CERN COURIER

VOLUME 20 5 JULY/AUGUST 1980

CERN COURIER
Journal of High Energy Physics

Editors: Brian Southworth
Henri-Luc Felder
Gordon Fraser

Advertisements: Micheline Falciola

Laboratory correspondents:
Argonne National Laboratory, USA
R. Arnold
Brookhaven National Laboratory, USA
P. Wanderer
Cornell University, USA
N. Mistry
Daresbury Laboratory, UK
V. Suller
DESY Laboratory, Fed. Rep. of Germany
P. Waloschek
Fermi National Accelerator Laboratory, USA
R.A. Carrigan
KfK Karlsruhe, Fed. Rep. of Germany
M. Kuntze
GSI Darmstadt, Fed. Rep. of Germany
H. Prange
INFN, Italy
M. Gigliarelli Fiumi
Institute of High Energy Physics, Peking, China
Tu Tung-sheng
JINR Dubna, USSR
V. Sandukovsky
KEK National Laboratory, Japan
K. Kikuchi
Lawrence Berkeley Laboratory, USA
W. Carithers
Los Alamos Scientific Laboratory, USA
O.B. van Dyck
Novosibirsk Institute, USSR
V. Balakin
Orsay Laboratory, France
J.E. Augustin
Rutherford Laboratory, UK
J. Litt
Saclay Laboratory, France
A. Zylberstejn
SIN Villigen, Switzerland
G.H. Eaton
Stanford Linear Accelerator Center, USA
L. Keller
TRIUMF Laboratory, Canada
M.K. Craddock

Copies are available on request from:
Federal Republic of Germany
Frau G.V. Schlenther
DESY, Notkestr. 85, 2000 Hamburg 52
Italy —
INFN, Casella Postale 56,
00044 Frascati,
Roma
United Kingdom —
Elizabeth Marsh
Rutherford Laboratory, Chilton, Didcot
Oxfordshire OX11 0QX
USA/Canada —
Margaret Pearson
Fermilab, PO Box 500, Batavia
Illinois 60510
General distribution —
Monika Wilson
CERN 1211 Geneva 23, Switzerland

CERN COURIER is published ten times yearly in English and French editions. The views expressed in the Journal are not necessarily those of the CERN management.

Printed by: Presses Centrales S.A.
1002 Lausanne, Switzerland
Merrill Printing Company
765 North York, Hinsdale,
Illinois 60521, USA

Published by:
European Organization for Nuclear Research
CERN, 1211 Geneva 23, Switzerland
Tel. (022) 83 61 11, Telex 23698
(CERN COURIER only Tel. (022) 83 41 03)
USA: Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510
Tel. (312) 840 3000, Telex 910 230 3233

Contents

Cover photograph: Celebrations in the control room of PEP, the Berkeley/Stanford electron-positron ring, on the morning of 21 April when beam was circulated for the first time. In the foreground (left to right), are Adele and Pief Panofsky (SLAC Director), John Rees (who led PEP construction) and Ewan Paterson. (Photo Stanford University)

Beams with PEP

The Berkeley/Stanford electron-positron storage ring PEP has begun operation at SLAC. Circulating electrons were achieved on 21 April and the first electron-positron collisions were seen on 4 May.

The design proposal for PEP (Electron-Positron Project) was prepared in 1974 to provide higher collision energies than were available from the dramatically successful SPEAR storage ring at Stanford. The peak energy was then foreseen as 15 GeV per beam with a luminosity of 10^{32} per cm^2 per s. The PEP ring, with a diameter of 700 m, has six straight sections where detection systems can be installed around the beam collision regions.

The stored beams (circulating in three bunches per beam) are intended to reach just over 50 mA intensity with a lifetime of over two hours. The ring is filled from the 2 mile electron linac. Overall the machine performance figures and the physics programme which can be confronted with PEP are similar to those at the PETRA electron-positron storage ring at DESY, which came into operation with remarkable speed in July 1978.

(Interestingly, the name PEP was coined by Andy Sessler in 1971, when thinking was concentrated on electron-proton possibilities, and initially stood for Proton Electron Positron. The Berkeley/Stanford group, together with visitors from CERN and Frascati, were then working on an ambitious e-p project. In the May issue, when we mentioned the first e-p work at DESY in 1972, we were writing in the European context of the developments which have culminated in the HERA project.)

Money was liberated for the construction of PEP in Fiscal Year 1977 as a result of enthusiastic lobbying of the powers that be, in which Pief Panofsky, the SLAC Director, was not uninvolved. John Rees of SLAC has headed the construction group with Tom Elliott of Berkeley as deputy. Responsibility for design and construction of the major components of the machine has been divided between the two Laboratories, making use of their different areas of special expertise (see February 1976 issue).

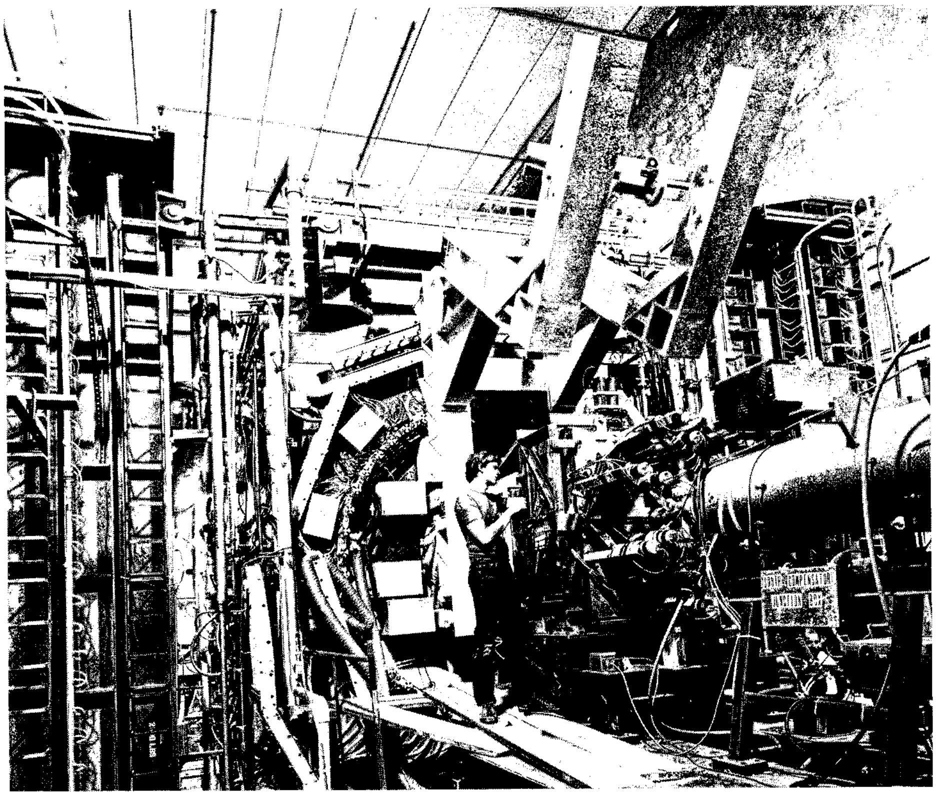
Recent aerial view of the Stanford site. The linear accelerator passes under the road, top left, culminating in the cluster of experimental halls and the SPEAR storage ring (centre). The PEP ring has been largely hidden by landscaping but the buildings at the six collision regions are discernable.

(Photo SLAC)

Despite money being released earlier than had first been expected, the rate of funding of the project, combined with heavier administrative procedures than have previously been borne by the US scientific community, slowed the construction. Also in recent months there have been frustrating problems with the availability of electricians to complete the installation. As a consequence, the scheduled completion date of the project (1 April 1980) was missed by a few weeks. The physicists and accelerator builders had in fact intended to bring the machine on six months earlier and, knowing the abilities and pride of Berkeley and Stanford in the building of accelerators, the last few months must have been nail-biting times. But PEP is now happily on the air and we welcome this powerful addition to the particle physics armoury.

Some key dates in the commissioning of the machine were as follows: On 21 April a circulating electron beam was achieved in the PEP ring for the first time. The initial currents were a few μA with lifetimes of a few minutes. In the subsequent two weeks currents were increased to 2mA and lifetimes to a few hours, while the machine physicists embarked on a systematic programme to understand the beam dynamics.

Positron injection started on 3 May and the first collisions were achieved on 4 May. All this running-



The Mark II detector being made ready for experiments. Successor to the famous Mark I psi discoverer, the detector has a cylindrical drift chamber inside a solenoid 3 m in diameter and 4 m long providing an 0.5 T field. A lead/liquid argon calorimeter and lepton and gamma detectors surround the target. End caps complete the nearly full solid angle coverage around the collision region.

(Photo Joe Faust)

Other detection systems being prepared are a High Resolution Spectrometer including the mighty superconducting magnet of the Argonne 12 foot bubble chamber (Argonne / Indiana / Michigan / Northwestern / Purdue), a magnetic monopole search (Berkeley / SLAC), the ambitious Time Projection Chamber (Berkeley/ Los Angeles/ Yale/ Riverside/ Johns Hopkins), a streamer chamber (Santa Cruz/ Berkeley/ Michigan/ SLAC) and 'forward detector facility' (Davis/ San Diego/ Santa Barbara).

in was done with a single bunch per ring at an energy of 8 GeV per beam because of breakdown in some pulsed kicker magnets which has since received attention.

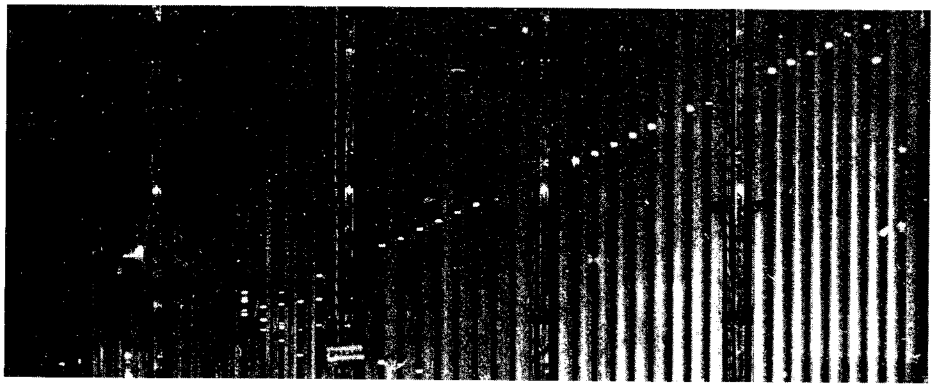
The control system is working well; it has some special features which enable the operators to feed in the desired beam optical conditions and the system calculates the appropriate setting of the hardware parameters. There have so far been no vacuum problems though large beam current, with the corresponding possibility of more outgassing due to synchrotron radiation, has still to be experienced. Klystrons have been developed to give an unprecedented 500 kW of output power with an efficiency of 63 per cent. There have been a few klystron failures but all eleven are expected to be back in action by the end of June so that the machine can be taken to full energy. Before then three-bunch operation is scheduled. Outstanding problems concern the reliability of the pulsed kickers at high energies and intermittent faults in the main d.c. power supplies.

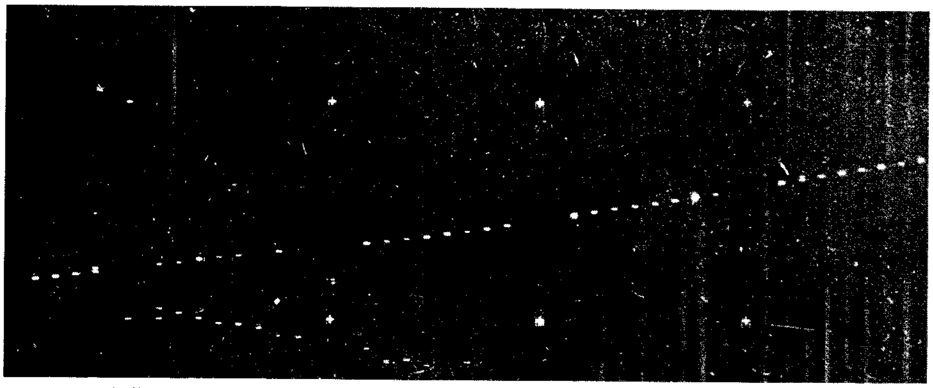
Three detection systems are ready to take data: Mark II is a general purpose spectrometer — the descendant of the famous Mark I system (which discovered the psi particles at SPEAR) adapted for operation at higher energies. It is being used by a Berkeley/Stanford collaboration and already has SPEAR operating experience behind it. A Berkeley / Stanford / Northeastern / Hawaii collaboration will be carrying out a 'free quark search' — almost a mandatory experiment in new experimental conditions. A Colorado/ Northeastern/ Stanford/ Wisconsin / Utah collaboration are using a system known as MAC to detect leptons and do total energy measurements.

More celebratory pictures taken in the control room on the morning of 21 April.

Oscillating neutrinos

Some of the first evidence of the interaction of high energy neutrinos with matter which revealed that neutrinos appear to exist in two distinct forms. In 1962, a Columbia team at Brookhaven produced a beam of neutrinos from the decay of pions and kaons. The neutrinos interacted to give muons, which easily passed through the spark chamber plates, as seen here. The fact that muons, rather than electrons, were produced showed that these neutrinos from meson decay were inherently different to those produced along with electrons in nuclear beta decay. However new results indicate that this might only be an approximation.





The neutrino has never ceased to provide a steady stream of physics surprises. The very existence of such an elusive particle (a low energy neutrino can pass through several light-years of lead shielding and still emerge unscathed) was a surprise in the first place. This initial reputation has been maintained by subsequent eutrino-related discoveries — the absence of a total left-right symmetry in Nature (parity violation), the existence of distinct types of neutrinos which appear not to mix, and the neutral weak current in which neutrinos can interact without changing their form.

Up till now, no evidence for any neutrino rest mass has been found, and there were compelling reasons why. A massless neutrino, travelling at the speed of light and possessing only kinetic energy, makes the theory very neat. This conventional 'two-component' neutrino formalism says that the particle has no mass and only exists in a left-handed form (spinning anticlockwise when viewed from behind).

In 1962 it was discovered that there are two different kinds of neutrino, one associated with muons and the other with electrons. Since then, two distinct conservation laws, of muon and of electron number, have always been found to hold for any reaction — the number of initial muons and muon-type neutrinos exactly balances the final number, likewise for electrons and electron-type neutrinos. It looked as though the neutrinos associated with muons and those associated with electrons were immutable and could never mix. (Since the discovery in 1975 of the tau particle, it would seem as though there is at least one more type of neutrino around, although no direct evidence for it has yet been seen.)

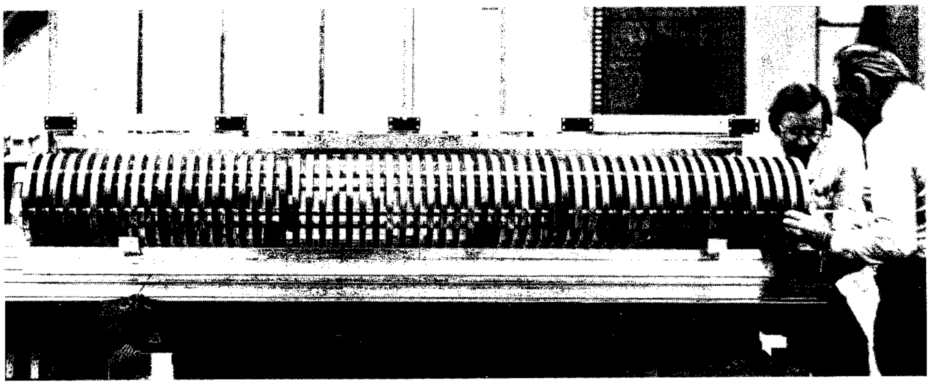
New evidence, much of it still preliminary, from very different experiments now indicates that the neutrino might have another of its periodic surprises in store for us. It could turn out to have a mass, and the muon- and electron-type neutrinos look as though they might mix in some way. If the experiments are right, the hitherto sacred immutability of electron- and muon-associated particles is only an approximation, and the appealing symmetry of conventional neutrino theory will have to be abandoned.

The ideas

The neutrino can acquire a mass in the theory if, in addition to the usual well-known form of the weak interaction, some tiny additional component exists which upsets the separate conservation of muon- and electron-affiliated particles. Theorists have speculated about this before, but the idea received new impetus with the arrival of the 'grand unified theories' which attempt to merge electroweak unification with the strong nuclear force to get a more complete picture of particle interactions (see May 1979 issue, page 116).

This bigger theory includes new aspects of particle behaviour which have interesting consequences. Some of them make the proton unstable, and some can upset the conventional description of neutrinos as massless particles. In this picture, it is generally expected that the neutrino masses are considerably less than those of the quarks and the other leptons.

In addition, each of the various types of neutrino can acquire its own characteristic mass, and so propagate at its own speed. This would mean that a neutrino beam is a superposition of the different com-



Assembly of a 'beam dump' for an experiment using the CERN neutrino beam which showed an unexpected asymmetry in the numbers of prompt electron- and muon-type neutrinos. This asymmetry could be indicative of neutrino 'oscillations' due to the particles having non-zero mass.

(Photo CERN 309.3.79)

ponents, the exact superposition depending on the components' relative magnitudes and their phases, which vary from point to point.

In this way, a neutrino beam could oscillate — a pure beam of, say, electron neutrinos produced at one place could be observed somewhere else as a coherent superposition of electron and muon neutrinos. A similar behaviour (although of different origin) is seen with the neutral kaons, where the K° and its antiparticle are not stationary, but are mixtures of a long-lived and a short-lived form. (This has been described at length in the coverage of the famous charge-parity violation experiments, for example in the October 1968 issue.)

The experiments

One of the new results comes from Fred Reines' Irvine group working at the Savannah River fission reactor. Getting neutrino data from fission reactors is something of a speciality for Reines. With Cowan, he obtained the first experimental evidence for neutrinos, back in 1953. Last year, the group reported the breakup of deuterons by neutral currents (see November 1979 issue, page 365), providing important evidence for the Weinberg-Salam electroweak unification theory.

The experiment has now compared the rates of deuteron dissociation by neutrinos through the charged weak current (giving a positron and two neutrons) and the neutral weak current (giving a neutrino, a proton and a neutron). The ratio of the cross-sections for these two processes is found to be very different to what is expected with no neutrino oscillations.

Definite conclusions are as yet difficult to draw. From the limited results obtainable it is not clear whether the heavy water neutrino detectors, placed several metres from the neutrino source, are seeing just one neutrino oscillation, or the average of many oscillations.

An additional clue comes from the data of the recent CERN neutrino 'beam dump' experiment (see for example October 1979 issue, page 313). In this investigation, special metallic targets (the beam dumps) were used instead of the usual primary target for the SPS proton beam. In such beam dumps the secondary kaons and pions, which are the usual sources of neutrinos, are quickly absorbed before they get a good chance to decay and produce their neutrinos. In this way, the usual flux of neutrinos is reduced by a factor of about a thousand, but additional 'prompt' neutrinos, from particles which do manage to decay before being absorbed, show up better.

These short-lived particles would be expected to carry charm, and decay to yield equal numbers of prompt electron and muon neutrinos. However an unexpected electron-muon asymmetry is seen in the prompt neutrino signal, and one possibility is that this is due to neutrino oscillations.

If neutrino oscillations are being seen in the reactor and beam dump experiments, then it looks as though it is the 'electron' neutrino which is changing into another non-muon associated neutrino, as earlier neutrino experiments using the Gargamelle bubble chamber saw no evidence for electron-muon neutrino mixing. The fact that an effect is seen at SPS energies implies that the neutrino mass difference responsible for the oscillation is large (by neutrino standards), being of the order of several electron volts. A further puzzle is that, other than the CERN beam dump study, previous neutrino experiments seem to have detected the expected level of electron neutrinos.

An independent indication that something unexpected is happening comes from a Moscow (ITEP) experiment which analyses the beta decay of tritium. Previous experiments on this beta decay have established a limit for the neutrino mass but the latest result, which comes after some six years of running, points to the electron neutrino mass probably being somewhere in the range 14 to 46 electron volts.

The other experiments measure the mass differences between different neutrinos, rather than absolute masses, and the Moscow value for the electron neutrino mass may set the absolute scale. However the Moscow value seems surprisingly high to some people.

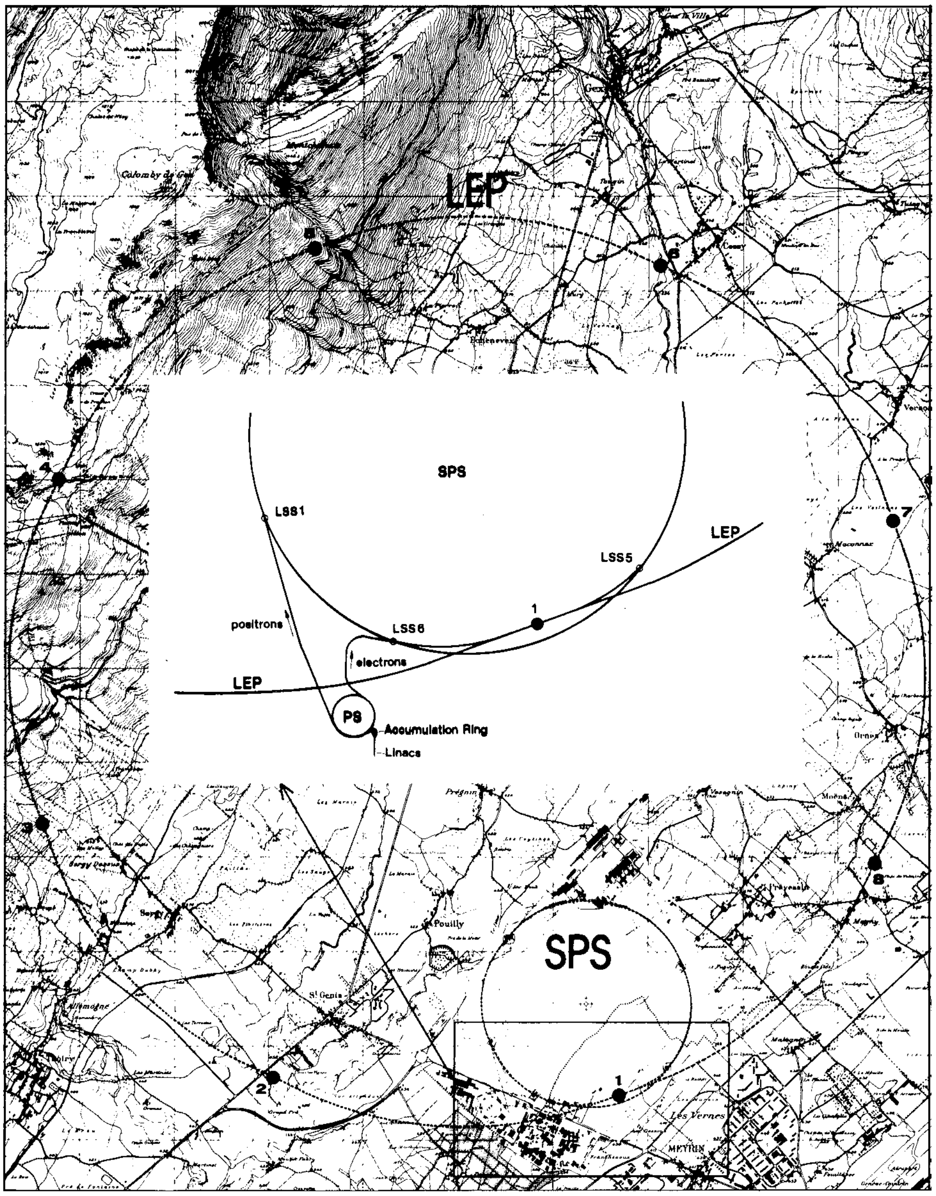
Neutrino oscillations have other implications, and are one possible explanation for the level of solar neutrinos detected so far being only a fraction of what is estimated theoretically (see October 1978 issue, page 351). But while it is fascinating to speculate about oscillating neutrinos, the evidence is still far from clear.

ECFA Meeting in May

LEP project changes / Backing for HERA / HEP in Europe

The European Committee for Future Accelerators held a Plenary Meeting at CERN on 9 May. The representatives of the Universities and Laboratories in the CERN Member States heard presentations on the latest developments concerning the LEP project at CERN. They supported a recommendation on the HERA project at DESY and they endorsed a detailed report on high energy physics in Europe.

The latest proposal for the injection system of the LEP scheme at CERN, making use of the existing accelerators.



New injection scheme for LEP

John Adams described the latest ideas concerning the use of the existing CERN proton synchrotrons in the injection system of the proposed high energy electron-positron storage ring, LEP. The initial proposal (described in the March issue, page 7) involved a 200 MeV electron linac, a converter for positron production, a further electron/positron linac taking the energy to 600 MeV, an accumulation ring and a 22 GeV electron/positron synchrotron prior to injection into the LEP ring proper. The new ideas dispense with the 22 GeV synchrotron by injecting into the PS after the accumulation ring and accelerating there to 3.5 GeV. The 3.5 GeV particles would then be transferred to the SPS and raised to 22 GeV for LEP injection.

The possibility of using the SPS for electrons has been talked about since the days when the CHEEP project (see June issue 1977, page 184) for electron-proton physics at CERN was mooted. It was revived in a recent paper by Y. Baconnier, O. Grobner and K. Hubner. Its main attractions are a reduction in LEP project costs by avoiding the 22 GeV machine (which would have been the highest energy electron synchrotron ever built) and a reduction in the manpower involved in construction (this, in particular, by liberating people for other things could shorten the necessary LEP construction time). It could also pull the sophisticated SPS control system into the LEP project with further cost and manpower reductions.

The problems could be the impact on the LEP cycle time, the impact on the physics programme with protons and the dangers for the SPS of the synchrotron radiation from the electron and positron beams. The first two of these potential problems are fortunately reasonably small. The LEP filling time increases from 15 to 23 minutes, which means about a 5 per cent effect on the average luminosity at top energy. The intrusion into the proton programme is an addition of about 1.5 s to the average cycle (involving a loss of some 10 per cent from the present SPS operation at 400 GeV). The main complication is that electron acceleration is obviously incompatible with the use of the SPS as a storage ring for proton/antiproton colliding beam physics.

The third problem — potential damage to SPS components due to synchrotron radiation — is still under study but the effects look entirely tolerable. Since the machine will be used only as an accelerator and not as a storage ring, the radiation deposited is small. Mechanical effects look negligible; radiation damage would be in the region of 10^5 rads per year.

The proposed scheme is to install the linacs and accumulation ring where the beamline to Gargamelle used to be at the PS. Positrons would follow the normal proton route in the PS and down beamline TT10 to the SPS. Electrons would go in the opposite direction in the PS and down the new antiproton beamline TT70 to the SPS. The precise SPS/LEP link is not yet decided but the take-off points are likely to be at long straight sections 5 and 6. In the SPS ring, room has to be found for some 40 m of radio-frequency equipment. This is not easy but it looks as if it can be solved.

One important consequence for the procedures involved in the authorization of the LEP project is that the use of the existing machines makes LEP an extension of existing CERN facilities. This formulation allows LEP to be absorbed as part of the 'basic programme' of CERN, which should avoid possible complications for the CERN Member States in authorizing LEP as a 'supplementary programme'.

Herwig Schopper, CERN's incoming Director General, covered the implications of the new injection ideas, and other new approaches, for the programme of LEP construction. It is now intended to build a 'stripped down' machine as fast as possible. Assuming that approval is given in 1981, the aim is for first stored beams for the end of 1986.

Some of the possible changes which would allow more rapid construction are as follows: The PS and SPS would be incorporated into the injection scheme as described above. Radio-frequency components, to the extent of 1/6 of the total ultimately foreseen, would be installed in only two stations. (This corresponds to an initial peak energy of 50 GeV per beam.) R.f. refinements, such as 1/3 harmonic equipment, would follow later. The SPS control system would be used. Cooling and ventilation would be initially limited. No new assembly hall would be built and there would be four rather than eight klystron halls. Only four of the experimental halls would have experiments installed.

Redoing the cost estimates for such a stripped-down version of LEP gives a figure for construction of 900 million Swiss francs. To distinguish it from the previous descriptions of LEP construction stages, this 50 GeV, four experimental hall version is known as LEP Phase 1. It will be presented formally to the delegates of the CERN Member States at the Council Session on 26 June.

Support for the HERA project

ECFA has always had a great interest in the possibility of an electron-proton colliding beam machine at the DESY Laboratory. This is because of the unique information which can be drawn from electron-proton physics and because the construction of such a machine will provide further 'front-line' facilities in Europe complementary to LEP.

This is why ECFA, while giving first priority to the construction of LEP at CERN, has participated extensively with the physicists from the Federal Republic of Germany in formulating the HERA project, which was described in our May issue (page 99).

At its 9 May meeting ECFA backed the following recommendation concerning the HERA project:

'As recommended at its meeting on 2 November 1979, ECFA puts first priority on the construction of the electron-positron collider LEP by CERN to keep Europe at the frontline of subnuclear physics.

The Electron-Proton Working Group of ECFA has conclusively demonstrated the unique scientific interest of electron-proton collisions. Such investigations are complementary to the programme realizable by LEP and other projects elsewhere.

From a study of the Working Group on High Energy Activities in the CERN Member States, it appears clearly that the scope of subnuclear

John Mulvey, chairman of the ECFA working group which has looked into high energy physics activities in the CERN Member States.

physics in Europe will be greatly broadened with a facility for such physics operational in the second half of the 1980's.

ECFA has considered at its meeting on 9 May 1980 the design of an electron-proton collider storage ring, HERA, that German physicists have proposed for DESY.

ECFA recommends strongly the construction of this machine at DESY and welcomes the possibility of it being used by the European community.'

High Energy Physics in CERN Member States

John Mulvey (Chairman of ECFA Working Group V) summarized the main points emerging from the study of the Group on 'High Energy Physics Activities in the CERN Member States'. The Working Group has presented its conclusions in two documents, ECFA/79/47 and ECFA/80/45. We have already covered the first of their reports which was concerned mainly with statistics on available manpower and resources and with an analysis of how well these resources would be adapted to the advent of LEP and HERA (see March issue, page 11). The overall conclusion was that, if present levels of support are sustained, a healthy physics programme can be mounted at both machines.

The second report covers several sociological aspects and makes recommendations to attempt to ensure a right balance. A major concern is that small Universities should still be able to participate fruitfully in the experimental programmes at the big accelerators where larger and larger collaborations of physicists are becoming the norm. It would be regarded as a bad development in high energy physics if research became concentrated in a few large centres. The many cultural benefits of working in a field of front-line research would then not be spread throughout Europe's educational system as they should be.

University groups can contribute in the area of detector development and construction, in computing and, of course, in ideas. It is considered very important to retain some technical work at home, to benefit research student training and to keep broad contact with other research activities. While no firm limits can be set, such projects usually require at least two full-time support staff or budgets in excess of 100 000 Swiss francs per year. It is suggested that smaller groups can associate with other fields of research to share technical effort. The use of links between workstations at Universities, central computer facilities and computer systems at the accelerator Laboratories is strongly recommended.

The report also looks at the age structure of the high energy physics community. There is a peak in the number of tenured staff around 40 years of age which means that it will be hard, for some years to come, for young physicists to move into senior positions unless steps are taken. The Working Group recommended the opening of new posts for young physicists and hopes that systems can be set up to encourage early retirement.

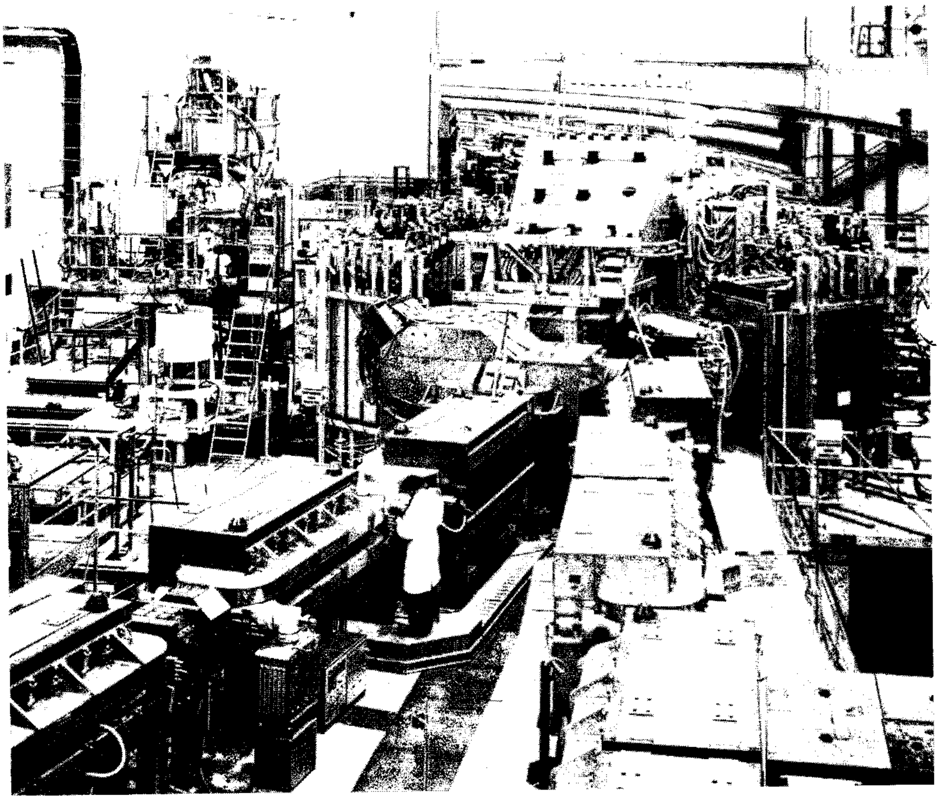
As covered in the first report, the Working Group was glad to see the complementarity which seems to be developing amongst the major facilities in different regions (Asia/Western Europe/USA/USSR and Eastern Europe). This may lead to further mobility amongst the regions so that physicists can work at the machine providing the physics which interests them most. The proposed 'principles of access' to different machines are listed as — the physics merit of the proposal and its feasibility; normal procedures for proposal acceptance should be applied; and no charge should be made for use of the accelerator. This keeps the door open to proposals from other regions and the smooth operation of such exchanges will depend on an overall balance between the regions in terms of front-line machines and the support facilities which are offered.

The report of the Working Group was endorsed by ECFA and will form a valuable background to the decisions regarding the future of high energy physics in Europe which will soon be taken.

Around the Laboratories

The Split Field Magnet at the CERN ISR, where on 21 May the first collisions were recorded between beams of alpha particles.

(Photo CERN 12.4.80)



CERN
World's highest collision energies

On 21 May, a new world record in centre of mass energies was established in the CERN Intersecting Storage Rings when two beams of alpha particles, each at an energy of 62 GeV, were collided. This took place with comparatively low intensities during a 'machine development' run, but the physicists operating the large Split Field Magnet (SFM) detector were able to gather some data.

The achievement followed a modest development programme, particularly in the Proton Synchrotron (PS) Division. The aim is to have two physics runs of about 60 hours each (one with alpha-alpha collisions and the other with alpha-proton collisions) in the ISR during the summer for an experiment by a CERN/Heidelberg/Lund collaboration using the SFM. Since the collisions involve compound nuclei (an alpha particle is a helium nucleus consisting of two protons and two neutrons) rather than particles, analysis of the data will not be easy.

However the experiment will probe an energy range never before attained, and which is not expected to be available with particles until the proton-antiproton collider at the CERN SPS begins operation next year. With the field wide open, the experiment plans a general study, covering both elastic and deep inelastic phenomena. It will certainly teach us more about nucleus-nucleus interactions.

Food for thought is that the alpha collisions in the ISR have in fact penetrated the energy range where, according to the electroweak theory, the intermediate bosons of weak interactions are expected to be found. Alas the production rate is expected to be very small and it would be a miracle if the experiment were able to pick out these particles from the debris of the hadronic collisions.

Earlier work at the PS had achieved some 10^{10} alpha particles per pulse. A crash effort for this latest run, with a modified duoplasmatron ion source giving singly charged helium ions and then using a gas stripping technique at 520 keV to yield the helium nuclei, achieved 10 mA of beam at the exit of the old linac. This was a satisfying improvement on the previous figures.

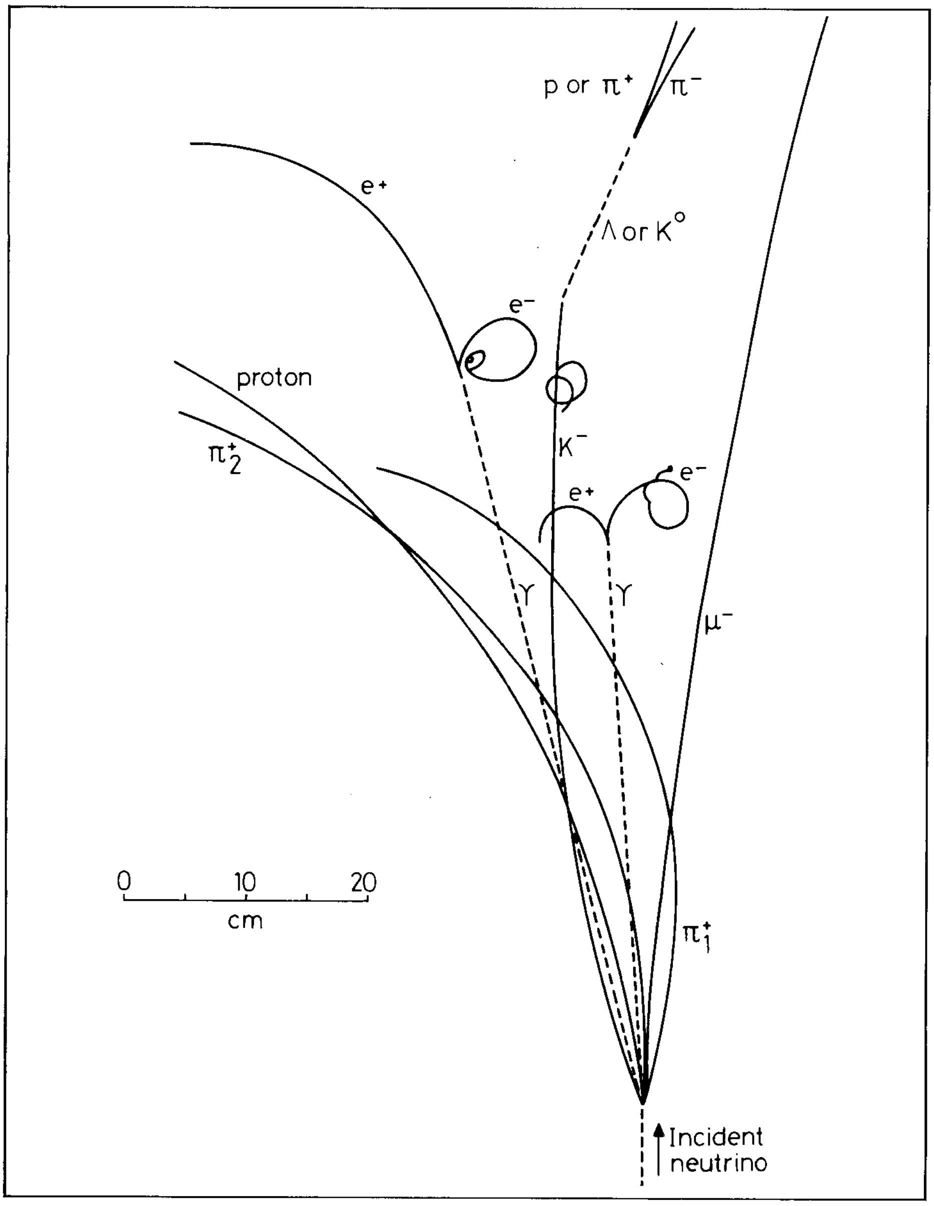
Injection into the PS ring was not very efficient but r.f. trapping worked well and the PS could accelerate some 1.5×10^{11} alphas. Not surprisingly, difficulties were encountered in defining the beam characteristics using the existing monitoring instrumentation given the low beam intensities — a salutary warning for the coming antiproton beams.

A similar instrumentation problem troubled the ISR, and was couple with the difficulty of coping with fluctuating input beam intensity. Nevertheless, without much effort or optimization, beams of just over 0.5 A were stored in each ring at the injection energy of 52 GeV. This is only a factor of four down on the intensity scheduled for the physics runs. The beams were held for many hours and accelerated virtually without loss to 62 GeV per beam. Luminosity was some 10^{28} per cm^2 per s.

New charmed baryon

The first example of the productior and decay of a singly chargec charmed sigma baryon has beer found in film from the Big Europear Bubble Chamber, BEBC, exposed tc the CERN neutrino beam.

First example of the production and decay of a singly charged charmed sigma baryon, seen in the BEBC bubble chamber equipped with a track sensitive target. Final particles are identified in the experiment and a unique kinematic fit is obtained.



The Bari/Birmingham/CERN/ Ecole Polytechnique/Rutherford/ Saclay/University College London collaboration took data with BEBC equipped with a hydrogen-filled track sensitive target (TST) surrounded by a neon-hydrogen mixture. This heavier liquid records the gamma rays from the decay of neutral pions. In this way, events can be reconstructed where otherwise invisible neutral pions are produced.

The event which has been found corresponds to an incident neutrino hitting a proton in the TST and producing a negative muon, a proton and a negative kaon, together with two positive pions and a neutral pion. This neutral pion decays into a pair of gamma rays. All the final particles are identified.

Such neutrino reactions producing negative kaons are characteristic of the production and decay of charmed particles. The proton, the negative kaon and one of the charged pions come from a singly charged charmed lambda baryon with a mass of 2290 MeV. This charmed baryon and the neutral pion come from the decay of the singly charged charmed sigma baryon with a mass of 2457 MeV.

BEBC has already provided examples of charmed meson production and decay (see November 1978 issue, page 394 and June 1979 issue, page 154), while evidence for charmed baryons has been seen at Brookhaven, Fermilab and SPEAR. However the charmed baryons detected up till now have been either doubly charged sigmas or singly-charged lambdas.

The doubly charged sigma is interpreted as one member of a charge triplet of sigmas containing also singly charged and neutral particles. This is the charmed version of the well-known triplet of hyperons (positively charged, neutral and negatively charged particles) with the strange quark (charge minus one-third) of the ordinary sigmas replaced by the charmed quark (charge two-thirds). Now the second member of this triplet has been found.

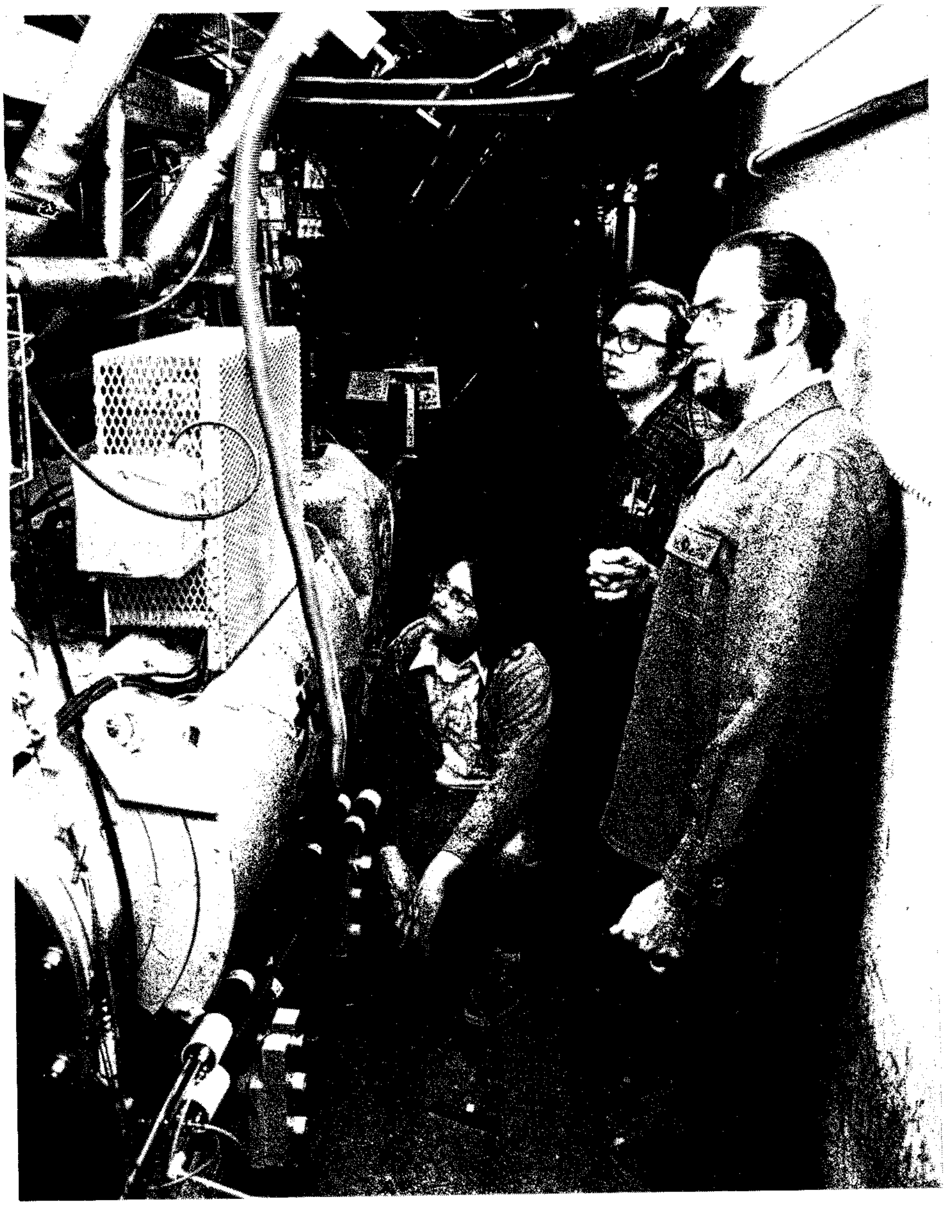
The group has more events to analyse and hopes for some further clear examples of charmed baryon decays.

FERMILAB
Cryogenic beamline in the high intensity area

Since the end of March, the Proton-West high intensity secondary beamline has been transported by a 4 foot-long prototype low-current superconducting dipole magnet. This represents the first operation of

The superconducting dipole magnet in place in the Fermilab Proton Area high intensity line. Inspecting it are, left to right, Rich Stanek, Peter Garbincius and Peter Mazur.

(Photo Fermilab)



a complete cryogenics system in P-West including liquid helium refrigerator, transfer line, superconducting magnet, and controls, all developed by the Fermilab Proton Department. This installation, along with some rearrangement of other existing elements, will upgrade the beamline capability in P-West to 400 GeV. With the doubler magnet string in M6 (see July/August 1979 issue, page 198) there are now two major superconducting beamline systems in operation at Fermilab.

The superconducting dipole magnet has attained a maximum field of 4.2 T over a 6 inch-diameter cold bore at an operating current of 210 A. Such low currents are advantageous for beamline use in order to minimize the many independent lead insertion thermal loads on the cryogenic system and to simplify the electrical power installation. The magnet uses a non-pressurized 'pool-boiling' cryogenics system, thereby simplifying controls and the liquid helium distribution system.

The 500-watt liquid-helium refrigerator features modified Energy Saver heat exchangers, a screw compressor, and unique reciprocating gas and wet-expansion engines. A liquid-helium transfer line extends 450 feet down the tunnel linking the refrigerator to the superconducting bend point. This line has stub connections for 23 additional magnets to service the downstream half of the beamline.

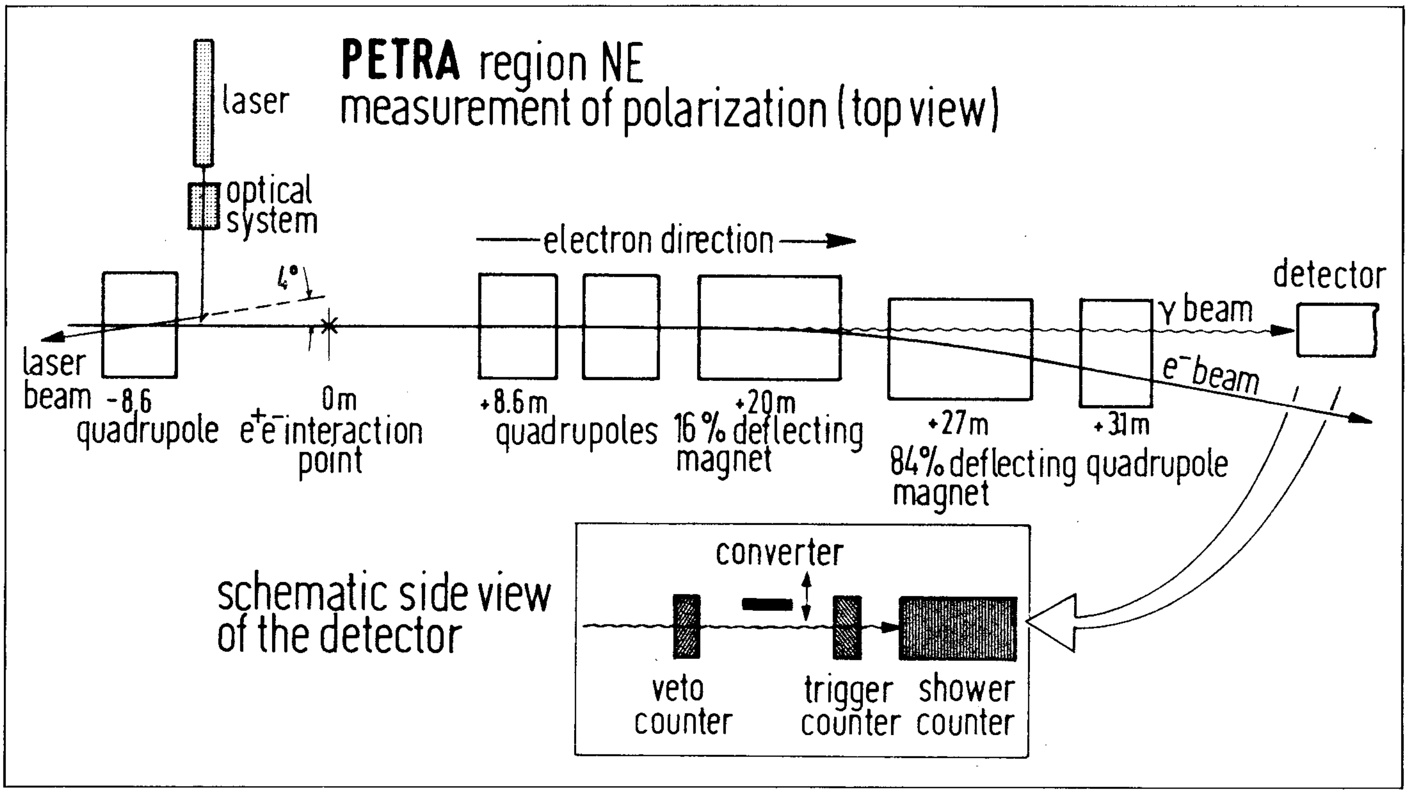
Current plans include system shakedown by continued operations and measurement of the refrigeration capacity and transfer line thermal loads. In addition, the susceptibility of the superconducting magnet to beam-induced quenching will be studied. Future projects include extension of the transfer line along the whole beamline, possible addition of a second liquid helium refrigerator, and continuation of research and development work on low-current dipole and quadrupole magnets.

DESY
Polarized beams at PETRA

The smooth running of PETRA in recent months gave the machine specialists a chance to measure the polarization of the stored electron beam. The method consists of determining up/down asymmetries in head-on collisions of beam particles with photons from a laser. The latter are polarized circularly by means of a Pockels crystal (the green laser light which is used originally has a linear polarization).

The laser beam and the electron bunch are timed so that they intersect (at a small angle of 4°) inside

Schematic view of the laser device which has been used to show that the electron beam at PETRA is polarized.



one of the big focusing quadrupoles preceding an interaction region. The laser photons have a momentum of only 2 eV and the electrons provide them with 6 GeV recoil momentum. The result is that most recoil photons practically follow the direction of the incident electrons. They can be detected after the next bending magnets after about 45 m. Beam divergence may smear out the up/down asymmetry expected when both the photons and the electrons are polarized. Therefore the choice of the interaction point between photons and electrons is crucial and must be carefully adjusted.

The photon detector consists of a veto counter against charged particles, a converter, a trigger counter and an energy sensitive shower counter. Asymmetries are detected by moving the converter up and down or inverting the polarization of the laser beam.

Polarization is expected to build up in stored electron (and positron) beams due to the emission of bremsstrahlung (synchrotron radiation) in the many bending magnets of the ring. However, it can be destroyed by relatively small inhomogeneities in the magnetic fields. In addition there are certain values of the beam energy at which polarization is killed. They are called 'depolarizing resonances' and have well-known positions. Once the energy of the beam has passed over such a resonance, the polarization process restarts.

At PETRA, polarization is expected to take less than half an hour and this has now been demonstrated several times. Severe condition had to be imposed in order to obtain reproducible results; all detector solenoids and the feedback system of PETRA were switched off. At a beam energy of 15.2 GeV, the asymmetry expected for polarized electrons is observed. Increasing the energy to 15.3 GeV (a depolarizing resonance), the asymmetry disappears and going back to 15.2 GeV it builds up again. It remains to be investigated if (and which) depolarizing effects are present under running conditions suitable for high energy physics experiments.

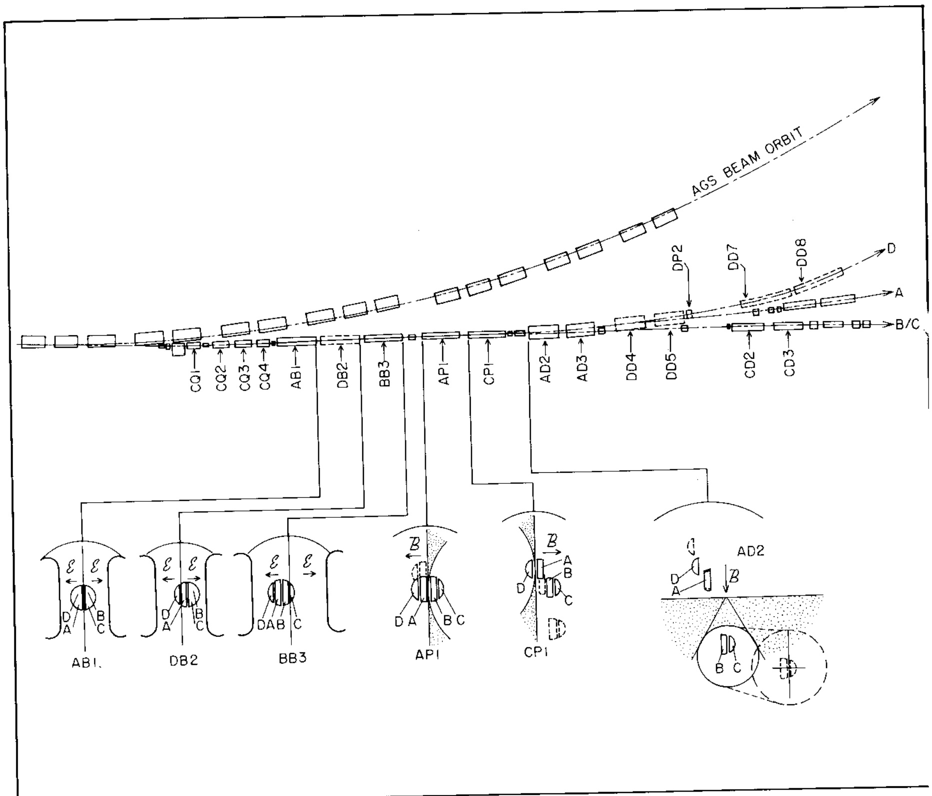
The polarization of electron and positron beams in storage rings due to the emission of synchrotron radiation was predicted theoretically by A.A. Sokolov and I.M. Ternov in 1963 and confirmed early in the 1970s by experiments at Orsay on ACO and at Novosibirsk on VEPP-2. Also during the early days of SPEAR operation at Stanford (beam energies around 2 GeV) analysis of the physics data showed that the beams were polarized.

However there were initial indications that polarization was not retained at higher energies. Ya. S.

Derbenev did further work on understanding depolarizing resonances and B. Montague applied the theory to PETRA conditions emerging with the conviction that polarized beams could be obtained.

This is very encouraging news for the physics programme since the usefulness of colliding polarized electron and positron beams increases with energy. Also for high energy electron-proton beams, the availability of polarized electron beams will be a very effective way of distinguishing between weak and electromagnetic effects in the region where the two forces become of comparable strength.

The new AGS beam switchyard produces an efficient four-way split in the space previously occupied by components for a less efficient three-way split. The beam is first split horizontally into four parts by three independently positioned electrostatic septum beam splitters. The splits are then enhanced by a system of Lambertson magnets bending in both planes. The components shown in dashed lines will provide beam to the new D station which will be installed in 1981.



BROOKHAVEN AGS celebrates in style

On 22 May there was a celebration at Brookhaven to mark the 20th anniversary of the first operation of the Alternating Gradient Synchrotron. We will be carrying news of that event in our next issue but in the meantime the machine has been celebrating in its own way.

Improvements in the slow external beam extraction and switchyard have been brought into action. The results are an increase of about 70 per cent in the number of protons that can be delivered to the primary targets and a more than fourfold reduction in beam loss and unwanted irradiation.

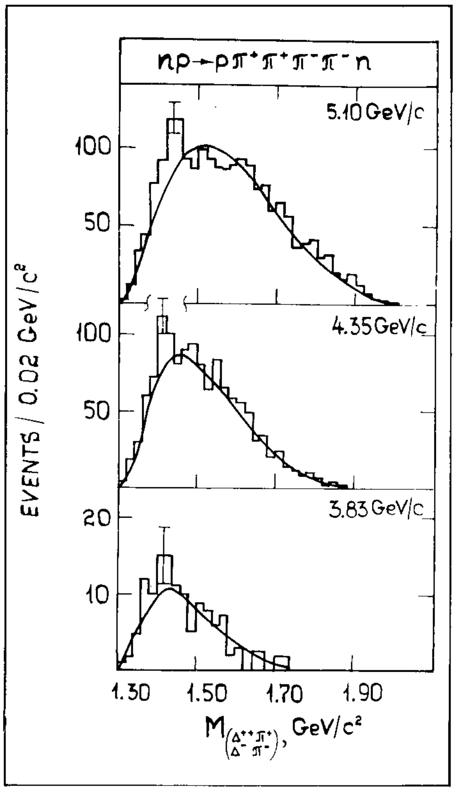
The improvements came about when an electrostatic septum was added to the existing complement of extraction septa. Since the AGS lattice was designed long before highly efficient slow extraction had been considered, it was necessary to use the electrostatic septum in a mode that exploits the nonlinear orbits during the third integer resonant extraction process. In all, protons that are split off by the septum make about 2 ²/₃ additional orbits before they are finally extracted. The overall result is an increase in extraction efficiency up to 98 per cent from the previous 75 to 90 per cent.

The second part of the improvement programme involved a reconstruction of the proton switchyard, from the extraction point up to the existing primary proton transport lines. The new switchyard design fits in an efficient four-way split, with electrostatic septa as the first stage, into the same area that had previously been used for a less efficient three-way split. The solution involves simultaneous development of the four splits in the same drift space and use of steel septum (Lambertson) magnets rather than the previous less effective copper septum magnets.

At present, only the three-way split to the existing A, B and C lines has been implemented; the new D line will be constructed next year. I will use superconducting 6 T bending magnets which are under devel opment.

The new switchyard was th largest single construction pro gramme ever undertaken by th Accelerator Department as part o its regular operations. Actual instal lation required a three-month shut down followed by three months i which beam was delivered by fas extraction only to the North Area fc a neutrino experiment.

Commissioning of the new sys tems went extremely smoothl Within an hour of the first extracte beam, protons were transporte through the upstream section wit all magnets at calculated values. Th new switchyard operates reliabl with an efficiency of 90 to 95 pe cent compared to 55 to 70 per cer with the old system.



Effective mass distributions of $p\pi^+\pi^+$ (with $n\pi^-\pi^-$) combinations, when the effective mass of the p(n) with one π^+ (π^-) meson, is in the range of the Δ_{33} isobar (1160–1300 MeV). The distributions were obtained from the $np \rightarrow p\pi^+\pi^+\pi^-\pi^-n$ reaction for three primary neutron momenta.

DUBNA
Possible baryon resonance with isospin 5/2

The reaction $np \rightarrow p\pi^+\pi^+\pi^-\pi^-n$ was studied in the 1 metre hydrogen bubble chamber of the Joint Institute for Nuclear Research High Energy Laboratory, irradiated with monochromatic neutrons having momenta of 5.10±0.17, 4.35±0.18 and 3.83±0.15 GeV. In the effective mass distributions of $p\pi^+\pi^+$ (with $n\pi^-\pi^-$) combinations, peaks were noted at 1420 ± 10, 1410 ± 10 and 1420 ± 10 MeV for the three momentum values indicated for the primary neutrons. The effect is enhanced if one selects the events in which the masses of the $p\pi^+$ (with $n\pi^-$) combinations lie in the band of the Δ_{33} isobar – 1160 to 1300 MeV. The production cross-sections of the assumed resonance with an isotopic spin of 5/2 are, respectively, 21 ± 3, 11 ± 3 and 7 ± 4 microbarn. The resonance width is 40 MeV, and the spin is greater than 1/2.

This exotic resonance should be constructed of no less than four quarks and one antiquark. The results of these experiments agree well with the predictions of A.B. Kajdalov and A.A. Grigoryan for an isospin 5/2 resonance obtained from superconvergent sum rules for Reggeon scattering on particles. The experiment was carried out jointly by physicists from JINR and Bucharest University.

LAPP ANNECY
New type of position sensitive photomultiplier

Thanks to the development of new scintillator materials and the use of photomultipliers to amplify the initial weak signals, scintillation counters for particle detection have come a long way since the classical researches of Rutherford. New techniques are constantly being developed to meet the demands of more complex experiments at accelerators of increasingly higher energy.

One such technique is the one-dimensional position sensitive photomultiplier developed by V. Rykalin and collaborators at Serpukhov. This exploits the transit time difference between photoelectrons coming from different points of impact on the photocathode. In a recent application of this device to scintillation hodoscopes, a final resolution of better than 1 mm has been achieved.

At LAPP (Annecy), a new high resolution device has been developed which uses the classical idea of an axial magnetic field to localize secondary electrons in the two dimensions perpendicular to the photomultiplier axis.

A preliminary study of these effects in a conventional Venetian blind type photomultiplier revealed that reduced gain at higher magnetic

The prototype high resolution position sensitive photomultiplier developed at LAPP (Annecy). The white frame (right) shows the sensitive area.

(Photo CERN 205.5.80)

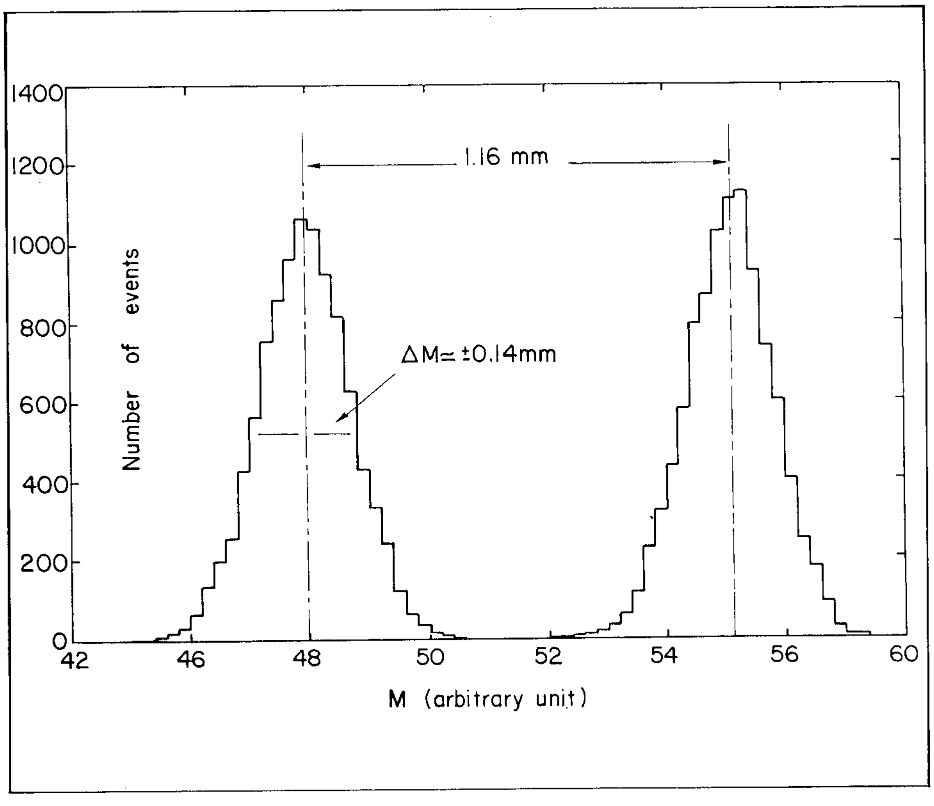
fields is due to secondary electrons, moving in tightly curved spirals, being recaptured at the dynode strip where they were emitted. Thus by making the dynode strips smaller, the lateral spread of the secondary electrons can be reduced without unduly affecting the gain of the photomultiplier. The focusing of electrons inside almost parallel electric and magnetic fields is exploited to improve localization.

A simulation procedure was used to establish the optimum configuration of focusing dynodes, and a ten-stage prototype developed in collaboration with Hamamatsu. It uses a bialkali photocathode, dynodes made of triangular strips of copper/beryllium, and a multianode consisting of a 4 x 4 matrix of anode cells.

The gain of about 10^5 to 10^6 and resolution of about ± 1.7 mm in the x and y directions are in good agreement with the simulation predictions. Pulse height analysis of signals from the multianodes allows the initial spot position to be reproduced with a precision of a few hundreds of microns, although the technique has still to be perfected. The prototype was also robust and reliable.

Further development seems to lie in increasing the sensitive area of the photocathode to increase the number of picture elements obtainable, and in improving the data handling capabilities. However the first results already indicate that the new device could be of significant use in particle and nuclear physics experiments, and in nuclear medicine.

A typical example of the results obtained by pulse height analysis in the new LAPP photomultiplier, showing the good space resolution which can be obtained. The horizontal axis gives the reconstructed spots corresponding to two positions of a light source, 1.16 mm apart.



TRIUMF
Clinical trials of cancer therapy

As reported in the January/February issue, clinical testing of negative pion radiation therapy was begun at TRIUMF in November 1979 on four patients with skin nodules. Preliminary results are now available. Tests, which are being directed by B.G. Douglas, G. Goodman, S. Jackson and C. Ludgate of the Maxwell Evans Cancer Clinic in Vancouver, are continuing with two further patients in March and more are expected during the summer. This follows several years of pion channel development and pre-clinical studies on cells, mice and pigs by L.D. Skarsgard, K.Y. Lam, B. Palcic, C.J. Eaves and R.M. Henkelman from the British Columbia Foundation.

Radiation has long been used to treat patients with cancer, mainly using photons of various energies (X-rays or gamma rays). Particle radiation (neutrons, protons, heavy ions and negative pions) offer various theoretical advantages, and investigations are under way to determine the various possibilities. It is interesting that no radiation yet used has failed to show an effect on tumours and thus it is necessary to carry out carefully designed tests to compare the effectiveness of negative pions with that of other radiation against the various forms of cancer.

All forms of radiation damage both tumour tissue and normal tissue. Damage to the tumour commonly results in a proportion of patients with local tumour eradication. Damage to normal tissue results in excessive normal tissue effects, causing symptoms in a small proportion of patients who may or may not have achieved local tumour control.

A patient being positioned at the end of the M8 channel of the TRIUMF cyclotron for negative pion irradiation of a skin nodule.

(Photo British Columbia Cancer Foundation)

The doses that can be given are restricted by the acceptable damage to normal tissue and it is important to establish these maximum doses. As a first step for negative pion irradiations, studies have begun on patients who have tumour nodules just underneath the skin surface.

Traditionally, it has been found that the doses that can be tolerated by skin are also tolerated by a number of other sites in the body and it is for this reason that skin effects have been chosen. In addition, the effects of irradiation depend on the number and size of the dose fractions or irradiation employed. Thus the study is designed to yield information on how the total dose must be changed to get a constant effect as the number of dose fractions is altered. This allows the relative biological effectiveness (RBE) for skin to be determined for a range of doses. While tumour response is not the primary object, tumour regrowth information may be available and thus the information may be obtained as to whether the tumour BE is greater or less than that for skin.

The patients being treated have multiple superficial subcutaneous tumour metastases. Such patients are not curable because the disease is widely disseminated. Multiple nodules in each patient have been randomly allocated to receive either conventional or pion therapy. To date either ten dose fractions or three dose fractions have been employed in the treatment of any given patient. Preliminary information is now available on patients treated with ten dose fractions using a total dose of either 2850 or 3000 rads of pion irradiation. The X-ray doses have been chosen to cover the RBE range of 1.4 to 1.6. This range was chosen from previous experiments on animals. The preliminary information indicates that the RBE of the negative pion beam is between 1.4 and 1.5. The doses employed to date have not yielded any complications. Ultimately it may be necessary to take the doses high enough so that some complications begin to be seen before the RBE of negative pion irradiation with respect to the more familiar photon radiation can be known for certain.

AMIENS Photon-Photon Workshop

An 'International Workshop on Photon-Photon Collisions', attended by about ninety physicists, was held at the Laboratoire de Physique Théorique des Particules (Director G. Cochard) of the University of Picardy (Amiens) on 8–12 April.

Photon-photon collisions have become an important area of investigation. After the pioneering papers of F. Low and of F. Calogero and C. Zemach in 1960, theoretical work was stimulated from about 1969 by the extensive studies at Collège de France, Novosibirsk and Cornell/SLAC. Presently, the theorists' interest concentrates mainly on crucial checks of quantum chromodynamics.

The first experiments (performed at Novosibirsk and Frascati from 1970-73) were basically tests of quantum electrodynamics but recent results from various Laboratories have a direct bearing on strong interaction physics. Examples include the measurement of the two photon decay width of the eta prime at SPEAR and of the f using PLUTO at PETRA; the determination of a cross-section for multi-hadron production in photon-photon collisions between 1 and 6 GeV by the PLUTO and TASSO collaborations at PETRA; the study of pion-pair production in the low energy region at DCI (Orsay); and the observation of a dozen jet-pair events obviously due to the photon-photon mechanism, again by the PLUTO collaboration.

After a general introduction on the history and the problems by P. Kessler (Collège de France), the experimental work was introduced by G. Barbiellini (CERN and INFN). The results and projects of the various groups at PETRA were presented by C. Berger (Aachen) for PLUTO, E. Hilger (Bonn) for TASSO, J. D. Burger (M.I.T.) for MARK-J, H. Wriedt (Lancaster) for JADE, and M. Goldberg (Paris) for CELLO. Recent data obtained at DCI by the Orsay/Clermont-Ferrand collaboration were shown by J.-C. Montret (Clermont-Ferrand). P. Jenni (SLAC and CERN) gave a review of the study of photon-photon processes at SPEAR. D. Burke (SLAC) presented the experimental programme at PEP, and J. Field (DESY) described the possibilities at LEP. F. Vannucci (LAPP) discussed the contribution of the photon-photon mechanism to lepton pair production in proton-proton collisions and showed some data obtained at the CERN ISR.

Problems of analysis, at the border of experiment and theory, play an important role. A. Courau (Orsay) spoke about 'Tagging and identification'; J. Vermaseren (CERN) discussed mutual contamination between one-photon and two-photon processes; C. Carimalo and J. Parisi (Collège de France) treated problems of 'back-factorization' and G. Cochard presented some recent calculations on radiative corrections.

The theoretical part of the Workshop was introduced by J. Smith (Stony Brook) who showed the results of computations of pair production (including heavy lepton and charm particle pairs). M. Greco (Frascati) discussed hadron production at low energy — mainly resonance production and applications of Regge-pole theory. J. Gunion (Davis and SLAC) treated QCD applications in general, T. Walsh (DESY) concentrated on deep inelastic effects and the determination of structure functions of the photon. Finally, C. Llewellyn Smith (Oxford) discussed 'Present trends in elementary-particle theory'.

A large part of the Workshop was devoted to parallel sessions. In the theoretical sessions (discussion leader K. Kajantie of Helsinki) subjects discussed were: the equivalent photon approximation; radiative corrections; lepton-pair production in proton-proton collisions; and some QCD applications (glueball production). In the experimental sessions (discussion leader G. Barbiellini) discussions were mainly devoted to machines and detectors for the study of photon-photon processes; suggestions were also presented on the use of the mechanism for luminosity measurements in colliding beam machines. The summary talk was given by G. Altarelli (Rome).

(A preliminary report of some of the results announced at this Workshop was included in our June issue, page 152.)

People

Burt Richter – new chair at Stanford.

On people

Burt Richter of SLAC, joint Nobel Laureate for 1976 following the discovery of the J/psi particle, has become first holder of a newly established chair at Stanford University — the Paul Rigott Professorship in the physical sciences.

The J. Robert Oppenheimer Memorial Prize, awarded annually by the Center for Theoretical Studies at the University of Miami, went this year to Richard H. Dalitz. The award was presented by Paul Dirac.

CERN Research Director General Leon Van Hove has been elected Foreign Associate of the US National Academy of Sciences, and has also become a Foreign Member of the American Philosophical Society.

and things

David Shirley, new Director of the Lawrence Berkeley Laboratory.

Andrzej Wroblewski, Director of the Institute of Experimental Physics of Warsaw University, has been awarded the degree of Doctor Honoris Causa by Siegen University. Professor Wroblewski has been involved in bubble chamber physics for many years at CERN, Serpukhov and Fermilab and is particularly well known for his work on empirical laws of multiparticle production in high energy hadron collisions.

At a ceremony at the University of Geneva on 5 June, Jean-Pierre Blaser, director of the Swiss Institute for Nuclear Research (SIN) at Villigen, received the honorary degree of doctor of science.

Gerald T. Garvey, Argonne's Associate Laboratory Director for Physical Research, has taken over responsibility for the Laboratory's High Energy Physics and Accelerator Research Facilities Divisions.

HEPAP plea for more USA accelerator research

In 1979, the USA Department of Energy set up a subpanel of HEPAP, under the Chairmanship of M. Tigner from Cornell, to review the overall quality and scope of the high energy accelerator research and development effort in the USA high energy physics programme (see November 1979 issue, page 367). The subpanel reported in May with what Maury Tigner described as a 'call-to-arms' to the USA high energy physics field in general to devote more attention to long range accelerator research.

Research in this field absorbs at present only about 1.5 per cent of the USA high energy physics operating budget and the subpanel believes that this figure should at least be doubled. Particular topics for accelerator research which are identified now are high field superconducting magnets (i.e. beyond the field levels attainable with niobium-titanium superconductors), superconducting radiofrequency cavities (essential for energy conservation at very high energy electron storage rings), new accelerator concepts (such as laser-driven devices and high current linacs) and the study of machine characteristics which limit performance.

Rutherford Laboratory Open Days

'Open Days' at the Rutherford and Appleton Laboratories are scheduled for 8–12 July. Under the theme 'Quarks to Quasars' the work of the Laboratories in support of UK Universities, Polytechnics, Government Departments and Industry will be presented; exhibits cover a wide range of scientific and engineering disciplines. In the field of accelerators and high energy physics, displays show preparatory work for the Spallation Neutron Source, including the completed 70 MeV proton linac, and of apparatus and electronics involved in several of the large experiments for the CERN and DESY accelerators. Any inquiries about the Open Days can be addressed to the 'Open Days Secretariat', Rutherford and Appleton Laboratories, Chilton, Didcot, Oxon OX11 OQX, U.K.

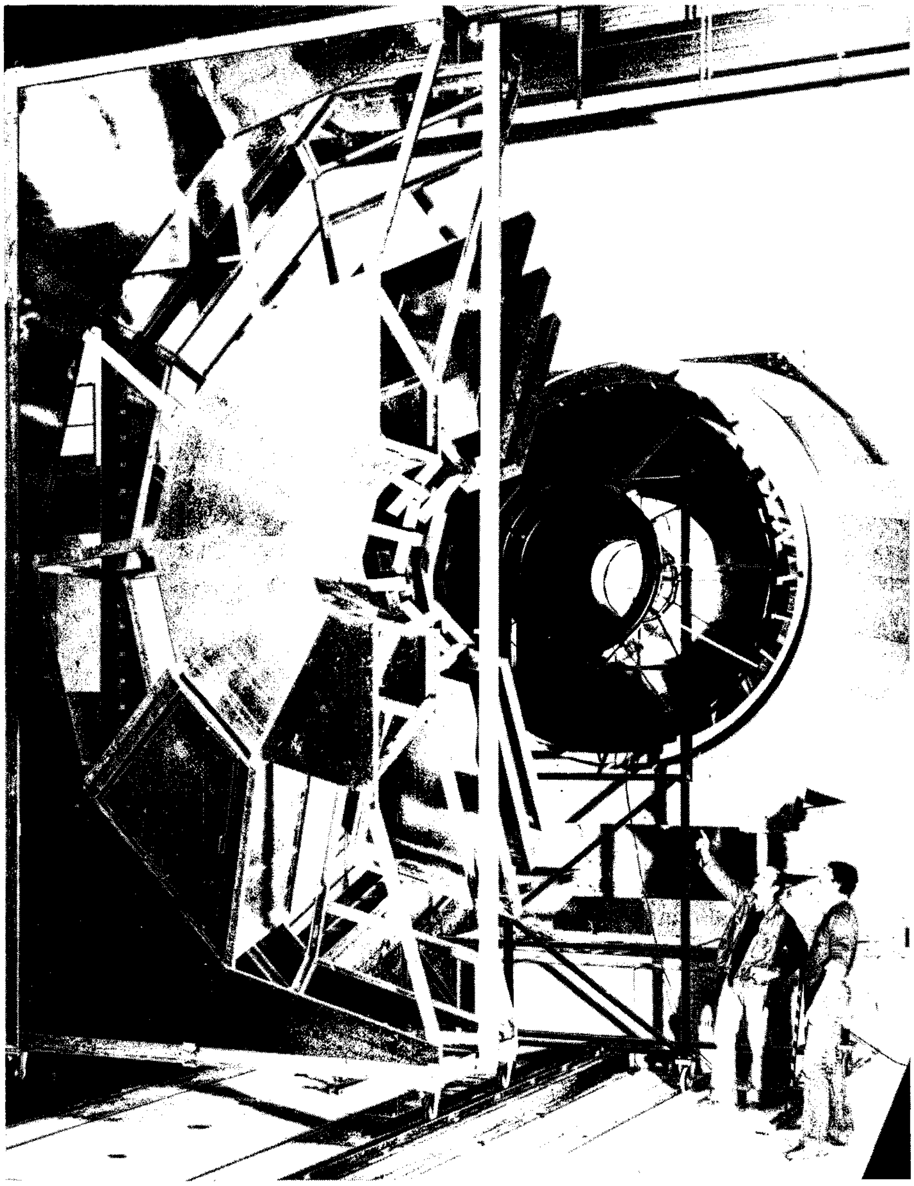
The Eighth International Vacuum Congress is being held from 22–26 September at Cannes, France. It will cover all aspects of vacuum science and technology, with the focus on fundamental and applied research. Further details from Société Française du Vide, 19 rue du Renard, F-75004 Paris.

SPS Programme Review

The SPS Experimental Committee (SPSC) is to hold a meeting at Cogne, Val d'Aosta, from 8 to 12 September preceded by an open meeting at CERN on 5 September. The Cogne meeting will review the experimental programme at the CERN accelerator and establish guidelines for the programme after the long shutdown during which the SPS will be prepared for proton-antiproton physics. The meeting will be examining the implications of reduced support for the SPS programme during the period of LEP construction, the balance between fixed target and colliding beam physics and the implications of higher energies at Fermilab when the Tevatron comes into operation. Reports on present experiments

A full-scale model for the UA2 experiment for the proton-antiproton collider at the CERN SPS. For a progress report on this experiment, see the June issue, page 147.

(Photo CERN 128.5.80)



and future plans for experiments after the shutdown have been requested to be sent to the Committee before 1 September.

Omega minus antiparticles

The first measurement of the production rate of omega minus antiparticles comes from a Bristol/Geneva/Heidelberg/Orsay/Rutherford/Strasbourg collaboration using the charged hyperon beam at the CERN SPS (see July/August 1978 issue, page 257). The latest results from this experiment compare the production rates of different baryons and antibaryons under the same kinematical conditions, and provide important input for theories of hadron dynamics. The experiment measures the more abundant particles using a DISC Cherenkov, however rarer particles, such as the anti-omega, have to be picked up through their decay products. Fifteen examples have been found of an anti-omega decaying into an antilambda and a positive kaon. It is found that the antibaryon to baryon ratio increases quickly with strangeness. Under the actual experimental conditions, antiprotons are seen a thousand times less frequently than protons, while anti-omegas are only three times as scarce as the omega minus.

Successful production of superconducting magnets

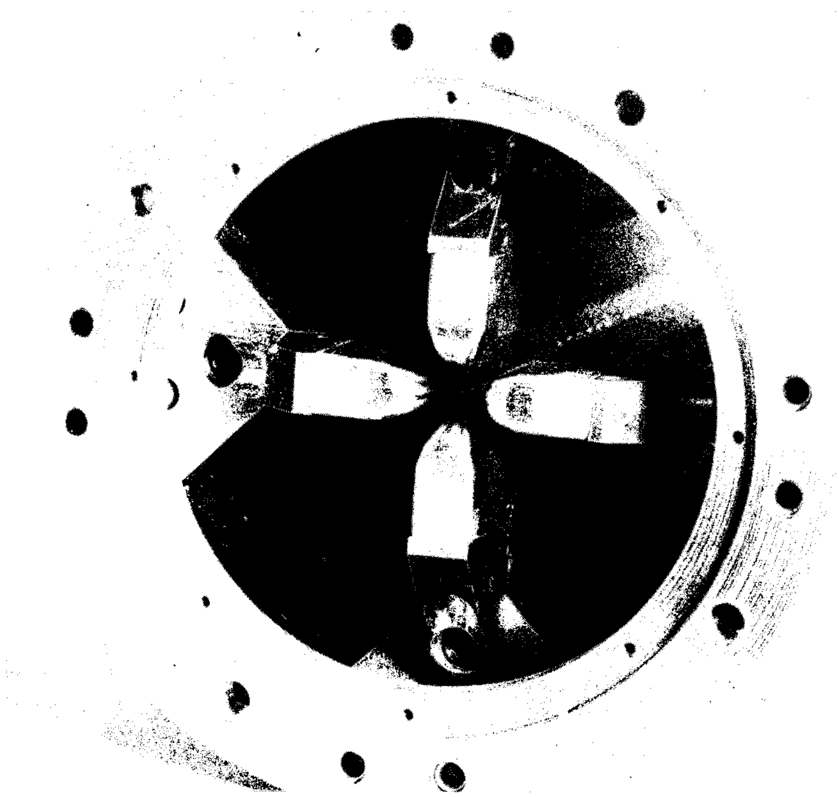
To produce a large increase in the luminosity at one point in the Intersecting Storage Rings, CERN decided to introduce superconducting quadrupoles at a beam intersection region. In addition to the physics interest of the higher event rate that will thus be made possible, there are two other interests to which the project can contribute — to check the ability in European industry to produce superconducting magnets to the required tight specifications and to check the performance of the magnets in the demanding environment of storage rings.

The first of these questions has now been answered in the affirmative. Eight superconducting quadrupoles have been produced by industrial firms according to CERN design and manufacturing specifications and have been successfully assembled and tested at CERN. The horizontal cylindrical cryostats, which contain windings and steel yoke in a boiling helium bath, have a 173 mm warm bore. For 31 GeV beam energy, the maximum operating gradient on the quadrupole axis is 43 T per metre and the maximum field in the windings is 5.5 T.

Four of the quadrupoles have

The injection end of the radio-frequency focusing quadrupole which has been successfully tested at Los Alamos. Tank diameter is 11 cm. The new RFQ technology (see May issue, page 108) may have fruitful applications in several accelerator schemes.

(Photo Los Alamos)



1.15 m and four 0.65 m magnetic lengths. They have been manufactured by the Alsthom-Atlantique factory in Belfort, using superconducting wire supplied by Vacuumschmelze, Hanau. The cryostats have been supplied by Leybold-Heraeus, Cologne.

Magnetic measurements, which finished in May, have shown that performance and field quality meet the specified requirements for the high luminosity insertion. Installation in the ISR will take place during the long shutdown starting in mid-August.

Proton radiography at Argonne

Recent results from the Argonne research into the possibilities of improved radiography using proton beams was reported in the May issue of 'Radiology'. Using a 205 MeV proton beam and test objects made of lucite or excised soft human tissue, accuracies in thickness measurement are now approaching 0.1 mm (equivalent to detecting a difference in mass smaller than one per cent across the specimen). The technique (described for example in the September 1974 issue, page 303) monitors the proton energy absorption, related to the density of the object transversed. Tumour detection and organ abnormalities should be detectable with radiation doses over an order of magnitude down on conventional X-ray methods, in addition to revealing far more detail. The Argonne work was promoted in the early days by Ron Martin and the recent results were reported by Steven Kramer. One of our favourite remarks is Ron's 'Anyone who closes down accelerators like the ZGS needs his head examined and here at Argonne we are developing just the tool to do it with'.

A CHEER for Fermilab

The annual Woods Hole meeting of the US HEPAP subpanel in early June, which surveys the US high energy physics scene, received a submission from Canadian physicists for the construction of an electron machine at Fermilab to make electron-proton colliding beam physics possible. The machine goes by the name of CHEER — Canadian High Energy Electron Ring.

For many years, the Canadian high energy physics community has benefitted greatly from contacts with its near neighbours in the US and from access to advanced accelerator facilities, like Fermilab. In April 1979, the Canadian Institute of Particle Physics (IPP) decided to review the contributions Canada could make in the next five to ten years. A Workshop discussed a wide variety of projects and emerged with a proposal to study the feasibility of electron-proton physics.

An Electron-Proton Steering Committee has been set up with Richard Hemingway (IPP) as Chairman, Nathan Isgur (Toronto) as Physics Coordinator, Doug Stairs (McGill) as Machine Coordinator, Cliff Hargrove (National Research Council, Ottowa) as Detector Coordinator and Jim Prentice (Toronto) as Strategy Coordinator.

Workshops were held at Fermilab in February and Toronto in April, and a third is scheduled at Carleton University, Ottowa, at the end of June. Physicists from twelve Canadian Universities are involved, together with participants from Chalk River, TRIUMF, the National Research Council and IPP, together with US colleagues.

Leon Van Hove (left) fires the starting pistol for the traditional annual relay race around the CERN site.

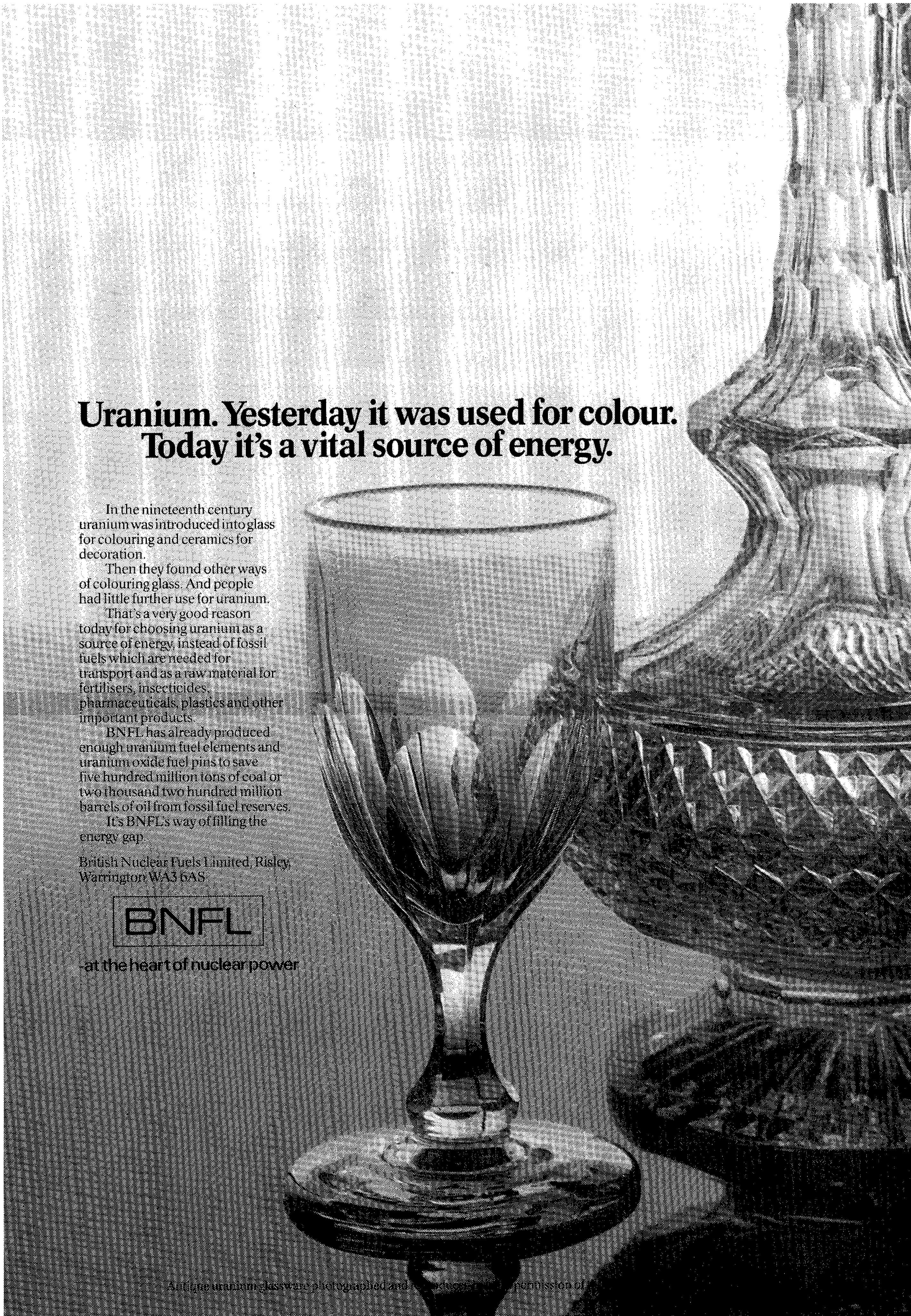
(Photo CERN 67.6.80)

The unique physics interests of experiments using colliding electron-proton beams were outlined in the article on the HERA project at DESY (see May issue, page 99). The plan which is emerging for CHEER foresees a 300 MeV electron linac feeding a 2 GeV booster. The 2 GeV electrons would pass into a 10 GeV storage ring, giving 10 GeV electrons colliding with 1000 GeV protons from the Tevatron. Design luminosity is 10^{32} per cm^2 per s. Attention is being given to ensuring the availability of polarized electron beams. Detector design, given the rather restricted space in a Tevatron ring long straight section, is under way.

Canadian physicists are optimistic about the prospect of securing funds for the project, the tentative cost estimate for which is about 60 million Canadian dollars. CHEER is emerging in a climate of assurances of much higher budgets in Canada for research and development. It is hoped that the feasibility study can be completed this summer and the proposal submitted to the Natural Sciences and Engineering Council on 1 September with the hope that it can be included in the budget presentation of 31 October. Funding could then be released from 1 April next year for detailed design work, and a year later for construction. If this optimistic schedule is met, CHEER could be in action in 1985.

Proceedings available

The Proceedings of the X International Symposium on Multiparticle Dynamics held last year in Goa, India, are now available on order from Prof. P. K. Malhotra, Bubble Chamber Group, Homi Bhabha Road, Bombay 400 005, India. Price of the 824-page volume is US$25, £12 or SF45. A reduced rate of US$17 is applicable for developing countries. Please include US$11 for USA and Canada, £5 or SF19 as additional charges if air-mail despatch is required. Cheques/drafts (crossed a/c payee only) should be drawn in favour of the Registrar, Tata Institute for Fundamental Research, Bombay, India.



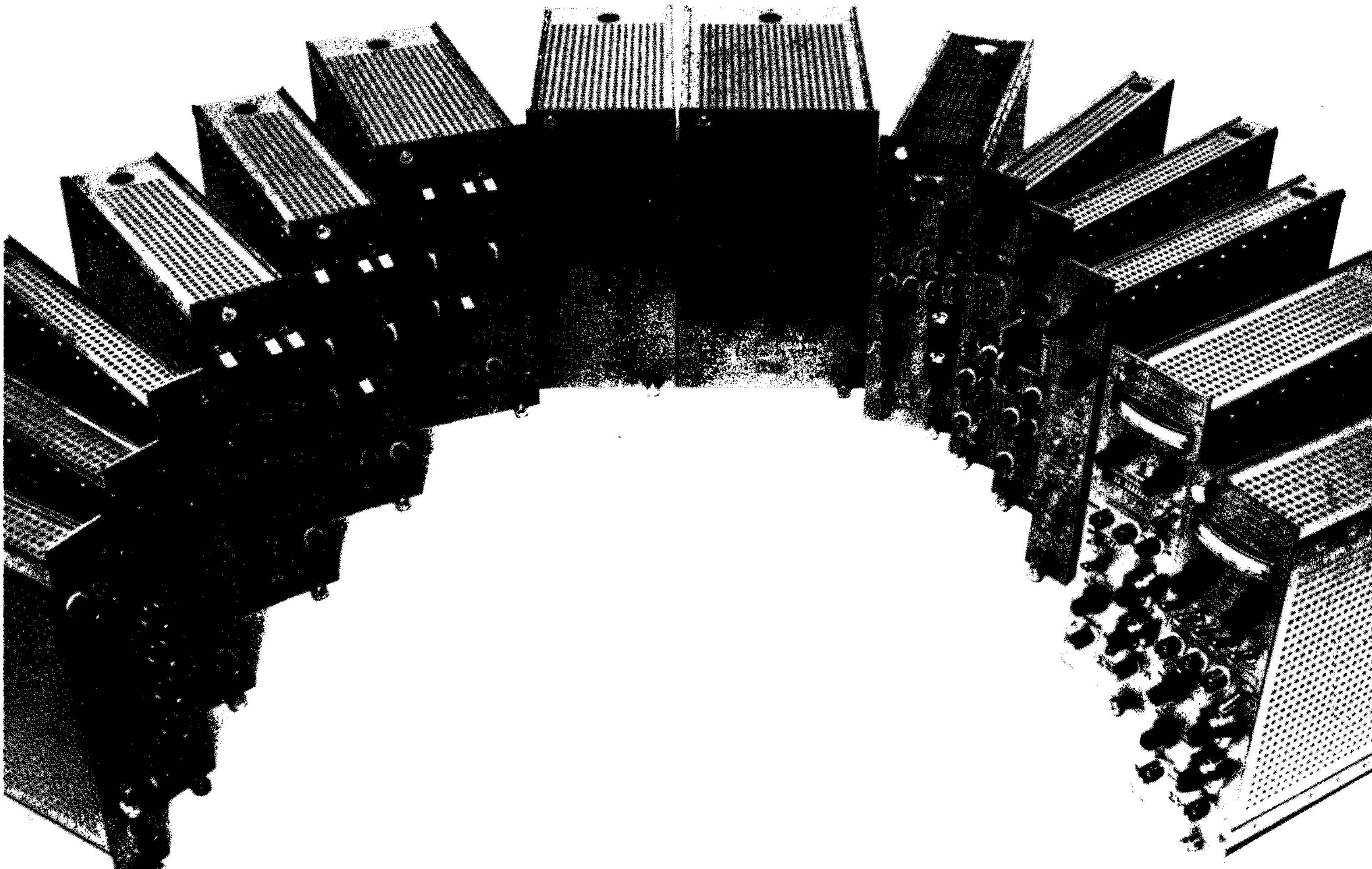
Uranium. Yesterday it was used for colour.
Today it's a vital source of energy.
In the nineteenth century uranium was introduced into glass for colouring and ceramics for decoration.
Then they found other ways of colouring glass. And people had little further use for uranium.
That's a very good reason today for choosing uranium as a source of energy, instead of fossil fuels which are needed for transport and as a raw material for fertilisers, insecticides, pharmaceuticals, plastics and other important products.
BNFL has already produced enough uranium fuel elements and uranium oxide fuel pins to save five hundred million tons of coal or two thousand two hundred million barrels of oil from fossil fuel reserves.
It's BNFL's way of filling the energy gap.
British Nuclear Fuels Limited, Risley, Warrington WA3 6AS
BNFL
-at the heart of nuclear power

BNF 51

SILENA

Base 2/Grafici Associati

Analog-to-digital converters and multichannel analyzers tailored to your needs



SILENA ADVANCED Σ ELECTRONICS

SILENA S.p.A.
SOCIETÀ PER L'ELETTRONICA AVANZATA
20133 Milano
uffici: Via Negroli, 10/A
laboratorio: Via Negroli, 6
Tel. (02) 7490565 - 713871

Sales agents in Benelux, Canada, France, Germany and Great Britain.

1024, 2048, 4096 channels NIM MCA's
10^6 - 1 counts per channel
X-axis expansion
Roll
Character generator
Selection of any number of ROI's
Spectra overlap
ROI integration with or without background subtraction
Wide range of interfaces for I/O peripheral devices and computers
Internal timing
Automatic cycles

8192 channels ADC,
100 MHz clock rate

2048 channels Charge,
Amplitude and Time converter
0,125 picocoulombs/channel;
50 picoseconds/channel

8192 channels ADC, **400 MHz CLOCK RATE** 0,3% differential non linearity
0,025% integral non linearity

Publicité dans le COURRIER CERN

Les annonces paraissent simultanément dans chacune des deux éditions anglaise et française. Les insertions dans la deuxième langue sont acceptées sans supplément. Par contre, les frais de traduction sont facturés à part.

Espace (page)	Surface utile (mm) largeur × hauteur	Prix par insertion (en francs suisses)		
		1 insertion	5 insertions	10 insertions
1/1	184 × 267	1300	1200	1100
1/2	184 × 130 88 × 267	700	650	600
1/4	88 × 130	380	350	320

Supplément pour une couleur	1200 Fr. s.
Pages de couverture :	
Couverture 3 (1 couleur)	1450 Fr. s.
Couverture 4 » »	2050 Fr. s.
Date de publication	1er du mois
Délai de réception des films positifs et textes	Le 1er du mois précédent Les frais de fabrication des films sont facturés à part
Trame offset	60 ou 54 suisse (150 anglaise et française) Les annulations parvenues après le 1er du mois précédent ne sont pas prises en considération

La publicité est limitée à 50% du volume de la publication. Les demandes seront satisfaites dans l'ordre strict de leur réception.

Pour toute demande de renseignements, s'adresser à :

Micheline FALCIOLA / COURRIER CERN - CERN
1211 GENÈVE 23 SUISSE
Téléphone (022) 834103 Télex 23698

Advertisements in CERN COURIER

All advertisements are published in both English and French editions. Second language versions accepted without extra charge.

Space (page)	Actual size (mm) width by height	Cost per insertion (Swiss Francs)		
		1 insertion	5 insertions	10 insertions
1/1	184 × 267	1300	1200	1100
1/2	184 × 130 88 × 267	700	650	600
1/4	88 × 130	380	350	320

Supplement for one colour	1200 SwF
Covers :	
Cover 3 (one colour)	1450 SwF
Cover 4 » »	2050 SwF
Publication date	1st of month of cover date
Closing date for positive films and copy	1st of month preceding cover date The cost of making films and of translation for advertisements are charged in addition
Screen (offset)	60 or 54 Swiss (150 English) Advertisements cancelled after 1st of month preceding cover date will be invoiced

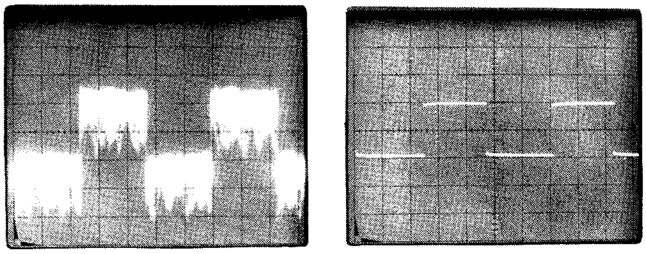
Advertising space is limited to 50% of contents and insertions are selected on a strict first-come first-served basis.

All enquiries to :

Micheline FALCIOLA / CERN COURIER - CERN
1211 Geneva 23 Switzerland
Tel. (022) 834103 Telex 23698

Between your electric input and output signals

the interference-free SUHNER Fiberoptic-System.



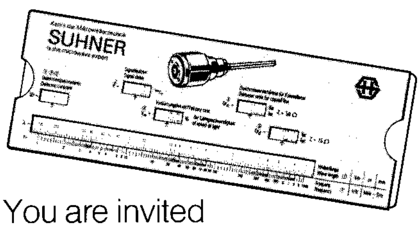
Compare the same signal after crossing an area of strong electromagnetic interference: Left on a copper coax line, right on an optical glass fibre.

Light signals travelling along glass fibres are immune to electromagnetic interference

They cannot influence each other (no crosstalk).

Electrical insulation between transmitter and receiver

Transmitter and receiver of the system are electrically isolated.

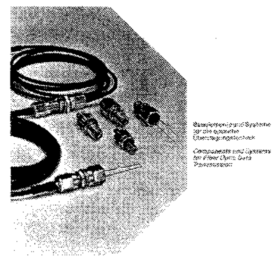


You are invited
to order your free copy
of the data slide rule for RF calculations
at your SUHNER-representative.

No risk of short circuits or arcing

No need for grounding or shielding. Saves space and weight. SUHNER «Series 9820» is a comprehensive range of components with various transmitters, receivers, and cable types permitting the building of fiber optic transmission lines tailored to individual applications. The system is especially suited to those users who want to benefit technically and economically from the well-known advantages of fiber optics without having to deal with the specific problems of optical transmission. The main fields of application are in process control, data processing, aircraft, and chemical industry.

Detailed technical literature is available. Don't forget to ask for your free data slide rule that covers the entire RF spectrum.



HUBER+SUHNER AG

CH-9100 Herisau / Switzerland

A W. Keilitz, 1015 Wien 1, Telex 112745, **AUS** Huber+Suhner, Dee Why, N.S.W. 2099, Telex 20475, **B** F. Léger, 1030 Bruxelles, Telex 24056, **D** Suhner Elektronik, 8 München 90, Telex 529767, **DK** Crimp A/S, 3450 Allerød, Phone (03) 274422, **E** Redislogar, Madrid-2, Telex 23967, **F** Tékélec Airtronic, 92310 Sèvres, Phone (1) 5347535, **GB** Suhner Electronics, Bicester, Telex 837615, **I** A. Hofmann, 20124 Milano, Telex 311366, **IND** Rashmi Enterprises, Bangalore-560011, **J** Repic Corporation, Toshima-Ku, Tokyo, Telex 2723523, **N** C. Bredengen, Arvoll-Oslo 5, Phone 152360, **NL** Blessing-Etra, 3011 ST Rotterdam, Phone (010) 113455, **NZ** Deverell Associates, Lower Hutt, Phone 687277, **S** D. Carlberg + Son, 18109 Lidingö 9, Telex 11167, **SF** Orbis Oy, 00421 Helsinki 42, Telex 123134, **USA** Micro-Mode Products, El Cajon, CA 92020, Telex 910-331-16-73, **ZA** Electronic Building Elements, Pretoria, Phone 789221.