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Cover photograph: The CERN site at Meyrin with the Jura mountains as backdrop. The designers of the proposed LEP electron-positron ring (see our story on page 439) have to confront these mountains. (Photo CERN 290.9.81)

Progress towards LEP

At a special session on 30 October, the CERN Council voted for the construction of the large electron-positron storage ring, LEP. Nine of the Member States (Austria, Belgium, Denmark, Federal Republic of Germany, France, Greece, Italy, Switzerland, UK) had been able to vote in favour of the project at the Council session in June. They have now been joined by the remaining Member States — the Netherlands, Norway and Sweden (subject to certain conditions). This vote opens the way to negotiations with the Host States (France and Switzerland) which must precede the start of construction work.

Following many years of discussion and study, the present version of the LEP project has emerged as the best facility to ensure continued excellence in particle physics research in Europe. With the present state of experimental knowledge and theoretical speculation, the consensus is that the collision of electrons and positrons at high energies is the best way to find the answers to many of the important questions about the behaviour of matter which can now be posed. (For a review of the physics interest in LEP and description of features of the machine see the March 1980 issue, page 5.)

The vote which has just been obtained concerns Phase 1 of the project as accepted by Council in 1980. Some of the main technical features of Phase 1 are:

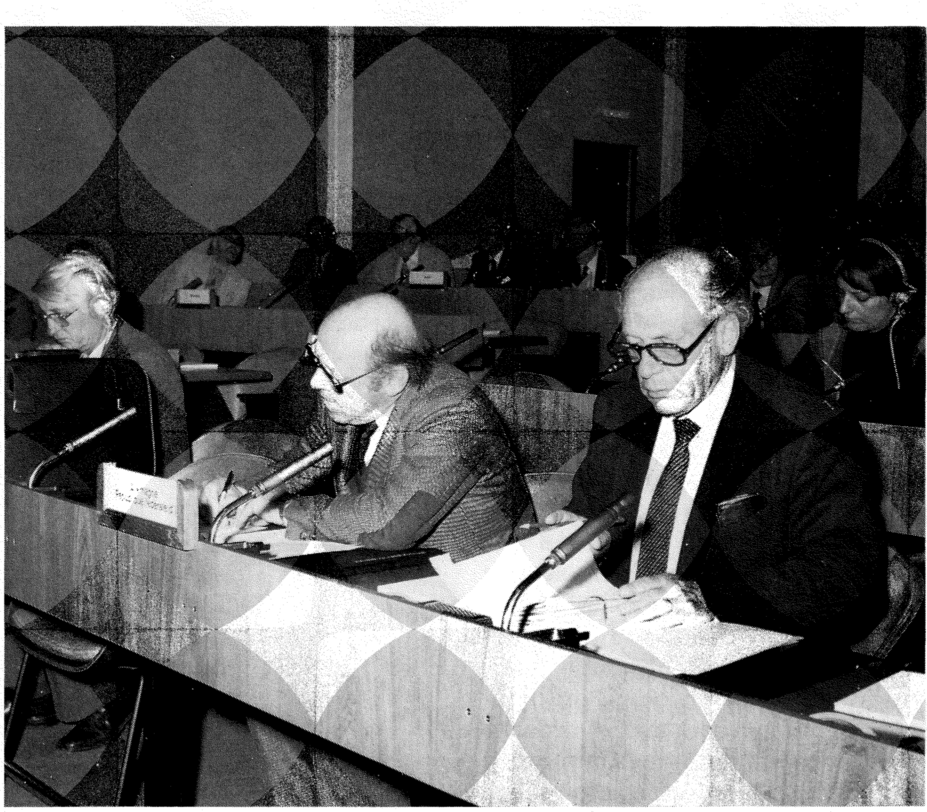
- Main Ring circumference of the order of 30 km,
- initial design energy of 50 GeV per beam of electrons and positrons at a luminosity sufficient for the initial research experiments,
- equipping four of the eight possible experimental areas with sufficient technical infrastructure to enable the initial experiments to be installed and operated,
- use of the existing CERN Proton Synchrotron (PS) and Super Proton Synchrotron (SPS) as part of the injection complex to provide LEP with electrons and positrons.

(However the definitive parameters of LEP and the exact position of the ring have yet to be fixed.)

In further Phases, the remaining experimental halls can be brought into action and the energy of the colliding beams can be increased. The move to significantly higher energies is likely to be dependent on the development of superconducting radiofrequency accelerating cavities so as to limit the power consumption of the machine. Also in the long term, the link with the proton synchrotrons gives the possibility of electron-proton colliding beams.

Obviously there is great satisfaction in the European high energy physics community that the Member States have again demonstrated their belief and confidence in the research at CERN. However it is also realized that CERN has not escaped the financial pressures which prevail in the Member States. At the CERN budget levels anticipated during the many years of LEP construction, it will be difficult to build the new machine while sustaining a vigorous programme of research on the existing machines.

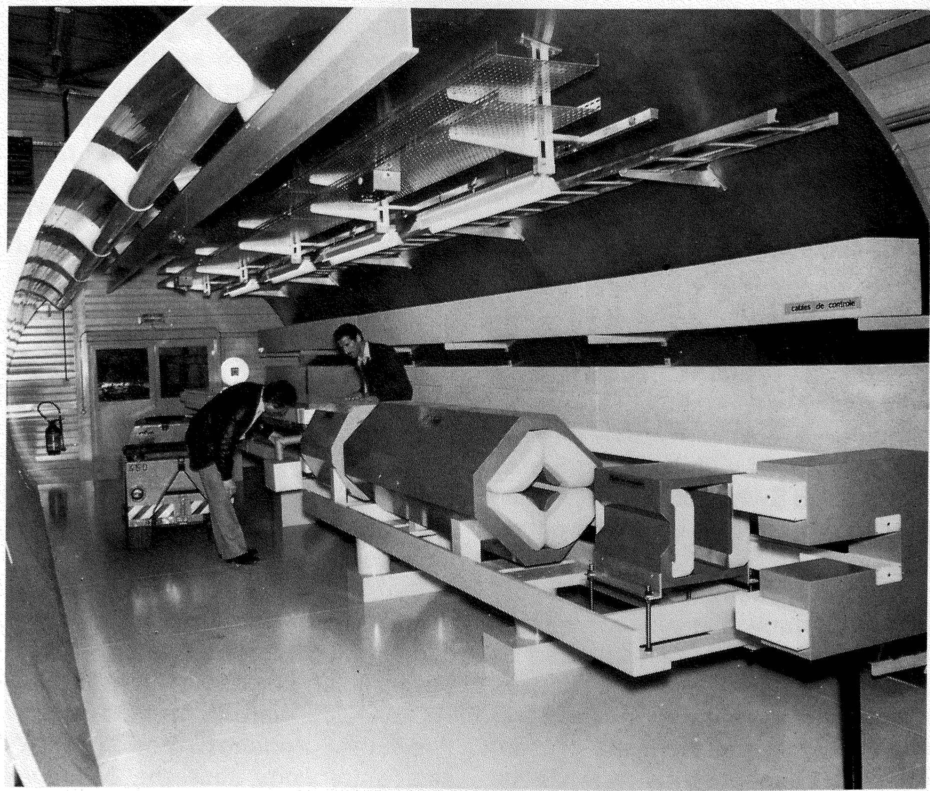
The special session of CERN Council on 30 October at which the remaining Member States voted in favour of the LEP project.



Balance of interregional collaborations

A mock-up of the LEP tunnel. It is not too early to look ahead at the implications of LEP for future international collaboration in physics experiments.

(Photo CERN 426.5.81)



The increasing cost of the accelerators and storage rings which are needed for front-line high energy physics is understandably reducing the number of these facilities available for research. Different world regions no longer have their own high energy machines with much duplication of experimental possibilities within or between regions. Instead, we are likely to see each region specializing in different types of physics. Already the front runners, in terms of approved or proposed new projects, give a worldwide spread of physics opportunities with less duplication than in the past.

In the USSR the plan is to construct the UNK fixed target 3 TeV proton synchrotron (with the possibility of colliding beams later). In Japan the emphasis is on the TRISTAN high energy electron-proton colliding beam machine (however beginning with a lower energy electron-positron phase). In Europe the main project is the LEP high energy electron-positron machine at CERN, while the HERA electron-proton project is being pursued at DESY, and the 270 GeV proton-antiproton scheme is in operation at the CERN SPS. In the USA, Fermilab is aiming for 1 TeV protons from the Tevatron plus proton-antiproton physics at that energy. Brookhaven has the ISABELLE 400 GeV proton-proton project and both Stanford and Cornell have schemes for high energy electron-positron colliding beams.

In these circumstances it would seem desirable to have an even greater mobility of physicists between the different regions, so that they can find the most appropriate machine to investigate the physics which interests them. Such interchanges have been going on modestly for many years and, in order to plan for their future development, a small group (John Mulvey, John Peoples, Karl Strauch and Gus Weber) has taken a look at the way in which interregional collaborations have worked.

They concentrated on collaborations between the most active regions, the USA and Western Europe, during the period 1974 to 1980. It became clear that the uniqueness of a research facility (which is exactly the situation that can be anticipated in the future) was the main spur in initiating the collaborations. Thus the existence of the Intersecting Storage Rings at CERN drew many scientists from the USA (as many as 25 per cent of the users in 1978) and, in the other direction, the earlier start up of the Fermilab 400 GeV machine drew many scientists from Europe until the CERN SPS began operation.

There is every reason to expect this pattern to continue with, for example, the Tevatron, LEP and ISABELLE. A Working Group of the European Committee for Future Accelerators estimated that the number of scientists from the USA using high energy physics facilities in Europe, and vice versa, may be double the 1978 figure (about 90) by the late 1980s.

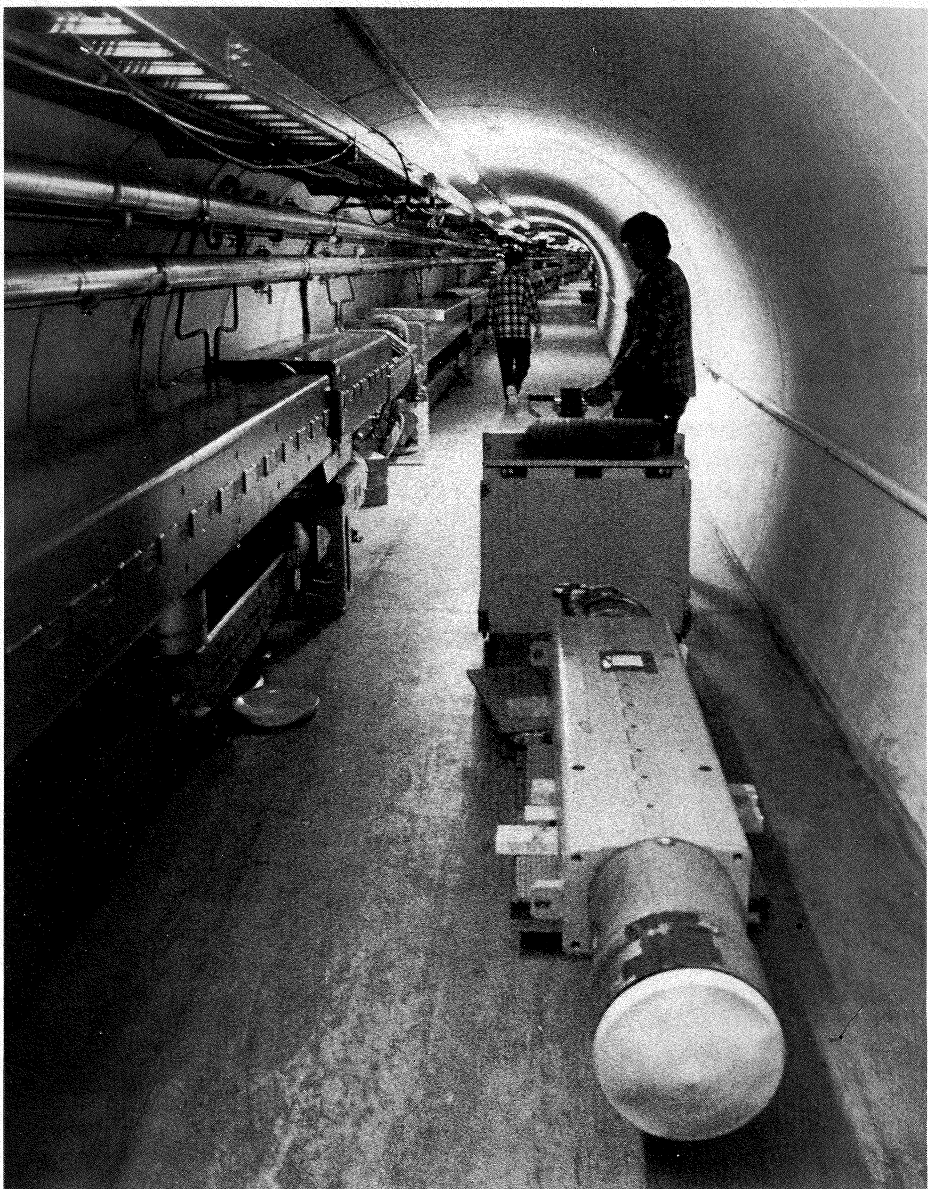
One of the surprising findings was how very evenly balanced, over a period of years, the exchange of people and resources has been.

The collaborations were considered under the headings of 'major' (involving the transfer of equipment worth over 100 thousand dollars) and 'smaller' (less than 100 thousand dollars but still involving a visiting team of several scientists). The major collaborations were examined in some detail to discover their origins and how they operated, and how costs for detectors and computing were shared.

In the period covered there were six major US participations at CERN and DESY and nine Western European involvements at Fermilab, Stanford, Cornell and Argonne. For the smaller collaborations the corresponding figures were sixteen and twenty-three. The smaller number of US collaborations reflects the fact that US teams were predominantly involved in colliding beam physics where teams are larger and costs of detectors and computers are correspondingly higher.

Interregional collaborations have always involved many physicists from the host region. Acceptance of proposals at the different Laboratories has been mainly on physics merit with some regional considerations, particularly at CERN, on the overall composition of the experimental team. Accelerator time has always been made available free and detector and computing costs have been shared after negotiation. No exceptional difficulties were found in interregional collaborations.

The investigators maintained that the collaborations between high energy physicists in the US and Western Europe have made significant contributions to the success of the research programmes in each region. There has been a good balance between the efforts made in each direction. For the continued good health of these interregional collaborations it is important that they continue to be in the interest of the regions concerned (which the development of unique facilities guarantees) and that this balance of exchange is maintained. There seems no need to change existing procedures in order to sustain this good health. Provided that flexibility continues in the future and scientific merit remains the main criterion, interregional collaborations should continue to be of great benefit to high energy physics research.



Installation of superconducting magnets for the Fermilab Saver/Doubler. The availability of 1000 GeV protons could provide a major attraction for physicists all over the world.

(Photo Fermilab)

25 years of the Joint Institute for Nuclear Research

Dubna's largest accelerator, the synchrophasotron, which when operated as a proton machine in 1957 was the highest energy machine in the world. Since 1970 it has been used to accelerate heavy ions to relativistic energies for nuclear physics research.

Progress in science during the last thirty years has been marked by a great increase in international scientific collaboration. The creation of the Joint Institute for Nuclear Research (JINR) at Dubna in the USSR is one vivid example of this important trend. This year Dubna celebrates its 25th anniversary.

In the early 1950s, progress in nuclear physics and technology demanded new forms of scientific collaboration. The installations to carry out experiments took on industrial dimensions and became complex and expensive. Many scientific staff were needed to do the experiments and to handle the enormous amounts of data. Therefore the Governments of the socialist countries embarked on a project to coordinate the activities of scientists and to pool financial and technical resources for the development of fundamental research in particle and nuclear physics.

In 1956 in Moscow, the delegates of the Member States signed a Convention establishing the Joint Institute for Nuclear Research. The Convention defined the main purpose of the Organization as a research collaboration which would lead to wider possibilities in the peaceful use of atomic energy. The principal tasks of the Organization are to promote the development of science in the Member States, to help in establishing national scientific Laboratories and to develop international cooperation with research centres throughout the world.

Today Dubna is known as a leading scientific centre and is one of the largest in the world. Scientists from Bulgaria, Cuba, Czechoslovakia, the German Democratic Republic, Hungary, Mongolia, the Korean People's Democratic Republic, Poland, Roumania, the USSR and Vietnam work at the Institute. Also, in accordance with its Convention, JINR keeps in contact with the research centres in Member States and with corresponding international organizations and research centres in other countries.

There are fruitful contacts with CERN, Fermilab, the Italian institutes of physics in Turin, Milan and Frascati, the Niels Bohr Institute in Copenhagen, the International Centre for Theoretical Physics in Trieste, the French research centres at Orsay, Saclay and Grenoble, and research centres in Great Britain, West Germany, Finland and Yugoslavia. JINR grants fellowships to scientists from non-member countries, and physicists from the IAEA, UNESCO and from different countries in Europe, Asia and Africa have worked in Dubna as fellows.

Scientists at Dubna have made an important contribution to the development of modern physics. They have initiated new research trends and have discovered new phenomena. Results in theoretical physics, particle physics, nuclear and neutron physics and in the development of accelerators and detectors have brought JINR international recognition and esteem.

Development of accelerator technology has always had a lot of attention. The synchrophasotron was the first relativistic accelerator of nuclei — it accelerates deuterons, alpha particles and carbon, nitrogen and oxygen nuclei. Heavy ion acceleration is also provided by a powerful 4 m isochronous cyclotron and a facility based on the collective acceleration method proposed and developed by JINR scientists. A new powerful pulsed reactor, IBR-2, has been constructed for neutron physics. JINR scientists take part also in the project for the new UNK 3 TeV acceleration and storage complex at Serpukhov.

The 680 MeV synchro-cyclotron which began operation at Dubna in 1949 before JINR formally came into existence. It is being reconstructed to provide more intense particle beams.

(Photos JINR Dubna)

The activities of the Joint Institute for Nuclear Research are based on international cooperation which meets the demands of modern science. It takes a variety of forms, the main one being experimental research conducted by teams of scientists from different Member States. There is collaboration with national research centres in the Member States in theoretical and experimental work. This form of cooperation covers more than 90 per cent of the whole scientific programme.

Great importance is attached to the visits of JINR scientists to other countries for completing joint projects, giving lectures, consulting and for exchanging experience. Annually there are over 500 visits of JINR specialists to the Member States and over 2000 visits to JINR from the Member States.

Dubna also provides excellent conditions for the training of scientists, giving them the opportunity to work with modern installations. Hundreds of scientists and engineers have been trained and have left Dubna highly qualified in many fields of modern science and engineering.

JINR scientists participate in important international and national scientific meetings. Reciprocally the Institute has sponsored many international conferences and workshops. Every other year JINR and CERN organize joint Schools of Physics for young scientists.

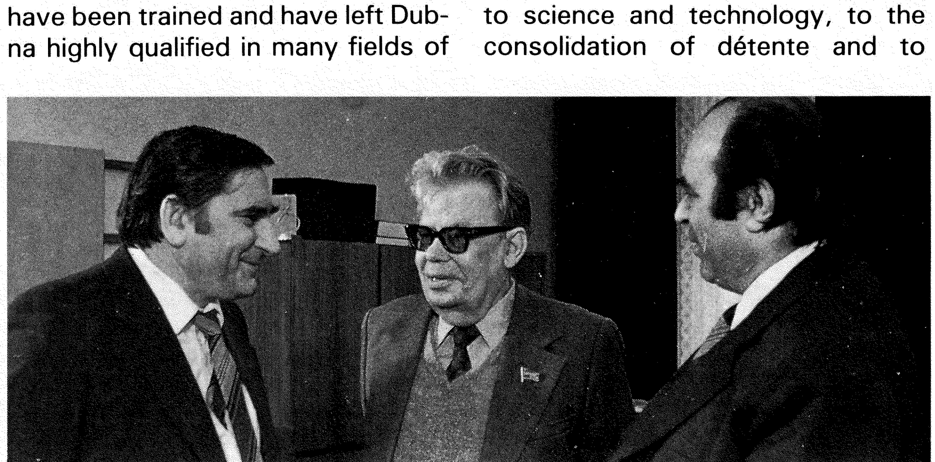
The work at Dubna over the past 25 years has more than fulfilled the expectations of the scientists and governments who decided to create the Institute.

The anniversary ceremony

Scientists, engineers and workers from all the Member States, together with those who helped to build the Laboratory's equipment, gathered at Dubna to celebrate the 25th anniversary. They were joined by many who had participated at different times in the research and in developing international cooperation. The meeting also brought together Heads of diplomatic missions, delegates of the Member States, representatives of Ministries of Atomic Energy, leading scientists and the local public.

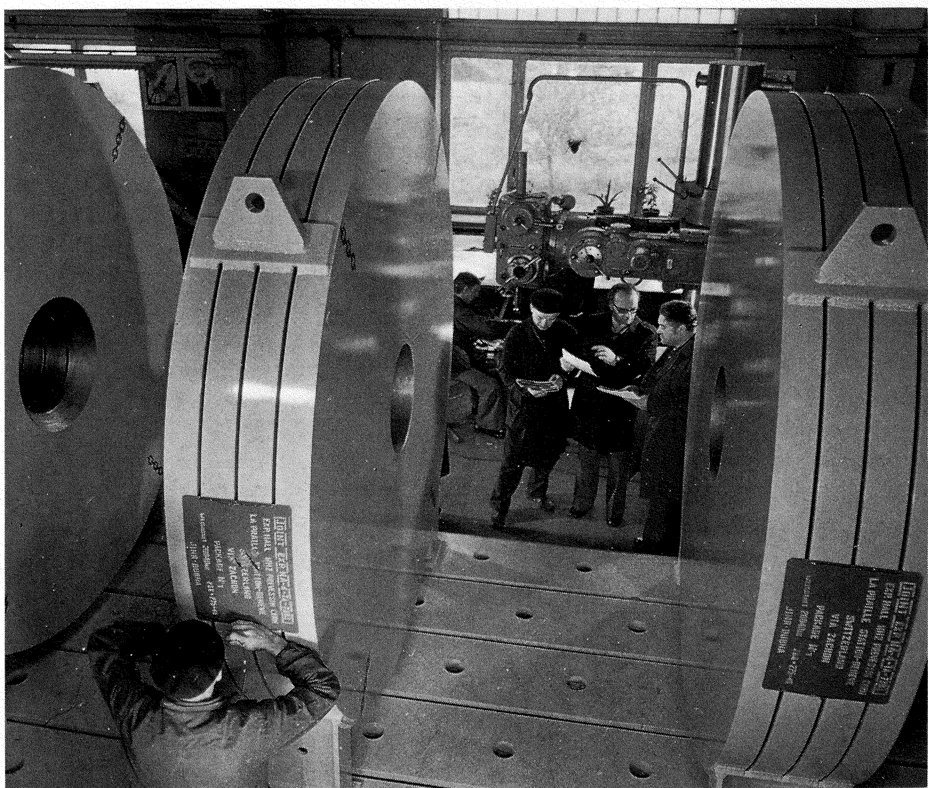
Leonid Brezhnev sent a Salutory Address which was read out at the gala meeting. He expressed his confidence in future achievements by the international staff of the Institute and gave high praise to its contributions to science and technology, to the consolidation of détente and to

Scientists from the Member States play leading roles in the administration of the Joint Institute for Nuclear Research and the work of its consultative committees. JINR Director N. N. Bogolubov (centre) is seen here flanked by Deputy Directors M. Sowinski from Poland (left) and I. Zlatev from Bulgaria (right).



peace. Addresses were also sent by Todor Zhivkov, Pham Van Dong, Fidel Castro Rus, Jumjagijn Tsedenbal, Gustav Husak and other Heads of Member States.

JINR Director Nikolai Bogolubov said: 'Today, when we celebrate the 25th anniversary of the creation of the Institute, we remember the deep intuition and firm decision of the socialist countries that made possible research in nuclear physics to promote the peaceful use of atomic research for the benefit of all mankind. Our Institute has made many great achievements and has excellent traditions, which ensure a promising future. There is no doubt that the international staff of the Institute will accomplish still more in the quest to uncover the secrets of Nature.



There have been many collaborations between JINR and CERN. Recently, toroidal magnet cores for a muon experiment at the CERN 400 GeV Super Proton Synchrotron were constructed in Dubna's Experimental Physics Department.

CERN SPS looks forward

The experiments committee of CERN's SPS 400 GeV proton synchrotron met recently at Cogne in the Aosta valley, Italy, to review the experimental programme and to look ahead at future possibilities.

For convenience, the physics discussions were divided into four areas — 'soft' physics (covering total cross-section measurements, spin physics, resonance production, etc.), new particles (charm and beauty), experiments with neutrino and muon beams, and hard hadron physics (constituent quark interactions). A useful comparison was provided by Peter Koehler, who described the Fermilab experimental programme.

In the field of 'soft' physics, high quality measurements had got under way right from the start of SPS operations in 1976. Over the years an impressive array of results has been provided by a range of experiments covering diverse areas such as photoproduction, hyperon studies, small angle scattering, electromagnetic form factors, etc. To a large extent, this research at the SPS is seen as naturally nearing its end, at least for fixed target experiments. However the European Hybrid Spectrometer now operational in the North Experimental Area could still have important contributions to make. At the proton-antiproton collider, UA4 (total proton-antiproton cross-sections) and UA6 (gas jet target in the antiproton beam) will probe fresh energy regions and provide new results.

The conclusion reached at Cogne was that while soft physics is not seen as a major part of the future SPS programme, the intrinsic flexibility of the available large detectors could still be used to test out any new ideas which might emerge in this field.

In the search for new particles, charm physics could benefit considerably from the new techniques (small bubble chambers, holography and novel electronic methods) developed to cope with the very short lifetimes which are involved. In the search for beauty particles, it was felt important to establish an optimal mix of searches which would avoid the twin pitfalls of putting too much emphasis on a few experiments on one hand and on the other hand spreading the effort too widely. It was thought that new particle searches would be prominent in the future SPS experimental programme.

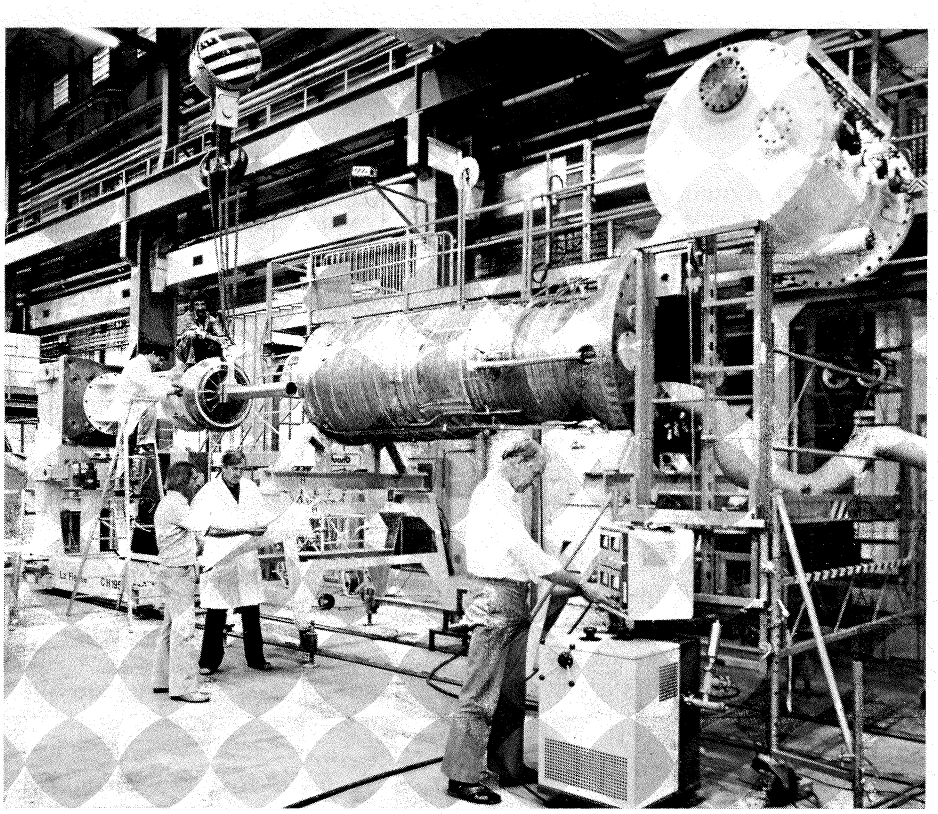
Physics with neutrino and muon beams is one of the strongpoints of the SPS programme. The determinations of nucleon structure functions in different experiments are generally compatible, but it was felt that one more round of high precision measurements is required to confirm this. In fragmentation studies which look at the hadrons liberated in quark interactions, the muon experiments are consolidating what has been learned previously with neutrinos and what is being learned from experiments at electron-positron machines. Also covered under this heading was another SPS speciality — neutrino beam-dump experiments. With the improved facilities now being installed in the West Experimental Area, together with improvements to existing experiments, neutrino beam-dumps could make further physics discoveries.

In the area of hard hadron physics, important contributions have come from the SPS — for example in the study of the electromagnetic interactions of quarks (Drell-Yan mechanism) and of hadron production at large momentum transfer. However, there was a feeling that perhaps the fixed target energies at the SPS are not high enough to probe the areas where interesting behaviour can be found. The higher energies available with colliding beams, notably the Intersecting Storage Rings and the SPS proton-antiproton collider are probably better suited for this kind of work. However there could still be a demand for special experiments to test specific new ideas.

A proposal to extract 270 GeV antiprotons from the SPS for fixed target experiments was not recommended for a variety of reasons. It was felt that the physics potential of this project was covered to a certain extent by the UA6 antiproton experiment with its gas jet target. This project would also imply increased operational difficulties for a machine already having to cope with a crowded fixed target schedule and operation as a proton-antiproton storage ring.

An optimistic note was provided by the prospects for the SPS proton-antiproton project, where the impressive experiments are now well instrumented. Everyone joined in wishing the experiments high luminosities to capitalize on the unique physics opportunities which the antiproton project offers.

In the Cogne discussions, one unwelcome but nevertheless important consideration was money. Financial restrictions are now becoming a fact of life, and availability of future funds could dictate the evolving pattern of experiments at the SPS.

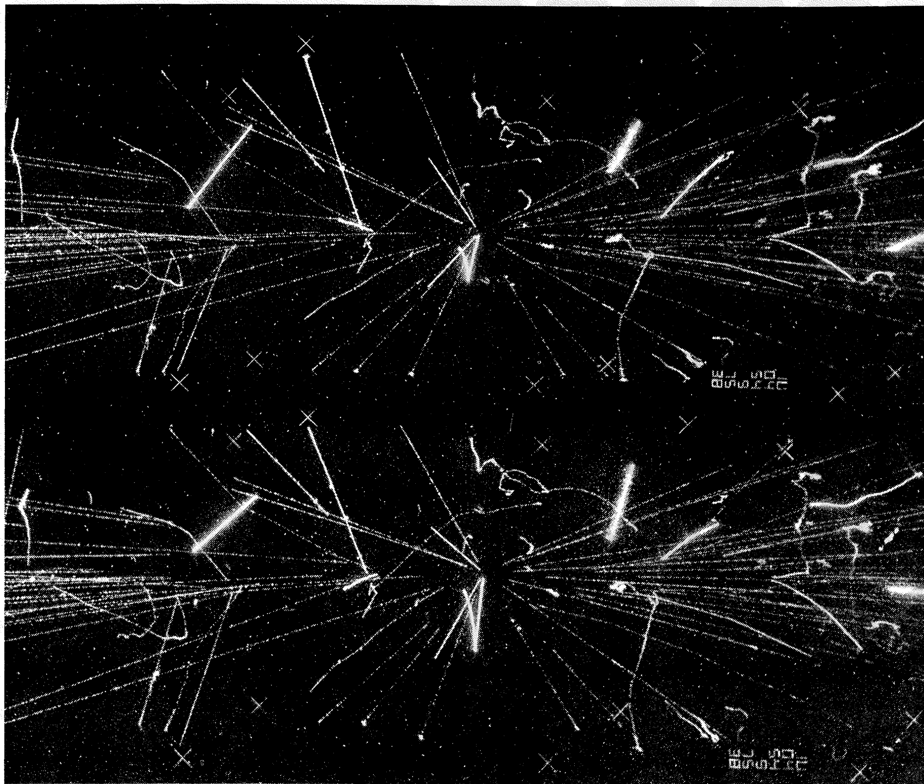


Assembly of the rapid cycling bubble chamber which forms the central detector of the European Hybrid Spectrometer. This could go on to make additional contributions to the 'soft' physics discoveries already amassed at the CERN SPS.

(Photo CERN 131.8.80)

Around the Laboratories

Two views of a 540 GeV total energy proton-antiproton collision, as recorded in one of the big streamer chambers of the UA5 experiment at the CERN SPS.



CERN
Antiprotons again

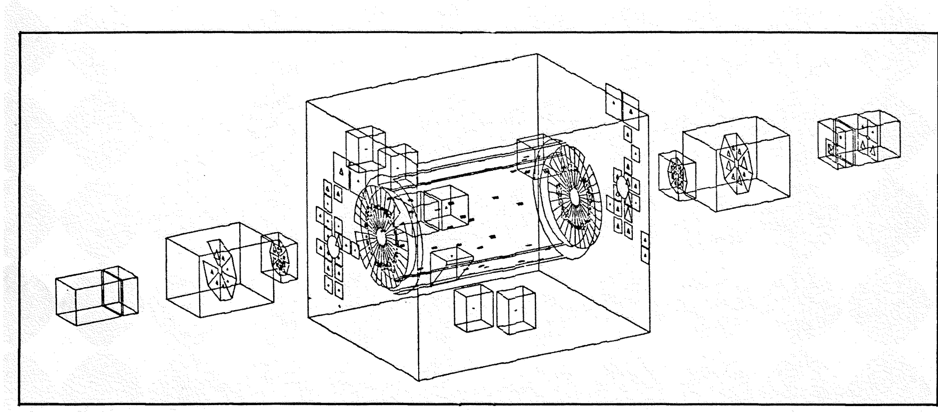
At the end of October, the CERN machines once more supplied antiprotons, and experiments at both the big SPS proton synchrotron and the Intersecting Storage Rings were able to record data from proton-antiproton collisions. This time the big streamer chambers of the UA5 experiment (Bonn / Brussels / Cambridge / CERN / Stockholm collaboration) came into action at the SPS (see June 1980 issue, page 148) and recorded some 2000 good examples of proton-antiproton collisions at 540 GeV total energy. Also in the SPS, the big UA1 experiment took more data to supplement that gathered in its first run in August. However this time the UA1 central detector came into action for the first time, supplying detailed information on the interaction vertices. Initial physics information from these experiments could soon emerge.

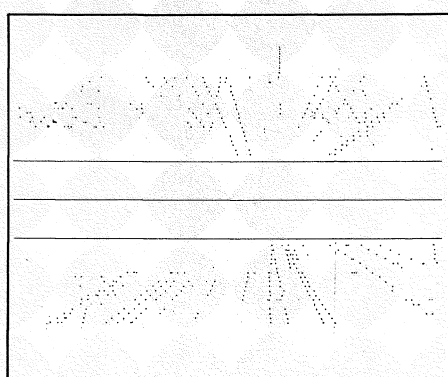
In the SPS, a bunch of some 10^9 270 GeV antiprotons circulated against two proton bunches, each containing about 5×10^{10} particles. Thus both UA1 and UA5, in different regions of the ring, were able to study collisions in parallel. The SPS beams were twice stored overnight. In the near future it is hoped to test the new SPS low beta magnets in readiness for increased antiproton luminosities.

Also during this run, the 'Roman pots' — drift chambers mounted in movable sections of beam pipe — of the UA4 experiment took their first samples of forward proton-antiproton elastic scattering at the SPS. This technique was first used in the early days of the CERN ISR to measure total reaction rates in the newly-available energy range. The UA4

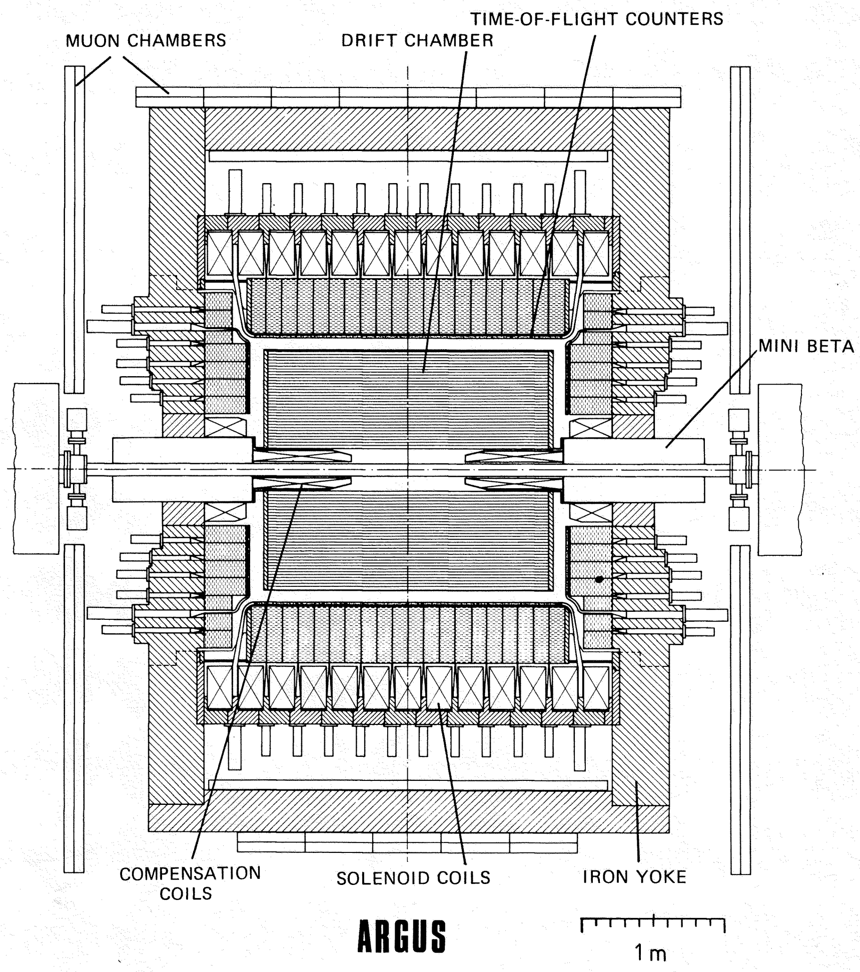
Below left, a representation of the UA1 apparatus used to study the energy flow in 540 GeV proton-antiproton collisions at the CERN SPS, showing the signals recorded in the calorimeters. The central electromagnetic calorimeters are enclosed by the large cubic instrumented return yoke of the magnet. The forward detectors extend on either side in the SPS tunnel.

Below right, the signals picked up in the middle cell of the cylindrical central detector which surrounds the beam pipe. These are the first tracks seen in the detector, with a small fraction of readout installed for the October run.





Layout of the ARGUS detector scheduled for the revamped DORIS-II electron-positron ring at DESY.



group (Amsterdam / CERN / Genoa / Naples / Pisa) soon hopes to provide a value for the total proton-antiproton reaction rate at 540 GeV.

While all this action was going on at the SPS, a two milliamp antiproton beam was quietly circulating in the ISR. The highly successful run was terminated on 2 November after the antiprotons had been kept for more than thirteen days! With a proton beam of 12 A, the proton-antiproton luminosity attained 9×10^{26} cm^{-2} s^{-1}. As a result of the run, a new lower limit for the antiproton lifetime was established.

Baryons from quarks

According to our present picture of the deep inelastic interactions of high energy leptons, the incoming lepton penetrates into the interior of the struck nucleon and interacts with one or other of its constituent quarks. Both the struck quark (current fragmentation) and the spectator quarks (target fragmentation) then produce sprays of hadronic matter. In principle, the hadrons from the struck and spectator quarks should be distinguishable, although this distinction only becomes really clear at higher energies. Because only one quark is assumed to be struck per interaction, the current fragmentation would be expected to be dominated by mesons (containing a quark and an antiquark), while baryons (three quarks) would be produced in the target fragmentation.

The European Muon Collaboration (EMC) experiment in the North Experimental Area of CERN's SPS 400 GeV proton synchrotron has studied the interactions of 120 and 280 GeV muons with protons and finds not only mesons, but also protons and antiprotons in the hadronic debris of current fragmentation. This baryon production had not been seen at lower energies with electron beams, and could turn out to be related to the unexpectedly high baryon yields seen in high energy electron-positron annihilations at DESY's PETRA ring.

According to simple quark counting rules, equal numbers of baryons and antibaryons should be seen, however the EMC data show an excess of protons over antiprotons. This is puzzling, but could be due to the difficulty of separating the products of current and target fragmentation, even at SPS energies. It could also be due to one of the mechanisms of current fragmentation.

The EMC experiment is now employing a streamer chamber as vertex detector together with more sophisticated particle identification immediately downstream. The new apparatus will be described in detail in our January/February 1982 issue.

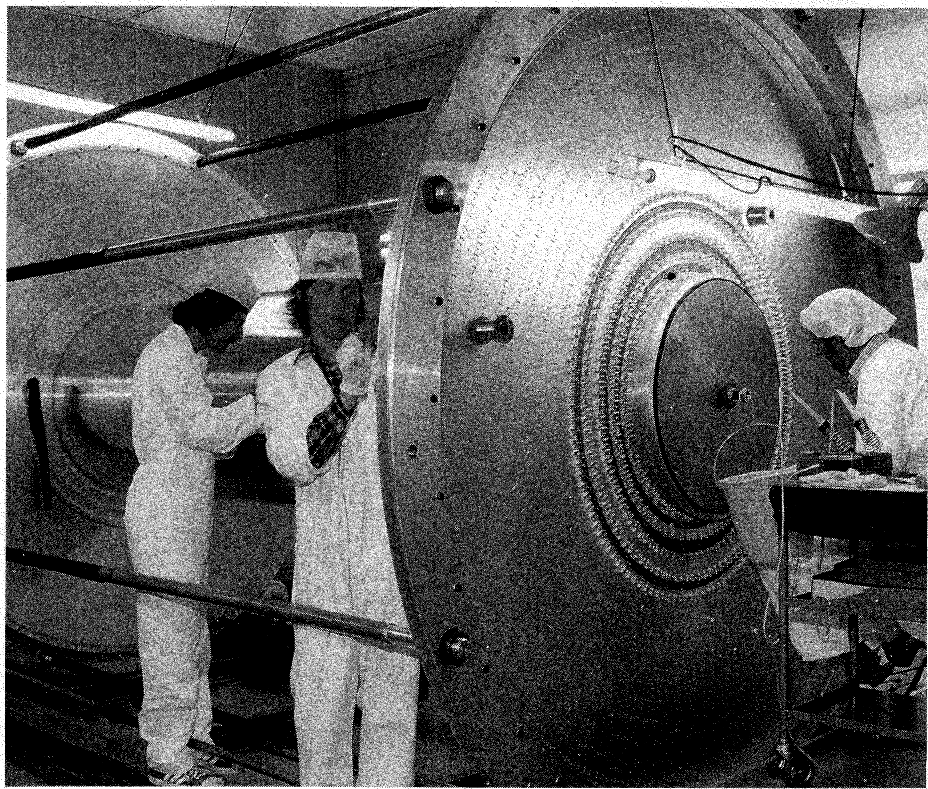
DESY
New detector for DORIS-II

ARGUS is one of the two big detectors which will be installed next spring at the revamped DORIS-II electron-positron storage ring at DESY (see November issue, p. 397). The second interaction region will house the Crystal Ball detector from SPEAR. The improved running conditions, in particular the higher luminosity expected at total energies up to 11.2 GeV, make DORIS-II an excellent tool for studying upsilon particles and beauty mesons. However DORIS-II also covers the entire charm production region, down to the J/psi at 3.1 GeV.

ARGUS is a universal detector with magnetic momentum analysis of charged particles, shower counters and muon identification covering

Carefully does it. Threading the 30 000 drift chamber wires for the new ARGUS detector.

(Photo DESY)



most of the solid angle around the interaction point.

The large ARGUS magnet is of the solenoid type and weighs about 400 tons. A field of 0.8 T is provided by 13 separate coils about 3 m in diameter. This unusual design allows installation of a system of lead/scintillator shower counters (a so-called 'sampling calorimeter') inside the solenoid. The corresponding light-guides pass between the coils to reach the photomultipliers outside. There is very little material in front of the shower counters and therefore good energy resolution is expected down to energies as small as 50 MeV. The shower counters, built at the Physics Institute of the University of Dortmund, are read out through wavelength-shifting light-guides. The complete calorimeter covers about 95 per cent of the solid angle and consists of 1760 shower counters, providing efficient reconstruction of particles decaying into photons.

Further components of ARGUS detect charged particles. A set of 160 time-of-flight counters, built at the Institute for High Energy Physics of the University of Heidelberg, helps to identify them. Resolution time is 270 picoseconds. They surround the main track measuring device, a large cylindrical drift chamber designed to reach a maximum of precision for measuring coordinates and for particle identification. About 30 000 wires are distributed over a volume 2 m long and 1.7 m in diameter. They define 5940 drift cells with square cross-section, arranged in 36 cylindrical layers. Half of them are slightly inclined, so as to provide three stereo views. Simulations showed that a reliable track reconstruction can be performed even for very complex events. Momentum resolution is good and ionization loss is measured in each drift cell. Using this information, kaons can be separated from pions up to 900 MeV. These properties will come in useful for the reconstruction of mesons carrying charm and beauty.

The ARGUS magnet is surrounded by a muon detection system consisting of 2000 proportional tubes and covering 80 per cent of the solid angle. To reach these tubes, muons must penetrate 5.1 absorption lengths of material in the lead of the shower counters, the copper coils and the iron flux return.

The mini-beta quadrupoles (see July/August issue, p. 237) required to achieve high DORIS-II luminosities had to be integrated into the detector. They are surrounded by small compensation coils which protect them from the high field of the main ARGUS magnet. To compensate the field along the beamline, two long solenoids are placed around the vacuum pipe leaving only its central region free. This part of the pipe is made of a thin carbon-fibre tube which minimizes the amount of matter placed in the way of particles going into the sensitive part of the detector. Particles leaving the interaction region at more than 13.5 degrees will reach the drift chambers through this tube.

The physics programme concentrates on the study of beauty quarks, covering both strong and weak interactions. The beauty quark-antiquark ground state, the upsilon, decays into three gluons and provides an excellent 'gluon factory' for investigating quantum chromodynamics. The spectroscopy of the excited upsilons and their transitions are also of great interest. The theory of weak interactions has to be extended to include the fifth quark, which requires the study of beauty meson decays. The ARGUS detector is ideally suited for this work.

Practical work was an important part of the recent 'College on Microprocessors' held at the International Centre for Theoretical Physics, Trieste.

TRIESTE
College on Microprocessors

The International Centre for Theoretical Physics, set up at Trieste in 1964, has as its major task the provision of a stimulating intellectual environment for physicists from developing countries. This goal is furthered by a varied programme of courses for visiting scientists. Not all the courses remain in the rarefied atmosphere of theory and in September a very successful 'College on Microprocessors: Technology and Applications in Physics' was held. It was a prime example of the efforts being made to spread important modern technology into the developing countries.

The College attracted some 140 physicists, mainly from the Far East, Middle East, Africa and South America. Held at ICTP, it consisted of four weeks of intense lectures and practical sessions on microprocessors and their applications. The College was directed by Andy Van Dam from Brown University and Rinus Verkerk and Paolo Zanella from CERN.

When ICTP decided to include a course on microprocessors, scientific programme director Professor Bertocchi contacted CERN for help in drawing up a series of appropriate lectures. It was at CERN that the ideas for the practical sessions emerged and where most of the necessary hardware and software were prepared. In his opening address, Bertocchi paid tribute to these contributions, referring to 'the usual CERN style, which means perfection'.

Each morning there were lectures on the basics of microprocessors and their potential uses, and covering some broader topics in computer science (such as programming tools and techniques). Microprocessor applications in many areas of physics were described.

However it was the practical sessions which really rubbed home the messages from the lectures. These were held in the afternoons in three shifts, each involving forty students for two hours at twenty work stations, with a team of instructors headed by Wolfgang von Rueden and Robert McLaren. The stations had a terminal and monitor, prepared at CERN, and were linked by telephone line to the CDC computer at the University of Trieste 9 km away.

The physicists participated very enthusiastically in the long hard course. Each of them left carrying a mountain of lecture notes and microprocessor kit to help spread their newly-gained knowledge in their home universities. The College was so successful that the possibility of making it 'transportable' to other appropriate international audiences is under discussion.

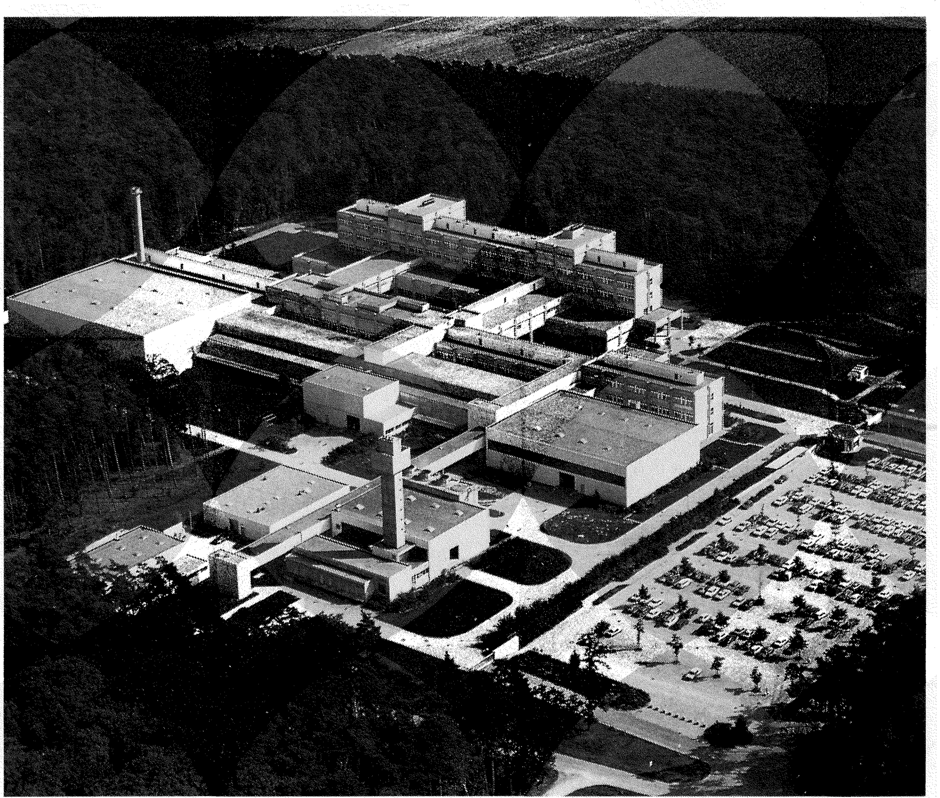
DARMSTADT
5 years of UNILAC

With the UNILAC heavy ion accelerator switched off for its energy upgrade from 10 MeV/u to 20 MeV/u, a two-day meeting was held recently at GSI Darmstadt to summarize five years of research with UNILAC and to look to the future.

It was especially interesting to compare actual results with previous predictions, beliefs and projections. In particular, the boundaries of nuclear stability are not as easily accessible as was once thought. In trying to reach these boundaries, much has been learned about heavy nuclei and more than 70 new isotopes have been found. These include two very neutron-deficient nuclei—lutetium

The GSI Laboratory, Darmstadt, recently the scene of a meeting to review five years of operation of its UNILAC heavy ion accelerator. The large building on the extreme left is the main UNILAC experimental hall.

(Photo Aero-Lux)



151 and thulium 147—whose radioactive decay gives protons (see October issue, page 357. Some errors crept into our coverage of this discovery, which was made using a nickel 58 beam on a ruthenium 96 target). Another nuclear achievement is the identification of an isotope of the heaviest known element with mass number 262 (see May issue, page 164).

These activities will be continued using more sophisticated instrumentation and an extended scale of available energy to learn more about the forces that drive unstable nuclei towards their ground state. Nuclear fission induced by Coulomb interaction could be demonstrated by firing heavy projectiles at uranium 238 and curium 248.

Deep inelastic scattering has been exploited as a special kind of reaction mechanism between heavy nuclei. As well as nucleon exchange, this type of reaction also shows the transfer of a considerable fraction of relative kinetic energy and angular momentum into excitation energy and spin. The neutron-proton ratio in the reaction system comes into equilibrium in about 10^{-22}s, a process which is not yet well understood. However a net mass transfer takes a hundred times longer to come about. It could be shown that nuclear structure influences the initial phase of deep inelastic reactions, but more study is required before the whole process can be revealed. This kind of reaction has been used to synthesize an excited compound nucleus containing 114 protons and with a measured lifetime longer than 10^{-20} seconds.

Analysis of deep inelastic reaction data allowed the timescale 10^{-22} to 10^{-20} s, typical of this kind of process, to be calibrated. With higher energies, this 'clock' can be refined.

Unexpected and extensive activities have developed in atomic physics. With energetic heavy ions available, spectra of hydrogen- and helium-like atoms with nuclear charge up to 40 can be studied. In addition it was found that heavy ions could produce unexpectedly high target ionization of atoms in a gas, allowing the study of electron capture to be extended. Energetic collisions of very heavy ions opened up the spectroscopy of electronic states in Coulomb fields far stronger than those of the heaviest elements. If in these quasi-atomic transient systems the combined charge exceeds 173, the electronic binding energy in the lowest atomic level should exceed twice the electron rest mass. A vacancy in this level could be filled by spontaneous creation of an electron-positron pair with emission of the positron. Whether this mechanism can occur or not has yet to be determined. However energy spectra of positrons of atomic origin could be measured in several heavy collision systems and throw light on the possibility of spontaneous electron-positron production in very strong atomic electromagnetic fields.

BROOKHAVEN Exotic nuclei at TRISTAN

This year saw the initial operation of the TRISTAN on-line mass separator at the Brookhaven National Laboratory High Flux Beam Reactor. This TRISTAN, not to be confused with the electron-positron project under way at the Japanese KEK Laboratory, is a counterpart to CERN's ISOLDE and is devoted to the production of exotic nuclei whose ratio of neutrons to protons departs from what is found for stable nuclei.

The TRISTAN on-line mass separator at Brookhaven. The ion source (behind the shielding blocks, top left) is in the neutron beam of the High Flux Beam Reactor. Fission fragments are extracted and the desired isotope is selected by the curved magnet (centre). The particles are directed to the appropriate detector by a switching magnet.

(Photo Brookhaven)

In the case of TRISTAN, these exotic nuclei are those neutron-rich isotopes produced as a by-product of thermal neutron fission. Other devices, such as ISOLDE, take advantage of high energy reactions to produce isotopes on the proton rich-side, as well as the neutron-rich side of stability.

The emphasis at TRISTAN is on the nuclear spectroscopy of neutron-rich nuclei, and the various radioactive emanations are detected as the nuclei decay back to stability. Systematic checks of various nuclear models are explored along the decay chain. Such checks carried out off the line of stability provide stringent tests of models developed largely on the basis of stable or near-stable nuclei.

TRISTAN uses an external beam of 2×10^{10} nuclei per cm^2 per s on an in-beam integral-target ion-source assembly. These targets consist of uranyl nitrate embedded in graphite cloth and heated to about 2000 degrees C. Various techniques are used to ionize the fission product atoms — the most successful one employed in initial TRISTAN experiments has been that of surface ionization. This method is successful in producing intense beams of the alkali metals rubidium and caesium, as well as interesting amounts of barium, strontium, and praseodymium isotopes. A curved magnet subsequently analyses the ion beam, which after passing through a defining slit falls on a mylar tape. This tape travels past various detectors in a series of motions which can be sequenced in such a way as to enhance the counting rate for a particular half-life in the decay chain at the detector locations.

One of the more notable achievements of the early TRISTAN operation was the first detection of two-neutron emission from a fission fragment rubidium-98. This phenomenon, which has also been systematically studied at CERN, occurs when the available beta decay energy exceeds that of separation energy for two neutrons in the daughter nucleus. Other achievements include the observation of the variation in energy of the first excited spin-zero, positive parity levels in even mass number cerium nuclei.

A rather sophisticated data reduction and analysis system is used to analyse the results. A unique feature is a four-detector analyser to simultaneously collect coincident gamma ray decay radiation in four high-resolution detectors positioned at various angles in the reaction plane.

The four-detector system is being extensively used in gamma ray angular correlation studies, which are crucial in making level/spin assignments. The computer-based data system features distributed data processing and can multiplex eight experimental inputs at a time.

BERKELEY
Electron microscopy

A National Center for Electron Microscopy was recently opened at Berkeley. It houses a 1.5 MeV High Voltage Electron Microscope (HVEM), and a 1 MeV Atomic Resolution Microscope (ARM) is scheduled to come into operation in about two years.

Commercial microscopes typically operate at about 100 keV but these new instruments will make it possible to investigate specimens under realistic conditions and to image them with the highest achievable resolution, so that individual atoms can be seen. When complete, the facility is expected to cost about $8 million.

The centre is open to all scientists meeting the DOE Materials Science Division's 'relevancy criteria'. Proposals for experiments are screened by a steering committee of researchers from Berkeley and elsewhere. K.H. Westmacott, HVEM Facility Manager, reports that over thirty projects are already approved.

Advanced as it is, the HVEM is not a marked technological improvement. However the ARM, now under construction in Japan, will break new ground. R. Gronsky, ARM Facility Manager, calls it 'the moonshot of electron microscopy'. The prime goal will be to break the 2 angstrom barrier (the present limit of transmission electron microscopes). Anything greater than 500 keV is considered a high voltage electron microscope and there are a dozen such instruments in the United States, but none has as high an energy as the HVEM and none has atomic resolution.

The centre was pioneered by Gareth Thomas, now its Scientific Director. He arrived at Berkeley in the early 1960s when a 200 keV microscope was the state-of-the-art, but by the end of the decade, he had a 650 keV machine. In the early 1970s, he teamed with biologist Robert Glaeser of Berkeley and physicist John Cowley of Arizona State University to propose a national centre with an atomic resolution instrument.

One advantage of high accelerating voltages is that the electron beam can penetrate thick samples. In materials science, for example, specimens are thinned to 1 micrometer or less so that electrons can pass through and be focused into an image. However if the material is too thin, most of its atoms are close enough to a surface to have their properties altered; there is a critical thickness below which surface-dominated rather than bulk behaviour prevails. If the electrons can penetrate thicker sections, it is easier to be sure one is observing bulk structure.

Also, with the HVEM, biologists do not have to resort to serial sectioning of thick samples, but can study entire specimens at once because of the great penetration.

Material scientists and solid-state chemists are becoming interested in in-situ studies. Rather than studying the oxidation of a metal alloy by heating it in a furnace and later thinning it and transferring it to the microscope, the oxidation can be done directly in the microscope's specimen chamber. High voltage instruments have quite large specimen chambers allowing 'mini-labs' to be constructed within the chambers for high temperature, high pressure, or other studies. Also, the more penetrating electrons again allow the use of thick samples rather than a thin alloy foil, which may oxidize differently than a bulk specimen. Alternatively, in studies of gas-solid surface interactions, the more penetrating high energy electrons allow the use of higher gas pressures.

Radiation damage is still a problem in the imaging of biological material. The energetic electrons ionize atoms and break chemical bonds and there is no guarantee that the structure does not change as a result. There is considerable evidence that the damage from very high electrons is less than that from electrons with the typical 100 keV energies.

However in metals and alloys a second type of radiation damage — displacement of atoms by collisions between electrons and nuclei — is increased by high electron energies. There is a threshold electron energy below which no displacement occurs and heavier elements have higher thresholds. High voltage machines can therefore be used to study this kind of damage in metals as heavy as uranium.

High voltages have two effects on resolution — one good and one bad. The good effect is that the resolution improves as the electron energy increases (although not linearly). The bad effect is slight fluctuations giving rise to the equivalent of chromatic aberrations in light optics (because the electron wavelength depends on its energy) due to the inability to keep the voltage absolutely constant. In general, it is harder to keep the voltage stable as the voltage increases.

The choice of 1 MeV for the ARM was a compromise between these two effects. By means of very precise feedback system, its 1 million volts should be kept steady to within 0.1 volt.

With atomic resolution, many investigations in materials science, chemistry, geology and biology will become feasible. One that is especially interesting is the study of the atomic structure of the boundaries between crystalline regions in metals. These grain boundaries can govern mechanical properties. From the biologists' point of view, studying cell membranes might represent a problem of comparable interest.

Physics monitor

Exploiting liquid argon

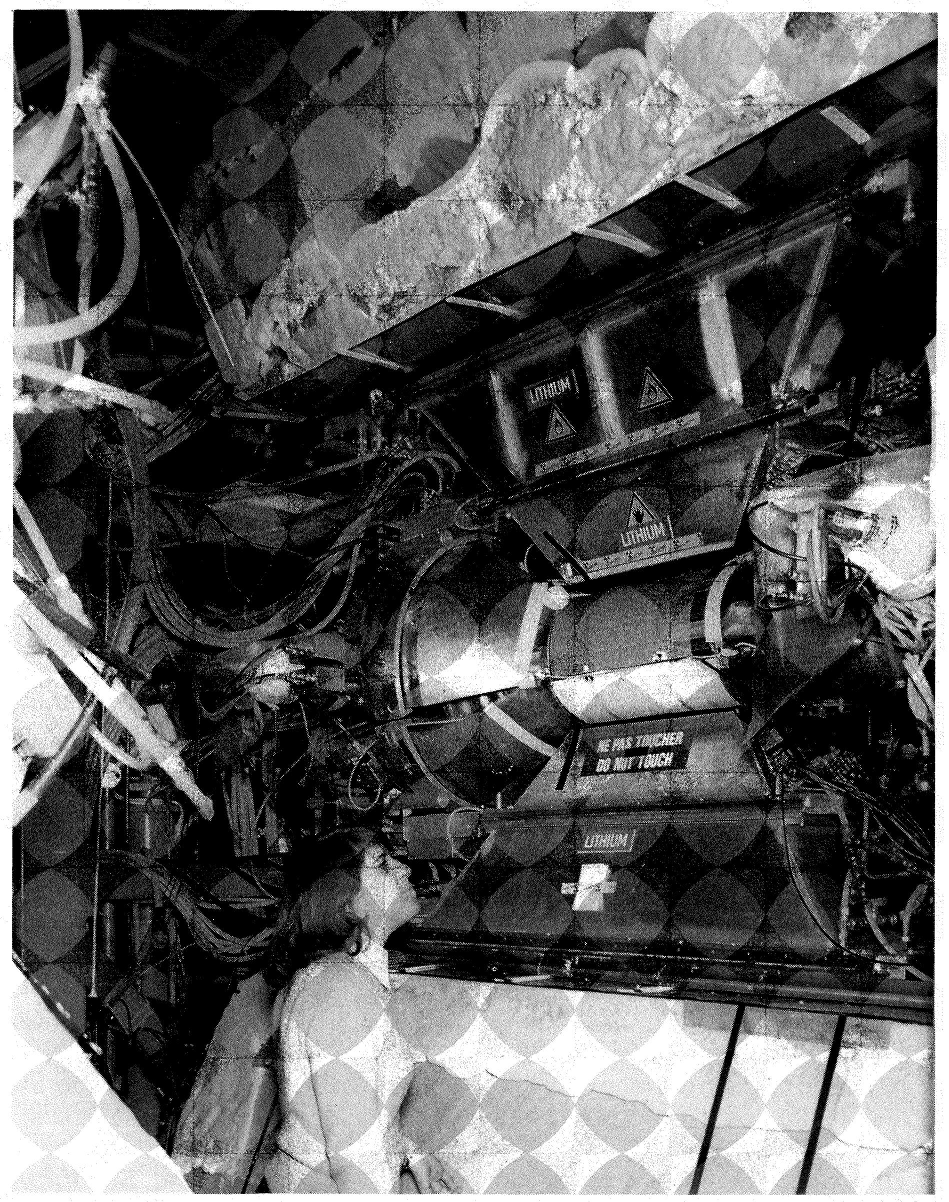
Detectors using liquid argon as an ionization medium are now an integral part of the current physics scene.

In a recent development at Fermilab, good space and time resolution has been achieved using a new liquid argon photon detector. With position measurement to within 700 microns and time resolution of 6 ns, applications are envisaged in the high interaction rates expected in many forthcoming experiments at high energy fixed target proton machines.

The liquid argon calorimeter (LAC) technique was developed in the early 1970s at CERN by W. Willis and collaborators for measuring energies of photons and electrons. The first LAC at Fermilab was built by a Fermilab/Minnesota team and was used in an experiment to measure radiative decays of mesons. Last winter, the group (now augmented by physicists from Michigan State and Northeastern) completed a study whose main aim was to assess the feasibility of a LAC for studying the production of direct photons in violent (large transverse momentum) hadronic interactions.

Quantum chromodynamics interprets these events as coming from quark-gluon interactions, thus providing a probe of gluon behaviour. Direct photon production has now been studied in a number of experiments (see April issue, page 116).

Because of the low rate at which these large transverse momentum events occur, the experiments must be carried out at least at megacycle interaction rates. However because of their long charge collection times, LACs are inherently slow. To circumvent this problem, the Fermilab experimenters put time-to-digital converters on each of the LAC channels so that the time of arrival of the energy pulses could be timed precisely. A 3 m diameter calorimeter using these techniques is being considered for use at the Tevatron.



Apparatus of the Athens/Brookhaven/CERN/Syracuse group at the CERN Intersecting Storage Rings. Nearest the intersection region are lithium foil transition radiation detectors, while top and bottom are the liquid argon calorimeters.

(Photo CERN 172.3.76)

At CERN, a large liquid argon detector came into operation at the Intersecting Storage Rings in 1975 for an experiment by an Athens/Brookhaven / CERN / Syracuse collaboration. This detector was primarily designed to look for electron pairs and provided some early evidence for the upsilon particle. However its main physics achievement was probably its measurements on the production of single photons (see June 1979 issue, page 153).

Its electronics was carefully designed to eliminate spurious noise and be able to detect the small charge deposited by electromagnetic particles, while the detector itself was built with an eye to good spatial resolution and electron/hadron discrimination. Suitable arrangements of the ionization sampling electrodes provided the spatial resolution and enabled the shape of the developing shower to be monitored, so that showers of electromagnetic and hadronic origin could be clearly distinguished. Lithium foil transition radiation detectors provided additional electron identification power.

In the single photon experiment which began in 1978, the lithium foil detectors were removed and the liquid argon calorimeter was moved further from the interaction region to increase the photon separation in closely spaced pairs and facilitate the isolation of a signal due to genuine single photons.

In 1980–81, this detector operated in tandem with the new Axial Field Spectrometer of a Brookhaven / CERN / Copenhagen / Lund / Pennsylvania / Rutherford / Tel-Aviv collaboration (see April 1979 issue, page 65). This apparatus measures the charged particles produced with the single photons and is used to test the prediction that in proton-proton collisions, the jet recoiling against the single high transverse momentum photon originates predominantly from a quark. (In proton-antiproton collisions in the ISR, the recoiling particles should come from gluon jets rather than quark jets.)

To extend the study of single photons, a new experiment (Athens / Bonn / Brookhaven / CERN / Moscow) is being prepared to run alongside the Axial Field Spectrometer, making use of the uranium calorimeter. The new experiment will pick up photons using an array of sodium iodide blocks mounted in front of the uranium calorimeter, and using existing electronics from the old liquid argon detector. The CERN/Columbia/Rockefeller experiment at the ISR has also been upgraded to make further studies of single photon production.

At the SPS 400 GeV proton synchrotron, a liquid argon detector is incorporated in the apparatus used by a Bristol/Geneva/Heidelberg/ Lausanne/London/Rutherford collaboration studying the interactions of charged hyperons.

Liquid argon detectors have also made significant contributions at electron-positron machines, with Mark II at the SPEAR and PEP rings at SLAC and with TASSO and CELLO at the PETRA ring at DESY.

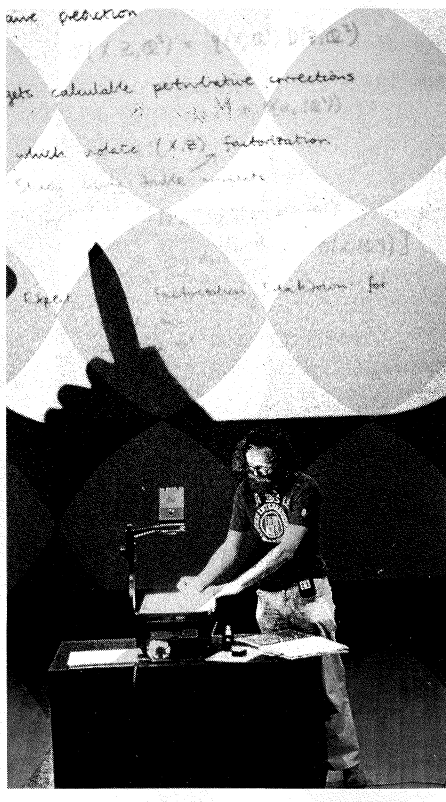
Technicolour; oasis or mirage?

This is the intriguing title of the talk given by CERN theoretician John Ellis at the recent Topical Conference on Particle Physics at SLAC.

Spurred by the promise of quantum chromodynamics in describing quark interactions and the successes of the unified electroweak theory, new 'grand unified' theories have been proposed which attempt to bring together the strong and the electroweak sectors. These schemes carry implications of a physics 'desert' with no radically new phenomena waiting to be discovered at energies accessible in the laboratory (see for example October issue, page 347). Meanwhile others, particularly at Harvard and Stanford, have been proposing different mechanisms, such as 'technicolour', which could soon provide a rich pattern of new physics. These adventurous theorists propose that the so-called Higgs particles are no longer indivisible, but appear as composites, in much the same way that hadrons are composites of the more elementary quarks.

The standard theory of electroweak interactions rests solidly on ideas of symmetry breaking which

John Ellis— 'adventurous (or foolhardy) souls are riding off into the sunset, looking for deeper theory'.



demand the existence of the Higgs particles, as yet unobserved. Even if the weak bosons predicted by the standard theory are discovered, all will not be finally wrapped up until the Higgs particles too appear.

However these ideas are also a prolific source of other possibilities, which as Ellis explains could make the desert of orthodox theory bloom with many kinds of exotic new phenomena.

'By now the orthodox picture of quantum chromodynamics (QCD) combined with the electroweak interaction is the generally accepted theory of fundamental physics at energies up to about 100 GeV. The model seems to pose few remaining problems of principle, and most work on it now concentrates on tinkering with technicalities, such as confining quarks in QCD so that they do not appear as free particles, and the existence of intermediate weak bosons.

It is not surprising that some adventurous (or foolhardy) souls are already riding off into the sunrise, looking for the deeper theory beyond the standard model. There is no consensus about which direction to ride in, or even how far one must ride until the next landmark is reached.

Perhaps there is indeed a great desert to be crossed first, as advocated by the ascetic minimalist devotees of grand unified theories of strong and electroweak interactions who suggest that there is no new interaction scale below 10^{15} GeV. They extrapolate the behaviour of the known coupling constants until they converge in a grand unified theory at the 'Planck' energy of 10^{19} GeV where quantum gravity effects are predicted to appear.

In making this enormous extrapolation, they assume that there are no intervening oases out in the great desert. In particular, they assume that the elementary quantities of existing theories — intermediate bosons, quarks, leptons and Higgs particles — remain structureless and pointlike down to distances of 10^{-29} cm or smaller.

However many physicists consider this grand scenario either a dangerous manifestation of hubris, technically unsound, or just boring. They prefer to replace it with a picture in which the great desert is riddled with oases caused by the onset of new types of strong interactions, whether they be called techni-, extended techni-, metahyper-, super- or heavy colour. These theories are certainly richer at low energies than the minimal grand unified theories, and all share the general feature that some or all of the particles now considered elementary take on a structure on an energy scale of 1 to 100 TeV. This new compositeness is accompanied by an embarrassing rash of new bosons, quarks and leptons, and possibly some new flavour-changing neutral interactions.

However these various possible oases may be judged on the grounds of aesthetics or theoretical plausibility, one thing cannot be denied. In contrast to prospects of a great desert, they do provide plenty of experimental tests to be performed at present accelerator energies. Contemporary experiments can prove these ideas right or wrong.'

Before the first three minutes

Steven Weinberg's book 'The First Three Minutes' has quickly established itself as a classic of modern physical theory. It uses 'Big Bang' cosmology and standard particle physics ideas to chart the probable formation of the universe. However even these imaginative ideas are insufficient to get to grips with the conditions immediately (less than one hundredth of a second) following the initial cataclysm.

Since the book's publication in 1977, theoreticians emboldened by the continued successes of the electroweak theory have embarked on ambitious 'grand unification' schemes encompassing electromagnetism and both the strong and the weak nuclear interactions.

When injected into cosmology, these new ideas push back the time frontier which can be probed, and can predict what happened as close as 10^{-35} seconds after the Big Bang. Describing these speculations in an invited paper earlier this year at the Lisbon particle physics conference, Qaisir Shafi upstaged Weinberg, proposing the title 'Before The First Three Minutes'!

The temperature of this primaeval fireball exceeded 10^{15} GeV and the full grand unified symmetry was exact — no degrees of freedom had yet had a chance to 'freeze' out and produce the physics we now know. Even at temperatures above a few hundred GeV (verging on the Weinberg era), quarks would not have been confined. The universe was then a quark-gluon plasma (a condition increasingly being sought in high energy experiments).

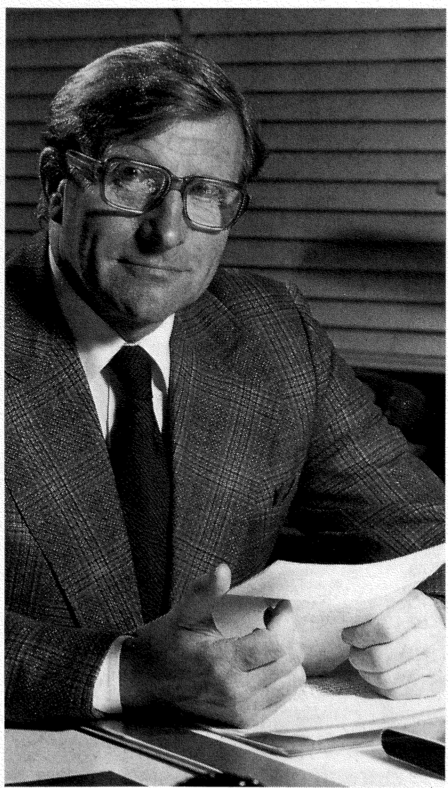
The excess of matter over antimatter in a universe whose equations of motion are largely matter/antimatter symmetric has long puzzled cosmologists, amateur and professional alike. However grand unified theories, with their concomitant prediction of the unstable proton (see May 1979 issue, page 116), together with the more familiar mechanism which violates the combined charge/parity symmetry (in kaon decays for example), provide the ingredients for a possible answer to this hoary question.

The idea is that the rapid expansion of the early exploding universe, which initially contained matter and antimatter in equal amounts, forced mechanisms out of thermal equilibrium, thus upsetting the particle/antiparticle balance. Numerous detailed explanations have been proposed.

Another remnant of this genesis could be free magnetic monopoles. These electromagnetic oddities were first proposed 50 years ago by Dirac but have never been observed. Interest has recently revived as modern theories, including grand unification, predict the existence of massive (about 10^{16} GeV) monopoles. These would have been plentiful in the initially symmetric universe and could still be around. However general arguments of the mass density of the universe deem that such superheavy particles should make up no more than 10^{-14} of the whole.

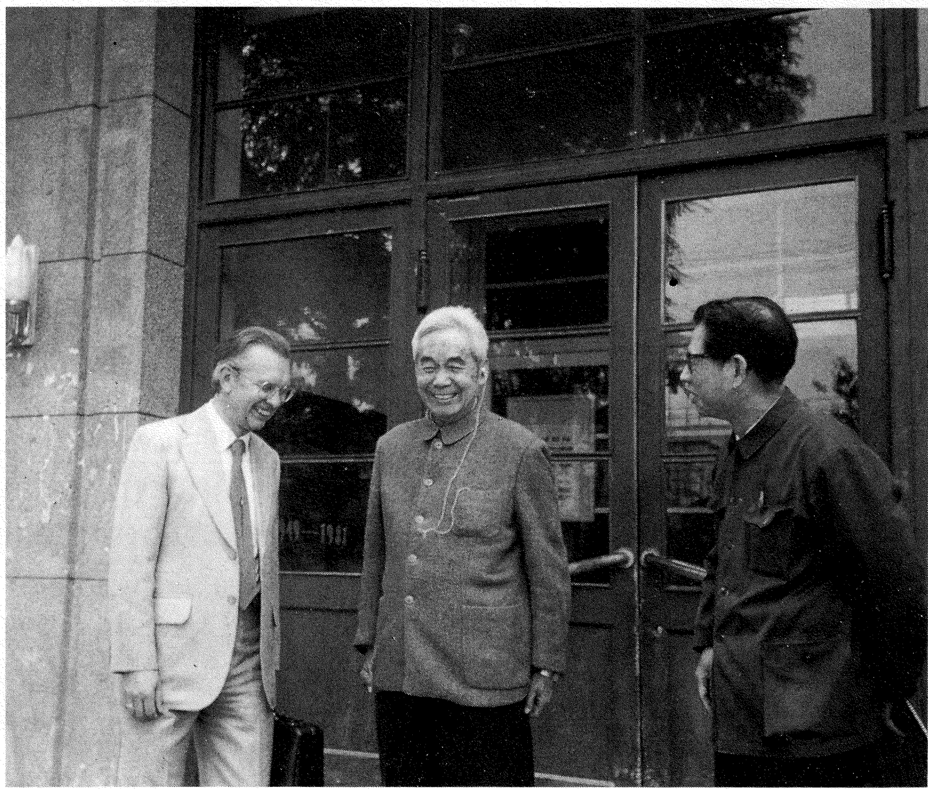
People and things

Sir Geoffrey Allen



CERN Director General Herwig Schopper (left) with Chang Wen-Yu, Director of the Chinese Institute of High Energy Physics (centre) and Xia Gia-Lin, leader of the design study for an electron-positron storage ring.

(Photo O. Lock)

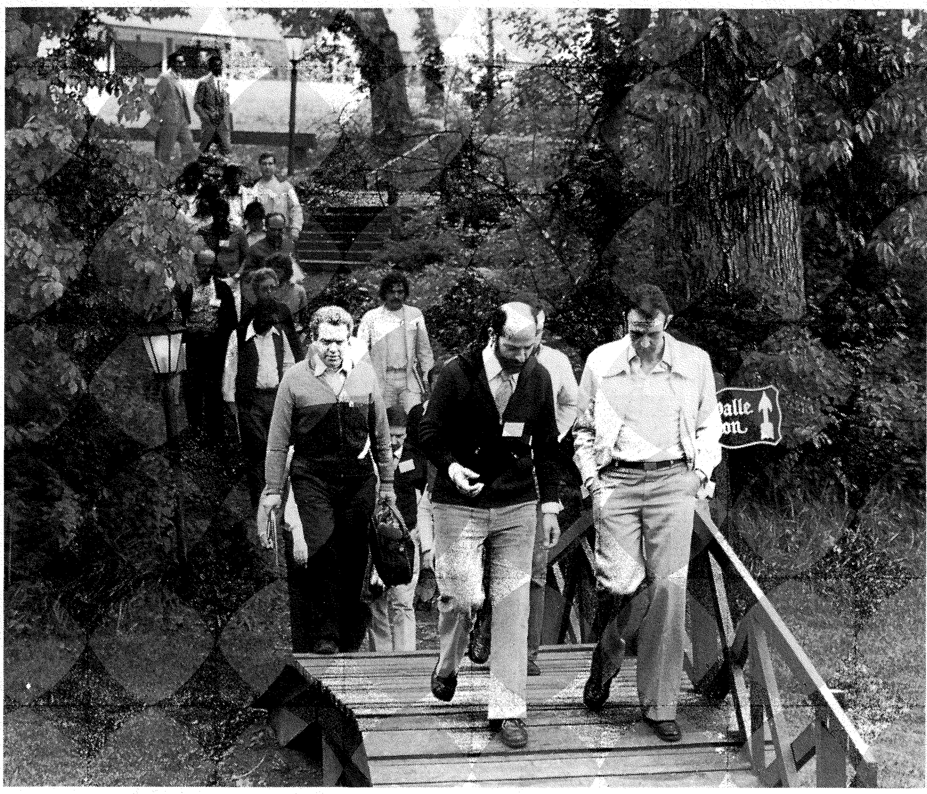


Sir Geoffrey Allen has completed his term of office as Chairman of the UK Science and Engineering Research Council and has been appointed Research Director for Unilever. As a result, he will no longer attend CERN Council sessions as the principal UK delegate. Sir Geoffrey, a leading expert on polymers, was formerly Professor of Chemical Physics at Manchester and then Professor of Chemical Technology at Imperial College, London. Despite his recent heavy administrative duties, he has participated in experiments at the CERN synchro-cyclotron as a member of an Imperial College / Parma / Rutherford collaboration using muon spin rotation to study polymer structure. He is a keen supporter of CERN and under his guidance the UK was the first Member State formally to approve the LEP project.

CERN-China contacts

At the end of September and during early October CERN Director General Herwig Schopper, together with Owen Lock and Ted Wilson, spent some time in China at the invitation of the Institute of High Energy Physics of the Academia Sinica. They gave a number of lectures and seminars at the Institute in Beijing and discussed ways and means of continuing the collaboration with CERN in the future, in view of the postponement of the 50 GeV BPS (proton) project in China. They learnt that emphasis is at present placed on design studies of an electron-positron collider of 50 metres radius with an initial energy of 2.2 GeV per beam, which could be increased to 5.7 GeV per beam in a second stage by the addition of more r.f. power. The injector would be a 1 GeV electron linac. Hence there is now a common interest not only in the construction of electron accelerators but also in the carrying out of experiments with electrons and positrons, and the possibility of Chinese participation in experiments at CERN, including LEP experiments, was raised during the discussions.

During his visit the Director General met Vice-Premier Fang Yi who is State Minister for Science and Technology and until recently also President of the Academia Sinica. Fang Yi expressed his support for the development of the collaboration between CERN and China in the coming years. The Director General and Professor Chang Wen-Yu, Director of the Institute of High Energy Physics, signed a memorandum outlining the specific forms the collaboration could take for the three-year period 1982–4, and



Some of the participants at the 'Physics in Collision' meeting held earlier this year in Blacksburg, Virginia.

in particular providing for the exchange of a number of scientists and engineers whose living expenses would be paid by the host Laboratory. Owen Lock will act as 'link-man' for CERN for the detailed implementation of this agreement after its formal approval by the appropriate authorities, together with an opposite number to be nominated by the Chinese.

Collision course

A new appearance on the physics scene this year was an international conference 'Physics in Collision' to look at electron-positron (lepton-lepton), electron-proton (lepton-quark) and proton-proton (quark-quark) interactions. This year's meeting was held in the scenic Appalachian mountain town of Blacksburg, Virginia, and was organized by G. Bellini of Milan and W.P. Trower of Virginia, together with an international committee.

The aim of the meeting was to examine the possible analogies among the different types of interactions, with particular emphasis on experimental data. It concluded with a comparison of proton-proton and electron-positron processes, and with a talk by Malcolm Derrick entitled 'Physicists in Collision' which covered production mechanisms of particles carrying charm and beauty.

The Organizing Committee responded to requests that the Conference become an annual affair by accepting the offer of the University of Stockholm to host the meeting from 2–4 June next year. Meanwhile the proceedings of the Blacksburg meeting will be available soon.

History of particle physics

An international colloquium on the history of particle physics will be held at the Collège de France, Paris, from 21–23 July next year, just before the 21st International Conference on High Energy Physics. It will cover the period from the 1930s to the 1950s when particle physics emerged as a separate subject to nuclear and cosmic ray studies. The programme is planned to include the main discoveries, together with the origin and evolution of concepts, fields of study and new theories. Development of new techniques will also be covered.

Participation is foreseen as being limited to about 150 persons accepted by the Organizing Committee. For further information, write to Marie-Simone Detoeuf, Secretariat, Colloque International sur l'Histoire de la Physique des Particules, 20, rue Berbier du Mets, 75013 Paris, France.

ITALY AT CERN

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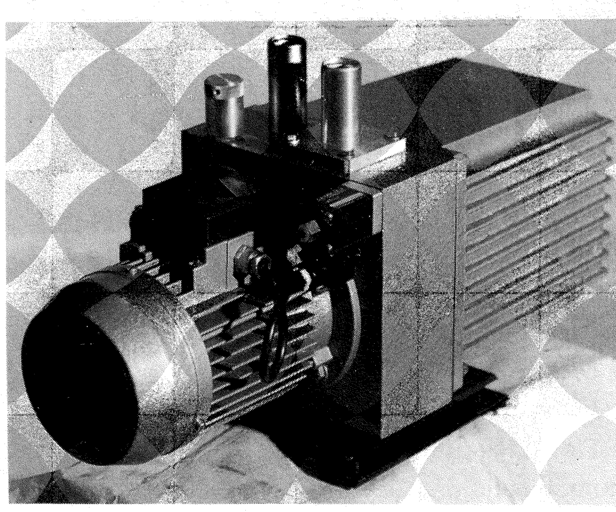

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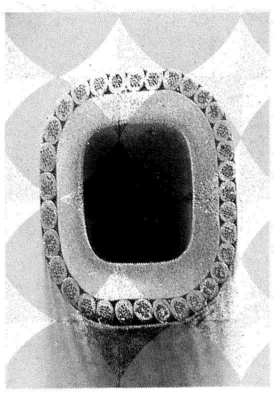

The cross-section of the hollow Niobio-Titanio superconducting conductor of the SULTAN magnet, a new test facility at the SIN Centre near Zurich.

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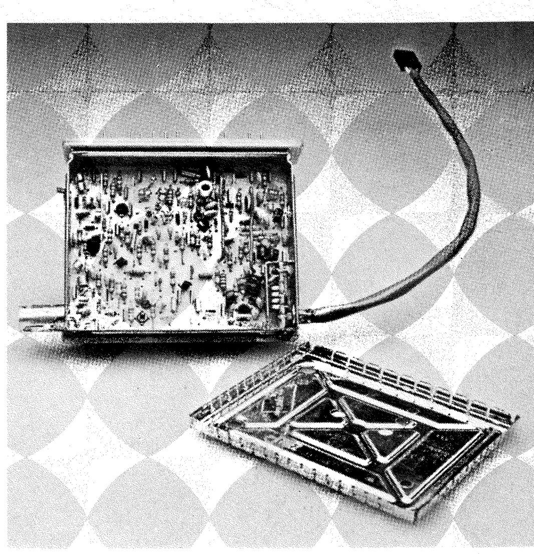
- Mineral insulated wiring cables
- Heat exchangers copper tubes
- Copper stranded wires
- Superconducting wires and cables

LARES COZZI S.p.A.

Via Roma, 88/92
20037 – PADERNO DUGNANO (MI)
Telefono 02/9181363–9181026
Telex 330119 LARES I



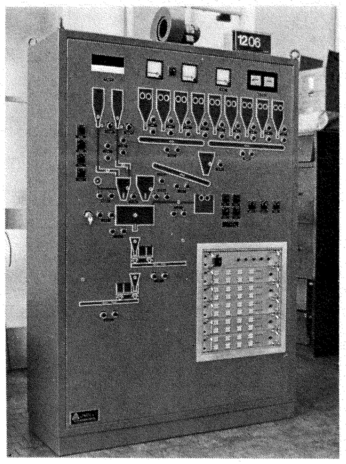
Trimosfet tuner with Prescaler for frequency synthesis

Product line:

- Rigid circuit boards, one or two sided, with and without pth
- Flexible circuit boards, one or two sided, with and without pth
- Rigid multilayer boards
- Mixed rigid-flexible boards
  Surfaces:
  Nickel, -gold, tin-lead, tin-lead reflown, bright tin, solder mask, component printing
- Power supplies
- TV tuners
- FM tuners
- Storage units
- Infrared remote controls

OFFICINA ELETTROMECCANICA LOVATO & C. S.p.A.

Via Don E. Mazza, 12
24020 – GORLE (Bergamo)
Telefono 035/340088
Telex 334019 LOVATO I



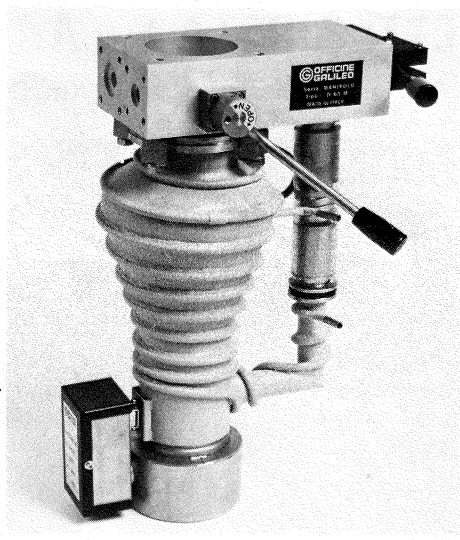
Control board of automated plant

Product line:

Production of contactors, relays, switchboards, starters, electronic devices and commercialization on the world market of products including measuring instruments, control accessories, capacitors, microprocessors and speed controls of various Italian firms.

OFFICINE GALILEO S.p.A.

Località Tomerello
50013 – CAMPI BISENZIO (Firenze)
Telefono 055/89501
Telex 570126 GALILE I



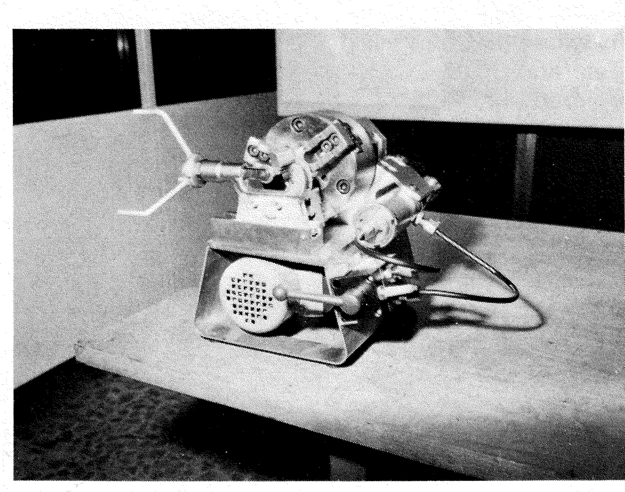
Compact diffusion pumping group, with 200 l/s 'Ecojet 63' pump

Product line:

- High vacuum components
- Hardness testers

OFFICINE MECCANICHE LATINE S.p.A.

Via Nettunense, Km 7,200
00040 ARICCIA (ROMA)
Telefono 06/9342151
Telex 614568 AVIOML I



Same example of OML metalworking

Product line:

- Equipment for aeronautic, military and nuclear industry.

ORMIC S.p.A.

Via G. da Procida, 10
20149 – MILANO
Telefono 02/315845/6/7
Telex 333209 ORMIC I

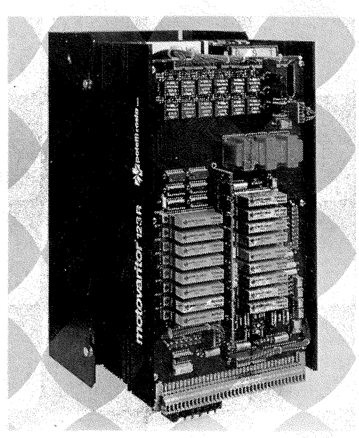
Fork lift truck 'ORMIC 10' Mod. W 10–36 P–Triplex

Product line:

– Fork lift truck

POLETTI & OSTA S.p.A.

Strada Provinciale Casale – Valenza Km. 0,5
15033 – CASALE MONFERRATO
Telefono 0142/74851
Telex 210540 POLOST I



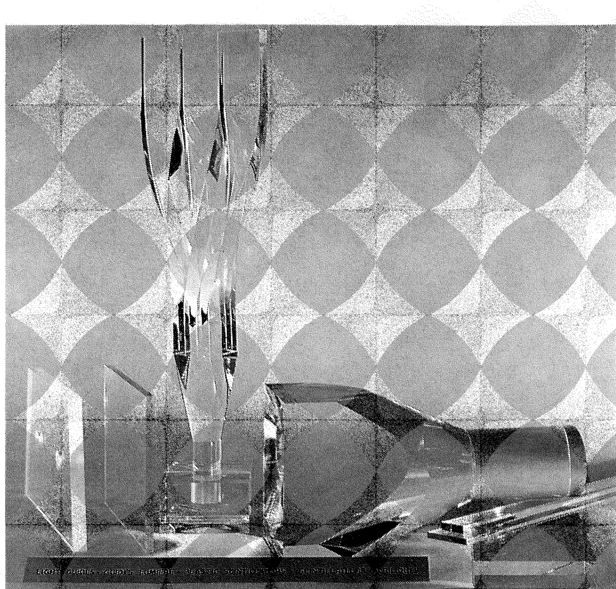
M execution: Motovariator series 3.
Alternate/Direct current thyristors convertor.
M execution: particularly designed to control d.c. motors speed executed with hybrid blocks using thick film technology.
A execution: specific use as power supply.

Product line:

– An integrated line of speed controls for the automation of coperating machines, machine tool and graphic units and A.C./D.C. converters for general purposes
– Isopower DC motors constant power – isoflux permanent magnet DC servomotors
– Automation, control and adjustment electronic systems for the automation of operating units

POLIVAR S.p.A.

Via Naro, 72 P.O. Box 111
00040 – POMEZIA (Roma)
Telefono 06/9121061
Telex 611227 PLV I



Product line:

– Cast acrylic sheets, bars, blocks, scintillators, light guides

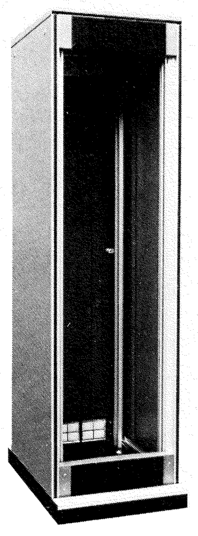
RACK PERUZZI S.r.l.

Viale A. Volta, 3
10090 – BRUINO (Torino)

Telefono 011/9086253 – 9086261
Telex 211679 RACKRP I

Product line:

- 19'' Rack cubicle
- Console
- Working table
- Cabinet
- Chassis
- Bearing slides
- Several containers and accessories



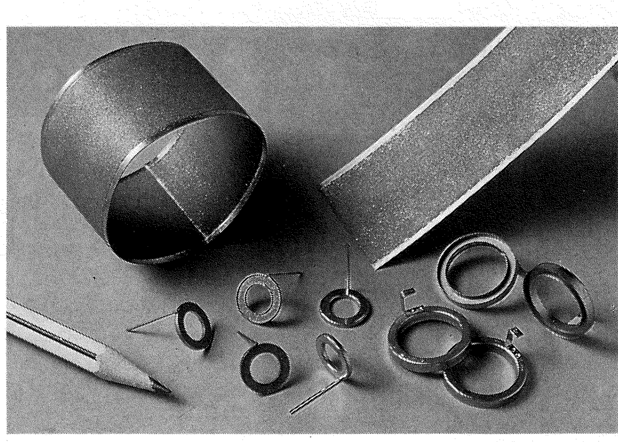
Cubicle Mod. Euro

SAES GETTERS S.p.A.

Via Gallarate, 215
20151 – MILANO
Telefono 02/306541/2/3
Telex 331108 SAESGT I

Product line:

Getters – Components for the production and maintenance of vacuum in pumped sealed off machines or devices



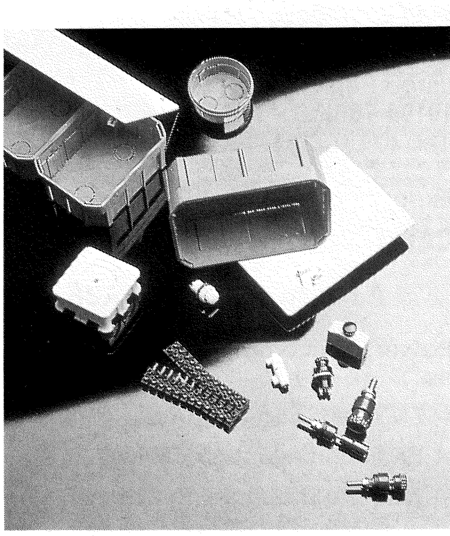
Getter coated strips and getter rings produced by SAES for vacuum systems and devices

SICILIANI EMILIO S.p.A.

Via Vincenzo Bellini, 13
20095 – CUSANO MILANINO (MI)
Telefono 02/6196421
Telex 331029 ESTEL I

Product line:

- Electrical junction and connecting boxes
- Junction connecting waterproof composite boxes, complete with swichgears, lighting, warning, devices
- Plugs and sockets, flat and torpedo type
- Coupling sockets under CEE 17 standards – sockets with locking safety device and fuse-holder
- Terminal strips
- Fuse-holders
- Panel connecting articles



Junction and connecting boxes for low tension plants, terminal strips, fuse-holder, panels connecting articles

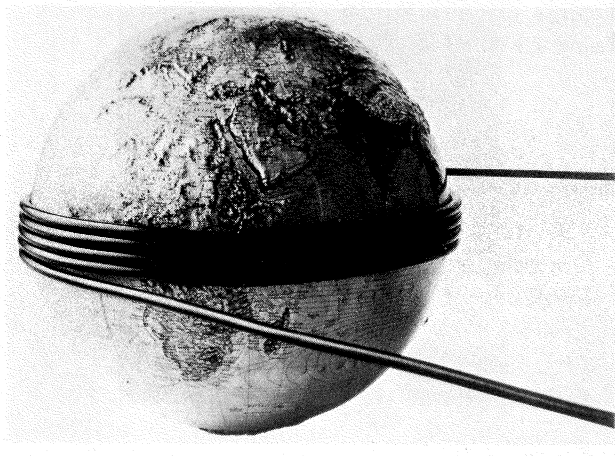
SOCIETÀ CAVI PIRELLI S.p.A.

Viale Sarca, 202
20126 MILANO – ITALIA
Tel. (02) 64421 –
Telex 310135 PIREMI I

Export Sales Office:

CABLEXPORT S.p.A.

Via Vespucci 2
20124 MILANO – ITALIA
Tel. (02) 64421
Telex 310135 PIREMI I –
314018 PIRECX I
Area manager for Europe:
Mr. A. Decorato
(phone 02 64422932)



LV, MV, HV power cables, telecommunication and special applications cables

A barrier to fire

Pirelli technology for safety of persons and equipment with a new line of cables that has won fire

- AFUMEX® fire retardant cables with low emission of smoke and toxic fumes
- RETOX® fire retardant cables with low emission of corrosive fumes
- FP 200 fire resistent cables

A. PASTA S.p.A.– PIRELLI GROUP

Via Giovanni XXIII, 23
20098 San Giuliano Milanese (Milano) ITALIA
Tel. (02) 9848671 – Telex 321304 PASTA I

Export Sales Office:

CABLEXPORT S.p.A.

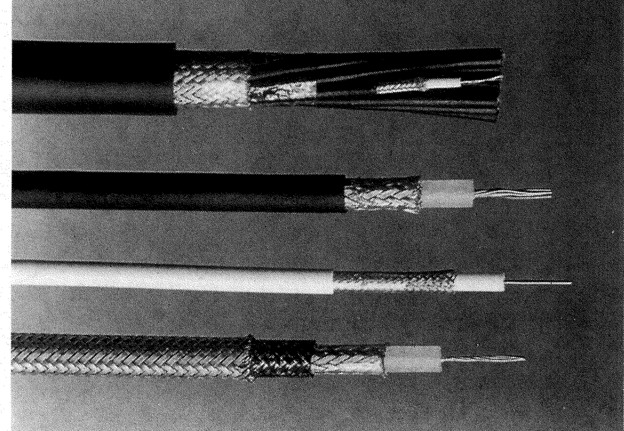
- High temperature cables (SUPERTHERM®)
- Cables and wires with special behaviour when exposed to fire (low toxicity, low fumes, low corrosion, fire resistant, fire retardant)
- Coaxial cables for high frequency, standard G and special types
- Control and signaling cables
- Compensating cables for thermocouples
- Flat ribbon cables for multiple connections
- Radiation resistant cables

CEAT CAVI S.p.A.

Largo Regio Parco 9
10100 TORINO – ITALIA
Tel. (011) 26081 –Telex 221603 CEAT I

Export Sales Office:

CABLEXPORT S.p.A.



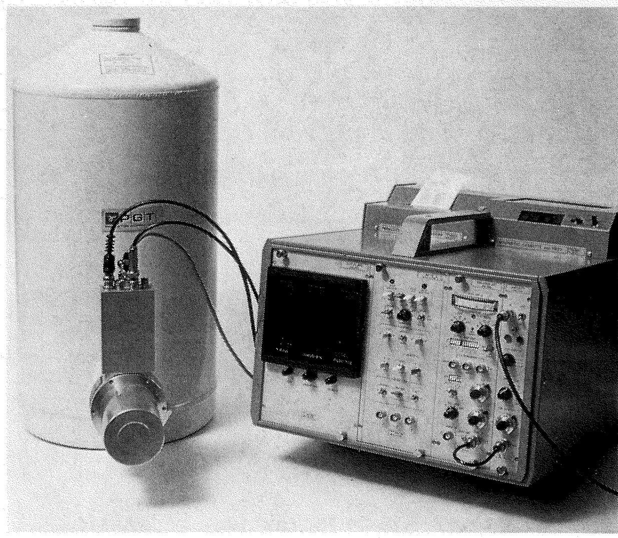
Power, telecommunication and control cables, such as:

- LV – MV and HV power cables
- Radiation resisting cables
- Non fire propagating cables
- Non toxic and low smoke gas evolution cables
- Cables for special applications

SILENA S.p.A.

SOC. IND. PER L'ELETTRONICA AVANZATA
Via Negroli, 10/a
20133 – MILANO
Telefono 02/7490565–713871
Telex 310514 ENCOS I

Product line:
- Spectroscopy amplifiers
- Timing single channel analyzers
- Analog-to-digital converters
- Charge, amplitude and time converters
- High-speed analog-to-digital converters
- Single input multichannel scaling units
- Display units
- High voltage power supply
- Bin/power supply
- Silena spectrum stabilizers
- 4-INPUT MIXER routing units



Silena NIM Multichannel analyzer

VARIAN S.p.A.

Via F.lli Varian, 54
10040 LEINI' (Torino)
Tel.: 011 –9968086
Telex: 210228 VARSPA I

Product line:

High vacuum and ultra-high vacuum pumps, valves, flanges, fittings and accessory components

Pressure measurement instrumentation

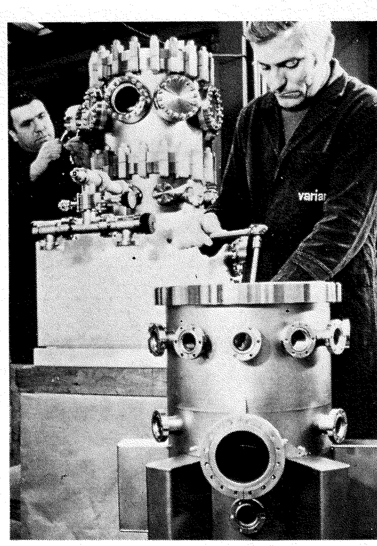
Leak detectors

Ultra-high vacuum pumping systems

Vacuum coaters

Vacuum furnaces

Semiconductor processing equipment



Assembly of UHV pumping systems in the Torino plant

FULGOR CAVI S.p.A.

Via del Crocefisso, **04100 – BORGOPIAVE (Latina)**
Tel. 0773/481011 / Telex 680012 FULGOR I

Product line:

Power cables: for medium and high voltage, paper insulated mass impregnated, plastic, rubber or pipe insulated; special purpose ship-wiring cable; signal cables – arcs conductors for high tensions over-head lines; enamelled copper winding wires; bare stranded conductors; telephone cables for trunk connection, coaxial pair and micro-coaxial pair types; copper rod by continuous casting and rolling from cathodes, copper bare drawn wires; PVC granulated compounds for insulating and covering cables rubber compounds for insulating and covering cables.

FILIPPO FOCHI S.p.A.

Via Portanova, 3, **40123 – BOLOGNA**
Tel. 051/267983/4/5 / Telex 511020 FOCHI I

Product line:

Construction and erection of steel structures, vessels, and piping systems for nuclear power plants.

LABEN-DIVISIONE DELLA SI.EL. S.p.A.

Via E. Bassini, **15-20133 – MILANO**
Tel. 02/2365551 / Telex 312451 – LABEN I

Product line:

Semiconductor detectors for Alpha, X and Gamma particularly devoted to small dimensions gas cooled detectors; analogic electronics for nuclear spectrometry, in particular for high rate and high resolution measurements or multiple acquisitions with thick films technology; high speed and high resolution analog-to-digital converters for spectrometry and multiacquisitions; high and low voltage power supplies; laboratory and portable multichannel analyzers with 1 to 4 K memory; microprocessed systems for data processing; multiparameter and multiacquisition systems with camac interfaces; installed and portable monitoring and analysis systems; peripherals with relevant interfaces.

PIANELLI E TRAVERSA FINANZIARIA S.p.A.

Corso IV Novembre, **55-10090 – CASCINE VICA – (To)**
Tel. 011/9591555 / Telex 210171 PTR I

Product line:

Material handling and warehousing equipment and relevant engineering; special iron and light alloy castings, investment castings, drop forged steel parts.

PRO.CU.RA IMPIANTI S.r.l.

Via dei Guarneri, **14-20141 – MILANO**
Tel. 02/5390281 / Telegramma PROCURAMA – MILANO

Product line:

Machines, gauges and equipments for vacuum freeze – dried products – microwaves.

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Space (page)	Actual size (mm) width by height	Cost per insertion (Swiss Francs)			
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All enquiries to:
Micheline FALCIOLA / CERN COURIER – CERN
CH-1211 Geneva 23 Switzerland
Tel. (022) 83 41 03 Telex 2 36 98

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

MOVING?

Please remember to let us know in good time. All notices of change of address must be accompanied by old and new addresses. (Include label from magazine wrapper.)

Any enquiries regarding subscriptions should be addressed to:

Monika WILSON
CERN COURIER/CERN
1211 Geneva 23 Switzerland

NEW SOFTWARE-MINDED SYSTEM CONCEPT

GENERAL: MEMORY MAPPED CAMAC ACCESS
STRUCTURED FOR TRUE NESTED INERRUPT HANDLING
RUNS ALL UNMODIFIED STANDARD DEC SOFTWARE
CAMAC DIAGNOSTICS, FORTRAN, BASIC, ASSEMBLER
SINGLE INSTRUCTION DATA TRANSFER (16 BITS)

FEATURES: USES ORIGINAL DEC LSI-11/2 OR LSI-11/23 CPU BOARDS
HAS FULL AUXILIARY CONTROLLER BUS (ACB) LOGIC
HAS Q-BUS CONNECTOR
INCORPORATED ASYNCHRONOUS SERIAL LINE INTERFACE
COMPLETE SYSTEM (CPU,64KB,20MA CL) IN A 3 WIDTH UNIT
INDIVIDUAL VECTORS FOR ALL LAM'S, Q, X, ETC.
CAN ALSO HANDLE 24 BITS OF DATA
HAS F CODE STORAGE FOR REPETITIVE USE
HAS AUTOMATIC CAMAC N AND A SCANNER
HARDWARE Q-SCAN AND Q-REPEAT MODES
CAN CONTROL SEVERAL CRATES
CAN WORK WITH CAMAC SHORT CYCLE (IN DMA)
SPECIAL HARDWARE TO SIMPLIFY SOFTWARE

PACKAGES: WITH EXTENSION MEMORIES, FLOPPY DISC SYSTEMS, ETC.

borer

BORER ELECTRONICS AG
CH-4501 SOLOTHURN / SWITZERLAND
Tel: 065-31 11 31 Telex: 34228
Suisse Romande: Tél. 022-76 38 46

LSI-11/CAMAC

RADIAMETRE PORTATIF
PORTABLE RADIAMETER

DEBITMETRE X ET GAMMA A SEUILS D'ALERTE
DOSE RATE INDICATOR FOR X AND GAMMA RADIATIONS WITH ALARM THRESHOLDS.

RPI 1244

G Geiger Muller counter, compensated type
Geiger Muller compensé

A Autonomy : 1200 hours
Autonomie : (1200 heures en fonctionnement continu)

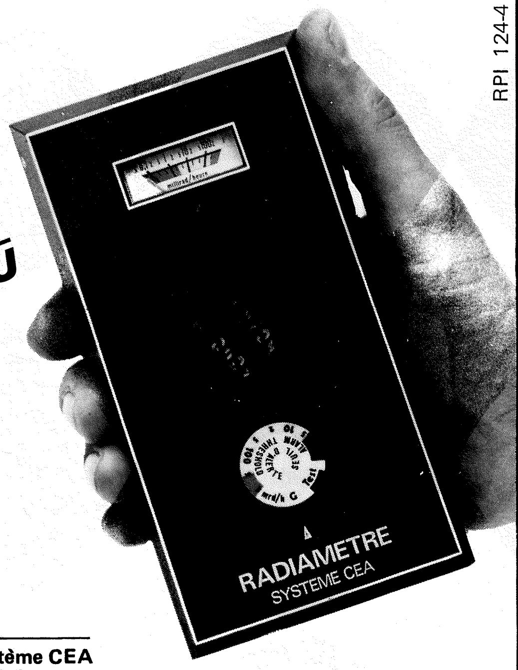
M Measurement of dose rate for X and γ radiations
Mesure du débit de dose X et γ

I Indicator with audible alarm
Indicateur sonore d'alerte

N Nardeux

Manufactured by...
Fabriqué par...

NEW
NOUVEAU



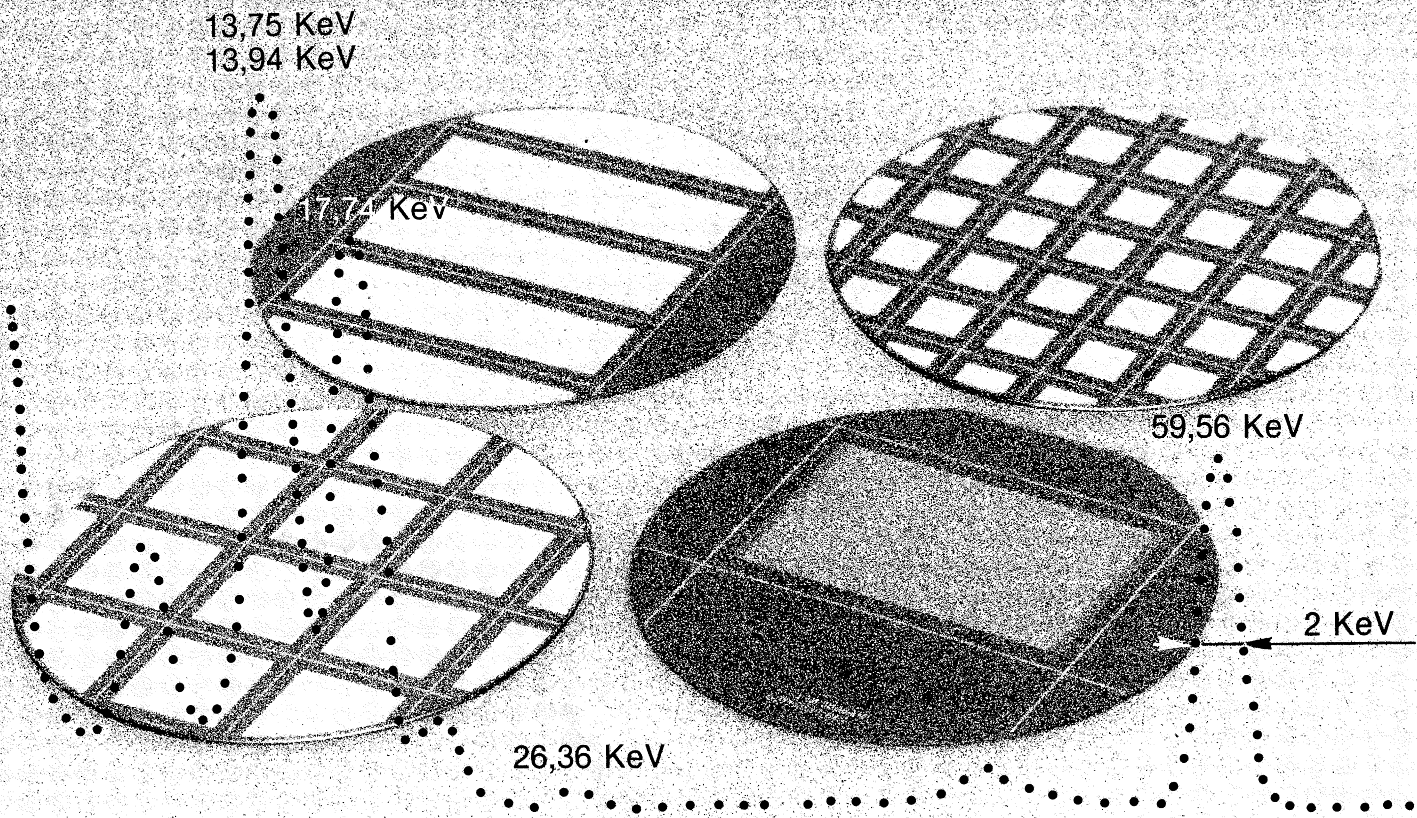
Système CEA
CEA System

Alarm thresholds { 0,5 - 2,5 - 10 - 20 m rad/h
Seuils d'alerte { 50 - 100 - 200 - 500 m rad/h

nardeux
Siège Social : BP 109 - Z.I. La Vallée du Parc - 37600 LOCHES
Head-Quarters : Tél. (47) 59.32.32 - Télex : 750 808 F
Agence Commerciale : Z.A. de Courtabœuf - Av. d'Islande EVOLIC 4 - 91940 LES ULIS
Commercial Branch : Tél. (6) 928.59.46 - Télex : 691 259 F

nuclear spectrometry :

ROOM TEMPERATURE



further surface barrier detectors a new step : passivated ion implanted silicon junction detectors

Reverse current 50 to 100 times lower than for surface barrier detectors therefore optimal resolutions for charged particles.

X rays spectroscopy at room temperature.

Design adapted to any needs : from mosaïc assemblies with a minimum dead region down to strip detectors.
Partially or totally depleted detectors, heavy ions detectors, X rays detectors, position sensitive detectors, strip detectors.
A complete range available.

ENERTEC
Schlumberger

ENERTEC
NUCLEAR INSTRUMENTATION BRANCH
1, Parc des Tanneries
67380 LINGOLSHEIM (France)
TEL : (88) 78.57.10. Télex : 890177F

Kick the liquid nitrogen habit...

use a DISPLEX® Cold Trap

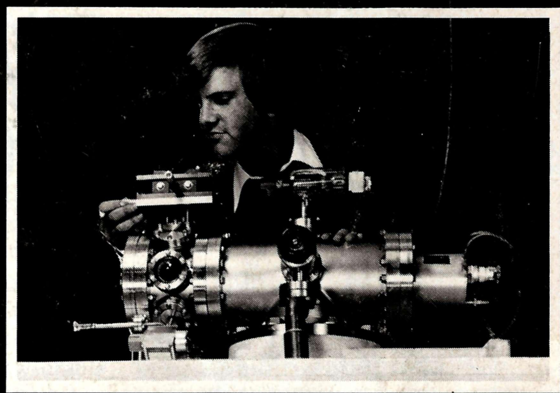
Diffusion pumps have an unending need for liquid nitrogen. And LN_2's not inexpensive these days! The new DISPLEX Refrigerated Cold Trap can quench that thirst forever.

The DISPLEX unit shown here is saving the Cornell Chemistry Facility For Laser Spectroscopy at least 350 liters weekly in LN_2 consumption.*

It's a simple system, comprising a reliable DISPLEX closed-cycle cryocooler with water-trapping panels, packaged in a compact spool assembly. It can replace your LN_2 guzzler in minutes!

- No more boil-off losses
- No more messy (and tricky) fills and spills
- No more consummables. A dime's worth of electricity an hour powers it.

Payback? With steady use, a DISPLEX Cold Trap can pay for itself in as little as six months. Send for details.



**Cornell had been using more than 50 liters a day in maintaining continuous vacuum on this multiphoton ionization source mass spectrometer used for studies of photofragmentation dynamics.*

Air Products

ADVANCED PRODUCTS
Air Products and Chemicals, Inc.

1919 Vultee Street, Allentown, PA 18103
(215) 481-8355 ● Telex: 84-7416