

**Meson and Nucleon Structure
Measurements at the EIC**

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University of York**

**EIC-Asia Workshop on QCD and
Hadron Structure
30/04/26**

- Part 1 - Overview of Meson and Nucleon Structure Measurements at the EIC

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- Part 2 - Meson Structure with the Sullivan Process at the EIC, F_π Measurements

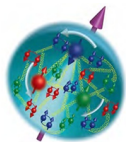
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Imaging Hadrons

- Examining structure → Imaging Hadrons

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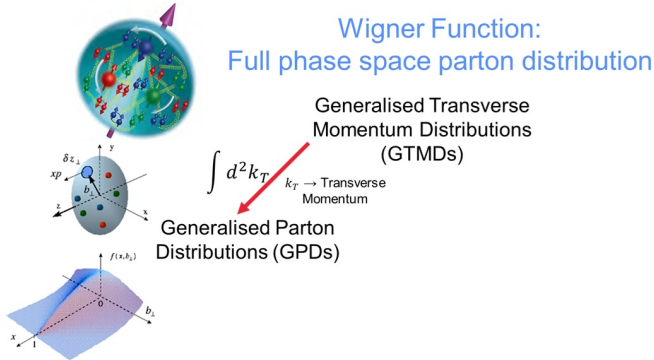
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Wigner Function:
Full phase space parton distribution

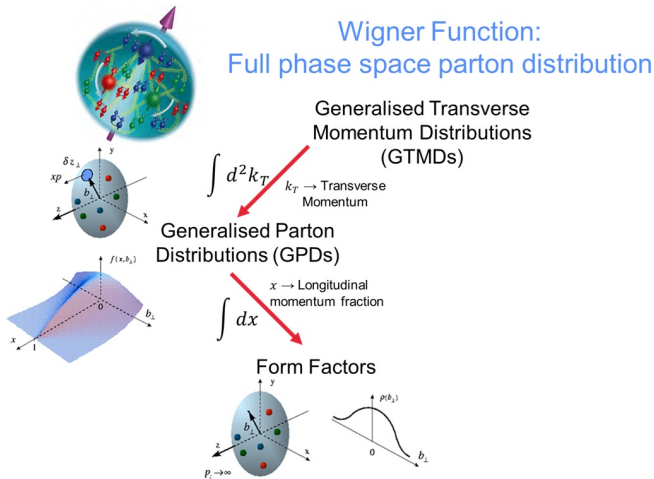
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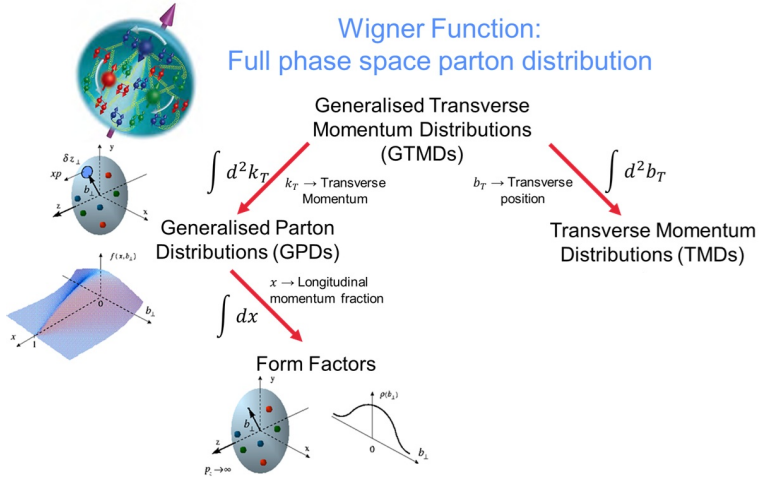
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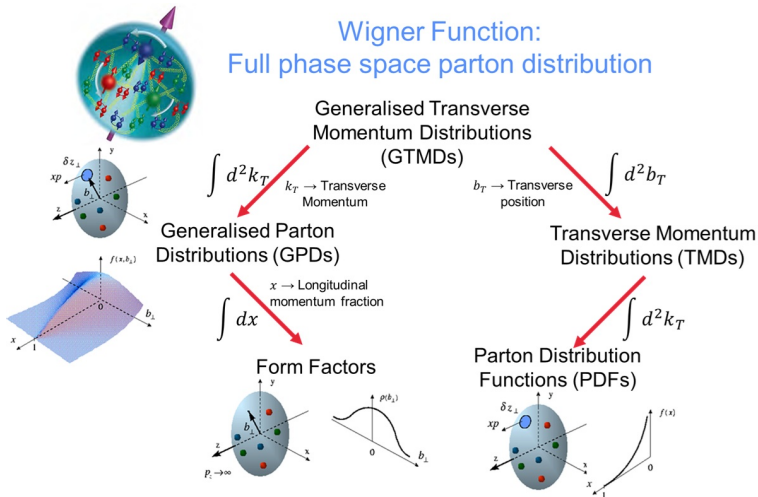
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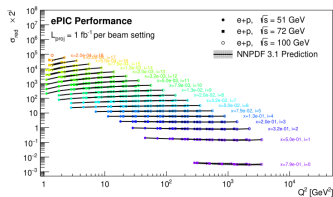


Image and Analysis by S. Maple, University of Birmingham (UK), see Analysis Note [epic-AN-AC-2025-004](#) for further details. [PDF discussion in upcoming ESR.](#)

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- **SFs are vital inputs to PDF fits to data**

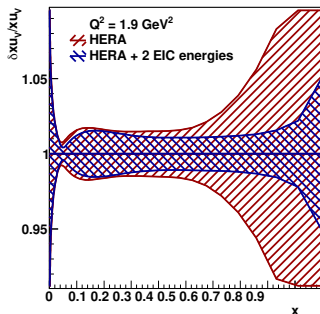


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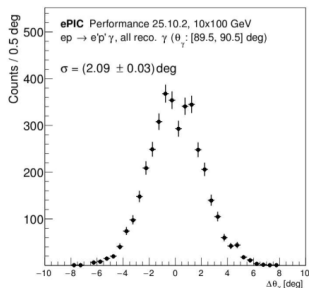


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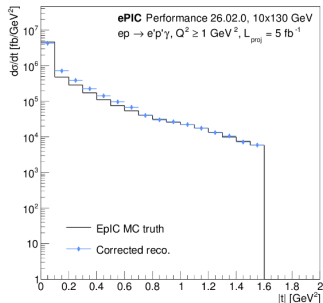


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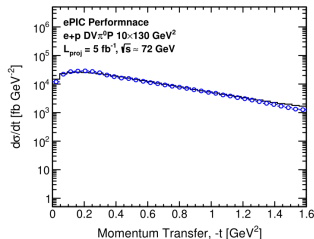


Image and Analysis by J. Kim, BNL, see Analysis Note [epic-AN-AC-2025-002](#) for further details.

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- Access to spatial imaging \rightarrow Fourier transform of differential cross section
- DV π^0 P also important to study as background to DVCS

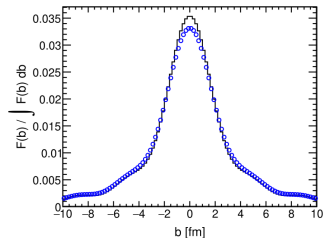


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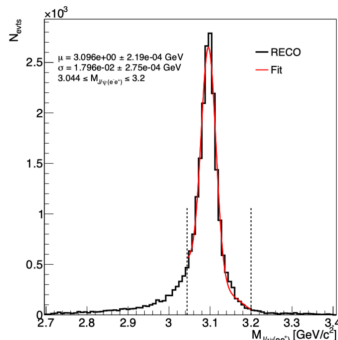


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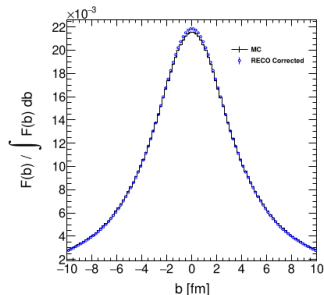
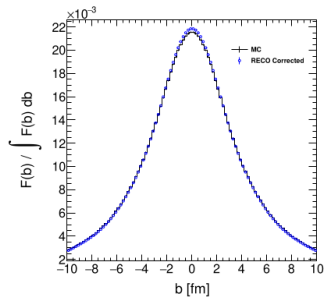


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- $\mu^+ \mu^-$ decay branch of J/ψ also under investigation



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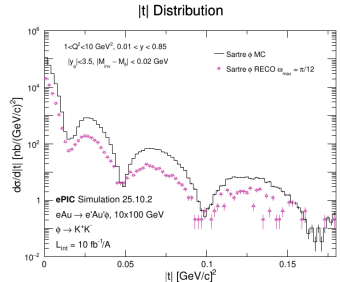


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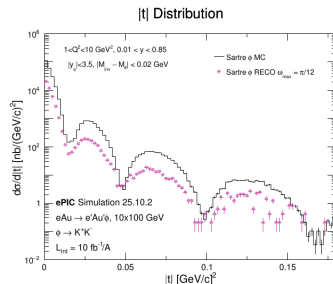


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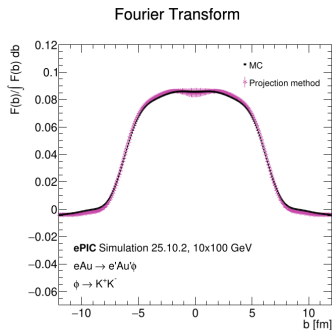


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- **Spin distribution and composition within the neutron**
- Projected results and and statistical uncertainty for g_1^n

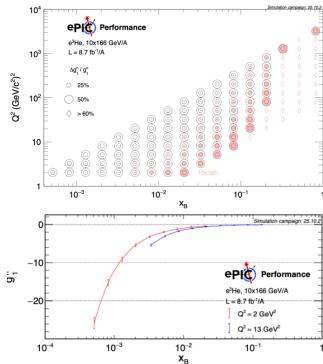


Image and Analysis by W. Lin, Stony Brook University, see Analysis Note [epic-AN-AC-2025-005](#) for further details.

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- So far, we've seen what can be done for **nucleon structure**, but what about **meson structure**?

Part 2 - Meson Structure with the Sullivan Process
at the EIC, F_π

Why Meson Structure - Hadron Mass Budgets

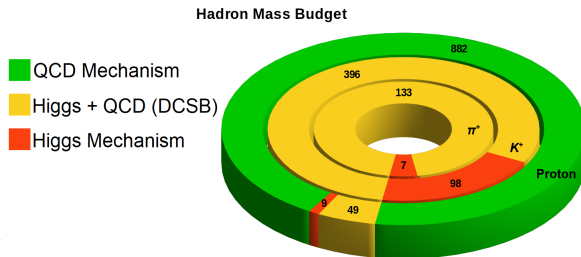
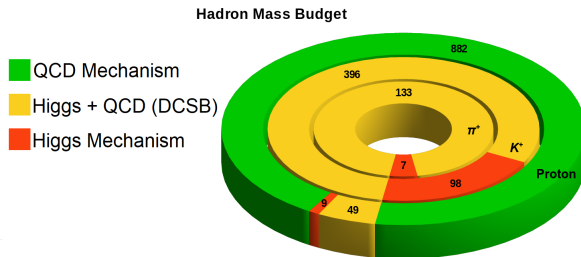


Image - G. Huber, modified figure from <https://doi.org/10.1088/1361-6471/abf5c3>

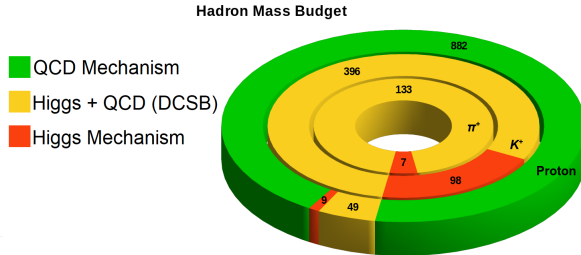
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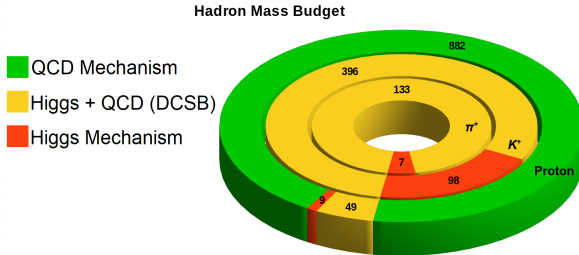
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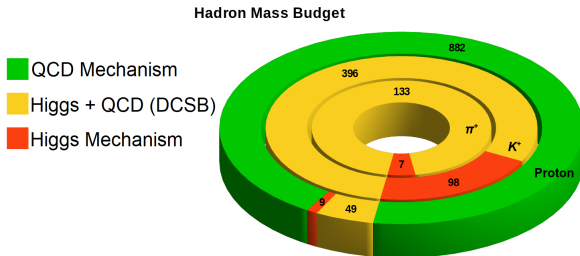
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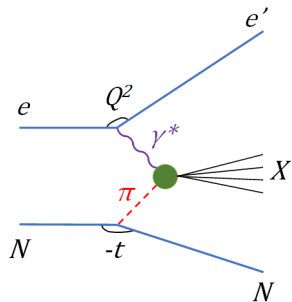
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- How can we examine their structure?

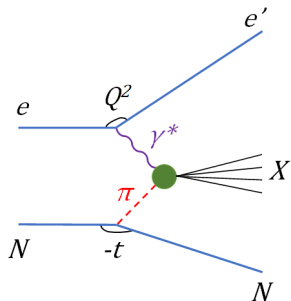
The Sullivan Process

- Can use the Sullivan process to study meson structure



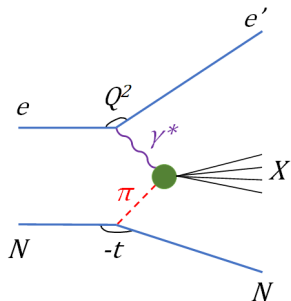
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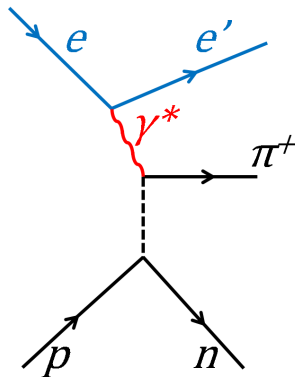
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 - Measure π/K structure functions
 - See [Tanja's talk](#) for further details



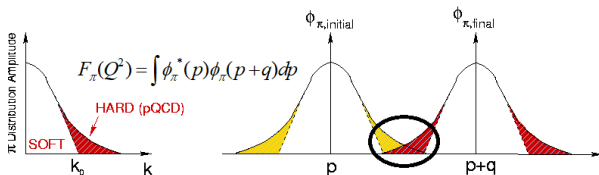
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- OR, if X is restricted to a single π or K , have **Deep Exclusive Meson Production (DEMP)**
 - **Access to meson form factors**
 - F_π and F_K



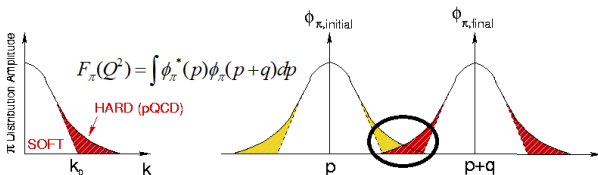
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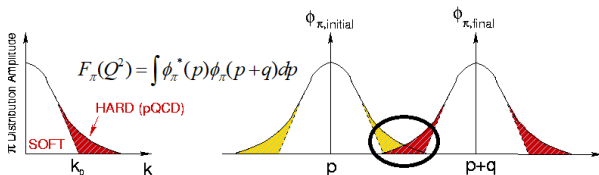
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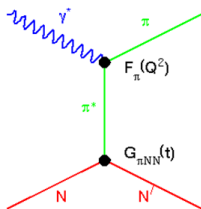
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- F_π and F_K of special interest in hadron structure studies
 - π - Lightest QCD quark system, simple
 - K - Another simple system, contains strange quark

Measurement of F_π at High Q^2

- To access F_π at high Q^2 , must measure F_π indirectly
 - Use the “pion cloud” of the proton via $p(e, e'\pi^+n)$

Measurement of F_π at High Q^2

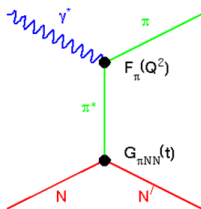
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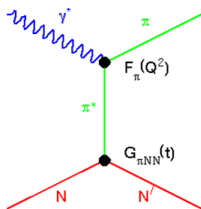


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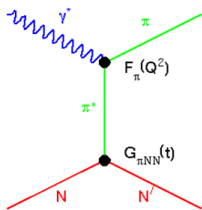


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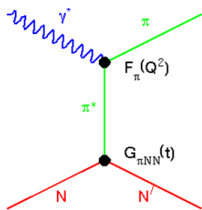


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 - Measure Sullivan **D**eep **E**xclusive **M**eson **P**roduction (**DEMP**)

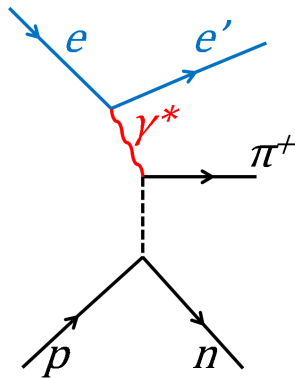


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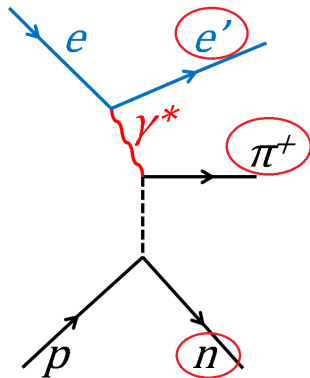
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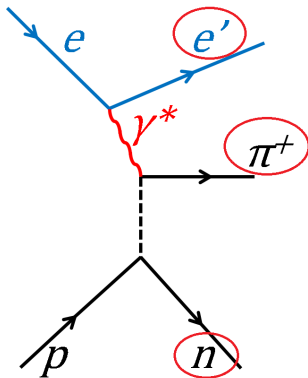
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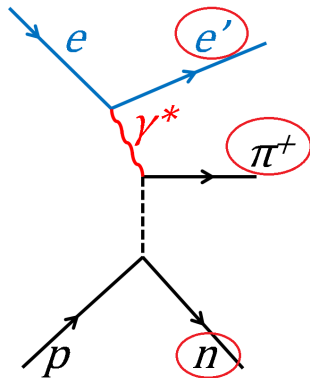
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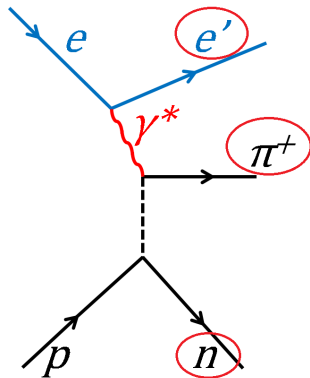
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Simulating Events - DEMPgen

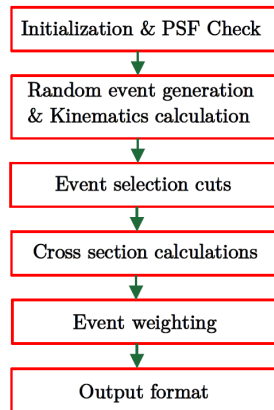
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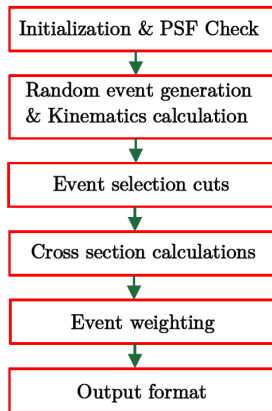
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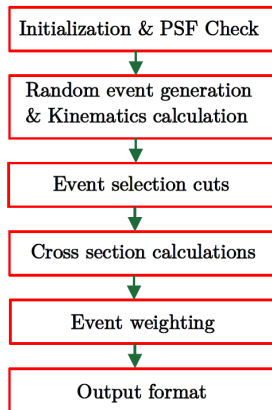
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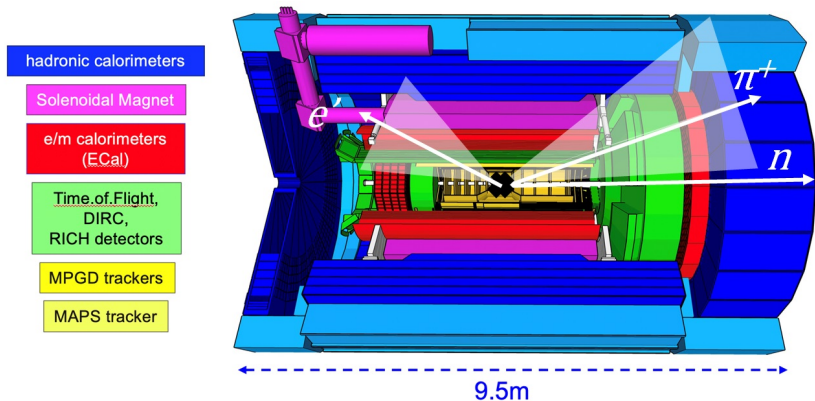
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- Further details in [recent paper](#)

<https://doi.org/10.1016/j.cpc.2024.109444>



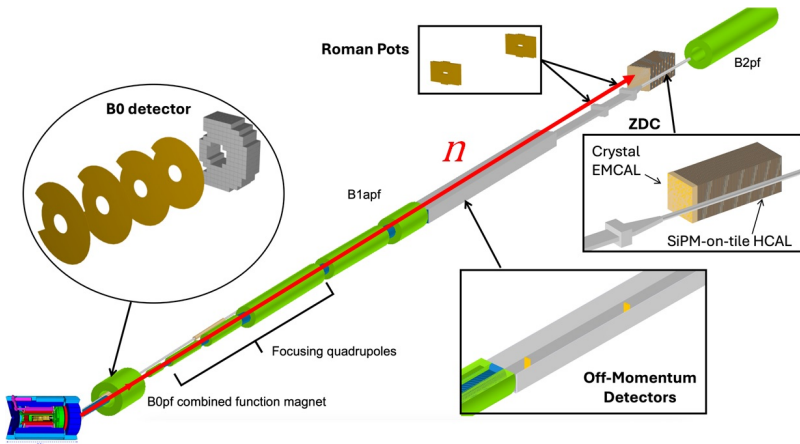
DEMP Kinematics - Visualising with ePIC

- e' and π^+ hit the central detector



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 - $E_n > 40$ GeV
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$E_n > 120$ GeV for 10x250, θ^* is after a rotation of 25 mRad around the proton axis to remove the crossing angle

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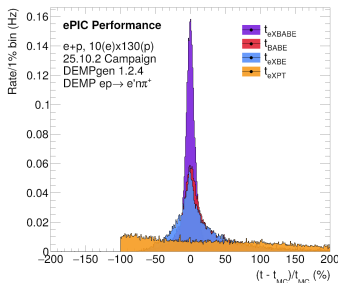
https://github.com/sjdkay/ePIC_DEMP_Analysis and <https://doi.org/10.5281/zenodo.18681414>

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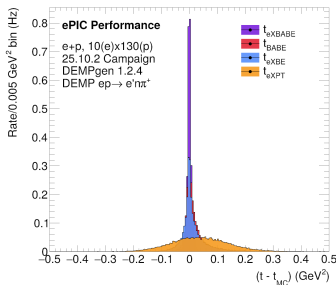
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$\sigma(eXBABE) = 11.03$, $\sigma(BABE) = 42.67$, $\sigma(eXE) = 43.26$, $\sigma(eXPT) = 83.92$. All $e^+ \pi^+ n$ triple coincidence

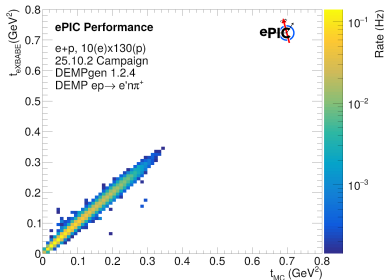
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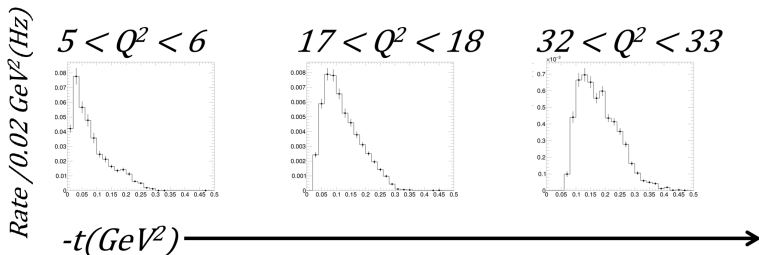
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Note, events only generated to $-t$ 0.4 GeV^2

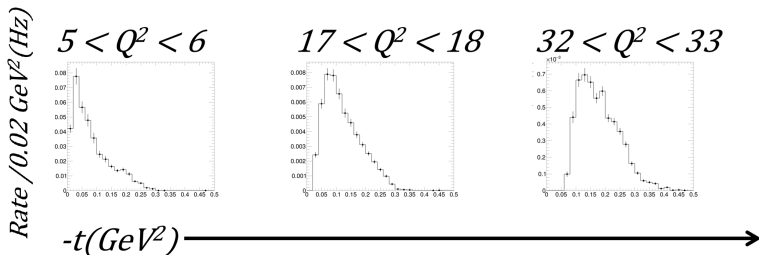
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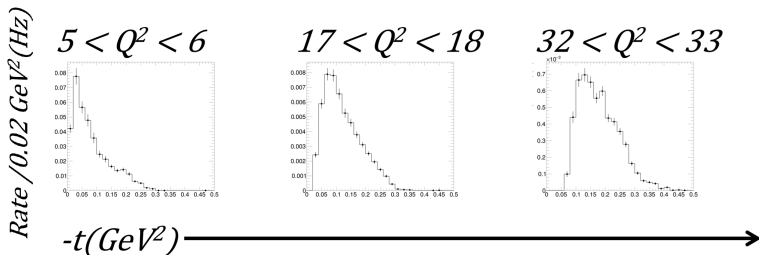
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Want bin width to be larger than resolution per bin, see next slide

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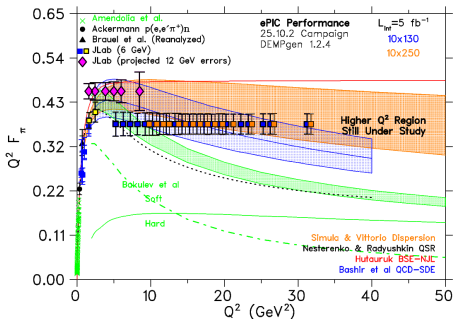
F_π Early EIC Outlook

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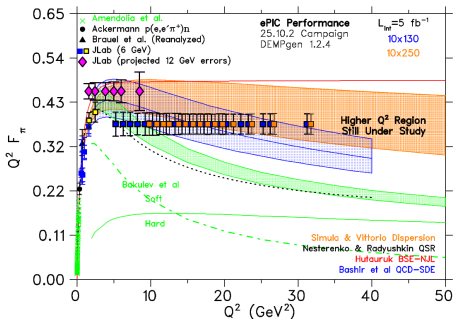


Projection plots by G.M. Huber, University of Regina

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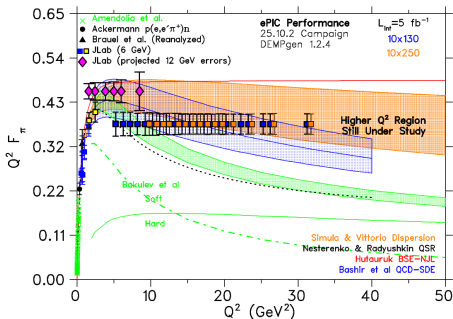


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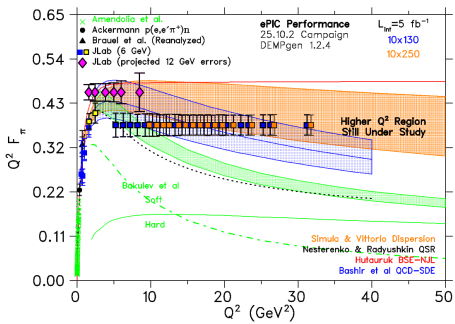
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- Sullivan process at the EIC \rightarrow Meson Structure
- Prospects for F_π measurements to high Q^2 look promising
 - Even in the early science period

Thanks for listening, any questions?



UNIVERSITY

of York



University
of Regina



Science and
Technology
Facilities Council



With thanks to the Meson Structure Working Group

stephen.kay@york.ac.uk

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