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Report of the

Jefferson Laboratory
Program Advisory Committee

PAC 25

Meeting of January 12 – 16, 2004

January 2004

Members of the Jefferson Lab User Group,

Ensuring the highest quality science from Jefferson Lab's world-class facilities is paramount for the success and vitality of Jefferson Lab and is essential for continued leadership in our field. In the past several months JLab has seen its experimental results recognized in the popular media such as The Economist and the New York Times in addition to the scientific and technical publications. This type of visibility for our program is very gratifying and enhances the appreciation for what our users do here.

The Program Advisory Committee plays a critical role in setting the bar high for experiments at Jefferson Lab. PAC 25 had a particularly difficult job, with 20 proposals to review. It has done an excellent job as they examined 20 proposals with 10 approved, 9 deferred, and 1 rejected. Our users continue to bring exciting and compelling science forward for consideration, and it is a difficult job that the PAC must do in assessing these proposals. One highly unusual action of PAC 25 was the recommendation that the beam time awarded in Hall B should substantially exceed the nominal allocation in view of the scientific priority and excitement about emerging evidence for hadrons consisting of more than three constituent quarks. I have accepted that recommendation with enthusiasm, and commit the laboratory to mount these important experiments rapidly.

PAC 25 also included a "mini-workshop" reviewing our program on Nucleon Excited States. This workshop completes a series that began with PAC 14, and provides a useful overview of both the status and directions of that very important part of the Jefferson Lab research program. Thanks to not only the PAC but also the invited speakers, Simon Capstick and Ralf Goethe and the three hall leaders for their contributions to this review.

I would like to take this opportunity to recognize the new PAC Chair, Dr. Berthold Schoch, and thank him for taking on this important role. Particular recognition and thanks go to the members of the PAC for their thoughtful deliberations on the physics program on behalf of Jefferson Lab and its User Community. I would also like to recognize retiring PAC member, Peter Bosted, for his service on this important committee. I look forward to the continuing flow of publications informing the scientific community of the exciting results coming from the Jefferson Lab experimental program. Attached is the PAC 25 Report.

Sincerely,

Christoph W. Leemann

Letter from the PAC Chairman

Introduction

The Jefferson Laboratory Program Advisory Committee held its 25th meeting on January 12 - 18, 2004. The membership of the Committee is given in Appendix A. In response to the charge (Appendix B) from the JLab Director, Dr. Christoph Leemann, the Committee reviewed and made recommendations for proposals and letters of intent submitted by JLab users.

General Overview

At the PAC 25 meeting an unusually-large number of requests for beam time at CEBAF were discussed. For this six-month period, twenty proposals and seven Letters of Intent were evaluated and are discussed in this report for possible inclusion in the JLab 6 GeV physics program.

The overall JLab experimental program continues to show solid growth; prior to PAC 25, it included 143 approved experiments. To date, 102.7 experiments (equivalent) have been completed at JLab, up by six over the past six months. Twenty-four papers have been published or submitted to Physical Review and Physical Review Letters over the past year, in addition to over 45 papers published elsewhere. A number of archival papers dealing with the construction of the experimental facilities in the three halls have been published or are in the process of publication. The number of Ph.D. projects completed to date at JLab is 164 (up by sixteen in the past six months), with an additional 140 projects in progress. This represents about one third of the U.S. production of Ph.D's in Nuclear Physics. All of this is indicative of a productive, very strong and healthy physics research program at JLab.

Following the recovery from Hurricane Isabel, the accelerator reached, remarkably quickly, the high level of performance of the previous year; during FY03 there were 39.6 weeks (equivalent) of physics delivered, based on 30.4 weeks of accelerator operation with 61% beam availability. The three hall availabilities ranged from 88% to 91%. Thus the hall multiplicity in this three quarter period was 2.39.

At this PAC 25 meeting, two topics dominated the discussions: the search for hadrons consisting of more than three constituent quarks (dubbed pentaquarks); and the inconsistencies of the results of Rosenbluth plot and polarization experiments extracting the G_E/G_M form-factor ratio for the proton. Two photon-exchange contributions of the e.m. interaction may be responsible for this discrepancy. The discussions concerning the pentaquarks have dramatically intensified worldwide since PAC 24. Nevertheless, the definitive proof of existence of this new species of bound states of quarks is still lacking. Thus, the PAC recommended that four new projects be added to the JLab research program to address questions about the nature of those states with the highest priority. By exploring different experimental methods, by increasing the amount of data by more than an order of magnitude and by extending the experimental studies on other members of the family of expected pentaquarks, there is a strong possibility that this situation will be clarified in the near future. In the case of a successful identification of pentaquark states, the determination of their quantum numbers, decay channels, and production cross sections on the neutron and the proton would provide decisive data for theory and would open up a new era of baryon spectroscopy.

Recent high precision measurements of absolute cross sections for elastic electron scattering appear to have crossed, in certain cases, the limit to which these cross sections are dominated by the mechanism of a single photon exchange between the scattered electron and the nucleon. Intensified experimental as well as theoretical investigations are necessary in order to establish a reliable procedure for the interpretation of the observables extracted from the cross section data. This topic has been addressed in four proposals. The PAC, however, was not convinced that the potential results of these experiments provide the most relevant information to solve this problem. A strong effort by theory groups is necessary to quantify the two-photon effects for various electromagnetic observables. In addition to finding a reliable procedure for calculating the corrections to one-photon exchange, the importance of such corrections in other reactions (e.g. in the electroweak sector) has to be investigated. These theoretical investigations would provide the basis for judging the merits of different observables. One experiment has been added to the program, which will test that the method of determining G_E/G_M using recoil polarimetry is independent of ε, the transverse polarization of the virtual photon. An extra paragraph preceding the individual reports outlines the issue in more detail.

In a measurement in Hall B, the search for new forms of hadronic matter in the meson sector will complement the ongoing investigations in the baryon sector. The chances of identifying exotic meson states with this experiment look very promising. The progress made by the proposers in establishing phase shift analysis procedures in the analysis of CLAS data has been remarkable. The measurements of structure functions on nuclear targets in the resonance region are of great interest for the interpretation of neutrino reactions as well as for nuclear physics. A group from both subfields are performing a measurement in Hall C.

The investigations of hadronization in nuclei by deep inelastic electron scattering test medium effects in nuclei and pave the way for a better understanding of hadronization in relativistic heavy ion reactions. Again, the data from this Hall A experiment have the potential to impact a wider community.

Recommendations

The high demand for beam time for pentaquark studies as well as “two photon” physics combined with the focus on two topics made the task of the PAC very challenging, as discussed below. Of the twenty proposals received, ten experiments were approved. The PAC approved four experiments in Hall A for a total of 68 days, four experiments in Hall B for 110 days, and two experiments in Hall C for 23 days. The ratings for these ten proposals were three with A, four with A^-, and three with B^+.

The laboratory guidelines provided for the approval of 102 days of beam time in Hall A, 30 days of beam time in Hall B, and 25 days of beam time in Hall C. Starting with PAC 24, the formula for these guidelines has been modified, and is based on three components: 30/45/25 days of new time to be made available in Halls A/B/C, plus 100%/100%/ 100% of the time recovered from approved experiments now required to return to the PAC due to the jeopardy process, and 50%/50%/50% of the days under target in each hall (applies in none of the halls at this time). The PAC is allowed to exceed the laboratory guidelines if it believes the physics has sufficiently high priority, that is at the level of an A^- rating or better, but the excess would then be deducted from the allocation available to the next PAC meeting.

The jeopardy process continues to evolve at JLab. At this meeting 72 days of approved time in three proposals were under jeopardy status, all of them in Hall A. Two of these proposals, comprising 46 days, were approved. Prior to PAC 25, the backlog in Hall A was about 5.2 years, while the backlog in Hall B was 3.7 years and that of Hall C, 4.2 years. PR-04-015, Precision Measurement of Longitudinal and Transverse Response Functions of Quasielastic Electron Scattering in the Momentum Transfer Range 0.55 GeV/c $\leq |q| \leq$0.9 GeV/c, an experiment rated A^-, has been deferred. This is an unusual decision , and certainly needs an explanation. The

PAC 16 workshop recommended such a measurement, stating: “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 methods are in hand to overcome the limitations of the past experiments in both technique (accuracy and background) and analysis (especially Coulomb and radiative corrections).” In approving the experiment, PAC 19 recommended that the proposers “... seek close collaboration with theorists to resolve the issues involving the Coulomb distortions.” PAC 25 agrees with each of the statements made by the previous PACs. However, the analysis issues are still not definitively addressed. The PAC is convinced that its decision of deferral of the experiment helps to pave the way not only to good data but also to a widely accepted result extracted from the those data.

The laboratory has the unique chance to be the leader in the pentaquark research. Its development will radiate to many subfields and will influence their development. Many laboratories worldwide have the opportunity to make contributions, but none has at hand the variety of experimental equipment as Jefferson Laboratory: the ideal energy range, spectrometers and detector systems of various types and, last but not least, the electromagnetic probe as a powerful tool to investigate the properties of these new states. The PAC has been aware of this exciting time and was pleased to see the extraordinary activities of the various groups involved in this field of research. Eight proposals had the aim to investigate different aspects of pentaquark research. It was not an easy task to filter out the proposals which seemingly hold the highest promise to advance this fast-changing field. The recommendation to run four experiments for pentaquark research, together with their very high assigned priorities, expresses the high hope of the PAC that with such a program the lead in this field can be kept. However, this puts a burden on the management, which therefore needs the understanding and support of the other users of the facilities. The PAC is convinced that all users of the Lab. and the nuclear physics community at large will profit from this research program. The PAC was fully aware that with this recommendation the normal laboratory guidelines will be exceeded. However, unusual challenges demand unusual efforts to meet them. The PAC is convinced that the possible identification of states, so far not seen, in a fierce competition with other laboratories justifies the concentration of beam time on this hot subject matter.

Four proposals were presented in which either the real or imaginary parts of purported two-gamma contributions are believed to enter into the determination of observables available to elastic electron-proton scattering. The latter include PR-04-008, PR-04-009 and one part of PR-04-019. PR-04-020 has been discussed under the same context. All of these are potentially fruitful directions to follow; however, at present it appears to the PAC that the ideas need to be refined and that a stronger case needs to be made for undertaking measurements of the imaginary parts of observables. Accordingly, the PAC recommends that these proposals be deferred.

It should be stressed at this point that the PAC judges proposals not only according to the feasibility of extracting precise and new data from the proposed experiments. In addition, the analysis tools appropriate to reaching the expressed goals of the experiments must be on hand. For proposal PR04-005 the PAC has been pleased to see this; for proposal PR04-015 and the “two photon” complex of experiments a convincing analysis or theory link to the final goal has not been demonstrated.

The proposal reports and the PAC recommendations for the reviewed proposals and the response to the letters-of-intent are given in Appendices D and E. The tables on the following pages summarize the status of the JLab commitments from PAC 4-PAC 25.

The PAC is very appreciative of the efforts of the Hall leaders and the Laboratory staff in support of the PAC meeting and review process. The enthusiastic and thoughtful contributions of Clara Perdue, Sue Ewing, and Suzanne Roseberry were especially effective in making the PAC process proceed gracefully and with high efficiency.

Berthold H. Schoch
Chairman, Jefferson Laboratory Program Advisory Committee

Tables

Totals for PAC 4-25

	Experiments Recommended for Approval	Experiments Recommended for Conditional Approval	Totals
Experiments	149	8	157
Authors	1096	36	1132
Institutions	184	3	187
Countries	30		30

Approved Experiments Totals by Physics Topics

Topic	**Number**	**Hall A**	**Hall B**	**Hall C**
Nucleon and Meson Form Factors & Sum Rules	25	11	4	10
Few Body Nuclear Properties	29	18	6	5
Properties of Nuclei	28	7	11	10
N* and Meson Properties	46	7	31	8
Strange Quarks	21	4	15	2
TOTAL	149	47	67	35

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	29	0	517.9	21	343.0	3
B	49	3×.40 2×.76 1x.25 1x.20	440.2	18	336.2	2
C	21	2×.5 1 ×.49	482.6	16	229.9	3
Total	99	10.00	1440.7	55	909.1	8

OVERVIEW ON PROPOSALS WHICH ADDRESS VARIOUS ASPECTS OF TWO-PHOTON CONTRIBUTIONS TO ELASTIC ep SCATTERING

Four proposals were presented in which either the real or imaginary parts of purported two-gamma contributions are believed to enter in the determination of observables available to elastic electron-proton scattering. The latter include A_y in PR-04-008, P_N (also called P_y) in PR-04-009 and one part of PR-04-019; P_l and P_t in the remainder of PR-04-019; and the unpolarized cross section with its two responses R_L and R_T for which a high-precision Rosenbluth separation is proposed in PR-04-020. Of these, the quantities A_y and P_N involve the imaginary parts of the two-photon contributions, whereas the polarizations P_l, P_t and the unpolarized responses R_L and R_T involve the real parts. At present the determinations of the ratio of the electric to magnetic form factors of the proton, when analyzed in the absence of two-photon effects, (1) via the Rosenbluth separation method and (2) via recoil polarimetry (through measurements of the ratio P_l/P_t) differ; this disparity is presently being attributed to the additional effects stemming from two-photon exchange processes. Importantly, this disparity involves the observables that arise from the real parts of the two-photon contributions. Clearly, it is desirable to undertake new experiments that could provide the additional (real part) information one requires to extract with high precision the underlying GEp/GMp ratio.

On the one hand, in the cases of PR-04-020 and the part of PR-04-019 (the one involving P_l and P_t) the real parts do enter and the recommendations of the PAC for these are discussed below. On the other hand, given our present understanding about the full scattering amplitude, the proposals that are aimed at the imaginary parts of the two-photon contributions have implications that are less directly related to the issue of determining the ratio GEp/GMp. While it may turn out that determining the imaginary parts of the amplitude has a bearing on the GEp/GMp problem, for instance via theoretical studies where real and imaginary parts are being modeled together, a compelling case for this has not yet been made. Furthermore, while it may turn out that the observables that involve the imaginary parts are of interest in their own right, perhaps via connections to much-sought-after weak interaction box diagram contributions or perhaps via interrelationships with GPDs, again no strong case for this has yet been made. These are potentially all fruitful directions to follow; however, at present it appears to the PAC that the ideas need to be refined and a stronger case for undertaking measurements of the imaginary-part observables provided. Accordingly, as discussed in more detail below, the PAC recommends that proposals PR-04-008, PR-04-009 and the P_N part of PR-04-019 be deferred.

APPENDICES

A. PAC 25 Membership

B. Charge to PAC 25

C. PAC 25 Recommendations

D. PAC 25 Individual Proposal Reports

E. PAC 25 Individual Letters-of-Intent Reports

F. Approved Experiments, PACs 4-25, Grouped by Physics Category

(To access Appendix F, go to http://www.JLab.org/exp_prog/PACpage/)

Appendix A
PAC 25 Membership

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Appendix B

Charge to PAC 25

Jefferson Lab requests that PAC 25:

1) Review both new proposals* and extensions[†] or updates[‡] to previously-approved proposals, and provide advice on their scientific merit, technical feasibility and resource requirements.

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

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

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

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 "N* and Meson Properties." 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?

* Previously-approved proposals that have not, within 3 years of PAC approval, been scheduled to run to completion 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.

[†] Extension proposals are treated as new proposals, and the merits and status of the original proposal are considered only to the extent that they may bear on the relevance and merit of the extension proposal.

[‡] In reviewing an experiment update, the PAC will treat the original proposal and any request for changes taken together as a single new proposal and treat the combination in a manner analogous to a previously-approved proposal undergoing a jeopardy review.

APPENDIX C

PAC 25 Recommendations

Class*/Grade/Days

A/B+/5	PR-04-001	Measurements of F_2 and R on the Nuclear Targets in Resonance Region
A/B+/15	PR-004-002	Hadronization in Nuclei by Deep Inelastic Electron Scattering
D	PR-004-003	The Neutron Electric Form Factor at Higher Q^2 up to 4.0 $(GeV/c)^2$ from the reaction $^2H(e,e'n)^1H$ via Recoil Polarimetry.
D	PR-04-004	Search for Exotic Pentaquark Θ^{++}, Θ^{*++} and Θ^+ in Hall C.
A/A/42	PR-04-005	Search for New Forms of Hadronic Matter in Photoproduction
	PR-04-006	WITHDRAWN
A/B+/16	PR-004-007	Precision Measurements of the Electroproduction of π^0 Near Threshold: A Test of Chiral QCD Dynamics
D	PR-004-008	Measurements of Target Single-Spin Asymmetry in Elastic $ep^{\uparrow}$ Scattering
D	PR-004-009	Measurement of the Born-Forbidden Recoil Proton Normal Polarization in Electron-Proton Scattering
A/A/20	PR-004-010	Search for Exotic Cascades with CLAS Using an Untagged Virtual Photon Beam
D	PR-04-011	Photoproduction of Θ^+ via the gamma plus deuteron $\rightarrow \Theta^+ \Lambda$ reaction
A/A-/7	PR-04-012	High Resolution Study of the 1540 Exotic State
R	PR-04-013	Measurement of the Nuclear Dependence of the EMC Effect at Large x
D	PR-04-014	Measurement of G^p_E/G^p_M using elastic polarized reaction $e(p,e')p$ up to $Q^2 = 3.50$ $(GeV/c)^2$
D	PR-04-015	Precision Measurement of Longitudinal and Transverse Response Functions of Quasi-Elastic Electron Scattering in the Momentum Transfer Range 0.55 GeV/c < q < 0.9 GeV/c
D	PR-04-016	Search for the Ξ pentaquark
A/A-/0	PR-04-017	Study of Pentaquark States in Photoproduction off Protons
A/A-/36	PR-04-018	Elastic Electron Scattering Off ^{3}He and ^{4}He at Large Momentum Transfers
A/B+/18	PR-04-019	Measurement of the Two-Photon Exchange Contribution in ep Elastic Scattering Using Recoil Polarization
D	PR-04-020	A Measurement of Two-Photon Effects in Unpolarized Electron-proton Scattering
A/A/25	PR-04-021	Spectroscopy of Exotic Baryons with CLAS: Search for Ground and Excited States

* A=Approve, C=Conditionally Approve, D=Defer, DR= Defer with Regret, R=Reject

Appendix D

Individual Proposal Report

Proposal: PR 04-001

Scientific Rating: B^+

Title: Measurements of F_2 and R on the Nuclear Targets in Resonance Region

Spokespersons: C. Keppel and A. Bodek

Motivation: The experiment is designed to measure the structure function F_2 and the ratio R in the resonance region for a variety of nuclear targets. The interest in duality and the effect of the nuclear medium on the nucleon structure provide solid theoretical motivation. Moreover, a detailed study of F_2 and R is an important ingredient in forming an integrated description of charged lepton and neutrino scattering cross sections.

Measurement and Feasibility: The proposed targets closely resemble the nuclear targets commonly used in neutrino experiments. Measurements will be made in the nucleon resonance region ($1< W^2< 4$ GeV^2), at momentum transfers $0.5<Q^2<5.0$ $(GeV/c)^2$ at identical kinematics points to those to be run during the deuterium experiment E02-109. Therefore, it is planned to integrate the proposed experiment with the data taking of E02-109 to avoid time consuming beam-spectrometer settings and to minimize the systematic error in the study of medium effects. The results already obtained in a similar experiment E 94-110 on hydrogen suggest that the experiment is feasible.

Issues: The PAC recognizes the importance of this measurement with regard to a better determination of the neutrino cross section. An accurate knowledge of the latter cross section is required for interpretation of measurements of neutrino oscillations.

Recommendation: Approve for 5 days in Hall C

Individual Proposal Report

Proposal: PR 04-002

Scientific Rating: B+

Title: Hadronization in Nuclei by Deep Inelastic Electron Scattering

Spokespersons: K. Wang, J.P. Chen, B. Norum

Motivation: The medium modification of the quark fragmentation and of the hadron formation process will be studied through a semi-inclusive measurement of deep inelastic electron scattering from various nuclei. By comparing yields of pions, kaons and protons for different nuclear targets in given kinematics, information on the propagation of fast quarks inside the nuclear medium and on the hadron formation lengths can be extracted. Data at different values of Q^2 may also allow to verify the factorization properties of the process which are basic issues in the physical interpretation.

Measurement and Feasibility: It is planned to run the experiment in Hall A with a 6 GeV electron beam on deuterium, carbon, copper and tungsten targets. The existing spectrometers HRSL and HRSR will be used to detect the hadrons and the scattered electrons respectively. The experiment will run at $\nu = 4.0$ GeV and $Q^2 = 2.81$ and 4.2 $(\text{GeV/c})^2$. Measurements away from the momentum transfer direction will be done to study the P_T dependence. The proposed experiment appears feasible as it is proposed.

Issues: In this field much data is now available from HERMES and new data will be generated by CLAS E02-104 over a wide kinematic range. Therefore, the PAC recognized the importance of an accurate measurement in the proposed selected kinematics to study precisely the A-dependence on the production of different hadrons and on their P_T distributions. In addition the understanding of the hadron formation is a crucial issue in a broad physics program like the ongoing one in heavy-ion interactions.

Recommendation: Approve for 15 days in Hall A

Individual Proposal Report

Proposal: PR 04-003

Scientific Rating: N/A

Title: The Neutron Electric Form Factor at Higher Q^2 up to 4.0 $(GeV/c)^2$ from the reaction $^2H(e,e'n)^1H$ via Recoil Polarimetry.

Spokespersons: R. Madey

Motivation: It is proposed to measure the neutron electric form factor G^n_E to high Q^2 with precision sufficient to improve significantly on the understanding of nucleon structure. In combination with neutron magnetic form factor data and proton form factor data, the proposed measurements would provide stringent constraints on nucleon models, and in particular would challenge anticipated rigorous Lattice QCD calculations. The new measurements would also help in the interpretation of few-body electron scattering experiments.

Measurement and Feasibility: The proposed technique consists of scattering longitudinally polarized electrons from quasi-free neutrons in a deuteron target, and measuring the recoil neutron polarization in a polarimeter. The scattered electrons are detected in the HMS spectrometer. The technique was successfully implemented in Hall C by the E93-038 collaboration at Q^2 values up to 1.45 $(GeV/c)^2$. With modest upgrades to the polarimeter, the experiment appears feasible up to Q^2=4 $(GeV/c)^2$, according to detailed simulations of backgrounds presented in the proposal. The systematic error on the proposed measurements is estimated to be very small, so that the total errors would be completely statistics dominated.

Issues: An already approved experiment at JLab will measure G^n_E using polarized ^3He to Q^2=3.4 $(GeV/c)^2$ with a projected total error of 0.0020, substantially smaller than the projected error of 0.0032 for the present proposal at somewhat higher and lower Q^2 [3 and 4 $(GeV/c)^2$]. While the PAC appreciates an independent measurement with the method of recoil polarimetry, the proposed level of statistical accuracy and the proposed Q^2 reach are not found sufficiently compelling to justify the large investment of setup and running time needed for this experiment.

Recommendation: Defer

Individual Proposal Report

Proposal: PR 04-004

Scientific Rating: N/A

Title: Search for Exotic Pentaquark Θ^{++}, Θ^{*++} and Θ^{+} in Hall C.

Spokespersons: H. Gao, S. N. Nakamura

Motivation: Several experiments have reported observations of the exotic baryon state denoted as the Θ^{+} (1540). The observed mass positions vary from 1525-1555 MeV with widths consistent with detector resolution. The proposed experiment would confirm the existence of this state, and measure the mass and width to high precision. In addition, a search would be performed for the doubly-positive-charged pentaquark states expected in certain theoretical models.

Measurement and Feasibility: The experiment requests 19 days of beam time in Hall C. The mass and width of the Θ^{+}(1540) are measured using untagged real photons incident upon a 4 cm. LD2 target. A forward K^{-} is detected in the SOS spectrometer in coincidence with a K^{+} in the HKS spectrometer. A neutron counter detects a final state neutron, so that the energy of the incident photon and the momentum vector of the spectator proton can be calculated uniquely, assuming that this is the only undetected final state particle. The invariant mass of the n K^{+} system is measured with a mass scale uncertainty δ M = +/- 1.0 MeV and a mass resolution 3.7 MeV full-width-half-maximum (FWHM). The forward K^{-} is detected in a momentum-transfer-squared range from 0.6-1.3 $(\mathrm{GeV/c})^2$. For the doubly-positive-charged measurements, a LH2 target is used, and a final state K^{-} and K^{+} detected in coincidence as for the Θ^{+} measurement. The incident photon energy and the momentum vector of the missing proton can again be calculated, under the assumption that only a proton is undetected. The K^{+}p mass scale is again well known (δ M = +/- 1.0 MeV), but the mass resolution ranges from 6.8 to 7.4 MeV (FWHM). The HKS spectrometer and beam splitter from the HN E01-011 experiment and the Bremsstrahlung radiator are required for this experiment, as is a neutron detector which has yet to be designed and built. Strong comments from the TAC have prompted a reconfiguration of the experiment, with the HKS and neutron detector now located out of plane, and with the HKS and SOS spectrometers now positioned at larger angles. The experiment as presented in the most recent proposal appears to be feasible, but would benefit from beam tests and direct confirmation of expected background levels, accidental rates, mass resolution and precision of mass scale.

Issues: The change in experimental configuration has reduced or eliminated many of the issues raised by the TAC. However, there remain concerns about background levels in the neutron counter and their impact on efficiency. In the new configuration, the forward K is detected at fairly large momentum-transfer-squared, and it is not clear what the impact will be on predicted signal size, since experimental knowledge of this angular distribution is not yet precise. This gives cause for concern over the significant time investment required.

Recommendation: Defer

Individual Proposal Report

Proposal: PR 04-005

Scientific Rating: A

Title: Search for New Forms of Hadronic Matter in Photoproduction

Spokespersons: P. Eugenio, C. Salgado and D. Weygand

Motivation: The experiment is designed to search for new forms of hadronic matter via meson spectroscopy. The spectra and properties of exotic mesons, such as gluonic hybrid mesons or four-quark mesons, are poorly known and the study of light-quark mesons in the mass range 1 to 2 GeV/c^2 will provide further understanding of confinement in QCD. An important step is to search for exotic mesons containing strange quarks, including exotic strangeonia which also requires exploring ordinary strangeonia. Photoproduction at intermediate energies is known to provide a powerful tool for all of these purposes.

Measurement and Feasibility: The experiment will study meson spectroscopy in the 1 to 2 GeV/c^2 mass range using a high-energy photon beam in Hall B. Based on results from the analysis of previous CLAS and other data, the experiment will concentrate on channels with three or four charged particles in the final state, which are known to be a good signature for the states of interest. The statistics will be sufficient to allow a complete partial-wave analysis of these reactions. Analysis of similar data taken under comparable conditions has produced significant results and demonstrated that the experiment is feasible.

Issues: This is an experiment of exceptional promise, putting Jefferson Laboratory at the forefront of exotic meson spectroscopy. It should be run at least at the proposed energy of 5.7 GeV to maximize the meson mass range achievable.

Recommendation: Approve for 35 days in Hall B.

Individual Proposal Report

Proposal: PR 04-007

Scientific Rating: B^+

Title: Precision Measurement of the Electroproduction of $\bullet^{0}$ Near Threshold: A Test of Chiral QCD Dynamics

Spokespersons: R. Lindgren; J.R.M. Annand, V. Nelyubin, D.W. Higinbotham

Motivation: The experiment is aimed at making a high-precision measurement of π^0 electroproduction near threshold in a fine grid of Q^2 and □W for $Q^2 < 0.14$ $(GeV/c)^2$ and • W < 20 MeV. The data will allow a partial-wave analysis and provide a stringent test of chiral perturbation theory, particularly by determining one of the P-wave amplitudes for which the theory is able to give definite predictions.

Measurement and Feasibility: The experiment will be performed in Hall A using an HRS spectrometer in coincidence with the BigBite spectrometer. The large acceptance of BigBite allows all measurements to be made with the spectrometers in a single configuration thereby minimizing systematic uncertainties.

Issues: The PAC notes the capability of the experiment to yield data of a quality which will allow a partial-wave analysis to be performed at all Q^2 and the largest P-wave amplitude to be extracted, providing a clear test of the limits of chiral perturbation theory. The change in the P-waves as Q^2 increases from zero is important and the collaboration is encouraged to reduce the minimum value of Q^2 as far as is practicable. The angular distributions are sensitive to small errors in the measurement of the recoil proton and in reconstruction of the photon momentum vector. Particular care has to be taken to maintain the projected accuracy.

Recommendation: Approve for 16 days in Hall A.

Individual Proposal Report

Proposal: PR 04-008

Scientific Rating: N/A

Title: Measurements of Target Single-Spin Asymmetry in Elastic $ep^{\uparrow}$ Scattering.

Spokespersons: X. Jiang, M.K. Jones, P. Bosted, D. Crabb

Motivation: The apparent discrepancy between the Rosenbluth separation and the polarization transfer techniques for extracting proton form factors was recently attributed to the presence of the two-photon exchange process. The target spin asymmetry (A_y) in elastic electron-nucleon scattering must vanish for pure one-photon exchange. A measurement of non-zero A_y would provide a clear evidence for effects arising from the interference between the one-photon exchange amplitude and the imaginary part of the two-photon exchange amplitude.

Measurement and Feasibility: The proposed experiment would use 50 nA electron beam at Hall C (or Hall A) incident on a vertically polarized NH3 target. Scattered electrons and protons would be detected by four identical lead-glass arrays providing capability for measuring both the e+p and the p+e events. The data would be divided into 4 bins covering $2.5 < Q^2 < 4.5$ (GeV/c)^2 with projected statistical errors of 0.23% to 0.33% and a systematic error of 0.1% for A_y. Although the feasibility for cleanly identifying ep elastic scattering using lead-glass arrays remains to be demonstrated experimentally, results based on Monte-Carlo simulation as well as an analysis of existing CLAS data are encouraging.

Issues: The PAC is concerned that the A_y measurement, although a clean channel for probing the imaginary part of the two-photon exchange, is not directly relevant for resolving the G_E/G_M discrepancy which is only sensitive to the real part of the two-photon amplitude. The physics impact of the proposed A_y measurement requires further studies, as discussed in the general overview of two-photon proposals of the PAC25 report. Furthermore, to achieve a 0.1% systematic error for A_y requires precise measurements of luminosity and a careful control and monitoring of the stability of various detectors.

Recommendation: Defer

Individual Proposal Report

Proposal: PR 04-009

Scientific Rating: N/A

Title: Measurement of the Born-Forbidden Recoil Proton Normal Polarization in Electron-Proton Elastic Scattering

Spokespersons: D. Mack

Motivation: The goal of the proposed experiment is to determine the imaginary part of the two-photon exchange amplitude through a measurement of the induced proton polarization (P_N) in unpolarized ep elastic scattering. The two-photon exchange process was suggested as the origin of the apparent discrepancy of the proton form factors ratio G_E/G_M extracted from the Rosenbluth separation and the polarization transfer techniques. A determination of the two-photon exchange amplitude could also impact our knowledge on possible contributions of the box diagrams to various electroweak processes.

Measurement and Feasibility: The proposed experiment would use a superconducting solenoidal polarimeter to measure the recoil proton polarization (P_N) in coincidence with electrons detected with the HMS spectrometer in Hall C. Several beam energies and two scattering angles are proposed for mapping out the dependences on the center of mass energies and Q^2 ($0.57 < E < 3.0$ GeV, $0.13 < Q^2 < 2.1$ (GeV/c)^2) of P_N. This technique is well suited for achieving a high precision required in this experiment.

Issues: The PAC is concerned that the P_N measurement, which is sensitive to the imaginary part of the two-photon exchange, is not directly relevant for resolving the G_E/G_M discrepancy which is only sensitive to the real part of the two-photon amplitude. The physics impact of the proposed measurement on the electroweak box diagrams also requires further studies, as discussed in the general overview of two-photon proposals of the PAC 25 report.

Recommendation: Defer

Individual Proposal Report

Proposal: PR 04-010

Scientific Rating: A

Title: Search for Exotic Cascades with CLAS Using an Untagged Virtual Photon Beam

Spokespersons: E. Smith, M. Holtrop, S. Stepanyan, R. Gothe

Motivation: The proposal aims at a specific search for pentaquark $\Xi_{.}$ states using the CLAS-detector with untagged virtual photons at maximum available energy. If observed with sufficient statistics, the particle mass, width and the production and decay angular distributions could be evaluated. The full emphasis on reconstruction of the decays bears the additional benefit of additionally getting valuable information on conventional cascade states.

Measurement and Feasibility: The experiment will use a 5.7 GeV electron beam incident on a deuterium target. The scattered electron would not be detected implying that the virtual photons remain untagged and no explicit flux measurement is done. The cascades are to be identified by their specific decays through known hyperons. The event time, necessary for particle identification and track reconstruction can be reliably determined as was demonstrated for the case of ordinary hyperons. This way, also various cascade states can be identified by valid Lambda and Sigma mass combinations, albeit with different sensitivities. A maximum sensitivity is expected for the manifestly exotic ●•, i.e. 46 counts per nb in the proposed 20 day run. This signal is expected to sit on a background level of about 1 count per day, based on analyzed data from a run with comparable conditions. Exploitation of displaced secondary vertices is expected to further reduce this background level. Though excitation functions of the production cross section cannot be directly measured, the production yield in the effective photon spectrum can be obtained. To cope with the increased data rate improvements in the DAQ-system will be made, which are part of the general CLAS strategy.

Issues: There is presently no reliable estimate for exotic cascade production cross sections. A maximum background reduction along with highest possible luminosity is mandatory to yield a significant upper limit if no signal can be found.

Recommendation: Approve for 20 days in Hall B

Individual Proposal Report

Proposal: PR 04-011

Scientific Rating: N/A

Title: Photoproduction of Θ^+ via the gamma plus deuteron $\rightarrow \Theta^+ \Lambda$ reaction

Spokespersons: E. Piasetzsky, R. Gilman and S. Wood

Motivation: This experiment proposes to photo-produce the exotic Θ^+ via the reaction $D(\gamma,p\pi^- K^+)n$, with the $p\pi^-$ pair reconstructed to a Λ^0. The Θ^+ signal would appear as a peak in the missing mass formed from the K^+ and the reconstructed neutron. The goals of this experiment are (1) a high statistics confirmation of the existence of the Θ^+ and (2) a substantial improvement over first generation experiments in the determination of its width. It is worth noting that this measurement would provide Θ^+ production data in a channel for which there is presently very little information.

Measurement and Feasibility: The proposal requests 11 days with 25 μA of 1.2 GeV electrons in Hall A. One HRS would be used for proton detection and BigBite for K^+ detection. A user-supplied scintillator array would be used for π^- detection. A single kinematic setting is proposed at low *t*, -0.01 $(GeV/c)^2$. The collaboration has the expertise needed to complete the measurements successfully.

Projected instrumental resolutions would result in a Θ^+ mass determination to an accuracy of ±2.5 MeV and a width of 5.9 MeV (FWHM). The intrinsic width of the Θ^+ resonance would appear as an increase in the width above the instrumental resolution and could be unfolded down to the level of about 3 MeV. The reconstruction can be accurately calibrated through the reaction $\gamma p \rightarrow \Lambda K^+ \rightarrow p\pi^- K^+$ to provide the same final state particles in the same detectors.

Issues: In the present early stage of pentaquark phenomenology, the identification of the exotic spectrum and the determination of the quantum numbers of exotic candidates are of the highest priority. The collaboration is encouraged to track the progress in this rapidly evolving field to determine the optimal kinematics and assess if the scientific impact of a proposal focusing on a width determination has become sufficient to warrant resubmission.

Recommendation: Defer

Individual Proposal Report

Proposal: PR 04-012

Scientific Rating: N/A for M1 and M2, A- for M3

Title: High Resolution Study of the 1540 Exotic State

Spokespersons: B. Wojtsekhowski

Motivation: Several experiments have reported observations of the exotic baryon state denoted as the Θ^{+} (1540). The observed mass positions vary from 1525-1555 MeV with widths consistent with detector resolution. The proposed experiment would confirm the existence of this state, and measure the mass and width to high precision. In addition, a search would be performed for the doubly-positive-charged and neutral pentaquark states expected in certain theoretical models.

Measurement and Feasibility: The experiment requests 47 days of electron beam time in Hall A. The mass and width of the Θ^{+} (1540) would be measured in two ways, denoted by M1 and M2, both of which would use a deuterium target. For M1, a forward K^- would be detected in the HRSL spectrometer, a low-momentum K^+ would be measured in Big Bite, and a neutron counter would detect a final state neutron. The invariant mass of the n-K^+ system would be measured with a mass scale uncertainty δM = +/- 0.5 MeV and a mass resolution 2.9 MeV full-width-half-maximum (FWHM). For M2, HRSL would detect a forward K^- while HRSR would measure the final state electron. The spectator proton from the deuterium interaction would be measured in Big Bite, so that the recoil missing mass system has the characteristics of the $\bullet_{+}$. The missing mass scale is precisely known (δM = +/- 1.3 MeV), and the resolution is excellent (FWHM = 2.8 MeV). A third measurement, denoted M3, would use a liquid hydrogen target, and would detect a forward K^- or K^+ using HRSL and the scattered electron in HRSR. The missing mass system then has the characteristics of the doubly-positive-charged (K^- forward) or neutral (K^+ forward) pentaquark states predicted in certain theoretical models. The missing mass scale is again well known (δM = +/- 1.3 MeV) and the resolution is very good (FWHM = 1.8 MeV), so that the mass range up to 1.64 GeV can be examined for the existence of any such narrow-width states. Measurements M1 and M2 propose to use a cold deuterium gas target (at present being developed at ANL), although this is not essential to M1. The neutron counter for M1 is under construction, while commissioning of the Big Bite Spectrometer is scheduled for October, 2004. As described, the experiment appears to be feasible but difficult, and would benefit from beam tests and direct confirmation of expected background levels, accidental rates, mass resolution and precision of mass scale. The construction of the cold gas target seems technically challenging.

Issues: The readiness of Big Bite affects the M1 and M2 measurements, while the deuterium gas target is necessary for the M2 measurement, and the neutron counter is essential to M1. The M3 measurement could be carried out on a relatively short time-scale, and appears to offer significant discovery potential for a fairly modest time investment. The PAC feels positive about the high precision offered by M1 and M2. However, these assume that $\bullet_{+}$ production is strongly correlated with low-angle high momentum K^- production. This is not unreasonable, but is not yet strongly supported by experiment, and this gives cause for concern over the large time investment required (40 days).

Recommendation:

M1: defer

M2: defer

M3: approve for 7 days in Hall A

Individual Proposal Report

Proposal: PR 04-013

Scientific Rating: N/A

Title: Measurement of the Nuclear Dependence of the EMC Effect at Large x

Spokespersons: D. Gaskell, J. Arrington

Motivation: The goal of the proposed experiment is to study the EMC effect observed in the cross section ratio σ_A/σ_D at large x for several nuclei. Special emphasis is put on the A-dependence of the high-x cross over. The experiment provides the opportunity to test current theoretical models on the EMC effect which are mainly based on Fermi motion. The interpretation of the data will rely on duality; data from the nucleon resonance region is to be analyzed in terms of DIS physics.

Measurement and Feasibility: It is proposed to study the EMC effect at large x ($0.5<x<0.9$) by inclusive electron scattering from deuterium and several nuclei ranging from ^{7}Li to ^{197}Au. It is planned to perform these measurements at the highest available beam energy of 6 GeV. Even with this energy the large-x region can only be accessed in the nucleon resonance region $W<2$ GeV, although Q^2 is large (4-7 $(\mathrm{GeV/c})^2$). Based on experience with previous experiments (E89-009, E99-118) this experiment is feasible.

Issues: The PAC25 is not convinced that this measurement will provide sufficient new insight into the EMC effect beyond what is already known from previous and planned experiments.

Recommendation: Reject

Individual Proposal Report

Proposal : PR 04-014

Scientific rating : N/A

Title : Measurement of G^p_E/G^p_M using elastic polarized reaction $e(p,e')p$ up to $Q^2 = 3.50$ $(GeV/c)^2$

Spokespersons : X. Zheng, J.R. Calarco and O.R. Rondon

Motivation: The determination of the proton EM form factors is of considerable physics interest, generating a wealth of experiments aiming at reaching the largest values of Q^2 possible. An experimental discrepancy has recently been observed between the results from the conventional Rosenbluth separation technique and those from a recoil polarization technique, when the two sets of results are interpreted in the absence of two-photon contributions. Initially the discrepancy raised experimental questions, and, as a consequence, the separation technique has been checked by a new analysis of the existing data and measurements performed at JLab. The discrepancy at large Q^2 has been attributed to the effect of two-photon exchange, which was neglected until recently, and theoretical calculations have accounted for part of the experimental deviation.

It is important to pin down the origin of the observed experimental discrepancy in order to allow the unambiguous extraction of the proton elastic form factors and to test the two-photon exchange calculations. This proposal is aiming at providing a new experimental observable. The measurement of the asymmetry in a doubly-polarized experiment should indeed provide an identical result to the transfer polarization data. This would then be a cross check, but with very different systematic errors.

Measurement and Feasibility: The experiment is proposed for Hall C and requests 25 days of running time. It is an asymmetry measurement using a polarized NH_3 target and a polarized electron beam of 6 GeV. This is a single-arm experiment, with the detection of the elastically scattered electron in HMS with its standard equipment. The electron beam intensity is limited to 85 nA by the polarized target. The spin orientation of the target and the scattered electrons detection angle are optimized in the angular regions allowed by the design of an existing polarized target. The asymmetry measurements, providing the ratio of the EM proton form factors, will be measured at two Q^2 values (2.1 and 3.5 $(GeV/c)^2$) with a measurement at lower Q^2 (3.6 GeV beam) to control the value of the product of the polarizations of the beam and target. The experiment appears feasible with the expected precision.

Issues: The PAC has, however, considered that given the present experimental situation a cross check of the transfer polarization data is not sufficient at the level of accuracy proposed. It has not been convinced that the range in Q^2 covered in the measurement is large enough nor that the precision it can attain makes a sufficiently compelling case for approval.

Recommendation : Defer

Individual Proposal Report

Proposal: PR-04-015

Scientific Rating: N/A

Title: Precision Measurement of Longitudinal and Transverse Response Functions of Quasi-Elastic Electron Scattering in the MomentumTransfer Range 0.55 GeV/c < |q| < 0.9 GeV/c

Spokespersons: J.-P. Chen, S. Choi, Z.-E. Meziani

Motivation: The possible quenching of the Coulomb sum rule, especially in heavy nuclei, has for many years been one of the most controversial subjects in electro-nuclear physics. Within the context of a quasi-elastic scattering mechanism one expects the sum rule to be saturated typically at momentum transfers between 500 and 1000 MeV/c. The failure of the sum rule to saturate would require the invocation of other mechanisms, including perhaps multi-nucleon correlations or modifications of the nucleon's in-medium electromagnetic form factors. Clear evidence for such effects would be of great interest in attempting to define the limits of a baryon-meson picture of the nucleus.

Measurement and Feasibility: At this time there exist data for various nuclei in the momentum transfer range up to about 600 MeV/c. The present proposal aims at extending the available data up to about 900 MeV/c, thus enabling a study of the q-evolution of the sum rule. It would also provide for the first time a consistent data set from a single facility for a variety of nuclei over a large range of three-momentum transfer. In principle the PAC would like to see such a measurement carried out, in line with previous PACs.

We note that the experiment is very difficult in that it is sensitive to various backgrounds, and that knowledge of the acceptances at forward and backward angles, as well as matching q-effective at forward and backward angles, are essential. Several concerns expressed by the previous PAC, such as simulation of backgrounds arising from scattering from and within the spectrometer elements, have satisfactorily been addressed and clear progress has been made in demonstrating the feasibility of the measurements. Where systematic errors are as critical as they apparently are for experiments of this type the PAC encourages continuing efforts be spent on simulations that will better define the ultimate uncertainties to be expected.

Issues: The main issue with this proposal is not so much whether measurements of the cross section can successfully be made, but whether the goal of the experiment, i.e., to determine the Coulomb sum rule for a set of nuclei in the range of momentum transfer proposed, can be accomplished with small enough uncertainties to resolve the basic sum rule problem. Whether the sum rule is obeyed or not hinges on several factors in the analysis leading from the obtained longitudinal response function to the integrated Coulomb sum. The most controversial is apparently how one handles the Coulomb distortions of the electrons especially when scattering from heavy nuclei. In particular, different estimates of the size of such distortions have led to quite different statements from competing groups, while using the same set of cross sections: one group claims the sum rule is satisfied, whereas another that it is quenched by up to 30%. While the apparent confirmation of the effective momentum approximation by positron versus electron scattering presented to the PAC is suggestive, the subject still appears to be highly controversial. A second, although lesser, concern is how the extrapolations in ω into regions that are inaccessible to the experiment are carried out.

Before considering this experiment again for approval the PAC would like assurances that the data obtained would lead to a result for the Coulomb sum rule that would be broadly accepted by the involved community. In particular, the PAC would like to see the following:

A. A set of broadly-accepted procedures for extracting the sum rule from the separated responses. This will include, in particular, procedures treating Coulomb distortion effects, as these are critical for achieving the stated goal of the proposal. This was emphasized by previous PACs and yet it remains in the way of a successful experiment. The PAC understands that the proponents themselves wish to call together interested theorists with the requisite experience to try to resolve this problem and provide a path to approval. The PAC strongly supports such a strategy and urges the laboratory, in concert with the collaboration, to host a mini-workshop to develop an approach that is broadly accepted and can provide a path to approval.

B. Simulations that allow one to arrive at projections for the uncertainty expected in the quantity of interest, the Coulomb sum rule.

Once these are done, it will be possible to see results of applying these procedures to existing data, further strengthening the level of confidence in reaching the goals of the experiment. The expectation is that, upon re-submittal, this issue of interpretation will have been resolved

Recommendation: Defer

Individual Proposal Report

Proposal: PR 04-016

Scientific Rating: N/A

Title: Search for the Ξ Pentaquark

Spokespersons: J. Price

Motivation: The proposal aims at a search for the •˙ pentaquark state for which recent experimental evidence has been raised in NA49. If the Ξ^{-} was observed with sufficient statistics, its mass and width could be determined and the excitation function and production angular distribution be evaluated.

Measurement and Feasibility: The experiment would use 5.7 GeV electrons to create a tagged photon beam incident on a deuterium target. The CLAS-detector would be used to investigate the reaction • + d ••> •⁺ •⁺ p X and missing mass distributions technique. This technique is well established for the CLAS detector and allows one to look also for other states. The quest for a shorter coincidence time window to achieve higher trigger purity at increased luminosity relies on the operation of a new start counter. With its installation a luminosity comparable to the g6c run can be used, while the background is believed to be comparable to the low intensity g6b run. A yield of 40 reconstructed •˙ /nb was estimated for the proposed ten-day run.

Issues: An optimum signal to background ratio S/B is crucial to obtain the highest possible sensitivity for the •˙, the production cross section of which is basically unknown. The PAC was concerned about the values given for S/B which were extrapolated from runs without the new start counter. They might be inferior to those achievable through the reconstruction of the decay chain.

Recommendation: Defer

Individual Proposal Report

Proposal: PR 04-017

Scientific Rating: A-

Title: A Comprehensive Study of Exotic Baryons with CLAS off a Proton Target

Spokespersons: D. Weygand, V. Kubarovsky and J. Price

Motivation: Recent analyses of a number of different experiments have provided intriguing evidence for a narrow Θ^+, an exotic S=+1, I=0 member of a 5-quark baryon anti-decuplet near 1530 MeV. One experiment has also reported evidence for two of the S=-2, I=3/2 members of this anti-decuplet, a Ξ_5^- and a Ξ_5^0, near 1860 MeV. The quantum numbers of such exotics are extremely important as they provide a basic discrimination between a wide variety of emerging models. For example, a parity assignment for the Θ^+ would immediately exclude half the available models. The scale of the photo-production cross section has been promoted as a *parity meter*, although this depends strongly on the reaction mechanism. Two principal reaction mechanisms have been proposed for Θ^+ production, t-channel K and K* exchange and excitation of a new intermediate N*. Qualifying the reaction mechanisms for Θ^+ production, confirming the existence of Ξ_5 baryons and qualifying the mechanisms for Ξ_5 production are very important steps in understanding the nature of these new exotics. These form the focus of the proposal.

Measurement and Feasibility: This proposal requests 5.7 GeV running with 5 x 10^7 s^{-1} tagged photons and a 40 cm long hydrogen target in the CLAS of Hall B. The long target and the high flux require a new start counter to improve K/π separation and this is presently under design. The strength of this proposal is its goal of providing broad kinematic coverage for a variety of channels. Its feasibility has been demonstrated in the analysis of the g6c data set in which a candidate Θ^+ peak was observed with the highest statistical significance to date. Interesting hints at reaction mechanisms have already been gleaned, including the suggestion of Θ^+ production through an intermediate N* near 2.4 GeV and the apparent absence of production associated with an accompanying K*.

The tagged energy range of this proposal has been chosen as a compromise to access a broad range of questions. Although projected rates for the possible Ξ_5^{--} are rather limited, Ξ^- states could be detected copiously. These have the potential for being at least as interesting, particularly if I=1/2 and I=3/2 Ξ_5^- states can be identified.

Issues: This experiment is proposed to run *concurrent* with PR-04-005, although the two have different requirements for a new CLAS start counter and different optimum settings for the CLAS magnetic field.

Recommendation: Approve for 35 days in Hall B, concurrent with E-04-005

Individual Proposal Report

Proposal: PR 04-018

Scientific Rating: A-

Title: Elastic Electron Scattering Off ^3He and ^4He at Large Momentum Transfers

Spokespersons: G.G. Petratos, J. Gomez, A.T. Katramatou

Motivation: It is proposed to measure the elastic electron scattering form factors of ^3He and ^4He up to the largest momentum transfers accessible at JLab. These data will double the Q^2 range over which the form factors are presently known. Models using meson-baryon based interactions predict a second diffraction minimum in the Q^2 range of the proposed experiment. Effects due to exchange currents, isobar configurations, three-body forces and relativity, i.e., by means of the relativistic modeling, and possibly the onset of scaling can be investigated.

Measurement and Feasibility: The two magnetic spectrometers of Hall A will be used to detect in coincidence the scattered electron and recoiling nucleus. In this way background events are effectively suppressed. In the case of ^3He it also guarantees the separation of the elastic and breakup channels. The charge and magnetic form factors of ^3He will be extracted by means of a Rosenbluth separation of data taken at two beam energies. The form factor of ^4He is obtained by measuring an angular distribution. The effective double-arm solid angle will be determined by means of a Monte Carlo simulation that will be verified by means of dedicated calibration measurements on ^1H. Collimators will be mounted close to the cryogenic target cells to prevent the electron spectrometer from viewing the Al end-caps.

Issues: This dataset will provide a bench mark for the few-body physics community. Many aspects of few-body theory, such as exchange currents, three-body forces and relativity will be tested. The form factor data may help in addressing the issue of where the description in terms of meson-baryon based interactions must be replaced by one that uses quark and gluon degrees of freedom. The question whether at these values of the momentum transfer scaling sets in, for instance as predicted by the dimensional-scaling quark model, will also be addressed. During the experiment the search for the position of the diffraction minima should be pursued.

Recommendation: Approve for 30 days in hall A.

Individual Proposal Report

Proposal: PR 04-019

Scientific Rating: B+

Title: Measurement of the Two-Photon Exchange Contribution in $\vec{e}p$ Elastic Scattering Using Recoil Polarization

Spokespersons: R. Suleiman, R. Gilman, L. Pentchev, C.F. Pedrisat

Motivation: Two-photon exchange has been suggested as a possible explanation for the observed discrepancy between results from Rosenbluth separations and polarization transfer measurements on the proton. It is proposed to measure the ε-dependence of the induced polarization (p_y) and the longitudinal (P_l) and transverse (P_t) polarization transfer components in $\vec{e}p$ elastic scattering at Q^2=3.2 (GeV/c)^2. In Born approximation p_y is identically zero, but interference between the imaginary part of the two-photon exchange amplitude (TPEX) and the one-photon exchange (OPEX) amplitude can, according to various calculations, lead to measurable values. Observation of an ε-dependence of P_l and P_t different from that predicted by OPEX, would indicate a signature from the real part of the TPEX amplitude. At Q^2 =3.2 (GeV/c)^2 the ratios of the proton electric to magnetic form factor as extracted from Rosenbluth separations and recoil polarization measurements differ by ≈35%. In a combined analysis of the $\tilde{\varepsilon}$-dependence of the three recoil polarization components in $\vec{e}p$ elastic scattering with the reduced cross section, as determined in the Super-Rosenbluth experiment, the importance of two-photon exchange processes can be quantified.

Measurement and Feasibility: A 75 μA polarized electron beam impinges on a LH2 target in Hall C. The scattered electron is detected in a lead-glass calorimeter in coincidence with the proton in HMS, equipped with the new focal-plane polarimeter that is being developed for G_E^p -III.

Issues: The measurement of an observable that is driven by the real part of the TPEX amplitude is vital for the electron scattering community. The proposed determination of P_t, P_l and their ratio fulfills this criterion. However, the measurement of p_y provides the imaginary part of TPEX whose relation to the discrepancy in the proton form factor ratio G_E/G_M is less clear, as elaborated on in the general overview of two-photon proposals of the PAC25 report. Therefore only the P_t and P_l part of proposal PR04-019 is approved. The collaboration is strongly encouraged to review the •-points at which the polarization transfer components will be measured, such that an optimal sensitivity of the results for TPEX effects is obtained.

Recommendation: Approve for 18 days in hall C if run concurrent with E01-109, otherwise 20 days.

Individual Proposal Report

Proposal: PR 04-020

Scientific Rating: N/A

Title: A Measurement of Two-photon Effects in Unpolarized Electron-proton Scattering

Spokespersons: J. Arrington

Motivation: From a high-precision measurement of the Rosenbluth plot for elastic ep scattering (this proposal), coupled with other measurements of the elastic ep recoil polarization ratio P_l/P_t and with some input from e^+/e^- scattering, it appears to be possible to refine our understanding of the role played by two-photon contributions. From the disparity between the extraction in the absence of two-photon effects of GEp/GMp from Rosenbluth plots on the one hand and from recoil polarimetry on the other, it is presently thought that two-photon contributions are significant and that these may explain the difference. This proposal aims to provide very high precision measurements of the ε dependence of the (unpolarized) elastic ep cross section for a broad range of ε , thereby testing the linearity (or lack thereof) of the Rosenbluth plot with higher precision than in previous studies. By making such measurements at various values of Q^2 the goal is to refine the determination of the two-photon contributions to the elastic ep cross section.

Measurement and Feasibility: The proposed measurements would be undertaken in Hall C using six linac settings with a total of 18 different energies (matched to E02-010) and detecting the proton to provide a significant reduction in systematics, as in E01-001. It is projected that these measurements would constitute a 3-4 times better extraction than is expected for E01-001 and 6 times better than presently available. If this goal can be achieved it appears that the measurement has the potential to help in constraining the two-photon effects and thus to improve the present ability to extract the underlying form factors GEp and GMp. In any case, it would provide a crucial test of the assumed linearity of the Rosenbluth plot to an accuracy never before achieved at momentum transfers which are relevant for many other experiments at JLab.

Issues: The ability to define the linearity (or degree of curvature, if it turns out to be nonlinear) in the Rosenbluth plot demands high control of systematic errors. The projected results as presented lacked sufficient detail for a full assessment of the likelihood of achieving the required level of systematics and, for a convincing case to be made for embarking on such an experiment, more thorough Monte Carlo simulations are desirable. For the experiment viewed simply as a refined Rosenbluth plot measurement, this might be adequate. However, as discussed above, the goals stated in the proposal go beyond this. The information provided in the proposal, in the presentation and privately to the PAC has gone a long way to making the case that ultimately the two-photon effects and the underlying proton form factors can be extracted with increased precision using the analysis scheme proposed. However, more detailed understanding of how systematic and statistical uncertainties in the measurements proposed, and in the other measurements that must be used in the analysis, propagate into the expected uncertainties in the two-photon contributions and in the basic form factors would help to motivate the proposed measurements. Finally, a more convincing case could be made by showing what is the present status of tests of the linearity of the Rosenbluth plot using all existing high-quality World data.

Recommendation: Defer

Individual Proposal Report

Proposal: PR 04-021

Scientific Rating: A

Title: Spectroscopy of Exotic Baryons with CLAS: Search for Ground and Excited States

Spokespersons: M. Battaglieri, R. De Vita, V. Kubarovsky

Motivation: The aim of the experiment is to confirm the existence of the Θ^+ exotic baryon, and to search for firm evidence of an excited state, for which some hints are found in existing data. Assuming convincing signals are observed, further goals include a more precise determination of the mass, width, and production and decay angular distributions of these exotic baryons. The experiment aims to establish in which production and decays channels they are observed, and to provide a solid foundation for the long-term investigation of the pentaquark spectrum and properties.
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Measurement and Feasibility: This experiment will use a 4 GeV electron beam and the Hall B tagged photon facility to measure photo-production from a 40-cm-long liquid hydrogen target. Hadrons will be detected in CLAS. A new start counter will be used to enable running at higher luminosity than in previous experiments. This is a straightforward extension of the previous photoproduction experiment, making the goal of ten times higher statistics eminently feasible.

Issues: The possible existence of an excited Θ^+ state would be extremely interesting and have a high scientific impact. It is important to run this experiment soon to preserve this discovery potential, and to establish a baseline for further pentaquark studies at Jefferson Lab. Serious attention should be paid to careful calibration of the tagged photon energy, and the momentum scale and alignment of the CLAS detector in order to ensure the best possible determination of the mass position and width of any observed signal.

Recommendation: Approve for 20 days in Hall B

Appendix E

Individual Letter of Intent Report

Letter of Intent: LOI-04-001

Title: Extraction of G^P_E from a Double-polarization Measurement of Two-body ^3He Breakup

Contact Person: S. Sirca

The discrepancy between the Rosenbluth method and the polarization transfer method extracting G^P_E / G^P_M needs an explanation. The prime motivation of this letter of intent is to present a third experimental approach that does not rely on recoil polarimetry and thus provides an independent check for the extraction of this form factor ratio.

The extraction of precise results for G^P_E from $^3He(e,e'p)^2H$ data using polarized electrons on a polarized ^3He target will be hampered by the following issues:

- the precise knowledge of the proton polarization in the two-body breakup of ^3He is highly model dependent,
- the contamination from the three-body final state will introduce an appreciable uncertainty: the relative contribution will be difficult to estimate and the corresponding dilution of the polarization will give rise to a model-dependent correction.

These issues will likely lead to systematic errors in the interpretation of the measurements that are too large for precision measurements of G^P_E.

In addition, even the projected level of statistical precision in the covered Q^2 region does not appear to provide a definitive test of the discrepancy between previous G^P_E extractions from the Rosenbluth and recoil polarization methods.

Individual Letter of Intent Report

Letter of Intent: LOI-04-002

Title: Measurement of the Spin and Parity of the Exotic Θ^+ via the Reactions n(γ,K^-K^+n) and n(γ,K^+n)K^- with polarized γ and polarized ^{3}He

Contact Person: X. Zheng

This letter of intent is being developed to study the reactions n(γ,K^-K^+n) and/or n(γ,K^+n)K^- with incident circularly polarized real photons and a polarized effective neutron target, the latter provided by polarized ^{3}He. By measuring the angular distributions involved and the double-polarization asymmetry, the goal of the LOI would be to provide information on the spin-parity of the $\bullet^+$ By the time such a measurement could be scheduled, the spin of the $\bullet^+$ will very likely have been determined, but conversely the parity will very likely be unknown. The latter is very important since a parity determination would exclude half the available models. The ability of such a double-polarization asymmetry to fix the parity will be the focus of scrutiny of a future proposal. At present the ideas behind the experiment are based on relatively unsophisticated modeling and clearly to justify a full proposal it will be necessary to provide better estimates of effects not presently included. In particular, the calculation outlined in this LOI is limited to kaon exchange while preliminary CLAS data suggest that the production of an intermediate N* near 2.4 GeV also plays a role in $\bullet^+$ photo-production. Thus, in addition to the expected elaboration of the technical details inherent in the measurements that is necessary to progress from the present state as a letter of intent to a full proposal, it is very important to have as sophisticated a theoretical basis for the experiment as possible. Lacking the latter, there will always be doubt that competing mechanisms will render the results ambiguous.

As stated above, although originally describing an electro-production experiment, this LOI is proceeding with the idea of using circularly polarized real photons; it would be useful to have some comparison between this approach and one that employs linearly polarized photons, including both theoretical issues and those related to the relative feasibilities of the two approaches.

In summary, the PAC regards the prospect for a $\bullet^+$ parity determination via a double-polarization asymmetry as very interesting and encourages the proposers to continue to develop these ideas further.

Individual Letter of Intent Report

Letter of Intent: LOI-04-003

Title: Single Spin Asymmetry Measurements in Semi-Inclusive Pion Electroproduction on a Transversely Polarized Proton Target

Contact Person: X. Jiang

Measurements of single spin asymmetries have been shown to be a powerful tool, with the potential to access new and unmeasured partonic distribution functions, including transversity. This LOI describes a measurement of the target single-spin asymmetry in $ep \rightarrow e'\pi^+X$ and $ep \rightarrow e'\pi X$ with a transversely polarized target.

It is planned to use a new polarized NH_3 target with a super-conducting magnet with a large horizontal and vertical acceptance. Pions and scattered electrons will be detected by HMS and by an extended BigCal, respectively.

The physics observables are related to the fundamental but still unmeasured transversity distribution h_1 and to new spin dependent T-odd fragmentation functions. Together with f_1 and g_1, h_1 enters at the leading order level in the description of the nucleon structure. Several experiments (HERMES, COMPASS, STAR, PHENIX, BELLE) are currently addressing this investigation and a similar experiment E03-004 on the neutron has already been approved in Hall A.

The x and z ranges of the present experiment partially overlap with the ones of the ongoing HERMES measurement on the proton. Therefore, a comparison with the projected final HERMES data will be important to judge the potential impact. It is noted that most of the large amount of the requested beam time will be needed to measure the asymmetry for the un-favored •˙ production.

In addition, the angular coverage for the Sivers type asymmetry, which is related to chiral-even distribution functions, is strongly reduced with respect to the one for the Collins type asymmetry, which is related to the chiral-odd h_1.

Individual Letter of Intent Report

Letter of Intent: LOI-04-004

Title: Determining the nature of the Θ^+ using polarization asymmetries

Contact Person: G. Cates

This letter proposes the study of the Θ^+ (1540) in photoproduction on a polarized ^3He target. It is suggested that asymmetry in the cross section with the normal to the final state K^-K^+ plane might provide information as to whether the Θ really exhibits the rapid phase change characteristic of a resonant state.

This is an interesting idea. However, the formalism presented relies heavily on the kaon-exchange production mechanism shown in Fig. 1. This takes no account of the possibility of contributions due to e.g. K^* exchange, and furthermore treats the virtual kaon as though it were real. These features would have to be addressed prior to any formal proposal being made.

A further concern, relates to equations (4) and (5), which present the asymmetry as proportional to sin $(\delta_0^+ + \delta_1^-)$ in the particular case considered. If the Θ^+ is narrow, this asymmetry will be averaged over mass (as a consequence of mass resolution), while δ_1^- makes a rapid change of π. Any net effect is dependent on knowledge of the value of δ_0^+ (e.g. if $\delta_0^+ = \pi/2$, the value is 0), and it follows that the interpretation is highly dependent on the nature of the relevant coherent "background" amplitudes in this mass region. The assumption in the letter is that these behave just as for real K^+n scattering, but this may well not be the case, hence making it difficult to draw conclusions from the measurement if a null value is observed. A non-zero value for the asymmetry would presumably indicate that a resonant interpretation of the Θ^+ is valid, but it would seem to be very difficult to draw any precise conclusion to spin and parity.

Individual Letter of Intent Report

Letter of Intent: LOI-04-005

Title: Two-Photon Exchange from a Precise Comparison of e^+p and e^-p Elastic Scattering in CLAS

Contact Persons: W. Brooks

The PAC recognizes that a precise measurement of e^+p and e^-p elastic scattering is essential for resolving the discrepancy observed in the measurements of proton's G_E/G_M ratios using two different techniques. The proposal to produce tertiary electron and positron beams in CLAS seems very attractive, since it offers the opportunity to detect e^+p and e^-p elastic scattering simultaneously using the same detector. This important feature, together with the ability to reverse the fields of the dipole magnet and the CLAS torus, allows several crucial systematic checks to be made that are required for a precise measurement.

Due to the tertiary nature of the e^+/e^- beam, the beam flux and beam energy are not sufficiently high for probing the interesting high-Q^2 kinematic region. The physics impact of the proposed measurement of e^+p/e^-p cross section ratios at $Q^2 < 1$ GeV/c^2 with the projected sensitivity is not evident and should be better elaborated. In addition, detailed simulation studies are required to ensure that the background level in CLAS is under control.

The PAC is enthusiastic about the spirit of this LOI and encourages further studies on a preparation of a e^+/e^- beam which could help to resolve the discrepancy.

Individual Letter of Intent Report

Letter of Intent: LOI-04-006

Title: Measurement of the Q^2-dependence of the Axial-vector and Pseudoscalar Nucleon Form Factors from Q^2=1 to 3 $(GeV/c)^2$

Contact Person: A. Deur

This letter of intent aims at a determination of the axial-vector and induced pseudoscalar form factors of the nucleon over the range $1<Q^2<3$ $(GeV/c)^2$. Two reactions are involved: (1) e(p,n) ν and (2) e(p,e'n) π^+. Reaction #1 is dominated by the axial-vector form factor and has only very small corrections (mass terms) from the induced pseudoscalar form factor, whereas reaction #2, which is needed to correct for background in #1 and will be measured concurrently, by itself is sensitive to the pseudoscalar form factor. In fact, at lower Q^2 pion electroproduction is the method of choice for determining the pseudoscalar form factor. The goal of the experiment is to reach uncertainties of 4-5% in these two form factors over the range of momentum transfer given above.

Presently the cross section estimates have been made and appear to be quite robust, whereas the feasibility study needed for a full proposal has only begun and clearly many issues will have to be explored in detail. For instance, some concerns were expressed that the very high luminosity (which is certainly necessary when attempting to measure cross sections at the 10^{-39} cm^2/sr level) may not be feasible when having to veto charged particles in the neutron detector, as envisioned. Another issue may be whether or not the beam structure for the experiment as presently foreseen is optimal and whether or not an alternate time structure can reach the required luminosity. The proposers are encouraged to proceed to explore all of these issues and anticipate a fully developed proposal at a subsequent PAC meeting.

Individual Letter of Intent Report

Letter of Intent : LOI -04 - 007

Title : Search for a narrow Δ^0 state in ^{9}Be(γ, pπ^-)^{8}Be and ^{12}C(γ, pπ^-)^{11}C Reactions

Spokespersons : Rafael Hakobyan, A. Margaryan

The physics case of this letter of intent is about the in-medium properties of hadrons and the search of (narrow) unstable baryon bound states. The LOI aims at investigating the existence of narrow Δ^0 states produced in photo-production reactions on ^{9}Be and ^{12}C targets. These states have been searched at MAMI in (e,e'pπ^-) reactions on a ^{12}C target by using triple coincidence in spectrometers and a missing mass technique. Under specific kinematical conditions reducing final state interaction, peaks were observed and interpreted as Δ^0 bound states using a Δ-Nucleus central potential approach. The proposed experiment intends to both reproduce this measurement and improve the statistics for the ^{12}C target and extend the observation to another target (^{9}Be).

The experiment is proposed in Hall B with tagged photons and makes use of CLAS and of a Low Energy Recoil Detectors (based on Low Pressure MWPC). The reactions will take place in a solid ^{9}Be target or the ^{12}C nuclei of the heptane gas. The detection of the recoil nucleus (^{11}C or 2 α) will be performed in the gas chamber whereas the one of the proton and π^- arising from the decay of the Δ^0 will be done using CLAS. A significant improvement of the statistics is expected over the MAMI results.

The surprising results of the MAMI experiment led already to a new, approved proposal on the same facility. The outcome of this future experiment at MAMI could also provide impact on the interest for this proposal. The simulation of the reaction in the CLAS configuration proposed need to be developed at a more sophisticated level. The PAC is also concerned that using real gammas the kinematics could not be flexible enough in the search of these narrow states e.g. in selecting the initial momentum of the p-wave nucleon in the target nucleus.

Appendix F

Jefferson Lab Experiments, PAC 4-25, Grouped by Category

(To access Appendix F, go to http://www.JLab.org/exp_prog/PACpage/)