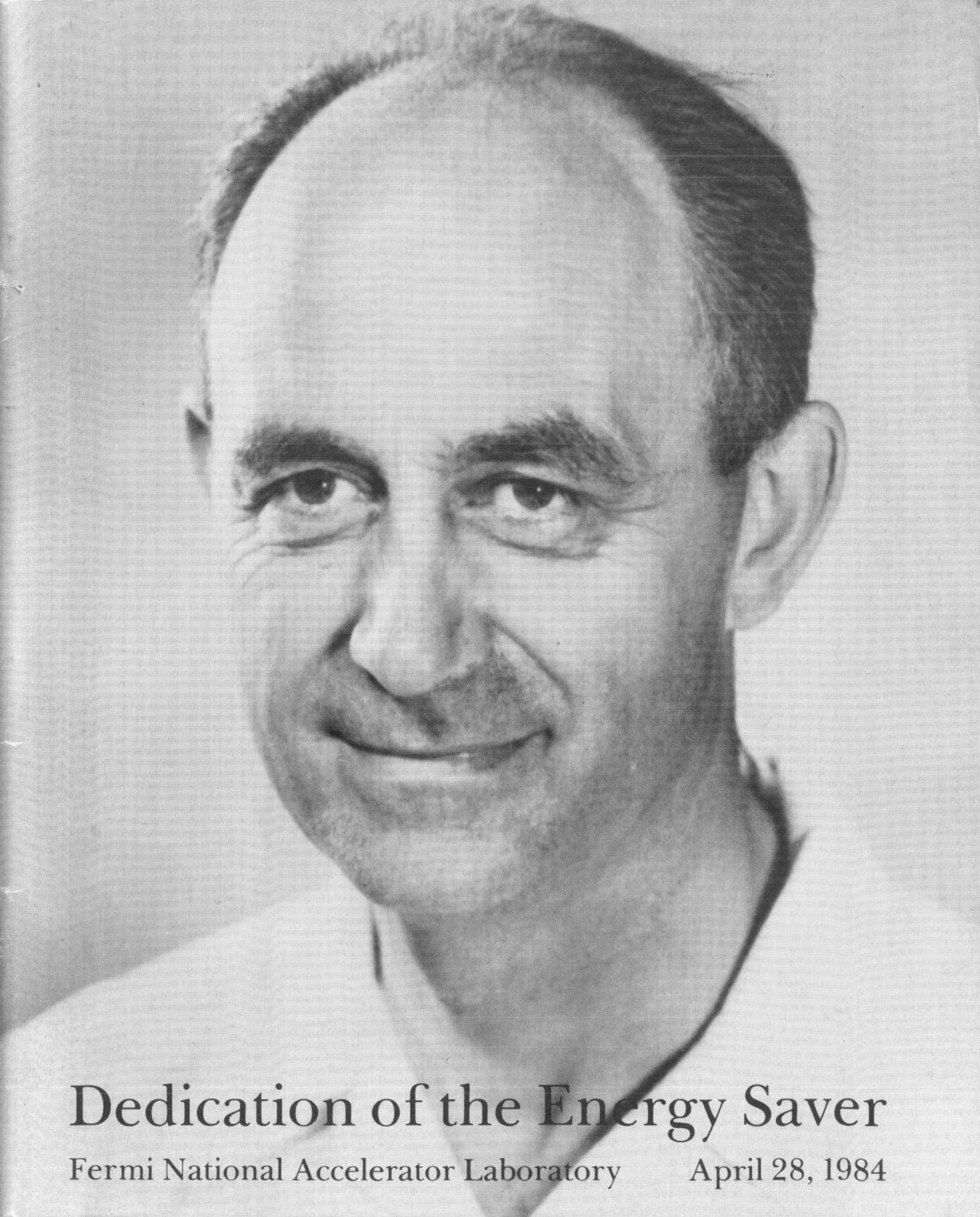
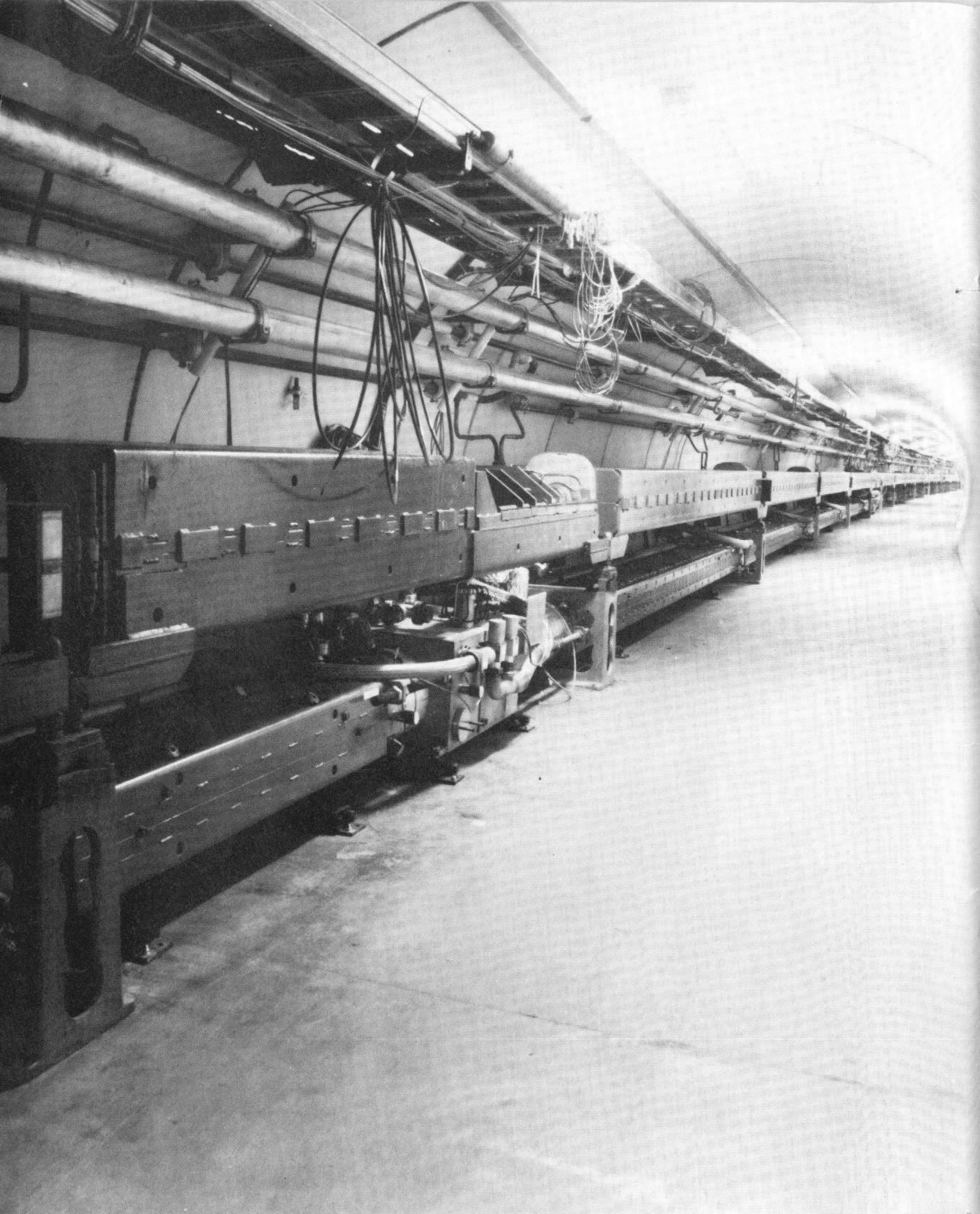


Dedication of the Energy Saver

Fermi National Accelerator Laboratory April 28, 1984



Dedication of the Energy Saver

April 28, 1984

Fermi National Accelerator Laboratory
Batavia, Illinois

Operated by Universities Research Association, Inc.
Under Contract with the United States Department of Energy

Preamble

On April 28, 1984, Fermilab dedicated the Energy Saver.
This is a record of that event.

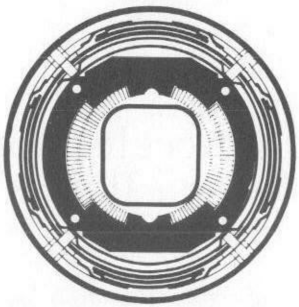
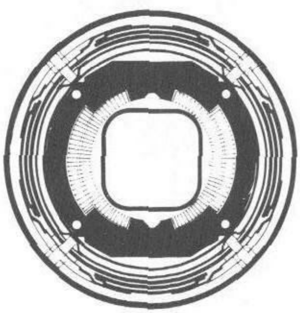
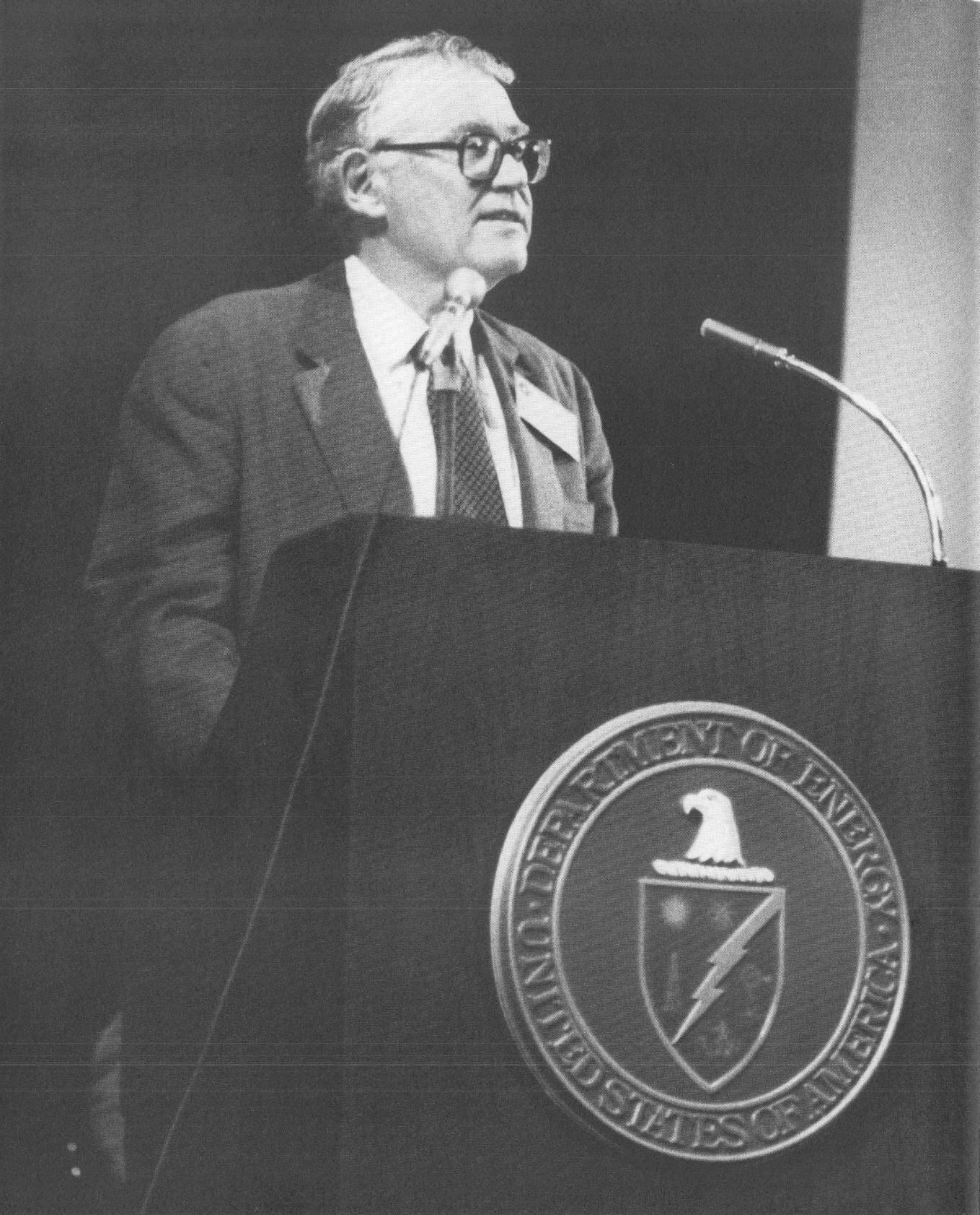


Table of Contents

Page




DEPARTMENT OF ENERGY
UNITED STATES OF AMERICA

Dr. H. Guyford Stever
President, Universities Research Association

Good afternoon ladies and gentlemen. I wish to extend to all of you a cordial welcome from the Universities Research Association, including the Council of Presidents of our 54 member universities, our Board of Trustees, and the director and staff of the Fermi National Accelerator Laboratory. Today is a happy day for us to have all of you present to celebrate an important scientific and technological achievement at Fermilab.

It was just ten years ago that we met here to dedicate and name the Fermi National Accelerator Laboratory in honor of Enrico Fermi. We met in the flag courtyard in front of what is now Robert Rathbun Wilson Hall for that ceremony; we celebrated about a decade of work of Dr. Wilson and the staff of the Laboratory in the achievement of the first objectives of this whole enterprise, namely the construction of Fermilab and the establishment of a vibrant community of dedicated people to operate the most powerful high-energy particle accelerator. As an added incentive for celebration, the proton energy then achieved was twice the original objective. We had succeeded in fulfilling our promises to our sponsor, the Department of Energy, and the people of our country.

Many of you were at the dedication; in fact, four of today's platform party were also members of the platform party then. Today we are in the Norman F. Ramsey Auditorium to celebrate another decade of technological and scientific achievement, particularly the building of the Saver. At the dedication a decade ago, though we did not know it at the time, we would soon enter an era in which the operating electrical power for accelerators would become much more costly; already the oil embargo of October, 1973, had occurred. Today, with our Saver, our accelerator is operating successfully in a power-saving mode and, as is becoming habitual, the decade has brought another doubling of the proton particle energy for our high-energy physics experiments.

Today, after more than a decade of operation of this Laboratory, in which scientists from our universities and those abroad, as well as those from our national laboratories, have had available this great apparatus to achieve their research ends, we can report to the Department of Energy, and to all of you that the original concept on which the Laboratory was formed, has been well served by the high-energy physicsists in the larger community and by the dedicated Fermi National Accelerator Laboratory staff.

Now it is my pleasure to introduce the platform guests, skipping over those who will speak later. First, I would like to introduce a team, the head and deputy head of the Energy Saver Project which we are dedicating today, Drs. J. Richie Orr and Helen Edwards. Helen Edwards and Rich Orr, members of the Fermilab staff, have distinguished accomplishments in high-energy physics accelerator design projects, and both of them have been key figures in achieving the triumph we dedicate today.

Next--Dr. Richard Lundy, member of the Fermilab staff and head of the Superconducting Magnet Facility. His magnet design and production have been the keys to the Saver success.

Next--Dr. Edward Knapp, the director of the National Science Foundation. Dr. Knapp is himself an accelerator physicist, having served as the division leader of the accelerator technology division at Los Alamos Scientific Laboratory before coming to the NSF. As Director of the National Science Foundation, he maintains close relationships to this field, for the NSF sponsors the research work of many of the physicists who use Fermilab, and they sponsor the accelerator activities at Cornell University.

Next--Dr. David Saxon, Chairman of the Corporation of the Massachusetts Institute of Technology. Dave Saxon is a theoretical nuclear physicist and was active in that field at the University of California at Los Angeles before he assumed the presidency of the University of California. He spoke to us at the luncheon on the subject of "Science: Its Promises and Problems."

Next--Dr. Alvin Trivelpiece, the Director of Energy Research at the Department of Energy. Al Trivelpiece has had a distinguished career in university and industry in his professional field of plasma physics. Today he oversees the large and powerful energy research program of the Department of Energy, one of the finest government sponsors of research.

Next--Dr. Robert Rathbun Wilson, Director Emeritus of Fermilab. Bob Wilson's great accomplishments and leadership as a high-energy physicist, accelerator designer, laboratory director, both at Cornell and at Fermilab, are legendary in the physics world.

Next--Mr. Hilary T. Rauch. Hilary Rauch is the Manager of the Chicago Operations Office of the Department of Energy which oversees the operations of Fermilab and other important DOE activities. He came to this post from the Directorship of Procurement and Assistance Management in the DOE. He has served DOE and the Office of Management and Budget for two decades following active military service.

Senator Charles Percy speaking at the Energy Saver Dedication. Platform guests, front row, left to right: Dr. Guyford Stever, Dr. Danny J. Boggs, Dr. George Keyworth, Governor James Thompson, Representative John Myers, and Dr. Leon Lederman.

It is now my pleasure to introduce the first of today's speakers: Dr. Leon M. Lederman, Director of Fermilab. Dr. Lederman became the second director of Fermilab just five years ago, coming to us from a brilliant academic and research career in the field of high-energy physics at Columbia University. Leon has proved to be a superb laboratory director in all dimensions of that job. Above all things, he has a warm human touch in his relationships with all of us, Dr. Lederman.


DEPARTMENT OF ENERGY
UNITED STATES OF AMERICA

Dr. Leon M. Lederman
Director, Fermi National Accelerator Laboratory

I am deeply honored by this very distinguished gathering of scientists, statesmen, our industrial vendors, friends, and last, but certainly not least, our Users from the Universities of America and abroad. We are, today, moved by this dedication, this pause in our activities, and by the fact that we are joined together in a celebration of science. Ten years ago, my predecessor selected a user as the principal speaker. I won't repeat that disastrous mistake.

We are enormously excited by the scientific possibilities which this Energy Saver has opened for us. Our science--in these past twenty years, has advanced dramatically.

From 1964 to the late 70's, we have been able to make a profound synthesis of the data that has emerged from the great accelerator laboratories: In Batavia, Berkeley, Palo Alto, Long Island, Ithaca, but also in Oxford, Geneva, Hamburg, Tsukuba, and Protvino.

A much clearer view of the architecture of the subnuclear world has emerged. What has been learned has given us a solid base and a clear vision of what we must do to resolve our current dilemmas. What we are learning are the **ingredients** of a total comprehension of the structure of the physical world **including** the ability to model the evolution of the universe from the original fireball.

Whereas we have been aware of four forces of nature for some sixty years, we now recognize strong mathematical similarities between at least three of them and, indeed, a sensible way of combining or unifying two of the forces. The goal of a grand unification of forces is now more of an expectation than a dream. It was Einstein's destiny to pursue this centrally important quest for most of his lifetime--probably all in vain without the data which we now have and will, in the near future, supplement.

We now have a concise list of candidates for the basic building blocks of matter--six quarks and six leptons. We need to know **much** more about these objects--we need quantitiative measurements over a **much** greater range of the important parameters and the Energy Saver will give us this opportunity.

The new accelerator we are dedicating gives us two widely different options for improving our understanding of the microworld.

In the fixed-target mode, which is now underway and which will continue to evolve in the next few years, we will subject our present theories to precision tests of great detail--crystallizing our grasp of these very abstract ideas by the variety of measuring probes.

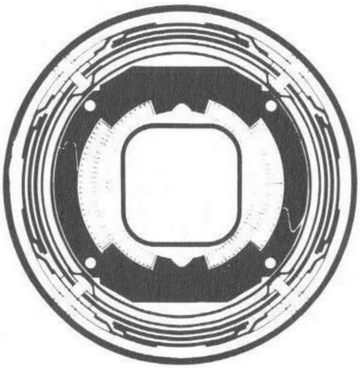
In the collider mode we expect to be able to observe the head-on collisions of protons against antiprotons reaching an energy of 2000 billion volts--all of it available for the exploration of a totally unknown domain of energies and hence of small distances. Here the potential for dramatic discovery is very great.

How did all of this come about and by what hands? There are so **many** to acknowledge! In the tradition of representative government, we can thank the American public through their elected officials--represented here by Senator Percy and Congressman Myers. We also acknowledge the essential leadership of the executive branch...the DOE, NSF, and OSTP. In these times of fiscal crises we appreciate the difficulty of seeking balance as between the needs of science and the needs of other activities; in science as between the obvious benefits of short-term technological advances against the vision of what particle physics, abstract as it is, will mean to the future culture and well-being of our society.

We would like to pay tribute to the State of Illinois, Governor Thompson, and its citizens, our neighbors, for their hospitality, for having the courage to accept in their midst, this strange thing called a particle accelerator. And there are the people who actually did the work. Here sitting uncomfortably on the platform are Rich Orr, Helen Edwards, and Dick Lundy; their talents and achievement will become part of our heritage, part of history. But they are also representatives--they are here, representing an extraordinary staff of dedicated, committed enthusiasts, the large staff that created the Energy Saver. This group took 4000 tons of steel, 680 miles of NiTi, 30 miles of vacuum tight welds, 40 acres of superinsulation, 30 miles of stainless tube, 30,000 microprocessor chips and fashioned all of this into a particle acclerator. And, since we are part, in fact owned by the Department of Energy, I do want to pay special tribute to one individual (out of the many) who has enobled the word Bureaucrat--this is Mr. Andy Mravca who sits in this building as our day-to-day connection with the real world--and who, in spite of his constant harrassment, is enthusiastically committed to the success of our mission.

Of course, there is our Founding Director, Robert Rathbun Wilson, whose vision provided our essential blueprint. Bob Wilson worked well with Alvin Tollestrup to solve many of the SC magnet problems which, over and over again, threatened progress in our mastery of this difficult technology. The final exhortation is to the **Users**, well represented in this auditorium--into whose hands we reluctantly entrust our brand new machine. It is up to them to extend the subject of particle science--by blending the art of observation and measurement with imagination. (These are needed because there is no money for equipment.)

To look in a place where no one has ever looked before, to observe deeper into the core of the atomic nucleus than has ever been probed; to measure in a domain more remote from human experience--much more remote--than the surface of the moon and Venus--to be able to recreate, in microcosm, the conditions which existed in the earliest instant after creation--this is the exalted privilege that has been given to us by our guests here and the public they represent. And for this we thank them.




DEPARTMENT OF ENERGY
UNITED STATES OF AMERICA

Senator Charles Percy
Senior Senator, Illinois

Dr. H. Guyford Stever

Our next speaker is the Honorable Charles H. Percy, the Senior Senator from Illinois. Like Dr. Lederman, Senator Percy was on the podium and made remarks at the dedication a decade ago. His distinguished service in the Senate of the United States has covered the entire period of interest to Fermilab in these first two decades; and he has been a constant loyal supporter and a friend of this institution and of high-energy physics.

Senator Percy

President Stever and friends of Fermilab, I thank you very much indeed. Perhaps you don't realize why we have such a beautiful day today, after the terrible warnings last night of thunderstorms and tornadoes; Dr. Lederman, with his usual thoughtfulness and vision, telephoned me with an urgent request to the Congressional delegation and to State Senator John Grotberg to do something about it. Before I left Washington this morning, we straightened it out, so we have a beautiful day today. Just one more service of your Congressional delegation.

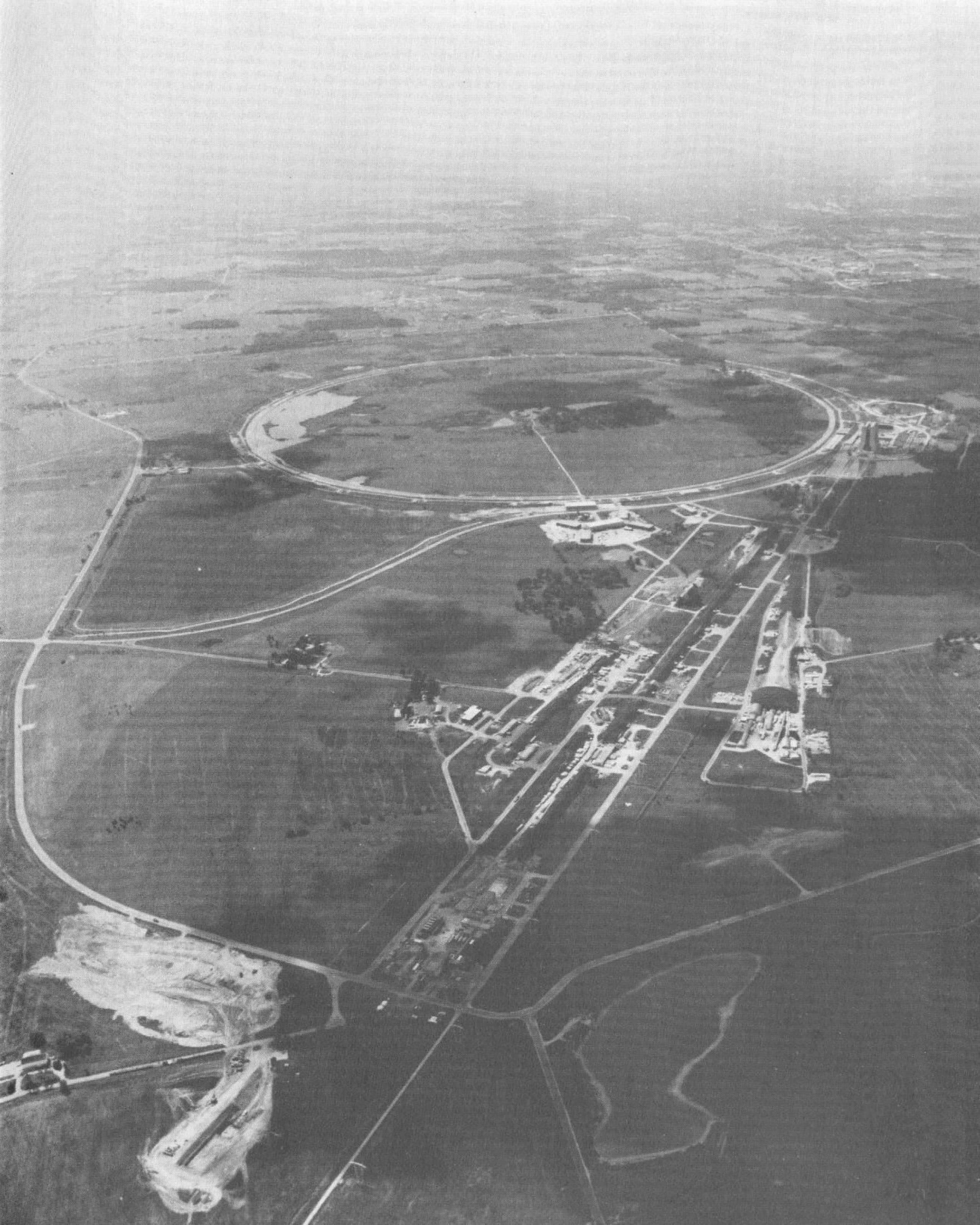
Little did I realize, after graduating from the University of Chicago in 1941, that the next year Enrico Fermi would head a secret team, that three years after I entered military service, would find a dramatic way to end World War II and bring victory to the United States and its allies. And, we hoped, find a means to end all such future wars.

When I was on the platform ten years ago, we talked about the great expectations we had for Fermilab. I want to pay tribute to those of you in the audience who were here and worked with us in making this Laboratory possible. I arrived in the Senate in January of 1967, a freshman senator was told to simply be seen but not say anything for the next six months. But there was one project that had to be talked about and we began in March and worked steadily together with Bob Wilson when he came on board. Working with many who are in this room today, we moved from 186 different sites to 35, then finally down to 6 in intense competition. One thing holding us up was that we didn't have a state open occupancy law, but that was overcome when every single community in the area here passed an individual law. Their city boards worked together, which began that tremendous community cooperation and support that Bob Wilson and Dr. Lederman have done such a fabulous job in fostering. The Friends of Fermi Laboratory have done an immense amount to make possible the growth and progress of this great National Laboratory and we pay tribute to you for the help that you provided.

We pointed ahead ten years ago to great expectations. Today is a landmark day when so many of them have been realized. In addition to the statistics that were given by Dr. Lederman, we can add that there are approximately 700 computers working. We were told in the Control Room that there are some 1500 miles of superconducting wire, twenty-four huge cooling plants, and 1,000 superconducting magnets that have made possible, last year, a breakthrough when an energy of 512 billion electron volts was reached. This year we are now running (I say we because all of us have a part in this great enterprise) at 800 billion electron volts and next year we should reach the trillion mark. To paraphrase my late colleague in the Senate, Everett Dirksen, the first trillion is the hardest and a trillion here and a trillion there and pretty soon you're talking about a lot of volts. We are not content just to look back today. We're going to look forward to ten years from now, because I feel confident (and I share this confidence with many of my colleagues in the House and in the Senate) that a great leader, Dr. Leon Lederman and his great team, will be able to convince the scientific community that Fermilab will be able, and has the capability and the leadership here, and the scientific team to now go to the next step to a superaccelerator, some twenty times larger than the one we are dedicating today, and that will continue Fermilab in an indisputable leadership role in uncovering the nature of matter.

We have great confidence in Fermilab. I don't know of any other laboratory or any other organization I've ever worked with that has had greater leadership than we have had in both Dr. Bob Wilson, whom we warmly welcomed aboard in 1967, and Dr. Lederman, who has followed in his shoes and has worked intimately with the scientific community to make this a truly great National Laboratory and great treasure.

So we pay tribute to that leadership and I know that I speak for everyone in this room in expressing confidence that the next step taken by this great scientific team backed up by a great administration, will be for the betterment of mankind, for the enrichment of education and knowledge and for the betterment of all of the people in the world. We warmly welcome the representatives of twenty-six different nations that today are working in this great Laboratory to take back to their own countries the story of what Fermilab means and the system of national laboratories under the supervision of the Department of Energy. Thank you very much.




DEPARTMENT OF ENERGY
UNITED STATES OF AMERICA

Congressman John T. Myers
Congressman, Indiana, Ranking Minority Member
Subcommittee on Energy and Water Development

Dr. H. Guyford Stever

Thank you, Senator Percy. I'm going to change what we used to call in World War II, the order of battle, so that the Governor can catch his breath and go to the speaker listed after him.

The honorable John T. Myers is a Congressman from Indiana. He is the ranking minority member of the Subcommittee on Energy and Water Development. All of us who studied physics when it was a kind of natural philosophy know that the universe is made up of air, earth, fire, and water. And Congressman Myers' Subcommittee has two of those--a powerful subcommittee, indeed. It gives me great pleasure to introduce John Myers.

Congressman Myers

Thank you very much President Stever and Governor Thompson, Senator Percy, Director Lederman, and the father of Fermilab, Robert Wilson, and other distinguished platform party and friends of Fermi all. I am honored today to be invited to be with you on this beautiful day. I too, Senator Percy, remember back years ago when this was only a concept out here. The discussion was about building a lab, west of Chicago, out in the prairie grass, as it was described by some easterners, who had never visited the Midwest. I also remember the debate that went on about just where it would be located. Now if I'd been a little bit more senior I think we might have gotten it in Indiana instead of Illinois, but we're glad it's close and we're close to you. I also remember about twelve years ago when an idea was presented before our Subcommittee on Appropriations of what was then called the Doubler. Now for laymen, the name Doubler didn't mean a lot, but now you've developed a new name which I think is more appropriate, the Energy Saver, because of the time that we face now. It's a name that can be related to easily by the public. But more important is what it can contribute to meet the needs of our society today and I would like to speak about that rather briefly.

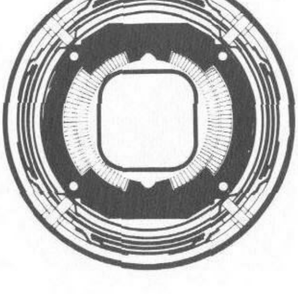
But I do want to say also that when Dr. Trivelpiece invited me to be here today, I thought I was just to come to see the Energy Saver and not to make remarks. But being a politician, I thought that I would not turn the opportunity down, even though I believe no one here votes in the Seventh Congressional District of Indiana. Nevertheless, just in case you do have friends, the election is in November so maybe the mail would get there by then, if you want to try that way.

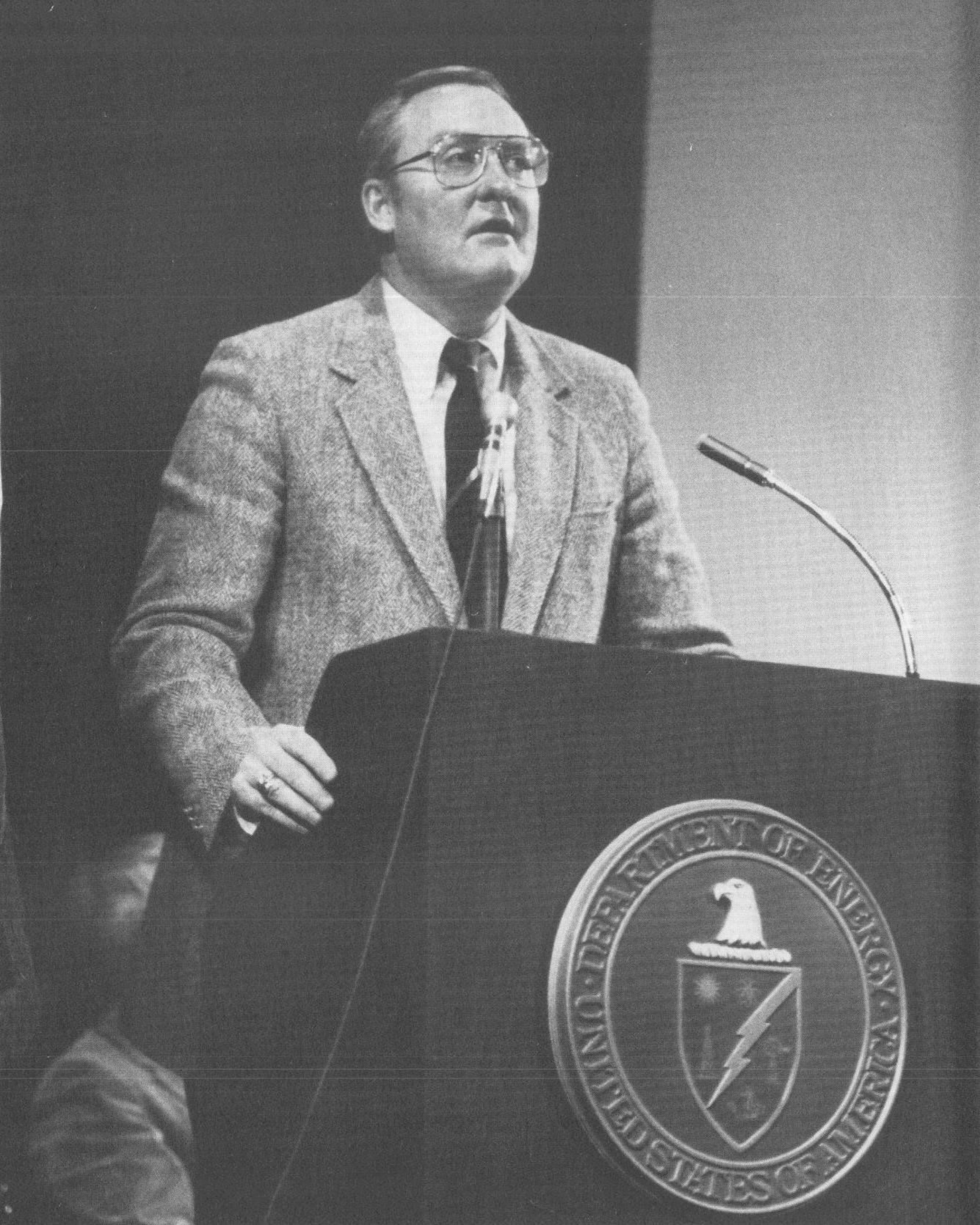
I didn't realize there would be so many doctors up here on the platform. You know, Chuck, you and I shoud be very impressed to be rubbing elbows with all these doctors. Years ago, in real life, before I went to Congress, I was a country banker. We used to put on a farm show every spring about the farm outlook and invite all the farmers. A constituent of mine, Earl Butz (I'm sure you remember that name, Earl Butz) was then Dean of Agriculture at Purdue University. Now Purdue University is just up the road about forty miles, so Earl Butz would come down every year and put on a show. And he really puts on a show, in case you've never seen Earl Butz. One year I introduced Earl Butz. Back then I had to introduce him as Dr. Earl Butz--that's before he got into politics. Now he's just Earl Butz. Then, I sat in the front row next to a couple of farmers. Earl Butz stood up there and told stories for about ten minutes. I had introduced him as Dr. Earl Butz and one farmer nudged the other and said, "That fellow up there a real doctor?" Second guy said, "Yeah, he is, but he ain't the kind to help you any."

We have the kind of doctors here and in this crowd that can help us. But you also can help yourselves. I hope I'm not preaching today, but I want to make some comments. Often you look to Congress for help. I know Dr. Trivelpiece and several others here have appeared before our Subcommittee, as well as before other committees of Congress, justifying the investment in our future that is being done by the research of the country. I don't know why Dr. Trivelpiece asked me to be here because I give him trouble. You know, as a layman, I ask him to explain all those fancy words that you tell us so I can go back home and tell my taxpayers how the dollars are being spent. I give him a lot of trouble, I must admit. But, we in Congress, either the Senate or the House, are extensions of you and we want to do what is right for the future of the country. But you, the people who know, can help our job by doing more backhome here, not just appearing before a subcommittee of Congress or the full Congress, which is important, but when you come back home you can talk to our constituents and explain to them the necessity of doing the research that is done here at Fermi, at Argonne, and at the other national labs and the universities. You can help us do our job by talking to the civic clubs, talking to the church groups, taking any opportunity to sell research for our country. Make my job easier, make life a lot easier for Dr. Trivelpiece so that when he comes before our committee, he doesn't have to answer all my questions. But we have a few in the Congress (I may use the word demagogue) who do not understand, or don't want to understand the value of research. They do not want to understand the great contributions that you in this room and others throughout the country and the world, have made so that we may live better and have a better life for each one of us and our children and our grandchildren.

I'm concerned about energy needs of the future, serving on the committee I do; when we do not build nuclear reactors today to generate electicity (we haven't ordered a new nuclear reactor in about seven years now and no prospects for the future) together with acid-rain legislation coming, where we will not burn that fine Illinois and Indiana coal. How are we going to produce the electricity for the future? It's a question, I think, that's more serious. What is the power source going to be for the nineties? Research by people like yourselves is going to be giving those answers.

So today, I am happy and pleased and honored to be a guest of Fermilab, to be invited to be here with you, to see the fine accomplishments of that idea that was developed a number of years ago as the Doubler, now known as the Energy Saver. There is much work to be done, working together. You who know how, helping tell the American people, the taxpayers, that it is necessary to do this with academia, industry, and government working in cooperation. That's how we'll solve all of our problems for the future. Congratulations to each of you and those on the stand here who have made today a reality. There is much work to be done. If there's to be a Doubler or an Energy Saver 2, 3, and 4 and others it's up to you in this room to help us in Congress to make it possible. Thank you very much for inviting me to be with you.




DEPARTMENT OF ENERGY
UNITED STATES OF AMERICA

Governor James R. Thompson
Governor, State of Illinois

Dr. H. Guyford Stever

Thank you, Congressman Myers. Our next speaker is the Honorable James R. Thompson, the Governor of the State of Illinois. Illinois has a large number of insititutions of science and technology of world class. The state donated the land on which this establishment has been built to the Atomic Energy Commission. Governor Thompson, during his term in office, has proven to be a very good friend of Fermilab and to science in general. We are grateful indeed to the State of Illinois and to Governor Thompson, and we're especially glad that he made it through that traffic jam.

Governor Thompson

Thank you very much. Thank you very much for changing the order of the program that I might attend. It's a very frustrating feeling to be sitting there on the Outer Drive in Chicago on a sunny Saturday afternon when nothing is moving your way and everything is flying by going north, with the construction on the Outer Drive to straighten out the S-curve, something that Chicago has been waiting for a number of years. It's the flip side of progress, which is delay in this case. But once into the helicopter, we came out here quickly and I'm very pleased that I could take a few minutes of this program because this is a very proud day for eleven and a half million people. This is one of the proudest possessions of this nation, and because it is located within the State of Illinois, a treasure of this state as well. It is renowned throughout the world and is in fact one of the federal assets in the State of Illinois that help contribute to our business climate and to our attractiveness for growth. I recently had the privilege of being in Europe with an Illinois investment mission. We visited Stockholm, Vienna, Frankfurt, Berlin, Paris, and London, seeking the investment of European dollars in the business community in Illinois. My job was to tell members of the European business community about the marvelous advantages of living and working and investing in Illinois. And of course no such speech could be delivered without references to the rapid advances and the diversity of high technology in this state and to the institutions which help make the state an attractive place in which to place such investment.

The Fermi National Laboratory, together with Argonne National Laboratory and the state's extraordinary network of university systems--University of Illinois, the sister universities within the state system around the state, the University of Chicago, Northwestern University, and IIT--all working together through institutions like Fermilab is an extraordinary asset. We take great pride in this Laboratory and in the work that has been done here for almost fifteen years. We also take pride in knowing that benefits of the research conducted here are not confined merely to the abstract. Congressman Myers, I sometimes feel like you do in trying to get past the fancy words and the theories of the doctors who can help us. But there are undeniable benefits of even the most abstract research done here. For example, the program refers to the side benefit of the research which went into the Tevatron being an improvement in NMR medical imaging. I think most people in the State of Illinois know that the Governor of Illinois has a back problem, a herniated disc, and arthritis too. In the diagnosis of my condition last fall, they used an NMR, the first, I believe, in the state. They scanned my back and found exactly what the doctors expected. An extraordinary advance in medical technology, performed on an out-patient basis; performed without any intrusion into the body. So it was a step forward for medical technology, though it came as a product of research in another field.

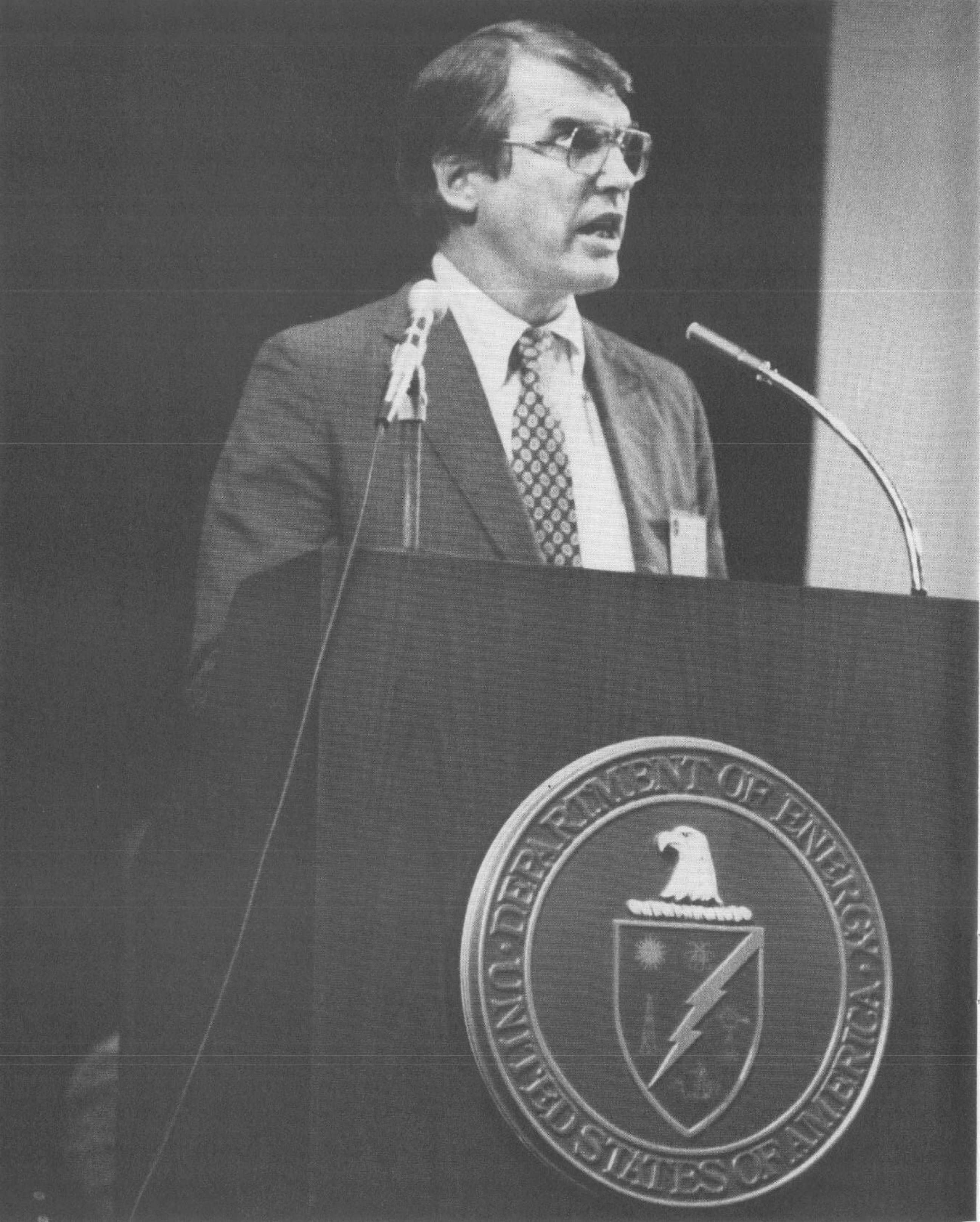
Congressman Myers mentioned the national problem of acid rain. It is one that confronts Illinois, Indiana and other states in the Illinois coal basin with a terrible dilemma, economic, environmental, and employment. We acknowledge that there are severe problems of acid-rain deposition and damage not only in the northeastern part of the United States but increasingly in the southeastern part of the United States as well, and in the Midwest. In fact, there are acid rain problems in Arizona, which the Arizonians tell me comes from automobile exhaust emissions that are in the atmosphere in California and blown over to Arizona. The difficulty we have is that the scientific evidence that seeks to link emissions from coal-fired burners in Illinois, Indiana, Ohio, Tennessee, Kentucky, Georgia, and all the other places that use our high-energy, low-ash, high-sulfur coal, is not 100%, four-square, for-sure, which immediately allows debate to spring up about who is directly responsible. What about the Canadians and what about primary sources in New England? What about sources of acid rain beyond what is created when you burn our coal? What about the 20,000 miners that would be put out of work and what about the towns that depend upon a mining economy? What about the railroads, the barge lines? What are we going to do about this? How much will it cost and who will pay? What kind of tax will be imposed to pay for $20 billion worth of retrofitting of coal-fired furnaces across the nation?

We strongly believe in Illinois that the acid-rain problem is real; the burning of Illinois basin coal contributes to the acid-rain problem without any question, although we question the degree of contribution. We in Illinois have a responsibility to help solve it. Rather than simply decry the problem, we are working actively in Washington, with the administration and with the Congress, to solicit support for taking the sulfur out of the coal before or in the process of burning. We believe that an increase of resources in research and development to desulfurize Illinois basin coal (not just Illinois coal, but Illinois-basin coal) will be of enormous benefit to the nation and we wish the nation would do more. We believe that for far too long the debate has gone on. We believe that we are pointing our dollars in the wrong direction, trying to ameliorate the damage once it's up the flue rather than taking it out in the course of burning or taking it out before the coal enters the furnace.

I talk about the problem of acid rain not because this is a coal conference but because this is Fermilab. Fermilab and its sister laboratory, Argonne, are important to us in our struggle in Illinois to assume our share of national responsibility for the solution of the acid-rain problem in a way that will benefit the environment, in a way that will benefit rather than detract from the economy of this region and indeed of the nation, and in a way that will help increase employment possibilities for our people. We have a proposal pending now within the administration to establish a national center for research in coal desulfurization here in Illinois. Argonne and, to the extent that it can help, Fermilab, would be an important part of that proposal, just as Argonne is an important part of the desulfurization research in which we are now engaged.

I know that the primary mission of Fermilab is basic research, but I also know that this work will ultimately pay off and provide the citizens of Illinois and the United States with a solution to the national problems involving the three big E's, Energy, Environment, and Employment.

If we can, working together with the scientific, governmental, educational, and political communities, bring to the people of America and to the people of the world answers to basic problems like acid rain, answers in better medical technology, as well as solving problems in fundamental physics then, Congressman Myers, I think people of America will be glad to fund institutions like this around the country and to fund increased research around the country. They won't have to worry about fancy words; they'll have results and in Illinois with partners like Fermilab we mean to get results. Thank you very much.


DEPARTMENT OF ENERGY
UNITED STATES OF AMERICA

Dr. George A. Keyworth
Science Advisor to the President

Dr. H. Guyford Stever

Our next speaker is the Honorable George A. Keyworth, Science and Technology Advisor to the President of the United States and Director of the White House Office of Science and Technology Policy. Along with Dr. Knapp, he has, in my somewhat biased opinion, one of the two best jobs in government. Jay Keyworth has indeed been a discerning and effective supporter of basic research. His broad understanding of science stems from his long service as an experimental nuclear physicist at the Los Alamos National Laboratory.

Dr. Keyworth

When I first took my current job as Science Advisor, I was forewarned about an important bit of Washington numerology. The older hands said that in years divisible by four, people in Washington are gripped by an uncontrollable urge to look at events in retrospect. They're right, of course. In our society, for better or worse, we measure many different kinds of progress on four-year cycles of national policy. Even what we pretend is that wonderfully isolated world of science is influenced by those quadrennial rhythms--though I like to think that science exerts as much or more influence in the other direction as well.

But even if this weren't an election year, it would still be a fateful time to take stock of U.S. science and technology--and to take stock of physics. Events over recent years have produced profound changes.

If I had to identify a single stimulus that dominated the past four years, it would be the competition--both real and perceived--that we've faced from other countries. And I'm not speaking just of the obvious competition of foreign industries. We've seen similar challenges in the area of national security, and we've seen them in science. Certainly a great deal of our focus in the White House Science Office has been on finding ways to respond to those challenges and stimulate competitiveness in **all** kinds of American institutions invloved with science and technology.

Looking back, we can see that as a society we were really poorly prepared for the onslaught of foreign industrial competition in the past decade. I think we had simply **assumed**, as a given, that American institutions and practices were inherently optimized to compete successfully. That assumption, which had always seemed self-evident in the past, was largely formed during the years when we could essentially take for granted the American competitive advantages--in our industries, in our military, in almost everything. Well, we got caught up short.

As a result, in the 1980's we're undergoing an important test of our national character--a test of just how determined we really **are** to compete. It's no secret that only a few years ago a lot of people who should have known better--but who were perhaps unused to the rough and tumble of **serious** competition--let this new era rattle them, sometimes very badly.

I think the example of the 64K RAM illustrates just how shaky our confidence had become by the early 1980's. Fueled by alarming reports in the papers and even in the business publications, we came to think the U.S. was about to abandon the microelectronics business because Japanese manufacturers had stolen a march on the market for those 64K memories.

In the Chicken Little hysteria of those years two points were overlooked. First, the Japanese were succeeding in that market not because of a unique technological edge, but because they had guessed right about a market that was about to expand rapidly. During a recession they had gambled and built up manufacturing capacity--while American manufacturers had not. The other point was that American technology was **hardly** beaten. At the height of the hand-wringing, the late, lamented telephone company was already quietly getting ready to mass-produce 256K RAMS, which have now been made in quantity for two years. Now IBM reports that it has made an experimental one-megabit RAM, but using a current manufacturing line, not a laboratory. Moreover, within a few years we expect an American industrial cooperative venture to be producing four-megabit RAMs.

But such things weren't perceived then, and even some of our strongest industries became part of the pilgrimage to Washington to argue for protection--for excluding competitive foreign products from the American market. We even heard some similar agruments urging that we further protect our domestic economy by restricting the importation of brains as well, by imposing stricter immigration restrictions on highly trained scientists and engineers. In truth, the main protection that any of those schemes would bring us would be protection against progress.

Well, Chicken Little, if we can excuse her excesses, did focus our national attention on the very real competition we were going to be facing from now on. The sky wasn't falling when we finally looked up, but we did see threatening clouds on the horizon. So with the chicken back in the coop, we began to sense a significant change in our national mood, a change from initial disbelief and despair to one of growing optimism. It's no coincidence that the most popular book of the past few years has been **In Search of Excellence**, a review that reminds us that the best-managed American businesses have been and continue to be among the most competitive in the world.

I still worry, though, about how much we've learned, as a society, from the past few years. I do think much of industry itself, on the front lines, has clearly recharged its batteries and is ready to go head-to-head with any and all competitors. But I have some serious reservations about whether the rest of society has really absorbed the lessons of the past few years--or whether we've already forgotten the concerns of yesterday. Let me offer just two examples that illustrate the reasons for my concern.

Over the past several decades the taxpayers of the United States have financed **billions** of dollars of basic research in molecular biology. Although this was done largely as an investment in pure knowledge, it happens to have been a very **good** investment--and it led to today's emerging biotechnologies. By all rights, if **any** industry ought to be dominated by the U.S., it's biotechnology. But what's the reality? From what I read in the papers we seem to be working overtime to find reasons **not** to exploit this knowledge. We're still suffering from the self-indulgent attitude that technology, rather than being the way to multiply human effort and make lives better, is inherently undesirable.

So, for example, even in the face of rising biotechnology industries in other countries, a lot of people in **our** society seem more intent on handicapping our own efforts with regulatory burden than they are intent on stimulating biotechnology's growth. Incredibly, there's still a kind of "start the next industrial revolution without us" attitude among many people in this country, as if these opportunities are so common that we can afford to pick and choose how we'll make our fortune.

My own opinion is that much of today's debate has gone far, **far** beyond questions of legitimate caution. In general, we pay too much heed to the professional critics of new technologies--the people with ideological axes to grind--and not nearly enough to our own common sense. All I can say is that if Henry Ford or the Wright Brothers were operating in today's climate, they might well have decided to become lawyers rather than try to get their life-threatening and environmentally hazardous products licensed for use.

I'll offer another example of how far we still have to go to convey the urgency of competition to our society. In New York State we may be about to see a never-used, four-**billion**-dollar nuclear power plant abandoned because of a dispute over evacuation procedures in the event of a nuclear emergency. Four billion dollars! How can a nation that torments itself over the problems of failing industries, inadequate schools, and the need to cut federal programs because of a deficit, stand by and watch that kind of investment go down the drain? Yet it may happen.

Well maybe we **can** afford that particular four-billion-dollar waste, and maybe billions more. But what we **can't** afford is to continue living with the attitude that lets us pay lip service to competitiveness and then tie cans to the tails of those who are trying to compete.

Now what, you may wonder, does this have to do with high-energy physics? If you'll bear with me for a few minutes more, I'll show you. It has to do with national direction and national commitment.

Consider Japan, which is, after all, **the** industrial competitor that challenges us most strongly. Decades ago Japan, as a developing nation, identified a national goal and then pursued it consistently. And today, even though Japan has joined the ranks of highly developed nations, it retains much of that lean and hungry attitude of a developing nation. Japan's goal was and is to develop industry geared to the profitable export market. That was its target, and Japanese institutions were optimized for that purpose.

So how do we compete industrially with Japan? Do we adopt its goals? Do we copy its methods and institutions? Of course not. We're not Japan; we have our own strengths to draw on. **Our** standards should be the best the U.S. can do, not the best Japan can do. And most of us know, instinctively, that we fall far shorter on the scale of our **own** potential than on any other scale.

So just as the Japanese targeted exports as their national focus, I believe the United States--as a nation--should be targeting competitiveness itself as our focus. If we intend to remain the leader of the free world, we have to reassert our industrial leadership and set the mechanisms and attitudes in place to maintain that leadership. First, we have to remember that we **have** the capability to create a future for our children that's every bit as rosy as the future we were presented with. Then, armed with that outlook, we have to build on our strengths.

If we're **going** to build on American strengths we have to have a firm fix on what they are. In fact, we **do** have a tremendous advantage over every other nation. Quite simply, we have the world's best science and technology base, the kind of base that year-in, year-out produces remarkable advances. It was no accident that in 1983 all the Nobel Prizes in the sciences were won by Americans; our success over the years has remained consistently high, with U.S. scientists capturing about 70 percent of all Nobel science prizes over the past decade. And to those people who point out that these prizes, for work done years ago, tell us little about the health of today's American science, I would emphasize that the trends have, if anything, shown an increased domination by American scientists over recent years. We have never been stronger.

In fact, it's appropriate to say that we truly possess a treasure house of science and potential technology. But in light of that resource, we do a generally pretty miserable job of taking advantage of it. Somehow, during those booming years when we made jokes about Japanese technology, we let a substantial barrier develop between the pursuit of science and the application of technology.

Well, the nation has made some impressive progress over the past few years in identifying mutual interests between the thinkers and the doers. And the federal government has taken big steps to solidify and extend our traditional strengths in talent and in knowledge.

I assume by now that most people are aware of the very high priority the Reagan Administration has given to science and technology. However, it never hurts to belabor the obvious. So let me just emphasize that next year we expect to see overall federal support for R&D rise by 14 percent over the current year. This year's actions bring the overall **four**-year increase in federal R&D top 52 percent. Within that category, basic research has grown by 55 percent, which makes it, after national security, the second highest priority element of the federal budget. It's evident that we're seeing very real increases in the resources being devoted to producing new knowledge.

The implications for competitiveness of this investment in basic research are straightforward. American industrial leadership can no longer rely on unique or inexpensive material resources or on a large pool of low-cost labor. Our industrial strength rises or falls on our ability to **generate** and to **use** knowledge. That means our industrial present and our industrial future is people-based. It begins in the schools and is critically dependent on the continuing flow of ideas **and** people from them to the rest of society. To create a productive and supportive environment for American economic progress, we have to pay heightened attention to developing new knowledge and new talent--and to making better use of both.

The administration has taken a variety of steps to bring this about--both directly and by joining forces between government and the private sector. These steps include today's high priority for university basic research, which permits the first-class training of tens of thousands of graduate students each year. They include incentives and stimulation to help the federal laboratories--which spend $18 billion each year on R&D--work more productively with industry. They include the new Presidential Young Investigators program to attract and retain desperately needed new university faculty in fields with high industrial importance. They include innovative industry/university engineering centers to permit broader and more realistic research and education on the campus.

But I can't think of any action we've taken that has more long-term importance for our nation's competitive spirit than our forthright commitment to the most challenging fields of basic research. That research is the spark that makes our universities the best in the world. That research is the inspiration that draws the most creative young minds into the world of science and technology. That research is the challenge we issue not only to ourselves, but to the rest of the world as well.

That doesn't mean we try to do everything, but it does mean we try to be best at what we choose to do. A few years ago, when I offered that philosophy to the science community, I set off alarms that rang for years. I was accused of suggesting that the U.S. was going to withdraw from its role as world leader in science. Apparently I broke a rule: I wasn't supposed to admit that we scientists can and **do**, in fact, establish priorities for research to be supported. Viewed from 1984, it's hard to remember what all that commotion was about. The fact is that over the past three years we **have** exercised more selectivity in spending federal funds on science--and by doing so we established the basis for becoming even stronger world leaders in science than we were then.

During that period physics--especially nuclear and high-energy physics--has seen some healthy turbulence--as well as healthy growth. The administration has relied heavily on the recommendations of the physics community itself to set goals and funding levels. In high-energy physics, we were all well-served by HEPAP. And I suspect we were also well-served a year ago by the discovery of the Z^0 particle at CERN. It reminded us, if not with a jolt, then with a sense of foreboding, that physicists working elsewhere in the world, including American physicists, were pushing hard at the frontiers of science while we wasted time, money, and creative energy in the mire of institutional and facilities squabbling.

Well, what a difference a year makes. The U.S. high-energy physics community has since put its affairs largely in order. We now enjoy and are in a position to profit from a relatively strong sense of unity, with a consensus on priorities for new experimental facilities. Presented at last with that consensus, the adminstration has responded enthusiastically. Tomorrow, we dedicate the Energy Saver here, and over the next few years the Tevatron will reach its target levels. We're moving as fast as possible to complete the Stanford Linear Collider. And we're getting ready to begin serious R&D on the SSC.

Moreover, we're also embarking on what's bound to be important new research in that formerly neglected realm between nuclear and high-energy physics. Both the heavy-ion experiment at Brookhaven and the new electron accelerator at Newport News promise real excitement a few years from now.

But let's focus for a few minutes on the far end of the spectrum--on where high-energy physics is headed. Let me repeat what I wrote just a few weeks ago in an article in **Science** Magazine. I said that particle physicists ask questions of nature that are in many ways the most fundamental of all, and the answers may just be the hardest to find.

But in spite of the important direct applications of knowledge first derived from this kind of front-line physics, the field is important as much for the way it attracts and stimulates human intellect. Particle physics--or, for that matter, fields like astrophysics, or Molecular Biology, or mathematics--are stimuli for our broad national strength in science and technology. But of those fields particle physics--as you know and as I **certainly** know--requires the most elaborate and concentrated facilities.

Well, particle physics is clearly approaching a critical period. To be sure, for the next decade or so, our planned developments will suport a tremendous amount of exciting research. But our steady progress toward a grand unified theory points inexorably towards an experimental probe of unprecedented scale--the supercollider.

For obvious reasons, one of our challenges is to design a supercollider that's affordable. That's going to take considerable ingenuity. SSC represents a fundamentally new concept; we can't get there by simply extrapolating from the past. SSC is far more than just the next step in a predetermined sequence of ever-larger accelerators.

We all know that the physics community, like any science community, would prefer to focus its efforts on so-called pure research, expanding its sphere of knowledge. But if we expect success on a supercollider, we'll also have to devote substantial research efforts to making its objectives clear and attainable.

Simply put, we'll have to change the way we've been used to thinking about physics facilities. And if there's one thing I've learned in my term in Washington, "change" is the number one enemy to the seat of **real** power--the bureaucracy. But, in spite of occasional contrary evidence, I'd like to believe that we scientists continue to reject the mediocrity that results from resistance to change. We have to realize that SSC won't be just another national big-science facility. It won't be an updated version of Fermilab, and it won't be the result of a single institution's efforts. The SSC design challenge is far more than just choosing between niobium-titanium or niobium-tin. That may be a necessary part of the job, but as IBM or AT&T or Apple would be quick to tell us, big challenges demand big leaps in thinking.

Moreover, we're talking about a **national** effort, one bearing marked resemblance to the Apollo project, albeit on a smaller scale. Ultimately, like Apollo, it's going to require cooperation and integration between the scientists who intend to use it and the technologists--many from industry and from unaccustomed disciplines--who will be full partners in this effort.

And, as in the Apollo project there are many perspectives as its ultimate value. Apollo was a response to competition, primarily to our national security, but also to our national pride. The supercollider will also be a response to competition, but more to a competition that challenges our creative vitality and our commitment to intellectual excellence. As I said earlier when discussing our nation's response to industrial challenge, SSC should be the embodiment of our national commitment to excellence.

There's going to be only one supercollider in the world. And wherever that turns out to be will become the international center for much of experimental physics, a place that draws the world's best minds to it. It's going to be a creative hub for a generation of new scientists--and I think persuasive arguments can be made--and must be made--for having it in the United States. But let me add--persuasive agruments will **have** to be made. We've got to work to achieve a design that's commensurate with the challenge we confront. And we've got to convince the American people, the people who will be asked to pay for a substantial portion of it, that it serves their national interests.

So if we expect to have SSC we have to make it a national effort, not unlike the proposed new manned space station. In all candor, I don't think the physics community yet appreciates the magnitude of the job they have before them. It's been the better part of a year now since we achieved unification behind SSC, but we should really question whether that time has been used wisely.

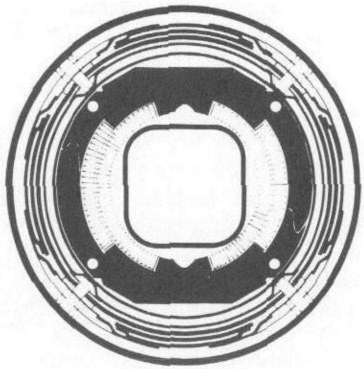
If anyone thought that the decision by the physicists to agree on priorities was the only hurdle to cross in the development of SSC, then you don't realize the intensity of the times we're in. Because the real decisions won't be made by physicists at all. Take it from one who has now had an illuminating post-graduate course in reality--it takes more than a vote by HEPAP and a receptive ear or two in DOE, the White House, and Congress to mount an effort like SSC. It takes years of preparation, not just of the technical design but of the public rationale as well.

What are you going to answer when, say, the biotechnologists or materials scientists ask you why physics of this magnitude deserves their support? Because you'd better believe that your're going to need their support before your job is done. And how will you answer those same questions about priorities and needs when asked by the Congress, which is also juggling urgent requests from that other 99 percent of the world outside of science?

My message, which I realize I'm repeating, is that if you sit back and wait for someone to deliver SSC to the physicists you'll never see it. You need to develop and refine a clear rationale for SSC that articulates not just the excitement of physics but also the importance of creative research and scientific discovery to national aspirations. SSC can, and should, be justified as a means to achieve excellence, not as a logical next step in an entitlement program.

Now, none of this emphasis on what the American Science Community must do is meant to preclude what I would hope will be significant participation by other countries too. We **know** foreign scientists will be an integral part of the research community using SSC; that goes without saying. We also want to benefit from their creativity in the construction phase as well. We've already been talking to our foreign colleagues. I recently visited Japan expressly for the purpose of inviting their interest at this earliest stage of our planning. Moreover, I hope that in the course of the London Economic Summit, we'll have further discussions with our European Partners.

Let me conclude by coming back to the theme I think is so important. To you in the physics community, SSC represents something very specific--an experimental tool for probing the structure of matter at very high energies. But SSC can, and should, also represent something more fundamental. It should be concrete evidence of our recognition of the value of new knowledge. It should be a statement to our youth--the ones we'll depend on to maintain our scientific leadership in the future--that as a nation we value creativity, not just in physics but in all areas of science. And it should be evidence to ourselves and the rest of the world of our commitment to excellence in what we choose to do.




DEPARTMENT OF ENERGY
UNITED STATES OF AMERICA

Dr. Danny J. Boggs
Deputy Secretary of Energy

Dr. H. Guyford Stever

Our principal address today will be given by the Honorable Danny J. Boggs, Deputy Secretary of Energy. Secretary Boggs, prior to his assumption of the Deputy Secretaryship served as a Special Assistant to the president and Assistant Director of Policy Development in the White House. His areas of responsibility covered agriculture, energy, natural resources, and environment. Prior to joining this administration, he had extensive experience in legal, policy, and press relations with several units of government including the Federal Power Commission, the senate Committee on Energy and Natural Resources, and the solicitor General's office. He has engaged also in private law and consulting practice and was Administrative Assistant and Legal Counsel to the Governor of Kentucky where he is a member of the Kentucky Bar Association. It gives me great pleasure to introduce the Honorable Danny J. Boggs, Deputy Secretary of Energy.

Dr. Danny J. Boggs

Thank you Dr. Stever, Governor Thompson, Senator Percy, Congressman Myers, Director Lederman, dais guests, and ladies and gentlemen. I'm certainly proud to be here today on behalf of Secretary Don Hodel, to be dedicating this marvelous machine. Coming from Washington, where sometimes immense amounts of political effort fail to result in any visible benefits or any visible results, it is a great pleasure to be here to celebrate this achievement, which has been carried through in spite of difficulties--intellectual, technical, financial--which has been carried through to success.

I had not intended to tell this story, but Dr. Saxon at lunch opened the subject of the theoretical and the experimental, and I noticed that, where relevant, as each person on the dais was introduced, there was attached a label of either theoretical or experimental, sort of like "skins and shirts" in basketball. And knowing that this machine and this success was in fact brought about by the work of theoreticians and experimentalists and engineers, it seemed perhaps relevant. The story is told that a competition was set for a mathematical proof that all odd numbers are prime. And the first entry that came in, was opened, was from a theoretical mathemetician, and it said, "3 is prime, 5 is prime, 7 is prime, so by induction they must all be prime." The second entry, from an experimental mathematician, said, "3 is prime, 5 is prime, 7 is prime, 9 is experimental error, 11 is prime, 13 is prime, and so by induction..." The final entry, from the engineer, said, "3 is prime, 5 is prime, 7 is prime, 9 is prime, 11 is prime, 13 is prime..." So that story is probably a libel on all three of those groups, but I think it also indicates that each of them has their strengths and weaknesses, and we are pleased that all of them have participated in and been instrumental in bringing our modern scientific achievement to the point that we have today.

In thinking about the make-up of the universe, the ancient Greeks believed that all matter was composed, as Dr. Stever has told us, of earth, air, fire, and water. This view persisted for more than 2,000 years. Now, today, our basic research people tell me that matter is composed of gluons, leptons, quarks, and photons, in all kinds of combinations and interactions. They say that particles call W (plus or minus), and Z (zero) have now been added to the list, and that there are intricate symmetry relationships among all these particles, and that these will not only explain how the building blocks of matter became the atoms and molecules that we learned about in lower school, but also will explain what happened at the creation of the universe.

Well, maybe.

That's a pretty tall order. The Greeks tried to put the whole picture together too, so we're in good company.

But more seriously, I've been the Deputy Secretary for only about six months, and I confess that I haven't had time to catch up on all of particle physics. I'm not sure that I ever will, even with the best of tutors, who have certainly been trying. But I must say from what I have seen of our basic science activities so far, it is clear that the Department supports a truly impressive array of programs that includes some the best basic research and facilities anywhere in the world. The Department is proud of these efforts and strongly endorses them. Indeed, the Administration and the Congress both recognize that this work is important, not only in continuing man's historic quest for knowledge, but also in providing our society with many practical benefits.

Many people are unaware of the extensive relationship of the Department with basic science--they just think of DOE as the agency that, in an earlier decade, brought you gas lines. But, actually DOE is a very diverse collection of activities. In addition to being a major Federal sponsor of basic science, we store oil in the Strategic Petroleum Reserve; we produce oil from the Naval Petroleum Reserve; we distribute electrical power across the Northwest; we enrich uranium for the world's utilities; we provide nuclear weapons for the Nation's defense; and we support a wide range of basic and applied research on energy technologies, from coal to solar to fusion.

In many respects, the DOE laboratories are the core of all of these efforts, and the intellectual vitality of the laboratories is central to the success of our various missions. The work of this Laboratory is part of a long-standing tradition of excellence in science that has been a hallmark of DOE and its predecessor agencies for more than 40 years.

Our present-day achievements in basic science build upon the efforts and inspiration of many pioneers of science in America. The history of modern science closely parallels that of our Nation. Twenty-five years before the Declaration of Independence, Benjamin Franklin, in the space of less than six years, made several classic discoveries about the nature of electricity that foreshadowed the discovery of the electron 150 years later. Seventy-five years after Franklin's experiments, while we were vigorously exploring our geographic frontiers, Joseph Henry discovered the principle of electro-magnetic induction--the relationship between electricity and magnetism. And some 50 years later as our age of geographic exploration was drawing to a close, J. Willard Gibbs was developing the principles of statistical mechanics that underlie much of our modern science. At the same time, Albert Michelson, our first Nobel Laureate, was beginning the studies of the speed of light and the search for the ether that would profoundly alter our ideas about electromagnetism and light. Science was already a thoroughly international endeavor, and ideas flowed across the Atlantic as the European scientific tradition matured.

While Michelson's research continued at the University of Chicago (a great university which has had and continues to have a strong and productive relationship with our Department through Argonne, Fermi, and elsewhere), while that continued, the founders of DOE's scientific tradition, E.O. Lawrence and Enrico Fermi, were growing up in South Dakota and Rome. It all happened--almost--overnight.

This is not meant simply to display historic scholarship but to make a fundamental point. The concepts of the Greeks endured for 2,000 years. The building of modern science took about 200 years; the development of nuclear science took only 40 years. These developments have accompanied a remarkable transformation of human existence. The pace of change in our scientific understanding during the lifetimes of Lawrence and Fermi was phenomenal. There are those of you here today who knew both of these men, and you yourselves, contributed to the momentous events with which Lawrence and Fermi are associated. This Laboratory grows upon, and builds upon, the eagerness to continue to search the frontiers. This dedication today indicates--by example--that the pace of change continues to accelerate.

At the end of 1967, some 37 years after Lawrence's invention of the cyclotron and 25 years after Fermi's demonstration of the chain reaction, Atomic Energy Commission Chairman Glenn Seaborg noted in his diaries:

> Design work began on a 200 billion electron volt accelerator to be built near Chicago which will enable the United States to maintain its preeminence in the field of high energy physics.

The energy of the accelerator has now doubled, and doubled again, with further upgrades in progress. But the goal is still, as Seaborg stated it in 1967, that it "...will enable man to attack, in depth, the most fundamental problems regarding the structure of matter." And that tradition of pioneering in science continues.

Lawrence and Fermi were, in a true sense, founders of the age of nuclear science. Not only the art and science of building accelerators and using them for discovery, but also the style of work that is needed for success. The Energy Saver is the latest, but by no means the last creative step to draw upon their example. It must not be forgotten that even though such research has been primarily motivated by curiosity about the unknown, it has led to major technological advances and important benefits to society. In a few days time our Department will be honoring two outstanding scientists with our Enrico Fermi Award, the highest scientific honor we present. This year the winners are not physicists, but a biologist and medical doctor. Alexander Hollaender contributed much to the foundation of radiation biology, from the building of the knowledge base and its institutions, to the extensions of its insights to other medical and environmental fields. John Lawrence, the brother of Ernest, is widely regarded as the father of nuclear medicine, which has revolutionized health care through techniques for diagnosis and treatment.

Work in these fields has been enormously beneficial to society, yet few of those who receive modern medical care appreciate or recognize their connection with the physicists who invented the cyclotron and the nuclear reactor.

Today, we are well into a new age of particle physics. From what I am told, the last decade or so has seen a major change in fundamental concepts. On the one hand, it is possible for physicists to talk about a standard model, as if all problems had fallen into place. While on the other hand, discrepancies abound. This machine will open new doors and explore a new world.

The pioneers of nuclear science established a new style of science done on a wholly different scale than that of the small group or the individual investigator. Fermilab typifies this change. This wonderful machine is tended by whole platoons of operators and technicians. Experiments take years to prepare and require teams involving collaborators, often from many nations. Al Trivelpiece tells me, you come here at 3 a.m. and always find people, busily at work in the control room and in the experimental labs.

I understand that even before the earliest version of this accelerator began its operations over 13 years ago, initial plans were laid for the vastly enhanced accelerator that we dedicate today. The superconducting magnets, sophisticated computer control, large-scale cryogenic refrigeration, and other advances were yet to be demonstrated, let alone proven. But your leadership had the foresight to look ahead to those achievements. Those achievements require hard work and tenacity, and can only be done through the efforts of many, many dedicated people. This Laboratory has had two outstanding leaders, Robert R. Wilson and Leon Lederman, who have had that drive and foresight to make this project a success. I am also told they have been very good at twisting arms in Washington, but that was all before my time.

Fermilab also illustrates the unique and effective partnership between government and science in this country. After all, the Laboratory is operated by a consortium of universities, not by the Government. It is part of a national enterprise that is guided by external seientific advice. Its research priorities and allocation of effort are set internally on the basis of peer scientific judgment, and not from the outside. Scientists may come from many universities and nations, with few restrictions and limitations. The Laboratory has made special efforts to contribute to the education of students, the employment and education of minorities, building bridges to lesser developed countries, and the transfer of technology. We at DOE recognize the importance of nurturing and encouraging such efforts. This Laboratory has contributed much to the society that pays its bills. It has proven to be a worthy citizen.

As to the future, we all look forward to the new scientific territory that will be explored by the Energy Saver and the subsequent experimental programs of Tevatron II and Tevatron I. There are sure to be many scientific landmarks and milestones ahead.

But there are also cautions that we in government must continually address if we are to preserve this partnership. Science and technology are cornerstones of our future economic well-being and competitiveness. As such, they deserve our careful attention and continuing review to see if we are going in the right directions. Sometimes, however, this results in a tendency to "pull the carrots out of the ground to see if the roots are growing." We need to have a long-term perspective that recognizes several essential aspects that tend to be overlooked in the hustle and bustle of our annual budget process, periodic elections, and recognition of economic conditions.

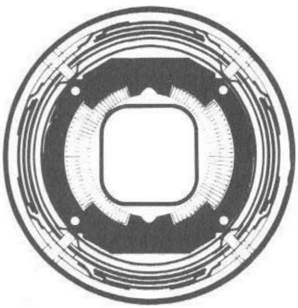
The first of these cautions is the peril of asking, "What breakthroughs have you planned for this year or next year?" Basic or fundamental research and even, to some extent, applied research, need to be rather loosely directed and allowed to rely mainly on the curiosity of scientists and engineers. We must not press for instant payoff.

There is a natural, if regrettable, tendency for those in government to look for results at about the time we are putting together the next annual budget, and sometimes for others to promise results about the time we are putting together the next annual budget.

Second, we must continue to recognize that science is a long-term proposition, and that the attraction of gifted young people into science is crucial to our future success. We must make sure that the excitement of discovery still challenges the imagination. And to do this, that excitement must reach not just the graduate students, but also the citizens of this nation.

Third, we must recognize that the future may call for new and innovative approaches to large-scale science. The next generation of devices, in this field as in some others, may call for international collaboration on a greater scale than ever before. New types of arrangements may be needed to bear the cost of the next wave of knowledge that properly will aid and belong to all of us. That next wave and all the knowledge that comes after, will be the means to the continued improvement of the condition of mankind. Today we are so often told that we are doomed from too much of this poison or too little of that resource. These voices have been heard in every generation, although only recently backed by spurious computer programs. They have always been proved wrong, though, where men and women were free to work, to innovate, and to improve. I am confident that if we can maintain a free society and free scientific inquiry, the future for our grandchildren will be seen as a great advance based on our efforts, just as we look back gratefully to the work of those who went before us.

I would like to close by sharing with you the thoughts of Energy Secretary Hodel in a letter to Dr. Lederman, the director of this Lab. I can only add my own contratulations as well. Thank you very much.



THE SECRETARY OF ENERGY
WASHINGTON, D.C. 20585

April 23, 1984

Dr. Leon Lederman
Director
Fermi National Accelerator Laboratory
P.O. Box 500
Batavia, IL 60510

Dear Dr. Lederman:

Fermilab is one of those rare places where unusual combinations of talent and resources come together to explore the outer limits of what we know about the world on which we live and the universe in which it exists. It is a place where excellence abounds, and curiosity is the order of the day.

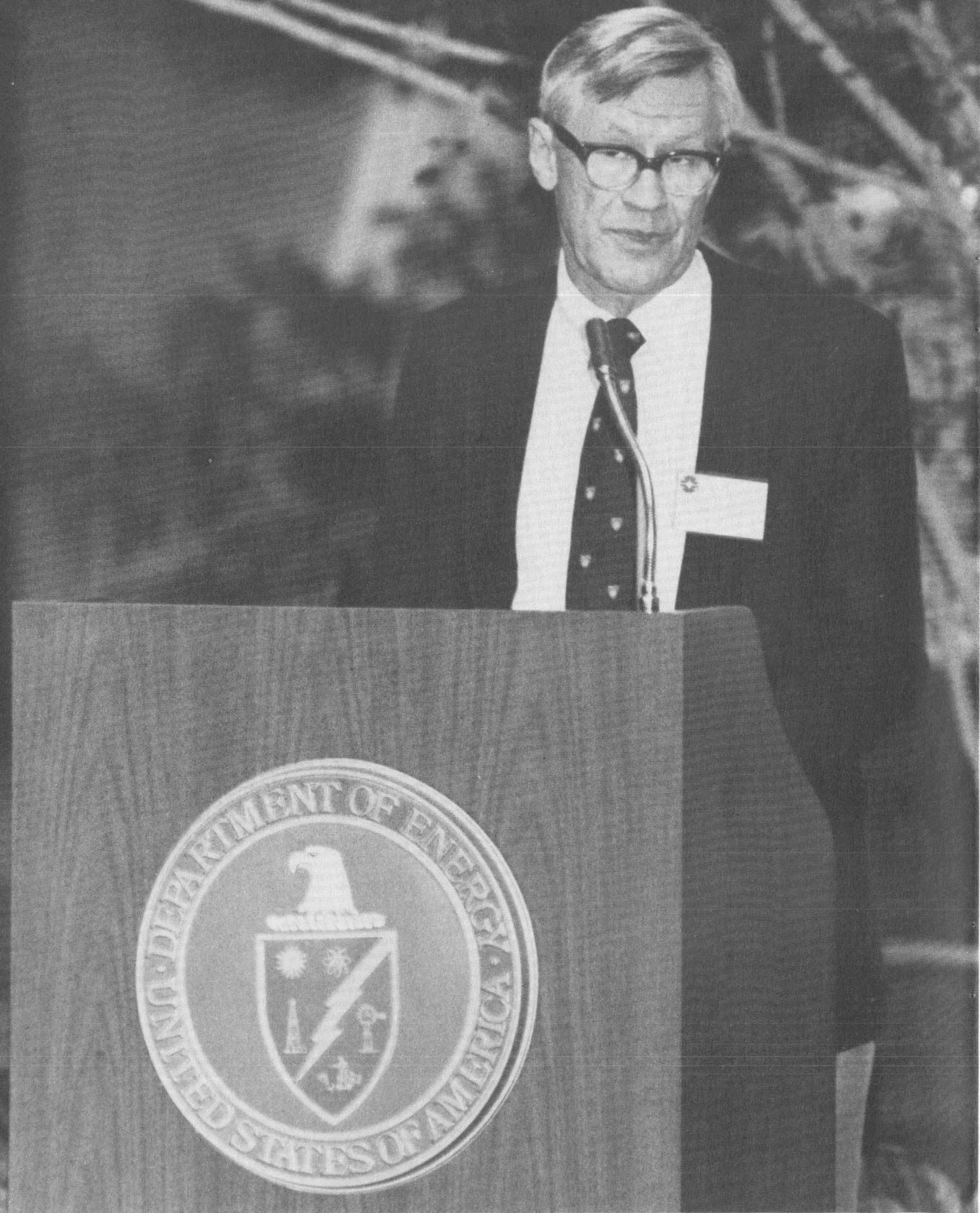
Today, you dedicate the completion of an improvement to Fermilab that gives it a new capability that not only represents a great technology accomplishment, but also breaks new records of particle energy. This Energy Saver project is an important milestone for Fermilab. It could not have been accomplished without the commitment of all who have worked to make it possible. The imagination to conceive of such an idea and the tenacity to see it through its many phases to completion demand a commitment to the pursuit of knowledge that I believe is one of the ingredients that has made our Nation great.

This is a happy occasion and recognizes an accomplishment for which all of you at Fermilab, your collaborators, and contractors can be justifiably proud. I am sure that this is just the beginning of many important scientific contributions. Congratulations on a job well done.

Sincerely,

Don Hodel

DONALD PAUL HODEL


DEPARTMENT OF ENERGY
UNITED STATES OF AMERICA

Science: Its Promise and Problems*

Dr. David S. Saxon
Chairman of Corporation,
Massachusetts Institute of Technology

It is a pleasure to be here and to see so many old friends. And it is a special pleasure to be here when there is so much to be happy about. As a fellow physicist, I take pride in your accomplishments. I can feel your anticipation at the physics this important milestone will make possible. What's more, even though it's been a time since I've actually worked as a physicist, my interest in the profession and my joy at its advances remain an essential element in my life; so I'm particularly delighted, and honored, to have a part in this celebration.

High-energy physics is in the midst of exciting and profound developments--both experimental and theoretical--that have already altered our views of the basic forces and elementary constituents of nature. The key discoveries of the past decade have intensified our hopes that we have at last identified a set of new and indispensable concepts, concepts essential for the understanding of nature at its most fundamental level--at least at the most fundamental level presently accessible to experiment and observation.

Many of us have been troubled because of the more recent of these developments, on the experimental side anyway, have mostly occurred elsewhere--in Geneva and in Hamburg, not in Batavia and in Palo Alto. And yet, if we step back and take a longer view, we can justifiably take pride in the fact that over the last three decades and more, most of the key discoveries which led to these developments were made in the United States. That didn't just happen. It required a conscious and deliberate marshaling of resources--intellectual, physical, and political--and a profound commitment to the idea that to understand nature is to respond to one of mankind's deepest needs. The Energy Saver we dedicate today is a magnificent example of that commitment.

In recognition of this achievement I begin these remarks by paying tribute on behalf of the science community to the great collaborative effort that has made it possible--starting with the several distinguished elected representatives here and the representatives from the key Federal agencies--the NSF, the OSTP, and above all, of course, the DOE, represented here by Secretary Boggs and Dr. Trivelpiece.

*Luncheon address

Besides this indispensable support of Government, the facility is a superb example of laboratory-university-industry collaboration at the cutting edge of technology. The muscles, sinews, and nerves of the machine--the various special quality metals, the helium refrigerators, the radiofrequency components, the microprocessors, the control electronics, and all the rest--depended absolutely on reliable and brilliant contractors from the private sector.

Finally, as one from the outside science community--but from an institution (MIT) that is part of the Fermi community--I offer special congratulations to Dr. Stever and his associates in the Universities Research Association, the fifty-four universities that comprise the governance of the Laboratory, as well as to all those right here in Batavia who, after a decade of research and development and construction, can now look back upon an enormously difficult task extraordinarily well done. And among those on the home team, I must mention in particular, of course, Leon Lederman, your Director, and that original, indomitable and ingenious spirit, Robert R. Wilson, your Director Emeritus.

And so now we have it--and the world has it--the Energy Saver, a super-exotic, super-sophisticated, super-low temperature, superconducting facility, altogether a **super** achievement, that by exploiting the potential of the state of superconductivity, has accomplished a substantial forward leap in accelerator development. In terms of energy, this machine has put the United States back on a par with, and eventually ahead of, the facilities in Switzerland at CERN. "Discovered at Fermi" has a **nice** ring to it--not better, perhaps, than "reported at CERN"--but decidedly nicer.

But there is more to physics, that indispensably experimental science, than experiment. Indeed, I must admit that, as a former theoretician, I view theory--naturally--as providing the essential framework for the description of nature.

Having said this, I should explain to the nonscientists here that there tends to be a bit of difference between the perspectives of the theoretical physicist and the experimentalist. Physicists know that--and probably know as well this story, which I heard from Frank Yang and which serves to illustrate that difference:

> Traveling salesman, suitcase full of dirty shirts, was delighted to see a sign in a window: "We Wash Shirts. "Marvelous! But when he offered his suitcase, the proprietor refused the package. Why? "We don't wash shirts, we just paint signs!"

And that is the difference between the two. Honesty compels me to add that Frank told this story with respect to the difference between mathematics and physics, not between theory and experiment.

Speaking as an emeritus member of the fraternity of theorists, I must emphasize that the experiments to be undertaken in this new very high energy facility will indeed begin within the outlines of a strong and beautiful new conceptual framework, a framework that promises to unify three seemingly very different forces: the electromagnetic forces, the weak forces of radioactivity, and the strong nuclear forces. That leaves gravity. Will Einstein's dream ever be realized? No one knows, of course. To some degree, I suppose, it already has, although not at all as he dreamt it.

And yet, despite our advances, basic questions about the precise character of these forces, and the elementary constituents which they affect, remain unanswered. Everything has not been nailed down. Far from it. But we do now see the possibility of confirming or denying this emerging picture of nature on the subnuclear frontier with decisive experiments using powerful detectors and accelerators like this one as well as other facilities now existing or planned or simply dreamed of--both in the United States and in Western Europe.

What impels us? A philosopher once said: "One engages in very basic research out of a sense of joy in enhancing the culture of man; out of awe at the heritage handed down by generations of masters; and out of a need to publish first and become famous." To the best of my knowledge, that was not said by one or another of the ancients, but instead by our own Leon Lederman --and at an NSF workshop, no less.

So be it. Obviously in our efforts to understand the nature of the universe, efforts of the kind that are undertaken here at Fermilab, we are continuing to respond to our most human and deep-seated need to understand more about the univese and our place in it. And as we look back over history, and even at the fragments of pre-history, we see posed in every culture, every society, this kind of questioning and questing: where did we come from, how did it start, what are the regularities that govern it all? And this has been true from ancient times up to our own age and the beginning of the modern study of particle physics.

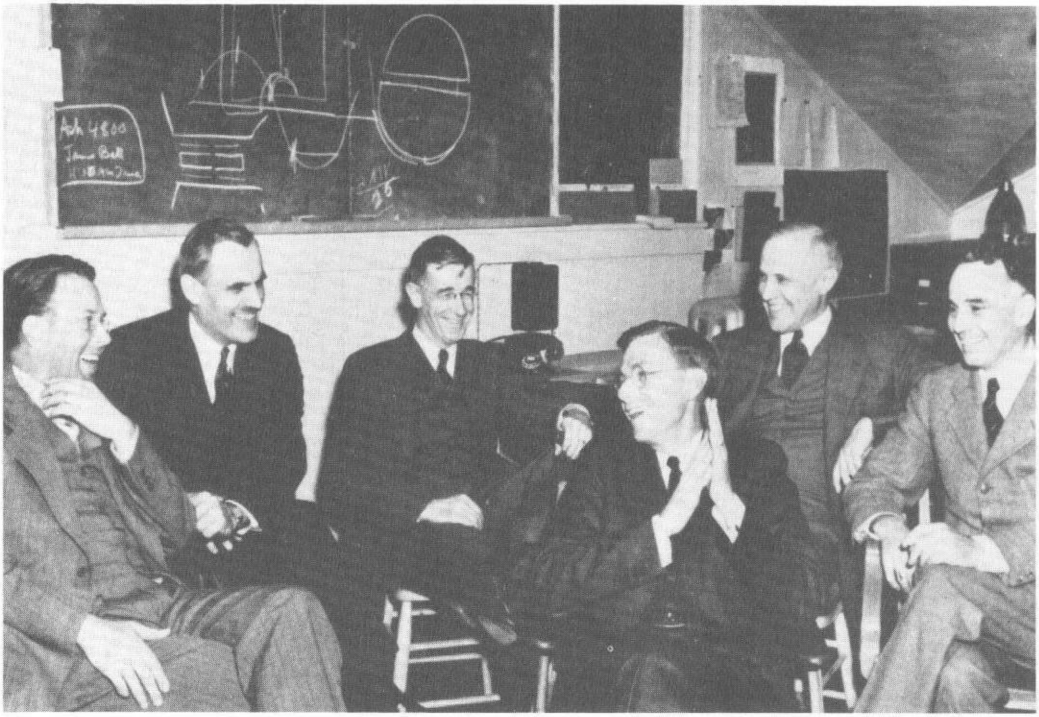
We are impelled by other considerations as well, of course. Indeed if our only concern were the response to mankind's need to know and understand nature, some would surely argue (but not I) that it makes little difference, little practical difference--as far as the physics of it is concerned--whether that understanding is achieved here, or in Western Europe, or in Russia or China for that matter. I would not so argue because it **does** matter. Because science is the great intellectual adventure of our time and of our age. Because no one can foresee where science will take us. Because no people, no society should forgo participation in that great human activity, should willingly deal itself out of that magnificent adventure.

But we are, in any case, impelled equally by forces which make a difference beyond argument, a crucial difference. There are two I want to mention.

The first has to do with what usually goes by the shorthand name of "technological spin-off." The spin-off in this instance, I would guess, will come not from learning about quarks or gluons--although Rutherford was absolutely wrong when he had a similar thought about the nucleus--but rather the spin-off associated with the first truly large-scale application of low-temperature physics, with the use of new materials, and with exquisite controls and exquisite precision. I have little doubt that in twenty-five years or so, as our use of the exotic techniques learned and developed here grows, we will look back at the Energy Saver's low-temperature facilities as primitive. There are some devices which seem to be impossibly complex until close scrutiny reveals their underlying simplicity. The Energy Saver, it seems to me, is the opposite. There is a tendency to be mesmerized by its mere size and scale but the closer you look, the more you scrutinize it, the more wonderous and magnificent an engineering feat it is seen to be. And that is what technological spin-off is all about.

The second reason has to do with the education of our students, with the sharpening of the best minds of each generation. It takes the challenge of work at the very deepest and most fundamental level to attract such minds. They are a precious national, even universal, resource. But here I must sound a warning because of the vastness--in both scale and expense--of the high energy physics enterprise.

In this field, and there are some others as well, the mode of research is no longer that of a professor and a few students. On the contrary, experiments are carried out by huge teams in which the student plays only a modest supporting role. How in that circumstance do we help him hone his own creative edge, strengthen his self-reliance, develop his own intellectual style? How in particular, given the enormous cost of some of today's experiments, do we provide that essential of learning, the freedom to make mistakes?



These are troubling questions, and I raise them for that purpose. Further, while I recognize keenly that we are here today to celebrate, and with good reason, I want to conclude by sounding, at greater length, another and deeper somber note having to do with the growing public misunderstanding of the powers and limits of science.

Let me set the stage by remarking that each day, on the way to my office at MIT, I pass in the hall a picture taken at Berkeley in the spring of 1940 of six men discussing--at a time, you will recall, when Europe was in flames anl Paris about to fall--discussing the plans for a new cyclotron at the University of California. In the picture were Ernest O. Lawrence, Arthur Compton, Vannevar Bush, James Conant, Karl Compton, and Alfred Loomis. That picture, taken at that time, provides for me a striking example of how integrally a part of our nature is our desire to know and understand the universe about us. For here were these six individuals, all of whom were already thinking about the applications of science to an inevitable military purpose and who would play such a large role in the subsequent U. S. war effort, taking time and devoting effort toward a more distant cultural goal.

For U. S. Science, and especially for nuclear physics, WWII made all the difference, a new ball game:

1) We had an influx of brilliantly talented scientists Einstein, Von Neumann, Bethe--and, of course, Fermi;
2) Post-war, new order of financial support, Bush: "Science the Endless Frontier"; establishment of the national laboratories (have become national treasure);
3) Because of the remarkable contributions of science to defense during the Second World War, public confidence in science was high perhaps due to the misguided notion that science could guarantee endless progress. Nevertheless, science, particularly physics, was surrounded by an aura of esteem and prestige;

Today the national mood is more one of skepticism; distrust has replaced confidence in science

1) Disenchantment: Science hasn't supplied easy solutions to difficult and pressing problems (energy, in spite of energy savers, for example)
2) Alarm: Has technology gotten out of control? (If nuclear engineering is presently threatening, doesn't nuclear science portend worse?)
3) But most important, suspicion: Born of lack of public understanding of science
   - We have mystified what we do
   - Science as an "inaccessible language" (Frankel)
   - Over last four decades, there is a steadily widening "intellectual" gap between the scientist and other intelligent and otherwise educated people
   - Likely that the exotic Energy Saver and its even more exotic experiments will only enlarge that gap.

This sense of concern, and of alienation, is not peculiar to physics and physicists. My MIT classmate, the biologist Robert Sinsheimer, Chancellor of the University of California at Santa Cruz, recently had this to say at a biology symposium:

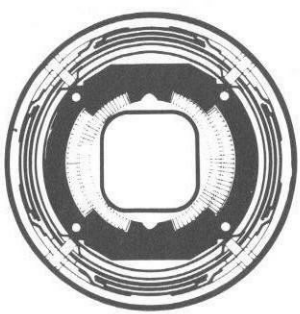
> There exists among many nonscientific members of my university faculty and many of the students who do not major in the sciences (which is, of course, the majority) not only a disinterest in science, but indeed an antipathy. I received recently a letter from a

> student, an articulate and intelligent student, which began with 'Science sours the spirit.' This is a cry of distress from one caught unwillingly in an age growing increasingly technological; a cry of alienation from a society whose patterns seem to many increasingly incomprehensible, increasingly impersonal, and--to some--increasingly inhumane, a society intellectually dominated by sciences whose increasingly successful quest for purposeless explanations has constructed for us a universe without meaning.

"It is," Sinsheimer continues, "at root a cry of fear. An understandable fear from a mind quite unprepared by our educational system to cope with a time of swift technological change."

This is an appalling situation, and growing worse. I do realize, of course, that Fermilab regularly offers programs for the public and that university faculties regularly teach physics and other sciences to liberal arts students. Good. But not nearly good enough. Surely the kinds of intellect that have created this great new facility, along with those others who are now prepared to exploit it in pressing forward the sub-nuclear frontier, can do something about this very difficult problem in education--if only they take it seriously, **really seriously.** The nation's ability to continue to marshal its resources and sustain its commitment to science (and to high-energy physics) may depend on its solution, and so may the nation's welfare. My own hope, of course, is that the past record of outstanding accomplishment will be but a prologue to an even brighter future.

Let me close, on a less somber note, with a toast and a wish for you. The story is told that when Fermi achieved the first chain reaction under the stands at Stagg Field, Arthur Compton reported in code to Conant: "The Italian navigator has reached the new world." May such a voyage of reach and discovery now be yours here in Batavia.



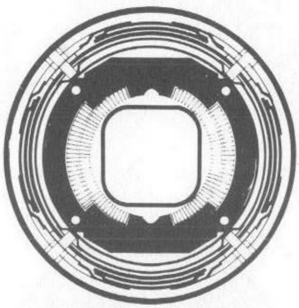
Acknowledgment

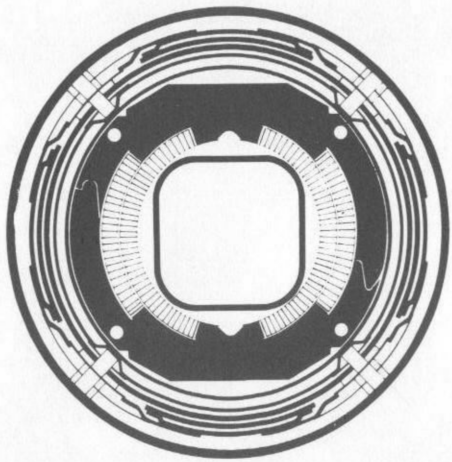
The cover photograph is of Enrico Fermi (1901-1954).

The back cover is an Energy Saver oscilloscope trace showing the number of protons and the increase in the proton energy with time from 150 to 512 GeV, July 3, 1983.

The historical photograph on page 47 is from Lawrence Berkeley Laboratory, courtesy of the American Institute of Physics Niels Bohr Library.

The support of the Fermilab Photography Unit is gratefully acknowledged.






ROBERT RATHBUN WILSON HALL