REPORT

PAC3

February 9-11, 1989

REPORT OF THE CEBAF PROGRAM ADVISORY COMMITTEE

March 28, 1989

1) INTRODUCTION

The Program Advisory Committee for CEBAF held its third meeting February 9-11, 1989. The charge to the Committee read:

a) Examine the Letters of Intent in order to form an overall assessment of the intended research program at CEBAF. Advise CEBAF on any components that may be missing. Also, please formulate questions and comments to be addressed to the scientists proposing this research in order to help them prepare full research proposals.

b) Examine the PCDR's presented for the experimental system and compare the intended capabilities of these facilities to the proposed research program. What is missing and where are there avoidable redundancies? How do these facilities match the overall scientific priorities foreseen for the initial research program at CEBAF?

c) The manpower estimates contained in the PCDR make it obvious that major participation by the users in the development of the experimental equipment is absolutely essential; this can best be accomplished by forming strong collaborations which assume responsibility for construction and initial operation of the major detectors. The formation of these collaborations will - in our view - require a commitment by the CEBAF management of initial priority use of this equipment to compensate the collaborations for their investment of several years of effort. It would also require a commitment of beam time for the initial experiments. Please advise CEBAF on the best method of making these commitments while at the same time avoiding a completely 'closed shop' and providing opportunities for doing the best physics."

Accordingly, the Committee spent its first day hearing the presentation of the material in the PCDR-s by the program managers and others involved in the preparation of these draft documents. The Committee was impressed by the progress that has been made and the considerable effort devoted to the development of the experimental system, both by the CEBAF staff and by the participating scientists from other institutions. Our detailed discussion and recommendations are in sections 2-4 below.

Major components of the experimental equipment are very close to their final status and these are identified: the electron spectrometer in Hall A, the basic CLAS magnet with drift chambers, and a photon tagger in Hall B, and probably the electron arm in Hall C, after it has undergone a TAP review. Other aspects, such as the hadron arm in Hall A, the shower counters in Hall B, and the various options in Hall C require some further analysis that is discussed below.

The second day was spent in the review of the 89 Letters of Intent received by the deadline. The Letters had been assigned to subcommittees of the PAC and the chairmen of these summarized the Letters for the whole Committee. Some of the Letters presented considerable detail, others were somewhat sketchy and truly expressions of future intent. The Committee spent time and effort in trying to understand the physics motivations and the actual measurements that might be carried out.

The Committee was encouraged to find in a number of the Letters a potential for first class physics experiments and looks forward to fully developed proposals at the appropriate time.

The PAC suggested questions and comments regarding these Letters to the CEBAF management; these are not included in this report, and their sense will be transmitted to the individual users by CEBAF management. Neither the Letters nor the Committee's reaction to them should be regarded as definitive at the present time.

The scientific potential of the research program for CEBAF, as reflected in these Letters, is a rich one, addressing essential issues in nuclear physics. The inception of this research capability continues to be awaited eagerly by the community. The Committee did not attempt an overall reassessment of the various elements of the program, nor of the relative priorities that were discussed in an earlier report.

The question of collaborations and how they may function was discussed on the third day. Some comments are presented below in section 5.

The question of the next meeting was discussed. The PAC stands by its earlier recommendation that six months should be allowed between the time that the Conceptual Design Reports are made available to the user community and the deadline for first set of proposals. It is important that the proposals be of high quality and have as detailed considerations of backgrounds and rates as is possible, in order for the PAC to form sensible judgments and responsible recommendations.

The committee was pleased to see the beginning of conventional construction for the CEBAF ring and enjoyed the hospitality of the CEBAF management and staff.

2) STATUS OF EQUIPMENT FOR HALL A

The Letters of Intent relevant to Hall A include possible experiments that address some of the central issues in nuclear physics and can provide a set of benchmarks for determining the minimal specifications of the Hall A spectrometers.

Such benchmarks are: 1) D(e,e')np -- Deuteron electrodisintegration up to approximately 2 GeV; 2) D(e,e'p)n -- Precise separation of all the response functions for the deuteron; 3) 3,4He(e,e'p) -- Extension of the measurement of the response functions to other few body systems and to selected larger nuclear systems, especially at large recoil momentum.

These generic few-body experiments were used as a basis for evaluating the necessary spectrometer capabilities. The electron spectrometer should have high resolution and a maximum momentum capability near 4 GeV/c. The highest resolution is needed up to 2.5 GeV/c with possibly less emphasis on resolution for higher momenta. A momentum capability of 4 GeV/c would allow for all of the proposed physics with some reasonable margin allowing for the possibility of an eventual accelerator energy higher than the design value. It represents an excellent match to the anticipated beam qualities of the CEBAF accelerator.

The few-body physics also drives the requirements for a second high quality hadron spectrometer in Hall A. Simple kinematic considerations for nucleon knockout limit the requirement for maximum momentum to about 2.5 GeV/c. The maximum momentum as well as the optimal parameters for resolution, solid angle, momentum acceptance, etc. should be re-examined in the context of the needs for precise separation of the nuclear response functions; though operational and cost considerations may make it reasonable that the pair of spectrometers in Hall A be of identical design.

Spectrometers

The collaboration presented a preferred reference design for an identical pair of high resolution spectrometers. The proposed QQDQ design has a momentum capability of 4 GeV/c, a resolution of 1×10^{-4}, a solid angle of about 8 msr and a momentum acceptance of about 10%. It is well matched for operation with long targets. Requirements for absolute calibrations and reproducibility have been addressed. The design appears to address the most critical needs of the Hall A component of the CEBAF physics program and the recent recommendations of the PAC.

Several design options were also presented. These included a possible superconducting design and a lower momentum hadron arm. The collaboration is on schedule for a second TAP review later this year, to be followed by a CDR.

High Power Targets

Much of the Hall A program will clearly require high power cryogenic targets. It is clear that substantial R&D will be required so that such targets may adequately utilize the high-intensity beams anticipated at CEBAF.

Polarization Capability

The exploration of spin degrees of freedom will be an important component of the Hall A physics program, with implications for the development of a polarized beam along with the necessary instrumentation for polarization diagnostics (beam line polarimeters, etc.). The development of polarized targets and focal plane polarimeters provide excellent opportunities for participating outside institutions.

Out-of-Plane Spectrometers

The PAC believes that plans for Hall A should not exclude the capability to proceed at a later date with out-of-plane measurements. Toward this end, it recommends that planning proceed to excavate the exit line trench necessary for beam-swinger operation. In view of the estimated costs provided to the PAC, this seems cost-effective in comparison to the major expense that would be required to implement this capability at a later date.

The option of constructing an instrument such as the STAR (assuming its principles of operation are confirmed) that could be used either in Hall A or Hall C should be explored.

Kaon Physics Program

The PAC believes that the possibility of exploring kaon and hypernuclear 'strange' physics should be carefully studied for Hall A. In particular, the idea of using a "magnetic septum" with the high resolution electron spectrometer, and a short, dedicated kaon (hadron) spectrometer, should be explored.

RECOMMENDATIONS: The PAC recommends that CEBAF move forward quickly with the final design, technical evaluation, and construction of a high resolution electron spectrometer in Hall A. The optimal choice for the hadron arm should continue to be evaluated for a balance between performance in terms of the anticipated physics and cost.

3) STATUS OF EQUIPMENT FOR HALL B

The CLAS spectrometer system will provide CEBAF with the experimental capability of detecting essentially all reaction products from an electromagnetic interaction from a single event. This capability, together with the 100% duty cycle of the accelerator allows experiments that could not be contemplated by physicists a few years ago. CLAS will contribute substantively in two major areas that are reflected in the large number of Letters of Intent directed at physics with this device.

i) An area central to the scientific motivation for CEBAF, and one in which present knowledge is rather limited, is the set of closely coupled questions that go under the names of:

   a) short-range correlations in nuclei,
   b) the propagation of nucleonic excitations in the presence of other nucleons,
   c) the role of three-body forces, and
   d) the modification of nucleon structure in the nuclear medium.

ii) Another area where CLAS provides unique capabilities is in the determination of electromagnetic properties of the nucleon and low-mass hyperon resonances -- where experimental information is still remarkably limited and where, in specific cases, quantitative tests of the description of these objects in terms of QCD is subject to rather stringent tests.

Experiments addressing these questions, either via photon absorption or electron scattering lead to at least two and often more particles in the final state. The almost complete geometric coverage provided by CLAS will permit the quantitative study of these questions for the first time.

RECOMMENDATIONS: The Committee fully supports the development of CLAS and recommends that the initial configuration should include the magnet, drift chambers, TOF array of scintillators, and photon tagging system. A forward shower counter is an important feature of CLAS and the PAC recommends that its design and costing be pursued expeditiously. It is clearly desirable to have the initial configuration available at the time of the first CEBAF beams, but the pace at which work proceeds on this complex device will depend on resource availability, both financial and human. The relative priority accorded the specific physics proposals which come forward is also likely to be an important factor.

The complexity of CLAS implies clearly that the need for involvement of outside users in constructing a facility for Hall B is especially acute. It is in Hall B that this shortage of manpower is likely to have the most serious consequences, and here that the Committee feels most apprehensive of the implications. The PAC urges the manager for Hall B to start an aggressive program to identify tasks, find user groups with the appropriate capability, and get their agreement to undertake specific tasks in connection with CLAS.

Before its next meeting the Committee would like to understand better the maximum luminosity usable at CLAS. Backgrounds, from beam halos, low energy photons, or other processes may limit the luminosity. The triggering and data acquisition systems may provide another limit. Or perhaps the limit will come from the amount of computer time required to do pattern recognition of events in the presence of high backgrounds. If such more detailed analyses were possible, they would play an important role in the Committee's evaluation of proposals.

OPTIONS FOR THE FUTURE: The Committee would encourage study of possible additions to the basic CLAS system to permit more flexibility in the types of experiments or to raise the maximum useable luminosity. The shower detector array still requires a detailed final design, and its coverage of the angular range has to be considered and understood by the PAC. Feasibility and design of detectors for neutral particles (neutrons, π^0-s), polarized targets, where both magnetic field and space constraints need to be explored, etc., could eventually further enhance the capabilities of CLAS. The PAC looks forward to hearing of these options as thinking and experience concerning CLAS progresses. The Committee would also like to understand the limitation on the use of polarized targets and the interaction of their magnetic field with the field configuration of the device. The possible use of the CLAS magnet as a focusing toroidal spectrometer for restricted solid angle was discussed; the physics motivation and techniques for implementing such an option will have to be considered by the PAC at the appropriate time.

4) STATUS OF EQUIPMENT FOR HALL C

One of the prime motivations for CEBAF is the capability to undertake a flexible program of coincidence experiments. With a pair of high resolution spectrometers in Hall A and a large acceptance device in Hall B, the plans for Hall C are to have a high momentum electron spectrometer, in combination with a variety of hadron arms tailored to the specific needs of given classes of experiments. The design of these devices is in progress, but has not yet progressed to the same level as in the other halls and reviews by TAPs have not yet taken place.

RECOMMENDATION: The Committee recommends that the design for a high momentum electron spectrometer (HMS, discussed below) be finalized with high priority. It is hoped that such a design of a core spectrometer could be reviewed by a TAP in the very near future, possibly together with HRS2 TAP2.

Some hadron arm or arms will also have to exist to undertake coincidence experiments. Several options were presented in the PCDR which are discussed in more detail below. In particular, the capabilities to perform out-of-plane measurements (perhaps with the STAR or the NFS spectrometers) and to conduct high-resolution hypernuclear studies (perhaps with HNSS or some combination of a variant of that system with SOS) are in areas where CEBAF has unique opportunities for important contributions, as was already pointed out in the 1987 PAC report.

HMS: The High Momentum Spectrometer -- Electron Arm

This spectrometer plays the essential role of measuring scattered electrons to define the momentum transfer for various coincidence experiments where the reaction products are measured in another detector. The PAC endorses the concept for such a general purpose spectrometer with medium resolution, large solid angle, and a maximum momentum of 6 GeV/c.

RECOMMENDATION: The PAC recommends that the following questions be reconsidered in the design optimizations, if possible before the TAP meeting:

a) Can the solid angle be increased above the present value, with reasonable compromise on other properties (for example decrease of resolution at the highest momentum, or using a less conservative design for the quadrupoles). Some concern was expressed that the projected solid angle was actually smaller than that for the high-resolution Hall A electron spectrometer.

b) What is the maximum luminosity that this device can stand, given the small bending angle?

HNSS: Hypernuclear Spectrometer System

The HNSS is a single-purpose system dedicated to the needs of the high resolution program of hypernuclear physics. While the Committee recognizes that such a facility would be a unique tool to probe hypernuclear structure, it had reservations about the following issues:

a) Suppression of high singles rates, mostly from pions, is one of the challenges for this kind of measurement. The Committee would like to see a further study of kaon identification, since this is a potential limitation to first-class physics experiments in this field.

b) The possibility of improving the resolution by a dispersion-matching technique should be discussed with bending in the horizontal plane, or perhaps with vertical bending after the primary splitting magnet.

c) Given that the possibility exists for using the SOS as a higher-momentum kaon arm for high-resolution hypernuclear studies (see the SOS below), the PAC would want to understand better, following discussions between the proponents of SOS and HNSS, the possibility of arriving at an optimal design that could serve both needs.

RECOMMENDATION: The PAC recommends that a program of study of electromagnetic strangeness production be pursued more vigorously by CEBAF; attempts to find a person to take responsibility for developing this capability, in response to a PAC recommendation of two years ago, have not been successful. Assuming that sufficient resolution, high enough counting rate and clear enough particle identification can be achieved for high-resolution studies, the PAC reiterates its strong 1987 encouragement for developing such a program at CEBAF.

SOS: Short Orbit Spectrometer -- decaying meson arm

The SOS is designed for coincidence experiments requiring the detection of low-energy hadrons. Its short flight path is tailored to detection of low momentum pions and kaons. This device is of special interest for kaon production; it is presently envisioned as being used for moderate-resolution studies of few-body hypernuclei, for example, and may have the potential even for use in a high-resolution program.

The committee is not convinced that the present design is optimized for the CEBAF environment. The following questions should be answered:

a) What is the maximum luminosity acceptable by this detector given its small bend angle?
b) Can the resolution be improved so that it can function as a kaon arm in (A>4) hypernuclear studies?
c) Given that the possibility exists for using the SOS as a high-momentum kaon arm for high-resolution hypernuclear studies, the proponents of SOS and HNSS should explore the possibility of combining their efforts in designing this arm.

NFS: Non-Focusing Spectrometer -- large acceptance arm

The NFS as a non-focusing, large acceptance device is intended for a variety of coincidence measurements, ranging from electroproduction of hadrons in the resonance region to potential future uses in the scaling region in an era of running with energies beyond 4 GeV. A non-focusing spectrometer could have the potential to measure reaction products in coincidence with electrons with a large acceptance and a modest resolution. The detector's stated capabilities include detection of high momentum hadrons and accommodation of polarized or extended targets. In addition, it would have some out-of-plane capability.

The committee recognizes the potential interest for such a device, but at the present stage of its development, several significant questions remain to be addressed regarding its luminosity limit and the choice of bend angle.

STAR: Symmetrical Toroidal Array -- out-of-plane device

The STAR is motivated primarily by the need for out-of-plane coincidence measurements, exploiting the idea of using a symmetric toroidal array of eight segments centered about the q-direction. Among these are experiments such as exploration of quadrupole excitation strength in the delta region and systematic studies of deuteron electrodisintegration. An attractive feature of this device is that it could be configured to serve a variety of other needs, such as an electron spectrometer for measurements of parity violation. A number of questions have been raised; they concern systematic errors that are not eliminated by the difference/ratio method proposed to eliminate a number of errors by simultaneous measurements.

a) The relative efficiency of the detectors of the different segments has to be calibrated to <1% to reach the performance goals stated. How can this be achieved in routine calibrations?

b) The θ_h pointing angle is a critical parameter. It should be demonstrated that the necessary accuracy for octants of slightly different properties can be reached.

c) At small recoil angle, the octants are at very different laboratory angles. Singles rates are very different, and may change the efficiencies of the different octants. How serious is this effect?

d) The detector has a rather open geometry; particles from the target can reach the detector with one small-angle bounce. What is the resulting maximum luminosity?

e) There is a strong correlation between particle angle, momentum and scattering vertex location along the STAR axis. When using the detector with an extended target in a single-arm experiment, what resolution can be achieved?

f) When using STAR in a parity experiment, false asymmetries may result from the interaction of the polarized electrons with the magnetized iron. At what level would such asymmetries come in?

5) COLLABORATIONS

The charge to the Program Advisory Committee asks for its advice on the best method of making commitments to users for initial priority use of the equipment by those participating in the facility collaborations necessary to construct the equipment.

Since the need for an electromagnetic facility in the few GeV regime was first identified in the 1970-s it has been clear that the scientific capability that is represented by CEBAF is essential for all of Nuclear Physics; the motivation for CEBAF is rooted in the scientific objectives of the field as a whole, transcending much more than the traditional 'electromagnetic community'. The need for substantive involvement, beyond the electromagnetic community, elements of other subfields of nuclear physics, such as hadronic and heavy-ion nuclear physics, is evident. CEBAF must draw on the skills and experience of Nuclear Physics as a whole. The task of constructing the CEBAF experimental system is technically demanding: groups from the whole Nuclear Physics community will have to be involved in the task in order to complete its construction in an effective and timely fashion and make its research goals come into reality.

The Committee urges that the Facility Managers identify specific tasks for each member (group) of their collaboration matched to their capabilities, and proceed to negotiate detailed agreements or memoranda of understanding -- this is much more important than the discussion of the generalities of these issues.

It is the expectation of the PAC that it will judge proposals at its next meeting on a competitive basis, by scientific merit, initial technical feasibility, and the ability of the proponents to carry out the measurement. Intellectual competition between possible experiments is important to selecting the best initial physics program.

However, the PAC does not favor overly rigid rules concerning the formation of scientific collaborations. The establishment of such collaborations is an issue to be resolved by the scientists who want to address a specific scientific issue with a specific experiment. The importance of early interaction with Laboratory management and with those intimately familiar with specific experimental devices generally grows with the complexity and scale of an experiment. However, the PAC has the task of evaluating the science and the feasibility of proposals, not of evaluating the process by which a collaboration was formed.

The proposers will have the responsibility of convincing the PAC of the merits and technical feasibility of the experiment and also that the measurement will be carried out successfully and in a timely fashion. A scientific proposal by individuals who are participants in the facility collaborations and involved in all aspects of the construction of the facility is likely to be an important ingredient of these considerations. The case will have to be made in the context of the reality that, during the early years of use of any complex apparatus, the involvement of those responsible for design, construction, and commissioning is essential.

Also, the Committee recognizes that its judgment of scientific and technical considerations may change in time, and that its early recommendations for specific experiments will have to be a subject of continuing review by the PAC.

LOG OF SECOND ROUND OF LETTERS OF INTENT AT CEBAF
2/9/89

LOI #	Title	Contact Person/Institution	Hall
88-01	Measuring the Number of Pions in the Nucleus	J. S. O'Connell National Institute of Standards and Technology	A
88-02	Deuteron Electrodistegration at Threshold	J. Jourdan University of Basel	A/C
88-03	Investigations of ^{3,4}He, ^{6}Li, and ^{12}C (e,e'2n) Reactions for T_e = .500 - 2GeV	G. J. Lolos University of Regina	A/C
88-04	Study of Short-Range Correlations in Light Nuclei in Processes of Electron Scattering in Coincidence with Backward Nucleons and Δ- Isobars	K. Sh. Egian Yerevan Physics Institute	B
88-05	High Momentum Transfer Measurement of the Recoil Tensor Polarization in Elastic Electron Deuteron Scattering	D. H. Beck California Institute of Technology	A
88-06	A Survey Measurement of ^{3}He (e, e'2p)n with the Large Acceptance Spectrometer at CEBAF	D. H. Beck California Institute of Technology	B
88-07	The Drell-Hearn-Gerasimov Sum Rule using the LAS	D. H. Beck California Institute of Technology	B
88-08	Hadronization of Quarks	C. C. Chang University of Maryland	A/B/C
88-09	A Proposal to Measure the A Dependence and Q^2 Dependence of Quasielastic (e.e'p) Scattering at Large Momentum Transfer	R. Milner Massachusetts Institute of Technology	C
88-10	Deuteron Photodisintegration	D. Jenkins Virginia Polytechnic Institute	B

88-24	Two-Body Photodisintegration of the Deuteron at Forward Angles and Photon Energies Between 1.5 and 4.0 GeV	R. J. Holt Argonne National Laboratory	A/C
88-25	The Energy Dependence of Nucleon Propagation in Nuclei as Measured in the (e, e'p) Reaction	D. F. Geesaman Argonne National Laboratory	C
88-26	Δ-Nucleon Cross Sections and Δ Propagation in Nuclear Matter	J. P. Schiffer Argonne National Laboratory	B
88-27	A Study of Longitudinal Pion Electroproduction in ^{2}D, ^{3}He, and ^{4}He	H. E. Jackson Argonne National Laboratory	C
88-28	Electroproduction of Kaons and Light Hypernuclei	B. Zeidman Argonne National Laboratory	C
88-29	Two-Body Photodisintegration of ^{3}He as a Test of Reduced Nuclear Amplitudes	J. Napolitano CEBAF	A/C
88-30	Measurement of the Electromagnetic Form Factor of the Pion	J. Napolitano CEBAF	A/C
88-31	Coincidence Reaction Studies with the LAS	W. Bertozzi Massachusetts Institute of Technology	B
88-32	Electromagnetic Properties of Baryon Resonances at High Momentum Transfer	P. Stoler Rensselaer Polytechnic Institute	C
88-33	Longitudinal Cross Sections in Single Pion Electroproduction at $\theta^*\pi = 0°$	P. Stoler Rensselaer Polytechnic Institute	C
88-34	High Momentum Pion Electroproduction from Nucleons and Nuclei in the Scaling Region	P. Stoler Rensselaer Polytechnic Institute	C
88-35	Baryon Resonances in Nuclei and Charged Pion Electroproduction	P. Stoler Rensselaer Polytechnic Institute	B
88-36	Experimental Study of Strangeness Photoproduction	R. Schumacher Carnegie-Mellon University	B

88-50	Determination of the Relativistic Deuteron Wavefunction with the D (e, e'p) Reaction	A. Saha CEBAF	A
88-51	The Q^2 and Target Dependence of the (e, e'p) Coincidence Cross Section at the Quasielastic Peak 2. Separated Momentum Distributions of the Response Functions in Perpendicular Kinematic Condition	A. Saha CEBAF	A
88-52	The Q^2 and Target Dependence of the (e, e'p) Coincidence Cross Section at the Quasielastic Peak 1. Study of the Modification of the Nucleon in the Nuclear Medium in parallel Kinematic Condition	A. Saha CEBAF	A
88-53	A Program to Study Electromagnetic Properties of Nucleon Resonances at CEBAF	V. Burkert CEBAF	B
88-54	Measurements of $p(e,e'\pi^+)n$ and $n(e,e'\pi^-)p$ in the Second Resonance Region	V. Burkert CEBAF	B
88-55	Photodisintegration of the Deuteron	S. T. Thornton University of Virginia	B
88-56	Photoproduction of Nucleon Resonances	R. Sealock University of Virginia	B
88-57	Electroexcitation of the Δ (1232) in the Nuclear Environment	R. Sealock University of Virginia	B
88-58	Deuteron Electrodisintegration in the Region of $W \sim 2$ GeV	D. Day University of Virginia	B/C
88-59	Study of the Quasielastic (e, e'p) Reaction in ^{16}O at High Recoil Momenta	R. W. Lourie University of Virginia	A

88-70	An Experiment to Measure the Electric Form Factors of the Neutron	J. McCarthy University of Virginia	A/B/C
88-71	Study of the Photoproduction and the Decay of Hypernuclei	B. Mecking CEBAF	B
88-72	Measurement of the Resonant Quadrupole Excitation of the N→Δ Transition using the H(e,e'p) and H (e,e'p gamma) Reactions	L. S. Cardman University of Illinois	C
88-73	Measurement of the Electric Form Factor of the Neuteron Using the d (e, e'p) Reaction	L. S. Cardman University of Illinois	C
88-74	A Toroidal Spectrometer for Out-of-Plane Measurements at CEBAF	L. S. Cardman University of Illinois	C
88-75	Measurement of the Interference Response in Few-Body Systems with Particular Reference to the D(e, e'p) Reaction	L. S. Cardman University of Illinois	C
88-76	Study of Quasi-Particle Orbits in Closed Shell Nuclei with (e, e'p)	E.A.J.M. Offerman University of Illinois	A
88-77	Measurement of the Electric Form Factor of the Proton by Recoil Polarization	C. F. Perdrisat College of William and Mary	A
88-78	Two-Nucleon Knock-out (e,e'2n) Reactions	R. Lindgren University of Virginia	
88-79	A Study of Two-Body Correlations in ^{3}He using the (e,e'pp) Reaction	R. A. Miskimen University of Massachusetts	B
88-80	Study of Coincidence Reactions in the Dip and Δ-Resonance Regions	H. Baghaei University of Massachusetts	B
88-81	Production of $K^{+}\Lambda^{0}$ and $K^{+}\Sigma^{0}$ from the Proton by Real and Virtual Photons	G. A. Peterson University of Massachusetts	B