Jefferson Lab
Thomas Jefferson National Accelerator Facility

REPORT OF THE 37TH PROGRAM ADVISORY COMMITTEE (PAC37) MEETING

January 10 – 14, 2011

The Thomas Jefferson National Accelerator Facility (Jefferson Lab) is a national physics user facility Operated by the Jefferson Science Associates, LLC, for the U.S. Department of Energy (DOE)

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June 20, 2011
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Dear Jefferson Lab Users,

At the time of PAC 37 in mid-winter 2010-11, we were eating into the penultimate year of 6 GeV operation and by now, mid-summer, we have completed much of the program that was laid out in 2008. QWeak in Hall C has had a successful first year of operation and can project achievement of its goal in terms of accuracy of the measurement if the 2012 run is also successful. In Hall B substantial FROST, polarized target running puts the N* proton data in good shape. We are counting on the HDice target, which underwent extensive installation and operational trials, providing neutron data in 2012. A Two Photon Exchange experiment also ran in Hall B as well as a new extension of the PRIMEX π^0 width measurement. In Hall A, the spring 2011 running was characterized by the short range correlation and high x_{Bj} experiments; 2012 will be dominated by the g2p/GEp measurement.

Of course PAC 37 was primarily occupied with consideration of the 12 GeV program. The process involved ranking of approved experiments in several categories, as well as considerations of new proposals. Nine new proposals were considered and in the ranking, three previously approved experiments and six conditionally approved experiments were also considered.

We continue to be impressed by the breadth and depth of the new initiatives being advanced for the 12 GeV era. This demonstrates to us the quality and importance of the science opportunities which will be available upon completion of the project. Thus far the support for the project from congress, from DOE Office of Science, and from the office of Nuclear Physics, has been excellent. The project is approximately halfway complete. Major phases of the civil construction are done; we are ready for equipment in the new Hall D and are installing accelerator components in the tunnel during the current 6 month shutdown. Of course, we are also anxiously following the congressional discussions of the 2012 budget.

The Chair of the PAC 37 was Naomi Makins, who focussed the discussions in excellent manner. Of course, as usual, the dedication of all the PAC members and the acumen, which they brought to the table, was remarkable. With his term as Chair of the users Group Board of Directors coming to an end at the June 2011 Users Meeting, Zein-Eddine Meziani rotates off the committee and will be replaced by Sebastian Kuhn.

Sincerely,

Hugh E. Montgomery
Laboratory Director

Introduction

The Jefferson Lab Program Advisory Committee held its 37th meeting from January 10th to 14th, 2011. 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 23 potential experiments: 9 new proposals, 4 Letters of Intent and 10 previously approved experiments for grading.

Previously Approved 12 GeV Experiments (including those approved following the first charge element) in the categories: "The hadron spectra as probes of QCD", "The longitudinal structure of the hadrons", and "Hadrons and cold nuclear matter." The grading should be consistent with the "scale" used for the scientific priority setting for the 6 GeV program

Recommendations

PAC 37 SUMMARY OF RECOMMENDATIONS

NUMBER	CONTACT PERSON	TITLE	HALL	DAYS REQUESTED	DAYS AWARDED	PAC DECISION	SCIENTIFIC RATE	Topic*
C12-09-001	Edward Brash	GEp/GMp with an 11 GeV electron beam	C	98		Deferred		2
C12-09-002	Kawtar Hafidi	E12-09-002; Charge Symmetry Violating Quark Distributions via Precise Measurement of pi+/pi Ratios in Semi inclusive Deep Inelastic Scattering.	C	22		Approved	PAC38	4
C12-09-017	Rolf Ent	Transverse Momentum Dependence of Semi-Inclusive Pion and Kaon Production	C	32		Approved	PAC38	4
C12-09-018	B. Wojtsekhowski	Measurement of Semi-Inclusive Pion and Kaon electroproduction in the DIS Regime on a Transversely Polarized 3He Target using the Super BigBite and BigBite Spectrometers in Hall A	A	64		C2		4
C12-10-001	Liguang Tang	Study of Light Hypernuclei by Pionic Decay at JLab	A	42		C2		5
C12-10-009	B. Wojtsekhowski	The A2 Experiment (APEX): Search for a New Vector Boson A2 Decaying to e+e	A	34	34	C1	A	6
C12-10-103	G. G. Petratos	Measurement of the F2n/F2p, d/u Ratios and A=3 EMC Effect in Deep Inelastic Electron Scattering Off the Tritium and Helium Mirror Nuclei.	A	42	42	Approved	A	3
E12-09-005	Prof. Krishna Kumar	E12-09-005: Update An Ultra-precise Measurement of the Weak Mixing Angle using Moller Scattering	A	344	344	Approved	A	6
E12-10-007	Paul Souder	Brief Update to PR10-007 (E09-012): Beam Time Request for SoLID.	A	338	169	Approved	A	6
E12-10-011	A. Gasparian	A Precision Measurement of the eta Radiative Decay Width via the Primakoff Effect	D	79	79	Approved	A-	1 / 6
LOI-11-001	Ken Hicks	Search for Scalar Mesons at low Q^2 using CLAS12	B					1
LOI-11-002	Zein-Eddine Meziani	Measurement of the Proton and Deuteron J/Psi Electroproduction Cross Section at Threshold; A Quest of QCD Van der Waals Forces	C					5
NUMBER	CONTACT PERSON	TITLE	HALL	DAYS REQUESTED	DAYS AWARDED	PAC DECISION	SCIENTIFIC RATE	Topic*

LOI-11-003	P. Solvignon	Letter-Of-Intent: The Deuteron Tensor Structure b1	A					3
LOI-11-004	Xiaohui Zhan	Semi-inclusive deep inelastic scattering from light nuclei by tagging low momentum spectators	B	20				5 / 3
PR-11-001	John Annand	Measurement of the Ratio GnE/GnM by the Double-polarized 2H(’e,e2’n) Reaction	A	55		Deferred		2
PR-11-002	Steffen Strauch	Proton Recoil Polarization in the 4He(e,e'p)3H, 2H(e,e'p)n, and 1H(e,e'p) Reactions	C	37	37	Approved	B+	5
PR-11-003	Silvia Niccolai	Deeply Virtual Compton Scattering on the Neutron with CLAS12 at 11 GeV	B	90		Approved	PAC38	4
PR-11-004	Ishay Pomerantz	Hard photodisintegration of ^{3}He into p-p, p-n, and p-d pairs	A	19		Deferred		5
PR-11-005	Marco Battaglieri	Meson spectroscopy with low Q2 electron scattering in CLAS12	B	119	119	Approved	A-	1
PR-11-006	John Jaros	Heavy Photon Search at Jefferson Laboratory	B	180		C2		6
PR-11-007	Jin Huang	Asymmetries in Semi-Inclusive Deep-Inelastic Electro-Production of Charged Pion on a Longitudinally Polarized He-3 Target at 8.8 and 11 GeV	A	35		Approved	PAC38	4
PR-11-008	Peter Fisher	A Proposal for the DarkLight Experiment at the Jefferson Laboratory Free Electron Laser	FEL	90		C2		A’
PR-11-009	John Arrington	The Neutron Electric Form Factor at Q^2 up to 7 $(GeV/c)^2$ from the Reaction d(e,e'n)p via Recoil Polarimetry	C	67	50	Approved	B+	2

Topic*

1 The Hadron Spectra as Probes of QCD
2 The Transverse Structure of the Hadrons
3 The Longitudinal Structure of the Hadrons
4 The 3D Structure of the Hadrons
5 Hadrons and Cold Nuclear Matter
6 Low-Energy Tests of the Standard Model and Fundamental Symmetries

C1=Conditionally Approve w/Technical Review
C2=Conditionally Approve 2/PAC Review

Proposal Reports

Proposal: C12-09-001 **Scientific Rating:** Unrated
Recommendation: Deferred

Title: "G_{Ep}/G_{Mp} with an 11 GeV Electron Beam"

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

Motivation: It is proposed to measure the proton elastic form factor ratio G_{Ep}/G_{Mp} up to values of momentum transfer squared of Q^2 = 11 GeV^2, exploiting the recoil polarization technique, i.e. the polarization transfer from longitudinally polarized electrons to the recoiling protons: $^1H(\vec{e},e'\vec{p})$. The recoil polarization technique is the method-of-choice, since it is much less susceptible to two-photon exchange corrections, which are believed to explain the experimental discrepancy between results obtained with "polarization" and the "Rosenbluth separation". Form factors are fundamental nucleon properties, and additional high precision data at higher Q2 are important for constraining nucleon models.

Measurement and Feasibility: This new experiment (GEp-IV) will be performed in Hall C, using a polarized electron beam incident on an unpolarized liquid hydrogen target. GEp-IV uses exclusively instrumentation which already exists. The scattered electron is detected in an electromagnetic calorimeter (BigCal), while the polarization components of the recoiling proton are analyzed in the focal-plane polarimeter (FPP) of the HMS magnetic spectrometer. The FPP and BigCal were already used in the GEp-III experiment, and both instruments performed very well during the six month duration of the experiment. So this new experiment GEp-IV can be carried out immediately after the 11 GeV becomes available in Hall C. The analysis method is also very well over controlled.

Issues: At 12 GeV two proposals have been proposed GEp-V (E12-07-109) in Hall A and GEp-IV (C12-09-001) in Hall C. The first experiment has been approved and graded with 45 days during the PAC35 and the second one, discussed here, was so far only conditionally approved by the PAC34, with the remark:

"While [the proponents] consider both experiments to be complementary (high resolution and small acceptance hall C vs. small resolution and large acceptance hall A), the PAC is not convinced that both of them should be pursued. The PAC therefore asks the two collaborations to either come up with one common proposal or to make an extremely compelling case as to why both of them need to be done."

Now the two collaborations have merged and the two experiments should be viewed as part of a coherent plan to obtain reliable measurements of sufficiently high statistics and quantifiable systematic uncertainties. Unfortunately the projections for the GEp-IV experiment realized in 98 days appear with a limited statistics comparatively to the projections of GEp-V experiment realized only in 45 days in a larger range in Q^2. This is due to the benefit of the large solid angle of SuperBigBite in Hall A. Background contamination is reduced by kinematic correlation between electron position and proton momentum and angle. The control and minimization of systematic errors in GEp-V which was brought up to justify the importance GEp-IV experiment, should be still improved in the new Hall A facility with dedicated studies even at low luminosity using additional equipments as GEM trackers in front of BigCal or Cerenkov.

Proposal: PR-09-002 **Scientific Rating:** Unrated

Recommendation: Approved

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

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

Motivation: This experiment will measure the semi-inclusive cross-sections for π^+ and π^- production from a deuterium target. The principal goal of the measurement is to look at the π^+ / π^- cross section ratio for a selection of x, z and Q^2 values and look for deviations of the factorized expression, in which charge symmetry violation (CSV) in the nucleon is allowed, in the form of PDF differences $u_p(x)$–$d_n(x)$ and/or $u_n(x)$–$d_p(x)$. The z dependence of the cross sections will also be measured, with the goal of studying symmetries of the fragmentation functions.

Measurement and Feasibility: The original proposal requested 17 days of running in Hall C. Standard equipment will be used, with the SHMS (HMS) detecting electrons (hadrons). No experimental challenges beyond those already addressed in the proposal are foreseen. The measurements will be performed at parallel kinematics with limited coverage in $p_{h\perp}$ and full coverage in ϕ, but particularly suited for the CSV studies. On request of PAC34 combining with PR-09-017 was investigated, resulting in a one-day combined running and combined preparation. The proposals were kept separate and authors explained this necessity after a careful study of kinematics and possible overlapping, the different aims require separate settings of spectrometers.

Issues: Isolating an isospin symmetry violation in the nucleon PDFs using SIDIS is extremely challenging. The proposers are clearly cognizant of the difficulties: modest deviations from pure independent fragmentation can overwhelm a small isospin difference, and there are more possibilities for broken fragmentation function symmetries than the one identified in Equation (15). This makes it doubtful that a large CSV effect should be attributed solely to PDFs, but one might get important information from the actual outcome of x-, z- or Q^2-dependence.

Nonetheless, the cross sections are such basic tests of the understanding of SIDIS at 11 GeV kinematics that they will play a critical role in establishing the entire SIDIS program of studying the partonic structure of the nucleon. In particular they complement the CLAS12 measurements in areas where the precision of spectrometer experiments is essential – in this case, precise control of the relative acceptance and efficiency for different particle charges. The PAC strongly recommends that these measurements occur in the early years of 12 GeV operation. The PAC37, therefore, recommended approval.

Proposal: PR12-09-017 **Scientific Rating**: N/A
Recommendation: Approval

Title: "Transverse Momentum Dependence of Semi-Inclusive Pion and Kaon Production"

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

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

Measurement and Feasibility: The experiment will use the HMS to detect the scattered electrons and the SHMS to detect the pions and kaons. Systematic uncertainties arising from acceptance will be small due to the use of small acceptance spectrometers. At low p_T the acceptance in azimuthal angle about the virtual photon direction is essentially 2π, while at high values of p_T, the spectrometer will be scanned in hadron angle to determine the larger-p_T dependence in a more limited azimuthal range. No significant technical issues were identified that would affect the experiment's feasibility. On request of PAC34 combining with PR-09-002 was investigated, resulting in a one-day combined running and combined preparation. The proposals were kept separate after a study of kinematics and possible overlapping showed that the different aims require separate settings of spectrometers.

Issues: Even if concerns remain that the experimental coverage in the full multi-dimensional space may be too limited to obtain integrated or weighted observables that can be theoretically interpreted, the cross sections are such basic tests of the understanding of SIDIS at 11 GeV kinematics that they will play a critical role in establishing the entire SIDIS program of studying the partonic structure of the nucleon. In particular they complement the CLAS12 measurements in areas where the precision of spectrometer experiments is essential, being able to separate p_T and phi-dependence for small p_T. The PAC strongly recommends that these measurements occur in the early years of 12 GeV operation.

Proposal: PR12-09-018 **Scientific Rating:** Unrated
Recommendation: Conditional Approval

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

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

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

Measurement and Feasibility: In this experiment an electron beam of 8.8 and 11 GeV scatters off a highly transversely polarized ^{3}He gas target. The relevant physics is accessed through a full azimuthal coverage achieved by the rotation of the target transverse spin direction with respect to the leading final hadron detection plane. A range of Q^2 will be used to study higher twist effects. Several design improvements over the existing target would be made to allow the use of higher beam currents (of the order of 50 μA) than is presently possible. The scattered electrons would be detected in the existing BigBite spectrometer, and semi-inclusive charged pions and kaons would be detected in a new Super BigBite spectrometer. GEM detectors would be used to perform tracking in the very high singles rate environment of each spectrometer. Pions and kaons would be identified using a large dual RICH detector taken from the HERMES experiment.

Issues: The PAC is keen to see a full comparison of this proposal with other competing SIDIS proposals with respect to the projected results as it will have to ultimately rank them within a single category. The PAC urges the proponents to provide their projections with a three dimensional binning (x, z, P_t) for a given Q^2

The PAC recognizes that clear progress was made in the study of backgrounds at 6 GeV by the proponents but it was short of fully demonstrating the feasibility of this experiment at the proposed luminosity, thus have not responded satisfactorily to item **1)** of the previous PAC report. While the PAC endorses the physics goals of the experiment it was not fully convinced that the simulations of the background are realistic enough at 6 GeV to warrant a confident extrapolation of the rates at the proposed luminosity.

Proposal: C12-10-001 **Scientific Rating:** Unrated
Recommendation: Continue conditional approval

Title: "Study of Light Hypernuclei by Pionic Decay at JLAB"

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

Motivation: The proposal describes a novel approach to produce hypernuclei by production in a fragmentation process. This promises to allow a wider range of hypernuclei, even ones potentially out to the drip lines, to be studied by observation of their pionic, weak, 2-body decay. The exciting scientific value of these measurements has been noted by previous PAC (including PAC35) and we concur with the previous assessment.

Measurement and Feasibility: The details of the experiment were discussed by previous PACs and are described in those reports. The program would proceed with a number of phases, starting with the study of the lightest hypernuclei produced from a 7Li target. Subsequent proposals would be submitted for production on heaver targets. The phased program is needed to correlate the observed pionic decays to specific parent hypernuclei. The validity of the proposed approach has been demonstrated by experiments using the FINUDA system. Ongoing experiments at Mainz will demonstrate that background levels are acceptable and determine the scale of the production cross sections. This will determine the range of hypernuclei and the breadth of the physics that might be accessible in experiments at JLAB.

Issues: The proposal was granted conditional approval pending a test run to measure production cross sections. We were sorry to hear that this test will not run in the 6 GeV period. However, it appears the goals of the test run can be completed in Mainz. Well look forward to an update and will consider full approval of the first phase of the measurements pending the outcome of these tests.

Proposal: PR12-10-009 **Scientific Rating:** A
Recommendation: Approval

The PAC approves the proposal contingent on a successful solution of the radiation issue. The PAC feels that the experiment should be carried out as early as possible (ideally before the 6 GeV shut down in 2012).

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 of about 10^{-3} e or smaller to electrons in the mass region 65-525 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 50-80 μA on a 0.7-8% radiation length long Tungsten multi-foil 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 PREX 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 34 days beam time. These statistics and the excellent mass resolution of the spectrometers allow sensitivity two to three orders of magnitude below current limits, in a region of parameter space of great theoretical interest.

The experiment is technically feasible, as demonstrated by the June 2010 test run of the APEX collaboration which are in detail described in section 8 of the proposal. The collaboration has addressed in a very satisfactory manner the issues raised by PAC35 when the proposal was conditional approved.

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.

One important issue for this proposal which remains, will be mitigation of the effects of neutron radiation on the Hall A electronics. This issue requires special attention as it could serious impact the experiment and the collaboration should work with the Jefferson Lab radiation group as well the Hall A technical staff and management together to come up with a solution to protect the electronics from the neutron radiation.

Proposal: C12-10-103 **Scientific Rating:** A
Recommendation: Approval

Title: "Measurement of the F^n_2/ F^p_2, d/u Ratios and A=3 EMC Effect in Deep Inelastic Electron Scattering Off the Tritium and Helium Mirror nuclei"

Spokespersons: J. Gomez, R.J. Holt, G. G. Petratos (Contact), R. Ransome

Motivation: The collaboration proposes to carry out a precise measurement of the ratio of F^n_2/ F^p_2 in deep inelastic kinematics (x = 0.23 to 0.87) (slightly higher than that proposed to PAC36, 0.82) using Tritium and Helium mirror nuclei to reduce uncertainties due to nuclear effects. The ratio of d/u at medium and large *x* values will be extracted from the data to test various model predictions of this ratio at large *x*. Furthermore, the A=3 EMC effect will be studied with measurements from Helium and Tritium at the same kinematics to allow for more stringent tests of various theoretical calculations of the EMC effect. This is one of the flagship experiments driving the original scientific case for the 12-GeV energy upgrade of CEBAF.

Measurement and Feasibility: The proposed experiment was conditionally approved by PAC30 with the condition that a safety review of the Tritium target be carried out by the laboratory, a review took place in June 2010. The proposed experiment will employ a room-temperature Tritium target with a pressure of 10.0 atm and a target length of 25 cm (activity of 1000 Curie). The finding of the safety review committee for the new design concept is that there is no show stopper for the proposed target design. However, significant amount of work at many levels, particularly on the engineering side, will be needed in the next stage of the target design.

To recover the loss of luminosity due to the use of a low-activity Tritium target, the proponents proposed to use the large-acceptance Super BigBite Spectrometer (SBS) in their submission of the proposal to PAC36. SBS is a different and new spectrometer setup compared to what was originally proposed to PAC30, namely the use of the well characterized HRS spectrometers. Subsequently, in the proposal to PAC36, one of the HRS spectrometers was to be used to carry out the L/T separation measurements at selected kinematics to determine the longitudinal to transverse photo-absorption cross section ratio, *R*. While the idea of using the SBS for this inclusive experiment was promising, a number of detector/spectrometer related technical aspects were not addressed to a level that convinced the committee that the physics outcome of this important experiment would not be compromised due to this major change. Thus the experiment was conditionally approved again by PAC36 with the condition changed from the target issues to SBS related detector design, particle identification and background issues. For further details refer to the PAC36 report.

In their submission to PAC37 the collaboration proposed to use the existing BigBite Spectrometer (BBS) instead of the SBS. The Hall A BBS has been tested and operated in previous experiments, and is proposed to be used in its standard configuration for electron detection with some modifications to its threshold gas Cherenkov counter. The proposed modifications to the Cerenkov detector and the expected improvement are feasible. Given the change of spectrometer from SBS to BBS, all questions raised by the PAC36 report in regard to the SBS detector design become irrelevant.

The proposed luminosity for the tritium target is about $4x10^{36}/cm^2/s$, this is about 4 times compared to what was previously used with a polarized ^{3}He target and the BBS in Hall A. The BBS is proposed to be at angles larger than 42 degree where the backgrounds are expected to be negligible or tolerable based on previous BBS running experience with the exception of the existing Cherenkov detector.

- The existing Cherenkov detector in BBS will not meet the requirement of this experiment. However, it is proposed to increase the radiator length from 40 cm to 70 cm, to recoat all mirrors as well as the Winston cones just in front of the PMTs. These two improvements are expected to triple the number of

photoelectrons so that higher thresholds and ADC cuts can be applied to suppress backgrounds. Also the ADC gate will be shortened from 120 ns to 30 ns. These proposed modifications and improvements are feasible.

- Three non-standard energy settings are requested.

Issues:

None

Proposal: E12-09-005 **Scientific Rating:** A

Title: "An Ultra-Precise Measurement of the Weak Mixing Angle Using Moller Scattering"

Spokespersons: K. Kumar

The Moller experiment aims to make a precision determination of the electroweak mixing angle using a polarized 11 GeV beam in Hall A. The experiment will, in fact, provide the most precise low energy determination of the electroweak mixing angle to date, comparable in precision to the best single measurement from LEP and SLD.

The experiment was approved in PAC34, proceeded through a successful Director's review in January 2010 and is planning to embark on the first DOE physics review in the summer of 2011 with the goal of obtaining CD-0 by the end of 2011.

The PAC enthusiastically endorses the experiment and considers it one of the flagship experiments for the Jefferson Lab 12 GeV program. The PAC also recognizes that this is a technically challenging and high-risk experiment and, hence, will require substantial support. The experiment requires 344 days of running.

Proposal: PR12-10-007 **Scientific Rating:** A

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

Spokespersons: P. Souder

The SoLID collaboration proposes to measure parity violating deep inelastic electron scattering asymmetries from a proton and deuterium target over a large kinematic range using a solenoidal magnetic spectrometer. The statistical and systematic precision of the asymmetry determination will be typically on the order of a half a percent per kinematic point. The proposed experiment is more of a new program than a single experiment for several reasons. The application of the the parity violating asymmetry measurements covers four physics topics: (1) a precision measurement of the electroweak mixing angle at the same Q^2 as the NuTeV experiment (2) a determination of the u/d ratio in the proton (3) a measurement of charge symmetry violation at high x that could be relevant to addressing the NuTeV anomaly and (4) a investigation of the presence of nucleon higher twist effects in polarized electron scattering. Another reason that the approval of this experiment should be regarded as the start of a program is that other experiments are being proposed and approved using the same SoLID detector setup. Notably, two experiments using a polarized ^{3}He target have also recently been approved.

The PAC enthusiastically supports the experiment and encourages the collaboration to proceed towards the DOE review process as well as the acquisition of a high field solenoid. Since the SoLID electroweak program (polarized electron-proton scattering) is of great relevance to a future electroweak program at an EIC, the PAC encourages the collaboration to take note of this as they proceed through the review process. For example, the experiment would naturally serve as a training ground for the future electroweak EIC community.

Since the beam time allotment for SoLID has an enormous impact on the Hall A 11 GeV program, the PAC recommends that the program begin with half the proposed beam time, namely a total of 169 days. This reduction has a minimal impact on the electroweak mixing angle determination, since it is limited by systematic uncertainties, but does impact the high x studies of the d/u ratio and charge symmetry violation where the limitation is due to statistics.

Proposal: E12-10-011 **Scientific Rating:** A

Recommendation: The PAC approves the proposal contingent of 79 days

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 3 σ 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 is feasible and is well suited to the tagged Hall D photon beam. It will use the standard Hall D equipment, the GLUEx spectrometer and the forward electromagnetic calorimeter FCAL to detect the η via 2 photon decay. The only addition to the standard GLUEx setup was the proposed small PbWO4 crystal colorimeter CompCal to measure the Compton cross section parallel to the experiment to control the absolute normalization, already approved by PAC35.

Recent and ongoing theoretical developments mentioned in the updated proposal strengthen the prospects that the η width can be reliably extracted from the measurement and underline the importance of this experiment for our fundamental understanding of QCD.

Issues: The proponents have joined the GLUEx collaboration and are contributing to the infrastructure of Hall D. The collaboration has addressed in a very satisfactory manner the issue, of parallel running with GLUEx, raised by PAC35. This experiment requires running conditions different from those of the experiment GLUEx, and therefore need a separate beam time to reach the goal of measuring the $\eta \rightarrow 2\gamma$ decay width to 3% accuracy. The transition between GlueX and PRIMEX is relatively easy and should require less than one or two weeks.

Proposal: PR-11-001 **Scientific Rating:** Unrated
Recommendation: Defer

Title: "Measurement of the ratio G_E^n/ G_M^n by double-polarized ^{2}H(\vec{e},e'\vec{n}) reaction"

Spokespersons: J. Annand (contact), B. Wojtsekhowski, N. Piskunov

Motivation: The collaboration proposes to carry out a double-polarization measurement of quasi-elastic electron scattering in the ^{2}H(\vec{e},e'\vec{n}) reaction at values of negative four-momentum transfer Q^2 = 1.5, 2.0, 2.5, 3.0, 4.0 $(GeV/c)^2$ with excellent precision to determine the neutron form factor ratio G_E^n/ G_M^n by measuring the ratio of the neutron polarization components P_x/P_z. The BigBite Spectrometer (BBS) will be used to detect the scattered electrons, and the recoiling neutrons in a polarimeter consisting of plastic-scintillator analyser and the ``HCAL'' hadron calorimeter. The Super BigBite Spectrometer (SBS) dipole, a horizontal magnet ``48D48'' is proposed as the spin precession magnet and charged-particle sweeping magnet.

While we applaud the collaboration in proposing this experiment in Hall A using the recoil neutron polarimeter with the combination of BBS and SBS with excellent, proposed precision, the committee is not convinced that this experiment in its proposed four-momentum transfer region, has the high priority to justify approval for the top half of the first 5-year 12-GeV program. This statement is based on the proposed precision and kinematic reach of the already approved Hall A experiment E12-09-016 using a high-luminosity polarized ^{3}He target (which also will use the combination of the SBS and BBS), and of the proposed Hall C neutron recoil polarimeter experiment (PR-11-009). However, this proposed experiment may prove to be very valuable and important in the future, should the two aforementioned experiments at higher values of Q^2 discover something unexpected.

Measurement and Feasibility:

1) BigBite spectrometer with gas Cherenkov, trigger scintillators, and preshower-shower counter, GEM trackers.

2) Super BigBite (SBS) spectrometer (magnet, hadron calorimeter, part of the GEM tracking system).

3) Neutron polarimeter analyzer (lead shield, veto tiles, the array of plastic scintillator blocks, new components of SBS). The neutron analyzing power A_y is poorly known at the proposed energies. The collaboration plans to take analyzing power measurement in the near future at Dubna, which is highly recognized and supported by the committee.
4) Possibly, one additional set of GEM chambers (covering 40x200 cm^2) for BigBite with "fast pixel readout" and FPGA-based trigger processing electronics (to be developed).

Issues:

1) Most components of the SBS arm, such as the neutron polarimeter analyzer and the GEM trackers, as well as some BigBite components, do not exist at this time. Although there does not appear any show stopper for the experiment, this experiment is a new development with a multitude of potential technical and instrumental issues. Detailed technical reviews of the individual subsystems are warranted.

2) The spin precession through the SuperBigBite dipole has to be studied in detail to evaluate the effect of fringe fields, which can directly affect the measured quantity.

Proposal: PR-11-002 **Scientific Rating:** B+
Recommendation: Approved

Title: "Proton Recoil Polarization in the 4He(e,e'p)3H, 2H(e,e'p)n, and 1H(e,e'p) Reactions"

Spokespersons: S. Strauch, E. Brash, G.M. Huber, R. Ransome

Motivation: The proposal is motivated by the search for nuclear medium modification of the proton. Previous JLAB (E03-104) and Mainz experiments have provided an indication for such a modification by the measurement of double polarization transfer ratios for He relative to H targets. Polarization transfer in quasi-elastic nucleon knockout is sensitive to the properties of the nucleon in the nuclear medium, but is less sensitive to FSI and MEC effects compared to other methods. The present proposal is to extend these measurements to higher Q^2 and add a measurement at 1.0 GeV^2. Further, the proposal is to measure the double ratios of He to H and D to H as a function of how off-shell the struck proton is. This potentially will provide exciting new information on the origin of the EMC effect and could show conclusive evidence for in-medium modifications.

Measurement and Feasibility: The measurements will be carried out in Hall C using the HMS and SHMS spectrometers. One part of the experiment uses a 4.4 GeV beam and will add a data point in the ^{4}He to H double ratio at 1.8 GeV^2. The data point will add to the existing data and will allow a comparison of theory with and without modifications to the proton form factors. The second part of the experiment using a 2.2 GeV beam will test for medium modifications as a function of proton virtuality. In particular the comparison of ratio of D to H may show strong evidence for medium modification if the ratio varies with how off shell the struck proton is. Observation of this effect should be clear with the proposed statistics and anticipated systematic errors.

Issues: The experiment appears to be feasible and the systematic errors are reduced by the measurement of double ratios. We do not anticipate any problems for the successful completion of this measurement.

Proposal: PR12-11-003

Scientific Rating: Unrated
Recommendation: Approval

Title: "Deeply Virtual Compton Scattering on the Neutron with CLAS12 at 11 GeV"

Spokespersons: S. Niccolai, A.El Alaoui, V. Kubarovsky, M. Mirazita

Motivation: The CLAS collaboration proposes to use the CLAS12 detector to measure the deeply virtual Compton scattering (DVCS) process on the neutron. The collaboration plans to access the beam-spin asymmetry for the n-DVCS process from the quasi-free scattering process on the deuteron : e d -> e γ n (p). The measurement on the neutron will provide the necessary complement to the DVCS program on the proton and allow for a quark flavor separation of unpolarized generalized parton distributions (GPDs). In contrast to the proton DVCS result for the beam-spin asymmetry, which is dominated by the GPD H (which does not flip the helicity of the nucleon), the corresponding result for the neutron DVCS exhibits a much larger sensitivity to the GPD E (involving a helicity flip of the nucleon) – due to the small Dirac form factor of the neutron. The GPD E is of special interest as it enters into the angular momentum sum rule. The large kinematical coverage of the CLAS12 data will allow a systematic study of the predicted scaling behavior of the DVCS process, which is a prerequisite to extract the GPDs.

Measurement and Feasibility: The experiment will provide an exclusive measurement of the e d -> e γ n (p) process by detecting the electron, photon, and neutron in coincidence. The experiment will use the polarized electron beam of the upgraded 11-GeV CEBAF. The scattered electron will be measured using the CLAS12 detector. For the measurement of the photon, the collaboration studied two variants : the standard option is to use the CLAS12 inner calorimeter. An alternative is to use a forward tagger which leads to an improved missing mass resolution important in the separation of physical backgrounds (see under issues). The recoiling neutron will be measured using a newly constructed scintillator barrel central neutron detector (CND). A prototype of such a detector was already built and test measurements using cosmic rays have demonstrated the feasibility of the project. No significant technical issues were identified that would affect the experiment's feasibility.

Issues: Two issues involving the interpretation were identified. They concern a test of the quasi-free scattering approximation and the contribution of physical backgrounds. For the first it is recommended to study the comparison of the e d -> e γ p (n) process with the free proton result. For the physical backgrounds, it is recommended to provide a more realistic estimate of the background of the e p (n) -> e γ π^+ n (n) process, where the π^+ is either a soft pion or results from the DVCS process e p -> e γ Δ^+ Ideally, the possibility to detect this channel directly in CLAS would provide a strong cross-check, besides being of physics interest by itself.

Proposal: PR-11-004

Scientific Rating: Unrated
Recommendation: Defer

Title: "Hard Photodisintegration of ^{3}He into pp, pn, and pd pairs"

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

Motivation: The proposal is to continue the JLab program on hard photodisintegration of few nucleon systems, in this case Deuteron and Helium 3, at high Q^2 in the expected scaling region. In the pp and pn photodisintegration channels, the measurements will cover the cm angular range $(30\text{-}140)^o$ at fixed photon energy of 2.2 GeV, in the pd channel they will explore the s-dependence (s=13-20 GeV^2) at fixed cm-angle. The goal of the proposed experiment is to determine the mechanism of hard photodisintegration and to see if the experiment either supports the scaling behaviour dictated by the constituent counting rule (CCR) or the oscillatory behaviour of the hard-rescattering model (HRM).

Measurement and Feasibility: The proposed measurements seem feasible. This experiment is proposed for Hall A, using an existing Helium-3 target. All equipment is a standard configuration of the two HRS and beam-line base equipment including the cryogenic He-3 target and the special Cu radiator. The neutron detector HAND will be used for the detection of neutrons. This detector has been used previously in (e,e'n) measurements and its characteristics and backgrounds are reasonable well known. The incoming electron energies needed are 2.2 and 4.4 GeV.

Issues: The primary focus of this experiment is the comparison of the pp hard photodisintegration cross section at gamma ray energies of 3 and 4.4 GeV. To be conclusive it will be necessary to demonstrate that these measurements are safely in the scaling regime. The earlier huge discrepancies for pp hard photodisintegration between expectations and the results of the previous experiment E-03-101 were meanwhile significantly reduced based on new calculations. To further explore this the collaboration proposed to measure in addition to pp channel the pn channel. This, the study of the cross section as a function of alpha, and the study of the ^{3}He disintegration into d-p pairs at high Q^2 does add additional motivation for the measurements, however, the committee is not convinced that the proposed measurements with limited kinematic coverage will lead to a clear picture of the hard photodisintegration mechanism in the scaling regime. Therefore, it does not meet the criteria for approval for the top half of the first 5 years of 12 GeV operation.

Proposal: PR12-11-005 **Scientific Rating:** A-
Recommendation: Approved

Title: "Meson Spectroscopy with low Q^2 electron scattering in CLAS12"

The purpose of this experiment is the study of meson spectroscopy via quasi-real photoproduction in Hall B, using the CLAS12 detector and a new Forward Tagger facility (FT). The proposed FT will consist of an electromagnetic calorimeter, a scintillation hodoscope and a tracking device.

The experimental technique is electron scattering at very low Q^2 (between 10^{-2} and 10^{-1} GeV^{-2}), which will provide a high flux of quasi-real linearly polarized photons. The scattered electrons will be detected in the FT, whereas the produced hadronic state will be detected in the CLAS12 spectrometer. The measurement of the electron energy and scattering angle in the FT will allow the determination of the energy and linear polarization of the associated quasi-real photon.

The experiments requests 80 days of run at full luminosity ($10^{35}cm^{-2}s^{-1}$) in parallel to the already approved CLAS 12 run. In addition 39 days at low luminosity ($5\times10^{33}cm^{-2}s^{-1}$) are required for commissioning, optimization and monitoring of the new detector.

The Collaboration has addressed in a satisfactory manner the issues raised by PAC35 when the letter of intent was presented. First simulations using the isobar model have been carried out to demonstrate the capability of the CLAS12 detector to reconstruct the final states of interest and to perform the Partial Wave Analysis (PWA) essential for this kind of studies. Detailed studies of a few selected benchmark channels, for example $\gamma p \rightarrow n \pi^+\pi^-\pi^+$, have shown that the acceptance is of the order of 15 % for final states with up to four particles detected in CLAS12. PWA of simulated data have shown that a signal up to a few percent of the total intensity can be reliably identified and reconstructed in a specific wave.

The PAC acknowledges the significant progress achieved in the simulation studies of benchmark channels and PWA analysis. At the same time the PAC encourages the collaboration to further refine these studies, taking into account the full complexity of the final states of interest and extending these studies to other physics channels.

The PAC recognizes that the proposed experiment is very attractive for its complementarity to the Hall D program and for its experimental impact on the understanding of the meson spectrum and on the possible discovery of exotic mesons.

The PAC recommends the allocation of the requested beam time of 119 days: 80 days in parallel to the already approved CLAS12 program and 39 days at low luminosity.

Complementarity between Hall B and Hall D. A comprehensive meson spectroscopy program devoted to the study of conventional states as well as to the search for exotic resonances requires the measurement of many different final states with both neutral and charged particles. This is essential to maximize the probability of finding new states and, in case of new discoveries, it enhances the ability to determine the nature of these new resonances by comparing quantities like branching ratios and production mechanisms. GlueX, with its large acceptance and excellent calorimetry, will be very strong in the identification and reconstruction of channels with many particles in the final states, pure charged as well as all-neutral final states. CLAS12 will feature the ability to determine the photon linear polarization on an event-by-event basis and, with its excellent momentum resolution and pion/kaon separation, will be able to reconstruct final states consisting of charged particles and kaons.

The presence of the two experiments at JLAB, combined with a common effort in PWA, will give it the possibility to become a worldwide center of excellence in the field of meson spectroscopy.

Proposal: PR12-11-006 **Scientific Rating**: Unrated

Recommendation: C2, i.e. the PAC conditionally approves this proposal contingent on the success of the test run. It feels that the test run should be carried out as early as possible (ideally before the 6 GeV shutdown), so that the full experiment can be carried out in a timely manner.

Title: "Heavy Photon Search at Jefferson Laboratory"

Spokespersons: M. Holtrop, J. Jaros, and S. Stepanyan

Motivation: This proposal aims to search for a light vector boson, *A'*, in the broad mass region 10-1000 MeV with weak coupling of about 10^{-3}e or smaller. Such a vector boson would couple to charged leptons via mixing with the photon and could be produced by radiation of electrons in scattering or decay processes. Its decay would produce a very narrow resonance in the invariant mass e^+e^- *or* $\mu^+\mu^-$ spectrum. If the coupling is very small, the vector meson lifetime can be long enough for a displaced vertex of the particle to be detected. Because of the small coupling and small production cross-section, the JLAB electron accelerator with its extremely high intensity and large duty factor is well matched to such a search.

The proposed search is motivated in part by models trying to explain inconsistencies observed in astrophysical data and connect them with dark matter interactions. It is very interesting, probing for a possible new force that is well within the realm of credible ideas for physics beyond the standard model. Part of the plane of coupling *versus* mass of the boson has already been excluded by previous experiments, but this proposal would cover a significant region of the favored parameter space. Included in its discovery capabilities is the entire band of masses and couplings that would solve the 3.6 sigma discrepancy between theory and experiment observed in the Brookhaven muon g-2 experiment. The PAC views that particular feature of this proposal as very compelling. In fact, if the muon g-2 favored mass and coupling range turns out to be realized, a discovery would be made quickly. If a null result is obtained, a significant region of light vector boson masses will be eliminated and a currently viable solution to the muon g-2 discrepancy will be ruled out.

This experiment has the potential to make a revolutionary discovery if carried out in a timely manner. Even in the event that other experiments are completed first, this experiment has the unique capability of exploring very small couplings because of its vertexing capabilities.

Measurement and Feasibility: The envisioned experiment is very ambitious. It requires extremely high rates and is potentially vulnerable to unforeseen backgrounds. A test run is requested by the collaboration to check out the detector and its various components. The PAC concurs with the need for a test run and feels that only after a successful test run that demonstrates the needed detector capabilities, will full approval be appropriate.

The PAC also believes that the success of the test run should be at such a level that it essentially ensures that the proposed goals would be met. For example, the test run itself should be able to exclude some region in the A' parameter space. The PAC would not recommend a long investment of the Lab resources or escalation of costs coming from the potentially overly demanding specifications for the experiment.

Issues: The proposed experiment's discovery capabilities cover a very broad range of masses and couplings for a light new boson. It has significant potential for a discovery that can change our picture of particle interactions. It could possibly provide a portal for exploring dark matter properties in the laboratory. Even if a signal is not seen, the experiment will constrain the plane of new boson masses and coupling's allowed and thereby provide important new constraints on the domain of possible new physics. It would even eliminate one currently viable solution to the muon g-2 discrepancy.

Proposal: PR12-11-007 **Scientific Rating:** Unrated
Recommendation: Approval

Title: "Asymmetries in SIDIS (e,e'$\pi^{\pm}$) on a longitudinally polarized ^{3}He target"

Spokespersons: Jian-Ping Chen, Jin Huang, Yi Qiang and Wenbiao Yan

Motivation: The goal of this proposal is to carry out precision measurements of azimuthal asymmetries in charged pion production on a longitudinally polarized ^{3}He target using the SoLID spectrometer in the same setup as E12-10-006 and to provide a high precision multi-dimensional mapping of A_{UL}, A_{LT} and A_{LL} for the neutron in Deep-Inelastic-Scattering kinematics using 11 and 8.8 GeV electron beams. The full 2π azimuthal angular coverage on the ϕ_S angle (mostly relevant for E12-10-006 goals and here for A_{LT}) and the large azimuthal angular coverage on the ϕ_h of the SoLID detector are the main assets to extract for the neutron the transverse momentum dependent PDFs that describe the longitudinal-transverse spin transfer from nucleon to parton (the socalled 'worm-gear' functions). The measurements including azimuthal angular dependence in $\sin(2\phi_h)$ and $\cos(\phi_h-\phi_S)$ employ the large luminosity (10^{-36}cm^{-2}s^{-1}) to provide a very accurate mapping in 1000 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 (GeV/c)^2). The results from this experiment, combined with those of E12-10-006 will provide a wealth of information on polarization of partons in the neutron, both spin-spin transfer as well as on coupling of spin to transverse motion of quarks and contribute to our picture on the spin structure of the nucleon, for this experiment in particular information on h_{1L}^q, g_{1T}^q and on g_{1L}^q (the latter is the TMD function giving upon integration the longitudinal spin PDF, more commonly denoted Δq)

Measurement and Feasibility:
This experiment in Hall A is using solenoid spectrometer SoLID) and the polarized ^{3}He target. This apparatus is also used by PVDIS experiment. As compared to the E12-10-006 experiment the only rearrangement is the longitudinal rather than transverse polarization of the target. Also in this experiment the full 2π azimuthal angular coverage on the ϕ_S angle (for the transverse running) and the large azimuthal angular coverage on the ϕ_h angle are essential to control the systematic uncertainties in extracting different asymmetries. The data taking requires 35 days of running with a longitudinally polarized target (cf the 90 days of data taking in E12-10-006).

Issues:
As also mentioned as a consideration for E12-10-006, there is the issue of similar measurements on longitudinally and transversely polarized proton targets using one facility of JLab, which will be needed in order to achieve a comprehensive view of this topic in this kinematic domain. It is important to fully clarify this before the rating.

Proposal: PR12-11-008 **Scientific Rating:** Unrated

Recommendation: C2, i.e. the PAC declines to approve this proposal, but encourages the collaboration to purse the technical issues and return to the PAC with a full detailed proposal.

Title: "A Proposal for the Darklight Experiment at the Jefferson Laboratory Free Electron Laser"

Spokespersons: P. Fisher

Motivation: This proposal aims to search for a light vector boson, *A'*, in the mass region 10-100 MeV with weak coupling of about 10^{-3}e or smaller. Such a vector boson would couple to charged leptons via mixing with the photon and could be produced by radiation off electrons in scattering or decay processes. Its decay would produce a very narrow resonance in the invariant mass *e+e-* spectrum or possibly an invisible, missing energy, decay mode. Because of the small coupling, a very high intensity electron accelerator is needed for the experiment. The FEL at JLAB is envisioned as a potentially useful facility for such a search because of its extremely high intensity and large duty factor. This idea was previously submitted to PAC35 as a LOI and the collaboration was then encouraged to submit a more detailed proposal.

The proposed search is motivated in part by models trying to explain inconsistencies observed in astrophysical data and connect them with dark matter interactions. It is very interesting, probing for a possible new force that is well within the realm of credible ideas for physics beyond the standard model. Part of the plane of coupling *versus* mass of the boson has already been excluded by previous experiments, but the unexplored region available for the proposed experiment coincides with a domain of particular theoretical interest, because it could naturally explain the 3.6 sigma discrepancy between theory and experiment observed in the Brookhaven muon g-2 experiment. The PAC views that particular feature of this proposal as very compelling.

This experiment has the potential to make a revolutionary discovery if carried out in a timely manner. Otherwise, other less focused experiments are likely to explore this mass/coupling region first. A window of opportunity exists, but the experiment should be mounted in a timely manner.

Measurement and Feasibility: The feasibility of this measurement hinges on the utilization of the JLAB FEL as a high current source of 100 MeV electrons. Its operation in such a role presents technical and financial challenges that must be studied and addressed. Some of the issues are: How well can the beam halo profile be understood? What target would be used? What are the backgrounds in such an environment? On the detector side, a conceptual design was outlined in the proposal; but a more detailed description is needed. Overall, the discussion of the facility and detector are not developed at a full proposal level.

Issues: The proposed experiment's discovery capabilities cover a very interesting range of masses and couplings for a light new boson. It has significant potential for a discovery that could change our picture of particle interactions. It could possibly provide a portal for exploring dark matter properties in the laboratory. Even if a signal is not seen, the experiment will constrain the plane of new boson masses and coupling's allowed and thereby provide important new constraints on the domain of possible new physics.

It would even eliminate one currently viable solution to the muon g-2 discrepancy. However, to be competitive with other likely searches for the new light boson, this search must be carried out in a timely manner. Although the physics case is strong, the current proposal lacks the technical discussion needed for the PAC to judge its viability at this time.

The PAC strongly encourages the collaboration to continue the development of the proposal, including detailed studies of the FEL facility, target and detector. It also encourages JLAB to work with the advocates in developing this proposal.

Proposal: PR12-11-009 **Scientific Rating:** B+

(approved by the PAC34 as PR-09-006 but not rated by the PAC35)

Recommendation: Approved

Title: "The Neutron Electric Form Factor at Q2 up to 7 GeV2 from the reaction d(e,e'n)p via Recoil Polarimetry"

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

Motivation: It is proposed to measure the neutron elastic form factor ratio G_{En}/G_{Mn} up to values of momentum transfer squared of Q^2 = 6.88 GeV^2, exploiting the recoil polarization technique, i.e. the polarization transfer from longitudinally polarized electrons to the recoiling neutrons: $^2H(\vec{e},e'\vec{n})p$. The double-polarization technique is the method-of-choice, since it is much less susceptible to two-photon exchange corrections, which are believed to partially explain the experimental discrepancy between proton results obtained with "polarization" and the "Rosenbluth separation". Form factors are fundamental nucleon properties, and additional high precision data at higher Q^2 are important for constraining nucleon models.

This experiment is an extension of prior measurements of G_{En} from deuterium (in Hall C) up to Q^2 = 1.45 GeV^2 and will nearly provide an overlap with recent measurements of G_{En} from polarized He3 target (in Hall A) up to Q^2 = 3.5 GeV^2 *(Riordan, PRL2010).* This last published measurement and the proposed measurement realized at the same level of accuracy on He3 and deuterium respectively will allow a better control of the nuclear corrections.

This experiment is also complementary to the approved experiment E12-09-016 using polarized He3 target in Hall A. However it investigates a smaller domain in Q^2 with larger statistical errors.

Measurement and Feasibility: This experiment will be performed in Hall C, using a polarized electron beam incident on a liquid deuterium target. The scattered electron is detected in the SHMS spectrometer and the polarization components of the recoiling proton are analyzed in a newly designed neutron polarimeter (NPOL). This experiment was approved by the PAC34 but not rated by the PAC35 due to a lack of information on the redesigned neutron polarimeter. The design has been optimized. The polarimeter consists of a large vertical dipole magnet used to precess the neutron spin and an array of 218 scintillator bars for neutron analyzers and recoil proton detection. The new arrangement studied through MC simulations gives a better matching to the experiment and provides a significant improvement of the FOM.

The analysis method has been very well experienced thanks to the previous Hall C measurement in order to minimize all systematic effects. The scattering asymmetry measured in the polarimeter is obtained by a double ratio for the four possible configurations (left and right electron helicity, up and down polarimeter scattering state). The ratio G_{En}/G_{Mn} is given by the ratio of two consecutive scattering asymmetries obtained with positive and negative precessions of the neutron polarization vector.

Issues: the PAC is concerned by the limited statistics of the future measurements in order to be compared to measurements using polarized He3 target. The PAC proposed a reduction of the experiment to 50 days to perform only two measurements:

- one at a Q^2 value slightly lower than the smallest proposed one in order to provide a better overlap with the published result *(Riordan, PRL2010)*

- and one at the largest value of Q^2 (6.88 GeV^2) but with still a better statistics to be compared to the future He3 measurement (experiment E12-09-016).

The PAC is also concerned by the estimation of the neutron analyzing power A_y based a rather rough assumption on its scaling with the neutron momentum while it is poorly known at the proposed momenta. This

point deserves a clarification with dedicated measurements. This could be a joint effort with the PR-11-001 collaboration which plans to perform analyzing power measurements in the near future at Dubna. This is highly recommended by the committee.

Letters of Intent Reports

LOI 12-11-001 "Search for scalar mesons at low Q^2 using CLAS12"

The purpose of this experiment is the study of scalar mesons via quasi-real photoproduction in Hall B, using the CLAS12 detector and a new Forward Tagger facility (FT).

The proponents of this LOI plan to use the experimental arrangement detailed in the proposal PR12-11-005 and to take data during the run time allocated to that experiment. The idea is to detect scalar mesons decaying to K^0_S K^0_S, with each neutral kaon decaying to $\pi^+\pi^-$ by studying the reaction e p $\rightarrow$ e p π^+ π^- π^+ π^-, with the scattered electron detected in the FT and the four pions identified in the CLAS12 spectrometer. A preliminary analysis of this reaction using CLAS6 data shows the hint of a structure at 1.5 GeV/c^2 in the 4 pion invariant mass distribution, which might be interpreted as the $f_0(1500)$ or the $f_2(1500)$ meson. A simple Monte Carlo simulation of the decay $f_0(1710) \rightarrow K^0_S K^0_S \rightarrow \pi^+ \pi^- \pi^+ \pi^-$ shows an acceptance of the order of 5 % for this channel. They estimate to be able to collect of the order of 3000 events in this channel in the 80 run of PR12-11-005.

The proposed measurement is of great interest in the context of meson spectroscopy, and the capability to reconstruct scalar mesons via their decay to neutral kaons would add further value to PR12-11-005 experiment. However further studies are needed to assess the effective capabilities of the proposed experiment to detect and reconstruct this final state, and in particular detailed Monte Carlo simulations and PWA analysis. The background issue also needs to be addressed in a quantitative way.

The PAC encourages the proponents to continue these studies. However, given the fact that no additional beam time or equipment are requested with respect to PR12-11-005, the PAC suggests that these studies be conducted within that experiment, without the need to submit a separate proposal. *Alternatively, the proponents are encouraged to explore options for studying this final state in other experiments (e.g. GlueX).*

LOI 12-11-002 "Measurement of the Proton and Deuteron J/Ψ Electroproduction Cross Section at Threshold – A Quest of QCD Van der Waals Forces"

Motivation: This Letter of Intent proposes to explore the possibility of studying J/Ψ electroproduction near threshold at JLab in a two-phase experiment. In a first phase, the proponents intend to measure the cross section near threshold, where no sufficient experimental data is available, to probe the gluon content of the nucleon. Once the cross section is determined, the goal of the second-phase experiment is to study the J/Ψ–N interaction in electroproduction on a quasifree proton in deuterium with the kinematics optimized to maximize the J/Ψ– neutron interaction. This result will be used to test lattice QCD calculations of the scattering length or to evaluate the possible existence of nuclear-quarkonium bound states predicted as a consequence of QCD Van der Waals forces.

Measurement and Feasibility: It is proposed to use the 11 GeV beam of CEBAF12 in Hall C and to detect the scattered electrons in the SHMS, the protons in the HMS and to use a set of two calorimeters to detect the J/Ψ decay leptons in a fully exclusive measurement. Alternatively, it will be investigated to use Hall A equipment for this experiment.

Issues: The optimized solution for the experimental setup for this experiment has to be worked out. Calorimeter design studies and simulations of the signal and background rates are required.

Recommendation: the PAC is very positive about the physics objective and recommends that this Letter of Intent be developed into a full proposal to be presented to a future PAC.

LOI-11-003 "The Deuteron Tensor Structure Function b_1"

Motivation: The collaboration proposes to measure the deuteron tensor structure function b_1 by measuring deep inelastic scattering from a tensor polarized deuterium. This structure function would be zero for a deuteron with constituents in a relative s-wave. The structure function b1 can be compared with conventional calculations of quark distribution functions convoluted with nucleon momentum distributions in the deuteron including the d-state admixture. Departures from such approach, as hinted at in pioneering data at HERMES, is conjectured to be sensitive to orbital angular momentum effects.

Measurement and Feasibility: The letter of intent proposes such experiment in Hall A using an 11 GeV beam and the SoLID spectrometer. The polarized target proposed is a ^{6}LiD target. The rates in the proposal only assume tensor polarizations that have been demonstrated previously. The projected precision on the tensor structure function using SoLID is compelling to improve on the HERMES measurement at small x and extend it into the large x region. The proposed measurement will allow to map out the qualitative behavior of b1, which will serve as a benchmark for theoretical interpretations. In the appendix to the LOI, a feasibility study has also been performed for a measurement in Hall C using the HMS/SHMS spectrometers. Given the projected precision obtained, such measurement using HMS/SHMS does not seem to be compelling at this stage.

Issues: The main issue is on the theoretical interpretation of such experiment. The authors are urged to consult some theorists to provide at least some qualitative behavior of b1 when making their physics case for a proposal.

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

Letter of Intent: LOI-11-004

Title: "Semi-inclusive Deep Inelastic Scattering from Light Nuclei by Tagging Low Momentum Spectators"

Spokespersons: R. Dupré, K. Hafidi, X. Zhan, S. Dhamija, S. Stepanyan

Motivation: The letter describes a study on light nuclei for which detection of low energy recoil protons or nuclear fragments in the final state is required. The measurements should allow to test the spectator mechanism of nuclear DIS and extract information on the bound nucleon structure functions, in particular the down to up ratio (d/u) of quark distributions in a bound proton and thus explore the isospin dependence of the EMC effect.

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 described in this letter was initially described in LOI12-10-009 and has to be adapted for the requirement of the rather similar EMC experiment described in LOI12-10-008. This resulting proposal should be clearly a common project of the CLAS12 Collaboration as was stated earlier in the report for LOI12-10-009 and LOI12-10-008.

Clear progress has been achieved in this updated letter on the feasibility of this particular measurement, however, as stated in the report of LOI12-10-009 some experimental tests needs to be achieved and reported.

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

Program Status

12 GeV Approved Experiments by Physics Topics

Topic	Hall A	Hall B	Hall C	Hall D	Total
The Hadron spectra as probes of QCD (rated) (GluEx and heavy baryon and meson spectroscopy)		1		1	**2**
The transverse structure of the hadrons (rated) (Elastic and transition Form Factors)	4	2	3		**9**
The longitudinal structure of the hadrons (rated) (Unpolarized and polarized parton distribution functions)	2	2	4		**8**
The 3D structure of the hadrons (unrated) (Generalized Parton Distributions and Transverse Momentum Distributions)	3	8	4		**15**
Hadrons and cold nuclear matter (rated) (Medium modification of the nucleons, quark hadronization, N-N correlations, hypernuclear spectroscopy, few-body experiments)	1	2	5		**8**
Low-energy tests of the Standard Model and Fundamental Symmetries (rated at PAC 37)	2			1	**3**
TOTAL	**12**	**15**	**16**	**2**	**45**

12 GeV Approved Experiments by PAC Days

Topic	**Hall A**	**Hall B**	**Hall C**	**Hall D**	**Total**
The Hadron spectra as probes of QCD (rated) (GluEx and heavy baryon and meson spectroscopy)		119	0	120	**239**
The transverse structure of the hadrons (rated) (Elastic and transition Form Factors)	144	70	168		**382**
The longitudinal structure of the hadrons (rated) (Unpolarized and polarized parton distribution functions)	65	120	118		**303**
The 3D structure of the hadrons (unrated) (Generalized Parton Distributions and Transverse Momentum Distributions)	225	891	134		**1250**
Hadrons and cold nuclear matter (rated) (Medium modification of the nucleons, quark hadronization, N-N correlations, hypernuclear spectroscopy, few-body experiments)	5	100	139		**244**
Low-energy tests of the Standard Model and Fundamental Symmetries (to be rated at PAC 37)	513			79	**592**
TOTAL	**952**	**1300**	**559**	**199**	**3010**

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Charge to PAC37

1.) Review new proposals, previously conditionally approved proposals, and letters of intent for experiments that will utilize the 12 GeV upgrade of CEBAF 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, are of sufficient scientific merit that they will be included in the top half of the priority list to be established for the first 5 years of 12 GeV operations and recommend for approval.

Identify other proposals with physics that have the potential for falling into this category pending clarification of scientific and/or technical issues and recommend for conditional approval. Provide comments on technical and scientific issues that should be addressed by the proponents prior to review at a future PAC.

2.) For the 12 GeV program category “Low-energy tests of the Standard Model and Fundamental Symmetries”, review previously approved proposals (including those recommended for approval at this PAC meeting under charge element 1) and recommend a scientific rating and beamtime allocation.

The grading should be consistent with the well-established “scale” used for the scientific priorities in the past at Jefferson Lab.

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