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Hugh E. Montgomery
Laboratory Director and Jefferson Science Associates President
March 11, 2009

Dear Jefferson Lab Users,

This year marks the start of construction of the 12 GeV Upgrade Project, which will significantly enhance the capabilities of our flagship nuclear physics facility, CEBAF. The Jefferson Lab PAC has played a major role over the years in the development of the scientific case for the Upgrade and the planning for its research capabilities; and this PAC is the third to review formal proposals for experiments that will use the Upgrade.

While there are many ways the performance of a laboratory can be measured, a particularly important yardstick is the proposals to use the facility. Our hopes were rewarded in the form of six letters of intent and nineteen proposals. Of the proposals, nine were approved, five conditionally approved and five deferred or rejected for various reasons. The committee also provided some guidance to proponents of experiments of Semi-Inclusive Deep Inelastic (SIDIS) experiments that they hope will guide our development of a coherent and comprehensive program. Five of the letters of intent were deemed sufficiently attractive for the team to be encouraged to proceed to develop a proposal.

PAC34 was the first 12 GeV PAC that considered new initiatives for the 12 GeV era that would go beyond the baseline equipment included explicitly as part of the 12 GeV Upgrade Project. Among the proposals well received were one to measure the weak coupling of electrons using Møller Scattering and three that will utilize various configurations of apparatus that is collectively known as the SuperBigBite Spectrometer. Another proposed experiment with major apparatus would more broadly explore parity violation in deep inelastic collisions. The Møller Scattering experiment falls into one of the categories, fundamental symmetries, which was explicitly called out both by NSAC and by the DOE Science Review of the 12 GeV Upgrade as a strength of the 12 GeV project and its planned program. We accept the recommendations without reservation and to the extent that resources permit, we will attempt to follow them.

The perspective of the physics embodied in the remarks and recommendations of the PAC is impressive. Their devotion to duty and attention to detail was likewise meticulous. The previous Chairman, Roy Holt, ensured the end of his term by signing a good fraction of the proposals so that recusal could not be denied. Mike Pennington stepped in and conducted the proceedings with consummate skill; we are delighted that he has agreed to continue as chair for the next two PACs. Finally it is traditional to remark on the fortitude of those who are leaving, graduating, if you will and in this category we have, David Bowman, Pierre Guichon, Roy Holt, Naomi Makins, and Marco Ripani. To all we express our gratitude and best wishes for the future.

Sincerely,



Hugh E. Montgomery
Laboratory Director

Letter from the PAC Chair

Introduction

The Jefferson Laboratory Program Advisory Committee held its 34th meeting from January 26th to 30th, 2009. The membership of the Committee is given in Appendix A. In response to the charge (Appendix B) from the JLab Director, Dr Hugh Montgomery, the Committee reviewed and made recommendations for the 19 proposals and 6 Letters of Intent for experiments at the 12 GeV upgrade, and commented on the proposed scheduling for the completion of 6 GeV running before the shutdown.

12 GeV upgrade:

With plans for the 12 GeV upgrade continuing apace, this PAC considered a range of proposals to add to the suite of experiments utilising the “baseline” equipment previously considered for the first 5 years of running in the 12 GeV era, plus a number of proposals that require significant additional equipment and consequently might only run beyond that period.

All 19 experiments considered at this PAC are part of the central mission of JLab physics to illuminate the properties of nucleons and how these are reflected by the flavor, momentum and angular momentum carried by their constituent quarks and gluons. The PAC grouped these proposals into 4 distinct programs for consideration:

- Precision measurements of electroweak coupling of leptons and quarks (2 proposals)
- Electromagnetic form-factors of the nucleon (4 proposals)
- Properties of hadrons and collective hadron systems (3 proposals)
- Semi-inclusive deep inelastic scattering (10 proposals)

The PAC believes that the development of the 12 GeV strategy could usefully lead to a “cultural” change in which instead of a series of separate experiments making disparate measurements (often by overlapping collaborations) these should be grouped into physics themes, like those above, and that these become the basis for comprehensive programs of study.

1: Precision measurements of electroweak couplings of leptons and quarks

Proposal PR12-09-005: This Moller scattering experiment measuring the electron’s electroweak couplings has the potential to maintain JLab’s position on the world stage, contributing to precision studies of the low energy Standard Model. To make this proposal a reality requires the development and construction of major equipment and the ability to roll this in and out of position to allow other experiments to run. The PAC believes the mission of this experiment to determine the electron’s couplings to new precision is so important that the Laboratory should make effort to support the securing of the resources required. This proposal is Approved.

Proposal PR12-09-012: This proposal to use Parity Violating Deep Inelastic Scattering (PVDIS) to measure the electroweak (especially axial vector) couplings of quarks has the potential to provide precise and valuable information. However, the PAC gives this proposal only Conditional Approval because of the need for the collaboration to determine a method for flexible use of the solenoidal detector allowing other experiments to run in Hall A over the 350 days of running of this experiment.

2: Electromagnetic form-factors of the nucleon

The electric and magnetic form-factors of the proton and neutron, and their Q^2 -dependence, are fundamental quantities, the measurement of which is a key mission of the JLab program.

Proposal PR12-09-001: This proposal using polarization transfer to determine the ratio of the electric to magnetic form-factors for the proton in Hall C would provide a benchmark measurement, the collaboration calls Gep5. However, the PAC was unclear whether (a) this should supercede Gep4, which has already been approved, or (b) what the compelling reason was to make these measurements twice. The collaboration, being so much closer to the technical details, should come back with a compelling proposal for Gep4 and 5. Consequently, this Proposal is Conditionally Approved.

Proposal PR12-09-006: This proposal to measure G_E^n by recoil polarimetry in Hall C is again a benchmark measurement. Given its importance, there is a need to build a strong collaboration. This Proposal is Approved.

Proposal PR12-09-016: This proposal to measure the ratio of the electric to magnetic form-factors of the neutron in Hall A is an important measurement. It requires GEMs, the technical challenges of which were extensively discussed in connection with PR12-07-109 at PAC32. A technical review of the feasibility of the proposed neutron detection, and the impact of the sweeping magnet on laboratory resources is critical. This Proposal is Approved.

Proposal PR12-09-014: This Proposal to measure G_M^n in Hall A is Approved to run up to Q^2 of 12 (GeV/c)^2 . It will then be clear what can be gained by adding the more resource intensive measurements at higher Q^2 .

3. Properties of hadrons and collective hadron systems

Proposal PR12-09-003: This proposal to determine the amplitudes for the γN transition to excited baryons is an element of the JLab hadron program. The extraction of these couplings requires the whole EBAC analysis and the interpretation of these requires a range of theory input. The collaboration has secured such interest. It will need to continue to foster this involvement. This Proposal is Approved.

Proposal PR12-09-015: The determination of the two photon decay rate of the η is an important constraint on the Goldstone nature of the light pseudoscalars. This experiment proposes to measure this with new precision using the Primakoff effect. However, its running in Hall D is presently incompatible with GlueX and so the PAC concludes this proposal should be Deferred. To proceed the collaboration should consider becoming integrated with GlueX, and at the same time consider including a measurement of the radiative width of the η' .

Proposal PR12-09-010: The determination of the isospin structure of two and three nucleon short range correlations is the aim of this Proposal. However, the physics to be revealed overlaps with the approved *Ca* experiment, and the PAC saw no compelling case for what can be learnt additionally by using tritium. This Proposal is Deferred with Regret.

4. Semi-Inclusive Deep Inelastic Scattering (SIDIS)

The determination of the momentum, flavor and angular momentum structure of parton distributions has become a major component of the JLab program, one to which the Laboratory can make a unique

contribution. So central is this to the 12 GeV upgrade, the PAC believes that now is the time to shape these studies into a single coherent program across a number of Halls, rather than as at this PAC in 10 different, but often overlapping, proposals.

The membership of this PAC brought together internationally renowned experts, both experimental and theoretical, in the study of parton distributions and hadron fragmentation. This allowed the PAC to hold a mini-workshop on the SIDIS program, and consequently to consider how the 10 proposals presented at PAC34 fit into this.

We urge the JLab Management, Hall Leaders and experimental collaborations interested in the SIDIS program to take note of our overarching comments:

Comments to All SIDIS Proposals

Semi-inclusive deep inelastic scattering (SIDIS) provides a powerful way to access the structure of the nucleon and the intricacies of the hadron formation process. The 12 GeV era at JLab can move this field to a new level of sophistication, thanks to the extraordinary statistical accuracy achievable and the extended kinematic reach provided by the 11 GeV beam. A new level of statistical accuracy must however be accompanied by a commensurate level of **systematic** precision, both experimental and theoretical. The multi-dimensional phase space of SIDIS is complex, with interesting and unknown physics reflected in each kinematic dependence. Fully differential analysis of SIDIS observables will be essential if one hopes to develop an understanding of the SIDIS mechanism at a level commensurate with the projected statistical accuracy. Examples of issues that must be addressed are the level of current/target separation, the applicability of x - z factorization to $p_{h\perp}$ -integrated distributions, the $p_{h\perp}$ -dependence of identified hadrons, and the size of higher-twist contributions. A strong SIDIS program at 12 GeV will be able to address these questions. It is the clear opinion of the PAC that **model-dependent** approaches to SIDIS analysis should be avoided, and that instead the proposals concentrate on a systematic, coherent approach to the field. We ask that SIDIS proposals focus on their kinematic coverage, experimental limitations, and complementarity with the rest of the laboratory program, rather than pursuing variegated model-dependent extractions based on uncontrolled assumptions. We also believe that a broad phenomenological effort is needed in which theory and experiment work together to explore the SIDIS reaction mechanism at JLab kinematics. We strongly encourage the involvement of experienced global-fitting groups such as the DSS, LSS, Torino, MRST, and CTEQ groups.

The SIDIS proposals fall naturally into two groups: large-acceptance detectors (such as CLAS), and small-acceptance spectrometers (such as the HMS and SHMS). In developing a coherent program, both of these must be represented, but they must coordinate their efforts and concentrate on what they can uniquely contribute.

Specifically:

(a) **Large-acceptance** experiments will form the core of the program, as they are uniquely capable of providing complete differential binnings of observables. Without this, the program cannot succeed. In addition, **multi-purpose** detectors such as CLAS, with the ability to measure many different channels in a given run period, allow one to explore unknown territory at “low cost” to the total JLab program, e.g. kinematic regions and observables which may or may not be dominated by higher twist effects or target fragmentation.

(b) **Small-acceptance spectrometers** provide other unique capabilities: L/T separations, precise measurement of unpolarized cross-sections with percent-level control over absolute normalization and

charge-dependent cross-section ratios, and the abilities to access kinematic corners *as needed* where the cross-section is low or where the resolution of the large-acceptance devices is inadequate.

All the 12 GeV proposals will have to re-present their case to a future PAC for beam-time allocation. In order to build the best possible program, it is vital to know what the large-acceptance experiments can do, and where they need support from more focused spectrometer experiments. The PAC asks that all the SIDIS experiments clearly show their capabilities in the following areas:

(1) **Multi-dimensional binnings** of projected observables. For example, azimuthal moments such as $\langle \cos(2\phi) \rangle_{\text{UU}}$ should be shown in a fully-differential $(x, Q^2, z, p_{h\perp})$ binning. (This can be easily accomplished in one figure with a grid of panels, e.g. Fig. 37 of PR12-06-117.) At the statistical precision of the 12 GeV experiments, it is useless to show one-dimensional projections of these observables with minute but irrelevant statistical errors. It is also vital that the large-acceptance proposals clearly present their fully correlated kinematic coverage so that other proposals may be developed to fill in important “holes”.

(2) **Resolution.** All proposals should evaluate their experimental resolution carefully; kinematic bin widths should be chosen accordingly, and regions of degrading resolution should be identified.

(3) **Specific dependences.** It is well known that the dependence of SIDIS observables on certain kinematic variables is of particular importance. The PAC requests that proposals address with their projections, if possible:

- (a) the ability to determine the Q^2 dependence of observables (such as $p_{h\perp}$ -integrated azimuthal moments) at some fixed x and z , to see how well higher twist effects and scaling behavior can be constrained.
- (b) the ability to vary x and z independently to test factorization and the separation of the target/current factorization regions.
- (c) the ability to measure the differential $p_{h\perp}$ distribution at fixed x and z , explore its change with Q^2 , and ascertain possible non-Gaussian behavior.
- (d) the ability to measure $p_{h\perp}$ -weighted integrals of azimuthal moments. Here, in addition to the fully-differential coverage plots requested above (which will include $p_{h\perp}$), we suggest that the experiments estimate the fraction of the full $p_{h\perp}$ integral they can measure without extrapolation; this fraction can be estimated using a current model of the Transverse Momentum Distributions.
- (e) the ability to integrate over ϕ and/or ϕ_s : experiments measuring azimuthal moments must show that they have enough coverage and resolution to fit the spectra up to third-order Fourier terms; experiments seeking to integrate over “unwanted” ϕ dependences must demonstrate that their azimuthal coverage is complete.

It is essential that results from the broad-based studies of SIDIS with CLAS will be made available in a timely fashion, to provide guidance for future high precision experiments with small-acceptance spectrometers. Past experience indicates however that experiments with small-acceptance spectrometers can provide important results on a much faster timescale, even without guidance from broad-based studies. Thus, it is highly desirable to have a parallel, dedicated and well-motivated programme with small-acceptance spectrometers.

Proposals PR12-09-007, 008, 009: In keeping with the above Comments, these 3 Hall B Proposals are Approved, but most importantly subject to a thorough evaluation of their overlap, compatibility and contribution to a comprehensive overall strategy for measuring semi-inclusive π^+ , π^0 , π^- , K^+ , K^- , K_s with complete 5-dimensional coverage. Common to all of these is the need for a RICH for improved kaon identification, as a key component to these studies.

Proposal PR12-09-013: This proposal aims to extract Δd by measuring the Semi-Inclusive Spin Asymmetry on polarized He in Hall A in a small corner of SIDIS phase-space at large W . The PAC saw

no compelling case for how this would add significantly to the multi-dimensional capabilities of CLAS12. This Proposal is Deferred.

Proposal PR12-09-014: This proposal aims to measure Target Spin Asymmetry using polarized ^3He in Hall A. This is an ambitious project, which the PAC considered technically challenging with the target subject to subtle nuclear and hadron effects. The proposal requires the major installation of a solenoidal detector SoLID, which is only justifiable if the PVDIS experiment (PR12-09-012) is also fully approved. As part of the overall SIDIS program a measurement of target spin asymmetry with a transversely polarized target is required. The PAC encourages consideration of a complete experiment with semi-inclusive detection of both pions and kaons in all charge states with good angular coverage. The present Proposal is Deferred with Regret.

Proposal PR12-09-018: This proposal aims to study semi-inclusive charged pion and kaon production from a transversely polarized ^3He target in Hall A using BigBite and SBS detectors. The physics is well-motivated, but the experiment is technically challenging. The high luminosity and the use of the GEMS requires both beam testing and financial resources. This Proposal is Conditionally Approved.

Proposal PR12-09-002: This proposal aims to study the ratio of π^+/π^- semi-inclusive deep inelastic scattering on a deuteron target. This directly tests Charge Symmetry Violation. This experiment has the capability to determine individual cross-sections with precision, providing a check for the CLAS12 experiments and is coherent with E06-104. The above “Comments to All SIDIS Proposals” apply. This Proposal is Conditionally Approved.

Proposal PR12-09-004: This proposal aims to study the ratio of π^+/π^- semi-inclusive deep inelastic scattering on deuterium and Au targets to unravel the flavor dependence of the EMC effect. Whilst this of interest, the PAC considers that one first needs to understand the SIDIS process more completely and so know what x - z dependences can be attributed to nuclear attenuation, hadronization in a nuclear medium and so separable from the EMC effect. This Proposal is Deferred with Regret.

Proposal PR12-09-011: This Hall C proposal to measure L-T separated kaon production and so test the expected approach to scaling of σ_L is critical to the GPD program. The PAC questioned the need for the lowest Q^2 data-taking. Removing these, this Proposal is Approved.

Proposal PR12-09-017: This Hall C proposal is a measurement of the Transverse Momentum Dependence of semi-inclusive π production on deuterium and hydrogen, with a study of the $\cos \phi$ dependence of the product of spin-dependent parton densities and fragmentation functions. This Proposal is Conditionally Approved: conditional on a coherent programme being proposed to a future PAC for PR12-09-002,-017 and E12-06-104.

Letters of Intent

LOI12-09-001: The PAC considers performing Deeply Virtual Compton Scattering on not only protons but also neutrons is essential. For this a central neutron detector is required. This collaboration is strongly encouraged to complete the required R&D and bring forward a Proposal.

LOI12-09-002: Three Nucleon short range correlations and their isospin structure is important in providing key inputs to current understanding of 3-body forces for spectroscopy. This collaboration is encouraged to bring forward a Proposal.

LOI12-09-003: The PAC found no compelling case for this measurement of G_M^n at low Q^2 .

LOI12-09-004: Measurement of transverse spin effects with a transversely polarized target is an essential part of the SIDIS program discussed at length above. This experiment should be fused with other proposals as part of a coherent, comprehensive study of π and K production. This collaboration is encouraged to play a part in developing such a program.

LOI12-09-005: Unpolarized semi-inclusive π^+ , π^- , π^0 should be integrated with other CLAS12 proposals in the SIDIS program. This collaboration is encouraged to promote such integration.

LOI12-09-006: The identification of excited Ξ 's and Ω 's as a window on the whole spectrum of excited baryons is well-motivated. This two man "group" should decide whether the required missing mass technique is most feasible within the CLAS or GlueX collaborations. They are encouraged to work with whichever grouping is appropriate to prepare a Proposal.

Completion of 6 GeV running

The PAC was charged with reviewing the Lab's proposals for the completion of running at 6 GeV. The PAC appreciated this opportunity to comment and the passion of the user community in its submissions. A separate brief report is attached. In summary, the PAC endorses the proposed scheduling, with a few caveats, as the best possible attempt to meet the Approved physics goals of the program within the currently known constraints. If further funding becomes available (for instance as part of economic stimulation), then we comment on where we see the priorities for additional running.

Acknowledgements

The PAC appreciates the support of Hall Leaders and JLab staff in elucidating details of the key laboratory infrastructure and in preparing TAC and theory reports. We are most grateful too to Rachel Harris and her colleagues for essential help in bringing the committee together, and preparing, and keeping track of, all its paperwork. All this was essential to the committee's deliberations. Personally, I would like to thank all my colleagues on the PAC for their commitment, expertise and insight that have made working with them a very great pleasure. Lastly, and most importantly, we thank all the scientists involved in developing these 12 GeV proposals – proposals that when brought to fruition will maintain and enhance JLab's capability to illuminate the very heart of matter.

Michael Pennington
Chair, Jefferson Program Advisory Committee

Consideration of the Schedule for Completion of 6 GeV running

Endorsement of priorities

PAC34 was charged to consider the schedule proposed by the Laboratory Management for the completion of 6 GeV running up to the shutdown. The User Community was also asked to comment on this proposal and the PAC noted the passion with which their many views were expressed.

The PAC in general only gives advice about the priorities for experiments. The detailed scheduling of the beam-time requested for Approved and Conditionally Approved experiments is naturally the responsibility of the Laboratory management. Only Management can take account of the laboratory resources of funding and manpower, timescales for equipment development, construction and installation, as well as the prevailing run conditions in each Hall. In planning the schedule for the completion of 6 GeV running, Management has clearly wrestled with the problem of squeezing effectively 4 years of approved experiments into 3 years (if the “mean” funding assumption is correct). After deliberation, the PAC endorses the priorities underlying the proposed scheduling.

In particular, PAC33 gave the Q_{weak} experiment its highest priority. The need to achieve the level of precision its aims require has had a major impact on the scheduling from now to the shutdown for the 12 GeV upgrade. The present PAC confirms the priority accorded to Q_{weak} . Consequently, the PAC acknowledges that the proposed scheduling is the best possible attempt to meet the Approved physics goals of the program within the currently known constraints.

Caveats and concerns

The PAC noted that several experiments requiring significant resources for which limited (or no) funding has been identified are “At Risk”. These include measurements of g_2^p (E08-027), DVCS on protons (E07-007) and neutrons (E08-025), which the PAC would like to see run if additional funding scenarios come to fruition.

A flagship of the JLab program has been the measurement of fundamental properties of the nucleon, such as electromagnetic formfactors. These have been measured with two different techniques: Rosenbluth separation and polarization transfer. These have led to different results. It is believed that a significant contribution to this difference comes from two photon exchange corrections that affect the Rosenbluth method most. A key experiment “At Risk” is E07-005, which explores these multi-photon exchange contributions. It is likely that the possibly competing *Olympus* experiment using the BLAST detector proposed for DORIS at DESY will not run, and so the PAC would be dismayed if this important check was not completed in a timely fashion.

The Laboratory has consistently given a major commitment to its excited baryon program, in particular to the requirement for state-of-the-art polarized targets FROST and HDIce so important for complete sets of measurements of observables for the missing N^* program. These measurements are essential in underpinning the credibility of the EBAC project, and so we believe every effort should be made to ensure these measurements are completed within the 6 GeV running period (if funding becomes available).

Whilst the focus of the upgrade program will inevitably be on experiments for which the maximum beam energy is essential, the PAC was of the opinion that a number of the “lost” low energy experiments that are key to understanding the underlying physics should be considered for running in the 12 GeV era, when 2.2, 4.4, and 6.6 GeV will still be available.

Status Summary of the 6 GeV Experimental Program

	Experiments Recommended for Approval	Experiments Recommended for Conditional Approval	Totals
Experiments	208	20	228
Authors	1301	223	1524
Institutions	237	65	302
Countries	31	14	45

Approved Experiments by Physics Topics

Topic				
	Number Total	Hall A	Hall B	Hall C
Nucleon and Meson Form Factors & Sum Rules	35	13	7	15
Few Body Nuclear Properties	28	17	6	5
Properties of Nuclei	34	12	11	11
N* and Meson Properties	61	13	38	10
Strange Quarks	27	7	16	4
Total	185	62	78	45

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	46 2	865.9	19	249.0	3
B	66 8	778.2	14	231.6	6
C	37 3	799.8	7	251.0	2
Total	149 13	2444.0	40	731.6	11

APPENDIXES

- A. PAC 34 Membership
- B. Charge to PAC 34
- C. PAC 34 Recommendations
- D. PAC 34 Individual Proposal Reports
- E. PAC 34 Individual Letters-of-Intent Reports
- F. Approved Experiments, PAC 34, Grouped by Physics Category

(To access Appendix F, go to http://www.jlab.org/exp_prog/proposals/09prop.html)

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PAC34 Charge:

Jefferson Lab requests that PAC 34:

1. Review both proposals* and letters of intent[†] for experiments that will require major new experimental apparatus not included in the base equipment currently planned for the 12 GeV Upgrade and provide advice on their scientific merit, technical feasibility and resource requirements.
2. Identify [proposals with](#) high-quality physics that: is of scientific merit comparable to that of the research that will be supported by the “base equipment” under construction for the 12 GeV Upgrade; represents an effective use of resources comparable to that of the base equipment; belongs in the priority list to be established for the first decade of 12 GeV Operations; [and merits detailed pursuit of resources and funding](#)
3. Provide comments on technical and scientific issues that should be addressed by the proponents prior to subsequent technical reviews and 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 proposed equipment.

[†] Letters of intent for 12 GeV at PAC34 will be given the same “rights” to their scientific ideas as are currently afforded to deferred experiments

Please also address the following questions about the draft plan for the remaining 6 GeV program:

1. Do the underlying scientific priorities that drove the overall plan, setting beam conditions and narrowing choices for experiments in other halls provide a firm conceptual foundation for our effort to optimize the remaining 6 GeV science program?
2. A number of experiments have been identified as “at risk”:
 - a. Those needing major equipment construction with resources not yet fully identified
 - b. Those falling in portions of the schedule that are likely to be eliminated in reduced budget scenarios

We welcome your suggestions for additional considerations in the decision process as budgets become known, and your comments on the merits of experiments in the “at risk” group that might be addressed if incremental funding is found

APPENDIX C
PAC 34 Recommendations

A	PR-09-003	Nucleon Resonance Studies with CLAS12
A	PR-09-005	An Ultra-precise Measurement of the Weak Mixing Angle using Møller Scattering
A	PR-09-006	The Neutron Electric Form Factor at Q^2 up to $7 \sim (\text{GeV}/c)^2$ from the Reaction ${}^2\text{H}(e, e'n){}^1\text{H}$ via Recoil Polarimetry
A	PR-09-007	Studies of partonic distributions using semi-inclusive production of kaons.
A	PR-09-008	Studies of the Boer-Mulders Asymmetry in Kaon Electroproduction with Hydrogen and Deuterium Targets
A	PR-09-009	Studies of Spin-Orbit Correlations in Kaon Electroproduction in DIS with polarized hydrogen and deuterium targets
A	PR-09-011	Studies of the L-T Separated Kaon Electroproduction Cross Section from 5-11 GeV
A	PR-09-016	Measurement of the Neutron Electromagnetic Form Factor Ratio G_E^n/G_M^n at High Q^2
A	PR-09-019	Precision Measurement of the Neutron Magnetic Form Factor up to $Q^2=18.0 (\text{GeV}/c)^2$ by the Ratio Method
CA	PR-09-001	G_E^p/G_M^p with an 11 GeV electron beam
CA	PR-09-002	Precise Measurement of π^+/π^- Ratios in Semi-inclusive Deep Inelastic Scattering Part I: Charge Symmetry Violating Quark Distributions
CA	PR-09-012	Precision Measurement of Parity-violation in Deep Inelastic Scattering Over a Broad Kinematic Range
CA	PR-09-017	Transverse Momentum Dependence of Semi-Inclusive Pion Production
CA	PR-09-018	Measurement of the Semi-Inclusive π and K electro-production in DIS regime from transversely polarized ${}^3\text{He}$ target with the SBS&BB spectrometers in Hall A
D	PR-09-004	Precise Measurement of π^+/π^- Ratios in Semi-inclusive Deep Inelastic Scattering Part II: Unraveling the Flavor Dependence of the EMC Effect
D	PR-09-010	Precision measurement of the isospin dependence in the 2N and 3N short range correlation region
D	PR-09-013	The Delta d experiment: Constraining d-quark Polarization through Semi-Inclusive Spin Asymmetry Measurements on a Polarized Helium-3 Target
D	PR-09-014	Target Single Spin Asymmetry in Semi-Inclusive Deep-Inelastic Electro-Pion Production Reaction on a Transversely Polarized ${}^3\text{He}$ Target at 11 GeV
D	PR-09-015	A Precision Measurement of the η Radiative decay Width via the Primakoff Effect

- A=Accept,
- C1=Conditionally Approve w/Technical Review,
- C2=Conditionally Approve w/PAC Review,
- C3=Conditionally Approve
- D=Defer

APPENDIX D

Individual Proposal Report

Proposal: PR12-09-001

Scientific Rating: N/A

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

Spokespersons: E. J. Brash, V. Punjabi, C. F. Perdrisat

Motivation:

It is proposed to measure the proton elastic form factor ratio G_E^p/G_M^p up to values of momentum transfer squared of $Q^2 = 13 \text{ GeV}^2$, exploiting the recoil polarization technique, i.e. the polarization transfer from longitudinally polarized electrons to the recoiling protons. The proposal is based on LoI12-06-103, which was submitted to and discussed at PAC30. The recoil polarization technique is the method-of-choice, since it is much less susceptible to two-photon exchange corrections, which are believed to explain the experimental discrepancy between results obtained with “polarization” and the “Rosenbluth separation”. The future availability of higher beam energies will enable an extension to higher Q^2 .

Form factors are fundamental nucleon properties, and additional precision data at higher Q^2 are important for constraining nucleon models. The new experiment (GEP-IV) would be performed in Hall C, using a polarized electron beam incident on an unpolarized liquid hydrogen target. The scattered electrons would be detected in an electromagnetic calorimeter (BigCal), while the polarization components of the recoiling protons would be analyzed in the focal-plane polarimeter (FPP) of the Super-HMS (SHMS) magnetic spectrometer.

Measurement and Feasibility:

The proposed experiment (GEP-IV) is an extension of an experiment performed by the same group (GEP-III) with the same technique and similar equipment (use of BigCal for e, but HMS instead of SHMS for p), and preliminary results were shown to the PAC for Q^2 up to 9 GeV^2 (which confirm the linear decrease of G_E^p/G_M^p with Q^2). Since SHMS is considered to be base-equipment of the JLab upgrade program, the PAC did not have any concerns about the feasibility of this experiment.

Issues:

The PAC took note that there are two proposals (this one, PR-09-001, called GEP-IV, and PR-07-109, GEP-V, which was approved by PAC32), aiming to measure the same quantity over similar momentum ranges (GEP-IV up to $Q^2 = 13 \text{ GeV}^2$, GEP-V up to 15 GeV^2), using the same technique. GEP-IV is a Hall C proposal, while GEP-V is for Hall A. There is a large overlap of the proponents of both measurements. While they consider both experiments to be complementary (high resolution and small acceptance vs. small resolution and large acceptance), the PAC is not convinced that both of them should be pursued. The PAC therefore asks the two collaborations to either come up with one common proposal or to make an extremely compelling

case as to why both of them need to be done. It also reminds the proponents that all the approved 12 GeV proposals will be subject to (at least) one more examination, just before the upgraded Laboratory program will actually start running.

Recommendation: Conditional Approval

Individual Proposal Report

Proposal: PR12-09-002

Scientific Rating: N/A

Title: Precise Measurement of π^+/π^- Ratios in Semi-inclusive Deep Inelastic Scattering Part I: Charge Symmetry Violating Quark Distributions

Spokespersons: K. Hafidi, D. Gaskell, D. Dutta

Motivation: This experiment will measure the semi-inclusive cross-sections for π^+ and π^- production from a deuterium target. The principal goal of the measurement is to look at the π^+/π^- cross section ratio vs x and Q^2 for evidence of isospin symmetry violation in the nucleon, in the form of PDF differences $u_p(x)-d_n(x)$ and/or $u_n(x)-d_p(x)$. The z dependence of the cross sections will also be measured, with the goal of studying symmetries of the fragmentation functions. The measurements will be performed at parallel kinematics with limited coverage in $p_{h\perp}$ and full coverage in ϕ (though no plots to this effect are included).

Measurement and Feasibility: The proposal requests 17 days of running in Hall C. Standard equipment will be used, with the SHMS (HMS) detecting electrons (hadrons). No experimental challenges beyond those already addressed in the proposal are foreseen.

Issues: First, see the “Comments to All SIDIS Proposals” in the overall report.

Isolating an isospin symmetry violation in the nucleon PDFs using SIDIS is extremely challenging. The proposers are clearly cognizant of the difficulties: modest deviations from pure independent fragmentation can overwhelm a small isospin difference, and there are more possibilities for broken fragmentation function symmetries than the one identified in Equation (15) of this Proposal.

Nonetheless, the cross sections are such basic tests of the understanding of SIDIS at 11 GeV kinematics that they will play a critical role in establishing the entire SIDIS program of studying the partonic structure of the nucleon. In particular they complement the CLAS12 measurements in areas where the precision of spectrometer experiments is essential – in this case, precise control of the relative acceptance and efficiency for different particle charges. The PAC strongly recommends that these measurements occur in the early years of 12 GeV operation. The case for this experiment will be strengthened if it focuses its attention on complementing the CLAS12 SIDIS program in areas where the precision of Hall C is essential, as is done more clearly in PR12-09-017 and PR12-06-104.

The PAC recommends approval subject to the condition that the collaborations of PR12-09-002, PR12-09-017, and the previously approved PR12-06-104 combine their measurement plans into a single coordinated experiment in Hall C, so that setup and data-taking time is not duplicated needlessly. This combined proposal should be presented at the next PAC review.

Recommendation: Conditional Approval

Individual Proposal Report

Proposal: PR12-09-003

Scientific Rating: N/A

Title: Nucleon Resonance Studies with CLAS12

Spokespersons: V. Burkert, P.L. Cole, 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 excited 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. The proposed experiment will run concurrently with the approved experiments: E12-06-119, E12-06-112, and E12-06-108.

Issues:

The experiment has strong support of different theoretical groups using coupled channel approach, fixed- t dispersion relations and unitary isobar models to extract the transition form factors as model independently as possible. This close collaboration between theory and experiment is needed to achieve the aim of determining the electrocouplings as a function of Q^2 for the nucleon and delta states.

Recommendation: Approval

Individual Proposal Report

Proposal: PR12-09-004

Scientific Rating: N/A

Title: Precise Measurement of π^+/π^- Ratios in Semi-inclusive Deep Inelastic Scattering Part II: Unraveling the Flavor Dependence of the EMC Effect

Spokespersons: K. Hafidi, D. Gaskell, D. Dutta

Motivation: Understanding the origin of the EMC effect has been a compelling problem for 30 years. New progress in understanding the underlying physics might be possible with new measurements, such as using SIDIS to tag the struck quark flavor to determine if the EMC effect is flavor dependent. A model calculation suggests that scalar and vector fields in the nucleus lead to ~10% differences in the EMC effect for u and d quarks.

Measurement and Feasibility: The current proposal uses SIDIS to search for the proposed difference in the EMC effect between u and d quarks. Of particular interest are the super-ratio $[Y_A(\pi^-)/Y_A(\pi^+)] / [Y_D(\pi^-)/Y_D(\pi^+)]$ and the difference ratio $[Y(\pi^+-\pi^-)_A] / [Y(\pi^+-\pi^-)_D]$, which are proposed to be sensitive to the EMC effect. Pion hadronization in the nucleus is assumed to be factorizable from the quark distributions and existing HERMES data (integrated over x) suggest that hadron attenuation effects are the same for π^+ and π^- to within a few percent. The lack of an observed EMC effect at $x \sim 0.3$ is proposed as a measure of the hadronization which can be used to correct for any remaining hadronization differences between π^+ and π^- in the proposed measurement.

Issues: Unpolarized SIDIS measurements are dependent on 5 kinematic variables, x, Q^2 , z, p_T , and ϕ . It was typical in early low statistics experiments to display the dependence on one variable integrated over the others, but the as yet unknown physics in SIDIS at 11 GeV makes determining the systematic uncertainties from missing regions in these integrations a difficult problem, possibly leading to large systematic uncertainties that undermine the principal physics goals. Attempts to perform high-precision SIDIS comparisons, integrating over some variables, will invariably lead to problems if there is not adequate coverage in these variables. These systematic uncertainties need to be convincingly estimated.

The current experiment focuses on the small p_T region, and it is uncertain at this point how the p_T dependence is changed in Au vs deuterium; such a dependence could mimic a flavor dependence. Furthermore, the HERMES data show that there is a significant v dependence in the nuclear pion attenuation at fixed Q^2 , implying an effective x dependence in the attenuation. The HERMES data also show v dependence at fixed z and in general the attenuation effects are strongest at the lower v values probed in this measurement. As v is generally thought to play a strong role in the distance scale of the hadronization process it is closely linked to nuclear size. The double ratio is likely unaffected by this effect, however, the charge difference asymmetry may be significantly changed. The use of the $x \sim 0.3$ region for calibrations is not sufficient, as there might be an underlying flavor dependence of the quark distributions in this region.

Measurements on a relatively large $N=Z$ target as a check of the understanding of the nuclear attenuation are desirable. Finally, QED effects could induce differences between π^+ and π^- between Au and deuterium.

The judgment of the PAC at this point is that the understanding of the nuclear attenuation at these kinematics is too crude to allow the results of the measurement to be used to study the flavor dependence. Nevertheless, the PAC strongly supports the goal of investigating the underlying physics of the EMC effect, and encourages future proposals focusing on this physics; these proposals should address how either a more expanded standalone measurement or a measurement combined with results from other JLab hadron attenuation measurements can be used to constrain the systematic uncertainties discussed above.

Recommendation: Defer with Regret

Individual Proposal Report

Proposal: PR12-09-005

Scientific Rating: N/A

Title: An Ultra-precise Measurement of the Weak Mixing Angle using Moller Scattering

Contact Person: Krishna Kumar

Motivation:

The goal of this proposal is to measure the parity violating, left-right asymmetry in polarized Moller scattering, $ee \rightarrow ee$, at the $\pm 2.3\%$ level. That measurement would determine $\sin^2 \theta_w$ to ± 0.00029 ; a sensitivity comparable to the best measurements made at the Z pole, but in a purely leptonic channel at low momentum transfer. Comparison of those distinct determinations as well as other precision electroweak observables would probe “new physics” effects at the multi-TeV level and complement potential discoveries at the LHC. Examples of possible new phenomena probed include: Z' bosons, supersymmetry, compositeness and doubly charged Higgs scalars. The proposed physics reach is outstanding and capable of making this effort a flagship experiment at JLAB.

Measurement and Feasibility:

The study of parity violating Moller scattering was successfully carried out in experiment E158 at SLAC. This proposal is more technically challenging because the asymmetry is smaller and the goal is more demanding. Nevertheless, the high quality and intensity of the JLab beam makes the measurement, in principle, doable.

Issues: The PAC believes:

- 1) The group is very capable and accomplished but increased manpower is needed. In that regard, it would be useful to recruit foreign collaborators.
- 2) The detector should be moveable; so, other experiments can be carried out in Hall A between the long intermittent runs of this experiment.
- 3) The beam and running conditions should be designed in a way that is minimally disruptive to experiments in other Halls.
- 4) The group should develop a plan for convincingly extrapolating the rate and asymmetry from elastic and inelastic $e-p$ scattering under the Moller acceptance.
- 5) The statistical and systematic uncertainty goals of the experiment are extremely demanding but cannot be compromised at any significant level without reducing the scientific impact of the measurement. The proponents argue that issues of systematic uncertainties, background from $e-p$ scattering, and noise that adds to counting statistics are under control.

The group must develop a full design of the apparatus and demonstrate in a series of technical reviews that the above conditions will be met.

Recommendation: Approval.

Individual Proposal Report

Proposal: PR12-09-006

Scientific Rating: N/A

Title: The Neutron Electric Form Factor at Q^2 up to 7 (GeV/c)^2 from the Reaction ${}^2\text{H}(e, e'n){}^1\text{H}$ via Recoil Polarimetry

Spokespersons:

B. D. Anderson, J. Arrington, S. Kowalski, R. Madey, B. Plaster, A.Yu. Semenov

Motivation:

The collaboration proposes to perform new measurements of the electric form factor of the neutron G_E^n at momentum transfers $Q^2 = 2.18, 3.95, 5.22, 6.88 \text{ (GeV/c)}^2$ by using recoil neutron polarimetry in the reaction ${}^2\text{H}(e(\text{pol}), e'n(\text{pol}))\text{H}$ from a liquid deuterium target, extending their previous published results that covered up to $Q^2 = 1.45 \text{ (GeV/c)}^2$, and overlap with recent preliminary data from JLab experiment E-02-013.

The primary motivation for this proposed experiment is the ability to measure a fundamental quantity of the neutron – one of the basic building blocks of matter. A successful model of confinement must be able to predict both neutron and proton electromagnetic form factors simultaneously. The neutron electric form factor is especially sensitive to the nucleon wave function, and differences between model predictions for G_E^n tend to increase rapidly with Q^2 .

Measurement and Feasibility:

It is proposed to measure G_E^n from the ${}^2\text{H}(e(\text{pol}), e'n(\text{pol}))\text{H}$ reaction on a liquid deuterium target at Q^2 values of 2.18, 3.95, 5.22, 6.8 (GeV/c)^2 . The experiment would use the same technique already successfully employed in JLab experiment E-93-038. A high-luminosity neutron polarimeter and a dipole neutron-spin-precession magnet would be used to measure the ratio of two scattering asymmetries associated with positive and negative precessions of the neutron polarization vector. The ratio technique is very appealing from the point of view of experimental accuracy, as many systematic uncertainties cancel or are reduced in the ratio. In addition, the reaction mechanism and nuclear physics corrections (for FSI, MEC, and IC) are best understood and most reliable for the deuteron.

The proposed measurements of G_E^n will be essential to challenge theoretical calculations of the nucleon structure, including both models and new rigorous lattice QCD calculations. Knowledge of this quantity will also help to reduce systematic errors in proposed experiments to measure G_M^n at high Q^2 .

Issues:

The PAC heard two proposals to measure neutron electromagnetic form factors (this one, PR12-09-006, and PR12-09-016, using a polarized beam and a ${}^3\text{He}$ polarized target). Since corrections are necessary to deduce the neutron quantities, which are different for the two measurements, the

PAC felt that it is worth pursuing both experiments because of the importance of such data. The PAC, however, would like to stress that funding of the additional equipment for this measurement has to be secured. While the committee is presently convinced that the experiment should run, it also reminds the proponents that all the approved 12 GeV proposals will be subject to (at least) one more examination, before the upgraded Laboratory program will actually start running.

The collaboration recognized that the proposed magnet is not adequate in terms of integrated field. The PAC urges the proponents to work with the laboratory to look for a viable and cost-effective solution, like identifying a second available magnet that could be used to increase the neutron path length in the field.

In order to have a better knowledge of the analysing power and therefore a better estimate of the expected errors, instead of just extrapolating the existing data at lower momentum, the PAC recommends the proponents investigate whether such data may be available from other facilities. The PAC also suggests that they look into the possibility of alternative, more hydrogen-rich, materials for the polarimeter, as the (target) proton analysing power is larger.

This being a precision measurement of a small quantity and in view of the issues raised above, the PAC encourages the proponents to make sure that there is a sufficient workforce of young physicists who can carry forward the experience from E-93-038.

Recommendation: Approval

Individual Proposal Report

Proposal: PR12-09-007

Scientific Rating: N/A

Title: Studies of partonic distributions using semi-inclusive production of kaons

Spokespersons: K. Hafidi, A. El Alaoui, H. Avakian, F. Benmokhtar, M. Mirazita

Motivation:

The collaboration proposes to use the CLAS12 detector in Hall B to study the electroproduction of pions and kaons at deep inelastic scattering (DIS) kinematics from unpolarized and longitudinally polarized proton and deuterium targets. The goals include a better understanding of fragmentation functions and the spin, flavor, and transverse momentum dependence of nucleon structure functions. This proposal emphasizes the measurement of kaons for which a new RICH detector is proposed. This will enhance the flavor separation goals.

Measurement and Feasibility:

CLAS12 with its large acceptance is particularly suitable for semi-inclusive DIS measurements, providing excellent coverage in x , Q^2 , z , p_T , and ϕ^* (the azimuthal angle around the virtual photon). The base CLAS12 proposal only allows for kaon identification over a limited momentum range. The addition of a new RICH detector just before the electromagnetic (EM) calorimeter will provide kaon particle identification (PID) over the full momentum range. Part of the running time requested is simultaneous with an already approved pion electroproduction experiment.

Issues:

First, see the “Comments to All SIDIS Proposals” in overall report.

As referred to in the above comments, a coherent coordination of all efforts in the area of DIS/SIDIS at JLAB is needed. In particular, it is important to understand if there are particular measurements in a narrow kinematic range which might be required to support the large acceptance spectrometer measurements as well as the information required from the large acceptance spectrometers which can support high luminosity focused physics investigations with small acceptance spectrometers.

The RICH detector proposed (in common with other CLAS12) proposals is still at an early stage of development and needs further study in order to understand not only the basic PID capabilities, but also how it might impact on the performance of the EM calorimeter, from which it is just upstream. The present choice of RICH technology is expensive and thus the coverage in spectrometer azimuthal angle is limited at present; we urge the collaboration to

investigate the tradeoff in detector cost/performance vs the loss of statistical and systematic precision resulting from the incomplete coverage.

The PAC strongly supports the measurement of these kaon observables from DIS electroproduction and therefore strongly supports the inclusion of a RICH detector which can identify kaons with adequate precision over the full kinematic acceptance of CLAS12. However, the present set of projection plots is insufficiently detailed to design a coherent, lab-wide SIDIS effort. As described in the section “Comments to all SIDIS Proposals”, it is vitally important to see CLAS12 projections in a fully differential binning so that the impact of other proposals may be accurately assessed. This is particularly true for kaon channels where the rates are more limited than for pions. Also vital for the kaon program is the ability of CLAS12 to constrain specific dependences of the Single Spin Assymetries – notably as functions of Q^2 – as kaons are likely subject to larger higher twist and target fragmentation effects. Further, as proposal PR-09-007 looks at transverse momentum integrated parton distribution functions and formfactors, it relies even more strongly than other CLAS12 proposals on a global understanding of the SIDIS measurements in the full kinematic domain available, including the understanding of higher twist and separation of current and target regions.

The PAC urges the CLAS12 proponents to prepare a comprehensive set of projections, as outlined in the “Comments to all SIDIS Proposals” section, to provide a baseline for the lab-wide SIDIS effort and to enhance the case for the CLAS12 RICH.

Recommendation: Approval

Individual Proposal Report

Proposal: PR12- 09-008

Scientific Rating: N/A

Title: Studies of the Boer-Mulders Asymmetry in Kaon Electroproduction with Hydrogen and Deuterium Targets

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

Motivation: The collaboration proposes to use the CLAS12 detector in Hall B to study the electroproduction of pions and kaons at deep inelastic scattering (DIS) kinematics from unpolarized proton and deuterium targets. This proposal emphasizes the measurement of the $\cos 2\phi$ azimuthal asymmetry of kaons for which a new RICH detector is proposed. These asymmetries provide information to constrain the underlying transverse momentum dependent quark distributions and fragmentation functions.

Measurement and Feasibility: CLAS12 with its large acceptance is particularly suitable for semi-inclusive DIS measurements, providing excellent coverage in x , Q^2 , z , p_T , and ϕ^* (the azimuthal angle about the virtual photon). The base CLAS12 proposal only allows for kaon identification over a limited momentum range. The addition of a new RICH detector just before the EM calorimeter will provide kaon identification over the full momentum range. The running time requested is simultaneous with an already approved pion electroproduction experiment.

Issues:

First, see the “Comments to All SIDIS Proposals” in the overall report.

As referred to in the above comments, a coherent coordination of all efforts in the area of DIS/SIDIS at JLAB is needed. In particular, it is important to understand if there are particular measurements in a narrow kinematic range which might be required to support the large acceptance spectrometer measurements as well as the information required from the large acceptance spectrometers which can support high luminosity focused physics investigations with small acceptance spectrometers.

The RICH detector proposed (in common with other CLAS12) proposals is still at an early stage of development and needs further study in order to understand not only the basic particle identification capabilities, but also how it might impact the performance of the electromagnetic calorimeter, from which it is just upstream. The present choice of RICH technology is expensive and thus the coverage in spectrometer azimuthal angle is limited at present; we urge the collaboration to investigate the tradeoff in detector cost/performance vs the loss of statistical and systematic precision resulting from the incomplete coverage.

The PAC strongly supports the measurement of these kaon observables from DIS electroproduction and therefore strongly supports the inclusion of a RICH detector which can identify kaons with adequate precision over the full kinematic acceptance of CLAS12.

Recommendation: Approval

Individual Proposal Report

Proposal: PR12-09-009

Scientific Rating: N/A

Title: Studies of Spin-Orbit Correlations in Kaon Electroproduction in DIS with polarized hydrogen and deuterium targets

Spokespersons: H. Avakian, E. Cisbani, K. Griffioen, K. Hafidi, P. Rossi

Motivation: The collaboration proposes to use the CLAS12 detector in Hall B to study the electroproduction of pions and kaons at deep inelastic scattering (DIS) kinematics from longitudinally polarized proton and deuterium targets. These asymmetries provide information to constrain the underlying transverse momentum dependent quark distributions and fragmentation functions. Special attention is given to the study of the single spin asymmetries.

Measurement and Feasibility:

CLAS12 with its large acceptance is particularly suitable for semi-inclusive DIS measurements, providing excellent coverage in x , Q^2 , z , p_T , and ϕ^* (the azimuthal angle about the virtual photon). The base CLAS12 proposal only allows for kaon identification over a limited momentum range. The addition of a new RICH detector just before the EM calorimeter will provide kaon PID over the full momentum range. The running time requested is largely simultaneous with an already approved pion electroproduction experiment.

Issues:

First, see the “Comments to All SIDIS Proposals” in the overall report

The RICH detector proposed (in common with other CLAS12 proposals) is still at an early stage of development and needs further study in order to understand not only the basic particle identification capabilities, but also how it might impact the performance of the electromagnetic calorimeter, from which it is just upstream.. The present choice of RICH technology is expensive and thus the coverage in spectrometer azimuthal angle is limited at present; we urge the collaboration to investigate the tradeoff in detector cost/performance vs the loss of statistical and systematic precision resulting from the incomplete coverage.

The PAC strongly supports the measurement of these kaon observables from DIS electroproduction and therefore strongly supports the inclusion of a RICH detector which can identify kaons with adequate precision over the full kinematic acceptance of CLAS12. However, the present set of projection plots is insufficiently detailed to design a coherent, lab-wide SIDIS effort. As described in the section “Comments to All SIDIS Proposals”, it is vitally important to see CLAS12 projections in a fully differential binning so that the impact of other proposals may be accurately assessed. This is particularly true for kaon channels where the rates are more

limited than for pions. Also vital for the kaon program is the ability of CLAS12 to constrain specific dependences of the SSAs – notably vs Q^2 – as the kaons are likely subject to larger higher twist and target fragmentation effects.

The PAC urges the CLAS12 proponents to prepare a comprehensive set of projections, as outlined in the “Comments” section, to provide a baseline for the lab-wide SIDIS effort and to enhance the case for the CLAS12 RICH.

Recommendation: Approval

Individual Proposal Report

Proposal: PR12-09-010

Scientific Rating:

Title: Precision measurement of the isospin dependence in the 2N and 3N short range correlation region

Spokespersons: J. Arrington, D. Day, P. Solvignon

Motivation:

A simple model predicts the local scaling of the inclusive electron scattering cross sections. Earlier studies demonstrated the scaling for $1.5 < x < 2$, i.e., in the region of two-nucleon short-range correlations (2N SRC) and suggested the appearance of the second plateau at $2.25 < x < 2.8$, attributed to three-nucleon (3N) SRC. Independently in two-nucleon knock-out reaction studies, the dominance of correlated np pairs over pp pairs in the range of relative momenta (275–550) MeV/c has been demonstrated and explained in terms of deuteron-like correlations due to the tensor force (Science 320, 1476 (2008)). The proposed study, which is a logical continuation of previous work, has two major objectives:

- (i) By using ^3He and ^3H targets, investigate isospin dependence of 2N-SRC with a 40% sensitivity; and
- (ii) Collect detailed information on the structure of the 3N-SRC.

The experimental results will be interpreted by means of ab-initio calculations based on realistic 2N and 3N forces that can be carried out for three-body systems. The measurement adds to the approved measurement E08-014 that will address the question of 2N-SRC scaling, will verify the existence/onset of 3N-SRC, and will study isospin dependence on $^{40,48}\text{Ca}$ isotopes with a 25% sensitivity. This is a very interesting experiment, with clearly defined objectives and a strong coupling with theory.

Measurement and Feasibility:

Apart from the ^3H target, the experiment is a straightforward application of the HRS and beamline base equipment.

Issues:

The use of tritium raises significant safety concerns.

The physics objectives of this experiment are closely linked to the approved E08-014. For that reason, the PAC believes that the further discussions regarding this proposal should be postponed until the impact of E08-014 has been fully assessed.

Recommendation: Defer with Regret

Individual Proposal Report

Proposal: PR12-09-011

Scientific Rating: N/A

Title: Studies of the L-T separated kaon electroproduction cross sections from 5-11 GeV

Spokespersons: T. Horn, G. Huber, P. Markowitz

Motivation: This experiment proposes to measure the electroproduction of kaons in the deep inelastic region in a wide range of Q^2 with separation of the longitudinal and transverse cross sections.

The first motivation is a detailed study of the reaction mechanism, in particular to check the dominance the kaon pole in the longitudinal cross section, which would allow to extract the kaon form factor. This later point is however doubtful because the pole is so far from the physical region that there is no reason to believe that it dominates the amplitude. Therefore the extraction of the form factor would go through a model, with all the ambiguities that this implies. So this first motivation reduces to a study of the reaction mechanism and by itself does not justify the experiment.

The second motivation, which is a study of the scaling behavior of the longitudinal cross section, is much better. According to the QCD factorisation theorem this part of the cross sections can be written as a convolution of generalized parton distributions (GPDs) with a known hard scattering kernel and a meson distribution amplitude. This would open a new domain for GPD study since virtually nothing is known concerning these quantities when strangeness is in play. As the factorisation theorem is only valid at asymptotically large Q^2 , it is compulsory to first test that the regime of validity has been reached and this can be done by comparing the Q^2 variation of the cross section against the prediction of QCD. This is a solid physics case which certainly justifies the experiment.

In summary the experiment is well motivated in so far as its major part is devoted to the scaling study, which of course must be performed at fixed x_B and t .

Measurement and Feasibility: The authors have extensive experience since this is the third generation of L-T separated meson production in Hall C. They will use the familiar HMS for the electrons and the SHMS for the Kaons.

Issues: The detection of the kaons requires several aerogels which have to be funded and built. Due to the beam intensity limitation in the early years of the 12 GeV operations a longer target may be necessary. The experience requires several non standard energies, which may pose scheduling problems.

The reaction mechanism study must be only a minor part of the experiment and there is moreover no reason to perform it at very small Q^2 . Therefore the measurements at $Q^2 = 0.4 \text{ GeV}^2$ should be removed from the proposal.

Recommendation: Approval

Individual Proposal Report

Proposal: PR12-09-012

Scientific Rating: N/A

Title: Precision Measurement of Parity-violation in Deep Inelastic Scattering Over a Broad Kinematic Range

Spokespersons: Paul Souder

Motivation:

The aim of the proposed experiment is a precise determination of a combination of axial-vector electron-quark couplings by measuring the longitudinal asymmetry in deep-inelastic electron scattering from a ^2H target using a large new solenoidal tracking spectrometer. The precise determination of the axial couplings will provide a test of the standard model that searches for new physics different from earlier searches, Moller scattering, or Q_{weak} . The use of deep inelastic scattering provides new opportunities to investigate the hadronic modification of the free-quark asymmetries; charge symmetry violation (CSV) and higher twist effects. At the same time, the modeling of incompletely-understood hadronic effects may introduce uncertainties of the same order as the statistical uncertainty in the proposed measurement. The proposed 12 GeV data and data from a scheduled 6 GeV measurement will cover a broad range of Q^2 and x . The proponents argue that a simultaneous fit of the combined data can separate A_{PV} , CSV, and higher-twist effects.

The new spectrometer will support a broadly-based program of interesting future studies including determination of the u/d ratio in the proton and studies of the EMC effect using nuclear targets.

Measurement and Feasibility:

The proposed spectrometer will shield the target from the tracking by a series of baffles. The rates are high, but achievable. The large size of the DIS asymmetries makes the use of tracking detectors feasible. The Q^2 and x dependence of the asymmetry require the measurement of the kinematical variables for individual events. The beam, target, and polarimetry requirements involve challenging but evolutionary improvements of existing techniques.

Issues:

In the view of the PAC, the major scientific issue is the question of how one can precisely disentangle A_{PV} on free quarks from the observed A_{PV} that is modified by CSV and higher-twist effects. The modifications may be of the same order as the expected experimental uncertainty. It has been suggested that the CSV effects are small at 6 GeV, where a currently approved PVDIS experiment will run, and the PAC looks forward to the results and analysis of these 6 GeV data. The proposal contains an excellent discussion of CSV and higher-twist effects, but the experts on

the PAC feel that these issues need further clarification. The proponents and the PVDIS community are encouraged to work to improve their understanding of CSV and higher-twist effects. In addition, the PVDIS apparatus is very large and will not be easily removed from the Hall A beamline. The PAC is acutely concerned about the impact that leaving PVDIS in place for many years will have on other experiments planned for the hall. The feasibility of running other experiments by leaving the magnet itself in place and removing the target and detector packages must be examined in detail.

Recommendation: Conditional Approval

Individual Proposal Report

Proposal: PR12-09-013

Scientific Rating: N/A

Title: The Δd experiment: Constraining d -quark polarization through semi-inclusive measurements on a polarized ^3He target

Spokespersons: J.-P. Chen, X. Jiang

Motivation:

The proposed experiment aims to constrain a certain ratio of polarized and unpolarized d - and u -quark densities, by measuring the double spin asymmetry of the difference of π^+ and π^- semi-inclusive electroproduction cross sections on a polarized ^3He target. By combining the results with inclusive spin structure function data, it is planned to extract also the flavor asymmetry of the polarized antiquark distributions, $\Delta\bar{u}$ – $\Delta\bar{d}$.

Measurement and Feasibility: The scattered electron is detected using the BigBite spectrometer in Hall A; leading hadrons are detected using the left-HRS spectrometer.

Issues:

The limited kinematic coverage in $p_{\text{h}\perp}$ and the strong correlations between the x , Q^2 , $p_{\text{h}\perp}$ and z (or W) dependences do not allow one to test the validity of assumptions made about the semi-inclusive production mechanism in the present experiment. The interpretation of the measured asymmetry will be subject to unknown systematic errors related to corrections to independent quark fragmentation and non-uniform sampling of quark k_T . While these corrections may in principle be controlled using phenomenological models and/or results of other future experiments, the PAC was not convinced that a high-statistics measurement with the proposed kinematics is warranted under these conditions. The proposed high-precision measurement may have merit as a next-generation SIDIS experiment, when the reaction mechanism in the JLab kinematic regime will have been explored by more broad-based measurements, and the need for further data can be assessed. The section entitled “Comments to All SIDIS Proposals” in the overall report puts our view of this proposal in context with our evaluation of the 12 GeV SIDIS program as a whole.

Recommendation: Defer

Individual Proposal Report

Proposal: PR12-09-014

Title: Target Single Spin Asymmetry in Semi-Inclusive Deep-Inelastic ($e, e'\pi^\pm$) Reaction on a Transversely Polarized ^3He Target at 11 GeV

Spokespersons: H. Gao, X. Qian, J.-P. Chen, X.D. Jiang, J.-C. Peng

Motivation: This collaboration proposes to measure target single spin azimuthal asymmetries (SSA) of semi-inclusive charged pion electroproduction from transversely polarized ^3He in deep inelastic kinematics, in particular the Collins, Sivers, and Pretzelosity asymmetries. Combined with knowledge of the Collins fragmentation functions from other experiments, the Collins asymmetry can be used to extract the quark transversity distribution of the neutron, and ultimately integrated over x to determine the tensor charge of the d quarks in the nucleon.

Measurement and Feasibility: The collaboration proposes to use the same solenoid as the PVDIS (PR12-09-012) experiment (SoLID) but with the detectors deployed to different locations and augmented with Čerenkov detectors, and with the polarized target located upstream of SoLID. The open geometry spectrometer allows significant study of the dependences of the asymmetries on p_T , z , x , Q^2 and ϕ^* (the azimuthal angle of the pion about the virtual photon direction). The 2π azimuthal coverage of the spectrometer around the beam direction will allow the collection of a larger event sample than that of small acceptance spectrometers, for a given luminosity. Clearly this is at the cost of requiring efficient and strong identification of both electrons and pions over the full acceptance. Furthermore, it is expected that the full azimuthal coverage will allow significant cancellation of systematic uncertainties arising from acceptance/efficiency variations across the spectrometer acceptance using a minimal number of target spin orientation. The proposed polarized target is already operating with adequate performance. Raw rates in the planned GEM appear to be acceptable, however, the rates in the Čerenkov detectors were of concern, especially given the large photon backgrounds. The overall factor of 100 increase in luminosity compared to CLAS12 and the effects of Møller scattering from the target raised significant concerns about the feasibility of the measurement with the spectrometer as described.

The spectrometer is claimed to be able to identify the events of interest both in the fast time required for a readout trigger as well as in the offline analysis, while operating with close to $10^{37} \text{ cm}^{-2} \text{ s}^{-1}$ luminosity. Particular technical concerns that should be addressed are:

- 1) Which specific processes and background reactions are included in the studies?
- 2) For the case of Møller scattering, what low energy cuts are applied to electrons and photons included in the simulations?
- 3) How will collimation around the target be implemented; how was the efficacy determined?
- 4) In addition to average rates in a given (entire) detector, what are the locally highest rates in particular sections of the detectors?

- 5) For the granularity of detectors proposed, what are the occupancies, again both peak and average, especially in those regions of the detectors where the bulk of the SIDIS yield is detected?
- 6) Tracking studies should be performed to demonstrate that the proposed tracking and PID detectors provide sufficient information and redundancy in the high rate environment to efficiently and correctly identify real SIDIS events out of the accidental coincidences/ghost tracks from charged and neutral background. Do the Čerenkov detectors have sufficient granularity/position resolution to allow adequate PID for each track? A detailed description of the tracking chambers positions, readout strip pitch and orientation should be included.
- 7) A plan should be developed which describes in detail how the change from the PVDIS setup to the ^3He setup would be accomplished, and what special constraints on the PVDIS detector designs are required. For example, how will the GEM planes be constructed so that the PVDIS GEMS can be redeployed in the upstream part of the solenoid?
- 8) A more detailed description of the trigger/DAQ including trigger definition and rate, at level 1, 2 (3?), data rates to the DAQ and data volume written to storage for analysis. Is the granularity sufficient to suppress accidental triggers?
- 9) What are the impacts of a solenoid this large being installed and instrumented in Hall A? What interference with other Hall A experiments is foreseen (not just the Møller PV experiment)?
- 10) A more detailed demonstration of how much the full azimuthal coverage reduces the systematic uncertainties, with simulation studies using realistic variations in efficiency/acceptance of the spectrometer, would be very useful.
- 11) Finally, what is the justification for the particular statistical accuracy which is the goal of the experiment; if a significantly lower luminosity was used, would the impact the measurement be significantly degraded relative to any other proposed experiments?

Issues:

First, see “Comments to All SIDIS Proposals” in the overall report.

As described in the above comments, it is important to understand the systematic uncertainties arising from gaps in the multidimensional space of SIDIS measurements. In this experiment, there are concerns that loss in ϕ^* acceptance at very small forward angles leads to larger systematic uncertainty in the azimuthal asymmetries than presently estimated. Future proposals should show the acceptance in p_T vs ϕ^* for each Q^2 - x bin separately, rather than just p_T vs x or p_T vs z (though this was very much appreciated).

In order to extract the SSA, corrections for intrinsic backgrounds will need to be applied. In particular, will data at lower beam energies (cross sections and asymmetries) be needed to adequately model the radiative tails from exclusive and resonance region ($\Delta(1232)$ in particular) pion production? Also, will the contributions from diffractive ρ^0 production be known well enough (not relying on Lund M.C., which doesn't model the SSA of a single pion from ρ^0 decay properly)? Is there a plan to measure this with π^+/π^- coincidences, and if so, if the acceptance big enough (*i.e.*, is better coverage at small angles needed)?

The PAC is also concerned that nuclear corrections, beyond the usual impulse approximations typically used to correct neutron structure from ^3He measurements, may play a larger role in azimuthal observables than in inclusive or semi-inclusive (yield) asymmetries. The collaboration is aware of these issues and the PAC endorses the theoretical efforts to investigate these nuclear effects.

Another complicating factor for the PAC was the coupling of this proposal to the PVDIS proposal (PR12-09-012). It was not felt that the ^3He measurement alone could justify the expense of the SoLID spectrometer; however, a broad program of high priority physics measurements beyond that of the PVDIS program certainly strengthens the case to invest in SoLID.

Despite the questions of feasibility raised above, the PAC strongly endorses the physics goals of the experiment and the collaboration is encouraged to submit a new proposal that addresses the technical concerns in some detail, as the ambitious experimental setup and high luminosity requires a more thorough justification than more modest proposals. These necessary simulation studies will be required by any subsequent technical review in any case.

Recommendation: Defer with Regret

Individual Proposal Report

Proposal: PR12-09-015

Scientific Rating: N/A

Title: A Precision Measurement of the η Radiative decay Width via the Primakoff Effect

Spokespersons: A. Gasparian, L. Gan, R. Miskimen, D. Dale

Motivation:

The collaboration proposes to measure the $\eta \rightarrow \gamma\gamma$ decay width with an accuracy of 2% in the tagged photon beam in Hall D via the Primakoff effect on a ^1H target. Values of the width measured at colliders are 3σ larger than a measurement using the Primakoff effect performed at Cornell. The proposed 2% accuracy is an improvement over the world average uncertainty. The improved measurement will constrain light-quark masses and chiral-symmetry breaking. The group proposes to use their PbWO_4 calorimeter which has better granularity, energy resolution, and radiation hardness than the Pb glass calorimeter in the GLUEX apparatus. The group has successfully measured the π^0 width using their PbWO_4 calorimeter in the *PRIMEX I* experiment.

Measurement and Feasibility:

The experiment appears to be feasible using the tagged bremsstrahlung beam in Hall D.

Issues:

The proponents request a dedicated run that involves substituting the group's PbWO_4 calorimeter for the GLUEX Pb glass detector, installing a liquid-hydrogen target, and turning off the solenoid-detector field. These changes are disruptive to the GLUEX program and apparatus.

The collaboration is encouraged to discuss joining the GLUEX collaboration with the members of the GLUEX collaboration and Hall D management. The group's PbWO_4 detector modules would be installed in the center of the GLUEX Pb glass detector, be integrated into GLUEX DAQ, and become a permanent part of the GLUEX apparatus. The PAC would then entertain a new proposal involving the GLUEX collaboration.

Recommendation: Defer.

Individual Proposal Report

Proposal: PR12-09-016

Scientific Rating: N/A

Title: Measurement of the Neutron Electromagnetic Form Factor Ratio G_E^n/G_M^n at High Q^2

Spokespersons: B. Wojtsekhowski, G. Cates, S. Riordan

Motivation:

The proposal is to measure the nucleon electromagnetic form factor ratio for the neutron G_E^n/G_M^n at three values of transferred momentum squared ($Q^2 = 5.0, 6.8$ and 10.2 GeV^2) by making use of the Jlab planned upgraded high energy electron beams. The proponents would use beam energies of 4.4, 6.6 and 8.8 GeV in semi-exclusive $^3\text{He}(e, e'n)pp$ scattering, exploiting polarized electrons incident on a polarized ^3He target and detecting the final state neutron. Since polarized ^3He is a good approximation to a polarized neutron, this effectively is a measurement of $n_{\text{pol}}(e_{\text{pol}}, e'n)$. The transverse and longitudinal components of the beam helicity asymmetry are proportional to the ratio of G_E and G_M .

Form factors are fundamental properties of the nucleon, and it is important to extend their knowledge to higher momentum transfers as further test of nucleon models.

The measurement would be performed at Hall A, using the large solid angle BigBite magnetic spectrometer, equipped with GEM-detectors for detection of the scattered electrons, together with a large area neutron detector (BigHand). An additional dipole sweeper magnet (BigBen) would be employed to deflect the produced protons in order to obtain a clean neutron signal. High luminosity and large solid angle are required to compensate for the steeply falling cross section.

Measurement and Feasibility:

The proponents have performed a similar experiment (GEN-I) and first preliminary results have been presented. They assured the PAC that with further improvements on the target (e.g. increase of the “polarizing power”, new gold coated metal target cell and forced flow in the He-target cell, allowing for higher electron beam intensity) and the implementation of the sweeper magnet, the experiment will be feasible. Some concerns were raised about neutral background in BigHand, which has been estimated from the experience gained during GEN-I and was extrapolated to the new experiment (GEN-II). By the time of the technical readiness review, this question should be addressed in more detail (simulations and/or experimental background tests).

Issues:

The PAC received two proposals to measure neutron electromagnetic form factors (this one, PR12-09-016, using a polarized beam and target, and PR12-09-006, using an unpolarized deuteron target and neutron recoil polarization). Since corrections are necessary to deduce the neutron quantities, which are different for the two measurements, the PAC felt that it is worth pursuing both experiments because of the importance of such data. The PAC, however, would

like to stress that funding of the new and additional equipment for this measurement has be secured. While the committee is presently convinced that the experiment should run, it also reminds the proponents that all the approved 12 GeV proposals will be subject to (at least) one more examination, just before the upgraded Laboratory program will actually start running.

Recommendation: Approval

Individual Proposal Report

Proposal: PR12-09-017

Scientific Rating: N/A

Title: Transverse Momentum Dependence of Semi-Inclusive Pion Production

Spokespersons: H. Mkrтчyan, P. Bosted, R. Ent,

Motivation: The collaboration proposes to use the HMS and SHMS to make precise measurements of the cross sections for π^+ and π^- electroproduction at deep inelastic scattering (DIS) kinematics and low p_T from hydrogen and deuterium targets. These data will be analyzed in order to extract measures of the mean k_T of up and down quarks in the nucleon. In combination with other data (particularly from CLAS12), the proposed cross section measurements will provide a strong test of the theoretical understanding of semi-inclusive DIS in terms of factorized parton distributions convoluted with fragmentation functions. In addition to the core pion electroproduction measurements, the collaboration plans to use longitudinally polarized electron beams to obtain high precision measurements of the azimuthal single beam spin asymmetries at low p_T ; these data will augment other measurements at CLAS12. The collaboration also proposes to install an aerogel Cerenkov detector to provide kaon identification. Kaon electroproduction cross sections will provide insight into the same issues of factorization as are planned for the pions

Measurement and Feasibility: The experiment will use the HMS to detect the scattered electrons and the SHMS to detect the pions and kaons. Systematic uncertainties arising from acceptance will be small due to the use of small acceptance spectrometers. At low p_T the acceptance in azimuthal angle about the virtual photon direction is essentially 2π , while at high values of p_T , the spectrometer will be scanned in hadron angle to determine the larger- p_T dependence in a more limited azimuthal range. No significant technical issues were identified that would affect the experiment's feasibility.

Issues:

First, see the "Comments on All SIDIS Proposals" in the overall report.

As referred to in the comments above, there are concerns that the experimental coverage in the full multi-dimensional space may be too limited to obtain integrated or weighted observables that can be theoretically interpreted. For such observables this results in significantly larger systematic uncertainties than estimated.

Nonetheless, the cross sections are such basic tests of the understanding of SIDIS at 11 GeV kinematics that they will play a critical role in establishing the entire SIDIS program of studying the partonic structure of the nucleon. In particular they complement the CLAS12 measurements in areas where the precision of spectrometer experiments is essential, being able to separate p_T and ϕ -dependence for small p_T . The PAC strongly recommends that these measurements occur

in the early years of 12 GeV operation. We agree that the use of polarized beams will provide useful azimuthal measurements at low p_T and also that the investigation of the kaon cross sections, while of much less statistical precision, will still be very interesting. Therefore we support the construction of the aerogel Cerenkov detector and the data collection using polarized beams. The latter is not expected to add any significant overhead or delay to the experiment.

The PAC recommends approval subject to the condition that the collaboration of this experiment and that of PR12-09-002 combine their measurement plans into a single coordinated experimental plan, so that running time to collect events at kinematics of use to both experiments is not duplicated needlessly. This combined proposal should be presented at the next PAC review.

Recommendation: Conditional Approval

Individual Proposal Report

Proposal: PR12-09-018

Scientific Rating: N/A

Title: Measurement of the Semi-Inclusive π and K electro-production in DIS regime from transversely polarized ^3He target with the SBS & BB spectrometers in Hall A

Spokespersons: G. Cates, E. Cisbani, G. Franklin, B. Wojtsekhowski

Motivation:

The motivation is to study the transverse spin structure of the neutron. By measuring the azimuthal dependence of semi-inclusive DIS with respect to the nucleon spin direction, different functions such as the Collins and Sivers asymmetries can be studied, which have sensitivity to initial state and final state quark interactions, respectively. This will lead to a better understanding of the role or orbital motion of quarks in the nucleon.

Measurement and Feasibility:

The experiment would use 8.8 and 11 GeV electron beams in Hall A, scattering off a highly polarized, transversely polarized ^3He gas target. A range of Q^2 will be used to study higher twist effects. Several design improvements over the existing target would be made to allow the use of higher beam currents (of the order of 50 μA) than is presently possible. The scattered electrons would be detected in the existing BigBite spectrometer, and semi-inclusive charged pions and kaons would be detected in a new Super BigBite spectrometer. GEM detectors would be used to perform tracking in the very high singles rate environment of each spectrometer. Pions and kaons would be identified using a large dual RICH detector taken from the HERMES experiment.

The proposed target upgrades are ambitious, but plausible. The factor of ten faster spin reversal rate requested in this proposal is likely to be a challenging goal if this is to be met without loss of target polarization. The tracking and particle identification of pions and kaons at forward angles at several times $10^{37} \text{ cm}^2 \text{ s}^{-1}$ luminosity, with only a very large opening dipole magnet between the target and the detectors, is likely to be a huge technical challenge. In particular, the HERMES RICH detector was previously used in a similar setup (behind a large dipole magnet) at luminosities of up to $10^{32} \text{ cm}^2 \text{ s}^{-1}$, five orders of magnitude lower than the proposed use. The tracking problem is much more difficult than for exclusive reactions using the same apparatus, since the coincident hadrons can be found anywhere within the acceptance. The experimental setup is not fundamentally different from CLAS12, which also has a magnetic field between the target and most detectors, but the proposal aims to run at 100 times the luminosity of CLAS12. Another possible feasibility issue is the ageing of the thousands of phototubes used in the RICH detector, which will be of order of fifteen to twenty years old by the time this experiment runs. The operation of BigBite at the proposed luminosity will also be challenging, but seems much more likely to be feasible than the operation of the hadron arm.

Issues:

First, see the “Comments to all SIDIS Proposals” in the overall report.

Some of the additional issues raised by this proposal include:

- 1) Can a combination of beam tests and fully realistic simulations demonstrate the feasibility of running the experiment at the proposed luminosity?
- 2) Will the very high rates affect the ability to extract relatively small spin asymmetries accurately?
- 3) Would a better coverage at smaller hadron angles, perhaps combined with running at lower luminosity, give a better overall result (due to better coverage in p_t , θ_{pq} and ϕ^*).
- 4) Is it possible to add some (limited) π^0 detection to enhance the physics output of the proposal?
- 5) Is a z cut of 0.2 too low for JLab kinematics?
- 6) What will the effect of diffractive vector meson production be on the extraction of SIDIS structure functions?
- 7) What is the impact of radiative tails from exclusive and resonance region scattering on the structure function extraction? (In particular, will the cross sections and spin asymmetries of these regions be sufficiently well known?)
- 8) Can the possibility of polarized proton and deuteron targets to obtain neutron structure functions be considered and integrated into a comprehensive program at JLab?

In addition the PAC feels that a strong theoretical effort to determine the nuclear effects in extracting neutron structure functions from ^3He measurements is highly desirable.

Despite the questions of feasibility raised above, the PAC strongly endorses the physics goals of the experiment and the collaboration is encouraged to submit a new proposal that addresses the technical concerns in some detail, as the somewhat ambitious experimental setup and proposed high luminosity requires a more thorough justification than more modest proposals. These necessary simulation studies will be required by any subsequent technical review in any case.

Recommendation: Conditional Approval

Individual Proposal Report

Proposal: PR12-09-019

Scientific Rating: N/A

Title: Precision Measurement of the Neutron Magnetic Form Factor up to $Q^2=18$ (GeV/c)² by the Ratio Method

Spokespersons: B. Quinn, B. Wojtsekhowski, R. Gilman

Motivation:

The neutron magnetic form factor $G_M(n)$ will be measured with high precision at nine kinematic points: $Q^2=3.5, 4.5, 6.5, 8.5, 10.0, 12.0, 13.5, 16.0$ and 18.0 (GeV/c)². The systematic errors are greatly reduced by the use of the “ratio method” in which $G_M(n)$ is extracted from the ratio of neutron-coincident to proton-coincident quasi-elastic electron scattering from the deuteron.

Measurement and Feasibility:

Scattered electrons will be detected with the BigBite spectrometer, equipped with a new gas Cherenkov and new GEM detectors. The nucleons (proton, neutron) will be identified with BigHAND, sitting 17m. away from the target to allow for time-of-flight measurements. In between a large aperture dipole magnet (BigBen) for deflecting the protons onto a spot different from the neutrons will be implemented. This is a large installation experiment where understanding the acceptance and efficiency of the BigHAND is essential. The proposal thoroughly discusses several simulation studies and specific calibration measurements that will be used to guarantee that this is successfully achieved.

Issues:

There is also an accepted proposal to measure $G_M(n)$ at higher Q^2 , using CLAS12, although a large overlap in Q^2 between the two proposals exist, the PAC is convinced that proposed measurement is very valuable to determine the magnetic form factor with high precision. Both experiments using different equipment, this will allow a better control for the systematic error on $G_M(n)$. The PAC approves the experiment for the Q^2 points 3.5, 4.5, 6.5, 8.5, 10.0, 12.0, and 13.5 (GeV/c)², the two high Q^2 points are excluded at this stage. This proposal uses the same equipment as PR12-09-016, which measures the neutron electric form factor ratio $G_E(n)/G_M(n)$ and should run first.

Recommendation: Approval

Individual Letter of Intent Report

Letter of intent: LOI-09-001

Scientific Rating: N/A

Title: Deeply virtual Compton scattering on the neutron with CLAS at 11 GeV

Spokespersons: S. Niccolai, R. De Vita, M. Mirazita, A. El Alaoui

Motivation: This letter proposes a measurement of quasi elastic DVCS on the deuteron in CLAS12. The general idea is that the isospin structure of Generalized Parton Distributions (GPDs) can only be unraveled by using a neutron target. The motivation is that the neutron DVCS cross section at small t is dominated by the essentially unknown GPD E . This provides a strong physics case, which justifies this experiment.

Measurement and Feasibility:

The experiment will measure the single spin asymmetry which is proportional to the imaginary part of the DVCS amplitude. To be feasible requires ability to discriminate neutrons and photons. The proponents are developing a central neutron detector (CND) to be added to the CLASS12 base equipment.

Issues:

The CND is not part of the base equipment, and consequently requires additional funding. The problem of operating the CLAS12 detector in a strong magnetic field needs to be addressed. If it can be made to work, proposed CND would significantly extend the detection capability for neutrons. To interpret the results it would be very valuable to make cross-section measurements rather than just asymmetries.

Recommendation: The proponents are strongly encouraged to complete the R&D needed for the neutron detector and to present a full proposal.

Individual Letter of Intent Report

Proposal: LOI-09-002

Scientific Rating: TBD

Title: Measurements of Three-Nucleon Short-Range Correlations with a Large Acceptance Detector (LAD)

Spokespersons: Eli Piassetzky

Motivation: In recent inclusive (e,e') experiments, the ability to identify and study two-nucleon short range correlations (2N-SRC) has been demonstrated. This LOI proposes the next generation of exclusive 3N-SRC studies: search for clusters of more than two correlated nucleons, by simultaneous 4-fold coincidence measurements of the hard $(e,e'ppp)$ and $(e,e'ppn)$ reactions, in which the two recoiled nucleons will have the sum of their momenta balanced by the missing momentum of $(e,e'p)$. The study will confirm whether the second plateau seen in the scaled cross sections at $2.25 < x < 2.8$ is indeed due to 3N-SRC, and it will directly investigate the character of the 3N clusters, in particular the isospin dependence and angular correlations. Will there be an excess of ^3He -like clusters (predominantly $T=1/2$) with respect to p^3 clusters ($T=3/2$)? The collaboration proposes to develop the new Large Acceptance Detector using the surplus CLAS TOF detector elements (not used in CLAS12). The detector can be designed to operate either in Hall A or in Hall C. It is a high impact experiment, which will stimulate theoretical developments in the area of SRC and three-nucleon interactions.

Measurement and Feasibility:

Issues: According to the TAC report, the experiment looks feasible. However, a number of detailed technical questions have been identified which need to be addressed in the future proposal.

Recommendation: The PAC recommends that this letter of intent be developed into a proposal to be presented to a future PAC.

Individual Letter of Intent Report

Proposal: LOI-09-003

Scientific Rating: N/A

Title: IncAs - Inclusive Asymmetries from Vector-Polarized Deuterium for a Precise Determination of G_n^M at Intermediate Momentum Transfer

Spokespersons: M. Kohl

Motivation: Measurements of G_n^M in the region of 0.5-1.0 GeV^2 show differences up to about 5%, differences that exceed the stated experimental uncertainties. This indicates that the use of the ratio method for higher Q^2 measurements may not be as accurate as generally believed. The differences at low Q^2 can be resolved, and the precision of the ratio technique used at higher energies can be verified, by an independent measurement.

Measurement and Feasibility: The LOI proposes scattering polarized electrons from a vector polarized deuterium target. By using two spectrometers at the same time, target polarization cancels and high precision form factor ratio determinations can be made. This technique has already been used by the Bates BLAST collaboration in published proton form factors, for example.

Issues: The PAC generally feels that the differences in the existing form factor measurements at Q^2 slightly below 1 GeV^2 is not among the most compelling problems proposed to be resolved by future 12 GeV experiments. Future ratio-method measurements at high Q^2 will provide a check of the systematics of this technique.

If a proposal is to be presented in the future, it should demonstrate why G_n^M needs to be improved significantly in the region of this proposal. A proposal will also require a more detailed discussion of the experimental details, including a more thorough discussion of the systematics.

Recommendation: N/A

Individual Letter of Intent Report

Proposal: LOI 09-004

Scientific Rating: N/A

Title: Transverse Spin Effects in Kaon SIDIS at 12 GeV with Transversely Polarized Target

Spokespersons: H. Avakian

Motivation:

The motivation is to study the transverse spin structure of the nucleon. By measuring the azimuthal dependence of semi-inclusive DIS with respect to the nucleon spin direction, different functions such as the Collins and Sivers asymmetries can be studied, which have sensitivity to initial state and final state quark interactions, respectively. This will lead to a better understanding of the role or orbital motion of quarks in the nucleon. Better separation of flavor dependence of the structure functions motivates the use of improved kaon identification with a RICH detector.

Measurement and Feasibility:

The measurements would be made with a transversely polarized target in CLAS12. Two possible targets are discussed. With dynamically polarized NH₃ in a 4 to 5 T holding field, a “sheet of flame” of degraded electrons and radiated photons will limit the available luminosity. If the HD-Ice target is used, the much lower holding field will result in less backgrounds from the sheet of flame, and have a better figure of merit due to the higher fraction of polarized nucleons in the target compared to ammonia. The figure of merit for the deuteron is especially high. Tests are needed to determine the highest current possible for this target.

Issues:

First, see the “Comments on All SIDIS Proposals” in the overall report.

The impact of including higher twist terms in the analysis, such as $\sin(\phi_s)$ sis should be considered. Transverse target polarization measurements are a crucial part of the JLab SIDIS program. Consequently, if this experiment is to proceed, the PAC recommends its integration into the full SIDIS program with transversely polarized protons and deuterons into a single proposal.

Recommendation: Develop a full proposal for a comprehensive program of SIDIS studies with transversely polarized protons and deuterons with pion and kaon detection.

Individual Letter of Intent Report

Proposal: LOI-12-09-005

Scientific Rating: N/A

Title: Unpolarized Semi-inclusive Pion Production on Deuteron and Proton with CLAS12

Proponents: N. Kalantarians et al.

Motivation: This letter of intent discusses the physics that can be addressed with a measurement of the ratio of unpolarized semi-inclusive pion production in deuteron and proton, $d(e, e'\pi)X/p(e, e'\pi)X$, for all three pion charge states, with the CLAS12 detector and the 11 GeV electron beam. The experiment would study the cross-section dependence on pion transverse momentum P_T and azimuthal angle ϕ_h to access the transverse motion of quarks (connected to their orbital angular momentum), the quark spin-orbit correlation (Boer-Mulders function), the ratios of down over up quark distribution functions as well as the corresponding fragmentation functions, and finally charge symmetry violation (CSV) effects.

Measurement and Feasibility:

First, see the “Comments to All SIDIS Proposals” in the overall report.

The measurements discussed in the letter aim to compare the intrinsic motions and the fragmentation functions for different quark flavours and to identify CSV effects. Positive, negative and neutral pions would be detected in CLAS12, making use of the base equipment in Hall B. The measurement could run concurrently with the approved G_n^M experiment E12-07-104. A preliminary analysis in this sense was already completed using existing data from the current program with CLAS at 6 GeV, where studying the above mentioned ratio for π^+ and π^- results in a rather flat dependence in some kinematic variables. For the 12 GeV physics potential, the only specific example reported is about the sensitivity to a possible difference in the u and d quark transverse momentum distributions, while sensitivity to the other effects presented have not been quantified. We also note that a proposal focusing on CSV, PR-09-002, has been conditionally approved by this PAC for Hall C. Clearly the proponents should confront their ideas with the physics and goals discussed therein. The PAC in its “Comments to all SIDIS Proposals” highlights the superior kinematic coverage and consequent possibility of fully exploring multi-dimensional cross sections of CLAS12. This requires a detailed demonstration of the potential for more specific measurements. In summary, the PAC believes that CLAS12 might possibly include the measurements sketched in this letter in its overall SIDIS program, so that the development and presentation of a full proposal is encouraged. However the PAC recommends that the full proposal be presented in the framework of the CLAS12 SIDIS program when all 12 GeV proposals will be revisited for rating.

Issues:

Running the proposed measurements with CLAS12 should be rather straightforward and could be performed in parallel with other approved beam time. The proponents should check with the

spokespersons of E12-07-104 whether switching the hydrogen and deuterium targets is compatible with their settings.

Recommendation: The collaboration is encouraged to develop a full proposal in the terms indicated above.

Individual Letter of Intent Report

Proposal: LOI-09-006

Scientific Rating: N/A

Title: Production of Ξ and Ω^- at CLAS12 and GlueX

Spokespersons: B.M.K. Nefkens and A. Starostin

Motivation:

This experiment continues the JLab program of elucidating the spectrum of excited baryons by focusing on the strangeness -2 and -3 sectors, where states below 2.5 GeV are expected to be narrower than states in the corresponding N^* sector, and so perhaps more readily identifiable. As part of the “missing” baryon program this is a very interesting and well motivated approach.

Measurement and Feasibility:

The aim is to look in channels in which cascades, for instance, are photo-produced together with a K^+K^+ system and identify these short lived states using a missing mass technique. This requires the photon 4-momentum to be well-defined. CLAS has already shown that such a procedure can clearly identify cascades at 1322 MeV and 1538 MeV with widths of 10 MeV or less. The aim is to extend the search range by performing this experiment with an 11 GeV electron beam in CLAS12 or the tagged photon beam in GlueX.

Issues:

This LOI is nothing more than an “Expression of Interest” and contains no experimental details, simulations or error analysis. If this program is to proceed a collaboration needs to be formed, or the proponents join an existing collaboration, and plan for whether this is better performed with the CLAS12 program with a new scattered electron detector or with the GlueX detector. In either case clean particle identification, especially of kaons, is essential. All such details need to be worked out.

Recommendation: The proponents are encouraged to proceed to a real Letter of Intent or full blown Proposal.

APPENDIX F

Jefferson Lab Experiments, PAC 34, Grouped by Category

(To access Appendix F, go to http://www.jlab.org/exp_prog/proposals/09prop.html)