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 -

☐ Extension ☐ Update ☒ Hall B Update

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Receipt Date: 12/9/94

By: 90 PR 94-129

Update for Experiment 93-019: Photoabsorption and Photofission of Nuclei

N. Bianchi, V. Muccifora, and B.L. Berman, Co-Spokespersons

December, 1994

This experiment will use real photons from the Hall-B Photon Tagger to study the total photoabsorption cross section for C, Al, Cu, Sn, and Pb and the photofission cross section for ^{238}U, ^{232}Th, and ^{237}Np in the energy range from 0.4 to 1.9 GeV. The primary purpose of this experiment is to study the formation and propagation of nucleon resonances in the nuclear medium. The physics we shall uncover remains at least as interesting as when we proposed this study last year.

Recent total photoabsorption data on various nuclei for photon energies from 0.2 to 1.2 GeV show strong suppression of the cross section in the region of the D_{13} and F_{15} resonances, compared with data on the free proton and the loosely-bound deuteron. The Δ resonance, by contrast, shows only broadening effects. Several approaches have been proposed to account for this effect:

- That there is a larger collision cross section for the higher-mass nucleonic resonances produced in nuclei;
- That there is a damping of the excitation of the higher-mass resonances inside nuclei due to quark exchange between overlapping nucleons; and
- That there is a low-energy onset of the shadowing effect due to the low-mass hadronic component of the photon.

Because of this striking result, it is vital to study in detail the effect of the nuclear medium on the propagation and interaction of the nucleon resonances, both as a function of A and as a function of E_γ, up to higher energies, through the resonance region and into the shadowing region.

We shall study the degree of suppression of the nucleon resonances in C, Al, Cu, Sn, and Pb directly, by measuring the total photoabsorption cross section by the photo-hadronic method. A cylindrical shell of NaI detectors will be used to measure the photoproduction rate of hadronic events, and a lead-glass shower detector downstream will provide a veto for the vast preponderance of purely electromagnetic events. For nuclei in the actinide region with fissility nearly equal to one, such as ^{238}U, measurement of the photofission cross section is a simple and effective way to measure the total photoabsorption cross section, using highly efficient parallel-plate avalanche detectors (PPADs) to detect the highly-ionizing fission fragments. Frascati and Genoa will supply the NaI and lead-glass detectors, GW the PPADs. INR (Moscow) will supply the fission targets. These measurements do not require the CLAS, and can be performed prior to or during the commissioning of the CLAS. In fact, this experiment is not a lengthy one, and would constitute an ideal commissioning experiment for the Photon Tagger.

Data for ^{238}U show that its fissility is in fact constant and consistent with unity over a large energy region, from the quasideuteron region well into the resonance region, up to 1.2 GeV. This is expected to be valid at higher energy as well. If this is not the case, however, several interesting questions would be raised: what is the branching ratio of non-fission events, what type of processes leave the residual nucleus cold, are these surface events, and are strong many-body forces important? Answers to these questions will require a follow-on experiment, using the CLAS as well as the Photon Tagger, to measure the light particles that are emitted in *anti*coincidence with a fission fragment.

The photofission of ^{232}Th shows a behavior different from the heavier actinide nuclei. This nucleus appears to have a photofissility between 0.6 and 0.8, and increases slowly with energy between 0.25 and 1.2 GeV. (Other actinide nuclei reach a fissility of nearly 1.0 at much lower energies.) This behavior has been attributed to a smaller transparency of ^{232}Th, although the explanation could be that the fissionability Z^2/A is simply too small. The ^{237}Np nucleus, on the other hand, has reported fissility *exceeding* that for ^{238}U by 20 to 40% between 0.06 and 0.24 GeV. This behavior is quite surprising, and thus the fissility of ^{237}Np needs to measured at higher energies as well.

It should be added that all of the photofission targets used for these measurements are irradiated simultaneously, so that we can add targets at no cost in additional beam time. For example, we may choose to add ^{235}U to our list, since there are results in the literature that indicate that the fissility of ^{235}U in the delta region is *smaller* than that for ^{238}U, contrary to expectations.

Meanwhile, we are making good progress on our various contributions to the Hall-B facilities and equipment. Construction of the focal-plane detector array for the Photon Tagger is proceeding on schedule at GW, construction of the large-angle sector of the shower-counter array is proceeding on schedule at Genoa and Frascati, and the Frascati group has contributed the sweeping magnets for the photon collimation system, the magnet for the pair spectrometer, and a quantameter as well. We look forward to fruitful experimental measurements in the very near future.

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HAZARD IDENTIFICATION CHECKLIST

CEBAF Proposal No.: 93-019 (For CEBAF User Liaison Office use only.) Date: 12/94

Check all items for which there is an anticipated need.

Cryogenics	Electrical Equipment	Radioactive/Hazardous Materials
___ beamline magnets ___ analysis magnets ___ target type: ___ flow rate: ___ capacity: ___	___ cryo/electrical devices ___ capacitor banks ___ high voltage ___ exposed equipment	List any radioactive or hazadorous/ toxic materials planned for use: Fission Foils (worst is ^{237}Np : 4×10^5 Bq [~ 10μCi]) ___

Pressure Vessels	Flammable Gas or Liquids	Other Target Materials
___ inside diameter ___ operating pressure ___ window material ___ window thickness	type: ___ flow rate: ___ capacity: ___ **Drift Chambers** type: ___ flow rate: ___ capacity: ___	___ Beryllium (Be) ___ Lithium (Li) ___ Mercury (Hg) ✓ Lead (Pb) ___ Tungsten (W) ✓ Uranium (U) ✓ Other (list below) Thorium ___

Vacuum Vessels	Radioactive Sources	Large Mech. Structure/System
___ inside diameter ___ operating pressure ___ window material ___ window thickness	___ permanent installation ___ temporary use type: ___ strength: ___	___ lifting devices ___ motion controllers ___ scaffolding or ___ elevated platforms

Lasers	Hazardous Materials	General:
type: ___ wattage: ___ class: ___ Installation: ___ permanent ___ temporary Use: ___ calibration ___ alignment	___ cyanide plating materials ___ scintillation oil (from) ___ PCBs ___ methane ___ TMAE ___ TEA ___ photographic developers ___ other (list below) ___ ___	Experiment Class: ___ Base Equipment ✓ Temp. Mod. to Base Equip. ___ Permanent Mod. to Base Equipment ___ Major New Apparatus Other: ___ ___

LAB RESOURCES REQUIREMENTS LIST

CEBAF Proposal No.: 93-019 Date: 12/94
(For CEBAF User Liaison Office use only.)

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)*

New Support Structures:

Data Acquisition/Reduction

Computing Resources:

New Software:

Major Equipment

Magnets

Power Supplies

Targets

Detectors

Electronics

Computer Hardware

Other

Other