Electroweak NC at EIC

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Motivation

- Asymmetry (ratio) measurements
  - many factors in x-section measurements canceled out
  - Small signals require careful systematics control
- Apv in ep at $Q^2 < m_Z^2$: structure functions
  - $F_1^{\gamma Z}, F_3^{\gamma Z}, g_1^{\gamma Z}, g_5^{\gamma Z}$ cleanly -> PDFs, especially for s and Δs
- Apv in eD: electron-quark coupling $C_{1,2q}$ and running weak mixing angle $\sin^2\theta_W$
  - PDFs effect cancel out at large x region
- Apv in eA: $\sin^2\theta_W$ <-> nuclear PDFs

Weighted analysis

Yuxiang Zhao et al, Eur. Phys. J. A, 53 3 (2017) 55

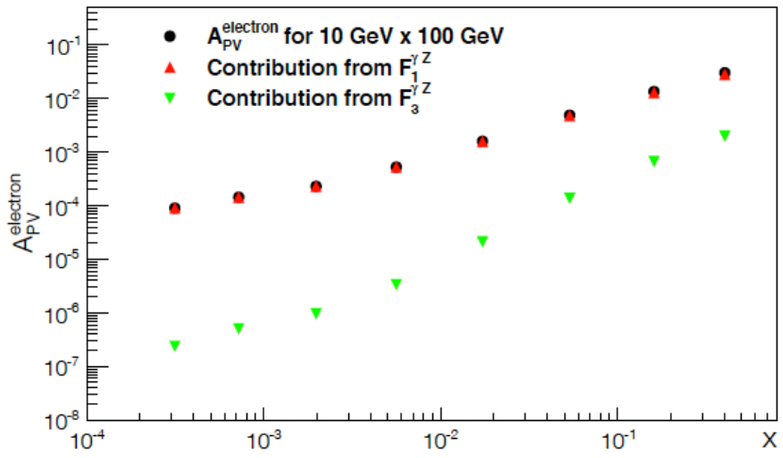
- Q2 sensitivity of Apv
  - Uncertainty estimation using Log-likelihood method to include event-by-event weights

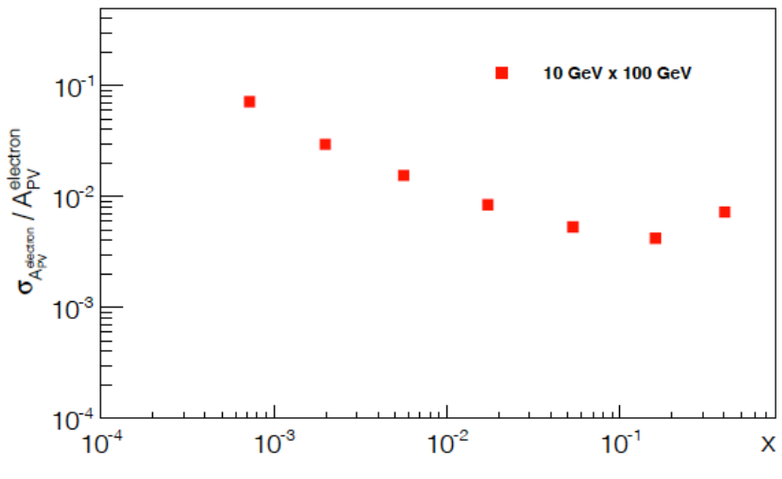
$$\mathcal{L} = -\log \prod_{\text{events}} \left(1 - \lambda P f(Q^2) A\right) \sigma_0$$

$$f(Q^2) = \frac{G_F Q^2}{2\sqrt{2}\pi\alpha}$$

$$A = g_A^e \frac{F_1^{\gamma Z}}{F_1^{\gamma}} + g_V^e \frac{Y_-}{2Y_+} \frac{F_3^{\gamma Z}}{F_1^{\gamma}}$$

$$\sigma_A = \sqrt{\frac{1}{\sum_{\text{events}} \lambda^2 P^2 f^2(Q^2)}}$$





Reweighting NNPDF replicas

NNPDF collaboration, Nucl. Phys. B849 (2011) 112-143

- Assess impact of new (pseudo-)data by commonly used reweighting methods
- Scripts to do reweighting available to use
- Challenge: only limited number of replicas available
  - Suggestions?

$$\mathcal{P}(f|y)\mathcal{D}f = \frac{\mathcal{P}(y|f)}{\mathcal{P}(y)}\mathcal{P}(f)\mathcal{D}(f)$$

y: EIC (pseudo-) data
f: PDFs

$$\omega_k = \mathcal{N}_\chi(\chi^2_k)^{(n-1)/2}e^{-\frac{1}{2}\chi^2_k}$$

$$\mathcal{N}_\chi = \frac{1}{N}\sum_{k=1}^{N}(\chi^2_k)^{(n-1)/2}e^{-\frac{1}{2}\chi^2_k}$$

χ^2_k: between pseudo-data and prediction from PDFs

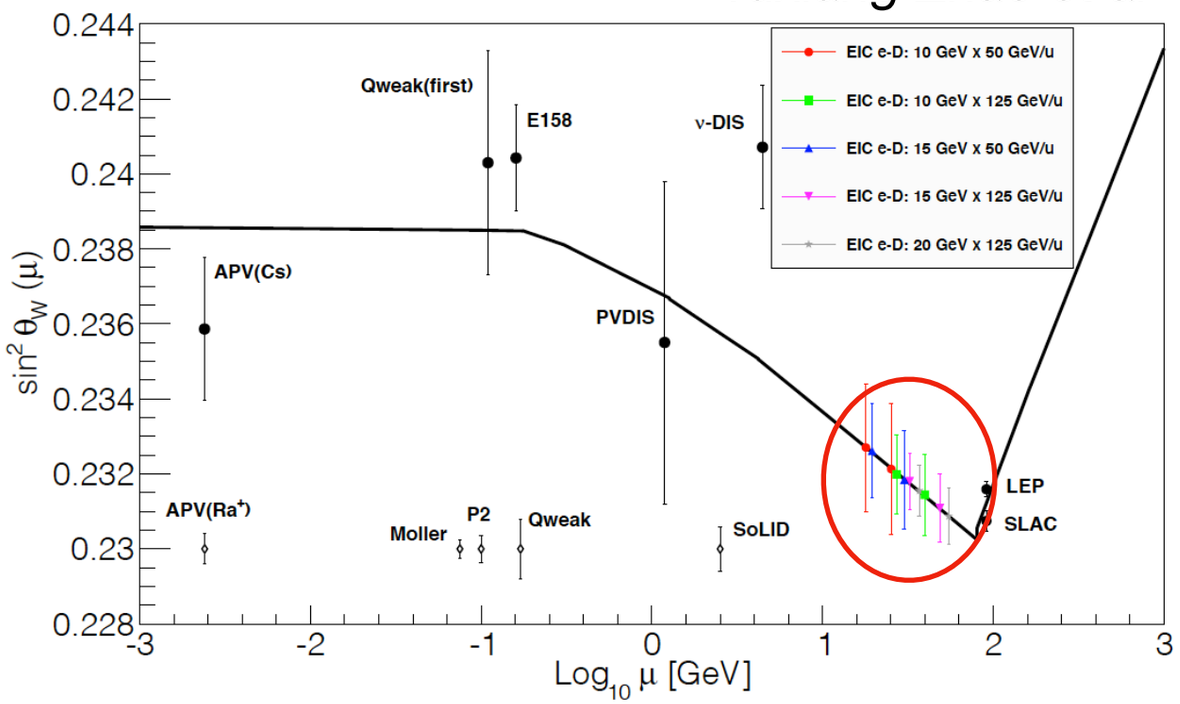
$\sin^2\theta_{\mathrm{W}}$

$$A_{PV}^{eD}(x,y) = \frac{-G_F Q^2}{4\sqrt{2}\pi\alpha}[a_1^d + f(y)a_3^d]$$

$$= -\frac{G_F Q^2}{2\sqrt{2}\pi\alpha}\frac{9}{10}[(1-\frac{20}{9}\sin^2\theta_{\mathrm{W}}) + (1-4\sin^2\theta_{\mathrm{W}})\frac{1-(1-\mathrm{y})^2}{1+(1-\mathrm{y})^2}]$$

- In the high x-region eD samples equal amounts of u and d
- Measurements in a little explored phase space region
- Potential to extend study in eA (A>2) collisions (nuclear effects needs to be handled or clever observable needs to be selected)

Yuxiang Zhao et al



Simulation

- DJANGOH + latest PDFs and nPDFs
- Latest energy configurations
- eicsmear + handbook configuration

Systematic uncertainties plan:

1. E, E', theta resolution -> x, Q2 resolution: using EIC smear
2. beam polarization: get from detector group
3. beam transverse polarization: get from detector group, but the effect on the asymmetry might need extra measurement.
4. luminosity: get from detector group
5. pair production background: use numbers from HERA
6. pion- background: pythia + pion rejection from detector group
7. radiative correction: get from theorists (EM radiative correction, EW radiative correction)

Hanjie's talk last week