

**REPORT OF THE
38TH
PROGRAM ADVISORY
COMMITTEE (PAC38)
MEETING**

August 22 – 26, 2011

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

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October 20, 2011
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Dear Jefferson Lab Users,

PAC 38 was held in the middle of the six month shutdown of the accelerator, in August of 2011. This shutdown saw the first, and very successful, installation of 12 GeV components. In fact, today the Lehman Review of the project was completed and the report was excellent.

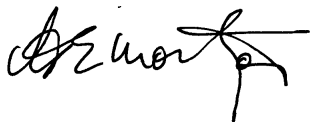
Thus it was entirely appropriate that the PAC concentrate on the 12 GeV program. The process involved ranking of approved experiments, primarily in the category labeled "The 3D structure of the hadrons", as well as considerations of new proposals.

Thirteen new proposals were examined. There were also seven letters of intent, one conditionally approved, and fifteen proposals returning for grading. Now for the first time, all of the approved 12 GeV proposals have been graded and assigned a beamtime allocation.

As we have said before, we are impressed by the breadth and depth of the new 12 GeV initiatives. The continuing popularity of the facility is surely an excellent motivation for us, the Office of Nuclear Physics and the Office of Science more broadly and other funding agencies as we seek support to build out the potential of the program.

The Chair of the PAC 38 was again Naomi Makins, whose intense concentration on the issues brings to a fore the important issues. We are incredibly impressed by the continued efforts of our diverse committee. The one retiring member of the committee was Bill Marciano who lived up to his reputation as one of the leading experts on weak interaction physics.

Sincerely,



Hugh E. Montgomery
Laboratory Director

Introduction

The Jefferson Lab Program Advisory Committee held its 38th meeting from August 22nd through August 26th, 2011. The membership of the committee is given in Appendix A. In response to the charge (Appendix B) from the JLab Director, Dr. Hugh Montgomery, the committee reviewed 36 potential experiments: 13 new proposals, 7 Letters of Intent 1 Conditionally approved and 15 previously approved experiments for grading.

For previously approved proposals in the 12 GeV category the “The 3D Structure of the Hadrons”, the PAC provided recommendations for scientific rating and beamtime allocations.

Recommendations

PAC 38 SUMMARY OF RECOMMENDATIONS

NUMBER	CONTACT PERSON	TITLE	HALL	DAYS REQUESTED	DAYS AWARDED	SCIENTIFIC RATE	PAC DECISION	TOPIC *
PR12-11-101	B. Michaels	PREX-II Precision Parity-Violating Measurement of the Neutron Skin of Lead	A	35	35	A	Approved	5
PR12-11-102	T. Horn	Measurement of the Ratio $R=\sigma_L/\sigma_T$ in Exclusive and Semi-Inclusive π^0 Production	C	69			C2	4G
PR12-11-103	P. Stoler	Exclusive Vector Meson Electroproduction with CLAS12	B	80			Deferred	4G
PR12-11-104	I. Pomerantz	Hard Photodisintegration of ^3He into pp and pn pairs	A	10			Reject	5
PR12-11-105	J. Grames	Polarized Electrons for Polarized Positrons: A proof-of-principle experiment	INJ	14	14	A	Approved	
PR12-11-106	A. Gasparian	High Precision Measurement of the Proton Charge Radius	B	10			C2	2
PR12-11-107	O. Hen	In Medium Nucleon Structure Functions, SRC, and the EMC effect	C	40	40	B+	Approved	5
PR12-11-108	H. Gao	SOLID-H(T) Target Single Spin Asym in SIDIS ($e,e'\pi^\pm$) on a Transversely Polarized Proton Target	A	120			C2	4T
PR12-11-109	H. Avakian	Studies of Dihadron Electroproduction in DIS with Unpolarized and Longitudinally Polarized Hydrogen and Deuterium Targets	B	164			Deferred	4T
PR12-11-110	K. Slifer	b1 The Deuteron Tensor Structure Function b_1	C	39.8			Deferred	3
PR12-11-111	M. Contalbrigo	Transverse spin effects in SIDIS at 11 GeV with a transversely polarized target using CLAS12	B	100			C2	4T
PR12-11-112	P. Solvignon	Precision measurement of the isospin dependence in the 2N and 3N short range correlation region	A	19	19	A-	Approved	5
PR12-11-113	L. Zhu	Detailed Studies of the Nuclear Dependence of $R=\sigma_L/\sigma_T$	C	17			Deferred	5

NUMBER	CONTACT PERSON	TITLE	HALL	DAYS REQUESTED	DAYS AWARDED	SCIENTIFIC RATE	PAC DECISION	TOPIC *
C12-09-018	B. Wojtsekhowski	Measurement of Semi-Inclusive Pion and Kaon electroproduction in the DIS Regime on a Transversely Polarized ^3He Target using the Super BigBite and BigBite Spectrometers in Hall A	A	64	64	A-	Approved	4T
E12-06-108	P. Stoler	Hard Exclusive Electroproduction of π^0 and η with CLAS12	B	120	80	B		4G
E12-06-112	H. Avagyan	Probing the Proton's Quark Dynamics in Semi-Inclusive Pion Production at 11 GeV	B	60	60	A		4T
E12-06-114	C. Hyde	Measurement of Electron-Helicity Dependent Cross Sections of Deeply Virtual Compton Scattering with CEBAF at 12 GeV	A	100	100	A		4G
E12-06-119	F. Sabatie	Deeply Virtual Compton Scattering with CLAS at 11 GeV	B	200	200	A		4G
E12-07-105	T. Horn	Scaling Study of the L-T Separated Pion Electroproduction Cross-Section at 11 GeV	C	36	36	A-		4G
E12-07-107	H. Avagyan	Studies of Spin-Orbit Correlations with Longitudinally Polarized Target	B	103	103	A-		4T
E12-09-002	Kawtar Hafidi	Charge Symmetry Violating Quark Distributions via Precise Measurement of π^+/π^- Ratios in Semi inclusive Deep Inelastic Scattering.	C	22	22	A-		3
E12-09-007	K. Hafidi	Studies of Partonic Distributions using Semi-Inclusive Production of Kaons	B	136	110	A-		4T
E12-09-008	H. Avagyan	Studies of the Boer-Mulders Asym in Kaon Electroproduction with Hydrogen & Deuterium Targets	B	56	TBA	A-		4T
E12-09-009	H. Avagyan	Studies of Spin-Orbit Correlations in Kaon Electroproduction in DIS with Polarized Hydrogen and Deuterium Targets	B	103	103	B+		4T
E12-09-011	T. Horn	Studies of the L-T Separated Kaon Electroproduction Cross Section from 5-11 GeV	C	40	40	B+		4G
E12-09-017	R. Ent	Transverse Momentum Dependence of Semi-Inclusive Pion and Kaon Production	C	32	32	A-		4T

NUMBER	CONTACT PERSON	TITLE	HALL	DAYS REQUESTED	DAYS AWARDED	SCIENTIFIC RATE	PAC DECISION	TOPIC *
E12-10-006	H. Gao	SOLID-He3(T) An update to PR12-09-014: Target Single Spin Asymmetry in Semi-Inclusive Deep-Inelastic Electro Pion Production on a Transversely Polarized ^3He Target at 8.8 and 11 GeV	A	90	90	A		4T
E12-11-003	S. Niccolai	Deeply Virtual Compton Scattering on the Neutron with CLAS12 at 11 GeV	B	90	90	A		4G
E12-11-007	J. Huang	SOLID-He3(L) 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	A		4T

Topic*

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

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

Proposal Reports

Proposal: PR12-11-101

Scientific Rating: A
Recommendation: Approval

Title: “PREX-II: Precision parity-violating measurement of the neutron skin of lead”

Spokespersons: K. Paschke, K. Kumar, R. Michaels, P.A. Souder, G.M. Urciuoli

Motivation: This proposal is a follow-up experiment to PREX-I which aims at a precise measurement of the neutron radius R_N in lead. PREX-I took data in 2010 and demonstrated successful control of systematic errors, however, due to technical problems and resulting limited statistics, could not achieve the projected precision required to discriminate among various models. The physics motivation remains very strong: the neutron radius of lead has important implications for astrophysics. It constrains the equation of state of neutron matter which is crucial to determine the structure of neutron stars and provides an important check for three-neutron forces. Finally, atomic parity violation is also sensitive to R_N . The PAC strongly supports this measurement to be completed.

Measurement and Feasibility: The method used is the measurement of the parity-violating electroweak asymmetry in the scattering of polarized electrons from ^{208}Pb at an energy of 1.0 GeV. Since the Z^0 boson couples mainly to neutrons, this asymmetry provides a clean measurement of R_N . Three main technical problems were encountered during PREX-I: deterioration and eventually melting of the lead target in the high-current electron beam, failure of the septum vacuum system, and radiation damage in the hall. The collaboration has presented suitable measures to reduce these problems to a tolerable level, such that the measurement seems feasible with the originally proposed experimental precision in R_N of +/- 1% .

Issues: The reduction of the high radiation level requires special attention and the collaboration should closely work together with the JLab radiation group and the hall A technical staff to optimize the shielding solution.

Title: “Measurement of the Ratio $R = \sigma_L/\sigma_T$ in Exclusive and Semi-Inclusive π^0 Production”**Spokespersons:** T. Horn, R. Ent, H. Mkrtchyan**Motivation:** This proposal aims to provide the first longitudinal transverse (L/T) separation for the exclusive $p(e,e'\pi^0)$ p reaction and semi-inclusive $p(e,e'\pi^0) X$ reaction. This experiment goes hand in hand with the similar already approved experiments dedicated to L/T separation:

- for charged pion and charged kaon electroproduction in Hall C at 12 GeV in SIDIS (E12-06-104),
- for exclusive production $p(e,e'\pi^+)n$ (E12-07-105),
- for exclusive production $p(e,e'K^+)\Lambda$ or Σ^0 (E12-09-011).

Until now the ratio R_{SIDIS} is assumed to be either zero or equal to the values determined from the inclusive deep inelastic scattering (DIS). Verifying $R_{\text{SIDIS}} = R_{\text{DIS}}$ is a test of the dominance of the electron quark scattering followed by a quark fragmentation process and of the deviations from this leading factorized picture. Moreover the relation $\pi^0 = (\pi^+ + \pi^-)/2$ is often considered.

R_{Excl} is rather poorly known. However it is an important quantity since factorization has only been proven for the longitudinal component σ_L of the pion production cross section, which is related unambiguously with GPDs. Comparison between charged and neutral pion production should quantify the impact of the non trivial non-pole contribution in pion production.

Measurement and Feasibility: This experiment will be performed in Hall C, using a $1\mu\text{A}$ electron beam incident on a liquid hydrogen target. Different beam energies ($E=4.4, 6.6, 8.2, 10.9$ GeV) will be required for a good epsilon lever arm necessary for the L/T separation. The scattered electron is detected in the well-known high resolution HMS spectrometer while the construction of a general purpose neutral pion detection system cantilevered off the SHMS carriage and thus remotely rotatable from 6° up to 29° is foreseen. The Horizontal-Bend Magnet of the SHMS will be removed to install a 0.3 T.m sweeping magnet. The neutral-pion detector will consist of 1116 PbWO4 blocks (from the PRIMEX experiment), comprising a 25msr device at a distance of 4 meters allowing a full azimuthal coverage at small transfer t or small transverse momentum p_T . This detector will be equipped with new PMT bases and flash ADCs to cope with the high rates. A dedicated beam pipe with as large critical angle as possible and shielding are foreseen to reduce background.

The proposed experiment proposes to study R as a function of z and x , to scan R in Q^2 at fixed x and to scan R in t at fixed x/W (this last study only for DES).

Issues: The PAC recognizes a higher priority to the exclusive case than to the semi-inclusive one and proposes to the proponents to represent this experiment focused on the first case, which is an important step for the GPD interpretation of exclusive pion production.

The PAC is concerned by the statistical error of the measurement if R is as small as predicted by the VGL model. Presently only projections are done for a mean value between the 2 models VGG and VGL, which is roughly the value of VGG divided by 2 (for a value of VGL close to zero). So a limit for the minimal value of R which can be reached in the proposed time should be given.

The PAC recommends a detailed and realistic simulation of the π^0 detector including single and double photon (combinatorial) backgrounds and the angle- and momentum- dependent efficiency of π^0 reconstruction to

demonstrate that the point-to-point systematic error on the acceptance and efficiency of the neutral pion device is as small as claimed in the proposal.

If R is not too small, the relatively large acceptance of the neutral detector should provide a first investigation of σ_L as a function of t , notably at small x .

Title: “Exclusive Vector Meson Electroproduction with CLAS12”

Spokespersons: A. Fradi, M. Guidal, V. Kubarovsky, P. Stoler, C. Weiss

Motivation: The proposal aims to study exclusive vector meson (ρ^0 , ρ^+ , ω , ϕ) electroproduction above the resonance region for momentum transfers up to 13 GeV^2 . The main aim is to study the reaction mechanism and the transition between a soft physics regime and the regime where the process takes place on valence quarks (in case of ρ^0 , ρ^+ , ω) and gluons (in case of ϕ) in the nucleon. Such study can test scaling predictions which are a signature of parton dominated descriptions in terms of GPDs or TDAs.

Measurement and Feasibility: The experiment will use the upgraded CLAS12 detector, an 11 GeV highly polarized electron beam, and an unpolarized hydrogen LH_2 target. The large acceptance of CLAS12 will allow simultaneous detection of the scattered electrons and the meson decay products allowing for an exclusive measurement of the process. Furthermore, the study of the meson angular decay distribution will allow to test the s-channel helicity conservation and infer in this way an L/T separation. The experiment will build upon the expertise gained with the 6 GeV program where the different vector meson channels have been measured. Detailed simulations demonstrate that the proposed measurements seem feasible and can run simultaneously with already approved experiments to measure deeply virtual Compton scattering and pseudoscalar meson electroproduction.

Issues: The main issue is to present a more compelling and coherent physics case. The proposal lists a number of different theoretical approaches that have been developed with different degrees of rigor and in different quantitative detail. To make their case more compelling, it is recommended that the proponents more sharply formulate which physics questions they consider most important and demonstrate through their simulations how the proposed measurement will quantitatively impact on these physics questions. As an example, it would be useful to see how the proposed measurement of the ϕ electroproduction will impact on the interesting question of the gluon imaging in the proton in a more quantitative way. For the ρ electroproduction part, it was not demonstrated convincingly how the role of the $\pi\pi$ non-resonant background can be better controlled, especially on the lower side of the rho peak and for the larger x_B , larger Q^2 kinematics. The 6 GeV data could be used to test such a more detailed subtraction procedure.

In view of the above issues on the physics case, the PAC had the opinion, that the proposal in its present form does not belong to “the top half of the priority list to be established for the first 5 years of 12 GeV operations”.

Title: “Hard Photodisintegration of ^3He into pp and pn pairs”**Spokespersons:** R. Gilman, D. Higinbotham, I. Pomerantz (contact), S. Strauch

Motivation: This experiment proposed to use 2.2 GeV electrons to make photons using a Cu radiator in order to photodisintegrate ^3He into hard pp and pn pairs. The underlying physics motivation is to understand the mechanism of production of hard NN pairs. Quark counting arguments give a cross-section scaling of S^{-11} for NN pairs, which was in fact observed by this group for photon+d, and from limited data on pp from ^3He . Early results for photon + ^3He to pp found a surprise that pp pairs were much smaller than extrapolated np pairs from the deuteron; even in the scaling regime at high Q^2 . This experiment is the next step in a series of measurements this group has pursued on hard photodisintegration and is focused on experimental observables that could distinguish between hard re-scattering and initial-state correlations. The experiment would observe pp and pn pairs over a wide kinematic range of CM angles and recoil nucleon virtuality. The data set would allow various assumptions in the models to be tested. The measurement of hard pn pairs would confirm the speculations on why the hard pp pairs were suppressed.

Measurement and Feasibility: The proposed measurements were judged to be feasible. The experiment would use spectrometers in Hall A, an existing ^3He target, and an existing neutron detector system. All equipment is a standard configuration of the two HRS and beam-line base equipment including the cryogenic He-3 target and the special Cu radiator. The neutron detector HAND will be used for the detection of neutrons. This detector has been used previously in (e,e'n) measurements and its characteristics and backgrounds are reasonable well known. The incoming electron energy needed is 2.2 GeV. Because the beam quality requirements are low, this experiment could run early in the 12 GeV program and could serve as a commissioning experiment.

While the technical feasibility is high, the PAC found the feasibility to meet the physics goals less certain. While the PAC agreed that the current proposal might test between hard-rescattering and initial-state correlations by observation of cross section versus neutron virtuality, they felt that the results would provide only limited information on the nature of hard photodisintegration in the scaling regime, and limited information to answer questions on the nature of the excess cross section observed below 2 GeV in hard pp production, or to probe the nature of nucleon-nucleon correlations in nuclei.

Issues: Versions of the current proposal were turned-down by the previous two PACs. While the current proposal is more focused and improved, the PAC had the opinion that the scientific output would be limited and the scientific impact of the results would not be high. Hence, the judgment of the PAC is that this experiment does not meet the criteria to place it in the top half of the experiments for the first 5 years of 12 GeV running.

Proposal: PR12-11-105

Scientific Rating: A
Recommendation: Approve for 14 days

Title: “Polarized Electrons for Polarized Positrons”

Spokespersons: J. Grames, E. Voutier

Motivation: This experiment is a feasibility study for a future polarized positron beam facility at Jefferson Lab. It will study the polarization transfer from a few MeV electron beam (from the CEBAF injector) to positrons generated in a two-step process: polarized bremsstrahlung emission followed by pair conversion. The positron polarization is measured by reconvert them to polarized photons (bremsstrahlung) which are analyzed in a Compton transmission polarimeter using a magnetized iron foil. A polarized positron beam with reasonable intensity would be a major addition to the 12 GeV CEBAF and open up the possibility of new experiments to constrain GPDs and 2-photon effects.

Measurement and Feasibility: The requested 14 days will be used to set up and diagnose a new beam line for this experiment and then measure the polarization transfer at the limit of very small currents (of order 1 μA primary electron beam yielding about 1 pA of positron beam). The experiment seems feasible and most components are in hand. Preparations are already underway and a successful test during the 12MSD should be possible, assuming scheduling conflicts with the 12 GeV upgrade can be avoided or mitigated.

Issues: A high-energy, highly polarized positron beam even at the level of a few nA (or better) would bring a significant enhancement of the Physics capabilities of CEBAF. While the path from a first demonstration of polarization transfer at very low intensities to a fully optimized, higher current facility is neither obvious nor straightforward, the possible payout warrants the modest investment of resources and manpower. The PAC notes that there is a strong and enthusiastic group of people who will work on this project.

Summary. The PAC38, therefore, recommends approval of the full 14 days requested at the highest rating of A.

Title: “High Precision Measurement of the Proton Charge Radius”

Spokespersons: A. Gasparian (contact), M. Khandaker, H. Gao, D. Dutta

Motivation: The goal of the experiment is to make a measurement of the proton charge radius to a precision of 0.5%. The proponents hope to resolve the “proton charge radius crisis” stemming from a 6-sigma discrepancy between a new measurement of the Lamb shift in muonic hydrogen and existing data (Lamb shift in ordinary hydrogen and electron scattering experiments at other labs, including MAMI). The new experimental proton radius result from the muonic hydrogen Lamb shift is significantly smaller than electron based determinations and has a precision of 0.1%, about ten times better than other measurements. Testing of this result is among the most timely and important measurements in physics.

Measurement and Feasibility: The collaboration proposes to determine the proton charge radius from a high-precision measurement of $e-p$ elastic scattering at very low four-momentum transfer squared, Q^2 , from 10^{-4} to 10^{-2} $(\text{GeV}/c)^2$. They will use the Primex HYCAL (PbWO_4) calorimeter in hall B to measure .7 deg to 5 deg elastically scattered electrons from H in the target. For the measurement, they propose to use a cryogenically cooled 4 cm windowless hydrogen gas target. The absolute value of the $e-p$ cross section will be monitored by Møller scattering off electrons in the target. This is a novel technique that should be able to achieve the required precision. They are asking for 10 days + 5 days not in the original proposal for a blank target run (2 days) and target commissioning (3 days).

The measurement is very challenging since it requires measurement of elastically scattered electrons very close to the beam axis with high precision. The experiment will be sensitive to beam halo at a level of below 10^{-7} a few mm from the beam spot and require beam stability in position and angle to .1 mm over the length of the target. Interpretation of the measurement will require extension of radiative corrections down to 10^{-4} GeV^2 with the required precision.

Issues: From the time of the proposal to the PAC meeting the target design changed significantly and the beam time was adjusted from 10 to 15 days. Before the proposal can be approved and beam time assigned, the PAC would need to see more careful modeling related to beam halo with the exact target geometry proposed and all sources of background included. Until a realistic and final target design is completed, the beam requirements cannot be firmly established and matched to expected accelerator performance. In addition, the PAC was not convinced that all Coulomb effects were properly included in the simulations presented. The proponents will also need to demonstrate that they have a path to extend radiative corrections to 10^{-4} GeV^2 with the required precision.

With approval following an updated proposal with final target details, credible simulations of beam requirements including halo and stability, and a well defined path to extend reliability of radiative corrections to Q^2 down to 10^{-4} .

Title: “In Medium Nucleon Structure Functions, SRC, and the EMC effect”**Spokespersons:** O Hen (contact), L. Weinstein, S. Gilad, S.A. Wood

Motivation: It is proposed to measure semi-inclusive deep inelastic scattering (DIS) off the deuteron by “tagging” the DIS scattering with high momentum recoiling protons or neutrons emitted at large angle relative to the momentum transfer. This experiment will provide basic information on the structure of the deuteron and on the nature of the EMC effect. The existing experimental data hint that the EMC effect arises from DIS scattering on correlated, high momentum (high virtuality) nucleons in the nucleus. The goal of the experiment is to clarify the relationship between the effect from medium modification of the structure function of the nucleon and that due to the virtuality of the nucleon in DIS events from scattering of the deuteron by “tagging” the spectator nucleons (proton or neutron) with high momentum. Two different x' (x' is a Bjorken x equivalent quantity for a moving nucleon) values are proposed corresponding to two different values of Bjorken x with one in the region with no or small EMC effect and the other with EMC effect. The proposed quantity to compare with theoretical predictions is the ratio of “tagged” events of higher x' and lower x' divided by the same ratio for free nucleon scattering. This double ratio is believed to be sensitive to the medium modification effect of the structure function of the nucleon and relatively less sensitive to the correction for final state effects (FSI).

Measurement and Feasibility: This experiment will be performed in Hall C, using HMS and SHMS for detecting DIS scattered electrons, and a Large Acceptance Detector (LAD) for detecting protons and neutrons at backward angles. To keep a low cost the LAD is proposed to be constructed by using the Time-of-Flight (TOF) counters of CLAS, which will not be used for CLAS12. A dedicated scattering chamber with a large and thin backward window will be constructed to allow the protons to reach the LAD. In addition, adding a GEM detector is being considered to improve the angular resolution in detecting the protons. The estimated signal to background ratio is rather low for detecting neutrons: 1:20 for larger value of the proposed x' quantity. The projected results for neutron will not have much impact given the large backgrounds, though the data are “free”.

Issues: PAC is concerned by two issues; namely, the limited x' values of the proposed measurements, and the uncertainty in FSI and as such the clear interpretation of the data in the end.

This experiment proposed two x' values due to the use of two magnetic spectrometers with small acceptance. Using a larger acceptance device such as the proposed SoLID would provide wider kinematic coverage, important for the convincing interpretation of the data. However, the experiment as it is proposed will provide timely results, important for the understanding of the origin of the EMC effect and it is optimized for the proposed experimental configuration.

Two theoretical calculations presented in the proposal predict rather different FSI: from small to rather large. However, both calculations show rather consistent independence in the effect with respect to the value of x' . Therefore, the proposed experimental technique by forming the ratio between two x' values and also “tagging” backward angle events aims at minimizing the effect due to FSI. The proposed experiment will also take data at kinematics where FSI is expected to be large to test/improve calculations as well as at kinematics where the high-momentum tail part of the deuteron wave function is not well known.

Proposal: PR12-11-108

Scientific Rating: N/A

Recommendation: C2

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

Spokespersons: H. Gao, K. Allada, J.-P. Chen, Z.-E. Meziani

Motivation: This experiment will measure the semi-inclusive cross-sections for π^+ and π^- production from a transversely polarized proton target, using the large acceptance detector “SoLID” in Hall A. By mapping out the dependence of the target single spin asymmetry on the angle ϕ_h of the hadronic plane and the angle ϕ_s of the target spin (relative to the leptonic plane), one can (in principle) extract three of the leading twist transverse momentum-dependent structure functions (TMDs) of the proton. Measuring double spin asymmetries (with beam helicity) simultaneously, a fourth TMD becomes available. Together with equivalent measurements on ^3He (n), this type of experiment is crucial for a complete picture of the 3-D quark structure of the nucleon.

Measurement and Feasibility: The Proposal outlines a plausible experimental set up to realize this experiment, assuming that SoLID can be built as presently envisioned. However, more details are needed before the experiment can be approved. In particular, the PAC is requesting a complete design and cost estimate for the transversely polarized target to verify the rather the opening angle of 28 degrees (cone). Given a fully fleshed-out design, a detailed calculation of magnetic forces (and their consequences on alignment etc.) and field homogeneity over the target volume is needed, as well. Finally, a detailed simulation of the “sheet of flame” background, including electrons degraded in energy by synchrotron radiation in the Hall A arc dipoles is requested, together with a full specification of detector modifications (mechanical and/or electrical removal of affected sectors) and the impact on detector operation and tracking efficiency.

Issues: Some assumptions (target polarization “flip” every 2 hours via AFP; only 2% beam time devoted to background measurements) are probably too optimistic, but have only minor impact. The figure of merit of the proposed combination of a “conventional” solid state DNP polarized target with SoLID appears favorable; on the other hand, some limitations in x , Q^2 , and p_T coverage as well as the absence of measurements of the π^0 and kaon channels make the direct comparison with alternative proposals (HD ice transverse target in CLAS12) less clear cut. A future PAC will weigh the relative merits of these two approaches once the conditions for approval have been met.

Summary. The PAC38, therefore, recommends conditional approval (C2).

Title: “Studies of Di-hadrons Electroproduction in DIS with Unpolarized and Longitudinally Polarized Hydrogen and Deuterium Targets”

Spokespersons: A. Avakian, A. Courtoy, K. Griffioen, L. Pappalardo, S.A. Pereira

Motivation: The proposal aims to study higher twist distribution functions describing quark gluon correlations and chiral-odd-dihadron fragmentation functions. This proposal is complementary to several SIDIS proposals being considered in that it aims to detect a Di-hadron in its various flavour combinations K^+ , π^+ , π^0 . The experiment probes parton-parton correlations and is therefore sensitive to higher twist effects, and specifically those at twist three. Since the role of higher-twist is a major source of uncertainty in the analysis of TMDs, this proposal provides an additional opportunity to investigate the formalism underlying SIDIS.

Measurement and Feasibility: The experiment will use the upgraded CLAS12 detector, an 11 GeV highly polarized electron beam, and unpolarized hydrogen and deuterium as well as longitudinally polarized ammonia targets (NH₃ and ND₃). The large acceptance of CLAS12 will allow simultaneous detection of the scattered electrons and hadrons from the hadronization of the struck quarks and target fragments. The kinematical dependence of the sin(ϕ) moments for the current fragmentation region and also in the target fragmentation region will determine the underlying distribution and fragmentation functions. The proposed measurements seem feasible and can run simultaneously (pion final state), with already approved measurements using pion electro-production.

Issues: The proposal requires the incorporation of a RICH detector for the identification of charged particles in the momentum range from about 3-8 GeV/c. A RICH is needed for Kaon identification at high momentum where the time-of-flight system loses its resolving power and the low threshold Cerenkov counter has insufficient detection efficiency to reduce the pion contamination in the kaon sample.

The PAC was concerned about the priority of this new proposal compared to the already approved SIDIS experiments and had the opinion, that it does not belong to “the top half of the priority list to be established for the first 5 years of 12 GeV operations”.

Title: “The Deuteron Tensor Structure Function b_1 ”**Spokespersons:** J.-P. Chen, P. Solvignon, N. Kalantarians, O. Rondon, K. Slifer

Motivation: This proposal, a follow-up of LOI-11-003 submitted to PAC37, is dedicated to the measurement of the deuteron tensor structure function b_1 by measuring deep inelastic scattering from a tensor polarized deuterium target. All available models predict a small or vanishing value of b_1 at low x , however the first pioneering measurement of b_1 at HERMES revealed a crossover to an anomalously large negative value, albeit with a relatively large experimental uncertainty. This justifies the intention to make a precise measurement: confirmation that b_1 is relatively large may then require an explanation based on more exotic models for the deuteron, such as hidden color due to a 6-quark configuration.

Measurement and Feasibility: The collaboration proposes to carry out this experiment in Hall C, using the polarized UVa/JLab ND₃ target, the HMS/SHMS spectrometers and an unpolarized 115 nA electron beam. The tensor structure function b_1 is derived from the measurement of the difference between the transversely and longitudinally tensor polarized cross-sections, which is directly proportional to b_1 itself. From the measured value of b_1 the tensor asymmetry A_{zz} can be calculated, provided the structure function F_1 is known. The collaboration proposes to perform the measurement in 28 days of data taking at 11 GeV at the two x values of 0.3 and 0.5, which cover the range in which the HERMES data display the crossover of b_1 to large negative values.

Issues: Despite the interesting physics case presented, the PAC has identified several issues with this proposal.

1. One obvious problem is the theoretical interpretation of the results of this kind of experiments. Following the recommendation of PAC37 the collaboration has partially addressed this question by expanding the discussion of the expected behavior of $b_1(x)$ in various theoretical models. However to draw significant conclusions from this measurement, also given the limited kinematical coverage (see below) chosen, would require further work.
2. The chosen x range, although overlapping with the region in which the HERMES results were obtained, does not seem sufficient to determine $b_1(x)$ in such a way as to unambiguously establish its conventional or exotic behavior. The PAC encourages the collaboration to explore the possibility to carry out the measurement using a large acceptance spectrometer covering a wider x range.
3. The PAC has concerns about the proposed experimental method using the cross section difference between the transversely and longitudinally tensor polarized target configurations. Given a 5-tesla field for this type of target, the effect on the acceptance due to the target field for these configurations can be quite different, and such systematic uncertainties due to the acceptance and other effects may well be larger than the effect that the proponents are trying to measure.
4. The proponents should pursue the tensor asymmetry measurement technique. Currently, the proposed target has a rather low tensor polarization ($\sim 10\%$). It is crucial and important to pursue more vigorously techniques such as the RF “hole” burning technique to improve the tensor polarization of the target.

Proposal: PR12-11-111

Scientific Rating: N/A
Recommendation: Conditional Approved (C2)

Title: “Transverse spin effects in SIDIS at 11 GeV with a transversely polarized target using the CLAS12 detector”

Spokespersons: H. Avakian, F. Klein, M. Aghasyan, K. Joo, M. Contalbrigo

Motivation: The experiment focuses on measurements of the transverse single and double spin asymmetries in inclusive hadron electroproduction from protons polarized transversely to the beam direction. The measured asymmetries provide access to the leading twist parton distributions: transversity, Sivers function, and so-called pretzelosity function. The expected asymmetries are in the range 2-10% and will be studied as a function of 4 kinematic variables (x , Q^2 , z and p_T) to allow constraining all chiral-odd leading twist TMDs and provide information on sub-leading distribution functions. Some models predict an important role of the transverse momentum dependence in partonic dynamics, lattice calculations indicate effects in the p_T distribution due to spin-orbit correlations.

Measurement and Feasibility: Using CLAS12 with a transversely polarized HD-Ice target and a longitudinally polarized 11 GeV electron beam, data for pions and kaons will be taken simultaneously in a 4-dimensional scan, aiming at a substantially improved statistical precision compared to previous HERMES and COMPASS data. The proposed 100 days include 80 days of data taking and 20 days for calibration, test and set-up. For part of the program flavor tagging is required. The low-threshold Cherenkov detector has to be replaced by a RICH. Tests of the target in a high-intensity electron beam are planned in early 2012. The impact of Moeller scattering on the detector performance has to be well controlled. A combined analysis of unpolarized and longitudinally polarized data will constrain different TMDs and will provide an important contribution to nucleon tomography.

Issues: The measurement requires incorporation of the transversely polarized HD-Ice target into the 3-5 Tesla field of the CLAS12 solenoid. The transverse holding field is applied in the region where the longitudinal field of the main solenoid has to be compensated by an additional small solenoid leaving 60° acceptance and requiring some central trackers to be removed. In such a difficult configuration one needs to be sure about the proper magnetic and mechanical design and a sufficiently precise track reconstruction in the complicated field arrangement.

Conditions: The operation of the HD-Ice target in an electron beam with the requested beam current has to be proven. The magnetic field and detector configuration has to be optimized and the track reconstruction code has to be developed including the final configuration.

Proposal: PR12-11-112

Scientific Rating: A⁻

Recommendation: Approval for 19 days of beamtime

Title: “Precision measurement of the isospin dependence in the 2N and 3N short range correlation region”

Spokespersons: J. Arrington, D. Higinbotham, D.B. Day, P. Solvignon

Motivation: The main goal of this proposal is to measure the isospin dependence of 2N short range correlations by inclusive electron scattering on ^2H , ^3H and ^3He at $x > 1$. It will also extend to the $x > 2$ region where 3N-SRCs dominate. The inclusive method is preferred over triple-coincidence knockout measurements because final state interactions are much smaller and are expected to cancel largely in the ratio $^3\text{H}/^3\text{He}$. Compared to previous measurements on Ca isotopes the sensitivity to isospin dependence is significantly larger and will be measured to higher precision. An important advantage is that the wave functions for all three targets can be calculated exactly and predictions of different models of the isospin structure of SRCs can be tested.

Measurement and Feasibility: The proposed measurements seem feasible. The experiment is proposed for Hall A and uses the ^3H target setup developed for the MARATHON experiment. All other equipment is a standard configuration of the two HRS and beamline base equipment. The incoming electron energies are 2.2 and 4.4 GeV.

Issues: There are no major issues.

Proposal: PR12-11-113

Scientific Rating: N/A
Recommendation: Deferred

Title: “Detailed studies of the Nuclear Dependence of $R = \sigma_L / \sigma_T$ ”

Spokespersons: L. Zhu, C. Keppel, E. Christy, D. Gaskell and P. Solvignon

Motivation: This proposal aims to measure the value of R in various targets under a range of kinematic conditions and thereby determine its nuclear dependence with x and Q^2 . Such a study would be useful to explore the nature of the EMC effect. The data could be used to determine the structure functions (F_T , F_2 and F_L) for a number of elements and form the nuclear EMC-type ratios in terms of structure functions over a wide kinematic range.

Measurement and Feasibility: The proposed measurements appear to be doable. However, there was some concern that Coulomb corrections and other QED effects may not be well enough understood to provide an unambiguous interpretation of the data, and clearly demonstrate significant nuclear dependence of R values. Based on previous data, R appears to be small and the corrections may be larger than the nuclear effects.

Issues: The main issue considered by the PAC was that even though the proposed measurements would cover a wider range of targets and kinematic conditions, a convincing case was not made that the claimed reach of this proposal would provide a significant improvement over already published results by E140 at SLAC.

The PAC recommends deferment of this proposal based on the view that it would not significantly improve our knowledge of R in nuclei beyond the already existing SLAC E140 results. At its projected sensitivity, this measurement would not sufficiently extend our physics understanding to a level that would make it one of the top half of the experiments to be approved by the PAC for the 12GeV era at JLAB.

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

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

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

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

Issues: The PAC endorses the physics goals of the experiment and recognizes that the data is expected be collected on a timescale that would be substantially earlier than the SOLID polarized ^3He SIDIS experiment. The data collected will also be at somewhat higher Q^2 and higher x than the SOLID experiment; it, therefore, represents a complementary measurement.

The PAC recognizes that there is a risk in the experiment coming from anticipated high background rates. If the spectrometer operation cannot handle the background rates, the experiment may have to run at a substantially reduced beam current. The program that depends on kaon tagging is especially at risk due to background issues. The PAC recommends that the Laboratory management keep close watch on the progress in the experimental design and simulations as they develop towards the running of the experiment. The experiment also requires a major upgrade of the ^3He target so that it can operate at 65% polarization in a 40 μA beam current. Significant R&D will be required to accomplish this technical goal.

Proposals for Grading

Proposal: E12-06-108

Scientific Rating: B
Recommendation: 80 days

Title: “Hard Exclusive Electroproduction of π^0 and η with CLAS12”

In view of new theory developments, the PAC wants to make a strong encouragement to strengthen the physics case for hard exclusive electroproduction of pseudoscalar mesons with CLAS12. In particular, it is very timely to better quantify which higher twist information is accessible in such measurement and how the proposed measurement will impact on these new physics quantities.

To achieve such goal, the PAC approves the 80 days of beamtime at 11 GeV which are concurrent with the DVCS CLAS12 experiment E12-06-119. The PAC felt that the case for a running at lower energies with the aim of an L/T separation was not convincingly demonstrated by the present proposal.

Proposal: E12-06-112

Scientific Rating: A
Recommendation: 60 days

Title: “Probing the Proton’s Quark Dynamics in Semi-Inclusive Pion Production at 12 GeV”

The main goal of the proposed experiment is accessing the Boer-Mulders (B-M) function, a leading twist transverse-momentum-dependent (TMD) distribution function by studying azimuthal asymmetries in semi-inclusive electro-production of pions using the JLab 12 GeV polarized electron beam and the CLAS12 detector with an unpolarized hydrogen target. The B-M function is sensitive to the interference between different L-waves in the light-cone wave function and as such it provides the much needed information on the orbital motion of quarks. E12-06-112 is an important component of the JLab 12-GeV program on TMDs with the CLAS12 base equipment.

Proposal: E12-06-114

Scientific Rating: A
Recommendation: 100 days

Title: “Measurements of the Electron-Helicity Dependent Cross Sections of Deeply Virtual Compton Scattering with CEBAF at 11 GeV” - UPDATE

The GPDs program is at the heart of the scientific motivation of the 12 GeV upgrade of JLab. The deeply virtual Compton scattering (DVCS) is the golden channel for this program. The main goal of this experiment is to provide very precise measurements of the DVCS cross sections in Hall A. This will test the validity of the twist-2 dominance or of the leading order analysis. This experiment is crucial to consolidate the theoretical framework to analyze the asymmetry measurements performed in a wider kinematic range with CLAS. The PR12-06-114 and PR12-06-119 are really complementary to emphasize the full potential of JLab 12 GeV.

The PAC38, therefore, recommends a rating of A and the full 100 days requested.

Proposal: E12-06-119

Scientific Rating: A
Recommendation: 200 days

Title: “Deeply Virtual Compton Scattering with CLAS12 at 11 GeV” - UPDATE

The GPDs program is at the heart of the scientific motivation of the 12 GeV upgrade of JLab. The deeply virtual Compton scattering (DVCS) is the golden channel for this program. Together with the precise measurements of the DVCS cross sections in Hall A which will consolidate the theoretical framework, the asymmetry measurements proposed in this experiment will paved the wide kinematic range accessible with CLAS and will provide an unprecedented DVCS data set to reveal the full potential of JLab upgrade at 11 GeV with a huge luminosity.

The PAC38, therefore, recommends a rating of A and the full 200 days requested.

Proposal: E12-07-105

Scientific Rating: A-
Recommendation: 36 days

Title: “Scaling Study of the L-T Separated Pion Electro-production Cross-Section at 11 GeV”

The measurement of the longitudinal cross section of exclusive electroproduction of charged pions at large momentum transfers in the scaling regime provides a way - complementary to the DVCS program - to access helicity flip GPDs. The present experiment will be able to explore this scaling regime at 11 GeV by performing an L/T separation. Besides the test of the GPD formalism in the L cross section, the simultaneous measurement of the subdominant T cross section, for which at present no firm theoretical formalism exists, will allow to trigger new theory developments.

The PAC approves the experiments for the full requested amount of 36 days.

Proposal: E12-07-107

Scientific Rating: A-
Recommendation: 103 days

Title: “Studies of Spin-Orbit Correlations with Longitudinally Polarized Target”

The objectives of the E12-07-107 experiment include asymmetries measurements sensitive to the $h_{1L}^{(x, kT)}$ distribution function describing transversely polarized quarks in a longitudinally polarized nucleon using polarized protons and neutrons. This experiment is an important contributor to the overall studies of SIDIS processes with large acceptance CLAS12 spectrometer. The measurements concentrate on pions, so they do not require a RICH, but an optimal solution would be parallel running with E12-09-007, which does require a RICH.

For the analysis methods with conversion to b_T space and Bessel function weighting are developed. Data would be complementary to information on neutron provided with SOLID.

The scientific rate assigned was A- and beam time approved is as asked 103 days.

Proposal: E12-09-002

**Scientific Rating: A-
Recommendation: 22 days**

Title: “Charge Symmetry Violating Quark Distributions via Precise Measurement of π^+/π^- Ratios in Semi inclusive Deep Inelastic Scattering.”

The PAC strongly endorses this proposal. (grade A-) as a precision experiment in Hall C, which could exhibit deviations pointing to possible charge symmetry violating distributions, and which also is of interest in combination with Hall B measurements. The PAC approves the 22 days asked for.

Proposal: E12-09-007

**Scientific Rating: A-
Recommendation: 110 days**

Title: “Studies of Partonic Distributions using Semi-Inclusive Production of Kaons”

The PAC strongly endorses this proposal (grade A-) as part of the study of improving our knowledge of integrated quark and antiquark polarized distributions separated for the various flavors, The PAC approves of the time asked for polarized measurements, 80 days, but is not convinced that this experiment justifies 56 days of unpolarized measurements and approves for this part 30 days

Proposal: E12-09-008

**Scientific Rating: A-
Recommendation: TBA**

Title: “Studies of the Boer-Mulders Asymmetry in Kaon Electroproduction with Hydrogen and Deuterium Targets”

The main goal of the proposed experiment is accessing the Boer-Mulders (B-M) function, a leading twist transverse-momentum-dependent (TMD) distribution function by studying azimuthal asymmetries in semi-inclusive electro-production of kaons using the JLab 12 GeV polarized electron beam, the CLAS12 detector, and unpolarized hydrogen and deuterium targets. The B-M function is related to the interference between the $L=0$ and the $L=1$ light-cone wave functions and provides the much needed information on the orbital motion of quarks. The identification of the kaons in the complete kinematic region requires the proposed CLAS12-RICH proximity-focusing detector. The final allocation of beam time requires a detailed justification of the request in terms of statistical precision required and a clear discussion of which targets (H2, D2 or combination H2-D2) are to be used and why.

Proposals: E12-09-009

**Scientific Rating: B+
Recommendation: 103 days**

Title: “Studies of Spin-Orbit Correlations in Kaon Electroproduction in DIS with Polarized Hydrogen and Deuterium Targets”

Scheduling of this proposal should be subject to a thorough evaluation of its overlap, compatibility and contribution to a comprehensive overall strategy for measuring semi-inclusive π^+ , π^0 , π^- , K^+ , K^- , K_s with complete 5-dimensional coverage. The need for a RICH for improved kaon identification is a key component to these studies.

Proposal: E12-09-011

Scientific Rating: B+
Recommendation: 40 days

Title: “Studies of the L-T Separated Kaon Electroproduction Cross Section from 5-11 GeV”

The PAC strongly endorses this proposal, which is part of the JLAB investigations into exclusive meson production, in this case emphasizing on Kaons. The specific emphasis of this experiment is on L-T separated data, checking scaling behavior and t-channel mechanisms. The actual grade being somewhat lower than some of the other experiments in related categories reflects the charge given to the PAC to emphasize priorities for the first five years. The PAC approves the 40 days of beamtime asked for.

Proposal: E12-09-017

Scientific Rating: A-
Recommendation: 32 days

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

The PAC strongly endorses this proposal (grade A-) as an essential study to clarify a number of aspects related to TMD distribution functions using high precision measurements from Hall C to complement the CLAS12 studies. It is approved for 32 days.

Proposal E12-10-006

Scientific Rating: A
Recommendation: 90 days

Title: “SOLID-He3(T) An update to PR12-09-014: Target Single Spin Asymmetry in Semi-Inclusive Deep-Inelastic Electro Pion Production on a Transversely Polarized ^3He Target at 8.8 and 11 GeV”

This proposal aims to measure Target Spin Asymmetry using polarized ^3He in Hall A. This is an ambitious project, which the PAC considered technically challenging with the target subject to subtle nuclear and hadron effects. The proposal requires the installation of a solenoidal detector SoLID. As part of the overall SIDIS program a measurement of target spin asymmetry with a transversely polarized target is required.

Proposal: E12-11-003

Scientific Rating: A
Recommendation: 90 days

Title: “Deeply Virtual Compton Scattering on the neutron with CLAS12 at 11 GeV” - UPDATE

DVCS measurement on the neutron is the necessary complement to the DVCS program on the proton. It allows a quark flavor separation of unpolarized GPDs contribution and it exhibits a large sensitivity to the GPD E which is of special interest as it enters into the angular momentum sum rule.

The experiment will access the beam-helicity asymmetry for the n-DVCS process from the quasi-free scattering process on the deuteron: $ed \rightarrow e \gamma n (p)$. The recoiling neutron will be measured using a newly constructed scintillator barrel central neutron detector (CND). Final designs of the CND detector, of the solenoid magnet and of the CTOF are now fixed in order to avoid any mechanical interference. Background coming from $ed \rightarrow e \pi^0 n (p)$ (when one photon of π^0 is not detected) is evaluated to be of the order of 15%. The issue of contamination by the channel $ed \rightarrow e \gamma \Delta^+ (n) \rightarrow e \gamma n \pi^+ (n)$ (when the π^+ is not detected) has been clearly investigated. A cut on missing mass of the system $e \gamma n$ allows a background contamination smaller than 4%. These two estimations are model dependent, and they will be determined in parallel to the main measurement.

The PAC38, therefore, recommends a rating of A and the full 90 days requested.

Proposal: E12-11-007

Scientific Rating: A
Recommendation: 35 days

Title: “Asymmetries in Semi-Inclusive Deep-Inelastic ($e, e'\pi^\pm$) Reactions on a Longitudinally Polarized ^3He Target at 8.8 and 11 GeV” - UPDATE

This experiment will measure the semi-inclusive cross-sections for π^+ and π^- production from a longitudinally polarized Helium-3 target, using the large acceptance detector “SoLID” in Hall A. By mapping out the dependence of the target single spin asymmetry and the beam-target double spin asymmetry on the angle ϕ_h of the hadronic plane, one can (in principle) extract two of the leading twist transverse momentum-dependent structure functions (TMDs) of the neutron (g_1 and h_{1L}^\perp), as well as higher twist TMDs. Together with equivalent measurements on the proton and deuteron, this type of experiment is crucial for a complete picture of the 3-D quark structure of the nucleon.

Assuming the availability of SoLID as presently envisioned, the experiment appears straightforward. The expected performance of the polarized ^3He target has already been achieved; a higher figure of merit is possible and might lead to even smaller error bars or shorter running time.

The PAC38, therefore, recommends a rating of A and the full 35 days requested.

Letters of Intent Reports

Letter of Intent: LOI11-101

Title: “Measurement of the Gluon Polarization with High-PT Kaon Pairs in CLAS12”

Spokespersons: G. Gavalian et al.

Motivation: The proponents of this Letter would like to determine the gluon contribution to the proton spin, $\Delta G/G$, at high x where it is expected to be relatively large. They hope to extract that quantity using polarized electron scattering on a polarized Hydrogen target and detecting high p_T kaon pairs with the CLAS12 detector upgraded with a RICH detector for kaon identification.

Measurement and Feasibility: The experiment would measure the double spin asymmetry in high p_T kaon pair production and after correcting for backgrounds, extract the photon-gluon fusion component of the asymmetry due to polarized gluon effects. It is argued that preliminary studies of backgrounds using Pythia suggest that a separation from background is possible. The PAC did not feel that a complete study was done.

Issues: The PAC was concerned about the use of Pythia at low energies, especially for kaons, where it is expected to be unreliable. The level of precision needed for the measurement was not demonstrated and not all background processes seem to have been considered.

Recommendation: At this time, the PAC does not encourage the proponents to submit a proposal.

Letter of Intent: LOI11-102

Title: “Measurement of (γ,α) reactions with a bubble chamber”

Spokespersons: C. Ugalde and R. Suleiman

Motivation: The proponents of this Letter aim to determine inverse fusion reactions via photo-production of alpha particles of various nuclear targets. A novel feature is the use of a superheated liquid bubble chamber to detect alpha-particles and recoil nuclei, an idea borrowed from dark matter detectors. The PAC was impressed by the physics goals and the originality of the experimental approach.

Measurement and Feasibility: The proponents would actually like to carry out a feasibility study to see if an appropriate broad low energy bremsstrahlung photon beam can be produced with the CEBAF injector. They also wish to study beam induced radiation backgrounds, requesting 48 hours of beam time to examine that issue.

Issues: Whether or not such a low energy bremsstrahlung facility can run parasitic to the main JLAB program needs to be examined by the laboratory and the proponents.

Recommendation: The PAC encourages the proponents to further examine, with laboratory input, the suitability of JLAB for their envisioned facility and if appropriate, to develop a full proposal for the requested 48 hours of beam time.

Letter of Intent: LOI11-103

Title: “Photoproduction of two Delta-isobars from the Deuteron”

Spokesperson: D. Dutta

Motivation: This proposal is dedicated to the measurement of the cross sections and angular distributions for $\Delta\Delta$ photoproduction from the deuteron at large transverse momenta. The purpose of these measurements is to understand the role of quark-gluon degrees of freedom in the short range structure of nuclei. In particular the proponents aim at testing the QCD prediction according to which there should be a sizeable “hidden color” component in the six quark wavefunction of the deuteron at short distances. The angular dependence of $\Delta\Delta$ photoproduction is sensitive to this “hidden color” component.

Measurement and Feasibility: The collaboration intends to carry out this measurement in Hall A, using a 6 % Cu radiator to generate the Bremsstrahlung photon beam which would be incident on a liquid deuterium target. The SuperBigBite (SBS) and BigBite (BB) spectrometers would be used to measure the cross sections of the processes $\gamma d \rightarrow \Delta^{++} \Delta^-$ and $\gamma d \rightarrow \Delta^+ \Delta^0$ at three different angles, at a photon energy of ~ 4.3 GeV, with an electron beam energy of 4.4 GeV. The decay products of the two Δ resonances would be measured in the two spectrometers. By measuring the angular distributions and ratios of cross sections for the two $\Delta\Delta$ final states the collaboration intends to distinguish between two different dynamical pictures: hidden color component in the deuteron versus $NN \rightarrow \Delta\Delta$ hard rescattering in the final states. The estimated beam time to accomplish this measurement is of 14 days at 4.4 GeV.

Issues: The main issue related to this measurement is the interpretation of the results in terms of the competing dynamical mechanisms responsible for $\Delta\Delta$ photoproduction. If both suggested mechanisms contribute, it is not known at present if there is any interference between them. An interpretation of the results in this scenario would be obviously problematic. Also this uncertainty makes it difficult to establish the sensitivity of this measurement to a hidden color component.

Recommendation: The possible existence of a sizeable “hidden color” component in the deuteron wave function at short distances is a longstanding, interesting idea. The PAC recommends that the above issues be addressed before this LOI is developed into a full proposal.

Letter of Intent: LOI11-104

Title: “Measuring the EMC Effect with tagged high momentum recoil nucleons”

Spokespersons: O. Hen, L.B. Weinstein, S. Gilad, S.A. Wood

Motivation: The letter of intent aims for a better understanding between the EMC effect and Short-Range-Correlations. While by now the EMC effect has been observed in many experiments, and its possible origins is a whole literature by itself, a few new insights have been gained beyond a suggestion that part of the effect may be connected to Short-Range-Correlations in the nuclei.

This letter of intent is related to the proposal PR12-11-107, by extending the measurements of tagged structure function ratios proposed there for the deuteron to the case of ^4He nuclei.

Measurement and Feasibility: The proposed measurements seem feasible. This experiment is a semi-inclusive deep inelastic scattering measurement on helium using the HMS and SHMS for electron detection and the Large Acceptance Detector (LAD) from decommissioned CLAS6 for back-scattered protons and neutrons.

Recommendation: The possible relationship between the size of the nuclear EMC effect at $x < 1$ and the nuclear cross section ratio plateaus at $x > 1$ is a fascinating one, which deserves further study. The PAC encouraged the collaboration to bring forward a full proposal.

Letter of Intent: LOI11-105

Title: “Deeply Virtual Compton Scattering at 11 GeV with transversely polarized target Using the CLAS12 Detector”

Spokespersons: H. Avakian, V.D. Burkert, L. Elouadrhiri, M. Guidal, M. Ungaro

Motivation: The proposed measurement is highly sensitive to GPD-E and contributions of u and d quarks to the total orbital angular momentum. Access to the real part of the target spin dependent DVCS amplitude through double spin asymmetries TDSA. Measurement on hydrogen and deuterium with the same experimental set-up.

Measurement and Feasibility: Measurement with transversely polarized target and CLAS detector dedicated to DVCS. Expected asymmetries of the order of 20-40%, importance of good acceptance for Phi moments determination. Requires HD-Ice target and RICH detector for wide range PID. Require 120 days including 80 days with HD target, 30 days with polarized deuterium and 10 days for calibration.

Issues: This project would only be possible if the HD-Ice target would work with electron beam of sufficient intensity. Incorporation of transversely polarized target to CLAS12 detector is challenging. Detailed design of the magnets in the central part of CLAS12 would be required as well as proof that in the proposed condition reconstruction could work and background stays under control. To allow concurrent data taking with SIDIS experiment E12-11-112 the tracking region should be extended to 70 deg. (required for DVCS) for the common solution.

Recommendation: proceed toward the full proposal as soon as the proof of the HD-Ice target working with electron beam will be obtained. Coordinate design of the target implementation with E12-11-112.

Letter of Intent: LOI11-106

Title: “ e^+e^- pair production with CLAS12 at 11 GeV”

Spokesperson: S. Stepanyan

Motivation: This LOI is dedicated to the study of exclusive e^+e^- pair photo- and electroproduction in Hall B. e^+e^- pair production gives access to timelike Compton scattering (TCS), which is relevant for the determination of nucleon Generalized Parton Distributions (GPDs) for quark in the valence region. Furthermore the measurement of J/ψ photo- and electroproduction on the nucleon (and possibly also on nuclear targets) will allow the study of the gluonic structure of the nucleon at large x .

Measurement and Feasibility: The collaboration intends to carry out this measurement in Hall B, using the CLAS12 detector with an 11 GeV electron beam hitting a 10 cm long LH₂ target. Exclusive and semi-exclusive final states will be used to identify (e^+e^-) pair production over a wide range of total c.m. energy s and transferred momentum squared t for (e^+e^-) invariant masses up to ~ 3.3 GeV/ c^2 . TCS will be studied in the range of outgoing photon virtualities from 4 GeV² to 9 GeV². J/ψ production will be studied in the energy range from threshold to 11 GeV. Monte Carlo simulations have been carried out, demonstrating that the intended measurements can be carried out in parallel with already approved electroproduction experiments using CLAS12 and the 11 GeV beam. The experiment requires the standard CLAS12 setup with the forward tagger.

Issues: The experimental program has a large overlap with that of a previously submitted proposal (C12-07-106, conditionally approved by PAC 32) and an LOI (LOI12-11-002, submitted to PAC37). The complementarity and relative merits of these proposals should be investigated. Most studies outlined in the present LOI can be done in parallel with other CLAS12 experiments, but some additional running time might be needed for J/ψ production on nuclear targets and for J/ψ electroproduction. This extra time should be quantified.

Recommendation: The physics addressed in this proposal is very relevant for the JLAB 12 GeV program. The PAC encourages the development of a full proposal.

Letter of Intent: LOI11-107

Title: “Helicity structure of exclusive hyperon production above the resonance region”

Spokespersons: Y. Iieva, R. Gilman, P. Mattione, P. Nadel-Turonski, B.J. Roy

Motivation: The letter of intent proposes a program to study the exclusive reaction $\gamma p \rightarrow K+\Lambda$ in the kinematic region of large center-of-mass energy, $s > 10 \text{ GeV}^2$, and large invariant momentum transfer $t, u \sim$ a few GeV^2 , corresponding to wide-angle scattering. By measuring a complete set of polarization observable it is planned to extract the helicity amplitudes of the process in a model independent way. The main aim of the LOI is in discriminating between different dynamical mechanisms of high- t photoproduction, the hard scattering mechanism against non-perturbative interactions.

Measurement and Feasibility: The proposed experimental program seems feasible. The experiment would be accomplished by combining measurements with linearly polarized photons with the GlueX-detector in Hall D and with quasi-real photons and a polarized target with the CLAS12-detector in Hall B.

Recommendation: The PAC considers that polarization observables can be very useful in discriminating between different dynamical mechanisms of high- t photoproduction, but one needs quantitative model calculations to show that one can distinguish between the different mechanisms. The spokespersons are encouraged to bring forward a proposal showing the necessary support from the theory side and the Hall-D and Hall-B collaborations, where the experiments are planned to be performed.

Program Status

12 GeV Approved Experiments by Physics Topics

Topic	Hall A	Hall B	Hall C	Hall D	Total
The Hadron spectra as probes of QCD (GluEx and heavy baryon and meson spectroscopy)		1		1	2
The transverse structure of the hadrons (Elastic and transition Form Factors)	4	2	2		8
The longitudinal structure of the hadrons (Unpolarized and polarized parton distribution functions)	2	2	5		9
The 3D structure of the hadrons (Generalized Parton Distributions and Transverse Momentum Distributions)	4	8	3		15
Hadrons and cold nuclear matter (Medium modification of the nucleons, quark hadronization, N-N correlations, hypernuclear spectroscopy, few-body experiments)	2	2	6		10
Low-energy tests of the Standard Model and Fundamental Symmetries	3			1	4
TOTAL	15	15	16	2	48

12 GeV Approved Experiments by PAC Days

Topic	Hall A	Hall B	Hall C	Hall D	Total
The Hadron spectra as probes of QCD (GluEx and heavy baryon and meson spectroscopy)		119	0	120	239
The transverse structure of the hadrons (Elastic and transition Form Factors)	144	70	102		316
The longitudinal structure of the hadrons (Unpolarized and polarized parton distribution functions)	65	120	140		325
The 3D structure of the hadrons (Generalized Parton Distributions and Transverse Momentum Distributions)	289	802	108		1199
Hadrons and cold nuclear matter (Medium modification of the nucleons, quark hadronization, N-N correlations, hypernuclear spectroscopy, few-body experiments)	54	120	179		353
Low-energy tests of the Standard Model and Fundamental Symmetries	547			79	626
TOTAL	1099	1231	529	199	3058

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Charge to PAC38

1.) Review new proposals, previously conditionally approved proposals, and letters of intent[†] for experiments that will utilize the 12 GeV upgrade of CEBAF and provide advice on their scientific merit, technical feasibility and resource requirements.

Identify proposals with high-quality physics that, based on what we know today, are of sufficient scientific merit that they will be included in the top half of the priority list to be established for the first 5 years of 12 GeV operations and recommend for approval. Also provide a recommendation on scientific rating and beamtime allocation for newly approved proposals.

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

2.) For the 12 GeV program category “The 3D structure of the hadrons”, review previously approved proposals (including those recommended for approval at this PAC meeting under charge element 1) and recommend a scientific rating and beamtime allocation.

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

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