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For more information or copies of this report contact:

Thomas Jefferson National Accelerator Facility

User Liaison Office, MS 12H5

12000 Jefferson Avenue

Newport News, VA 23606

Phone: (757) 269-6388 / Fax: (757) 269-6134

E-mail: users@JLab.org

WWW: http://www.JLab.org/exp_prog/PACpage/pac.html

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Hugh E. Montgomery
Laboratory Director and Jefferson Science Associates President

March 1, 2010
Phone: (757) 269-7552
e-mail: mont@jlab.org

Dear Jefferson Lab Users,

By now, 12 GeV Project construction is well underway; despite execrable weather during the Fall of 2009 and the early part of this year, we now have foundations for the new Hall D and a new Central Helium Liquefier building frame. Less visible on-site but important nevertheless are the numerous procurements which have been placed with industry and the detector construction which is going on at universities and laboratories across the world. The Jefferson Lab PAC continues to play a major role in the development of the scientific program for this new facility.

We continue to receive new proposals; this year the PAC considered 12 proposals and 10 letters of intent indicating a continued strong interest in the physics on offer. Despite the requirement that the proposals be expected to be in the top half of experiments during the first 5 years of operation, six of the proposals were approved, two conditionally approved and two were deferred. For nine of the letters of intent the proponents were encouraged to proceed to develop a proposal.

It was notable that at the level of the science the Hall A program again made some advances, especially in the development of its parity violating program. By now we see a healthy approved program in all four experimental halls. One of the proposals received, and one of the letters of intent, concerned a search for a “dark photon” the putative mediator of a new U(1) interaction, somewhat akin to electromagnetism, which might be the mediator of interactions with the dark matter, which appears to make up nearly a quarter of the mass of the universe in many cosmological models. One of the letters of intent concerned an experiment with a similar goal but to be performed using the FEL accelerator; the PAC saw these as interesting developments and encouraged us to initiate a workshop to ensure that we have a sound approach to this new opportunity.

The way the members of the PAC apply themselves to the assessments is always impressive. They are not necessarily starting their deliberations from a position of knowledge, but they certainly finish in such a state. The Chair, Mike Pennington was leading his second PAC having stepped up at the 2009 PAC. Unfortunately, or fortunately, depending on your perspective, he will not be continuing. Since the PAC met, Mike has accepted a position as Associate Laboratory Director for Theoretical and Computational Physics here at Jefferson Lab. We are, of course, delighted. Patrizia Rossi stood in for Diego Bettoni who could not attend. In principle this was a temporary assignment, but we have noted how well she participated and down the line we expect to seek her help again. Among the regular PAC members, only Ed Kinney had served a full term and so rotated off; he has served us well and will be missed.

Sincerely,



Hugh E. Montgomery
Laboratory Director

Letter from the PAC Chair

Introduction

The Jefferson Laboratory Program Advisory Committee held its 35th meeting from January 25th to 29th, 2010. The membership of the Committee is given in Appendix A. In response to the charge (Appendix B) from the JLab Director, Dr Hugh Montgomery, the Committee reviewed 30 potential experiments: 12 new proposals, 10 Letters of Intent and 8 previously approved experiments for grading. All these experiments, with some notable exceptions, were considered for running in the 12 GeV era.

12 GeV upgrade:

With plans for the 12 GeV upgrade well under way and concrete being poured for Hall D, this PAC was charged with approving only those experiments of such high priority that they should be in the top 50% of experiments to run in the first 5 years of the upgrade. This “raising of the bar” means that several of the proposals discussed below, which add measurements to previously approved experiments were Deferred, even though the physics is interesting, the experiments perfectly feasible, the results “nice to know” but they were not considered to be of the highest priority.

All 12 new proposals presented to this PAC are part of the central mission of JLab physics to determine low energy electroweak couplings with precision and to illuminate the strong interaction properties of nucleons and how these reflect the innate characteristics of constituent quarks and gluons. The deliberations of the PAC are reported below in terms of 4 broad themes (as for PAC 34):

- Precision measurements of electroweak coupling of leptons and quarks (2 proposals)
- Electromagnetic form-factors of the nucleon (1 proposal)
- Properties of hadrons and collective hadron systems (4 proposals)
- Inclusive and semi-inclusive deep inelastic scattering (5 proposals)

1: Precision measurements of electroweak couplings of leptons and quarks

Proposal PR12-10-007: This proposal to use Parity Violating Deep Inelastic Scattering to measure the electroweak (especially axial vector) couplings of quarks has the potential to provide precise and valuable information on a unique combination of Standard Model couplings, as well as study higher twist effects and charge symmetry violation. This experiment requires a major solenoidal detector (SoLID) the acquisition of which would create a facility generating further experimental proposals, see also PR12-10-007. The PAC believes the mission of this and future experiments using SoLID are sufficiently important that the Laboratory should make every effort to assist in securing the necessary funding. This experiment is Approved.

Proposal PR12-10-009: Several recent popular extensions of the Standard Model envision the existence of a relatively light vector boson that couples very weakly to ordinary charged particles through its small mixing with the photon. Motivation for such a particle stems from astrophysical observations as well as theoretical considerations of dark matter models. The mass for this particle, sometimes called "the dark photon", is expected to be in the MeV to GeV range, a region accessible to JLAB experiments. Indeed, it appears that high intensity electron scattering experiments can be sensitive to extremely small couplings over a broad mass range of such hypothetical particles. They could either significantly constrain their properties or discover them. The PAC believes that JLab provides a unique opportunity to pursue such measurements. The high impact on the global physics scene of such measurements makes this experiment

of high priority. Much work is still required as set out in the detailed report. This experiment is Conditionally Approved.

2: Electromagnetic form-factors of the nucleon

The electric and magnetic form-factors of the proton and neutron, and their Q^2 –dependence, are fundamental quantities, the measurement of which is a key mission of the JLab program and will be discussed again below in the context of grading.

Proposal PR12-10-005: This proposal to measure G_M^n in Hall A had been previously Approved to run up to Q^2 of 12 (GeV/c)², a proposal graded below. However, the PAC did not consider that the more resource intensive measurements at higher Q^2 were of sufficient priority to merit running in the first 5 years of the 12 GeV upgrade. Consequently, this proposal was Deferred.

3. Properties of hadrons and collective hadron systems

Proposal PR12-10-001: This proposal has the potential to provide unique information about hyperfragments in for instance ${}^{5,6}_\Lambda\text{H}$. Essential to this program is a test run of 5 days previously approved for Hall C. The PAC supports the transfer of this test run on ${}^7\text{Li}$ to Hall A. On this basis the experiment is Conditionally Approved.

Proposal PR12-10-003: This proposal for Hall C to study deuteron electrodisintegration at higher missing momentum has the potential to probe the shorter range aspects of NN interactions and the transition to constituent degrees of freedom. It will provide information on the reaction dynamics, the deuteron wavefunction and the role of final state interactions. This experiment is Approved.

Proposal PR12-10-004: This proposal is to study the appearance of proton pairs at 90° in hard photodisintegration on ${}^3\text{He}$ at two new energies of 2.2 and 4.4 GeV. The PAC members were not convinced that a greater understanding of the mechanisms at work would be achieved by these measurements. This experiment is Deferred.

Proposal PR12-10-011: The determination of the two photon decay rate of the η is an important constraint on the Goldstone nature of the light pseudoscalars. This experiment proposes to measure this with new precision using the Primakoff effect. This collaboration is integrating with GlueX to ensure compatibility with running in Hall D. While the experiment requires some dedicated runtime, the PAC urges the collaboration to consider whether the increase in statistics gained by some parallel running with GlueX may outweigh the disadvantages. This experiment is Approved.

4. Inclusive and Semi-Inclusive Deep Inelastic Scattering (DIS & SIDIS)

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

Proposals PR12-10-002: This proposal is to measure the structure function F_2 at large x in the resonance region. This study has the important goal of extending the domain covered by studies of parton distribution functions (pdfs) into the resonance region, using the concept of quark-hadron duality, allowing experimental exploration of the large x behaviour of pdfs and ability to pin down higher twist effects. In the longer term, the collaboration is urged to establish links to phenomenological teams like

CTEQ and MRST (and their successors) to maximise the physics impact of their results. This experiment is Approved.

Proposal PR12-10-006 (update on PR12-09-014): This proposal aims to measure Target Spin Asymmetry using polarized ^3He in Hall A. This is an ambitious project, which the PAC considered technically challenging with the target subject to subtle nuclear and hadron effects. The proposal requires the major installation of a solenoidal detector SoLID, which is only justifiable with the approval of PVDIS experiment (PR12-10-007) discussed above. As part of the overall SIDIS program a measurement of target spin asymmetry with a transversely polarized target is required. The experiment is Approved.

Proposal PR12-10-008: This proposal studying the nuclear dependence of the structure function F_2 on light nuclei aims to pin down one key aspect of the EMC effect with accuracy. Whether the eventual results can be interpreted in terms of local nuclear densities is something for later investigation. Taking sufficiently precise data is the key to sorting out at least one contribution to the EMC effect. This experiment is Approved.

Proposal PR12-10-010: This proposal is part of a wider study of SIDIS processes, reported on in detail at PAC34. However, the PAC was not convinced that this particular proposal to study pion production on deuterium at 6.6 and 8.8 GeV, would add greatly to the approved 11 GeV running. Consequently, this experiment is Deferred.

Proposal PR12-10-012: This Hall C proposal is to measure nucleon/nuclear structure functions to constrain the gluon distribution. The PAC believed the constraints on the gluon distribution were oversold. The constraints are largely those imposed by momentum conservation. The experiment was essentially a measurement of F_L at small x . The error analysis was not of the professional standard expected. The experiment was not one that could be classed as being in the top 50% of physics in the first 5 years of 12 GeV running. This experiment is Deferred.

Letters of Intent:

LOI-10-001: The study of the hadron spectrum excited by a low Q^2 γ^* with high luminosity and high degree of linear polarization using the CLAS12 detector, with the addition of a small angle tagger to identify the scattered electrons, is an interesting one, complementing studies approved at Hall D. This is a major program to add to the other CLAS12 activities and consequently has manpower implications, particularly for analysis. This letter should be followed by a full proposal detailing not only the experimental aspects but how the required precision will be achieved within the partial wave analysis.

LOI-10-002: The study of deeply virtual ϕ -production to investigate the gluon distribution should become a proposal. Theoretical input is required if results on the gluon distribution are to be realistically extracted.

LOI-10-003: The study of the systematics of the EMC effect by identifying short range correlations by measurement of backward fragments is a clever idea. The letter is very close to a proposal. We urge the collaboration to complete this development.

LOI-10-004: The production of an Ω^- and three kaons by electroproduction in CLAS12 is interesting. However, the PAC saw this as part of the program of LOI12-10-001, into which it should be incorporated. A separate proposal would not be welcomed.

LOI-10-005: The study of the EMC effect in spin structure functions may add to our understanding of the degrees of freedom within nuclei. There are many technical issues to be resolved. A proposal with the details and realistic uncertainties worked out is encouraged.

LOI-10-006: The importance of the identification of a possible low mass vector boson has been discussed under PR12-10-009. Using the Free Electron Laser as a facility for such studies is one JLab is urged to embrace. The Lab management needs to hold a number of workshops on the physics program as well as the technical and funding aspects to identify the optimal strategy for making an essential contribution to the discovery (or at least constraining the parameters) of such a dark matter candidate within a global context. This will inform how this Letter is to be developed into a proposal.

LOI-10-007: It is essential to have neutron, as well as proton, measurements to determine the pattern of nucleon electromagnetic form factors. However, the design of the neutron polarimeter has yet to be settled. This Letter is the basis for a proposal, which the collaboration is encouraged to produce.

LOI-10-008, 009: These two letters should be seen as part of a coherent program for deep inelastic studies with CLAS12. A proposal bringing these together and embedding them in the wider program is essential.

LOI-10-010: Any accelerator facility, like JLab, using polarized electrons for its physics program would like an intense beam of polarized positrons. This Letter marks a proof of principle experiment that should become a full proposal.

Grading panel:

Previous PACs have “approved” 12 GeV experiments without assigning grades and run periods. This PAC is the first of several that are charged to grade the Approved experiments and assign the number of Days to their running, as well as consider whether any conditions set for approval have been met. The first category to be so reviewed are those specified as being “the study of the transverse structure of nucleons”, largely form factor experiments. The 8 previously Approved experiments in this category were considered by PAC35 following both a written and oral update from each collaboration. The outcome is set out in the grading table. Where the decision differs significantly from the request in the proposal, a commentary on the reason for the decisions made is given below.

Grading of previously Approved 12 GeV experiments on the *Transverse Structure of Nucleons*

Proposal	Spokes-Person	Title	Hall	Days Requested	Days Awarded	PAC Rating
PR12-06-101	G. Huber	Measurement of the charged pion form factor to high Q^2	C	52	52	A
PR12-07-104	G. Gilfoyle	Measurement of the neutron magnetic form factor at high Q^2 using the ratio method on deuterium	B	56	30	A-
PR12-07-108	B. Moffitt	Precision measurement of the proton elastic cross-section at high Q^2	A	31	24	A-
PR12-07-109	L. Pentchev	Large acceptance proton form factor ratio measurements at 13 and 15 $(\text{GeV}/c)^2$ using recoil polarization method	A	60	45	A-
PR12-09-003	R. Gothe	Nucleon resonance studies with CLAS12	B	60	40	B+
PR12-09-006	A. Semenov	Neutron electric form factor at Q^2 up to 7 $(\text{GeV}/c)^2$ from ${}^2\text{H}(e,e'n){}^1\text{H}$ via recoil polarimetry	C	66		Unrated
PR12-09-016	B. Wojtsekhowski	Measurement of the neutron electromagnetic form factor ratio G_E^n/G_M^n at high Q^2	A	58	50	A-
PR12-09-019	B. Wojtsekhowski	Precision measurement of the neutron magnetic form factor up to $Q^2=18$ $(\text{GeV}/c)^2$ by the ratio method	A	48.5	25	B+

Comments on beam time requests follow:

PR12-06-101: Beam time request approved.

PR12-07-104: The proposed measurements are dominated by overall systematic uncertainties. The PAC believes that a reduction in the requested beam time from 56 days to 30 days would not seriously impact on the final outcome of the proposed measurements, since the running of this experiment would be concurrent with some of the other approved CLAS12 experiments.

PR12-07-108: The PAC recommends a beam time assignment of 24 days, compared with the request for 31 days, by asking the experimentalists not to pursue a measurement at the highest Q^2 point.

PR12-07-109: The PAC recommends the beam time be reduced from 60 to 45 days by only measuring the ratio G_E/G_M up to a maximum value of $Q^2=12 \text{ GeV}^2$. Different models can already be discriminated at this lower Q^2 value and the trend in the behaviour of the ratio G_E/G_M can be established before reaching $Q^2=14.5 \text{ GeV}^2$.

PR12-09-003: The PAC believes that the trend of the N^* excitation can be discerned by taking less data and defining fewer bins in Q^2 . Consequently a reduction of beam time from the requested 60 days to 40 is recommended.

PR-09-006: In the update presented to this PAC of this proposal a new recoil polarimetry technology is now envisaged to detect the recoil proton instead of the scattered neutron which could provide a better Figure of Merit. Nevertheless, the PAC is really concerned by the issues of this new technology. Some precise details on simulation of the recoil proton detection and of the analyzing power, as well as results on experimental tests must be presented. A detailed comparison of the analyzing power and of the corresponding statistical accuracies, which can be achieved, should be made for the two solutions, with the old polarimetry device and the new one. Moreover, the PAC recommends the experiment focuses on 2 (rather than 3) measurements adequately chosen as a function of Q^2 to keep the statistical error below 15% so as to provide the optimal ability to discriminate between theoretical models. In conclusion, before rating this proposal, the PAC recommends the proponents to submit a more detailed update of the proposal in view of the major technological changes envisaged.

PR12-09-016: The PAC believes that the study of a possible change in the behavior of G_E/G_{dipole} for the neutron does not require data to be taken at $Q^2 = 10.2 \text{ GeV}^2$, which is particularly expensive in beam time. The PAC recommends that Q^2_{max} be reduced to $\sim 8 \text{ GeV}^2$ and the two other momentum transfer points optimized, possibly with an overlap with existing data (with much improved uncertainty).

PR12-09-019: The original request for 48.5 days of running included Q^2 values of 16 and 18 $(\text{GeV}/c)^2$. The 16 days required for these in PR12-10-005 have been Deferred. The measurement improvements presented in the update should allow the precision of the anticipated results to be achieved with 25 days of beam time (rather than 32.5 days).

Completion of 6 GeV running

The PAC was charged with reviewing the Lab's proposals for the completion of running at 6 GeV. The PAC appreciated the presentation by the Lab management of the schedule and how this meets the restrictions on resources of presently available equipment and funding. Overall the PAC endorses the proposed scheduling. It urges the Lab management to look creatively on any opportunity that might allow the inserting of test runs required to progress the experiments presented at this PAC, without impacting on the completion of key experiments like Q_{weak} and the excited baryon program.

Acknowledgements

The PAC appreciates the support of Hall Leaders and JLab staff in elucidating details of key infrastructure and in preparing TAC and theory reports. We are most grateful too to Rachel Harris and her colleagues for essential help in bringing the committee together, and preparing, and keeping track of, all its paperwork and presentations. All this was essential to the committee's deliberations. Lastly, and most importantly, we thank all the scientists involved in developing these proposals – proposals that will ensure a vigorous, dynamic program in the 12 GeV era.

Michael Pennington
Chair, Jefferson Program Advisory Committee

Tables

	<i>Experiments Recommended for Approval</i>	Experiments Recommended for Conditional Approval	Totals
Experiments	185	4	189
Authors	1419	36	1337
Institutions	257	3	207
Countries	32		28

Approved Experiments Totals by Physics Topics

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

Approved Days and Conditionally Approved Experiments

Hall	Approved Experiments				Conditionally Approved Experiments
	# Expts Completed (full/partial)	Days Run	No. Exps in Queue	Days to be Run	
A	54 0	955.5	11	159.4	3
B	68 10	872.6	10	137.3	6
C	37 5	835.6	5	215.2	2
Total	159 15	2663.7	26	511.9	11

APPENDIXES

- A. PAC 35 Membership
- B. Charge to PAC 35
- C. PAC 35 Recommendations
- D. PAC 35 Individual Proposal Reports
- E. PAC 35 Individual Letters-of-Intent Reports
- F. Approved Experiments, PAC 35, Grouped by Physics Category

(To access Appendix F, go to http://www.jlab.org/exp_prog/Proposals/10prop.html)

Appendix A
PAC35 Members

<p>MICHAEL PENNINGTON (CHAIR) University of Durham Science Laboratories South Rd Durham Dh1 3LE UNITED KINGDOM Phone/Fac: 44-(0) 191-334-3668/3658 m.r.pennington@durham.ac.uk</p>	<p>WILLIAM MARCIANO Physics Department Brookhaven National Lab UPTON, NEW YORK 11973 Marciano@bnl.gov Tel. 631-344-3151</p>
<p>REINHARD BECK University bonn Physikalisches Inst. Nassallee 12 D-53115 BONN, GERMANY Phone/Fax: 49-228-732341/737869 beck@hiskp.uni-bonn.de</p>	<p>ZEIN-EDDINE MEZIANI Temple University, Philadelphia, PA 1900 N. 13th St. PHILADELPHIA, PA 19122-6082 USA Phone: 215-204-5971 meziani@jlab.org</p>
<p>NICOLE D'HOSE Centre d'Etudes de Saclay (CEA-Saclay) Orme des Merisiers F-91191 Gif-sur-Yvette Cedex FRANCE Phone: +33(0)1-6908-7385 Fax: +33(0)1-6908-8120 Nicole.dhose@cea.fr</p>	<p>PIET MULDER NIKHEF Natl. Inst. For Nuclear & HEP PO Box 41882 1009 DB Amsterdam NETHERLANDS Phone: 31-20-5922000 Fax: 31-20-5925155 pietm@nikhef.nl</p>
<p>HAIYAN GAO Duke University, Durham, NC Box 90305 Duke University DURHAM, NC 27708 Phone: 617-258-0256 gao@tunl.duke.edu</p>	<p>WITOLD NAZAREWICZ Department of Physics & Astronomy Physics Division University of Tennessee, Oak Ridge National Laboratory 401 Nielsen Physics Bldg. 6025 MS6373, P.O. Box 2008 KNOXVILLE, TENNESSEE 37996, USA OakRidge, Tennessee 37831 Tel: 1-865-574-4580 Fax: 1-865-576-8746 witek@utk.edu</p>
<p>EMLYN HUGHES Columbia University Physics Department 718 Pupin, Box 15 538 W 120 St. NEW YORK, NY 10027 Phone: 212-854-0796 EWH42@columbia.edu</p>	<p>EWA RONDIO Soltan Inst. For Nuclear Studies PL-05-400 OTWOCK-SWIERK, POLAND Phone: 22-7798948 Fax: 22-7793481 Ewa.rondio@cern.ch</p>

<p>ED KINNEY University of Colorado 390 UCB BOULDER, CO 80309-0390 Phone: 303-492-3662 Edward.kinney@COLORADO.EDU</p>	<p>PATRIZIA ROSSI INFN-LNF Via Enrico Fermi 00044 Frascati Roma ITALY Phone: 39-6-9403320 rossi@lnf.infn.it</p>
<p>HANS STROHER Forschungszentrum Julich Institut for Kernphysik D-52425 JULICH Phone: 49-2461-61-3093 Fax: 49-2461-61-3930 h.stroher@fz-juelich.de</p>	

Appendix B

Charge to PAC35

1. Review both proposals* and letters of intent† for experiments that will use the base equipment currently planned for the 12 GeV Upgrade and provide advice on their scientific merit, technical feasibility and resource requirements.
 - Identify proposals with high-quality physics that, based on what we know today, is of sufficient scientific merit that it will be included in the top half of the priority list to be established for the first 5 years of 12 GeV Operations.
 - Identify other proposals with physics that has the potential for falling into this category pending clarification of scientific and/or technical issues.
 - Provide comments on technical and scientific issues that should be addressed by the proponents prior to a second review and the assignment of scientific priority at a future PAC.

2. Review proposals and Letters of Intent for experiments that will use major new experimental apparatus not included in the 12 GeV Upgrade complement of “Base Equipment”.
 - Identify proposals with high-quality physics that:
 - is of scientific merit comparable to that of the research that will be supported by the “base equipment” under construction for the 12 GeV Upgrade;
 - represents an effective use of resources comparable to that of the base equipment;
 - belongs in the priority list to be established for the first decade of 12 GeV Operations; and
 - merits detailed pursuit of resources and funding.
 - Provide comments on technical and scientific issues that should be addressed by the proponents prior to subsequent technical reviews and a second review and the assignment of scientific priority at a future PAC.

3. Provide Scientific Ratings and Beam Time Recommendations for the Previously Approved 12 GeV Experiments in the “Transverse Structure of the Hadrons” Category.
 - The grading should be consistent with the “scale” used for the scientific priority setting for the 6 GeV program.

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

† Letters of intent for 12 GeV at PAC35 will be given the same “rights” to their scientific ideas as are currently afforded to deferred experiments

APPENDIX C

PAC 35 Recommendations

Action	Proposal #	Proposal Title
A	PR12-10-001	Study of light hypernuclei by pionic decay at JLab
A	PR12-10-002	Precision measurements of the F_2 structure function at large x in the resonance region and beyond
A	PR12-10-003	Deuteron Electro-Disintegration at Very High Missing Momentum
D	PR12-10-004	Hard Photodisintegration of a Proton Pair
D	PR12-10-005	Precision Measurement of the Neutron Magnetic Form Factor at $Q^2=16.0$ and 18.0 $(\text{GeV}/c)^2$ by the Ratio Method
A	PR12-10-006	An update to PR12-09-014: Target Single Spin Asymmetry in Semi-Inclusive Deep-Inelastic Electro Pion Production on a Transversely Polarized ^3He Target at 8.8 and 11 GeV
A	PR12-10-007	Precision Measurement of Parity-violation in Deep Inelastic Scattering Over a Broad Kinematic Range
A	PR12-10-008	Detailed studies of the nuclear dependence of F_2 in light nuclei
C2	PR12-10-009	Search for new Vector Boson A' Decaying to e^+e^-
D	PR12-10-010	A Detailed Study of the Reaction Mechanism in Semi-Inclusive Deep Inelastic Scattering with the CLAS12 Detector
A	PR12-10-011	A Precision Measurement of the η Radiative Decay Width via the Primakoff Effect
D	PR12-10-012	Precision Measurements of Nucleon and Nuclear Structure Functions to Constrain Gluon Distributions

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

APPENDIX D

Proposal Report

Proposal: PR12-10-001

Scientific Rating:

Title: Study of light hypernuclei by pionic decay at JLab

Spokespersons: L. Tang, A. Margaryan, L. Yuan, S.N. Nakamura, J. Reinhold, F. Garibaldi, J. LeRose

Motivation:

This proposal describes a potential program of novel systematic studies of light hypernuclei at JLab using the pionic weak 2-body decay. The project aims to determine structural properties, such as binding energies, lifetimes, production mechanism, charge symmetry breaking (CSB) effects in mirror pairs, and in-medium effects on electric and magnetic properties of hypernuclei. The highlights of the proposed program include:

- (i) High precision measurements of binding energies of hypernuclear ground and isomeric states
- (ii) Studies of exotic, extremely rich halo hypernuclei such as superheavy hydrogen ${}^6\text{H}$;
- (iii) Measurements of electromagnetic rates (and moments);
- (iv) Studies of the production of neutron-rich hypernuclei by means of multi-fragmentation; and
- (v) CSB studies in mirror pairs.

This program has the potential to move JLab into the field of precision hypernuclear spectroscopy that is essential for making an impact on modern shell-model and *ab-initio* calculations of hypernuclei. In this proposal, the collaboration asks to transfer the previously approved 5 days test beam (E08-012) from Hall C to Hall A to carry out a feasibility test run with a ${}^7\text{Li}$ target.

Measurement and Feasibility:

The proponents want to use the seemingly only possible experimental installation available before the shut-down for the accelerator upgrade to perform the test measurement, which is possible in Hall A, using the HRS (for K) and the Enge split pole (for π^-). This implies only a moderate set-up effort, while the final equipment will involve a large installation.

Issues:

The PAC is convinced that this is an outstanding program with very high impact that should be pursued. Nevertheless, for the success of this new program it is important to demonstrate that the proposed measurements can be performed without major issues. The PAC believes that a test study of the production mechanism is necessary.

Recommendation: Conditional Approval.

Transfer the previously approved 5 days test beam (E08-012) from Hall C to Hall A so that the feasibility test-run with a ${}^7\text{Li}$ target can be carried out.

Individual Proposal Report

Proposal: PR12-10-002

Scientific Rating:

Title: Precision measurements of the F_2 structure function at large x in the resonance region and beyond

Spokespersons: S. Malace, I. Niculescu, T. Keppel

Motivation:

It is proposed to extend the inclusive cross section measurements on hydrogen and deuterium to large momentum transfer up to a Q^2 value of 17 (GeV/c)^2 covering the resonance region and beyond (large W) with the goal of a precise extraction of the F_2 structure function at very large Bjorken, x , up to 0.99 for both the proton and neutron. Through quark-hadron duality, it is proposed to use these resonance data to extract the *up* and *down* helicity independent parton distributions in the proton. These data will be important to study valence quark structure and help constrain PDFs at large x , where currently they are not known experimentally. These data are important for lattice QCD tests using higher moments of the parton distributions. They also provide key information for interpreting physics backgrounds in collider experiments (like the LHC) and also help interpret neutrino scattering data.

Measurement and Feasibility:

The proposed measurements are inclusive single arm measurements using standard SHMS and HMS spectrometers in Hall C. The targets are liquid hydrogen and liquid deuterium targets. These measurements are a natural extension of measurements already performed at 6 GeV. The proponents have proved the feasibility and achievable precision of such measurements in the 6 GeV program. There are no technical issues associated with the proposed measurements.

Issues: There are no major issues.

Recommendation: Approval.

Individual Proposal Report

Proposal: PR12-10-003

Scientific Rating:

Title: Deuteron Electro-Disintegration at Very High Missing Momentum

Spokespersons: W. Boeglin, M. Jones

Motivation:

This experiment addresses two fundamental questions in nuclear theory:

- (i) behavior of NN wave function at small distances and
- (ii) transition from nucleonic to quark degrees of freedom.

It would measure the $d(e,e'p)$ cross section for $Q^2 = 3.5 \text{ GeV}^2$ and $x_{Bj}=1.3$ for missing momenta $0.5 \text{ GeV} \leq p_m \leq 1 \text{ GeV}$, doubling the current range. These kinematics minimize the contribution of final state interactions and should provide information about non-nucleonic degrees of freedom at large missing momenta.

Measurement and Feasibility:

The measurement requires a fixed beam energy of 5.25 GeV and a fixed scattering angle of 24.13 degrees for $Q^2=3.5 \text{ GeV}^2$ and $x_{Bj}=1.3$. Standard Hall A equipment is used and the experiment poses no special difficulties. The relative simplicity of this experiment would make it a good candidate for a commissioning experiment at the early stages of 12 GeV running; hence, a sketch of a commissioning plan should be laid out. Required beam specifications, such as energy and current uncertainty, should be stated.

Issues:

The PAC was convinced that this is an outstanding experiment with very high impact that should be pursued. While the PAC was concerned about the interpretability of these data given the current state of theory, it believes that the data are essential to constrain further theory developments.

Recommendation: Approval

Individual Proposal Report

Proposal: PR12-10-004

Scientific Rating:

Title: Hard Photodisintegration of a Proton Pair

Spokespersons: R. Gilman, D. Higinbotham, E. Piassetzky, I. Pomerantz, S. Strauch

Motivation:

This experiment continues the JLab program on photodisintegration of the few nucleon systems, Deuteron and Helium 3, in the expected scaling region above incoming photon energy of a few GeV. The goal of the proposed experiment is photoproduction of a proton pair from Helium 3, in the kinematics when two protons are produced at 90° in the γ -pp center of mass system.

This reaction was already studied in the E-03-101 experiment, where large differences with existing model predictions were found. The observed cross section is 200 times smaller than the RNA-model and a factor 5 smaller than the QGS-model, although hints of the characteristic rise in pp scattering in comparison with the HRN-model are visible.

Measurement and Feasibility:

This experiment is proposed for Hall A, using an existing Helium 3 target. All equipment is a standard configuration of the HRS and beam-line base equipment including the cryogenic He-3 target and the special Cu radiator. The incoming photon energies needed are between 2 and 5 GeV.

Issues:

The PAC is not convinced that the proposed experiment, measuring more accurately two energy points will make a significant contribution to clarifying the present situation of a large discrepancy between existing data and theoretical models.

Recommendation: Defer

Individual Proposal Report

Proposal: PR12-10-005

Title: Precision Measurement of the Neutron Magnetic Form Factor at $Q^2=16.0$ and 18.0 $(\text{GeV}/c)^2$ by the Ratio Method

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

Motivation:

The collaboration proposes to measure the neutron elastic form factor at very high Q^2 using quasi-free scattering from neutrons in deuterium. This would allow comparison with proton elastic form factors at high Q^2 and the extraction of the isovector nucleon form factor. The isovector form factor is likely to be the first reliably calculated using lattice QCD, though perhaps not very soon with realistic quark masses at such high Q^2 values. The results may also be compared to a variety of different models of the nucleon structure at short distances.

Measurement and Feasibility:

The goal of the experiment is the precise measurement of the ratio of the $d(e,e'n)$ yield to the $d(e,e'p)$ yield at quasi-elastic kinematics. The measurement is proposed to be performed in Hall A using the Bigbite magnet instrumented for high luminosity running using GEM trackers built for the Super Bigbite Spectrometer (SBS); the recoil protons and neutrons would be detected in a different component of the SBS, the HCAL hadronic calorimeter placed 17 m from the target. A separate magnet placed close to the target would move the recoil protons to a different part of the HCAL acceptance.

Careful studies of the experimental setup and running conditions have been performed. The most stringent requirements are demanded by the large inelastic background, which also makes the largest contribution to the systematic uncertainty. The constraint of the angle of the recoil nucleon relative to the q vector of the virtual photon provides the primary means to reduce the background. Using the ratio of yields allows cancellation of many factors required to determine cross sections that would be difficult to determine precisely. The accurately measured ratio can then be used to find the ratio of elastic magnetic form factors of the neutron to proton, by using input from other experiments and by applying a small correction to account for the quasi-free process from bound nucleons and possible final state interactions.

Issues:

There is concern that at the proposed high Q^2 's of these measurements the model of the deuteron as a "simple" bound state of (only) nucleons may break down; these concerns may be addressed with an experiment to determine the proton elastic form factor at high Q^2 from both hydrogen and deuterium. Given that this uncertainty can eventually be removed, the PAC feels that measurement of the elastic form factors at these high Q^2 is interesting and should be pursued. However, it was not felt that a dramatic change in the form factors was likely to occur between the $13\text{-}14$ GeV/c^2 of the already approved experiments and the values of Q^2 explored in this proposal. Hence it was not felt that these data were urgently needed in the high priority program of the first years of 12 GeV running.

Recommendation:

Defer

Individual Proposal Report

Proposal: PR12-10-006

Scientific Rating:

Title: An update to PR12-09-014: Target Single Spin Asymmetry in Semi-Inclusive Deep-Inelastic Electro Pion Production on a Transversely Polarized ^3He Target at 8.8 and 11 GeV

Spokespersons: JP Chen, H. Gao, X. Jiang, Jen-Chieh Peng, X. Qian

Motivation:

The goal of this proposal is to carry out precision measurements of Single target Spin Asymmetries (SSA) from semi-inclusive electroproduction of charged pions from a 40-cm long transversely polarized ^3He target in Deep-Inelastic-Scattering kinematics using 11 and 8.8 GeV electron beams. The full 2π azimuthal angular coverage on the ϕ_S angle and the large azimuthal angular coverage on the ϕ_h of the SoLID detector are the main assets to extract the Collins, Sivers and Pretzelosity asymmetries for the neutron through the azimuthal angular dependence in $\sin(\phi_h+\phi_S)$, $\sin(\phi_h-\phi_S)$, $\sin(3\phi_h-\phi_S)$ respectively. The large luminosity ($10^{-36}\text{cm}^{-2}\text{s}^{-1}$) will provide a very accurate mapping in 1400 4-D bins (with x from 0.05 to 0.65, z from 0.3 to 0.7, p_T from 0 to 1.2 GeV/c and Q^2 from 1 to 8 $(\text{GeV}/c)^2$).

1. The results from this experiment, when combined with the future proton Collins asymmetry measurement and the Collins fragmentation function determined from the e^+e^- collision data, will allow for an extraction of the quark transversity distribution of the neutron, and ultimately for a determination of the tensor charge of the d quarks in the nucleon to 10% accuracy (with integrated over x).
2. The extracted Sivers and Pretzelosity asymmetry will provide important information to understand the correlation between the quark orbital angular momentum and the nucleon spin.

Measurement and Feasibility:

This is a coincidence experiment ($e^-\pi^\pm$) in Hall A using new equipment (the newly proposed solenoid spectrometer SoLID) and the Hall A polarized ^3He target. This new apparatus is common also to the PVDIS experiment nevertheless some rearrangements of the configuration of the detectors have to be made. The full 2π azimuthal angular coverage on the ϕ_S angle and the large azimuthal angular coverage on the ϕ_h angle are essential to control the systematic uncertainties in extracting different asymmetries. An experimental procedure based on known reactions (as elastic or exclusive reactions) is highly recommended to control the stability study along the long data taking (90 days).

Issues:

Similar measurements on a transversely polarized proton target using one facility of JLab will be needed in order to achieve a comprehensive view of this topic in this kinematic domain.

Recommendation: Approval

Individual Proposal Report

Proposal: PR12-10-007

Scientific Rating:

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

Spokespersons: P. Souder

Motivation:

The goal of the proposal is to perform precision studies of parity violation in deep inelastic scattering in Hall A using a new solenoidal spectrometer, named SoLID. The experiment addresses three physics topics, namely a search for higher twist effects in nucleon scattering at high x , a precision measurement of the electroweak mixing angle, and a study of charge symmetry violation in the nucleon.

The results from this experiment will address issues in electroweak physics that are, notably, relevant to the NuTeV anomaly, though this is not a primary motivation.

In addition, the experimental program has relevance to other projects being considered in the nuclear and high-energy physics communities. The issues addressed by this proposal lead naturally to electroweak physics studies that could be relevant to a high luminosity Electron Ion Collider. The stringent requirements on electron beam polarimetry (0.4% precision) are of relevance to polarimetry at a future International Linear Collider.

Measurement and Feasibility:

The proposal aims to measure the parity violation asymmetry to a precision of 0.6% by scattering highly polarized electrons from deuterium. The beamtime request is 338 days. The experiment will study asymmetries over the range $\sim 0.15 < x < 0.75$. The experiment requires the construction of a large solenoid and a new matching detector package. The event rates are high.

Issues:

The experiment is a large installation proposal, similar in scope and size to the Moller experiment. A major risk in the proposal is to identify, or cost, a moveable solenoid for Hall A. PAC34 flagged the interference with staging the existing approved experimental program. We found the experimentalists responsive to the issue of having to run the experiment in stages.

Higher twist uncertainties, an issue also flagged by PAC34, are difficult to calculate as well as being a motivation for the experimental program. The proponents organized a workshop on the issue, partially in response to these concerns. The theoretical issues remain a challenge. But, at present, there is no data on the issue. The only results that exist up to now come from the old SLAC E122 experiment. A 6 GeV JLab experiment in Hall A will provide some additional data on parity violation, and the experiment has just finished collecting data; however, the experiment only covers two kinematic points at relatively low x and Q^2 .

If higher-twist effects are found to be small and manageable, this would increase the impact of the electroweak physics test. If the higher twist effects are found to be sizeable, they open up a new study for understanding nucleon structure at high x .

Knowledge gleaned from a study of charge symmetry violation and the d/u ratio at high x will be complementary to other searches for the high x behavior of nucleon structure functions.

Recommendation: Approval

Individual Proposal Report

Proposal: PR12-10-008

Scientific Rating:

Title: Detailed studies of the nuclear dependence of F_2 in light nuclei

Spokespersons: A. Daniel, J. Arrington, D. Gaskell

Motivation:

The primary goal of the proposed experiment is the precise measurement of the EMC effect for a large set of light, medium and heavy nuclei. These data will extend an existing Jlab measurement (E03-103) to larger x values and to additional light nuclei ($A < 12$). The importance of measuring the EMC effect in light nuclei is manifold, but the main thrust is to study well understood nuclei with precision data that can help constrain calculations of nuclear effects. Moreover, precise data in the large x region where binding and Fermi motion effects are thought to dominate, will provide strict constraints on the “conventional” nuclear physics, that are necessary for any calculation of the EMC effect.

The new more accurate data allows for a substantial test of models for these effects. In addition, the data from Jlab experiment E03-103 suggests that a simple parameterization of the EMC effect as a function of A , or of average nuclear density, may not apply for light nuclei. Additional measurement on light nuclei, as planned by this experiment, will help to clarify these points.

Measurement and Feasibility:

It is proposed to measure inclusive electron scattering off ^1H , ^2H , ^3He , ^4He , ^6Li , ^7Li , ^9Be , ^{10}Be , ^{11}B , ^{12}C , ^{40}Ca , ^{48}Ca , Cu, over a range of x from 0.1 to ~ 1.0 and for $Q^2 \approx 15$ (GeV/c) 2 . The measurement will use the SHMS and HMS spectrometers and for most of the running period, both spectrometers will take data simultaneously. All data will be taken at the highest beam energy available (11 GeV assumed).

Based on the experience with the E03-103 analysis, we believe that the group can achieve the precision in the data they claimed in the proposal.

Issues: None

Recommendation: Approval

Individual Proposal Report

Proposal: PR12-10-009

Scientific Rating:

Title: Search for new Vector Boson A' Decaying to e^+e^-

Spokespersons: R. Essig, P. Schuster, N. Toro, B. Wojtsekhowski

Motivation:

The proposal is to search for a vector boson A' with weak coupling to electrons in the mass region 65-550 MeV. The proposed search is motivated by recent developments of models trying to explain inconsistencies observed in astrophysical data and dark matter search experiments. Such a vector boson would couple to charged leptons as it will mix with photon. If A' is produced by radiation off an electron beam, it would decay producing very narrow resonance in the invariant mass e^+e^- spectrum.

The proposal is very interesting and has the potential to make an important discovery. There are not many places where such measurement can be done, as it requires very high integrated luminosity and good control of the electromagnetic background. Part of the plane of coupling constant *versus* mass of the boson has already been excluded, but the region available for the proposed experiment coincides with the domain of greatest theoretical interest, for example explaining the deviation from SM expectations observed in the latest $g-2$ experiment.

Measurement and Feasibility:

The experiment is proposed to run in Hall A. It will measure the invariant mass spectrum of electron-positron pairs produced by scattering an electron beam with 75 μ A on a long (50 cm) tilted high- Z Tungsten wire mesh target. The electron and positron will be detected in coincidence in the HRS magnetic spectrometers. For the mass range of interest, the spectrometer will be positioned at small angles (5°), which can be achieved using the recently constructed septum magnet. The proposed run plan is for the 12 GeV running period, using 4 energy settings at 1.1, 2.2, 3.3 and 4.4 GeV and 2 angle settings for a total of 33 days beam time.

Issues:

The measurements proposed cover a very interesting range with a large potential for discovery which can change the picture of interactions and our understanding of physics beyond the Standard Model. Even if a signal is not seen, the experiment will constrain the plane of new boson mass and coupling allowed and so provide important limits on the domain of possible new physics.

However, running conditions push the detector performances to the extreme in terms of relative angular resolution (positioning of spectrometers), acquisition rate, particle identification. The feasibility of the measurements relies on a detailed understanding of the experimental conditions as well as on the proper background estimates.

Taking into account the very high requirements on the detectors and strong dependence of the

obtained results on the understanding of very high background, the PAC recommends tests of as many elements of the proposed setup as possible as well as detailed study of the calculated background and comparison with measurements. *The PAC strongly encourages the collaboration to continue the development of the proposal.*

Recommendation: Conditional approval

The experiment requires careful preparation and detailed commissioning studies before it can run. Without these, the results might not attain the credibility they deserve.

Individual Proposal Report

Proposal: PR12-10-010

Title: A Detailed Study of the Reaction Mechanism in Semi-Inclusive Deep Inelastic Scattering with the CLAS12 Detector

Spokespersons: X. Jiang, A. Puckett, H. Avakian, K. Joo

Motivation:

Within the SIDIS program of the CLAS12 collaboration, this group puts emphasis on differential cross sections and hadron multiplicities in deep inelastic pion electroproduction. This is an essential and important part of the SIDIS program. Inclusion of measurements at a range of energies, in particular 6.6, 8.8 and 11 GeV, allows one to perform an L/T separation and obtain broad coverage in x , z and Q^2 . The additional coverage in p_T and ϕ afforded by the CLAS12 spectrometer will be important in reducing systematic uncertainties in the “integrated” cross sections and multiplicities.

Measurement and Feasibility:

There is no doubt about the feasibility and necessity of these measurements. They are also essential and as such an integral part of the full deep inelastic pion electroproduction experiment(s). As far as the 11 GeV running is concerned, however, the experiment has a considerable overlap with E12-06-112, for which several of the above considerations mentioned above (under Motivation) also apply.

Issues:

Rather than seeing this as an independent experiment, the PAC feels that this type of measurements should be considered as part of the SIDIS program of the CLAS12 collaboration. The PAC recognizes the specific emphasis this group gives to the connection with the world data on PDFs and FFs and their scaling behavior using their contacts with several experts on NLO and higher QCD calculations. In part the data aimed for in this experiment are the same as in the approved (not yet rated) E12-06-112 experiment. With the addition of measurements at the lower energies 6.6 and 8.8 GeV the interpretation and embedding of the p_T -integrated results in the world dataset for SIDIS will be made easier.

The serious concern of the PAC is that the proposal did not contain a detailed justification for the amount of running time requested as a standalone experiment. The collaboration is encouraged to develop and submit a more detailed proposal in which it is clearly identified what precision is required to address its physics goals and the specific running time necessary to achieve these. Such a proposal should also address the complementary aspects of the running request with that of other approved (but yet unrated) experiments.

Recommendation: Defer

Individual Proposal Report

Proposal: PR12-10-011

Scientific Rating:

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

Spokespersons: A. Gasparian & L. Gan

Motivation:

The collaboration proposes to measure the $\eta \rightarrow 2\gamma$ decay width with an accuracy of 3% in the tagged photon beam in Hall D via the Primakoff effect on Hydrogen and Helium targets. Currently, width values measured at colliders using two photon production are about 3σ larger than a Primakoff determination at Cornell. The proposed 3% measurement is better than the current world average and could resolve existing discrepancies. In addition, it would have interesting implications for η - η' mixing, determination of light-quark masses and chiral-symmetry breaking. The group has previously measured the neutral pion decay width via the Primakoff effect and the current proposal can be viewed as a natural extension of their program to higher electron energy.

Measurement and Feasibility:

The experiment appears to be feasible and is well suited to the tagged Hall D photon beam. In addition, it would use the GLUEX spectrometer to detect the η via 2 photon decay. The envisioned dedicated Primakoff effect runs would have little disruption on the GLUEX facility.

Issues:

The proponents are joining the GLUEX collaboration and contributing to that facility. The present proposal is in accord with PAC34 encouragement when an earlier proposal was deferred and collaboration within the GLUEX collaboration was recommended. The proponents have requested a dedicated run with the solenoidal-detector field turned off. They should consider whether part of their running could be concurrent with GLUEX.

Recommendation: Approval

Individual Proposal Report

Proposal: PR12-10-012

Scientific Rating:

Title: Precision Measurements of Nucleon and Nuclear Structure Functions to Constrain Gluon Distributions

Spokespersons: L. Zhu, E. Christy, C. Keppel

Motivation:

The proposal has three goals:

- (1) To carry out measurements of F_2 structure functions from a series of nuclear targets (D, C, Al, Ca, and Sn) in an x region of 0.01 to 0.1 and a Q^2 region of 0.2 to 3.8 (GeV/c)². The ratio of the F_2 structure function from one nucleus to another will be formed and the slope of this ratio with respect to $\ln(Q^2)$ will be investigated. This study is largely motivated by the NMC data on this quantity in a similar x region, but at high Q^2 values where positive slopes are seen in the slope of the ratio of Sn to C, but not in the slopes of other ratios such as C/D, Ca/D. The proposed data will also help constrain the nuclear gluon distributions through global fits of nuclear parton distribution functions.
- (2) Perform L-T separation of inclusive cross section data from H, D, C, Al, Ca and Sn to determine the nuclear dependence in the longitudinal structure function F_L and the ratio of longitudinal to transverse structure function, R from a Q^2 region of 0.4 to 3.3 (GeV/c)². The goal is to constrain the nuclear gluon distributions through global nuclear PDF fits to see whether there is nuclear dependence in gluon distributions.
- (3) Determine the $n=4$ and higher moments of F_L in order to test lattice QCD predictions.

Measurement and Feasibility:

The proposed measurements are inclusive cross section measurements using standard SHMS and HMS spectrometers and doing L/T separation from a number of nuclear targets. There are no technical issues associated with the proposed measurements.

Issues:

While the experiment is straightforward, it has high demand on the control of systematic uncertainties. While the group has extensive experience with running similar inclusive experiments at 6 GeV using the HMS spectrometer, and it is also clear that some of the systematic uncertainties will become better known only from the commission and calibration of the SHMS using HMS, we believe some of the numbers in the systematic uncertainty table are optimistic, for example, the uncertainties associated with the acceptance, radiative corrections, charge symmetric background subtraction. More detailed studies and justification will be necessary.

The PAC is also not convinced that the proposed experiment will be able to constrain the nuclear gluon distributions as presented in the proposal. As pointed out in the theory TAC report, the

proposed Q^2 region is limited to 1 (GeV/c)^2 for x values less than 0.1 and the highest Q^2 value is around 3 (GeV/c)^2 corresponding to an x value of around 0.3, where the gluon contribution is small.

Recommendation: Defer

We encourage the proponents to carry out a more detailed study of systematic uncertainties and have better defined and more focused physics goals.

APPENDIX E

Individual Letter of Intent Report

Letter of Intent: LOI-10-001

Title: Large Hadron Spectroscopy with low Q^2 electron scattering in CLAS12

Spokespersons: M. Battaglieri, R. DeVita, S. Stepanyan

Motivation:

In an attempt to gain an understanding of QCD in the strong couple regime, meson and baryon spectroscopy is proposed to be investigated using high energy quasi-real linearly polarized photons by tagging scattered electrons at low energy and small angles (between 2^0 and 5^0) in combination with the operation of the CLAS12 detector. A study of the confinement mechanism of quarks and gluons in hadrons is proposed through the search for hybrid and exotic hadrons. The physics motivation in this Letter of Intent is in many ways similar and complementary to that giving the “*raison d’être*” of the dedicated GlueX experiment in Hall D, its importance and impact has been established over recent years. The described capability is very attractive on one hand for its complementarity to the Hall D program and to its experimental impact on the possible discovery of hybrid mesons.

Measurement and Feasibility:

The series of measurements described in this letter require the proposed forward electron tagger and take advantage of the large acceptance, multiparticle detection capability of CLAS12. The forward tagger would provide key information on the energy and linear polarization of the quasi-real photons responsible for the hadronic reactions under studies. A post-tagging technique (that is tagging only electrons corresponding to virtual photons involved in a hadronic interactions) is proposed to allow for increased luminosity. A study of rates from electromagnetic backgrounds, in the forward tagger for energies of photons between 7 and 10.5 GeV, shows that adding such device seems feasible. A safety margin on the rates is provided with a possible increase in the total energy threshold. Several options for the calorimeter are under investigation with a *PbWO* calorimeter as the most promising one. On the experimental side there does not seem to be any show stopper for a given luminosity. However to access some of the physics, like charm production near threshold on hydrogen and light nuclei, mentioned in this letter, the “high luminosity” capabilities will need to be demonstrated once the device is built or optimized.

Issues:

One issue that needs to be addressed is a clear demonstration of the capability of CLAS12 in combination with the tagger to provide data that would permit the extraction of the sought over resonances in a background where no peak is seen, and not just when an obvious peak is observed. In this case, effects of acceptance and hermeticity of the detector need to be addressed for the most promising channels. As mentioned in the TAC report the hole in the acceptance at 35^0 shown in Fig. 26 of the LOI in the 3π channel is not reassuring and the issue needs to be addressed of its impact on the PWA analysis. Such studies have been carried out in Hall D and could be replicated for this case. There was also a concern expressed in terms of the man power

needed to carry out the analysis. This issue also needs to be discussed when a full proposal is submitted. It was not clear that even with the proposed tagger facility the luminosity for a quasi-real photoproduction of charm near threshold is possible with reasonable statistics. Perhaps the proponents could show that in a full proposal.

Recommendation:

The proponents are encouraged to develop a full proposal with the key reactions that form the heart of the motivation are presented and where issues of acceptance and PWA analysis are fully addressed.

Individual Letter of Intent Report

Letter of Intent: LOI-10-002

Title: Deep Virtual Phi Production with the Hall A HRS-SBS Pair as a Probe of Gluon Densities of the Proton

Spokespersons: C. Hyde, C. Munoz Camacho, E. Fuchey

Motivation:

This Letter of Intent explores the possibility of studying large x gluon distributions in the nucleus via ϕ meson production at high momentum transfer, where the proponents argue that factorization occurs and the two gluon production mechanism can be isolated. Consequently, the intention is to study deeply virtual production of the ϕ vector meson using the HRS-SBS pair with the 11 GeV electron beam as a probe of Gluon Generalized Parton Distributions (GPDs) of the Proton at large x_B . ($(Q^2, x_B) = (4.6 \text{ GeV}^2, 0.36), (7.0 \text{ GeV}^2, 0.5), (10.0 \text{ GeV}^2, 0.7)$).

Measurement and Feasibility:

It is proposed to use the 11 GeV electron beam, the HRS spectrometer of Hall A to detect the electron and the Super Big Bite Spectrometer equipped with the HERMES RICH detector to collect the two charged kaons of ϕ decay. Angular analysis of the ϕ decay allows the separation between transverse and longitudinal contributions if the s-channel helicity conservation works.

Issues:

This proposed experiment seems very attractive not only in order to investigate the gluon GPDs but also the strange quark GPDs at very large x_B . Nevertheless one main concern is the dominance of the specific factorized contribution that is the product of Generalized Parton Distributions multiplied by an integral over the ϕ wave function. How reliable do we theoretically know the magnitude of the various contributions?. Furthermore, if there is some indication from earlier result of CLAS, this dominance in the domain of very high x_B should be more clarified.

Other issues concern the technical feasibilities:

- In what way can the HERMES RICH detector be adapted to SBB, how can it handle the very high rates at this huge luminosity? How can we get a good efficiency and purity at high momentum? (when the π/ϕ separation is obtained by vetoing on the presence of the gas Cerenkov disk for the pions?)
- are the consequences of the modification of SBB (for the access at very small angle) under control?
- how large is the background?
- how can we precisely determine the efficiency and relative acceptances over the 4 main variables of the problem: t , ϕ , θ_K , ϕ_K in order to get the required angular distributions to perform a longitudinal and transverse separation and determine the t evolution?

Recommendation: the PAC recommends that this Letter of Intent be developed into a proposal to be presented to a future PAC.

Individual Letter of Intent Report

Letter of Intent: LOI-10-003

Title: SRC, DIS, and the EMC effect

Spokespersons: V. Sulkosky, J. Watson, D. Higinbotham

Motivation:

The collaboration proposes to study the possible modification of the neutron F_2 structure function at two values of Bjorken x as a function of the recoil momentum of a backward going proton. Recoil protons with high momentum are expected to come from nucleon pairs with short-range correlations (SRC). The goal is to address the question of whether a possible source of the EMC effect in DIS from nuclei results from modification of the nucleon structure when it is part of a pair with SRC. This group has previously found evidence that suggests that a significant fraction (20%) of the nucleons in ^{12}C are nucleon pairs with SRC, around 80% of which are np pairs. Hence modification of F_2 in pairs with SRC could be a sizeable effect in the total nuclear F_2 .

Measurement and Feasibility:

The scattered electrons will be detected in one of the existing Hall A HRS spectrometers (both will be used) while the backward recoiling proton will be detected in coincidence in an array of scintillation counters, the Large Acceptance Detector (LAD). The scintillators are the TOF counters taken from the existing CLAS spectrometer that will not be used in the CLAS12 spectrometer. Particle identification will use dE/dx in the counters combined with TOF. While the electron detection is straightforward, the singles rates in the LAD will be quite high, leading to a random coincidence rate comparable or even larger than the true rate, at some of the kinematics. Initial studies have already been performed and have been used to develop the run time estimate. The full proposal should contain simulations for a detailed layout of the target, scattering chamber and LAD to fully evaluate the background in the detectors as well as the energy loss and multiple scattering effects on the recoil protons.

Issues:

The PAC has some concern about the theoretical interpretation of the results. For instance effects of final state interactions should be investigated in order to ensure that they are well understood for events tagged with large recoil proton momentum, so that these events can be cleanly related to SRC. Whatever FSI are present, they are likely independent of the Bjorken x of the DIS measurement, but it is not clear that one can interpret the high x /low x comparison as a simple EMC/no-EMC test. Thus the full proposal should clearly identify the observables and how they will be cleanly interpreted theoretically.

Recommendation: The PAC encourages the submission of a fully developed proposal that addresses the issues raised above.

Individual Letter of Intent Report

Letter of Intent: LOI12--10-004

Title: Production of the Strangest Baryon with CLAS12

Spokespersons: A. Afanasev, E. Pasyuk, W. Roberts, I. Strakovsky

Motivation:

This Letter of Intent proposes to make a direct measurement of the Ω baryon mass spectrum and, importantly, the spin. As in the LOI emphasized, the spectrum of the Ω is very poorly known, and even the spin of the ground state is not directly measured. The strange quark mass spectrum is of continued interest, especially for the lattice QCD effort at JLab (The Hadron Spectrum Collaboration) and elsewhere.

Measurement and Feasibility:

The experiment will use the base equipment of the CLAS12 detector. LOI12-10-001 described in detail a future quasi-real photon facility of CLAS12. The ability to continue a program of photoproduction studies into the 12 GeV era with the CLAS12 detector is very attractive, especially as a complement to the dedicated GlueX experiment.

Issues:

Overall, it looks feasible to measure the photoproduction $\gamma N \rightarrow \Omega^- K K K$ cross section with CLAS12. There are several open questions which a future proposal has to address. One problem of the experiment is that the photoproduction cross section is not known and the couplings needed for estimating the rates are not determined. The acceptance for multi-meson final states is another important issue for the experiment. The quality of a partial wave analysis will strongly depend on well determined angular cross sections. For this, a full GEANT simulation of proposed reaction in the CLAS12 acceptance is necessary.

Recommendation:

The Letter of Intent LOI-10-004 (Production of the Strangest Baryon with CLAS12) should be integrated with the Letter of Intent LOI-10-001 (Hadron Spectroscopy with low Q^2 electron scattering in CLAS12) and a full proposal prepared.

Individual Letter of Intent Report

Letter of Intent: LOI-10-005

Title: The EMC Effect in Spin Structure Functions

Spokespersons: W. Brooks

Motivation:

The proposed measurements are inclusive spin-dependent asymmetry measurements using a longitudinally polarized ${}^7\text{LiH}$ target in the DIS kinematics with a Q^2 ranging from 2 to 9 $(\text{GeV}/c)^2$ and x ranging from 0.1 to 0.7. The goal of the proposed experiment is to determine the spin structure function ratio of $g_1(\text{Li})/g_1(\text{p})$ in order to investigate whether there is a spin EMC effect.

A number of models predict a spin EMC effect and the proponents chose to investigate this effect using polarized ${}^7\text{LiH}$ first because of the availability of the model predictions of spin EMC effect for ${}^7\text{Li}$ and the availability of reliable theoretical calculation of the ${}^7\text{Li}$ wave function. The proposed measurement is very interesting and well motivated.

Measurement and Feasibility:

The proposed measurements will employ a dynamically polarized ${}^7\text{LiH}$ target in CLAS12 with a longitudinal polarization. The experiment will measure the spin dependent asymmetry. Similar measurements have been performed previously in CLAS and there is no issue of feasibility for the proposed measurements. Similar targets have been built at other laboratories.

Issues:

There are a number of physics and technical issues which need to be addressed before a full proposal is submitted:

- (1) The sensitivity to spin EMC effect with the intended precision as pointed out in the theory TAC report.
- (2) How does one remove the un-polarized EMC effect reliably?
- (3) A target polarization of 80% is assumed in the projection. The achieved high polarization for ${}^7\text{LiH}$ target was at a 6.5 Tesla field and a temperature of 200 mK. The proposed target will be at 5 Tesla and ~ 1 K. Significant R&D work is crucial to demonstrate that the proposed target polarization can be achieved.
- (4) The LOI quotes a precision of 1% for the target polarization based on equal spin temperature theory. However, in the reference quoted in the LOI where equal spin temperature theory was verified experimentally, a 4% experimental uncertainty in target polarization was reported. Therefore, the 1% target polarization determination is a very ambitious goal. The elastic asymmetry measurement is discussed in the LOI, but it also mentioned that this will not be used. It would be helpful to calculate how long it would take to have a good measurement of the elastic asymmetry in order to determine the product of the beam and target polarization.
- (5) An important experimental issue with the proposed the experiment is to determine the dilution factor reliably. The proposed series of measurements to determine the dilution factor is not trivial and needs to be studied very carefully.

- (6) How does one determine the tensor polarization of the target?
- (7) What about false asymmetries which usually can be reduced by combining two opposite target spin states in data taking for a spin $\frac{1}{2}$ target, and with beam half-wave plate in and out?
- (8) Why the unwanted contribution from tensor polarization cancels out?
- (9) Neutron is also polarized in ${}^7\text{Li}$ to some degree, therefore one needs to remove the neutron contribution to the spin-dependent asymmetry in order to extract $g_1^p(\text{Li})$. Also, nuclear effect is not just to figure out the effective proton polarization in ${}^7\text{Li}$. What is the effect due to Final State Interactions?

Recommendation:

We think the proposed physics is very interesting and important. We encourage the proponents to address the technical and physics issues listed above while developing the full proposal.

Individual Letter of Intent Report

Letter of Intent: LOI12--10-006

Title: Search for dark forces in electron-proton scattering using the Jefferson Lab FEL

Spokespersons: P. Fisher

Motivation:

Some theories extending the Standard Model (SM) predict a gauge boson in the mass range 0.01-10 GeV weakly coupling to charge leptons and mixing with photon. Existence of such a boson would explain some observations of astrophysical and dark matter searching experiments as well as apparent deviations from SM expectations (for example $g-2$).

The proponents present a unique possibility of adding information about such boson (most likely exclude) in the low mass (10-70 MeV) range and setting upper limit on its coupling with a dedicated experimental setup at the Free Electron Laser (FEL) facility. The range covered by such measurements would be complementary to the searches proposed with the regular electron beam running at a few GeV.

Measurement and Feasibility:

Such a dark force particle would decay into an electron-positron pair and become visible as very narrow peak in the invariant mass spectrum. The selection is based on the measurement of complete event kinematics and requires a dedicated detector. The proposed target can be either gas jet or storage cell target. The gas density is limited by the FEL power recovery performance.

Issues:

Running with a FEL requires additional arrangements for running the facility. Detector design requires more studies as the performance requirements (1% mass resolution for e^+e^- pairs) are very demanding. In the LoI there is a rather complete list of points which should be addressed on the path to proposal. The expected background is very high, estimated reduction has to be based on complete understanding of simulations including all material in and around the detector.

Recommendation:

The proposed idea should be followed and if no showstoppers are identified lead to the full proposal. Planning of this and other possible experiments testing different regions in mass and coupling constant for a possible new light boson has to be coordinated and a workshop with the discussion of theoretical situation and different experimental approaches is recommended.

Individual Letter of Intent Report

Letter of Intent: LOI12-10-007

Title: Neutron Properties in the Nuclear Medium Studied by Polarization Measurements

Spokespersons: G. Ron, R. Gilman, D. Higinbotham, S. Strauch, J. Lichtenstadt

Motivation:

It is proposed to investigate possible changes of the internal structure of bound neutrons by studying the form factor ratio G_E/G_M in the polarization transfer from longitudinally polarized electrons to neutrons in quasifree knockout reactions. These measurements will complement corresponding measurements for protons, which have recently been obtained at JLab. The bound neutron is an important test, because theoretical models predict the ratio to behave differently from that for the proton.

Measurement and Feasibility:

As in the proton case, the $^4\text{He}(e,e'\text{N})$ reaction will be utilized. An obvious problem for the neutron is that no free neutron targets are available, but deuterons are expected to be a good approximation to free neutrons. Polarization components of the recoil neutron will be measured by the neutron scattering reaction off hydrogen in the neutron polarimeter. In order to measure the longitudinal spin component, the vector must be rotated in a magnetic field. The problem may be that final state interactions introduce a normal component, which is why all three polarization components must be measured, and this requires two magnet settings.

Issues:

The proponents identify several potential problems for the proposed measurement, which they intend to work on before submission of a proposal. In particular, the neutron polarimeter design should be fixed. The PAC notes that a similar proposal (PR99-004) was deferred at an earlier PAC meeting (PAC15) (“until initial proton results are available”), which is now the case.

Recommendation:

The PAC recommends the proponents to produce a full proposal.

Individual Letter of Intent Report

Letter of Intent: LOI12-10-008

Title: Measurement of Complete Final States in Deep Inelastic Scattering from Light Nuclei to Study the EMC Effect

Spokespersons: R. Milner

Motivation:

The goal of this measurement is to study the EMC effect by re-measuring with light nuclei and mapping out the complete final states interactions. The experiment proposes to study only light nuclei, specifically hydrogen, deuterium, helium-3, helium and nitrogen., using CLAS in Hall B. The main technical challenge is to implement tagging detectors for the low energy nuclear fragments. The experiment discusses tagging proton, neutrons, deuterons, tritons, pions and kaons down to the MeV level.

Measurement and Feasibility:

The proponents envisage using an upgraded version of the BONUS detector as well as incorporating technology from a TPC developed at MIT for tagging neutrons. The desired kinematic coverage would extend from $0.05 < x < 0.8$ and $Q^2 > 1 \text{ GeV}^2$. Rates for some of the final state interactions are estimated in the Letter of Intent. At first glance, the rates look manageable with a realistic additional upgrade of the electronics to, for example, the BONUS detector.

Issues:

No statistical or systematic uncertainties or beamtime estimates are presented in the document. The Letter of Intent is still at an early, conceptual state. Only a minimal interaction between the proponents and the CLAS collaboration exists up to now. The integration of the dark matter TPC into the CLAS12 experimental program is at such a conceptual stage that it requires a major review from the CLAS collaboration. The desire to perform tagging down to 1 MeV may be too aggressive to be realizable. The implication of tagging different energies on different constituents needs to be folded into a proposal to be able to evaluate the physics. Guidance from theoretical calculations on the EMC effect with tagging would help the proposal significantly.

Recommendation:

The proponents should proceed with discussions with the CLAS collaboration to see if there is support for the physics and technical ideas, in general. There are competing proposals on this topic. The CLAS collaboration should resolve these issues.

Individual Letter of Intent Report

Letter of Intent: LOI12-10-009

Title: Nuclear Exclusive and Semi-inclusive Physics with a New CLAS12 Low Energy Recoil Detector

Spokespersons: K. Hafidi, W. Brooks, M. Amarian, R. Dupre, D. Dutta, H. Egiyan, A. El Alaoui, D. Gaskell, G. Gilfoyle, F.-X. Girod, S. Liuti, S. Stepanyan, L. Zhu

Motivation:

The letter describes a broad range of studies on light nuclei for which detection of low energy recoil protons or nuclear fragments in the final state are needed. Specifically discussed are coherent and incoherent DVCS on deuterium and on ^4He , the pion structure function, hybrid meson spectroscopy, and the EMC and off-shell nucleon structure measurements.

Measurement and Feasibility:

CLAS12 Central Detector is designed to detect and identify charged particles (π -mesons, K-mesons, protons, deuterons ...) in a wide momentum and angular range. However, due to the thickness of layers of the silicon tracker, the minimum momentum for charged particles to be detected in the Central Detector (typically 200 MeV/c for recoil protons) is too high for the proposed physics. Several solutions are proposed to replace the Si trackers. One solution has already been tested recently with success in the 2 CLAS run periods, BoNuS and eg6, using Radial Time-Projection Chamber (RTPC) based on Gas Electron Multipliers (GEM). One main issue using RTPC at high luminosity is the rate of accidental tracks that is defined by the drift time of a few μs . Other options using faster detector and tight time coincidence with CLAS12 can be envisaged as a low pressure recoil detector (LPRD) used in AmPS (at NIKHEF) for internal target experiments or a fission fragment detector (FFD) used for the hyper-nuclear experiments in Hall C.

Issues:

This new device has to be adapted for the requirements of all these measurements and also for the requirement of the rather similar EMC experiment described in the LOI12-10-008. This resulting proposal should be clearly a common project of the CLAS12 Collaboration.

The feasibility of each measurement needs to be confirmed and a comprehensive study which includes the design of the detector and its readout, the detailed simulations and some experimental tests needs to be achieved and reported.

Recommendation:

The proponents of the two letters of intent LOI12-10-009 and LOI12-10-008 are strongly encouraged to complete these studies and to present a full common proposal.

Individual Letter of Intent Report

Letter of Intent: LOI12-10-010

Title: Polarized Electrons for polarized positrons: A proof-of-principle experiment

Spokespersons: J. Grames and E. Voutier

Motivation:

The LoI proposes a first-ever demonstration of producing a beam of polarized positrons from a beam of polarized electrons via the intermediate production of circularly polarized photons and subsequent pair production. This is seen as an important possible future capability of electron accelerators.

Measurement and Feasibility:

The second step in the production, i.e. the polarized positron production in pair production with circularly polarized photons, has recently been demonstrated in SLAC experiment E166. The new aspect of this LoI is the way to produce the polarized photons: while E166 used an unpolarized electron beam of high energy (~ 50 GeV) together with a helical undulator, here one would use the longitudinal polarization transfer from a highly polarized (85%) electron beam to photons in the bremsstrahlung process. Polarization transfer in bremsstrahlung and pair production is well known, and has been implemented in simulations to predict positron polarizations and intensities. The aim of the proposed measurements is to verify these predictions and to optimize the figure-of-merit. Since only low energy (polarized) electrons are needed, the project would be to use the CEBAF injector ($I = 1 - 10 \mu\text{A}$, $P \sim 85\%$) to build a compact low energy driver. Large parts of E166 equipment would be used for electron and photon polarimetry.

Issues:

The major issue is that resources will be needed to set up the experiment at the injector beam line with some temporary modification and building an additional shielding wall. However, the amount of work seems to be moderate and the proponents want to do this during the shut-down time in 2011.

Recommendation:

The PAC is very positive about this LoI and it would like to see this developed into a full proposal.

APPENDIX F

Jefferson Lab Experiments, PAC 35, Grouped by Category

(To access Appendix F, go to http://www.jlab.org/exp_prog/Proposals/10prop.html)