

DESY Unveils Plan for the TESLA Collider

Germany has taken an important step toward the realization of the next-generation electron-positron collider. At an impressive two-day colloquium in March at the DESY (Deutsches Elektronen-Synchrotron) laboratory in Hamburg, the DESY directorate unveiled its technical design report for TESLA, an ambitious superconducting 500- to 800-GeV variant of the kind of linear e^+e^- collider toward which competing groups all over the world are striving.

Appropriate to TESLA's unprecedented length (33 km from end to end), the technical design report is a five-volume opus replete with detailed cost estimates. The cost of the entire facility, including a 10-keV x-ray free-electron laser and FEL users' laboratory, is about \$3.5 billion. That sum also includes a high-energy-physics detector at the point where the positron and electron beams collide. But it does not include some 7000 scientist-years of labor that US costing procedures would have added. The proposal is to build TESLA in a tunnel that would run northward from DESY into the Schleswig-Holstein countryside. Construction would take about eight years.

Now that construction has begun at CERN for the 14-TeV Large Hadron Collider, many in the worldwide particle physics community regard a linear e^+e^- collider with a collision energy of about 500 GeV as the obvious and necessary next step. For some years now, the theoretical parameter space for the onset of expected new physics in the electroweak-unification regime has been converging on energies well below 1 TeV. Therefore most particle theorists now expect that a 500-GeV e^+e^- collider should suffice to reveal the Higgs boson or some alternative mechanism for electroweak-symmetry breaking. Similarly, the lightest new particles predicted by supersymmetry (or manifestations of a rival theory) are expected to be accessible at 500 GeV.

The international TESLA collaboration's proposal calls for a 15-km-long superconducting radio-frequency linac to accelerate an electron beam to 250 GeV, standing face-to-face opposite a second, almost identical linac that does the same for positrons. The heart of each linac is a linear array of more than 10 000 resonant RF cavities made of superconducting niobium. German industry can routinely manufacture superconducting cavi-

The superconducting 500-GeV e^+e^- linear collider would run under town and country for 33 kilometers.

ties that will operate at the 25-MV/m accelerating field necessary for the 500-GeV collider. TESLA is designed to be upgradable to 800 GeV. The 35-MV/m cavities necessary for the upgrade have been demonstrated at the TESLA test facility.

Cold versus warm

The superconducting TESLA cavities would be maintained at a temperature of 2 K. The leading rival technology for a 500-GeV e^+e^- linear collider is the "warm" RF linac scheme with normally conducting copper cavities, under active development in the US and Japan. Such a warm linac would operate at a radio frequency of 11 GHz, ten times the proposed TESLA frequency. The correspondingly shorter RF wavelength imposes much more demanding structural and alignment tolerances on the copper linac scheme.

On the other hand, a superconducting niobium cavity is limited by the properties of niobium to electric fields below 50 MV/m. Proponents of the copper alternative aspire to accelerating fields as high as 70 MV/m, thus allowing for a shorter collider with correspondingly lower civil-engineering cost. But copper cavities under study at SLAC have thus far shown surprising deterioration in extended test operation at these very high field intensities.

The list of relative pros and cons of these competing technologies is long and debatable. And the debate must constantly take account of new R&D results. At one point it was thought that, for all its merits, the supercon-

ducting scheme would ultimately prove too expensive. "But TESLA has now demonstrated that cost will not be the dominant issue," says SLAC director Jonathan Dorfan.

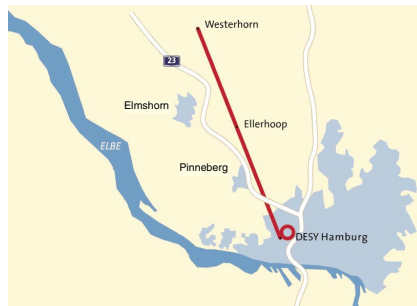
SLAC leads the collaboration working to develop the Next Linear Collider (NLC), the principal US warm alternative to TESLA. But the NLC group has not yet been authorized to produce a conceptual design report. For one thing, the US high-energy community, unlike its Japanese and European counterparts, has not yet expressed an explicit consensus that a 500-GeV e^+e^- collider is indeed its highest priority for the next big accelerator. This issue is being addressed at a series of town meetings at the major US labs, convened by the HEPAP (High Energy Physics Advisory Panel) subpanel on long-range planning (see *PHYSICS TODAY*, April 2001, page 28). Then in July, the discussion will move on to the Snowmass 2001 workshop in Colorado.

Global participation

The TESLA design report will now be scrutinized by the German government's scientific advisory council. With government approval and adequate financial commitment from other participating countries, construction could begin in 2003. It is generally understood that no more than one such accelerator will be built worldwide. Many in the US and Japan would prefer that their own country host the e^+e^- collider. But hosting such a machine is an expensive business. DESY assumes that foreign contributions will cover half the cost of building TESLA, its detector, and the FEL facility. DESY director Albrecht Wagner proposes that TESLA should be run as a truly worldwide facility, with much of the accelerator's operation and data-taking being done remotely at participating foreign laboratories.

"The TESLA collaboration has put an impressive proposal on the table, and now it is up to the US community to respond," says HEPAP chairman Fred Gilman. International modalities will have to be created for comparing and evaluating R&D results still coming from the competing laboratories. "We will need fair and transparent procedures for arriving at an international consensus on—in priority order—the scientific urgency, the best technology, and the site selection," says Hermann Schunck, chairman of DESY's administrative council.

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THE TESLA COLLIDER would extend northwest for 33 km from DESY in Hamburg (cities shown in light blue). At Ellershooop, just north of the e^+e^- collision point, a free-electron-laser laboratory would be built.