"However, it is obvious that weather modification used as a weapon of war has the potential for causing large scale and quite possibly uncontrollable and unpredictable destruction. Furthermore, such destruction might well have a far greater impact on civilians than on combatants. This would be especially true in areas where subsistence agriculture is practiced, in food deficit areas, and in areas subject to flooding."

Leonard S. Rodberg, a fellow of the Institute for Policy Studies who assisted in publishing the Gravel *Pentagon Papers*, said, "I don't think we have a right to experiment on other people. It's a standard issue which in medical terms would be called informed consent. The people in that area [Indochina] are totally dependent on the weather for their livelihoods. If we change the pattern we destroy their ability to exist. We've done it not only with weather modification but with defoliants and herbicides." Rodberg adds, "It's quite clear that many kinds of experimentation have been permitted in Indochina. So long as it's not a large operation that would get a lot of publicity, anything can be done."

Most of those queried favored some sort of ban on military uses of weather modification technology. But Adrian S. Fisher, deputy director of the Arms Control and Disarmament Agency from 1961–1969, now dean of the Georgetown University Law School, says, "Weather modification is really an appropriate subject, not only for an arms control agreement, but for a peaceful uses agreement," which would "regulate allocation of resources in such a way as to recognize its good qualities as well as its bad ones."

Finally, another well-known arms control specialist, Herbert P. Scoville, Jr., favors a ban on weather modification's military uses. "I would strongly support any statement that we ought to ban the use of weather modification for military purposes and seek an international agreement on this.

"At some stage of the game, somebody may start doing it—even if it's not going on now. To me it is a terrible way to be using science."

—DEBORAH SHAPLEY

Accelerators: Big Physics Moves toward Consolidation

It is obvious that the $250 million accelerator at Batavia, Illinois, which on 1 March pushed its first proton beam up to 200 Gev, will dominate America's physics landscape for decades to come, and the world's as well for at least another couple of years until Europe's CERN II goes on the air.

The big investment in the National Accelerator Laboratory (NAL) reflects the government's policy of consolidating resources at a few major installations, often at the cost of shutting down or drastically reducing support of other machines, so the country can sustain a virile and innovative, even if selective, physics research program.

The same trend obtains in medium energy physics, which now has as its centerpiece the new $57 million Los Alamos Meson Physics Facility. LAMPF, an 800-Mev proton linear accelerator, will have an operating budget of about $9.3 million for fiscal 1973 and is scheduled to start operations early next year.

Some reshuffling of priorities has been necessary to boost these big machines into orbit. Back in 1971, the Atomic Energy Commission (AEC) dropped support of the 3-Gev Princeton-Penn Particle Accelerator, which helped free funds for NAL (*Science*, 2 July 1971). The AEC's budget for high energy physics, $116.4 million in fiscal 1972, will be $126.4 million for 1973, with most of the increment going to Batavia. Despite this, the laboratory is getting nothing like the $60 million projected several years ago for new equipment, and the $20 million slated for 1973 is $6 or $7 million short of what is seen as desirable.

Other laboratories are making much bigger sacrifices. Most of the AEC's five remaining high energy accelerators are operating at between 60 and 70 percent of capacity. (The only other high energy machine, the 12-Gev Cornell synchrocyclotron, supported by the National Science Foundation, is also cutting down on services and the use of some facilities.) It has been rumored for some time that new sacrifices will have to be made to feed NAL, which is expected to devour from $60 to $70 million per year by 1975 (this figure includes funds for operation, equipment and accelerator improvements). The principal candidates are the Berkeley Bevatron-Super Hilac, the Argonne National Laboratory's Zero Gradient Synchrotron (ZGS), and the Cambridge Electron Accelerator (CEA), whose operations are now limited to experiments with colliding beams. But AEC officials insist that no further shutdowns are being planned.

The Joint Committee on Atomic Energy last year asked the AEC to make a priority listing of which of its high energy machines should be kept open if there were not enough money to go around. This request, considering the favorably disposed nature of the committee, was taken as an invitation to make a strong case for all of them (*Science*, 3 September 1971). The report, "Considerations for a Viable and Productive High Energy Physics Program," was released last January. Priorities were, not surprisingly: (i) NAL; (ii) SLAC and the Alternating Gradient Synchrotron (AGS) at Brookhaven National Laboratory; (iii) Berkeley Bevatron and ZGS; and (iv) CEA. SLAC and the AGS are accepted as indispensable. Bevatron and ZGS, it was pointed out, cannot be compared to each other because Bevatron is cheaper to run, has just been tooled up for heavy ion experiments, and has a superb staff at Lawrence Berkeley Laboratory, while Argonne has twice the energy (12.5 Gev) and a new hydrogen bubble chamber, and its data are relied on by a large portion of university user groups.

The AEC report repeatedly points up the need to halt current "erosion" in manpower, which has decreased by 20 percent in the last 3 years, despite the fact that NAL now has 1000 employees. This feat can presumably be accomplished within the fiscal 1973 budget because of the smaller proportion of funds going into new construction.

In addition, the report describes, optimistically enough, new construction projects that should be started in 1974, all of which would be attached to existing accelerators. Besides various refinements for NAL, high priority is given to construction of an intersecting storage ring facility. New storage rings are regarded as an absolute must, because at this point both European countries and the USSR are way ahead of the United States in this technology and its applications. The United States has no storage rings for protons and only two facilities for electrons—at CEA and SLAC.

But nothing is more important than keeping NAL in a viable state: in the minds of the big physics planners, the world falls into two categories—NAL and everything else.

In medium energy, more or less the same generalization applies to LAMPF, which will have a wide spectrum of applications in basic and applied physics. It will provide secondary beams of pions intense enough to be used as the primary beam for studying nuclear properties. The facility will also be used to accelerate pions for biomedical applications and will be producing new isotopes for biomedical and industrial use.

Also brand-new, but much cheaper, is the $7 million, 400-Mev linear electron accelerator (Linac) at MIT. This accelerator is justified on the grounds that it can perform electron spectroscopy with spectacular precision. Together, LAMPF and the new Linac will consume about $10.6 million in fiscal 1973, or almost two-thirds of the AEC medium energy budget of $16 million.

In making room for LAMPF, the AEC has dropped several medium energy machines in the past few years. This year's casualties were Ames Laboratory's electron synchrotron in Iowa; the Texas A&M 60-Mev cyclotron; and the 75-Mev cyclotron at the University of California at Davis. Support for the latter two is being shouldered by the NSF, which last year received an additional $7.5 million to pick up projects dropped by other agencies. But the NSF is unable to support them in the style to which they have been accustomed, and how long it will be able to take care of them is questionable.

The AEC in 1965 created a new budgetary category for medium energy physics to accommodate LAMPF and to help insulate the low energy physics program from the high costs expected in the intermediate program. Nonetheless, many nuclear physicists, most of whose work is with low energy machines (defined by the AEC as below 50 Mev), have strong suspicions that the big new installations are sucking away at their budgets.

Unhappiness at Low Energies

Consolidation of resources, they point out, is rougher on them than it is on the high energy people. In the latter field, everyone agrees that the highest possible energies are where the action is—that is, at NAL. But in nuclear physics, no one knows where the next big breakthrough is coming from, and an old Van de Graaff, for some people, holds just as much potential as a big new LAMPF. These small, inexpensive, low energy machines have proliferated at university campuses over the last 30 years, and quite a few have lost their support from both the NSF and the AEC. This has created a good deal of consternation among university researchers.

Fred Moore, a young nuclear physicist at the University of Texas, received considerable support at this spring's meeting of the American Physical Society (APS) when he deplored the fact that physics is becoming concentrated at national laboratories. "During World War II, national labs were necessary, but now the same work can be done in university laboratories. The frontiers can be approached in our lab as well as any other. Our low energy Van de Graaff is a beautiful machine. There are a lot of exciting things to be done and [it's economical because] most of the money goes into salaries. In high energy physics things are different. I can see how you shut down a machine that's not as good as NAL."

Faye Eisenberg-Selove from the University of Pennsylvania, who is head of the APS nuclear division, also believes that too much concentration at national laboratories shortchanges research. Not only is the style and atmosphere of research different, she says, but "at a big machine a student becomes almost a cog. User groups have to band together and make a single proposal. As a result, individual work becomes almost insignificant." A large machine such as LAMPF, whose operating costs will soon be going up to $16 million per year, builds its own inertia. "No one can predict what will be the most exciting field in the next few years, but the momentum at LAMPF makes it hard to stop" and say we should go in another direction.

At any rate, nuclear physicists seem torn between which to deplore more: the decrease in support for existing facilities, or the fact that no new construction has been authorized recently. In a talk at the APS meeting, Thomas Lauritsen of Caltech predicted that, if recent funding trends continue, "massive shutdowns of productive installations," necessitated by the need to support new machines now coming on the air, will "jeopardize the viability" of the whole field.

He then went on to point out that no new installations have been authorized since 1968, a circumstance that "seriously hampers exploration of new fields already clearly identified."

He said it was imperative that a new heavy ion physics facility be built to advance, among other things, the search for superheavy elements. Heavy ion research is regarded as a major priority for nuclear research. Oak Ridge and Argonne national laboratories are both preparing proposals to be submitted to the AEC for such a facility, which would cost in the neighborhood of $25 million.

The most common recourse for a gasping research entity these days is to do something to prove that its work is directly relevant to society's needs. In physics, the most directly relevant area of research is the use of particles for cancer therapy, but so far not many laboratories have been able to persuade the National Cancer Institute (NCI) to augment their thinning budgets. The NCI is putting substantial sums into several installations where biomedical expertise is deemed adequate—notably LAMPF, which is getting $1 million for construction of a beam channel designed for treating cancer with pions, and the Texas A&M Cyclotron, which the M. D. Anderson Hospital and Tumor Institute wants to use for neutron experiments.

But Princeton-Penn finally bit the

dust in April, after NCI declined to support its research in radiotherapy with heavy ions. A group of Chicago doctors asked NCI for money to conduct a study on the possibility of using NAL's 200-Mev linear accelerator for proton therapy research, but the request was also turned down. Most recently, the National Aeronautics and Space Administration's Langley Research Center, informed by NASA that its synchrocyclotron would be going down the drain, has asked NCI for $50,000 to help support research with alpha particles. NASA will give limited support for another year if the grant comes through, but hopes are not high.

An NCI official explains that the institute's reluctance to support experiments with new kinds of radiotherapy systems, in part, from the fact that they are afraid of finding themselves carrying an accelerator which may produce nothing of clinical applicability. The deeper problem is that physicists and biologists have a long way to go in understanding each other's fields. Physicists make proposals that biologists think are naive; biologists can't see themselves putting money into a machine designed for physics research.

Even more fundamental is the fact that physicists, long accustomed to getting their way, have not taken the trouble either to establish links with other disciplines or to lay their case clearly before the public.

For these reasons, a report commissioned by the National Academy of Sciences, 2½ years in the making and the most extensive scientific survey ever undertaken by the academy, is being eagerly anticipated. The Physics Survey Committee, according to its director, Allan Bromley of Yale University, will undertake a comprehensive study of the present status, opportunities, and problems of physics. Says Edwin Goldwasser, deputy director of NAL, "For the first time, physicists are facing up to their problems in a quantitative way." The report is expected to be public in a matter of weeks, and if it lives up to expectations, it should supply physicists with potent rationales and a clear set of priorities to prevent further deterioration of the field and wrest back decision-making, which, in these times of stress, has increasingly fallen into the hands of the Office of Management and Budget.

—CONSTANCE HOLDEN

Science Committees: NRC Report Asks Better Mix in Advisory Groups

The committee of outside experts is the primary mechanism through which the federal government gets scientific and technical advice and gives money to support research. For the individual scientist or engineer, being appointed to one of these committees can be like being anointed. It is a mark of acceptance by one's professional peers and can open the way to practical benefits available only to the insider.

From the outset, there have been complaints that the system creates an advisory elite, that it favors a relatively few individuals and institutions, but over the two decades after World War II, when the system reached full flower, both sides, by and large, seemed satisfied with arrangements. More recently, however, critics have complained that younger scientists, members of minorities, and women are grossly underrepresented in the advisory process. In addition, antiwar sentiment has produced a questioning of the morality of scientists' advising government, particularly of serving on Defense Department advisory groups.

One result of the complaints was the formation in 1968 of a National Research Council (NRC) study group to deal with questions raised about advisory committees. The product is a report recently published by the NRC's parent National Academy of Sciences entitled *The Science Committee: A Report by the Committee on the Utilization of Younger Scientists and Engineers in Advisory Services to Government.**

As the report's subtitle implies, the original focus was the involvement of younger scientists and engineers in advisory committees. Funds for the study were provided through ARPA (the Advanced Research Projects Agency), so it is clear that the Department of Defense has a special interest in the matter. But the focus of the study was broadened considerably to comprehend general questions of recruitment, organization, and administration of advisory committees. For the academy, the report is timely because the NRC is in the throes of reorganization, and the NRC, after all, is really one big advisory committee.

Chairman of the study group was Detlev W. Bronk, former president of Rockefeller University, president of the academy from 1950 to 1962, and himself a grand sachem of the advisory system. Among the group's members were Frederick Seitz, Bronk's successor at both the academy and Rockefeller, and Robert K. Merton of Columbia, who is a pathfinder in the sociology of science.†

Nobody would mistake *The Science Committee* for a Nader Raider report. The assumption underlying the report is that the committee system is a necessity, that, on balance, it has proved its usefulness, but that it has some shortcomings which need to be corrected and some inherent weaknesses which need to be guarded against. If ARPA wanted detailed advice on how to recruit young scientists, it did not get it in the report, which it supported, incidentally, to the tune of $100,000. What it did get is a general anatomy lesson on the committee system. The authors, however, are frank in acknowledging the system's flaws as they did in the following excerpt:

> In our exploration and in our own experience we have found both concern and neglect. We have also found examples of the improper employment of committees—for example to avoid or delay executive decision. Sometimes an existing committee is used or a new one is formed out of habit or inertia simply because the advisory framework exists and is convenient, without a clear decision that reference to a committee is the best course in the circumstances.

* Available from Printing and Publishing Office, National Academy of Sciences, 2101 Constitution Avenue, NW, Washington, D.C. 20418.

† Other members of the group were George S. Ansell, Rensselaer; Michael Ference, Jr., Ford Motor Co.; Timothy Merz, Johns Hopkins; J. A. Stratton, Ford Foundation; Lewis Thomas, New York University; and Robert K. Weatherall, Massachusetts Institute of Technology, secretary.