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Covering current developments in high energy physics and related fields worldwide

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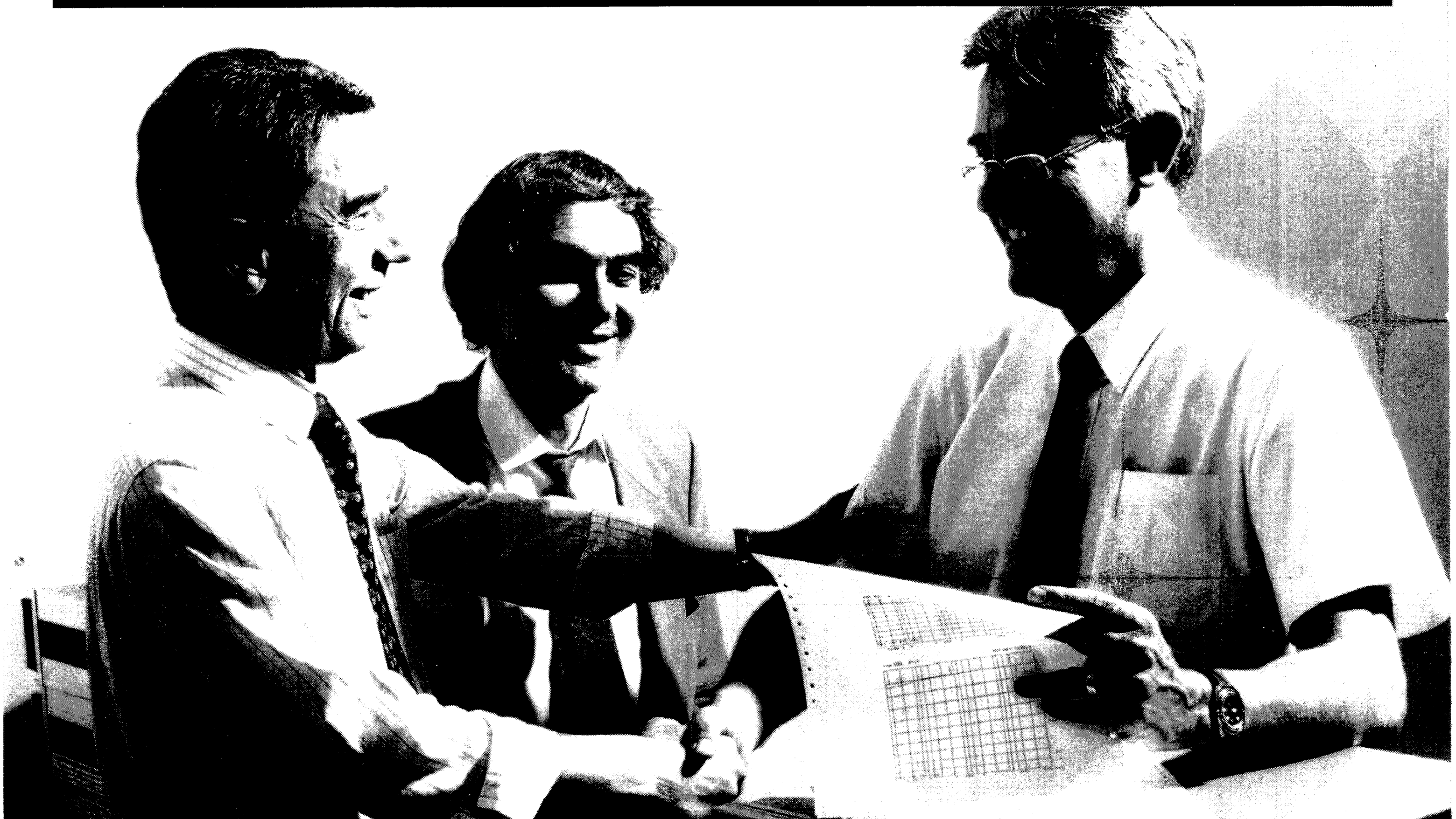
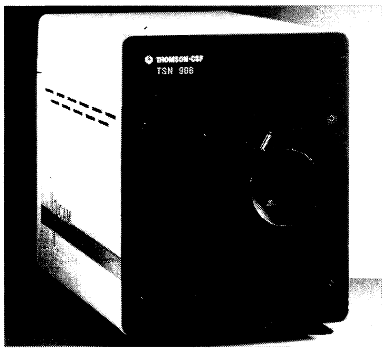
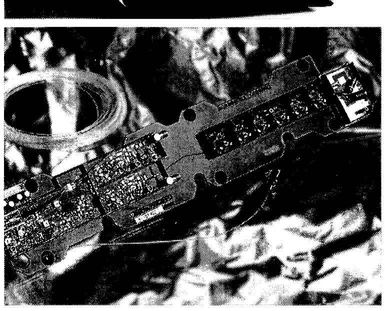
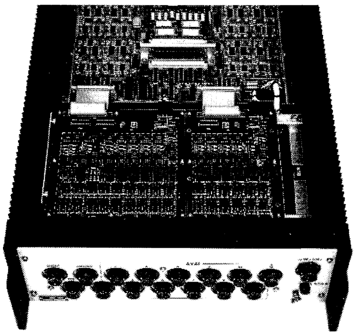
Cover photograph: A dramatic demonstration of the conservation of momentum. Even using a sledgehammer, so much energy is absorbed by a heavy target that the result is virtually painless, especially when the effect is spread over several hundred nails. The demonstration featured at the conference dinner of the recent European Research Conference "Physics of High Energy Heavy Ion Collisions", held in Helsinki from 17-22 June (see page 19), with courageous target Hans-Uno Bengtsson making himself 'comfortable' on a bed of nails prior to being attacked by Hans Gutbrod (wielding sledgehammer). It is not advisable to repeat the experiment using a light target and only a few nails.

OPTRONICS - CHRONOMETRY - RADIATION









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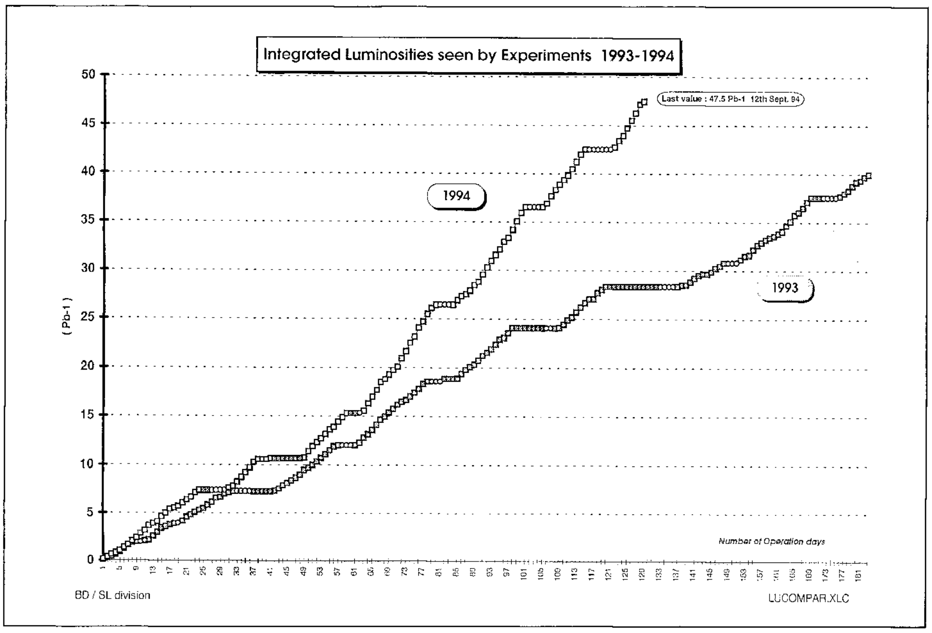
Inverse picobarns to you

Integrated luminosity at CERN's LEP electron-positron collider is building up well this year. By the end of August it had already surpassed the total figure for 1993.



The impact of some spectacular colliding beam records this summer has been muted by the cryptic terminology which scientists invariably use when describing their best achievements.

Early this century, nuclear physicists calculated the collision rate of a particle beam with a sample of stationary atoms by multiplying the intensity of the beam (particles per unit area per second), the total number of targets, and the area of each target. In searching for a yardstick to measure this effective 'cross-section', they first thought of a unit called a 'barn', equal to 10^{-24} square centimetres, the approximate surface area of a nucleus. A beam crossing such an area would be almost certain to produce a nuclear collision - 'as easy as hitting a barn door'.

This cross-section is a measure of the probability that two particles will collide. Today's physicists, searching for very rare and interesting events, measure probabilities in much smaller units - milli-, micro-, nano-, and finally picobarns. A picobarn is a million-million times smaller than a traditional nuclear barn. As always, multiplying the beam intensity by the number of targets and the cross-section (probability) gives the rate at which events occur.

However nomenclature had to be revised when particle physicists started to collide two counter-rotating beams. They needed a quantity, analogous to the product of beam intensity and number of target nuclei, which they could simply multiply with the cross-section to calculate the rate.

This new quantity is called "luminosity", defined as the number of particles per second circulating in one beam multiplied by the average number of intercepted particles per square centimetre in the other. Colliders have lots of circulating particles, so luminosities are big numbers - LEP, for example, has attained 2.2×10^{31} cm^{-2} s^{-1}. Fermilab's Tevatron proton-antiproton collider is close behind. The world's highest luminosities are provided by Cornell's CESR ring, which goes beyond 10^{32}.

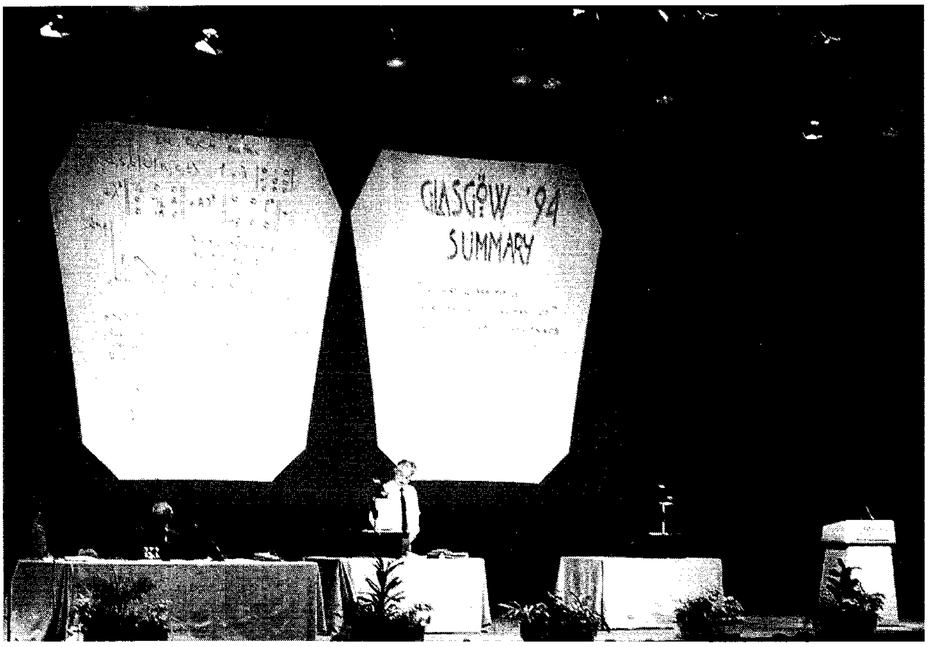
As well as pumping in particles, machine physicists maximize luminosity by squeezing their colliding beams as small as possible. Luminosity is a property of the beams - not of the process being studied. To keep track of what their collider may have achieved, machine physicists use 'integrated luminosity' - luminosity accumulated so far. It is the total number of particles that have circulated in one beam multiplied by the average number of intercepted particles per square centimetre in the other.

This integrated luminosity, the product of luminosity and time, is a dose, analogous to the dose which produces sunburn - it is not the intensity of the sun alone which counts, but the intensity multiplied by the time spent on the beach.

Multiplying the luminosity by the "barns" gives the event rate. From an expected integrated luminosity and a theoretically-predicted cross-section, physicists can assess their chances of making a discovery. They might tentatively book tickets to Stockholm on the basis of multiplying the theoretical cross-section (measured in picobarns) by the integrated luminosity expected during a forthcoming collider run (measured in inverse picobarns).

The total luminosity delivered by LEP in the whole of 1993 was some 40 inverse picobarns. An inverse picobarn is a large number - the number of quarks which would cover a small coin, or the number of atoms on the surface of the Earth. With colliders like LEP and Fermilab's Tevatron running at their current luminosity levels, an inverse picobarn - 10^{36} per square cm - of integrated luminosity in just one 24-hour period (8.6×10^4 seconds) is quite an achievement.

Glasgow conference



Pierre Darriulat of CERN gives the summary talk at this year's International Conference on High Energy Physics, held in Glasgow. (Photos University of Glasgow)

The biennial 'Rochester' International Conferences on High Energy Physics which tick the rhythm of high energy physics progress reflect the dominance of the 'Standard Model' - the picture of electroweak and quark/gluon interactions in a simple framework of six weakly-interacting particles (leptons) and six quarks. Despite its limited intellectual appeal, after a decade of intense probing the Standard Model still refuses to budge.

This year's Rochester event, held in Glasgow from 20-27 July, followed the trend. But conformity is not a synonym for a physics vacuum. The advent of high precision data from big colliding beam experiments provides a treasure trove of detailed information on particle characteristics and decays, so that Standard Model physics becomes charted in finer and finer detail. (A preliminary Glasgow report appeared last month, page 1.)

However the map is far from complete, and as Glasgow summarizer Pierre Darriulat of CERN concluded, there is a lot to do while waiting for the next round, which will begin in about ten years when CERN's LHC proton-proton collider begins operations.

Top quark

A new feature of physics in 1994, still firmly part of the Standard Model, is first evidence from Fermilab's Tevatron proton-antiproton collider of the long-awaited sixth ('top') quark. First presented at Fermilab earlier this year (June, page 1), the data had slightly matured at Glasgow.

In the plenary sessions, Hans Jensen presented the top quark evidence from the CDF experiment, while Paul Grannis spoke for the companion Tevatron D0 experiment, which has already definitely ruled out the top quark being lighter than 131 GeV.

After careful elimination of background effects in the initial data sample, CDF found two spectacular events producing an electron and a muon, but none with an electron or a muon pair. It is almost impossible to explain these spectacular electron-muon events by any other mechanism.

In searches where the top leaves its fingerprint as a characteristic accompanying particle containing the fifth ('beauty' - b) quark and a confined 'jet' of accompanying hadrons ('the nicest part of the analysis' according to Jensen), CDF sees six candidates using the vertex detector to pick up the short track stubs left by decaying B particles (containing a b-quark) and another seven through the analysis of weak decays producing a lepton.

In total CDF sees 15 candidate top events (really 12, as several examples are caught in two analysis nets), compared with an expected background of six. 'This gives evidence for the top quark but does not firmly establish its existence,' declared Jensen.

Seven CDF events have enough kinematical information to calculate the top quark mass, giving a value of 174 GeV $\pm$ 10%.

D0 reports one example of a muon-electron pair, and six candidates including jets. 'There is no significant excess over background,' said Grannis, adding that the interim D0 result is consistent with no top production.

Earlier in a parallel session, Keith Ellis of Fermilab had compared the top production rates as calculated from CDF and D0 interim results with the theoretically expected value. CDF overshoots and D0 undershoots, making it tempting to combine the two small sets of data, but several speakers warned that this would be premature.

If the top quark mass could be fixed to within 3 GeV, the consistency net of the Standard Model could trawl a value for the mass of the long-

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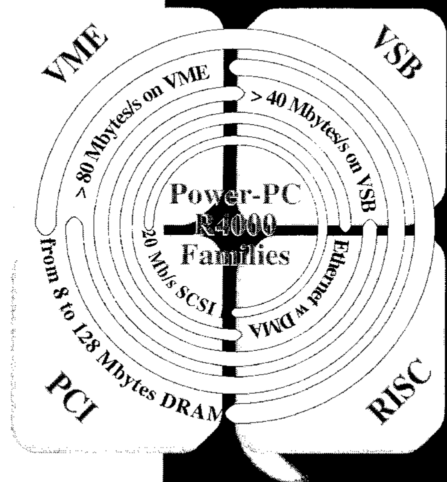

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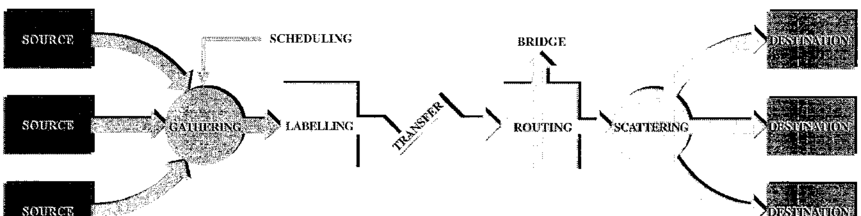

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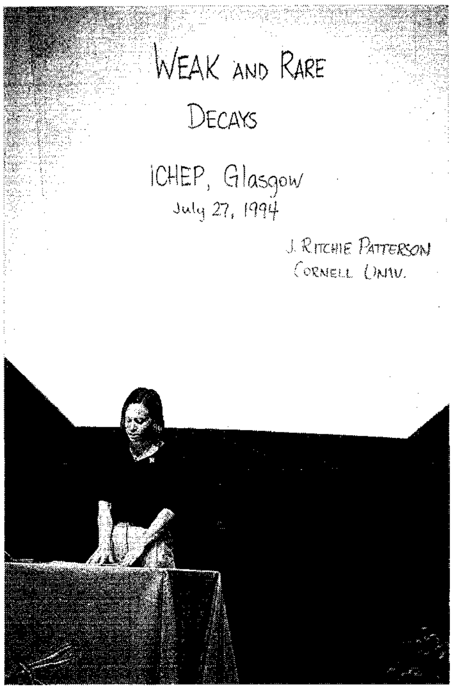
Ritchie Patterson of Cornell - weak and rare decays.

Joel Feltesse of Saclay, spokesman for the H1 experiment at HERA - 'The structure of the proton continues to be mysterious'.



awaited higgs particle at the root of the delicate electroweak symmetry breaking mechanism which makes the Standard Model tick.

Far heavier than any other known particle, the top quark could be trying to tell us something. The possibility of new insights into quark dynamics was underlined by Pierre Darriulat in his summary, who eagerly looked forward to more Tevatron top data. (During the conference, the Tevatron broke new luminosity records - September, page 42 - promising well for the future.)

Obviously the top evidence was high on Darriulat's summary agenda. As well as congratulating CDF in communicating these exciting new results, he underlined the close agreement between the top quark mass emerging from the Tevatron data and the limits now emerging from the world mass of Standard Model data, where the precision results from CERN's LEP electron-proton collider play the major role.

Electroweak physics

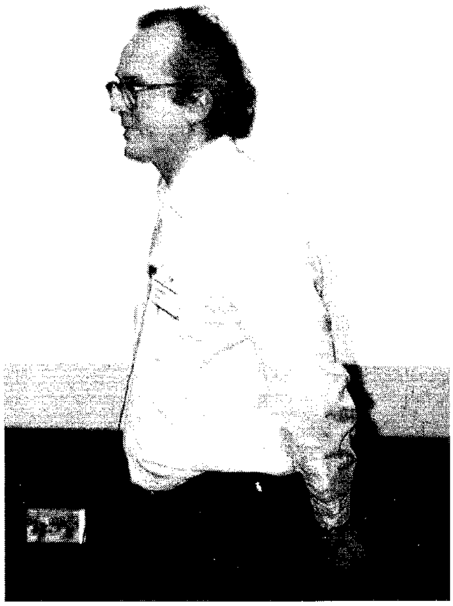
Dorothee Schaile of CERN, covering precision electroweak tests, followed the top quark talks on the first day of the Glasgow plenaries. In a field dominated anyway by the weight of statistics from the four experiments at LEP, added precision now comes from improved luminosity measurements and a new calibration of LEP beam energy, potentially fixing the Z mass to within a few MeV. Not all these refinements have yet been incorporated in the ongoing analysis, and updated figures are continually emerging. While LEP's energy now takes account of tidal effects and other minutiae, a now predictable residual effect remains.

LEP data provides more and more fixes on Standard Model parameters, with even once esoteric areas like tau physics and B production contributing. Tuned to the Z, LEP cannot yet get at the Z's electrically charged companion, the W boson. A new precision fix on the W mass (80.23 GeV) comes from CDF and D0 at the Tevatron.

A new but not unexpected electroweak effect involving the W comes from the HERA electron-proton collider, where the falloff in neutrino production attains the energy region which reflects the W mass.

A highly precise electroweak measurement is the left-right asymmetry in Z production by the SLD detector using polarized beams at the SLC linear electron-positron collider at Stanford (SLAC - May, page 11) and described by Mike Fero of SLAC in the early Glasgow parallel sessions.

While not impossible, it is not easy to reconcile this precision result with the majority of the electroweak data.

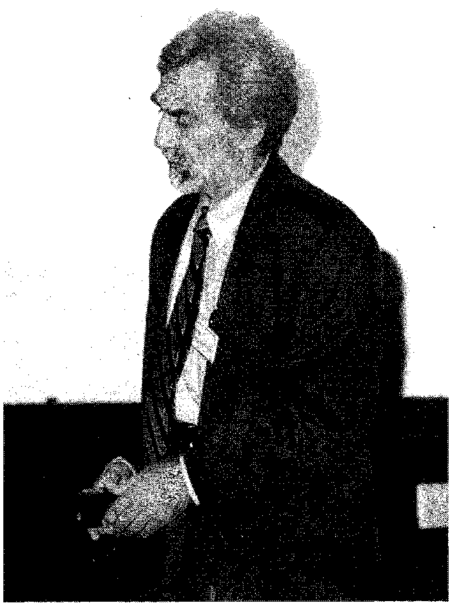


Darriulat, echoing C.K. Jung of D0 in the parallels, pointed to the particular example of the W mass, which does not favour the SLD result. The offset between the SLD and 'other' results drives the world average limit for the top quark mass from 171 to 178 GeV. By itself, the SLD results centres on a top quark mass of 240 GeV.

Third generation

The top's companion quark in the heaviest quark duo is beauty (b). The properties and spectroscopy of the B particles containing this quark have now developed into a minor research industry. As well as the mass of data from the CLEO detector at Cornell's CESR electron-positron collider and final results from the now complete ARGUS study at DESY's DORIS ring, summarizer Darriulat pointed to many important contributions from LEP experiments, at CDF and at S using new microvertex detectors

Michal Turala's Glasgow overview of new detectors and experimental techniques showed the impressive progress being made to meet new physics challenges.



These precision detectors immediately around the beam collision point reveal the tiny track stubs left by the decaying b particles.

In his talk on heavy quark physics, Patrick Roudeau of Orsay showed how the B quark sector is now emerging as another realm where the Standard Model reigns supreme. However there is still plenty of work to be done in pinning down B lifetimes and the details of many decay channels.

While last year the sighting of a rare ('penguin') neutral B decay into a K* and a photon by CLEO was a talking point (June 1993, page 1), a more general measurement by CLEO of the neutral B decay into any strange-quark state and a photon gives a better fix on the underlying quark physics.

This was one of the features of a memorable rapporteur talk on weak and rare decays by Ritchie Patterson of Cornell, who also showed how the third and heaviest lepton, the tau, the Standard Model's lepton partner of the t- and b-quarks, is also in better shape this year. In previous years some apparent shortfalls in certain decay sectors had given mild concern. '

Roger Forty of CERN showed how LEP experiments also see the actual oscillations between different neutral B states (rather than just broad evidence for mixing). Awaiting more B particles and the next generation of neutral kaon experiments, the CP violation scene features first results from the CPLEAR experiment at CERN's low energy antiproton ring.

Proton structure

'The structure of the proton continues to be mysterious,' remarked Joel Feltesse of Saclay. As spokesman for the H1 experiment at HERA, Feltesse was naturally proud to show the new HERA results on the proton structure when the struck quark contains only a tiny fraction of the parent proton momentum.

But first Feltesse preferred to look at results from CERN's NA51 muon pair experiment and from a comparison of positive- and negatively-charged W production by CDF. These show that the three valence quarks of the proton are accompanied by a collection of 'sea' quarks which is not flavour symmetric (more down- than up-quarks). The fresh crop of spin-dependent proton (and neutron) structure information (July, page 19) shows that constituent quarks carry at most only half the nucleon's spin.

The polarization information from SLAC, both in the proton structure and in Z production, displays the power of the new strained semiconductor techniques (July 1993, page 5).

Physicist Hallstein Høgaasen of Oslo and his wife sailed to Glasgow from Norway in their boat 'Emotion', which during the Conference was moored on the River Clyde in front of the Conference Centre.

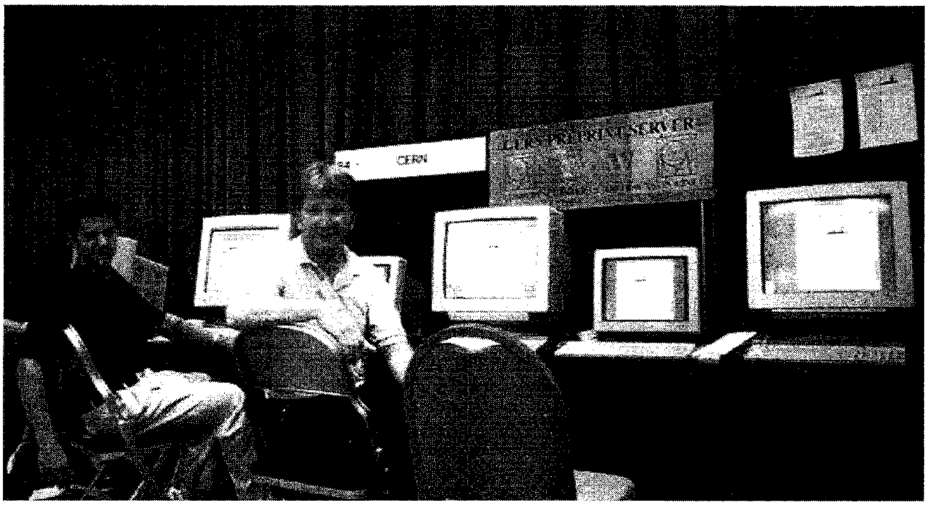
HERA data now probes deep inside the low x (momentum fraction) region, so that the increasing richness of nucleon quark/gluon content first seen last year is both continued and accelerated. This hints at a large variation in gluon content for the proton. A flat gluon content can be ruled out under these conditions.

Another continuing feature of the HERA data is the 'rapidity gaps', the kinematical bunching which suggests that sometimes the incoming electron probes the proton 'diffractively' - analogous to what happens in elastic scattering.

This could be due to the 'pomeron' which mediates the 'bounce' of elastic scattering (March 1992, page 4). The pomeron might be made of hard gluons, the carrier of the inter-quark force, but carrying no net quark/gluon labels.

Experiments at lower energies have long been searching for 'glueballs' - particles made of glue but no quarks. In his survey of light particle

Glasgow papers on line - Mick Draper (right) and Jean-Yves le Meur of CERN's Document Handling group.



spectroscopy, Claude Amsler of Zurich had displayed new scalar states from the Crystal Barrel experiment at CERN's LEAR low energy antiproton ring which reinforce the case for glueballs.

Darriulat warned against expecting a single 'golden' glueball, and looked forward to new understanding from the emerging spectroscopy of gluon-rich states.

Elsewhere

The Glasgow neutrino content largely echoed what had been said at the Neutrino 94 meeting in Eilat (September, page 2). However post-Eilat were new results - from Beijing of the tau-neutrino mass limit at 29 MeV, from the Swiss PSI Laboratory of the muon-neutrino mass limit at 160 keV (see page 14), and from a Russian study of the tritium beta-decay spectrum indicating an electron-neutrino mass limit of 4.5 electronvolts. Insight from this Russian mass study could help understand the puzzling negative mass-squared numbers coming in from other mass surveys.

In theory, hot news in Mike Green's field and string theory overview was the proposal from Ed Witten and Nathan Seiberg for a fully analytic two-dimensional supersymmetric theory. Green wondered whether the tumultuous physics conditions at the horizon of black holes could probe the otherwise unattainable 'Planck' energy range where a new range of force unification should set in.

Highly entertaining and scientifically informative was Rocky Kolb's summary of astro-particle physics, while Michal Turala's overview of new detectors and experimental techniques showed the impressive progress being made to meet new physics challenges.

'The future is too important to be left to the experts,' observed Maury Tigner in his survey of the accelerator scene.

Marking the break between the initial parallel sessions and the final plenaries, a keynote address by Robert Hughes, the UK's new Under-Secretary for Public Service and Science, emphasized that in the intense competition for funding, top quality science needed sound forward planning and should provide good value for money.

The Glasgow meeting, catering for close on a thousand physicists and with four streams of parallel sessions, was memorably organized by a project team under David Saxon. A feature of the meeting was the availability of conference papers through CERN's preprint server.

During the Conference, a meeting of the sponsoring International Union of Pure and Applied Physics (IUPAP) committee decided that the venue for the next Rochester, from 25-31 July 1996, would be Warsaw.

Report by Gordon Fraser

Glasgow on-line

For the Glasgow Conference, the Document Handling group of CERN's Administrative Services Division collaborated with the organizers to setup an electronic database for all submitted abstracts/papers. Papers submitted in TeX were converted into PostScript while those received as manuscripts were scanned and converted into appropriate TIFF format. This electronic database was accessed via the CERN Preprint server, which uses World Wide Web (WWW). Anyone with access to WWW could consult the list of abstracts, ordered by parallel session, and, if the paper had been supplied, view the text. Information on contact people and speakers was also available. The transparencies of the Glasgow plenary talks are now public on WWW.

Around the Laboratories

CERN
Producing radioactive beams

Accelerating radioactive beams has long been of interest at CERN's ISOLDE on-line isotope separator - the possibility was discussed at a CERN Workshop on intermediate energy physics as early as 1977. Meanwhile, as was highlighted in the 1991 report of the Nuclear Physics European Collaboration Committee (NuPECC - March 1992, page 1), widespread scientific interest in these beams has developed and a range of projects are proposed, under construction or operational throughout the world.

The bottleneck in these projects is the production of multiply-charged radioactive ions beams, since the efficiency and cost of an accelerator is directly related to the charge/mass ratio of the ions to be accelerated.

While most projects are installing an Electron Cyclotron Resonance (ECR) ion source in the rather hostile environment of the production target, the ISOLDE group, in collaboration with specialists from Stockholm's Manne Siegbahn Laboratory, Saclay's Saturne Laboratory and the Max Planck Institut at Heidelberg, is contemplating a different approach. Here the low-energy ISOLDE beams would be injected into an Electron Beam Ion Source (EBIS) system acting a charge state breeder and - in some cases - as an ion buncher.

In an EBIS system, a dense electron beam focussed by a strong magnetic field radially confines the ions, which are controlled axially by voltages applied to cylindrical electrodes. Particles undergo successive further ionizations by electron impact, increasing the ionic charges. Extraction can be precisely timed, giving a good handle on the output ionic charge. These sources are widely used in atomic physics and as injectors.

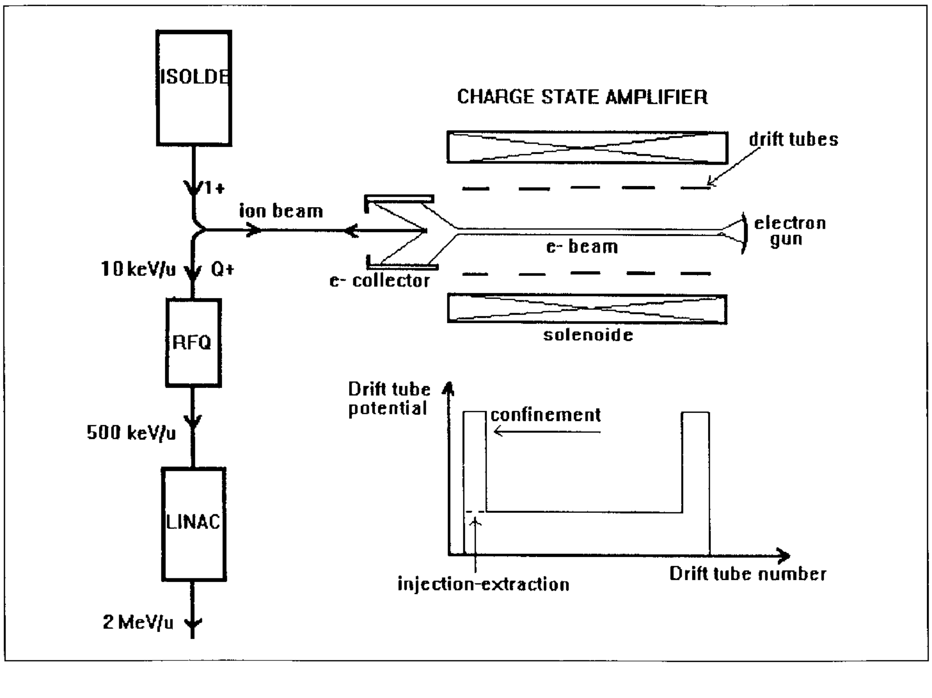
In the new ISOLDE scheme, the low-energy singly-charged beams would be injected into an EBIS system in the experimental hall. After charge state breeding the multiply charged ions are extracted and injected into an accelerator consisting a 4-rod RFQ followed by a matching section and a linac with five 108 MHz 7-gap resonators (similar to the high current injector of MPI Heidelberg). The RFQ takes ions from 10 to 500 keV/nucleon, while the linac can furnish beams from 0.5 to 2 MeV/nucleon.

In this scheme, low-energy singly-charged ion beam production builds on the vast ISOLDE experience and obviates the need to install delicate equipment like high charge state ion sources in the hostile high-radiation environment around the target of an on-line separator.

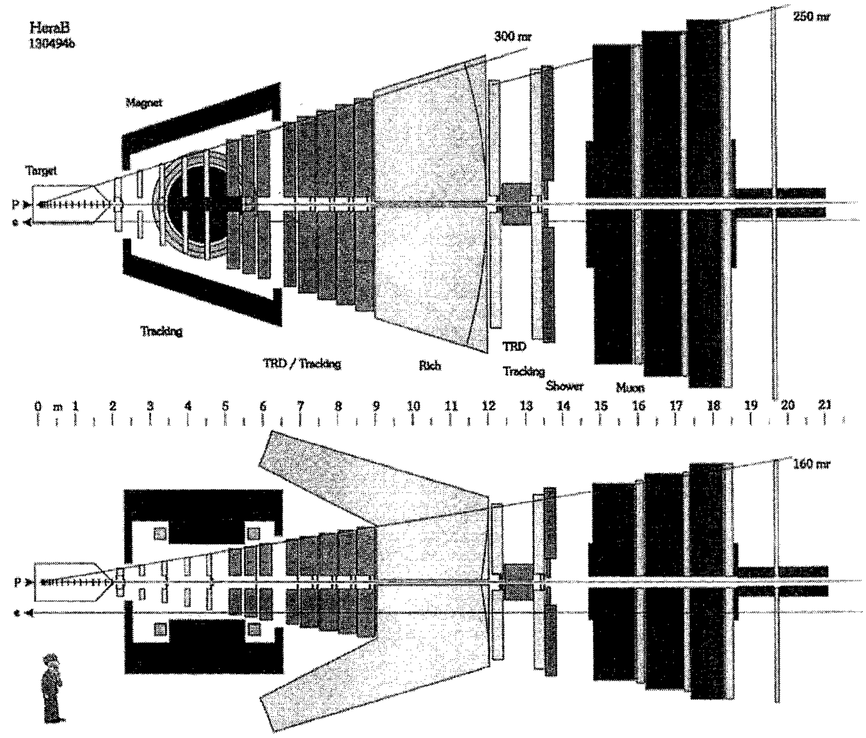
The improved ISOLDE yields at the 1 GeV Booster for isotopes far from the line of stability add substantially to the physics potential.

The EBIS device and the external ion injection scheme have been initially tested at the Manne Siegbahn Laboratory, Stockholm, using 100 microsecond pulses of nitrogen 1^+ ions. After being trapped for about 200 milliseconds, the nitrogen ions are effectively fully stripped of electrons.

The efficiency, defined as the fraction of injected ions finally extracted was a useful 14.5%. More recently these results have been confirmed at Saclay using beams of argon as well as nitrogen.



Schematic of a proposed scheme to produce energetic radioactive beams at CERN's ISOLDE on-line isotope separator, with the low-energy ISOLDE beams injected into an Electron Beam Ion Source (EBIS) system (right) acting a charge state breeder and ion buncher.



The HERA-B detector, using an internal target in HERA's proton ring.

DESY
HERA-B, fourth HERA experiment

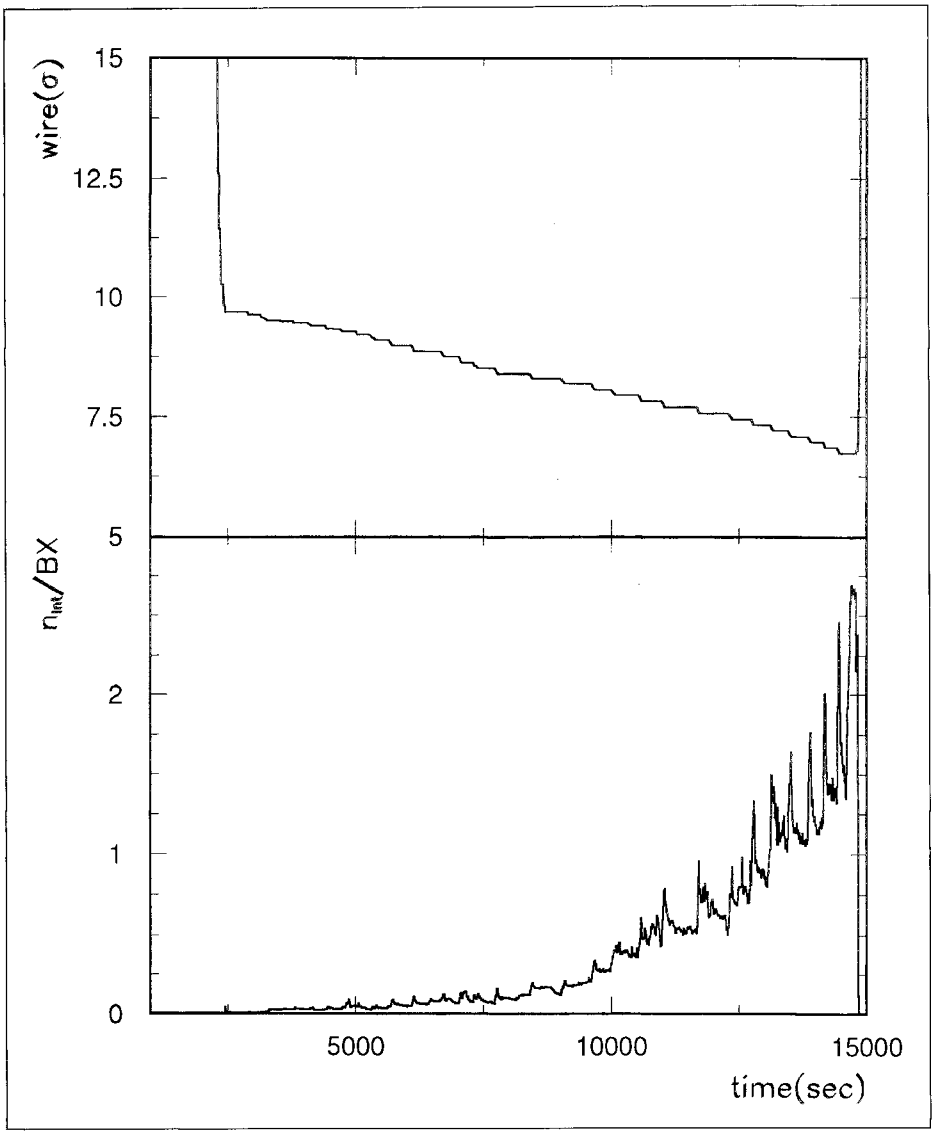
The phenomenon of CP violation (the subtle disregard of physics for invariance under simultaneous particle-antiparticle and left-right reversal, observed so far only in decays of neutral kaons) is one of the very fundamental issues in particle physics. The availability of neutral B mesons - particles composed of a heavy beauty quark and a light down quark - provides a fresh arena for observing CP violation, opening up new tests of theories on the origin of this mysterious effect. CP violation in B decays is now the target of a number of major initiatives all around the world.

One approach, which emerged about two years ago, is to use DESY's HERA proton ring as a source of B mesons, operated as a fixed target accelerator by installing an internal target inside the machine vacuum. (HERA, with two separate rings, was designed to provide electron-proton collisions.) A group centred around the old ARGUS collaboration at DESY's DORIS ring submitted a Letter of Intent for "An Experiment to Study CP Violation in the B System Using an Internal Target at the HERA Proton Ring", followed in 1994 by a detailed proposal. This June, the DESY directorate approved the experiment on the condition that the collaboration finds sufficient resources to build the detector in a timely fashion.

Using the HERA proton ring for a fixed-target experiment is made possible by the fact that a stored beam is always accompanied by halo particles which diffuse outward and eventually hit the beam pipe or the collimator system. In the HERA-B setup, thin wires positioned inside the machine vacuum serve as a target for these halo protons and provide well-localized, high-intensity source. Since CP violating decays of B mesons are rare, HERA-B aims for very large interaction rates of about 30 to 40 MHz, corresponding to 3 to 4 interactions in each proton bunch crossing the target. Prototype halo targets have been tested over the last two years, and have demonstrated that sufficient rates can be reached.

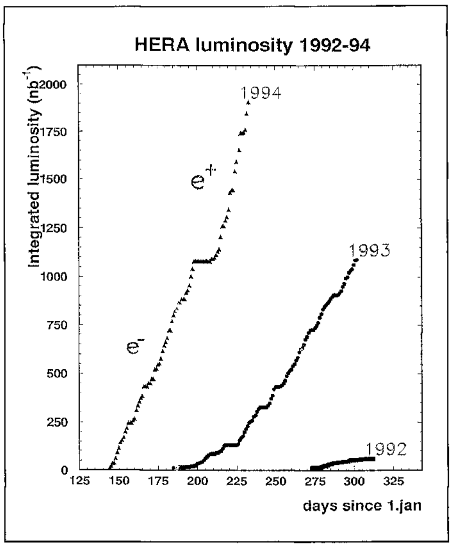
At first glance, the proposed HERA-B detector looks like a normal fixed target detector, with a silicon vertex detector, followed by a magnetic spectrometer with a dipole magnet and tracking chambers, a ring imaging Cerenkov counter (RICH) for particle identification, an electromagnetic calorimeter and a muon detector system. The challenge resides in the huge number of particles entering the detector - over 10^9 per second. In many aspects, the requirements of the HERA-B detector correspond to those of detectors at LHC, and HERA-B construction necessarily exploits the extensive R&D carried out towards LHC.

A particular challenge is the trigger system, which has to locate among 10 million bunch crossings per second those 100 or so most likely to contain interesting B meson decays. The HERA-B group has chosen to concentrate on B decays with a particularly clean signature, namely those producing a J/psi meson decaying into a lepton pair. This channel has the additional advantage that theoretical predictions of CP asymmetries are particularly clean and model- independent.



Test run of an internal target in the proton ring of DESY's HERA collider. Top: distance between the target wire and the beam, in units of the beam width, as a function of time. Bottom: mean number of protons interacting in the wire target per bunch crossing. The HERA-B experiment aims for four interactions per crossing at design current, consistent with the rate of about two interactions per crossing reached in these tests at 30% of the design bunch current.

With less frequent need to inject, accumulated luminosity should also build up faster than before.



Rapid growth in HERA proton-electron luminosity at DESY following the introduction of positrons in the collider's 'electron' ring.

The present schedule calls for the installation of first detector prototypes and the spectrometer magnet in HERA in the winter shutdown 1995-6, with a complete detector available for the 1998 run. With a bit of luck, after just one year of running HERA-B could see evidence for CP violation in the B system, in addition to a broad programme of other topics in heavy- quark physics.

The HERA-B proponents are now seeking to enlarge their collaboration. An "Open Collaboration Meeting" at DESY from 4-6 October is a major milestone towards the formation of the final collaboration. The collaboration will submit a technical design report by the end of the year which should provide the basis for a final approval early in 1995. For further information: A.S. Schwarz, DESY-F15, Notkestr.85, D- 22603 Hamburg, Phone:+49-40-89 98 2524; fax: +49-40-89 94 4306; e-mail: schwarza@x4u2.desy.de

HERA gets better

Following the introduction of positrons in its 'electron' ring, luminosity at the HERA proton-electron collider, DESY, Hamburg, has attained 4.7 x 10^{30} cm^{-2} s^{-1}, 31% of the design figure of 1.5 x 10^{31}, and is still improving.

With electrons, filling had to start with very low currents (2.5 mA) due to deleterious effects (probably due to electrons absorbed by residual impurity ions). With positrons, relatively immune to positive ions, the current has already given 32 mA - 55% of the design value, while protons are now at 35% of the design current with 55 mA.

CORNELL
More penguins in upstate New York

A major physics result last year (June 1993, page 1) was the sighting by the CLEO collaboration working at Cornell's CESR electron-positron collider of rare events where a B particle (containing the fifth - 'beauty' quark) decays into a particle containing a strange quark.

These 'penguin' processes cannot be mediated by the single quark transformations of ordinary weak decays, needing instead two such quark transformations coupled back-to-back. Proceeding through this secondary route, 'penguin' processes can play a major role in the delicate CP violation

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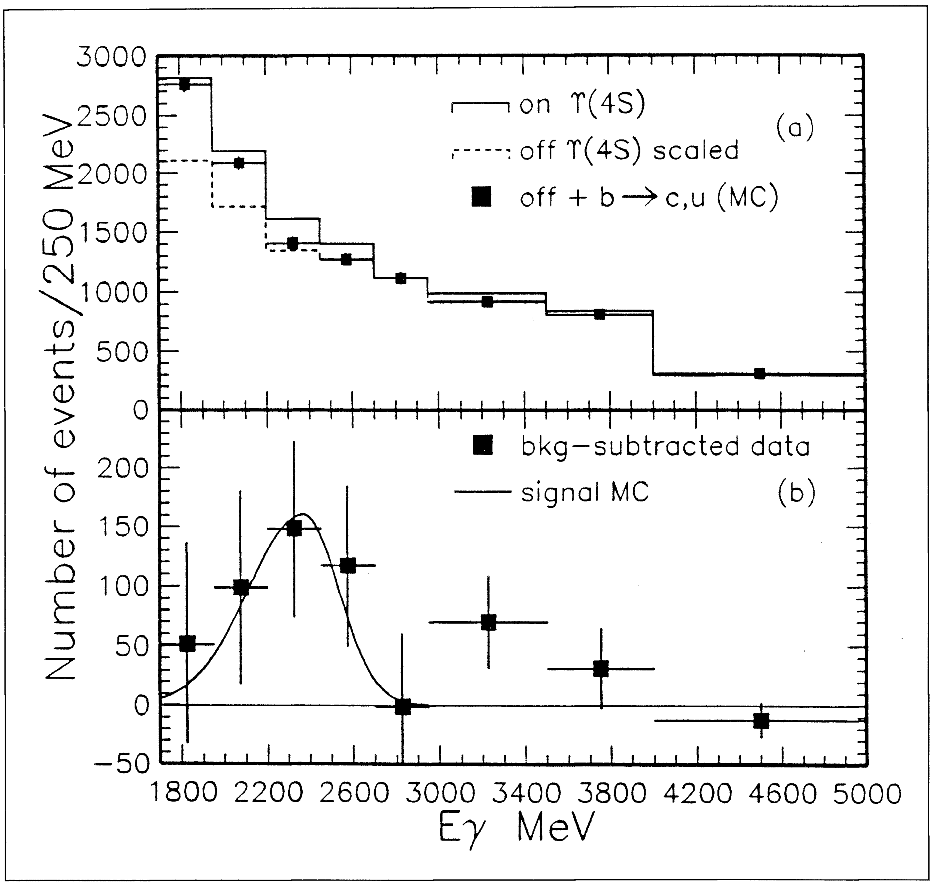
More penguins. The CLEO detector at Cornell's CESR electron-positron collider reveals a clear excess signal of photons from rare B particle decays, once the parent upsilon 4S resonance has been taken into account. The convincing curve is the theoretically predicted spectrum.



seen in neutral kaon decay.

CP violation - the disregard at the few per mil level of a invariance of physics with respect to a simultaneous left-right reversal and particle-antiparticle switch - has been known for thirty years. While the basic equations of physics could otherwise run equally well forwards or backwards, CP violation imposes a definite direction to the arrow of time and could have played a major role in shaping the Universe as it emerged from the Big Bang.

The penguin process seen at Cornell last year was the decay of a B meson into a K* meson (mass 892 MeV) and a photon. The K* is only one example of a penguin beauty-strange quark transition - in principle a whole range of strange particles can emerge. Drawing physics conclusions from the K* example was therefore difficult.

Now the CLEO group has collected all such events producing a photon with energy between 2.2 and 2.7 GeV. This sample implicitly includes the whole range of produced strange-quark states, and is therefore more accessible to theoretical analysis.

Separate analyses (neural net and B reconstruction) clearly display the excess signal of photons from the penguin processes.

The branching ratio of some two parts in ten thousand is in excellent agreement with the Standard Model. When combined with other precision Standard Model results, it already rules out a range of low masses for possible charged higgs particles that could be at the root of the symmetry breaking mechanism which drives the Standard Model.

PSI
Muon-neutrino and pion masses

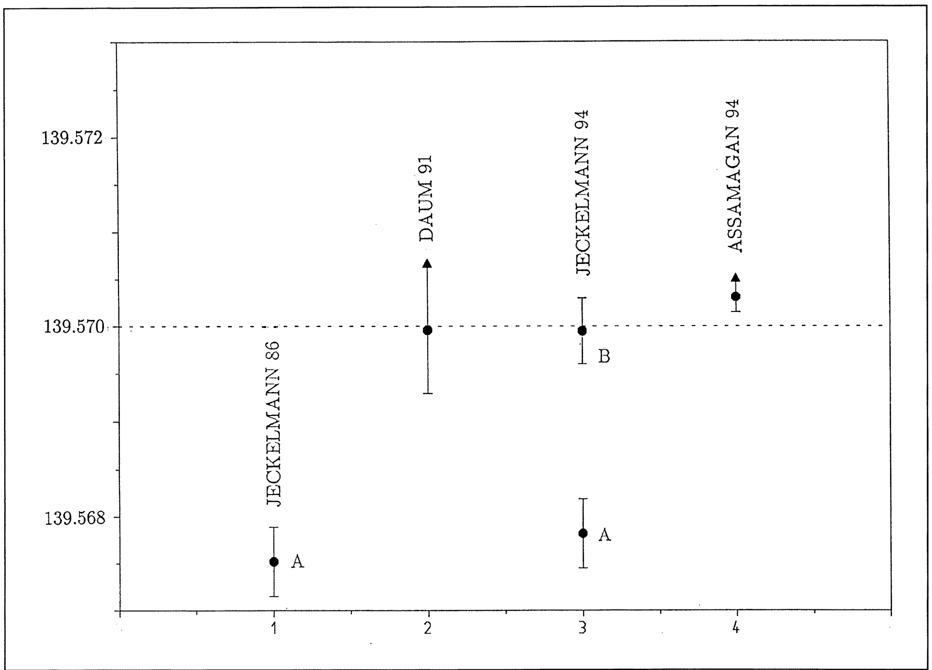
Two experiments at the Swiss Paul Scherrer Institute (PSI) in Villigen have recently led to more precise values for two important physics quantities - the masses of the muon-type neutrino and of the charged pion.

The first of these experiments - B. Jeckelmann et al. (Fribourg University, ETH and Eidgenoessisches Amt fuer Messwesen) was originally done about a decade ago. To fix the negative-pion mass, a high-precision crystal spectrometer measured the energy of the X-rays emitted in the 4f-3d transition of pionic magnesium atoms. The result (JECKELMANN 86 in the graph, page 16), with smaller errors than previous charged-pion mass measurements, dominated the world average.

In view of more recent measurements on pionic magnesium, a re-analysis shows that the measured X-ray line leads to two possible negative-pion masses - JECKELMANN 94(A) or (B) - separated by 15 parts per million. The two solutions use different electron-screening corrections, the strongest component of the X-ray line being attributed to the presence of one or two K-electrons, respectively. The 1986 measurement of the pion mass was based on solution A, favoured at that time by the available pionic-magnesium data.

Additional information on the charged-pion mass was recently

Charged-pion mass (vertical axis) results obtained at PSI. The values 1 and 3 are from pionic-magnesium X-ray data (A,B: different electron-screening corrections); the results 2 and 4 are based on the muon mass and the momentum of muons from pion decay at rest. Taken together, the 1994 results imply a pion mass close to 139.570 MeV, larger than the previous world average.



contributed by another precision experiment at PSI - K. Assamagan et al. (PSI, Zurich University, ETH, University of Virginia), in which the momentum of muons from the decay of positive pions at rest into a muon and a muon-neutrino was measured by a new technique. Muons in a surface muon beam, originating from stopped pion decays at the surface of a pion production target at the 590 MeV proton accelerator, are momentum analysed in a magnetic spectrometer. The resulting muon momentum of 29.79207(12) MeV/c is consistent with the 1991 PSI measurement of M. Daum et al., using a positive pion beam.

The new muon momentum value and the muon mass lead to the charged-pion mass ASSAMAGAN 94. In the graph, the pion mass value indicated by a filled circle and the uncertainty given by the lower error bar are obtained if the muon-neutrino mass is assumed to vanish, while larger pion mass values are obtained for non-zero neutrino masses. The pion-mass result ASSAMAGAN 94 is consistent with JECKELMANN 94(B) but excludes JECKELMANN 94(A) by 6.2 standard deviations, thus confirming the conclusions of the earlier muon-momentum measurement DAUM 91 with improved significance.

The 1994 results of the two experiments together yield a charged-pion mass close to 139.570 MeV, significantly higher than the previous world average. The neutral-pion mass is also affected, as this is obtained by subtracting the pionic mass difference of 4.5936(5) MeV from the charged-pion mass.

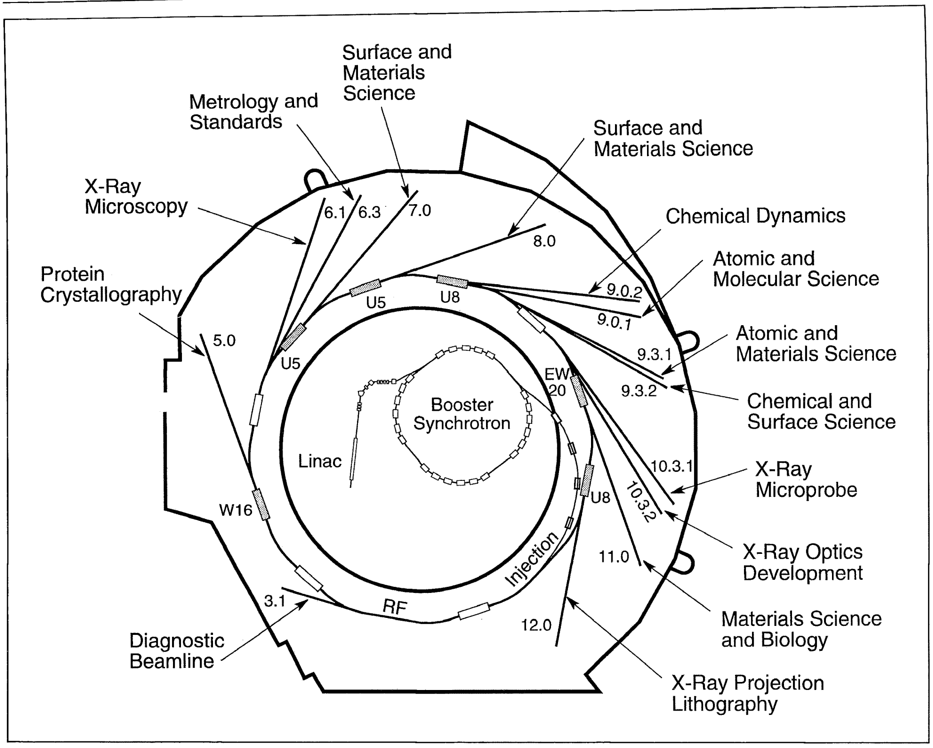
The muon-neutrino mass is derived from the charged-pion mass JECKELMANN 94(B) (which in contrast to JECKELMANN 94(A) is consistent with DAUM 91 and ASSAMAGAN 94), together with the muon momentum mentioned above and the muon mass. A muon neutrino mass squared of -0.022(23) MeV^2 yields an upper limit for the muon neutrino mass of 0.16 MeV (90% confidence level). This is interesting as certain non-standard models allow unstable muon-neutrinos with masses above about 100 keV.

BERKELEY Light Source anniversary

The staff of the Advanced Light Source (ALS) at the Lawrence Berkeley Laboratory has been too busy to celebrate the first anniversary of the facility's transition from a US Department of Energy construction project to operating third-generation synchrotron radiation source. Based on a 1.5-GeV, low-emittance electron storage ring that accommodates up to ten insertion-device radiation sources optimized primarily for the soft X-ray and vacuum ultra-violet regions of the spectrum, the ALS has completed.

A year ago, we reported the blistering pace set by accelerator physicists, operators, and engineers as the storage ring surpassed many of its performance goals in the first six weeks of operation (June 1993, pages 8-9). In particular, the maximum observed storage-ring current of 457 mA - reached at the end of April 1993 - was well beyond the design goal of 400 mA for the normal multibunch mode of operation. Although there is no readily recognizable barrier to reaching significantly higher current, the policy has been to operate at the design value.

After this initial round of successes, the ALS went into a lengthy shutdown from May through August 1993. This saw the installation of the first two insertion devices and undulators for beamlines 7.0 and 8.0,



After only one year of operation, the Advanced Light Source (ALS) at the Lawrence Berkeley Laboratory is already up and running for more than 90% of the scheduled time.
Locations of the beamlines currently identified to come on line during 1993-6 are indicated on the floor plan according to their general research areas. U and W refer to undulators and wigglers, with the number representing the period length in centimetres. Beamlines are designated according to the convention X.Y.Z, where X is the sector number, Y is the port number, and Z is the branch number. There are 12 sectors and four available ports per sector. Port 0 is the insertion-device port; ports 1, 2, and 3 are bend-magnet ports.

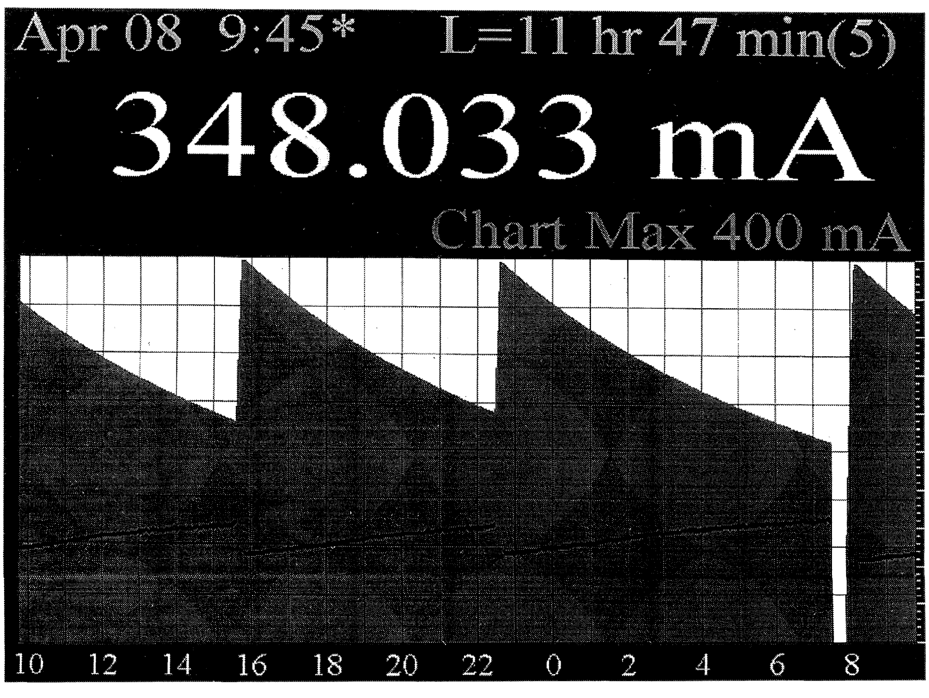
as well as beamline hardware. But a number of storage-ring tasks were also completed that proved critical in the next phase of commissioning. These included surveying and precisely realigning the ring, baking out the vacuum chamber, and installing two important new diagnostic systems. The first of these was a system of transverse kickers that allows betatron motion to be driven resonantly, so that betatron tunes can be measured. The other was diagnostic beamline 3.1, providing an image of the electron beam.

From September 1993 through April 1994, operations were shared between accelerator development and user shifts. Light was provided to the first beamline (bend-magnet beamline 10.3) in October, when accelerator physics and operations teams made major advances in the areas critical for user acceptance: beam-emittance (less than 5 nm-rad horizontal and less than 0.2 nm-rad vertical), beam lifetime (11 hours at 400 mA), beam stability (may not need active beam-position feedback systems), compensating for the effects of undulators on the beam, and operating at energies other than 1.5 GeV over the range from 1.3 to 1.9 GeV.

Adding to these achievements, the ALS has turned out to be reliable and robust. With present funding, it can operate five days per week. The present schedule comprises 14 shifts per week from Monday through Friday (1 startup, 1 maintenance, 3 accelerator physics, and 9 user). For the first four months of 1994, the ALS was available for users 92.2 percent of the scheduled time, and, for the months of March and April, was available an incredible 95 percent of the time.

The problem of most concern now is beam energy spread, probably due to a longitudinal multibunch instability, causing the spectral broadening of the undulator third and fifth harmonics at high electron current. For example, in the multibunch mode, the harmonics are broadened by 0.5% at 50 mA and 0.7% at 400 mA. In collaboration with the Stanford Linear Accelerator Center and the LBL Center for Beam Physics, feedback systems are being developed to damp the very fast longitudinal oscillations observed during multibunch operation. Since there is evidence that the damping of the longitudinal oscillations may result in the increased prominence of now negligible transverse oscillations, development work uses a transverse feedback system.

In a six-week shutdown period that began on 1 May, a third undulator was installed in beamline 9.0, front ends were put in place for bend-



Recording of the ALS storage-ring beam current during a 24-hour period in April illustrates the steady performance of the storage ring with an operating current (shaded area with vertical axis on the left) of 400 mA and lifetime (dark solid line with vertical axis on the right) of about 11 hours. The current is dumped daily for an accelerator check.

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Physics monitor

magnet beamlines 6.1 and 6.3, and the longitudinal kickers for the feedback system were installed to provide energy stability in the ring. In addition to continuing user experiments on undulator beamlines 7.0 and 8.0 and on bend-magnet beamline 10.3, commissioning of undulator beamline 9.0 and bend-magnet beamline 9.3.2 is underway. Light will soon be become available in bend-magnet beamlines 6.1, and 6.3.

ALS information is now available electronically via World Wide Web - go directly to the Universal Resource Locator (URL) for the ALS home page - http://beanie.lbl.gov:8001/als/als_homepage.html. Information available includes the schedule for operations and information about ALS performance.

Quark matter

Precisely one decade ago the GSI (Darmstadt)/LBL (Berkeley) Collaboration at the Berkeley Bevalac reported clear evidence for collective sidewards flow in high energy heavy ion collisions. This milestone observation clearly displayed the compression and heating up of nuclear matter, providing new insights into how the behaviour of nuclear matter changes under very different conditions.

This year, evidence for azimuthally asymmetric transverse flow at ten times higher projectile energy (11 GeV per nucleon gold on gold collisions) was presented by the Brookhaven E877 collaboration at the recent European Research Conference on "Physics of High Energy Heavy Ion Collisions", held in Helsinki from 17-22 June.

Such flow is predicted to show up also in experiments at the CERN SPS when lead beams become available this year. Strong changes due to the phase transition threshold are expected if the thermodynamics of the long-awaited phase transition to Quark-Gluon Plasma (QGP) is strongly first order.

Phase transition

Not only the existence of a QGP phase transition, but also the thermodynamical nature of the transition itself is crucial. Lattice calculations, reviewed by Hildegard Meyer-Ortmans and Helmut Satz, are presently limited to small volumes, where naively no phase transition can exist or be detected.

However the probability distribution of the energy density may reveal the expected behaviour even in finite volume calculations. In experiments, large colliding systems - heavy beams and high energy - provide the most favourable conditions.

For QGP formation, phase transition dynamics is also a key issue. As Keijo Kajantie pointed out, neither

Hans Bøggild, centre, convener of the nightly Helsinki 'Quark Matter' poster sessions, with performance winners Yingchao Zhang (right, of Stony Brook, best poster presentation) and Leonid Razumov (Marburg, best entertainment value).

Johann Rafelski dispenses wine during heavy ion discussions at Helsinki.

finite volumes nor short time scales hinder the application of the theory to the early Universe.

At Helsinki, Miklos Gyulassy discussed fluctuations in a phase transition in a small system, where the initial quark and particularly gluon distributions may vary strongly. This could also lead to observable signatures - fluctuations in the neutral/ charged pion ratios or through pion interferometry. H. Satz recommended the J/psi, broken up by deconfined gluons, as a probe.

No transition?

Until it is convincingly proven experimentally, the phase transition remains a suggestion. Some theorists attempt to describe all observed phenomena in terms of conventional hadronic behaviour. The decrease of effective hadronic masses in dense matter is a central assumption of this approach. Robert Pisarski pointed out that the expected decrease of effective masses may be false, and presented an example where the rho mass increases with increasing density and temperature. Such variations can be uniquely studied by lepton-pair experiments, where Roberto Salmeron summarized the experimental data on vector meson production.

Strangeness

The increased strangeness signal is well and alive, particularly where strange antibaryons are concerned. Several groups measured strangeness enhancement or performed strangelet searches. The excess over proton data is obvious and rather consistent between different experiments, and discussions revealed that even the most sophisticated models cannot reproduce the strange antibaryon production unless exotic behaviour is incorporated. Although QGP scenarios are supported by the data, as pointed out by Jan Rafelski, a detailed dynamical model still needs to be worked out.

Interferometry

With the advent of second generation experiments on both sides of the Atlantic, two particle correlation studies now focus on high statistics as well as on clean particle identification, leading to detailed comparisons of pion and kaon correlations.

The substantial experimental data, presented by Hans Bøggild, needs proper treatment of various dynamical processes and contributions from resonances. New attempts in this direction may help unravel the information from many different correlations.

Photons and leptons

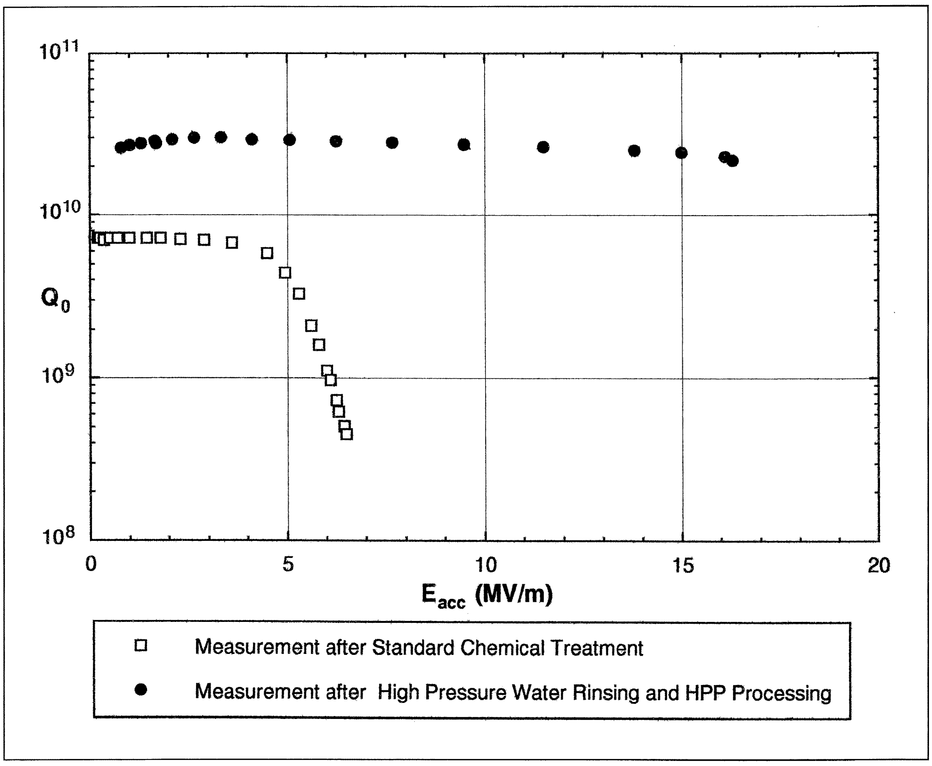
Electromagnetic probes - measured as real and virtual photons - are the only QGP signal that would reach the detectors directly, but are very rare, pointed out Vesa Ruuskanen.

Four experiments at CERN aiming to look for this signal were reviewed by Karl-Heinz Kampert. Preliminary data indicate an excess over known hadronic sources in central collisions, and are compatible with background in peripheral and proton-nucleus collisions.

This dominant photon contribution is believed to originate from the hadronic phase, with some additional lepton pair contribution, possibly due to enhanced charm production.

To account for the photon yields, the system is required to rest for a significant time at a temperature close to the critical one, a picture supported by the observed slope of the prompt photon transverse momentum spectrum. If this signal persists, it could be an indication for hadronic matter at its boiling point.

After high pressure water rinsing and high peak power (HPP) radiofrequency treatment at DESY's TESLA Test Facility, promising accelerating fields have been produced by prototype superconducting cavities for a proposed TeV Superconducting Linear Accelerator (TESLA).



The existence and particularly the experimental verification of a phase transition should be easier to see in larger nuclear systems and/or higher beam energies. The next round is the lead beam experiments which begin at CERN's SPS this year, with a longer term view at Brookhaven's RHIC collider and subsequently the LHC at CERN.

As Ingvar Otterlund pointed out in his opening address, the European Research Conference could also demonstrate the healthy age distribution in the field. Among the 110 participants, almost half of the researchers were still below 35.

From L. Csernai and K.H. Kampert

Linear Colliders TESLA

The aim of the TESLA (TeV Superconducting Linear Accelerator) collaboration (at present 19 institutions from seven countries) is to establish the technology for a high energy electron-positron linear collider using superconducting radiofrequency cavities to accelerate its beams. Another basic goal is to demonstrate that such a collider can meet its performance goals in a cost effective manner.

For this the TESLA collaboration is preparing a 500 MeV superconducting linear test accelerator at the DESY Laboratory in Hamburg. This TTF (TESLA Test Facility) consists of four cryomodules, each approximately 12 m long and containing eight 9-cell solid niobium cavities operating at a frequency of 1.3 GHz.

The infrastructure to process and test these cavities has already been installed. This heroic work calls for scrupulously clean conditions to avoid contamination which would otherwise mar performance. The facility thus includes a complex of clean rooms, an ultraclean water plant and a chemical etching installation for cavity surface preparation and cavity assembly. To improve the cavity performance a firing procedure at 1500 C in an ultrahigh vacuum furnace is foreseen.

Radiofrequency power will be provided by a 4.5 MW klystron (pulse length 2ms) in connection with a modulator, built by Fermilab. This system is also used for a high peak power radiofrequency treatment (HPP) to further improve cavity performance by eliminating potential sources of field emission. For cavity testing, an existing cryogenic plant has been modified to cool the cavities to 1.8 K and measure them in vertical and horizontal test cryostats, provided by Fermilab and Saclay respectively.

Prototype cavities have been already delivered to DESY and are presently being used to commission the complete infrastructure. First measurements indicate that cavity performance can be drastically improved by advanced surface processing techniques like high pressure water rinsing developed at CERN and high peak power radiofrequency treatment developed at Cornell. Further improvements are expected from high temperature cavity annealing in the UHV furnace. The initial TTF goal is an accelerating field of 15 MV/m at a resonance (Q) value of 3×10^9.

The first series cavities for the TTF arrived in September and initial beam tests of a complete TESLA cryomodule (constructed by INFN Frascati/Milan/Rome) with an injector

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Colliding muons

Is a muon-muon collider really practical? That is the question being asked by Bob Palmer. Well known in particle physics, Palmer, with Nick Samios and Ralph Shutt, recently won the American Physical Society's Panofsky Prize (March 1993, page 26) for their 1964 discovery of the omega minus. As well as contributing to other major experiments, both at CERN and in the US, he has contributed ideas to stochastic cooling and novel acceleration schemes.

Earlier this year he gave a series of CERN academic lectures on electron-positron colliders. Such machines with collision energies up to 1 TeV seem relatively practical, but, because of energy loss due to synchrotron radiation, must be linear (which makes them expensive) and suffer from additional energy loss (beamstrahlung) at their collisions.

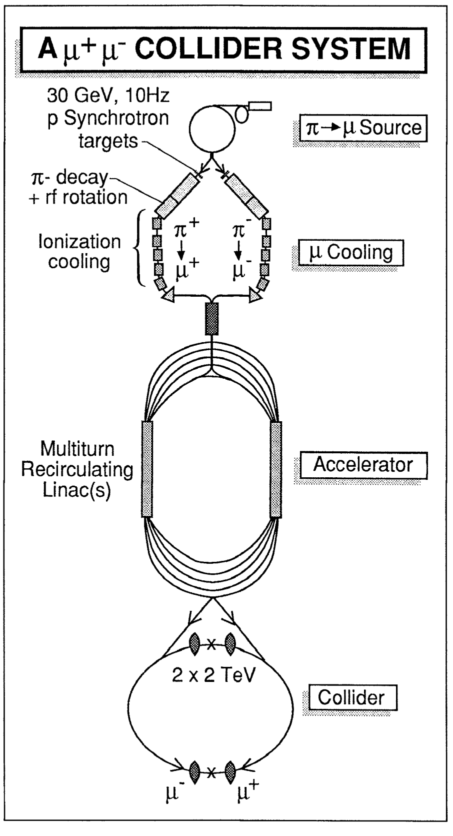
An alternative approach would be a muon-muon collider, with synchrotron radiation suppressed by the 'heavy' muons - more than two hundred times heavier than electrons. The machine could be circular, much smaller than an electron machine of the same energy, and could give a comparable luminosity.

Muon colliders were first proposed by A.N. Skrinsky (in the 60s), using Gersh Budker's ionization cooling ideas to control the muons. He and others have proposed various parameter sets, but no complete scenario has been presented. This year David Neuffer and Bob Palmer presented one.

With a small group at Brookhaven, they have started to simulate the production, transport and cooling of the muons. Using a realistic proton source (like that proposed for the Vancouver KAON machine), realistic targeting (such as used in CERN's antiproton scheme) and ionization cooling using current-carrying rods, they calculate a luminosity of 3×10^{34} $cm^{-2} sec^{-1}$ at a beam energy of 2 TeV.

Such a machine would be of moderate size (it might fit in a Fermilab-size ring of some 6 kilometres). It appears to use more or less conventional technology, and might be almost an order of magnitude cheaper than an electron machine of the same energy.

However unlike electrons, muons are not stable, and decay into electrons and neutrinos. The greatest problem may be background in the detectors due to these decay electrons. The proponents of the idea are looking into this and other problems and are hoping to form a collaboration to look in more detail at all aspects of this proposal, and to perform an experiment to demonstrate the feasibility of ionization cooling.



Possible muon collider, as envisaged by Dave Neuffer and Bob Palmer, with the muon beams (from the decay of pions) controlled by ionization cooling before injection into a multi-turn recirculating linac arrangement, à la CEBAF, before finally being prepared for collision.

New body starts independent advisory work for EU Commission

The new European Science and Technology Assembly (ESTA) had its first General Assembly on 6-7 September in Brussels. According to Commissioner A. Ruberti, the European Union's 'Minister' for science, technology and higher education, who has been largely responsible for ESTA's creation, the tasks of the new and independent Assembly of Scientists are to give opinions and advice and to help the European Commission implement the EU research policy.

The EC's first request was for advice regarding the 4th Framework programme 1994-98 (preliminary 'expressions for interest' in view of formal calls for proposals for the 13 specific R & D programmes are being announced and the first formal calls are expected before the year's end). The Assembly indicated that it intends to review work programmes, including scientific referee procedures for proposals (these have not yet been announced although a draft for simplified proposal forms has been published this summer in order to solicit constructive criticism from potential users).

Some nine working parties are therefore being set up right away to examine groups of specific programmes as well as each of the three remaining 4th Framework activities, which - for the first time - includes all R & D activities of the European Union (international cooperation, dissemination of information and the Human Capital and Mobility follow-on).

J. Borgman, formerly Professor of Astronomy at the University of Groningen and currently President of the Dutch national research council (The Netherlands Organization for Scientific Research: NWO in Dutch) was elected as the President of the Assembly. ESTA has some 100 members nominated ad personam, including the entire CODEST (Committee for the European Development of Science and Technology) committee of some 27 scientists that has among other activities been responsible for the scientific peer-reviewing of proposals to the 3rd Framework's Human Capital and Mobility Programme and, with ESTA now in place, will cease its activities at the end of the year.

Also included are the three advisors to A. Ruberti: the molecular biologist F. Gros, chemist I. Prigogine and former CERN Director General Carlo Rubbia. On proposal by the CERN management the Commission also nominated CERN's former Technical Director Hans F. Hoffmann. ESTA elected half of the members of a 20-person bureau chaired by Professor Borgman with the ESTA Vice-Presidents D. Donnelly from University College, Dublin and H. Danielmeyer, a Senior Vice-President at Siemens and President of the German Physical Society.

The bureau's 10 remaining members are ex officio nominated by the Commission from among members proposed by major european organizations in the field of R & D and include: Ansaldo's Vice-President for research, S. Barabaschi, European Science Foundation President D. Rees, the President of the European Rectors Conference, H. Seidel, and the Vice-Chairman of the European Council of Applied Sciences and Engineering, R. Bryssinck. The ESTA General Assembly will meet next in December.

CERN's 40 anniversary

CERN's 40th anniversary was celebrated in style with a site-wide gala on Saturday 17 September. The accent was on interest and fun for staff and their families. Some 15,000 turned up to enjoy a full programme of entertainment, demonstrations and exhibitions. Photo coverage and speech extracts will feature in our November issue.

External correspondents

Argonne National Laboratory, (USA)
D. Ayres

Brookhaven, National Laboratory, (USA)
P. Yamin

CEBAF Laboratory, (USA)
S. Corneliussen

Cornell University, (USA)
D. G. Cassel

DESY Laboratory, (Germany)
P. Waloschek

Fermi National Accelerator Laboratory, (USA)
J. Cooper, J. Holt

GSI Darmstadt, (Germany)
G. Siegert

INFN, (Italy)
A. Pascolini

IHEP, Beijing, (China)
Qi Nading

JINR Dubna, (Russia)
B. Starchenko

KEK National Laboratory, (Japan)
S. Iwata

Lawrence Berkeley Laboratory, (USA)
B. Feinberg

Los Alamos National Laboratory, (USA)
C. Hoffmann

Novosibirsk, Institute, (Russia)
S. Eidelman

Orsay Laboratory, (France)
Anne-Marie Lutz

PSI Laboratory, (Switzerland)
R. Frosch

Rutherford Appleton Laboratory, (UK)
Jacky Hutchinson

Saclay Laboratory, (France)
Elisabeth Locci

IHEP, Serpukhov, (Russia)
Yu. Ryabov

Stanford Linear Accelerator Center, (USA)
M. Riordan

TRIUMF Laboratory, (Canada)
M. K. Craddock

Bookshelf

H. Wade Patterson and Ralph H. Thomas, editors; "A History of Accelerator Radiation Protection", Nuclear Technology Publishing Ashford, Kent, 1994 (ISBN 1870965 310).

This book is a collection of contributions on the history of accelerator radiation protection by people who have worked or still work in this field at particle accelerators around the world. The radiation environment of these machines is the most complex man-made radiation field one could face. In fact, protection efforts must cover a large spectrum of particles and energies ranging from thermal, in the case of neutrons, to the primary energy of the accelerator. Therefore the correct assessment of the exposure risk for people working in such stray radiation fields is a theme of many of the articles.

The editors deliberately refrained from guiding the authors' styles, so the book contains a collection of papers ranging from articles with literary ambitions to dry accounts on radiation protection efforts around a particular accelerator complex. Although this retains the originality of the individual contributions, one would have liked to see a somewhat more anecdotal/historical approach rather than concentrating on scientific depth.

Considering the types and energies of the radiations involved another outstanding and reoccurring issue is the question of accelerator shielding, where correct answers require considerable experimental and calculational efforts. While no shielding (it has happened!) proved to be bad, overshielding never turned out to be a problem in view of the increase in intensities that older machines have gone on to achieve.

Is this a book only for the few radiation protection specialists working in an accelerator environment? Not necessarily. The physics aspects of radiation protection (generally called health physics in the US) is always evident and makes many articles interesting to read even for the non-specialist.

The editors' epilogue proudly claims that most health physicists working around accelerators regard themselves as the élite of their profession. On the other hand the statement made by one eminent colleague - "that health physics became a little less physics and a little more metaphysics" - cannot be ignored.

By Manfred Höfert

CERN
Lead on to lead

At the end of August, CERN's PS 'proton' synchrotron added another item to its already wide repertoire when it accelerated a beam of 10^8 lead 53+ ions to 4.25 GeV/nucleon. This beam, about two-thirds of the design intensity for CERN's lead-ion experiments programme scheduled to begin later this year, was subsequently fully stripped to lead 82+ in the extraction line leading to the final link in the lead-ion acceleration chain, the SPS.

Postdoctoral Position in Quantum Field Theory University of California at Davis

The Physics Department of the University of California (UC) at Davis will have a postdoctoral opening, beginning in September 1995, in the area of quantum field theory and integrable system. The initial appointment would be for one year, with a probable extension to a second year contingent on funding and satisfactory performance.

UC Davis currently has a faculty member, Ling-Lie Chau, working on the interdisciplinary area of quantum field theory and integrable system, and two others – Steve Carlip in physics and Albert Schwarz in mathematics – with related interests.
The Physics Department also has a strong high energy group, including John Gunion, Joe Kiskis, and Tao Han. Davis is located in California's Central Valley, about 70 miles east of Berkeley.

Applications and letters of recommendation should be sent to:

Professor Ling-Lie Chau
Physics Department
University of California
Davis, CA 95616; USA

The deadline is Dec. 15, 1994, although applications received after that date may be considered if the position is not yet filled.

The University of California is an equal opportunity/ affirmative action employer.

UNIVERSITE DE LAUSANNE

La Faculté des sciences met au concours un poste de

professeur ordinaire de physique théorique

Entrée en fonction: 1.9.95 ou date à convenir.

Le titulaire devra participer à l'enseignement de la physique théorique, en collaboration avec d'autres théoriciens de l'Université et de l'Ecole polytechnique fédérale de Lausanne. A un niveau plus spécialisé, il serait souhaitable qu'il soit en mesure de donner des cours dans le domaine des champs quantiques relativistes.

Le nouveau professeur poursuivra des recherches et dirigera des thèses de doctorat dans un domaine de son choix; il est souhaité qu'il ait une solide formation et de l'expérience en physique des particules élémentaires.

Candidatures (C.V., liste de publications, tirés à part choisis-trois au plus-, projets de recherche, trois références) doivent parvenir **avant le 15/12/94** au Doyen de la Fac. des sciences, CP, CH - 1015 Lausanne. Rens. complémentaires: prof. J.-J. Loeffel, tél. +41 21 692 37 51 ou 692 37 50 fax 692 36 05, E-mail jvuille@ula.unil.ch. Rens. administratifs: Doyen de la Fac. des sciences tél. 692 35 01 fax 692 35 05.

Soucieuse de promouvoir l'accès des femmes à la carrière académique, l'Université encourage les candidatures féminines.

Research Associate Position Experimental High Energy Physics Carnegie Mellon University

The Department of Physics at Carnegie Mellon University invites applications for a Research Associate position in experimental high energy physics to work on the L3 experiment at CERN. The individual who fills this position will be based at CERN. Applicants should submit a curriculum vitae and arrange to have three letters of recommendation sent to **Professor Arnold Engler, Department of Physics, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213.**

Carnegie Mellon University is an equal opportunity / affirmative action employer.

TENURE-TRACK FACULTY POSITION THEORETICAL HIGH ENERGY PHYSICS THE OHIO STATE UNIVERSITY

The Department of Physics invites applications for a tenure-track assistant professor (or possibly tenured associate professor) position in theoretical high energy physics to begin in Autumn Quarter 1995. Candidates should have a strong background in high energy physics with significant field-theoretic foundations and demonstrated experience and keen interests in particle and/or particle/astrophysics phenomena. A commitment to teaching is also required. The theoretical high energy physics group includes: G. Kilcup, W. Palmer, S. Pinsky, S. Raby, J. Shigemitsu, K. Tanaka, and K. Wilson. There are also close ties with the theoretical astrophysics and cosmology group, including R. Boyd, R. Scherrer, G. Steigman, and T. Walker, in the Physics Department, and others in Astronomy as well as the theoretical nuclear physics group, including B. Clark, R. Furnstahl and R. Perry.
In addition, the department has a strong experimental high energy group, whose members are actively involved in CLEO II at Cornell and in Zeus at HERA. The extensive computer facilities available on campus include a Cray Y/MP and T3D supercomputers. For fullest consideration, applications, including a resume and at least three letters of recommendation, should be sent no later than February 15, 1995 to: Professor S. Raby, Department of Physics, The Ohio State University, 174 W. 18th Ave., Columbus, OH 43210-1106. Further inquiries can be made by phone at (614) 292-3910 or via email to RABY@MPS.OHIO-STATE.EDU.
The Ohio State University is an Equal Opportunity/ Affirmative Action Employer. Qualified women, minorities, Vietnam-era Veterans, disabled veterans and individuals with disabilities are encouraged to apply.

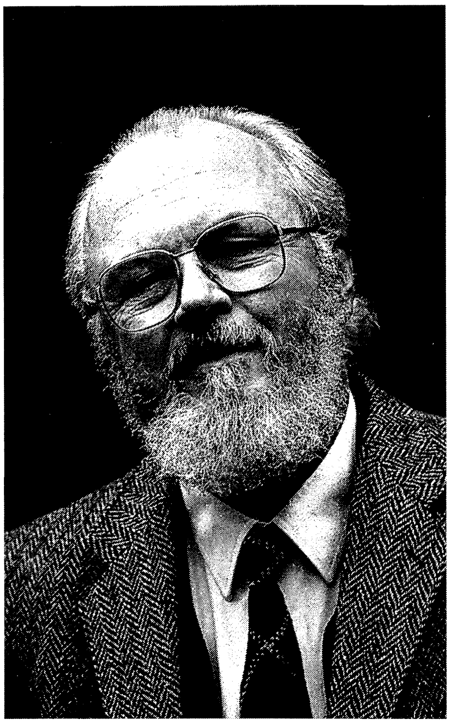
People and things

Pedro Waloschek

Now officially retired from the DESY Laboratory, Hamburg, but continuing to act as the Laboratory's CERN Courier correspondent is Pedro Waloschek. Born in Buenos Aires, Pedro began his physics research career there in the early 1950s, participating in the heady post-war era of cosmic ray studies, moving in 1955 to Göttingen to continue this work. In Bologna from 1957, he organized a bubble chamber group and participated in one of the pioneer experiments which revealed parity (left-right) violation in beta decay. Subsequently he transferred to Bari to work on a new bubble-chamber film analysis machine. At CERN, Pedro became interested in the new electronic detectors being developed in the late 60s by Georges Charpak. In 1968 he moved to DESY as a Senior Scientist, applying the new wire chamber techniques and contributing to the design of the PLUTO detector at the DORIS electron-positron ring. In 1988 he joined the H1 collaboration at the HERA electron-proton collider.

From 1978, still based at DESY, Pedro also began a new career - communicating the wonders of modern physics in general and DESY in particular to the German-speaking public. From most of the 1980s he headed DESY's Public Relations group. As well as articles for newspapers and magazines, he also wrote a series of books - 'Die Welt der kleinsten Teilchen' (The World of the Smallest Particles - with Oskar Höfling, published in 1984), 'Der Multimensch' (1986), 'Neuere Teilchenphysik - einfach dargestellt' (New Particle Physics - simply explained, 1990), 'Der Schlüssel zur Physik' (The Key to Physics - with Olivia Meyer, 1990), 'Reise ins Innerste der Materie' (Journey into Innermost Matter, the story of DESY's HERA electron- proton collider, 1991), and most recently a volume on the life and work of Rolf Wideröe, published in German and in English - 'Als die Teilchen laufen lernten' (ISBN 3-528-06567-2), 'The Infancy of Particle Accelerators' (ISBN 3-528- 06586-9), published by Vieweg, distributed in the USA by Ballen, 125 Ricefield Land, Hauppauge, New York 11788. In 1979 Pedro became DESY's official CERN Courier correspondent, and as such is one of the longest-serving and certainly the most productive of our faithful informants. In these 15 years, scarcely an issue has gone by without a contribution from him. As well as a prolific writer, Pedro is an enthusiastic photographer and cameraman with a ready eye for an impressive shot, and is at home in several languages.

CERN Courier's DESY correspondent Pedro Waloschek



On people

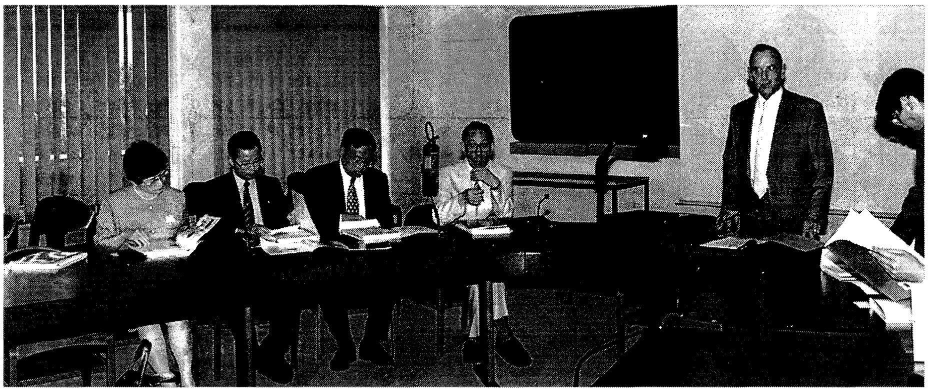
At Brookhaven, Bill Weng has stepped down as AGS Accelerator Division head to spend a sabbatical year in Taiwan working on the new synchrotron light source. Thomas Roser, who takes over from Bill, was the initiator and leader of the new polarized proton effort at the AGS and RHIC.

1994 ICTP (Trieste) Dirac Medal

Every year, on 8 August, the birthday of P.A.M. Dirac, the Dirac Prize Committee of the International Centre for Theoretical Physics (ICTP) Trieste announces the award of the Dirac Medal and Prize. This year it goes to Frank Wilczek (Institute for Advanced Study, Princeton) who in 1973 was one of the discoverers of the "asymptotic freedom" of non-Abelian gauge theories - how strong interactions can become weak at short distances - which led to the development of a new picture of quark physics and is now a cornerstone of the Standard Model of elementary particles and its extensions that aim to unify the fundamental forces. Wilczek has also made important contributions to the study of particle-like excitations in two-dimensional systems that obey "fractional statistics". These particles, for which he coined the name "anyons", are now recognized to have a role in phenomena such as the fractional quantum Hall effect.

The Dirac award is conferred for contributions to theoretical physics and mathematics but is not awarded to Nobel Prize or Wolf Foundation Prize winners.

CERN Particle Physics Experiments (PPE) Division Leader and Regional Coordinator for the Far East Jim Allaby welcomes a delegation of Members of Japan's House of Representatives to CERN on 17 August.
(Photo CERN HI27.8.94)



Pavle Savic 1909 - 1994

Prominent Yugoslav scientist Pavle Savic, one of the twelve signatories of the CERN foundation charter, died on 30 May at the age of 85. With this document, the former Yugoslavia became one of the twelve founding Member States of CERN.

From 1935 - 39 he worked at the Institute of Radium in Paris (France) as a close collaborator of Irene Joliot-Curie, participating in pioneer work on fission, and where his work on the interaction of thermal and resonant neutrons with uranium was also of great importance. In 1944 he joined Kapitza's group at the Institute for Low Temperatures in Moscow. In 1946 he became Professor at Belgrade University, launching the Institute of Physics (now the Institute of Nuclear Sciences) at the Vinca site near Belgrade, and went on to become its first Director General. From 1956 - 58 under his directorship and supervision, the first local scientific nuclear reactor was completed. Professor Savic received a number of domestic and international awards including the Lomonosov and Rutherford gold medals and was a member of several foreign academies of sciences. He was an outstanding researcher, highly respected teacher and competent and authoritative director. Many distinguished Yugoslav scientists began their careers under his guidance.

Meetings

From 9-13 May 1995 the 10th Topical Workshop on Proton-Antiproton Collider Physics will be held at the Fermi National Accelerator Laboratory, Batavia, Illinois. Rajendran Raja and John Yoh of Fermilab are Co-Chairmen of the Workshop. Contact: C. M. Sazama, Fermilab, M.S. 122, P.O. Box 500, Batavia, IL 60510; Telefax: 708-840-8589 E-Mail: SAZAMA@FNALV.FNAL.GOV

The Fourth International Workshop on Theoretical and Phenonenological Aspects of Underground Physics will be held from September 17-21, 1995 in Toledo, Spain. This Workshop is the fourth in the TAUP series which began in 1989 at Laboratori Nazionali del Gran Sasso (LNGS) and L'Aquila (Italy) and continued in 1991 at Toledo (Spain), and in 1993 at LNGS. Emphasis will be put on the many aspects of Astroparticle Physics, where astrophysical and cosmological problems are examined in the light of new results from nuclear and particle physics. Information from TAUP 95 Secretariat, Ms. Mercedes Fatas, Laboratorio de Fisica Nuclear, Universidad de Zaragoza, E-50009 Zaragoza, SPAIN. Phone: ++ 34 76 35.83.21 Fax:=++ 34 76 56.80.60 Telex: 58198 EDUCI E e-mail: decnet: 16456::TAUP95 internet: TAUP95@GAE.UNIZAR.ES

Japanese brochure

Now available is a brochure in Japanese entitled "1993 Joint Report of The Japanese Experimental Groups at CERN" describing the active collaboration between CERN and Japanese scientific laboratories involved in international particle physics research. Copies available from : Prof. Kiyoshi NIU, Physics Department, Nagoya University, Chikusa-ku, Nagoya 464, Japan or from Dr. James V. Allaby, PPE Division, CERN, 1211 Geneva 23, Switzerland (Fax. + (41-22) 767 94 50)

Project Head Satoshi Ozaki speaks as the first superconducting dipole is installed at Brookhaven in the tunnel for the Relativistic Heavy Ion Collider (RHIC) at Brookhaven on 5 August. Manufactured by Northrop Grumman, it is the spearhead of the 373 dipole and 1,700 total RHIC superconducting magnet complement.

RESEARCH ASSOCIATE POSITION EXPERIMENTAL HIGH ENERGY PHYSICS INDIANA UNIVERSITY

The Department of Physics at Indiana University invites applicants for a research associate position to work with the high energy physics group on the OPAL experiment at CERN. The position will be available beginning November 1994.

In OPAL the Indiana University Group has been playing a leading role in heavy flaver physics and in the development of the silicon microvertex detectors. We also have developed and maintain the effine analysis facility. SHIFT, which uses RISC computers and a high-speed network to access the large amount of data that has been collected by the OPAL detector.

Applicants should have an interest and experience in physics analysis and computing. Candidates must have a Ph.D. degree. Applications, including vitae, list of publications, and three reference letters, should be sent to:

High Energy Physics Secretary
Department of Physics
Indiana University
Bloomington, IN 47405

by November 1, 1994. Indiana University is an Equal Opportunity / Affirmative Action Employer.

Research Associate Experimental High Energy Physics University of Toronto

Applications are invited for a Research Associate position in High Energy Physics at the University of Toronto. The position is associated with the Third Level Trigger for the ZEUS experiment in DESY. The successful candidate will take part in a project to upgrade the cpu power and bandwidth of the system using an FDDI, and later perhaps ATM, network. For this aspect of the duties, a knowledge of C, UNIX, and TCP/IP would be a distinct advantage. The successful candidate will also demonstrate a strong interest in the physics accessible to ZEUS in the coming years, and will be encouraged to play an active role in the ZEUS physics analysis effort. Interested individuals should send a letter of application and curriculum vitae, and arrange to have three letters of reference sent to:

Professor Bob Orr
Physics Department
University of Toronto
60 St. George Street
Toronto, Ontario
Canada M5S 1A7

Fax: (416) 978-8221
Phone: (416) 978-6029
E-mail: orr@physics.utoronto.ca

In accordance with Canadian immigration regulations, this advertisement is directed in the first instance to Canadian citizens or permanent residents. Nonetheless, anyone interested is encouraged to apply. The University of Toronto strongly encourages applications by women, members of minority and aboriginal groups.

Post Doctoral Position

Max-Planck-Institute of Physics Munich, Germany

The Max-Planck-Institute of Physics invites applications for a postdoc position for the ALEPH experiment at CERN. The successful candidate is expected to contribute to the development of software for the silicon vertex detector and to contribute significantly to the physics analysis, especially in the field of B-physics.

The contract will be limited to two years, with the possibility of extension up to five years.

Candidates should have good knowledge of the hardware aspects and data analysis of modern experiments in particle physics, and they should hold a PhD or equivalent in physics. They should send a curriculum vitae, a list of publications, a summary of past and present research interests, and the names of three referees to

Frau Renate Saffert
Max-Planck-Institut für Physik
Postfach 40 12 12
Föhringer Ring 6
D-80805 München (Email REL@dmumpiwh.bitnet)

where also further information can be obtained. Applications should be sent as soon as possible, at latest by 30 November 1994.

FAKULTÄT FÜR PHYSIK UNIVERSITÄT FREIBURG

A position for a **RESEARCH ASSOCIATE** is open for applications. The successfull candidate would be expected to work on matters related to the ZEUS detector components, for which our group has major responsabilities, i.e. calorimeter and presampler. It would be expected that the candidate becomes involved in physics analysis of the ZEUS data and also has interest in hardware. The position is available now. The appointment will be for 1 1/2 years with a renewal of 3 more years. The salary will be according to BATIIa. Also the option of an extension as a C1-position can be envisaged according to the ability of the candidate. Applicants should have obtained a PhD in Experimental Particle Physics or a related topic. Letters of application supported by a full *curriculum vitae* should be received by October 30, 1994 and adressed to:

Prof. A. Bamberger
Fakultät für Physik der Universität Freiburg
Hermann-Herderstr. 3
79104 Freiburg
Tel. +49 761 203-5714
e-mail: bamberger@vxdesy.desy.de

The **Max-Planck-Institut für Physik,** München, offers the position of an

experimental physicist (Ph.D.)

to participate in the execution of the experiment HEGRA (High Energy Gamma Ray Astronomy) to investigate ultra-high energetic cosmic rays at La Palma, Spain. In particular, his/her work will concentrate on the data analysis, but participation in the measurements at La Palma and in detector development is also expected.
Candidates should have broad experience in complex analysis programs and should be able to carry out scientific tasks independently.
The position is available as of fall 1994, and the contract will initially be limited to 3 years, with the possibility of an extension.
Applications together with a curriculum vitae, a list of publications and two references, should be sent as soon as possible to

Prof. N. Schmitz
Max-Planck-Institut für Physik
Föhringer Ring 6
80805 München
Germany

Advertisements in CERN COURIER

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Telephone: 022/767 41 03 **Telex 419 000 CER CH**
Telefax 022/782 19 06

Inquiries for the rest of the world: **please see page III.**

ISTITUTO NAZIONALE DI FISICA NUCLEARE (I.N.F.N.)

Post-doctoral fellowships for non Italian citizens in the following research areas: Theoretical Physics (n.8) Experimental Physics (n.14)

Applications are invited for one year fellowships, which will start from September to November 1995.

Fellowships are intended for young post-graduates (candidates must not be more than 35 years of age at the time of application).

Each fellowship is granted for one year, and may be extended for a second year.

The annual gross salary is lit. 30,000,000, plus travel expenses for a return trip from home Institution to the I.N.F.N. Section or Laboratory. Lunch tickets will be provided during work days.

Candidates should submit an application form and a statement of their research interests, including three letters of reference.

Applications should reach I.N.F.N. not later than November 30, 1994.

A decision will be taken and candidates informed by the end of April 1995.

The successful applicants may carry on their research at any of the following laboratories and sections of I.N.F.N.:

National Laboratories of Frascati (Rome), National Laboratories of Legnaro (Padova), National Southern Laboratories (Catania) and National Gran Sasso Laboratory (L'Aquila).

INFN Sections in the universities of:

Turin, Milan, Padua, Genoa, Bologna, Pisa, Rome "La Sapienza", Rome II, Naples, Catania, Trieste, Florence, Bari, Pavia, Perugia, Ferrara, Cagliari, Lecce and National Institute for Health (Rome).

Enquiries, requests for application forms, and applications should be addressed to:
Fellowship Service - Personnel Office, Istituto Nazionale di Fisica Nucleare (INFN) -
Casella Postale 56 - 00044 Frascati (Roma) Italy.