Analysis Coordinators' Report

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Communication and Meetings

- Analysis Coordination meetings have moved from Friday at 11 am to **every other Tuesday at 830 am BNL time**
  - Friday schedule has always been complicated and we often needed to "move" out of the way
  - Previous Meeting Jan 14: Indico
  - Next meeting is February 4: Indico
- Joint S&C and Physics meeting → Typically, once a month!
  - Generators, simulation campaigns, status of reconstruction, needs and mutual feedback! Stay tuned for the next date!
- Joint meeting of the SCC and AC Coordinators AC⚡SCC : every Thursday at 9:00am
- Also please attend the regular PWG meetings!

PWG Meetings

Generally every other week – See Indico

- Inclusive: Mondays at 12 pm ET → Previous: Inclusive Indico
  - Stephen Maple (University of Birmingham)**, Tyler Kutz (MIT)
- SIDIS: Tuesdays at 830 am ET → Next Meeting Jan 28th
  - Ralf Seidl (RIKEN), Stefan Diehl (JLU Giessen and UCONN)
- Jets + HF: Tuesdays at 1130 ET → Previous: Jets+HF Indico
  - Olga Evdokimov (UIC), Rongrong Ma (BNL)
- Exclusive: Mondays at 12 pm ET → Next Meeting Feb 10
  - Raphael Dupre (IJCLab, CNRS, Univ. Paris-Saclay), Zhoudunming Tu (BNL)
- BSM + precision EW→ Meeting with Inclusive
  - Ciprian Gal (SBU), Juliette Mammei (University of Manitoba)

Analysis Events at this Collaboration Meeting

- Early Science Day – Wednesday 9 am – 1:25 pm (Italy Time)
  - Please volunteer for the open mic! (Email myself Rosi Email and Sal Salvatore Email)
    - Your chance to have input into the community
  - Will be followed by another workshop in March
- Jets and HF Session
  - Tuesday 9 am – 1 pm (Italy Time)
- Exclusive + Tagging + Diffraction
  - Thursday 9 am – 1 pm
  - Friday 10 am – 1pm (Italy Time)

pTDR

- Chapter 2: (~60 pager) focus on holistic detector performance, physics performance and science reach
  - Holistic detector performance → Technical Coordinator office acts as editor
  - Physics and science reach → Analysis Coordinators act as editors
  - We envision a **couple of performance plots per PWG**

Status
Lehigh
Meeting

- Drafts:
  - ePIC draft pre-TDR Version 0.1 → Sept. 30, 2024
  - ePIC draft pre-TDR Version 1→ December 6, 2024 (Analysis Draft)
  - Needed for: EIC Project CD-3B/Status Review → January 7-9th, 2025
- pTDR (60% design completion) → TDR (90% design completion)

Extended physics paper

- Aligned with the TDR
  - The Physics WP is a deliverable of the ePIC Collaboration
  - To be published on a scientific peer-reviewed journal (such as PRC)
  - Extended description of the physics performance and science reach at ePIC
- Holistic detector performance → Technical Coordinator office acts as editor
- Physics and science reach → Analysis Coordinators act as editors
  - Gives full details on physics studies and performance plots
  - Includes physics impact studies
  - Authorship regulated by ePIC membership and publication policies (now being formalized!)

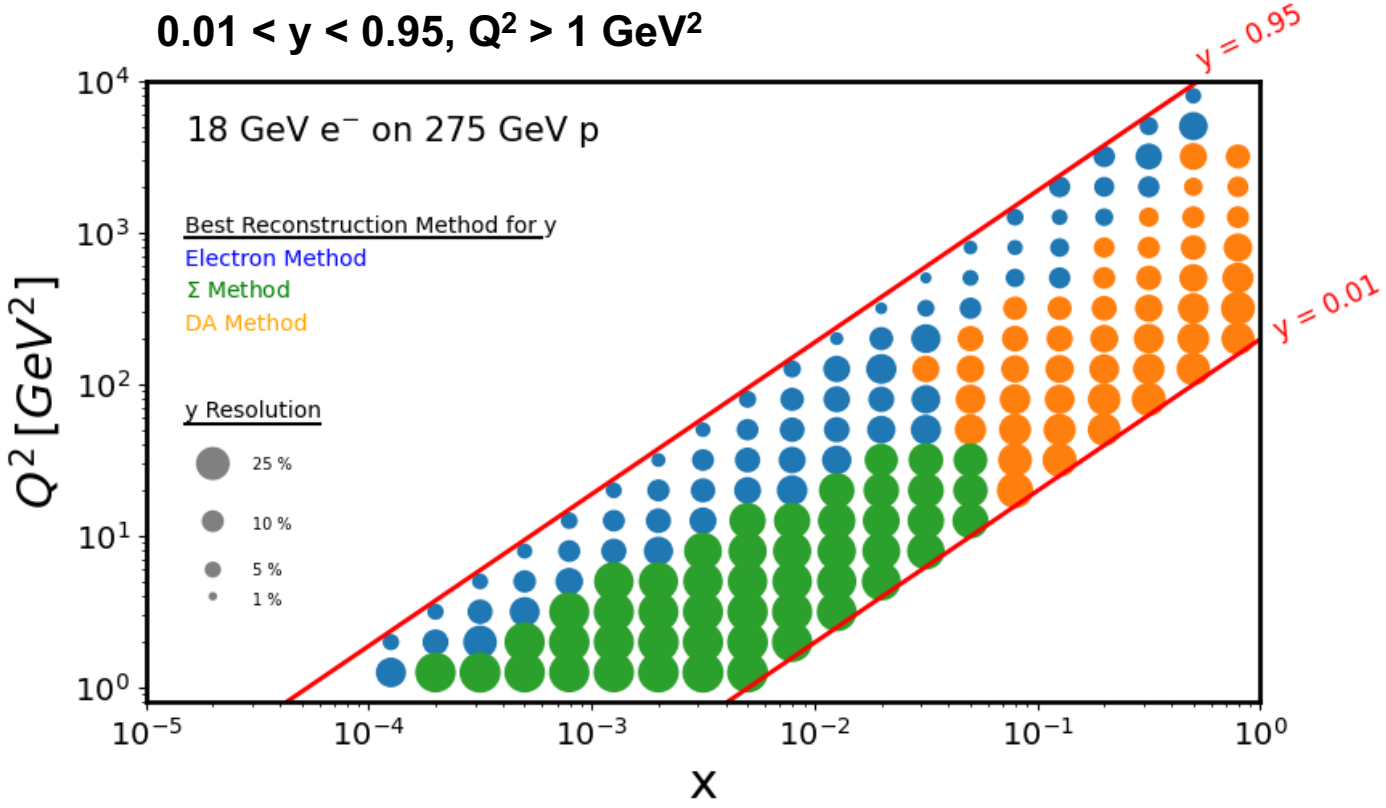
European Strategy for Particle Physics Paper

- https://europeanstrategy.cern/
- Mandated and organized by the CERN council
- Seeks broad consultation with the grass-roots European community
  - Deadline March 31st!
- In 2018 several papers in support of the EIC were submitted
- Start from the 2018 input to the EPPSU and update
  - Marco has given access to 2018 document → Ported to overleaf
- Submit a joint update on behalf of both the EICUG SC and ePIC
  - Authors to include PWG conveners
  - Internal review by ePIC PWG's ~early March

Inclusive Physics Updates

Kinematic Resolutions

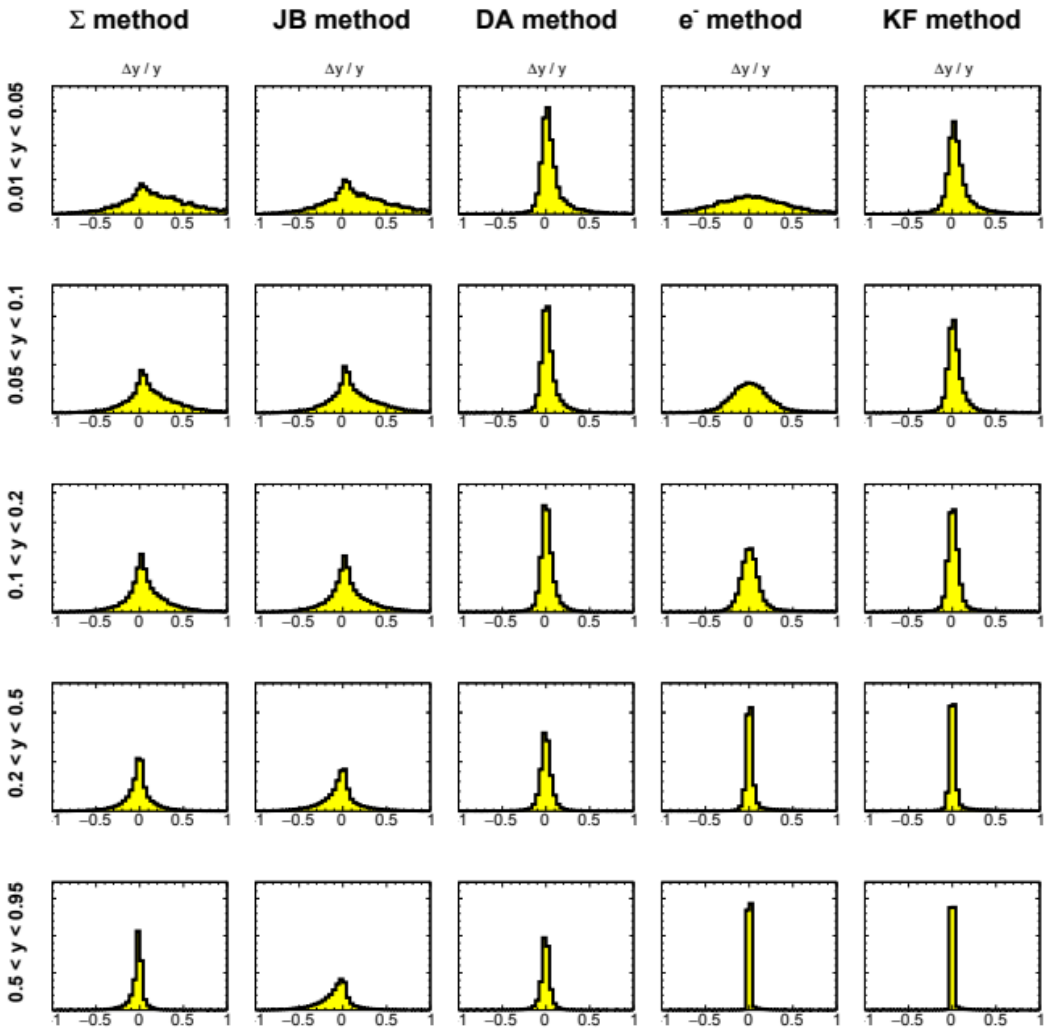
- Reconstruct inclusive kinematics using various methods → **compare reconstruction performance**
  - Color of point indicates best method for y (inelasticity)
  - Size of point indicates y resolution
- **~30% or better y resolution across x-Q^2 plane**



Inclusive Physics Updates

Inclusive reconstruction using a kinematic fit

- Parametrize detector resolutions → use as inputs for kinematic fit
- Bayesian method: informative prior
- HFS correlations included in fit
- Inclusive kinematics reconstructed from maximum of posterior distribution
- **Performance consistent with best reconstruction method for any given bin**



$0.01 < y < 0.95$, $Q^2 > 100\ GeV^2$

Inclusive Physics Updates

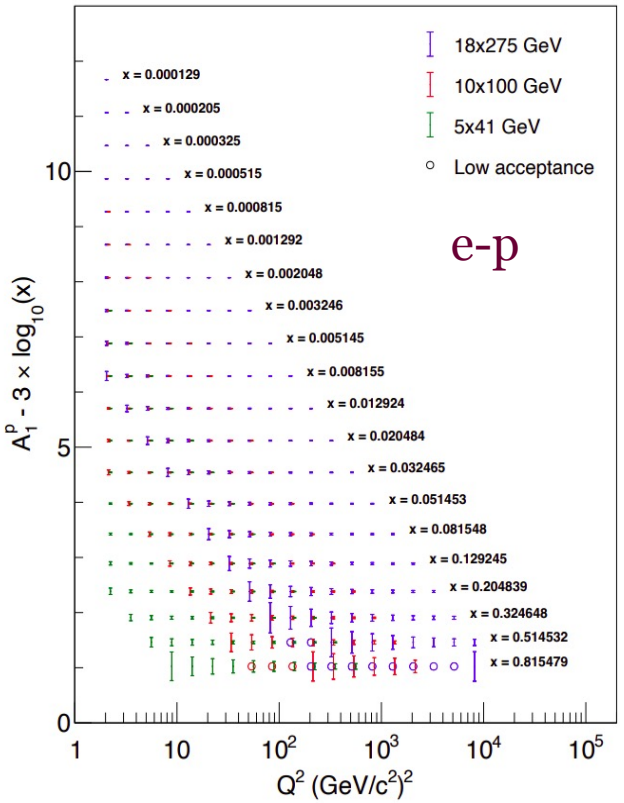
Double Spin Asymmetries (e-p and e-^{3}He)

Win Lin (SBU)

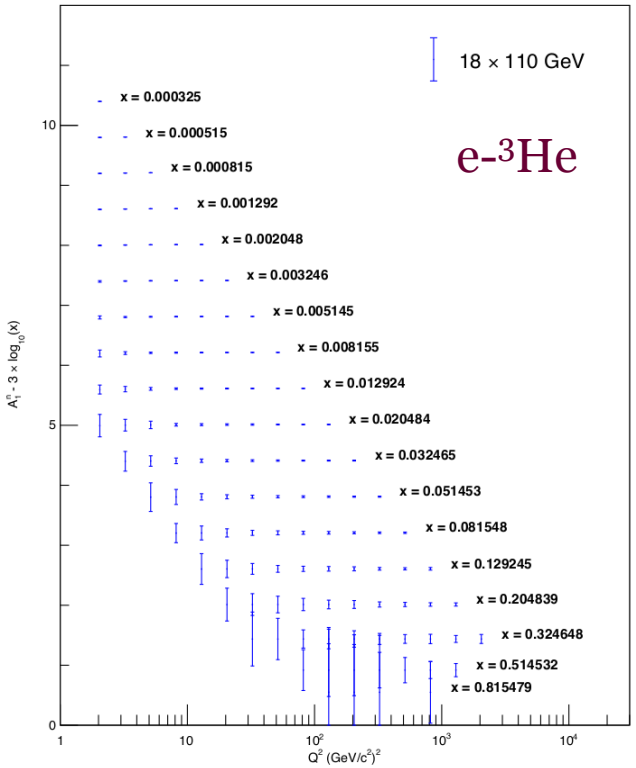
- **Fully simulated A_1^p, A_1^n determination**
  - Realistic eID
  - Electron method
  - Acceptance and Bin migrations from simulation
- A_1^p calculated according to parametrization
- A_1^n Look for proton tracks in RP/OMD
  - If there are two proton tracks → *en* scattering

$$A_{||} = \frac{\sigma_{\downarrow\Uparrow} - \sigma_{\uparrow\Uparrow}}{\sigma_{\downarrow\Uparrow} + \sigma_{\uparrow\Uparrow}}, \quad A_{\perp} = \frac{\sigma_{\downarrow\Rightarrow} - \sigma_{\uparrow\Rightarrow}}{\sigma_{\downarrow\Rightarrow} + \sigma_{\uparrow\Rightarrow}}$$

$$\rightarrow A_1 \approx g_1/F_1$$



$Q^2 > 2$ GeV^2, $W > 4$ GeV^2
$0.05 < y < 0.95$



$Q^2 > 2$ GeV^2, $W > 4$ GeV^2
$0.05 < y < 0.9$

SIDIS Physics Updates

Projections for unpolarized TMDs:

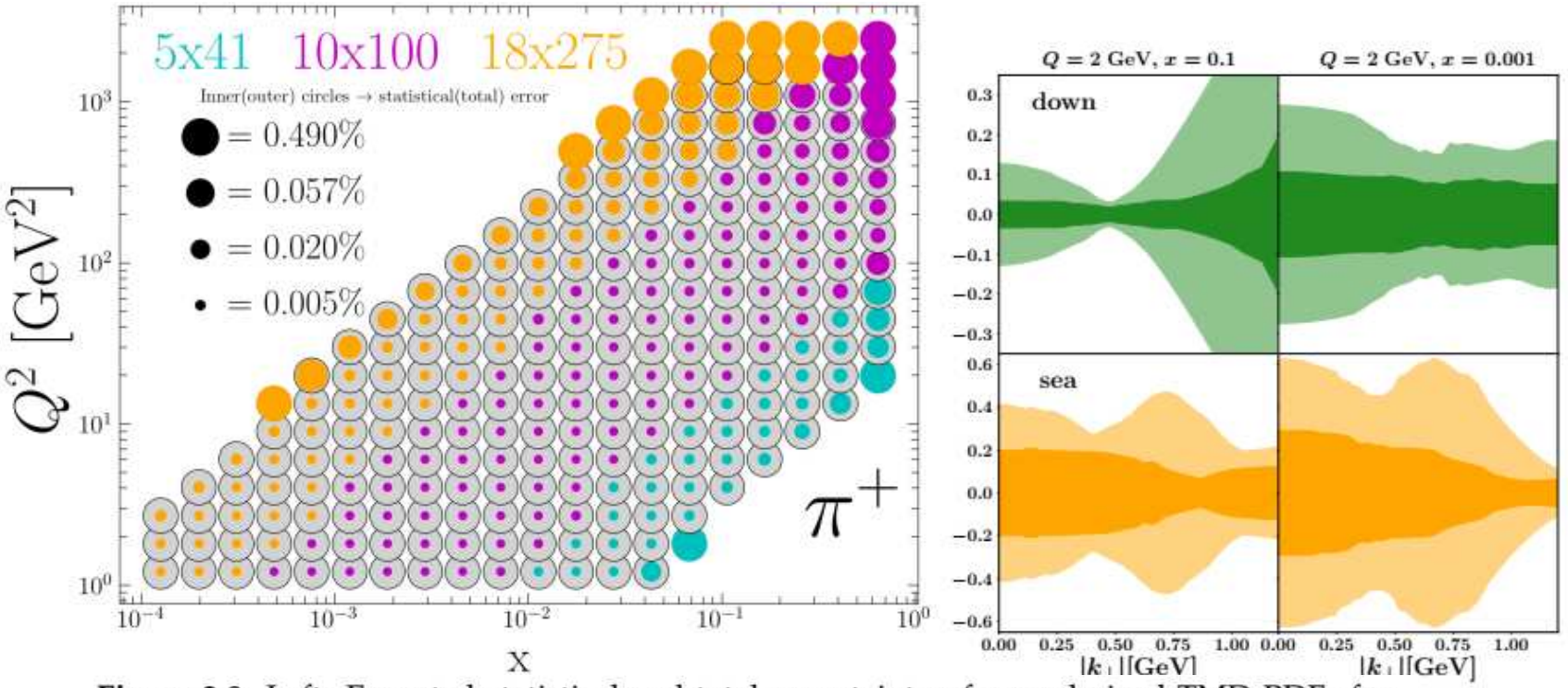


Figure 2.8: Left: Expected statistical and total uncertainty of un-polarized TMD PDFs for π^+ in the $Q^2 - x_B$ plane. The inner (colored) circle shows the statistical uncertainty, while the outer circle provides the total uncertainty for each $Q^2 - x_B$ bin. The color shows the beam energy configuration which provides the highest statistics in a specific bin. Right panel: Expected uncertainties of valence down (green) and sea quark (orange) TMD PDFs at $x = 0.1$ (left) and $x = 0.001$ (right) as obtained based on the MAP24 [1] global TMD fit. The lighter shaded regions show the uncertainties based on existing data while the darker shaded regions show the expected uncertainties after including ePIC data.

L. Rossi
M. Radici
G. Matousek

Further studies, also including Kaon data are ongoing / planned

SIDIS Physics Updates

Projections of A_{UT}: **R. Seidl**

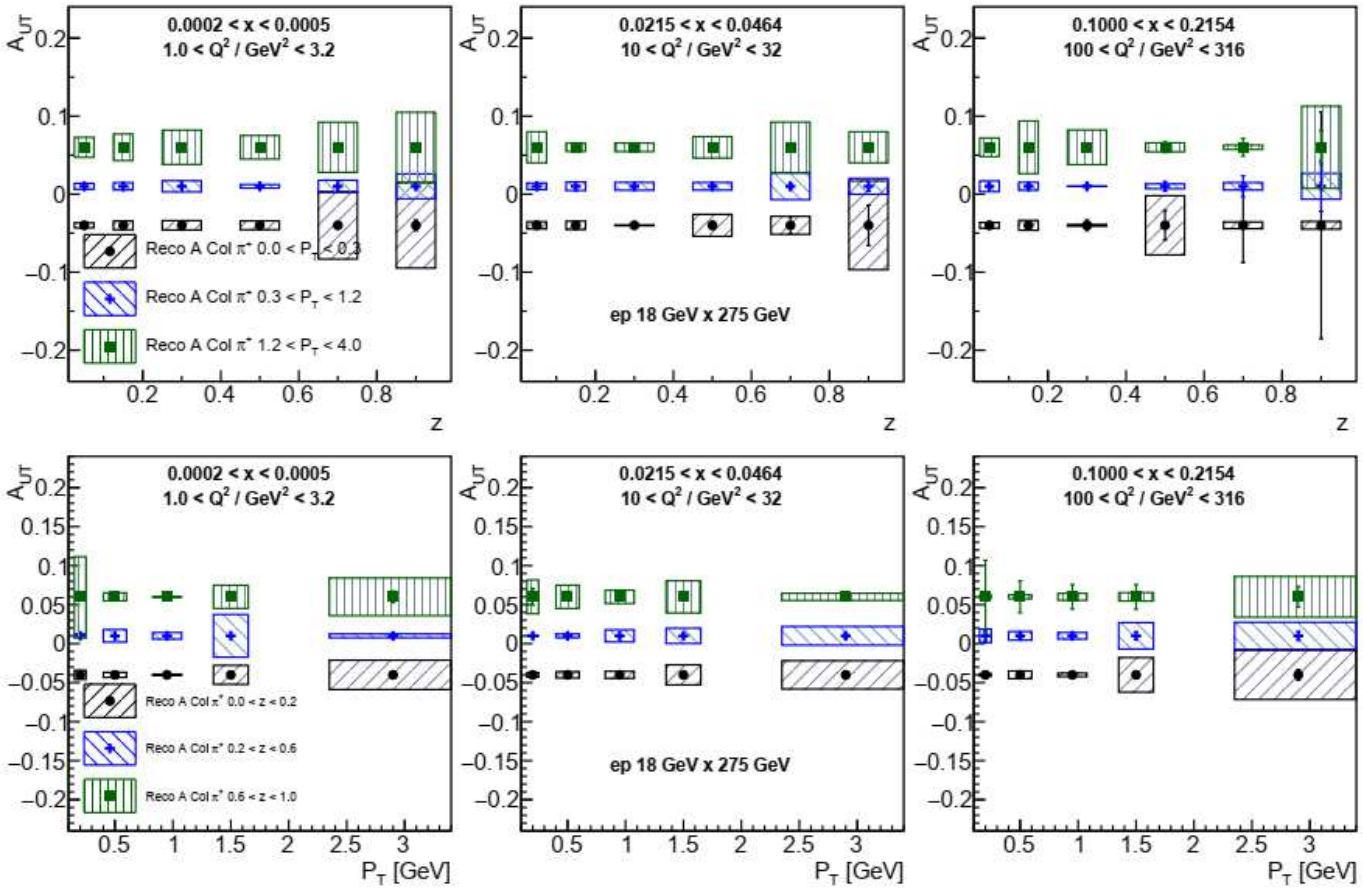


Figure 2.9: Top: Expected uncertainties in three example x-Q^2 bins for the Collins asymmetries for positive pions as a function of the momentum fraction z and in three bins of hadron transverse momentum relative to the virtual photon direction assuming a luminosity of 10 fb^{-1}. Bottom, the same but as a function of the hadron transverse momentum in bins of z.

SIDIS Physics Updates – Projections for A_{LL}

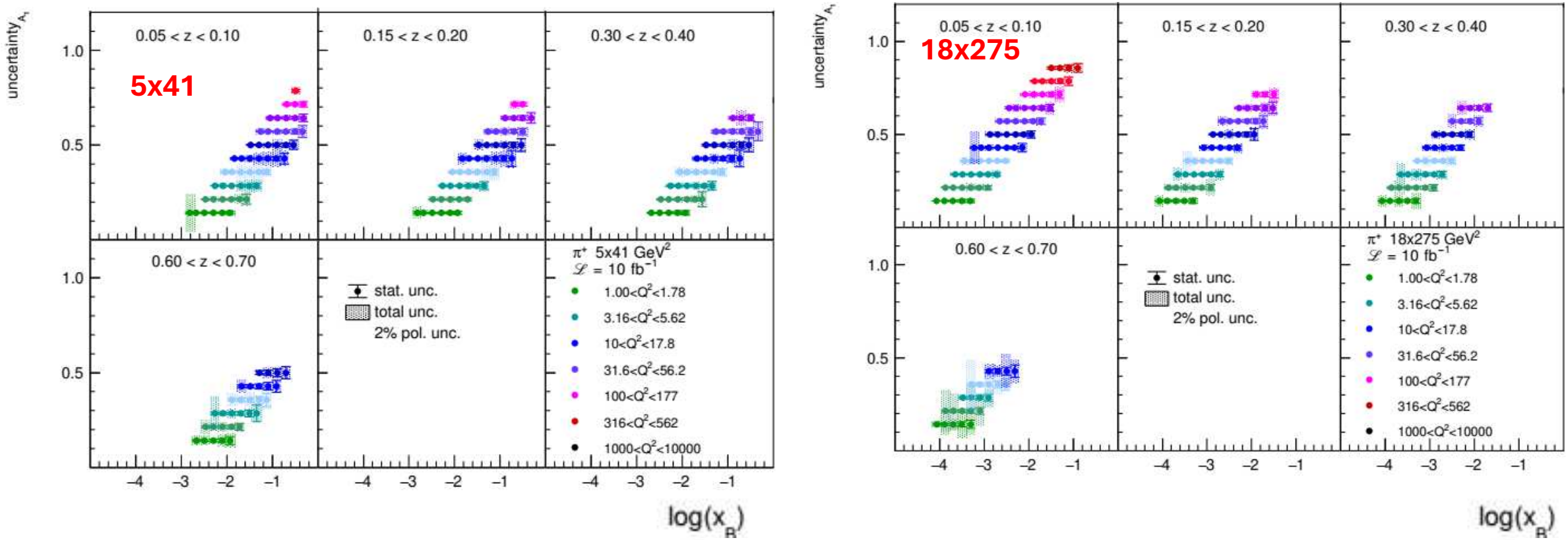


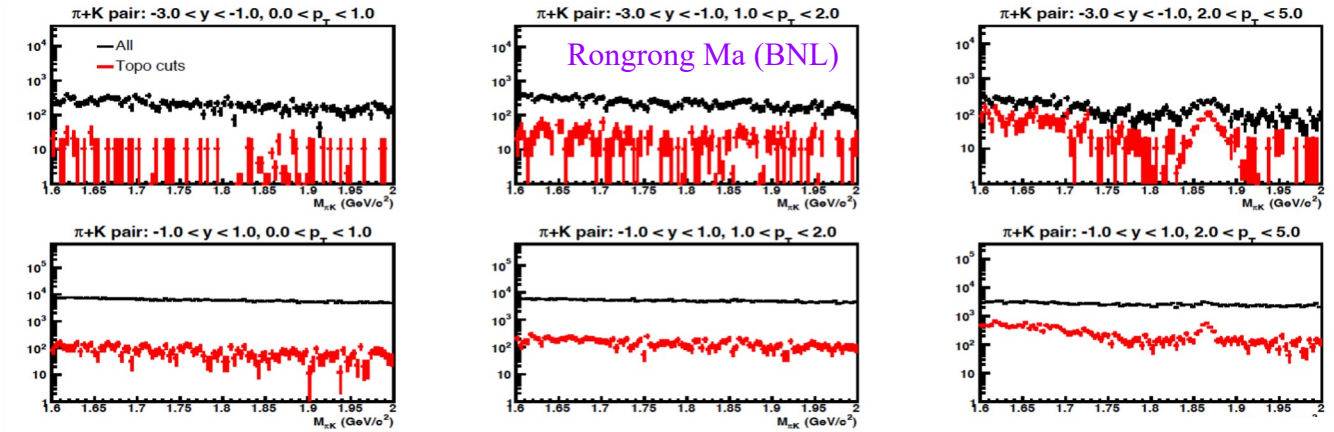
Figure 2.7: Statistical (error bars) and total (error bands) uncertainty for each selected bins in x_B and Q^2 and for selected ranges in z, for positive-pion A_1 asymmetries at 5×41 GeV^2 (top two rows) and 18×275 GeV^2 (bottom two rows). An additional global scale uncertainty of 2% accounts for the uncertainty in the beam polarizations, as indicated in the figure. The central value on the vertical axis of the data points has no meaning.

Jets+HF Physics Updates

- Progress made on D^0 topological reconstruction
  - Helix swimming
  - Truth PID
  - Topological cuts
  - Machine Learning

All

Topo Cuts



$M_{\pi k}$ (GeV/c^2)

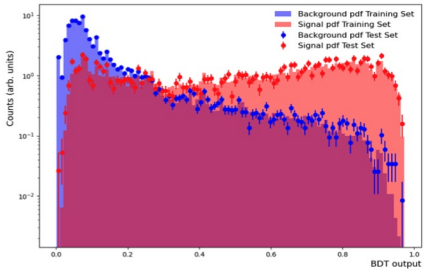
Model Performances

Model can be saved to .onnx format

	P	N
T	TP	TN
F	FP	FN

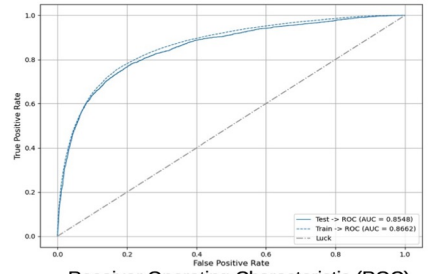
$$TPR = \frac{True\ Positive(TP)}{True\ Positive(TP) + False\ Negative(FN)}$$

$$FPR = \frac{False\ Positive(FP)}{False\ Positive(FP) + True\ Negative(TN)}$$



How Boosted Decision Tree (BDT) classifier separates signal from background

AUC: Area Under Curve

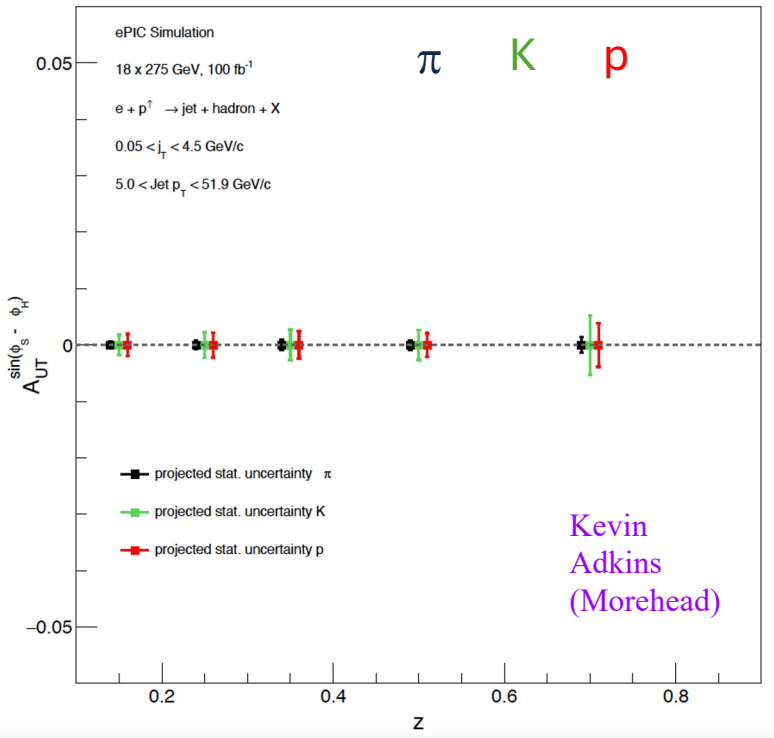


Receiver Operating Characteristic (ROC)

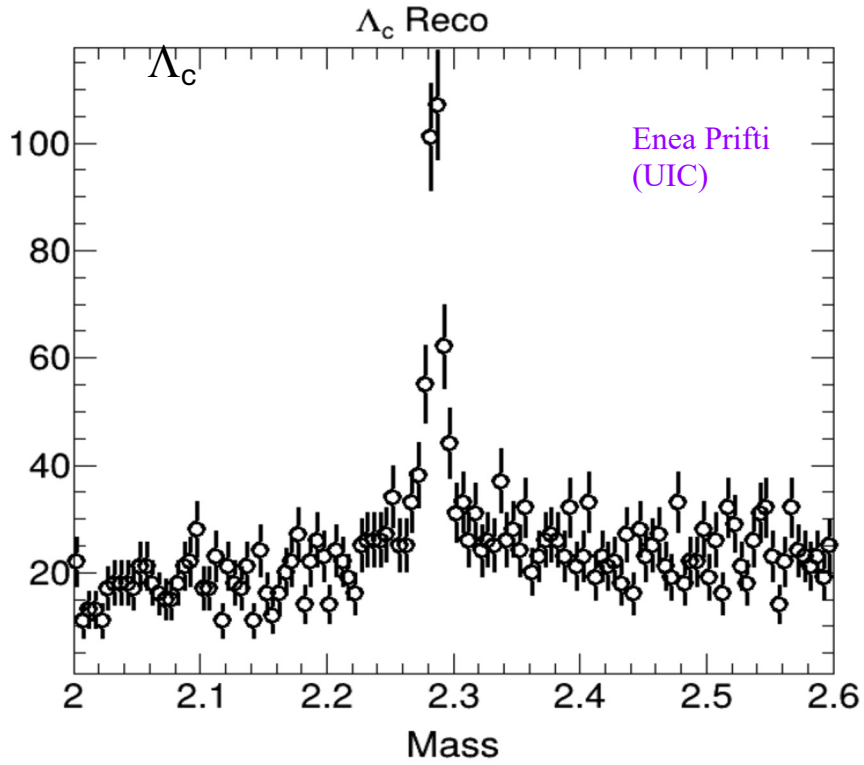
A perfect classifier would have a point at (0, 1), indicating no false positives and all true positives

14/01/25 D0 Reconstruction with ML:Shyam Kumar 9

Jets+HF Physics Updates



- Recent progress: hadron-in-jet Collins asymmetry → Next: (x, Q^2) binning



- A first look at Λ_c simulation

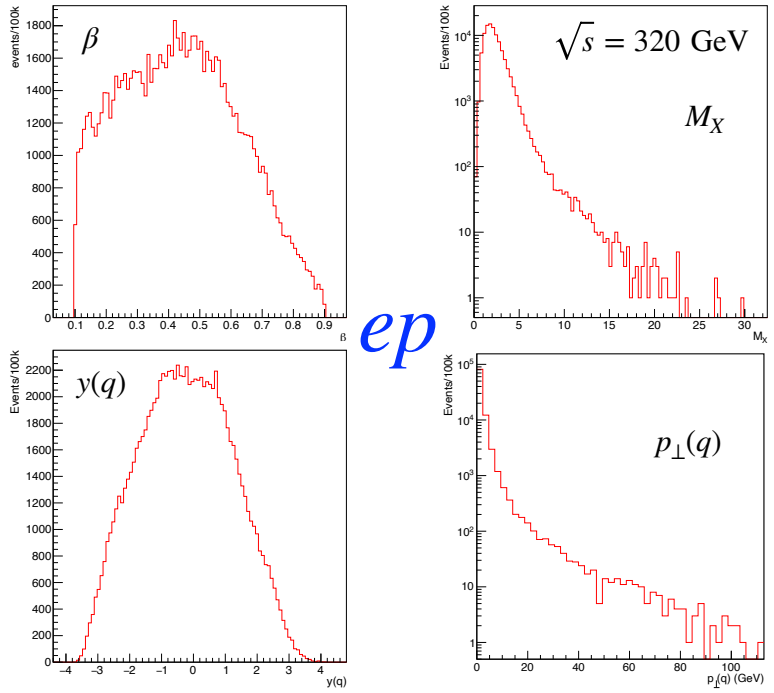
Exclusive + Diffraction+Tagging Physics Updates

Event Generation Sartre

$2 \le Q^2 \le 201$ GeV^2

$0.1 \le \beta \le 0.9$

$20 \le W \le 240$ GeV



Tobias Toll
Indian Institute of Technology Delhi

Event Generation Sartre

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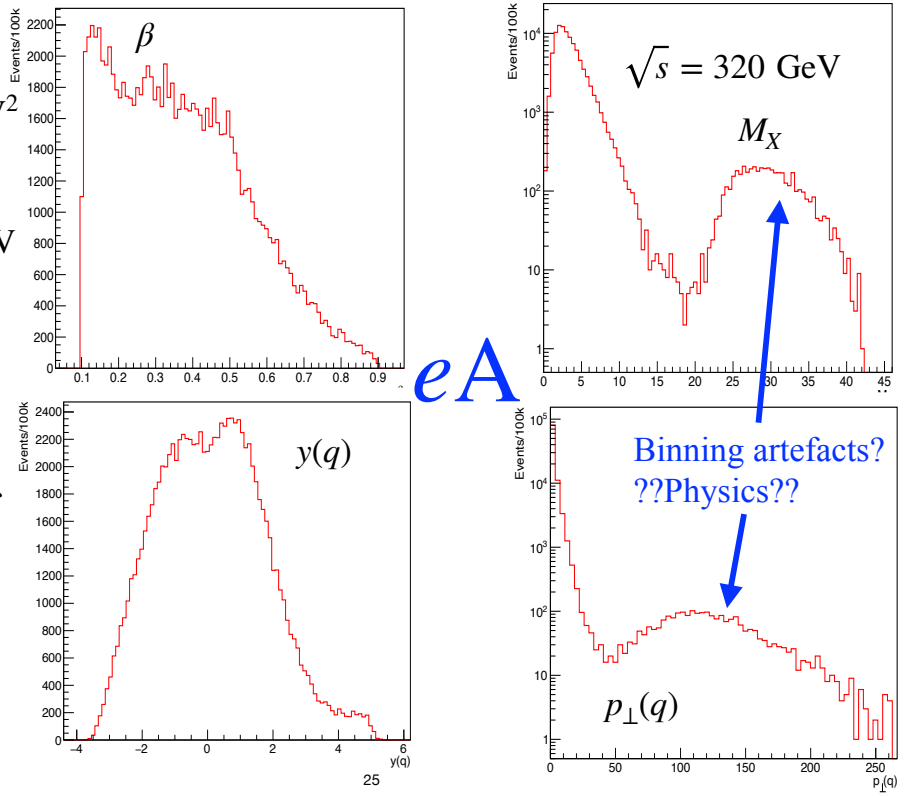


To Do (short term):

Implement saturation effects in final state

Create full tables for several initial state species

Thorough testing

To Do (intermediate term):

Implement *t*-dependence

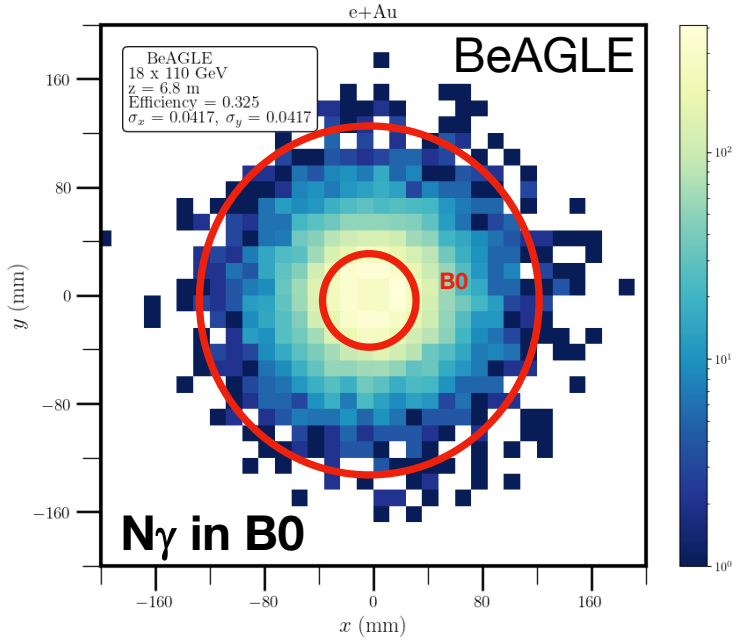
To Do (long term):

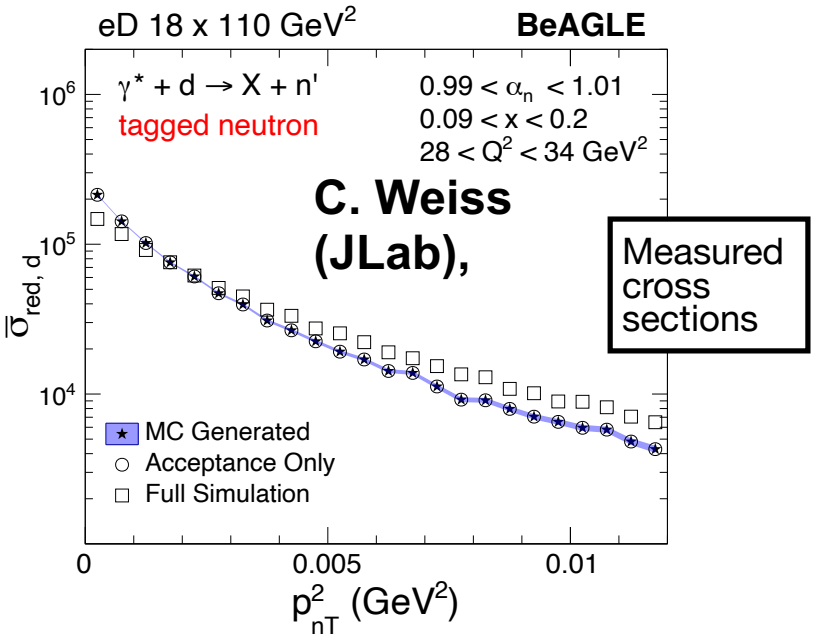
Incoherent Diffraction?

Exclusive + Diffraction+Tagging Physics Updates

- We can tag incoherent events with the:
  - ZDC ~38% efficiency
  - B0 ~34% efficiency

Mathias Labonté – UC Davis

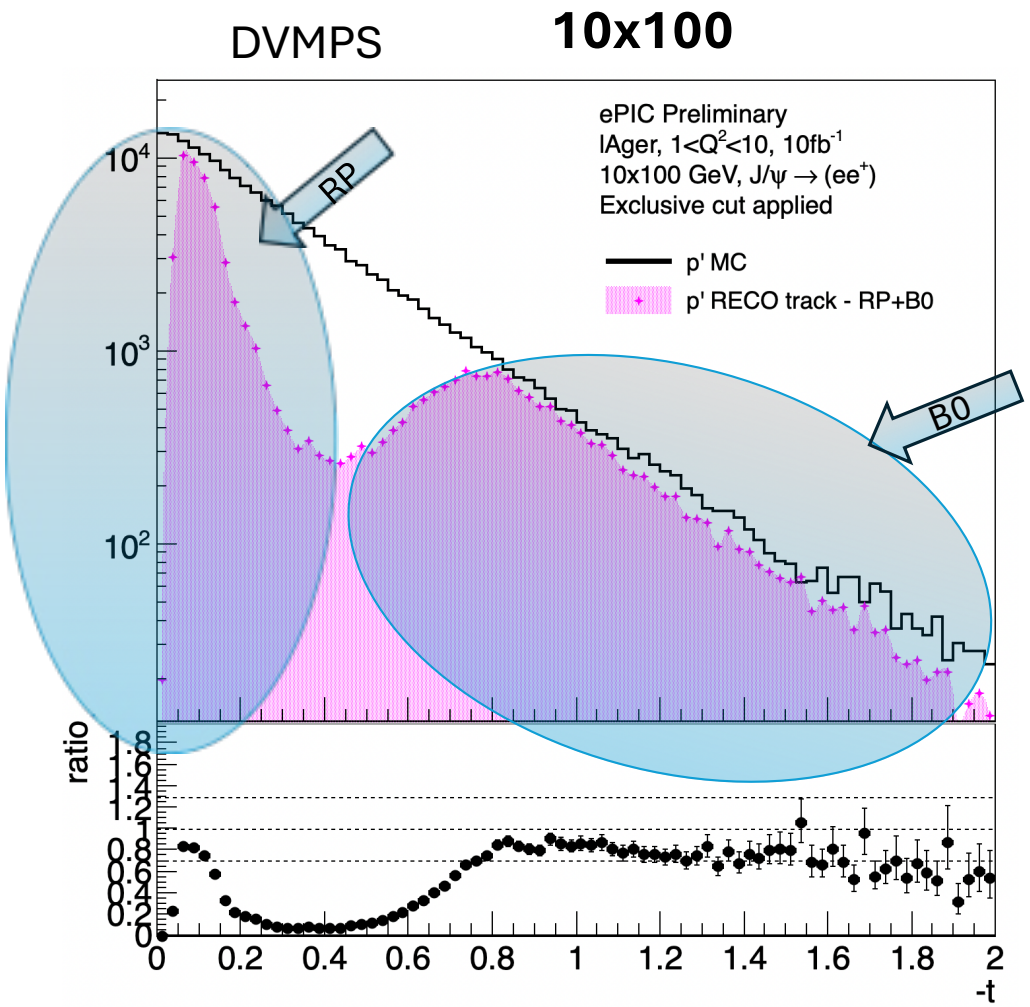




Interesting physics measurements with spectator tagging possible under early running conditions

Shadowing dynamics in tagged diffractive DIS	$x \sim 10^{-3} - 10^{-2}$	$L_{\text{int}} \sim$ few $\times$ 1
Free neutron and proton structure from tagging with on-shell extrapolation	$x \sim 0.01 - 0.3$	$L_{\text{int}} \sim$ few $\times$ 1 fb^{-1}
Bound neutron and proton structure and tagged EMC effect	$x \sim 0.3 - 0.6$	$L_{\text{int}} \sim$ few $\times$ 10 fb^{-1}

Exclusive + Diffraction+Tagging Physics Updates



Olaiya Olokunboyo
U. Of New Hampshire

Work not included here, check out:

- https://indico.bnl.gov/event/24953/ - Hadi's diffractive PDF
- https://indico.bnl.gov/event/24952/ - Odderon search theory talk
- https://indico.bnl.gov/event/25015/ - preTDR analysis, DVCS, and Upsilon!
- https://indico.bnl.gov/event/24839/ - DEMP from Stephen

Conclusions and Outlook

- Volunteer for the open mic! (Rosi Email and Salvatore Email)
  - Wednesday Early Science Session
- Multiple Analysis Specific Events at this Collaboration Meeting
  - Check them out, or send your early career scientists to be involved!
  - Jets and HF: Tuesday 9 am – 1 pm
  - Exclusive: Thursday 9 am – 1 pm, Friday 10 am – 1pm
  - Early Science
- Early Science Workshop ~March → Paper?
- Ongoing efforts on pTDR → Long Paper
- European Strategy for Particle Physics Paper (March 31st)