Advice on Three Low Energy Heavy Ion Facilities
by the
NSF/DOE Nuclear Science Advisory Committee

December 18, 1990

1. Background

On March 29, 1990, DOE/NSF requested advice from NSAC regarding phaseout activities at one of three DOE funded national low-energy heavy ion facilities: ATLAS at Argonne National Laboratory, the 88-in Cyclotron at Lawrence Berkeley Laboratory, and the Holifield Heavy Ion Research Facility at Oak Ridge National Laboratory. The specific charge to NSAC is attached as Appendix I. NSAC was requested to respond by July 15, 1990. In the end the Committee was not able to respond within this short time frame.

These three facilities are a major part of the low-energy nuclear physics subprogram in the U.S., which also includes a number of recently improved university based facilities. Each of the three laboratories has developed its own style of operation and scientific character. Each operates a state-of-the- art accelerator employing distinctly different technologies, and has a substantial complement of forefront instrumentation. They are all embedded into the national and international low-energy nuclear physics research effort through active and strongly laboratory-supported user programs and play important regional roles as the dominating low-energy facility in a large section of the country. Closing down any one of these three would clearly constitute a dramatic re-direction of effort in the field.

Phaseout of one of these facilities has to be seen in the context of recent changes in the field of nuclear structure. Research in this area is making a major step in the sophistication of its instrumentation, and thereby its research potential for the near future. This development is exemplified by the Gammasphere detector, by the large APEX detector, and by large nuclear online mass separators and analyzers. In terms of medium-range new programs, a number of imaginative proposals on cost-effective radioactive beam facilities using these existing low-energy accelerators are being discussed. These developments will lead to an increasing trend to do nuclear structure research in the user mode, with an ensuing concentration at the national facilities. Elimination of one of these three facilities will represent a serious curtailment of beam time available for nuclear structure research in the U.S.

This subprogram shares in the problems created by a serious shortfall in operating funds available for nuclear facilities which has been recognized since the 1983 Long Range Plan for Nuclear Science. A high priority recommendation of that plan, for a step increase of $20Million in the base program, was not implemented. The present shortfall in funds for operation at many, if not all,nuclear facilities has been a subject of many discussions within NSAC and is a serious, continuing problem for the field. The need for operations funds for the new facilities under construction, such as CEBAF and RHIC, exacerbates the problem, as these have so far come out of an almost constant base. In light of this trend, the DOE made the decision in 1988 to seek savings by phasing out one of these three low-energy nuclear facilities. The agency charge to NSAC projected a possible saving of about $3Million in FY91 from such a phaseout.

The proposed phaseout of one of these facilities has caused great distress in the U.S. nuclear structure community and in a large and distinguished group of supporters abroad. The Committee has received many letters which express dismay that this shutdown would occur just when major new initiatives, such as Gammasphere and radioactive beams, provide a strong impetus to nuclear structure research.

2. The Facilities Subcommittee and its Report

In response to the NSF/DOE charge NSAC set up a Heavy Ion Facilities Subcommittee, chaired by Professor Peter Parker (NSAC member). The serious nature of the charge and the broad areas of research, which extend from nuclear physics through nuclear chemistry to beam-related atomic physics, as well as accelerator development, that are being pursued in these laboratories, mandated a most careful selection of the membership of the Subcommittee. This selection process and the need to schedule time for three site visits made it impossible to constitute the Subcommittee on a schedule to meet the deadline originally mandated in the NSF/DOE charge.

The Subcommittee, as finally convened, consisted of eight members, among them four from NSAC, with high credentials in the field. The membership expertise spanned the full range of the broad programs of the three laboratories. Most of the Subcommittee members are active in the areas of research in which these laboratories are engaged, but some were outsiders to the heavy ion field. The directors of all three facilities expressed their acceptance of the Subcommittee membership.

The Subcommittee undertook three review site visits in early August and submitted its final report to NSAC on November 29, 1990. This report is attached as Appendix II. The findings of the Subcommittee can be summarized as follows:

- The low energy nuclear spectroscopy and nuclear reaction subfields represented by these three facilities continue to be active, exciting and important parts of nuclear science. Closure of any one of these three facilities will have a significant negative impact on the vitality of the field and will leave many exciting opportunities unrealized. The Subcommittee recommends that NSAC consider " whether optimal action in regard to a phaseout would not be continued support of all three facilities". To make this possible the Subcommittee urges that the nuclear physics operating budget be increased.

- Based on an assessment of overall scientific excellence, impact, leadership and potential of research programs at these facilities, the Subcommittee concludes unanimously that closure of either ATLAS or the 88-in Cyclotron would be unacceptable.

- If one of these three facilities must be phased out the Subcommittee urges that NSAC recommend a strengthening of the operating support for the remaining low-energy heavy ion facilities so that they can effectively handle the most competitive of the displaced programs. Important opportunities and initiatives must not be lost in this process.

The Subcommittee report gives an extensive overview of the impact of closing any one of these three facilities. The loss of programs, some of which are unique in the U.S., may be extensive. The report emphasizes that even though a number of programs and equipment may be relocatable from one facility to another, this may not be helpful in practice, because of shortage of beam time. The reduction in available beam hours will impact both the displaced and current research programs. This problem will be soon exacerbated by the additional substantial beam time requirements of Gammasphere.

3. NSAC Response to the Charge

NSAC had extensive and open discussions of a preliminary Subcommittee report at a meeting on September 7 – 8, 1990, and of the final report at a meeting on November 29, 1990. The Committee's discussions can be summarized by the following impact statements:

- As noted in the Subcommittee report "Closure of any one of these three facilities will have a significantly negative impact on the vitality of the field and will likely lead to a premature termination of a number of high-quality research programs., and will thus leave many opportunities unrealized". In addition, each facility has unique capabilities. Phasing out any one will necessarily foreclose productive research directions in accelerator and ion source developments and result in the loss of major pieces of instrumentation.Two timely initiatives that explore the inexpensive implementation of a (limited) radioactive beam capability at the 88-in cyclotron and the Holifield facility, would be seriously affected by a phaseout before the potential of these initiatives can be fully assessed.

- An abrupt closure of one of these facilities will severely disrupt the education of young scientists from universities that depend on the accelerator for their research program. In addition small regional user groups and their students might disappear.

- The productivity of researchers in low-energy nuclear physics will be slowed for several years as users make a transition to a new facility or a new subfield. This will have a detrimental effect for the U.S. effort relative to the keen international competition.

- It is likely that the closure of one of these facilities will not realize the full savings associated with present operation. There will be increased costs for additional operation of the two remaining facilities, for relocation of instrumentation, increased travel by users, and loss of non-federal funds (which are substantial in the case of Holifield).

- On the other hand, the impact of taking no action would be a further erosion of the scientific strength of each of these three laboratories, all of which presently document a lack of base funding.

The response of NSAC to the NSF/DOE charge is as follows:

1. NSAC unanimously accepts the report of the Facilities Subcommittee in its final form of November 29, 1990 and with majority vote endorses its findings as summarized above. The Subcommittee report is appended to this report as Appendix II.

2. All three laboratories presently maintain strong programs in low energy nuclear science and strongly merit support. Therefore, NSAC strongly recommends that all three facilities continue operation. In view of the widespread shortage of operating funds that affects almost all facilities in the field, continued operation of the three facilities would require an adequate increase in the DOE operating budget.

3. If additional operations funding for this area of nuclear physics cannot be found, phasing out one facility appears to be unavoidable. Such a phaseout should be done in accordance with the findings of the Subcommittee and carried out in an orderly fashion. To insure continued scientific vitality of this subfield, the remaining national and university facilities must be able to take over the strongest of the displaced programs. This will require an increase in funding for operation and user support.

4. The most exciting initiative in nuclear structure physics today is Gammasphere. It is a most timely project and NSAC is pleased that it has received an appropriation for construction in FY91. NSAC strongly agrees with the Subcommittee that construction should proceed at a rapid pace, and that an early usage, even in incomplete form, is desirable. This requires that the final siting decision for the start-up phase of Gammapshere be made as soon as possible.

Department of Energy
Washington, DC 20585

March 29, 1990

Dr. Peter Paul, Chairman
DOE/NSF Nuclear Science Advisory Committee
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Dear Dr. Paul:

In the Department of Energy's (DOE's) Fiscal Year 1991 budget submission, it is stated that DOE will continue phase out activities at one of three National Laboratory low energy heavy ion facilities. These are the Argonne Tandem/Linac Accelerator System (ATLAS) at Argonne National Laboratory, the 88-inch Cyclotron at Lawrence Berkeley Laboratory, and the Holifield Heavy Ion Research Facility (HHIRF) at Oak Ridge National Laboratory.

Our decision to phase out one of these facilities is based on the following considerations. The Report of the 1987 DOE Review Panel on Heavy Ion Facilities stated "But much of the excitement in nuclear reactions is moving to still higher energies." and we find that scientists are directing their research to higher energy facilities and other areas of nuclear science research. In addition, DOE Nuclear Physics operating funds are required to accommodate to new research directions and there is recent increased capability in low-to-medium energy heavy ion facilities at university laboratories in both the DOE and NSF programs.

We request the Nuclear Science Advisory Committee (NSAC) to provide advice to DOE as to which facility should be selected for closure. Specifically, NSAC is requested to:

- Evaluate the overall scientific excellence and productivity of the nuclear physics research program at each of the facilities.

- Evaluate the importance of each facility for other scientific programs, its role in graduate education, and in technical research and development areas.

- On the basis of these considerations evaluate the impact of closure of each of the facilities and recommend the optimum action with respect to facility closure.

In performing this evaluation, NSAC should consider the scientific quality, breadth, cost effectiveness, and uniqueness of each facility's program. NSAC considerations should conform to the priorities developed in the December 1989 Long Range Plan.

Since the FY 1991 DOE Nuclear Physics budget contains a $3.1 million designated savings and this closure must take effect early in that year, it is important that we have NSAC's advice by July 15, 1990. In addition, designation of a host laboratory for the Gammasphere detector will await the laboratory phase out decision.

We appreciate very much your assistance in helping us with this difficult decision.

Sincerely,

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June 15, 1990

Professor Peter Parker
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Dear Peter,

At its meeting of March 30, 1990 the Nuclear Science Advisory Committee (NSAC) was requested by DOE and NSF to provide advice on the phase-out of one of three DOE operated low energy nuclear physics facilities, ATLAS at ANL, the 88-in Cyclotron Facility at LBL, and the Holifield Heavy Ion Research Facility at ORNL. I attach the specific charge, dated March 29, 1990, that was given to NSAC.

In response to this request NSAC, in consultation with DOE and NSF, and with the management of the three laboratories, has set up a facilities subcommittee consisting of eight members. I would like to ask you to chair this subcommittee, which has the following membership:

Peter Parker, Yale University, NSAC member, chairman;
Konrad Gelbke, Michigan State University, NSAC member;
John Huizenga, University of Rochester;
Steve Koonin, California Institute of Technology, NSAC member;
John McClelland, Los Alamos National Laboratory, NSAC member;
Robert Pollock, Indiana University;
Gene Sprouse, SUNY at Stony Brook;
Peter Twin, University of Liverpool.

On behalf of NSAC I ask that this subcommittee, under your chairmanship, undertake the evaluations requested in the DOE/NSF charge to NSAC, address the issues stated therein, and prepare appropriate recommendations for the consideration of the full Nuclear Science Advisory Committee. A schedule has already been set up for site visits to the three laboratories over the first two weeks in August. It would be most helpful if the subcommittee would make its report available to NSAC before September 1, 1990.

NSAC is greatly indebted to you and to the other subcommittee members for your willingness to help with this difficult and serious task.

Sincerely,

Peter Paul

Peter Paul
Chairman, NSAC

An Evaluation of ATLAS, HHIRF, and the 88"-Cyclotron

NSAC Heavy-Ion Facilities Subcommittee Report

29 November 1990

Physics with low-energy heavy-ion beams is a strong and thriving field. In our investigations, we found no evidence of any decline in the quality of these research programs and no indication of any decline in the utilization of these facilities. In fact, because of the limited beam time currently available, the recent PAC meetings at these three facilities have been able to approve only half of the proposals submitted. We found exciting, new science being addressed by a new generation of instrumentation and accelerators at all three of these facilities. While some nuclear scientists are moving to programs at new, higher energy facilities, at the same time new scientists, programs, and instruments have continued to keep the field of low-energy heavy-ion nuclear physics active and exciting and to keep these facilities fully subscribed with high quality experiments.

The restricted nature of our charge did not allow us to judge whether or not closing one of these three specific facilities -- rather than looking for savings in other heavy-ion activities or in other subfields of nuclear science -- is the best strategy for realizing the required budgetary savings while minimizing damage to nuclear science as a whole.

While we have struggled to carry out the charge given to this subcommittee, we have been particularly troubled, both collectively and individually, by the following aspect of this exercise: The facility operating funds which could be saved by the closure of one of these major facilities would correspond to only ≈1% of the total D.O.E. Nuclear Physics budget! These are high leverage dollars, and it would seem much more reasonable to work for a 1% increase in the level of these funds, rather than closing one of these facilities. In recent years, Nuclear Physics has broadened its perspectives and its frontiers in a very important way with the CEBAF and RHIC initiatives. At the same time, however, Nuclear Physics operating funds have not kept pace with the broadened scope of the field. As a result, the lower energy nuclear spectroscopy and nuclear reaction-mechanism subfields (represented in part by the three facilities included in this review) are being squeezed out; these subfields continue to be active, exciting, and important parts of nuclear science and should not simply be abandoned.

Closure of any one of these three facilities will have a significantly negative impact on the vitality of the field and will likely lead to a premature termination of a number of exciting and high quality research programs and will thus leave many opportunities unrealized. From our limited perspective, we therefore recommend that, in making its response to the DOE, NSAC consider whether the "optimum action with respect to facility closure" is the continued support of all three of these facilities.

If NSAC chooses to respond explicitly to the agencies' charge by providing advice as to which facility should be selected for closure, having evaluated each of the three facilities using the criteria listed in our charge, we note the following:

- Although we found differences among the labs under most of the criteria, we judged some of the criteria to be more important than others in evaluating the facilities.
- Based primarily on our assessment of the overall scientific excellence, impact, leadership, and potential of the research programs at these facilities, we are unanimous in our judgement that the closure of either ATLAS or the 88"-Cyclotron would be unacceptable.
- If NSAC chooses to recommend the closure of one of these three facilities, we urge that it also recommend a strengthening of the operating support for the remaining low-energy heavy-ion facilities so that they can effectively handle the most competitive of the displaced programs. Important opportunities and initiatives must not be lost in this process.

The following sections discuss our considerations and evaluations concerning specific aspects of the criteria in our charge:

Education:

All three facilities are actively involved in the education and training of the next generation of nuclear scientists at the undergraduate, graduate, and post-doctoral level. In 1987-89, 42 Ph.D. degrees were awarded to students who did half or more of their thesis work at one of these facilities, 21 at HHIRF, 14 at the 88"-Cyclotron, and 7 at ATLAS. In the education of students at all levels, HHIRF has very close and productive ties with the University of Tennessee, Vanderbilt University, Tennessee Technological University, and a cross section of other colleges and universities especially in the south-east; the facility management, the state of Tennessee, and a number of the user institutions have been especially creative in their support of these students, as well as other user programs. ATLAS is also making significant contributions to undergraduate, graduate, and post-doctoral education, and we were particularly impressed by the quality and number of post-docs active in the ATLAS program. The 88"-Cyclotron at LBL has a long tradition in nuclear science education, and many of the world's nuclear scientists have spent time at Berkeley as students, research associates, or as short or long term visitors. All three facilities are in the process of expanding and improving their educational opportunities. Based on the criterion of education, we judged that the strengths of each of the facilities were comparable; the differences among them were not important enough on the national scale to form a significant basis for our evaluation of these facilities.

Outside Users:

All three facilities support substantial outside-user programs. Facility access and beam time are allocated on the basis of scientific merit as evaluated by independent Program Advisory Committees, without discrimination between inside and outside users. In recent years the fraction of successful proposals that have had outside users as spokespersons has ranged from one-third (88"-Cyclotron) to one-half (ATLAS) to two-thirds (HHIRF). Each of the facilities has at least one staff person who serves as a full-time user liaison, and each facility has also assigned in-house scientists as "mentors" for each of their major pieces of research equipment to provide support and coordination for outside users wanting to use that equipment. User needs and priorities are communicated to the facility management by the respective User Executive Committees, each of which expressed to us their satisfaction with the support they are receiving from the facilities and their staffs. While differences exist with regard to the breadth of instrumentation available to users and to the level of support available in the lodging arrangements at the three sites, these differences did not significantly affect the scientific quality and/or productivity of the experiments performed by the outside users or the accessibility of these facilities to the outside users. The management at each of these three facilities is clearly concerned with providing outside users with any possible help consistent with their budgetary constraints.

Accelerators and Instrumentation:

The three laboratories provide an array of complementary, forefront accelerator facilities, each with very different techniques for producing the range of ion species and energies required to meet the diverse needs of their user community. Each of the three facilities has a very active program of accelerator development that has had very important achievements in improving their capabilities in the last few years, keeping each accelerator at the forefront of its field by making new beams, higher energies, and increased intensities more readily available. ATLAS, which pioneered the application of niobium superconductivity technology to the acceleration of heavy ions, has now successfully extended that technology to the very low $\beta=0.008$ resonators required for their ECR-based Positive Ion Injector; the ^{238}U beam needed for APEX is an example of one of the many beams which will be made available by this new injector. The excellent time resolution ($<$ 200 psec) achieved in the ATLAS beams using their superconducting bunching systems remains a benchmark for comparisons at other facilities. HHIRF has achieved the highest stable voltage operation of any electrostatic accelerator in the world, running routinely with terminal voltages in excess of 24 MV. The HHIRF staff has also significantly improved both the variety and intensity of the beams available using negative ion-source technology. The 88"-Cyclotron staff was the first US group to take advantage of ECR ion sources and has now become one of the leaders in their further development. The high-intensity multiply charged heavy-ion beams that can be achieved from these sources have greatly enhanced the scientific program at the 88"-Cyclotron during the past several years; their recently completed Advanced-ECR source (using cold electron injection) will significantly increase the available intensities and beam energies at this facility.

Research Programs:

While each of these three facilities has a number of excellent and productive research programs, we were particularly impressed with the strength and palpable enthusiasm of the in-house staff at ATLAS and at the 88"-Cyclotron. We are unanimous in our judgement that the overall research programs at ATLAS and the 88"-Cyclotron were of the highest quality and demonstrated the strongest scientific leadership and creativity. Examples of this quality and scientific leadership are to be found in the superdeformation research and related gamma-ray programs using the Compton-Suppressed Germanium arrays at the 88"-Cyclotron and at ATLAS. The current, collaborative development of the APEX e^+e^- program at ATLAS is an important and unique opportunity; the capabilities provided by the Transactinide Research Program at the 88"-Cyclotron play a unique and essential role in nuclear chemistry research and in the training of nuclear chemistry students. While we are unanimous in our decision that the programs at ATLAS and the 88"-Cyclotron must be continued, we are also deeply concerned that the closure of HHIRF will have strongly adverse effects on a number of important, high-quality research programs such as the Spin-Spectrometer/Dwarf-Ball program. If HHIRF is closed, it is essential that the funding agencies strengthen the support for the remaining facilities so that they can better handle the most competitive of the displaced programs.

Comments on the Siting of Gammasphere

While it must be emphasized quite clearly that this Subcommittee was neither charged with the responsibility of commenting on the siting of Gammasphere nor constituted in such a way as to concentrate within its membership a significant number of Gammasphere "experts", it must also be recognized that Gammasphere could not be ignored in this review, since it will inevitably play a dominant role in the physics to be done during the next several years in the subfield represented by the facilities included in this review.

Recognizing the two limitations noted in the previous sentence, we make the following comment:

> In light of the competition implied by the scheduled completion of the Eurogam array in late 1991, it is imperative that the D.O.E. decide the initial siting of Gammasphere as quickly as possible and that every effort be made to achieve an early implementation of Gammasphere, even if that means that its initial operation is in a less than complete or final form.

SUPPLEMENTARY MATERIAL

HHIRF:

HHIRF successfully and reliably operates the world's largest electrostatic accelerator, with ORIC (Oak Ridge Isochronous Cyclotron) used as a post-accelerator for their highest beam energies. Terminal voltages above 25 MV have been achieved, and voltages over 24 MV are used for routine operation. A state-of-the-art negative ion source development program has made it possible to accelerate beams of a wide variety of different elements and isotopes (36 elements and 66 ion species).

The facility has a well maintained and diverse array of experimental apparatus, the major components of which include the following:

Spin Spectrometer: A 4π array of 72 NaI detectors, up to 19 of which can be replaced with Compton-suppressed Ge detectors. This array can also be used in conjunction with the Dwarf-Ball (a 4π-phoswich detector array and a set of Breskin-type position sensitive detectors.

Close-Packed Ge Ball: A 4π array of 21 close-packed Compton-suppressed Ge detectors.

BaF_2 Detector Arrays: Four arrays of 19 hexagonal BaF_2 detectors for high energy photons.

UNISOR: An on-line mass separator for the selection of radioactive isotopes. This can be used in conjunction with the newly completed Nuclear Orientation Facility (NOF), a 4.3 mK nuclear alignment facility.

HILI: A forward-angle charged particle array consisting of layers of PPAC's, multi-mode ionization chambers, and phoswich detectors.

Two Magnetic Spectrographs: An Elbeck ($ME/Q^2=240$ and $\Delta\Omega=5$msr) and an Enge Split-Pole ($ME/Q^2=100$ and $\Delta\Omega=8$msr) equipped with a windowless gas-jet target.

(Recoil Mass Spectrometer (RMS)): There is currently an approved and funded proposal for a recoil mass separator with the following specifications ($\delta M/M \approx 1/1000$; $\delta E/E \approx \pm 10\%$; $\Delta\Omega \approx 10$msr, and $M/q \approx \pm 5\%$) and with an energy-to-charge bending capability of 15MeV/q and a designed primary beam reduction ratio of 10^{13}.

Over the years, HHIRF/ORNL has played a leading role in the development of versatile, fast data acquisition systems. The recent ACP-based implementation of fast parallel preprocessing of data before taping and the planned use of RISC based machines for data taking and analysis are important steps to cope with the increased flow of data provided by new 4π arrays such as Gammasphere.

Over the years, HHIRF has fostered a close and supportive relationship with a collection of large and small nearby universities. Major new instruments have been brought into existence by the provision of additional State and university funds, including substantial support promised for both the RMS ($1.6M) and Gammasphere ($2.4M). The Joint Institute for Heavy Ion Research (JIHIR) was funded to a large extent by the State of Tennessee and a consortium of universities which continue to provide funds for users and visitors.

HHIRF has a large and very supportive user program. Outside users are currently the spokespersons on ~65% of the approved proposals. In 1989 a total of 168 outside users participated in experiments at HHIRF, and during the period 1987-1989 a total of 21 graduate students received PhD degrees for which ≥50% of their thesis research was done on HHIRF. Many instruments have been designed and built by users or with important contributions from users. On-site lodging is provided free of charge for users, thus allowing many small university groups to participate in high tech nuclear research at an affordable cost, making it possible for students to stay on site for several weeks or months to obtain valuable technical training not available at their home institutions. Another outgrowth of this very constructive interaction has been the nuclear-structure theory program at the JIHIR and neighboring universities

ATLAS:

The ATLAS facility operates a world-class superconducting heavy-ion linac which is currently being converted from a negative-ion-source/tandem injector to a positive-ion injector based on an ECR ion source (with a mass selection of 1/400) coupled to a section of very low-beta pre-injection cavities. All of these components have been tested and already used in actual experiments. The final preaccelerator section is currently being installed, and when this is completed in early 1991, this injector will make it possible for ATLAS to provide the uranium beams required for the APEX collaboration (10 pnA of ^{238}U at energies up to 6 MeV/A).

The facility has a well maintained and diverse array of experimental apparatus, the major components of which include the following:

Germanium Array: An array of 12 Compton-suppressed Ge detectors which can be used in conjunction with a 50-element BGO multiplicity array. In order to exploit the capabilities of these arrays together with the t.o.f. possibilities for particle identification using the 100 ps time resolution of the ATLAS beam, a charged-particle-detector chamber has been designed and built. When in use, this chamber replaces the 4 forward-angle Compton-suppressed Ge detectors and provides space for detector arrays with flight paths of up to 1 meter.

Magnetic Spectrograph: An Enge Split-Pole instrumented with a focal plane PPAC backed by a Bragg-curve detector for measuring t.o.f., magnetic rigidity, total energy, nuclear charge, range and entrance angle.

Fragment Mass Analyzer(FMA): A recoil mass spectrometer which can be rotated from θ=-5° to +45° and which has the following specifications ($\delta M/M \approx 1/300$; $\delta E/E \approx \pm 20\%$; $\Delta\Omega \approx 8$msr, and $M/q \approx \pm 7\%$) and with an energy-to-charge bending capability of 10MeV/q and a designed primary beam reduction ratio of 10^{12}.
This spectrometer is currently undergoing installation at ATLAS and is expected to be operational in early 1991.

ATLAS Positron Experiment(APEX): This spectrometer is specifically designed to answer a number of questions regarding the origin and nature of the e^+e^- peaks found in very-heavy-ion collisions at GSI. It is currently under construction and is scheduled to become operational in the spring of 1991 at roughly the same time that the necessary uranium beams become available.

While ATLAS does not have the same long history of active, supportive user-group involvement as HHIRF, in the past 5 years there has been very positive changes in this situation: there is a staff person who serves as a full-time user liaison, as well as other staff members who serve as mentors for each of the major pieces of research equipment; 50% of housing costs are subsidized by the University of Chicago; outside users participate in 90% of the experiments and are spokespersons for about 50% of the experiments. In 1989 a total of 96 outside users participated in experiments at ATLAS, and during the period 1987-1989 a total of 7 graduate students received PhD degrees for which ≥50% of their thesis research was done on ATLAS. Users are making important contributions to a number major new equipment projects. For example, four of the five major instruments listed above (the Ge and BGO arrays, the FMA, and APEX) were designed and implemented with very substantial outside user input and participation. ATLAS has clearly made the transition to a national user facility.

88"-Cyclotron:

The 88"-Cyclotron produces a wide variety of beams, 32 different elements ranging from protons to uranium, including beams of polarized protons and deuterons. Part of the 88"-Cyclotron operations effort supports a world-class ECR ion source R&D group. Since the ECR source began operation in January 1985, the high-intensity, multiply-charged heavy-ion beams that can be achieved from this source have revitalized this accelerator in terms of its operational reliability and the achievable beam species, energies and intensities. These capabilities have very significantly enhanced the scientific program. The newly installed (June 1990) Advanced-ECR source will further expand those capabilities.

The facility has a well maintained and diverse array of experimental apparatus, the major components of which include the following:

<u>HERA</u>: An array of 21 Compton-suppressed Ge detectors together with a BGO inner ball (40 elements covering ~80% of 4π). A mini-orange conversion-electron spectrometer has been designed and built to fit inside HERA, and a Stack detector (a stack of edge-on planar Ge detectors) is currently under development.

<u>Transactinide Facility</u>: A heavily shielded and interlocked facility for performing high intensity bombardment of highly radioactive actinide targets (e.g., ^{248}Cm, ^{249}Bk, and ^{254}Es) - including facilities for fast, on-line chemical separations to determine the chemical properties of these elements, as well as measurements of alpha and spontaneous-fission spectroscopy from the decay of these isotopes.

<u>RAMA</u>: A fast helium-jet-fed on-line mass separator for activities with half lives down to 25 msec. This is supplemented with a 5000 rpm recoil-catcher wheel for half lives as short as 100 μsec.

<u>Large NaI Detectors</u>: Two large(10"x11"), NaI detectors which can be used in conjunction with a LN_2-cooled gas target together with a shielded beam dump and a 2-meter flight path for detecting recoil particles at forward angles.

<u>Phoswich Array</u>: An array of 48 phoswich detectors with sufficient granularity and angular and Z resolution to observe the breakup of projectiles into as many as five fragments.

While the 88"-Cyclotron does not have the same long history of active, supportive user-group involvement as HHIRF, in the past 5 years there has been a very positive change in this situation. There is now a staff member who serves as a full-time user liaison, as well as staff members who serve as mentors for each of the major pieces of research equipment. A second feature of the outside user program at the 88"-Cyclotron is an applied-research component which is run on a full-cost-recovery basis and accounts for ~12% of the accelerator beam-on-target time. The largest piece of this component is involved with microcircuit diagnosis and testing for JPL and a variety of aerospace industries. Outside users are currently the spokespersons on ~35% of the approved proposals. In 1989 a total of 148 outside users (including 62 aero-space scientists) participated in experiments at the 88"-Cyclotron, and during the period 1987-1989 a total of 14 graduate students received PhD degrees for which ≥50% of their thesis research was done on the 88"-Cyclotron. Outside user groups have also played the major role in the design and construction of the mini-orange spectrometer for HERA and in supplying one of the two large NaI detectors as well as in designing and building the associated forward-angle time-or-flight facility.

The transactinide facility at the 88"-Cyclotron provides unique capabilities for nuclear-chemistry research in the United States: for training new PhD students, for searches for new heavy elements and new decay processes (such as EC-delayed spontaneous fission), and for detailed studies of both the chemical and nuclear-decay properties of transactinide elements and isotopes. This facility is the major resource for the Transactinium Institute (LLNL, LANL, and UC-LBL). Because of its unique capabilities it is recognized as essential for performing the irradiations of the $500\mu g/cm^2$ ^{254}Es target ($50\mu g$) which the Large Einsteinium Activation Project proposes to produce at the HFIR reactor.

Impact of Closure:

While some of the research programs and instrumentation at HHIRF (such as: the charged-particle spectroscopy program; the Ge-Array research program which will ultimately follow Gammasphere wherever it travels; and the BaF_2/Giant-Resonance program which already spends a substantial fraction of its efforts as a user group at other facilities) can reasonably be expected to be *in principle* relocatable (see the final paragraph in this section) to other facilities, others (such as the Spin Spectrometer) may require substantial resources to make such a transition. Others (such as UNISOR and its associated NOF) would almost certainly be lost if HHIRF is closed. Nuclear Physics would also lose a truly excellent, world-class accelerator together with its associated negative-ion-source development program and would also lose a possibly attractive future option for radioactive ion beams.

Major impacts associated with the closure of ATLAS would include the cancellation of the APEX experiment and the loss of the very promising FMA program before it can even come to fruition. A number of the other programs, such as heavy-ion fission and fusion , could *in principle* be relocatable (see the final paragraph in this section) to other facilities, and the Ge-Array research program will ultimately follow Gammasphere wherever it travels. However, a number of those experiments make use of the very short pulse widths available at ATLAS to make time-of-flight measurements for particle identification and for neutron-gamma separation, a capability that is not presently available at this same high quality at the other facilities. Nuclear physics would lose a truly exceptional, world-class accelerator including a range of special features, such as its unique 100-ps precision-timing capabilities and its accel/decel capabilities as well as its cutting-edge superconducting-linac R&D program.

Clearly, one major impact of the closure of the 88"-Cyclotron (but one which is difficult to evaluate) would be the serious dislocation of the Diamond-Stephens group which the Gammasphere Siting Panel rated as the "most distinguished" and which the present Subcommittee judged to represent the major intellectual leadership of Gammasphere. While this group will also ultimately follow Gammasphere wherever it travels, it is our judgement that it will be able to much more effectively continue to exercise its important leadership in the future if it is allowed to operate in a situation in which it still has the 88"-Cyclotron and HERA at its home base. A second major impact would be the loss of the *unique* research and training capabilities of the transactinide facility. A number of other important and productive programs, such as the nuclear astrophysics program, the exotic proton-rich nuclei program, and the Multiple-Breakup/Subbarrier-Fusion program would be *in principle* relocatable (see the final paragraph in this section); however, it must be recognized that many of these programs and the "relocatable" programs at ATLAS and HHIRF would simply be lost. Nuclear Physics would also lose a truly excellent and very cost-effective world-class accelerator together with its highly successful ECR-ion-source development program and would also lose a possibly attractive future option for radioactive ion beams.

It has been emphasized by the HHIRF Director (both at the end of the HHIRF site-visit and at the September 7th NSAC meeting), that in addition to the lost experimental research capabilities it is also important to recognize that perhaps the most serious impacts of the closure of HHIRF would be (a) the loss of that style and support that have so characterized the superlative HHIRF user program, (b) the very detrimental effect which that loss will have on the educational programs of the HHIRF users, especially the regional users, and (c) the loss of the JIHIR nuclear-structure theory program, as well as (d) the loss of the additional university and state funds which supported specific projects at HHIRF and provided high-leverage supplementary operating funds.

Finally, in discussing the impact of closure of any one of these facilities it should be emphasized that even though a number of the programs and equipment described above may be "relocatable" to other heavy-ion facilities, this may not be particularly helpful - given the inevitably more-restricted availability of beam time at those facilities. It should also be noted that the reduction in the number of available beam-hours/year will, of course, have an impact not only on the displaced programs but also on the current programs at the surviving facilities, as the competition for these dwindling resources becomes more severe. This problem will soon be even further exacerbated by the substantial additional beam-time requirements associated with the Gammasphere.

Comparative Comments:

While the Subcommittee found (as outlined above) that each of these three laboratories is an active, productive, important, and high-quality research facility, the Subcommittee was also charged with making a relative evaluation of these facilities. In making this relative evaluation, the present Subcommittee inevitably applied a different perspective to the various criteria than was applied by two other recent reviews (the 1987 DOE Review and the Gammasphere Siting Report); a decision concerning the closure of a facility is clearly very different from a decision regarding the initial siting of a moveable instrument, even one as large and complex as Gammasphere. On that basis, as indicated in the attached Report, the present Subcommittee focussed its decision on the criterion of where the best nuclear science research is being done -- "the overall scientific excellence and productivity of the nuclear physics research program at each of the facilities". In responding to its charge the present Subcommittee decided that it had to opt for the best science rather than the largest user program.

The present Subcommittee's findings are, in fact, quite consistent with the findings of the other two recent reviews which, while giving high praise to HHIRF for its user program as "the best" and "unique amongst North American facilities", did not describe its scientific merit and its scientific staff in such superlative terms relative to ATLAS and the 88"-Cyclotron. Furthermore, things do change, and it should be noted that one of the stronger groups at HHIRF at the time of the 1987 Review was Plasil's group which has now shifted its interests to the relativistic-heavy-ion program at Brookhaven.

It should also be noted that in focussing on the scientific excellence of the research programs, the Subcommittee deliberately decided *not* to give significant weight to either the relative sizes of the facility operating budgets or the additional university and state funds used to support some of the projects within these facilities. [In any case, to zeroth order these two effects cancel out with the larger supplemental support which goes into HHIRF from its associated universities and from the state of Tennessee balancing out the larger facility-operations costs at HHIRF, $4.8M *vs*. $3.5M at ATLAS and $2.4M at the 88"-Cyclotron in FY1990.]

If specific, significant differences had existed in the accelerator capabilities of these facilities (for example, in their abilities to provide the range of beam species and energies required for the anticipated Gammasphere program), then this would certainly have been an equally important consideration and would have formed a less subjective basis for the evaluation with which this Subcommittee was charged. However, each of the three facilities has a very active program of accelerator development that has had very important achievements in improving their capabilities in the last few years, keeping each accelerator at the forefront of its field by making new beams, higher energies, and more intensities more readily available. Although ATLAS was judged to be the most capable of the accelerators in the long term, both the 88"-Cyclotron and HHIRF were judged to be more than adequate for the present and anticipated research programs at these facilities, and therefore these accelerator capabilities were not judged to be a decisive criterion in comparing these facilities. *If any one of these three facilities is closed, Nuclear Physics will be losing a world-class accelerator with ongoing highly innovative and successful accelerator/ion-source development programs.*

One of the future prospects mentioned in the 1989 Long Range Plan is for a radioactive-beam facility capable of producing very intense beams of nuclei very far from stability. We were presented with attractive proposals for interim solutions for producing modest-intensity beams of a limited range of proton-rich radioactive-nuclei at both the 88"-Cyclotron and HHIRF; both proposals had relatively modest cost estimates. When these proposals are complete, they should be reviewed by NSAC, together with other competing capital equipment and facility proposals. At the present time, the LBL proposal was clearly in a more advanced stage of development, but both proposals were viewed as being too premature at this time to form a decisive basis for our evaluation of these facilities. One of the unfortunate impacts of the closure of either of these two facilities at this time would be the loss of its possible option for a modest interim radioactive-beam facility in the near future.

In evaluating the level of outside-user support and the role of each of these three facilities in the education and training of students and post-docs, it is clear that HHIRF has an excellent program which may well still qualify as "unique amongst North American facilities" (1987 DOE Review). It is also clear that the outside-user programs at the other two facilities have been greatly enhanced during the intervening 3 years so that a comparison between the user-support resources available at these three facilities is now a question of degree rather a question of whether or not support is available. Each of the facilities has at least one staff person who serves as a full-time user liaison, and each facility has also assigned in-house scientists to serve as "mentors" for each of their major pieces of research instrumentation, in order to provide support and coordination for outside users wanting to use that equipment. In the area of logistical support: at HHIRF free lodging is provided at the Joint Institute, adjacent to the accelerator; at ATLAS the University of Chicago covers half of the users' lodging expenses; at the 88"-Cyclotron the management has been able to make arrangements for inexpensive lodging either on campus or in local housing for more extended visits. We talked frankly with members of each of the facility user-group organizations, and each of them expressed their appreciation and satisfaction with the support they are receiving from the host facility. On the basis of what we saw, we conclude that although there are still differences in the level of support for users and students, these differences do not significantly affect the accessibility of these facilities to outside users.

Recognizing that if the DOE decides to close down any one of these three accelerators, Nuclear Physics will lose a front-line laboratory with unique facilities and with extremely valuable, productive, and over-subscribed research programs together with active and important user and educational roles, but being nevertheless faced with the requirement of making a relative evaluation of the quality of the research at these facilities, the Subcommittee made the following judgements:

- The Gamma-Ray-Spectroscopy/Super-Deformation programs at ATLAS and the 88"-Cyclotron are superb, world-class programs which have made major advances in this very interesting and very competitive area. At this time, the program at HHIRF using the "Close-Packed-Ge-Ball/Spin-Spectrometer", although broader in scope and of high quality, has not had nearly as much impact in this field.

- The Uranium beams at ATLAS provide a unique capability for the important APEX experiment.

- The on-line trans-actinide nuclear chemistry facility at the 88"-Cyclotron is a unique facility, providing important measurements of both the chemical properties of these elements and their nuclear decays.

- The high-energy-photon spectroscopy group at HHIRF carries out a world-class program which utilizes an excellent array of 4 x 19 hexagonal BaF_2 detectors to study problems, such as giant resonances built on excited states. This group already maintains a highly visible and imaginative program at several intermediate-energy facilities (e.g., GANIL and MSU) and would be more readily compatible with a transition to a user mode of operation than would be the Spin-Spectrometer group.

- The Spin Spectrometer (a 4π NaI array), augmented with auxiliary detectors such as PPAC's and the Dwarf Ball (a 4π phoswich array), is a first-class instrument at HHIRF with a first-class research program providing important insights into coulomb excitation and heavy-ion transfer reactions, into the formation and decay of compound nuclei at high angular momentum and/or high excitation energies. At the present time we would judge that these are two of the stronger research programs at HHIRF. With considerable effort, some parts of these programs could be continued at other heavy-ion facilities.

- There continues to be an active, inventive program at the 88"-Cyclotron in the search for proton-rich light nuclei, at the moment focussing on ^{39}Ti; unfortunately, as these nuclei become more and more exotic, the experiments become more and more difficult, and positive results become scarcer and scarcer. The nuclear-astrophysics group at the 88"-Cyclotron has a very active and competitive program using careful nuclear spectroscopy measurements to relate nuclear decay rates to the conditions in astrophysical environments.

- Although the HILI project at HHIRF represents a sound detector-development, it was not made clear to the subcommittee what important physics goals are associated with this program which appears unfocussed and shows signs of lacking leadership.

- The major portion of the research program at UNISOR appears to be devoted to studies of the systematics of shape coexistence in nuclei far from stability, but the case for exciting/important new physics was not made clear to the Subcommittee. The laser facility was not seen as competitive with the world-class effort at ISOLDE. The subcommittee did not perceive the present UNISOR program as one of the stronger research programs at HHIRF. The newly completed Nuclear Orientation Facility might significantly improve the quality of research at UNISOR. Overall, the UNISOR program appeared to be fragmented and lacking in leadership. One could perhaps argue that although this program does not have the "flashy" presence of newer areas of study, it still represents good solid physics investigation and that perhaps more importantly, it supports a style and size of effort that is particularly tractable to smaller university groups and provides an excellent "hands on" teaching tool for many students who will be important for this country's future technology base. This would not be inconsistent with this subcommittee's findings.

It should be clear that one of the most negative impacts of any DOE decision to close HHIRF would be the loss of the very valuable educational role which this facility plays for a number of colleges and universities in the south-east.

APPENDIX

In response to a Charge (Attachment A)) from DOE and NSF delivered to NSAC on 30 March 1990, a Subcommittee (Attachment B) was formed to review the ATLAS, HHIRF, and 88"-Cyclotron facilities, according to the terms of the DOE/NSF Charge.

As part of this review, site visits were conducted at each of these facilities during the first two weeks of August, as follows:

August 2nd+3rd HHIRF
August 6th+7th ATLAS
August 8th+9th 88"-Cyclotron.

Prior to the site visits the facilities were requested (Attachment C) to send a packet of written information to the Subcommittee members to help prepare the members for the visits. The Agenda for each site visit is included as Attachment D, E, and F, respectively. David Hendrie (DOE) accompanied the Subcommittee as an observer at all of the site visits. Peter Paul met with the Subcommittee in Oak Ridge on the evening of August 1st, prior to the beginning of the site visits, to discuss the nature of the Charge and role of the Subcommittee. Peter Paul also joined the Subcommittee as an observer during its deliberations immediately following the completion of the site visits.

Since the budgetary issue is one of the key issues driving this review, we have also included a brief listing of the operating budgets for each of these three accelerator facilities. (See Attachment G.) These figures do not include the research budgets for these laboratories; D.O.E. has clearly and repeatedly stated that, to first order, the research budgets of these laboratories would not be affected by the closure of one of these accelerators.

Finally, while it could never be said that the Subcommittee enjoyed this task, we did enjoy the opportunity to meet and discuss physics with our colleagues and friends at these three facilities. We wish to express our thanks to all of those individuals for their hospitality during our visits, for their work in preparing for these reviews, and for their prompt and helpful responses to our numerous requests and questions.

Department of Energy
Washington, DC 20585

ATTACHMENT A

March 29, 1990

Dr. 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 Dr. Paul:

In the Department of Energy's (DOE's) Fiscal Year 1991 budget submission, it is stated that DOE will continue phase out activities at one of three National Laboratory low energy heavy ion facilities. These are the Argonne Tandem/Linac Accelerator System (ATLAS) at Argonne National Laboratory, the 88-inch Cyclotron at Lawrence Berkeley Laboratory, and the Holifield Heavy Ion Research Facility (HHIRF) at Oak Ridge National Laboratory.

Our decision to phase out one of these facilities is based on the following considerations. The Report of the 1987 DOE Review Panel on Heavy Ion Facilities stated "But much of the excitement in nuclear reactions is moving to still higher energies." and we find that scientists are directing their research to higher energy facilities and other areas of nuclear science research. In addition, DOE Nuclear Physics operating funds are required to accommodate to new research directions and there is recent increased capability in low-to-medium energy heavy ion facilities at university laboratories in both the DOE and NSF programs.

We request the Nuclear Science Advisory Committee (NSAC) to provide advice to DOE as to which facility should be selected for closure. Specifically, NSAC is requested to:

- Evaluate the overall scientific excellence and productivity of the nuclear physics research program at each of the facilities.
- Evaluate the importance of each facility for other scientific programs, its role in graduate education, and in technical research and development areas.
- On the basis of these considerations evaluate the impact of closure of each of the facilities and recommend the optimum action with respect to facility closure.

In performing this evaluation, NSAC should consider the scientific quality, breadth, cost effectiveness, and uniqueness of each facility's program. NSAC considerations should conform to the priorities developed in the December 1989 Long Range Plan.

Since the FY 1991 DOE Nuclear Physics budget contains a $3.1 million designated savings and this closure must take effect early in that year, it is important that we have NSAC's advice by July 15, 1990. In addition, designation of a host laboratory for the Gammasphere detector will await the laboratory phase out decision.

We appreciate very much your assistance in helping us with this difficult decision.

Sincerely,

James F. Decker
Acting Director
Office of Energy Research
U.S. Department of Energy

M. Kent Wilson
Acting Assistant Director
for Mathematical & Physical Sciences
National Science Foundation

NSAC Heavy-Ion Facilities Subcommittee

Konrad Gelbke; Michigan State University.
John Huizenga; University of Rochester.
Steven Koonin; California Institute of Technology.
John McClelland; Los Alamos National Laboratory.
Peter Parker; Yale University. (Chair)
Robert Pollock; Indiana University.
Gene Sprouse; State University of New York at Stony Brook
Peter Twin; University of Liverpool

Please arrange to have the following information (covering the last 3 years) sent so that it is received by the Sub-committee members on or before Friday, July 20th:

Summary of Major Facility Research Programs ($\leq$5 pages/program) (It is anticipated that you will want to make presentations about these programs at the time of our visit; this material is requested prior to our visit simply to help us be better prepared to understand and discuss those presentations.)

The extent of Outside-User Involvement in the facility research program and in facility development projects.

Facility Publications (include in-house staff and outside users) (Simply xerox first pages, including abstract and journal reference.)

Primary features and capabilities of the Facility
Planned future directions for Facility development, etc.

Budget Information relating to facility operations in categories such as: Personnel, Utilities, Capital-Equipment, Other-Hardware, Maintenance, etc.

Operations and Facility Research Statistics
- Hours per year
- Local-Staff vs. Outside-User Involvement - relative components
- PAC statistics (requests vs. approved, etc.)
- Beam Time Distribution across variety of programs
  (e.g., γ-array, nuclear physics, chemistry, atomic, astro, etc.)

PhD Students - (list, thesis titles, advisor, where now, etc.)

Post-Docs - (list, where from, where now, etc.)

Staff Lists and Outside-User Lists --- (each year)

HOLIFIELD FACILITY ON-SITE REVIEW

NSAC Heavy Ion Facilities Subcommittee

MEETING AGENDA

Thursday, August 2, 1990

Moderator: *J. B. Ball*

8:00	Welcome	*A. W. Trivelpiece*
8:05	Overview	*J. B. Ball*

<u>Accelerator System</u>

8:30	The Holifield Facility Accelerator System	*C. M. Jones*
9:20	The Use of the HHIRF to Produce Radioactive Beams	*D. K. Olsen*
9:35	Coffee Break	

<u>Facility/Users Program</u>

9:50	Experimental Facilities and User Interaction	*R. L. Robinson*
10:40	Directions in HHIRF Computing for Data Acquisition and Analysis	*R. L. Varner, Jr.*
10:55	Facility Tour	
12:05	Lunch	

Moderator: *R. L. Robinson*

<u>State and University Involvement</u>

12:55	Introduction	*B. R. Appleton*
1:00	Remarks from University of Tennessee President	*Lamar Alexander*
1:10	The Science Alliance and the JIHIR -- University/Laboratory Partnerships	*L. L. Riedinger* (*Univ. of Tennessee*)

<u>Physics Presentations I</u>

1:35	Role of Internal Research Staff	*F. E. Bertrand*
1:50	Nuclear Structure Studies at UNISOR	*E. F. Zganjar* (*Louisiana State Univ.*)
2:20	The UNISOR Nuclear Orientation Facility	*K. S. Krane* (*Oregon State Univ.*)

2:40 Hard Photon Spectroscopy at HHIRF: Giant Resonances, Hot Nuclei, and Bremsstrahlung .... *J. R. Beene*

3:15 Coffee Break

Physics Presentations II

3:30 Fusion, Incomplete Fusion, and Hot Nuclei Studied with the Dwarf Ball .... *D. G. Sarantites (Washington Univ.)*

3:50 Reaction Mechanisms in Central Collisions .... *J. Gomez del Campo*

4:10 Nuclear Structure Studies of Rapidly Rotating Nuclei at HHIRF .... *J. D. Garrett*

Friday, August 3, 1990

Moderator: *F. E. Bertrand*

Physics Presentations III

8:30 Atomic Physics at HHIRF .... *J. Burgdorfer (Univ. Tennessee)*

8:55 Reactions Between Medium-Mass Nuclei at Sub- and Near-Barrier Energies .... *H. J. Kim*

9:15 Octupole and Pairing Correlations in Nuclei .... *D. Cline (Univ. Rochester)*

Users Organization and Experience

9:35 HHIRF Users Group: Profile and Interaction .... *C. R. Bingham (Univ. Tennessee)*

9:50 An Outside User's Perspective of HHIRF ..... *A. Mignerey (Univ. Maryland)*

10:10 Coffee Break

Physics -- Future

10:25 A New Generation of Recoil Mass Spectrometers .... *T. M. Cormier (Texas A&M Univ.)*

10:45 Physics with the RMS .... *J. H. Hamilton (Vanderbilt Univ.)*

11:05 New Physics with GAMMASPHERE .... *I. Y. Lee*

11:25 A Preliminary Scientific Program for Radioactive Beams at HHIRF .... *J. D. Garrett*

Closing Remarks

11:45 Summary/Future Directions .... *J. B. Ball*

AGENDA

ATTACHMENT E

NSAC Sub-Committee
Heavy-Ion Facilities Site Visit

Breakfast at Argonne Cafeteria [Opens at 7:00 a.m.]

Monday, August 6, 1990 [Bldg. 203-R150]

8:30 a.m.	Welcome and Introduction	D. S. Gemmell
8:45 a.m.	Perspective on the Role of ATLAS in Research	J. P. Schiffer
9:05 a.m.	ATLAS - Overview	L. M. Bollinger
	Superconducting RF Technology	K. W. Shepard
	Operations	R. C. Pardo
10:35 a.m.	Coffee (10 minutes)	
10:45 a.m.	Tour of ATLAS Accelerator	
11:30 a.m.	ATLAS Research - Overview	K. E. Rehm
11:45 a.m.	Users' Perspective	J. A. Cizewski
12:00 p.m.	Lunch [with Non-ANL Users] "through the line", Cafeteria - Dining Room A	
1:30 p.m.	Charged-Particle Research - Overview	K. E. Rehm
2:00 p.m.	Fission Research	B. B. Back
2:20 p.m.	High-Resolution Experiments with Heavy Beams	A. H. Wuosmaa
2:35 p.m.	Particle-Gamma Coincidence Studies	S. J. Sanders
2:50 p.m.	Coffee (10 minutes)	
3:00 p.m.	FMA -- The Instrument	C. N. Davids
	Research Program	B. B. Back
	Instrumentation Projects	
	Bragg-Curve Detector	J. J. Kolata
	Magnetic Moments	N. Koller
	Neutron Detectors	A. V. Ramayya
4:05 p.m.	APEX - Overview	R. R. Betts
	Performance of APEX	F. L. Wolfs
	Magnet and Vacuum Vessel	A. L. Hallin
	HI Counter and Electronics Development	E. Kashy
	Annihilation Detectors	C. J. Lister
5:10 p.m.	Sub-committee executive meeting	
6:00 p.m.	Target Area IV -- Posters, Refreshments	
7:00 p.m.	Cocktails and dinner at the Lodge [Bldg. 600]	

Tuesday, August 7, 1990

[Bldg. 600]		
7:30 a.m.	Buffet Breakfast at the Lodge Discussions of Laboratory Support	A. Schriesheim F. Y. Fradin
[Bldg. 203-R150]		
8:40 a.m.	Gamma-ray Research - Overview	R. V. F. Janssens
9:10 a.m.	Lifetimes and Decay of Superdeformed Band in ^{192}Hg	M. Carpenter
9:25 a.m.	^{191}Hg, a Nucleus with Many Shapes	D. Ye
9:40 a.m.	GAMMASPHERE	T. L. Khoo
10:10 a.m.	Coffee (15 minutes)	
10:25 a.m.	Summary of Nuclear Theory	T. S. H. Lee
10:40 a.m.	Accel-Decel Capabilities and Radioactive Beams	W. Kutschera
11:00 a.m.	Atomic Physics	R. W. Dunford
11:25 a.m.	Precision X-ray Spectroscopy of One- and Two-Electron Ions	R. D. Deslattes
11:40 a.m.	Close-out Discussions	
12:30 p.m.	Adjourn Lunch [Cafeteria - Dining Room A is reserved]	

NSAC Heavy-Ion Facilities Subcommittee Review
LBL 88-Inch Cyclotron Facility
August 8-9, 1990

Wednesday Morning, August 8 — Bldg 50B Conference Room (4205)

8:00	Continental Breakfast	
8:15	Closed session: T.J.M. Symons, Chairman, C.V. Shank, B. Moore, P.B. Price, J. Cerny, G.T. Seaborg, R.G. Stokstad	

Open session: T.J.M. Symons, Chairman — Director's Conference Room, Bldg 50A-5132

The Cyclotron Facility

9:00	*Overview*	R.G. Stokstad
9:45	*Cyclotron Performance and ECR Development*	C.M. Lyneis
10:30	Coffee Break	

The Nuclear Science Program

10:45	*High Spin Physics with HERA*	F.S. Stephens
11:30	Tour of Cyclotron Facility	
12:30	Lunch at Building 88	

Wednesday Afternoon — Director's Conference Room, Bldg 50A-5132

The Nuclear Science Program (cont.), E.B. Norman, Chairman

1:30	*Shape Isomers* *Users' Executive Committee*	J.A. Becker (LLNL)
1:50	*Radiative Capture Program*	H.R. Weller (Duke)
2:10	*Heavy Element Nuclear Chemistry* (25) *EC-Delayed Fission* (15) *Chemical Properties* (15) *Element 105 Collaboration* (10)	D.C. Hoffman H.L. Hall (LLNL) K. Gregorich J.V. Kratz (Mainz)
3:15	*Exotic Proton-rich Nuclei*	J. Cerny
3:40	Coffee Break	
4:10	*Complex Fragment Emission*	G.J. Wozniak
4:30	*Multiple-breakup, Subbarrier Fusion*	R.G. Stokstad
5:10	Poster Session and Refreshments in Building 88 High Bay	
6:30	Dinner at the UC Berkeley Faculty Club	

Thursday Morning, August 9 Director's Conference Room, Bldg 50A-5132

The Nuclear Science Program (cont.), D.C. Hoffman, Chairman

8:15	*Astrophysics, Fundamental Symmetries*	E.B. Norman

Atomic Physics and Applications

9:00	*Atomic Physics at the ECR Sources*	M.H. Prior (MCSD)
9:15	*Microcircuit Test Program*	J.B. Blake (Aerospace)
9:30	Coffee Break	

Major Initiatives

9:45	*GECR*	C.M. Lyneis
10:00	*GAMMASPHERE*	F.S. Stephens
10:45	Break	
10:50	*LEAP*	E.K. Hulet (LLNL)
11:10	*EB-88*	J.M. Nitschke (20) J. Cerny (25)
11:55	Break	
12:00	*Divisional Perspective*	T.J.M. Symons
12:20	*Concluding Remarks*	R.G. Stokstad
12:45	Lunch with the Committee (Closed), Bldg-88 Conference Room	
1:45	Committee returns to the Durant	

FACILITY FUNDING (1990)
($M)

	ATLAS	HHIRF	88"-Cyc.
Facility Operations:	3.5	4.8	2.4
Captial Equipment:	2.9	0.8	0.1
A.I.P.:	0.1	0.2	0.5

Recent Capital Equipment and A.I.P Projects:

ATLAS:

Positive Ion Injector	$4.4M
FMA	1.5M
APEX	2.4M

HHIRF:

BaF_2 Array	$1.0M
RMS	0.4M + (1.7M from outside sources)

88"-Cyclotron:

Advanced ECR Source	$1.1M