Jefferson Lab

50th PROGRAM ADVISORY COMMITTEE (PAC 50)

July 11 – 14, 2022

U.S. DEPARTMENT OF ENERGY

JSA

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From the Director

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

August 5, 2022

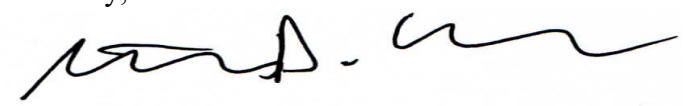
Dear Jefferson Lab Users,

It was a pleasure to see the new and exciting experimental proposals from our user community at the recent Program Advisory Committee (PAC50) meeting. And it was wonderful to see the PAC and proposers in person during PAC week. The quality of these proposals is a testament to the tremendous scientific opportunities that Jefferson Lab's CEBAF enables for our scientific community.

This year the committee considered 6 new proposals, 3 conditional proposals, 5 jeopardy proposals, 2 letters of intent and 1 run group addition. The PAC approved 5 new proposals and reaffirmed the jeopardy proposals. One jeopardy proposal improved from proposal grade A- to A.

The meeting was run very efficiently and effectively, thanks to the efforts of the Chair, Markus Diehl and the efforts of Sadie Cherry, Jennifer Finch, and Susan Brown. I would like to thank Markus and all the PAC members for their efforts to provide expert advice to the Laboratory. Special thanks goes to Bob McKeown for his guidance of the PAC process for the Laboratory during the past 12 years.

Sincerely,



Stuart Henderson
Laboratory Director

From the Chair

Markus Diehl
Theory Group
Deutsches Elektronen-Synchrotron DESY
22603 Hamburg
Germany

Newport News, 14 July 2022

Robert D. McKeown
Scientific Advisor to the Director
Jefferson Lab

Dear Bob,

This letter transmits the findings and recommendations of the 50th Jefferson Lab Program Advisory Committee (PAC50). The Committee met from July 11 to 14 and considered 6 new proposals, 3 conditionally approved proposals, one proposal for a run group addition, and 2 letters of intent. In addition, it reviewed 5 experiments in Jeopardy.

Written reports on the proposals, letters of intent and experiments in Jeopardy were prepared and reviewed by the Committee before we adjourned. 5 proposals were granted full approval, 2 were approved pending review by a future PAC (C2), and 2 proposals were deferred. The proposed run group addition was endorsed. All experiments in Jeopardy were recommended to stay active, with no change to the previously recommended beam time. The PAC decided to revise the scientific grade of one experiment.

The chair of the Jefferson Lab Users Organization (JLUO) participates in all PAC sessions and is included in all communication between the PAC and the spokespersons of proposals. He represents the user community at all stages of the PAC review. We regard this as highly beneficial for both sides and would like to see this tradition continue.

The TAC physics and theory reports provided to the PAC were a most valuable resource for our review, and we thank all those involved in their preparation.

Two out of the 6 new proposals and all experiments in Jeopardy that were reviewed by this PAC concern measurements with the planned SoLID detector. The submitted proposals underline the community interest in the SoLID program, and the outcome of the PAC review confirms its scientific strength. To judge the feasibility and expected performance of measurements with SoLID is more difficult than for proposals using detectors that largely exist. The PAC would like to emphasize that a positive assessment of an experiment is based on the assumption that the SoLID detector will indeed reach the performance specifications upon which the proposals are based.

After two years of PAC meetings that were held purely online, the committe could again meet with proponents and the Lab management in person (even though, very unfortunately, two committee members had to cancel their trip to JLab on short notice due to COVID). The committee feels that PAC meetings should continue to be held in presence, the toils of travel being far outweighed by the benefits of being able to communicate in person.

The committee appreciates the amount of logistics behind such a meeting, and would like to extend its warmest thanks to Susan Brown, Sadie Cherry, and Jennifer Finch for their tireless work ahead of, during, and after PAC week.

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.

With best regards,
Markus

Markus Diehl
PAC50 Chair

Introduction

The Jefferson Lab Program Advisory Committee held its 50th meeting from July 11th through July 24th, 2022. The membership of the committee is given on page 34. In response to the charge (page 35) from the former JLab Deputy Director, Dr. Robert McKeown, the committee reviewed 6 new proposals, 3 conditional proposals, 5 Jeopardy proposals, 1 run group addition and 2 letters of intent.

Recommendations

PAC 50 SUMMARY OF RECOMMENDATIONS								
Number	**Contact Person**	**Title**	**Hall**	**Days Req'd**	**Days Awarded**	**Scientific Rating**	**PAC Decision**	**Topic**
C12-21-004	L. Weinstein	Semi-Inclusive Deep Inelastic Scattering Measurement of A=3 Nuclei with CLAS12 in Hall B	B	58			C2	1
C12-21-003	A. Gasparian	A Direct Detection Search for Hidden Sector New Particles in the 3-60 MeV Mass Range	B	60	60	A	Approved	Other
C12-18-005	M. Boer	Timelike Compton Scattering off a Transversely Polarized Proton	C	50			Deferred	4
PR12-22-001	N. Sparveris	Measurement of the N to Delta Transition Form Factors at low four momentum transfers	C	11	11	A-	Approved	2
PR12-22-002	J. Arrington	First Measurement of the Flavor Dependence of Nuclear PDF Modification Using Parity-Violating Deep Inelastic Scattering	A	83			C2	5
PR12-22-003	I. Larin	Precision Measurement of the Neutral Pion Transition Form Factor	B	67	67	A-	Approved	6
PR12-22-004	M. Nycz	Measurement of the Beam Normal Single Spin Asymmetry in Deep Inelastic Scattering using the SOLID Detector	A	38	38	A-	Approved	Other
PR12-22-005	B. Wojtsekhowski	A Search for a Nonzero Strange Form Factor of the Proton at 2.5 (GeV/c)2	C	35			Deferred	2
PR12-22-006	C. Munoz Camacho	Deeply Virtual Compton Scattering off the neutron with the Neutral Particle Spectrometer in Hall C	C	44	44	A	Approved	4

Topic*

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

C1=Conditionally Approved w/Technical Review
C2=Conditionally Approved w/PAC Review

PAC 50 SUMMARY OF JEOPARDY RECOMMENDATIONS						
Number	**Contact Person**	**Title**	**Hall**	**Days Requested (Already taken)**	**Days Awarded**	**PAC Decision**
E12-10-007	P. Souder	Precision Measurement of Parity-Violation in Deep Inelastic Scattering over a Broad Kinematic Range	A	338	169	Remain active
E12-12-006	Z.-E. Meziani	Near-Threshold Electroproduction of J/psi at 11 GeV	A	60	60	Change rating from A- to A
E12-11-007	J.P. Chen	Asymmetries in Semi-Inclusive Deep-Inelastic Electro-Production of Charged Pion on a Longitudinally Polarized He-3 Target at 8.8 and 11 GeV	A	35	35	Remain active
E12-10-006	H. Gao	Target Single Spin Asymmetry in Semi-Inclusive Deep-Inelastic Electro Pion Production on a Trasversely Polarized 3He Target at 8.8 and 11 GeV	A	90	90	Remain active
E12-11-108	H. Gao	Target Single Spin Asymmetry in Semi-Inclusive Deep-Inelastic (e, e' $\pi^{\pm}$) Reaction on a Transversely Polarized Proton Target	A	120	120	Remain active

RUN GROUP ADDITION SUMMARY				
Number	**Contact Person**	**Title**	**Hall**	**Topic**
E12-07-107A	Timothy Hayward	Studies of Single Baryon Production in the Target Fragmentation Region with a Longitudinal Polarized Target	B	4

Proposal Reports

C12-18-005

Scientific Rating: N/A

Recommendation: Deferred

Title: Timelike Compton Scattering off a Transversely Polarized Proton

Spokespersons: M. Boer (contact), V. Tadevosyan, A. Camsonne, D. Keller

Motivation: This proposal aims to measure Timelike Compton Scattering (TCS) off the proton using a transversely polarized NH_3 target in Hall C. By measuring transverse spin asymmetries and the unpolarized cross-section, this process gives access to Compton Form Factors, some of which are accessible in approved DVCS and TCS experiments. Assuming the applicability of factorization, the Compton Form Factors can be parametrized in terms of 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 and of a transversely polarized NH_3 target. The recoil proton is reconstructed using the GEM tracking chambers, and the e^+e^- pair is reconstructed using the GEMs, a set of Hodoscopes, and a modified NPS-like electromagnetic calorimeter (ECal). The proposal requests 50 PAC days. This measurement requires the selection of the exclusive final state $p\ e^+e^-$ with an untagged bremsstrahlung photon beam. As the photon beam is untagged, a first and second level trigger setup is used to suppress the non-exclusive background.

Issues: The scientific goals of the experiment have been clarified following previous PAC recommendations. However, there remain many open problems on the technical realization of the proposal, which could jeopardize the measurement. In the following, we list several technical challenges that we think need to be addressed in detail to establish that the measurement is feasible.

- The questions in the TAC report should all be answered in detail: many relevant points are raised that need to be addressed before one can be confident that the experiment is technically feasible.
- It must be shown that the GEMs to be used can operate at the luminosities of the experiment without a negative impact on their resolution and efficiency.
- The radiation damage on the hodoscope and on the photosensors used in the different subdetectors has to be assessed.
- The proposal must discuss the required level and stability of calibration of the different subdetectors that will allow one to measure the kinematic variables to the precision discussed in the proposal.

- It should be demonstrated that the particle identification for the e^+e^- pair suppresses the non-resonant exclusive and the SIDIS $\pi^+\pi^-$ backgrounds enough to cleanly isolate the small TCS signal.
- The plan to realize the modifications to the NPS needed for the experiment should be specified in detail.
- The PID response and its fluctuations should be simulated in a full GEANT simulation of the detector setup.

Summary: The PAC acknowledges that the physics case of the proposal is strong and nicely complements the extensive program of GPD-related measurements at JLab. However, given the difficulty of the measurement, the PAC feels that a deeper review of the experimental issues raised above is required, and that the collaboration needs to increase their workforce focusing on the challenging technical issues of this proposal. Given the extent of the additional work needed, the PAC recommends a deferral of this proposal, to enable sufficient time for addressing the technical issues.

C12-21-003

Scientific Rating: A

Recommendation: Approved for 60 PAC days

Title: A Direct Detection Search for Hidden Sector New Particles in the 3-60 MeV Mass Range

Spokespersons: A. Gasparian (contact), H. Gao, D. Dutta, N. Liyanage, T. J. Hague, C. Peng, R. Paremuzyan

Motivation: In the late 1990s, an experiment carried out at the University of Frankfurt showed an unexpected 4.5 sigma deviation in the kinematic distribution of electron-positron pairs in a low energy measurement. A different experiment – ATOMKI - in 2015 explored this in a similar measurement, which led to a greater than 6 sigma excursion in the distribution. A follow-up ATOMKI experiment, using a different target nucleus than before, verified this resonance in the e+e- angular distribution, in the same energy range. This resonance was given the label X-17 since the mass range associated with this kinematic excursion was roughly 17 MeV. Proposal C12-21-003 seeks to test and either confirm or refute these apparent new phenomena that have in some cases been related to fifth-force models.

Measurement and Feasibility: The collaboration has proposed to search for X-17 using electron scattering off a Tantalum foil target in Hall B. Detectors, electronics, and techniques from both the former PrimeEx and PRad experiments will be used in the measurement. More than that, the collaboration will search the entire mass/energy range from 3 to 60 MeV using beam energies of either 3.3 and 4.4 GeV or of 2.2 and 3.3 GeV, depending upon the Hall B schedule. In general, the search will be for so-called Hidden Sector phenomena over the mass/energy range just stated, including the region around 17 MeV. The experiment will either find the X-17 particle, or set new limits on its coupling parameter squared (ε^2). Concerns raised by PAC 49, as well as in the current and previous TAC reports were addressed to the satisfaction of the current PAC.

Issues: The PAC encourages the collaboration to pay special attention to obtaining flash-ADC modules (FADC-250) as proposed. A second issue is that there is competition from several other collaborations, in Europe and in Canada.

Summary: This proposal is exciting and timely. The measurement/search is needed, and it will receive significant attention if completed before their competitors.

C12-21-004

Scientific Rating: N/A

Recommendation: Conditionally approved (C2)

Title: Semi-Inclusive Deep Inelastic Scattering Measurement of A=3 Nuclei with CLAS12 in Hall B

Spokespersons: L. Weinstein (contact), D. Dutta, D. Gaskell, O. Hen, D. Meekins, D. Nguyen, J. Rittenhouse West, Z. H. Ye

Motivation: The current proposal aims at a precision measurement of ratios of charged pion electroproduction in SIDIS from ^{2}D, ^{3}He and ^{3}H targets, in order to test the flavor dependence of the EMC effect in the valence quark region. Comparing different yield ratios for light mirror nuclei allows one to decrease the nuclear uncertainties due to final state effects in hadronization.

Measurement and Feasibility: The standard configuration of the CLAS12 detector will be used with a 10.6 GeV beam incident on identical ^{2}D, ^{3}He and ^{3}H targets. The scattered electron and the produced pions will be detected.

The experiment will use the same new target system as the approved CLAS12 Tritium-SRC experiment (E12-12-005). The observables, proposed here and argued to be sensitive to the EMC effect, are the ratios of the sum of yields $Y(\pi^+) + Y(\pi^-)$ and of the difference of yields $Y(\pi^+) - Y(\pi^-)$ for the different nuclei relative to deuterium.

Issues: The proposal was already examined by PAC 49. Some of the issues raised during PAC 49 have been addressed in the updated version of the proposal, but not all of them.

The proposal does not sufficiently address the challenges in extracting PDFs from SIDIS measurements in JLab kinematics, which might be enhanced in nuclear targets. The proponents should understand what the contamination from target fragmentation is as a function of the W^2-cut and study the impact of more stringent cuts on the precision and kinematic coverage in x_B and Q^2. A closer interaction with theorists has started and should be further pursued. A NLO analysis of pseudo-data, using in-medium fragmentation functions, would better clarify what is the sensitivity of the proposed measurement. This analysis should account for any possible target fragmentation contribution in the extraction. To make a strong case for the measurement it is important to show the impact of different cuts and model assumptions on the physics goal, i.e., the flavor dependence of the EMC effect.

The measurement of cross sections as a function of x_B, Q^2, z, and p_T is strongly encouraged by the PAC, as it allows one to study the applicability of the SIDIS factorization formalism, and possibly to extract (nuclear) unpolarized PDFs, TMDs, and fragmentation functions.

Summary: The proposal has the potential to address the fundamental question of the origin of the EMC effect. The physics programme is very rich, but the extraction of the underlying physics

observables is very challenging. The PAC strongly encourages the proponents to provide more convincing arguments for the impact of the proposed measurements.

PR12-22-001

Scientific rating: A-

Status: Approved for 11 PAC days

Title: Measurement of the N to Delta Transition Form Factors at low four momentum transfers

Spokespersons: H. Atac, M. Jones, M. Paolone, A. Camsonne, N. Sparveris (contact)

Motivation: The electromagnetic multipole structure of the nucleon and its excitations is of key interest in understanding its structure. In particular, the quadrupole deformation of the nucleon has been addressed for decades but not been much studied experimentally. The motivation connects to the non-sphericity of the nucleon requiring D-wave admixtures in the classical SU(6) quark wave functions. This experiment plans to study the $p \rightarrow \Delta$ transition form factors at very small values of Q^2 and wants to separate the Coulomb and electric transition form factors through the angular analysis of asymmetries.

Measurement and Feasibility: This proposal is based on LOI 12-20-002 and PR12-21-001. The reaction $e\,p \rightarrow e\,\Delta^{+} \rightarrow e\,p\,\pi^{0}$ at a beam momentum of 1.3 GeV/c is reconstructed, using the double arm spectrometer in Hall C and reconstructing the π^{0} through missing mass. The measurement technique builds on many similar measurements that were performed in the past at larger values of Q^2. The low Q^2 region of these amplitudes addresses the long wavelength regime, which is dominated by the pion cloud in addition to the quark degrees of freedom.

Normalization is a key issue, as different Q^2 values require different settings of the magnetic spectrometers. Using asymmetries in the proton polar angle with respect to the virtual photon, the electric and quadrupole $p \rightarrow \Delta$ transition form factors can be extracted. These asymmetries result from interferences of the two quadruple transition amplitudes with the dominant magnetic dipole transition.

The collaboration has successfully addressed open issues raised by PAC 49. It has performed and analyzed a first pilot measurement using the same apparatus but at higher momentum. There is no doubt left about the feasibility of the full measurement as proposed. An accuracy in the percent region is envisaged.

Summary: The PAC regards the motivation for the proposed measurements of $p \rightarrow \Delta$ transition form factors at very small Q^2 as sound and very solid. The science case is strongly supported by the TAC theory report. The proposal puts emphasis on providing high precision data at small values of Q^2, which do not yet exist. These data will constitute a benchmark for theoretical calculations, for instance in chiral effective field theories. The collaboration has successfully clarified open technical issues raised in 2021. The PAC welcomes these measurements, which are relevant to describe and understand low energy QCD.

PR12-22-002

Scientific Rating: N/A

Recommendation: Conditionally approved (C2)

Title: First Measurement of the Flavor Dependence of Nuclear PDF Modification Using Parity-Violating Deep Inelastic Scattering

Spokespersons: J. Arrington (contact), R. Beminiwattha, D. Gaskell, J. Mammei, P. Reimer

Motivation: The proposed experiment aims at measuring parity violating asymmetries with longitudinally polarized beams off a ^{48}Ca target using the SoLID detector. These asymmetries are expected to have good sensitivity to possible differences in the nuclear modification of up- and down-quark distributions, i.e., to a flavor dependence of the EMC effect.

Measurement and Feasibility: The experiment shares with the PVDIS-SoLID program all challenges of parity violating measurements for the beam, the kinematics calibration, the GEM detectors, and the understanding of the backgrounds. The target has been designed such as to make use of the existing amount of ^{48}Ca present at the lab. The experiment would be performed after extensive earlier SoLID operation.

Issues: To quantify the physics reach of the experiment, several aspects of the theoretical uncertainties need more quantitative work. The PAC recommends to seek expert advice on PDF uncertainties and NLO corrections. At the same time, the PAC suggests to clarify what the primary experimental goal is (i.e., the extraction of nuclear structure functions and of ratios thereof) and to distinguish this from the theoretical interpretation.

In addition, to guarantee optimal detector performance, the impact of the integrated radiation dose should be carefully evaluated in the context of the overall SoLID program.

Summary: The PAC thinks that the proposed experiment may shed light on the fundamental question of the flavor dependence of the EMC effect. However, the physics reach of the experiment may be affected by uncertainties that have not been investigated with sufficient care. The PAC therefore recommends to improve this aspect of the proposal.

PR12-22-003

Scientific Rating: A-

Recommendation: Approved for 67 PAC days

Title: Precision Measurement of the Neutral Pion Transition Form Factor

Spokespersons: D. Dale, D. Dutta, L. Gan, I. Larin (contact), R. Miskimen, E. Pasyuk

Motivation: A precision measurement of the space-like π^0 TFF through the Primakoff reaction with virtual incident photons is proposed. The TFF in the low Q^2 space-like region determines two key observables, namely the π^0 radiative width and its transition radius. Both are important for calculations based on fundamental symmetries and chiral perturbation theory. The experiment will extract the slope and curvature of the TFF with projected statistical uncertainty of 6% and 17% respectively. In addition, the proposed experiment will constrain approximately 65% of the pseudo-scalar pole term in the hadronic light-by-light scattering contribution to the anomalous magnetic moment of the muon, with an estimated uncertainty of 6%. This quantity can serve as a benchmark for corresponding lattice calculations.

Measurement and Feasibility: The experiment will use a 10.5 GeV electron beam with a 10 nA current impinging on a 250 μm thick silicon target in front of the PRad setup. The measurement will be performed via the Primakoff reaction with virtual incident photons ($e\,A \rightarrow e'\,A\,\pi^0$). The scattered electron and the two photons from the π^0 decay will be detected in the hybrid electromagnetic calorimeter HYCAL, with two GEM detectors foreseen for the PRad II experiment (C12-20-004) being used for electron tracking and to veto charged background. Triggering will be based on three HYCAL clusters, which requires HYCAL readout with flash ADCs (either fADC-125 or alternatively fADC-250 modules). The proposed experiment will measure the TFF over a Q^2-range from 0.003 to 0.3 GeV^2 with high accuracy of 0.4% to 8%. The extraction of the radiative width is similar to the PrimEx photoproduction measurement, but will add an independent measurement with comparable precision. This experiment will be an improvement w.r.t. the two largest contributions to the total systematic error of PrimEx, namely beam flux determination and the size of beam related background.

Issues: The TAC physics report points out two technical issues related to the second GEM detector plane and the calorimeter readout modules, which should be addressed. The proponents are encouraged to closely cooperate with the groups of proposals C12-21-003 and C12-20-004, which have similar experimental requirements.

Summary: The motivation of the experiment is strong and timely. The PAC welcomes these high precision measurements and encourages the collaboration to ensure the timely provision of the necessary equipment.

PR12-22-004

Scientific Rating: A-

Recommendation: Approved for 38 PAC days

Title: Measurement of the Beam Normal Single Spin Asymmetry in Deep Inelastic Scattering using the SOLID Detector

Spokespersons: M. Nycz (contact), X. Zheng, W. Henry, Y. Tian, W. Xiong

Motivation: It is proposed to measure the beam-normal single-spin asymmetry A_N for DIS on a proton target. In the Born approximation, in which a single photon is exchanged, single spin normal asymmetries– with either the electron or the hadron target polarized transverse to the scattering plane – are strictly forbidden due to time-reversal and parity invariance. Going beyond the Born approximation, one finds non-zero asymmetries due to two-photon exchange. Previous measurements of parity violating elastic scattering measured large A_N asymmetries, but the 6 GeV PVDIS experiment at JLab (E08-011) found A_N in DIS to be consistent with zero, albeit with large statistical uncertainty. Therefore, the proposed measurement will investigate, for the first time to a high precision, the effect of two-photon exchange in DIS via a beam normal single spin asymmetry. This will provide new constraints to further the understanding of two-photon exchange.

Measurement and Feasibility: The experiment uses an electron beam with the spin polarized in the transverse direction, incident on a 40 cm long liquid hydrogen target. Scattered electrons will be detected in the SoLID spectrometer in Hall A in its PVDIS configuration, with the scattering angle θ between 22° and 35°, and with full azimuthal angle (φ) coverage. By flipping the electron spin direction between beam-left and beam-right or between vertical up and down, the beam-normal asymmetry A_N will be determined by the φ-dependence of the measured asymmetry.

Issues: As SoLID is still at a very early stage of being designed, the performance of the individual subdetectors and of SoLID as a whole is not yet understood in detail. This makes it difficult to evaluate the experiment's technical realizability as currently proposed. Possible concerns are: the background suppression; the efficient and clean identification of the electron; the question whether all subdetectors, i.e., GEM-trackers, can be operated at the proposed luminosity; performance changes of the subdetectors due to radiation damage.

Summary: The PAC agrees that the experiment is scientifically well motivated and addresses an important question to characterize two-photon exchange. The PAC recommends that the issues listed above be revisited at future PAC Jeopardy reviews of the proposal.

The PAC recommends approval of the requested 38 PAC days. We note that the allocation of beam time is based on the assumption that SoLID will reach its performance specifications.

PR12-22-005

Scientific Rating: N/A

Recommendation: Deferred

Title: A Search for a Nonzero Strange Form Factor of the Proton at 2.5 $(GeV/c)^2$

Spokespersons: R. Beminiwattha, C. Palatchi, K. Paschke, B. Wojtsekhowski (contact)

Motivation: The experiment aims at measuring the strange quark contribution to the proton electromagnetic form factors. This is crucial for their flavour decomposition. This compelling physics case is motivated by recent progress in lattice QCD calculations and by phenomenological models highlighting the potential of a measurement at large Q^2.

Measurement and Feasibility: The experiment proposes to measure the parity violation asymmetry in electron-proton scattering at $Q^2 = 2.5$ $(GeV/c)^2$. For this purpose, modules of the existing HCAL and NPS need to be rebuilt in a very different detector arrangement, and a new scintillator-based hodoscope (a 45700 channel scintillator array read out by fibers and pixel PMTs) needs to be built. Although the setup is very simple from the kinematic point of view and the measurement is largely limited by statistical uncertainty, the PAC is concerned by the lack of several important experimental details in the proposal.

Issues: The PAC would like to see the results of a detailed Geant4 simulation of the experiment confirming the claim of low background in the experiment, as the independent TAC report recommended. In addition, a detailed design of the experimental setup (including electronics and DAQ) should be presented to assess the viability of the measurement.

Summary: The presented physics case is timely and extremely compelling. However, the PAC has identified a number of critical items especially in the experimental method, which should be addressed to make sure that no hidden technical problems will jeopardize a successful experimental campaign. The PAC strongly encourages the collaboration to address these items in the future.

PR12-22-006

Scientific Rating: A

Recommendation: Approved for 44 PAC days

Title: Deeply Virtual Compton Scattering off the neutron with the Neutral Particle Spectrometer in Hall C

Spokespersons: C. Hyde, M. Mazouz, C. Munoz Camacho (contact), J. Roche

Motivation: The experiment proposes to use the High Momentum Spectrometer (HMS) of Hall C combined with its NPS to perform high precision measurements of the DVCS cross sections off quasi-free neutrons in a liquid deuterium (LD_2) target. These data are essential to probe the flavor dependence of the GPDs of the nucleon.

Measurement and Feasibility: The PAC has no concern about the realizability of the experiment. The scattered electron will be detected in the HMS and the emitted photon in the NPS, and the recoil particle from the deuteron target will be identified by its missing mass. The NPS with its high resolution due to the use of $PbWO_4$ crystals improves the missing mass resolution by a factor of 2 compared to previous measurements and thus allows for improved exclusivity. The NPS combined with the HMS allows to better separate coherent DVCS on the deuteron from incoherent scattering on the individual nucleons. In addition, the use of the NPS sweeping magnet allows one to reduce charged particle backgrounds in the calorimeter and thus increases the luminosity with respect to previous experiments. Alternating between the LD_2 target of this experiment and the LH_2 of the experiment E12-13-010 minimizes systematics due to instabilities in the detector responses. This is critical to have an effective subtraction of the proton DVCS cross section measured on LH_2 from the LD_2 data to extract DVCS on the neutron and thus to constrain the flavor dependence of GPDs.

The PAC strongly encourages the collaboration to use the excellent performance of the NPS to also measure all accessible observables for exclusive π^0 production, so as to provide further constraints on GPDs.

Summary: The PAC agrees that the experiment is very well motivated and the experimental realization is sound. It therefore recommends approval of the requested 44 PAC days.

Jeopardy Experiments

E12-10-006

Title: Target Single Spin Asymmetry in Semi-Inclusive Deep-Inelastic Electro Pion Production on a Transversely Polarized ^{3}He Target at 8.8 and 11 GeV

Spokespersons: H. Gao (contact), J.-p. Chen, J.-C. Peng, X. Qian

Motivation: This experiment will measure three target single-spin asymmetries of π^+/π^- produced in SIDIS, using the proposed SoLID apparatus. The high precision results to be obtained from these measurements will provide essential "neutron" information to the world data, together with the results from the SoLID SIDIS experiment E12-11-007 on a longitudinally polarized ^{3}He target and its associated run-group addition.

1) Is there any new information that would affect the scientific importance or impact of the Experiment since it was originally proposed?

Since the approval of five SoLID experiments in 2010, the collaboration has developed a Pre-CDR, which has successfully passed the second of two JLab Director's Reviews. In 2020, the DOE funded a Pre-R&D plan, which has demonstrated that there are no show-stoppers in the design of SoLID. In March of 2021, the DOE performed a Science Review of SoLID.

Significant progress has been made for all subsystems, and components have been tested and shown to meet specifications. Among them, it is worthwhile to mention that a prototype Čerenkov detector was tested with a beam at JLab Hall C in 2020, both at low rates and also at high rates equal to those expected in the SoLID spectrometer.

Updates on the simulations for the sensitivity to the transversity, Sivers, and pretzelosity distributions from SIDIS measurements were presented to the PAC. Also included were updates on five approved run-group additions: E12-10-006A on SIDIS di-hadron production, E12- 11-108A/E12-10-006A on an A_y measurement, E12-10-006B on deeply virtual exclusive meson production, E12-10-006D on SIDIS kaon production, and E12-10-006E on g_2^n and d_2^n measurements.

Theoretical work in recent years has examined in detail the limitations of interpreting SIDIS measurements in terms of parton distributions (PDFs or TMDs) and fragmentation functions. The PAC recommends the collaboration to continue working with theorists to identify observables that can help to elucidate these questions in the kinematics accessible at SoLID.

2) If the Experiment has already received a portion of its allocated beam time and/or is on the presently published accelerator schedule, the spokespersons should provide an analysis of the existing data set, the projected result for any additional time on the published schedule, and the projected result for the complete data set including all remaining unscheduled time. The goal is to show the physics impact of the respective data sets.

N/A

3) What is the status of the collaboration in terms of institutes, committed staff, and prospective students?

The SoLID collaboration is active and growing with over 270 collaborators from over 70 institutions in 13 countries. It has encouraged young collaborators to take leadership roles. The PAC finds that this is a good sign.

4) Should the remaining beam time allocation and experiment grade be reconsidered?

The approved 90 PAC and the A rating should be maintained, as the scientific motivation of this experiment remains very strong.

Summary: This experiment will provide data of unprecedented quality on SIDIS in JLab-12 GeV kinematics. The theory and phenomenology developments in the last decade make this experiment yet more compelling and highlight the impact of SoLID program.

E12-10-007

Title: Precision Measurement of Parity-Violation in Deep Inelastic Scattering over a Broad Kinematic Range

Spokespersons: P. Souder (contact), X. Zheng, P. E. Reimer

1) Is there any new information that would affect the scientific importance or impact of the Experiment since it was originally proposed?

Searches at the LHC have produced bounds on rare Higgs decays $H \rightarrow Z Z_d$ with a hypothetical dark sector boson Z_d. A theory analysis [Phys. Rev. D 92, 055005 (2015)] finds that parity violation experiments such as E12-10-007 can significantly constrain the parameter space for such a new boson and will be complementary to improved bounds from direct searches at the LHC.

2) If the Experiment has already received a portion of its allocated beam time and/or is on the presently published accelerator schedule, the spokespersons should provide an analysis of the existing data set, the projected result for any additional time on the published schedule, and the projected result for the complete data set including all remaining unscheduled time. The goal is to show the physics impact of the respective data sets.

N/A

3) What is the status of the collaboration in terms of institutes, committed staff, and prospective students?

The SoLID collaboration is active and growing with over 270 collaborators from over 70 institutions in 13 countries. It has encouraged young collaborators to take leadership roles. The PAC finds that this is a good sign.

4) Should the remaining beam time allocation and experiment grade be reconsidered?

PAC 37 recommended that the experiment should begin with 169 PAC days out of the 338 PAC days requested in the original proposal. At the present PAC, the collaboration asked for the full amount of 338 PAC days to be allocated. To justify such a change, the committee would need to be presented with sufficient detail, such as projections for the physics reach with 338 versus 169 PAC days. A revision of the beam time allocation may be discussed by a future PAC when the experiment comes closer to its running period.

The scientific motivation of the experiment remains very strong, and the A rating should be maintained.

E12-11-007

Title: Asymmetries in Semi-Inclusive Deep-Inelastic Electro-Production of Charged Pion on a Longitudinally Polarized He-3 Target at 8.8 and 11 GeV

Spokespersons: J. Huang, C. Peng, W. Yan, J.-p. Chen (contact)

Motivation: This experiment will measure one target single-spin asymmetry and two beam-target double spin asymmetries of π^+/π^- particles produced in SIDIS, using the proposed SoLID apparatus. The high precision results to be obtained will add valuable and essential "neutron" information to the world data, together with the results from the SoLID SIDIS experiment E12-10-006 on a transversely polarized ^{3}He target and its associated run group additions.

1) Is there any new information that would affect the scientific importance or impact of the Experiment since it was originally proposed?

Since the approval of five SoLID experiments in 2010, the collaboration has developed a Pre-CDR, which has successfully passed the second of two JLab Director's Reviews. In 2020, the DOE funded a Pre-R&D plan, which has demonstrated that there are no show-stoppers in the design of SoLID. In March of 2021, the DOE performed a Science Review of SoLID. Significant progress has been made for all subsystems, and components have been tested and shown to meet specifications. Among them, it is worthwhile to mention that a prototype Čerenkov detector was tested with a beam at JLab Hall C in 2020, both at low rates and also at high rates equal to those expected in the SoLID spectrometer.

There has been one run group addition approved, namely E12-11-007A on g_2^n and d_2^n measurements. The collaboration provided updates on the simulations related to the so-called worm-gear disributions and to other TMDs, as well as on the run group addition.

Theoretical work in recent years has examined in detail the limitations of interpreting SIDIS measurements in terms of parton distributions (PDFs or TMDs) and fragmentation functions. The PAC recommends the collaboration to continue working with theorists to identify observables that can help to elucidate these questions in the kinematics accessible at SoLID.

2) If the Experiment has already received a portion of its allocated beam time and/or is on the presently published accelerator schedule, the spokespersons should provide an analysis of the existing data set, the projected result for any additional time on the published schedule, and the projected result for the complete data set including all remaining unscheduled time. The goal is to show the physics impact of the respective data sets.

N/A

3) What is the status of the collaboration in terms of institutes, committed staff, and prospective students?

The SoLID collaboration is active and growing with over 270 collaborators from over 70 institutions in 13 countries. It has encouraged young collaborators to take leadership roles. The PAC finds that this is a good sign.

4) Should the remaining beam time allocation and experiment grade be reconsidered?

The approved 35 PAC days and the A rating should be maintained, as the scientific motivation of this experiment remains very strong.

Summary: This experiment will provide data of unprecedented quality on SIDIS in JLab-12 GeV kinematics. The theory and phenomenology developments in the last decade make this experiment yet more compelling and highlight the impact of SoLID program.

E12-11-108

Title: Target Single Spin Asymmetry in Semi-Inclusive Deep-Inelastic (e,e' $\pi^{\pm}$) Reaction on a Transversely Polarized Proton Target

Spokespersons: H. Gao (contact), J.-p. Chen, V. Khachatryan, X. Li, Z.-E. Meziani

Motivation: This experiment will measure three target single-spin asymmetries of π^+/π^- particles produced in SIDIS, using the proposed SoLID apparatus. The high precision results to be obtained will provide essential "proton" information to the world data, together with the results from the SoLID SIDIS experiment E12-10-006 on a transversely polarized ^{3}He target and its related run-group additions. Moreover, the combination of the results from E12-11-108 and E12-10-006 will render smaller overall uncertainties in the extraction of TMDs, and in particular allow for their flavor separation.

1) Is there any new information that would affect the scientific importance or impact of the Experiment since it was originally proposed?

Since the approval of five SoLID experiments in 2010, the collaboration has developed a Pre-CDR, which has successfully passed the second of two JLab Director's Reviews. In 2020, the DOE funded a Pre-R&D plan, which has demonstrated that there are no show-stoppers in the design of SoLID. In March of 2021, the DOE performed a Science Review of SoLID. Significant progress has been made for all subsystems, and components have been tested and shown to meet specifications. Among them, it is worthwhile to mention that a prototype Čerenkov detector was tested with a beam at JLab Hall C in 2020, both at low rates and also at high rates equal to those expected in the SoLID spectrometer.

There have been two run-group additions approved: E12-11-108A on an A_y measurement and E12-11-108B on SIDIS kaon production. The collaboration provided updates on the simulations for the sensitivity to the transversity, Sivers, and pretzelosity distributions from SIDIS measurements. Also included were updates on simulations for the run group additions with SIDIS kaon and A_y measurements.

Theoretical work in recent years has examined in detail the limitations of interpreting SIDIS measurements in terms of parton distributions (PDFs or TMDs) and fragmentation functions. The PAC recommends the collaboration to continue working with theorists to identify observables that can help to elucidate these questions in the kinematics accessible at SoLID.

2) If the Experiment has already received a portion of its allocated beam time and/or is on the presently published accelerator schedule, the spokespersons should provide an analysis of the existing data set, the projected result for any additional time on the published schedule, and the projected result for the complete data set including all remaining unscheduled time. The goal is to show the physics impact of the respective data sets.

N/A

3) What is the status of the collaboration in terms of institutes, committed staff, and prospective students?

The SoLID collaboration is active and growing with over 270 collaborators from over 70 institutions in 13 countries. It has encouraged young collaborators to take leadership roles. The PAC finds that this is a good sign.

4) Should the remaining beam time allocation and experiment grade be reconsidered?

The approved 120 PAC days and the A rating should be maintained, as the scientific motivation of this experiment remains very strong.

Summary: This experiment will provide data of unprecedented quality on SIDIS in JLab-12 GeV kinematics. The theory and phenomenology developments in the last decade make this experiment yet more compelling and highlight the impact of SoLID program.

E12-12-006

New scientific rating: A

Title: Near-Threshold Electroproduction of J/psi at 11 GeV

Spokespersons: S. Joosten, Z.-E. Meziani (contact), X. Qian, N. Sparveris, Z. Zhao

1) Is there any new information that would affect the scientific importance or impact of the Experiment since it was originally proposed?

After the experiment was approved in 2012, interest in J/psi production has been growing. In 2015, LHCb announced the observation of resonances that are consistent with charmed pentaquarks, which inspired many experimental and theoretical investigations. Among these, the GlueX and Hall C E12-16-007 experiments have obtained new results on J/psi production near threshold. The photoproduction results from GlueX suggest a larger production cross section than old measurements, which increases the rates projected for this experiment.

Previous PAC reports, for E12-12-006 at PAC39 and for the run group addition E12-12-006A at PAC43, raised concerns about the modification of the SoLID setup and recommended a common solution appropriate for the whole SoLID program. The collaboration documented in the pre-CDR a setup that is identical for the SoLID-SIDIS configuration. The only difference of the present experiment from others is the position of the target, which is unproblematic.

The proponents addressed the issues raised by PAC43 on the trigger. It is now foreseen to run the experiment with an L1 trigger, rather than with an L3 trigger envisaged in the original proposal. Regarding the background for TCS, a controllable level of the background below 1% can be expected from recent CLAS12 results [Phys. Rev. Lett. 127 (2021) 262501].

2) If the Experiment has already received a portion of its allocated beam time and/or is on the presently published accelerator schedule, the spokespersons should provide an analysis of the existing data set, the projected result for any additional time on the published schedule, and the projected result for the complete data set including all remaining unscheduled time. The goal is to show the physics impact of the respective data sets.

N/A

3) What is the status of the collaboration in terms of institutes, committed staff, and prospective students?

The SoLID collaboration is active and growing with over 270 collaborators from over 70 institutions in 13 countries. It has encouraged young collaborators to take leadership roles. The PAC finds that this is a good sign.

4) Should the remaining beam time allocation and experiment grade be reconsidered?

Because of the significantly increased interest in J/psi production near threshold, due to the LHCb pentaquarks, GlueX and Hall C results, as well as interesting theoretical developments, the physics importance of the experiment has grown. This experiment is unique in its capability to measure both photoproduction and electroproduction of J/psi with high statistics. The PAC recommends to raise the scientific grade of the experiment from A- to A. The beam time allocation should remain unchanged.

Run Group Additions

E12-07-107A

Title: Studies of Single Baryon Production in the Target Fragmentation Region with a Longitudinal Polarized Target

Spokespersons: T. Hayward (contact), H. Avakian

Motivation: The experiment aims at measuring fracture functions (FrFs), which specify the probability for the target remnant to contain a certain hadron given a particular ejected quark. The FrFs characterize the target fragmentation region (TFR), where hadrons form out of the fragmenting spectator partons. Compared to the current fragmentation region, the TFR is relatively little studied, and the measurement of the FrFs may provide deep insights into the partonic structure of the hadrons.

Measurement and Feasibility: The experiment will measure the double spin asymmetry in inclusive proton production ($eN \rightarrow e'pX$) with polarized protons (NH_3) in the TFR, in parallel to the existing Run Group C experiments in Hall B. Because this experiment will use the dataset from Run Group C, and because the theory necessary for analyzing the data is well established, the experiment is judged as feasible.

Summary: The PAC finds that the physics case of the proposal is sound, and that the experiment is feasible.

Letters of Intent

LOI12-22-001

Title: Color Transparency in Dirty Kinematics

Spokespersons: Shujie Li (contact), D. Higinbotham, J. Rittenhouse West, H. Szumila-Vance, C. Yero

Motivation: Color transparency (CT) is a phenomenon in baryon or meson knockout off nuclei at high four-momentum transfers. The experimental signal for CT is an increase in the transparency variable — defined as the ratio of the nuclear cross section per nucleon to the free nucleon cross section — as a function of the four-momentum transfer. Data taken in exclusive *(e, e'p)* reactions on deuteron, carbon, and iron did not show any evidence for CT up to momentum transfers of $Q^2 \sim 14$ $(GeV/c)^2$. The proposal introduces a new variable, the ratio of the cross section at large final-state-interaction (FSI) effects to the one at small FSI effects, and aims at measuring this ratio in the *d(e, e'p)* reaction. The effect of the point-like configuration, which is a key concept for CT, could be larger in large-FSI kinematics, and a theory calculation suggests that for $Q^2 = 8 – 15$ $(GeV/c)^2$ the above ratio could be lower (by up to 20%) in the presence of CT than in the no-CT case.

Measurement and Feasibility: The experiment aims at measuring the *d(e, e'p)n* reaction to search for the onset of CT, by detecting the electron and proton in coincidence in Hall C with the standard HMS and SHMS spectrometers using a 11 GeV beam. The feasibility of the experiment is unclear from the LoI from both the experimental and the theoretical points of view.

Issues: The experimental details should be presented. Especially, the final expected accuracy of the ratio should be compared with theoretical uncertainties. For the theory side, the estimation of the ratio depends only on a single theory calculation that is yet to be published. In order to estimate theoretical uncertainties, contribution from several models is necessary.

Summary: The PAC recommends the proponents to proceed to a full proposal only after the issues raised are carefully considered. In particular, considering several theoretical predictions based on a broader spectrum of theory expectations is important to make a convincing physics case.

LOI12-22-002

Title: Exploring the Light Anti-Quark Flavor Asymmetry in the Nucleon Sea using Semi Inclusive Charged Pion Production in Hall C

Spokespersons: A. Tadepalli (contact)

Motivation: The LOI proposes to measure $\pi^{\pm}$ produced in SIDIS in Hall C on hydrogen and deuterium targets. The precise measurement of pion yield ratios could be sensitive to $\overline{d}/\overline{u}$ and $\overline{d} - \overline{u}$ and therefore contribute to the understanding of the flavor composition of the nucleon sea.

Measurement and Feasibility: The proposed measurement partially overlaps in kinematic phase space with approved experiment E12-06-104 and requires the same setup. The LOI requires extra days of running at the highest beam energy, with both LH_2 and LD_2 targets.

Issues: The PAC shares the concerns clearly described in the TAC theory report: without a proper evaluation of theoretical systematics, it is far from established that the proposed measurements will be able to substantially change the current knowledge of the sea quark flavor asymmetry. It is mandatory to perform an impact study in a NLO framework, including mass corrections and nuclear corrections for the deuteron. It is also important to address to which extent the collected data are really in the current fragmentation region and can be correctly interpreted in terms of collinear PDFs and fragmentation functions. In order to do this, multidimensional binning is necessary. The impact of limited acceptance should be carefully studied.

The LOI does not clearly indicate how many days of beam time are required and what would be the beam time shared with the approved experiment E12-06-104.

The PAC also suggests to consider the wider physics potential of SIDIS measurements in Hall C, including, for instance, the study of the impact on other flavors, the study of the P_T dependence of the asymmetries, the identification of higher twist and target fragmentation contributions.

Summary: An improvement in the knowledge of the sea quark asymmetries in the large *x* region would be timely and important, however the interpretation of the proposed measurement is affected by several uncertainties that may considerably limit its impact and should be thoroughly addressed if the proponents plan to submit a full proposal.

Program Status

12 GeV Approved Experiments by Physics Topics

Topic	Hall A	Hall B	Hall C	Hall D	Other	Total
Hadron spectra as probes of QCD	0	2	1	4	0	**7**
Transverse structure of the hadrons	7	4	3	1	0	**15**
longitudinal structure of the hadrons	3	3	7	1	0	**14**
3D structure of the hadrons	6.5	9	6.5	0	0	**22**
Hadrons and cold nuclear matter	10	6	8	1	0	**25**
Low-energy tests of the Standard Model and Fundamental Symmetries	3	2	0	1	0	**6**
Other	1	1	0	0	0	**2**
Total	**30.5**	**27**	**25.5**	**8**	**0**	**91**
Total Experiments Completed	**11**	**10**	**8.6**	**2.9**	**0**	**33**
Total Experiments Remaining	**19**	**17**	**17**	**5**	**0**	**57.5**

12 GeV Approved Experiments by PAC Days

Topic	Hall A	Hall B	Hall C	Hall D	Other	Total
Hadron spectra as probes of QCD	0	219	11	740	0	**970**
Transverse structure of the hadrons	152.5	125	157	25	0	**459.5**
Longitudinal structure of the hadrons	42	170	211	33	0	**456**
3D structure of the hadrons	371	872	269	0	0	**1512**
Hadrons and cold nuclear matter	254.5	305	205	15	0	**779.5**
Low-energy tests of the Standard Model and Fundamental Symmetries	547	247	0	79	0	**873**
Other	38	60	0	0	0	**98**
Total Days	**1405.0**	**1998.0**	**853.0**	**892**	**0**	**5148.0**

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Charge to PAC50

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.

List of common acronyms

ADC	Analog-to-digital converter
CDR	Conceptual Design Report
DAQ	Data Acquisition
DIS	Deep inelastic scattering
DVCS	Deeply virtual Compton scattering
EMC	European Muon Collaboration
GEM	Gas electron multiplier (detector)
GPD	Generalized parton distribution
NLO	Next-to-leading order (in perturbation theory)
NPS	Neutral Particle Spectrometer (in Hall C)
PAC	Program Advisory Committee
PDF	Parton distribution function/parton density
PMT	Photomultiplier tube
PVDIS	Parity violating DIS
SIDIS	Semi-inclusive DIS
SoLID	Solenoidal Large Intensity Device (planned detector in Hall A)
TAC	Technical advisory committee (for the PAC)
TCS	Timelike Compton scattering
TFF	Transition form factor
TMD	Transverse-momentum dependent PDF or fragmentation function