PR-06-101:
N^* *resonances in pseudoscalar meson photoproduction from polarized neutrons in* $\vec{H} \cdot \vec{D}$ *and a complete determination of the* $\gamma n \to K^0\Lambda$ *amplitude*

M. Paris, N. Mathur

The proposed experiment offers the opportunity to completely determine the $\gamma n \to K^0\Lambda$ amplitude by measuring an overdetermined set of cross section and polarization observables. The amplitude is completely described by eight polarization observables. Using linearly and circularly polarized photons, a version of the FROST polarized target or the polarized HD target and, in the case of KY final states, recoil polarization measurements, the experiment will measure fourteen observables. Additional channels such as πp and $\pi\pi p$ will provide important constraints for partial wave fits to amplitudes. The extraction of neutron amplitudes from the γD reaction requires kinematic restriction and input from theory. The well developed theoretical model of Laget should, ideally, be complemented by other models if they are available. The proposal lacks specification of which groups will carry out particular analyses which would strengthen this valuable program, central to the program of the Lab and well suited to the aims of the recently formed Excited Baryon Analysis Center (EBAC).

PR-06-102:
Search for modification of vector meson properties in nuclei

J. L. Goity, N. Mathur

The search for medium modifications of meson properties has been a topic of interest for many years. In particular, some theoretical predictions of significant changes of meson masses and widths in a nuclear medium have strongly motivated numerous experiments. There are, however, profound disagreements between different experiments, which calls for definitive studies. This proposal addresses the in-medium modifications of the ρ meson through an analysis of the e^+e^- decay channel, where the interaction of the final state with the nucleus is minimized. One such experiment by the same collaboration has already been completed and the preliminary analysis shows small to insignificant medium effects. Carrying out the program to a new level of accuracy seems to be the natural progression as spelled out in this proposal, and will help settle the issue, at least for the ρ meson.

From the theoretical point of view, it is clear that experimental results will help constrain models and further help one to understand the general issue of nuclear medium effects on hadrons, a topic that is still wide open.

PR-06-103:
Kaon production on the deuteron using polarized photons

F. Gross, M. Vanderhaeghen

The photoproduction of kaons from deuterons using polarized photons, of interest in its own right, is also an important part of the larger program to establish the existence (or non-existence) of resonances not seen, but predicted by quark models (the so-called missing resonances). The measurements proposed here promise to add significant new data by measuring 8 polarization observables for the kaon photoproduction from the deuteron using both linearly and circularly polarized photons. The anticipated new data are needed for the theoretical coupled channel studies of resonances. The coupled channel theory is still under development as part of the EBAC program, and the data collected here will provide a valuable stimulus to its development. The theoretical support of the GW group will allow one to perform such a coupled channel analysis including πN, $\pi\pi N$, ηN, $K\Lambda$ and $K\Sigma$ channels. In particular, the quasi-free reactions on the neutron will allow data to be obtained on the $\gamma n \to K^0\Lambda$, $\gamma n \to K^0\Sigma$, and $\gamma n \to K^+\Sigma^-$ channels, which are most urgently needed in coupled channel analyses. In order to extract the quasi-free channels on the deuteron, the experiment plans to test the final state interactions on the deuteron by comparing results for the quasi-free reaction on the proton with recent CLAS results on the free proton, performed under nearly identical conditions. This experiment is complementary to another proposed CLAS experiment (PR-06-101) measuring kaon photoproduction on the proton and deuteron using a polarized target.

The goal of this program, to understand hadronic resonance states, both by searching for missing states and by extracting photocouplings of existing N^* states, is one of the central tools for the study of low energy QCD and therefore part of the central mission of the JLab scientific program.

PR12-06-101:
Measurement of charged pion form factor to high Q^2

J. Dudek, R. Young

The pion form factor is an object of great theoretical interest, especially at larger values of Q^2 where one can study nonperturbative dynamics of QCD while searching for the transition to the perturbative regime. While the merits of studying this observable are clear, the extraction of the pion form factor from data is a non-trivial exercise.

This proposal plans to extract the on-shell form factor by using the Regge model of VGL for the longitudinal cross section of the $\gamma^* p \to \pi^+ n$ reaction, which they suggest constrains the extrapolation in t. Further, since the references in [16] do not explicitly spell out how this is done in equations, we would advise including the formulae that will be used within the proposal. The fact that the collaboration plans to publish the cross section data is to be applauded, as this would enable any future theoretical advances to subsequently improve on the extracted number.

We feel the proposal would benefit from inclusion of a definition of 'isoscalar backgrounds' within the proposal and some discussion of the possible effect of two-photon exchange on the Rosenbluth separation.

PR12-06-102:
Mapping the spectrum of light quark mesons and gluonic excitations with linearly polarized photons

K. Orginos

This proposal aims to map out the light meson spectrum including hybrids. The light hadron spectrum is a fundamental property of QCD and should be studied both theoretically and experimentally. This study is one of the major components of the JLab program and will have significant support from the lattice QCD effort at JLab.

PR12-06-103:
Single charged pion photoproduction from the nucleon at 11 GeV

A. Radyushkin, R. Edwards

This proposal is for the measurement of $\gamma n \to \pi^- p$ and $\gamma p \to \pi^+ n$ for photon energies between 4.4 and 11 GeV in wide-angle kinematics $30^\circ < \theta_{CM} < 150^\circ$. The motivation for this experiment is to resolve fluctuations or "oscillations" about the scaling curve for the differential cross section $(d\sigma/dt)$ for $p(\gamma, \pi^+)n$ and $n(\gamma, \pi^- p)$ using a deuterium target. While the $\sqrt{s}$ coverage does cover the scaling region, the experiment can go to significantly higher $\sqrt{s}$. This coverage then means the experiment is probing regions not well accessed before. Hence, there is an exploratory aspect to this proposal. In this light, earlier DVCS experiments have revealed interesting new physics, and it is quite possible these single charged pion experiments can do the same. In fact, this reaction is next in complexity to wide-angle Compton scattering, the study of which already revealed nontrivial information about the possible mechanism of wide-angle exclusive reactions, producing strong evidence for the dominant role of the handbag contribution. The study of wide-angle pion photoproduction is the natural next step in this direction. The proposed experiment would allow one to determine the differential cross-section at 4 different values of s and 7 different angles. This, first, would allow one to determine the scaling power n in the parametrization $d\sigma/dt = h(\theta_{CM})/s^{n-2}$ for each particular angle, and study its θ_{CM} dependence. Second, it would allow one to get the patterns $h(\theta_{CM})$ of θ_{CM} dependence at fixed s, and study how they change with s. Such studies are very important for stimulating the theory of wide-angle exclusive reactions.

PR12-06-104:
Measurement of the ratio $R = \sigma_L/\sigma_T$ in semi-inclusive DIS

D. Richards, C. Weiss

The proposed experiment aims to measure the ratio $R = \sigma_L/\sigma_T$ in semi-inclusive charged pion electroproduction, with the purpose of exploring the limits of the leading–twist fragmentation mechanism and studying quark–hadron duality in semi-inclusive DIS. In particular, the authors plan to study the transition from the semi–inclusive regime, where R is expected to drop with increasing Q^2 as in inclusive DIS, to the exclusive regime ($z \to 1$), where QCD factorization implies that it increases with Q^2.

The physics motivation for the proposed measurements is obvious. A clear understanding of the limits of the leading–twist fragmentation mechanism is a prerequisite for extracting information about the flavor decomposition of the nucleon PDFs from semi-inclusive DIS data. The proposed study is also interesting in its own right, as the semi-inclusive cross sections are the simplest observables for duality studies next to inclusive ones. Experience with the 6 GeV data has shown that L/T separated cross sections contain many more clues about dynamics in the quark–hadron transition region than unseparated ones. Finally, mapping the L/T ratio near the exclusive limit is important for understanding the transition to the hard regime in exclusive electroproduction, where it can be described in terms of the GPDs in the nucleon.

Our only critical comment is that the formulation of the analysis of the expected data remains somewhat qualitative. The theoretical discussion of duality is mostly at the level of the correspondence arguments put forward by Bjorken and Kogut more than 30 years ago. This makes it difficult to quantify the extent to which the expected 12 GeV data will advance our knowledge beyond what is known already from present data. It is clear, however, that meaningful studies of leading–twist factorization in semi-inclusive DIS require both the Q^2 and W range available with the 12 GeV upgrade (in particular, when aiming for L/T separation). In this sense it can be stated that the realization of the physics objectives of the proposed experiment depends on the unique capabilities provided by the 12 GeV upgrade. Also, given the current interest in semi-inclusive DIS, it can be expected that our understanding of factorization in semi-inclusive DIS, and perhaps of duality, will have evolved significantly by the time the proposed measurements

would be done. The proposed experiment would certainly provide additional impetus for such studies.

Phenomenological estimates show that the cross section for semi-inclusive charged pion production at $z \to 1$ is dominated by the exclusive ρ^0 production channel, see e.g. Szczurek and Uleshchenko, PRD63:114005 (2001) [hep-ph/0009318]; Diehl et al. PRD72:034034 (2005) [hep-ph/0506171]. When discussing duality in semi-inclusive pion production at $z \to 1$ and the semi-inclusive–exclusive connection, one must specify how to treat these contributions. This is related to whether (or not) one should subtract a diffractive ρ^0 contribution from the data. It could be interesting for the authors to further develop their arguments how to treat the exclusive vector channel in their analysis. This problem clearly deserves further theoretical studies.

PR12-06-105:
Inclusive scattering from nuclei at $x > 1$ in the quasielastic and deeply inelastic regimes

K. Orginos

The goal of this proposal is to make inclusive electron scattering measurements on light and heavy nuclei at high momentum transfers. The high-x region is sensitive to short-range correlations of nucleons inside the nucleus. These data will allow the extraction of nuclear structure functions at $x > 1$, providing information about the distribution of the so-called super-fast quarks, which in turn are useful in understanding the short-range correlations of nucleons.

The current proposal will extend previous measurements at 4 and 6 GeV. The results are expected to be cleaner at higher energies, where contamination from quasielastic and resonance production from high momentum nucleons will be eliminated. Experimental knowledge of NN interactions in the nuclear medium is also important in connection with recent theoretical developments in the area of few-body nuclear forces using modern effective field theory techniques.

PR12-06-106:
Study of color transparency in exclusive vector meson electroproduction off nuclei

F. Gross, J. W. Van Orden

Color transparency remains one of the more interesting predictions of QCD, yet experimental evidence for it is limited and a detailed theoretical understanding is missing. This experiment proposes to use the CLAS12 detector to look at $(e, e'\rho_0)$ production from a variety of nuclear targets. Transparency, the ratio of the nuclear production cross section to the production cross section from protons (or deuterons), is expected to depend on the hadronic formation time, and to approach unity as this time becomes large compared to the time it takes for the ρ to traverse the nucleus. The cross section ratio is also sensitive to the coherence length, an initial state phenomenon not associated with transparency, and to control for this effect the experiment will study transparency as a function of formation time for a fixed coherence length.

This experiment could provide important experimental information about transparency needed for further theoretical development.

PR12-06-107:
The search for color transparency at 12 GeV

J. W. Van Orden, A. Radyushkin

This proposal is for the measurement of nuclear transparency of protons for $8 < Q^2 < 16$ GeV^2 and π^+ mesons for $5 < Q^2 < 9.5$ GeV^2. Color transparency is a prediction of QCD but to this point the best evidence for this effect is in ρ^0 production where the formation of small configurations is rather well understood theoretically. This is not the case for proton and π^+ production, where there is still controversy over the relation between the exchanged photon virtuality Q^2 and the size of quark configurations induced by it in the proton. These measurements would help to clarify the experimental situation, but further theoretical progress is needed to interpret the results.

PR12-06-108:
Hard exclusive production of π^0 and η with CLAS12

J. L. Goity, I. Balitsky

The exclusive electroproduction of π^0 and η mesons off the nucleon is a fundamental process in the study of GPDs. It complements DVCS and as such it is an integral part of Jefferson Lab's program to explore the structure of the nucleon with the 12 GeV Upgrade. The electroproduction of the pseudoscalar mesons gives access to the axial type GPDs $\tilde{H}$ and $\tilde{E}$, and thus gives particular emphasis to the spin structure.

The exploration of the t dependence of the electroproduction process can give some information about the corresponding dependence of the GPDs. The small-t dependence seems amenable to a theoretical understanding, while the large-t dependence is likely to be much more difficult to address theoretically. It is clear that these studies will push the limits of current theory and will motivate further theoretical developments.

The study of the Q^2 dependence at small t will also help understand issues in this case related to the pseudoscalar meson distribution amplitude.

In summary, this proposal addresses issues that are at the core of the studies of hard exclusive processes with the 12 GeV Upgrade. The proposed experiment seems quite compelling and well thought out, and holds the promise of providing important results for a further understanding of the structure of the nucleon.

PR12-06-109:
The longitudinal spin structure of the nucleon

W. Melnitchouk, R. Young

This is a comprehensive program of measurements of double spin asymmetries and spin structure functions, over a large range of kinematics, up to the highest x values reachable at any modern facility. It is in fact a cornerstone of the entire 12 GeV physics program, and is expected to produce important physics results.

The major goal of this experiment is the exploration of the limit $x \to 1$ of the polarization asymmetry A_1. An important question that these measurement will answer is whether the $\Delta d/d$ ratio remains negative at large x or turns upwards towards the pQCD limit of 1 as $x \to 1$, something which the present data cannot verify. The improved statistics at intermediate x, together with the access to a range of Q^2 values, will also provide better constraints on global (NLO) pQCD analyses. The authors show a clear commitment to extracting meaningful physics from the experiment, as evidenced by the recruitment of 3 leading theorists from the LSS group to assist with the NLO analysis. The NLO analyses will include also semi-inclusive data, which will be collected together with the inclusive data with CLAS12, thus allowing flavor separation of the polarized parton distributions. The new data will lead to a large improvement in errors, on Δq as well as ΔG (through Q^2 evolution), and the projected improvement in the size of the errors (Fig. 27) is very impressive.

As well as the x dependence, the experiment will extract moments of structure functions, which will allow direct comparison of the data with lattice QCD. From the moments one will also be able to extract higher twist contributions through an accurate determination of the Q^2 dependence. The twist-4 matrix element f_2^{p-n}, for example, will have errors reduced by up to a factor of around 5 with new data.

As the authors are aware, it will be important in the future to perform measurements with transversely polarized targets, in order to remove model dependence of the g_1 extraction.

PR12-06-110:
Measurement of neutron spin asymmetry A_1^n in the valence quark region using a 11 GeV beam and a polarized ^{3}He target in Hall C

R. Edwards, J. Dudek

This experiment intends to determine the Q^2 dependence of $A_1^n(x, Q^2)$ in the DIS region of $0.3 < x < 0.77$, so in particular fairly large x. The large-x dependence is not well determined experimentally, and there is wide variation in model predictions. These large-x measurements would significantly improve the determination of this observable. Combined with corresponding A_1^p measurements, a flavor decomposition of polarized parton distributions can be made. This experiment is complimentary in Q^2 coverage to the PR12-06-122 proposal in Hall C.

The virtual photon asymmetry is an important fundamental quantity to measure, and because it is anticipated that the sea quark and gluon contributions are small, these experiments should provide important insight into the transition to the valence quark region.

PR12-06-111:
Probing the light quark sea flavor asymmetry with semi-inclusive charged pion production in Hall C

C. Weiss

The proposed experiment plans to measure semi-inclusive charged pion electroproduction from proton and deuteron targets in DIS kinematics over a broad range of Q^2, x and z, with the aim of extracting information about the light quark sea flavor asymmetry, $\bar{d}/\bar{u}$, in the proton. It is also planned to test the leading–twist fragmentation mechanism in semi-inclusive DIS. Additional results are expected for charged kaon production and the kaon fragmentation function ratio.

The proposed investigations are clearly well–motivated. Measurements of the Gottfried sum in inclusive DIS, and the Fermilab E866 Drell–Yan data, have shown the existence of a large flavor asymmetry of the light sea quarks, $\bar{d} - \bar{u} > 0$. Because of its non-singlet character this asymmetry exhibits only very weak scheme dependence, and is thus a particularly clean probe of the quark structure of the proton. Considerable theory efforts have been devoted to explaining the dynamical origin of this asymmetry on the basis of different mechanisms (pion cloud, Pauli blocking, instantons). While most models describe well the data on the absolute difference, $\bar{d}(x) - \bar{u}(x)$, they show large discrepancies in the $\bar{d}/\bar{u}$ ratio at $x > 0.2$, where the Drell–Yan data are limited by statistics. Precise measurements of the ratio in this x–region would have a significant impact on our understanding of the origin of the light quark sea flavor asymmetry.

The procedure for the analysis of the semi-inclusive data is clearly formulated, and reflects the progress which has been made in this area in recent years. The leading–order (LO) methods allow for a transparent analysis which incorporates information about certain combinations of the PDFs measured in inclusive DIS. The comparison between the two LO methods serves as a useful check. The NLO fits, while more complicated, will connect the semi-inclusive analysis to state–of–the–art NLO global fits to inclusive data. Given the current interest in semi-inclusive DIS, it can be expected that these analysis methods will be significantly refined and updated by the time the proposed measurements would be done. While the size of higher–twist corrections in semi-inclusive DIS is presently unknown, experience with the 6 GeV data suggests that leading–order x–z factorization works reasonably

well, providing a strong indication that a QCD analysis at 12 GeV should be sensible; doing the experiment is ultimately the only way to settle this questions.

It may be of interest for the authors to study the relative impact of their data and the anticipated data from W^+/W^- production at the LHC on the determination of $\bar{d}/\bar{u}$. LHC experiments plan to measure the $\bar{d}/\bar{u}$ ratio via the ratio of W^+/W^- production in the low–luminosity run planned for the first year (2007). Published projections suggest that, because of the high rate for W production, LHC will be able to significantly improve the existing parametrizations with data collected over a short period of time. While the LHC data will be for $x \sim 10^{-2}-10^{-3}$, they could connect with the JLab large-x data through DGLAP evolution, because of the large evolution distance from $Q^2 \sim$ fewGeV^2 to $\sim 10^4\,$GeV^2 (evolution transports information from high to low x as one goes up in Q^2). Even if it turns out that there is no direct relation between the data sets in this way, it would be interesting to see how both experiments constrain $\bar{d}/\bar{u}$ in global fits.

PR12-06-112:
Probing the proton's quark dynamics in semi-inclusive pion production at 12 GeV

R. Edwards, M. Vanderhaeghen

This proposal intends to measure azimuthal asymmetries in pion electroproduction at 12 GeV in CLAS12. These asymmetries give access to Collins functions and transverse-momentum-dependent parton distributions. This experiment is one part of the motivations for the 12 GeV upgrade, and as such is a flagship experiment. The anticipated increase of statistics it will bring over CLAS and Hermes is significant. As such, the expected physics results are as interesting now as when the 12 GeV upgrade was proposed.

PR12-06-113:
Structure of the free neutron at large x

K. Orginos, J. Goity

Although the proton structure functions are well known, this is not the case for the neutron. Measurements rely on the scattering from neutrons bound in nuclei. This proposal uses a method that involves scattering from the deuteron and tagging a slow, backward moving recoil proton, which provides for the scattering on a nearly free neutron. The experiment (BONUS, or E03-012, in Hall B) has been carried out at 6 GeV, and this proposal is a natural extension to 12 GeV. In particular, at the higher energy one will be able to measure the neutron structure function to larger values of x, and resolve the long-standing questions about the behavior of the d/u ratio at large x. The theoretical issues associated with the on-shell extrapolation of the neutron structure function have been addressed in quite some detail, and the experiment should provide significant enhancement of the knowledge of the neutron structure.

PR12-06-114:
Measurements of the electron-helicity dependent cross sections of DVCS with CEBAF at 12 GeV

D. Richards, I. Balitsky

This (Hall A) proposal aims to measure helicity-dependent and helicity-independent cross sections in DVCS, and also in exclusive pion electroproduction, building on the current Hall-A run, the draft of which they attach. The proposed measurement addresses one of the central goals of the JLab 12 GeV program on GPDs. A crucial issue for the DVCS/GPD program is the applicability of factorization, and the extent to which the various operators (twist-2 and twist-3) can be extracted from the data.

The proposal concentrates on the formalism, and the degree to which it will indeed be possible to extract the twist-2 and twist-3 contributions from the Q^2 dependence of the various angular distributions. In order to do this, it is necessary to "model" the distributions in some way; the hope is that, as the program evolves, there will be further constraints on the models from, for example, lattice QCD calculations. Furthermore, there has been an active theoretical effort (e.g. by Christian Weiss at JLab and collaborators) to investigate our ability to extract GPDs from data in a model- and process-independent way at HERA.

The proposers make the point that they are measuring absolute cross sections; in the case of meson electroproduction, there is a convolution over the GPDs and the pion distribution amplitude. They may wish to discuss the extent to which our lack of knowledge of the pion distribution amplitude will impact the significance of their results.

PR12-06-115:
Study of the short range properties of nucleons

A. Radyushkin, J. W. Van Orden

The object of this proposal is to study the production of point-like configurations and modifications of nucleons involved in short-range correlations using the $d(e, e'p)n$ reaction at large Q^2. Experiments at lower Q^2 have shown no evidence for either effect. There are theoretical concerns associated with both parts of this experiment. Currently there is no consensus on the relation between the exchanged photon virtuality Q^2 and the size of the configurations induced by it in the proton. The extraction of nucleon modifications due to short range correlations seems to be heavily dependent on reaction models that are poorly constrained at the large missing momenta proposed for this experiment. Furthermore, the discussion of this physics in the proposal gives no indication that there is a well defined, consistent framework for understanding the physics to be studied.

PR12-06-116:
Nucleon resonance studies with CLAS12 in the transition from soft to partonic physics

J. Dudek, D. Richards

We feel that the content of this proposal is of sound physical interest, but is not well described by the title. There is little discussion of the partonic end of the transition and we would suggest simply changing the title to better fit the bulk of the text. Some mention of the connection between the angular and mass dependencies and the T-matrix amplitudes to be used by EBAC would be of use as would discussion of how the acceptance correction of data to produce differential cross-sections will be performed.

Section 2.1 regarding the numerical contribution of the 'meson cloud' could be made clearer. The sentence beginning "The presented helicity coupling..." on page 17 does not make clear the situation regarding models.

PR12-06-117:
Quark propagation and hadron formation

I. Balitsky, M. Paris

The proposed series of experiments is devoted to the study of mechanisms of confinement. These experiments will exploit various nuclei to resolve the space-time structure of hadron production and formation in deep inelastic electron scattering on nuclei. A primary objective of the study is the development of a quantitative understanding of confinement and the differentiation of an array of existing model predictions. The proposed physical picture is a two-stage process consisting of well separated dynamical mechanisms: first, the struck quark is deconfined, radiating gluons as it propagates through the nuclear medium during the 'production time'; next, it develops the color field of a particular hadron and picks up, for example, an antiquark. The resulting $q\bar{q}$ pair is converted into a meson during the 'formation time.' Choosing different targets analyzes the production time and, by choosing various final state hadrons, one can study the formation time. It is proposed that the two-stage picture of well separated hadronization dynamics can be confirmed by the observing a "plateau" in the broadening of the transverse momenta versus energy. The proposed experiments will help to confirm this heuristic physical picture and to distinguish between different quantitative theoretical models of the hadronization process. This would, it is hoped, stimulate further studies of this crucial problem of QCD. In addition, comparison of RHIC experiments on the propagation of partons through the hot nuclear media and the suggested experiments (studying the propagation of quarks/gluons in the cold nuclear matter) will bring new information about the quark-gluon plasma in QCD.

PR12-06-118:
Measurement of He-3/H-3 structure functions

J. W. Van Orden, R. Higa

This is a proposal for extracting the ratio F_2^n/F_2^p by measuring the ratios of the F_2 structure functions in deep inelastic scattering off ^{3}He and ^{3}H. The precision of F_2^n/F_2^p via these processes is expected to increase significantly at large x, therefore, discriminating among different theoretical predictions for this quantity. It is complimentary to the BONUS experiments, which aim at extracting the same ratio with similar precision from deuterium targets, but also unique in extracting EMC effects in $A = 3$ nuclei. A crucial assumption in this extraction is that the super-ratio of the EMC ratios for ^{3}He to ^{3}H has a central value $\mathcal{R} = 1.01$ with a systematic uncertainty that grows from 0.0% at $x = 0$ to $\pm 1\%$ at $x = 0.8$, which is supported by the several theoretical studies presented in the proposal.

PR12-06-119: *Deeply virtual Compton scattering with CLAS at 11 GeV*

D. Richards, M. Vanderhaeghen

The deeply virtual Compton scattering (DVCS) process is a unique tool to integrate and extend our view on the quark structure of the nucleon. The theoretical formalism has been developed in great detail over more than ten years. Provided the initial virtual photon has sufficiently large momentum transfer, the DVCS process accesses generalized parton distributions (GPDs) which are new observables that reduce to the usual parton distributions in the forward limit, and whose first moments correspond with the nucleon elastic form factors. GPDs complement these observables by providing information on longitudinal momentum correlations of quarks in the nucleon, and by mapping out the distribution of the quarks in the transverse direction.

The current proposal plans to measure two different DVCS observables which are proportional to GPDs. Both proposed measurements of beam and target single spin asymmetries measure the GPDs along the line $x = \xi$, very different from the forward parton distributions, which correspond with $\xi = 0$. The two asymmetries complement each other as the beam spin asymmetry is mostly sensitive to the unpolarized GPD H, whereas the target spin asymmetry is mostly sensitive to both H and the polarized GPD $\tilde{H}$. Both observables have already been measured at CLAS at 6 GeV and have shown to yield sizable asymmetries.

The current proposal is an extension of those 6 GeV measurements by using an 11 GeV electron beam and an upgraded CLAS. This will allow one to extend the range in Q^2 up to about 9 GeV^2 compared to the highest momentum transfers of around 2.3 GeV^2 accessible with the present 6 GeV experiments (both at CLAS and Hall A). Even though the existing DVCS experiments at momentum transfers around 2 GeV^2 already indicate the dominance of the twist-2 amplitude in terms of GPDs, the new measurement will provide an unambiguous test of the scaling prediction which is the necessary condition to apply the GPD formalism.

The proposers note that it is not possible, at present, to distinguish the angular dependence of the BH-DVCS and DVCS-DVCS contributions but future, more accurate data, may enable this to be done. They might wish to discuss in greater detail how this lack of knowledge will impact their analysis and give an estimate of the DVCS-DVCS contribution in the proposed

kinematics. It may also be useful to cite future experiments that will enable a distinction to be made.

The proposers intend to fit their data to parametrizations of the GPDs. An important theoretical issue is the extent to which reliable, model independent parametrizations can be constructed. Fortunately, several groups are working on such parametrizations and will be able to incorporate those new data in their fits.

PR12-06-120:
Probing quark-gluon correlations in the neutron: a precision measurement of the neutron g_2 and d_2 at High Q^2 in Hall A

J. L. Goity, W. Melnitchouk

This proposal aims to measure the neutron spin structure function $g_2(x, Q^2)$ in the kinematic region $0.31 < x < 0.98$ and $3.2 < Q^2 < 7.6$ GeV^2, extracted from the parallel and perpendicular spin asymmetries in polarized electron scattering on a polarized ^{3}He target in Hall A. This is a similar, yet complementary experiment, to the one proposed in PR12-06-121 in Hall C. The combined result of the two experiments will allow one to extract moments of structure functions directly from data, as well as perform studies of the Q^2 evolution of these quantities.

The merits of the physics addressed in the combined experiment are unquestionable. The g_2 structure function gives us a relatively clean handle on higher twists and more generally on QCD. It will allow one to study the third moment of a particular combination of structure functions, namely, $d_2 \equiv \int_0^1 x^2[2g_1 + 3g_2]dx$, related to the color electric and magnetic polarizabilities inside the nucleon. In the proton case, the SLAC E155X extraction of this quantity agrees well with many model predictions, as well as with lattice QCD results. However, a combined SLAC E155X and JLab E99-117 result for the neutron case disagrees with both theoretical models and lattice results. According to the proposal, systematic uncertainties were carefully analyzed (radiative corrections, ^{3}He to neutron nuclear effects, target spin misalignment) and estimated to be smaller than 10%, enabling an improvement on the current precision of d_2^n by a factor of almost four. It will also make possible to address large-x contributions to the Burkhardt-Cottingham sum rule, which states that the first moment of g_2, $\Gamma_2 = \int_0^1 g_2\, dx$, is zero. In the proton this sum rule seems to be violated at the level of three standard deviations, while in the neutron it seems to be valid, but within large error bars. The experiments will extend the available test to higher Q^2, $Q^2 > 1$ GeV^2.

The results from this experiment, and the 'sister' experiment PR12-06-121, will be very important in the progress towards a detailed understanding of the neutron's spin structure.

One comment on the proposal is the apparent confusion about the moments of structure functions. It is written that Eq. (1) is the second moment

of a linear combination of g_1 and g_2, while Eq. (5) is called the first moment of g_1.

PR12-06-121:
A path to "color polarizabilities" in the nucleon: a precision measurement of the neutron g_2 and d_2 at high Q^2 in Hall C

W. Melnitchouk, R. Higa

This proposal aims to measure the neutron spin structure function $g_2(x, Q^2)$ in the kinematic region $0.2 < x < 0.95$ and $2.5 < Q^2 < 6$ GeV^2, extracted from the parallel and perpendicular spin asymmetries in polarized electron scattering on a polarized ^{3}He target. The upgraded SHMS/HMS combination in Hall C will allow measurements over a broad x region at nearly constant Q^2, something that has not been possible before. Another proposal, PR12-06-120, plans to measure the same structure function at higher x and higher Q^2 values, and the combined result will allow one to extract moments of structure functions directly from data, as well as perform studies of the Q^2 evolution of these quantities.

The merits of the physics addressed in the combined experiments are unquestionable. The g_2 structure function gives us a relatively clean handle on higher twists and more generally on QCD. It will allow one to study the third moment of a particular combination of structure functions, namely, $d_2 \equiv \int_0^1 x^2[2g_1 + 3g_2]dx$, related to the color electric and magnetic polarizabilities inside the nucleon. In the proton case, SLAC E155X extraction of this quantity agrees well with many model predictions, as well as with lattice QCD results. However, a combined SLAC E155X and JLab E99-117 result for the neutron case disagrees with both theoretical models and lattice results. According to the proposal, systematic uncertainties were carefully analyzed (radiative corrections, ^{3}He to neutron nuclear effects, target spin misalignment) and estimated to be smaller than 10%, enabling an improvement on the current precision of d_2^n by a factor of almost four. It will also make possible to address large x contributions to the Burkhardt-Cottingham sum rule, which states that the first moment of g_2, $\Gamma_2 = \int_0^1 g_2\, dx$, is zero. In the proton this sum rule seems to be violated at the level of three standard deviations, while in the neutron it seems to be valid, but within large error bars.

An important feature of this measurement is that d_2 will be determined at essentially constant Q^2 values. Previous measurements have been unable to extract d_2 at a constant Q^2 value, and have relied on (model-dependent)

extrapolations to a common Q^2 point. Furthermore, measurements at several different Q^2 values will allow one determine whether d_2 is indeed twist-3 dominated, or whether there are yet higher twist contributions to d_2.

The results from this experiment, and the 'sister' experiment PR12-06-120, will be very important in the progress towards a detailed understanding of the neutron's spin structure.

One comment on the proposal is the apparent confusion about the moments of structure functions. It is written that Eq. (1) is the second moment of a linear combination of g_1 and g_2, while Eq. (5) is called the first moment of g_1.

PR12-06-122:
Measurement of neutron spin asymmetry A_1^n in the valence quark region using a 8.8 GeV and 6.6 GeV beam energies and BigBite spectrometer in Hall C

R. Edwards, N. Mathur

This experiment intends to determine the Q^2 dependence of $A_1^n(x, Q^2)$ in the DIS region from about $0.3 < x < 0.71$, so in particular fairly large x. The large-x dependence is not well determined experimentally, and there is wide variation in model predictions. These large-x measurements would significantly improve the determination of this observable. Combined with corresponding A_1^p measurements, a flavor decomposition of polarized parton distributions can be made. This experiment is complimentary in Q^2 coverage to the PR12-06-110 in Hall A.

The virtual photon asymmetry is an important fundamental quantity to measure, and because it is anticipated that the sea quark and gluon contributions are small, these experiments should provide important insight into the transition to the valence quark region.

LOI12-06-102:
Study of hypernuclei by pionic decay at CEBAF

R. Edwards

This experiment intends to measure the binding energies of the Λ in nuclei, from $3 \leq A \leq 15$, via π^- decays. The expected errors are about 100 keV, which is about 5 to 10 times better than in current experimental measurements. The experiment setup can be extended to other properties like in-medium effects, and impurity studies, plus other decays near the drip line.

These measurements provide useful information about baryon-baryon interactions, which is needed for high density nuclear matter studies. Given current nuclear physics interest in nuclear decays far from stability, these experimental measurements are of general interest in the nuclear physics community; hence, the LOI should be considered for a full proposal.

LOI12-06-103:
G_{Ep}/G_{Mp} *with an 11 GeV electron beam*

W. Melnitchouk

Two previous polarization transfer experiments in Hall A measured a dramatic fall-off of the G_E^p/G_M^p ratio up to $Q^2 \sim 6$ GeV^2. This has been one of the most widely cited results to come from JLab, and has stimulated considerable theoretical interest. A third experiment in Hall C will extend the range to $Q^2 \sim 9$ GeV^2 in 2007. The proposal in this LOI is for a new experiment in Hall C, which will extend the range to $Q^2 \approx 13$ GeV^2, with two new data points selected above $Q^2 = 10$ GeV^2, requiring 30 days at 10.5 GeV^2 and 60 days at 13 GeV^2. The errors will be somewhat larger than the polarization transfer data at lower Q^2, but still impressive given the very low rates at high Q^2. There do not appear to be any serious theoretical interpretation issues, as far as extracting the form factor from the data. Given that the elastic form factors are one of the most fundamental observables which characterize the extended nature of the proton, the importance of such data is clear, and will further stimulate theoretical activity.

LOI12-06-104:
Charged pion electroproduction ratios at high p_T

A. Radyushkin

The object of this proposal is to study the π^-/π^+ ratio in charged pion electroproduction in the wide-angle scattering regime, with $s \sim 5-9$ GeV^2, $-t \sim 2.5-5$ GeV^2 and $Q^2 = 2.5$ GeV^2. As a possible theoretical description, the author refers to hard-gluon-exchange/handbag model and points out that existing data on the ratio π^-/π^+ are consisted with predictions based on this mechanism. However, this hard mechanism cannot account for the size of the cross section. An evident conclusion is that there is a large soft contribution: $\sigma^{\rm observed} = \sigma^{\rm soft} + \sigma^{\rm hard}$. If the π^-/π^+ ratio for the observed cross sections, call it $R^{\rm observed}$, agrees with the ratios calculated for $\sigma^{\rm hard}$, then the conclusion is that the π^-/π^+ ratio for the soft parts should also be close to $R^{\rm observed}$ (especially since $\sigma^{\rm hard}$ is a small part of $\sigma^{\rm observed}$). This means that the π^-/π^+ ratio is not sensitive to the reaction mechanism. The author argues that the extraction of π^-/π^+s ratioq "is of particular interest because the ratio allows certain soft contributions to be divided out, allowing hard-scattering contributions to be more readily observable". However, existing data mentioned by the author indicate that there are large soft contributions which are *additive* to hard contributions, hence their effect cannot be factored out by taking ratios. Thus, there seems no advantage of measuring the ratios. On the other hand, the measurement of cross sections themselves at a fixed Q^2 but various angles and s would be very interesting and stimulating for theory of wide-angle exclusive reactions.

LOI12-06-105:
Deuteron photo-disintegration at high energies

F. Gross

The previous deuteron photo-disintegration measurements up to E_γ=5.5 GeV have provided very interesting evidence for the onset of scaling predicted by the constituent counting rules of perturbative QCD. It is of great theoretical interest to extend these measurements up to higher energies at a variety of forward angles to see if the onset of scaling remains, and if it continues to occur at a transverse momentum $p_T \sim 1.3$ GeV/c. With the 12 GeV upgrade the energy range can be extended to 6.6 GeV. These measurements have a clear meaning independent of the theory, and are important even though the theory for this process continues to be in a rather primitive state (and probably will be for some time).

LOI12-06-106:
Anti-shadowing and EMC effect at large x

I. Balitsky

The ratios of the nuclear structure functions to the structure functions of the nucleon have been the subject of intensive theoretical and experimental study since the discovery of the EMC effect more than 20 years ago. The proposed experiment is devoted to the study of the anti-shadowing region, $x \sim 0.1 \div 0.3$, where this ratio is greater than 1. Previous SLAC, EMC, and BCDMS experiments in this region have produced inconclusive results, and do not give a clear A-dependence of the ratios, so that new experimental information is highly desirable. From the theoretical perspective, there are several explanations of the anti-shadowing effect, in particular the explanation based on the version of NJL model (the Quark-Meson Coupling model) and the analysis in the framework of the chiral soliton model. The predictions of the theoretical models in the anti-shadowing region are quite different and the proposed measurement will most definitely stimulate the theoretical study of this subject.

LOI-12-06-107:
Measurement of the neutron magnetic form factor at high Q^2

K. Orginos

This Letter of Intent proposes to study the neutron magnetic form factor using the 11 GeV electron beam, covering the range of $Q^2 = 2 - 14$ GeV^2. The extraction of the form factor will be done using the ratio method of $e-n$ to $e-p$ scattering on deuterium. This experiment addresses important physics which has direct contact with the lattice QCD program, and will help to clarify issues related to the Q^2 dependence of nucleon form factors.

LOI12-06-108:
Transverse polarization in hard scattering at CLAS

I. Balitsky

The proposal is devoted to study DVCS, exclusive, and semi-inclusive deep inelastic scattering using a transversely polarized target. The DVCS on a transversely polarized nucleon provides unique access to the generalized parton distribution E entering Ji's sum rule for the orbital momentum carried by quarks in the nucleon. The single-spin asymmetry in the exclusive meson production will give us an important test of the GPD formalism at JLab energies. The semi-inclusive deep inelastic scattering enables us access to a new set of structure functions – the transversity distributions, which cannot be measured in an ordinary deep inelastic scattering. There are two competing mechanisms – Collins and Sivers contributions. They can be distinguished experimentally and lead to two different types of correlations of the transverse spin of the nucleon and the momentum of the emitted pion. The transversity distributions have been intensively studied in the recent literature, both theoretical and experimental; for example, there are recent measurements by 6 GeV JLab, HERMES and COMPASS. The proposed 12 GeV JLab experiment would provide crucial new information about the transverse distributions and stimulate new theoretical activity in this field.

LOI12-06-109:
Semi-inclusive pion production with a longitudinally polarized target at 12 GeV

M. Vanderhaeghen

This LOI proposes to measure the $\sin 2\phi$ azimuthal moment in semi-inclusive electroproduction of pions with an 11 GeV electron beam and the CLAS12 detector with a longitudinally polarized proton target. The experiment is proposed to run with the DVCS experiment and is complementary to another semi-inclusive DIS proposal (PR12-06-112) using an unpolarized target. The main goal of the present proposal is the interpretation of the SIDIS asymmetries in terms of transverse momentum dependent (TMD) parton distributions. The formalism has been worked out in quite some detail over the past year by several groups. A necessary condition to access the TMD is to test the factorization of the SIDIS cross sections into a product of quark distribution functions and fragmentation functions. Existing 6 GeV CLAS data seem to support this factorization, although the kinematical range is very limited. The present measurement will be able to extend this range significantly and test the factorization.

The authors are encouraged to submit a detailed proposal. On the theoretical side, they might want to give an estimate of how large they expect the contribution from exclusive ρ^0 production to be to the π^+ and π^- asymmetries. They may also want to work out in more detail how complementary 12 GeV proposals on exclusive vector meson production may contribute to quantify this contribution.

L0I-06-110:
Measurement of azimuthal asymmetry in deuterium disintegration

J. W. Van Orden

Previous deuteron photodisintegration experiments at Jefferson Lab have shown the cross sections at large angles behave as s^{-11} as predicted by quark counting rules. This Letter of Intent proposes that the linear photon polarization observable Σ be measured for photon energies of 1.1 to 2.3 GeV. This data along with existing polarized and unpolarized data would be useful in understanding the nature of this process in regions where the quark counting rules should not apply.

LOI12-06-111:
Precision measurement of the parity-violating asymmetry in deep inelastic scattering off deuterium using baseline 12 GeV equipment in Hall C

R. Young

This Letter of Intent proposes to measure the parity-violating asymmetry in deep inelastic scattering off deuterium. The ability to perform high-precision measurements of the electroweak interaction at low energies is a highlight of the world-leading capabilities of Jefferson Lab.

The principal motivation for this measurement is claimed to be a Standard Model test, with sensitivity to poorly known weak neutral current couplings involving the axial quark charges. Given the hadronic uncertainties, as discussed in Section 4, the actual sensitivity to physics beyond the Standard Model is unclear. The projected error bar displayed in Figure 1, neglecting hadronic effects, is perhaps an overstatement of this experiment's new physics reach. Nevertheless, combined with a larger PV-DIS program including a large acceptance device, the further control of hadronic effects would allow this measurement to probe new physics.

The hadronic physics aspects of this measurement are interesting in their own right. The potential to directly see charge symmetry violation at the parton level would be a fantastic result. Further, continued measurements in this program could provide a new handle on higher-twist effects. Measurement of both of these effects would have direct relevance to the reported NuTeV anomaly.