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CERN COURIER

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Around the Laboratories

Cover photograph: Assembly at Brookhaven of a prototype superconducting magnet for the proposed ISABELLE collider. While the provisional funding picture is still cloudy (see page 111), magnet development work forges steadily ahead (see page 96). (Photo Brookhaven)

Around the Laboratories

KEK Director General T. Nishikawa breaks ground for the new TRISTAN ring. Alongside him is a white-robed Shinto priest.

(Photos KEK)

KEK
Looking forward after ten years

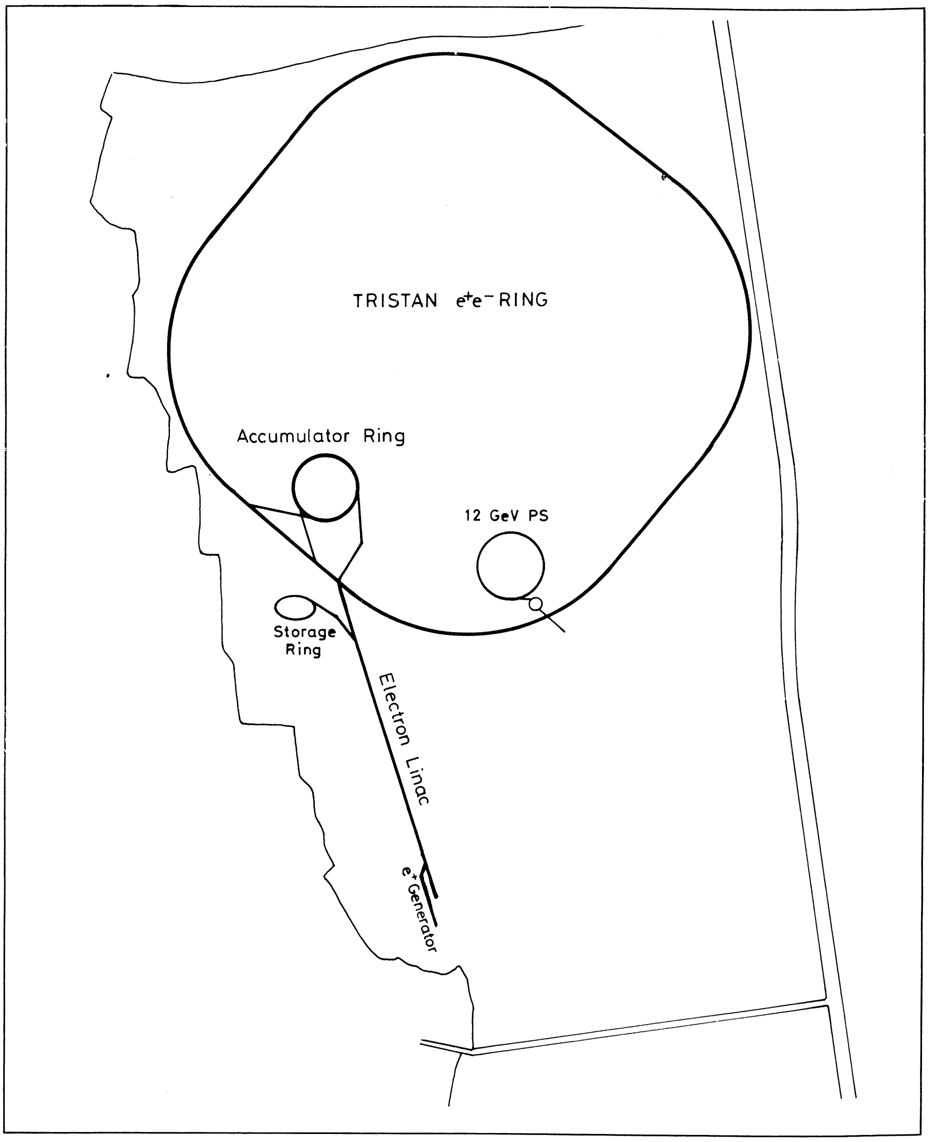
Although KEK was formally established on 1 April 1971, the Japanese National Laboratory for High Energy Physics chose to celebrate its tenth anniversary on 20 November last year, seven years to the day that first beam was injected into the main ring of its 12 GeV proton synchrotron.

As well as looking back over ten years of fine achievement, KEK is also able to look forward to a new era of physics with the 3 km circumference TRISTAN electron-positron collider ring. In fact the anniversary also saw the ground-breaking ceremony for TRISTAN, carried out in the traditional Japanese Shinto manner. Many of the guests had previously participated in an international TRISTAN workshop.

Besides the events organized on the site, the anniversary was also marked by a well attended public meeting in downtown Tokyo which heard memorable presentations by SLAC Director Pief Panofsky on 'The impact of high energy accelerators in science and technology', and by Yoichiro Nambu on 'How has the tiny world been made clear?'.

For TRISTAN, the equipment budget allocated for the 1982 fiscal year (beginning in April) is about 5×10^9 yen (1000 yen = $ 4.2). The present KEK level of funding, including the 12 GeV PS, the Photon Factory and support for international collaboration, is 1.1×10^{10} yen, of which personnel costs account for 12 per cent. In Japan, budget for building and for utilities is allocated separately and is not yet definite.

Yoichiro Nambu talks about quarks and subquarks at a public lecture in Tokyo to commemorate the tenth anniversary of the Japanese KEK Laboratory.



Plan of the KEK site, showing the new 3 km circumference TRISTAN electron-positron ring.

The 5 x 10^9 yen TRISTAN budget includes 2 x 10^9 yen for the accumulator ring and 2.4 x 10^9 yen for the main ring. Equipping experimental areas at two of the four beam intersection regions is foreseen in the present programme, while the other two intersections are open for proposals.

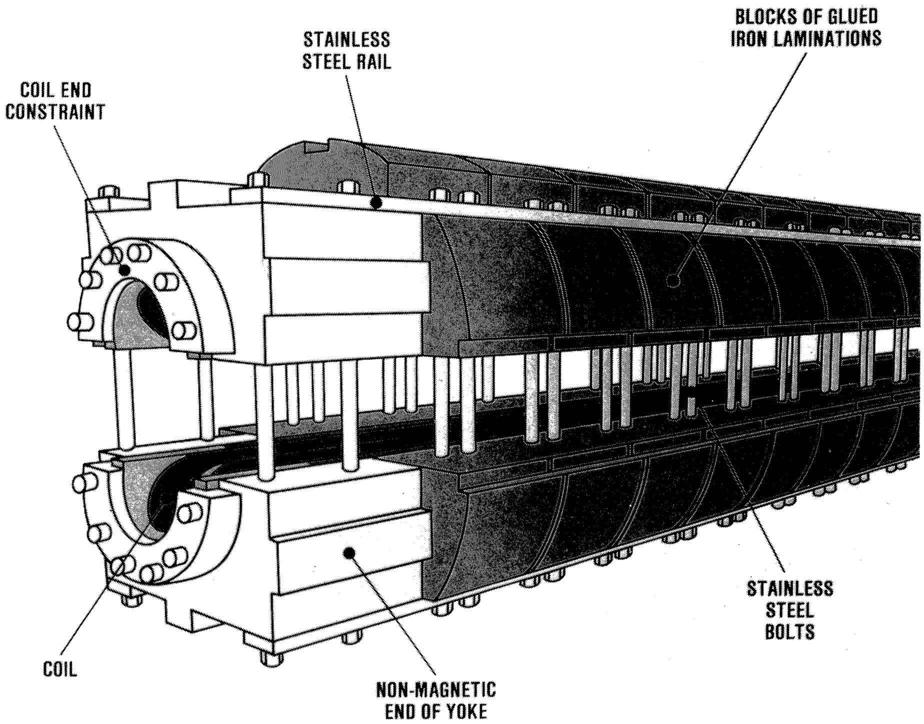
Detectors will be built by two Japanese groups — KEK/Tokyo INS/Nagoya and KEK/Tsukuba/Kyoto/Osaka. Work began after the November workshop.

BROOKHAVEN ISABELLE magnets show their paces

While funding for the ISABELLE 400 GeV proton-proton collider project is yet to be finalized (see page 111), development continues of the superconducting magnets for this machine.

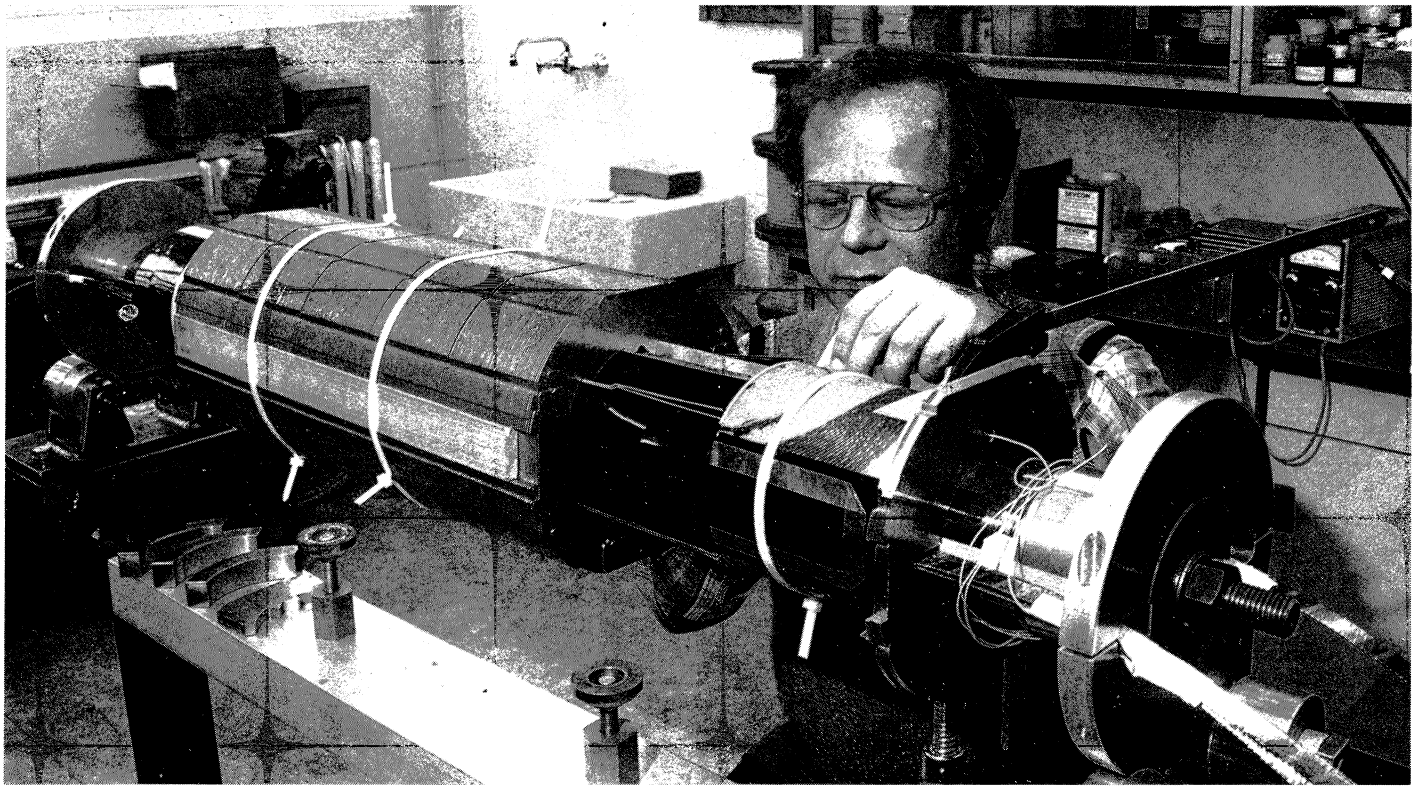
The modified magnet design (see October 1981 issue, page 353) is based on a Rutherford-type cabled conductor, replacing the earlier braid, and is wound in a two-layer coil somewhat similar to that of the Fermilab magnets, and incorporating strategically located slip planes. A bolted split iron yoke ensures a compressive azimuthal coil prestress considerably higher than that obtainable with the earlier unsplit yoke. The yoke is divided longitudinally into blocks of epoxy-glued laminations, separated by small gaps and joined by stainless steel rails, to compensate for longitudinal stresses from differential thermal contraction. The design allows most other ISABELLE magnet components to be retained.

Tests of the first short (1.65 m long) dipole took place last July, six



Drawing of ISABELLE cable magnet showing the bolted split-core assembly.

Inserting the 'collars' (non-magnetic steel supports) in the prototype superconducting bending magnet for the HERA proton ring proposed for DESY. The coil has now been successfully tested.



months after development of this design began. The first full-length dipole was tested in October; three more followed early this year. Two more full-size dipoles (and an assortment of short dipoles) are also scheduled for testing soon, concluding the initial 'demonstration' phase of the new magnet design.

Encouraging results have been achieved so far in the 'training' of four of the magnets operated in liquid helium at 4.5 K. All operate above the design field, corresponding to a proton beam energy of 400 GeV. Tests are under way on the magnets' resilience to quenches. Investigations of field quality were not among the objectives with these first magnets, but will be carried out with the short dipoles now under construction. The magnets seem well on the way to being able to meet the required conditions, and work continues apace.

DESY
HERA prototype coil successfully tested

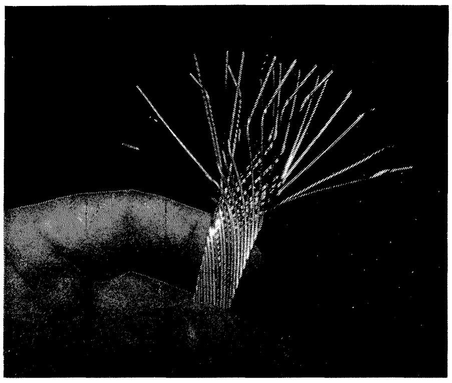
On 2 February a short prototype (1 metre long) of a superconducting bending magnet coil for the proposed HERA electron-proton collider (see May 1980 issue, page 99) was successfully tested at DESY. It satisfied at the first try the required specifications on strength and homogeneity of the generated magnetic dipole field. The coil, held together by stainless steel support plates (called 'collars'), was suspended in a standard vertical helium cryostat and powered to a maximum current of 7912 A, reached after two quenches at 7416 and 7576 A. Both these quenches correspond to operating conditions well above those expected at HERA. The iron return yoke was not used in these first tests. The maximum current produced a field of 4.88 T at the centre of the magnet.

The rotating-coil method was used to determine the homogeneity of the field in the central region. The field turned out to be a nearly pure dipole configuration over a 5 cm diameter region, with unwanted higher order components (quadrupole, sextupole, etc.) each contributing less than 0.03 per cent, thus satisfying the requirements for quality and strength of the field for the HERA proton ring. With an iron yoke the magnet performance is still expected to improve and it could be run at a smaller current. The first tests demonstrated the correct geometrical arrangement of the coil and the mechanical accuracy of the mountings and supports under realistic stress conditions.

The tested prototype still has the 100 mm bore of the earlier HERA design. This would allow for a beam

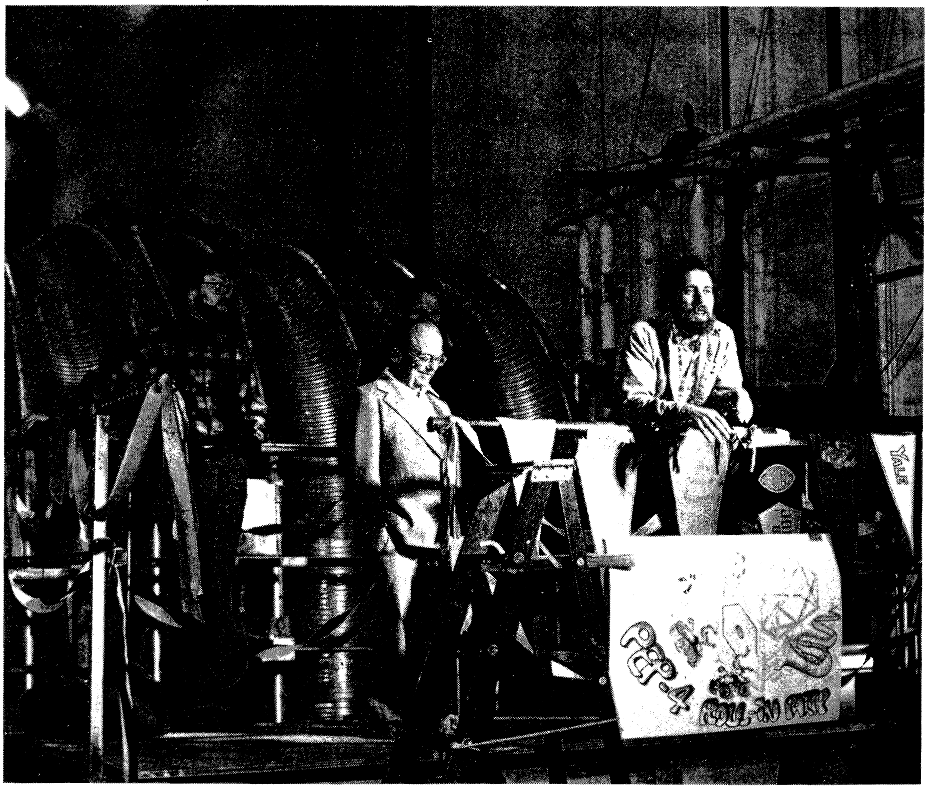
The 24 strand superconducting cable used in the prototype HERA dipole coil.

(Photos DESY)



Speakers at the recent roll-in ceremony of the TPC detector at SLAC. Left to right, TPC inventor Dave Nygren, SLAC Director Pief Panofsky, Berkeley Director Dave Shirley (behind Panofsky), and Jay Marx, the experiment's scientific spokesman.

(Photo LBL)



pipe at room temperature. The new HERA design foresees a 75 mm coil aperture and a cold beam pipe of 60 mm diameter. However the scaled-down construction details will remain essentially the same so that much can be learned from the present tests.

The coil was made of Rutherford-type cable composed of 24 strands, each containing about 2200 niobium-titanium filaments 12 microns thick in an 0.95 mm copper matrix. Short sample tests of single strands had been made at Karlsruhe and Saclay. The windings essentially followed the successful Fermilab design. The present tests of the 1 metre prototype dipole (complete with its special cryostat and iron yoke) are expected to be complete within the next few months. The first of three full size dipoles (6 metres long and with the smaller bore) should be ready for tests early next year.

In parallel with this work, a second dipole version with cold iron, similar to the new Brookhaven design but with fully epoxy-impregnated coils, will be developed by an industrial firm. Three prototypes have been ordered. The final decision on the HERA dipoles will be taken after both types of prototypes have been thoroughly tested.

The first superconducting quadrupole for HERA is being developed at Saclay and should be tested at DESY this year. The DESY/Saclay collaboration is also investigating another dipole design, proposed by Saclay.

BERKELEY/STANFORD TPC rolls in

On 6 January the detector based on the Time Projection Chamber (TPC) was rolled into the PEP electron-positron storage ring at SLAC. It now joins the other PEP experiments — Mark II, Two Gamma, MAC, HRS (which replaced the Free Quark Search last year), DELCO, and the Monopole Search (see September 1980 issue, page 245).

Nearly 300 people attended the 'roll-in party', where they celebrated with food and drink, saw the roll-in begin, and heard brief speeches by TPC inventor Dave Nygren, SLAC Director Pief Panofsky, Berkeley Director Dave Shirley and Jay Marx, the experiment's scientific spokesman. The roll-in ceremonies were a climax to over eight years of work on the TPC from its inception in 1974, through its R & D and acceptance as a PEP facility in 1977, and then through assembly and testing. Progress was not without its setbacks (see June 1981 issue, page 203).

The detector is a collaborative effort involving Berkeley, Los Angeles, Riverside, Johns Hopkins, Yale and Tokyo. It cost 25 million dollars, and was funded jointly by the US Department of Energy and National Science Foundation, and the Japanese Ministry of Education, Science and Culture. Its design and fabrication involved more than seventy physicists and hundreds of other technical personnel. It is the largest piece of experimental apparatus to be built at LBL since the 1950s.

The central element is the TPC

itself, which is a large-solid-angle compact system that provides in one detector excellent pattern recognition and three-dimensional nonprojective tracking information together with good spatial and momentum resolution and excellent particle identification over the full PEP energy range. The TPC is a 2 m long, 2 m diameter cylindrical drift chamber which provides three-dimensional spatial data by using proportional wires and segmented cathode pads on the end-planes to read out the two coordinates orthogonal to the drift direction, and uses timing information to determine position along the drift direction. This high density spatial information not only provides outstanding pattern recognition but also, since the TPC is immersed in a solenoidal magnetic field, provides precise measurement of particle momentum by accurately measuring the curvature of the track.

In addition, the ionization left along the path of a charged particle gives the energy loss of the particle in the TPC gas. Since this energy loss depends on the particle's velocity, it can be used in conjunction with the momentum measurement to determine the particle's mass, and thus its identity. The TPC can make a precise measurement of this energy loss because it samples the ionization due to the particle many times along its path. This frequent sampling eliminates the effect of occasional large fluctuations in the energy loss.

The other systems which make up the detector are an inner drift chamber (4 layers, 60 cells / layer), an outer drift chamber (3 layers in 6 azimuthal segments), a muon detector (4 layers of triangular cell chambers with 1 metre of iron), pole tip calorimeters (50 layers of proportional wire chambers, 13 radiation lengths) and a hexagonal calorimeter (6 modules of 39 layers of Geiger mode wire chambers, 10 radiation lengths).

Two months before the detector rolled into the beam, the TPC and other systems were assembled in their final configuration and tested using cosmic rays. All twelve end-plane proportional chamber sectors were operating, and about 80 per cent of the TPC electronics was installed and operating. Cosmic ray data were taken under a variety of operating conditions. The other systems, except for four of the six hexagonal calorimeter modules, were fully installed and operating during the tests.

To determine the energy loss resolution using the cosmic ray data, tracks are detected by two opposing end-plane sectors, and the energy loss of the track as measured in one sector is compared with that measured in the other sector. The energy loss for each sector is calculated as the average of the smallest 65 per cent of the samples (in order to eliminate the effect of the large Landau fluctuations), corrected for absorption of the ionization due to electron capture. This procedure gives a preliminary result for the energy loss resolution of 2.8 per cent at a pressure of 8.6 atmospheres and a magnetic field of 0.39 T. This precision in measuring the energy loss is unsurpassed by any other large detector.

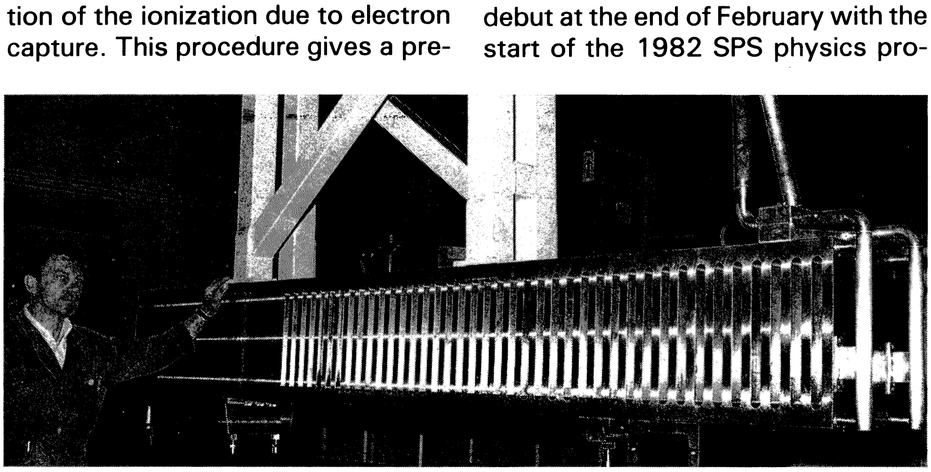
Under the same conditions, the spatial resolution in the plane orthogonal to the axial drift direction was measured and gave a preliminary result of 250 microns. Both of these results are expected to improve with further calibration of the detector and the electronics, and with more analysis of the data.

PEP is now in a four month running period, during which time the new detector will learn how to live in a colliding-beam environment, and will start to do some of the unique physics for which it was designed.

(We are grateful to Ronald Madaras for this information.)

CERN
New beam dump

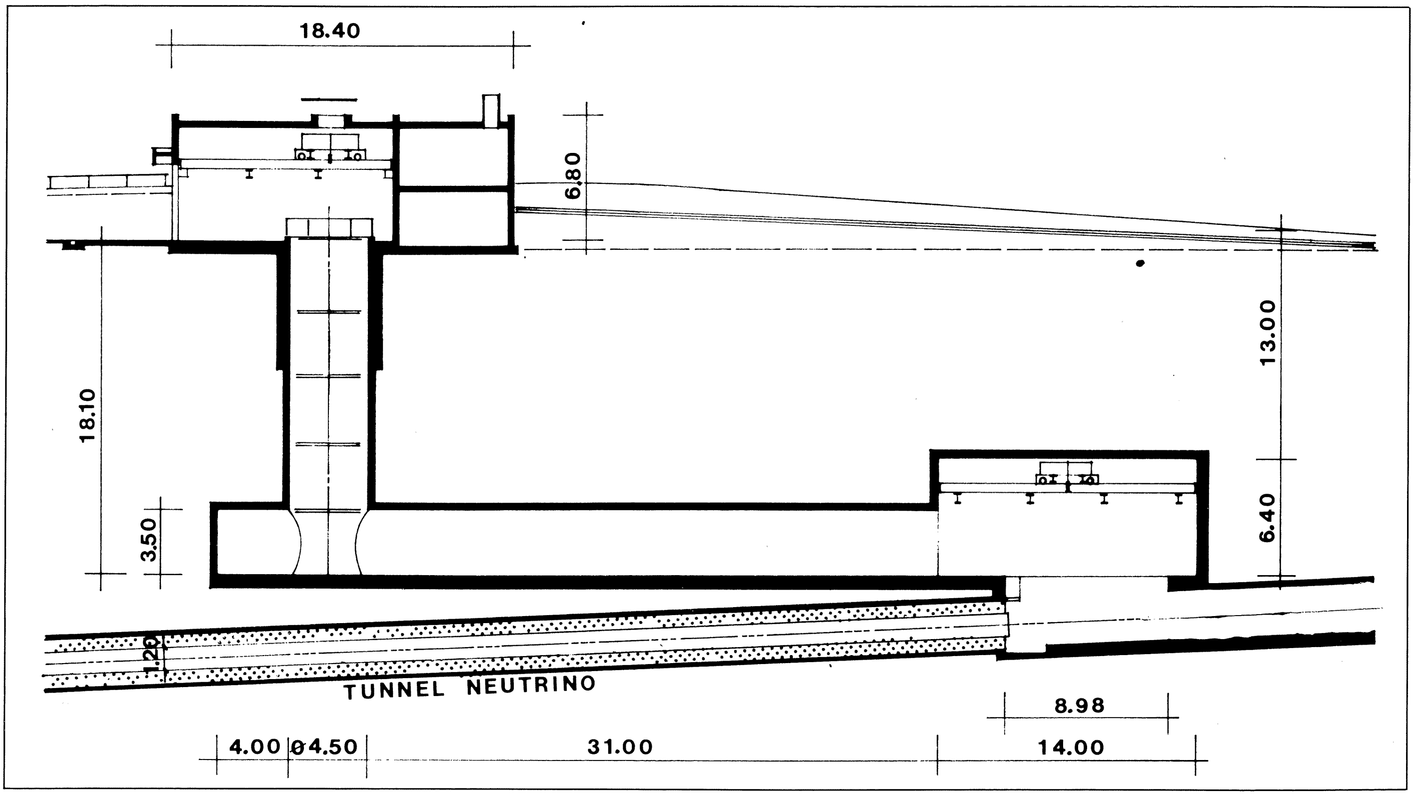
'Beam dump' experiments have featured prominently in the neutrino physics programme at the West Experimental Area of the SPS 400 GeV proton synchrotron and a few intriguing hints of new behaviour have been found. Last year an impressive new beam dump facility was constructed which made its operational debut at the end of February with the start of the 1982 SPS physics pro-



A 'beam dump' such as this is designed to produce a residual secondary beam which can be examined for signs of new particles. Most of the secondary particles produced when the primary proton beam hits the end of the dump are absorbed along the length of the target.

(Photo CERN 116.1.82)

Vertical plan of the new beam dump facility for neutrino physics at the CERN SPS 400 GeV proton synchrotron. The surface building and vertical shaft (left) lead to a horizontal tunnel and a hall with access to the sloping neutrino tunnel.



gramme. This addition to the SPS experimental resources should considerably increase the physics potential of beam dump experiments and throw further light on the effects seen so far.

High energy neutrinos come from the decay of the pions and kaons produced (with other particles) when a primary proton beam hits a target. In the beam dump technique, a large metal block is substituted for the usual target. In this block, the secondary kaons and pions are absorbed before they have a good chance to decay and produce neutrinos.

This considerably reduces the usual flux of neutrinos. However additional 'prompt' neutrinos (or other particles) coming from the decay of very short-lived parent particles (which manage to decay before they are absorbed in the block) are relatively unaffected. While these particles are swamped in a conventional neutrino beam, they are more likely to show up under beam dump conditions.

In previous CERN experiments, the beam dump was placed some 800 m upstream of the detectors. Now a new variable density dump has been installed in a special pit now only 400 m from the experiments. (These are the WA1 electronic detector of the CERN / Dortmund / Heidelberg / Saclay group, the WA18 electronic detector of the CERN/Hamburg/Amsterdam/Rome/Moscow 'CHARM' collaboration, and the BEBC bubble chamber.) The experiments will be able to intercept more prompt particles, which hopefully will clarify the effects suggested by earlier studies.

In addition, new instrumentation has been installed alongside the existing detectors in the CERN neutrino beam. This will look for decay products of new particles emerging from the beam dump but subsequently managing to decay in air. An indication of such behaviour has been seen in a low energy beam dump study at the Swiss SIN centre using a 590 GeV primary proton beam (see May 1981 issue, page 161).

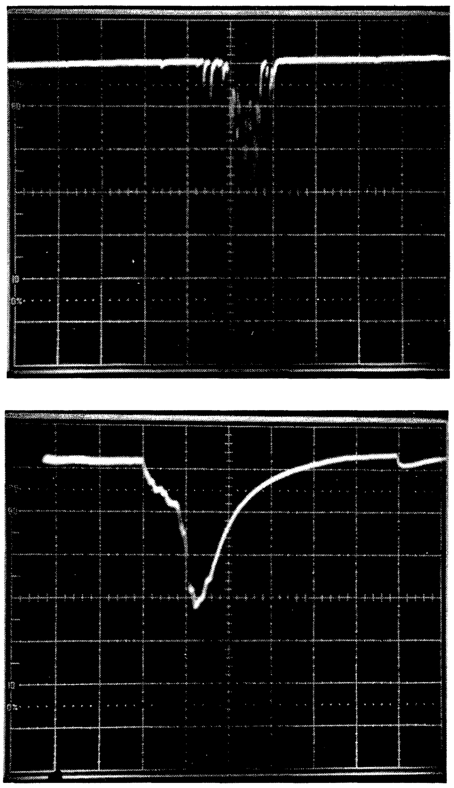
(For some new results from a Fermilab experiment using the beam dump technique for muons, rather than neutrinos, see page 102).

Tests of liquid argon hybrid detector

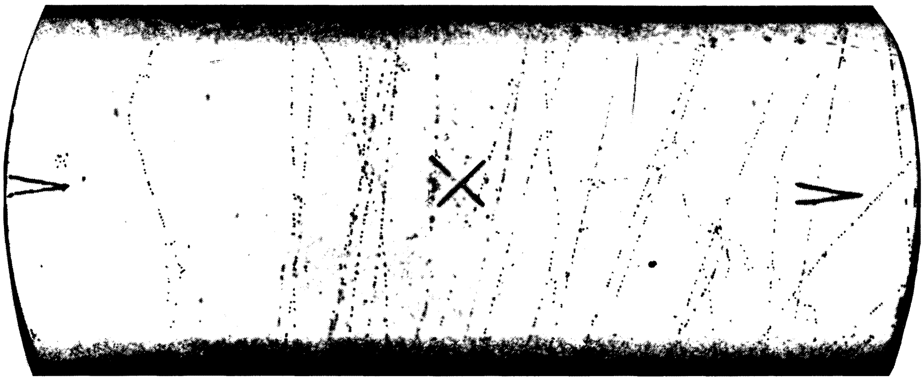
Further studies with a small argon-filled bubble chamber have revealed the interesting possibilities of triggering the chamber photos using scintillation light, and of calorimetry by collecting ionization electrons.

Argon is a noble gas with many useful characteristics for particle de-

Some promising results with a liquid argon-filled bubble chamber. Above: photomultiplier scintillation pulses produced from a 200 MeV 40 microsecond spill. Below: integrated charge collection signal from 100 pion tracks. (Horizontal scale 50 microseconds, in both cases.) Such signals could be used respectively to trigger the chamber and to provide calorimeter-type information.



Liquid argon bubble chamber tracks produced by 200 MeV pions. The remainder of the chamber window was covered with an opaque wavelength shifter, leaving just this 4 cm strip.



tectors. The scintillation signals produced by particles passing through gaseous or liquid argon have been widely used for some 30 years. Following the pioneering work of W. Willis and co-workers at CERN, free electrical charges from ionization in liquid argon can be drifted in high electrical fields and detected in charge sensitive amplifiers. Many varieties of liquid argon calorimeters with small drift spaces are active in experiments, and the drift over larger distances is being extensively studied.

Recently an argon-filled bubble chamber has been successfully operated and the possibility of producing narrow bubble tracks with a subnanosecond laser pulse during bubble chamber expansions has been demonstrated (see September 1980 issue, page 251, and September 1981 issue, page 298). During the last few months, work with the 2.7 litre test device continued using a 200 MeV pion beam at the CERN synchrocyclotron. It was shown that the detection of scintillation light via wavelength shifter and photomultiplier is compatible with the operation of the flashtube for bubble chamber photography. Moreover when an event with more than a predetermined number of tracks is produced, the signal is sufficiently large to allow triggering of the flashtube to give crude information on energy contained in massive events, and to initiate a laser pulse to mark events by a track along its trajectory.

Furthermore it was found possible to collect free electrons from ionization over distances of 5 cm during bubble chamber expansions, so giving calorimeter-type information. The adverse effects of microphonic and electronic noise can be largely overcome by proper pulse clipping, and further improvements may be achieved by the use of the fast scintillation signal, which allows the calorimeter electronics to be triggered when the event has occurred. This may be particularly important during the application of this technique to long beam spill times and low event rates.

Together, these features open up a wide field for future applications. Since argon is fairly inexpensive and non-inflammable, multiton detectors could be built for neutrino experiments in the TeV energy range. Smaller detectors may be wrapped around the beam tube of pulsed colliding beam machines. While the large physics potential of such hybrid detectors should be checked in more detail, in the meantime some interest has been expressed already.

ACCU for action

Purely scientific considerations apart, the implications of carrying out research at CERN are many and wide ranging. Researchers, and sometimes their families too, leave their homes, sometimes for years at a stretch, to live and work in a new environment which is literally foreign to them. To make this path easier to negotiate, an extensive range of services has been developed over the years to assist visitors and new arrivals.

With a view to providing further help and to provide two-way communication between CERN users and management, the Advisory Committee of CERN Users (ACCU) was set up some four years ago. Its aim was to provide a point of direct contact between management and users, and to enable the users to advise CERN on the multitude of practical problems arising from working at CERN and using CERN's facilities.

A whole gamut of topics has been

CERN Director Robert Klapisch addresses a meeting of the Advisory Committee of CERN Users.

(Photo CERN 109.12.81)

covered in the relaxed atmosphere of ACCU meetings, and it is the view of outgoing ACCU Chairman Egil Lillestol of the University of Bergen that this contact has led to better understanding on both sides.

The Committee is composed of one or two delegates from each of the twelve CERN Member States and from CERN itself, together with representatives from CERN's Personnel Department, from the Directorate, from Experimental Physics Division, and from the Staff Association. From March ACCU is chaired by Konrad Kleinknecht of Dortmund.

ACCU steers clear of matters related to the scientific programme, and a better idea of its work can be gained from a summary of what has been accomplished so far.

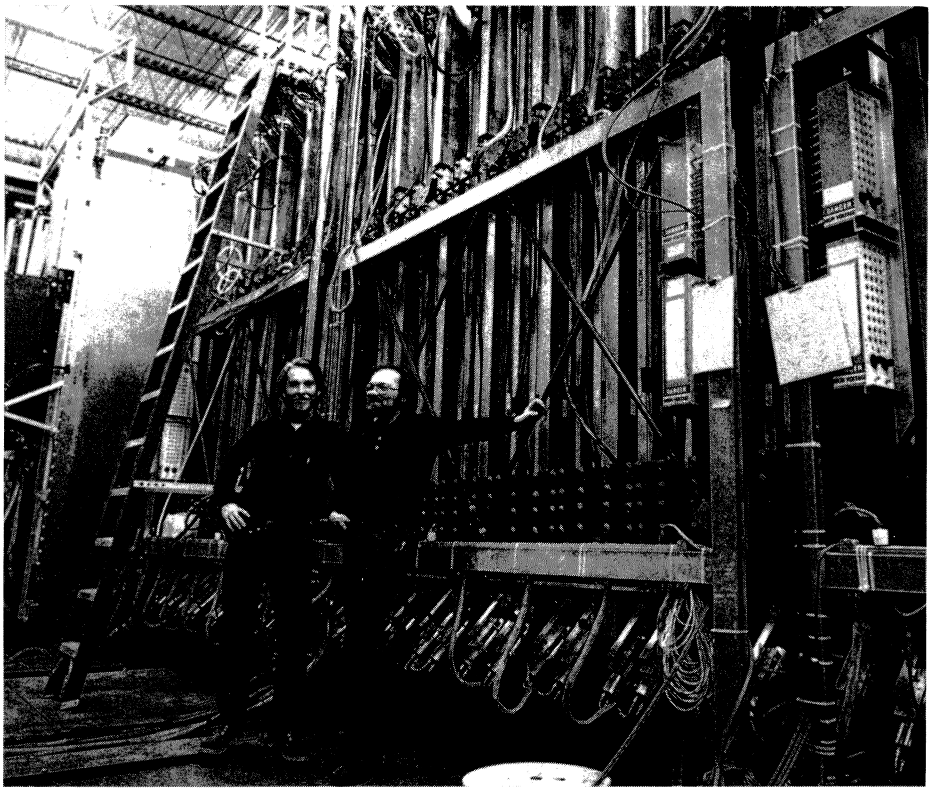
One topic which has been covered in some detail is the accommodation requirements for short-term visitors, and this has led to the construction of a new on-site hostel which it is hoped to complete next year. This would improve and supplement the existing accommodation.

The Library facilities have also been debated, and some ACCU proposals are being implemented. Some disparities between the conditions for researchers paid by CERN and those paid from their own countries have been pointed out, and interventions have been made in specific cases.

Other topics covered which have led to new arrangements being made include on-site transport, catering, and stores. Problems have been identified in other areas and further progress is expected.

FERMILAB
Prompt forward muons

There have been theoretical conjectures that the large diffractive charm cross-sections seen at the CERN Intersecting Storage Rings result from an intrinsic charm quark component at the one per cent level in the hadron. The semileptonic decays of such charm states would result in high energy prompt muons in the forward direction. A recent prompt muon experiment by a Caltech/Chicago / Fermilab / Rochester / Stanford collaboration indicates a very low rate for such prompt muons. The prompt muon data is consistent with diffractive charm cross-sections of only a few microbarns at these energies, compared with hundreds of microbarns at the ISR.



The downstream muon identifier of the Caltech / Fermilab / Chicago / Rochester /Stanford experiment. Analysis of the forward muons shows no evidence for 'intrinsic' charmed quarks in hadrons.

(Photo Fermilab)

The experiment has taken data with both 350 GeV proton and 278 GeV negative pion beams. The hadron beam interacted in a target calorimeter which measured the total hadronic energy in the interaction. The density of the target calorimeter was varied to separate prompt muons from muons originating from pion and kaon decays. The 800 ton downstream muon identifier and steel spectrometer, built by a Caltech / Fermilab / Rochester / Rockefeller collaboration, also serves as a neutrino detector in other experiments.

Prompt muon events were identified as either single muon or dimuon events using the large solid angle muon identifier. Preliminary data for the momentum spectrum of prompt single muons in 350 GeV proton collisions is consistent with central charm production distributions and yields a central charm production cross-section of 15 microbarns. The low rate of high momentum prompt muons can only accommodate diffractive cross-sections of order 3 microbarns. This indicates that the intrinsic charm component is two orders of magnitude smaller than needed to explain the ISR results.

The experiment has also investigated dimuon events with missing energy (indicative of final state neutrinos). Such events come from the semileptonic decays of both charm and anticharm states. The rate of such events in both 350 GeV proton and 278 GeV pion interactions also indicates that diffractive charm production cross-sections are no larger than a few microbarns at these energies. The data was also used to obtain a very low limit (most likely less than four per cent) on neutral D meson mixing, by observing that there were very few like sign muon pairs, which would originate from such mixing.

(A low intrinsic charm content of the nucleon is also indicated by the charm production data of the European Muon Collaboration's experiment at the CERN SPS 400 GeV proton synchrotron.)

Experimental programme

Fermilab's 1982 programme began with twelve experiments. A significant neutrino experiment with two large detectors several thousand feet apart is looking for neutrino oscillations, a measurement which could turn out to have profound significance. The experiment is being carried out by a Chicago/Columbia/Rochester/Fermilab group. Another neutrino experiment, this time to measure neutral current structure functions, is being carried out by an MIT / Michigan State / Northern Illinois / Fermilab collaboration. Other experiments in the Neutrino Laboratory include a search for chi mesons (Illinois / Pennsylvania / Tufts / Fermilab) using the old Chicago cyclotron magnet. A test on a Downstream Particle Identifier for the thirty inch bubble chamber is also under way. This test will lead to two extensive bubble chamber exposures using the DPI. These investigations include bubble chamber groups from all over the world.

In the Proton Laboratory a McGill / Michigan / Shandong / Athens / Fermilab consortium is looking at the systematics of dimuon production. An elegant time projection chamber is being used by a group from Rockefeller to look for photon dissocia-

Following upsilon

A lot of effort is being put into a new Fermilab experiment for the Meson Area, seen as the follow-on to the study of lepton pairs which in 1977 discovered the upsilon. Last summer, construction began of the aluminium coils for a huge magnet. Working around the clock, the Fermilab Magnet Facility took the preformed coil layers, built industrially, sprung the individual turns apart, and applied tape insulation to approximately five miles of 2½ inch square conductor. The formed three- or four-layer coils were wrapped with tape and heated electrically to 300 degrees F to cure the epoxy in the insulation. All four coil assemblies, totalling 95 tons, have been completed and are installed on their yoke in the Meson Detector Building.

The aluminium conductor in the coils has a half-inch hole for cooling water. A supply of more than 1000 litres/minute will be required to cool the magnet, which operates at a power level of 1.5 MW.

The steel in the yoke comes from the dismantled synchrocyclotron used for many years at the Nevis Laboratory at Columbia University. The yoke pieces were cut at Nevis before being shipped to Fermilab. The colossal magnet measures 18 feet from top to bottom, 47 feet from front to back and nine feet across, and has a total weight of 1500 tons.

This experiment also features the Ring Imaging Cherenkov (RICH) technique for particle identification (see March issue, page 49).

Experimenters and builders pose with the giant new Fermilab experiment magnet which uses steel from the old Nevis synchro-cyclotron. The magnet has operated with fairly high currents. (See previous page.)

(Photo Fermilab)

tion. Several hadronic charm searches are under way including one in the Proton Laboratory by Fermilab and Yale and another in Meson by a Carnegie-Mellon / Northwestern / Notre Dame / Rutgers / Fermilab group.

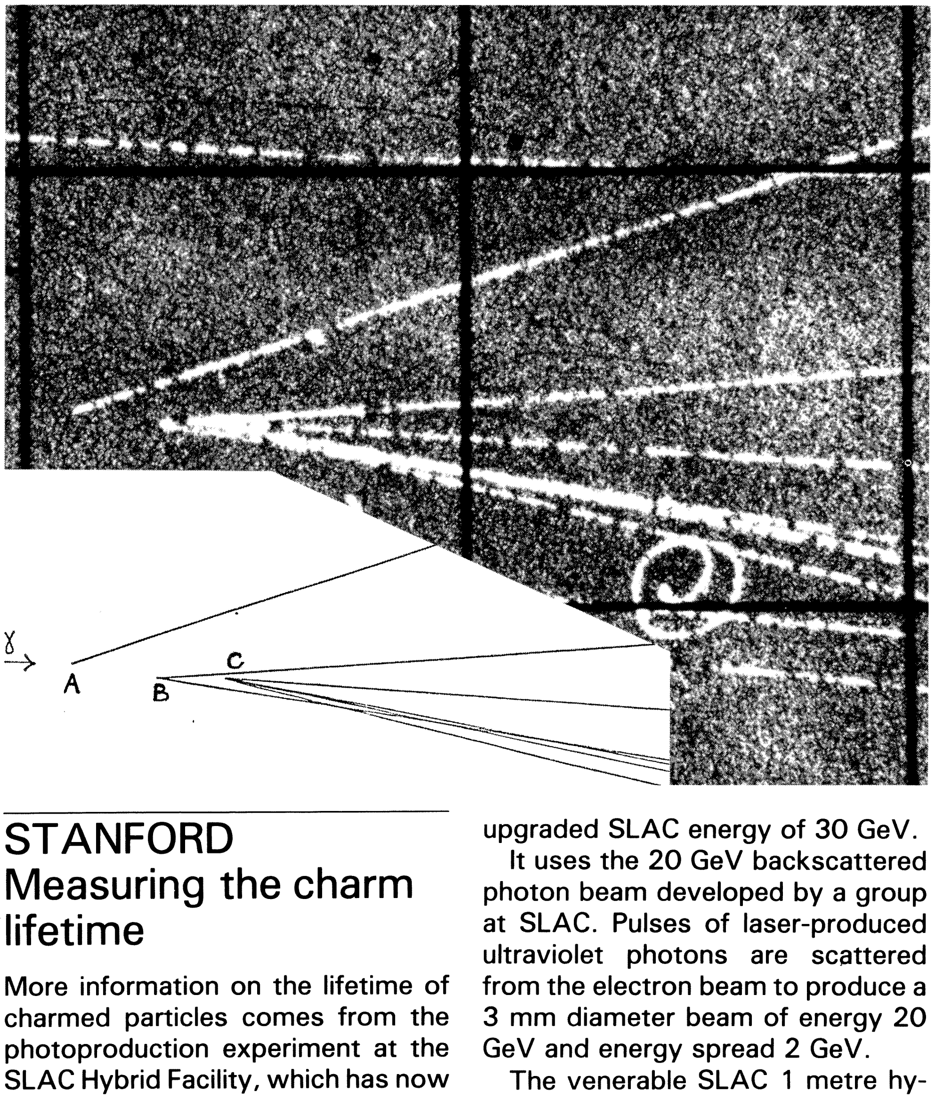
A Chicago/Stanford/Saclay group is carrying out a precise measurement of time reversal violation in neutral kaon systems, another measurement which could have profound implications. Another experiment (Michigan / Minnesota / Rutgers/Wisconsin) is extending a long and very successful series of investigations on hyperon polarization. In the M (for Meson Laboratory) 4 beam, many institutions are testing elements of the future Collider Detector Facility. A new jet experiment has been installed in M6 by an Argonne / Lehigh / Pennsylvania / Rice / Wisconsin / Fermilab team.

Later this spring a group from Illinois and Fermilab will continue a particle search in Proton-East looking for particles produced in association with psions. In Proton-Center the Michigan / Minnesota / Rutgers / Wisconsin group will undertake a measurement of the neutral sigma to lambda transition magnetic moment using the apparatus currently running in M2. In Proton-West an investigation of forward muon pairs will begin by a Chicago/Iowa State/Princeton/Fermilab collaboration using a new large aperture magnetic spectrometer. Another Chicago/Princeton group will continue an investigation of muon pair production using an iron toroid spectrometer.

In the Meson Laboratory another large scale investigation is being prepared by a Columbia/Stony Brook / Washington / Fermilab / CERN / Saclay / Japanese collaboration. The experiment, a follow-up to the first upsilon experiment, utilizes a gigantic new magnet that is now being assembled on the Meson Laboratory floor (see box). The aim is to look for signs of new particles and new behaviour in the detected muon pairs as far out as the kinematics allow.

Later this period a Michigan/Ohio State/Washington/Wisconsin/Florence group will continue a prompt neutrino experiment in M2. In M4 investigations of a technique for detecting particles with single crystals by a group from SUNY (Albany)/ Fermilab/New Mexico/Chalk River/ Dubna/Strasbourg will continue. In M6 a particle search experiment using the MPS multiparticle spectrometer will be under way. The experiment involves an Arizona/Florida State/Georgia Tech/Chicago Circle / Michigan State / Notre Dame / Tufts / Vanderbilt / Virginia Polytechnic / William and Mary / Fermilab / Milan / Pavia group.

Production and decay of two neutral charmed particles as seen in the bubble chamber of the SLAC Hybrid Facility exposed to a 20 GeV backscattered photon beam. The grid spacing seen in the photograph is about 5 mm. Below is the interpretation. The incoming photon interacts at the point A, producing two (unseen) charmed particles together with a positive track, probably a proton. 1 mm downstream at the point B, a D^0 charmed meson decays, producing two charged prongs and undetected neutrals. At the point C, 1.6 mm from the production vertex, a $\bar{D}^0$ decays into $K^+\pi^+\pi^-\pi^-\pi^0$, where the photons from the subsequent decay of the neutral pion were registered in the downstream lead glass wall.



STANFORD
Measuring the charm lifetime

More information on the lifetime of charmed particles comes from the photoproduction experiment at the SLAC Hybrid Facility, which has now accumulated twenty-nine events with one or two visible charm particle decays in the hydrogen bubble chamber. Both the charged and neutral charm lifetimes have been determined.

This experiment involves groups from four countries: the US (Brown, Duke, Florida State, MIT, Oak Ridge, SLAC, Tufts, Berkeley, and Tennessee), the UK (Birmingham, Imperial College, and Rutherford), Japan (KEK, Nara, and Tohoku) and Israel (Technion, Tel-Aviv, and Weizmann). The experiment is also the first to take full advantage of the upgraded SLAC energy of 30 GeV.

It uses the 20 GeV backscattered photon beam developed by a group at SLAC. Pulses of laser-produced ultraviolet photons are scattered from the electron beam to produce a 3 mm diameter beam of energy 20 GeV and energy spread 2 GeV.

The venerable SLAC 1 metre hydrogen bubble chamber, operating 10 times a second and at relatively high temperatures (29 K), is able to produce tracks with high bubble density (about 65 per cm). To exploit this, it was suggested that a fourth view of the events be used, in addition to the normal stereo triplet of pictures. This fourth view would use a high resolution camera to record the bubbles before they grew beyond about 60 microns in diameter. A large batch of photographs has resulted.

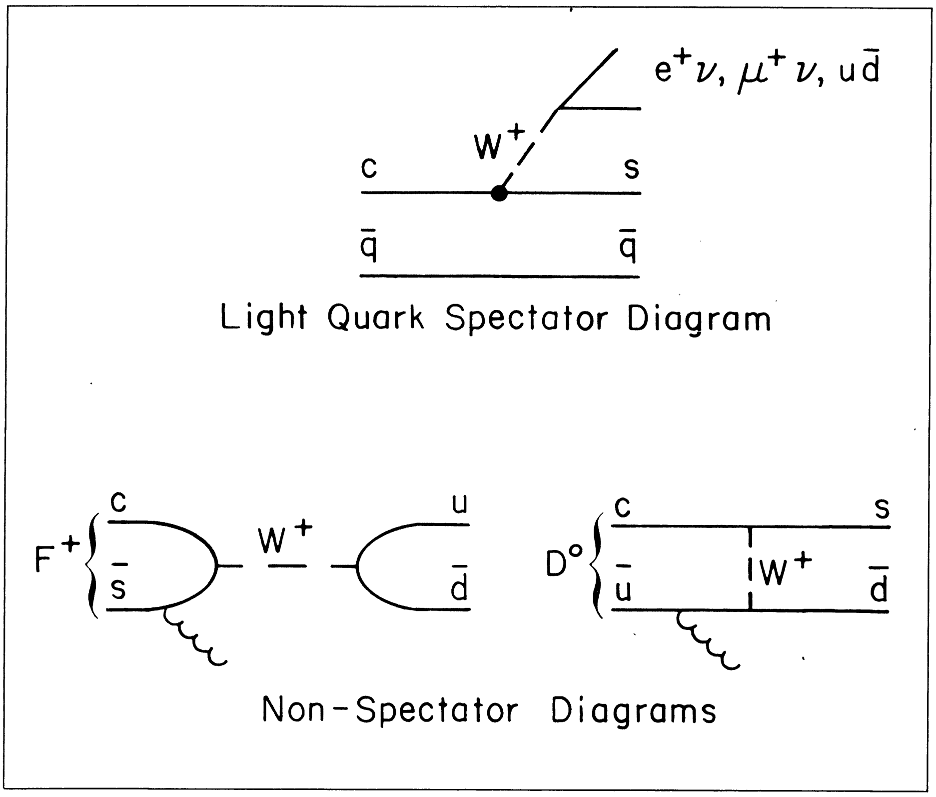
The pictures are taken in the hybrid mode, triggered when a hadronic interaction has been detected by the downstream electronic detectors. These detectors (proportional and Cherenkov counters, and lead glass arrays) also improve event reconstruction resolution, particle identification and photon detection.

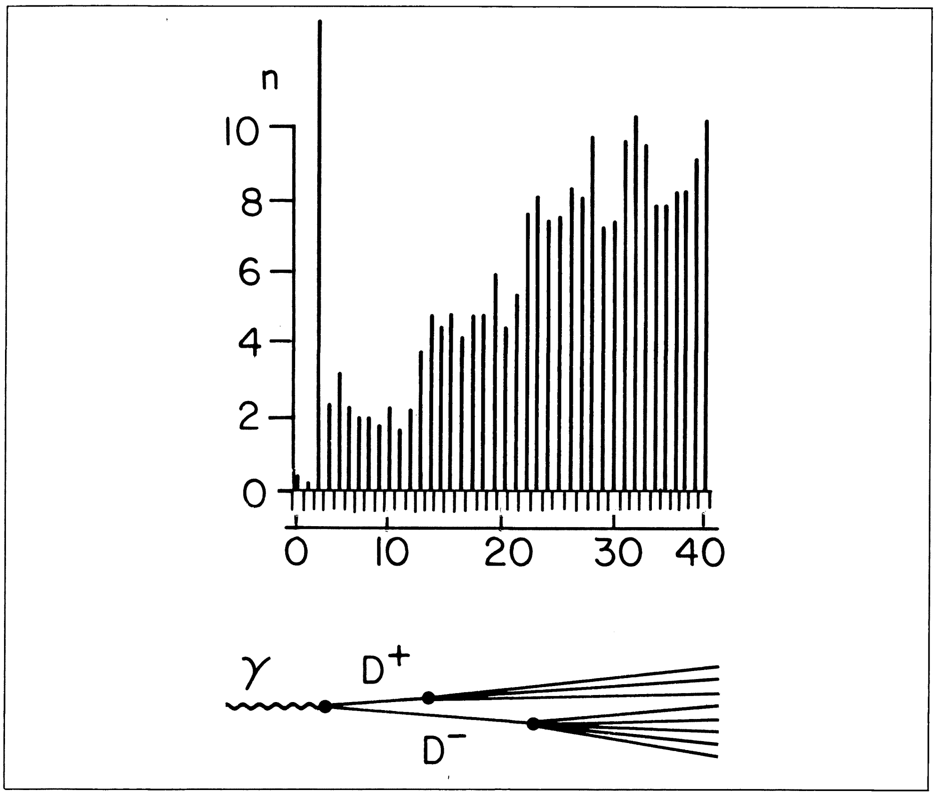
The high resolution pictures frequently allow the short tracks of charmed particles to be seen before they decay (only decaying tracks longer than 0.5 mm are used in the analysis, although shorter tracks can usually be seen). The principal difficulty so far is identifying the different kinds of charged charmed particles. For this reason the group prefers to quote separate lifetime measurements on the total sets of charged and of neutral decays.

A maximum likelihood analysis combining distributions of decay lengths, impact distances and flight times yields a neutral charmed meson lifetime of $6.7 + 3.5 - 2.0 \times 10^{-13}$ s and a charged lifetime of $8.2 + 4.5 - 2.5 \times 10^{-13}$ s. This gives a charged to neutral lifetime ratio of 1.2 + 0.9—0.5.

The decay processes for charmed mesons are thought to be of two general types. In one, the light non-charmed quark is just a 'spectator', and in the other type both quarks in the meson are involved. Under the most naive assumptions of light quark spectator dominance, the charged and neutral D mesons are expected to have equal lifetimes. Once non-spectator diagrams are introduced, the ratio of charged to neutral meson lifetimes increases due to the absence of the most prominent non-spectator diagrams in the decay of the positive D meson. Experimental results for this ratio range from this experiment's 1.2 to values as large as 10. Therefore the understanding of the decay mechanisms awaits the convergence of experimental results.

Different possible mechanisms for the decay of charmed mesons. Above only the heavy charmed quark is involved, while below both constituent quarks come into play.





The collaboration has obtained more pictures which should soon double the sample of observed decays.

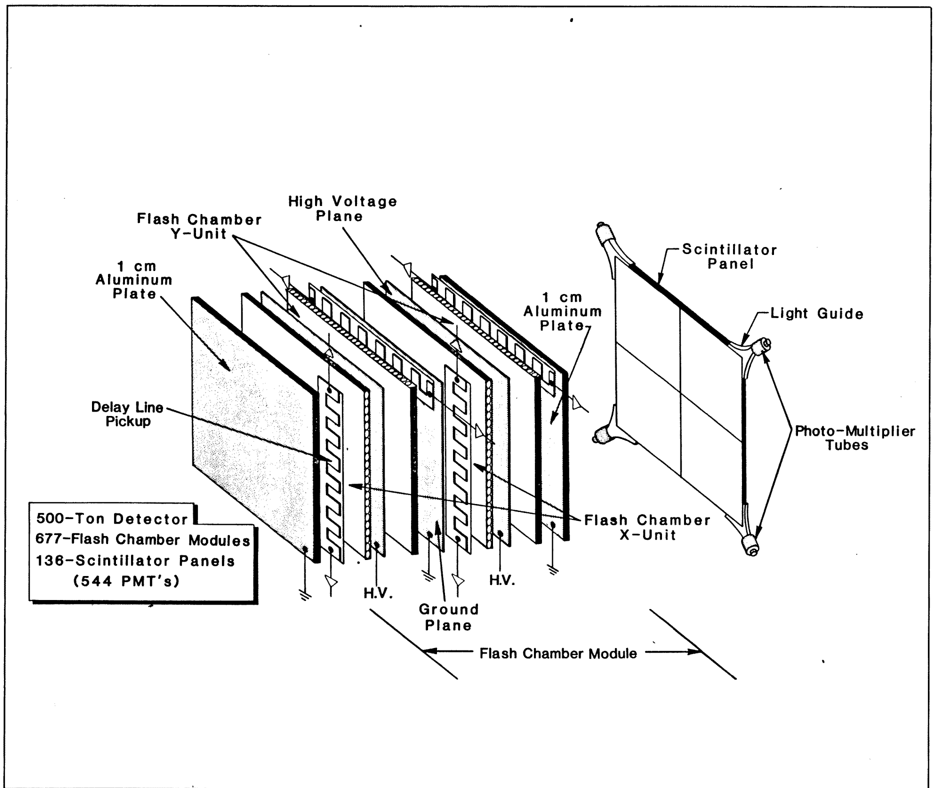
CERN

Electronic charm lifetime

A value for the charged charmed meson lifetime comes from the NA 1 Frascati/Milan/Pisa/Rome/ Turin/Trieste group using a multiparticle forward calorimeter for identifying charmed meson pairs, together with a specially designed active silicon target exposed to a photon beam from the CERN SPS 400 GeV proton synchrotron. This is the first time that electronic techniques have been used to measure the charm lifetime—previous measurements have been based on photographic methods. From a sample of nearly a million events recorded in 1980, nearly a hundred charm decays have been identified, giving a charged meson lifetime of $9.5 + 3.1 - 1.9 \times 10^{-13}$ seconds.

Signals from the 300 micron thick silicon target layers of the NA 1 detector at CERN. The signal levels (vertical scale) are proportional to the number of particles crossing each layer. Here the incident photon hits a nucleus which recoils briefly in layer 3. The subsequent layers show the passage of two charmed particles, which eventually decay in layers 13 and 23. The forward spectrometer identifies the charmed mesons and measures the event energy, allowing the path lengths to be translated into lifetimes.

A neutrino detector, based on flash chambers for event location, for a proposed neutrino facility at Los Almos.



LOS ALAMOS Proposed neutrino facility

Neutrinos have always been prominent in the experimental programme at the 800 MeV proton linear accelerator, LAMPF, at Los Alamos National Laboratory. This interest has heightened in anticipation of the proton storage ring (PSR) which is soon to be built. The PSR can operate in a mode which compresses the 750 μs LAMPF beam pulse to 270 ns. Thus high neutrino flux at low duty factor would be available, permitting a great improvement in background rejection from cosmic rays and good time separation of electron neutrinos from muon neutrinos.

To explore the physics that could be done with such a facility, a Workshop on Neutrino Physics was held last year, chaired by Felix Boehm of the California Institute of Technology. The Workshop identified several interesting problems that could be attacked with neutrinos in the 30 to 300 MeV range.

The first is the study of oscillation phenomena using muon neutrinos. A muon neutrino beam produced by in-flight pion decays can have sufficient energy to make muons in a detector yet with low enough energy to explore the possibility of small neutrino masses. The LAMPF Program Advisory Committee has already approved one such experiment. A second fundamental measurement is the elastic scattering of muon neutrinos from protons and electrons. With sign selection possible in a focusing device at the production target, an intense beam of muon antineutrinos can also be generated. These scattering experiments will allow precision measurements of neutral current parameters and the possible presence of non-standard weak interactions. The low energy at LAMPF ensures a clean electron scattering experiment; for instance, kaons cannot be produced in the production target, so the electron neutrino background from neutral kaon decays will not be present.

The Workshop also considered a large number of experiments using nuclear targets in which the specific nature of the initial and final states allows one to use the target as a filter for the space-time characteristics and the isospin structure of weak neutral currents. A copious source of electron neutrinos, separated in time from muon neutrinos, allows a class of experiments to test weak interaction universality. Among other experiments discussed were elastic scattering on deuterons (as well as breakup of the deuteron, including coincidence measurements in the final state), coherent elastic scattering from helium-4 (to test neutral current predictions of great astrophysical interest) and inelastic scattering to carbon-12 states and corresponding charged-current reactions in boron-12 and nitrogen-12.

The Workshop concluded that there was a rich variety of experiments at LAMPF energies which could shed light on several fundamental questions involving the weak interactions. The Laboratory therefore prepared a proposal to construct such a facility capable of accepting beam directly from LAMPF or from the PSR.

The facility includes a pion production target capable of accepting 100 μA of 800 MeV protons and a pion focusing device. A 'detector house' is situated directly after the pion decay volume for experiments requiring muon neutrinos. Viewing the beam-stop area from 90° is a separate detector building for muon neutrinos, electron neutrinos and muon antineutrinos at energies below 50 MeV. The proposal calls for the construction of a 500 ton detector, composed mostly of aluminium planes and scintillator panels, in which particle tracking will be done by either flash chambers, wire chambers, or proportional drift chambers. Augmented by a small 20 ton detector of the same design, located 200 m from the neutrino source, and the large 500 ton detector 3800 m away it will be possible to measure any neutrino oscillations with high sensitivity.

The proposal requests major funding in 1984 with the aim of completing construction in summer 1985. It has been submitted to the Department of Energy for review by the Nuclear Science Advisory Committee.

Pan American physics

Early in January, a unique meeting of Latin American physicists took place at Cocoyoc in Mexico. Apart from a strong summer school programme, the last time so many Latin American institutions got together was more than ten years ago. The meeting had about 50 attendees with strong representations from the US, Brazil and Mexico.

The meeting was designed with two objectives — to review the substance, current status and future expectations of high energy particle physics, and to survey the state of physics research and education in Latin America and explore the possibilities of increased collaboration with the US, consistent with the idea of a host US Laboratory.

One form of collaboration is to provide assistance to groups interested in becoming users of high energy facilities. Another form, more appropriate to countries less advanced in their physics development, is to provide a stimulus to experimentalists in any field of physics who would profit from exposure to the advanced technology associated with high energy Laboratories. Implicit in these objectives was the assumption, perhaps even deep conviction, that a strong physics capability is a necessary component in the potential for technological development.

Superb lectures were given by Sheldon Glashow, J. D. Bjorken and Burton Richter on the accomplishments, the current state and expectations for the near and far future in high energy physics. Topics of current physics interest were also discussed by J. Chela Florez, G. Perez, M. Moreno and A. Zepeda. The more sociological aspects were covered in three round table discussions and three forums.

Round Table I described the modes of utilization of high energy physics facilities, covering how users form collaborations, how they manage their university obligations and carry out research at the big Laboratories. The spur to local industry was discussed and illustrated by a description of the technically sophisticated devices which users construct at home and bring to the accelerator.

The ICFA (International Committee on Future Accelerators) statement on utilization policy, which has been acknowledged by all of the world's Laboratory managements, apparently was not known to Latin American scientists. The statement declares that facilities are open to all users on a world-wide basis, the only criteria of selection being scientific merit and technical competence of the proposal. This point was emphasized at the meeting by the assertion that if experimental high energy physics is deemed to be a useful activity at any institute in the world, then admission to any of the world's accelerators is scientifically compelling.

The requirement for formation of a small but viable physics group and the activities of such groups was well described by M. Kreisler, currently collaborating with Columbia and the University of Mexico in a Brookhaven / Fermilab experiment. The very relevant Canadian experience of depending on accelerator facilities abroad was cited. The interest of Canadian physicists in the possibility of constructing an electron ring at one of the large proton Laboratories is an example of the evolution of involvement.

The sociology of large teams was given full treatment. Doubt as to the value of such an educational experience was expressed and debated. US practitioners stressed the opportunities for innovation and learning in well led groups, the various skills in sophisticated technologies which physicists can command and the excitement of dealing with data at the frontier of science. Opportunities for abuse, including overspecialization, use of 'black box' apparatus and the possible damping of the free spirit, were acknowledged.

Perhaps the most dramatic and illuminating session was a review of physics research in Latin America with emphasis on problems and on the vast differences between say Brazil (600 PhD physicists in a population of 120 million) and Honduras (3 in a population of 3 million). For reference, the US has 25000 PhD physicists in a population of 200 million. This may be as good an indicator of development or at least the potential for development as any statistic. It appears that out of a total physics PhD population in Latin America of about 1200, roughly half are active in research. About 200 PhDs are obtained each year with more than half being obtained abroad. The total population base is 350 million.

M. Moravcsik led a Round Table discussion of social implications of physics research and technology by stressing that the subject is a central feature of our intellectual age, and all who aspire to develop university activities must participate, not only for the scientific prestige but also because of the intrinsic role in cultural development. The problem was raised of building confidence and a strong plea was made for eventual self-sufficiency. A plea by the doyen of Mexican physics, Marcos Moshinsky, underlined the objectives: strong physics, with its implied grasp of technology, is necessary for technological self-confidence, self-reliance and ultimately self-sufficiency.

It was also noted that the cultural appeal of physics attracted highly talented people who can go on to have considerable influence in other fields. The training value was emphasized — the bright and versatile practitioners go off and make contributions to free electron lasers, to applying theoretical physics ideas to the propagation of sound in oceans and to apply their accelerator expertise in building tokomaks for nuclear fusion energy.

This and the subsequent Round Table chaired by R. R. Wilson explored the technology associated with the machines and detectors and on the interaction between physicists and industry in Latin America. Again this varied a lot — there being a close connection in Colombia and almost none in Brazil. Reasons for this were explored.

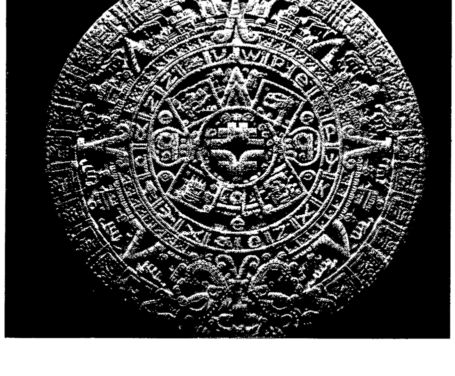
Georges Charpak and Burt Richter described spin-off technology — Charpak stressed instruments and Richter described the application of particle accelerators to medicine, microelectronics and radiation processing.

A lively discussion covered the issue of graduate education which, for most of Latin America, must be done abroad. There appears to be a trend away from the US and towards Europe because of the cost and the admission requirements of US graduate schools.

This issue and others related to collaboration were further developed in a forum which carried the motivating idea of the meeting. While Fermilab customarily provides facilities for physicists from about thirty countries and therefore is well set up with housing, a foreign visitor desk, language lessons, counseling, etc., many other US Laboratories provide the science which is the compelling cultural attraction and could contribute.

Playing a prominent role in this drive for pan American physics is Fermilab Director Leon Lederman, who concludes 'It is my feeling that we experienced something very serious, perhaps historic. If one believes that the technological gap between North and South tends to an unstable world, then we are moved to diminish this. The profit to the US in taking vigorous leadership would reap multiple rewards. Physicists trained in the US will use US technology. The human connections forged in this important enterprise must have positive political benefits. An explosion in physics in Latin America will substantially broaden the potential for producing the breakthroughs which change our lives, increase our comforts or at least preserve the technological society upon which we now depend.

What happens next? Fermilab is already 'open' and several theorists have come for short stays. We have also accepted engineers and technicians in cases which benefit the



sending institution. We have advised and encouraged the first user group from Mexico. We are seeking modest Foundation and International Agency support in order to minimize the problems of government involvement. Agreements between institutions are simple to administer and should be the rule as far as possible. In the course of the next few years, if Fermilab and other US Laboratories can play host to 20, 30 or 50 teachers and researchers from Latin America, each of these will in turn touch hundreds of students and colleagues and the leverage will be very great. Being even more optimistic, we can look forward, perhaps in five or ten years, to the serious notion of a Pan American Accelerator Laboratory — a hemispheric Centro Americano de Investigaciones Nucleares.'

One of the international discussion panels at the Pan American Symposium on High Energy Physics and Technology, held at Cocoyoc, Mexico, in January. Left to right, R. Taylor from SLAC (representing Canada), Fermilab Director Leon Lederman (representing the US), J. Flores of Mexico, M. Kreisler of the US, C. Avilez of Mexico, and Burt Richter also from SLAC, representing the US.

People and things

On people

Among the awards distributed at the recent joint annual meeting of the American Physical Society and the American Association of Physics Teachers were the Dannie Heineman Prize for Mathematical Physics, to John C. Ward of Macquarie University, Australia, for his contributions to the development of particle gauge theories, and the Oersted Medal for physics teaching, to I. I. Rabi of Columbia University.

LEP people

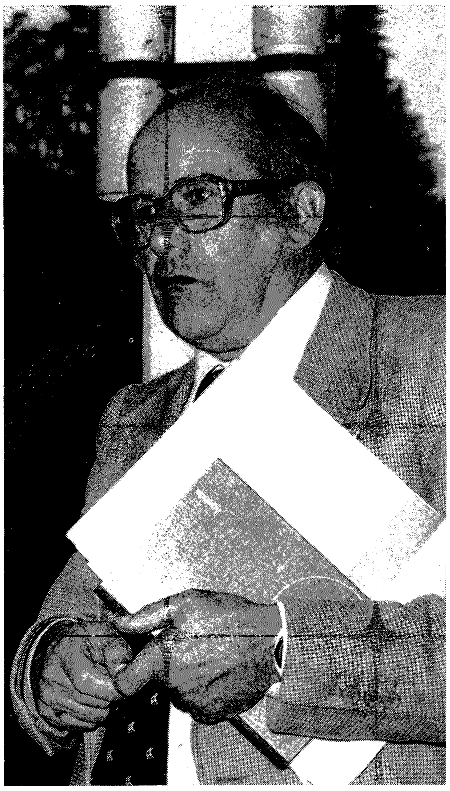
Now that the LEP electron-positron collider project is under way at CERN, decisions have been taken on the management of the machine construction and on preparations for the experimental programme.

At CERN itself, a LEP Management Board has been set up to study and propose solutions to major problems of the construction programme and to share responsibility for major decisions concerning the project. The members of the Board (appointed for two years) are E. Picasso (Chairman), G. Plass, H. Laporte. H.P. Reinhard, L. Resegotti and W. Schnell, together with M. Crowley-Milling (for 1982). CERN Director General H. Schopper and Technical Director G. Brianti are ex-officio members.

To prepare for the experimental programme, a LEP Experiments Committee is being set up and its first meeting scheduled for 24 March. G. Wolf of DESY has been appointed Chairman.

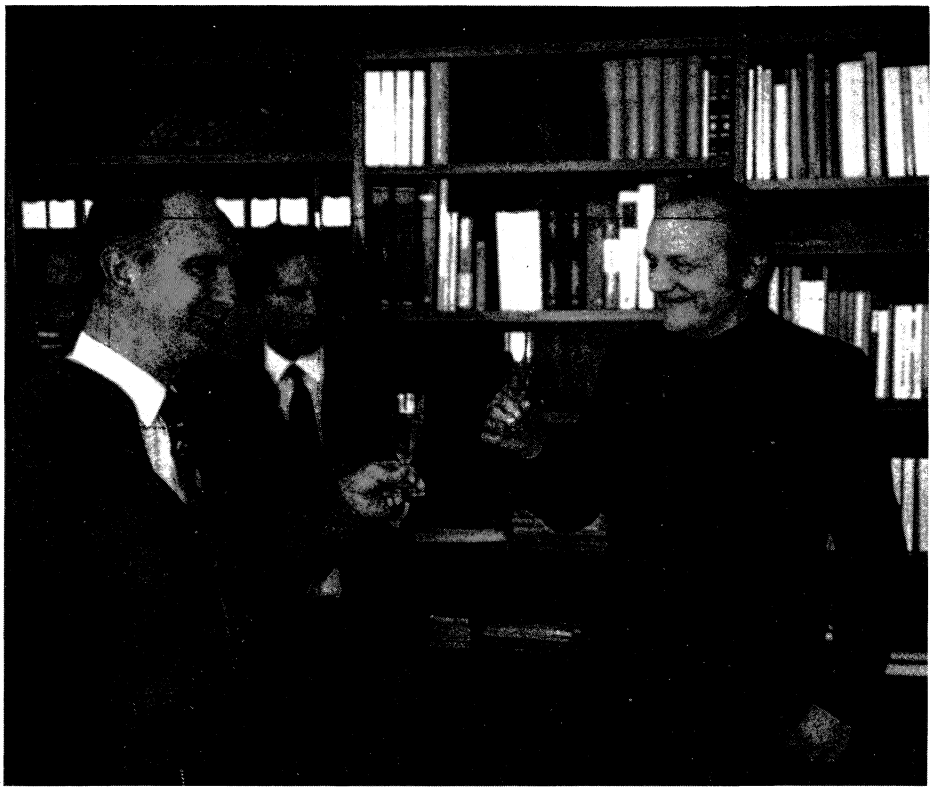
To advise on decisions concerning the machine, a LEP Machine Advisory Committee has been operating for some time under the Chairmanship of G.A. Voss of DESY.

LEP Project Leader Emilio Picasso.



DESY Director Volker Soergel (left) congratulates Gustav-Adolf Voss on the news of his being nominated Doctor Honoris Causa by the University of Heidelberg.

(Photo DESY)



Other members are J. Le Duff, G. Rees, B. Richter, G. Saxon, A.N. Skrinsky, S. Tazzari and M. Tigner, together with Sir John Adams, G. Brianti, E. Gabathuler, A. Hutton, E. Picasso and H. Schopper from CERN.

Gustav-Adolf Voss, member of the DESY Directorate and Chairman of CERN's LEP Machine Advisory Committee, has been made Doctor Honoris Causa by the University of Heidelberg. The award came in special recognition of his contributions to the development of storage rings, and the role he played in the construction of the PETRA electron-positron ring at DESY. Working with Ken Robinson in the late 1960s, he helped develop the idea of 'low beta insertions' to compress the beams at the collision regions of storage rings and boost the available luminosity, a technique much in vogue these days.

US Funding

In bad shape with the 1982 budget inherited from the previous administration, the US high energy physics funding has been reviewed by the Reagan administration in the light of the current US economic situation. In the meantime the US High Energy Physics Advisory Panel (HEPAP) formed a committee under the chairmanship of George Trilling to look at the implications of different possible funding levels for the long range planning of US high energy physics.

A number of projects are under way or being studied at Brookhaven, Fermilab, SLAC and Cornell. Diversity has always been a strong point of the US high energy physics programme, but lack of money could result in one or other of the projects being held back. If insufficient funds were available, something would have to go, and while nobody wanted to see imaginative projects curtailed, a choice had to be made on a least of evils basis.

The proposed victim was the ISABELLE project for 400 GeV colliding proton beams at Brookhaven. The committee underlined the considerable scientific merit of this project, and strongly recommended its timely completion. However it was felt that further erosion of funding would damage the project and prevent its timely completion.

The initial budget figure which has emerged is one of $429 million. Although this represents an increase over the inherited budget, it could be insufficient for the present ISABELLE scheme.

Ten years ago, on 1 March 1972, Fermilab Director Robert R. Wilson toasted the attainment of 200 GeV, the nominal Main Ring design energy. In 1976 this was boosted to 500 GeV, and now the Laboratory looks towards 1 TeV (1000 GeV).

(Photo Fermilab)

While Brookhaven's operating funds have been increased, allowing for an extensive superconducting magnet research and development programme, initially no funds are earmarked for ISABELLE construction. However it is hoped that support will be restored in the months ahead as the budget is finalized.

Work on the 3.8 km circumference ISABELLE tunnel began in 1978 and is now largely complete. The project was originally seen as taking about ten years, however difficulties were encountered in the development of the superconducting magnets to handle the particles. Although these problems have now been largely solved, the project was nevertheless held up. However good progress continues to be made using the new magnet design (see page 96).

Tevatron II approval

The Tevatron II project at Fermilab to convert the Energy Saver to full 1000 GeV experimental operation has received US government authorization. The construction project is authorized for $49 million. It includes the extraction system to bring the beam out at 1000 GeV, upgrading the external beam switchyard to handle transporting and targetting of beams up to 1000 GeV, and modification and construction of new secondary beams and support facilities in each of the three existing experimental areas to fully exploit the physics capabilities of the 1 TeV accelerator. The project will start this year and be fully complete in late 1985. Tom Kirk, Deputy Head of the Research Division, is Project Manager for Tevatron II.

Meanwhile another key milestone on the way to completion of the Fermilab Energy Saver/Doubler has been achieved with the operation of a 2400 foot-long superconducting magnet string comprising three-quarters of a sector of the total ring.

Tests of the first sector of the Saver have been under way since mid-January. Nearly half a mile of superconducting bending magnets in the main ring tunnel have been cooled and powered to 2200 A which is equivalent to an energy of approximately 500 GeV. The string includes roughly one-eighth of the Saver magnets.

Three separate cryogenic loops are in operation from the A1, A2, and A3 service buildings. The total system is operating in conjunction with three satellite refrigerators and the Central Helium Liquefier. Twenty-four half cells are in the string with each half cell consisting of four dipoles, one quadrupole and a spool piece which contains the correction elements.

Many tests are under way as the current through the system is raised by stages. The entire system has been ramped at the design rate of 100 A/s for several hours with no unexpected problems. The system is also periodically dumped into a resistive load, or made non-superconducting (quenched) by turning on internal heaters, in order to test the power supplies, magnet quench protection and refrigerator recovery. Tests are being run on pressurization, refrigeration, the control system, power supplies, vacuum and general safety systems. Operation at 1000 A occurred on 12 February, 1500 A on 13 February, and 2200 A on 19 February. Over the next months the current will be gradually raised to 4000 A. All of these tests are being carried out while the present accelerator is in operation for the normal 400 GeV research programme. The system is handled from the existing central control room in parallel with normal operation.

SLC Workshop

Some 150 physicists met at SLAC recently to discuss reports on the experimental prospects at the SLAC Linear Collider (SLC). This meeting concluded the first phase of study for the SLC physics programme.

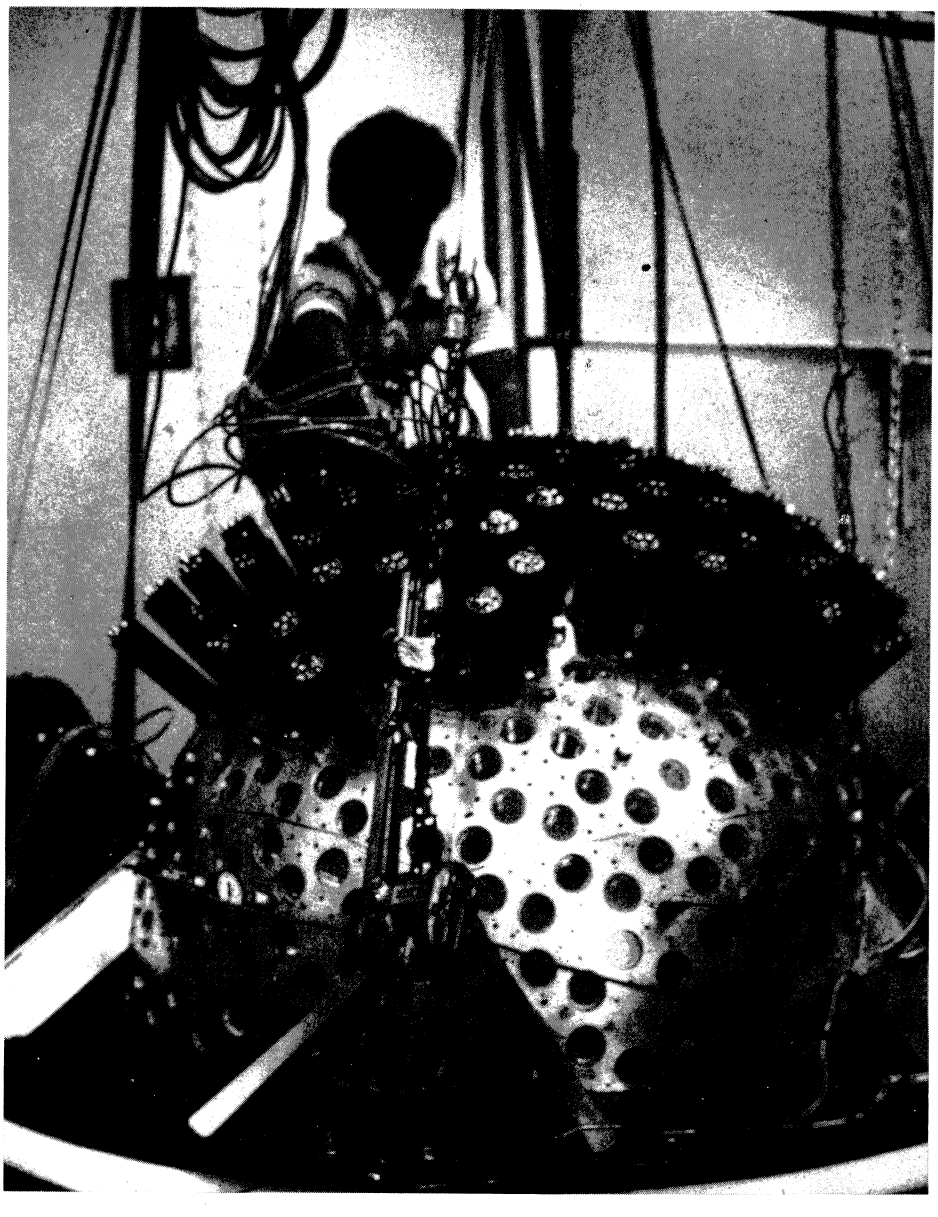
Most of the agenda was devoted to the presentation of the reports of the eight specialist subgroups set up last year (see June 1981 issue, page 199). These reports are being published as proceedings.

On view was new hardware developed for SLC, including a new beam position monitor to handle the intense SLC bunches. The control system which monitors beam position, calculates orbit corrections and adjusts steering dipoles has been successfully tested. Also shown was a new klystron cathode, designed to improve the performance of the existing 36 MW devices to provide the energy and reliability needed for the SLC. Meanwhile a 150 MW klystron is being developed with Japanese assistance, and a prototype is expected to be ready this summer. These tubes would meet SLC requirements without the need for additional linac r.f. power.

Progress at CESR

More news from the CESR electron-positron ring at Cornell to update our recent story (January/February issue, page 9). After further operation with the new mini-beta insertions, normal operating luminosity has been improved by a factor of three. Peak figures of more than 8×10^{30} cm^{-2} s^{-1} have been recorded, while integrated luminosities of 2000 inverse nanobarns per week are now routine. The new CLEO superconducting magnet has paid dividends in the form of power savings equivalent to half a million dollars per year, welcome news when operational budgets are severely pressed. During the recent major shutdown, additional sodium iodide scintillator counter end caps were installed in the CUSB lepton-photon detector to complete its angular coverage. A magnetized iron muon identifier was also brought in.

After a three-month run at the third upsilon, CESR energy will be raised for an extended run at the fourth upsilon.



The Crystal Ball detector being prepared for removal from the East Pit at the SPEAR electron-positron ring at SLAC and shipment to DESY for installation in the revamped DORIS ring.

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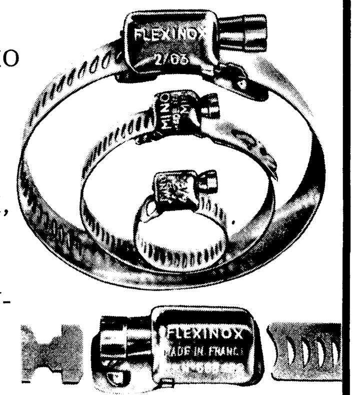

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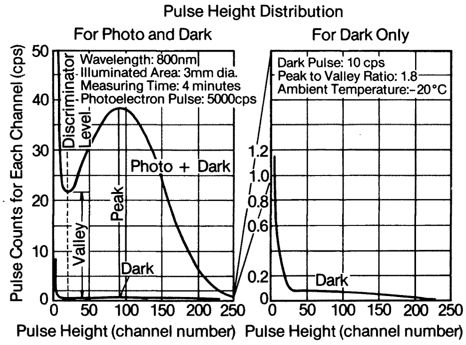

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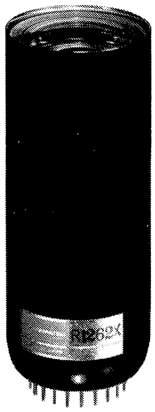

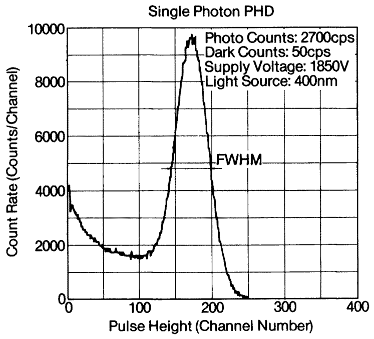

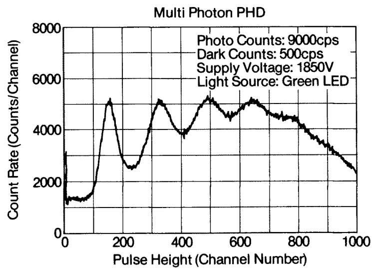

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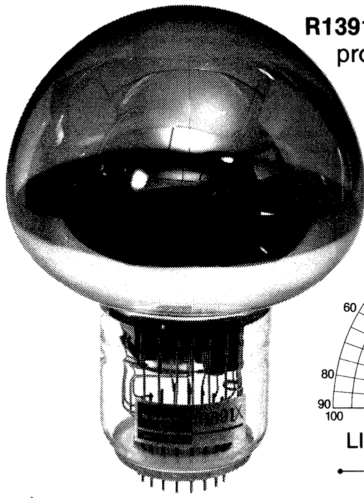

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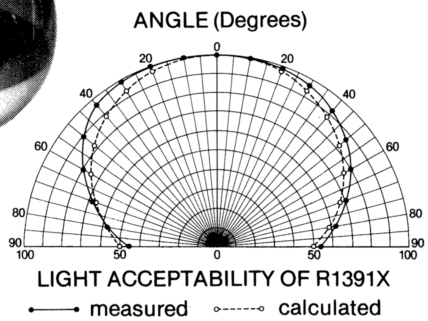

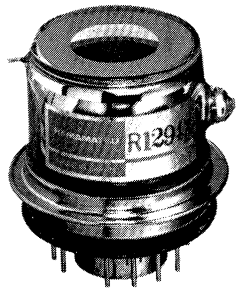

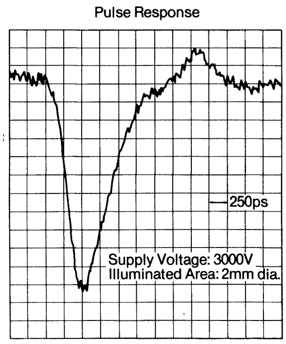

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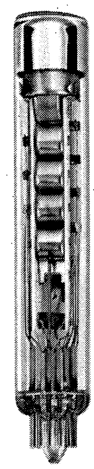

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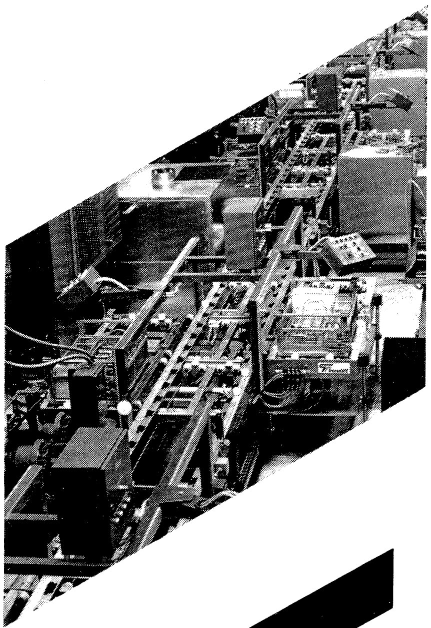

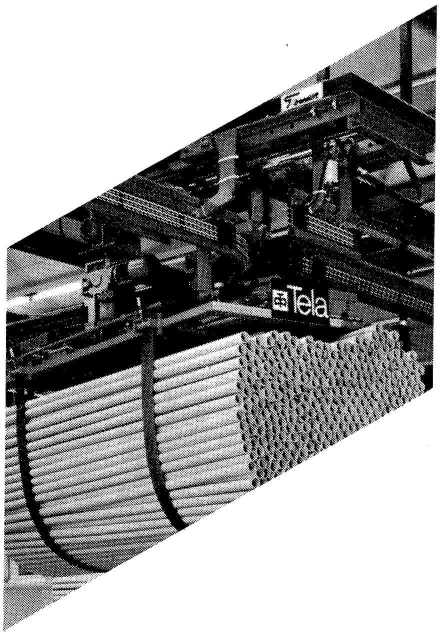

High Gain $d_1 \Rightarrow$ 70% SER*

New XP2262 facilitates multiplier noise discrimination

A complete range of fast 2″ PMTs for physics and industry						
PMT	number of stages	t_r (ns)	t_w (ns)	σ_t (ns)	Δt_{ce} (ns)	pulse linearity (mA)
XP2262	12	2,0	3,0	0,50	0,70	250
XP2242B	6	1,6	2,4	–	0,70	350
XP2020	12	1,5	2,4	0,25	0,25	280
XP2230	12	1,6	2,7	0,35	0,60	280
High sensitivity bialkali 44 mm diameter cathode						

t_r = anode pulse rise time for a delta light pulse

t_w = anode pulse duration FWHM for a delta light pulse

σ_t = transit time spread for single electron mode

Δt_{ce} = transit time difference centre-edge

XP2262 replaces XP2232.

*SER = Single Electron Resolution

Other fast tubes:
3/4″ PM1911 3″ PM2312
1″ PM2982 5″ XP2041

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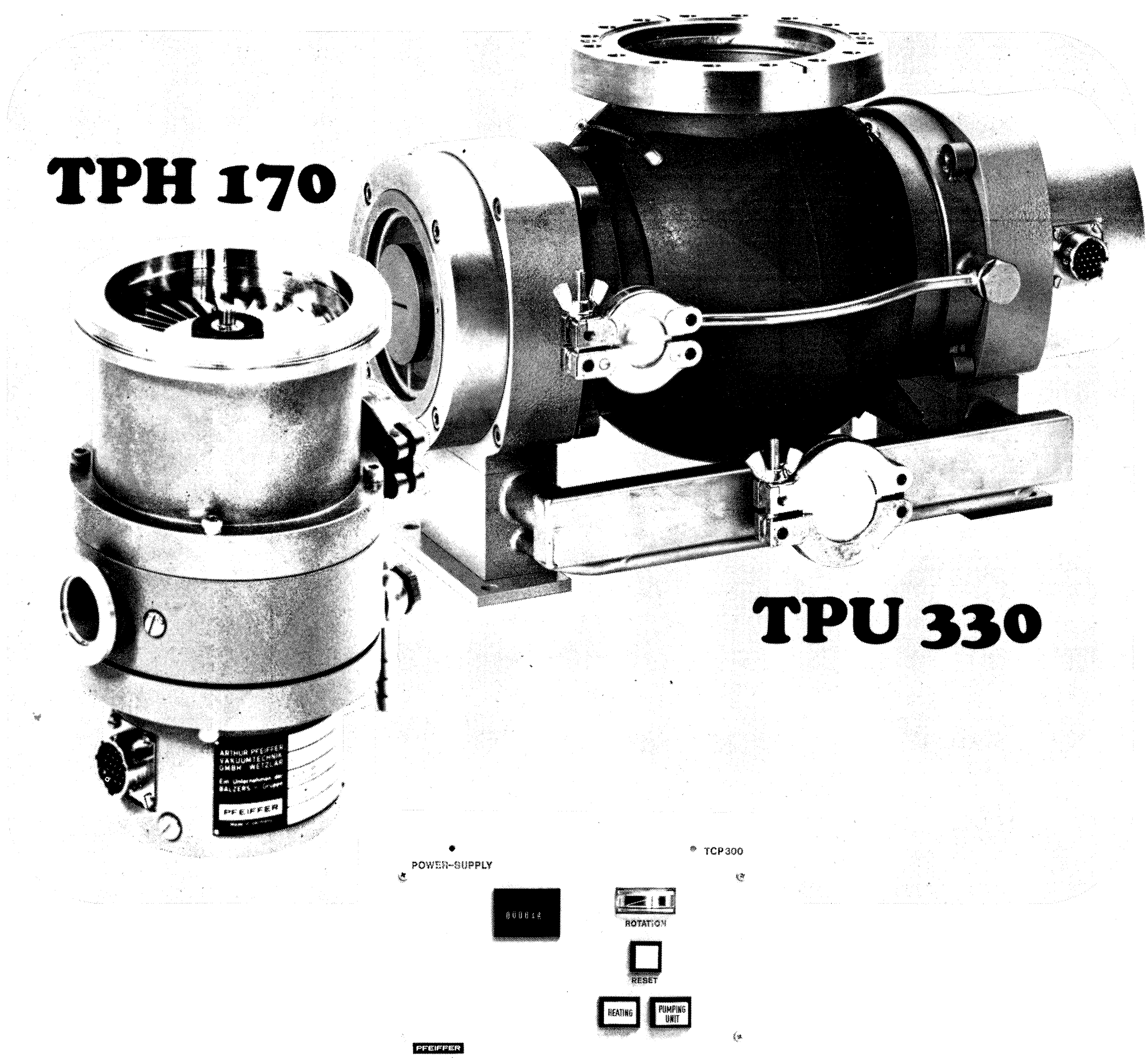
PFEIFFER TURBO PUMPS



TCP 300 electronic drive unit

Turbomolecular pumps used to generate high and ultra-high vacuum without any hydrocarbons have proven their usefulness both for scientific and industrial application. The PFEIFFER TURBO has been the pioneer for this type of pump. Research and development over nearly 25 years have over and over again led to new and better solutions.

As a result of the optimization of the rotor and stator design, a considerable increase in volume flow rate has been attained for the turbo pump models 170 and 330.

Both pumps are driven by the newly developed electronic drive unit type TCP 300. The TCP 300 has been equipped for connection to the interface unit TCI 001 which is also a new development and which permits the most important operating data of the pump and the electronic drive unit to be processed by a computer.

Detailed information on pumps and pumping units can be supplied to you on request.

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