Soviets Plan Huge Linear Collider

Soviet leadership moves to reinvigorate high energy particle physics program; backs new synchrotron collider and long linear collider at Protvino

Not wanting to be left behind in the particle dust of the United States' proposed Superconducting Super Collider (SSC), the Soviet Union high energy physics community is planning to build the Very Long Linear Collider (VLLC).

Information about the proposed collider is sketchy, but knowledgeable Soviet and American researchers told *Science* that the machine is being designed to eventually produce collisions with center-of-mass energies of 2—and perhaps even 4 trillion electron volts (TeV). The Soviet plan calls for constructing the machine in two phases, the first being 20 kilometers long with a collision energy of about 1 TeV. The electron-positron collider later would be stretched another 20 kilometers.

The SSC, a proton-proton collider, would produce 40-TeV collisions that will enable physicists to identify particles with masses of up to several TeV. Theorists hope to uncover new phenomena that will allow them to advance man's understanding of matter and to comprehend deviations in the Standard Model's explanations of particle behavior. The VLLC would enable Soviet researchers to explore much of the same territory, even though the linear collider's energy would be much smaller. The electron-positron collider is expected to produce a narrower assortment of quarks and leptons than a proton-proton device. The reduced variety of events, however, can be an advantage in detection and analysis.

Although some uncertainty exists about the new Soviet linear collider, the plan reportedly was endorsed by the Central Committee Politburo on 18 June. This project is part of a larger national goal to rejuvenate the Soviet high energy physics research program. The Protvino area near Serpukhov, about 130 kilometers outside of Moscow, has been designated as the national center for particle physics research.

In addition, the State Committee for Science & Technology has moved to resolve the long-standing question of whether to incorporate a collider into the Clashing Accelerator Complex (UNK) being constructed at Protvino. The proton-proton collisions for this machine will have center-of-mass energies of 6 billion electron volts (GeV). A proposal for a proton-antiproton machine, which was championed by physicists at Novosibirsk, was rejected, according to Soviet researchers at the European Laboratory for Particle Physics (CERN).

The decision to proceed with the two projects appears to have been somewhat sudden and has surprised many western researchers. A decision on whether UNK should be equipped for both fixed target and colliding beam experiments had been left undecided for almost 10 years. The projects have attained momentum, according to Soviet and American physicists, because they have had the backing of ranking Soviet officials such as Anatoly A. Logunov, vice president of the Soviet Academy of Sciences. Yevgeniy P. Velikhov, former vice president of the Academy and a long-time friend of Secretary General Mikhail S. Gorbachev also has pushed the project.

The Soviets are banking on the linear accelerator project to deliver more than new insights into particle physics, says Edward Knapp, president of Universities Research Association. The organization manages Fermi National Accelerator Laboratory and the SSC Central Design Group located at Lawrence Berkeley National Laboratory under Department of Energy contracts. In recent discussions with Soviet officials, Knapp says he got the impression the project is to serve as a model for executing future industrial projects.

In addition, a member of Central Commiittee Secretariat and former ambassador to the United States, Anatoliy F. Dobrynin, has pushed the UNK collider and linear collider projects as a ways to strengthen internatonal collaboration with the West, sources say. The Soviet government is reportedly budgeting 2 billion rubles (0.65 rubles = $1) for building the UNK collider and for the first phase of VLLC.

The linear collider project is being given a high priority status, according to Knapp. The government is preparing to build entire new towns near Protvino to accommodate thousands of construction workers and hundreds of additional scientists who will be working at the Serpukhov particle physics facilities. More than 100 researchers and technicians from Novosibirsk are expected to move to Protvino. Construction is tentatively slated to start in 1990.

Other evidence also indicates that the Soviets are serious about making this a model industrial project from a construction, engineering, and scheduling standpoint. In a break with tradition, the State Committee for the Utilization of Atomic Energy may manage the project instead of the ministry of heavy industry. In addition, magnets for UNK and the linear collider are to be built in a new factory at the Serpukhov laboratory under the supervision of the National Academy of Sciences and the State Committee for Science & Technology. The Ministry of Machine Building has been the traditional magnet supplier for Soviet particle physics machines. "This is considered a dramatic change," says Knapp, noting that the bureaucracies in the heavy industry and machine building ministries have stifled innovation.

Western physicists say the VLLC is a logical device to build following the SSC—and they add that it is a daring undertaking at this time. Chris Quiqq, a particle physics theorist with the SSC Central Design Group, notes that "the best minds in the West say that building a 2 to 4 TeV electron-positron machine is a very ambitious goal."

But, some Western physicists question whether the Soviets have the technology in hand to build such a machine. "They are not at the stage where they could make a believable proposal to Congress," asserts James M. Paterson, head of the accelerator department at Stanford Linear Accelerator Center (SLAC).

One problem that researchers cite is the need to drastically reduce the size of the particle interaction area while obtaining a high enough volume of events in any one shot. SLC's interaction area is 5 to 2 micrometers, but linear collider envisioned by the Soviets and other nations will require interaction regions with a focus of about 0.03 micrometer or smaller, Paterson notes. Other challenges include particle beam alignment and focus; and finding ways to cut power requirements for particle drivers.

Soviet researchers are not the only ones who yearn to build a long electron-positron linear collider. Since about 1980, Burton

Richter, director of SLAC, has envisioned building a device with an energy range of about 1-TeV center-of-mass. A year ago Richter assembled two SLAC teams to examine the technical hurdles and physics research opportunities that such a machine would present.

In addition, European physicists are examining building a 20-kilometer machine at CERN in Geneva. The so-called CERN Linear Collider (CLIC) has been analyzed by an advisory panel led by Professor Kjell Johnsen. That report is under review by CERN's long-range planning council, which is chaired by Carlo Rubbia.

Johnsen says CERN researchers are looking at two different collider schemes—one based on a machine that can accelerate particles at an energy level of 80 MeV per meter and another at 160 MeV. The higher energy range would permit CLIC to be shorter than now planned, yet still produce collisions with a center-of-mass of about 1 TeV. Japan also has proposed building a 7-kilometer machine at the Japanese National Laboratory for High Energy Physics (KEK).

Despite the flurry of activity in the Soviet physics community, it remains to be seen whether the Soviets can execute their plan in a timely way. Indeed, some European and American physicists, noting that the Soviet research community has had no major impact on physics in recent memory. Nevertheless, William Wallenmeyer, director of the Department of Energy's high energy physics program, notes that at several times in modern history the Soviet Union has had the world's most powerful particle physics tools—most recently in 1967 when the 70 GeV Serpukhov synchrotron commenced operation.

Tim Toohig, a physicist with the SSC Central Design Group who has worked with the Soviets for years, says that Western physicists should not underestimate the Soviets. Even if they don't have the best technology in hand, he contends there is a high probability that Soviets could build such an accelerator. Such undertakings, he notes, are not always constrained by cost factors and the need to use materials efficiently.

Knapp says that if the United States proceeds with the SSC and the Soviets can demonstrate that they can build the VLLC on schedule, it "wipes [the Europeans] clean out of the game for the next machine." But, whether Europe's plans, or those of Japan or the United States are foiled remains to be seen, asserts Michael Peskin of SLAC. Says Peskin, "I don't think anything the Soviets have done has ever shut the door on anything being done in the West." ■

MARK CRAWFORD

Big Brother Is Counting Your Keystrokes

Frederick W. Taylor, the father of "scientific management," would be pleased. At the turn of the century, Taylor warned that management needed to exercise greater control over workers, even down to choreographing the smallest movements performed on the shop floor. The road to efficiency, Taylor argued, must be lined with monitoring gadgets and constant supervision. *The Electronic Supervisor*, a report issued by the Congressional Office of Technology Assessment (OTA) on 21 September, concludes that employers today have extremely sophisticated tools at their disposal for monitoring workers through their use of computers and telephones, counting, for example, the number of times per hour a clerk strokes a letter on his keyboard.

Alan Westin, a professor of public law and government at Columbia University who compiled information for the OTA report, interviewed 1100 workers and 650 supervisors at 110 organizations between 1982 and 1986. Of the corporations and government agencies which monitor individual employees, Westin found that roughly two-thirds follow a model that is more "Tayloresque" than not. A Taylor model, according to Westin, would include such practices as constant monitoring of employees by a machine; a standardized pace; individual quotas; and work paid per piece.

OTA notes that in the worst of cases, the office could become an Orwellian nightmare, a brand of "electronic sweatshop," in which employees must do "boring, repetitive, fast-paced work that requires constant alertness and attention to detail," where "the supervisor isn't even human" but an "unwinking computer taskmaster."

Westin estimates that between 20 and 35 percent of all U.S. clerical workers—or between 4 million and 6 million people—are currently being monitored. Who gets monitored? Word processors, data transcribers, and telemarketers, among others. The clerical work force is predominately female and disproportionately composed of minorities.

Monitoring employees is not a new trick. What is new is the sophistication brought to the practice, OTA notes. "The technology is much more refined and elaborate now than it was even in the early 1980s," says Westin. Robert E. Nolan, a work-study specialist who consulted for OTA's study, sells software to companies that want to increase worker productivity. One package, the Auto-AOC (for Advanced Office Controls), contains 223 blocks of time, each block representing a part of a task. If an employer, for example, wants to know how many envelopes a worker should open in an hour, he would enter into Auto-AOC the letters "GRSF," for Gather, Receive, Sealed envelope, Folded contents. GRSF is alloted 185 time units, or about 7.5 seconds per envelope. Stapling sheets together is awarded 41 time units, or about 2.9 seconds. These time standards did not come out of thin air, but from the Methods-Time Measurement system, which since the 1940s has been tabulating time values for every motion performed by the human body "in a productive setting." Software designed to monitor employees is an area of great growth. "We're finding that everybody is trying to be as mean and lean as possible," says Nolan.

In addition, employers are using the telephone to monitor workers. For example, most of the country's 226,000 telephone operators are subjected to "service observation," meaning their boss gets on the line and listens to them assist customers. Today, operators hear no telltale click or drop in volume to indicate that someone else in on the line listening. According to OTA, "telephone accounting is one of the fastest growing segments of the telecommunications market." No wonder. A recent audit by the Office of the Inspector General found that 20% of calls made on the government's commerical lines were personal. Analysis by various private companies and government agencies of frequently called numbers revealed many calls to off-track betting establishments, the weather report, and so-called "Dial-a-Porn" numbers.

Stress-related illnesses and absenteeism are just two problems that might arise from compulsive monitoring. According to an earlier OTA report, stress-related illnesses cost businesses $50 to $75 billion a year. Constantly monitoring workers with computerized standards and listening in on private phone calls—even to Dial-a-Porn—raises some tricky ethical and legal questions. But as OTA notes, "there are no legal requirements in U.S. law that monitoring be fair, that jobs be well designed, or that employees be consulted about work standards." The future, it seems, holds more in store. The OTA report mentions the possibility of widespread use of polygraph testing (already 2 million are given to job applicants and employees every year), drug testing, genetic screening, and brain-wave testing. As OTA puts out, the technologies are "controversial because they point out a basic tension between an employer's right to control or manage the work process and an employee's right to autonomy, dignity, and privacy." ■ WILLIAM BOOTH