Kinematics of exclusive measurements with EIC: How to assess and discuss it in the Yellow Reports

C. Weiss, EIC User Group Yellow Reports Meeting, 20-22 May 2020

YR physics-detector studies are organized by "final states"
Kinematics needs to be assessed by "physics objectives"
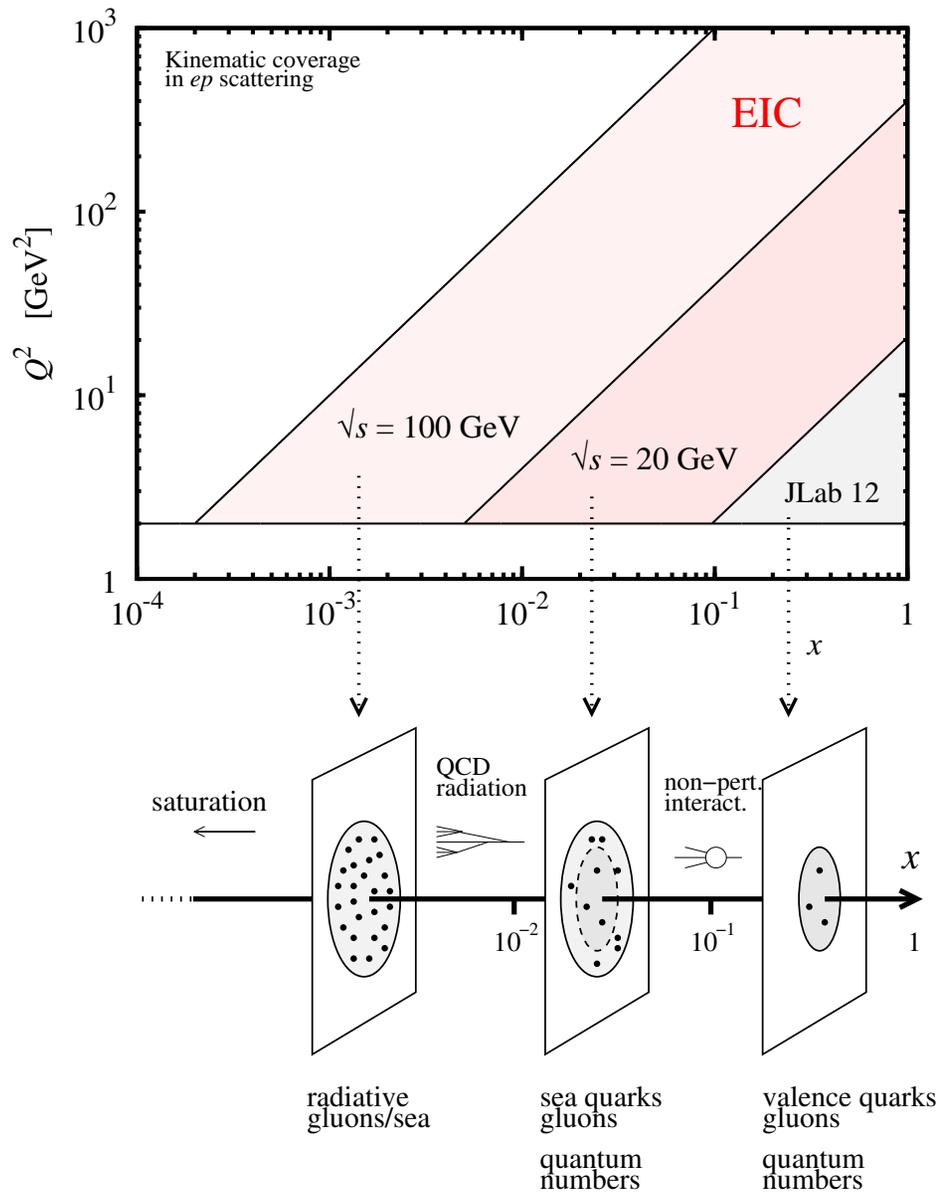
Basic considerations:

- Regions of nucleon structure and QCD dynamics

  "small x" $\leftrightarrow$ "intermediate x" $\leftrightarrow$ "large x"

  $x \ll 10^{-2}$ $x \sim$ few 10^{-3}–10^{-1} $x > 0.1$

- Vacuum vs non-vacuum exchange processes in $\gamma^* N \to MN$

  $M = \gamma, \rho^0, \phi, J/\psi$ all x, but physics obj depends on x

  $\pi^0, \pi^+, K^+, \rho^+, K^*, \gamma$ spin-flavor   intermediate + large x

$\to$ **Natural and reasoned discussion of kinematics!**

Regions of structure and dynamics

- Components of nucleon structure

  $x > 0.1$: Valence quarks and gluons, spin/flavor, few-body dynamics

  $x \sim 10^{-1}...10^{-2}$: Sea quarks, gluons, spin/flavor, non-perturbative dynamics

  $x \ll 10^{-2}$: Gluons and singlet sea, radiative dynamics

- Exclusive measurements objectives

  Transverse imaging of valence quarks, sea quarks incl spin-flavor, gluons

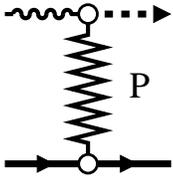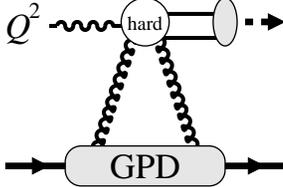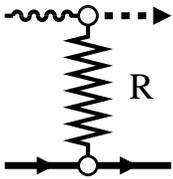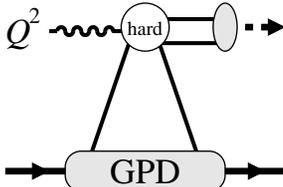 EM tensor form factors, D-term, OAM

  Quark transversity w pseudoscalars

  Regge dynamics soft-hard, odderon

  Valence quark TDAs

  Need to ask: Where do these structure sit? Where do we need to measure?

Vacuum vs non-vacuum exchange processes

	soft	hard $Q^2 \gg \mu_{\mathrm{had}}^2$	cross section	channels
vacuum exchange	Pomeron	Gluons + singlet q	increases with $W^2 \sim 1/x$	$\gamma, \rho^0, \phi, \omega, J/\psi$
non-vacuum exchange	Reggeons	Nonsinglet quarks	decreases with $W^2 \sim 1/x$	γ spin-flavor, $\pi^0, \pi^+, K, \rho^+, K^*$

- Qualitative differences based on high-energy behavior

Need to ask: Where can we reasonably measure the various processes?
What structures do they access in different regions of x

Vacuum vs non-vacuum exchange processes
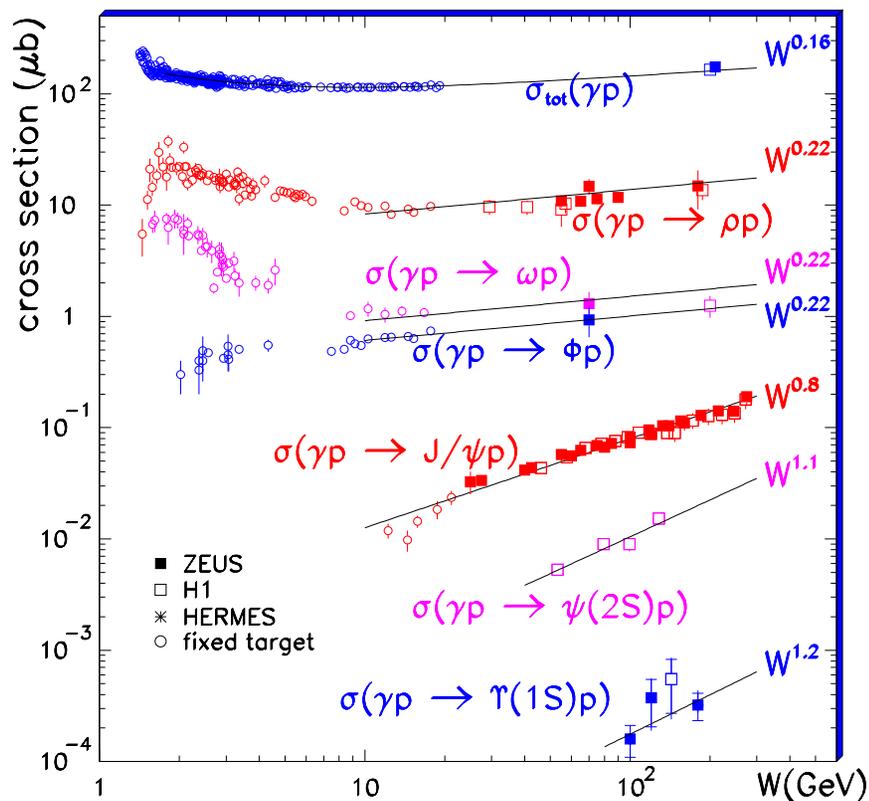
Vacuum exchange: Vector meson photo-production [Summary Levy 2007]
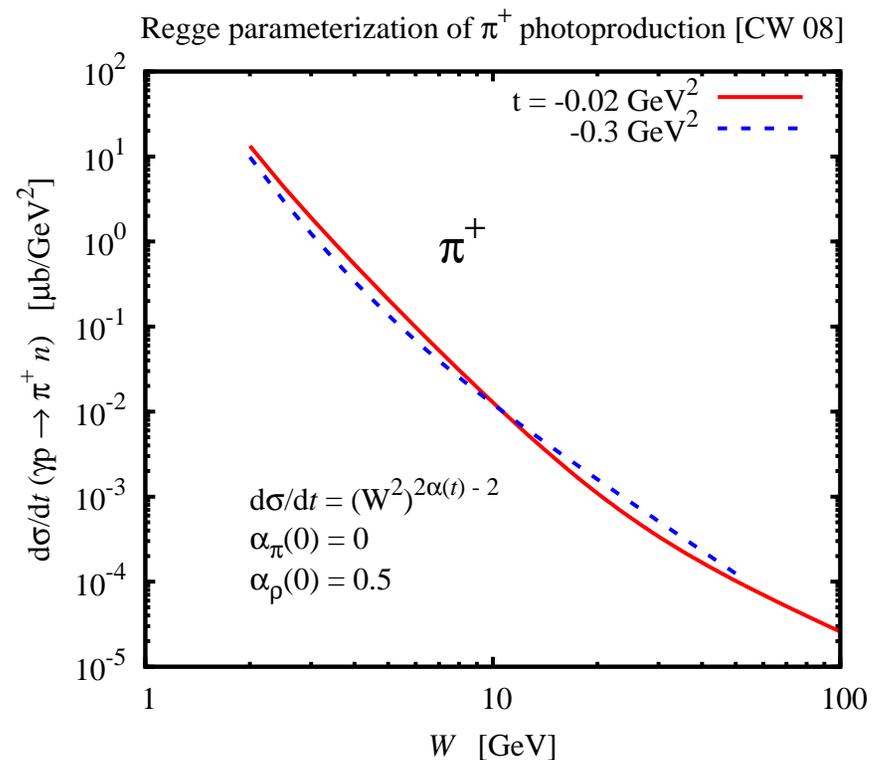
Non-vacuum exchange: π^+ photoproduction from Regge parameterization (based on data)

- Similar results for electroproduction: Effective trajectories become Q^2-dependent, smooth soft-hard transition

Processes and kinematics – tentative

Process	Objectives	Questions/comments
DVCS γ		
$x > 0.1$	valence GPDs spin/flavor	rates? overlap JLab12?
few $10^{-3} < x < 10^{-1}$	nonsinglet/singlet/gluon GPDs spin/flavor	
$x \ll 10^{-2}$	gluon/singlet GPDs	joint physics with $J/\psi, \phi$
$J/\psi, \phi$		
$x > 0.1$	valence-like gluons	rates? helicity-flip GPD E?
few $10^{-3} < x < 10^{-1}$	gluons	
$x \ll 10^{-2}$	gluons	joint physics with γ
ρ^0		
$x > 0.1$	valence quark GPD flavor	rates?
few $10^{-3} < x < 10^{-1}$	singlet/gluon GPD	soft-hard transition?
$x \ll 10^{-2}$	singlet/gluon GPD	complements $\gamma, J/\psi, \phi$
ρ^+, K^*		
$x > 0.1$	valence quark GPD flavor	rates?
few $10^{-3} < x < 10^{-1}$	sea GPD flavor	soft-hard transition?
$x \ll 10^{-2}$	—	—
π^0, η		
$x > 0.1$	valence quark transversity	rates? overlap JLab12?
few $10^{-3} < x < 10^{-1}$	valence/sea transversity	soft-hard transition?
$x \ll 10^{-2}$	odderon?	rates?
π^+, K^+		
$x > 0.1$	valence quark transversity	rates? overlap JLab12?
few $10^{-3} < x < 10^{-1}$	transversity, π/K form factor	soft-hard transition?
$x \ll 10^{-2}$	—	—

Proposed organization, to be discussed/refined/continued