Department of Energy
Washington, DC 20585

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Dr. Donald F. Geesaman
Physics Division
Argonne National Laboratory
9700 S. Cass Avenue
Argonne, IL 60439

Dear Dr. Geesaman:

Enclosed is the report from the Facility Operations Review of the Argonne Tandem-Linac Accelerator System (ATLAS) held at Argonne National Laboratory on December 8-10, 2003. The Executive Summary describes the major findings and a list of DOE recommendations is included. Also included in the body of the report are excerpts of the comments provided by the reviewers for your information and consideration. Please submit a written response, including a plan of action addressing the DOE recommendations identified in the review report, to this office by July 1, 2004.

Overall, the review found that ATLAS is a first class stable beam facility, with a broad physics program that is well aligned with the goals of the low energy nuclear physics program. Based upon this review, a challenge for the future will be the implementation of an optimum scientific program in the context of available funding. It is important that ATLAS management develop a prioritized strategic plan with a five to ten year outlook that balances operations, accelerator improvement projects, new instrumental initiatives and R&D.

I would like to thank again all the staff of ATLAS for their efforts in preparing for this very productive review. If you have questions, please contact me or Gene Henry.

Sincerely,

Dennis Kovar
Associate Director of the Office of Science
for Nuclear Physics

cc: Gene Henry
Jehanne Simon-Gillo

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Department of Energy Report

on the

Facility Operations Panel Review

of the

Argonne Tandem-Linac Accelerator System

(ATLAS)

March 2004

DOE EXECUTIVE SUMMARY

The Department of Energy (DOE) review of the Argonne Tandem-Linac Accelerator System (ATLAS) at the Argonne National Laboratory (ANL) was conducted during December 8-10, 2003, at the request of Dr. Dennis Kovar, Associate Director of the Office of Science for Nuclear Physics. The panel was requested in the review charge to perform an analysis and evaluation of the present facility operations, and evaluate the impacts of different funding levels on the productivity of the facility.

Overall, the panel found the following concerning ATLAS:

- The ATLAS facility has an outstanding broad-based program, aligned with, and in many areas driving forward, the present and future goals of the low energy nuclear physics field as expressed in the Nuclear Science Advisory Committee (NSAC) 2002 Long Range Plan.
- The ATLAS is a first class stable beam facility that is at the low energy nuclear physics forefront.
- ATLAS will not be able to sustain the present level of operations with constant effort funding.

The Physics Division management provided a mission statement with six elements summarized briefly as (1) carry out a research program at the highest level of excellence, (2) develop new techniques, instruments and technology, (3) operate the ATLAS accelerator efficiently and safely as a national user facility, (4) work toward the realization of the Rare Isotope Accelerator (RIA), (5) encourage diversity and help develop the workforce for the future, and (6) conduct all activities efficiently, safely, and cost-effectively.

The allocation of resources and staffing levels at ATLAS to carry out this mission were provided by ANL and examined by the panel; however a complete bottoms-up analysis could not be carried out in the short time of the review. The panel utilized its experience with and knowledge of other facilities to evaluate the budget and staffing allocations, and to assess how the available resources address the needs of ATLAS and its experimental program.

The resources at ATLAS appear to be optimized for a highly productive program in the short term. In FY 2003, the facility provided approximately 5500 hours of beam on target for research. With seven day/per week operation supported in FY 2004, the facility would provide at least 6000 hours of beam for research. A suite of world-class instruments, along with the return of Gammasphere to ATLAS, provide outstanding research capabilities for users. However, even at the present level of support, certain constraints were apparent to the panel such as reduced operator staff on weekends limiting flexibility for beam tuning and changing experiments, and the limited ability to respond to growing user requests for specialized targets.

Given a constant level of funding, the panel found that the present level of operations can not be sustained for long. The present staff is making above ordinary efforts to operate ATLAS twenty four hours per day, seven days per week. This level of operations can only be sustained with increased resources for operations and support activities in the future. With constant funding, the ATLAS management will have to re-evaluate its program to find a sustainable level, possibly involving a return to five day per week operations, reduced detector support, and/or more limited response to requests for specialized targets.

The laboratory presented prioritized scenarios for incremental funding above the constant funding level. The panel recognized, as a first priority, that an additional funding increment of approximately 12% would result in additional operator and engineer/physicist personnel for accelerator operations, additional materials and supplies (M&S) for operations, a target maker, and a support person for experimental support. The panel found the proposal for a Californium source for the accelerator to have promise as an improvement project for ATLAS (second priority), and urged ANL to develop the case, the community support and a proposal for this idea. Regarding the laboratory's third priority, the panel urged ANL to quantify the return in performance for an additional approximate 6% increment to support three more operations and experimental support staff, and increased materials and supplies.

The panel urged that the ANL management and staff to develop a strategic plan with a five to ten year outlook, soliciting the input of the user community. This plan should be specific about goals and priorities for future developments and updated on a regular basis.

In conclusion, the panel found that ATLAS is an outstanding stable beam facility that is effectively managed, has excellent capabilities and performance, has a well satisfied user community, and is producing and publishing high quality science. The present funding level is utilized by the facility for a highly productive program, but one that can not be sustained into the future. It is believed that additional increments of funding will allow for a flexible and sustainable program, and for a moderate increase in beam hours to near the maximum level possible for even greater scientific productivity.

DOE SUMMARY OF RECOMMENDATIONS

- Generate a mission statement for the ATLAS facility.
- Develop a strategic plan with a five to ten year outlook. It should include scientific goals and priorities for the experimental support and accelerator initiatives needed to realize the science. This plan should be available to all, and be up-dated on a regular basis.
- Make the case for the distribution of available funds, optimized to the needs of your strategic plan and balanced between facility operating and M&S, capital equipment facility base, accelerator improvement projects and research. Consider requesting the splitting of research into experimental support funding and research funding into separate B&R accounts.
- Perform an analysis on the impact of sustaining seven day operations in the out-years with constant level of effort funding and the trade-offs to accomplish this.
- Develop a request for incremental funding in the context of the strategic plan, integrating the needs for seven day operations, experimental support staff, and new experimental and accelerator initiatives.
- Develop the case for the proposed Californium source AIP project. Generate a proposal that has input from the general community and has been carefully vetted for cost, schedule and feasibility.

CONTENTS

1. INTRODUCTION

Background

In 2003, Dr. Dennis Kovar, Associate Director of the Office of Science for Nuclear Physics, directed the Low Energy subprogram to perform a facility operations review of the Argonne Tandem-Linac Accelerator System (ATLAS) facility at Argonne National Laboratory (ANL). The Office of Nuclear Physics requested this review to evaluate the performance, the cost of operations, and the funding needed to effectively support the research mission. This review was considered necessary in the context of funding constraints and because of the emphasis on performance from the Administration, Congress and the Department of Energy (DOE). This review follows a similar review of the Holifield Radioactive Ion Beam Facility at Oak Ridge National Laboratory in June 2002.

The Charge

In order to accomplish this review, Dr. Kovar established a review panel that was asked to examine all of the ATLAS/ANL activities associated with facility operations supported by the Nuclear Physics program, determine the real cost (especially manpower) that is being incurred by Nuclear Physics for each activity, advise whether these activities are required and in the best interest of the Nuclear Physics program, and explore options of reducing funding for this facility with an evaluation of the associated impacts. In particular, the charge letter (Appendix A) asked the review Panel to:

1. Analyze and evaluate the present facility operations.
   - What is the mission of the facility?
   - How are the resources currently used (bottoms-up analysis) to carry out this mission?
   - Are available resources optimized for the most productive program?

2. Evaluate the impacts of different funding levels on the productivity of the facility.
   - What level of facility operations and scientific productivity could be sustained into the out years with constant effort funding at the FY03 Appropriations level?
   - What benefits, in order of priority, could be realized with incremental funding above this level?

The ATLAS Facility

The University of Chicago manages and operates ANL for DOE. ANL receives approximately $9.8 million annually from Nuclear Physics to support ATLAS operations and to provide experiment and user support. ATLAS is primarily a stable beam facility, with approximately ten percent of the time devoted to producing radioactive beams for research by the two-accelerator method or by the in-flight method. ATLAS is a national user facility used to perform frontier research in nuclear structure, nuclear astrophysics and fundamental symmetries, to conduct R&D on accelerator concepts and components,

and to design and fabricate experimental instruments. A strong coupling exists between ATLAS and pre-conceptual research and development for the Rare Isotope Accelerator (RIA) through personnel involvement and testing of concepts and components.

ATLAS is the only national user facility in the U.S. that is devoted mainly to experiments using stable nuclear beams. Two DOE-supported accelerator facilities at universities, the tandem Van de Graaff accelerator at Yale University and the superconducting cyclotron at Texas A&M University, provide complementary stable beam capabilities. Internationally, two examples of facilities devoted mainly to stable beam production are the accelerator facilities (tandem Van de Graaff plus linac) at The Australian National University and the superconducting cyclotron at the University of Jyvaskyla (Finland).

ATLAS was the world's first superconducting accelerator for heavy ions. It consists of the ATLAS linac, the booster linac and two injector systems, the tandem Van de Graaff and the Positive Ion Injector (PII). The PII is capable of receiving ions from one of two electron cyclotron resonance (ECR) ion sources. ATLAS provides all beams from protons to uranium. Maximum beam energies range from ~18 MeV per nucleon for the lightest ions to ~8 MeV per nucleon for uranium for beam currents greater than one particle nanoAmpere. The ATLAS beams have excellent emittance, and beam bunching or debunching can optimize time resolution or energy resolution.

The major equipment at ATLAS includes the Fragment Mass Analyzer (FMA), the radioactive isotope production beamline, Canadian Penning Trap (CPT), split-pole spectrograph, and the large scattering chamber. The Gammasphere germanium detector array was moved back to ATLAS near the end of 2002 for its second research campaign there. The Advanced Penning Trap (APT) is under development.

The Review

The review was conducted on December 8-10, 2003 at ANL, and chaired by Dr. Eugene Henry, Program Manager for Low Energy Nuclear Physics of the Office of Nuclear Physics. To address the charge, the individual panel members (Appendix B) examined the physics and experimental program, accelerator operations including accelerator R&D, environment, safety and health, funding, and management and administration. Panel members were drawn from the Office of Science's multi-program and single-program laboratories, DOE- and NSF-supported university facilities, and a foreign laboratory. Representatives from the Office of Nuclear Physics observed the proceedings.

The review was based on formal presentations given by ATLAS personnel, detailed discussions with ATLAS employees, and panel members' extensive experience. The review panel members were provided with a background document by ATLAS before the review and with copies of the presented material. The first day of the review (Agenda—Appendix C) was devoted to overview presentations by senior ATLAS personnel, a tour of the facility, and a presentation by a user representative. The morning of the second

day was divided into parallel sessions on accelerator operations and experiment operations with presentations by a number of facility scientists and engineers, which afforded more interaction with the panel members. The afternoon of the second day had presentations on accelerator R&D and the relationship with RIA, and a presentation on facility upgrade plans. The balance of the second day and the morning of the third day were devoted to panel working sessions and deliberations, and to report writing. The panel discussed the preliminary results of the review with the ATLAS management in a closeout briefing on December 10, 2003.

This Report

This report represents the evaluation by the review panel members and is a collection of each panel member's individual input. The DOE Executive Summary presents a concise response to the charge based on the panel member's evaluations and a list of recommendations. Section 1 is general introductory material. Sections 2 through 6, on the Physics and Experimental Program; ATLAS operations; Environment, Safety, and Health; Operations and Support Funding; and Management and Administration, provide context for the response to the charge and offer the opportunity for the panel members to make findings, comments, and recommendations of value to ANL and the Office of Nuclear Physics.

It is believed that the findings of this operations review are responsive to the Office of Nuclear Physics charge, and provide a better understanding of both costs to productively operate ATLAS, and the impacts and the benefits if funding resources are changed.

2. PHYSICS AND EXPERIMENTAL PROGRAM

2.1 Findings

Mission

[The ANL Physics Division management presented a mission statement with six elements to the review panel.] "The first three points of the physics division mission statement deal with general goals: do excellent research, develop new techniques and equipment, and operate the ATLAS accelerator most effectively as a national user facility. The fourth targets a more specific outcome: the realization of the Rare Isotope Accelerator, RIA. The last two points deal with encouraging diversity, and operating safely and effectively. Until the panel visit, there was no prioritized strategic plan in place to guide staff and management in future planning consistent with these goals."

"There is not mission statement for the ATLAS [facility]."

Program

"The ATLAS facility has an outstanding broad-based program, fully in synch with, and in many areas driving forward, the present and future goals of the field as laid out in the 2002 Long Range Plan and the road towards RIA. The strength of the scientific program rests on the effective synergy of a strong local scientific staff, excellent support staff, an extensive group of active users, and innovative accelerator physics group."

Instrumentation

"The facility has a strong track record in developing new equipment, and the panel was told about several new projects currently in progress or in the wings: the Advanced Penning Trap, the solenoid detector for inverse reactions and the X-array for the FMS focal plane." "At ANL the coupling of Gammasphere with the Fragment Mass Analyzer (FMA) to study nuclei far from stability with excellent channel selection capabilities continues to produce highly significant scientific results.... In addition the two beamline implementation (FMA beamline and new stand alone beamline) will benefit both the long term Gammasphere and FMA experimental programs."

2.2 Comments

Mission

"[T]he mission statement comprises reasonable and achievable goals for the Physics Division. There is no reason to change it. However, the division needs a clearer map for paths it must follow to continue to achieve these goals." "The vast majority of the various aspects of the mission are being carried out with enthusiasm, and the staff is clearly dedicated to achieving the physics goals. This is a credit to everyone from

management down to the technicians and operators.... The mission statement of the lab does not give any idea of the present focus and future direction of the facility, particularly as to the relative importance of stable ions and radioactive ions in the program. [A statement focused on this aspect] can assist the staff in coalescing around common goals."

Program

"The science program at the ATLAS facility is outstanding, with a broad spectrum of nuclear physics being pursued at the highest level of accomplishment. The facility's publication record is superb. User participation in the research effort is extensive and the users themselves report a high degree of satisfaction with the support they receive from ATLAS staff. Experiments are generally planned on a short-term basis set by the semi-annual meetings of the Program Advisory Committee, which selects among submitted proposals; the demand for beam time is high and currently only ~50% of the requested time can be accommodated. Longer term (strategic) planning for future experimental developments is uncoordinated and priorities are not clearly determined and/or disseminated. Most initiatives for future developments currently come from the in-house staff. There is no established mechanism for involving users in long-term planning."

"Here again, the heroic efforts required from the scientific and technical staff are clearly evident, as is the impossibility of maintaining such intensity of effort indefinitely. We have already identified the need for long-term planning in order to relieve some of the pressure on in-house staff. Further improvement could result from stimulating more direct participation by the user community in the planning process. Particularly in the area of experimental development, increased user involvement in the generation of a plan would undoubtedly lead to increased user contributions to the development effort itself."

Instrumentation

"The facility has a highly successful track record of important technical developments.... The conceptual solenoidal transport device may be a very powerful tool for studying few particle transfer reactions with exotic beams. The X-Array fills an important niche for a high efficiency, high resolution, versatile focal plane detector. The development of gamma-ray tracking with planar Ge strip detectors is again in line with national recommendations, as laid out in the 2002 Gamma-Ray Tracking Coordinating Committee report."

"Gammasphere is a vital national resource in low energy nuclear physics.... Gammasphere continues to be an enormously productive physics device, and ANL is to be highly commended for their tireless efforts in supporting outside users, as well as bringing it back into tip-top condition."

"The movement of Gammasphere from Lawrence Berkeley National Laboratory (LBNL) to ANL has been superbly orchestrated and executed.... [The last move] started in late October 2002, and by the middle of February 2003 the first beam tests were being performed at ANL. Certainly the scientific output has benefited, but the committee noted some significant areas of concern related to the continued successful operation of the

instrument. (i) One of the major reasons for the super-high resolving power of Gammasphere is its outstanding peak-to-total ratio. The BGO detector shields are a crucial component in these performance equations, and so it is…worrying when at least one phototube was found to be not functioning in 95% of the shields due to failures in the resistor chains. ANL has [fixed] these problems but the old bases continue to fail. (ii)The critical Ge detectors have also shown aging problems. Of the 104 [Ge detectors] annealed after the move, 12 did not survive. [ANL in-house experts] came to the rescue of 8 but 4 needed to be sent back to the manufacturer, as well as three other non-working Ge detectors from LBNL. This in-house expertise not only saves money…but also saves time…so that Gammasphere can always contain the maximum number of detectors possible. (iii) It seems that ORTEC will no longer build segmented detectors, nor supply critical components such as Ge preamplifiers and HV filters. …ANL is to be commended for beginning to design and build these electrical components in house. (iv) Important modifications and upgrades…are being implemented to modernize and increase the capabilities of Gammasphere. These upgrades have come through the successful collaboration between ANL and LBNL. ANL is to be commended for shifting the necessary personnel and expertise to operate Gammasphere in such a professional manner."

"With LBNL now concentrating their efforts towards GRETINA, the center of gravity for Gammasphere has moved to ANL. Gammasphere should always be moved to optimize its science output…. It would help [the national user facilities] as well as user community planning if…clarity is brought soon to the question of how long Gammasphere is expected to stay at ANL."

Overall

2.3 Recommendation

- "Generate a mission statement for the ATLAS facility"

3. ATLAS OPERATIONS

3.1 Findings

Operations Background

"The ATLAS operation group reported very reliable beam delivery to experiments over the last seven year period, with different ion beams and increasing beam intensities resulting from efficient maintenance and a well prioritized and successful accelerator improvement program, in line with PAC priorities. Beam availability increased gradually from 91.5% in 1997 to 96.1% in 2003."

"In June 2001 the weekly beam production schedule had to be reduced from 7 days/week to 5.3 days/week because of insufficient personnel resources. Consequently the experimental activity slowed down and yearly delivered beam hours went from 6046 in 1999 to as low as 4416 in 2002 with corresponding reduction of yearly experiments from 56 to 37. In April 2003 the funding situation was partially rectified and 7 days/week operation could be resumed with a return to previous standards. It was pointed out that even at present the staff of seven operators is not sufficient for fully efficient operation. During shifts with a single operator, the set-up of new ion beams or tunes is difficult, especially during nights or weekends, although an experimentalist is normally asked to be available on call if required for occasional support and safety."

"The FY2004 program is expected to deliver 6000 hours of beam time in a 7 day per week operation. One expects that approximately 35 different species will be accelerated and delivered to the order of 50 experiments. The availability of the Gammasphere detector has led to a doubling of the experimental proposals."

Current Resources

"In FY 2003, total operating expenditures were $11.6M, made up of $5.35M for accelerator operations, $3.08M for experimental support and $3.17M for research. This constituted a $367k budget overrun. The FTE supported staff effort totaled 47.9, comprising 21.3 in accelerator operations, 11.85 in experimental support and 14.75 in research. Some areas – accelerator operations, target making and computing, for example – are seriously under-resourced. The Director's Allocation for LDRD was roughly cost-neutral for the Division."

Optimization of Resources

"Limited resources, both human and financial, are hampering the facility from making optimum use of its full capabilities.... Some areas – accelerator operations, target making and computing, for example – are seriously under-resourced. In general, the limited resources available currently tend to be used to put out the most urgent fires; long-term improvements are often neglected."

"Adequate manpower allocations and funding to support the ATLAS program is in a precarious state to provide a continuing vigorous scientific program. The ATLAS accelerator facility is aging and is composed of several obsolescent or obsolete hardware

and software items. This will require both purchases and especially expert personnel to replace these systems. The experimental program requests are also making similar demands. The ATLAS and RIA programs are competing for expert manpower"

Experiment Support

"The users are clearly appreciative of the support they receive from facility staff in mounting and operating their experiments.... A unique asset at ANL is their target manufacturing capabilities (John Greene in particular). The increase in demand from users, as well as the need to develop ever more specialized targets for increasingly complex experiments, has meant that the range of responsibilities for the small staff has increased dramatically. "

Improvement Projects

"There is a very active beams development activity that is closely tied to the User program. This requires a very high level of expertise and the staff is clearly capable of functioning at this level. Each of the accelerator groups (most of which consist of only two or three people) had ambitious plans for the future, not all of which were self-consistent."

"Accelerator development initiatives over the last several years included the upgrade of the ECR ion sources resulting in better charge state distributions and higher beam currents. Modifications to the low energy beam transport section of the positive ion injector improved the overall beam transmission from 30% to 70% for critical control ranges of ion mass.... Different initiatives were taken to improve beam diagnostic and accelerator tuning including the 12 MHz traveling wave chopper system, the method of using on-line SC resonators as beam phase detectors and the implementation of a bunch shape monitor for the exploration of longitudinal beam structures. For exotic beams, an RIB ion source hot laboratory was set up and an in flight secondary beam production scheme was designed and partially implemented. Reliability and improved beam capabilities resulted from key refurbishments like the overhaul of the tandem-injector voltage distribution system and the stability upgrade of the high voltage platform."

"Some components of the facility are more than 25 years old and refurbishment is mandatory. At the same time the facility is being upgraded to higher energies (> 10 MeV/u), higher intensities, more ion beams, radioactive ion beams, in line with scientific priorities and demands. Future initiatives proposed include additional refurbishing of critical systems, a further increase in energy, well beyond the Coulomb barrier through a additional cryostat with eight new efficient superconducting RF cavities and a newly proposed RIB development based on Cf fission fragments, charge breeding and acceleration."

ATLAS and RIA

"Superconducting ion linac technology was initially developed at ANL in 1978 by Bollinger, Shepard et al. Later the ATLAS facility was developed to include three superconducting linac sections to provide, with two ECR sources and the original injector Tandem, efficient and precise cw beams covering all stable ions from protons to uranium.

Because of this experience, ATLAS accelerator physicists have been able to propose a high intensity superconducting linac accelerator as the ideal driver for RIA."

"It should be underlined that the inclusion of RIA design R&D activities within the responsibilities of the ATLAS facility group has been very beneficial for ATLAS in terms of promoting and installing much needed developments and improvements. Important is also the fact that the ATLAS accelerator, with a few improvements, may serve as post–accelerator for the ISOL/RIB acceleration in the RIA complex, making its optimization very relevant in terms of RIA design. Finally, interest in RIA development and design studies had the invaluable effect of keeping key accelerator professionals active with ATLAS and involved with operational facility. This arrangement is however somehow fragile due to the fact that a few key accelerator development personnel are on "soft money", depending on the availability of RIA R&D funding."

3.2 Comments

Current Resources

"The ATLAS management and staff must be commended for providing a truly forefront laboratory in spite of severe budget restraints. They are a national asset. Because they have done such a superb job, it is all too easy to think that they can do even more. In the panel's opinion, however, the projected increase in experimental beam time cannot be properly supported with existing resources. It would not be effective – or humane – to attempt to stretch the facility staff even farther, and it would not be acceptable to continue to overspend the operating budget."

"The committee did not hear anything about the need for budget to purchase spares, especially for single point-of-failure components. We can only assume that this is not a concern."

Optimization of Resources

"There is a remarkable willingness on the part of staff at all levels to work long and unpredictable hours. Surely this cannot continue indefinitely. To the extent that a short visit allows a real financial assessment, the panel considered recent expenditures to be defensible and in no way excessive. Even so, management had to cover an overrun in operating expenditures with other funds. Obviously the staff and budget are under stress to provide the support required for even 5500 hours of experimental beam time in a year; with more than a 10% increase in experimental hours expected in FY2004, this situation will only get worse unless changes are made. Although better long-term planning could relieve some of the pressure on staff, it is hard to see under the circumstances how existing resources could be used to better advantage in accomplishing the mission. What are urgently needed are *more* resources if full seven-day operation is to be maintained."

"The Division is clearly trying to do too much with too little. The assumption has been is that all this work "must" be funded, while the reality is that it is the function of management to maximize the amount of work done within the limitations of the available budget. Additional funds were given to increase operations from 5.3 days per week to 7

days per week. This resulted in hiring one operator, but this was considered an untenable long-term situation for operating 7 days a week. The assignment of additional funds was apparently not optimum to reach the goal for which the money was given. Much was made of the operator turnover, but over the past four years the average turnover was only 1.25 per year, of which 0.5 per year were fired for cause. This turnover rate is similar to most other facilities where shift workers normally stay for an average of 5-7 years."

"Overall, the available accelerator resources appear to be optimized for the most productive short-term program. It is not at all clear that this optimization leads to the best long-term program, especially with the arrival of RIA, albeit on an unknown time horizon."

Experiment Support

"Since the experimental support scope is less well defined than the accelerator area, it was more difficult to understand whether the experimental support was optimized, especially with the new support needed for the Gammasphere detector. The mixing of research and experimental support funds exacerbates the situation."

"The scope of the experimental support area is less well defined than for the accelerator. It was not possible to ascertain directly whether the experimental support was optimized, especially with the new support needed for the Gammasphere detector. The only area of concern that was voiced was the lack of engineering design support for the experimental teams. The mixing of research and experimental support funds does not allow for a clear understanding of how priority decisions are made."

"The single target maker is of special concern since this individual is a "single-point-of-failure" for the experimental program. This individual needs to be backed up with an apprentice."

"The production of specialized targets for low energy nuclear physics experiments in this country is in a critical risk situation. A unique asset at ANL is their target manufacturing capabilities.... With the increase in demand from users, as well as the need to develop ever more specialized targets for increasingly complex experiments, has meant that the range of responsibilities for the small staff has increased dramatically. The target staff are to be commended for their heroic efforts, but such enormous demands cannot be sustained."

"It is essential that additional manpower (at least one dedicated assistant) be brought into the group as soon as possible to learn the secrets of the trade and relieve the pressure. Target making is still very much an art form where the advanced techniques and insight necessary can only be passed on from a seasoned veteran to their assistant."

Improvement Projects

"The Software Group had a list of past successes, and an even longer wish list. The size and selection of these projects seemed incommensurate with the size of the group. The Electronics Group had a long list of projects that were being developed and an even

longer list of projects that they wanted to develop. While it was unclear who established the priorities between the various requests, the quality and quantity of work being performed is impressive.... The Ion Source Group is clearly at the absolute forefront of the field, a position that is even more remarkable for a group of only two people. The list of proposed development plans did not include the Californium source, an example of lack of coherence of the research goals across the Division."

"The Software Group should put emphasis on integrating a simple scripting language that would enable operators to participate more closely in creating application programs. LabView is being integrated into EPICS at various sites and selecting this as the scripting language would give the Software Group an exposure to EPICS, a stated (and understandable) desire. It would also be rather easy to hire operators who have had exposure to LabView."

"The development of radioactive beams was an excellent example of clever ideas coming out of an intimate knowledge of the current capabilities of ATLAS and an understanding of the desires of the User community. This work will clearly grow into a multi-year program whose scope was only hinted at. It will be necessary to prioritize these plans not only including the present radioactive beam program but also to include the special needs of the Californium source. Much of this development will also have applications for RIA. It would be advantageous to petition for LRDP funds from the laboratory to support some of these activities."

"The quality of the R&D being carried out is excellent. The quantity is also impressive, but ATLAS would be better served by focusing effort on fewer tasks, preferably those that integrate work from several Groups to create a larger impact. The SRF Cavity phasing project undertaken in FY03 is an example of how powerful this way of working can be."

"The committee found that the future program plan has not been thoroughly studied or vetted with the staff and the experimental community. The ^{252}Cf source project was pushed forward as the highest new initiative during this review. The day 1 presentations identified it as a future possibility and by the end of day 2 it was identified as priority 2 behind increased running support and the energy upgrade II project, which was slated to be the next major effort and is now relegated to priority 8. This project requires a formal proposal and a rigorous review process."

"For the future another Accelerator Improvement Project, "ATLAS energy upgrade-II", recommending the addition of a new cryomodule with 8 RIA type resonators at the end of the accelerator, had been proposed for FY2005 and FY2006 for an estimated total cost of 2200K$. The addition allows another ~30% increase in ion energy (to ~12 MeV/u for heavier ions) and would be important for the study of transfer reactions with mid-mass, neutron rich accelerated ions. The project was outlined in the introductory documents and its importance confirmed during the first day of the review."

ATLAS and RIA

"The enthusiasm and R&D effort in the direction of the RIA design by key ATLAS personnel, in collaboration with accelerator physicists from other laboratories, should be commended since it has provided valid design options for a high intensity RIB world-class facility. Recently the RIA R&D effort received special funding and a few individuals were assigned principally to the RIA effort. New technology was envisaged, designed, prototyped. This includes a spoke-type SC cavity for intermediate velocities in the driver, a low frequency hybrid RFQ for RIB acceleration, new RIB production target concepts, fast gas catcher technology, multicharged beam acceleration design and testing etc. Other technology implemented or being developed at ATLAS has been or will be very important for RIA. This includes SCRF cavities, room temperature RF structures, special diagnostic techniques, ion sources, cryostat vacuum techniques, and innovative control approaches. On the other hand new cavities,1/4 wave and 1/2 wave, developed because of RIA became the obvious choice for the refurbishing of the last ATLAS cryomodule and for the ongoing construction of additional modules for the energy upgrade to 10 MeV/u or higher. The synergy of the SC RF work between ATLAS and RIA R&D has been positive for both endeavors. The same can be said for the other systems like ion sources, diagnostics, controls, injection etc. The groups should be congratulated for very productive initiatives in both directions."

"The ATLAS and RIA programs are both complementary and conflicted as they compete for the same skilled staff. Adequate accelerator manpower and funding to support the ATLAS program is in a precarious state. Several physicists, who are being supported by RIA soft money, are providing benefits to both ATLAS and RIA. There is a possible future problem of finding support for these individuals. The ATLAS accelerator facility is aging and is composed of several obsolescent or obsolete hardware and software items. This will require both purchases and especially expert personnel to replace these systems. The experimental program requests are also making similar demands, especially in the area of data acquisition systems."

"...[I]t appears that the new emphasis given to the RIA effort was not balanced in terms of resources by sufficient additional support given to ATLAS operations, to address the difficulties that may have been created by the shift in laboratory priority. This has impacted primarily the accelerator group and to minor extent the experimental support group, due to the limited experienced manpower available for the overall scope encompassing both RIA and ATLAS. Nevertheless, the number of yearly beam hours delivered to the experiments, the number of different ion beams produced, beam availability during the scheduled operating time and the record of completed experiments were very respectable during the last seven or eight years. ATLAS operation should be commended for having been able to maintain very satisfactory overall records during a very intensive period for the division."

"There is an urgent need to formulate a long-range plan that identifies the experimental and accelerator programmatic goals for the next 5-10 years. This physics section must identify a coherent underlying reason and goal for pursuing low energy ion research. A summary of individual experiments is unlikely to produce strong budgetary support."

3.3 Recommendations

- "[ONP should] consider providing experimental support funding under a separate B&R code to DOE."
- "Consider asking ONP to reprogram some capital equipment funds to operating if there is no relief in the operating M&S budget."
- "Give priority to sustaining 7 day operations. Perform an analysis on the impact of sustaining 7 day operations and the trade-offs to accomplish this and present to ONP."
- "The Cf source project requires a formal proposal and then must undergo a rigorous review process and its priority should be determined with respect to other scientific priorities."
- "Integrate the ATLAS energy upgrade II with the medium term vision of the facility."
- "Hire an apprentice target maker."

4. OPERATIONS and EXPERIMENT SUPPORT FUNDING

4.1. Findings

Use of Current Resources

"The FY2003 ATLAS Facility expenditure excluding the research category, consisted of the following categories:

Accelerator operations	$5350K
Experimental support	$3082K
Capital equipment	$1000K
Accelerator improvement	$ 400K
Facility Total	**$9832K**
Research	$3173K
Program total	$11605K

The FY2003 budget allocation was $11238K, an overrun by $367K.

The FTE support effort was distributed in the following three categories:

Accelerator operations	21.3 FTE
Experimental support	11.85 FTE
Research	14.75 FTE
Capital equipment	0
Accelerator improvement	0
Total	**47.9 FTE"**

Sustainability of Operations at Constant Effort

"The FY 2003 accelerator operations delivered 5490 R&D hours at 96.1% availability to 46 experiments. [The main control room (MCR)] operations staffing presently consists of an operations coordinator, 6 operators and 1 operator trainee. There is a single part-time accelerator / beam physicist who supports ATLAS machine operations and one target maker who supports the experimental community."

Incremental Funding

"Individual groups presented long lists of future needs, each list apparently uncoordinated with the others. At the panel's request, the director produced an ordered list of how he thought additional funds should be spent, but admitted that the list had not previously existed nor had the priorities it contained been widely discussed. The first priority was to hire two new operators, an operations engineer, a target maker and a computer support person; and to add $400k to the operating budget. Second priority was to fund a ^{252}Cf fission-source radioactive-beam upgrade to ATLAS. Third was a further operations increment – three staff and $150k. In order, the total costs of these three items were $1.37M, $2.1M and $0.75M."

4.2 Comments

Use of Current Resources

"The ATLAS staff should be commended for the superb operations of the physics program. In contrast to other such facilities, they are the most efficient and productive."

"The operations budget is under stress to provide for 6000 hours per year operations, adequate experimental support and facility upgrades. We learned that the management covered the $367k FY2003 overrun with GSO funds. The committee was provided with backup material for the M&S expenditures and we find that the purchases were not excessive and are defendable. They covered the needed items such as cryogens, gases, power etc."

"With the transfer of personnel from ATLAS operations to RIA R&D over the past years, and increases in the ATLAS budget, one has difficulty in understanding as to where the released funds were applied."

"The ATLAS program is being subsidized by ANL at ~$75K per year with LDRD funds and possibly through some additional support of staff with RIA LDRD funds."

Sustainability of Operations at Constant Effort

[In response to questions by the panel, the Director presented his view of the consequences of the budget remaining at FY 2003 levels in the final question and answer period.]

"There was no presentation that directly addressed this important part of the charge. The following information is gleaned from discussions during the Review. The ATLAS staff is small and achieves a lot with the resources allotted. The continued high availability of the accelerator (due in part to having redundant Injectors) and the high number of hours delivered for Physics are a credit to the staff. It is also indicative that the funding levels are not too far below what is needed. It was unclear whether there is any planning mechanism other than the PAC. This means that the Division is permanently in reactive mode, responding to user demands, rather than having an independent vision. Some members of the Committee felt that this is a good example of how a user facility should be managed; others felt that more structure would match the workload to the capacity of the staff."

"ATLAS operations would **not** be able to sustain the present level of operations with constant effort funding. The present manpower levels are very stretched, yet they have managed to operate an excellent program over the past year. For the long-term, at this support level, the performance will suffer."

"The degree to which ATLAS can continue at the present funding levels depends to a certain degree on the long-term future of the facility. If, as is hoped, ATLAS becomes the basis for RIA, the facility must be kept up at a level to permit that. If the facility is not selected as the RIA site, it should be maintained at a level that would permit ten years

of forefront exploitation. The funding that is currently provided makes reaching either of these goals a stretch. Some degree of additional funds would be needed. Any additional funds that come to ATLAS must be linked to higher Physics output."

"The MCR operations staffing level would not be able to sustain a 24/7 effort over an extended period beyond one year. There are concerns that shifts that have only one operator could have safety implications in the event of an emergency or response to equipment failures. Presently a trained experimenter is made available to act as a safety person for the single MCR operator."

"The present level of physicist support for accelerator setup and tuning is inadequate for ATLAS operations. An additional physicist would be available to attack those problems that the operators have difficulty managing, such as tuning new species beams. This would eliminate the constraint of changing beam species during off-shifts and weekends."

"The FY2003 capital equipment budget was tapped for $250K to cover operating M&S needs. This is not an appropriate long-term use of these funds. ATLAS might consider asking ONP to reprogram some capital equipment funds to operating if there is no relief in the operating M&S budget."

"The operating budget for Gammasphere has not changed since 1995. Given the change in the national laboratory landscape in the past year, coupled with personnel changes at LBNL, the fact that Gammasphere has started to develop some serious aging problems, and that there were questions raised by the committee on this topic, it seems prudent that a fresh appraisal of its operations budget (and the manpower needs for operation) take place soon."

Incremental Funding

[The Director presented his prioritized list describing how ANL would expend increments above the FY 2003 level in the final question and answer period. His first priority is for an increment of $1,370K to cover 2 additional operators, 1 engineer, M&S for accelerator operations (~$200K), 1 target maker, 1 computer support person for experimental support, and M&S for experiment support ($200K). The second priority is for the fabrication of a Californium source for selected radioactive beams ($2100K). The third priority is for an increment of $750K for one operator, one engineer for operations, one engineer for experiment support and M&S for experiment support ($150K).

All reviewers supported a recommendation that the ANL management request an increase of funding for operations for ATLAS (first priority), but had differences of opinion in certain details. These differences can be discerned in some of the comments below. The first recommendation below is the one presented to ANL at the closeout session.]

"The absence of a strategic plan on which to base many of these funding requests complicates their justification. However, the items in the highest priority package

proposed by the director are all required to allow the facility to establish and maintain full seven-day operation. The panel agreed that this should be of highest priority. Not only was there a strong case made that more accelerator operations staff members were required for full and effective operation on the weekends, but also the urgent need for an additional target maker and a computer support person was made abundantly clear.... It is absolutely essential for ATLAS – and important for nuclear physics in this country – that the art of target making be maintained through the recruitment of new blood. The need for an additional computer person was also strongly made: currently the data acquisition system at ATLAS is obsolete, making it very difficult for users to access and analyze the data they take home from experiments. There is simply no individual currently available to make the essential software changes and support a new system."

"For the priority 1 items, the 2 operators, or preferably 1 operator and 1 beam physicist, are needed to support 24/7 operations. The +$200k of M&S matches the FY2003 expenditure rate. The controls engineer is marginally defensible, since the operators should help in this area. The target maker is essential. The computer support person is not defensible and the experimental community must take on a larger role. The +$200k of experimental M&S is probably not defensible. FY2003 expenditures were stressed by the introduction of Gammasphere into the experimental program. This was deemed to be a one-time expenditure."

"The ^{252}Cf radioactive beam upgrade (Director's priority 2) has not yet been formally proposed nor technically developed and not aired with the experimental community."

"The next operations increment (priority 3 on the Directors list) was for $748k to fund 1 additional operator and 1 engineer for accelerator operations and 1 engineer and $150k M&S for experimental operations. No proposal for a metric to judge the impact of this additional funding was made."

"The priority 3 operations increment has not been justified. The accelerator electrical engineer seems to be related to the development of the enhanced radioactive beam program. The additional $150k of M&S is possibly Gammasphere related."

"The Division needs to develop a process for evaluating the relative importance of projects requesting additional funding and to tie them to specific, quantifiable Physics deliverables. The lack of structured decision-making processes does not provide a track record of managing projects, which would be beneficial in achieving the goal of convincing all of the stakeholders that ATLAS should be the basis for RIA."

"The ATLAS is urged to use capital equipment funds to pay for projects such as the chopper upgrade, the inverse reaction solenoid, and the radioactive beamline upgrade (priorities 4, 5 and 6 on the Director's list) instead of routine maintenance.... [The Division should] evaluate the need for investment in the X-Array if the Gammasphere remains at ATLAS for the next few years.... [The facility should] justify the ATLAS energy upgrade, and integrate it with the medium term vision of the facility."

4.3 Recommendations

- "The operating budget should be increased to cover 2 additional operators/beam physicists, 1 engineer and M&S for accelerator operations, 1 target maker, and 1 computer support person for experimental support. The case for additional M&S for instrument support should be investigated. These additional funds should be tied to delivering greater than 6000 hours of beam on target for Physics Users with no limitation on accelerator tune-up during weekends."
- "Capital equipment funds should continue at the same level and, with the addition to the operating budget, should only be applied to capital equipment projects."
- "The proposed Californium source AIP project appears interesting and the case should be further developed."
- "The second operations increment to fund 1 additional operator and 1 engineer for accelerator operations and 1 engineer and M&S for experimental operations potentially has merit, but no proposal for a metric to judge the impact of this additional funding was made."

5. ENVIRONMENT, SAFETY AND HEALTH

5.1 Findings

Safety Record

"The Physics Division would have had a good safety record, but it is marred by a few minor incidents. The recent incidents since 2000 are: one bilateral carpal tunnel syndrome (2001) with no lost work days; one second degree burn (employee touched a gas heater) and one back injury moving a pallet (2002), one lost work day; and one slip on a stairway when on travel, one twisted ankle walking on grass by the cooling tower, and one burn when touching a hot appliance (2003) with one lost work day."

"Processes are in place for safety checks before installing new equipment. There is a full complement of oversight committees. None the staff received any radiation dose at all, an excellent result."

"[It is a notable finding that] almost a quarter of the staff (at all levels) has participated in safety committees of one sort or another, making everyone aware of the importance of safety. This is an excellent idea that deserved credit."

"The panel did not have the opportunity to review the operations procedures and ISM practices of the ATLAS staff and experimenters."

5.2 Comments

Safety

"The incidents noted above are the kind that could happen in any light industrial facility and, apart from the two cases of burns, are difficult to guard against. The burns should be studied to see if greater protection could be provided."

"The tour of the experimental area revealed problems that would be considered OSHA related. General housekeeping, stored combustibles, trip hazards, stairs and platform hazards, improper electrical wiring, blocked electrical panels, and so forth." "This should be addressed, preferably by a general clean-up campaign as it would serve to send a message that management believes that a clean and orderly working environment is also a safe working environment. Working professionally should be an expectation of the staff."

5.3 Recommendations

None

6.0 MANAGEMENT and ADMINISTRATION

6.1 Findings and Comments

"The mission statement comprises reasonable and achievable goals for the Physics Division. The vast majority of the various aspects of the mission are being carried out with enthusiasm, and the staff is clearly dedicated to achieving the physics goals. This is a credit to everyone from management down to the technicians and operators."

"The ATLAS management should be commended for providing a first class facility that is at the low energy nuclear physics forefront and is superior to similar facilities. This is all under the stress of limited budgets."

"[It is a notable finding that] almost a quarter of the staff (at all levels) has participated in safety committees of one sort or another, making everyone aware of the importance of safety. This is an excellent idea that deserves credit."

"The overall scientific accomplishments at ATLAS speak for themselves, and their success argues strongly against making any radical changes. However, long-term developments are too haphazard to suit current funding and staffing constraints."

"The Division needs to develop a process for evaluating the relative importance of projects requesting additional funding and to tie them to specific, quantifiable Physics deliverables. The lack of structured decision-making processes does not provide a track record of managing projects, which would be beneficial in achieving the goal of convincing all of the stakeholders that ATLAS should be the basis for RIA."

"Until the panel visit, there was no prioritized strategic plan in place to guide staff and management in future planning consistent with the mission goals.... Unquestionably, the laboratory staff and management are making heroic and successful efforts to achieve their objectives. It is hard to believe, however, that the intensity of effort that this has demanded from staff in recent years can continue indefinitely. Some relief should be provided through increased staffing where that is possible, but some can also be derived from having a clear strategic plan established with priorities made known to everyone in the division. This would allow the division to apply its limited resources with optimum effectiveness and would give all staff members a clear view of how their efforts fit into the overall picture. Naturally, the strategic plan should be revised on a regular – probably annual – basis to reflect the natural changes that occur in any active field of research."

"The overall scientific accomplishments at ATLAS speak for themselves, and their success argues strongly against making any radical changes. However, long-term developments are too haphazard to suit current funding and staffing constraints."

6.2 Recommendations

- "Develop a strategic plan with a 5-10 year outlook. It should include specific targets and priorities for future developments. This plan should be available to all, and be up-dated on a regular basis."

APPENDIX A

CHARGE MEMORANDUM

Panel Charge

The purpose of this review of ATLAS is to evaluate present performance and cost of operations, and to determine what funding is needed to effectively support its research mission. In order to do this, the review panel should examine all the ANL/ATLAS activities associated with facility operations supported by the Nuclear Physics program, determine the real cost (especially manpower) that is being incurred by Nuclear Physics for each activity, advise whether these activities are required and in the best interest of the Nuclear Physics program, and explore potential impacts of changes in funding. In particular, it is requested that you:

- Analyze and evaluate the present facility operations.
  - What is the mission of the facility?
  - How are the resources currently used (bottoms up analysis) to carry out this mission?
  - Are available resources optimized for the most productive program?

- Evaluate the impacts of different funding levels on the productivity of the facility.
  - What level of facility operations and scientific productivity could be sustained into the out years with constant effort funding at the FY03 Appropriations level?
  - What benefits, in order of priority, could be realized with incremental funding above this level?

APPENDIX B

REVIEW PARTICIPANTS

Department of Energy Operations Review
of the
Argonne Tandem-Linac Accelerator System

Address/Phone Listing

Review Panel

Dr. Gerardo Dutto
TRIUMF
4004 Wesbrook Mall
Vancouver, B.C., Canada
V6T 2A3
604-222-7419
dutto@triumf.ca

Prof. John C. Hardy
Department of Physics
Texas A&M University
College Station, TX 77843-1411
979-845-1411
hardy@physics.tamu.edu

Dr. Andrew Hutton
Jefferson Laboratory
12000 Jefferson Avenue
Newport News, VA 23606
757-269-7396
andrew@jlab.org

Dr. Derek Lowenstein
Brookhaven National Laboratory
Collider Accelerator Department
Bldg. 911B
PO Box 5000
Upton, NY 11973
631-344-4611
lowenstein@bnl.gov

Prof. Mark A. Riley
Department of Physics
Florida State University
218 Keen Building
Tallahassee, FL 32306-4350
850-644-2066
mriley@nucott.physics.fsu.edu

ANL Contact Person

Dr. Donald F. Geesaman
Physics Division
Argonne National Laboratory
9700 S. Cass Avenue
Argonne, IL 60439
630-252-4004
geesaman@anl.gov

DOE Observers

Dr. Dennis Kovar
Division of Nuclear Physics
U.S. Department of Energy
MS: SC-90/GTN
1000 Independence Ave., SW
Washington, DC 20585-1290
301-903-3613
dennis.kovar@science.doe.gov

Dr. Jehanne Simon-Gillo
Division of Nuclear Physics
U.S. Department of Energy
MS: SC-90/GTN
1000 Independence Ave., SW
Washington, DC 20585-1290
301-903-1455
jehanne.simon-gillo@science.doe.gov

Dr. Eugene Henry
Division of Nuclear Physics
U.S. Department of Energy
MS: SC-90/GTN
1000 Independence Ave., SW
Washington, DC 20585-1290
301-903-6093
gene.henry@science.doe.gov

APPENDIX C

REVIEW AGENDA

Argonne National Laboratory - Physics Division
DOE ATLAS Operations Review
December 8-10, 2003

(Bldg. 203)

Monday, December 8

Conference Room R-150

8:30	Executive Session	
9:00	Overview	D. Geesaman
9:40	The Science Driving ATLAS	R. Janssens
10:40	*Break*	
11:00	Accelerator Operations Overview	R. Pardo
12:00	*Lunch Executive Session*	
01:30	Researeh Operations Overview	K. Lister
02:30	ESH	D. Geesaman
02:50	Tour	
04:20	User and PAC Presentation	A. Wuosmaa
04:50	Executive Session	
06:00	Adjourn	
07:00	Dinner – Panel and Division Management	

Tuesday, December 9 (Parallel Sessions):

Accelerator Operations (R-150)

08:30	Operations/Maintenance	G. Zinkann
09:00	Controls	F. Munson
09:30	RF and Electronics	S. Sharamentov
10:00	Ion Sources	R. Vondrasek
10:30	*Coffee Break*	
11:00	Radioactive Beams	R. Pardo
11:30	SRF	M. Kelly

Experimental Operations (A-114)

Experiment Support Introduction	K. Lister
User Support	F. Moore
Target Lab	J. Greene
Gammasphere	M. Carpenter
Experiments with Radioactive Beams	E. Rehm
Experiment Upgrades and R&D	A. Wuosmaa
	K. Lister

12:00 Lunch (Cafeteria)

Plenary Sessions (R-150)

01:00	Accelerator R&D and Relation with RIA	J. Nolen
01:45	Upgrade Plans	G. Savard
02:45	Summary	D. Geesaman
03:00	Executive Session	

Wednesday, December 10 (Executive Session)

Conference Room R-150

8:30	Executive Session
12:00	Closeout with Division Management