CEBAF Program Advisory Committee Nine
Extension and Update Cover Sheet

This update must be received by close of business on Thursday, December 1, 1994 at:

CEBAF
User Liaison Office, Mail Stop 12 B
12000 Jefferson Avenue
Newport News, VA 23606

Experiment: E -

Check Applicable Boxes:

☐ Extension ☒ Update ☐ Hall B Update

Contact Person

Name:
Institution:
Address:
Address:
City, State ZIP/Country:
Phone: **FAX:**
E-Mail → Internet:

CEBAF Use Only

Receipt Date: 12/15/94 PR 94-125

By: P

A Summary of the CLAS $\gamma 2$ Running Period

B. G. Ritchie, Arizona State University,
for the
$\gamma 2$ Experiment Group

[December 15, 1994]

Introduction

During previous Program Advisory Committee meetings, the PAC has urged experiment participants to maximize the scientific output from beam delivered to Hall B by exploiting the capability of the CLAS to simultaneously obtain data for experiments with similar trigger, beam, and target combinations. At the same time, however, all experiments were evaluated on their individual merits as "stand-alone" experiments.

The CLAS collaboration has identified a number of experiment combinations which will run simultaneously with minor compromises in terms of event rates and resolution. One such combination identified by the CLAS Collaboration, which has been labelled as the "$\gamma 2$" running period, involves the following approved experiments with similar target/trigger/beam requirements as described below:

- E89-045–Study of Kaon Photoproduction on Deuterium, B. A. Mecking, *et al.*
- E93-008–Inclusive η Photoproduction in Nuclei, M. F. Vineyard, *et al.*
- E93-017–Study of the $\gamma d \rightarrow pn$ and $\gamma d \rightarrow p\Delta^0$ Reactions for Small Momentum Transfers, P. Rossi, *et al.*
- E94-008–Photoproduction of η and η' from Deuterium, B. G. Ritchie *et al.*

The purpose of this communication is to provide a brief synopsis of the motivations and design parameters which make this grouping of experiments feasible and appealing in terms of physics to be produced and in terms of efficient utilization of beam time.

Scientific motivations

The scientific motivations for these studies span much of the intersection between particle and nuclear physics.

Cross sections measurements for photoproduction of kaons (E89-045) and eta mesons (E93-008 and E94-008) on deuterium will provide insight into the photoproduction amplitudes on the neutron, complementing similar studies on the proton, while also allowing the possibility of investigating nuclear effects in coherent photoproduction. The combination of data from the various channels will permit critical investigations of models of nucleon resonances and the mesons themselves, as well as providing a test of the role of final state interactions in this very simple nucleus. Existing data on these photoproduction processes is either very limited or non-existent.

Running in parallel with these measurements, E93-017 will provide accurate cross sections over a broad kinematical range for the photodisintegration of the deuteron. The present database is limited in kinematical coverage and accuracy, leading to significant ambiguities in the theoretical description of the process. As the simplest nucleus, electromagnetic studies of the deuteron are crucial in elucidating the important reaction mechanisms and phenomena present in heavier nuclei. Previous studies of photodisintegration have been crucial in establishing the limits of meson field theory models of the process. This experiment will also pay particular attention to the channel $\gamma d \rightarrow p\Delta^0$ in order to yield stringent tests of conventional meson/isobar-based and quark-gluon-string-based models of the photodisintegration process at energies where quark degrees of freedom may prove useful.

While the motivations for these experiments are discussed more fully within the original proposals and updates, it is important to underscore that these experiments fall into a context including much of the physics to be accomplished in Hall B. They provide important connections and extensions to experiments using other targets and using electroproduction measurements to address similar physics interests as those outlined above.

Experiment design parameters

While their scientific motivations and goals are diverse, these experiments share the following experiment design features:

- **Electron beam energy**: 1.6 GeV
- **Tagged photon energy**: 0.6 to 1.5 GeV
- **Target:** CLAS standard liquid deuterium target
- **Trigger:** Tagged photon + one hadron in CLAS
- **Photon tagger rate:** about 10^7/sec
- **CLAS event rate:** $\leq$ 1500/sec
- **CLAS magnetic field:** full field, with positive particles bent outward

One of these experiments, E93-017, requires an additional running period of about 3 days to cover the photon energy range from 0.4 to 1.5 GeV.

The various collaborations responsible for each of these experiments have provided significant and critical components of the instrumentation in Hall B, as detailed in their individual updates. All of the experiments were reviewed and approved by the CLAS Collaboration, and all are designated CLAS Collaboration experiments.

These experiments have been approved for approximately 20 days of running on a liquid deuterium target. With set-up time, the γ2 running period would require about 28 days. Should the running period be broken up into several periods, as might be expected during the early stages of Hall B operation, additional set-up time of about 5 days per period would be anticipated.

CEBAF Program Advisory Committee Nine
Extension and Update Cover Sheet

This update must be received by close of business on Thursday December 1, 1994 at:
CEBAF
User Liaison Office, Mail Stop 12 B
12000 Jefferson Avenue
Newport News, VA 23606

Experiment: **Check Applicable Boxes:**

E 89 - 045 ☐ **Extension** ☐ **Update** ☑ **Hall B Update**

Contact Person

Name: Dr. Bernhard A. Mecking

Institution: CEBAF

Address: Continuous Electron Beam Accelerator Facility

Address: 12000 Jefferson Avenue

City, State, ZIP/Country: Newport News, VA 23606

Phone: (804) 249-7561 **FAX:** (804) 249-~~7398~~ 5800

E-mail--Internet: mecking@cebaf.gov

CEBAF Use Only

Receipt Date: ______________________________

By: ______________________________

PAC9 Update of Experiment E89-045

STUDY OF KAON PHOTOPRODUCTION ON DEUTERIUM

Spokesperson: B.A. Mecking

B.L. Berman[1], W.J. Briscoe[1], V.D. Burkert[2], W. Brooks[2], P.L. Cole[1], J.P. Connelly[1], H. Crannell[3], K.S. Dhuga[1], D. Doughty[4], D. Heddle[4], E.V. Hungerford[5], K. Lan[5], K. Maeda[6], B.W. Mayes[5], B.A. Mecking[2], M.D. Mestayer[2], B. Niczyporuk[2], J.T. O'Brien[3], L.S. Pinsky[5], B.G. Ritchie[9], R.A Schumacher[7], R. Sealock[8], E.S. Smith[2], D.I. Sober[3], S. Thornton[8], A. Yegneswaran[2]

[1]George Washington University, [2]CEBAF, [3]Catholic University of America, [4]Christopher Newport University, [5]University of Houston, [6]Tohoku University, Sendai (Japan), [7]Carnegie Mellon University, [8]University of Virginia, [9]Arizona State University.

Physics Motivation

The photoproduction of kaons on deuterium is governed by three main ingredients:

(1) the amplitudes for the elementary $\gamma N \rightarrow KY$ process,
(2) the deuteron wave function, and
(3) the interaction between the final state hadrons.

The relative importance of quasi-free production and final state interactions can be emphasized or de-emphasized by the choice of the kinematical conditions. The following questions can be investigated:

1. In quasi-free kinematics, the differential cross sections for the elementary hyperon production on the neutron can be determined. The measurements can be used to test the predictive power of the present theoretical description of hyperon photoproduction, and to determine the KYN coupling constants. The following reactions for which little experimental information is available can be investigated:

   $\gamma n \rightarrow K^+\Sigma^-$
   $\gamma n \rightarrow K^0\Lambda$
   $\gamma n \rightarrow K^0\Sigma^0$

2. Λn and Σn interactions can be studied by selecting kinematical conditions far away from the quasi-free kinematics.
3. $\Lambda - \Sigma$ channel coupling effects can be investigated; channel coupling has been predicted to lead to a rapid variation of the differential cross section (cusp) as the threshold for Σ-production is crossed.

Theoretical Developments

Since the submission of the original proposal, substantial progress has been made in the theoretical description of photo- and electroproduction of kaons. In particular, the combined analysis of all available data puts stronger constraints on the KYN coupling constants. Cotanch[1] et al. have made a combined fit of the Λ and Σ photo- and electroproduction data. Bennhold[2] et al. have also taken charged Σ production into account. Li[3] et al. have analysed kaon production off the neutron using a deuterium target. An interesting approach is the treatment of hyperon photoproduction in a semi-relativistic quark model by Kumar and Onley[4].

The Experimental Procedure

Experiment E-89-045 will study the photoproduction of Λ and Σ hyperons on deuterium using the CEBAF Large Acceptance Spectrometer (CLAS) and the photon tagging system in Hall B. The aim of the experiment is threefold:

1. Measurement of inclusive K^+ and K^0 momentum distributions as a function of primary photon energy and kaon emission angle.
2. Measurement of the exclusive K^+ and K^0 production channels off the neutron via a complete identification of the hadronic final state to determine the elementary production amplitudes off the neutron.
3. Measurement of the complete hadronic final state to derive information on hyperon-nucleon interaction.

Hyperons will be produced by tagged photons via the $\gamma D \rightarrow KYN$ reaction. Charged particles will be tracked by the CLAS drift chambers; neutral particles will be detected in the electromagnetic calorimeter.

The photon energy range of interest in this experiment is $E_\gamma = (900 - 1500)$ MeV with the primary electron energy E_o at 1600 MeV. A rate of tagged photons of 10^7/sec will be used. The kaon momentum range of interest is $p_K \sim (300 - 1300)$ MeV/c. Charged kaon identification will be achieved by combining time-of-flight between the target and the timing counters with the dE/dx information from the drift chambers. Neutral kaons will be identified via their $K_L \rightarrow \pi^+\pi^-$ decay. The data acquisition system will be triggered by a single charged hadron in coincidence with the tagging system; this leads to a data recording rate of 1000/sec.

Since the submission of the proposal, the detection efficiency for complete final states has been studied using a Monte Carlo simulation of the CLAS response. Including the relevant branching ratios, the detection efficiency for the $\gamma n \rightarrow K^+\Sigma^-(\rightarrow \pi^- n)$ channel is 8%. The smaller branching ratio and the detection of an additional particle reduces the efficiency for the $\gamma n \rightarrow K^0(\rightarrow \pi^+\pi^-)\ \Lambda(\rightarrow p\pi-)$ channel to 3%. The detection of the low energy photon from the $\Sigma^0 \rightarrow \gamma\Lambda$ decay is hampered by the limited solid angle coverage for photons. Therefore, the detection efficiency for the $\gamma n \rightarrow K^0\Sigma^0$ channel is 0.6%, still sufficient to obtain $\sim$ 6% statistical uncertainties for the differential cross sections.

Relationship with Other Experiments

Experiment E89-045 is a companion to E89-004 which will investigate hyperon photoproduction off the proton. The E89-045 run time will be used for several other experiments: the investigation of $\gamma d \rightarrow pn$ and $\gamma d \rightarrow p\Delta^0$ (E93-017), inclusive η-production (E93-008), and coherent η and η' production (E94-008).

References

[1] R.A. Williams, C.R. Ji, and S.R. Cotanch, Phys. Rev. C46, 1617 (1992).
[2] T. Mart, C. Bennhold, and C.E. Hyde-Wright, GWU Preprint (1994).
[3] X. Li and L.E. Wright, Phys. Rev. C45, 2011 (1992).
[4] A. Kumar and D.S. Onley, Ohio University Preprint (1994).

CEBAF Program Advisory Committee Nine
Extension and Update Cover Sheet

This update must be received by close of business on Thursday December 1, 1994 at:
CEBAF
User Liaison Office, Mail Stop 12 B
12000 Jefferson Avenue
Newport News, VA 23606

Experiment: **Check Applicable Boxes:**

E 93 - 008 ☐ **Extension** ☐ **Update** ☑ **Hall B Update**

Contact Person

Name: Prof. Michael F. Vineyard
Institution: University of Richmond
Address: Department of Physics
Address: University of Richmond
City, State, ZIP/Country: Richmond, VA 23173
Phone: (804) 289-8257 **FAX:** (804) 289-8482
E-mail--Internet: vineyard@urvax.urich.edu

CEBAF Use Only

Receipt Date: ____________________

By: ____________________

Update for Experiment 93-008

Inclusive η Photoproduction in Nuclei

M. F. Vineyard (Spokesperson)
University of Richmond, Richmond, VA 23173

[December 15, 1994]

Through the study of the excitation, propagation, and decay of nucleon resonances in the nuclear environment one ultimately expects to understand how the strong interaction is affected by baryon structure. Over the last twenty years, a wealth of information on the $\Delta(1232)$ and its dynamics within the nuclear medium has been obtained through pion studies. However, very little is known about medium properties of the higher energy excited states of the nucleon. This is primarily due to the fact that the dominance of the Δ and the overlapping of higher resonances prevents studying one specific state by π-production experiments. The η meson, on the other hand, couples only with isospin-1/2 N^* resonances since it is an isoscalar particle, and therefore provides an excellent way to isolate these resonances. In this experiment, inclusive measurements of the photoproduction of η mesons in nuclei will be performed to investigate medium modifications of the $S_{11}(1535)$ and $P_{11}(1710)$ resonances which are the only nucleon resonances of mass less than 2 GeV with significant η decay branches.

These measurements will also provide information on the η-nucleon interaction. Due to the lack of η beams, very little is known about the interaction of η mesons with nucleons. In this experiment, final-state interactions of the η meson propagating through the nucleus will be used to investigate the ηN interaction. The study of η interactions with nucleons and nuclei can provide significant tests our understanding of meson interactions which has been developed through pion studies. Also a comparative study of the response of η and η' mesons in the nuclear medium may provide insight into the mixing in these two mesons and the structure of the η'.

Recently, Carrasco [1] calculated inclusive η photoproduction cross sections through the excitation of the $S_{11}(1535)$ resonance with a model that includes nuclear-medium modifications of the decay width, Fermi motion, Pauli blocking, and final-state interactions. The results indicate that the inclusive cross sections are sensitive to both nuclear-medium modifications and final-state interactions at energies around the $S_{11}(1535)$.

Since the experiment was approved by PAC6 in the summer of 1993, we have performed simulations to investigate the CLAS acceptance for the recoil nucleons in coincidence with the η mesons assuming quasi-free photoproduction. The angle-summed acceptance at an incident photon energy of 0.8 GeV is 2% for either (proton + 2γ) or (neutron + 2γ) coincidences, and increases to 7% and 4% at 1.5 GeV for (proton + 2γ) and (neutron + 2γ) detection, respectively. Detection of the recoil nucleons will allow the reconstruction of the invariant mass squared $s = (p_\eta + p_N)^2$ of the system which should provide an independent measure of the in-medium mass and width of the resonances. It will also enable the use of the missing mass from the recoil baryon kinematics, in addition to the invariant mass from the 2γ decay, to improve the η identification.

Two η photoproduction experiments have been performed recently at other laboratories. Measurements were made at MAMI on ^{1}H, ^{2}H, ^{12}C, ^{40}Ca, ^{93}Zr, and ^{nat}Pb targets over the photon energy range from 600 to 790 MeV [2]. The preliminary results of these measurements indicate that the data is of high quality, however, the energy range covered is only from threshold to just below the peak of the $S_{11}(1535)$ resonance. The other experiment was performed at Bonn on ^{1}H, ^{2}H, and ^{14}N targets from threshold to 1.15 GeV. The preliminary results for the energy dependence of the inclusive cross sections measured in this experiment show a depletion and broadening of the $S_{11}(1535)$ resonance in the nuclear medium [3]. A comparison of their ^{14}N results with Carrasco's calculation for ^{16}O shows good agreement up to 900 MeV which is the high energy limit of the calculation. The CEBAF experiment discussed here will complement these measurements and extend them to higher energies and more targets. The extended energy range will allow the investigation of the contributions to the cross section from the $S_{11}(1535)$ and $P_{11}(1710)$ resonances, and non-resonant production. The measurements will be made on ^{2}H, ^{3}He, ^{4}He, and ^{12}C targets enabling the study of the evolution of medium effects with target mass.

The members of this experiment collaboration are making various important contributions to the experimental equipment in Hall B. The University of Richmond group is responsible for the construction of the drift-chamber gas system and the associated control system. The group is also working on the development of drift-chamber and data-acquisition software.

[1] R. C. Carrasco, Phys. Rev. **C48**, 2333 (1993).
[2] H. Stroeher, private communication.
[3] M. Breuer *et al.*, Bonn preprint.

CEBAF Program Advisory Committee Nine
Extension and Update Cover Sheet

This update must be received by close of business on Thursday December 1, 1994 at:

CEBAF
User Liaison Office, Mail Stop 12 B
12000 Jefferson Avenue
Newport News, VA 23606

Experiment: **Check Applicable Boxes:**

E 94 - 008 ☐ **Extension** ☐ **Update** ☑ **Hall B Update**

Contact Person

Name: Prof. Barry G. Ritchie

Institution: Arizona State University

Address: Department of Physics and Astronomy

Address: Arizona State University

City, State, ZIP/Country: Tempe, AZ 85287-1504

Phone: (602) 965-4707 **FAX:** (602) 965-7954

E-mail--Internet: barry.ritchie@asu.edu

CEBAF Use Only

Receipt Date: ______________________________

By: ______________________________

Update for Approved Experiment 94-008

Photoproduction of η and η' Mesons from Deuterium

Arizona State University: B. G. Ritchie (Spokesman)
Catholic University of America: H. Crannell, J. O'Brien, D. Sober
CEBAF: B. A. Mecking
Georgetown University: J. Lambert
University of Richmond: G. P. Gilfoyle, R. W. Major, M. F. Vineyard
University of South Carolina: G. Blanpied, C. Djalali, B. Preedom, and S. Whisnant
CEBAF Large Acceptance Spectrometer Collaboration

ABSTRACT

Differential cross sections for photoproduction on deuterium of η and η' mesons will be measured using the Hall B Bremsstrahlung Photon Tagger and the CEBAF Large Acceptance Spectrometer. Tagged photons of energies from 0.60 to 1.52 GeV will be incident on a liquid deuterium target. The measurements will provide important information on the behavior of these mesons in a lightly bound two-nucleon system, give insight into the structure of the $S_{11}(1535)$ and $P_{11}(1710)$ nucleon resonances, extend knowledge of the properties of the mesons themselves, and form a firm basis for future experiments studying η and η' interactions with heavier nuclei.

Collaboration Activities

As noted in the proposal, the collaboration responsible for this experiment has been active in the development of the Hall B Photon Tagger through participation in the Photon Tagger Working group. Several members of the collaboration have also worked on design and construction activities on other components of Hall B instrumentation and support. The spokesman, working within the Photon Tagger Working Group, is responsible for the focal plane electronics for the tagger. His group has led efforts in determining the electronics logic for the tagger, and has designed and prototyped modularized electronics for the focal plane. Presently, the group has a contract with CEBAF to assemble the full complement of modularized electronics specific to the tagger. Other members of this collaboration are playing critical roles in the design and construction of Hall B instrumentation crucial to this and all approved experiments using the CLAS and photon tagger.

Current Physics Issues

As described in the original proposal, the measurements to be made in this experiment are of great interest for many reasons, among which are:

- Published data on coherent and incoherent photoproduction from deuterium are limited to a few non-zero data points near threshold with large uncertainties.
- Existing theories of the mechanisms believed responsible for photoproduction of η mesons on deuterium are grossly inconsistent with the sparse measured cross sections.

- Data on the photoproduction of η' mesons from the deuteron are non-existent.
- Deuterium η and η' photoproduction measurements are a critically needed complement to studies of the photoproduction of these mesons on the proton and on heavier nuclei.
- Models of isoscalar nucleon resonances can be subjected to stringent tests by data obtained from coherent and incoherent photoproduction of η and η' mesons from deuterium.

The cross sections provided by this experiment for η photoproduction will be of much greater precision than existing measurements and will greatly extend coverage to regions presently unmeasured and inaccessible at other facilities. At the same time, the first extensive cross sections for η' photoproduction will be measured. The simultaneous measurement of both coherent and incoherent processes for η and η' photoproduction will help elucidate the isospin structure of the electromagnetic transition densities, and, as a complement to a previously approved study of photoproduction on the proton, will facilitate specific determination of the amplitudes for photoproduction on the neutron.

This experiment represents an important component of a series of related initial studies of the photoproduction of eta mesons and their interactions with nucleons. The physics underpinnings of these motivations have not changed significantly since the approval of the proposal in January. In particular, it is still true that practically nothing is known concerning η' photoproduction, and that situation is unlikely to change until CEBAF and GRAAL are operating with sufficiently energetic photon beams. The database with respect to η photoproduction on the deuteron will soon be expanded, however. Recently, the spokesman and collaborators at Bonn have extended η photoproduction measurements on the proton, deuterium, and nitrogen to 1.2 GeV.[1] The Bonn measurements on hydrogen, deuterium, and nitrogen indicate that the $S_{11}(1535)$ appears to shift in energy and broaden with increasing mass, with a mass dependence similar to that suggested by Carasco. [2] These results are intriguing in themselves, but the opportunity to more fully investigate these phenomena, to extend such a study to greater solid angle coverage, to investigate other resonances (such as the $P_{11}(1710)$) in the baryon resonance spectrum, and the entire field of η' photoproduction must await the capabilities of Hall B and GRAAL.

Thus, the motivations and interests for this experiment remain strong. These measurements will be critical to resolving important questions related to our understanding of the structure of the nucleons, the structure of the mesons themselves, and the interactions of nucleons and these mesons with each other. They also will provide a foundation for understanding the results of other approved experiments at CEBAF and elsewhere.

References

1. M. Breuer, *et al.*, in preparation.
2. R. C. Carasco, Phys. Rev. C **48**, 2333 (1993).

BEAM REQUIREMENTS LIST

CEBAF Proposal No.: ____________________ Date: ____________________
(For CEBAF User Liaison Office use only.)

List all combinations of anticipated targets and beam conditions required to execute the experiment. (This list will form the primary basis for the Radiation Safety Assesment Document (RSAD) calculations that must be performed for each experiment.)

Condition #	Beam Energy (MeV)	Beam Current (μA)	Polarization and Other Special Requirements (e.g., time structure)	Target Material (use multiple rows for complex targets — e.g., w/windows)	Target Material Thickness (mg/cm^2)
1	1,600	≈ 0.005	standard (2 nsec sep.)	liquid deuterium	≈ 1 g/cm²
			for Hall B γ2 running period		
			serving experiments		
			E89-045		
			E93-008		
			E93-017		
			E94-008		

Beam energies, E_{Beam}, available are: $E_{Beam} = N \times E_{Linac}$ where N = 1, 2, 3, 4, or 5. For 1995, E_{Linac} = 800 MeV, i.e., available E_{Beam} are 800, 1600, 2400, 3200, and 4000 MeV. Starting in 1996, in an evolutionary way (and not necessarily in the order given) the following additional values of E_{Linac} will become available: E_{Linac} = 400, 500, 600, 700, 900, 1000, 1100, and 1200 MeV. The sequence and timing of the available resultant energies, E_{Beam}, will be determined by physics priorities and technical capabilities.

HAZARD IDENTIFICATION CHECKLIST

CEBAF Proposal No.: ______________________ Date: ______________
(For CEBAF User Liaison Office use only.)

Check all items for which there is an anticipated need.

Cryogenics
- ______ beamline magnets
- CLAS analysis magnets
- Saclay target
- type: ______
- flow rate: ______
- capacity: ≈ 1 liter liquid deut.

Electrical Equipment
- ______ cryo/electrical devices
- ______ capacitor banks
- ______ high voltage
- ______ exposed equipment

Standard Hall B

Radioactive/Hazardous Materials
List any radioactive or hazadorous/ toxic materials planned for use:

None

Pressure Vessels
- ______ inside diameter
- ______ operating pressure
- ______ window material
- ______ window thickness

None

Flammable ~~Gas or~~ Liquids
- type: liquid deuterium
- flow rate: (see cryogenics)
- capacity: ______

Drift Chambers
- type: Standard CLAS
- flow rate: drift chambers
- capacity: ______

Other Target Materials
- ___ Beryllium (Be)
- ___ Lithium (Li)
- ___ Mercury (Hg)
- ___ Lead (Pb)
- ___ Tungsten (W)
- ___ Uranium (U)
- ___ Other (list below)

None

Vacuum Vessels
- ______ inside diameter
- ______ operating pressure
- ______ window material
- ______ window thickness

CLAS magnet + beam pipe

Radioactive Sources
- ______ permanent installation
- ______ temporary use
- type: ______
- strength: ______

None

Large Mech. Structure/System
- ______ lifting devices
- ______ motion controllers
- ______ scaffolding or elevated platforms

Standard Hall B

Lasers
- type: ______
- wattage: ______
- class: ______

Installation:
- ______ permanent
- ______ temporary

Use:
- ✓ calibration
- ______ alignment

Several low power lasers for PMT calibration (standard Hall B equipment!)

Hazardous Materials
- ___ cyanide plating materials
- ___ scintillation oil (from)
- ___ PCBs
- ___ methane
- ___ TMAE
- ___ TEA
- ___ photographic developers
- ___ other (list below)

None

General:

Experiment Class:
- X Base Equipment
- ______ Temp. Mod. to Base Equip.
- ______ Permanent Mod. to Base Equipment
- ______ Major New Apparatus

Other: ______

Standard Hall B equipment for experiments E89-045 E93-017 E93-008 E94-008

LAB RESOURCES REQUIREMENTS LIST

CEBAF Proposal No.: ______________ (For CEBAF User Liaison Office use only.) Date: ______________

List below significant resources — both equipment and human — that you are requesting *from CEBAF* in support of mounting and executing the proposed experiment. Do not include items that will be routinely supplied to all running experiments, such as the base equipment for the hall and technical support for routine operation, installation, and maintenance.

***Major Installations** (either your equip. or new equip. requested from CEBAF)*

Standard Hall B equipment:

CLAS +

Photon tagging system

New Support Structures: No

Data Acquisition/Reduction

Computing Resources: Standard

New Software:

Major Equipment

Magnets

Power Supplies

Targets: Saclay deuterium cryo-target (Standard)

Detectors: CLAS in standard configuration

Electronics

Computer Hardware

Other

Other

Hall B γ2 Run Period

Epeiments

E89-045

E93-008

E93-017

E94-008

CEBAF Program Advisory Committee Nine
Extension and Update Cover Sheet

This update must be received by close of business on Thursday, December 1, 1994 at:

CEBAF
User Liaison Office, Mail Stop 12 B
12000 Jefferson Avenue
Newport News, VA 23606

Experiment: E -

Check Applicable Boxes:

☐ Extension ☐ Update ☒ Hall B Update

Contact Person

Name: ROSSI PATRIZIA
Institution: INFN - LABORATORI NAZIONALI DI FRASCATI
Address: VIA ENRICO FERMI 40
Address: CASELLA POSTALE 13
City, State ZIP/Country: I - 00044 FRASCATI (Rome) ITALY
Phone: +39-6-9403549 **FAX:** +39-6-9403559
E-Mail → Internet: VAXLNF :: ROSSI

CEBAF Use Only

Receipt Date: 12/5/94 E 93-017

By: gp

Update for Experiment 93-017 : Study of $\gamma d \rightarrow pn$ and $\gamma d \rightarrow p\Delta^0$ reactions for small momentum transfers.

E. De Sanctis and P. Rossi, Co-Spokespersons

This experiment will use real photons from the Hall B Photon Tagger to measure the differential cross section for the deuteron photodisintegration into proton + neutron and proton + delta in the region of small momentum transfers and over the energy range from 0.5 to 1.5 GeV. The purpose of this experiment is to check the predictions of the Regge phenomenology and of the quark-gluon string model and to test the conventional nuclear meson-exchange models in the low energy interval 0.5 - 0.8 GeV. The physics we hope to uncover remains at least as interesting as when we proposed this study last year.

Cross sections for photodisintegration of deuteron have been measured up to 4.2 GeV. The data available in the literature at photon energies below about 400 MeV cover a broad angular range, while those at higher energy are limited to a few angles. In particular, above 1 GeV there are only the data of the two recent SLAC experiments: NE8 and NE17. It is worth noting that, the lack of an accurate knowledge of the incoming photon flux has caused large discrepancies, up to 50%, among the experimental results on the absolute cross section obtained with bremsstrahlung photon beams.

At high energy, and small t or u, we have examined the process in the framework of the the Regge phenomenology and the quark-gluon-string (QGS) model obtaining an expression for the cross section which predicts a different behaviour of the cross section with energy with respect to that predicted by the constitent counting rules. This expression is able to describe quite well the NE8 and NE17 data. Moreover, we have evaluated the ratio of the forward and backward values of the cross section for the reaction $d(\gamma,p)n$ in the framework of the same model finding a good agreement with the scarce data available only at intermediate energies.

We consider both these results very encouraging and we think that one should deeply check the capability of this simple model do describe the process. A proposal has been approved by CEBAF (PR-89-012) for a measurement of the cross section for the $d(\gamma,p)n$ reaction at three angles ($\vartheta_{C.M.}$= 30°, 53°, and 90°) from 1.5 to 4.0 GeV in 0.5 GeV steps in Hall C. This measurement represents the natural extension of works begun at SLAC by the NE8 and NE17 experiments in order to determine whether the energy dependence of the cross section is consistent with that expected from the constituent counting rules. However, to better discriminate between this simple rule and other theoretical models, it would be helpful to have data over a broad angular and energy ranges and with low statistical and systematic uncertainties (we note that the fulfillment of the last request is made easy by the use of tagged photons).

Therefore, we propose the measurement of the cross section for the $\gamma d \rightarrow pn$, and $\gamma d \rightarrow p\Delta^0$ reactions by using the Hall B tagged photon beam to obtain accurate data between 800 and 1500 MeV and suitable kinematical conditions in order to:

a) Test if $\gamma d \rightarrow pn$ and $\gamma d \rightarrow p\Delta^0$ reactions obey to the same energy behavior which is predicted for hadronic reactions by the QGS model, checking whether the energy behavior of these reactions at fixed t is consistent with the contributions of the nucleon and Δ trajectories, respectively;

b) Verify the QGS model prediction of the appearence of the forward and backward peaks in the angular distributions of the $\gamma d \rightarrow pn$ reaction; and

c) Measure the values of the forward-to-backward ratio of the cross sections.

These measurements will run concurrently with the approved experiment "Studies of kaon photoproduction on deuterium", PR-89-045, which has identical target and detector configuration. Moreover,

d) We will use the 70 hours in addition to the one assigned to PR-89-045 (500 hours) to extend the data collection down to 500 MeV to overlap measurements at other laboratories and provide an accurate data set over broad angular and energy ranges to test the different theoretical models of deuteron from low energies, where pion exchange phenomena are dominant, to higher energies,where quark phenomena are expected to appear.

In evaluating the time estimates for the measurement we have assumed:

Tagged Beam Intensity = 10^7/sec, for the interval (0.8-1.5) GeV;

Target Thickness = 5 cm of liquid deuterium (density 0.8 g/cm^2).

Then, for 570 hours of beam time the statistical accuracy varies respectively between 0.7% at the lower end and 2.5% at the higher end of the energy range.

Meanwhile, we are studying a possible extension of the measurement with polarized photon beam.

We are also making good progress on our various contributions to the Hall B facilities and equipment. Construction of the large angle sector of the e.m. calorimeter is proceeding on schedule at Frascati and Genova and the Frascati group has contributed the sweeping magnets for the photon collimation system, the magnet for the pair spectometer and a quantameter as well. We have no major setbacks to report and we look forward to fruitful experimental measurements in the very near future.

HAZARD IDENTIFICATION CHECKLIST

CEBAF Proposal No.: ______________________ Date: ______________

(For CEBAF User Liaison Office use only.)

Check all items for which there is an anticipated need.

Cryogenics

- ____ beamline magnets
- ____ analysis magnets
- X target

type: Deuteron

flow rate: ______

capacity: ______

Electrical Equipment

- ____ cryo/electrical devices
- ____ capacitor banks
- ____ high voltage
- ____ exposed equipment

Radioactive/Hazardous Materials

List any radioactive or hazadorous/ toxic materials planned for use:

______

Pressure Vessels

- ____ inside diameter
- ____ operating pressure
- ____ window material
- ____ window thickness

Flammable Gas or Liquids

type: ______

flow rate: ______

capacity: ______

Drift Chambers

type: ______

flow rate: ______

capacity: ______

Other Target Materials

- ____ Beryllium (Be)
- ____ Lithium (Li)
- ____ Mercury (Hg)
- ____ Lead (Pb)
- ____ Tungsten (W)
- ____ Uranium (U)
- ____ Other (list below)

______

Vacuum Vessels

- ____ inside diameter
- ____ operating pressure
- ____ window material
- ____ window thickness

Radioactive Sources

- ____ permanent installation
- ____ temporary use

type: ______

strength: ______

Large Mech. Structure/System

- ____ lifting devices
- ____ motion controllers
- ____ scaffolding or
- ____ elevated platforms

Lasers

type: ______

wattage: ______

class: ______

Installation:

- ____ permanent
- ____ temporary

Use:

- ____ calibration
- ____ alignment

Hazardous Materials

- ____ cyanide plating materials
- ____ scintillation oil (from)
- ____ PCBs
- ____ methane
- ____ TMAE
- ____ TEA
- ____ photographic developers
- ____ other (list below)

______

General:

Experiment Class:

- X Base Equipment *
- ____ Temp. Mod. to Base Equip.
- ____ Permanent Mod. to Base Equipment
- ____ Major New Apparatus

Other: ______

*USE OF THE CLAS SPECTROMETER

BEAM REQUIREMENTS LIST

CEBAF Proposal No.: PR - 93 - 017 Date: ______

(For CEBAF User Liaison Office use only.)

List all combinations of anticipated targets and beam conditions required to execute the experiment. (This list will form the primary basis for the Radiation Safety Assesment Document (RSAD) calculations that must be performed for each experiment.)

Condition #	Beam Energy (MeV)	~~Beam Current (μA)~~ Tagged Photons	Polarization and Other Special Requirements (e.g., time structure)	Target Material (use multiple rows for complex targets — e.g., w/windows)	Target Material Thickness (mg/cm²)
	1600	10^7	NO	liquid deuterium	5cm (0.8 g/cm²)

Beam energies, E_{Beam}, available are: $E_{Beam} = N \times E_{Linac}$ where N = 1, 2, 3, 4, or 5. For 1995, E_{Linac} = 800 MeV, i.e., available E_{Beam} are 800, 1600, 2400, 3200, and 4000 MeV. Starting in 1996, in an evolutionary way (and not necessarily in the order given) the following additional values of E_{Linac} will become available: E_{Linac} = 400, 500, 600, 700, 900, 1000, 1100, and 1200 MeV. The sequence and timing of the available resultant energies, E_{Beam}, will be determined by physics priorities and technical capabilities.