Jefferson Lab
Thomas Jefferson National Accelerator Facility

REPORT OF THE
43rd
PROGRAM ADVISORY COMMITTEE (PAC43) MEETING

July 7 – 10, 2015

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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Jefferson Lab
Thomas Jefferson National Accelerator Facility
Exploring the Nature of Matter

July 15, 2015
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Dear Jefferson Lab Users,

This is an exciting time for Jefferson Lab, as the newly upgraded CEBAF undergoes commissioning in preparation for the first physics experiments. While there is a substantial backlog of experiments have been recommended for approval, we are only now beginning to operate the facility in order to actually execute some of these. As Laboratory Director, I am very pleased to see the continuing interest in enhancing the program of approved experiments for the 12 GeV era of CEBAF at each PAC meeting.

The Program Advisory Committee (PAC43) reviewed 8 new proposals, 7 letters of intent, and 2 parallel or run group proposals. This review resulted in 1 Conditional 1 approval, 4 Conditional 2 approvals and 3 deferrals. The results can be viewed at http://www.jlab.org/exp_prog/PACpage/PAC43/PAC43_Results_VGr.pdf.

This time the PAC clearly indicated that there were additional issues to be addressed by all the newly submitted proposals, but in some cases offered encouragement and a path to resolve these issues by recommending conditional approvals. The meeting was run very efficiently thanks to the efforts of the chair, Jim Napolitano. With the assistance of Susan Brown, the PAC was able to produce its report in very short order following the meeting. I thank Jim and the PAC for their efforts to provide expert advice to the Lab.

Sincerely,

Hugh Montgomery
Laboratory Director

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July 12, 2015

Robert D. McKeown
Deputy Director for Science
Jefferson Lab

Dear Bob,

This letter transmits the findings and recommendations of the 43rd Jefferson Laboratory Program Advisory Committee (PAC43). The Committee met July 7-10, 2015, and considered eight proposals for new beam time, two parallel run group proposals, and seven letters of intent. We also discussed some procedural issues regarding future beam time requests from CLAS12, SoLID, and any other potential "run group" situations.

Written reports on all of the proposals and letters of intent were prepared and reviewed by the Committee before we adjourned. Of the new requests for beam time, we conditionally approved one as $C1$ and three as $C2$, deferred three, and treated one as a combination of $C2$ and deferral. The $C1$ proposal was rated $A-$, but was ineligible to be considered as "high impact" because it is in Stage-I. The PAC endorsed the two run group proposals, and provided feedback on all the letters of intent.

To be sure, PAC43 held itself to a very high standard, not just for the quality of physics proposed, but also for the preparedness of the potential experiments and their incorporation of available results and existing, ongoing efforts at JLab and elsewhere. The lack of any proposals approved outright, for example, is not a reflection on the proposers, but rather the Committee's realization that CEBAF is a valuable and oversubscribed resource.

We encountered a serious issue regarding Parallel Run Group proposals, affecting CLAS12 and SoLID at this meeting. The instructions for proposal preparation for PAC43, posted December 11, 2014, clearly state the procedure by which new beam time is to be requested. One of the proposals we considered disregarded that procedure in several aspects, making it very difficult for us to decide on it. In addition, two letters of intent formulated their anticipated beam time request in a similar fashion.

The PAC urges the community to follow the guidelines set by the Laboratory for submission of proposals. The errant proposal was judged to represent highly compelling physics, so after long discussion we approved it, albeit as $C2$ with several conditions. However, these were special circumstances, where we dealt for the first time with this kind of submission, and I do not believe the PAC would react favorably again. The PAC is happy to help you in any way that we can to avoid such situations.

PAC43 was quite impressed, both with the quality of the physics program and the successful efforts of JLab to meet the needs of the Nuclear Physics community in these times of lean funding. The future of the 12 GeV program is bright, filled with exciting new physics that makes use of new ideas and emerging technologies.

On behalf of PAC43, I congratulate and thank you and your colleagues on continuing to build an outstanding nuclear physics program at Jefferson Lab. We are also grateful for the opportunity to contribute to the decision making process for allocating precious beam time.

The Committee and I are at your disposal for any other information or assistance we can give you.

Best wishes,

Jim Napolitano
PAC43 Chairperson
Professor and Chair, Temple University Physics

Introduction

The Jefferson Lab Program Advisory Committee held its 43rd meeting from July 7th through July 10th, 2015. 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 8 potential experiments: 8 new proposals, 7 Letters of Intent.

In addition the PAC held discussions regarding reassessment of scientific priorities prior to the beginning of full 12 GeV production running.

Recommendations

PAC 43 SUMMARY OF RECOMMENDATIONS								
NUMBER	CONTACT PERSON	TITLE	HALL	DAYS REQUESTED	DAYS AWARDED	SCIENTIFIC RATE	PAC DECISION	TOPIC*
PR12-15-001	N. Sparveris	Measurement of the Generalized Polarizabilities of the Proton in Virtual Compton Scattering	C	15			C2	2
PR12-15-002	B. Wojtsekhowski	The sidereal time variations of the Lorentz force and maximum attainable speed of electrons	Acc	3.5			Defer	6
PR12-15-003	B. Wojtsekhowski	Polarization Observables in Wide-angle Compton Scattering at Photon Energies up to 8 GeV	A	15			Defer	4
PR12-15-004	S. Niccolai	Deeply virtual Compton scattering on the neutron with a longitudinally polarized deuteron target	B	125			C2	4
PR12-15-005	E. Long	Measurements of the Quasi-Elastic and Elastic Deuteron Tensor Asymmetries	C	44.3			C2	2
PR12-15-006	C. Keppel	Measurement of Tagged Deep Inelastic Scattering	A	27	27	A-	C1	3
PR12-15-007	G. Petratos	Measurements of the Charge and Magnetic Form Factors of the Triton at Large Momentum Transfers	A	10			Defer	2
PR12-15-008	S. Nakamura	A study of the Lambda-N interaction through the high precision spectroscopy of Lambda-hypernuclei with electron beam	A	73			C2/D	5

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 w/PAC Review

PARALLEL PROPOSAL SUMMARY				
NUMBER	**CONTACT PERSON**	**TITLE**	**HALL**	**TOPIC**
E12-11-003A	Or. Hen	In Medium Proton Structure Functions, SRC, and the EMC effect	B	5
E12-12-006A	Z. Zhao	Timelike Compton Scattering on the proton in e^+e^- pair production with Solid at 11 GeV	A	3

Proposal Reports

PR12-15-001

Scientific Rating:

Recommendation: Conditionally approved (C2)

Title: "Measurement of the Generalized Polarizabilities of the Proton in Virtual Compton Scattering"

Spokespersons: M. Jones, A. Camsonne, M. Paolone, N. Sparveris

Motivation: The polarizabilities of the nucleon are measures of its response to external electric and magnetic fields. They basically express how easily the nucleon's charge or magnetic moment distributions can be deformed. As such they are fundamental properties of the nucleon. The proven method to access these quantities is Compton scattering, γ+N —> γ+N, where the initial photon can either be real (RCS) or virtual (VCS). Scattering of virtual photons offers the unique opportunity to probe the spatial distributions of the polarizabilities, by a Fourier transform in momentum transfer. The theoretical description of VCS is fairly involved. For the energies relevant in the present proposal the "Dispersion Relation (DR)" approach by B. Pasquini et al. is the best explored and arguably theoretically most solid method. It uses dispersion relations along with an additional asymptotic high-energy contribution that is modeled phenomenologically. DR predicts four out of the six generalized polarizabilities; the other two (scalar ones) need to be determined by experiment.

Generalized polarizabilities have been measured at MAMI (Mainz), MIT-Bates, and also at JLab. While the Q^2 dependence of data for the electric generalized polarizability from the latter two laboratories can be well described by a dipole fall-off, the MAMI data are strikingly higher than that dipole fit. A theoretical understanding of this apparent non-trivial Q^2 dependence is so far not available. Parameterizations of the form "dipole+Gaussian" are phenomenologically successful. Clearly, additional experimental information (and confirmation) is needed, which is what the present proposal aims at providing. We note that new data from MAMI have been taken in the meantime and are expected to become available soon. These will be at Q^2 values around 0.2 and 0.5 GeV^2.

Measurement and Feasibility: This experiment is planned for Hall C. The request is for 15 days (one of which is for calibration), running with a 4.4 GeV beam on a 15cm liquid hydrogen target. Scattered electrons are to be detected with the Super High Momentum Spectrometer (SHMS) and protons with the HMS. According to the proponents, the experiment could also be done in Hall A, but Hall C is better suited. The PAC emphasizes that there is a lot of prior experience at JLab with measurements of generalized polarizabilities, so that there are no concerns regarding feasibility.

Issues: The PAC wondered why a measurement at exactly the $Q^2 = 0.33$ GeV^2 value of the MAMI experiment is not planned as an integral part of this proposal. Given that the measurements at the two lowest $Q^2 = 0.43$ GeV^2 and $Q^2 = 0.52$ GeV^2 can be done within 3.5 days suggests that a measurement near $Q^2 = 0.33$ GeV^2 might well be possible. This was confirmed in the response to PAC questions, although according to the presentation to PAC this has not yet been thoroughly studied.

Summary:
The PAC is excited about this proposed measurement, but believes that it is important to see the forthcoming MAMI results before a final decision can be made. The PAC can then perform a better evaluation of the impact the proposed measurements would have.

PR12-15-002

Scientific Rating:

Recommendation: Defer

Title: "The sidereal time variations of the Lorentz force and maximum attainable speed of electrons"

Spokespersons: B. Wojtsekhowski and Y. Roblin

Motivation: The goal of PR12-15-002 is an accelerator based high precision test of special relativity by investigating the directional isotropy of the Lorentz force. At present, CEBAF is the accelerator employing the highest relativistic γ-factor allowing in principle for the most sensitive test of special relativity based on accelerated particles.

The proposal aims at using the existing dipole magnets and the existing beam diagnosis elements in the different arcs of the CEBAF accelerator in order to compare the Lorentz force in two directions (almost 180 degrees opposite), at the entrance to the arc and at the exit.

The proposal uses the connection of the speed of light (as maximum attainable relativistic speed) with the Lorentz force (so called "one-way test of Lorentz invariance").

The ratio R of the momentum measurement at the beginning of the arc to the end of the arc is the measured quantity. While it reduces largely systematic effects from energy variations, Lorentz invariance violation would manifest as a sidereal variation of R.

Measurement and Feasibility:
PR12-15-002 proposes to measure purely parasitically in parallel to any ongoing experiment and is based on existing hard- and software. In order to disentangle beam parameter fluctuations from Lorentz force variations, alignment and calibration of beam line elements like quadrupoles, beam monitors etc. is necessary. In addition, calibration and measurement of the beam transport matrix is necessary and will enable linear regression of the Lorentz force in the arc.

Issues:
While the committee is intrigued by the physics possibilities of this proposal, there are some concerns:

1. The authors should investigate and present more carefully and in detail how this proposal compares with the many other existing tests of Lorentz-Invariance.
2. No detailed run plan for the requested 80 hours of beam has been presented, which is the main reason for deferral. The committee had the impression that part of the requested beam time for the alignment of beam elements is already part of the usual machine tuning and development procedure.
3. Further analyze existing data from the upgraded accelerator to demonstrate the present limits on Delta-R/R in detail.
4. Other environmental or external effects (for example temperature variations, line power fluctuations, tidal effects, etc…) on beam feedback loop systems, electron beam phase variations, and so on, have neither been taken into account nor discussed.
5. The collaboration should investigate whether correlations with beam polarization are useful.

PR12-15-003

Scientific Rating:

Recommendation: Defer

Title: "Polarization Observables in Wide-Angle Compton Scattering at Photon Energies up to 8 GeV"

Spokespersons: B. Wojtsekhowski, A. Niculescu

Motivation: Wide-angle Compton scattering offers important probes of the structure of the nucleon. A primary goal has been to determine the dominant reaction mechanism that allows the proton to accommodate the large momentum transfer while remaining a proton. According to pQCD the three active valence quarks share the momentum transfer via the exchange of two gluons that each carry a large momentum. Expected to provide the correct description only at very large momentum transfer, this approach fails quantitatively in the kinematic regime accessed by present-day experiments. Instead, other mechanisms, including the GPD (soft overlap) mechanism or the constituent quark model (CQM) approach, both based in some form on the handbag diagram, are expected to provide a better description. All approaches make predictions for the spin asymmetries A_{LL} and K_{LL} to be observed for the process, which correlate the helicity of the initial photon with that of the initial or final proton, respectively. Both the pQCD and the GPD approach predict $A_{LL}=K_{LL}$, whereas sizable differences between the asymmetries are expected in the constituent quark model approach at large scattering angles. Two experiments have measured K_{LL}. The earlier result by E99-114 is consistent with both the GPD and the CQM predictions and once again shows that the pQCD approach is not viable in this kinematic regime. Interestingly, the very recent E07-002 result around 70 degrees scattering angle is far off all theory predictions. These results clearly motivate a study of the other asymmetry, A_{LL} , at sufficiently high Mandelstam invariants s,-t,-u. We note that PAC42 recently approved experiment E12-14-006 which will measure A_{LL} at 60 degrees and 135 degrees although at lower energy than planned for the presently proposed experiment.

Measurement and Feasibility: The experiment requests 15 days running with an 8.8 GeV electron beam. A conceptually new compact photon source is to be set up employing a 2.5T magnet. Electrons will be swept away and the photons will impinge on an NH_3 target 2m downstream. The Super Bigbite Spectrometer (SBS) will be used to detect the final-state protons, while photons are detected with the Neutral Particle Spectrometer (NPS). The PAC views the experiment as technically well thought-out and feasible.

Issues: The PAC is not convinced that the experiment's focus on measurements at various c.m. energies root(s) in a narrow range of scattering angles offers the best way of addressing the physics issues mentioned above. Clearly, in order to distinguish the GPD approach from the CQM, a measurement at larger scattering angle is more favorable, even though the Mandelstam invariant -u will on average be smaller. Also the previous measurement of K_{LL} is at larger angle (120 degrees). The experiment proposes to distinguish between GPD and CQM by measuring the slope of the asymmetry over the narrow angular range accessed. To the PAC it seems that this approach relies on the assumption of a higher precision of the theoretical predictions than they actually have.

Summary:
The PAC considers the measurement of A_{LL} to be very valuable. However, as discussed above, it feels that the present proposal does not describe the best approach of addressing the main physics issues. Clearly, coverage of a broader angular range appears necessary. That said, there is added value of going to larger energies. The PAC is impressed by the concept for a new photon source. It strongly encourages the proponents to work with the members of the previously approved E12-14-006 in order to see whether it could possibly be incorporated there. We also note that connecting with E12-14-006 would bring additional polarized target expertise.

PR12-15-004

Scientific Rating:

Recommendation: Conditionally approved (C2)

Title: "Deeply Virtual Compton Scattering on the neutron with a longitudinally polarised deuteron target"

Spokespersons: S. Niccolai, A. Biselli, C. Keith, S. Pisano, D. Sokhan

Motivation: Our knowledge of the 3D structure of the proton has progressed considerably thanks to the 6 GeV DVCS data, and will do so with the future 12 GeV proton DVCS data. In order to perform a flavor separation, also data on the neutron are mandatory. A large kinematical range must be covered to disentangle the contributions of the various Generalized Parton Distributions (GPDs) while neutron GPDs remain a mostly virgin field at this stage. The proposed experiment will provide the first ever neutron DVCS measurements of spin observables, target- and double-spin asymmetries, with a longitudinally polarized target in a wide 4-dim (Q^2, x_B, -t, ϕ) range. The data are expected to be mostly sensitive to the neutron Compton Form Factors Re(H_n) and Im(H_n), which will be extracted from a combined analysis including also neutron data on beam spin asymmetries from E12-11-003 (rated as high impact because of its sensitivity to E_n, and hence to the nucleon orbital angular momentum). It should be noted that additional exclusive measurements (hard exclusive production of mesons) will obviously complement the harvest of data simultaneously. Although not mentioned in the proposal, they will contribute to the same physics case.

Measurement and Feasibility: For 50% of the requested time, i.e. 63 days, the proposed experiment would run in parallel with the experiments aimed at g_1d and more, in RG-C (E12-06-109, E12-07-107, E12-09-007b) using the longitudinally polarized ND3 target. Thanks to the new neutron recoil detector CND, the exclusive process of neutron DVCS, e d —> e' n γ (p), can be accessed. Double Spin Asymmetry (DSA) and Target Spin Asymmetry (TSA) data will cover an important almost empty territory in neutron DVCS measurement. Although with less statistics, they will nicely complement proton data. To cover the same full t range, 62 additional days are needed. In order to increase angular acceptance the proponents consider running the experiment in a configuration where the Forward Tagger (FT) is installed in CLAS12.

Issues: The main limitation being the statistics, accented by the necessity of using a neutron detector (10% efficiency), it would be better to run without the FT to cope with highest possible luminosity, and be compatible with all other group experiments. The importance of a charge exchange process in analyzing the data should be seriously considered.

Summary:
The PAC considers such a proposal an important piece of the main physics program dedicated to the exploration and interpretation of GPDs. It can be carried out in parallel with the physics explored by RG-C (E12-06-109, E12-07-107, E12-09-007b) for 50% of the beam time requested. In that the proposal can be considered as a parallel experiment, well worth of being performed.

The PAC points out that the presentation procedure followed by this proposal is unusual. As a parallel experiment it should have been discussed and presented within the RG-C. The request of 62 additional days, independently of the other experiments in the same RG-C, is also anomalous. It should be considered in the context of creating a new run group, potentially optimizing the CLAS12 configuration for the measurement, including a possible suite of new experiments that would also make use of the additional running period.

To obtain full approval, the collaboration needs to fulfil **two conditions**. One would be the submission of a Run Group proposal, connected to RG-C, that has been fully vetted according to standard procedures in the CLAS12 collaboration. The second would be the submission of a new proposal, defining a new run group, for the extended running time, optimized for this measurement (for example with increased neutron detection efficiency), and possibly incorporating other experiments. The PAC encourages the collaboration to consider the opportunities, and looks forward to understanding the full physics potential of a new run group.

PR12-15-005

Scientific Rating: N/A

Recommendation: Conditionally approved (C2)

Title: "Measurements of Quasi-Elastic and Elastic Deuteron Tensor Asymmetries"

Spokespersons: Donal Day, Douglas Higinbotham, Dustin Keller, E. Long (contact), Karl Slifer, and Patricia Solvignon

Motivation:
The motivation of the proposed experiment is to probe short-range repulsion and tensor force in nucleon-nucleon interaction by measuring tensor asymmetries from quasi-elastic and elastic deuteron scattering - tensor asymmetries are predicted to be sensitive to the D state probability in the deuteron wave function, as well as relativistic effects. The additional proposed measurement on T_{20} will also provide data for this observable.

Measurement and Feasibility:
The proposed measurements will be carried out in Hall C using a tensor polarized deuteron target, the HMS, and the SHMS spectrometers. The proposed kinematic settings were chosen to cover both the quasi-elastic and elastic kinematics in order to provide data on T_{20} as well as calibration of the tensor polarization measurement using an existing data point from NIKHEF at low momentum transfer squared. The proposed measurements appear feasible and there are no major technical issues with the assumption that a tensor polarization of 30% or more will be achieved before the proposed experiment will run.

Issues:

The measurements, as proposed, will rely solely on positive tensor polarization due to the current UVa target setup. This has two drawbacks: (i) lower positive tensor polarization compared with the negative case; (ii) potential systematic issue associated with the ability to measure tensor asymmetries with only positive tensor polarization. The proponents are strongly encouraged to investigate techniques to obtain negative tensor polarization in addition to the positive tensor polarization. While the proposed measurements are important, the PAC believes more work is needed to demonstrate the impact of the measurements in the following two areas: (i) higher tensor polarization, particularly the negative one, should reduce uncertainties in the region that is sensitive to short-range repulsion and tensor force; (ii) provide quantitative comparison between the proposed tensor asymmetry and unpolarized measurements regarding sensitivity to the D-state probability. The NMR technique using line shape analysis for the tensor polarization determination needs to be further developed.

Recommendation:
Conditional approval (C2)

PR12-15-006

Scientific Rating: A-

Recommendation: Conditionally approved (C1) for 27 days

Title: "Measurement of Tagged Deep Inelastic Scattering (TDIS)**"**

Spokespersons: Cynthia Keppel, Bogdan Wojtsekhowski, Paul King, Dipangkar Dutta, John Annand, Jixie Zhang

Motivation:
PR12-15-006 proposes to place a Radial Time Projection Chamber (RTPC) around a target in Hall A, in order to study Tagged Deep Inelastic Scattering (TDIS). The experimental technique is to detect both the outgoing proton and electron in electron-proton and electron-deuteron scattering. The electron will be detected in the SuperBigBite spectrometer (SBS), while a proton will be detected in the new RTPC placed around a gaseous target, sensitive to protons with momenta down to ~35 MeV. Among other useful physics measurements, inclusive events in which the scatter occurs off an initial pi^0 — a component of the proton pion cloud — can be isolated by detection of the scattered proton in the final state. It is the so-called Sullivan process, according to which the tagged proton structure function F_2^T can be written as the product of the pion content of the proton (pion flux) and the pion structure function. Current measurements of the pion structure function in the high x region show an anomalously stiff x dependence which this experiment could shed light on. A similar measurement on the deuteron with two final state protons detected is potentially sensitive to the pion content of the neutron.

Measurement and Feasibility:
The actual measurement is the ratio of tagged (e N —> e p X) over untagged (e N —> e X) DIS events, which gives the nucleon tagged structure functions F_2^T. Sensitivity, particularly to the low momentum protons in the deuteron measurement, requires very low amounts of material in front of the RTPC as well as high luminosity. This drives the aggressive design of the target/RTPC system which are proposed to run at cryogenic temperatures in order to maximize the target density while eliminating thermal insulation between the target and detector volume. Likewise, the need for sufficient luminosity to explore the rare TDIS process results in high detector occupancy which drives the large channel count and data rates expected.

Issues:
While the committee is excited about the physics possibilities of this experiment and impressed by the boldness of the proposal, the PAC is concerned about the technical risk inherent in running the RTPC at cryogenic temperatures and the costs of the high channel count necessary to overcome the high occupancies necessary to achieve the luminosity goals.

The interpretation of the data must assume a dominant contribution from the Sullivan process; moreover, as such data are related to a product of the desired pion structure function and the pion flux, their interpretation has to rely on models for the pion content of the nucleon. While this might not affect the determination of the functional shape of the pion structure function, it might affect its normalization. Such an issue has to be carefully addressed.

Recommendation: C1 conditional approval for 27 days of running

We recommend that the collaboration seriously consider the tradeoffs in physics reach vs. reliability inherent in the cryogenic design and that the laboratory convene a rigorous technical review of the resulting optimized design before going forward with construction of this experiment.

PR12-15-007

Scientific Rating:

Recommendation: Defer

Title: "Measurements of the charge and magnetic form factors of the triton at large momentum transfers"

Spokespersons: A. Camsonne, A. T. Katramatou, G.G. Petratos (contact), N. Sparveris

Motivation:
This proposal aims to measure cross sections from elastic electron-triton scattering and perform Rosenbluth separations to determine the charge and magnetic form factors of the triton for a Q^2 range of 22 fm^{-2} to 45 fm^{-2} (or 0.86 GeV^2 to 1.75 GeV^2) with high precision. These proposed measurements together with data from JLab on the ^{3}He charge and magnetic form factors in similar four-momentum transfer squared region would complete the picture for three-body systems, and allow for the separation of the isoscalar and isovector contributions to these form factors. As such they would provide sensitive tests of the state-of-the-art three-body calculations, and further advance our knowledge about the few-body systems.

Measurement and Feasibility:
The experiment can be performed in the JLab Hall A Facility using the two High Resolution Spectrometers, and the tritium target that is under construction for other approved 12-GeV experiments. For the forward scattered electrons, the e' would be detected in the Left HRS in coincidence with recoil tritons in the Right HRS. For the backward electron scattering, recoil nuclei would be detected at forward angles in the Right HRS, but only about 20% of the e' would be measured in the Left HRS, requiring to identify tritons by TOF provided by a thin scintillator and beam RF signals. Five beam energies would be needed to do the Rosenbluth separation, three of which are at non-standard energies.

Issues:

1) There was no discussion of systematic uncertainties. It was pointed out, however, that the data would be statistics limited over the entire kinematic range and that systematic uncertainties even at the 4% to 5% level would not limit the interpretation of the results.
2) There was a brief discussion of two-photon exchange corrections. Preliminary theoretical calculations revealed that the two-photon exchange corrections are at a level of 10%, and the effect on the Rosenbluth separation needs to be carefully evaluated.
3) The proposal claims to be able to separate isoscalar and isovector contributions to the meson-exchange current mechanism. No convincing case has been made in this proposal however to cleanly disentangle those contributions.

Summary: The PAC notes that there is a unique opportunity for studying the three-body system with the availability of a tritium target at Jefferson Lab, which would provide sensitive tests of state-of-the-art calculations. However, the PAC is concerned that the proposal may be too optimistic about its ability to disentangle the theoretical contributions to the electromagnetic form factors. It would be necessary to demonstrate how the proposed measurements would improve our understanding of nuclear effects on the electromagnetic elastic form factors. The PAC is not convinced that the selected distribution of kinematic coverage and statistical precision is optimized for clarifying the theoretical uncertainties.

Furthermore, the comparison with old data from SLAC and Saclay has been performed without applying the necessary and substantial two-photon corrections. It is not clear how the overlap and consistency check with old data can be achieved by the present choice of kinematical coverage. The PAC is also not convinced that the 10%-20% corrections over existing calculations, which might be achieved with the data set proposed here, are of sufficient scientific merit to warrant the 10+ days of running time. This is compounded by the fact that after the 12 GeV upgrade, large efforts would have to be invested by the accelerator group to tune for non-standard low energy beam, since they are confronted basically with a new machine.

PR12-15-008

Scientific Rating:

Recommendation: Conditionally approved (C2)

Title: "A study of the ΛN interaction through the high precision spectroscopy of Λ-hypernuclei with electron beam"

Spokespersons: S. Nakamura (presenting), F. Garibaldi, P.E.C. Markowitz, J. Reinhold, L. Tang, G.M. Urciuoli

Motivation: The recent discovery of 2 solar mass neutron stars presents a fundamental and fascinating challenge to the nuclear physics community. Utilizing only ΛN forces, in addition to standard NN and NNN forces, nuclear matter calculations indicate that neutron stars cannot have such large masses. The next level of complication in the nuclear many-body theory would be to invoke a repulsive hypernucleon three-body force, a ΛNN force. This can be done in a systematic way through the use of effective field theory techniques and can also be justified through standard NNN force formulations such as those followed to obtain the Illinois three nucleon potentials.

This proposal describes several areas of hypernucleon physics that could be investigated through the production and investigation of hypernuclei. The main measurements included a reinvestigation of the charge symmetry breaking (CSB) term in the three-body ΛNN force; an investigation of the binding energies of medium mass hypernuclei, including ^{40}ΛK and ^{48}ΛK; and an investigation of a heavy hypernucleus such as ^{208}Pb. The proposal also described a potential measurement of ^{3}Λn and ^{3}ΛH as a way to confirm the existence of a bound ^{3}Λn system, recently obtained at GSI (Phys. Rev. C88, 041001 (2013)).

Measurement and Feasibility: The experimental setup requires a combination of the HRS and HKS spectrometers. While there is a large lead-time associated with preparing for the experiments, no new equipment is required. Requested beam time for the main experiments discussed in the presentation is 147 hours for calibrations, 346 hours to test the CSB, 272 hours to investigate the ground states of ^{40}ΛK and ^{48}ΛK, 642 hours to measure the ground state of ^{208}ΛTl. The nnΛ re-measurement requires 130 hours.

Issues: The PAC views the most compelling science presented as the measurements of binding energy of the medium mass nuclei ^{48}ΛK and ^{40}ΛK. It is these measurements, along with the calibration measurements, that are conditionally approved. The PAC believes there should be a strong connection between understanding the ΛNN force and the 2 solar mass neutron star observations. However, the science case even for these measurements still needs refinement, and the connection has not been well articulated. Theoretical calculations are possible in the 40,48 nuclei, as well as in neutron matter. While AFDMC (Pederiva et al, arXiv:1506.04042) calculations have been performed with simplified interactions (AV4' + one term in UIX, and a ΛN and ΛNN interaction), a more complete picture may be feasibly obtained. Even using the simplified interaction in AFDMC, the calculations indicate that the tensor parameter could be well constrained by a measurement of BΛ in an asymmetric nucleus. This argument should be strengthened and explored, possibly by a workshop. The PAC believes the collaboration would benefit from a more integrated theoretical effort in this area.

Summary:
The collaboration should submit an updated proposal to study ^{48}ΛK and ^{40}ΛK along with a stronger theoretical connection to neutron star physics.

The PAC is not convinced that measurements of the A dependence of BΛ will provide meaningful input to theoretical calculations of the equation of state for neutron stars. Therefore the ^{208}Pb measurements and other parts of this proposed work, including CSB efforts, are deferred. Completely new proposals would need to be submitted to the PAC in order to address these additional physics topics.

Run Group Proposals

E12-11-003A

Title: "In Medium Proton Structure Functions, SRC, and the EMC Effect"

Spokespersons: Or Hen**,** L.B. Weinstein, E. Piasetzky, H. Hakobyan

Motivation: Study the proton structure function when the proton is in a deuterium nucleus as function of the kinematics of the spectator neutron. If the EMC effect is influenced by short range correlations, the size of the effect should be detectable as a function of the neutron kinematics.

Measurement and Feasibility: This proposal would join several Hall B run groups running on deuterium targets with the CLAS12 detector. It will study in-medium proton structure functions in the deuteron by measuring the process $d(e,e'n_s)X$ and tagging the outgoing electron and neutron. It is complementary to the Hall C experiment E12-11-107 that will measure in-medium neutron structure functions using proton tagging. In principle, one can disentangle FSI effects by measuring the EMC effect slope between different x values but at common values of recoil momentum, but the collaboration should work towards a clearer justification of this statement.

No additional run time is requested but the collaborators will add a backward neutron detector (BAND) made up of four layers of scintillation counters arranged in petals around the beam direction. Timing resolution of 200 ps is anticipated. The CLAS12 collaboration has reviewed this addition and approves.

Issues: none

Summary: This experiment represents a strong addition to the existing scientific program in Hall B.

E12-12-006A

Title: "Timelike Compton scattering on the proton in e+e- pair production with SoLID at 11 GeV"

Spokespersons: Boer, Mkrtchyan, Nadel-Turonski, Tadevosyan, Zhao

Motivation: The experiment aims at testing the universality of Generalized Parton Distributions, via the extraction of Compton Form Factors (CFFs). By using Timelike Compton Scattering (TCS), $\gamma p \rightarrow \gamma^* p' \rightarrow e^+e^- p'$, as an alternative to the space like DVCS, it will explore factorization and higher twist effects.

Measurement and Feasibility: Using the 11 GeV polarized beam, an LH2 target and the SoLID detector, the exclusive production of $e^+ e^-$ will be studied. Beam spin asymmetries with circularly polarized photons, differential cross-sections and moments of weighted cross-sections for the TCS reaction will be measured in bins of t, Q2 and skewness η, to access both imaginary and real parts of CFFs.

The experiment is proposed to run in parallel with E12-12-006, approved for 60 days, but requires additional installations:

1. Scintillator pad detectors (SPDs) in both forward and large angle regions
2. Modifications of the trigger conditions compared to E12-12-006

Issues: TAC questions the compatibility of this experiment with the approved E12-12-006 with regard to trigger (higher level needed), DAQ (40 kHz needed instead of 1kHz), and other running conditions (e.g. variable calorimeter threshold). Indeed, the TAC report on E12-12-006a brings up some questions on modifications needed to run E12-12-006a and suggests that combining it with E12-12-006 could affect scheduling.

At the PAC meeting, however, SoLID management argued that these issues are mitigated by recent design developments regarding the Level-3 (L3) trigger.

Questions arose during the presentation regarding background processes that would contribute to this untagged bremsstrahlung measurement, but the collaboration seems to be aware that better background simulations need to be worked out.

A theory/spectroscopic issue was discussed, concerning contributions to the e^+e^- continuum from broad vector mesons in the 2-3 GeV mass region.

Summary: The PAC endorses this as a run group proposal, in parallel with E12-12-006. Successful operation of the L3 trigger is critical for running this experiment at an acceptable data rate.

Letters of Intent

LOI12-15-001

Title: "Physics Opportunities with a Secondary K_L Beam at JLab"

Spokespeople: M.J. Amaryan,

Motivation: To study kaon initiated hyperon physics, including hyperon spin from polarized targets and Cascade and Omega spectroscopy. The argument for doing this at JLAB is that a photon-generated neutral kaon beam has a lower neutron contamination than a proton-generated beam.

Measurement:
The proposal is to add a Be target in the photon beam 16 m upstream of the main GlueX target to photoproduce kaons. The Be target is followed by a sweeping magnet and a lead dump for the remaining photons. This would produce neutral kaon rates of $2x10^3$ - 10^4 Hz, which are higher than LASS at SLAC but substantially lower than the > 10^5 Hz rates at similar energies in the proposed JPARC higher energy charged kaon beams. The beam request is for 10 days.

Issues:
It is not clear what this experiment can do that the JPARC charged kaon program cannot do substantially better.

An experimental concern is the transverse size of the K_L beam that must impinge on a 2-3 cm target. Backgrounds from neutrons and K_L outside the target acceptance may be important in event rates and signal to background rejection.

Recommendation:
Any proposal would require a full simulation of the beam line and detector to determine the effect of backgrounds from neutrons and kaons outside the target acceptance. But it is not clear to the committee if this experiment would in any way be competitive with JPARC or a potential Fermilab or CERN program in this energy range. The superiority of a neutral beam and/or the GlueX detector for these measurements would need to be demonstrated before a future proposal would be considered favorably.

LOI12-15-002

Title: "Compton Edge probing basic physics at JLab: light speed isotropy and Lorentz invariance"

Contacts: V. Gurzadyan and D. Gaskell

Motivation: Test of the isotropy of the one-way speed of light. The constancy and the direction-independence of the speed of light is of such fundamental importance that their high-precision tests are of importance in their own right. The proposed measurement has the potential to improve on a similar experiment (GRAAL) at the European Synchrotron Radiation Facility at Grenoble which used a 6 GeV electron beam. It is noted that the GRAAL data were indicative of some azimuthal dependence, but not at a statistically significant level. A factor of 4 improvement in precision would help to clarify its origin.

Measurement and Feasibility: The experiment would run in Hall A using the 11 GeV CEBAF beam intersecting a monochromatic laser beam and can probably be performed with the existing Compton polarimeter possibly with minor modifications. Another option is to develop a new detector. The main amount of data could be obtained working in parasitic mode, *i.e.* in this stage no dedicated beam time is required. Some of the authors of this LoI participated in the 2008 GRAAL experiment providing confidence that sufficient expertise and experience would be available for a successful experiment at JLab.

Issues: The LoI offers as additional theory motivation the observed acceleration of the universe, dark matter, the search for B-mode polarization in the cosmic microwave, etc., but the connections to Lorentz-invariance violation (LIV) are not clear. Also, LIV is not strictly predicted from string theory. As pointed out in the TAC report the need for some hardware changes to the Hall A Compton polarimeter to improve accuracy is expected, but that could benefit polarimetry as well.

Recommendation: The PAC encourages the submission of a full proposal. It should be shown there that the available 6 GeV running data are reflective of the factor of five improvement in energy resolution expected at JLab relative to GRAAL. The physics motivation should be laid out more carefully, including comparisons, where possible, to other tests of LIV. The PAC seconds the TAC report's recommendation of simulations to determine limits that can be extracted with the existing Compton polarimeter and the minimal modification that would improve the measurement.

LOI12-15-003

Title: "Measurements of the Ratio G^n_E/G^n_M by the Double-Polarized $^2H(e_{pol},e'n_{pol})$ Reaction"

Spokespersons: J. Annand, V. Bellini, N. Piskunov, B. Wojtsekhowski

Motivation:
The motivation is to measure the neutron form factor ratio G^n_E/G^n_M up to a Q^2 value in excess of 9 $(GeV/c)^2$ by measuring recoil neutron polarization from polarization transfer of longitudinally polarized electron to the neutron from quasi-elastic $^2H(e,e'n)$ reaction**.** This form factor ratio, together with the upcoming neutron magnetic form factor values in a similar momentum transfer range from the approved 12-GeV experiments, will allow for the determination of the neutron electric form factor from the deuteron up to a Q^2 value of 9.3 $(GeV/c)^2$.

Measurement and Feasibility:
The proposed measurements will be carried out in Hall A using the BigBite spectrometer for electron detection, and a neutron recoil polarimeter consisting of mainly a polarization analyzer, and hadron calorimeter (HCal). In addition the 48D48 dipole magnet is proposed as part of the experimental setup to process the spin of the recoil neutron from longitudinal to vertical direction. The proposed neutron polarimeter will aim at improving the figure-of-merit from the existing one by a factor of ten utilizing the charge exchange n-p process, that is important for neutrons with momentum higher than 3 GeV/c. The experiment will utilize some components of SBS.

Issues:
The TAC raised a number of issues including high rate for the DAQ and backgrounds in the neutron arm. The proposed method in general is the same as what is proposed in the already approved E12-11-009, and the proposed improvement in the FOM of the recoil neutron polarimeter if demonstrated will benefit E12-11-009. There is also an approved Experiment E12-09-016 using a polarized ^3He target which allows for an extraction of the neutron electric form factor in excess of Q^2=10 $(GeV/c)^2$. While the PAC believes in the importance of extending the G^n_E determination from the deuteron to a Q^2 value comparable to that of E12-09-016, the PAC does not believe there should be parallel efforts in pursuing the same experimental technique.

Recommendation:
The proponents are encouraged to work with the lab management and the E12-11-009 collaboration to improve the FOM of the recoil neutron polarimeter in order to optimize the measurements using the already approved beam time of E12-11-009.

LOI12-15-004

Title: "Search for Hybrid Baryons with CLAS12 in Hall B"

Contactpersons: Volker Burkert

Motivation: This letter of intent proposes an extension of the ongoing N* program at CLAS12 and aims to discover hybrid baryons, namely baryons whose internal structure contains an excitation of the gluon field as well as the required quarks. QCD allows for the existence of baryons with dominant gluonic contributions (hybrid baryons), and Lattice QCD calculations now predict several baryon states with dominant gluonic admixture to the wave function, and with the lowest mass hybrids in the range W = 2.2-2.3 GeV. At variance with the meson sector, hybrid baryons have quantum numbers that are also populated by ordinary excited 3-quark states and their identification is difficult.

Measurement and Feasibility: In the LoI the focus is on the lowest mass hybrid baryons electroproduced on protons with possible signatures:

- resonance with I=1/2, J^P=1/2+ or 3/2+
- masses in the range 2<W<2.5 GeV
- specific Q^2 dependence of the helicity amplitudes.

To cover the low Q^2 range and to collect the statistics needed for the partial wave analysis, the first estimate of beam time is 20 days at 6.6, 40 at 8.8, 60 at 11 GeV, the last possibly in parallel with another approved experiment. This program would complement that of the already approved experiments E12-09-003 and E12-06-108A addressing a topic of great importance in QCD and the Collaboration already has much experience in the field.

Recommendation:
The PAC encourages the preparation of a full proposal. However, we emphasize that the 11 GeV running should be put forward as a **Run Group Proposal**, if it is indeed to run in parallel with other approved experiments. Further, the additional beam time at 6.6 and 8.8 GeV must be considered as a **separate proposal** that may include other measurements that could be carried out with the additional beam time.

LOI12-15-005

Title: "Measurement of Double Deeply Virtual Compton Scattering (DDVCS) in the di-muon channel with the SoLID spectrometer."

Spokespersons: Boer, Camsonne, Voutier, Zhao

Motivation: The DDVCS, or DVCS producing a virtual photon, aims at investigating in a non-correlated way the x and ξ dependences of the GPDs, as opposed to DVCS exploring x=ξ. Being sensitive to the so called D term, this region is relevant for studying the transverse parton densities and the distribution of nuclear forces.

Measurement and Feasibility: Using the 11 GeV polarized beam, an LH2 target, the SoLID spectrometer, and adding the CLEO II muon chambers for the di-muon detection, the e p → e p γ* → e p μ+ μ- reaction will be studied. The experiment would run for the first 50 days in parasitic mode to the SoLID J/ψ experiment E12-12-006. It would then run 90 days on its own at 10 times higher luminosity and with a specific detector configuration (using the PVDIS target and adding trackers and the SBS-BT-GEM) to investigate larger Q2 and x_B.

With the CLEO II muon chambers, the parasitic mode looks quite feasible and should also improve the original experiment.

Issues: The TAC encourages the first step of parasitic mode, with the interesting idea of reusing CLEO II muon chambers, but judges discussion on second step premature. The TAC also notes that additional resources are needed for more electronics.

The theory report points out that one should be sure that the muon pair is not produced from a meson decay in the reaction γ* p → M p → μ+ μ- p; for this one must be well above the resonance region and have sufficient statistics for a reliable extraction of a non resonant signal.

Summary: The PAC endorses the phase of this experiment that would be in the run group led by E12-12-006, which is at a lower luminosity than the second phase.This run would be enough to demonstrate operation of the muon system and observe the reaction, albeit at relatively low Q2. Consideration of this phase **will still require a run group proposal**, vetted by the SoLID collaboration using whatever are the appropriate internal means. **The second, high luminosity, phase must be considered as a separate proposal**, along with whatever other physics goals might be achieved in the new run group defined by this high luminosity configuration.

LOI12-15-006

Title: Study photoproduction of ω mesons on nuclei with the GlueX detector

Spokespersons: Alexander Somov, Sergey **Gevorgyan** (**contact**), Eugene Chudakov

Motivation:
This LOI proposes to look at ω photoproduction on nuclear targets to determine the cross section for transversely polarized ω 's through coherent photoproduction, and for longitudinally polarized ω 's through incoherent photoproduction. The physics goal is to confirm whether the interaction of a vector meson, such as a ρ or ω, whose constituents have non-zero orbital angular momentum is correlated with its polarization. The advantage of ω photoproduction off nuclei is that it can proceed through Pomeron exchange (i.e. vacuum quantum numbers) which produces transversely polarized ω's, or through one-pion exchange producing longitudinal polarized mesons.

Measurement and Feasibility:
The experiment can be performed in the JLab Hall D Facility using the GlueX detector and 4 targets (C, Al, Cu and Pb). The proposed measurement seems to be feasible with the assumption that it can be run with the GlueX detector.

Issues:

- Beam currents need to be reduced to 10 nA to bring coincidental rates (originating from different events) to manageable levels. It will be important to carefully study the details of carrying out such a measurement and present the results from a tradeoff study with beam flux and target thickness.
- The choice of A was not addressed specifically. It should be considered to run with isoscalar targets to possibly eliminate the one-pion exchange process.
- It should be considered to extend the analysis to φ mesons as well.

Recommendation:
Given that useful information may already be gleaned from scattering off the endcaps of the GlueX H_2 target, we encourage the proponents to perform parasitic measurements before submitting a formal proposal. If indeed interesting information can be extracted, the proponents are encouraged to perform a more comprehensive study, and move forward with the development of a full proposal for review by a future PAC.

LOI12-15-007

Title: "Timelike Compton Scattering on the transversely polarised proton at 11 GeV"

Spokespersons: A. Mkrtchyan, V. Tadevosyan, P. Nadel-Turonsky, M. Boer

Motivation: This LOI proposes to study Timelike Compton Scattering (TCS) on a transversely polarized proton with quasi-real photons, gamma p —> gamma* p' —> e+ e- p'. It would be the first ever measurement of this process with a transversely polarized target (NH3). Several spin asymmetries can be measured which give access to Compton Form Factors and GPDs. In particular information on he Imaginary part of H tilde and E could be obtained. As the amplitudes for the usual Deeply Virtual Compton Scattering (DVCS) and the TCS are, at leading order, complex conjugate, their universality can be tested.

Measurement and Feasibility:
The photons are circularly polarized, so that there can be several asymmetries to be measured: the beam spin asymmetry, the target (transverse) spin asymmetry and the double spin asymmetries. They are mainly generated by the interference between the TCS and the Bethe-Heitler amplitudes. Predictions are given, without any indication of the expected errors, adopting a particular model for the GPDs. This experiment is complementary to the approved CLAS12 experiment E12-12-001, which operates with a polarized photon beam on an unpolarized hydrogen target and to the Hall A experiment E12-12-006A, with a polarized photon beam on an unpolarized LH2 target. This experiment requires the cryogenic UVA ammonia polarized target in transverse mode. It also requires lepton detectors (e^+,e^-) which are new, though based on Neutral Particle Spectrometer technology and recoil proton hodoscopes and trackers which would also be new (as stated in the TAC technical report).

Issues:
The TAC technical report shows doubts about the performance of the magnets that the Collaboration seems to be going to use. Some of the observables, their relation with the Compton Form Factors and the GPDS are not well described and illustrated.

Recommendation:
The Collaboration should present the novel aspects of their measurements more convincingly, in comparison with the other approved experiments; they should carefully address the points raised by the TAC report and fully describe the procedure for the extraction of the GPDs.

Program Status

12 GeV Approved Experiments by Physics Topics

Topic	Hall A	Hall B	Hall C	Hall D	Other	Total
The Hadron spectra as probes of QCD (GluEx and heavy baryon and meson spectroscopy)		1		3		4
The transverse structure of the hadrons (Elastic and transition Form Factors)	5	3	2	1		**11**
The longitudinal structure of the hadrons (Unpolarized and polarized parton distribution functions)	2	3	6			**11**
The 3D structure of the hadrons (Generalized Parton Distributions and Transverse Momentum Distributions)	5	9	7			**21**
Hadrons and cold nuclear matter (Medium modification of the nucleons, quark hadronization, N-N correlations, hypernuclear spectroscopy, few-body experiments)	6	3	7		1	**17**
Low-energy tests of the Standard Model and Fundamental Symmetries	3	1		1	1	**6**
TOTAL	**21**	**20**	**22**	**5**	**2**	**70**

12 GeV Approved Experiments by PAC Days

Topic	Hall A	Hall B	Hall C	Hall D	Other	Total
The Hadron spectra as probes of QCD (GluEx and heavy baryon and meson spectroscopy)		119		540		**659**
The transverse structure of the hadrons (Elastic and transition Form Factors)	145.5	85	102	25		**357.5**
The longitudinal structure of the hadrons (Unpolarized and polarized parton distribution functions)	65	230	165			**460**
The 3D structure of the hadrons (Generalized Parton Distributions and Transverse Momentum Distributions)	409	872	212			**1493**
Hadrons and cold nuclear matter (Medium modification of the nucleons, quark hadronization, N-N correlations, hypernuclear spectroscopy, few-body experiments)	180	175	201		14	**570**
Low-energy tests of the Standard Model and Fundamental Symmetries	547	205		79	60	**891**
TOTAL	**1346.5**	**1686**	**680**	**644**	**74**	**4430.5**

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Charge to PAC43

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.

    a. Identify proposals with high-quality physics that, represent high quality physics within the range of scientific importance represented by the previously approved 12 GeV proposals and recommend for approval.
    b. Also provide a recommendation on scientific rating and beam time allocation for proposals newly recommended for approval.

2. 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.

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