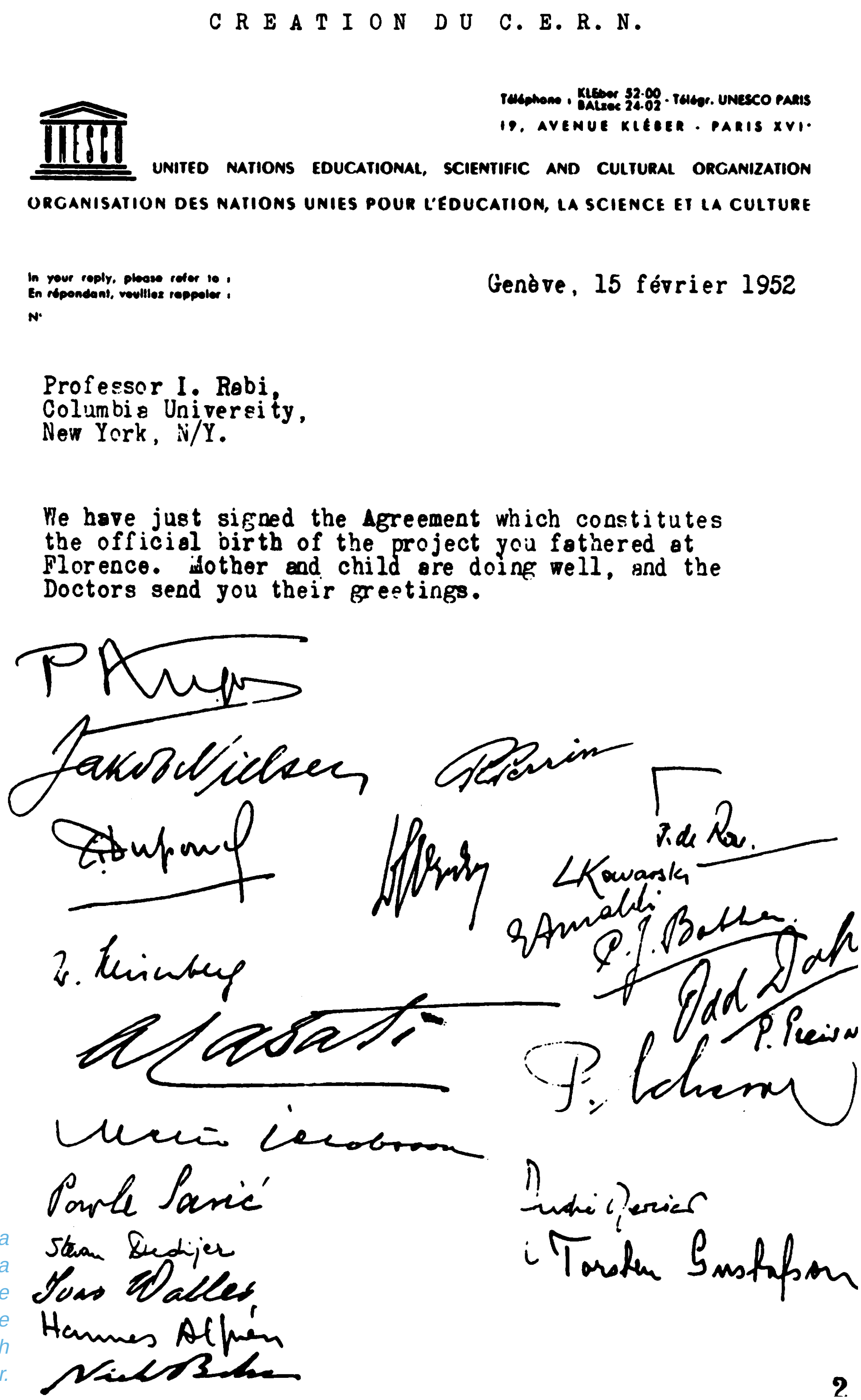
All We Want Is th

Contributing Editor Gordon Fraser follows up on his piece on the origins of international collaboration in Europe (Winter 1997) to describe the creation of CERN. This article is adapted from a chapter in his book The Quark Machines *on the political history of particle physics and the parallel evolution of its big machines.*



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N°

Genève, 15 février 1952

Professor I. Rabi,
Columbia University,
New York, N/Y.

We have just signed the Agreement which constitutes the official birth of the project you fathered at Florence. Mother and child are doing well, and the Doctors send you their greetings.

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Isidor Rabi had proposed the idea of a European physics laboratory at a UNESCO conference in Florence in June 1950. The signatories to the initial 1952 agreement to establish CERN sent him this letter.

World's Biggest Machine!

by GORDON FRASER

BETWEEN 1949 AND 1959, the dream of an international European laboratory for particle physics—'CERN'—became a reality, briefly sporting the world's highest energy proton synchrotron. In those ten years, scientists from countries that had been at war only a few years earlier set aside their differences and collaborated in a dramatic demonstration of what could be achieved when national characteristics dovetail smoothly in the achievement of a common goal. The ideals and insights of CERN's founding fathers provide vital lessons in the continued quest for wider international collaboration in particle physics.

Scientific objectivity is a common bond between nations. In every country, scientists address the same problems. If one nation hushes up its research findings, the knowledge will ultimately be acquired elsewhere. Scientific curiosity cannot be quenched. In the aftermath of World War II, science was seen as a potential olive branch. However the war had shifted much of the scenery. Major efforts to harness fission and microwaves had demonstrated the value of large-scale collaboration. Militant national pride had given way to new international awareness. Embarrassed by having caused so much strife and inflicting it on the rest of the planet, Europe felt it had to present a more united front.

The United States, as the leading postwar scientific power, attracted scientific emigrants from Europe in what would eventually be called the "brain drain." This leak first had to be stemmed if the Continent was not to find itself starved of talent. Following the Congress of Europe in The Hague in May 1949, the European Cultural Conference in Lausanne in December 1949, attended by 170 influential people from 22 countries, helped set the stage.

At Lausanne, the Swiss writer Denis de Rougemont, founder of the European Cultural Centre, deplored an increasing trend towards secrecy in nuclear physics and advocated a "European centre for atomic research." Then Raoul Dautry, Administrator-General of the French Atomic Energy Commission, read a message from Louis de Broglie, winner of the 1929 Nobel prize for his elucidation of particle waves. De Broglie maintained that scientific collaboration between European countries could open up projects that were beyond the means of individual nations. Following up with his own ideas, Dautry affirmed that astronomy and astrophysics on one hand, and atomic energy on the other, would be ideal vehicles for such international collaboration.

Dautry could call on powerful colleagues in France. One was Pierre Auger, who had made important contributions to atomic and nuclear physics in the 1930s and became Director of Exact and Natural Sciences of the new United Nations Educational, Scientific and Cultural Organization (UNESCO). Another prominent French figure was nuclear fission pioneer Lew Kowarski, who had worked in Britain during the war and understood the special position of the United Kingdom, which was trying to "go it alone."

At the UNESCO General Conference held in Florence in June 1950, however, the seed planted at Lausanne still lay dormant. In the U.S. delegation was Isidor Rabi, winner of the 1944 Nobel physics prize who had supervised research at the MIT Radiation Laboratory during the war. After the war Rabi, with Norman Ramsey, had pushed for the establishment of a major new U.S. research laboratory, Brookhaven, on New York's Long Island. In Rabi's mind this was a role model for what could be achieved elsewhere.

Edoardo Amaldi in 1971 at the age of 63. One of Europe's leading postwar scientific statesmen, he played a key administrative role in the founding of CERN. (Courtesy CERN)

Upon arriving at Florence, Rabi was surprised to discover that the agenda included no mention of the European physics collaboration mooted at Lausanne. Setting up physics laboratories was something Rabi knew well, but international committee work was not. The first thing was to get an item onto the agenda, overcoming the apparent indifference of his American colleagues. More helpful were Auger and the Italian physicist Edoardo Amaldi, who had worked in Enrico Fermi's Rome laboratory before the war. Invited to the United States by Fermi, Amaldi preferred to stay in Italy and help restore Italian physics after the chaos of the war. Amaldi went on to become one of Europe's great postwar scientific statesmen, his achievements appearing to stem from a deep sense of duty rather than personal ambition.

Drafted with the assistance of Auger and Amaldi, the proposal from Rabi at Florence requested UNESCO "to assist and encourage the formation and organization of regional research centres and laboratories in order to increase and make more fruitful the international collaboration of scientists in the search for new knowledge in fields where the effort of any one country in the region is insufficient for the task." Rabi pointed out that the initiative "was primarily intended to help countries which had previously made great contributions to science," and that "the creation of a centre in Europe . . . might give the impetus to the creation of similar centres in other parts of the world." The motion was unanimously accepted. Where Europeans had failed to reach a consensus, an American resolution for Europe at a meeting of a United Nations agency had opened a new door.

The two men who took Rabi's baton and sprinted with it were just those who had helped him draft the Florence resolution—Amaldi and Auger. Just a few weeks later, Amaldi was stimulated by a visit to Brookhaven, where the Cosmotron was already taking shape. Few Europeans had ever seen a physics effort of such proportions. "*Colossale*," he remarked.

Under the auspices of the European Cultural Centre, a meeting was organized in Geneva in December 1950 with delegates from Belgium, France, Italy, the Netherlands, Norway, and Switzerland. Auger unveiled a plan for a new laboratory dedicated to the physics of elementary particles. He knew that intriguing new discoveries had already been made in cosmic rays, but that this windfall sprouting could become a major harvest once the big new U.S. accelerators were up and running.

Initial contacts with Britain had established that while its physicists were not against the idea of a European laboratory, they still wanted to go their own way. Their support was vital to get the idea off the ground, however, as in Europe only Britain had experience in major projects. Possible sites mentioned for the new European laboratory included Geneva and Copenhagen.

The resolution passed at the Geneva meeting was startling. It recommended the creation of a laboratory for the construction of a particle accelerator whose energy should exceed those of machines currently under construction elsewhere (which meant the mighty 3 GeV Cosmotron and the even bigger 6 GeV Berkeley Bevatron). In a field where, apart from Britain, Europe had no tradition and little expertise, the plan was simply to jump into the lead by cash and enthusiasm. These bold proposals were enthusiastically endorsed in Italy, Belgium, France, Norway, Sweden, and Switzerland. In Britain, where physicists were busy building several new accelerators, there was astonishment and skepticism. "Who is behind the scheme?" thundered P. M. S. Blackett, "Is it serious?"

A study group to define the new accelerator included Cornelis Bakker from the Netherlands, who had built a synchrocyclotron at Amsterdam, Odd Dahl from Norway, a talented engineer responsible for the first nuclear reactor to be built outside the original "nuclear club," and Frank Goward, a British physicist who had graduated into wartime radar work. In a flush of modesty after the initial strident proclamation, the new advertised goal was to copy the 6 GeV Berkeley machine instead of the original idea of building the world's largest machine.

One suggestion was to use Niels Bohr's laboratory in Copenhagen as a home for the new institute, an idea that also found favor in Britain, and naturally stimulated interest in Norway and Sweden. Bohr, who had not been party to the previous discussions around the Auger-Amaldi axis, began to exert his considerable influence. Others thought that he was past his prime. The remoteness of Copenhagen and the difficulty of the Danish language were also a deterrent.

To sidestep the challenge of going straight for the world's largest machine, a new plan envisioned a smaller initial machine to launch the new laboratory. Proposals were put forward for a 500 MeV synchrocyclotron and a 5 GeV proton synchrotron, with design and construction proceeding in parallel. European physicists seemed optimistic about government funding. On the question of the site, new criteria, designed to undermine Copenhagen's case, stipulated the use of a major language.

A November 1951 meeting in Paris suggested that the energy goal of the new synchrotron could be as high as 10 GeV, but to defuse the thorny siting issue, the respective group leaders would remain at their home bases—Dahl in Norway working on the synchrotron, Bakker in The Netherlands on the synchrocyclotron, Kowarski in France on infrastructure, and Bohr in Copenhagen on theory, with Amaldi's administrative hub in Rome.

A meeting at Paris that December brought representatives together from thirteen European nations, including West Germany. The Netherlands delegation put forward a fivefold plan, with two points designed to appeal to the Northern faction, expressing interest in using the existing Copenhagen center and Britain's accelerators, and the remaining points designed to appeal to Franco-Italian sentiment, covering the

In 1951, before a site for the new laboratory had been chosen, Odd Dahl of Norway (standing) was appointed head of CERN's proton synchrotron group and Cornelis Bakker of the Netherlands (seated) head of the synchrocyclotron group. After a trip to the U.S. in 1952 where he learned of the invention of strong focusing, Dahl wisely pushed for the CERN synchrotron to adopt the new, as yet untested technique. But with the decision to build the machine in Geneva, Dahl retired from the project in 1954. In 1955, following the resignation of CERN's first Director General, Felix Bloch, Bakker succeeded him. (Courtesy CERN)

An early CERN Council meeting in 1953. Left to right, Jean Bannier representing The Netherlands, and Pierre Auger and Jean Mussard of UNESCO. (Courtesy CERN)

construction of two new machines and the establishment of a "European Council for Nuclear Research"—in French "Conseil Européen pour la Recherche Nucléaire." The acronym CERN was born.

The meeting was continued in February 1952 in Geneva, where the provisional CERN Council was asked to prepare plans for a laboratory. The proposal was immediately accepted by Germany, the Netherlands and Yugoslavia, and accepted subject to ratification by Belgium, Denmark, France, Greece, Italy, Norway, Sweden, and Switzerland. Denmark offered the new Council the use of the premises at the Institute of Theoretical Physics of the University of Copenhagen. While this meeting was a major step forward, the enigmatic British were not even present.

Emphasis switched from negotiation to organization and planning. With the new organization open for business, the word "Council" was no longer appropriate. However nobody could think of a better acronym, especially when it had to have multilingual appeal, and CERN has stuck ever since. With the four groups dispersed and Amaldi still in Rome, the organization advanced only slowly.

A major international physics meeting at Copenhagen in June 1952 heard that the first beams had been produced by the new Cosmotron. A CERN Council meeting immediately advocated that Dahl's group aim for a scaled-up Cosmotron to operate in the energy range 10–20 GeV.

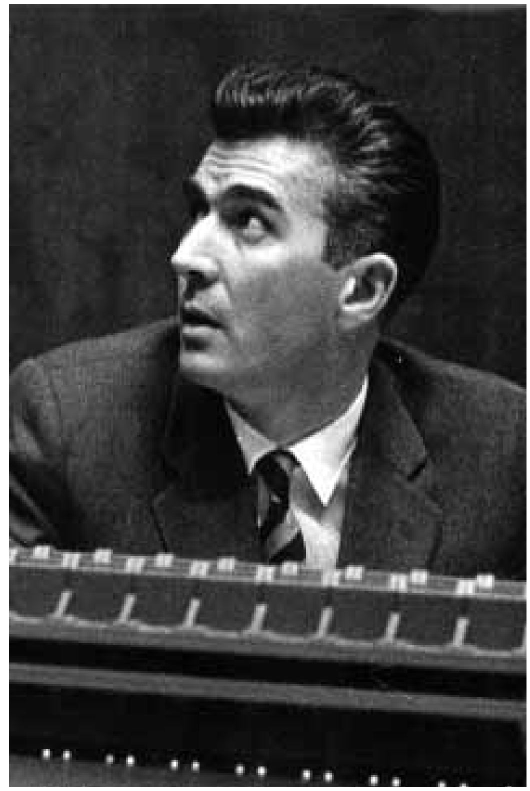
To make their scaled-up version of the Cosmotron, the group needed to go to Brookhaven and inspect the new machine. That August, Dahl and Goward made the trip. Also passing through was accelerator pioneer Rolf Wideröe, then working on betatrons. To receive their European visitors, M. Stanley Livingston had organized a think tank. The Cosmotron's C-shaped magnets all faced outwards, making it easy for negatively charged particles to be extracted, but not positive ones. "Why not have the magnets alternately facing inward and outward?" suggested Livingston. Ernest Courant, Hartland Snyder, and John Blewett seized on the suggestion and quickly realized that this increased the focusing power of the magnets. The new suggestion, variously called "strong focusing" or "alternating gradient," might allow the proton beam to be squeezed into a pipe a few centimeters across, instead of the 20×60 centimeters of the Cosmotron beam pipe. The relative cost of the surrounding magnet, the most expensive single item in synchrotron construction, would be greatly reduced.

The European visitors arrived at Brookhaven prepared to learn how to make a replica of the Cosmotron and discovered instead that the design had suddenly become outdated. This 1952 visit set the tone for the relationship between the new European generation of physicists and their American counterparts. Based on mutual respect and colored by a healthy spirit of competition, this relationship was to work to their mutual advantage. Untempered, competition can lead to jealousy and secrecy, but in particle physics this has rarely occurred. Although each side has striven to push its own pet projects, collaboration and assistance have always been available, and the community as a whole welcomes and admires breakthroughs and developments, wherever they may be made.

Dahl was adamant that the new strong-focusing technique had to be used for the CERN machine they were planning. It would open up the prospect of at least 20, and possibly 30 GeV, and save money. The only problem was that nobody had built one yet. Although a gamble, taking this unexplored strong-focusing route turned out to be one of the most important decisions in CERN's history. In Britain, the strong-focusing proposal gave a new appeal to the European project. The traditional national approach and the more ambitious international venture became complementary. However before Britain could be persuaded to join CERN, key figures had to be convinced, including the formidable Lord Cherwell, Winston Churchill's staunch friend and scientific advisor.

In December 1952 Edoardo Amaldi was given a frosty reception by Cherwell in London. Within minutes, Cherwell told Amaldi in no uncertain terms that he was skeptical of the CERN idea. Undeterred, Amaldi wanted to meet some of the young Britons who might be interested in joining Dahl's group. Delegated to drive Amaldi from London to Harwell was John Adams, a young engineer who had moved to synchrotron development after wartime radar work. At Harwell, Amaldi met others who were working on both the CERN machine design and a major new British machine.

With the national machine committed to the old weak-focusing design, Adams and colleagues had been taking a close look at strong focusing, and discovered that the initial idea was optimistic. Small errors in the magnets—tiny misalignments and field variations—would be naturally amplified and might cause the beam to blow up. To allow for this possibility, the aperture of the strong



Fate led British engineer John Adams to become head of CERN's proton synchrotron project in 1954 at the age of 34. Under his inspired leadership, CERN was to fulfill the dreams of its founding fathers. (Courtesy CERN) focusing machines would have to be larger than the Brookhaven physicists had initially suggested. To accommodate a larger tube, the enveloping magnet had to be much larger too, and the design energy of the CERN machine was compromised to 25 GeV.

In parallel with these technical advances, the British suddenly switched from aloofness and formally joined CERN, which finally decided on Geneva as the site for the new laboratory. On the map, the canton of Geneva appears as a curious appendage at the extreme west of Switzerland. Almost totally surrounded by France, it is joined to the rest of Switzerland by an umbilical cord a few kilometers across. Beginning with the Red Cross in 1863, the city of Geneva has become the home of many international organizations.

An advance party of the proton synchrotron group arriving in Geneva was joined by John and Hildred Blewett from Brookhaven. After bestowing crucial insights, Dahl preferred to remain in Bergen, first appointing Goward as his on-site supervisor, and finally resigning from the new project. Just a few months later, in March 1954 and only 33 years old, Goward died of a brain tumor. At the tender age of 34, Adams became leader of CERN's proton synchrotron project. Fate had provided the new project with its leader. John Adams was to be the Moses who would take CERN into the Promised Land.

CERN's first machine, the 600 MeV synchrocyclotron, was commissioned in 1957 and soon began producing useful physics. However it was far outgunned by the Cosmotron and Bevatron, by the big new Dubna Synchrophasotron attaining 10 GeV, and even by Britain's 1 GeV synchrotron at Birmingham. Eyes were focused on the race between the two proton synchrotron teams at Brookhaven and CERN.

On November 24, 1959, CERN's proton synchrotron accelerated protons to 25 GeV and briefly became the world's highest energy accelerator. Here a jubilant Gilberto Bernardini from Italy embraces John Adams.

On November 4, 1959, CERN's new proton synchrotron unexpectedly accelerated protons all the way to 25 GeV, becoming the world's highest energy machine, easily outstripping Dubna's 10 GeV. The CERN team was jubilant, and emotional and dramatic scenes offered a sharp contrast in national stereotypes. Gilberto Bernardini from Italy jubilantly kissed a disconcerted Adams on both cheeks. The laconic Adams phoned Alec Merrison, who later recalled, "He did not tell me in highly excited tones. He said 'Remember those scintillation counters you and Fidecaro put in the ring? Will they detect 20 GeV protons?' I paused long enough to grab a bottle of whisky and Professor Fidecaro, in that order, and came along to celebrate."

The following day, at a special news meeting for CERN staff, Adams showed a vodka bottle he had been given several months earlier on a trip to Russia with strict instructions that it should be drunk when the CERN synchrotron surpassed Dubna's energy. The bottle was now empty.

But Dubna's vodka bottle was not the only unfilled thing at CERN. Also very empty were the experimental halls around the new synchrotron. In the rush to build the new machine, few people had paid attention to the instrumentation needed to carry out experiments. At Brookhaven, the new Alternating Gradient Synchrotron (AGS), the twin of the new CERN machine, did not accelerate a beam until six months later. But this delay was more than compensated by the enthusiasm and ingenuity that went into planning experiments. U.S. physicists had cut their high energy accelerator teeth on the Cosmotron and the Bevatron. Within a few years of its commissioning, the AGS reaped an impressive harvest of important new physics results.

CERN had risen to the challenge of building the world's most powerful machine from scratch in just a few years, but developing research infrastructure and fostering experimental prowess was to take somewhat longer.