New doctoral programs in accelerator physics are started

A number of universities and laboratories have well-established and well-regarded programs in accelerator physics that have produced a steady stream of doctorates. But by general consensus among high-energy physicists and accelerator experts, existing doctoral programs in accelerator physics have not been producing enough graduates to keep pace with demand.

That situation seems to be changing. Two years ago a Texas Accelerator Center was established at The Woodlands, just north of Houston, and it already is training doctoral candidates in cooperation with affiliated universities. At Stanford University Helmut Wiedemann is starting an accelerator-science program in the university's department of applied physics. Most recently Fermilab offered a new PhD program in accelerator physics to any qualified universities that wish to cooperate in training students.

Concern about Europe's perceived lead in high-energy physics, highlighted by the 1984 Nobel Prizes to Carlo Rubbia and Simon van der Meer for work at CERN, ranks high among the reasons for the new attention being given to education in accelerator physics. If the United States is to build the Superconducting Super Collider successfully and recover the lead in the next major phase of experiments in particle physics, it stands to reason that it will need a bigger pool of accelerator scientists.

Job market. When the Department of Energy's High-Energy Physics Advisory Panel surveyed manpower needs in summer 1985, it found the supply of experimenters satisfactory but anticipated a "scarcity of accelerator physicists during the SSC construction period." The panel estimated the current number of accelerator physicists at 330 and concluded that 20–30% more would be needed—implying a net increase (taking retirements into account) of 60–80 physicists.

Those involved in inaugurating and maintaining accelerator programs express confidence that the future is bright even apart from SSC. Robert

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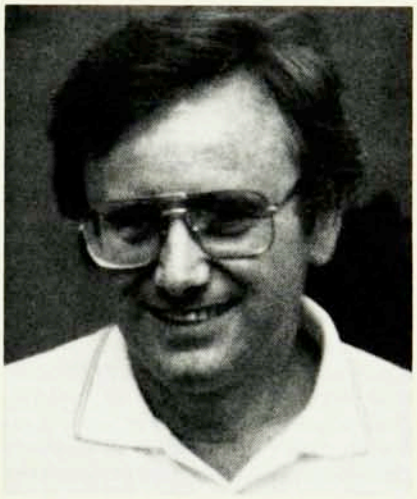

WIEDEMANN

Siemann, an experimental physicist turned accelerator scientist at Cornell, points to several important areas in which there will be ongoing work. First of all, in high-energy physics, there is a pressing need for people to maintain and operate the Stanford Linear Collider and the Tevatron at Fermilab, "both very complicated machines," Siemann observes; in nuclear physics, CEBAF is being designed and there are plans for a heavy-ion accelerator at Brookhaven; in materials science, the Advanced Light Source at Lawrence Berkeley Laboratory and a 6-GeV source at Argonne are anticipated; and finally, the Defense Department will have a hefty demand for accelerator scientists, notably in work on the free-electron lasers and neutral-beam accelerators that greatly interest the Strategic Defense Initiative Organization.

Stanford. Stanford's Wiedemann says it is important to realize that accelerator rings may have wide applications outside traditional areas. He believes that rings eventually will be built in many places for use in x-ray lithography and angiography (the diagnosis of circulatory problems). Sixty-six proposals to develop compact synchrotron light sources, which could be used for such applications, were discussed at a recent Brookhaven conference. Current techniques in angiography are quite dangerous, and Wiedemann thinks that if an innovative procedure employing intense monochromatic x rays were developed successfully, it would be adopted at many major hospitals. Fermilab Director Leon Lederman notes that there are more than 1000 medical accelerators at hospitals, and as interest rises in proton therapy, the number will increase.

Wiedemann says that the Stanford applied-physics department started to build an accelerator group around the middle of last year and already has quite a strong team. Three students in the department have just embarked on programs in accelerator science.

The main activity of the accelerator group will be the design and construction of a free-electron laser and storage ring, a project that has received funding from the SDI program. The storage ring will be optimized to provide a particle beam with a peak current of up to 300 amps, which will drive a free-electron laser with wavelengths as short as 100 angstroms or even less. Wiedemann agreed to lead the design team for the free-electron laser on the condition that it be connected with a

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program to teach accelerator science.

Wiedemann hopes to develop a course in accelerator science and perhaps to write a textbook on the subject. He sees the lack of textbooks as a major problem facing physicists who wish to launch accelerator-science teaching programs.

Fermilab. In Fermilab's new program, student applicants are expected to have passed all graduate qualifying exams and to be ready to select a thesis topic. A sponsoring faculty member at the student's university monitors the student's progress, working with the Fermilab Accelerator Science Committee. A Fermilab staff member approved by the sponsor and the committee supervises the student's thesis research.

Fermilab provides housing for students accepted into the program and pays them stipends comparable to what they would get at their own universities. The laboratory hopes to maintain about six students in the program.

When the laboratory initially contacted about 20 universities in the Midwest, the response was uniformly favorable, but some department representatives expressed concern about recruiting students. It is no secret that many physicists have been inclined to view accelerator science as "second-class physics." And partly because so few physicists do research on accelerator science at universities, students have found it difficult to get interested in the subject.

As it happens, Fermilab has now sent a poster announcing its new program to some 100 universities, and applications are likely to exceed the acceptance limit of six the laboratory has placed on the program, Fermilab's Roy Rubinstein reports. Two students have been accepted into the program, one from MIT and one from the University of Illinois, Chicago. Serious negotiations are being conducted with several more.

Texas Accelerator Center. Student interest in accelerator physics also turns out to be lively in Texas. The Texas Accelerator Center, a joint project of Texas A&M, the University of Texas at Austin, Rice University and the University of Houston, currently has about a dozen doctoral students from the four universities, and the aim is to boost the number to around 20. Two of the students have finished their course work, and another six or so will be that far along by the end of the summer.

In addition to training PhD students, the center brings about 20 juniors, seniors and beginning graduate students to the lab in The Woodlands to expose them to accelerator science. The students spend three months at the center, during which they get free housing and a stipend of $1000–$1500 per month. The center has applied to DOE, NSF and private industry for funds to support the summer program.

TAC's current budget comes to about $5 million a year, according to its director, Russ Huson. It receives some of its funding from the Baylor College of Medicine for the development of a 4-tesla magnet for use in magnetic-resonance imaging, and another portion of its funds from the SDI program, Huson says. Most of its money, however, comes from the Department of Energy, and most of it goes for design work on SSC.

Huson was the head of the accelerator division at Fermilab for five years and left, he says, partly because he feels that national laboratories are not ideal for teaching accelerator physics. They tend to be too isolated from the academic world, he thinks, and students tend too often to get sucked into established and inflexible projects.

Huson anticipates that the Texas Accelerator Center will send students to visit national laboratories but that most will do the bulk of their thesis research at the lab, working mainly on design and computer work for an advanced-technology, multi-GeV proton linac with a 15-MeV/m gradient. Peter McIntyre, a physicist at Texas A&M who serves as spokesman for TAC, says that TAC has submitted a proposal for the linac to the Department of Energy and is anxiously awaiting a reply.

Other programs. It is of course nothing new for the major national laboratories to accept an occasional graduate student to do thesis work in accelerator science, and a few physics departments have encouraged students to study accelerators. At Cornell University there usually are about six to eight physics-department faculty members specializing in accelerator science, supported by about a dozen accelerator specialists. The number of students working for doctorates in the field generally ranges from six to eight.

The Cornell accelerator group is generally recognized as the premier team in the academic world and includes luminaries such as Maury Tigner, chairman of the SSC central design group; Boyce McDaniel, head of the SSC board of overseers; and Robert R. Wilson, who designed the Cornell Electron Storage Ring.

The State University of New York at Stony Brook, the University of Maryland, the University of California at Berkeley, the University of Wisconsin and Caltech also turn out an occasional PhD in accelerator physics, according to Cornell's Siemann. It is Siemann's impression that accelerator science is a substantial part of the physics program only at Cornell and Maryland.

Asked for examples of the kind of doctoral work a student might do in accelerator physics, Siemann mentioned three Cornell dissertations ranging from the purely theoretical to the purely technological: "Statistical method for nonequilibrium systems with applications to accelerator beam dynamics," "Multibunch instabilities and current-dependent phenomena in the Cornell Electron Storage Ring" and "Injection process of the Cornell Electron Storage Ring."

Siemann notes that a great many accelerator physicists started out in other fields and were retrained as accelerator physicists while doing postdoctoral work or later. Brookhaven has a formal Accelerator Technology Fellow Program, run by Paul Reardon, to provide postdocs with such training.

In addition Melvin Month of Brookhaven conducts a regular summer school in accelerator physics at varying locations. These summer sessions provide established accelerator physicists with refresher courses, give young postdocs an opportunity to learn something about accelerator physics and yield useful conference proceedings that are published by AIP. Month has just established an APS topical group on particle-beam physics.

—WILLIAM SWEET

Britain and Germany sign SDI-research agreements with US

The Strategic Defense Initiative has gained some ground among US allies, though opinion about SDI in allied countries remains deeply divided. The US government has concluded agreements with the British and West German governments permitting companies in the two European countries to bid for work supported by the SDI Organization, and it is anticipated that other major US allies will sign similar memoranda of understanding in the coming months.

When the US government invited friendly countries to join in research on missile defenses early last year, there was a lively response from European and Israeli companies, especially those in the electronics and aerospace industries. The initial reaction from most government leaders, however, was wary. The most prevalent first reaction from Europeans was that a missile-defense system would not be in their interests even if it worked, because it might enable the United States to protect itself in a nuclear war while