

Linear colliders

At the recent Linear Collider Workshop at the Stanford Linear Accelerator Center (SLAC) – left to right, Pisin Chen of SLAC, Kaoru Yokoya of KEK (Japan), Norman Kroll of UC San Diego and Ron Ruth of SLAC. Below – Karl Brown of SLAC with Joel Le Duff and Michel Davier of Orsay.

(Photo SLAC)

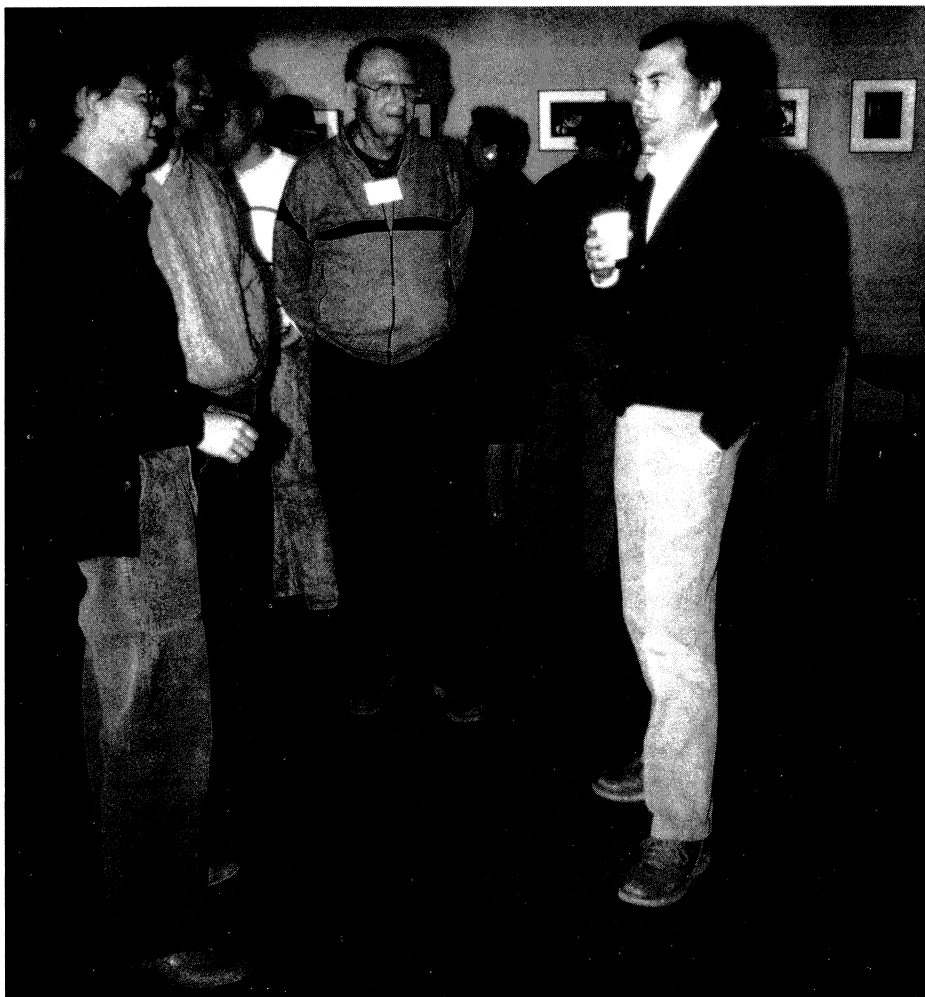
From November 28 to December 9, the Stanford Linear Accelerator Center hosted an International Workshop on Next Generation Linear Colliders. The attendance, including delegations from CERN, Frascati (Italy), KEK (Japan), Livermore (US), Novosibirsk (USSR), Orsay (France) and SLAC itself reflected the international interest in this new approach to higher energies.

The world's experts on linear colliders had come to learn from recent experience with the Stanford Linear Collider (SLC), to discuss their research and development programmes, and to compare notes on the design of possible new machines. SLAC Director Burton Richter opened the two-week conclave with a recommendation that the various interested groups of accelerator physicists pool their talents and collaborate on the R & D necessary for the next linear collider.

Subsequent plenary speakers outlined the current state of knowledge in such areas as design parameters, damping rings and sources, accelerator structures, beam dynamics, instrumentation and control, radiofrequency power sources, and final focus design.

In his 'Struggle for High Luminosity' talk, Robert Palmer of Brookhaven and SLAC explained the thinking behind the TeV Linear Collider (TLC). This 7/8 kilometre, 1 TeV collider intended for the SLAC site must produce the $10^{33-34} \text{ cm}^{-2} \text{ s}^{-1}$ luminosities required for electron-positron physics in this energy range.

Then Wolfgang Schnell outlined the choices made by the CERN team designing its CLIC linear collider, a 2 TeV machine to give 10^{33} luminosity and a possible increase in a multibunch mode. Accelerating



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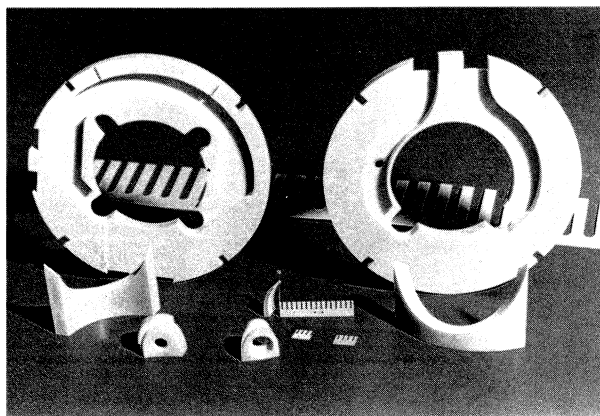
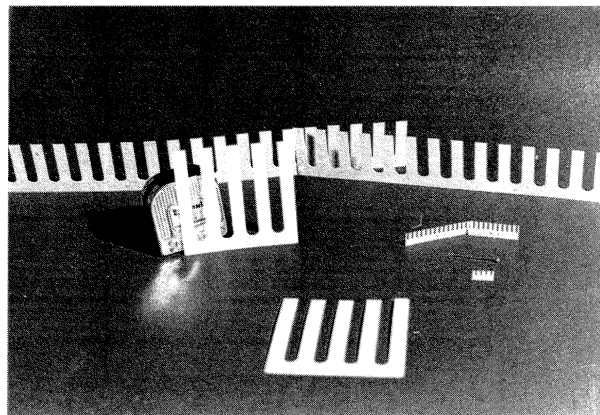
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sections would be powered by a superconducting drive linac running in parallel.

Alexander Skrinsky described the Soviet VLEPP project, including the 1 TeV electron-positron linear collider scheduled for construction at Serpukhov in the mid-1990s. Mazakasu Yoshioka discussed parameters for the Japan Linear Collider (JLC) and summarized the extensive development underway at KEK.

Workshop participants then broke up into smaller groups for a week of intensive discussions on areas of special interest, reconvening for the final two days of summary talks from the various working groups.

One of the most significant results to emerge came from the 26-strong group considering final focus designs. In discussions with Valery Telnov of Novosibirsk, Pisin Chen of SLAC recognized that coherent electron-positron pair production – by beamstrahlung photons interacting with the magnetic field of the other bunch – may generate intolerable backgrounds in the surrounding detector. For TLC beams with 10^{10} particles per bunch, the coherent production dominates the incoherent by about a factor of 200. What's more, background particles are generated with the *same* charge as the opposing beam, so that they can receive a substantial transverse kick.

The coherent pair production rate can fortunately be controlled by reducing the magnetic fields of the beams. This can be accomplished by reducing the charge density per bunch, which in turn requires increasing the number of bunch crossings per second in order not to lose luminosity, or by increasing the aspect ratio of the beams. Allowing a larger exhaust

port for the pairs (through the final focus quadrupoles) may require use of a larger crossing angle than previously anticipated – 60 milliradians instead of 3 – which may require the so-called 'crab crossing' design to retain luminosity. Whatever the eventual outcome, all sets of parameters advocated in the various linear collider designs will have to be reviewed and revised to take account of this pair-production phenomenon.

Other groups had significant, if less startling, results to report. Those physicists working on damping rings agreed that wiggler magnets were an attractive means of producing low-emittance beams rapidly – permitting higher repetition rates. The favoured accelerator structure is the disk-loaded waveguide with an iris radius of 20 percent of the r.f. wavelength – 2-6 cm in the designs being considered. For multibunch operation (many bunches per r.f. fill, as in the SLAC design and as an add-on for CLIC) slotted structures are needed to damp the transverse r.f. modes that would otherwise cause beam breakup. BNS damping (December 1988, page 13) was a favourite method advocated to control growth of transverse tails on the bunches.

One of the key problems to be solved is in the r.f. power sources needed to drive the linear colliders. No current solutions simultaneously meet all the requirements of peak power, repetition rate, efficiency and cost, although the first three have been demonstrated separately.

Although the present sets of design parameters appear diverse, there are common problems that will benefit from collaboration on R & D, as underlined in the working groups. For example, ongoing col-

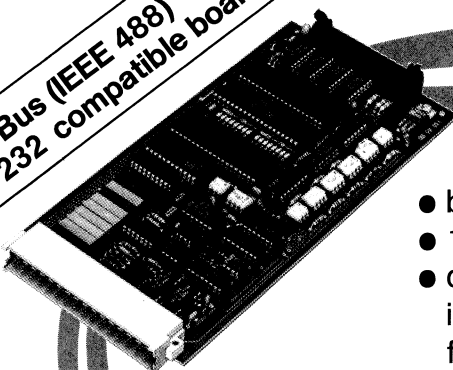
laboration between KEK and SLAC has benefited r.f. power source and accelerator structure development, as well as final focus design.

One possible international collaboration is the Final Focus Test Beam being considered for SLAC. This beamline would take the beam straight ahead from the end of the linac and use TeV linear collider optics scaled down to 50 GeV to produce intense, submicron beam spots. Optics, components, instrumentation and precision alignment techniques could be tested.

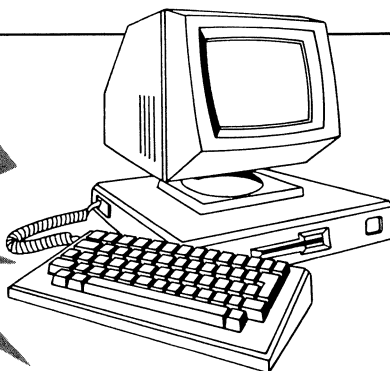
In summary, workshop organizer Ewan Paterson of SLAC observed that the problem of beamstrahlung pair production had already ushered in a 'new wave' of linear collider fashions. Multibunch operation, slotted accelerator structures, large crossing angles, crab crossing, wigglers in damping rings, and BNS damping were all 'in' now. Collimators in the final focus were decidedly out, and the need for more r.f. power has not changed. 'Complementary linear collider designs are very important', Paterson added, 'because we learn from everybody's different problems.'

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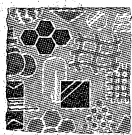
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