I. CONSTRAINING σ_L AND σ_T IN EXCLUSIVE π^0 PRODUCTION

Recent experimental results on pion electroproduction provided clear evidence for strong contributions from transversally polarized virtual photons. This observation is in sharp contrast to the handbag factorization which tells us that for asymptotically large photon virtualities, Q, longitudinally polarized photons dominate[1, 2]. According to the handbag approach the amplitudes for transverse photons are suppressed $\sim 1/Q$ as compared to those from longitudinal photons. The experimental evidence for strong transverse virtual photon transitions comes from the HERMES π^+ data [3] on the sin ϕ_s harmonics measured with a transversally polarized target and from the CLAS measurement [4] of the π^0 cross sections which reveals a transverse-transverse interference cross section that amounts to a substantial fraction of the unseparated cross section. A large contribution of the transverse cross section was also observed in separated charged pion cross section data [5].

It has been argued in [6, 7] that, within the handbag approach, the amplitudes for transitions are under control of transversity GPDs, in particular of H_T and $\tilde{E_T}$=$2H_T$ + E_T[8, 9]. The amplitudes for transversely polarized photons are parametrically suppressed by μ_π/Q as compared to the asymptotically leading amplitudes for longitudinally polarized photons (related to the usual GPDs $\widetilde{H}$ and $\widetilde{E}$). The parameter μ_π is fixed by the divergency of the axial-vector current and amounts to 2 GeV (at a scale of 2 GeV). This would suggest that there is no strong suppression of the transverse amplitudes at values of Q^2 accessible in present-day experiments. It would thus be of great interest to determine the relative longitudinal and transverse contributions to the π° cross section.

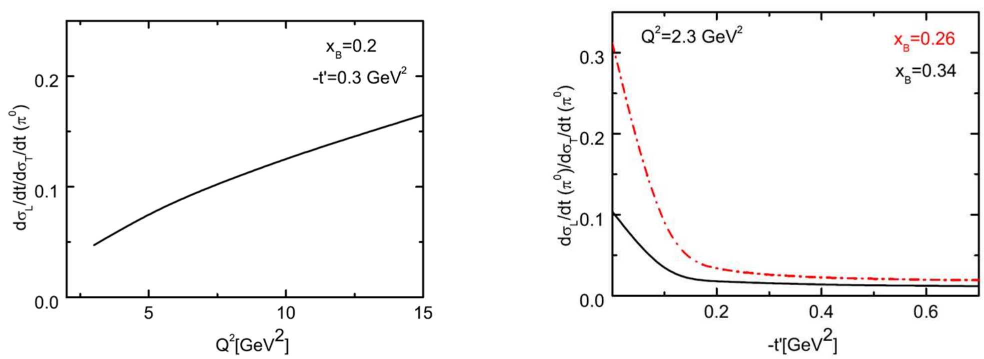

FIG. 1: *The ratio of the longitudinal and transverse cross section for* π^0 *electroproduction. The predictions are taken from [11] and are based on [7].*

In order to evaluate the amplitudes the transversity GPDs are modeled with the help of the double-distribution ansatz. The pertinent parameters are fixed by fitting the HERMES data on π^+ electroproduction and by lattice QCD results [10]. Model predictions are shown in Fig. 1. One should bear in mind that these estimates could have uncertainties of about at least a factor of two [11]. In order to determine the transversity GPDs more precise data on π^0 (and on other pseudoscalar meson) electroproduction at larger values of Q^2 and W than available from JLab 6 GeV, are needed. A particularly clean probe of large transversity effects in pion electroproduction is the measurement of the relative contribution of σ_L and σ_T to the cross section as a function of Q^2. The standard handbag approach predicts $\sigma_L >> \sigma_T$ while strong transversity effects would lead to $\sigma_L < \sigma_T$. Exclusive π^0 electroproduction cross sections with L/T separation could confirm the large contribution from transversely polarized photons to this process and may subsequently allow for a detailed investigation of transversity GPDs [11]. Conversely, if the measured longitudinal cross section should dominate this would allow for probing the usual GPDs through neutral pion production.

As discussed above the relative contribution of σ_L and σ_T plays an important role in the reliable interpretation of the results from the GPD program. However, there are currently no L/T separated π° data available above the resonance region and theoretical predictions have large uncertainties. This emphasizes the need to experimentally determine the longitudinal and transverse cross sections (or put a boundary on their values). The exclusive kinematics proposed here for DVCS also allow for making measurements of the L/T separated exclusive π^0 cross section providing a constraint on σ_L and σ_T. If σ_T is confirmed to be large this could subsequently allow for a detailed investigation of transversity GPDs. If, on the other hand, σ_L is measured to be larger than expected this would allow for probing the usual GPDs.

The measurement will be done in parallel with the DVCS measurement by detecting in coincidence scattered electrons in the existing HMS and photons from the decay of neutral pions using the neutral particle spectrometer (NPS). The NPS will detect photons corresponding to π° electroproduction close to the direction of $\vec{q}$ (parallel kinematics). These events correspond to θ_{π° near zero degrees. A high luminosity spectrometer+calorimeter system like the HMS+NPS combination in Hall C is well suited for such a measurement. The magnetic spectrometers benefit from relatively small point-to-point uncertainties, which are crucial for meaningful L-T separations. In particular, the optics properties and the acceptance of the HMS have been studied extensively and are well understood in the kinematic range between 0.5 and 5 GeV, as evidenced by more than 200 L/T separations ($\sim$ 1000 kinematics). The position of the elastic peak has been shown to be stable to better than 1 MeV, and the precision rail system and rigid pivot connection have provided reproducible spectrometer pointing for about a decade.

A large acceptance device like CLAS12 is well suited for measuring pseudoscalar meson electroproduction over a large range of $-t$ and x_B. Though the large azimuthal coverage allows for a good determination of the interference terms, the main constraint is the error amplification in the extraction of longitudinal and transverse components. The use of the HMS and NPS in Hall C is proposed here as their characteristics best address the experimental requirements, and the existing knowledge of the properties of the HMS is expected to allow for a well understood isolation of the longitudinal and transverse cross sections. The sensitivity of the measurement is illustrated in Fig. 2 projecting an uncorrelated point-to-point uncertainty of 1.6% and correlated uncertainties listed in Table I.

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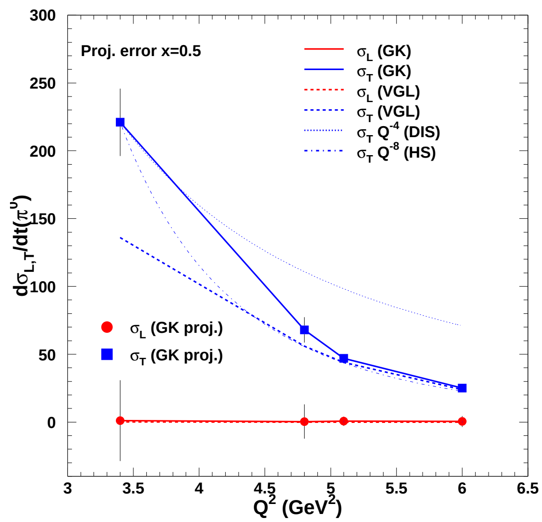

FIG. 2: . *Projected uncertainties for the Q^2 dependence of σ_L and σ_T at fixed x_B=0.36, 0.5. The points are plotted assuming the GK model predictions. Also shown are the hard scattering (HS, R=σ_L/σ_T $1/Q^{-2}$) and the DIS (DIS, R $1/Q^2$) expectation, and the model predictions of the VGL and VGG models.*

TABLE I: *Estimated systematic uncertainties for the π° separated and unseparated cross sections based on previous Hall C experiments. It is important to realize that the HMS is a very well understood magnetic spectrometer which will be used in modest requirements (beyond the momentum), defining the (x, Q^2) kinematics well. The pt-to-pt (scale uncertainties) for radiative corrections and Monte Carlo model are 1.2% (2%) and 0.5% (1%) and should be added in quadrature in the total. The uncorrelated errors between high and low ϵ settings are listed in the first column. The point-to-point uncertainties are amplified by $1/\Delta\epsilon$ in the L-T separation. The scale uncertainties propagate directly into the separated cross sections.*

Source	pt-to-pt (%)	scale (%)
Acceptance	0.4	1.0
Electron PID	<0.1	<0.1
π° efficiency [a]	0.5	1.0
Electron tracking efficiency	0.1	0.5
Charge	0.5	2.0
Target thickness	0.2	0.5
Kinematics	0.4	<0.1
Total (including rad, mod)	1.6	3.4
Total	0.9	2.5

[a]includes combinatoric background, geometric acceptance, etc.

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