Evaluation of CEBAF Equipment Plan

by the

Nuclear Science Advisory Committee

July 7, 1990

Introduction

As construction of the Continuous Electron Beam Accelerator Facility (CEBAF) approaches its completion, projected for the second quarter of 1994, the needs of its experimental programs are moving rapidly to the forefront. The laboratory and its user community have laid out an equipment plan, detailed in the Conceptual Design Report (CDR). This plan has obtained the endorsement of the Program Advisory Committee (PAC4), and has been evaluated for both its technical soundness and its cost basis by a DOE Review panel. It requires substantially more funds than had been allocated for equipment in the construction project definition.

In a letter dated May 25, 1990 (Appendix I), NSF and DOE asked NSAC for an evaluation of this experimental plan and the associated needs, from the vantage point of the 1989 Long Range Plan for Nuclear Science (LRP). In response to this charge, NSAC held a meeting at the CEBAF site in Newport News,Virginia, on June 4, 1990. The agenda of that meeting (Appendix II) contained presentations by the CEBAF directors, by the scientific coordinators of the three experimental areas, Hall A, B and C, the chairman of PAC4 (J. Schiffer), and by the head of the DOE technical evaluation review (E.Temple). The directors of the nuclear physics programs at NSF and DOE presented budget possibilities for their agencies. Major background material, i.e. the full CDR and a condensed version of it, as well as the PAC4 Report were made available to NSAC prior to the meeting. A funding scenario outlining the projected needs for the three experimental halls was provided by CEBAF management for the committee (Appendix III).

The following represents the committee's unanimous conclusions and its response to the charge.

Research Equipment.

The NSAC 1989 LRP, responding to the major scientific opportunities in nuclear science and building upon earlier LRP's, states that " the highest scientific priority in U.S. nuclear science at this time is the timely completion of CEBAF and the beginning of its important research program". A basic set of research equipment for CEBAF has been developed around major expected scientific programs which have considerable user interest and which have been endorsed by the CEBAF Program Advisory Committee. We summarize here the major detectors that are being proposed:

- **Hall A**— This hall will have two high-resolution (Δp/p = 10^{-4} at p_{max}=4 GeV/c) magnetic spectrometers (HRES and HRHS). These devices, in combination with the CEBAF beam properties, will permit unprecedented precision in missing mass resolution for coincidence experiments in the full CEBAF energy range. One of the spectrometers (HRHS) will have a focal plane polarimeter for measuring proton polarization. With this capability for electromagnetic coincidence measurements CEBAF will greatly advance the precision study of nuclear constituents.

- **Hall B**---This hall will house the CLAS detector, a large acceptance detector designed around a novel superconducting toroid. This instrument complements those in the other halls by providing a unique capability for multi-particle detection. It thereby allows a significant expansion of the scope of CEBAF's research program, e.g. a quantitative understanding of nucleon excitations will be within reach. Hall B will also provide a photon tagging capability and tagged-photon research will greatly profit from the large solid angle of CLAS.

- **Hall C**— The intial set of equipment in this hall includes two major spectrometers: A 6 GeV/c spectrometer (HMS) will serve to define the electron (and therefore virtual photon) kinematics precisely. Another spectrometer (SOS) will provide a coincidence capability and is optimized for meson detection. This equipment will often be used in conjunction with experiment-specific special purpose detectors (e.g., polarimeters for the study of spin transfer reactions). Observables related to the internal structure of nucleons and light nuclei will be made accessible by this instrumentation.

NSAC finds this plan well matched to the impressive capabilities of the CEBAF accelerator and to the scientific opportunities identified in the LRP (most especially those of Chapters II.1, 2 and 3, discussing the role of hadrons and quarks in nuclei). The plan provides sufficient scope for the pursuit of many important research programs. We recommend that the funding agencies adopt this plan as one providing the base for a long-term first-class research program at CEBAF.

Implementation

The CEBAF implementation plan (see Appendix III) has the two spectrometer coincidence capability in Hall C available in the second quarter of FY94, i.e. when the accelerator will be ready for first use in the experimental program.

NSAC strongly endorses the importance of having a coincidence capability operational at that time.

The two Hall A high-resolution spectrometers will then become available in roughly six-month intervals. We note that single arm measurements with one Hall A high resolution spectrometer will already permit important new measurements because of the unique combination of CEBAF energy, beam quality and intensity. Finally, the Hall B large acceptance spectrometer is slated to become available in the third quarter of FY95. Thus all major first generation research programs will be fully engaged in FY96.

NSAC strongly supports this implementation plan for all three halls as providing a timely and responsible utilization of CEBAF's capabilities. A coincidence program which takes advantage of CEBAF's unique combination of energy, duty factor and intensity can start as soon as beam becomes available and the full complement of equipment can be realized consistent with projected financial and human resources.

In the latter regard, CEBAF management has been very constructive in involving the user community, not only in program planning, but also in structuring the detector projects so as to involve numerous university groups.

Funding

The CEBAF estimate for the total funds needed to realize the equipment plan as outlined in the CDR is \$73 Million (all costs will be given in FY89 dollars, as are the fiscal schedules of Appendix III). This is about \$30M more than is available in project funds. Since \$5M of foreign contributions are expected for detector development, there is a shortfall of \$25M. A DOE technical review has largely confirmed the estimated base costs but has suggested a substantially higher contingency cost. CEBAF management is committed to providing a research capability within the framework of the CDR within the costs listed in Appendix III.

As stated above, NSAC feels that equipment plan and the implementation plan are both very good, but also recognizes the need to maintain sufficient flexibility in the nuclear physics equipment budget to fund a reasonable number of new initiatives anticipated from other groups over the next few years.

With the available project funds of about \$43M, the Hall C spectrometers, one Hall A spectrometer, and the long-lead items for Hall B will be advanced according to schedule. Importantly, a coincidence capability will be available in the second quarter of FY94. However, it is equally clear that, without additional funds, the full

utilization of the CEBAF accelerator capability would be delayed too long. Dr. Hendrie indicated that, with reasonable expectations for out-year budgets, approximately $6M of additional equipment funding might be available, summed over the FY91 to FY93 time period, without excessively limiting the opportunities for other nuclear physics initiatives. Such an increment would permit completion of the high-resolution capability in Hall A on the indicated schedule.

This will be a very significant addition to the program permitted with the project funds alone, and NSAC, assuming that budgets do indeed follow expectations, endorses this approach.

This leaves approximately $19M to complete the Hall B large acceptance spectrometer CLAS. The toroidal field configuration of CLAS represents a whole new detector concept and has already sparked great interest from other areas in nuclear physics and from high energy physics. It opens up major new programs for investigation and has inspired the largest group of outside users of any of the three halls.

NSAC sees Hall B as an important part of the CEBAF program. We strongly support that it be instrumented in the time frame outlined in Appendix III. On the other hand, it is clear that an additional $19M of equipment funding over the next five years would unacceptably limit opportunities for other laboratories and university groups in a more or less constant funding scenario for the field. Consequently, we urge that the agencies seek additional funds into the nuclear physics program for the timely realization of CLAS. The alternative of stretching out the full development of this important detector beyond FY95 would substantially restrict the opportunities which CEBAF makes available to the national research community.

Additional Comments

The committee applauds the progress on the accelerator that it could witness from its site visit. A sense of adventure and excitement seems to pervade the laboratory. It is also clear that the procedure of a CEBAF coordinator for each experimental hall, each assisted by a designated user coordinator, is working well. The committee was impressed by the presentations of the three hall coordinators.

A vast scientific program will be made possible by the equipment which is projected in the CDR for all three halls. Additional projects are already being proposed. Just to complete the equipment reviewed by NSAC at this time, the projected manpower needs (technical and scientific) until 1994 total about 700 man-years (207 man-years in Hall A, 319 in Hall B, and 176 in Hall C). Of these, about 400 man-years appear to have been already committed by outside users (115 in Hall A, 230 in Hall B, and 52 in Hall C)(The remaining manpower needs will be covered from CEBAF staff).

It is clear that this large program requires full involvement of university groups, both large and small. It is important that these users be put in a strong position

to compete and participate in the CEBAF program on an equal footing with the scientists from national laboratories.

A major recommendation of the 1989 LRP stresses the importance of strengthening the technical infrastructure of experimental university groups and of increasing university equipment budgets. We underline here again that this recommendation is essential for the success of the major new nuclear physics user facilities, such as exemplified by CEBAF (but not restricted to it).

Historically, university research in nuclear physics has been funded at about equal levels by NSF and DOE, and this has served the field well by providing for a healthy competition of ideas.

The committee urges both agencies to maintain balanced funding levels to assure this successful distribution of effort at the universities. As nuclear science projects increase in scope, as exemplified by the CEBAF equipment plan, it is also essential to recognize the continuing important role of the individual faculty investigator and his students.

Department of Energy
Washington, DC 20545

May 25, 1990

Professor Peter Paul, Chairman
DOE/NSF Nuclear Science Advisory Committee
Department of Physics
State University of New York
at Stony Brook
Stony Brook, New York 11794-3800

Dear Professor Paul:

CEBAF and its user community have prepared a conceptual design report (CDR) for a basic set of research equipment for Experimental Halls A, B, and C. The CDR was prepared in consultation with a technical advisory panel for each hall and has been coordinated with a program advisory committee. The definition of the CEBAF construction project requires that an initial experimental capability, using project funds of about $43 million, must be ready for use by the second quarter of FY 1994, when the accelerator is scheduled to start operation. The present CEBAF cost estimate for implementing the full set of basic equipment described in the CDR substantially exceeds this initial allocation for experimental detectors included in the construction project. A DOE technical review panel has reviewed the technical readiness and cost estimates for the basic set of equipment described in the CDR.

In keeping with the above, CEBAF has developed an equipment plan to provide the basic set of research equipment as described in the CDR. This plan includes a proposed schedule of installation, costs and manpower requirements. DOE must now determine an appropriate response to this plan. The rate of buildup of participating outside user groups by both DOE and NSF must also be keyed to the development of the CEBAF equipment.

NSAC is therefore asked to evaluate and provide advice to the DOE and NSF, by July 2, 1990, on the merit of the CEBAF equipment plan within the scientific priorities of the field as defined in the NSAC Long Range Plan of December 1989. The Committee should include in its considerations the results of existing technical and scientific reviews, as available. The funding agencies will also provide the Committee with an understanding of the financial implications of a decision to fund the proposed equipment, and ask NSAC to take this into consideration, as well.

Sincerely,

Marcel Bardon
Director, Division of Physics
National Science Foundation

Wilmot N. Hess
Associate Director for
High Energy and Nuclear Physics
Office of Energy Research
U.S. Department of Energy

Appendix II

Agenda for NSAC Meeting

at CEBAF, Newport News, Virginia

Monday - June 4, 1990

VARC BUILDING, ROOMS 53/55

9:00 a.m.	Opening Remarks by Chairman	
9:10	Status of CEBAF Facility	H. Grunder
9:25	Summary of Research Plans	J. D. Walecka
9:35	Equipment Plans for Hall C	R. Carlini
10:10	Equipment Plans for Hall A	J. Mougey
10:45	Coffee Break	
11:00	Equipment Plans for Hall B	B. Mecking
11:35	Discussion of Isotope Production	R. Meyer
12:30 p.m.	Lunch	
1:15	CEBAF Tour	
2:15	Discussion of CEBAF Equipment	Hendrie/Lightbody Schiffer
3:00	Discussion of Facilities Subcommittee	Parker
3:40	Coffee Break	
4:00	Other Business and Public Comment	
4:30	Further discussion of CEBAF Equipment Plans	
6:30	Adjourn	

agendas:pas
1-JUN-90

A. Cost Estimate and Obligation Profiles

1. Cost Estimate and Funding Sources for Basic Experimental Equipment (in FY89 M$)

	CEBAF Project	CEBAF Ops	Capital Equipment	Foreign	Total Cost Est.
Total	22.1	9.2	21.0	5.0	57.3
Cost & Commitments (Thru 9/89)	2.3*				2.3
Contingency	8.9*		4.0		12.9
TEC	33.3	9.2	25.0	5.0	72.5

2. Obligation Profile for Basic Experimental Equipment Plan (in FY89 M$)

	FY 90	FY 91	FY 92	FY 93	FY 94	FY 95	Total
Hall A (6.5)	0.5	7.7	7.5	3.5	1.0		20.2
Hall B (6.6)	0.2	3.3	5.3	5.0	5.0	1.3	20.1
Hall C (6.7)		2.7	5.3	2.8	0.6		11.4
Common			0.6				0.6
Contingency			1.9*	7.6*		3.4	12.9
Cost and Commitments (Thru 9/89)							2.3
Foreign							5.0
Total	0.7	13.7	20.6	18.9	6.6	4.7	72.5

*Entries in Actual Year (AY) Dollars