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Jefferson Lab
Thomas Jefferson National Accelerator Facility
Exploring the Nature of Matter

October 18, 2006

Members of the Jefferson Lab User Group,

One of the greatest pleasures that I have as Director is seeing the new and exciting experimental proposals that come from our user community. The quality of these proposals is an indicator of the forefront scientific program that Jefferson Lab enables for its users, and this PAC was no exception.

This Program Advisory Committee reviewed 25 proposals and 9 letters of intent for both 5 GeV (3 proposals, 1 LOI) energy and for the 12 GeV Upgrade (22 proposals, 8 LOIs). These submissions illustrate the enthusiasm the community has for the 12 GeV Upgrade and the science that can be accessed as a result. PAC 30 assessed these proposals and selected the highest impact and best science. The PAC approved 13 of the experimental proposals submitted, conditionally approved 4, and 5 were deferred.

I want to take this opportunity to thank Berthold Schoch and Serge Kox, who are rotating off the PAC, for their contributions to the Jefferson Lab nuclear physics program. Their dedication and involvement in the Jefferson Lab Physics program has made a real mark on our field. I wish them continued success in their research. I also want to recognize Ed Kinney and Roy Holt for their willingness to be part of the PAC process and I look forward to working with you.

Sincerely,

Christoph W. Leemann
Director, Jefferson Lab

Letter from the PAC Chairman

Introduction

The Jefferson Laboratory Program Advisory Committee held its 30th meeting on August 21-26, 2006. The membership of the Committee is given in Appendix A. In response to the charge (Appendix B) from the JLab Director, Dr. Christoph Leemann, the Committee reviewed and made recommendations concerning the 22 proposals and 8 letters of intent for experiments that will use the base equipment currently planned for the 12 GeV Upgrade and three proposals and one letter of intent for running requiring only low (<5 GeV) energy beams in Hall B submitted by JLab users.

General Overview (12 GeV)

Since the last meeting, PAC29, two very important events took place that will strongly influence the future of Jefferson Laboratory: the decision of DOE to grant the 12 GeV Upgrade's Critical Decision-1, and the creation of a new team, Jefferson Science Associates (a joint venture of SURA and Computer Sciences Corporation) to manage and administer the laboratory. The positive decision to go ahead with the JLab 12 GeV Upgrade gave the ongoing activities to plan for the physics program at 12 GeV a real boost. The management took the steps necessary to provide all possible resources to optimize the preparation for the 12 GeV Upgrade. PAC30 was an essential part of those preparations.

PAC30 reviewed the physics and equipment described in 22 proposals and 8 letters of intent. The experiment proposals were considered with respect to their appropriateness for data-taking with the base equipment during the first five year running period with a 12 GeV beam. The PAC heard excellent talks covering a physics program that reflected almost a decade of discussions and preparations focused on the physics possibilities opened by the availability of 11-12 GeV beam at JLab. The basis for those discussions has been the tremendous progress at the laboratory and in the community in both experiment and theory. On the experimental side the implementation and reliable operation of highly polarized, intense beams and polarized proton and neutron targets, complemented with efficient proton recoil polarization capabilities opened up new directions for investigations. Together with very specialized, sophisticated detector systems a broad range of physics questions could be addressed. The precision of the observables extracted from the data inspired new developments on the theory side. The dynamics of extensive physics discussions during the years of preparation became transparent for the PAC members during the talks and, especially, during extended discussions with the proponents of the proposals. We noted with particular pleasure the large number of young spokespersons who gave excellent presentations.

A physics overview of the topics and the number of proposals reflect the science case for the JLab 12 GeV Upgrade that were discussed extensively and recommended by PACs 18, 23 and 27, each of which reviewed the developing science case for the Upgrade and the equipment proposed to realize it. This program was summarized in the CDR for the Upgrade that was reviewed by the PAC and presented to the DOE Science Review last April. The basic topics include:

- **QCD in the Confinement Regime** by the search for Gluonic Excitations and thus the investigation of the Origin of Quark Confinement. A new set-up (GlueX) will be installed in a new experimental Hall D to carry out this major experiment.

- **The Fundamental Structure of Nuclear Building Blocks** by investigating:

    1. **Valence Quark Structure Parton Distributions** (two experiments);

2. **The spin structure of the nucleon** including the extended GDH integral and sum rule, and transverse parton distributions via SIDIS (seven experiments);

3. **The 3D quark/gluon structure of the nucleon** via GPD's, form factors, etc. (four experiments); and

4. **Quark structure and nucleon excitations (**three experiments).

- **The Physics of Nuclei** by investigating:

1. **The emergence of Nuclei from QCD** including the study of short-range correlations in nuclei: the nature of QCD at high density and the structure of cold, dense nuclear matter. (two experiments); and

2. **Fundamental QCD Processes in the Nuclear Arena** including color transparency, and quark propagation through cold QCD matter via studies of nuclear hadronization and transverse momentum broadening. (three experiments).

The Letters of Intent generally expanded on the topics presented in the proposals. However LOI12-06-111, *Precision Measurement of the Parity-Violating Asymmetry in Deep Inelastic Scattering of Deuterium Using Baseline 12GeV Equipment in Hall C,* addresses the topic **Standard Model Tests,** which is already part of the 6 GeV program. A more than an order of magnitude improvement for the difference of the low energy weak neutral current coupling constants ($2C_{2u}$-C_{2d}) can be achieved with a moderate amount of beam time. At the proposed precision, the measurement would provide unique constraints on physics beyond the Standard Model at the multi-TeV scale.

Recommendations (12 GeV)

Of the twenty two proposals received, seventeen experiments were approved (four of them conditionally). Five experiments have been deferred.

The PAC approved three experiments in Hall A: PR12-06-114, *Measurements of Electron-Helicity Dependent Cross sections of Deeply Virtual Compton Scattering with CEBAF at 12 GeV*; PR12-06-118, *Measurement of the F_2^n/F_2^p , d/u Ratios and A=3 EMC Effect in Deep Inelastic Scattering off the Tritium and Helium Mirror Nuclei*; PR12-06-122, *Measurement of Neutron Asymmetry A_1^n in the Valence Quark Region Using 8.8GeV and 6.6GeV Beam Energies and Bigbite Spectrometer in Hall A.*

Seven experiments have been approved in Hall B: PR12-06-106, *Study of Color Transparency in Exclusive Vector Meson Electroproduction off Nuclei*; PR12-06-108, *Hard Exclusive Electroproduction of π^0 and η with CLAS12*; PR12-06-109, *The Longitudinal Spin Structure of the Nucleon*; PR12-06-112, *Probing the Proton's Quark Dynamics in Semi-inclusive Pion Production at 12GeV*; PR12-06-113, *The Structure of the Free Neutron at Large $x_{Bjorken}$*; PR12-06-117, *Quark Propagation and Hadron Formation*; PR12-06-119, *Deeply Virtual Compton Scattering with CLAS at 11GeV with polarized and Unpolarized targets*.

Six experiments have been approved in Hall C: PR12-06-101, *Measurement of the Charged Pion Form Factor to High Q^2*; PR12-06-104, *Measurement of the Ratio $R=\sigma_L/\sigma_T$ in Semi-inclusive Deep-inelastic Scattering*; PR12-06-105, *Inclusive Scattering from Nuclei at x>1 in the Quasielastic and Deeply Inelastic Regimes*; PR12-06-107, *The Search for Color Transparency at 12 GeV;* PR12-06-110, *Measurements of Neutron Spin Asymmetry A_1^n in the Valence Quark Region Using an 11GeV Beam and a Polarized ^{3}He Target in Hall C*; PR12-06-121, *A Path to "Color Polarizabilities" in the Neutron: A Precision Measurement of the Neutron g_2 and d_2 at High Q^2 in Hall C*.

One experiment, PR-06-102, *Mapping the Spectrum of Light Quark Mesons and Gluonic Excitations with Linearly Polarized Photons,* the GlueX-Experiment, will occupy the new Hall D.

For the four conditionally approved proposals, specific issues were raised. For PR12-06-107, *The Search for Color Transparency at 12 GeV,* the PAC raised concerns over the interpretability of the results. A thoughtful re-evaluation might lead to a different running plan. It must be clearly shown as a condition for approval of PR12-06-110, *Measurements of Neutron Spin Asymmetry A_1^n in the Valence Quark Region Using an 11 GeV Beam and a Polarized ^{3}He Target in Hall C,* that this experiment, compared with PR12-06-122, *Measurement of Neutron Asymmetry A_1^n in the Valence Quark Region Using 8.8 GeV and 6.6 GeV Beam Energies and Bigbite Spectrometer in Hall A,* offers the only option to get the data at the highest x and Q^2 . The demonstration of a successful running of the first experiments with the BoNuS detector can remove the condition for approval of PR12-06-113, *The Structure of the Free Neutron at Large $x_{Bjorken}$.* A special JLab. Management review of the technical and safety aspects of the Tritium target is the condition for approval for PR12-06-118, *Measurement of the F_2^n / F_2^p , d/u Ratios and A=3 EMC Effect in Deep Inelastic Scattering off the Tritium and Helium Mirror Nuclei* .

Given the large number of proposals, all but one asking for either a 12GeV beam energy (in the case of Hall D) or 11GeV beam energy (for the other Halls), the PAC strongly recommends that JLab Management investigate the technical (and financial) feasibility of delivering the highest beam energies simultaneously to any three halls that can run in parallel. Only by exploring and using efficiently the widest possible kinematical range for each experiment mounted will the upgrade maximize the new insights that can be gained into the structure of the nucleon, the transition between the hadronic and quark/gluon descriptions of matter, and the nature of quark confinement.

Overview (< 5GeV Hall B)

In addition to the 12GeV proposals the PAC reviewed 3 proposals and a letter of intent for experiments in Hall B. Two proposals, PR-06-101, *N* Resonances in Pseudoscalar Meson Photoproduction from Polarized Neutrons in HD and a Complete Determination of the $\gamma n \rightarrow K_0 \Lambda$ Amplitude,* and PR-06-103, *Kaon Production on the Deuteron Using Polarized Photons,* ask for beam time that are well aligned with recommendations of PAC25 made after a mini-workshop for the future studies at JLab concerning the N* program. It was felt that high priority should be given for "experimental investigations of reactions for which a complete set of amplitudes can be extracted, model independently, like in the photoproduction of kaons by measuring the reactions $\gamma + p \rightarrow \Lambda + K^+$ and $\gamma + n \rightarrow \Lambda + K^0$ with polarized beams and targets and using the weak decay of the Λ to determine the recoil polarization of the Λ." In addition, those proposals have to be seen in the context with another recommendation of PAC25 after that mini-workshop: "A strong case has been made for a combined effort to create a kind of Excited Baryon Analysis Center which coordinates the activities and develops the tools for a fully coupled channel analysis including all final states, in all spin and isospin channels. The feeling has been that if the manpower can be provided such an ambitious program can be carried out." In the meantime the Excited Baryon Analysis Center (EBAC) exists and has started its work.

The third proposal, PR-06-102, *Search for Modification of Vector Meson Properties in nuclei,* deals with a topic that has been characterized by PAC29 as: "…a truly definitive demonstration of medium effects would be of tremendous value and quite exciting".

Recommendations (< 5 GeV Hall B)

Of the three proposals received, two experiments were approved, one of them conditionally. The ratings for these two proposals were one with A, one with A$^-$. One experiment has been deferred. The PAC approved two experiments in Hall B for a total of 133 days: PR-06-101, N* Resonances in Pseudoscalar Meson Photoproduction from Polarized Neutrons in HD and a Complete Determination of the $\gamma n \rightarrow K_0 \Lambda$ Amplitude, for 85 days; PR-06-103, Kaon Production on the Deuteron Using Polarized Photons, for 48 days.

The experiment PR-06-101, N* Resonances in Pseudoscalar Meson Photoproduction from Polarized Neutrons in HD and a Complete Determination of the $\gamma n \rightarrow K_0 \Lambda$ Amplitude, has been approved conditionally. The approval is subject to a JLab Management Review of the feasibility of installing and operating the polarized HD target. In addition, the PAC asks the PR-06-101 collaboration to demonstrate in a few cases that data from the HD target will result in a substantial improvement in what would be obtained from the results of PR-06-103 alone.

The laboratory guidelines provided for the approval of 90 days of beam time in Hall B. The PAC is allowed to exceed the laboratory guidelines if it believes the physics has sufficiently high priority, that is at a rating of A- or better, but the excess would then be deducted from the allocation of the next PAC meeting.

The proposal reports and the PAC recommendations for the reviewed proposals and the response to the letter of intent are given in Appendices D and E. The tables on the following pages summarize the status of the JLab commitments from PAC 4-PAC 30.

The PAC is very appreciative of the efforts of the Hall leaders and the Laboratory staff in support of the PAC meeting and review process. The TAC reports continue to be a very important ingredient in the process of evaluation of proposals. The comments provided by the theory group help greatly by putting the proposals in the context of ongoing theoretical work.

The enthusiastic and thoughtful contributions of Rachel Harris and Shannan Kyte were especially effective in making the PAC process proceed gracefully and with high efficiency.

Berthold Schoch
Chairman, Jefferson Program Advisory Committee

Tables

Totals for PAC 4-30

	Experiments Recommended for Approval	Experiments Recommended for Conditional Approval	Totals
Experiments	183	8	191
Authors	1193	36	1229
Institutions	209	3	212
Countries	30		30

Approved Experiments Totals by Physics Topics

Topic	**Number**	**Hall A**	**Hall B**	**Hall C**
Nucleon and Meson Form Factors & Sum Rules	31	11	6	14
Few Body Nuclear Properties	29	18	6	5
Properties of Nuclei	32	10	11	11
N* and Meson Properties	58	12	35	11
Strange Quarks	24	5	16	3
TOTAL	174	56	74	44

Approved Days and Conditionally Approved Experiments

Hall	**Approved Experiments**				Conditionally Approved Experiments
	# Expts Completed (full/partial)	Days Run	No. Exps in Queue	Days to be Run	
A	37 1	713.9	19	312	0
B	59 3	638.8	16	355	1
C	28 7	649.7	14	266.1	1
Total	124 11	2002.4	49	933.1	2

APPENDICES

A. PAC 30 Membership

B. Charge to PAC 30

C. PAC 30 Recommendations

D. PAC 30 Individual Proposal Reports

E. PAC 30 Individual Letters-of-Intent Reports

F. Approved Experiments, PAC 30, Grouped by Physics Category

(To access Appendix F, go to http://www.jlab.org/exp_prog/proposals/06prop.html.

APPENDIX A

PAC 30 Membership

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APPENDIX B

Charge to PAC 30

PAC Charge for 12 GeV Review

Jefferson Lab requests that PAC 30:

1. Review both proposals* and letters of intent† for experiments that will use the base equipment currently planned for the 12 GeV Upgrade and provide advice on their scientific merit, technical feasibility and resource requirements.

2. Identify high-quality physics that, based on what we know today, is highly likely to be of sufficient scientific merit that it will be included in the priority list to be established for the first 5 years of 12 GeV Operations

3. Identify other physics that has the potential for falling into this category pending clarification of scientific and/or technical issues

4. Provide comments on technical and scientific issues that should be addressed by the proponents prior to a second review and the assignment of scientific priority at a future PAC.

* Proposals and letters of intent will be considered ONLY if the proponents clearly state their intent to participate in and contribute to the construction of the base equipment.

† Letters of intent for 12 GeV at PAC30 will be given the same "rights" to their scientific ideas as are currently afforded to deferred experiments

Additional PAC Charge for Hall B Only

Jefferson Lab requests that PAC 30:

1. Review both new proposals* *for low (<5 GeV) running* and extensions† or updates‡ to previously-approved proposals *requiring only low (<5 GeV) beams*, and provide advice on their scientific merit, technical feasibility and resource requirements.

2. Recommend one of four actions on each proposal, extension or update:
   approval,
   conditional approval status pending clarification of special issues,
   deferral with regret,
   deferral, or
   rejection.

   (There are two types of conditional approval: conditional pending PAC review of open scientific questions; and conditional pending Jefferson Lab management review of open technical issues. In the later case, the PAC should recommend a beam time allocation.)

3. Provide a scientific rating and recommended beam-time allocation for all proposals recommended for approval.

* Note "Jeopardy" has been suspended for 6 months to accommodate the 12 GeV review focus of PAC30.
† Extension proposals are treated as new proposals, and the merits and status of the original proposal are considered only to the extent that they may bear on the relevance and merit of the extension proposal.
‡ In reviewing an experiment update, the PAC will treat the original proposal and any request for changes taken together as a single new proposal and treat the combination in a manner analogous to a previously-approved proposal undergoing a jeopardy review.

APPENDIX C

PAC 30 Recommendations

CA/A/85	PR-06-101		N* Resonances in Pseudoscalar-meson photo-production from Polarized Neutrons in HD and a complete determination of the $\gamma n \rightarrow K^0$ Lambda amplitude
D	PR-06-102		Search for Modification of Vector Meson Properties in Nuclei
A/A-/48	PR-06-103		Kaon Production on the Deuteron Using Polarized Photons
	LOI-06-101		Measurement of the Azimuthal Asymmetry in Deuteron Disintegration by Linearly Polarized Photons at $E_\gamma = 1.1 – 2.3$ GeV

12 GeV

A	PR12-06-101		Measurement of the Charged Pion Form Factor to High Q^2
A	PR12-06-102		Mapping the Spectrum of Light Quark Mesons and gluonic Excitations with Linearly Polarized Photons
D	PR12-06-103		Single Charged Pion Photoproduction from the Nucleon at 11 GeV
A	PR12-06-104		Measurement of the Ratio $R=\sigma_L/\sigma_T$ in Semi-Inclusive Deep-Inelastic Scattering
A	PR12-06-105		Inclusive Scattering from Nuclei at x>1 in the quasielastic and deeply inelastic regimes
A	PR12-06-106		Study of color Transparency in Exclusive Vector Meson Electroproduction off Nuclei
CA	PR12-06-107		The Search for Color Transparency at 12 GeV
A	PR12-06-108		Hard Exclusive Electroproduction of π^0 and η with CLAS12
A	PR12-06-109		The Longitudinal spin Structure of the Nucleon
CA	PR12-06-110		Measurement of Neutron Spin Asymmetry A_1^n in the Valence Quark Region Using an 11 GeV Beam and a Polarized ^{3}He Target in Hall C
D	PR12-06-111		Probing the Light Quark Sea Flavor Asymmetry with Semi-inclusive Charged Pion Production in Hall C
A	PR12-06-112		Probing the Proton's Quark Dynamics in Semi-Inclusive Pion Production at 12 GeV
CA	PR12-06-113		The Structure of the Free Neutron at Large $x_{Bjorken}$
A	PR12-06-114		Measurement of Electron-Helicity Dependent Cross Sections of Deeply Virtual Compton Scattering with CEBAF at 12 GeV
D	PR12-06-115		Study of the Short Range Properties of Nucleons at $Q^2 \leq 12$ GeV^2 Using d(e,e'p)n with CLAS12
D	PR12-06-116		Nucleon Resonance Studies with CLAS12 in the Transition from Soft to Partonic Physics
A	PR12-06-117		Quark Propagation and Hadron Formation
CA	PR12-06-118		Measurement of the F_{2n}/F_{2p} , d/u Ratios and A=3 EMC Effect in Deep Inelastic Scattering off the Tritium and Helium Mirror Nuclei
A	PR12-06-119		Deeply Virtual Compton Scattering with CLAS12 at 11 GeV
D	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
A	PR12-06-121		A Path to "Color Polarizabilities" in the Neutron: A Precision Measurement of the Neutron g_2 and d_2 at High Q^2 in Hall C
A	PR12-06-122		Measurement of neutron asymmetry Aln in the valence quark region using 8.8 GeV and 6.6 GeV beam energies and Bigbite spectrometer in Hall A

- A=Approve, C=Conditionally Approve, D=Defer

APPENDIX D

Proposal: PR-06-101

Scientific Rating: A

Title: N* Resonances in Psuedoscalar-meson photo-production from Polarized Neutrons in HD and a complete determination of the $\gamma n \rightarrow K^0\Lambda$ amplitude

Spokesperson: A. Sandorfi

Motivation: The proposal aims to determine a complete set of amplitudes for the $\gamma n \rightarrow K^0\Lambda$ reaction using polarized photons and a polarized HD target installed in the CLAS spectrometer system. In addition beam and target asymmetries will be measured for other reactions. The self analyzing feature of Λ decay will be exploited. Fourteen polarization observables will be determined allowing an over determination of the $\gamma n \rightarrow K^0\Lambda$ amplitudes. The scientific motivation is of the highest quality. Furthermore, this physics is central to the JLab Program.

Measurement and Feasibility: The measurement is feasible provided that the HD target can be successfully installed and operated.

Issues: The PAC urges the PR-06-101 and PR-06-103 collaborations to jointly optimize their experiments in order that the best possible determination of a complete set of amplitudes will result from the combined analysis of data from the two experiments.
The approval is subject to a JLab. Management Review of the feasibility of installing and operating the polarized target. In addition, The PAC asks the PR-06-101 collaboration to demonstrate in a few cases that data from the HD target will result in a substantial improvement in what would be obtained from the results of PR-06-103 alone.

Recommendation: Conditional approval.

Proposal: PR-06-102

Scientific Rating: N/A

Title: Search for Modification of Vector Meson Properties in Nuclei

Contact Person: D. Weygand

Motivation: Experiments of this type are aimed at a very important issue in nuclear physics. There has been a world-wide effort to determine the existence of medium modifications in nuclei and experiments of this type represent an outstanding opportunity for JLab. The idea of photoproducing the ρ is excellent since the photons should illuminate the entire nucleus more uniformly than hadron induced production. The idea to detect lepton pairs from ρ decay is also excellent for the same reason.

Measurement and Feasibility: The measurement relies on extracting the ρ resonance from relatively large background conditions. The collaboration has made an enormous effort at understanding the background in the eg7a experiment and it appears that the ρ peak can be reasonably isolated and its parameters measured for D, C and Fe nuclei. The eg7a data appear to have placed a very tight constraint on medium modifications, yielding a value for the alpha parameter in the Hatsuda-Lee formulation of 0.02 +- 0.02. This contradicts several other experiments which found large medium modification effects for the vector mesons in nuclei. The PAC does not believe that the proposed experiment will significantly improve on this already impressive work.

Issues: The case for the Nb target and the resulting factor of three improvement in sensitivity is not compelling because of the limited lever arm beyond the Fe results and the concommitent large increase in the background conditions. In addition, there remains uncertainty in the effective density assumed and the quantitative understanding of the reaction mechanism. For a topic of this importance and visibility, it is essential that the method be aggressive and definitive.

Recommendation: Defer

Proposal: PR-06-103

Scientific Rating: A^-

Title: Kaon production on the deuteron using polarized photons

Spokespersons: P. Nadel-Turonski, B.L. Berman, Y. Ilieav, A. Tkabladze, D.G. Ireland

Motivation: This experiment is an integral part of the N* program at JLab. The experiment plans to measure the photoproduction of kaons on a deuterium target using linearly and circularly polarized photons in Hall B. The measured single- and double-polarization observables will be key inputs into the EBAC and other coupled channel analyses, for instance that of Bennhold and Waluyo. The self-analyzing power of hyperons, especially the Λ, will allow the angular distribution of 7 observables to be measured up to E_γ =2.4 GeV with considerable precision, leaving just two double-polarizations undetermined. When combined with detailed amplitude analyses, it will constrain the spin structure of the couplings of established baryon resonances to KY channels, as well as having the potential to shed light on so called "missing baryons". These measurements will mark a significant step forward in the N* program.

Measurement and Feasibility: An important aspect of this experiment on the deuterium target is to understand the relationship of the results on a quasi-free proton, with those on a genuinely free proton. Once the final state interactions involved are accurately modeled, this will be applied to extracting the neutron data.

Issues: PR-06-103 and PR-06-101 should coordinate their efforts and design their programs so as maximize the physics impact from a combined analysis

Recommendation: Approval

Proposal: LOI6-06-101

Title: Measurement of the Azimuthal Asymmetry in Deuteron Disintegration by Linearly Polarized Photons at $E_\gamma = 1.1 – 2.3$ GeV

Contact person: H. Avagyan

Motivation: The aim of the letter of intent is to provide measurements of the angular distribution for Σ asymmetry for exclusive two-body photodisintegration of the deuteron at 6 energies between 1.1 and 2.3 GeV. This is a very interesting energy region for this reaction since there has been some evidence for a scaling effect. Numerous models have been created to explain the physics of this reaction and polarization measurements of this type can discriminate among these models.

Measurement and Feasibility: The experiment appears to be feasible and can run concurrently with experiment PR-06-103.

Issues: There are no technical issues identified.

Recommendation: A measurement of this type is encouraged.

Proposal: PR12-06-101

Title: Measurement of the Charged Pion Form Factor to High Q^2

Spokespersons: D. Gaskell, G. M. Huber

Motivation: This proposal plans to extract the on-shell pion form factor at much higher Q^2 values (from 2.5 to 6 GeV^2) with the 11 GeV beam. This is done by measuring the longitudinal part of the single pion electroproduction cross section. The Regge model of Vanderhaeghen, Guichon and Laget (VGL), which has proven to be able to describe existing data on the longitudinal cross section, would be used to constrain the extrapolation in the invariant momentum transfer *t*. 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. It is worth to note that perturbative QCD makes an exact prediction for the absolute value of the form factor at $Q^2 \rightarrow \infty$, thereby providing a benchmark for all models used to calculate the structure of hadrons. This asymptotic regime is presumably out of reach even for an upgraded JLab, however, a variety of models ranging from the Relativistic Constituent Quark Model to Hard QCD calculations make predictions about the behavior of the form factor, differing in both absolute value and shape, at the scale of a few GeV^2 corresponding to existing as well as future 11 GeV JLab data, thereby justifying the need for further measurements at higher momentum transfer.

Measurement and Feasibility: The experiment is proposed in Hall C and would use its base equipments specifically developed for the 11 GeV beam, specifically detecting the electron in the existing HMS and the pion in the foreseen SHMS. It is worth noticing that this experiment is the one actually driving some of the basic requirements for the new SHMS spectrometer. The extraction of the form factor is based on the measurement of the single π^+ electroproduction cross section, whose longitudinal part can be separated by the tradional Rosenbluth method as well as by measuring the azimuthal pion distribution at several beam energies and electron scattering angles. The obtained longitudinal cross section as a function of *t* has to be extrapolated to the pion pole and this is done by assuming the analytic shape provided by the VGL model. This model was already shown to reproduce existing data on the longitudinal pion electroproduction. While this is clearly a model-dependent extrapolation, the experimental strategy outlined by the proponents would include repeating measurements at similar Q^2 but with different range in *t*, as well as measuring the form factor at $Q^2 = 0.3$ GeV^2 where a model-independent measurement based on pion scattering on atomic electrons exists. This cross checks would provide a more realistic estimate of systematic errors and indicate how much the method really works. Furthermore, it is proposed to measure the π^- cross section, thereby allowing a check of isoscalar backgrounds in the *t* channel. In any case, the measured cross section data will be published allowing future alternative approaches for the extrapolation of the data to the pole.

Issues: Since the measurement requires a large number of measurements at different energy and spectrometer settings, a careful optimization of the schedule is strongly recommended. The use of a longer target envisaged in the proposal requires a proper understanding of the corresponding variation in the acceptance. This does not look an issue since the simulated variation is smooth. On the other hand a longer target, but not beyond 10 cm, may allow a reduction in the beam current that could be a benefit for operation in other halls. Given the delicate nature of acceptance issues in Rosenbluth separations that require adequate understanding of the spectrometer performance, it is clear and acknowledged by the proponents that the experiment could only run after an adequate commissioning of the new SHMS.

Recommendation: Approval

Proposal: PR12-06-102

Title: Mapping the Spectrum of Light Quark Mesons and Gluonic Excitations with Linearly Polarized Photons

Spokespersons: A. Dzierba, C. Meyer, E. Smith

Motivation: The spectrum of hadrons directly reflects the nature of their constituents and the forces that bind them together. The spectrum of light hadrons, i.e. those built of *u* and *d* quarks and gluons, is a particularly direct consequence of color confinement and provides a unique window on the strong coupling regime of QCD. A key prediction of the theory is that there should exist color singlet states, in which glue contributes in an essential way to their J^{PC} quantum numbers, leading to states beyond the simple quark model. The GlueX experiment is aimed at the unambiguous search for such states. It is a cornerstone of the 12 GeV program.
This ambitious project requires the development and construction of a hermetic detector of high efficiency, with excellent particle identification, good energy and momentum resolution, capable of high data-taking rates. The GlueX detector will allow a mapping of the hadron spectrum up to 2.8 GeV in mass by studying multiparticle final states involving both charged and neutral mesons to which they decay all within a single experiment. The specific goal is the exploration of channels with quantum numbers not accessible to purely quark-antiquark mesons.
The collaboration has the leadership and motivation to take this highly significant program of detector and amplitude analysis development and construction forward to a successful conclusion. Even if exotic states are not there to be found, GlueX will detail the whole light meson spectrum with conventional quantum numbers with great precision.

Measurement and Feasibility: Considerable R & D is under way for all aspects of the complete GlueX detector. Timelines were presented into 2007, but in fact a full Gant chart with critical milestones exists to ensure this detector will be complete and available for running on Day 1 of the upgrade.
Developing and building the detector over the next decade and having run the experiment for several years is not the end of the story. The analysis of the complex data to separate amplitudes with well-defined quantum numbers in each final state will require several years of dedicated effort. This will have to be preceded by a significant program of R & D on amplitude analyses routines. Considerable expertise already exists within the collaboration, particularly at IU, CMU, but also as FSU and elsewhere, to ensure the appropriate tools to allow as model independent separation as possible of amplitudes with definite quantum numbers. Hints of exotic states with $J^{PC} = 1^{-+}$ indicate that these may contribute at most a few percent in pion production. While their photoproduction couplings may be larger, the analysis must be of sufficient precision to be able to extract signals unambiguously at the few percent level from cross-sections involving 50-100 partial waves.
Importantly, this experiment motivates a parallel effort to map out the same hadron spectrum in strong coupling QCD using lattice techniques. The next decade will be needed to bring the finite volume effects under control, to allow the lattice spacing to approach the continuum and to simulate quarks that are realistically light to model the behavior of the known up and down quarks. This will require a dedicated effort comparable to that required for the development and testing of the amplitude analyses routines. The outcome should be not just masses, but importantly decay rates for the states to be observed and measured in GlueX.

Issues: Critical milestones for the detector development and construction must be kept under constant review.

Recommendation: Approval

Proposal: PR12-06-103

Title: Single Charged Pion Photoproduction from the Nucleon at 11 GeV

Spokespersons: D. Dutta, H. Gao, R. Holt

Motivation: This experiment aims to measure $d\sigma/dt$ for the exclusive reactions $\gamma n \to \pi^- p$ and $\gamma p \to \pi^+ n$ at high t and high s. Existing data from E94-104 and earlier data from Anderson *et al.* in 1997 show that $d\sigma/dt$ displays a clear scaling behavior: at sufficiently high s and t, the quantity becomes smoothly dependent on s (at fixed θ_{CM}), with an s^{-7} power-law behavior. This behavior is apparently consistent with the expectations of the Constituent Counting Rules. However, many other models (such as the Generalized Counting Rules and the handbag-diagram/GPD picture) have addressed such scaling behavior, in this and other exclusive processes at hard scales. The proposed experiment's motivation is twofold: (1) to extend pion photoproduction data to larger s and a broader range of θ_{CM} (and so of t) in order to determine more completely the kinematic thresholds at which scaling sets in, and (2) to use the ratio of the π^+ and π^- photoproduction cross-sections to determine if the handbag-diagram is the dominant production mechanism at these kinematics, in which case these data can provide constraints on the GPDs. Finally, the proposal indicates that this experiment will be an exploratory precursor to further more detailed measurements, which would look for the oscillatory behavior seen in other hard-exclusive cross-sections around their overall power-law scaling, and also explore the influence of crossing the charm-production threshold at $\sqrt{s} \approx 4$ GeV.

Measurement and Feasibility: The experiment requests 10 days of running in Hall C using only the standard 12 GeV equipment. The three points raised by the technical review of the experiment were convincingly addressed by the proposal's authors.

Issues: The only issues raised by the PAC concern the ability of the proposed experiment to address its two physics motivations.
(1) *Expanded exploration of the kinematic region in which pion photoproduction exhibits a power-law scaling with s*: A large amount of data currently exists on a wide variety of exclusive processes at hard scales, and no model is currently able to explain the behavior of all observables currently measured. In particular, power-law scaling is observed in the unpolarized cross-sections of many such reactions, while polarization observables at the same kinematics do not display the anticipated behavior. Examples include $d(\gamma,\pi)$, $d(\gamma,\rho)$, $p(\gamma,\pi^+\pi^-)$, $p(\gamma,\rho_0)$ and $p(\gamma,\pi\gamma)$ where the measured spin-transfers do not display scaling behavior in the same kinematic region. Given this volume of exclusive data which no model can yet explain, it is unclear how the additional data points proposed here will assist in illuminating the situation.

(2) *Constraining the GPDs*: If one could demonstrate that exclusive pion photoproduction at the proposed kinematics is dominated by the handbag diagram, then valuable new information on the GPDs of the nucleon could be obtained. However, the PAC does not find the proposed test of the scaling of the π^+ / π^- cross-section ratio to be sufficient, as the theory on which this scaling prediction is based involves the seemingly arbitrary selection of a subset of the available diagrams. The handbag/GPD formalism should be shown to reproduce, to some reasonable degree of accuracy, the cross-sections already measured.

Recommendation: Defer

Proposal: PR12-06-104

Title: Measurement of the Ratio $R=\sigma_L/\sigma_T$ in Semi-Inclusive Deep Inelastic Scattering.

Spokespersons: R. Ent and H. Mkrtchyan

Motivation: It is proposed to measure the ratio $R=\sigma_L/\sigma_T$ in semi-inclusive deep inelastic scattering (SIDIS) and deep exclusive scattering (DES) at large Q^2 as a testing ground for the reaction mechanism. The dominance of quark fragmentation is tested by verifying that R_{SIDIS} is equal to the well measured deep inelastic scattering (DIS) ratio.
Another important goal for this measurement is to test the transition from SIDIS to DES ($z = 1$), investigating the rather different Q^2 dependence of this ratio in the case of SIDIS where $R_{SIDIS}\sim 1/Q^2$ compared to DES where $R_{DES}\sim Q^2$ at large Q^2. This measurement will also provide necessary data for experiments planning a precision determination of the helicity-dependent quark momentum distribution functions with flavor decomposition at large x through measurements of double spin asymmetries, not cross sections.

Measurement and Feasibility: This experiment would be performed in Hall C using the HMS spectrometer to detect scattered electrons in combination with the SHMS where the produced pions are detected in coincidence. Both hydrogen and deuterium targets will be used and both charged pions will be detected. The inclusive *(e ,e')* and semi-inclusive *(e ,e'h)* are measured simultaneously in a broad range of kinematical settings of z, Q^2 and p_T^2 covering a region well matched to the general SIDIS physics.

Issues: Since the azimuthal (Φ_{pq}) coverage defined by the HMS-SHMS combination is limited for the SIDIS kinematics regime it is important to evaluate the impact of the finite angle integration of cos Φ_{pq} and cos 2 Φ_{pq} terms on the resulting uncertainties of the Rosenbluth separation. Measurements planned in Hall B should help determine and correct for these effects if they are not too large, but models are presently available for a first evaluation.
In the exclusive limit (z =1) the exclusive ρ^0 production contamination is an important channel that deserves alternative studies besides the MC approach.

Recommendation: Approval

Proposal: PR12-06-105

Title: Inclusive Scattering from Nuclei at x > 1 in the quasielastic and deeply inelastic regimes

Spokespersons: J. Arrington, D. B. Day

Motivation: Inclusive scattering from nuclei at x > 1 is sensitive to the distribution of high momentum nucleons, and high momentum quarks at large Q^2 values. With the 11 GeV beam, data taken at low Q^2 values in the quasielastic region at very large x values, up to and exceeding x = 3, would extend previous studies of Short Range Correlations (SRC) in few-body and heavy nuclei. Experimental knowledge of NN interactions in the nuclear medium is important in connection with recent theoretical developments in the area of few-body nuclear forces using modern effective field theory techniques. This is a sound conventional nuclear physics measurement that would improve and extend our knowledge of SRC. On the other side, data taken at high Q^2 values would make it possible to access the Deep Inelastic Scattering (DIS) region and provide clean measurements of the quark distributions in light and heavy nuclei for x > 1. The distribution of these superfast quarks (quarks carrying a momentum greater than that of a nucleon) is connected to the short distance structure of nuclei, and this is a promising region to examine for the importance of the underlying quark degrees of freedom in nuclear structure. Any deviation from the model that convolutes nucleon parton distribution functions with the motion of nucleons inside the nucleus would represent a very peculiar nuclear effect and therefore would be of extreme interest, comparable to the discovery of the EMC effect. The PAC instead does not see as compelling the part related to the evaluations of moments of the nuclear structure function, as much has been done already on the deuteron and it is not clear how much will be done with existing data on nuclei. However, even neglecting this part, the remaining motivations are interesting enough in their own right.

Measurement and Feasibility: The measurement would require simultaneous data taking with the HMS and SHMS spectrometers at 11 GeV, to cover the x > 1 region at low momentum transfer and the 1 < x < 2 region at high momentum transfer at the same time. Measurements on several nuclei would be performed, to be able to study the dependence of SRC and superfast quarks on A.

Issues: It was shown by the proponents that several technical aspects like pion background, Coulomb distortion etc. can be dealt with likely at all proposed kinematics and nuclei. It is recommended however that the experimental setup and run plan be well studied, with particular regard to the choice of target thicknesses versus the specific beamline design, to keep radiation budget and run time at the minimum, an aspect the authors have already considered but which may deserve further attention. Since the experiments deals with absolute cross sections at extremely low counting rates, a good understanding of the SHMS spectrometer acceptance and performance will be needed in particular for the low Q^2 part related to short range correlations, where data will have to be precise enough to allow a good discrimination of models.

Recommendation: Approval

Proposal: PR12-06-106

Title: Study of color Transparency in Exclusive Vector Meson Electroproduction off Nuclei

Spokespersons: K. Hafidi, B. Mustapha, L. El Fassi, M. Holtrop

Motivation: As a consequence of QCD degrees of freedom namely quarks and gluons, color transparency (CT) was proposed by Brodsky and Mueller in the early 80's in analogy to observations made about the weakness of the electromagnetic interaction (ionization) of Dalitz pairs created in decays of π^0 in emulsion chambers near the decay point, thus when the pair size is small. In QCD CT would manifest itself by a reduced attenuation of hadron transmission in nuclear matter when it is in a point like configuration (PLC). CT remains a QCD prediction worth confirming since present experimental evidence remains limited and elusive. Vector mesons likeρ^0 provides for a clean case to control the initial state, namely the photon fluctuation into a $q\bar{q}$ PLC configuration. In this experiment the coherence length related to the production time will be fixed shifting the focus of this investigation solely on the CT phenomenon in comparison with the usual hadron interactions.,

Measurement and Feasibility: In this experiment the electroproduction of vector meson (e,e'ρ^0) is measured using CLAS 12 on three targets, carbon, iron and tin. The ρ^0 is identified through its $\pi^+\pi^-$ decay. Recent results from CLAS eg2 experiments show that the method is sound and that the invariant mass of $\pi^+\pi^-$ when produced in a medium weight nucleus is roughly similar in shape and position compared to that produced on a free nucleon. With the 12 GeV upgrade the kinematical conditions are set to avoid the resonance region, select the diffractive process, select exclusive channels and fix the coherence length at a larger value then previously possible while covering a wide range of Q^2 from 1 to 5.5 GeV ^{2}.

Issues: There is significant current activity at HERMES in DESY in regard to this reaction which needs to be followed closely in order to insure complementarities and address any new issues that may arise from the results. The PAC requests that the collaborations of PR12-06-106 and PR12-06-117 work towards developing a run plan where targets and other aspects of their experiments are coordinated to maximize their concurrent running.

Recommendation: Approval

Proposal: PR12-06-107

Title: The Search for Color Transparency at 12 GeV

Spokespersons: D. Dutta, R. Ent

Motivation: Color transparency (CT) was first proposed by Mueller and Brodsky in the early 1980's. Its observation would give direct evidence for hadrons fluctuating to a smaller size and thus having reduced color-related interactions while passing through the nuclear medium. CT is a direct consequence of QCD in that one would not expect it to occur in the absence of quark and gluon degrees of freedom. Despite long standing interest in this phenomenon, and a number of previous experiments, there remains controversy as to whether CT has been unambiguously observed. The proposed experiment would shed light on recent results from hard proton scattering at Brookhaven and pion-nuclear scattering at Fermilab, both of which were suggestive of CT. There are also suggestive results from Hall B on the reaction ^{4}He(γ,π^-p), as well as preliminary results from E01-107 on the reaction A(e,e'π^+), which can be seen as the 6 GeV version of the current proposal.

Measurement and Feasibility: Measurements of color transparency (CT) are proposed in the reactions A(e,e'p) (proton knockout) and A(e,e'π^+) (pion electroproduction). For proton knockout, hydrogen and carbon targets are proposed. For pion electroproduction, hydrogen, deuterium, carbon and copper are all proposed. The experiment would be performed in Hall C using the HMS and new SHMS spectrometers with a non-standard aerogel counter in the detection package. The beam intensity would be 80 μA, and the targets would include 15 cm long LH_2 and LD_2 targets, as well as 6% radiation length ^{12}C and ^{63}Cu solid targets. Only two targets (H and C) are proposed for the search of CT on the proton.

Issues: As mentioned by the theory group, there is considerable theoretical uncertainty regarding expectations for the proposed reactions, causing some concern over the interpretability of the results. Also, on the experimental side, it is certainly not obvious that a definitive result will be obtained. If the existing data from E01-107 are taken as an indication of the expected results from the proposed experiment, it may well turn out that even with the new data the evidence for CT will be ambiguous. The PAC would like to see the authors of the proposal develop a plan that would increase the likelihood of a result with greater statistical significance. For example, considering the undeveloped state of the theoretical understanding of CT, is it really necessary to have so many different target nuclei? Perhaps the beam time would be better spent focusing on fewer targets with better statistics. The TAC also raised a number of issues, but we will not reproduce them here.

Recommendation: Conditional approval

Proposal: PR12-06-108

Title: Hard Exclusive Electroproduction of π^0 and η with CLAS12

Contact person: P. Stoler

Motivation: The aim of the experiment is to provide π^0 and η electroproduction cross section data from the proton over a broad range of Q^2, W and t. Further the aim is to provide separated – L, T, LT, TT -cross section data over much of the kinematic range. At low t, the data are intended to have an important impact on the GPD program at JLab and provide a means to constrain the axial GPD of the proton. The utility of the data for the GPD program must be demonstrated by providing a test of factorization for neutral pion and η electroproduction on the longitudinal cross section. In particular, there will be a study of the scaling of cross sections, t slopes and longitudinal structure function dominance as a means to investigate the reaction mechanism. Both pseudoscalar meson channels are interesting because they provide information on the flavor components of the axial GPD. For example, the π^0 is expected to be sensitive the $2\Delta u-\Delta d$ spin structure while the η is sensitive to the $2\Delta u+\Delta d+2\Delta s$ spin structure. At high t, the goal of the experiment is to provide a test of one-gluon exchange models for electroproduction.

Measurement and Feasibility: The major technical challenge is making a high accuracy separation of the longitudinal and transverse cross sections. An assumed aggressive 3% point-to-point error will yield relative errors of approximately 10% on the separated cross sections. The 11 GeV part of this experiment will run concurrently with the DVCS experiment where a more conservative cross section error of approximately 10% was presented. A 10% point-to-point error is likely not sufficient to significantly constrain the separated cross sections.

Issues: It is essential for this experiment to minimize this error for cross section measurements for CLAS12.

Recommendation: Approval

Proposal: PR12-06-109

Title: The Longitudinal Spin Structure of the Nucleon

Spokespersons: D. Crabb, A. Deur, V. Dharmawardane, T. Forest, K. Griffioen, M. Holtrop, S. Kuhn, Y. Prok

Motivation: The collaboration proposes to determine the g_1 spin structure functions of the proton and deuteron at medium to high x: At present there are large uncertainties at high x, where the valence structure is dominant. In addition, it is proposed to use semi-inclusive scattering to perform a flavor decomposition of the polarized parton distributions. It is proposed to use the precise high x determination of g_1 to test the quark model predictions at x=1 and to constrain ΔG using NLO-based global parton analyses. Measurements from the resonance region will be used to determine the first moments of g_1 at low Q^2.

Measurement and Feasibility: The experiment is planned in the CLAS12 spectrometer using longitudinally polarized NH_3 and ND_3 targets. The technical demands of the experiment are not exceptional and should be feasible. There is some concern that the semi-inclusive analysis may be significantly more difficult due to possible z and hadron type dependent nuclear effects that will need to be determined for a precise extraction of the nucleon semi-inclusive asymmetries.

Issues: The PAC is concerned that the impact of the measurement on ΔG did not take into account the measurements of inclusive and semi-inclusive asymmetries (along with ΔG) underway at the COMPASS experiment, as well as the ongoing ΔG measurements at RHIC or the future light sea polarization measurements using W boson production. However, none of these experiments is sensitive to the high-x region of the quark distributions, where this experiment will provide important new information. It would be useful to know the impact of having good kaon identification on the physics reach of the semi-inclusive program.

Recommendation: Approval

Proposal: PR12-06-110

Title: Measurement of Neutron Spin Asymmetry A_1^n in the Valence Quark Region Using an 11 GeV Beam and a Polarized ^{3}He Target in Hall C

Spokespersons: J.-P. Chen, X. Zheng, Z. E. Meziani, G. D. Cates

Motivation: This experiment intends to measure the inclusive spin asymmetry $A_1^n(x,Q^2)$ on the neutron in the DIS region of $0.3 < x < 0.77$, so in particular fairly large x, extending previous JLab measurements with comparable precision. This x region would be uniquely covered at the Jefferson Laboratory, thanks to the increase in energy and the high luminosity. The asymmetry $A_1^n(x,Q^2)$ is related to the nucleon spin structure and tests the constituent quark models in the DIS regime, as well as the Helicity conservation in pQCD predictions (in particular the tantalizing role of Orbital Angular Momentum between quarks). 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. 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.

Measurement and Feasibility: The measurement would be performed in Hall C by simultaneously measuring scattered electrons in the HMS and SHMS spectrometer, to allow for systematic checks. The target would be an adapted version of the existing polarized ^{3}He target for Hall A. The choice of the kinematics of this measurement should allow exploring a possible Q^2dependence of A_1^n, especially when combined with the results of the proposal PR12-06-122 in Hall A (in average: 2 (common), 5 (Hall A) and 8 (Hall C) GeV^2). The two experiments would provide the same observable via a similar measurement.

Issues: It appears that in principle the kinematics covered by this experiment may be accessible in Hall A with the existing HRS + BigBite setup, with the addition of the new Cherenkov counter in the BigBite detector package. How far in x and Q^2 the experiment in Hall A could go depends on how good the pion rejection will be in the upgraded BigBite, which at the moment is unknown. On the other hand, it is obvious that once the 11 GeV beam will be available Hall A would be ready to take data. Therefore, the PAC sees that the performance of the upgraded BigBite package should be assessed first in the upcoming Hall A experiments and by an exploratory run at 11 GeV in Hall A. Should the performance of the Hall A apparatus turn out not to be sufficient for extending the measurement to higher x and Q^2, then the Hall C measurement will remain as the only viable option to extend the kinematic range. In this spirit the condition for approval of this experiment has to be understood, that it be clearly shown to be the only option to get the data at the highest x and Q^2.

Recommendation: Conditional approval

Proposal: PR12-06-111

Title: Probing the Light Quark Sea Flavor Asymmetry with Semi-inclusive Charged Pion Production in Hall C

Spokespersons: H. Gao, A. Bruell, H. Mkrtchyan

Motivation: The goal of this experiment is to measure the flavor asymmetry $\bar{d}(x)/\bar{u}(x)$ of the proton's light-quark sea using semi-inclusive deep-inelastic scattering (SIDIS) of charged pions from hydrogen and deuterium targets. In a 1998 publication, the FNAL-E866 Drell-Yan experiment conclusively demonstrated that, at moderate *x*, there is a pronounced (> 50%) excess of $\bar{d}$ quarks compared to $\bar{u}$ quarks in the proton sea, a finding which is perhaps the most dramatic evidence to date that a picture of a perturbatively-generated sea (via flavor-blind $g \to q\bar{q}$ gluon splitting) is grossly misleading even at a qualitative level. The proposed $\bar{d}(x)/\bar{u}(x)$ measurement will cover the kinematic range $0.1 < x < 0.5$, and is particularly focused on the region $x > 0.3$ where no data yet exist on this important quantity. An ancillary measurement of the valence-quark ratio $d_v(x)/u_v(x)$ will also be performed. A secondary portion of the proposal involves the (simultaneous) measurement of kaon production, and offers the possibility to measure the fragmentation functions for kaons from different struck-quark flavors, as well as a second route to $d_v(x)/u_v(x)$.

Measurement and Feasibility: The experiment requests 52 days of running in Hall C, and will use the new SHMS spectrometer for electron detection in coincidence with semi-inclusively produced hadrons detected in the HMS spectrometer. Though the proposal describes an impressive array of systematic studies, the technical (TAC) review of this experiment enumerated 6 experimental issues which should be addressed to support the "aggressive" systematic errors quoted, particularly as the projected $\bar{d}(x)/\bar{u}(x)$ measurement is systematics-limited. However, at present, more pressing systematic issues exist, as described below.

Issues: (1) Both techniques (termed "Method 1" and "Method 2") for the sea-flavor asymmetry measurement rely critically on the assumptions detailed in Equations 17 and 18 of the proposal: that all four "favored" pion fragmentation functions are equal, and the same for the four "disfavored" functions. These symmetries are true in the limit of perfectly-factorized fragmentation in the current-quark regime: i.e., when the fragmentation process depends only on the nature of the struck quark, and has no "memory" of the target remnant. However, though the Lund Monte Carlo has been shown (by CLAS) to reproduce well the pion multiplicities in the $W < 3.2$ GeV (e.g. Fig. 6 of the proposal, though a different Monte Carlo was used for that comparison), the same Lund Monte Carlo suggests that considerable breaking of these symmetries exists at the $W > 3.2$ GeV kinematics of the HERMES experiment, and becomes worse at lower *W*. Unlike the measurements proposed here, the pion multiplicities are strongly dominated by *u*-quark fragmentation, and so are quite insensitive to the symmetries of Eqs. 17 and 18. HERMES is presently engaged in the analysis of $\bar{d}(x)/\bar{u}(x)$ and $d_v(x)/u_v(x)$ using precisely the techniques proposed here and the high-statistics dataset collected over 10 years of running. Even with $W > 3.2$ GeV, the analysis is confronting systematic effects in the data that appear to reflect the symmetry-breakings suggested by the Lund Monte Carlo. Until the HERMES analysis, at higher *W*, reaches a conclusion in the next 2 – 3 years (i.e. quantifying the influence of these symmetry-breakings in various kinematic regions), it is simply unclear whether or not this SIDIS technique will work at anywhere near the projected accuracy of the proposed measurement at modest values of *W*. It is simply premature to endorse the proposed experiment before these findings are released. Further, experiment E-04-114, conditionally-approved for Hall A,

will perform the same experiment proposed here at more restricted but similar kinematics, notably 2.5 < W < 3.1 GeV. Those data offer another opportunity to explore the feasibility of this technique. Finally, the proponents are encouraged to explore the possibility of using this technique at CLAS12, where the open geometry removes the W < 3.2 GeV restriction.

(2) Fig. 28 of the proposal compares the projected accuracy of the proposed $\bar{d}(x)/\bar{u}(x)$ measurement to that of Drell-Yan experiment E906, which is expected to run in 2009 at Fermilab. As E906 will provide greater accuracy and kinematic coverage, the proposal states that its primary purpose is to *cross-check* the anticipated Drell-Yan result, via a different technique with entirely different systematic issues and at much lower Q^2. However, when HERMES ceases data-taking in mid-2007, it will have collected more than 25 times the statistics of the 1996 data used in its published $\bar{d}(x)/\bar{u}(x)$ measurement (shown in Fig. 27). Though the final HERMES results will be at lower x than those proposed here, comparing them with the E866 measurement may provide a sufficient cross-check between the SIDIS and Drell-Yan techniques (and information on the scale-dependence). It is advisable to wait for the next HERMES release of $\bar{d}(x)/\bar{u}(x)$ to see whether further precision from the SIDIS technique is needed.

(3) Section 2.7 suggests that measurements of kaon SIDIS can provide information on the flavor-dependence of the kaon fragmentation functions, and even on the quark substructure of the kaon itself. However, these assertions are based on the symmetries presented in Equations 31–33 between the various kaon fragmentation functions, and these postulated symmetry-relations are impossible. The simplest illustration is equating the fragmentation function for $u \to K^+$ to that for $\bar{s} \to K^+$. This relation requires that the probabilities for the "pickup" of an $\bar{s}$ or u quark from string-breaking is the same. Even at LEP energies, a strangeness-suppression factor of order 1/3 damps the creation of $s\bar{s}$ pairs as compared with $u\bar{u}$ or $d\bar{d}$ (e.g. the default value of the strangeness-suppression parameter PARJ(2) in PYTHIA is 0.3).

Recommendation: Defer

Proposal: PR12-06-112

Title: Probing the Proton's Quark Dynamics in Semi-Inclusive Pion Production at 11 GeV

Spokespersons: H. Avakian, K. Joo, Z. E. Meziani, B. Seitz

Motivation: It is proposed to make an extensive study of the novel transverse momentum proton structure functions and fragmentation functions. These functions arise from parton transverse momentum and its coupling to spin within the nucleon. Due to immense theoretical progress in recent years in this area as well as that of generalized parton distributions, the true three-dimensional nature of the proton is beginning to be explored. In particular, one is starting to understand transverse parton motion not as a random uniform distribution, but rather as naturally correlated with the nucleon spin arising from orbital motion. In this proposal, the primary focus is on the cos φ and cos 2φ moments of the semi-inclusive azimuthal asymmetries as a function of the transverse momentum of the detected hadron. Assuming factorization, the moments can be related to the Cahn-effect (a measure of the "uncorrelated" transverse parton momentum in the nucleon) and the Boer-Mulders function (arising from the correlation of transverse momentum and transverse spin), respectively. The latter would be the natural result of a spin-orbit correlation of the partons. Since the cos φ moment only arises from the Cahn effect (which has been previously studied), it can be used as an important check of the assumptions within the physics extraction (e.g. factorization). In addition, the use of a polarized electron beam allows the extraction of the sin φ moment of the beam-spin asymmetry, allowing further cross checks and sensitivity to the Boer-Mulders distributions.
The measurement and understanding of these novel functions (including transversity and the Sivers function) are of world-wide interest, with experimental programs at BELLE, HERMES, RHIC, CERN, and GSI, for example. In the area of semi-inclusive deep inelastic scattering, the CLAS12 program will be completely dominant for the foreseeable future.

Measurement and Feasibility: The proposed techniques to extract the azimuthal moments appear feasible given the foreseen acceptance and performance of the CLAS12 spectrometer. The proposal presented statistics using data with W^2 down to 4 GeV^2, which may introduce problems of interpretation in the framework of DIS and pQCD, for example, concern of ``contamination'' by target fragmentation and failure of factorization. It was demonstrated that one can raise the W^2 constraint to 10 GeV^2 with a loss of only 50% of the statistics, i.e., the experiment is still quite viable.

Issues: Measuring the kaon asymmetries is likely to be as important as pions; new preliminary results from the HERMES experiment suggest that the kaon Sivers moments provide strong access to the orbital angular momentum of the sea quarks. The present capabilities of the present CLAS12 design are weak in this respect and should be strengthened.

Recommendation: Approval

Proposal: PR12-06-113

Title: The Structure of the Free Neutron at Large $x_{Bjorken}$

Spokespersons: S. Bueltmann, S. Kuhn, H. Fenker, W. Melnitchouk, M.E. Christy, C.E. Keppel, V. Tvaskis, K. Griffioen

Motivation: The ratio of proton to neutron spin-independent nucleon structure functions F_{2n}/F_{2p} in deep-inelastic scattering is poorly known at large x due to the remaining large nuclear theoretical uncertainty in the determination of the free neutron structure function. To clarify once and for all the behavior of this important ratio as x tends to unity, it is proposed to minimize the effect of the nuclear corrections by insuring that the deep inelastic scattering (DIS) occurs on an almost on-shell neutron. This is achieved by tagging the slow recoiling proton (of about 70 MeV/c) momentum in the backward hemisphere of CLAS12 from the electro-disintegration of the deuteron. The d/u parton distributions ratio will then be determined at large x within the quark parton model with a precision capable of discriminating between constituent quarks models and pQCD predictions using current quarks.

Measurement and Feasibility: It is proposed to measure the ^{2}H(e,ep)X reaction in the DIS region for $Q^2 > 1$ (GeV/c)^2 using the CLAS 12 detector in combination with an RTPC to detect recoiling protons with slow momenta $p_s < 200$ MeV/c and large recoil angles $\theta_{pq} < 110^0$. This measurement is a natural extension of the BONUS experiment (E03-02) which ran successfully in the fall of 2005 demonstrating the feasibility of this elegant experimental technique. The proposed measurement will reach a value of $x = 0.75$ with a stringent $W = 2$ GeV cut, but would have data to extend this study to values of x in the resonance region.

Issues: While the PAC is encouraged to note the successful running of the BONUS experiment, it would benefit by knowing the results which are not yet available. The PAC is optimistic that the BONUS technique will provide a good understanding of the nuclear effects, but would like to see it established once the first BONUS experiment analysis is complete and experience with at least one other experiment has been gained . The upgrade of the RTPC and associated electronics, as well as the increase of the present RTPC length and diameter, are crucial to achieving the statistical uncertainty and to reaching the physics goals at the largest possible x.

Recommendation: Conditional approval

Proposal: PR12 – 06 - 114

Title: Measurements of the Electron–Helicity Dependent Cross Sections of Deeply Virtual Compton Scattering with CEBAF at 11 GeV.

Spokespersons: Charles E. Hyde – Wright, Bernard Michel, Carlos Munoz Camacho, J. Roche

Motivation: Generalized parton distributions (GPDs) are physical observables which can provide deep insight into the internal structure of the nucleon. They contain the usual parton distributions and elastic form factors as their special limits. In addition, the GPDs allow to probe the quark angular momentum and picture the quark motion in the quantum phase space. Deep Virtual Compton scattering is a very clean way to access the GPDs. Previous experiments have established the reliability of the GPD measurements at the JLAB kinematics. The proposal asks for extension of the current Hall A DVCS experiment E00-110 into higher energy, thus considerably expanding its kinematical coverage and using its successful technique. The strong point of the proposed experiment is that, as E00-110, it would measure the absolute (helicity dependent and helicity independent) cross sections which will permit to extract DVCS observables inaccessible in e.g. measurements of the cross section asymmetries.

Measurement and Feasibility: The experiment requests 100 days of running in Hall A (88 days of production running and 12 interlaced days for optical curing of the calorimeter; no parasitic use of the beam would be possible during the latter days). Only standard Hall A equipment is requested: 15 cm LH2 target, HRS-L, (expanded) PbF2 calorimeter with necessary upgrades. No technical comments were filed.

Issues: GPD measurements are fundamental for a complete description of nucleons in terms of partons and for our understanding of the QCD. This proposal, together with PR12–06–119 and LOI12–06-108 and LOI12–06-109 define the full programme of the DVCS/GPD measurements at JLAB at 11 GeV. In view of the limited statistics of the future HERMES and COMPASS DVCS data at high x, the planned measurements will be the only ones – and very accurate - in that kinematic region.

Recommendation: Approval

Proposal: PR12-06-115

Title: Study of the short range properties of nucleons at $Q^2 \leq 12$ GeV^2 using d(e,e'p)n reaction with CLAS 12 GeV.

Spokespersons: K. Egiyan, N. Grigoryan, L. Weinstein

Motivation: The physics case of the proposal is the search for possible modification of properties of deeply bound nucleons, and the search for Point Like Configuration of the nucleon. These features have been investigated in previous experiments at Jefferson Laboratory and the results have been inconclusive. The measurement will be performed with exclusive d(e,e'p)n data. The expectation is that with larger beam energy, these effects might be then observed due to an increase of Q^2 (from typically 5 to 10 GeV^2). These new data could help in testing our knowledge of nuclear models and nucleon modification with an extended kinematical range covered with good precision.

Measurement and Feasibility: This is a natural extension of a CLAS e6 run with beam energies allowing access of higher Q^2 (6 to 12 GeV^2) to be performed with an upgraded CLAS 12 GeV detector in Hall B. Both the electron and proton from the reaction are measured with the d(e,e'p)n reaction (exclusivity is obtained from missing mass technique, and the neutron momentum from kinematical selections). The experiment is to be run at nominal luminosity and with rather standard requirements for this new device, as acknowledged by the Technical Advisory Committee. The analysis and extraction of observables, as well as their interpretation, will follow the procedure used in the previously performed experiment with CLAS at 6 GeV.
The (e, e'p) reaction is used on a deuterium target and for different kinematics conditions, aimed at enhancing these possible effects. The PLC is investigated by means of a decrease of Final State Interactions. The choice of deuterium is motivated in part by the fact that the wave function is well known for this nucleus. Looking at the ratio of cross sections at different kinematics, and comparing it with the same ratios obtained by state-of-the-art nuclear models, the nucleon modification is to be assessed.

Issues: The Theory Advisory Committee pointed out several concerns with this proposal. For the PLC, it questioned the stated relation between Q^2 and the size of the configuration of the proton, and concerning the nucleon modification noted the strong dependence of the extracted value with the reaction models to be used in a domain where they are poorly constrained. While the collaboration has answered each of these arguments in mail and during the presentation, the concerns remain.

Recommendation: Defer

Proposal: PR12-06-116

Title: Nucleon Resonance Studies with CLAS12 in the transition from soft to partonic physics

Spokespersons: R. Gothe, K. Joo, V.I. Mokeev, P. Stoler

Motivation: This experiment continues the JLab program of elucidating the spectrum of excited baryons using CLAS12. The aim is to measure the photocouplings of established baryon resonances, in particular Δ, S_{11}, D_{13}, F_{15}, as functions of Q^2. This has the potential to provide valuable input at higher Q^2 for the comprehensive coupled channel analyses being undertaken by EBAC. Since many of these states have strong couplings to two pion as well as single pion channels, this motivates the common measurement of both these channels. There is evidence already that some resonant signals rise relative to the background as Q^2 increases, which provides confidence in the possibility of extrapolating the program to higher Q^2.
In the π^+n and π^0p channels, the measurement of complete azimuthal and polar angular distributions are proposed for each bin of W and Q^2. In $\pi^+\pi^-$-p production complete angular and mass distributions are proposed for each pair of final state particles. All 18 observables in each bin are key inputs to determine the photocouplings of the N*.

Measurement and Feasibility: The resonances to be identified in the relevant partial waves have widths greater than 120-150 MeV. For these the expected CLAS12 energy resolution of 60 MeV looks adequate. While the ultimate goal is to extract N* photocouplings from the data, the experiment could produce absolute cross-sections that may be analyzed by independent theoretical groups.

Issues: Whether the Q^2 dependence of the photocouplings of the observed excited baryons really reveals an undressing of the constituent quarks appears to be highly model dependent at present. This situation may well develop over the next decade aided by lattice calculations, for example.
The ongoing work of the collaboration in addressing the nature of the N*'s is appreciated. They are urged to consider developing a more adequate proposal for the 12 GeV upgrade in which the interpretation issues of what one learns from the Q^2 dependence of the resonance photocouplings are more sharply addressed.

Recommendation: Defer

Proposal: PR12-06-117

Title: Quark Propagation and Hadron Formation

Spokespersons: W. Brooks (contact person), K. Hafidi, K. Joo, G. Niculescu, I. Niculescu, M. Holtrop, K. Hicks, L. B. Weinstein, M. Wood, G. Gilfoyle, H. Hakobyan

Motivation: This proposal describes a program in which nuclei are used as laboratories for the study of the process of hadronization. The experiments involve electroproduction using deep inelastic kinematics and target nuclei of varying mass A. The described approach relies on a characterization of the hadronization process in which one identifies two distinct time periods. During the *production time* the struck quark travels unconfined through the nuclear medium while carrying a net color charge. During the *formation time*, which occurs after the struck quark picks up one or two quark partners and becomes color neutral, a "pre-hadron" travels through the nuclear medium while evolving into a meson or baryon. It is during the formation time that the bare quarks of the pre-hadron become dressed and the hadron acquires its full mass. During the production time, the struck quark can be expected to radiate gluons in analogy with bremsstrahlung radiation. This causes a broadening, Δp_T, of the leading hadron's transverse momentum. By studying Δp_T as a function of the mass A of the target nucleus one can in principle determine production time. During the formation time the pre-hadron is less likely to scatter from the nuclear medium. Thus, by studying the hadron multiplicity as a function of the target mass A one can in principle determine the formation time.
In addition to probing subtle aspects of the formation of hadrons, this experiment also provides data that are of considerable value to the RHIC community.

Measurement and Feasibility: The experiment would use CLAS12 and an unpolarized 11 GeV beam to study semi-inclusive electroproduction of a variety of hadrons using a range of nuclear targets. With one caveat, discussed below, the experimental requirements appear well within the capabilities of CLAS12.
Measurements such as those proposed represent a relatively new direction in hadronic physics that appears quite promising. HERMES has published some data along these lines, and while limited in quantity, they are quite impressive, and give confidence that the proposed experiment has considerable potential.

Issues: One concern is technical in nature and regards particle ID. It is not obvious that the ability of CLAS12 to identify the higher-energy kaons is adequate to meet all the demands of the experiment. Something along the lines of a RICH detector may well be necessary.
That PAC requests that the collaborations associated with PR12-06-117 and PR12-06-106 work toward developing a run plan in which targets and other aspects of the experiment are coordinated in such a way that the two programs can maximize the time during which they can run concurrently.

Recommendation: Approval

Proposal: PR12-06-118

Title: Measurement of F_2^n/F_2^p, d/u Ratios and A=3 EMC Effect in Deep Inelastic Scattering off the Tritium and Helium Mirror Nuclei

Spokesperson: G. Petratos

Motivation: The experiment addresses important physics issues. The EMC effect, F_2^n/F_2^p, and d/u will be studied with 1% accuracy up to x=.83 in the mass-3 system where the nuclear wave functions are well known. At high x, the d/u will be determined for valence quarks. Model calculations using different nucleon-nucleon interactions and different nucleon structure functions demonstrate that F_2^n/F_2^p can be extracted with a systematic uncertainty of .02. Because the two targets are measured in one set up, many experimental uncertainties cancel out.

Measurement and Feasibility: Based on the wealth of experience with this kind of experiments in Hall A, the experiment appears feasible**.**

Issues: The PAC is aware that Tritium safety is a major issue for Lab. Management. However, given the experience with a tritium target in experiments with electron beams at Saclay and MIT/Bates the safety issue might be solved. A special JLab. Management review of the safety aspects of the Tritium target is the condition for approval.
At this point it is important to stress that the PAC considers the physics goals of this experiment as highlights of the 12GeV physics program. Part of the program – the u/d ratio- will probably be investigated by PR12-06-113 that has been conditionally approved. Given the importance of the physics issues and the unique position of JLab. to address those questions the PAC would like to see both experiments to be done. The methods are completely different and, thus, provide the necessary cross check of the results. This PAC is convinced that this proposal alone justifies the effort to implement the Tritium target.

Recommendation: Conditional approval

Proposal: PR12-06-119

Title: Deeply Virtual Compton Scattering with CLAS at 11 GeV

Spokespersons: F. Sabatie, A. Biselli, H. Egiyan, L. Elouadrhiri, D. Ireland, M. Holtrop, W. Kim

Motivation: Generalized parton distributions (GPDs) are physical observables which can provide deep insight about the internal structure of the nucleon. They contain the usual parton distributions and elastic form factors as their special limits. In addition, GPDs allow to probe of quark orbital angular momentum and picture the quark motion in quantum phase space. Deeply-virtual Compton scattering is one of the cleanest processes to measure GPDs. Past experiments have shown higher-twist corrections to the hand-bag diagram small and hence established the reliability of measuring the GPDs at JLab kinematics. The proposal asks to extend the current measurement of DVCS in Hall B to higher-energy, expanding the kinematical coverage in x_B and Q^2 considerably.

Measurement and Feasibility: Two measurements are proposed: beam spin asymmetry with unpolarized target (80 days) and target spin asymmetry with unpolarized beam (120 days). Both types of measurements have been made at CLAS with lower energy. The new measurements define much of the design parameters and particle identification requirements for CLAS12. The outgoing electron, photon and recoiling proton are completely measured. The experiment can to a large extent run in parallel with other experiments.

Issues: Neutral pion background is severe, but various cuts and estimations based on earlier measurements and simulations can be used to reduce its uncertainty. It is unclear what will be the ultimate uncertainty on the total DVCS cross section which is important for extracting the real part of the Compton amplitude. Strong effort is recommended to reduce this uncertainty.

Recommendation: Approval

Proposal: PR12-06-120

Title: 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

Spokespersons: T. Averett, W. Korsch, B. Sawatzky

Motivation: The collaboration proposed to determine the g_2 structure function over a broad range of x in order to calculate the d_2 moment with high precision. The d_2 moment comes from the twist-3 terms in the nucleon structure which represent quark-gluon correlations in the nucleon. This moment can be precisely calculated on the lattice and is independent of the renormalon effect. This is an extremely important test of our understanding of perturbative QCD in the nucleon.

Measurement and Feasibility: The measurement in Hall A uses the already developed polarized ^{3}He target. The longitudinally and transversely polarized asymmetries will be detected in the BigBite spectrometer while one of the HRS spectrometers will measure the cross section at the beam energies of 6.6 and 8.8 GeV. The planned measurement with BigBite uses a single angle setting for each beam energy, so that the large range in x that is accepted is strongly correlated with the value of Q^2. The estimates of the performance of the target and spectrometer are conservative, and the estimated uncertainties are likely achievable. The collaboration has extensive experience with the target and spectrometers.

Issues: Although the precise measurement of d_2 at a single Q^2 is of high merit, the committee did not feel that the case for the high Q^2 measurement at high x was strongly justified, and could possibly be covered in an extension to the Hall C experiment, that was approved. The evolution of g_2 itself at high x is complicated and it is difficult to evaluate the impact of the measurement at the proposed kinematics. We urge the collaboration to investigate the requirements of the high Q^2 measurements (at low and high x) being performed in Hall C, in order to contrast them with the Hall A plan. It is appreciated that it is important to perform a precise measurement of d_2 at the highest Q^2.

Recommendation: Defer

Proposal: PR12-06-121

Title: A Path to "Color Polarizabilities" in the Neutron: A Precision Measurement of the Neutron g_2 and d_2 at High Q^2 in Hall C

Spokespersons: T. Averett, W. Korsch, Z. E. Meziani, B. Sawatzky

Motivation: The transverse-polarization-dependent structure function g_2 contains twist-3 quark-gluon correlation effect which goes beyond the simple parton model. It represents one of the most-well-defined higher-twist contributions in theory. In particular, the moments of g_2 structure function are related to local quark-gluon operators which have simple scale evolution properties and can be calculated straightforwardly in lattice QCD. The second moment of g_2 is related to the color field response inside of the nucleon to its spin polarization. At present, the neutron g_2 structure function in the deep-inelastic region has very large uncertainty, and appears to imply a large flavor violation.

Measurement and Feasibility: The proposed measurement of the neutron transverse-spin structure function will be done at Hall C using combined SHMS and HMS spectrometers. Each spectrometers are positioned at three different angles, producing data at almost constant Q^2 = 3, 4 5 GeV^2 . The measurement will be done on the well-developed polarized He-3 target with a new design. The proposal asks for 29 days to accomplish the measurement. It appears that the experiment is feasible.

Issues: The d_2 moment could have a large contribution from the resonance region, particularly at low Q. These contributions shall be quantified. Large systematic uncertainties appear from He-3 to neutron and QED radiative corrections. These uncertainties shall be investigated carefully in the data analysis.

Recommendation: Approval

Proposal: PR12-06-122

Title: Measurement of neutron asymmetry A_1^n in the valence quark region using 8.8 and 6.6 GeV beam energies in hall A.

Spokespersons: B. Wojtsekhowski, G. Cates, N. Liyanage, Z. E. Meziani, G. Rosner, X. Zheng

Motivation: The goal of this proposal is to measure the Neutron Spin Asymmetry A_1^n (virtual photon asymmetry) in the valence quark region (extending Jlab data at much larger x values, and covering the range from 0.3 to around up to 0.71 with a finer binning and comparable precision). This x region is uniquely covered at the Jefferson Laboratory, thanks to the high luminosity achieved. The important physics case is related to the nucleon spin structure and tests of the constituent quark models in the DIS regime, as well as the test of Helicity conservation in pQCD predictions (with in particular the tantalizing role of Orbital Angular Momentum between quarks). The beam energies necessary are obtained with the 11 GeV gradients. This observable is also measured simultaneously in the resonance region due to the large acceptance of the spectrometer (BigBite) that is used. The choice of the kinematics of this measurement should allow exploring possible Q^2 dependence of A^1_n, especially when combined with the results of the proposal PR12-06-110 in Hall C. The two experiments will provide the same observable via a similar measurement.

Measurement and Feasibility: The measurement is to be performed in Hall A, with different beam energies (2.2, 6.6 and 8.8 GeV obtained in 1, 3 or 4 passes with the LINAC 11 GeV gradient). The key experimental devices required by this experiment are already in use with the 6 GeV beams. The scattered electrons are detected in the BigBite spectrometer. The polarized neutrons are obtained from a polarized ^{3}He gas target. The electron beam is polarized (80%) and the intensities of 10 μA requested are limited by the target operation. The BigBite spectrometer will be located at 30°, at a single field setting (1.2 T) and placed at 1.55 m from the target (covering a solid angle of 50 msr, when averaged over a 30 cm length of the target). This experimental configuration has been designed from GEANT simulations and previous data taking, and will be checked in experiments scheduled in the coming years. New features should be implemented in the detection package (gas Cherenkov, distance between Multi-Wire Drift Chambers) for this experiment. Asymmetry data recorded with HRS, although with smaller statistics, can be used as a crosschecks and systematic errors estimates.
The procedures concerning studies of systematic errors as well as the extraction of A_1^n from measured data have been already tested in previous (successful) measurements at 6 GeV. Beam and target polarization, as well as other systematical errors, are checked with the measurement of elastic scattering and transverse asymmetry in Δ production with a beam of lower energy (2.2 GeV, 1 pass) and using the HRS spectrometer. In this experiment, the charged pion background will be rejected by means of PID (gas Cherenkov and lead glass counter), whereas the contribution of pair production (e^+e^-, from photons produced in π^0 decay) will be corrected for by measurements with reverse spectrometers polarity.

Issues: Some concerns raised by the Technical Advisory Committee have not appeared as showstoppers for the measurement; although pion backgrounds should be checked at the early stage of the Hall A commissioning due the open geometry of the Bigbite spectrometer. The first data taking should also set limits and feasibility for the extension of the program at larger Q^2 either in Hall A or in Hall C as proposed in the companion proposal PR12- 06-110.

Recommendation: Approval

APPENDIX E

Letter of Intent: LOI12-06-103

Title: G_E^p/G_M^p with an 11 GeV Electron Beam

Spokespersons: C. Perdrisat, V. Punjabi, M. Jones, E. Brash

Motivation: The form factor ratio G_E^p/G_M^p has been measured at JLab using the recoil polarization method to $Q^2 = 5.5$ GeV^2. The result was a surprise compared with the early data from the Rosenbluth separation method. It has also motivated various theoretical studies of the proton form factors. At 11 GeV, one can use the same polarization method to measure the form factor ratio to $Q^2 = 13$ GeV^2. The future result can differentiate different theoretical ideas about the proton form factors at large Q^2.

Measurement and Feasibility: The LOI indicates that the experiment will use SHMS in Hall C to detect the recoiling protons, and the BigCal lead glass calorimeter to detect the scattered electrons. The focal plan in the SHMS will be equipped with the Focal Plane Polarimeter. The experiment plans to measure three points: $Q^2 = 6.0$, 10.5 and 13.0 GeV^2, with the first point as a check. The two new points will take about 90 days, with error about 15%. The experiment appears feasible.

Issues: Although 2-photon effect is significantly reduced in the present approach, it is unclear that the effect is also negligible at very high Q^2.

Recommendation: A full proposal is encouraged for the next PAC.

Letter of Intent: LOI-06-104

Title: Charged pion photoproduction ratios at high p_T

Spokesperson: G.M. Huber

Motivation: A series of hard exclusive measurements of the charged pion electroproduction from protons and deuterons, at high $p_{T(t)}$ have been proposed to determine the t-dependence of the π^-/π^+ cross section ratios. These measurements should help to clarify the reaction mechanism and in particular to determine the contributions from the hard scattering, since soft contributions are claimed to divide out in the π^-/π^+ ratios. A possibility to separate the σ_{LT} and σ_{TT} components at small -t and, with a model , to use them to constrain the LT and TT contributions at high –t, have also been proposed.
However the data already taken, and mentioned by the Author, indicate that there must be large soft contributions, which are additive to the hard ones, and so will not divide out in the cross section ratios. Consequently the assumed goals cannot be achieved.

Issues: Technical comments have brought up the following objections:

- very low event rates (O(1/hour) in the worst case) which may also induce a large error to a precision L-T separation,
- very high demands on the beam current and energy (severely limiting the running power in the other halls) and,
- finally, sophisticated (albeit possible) demands concerning the non-standard target.

Recommendation: In view of the program deficiencies and the very high technical demands, the PAC does not encourage the proposers to work out a proposal.

Letter of Intent: LOI12-06-105

Title: Deuteron Photodisintegration at High Energies

Spokespersons: E.C. Schulte, R.J. Holt

Motivation: This experiment aims to measure $d\sigma / dt$ for the exclusive photodisintegration reaction $\gamma d \to pn$ at higher *s* than previously measured at three scattering angles θ_{CM}. Previous data appear to display a clear scaling behavior: at sufficiently high *s* and *t*, the quantity becomes smoothly dependent on *s* (at fixed θ_{CM}), with an s^{-11} power-law behavior. This behavior is apparently consistent with the expectations of the Constituent Counting Rules, derived from perturbative QCD. However, many other models have addressed such scaling behavior, in this and other exclusive processes at hard scales, and none is yet able to explain the full body of measurements.

Measurement and Feasibility: The letter proposes to measure 15 kinematic points: 10 will be taken at the same kinematics as previous data, as a systematic check, and the remaining 5 will extend the data to higher E_γ: one point at 37°, one at 53°, and three at 90°. The technical review of the experiment raised six points which need to be addressed, including the observation that the thick radiator necessary might bring the experiment close to the Hall's annual radiation budget.

Issues: As demonstrated clearly in Fig. 7, no model is yet able to explain the existing data on deuteron photodisintegration alone. The five new kinematic points being proposed represent only a small extension of the kinematic range, and it is unclear how they will help the development of theoretical models.

Recommendation: Given the current state of theory in this area and the large available volume of unexplained measurements, the PAC does not see that the proposed data will have significant impact on the modeling of hard-exclusive reactions.

Letter of Intent: LOI-12 06-106

Title: Anti-shadowing and the EMC effect at very large x

Spokespersons: J. Arrington, A. Bruell

Motivation: This LOI aims at providing new data on the nuclear-mass dependence of the DIS structure functions. The measurements would cover the anti-shadowing region ($0.1 < x < 0.3$) as well as the large x domain. The study would also cover a large range of masses (A= 2 to 200). The goal is to improve on the existing data set with larger x coverage, finer binning and an extended mass range. The data collected would be combined in a global analysis with DY and neutrino scattering measurements, to be measured at Fermilab with improved precision, in order to try to separate the nuclear effects for valence and sea quarks as well as for gluons. The second kinematical region is at large x values, up to 1.1, with a check for a Q^2 dependence of the EMC effect for a subset of 3 targets.

Measurement and Feasibility: The experiment is proposed in Hall C, using the existing HMS and the SHMS which is being developed for the 11 GeV upgrade. An 11 GeV beam energy is required with beam currents of 25 and 80 μA. The anti-shadowing data will be recorded with scattered electrons detected at angles of 20-30° degrees in the SHMS spectrometer, and the large x data with both the HMS and SHMS spectrometers at larger angles (40-50°). The set of nuclear targets (liquid/gas (D, ^{3,4}He) and solid from ^{7}Li to Au) will allow a mass range from A= 3 to 200. Radiative corrections are believed to be under control from the experience gained in previous measurements and this will be tested through data taking at different scattering angles. Also, detailed measurements of background electrons are planned.

The beam-time estimate is 21 PAC days, including calibration with Hydrogen, dummy target runs for end cap subtraction and measurements of (charge symmetric) background. Also data taking on a subset of targets at several angles will be done to determine the Q^2 dependence of the EMC effect. Overall, an error similar to the ones (several %) of the E139 SLAC experiment is foreseen but with an extended x range and a finer binning.

Issues: The PAC was not convinced that this LOI, as presented, has the potential to have high priority during the first five years of operation of the Jlab 12 GeV program. Two issues contributed to this conclusion. First, with limited theoretical guidance with which to compare, the additional data that would be added would have limited impact. Secondly, while the proposal stressed the anti-shadowing region, the coverage in x over this region is in fact limited.

Recommendation: Not recommended to go for a proposal

Letter of Intent: LOI12-06-107

Title: Measurement of the Neutron Magnetic Form Factor at High Q^2 with the Ratio Method on Deuterium

Spokesperson: G. Gilfoyle

Motivation: The CLASS12 spectrometer will be used to measure the ratio of quasi-elastic e-n scattering to e-p on the Deuteron. These data will determine ratio of neutron to proton magnetic form factors in the range $2<Q^2<14$ GeV^2. The proponents have demonstrated the method at 6 GeV, and the approximations used to extract the ratio of form factors are better satisfied at 12 than at 6 GeV. ep elastic and ep$\rightarrow$e' n π^+ reactions will be used to match the neutron and proton acceptances of the spectrometer, and, especially, to calibrate the neutron detection efficiency . The proponents argue that a clean sample of quasi-elastic can be obtained by cuts on W and θ_{pq}.

Measurement and Feasibility: The measurement appears feasible.

Issues: The letter of intent assumes that the torus magnet coils will be instrumented. The originally-planned "coil calorimeter" is not part of the base equipment.
The physics impact of the experiment is high. The group has already successfully performed similar measurements at 6 GeV. This measurement is an important part of the Jlab program to study the 4 elastic nucleon form factors.

Recommendation: Encourage to submit a full proposal.

Letter of Intent: LOI12-06-108

Title: Transverse Polarization Effects in Hard Scattering at CLAS12

Spokespersons: H. Avagyan

Motivation: It is proposed to perform a program of measurements of semi-inclusive deep-inelastic scattering (SIDIS) and of hard-exclusive processes with CLAS12 using a *transversely* polarized proton (NH_3) target. The use of a transversely polarized target has been revealed in recent years to be the *ideal* test bed for the exploration of quark orbital angular momentum and its correlation with transverse spin, both within the nucleon and in the fragmentation process. First SIDIS data with transverse targets from HERMES and COMPASS have revealed many intriguing surprises, and it is of vital importance to continue this exploration. (HERMES has completed its polarized-target phase, and though a transverse-proton run is expected for COMPASS in a few years, those data will be at much lower values of x that those obtained at CLAS12). The two principal physics measurements proposed are as follows. (1) Measurements of the azimuthal distribution of charged and neutral pions in the asymmetries A_{UT} provide access to transversity, the Collins fragmentation function, and the Sivers distribution function. (2) Measurements of the A_{UT} asymmetry in DVCS provide the cleanest possible access to the GPD $E(x,\zeta,t)$, which is an essential component of the Ji Sum Rule – the current best hope of model-independent access to the orbital angular momentum of quarks in the proton. Hard-exclusive production of ρ^0 from the transverse target offers a second route to this GPD.

Measurement and Feasibility: The PAC has no concerns as to the feasibility of the proposed analyses as the CLAS collaboration already has much experience in the area of azimuthal single-spin asymmetries. The only concerns from the technical review involve the use of a transverse target with CLAS12, and the recoil detection necessary for precise hard-exclusive measurements; these concerns should be addressed in the full proposal. Next, the PAC strongly encourages the CLAS12 collaboration, and the proponents of this LOI in particular, to develop the detector design in such a way as to permit good *kaon* identification. Recent data on the Sivers effect for kaons from HERMES, for example, have revealed yet another surprise, and it is vital that it be explored with greater precision. , one of the unique advantages of CLAS12 is its high luminosity, and it is hoped that this will permit a *multidimensional* exploration of the kinematic dependences (e.g. on x, Q^2, z, p_T) of the proposed measurements. The feasibility of this should be explored in the proposal, as well as the impact of a $W^2 > 10$ GeV^2 cut on the SIDIS measurements (which will assist in curtailing target-fragmentation effects).

Recommendation: The physics presented in this LOI will be a critical component of the CLAS12 program, and the PAC looks forward to its development into a full proposal.

Letter of Intent: LOI12-06-109

Title: Semi-Inclusive Pion Production with a Longitudinally Polarized Target at 11 GeV

Spokespersons: H. Avagyan

Motivation: This experiment aims to perform semi-inclusive measurements with the CLAS12 detector using a longitudinally polarized proton (NH_3) target. This will be a natural extension to the accepted proposal PR12-06-109 (with which it will run concurrently) to include *semi-inclusive* spin-dependent measurements. Two classes of measurements are described. (1) Double-spin asymmetries A_{LL} for charged and neutral pion production, when integrated over the pions' azimuthal angle, will permit sensitivity to the helicity distributions of different quark flavors in the proton. The azimuthal $\cos(\phi)$ moment of the double-spin asymmetry is also interesting, sensitive to the transverse momentum of different quark flavors in the proton. (2) Single-spin asymmetries A_{UL} (unpolarized beam on longitudinal target) for charged and neutral pion production contain $\sin(2\phi)$ moments which are sensitive to the poorly-explored leading-twist structure function $h_{1L}^{\perp}$, describing the transverse polarization of quarks in a longitudinally-polarized proton. Predictions indicate that the high-x region covered by the proposal is exactly where these asymmetries will be the most sizeable.

Measurement and Feasibility: This extension of the physics of PR12-06-109 to include semi-inclusive asymmetries is an obvious and important one. The CLAS collaboration already has much experience in measurements of precisely this type, and so the PAC has confidence that the proposed measurements are entirely feasible (e.g. that the detector acceptance can be understood to the necessary degree of precision using Monte Carlo). In developing the proposal, the PAC suggests that care should be paid to QED radiative effects, which will affect even azimuthal moments such as $\cos(\phi)$, as well as to the diluting effects of the unpolarized nitrogen nuclei in the target. Finally (as noted for similar CLAS12 proposals letters of intent), the proponents are strongly encouraged to concentrate on the development of good kaon identification for the CLAS12 detector and to extend the forthcoming proposal to include the measurement of kaon asymmetries (sensitive to strange-quarks in particular, and providing important leverage on isolating sea-quark effects in general).

Recommendation: The physics motivation of this Letter of Intent is strong and the PAC eagerly encourages the proponents to develop it into a full proposal.

Letter of Intent: LOI12-06-110

Title: Precision Measurement of the Parity Violating Asymmetry in DIS off Deuterium using Baseline 12 GeV Equipment in Hall C

Spokespersons: P.E. Reimer, X. Zheng, K. Paschke

Motivation: This physics case of this LoI is to perform to low energy precision tests of the Standard Model that can be performed in high precision PV experiments with the 12 GeV Jlab beams. The DIS-Parity experiment discussed here could considerably improve a combination of two Weak Neutral Coupling constants (c_{2u} - c_{2d}) involving axial quark charge accessed here in lepton-quark scattering. The results, if obtained with enough precision, have the potential to test, in a complementary way to other low energy experiments, extension of the Standard Model. Work is underway with theorists to define the limits over this new Physics that can be deduced from this measurement.
The limitation in interpreting the data might come from hadronic effects, which are however interesting in their own (Higher Twist Effects, Charge Symmetry Violation). Results from this proposal (complemented by the accepted experiment at 6 GeV) could thus in turn provide information on these effects.
As requested by the management, the leading institution have strong involvements in devices being developed for the baseline equipments of the Hall C for the 12 GeV upgrade.

Measurement and Feasibility: The experiment is to be performed in Hall C using the HMS and new SHMS spectrometers to detect scattered electrons at angles around 13.5°. The gain with a higher beam energy of 11 GeV, is on the extension of kinematics toward higher W^2 and Q^2 values (7.3 GeV^2 and 3.3 GeV^2 in average respectively, for a x value of about 0.34), well in the DIS region ((> 4 GeV^2 and > 1 GeV^2) respectively and complementing the approved experiment to be performed at 6 GeV with moderate Q^2 coverage (1-2 GeV^2). The experiment will be run with a beam with 85 μA intensity, 85% polarization scattering on a 40 cm long target. Asymmetries of the order of 300 ppm are expected and this reduced the requirements on Parity quality of the beam. The precision expected on the measurement is extremely challenging in terms of systematics (0.6 %) involving in particular work to achieve a 0.5% precision in polarization measurement whereas the state of the art is at present at the % level.
The beam time estimate is 30 (24+6) days to achieve a statistical precision of about 0.5%.

Issues: At the present stage of understanding of hadronic uncertainties, the projected experimental data will not improve significantly of our knowledge of θ_W. However with a concerted effort, involving theorists, to understand the hadronic contributions. The DIS asymmetries have the potential to improve both our knowledge of θ_W and hadronic physics such as HTE and CSV. This theoretical work could then provide the basis for the construction of a dedicated large acceptance DIS spectrometer.
On a different ground, the technical challenges have naturally to be further considered in order to achieve the necessary precision.

Recommendation: The PAC is encouraging the proponents to work for a proposal.

APPENDIX F

Jefferson Lab Experiments, PAC 30,
Grouped by Category

(To access Appendix F, go to http://www.jlab.org/exp_prog/proposals/06prop.html.