Kaon Form Factors at the EIC

Stephen JD Kay
University of Regina

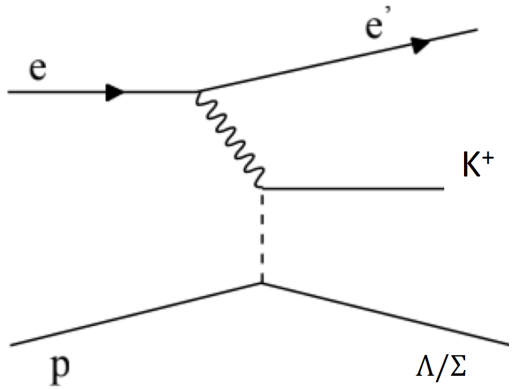
ePIC Exclusive, Diffractive and Tagging
14/11/22

F_K at the EIC - Challenges and Possibilities

- F_K at the EIC via DEMP will be extremely challenging

- Would need to measure two reactions
  - $p(e, e' K^+ \Lambda)$
  - $p(e, e' K^+ \Sigma)$
  - Need both for pole dominance tests

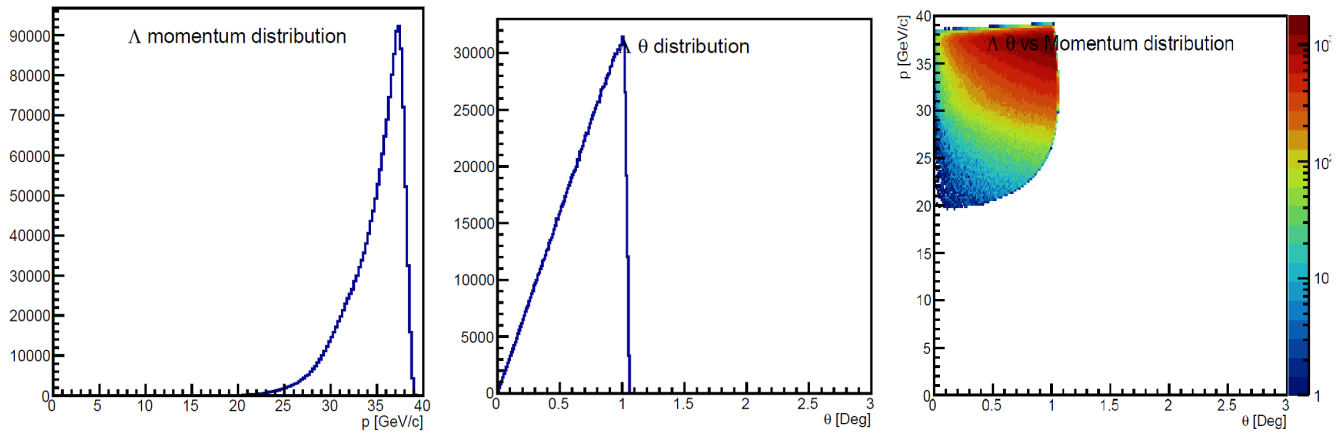
$$R = \frac{\sigma_L \left[p(e, e' K^+ \Sigma^0) \right]}{\sigma_L \left[p(e, e' K^+ \Lambda^0) \right]} \rightarrow R \approx \frac{g^2_{pK\Sigma}}{g^2_{pK\Lambda}}$$



- Consider just the Λ channel for now
  - Λ plays a similar role to neutron in π studies
  - Very forward focused, **but**, Λ will decay
    - $\Lambda \rightarrow n\pi^0$ - ~ 36 %
    - $\Lambda \rightarrow p\pi^-$ - ~ 64 %
  - Neutral channel potentially best option
    - **Very challenging 3 particle final state**

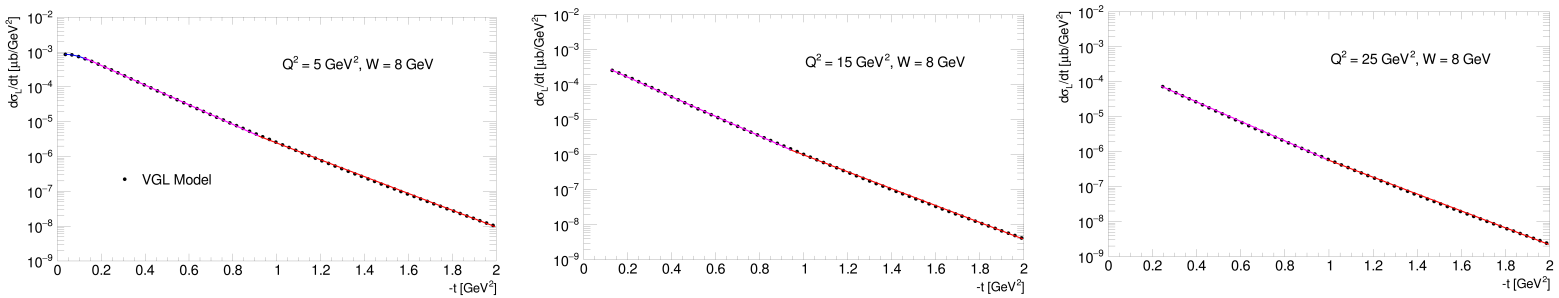
F_K at the EIC - DEMP Kinematics

- Preliminary testing of $p(e, e'K^+\Lambda)$ showed kinematics were similar to $p(e, e'\pi^+ n)$
- Very forward going Λ
  - Carries the majority of the momentum
- Decay and subsequent detection of the Λ in the far forward region is the biggest challenge for this measurement
- **Could test this with particle gun studies of Λ^0**
  - **Must go into the far forward detection region**
- 5 on 41 events with no crossing angle (not afterburned)



F_K at the EIC - Generator Updates

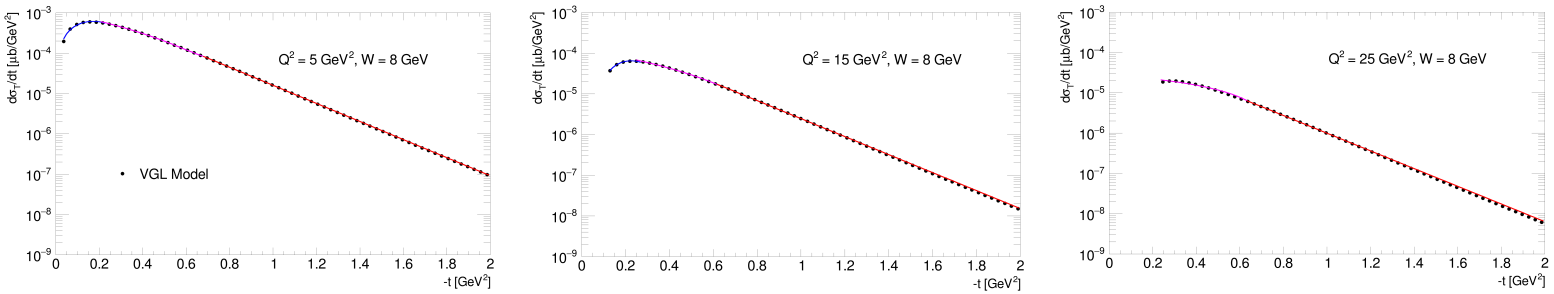
- URegina MSc student Love Preet working on adding Kaon DEMP event generator module to DEMPGen
  - Starting with $p(e, e'K^+\Lambda)$
- Parametrise a Regge-based model in a similar way to the pion
- For $p(e, e'K^+\Lambda)$ module, use the Vanderhagen, Guidal, Laget (VGL) model
- Parametrise σ_L, σ_T for $1 < Q^2 < 35$, $2 < W < 10$, $-t < 2.0$
  - Parametrise with a polynomial, exponential and exponential



VGL Model - M. Guidal, J.-M. Laget, M. Vanderhaeghen, PRC 61 (3000) 025204

F_K at the EIC - Generator Updates

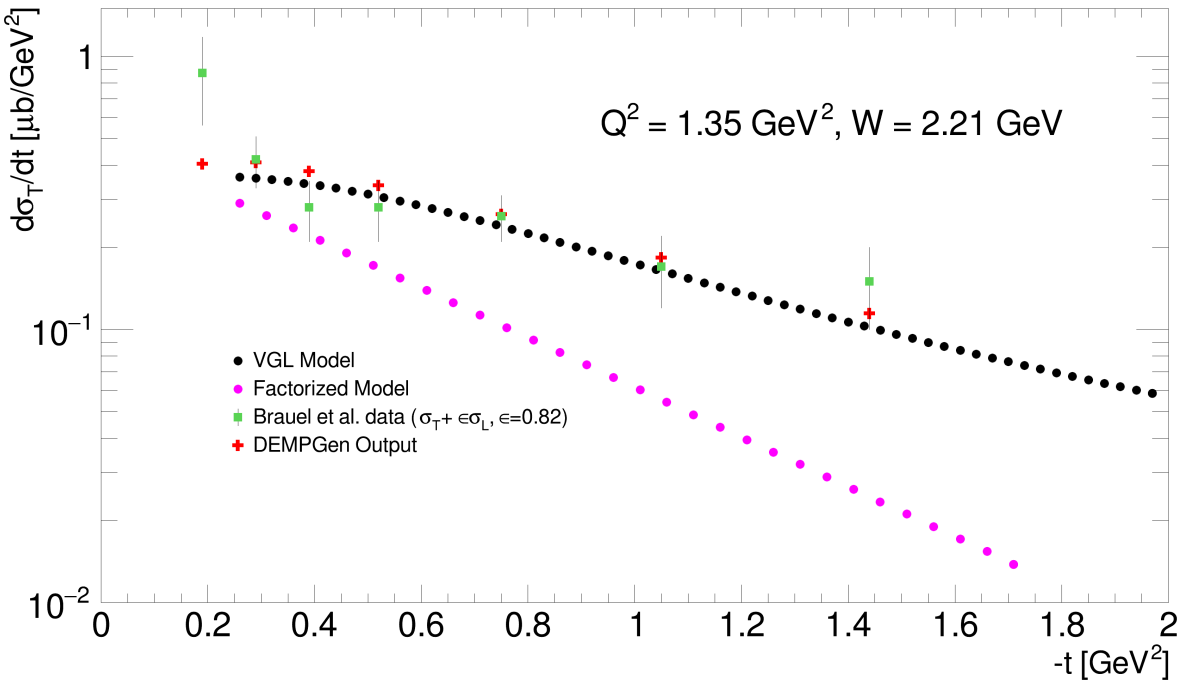
- URegina MSc student Love Preet working on adding Kaon DEMP event generator module to DEMPGen
  - Starting with $p(e, e'K^+\Lambda)$
- Parametrise a Regge-based model in a similar way to the pion
- For $p(e, e'K^+\Lambda)$ module, use the Vanderhagen, Guidal, Laget (VGL) model
- Parametrise σ_L, σ_T for $1 < Q^2 < 35$, $2 < W < 10$, $-t < 2.0$
  - Parametrise with a polynomial, polynomial and exponential



VGL Model - M. Guidal, J.-M. Laget, M. Vanderhaeghen, PRC 61 (3000) 025204

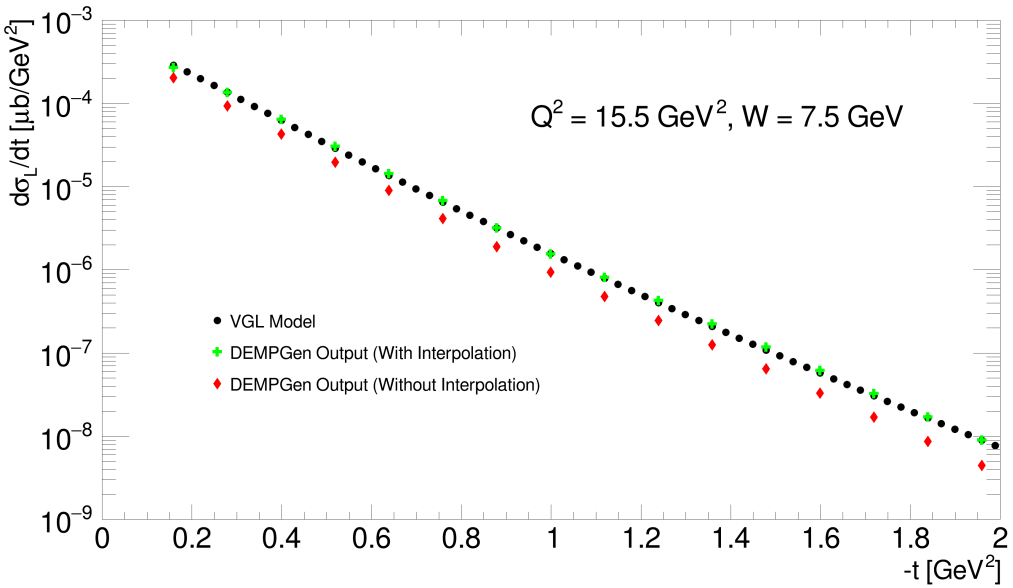
F_K at the EIC - Data Comparisons

- Sparse data for LT separated kaon cross sections
  - Only available at low Q^2, W
- VGL model describes data reasonably well
- VGL model behaves smoothly at higher Q^2, W
  - VGL model chosen over other available models



DEMPGen Improvements

- In addition to adding the $p(e, e'K^+\Lambda)$ module, improvements to the generator implemented
- New method to interpolate parametrisation
- Interpolation matches generator output very closely
  - Even at points far from the initial parametrisation
- Will incorporate improvements in pion model too in the near future



Thanks for listening, any questions?

University of Regina

Canadian Institute of Nuclear Physics

Institut canadien de physique nucléaire

Meson Structure Working Group - **Stephen JD Kay**, Garth M Huber, Zafar Ahmed, Love Preet, Ali Usman, John Arrington, Carlos Ayerbe Gayoso, Daniele Binosi, Lei Chang, Markus Diefenthaler, Rolf Ent, Tobias Frederico, Yulia Furletova, Timothy Hobbs, Tanja Horn, Thia Keppel, Wenliang Li, Huey-Wen Lin, Rachel Montgomery, Ian L. Pegg, Paul Reimer, David Richards, Craig Roberts, Dmitry Romanov, Jorge Segovia, Arun Tadepalli, Richard Trotta, Rik Yoshida

EIC-Canada

This research was supported by the Natural Sciences and Engineering Research Council of Canada (NSERC), FRN: SAPPJ-2021-00026

The University of Regina is situated on the territories of the nêhiyawak, Anihsināpēk, Dakota, Lakota, and Nakoda, and the homeland of the Métis/Michif Nation. The University of Regina is on Treaty 4 lands with a presence in Treaty 6.