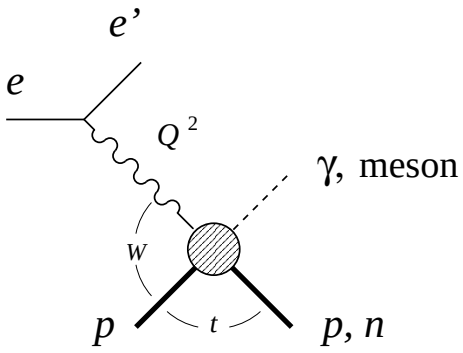
Exclusive processes and GPDs with EIC: Status report

C. Weiss (JLab), ELIC Science Meeting 21–Mar–08

- Exclusive processes: Physics interest
- Collider energies ($W > 10\,\text{GeV}$): "Diffractive" vs. "non–diffractive" channels
- Cross section parametrization for $ep \to e'\pi^+ n$
- First counting rate estimates for EIC [→ Presentation by T. Horn]
- Work in progress, future plans

Exclusive processes: Physics

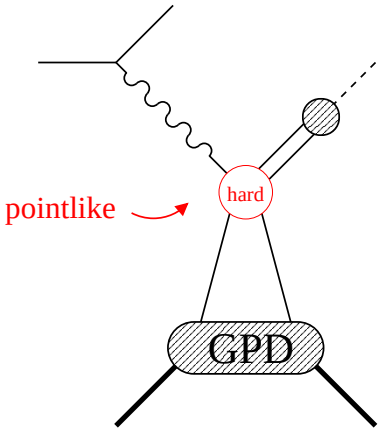


- Study of high–Q^2 exclusive processes
  essential part of physics program for ep collider

$$\begin{array}{lcll} e+p & \to & e'+\gamma+p & W^2, Q^2 \gg 1\ \text{GeV}^2 \\ & & e'+\text{meson}+N & |t| < 1\ \text{GeV}^2 \end{array}$$

  → Reaction mechanism: QCD factorization

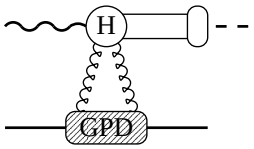
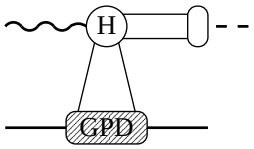
  → Information about GPDs, meson wave functions
  (baryon/meson structure)



- Experimental challenge
  - Small cross sections, $\sigma(\text{meson}+N) \sim 1/Q^8$
  - Detection of recoil nucleon
  - Differential measurements in x, Q^2, t

  [cf. GPD White Paper for NSAC Long–Range Plan,
  presented at Rutgers Town Meeting Jan–07]

Exclusive processes: Collider energies

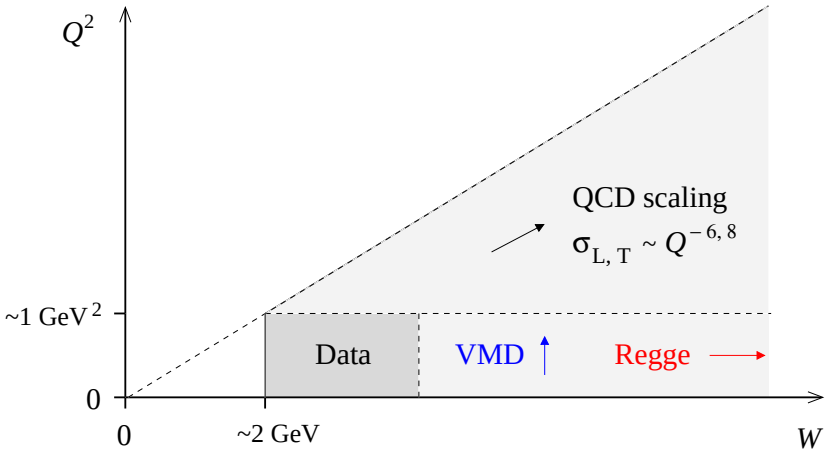
	"diffractive" (vacuum exchange)	"non-diffractive" (quantum number exchange)
Channel	$\gamma p,\ \ \rho^0 p,\ \ J/\psi\, p, \ldots$	$\pi^+ p,\ \ \pi^0 p,\ \ K\Lambda,\ \ \rho^+ n, \ldots$
GPDs	 gluon	 non-singlet quark
Cross section	rises with energy	drops with energy
Interest	gluon imaging of nucleon	spin/flavor structure of quark GPDs
	"one channel"	"many channels"

Exclusive processes: EIC potential and simulations

- Diffractive channels
  - Data/experience from HERA: γp (DVCS), $\rho^0 p$, ϕp, $J/\psi\, p$
  - DVCS simulations [A. Sandacz 06/07; cf. GPD/EIC White Paper]
  - Certainly feasible even with modest luminosity ($10^{33}\text{cm}^{-2}s^{-1}$)
    Discussion about "quantitative" issues

- Non-diffractive channels
  - New territory for collider!
  - Much more demanding in luminosity
  - Physics interest closely related to JLab 6 + 12 GeV program:
    Quark spin/flavor distributions, nucleon/meson structure
  - Feasibility study of $\pi^+ n$, $\pi^0 p$, $K\Lambda$
    [A. Bruell, T. Horn, C. Weiss, V. Guzey, in progress]

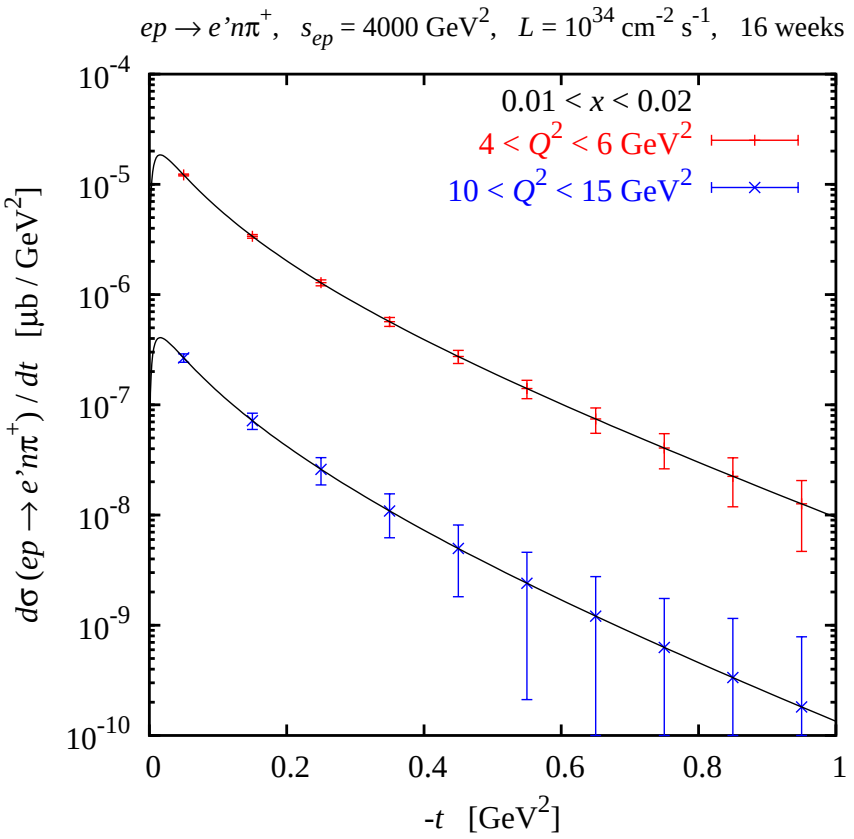
$\pi^+ n$ at EIC: Cross section parametrization



- Phenomenological parametrization based on
  - Regge parametrization of $Q^2 = 0$ data [cf. Guidal, Laget, Vanderhaeghen 98]
  - Vector meson dominance ($Q^2 < 1\text{GeV}^2$)
  - QCD scaling ($W^2, Q^2 \gg 1\text{GeV}^2$)

- Correct asymptotic behavior at large W, Q^2
- Describes σ_T and σ_L ($\leftrightarrow$ GPDs)
- Simple analytic forms, suitable for MC [C. Weiss, Technical Report 08]

$\pi^+ n$ at EIC: First estimates



Luminosity	$10^{34}\text{cm}^{-2}s^{-1}$
Running time	16 weeks
Energy	10 on 100 GeV
Detection	100%

[C. Weiss, EIC Collaboration Meeting, Stony Brook University, 07–Dec–07]

- Many uncertainties (model dependence, extrapolations)
- No proper integration ($d\sigma\times$ bin size)
- Seems feasible at not too small x $(\sim 0.05 - 0.1)$

Work in progress

[→ EIC Collaboration meeting May–08]

- Extend parametrization to $\pi^0 p$, $K\Lambda$
- Full MC simulations [→ T. Horn]

Future extensions

- Develop GPD–based parametrizations,
  extract nucleon structure information from simulated data
- Other non-diffractive channels ($\rho^+ n$, $K^*\Lambda$, . . .),
  polarization observables
- Diffractive channels at high luminosity:
  DVCS + BH, $\rho^0 p$, ϕp, $J/\psi\, p$.