Proposal PR12-20-012: *Deeply Virtual Compton Scattering using a positron beam in Hall C*

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The goal of the proposed experiment is to cleanly separate the DVCS^2 term from the DVCS-BH (Bethe-Heitler) interference in the deeply virtual electroproduction cross section. The separation is based on the fact that the overall sign of the interference term is determined by the charge of the particles in the beam, i.e. it is opposite for the positron and electron beams. The separation of the DVCS^2 and DVCS-BH interference terms, in its turn, allows one to disentangle the real and imaginary parts of the Compton Form Factors (CFFs) that can be expressed in terms of Generalized Parton Distributions (GPDs).

Accurate determination of both real and imaginary parts of the CFFs is essential for the analysis of hard exclusive processes and GPD extraction. Dispersion relations can express the real part of the CFFs as a ξ-integral of the measured imaginary part and provide powerful model-independent constraints for the analysis of DVCS data. To employ them, one needs to separately determine the real and imaginary parts of the CFFs from the observables. The imaginary part can be obtained from the beam-spin asymmetry in electron-proton DVCS. The positron beam would help to access the real part through the DVCS^2 term and the charge asymmetry. This could greatly increase the reach and impact of dispersion methods and lead to major advances in GPD extraction.

In particular, the real part of the CFFs gives access to the D-term, which is one the form factors of the QCD energy-momentum tensor and contains information on the forces acting on quarks in the nucleon. The D-term appears as the subtraction constant (ξ-independent part) in the dispersion integral for the principal CFF H and can be extracted reliably from data on the real part. The physics content of the D-term has attracted much attention recently, and the proposed experiment would significantly advance this area of study.

The comparison of electroproduction measurements with electron and positron beams puts new demands on the theoretical treatment of QED radiative corrections. In deeply virtual electroproduction, at higher orders in $\alpha_{\rm EM}$ both the BH and DVCS amplitudes acquire terms with "opposite" charge dependence from two-photon exchange (in fact, electron-positron comparison in elastic scattering is being used as a way to isolate the two-photon exchange terms). While these corrections are not expected to substantially affect the analysis of the proposed experiment (where a charge asymmetry appears at leading order in $\alpha_{\rm EM}$), the inclusion of two-photon exchange and a complete higher-order treatment of QED radiative corrections in electroproduction should be a long-term goal of this effort. To realize the full potential of the planned positron program at JLab, the laboratory and the user community should support the theory and implementation of QED radiative corrections in a sustained fashion.