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 93-017

Check Applicable Boxes:

☐ Extension ☐ Update ☒ Hall B Update

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Receipt Date: 12/5/94 PR 94-146

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)

he 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)0, 1600, 2400, 3200, and 4000 MeV. Starting in 1996, in an evolutionary way (and not necessarily in the order given) the following ıdditional values of E_{Linac} will become available: E_{Linac} = 400, 500, 600, 700, 900, 1000, 1100, and 1200 MeV. The sequence and ming of the available resultant energies, E_{Beam}, will be determined by physics priorities and technical capabilities.