

CERN Host State Presidents – François Mitterrand of France and Jean-Pascal Delamuraz of Switzerland.



sponsibility' to plan CERN's activities, and proposed a special meeting of Member State Ministers, which could take place in Italy to-

wards the end of 1990.

Federal German Minister for Research and Technology Heinz Reisenhuber, speaking for the Member States, said 'we feel our responsibility for the future of this beautiful equipment'.

The extent of the research collaboration at LEP, extending far beyond the community of CERN Member States was underlined in the toasts by Finnish Minister of Education C. Taxell, R.A. Roe (Chairman of the US House of Representatives Committee for Space, Science and Technology), and Soviet Minister for Atomic Energy and Industry V. Konovalov.

Meanwhile other guests had mi-

grated to the back half of the SM18 hall, there to enjoy a buffet lunch including specialties of all 14 CERN Member States, topped with a giant 380-kilo LEP cake, paraded round the hall under a travelling crane before being cut up.

The day, impeccably organized by a committee chaired by Robert Klapisch, went without a hitch. LEP had been switched off at only 6 a.m. that morning and was back in action the next day, taking the showpiece inauguration in its stride. By the end-year shutdown, the four LEP experiments had intercepted 100,000 Z particles.

Around the Laboratories

BROOKHAVEN R&D for RHIC detectors

As Brookhaven prepares for construction of the Relativistic Heavy Ion Collider (RHIC), expected to begin later this year, research and development work for the project is in high gear.

For the past three years the Laboratory has been receiving R&D funds from the US Department of Energy to prepare the way for construction. A detailed conceptual design has emerged and the superconducting magnet designs have been tested in an extensive series of prototypes (September 1987, page 23). These magnets are now being readied for industrial produc-

tion once the President and Congress give the green light, hopefully for fiscal year 1991.

In the meantime preparations for experiments are underway, with a substantial part of the R&D effort being turned to detector development, shared widely among potential RHIC users, as some 17 groups responded to Brookhaven's call for proposals for detector R&D.

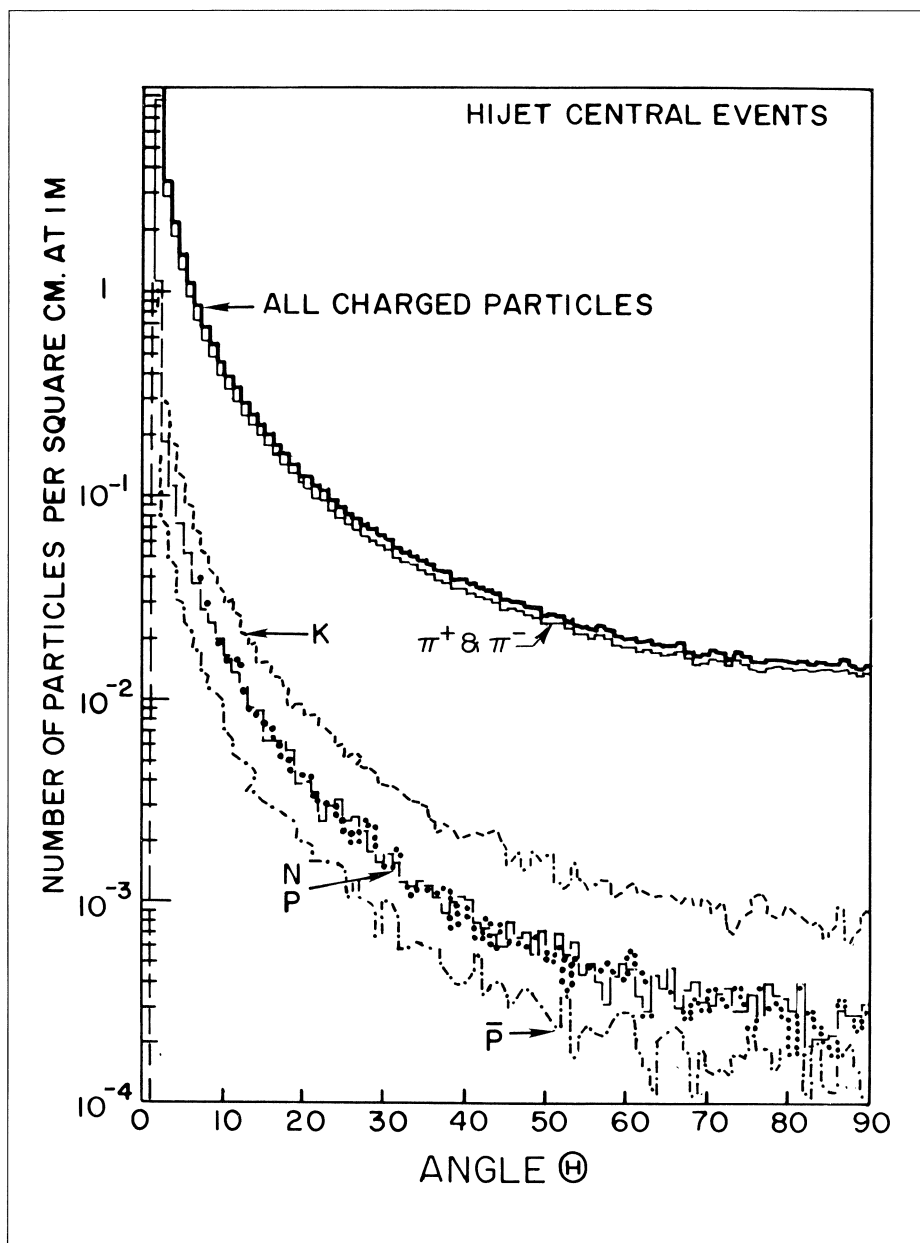
After review by a Detector Advisory Committee (P. Braun-Munzinger, Stony Brook; M. Breidenbach, SLAC; M. Gilchriese, SSCL; H. Gutbrod, GSI/CERN; R. Klanner, DESY; B. Mecking, CERN; and L. Schroeder, Berkeley, as Chairman) ten projects were funded, attacking the most pressing issues for detector R&D identified in RHIC workshops. These are the first steps on the long road to the first experiments at the collider – planned to

begin in 1997. A call for proposals for major RHIC detectors should follow this year.

For 1989, detector development funding amounted to about a million dollars. This is expected to increase eventually to about 15 million dollars.

RHIC will collide beams of heavy nuclei at ultra-relativistic energies, subjecting nuclear material to extreme conditions where the familiar structure of neutrons and protons is expected to be fleetingly transformed into a 'plasma' of quarks and gluons.

Recording such events with sufficient sensitivity to pick up signals for new plasma phenomena will require extending known techniques for particle detection. With beam energies up to 100 GeV per nucleon and with ions containing 200 nucleons or more, the total



The challenge for detectors at the proposed RHIC heavy ion collider at Brookhaven – a simulation of the charged particle flux at one metre from collisions of gold ions carrying 100 GeV per nucleon.

large number of channels to be read out, upwards of 10^4 per detector. Handling such a vast number of detector elements by conventional techniques, if not prohibitive in cost, would severely constrain the detector configuration due to the sheer size and mass of the cabling.

In response to these challenges, a number of groups have proposed developing compact, low-power, low-cost circuits using VLSI techniques to store signals in analog memory devices on a small chip – rather than in a long cable – and make it possible to amplify, store, and ultimately digitize data directly on the detector, with serial transfer of 'processed' signals to storage only after several levels of trigger decisions.

The basic technologies exist, and to produce circuits matched to RHIC's requirements will take the coordinated efforts of a number of research centres over 4-5 years. This is clearly a high priority item.

Experiments with ion beams both at Brookhaven and CERN have emphasized the importance of 'energy flow' measurements using fine-grain calorimetry over large solid angles, and of particle identification, distinguishing for example protons and kaons from the large numbers of pions produced. These methods are expected to have equally important roles in RHIC where, in contrast to fixed-target experiments, most of the particles of interest will have rather low momenta. This poses formidable problems which are not being attacked in the detector development work for other high energy collider schemes, such as the Italian-funded LAA effort at CERN or the SSC detector R&D in the US. The detailed response of calorimeters to large numbers of low energy particles,

energy per collision can reach up to 40 TeV, far beyond that of any present accelerator or existing detector.

Although the Superconducting Supercollider (SSC) will accelerate particles to this energy and produce hundreds of very high energy particles, the most interesting RHIC collisions are expected to produce tens of thousands of particles, with proportionately less energy carried away by each particle.

In addition to very high production levels, experiments in a heavy ion collider have to confront plasma signals from particles whose transverse momenta and thermal energies are relatively small, and similar to that of the background. This contrasts to hard scattering in particle colliders, where high transverse momentum triggers can cut

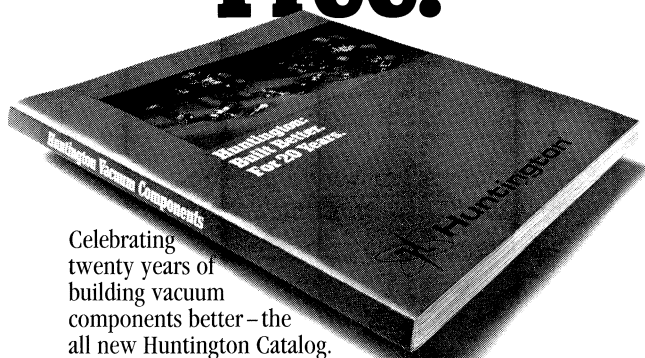
out most of the background.

RHIC detectors will require new approaches to tracking, calorimetry, particle identification, fast trigger decisions and on-line data processing. In a series of workshops over the past five years, a number of ideas and concepts have emerged and subsequent development work has identified specific targets to attack.

One of the most urgent and universal needs is in the area of read-out electronics. Here, RHIC poses two principal challenges. The first is the short time between bunch crossings, 114 nanoseconds compared with the several microseconds enjoyed by today's colliders. RHIC (like future particle colliders), will need to store analog signals while trigger decisions are made.

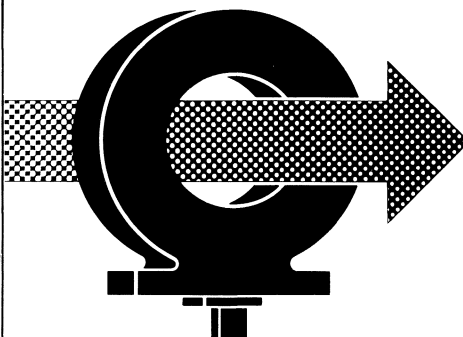
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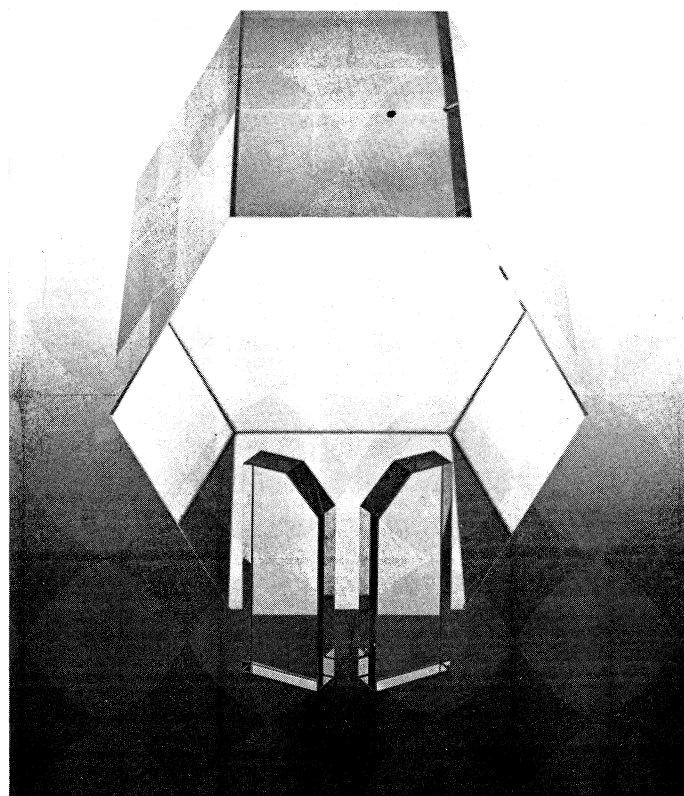
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and the development of time-of-flight and ring-imaging Cherenkov techniques capable of handling very high particle densities as well as rates, are examples.

Important RHIC measurements will centre on the lepton pairs radiated electromagnetically from inside a volume of dense hadronic matter. These measurements are also among the most difficult, as the relevant lepton pair masses and transverse momenta are not large enough to be easily separated from the background due to pion decays.

At RHIC workshops complementary lepton pair scenarios have been worked out – one involving electrons and the other muons. For efficient electron pair measurements in the high multiplicity environment it may be possible to apply the 'hadron-blind' detection technique using light, highly segmented ring imaging Cherenkov counters with a suitable radiator. Such a device is being developed for a heavy ion experiment at the CERN SPS, but collider application would require considerable further development. A RHIC dimuon experiment could consist of a carefully designed instrumented hadron absorber surrounding the collision point, followed by detectors to track penetrating muons.

From T. Ludlam

First results from ATF electron gun

Brookhaven's Accelerator Test Facility (ATF – April 1987, page 21) passed a major milestone last year when it produced its first beam of photoejected electrons. With the initial phase of construction com-



The control room for Brookhaven's AGS synchrotron has been remodelled and expanded to cover all linked machines (Linac, Booster). It features five general purpose consoles based on networked Apollo workstations, plus a special safety console (centre rear). In the foreground are AGS operations head Peter Ingrassia (left), and AGS controls section head Don Barton.

pleted later this year, the ATF should provide a low emittance beam of 50 MeV electrons for studies of new radiation sources and advanced accelerator concepts.

The major components of the ATF are the electron gun, low energy beam transport, linear accelerator, laser systems, and synchronization systems. The electron gun uses a laser-irradiated yttrium photocathode on one of the end walls of a radiofrequency cavity with a 2856 MHz standing wave. The configuration is designed so that the electrons are emitted when the electric field is nearly maximum so that the bunch reaches relativistic velocities as soon as possible. The design goal calls for a field of 100 MV/m on the cathode to help control space-charge blow-up of the emittance.

In its initial configuration the bunch leaving the gun passed through a quadrupole triplet to capture and focus the beam, followed by a 90-degree bending magnet, a

quadrupole singlet, momentum slit, profile monitor, and Faraday cup. The initial energy of the electrons exiting the gun was 3.6 MeV.

When the necessary construction is complete, the low energy injection system will take the beam from the r.f. gun and bend it through two 90 degree-dipoles into the linac, allowing the laser light to follow the electron beam axis to the photocathode.

Power for the linac sections and the r.f. gun is supplied by a single 20 MW klystron, provided by SLAC. The modulator was assembled on-site using several important components from SLAC. The system can run at repetition rates up to 6 Hz.

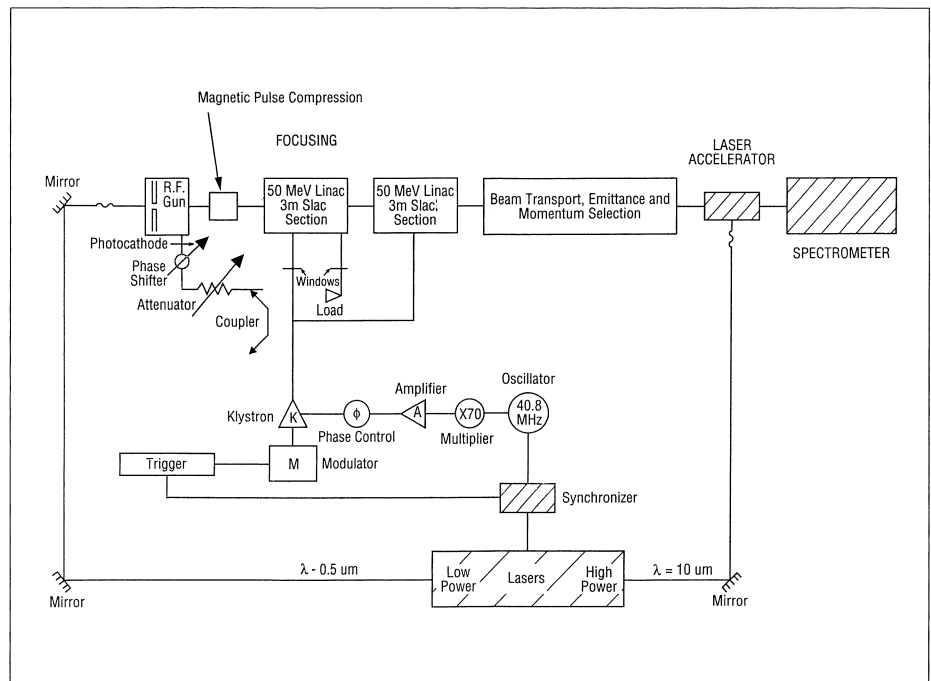
At least three types of experiments for the ATF have been discussed or are under construction. Prominent are investigations of new methods for particle acceleration, including laser acceleration and focusing of electrons using 10-micron etched silicon structures, to allow a longitudinal electric field

near the electron beam trajectory. Another experiment studies the inverse of the acceleration mechanism (Smith-Purcell effect). Other proposals cover acceleration using the inverse free electron laser, inverse Cherenkov and switched power approaches.

A second class of experiments concentrates on coherent radiation. A free electron laser (FEL) study will use an 8 mm-pitch superconducting microwiggler to produce visible light. Other FEL experiments are under discussion.

The third type of experiment looks at fundamental photon-electron physics, including measurements of the non-linear Thomson scattering of an electron meeting an intense laser focus head-on.

Schematic of the electron and laser beam systems at Brookhaven's Accelerator Test Facility (ATF). The low-power (YAG) laser simultaneously produces photoelectrons in the r.f. gun and selects a portion of the high power (CO₂) laser pulse for experiments.

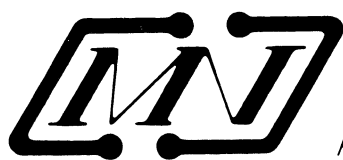


Electron beam R&D

The technological problems of producing 1 TeV electron beams are under attack at Laboratories all over the world, and new facilities are under construction to provide testbenches for novel techniques. As well as the Accelerator Test Facility at Brookhaven (see accompanying article), a Test Accelerator Facility is under construction at the Japanese KEK Laboratory (November 1989, page 13). At CERN, the long-term goal of a CERN Linear Collider (CLIC) is steadily being pushed, and a CLIC Test Facility (CTF)

is being built to house experiments on laser techniques for a CLIC driver beam, and on 30 GHz radiofrequency generation. At the Stanford Linear Accelerator Center, a Final Focus Test Beam will use the business end of the SLC Stanford Linear Collider to look at the problems of making and monitoring sub-micron beams. At Argonne, accelerator studies with an electron linac have given significant results (June 1988, page 16). In the Soviet Union, a branch of the Novosibirsk Institute of Nuclear Physics has been

established at the Institute for High Energy Physics at Serpukhov, near Moscow, scene of the construction of the multi-TeV UNK proton machine. The aim is to develop a linear electron-positron collider, VLEPP, alongside UNK, initially to provide 500 GeV beams for 1 TeV collisions, but with the door open for an upgrade to 1 TeV per beam. Complementing these projects is a healthy level of international collaboration.



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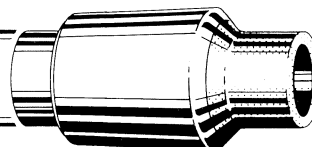


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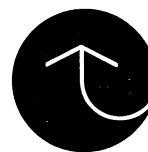
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