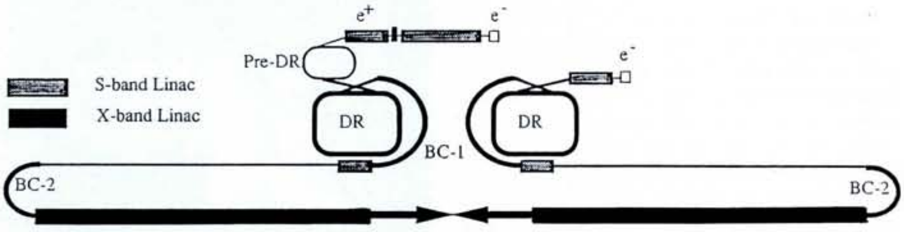
Internationalising Linac Research



An outline of the KEK (Tsukuba) JLC proposal for a next generation 0.5 TeV linac for particle physics. Electrons are injected into damping rings (DR) and then bunch compressed (BC), pre-accelerated to 10 GeV in an S-band linac, compressed again, and accelerated in two, 7 km long, X-band linacs.

Dr. Burton Richter, Director of the Stanford Linear Accelerator Center, argues that the sensible next step in linear accelerators for particle physics should involve a significantly higher energy than the upgraded LEP machine's 200 GeV, as well as aiming for at least twice the top quark's mass (the next physics frontier now estimated to be at < 200 GeV). So SLAC's Next Linear Collider proposal is for a 500 GeV machine, expandable to 1.5 TeV, working in the X-band at four times the present SLAC frequency, representing a trade-off between economies and tolerances. The Japanese JLC proposal by KEK (Tsukuba) envisages similar targets for a 15 km long, 1 TeV linac collider, which could also be built up in phases starting at 0.5 TeV. Based on current linac projects, the cost of the NLC or the JLC would be about $1 M per GeV, or 500–1500 M$ in total — significantly less than the SSC.

One alternative is to stay with SLAC's $\approx$ 3 GHz S-band technology and progressively replace most of the collider with X-band components. Another is to have a high accelerating gradient, entirely superconducting machine working in the $\approx$ 1.5 GHz L-band. But Dr. Richter does not believe in the 25-50 fold decrease in cost which has been claimed in view of less stringent requirements for beam alignment and final focussing (*e.g.* the TESLA SC-LINAC proposed by an international study group, which could also be constructed in phases, has a beam size of 58×554 nm^2 compared with 2.5×220 nm^2 for NLC). Meanwhile, the novel $\approx$ 30 GhZ K-band two-beam approach offering high power efficiency (CERN's 2 TeV CLIC proposal calls for 35 MW/TeV compared with 200 MW/TeV for the NLC) is only in the early stages of development at CERN and is seen as the route towards a multi-TeV machine. Another proposal is the DESY (Hamburg) S-band multi-branch LC collider using essentially SLAC technology, working at $\approx$ 3 GHz, with an accelerating voltage gradient of 17 MV/m which is several times smaller than the 80-100 MV/m used in the other approaches. The LC proposal calls for a 0.5 GeV energy with a five-times smaller luminosity than NLC: the beam size (7.8×192 nm^2) remains a problem. Finally, Russian workers have proposed a 1-2 TeV machine, similar to NLC and JLC but with a larger beam size and a long bunch length.

Joint Projects

Commenting on internationalisation efforts and whether it was wise to continue developing major projects for different parts of the world, Dr. Richter felt collaborating groups would eventually come together to build a next generation machine. For the time being the interest was on joint projects. All regard the 16 M$ Final Focus Test Beam facility at SLAC, planned to be operational in 1992-93, as a milestone. The facility, involving a collaboration between SLAC, LAL (Orsay), MPI (Munich), DESY, KEK, and INP (Novosibirsk), aims to achieve the same demagnification as would required in the next generation linac by producing a 60×1000 nm^2 beam (SLAC's beam is presently 2000 nm in diameter).

For the injector system, problems associated with high power sources for a next generation machine based on klystrons augmented by pulse compression units are largely solved, although Russian workers have indicated they would like to collaborate with SLAC on aspects of high power positron sources. KEK may meanwhile take the lead with the M$ 10-20 JLC Accelerator Test Facility to design and test an improved damping ring (a sort of storage ring) that would be used to inject a low emittance 1.5-2 GeV beam into each of the two main linacs of a future collider (see figure).

The future is less clear for the development of the main linac accelerator structure, which demands highly accurate beam-based alignment, control of beam breakup instability and the solution to problems associated with high gradient acceleration (surface damage, high dark current, *etc.*). SLAC, KEK, LAL, and INP have collaborated on high gradient experiments for which SLAC has proposed an accelerator test facility along with an engineering model of an NLC section. KEK envisages a similar 100 m long, 0.5 GeV, S-band test linac for its test facility.

There is clearly more-or-less general agreement on what the next major linear collider for particle physics should look like: maybe it will get off the drawing boards as new international projects mature.