π^0 Production in the Deeply Virtual Regime

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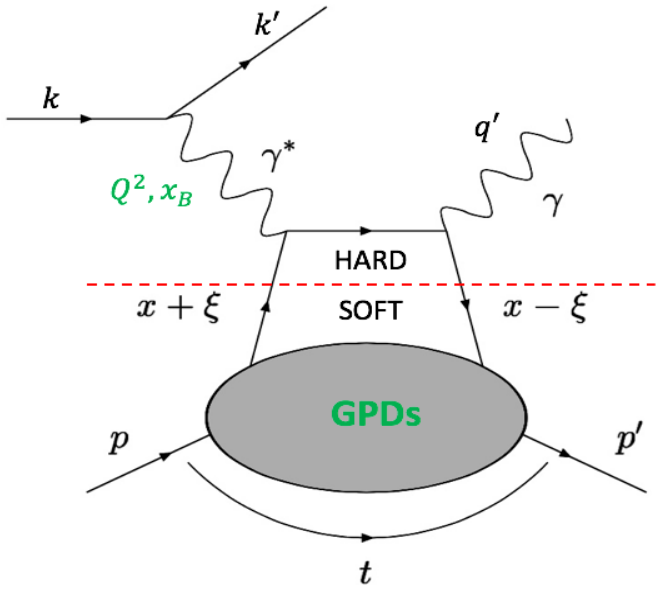
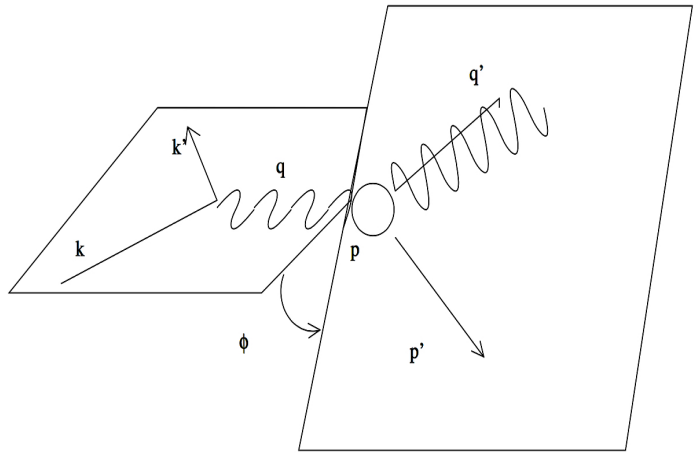
Motivation: Generalized Parton Distributions



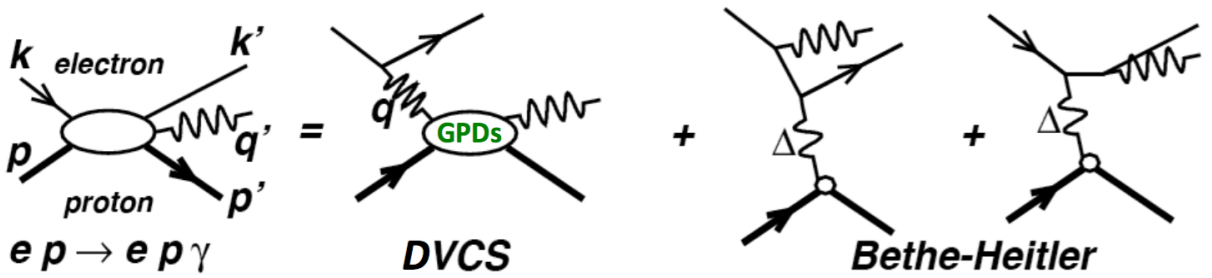
- The hard part is measured at high energies using perturbative QCD.
- The soft or low energy part is measured via non-perturbative QCD, where GPDs are accessible.

Short distances → Perturbative regime
Large distances → Confinement → Non-perturbative regime
Momentum distribution of partons → Parton Distribution Functions (PDFs)
Spatial distribution of partons → Generalized Parton Distributions (GPDs)

- k and k' is the four-momentum of the incoming and outgoing lepton.
- γ^* is the incoming virtual photon, γ is the outgoing real photon, q' is the real photon momenta x is the average longitudinal momentum
- ξ the fractional longitudinal momentum
- t is the momentum transfer of the incoming and outgoing proton four-momentum, p and p'.



Accessing GPDs via Deeply Virtual Compton Scattering (DVCS)

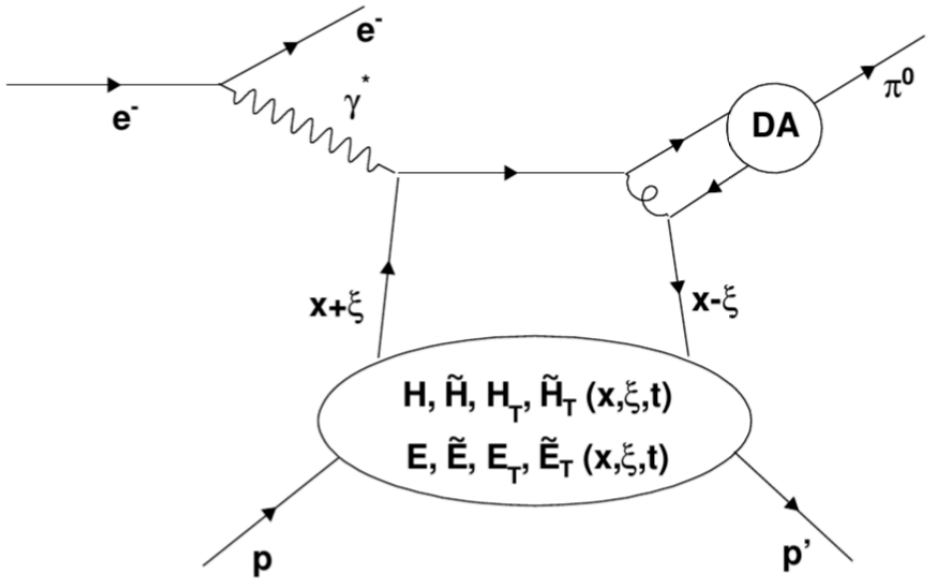


The Bethe-Heitler (BH) terms from the deep exclusive reaction ep → epγ interfere with the DVCS process at leading-twist in photon electroproduction.

- The interference comes from the QED Bethe-Heitler process where the electron emits a photon.
- GPDs can only be accessed in the DVCS term where the nucleon emits the photon.

$$d\vec{\sigma}^5 - d\overleftarrow{\sigma}^5 = \mathcal{Im}\{\mathcal{T}_{BH} \cdot \mathcal{T}_{DVCS}\}$$
$$d\vec{\sigma}^5 + d\overleftarrow{\sigma}^5 = |\mathcal{T}_{BH}|^2 + \mathcal{Re}\{\mathcal{T}_{BH} \cdot \mathcal{T}_{DVCS}\} + |\mathcal{T}_{DVCS}|^2$$

Where are the π^0's?



Leading twist and leading order of the electroproduction of π^0.

- Deeply Virtual Meson Production (DVMP) process can be isolated to obtain π^0's.
- Theoretically, the cross section can be obtained by:

$$\frac{d^4\sigma}{dtd\phi dQ^2dx_B} = \frac{1}{2\pi}\Gamma_{\gamma^*}(Q^2, x_B, E)\left[\frac{d\sigma_T}{dt} + \epsilon^*\frac{d\sigma_L}{dt} + \sqrt{2\epsilon^*(1+\epsilon^*)}\frac{d\sigma_{TL}}{dt}\cos(\phi)\right.$$
$$\left. + \epsilon^*\frac{d\sigma_{TT}}{dt}\cos(2\phi) + h\sqrt{2\epsilon^*(1-\epsilon^*)}\frac{d\sigma_{TL'}}{dt}\sin(\phi)\right],$$

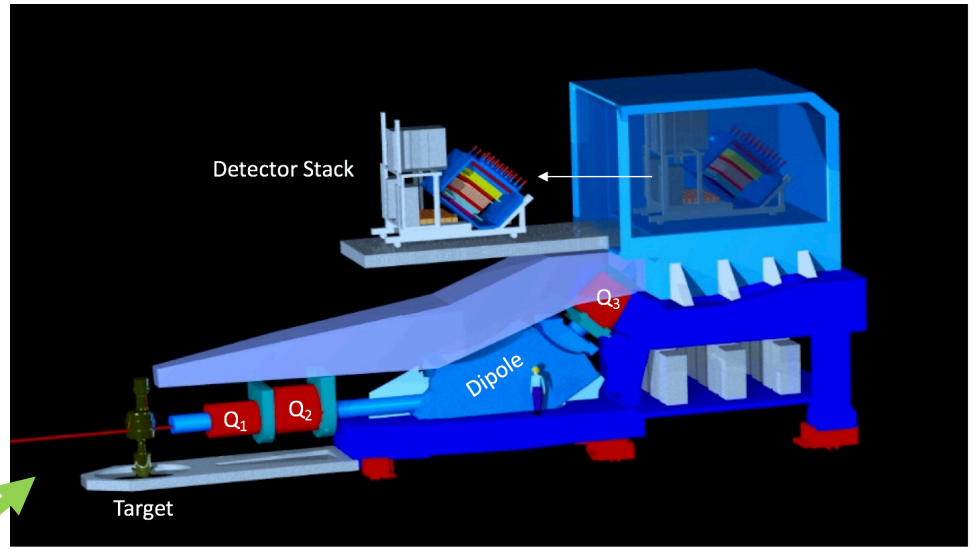
$$\Gamma_{\gamma^*}(Q^2, x_B, E) = \frac{\alpha}{8\pi}\frac{Q^2}{M^2k^2}\frac{1-x_B}{x_B}\frac{1}{1-\epsilon},$$

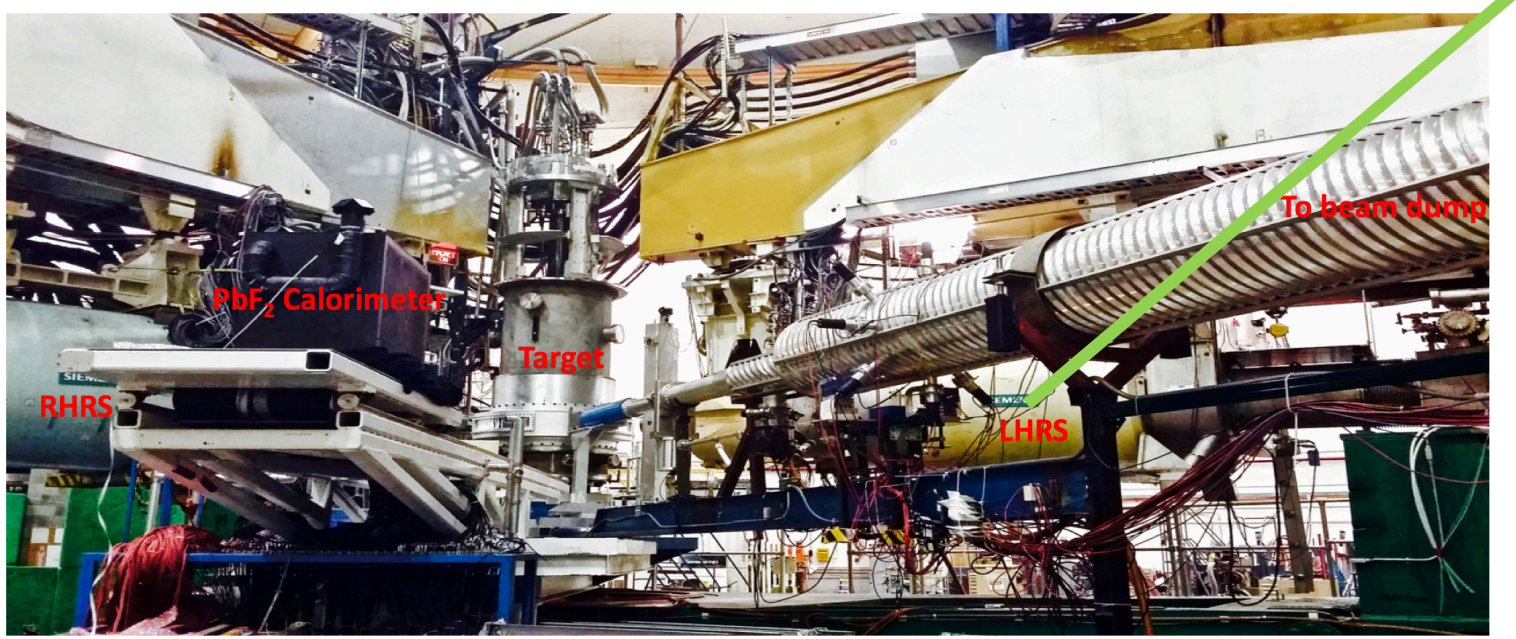
$$\epsilon^* = \frac{1 - y - \frac{Q^2}{2k^2}}{1 - y + \frac{y^2}{2} + \frac{Q^2}{4k^2}},$$

$$y = \frac{k - k'}{k},$$

Experimental Setup

- DVCS Calorimeter (PbF_2 Crystals) – for photon and π^0 detection
- Left High Resolution Spectrometer (LHRS) – for electron detection





Kinematic Settings for E12-06-114

kin	Q^2 (GeV^2)	x_B	E_{beam} (GeV)
36_1	3.2	0.36	7.36
36_2	3.6	0.36	8.52
36_3	4.5	0.36	10.6
48_1	2.7	0.48	4.48
48_2	4.4	0.48	8.84
48_3	5.3	0.48	8.84
48_4	6.9	0.48	11.0
60_1	5.5	0.60	8.52
60_3	8.4	0.60	10.6

Currently analyzing ←

50% of data has been taken