

Physics monitor

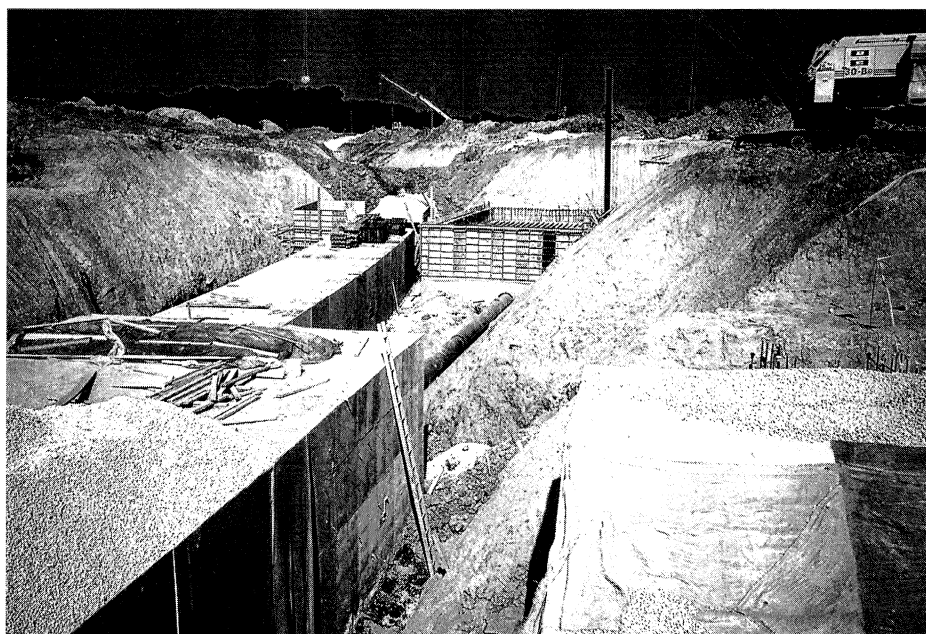
research and development (gaseous detectors, RICH techniques, liquid xenon calorimetry, scintillating fibre calorimetry and read-out systems and data transfer). LIP plans to participate to both Atlas and CMS, contributing to the tile calorimeter and calorimetric trigger respectively. Because of this involvement in specific detector elements, Portugal is able to make important contributions to these two major LHC experiments.

Theoretical particle physics has also boomed, with the number of theorists more than doubling. Currently there are 36 researchers (26 PhDs) in a national network based at Lisbon's GTAE (Grupo Teorico de Altas Energia, Head G.C. Branco) and including CFIF (Study of Fundamental Interactions) at Lisbon's Instituto Superior Tecnico. GTAE also supports astrophysics.

With the university system expanding, there has been no problem so far finding positions for good young researchers, but this expansion cannot continue indefinitely. The need for stable research positions, independent of those offered by the universities, is already pressing.

The Portuguese-CERN Committee, set up in 1986, has played an important role, and the value of contracts for Portuguese industry has increased significantly. Portugal is exemplary in its willingness to develop its scientific research as a support to its budding high-tech industry.

At Fermilab, construction is now underway for the new 150 GeV Main Injector. The pipe to the right of the tunnel is an abort line.



Accelerator update

When the Accelerator Conference, combined International High Energy and US Particle versions, held in Dallas in May, was initially scheduled, progress nearby for the US Superconducting Supercollider was high on the preliminary agenda. With the SSC voted down by Congress in October 1993, this was no longer the case. However the content of the meeting, in terms of both its deep implications for ambitious new projects and the breadth of its scope, showed that the worldwide particle accelerator field is far from being moribund.

A traditional feature of such accelerator conferences is the multiplicity of parallel sessions. No one person can attend all sessions, so that delegates can follow completely different paths and emerge with totally different impressions.

Despite this overload, and despite the SSC cancellation, the general

picture is one of encouraging progress over a wide range of major new projects throughout the world. At the same time, spinoff from, and applications of, accelerators and accelerator technology are becoming increasingly important.

Big machines

Centrestage is now CERN's LHC proton-proton collider, where a test string of superconducting magnets is operating over long periods at the nominal LHC field of 8.36 tesla or more. The assignment of the underground areas in the existing 27-kilometre LEP tunnel is now quasi-definitive (see page 3).

For CERN's existing big machine, the LEP electron-positron collider, ongoing work concentrates on boosting performance using improved optics and bunch trains. But the main objective is the LEP2 scheme using superconducting accelerating cavities to boost the beam energy (see page 6). After

23 kilometres in length - a possible scheme for a next-generation electron-positron collider.

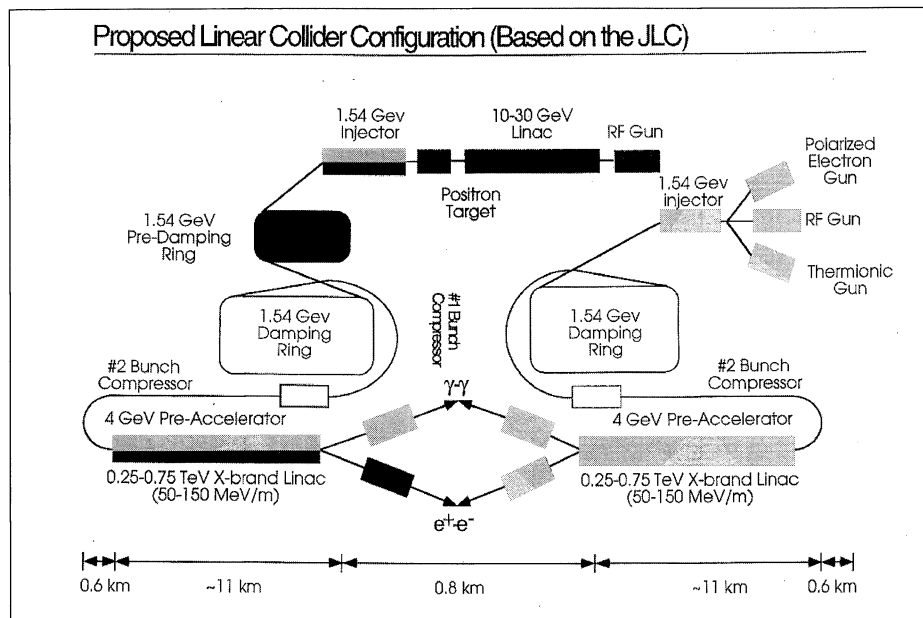
some initial teething problems, production and operation of these cavities appears to have been mastered, at least under test conditions.

A highlight at CERN last year was the first run with lead ions (December 1994, page 15). Handling these heavy particles with systems originally designed for protons calls for ingenuity. The SPS has managed to accelerate them making full use of the travelling wave properties of the SPS 200 MHz system.

For Fermilab's Tevatron, the US flagship machine, construction is now underway for the new 150 GeV Main Injector to provide an improved feed to the superconducting ring. This will ultimately boost Fermilab's proton supply to 6×10^{13} protons per pulse for fixed target work and, with additional recycling and buffer rings for precious antiprotons, the proton-antiproton collision luminosity could climb to 10^{33} per sq cm per s. As well as feeding the Tevatron, the new Main Injector will provide capabilities for neutral kaon studies and for neutrino beams.

Such a high collision rate has much physics potential - CP-violation in the B particle sector and/or the discovery of supersymmetric particles. The improved Tevatron and LEP2, as well as Cornell CESR electron-positron collider and new B-factories being built at SLAC and at KEK, Japan, will ensure that no physics falls through any intervening energy gap between them and the LHC.

At Europe's other big machine, the HERA electron-proton collider at DESY, Hamburg, the emphasis is on getting the maximum proton supply from the DESY III synchrotron to the HERA proton ring. On the electron side, tests will be made of getter pumps to improve HERA electron



ring conditions and permit high current running with electrons, rather than positrons (see page 10).

At Brookhaven, the new booster has accomplished what its name suggests, with proton levels climbing to new world records beyond 6×10^{13} per pulse (see page 10), while preparations for the RHIC heavy ion collider are in full swing.

Also relying on superconducting cavities are CEBAF's recirculating linacs at Newport News, Virginia, which have now reached their nominal energy with five passes (June, page 20). However an increase in accelerating field in the superconducting cavities should enable CEBAF to climb higher in energy. A full commissioning report will appear in a forthcoming issue.

Superconducting cavities have been tested with high beam currents in Cornell's CESR electron-positron ring, which has established a world

record for collision luminosity at 3.3×10^{32} (see page 11). The importance of Cornell's work in machine physics was underlined by the award of the American Physical Society's Robert R. Wilson Prize to Raphael M. Littauer of Cornell (see page 14).

Linear accelerators

With much effort now invested in development work for the next generation of electron-positron linear colliders, the 2-mile linac at SLAC, Stanford, assumes increased importance as a 'model' machine.

Collision luminosity is nearing 10^{31} , but the trump physics card is polarization, where 80% levels have been achieved in the electron beam.

Laboratories throughout the world are contributing to the ongoing effort. Many avenues are being explored, but the main challenge is the effi-

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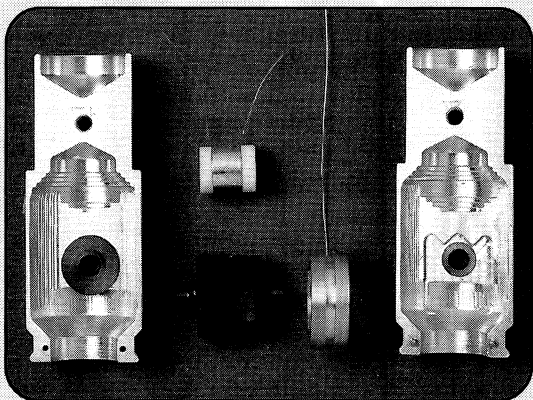
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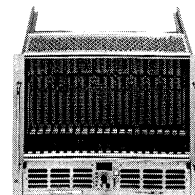
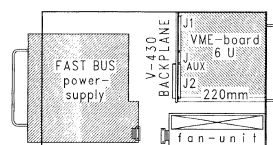
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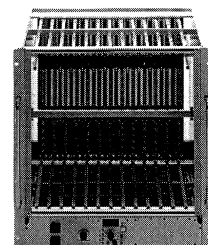
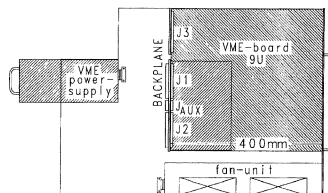
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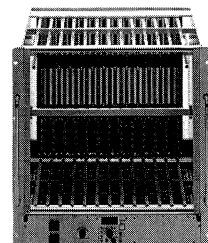
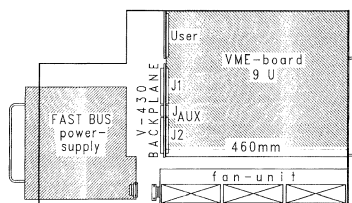


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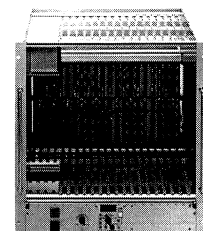
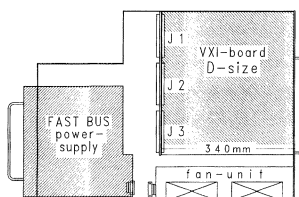
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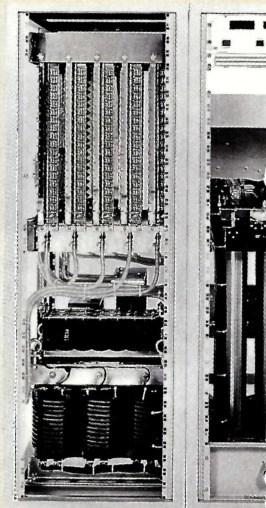


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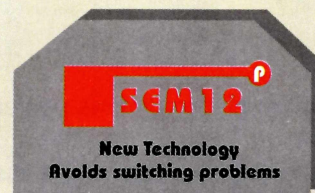
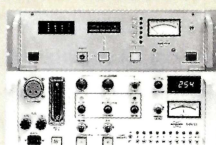
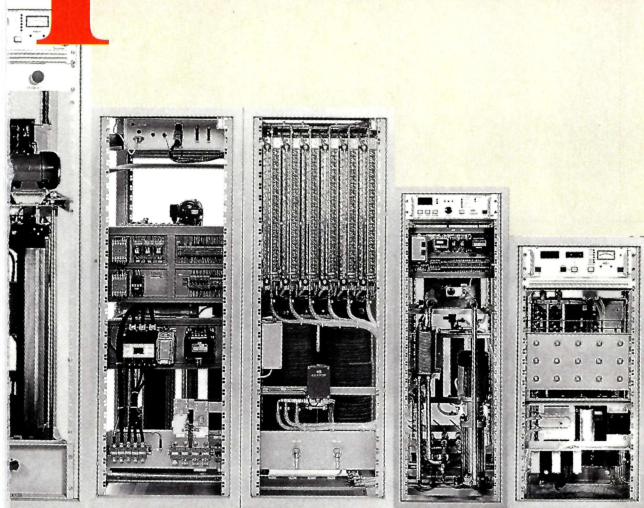
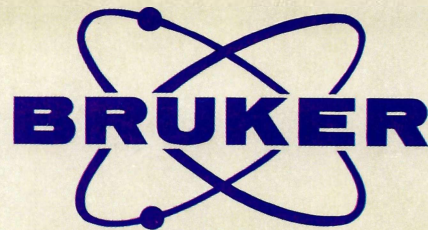
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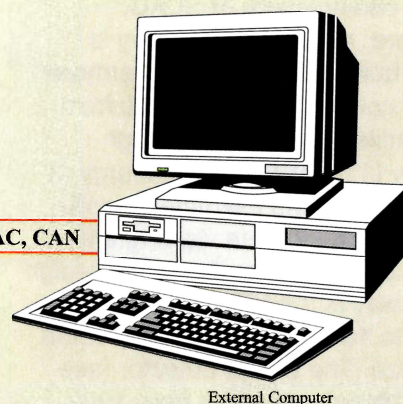
Specialist



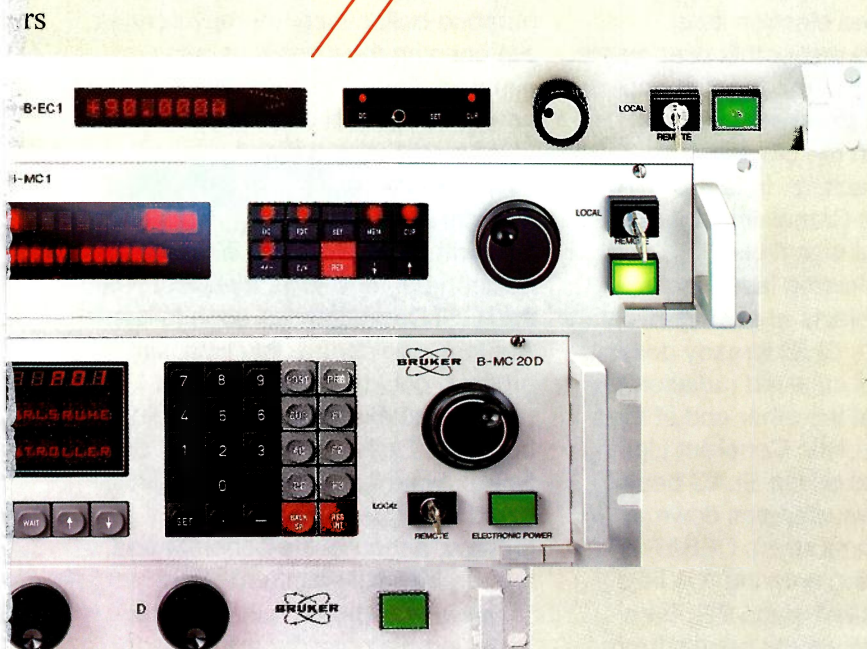
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ciency of transferring mains power to the beam.

With so many avenues under study, covering frequencies from 1.3 GHz (DESY S-band) to 30 GHz (CERN's CLIC scheme) the main question is which route to take. Test results over the next few years will help select an optimal route.

Factories

Several new 'factories' - high luminosity colliders providing a copious supply of new particles - are under construction. At SLAC, Stanford, the PEP-II B factory is being built by a Berkeley/Livermore/SLAC collaboration. Particles from the 2-mile linac will feed a high energy (11 GeV) and low energy (3 GeV) ring, giving asymmetric collisions which facilitate viewing the highly unstable B particles. Its design luminosity is 3×10^{33} , which could climb to 10^{34} with a (low beta) beam squeeze. The BaBar detector (see page 16) would benefit from 1999.

Also using an asymmetric approach is the Japanese KEK B-factory (April 1994, page 18), with 8 and 3.5 GeV rings supplying a collision luminosity of 10^{34} , with first collisions expected in 1998. These rings would be built in the tunnel originally built for the Tristan electron-positron ring, soon to be dismantled.

Using lower energies is the DAPHNE phi-factory ring at Frascati, near Rome, where commissioning should begin late next year.

Completing the current electron-positron collider picture are Beijing's BEPC machine (luminosity 7×10^{30}) and Novosibirsk's VEPP4M (looking for 7×10^{31}). Both these laboratories also have aspirations to build tau/charm factories.

Synchrotron radiation

Synchrotron radiation, once a useful by-product of electron rings, now has its own thriving community. The largest new ring to come into operation is the Advanced Photon Source at Argonne with 7 GeV beams. A 'third generation' machine, it has very low beam emittance designed for optimal exploitation of beam wigglers and undulators in straight sections.

Another third generation machine now operational is the Pohang Storage Ring in South Korea using 2 GeV beams. The Russian 2.5 GeV ring in Moscow, named Siberia II in recognition of its design team, is another new arrival. New synchrotron radiation projects in the pipeline include the Swiss Light Source and the French Soleil project, where beam emittances will be reduced to about 3 nm. The ring at Duke, North Carolina (March, page 8), was specifically developed to supply beams to a free electron laser.

(In our article earlier this year on the Duke installation, the injector was claimed to be the second highest energy linac in the US, after the 2-mile SLAC machine. In fact CEBAF's linacs and the Cornell injector are more powerful than Duke.)

In the free electron laser sector, many new projects are being investigated. Orsay's CLIO already delivers many hours of infra-red radiation to users, while at the other end of the spectrum the Linac Coherent Light Source, based on the SLAC beam, could reach wavelengths down to 0.15 nm (gamma rays). CEBAF is also considering entering this field (September 1994, page 20). Free electron lasers should benefit from ongoing development work for linear colliders.

Applications

The September issue of the CERN Courier highlighted the growing range of applications to which particle accelerators can be harnessed.

This usefulness was covered in special streams at the Dallas meeting.

Some highlights: Free electron lasers are used for precision work such as eye surgery and dental treatment; X-ray lithography for microcircuit manufacture is booming as the need for chips increases - each person in the US already effectively owns the equivalent of 30 million transistors; X-ray holography is another expanding field, where the trend is to use higher energies (1-4 keV).

Particle beams have been used for cancer therapy for almost 60 years. In the past, this work has been mainly confined to the sidelines of major accelerator centres, but now purpose-built cancer therapy centres are opening their doors or being planned. Thousands of patients have now been treated and success rates of up to 85% are claimed.

The Japanese HIMAC (Heavy Ion Medical Accelerator in Chiba) using ions with energies up to 800 MeV per nucleon began clinical trials last year and GSI Darmstadt will soon follow. Another new centre, this time with protons, could be provided by a proposal to exploit the linac originally built near Dallas for the defunct SSC. Spare capacity at the Fermilab linac could also be used for cancer therapy, although the general trend is for purpose-built centres.

Less well explored but also with considerable potential are ideas for high current proton machines to drive new energy sources, for radio-

pharmaceutical production, or for nuclear waste transmutation.

A highlight of the Dallas meeting was Gus Voss' 'farewell' speech following his recent retirement from the DESY Laboratory in Hamburg, extracts from which will be published in a forthcoming issue.

(Information compiled by Daniel Dekkers, Helmut Haseroth, Albert Hofmann, Kurt Hübner, Eberhard Keil, Stuart Turner and Ted Wilson)

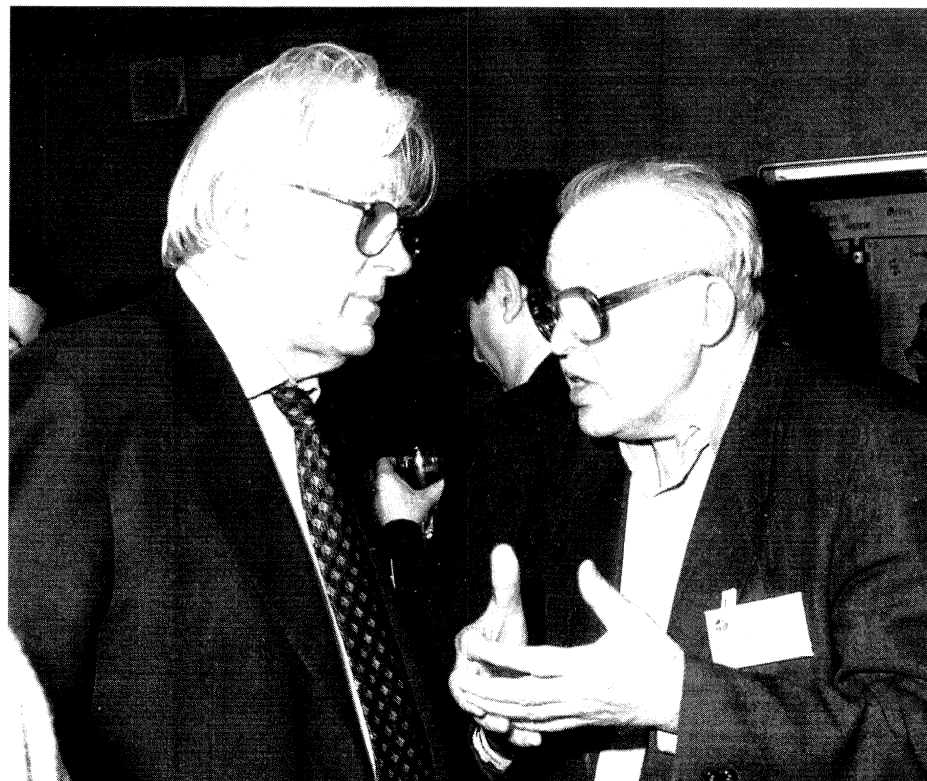
DETECTORS

Vienna - beyond the wire

In 1986, at the fourth Vienna Wire Chamber Conference, Georges Charpak, the inventor of the multiwire proportional chamber, had confidently announced "Les funérailles des chambres à fils". Was this the writing on the wall for the conference series as well as this type of detector technology?

The demand for detector innovation, coupled with imaginative thinking on the part of the organizers, have kept the Vienna venue at the forefront of the physics calendar. An additional boost to the success of the series was certainly the Nobel Prize awarded to Georges Charpak in 1992.

While the major topic naturally is still wire chambers, alternative technologies are also covered. However in fields like calorimetry or ring imaging Cherenkovs, a sample of only a few prominent detectors were presented, giving some participants



Georges Charpak (left), the inventor of the multiwire proportional chamber, in discussion with Vice-Director of Novosibirsk's Institute for Nuclear Physics Benjamin Sidorov at this year's Vienna Wire Chamber Conference.

the impression of a biased selection.

The fact that silicon detectors, electronics and track reconstruction strategies were, with the exception of the invited talks, restricted to poster presentations led to the same conclusion. As a result the organizing committee saw that it will have to revise its brief for the next conference.

The conference opened with philosophical thoughts by Nobel Prizewinner Georges Charpak. The first day at Vienna is traditionally devoted to applications of gaseous detectors outside high energy physics. L. Shektman gave an overview of wire chambers for medical imaging. Further applications in medicine and in other fields like biology and space science were described by subsequent speakers. The exciting idea of flying a spectrometer on a balloon to study the fraction of electrons and

positrons in cosmic rays attracted a lot of attention.

The next day covered wire chambers in general. V. Polychronakos presented applications of cathode strip chambers in muon spectrometers for experiments at CERN's LHC proton-proton detector. Certainly the challenges of LHC for detector development dominated many presentations. Both ATLAS and CMS demonstrated different approaches to mastering the difficulties of covering large areas with precise detectors capable of resolving consecutive bunches. Proposed techniques included thin gap chambers, straw drift tubes, pressurized drift tubes, resistive plate chambers....

Next year will see the commissioning of Frascati's DAFNE phi factory, and several presentations were made by the DAFNE FINUDA and