CERN COURIER

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Cover photograph: Construction work for the LEP electron-positron collider at CERN forges ahead. After the first tunnelling machine began work in April (see page 336), a second, seen here on the left, was lowered into position in July to begin work on another sector of the ring. On the right is a side gallery (Photo CERN X618.7.85).

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Anomaly Busters hit Kyoto

Summer Conferences

This summer saw two major particle physics meetings – the International Europhysics Conference at Bari in July, and the International Symposium on Lepton and Photon Interactions at High Energies, held in Kyoto, Japan, one month later.

By and large, the physics messages were the same – the disappearance of unexplained effects, leaving conventional physics largely unchallenged. In the intervening month, one anomaly which was still a talking point at Bari – the strongly oscillating muon signals picked up from the star Cygnus X-3 – went sharply into reverse, with several negative reports coming in.

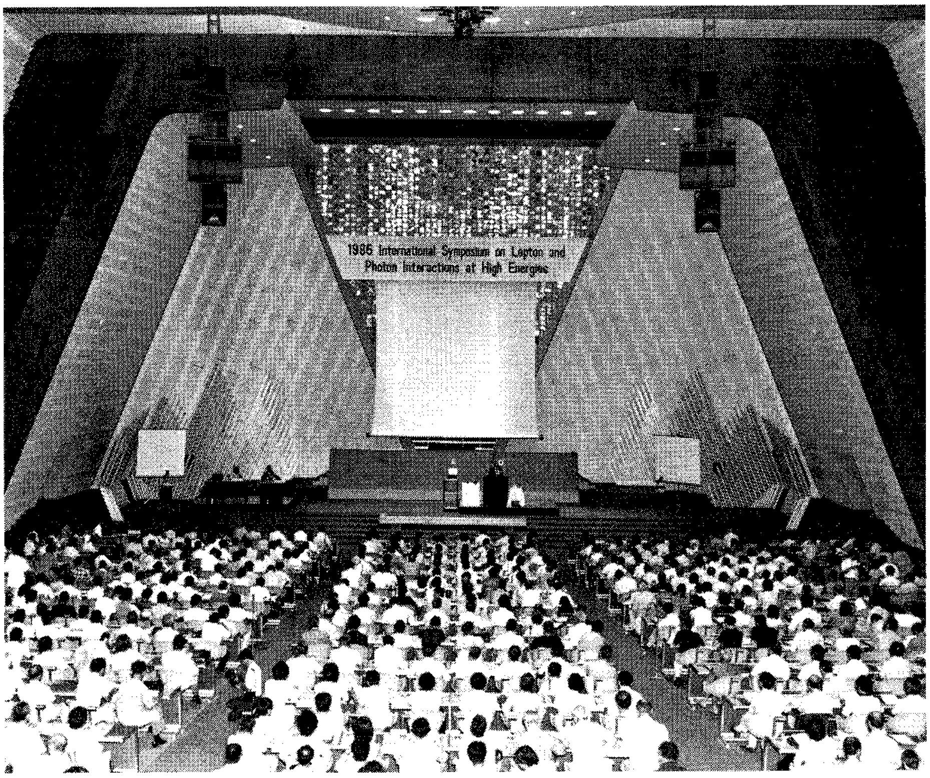
'The Anomaly Busters' – this was how Roy Schwitters of Harvard summed up the International Symposium on Lepton and Photon Interactions at High Energies, held in Kyoto from 19-24 August. Recent results had given clues of possible anomalous behaviour – neutrino masses, the so-called 'monojets' in high energy proton-antiproton collisions, unexplained muon signals from the star Cygnus X-3, etc.

According to Schwitters, none of these anomalies were confirmed by the results presented at Kyoto. While the success of the Standard Model (electroweak interactions plus the conventional quark/gluon field theory of nucleons) is now impressive, Schwitters confessed to being 'frustrated' by the negative results coming in. 'There has to be something beyond the Standard Model,' he surmised, 'but we can't get our hands on it'.

Both Schwitters and the previous speaker on the last day of the meeting, John Ellis of CERN, maintained that the 'monojet' signal coming from the UA1 experiment at the CERN proton-antiproton Collider (a jet of hadrons accompanied by 'missing energy' indicative of a neutrino) can be accounted for without too much effort.

In his talk earlier in the meeting, Carlo Rubbia, head of the UA1 experiment, had however pointed to monojet signals which could be beyond conventional physics. 'There is a clean signal from tau events, but there may be something additional, a question which can only be resolved with more statistics,' he declared.

On the first day of the meeting, Yoji Totsuka of Tokyo covered experiments searching for baryon decays and went on to survey studies of stellar muons. Accord-



The Kyoto Symposium Hall.

ing to Totsuka, the few candidate proton decay events seen in recent years are not clean enough and the accompanying neutrino background is too high. However more data is needed before proton decay can be ruled out.

Recent reports from underground experiments NUSEX (Mont-Blanc) and Soudan (Minnesota) had uncovered unexplained intense pulsed muon signals apparently coming from the star Cygnus X-3 (see September issue, page 264). Totsuka revealed that similar searches by the Kamioka (Japan) and Fréjus (France) experiments had found nothing, although their exposure time was shorter. A remark from the floor indicated that the big water detector operated by the Irvine/Brookhaven/Michigan team was also seeing nothing.

In another controversial area, Karl Bergkvist of Stockholm spent a substantial part of his talk demolishing the claims of the Moscow experiments which for several years have been saying that the electron-type neutrino has a mass of a few tens of electronvolts. Nobody from the Moscow experiment was at Kyoto to react. Bergkvist also claimed that other odd neutrino results, like an unexplained heavy neutrino at 17 keV (see July/August issue, page 241), and possible neutrino oscillations seen in experiments at reactors are being 'anticonfirmed' by other studies.

Last year the UA1 experiment reported examples of a widely separated hadron jet and a lepton, accompanied by the missing energy of a neutrino. This suggested that the decay of the long-awaited heavy sixth 'top' quark was being seen. At Kyoto, Rubbia still pointed to such events clustered round a top quark mass of 40 GeV, but looks forward to more data at higher collision rates and energies.

In his talk on heavy quarks, Jon Rosner of Chicago did not find this evidence too compelling and urged the CERN Collider experiments to fix better limits on the top quark mass. For his part, summarizer Schwitters admitted that a top quark in the mass range between 30 and 50 GeV is possible, but is 'not established'.

Kyoto speakers repeatedly underlined that while the Standard Model now looks very solid, it has too many free parameters to be the complete picture. There is no lack of deeper candidate theories, but as yet little or no evidence to go on. But new physics could be 'right round the corner in the TeV region,' declared Schwitters, gathering up his transparencies.

(A fuller report on the Kyoto meeting will feature in our next edition.)

Death at Bari

Summarizing the International Europhysics Conference held at Bari, Italy, from 18-24 July, theorist Alvaro De Rújula declared 'we have seen at this Conference a dozen wonderful, revolutionary discoveries die. The Conference would have been extraordinarily more optimistic (and cool) a few months ago'. (Participants at Bari had to contend, among other things, with temperatures of 42 degrees with minimal or no air conditioning.) However his comment was restricted to the experimental sector. In theory, new ideas are very much alive.

Among these experimental effects which seemed to be slipping off the map at Bari were the heavy neutrino (17 keV) from the analysis of tritium beta decay (see July/August issue, page 241), the 'zeta particle' once seen at 8.3 GeV in upsilon decays (see September 1984 issue, page 266), and several first indications reported last year by the big experiments at the CERN proton-antiproton Collider which do not seem to be standing the test of time. De Rújula proposed 'Parkinson's Law of Physics' – 'As the statistics increase the evidence decreases'.

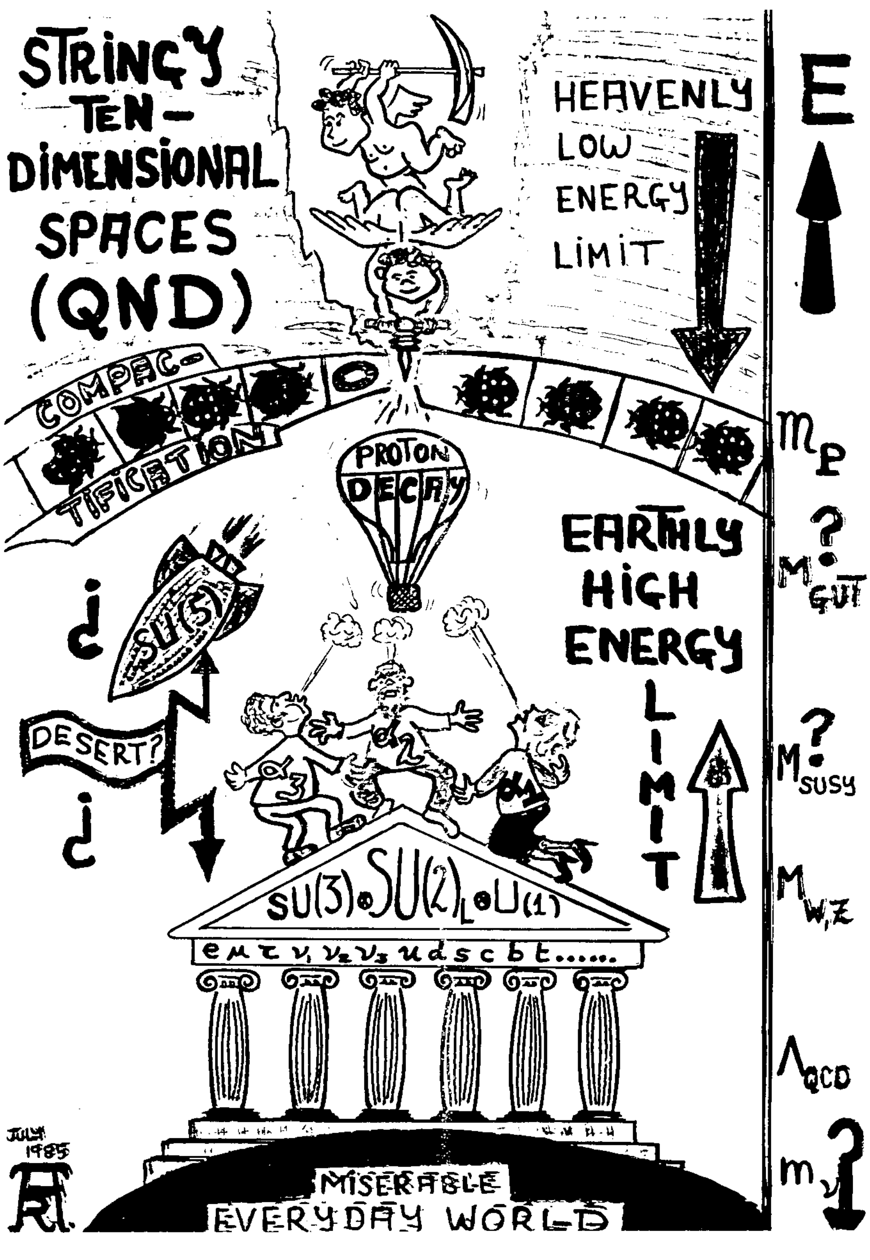
The preliminary (and unexplained) Collider effects which are not being confirmed include a jet-jet resonance at 160 GeV, additional jet activity accompanying the production of Z bosons, excess signals of jet plus leptons, the highly energetic photons accompanying Z decays, and puzzles in the production of muon pairs of the same sign.

As if to counter the disappearance of so many potentially interesting phenomena, new enigmas have been provided by some underground experiments looking at particles coming from the binary star Cygnus X-3 (see September issue, page 264). According to De Rújula, these data are either 'too peculiar and too few to be taken seriously in all of their implications' (the pessimistic viewpoint), or are 'absolutely mind-boggling, revolutionary' (the optimistic viewpoint).

Participants at Bari hoping to get more news on the unexplained 'monojet' events seen by the UA1 experiment at the CERN Collider (collisions apparently producing a spray of hadrons on one side and the 'missing energy' signal of a neutrino on the other) met only a stony silence. 'Why should UA1 submit to pressure and release their data before they are fully analysed?' maintained De Rújula.

Impressive now is the volume of data which confirms the Standard Model of the electroweak sector plus conventional quark theory (quantum chromodynamics). The electroweak mixing angle has been measured under a wide range of conditions and all results concur. Results from the CERN Collider now show that at the very most there can only be a few additional types of neutrinos beyond the three (electron, muon and tauon) already discovered.

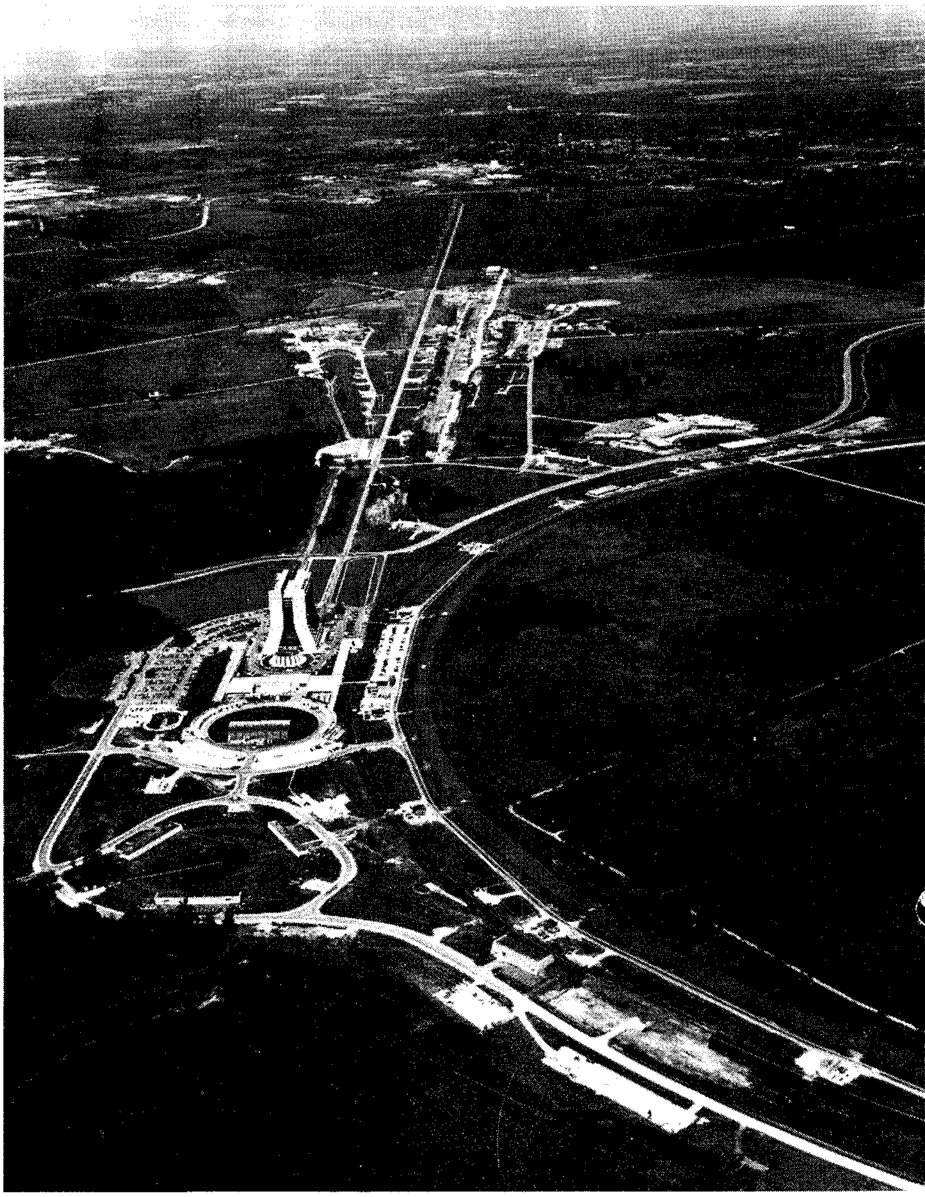
However the Bari graveyard of odd experimental effects was in stark contrast to the optimism verging on hysteria of theorists succumbing to 'superstring fever' (see June issue, page 185). Superstrings are being widely heralded as the best ever contender for the theory of everything. De Rújula summarized the development of the ideas, but turned his audience's attention to Michael Faraday's premature enthusiasm of 150 years ago in trying valiantly but unsuccessfully to unify electricity and gravity. A remark made by Faraday nearly 150 years ago still applies to the theoretical physics effort of today – 'If the hope should be well-founded, how great and mighty and sublime is the force I am trying to deal with, and how large may be the new domain of knowledge that may be opened to the mind of man'.



Alvaro De Rújula's view of the present state of particle physics theory.

Fermilab enters the Tevatron era

Recent aerial photo of Fermilab with the Main Ring to the right with, bottom left, the roughly triangular shape of the antiproton source. Beyond the hi-rise building, the beamlines for fixed target experiments stretch away into the middle distance.



The advent of the world's first superconducting accelerator/storage ring has transformed the physics programme at the Fermi National Accelerator Laboratory. The primary and secondary beam energies (and the coming colliding beam energies) are double those previously available at Fermilab and at the CERN SPS. There is heavy investment in the fixed target programme to use these beam energies and, at present, even more pressure is driving the preparations for proton-antiproton colliding beam operation at energies up to 1 TeV per beam. Since it is the revitalized machine which is making all this possible, we begin with news on machine performance and development.

The Tevatron and first colliding beams

The 1000 GeV (1 TeV) superconducting ring spent much of its life under the title 'Energy Doubler/Saver'. It has lived up to its name having virtually doubled the beam energy available from the conventional magnet Main Ring and having saved some 40 MW of energy in operation because of the lower power requirements of the superconducting magnets.

Since the beginning of this year, the Tevatron has been operating at 800 GeV with a cycle time of 57 s (which experimenters have learned to live with, particularly because they enjoy a 20 s slow spill as well as three 1 ms fast spills). The peak beam intensity is 1.5×10^{13} protons per pulse and regular operation is not much below this peak. Operating efficiency has reached 80 per cent.

To sustain or improve such operating efficiencies and to push for 2×10^{13} intensities, a thorough programme on component reliability is planned. For example, one of the systems under strain is the cryogenics which keep the magnets at superconducting temperatures. As development of the Tevatron magnets proceeded, all the safety factor, in terms of the built-in cooling capacity, was gradually eaten away with modifications to the magnet design, so that now the Central Helium Liquefier has always to be in operation in support of the satellite refrigeration systems installed around the ring. It is intended to increase the cooling capacity and go through a detailed list of component reliability improvements.

The refrigeration systems proved one of the toughest parts of the Tevatron project but, en route, a great deal of cryogenic expertise has been accumulated at

***Late news – Antiprotons were captured and stored in the Fermilab debuncher-accumulator complex on 7 September, achieving an antiproton current of about one microamp in the accumulator core. In the short time available, current was limited by momentum matching between the debuncher and the accumulator. Meanwhile the big CDF detector has been rolled into position ready to see its first proton-antiproton collisions.**

the Laboratory. (For example, Fermilab was assigned the cryostat design in the collaboration with Brookhaven and Berkeley in the development of high field magnets for the Superconducting Super Collider. The aim is to reduce the heat load of the SSC magnets by a factor of at least five compared to the Tevatron magnets. SSC cryostat tests are underway and are reaching the required performance.)

In general, performance of the superconducting ring since January has been very satisfying. In many ways, the superconducting accelerator has proved much 'tamer' than the conventional Main Ring which requires as much or more attention in the push to higher energies. A programme to take the regular operating energy up to the magic figure of 1 TeV over the next few years started in September when a three day run, attempting to ramp the magnets to 900 GeV, was scheduled. The aim is to identify any weak magnets so that they can be replaced during the year-long shutdown which is necessary for conversion to a proton-antiproton collider. The collider could then start physics operation in 1986 at energies of 900 GeV. The subsequent two years, via weak magnet replacement and operation at a lower temperature, should bring 1 TeV colliding beams.

The beginning of proton-antiproton colliding beam physics is scheduled for Autumn 1986 following a year's shutdown for construction of a bypass around the region where the 'Colliding Detector Facility', CDF, is located and of an additional experimental hall where the DO collider detector will be located. Before this construction starts, there is a desperate effort to bring the antiproton source into first operation, to install a substantial part of the CDF (as from 3 September) and to see some 1.6 TeV proton-antiproton collisions*.

A rather full story on the antiproton source appeared in the September issue (page 273). It is worth noting that its development and commissioning is another fine example of inter-Laboratory collaboration. Novosibirsk collaborated on the lithium lens in the antiproton target station. Fermilab benefitted from access to the antiproton experience at CERN, and CERN, in turn, was able to lean on Fermilab thinking for the ACOL collector ring upgrade of the CERN antiproton source.

Big time electrons

A 400 GeV electron beam has been established using the new wide-band photon beam at Fermilab. A strong beam of several million particles per spill was seen with the expected spot size, and muon background was down at an acceptable level. The aim is to push the energy up to 600 GeV.

In normal operation an electron beam (produced by photons coming from the decay of neutral pions) strikes a lead converter to produce the photons. This process of going from pions to photons to electrons and back to photons produces a very clean beam, free of neutrons. As well as more than doubling the average photon energy available with the previous setup, the intensity is also much higher.

The collider detectors

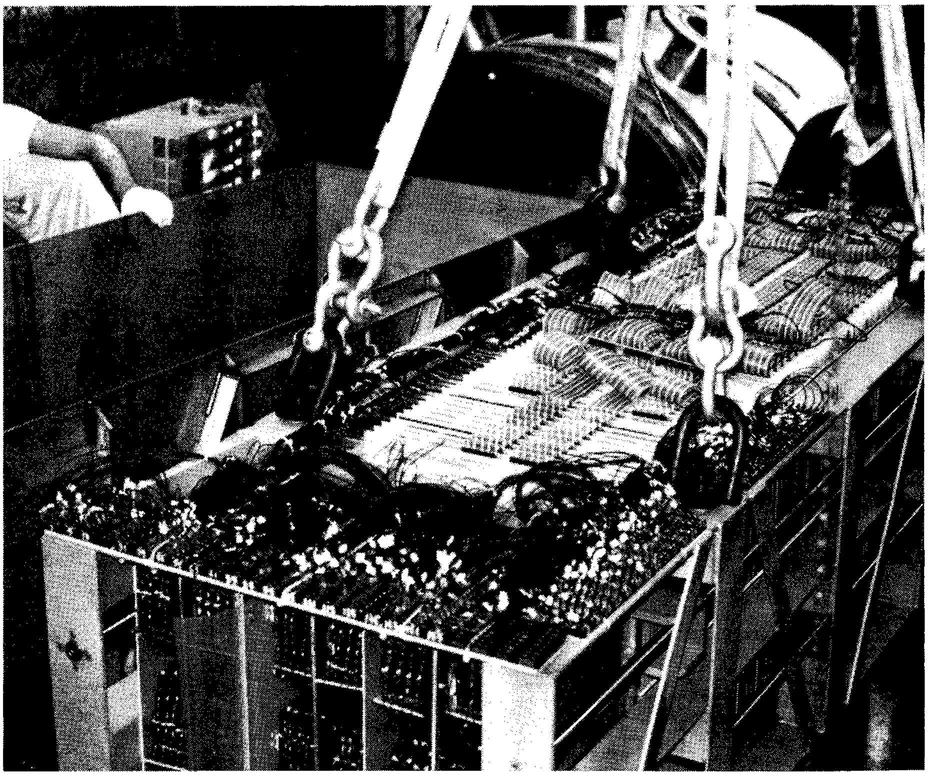
The Collider Detector Facility, to be installed in Main Ring sector BO, was described in the January 1984 issue; it involves some 175 physicists from 17 universities and Laboratories. It has electromagnetic and hadronic calorimetry over almost the complete solid angle around the collision region with segmentation of the detector volume to match the high energies and expected high multiplicities from the interactions. A superconducting solenoid, successfully operated earlier this year, provides a 1.5 T field in the central volume filled with drift chambers to provide a visual reconstruction of the interactions. Muon detectors surround the detector.

Construction is over two-thirds complete and it is hoped to see a few events in September to test out the various systems, prior to the start of the serious running in 1986. Thoughts are already turning to 'upgrades' to take advantage of detector technology developments (silicon strip detectors), more advanced electronics (programmable 'level 3' trigger system and even more advanced FASTBUS systems) and more complete solid angle coverage. Funds may be available for this from the end of 1986.

The plans for the other large detector, known as 'DO' from its location in the Tevatron ring, have escalated considerably from the initial intention to add another modest experiment (see May 1984 issue, page 147). The DO collaboration now involves some 100 physicists from sixteen universities and Laboratories. The detector design profited from the UA1 and

Prototype of the liquid argon/uranium calorimeter being developed for the DO collider detector at Fermilab. The predicted uranium compensation is giving encouraging results.

(Photos Fermilab)



UA2 experience at CERN and is optimized for jet, missing transverse energy and lepton observation.

There is no central magnetic field, allowing more complete coverage for the calorimetry which will involve the uranium/liquid argon technique. Recent tests with a calorimeter prototype by the collaboration have given encouraging indications that the predicted 'compensation' (by the fissions caused in the uranium) of the energy lost in the insensitive uranium, does work. The central detector uses drift chambers and transition radiation detectors; on the outside are muon detectors – magnetized iron and chambers. The total weight is 5500 tons.

Construction of the building for the detector started in September and will continue until July of next year. It is hoped that significant money for detector manufacture will start to be liberated in October with the aim of completion and observation of first collisions in 1989.

To complete the colliding beam picture, an additional three more modest experiments will run during the early days of proton-antiproton operation. They are a total reaction rate measurement, a search for quark-gluon plasma and a search for anomalously ionizing particles using lexan plates (without which a machine first penetrating a new energy range would not feel comfortable).

Fixed target facilities and experiments (Tevatron II)

To use the primary proton beams of 800 to 1000 GeV, the beamlines and facilities for fixed target experiments are being upgraded in a programme known as 'Tevatron II'. The fixed target research programme involves some 500 physicists.

New beams include a wide-band photon beam (see box), a new muon beam and neutrino beam. Experiment detectors are coming together in the wide-band hall and muon hall and there is evidence of thoroughness and excellence in the engineering of all these facilities. The photon beam has been commissioned and has exceeded its design parameters; an experiment on the photoproduction of charm and bottom particles (Colorado/Fermilab/Illinois/Frascati/Milan/Northwestern/Notre Dame) is taking some first data. The new beam energies cross the threshold for reasonably copious production of these particles.

Commissioning of the muon beam started in July yielding muons of up to 750 GeV and a muon scattering experiment detector is being installed in an elegant hall, designed by 'itinerant architect' R. R. Wilson. The experiment (involving Argonne/Cracow/CERN/Fermilab/Freiburg/Harvard/Maryland/MIT/Munich/San Diego/Washington/Wuppertal and Yale) uses the vertex detector of the CERN EMC experiment followed by the magnet of the Chicago cyclotron in yet another reincarnation, a huge ring imaging Cherenkov counter, the steel of the Rochester cyclotron as shielding and further muon detectors.

The upgraded neutrino beam compensates for loss of flux due to the longer cycle time of the Tevatron (where three fast spills of some 2×10^{12} protons on target occur in each one minute cycle) by the rise in total cross-section because of the higher energies and better neutrino beam quality. The beam illuminates the reactivated 15 foot bubble chamber filled with a neon-hydrogen mix using holographic photography of the events with a pulsed ruby laser, and, of course, supplemented by external counter detectors (Berkeley/Birmingham/Brussels/CERN/Fermilab/Hawaii/IIT/Imperial College/Munich/Oxford/Rutgers/Rutherford/Saclay/Stevens/Tufts collaboration).

Use of the 15 foot chamber as new energies are reached is in the tradition of bubble chamber physics – the all-seeing eye which can reveal the unexpected, compared to the electronics experiment which has been traditionally tuned to observe some specific features of an interaction. The 15 foot (like the Tohoku chamber mentioned below and a counter experiment) is also lined up for a beam-dump experiment. Unfortunately, the beam-dump programme at the new high energies has been delayed because the facility is fairly expensive to introduce (it uses magnets to eliminate charged particles rather than an earth shield or other passive filter) and it has not yet been possible to finance its construction.

Fermilab remains well populated with bubble chambers, which have now been exterminated at CERN. A 1 m heavy liquid bubble chamber from Tohoku, also using the holographic technique, has recently come into action for a Beijing/Brown/Fermilab/Haifa/Indiana/MIT/Nagoya/Oak Ridge/Tel-Aviv/Tennessee/Tohoku experiment using the narrow-band neutrino beam. Also the 'Little European Bubble Chamber', LEBC, is being used in conjunction with the Fermilab multiparticle spectrometer to study charm particle production in proton-proton interactions (Aachen/Brussels/CERN/Duke/Fermilab/Florida/Collège de France/Kansas/LPNME/Michigan/Mons/Notre Dame/Strasbourg/Vanderbilt).

These are just a few of the experiments in the fixed target programme. Other special ones await facilities planned in the second phase of Tevatron II. These include a new meson beam to provide a high flux of pions up to 800 GeV and a polarized proton beam (from polarized lambda decay) at energies of over 100 GeV.

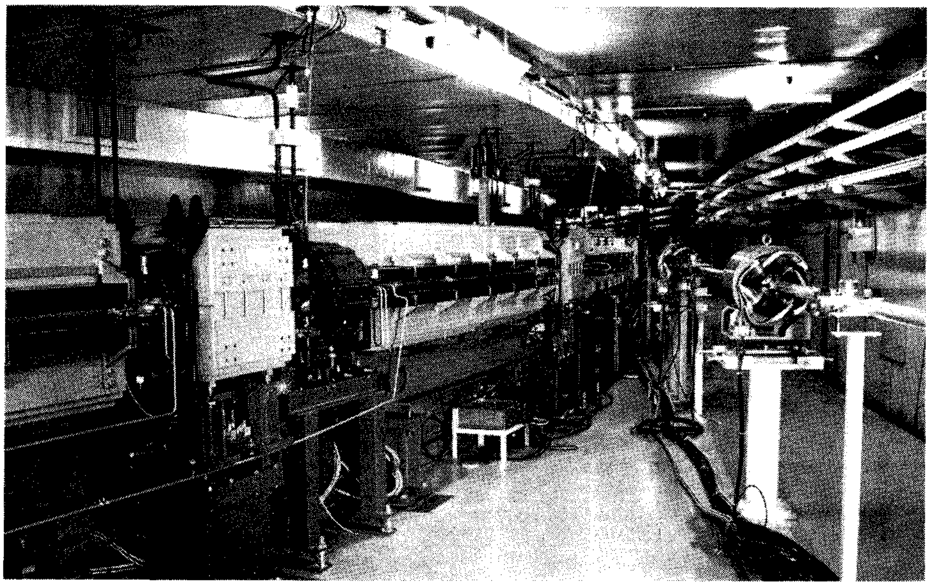
By Brian Southworth

The rising sun of particle physics

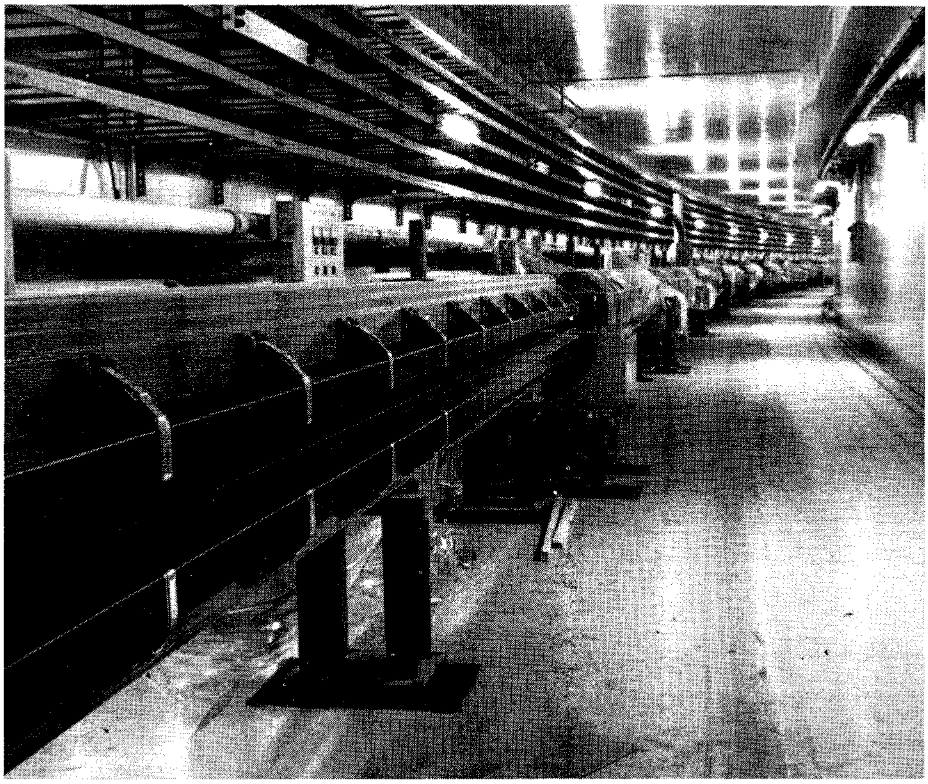
A new entrant is set to join the select league of big-time high energy Laboratories. Thanks to imaginative planning and hard work, the Japanese KEK (Ko Enerugi butsurigaku Kenkyusho) National Laboratory will soon become a new world focus for particle physics research.

KEK's original research programme was (and still is) based on a modest 12 GeV Proton Synchrotron which began regular operation in 1977. But even before this got underway, plans were being prepared for a big new machine which would push the Laboratory to the forefront of physics.

The TRISTAN Accumulation Ring with, right, the positron injection line, which should soon come into action.



A completed portion of the TRISTAN Main Ring. Note the roominess of the tunnel.



The TRISTAN project as initially proposed foresaw a variety of colliding beam options, hence the name 'TRi-ring Intersecting STorage Accelerators in Nippon'. Subsequent thinking focused on the electron-positron option, leaving other possibilities for the future. Hence the Tri-ring in the original name has been modified to 'Transposable Ring'.

For five years, KEK confined its attention to experiments with proton beams. Then in 1982, a 400 metre-long electron linac, the second longest in the world after the two-mile machine at Stanford, began pumping out 2.5 GeV electrons. Its initial job was to feed a storage ring for synchrotron radiation experiments, hence the name 'Photon Factory'. However the linac was destined to serve also as the injector for TRISTAN.

TRISTAN construction work is forging ahead fast. The 3 kilometre Main Ring tunnel is complete and installation work is progressing well. A 650 metre arc has been fitted out and Japanese hopes are high that first colliding beams will be achieved in the fall of next year. The stated energy goal of the 'site-filler' Main Ring is 30 GeV per beam. While initial performance might be below this figure, the machine could be pushed up to 40 GeV per beam.

While the Photon Factory quietly built up a multidisciplinary community (2000 synchrotron radiation users now), a 370 metre circumference ring, to accumulate the positrons and electrons prior to injection into the Main Ring, was built near the synchrotron radiation source. Upstream, a high current 200 MeV linac was installed to provide the positrons, providing one antiparticle per 700 electrons.

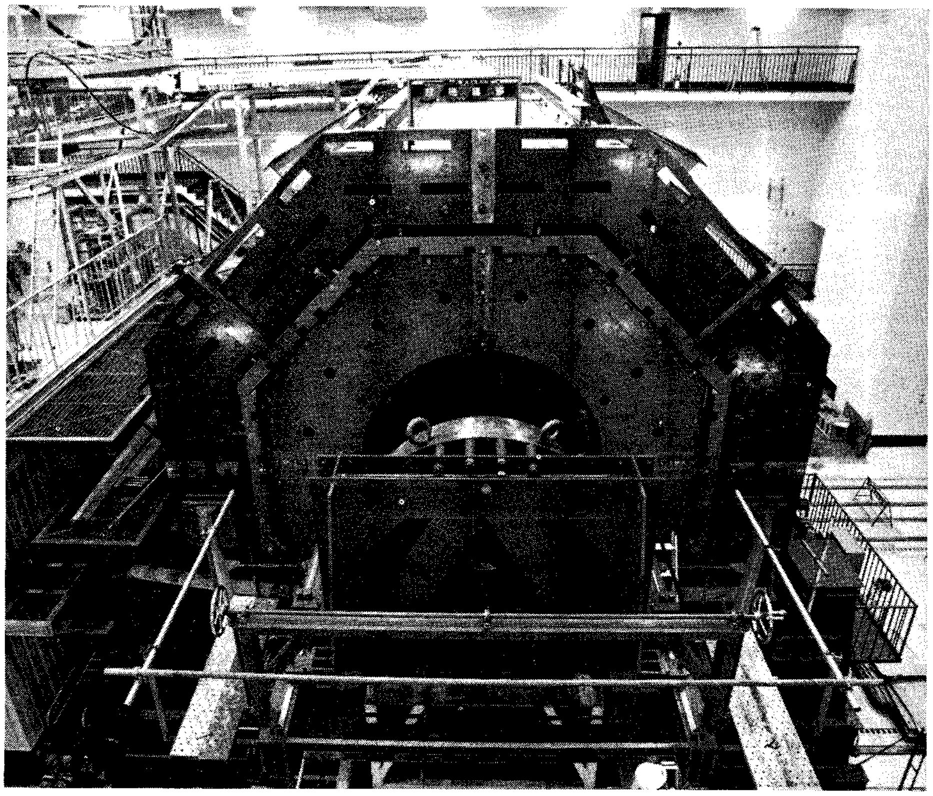
This year, positrons have run the full length of the linac, and it is hoped to have them soon circulating in the Accumulation Ring. The first electrons circulated in the Accumulation Ring in November 1983, but this year electrons have been extracted into the main ring injector line, hitting a temporary beam stop just before the first completed arc of the Main Ring.

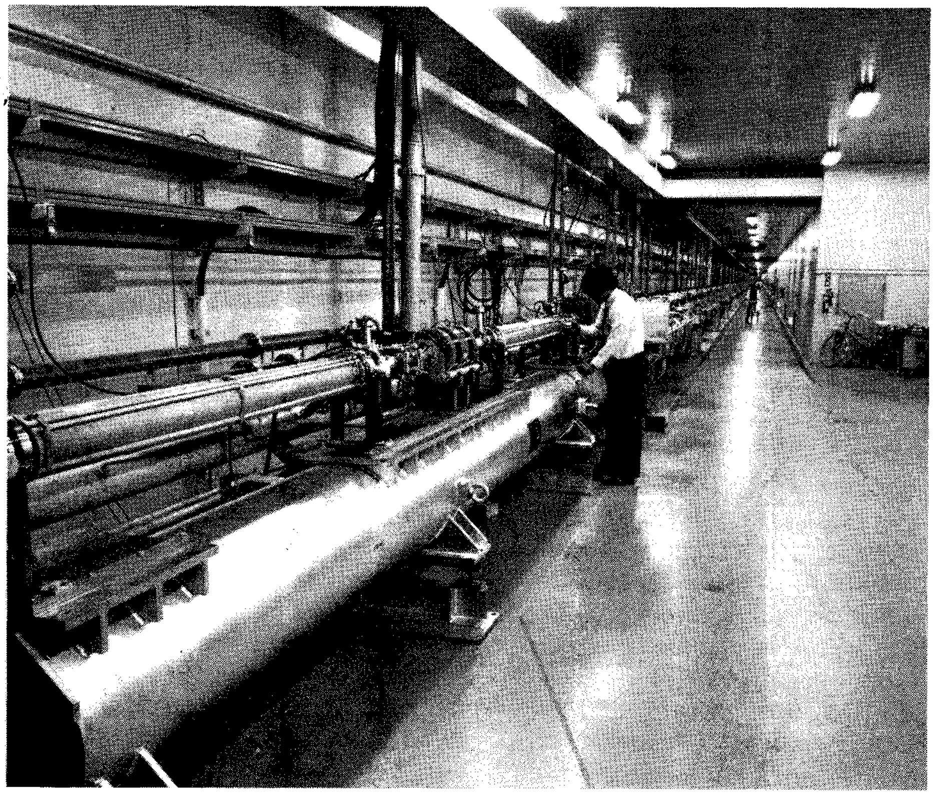
In the Accumulation Ring, the electrons and positrons will be taken from the 2.5 GeV level provided by the linac up to 8.5 GeV for injection into the Main Ring. The immediate aim is to complete the Main Ring and give the detectors their first taste of colliding beams, but with an eye to the future, the Accumulation Ring is equipped with two sizeable halls to house experiments to study electron-positron annihilations at 13 GeV collision energy. As yet no call for experimental proposals has been made. Synchrotron radiation applications are also foreseen for the Accumulation Ring.

The Main Ring will have four colliding beam areas. The two largest of these will house the all-Japanese TOPAZ and VENUS experiments (see January/February 1983 issue, page 3), while two smaller halls are nearing completion. One will be used initially for a particle search experiment (SHIP) by a Harvard team, while the other will be the home of an enthusiastic Japanese/US/Korea/China collaboration called AMY, using a compact but high resolution lepton detector. An article on AMY will feature in our next issue.

Meanwhile the components of the big VENUS and TOPAZ detectors continue to come together.

The superconducting magnet of the TOPAZ experiment for the TRISTAN electron-positron collider at the Japanese KEK Laboratory. Inside the magnet will be a Time Projection Chamber.





The Japanese approach is for the majority of the components for these detectors to be manufactured by industry, with of course constant close collaboration by Japanese physicists. Both industry and the physicists feel they benefit.

A key feature in the development work for TRISTAN is the use of superconducting cavities for radiofrequency acceleration. At KEK, a three-cell cavity installed in the Accumulation Ring has provided an accelerating field of 4.3 MV/m, which could yet rise higher. The original Main Ring design included only conventional r.f. equipment, but it is hoped to include five-cell superconducting cavities, even for 30 GeV working.

Although many people try hard, nobody can predict exactly what a new machine will find. But the TRISTAN community is optimistic that with an unexplored energy range for electron-positron collisions being opened up, and a luminosity (measure of the collision rate) of some 10^{31} cm^{-2} s^{-1}, there will be plenty of good things.

Meanwhile KEK's faithful 12 GeV Proton Synchrotron still has its hands full, with a full programme of experiments well underway again after a one-year interruption while the TRISTAN tunnel was being built. Some sterling work is being done on particle decays. One new customer is a Heidelberg group specializing in hypernuclei.

With a 12 GeV proton synchrotron already working and a 30 GeV electron ring nearing completion,

The 400 metre linac which supplies electrons for synchrotron radiation research at KEK and which will also serve as the TRISTAN injector.

(Photos KEK)

what of electron-proton collisions? TRISTAN Project Director Satoshi Ozaki points out that with HERA now being built at the German DESY Laboratory to supply 820 GeV protons and 30 GeV electrons, KEK prefers to leave this option alone for the moment.

But there is plenty of room at KEK for the options originally foreseen for TRISTAN. The large cross-section Main Ring tunnel is big enough to house a proton ring of several hundred GeV.

By Gordon Fraser

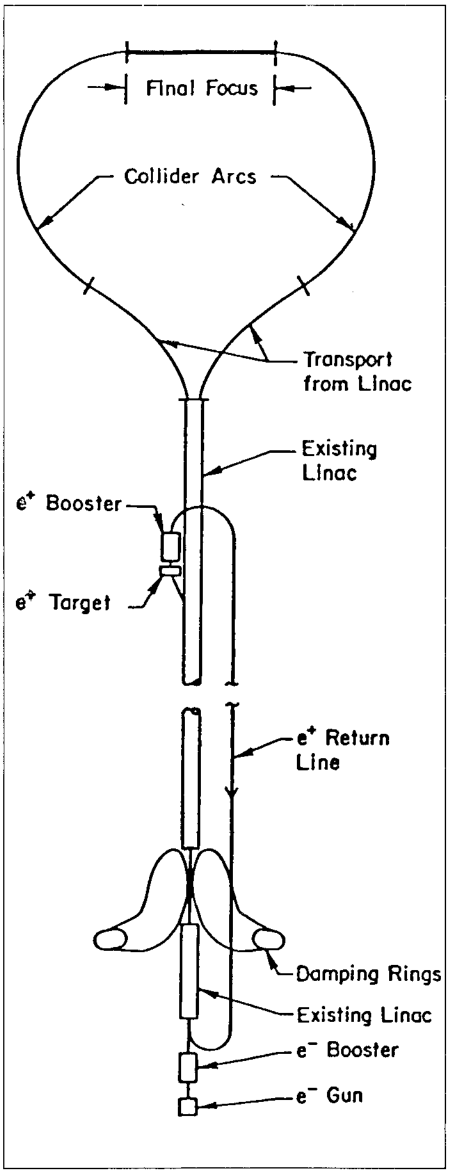
Stanford's Linear Collider

The peak of the construction phase of the Stanford Linear Collider, SLC, to achieve 50 GeV electron-positron collisions has now been passed. The work remains on schedule to attempt colliding beams, initially at comparatively low luminosity, early in 1987.

The tunnels are completed where the magnet arcs, which will guide the electron and positron bunches from the linac into collision, will be installed; construction of the hall for the experiment detectors is well advanced. Most effort during the summer months has been going into the refurbishing of the linac with new beam monitoring instrumentation and controls. Installation of all the more powerful (50 MW) klystrons may not be complete by early '87 but a full complement is not needed to reach 50 GeV. One of these klystron tubes was recently run to 110 MW without failure to test maximum available power. The required operating power of 50 MW therefore looks comfortable but there is not yet enough experience to be able to estimate the average lifetime of these new klystrons. In a SLAC/Japan collaboration, a tube to reach 130 MW has been developed.

By May of next year it is intended to start commissioning the linac systems (electron and positron bunch creation and acceleration). Already electron bunches of the desired intensity (5×10^{10} particles) and high quality have been achieved at the end of the first sector of the linac. The 'South Damping Ring' has stored 4×10^{10} particles in a single bunch but there are some problems with the magnet field quality and it has been decided to rebuild the South Ring. The North Damping Ring is due for completion in January of next year and the reconstructed South Ring should be ready a month later.

The commissioning schedule aims to achieve beams of the required quality at the end of the linac, ready to be fed to the SLC magnet arcs, by October 1986. The subsequent three months to the end of next year would then be available for the tricky man-



Schematic of the Stanford Linear Collider, SLC. The upgraded electron linac of the Stanford Linear Accelerator Centre will produce positron beams which will be brought back for acceleration through the linac. Pulses of electrons and positrons will be moulded to high quality in the damping rings, accelerated along the linac to 50 GeV, sent through opposing arcs and collided. The construction and commissioning schedule aims for colliding beams in February 1987.

oeuvres attempting to bring the micron size beams into collision. The Mark II detector will be installed at the SLC in January 1987 to begin physics the following month, if all goes well.

The initial luminosity is not expected to exceed 5×10^{28} per cm^2 per s, which is 1 % of the ultimate design aim. Nevertheless, even at this level, Mark II could see some twenty thousand Z^0 events in the five month physics run planned until June '87. By 1989 it is hoped that the design luminosity of 6×10^{30} will be reached but the SLC physics potential could then be swamped by the advent of LEP at CERN. One advantage that the SLC programme could retain is that polarized beams may be available for acceleration by the time LEP comes on – it is hoped to start the development programme to implement polarized beams during the next year.

By 1989 also (if construction funds are assured) the Stanford Linear Detector, now being built by a collaboration of some 120 physicists, could be ready to take over from Mark II with more sophisticated detection techniques. It has been designed for 98 % of the solid angle around the collision region with identical instrumentation in all directions. The SLD will have a CCD charge coupled device (see June 1982 issue, page 179) vertex detector. This is feasible because of the very small beam pipe at the collision point and because of the pulsed nature of SLC operation which will give enough time to clear the CCDs before the next collision pulses arrive. This vertex detector should be capable of 5 micron resolution in three dimensions. Drift chambers form the next layer of the detector and recent tests have achieved a spatial resolution twice as good as anticipated. This has been a satisfying development since the better resolution will compensate for the decision to change from a superconducting to a conventional detector magnet (giving a 0.6 T field in the detector central volume), restoring the detector resolution announced in the design proposal.

The next layer is Cherenkov ring imaging detector (CRID or RICH in CERN parlance), followed by liquid argon calorimeters, the magnet coil and muon detectors. The hope is that the SLD will be ready to have a first spell in the beams early in 1989 for 'shakedown' and will share time on the SLC with the Mark II detector for some six months before taking over completely. For this reason as many services (cryogenics, electronics, etc.) as possible are being built onto the detector itself so that the SLD can roll in and out of the beams with ease.

With the higher energy collider on the horizon there is obvious concern for the future physics programme of the existing 15 GeV PEP electron-positron storage ring. A Workshop was held to define areas of interesting physics with a higher PEP luminosity and as a result the Laboratory has decided to go ahead with an improvement programme for PEP known as 'Mini-Beta'. Just how this would be implemented depends on the experiments which are proposed and for this reason a call for 'letters of intent' was circulated to the physics community in June. It seems likely that the collaboration now working on PEP with the 'Time Projection Chamber' will propose experiments. The TPC took longer than expected to bring into action but it is now working well – in fact so well that other collaborations may not be eager to be in competition on the upgraded PEP.

Beyond this stage there are thoughts about using PEP as a synchrotron radiation source in the venerable tradition established by its predecessor, the SPEAR electron-positron storage ring. An undulator has already been installed in one of the PEP straight sections to extend research with light beams to the sub-angstrom range. Undulators, as opposed to 'wigglers' which the Stanford Synchrotron Radiation Laboratory, SSRL, launched on the world (and of which their latest 54 pole version is so intense that it could be used as a welding torch!), have only a narrow wavelength tuning range. The PEP version has therefore been made as a 'multi-undulator' so that wavelengths can be switched. A second synchrotron light installation on PEP is being planned. It may be that the use of PEP for synchrotron radiation will be extended to some 25 per cent of operating time by 1987.

The SSRL is now studying how effective PEP could be as a synchrotron radiation source when PEP particle physics fades in importance. They are also participating in the various studies going on in several Laboratories in the US to design a 6 GeV dedicated synchrotron radiation source.

By Brian Southworth

From heavy ions to light sources at Brookhaven

The Brookhaven National Laboratory, recovered from the debacle of the cancelled CBA proton-proton collider project, is now more than busy with an excellent physics programme at the 33 GeV Alternating Gradient Synchrotron and with solid projects for the years to come.

AGS physics

With the CERN 28 GeV PS so occupied as injector for higher energy machines, the AGS almost has the field to itself in an energy range where several key experiments can still be done. The first batch of these cover rare kaon decays and four experiments are lined up to push the limits on these measurements down by several orders of magnitude.

Two (Brookhaven/Yale and Los Angeles/Argonne/Pennsylvania/Princeton/Stanford/Temple/William and Mary) are being prepared to look for the decay of the long-lived neutral kaon into a muon and an electron, which has been measured down to a branching ratio level of around 10^{-8}. The decay would be a violation of the 'Standard Model', but is predicted in several theoretical approaches where lepton types can mix.

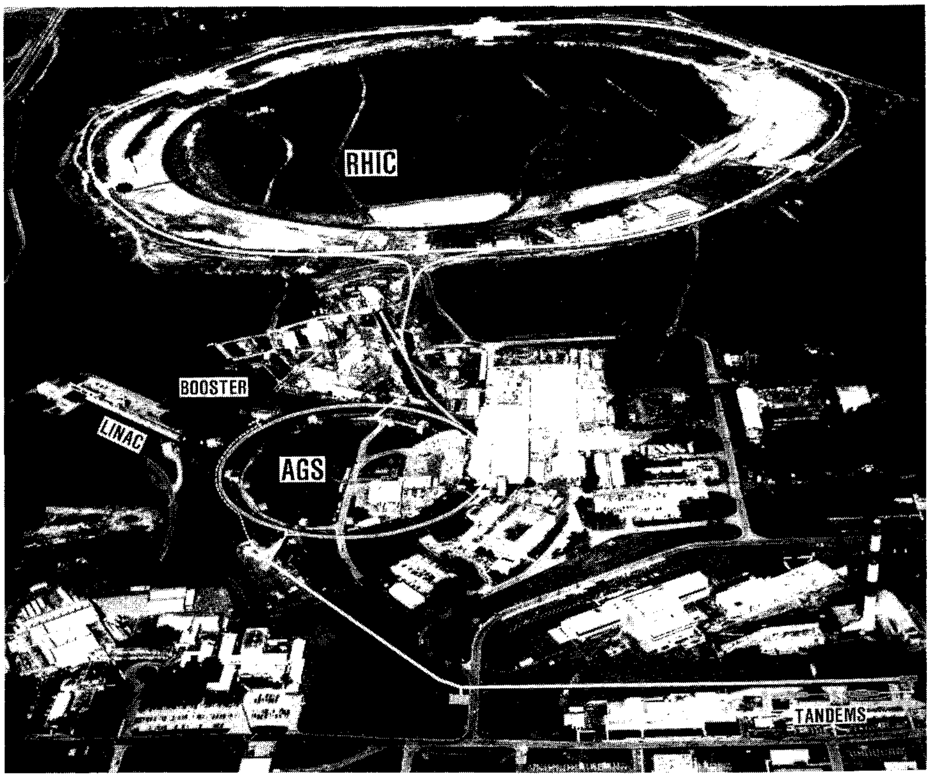
If the decay does occur it should be easy to identify though great care will be needed to eliminate events in which the muon comes from pion decay. (Maurice Goldhaber says – 'as in social life, the most important thing about a candidate is his background'.) One of the experiments hopes to reach a branching ratio level of 10^{-12}. Such precise measurements are equivalent to probing interactions mediated by the exchange of particles weighing hundreds of TeV, so that a lot of ground is being covered where new physics could turn up.

The experiments will obviously look for other leptonic decays using photon identification as well. Some of these decays are predicted by the Standard Model to occur with very low rates, and will provide refined checks.

A third experiment, by a Brookhaven/Yale/Washington/SIN (Switzerland) group, has commenced a study of the decay of the positive kaon into pion, muon and electron with a sensitivity better than 10^{-11}. This could probe new couplings which are not found in the neutral kaon sector.

A fourth experiment (Brookhaven/Carnegie-Mellon/Columbia/Princeton/TRIUMF) will use stopped positive kaons and look for their decay into a positive pion and two neutrinos. Again the hope is to push the measurement limits out by several more orders of magnitude and to search for light neutral particles.

An important experiment (Brookhaven/Columbia/Illinois/Johns Hopkins/NRL), looking for neutrino oscillations, is just beginning to take data in a search for muon-type neutrino conversions into electron-type neutrinos or for muon-neutrino disappearance. There are two detectors, one some 300 m from the target and the other a kilometre away in the middle of the (empty) CBA ring. Inter-



The changing face of Brookhaven. At the bottom is drawn the path of the heavy ion transfer line linking the tandem Van der Graaff with the Alternating Gradient Synchrotron. Construction of the tunnel is nearing completion. On the left is the proposed booster which should do several good things for the AGS physics programme. In the background is the CBA collider ring in its new guise as the RHIC relativistic heavy ion collider – the major new Brookhaven project.

est in these measurements follows hints by an Athens/CERN/Paris experiment at the CERN PS. This is being transported to Brookhaven to look (from early next year) to see if American neutrinos behave like European ones, gathering some twenty times its present statistics in the process.

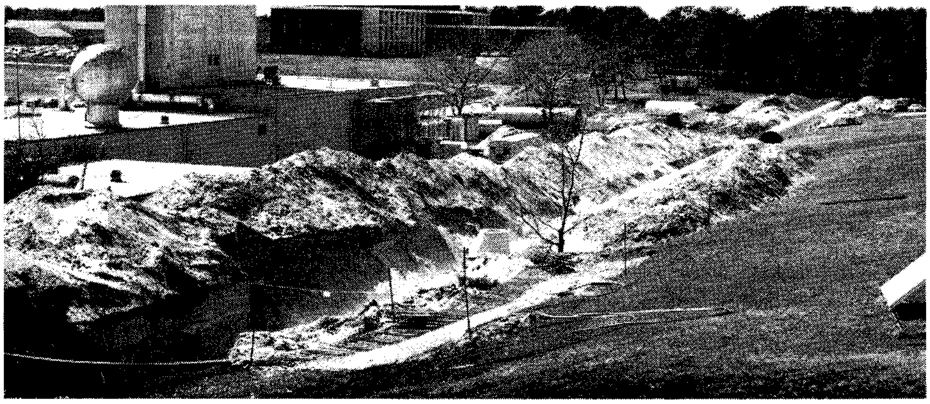
Special features of the AGS physics programme come from the currently available high energy polarized protons and a soon-to-be-available range of heavy ions at energies beyond those provided by the Berkeley Bevalac. Construction of the transfer tunnel to bring these ions to the AGS from the neighbouring Van der Graaff is virtually complete and magnets have started to arrive. This link will allow fully stripped ions (up to sulphur) to be injected into the AGS and experiments are scheduled to begin in about a year. At present, the polarized proton runs are 'expensive' in that beam intensities will not allow many experiments to take data simultaneously. Also higher beam intensities are needed to get sufficient data with high momentum transfers, where surprising spin-dependent effects were seen in experiments at the old Argonne ZGS.

Future projects

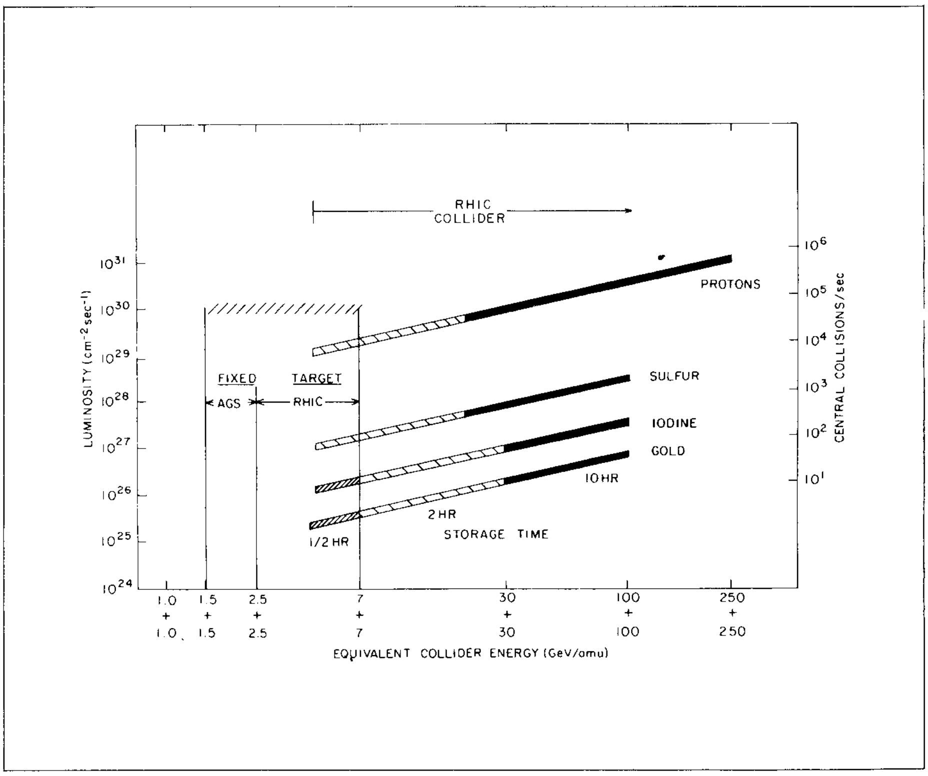
The AGS horizons will broaden with the construction of a rapid cycling booster synchrotron capable of taking the 200 MeV beam from the linac and accelerating it up to 2.5 GeV prior to injection into the AGS (limited to 1 GeV injection for protons). The first construction money for this booster should soon be authorized. There are several aims – the present high energy physics programme (such as the experiments described above) would benefit greatly from more protons. The booster should take the AGS intensity from around 1.5×10^{13} protons per pulse (record 1.65×10^{13}) to around 6×10^{13}. In addition, using the booster as an accumulator, the polarized proton beam intensities could be increased by a factor of over twenty. Combined with ion source improvements, this should give polarized beams in the mA range so that a normal user programme could be run with protons or with polarized particles, which would no longer be 'expensive'. Finally, the additional energy prior to injection into the AGS will make it possible to fully strip heavier ion species, beyond the present limit of sulphur, the heaviest species which can be fully stripped at the energies available from the tandem. (Acceleration of adequate beam intensities in the comparatively modest vacuum of the AGS requires fully stripped ions.)

While the booster is the most important step in improving AGS performance, there is also a detailed programme of other improvements and component consolidation. (Like the CERN PS, the machine is badly in need of care and attention after twenty-five years of operation.) Injection systems, ion sources, radio-frequency quadrupole, modernization of the computer control system, vacuum system refurbishing, power supply upgrade, etc., are all planned.

Authorization of the booster construction would be another step in the direction of the relativistic heavy ion collider, RHIC, which would aim to study the behaviour of nuclear matter at temperatures and densities never accessible before. RHIC would be installed in the tunnel already built for the abandoned CBA. A project proposal was put to the Department of Energy a year ago, aiming for energies of 100 GeV per nucleon (gold ions) which corresponds to fields of 3.5 T in the bending magnets of the two collider rings. Research and development work has started, particularly on the superconducting magnets and higher fields (4.5 T) than those cited in the design look feasible. Two 4.5 m prototype magnets have already been tested successfully; the second involved Fermilab for coil winding, DESY for fitting collars and Brown Boveri for the ion laminations. (Brookhaven and DESY will also collaborate on the magnets for the HERA electron-proton collider at DESY.) Next year the construction and testing of a string of four 9.7 m RHIC magnets is scheduled.



A view from the Brookhaven tandem Van der Graaff building showing construction of the tunnel for the heavy ion transfer line linking the tandem with the Alternating Gradient Synchrotron.



The heavy ion future at Brookhaven. To the left are the energy ranges which will be studied by the heavy ion injections into the AGS (ions up to sulphur). Completion of the booster would extend the range of ions up to gold. With RHIC the energy range goes dramatically higher. At high luminosity, and with heavy ion collisions giving thousands of secondary particles, detectors could have their work cut out.

Brookhaven is taking care to keep the evolution of the RHIC project in line with the desires of the nuclear physics community. A workshop in the spring of this year developed conceptual designs for four detectors each specializing in some particular feature of the collisions (large aperture spectrometer, calorimeter, muon detector, narrow angle detector) which could occupy four of the six intersection regions of the RHIC rings. The detectors have difficult problems to handle because of the expected high multiplicities (some 5000 secondary particles per collision).

RHIC is not the only project using the developed expertise at Brookhaven on superconducting magnets. The Laboratory is a major centre for the preparatory work on the US 20 TeV Superconducting Super Collider, SSC. Together with Berkeley and Fermilab, Brookhaven is concentrating on the higher field/smaller radius version of the SSC (while the Texas Accelerator Center works on the lower field/larger radius version). Later this year six 4.5 m model magnets should be built and tested; the first of them has already reached 6.5 T, just above the design level of 6.3 T. Work has started on a prototype full-length 16 m magnet and a string of six is scheduled for testing next summer.

Brookhaven is one of the Laboratories where thinking has already turned to the era beyond the SSC when new acceleration techniques will be needed. Pushed by Bob Palmer, a continual innovator, a modest effort has begun which it is hoped might involve some thirty people in a few years. Working backwards from the beam parameters in such accelerators, the effort is concentrating on the problems of providing appropriate power sources where photodiode switching and solid state switching using laser light look promising for providing power in the millimetre wavelength region. Micro-machining skills at Brookhaven also raise hopes for a 'conventional' accelerating cavity structure. Perhaps the most important aspect of these investigations is that thinking and working on accelerator devices for the next century is becoming respectable.

Light Source

To conclude this brief summary of Brookhaven's programme we turn away from high energy physics to report on progress at the National Synchrotron Light Source, where two electron rings – a 750 MeV vacuum ultraviolet ring and a 2.5 GeV X-ray ring – are now in reliable operation for synchrotron radiation experiments, each using some 25 beamlines. Like most synchrotron radiation facilities, the NSLS was plagued with start-up problems, but these have largely been overcome and the facility has moved into the front line of this research.

The VUV ring can be run in one to nine bunch modes with as much current as 720 mA in the single bunch mode. The Ken Green/Rena Chasman design, aiming for high beam brightness, has paid off, and measured beam parameters are well up to expectations. The major limitation comes, as usual, from ion trapping, and improvements aim to achieve a better vacuum by installing new pumps and better vacuum instrumentation.

Two straight sections will be fitted, one with a wiggler (0.85 T field) and the other with an undulator (6.5 cm wavelength) and the X-ray ring will have four additional straight section insertions – a superconducting wiggler (5 T field), two hybrid wigglers (1 T field), and an undulator (8 cm wavelength). These NSLS extensions are part of a funded 'Phase II' upgrade which also includes urgently required square metres to relieve the congestion in the experimental areas and to provide more office and laboratory space.

This reflects the explosion in the exploitation of synchrotron radiation for experiments and for practical applications over a wide range of areas. It is one of the most fruitful areas of 'spin-off' of the accelerator technology developed for particle physics.

Focus on focusing

The discovery and impact of the principle of strong focusing was celebrated at a history Symposium at Stanford on 25 July in the course of the 1985 US Summer School on Particle Accelerators. Burt Richter, Stanford Linac Director, who introduced all the speakers with well chosen reminders about their various contributions related to the theme of the symposium, remarked that it was an appropriate time to be lauding the great contributions of accelerator physicists following the Nobel Prize award to Simon van der Meer for outstanding achievements in accelerator physics.

Donald Kerst was the first speaker reviewing the years prior to the discovery of strong focusing when, motivated by the urge to reach higher energies and to handle particle beams more effectively, a long list of scientists helped increase knowledge of beam behaviour and of what magnetic fields do to beams. Vital steps en route to our present machines were the discovery of the cyclotron principle around 1930 (E. O. Lawrence and S. Livingston) and the discovery of phase focusing in 1945 (E. McMillan and V. I. Veksler).

An album shot of Stan Livingston, architect of the strong focusing technique.

In cyclotrons, the particle beams were kept focused fortuitously by the shape of the magnetic fields at the edges of the magnets in which they orbited. The effect was used more conscientiously in the weak focusing synchrotrons, like the 3 GeV Cosmotron built at Brookhaven in the early 1950s, by contouring the polefaces of the ring magnets. This was the state of the art in the summer of 1952; Stanley Livingston and Ernest Courant described the days of the discovery of strong focusing which then followed.

Stan Livingston had gone to Brookhaven to do physics on the 3 GeV Cosmotron and found himself working on ideas to improve the design of the weak focusing Cosmotron magnets. An additional spur was the imminent arrival of a delegation from the embryonic CERN (Odd Dahl, Rolf Wideroe, Edouard Regenstreif and Frank Goward) who were looking for ideas for the design of the projected CERN 10 GeV proton accelerator. He thought of switching the orientation of the C-shaped magnets around so that their gap faced alternately towards the inside and then towards the outside of the accelerator ring. The anticipated problem was that the focusing fields, since they would now be alternately focusing and defocusing in a particular plane of the beam, would no longer hold the beam confined.

Ernie Courant had been working on the Cosmotron straight sections and knew the mathematics to apply to the tricks Stan Livingston was trying to do. To their surprise, successive calculations with progressively stronger focusing/defocusing effects showed that, rather than being destroyed, the focusing was increased. Hartland Snyder added his contribution by generalizing the work and showing that alternating gradients gave a stable dynamic situation. What was happening was similar to sending a beam of light through a series of equal strength concave and convex lenses – the focusing effects of the concave lenses operate more powerfully than the defocusing effects of the convex lenses.

Strong focusing was born. The European delegation was first to realize the implications and rushed back to upgrade their planned accelerator to become the CERN 28 GeV proton synchrotron. Brookhaven soon followed with their proposal for the 33 GeV alternating gradient synchrotron. All the high energy accelerators from then on have had strong focusing built in.

The essence of the strong focusing idea had already been worked out independently by Nick Christofilos in a paper which was then unknown in the accelerator Laboratories (see July/August issue, page 234). In some ways, this was an even greater intellectual achievement because he was working without the immediate spur of practical problems and the interplay of ideas with his colleagues.

The first one on the ball (and not for the last time) was Robert Wilson. Bob Wilson at that time was working on a 1 GeV electron synchrotron at Cornell; he converted the design at high speed and proved the strong focusing principle in practice. He spoke at the Symposium about the big synchrotrons, a task he was eminently qualified to do since he has been a leader in the field from that electron machine through to the Fermilab Tevatron. (He also recounted his vital contribution to Ed McMillan's paper on phase stability. They were both working at Los Alamos at the time and Ed dreaded the censor's delays on getting his work through for publication to Physics Review. Bob Wilson took the paper off-site and dropped it in a mail box!)

The strong focusing principle did not only open the door to higher energy fixed target machines, it also made the era of the particle colliders possible. Fernando Amman (for leptons) and Kjell Johnsen (for hadrons) described these impacts. Fernando Amman led construction of the Adone electron-positron machine at Frascati where an adventurous leap to a 1.5 GeV machine was taken from the tentative work on AdA in 1961. He paid tribute to the contributions of Bruno Touschek and he also made the thought-provoking remark, 'If one is required to make progress, one must be allowed to make mistakes.' Kjell Johnsen led construction of the CERN ISR proton-proton Intersecting Storage Rings, perhaps the most perfect particle beam machine yet constructed. He recalled some of the staggering achievements – beam currents up to 58 A, luminosities to 1.4×10^{32}, beam-lifetimes up to 345 hours, average vacuum of 3×10^{-12} torr, etc. He compared lepton and hadron machines to cats and dogs respectively; the lepton machines somehow have their individual personalities and there isn't much we can do about them but the hadron machines if handled carefully will do whatever we want.

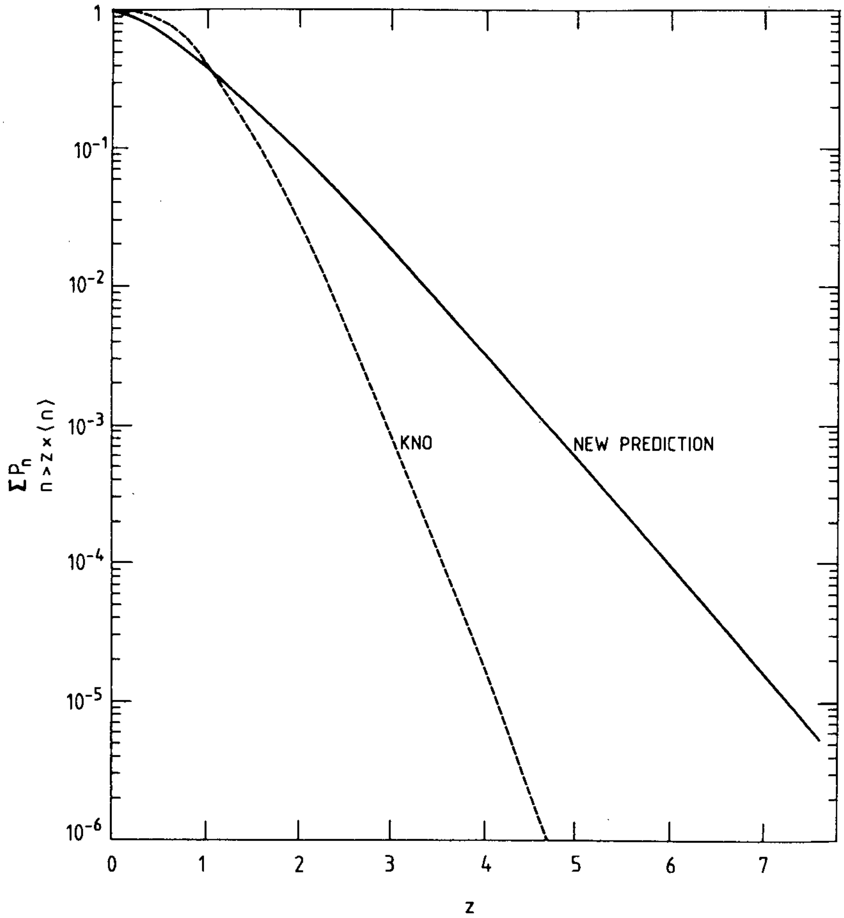
Finally Nicola Cabibbo and Norman Ramsey covered aspects of the early project decisions on either side of the Atlantic. Norman picked out development in accelerator technology, like the strong focusing principle, as criterion number one to urge on favourable decisions for new projects. He also picked out another criterion which perhaps deserves particular attention on both sides of the Atlantic in the present situation – 'the projects need excellent and enthusiastic proponents.'

The Symposium moved into a celebratory phase in the evening with a 'luau', traditional Hawaiian feast, which included a performance by Polynesian dancers at which the accelerator specialists were able to continue indulging their interest in coupled motion in several dimensions.

An awards ceremony followed with Burt Richter as Master of Ceremonies and Matt Sands, distinguished accelerator physicist from Santa Cruz, giving the keynote address. Honorary awards were made to Courant, Livingston and Wilson for their roles in the strong focusing discovery and proof of principle. Finally, prizes for achievements in accelerator physics were presented to Helen Edwards of Fermilab (in absentia) 'for essential contributions in making the world's first superconducting synchrotron a reality' and to John Madey of Stanford 'for the invention and demonstration of the free electron laser.'

Around the Laboratories

A glimpse of what could happen at 40 TeV – collision energies which could be reached in the proposed US Superconducting Super Collider (SSC). This shows the probability (at 40 TeV) of seeing at least z times the average number of secondary charged particles according to the old (KNO) picture, and the prediction based on the new distribution measured by the UA5 experiment at the CERN Collider. The probabilities for seeing larger numbers of secondaries increase by several orders of magnitude.



CERN
Scale model

One of the major initial objectives of the experiments at CERN's unique proton-antiproton Collider at the SPS was to survey the general behaviour of particle interactions in the new energy range opened up by having particle beams of hundreds of GeV crashing head-on into each other, and to see if it corresponded to what is seen at lower energies.

In the late 1960s, experiments were searching for the deep inner structure of the proton. If an incoming beam could penetrate deep enough inside a proton and interact with hard constituent grains ('partons'), then the description of the observed behaviour could be simplified to depend only on kinematical variables and on the distribution of the partons inside the nucleons. With these 'scaling' ideas, once behaviour under one set of conditions had been observed, then what happens elsewhere could be predicted by rescaling according to the kinematics.

At the big Stanford linac, 20 GeV electron-proton scattering experiments showed this behaviour, demonstrating for the first time that the deep interior of the proton was being probed.

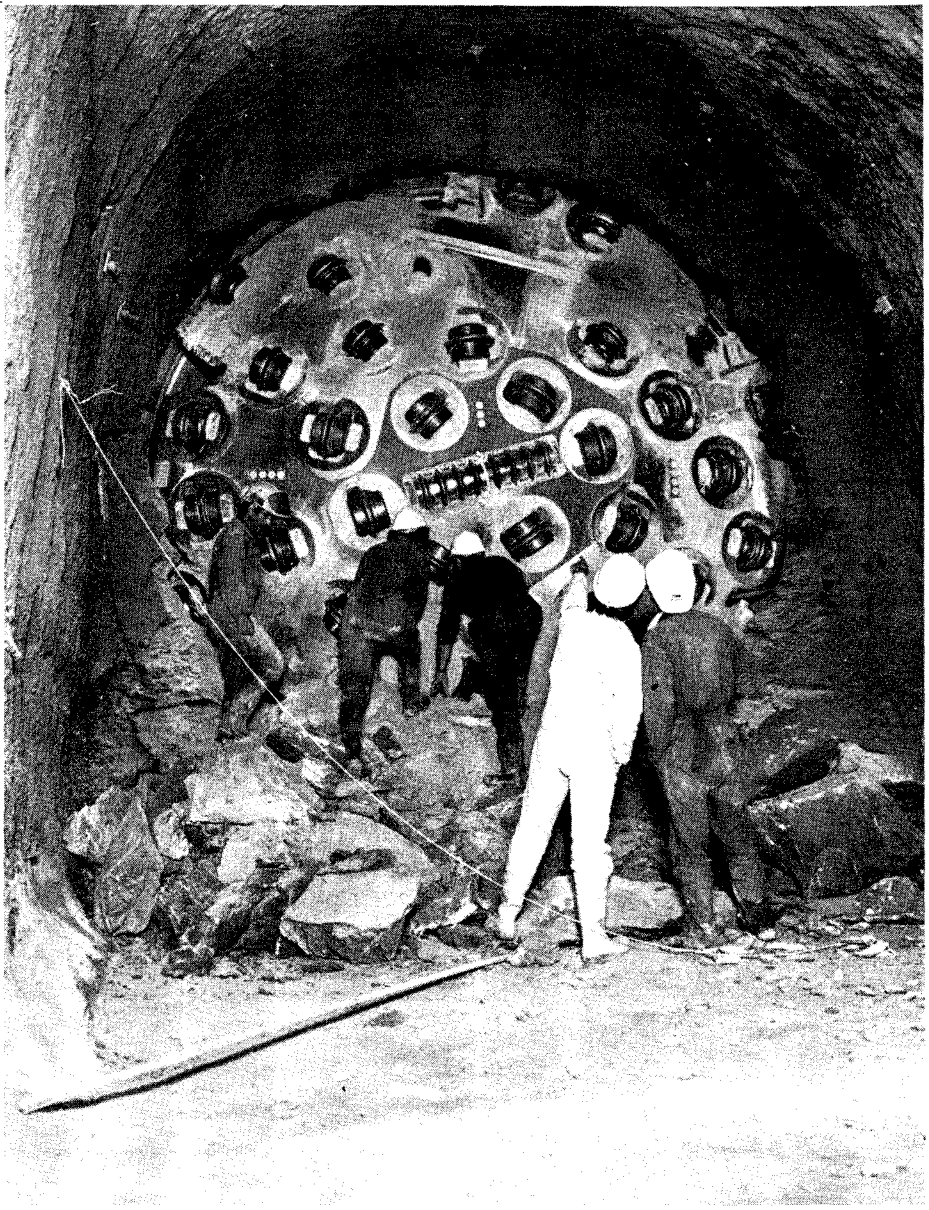
Extensions of this scaling idea were formulated, and in 1972 Z. Koba, H. B. Nielsen and P. Olesen predicted that the number of charged particles produced (multiplicity) in high energy hadron collisions should follow a simple rule – the so-called KNO scaling. Surveys of particle multiplicities at the highest hadron energies available showed that KNO scaling seemed to fit.

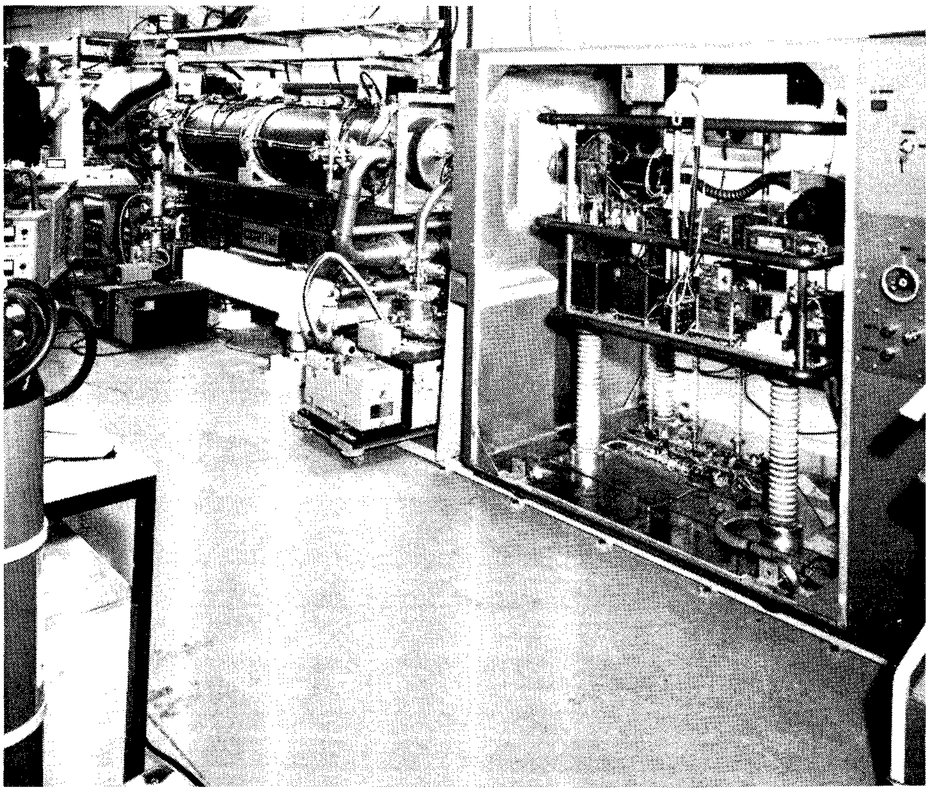
However in the meantime further experiments using a variety of particle beams showed that the original scaling as seen at Stanford was only approximate. This was no surprise, as after all the arguments supporting scaling were only a first approximation to the complexities of nucleon constituent scattering. The subtle 'scaling violations' seen in these subsequent experiments gave useful clues to what happens deep inside nucleons.

In 1981, the CERN proton-antiproton Collider came into operation and opened up a new energy horizon. The first experiment to take data was the UA5 collaboration (Bonn/Brussels/Cambridge/CERN/Stockholm) using two 7.5 metre streamer chambers above and below the interaction region to record the tracks emerging from

At CERN, work for the new LEP electron-positron collider pushes steadily forward. On 26 July, the first tunnelling machine broke through into the vertical shaft at Point 2 after having started its journey at Point 1, thus completing one-eighth of the 27-kilometre tunnel. Meanwhile (below) the first electron gun to provide LEP's particles has been installed in the new injector building.

(Photos CERN 471.7.85 and 60.5.85)





the collisions, initially at a total energy of 540 GeV. In 1984 this collision energy was increased to 630 GeV, and in a run earlier this year to 900 GeV (see May issue, page 131). Charged particle multiplicities of a hundred or more are efficiently recorded.

The UA5 team finds particle multiplicities to be well described by a two-parameter (negative binomial) distribution, resembling that used for counting photons (generalized Bose-Einstein statistics). One parameter is the average multiplicity (which obviously varies with energy), while the second comes from statistical mechanics and is a measure of the number of independent quantum states available. This distribution covers the full energy range, from fixed target experiments right up to the 900 GeV collision energies recorded earlier this year.

The second parameter of the multiplicity distribution varies with energy in a very simple and unexpected way – depending inversely on the logarithm of the energy. KNO scaling on the other hand would require this parameter to be constant. Looking back at the empirical multiplicity distributions measured in the collision energy range from about 10 to 60 GeV, the approximate scaling which showed up is now seen to be fortuitous rather than reflecting some aspect of particle behaviour.

The new distribution suggests that at higher energies, still wider ranges of multiplicities can be expected. These are already being seen by UA5 in the 900 GeV data from the CERN Collider, and would lead to striking effects at the 20 TeV Superconducting Super Collider (SSC) being proposed in the US.

MEDDLE in business

The four big experiments currently being prepared for CERN's new LEP electron-positron collider have to face up to the technology explosion in the areas of data handling and communications.

Because of their sheer size, the dimensions of LEP itself (a ring 27 km in circumference) and the highly international makeup of the participating teams, these experiments encounter special problems, which are moreover not alleviated by increasing manpower and financial restrictions.

To coordinate the computing and related requirements for LEP experiments, a CERN committee has been set up, named 'MEDDLE' after a highly contrived acronym. It is comprised of two people from each of the four LEP experiments, plus the leaders of the support groups involved at CERN, and other interested parties, including Ian Butterworth, CERN Director responsible for both LEP experiments and for the Laboratory's computing, and Data Handling Division Leader Paolo Zanella, who is chairman of the committee.

In his introduction, Ian Butterworth said that one major function of MEDDLE will be information exchange, with the experiments presenting their needs for computing and related services, and the support groups presenting the workplans that they feel they can sustain given the money and manpower constraints. However, he hopes that MEDDLE will also be powerful and representative enough to set priorities and allocate resources, especially in the area of setting up collaborative projects. He emphasised that in the present situation of limited budgets and manpower, the choices facing MEDDLE may be rather brutal.

The new committee has no shortage of business to discuss, and no less than 27 topics having been brought up by at least one LEP experiment. A series of whole day meetings have been scheduled to deal with groups of related topics such as networks; general topics and support for computers, workstations and terminals; offline; online, etc. Other topics, including compiler problems and the cost of cooled Fastbus electronics, have been deemed urgent.

To coordinate European inter-Laboratory computing, a Computing Coordination Committee, with members from major European national Laboratories and research centres, was set up last year (see April 1984 issue, page 102).

DESY
The birth of H1 and ZEUS

Two formal letters of intent for experiments at the HERA proton-electron collider were aired in an all-day meeting at the Germany DESY Laboratory in Hamburg on 11 July. The new collaborations, H1 and ZEUS, include about 400 physicists from 65 institutes in 11 countries. The experiments should be ready to take data at the beginning of 1990, – but installation will of course start much earlier.

Recommendations on these letters of intent are expected to be made by the DESY Physics Research Committee (PRC) before the end of the year. After technical clarifications, a decision will be taken by the middle of next year.

The 'letters' are in fact rather detailed papers, each about 90 pages, including a lot of preliminary information on the ideas of the two groups. It is certainly premature to go into the details of these two devices. As initially presented, both include a superconducting solenoid, providing a longitudinal magnetic field for transverse momentum measurements in a central jet-type tracking device. Both detectors include big electromagnetic and hadronic calorimeters, as well as muon chambers, covering most of the solid angle. They both have an iron toroid for muons in the forward direction. However the two designs are quite different, reflecting the technological background of the collaborating groups. H1 uses a liquid argon calorimeter while ZEUS prefers scintillator readout.

The DESY meeting showed the remarkable international interest in the HERA project. In addition to 120 physicists from West Germany, the collaborations include 54 from the United Kingdom, 48 from the US, 25 each from Canada and France, 21 from Poland, 10 from the Netherlands, 5 from Israel, 4 from Switzerland, 2 from Spain, and no less than 82 from Italy.

While Italy has been involved from the beginning in the construction of HERA and now continues for the experiments, the level of British participation is also worth noting. The investment required for each of the two new detectors will amount to about 100 million DM, the major part of which will have to come from outside Germany.

Meanwhile the first section of the HERA tunnel has been cut (see photo on next page).

Herakles round the bend! The Herakles boring machine for the tunnel of the HERA electron-proton collider at the German DESY Laboratory has disappeared round the first curve of the 6.3 kilometre ring.

WORKSHOP
Soviet spin

A recent workshop on spin physics held at Serpukhov, Moscow region, provided a broad picture of spin physics results. Many of these had also been covered in last year's Marseille International Spin Physics Symposium (see January/February issue, page 5), but the Serpukhov meeting also highlighted the impressive amount of spin physics carried out at research institutes in the USSR.

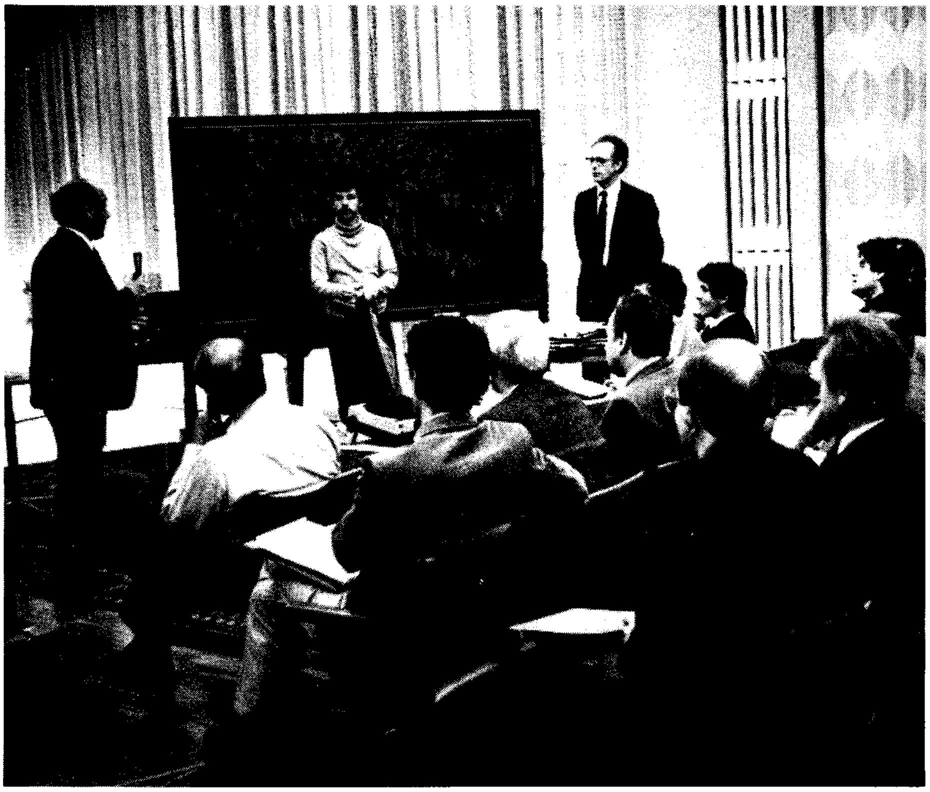
The Serpukhov Institute for High Energy Physics has amassed a sizeable amount of data on spin effects in quasi-elastic scattering using 40 GeV negative pion beams on polarized proton targets, covering a range of two-body final states.

At the 10 GeV machine at the Joint Institute for Nuclear Research, Dubna, polarized (spin oriented) beams of protons and deuterons have been obtained and experiments should soon begin.

Other interesting studies are underway at the 7 GeV machine at Moscow's Institute for Theoretical and Experimental Physics, at Gatchina (Leningrad), and at Kharkov.

Next September, the seventh International Symposium on High Energy Spin Physics will be held in Serpukhov and will provide a focus for progress in the interesting but frequently overlooked field of spin physics.

From S. Nurushev, V. Solovianov and A. Vasiliev.



Discussion session at the recent Serpukhov spin physics workshop.

People and things

COMPUTERS
Physics data at your fingertips

For many years all well-informed high energy physicists have carried around the famous Particle Data Booklet packed with vital physics information. This indispensable pocket 'database' produced by the Particle Data Group at Berkeley is now just one of several databases of high energy physics compiled by international groups, which are readily accessible to an increasing number of physicists.

The modern way to provide up-to-date information rapidly and efficiently is through the computer and with the growth of networks in Europe and the US it is possible for users at many universities and Laboratories (including CERN) to get the data they require from their own terminal.

The initiative to compile computer databases of high energy physics reactions was taken over ten years ago at Durham University (UK), in conjunction with the group at Berkeley. This project has now grown to involve also physicists at CERN, DESY, and Serpukhov. These reaction data bases contain information on scattering distributions and structure functions from a wide range of particle physics experiments, e.g. hadronic two-body, inclusive hadronic, and inclusive lepton scattering, as well as electron-positron processes. This information, together with the more familiar data on particle properties and experimental details and proposals, resides on the central computers at the Rutherford Appleton Laboratory and SLAC (Stanford). Implementation is also underway so that the data can be retrieved directly from the new CERN CMS system. Users at institutes which can access these machines either directly, or through networks, can quickly obtain detailed information on a host of particle physics data.

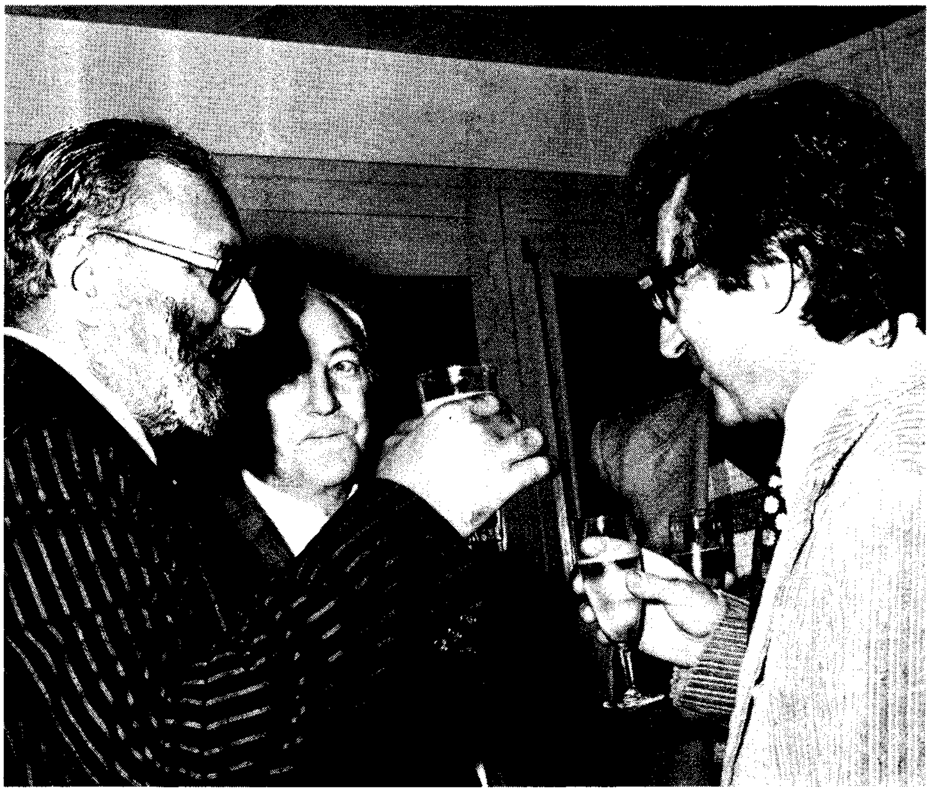
Like all 'user-friendly' systems, on-line 'HELP' is available to guide the unfamiliar user. However printed guides, and more information on the database (HEPDATA) can be obtained from Mike Whalley, Physics Dept, Durham University, DH1 3LE, UK.

On hearing the news that he was to share the 1979 Nobel Physics Prize with Sheldon Glashow and Steven Weinberg for their unification of the electromagnetic and weak forces, Abdus Salam (left) rushed to CERN to toast Paul Musset of the Gargamelle collaboration which had discovered the neutral current in 1973, showing that the new theory was on the right path. On 4 September this year, Musset was killed in a mountaineering accident.

(Photo CERN 396.10.79)

Paul Musset 1933–1985

On 4 September, Paul Musset was killed in a mountaineering accident in the French Alps. His name will always be linked with the landmark discovery at CERN in 1973 of the neutral current of the weak interaction, observed in neutrino interactions in the Gargamelle heavy liquid bubble chamber. As well as participating in the discovery itself, Musset played a key role in the large collaboration which built this mighty detector. Subsequently he embarked on a patient quest for magnetic monopoles, and just this year his latest project, an ambitious emulsion experiment, came to fruition, giving for the first time directly observable tracks of 'beauty' particles. A charming and modest man, he was also a talented teacher and administrator, and a gifted musician.



Edward A. Knapp, new head of the US Universities Research Association.

On people

Klaus Berkner has been named associate director and head of the Accelerator and Fusion Research Division at the Lawrence Berkeley Laboratory, while James Symons, also named an associate director, becomes head of Berkeley's Nuclear Science Division.

Masatoshi Koshiba, director, International Centre for Elementary Particle Physics, Faculty of Science, University of Tokyo, has been awarded the Commander's Cross of the Order of Merit of the Federal Republic of Germany by that nation's president, Richard von Weizsäcker. The award was presented by chargé d'Affaires Rolf-Eberhard Jung, during a brief ceremony at the Embassy of the Federal Republic of Germany in Japan. The decoration was conferred on Prof. Koshiba for his promotion of bilateral cooperation in high-energy physics.

The University of Glasgow's John G. Rutherglen Memorial Prize Fund, set up in memory of the late Professor J. G. Rutherglen, finances an annual award to a postgraduate student in experimental particle physics from one of the universities formerly associated with the electron synchrotron NINA at Daresbury Laboratory, UK. The award for 1985 goes to Paul Hill of Manchester University.

Dirac medals

Commemorating the special association of the late Paul Dirac with the International Centre for Theoretical Physics in Trieste, the Centre has instituted Dirac medals, awarded yearly on 5 August – Dirac's birthday – for contributions to theoretical physics. This year Yakov Zeldovitch of the Space Research Institute, Moscow, is honoured for his far-ranging contributions to relativistic astrophysics, particularly in theories of compact objects and of cosmic evolution, while Ed Witten of Princeton receives his medal for his stimulating contributions to quantum field theory, in particular for the implications of new kinds of anomalies.

Ed Knapp to head URA

Edward A. Knapp has been elected President of the Universities Research Association, succeeding H. Guyford Stever, President since March 1982. Universities Research Association is the consortium of 56 universities which operates the Fermi National Accelerator Laboratory for the US Department of Energy, and assists the Department in the management of the national effort during the R&D and conceptual design phase of the Superconducting Super Collider accelerator project.

Knapp comes to the Association from the position of Senior Fellow and Research Advisor at the Los Alamos National Laboratory. Prior to returning to Los Alamos in August 1984, he was the Director of the National Science Foundation in Washington, D.C.

Japanese RFQ

The big radio-frequency quadrupole (RFQ) at the Institute for Nu clear Study, Tokyo, recently accelerated its first proton beam. Operating at 100 MHz, the 7.25 metre pre-accelerator took beam to 800 keV per nucleon with no difficulty. Development work at INS is pushing towards the Numatron high energy ion accelerator.

Meetings

The VIII International Congress on Mathematical Physics will be held in Marseille from 16-25 July 1986. More information from the IAMP 1986 Congress Secretariat, CPT-CNRS Luminy, Case 907, 13288 Marseille Cedex 9, France.

An Advanced Study Institute on

Techniques and Concepts of High Energy Physics will be held from 19-30 June 1986 in St. Croix, US Virgin Islands. Topics will include detectors, machines, results and theoretical ideas. The Institute is designed for about sixty young experimenters. More information from T. Ferbel, ASI-1986, Dept. of Physics, University of Rochester, NY 14627, USA.

The Division of Particles and Fields of the American Physical Society has published the Proceedings of the 1984 Summer Study on the Design and Utilisation of the Superconducting Super Collider held at Snowmass, Colorado. A limited number of copies are still available from The Publications Office, Fermilab, P.O. Box 500, M.S. 107, Batavia, IL 60510, USA.

Nobel Round Table

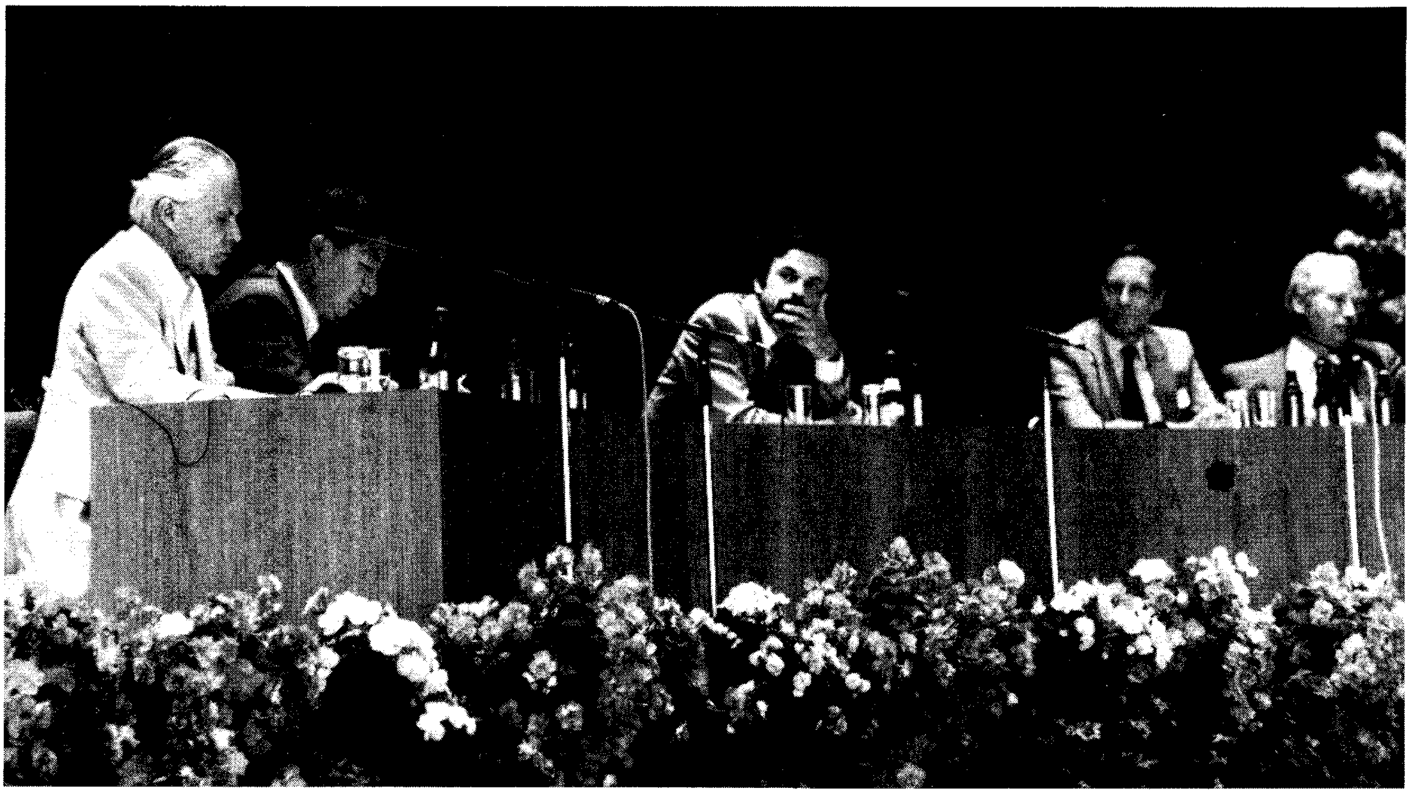
One highlight of the now traditional meeting of Nobel Laureates in Lindau, the island town just off the Bavarian (West German) shore of Lake Constance was a round table discussion, chaired by theoretician Harald Fritzsch, between Physics Prizewinners Simon van der Meer (1984), Rudolf Mössbauer (1961), Sam Ting (1976) and Steven Weinberg (1979), attended by an audience of over 400.

The theme of the discussion was the present state of high energy physics and possible developments in theory, technology and experiment. Do we necessarily have to go as far as 10^{18} GeV to find something new? However if higher energy frontiers have to be passed, then new techniques are needed, and on the way additional insights will surely be provided by detectors of higher sensitivity and precision.

Thinking is increasingly turning to new international agreements to finance proposed big machines. With these accelerators getting bigger and bigger, experiments grow too, and their design, construction and exploitation span longer periods of time. This could make difficulties for younger physicists wishing to embark on careers, but as always the difficulties which deter some are the challenges which inspire others.

Nobel Round Table at Lindau. Left to right, Rudolf Mössbauer, Sam Ting, Harald Fritzsch (chairman), Simon van der Meer, Steven Weinberg.

(Photo R. Böcher)



Italy at CERN

7.10 — 11.10.85

Organized by the Italian Institute for Foreign Trade (ICE)

About 40 firms will present

AMERIO S.n.c.

Via Caraglio 132/7
10141 - TORINO
Tlx. 220 286
Tel. 011/33 59 861 - 336 502

Production line:
Small and medium series of turned parts-
Thread rollings

Export sales organization by METALLIA. Realizzazioni metal-meccaniche Avanzate-Consorzio tra Imprese.
C.so Orbassano, 249
10137 TORINO
Tel. 011/32 31 12
Tlx. 220 286

Roberto Seni, Ettore Gandini
Area Manager

Exhibited products:
Turned and rolled parts

ATLA S.r.l.

Via Padana Inferiore, 44
10023 - CHIERI (TO)
Tlx. 220 286
Tel. 011/94 72 346

Production line:
Tanks and parts for vacuum-Welding and brazings under vacuum-Electroerosion

Export sales organization by METALLIA. Realizzazioni metal-meccaniche Avanzate-Consorzio tra Imprese.
C.so Orbassano, 249
10137 TORINO
Tel. 011/32 31 12
Tlx. 220 286

Roberto Seni, Ettore Gandini
Area Manager

Exhibited products:
Vacuum tank, flanges and honeycombs

BOCONSULT S.r.l.

Via Vizzani 72/G
40138 BOLOGNA
Tlx. 511 238 DAVERI I
Tel. 051/344 544 - 344 975

Production line:
Special purpose microprocessor based systems for automation and control. Data communication equipment for local area network.

Paolo Sgarbi, General Manager

Exhibited products:
A fast local area network for serial lines M3BUS 80286 Board. Single board computer for MODIAC automation system.

BOSCHIS & C. S.n.c.

Strada del Francese, 152
10156 TORINO
Tlx. 221 109 rif 966
Tel. 47 01 996 - 47 01 997

Production line:
Office furniture.

Edoardo Boschis, Commercial Manager

Exhibited products:
Office furniture

CAVICEL S.p.A.

Fabbrica conduttori elettrici
Via Gabriele D'Annunzio, 44
20096 - PIOLTELLO (MI)
Tlx. 340 146 CELCAV
Tel. 02/92 66 018 - 92 66 669

Production line:
Design and production of special electrical cables realized with thermoplastic, elastomeric, fluoropolymer materials, with tape or textile insulation. Cables for instrumentation, control, data transmission. Fire-resistant cables «Firecel» with low smoke emission and halogen free. Cables for mobile application. Fiber optic cables.

Dario Ratti, Sales Manager

Exhibited products:
Safety cables Firecel.

CEAT CAVI

Lgo Regio Parco, 9
10100 - TORINO
Tlx. 221 603 CEAT I
Tel. 011/26081

Production line:
Power-telecommunication and control cables. LV-MV and HV power cables. Radiation resisting cables. Non fire propagating cables. Non toxic and low smoke gas evolution cables for special applications. Optical fiber cables. Cables accessories.

Export sales organization by
CABLEXPORT S.p.A.
Via Vespucci, 2
20124 MILANO
Tel. 02/85 351. Tlx. 314 018 PIRECX I

Area Manager for Europe: Mr. A. Decorato
(phone 02/853 54 508

Exhibited products:
Enlarged slides illuminated panels

CEIS S.r.l.

Via Saccardo, 39
20134 - MILANO
Tlx. 334 357 ALBMI
Tel. 02/95 22 061

Production line:
Transformers. Switchboards. Inverters. Battery charger. Loose electrical components.

Roberto Bianchi, Area Manager

Exhibited products:
UPS System: Battery charger.
Loose electrical Components

C.P.C.E.N. - Cons. Piemon. Electro Nuclear Manufacturers

C.so G. Ferraris, 70
10129 - TORINO
Tlx. 221 109 API TO
Tel. 011/505 941

Production line:
Components, Carpentry, Installations, electro-mecha[illegible], other working.

Gaetano Saccà, General Manager

The C.P.C.E.N., Consortium of Piemontese Electro-Nuclear Manufacturers, was born in December 1984 as a spontaneous group of 16 small and medium size enterprises whose mutual aim is to get important orders both from the economic and the technological point of view. The main purposes of the consortium are: the promotion all over the world of the member companies; the guarantee of the quality in the supplies to the end users.

C.P.M. – Cranes – moving stores – structural steelworks – carpentry.

DESTRO – Industrial electric plants and equipments – control panels.

ELFIN – Transformers – electric welders – robots – push-button panels.

F.LLI CUSINO – Cabs and manels for electric equipments – carpentry.

GRI-CA – Prefabricated electric cells – carpentry for electric plants.

ILMAS – Finishing machining.

ITIC – Structural steelworks – carpentry – plant engineering.

JURA – Travelling cranes – carpentry.

MEVIS – Industrial pipe's plant – plant engineering and setting up.

MICROELETTRICA – Medium voltage transformation cabs – electric panels and drivings.

OSU – Machining of components and tools of high accuracy.

RE.MAC.UT – Industrial special equipments – overhaul of machine tools.

SIAT – Exhaust. air conditioning, ventilation plants.

S.V.E.A.T. – Varnishes for industry and building.

TESSILTRECCE BOZZOLA – Special electric sheated cables for high temperatures.

VAGNONE E BOERI – Machine tools – industrial equipments – second level chemistry.

Exhibited products:
Enlarged slides panels

DEMO ARMADI RACKS

C.so Lombardia, 52
10099 - S. MAURO TORINESE
Tlx. 213 279
Tel. 011/244 352/6/9

Production line:
International standard 19" size cabinets, Car baskets and containers with international DIN 41494 standards and consoles entirely made in aluminium.

Luigi Demo, Commercial Manager

Exhibited products:
Racks cabinet and card basket and containers.

DUE M.C. S.n.C.

Via Bard 43/2
10142 - TORINO
Tlx. 220 286
Tel. 011/70 16 72 - 70 71 800

Production line:
Equipment, prototypes and mechanical components of medium and small series.

Export sales organization by METALLIA. Realizzazioni metal-meccaniche Avanzate-Consorzio tra Imprese.
C.so Orbassano, 249
10137 TORINO
Tel. 011/32 31 12
Tlx. 220 286

Roberto Seni, Ettore Gandini
Area Manager

Exhibited products:
Flanges, rings and shafts

EASY S.p.A.

Via Monti, 48
10126 - TORINO
Tel. 011/65 08 507

Production line:
Caldorobot, computerized control of heating, equipment of buildings, it gives comfort, energy savings and expenses shavings.

Roberto Olivo, Marketing Manager

Exhibited products:
Enlarged slides illuminated panels.

E.E.D. S.r.l.

Via Brandizzo, 178
10088 VOLPIANO (TO)
Tlx. 214 489 EED TO
Tel. 011/98 84 666

Production line:
Magnetic cassette units ECMA 34 (DRU). Design of electronic items witch assembling and testing.

Gino Genta, General Manager

Exhibited products:
Security access control, Magnetic cassette units ECMA 34.

ELEMER S.r.l.

S.S. 407 BASENTANA KM. 75,500
75010 - BORGO MACCHIA FERRANDINA (MT)
Tlx. 812 564 IMPES I
Tel. 0835/7 57 181

Production line:
Instruments control panel, power center, motor control center, synoptic control panel, electronic systems.

Antonio Calciano, General Manager

Exhibited products:
Instruments control panel.
Electronic systems.

EURO-BIT S.p.A.

Via G. Armellini, 33
00143 - ROMA
Tlx. 616 264
Tel. 06/59 21 541

Production line:
Telecommunications, computer graphics, nuclear medicine.

Luciano Patacchiola, Sales Manager

Exhibited products:
Printed boards for general computing purpose, real-time signal processing, IEC 625 bus interfacing. Graphics packages applications for cartography 3D modelling working on HP1000A and apollo workstations.

FIL-PA

Via Caraglio, 132/11
10141 - TORINO
Tlx. 210 443 CALIER
Tel. 011/383 263

Production line:
Medium and high series of small turned parts.

Export sales organization by METALLIA. Realizzazioni metal-meccaniche Avanzate-Consorzio tra Imprese.

C.so Orbassano, 249
10137 TORINO
Tel. 011/32 31 12
Tlx. 220 286

Roberto Seni, Ettore Gandini
Area Manager

Exhibited products:
Small turned parts.

FIMS - Fabbr. Ital. Molle a Spirale

Via Frejus, 16
10092 - BEINASCO
Tlx. 220 286
Tel. 011/34 90 586

Production line:
Springs in Steel wire and strip.

Export sales organization by METALLIA. Realizzazioni metal-meccaniche Avanzate-Consorzio tra Imprese.

C.so Orbassano, 249
10137 TORINO
Tel. 011/32 31 12
Tlx. 220 286

Roberto Seni, Ettore Gandini
Area Manager

Exhibited products:
Springs.

GROUND di Martinelli Ugo e Papotti Daniele

Via Greca, 31
41100 - MODENA
Tlx. 226 376 GROUND I
Tel. 059/31 00 89

Production line:
With the use of computers, control of light system, production of litted signs and of graphic panels that both write.

Ugo Martinelli, Sales Manager

Exhibited products:
Luminous panels.

ITALCOPPIE S.n.c.

Via Diritta, 9
26100 - CREMONA
Tel. 0372/43 23 11 - 43 40 96
Tlx. 312 819 CR EXP IC

Production line:
Metal sheated mineral insulated thermocouples and rtd (Also in smaller diametres) manufactured under controlled quality system.

Canzio Noli, Sales Manager

Exhibited products:
Thermocouples with external connectors. Sheated thermocouple with MgO insulation.

ITALVALV di R. Roveta & C.

Strada del Corriere, 27
15060 - SANT'ANTONIO DI BASALUZZO (AL)
Tlx. 215 014 IIV SAB
Tel. 0143/48 491/2

Production line:
Ball valves, Butterfly valves, Diaphragm valves, Check valves.

Roberto Roveta, General Manager

Exhibited products:
Manual butterfly valve wafer type ASA300 size 6" with metallic seal. Pneumatic butterfly valve type ASA300 size 6" with seal in PTFE. Ball valve.

LARES COZZI S.p.A.

Via Roma, 88/92
20037 - PADERNO DUGNANO (MI)
Tlx. 330 119 LARES I
Tel. 02/91 81 363 - 91 81 026

Production line:
Rigid printed circuit boards, one or two sided, with and without plated through holes. Flexible P.C.B., one or two sided with and without P.T.H. Rigid multilayers P.C.B. Mixed rigid-flexible P.C.B. Surface treatment: nickel-gold, tin-lead, tin-lead reflown, bright tin, solder mask, component printing.

Luigi Cozzi, Commercial Manager
Arcangelo Barbieri, Export Sales Manager

Exhibited products:
Printed circuits.

LUNGARI Giuseppe

Via dell'Industria, 54
41100 - MODENA
Tlx. 512 087 P.P. MO I
(Att. ne Sig. Ogliari C.N.A.)
Tel. 059/36 00 50

Production line:
Prismatical and tangential grinding. Overhauls. Transformations. Mechanical and machine-tools manufacture.

Giuseppe Lungari, Sales Manager

Exhibited products:
Enlarged slides illuminated panels.

MIZAR S.r.l.

Via Monti, 48
10131 - TORINO
Tel. 011/65 08 507

Production line:
Big system automation software (E.D.: urban traffic automation).

Adriana Galliano, General Manager

Exhibited products:
Enlarged slides panels.

M.P.G. S.r.l.

Meccanica Precisione Giaveno
Str. Sabbioni, 15
10094 - GIAVENO (TO)
Tlx. 221 109 APITO I RIF. 503
Tel. 011/937 61 93 - 937 71 67

Production line:
High precision mechanical elements, oleodynamics, pneumatics.
Rinaldo Paviolo, General Manager

Exhibited products:
Mechanical elements of small dimension.

NORDEL S.r.l.

Frazione Losa
10070 - PESSINETTO
Tlx. 214 439
Tel. 0123/54 201 - 54 419

Production line:
Printed circuits
Lorenzo Clerico, General Manager

Exhibited products:
Printed circuits.

NOVACAVI S.p.A.

Via Martiri di Cefalonia, 1
20068 - PESCHIERA BORROMEO (MI)
Tlx. 322 333 NOCAVI I
Tel. 02/54 71 053 - 54 71 088

Production line:
Cables for special purposes
Ferruccio Ramplond, General Manager

Exhibited products:
Computer cables, radio-frequency cables, security-alarm cables, high temperature cables, telephonic cable, other cables.

NOVATEC

Tecnologia del vuoto
Via Montegani, 21
20141 - MILANO
Tel. 02/84 93 542

Production line:
Project and construction of apparatus and special plants for high and ultra vacuum.
Gabriella Giussani, General Manager

Exhibited products:
X rays monochromator, Space simulator chamber, laboratory apparatus for material activation by proton bombardment, Laboratory apparatus for generator plasma, High vacuum furnaces, Leakproofing apparatus for electronic components, Insulating oil treatment plants, Vacuum pumping units, Vacuum fimming plants, Impreganting plants.

NUOVA TERMICS S.n.c.

Via Decia, 49
26100 - CREMONA
Tlx. 312 819 CR EXP NT
Tel. 0372/227 53 - 411 072

Production line:
Special heating elements. Instruments and probes to mesure temperature and humidity.
Claudio Arisi, Sales Manager

Exhibited products:
Heating elements.
High precision psychrometer device.

OFFICINE GALILEO S.p.A.

Via A. Einstein, 35
50013 - CAMPI BISENZIO (FI)
Tlx. 570 126 GALILE I
Tel. 055/89 501

Production line:
Mechanical vacuum pumps and accessories. Vacuum valves. Cryogenerator and cryopump. Vacuum gauge.

Marco Panizza, Sales Manager
Argeo Pasqui, Assistant Sales Manager

Exhibited products:
High vacuum rotary pump, double stage mod. D020. High vacuum rotary pump, double stage mod. B040. Ionization gauge mod. OG 611. Piezo-restive gauge mod. OG 713. Cryopump mod. KI-160.

ING. C. OLIVETTI & C. S.p.A.

Via Jervis, 77
10015 - IVREA (TO)
Tlx. 210 030 OLIVR I
Tel. 0125/525

Production line:
Electronic typewriter and word processor. Micro-computer and management system. Terminals and telecommunication systems. Portable typewriters, calculators and photocopying machines.

Exhibited products:
Personal computers, local area network, periphals.

OLIVETTI-HERMES (SUISSE) SA

Steinstrasse 21
Postfach, 8036 ZURICH
Tlx. 813 228
Telegr. Olivettico Zurich
Tel. 01/46 39 550

Production line:
Portable typewriters,
calculators and photocopying machines

OMICRON DUE S.n.c.

Vicolo Mungis, 13
10043 - ORBASSANO (TO)
Tlx. 220 286
Tel. 011/90 11 205 - 90 03 568

Production line:
Dies for sheet, plastics and rubber-Cold forming of parts.

Export sales organization by METALLIA. Realizzazioni metal-meccaniche Avanzate-Consorzio tra Imprese.
C.so Orbassano, 249
10137 TORINO
Tel. 011/32 31 12
Tlx. 220 286

Roberto Seni, Ettore Gandini
Area Manager

Exhibited products:
Clamps, supports and parts.

PROVEX - Export Consortium of the provincia di Varese

Viale Milano, 16
21100 - VARESE
Tlx. 380 378 PROVEX I
Tel. 0332/24 00 06

Production line:
Machine tools for metal working and accessories. Air treatment, fan propellers and similar equipment. Chemical, petrochemical plant installations and apparatuses. Electric and electronic components and devices. Motor speed gear reducers. Steel and aluminium alloys hot forged pieces and castings. Metal working workshop. Instrumentations.

Giovanni Castagnoli, General Manager

Exhibited products:
Enlarged slides illuminated panels.

PROVEX is a non-profit making Co-operative Society whose aim is to promote the import/export transactions of its associated producing firms. This Co-operative Society was founded in 1975. Its members are the small and medium size firms grouped together under the patronage of the Chamber of Commerce of Varese.
The Society has two poerating offices which are at the disposal for advices, assistance and services in favor of its associated firms and their client firms abroad.

At the CERN the PROVEX firms exhibit:
- Machine tools and accessories for wood and metal working
- Machines for the plastics industry
- Lifting equipments
- Generating boilers
- Refrigerating equipment
- Sundry equipment

Petroleum
- Industry tands etc. assembly work of petroleum plants – industrial dust exhaust equipment
- Metal pipes, profiles, etc.
- Metal castings, drop forgings
- Flanges, valves, bolts for petroleum plants and other industry
- Bolts and small pressed, turned, metalwares
- Fire trucks, public-utility motor vehicles
- Plastic materials: pipes, extruded articles Containers and molded articles
- Films, sheets bags, etc.

SILENA S.p.A.

Via Negroli, 10/a
20133 - MILANO
Tlx. 322 523
Tel. 02/71 38 71

Production line:
Electronic instrumentation for acquisition and analysis of muclear data.

Carlo Bonsignori, Commercial Manager
Paolo Rizzacasa, Export Manager

Exhibited products:
New silena microprocessor-based multichannel analyser for automatic analysis of nuclear data «Livius». New silena ultra high-speed analog-to-digital converters mod. 7423/UHS. New silena 8-Input analog-to-digital converter for voltage, charge and time conversion featuring high integral and differential linearity mod. 4418/O/T/V.Silena multichannel analyser mod. «CATO».

Soc. CAVI PIRELLI S.p.A.

P.zza Cadorna, 5
20124 - MILANO
Tlx. 310 135 PIREMI I
Tel. 02/8 53 51

Production line:
LV, HV power cables, telecommunication and special applications cables. Afumex (R) fire retendant cables with low emission of smoke and toxic fumes. Retox (R) fire retardant cables with low emission of corosive fumes. FP 200 fire resistant cable. Potical fiber cables. Cables accessories.

Export sales organization by
CABLEXPORT S.p.A.
Via Vespucci, 2,
20124 MILANO
Tel. 02/8 53 51 Tlx. 314 018 PIRECX I

Area Manager for Europe: Mr. A. Decorato
(phone 02/853 54 508

Exhibited products:
Enlarged slides panels and samples

SP-Costruzioni Mecc. di SELMI IRMO & C. S.n.c.

Via Don Milani, 15
41100 - MODENA
Tlx. 512 087 P.P. MO I
(Att.; ne Sig. Ogliami - C.N.A.)
Tel. 059/25 13 59

Production line:
Manufacture of mechanical parts by means of precision machines with numerical control, their treatment and assembling.

Renato Brescancin, Sales Manager

Exhibited products:
Enlarged slides illuminated panels.

TECNOIDEAL di SITTA & C.

Costr. Attrezz. Meccaniche
Via Lea Cazzuoli, 19
41030 - S. GIACOMO RONCOLE (MO)
Tlx. 512 087 P.P. MO I
(Att. ne Ogliari A-CNA)
Tel. 0535/23 653

Production line:
Manufacture of mechanical parts (also by numerical control) in stainless steel, PTFE, polypropylene, delrin, polysulphone, pvc, plexiglas, for sanitary, hospital and feeding equipments.
Planning and manufacture of special equipments for sanitary, disposable products assembling. Automations in general.

Settimio Sitta, Sales Manager

Exhibited products:
Enlarged slides illuminated panels.

TELEMA S.p.A.

Viale Papiniano, 57
20123 - MILANO
Tlx. 310 125 TELEMA I
Tel. 02/83 75 127 - 83 72 500

Production line:
Electrical block resistors in stainless steel AISI 304 and other special types, and in particular: Starting and regulating equipments for motors of any type and power. Load resistors of any type (charge resistors for diesel-electric sets, for testing rooms – battery discharge resistors etc.). Grounding resistors.

Giovanni Fornari, General Manager
Michele Fornari, Commercial Manager

Exhibited products:
Enlarged slides illuminated panels.

7.10 — 11.10.85

Italy at CERN

Organized by the Italian Institute for Foreign Trade (ICE)

About 40 firms will present

TERCOM S.r.l.

Via Ippocastani, 8
26100 - CREMONA
Tlx. 312 819 CR EXP TERCOM
Tel. 0372/43 27 27

Production line:
Connectors for thermocouples and RTD Instruments and accessories to measure the flow, the pressure and level.

Ettore Presenti, Sales Manager

Exhibited products:
Flow measurement – tube venturi.

TOZZI S.p.A.

Il Traversa di Via Classicana,
48100 - RAVENNA
Tlx. 550 576 TOZZI I
Tel. 0544/43 62 74

Production line:
MV switchgears. Switchgears qualified for nuclear plants. LV Switchgears. On-load LV isolators.

G.F. Menti, Commercial Manager

Exhibited products:
Electronic boards.

VIMMA S.p.A.

Officine meccaniche di precisione
Corso Porta Nuova, 42/44
20121 - MILANO
Tlx. 315 648 ASLOMB I
Att. 569 VIMMA
Tel. 02/65 54 082 - 65 92 589

Production line:
High-precision machining

Alberto Redaelli, General Manager
Delfino Gambino-Mayola, Commercial Manager

Exhibited products:
Precision mechanical items for the following areas:
- airplanes and helicopters
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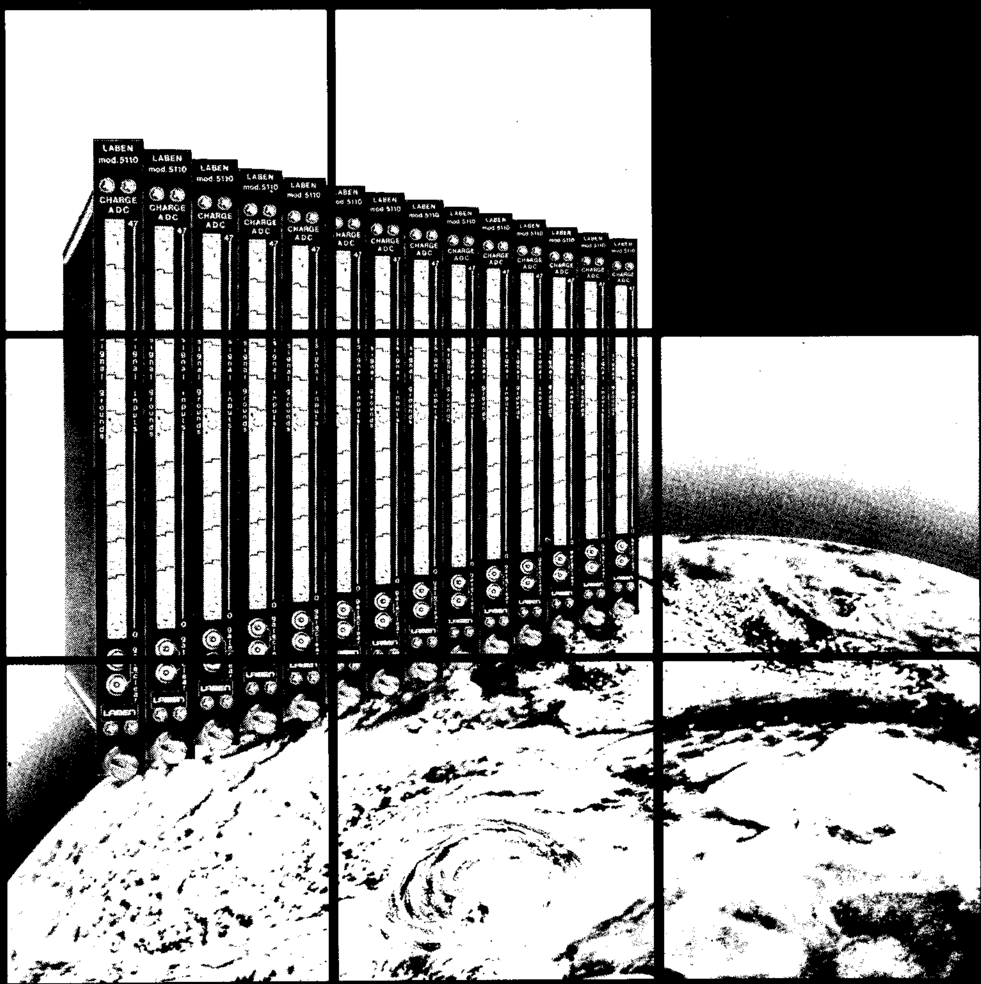

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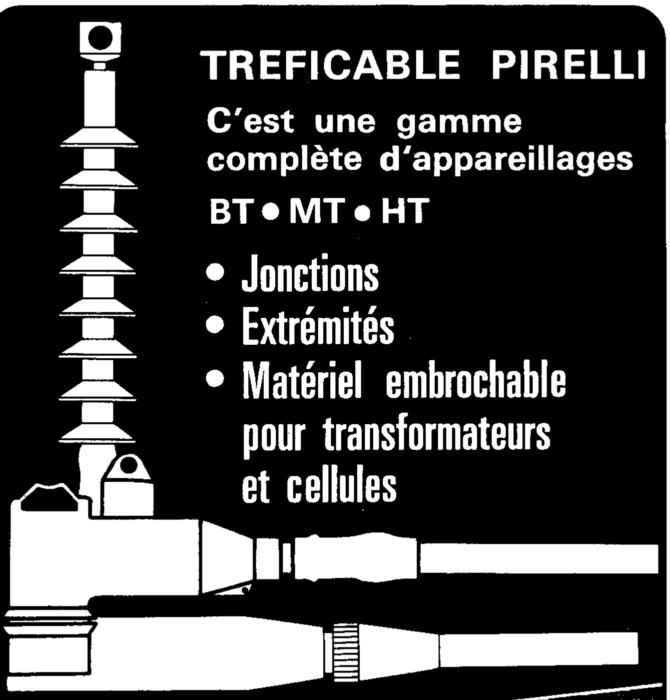

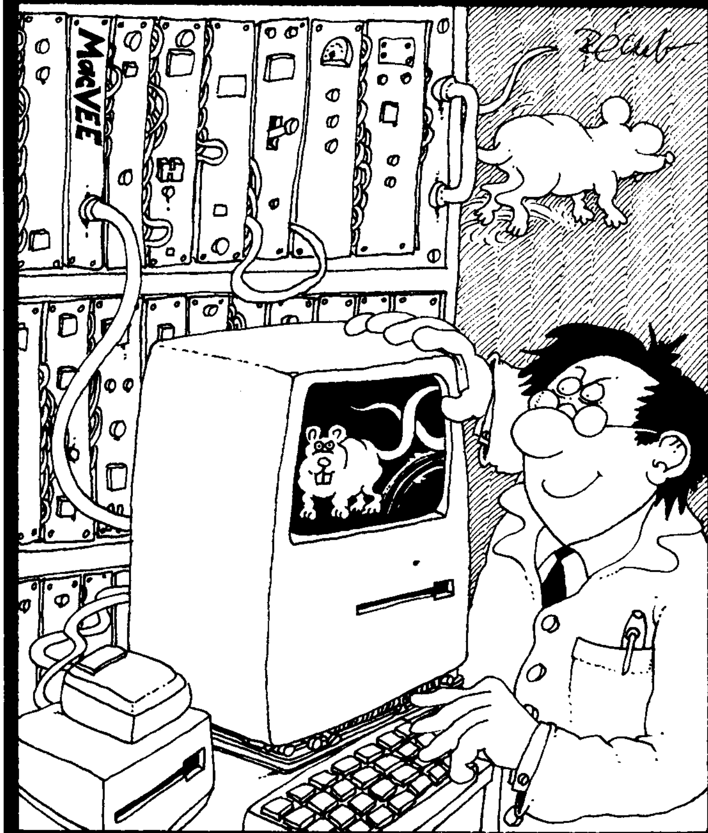

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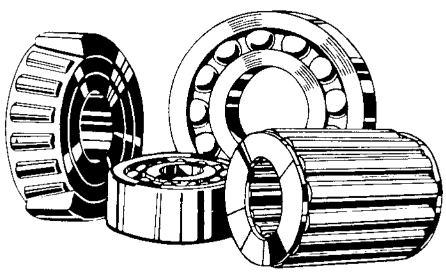

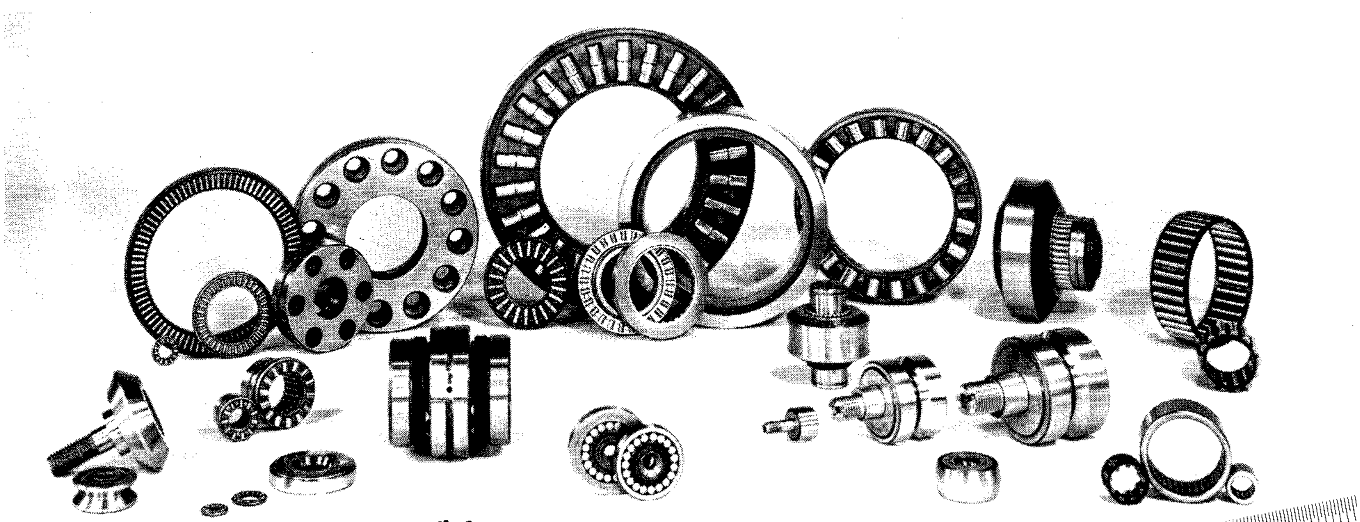

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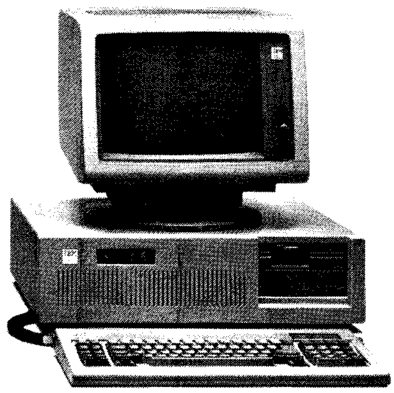

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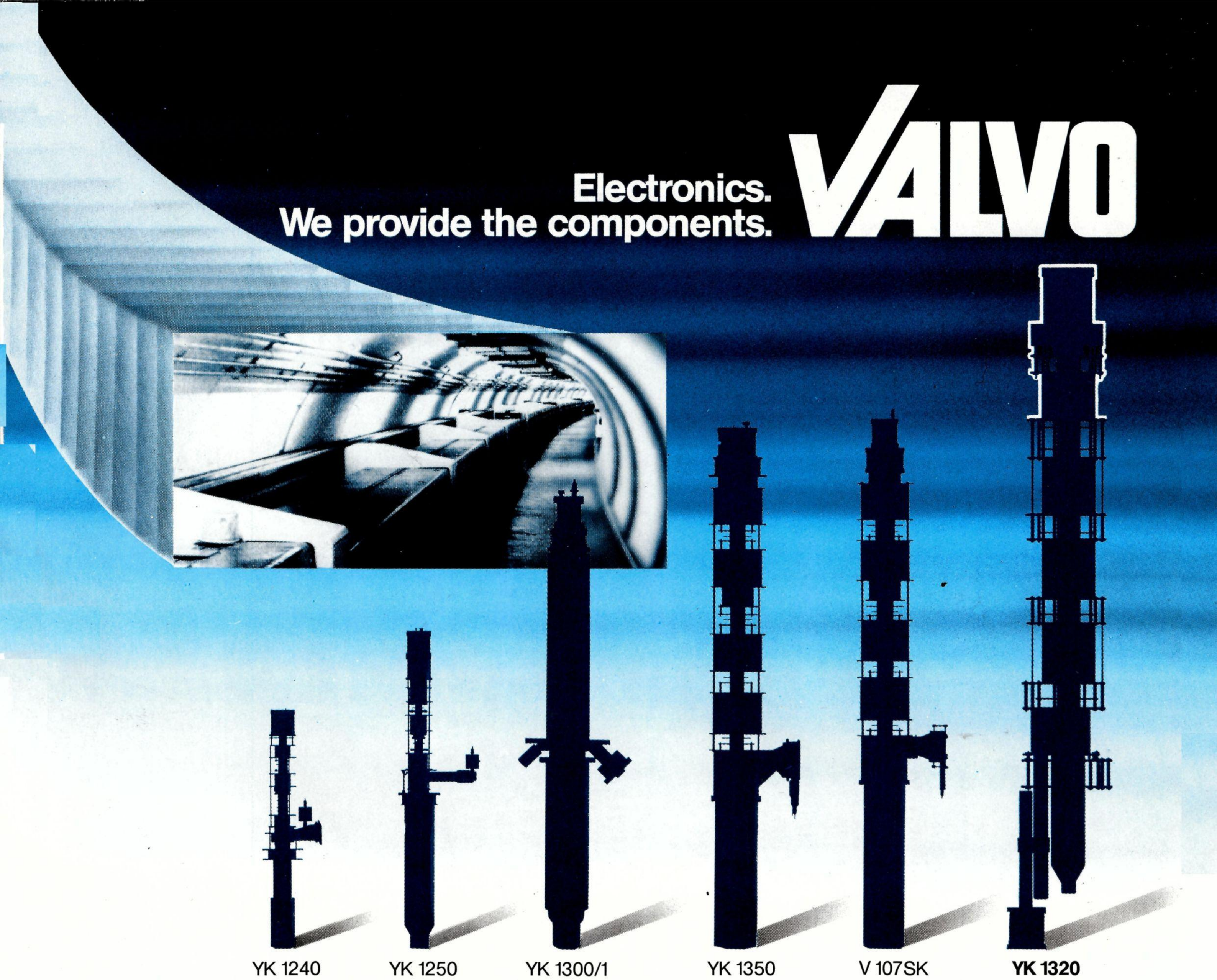

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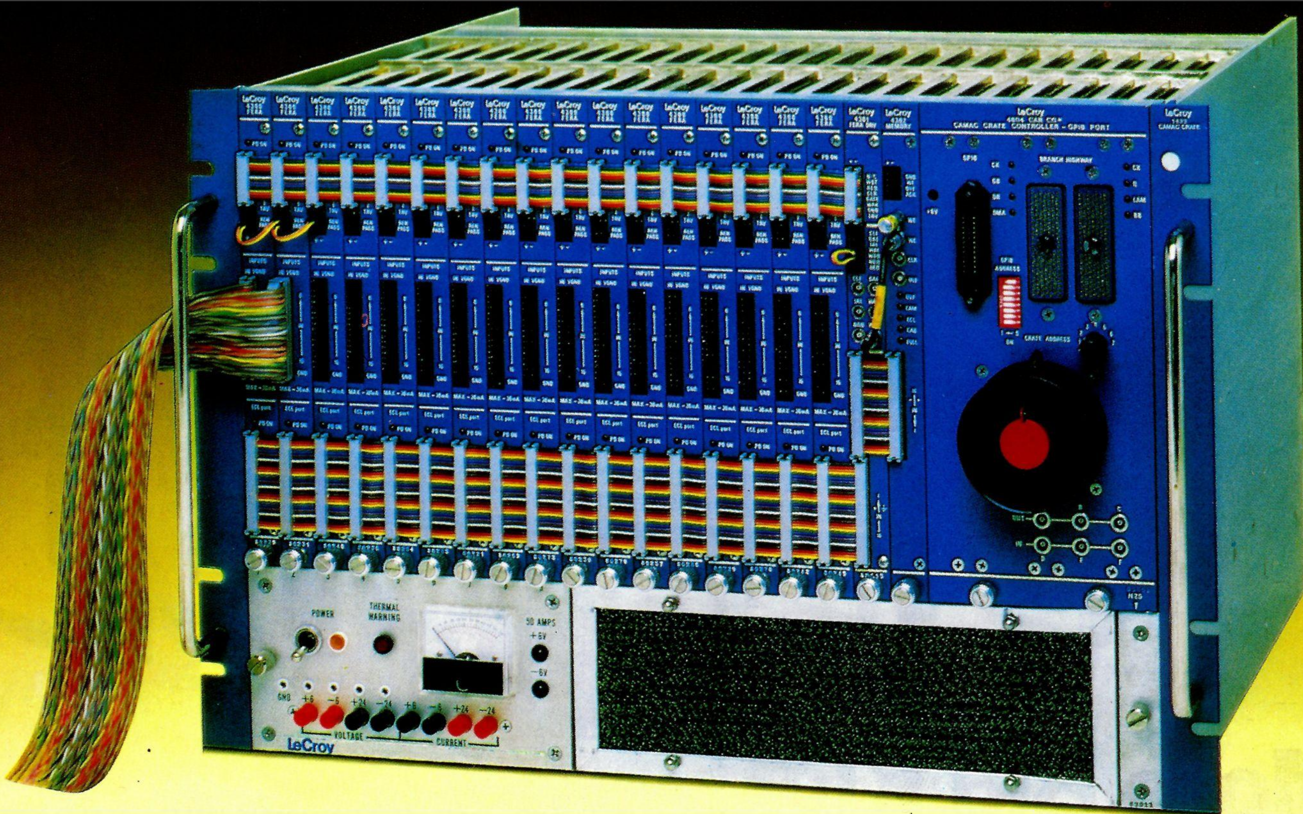

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For more information on FERA, contact your local sales representative.

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