News and views

MURA Organized

ON September 27, 1954, the Midwestern Universities Research Association (MURA) became a corporation under the laws of the State of Illinois. The present members are the Universities of Illinois, Iowa, Michigan, Minnesota, and Wisconsin, Purdue University, Indiana University, and Iowa State College. The Board of Directors of the Corporation includes one scientist and one administrative officer from each of the member universities. At the first regular annual meeting of the Board of Directors, a statement of the origin, objectives, and accomplishments of the Corporation was formulated for purposes of publication. Because of its general interest for physicists throughout the country, the statement is reproduced in full below.

Midwestern Universities Research Association
A Statement of its History, Organization, Objectives, and Accomplishments
December 31, 1954

DURING the past decade the frontier of nuclear physics has moved into a new area, where experiments are performed not on the atomic nuclei as a whole but on the individual constituent particles of which they are composed, and on particles which are created through high-energy collisions of subnuclear particles. This new field, which has come to be called high-energy physics, is, and surely will continue to be for a long time to come, the major land of the unknown in physics. But as one horizon after another has appeared in high-energy physics, the investment, both in equipment and in scientific manpower, required for effective work in the field, has come to be beyond the reach of the individual university.

The problem of the great expense, in money and manpower, of high-energy physics can be solved if groups of universities will organize and combine forces for the creation of cooperative laboratories. The effectiveness of this solution has been well demonstrated on the East Coast by the Associated Universities, Inc., in the creation and operation of the Brookhaven National Laboratory. There the control of the laboratory is vested in a board of directors elected by the member universities, and the financial support is provided by the Atomic Energy Commission. The AUI arrangement represents a pioneer experiment, and a successful one, toward the solution of the many problems which attend the support, by the Government, of large scale university research, particularly cooperative research involving several universities. A notable degree of success has been achieved toward extending into the laboratory many of the elements of a free university atmosphere, toward making the laboratory attractive to many scientists from all over the world, and toward preserving the valuable interplay between senior scientists and graduate students.

Until very recently, there has been no similar movement on the part of the universities of the Midwest to combine their forces to create a cooperative laboratory for high-energy physics. As a result the Midwest has lagged seriously, relative to both the East Coast and the West Coast, in high-energy physics. The need for such a laboratory in the Midwest is very clear and urgent. There are, in this region of the country, a large number of young physicists who are intensely interested in the field of high-energy physics and who do not have ready access to the necessary facilities. The first really strong movement in the Midwest toward finding an answer to this need began early in 1953 when some of the nuclear physicists of midwestern universities constituted themselves an informal committee for the purpose of promoting a cooperative high-energy laboratory and began an intensive series of meetings. From that beginning has grown the present full-fledged Corporation, which has the active participation not only of the scientists of the member universities but of the administrative officers as well. The task to which the committee, and later the Corporation, addressed itself was fourfold: (a) to determine, with the help of what little experience existed on the subject, the form of organization that would be the most advantageous for the operation of a cooperative laboratory and to bring such an organization into existence; (b) to determine what environmental and geographical conditions would be the best; (c) to gather together, immediately, a group from among those young physicists who would be most directly concerned with using a high-energy laboratory, and to set this group to work studying high-energy machines and designing one for the Midwest; (d) to take immediate steps to raise funds both for the study program and for the eventual construction of a high-energy machine.

The fourfold task described is a heavy one, but the committee has worked for more than a year with the greatest of enthusiasm and vigor. The administrative officers of the universities concerned have not only given their full support at all times, but have actually worked alongside the physicists in thrashing out the many complicated problems of organization. A cooperative laboratory is not yet on the way, but the committee can point to many accomplishments which represent real progress. What has been accomplished under each of the four headings is described in some detail in the following paragraphs.

(a) *The form of organization.* A thought foremost in the minds of the members of the committee was that the responsibility for the kind of research envisioned rests, and must rest, upon the shoulders of the universi-

ties. The research is of a kind that reaches out very far in advance of the practical applications of today. It cannot, therefore, derive its stimulus from the practical problems or needs and emergencies of the moment, as is true of the type of research done in many industrial and government laboratories. The universities alone have shown the ability, over long periods, to keep alive and flourishing those lines of research which are truly described as basic, i.e., very far in advance of application. It is the unanimous belief of the committee that in the organization for the projected laboratory, the primary responsibility, and therefore also a large measure of the control, should be vested in the universities, quite aside from the question of the source of funds. Responsibility and control, it is firmly believed, must go together; neither will be effectively maintained over a long period of time without the other. The organizational scheme of the AUI was used as a starting point and model, and, as it turned out, only minor departures from that scheme were made. An organization very similar to the AUI was completed and it was incorporated under the laws of Illinois on September 27, 1954. Each member university either paid or pledged $10 000 to be used as an operating fund. Considering the fact that all of the universities involved are tax-supported institutions, and that in several cases their joining a corporation outside their own states required an act of the legislature, the successful formation of a corporation attests to the seriousness of purpose of the committee.

(b) *Environment and location.* It was fully realized that the question of the location of a Midwest laboratory would be a complex one, for the reason, among other considerations, that one laboratory already exists in the Midwest which is authorized to enter into cooperative work with the universities, i.e., the Argonne National Laboratory. Nevertheless the committee tried to approach the question on a new basis and to at least attempt to define the most advantageous set of conditions. The importance of proceeding in this manner is pointed up when one recalls that the choice of the location of Brookhaven, which was influenced to a large extent by the availability of a piece of government-owned real estate, proved to be a serious deterrent to the laboratory's development during the early years. The location has only recently been reduced to secondary importance by the uniqueness of the research tools which have become available. The committee therefore takes a strong stand, and will try to maintain it, that a cooperative university laboratory, which is to be built for many decades of use, should not start life with a handicap in location or environment.

The most important requirement in respect to location is, in the opinion of the MURA group, that the laboratory be in a place which is attractive to university scientists. A laboratory is only as good as the scientists who use it. Since a cooperative laboratory would rely heavily upon university scientists going to it for a summer, a semester, or a year at a time, the willingness of university people, and in particular their families, to move to it for these periods is of vital importance. Much would be contributed to the success and value of the laboratory if it could be located in, or close to, an established community of scholars having a variety of fields of interest.

Another important requirement, which is connected with location as well as with organization, is that security restrictions be held at an absolute minimum, making the interchange of scientists and of information with other laboratories and with friendly nations as free as possible.

(c) *Accelerator design and study.* A study and machine design group, sponsored by the committee and now by the Corporation, and under the chairmanship of Professor D. W. Kerst, has been active since the very beginning, in the summer of 1953. With a membership ranging from 10 to 20, from the member institutions as well as from Argonne National Laboratory, the University of Chicago, and Wayne University, it has met for a three-week and an eight-week session at Madison, and for sessions of two or more days at monthly intervals at the various universities. For the present school year it will continue, meeting for two days of every week, with a center of activity at Ann Arbor. In addition to group meetings, experimental projects on specific problems relating to machine design are being carried on at a number of the member universities. An intensive program using the Illiac electronic computer has been under way at Illinois for the past year. Experiments on the design of the radio-frequency accelerator system for a large machine are under way at Iowa State College. Magnet design studies are beginning at Purdue, and electromechanical analog work has been in progress at Michigan for the past year. At Minnesota work is being done on the problem of injecting protons into an AG machine by means of a linear accelerator. The amount of experimental work specifically aimed at the design of a machine is steadily increasing. Scientific contributions by the Midwest study group have already been significant and of value to other laboratories planning high-energy machines. The work is described in detail in numerous technical memos which have been written and distributed over the past year and a half. In addition, the most recent work will be presented in several talks scheduled for the New York meeting of the American Physical Society in January, 1955.

Among the specific accomplishments of the Midwest study group, the one which has attracted the greatest interest is the invention and theoretical exploration of a fixed-field, alternating-gradient (FFAG) accelerator. Briefly, it was found that narrow ring magnets can be made which can simultaneously contain a high-energy orbit, for example a 20 Bev orbit, and a low-energy orbit of about 1 Mev. This means that the magnet can be operated continuously on direct current, thus avoiding the complex power equipment needed to pulse a magnet. It also simplifies the radio-frequency modulation, which in the case of the more conventional pulsed magnets must be very precisely controlled to track with

the magnetic field. With the new FFAG magnets an arbitrary frequency modulation program may be used. Since the magnet is always able to receive particles, a pulse of particles can be injected as frequently as the radio-frequency modulation cycle can be repeated. Thus the average beam current can be much higher than that from a conventional machine, whose magnet is pulsed.

About six different types of FFAG accelerators have been worked out. Some involve reverse field sectors and some involve ridges on poles or prismatic edges on magnet sectors. A unified theory which describes all the types so far imagined and suggests other types has been developed, so it may soon be possible to determine the optimum physical design for an ultra-high-energy machine.

It will require more theoretical analysis in order to determine whether or not the FFAG magnet will have an over-all advantage over existing designs in the 20 Bev range; however, it has already become clear that there will be important applications of the FFAG principle to the better-known accelerators at lower energies. For example, betatron acceleration with an FFAG ring magnet used for the guide field will make possible an intensity increase of several orders of magnitude, and existing FM cyclotrons can be changed to give higher current by the application of the spiral ridge form of FFAG poles. An early experimental test of the FFAG principle will therefore be of great importance to several branches of nuclear physics. The MURA group is laying plans for such a test in the very near future at the University of Illinois, using one of the betatrons.

Another activity of the study group which deserves special comment is the development of new computational methods, which make possible rapid experiments on orbit stability, using the Illiac electronic computer. Transformations have been discovered which have not only greatly accelerated the digital computer work, but which have made it possible to explore the more general nonlinear cases which are practically inaccessible analytically. Orbits can now be run through so quickly that the results can actually lead, rather than follow, the conjectures and speculations on modifications of design. Analytical work supporting, and feeding into, the digital computer program is carried out at the Universities of Iowa, Illinois, Wisconsin, and Indiana, and at Wayne University. This theoretical work is putting MURA in a position to answer some of the difficult questions about general (nonlinear) forces which arise in the conventional AG machines as well as in some of the especially interesting machines recently devised by the members of the MURA group.

(d) *Financial support.* The matter of financial support for the MURA objectives has been pursued continuously. So far no support for the construction of a laboratory has been obtained, but adequate support for the study group has been made available from several sources. In the early months of the study program, support was provided by the Atomic Energy Commission through its contracts at Argonne and Brookhaven, and by both the Atomic Energy Commission and the Office of Naval Research through their contracts at some of the universities. Since the spring of 1954 the outside financial aid has been provided entirely by the National Science Foundation.

The member universities have contributed substantially from the time of the early stage of the organization. Faculty members' time has been released freely and in many instances travel expenses have been paid by the universities. The University of Illinois has provided services of its electronic digital computer, Illiac, which has by now amounted to a very large number of hours. The University of Michigan, through its Phoenix Project, has provided a special fund to cover the expenses of its scientific participants and for experimental work at Michigan. To provide for business expenses of the Corporation each of the eight-member universities has contributed $5000 and has pledged another $5000.

Science Education

OVER the past half-century, the number of science students among college graduates has dropped from about seventeen percent of the total to ten percent, a matter of steadily increasing concern to those who must deal with the realities of a shortage of trained manpower. Atomic Energy Commissioner Willard F. Libby addressed himself to the general subject at the Fall Convocation of the University of Chicago on December 17th.

Noting that a large fraction of the nation's ablest students "do not choose to become scientists", Libby indicated that a prime cause is the fact that "the pickings apparently are not as green for the young student as they were in our school days" because the sciences "have been so thoroughly and dramatically explored by the greatest men of science the world has known—men who still are with us in spirit and sense and memory. They have set a pattern and stride proper to giants and geniuses but most frightening to ordinary mortals. They have left few obvious opportunities for easy attack and apparently cleared the fields of physics and chemistry, so little undiscovered remains. Of course, one realizes that similar situations apparently have existed before in science and, much to the embarrassment of the prophets of the time, have been shown to be purely temporary in character. In each instance, a few years later new opportunities have been revealed which have greatly increased the scope and range of the particular fields. We can well imagine that this may happen again but until it does happen, we must understand that a young man contemplating studying physics or chemistry looks around him and observes with considerable discouragement that the obviously important fields are being well tilled. This is unfortunate for, of course, it is not entirely true. The principle of research is such that it leads to new research, to new investigations and to new queries, to new understanding and to new thought. We cannot imagine that fruitful research will ever lead to a satiation or to an exhaustion or termina-