

EPAC in Nice

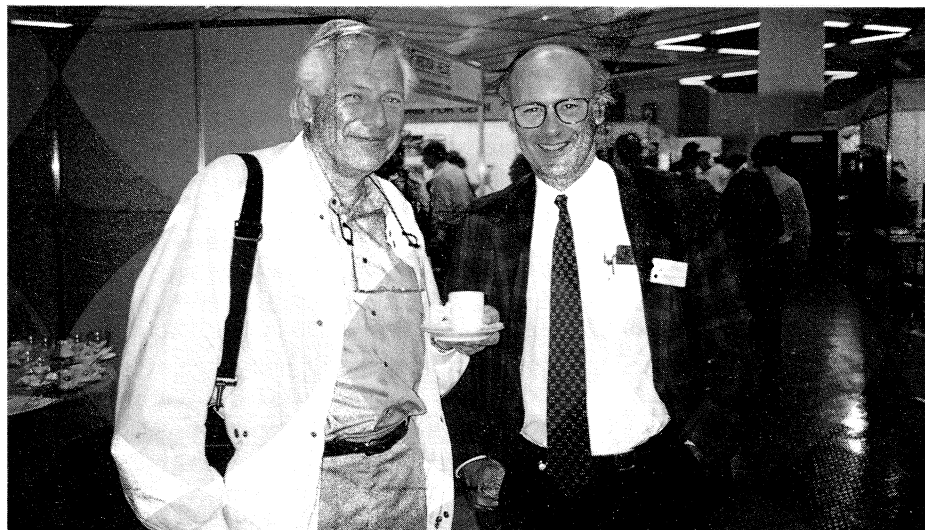
The signpost to the accelerator future points in several directions, and the second European Particle Accelerator Conference (EPAC), held in Nice from 12-16 June provided a good opportunity to survey the terrain ahead.

Building on the experience of the first EPAC, held in Rome in 1988, the organizers planned for a large meeting and were rewarded with 800 participants. In parallel, the involvement of industry, with a comprehensive 44-strong exhibition, prompted many speakers to refer to the symbiosis of accelerators and industry.

The main *raison d'être* of high energy accelerators has always been, and still is, particle physics research. In the first invited paper Maurice Jacob of CERN enthusiastically outlined the progress so far and the hopes that theorists placed in future accelerators. An accelerator is like a time machine that goes back to the very first moments of the Big Bang – the greater the energy, the higher the temperature and the further back in time it can go.

The three-stage EPAC programme began with reviews of the major working accelerators, continued with oral and poster presentations covering the full extent of accelerator R&D, and culminated with the big machines of tomorrow – the HERA electron-proton collider now being completed at DESY, Hamburg, and the plans for the big proton-proton colliders, LHC at CERN and SSC in the US.

Electron machines have traditionally taken longer to reach their design levels than their proton counterparts. However in less than a year, CERN's new LEP electron-positron collider, has already equalled, or exceeded, design values for separate parameters that would yield



At the European Particle Accelerator Conference in Nice, Organizing Committee Chairman Gunther Plass of CERN (left), and Local Organizing Committee Chairman Pierre Mandrillon.

the design luminosity were it not for an unexpectedly low threshold for the beam-beam effect.

In Japan, the TRISTAN electron-positron collider has successfully installed superconducting cavities to reach 32 GeV per beam and experience will be closely followed for the superconducting cavity energy boost for LEP (May, page 1).

Stanford's SLC linear collider cannot compete with LEP as a Z factory, but finds specialized physics niches with polarized electrons, while also serving as a unique testbed for the next generation of linear colliders. Stanford's bid for the 'Next Linear Collider' (NLC) with 0.5 to 1 TeV beams needs a final focus compression factor of three hundred compared to thirty for the present SLC. This particular problem is being attacked, with a the Final Focus Test Facility currently under construction at Stanford.

There is an ongoing effort at many Laboratories on advanced accelerating techniques for the next generation of linear electron machines, but there is a general consensus that the first to appear will have quasi-conventional accelera-

ting structures. Starting at low frequency with about 20 MV/m superconducting structures at 1.5 GHz or copper at 3.6 GHz would be closest to the existing technologies. This route implies brute force of numbers and economy of scale to offset the lack of a new technology. Stepping up to around 100MV/m with a copper structure, klystrons are discussed for 7 GHz, free electron lasers for 19 GHz and a two beam accelerator scheme at 30 GHz, the latter option being followed at CERN in the CLIC study.

With new linear colliders still some way off and LEP believed to be the highest energy circular electron machine feasible, it is not surprising that 'electron-positron factory fever' has taken hold. Factories have been proposed for producing phi, beauty or tau/charm particles, but in all cases it means delivering a hundred times the collision rates currently achieved. This challenge is set by the particle physicists who require tougher tests for the Standard Model.

Maury Tigner identified 13 studies being carried out in seven countries with energies in the range 1-11 GeV. Whatever the outcome,

these factories are unlikely to become as widespread as the ubiquitous synchrotron light source. Tigner believed that only one machine could conceivably be built in the US and even that may never materialize. The most popular choice is the Asymmetric (energy) Beauty Factory, but the asymmetry is the main stumbling block to achieving the high luminosity. The term 'energy transparency' has consequently appeared to cover efforts to make the beams appear symmetric, but the list of requirements is becoming so long that one speaker suspected unequal energies might be ruled out.

The compact synchrotron light source is another example of lateral development in the electron world. HELIOS, the compact source being custom built for lithography by Oxford Instruments for IBM, is close to delivery after some problems with its two 180-degree superconducting dipoles. The second generation is now being discussed, the main emphasis being on reducing cost by lowering the injection energy and replacing the bulky injection linac with another 'table top' accelerator, the microtron.

A possible upgrade of CEBAF from the current 4 GeV to 16 GeV was mentioned in response to a question from the floor, indicative of the need to design for higher energies in any future facility of this type.

Almost ten years after initial operation of such a machine at CERN, there is now a sense of maturity in the proton-antiproton collider field. With friendly rivalry more than compensated by close

collaboration, the present situation was covered by a joint CERN/Fermilab review. Both machines are well understood and their operation is essentially resonance limited. Stochastic cooling has the stamp of an established technique, with contributions on design refinements for kickers and pickups. The main future interest is the cooling of heavy ions for CERN's LHC.

In contrast with the proton scene, where polarized particles are again part of the local scenery, polarized electrons are still hotly debated for machines like LEP. Although the theoretical understanding has improved and the ability to explain observations with the SMILE program is considered as a significant breakthrough, reviewer D. Barber still concluded with the appeal 'Any ideas?'.

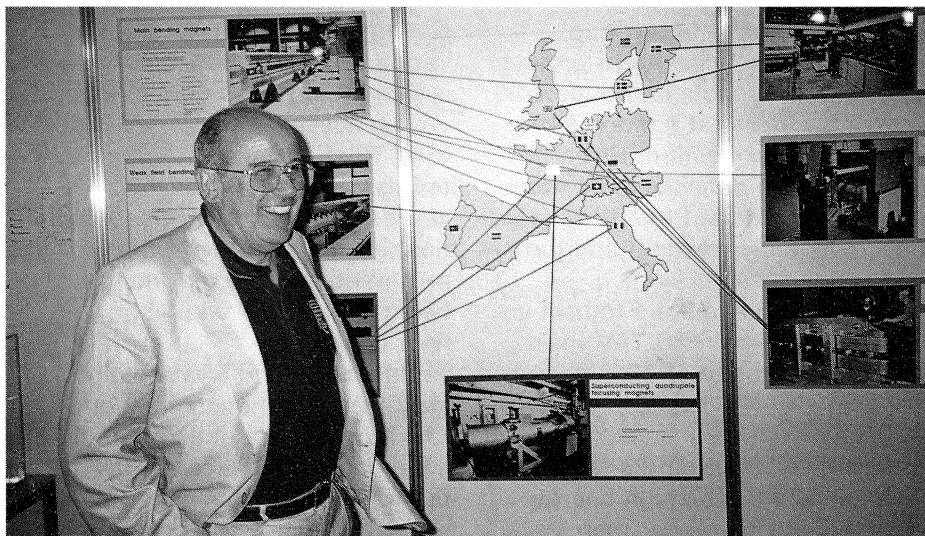
The physics interest for light and heavy ions is moving to higher energies where RHIC at Brookhaven is preparing to open up new energy horizons. Before testing a full cell of superconducting magnets, changes were made to the lamination thickness and to the cryostat. Magnet production will be in industry and is planned for 1993-6.

At low energies, there is considerable interest in the radiotherapy applications of light and heavy ions. This was underlined by joint sessions with a parallel medical conference and a visit to the 'Centre Antoine- Lacassagne' (CAL) where the Medicyc medical cyclotron is presently being installed.

Protons and ions deposit their energy in a small volume at a precise depth in tissue (known as the Bragg peak). Heavy ions however are somewhat less efficient in this respect and deposit some energy beyond this region due to fragmentation.

A spin-off of accelerator technology which attracted considerable interest was a Japanese proposal to transmute long-lived radioactive waste into short-lived waste by high energy proton-induced spallation. The basic idea has been aired before, but advances in accelerator technology are making such a nuclear waste 'incinerator' a feasible proposition. A conceptual design with a 1.5 GeV 10mA proton linac is challenging but far from impossible, and is certain to be followed with interest.

Emilio Picasso of CERN in front of CERN's EPAC exhibit. The involvement of European industry in ongoing accelerator R and D work is one of CERN's big success stories.





Malika Meddahi's contribution to LEP beam dynamics formed part of the EPAC poster session.

The review of the UNK high energy project at the Soviet Serpukhov Laboratory reported accelerated progress since 1987, although the start of installation of the superconducting magnets is not foreseen before the end of 1992.

The ongoing big projects were left for the conference finale, where Bjorn Wiik opened with a presentation of HERA. This project for 820 GeV protons colliding with 30 GeV electrons was authorized in 1984 and commissioning will start this autumn. With DESY's electron traditions, the electron ring and injector chain were completed and commissioned well in advance of the attack on protons. For the main HERA ring most of the superconducting dipoles have been delivered. With production running 20% faster than anticipated, deliveries will soon be complete, with installation not far behind.

It was then the turn of the world's largest accelerator project, the US Superconducting Supercollider, SSC. Being at a much earlier stage in its conception, Helen Edwards had no definitive hardware to show and turned to site-specific design features, magnet aperture and schedules.

The main parameters remain unchanged with twin 20 TeV main rings, a luminosity of 10^{33} per sq cm per s, and an injection energy of 2 TeV. Higher luminosity may be obtained by reducing the bunch spacing to 5m. The high energy booster (already bigger than any

existing machine) and the main rings would be superconducting with dipole fields of 6.4T and 6.55T respectively.

The emittance budget through the 5-element injector chain assumes a 20% dilution per machine. The main magnet now has a 5cm aperture and Bob Palmer is leading a task force to design the definitive dipole. The changes also include a wider cable, a vertically split yoke and a modified cryostat. The testing and installation schedule is geared to collider commissioning in October 1998.

For CERN, Giorgio Brianti described the design for the multipurpose LHC collider, which would be able to accept ions as well as protons. Its protons could also collide with LEP electrons, giving a total energy of about five times that of HERA. Geneva. Preparations at CERN are now in full swing, the objective being formal project approval in 1992.

With 10 Tesla dipoles the beam energy of 8 TeV can be reached with a luminosity in excess of 10^{34} per sq cm per s, and the intensity of 10^{11} particles per bunch is well within present operational limits. The kinematics of the electron-proton option are more favourable with a lower proton energy and it is likely that 55-60 GeV electrons will be collided with 2 TeV protons. For ions the intra-beam scattering and charge-exchange processes are important and luminosities would be far lower than for the proton option, the maximum figure being about 10^{28} with about a 6 hour lifetime.

Ongoing R and D work centres on the superconducting magnets. The arcs will use niobium-titanium superconducting technology at 2K, but for the low-beta quadrupoles niobium-tin at 4K is being seriously

* See page 17

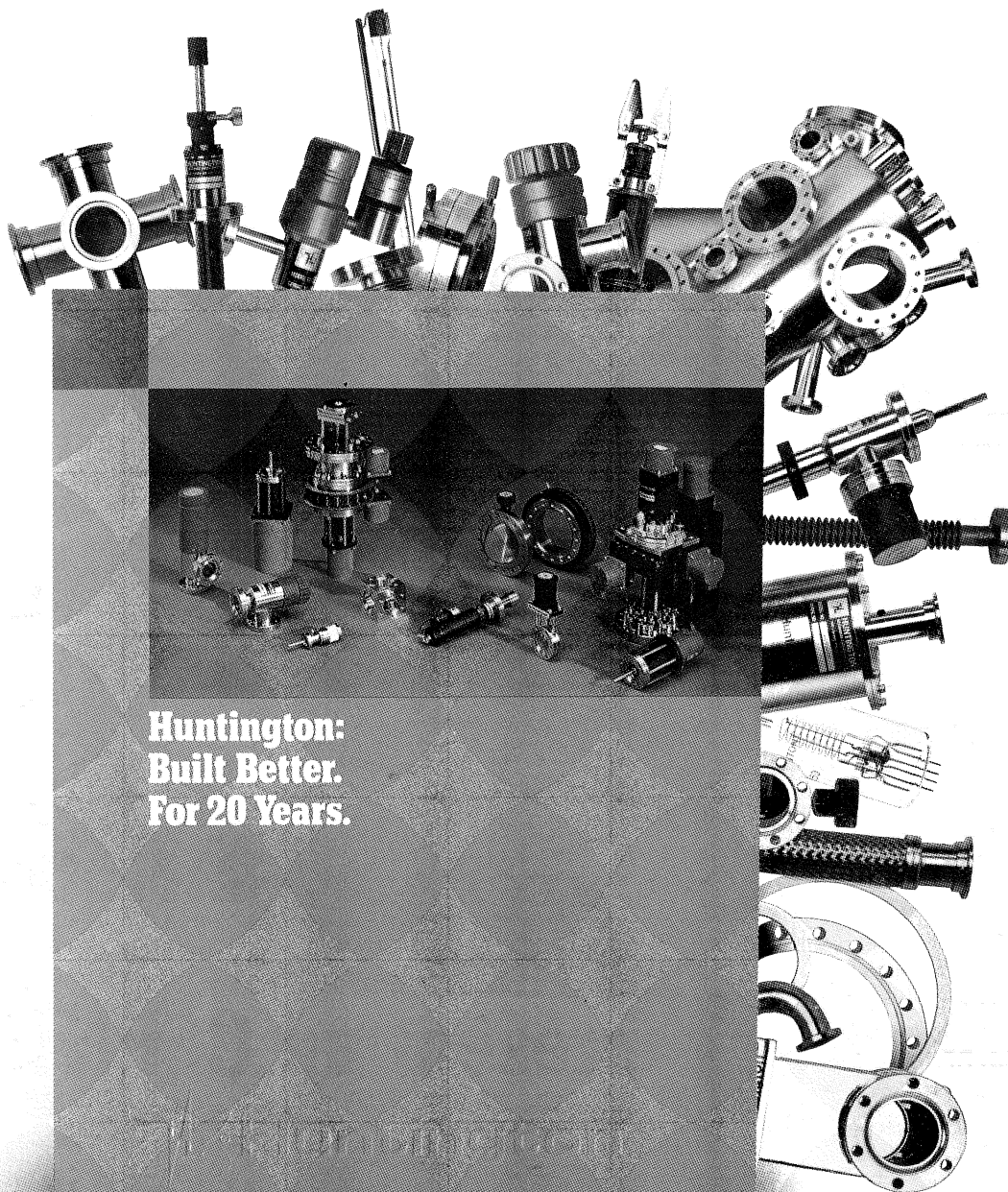
considered. Collaborations between CERN and European industry have been an outstanding feature of this project, with some 30 firms now involved on various aspects of the project*. Bids have been received to build the eight two-in-one dipoles needed for a 100m test string for 1992 and orders will soon be placed.

Quadrupoles, also of the two-in-one type, are being designed by Saclay. The dipole/sextupole lumped corrector is being developed by a British company, Tesla, in collaboration with the Rutherford Appleton Laboratory. In total about 1800 dipoles and a corresponding number of quadrupoles would be required.

As well as capitalizing on the existing CERN infrastructure, there is the added attraction of little expenditure on the low technologies of 'pouring concrete and digging rock', with the high technology aspects attracting European industry on an unprecedented scale.

Concluding the meeting, EEC Director General for Science, Research and Development Paolo Fasella, speaking on 'Scientific Collaboration in Europe', assured the scientific and industrial communities that the EEC was closely following the progress in the high technology of accelerators, and was consequently ready to help. He cited earlier programmes such as ESPRIT and described the present FRAMEWORK channel for EEC aid (CERN already benefits with money for CERN Fellowships). An open invitation was extended to formulate requests for assistance on behalf of valid scientific projects, where the accelerator community should not be short of suggestions!

By Philip Bryant



**Huntington:
Built Better.
For 20 Years.**

Huntington has it.

The broadest selection of vacuum components: Built better, delivered faster.

Huntington offers you more types of vacuum components — in more varieties — than anybody else...

All kinds of chambers. All kinds of positioners and feedthroughs. All kinds of valves. All kinds of connectors. And all kinds of everything else you need to build a better vacuum system.

Including superior design and engineering capability, to build components to your individual requirements.

© 1990 Huntington Laboratories

Since it's Huntington, everything's built better. And delivered to you faster. Because Huntington keeps more inventory in stock.

Get your free catalog.

It's all shown in the new Huntington catalog. To get your free copy, simply call or write: Huntington Laboratories, 1040 L'Avenida, Mtn. View, CA 94043. (800) 227-8059 or (415) 964-3323. Fax: 415-964-6153.

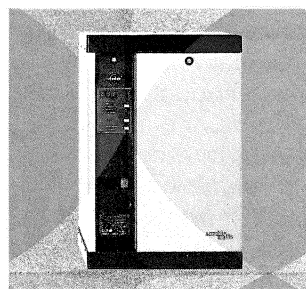
 **Huntington®**
Better-Built Vacuum Components



Condair présent au CERN !



Des humidificateurs à vapeur Condair, sont installés au CERN, car dans un domaine aussi sensible que la physique des particules, il est absolument nécessaire pour que le poste de commandement central fonctionne sans défaillance, qu'il soit correctement humidifié.



Condairmatic MC. Un humidificateur à vapeur entièrement automatique, à commande par micro-ordinateur, pour une utilisation rationnelle de l'énergie. Idéal pour bâtiments administratifs, musées, centrales d'ordinateurs et pour le stockage de denrées périssables.



Toujours à la pointe du progrès.

Demandez-nous des prospectus.

Conseil, vente et services

Condair AG Heiligholzstrasse 6 CH-4142 Münchenstein 2 Tel.: (061) 46 31 46

Büro Volketswil Ifangstrasse 7 8604 Volketswil Tel.: (01) 945 64 97

Bureau Lausanne 6, chemin de la Lisière 1018 Lausanne Tél.: (021) 312 91 32

Une entreprise de **WMH** Walter Meier Holding AG.