Report of the January 26-28,2000

JLab Program Advisory Committee

PAC17

The Thomas Jefferson National Accelerator Facility (Jefferson Lab) is a national physics user facility managed by the Southeastern Universities Research Association (SURA), Inc., for the U.S. Department of Energy (DOE) under contract DE-AC05-84ER40150.

For more information or copies of this report contact:
Thomas Jefferson National Accelerator Facility
User Liaison, MS 12B
12000 Jefferson Avenue
Newport News, VA 23606
Phone: (757) 269-6388 / Fax: (757) 269-7003
E-mail: users@JLab.org
WWW: http://www.JLab.org/exp_prog/PACpage/pac.html

February 7, 2000

Dear Members of the Jefferson Lab User Group,

We continue to make significant progress in our endeavor to deliver high quality polarized beams and are also making steady improvements in the maximum energy available and the reliability of beam delivery. Thirty micro-ampere, 75% polarized beams with energies up to 5.5 GeV have been delivered for the experimental program simultaneously with high current unpolarized beam. We expect to be able to deliver 6 GeV beam for physics in the near future.

The research program is well underway in all three halls, and a steady stream of publications has been established in both Hall C and Hall A. We anticipate the first physics results from Hall B will be submitted for publication this year. The base equipment in each Hall is performing well, and as I write Hall C is on track in preparations for its third major installation experiment, the HNSS. This experiment, which will investigate the feasibility of producing and studying hypernuclei at Jefferson Lab via the electroproduction of strangeness, requires the installation of a new magnetic spectrometer on the Hall C pivot.

Last year our FEL set a world's record of over 1kW of average output power in the infrared; as a consequence of that achievement the laboratory has received funding from the Navy to upgrade the FEL to 10 kW. We anticipate receiving approval from the DOE to operate the FEL as a user facility shortly, and are actively seeking new operating funds to support this undertaking. The requests for beam time at the FEL already exceed the time available, and I hope that in the near future a user program as successful as the one we have in our nuclear physics program will be underway using this remarkable new facility.

The most recent Users Group Board of Director's meeting was held on Nov. 10, 1999. An important outcome of this meeting was the decision that an "Experimental Run Report" will be requested after each newly-completed experiment. This report will provide us with rapid feedback on areas where we can improve and on what we are doing well. It is another example of our commitment to seek advice and input from you on how to continually improve the laboratory and its ability to serve your needs.

The annual Science and Technology Review of the laboratory by SURA and DOE was held on September 14–15. The review went very well, with the overall program being judged outstanding. This is a tribute to our hard work together to mount the best possible research program using CEBAF. The committee urged the laboratory to continue to pursue development of the physics case and equipment requirements for the 12-GeV upgrade.

In a step toward that goal, a sub-committee of the PAC chaired by David Cassel of Cornell reviewed the Hall D proposal for the photoproduction of unusual mesons on Dec. 6-7. They noted that the project is "very high priority physics" and "will permit a definitive search for mesons with exotic quantum numbers, particularly hybrid states and glueballs." The report went on to observe that "JLab is unique in being able to provide the high quality, low emittance, CW photon beams required for this experiment," and that "the general design of the detector is technically sound." Following their recommendations we will be working with the Hall D group to carry out the R&D needed to complete the development of a conceptual design report for this important new facility.

Other physics programs driving the upgrade plans were the subject of a user-sponsored workshop held January 13–15 at the laboratory. A series of working group meetings are planned for the next few months, which will culminate in the preparation of a white paper on the physics of the upgrade. Another general workshop on the upgrade will be held June 21–23, and a review of the upgrade plans by the PAC will take place at the summer PAC meeting.

As NSAC gears up for the next long range planning exercise, we must work with the nuclear physics community to develop a vision for the entire field, and to ensure that the larger community shares the enthusiasm of our users for the 12-GeV upgrade.

Finally, I am pleased to enclose the PAC 17 report. While the number of new proposals for this PAC was small, the quality of these proposals was excellent, as can be seen by the PAC's recommendations that we exceed slightly the nominal beam allocations for Halls A and C. I am pleased with the progress in our present experimental program and look forward to additional exciting results in the coming year.

Sincerely,

Hermann A. Grunder
Director

Report of the January 26–28, 2000 Meeting of the Jefferson Lab Program Advisory Committee (PAC17)

Introduction

The Jefferson Lab Program Advisory Committee held its 17th meeting on January 26–29, 2000. Following the main meeting, the PAC met for one day to discuss the laboratory's program in the physics of strange quarks. 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 six new proposals and two letters of intent.

The PAC would like to acknowledge the efforts of the laboratory staff in support of the PAC meeting and workshop, especially Karen Hokansson, Shauna Cannella, and Greg Adams.

General Overview

Larry Cardman reviewed the progress of the laboratory for the past six months. The PAC noted that the experimental program continues to proceed exceedingly well. The number of weeks of beam delivered to experiments, combining the accelerator performance and the Hall multiplicity, grew by almost 30% in FY99. The members of the PAC have become so accustomed to the outstanding performance in polarized beam delivery that we did not hesitate to consider new proposals with even more demanding requirements. We also note with pleasure that CLAS is now running at design luminosty.

While a stream of important scientific results from JLab research is now appearing in the scientific literature, to date, these have all been short reports in letter journals. The PAC strongly encourages more complete archival publications of the results of each JLab experiment. Beam time is sufficiently precious that experimenters have a responsibility to the community and the laboratory to make as much information as possible easily available.

Plans for 12 GeV

At PAC15, a subcommittee was set up to review the science and technical feasibility of the proposed Hall D project. We welcome the report of the subcommittee chaired by D. Cassel. This report noted that the Hall D project addressed "very high priority physics" in meson spectroscopy for the mass range up to 2.5 GeV and that "JLab was unique in being able to provide the high quality, low emittance, CW photon beams required for this experiment." The subcommittee judged the experiment to be technically sound, and concluded that the proposed beam and detector combination will be able to realize the physics goals of the project.

The laboratory would like critical advice from the PAC on the development and priorities of the 12-GeV experimental program. The new series of user workshops and meetings under way will be very useful for the PAC in giving this advice. The PAC expects to consider the plans for 12-GeV experiments in detail at a PAC workshop prior to the next PAC meeting in July 2000.

Physics of Strange Quarks

The fourth PAC workshop addressed the status and experimental opportunities in understanding the physics of strange quarks, both in measurements of intrinsic strangeness in parity violating electron scattering and in the production of hadrons with open and hidden valence strangeness. Michael Ramsey-Musolf and Doug Beck were invited to review the current situation. The Hall leaders presented the programs of approved experiments in each Hall that address this physics. The conclusions of the workshop were reached following a round table discussion to summarize the scientific context of these experiments and to suggest ideas for experiments which the PAC views as having particular promise. A summary of the workshop is included in this report as Appendix G.

Recommendations

The laboratory guidelines provided for the approval of 30 days of beam time in Halls A and C. No proposals were received for Hall B. These guidelines were established beginning with PAC14 in order to reduce the significant backlog of approved experiments. The PAC is allowed to exceed these guidelines if it believes the physics has sufficiently high priority, at the level of an A- rating or better, but the excess is then deducted from the allocation of the next PAC meeting. At this meeting the PAC chose to exercise this option for the first time, approving experiments for 37 days in Hall A and 32 days in Hall C.

The reports and PAC recommendations for the reviewed proposals and the letters-of-intent are given in Appendices D and E. The tables on the following pages summarize the results from PAC 4–17.

Donald Geesaman
Chair, Jefferson Lab Program Advisory Committee

APPENDICES

A. PAC17 Membership

B. Charge to PAC17

C. PAC17 Recommendations

D. Individual Proposal Reports

E. PAC17 Letters-of-Intent

F. Approved Experiments, PACs 4–17, Grouped by Physics Category
(To access Appendix F, go to http://www.JLab.org/exp_prog/PACpage/)

F. Summary of PAC17 Workshop on the Physics of Strange Quarks
(Duck, North Carolina, January 29, 2000)

Totals for PACs 4–17

	Experiments Recommended for Approval	Experiments Recommended for Conditional Approval	**Totals**
Experiments	118	14	**132**
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	24	13	6	5
Properties of Nuclei	23	5	10	8
N* & Meson Properties	40	6	26	8
Strange Quarks	17	4	10	3
Total	**118**	**34**	**55**	**29**

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	1 x .10 10 / 2 x .5 1 x .17	199.9	22.73	567.1	6
B	1 / 8 x .50 19 x .27 6 x .61 4 x .72 3 x .76 2 x .80	168.7	33.45	347.39	5
C	12 / 1 x .5 1 x .25	222.5	16.25	421.5	3
Total	**23 / ~21.57**	**591.10**	**72.43**	**1335.99**	**14**

Appendix A
PAC17 Membership

DON GEESAMAN (Chair)
Argonne National Laboratory
Physics Division, Bldg 203
9700 South Cass Avenue
Argonne, IL 60439
Phone/Fax: (708) 252-4059/3903
geesaman@anl.gov

JURGEN AHRENS
Institut fuer Kernphysik
Universitaet Mainz
D-55099, Mainz, Germany
Phone/Fax: 49-(0)-6131-39-25195/22964
ahrens@kph.uni-mainz.de

HENK BLOK
Dept. of Physics and Astronomy
Vrije Universiteit
De Boelelaan 1081
1081 HV Amsterdam
Phone/Fax: 31-20-444-7901/7992
henkb@nat.vu.nl

FRANCIS CLOSE
Rutherford Appleton Lab
Didcot
0X110QX England
Phone/Fax: 44-1235-445605/523302
F.E.Close@RL.AC.UK

JAMES L. FRIAR
Los Alamos National Lab
Theory Division, MS B283
P. O. Box 1663
Los Alamos, NM 87545
Phone/Fax: (505) 667-6184/4055
Friar@sue.lanl.gov

CHARLES GLASHAUSSER
Department of Physics
Rutgers University
136 Frelinghuysen Rd.
Piscataway, NJ 08854-8019
Phone/Fax: (732) 445-2526/4343
glashaus@physics.rutgers.edu

MAURO TAIUTI
Dipartimento di Fisica
Universita´ di Genova
Via Dodecanneso, 33
1-16146 Genova, Italy
Phone/Fax: 39-010-353-6458
Mauro.Taiuti@ge.infn.it

BARBARA JACAK
Dept of Physics & Astronomy
SUNY at Stony Brook
Stony Brook, NY 11794-3800
Phone/Fax: (516) 632-6041
Jacak@skipper.physics.SUNYSB.edu

STANLEY KOWALSKI
Massachusetts Institute of Tech.
Department of Physics. MS 26-427
77 Massachusetts Avenue
Cambridge, MA 02139
Phone: (617) 253-4288
sk@MITLNS.MIT.EDU

JACQUES MARTINO
DAPHNIA/SPhN
CEA Saclay
91191 Gif-Sur-Yvette Cedex, France
Phone/Fax: 33-(0)1-6908-7455/7584
jmartino@cea.fr

GERALD MILLER
Physics, Box 35-1560
University of Washington
Seattle, WA 98195-1560
Phone/Fax: (206) 543-2995/685-9829
MILLER@nucthy.phys.washington.edu

SHELLEY PAGE
Department of Physics and Astronomy
University of Manitoba
301 Allen Building
Winnepeg, Maitoba Canada R3T 2N2
Phone/Fax: (204) 474-6202/7622
PAGE@Physics.Umanitoba.CA

CHARLES PRESCOTT
SLAC MS78
P.O. Box 4349
Stanford, CA 94309
Phone: (650) 926-2856
prescott@SLAC.Stanford.EDU

Appendix B

Charge to PAC17

Jefferson Lab requests that PAC17:

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, or
   - rejection.
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 "strange quarks." 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 3 years of approval or 3 years after 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.

† 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

PAC17 Recommendations

Class*	Grade (days)	Number	Title
A	A$^-$ (8)	E-00-002	F_2^N at Low Q^2
C	A$^-$ (30)	E-00-003	A Clean Measurement of the Neutron Skin of ^{208}Pb through Parity Violating Electron Scattering
D		PR-00-004	Duality in Meson Electroproduction
R		PR-00-005	Study of Excited Intermediate States in $p(e,e'K^+)\Sigma^0$ Reactions
A	A (70)	E-00-006	G^0 Experiment
A	A$^-$ (7)	E-00-007	Proton Polarization Angular Distribution in Deuteron Photo-Disintegration

‡ The number of days for G^0 includes 46 days previously approved as E-99-016.

* A=Approved, C=Conditionally Approved, D=Defer, R=Reject.

Individual Proposal Report

Proposal: E-00-002

Scientific Rating: A^-

Title: F_2^N at Low Q^2

Spokespersons: C. Armstrong, I. Niculescu

Motivation: The aim is to determine F_2^p (x, Q^2) and F_2^n (x, Q^2) at low x and Q^2 where there is presently little data. The low Q^2 data that do exist exhibit unexpected behavior.

Measurements and Feasibility: Inclusive cross sections will be measured with the HMS in Hall C. Rates are high and running times are short at each kinematic setting. The HMS must be run in small angle mode, which is likely to add several days to the setup time. Overhead for calibration, etc., at the various settings is relatively high so an additional day was added to the original request.

Issues: Almost half of the data are at high enough W^2 that F_2 can be interpreted straightforwardly within the parton model. The analysis will use the measurements of R from E-94-110; these data are expected to be available soon. The PAC found that the determination of F_2 in this entire kinematic region was important, though it remains somewhat skeptical about the emphasis on local duality for the analysis of the low W^2 data.

Recommendation: Approved for 8 days.

Individual Proposal Report

Proposal:	E-00-003
Scientific Rating:	A-
Title:	Clean Measurement of the Neutron Skin of ^{208}Pb through Parity Violating Electron Scattering
Spokespersons:	R. Michaels, P.A. Souder, G.M. Urciuoli

Motivation: The aim of this experiment is to carry out a precision measurement (±3%) of the parity violating asymmetry in ^{208}Pb at a forward scattering angle of $\theta = 6°$ and Q=0.45 fm^{-1}. This would allow an extraction of the neutron radius in this closed-shell nucleus to a precision of 1%. Accurate knowledge of the neutron radius is fundamentally important for nuclear physics and provides a test of microscopic calculations. It could also provide an important constraint for the interpretation of atomic physics experiments measuring the electroweak mixing angle.

Measurements and Feasibility: The measurement techniques are similar to those for the HAPPEX experiments and will be carried out by the same group. The new septum magnets required to operate the Hall A spectrometers at small forward angles will be commissioned for other experiments. The parity violating asymmetry is 0.6 ppm and must be measured to a precision of ± 3% statistical and ± 1% systematic error. The polarized source must deliver 50μA at 80% polarization. Corrections due to helicity-correlated beam parameters (position, angle, energy, etc.) must be kept below 1 ppb. This is a factor of 30 below what has so far been achieved for HAPPEX. Beam polarization must be measured with a precision at the 1% level. The lead sandwich target must be operated reliably for long periods at 50μA beam current. These are very ambitious but credible goals. The impressive steady progress made by the JLab polarized source group and the remarkable success of the earlier HAPPEX experiment give the PAC confidence they can be achieved.

Issues: The success of this experiment is dependent on the demonstration that a number of very challenging precision requirements on the polarized source, target, detector, and theoretical interpretation can be met. Recent work on the theoretical interpretation of this experiment is very promising and should continue to be pursued. While polarized source developments at the laboratory are already aimed at reducing helicity-correlated beam properties to the required levels, this remains to be demonstrated. Issues that will require considerable work by the collaboration include: a) improving the precision to which the beam polarization can be determined with the Hall A Moller and Compton polarimeters to the 1% level at 850 MeV from the current performance of approximately 3% and 4% respectively at 3 GeV, b) demonstrating that the proposed Pb-diamond layered target will work reliably with a beam power deposition of 40W, and c) incorporating improved beam position monitors with the required low noise levels to be able to demonstrate that the helicity-correlated position modulations are sufficiently small.

The physics goals of this experiment are compelling. Conditional approval is contingent upon demonstration to the laboratory that the technical and theoretical challenges outlined above have been met to permit a 1% measurement of the neutron radius in ^{208}Pb.

Recommendation: Conditionally approved for 30 days at 50μA and 80% polarization.

Individual Proposal Report

Proposal: PR-00-004

Scientific Rating: N/A

Title: Duality in Meson Electroproduction

Spokesperson: C. Armstrong

Motivation: The aim is to determine if factorization holds at low values of ν. If so, u_v/d_v can be measured, and the applicability of duality to semi-inclusive reactions could be studied.

Measurement and Feasibility: The experiment proposes to measure meson electroproduction on H and D at an energy of 6 GeV. An Al target will be used for window subtraction. The scattered electron is detected in the SOS and the meson in the HMS. A study of the feasibility of detecting kaons is contemplated. The kinematics are $0.45 < z < 0.85$, $1.4\ \mathrm{GeV}^2 < W'^2 < 4.9\ \mathrm{GeV}^2$, and Q^2 between 1 and 4 GeV^2. The range of the pion's transverse momentum varies with z and with θ_e. The running time is 15 days.

Issues: The committee is convinced of the importance of testing factorization in this new kinematic regime. If factorization holds, the doorway to future interesting studies of duality and valence quark distributions would be opened. A demonstration of the interpretability of semi-inclusive reactions at JLab energies would be important for the future program at higher energies.

For approval, the committee needs to be convinced that the kinematics are optimized to test the validity of factorization. The proposers should be alert for the kinematic signatures of mechanisms that break factorization. For example, possible confusion caused by having different ranges of p_T for different values of z and the possible influence of meson pole terms need to be addressed more fully.

Recommendation: Defer.

Individual Proposal Report

Proposal: PR-00-005

Scientific Rating: N/A

Title: Study of Excited Intermediate States in $p(e,e'K^+)\Sigma^0$ Reactions

Spokesperson: P. Gueye

Motivation: The experiment studies excited Δ^* intermediate states in kaon electroproduction via the K^+–Σ^0 channel and in comparison with the $p\pi^0$ channel. The aims are to investigate SU(3) violation, to provide information on transition form factors, to test Regge theory at intermediate energies and to search for possible missing, molecular or exotic resonances.

Measurement and Feasibility: The invariant mass distribution of the $p(e,e'K^+)\Sigma^0$ and $p(e,e'\pi^0)p$ reactions will be used to investigate Δ^* resonances in the 1900 MeV/c mass region, to study the candidate pentaquark state X(2000), and to search for missing resonances of the quark model. The Σ^0 will be selected by missing mass in the p(e,e'K)Y reaction (where $Y = \Lambda,\Sigma$). By detecting the proton from the Δ^* to $p\pi^0$ decay for the same kinematics as the Σ^0 channel, relative information on the $g(\Delta^*\text{- K }\Sigma^0)$ and $g(\Delta^* - \pi^- p)$ coupling constants will be extracted. In addition, a fine-grained measurement of the Q^2 dependence is planned in order to probe the transition form factors of these resonances, and to help distinguish among Δ^* resonances, background threshold effects and/or the exotic pentaquark baryon.

Issues: The PAC was not convinced by the proposed tests of SU(3) violation. Problems discussed included contamination by resonances other than those considered in the proposal, possible model dependence due to exclusive channel form factors that could further cloud the SU(3) analysis and also experimental problems with detecting low momentum protons in the $p\pi^0$ channel. The search for possible narrow resonances, whose existence has been suggested by SAPHIR, could be potentially interesting. If CLAS data show hints that such narrow states may be present, then this could lead to a resurrection of aspects of the present proposal in the future.

Recommendation: Reject

Individual Proposal Report

Proposal: E-00-006

Scientific Rating: A

Title: G^0

Spokesperson: D. Beck

Motivation: The G^0 experiment proposes to study parity violation asymmetries in elastic ep scattering at forward and backward angles. The data will allow the strangeness contributions to G_e and G_m separately to be determined. This proposal covers the forward angle measurements.

Measurement and Feasibility: Based on the current successes and development plans for the polarized source, the Committee believes that G^0 will have the benefit of 40 microamps at high polarization (~75%). G^0 can achieve its forward angle data with the proposed errors in 30 days of beam time.

Feasibility of the experiment depends on experimental factors including backgrounds and beam systematics (helicity correlated effects) that can only be studied with beam tests. These details will be studied during an approved period of commissioning. Feasibility depends on the successful completion of the tests during this commissioning period.

Issues: G^0 is a large project that has undergone considerable review, both scientific and technical. The PAC17 considerations were formed in the context of these past reviews.

The PAC wishes to reaffirm the importance of the physics goals of the G^0 experiment. The issue of strange quark contributions to the nucleon structure remains an open question. G^0 addresses these issues in a unique manner, not covered by other experiments. The PAC was pleased to hear that the G^0 detector was making good progress toward its completion of construction by the middle of 2001.

G^0 already has approval for 36 days of commissioning and 10 days of preliminary running ("dress rehearsal"). The successful completion of the commissioning and the outcome of the 10 days of preliminary running will strongly affect the strategy for further running. In the best of scenarios, G^0 will achieve a full 10 days of good data during the preliminary running. If this succeeds, then it would be expected that the forward angle run would commence in a timely manner, and that the 10 days of preliminary running would be accounted toward the time allotted for the forward angle running.

The Committee has technical concerns similar to ones expressed in earlier reviews. For example, background studies and beam systematics (helicity correlated effects) may not proceed as rapidly as planned and commissioning may take longer than the 36 days allotted. If the commissioning and preliminary running are not completed in the 46 days approved, then this Committee expects that further commissioning and running would have to be scheduled.

Recommendation: Approval for a total of 24 additional days at 40μA and 75% polarization for forward angle running. If the 10 days of physics running in the dress rehearsal does not prove useful, we recommend up to an additional 10 days.

Individual Proposal Report

Proposal: E-00-007

Scientific Rating: A^-

Title: Proton Polarization Angular Distribution in Deuteron Photo-disintegration

Spokesperson: R.Gilman

Motivation: The aim of the experiment is to study the angular dependence of induced and transferred proton polarization in deuteron two-body photo-disintegration in an energy region where the 90° cross section shows scaling behavior.

Measurement and Feasibility: It is proposed to extend the measurement of the induced and transferred proton polarization from deuteron two-body photo-disintegration at E_γ= 2 GeV (see E- 89-019) to different proton angles. The measurement includes the calibration of the polarimeter using polarized elastic ep scattering at E_e around 3.5-4 GeV. Feasibility has been shown in E-89-019, but to obtain the same precision within the requested time the use of the analyzer adopted by E-99-007 is necessary.

Issues: Presently there is no complete theory available to describe the current data. The PAC agrees that the measurement would add to the data set on deuteron photo-disintegration and encourage model descriptions of polarization observables in an energy regime where the cross section shows interesting features. The set of angles 37°, 70°, and 110° appears to be enough to perform comparisons.

The PAC also considers it to be more efficient to schedule the experiment in conjunction with E-99-007.

Recommendation: Approved for 7 days.

Letter-of-Intent

Letter of Intent: LOI-00-001

Title: Coherent Photo-Production of Mesons from Closed Shell Nuclei

Spokespersons: A. Sarty

The proposed experiment would measure coherent photo-production of mesons on closed shell nuclei using near-real electro-production on very thin targets and detecting the recoiling nuclei. The scientific goals are to use the restricted spin-isospin structure of the reaction as a spin-isospin filter of the elementary electro-production amplitudes, to measure the ground state tensor densities and to study the meson-nuclear optical potential for pion-nucleus and eta-nucleus interactions. This could be a promising technique to study the threshold region and the suggestions of eta-nucleus bound states. Experimentally the procedure is quite attractive if unit mass and charge resolution for the recoiling nuclei can be obtained. This is quite difficult for such low energy recoils and a proposal would have to address this, and likely require a demonstration of the technology. The contributions from excited states, and from other recoils if unique isotope resolution cannot be obtained, needs to be addressed. The ability to perform such experiments parasitically with some other classes of measurements would definitely be an asset.

The PAC had a number of concerns about the physics goals based on knowledge of the reaction mechanisms in pion-nucleus collisions. Coherent pion photoproduction in the resonance region is dominated by Delta-nucleus dynamics effects which were not discussed. While eta-nucleus information is much more limited, the reactions proposed here are at relatively high nuclear momentum transfer, where multi-body interactions might be important. While the differences between the relativistic and non-relativistic calculations are striking, we are not convinced a one-body DWIA approach is adequate.

A proposal would need a focused scientific goal that significantly advances our knowledge of meson-nucleus dynamics or nuclear structure.

Letter-of-Intent

Proposal: LOI-00-002

Title: Study of the Parity Non-Conserving Force between Nucleons through Deuteron Photodisintegration

Spokesperson: B. Wojtsekhowski

The injector facility at JLab is capable of producing an intense beam of circularly polarized photons in the MeV range. This capability may permit the measurement of important couplings involved in the weak nucleon-nucleon interaction. The Committee regards the experimental concept under consideration to be a very challenging experiment. With the excellent developments in the polarized source, JLab may be the appropriate place for such a proposal. The PAC believes that f_π is an important coupling parameter, well worth an appropriate experiment.

The experiment requires a 10-MeV Bremsstrahlung beam from the polarized electron source in the JLab injector. Controlling the systematic errors requires excellent control of helicity dependent effects in the beam. Backgrounds from scattered photons into the detector are an issue of concern.

Questions, which should be addressed in a proposal, include understanding the detector backgrounds, compatibility of the experiment in the injector area, and scheduling compatibilities with the experimental program. The running of the experiment should not have a negative impact on the normal injector operations.

The PAC would welcome a proposal that can reach a sufficient level of sensitivity and precision to be a definitive measurement.

Appendix G

Summary of the PAC17 Workshop on the Physics of Strange Quarks at JLab (Duck, NC, January 29, 2000)

Introduction

This was the fourth workshop to provide an 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.

Mike Ramsey-Musolf presented an overview of the theoretical status and prospects for parity violating electron scattering experiments. This experimental technique offers a unique flavor decomposition of the nucleon elastic form factors and can isolate the contributions of strange quarks. Such experiments also can search for physics beyond the standard model. Doug Beck reviewed the framework of neutral weak currents and the experimental situation worldwide, including the SAMPLE experiment at M.I.T. Bates, the PVA4 experiment at Mainz, and the HAPPEX results from JLab. The preliminary SAMPLE results on deuterium may indicate a significant nucleon anapole moment and suggest that the nucleon structure implications are even richer than previously thought. Overviews of all the approved experimental programs in the physics of strange quarks category 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

Historically this subprogram of JLAB physics includes measurements of strange contributions of nucleon form factors, strange meson and baryon electroproduction experiments and hypernuclear measurements. The latter measurements were included in the physics of nuclei discussions at the PAC16 workshop and so were not discussed in detail here.

The heart of the strange quark program is firmly rooted in our goal to understand the structure of hadrons in quantum chromodynamics. In particular, strangeness gives us a special window on the nature of the sea of quark-antiquark pairs in the nucleon. While many of the same scientific questions apply to the light up and down quarks and antiquarks, these quarks are also involved in the special role of the pion as a Goldstone boson of chiral symmetry in the theory. Studies of strange quarks in, for example, the proton look directly at the sea of the nucleon. Thus the physics of the strange quarks in the strange form factors of the proton is closely linked to other properties which have small valence contributions such as the electric form factor of the neutron.

Quark flavor only enters into QCD in quark mass terms. With heavier quark flavors, the heavy quark symmetry of QCD provides a valuable expansion to examine the physics. As the energy of Jefferson Lab is upgraded to charm threshold, this will be exploited much more extensively, but the strange quarks are in an interesting transition region where quark mass effects and other dynamics are on comparable footing.

The weak interaction as employed in parity violating electron scattering offers a precise tool to separate the flavor contributions of nucleon form factors and isolate the strange quark matrix elements. The progress of the laboratory and the experimenters in these measurements is outstanding. The exquisite quality of the polarized beam at JLab is the best in the world for these kinds of measurements. An extensive program of parity violating elastic electron scattering from the proton in HAPPEX and G^0 will provide separated electric and magnetic strange quark matrix elements over a broad range of Q^2. A simplification is provided by ^{4}He with only one form factor and the opportunity exists either to examine changes of the strangeness content in nuclei or to focus specifically on the strangeness radius. Future G^0 measurements on the deuteron will determine the axial contribution to the proton measurements.

More precise measurements of the nucleon electromagnetic form factors are necessary to garner the maximum information from the parity violating measurements. Programs to improve the electromagnetic form factors measurements to the required precision are part of the JLab experimental program and must be carried out effectively in a timely manner. At the same time, theoretical progress is essential for interpreting the new results. Lattice QCD offers considerable promise in the long run to place these measurements in a firm theoretical context and we believe that the new collaborative initiative of the JLab theory group in this area could have a real impact.

It is the opinion of the PAC that the program described above will provide us with a comprehensive look at the strange quark effects in nucleon form factors. We believe now is the time to run these experiments efficiently and then it is appropriate to digest the experimental results before undertaking significant further effort along these lines. However we do believe that parity violation in deep inelastic scattering could become a valuable new tool for flavor decomposition. With the 12-GeV upgrade this should be even more important to the JLab program.

While not directly involving strange quarks, the flavor decomposition made possible with parity violating electron scattering also permits measurements of neutron distributions in heavy nuclei, and possibly even the charge distribution of the neutron itself. The PAC conditionally approved one such experiment at this meeting and looks forward to new ideas for this type of measurement.

While the strange form factors directly measure the contributions of the current quarks, looking directly at hadronic production channels may give us special insight into the low energy degrees of freedom of QCD that dominate the strange quark physics and identify the essential physics elements that model builders need to interpret the strange quark distributions. If the strange form factors prove to be small, it may be due to delicate cancelations rather than an inert strange sea. For example in the isocalar charge distribution of the nucleon, the s-sbar contribution of the ϕ meson plays an important role in the spectral function decomposition. We have received interesting proposals to use ϕ production to examine the strange quark content of the proton. In our opinion the reaction mechanisms are not well enough understood for a definitive measurement at this time, but the CLAS will provide much valuable data on the reaction mechanism. If this proves to be under control, such experiments will become more attractive. Similarly, kaon electroproduction experiments may under carefully controlled circumstances provide new insight. Complementary data at the hadronic and quark level could provide a compelling case that we have gotten the essential physics right.

There is certainly much still to learn about the reaction mechanism in other strangeness production reactions. However, the PAC is not enthusiastic about new proposals where these studies are the primary focus. We expect much will be learned in the approved CLAS program.

While in the nucleon, the strange quarks isolate sea effects; in hyperons, the strange quarks contribute to the valence distributions. Again considerable insight can be obtained in replacing a light quark with a strange quark, but now at the constituent quark level. Indeed it was the SU(3) symmetry of the hadron states which led to the constituent quark model. The physics is well addressed by the CLAS baryon resonance program and will be discussed at a later workshop. We would certainly like to see measurements of the electromagnetic properties of hyperons, such as the electric form factor of the Λ, but such measurements are difficult and we are not convinced a decisive experiment is possible.

Several other physics ideas surfaced in the strange quark program. At the PAC16 physics of nuclei workshop, the importance of addressing possible medium modifications of hadron masses in nuclei with electromagnetic probes was highlighted. Di-lepton decay modes of vector mesons were identified as the most promising avenue. The relative effect on the ω and ϕ channels will be a revealing measurement. Heavy ion experiments have been interpreted to indicate a significant change in kaon masses in the medium. A definitive experiment with electromagnetic probes in the entrance channel would be welcomed.

Stan Brodsky has pointed out that the energy dependence of polarization observables in p-p scattering seems to change dramatically as the strangeness and charm production thresholds are crossed. He suggests that there may be very interesting meson-nucleon dynamical effects near these thresholds with a mixture of hard and soft scales at work. Several ideas for charm physics at threshold are being discussed for the 12-GeV upgrade. Pursuing this now at the strangeness threshold may address the same physics.

Finally a precision measurement of the weak charge of the proton offers a precise test of physics beyond the standard model at mass scales beyond the reach of present colliders. We heard about ideas to perform such a measurement using the G^0 spectrometer. Such an experiment in the leptonic sector in Moeller scattering is underway at SLAC, but the hints of such effects in atomic parity violation and Fermi beta decays are only seen in semi-leptonic experiments. A sufficiently precise experiment would be of great interest to the particle and nuclear communities.

Appendix F

Approved Experiments, PACs 4 –17, Grouped by Physics Category

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