

46th PROGRAM ADVISORY COMMITTEE (PAC46)

July 16, 2018

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From the Director



July 24, 2018

Dear Jefferson Lab Users,

It was a real pleasure to see the new and exciting experimental proposals from our user community at last week's Program Advisory Committee (PAC46) meeting. The quality of these proposals is an indicator of the forefront scientific program that Jefferson Lab enables for its users, and this PAC was no exception.

The PAC reviewed 5 new proposals, 1 of which was a new run group proposal. In addition, there were 2 conditionally approved proposals returned for review, 5 Letters of Intent were submitted and 2 Run Group Addition proposals. This review resulted in the approval of the 2 returning conditionally approved proposals, conditionally approved 1 of the new proposals and deferred a total of 4 new proposals.

The meeting was run very efficiently thanks to the efforts of the chair, Jim Napolitano. With the assistance of Susan Brown, the PAC was again able to produce its report in very short order following the meeting. I thank Jim and all the PAC members for their efforts to provide expert advice to the Lab.

Sincerely,

Stuart Henderson
Laboratory Director

From the Chair



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July 19, 2018

Robert D. McKeown
Deputy Director for Science
Jefferson Lab

Dear Bob,

This letter transmits the findings and recommendations of the 46th Jefferson Laboratory Program Advisory Committee (PAC46). The Committee met July 16-19, 2019. We considered seven individual proposals and one Run Group Proposal for new beam time; two parallel run group additions; and five letters of intent. We are pleased to say that we continue holding to high standards for approving proposals.

The PAC congratulates the user community and the laboratory on demonstrating first analysis results from beam time in the 12 GeV era. This is a wonderful achievement for Nuclear Physics, and a testament to the hard work and dedication of everyone involved. We look forward to continued success, and dissemination of new results, and the PAC is happy to take this progress into consideration at future reviews.

Written reports on the proposals and letters of intent were prepared and reviewed by the Committee before we adjourned. We approved a Stage I proposal that was conditionally approved by PAC44. We also approved, and combined into a new CLAS12 Run Group, a proposal conditionally approved by PAC45 and a new proposal to PAC46. In addition, we conditionally approved a new proposal for Hall C. Four proposals were deferred. We also endorsed two Run Group Additions, one each for CLAS12 and SoLID. Details of these recommendations are in the written reports, but we are of course happy to further explain or clarify our reasoning if you request.

As started at PAC45, the JLab User BoD Chair now has a special role in the PAC. Sitting in on all discussion, the BoD Chair is in a position to explain to the users how proposals are discussed and recommendations are reached. They also represent the User Community's interests to the PAC. Prior to the meeting, the BoD Chair made a special effort to ensure good communication between the proposal contact persons and assigned readers. This new role has worked out well for everyone, and we would like to see the practice continue.

There is one particular issue that we want to bring to your attention. We understand that the GlueX Collaboration enjoys a symbiosis with the Hall D staff and the Laboratory, that is rather different in character to the collaborations in the other Halls. We also realize that this symbiosis has led to an especially productive period of commissioning and initial data taking. On the other hand, it is difficult for the PAC to see the future evolution of the Hall D program, which would provide context for reviewing new proposals that are beyond the scope of the currently approved beam time.

Therefore, we would like to suggest that the GlueX collaboration and Hall D leadership develop a vision for the future of Hall D. A brief White Paper that discusses the options and provides guidance for the PAC, would be particularly useful.

Finally, we were glad to discuss Jeopardy scenarios with you. The PAC looks forward to a thorough review of any experiments that come before us, in addition to considering any new proposals and letters of intent. We agree that it will take further discussion to manage the work load to the PAC, but I am confident that we can arrive at a plan that completes the PAC's on site work within the business week. This plan will naturally be drawn up in collaboration with the Users Group Board of Directors.

The PAC is at your disposal for any other information or assistance we can give you. Congratulations to you, Jefferson Lab, and the User Community on continued success.

Best wishes,

A handwritten signature in black ink that reads "Jim Napolitano". The signature is written in a cursive, slightly slanted style.

Jim Napolitano
PAC46 Chairperson
Professor and Department Chair
Temple University Physics

Introduction

The Jefferson Lab Program Advisory Committee held its 46th meeting from July 16th through July 19th, 2018. The membership of the committee is given on pages 28-29. In response to the charge (page 30) from the JLab Science Director, Dr. Robert McKeown, the committee reviewed 2 returning C2 proposals, 6 new proposals, 2 run group additions, and 5 Letters of Intent.

Recommendations

PAC 46 SUMMARY OF RECOMMENDATIONS								
NUMBER	CONTACT PERSON	TITLE	HALL	DAYS REQUESTED	DAYS AWARDED	SCIENTIFIC RATE	PAC DECISION	TOPIC*
C12-17-006	Or Hen	Electrons for Neutrinos: Addressing Critical Neutrino-Nucleus Issues	B	25.5	45	A	Approved	5
12-17-006A PR12-18-003	Or Hen	Exclusive Studies of Short Range Correlations in Nuclei using CLAS12	B	38				
C12-16-001	Marco Battaglieri	Dark matter search in a Beam-Dump eXperiment (BDX) at Jefferson Lab -- 2018 update to PR12-16-001	A	285	0	A	Approved	6
PR12-18-001	Alexander Somov	Photoproduction of vector mesons on nuclei with GlueX detector	D	28			Deferred	5
PR12-18-002	Moskov Amaryan	Strange Hadron Spectroscopy with Secondary KL Beam at GlueX	D	200			Deferred	1
PR12-18-004	Franco Garibaldi	Studying Lambda interactions in nuclear matter with the $^{208}\text{Pb}(e,e'\text{K}^+)^{208}\text{Tl}$ reaction.	A	35			Deferred	5
PR12-18-005	Marie Boer	Timelike Compton Scattering off a transversely polarized proton	C	35			C2	4
PR12-18-006	Jan Bernauer	DarkLight: Search for New Physics in e^+e^- Final States Near an Invariant Mass of 17 MeV Using the CEBAF Injector	Inj	55			Deferred	6

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*
E12-11-108B/E12-10-006D	Zhihong Ye	K^\pm Production in Semi-Inclusive Deep Inelastic Scattering using Transversely Polarized Targets and the SoLID Spectrometer	A	4
E12-11-003B	Yordanka Ilieva	Study of J/psi Photoproduction off the Deuteron	B	5

Proposal Reports

C12-16-001

Scientific Rating: A

Recommendation: Approve

Title: Dark matter search in a Beam-Dump eXperiment (BDX) at Jefferson Lab – 2018
update to PR12-16-001

Spokespersons: M. Battaglieri (contact), A. Celentano, R. De Vita, G. Krnjaic, E. Smith, M. De Napoli

Motivation: The BDX proposal aims to set up a parasitic experiment for the detection of a light dark matter particle in the range of MeV to several GeV with segmented CsI (Tl) scintillation detector behind the beam dump of Hall A. BDX looks at hidden (or invisible) decays of the dark photon A' , i.e. radiative pair-production of light dark matter particles, which then interact in the detector by elastic or inelastic χ -electron and possibly χ -nucleon scattering.

Measurement and Feasibility: This is a requested update that includes work by the BDX collaboration concerning the following issues identified by PAC44:

- Results from a dedicated experimental test to assess the beam-on background by measuring the muon flux downstream of the Hall A beam dump. A sampling calorimeter detector based on BaBar CsI(Tl) crystals with modern type SiPM readout has been built and used in the test measurements as a prototype for a detector module in the BDX experiment. It had been inserted into vertical wells drilled at different transverse locations downstream of the beam dump. The analysis of transverse shape variables will allow reduction of background from rescattering.
- In addition, the collaboration has extended the existing simulations based on GEANT4 to FLUKA. Several high statistics simulations of beam backgrounds have been performed to evaluate the impact of irreducible backgrounds, including charge and neutral current neutrino interactions. Quantitative agreement concerning muon flux rates and spectrum could be achieved.
- Various shielding configurations have been studied in simulations in order to improve the signal-to-background ratio for the experiment.
- A systematic procedure for optimizing the configuration of the detector has been developed by maximizing the expected reach of the experiment.

Issues: The main uncertainties in the simulation stem from unknown material budget of the present subsoil between beam dump and the wells used for the test. This uncertainty will disappear once the material between beam dump and future experiment cave will be filled with known shielding material. While the experiment runs in a parasitic mode, the civil construction of the experiment cave and the installation of the shielding material between beam dump and experiment need to be optimized for least impact on the running of Hall A.

Summary: The committee is excited about the physics case and encourages the BDX collaboration to acquire the necessary funding for the experiment as soon as possible. Most issues and comments raised by PAC44 and PAC45 have successfully been addressed and resolved in this update. It remains to gain a firm handle on potential background from neutrino sources in the beam dump. If the experiment sees a signal, it will have an extraordinary influence on the field.

C12-17-006

Scientific Rating: A

Recommendation: Approve for 45 PAC Days

Title: Electrons for Neutrinos: Addressing Critical Neutrino-Nucleus Issues, Exclusive Studies of Short Range Correlations (SRCs) in Nuclei using CLAS12

Spokespersons: Or Hen (contact), A. Ashkenazy, K. Mahn, L. Weinstein, S. Stepanyan, A. Schmidt, H. Szumila-Vance, E. Piasetsky

Motivation: Electron and neutrino beams share common physics processes but only electron beams have well measured incoming beam energies. Therefore, the JLab experiment can provide important information about reaction mechanisms and event reconstruction. In particular, reconstruction of the beam energy from final state information is extremely important for neutrino oscillation studies; they would benefit from the ability in electron scattering experiments to compare against the known beam energy and to better separate physics processes in the final state.

Existing results of this group studying SRCs using archival CLAS data have been used to advantageously study the np and pp pair formations in more detail, search for three-nucleon SRCs, and explore the dependence of pair SRCs on the nuclear asymmetry. The new data will result in much improved statistics compared with previous results, allowing further exploration of the dependence of pair SRCs on the nuclear asymmetry and search for three-nucleon SRCs. Looking into the future, the 3-body correlation is a long-standing and important issue. It will be a very difficult but highly rewarding enterprise.

Measurement and Feasibility: This run group proposes a series of targets and energies with a total of 23 PAC days for C12-17-006 and 37 PAC days for PR12-18-003. Counting overlaps, the total request is 49.5 PAC days. Both experiments use the existing CLAS12 detector with new target holders; USM in Chile will provide the solid target holder.

The PAC acknowledges and appreciates the collaboration's response to the PAC45 report, including recognition of the most relevant energies and testing GENIE against CLAS6 data.

Issues: The PAC is convinced of the importance of both experiments. The main issue is to establish the correct beam-time allocation for the optimum physics output for this run group. It is important that the neutrino oriented running happen in a timely fashion in order to inform the simulations needed for interpretation of the NOvA, MicroBooNE, and T2K neutrino oscillation experiments and optimal extraction of oscillation parameters from early DUNE running. We therefore recommend that running on the targets relevant to neutrino physics be scheduled expeditiously.

The SRC measurements are also of strong interest to a broad community. However, justification for the full list of targets seems weak. In particular, we question the need for silicon and tin (and/or lead) targets and put them at lowest priority.

Summary: The PAC views the beam time requested in two categories. First, a reasonably small number of days (~20) of running on targets relevant for the neutrino program, will have a strong impact. We recommend that these days be scheduled expeditiously. Secondly, ~25 days of SRC studies on an optimized set of targets. The PAC finds some targets marginally motivated. As a result, we recommend allocation of 45 PAC days for this run group.

PR12-18-001

Scientific Rating: N/A

Recommendation: Deferred

Title: Photoproduction of vector mesons on nuclei with GlueX

Spokespersons: A. Somov (contact), L. Gan, A. Gasparian, L.Larin

Motivation: The experiment aims at studies of ρ , ω and ϕ vector meson photoproduction on various nuclear targets. The goal is to measure the total nuclear cross section σ_A , and validate models, presently contradicting old existing ρ data. Using the energy dependence, they will extract the cross section of the longitudinally, σ_L and transversely, σ_T polarized mesons, as well as vector meson absorption in nuclear medium. It would be the first measurement of σ_L for ω . Results from existing ρ data would be used to reinterpret earlier data on color transparency measurements.

Measurement and Feasibility: The experiment requests using a tagged photon beam of 6-12 GeV for 28 days, with a lower intensity than for the current GlueX experiment, and 4 nuclear targets: C, Si, Sn and Pb. Two measurements are proposed: (1) The nuclear transparency versus energy, and (2) the spin density matrix element ρ_{00}^A . Both seem straightforward to realize.

Issues: The physics case is not a sufficiently compelling use of beam time with these targets. In particular, the connection between the proposed measurements and the re-interpretation of existing color transparency data is not clear. The proposal would also benefit from further simulation studies. Opportunities to join efforts with proposal PR12-17-007 should also be explored, as recommended by PAC45.

Summary: The PAC encourages a run group, enlarging the initial scope of the physics, and including all relevant measurements that can be done with photoproduction on nuclear targets, including spectroscopy. This would strengthen both the case for the physics, as well as the collaboration.

PR12-18-002

Scientific Rating: NA

Recommendation: Deferred

Title: Strange Hadron Spectroscopy with Secondary KL Beam at GlueX

Spokespersons: M. Amaryan (contact), M. Bashkanov, J. Stevens, I. Strakovsky, J. Ritman

Motivation: The experiment would use the GlueX apparatus with a new beam line to study the spectroscopy of strange baryon and meson resonances. Identification of previously unseen states is an important component of the proposed physics.

The physics of a KL beam in Hall D has been the subject of a series of workshops with substantial attendance. A broad suite of physics possibilities for the experiment is presented in the proposal. The entire GlueX collaboration has signed on to the proposal.

Measurement and Feasibility: PR12-18-002 proposes an extended program of running (100 days on H2 and 100 on D2 targets) in Hall D with the GlueX detector paired with a compact photon source (CPS) and heavily shielded beryllium target, yielding a high intensity KL beam with low neutron contamination.

Issues: This is potentially an exciting opportunity to continue the physics program in Hall D with an enlarged user community. However, the PAC had significant concerns about the proposal and the degree to which the proponents have critically evaluated both the technical aspects of mounting the experiment and the effects of systematic uncertainties on their results. The PAC is also concerned with the lack of awareness of competition in the international community for this science, and the impact this would have on scheduling this ambitious experiment.

The proposal was very difficult to evaluate due to the large number of topics discussed in insufficient detail. While it has successfully established the breadth of science accessible with a high intensity KL beam, the PAC would like to see a more convincing and detailed discussion of at least a small number of highlights. For example, there were concerns regarding the theoretical difficulties in the extraction of the phase shifts from the data. The proponents should describe the physics impact (for example, how will new baryon states test lattice QCD?), and also include detailed discussion of the effects of systematic errors such as the impact of energy resolution and acceptance uncertainties on partial wave analyses. Demonstration of the amplitude extraction, using a complete detector simulation, would be necessary for approval.

As another example, we were given a clear presentation on the impact of increased statistical power (20 vs 100 days) on a phase shift analysis in πN scattering. It was, however, not clear how systematic uncertainties relevant to *this* experiment would impact the conclusions of that study and, given the 1% statistical errors in many bins, one would expect systematic errors to have a dominant effect. Given the dependence of many of the proposed studies on high statistics at low $-t$, understanding of the detector acceptance and extrapolation issues in the low $-t$ region will be critical.

The GlueX detector and liquid target systems are well understood technically but the CPS and KL systems are both expensive and, to date, not fully fleshed out. As CPS systems are proposed for other halls, it is likely that there will be a much better understanding of the CPS design in 1-2 years, independent of this proposal. But the collaboration needs to present a more realistic view of the likely timeline and design details for an experiment of this degree of novelty and cost.

Summary: There are several aspects of this initiative which are attractive for a future Hall D program. However, in several respects the PAC was not convinced that the experiment/project demonstrated realism. These ranged from the clarity of the physics case and its theoretical interpretation, through the incorporation of experimental uncertainties in the analysis to the realism of the cost and schedule, and the level of commitment and strength of the collaboration.

PR12-18-004

Scientific Rating: NA

Recommendation: Deferred

Title: Studying Λ interactions in nuclear matter with the $^{208}\text{Pb}(e, e'K^+)_{\Lambda}^{208}\text{Tl}$ reaction

Spokesperson: O. Benhar, F. Garibaldi (contact), P.E.C. Markowitz, S.N. Nakamura, J. Reinhold, L. Tang, G..M. Urciuoli

Motivation: The proposal focuses on measuring the excitation spectrum of $^{208}_{\Lambda}\text{Tl}$ obtained from the $^{208}\text{Pb}(e, e'K^+)_{\Lambda}^{208}\text{Tl}$ reaction to aid the resolution of problems associated with the role of hyper-nuclear matter in determining the maximum mass of neutron stars. A similar experiment using ^{40}Ca and ^{48}Ca targets, proposed by this group, has been approved to investigate the isospin dependence of hyperon dynamics (E12-15-008).

The aim of the proposed measurement is to obtain the Λ binding energies. The proposers would use a well-established, though not state of the art, mean field formulation of heavy nuclei. It is assumed that this information will provide valuable insights about the repulsive nature of ΛNN forces, which in current calculations is needed to obtain a stiffer equation of state. A reaction on a Pb target is seen as uniquely suited to stand in for nuclear matter.

Measurement and Feasibility: The measurement is proposed to take place in Hall A, using the same experimental apparatus as for experiment E12-15-008 but a cryogenic cooled Pb target. The proposal gives almost no specific information on the feasibility of the proposed measurement, such as details and simulation results for resolution and background, as well as on the extraction of the Λ binding energy from the measurement and on the improvement with respect to the already approved E12-15-008 experiment.

Issues: The PAC is not convinced that this is the appropriate nucleus in which to extract this physics. Furthermore, the experimental technique is not sufficiently described for us to be convinced that the necessary resolution can be achieved. Thirdly, the theoretical tools that would be used to extract ΛNN forces have since been replaced by more modern techniques that are more suited to determine the necessary fine detail required.

Summary: There are two issues with the proposals leading to a deferral: First, it does not present in a convincing way the feasibility of the measurement. Second, while motivating the physics case with a need of better pinning down the ΛNN force, the extraction of this information from the measurements was not convincingly laid out. Thus, the impact on the solution of the “hyperon puzzle” is not at all clear and cannot justify the approval of this proposal. In addition, it will be highly valuable to see the results of the approved ^{40}Ca and ^{48}Ca measurements and their impact on ΛN and ΛNN forces to better understand the need of studying even heavier targets.

PR12-18-005

Scientific Rating: N/A

Recommendation: C2

Title: Timelike Compton Scattering off a transversely polarized proton

Spokespersons: M. Boër (contact), D. Keller, V. Tadevosyan

Motivation: This proposal aims to measure Timelike Compton Scattering (TCS) off the proton using a transversely polarized NH₃ target in Hall C. By measuring transverse spin asymmetries and the unpolarized cross-section, this process gives access to four Compton Form Factors (CFFs), some of which are accessible in approved DVCS and TCS experiments. Assuming the applicability of factorization, CFFs can be parametrized in terms of four universal Generalized Parton Distributions (GPDs). This measurement can be used to test the universality of GPDs and to obtain useful information to constrain them, in particular the GPD E, which is of considerable interest due to its relation with partonic angular momentum.

Measurement and Feasibility: The measurement will take place in Hall C and requires the use of a Compact Photon Source, a transversely polarized target, a recoil-proton detector and electromagnetic calorimeters, similar to the calorimeters of the Neutral Particle Spectrometer project. The proposal requests 52 PAC days. This challenging measurement requires selection of the exclusive final state pe^+e^- with an untagged bremsstrahlung photon beam and a NH₃ target. Solid estimates of resolution and background (missing in the present proposal) are necessary to demonstrate the feasibility of the measurement.

Issues: It is claimed that the goals of the proposed measurement are proving the validity or violation of GPD universality and accessing the GPDs H, \tilde{H} and, in particular, E. However, these tasks are most probably not achievable by a single experiment, but they rather require a synergy with the other measurements involving DVCS and TCS at the lab. The proponents should better emphasize what the experiment plans to deliver, what is an improvement compared to other approved or conditionally approved experiments and what is unique. At the same time, they should put the proposal in a broader context and discuss more realistically what will be the impact on testing GPD universality and on GPD extractions.

From the experimental side, several technical issues have been pointed out and need to be addressed. In particular it is not clear to the PAC how the selection of exclusive events will be done, or how effective it will be, especially against final states such as $pe^+e^-\pi^0$.

Summary: The PAC thinks that the physics case of the proposal is strong and nicely complements the extensive program of GPD-related measurements at JLab. However, the goals were not clear, and the proposal should better identify these goals, and at the same time put the experiment in a broader context of other DVCS and TCS measurements. This is necessary in order to estimate more reliably the impact on GPD extractions. An updated proposal should provide a thorough description and simulation of the event selection, including an estimate of the effect from other final states that survive the selection criteria due to the finite energy resolution. The technical questions from the TAC report also need to be addressed.

PR12-18-006

Scientific Rating: N/A

Recommendation: Deferred

Title: Search for New Physics in e+e- Final States Near an Invariant Mass of 17 MeV Using the CEBAF Injector (DarkLight)

Spokespersons: Jan Bernauer (contact), Ross Corliss, Peter Fisher, and Richard Milner

Motivation: To search for a narrow resonance in e+e- invariant mass region around 17 MeV, motivated by an anomaly observed in 8Be decay, which can also be used to explain the muon g-2 result. This 17 MeV resonance could be a 5th force carrier, with a suppressed proton coupling relative to neutron.

Measurement and Feasibility: A run of 1000 hours (45 days) at the CEBAF injector (45MeV beam with 150 μ A current) to search in the e+e- invariant mass region around 17 MeV in electron scattering from tantalum target: e- X -> e- Ta A' -> e- Ta (e+e-) is requested, with an additional 3 days for 1497 MHz accelerator commissioning and setup, and 7 days for the commissioning of the spectrometers. This is a new proposal from the existing DarkLight collaboration as its Phase-1C project. The original DarkLight experiment would have used the LERF 100 MeV electron beam to search for dark photon in a wide mass and coupling range was approved and Phase-1 funded by NSF. Phase-1A installation and initial commissioning was done in 2016 and Phase-1B of radiative Moller scattering is currently carried out at MIT. The physics goal, experiment layout, and detector design of current proposal, however, are different from the earlier phases of DarkLight experiment.

Issues: (1) The explanation for the 17 MeV anomaly observed in 8Be decay is still unsettled. It could be due to unaccounted nuclear reactions, possible experimental systematics, or new physics interpretations that are already tightly constrained by existing experiments. Without further confirmation of this 17 MeV anomaly from other experiments, the PAC feels the scope of the physics motivation is too narrow and the impact of its results on the broader search for a light dark force mediator is limited. (2) The experimental design, the detector simulation, and the background considerations presented in the proposal have not been fully worked out. (3) The possible interference of commissioning and running this experiment with the beam delivery to other JLab halls, and the beam maintenance schedule, is unclear.

Summary: Given the relatively weak physics motivation and not fully developed experimental program, the PAC recommends that this proposal be deferred. The DarkLight collaboration has a strong track record in designing novel experiments to search for a dark force mediator in the light mass region using electron beam scattering. The PAC encourages the collaboration to continue developing new ideas along this line using the JLab facility.

Run Group Additions

E12-11-003B

Title: Study of J/ψ Photoproduction from the Deuteron

Spokespersons: Y. Ilieva (contact), B. McKinnon, V. Kubarovsky, S. Stepanyan, Z.W. Zhao

Motivation: The proposed addition to Run Group B contains three components. The first is to use final state interactions in incoherent J/ψ photoproduction from a deuteron target ($\gamma+d \rightarrow J/\psi+p+n$) to study the $J/\psi+N$ cross-section at low energies. The cross-section is sensitive to the gluonic Van der Waals effects between the J/ψ and N , which are in turn sensitive to the chromo-electric polarizability of the J/ψ . The second component is the measurement of the quasi-free J/ψ photoproduction off the deuteron. Isospin arguments motivate the existence of a charged and neutral pentaquark state and should be experimentally verified. The deuteron provides access to photo-production off both the bound neutron and proton and would therefore isolate the pentaquark production mechanism. The third component is the measurement of coherent production of J/ψ off the deuteron at large Q^2 . This channel is sensitive to the gluon structure of the deuteron.

Measurement and Feasibility: This addition to Run Group B (RGB) requests 80 days of beam time. The proposal uses the nominal CLAS12 detector and has complete overlap with the approved target, running configurations and beam time for RGB. The only potential addition is the muon trigger which would trigger on $\mu^+\mu^-$ pairs from the J/ψ decay. This trigger was implemented and tested during Run Group A running and was estimated to increase the nominal trigger rate for RGB by 20%.

Issues: In general the proposal was well written, with clear physics motivation and sufficient analysis details. In the case of the $J/\psi+N$ cross-section analysis the collaboration should be careful to account for theoretical systematic errors introduced in the cross-section extraction. The collaboration should work with RGB to estimate the additional tape needed to store the data taken with muon triggers.

Summary: The PAC recommends that RGB integrate this proposal into their running plan.

E12-11-108B/E12-10-006D

Scientific Rating: N/A

Recommendation: Note taken as a run group addition pending full approval by SoLID

Title: “ K^\pm Production in Semi-Inclusive Deep Inelastic Scattering using Transversely Polarized Targets and the SoLID Spectrometer”

Spokespersons: Zhihong Ye (contact), Tianbo Liu, Sanghwa Park, Yi Wang, Zhiwen Zhao

Motivation: The proposal aims at TMD studies in kaon production in semi-inclusive deep-inelastic scattering off transversely polarized NH_3 and ^3He targets. The expected extractions of Collins and Sivers contributions would be valuable thanks to the fact that kaon production offers probes of strangeness. This is especially relevant given the history of strangeness measurements at COMPASS and HERMES. The measurements to be performed should help to broaden our understanding of the three-dimensional momentum structure of the nucleon.

Measurement and Feasibility: The proposed measurement does not require additional beam time or new equipment. Proper separation of pions and kaons out to momenta of 7 GeV/c is important for this measurement. This may be achieved by improving the time resolution of the MRPC. With resolution of 40ps, separation out to 5 GeV/c is possible with the MRPC; separation at higher momenta is then available by using the HGC. With resolution of 20ps, the MRPC allows separation up to 7 GeV/c, and the HGC information may be used for redundancy checks. Benchmark studies with cosmic rays have shown time resolution of 27ps, which is very promising. It remains to be seen whether such a value can be reached in a high-rate environment. In fact, the SoLID collaboration has conditionally approved the proposal pending demonstration of 40ps time resolution under high rates. Projections and sensitivity studies under assumptions of sufficient MRPC time resolution look encouraging.

Issues: The proponents expect that about 20% of their data fall into the current-fragmentation regime in which the theoretical analysis and interpretation of the data is best understood. This estimate is based on a single theoretical study and on use of a variable (R_1) proposed by theorists that is not directly accessible experimentally. The PAC views this as insufficient and encourages the authors to consult theorists for additional input. The PAC also recommends that more detailed Monte Carlo studies be carried out by the collaboration, in order to see whether one can get a better handle on the separation of current and target fragmentation regions. This may include a judicious study of invariant masses and rapidities of final states.

The PAC also encourages the collaboration to explore whether a broader program with kaon measurements could be established in SoLID, once the detection technique has been demonstrated to be viable.

Summary: The PAC is excited at the prospect of kaon measurements in SoLID. It endorses the effort to reach suitable time resolution of the MRPC and, if this can be realized, supports the run group addition.

Letters of Intent

LOI 12-18-001

Title: Measurement of the parameters of the LHCb pentaquark states through double polarization asymmetries with SBS in Hall A

Spokespersons: C. Fanelli (contact), L. Pentchev, B. Wojtsekhowski

Motivation: The LOI proposes experiments sensitive to the spin, parity and t-dependence of the recently observed $P_c^+(4280)$ and $P_c^+(4450)$ pentaquark states. Recent calculations from the JPAC collaboration indicate that measurements of initial (A_{LL}) and final (K_{LL}) state polarization observables in the $\gamma+p \rightarrow P_c \rightarrow J/\psi+p$ channel will provide enhanced sensitivity, compared to differential cross-section measurements, to pentaquark parameters.

Measurement and Feasibility: The LOI proposes to stage the experiment in Hall A in order to utilize the SBS and ECAL for proton, electron and positron detection and reconstruction of the J/ψ . A polarized photon source is created by passing a polarized electron beam through a copper radiator. The K_{LL} measurements require a liquid hydrogen target and the proton polarimeter in the SBS, while the A_{LL} measurements will utilize a solid state NH_3 target. The conservative assumption of 2% branching ratio predicts 4400 events per day, motivating the request for 20 PAC days each for A_{LL} and K_{LL} .

Issues: It is not clear if a measurement of both A_{LL} and K_{LL} is necessary or optimal. Although not shown, the statistical power of K_{LL} must be reduced compared to A_{LL} and therefore the additional 20 days for the K_{LL} measurement should be more strongly motivated. Future proposals should also include a detailed evaluation of the background radiation induced by the copper radiators and the effect on the polarized target performance. Fully developed simulations, incorporating GEANT detector responses of both the HCAL and ECAL, are necessary to confirm the current estimate of the J/ψ invariant mass reconstruction resolution.

Summary: The measurement of polarization observables will be a novel and innovative way to probe the parameters of the newly discovered pentaquark states. The PAC encourages submission of a full proposal after observation through photoproduction is confirmed by an approved JLAB experiment.

LOI12-18-002

Title: Deeply Virtual Compton Scattering using the Tagged Deeply Inelastic Scattering Experimental Setup

Spokespersons: Eric Fuchey (contact), Alexandre Camsonne, Marco Carmignotto, Rachel Montgomery, Zhenyu Ye, Zhihong Ye

Motivation: The LOI proposes to perform DVCS measurements off deuterons in Hall A.

The focus is on measurements off the neutron, which provide different flavor sensitivity as compared to proton targets. It is planned to measure both the unpolarized cross section and the longitudinal beam-spin asymmetry. The former involves integrals over GPDs (hence probing the region $x \neq \xi$), while the latter provides information on the imaginary part of the DVCS amplitude at the point $x = \xi$ and especially on the GPD E which is of great interest in nucleon spin structure. In addition to investigating DVCS off the neutron there are also ideas to study coherent DVCS off the deuteron, which so far has not been explored. The PAC finds the physics case interesting and the proposed measurements to be well motivated.

Measurement and Feasibility: Neutron DVCS measurements in Hall A have in the past been carried out by subtracting results from scattering off deuterons and protons, a technique that is prone to large systematics. The idea in the present experiment is to employ TDIS methods to observe the spectator proton in the TPC and measure its momentum, so that scattering off a quasi-free neutron can be established. Measuring the momentum of the produced photon and using missing-mass techniques, the exclusivity of the event may then be validated. It is noted that the ALERT run group plans to use a similar technique; the proponents of the present LOI expect that they will achieve significantly higher statistics in the region of kinematic overlap.

While the proposed experiment would use components of the approved TDIS experiment, it does require a new DVCS calorimeter for photon detection, for which the proponents envisage to use PbWO_4 crystals from NPS. Initial studies based on the assumption of availability of these components are encouraging overall.

Issues: This LOI is put forward as a potential run group addition to TDIS. The PAC rejects this notion. Given that new equipment (and hence funding) is needed, as well as a modest amount of additional beam time over that allocated for TDIS, this LOI cannot be considered as seed for a run group addition. Run groups are fixed entities with common apparatus and beam time, and any additions that might impact the program need to be blessed by the full collaboration.

The proponents would thus have to come up with their own full proposal that is based on use of TDIS equipment and on a robust plan for the additional DVCS calorimetry, along with its own request for beam time. If the proponents prepare such a proposal they should do so in close discussion with TDIS and Lab management. The proposal should address radiative corrections and their role for missing-mass reconstruction, final-state interactions, and $\phi_{\gamma\gamma}$ acceptance.

The PAC is concerned about the potential unavailability of the NPS crystals. Using instead PbF_2 crystals will significantly impact resolution and coverage and might require upgrades. If such a backup solution is seriously considered careful simulation studies will be necessary.

Summary: The PAC values the scientific case. It cannot consider this as an LOI for a run group addition to TDIS but instead recommends preparation of a separate proposal.

LOI12-18-003

Title: High precision measurement of ${}^3\Lambda\text{H}$ and ${}^4\Lambda\text{H}$

Spokespersons: T. Gogami

Motivation: The proposed high precision measurement of the binding energies of ${}^3\Lambda\text{H}$ and ${}^4\Lambda\text{H}$ intends to add a high precision measurement in light nuclei to allow pinning down parameters in the theoretical derivation of the ΛN interaction. Due to the lack of precise ΛN scattering data, determining e.g. the constants in developing interactions based on chiral perturbation theory, binding energies of the 3- and 4-body Λ -systems need to be used. E.g. in the case of ${}^3\Lambda\text{H}$ present data for the binding energy from emulsion experiments span a broad range depending on the decay mode analyzed, and thus are not suited to constrain constants in the ΛN interaction. The case of ${}^4\Lambda\text{H}$ is important for understanding the observed charge-symmetry breaking in the ΛN force. From this point of view the experiments proposed are very timely and important for the theory of ΛN interactions.

Measurement and Feasibility: The measurement is intended to be added with 12 days of beam time to the already approved experiment E12-15-008 experiment in Hall A, and requires a 50- μA beam and cryogenic targets. As such the measurement itself seems feasible.

Issues: This experiment is most important if the binding energies are measured very precisely. Statistical and systematic errors are given in the proposal, however the justification for the given values is missing or difficult to find. The LOI mentions the J-PARC experiments E13 and E63, but not the MAMI-C measurement of ${}^4\Lambda\text{H}$ with a combined error apparently a little smaller than the estimate given in the LOI. For developing this LOI into a proposal that has impact on the field, the proposed measurements must be viewed in the context of similar measurements carried out worldwide, and if a counter-experiment seems important it will need strong justification.

Summary: The PAC recommends that the proposers very carefully evaluate the additional benefit to the field before developing this LOI to a full proposal. We expect that a full proposal will contain a thorough justification with respect to other measurements worldwide, together with a more refined estimate of the expected errors.

LOI12-18-004

Title: Physics with Positron Beams at Jefferson Lab 12 GeV

Spokespersons: E. Voutier, J. Grames,

Motivation: There are three general areas that motivate this proposal. 1) Two-photon contribution to ep scattering. The Q^2 dependence of G_{Ep} has been an important puzzle for over a decade. The advantage of JLab measurements is the access to higher Q^2 than existing measurements. 2) Having positron and electron data will make it possible to separate the different contributions to the cross section of the lepton production of photons, significantly improving the determination of the nucleon Generalized Parton Distributions (GPDs). The proponents foresee an impact, for instance, on the determination of the GPD E, related to quark angular momentum, on the so-called D-term, related to the radial pressure inside the proton. 3) The dark photon (A') search part of the LOI proposes a PADME-like experiment at JLab, looking for a monoenergetic photon from $e^+e^- \rightarrow \gamma A'$. It is certainly a unique process that can be done with a positron beam on a fixed target. In addition, any results will be independent of the A' lifetime. The projected sensitivity to the dark photon mass and its coupling to electrons is beyond current results.

Measurement and Feasibility: The beam time request is 525 days, but there is no accounting for parallel running. The A' search has the largest request of 180 days. While the A' search requires a separate detector, the other measurements use detectors which exist now or are being installed.

Issues: A primary issue is the impact on the laboratory and the already-approved experimental program. The proposers should work out a plan with lab management. The difficulties in developing a technique for fast switching between e^+ and e^- could be large, as would be the impact on the existing program. Specific issues, relevant to the three areas outlined above, include the following: 1) Differences between e^+p and e^-p are expected to be about 10% (see Fig. 20). This puts a significant constraint on the accelerator conversion between e^+ and e^- and back again. 2) Differences between e^+p and e^-p are expected to be up to 0.5 (see Fig. 29). This is likely more feasible than 1). 3) This is a discovery experiment. Most of the potential sensitivity region of the proposed experiment will be covered by NA64 in a few years and will be completely covered by Belle-II in 5-10 years. Therefore, this proposed experiment will have to be scheduled accordingly.

Summary: These measurements all have significant physics interest. The proposers should carefully evaluate feasibility and present the best case possible in a future proposal. The justification must be very strong to enable the significant changes needed in the accelerator, both in equipment and in schedule. Any proposal should have a section on the linkage between a realistic plan for beam and the way the measurement is made.

LOI12-18-005

Title: Timelike Compton Scattering off a transversely polarized proton

Spokespersons: W. Li (contact), J. Stevens, G. Huber

Motivation: This LOI proposes to measure deep exclusive meson and photon production in the backward region. This process can be described in terms of Transition Distribution Amplitudes (TDAs), which are nonperturbative functions similar to GPDs. Since the applicability of the TDA formalism is not guaranteed, the LOI aims at checking two specific predictions: the dominance of the σ_T cross section over σ_L and the $1/Q^8$ behavior of the cross section. Checking these expectations could be a first step in the direction of extracting TDAs from data.

Measurement and Feasibility: The proposed measurement will take place in Hall C. Backward pion production requires the use of the HMS and SHMS spectrometers (the pion is reconstructed with the missing-mass method). Backward photon production further requires a Neutral Particle Spectrometer (to be placed opposite to the SHMS) and it is a much more challenging measurement. The requested time is 50 PAC days, with different beam energies.

Issues: Other experiments at JLab measured backward pion production, which gives confidence about the feasibility of this measurement. It should be however noted that previous experiments required years of careful study and often did not lead to the desired outcome. Backward photon production demands a much deeper study and should be treated independently.

Assuming the measurement is feasible, the significance of the results may not be very strong. As argued in the Theory TAC report, one experiment by itself is most probably insufficient to draw clear conclusions about the applicability of the TDA formalism. The situation may turn out to be similar to forward meson production, where after a decade of studies there are serious doubts about the applicability of the GPD formalism.

Even if the applicability of the TDA formalism is established, it seems not realistic to carry out at JLab a full-fledged program of measurements leading to the extraction of TDAs. It is therefore not clear how much can follow from this measurement.

Finally, the significance of TDAs themselves is not sharply defined. So far, the theoretical work on TDAs is limited and essentially carried out by a single group.

Summary: The exploration of backward pion electroproduction is likely to be feasible and JLab is an ideal venue at which to perform it. However, the PAC has several concerns about the relevance of the proposed measurement and invites the proponents to strongly sharpen the physics case before they submit a full proposal.

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	0	2	1	3	0	6
The transverse structure of the hadrons	6	3	3	1	0	13
The longitudinal structure of the hadrons	2	3	6	0	0	11
The 3D structure of the hadrons	5	9	6	0	0	20
Hadrons and cold nuclear matter	8	5	7	0	1	21
Low-energy tests of the Standard Model and Fundamental Symmetries	3	1	0	1	2	7
Total	24	23	23	5	3	78
Total Experiments Completed	4.6	2.7	2.1	0.8	0	10.2
Total Experiments Remaining	19.4	20.3	20.9	4.2	2.0	67.8

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	0	219	11	540	0	870
The transverse structure of the hadrons	150.5	85	110	25	0	470.5
The longitudinal structure of the hadrons	65	230	165	0	0	460
The 3D structure of the hadrons	409	872	197	0	0	1478
Hadrons and cold nuclear matter	220	275	205	0	14	759
Low-energy tests of the Standard Model and Fundamental Symmetries	547	180	0	79	60	866
Total Days	1391.5	1861	688	644	74	4658.5
Total Approved Run Group Days (includes MIE)	1391.5	1026	645	444	74	3580.5
Total Approved Run Group Days (without SoLID)	917.5	1026	645	444	28	3060.5
Total Days Completed	138.4	52	44.5	48	93	327.9
Total Days Remaining	779	974	600.5	351	28	2733

PAC "High Impact" Selection

PAC Days

Boldface = days designated High Impact

Parentheses = days not counting toward High Impact total

Row Color

Yellow = High Impact

Green = backup expt

Exp#	Exp Name	Hall	Run Group/Days	PAC Days	PAC Grade	Comments
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TOPIC 1: SPECTROSCOPY

E12-06-102	GlueX : Mapping the Spectrum of Light Quark Mesons and Gluonic Excitations with Linearly Polarized Photons	D		(120) approved ★90	A	GlueX - assumed half commissioning/half physics ★plus (30) commissioning days
E12-16-007	A Search for the LHCb Charmed "Pentaquark" using Photoproduction of J/Psi at Threshold in Hall C at Jefferson Lab	C		11	A	

TOPIC 2: FORM FACTORS

E12-06-101	Measurement of the Charged Pion Form Factor to High Q ²	C		52	A	Requires fully commissioned SHMS
E12-07-109	GEp/GMp : Large Acceptance Proton Form Factor Ratio Meas's at 13 and 15 (GeV/c) ² Using Recoil Polarization Method	A		45	A-	Requires SBS and high power cryo target
E12-11-106	High Precision Measurement of the Proton Charge Radius	B		15	A	Non-CLAS12 experiment, Prad

TOPIC 3: PDFs

E12-06-113	BONuS : The Structure of the Free Neutron at Large x-Bjorken	B	F/40	(40) approved ★21 ↓	A	Requires BONuS Radial TPC upgrade ★42 days High Impact for the experiment
E12-10-103	MARATHON : Measurement of the F _{2n} /F _{2p} , d/u Ratios and A=3 EMC Effect in DIS off the Tritium and Helium Mirror Nuclei	A	Tritium target group/61	↑ ★21 (42) approved	A	that runs first; experiments are equally important & both are essential
E12-06-110	A1n HallC-3He : Meas of Neutron Spin Asymmetry A _{1n} in the Valence Quark Region Using an 11 GeV Beam and a Polarized 3He Target in Hall C	C		36	A	Requires high luminosity 3He

TOPIC 4T: TMDs

C12-11-111	TMD CLAS-HDICE : SIDIS on Transverse polarized target	B	G/110	110 concurrent	A	Requires transversely polarized HDICE with electron beam
C12-12-009	Dihadron CLAS-HDICE : Measurement of transversity with dihadron production in SIDIS with transversely polarized target	B	G/110	(110) concurrent	A	Requires transversely polarized HDICE with electron beam C1 Proposal
E12-06-112	TMD CLAS-H(Unpol) : Probing the Proton's Quark Dynamics in Semi-Inclusive Pion Production at 12 GeV	B	A/139	(60) approved ★10	A	Hall B commissioning + 10 days ★plus (50) commissioning days

TOPIC 4G: GPDs

E12-06-114	DVCS HallA-H(UU,LU): Measurements of Electron-Helicity Dependent Cross Sections of DVCS with CEBAF at 12 GeV	A	Early: DVCS & Gmp/62	(100) approved ★70	A	Hall A commissioning
C12-12-010	DVCS CLAS-HDice: DVCS at 11 GeV with transversely polarized target using the CLAS12 Detector	B	G/110	(110) concurrent	A	Requires transversely polarized HDIce with electron beam C1 Proposal
E12-11-003	DVCS CLAS-D(UU,LU): DVCS on the Neutron with CLAS12 at 11 GeV	B	B/90	(90) approved	A	Requires D target; central neutron detector ready in 2016 ★Backup GPD-E meas if HDIce delayed

TOPIC 5: NUCLEAR

E12-13-005	Bubble Chamber: Measurement of $^{16}\text{O}(\text{e},\text{e}')^{12}\text{C}$ with a bubblechamber and a bremsstrahlung beam	INJ		14	A-	Our guess: 2017
E12-11-101	PREx-II: Precision Parity-Violating Measurement of the Neutron Skin of Lead	A		35	A	Requires septum, Pb target, 1% Moller polarimetry
E12-06-105	SRC-hiX: Inclusive Scattering from Nuclei at $Q^2 > 1$ in the quasielastic and deeply inelastic regimes	C		32	A-	
E12-11-112	SRC-Tritium: Precision measurement of the isospin dependence in the 2N and 3N short range correlation region	A	Tritium target group/61	19	A-	
E12-17-003	Determining the Unknown Lambda-n Interaction by Investigating the Lambda-nn Resonance	A		12	A-	

TOPIC 6: FUNDAMENTAL SYMMETRIES

E12-11-006	HPS: Status of the Heavy Photon Search Experiment at Jefferson Laboratory (Update on PR12_11_006)	B	H/180	(155) approved ★39	A	Non-CLAS12 experiment, HPS ★25 pre-CLAS engr + 14 physics @ 4.4 GeV
E12-10-009	APEX: Search for new Vector Boson A1 Decaying to e+e-	A		34	A	

<<<SUMMARY of "HIGH IMPACT" DAYS>>>

by Topic	1	2	3	4GT	5	6	total post - commissioning
	101	112	78	190	112	73	666
Days Complete	20	15		50		15	
	81	97	78	140	112	58	566
by Hall	A	B	C	D	INJ		
	236	195	131	90	14		666
Days Complete	50	30		20			
	186	165	131	70	14		566

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Charge to PAC46

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, represent high quality physics within the range of scientific importance represented by the previously approved 12 GeV proposals and recommend for approval.

Also provide a recommendation on scientific rating and beam time allocation for proposals newly recommended 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.