Speeches
delivered on the occasion of the
tenth anniversary
of the entry into force of the convention for the establishment of a
European Organization for Nuclear Research
10 October 1964
Speech of Welcome
by Mr. J.H. BANNIER, President of CERN Council

Ladies and Gentlemen,

It is an honour for me to open this special meeting and to welcome those of you who have kindly accepted our invitation. You will excuse me, I hope, if I do not address each one of you personally. There is certainly no need to welcome members of the Council and representatives from observer countries, or the other persons who regularly attend the meetings held in this hall several times a year.

I do wish, however, to give a particular word of welcome and friendship to the directors of the international organizations — or their representatives — with which we have close relations and several of which have in the past shown a great interest in CERN.

Unfortunately I cannot have the pleasure of greeting the Director General of UNESCO, who has been obliged to stay in Paris by the preparations for the thirteenth session of the General Conference, opening in a few days’ time. I should, however, like to read you the telegram that he has sent us:

'Very touched by your invitation to attend celebration of tenth anniversary of foundation of CERN in which UNESCO is honoured to have taken part. Deeply regret unable to come to Geneva owing to pressure of work in sixty-eighth session of Executive Council. Send you hearty congratulations on achievements of CERN which are remarkable example of international scientific co-operation and extend most sincere wishes for future of your organization.

— Sincerely, Maheu.'

We are also particularly happy to see here one who, as head of UNESCO's Department of Natural Sciences, gave us the benefit of his great gifts as a physicist and administrator in order that CERN might be created. Today it is in his capacity as Director General of the European Space Research Organization that Professor Auger is among us.

My most cordial welcome goes to the Ministers and other representatives of the Governments of the Member States of CERN. I regret very much that urgent engagements elsewhere have prevented some Ministers from coming here. They themselves regret this and have sent us telegrams to congratulate CERN on its anniversary. I should have liked to read their kind messages but time does not allow me to do so.

When all is said and done I should not need to welcome you here, for you are the real members of Council. In the last analysis, it is you who collectively steer the course of our Organization, provide for its present needs and decide its future, while we, the members of Council, are only here to represent you, to carry out your decisions and to negotiate on your behalf. It was you and your predecessors who had the courage and the imagination to create CERN at a time when only a handful of enlightened scientists — and a few of them are amongst us, whom I would like to greet as old friends — at a time, I repeat, when only a few scientists had an idea, albeit not very precise, of what this new laboratory would mean and what could be achieved there. Your predecessors had the courage to put into effect, through their policy decisions, the ideas of those scientists. I am sure that today you recognize the wisdom of their actions.

I am also sure that your admiration will increase, if that is possible, when confronted with what those at CERN have achieved, thanks to your confidence... and to the funds that you have made available. In speaking of those at CERN I do not think only of the Director General, Professor Weisskopf and his predecessors, one of whom, my friend and compatriot Bakker, was taken from us in a tragic accident, and another, John Adams, I have the pleasure to see here. I am thinking also of all the present members of the staff and those who were here in the early years. Those who, like myself and many other members of Council, were present at the birth of CERN, saw the infant come through the first difficult years, and are still watching it almost daily, know how indispensable the energy, the perseverance, the enthusiasm and the tact of the whole staff have been for the achievements we now see before us. Our first duty, as representatives of our countries on the Council, is to be impartial and to remain above problems of a personal and practical nature submitted to us. You will understand, however, that we feel personally committed to this enterprise, this example of international co-operation, which has fortunately been crowned with such obvious success.

I am only one of the members of Council who feel strong ties of friendship with the Director General and many of his colleagues, and are rather fond of CERN, but I can assure you that that friendship does not distract us from our essential duties: to represent our countries and to defend their interests. This is proved by our discussions at many meetings of Council and in the Committees, which are not always to the complete satisfaction of the Director General. But we also consider CERN as a part of each of our countries. It must be obvious to you all — not only the members of Council, but also and especially the Ministers and those accompanying them — that you are today on a part of your own territory and everything around you represents some of the scientific potential and the spirit of your own country.

We have invited you to come here today not only to look back on what has been achieved up till now. The fact that the Convention creating CERN came into force 10 years ago, on 29 September 1954, is undoubtedly an important fact, but not more important than other events which we could have commemorated: for example, the signature at Geneva of an Interim Agreement on 15 February, 1952, the signature in Paris of the Convention itself on 1 July, 1955, the laying of the foundation stone on the site, 10 June, 1955, and

Note: This is a translation of Mr. Bannier's original speech in French.
the fact that it was Professor Niels Bohr himself, that great friend and defender of CERN, who on 5 February, 1950, inaugurated the Proton Synchrotron with a bottle of champagne — these are just a few of the more striking occasions. There are also many important scientific and technical achievements which could be commemorated. There is not only the 24 November, 1959, the day when the PS was tested to see if it worked and — what a marvel! — it proved to be a machine that worked perfectly; then all the many scientific discoveries, which I will not list here. All these events could have been commemorated, but our meeting is looking towards the future.

Our invitation to you arose particularly from the fact that we — and by ‘we’ I mean the Council, the Director General and his colleagues, and the various Committees — think that CERN has reached a stage of the greatest importance, a stage where it is no longer sufficient to look at the past with a certain satisfaction and to be pleased with all that has been achieved and can be achieved at the present moment. We are now at a stage where we must look closely at the problems that the future holds for us.

What steps must be taken to enable CERN in the future to remain a flourishing institution producing important scientific results?

What must we do so that in the course of the next decade Europe may continue to play a major part in that most fundamental field of science, high-energy physics?

How can the international co-operation that has been such a success at CERN be developed to the advantage of our Continent and of the whole world?

What role will modern science play in the civilization of tomorrow and the days after? And what means will be required for Europe to take its rightful place and to carry into effect what the world demands of it?

These are some of the questions to be looked into. It will not have escaped your notice that some of the replies that could be given to these questions would require from our Governments decisions whose consequences would be much greater and whose influence, on a world scale, would be much wider than those arising from the decisions taken 10 or 12 years ago.

We do not intend to bother you today with the results — which are only provisional after all — of our reflections on some of these problems. But we shall be happy if all that you hear and see here encourages you to join us in giving thought to these questions. That is why we have asked two of our members to give you their own ideas on some of the problems. Professor Powell will talk on the role of science in European civilization, and Professor Amaldi will discuss the future of European scientific co-operation.

In these scientific surroundings we have naturally invited speakers who have exercised considerable influence on the development of CERN. Each has been, for three years, chairman of the Scientific Policy Committee of CERN and they still play an important part in the work of that Committee.

Ladies and Gentlemen, let us now pass to the next item on the Agenda. I hope that you will have a pleasant day here, in spite of the bad weather, and that what you learn will help you to serve your country and Europe even better than in the past.
The Role of Pure Science in European Civilization

by Prof. C.F. POWELL

The rapid advance of science and its consequences: international collaboration in science

The subject on which I am to address you raises novel problems of great public interest and importance. We are surely all very conscious of the fact that the headlong advance of science, and the technological developments which it has called into being, have profoundly modified our whole civilization and the process is manifestly continuing. Science is an indispensable and rapidly growing element in our culture.

In a sense this development has crept upon us unawares, for science has not, at least until recently, been advanced on the basis of any well considered principles of public policy, but rather as a result of the particular interests and abilities of gifted men with very limited technical resources. Indeed, until quite recently, the requirements for the advancement of science, both of men and treasure, were entirely negligible in comparison with the profound changes to which they led. In the circular diagrams which show how the national cake is divided up, there was never any indication of the amount spent on fundamental science because it corresponded to less than the thickness of the lines defining the different sectors. And this is still true today.

But after the last war, the technical needs of science grew rapidly, and in one or two particular sciences they reached the point where the most significant investigations required resources beyond the individual means of any except the economically most powerful states. This first appeared in high-energy nuclear physics, particle physics, and this organization of CERN, in which many European states pooled their resources and shared the cost, is the result.

The importance of CERN, however, does not depend only on its brilliant success in ensuring that we have an excellent centre for particle physics in Europe, in the first rank on a world scale. Developments in other sciences are forcing them also into forms of international co-operation for which the history of CERN serves as a model and an inspiration.

But we are now looking forward to the needs of the 1980s and you are to hear proposals for a new generation of accelerators which, in the next decade, will eventually involve an annual expenditure several times greater than that of CERN. Although a similar relative increase in pure science as a whole would certainly not make grave inroads into our economies, the amounts involved are no longer insignificant and governments must ask such questions as: — Should we in Europe continue to support pure science in general, and particle physics in particular, at the levels of expenditure with which we are now faced? What can we expect to gain from it? What shall we lose if we withdraw? In approaching these problems I shall be particularly concerned with particle physics, but many of the considerations will, I believe, be relevant to other fields of science in the next 20 years; in some of them much earlier.

The progress of high-energy physics

Let me begin by emphasising the immense promise and vitality of the subject of particle physics, for it is an essential condition for its continued support. High-energy particle physics is the present form of the age-old enquiry into the nature of the fundamental constituents of the material universe. Thirty years ago, as a result of a series of great European discoveries which included the picture of the neutron and the proton as the constituents of the atomic nucleus, we were tempted to think we were reaching the end of the possibility of penetrating much more deeply into nature; it seemed that, in the final analysis, we could reduce the world to nucleons, electrons and the quanta of radiation and their interactions. But this view proved to be quite illusory. Especially after the last war, in experiments with cosmic radiation, a whole new world of particles, the mesons and hyperons,
which had escaped discovery because they were so extremely short-lived, began to be found.

Later, especially in the past ten years, as the great new accelerators came into operation, the study of the detailed properties of these particles was rapidly advanced. The resource for experiment were also increased by powerful new methods of observation, such as the bubble chambers and the spark chambers, together with sophisticated computing methods for analysing the significant events which they record in large numbers.

As a result of these innovations, a new world of phenomena has again been revealed. The number of known particles, most of them exceedingly ephemeral, now exceeds one hundred and they have consequences of fundamental importance for our philosophy. In the first place we begin to believe that the old basic idea of the world as built up of elementary particles in the Greek sense of 'atom', 'that which cannot be cut', is illusory. All particles, including the proton, have a structure which we are elucidating. Particles of all types can be created in sufficiently energetic collisions between other particles; and they can be annihilated into other forms of matter and energy when they encounter their own antiparticles. Any particle is not to be conceived as a permanent structure, as was the Greek atom, but as continually transforming, for brief instants, into other forms and then rapidly resuming its identity. Most of our familiar world is made up of nucleons, electrons and the quanta of radiation; but only because they are the most stable of the great family of particles, not because they are the more fundamental, so that at our familiar temperatures it is exceedingly improbable that others will secure even the temporary independent existence which their very short lifetimes impose. The very notion of 'elementary particle', in the sense in which it has been employed since the time of classical antiquity, has been undermined.

Secondly, the behaviour of particles in their interactions with one another has forced us to extend widely the conservation laws familiar in classical physics. In describing the complexities of their behaviour we have to acknowledge that they have attributes for which there are no parallels in classical physics or in the world of everyday experience.

Particle physics is thus pursuing its familiar role of penetrating ever more deeply into the material universe so that we are forced to introduce basically new concepts for the description of a radically new experience. 'Experimental science', said Clerk Maxwell a hundred years ago, 'is continually revealing to us new features of natural processes, and we are thus compelled to search for new forms of thought appropriate for their description'.

Bacon also remarked: 'the Universe is not to be narrowed down to the limits of the understanding, as has been man's practice up till now; but rather the understanding must be stretched and enlarged to take in the image of the Universe as it is discovered'. At the present time, particle physics is exceedingly active in this stretching and enlarging process, and the resources of the human mind are thus being rapidly extended. For us who are well past our first youth, it is a process which, whilst immensely stimulating, is sometimes a little uncomfortable.

Thirdly, in the past year, a very important step has been taken, in the recognition of a remarkable degree of order among the particles. Until quite recently their precise masses, spins, lifetimes and other parameters appeared as a body of empirical fact, and very few significant regularities had been distinguished. Now, however, it has been shown that the particles can be arranged in well-defined groups, and the validity of the new groupings has been demonstrated by the fact that the existence of missing members and their properties have been predicted and subsequently confirmed.

The significance of recent advances

The analogy of these advances to the recognition of the Mendeleef Periodic Table of the chemical elements seems very close. It is a recognition of regularities which guarantee the existence of an underlying order, the fundamental basis of which we may hope to discover. It is not yet the equivalent of the discovery of a new quantum mechanics or of a Pauli exclusion principle, which gave the key to an understanding of the relations between the chemical atoms as a single, ordered family, but it gives the assurance that we may, perhaps quite soon, make fundamental discoveries of no less significance.

The solution of these problems, and there are others of equal significance in the subject, are of profound importance for our deeper understanding of the material universe. All our experience of the development of science suggests that there is indeed an order in nature which we can discover, and that we may hope to resolve our present problems. Such an attitude is very deep in our traditions. A confidence of order in nature, of the existence of laws of nature which men can aspire to elucidate, was an essential condition for the emergence of modern science in Western Europe, rather than in another civilization, such as the Chinese, of which the thought was in some ways more sophisticated, but in which nature tended to be regarded as inscrutable.

Thus, when the Jesuit missionaries first visited China and explained to the Chinese the Western view that the behaviour of things is ordered by the laws of nature, they were received with a polite scepticism. 'We understand', said the Chinese, 'that a human law-giver can make laws and establish sanctions to secure their observance. But surely that presupposes understanding on the part of those governed. Are you suggesting to us that air and water, sticks and stones, have understanding?'

Particle physics is then full of life and vitality and will continue to attract a large fraction of the most gifted of the youth of the world in the economically
developed countries who devote themselves to science. It seems certain, however, that the solution of present problems will again require a considerable increase in our technical resources, such as the 300-GeV proton accelerator. Can we afford it?

Needs of pure science and the material benefits flowing from it

In approaching this question we must acknowledge that the share of our resources asked for by science, including fundamental science, is rapidly increasing and that it is a process which cannot continue indefinitely. But it could go on for some time at its present rate without making any very great inroads into the economy. Thus, in economically advanced countries, between 2 and $\frac{3}{4}$ of the gross national product now goes into all forms of research and development, and between two and three parts per thousand on fundamental science, as compared with $\frac{7}{10}$ on armaments: such a proportion should not, I suppose, be regarded as unduly favourable to fundamental research in a period of human history in which the development of science is the dominant feature of the times, so that a country cannot be strong in any sense without excellent science and scientists.

Although pure nuclear science only gets about a sixth part of the amount allocated to pure science as a whole, even one part in two thousand of our resources is a substantial sum, and other demands on the public purse are pressing. Why should we allocate a considerable proportion of our scientific resources and manpower to particle physics? Although the subject is so promising, we cannot assert precisely how useful it will be in its influence on other sciences and on practice. In the same speech from which I have already quoted, Clerk Maxwell remarked: — "For us who breathe only the spirit of our own age, and who know only the characteristics of contemporary thought, it is as impossible to anticipate the general tone of the science of the future as to predict the particular discoveries it will make". All that we can say is that always in the past great advances in natural philosophy have in the long term led to radical changes in all our thinking and eventually, through their influence on the resources and morale of science, on all our practice.

If then we speak of pure science, it is in the sense that it is not directed to the solution of immediate concrete practical problems; but that does not mean that it is not immensely profitable in the long term. The overall long-term return from investments in the fundamental science of the past is very difficult to estimate, but all writers on the subject agree that it is very high. Thus it has recently been remarked that whereas our present civilization is essentially based on the consequences of the pure science of the past, everything that has ever been spent on pure science, up till now, is equivalent to only two weeks of our total industrial production at present levels. Or, to put it another way, everything that has ever been spent on fundamental science in the past is equivalent to the amount by which this year's production is expected to exceed last year's.

But in different sectors of science the period from discovery to fruition differs widely. The lady of the old story of Benjamin Franklin was right to ask about the use of his new discovery and he was right to emphasize the time-scale to maturity. You will remember that the lady, on being shown the demonstration of a new effect in pure science, asked: 'But Professor Franklin, what's the use of it?'; and Franklin replied: 'Madam, what is the use of a new-born baby?'

The eventual profitability of particularly penetrating and significant branches of science, such as particle physics or the elucidation of the genetic code in bio-physics, is bound to be of a different order of magnitude from that given by less widely ranging investigations, and it will take longer to mature.

The importance of balanced development of science and technology

It is also important to remark that the eventual benefits derived from pure research are not only those to which it leads directly. Fundamental research in nuclear physics, in pure science, was undoubtedly an essential element in making nuclear power stations a possibility; but it was only one element in addition to many others involving advances in chemistry, engineering and solid-state physics, to name only a few. The scientific age is the product of a complex interplay of all science and technology. The problem is to ensure their balanced development, for a deficiency in one branch weakens the whole front of advance.

It is very important not to see the problem too narrowly or to make a judgement on the value of a branch of science solely on the basis of immediate material benefits. The discovery of the universal law of gravitation or of the origin of species had little direct influence on economic affairs, but their impact on the standing of science and its development was immense. Or again, the development of quantum mechanics seemed a remote and abstract advance when it first appeared, but in addition to its great importance for physics, it laid the foundations for theoretical chemistry. It was, therefore, an indispensable element in the chain of developments which contributed to the advances in molecular biology, and the great and significant recent advances in our understanding of living processes. Its ramifications are manifold and priceless.

It is a reasonable speculation that the new advances in particle physics which now seem to be coming within our grasp will not be less significant and productive in the long term than were those in this field in the past. They may not contribute to the advancement of chemistry, for example, because the methods and theory created by past physics may provide all that is there needed. But they may instead be an essential element in bringing into being whole new fields of human practice, of which at the moment we have no inkling. Nobody in the eighteenth century had any intimation of an electrical industry; or in the
nineteenth, of the atomic-energy industry; and certainly there will by fields of practice in the twenty-first century of which we in the twentieth will know and anticipate nothing, but the foundations for which will be laid by the science of our own times.

We have indeed, in the past year, had a clear indication that particle physics, in addition to its intrinsic interest, will also be of great importance for another vital branch of science, cosmology. Among some of the radio sources, there are recently discovered visible objects, called quasi-stellar, with a brightness about $10^{12}$ times that of the sun, and in which the energy-source is approximately equivalent to the rest-mass of a million suns. Among them are the most remote objects in the Universe hitherto identified. Their rate of energy generation is so prodigious that it cannot be due to the kind of nuclear processes which provide the energy liberation in ordinary stellar evolution. For an understanding of those objects it seems probable that we shall need all the resources of general relativity and of the processes we encounter in particle physics at the highest energy; that for an understanding of the greatest energy-sources known to us in the Universe, two branches of natural philosophy which are commonly regarded as among those most remote from practical affairs are indispensable.

In the development of science similar situations have occurred again and again; yet there is an innate intellectual conservatism in us which makes us slow to see that the explosive developments in science through which we have lived are likely to continue, so that, in the absence of a great human catastrophe, the advance of science, the progress of discovery and of technical innovation, knows no limits; and we fail to draw the appropriate conclusions on major problems of policy.

**Pure science as an indispensable element in our culture**

But why should we in Europe continue to support elementary-particle physics here and now when the expenses are becoming so heavy and other demands on the public purse are so pressing? Why should we not leave this field to other countries and hope to share the fruits of their researches when they mature? It is a question which must be faced; and it should be convincingly answered if we are to proceed.

The tone, the morale, of a laboratory, of a nation, even of a civilization, is a very delicate and impalpable quality, yet of immense importance for the whole organism. The transition from high achievement to decadence has often in the past seemed to rest upon a razor’s edge. There is a sudden loss of confidence; it is as if the well-springs of human creative power have suddenly been dammed up, frustrated; and this is followed by a rapid decline.

Ours is an advancing scientific culture and if in Europe we are to make an important contribution to it we must continue to engage in the most advanced science and technique, both nationally and in collaboration. Man does not live by bread alone and the benefits derived from science are not to be measured only in terms of its technological consequences. Our forefathers made great decisive contributions to all the arts; to music and drama; to sculpture and architecture; to painting and literature; they built the Parthenon and the Cathedrals of Chartres and Bourges, Durham and Salisbury, Toledo and Burgos, Pisa and Lucca, Freiburg and Ulm. All these things gave little economic return but who would regret the effort? In our time, it is in the sciences that the human creative spirit finds one of its chief means of expression. We must therefore encourage the most gifted of our youth to apply themselves to the most difficult, significant and demanding of the sciences, and at the present time that must include the physics of ‘elementary’ particles.

In the long run it is most painful, and very expensive, to have only a derivative culture and not one’s own, with all that that implies in independence in thought, self-confidence and technical mastery. If we left the development of science in the world to the free play of economic factors alone, there would inevitably result a most undesirable concentration of science and scientists in too few centres, those rich in science becoming even richer, and those poor, relatively poorer.

It is not easy to distinguish all the factors which contribute to morale, but I suppose that it is important for the whole of our educational system that the tradition of penetrating independent enquiry should be kept vigorously alive among us. This is surely especially so in our times, when science is beginning to infuse every aspect of education and the characteristic feature of science is change and development. The continuing theme in human history is the great battle to comprehend better the world of which we are part, and to improve practice in the interests of every aspect of human advancement. People, including children, respect those who are successfully exerting themselves, at all kinds of levels, in this struggle. Immediately we cease to participate, our teaching tends to become stereotyped and pedantic; and in our universities that means that we must be involved continually in significant and essential research.

So it is most important that we should continue to promote science in Europe effectively, and elementary particle physics as an important part of it. The programme you are to hear about is an important element in providing the necessary support. We all understand that it must be considered taking into account the legitimate claims of other sciences and other public demands upon manpower and treasure. We should all be deeply concerned to see a balanced development. Gifted people are always in demand and they are needed in many fields of technology as well as in fundamental science. But it may be remarked that the great attraction which elementary-particle physics and other growing points in pure science have for many of the most able young minds is not due to an arbitrary fashion. They are drawn to the frontiers of knowledge where the intellectual
challenge is greatest. On such minds the subject exerts such a fascination that they will not easily be deflected but will go where it is actively pursued, wherever that may be. But if the subject loses its significance they will quickly drift away to other fields.

Particle physics at the present time is a large-scale operation involving thousands of people in the great national and international laboratories, but the number of key people is rather few and they do not seem to emerge in direct proportion to the increasing number of students we educate. It has been remarked that if, in particle physics, we lost a dozen of our best young physicists from Europe, our future contribution to the subject would be gravely prejudiced. A large number of competent scientists would be left with an indifferent leadership, and good generals make a great difference to the fate of armies. We are producing an encouraging number of gifted young physicists in Europe because we have a great tradition in the subject and have given it adequate support since the war, and we must not lose the position we have built up.

Conclusions

In the future, science may perhaps be organized not on a regional or continental, but on a world scale. It may become the principal creative activity of mankind, employing a major part of our growing total resources. We may then be able to plan the general advance of the whole world scientific and technical front in a balanced way on the basis of the internal scientific needs of the different disciplines, with a rational distribution of the total effort between countries or continents, and without first considering their economic costs and returns. But we are clearly far from that situation today; and we in Europe must look to our own culture and our own future.

Mr. President, it is said in my country, and no doubt in yours too, that 'to the shoemaker there is nothing like leather'. But out of a deep respect both for those I am privileged to address and their grave responsibilities, I have felt bound to express myself with a studied moderation. Nevertheless, I believe the conclusion is inescapable that, for the future strength and vitality of this continent and for the maintenance of its great scientific tradition it is essential to ensure a balanced and effective development of all science and technology. For this purpose we need to establish a well-informed and imaginative attitude to the role of fundamental science, its profound significance for our whole future, and the principles which should govern its proper support.; and at the present time the balanced support of science must include adequate provision for one of its most vital and promising branches, high-energy particle physics. For several decades the needs of science have been rapidly increasing, but they still make a relatively very small demand on our resources and this is not the time to stop. If we do we shall slowly decline, like a limb to which the supply of the life blood is restricted. This continent will then become a sad memorial to its past glories and achievements, and to the inadequacy of the effort with which we met the challenge of our own times.

But if we go on boldly, we shall surely be able to take our full part in the brilliant world of the future which is coming within our grasp as the scientific epoch of mankind, which we are only just entering, comes to maturity.
The Future
of European Scientific Co-operation

by Prof. E. AMALDI

The idea of a close scientific and technical co-operation between European countries has been developed in various directions with considerable vigour during the past fifteen years. Such co-operation was dictated both to scientists and government administrations by the very nature of the problem to be tackled, since the manpower required and financial means involved were far too large to be afforded by one single nation.

Among the various organizations created during these fifteen years, CERN is the very first to have started operating — the one which has, in many respects, achieved the greatest success. The causes that have led to its success are not easy to analyse; they are manifold and have, perhaps, not been fully singled out as yet.

Among these, however, there is certainly the nature of the subject, since it concerns a sector of the scientific culture of our century, which was created in Europe and which, in the past, had its maximum vigour in Europe, while later on, owing to the moral and material conditions generated by the second World War, it appeared to have found in other continuents a more congenial home.

A second reason for CERN's success has certainly been the fact that its aims were well defined and clearly delimited; a third may be recognized in its organizational structure, since it reflects, more than in any other case, the ideas and aspirations of the scientists, in particular of those who were later to work for many years within the Organization.

The tenth anniversary of the entry into force of the Convention that established CERN in its final form represents the most appropriate occasion for an assessment of the extent to which the principal aims of its founders have been accomplished, and also for reviewing the stage reached by our knowledge as regards properties of the sub-nuclear constituents of matter.

This circumstance also provides an opportunity for casting a glance into the future, for trying to estimate the fertility of this field of research and for considering which instrumental means appear today indispensable in order that the European countries might continue, during the next ten or twenty years, to maintain the position they have been able to reach in the recent past.

This position is largely due to the contributions made by the universities and by the national laboratories of our countries taken together, and by the

Of Prof. Amaldi, Mr. Bannier said:

If I reckon myself to be amongst those who were interested in the creation of CERN from very nearly the first moment, I still must recognize Edoardo Amaldi, Professor at the University of Rome, as my senior in this as in many other respects. He was a member of the group of experts who advised Professor Auger already prior to the conference convened by the UNESCO in December, 1951. As Secretary General of CERN in its preliminary form he was more instrumental than anyone else in giving our organization its actual form and impetus. As a member of the famous group, led by Fermi, that played such an important role in the scientific work that lies at the bottom of our atomic age, he knew the value of team work. Interested, like Powell, in cosmic-ray research, he had first-hand knowledge of the necessity of international co-operation. With that background it is not to be wondered at that he is one of those mainly responsible for the creation and the success of CERN, but also that, although he did not play an active role in the creation of ESRO, it was actually his stimulating discussions and discourses which brought to life that European Space Research Organization.

Nobody is more qualified to speak on the Future of European Scientific Co-operation than Professor Amaldi, whom I now invite to address our assembly.

CERN Laboratory in particular, since it is here that the major instrumental means and the largest group of highly qualified scientists and technicians are concentrated.

It is important to realize that another essential factor in the success of CERN has been the policy that research here should be carried out by scientists belonging to universities and institutes in the Member States, and not by a special class of international physicist isolated in a private laboratory in Geneva. The planning of experiments, their selection, their execution and the analysis of their results are all done by individuals and groups from outside CERN, in collaboration with a much smaller number of colleagues who belong to the Organization. In July this year, there were at Meyrin about 70 research physicists belonging to CERN and about 300 fellows and visitors, who come to CERN for periods between 2 weeks and 2 years to do research. Several of the bubble chambers in continual use have been sent to CERN by Member States, to be operated for the benefit of the whole of Europe. The pictures taken are distributed to universities, or more usually to collaborations of two or three universities in different countries, for measurement and evaluation, in accordance with a programme set up by a committee
representative of all the laboratories involved, with a chairman from outside CERN. Similar arrangements apply to emulsion experiments.

Other types of experiments have to be carried through completely in the Laboratory, but again the participation of visitors is very strong. The neutrino experiment which was performed recently at CERN involved about 25 physicists from 14 different countries, the majority being visitors.

In this way, CERN has been trying to achieve one of the aims of its founders: to make a European laboratory which could still be an integrated part of the national research programmes of the Member States.

This technique of running a centralized laboratory efficiently, but giving the maximum initiative to outside groups to determine the research to be done and to carry it out themselves, has not been arrived at easily, nor does it work perfectly even now. Nevertheless, it is becoming more and more essential as the major research facilities become centralized, and it implies some changes also in the habits of research workers and their institutes before it can be used really effectively.

Already, the dependence of national programmes on the facilities and material which CERN provides is so great that decisions affecting CERN are of immediate concern to physicists all over Europe, and for this reason there have recently been attempts to produce coherent programmes for new accelerators covering both national and international laboratories.

The problem concerning future developments has been the subject of discussions since 1960, here at Meyrin as well as in the universities and national laboratories of Member States.

At the end of 1962, it was found necessary to start a comparison between the different points of view and ideas that had been developed in various parts of Europe, in order to be able to set down a programme to be agreed upon by the majority of the European physicists concerned directly or indirectly with high-energy research.

Thus, at the beginning of 1963 the so-called European Committee for Future Accelerators was created; it consists of about 60 physicists from laboratories in all the CERN Member States as well as from CERN itself. The Committee was to discuss and provide an answer to the question of what is the most desirable programme for the construction of high-energy accelerators by the European nations, members of CERN. The programme, which was defined during the first semester of 1963, includes, besides very-high-energy accelerators that are to be built jointly by the European nations, also medium and rather small-size machines, which should be constructed at universities, national institutions and, possibly, regional laboratories where two or three countries could join their efforts in undertakings deemed too burdensome for a single nation.

The construction of the machines dealt with in the latter part of the programme should, of course, be decided by the individual countries, on the basis of their own need for new accelerators suited to high-energy research, teaching and training. The so-called 'summit programme' involves, on the other hand, a common decision of all or at least a large fraction of the CERN Member States.

Since June 1963, this programme has been re-examined on various occasions, taking also into account more recent developments of a similar programme set down at about the same time by scientists in the U.S.A. for their own country.

The modifications with respect to the original scheme have been only of minor importance and represent some improvements to the same general philosophy.

The summit programme consists of two parts. The first and more important part concerns the construction of a new proton accelerator of very high energy.

According to the recommendations of the European Committee, endorsed by the CERN Scientific Policy Committee, the energy of the protons should be about 300 GeV, provided that the necessary authorization for its construction can be obtained by the end of 1965, so that the machine may be completed between 1973 and 1975. This proviso is partly dictated by the existence of a similar programme in the U.S.A., with which the European programme must inevitably be compared in some ways. The choice of energy should be reconsidered if, for any reason, the delay in starting physics with the big European accelerator should turn out to be substantially longer than now foreseen.

The choice of 300 GeV was determined by various factors that I will mention here very briefly.

On the one hand, it was found that, by using high-energy injection, a high-energy accelerator is at the same time a high-intensity machine, with the result that, by decreasing the energy — for example from 300 GeV to 200 or 150 GeV — one loses in two respects: in energy as well as in intensity; and the intensity is a point of the utmost importance, especially for the beams of secondary particles like pions, kaons and antiprotons, and even more for tertiary particles, such as gamma rays, muons and neutrinos.

On the other hand, the long construction time, the total cost and scale of effort involved and the difficulty of finding suitable sites are factors which become increasingly important as the accelerator energy is increased beyond, say, 300 GeV. In addition, the problems of beam separation and particle identification become increasingly difficult.

To these technical and scientific remarks it may be added that the cost per annum of large accelerators
of a given type is about the same during the first 10 years, for energies between 150 and 300 GeV. Only at a later stage will the bigger machine entail larger annual expenditures than the smaller one; when starting construction, the expenditure per annum increases according to the same linear law during the first four years and reaches about the same plateau value, which remains constant during the following six years.

A new big accelerator of the type considered here cannot be built in Geneva because of the very large dimensions of the site needed and the extreme stability required for the ground.

A new and more suitable site ought therefore to be found on the territory of one of the States participating in this new great enterprise.

The second part of the summit programme concerns the development of the Meyrin Laboratory. It includes an increase in intensity of the present proton synchrotron by means of various improvements, among which I should mention an increase by a factor of about four in the injection energy. It deals also with the construction of two intersecting storage rings in which two high-energy beams injected from the CERN PS and moving around in opposite directions deliver — in their collisions producing secondary particles — the same energy that one would obtain with a conventional machine with 1700-GeV protons. Thus the storage rings would provide a very useful, and indeed essential, window through which the future course of experimental physics at the highest energy could be viewed.

The storage rings would also increase considerably the possibility of experimentation of the same type as that made now at the proton synchrotron, since the protons could be stored in the rings and spilled out of them in the way most suited to the chosen detector.

The second part of the summit programme is essential if one wishes to prevent — in less than 10 years from now — the proton synchrotron becoming a second-rate machine and the Geneva Laboratory losing its present position in the forefront of high-energy research. I should add that this second part of the programme entails a cost corresponding to about one quarter of that involved in the construction of a 300-GeV accelerator; it would also be completed in a shorter period of time, i.e. six years instead of the eight or nine years necessary for the construction of the 300-GeV machine, and it could be started now.

Although the storage rings represent a very important part of the summit programme, they could never form an acceptable alternative to a high-energy proton synchrotron. This is mainly because the storage rings do not provide beams of high-energy secondary particles and therefore are limited to experiments almost solely on proton-proton high-energy collisions; the study of other processes involving incident high-energy secondary particles such as mesons, strange particles and antiprotons, or tertiary particles, such as gamma rays, muons and neutrinos, is completely outside the domain of experimentation open to storage rings.

Therefore, a high-energy accelerator should be regarded as being by far the most important part of the future European common programme. Its construction would provide the opportunity of continuing high-energy physics research in Europe from 1973-1974 onwards. If this project were to be abandoned, all the efforts made during the last few years — which have enabled Europe to regain its place in the forefront of the world scientific effort — would have been in vain.

If we try to go back in our minds to more than ten years ago, i.e. to the time when the permanent Organization did not yet exist, and if we recall what happened in the years between 1951 and 1954, during the planning and interim stages of CERN, we are deeply impressed by the enthusiasm and rapidity with which scientists and technicians of different ages and backgrounds left the universities and laboratories to which they had devoted years of activity and where they had attained remarkable positions, to come to Geneva and work for an Organization which, at that moment, existed more on paper and in their minds than in reality.

But we cannot fail to be even more impressed by the support and assistance that the scientists' proposals received from the authorities of all the States which were later to become members of the new Organization, by their willingness and determination to overcome the many difficulties that arose at the time at all levels, whether organizational, legislative or financial.

The intelligence, the enthusiasm and wide vision of the problem shown by those highly responsible persons is another fundamental factor which has led to the success of CERN — I dare say that in many respects it is the most important and indispensable of all factors.

From many points of view we find ourselves today in a similar situation. The problems confronting us now are even harder to cope with than those we faced ten or twelve years ago. But the technical and scientific level of our countries is now correspondingly higher, the enthusiasm and concern are greater than ever before; and so let me express the confidence that our present authorities will show as much wisdom and deep understanding of the problem as they did more than ten years ago, and with the same beneficial results.