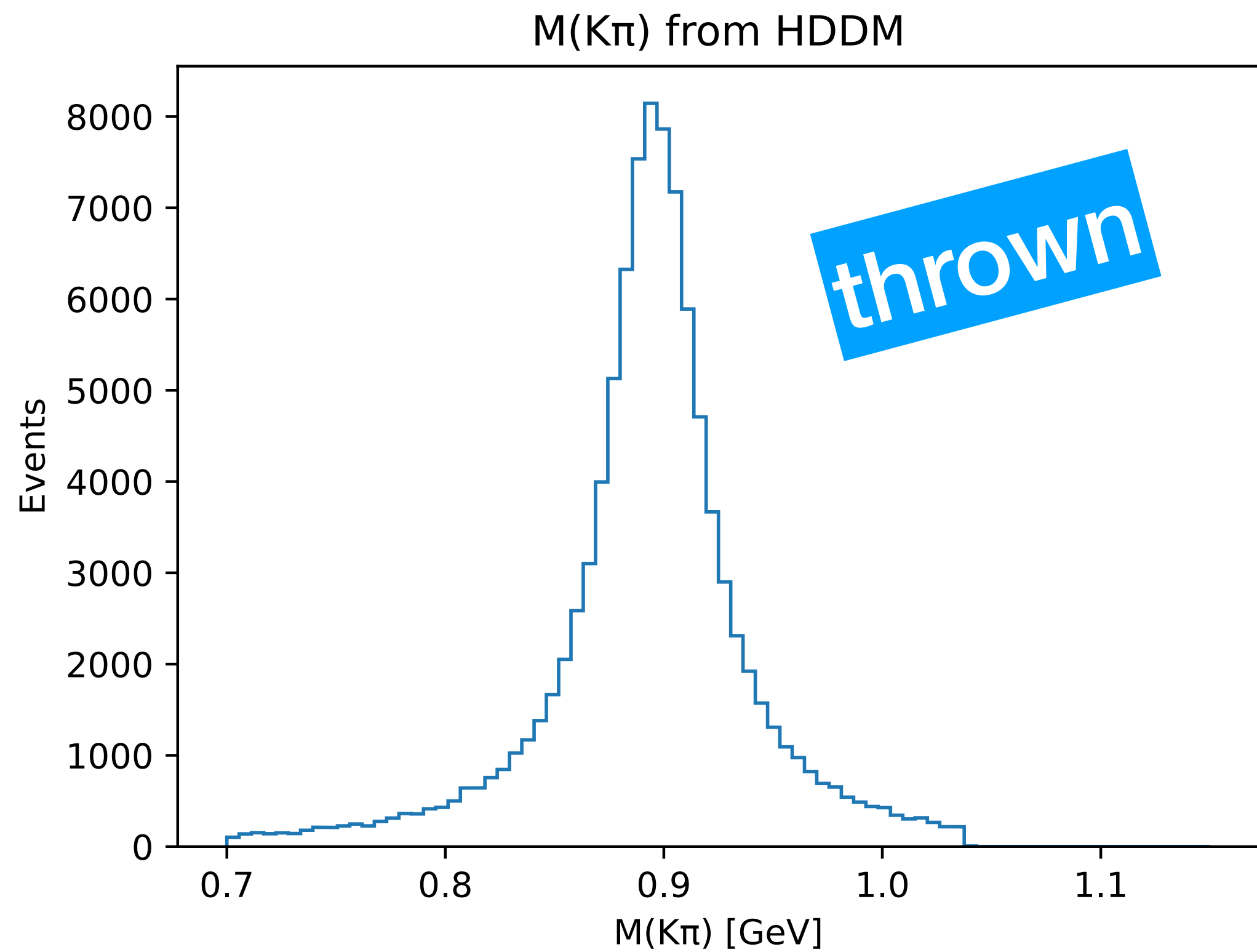
forward K, π

backward proton

- Reduced-field running may improve acceptance for low-momentum particles in near-threshold KLF physics, such as hyperon production.
- Forward $K\pi$ production relies on relatively high-momentum K and π tracks.
- This study is performed with the updated JANA2-based KLF reconstruction chain.
- Need to check the impact on:
 $M(K\pi)$, missing mass, t reconstruction, efficiency, and resolution.

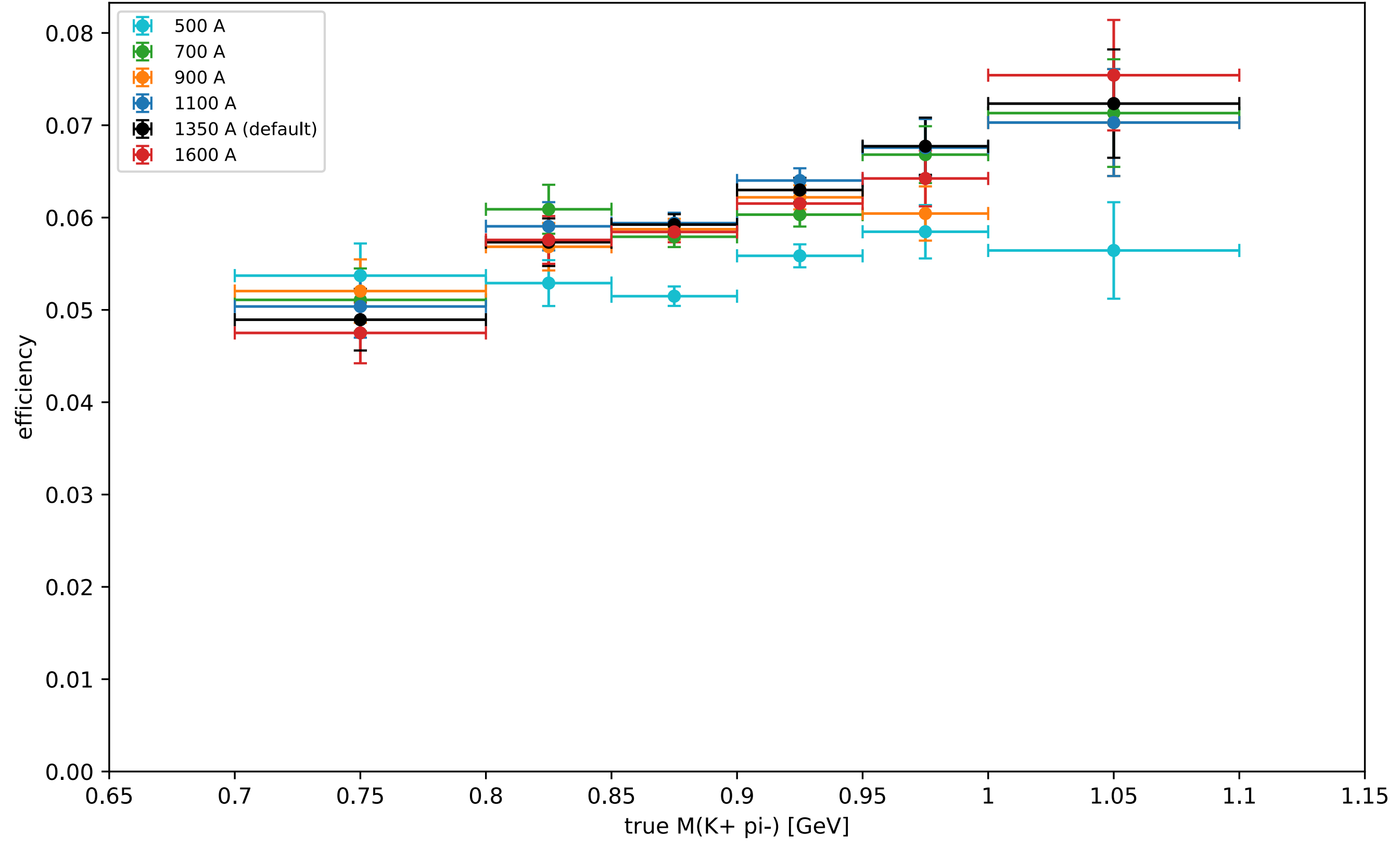


Broad K , π , and proton coverage, except in the very-forward region.

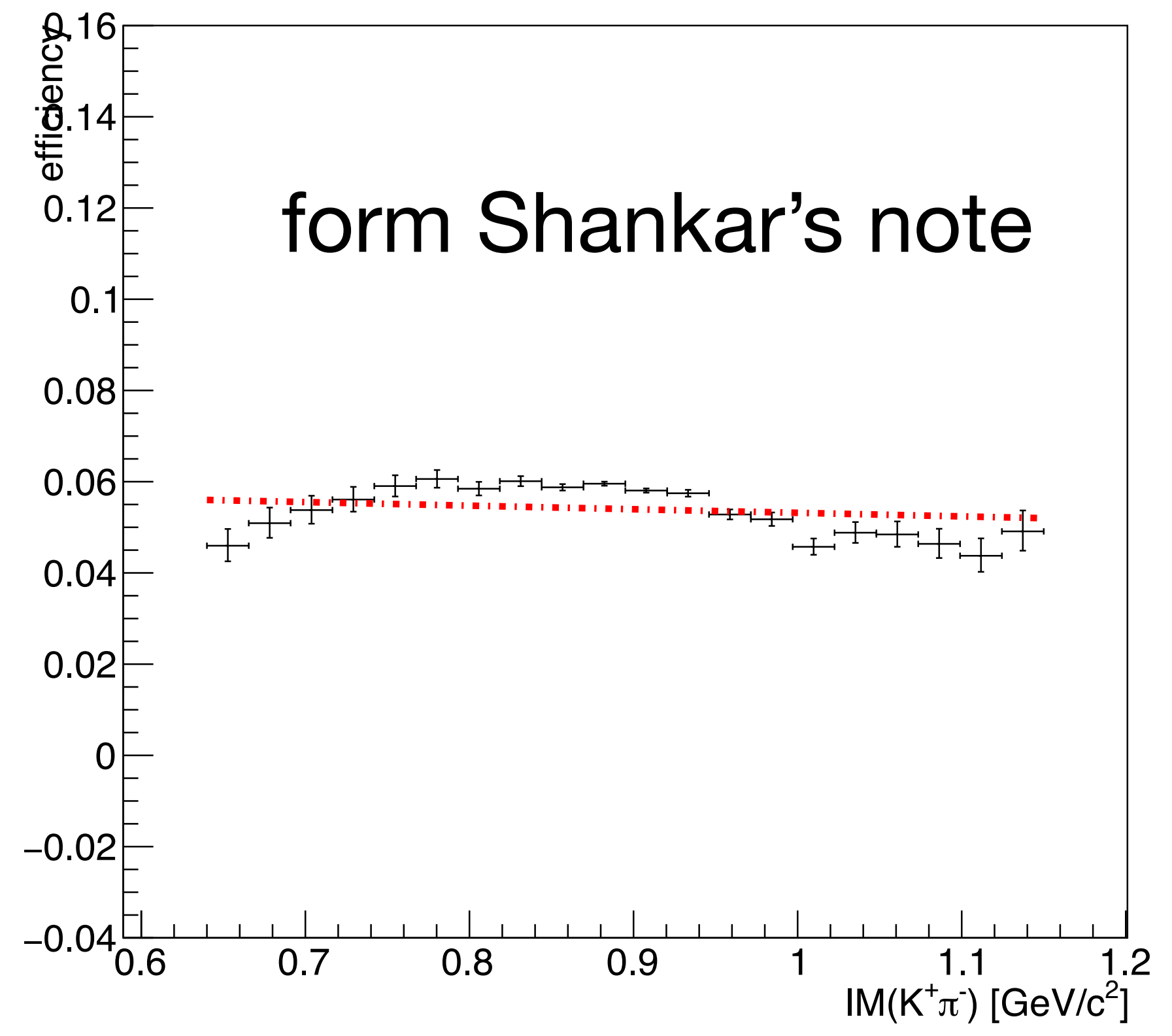


comparison under different field settings

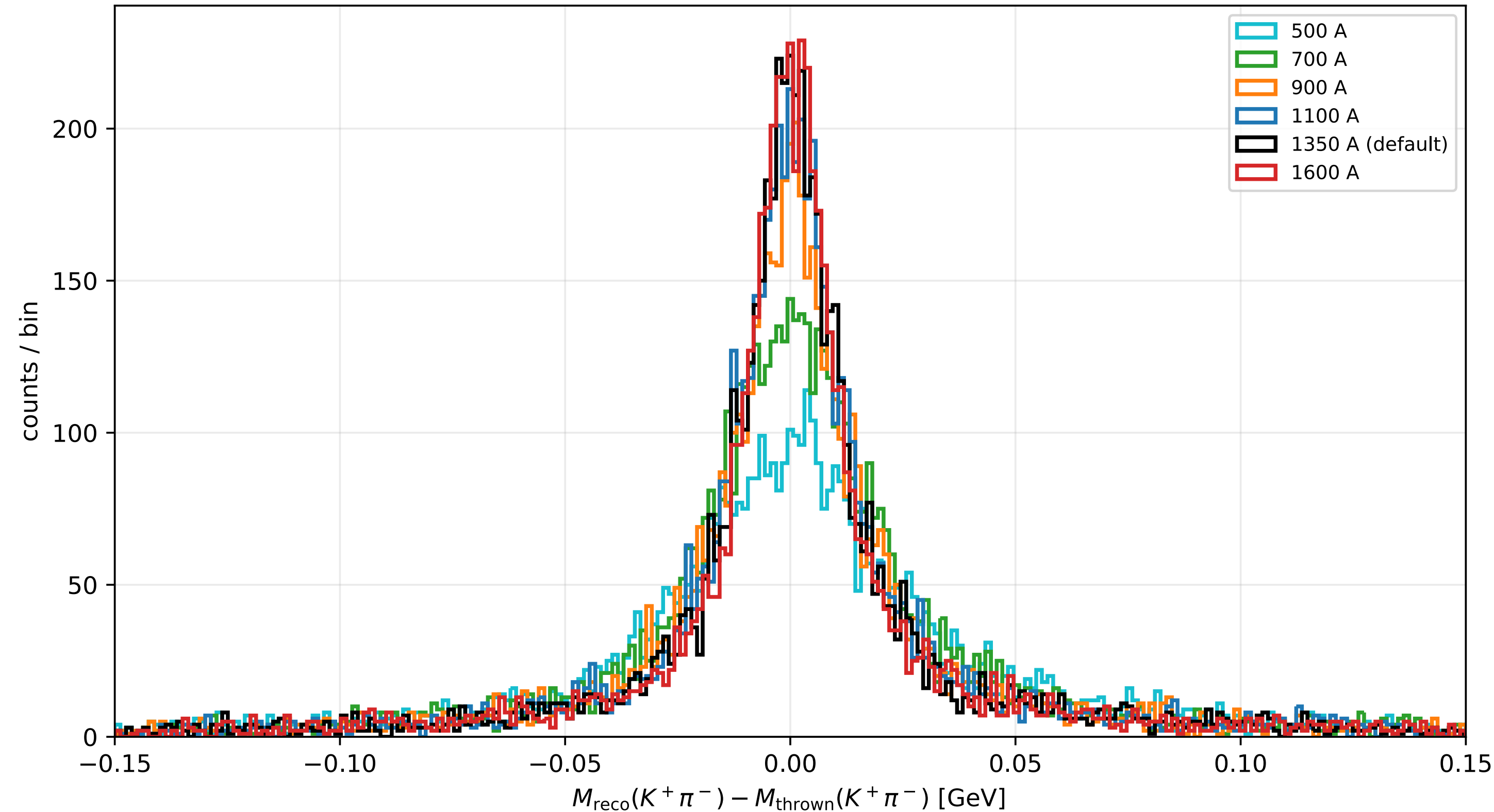
K+ pi- invariant mass efficiency



$K^+\pi^-$ Invariant Mass Efficiency

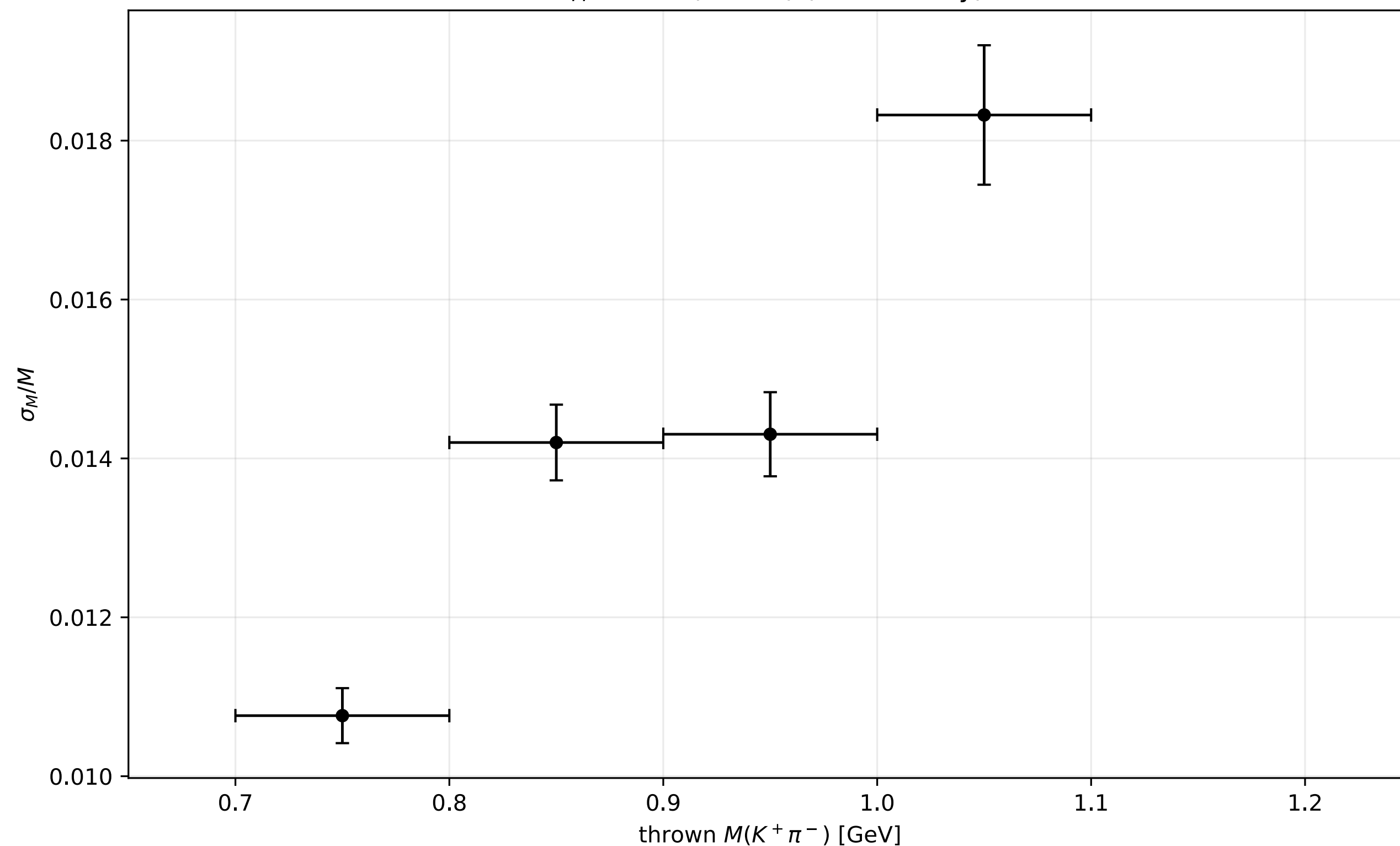
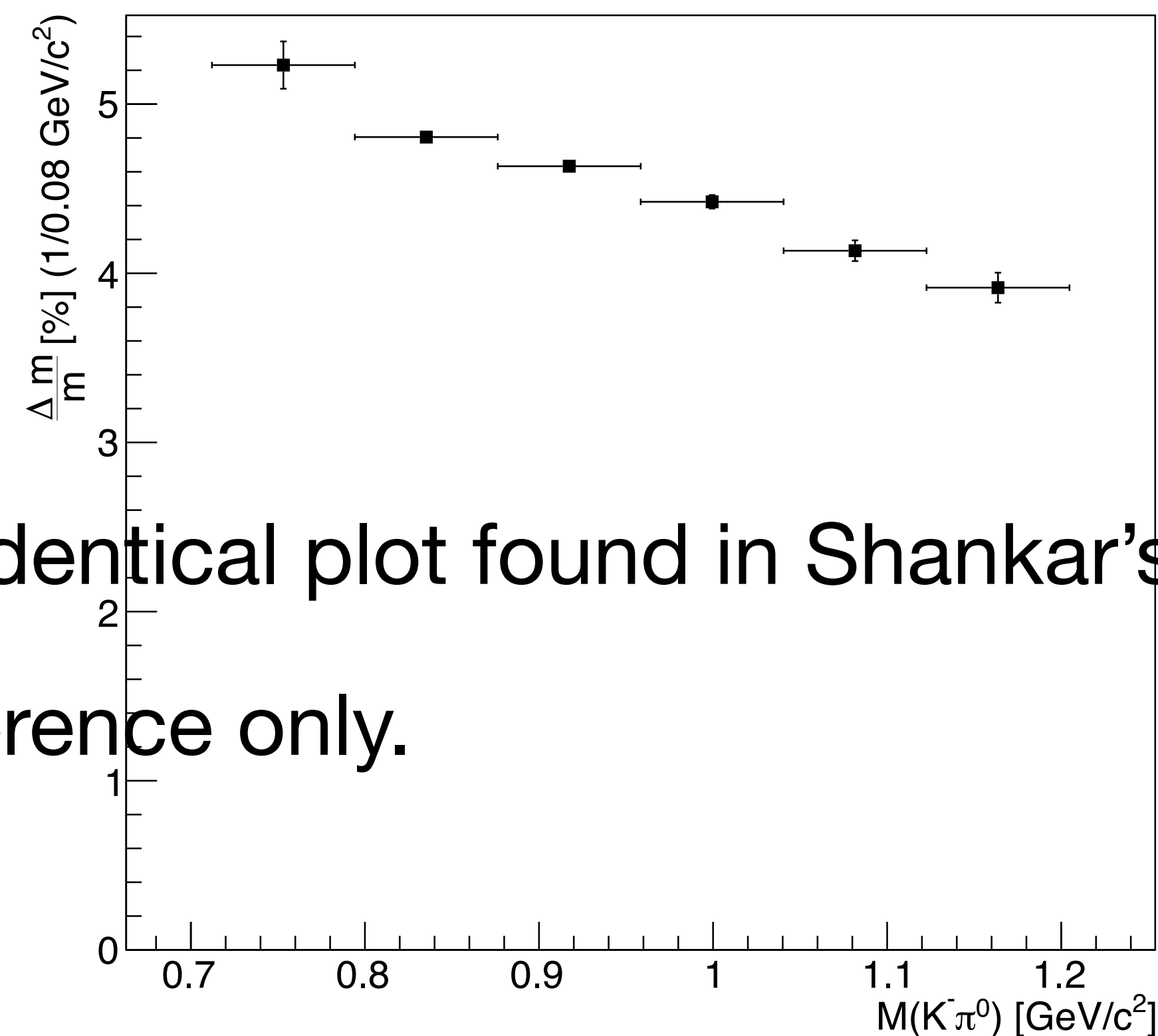


- No strong $M(K^+\pi^-)$ dependence observed so far
- Small field dependence; 500 A is slightly lower
- Default-field result is broadly consistent with the previous 5–6% level



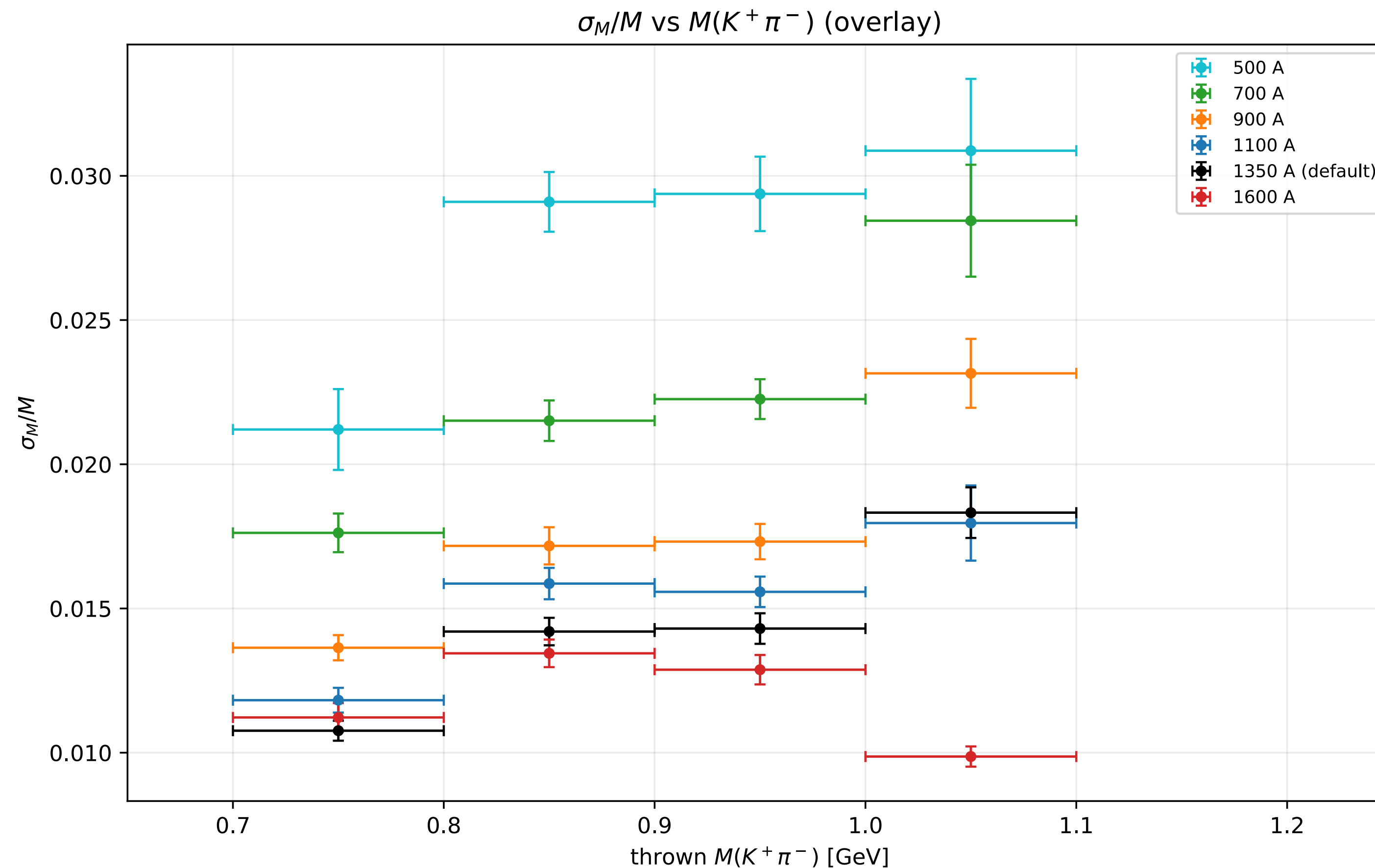
$$\Delta M = M_{\text{reco}}(K^+\pi^-) - M_{\text{gen}}(K^+\pi^-)$$

- Lower solenoid field settings show broader ΔM distributions.
- This indicates degradation of the $K\pi$ mass resolution at reduced field.

σ_M/M vs $M(K^+\pi^-)$ (default only) $K^-\pi^0$ Invariant Mass Resolution for $K_L p \rightarrow K^-\pi^0\Delta^{++}$ 

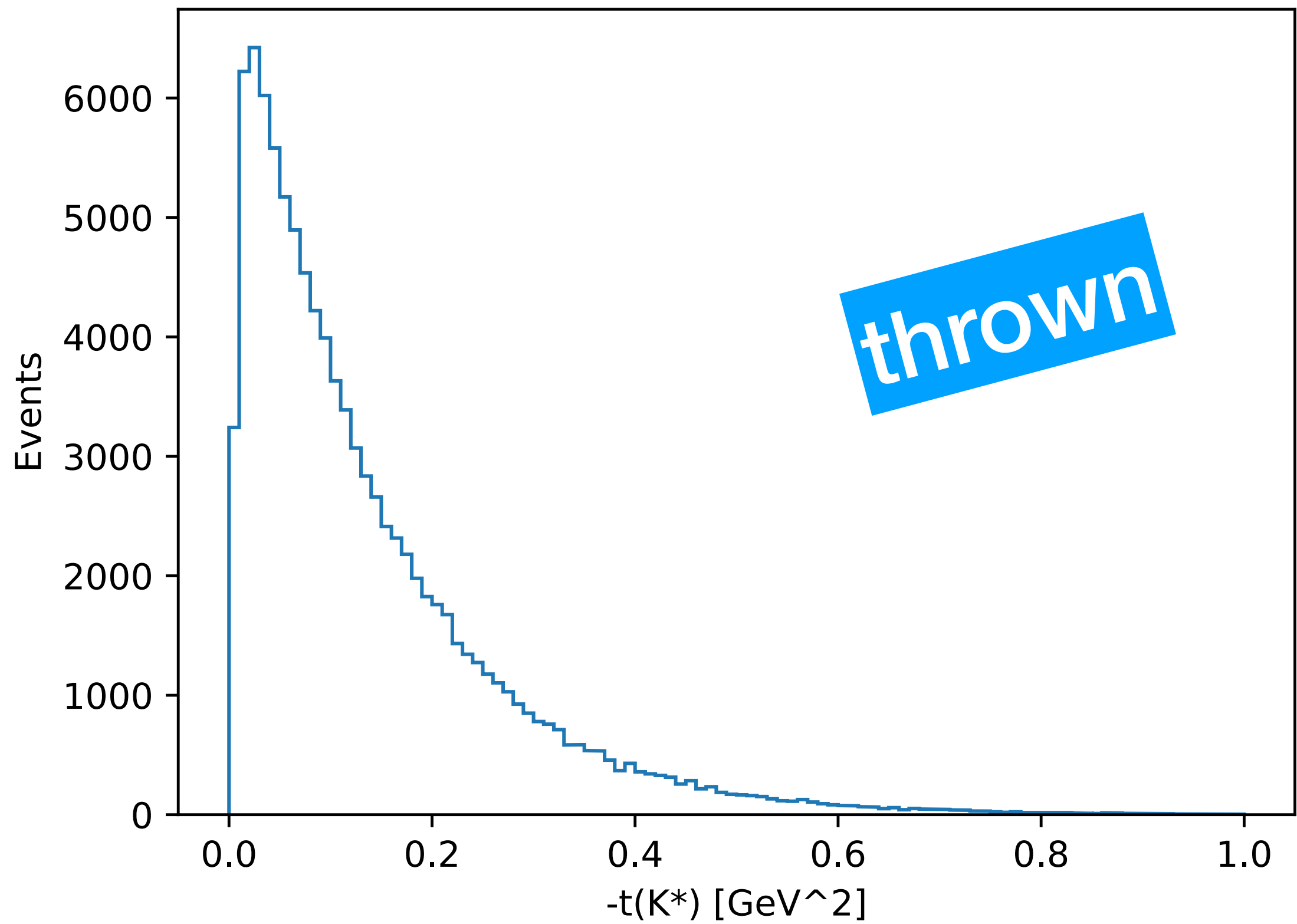
No identical plot found in Shankar's note
Reference only.

- The default-field result shows a mild increase with $M(K\pi)$.
- The relative mass resolution is about 1.5% in this mass region.

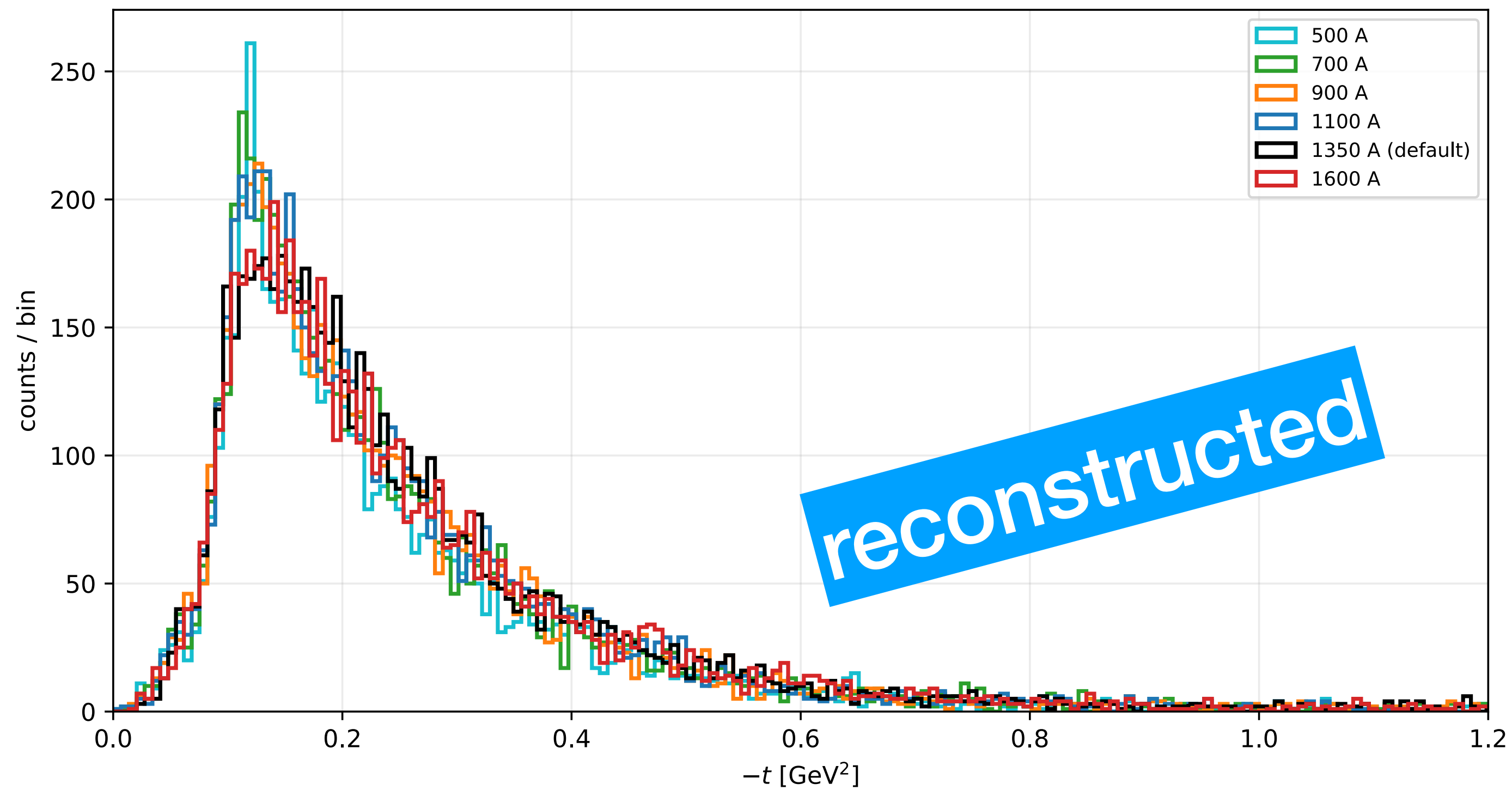


- The relative mass resolution worsens as the solenoid field is reduced.
- A clear degradation is seen toward 500 A.
- Even at 500 A, $M(K\pi)$ is reconstructed with about 3% relative resolution.

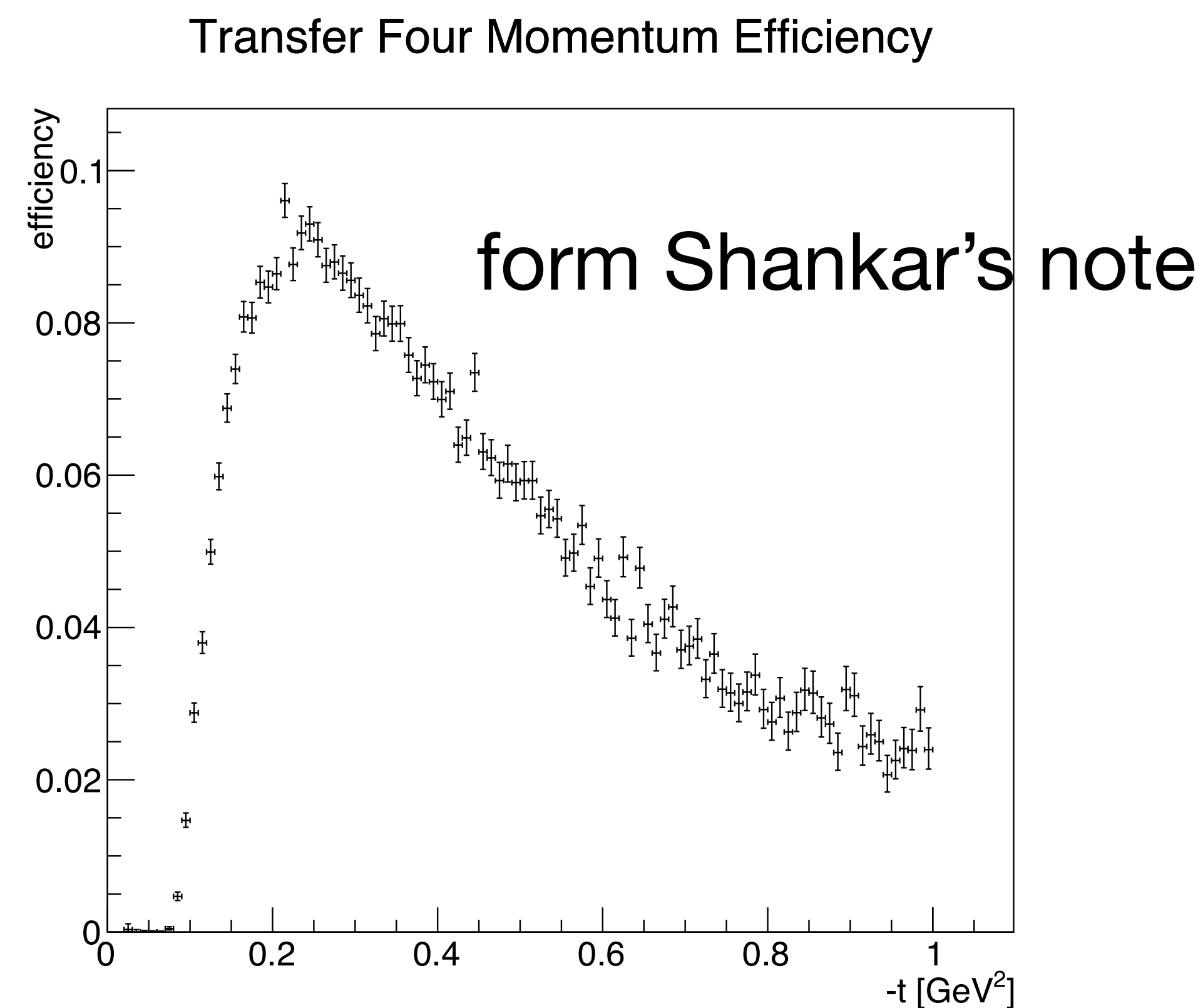
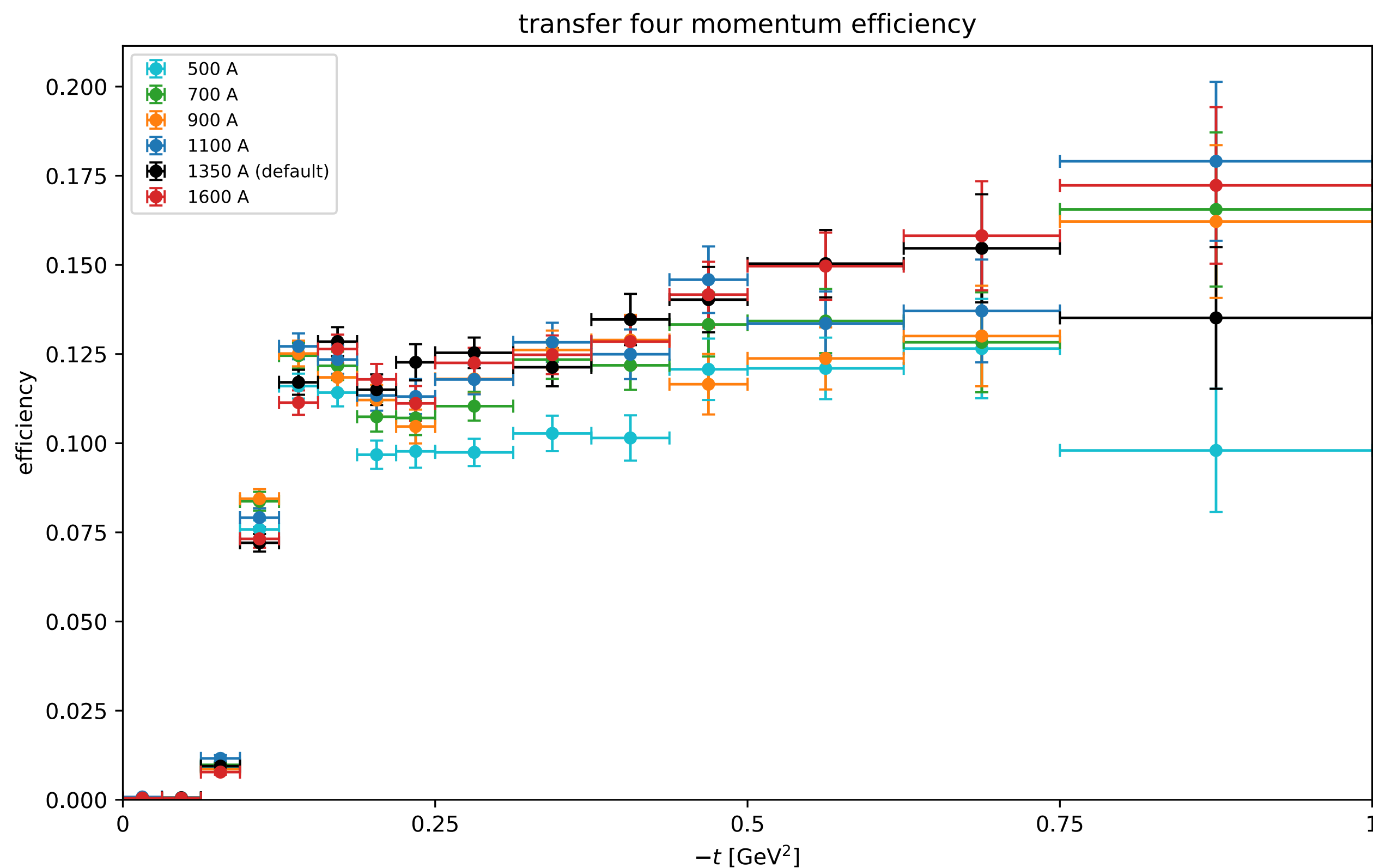
$-t(K^*)$ from HDDM



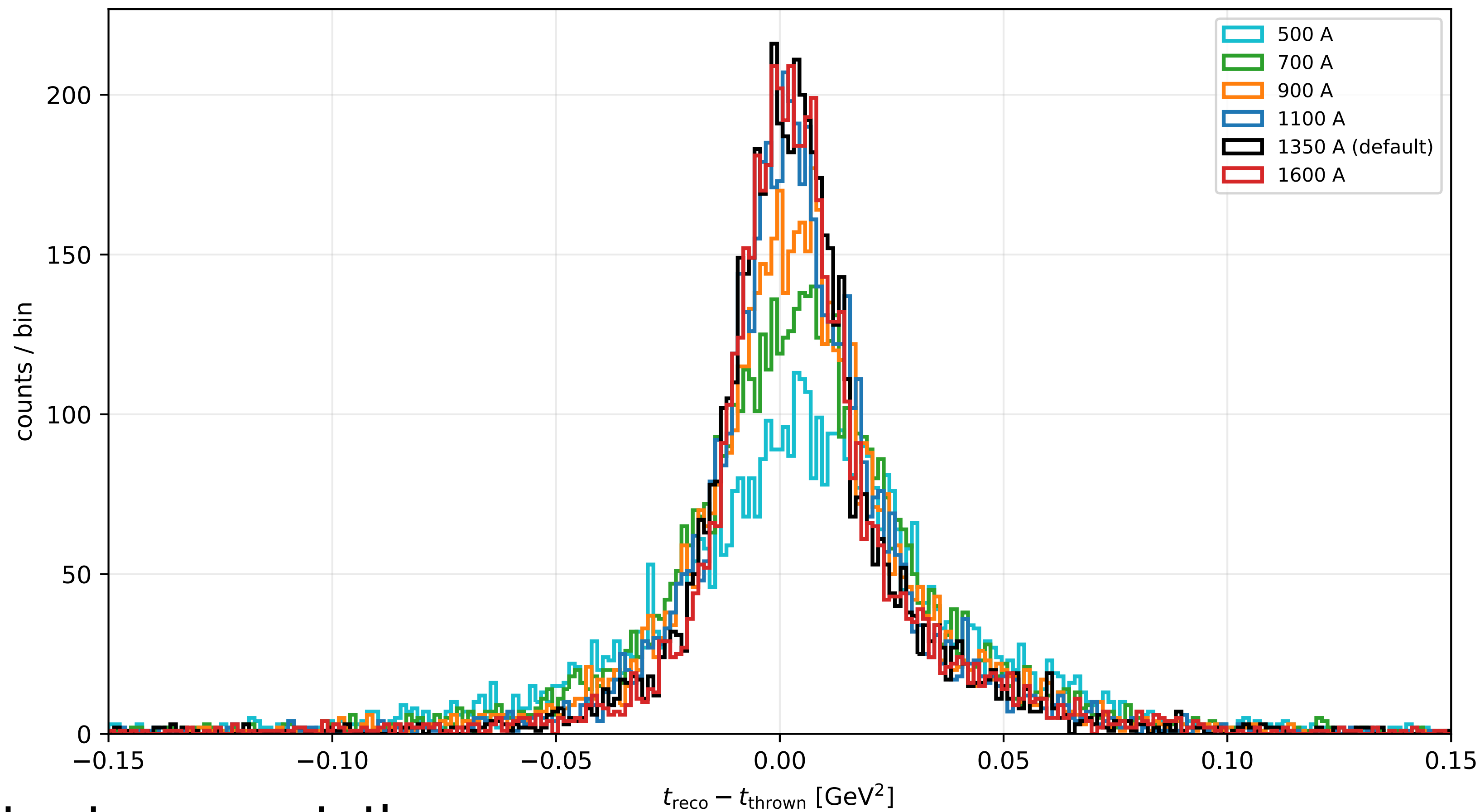
Reconstructed Mandelstam $-t$



comparison under different field settings



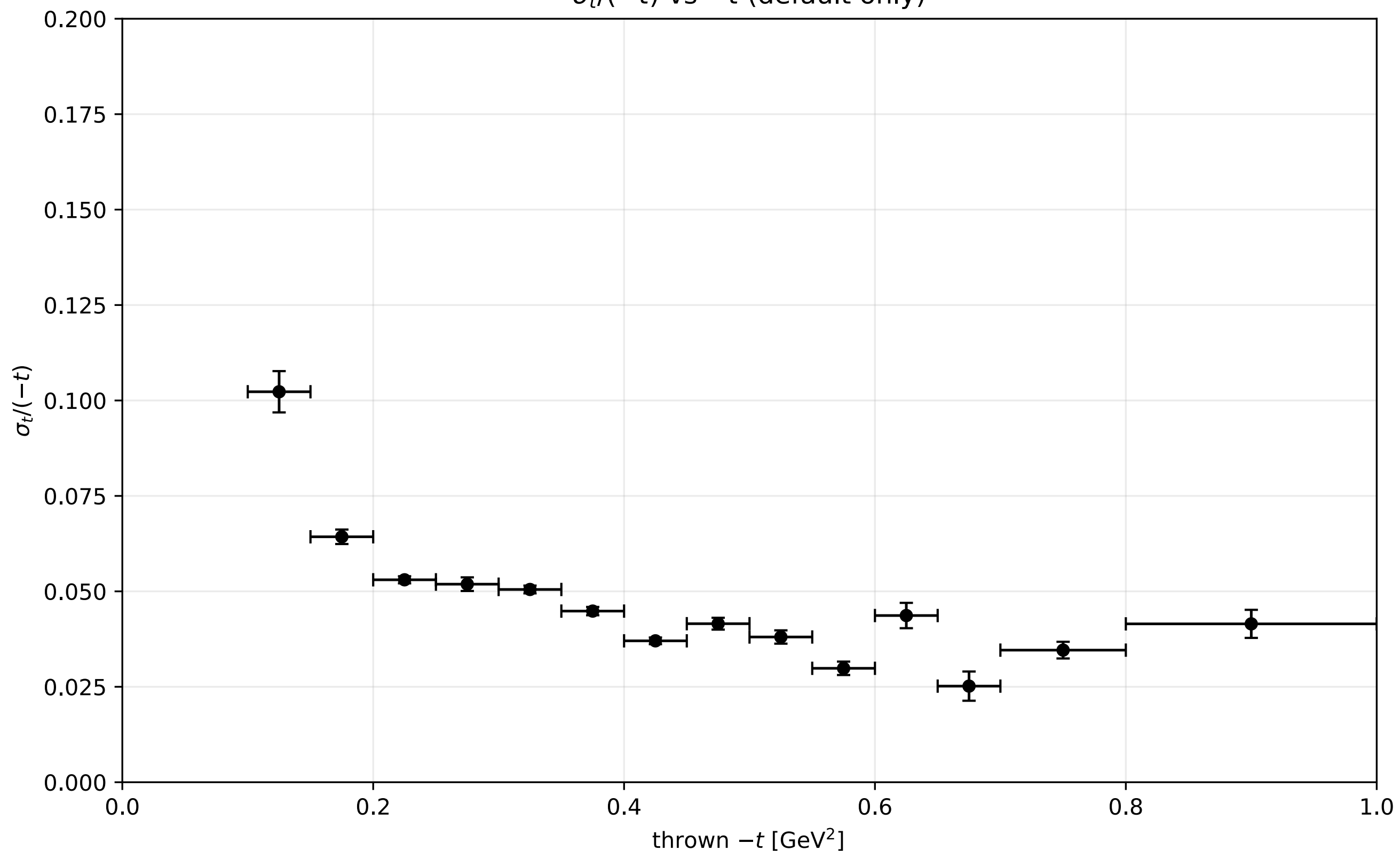
- The efficiency shows only a weak $-t$ dependence in the present study.
- The 500 A setting gives a slightly lower efficiency.
- The trend differs from Shankar's result; the origin is under investigation.



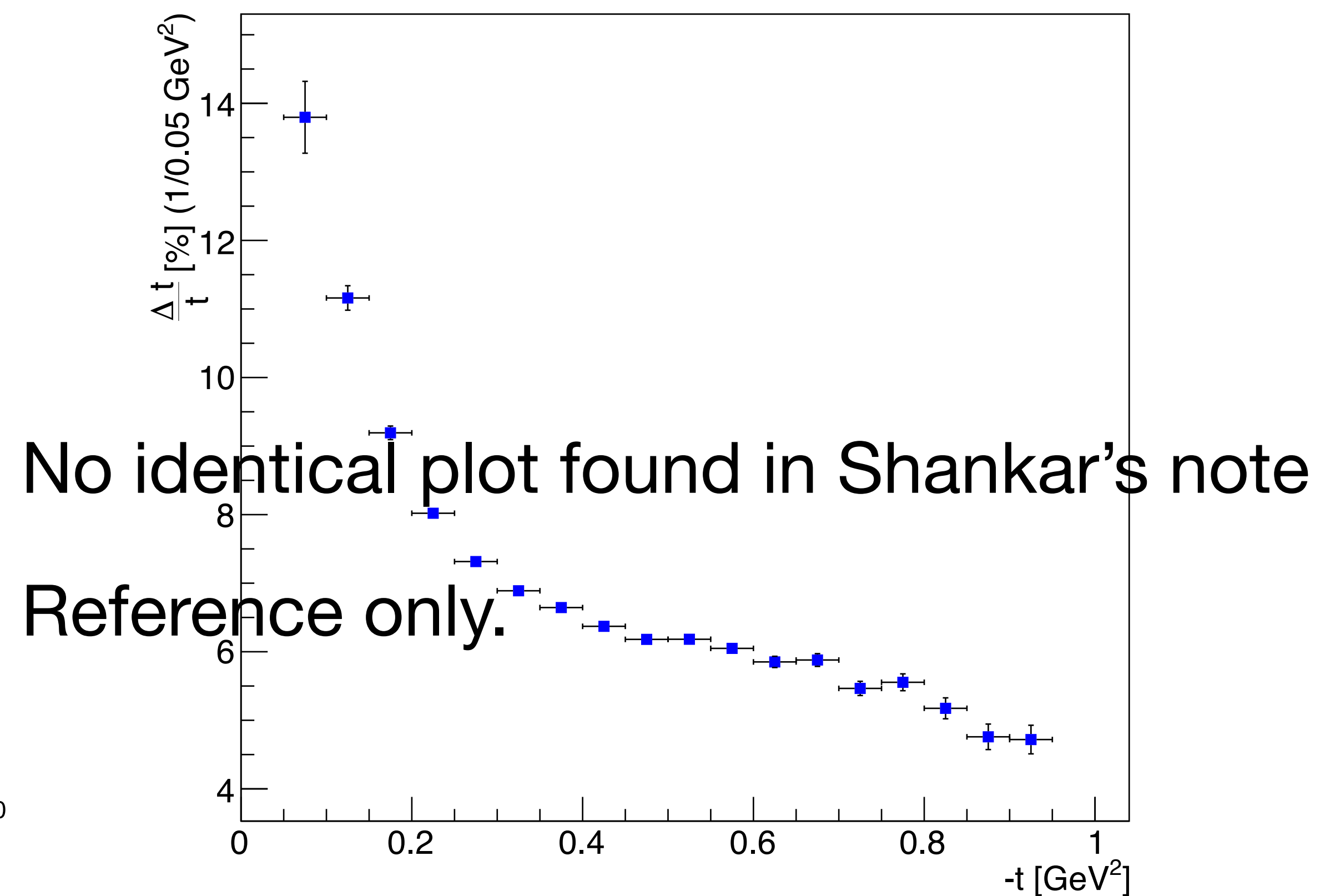
$$\Delta t = t_{\text{reco}} - t_{\text{thrown}}$$

- The Δt distribution broadens as the solenoid field is reduced.
- The 500 A setting shows the largest degradation in t resolution.

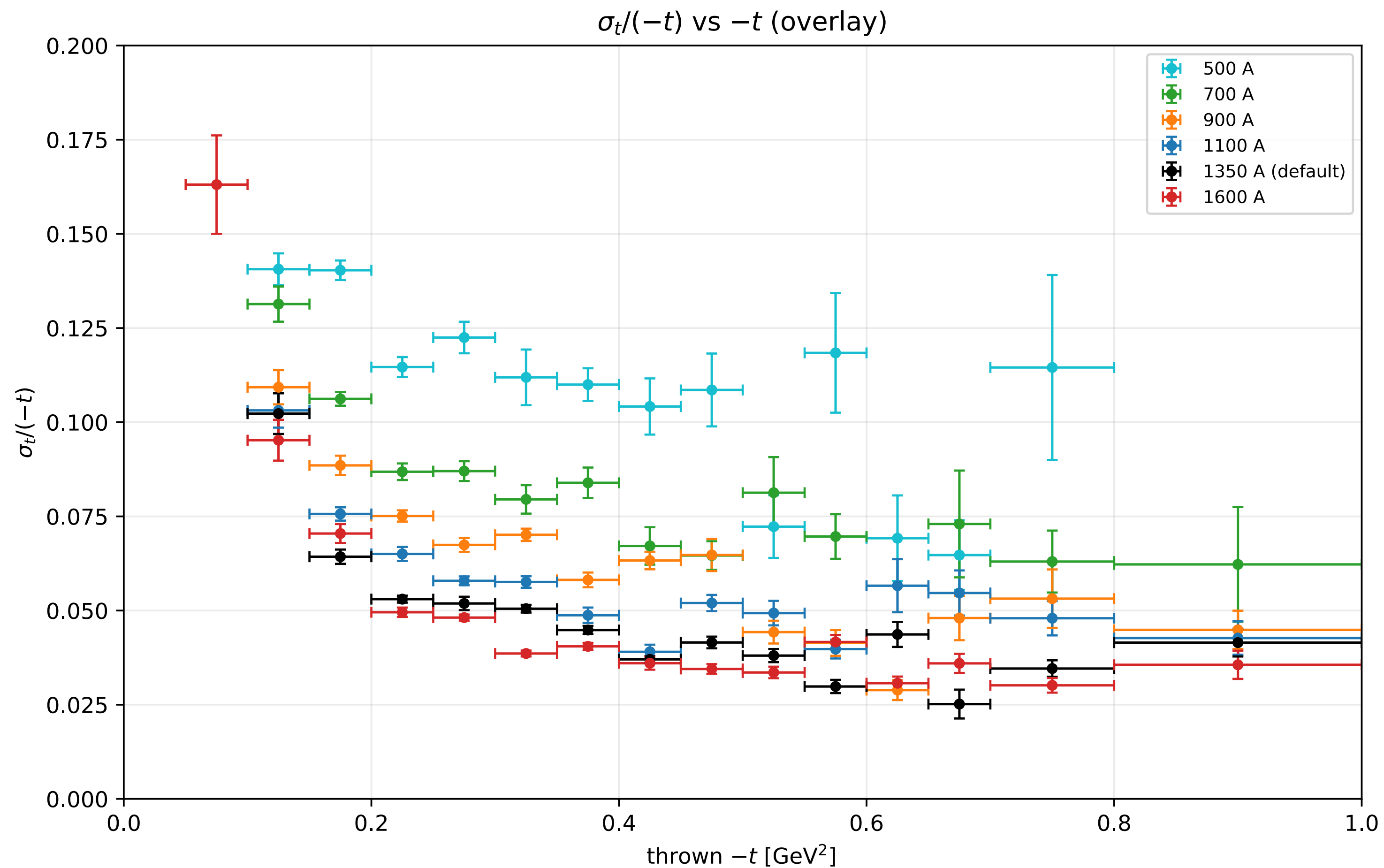
$\sigma_t(-t)$ vs $-t$ (default only)



Four Momentum Resolution for $K_L p \rightarrow K^- \pi^0 \Delta^{++}$



- The relative t resolution improves as $-t$ increases.
- In the present study, σ_t/t is below 5% over much of the $-t$ range.



- The relative t resolution worsens as the solenoid field is reduced.
- A clear degradation is seen toward 500 A.
- Even at 500 A, t is reconstructed with about 12–13% relative resolution.

Current status:

- JANA2-based KLF reconstruction chain is running for the forward $K\pi$ channel.
- Default-field efficiency and resolution are broadly consistent with the previous study.
- Reduced field settings degrade mass and t resolutions, but the channel remains reconstructable.

Next:

- Start Counter geometry dependence
- Δ -recoil $K\pi$ channels
- Improved generator and systematic efficiency / resolution studies