A World-Class Accelerator

A ten-teravolt physics laboratory will need worldwide ownership

BY DIETRICK E. THOMSEN

In the 1890s, gentlemen sportsmen brought up on the playing fields of Eton and other consecrated public schools, where so many of Imperial Britain's battles had been won, conceived a novel contribution to international peace and understanding, a revival of ancient Greece's Olympic games. Sportsmen from all over the world would compete with each other in an atmosphere of gentlemanly amity. Well, the Olympiads have been held since 1896, and it turns out that the British definition of "gentlemanly" was rather hard to get across to Nazis, Communists or Palestinians. To paraphrase Clausewitz, the Olympic games have become war pursued by other means.

Now it is the turn of the physicists to propose, in their own way, a kind of gage of international amity. This idea was born around the proton racetracks of Geneva, Batavia and maybe Dubna. It says nothing about gentlemanly sportsmanship and a good deal about cold cash in a hard currency. It proposes worldwide investment in a complex of particle physics laboratories known under the working title of Very Big Accelerator. Since the proposed project would call on the Eurodollar, petrodollar or Swiss franc accounts of many of the most powerful nations, its hope to be a symbol of international amity is based on the much more realistic principle that where their treasure is, there shall their hearts be also.

Though the VBA project may be described in such highfalutin, hopeful terms, it is brought forward out of dire necessity, probably the best reason for making any proposal. As physicists probe ever deeper into the bowels of nature seeking the ultimate secrets of the structure of matter, they find they need ever more energetic probes. Present laboratories are straining toward energies of 10^{12} volts (one teravolt), and it seems that another factor of 10 at least will ultimately be necessary. Now the laboratories that operate in the hundreds of gigavolts (1,000 gigavolts equals 1 teravolt) already cost as much as good-sized warship. Knowing how much governments love their navies, physicists have concluded that further progress is possible only if a large number of nations can be persuaded to throw donations into the pot. And so discussions, still more or less informal, are going on.

As one of the final talks at the recent Particle Accelerator Conference in Chicago, Leon Lederman of Columbia University described the present status and future prospects of the idea. He did so with a combination of wit and seriousness, which appears to be the proper frame of mind for such a proposal. If one presents it in dead earnest, it could easily get frozen in the constipated bowels of the world's bureaucracies. Dead earnest is something bureaucrats know how to deal with; humor is a secret weapon against them.

The first organized discussion of the VBA began in March 1975 at a meeting in New Orleans, and the formation of a study group was proposed. The next meeting took place in 1976 at Serpukhov and Moscow. It took a fairly cautious approach, but the upshot seems to be that by sometime in the 1980s physicists will have a good understanding of physics at energies around 2 teravolts. At that point it would be well to consider going on to the multiteravolt VBA.

What is envisioned is fixed-target accelerators in the 10-to-20 teravolt range coupled to colliding beam facilities that would provide all the useful alternatives (proton-proton, electron-positron, proton-antiproton, electron-proton) that can be thought of. Although most of the physicists are well aware what such things can be used for, Lederman proceeded to remind them of the main points.

It is fair to say that today particle physicists are animated by the so-called unified field theory, which in its overall vision is philosophically breathtaking. Although the theorists who have had the most success with the beginnings of the theory tend to speak in whispers of its final consummation, the ultimate picture is of a universe that began in perfect symmetry (in a mathematical sense), but with a built-in capacity for spontaneous symmetry breaking. As time went on, gradual breakings of symmetry brought about the existence of particles and forces that we now find, and from these, larger and larger pieces of matter were built up. So from a universe that was perfectly symmetrical and undifferentiated successive acts of particularization, which were potential in the nature of the original symmetry, built up the material objects and forces that we know.

Among many subsidiary questions three are of prime importance: Are the quarks real? Quarks are supposed to be the building blocks of the majority of subatomic particles, but their reality as independent physical objects has never been shown. Presumably this is because they are too massive to be made in present-day accelerators. If so, the VBA might be able to make them. A project that would follow from this is a determination of the nature of the forces that hold quarks together.

The second question is the existence of the intermediate vector bosons, a group of particles whose existence and interconnection must be proved for a final confirmation of the most successful branch of unified field theory now written down. This is the unification of phenomena involved with electricity and magnetism and those involved with the forces of the weak interaction characteristic of certain subatomic processes.

Third comes the question whether the Higgs bosons are real physical particles. The Higgs bosons were invented by Peter Higgs of the University of Edinburgh, and they are intimately involved with one of the early and highly consequential breakings of the pristine symmetry. The question arises whether they are something physical or only mathematical conveniences in the theory. Listening to a lecture on Higgs bosons, one begins to wonder whether they are still burning coal in the fireplaces of Auld Reekie or something more lightheaded. But physicists, whose profession is turning abstractions into reality, want to make the Higgs bosons real if they can. Since the mass of a Higgs boson could be as much as the equivalent of 300 giga-electron-volts of energy, one would need a several-teravolt accelerator to hope to produce them in numbers.

It will be sometime in the next decade before physicists can think of beginning to build the VBA. Meanwhile talks and planning are in order. Eventually the United Nations or one of its agencies should be brought in. Physicists have experience in international cooperation, both in formally international laboratories such as West Europe's CERN and East Europe's Dubna and in collaborations of a less formal nature. On the other hand, diplomats have experience dealing with matters of politics, ideology and national sovereignty that the physicists have ignored in order to smooth their own endeavors.

A site for the VBA might take some delicate negotiation. Lederman estimates the optimum to be a territory about 10 kilometers square, which the host country would have to be willing to cede to international use. The location would have to be near a major educational center, and sophisticated technological support would have to be routinely available. In a ploy that may be not quite facetious, Lederman suggests Manhattan island. Well, if we turned Manhattan over to international administration, maybe that would prevent the New York City government from going around the country every quarter with its begging bowls stretched out. □