Report of the July 14-16, 1999

JLab Program Advisory Committee

PAC16

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August 1999

Dear Members of the Jefferson Lab User Group,

Now that Jefferson Lab has gained more experience in meeting the diverse demands of a forefront physics program, things are going well, and while we occasionally hit rough spots which we can't respond to as quickly as we'd like, we are making real progress with our physics program. In Hall A the second experiment using a polarized ^{3}He target has been completed, and the final production run for the HAPPEX experiment successfully used high polarization beam – the first time ever that a parity violation experiment was run with a strained GaAs wafer. Hall B is progressing well toward the publication of its first round of papers, and data acquisition rates from the CLAS are routinely exceeding the design goal of 1500 events/sec by more than 50%. Hall C has completed several key experiments and is preparing to stage the HNSS (HyperNuclear Spectrometer System). We have also exceeded our 1 kW goal for the FEL and the Detector Group has developed an advanced scintimammography camera designed to detect breast cancer through superior imaging.

The User Group held its Annual Meeting on June 24-25, 1999, with the plenary session focusing on recent experimental results from JLab and progress toward higher energies. The Jefferson Lab Program Advisory Committee (PAC 16) met on July 14-16 to review new and updated proposals for the use of CEBAF beamtime. They also heard about progress in the accelerator's capabilities and operation, and on the physics programs in three halls. The run plans for the three experimental areas were discussed, and the PAC continued its review of the lab's overall physics program with its third "mini-Workshop," which looked at approved experiments and opportunities in the area of investigations of the properties of nuclei. As I write, the lab is preparing for the Institutional Planning review to be held on September 30, in which our five-year plans including the upgrade will be presented. We are hopeful that this plan will be accepted by DOE as a logical next step and a part of Jefferson Lab's future.

Attached is the PAC 16 report. I want to thank Don Geesaman and the members of the PAC for their efforts on behalf of Jefferson Lab and its User Community, and for the PAC's thoughtful deliberations on the physics program. I also wish to thank you, the Users, for your efforts on the proposals, updates, and letters-of-intent. I look forward to the continuing flow of publications informing the scientific community of the exciting results coming from the Jefferson Lab experimental program.

Sincerely,

Hermann A. Grunder
Director

Report of the July 14–16, 1999 Meeting of the Jefferson Lab Program Advisory Committee (PAC16)

INTRODUCTION

The Jefferson Lab Program Advisory Committee held its 16th meeting on July 13–15, 1999 in CEBAF Center. The membership of the Program Advisory Committee is given in Appendix A. In response to the charge (Appendix B) from the director, Dr. Hermann Grunder, the committee reviewed and made recommendations on 18 new proposals and one letter-of-intent. Following the main meeting, the PAC met for one day in Williamsburg, Virginia, to discuss the laboratory's program in the "Physics of Nuclei."

The PAC would like to acknowledge the efforts of the laboratory staff in support of the PAC meeting and workshop.

The PAC was also delighted to welcome Dennis Skopik to the laboratory and looks forward to working with him in his PAC Liaison role.

GENERAL OVERVIEW

Larry Cardman reviewed the progress of the laboratory for the past six months. The PAC noted that the experimental program is proceeding exceedingly well. The performance of the polarized source, as established in the second HAPPEX run, continues to astound and delight everyone. The accelerator efficiency shows slow but steady improvement even while the experimental program places ever greater demands for beam performance, including running at energies up to 5.6 GeV. The PAC also was impressed by the excellent efficiencies of the experimental equipment in Halls A (94%) and B (83%). This demonstrates that the users and the JLAB staff are committed to the responsibility of effectively running experiments and should lead to more physics getting done each year, and to the reduction of the backlog of approved experiments. There remains concern about the lower (54%) efficiency of Hall C, though the complexity and heavy installation burden for many of the Hall C experiments provides a partial explanation. The PAC supports the stated priority of focusing additional requested operating funding in the Physics Division on experiment installation and operation.

CLAS 6-GeV RUN GROUP

At this PAC, the Hall B collaboration requested a new form of proposal presentation for nine proposals which all involved CLAS experiments with a 6-GeV electron beam on a hydrogen target. Only four presentations were made to the PAC, an overview of the performance of CLAS for 6 GeV and three summaries of the physics of the experimental proposals. This considerably reduced the proposal presentation time and allowed us to shorten the PAC meeting by one day. The overview presentation was useful and may continue to be a good idea when several proposals share running conditions or when some new CLAS capability has been demonstrated relevant to proposals. However, in many cases the PAC did not feel it was able to obtain enough information from the relatively brief written and verbal presentations. The committee welcomes new ideas from the collaboration for effectively evaluating Hall B proposals.

A number of new CLAS proposals plan to do longitudinal-transverse separations. In general, the PAC wants to be convinced that absolute cross-section measurements are under control with the required precision in CLAS before approving significant new efforts of this type. An ideal demonstration would be the publication of convincing absolute cross section results.

IMPACT OF BEAM TIME GUIDELINES

The PAC charge specifies a limited number of days to be approved in each of the three halls. In the past, it has been necessary to defer proposals addressing important physics topics in order to meet the charge. At this meeting, the PAC, for the first time, has taken the step of rejecting an approved experiment that came back for reevaluation (and additional beam time) in order to comply with the guidelines. This was a painful decision for everyone. This experiment, like many of the experiments that are deferred or rejected, is an experiment the PAC believes has significant physics impact and should be done. However, the strength of the Jefferson Lab program is such that there are more such experiments than can be accommodated. When the jeopardy process takes effect in Hall A in the summer of 2000, the PAC will be forced to make many more such tough decisions.

PHYSICS OF NUCLEI WORKSHOP

The third PAC workshop addressed the status and experimental opportunities in measurements of the physics of nuclei with $A > 4$.

Vijay Pandharipande and Ingo Sick led off the main thrust of the workshop with theoretical and experimental overviews of the recent developments in the physics of nuclei with electromagnetic probes. The Hall leaders presented the program of approved experiments in each Hall that address this topic. The conclusions of the workshop were reached following an extensive round table discussion to identify the key scientific areas and to provide ideas for experiments which the PAC views as having particular promise. A summary of the workshop is included in this report as Appendix G.

Also included in the workshop was a summary of the physics justification for the 12-GeV upgrade presented by Nathan Isgur. The PAC provided comments on the importance of various physics issues for the upgrade and suggested some new topics for consideration. The PAC believes a powerful physics case can be made for the 12-GeV upgrade and welcomed the opportunity to help shape the physics ideas.

RECOMMENDATIONS

The laboratory guidelines provided for the approval of 30 days of beam in Halls B and C, and 75 days in Hall A. These guidelines were established beginning with PAC14 in order to reduce the significant backlog of approved experiments; 30 days (if 100% efficient operation) corresponds to about two-thirds of the equilibrium rate. The number of days allocated for Hall A was larger as a consequence of three previously approved experiments returning with new requests. The PAC approved experiments for 69 days in Hall A, 30 days in Hall B, and 16 days in Hall C.

The reports and PAC recommendations for the reviewed proposals and the letter-of-intent are given in Appendices D and E. The tables on the following pages summarize the results from PACs 4–16.

Donald Geesaman
Chair, Jefferson Lab Program Advisory Committee

APPENDICES

A. PAC16 Membership

B. Charge to PAC16

C. PAC16 Recommendations

D. Individual Proposal Reports

E. PAC16 Letters-of-Intent

F. Approved Experiments, PACs 4–16, Grouped by Physics Category
(To access Appendix F, go to http://www.jlab.org/exp_prog/PACpage/)

G. Summary of PAC16 Workshop on the Physics of Nuclei
(Williamsburg, Virginia, July 17, 1999)

Totals for PACs 4–16

	Experiments Recommended for Approval	Experiments Recommended for Conditional Approval	**Totals**
Experiments	116	12	**128**
Authors	811	47	**858**
Institutions	141	7	**148**
Countries	20		**20**

Approved Experiment Totals by Physics Topics

Topic	Number	Hall A	Hall B	Hall C
Nucleon & Meson Form Factors & Sum Rules	14	6	3	5
Few Body Nuclear Properties	23	12	6	5
Properties of Nuclei	23	5	10	8
N* & Meson Properties	39	6	26	7
Strange Quarks	17	4	10	3
Total	**116**	**33**	**55**	**28**

Approved Days and Conditionally Approved Experiments

Hall	Approved Experiments				Conditionally Approved Experiments
	No. of Exps Completed (full/partial)	Days Run	No. of Exps in Queue	Days to be Run	
A	5 / 2 x 1/2 / 1 x 3/4	147.5	26.25	577.5	5
B	8 x .50 19 x .27 6 x .12 2 x .59	97.8	41.96	450.17	5
C	8 / 1 x 3/4 2 x1/2 1 x 1/4	185.3	18	408.8	2
Total	**14 / ~14.78**	**430.60**	**86.21**	**1436.47**	**12**

Appendix A
PAC16 Membership

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Appendix B

Charge to PAC16

Jefferson Lab requests that PAC16:

1) Review proposals*, extensions, and updates and provide advice on their scientific merit, technical feasibility and resource requirements.
2) Recommend one of four actions on each proposal, extension or update:
   - approval,
   - conditional approval status pending clarification of special issues,
   - deferral, or
   - rejection.
3) Provide a scientific rating and recommended beam-time allocation for all proposals recommended for beam-time.
4) Provide comments on letters-of-intent.
5) Comment on the Hall running schedules.
6) Review the scientific opportunities accessible through CEBAF's capabilities in the area of "properties of nuclei." Are the key open questions in this subfield addressed optimally by the presently approved experiments? Would extensions to or modifications of presently approved experiments provide clearer answers to these questions? Finally, are there important open questions not addressed by approved experiments that should be added to the program?

* Beginning with PAC15, previously-approved proposals that have not run within three years of approval or three years of the start of physics in the relevant hall (whichever is later) are returned to the PAC for a fresh scientific review. For the purposes of these reviews, the "jeopardy" experiments are to be treated consistently with new proposals.

APPENDIX C

PAC16 Recommendations

Class*/ Days		
R	E-99-101	Medium Modification of Vector Mesons in the Subthreshold Region
D	PR-99-102	Isolation of Short-Range Correlations in the ^{3}He(e,e′pp) Reaction-Driven by One-Body Currents
R	PR-99-103	The Electric Form Factor of the Neutron Extracted from the $^3\overrightarrow{He}(\vec{e},e'n)pp$ Reaction
R	PR-99-104	Recoil Polarization Measurement in Electroproduction of Vector Mesons from a Proton Target
B+/30	PR-99-105	Deeply Virtual Electroproduction of Vector Mesons
D	PR-99-106	Deeply Virtual Electroproduction of Pseudoscalar Mesons
B+/30	E-99-107	N* Excitation at High Q^2 in the $p\pi^0$, $p\eta$ and $n\pi^+$ Channels
B+/30	E-99-108	N* Excitation at High Q^2 in the Two-Pion Channel
D	E-99-109	Measurement of η' Electroexcitation
D	E-99-110	Exclusive Kaon Electroproduction
D	PR-99-111	High Q^2 ϕ Meson Production
D	PR-99-112	Search for $J^{PC} = 1^{-+}$ Exotic Mesons
D	PR-99-113	Forward Pseudoscalar Meson Production Above the Resonance Region
A-/18	PR-99-114	Exclusive Compton Scattering on the Proton
A/30	PR-99-115	Constraining the Nucleon Strangeness Radius in Parity-Violating Electron Scattering
D	E-99-116	$K^+\Lambda$ photo-production for $E_\gamma > 3$ GeV
B+/21	E-99-117	Precision Measurement of the Neutron Asymmetry A_1^n at Large X Using CEBAF at 6 GeV

B+/16	E-99-118	Measurement of the Nuclear Dependence of R ($=\sigma_L/\sigma_T$) at Low Q^2

* **A=Approve, C=Conditionally Approve, D=Defer, R=Reject**

Individual Proposal Report

Proposal: PR-99-101

Scientific Rating: N/A

Title: Medium Modification of Vector Mesons in the Subthreshold Region

Spokesperson: G. Lolos and P.L. Cole

Motivation: This is an update of deferred proposal PR 99-001. The proposed experiment would examine the physics origin of changes in the mass and width of vector mesons photoproduced on ^{3}He (compared to H).

Measurement and Feasibility: Subthreshold (with respect to H) photoproduction of $\pi^+\pi^-$ pairs from ^{3}He will be observed in the CLAS detector and analyzed to determine the masses and widths of vector mesons (ρ^0, ω and hopefully, ϕ). It is expected that the presence of the additional nucleons in ^{3}He will change the free values of these quantities. Many possible mechanisms might contribute to this process, and the experiment seeks to discriminate amongst the various theoretical models. Analysis of the TAGX experiment suggests a 17% reduction in the ρ^0 mass. A total of 420 hours are requested, of which 150 could be part of g3.

Issues: The PAC was unconvinced that medium modification could be demonstrated in this experiment. Many background processes contribute coherently with, and may even dominate, ρ-production in a subthreshold experiment. Unfortunately, there is not yet enough information on 2π photoproduction on hydrogen to constrain mechanisms. The PAC was not convinced of the uniqueness of the $\cos^2(\theta)$ angular distribution as a signature of the ρ. Finally, it was not clear that a convincing analysis of the vector meson parameters could be performed in this experiment.

Recommendation: Rejected

Individual Proposal Report

Proposal: PR-99-102

Scientific Rating: N/A

Title: Isolation of Short-Range Correlations in the ^{3}He(e,e′pp) Reaction Driven by One-Body Currents

Spokespersons E. J. Brash and Z. Papandreou

Motivation: The goal of the experiment is to isolate and measure short-range correlations (SRC) in the two-proton knockout reaction, (e,e′pp). The choice of the nucleus, ^{3}He, is motivated by the availability of realistic wave functions and the possibility to perform a kinematically complete measurement.

Measurements and Feasibility: The ^{3}He(e,e′pp)n cross section will be measured for the values of Q^2 in the range 0.25–0.40 $(GeV/c)^2$ and three values of ω spanning 500–900 MeV. Super-parallel kinematics will be used where one proton is parallel to $\vec{q}$ while the other is anti-parallel and the neutron is a spectator. A Rosenbluth separation will be carried out to extract the longitudinal and transverse pieces of the cross-section. These kinematic choices and experimental approaches are designed to isolate SRC and minimize the final state interaction contributions and also to minimize the two-body correlation effects due to meson-exchange and isobar currents. The measured cross sections will be directly compared with theoretical calculations that include contributions due to SRC.

Issues: The application of various cuts to the data reduces the useful data sample by a factor of 5–10. The proposal did not present a careful error analysis showing the expected accuracy of the extracted longitudinal cross sections. It is also not clear that the choice of ω has been optimized for SRC. The PAC believes that a more carefully designed (e,e′pp) experiment for an L/T separation in ^{3}He is a good idea to pursue.

Recommendation: Defer

Individual Proposal Report

Proposal: PR-99-103

Scientific Rating: N/A

Title: The Electric Form Factor of the Neutron Extracted from the $^3\overrightarrow{He}(\vec{e},e'n)pp$ Reaction

Spokesperson: R. McKeown and W. Korsch

Motivation: The proposed measurement would extend values of G_e^n to momentum transfers higher than previously measured ones using a polarized ^{3}He target and a polarized electron beam. This is an update of proposal PR-95-006. An upgraded rating and additional beam time are sought.

Measurement and Feasibility: Measurement in Hall A of polarized electron scattering from polarized ^{3}He with coincident neutron detection is sensitive to the neutron's electric form factor, since to a first approximation polarized ^{3}He behaves like a polarized neutron. Two recent measurements at Mainz using both polarized deuterium and polarized ^{3}He were in contradiction. This has now been resolved using high-quality Faddeev calculations of the ^{3}He reaction. Both a rating upgrade (from B+) and an additional 15 days beam time (added to the original 14 days) are sought in order to match to the Mainz measurements and extend them to higher momentum transfers.

Issues: The PAC questioned the need for three different measurements of G_e^n for the same range of Q^2. Two experiments using polarization observables in deuterium are scheduled; one has a firm commitment for installation and running in the second half of 2000 while the second has been tentatively scheduled to follow it. One of these projects a factor of two smaller error bars than the present proposal. In addition, the large theoretical correction reported for the Mainz ^{3}He measurement at $Q^2 \cong 0.4$ GeV^2 raised concerns due to the absence of calculated corrections for higher values of Q^2. The PAC believes that a total of 20 days would be required to do a credible measurement at two Q^2 values: 0.7 and 1.3 (GeV/c)^2. It was felt that the proposed experiment did not have sufficient priority to add to the Hall A backlog.

Recommendation: Rejected.

Individual Proposal Report

Proposal: PR-99-104

Scientific Rating: N/A

Title: Recoil Polarization Measurement in Electroproduction of Vector Mesons from a Proton Target

Spokespersons: H. Gao, J. Calarco and R. Ransome

Motivation: This is an update of PR-98-103. The experiment would measure polarization asymmetries in ϕ and ω electroproduction to probe the $s\bar{s}$ content of the nucleon. The measurements for ω production, along with the ϕ differential cross sections as a function of t and Q^2, will help determine the reaction mechanism for production of vector mesons; furthermore the ω data could yield insights on missing N* resonances if they couple to the ωN channel.

Measurements and Feasibility: The recoil polarizations from ϕ production will be measured at W = 2.15 GeV and $Q^2 = 0.135$ $(GeV/c)^2$. Measurement of the polarization transfer is required since cross section measurements are not sensitive to small amplitudes. Requested beam time is 584 hours which allows for the ϕ measurement at a single kinematic setting and ω at two. Beam time limitations prohibit a larger number of kinematic settings for the ϕ measurement, though these would be very desirable to sort out the complex mix of production reaction mechanisms. The technical feasibility of the measurements was demonstrated.

Issues: Determination of the intrinsic $s\bar{s}$ content of the nucleon is clearly of great interest. However, the PAC was concerned that this is a difficult measurement and would yield results on ϕ production at a single, kinematic point. The uncertainty in the reaction mechanism makes this single datum difficult to interpret. The theoretical underpinnings are as yet insufficiently well established to allow defensible extraction of the $s\bar{s}$ content from such a measurement. The ω measurement might be affected by different resonance contributions and by $\rho-\omega$ interference. Though the experiment will provide new information, the PAC feels that it will not sufficiently constrain the interpretation. Should the reaction mechanism be in hand from the Hall B experiment, a new proposal may be appropriate.

Recommendation: Reject

Individual Proposal Report

Proposal: E-99-105

Scientific Rating: B+

Title: Deeply Virtual Electroproduction of Vector Mesons

Spokespersons: M. Guidal, C. Marchand and E. Smith

Motivation: The cross sections for electroproduction of vector mesons above the resonance region at high Q^2 and ν are of wide interest because of their relationship to deep inelastic scattering observables. The recent development of the formalism of "off-forward parton distributions (OFPD)" is an attempt to establish the details of this connection. Deeply virtual ρ production is relevant because of the prediction that the ρ longitudinal cross section has a characteristic Q^{-6} dependence and amplitudes that factor in the form of OFPDs. The goal of this experiment is to test the Q^{-6} scaling predicted by pQCD as an indication of the applicability of the OFPD formalism. Vector meson production is the most accessible exclusive reaction for such a study. In addition the systematics of vector meson production in this unexplored region are of intrinsic interest.

Measurements and Feasibility: To establish the Q^{-6} behavior predicted by pQCD requires measurement over a substantial range of values of Q^2, and the low count rates at the highest Q^2 require a large block of beam time. Measurements of the decay angular distributions will be analyzed to establish the validity of s-channel helicity conservation, which will in turn allow the determination of the cross section for longitudinal ρ production. These are necessary but not sufficient conditions for the study of the OFPD's.

Issues: This proposal was approved by PAC14 with the condition of running simultaneously with other experiments at 6 GeV. Interest in OFPDs has grown with time and they offer the prospect of unifying a large body of physics, if measurements such as this can be correlated with those of other channels. This experiment is an important first step in that direction.

Recommendation: Approval for 30 Days at 6 GeV.

Individual Proposal Report

Proposal: PR-99-106

Scientific Rating: N/A

Title: Deeply Virtual Electroproduction of Pseudoscalar Mesons

Spokespersons: A. Empl, M. Guidal, V. D. Burkert and P. Stoler

Motivation: Within the framework of the "off-forward parton distributions (OFPD)" it was proven that, for high enough Q^2 exclusive reactions with longitudinal photons, the cross section can be factorized into parts containing the soft and hard physics involved. The pseudoscalar channels are sensitive to the polarized OFPDs ($\tilde{H}$ and $\tilde{E}$). Therefore, by selecting pseudoscalar mesons one can access polarized nucleon structure without any polarization of the external particles. Many of the scientific goals of the high W measurements are shared with PR-99-113.

Measurements and Feasibility: Before a reliable extraction of the OFPDs from the longitudinal cross section becomes possible, the data should exhibit the Q^{-6} behaviour predicted by pQCD. Therefore a Rosenbluth separation has to be performed up to a rather high Q^2 (3.3 $(GeV/c)^2$).

Issues: Given the importance of a good separation of the longitudinal and transverse pieces of the cross sections, the systematic uncertainties due to a Rosenbluth separation with the CLAS detector have to be investigated in detail with the data already taken. The expected high quality of the π^+ data in a wide range of t and Q^2 will allow the extraction of the pion form factor and, possibly, the $\rho-\pi\gamma$ transition form factor. The implications arising from such an extension of the scope of the experiment should be addressed in detail. In addition, the extent to which the determination of the σ_{LT} and $\sigma_{LT'}$ help to isolate the longitudinal piece of the cross section should be explored.

Recommendation: Defer

Individual Proposal Report

Proposal: E-99-107

Scientific Rating B+

Title: N* Excitation at High Q^2 in the $p\pi^0$, $p\eta$ and $n\pi^+$ Channels

Spokespersons: V. Burkert, R. Minehart, P. Stoler and M. Taiuti.

Motivation: The experiment extends the study of N* electroproduction to higher Q^2. This enables the Q^2 dependence of transition form factors to be established, providing insight into the structure of these states and the mechanisms governing their excitations.

Measurements and Feasibility: The $p\pi^0$, $p\eta$ and $n\pi^+$ decay channels will be studied up to the highest measurable Q^2 values. The pion channels enable N* and Δ excitations to be filtered via their different isospin couplings while the $p\eta$ channel probes isospin 1/2, especially the $S_{11}(1550)$. The relative Q^2 dependences of D_{13} and S_{11} can be probed, thereby testing models and the nature of the excitation dynamics. In addition the relative importance of Δ and N* excitations with Q^2 can be measured and compared with the systematics of deep inelastic structure functions as x approaches 1. The evolution of observed cross sections with Q^2 can provide checks and constraints on the extraction of resonant signals from the data.

Issues: A test run at 5.5 GeV has demonstrated the feasibility of using 6-GeV incident electrons in CLAS and the analysis procedure developed for lower energy measurements in CLAS can be applied at 6 GeV. The increased Q^2 lever arm at 6 GeV makes these measurements a natural and important extension of the CLAS N* program.

Recommendation: Approved for 30 days in Hall B.

Individual Proposal Report

Proposal: E-99-108

Scientific Rating: B+

Title: N* Excitation at High Q^2 in the Two-Pion Channel

Spokespersons: M. Ripani and V. D. Burkert

Motivation: The experiment proposes to study N* excitations of the nucleon that decay through two-pion channels. Several high-mass states that de-couple from the $N\pi$ channels are expected to have substantial two-pion decay widths. In quark models the two-pion channels are also expected to couple strongly to many of the "missing" quark-model states that populate the mass region from 1.9–2.2 GeV. Measurements of N* coupling to the two-pion channel will test predictions of the different constituent quark models proposed to account for the spectrum of N* states. It is suggested that a failure of the CQM to describe the higher-mass resonances at high Q^2 may signal the onset of the perturbative regime.

Measurements and Feasibility: Approximate yields for two-pion final states have been obtained from the 1998 e1 run at 4 GeV, and a short test run in March 1999 at 5.56 GeV. The 4-GeV data are in good agreement with data from an old DESY experiment. The data from the 5.56 GeV run provide a good estimate of the two-pion yields to be expected in an extended run at 6 GeV. Plans are in place for a first phenomenological analysis of the cross section data in terms of standard resonance couplings and decay amplitudes plus a non-resonant background term.

Issues: This proposal is an extension of E-93-006 previously approved to run at 4 GeV. Running at 6 GeV provides a larger dynamic range for studying Q^2 dependences. The variation of the resonance parameters as one moves away from the photon point is of considerable interest, particularly the Q^2 dependences of the resonance yields. The complementarity of the two-pion channel to those already extensively measured is an important feature of the experiment.

Recommendation: Approved for 30 days in Hall B.

Individual Proposal Report

Proposal: PR-99-109

Scientific Rating: N/A

Title: Measurement of η' Electroexcitation

Spokespersons: F. J. Klein and J. A. Mueller

Motivation: This proposal would extend up to 6 GeV the study of N* electroproduction of the $N\eta'$ channel with the hope of discovering the so-called missing resonances expected at W > 2 GeV.

Measurements and Feasibility: The large coverage assured by CLAS provides the opportunity to span the whole W regime where resonance production may contribute and to extract the N* candidates by fitting the total and differential cross sections. The proponents propose to observe the reaction $ep - ep\eta'$ using the dominant η'-$\rho\gamma$, η'-$\eta\pi^+\pi^-$, and η'-$\eta\pi^0\pi^0$ decay modes. The η' candidates will be identified via selected missing mass cuts in the electroproduction data.

CLAS is appropriate for such measure0ments: its acceptance is reasonable for such a complicated final state. Coverage in the decay phase space is fairly large and a mulitpole decomposition possible.

Fifteen days are requested with reversed magnetic field for optimal Q^2 coverage.

Issues: The PAC does not believe that the physics motivations stated in the proposal justify the run time requested. The $N\eta'$ channel does not address the so-called $U_A(1)$ question and the N* physics is covered significantly by the $N\eta$ decays. The PAC is not convinced of the advantage of the electroproduction experiment over the approved photoproduction experiment.

Recommendation: Defer.

Individual Proposal Report

Proposal: PR-99-110

Scientific Rating: N/A

Title: Exclusive Kaon Electroproduction

Spokespersons: D.S. Carman, K. Joo, L.H. Kramer, and B.A. Raue

Motivation: This proposal requests time to extend to 6 GeV the studies of kaon electroproduction now underway at lower beam energies. An important goal is the understanding of the reaction mechanisms for kaon electroproduction over a wide kinematic range. The proposal includes measurements of the ratio of Λ to Σ production cross sections, cross sections for excited hyperon production and neutral kaon production, and a search for missing N* resonances. The higher energy will reduce uncertainties in extracting response functions and extend their range in Q^2, access new resonances, including higher spin resonances, and provide more appropriate kinematics for the application of some reaction models.

Measurements and Feasibility: Cross sections and polarizations will be measured for $(e,e'K^+)$ and $(e,e'K^+p)$ over a wide range of kinematics. The Q^2 range extends from 1.5 to 6 $(GeV/c)^2$, and W from 1.6 to 3.0 GeV. Polarizations will be measured for Q^2 up to 3.5 $(GeV/c)^2$. Rosenbluth separations will determine σ_L and σ_T; LT, TT, and TL' response functions will be determined from the ϕ dependence of the cross sections. The errors on these separated quantities were not estimated, and there was little discussion of possible systematic errors in extracting them.

Issues: While a number of interesting topics are proposed here, the PAC would like to see the results of a preliminary analysis of lower energy data before deciding on the present proposal. The low-energy data will be important in determining the feasibility of the 6 GeV work and the appropriate physics focus.

Recommendation: Defer

Individual Proposal Report

Proposal: PR-99-111

Scientific Rating: N/A

Title: High Q^2 ϕ Meson Production

Spokespersons: W. Brooks and H. Funsten

Motivation: According to a QCD-based prediction, the transverse size of the hadronic component of the longitudinal photon should shrink with a Q^2 increase. Recently, data became available for ρ mesons on this effect. With the 6 GeV-beam an extensive data set for ϕ mesons can be extracted via electroproduction and with the use of existing photoproduction data, the Q^2 dependence of the t slope parameter, b, can be determined.

Measurements and Feasibility: The variation of the slope parameter as a function of Q^2 will be analyzed at constant fluctuation times. The measurement with the 6-GeV beam allows coverage of a Q^2 range of $1 < Q^2 < 6$ $(GeV/c)^2$ and a W range of $1.4 < W < 3.0$ GeV. Together with the photoproduction data the accuracy of the result of the proposed measurement may be good enough to discriminate between the vector dominance model and quark model predictions.

Issues: The underlying physics was not clearly articulated in the short written proposal. A clear presentation of the model dependences is missing. The importance of isolating the longitudinal piece of the cross section has been used to motivate the proposal but the question has not been discussed in detail.

Recommendation: Defer.

Individual Proposal Report

Proposal: PR-99-112

Scientific Rating: N/A

Title: Search for $J^{PC} = 1^{-+}$ Exotic Mesons

Spokespersons: I. Aznouryn, H. Funsten and S. Stepanyan

Motivation: The aim is the electroproduction of an exotic hybrid with I = 1 and $J^{PC} = 1^{-+}$ as a test of strong QCD and for understanding the non-perturbative structure of hadrons.

Measurements and Feasibility: The plan is to use CLAS to search for exotic hybrids in the charged and neutral modes, $\pi\eta$ and $\pi\eta'$ at $E_e = 6$ GeV. Measurements would be done at $Q^2 > 0.5$ $(GeV/c)^2$. The final-state mesons π, η, η' ensure the desired C parity of the decaying meson. Detection of multi-particle final states will allow determination of the spin and the parity from the angular distributions of the pseudoscalar mesons and the polarization of the hybrid meson can be determined. The production is dominated by pion exchange and so 0^{++} production will be absent. This feature, and the spin and polarization provided by the incident photons, make the measurement complementary to experiments with pion beams elsewhere that have given the first hints of a signal in the 1^{-+} channel.

Issues: The PAC recognized the potentially fundamental importance of this measurement. However, it was deemed premature at this stage to approve the additional beam time needed for the electroproduction proposal. A photoproduction search for exotic hybrids is planned (E-99-005) and experience gained from that could provide the basis for a subsequent Q^2 extension.

Recommendation: Defer

Individual Proposal Report

Proposal: PR-99-113

Scientific Rating: N/A

Title: Forward Pseudoscalar Meson Production Above the Resonance Region

Spokespersons: B. B. Niczyporuk and F. J. Klein

Motivation: This proposal concentrates on exclusive measurements of π^+, π^0 and K^+ electroproduction at low t, $Q^2 > 1.4$ $(GeV/c)^2$ and $W > 2.0$ GeV to probe the transition of the reaction mechanism to the hard scattering regime and ultimately, to measure the helicity dependent off-forward parton distributions. Many of the scientific goals of the high W measurements are shared with PR-99-106.

Measurements and Feasibility: The approach is a systematic study of the four response functions, $\sigma_L, \sigma_T, \sigma_{LT}$ and σ_{TT}. Data will be acquired at several beam energies between 4 and 6 GeV to perform the L/T separations. The data at 4.0, 4.5 and 5.0 GeV will be taken within already approved e1 running. It is likely that, in the future, time will be requested for 5.5-GeV running. The PAC believes that such a systematic study of the response function has merit for providing an unbiased approach to establish the reaction mechanism.

Issues: The PAC believes it is premature to approve these measurements before the CLAS has demonstrated the ability to measure absolute cross sections with the required precision. The relationship between the experimental precision and the physics impact of the results was not sufficiently clear. The PAC would like to see a clearer explanation of the path from the measured response functions to the understanding of the reaction mechanism and the off forward parton distributions.

Recommendation: Defer

Individual Proposal Report

Proposal: E-99-114

Scientific Rating: A-

Title: Exclusive Compton Scattering on the Proton

Spokespersons: B. Wojtsekhowski, A. M. Nathan and C. Hyde-Wright

Motivation: The experiment proposes to probe the short-distance structure of the nucleon through Compton scattering at large momentum transfer with the aim to discriminate among different reaction mechanisms and to get new insight into the structure of the proton. The proposal extends and supersedes E-97-108 that was approved by PAC13 for 10 days of running at 6 GeV.

Measurements and Feasibility: The experiment will measure the cross section for Compton scattering from the proton, at photon energies between 3 and 6 GeV over a wide range of center-of-mass scattering angles. In addition, it will measure the longitudinal and transverse components of the recoil-proton polarization at 4 GeV, using a circularly polarized photon beam. By the use of a mixed beam of electrons and Bremsstrahlung photons and a 15-cm long target, a high luminosity is achieved. The scattered photon is detected in a highly segmented lead-glass array. The coincident proton is detected in one of the Hall A magnetic spectrometers and its polarization components are measured in the focal plane polarimeter.

During 1998, a prototype photon calorimeter has been built and tested with both parasitic and dedicated beam time. In addition, a test experiment has been performed showing that the measurement is feasible with the planned equipment. No deterioration of the calorimeter block response due to radiation dose has been observed. The π^0 background is understood and under control, the photon-electron beam can be dealt with and allows *in situ* calibrations of the energy and position response of the calorimeter.

Issues: The PAC found the polarization measurement an interesting addition to the approved experiment. The PAC recommends that particular care should be devoted to managing the threshold $p\gamma X$ background.

Recommendation: Approved for 18 days in Hall A.

Individual Proposal Report

Proposal: E-99-115

Scientific Rating: A

Title: Constraining the Nucleon Strangeness Radius in Parity-Violating Electron Scattering

Spokespersons: K. Kumar

Motivation: A precise measurement of the parity-violating asymmetry for elastic electron scattering from the proton, at the same low Q^2 as the SAMPLE experiment at Bates, but now emphasizing the electric form factor, can determine the poorly known mean-square radius $\langle r_s^2 \rangle$ of the strange quark charge distribution in the proton.

Measurements and Feasibility: The measurement techniques are quite similar to those for the HAPPEX experiment, and are to be carried out by the same group. A few significant changes are required by the more forward (6^o) Hall A spectrometer angles needed to reach $Q^2 = 0.11$ $(GeV/c)^2$ and by the desired precision level (± 4.5% statistical and ± 2.5 % systematic uncertainties) on a very small (~2 ppm) asymmetry. The required septum magnet is already planned for other Hall A experiments, and should not introduce serious complications. The polarized source must produce 100 μA at 75% polarization, and somewhat smaller helicity correlations than yet achieved in HAPPEX with the strained GaAs photocathode. These are ambitious but credible goals: the impressive steady progress made by the JLAB polarized source group and the remarkable success of the earlier HAPPEX runs give the PAC confidence they can be achieved.

Issues: The proposed kinematics and uncertainties are similar to those for the lowest Q^2 point already planned for the G0 experiment at JLab. Nonetheless, the PAC judges the importance of the physics goal to be sufficiently high for the laboratory to pursue this experiment as expeditiously as possible.

Recommendation: Approved for 30 days in Hall A.

Individual Proposal Report

Proposal: PR-99-116

Scientific Rating: N/A

Title: $K^+\Lambda$ Photo-Production for $E_\gamma > 3$ GeV

Spokespersons: A. Afanasev, R. Gilman and M. Liang

Motivation: $K^+\Lambda$ polarized photoproduction and measurement of the three Λ polarization components are proposed in order to investigate the reaction mechanism at energies above the resonance region. Photo-production cross sections and polarization observables should provide selective constraints on theoretical models (Regge, di-quarks, pQCD, OFPD).

Measurements and Feasibility: The polarized photon beam, obtained in Hall A by a 25 μA, 80% polarized electron beam striking a copper radiator, has already been commissioned. The K^+ and Λ-decay proton are simultaneously detected in the two Hall A spectrometers. The Λ-decay proton emission cone is covered by successive spectrometer settings and determines the Λ polarization. Particle identification has already been tested, and planned improvements (Cerenkov, RICH, timing) will allow a good background rejection.

Issues: The PAC believes that the experimental techniques proposed are well under control, and could allow such a measurement. The case for the measurements of polarization observables appears interesting, but the theoretical predictions and the general physics objectives are still not sharp enough. The PAC considers that new results from approved experiments on $K\Lambda$ production should be assessed before any future proposal.

Recommendation: Defer

Individual Proposal Report

Proposal: E-99-117

Scientific Rating: B+

Title: Precision Measurement of the Neutron Asymmetry A_1^n at Large X Using CEBAF at 6 GeV

Spokespersons: Z.-E. Meziani, J.-P. Chen and P. Souder

Motivation: Previous measurements of the polarization asymmetry A_1^n for deep inelastic scattering from the neutron do not establish the expected rise of A_1^n from negative values at low x toward +1 as x approaches 1.0. This experiment aims to determine A_1^n with typical uncertainties of ± 0.05 over an x-range (0.33–0.63) where the asymmetry is predicted to take on sizable positive values.

Measurements and Feasibility: The spin asymmetries for inclusive inelastic scattering of longitudinally polarized electrons will be measured for both longitudinal and transverse spin orientations of a high-pressure polarized ^{3}He target. The two Hall A spectrometers will be used independently to detect the scattered electrons. The required polarized-beam performance (70% polarization at 15 μA) is consistent with that already achieved, while a modest improvement in target polarization (to 40%) is expected. The PAC judges the proposed uncertainty goals to be realistic.

Issues: The predicted trend in A_1^n at large x is tightly constrained in quark models that are consistent with the measured neutron-to-proton structure function ratio and with charge symmetry of the quark distributions. The PAC considers it important to obtain high quality measurements to test this clear prediction. This could best be done at an energy upgraded CEBAF. With the present energy limit of 6 GeV, the relevance of the proposed measurement can be questioned because the W values are close to the resonance region. The PAC encourages initial measurements at two different W-values for fixed x (e.g., 2.0 and 2.3 GeV at x ~ 0.5) to probe possible resonance effects on the asymmetry. The proposed single measurement at x = 0.33 also seems well-advised in order to establish the consistency of the JLab results with earlier measurements from SLAC.

Recommendation: Approve for 21 days in Hall A.

Individual Proposal Report

Proposal: E-99-118

Scientific Rating: B+

Title: Measurement of the Nuclear Dependence of R ($=\sigma_L/\sigma_T$) at Low Q^2

Spokespersons: A. Brull, J. A. Dunne, C. Keppel

Motivation: Few measurements of R (the ratio of longitudinal to transverse cross sections) exist for inclusive electron scattering on nuclear targets in the deep inelastic region. Comparison of recent cross section data from HERMES with the world data set has been interpreted to imply that R may be highly A dependent at low Q^2. The proposers want to obtain good data on R in the kinematic region close to the HERMES results to look for interesting nuclear effects on R.

Measurements and Feasibility: Inclusive cross sections will be measured with the HMS in Hall C over the kinematic region $3.1 < W^2 < 8.5$ GeV^2 and $0.07 < Q^2 < 2.2$ (GeV/c)^2, corresponding to values of Bjorken x from 0.02 – 0.5. Targets include H, D, C, Al, Fe, and Au. Rosenbluth separations will be carried out. Uncertainties in the determination of R are expected to be small, of order 0.03, limited by systematic errors. These error goals seem optimistic, but probably achievable over much of the region. Most contributions to the uncertainty are based on recent experience with the spectrometers.

Issues: The PAC agrees that R is an important quantity to measure for nuclear targets in the kinematic region available at JLab. The hint of unexpected physics provided by the HERMES data may lead to the discovery of interesting nuclear effects. Nevertheless, it is not clear that the proposed data will help in understanding the HERMES data since the targets and kinematics are not identical—the data may be highly sensitive to the target and kinematics. The group should give serious consideration to a measurement on nitrogen, a HERMES target.

Recommendation: Approval for 16 days.

Letter-of-Intent

Letter of Intent: LOI-99-101

Title: Measurement of G_{ep} / G_{mp} to Q^2=10 $(GeV/c)^2$

Spokespersons: C. Perdrisat

The proposed experiment would extend the measurement of the ratio of proton form factors, G_{ep} / G_{mp} from the currently approved Q^2 = 5.6 $(GeV/c)^2$ to approximately Q^2 = 10 $(GeV/c)^2$. This would extend the range in Q^2 over which the deviation from the dipole form for G_{ep} can be measured. The PAC encourages the development of a full proposal for this experiment. The proposal should be in the context of a maximum accelerator energy of 6 GeV. It should include an evaluation of all sources of backgrounds and anticipated performance of the electron and proton detector arms.

Appendix F

Approved Experiments, PACs 4 –16,
Grouped by Physics Category

Go to http://www.jlab.org/exp_prog/PACpage/

Appendix G

Summary of PAC16 Workshop on the Physics of Nuclei (Williamsburg, Virginia, July 17, 1999)

Introduction

This was the third workshop to provide the opportunity for the Program Advisory Committee to focus on one of the five broad scientific areas that comprise the Jefferson Lab physics program. The goals of these workshops are to review the approved program in the context of recent developments, to identify the key scientific questions in the area of concentration and to suggest opportunities for future experimental work.

Vijay Pandharipande began the discussion with a summary of the key theoretical developments, recent progress and the reasonable expectation of future progress. Ingo Sick presented his views on how the experimental program at JLab could make progress on a variety of fronts. Overviews of the approved physics of nuclei experimental program were then presented by the three Hall leaders. In a round-table discussion each PAC member summarized the areas of interest and possible experiments for the laboratory.

Scientific Areas and Experiments

Electromagnetic probes have been used effectively to study nuclei for at least six decades. The capabilities of Jefferson Lab offer obvious advantages in reaching high momentum transfer to study short distance phenomena in nuclei and in coincidence experiments. In the early PAC deliberations, there was some skepticism that sufficient resolution could be obtained for many nuclear structure studies. Hall A has now achieved 2×10^{-4} resolution and it is appropriate to readdress this program. However, it is essential to consider the suggestions for further experiments in light of the large body of existing data worldwide. In many cases what is needed is a single definitive measurement that spans a significant range of several kinematic variables. Such measurements can validate the existing data set and, where problems with the reaction mechanism exist, point the way to more reliable future work.

- Testing the Standard Model of Nuclear Many Body Theory in $A > 4$ systems.

In the previous workshop on few-nucleon systems, the PAC identified as a key scientific question the testing of our standard model of nuclear physics. This standard model was

defined as nuclear many-body calculations with the best current understanding of two- and three-nucleon interactions and one- and two-body electromagnetic currents. With present day computational resources, such calculations have been extended to systems of up to eight nucleons. New techniques have promise for extending calculations to $A \approx 50$.

Precise measurements of electromagnetic observables at high momentum transfer can test key assumptions in this standard model which are not well constrained by tests for systems with A = 2, 3 and 4.

⇒ High Q^2 elastic and inelastic electron scattering form factor measurements on ^{6}Li, ^{7}Li, and ^{9}Be.

(e,e′p) reactions over wide range of initial proton momenta in $6 < A < 9$.

(e,e′n) reactions to discrete states in $6 < A < 9$.

(e,e′π) reactions at high E_π to test the structure of pair currents.

- Nuclear Single Particle Structure.

  The properties of deeply bound hole states—spectroscopic strengths, positions and widths—are still only poorly known. Hypernuclei also provide an important tool for studying deeply bound states with relatively narrow widths in nuclei. While detailed knowledge of the wave functions of protons near the Fermi surface in nuclei exists, the data for neutrons is still poor.

  ⇒ (e,e′p) reactions to deeply bound hole states. Additional valuable information could be obtained by the detection of the nuclear decay particles.

  (e,e′K^+) reactions to bound hypernuclear states.

  (e,e′n) reactions to measure neutron hole states on a carefully considered choice of one light and one heavy system.

  ^{206}Pb –^{205}Tl comparisons at higher Q^2 to reduce the error on this textbook example of a hole state with significant density in the nuclear interior.

- Neutron Densities

  Parity violating electron scattering offers a unique quantitative probe of neutron distributions in heavy nuclei. A single, precise measurement would constrain a number of nuclear models used to describe the difference in neutron and proton density distributions. While PAC15 deferred a proposal in this area, interest remains high.

⇒ ^{208}Pb($\vec{e}, e$) parity violation to measure neutron skin thickness.

- Medium Modifications of Hadrons in Nuclei.

  If the nuclear medium causes substantial modification to the internal structure of hadrons then it is quite possible that our standard model discussed in the first section will not provide a complete description of heavier nuclei. Both the currents and interactions could change in the nuclear medium. The difficulty is separating these effects from many body affects that naturally arise with three body forces and two body currents as contrasted to effects where the internal structure of the hadrons becomes important.

  ⇒ Polarization transfer measurement of G_E^P / G_M^P in A > 4 systems.

  L/T separations in (e,e′p) to discrete states

  A couple of careful studies of the Q^2 dependence of the (e,e′p) reaction to discrete states over a broad range of Q^2.

  Masses and widths of vector mesons in nuclei studied in the di-lepton decay channels.

  Bound states of ω and η mesons in nuclei.

  (e,e′π) reactions to study the properties of the pion field in nuclei, especially at high Q^2. While it is not clear how to cleanly 'count' pions in nuclei, the strong connection with meson-exchange models of the nucleon-nucleon interaction and chiral models of the nucleon suggests that both theory and experiment in the quasifree ($e, e'\pi$) reaction should be actively pursued.

- Nucleon Correlations.

  Understanding the consequence of nucleon correlations is a must do program at JLAB, but it is still not clear what types of data are both clean enough to interpret and realistically measurable. The PAC believes the correct approach is to examine some of the results of the survey experiments that have been approved and then move decisively.

  ⇒ CLAS measurements on nuclear targets will provide an important overview of multi-nucleon reaction mechanisms.

  L/T separations in the ^{3}He(e,e′π) reaction appear to be an excellent case to study. The PAC deferred a proposal for this topic but remains enthusiastic about the possible physics insight of such a measurement.

- Hadronic Resonances in Nuclei.

This is an old problem in nuclear physics that was studied intensively for the Δ with pion beams. In many ways it is related to the search for medium modifications except well-known traditional mechanisms also can play essential roles. The PAC was not able to identify any new experiments in this area.

- Nuclei as a Length Scale or a Source of Nucleon Targets.

  Examining the nuclear dependence of a variety of electromagnetically induced reactions allows the study of hadron-nucleon final state interactions under controlled conditions. The nuclear size provides a controllable length scale to establish the elementary cross sections and coherence times at work.

  $\Rightarrow$ (e,e′p) searches for color transparency.
  (e, e′V) production of vector mesons studying coherence lengths and color transparency (photon shrinkage).
  Electroproduction or photo-production of short-lived hadrons to extract the hadron-nucleon cross sections. Examples: η, J/Ψ at higher energies.

- Nuclear Response Functions in the Quasifree Region.

  There still remains controversy in the measurements of the Coulomb sum rule in L/T separations of the cross sections in (e,e′) reactions as well as in the L/T separations in (e,e′p) reactions. Jefferson Lab should perform definitive studies in this area, but the demands for precision are very high. The proposers would need to convince the PAC that the methods are in hand to overcome the limitations of the past experiments in both technique (accuracy and backgrounds) and analysis (especially Coulomb and radiative corrections).

- Reaction Mechanism Studies on Nuclei.

  Unfortunately, to study much of the physics above, one needs better control of the reaction mechanisms than is currently in place. Many hints of multi-nucleon processes and excess transverse strength cloud the interpretations, even in apparently simple (e,e′p) reactions. The PAC is unlikely to approve experiments dedicated solely to tests of nuclear reaction mechanisms, however proposers are encouraged to include components of experiments focused primarily on some of the physics issues above which test key elements of the reaction mechanism that are essential for their experiments.