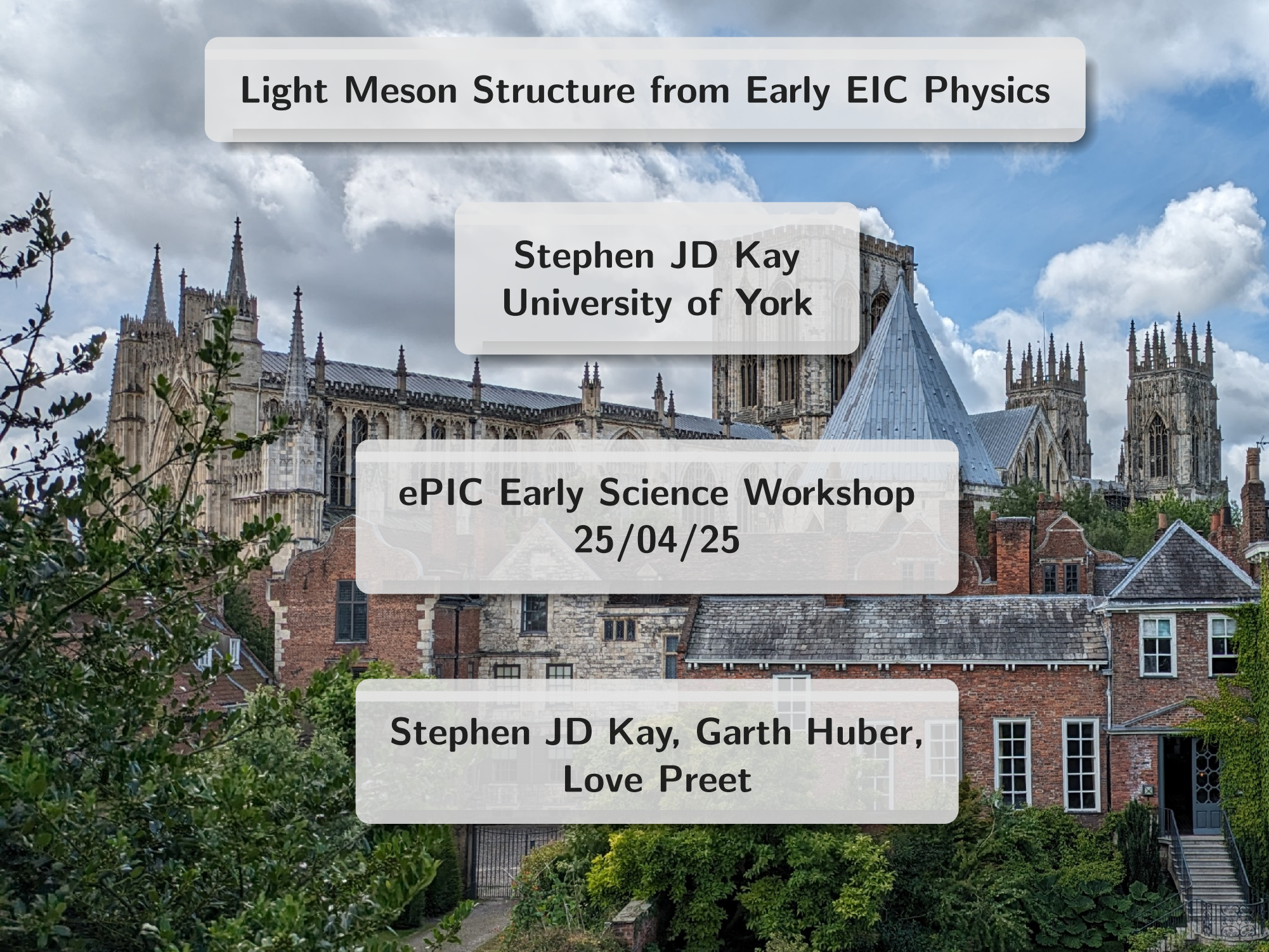

Light Meson Structure from Early EIC Physics

Stephen JD Kay
University of York

ePIC Early Science Workshop
25/04/25

Stephen JD Kay, Garth Huber,
Love Preet

Outline

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- Brief Form Factor Recap

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- Simulation Conditions

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- ePIC Projections - Latest Results and Improvements

Form Factors from DEMP at the EIC

- Form factors $\rightarrow$ Momentum space distributions of partons
  - Insights into emergent hadronic mass (EHM)
- Measurements $p(e, e'\pi^+ n)$ and $p(e, e'K^+\Lambda/\Sigma)$ at the EIC can potentially extend the Q^2 reach of F_π/F_K

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A. Bylinkin. et. al., NIMA 1052 (2023) 168238 https://doi.org/10.1016/j.nima.2023.168238

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- F_K studies still to be done
  - Promising signs on Λ reconstruction in ZDC though

See https://doi.org/10.48550/arXiv.2412.12346

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Used $\mathcal{L} \approx 0.2629 \times 10^{33} cm^{-2} s^{-1}$, based upon assumptions on per fill $\int \mathcal{L}$ in Elke's slides

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  - $3 < Q^2 < 10$, $10 < Q^2 < 20$ and $20 < Q^2 < 35$
  - Roughly ~300k generated per Q^2 range

Technically, actually a cut on the range of $\theta_{e'}$ values, directly feeds into Q^2

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- For π, processed with high acceptance (lower divergence) beam profile
  - Only pion high acceptance analysed so far
- Submit as a request to simulation campaign (300k events total), but also ran independently
  - Used 10x130 epic-craterlake detector config
  - Plots shown are from own simulation

DEMP Kinematics - Truth Distributions

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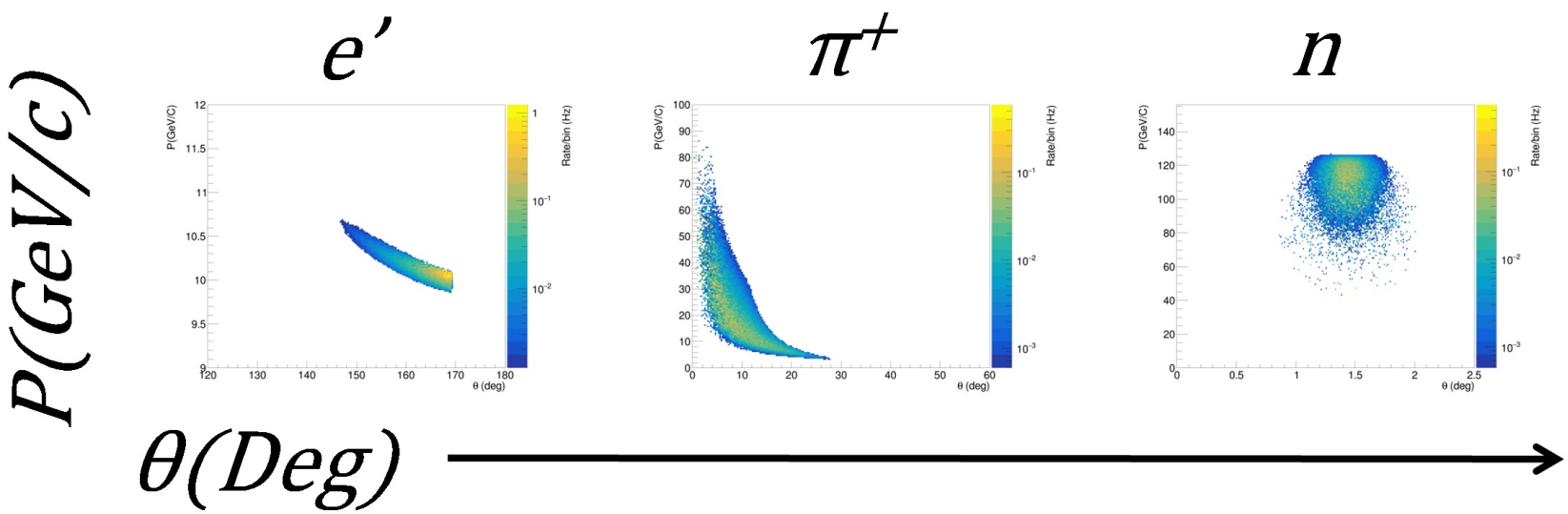

Beam effects *not* removed here.
Note, in η the ranges are $-1.15 < \eta_{e'} < -2.45$, $0 < \eta_{\pi^+} < 0.9$ and $4 < \eta_n < 5.1$.

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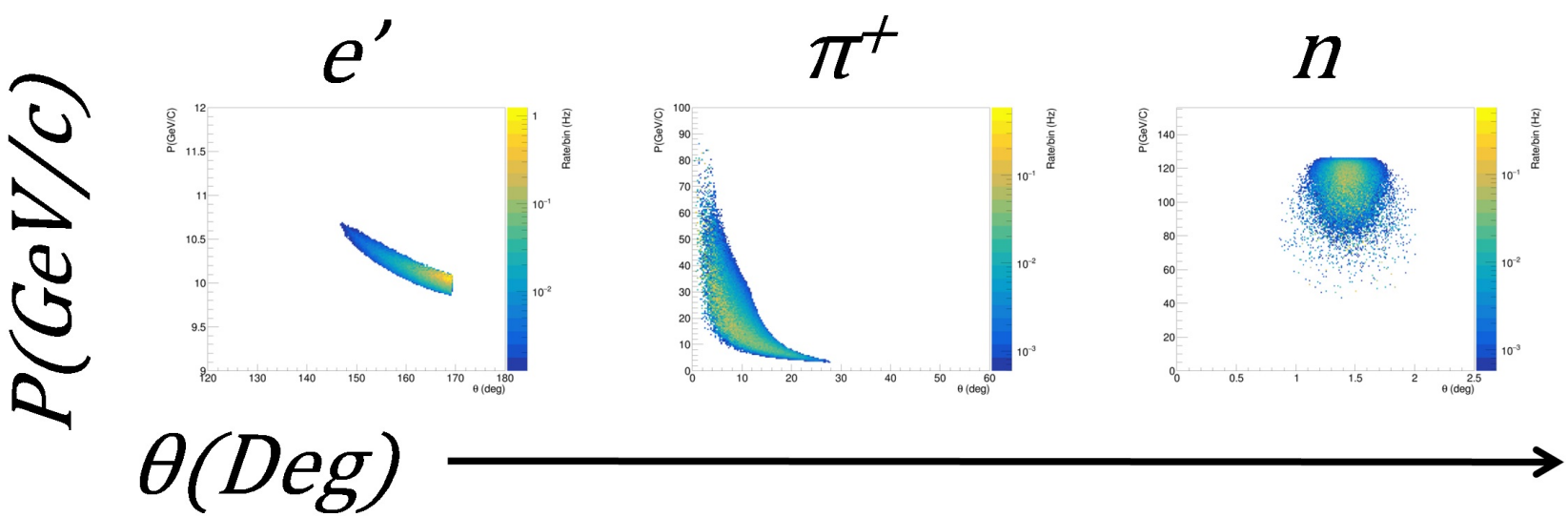

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θ^* is after a rotation of 25 mRad around the proton axis to remove the crossing angle

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$\vec{P}_{Miss} = (\vec{e} + \vec{p}) - (\vec{e\prime}_{Rec} + \vec{\pi}_{Rec})$ - More on this in a moment

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- Also cut on $-t_{eXBABE} < 1.4$ and $W_{rec} > 0$
  - Using the TRECO convention for -t reconstruction methods

DEMP Analysis Overview - $\Delta\theta^*$ and $\Delta\phi^*$ Cuts

- P_{Miss} vector should correspond with hit location on the ZDC
- For a non-exclusive event, P_{Miss} vector should not correspond to a ZDC hit
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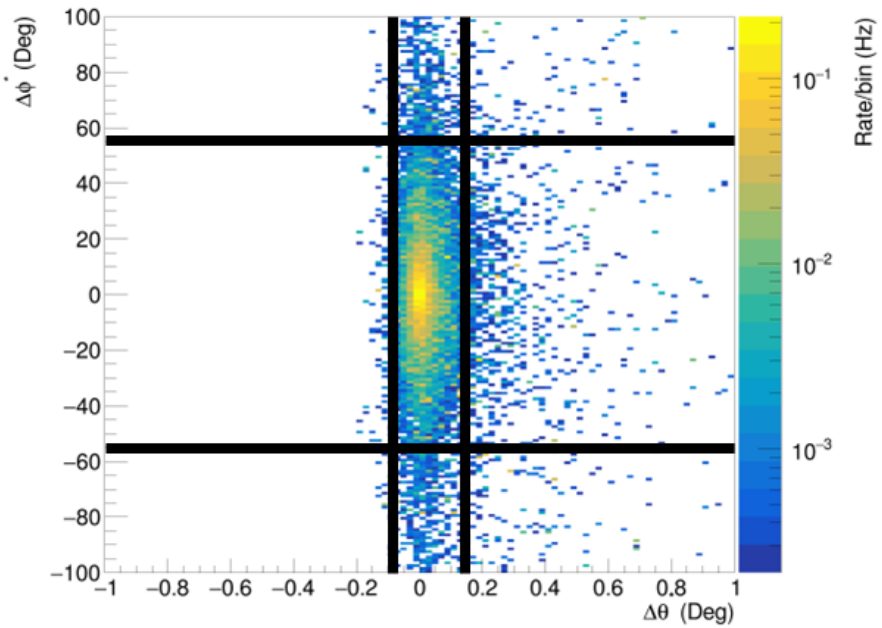

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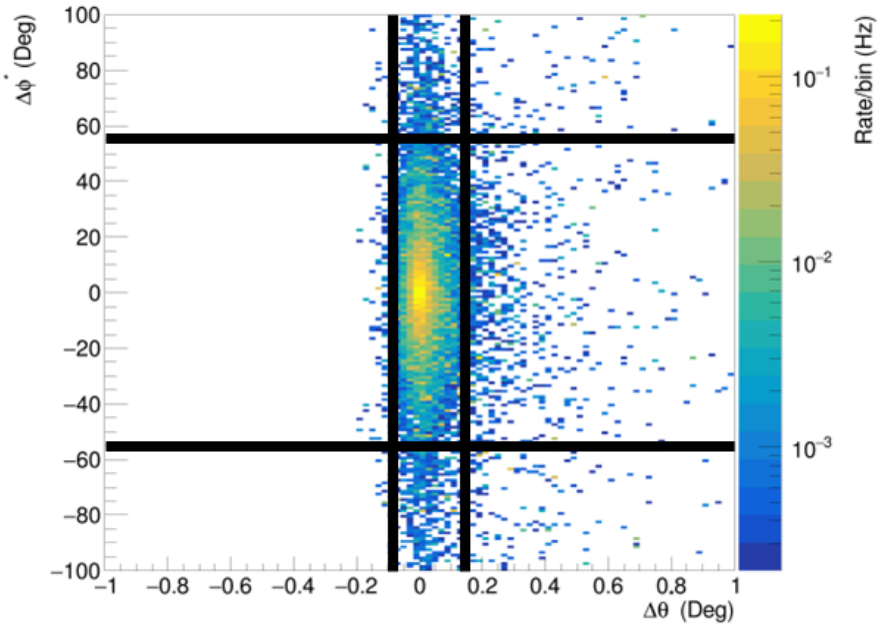
- $\Delta\phi^* = \phi^*_{PMiss} - \phi^*_{ZDC}$
- Simulation is **exclusive only**, inclusive events spread over broader range



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I.e. it is a neutron, so set the mass to the neutron mass. $\vec{P}_{Miss} = (\vec{e} + \vec{p}) - (\vec{e\prime}_{Rec} + \vec{\pi}_{Rec})$

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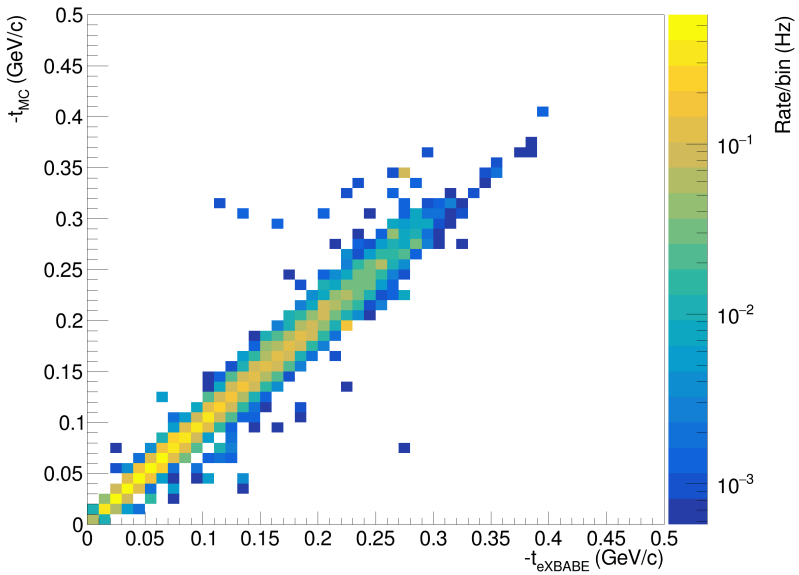

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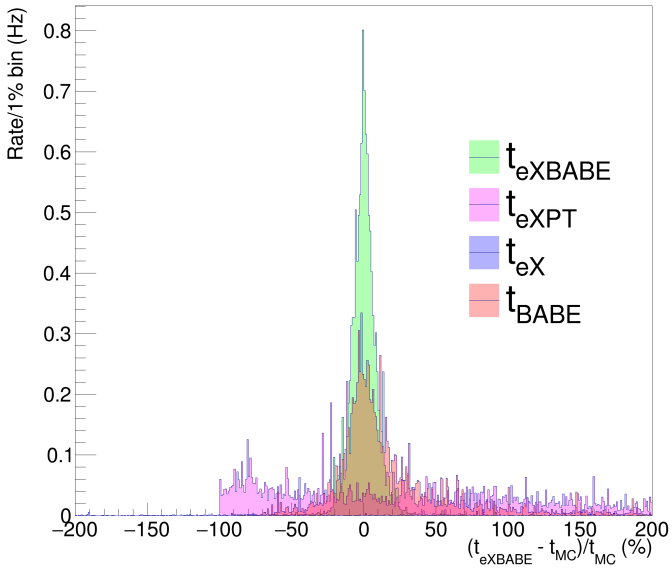
- $-t_{eXBABE}$ correlates well with truth
- Far better than methods using uncorrected neutron track (t_{BABE}) and methods utilising electron information (t_{eX}) and electron P_T (t_{eXPT}) info



$\sigma(eXBABE) = 13.36$, $\sigma(eXPT) = 83.67$, $\sigma(eX) = 111.87$, $\sigma(BABE) = 43.01$. **All $e'\pi^+n$ triple coincidence events**

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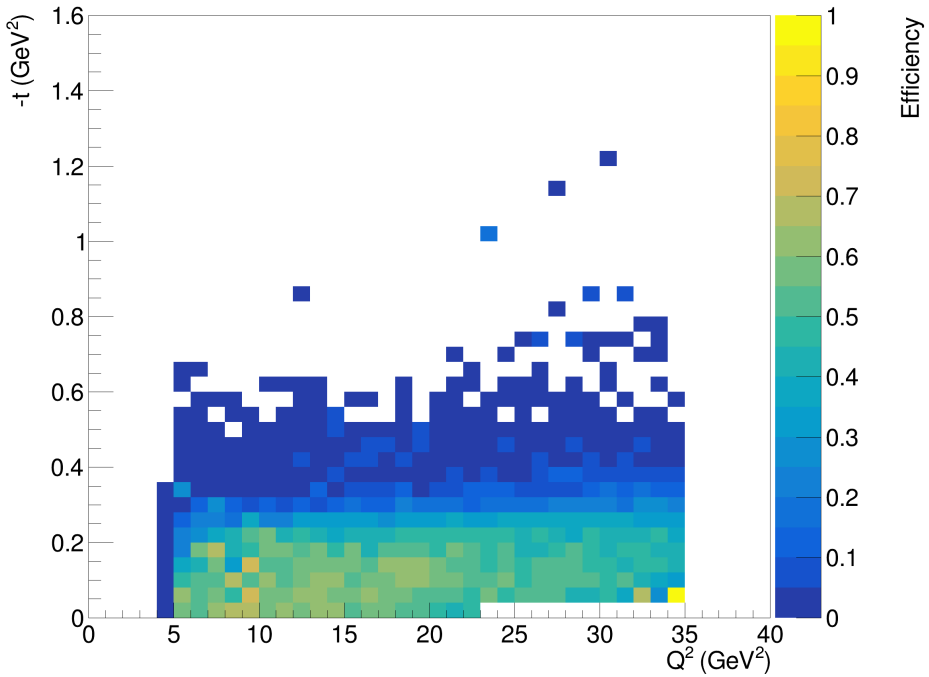

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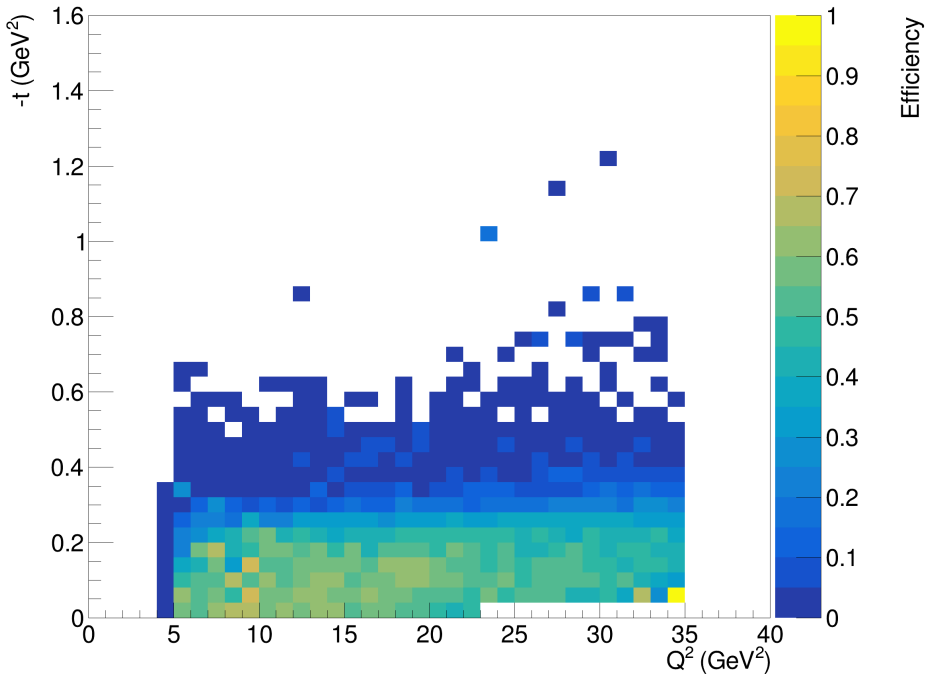
- Without B0, rapid tail off beyond $-t$ of 0.4



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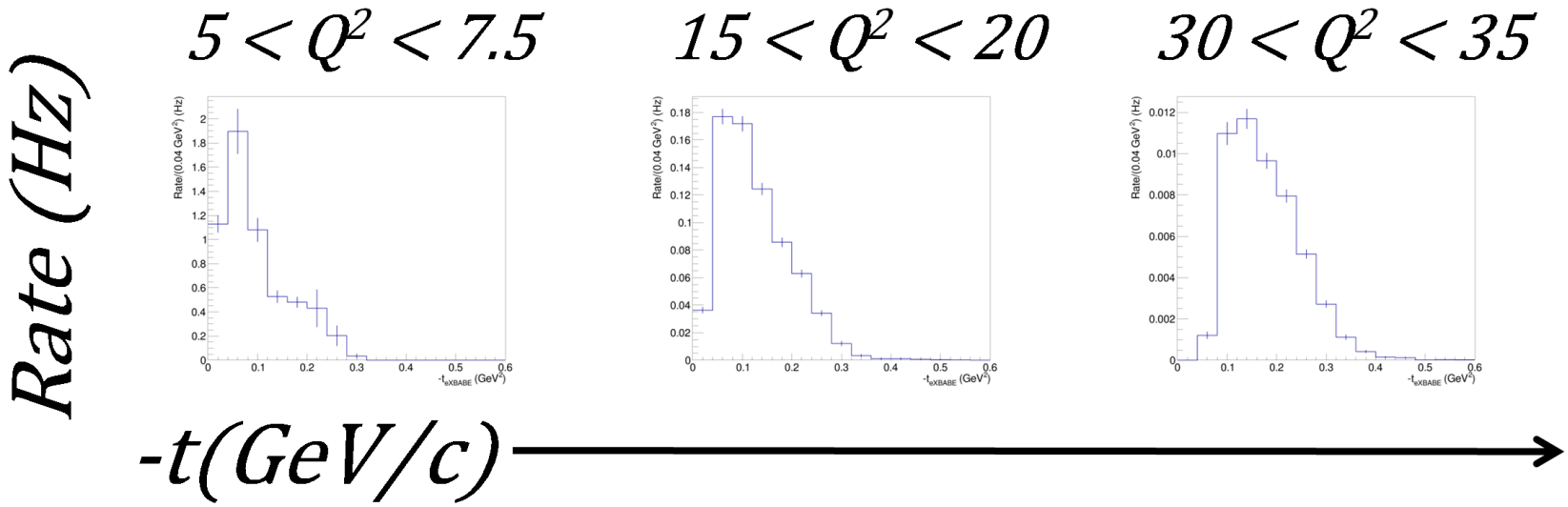

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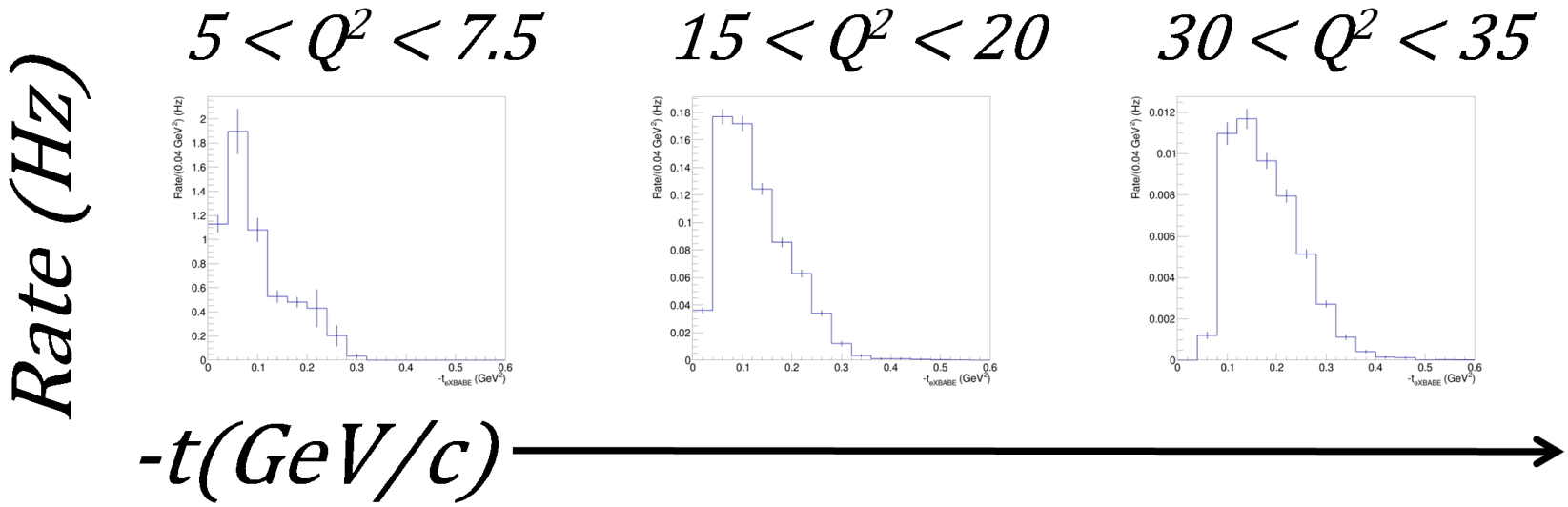
- From rate per bin, extrapolate to number of events with $\int \mathcal{L} = 5\ fb^{-1}$, project to F_π



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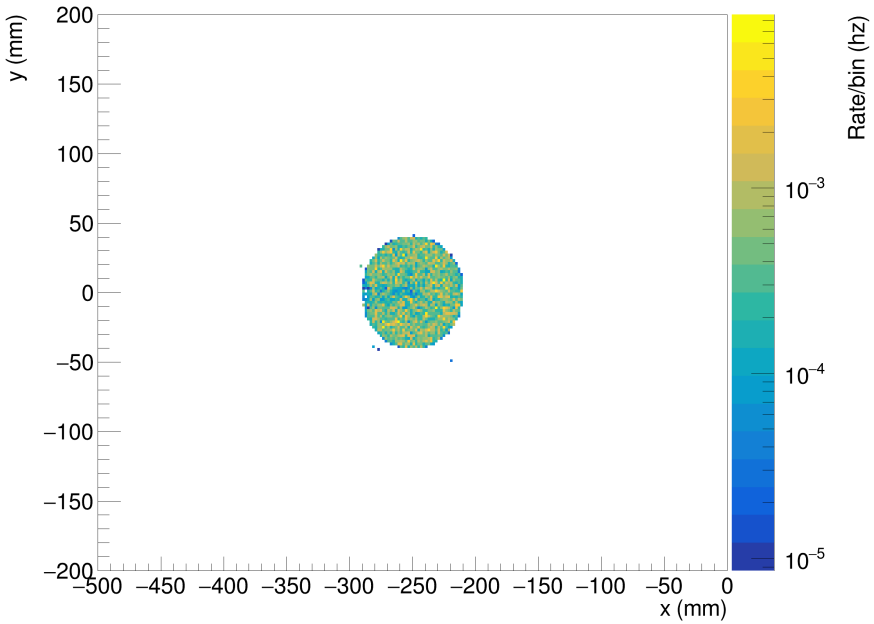

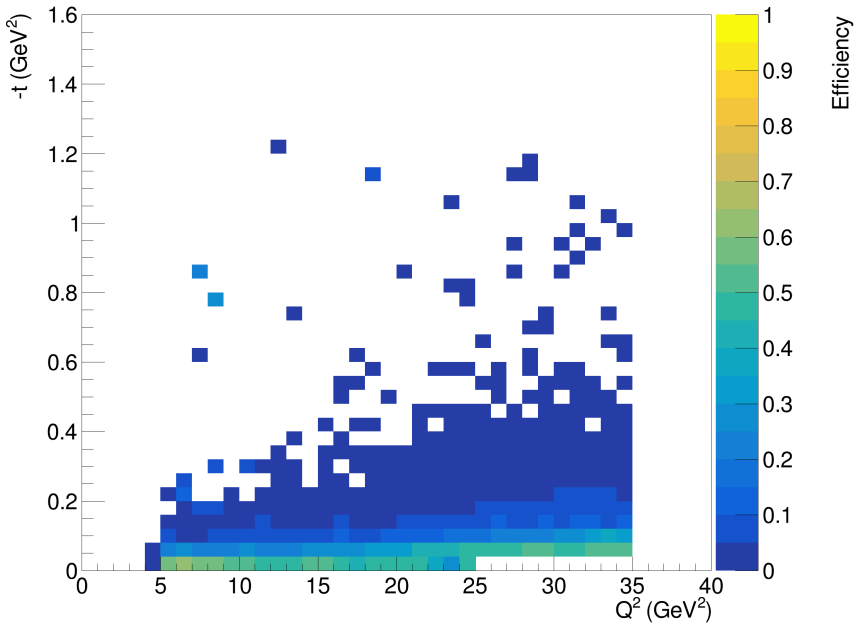

Tracks from ZDC n hits projected to $Z = 10m$

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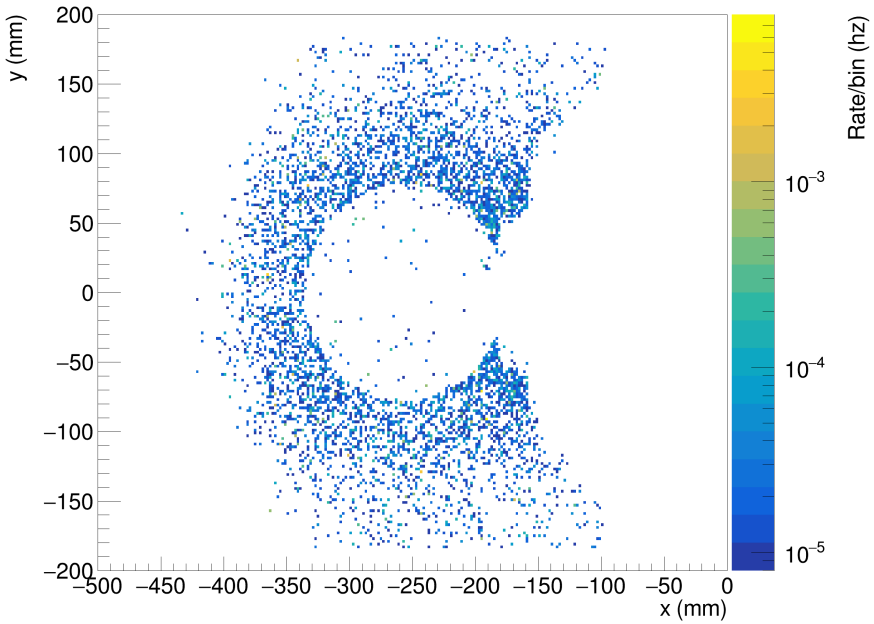

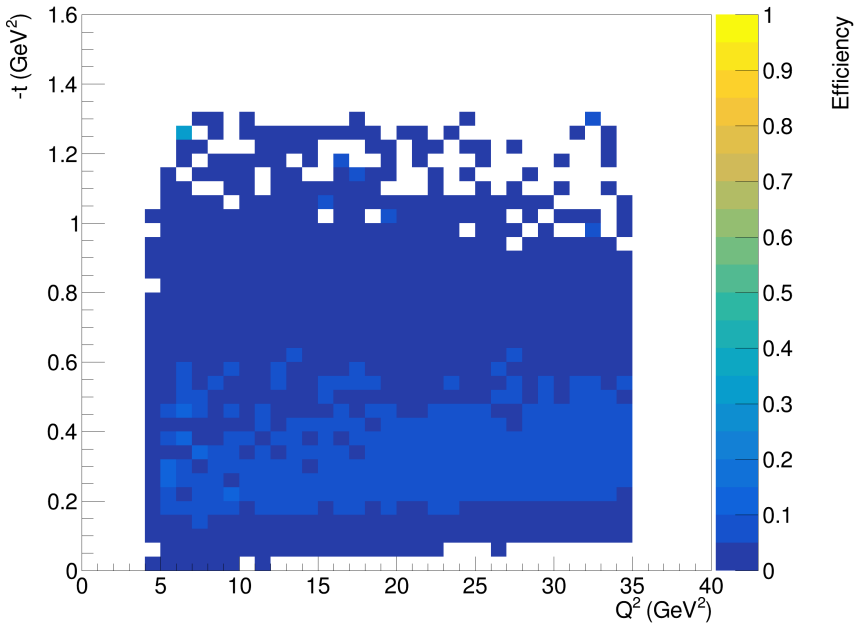

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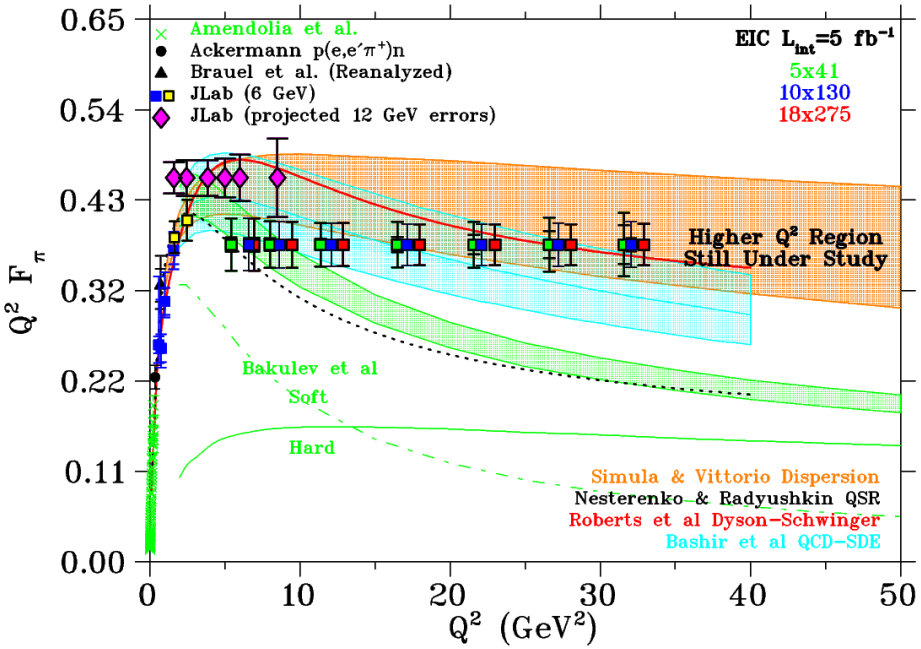

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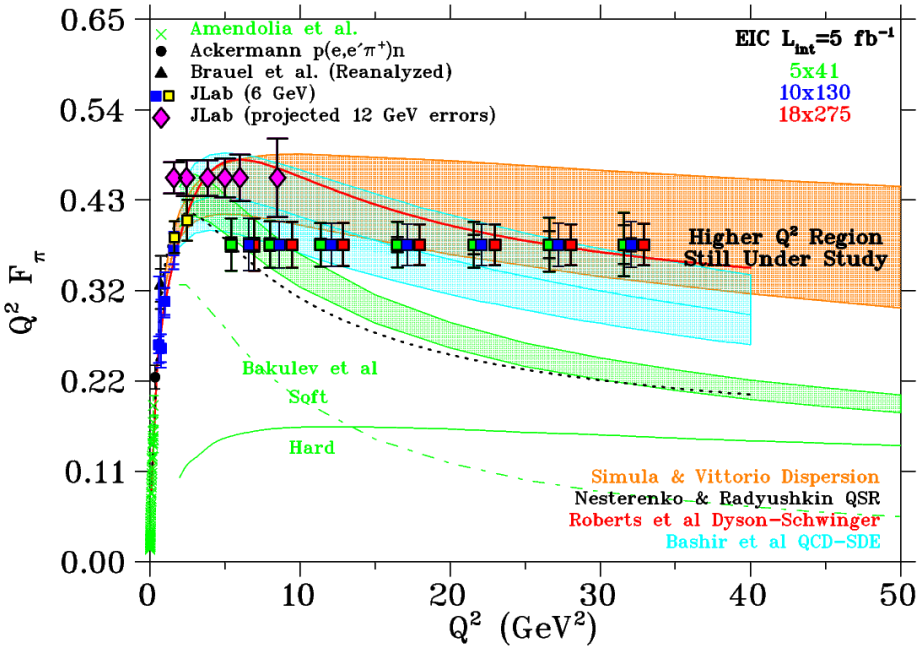

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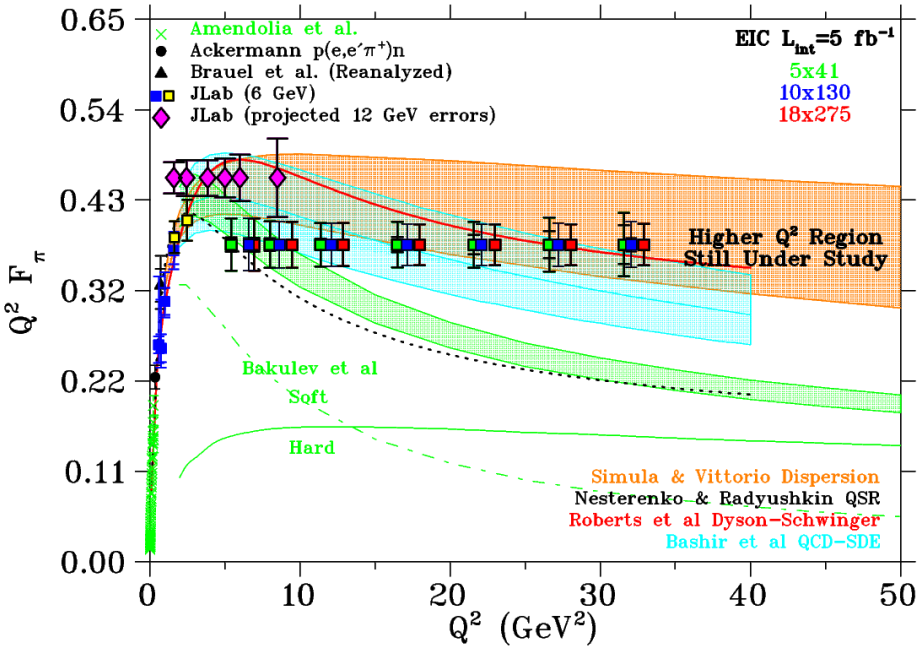

- Even from low $\int \mathcal{L}$ in early science programme, looks promising!
- How high in Q^2 will be possible?

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- $K^+\Lambda$ channel is on the agenda for later in the year

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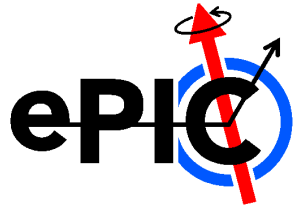
Thanks for listening, any questions?

UNIVERSITY of York

University of Regina



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