Possibility for Double DVCS measurement in Hall A

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Double DVCS

\[ \gamma^* + p \rightarrow \gamma'^* + p' \]


Double Deeply Virtual Compton Scattering

\[ \Delta = p_1 - p_2 = q_2 - q_1 \]
\[ p = p_1 + p_2 \]
\[ q = \frac{1}{2} (q_1 + q_2) \]
\[ Q^2 = -q^2 \]
\[ \xi = \frac{Q^2}{2p \cdot q} \]
\[ \eta = \frac{\Delta \cdot q}{p \cdot q} \]

\[ Q^2 = -(k - k')^2 \]
\[ x_{bj} = \frac{Q^2}{2p_1 q_1} \]
Double DVCS

- Detect dilepton pair instead of real photon
- Allow to vary skewness $\xi$ of the reaction
- Charged particle in final state can use spectrometer to measure momentum (less requirement on calorimeter energy resolution)
- Muon channel can go through large amount of material, possibly clean trigger with coincidence
Double DVCS and Virtual Bethe Heitler

- Interference of Double DVCS and virtual Bethe Heitler
Kinematical coverage

- DVCS only probes $\eta = \xi$ line
- Example with model of GPD $H$ for up quark
- Jlab : $Q^2 > 0$
- Kinematical range increases with beam energy (larger dilepton mass)
DDVCS cross section

\[ E_e = 6 \text{ GeV}, \quad Q^2 = 2.5 \text{ GeV}^2, \quad x_B = 0.3, \quad \Phi = 0 \text{ deg.} \]

\[ e^- + p \rightarrow e^- + p + \gamma, \rho_L^0 \quad \rightarrow (e^- e^+) \]

\[ q^2 = 0.3 \text{ GeV}^2 \]

\[ \frac{d\sigma}{d\Omega_8 dQ^2 dt d\phi} \quad \text{(nb/GeV)} \]

- VGG model
- Order of \( \sim 0.1 \text{ pb} = 10^{-36} \text{ cm}^2 \)
- Virtual Beth and Heitler
- Interference term enhanced by BH
- Contributions from mesons small when far from meson mass
DDVCS measurement

• Need high luminosity
  – Hall B : $10^{35}$- $10^{36}$ cm$^{-2}$s$^{-1}$
  – mEIC : $1.5 \times 10^{34}$ cm$^{-2}$s$^{-1}$
  – Want $10^{38}$cm$^{-2}$s$^{-1}$ ideally $10^{39}$ cm$^{-2}$s$^{-1}$

• Pair detection and vertex reconstruction : clean trigger

• Ideally look at muons channel to avoid ambiguity with initial electron
  ( muon source low luminosity )
DDVCS measurement

• Large acceptance to get the whole angular coverage of the pair

• Forward angle for increase of Bethe and Heitler interference
SoLID

- Full azimuthal coverage
- Small angle in SIDIS configuration
- Solenoidal field contains low energy background: should allow increase current to look at high
- Possibility of use of baffles similar to PVDIS
  - Increase electron current
  - Though will reduce resolution on muons pairs
SoLID SIDIS layout

Solenoidal detector for SIDIS

Scintillator +
trackers

Muon ID
and trigger
Option with CLAS DVCS solenoid
Double DVCS

• Challenges

  – Pion muon discrimination
    • Record shower profile

  – Vertex reconstruction

  – Need detector without shielding for accurate momenta and vertex resolution (GEM)
Muon identification

• Add material to stop other electromagnetic process
• Scintillator planes for muon trigger
• Use sampling calorimeter to look at shower: layers of material + GEM or Micromegas with pads and digital readout (CALICE, SdHCAL, dHCAL)

![Diagram of GEM or MicroMegas]

Pion showers
Muon only does energy loss
To do for proposal

• Optimize luminosity
  – Baffle ?
  – Occupancy in detector

• Study background in muon detector

• Systematics on cross section measurement ( tracking and muon detection efficiency )

• Best compromise price vs luminosity
  – vertex tracker
  – baffles
  – Bonus type TPC (lower rate /less channels ) vs high segmentation tracker
Conclusion

• Opportunity to measure double DVCS at JLab12 GeV in dimuon channel with high statistics

• SoLID detector suitable to make a high statistical accuracy measurement

• Simulation work and detector R&D for proposal