control magnets. Furthermore, six of these 600-ton devices would have to be aligned to within 0.1 millimeter and kept in alignment for months at a time. Because such high standards have never been met, NSAC's subgroup of technical experts worried that even if the magnets were built correctly, they might not remain stable and might require high-cost maintenance.

Second, the experts worried that fluctuations in the synchrotron radiation of the beam might increase the diameter to a size that would not fit within the given aperture. This could lead to a power loss and might even damage the accelerator. The synchrotron radiation problem becomes pronounced over 3.5 GeV. Thus, the experts feared that the machine might never be useful at higher energy levels, or not without some expensive new beam confinement systems.

As one NSAC member says, "These involve state-of-the-art advances. On one hand, they might be a great thing to do, but on the other, nuclear physics badly needs a few successes." The problems of the Isabelle accelerator on Long Island clearly weighed on NSAC's thinking. In off-the-record discussions, panel members made distinctions between Argonne's potential "hard failures" and SURA's "soft failures."

Argonne's backers make the most of the latter. These include all the uncertainties that go with inexperience and a lack of infrastructure. Massey says, "There is no way on earth anybody will convince me that building a new laboratory from nothing is going to cost the same" as giving the task to an old hand like Argonne. On matters of pricing, NSAC did a curious thing. It threw out the estimates that were submitted and worked directly with the proposers to come up with numbers it could trust. In the end, the top contenders came out costing about the same, $150 to $160 million for construction and $275 million for operation over 15 years. But NSAC found one major flaw in SURA's proposed location, Newport News, Virginia. Some panel members argued vehemently that the lab should be near a major airport or university. Argonne has both of these, of course. NSAC's final report urges SURA to consider relocating in order to "provide improved access" to major universities and airports, provided it can be done "without significant increase" in the total cost.

SURA will not move from Virginia, that much is clear. There are several reasons. This is where SURA was born (physicist James McCarthy of the University of Virginia at Charlottesville conceived it); this is its political base; and the state has already promised funds for five professorships. Virginia's Senator Warner and other state politicians backed the proposal from the outset, not only because of the construction jobs it would bring, but also because they saw it as a way of establishing a local colony of high-technology enterprise, the kind that has been so important for the economies of California and Massachusetts.

The Newport News site was chosen

CERN Physicists Have Evidence of Z^0

While the American physics community continues to agonize over the design and location of future accelerators, the Europeans may have scored another experimental coup. Researchers at the European Laboratory for Particle Physics (CERN) near Geneva may have found the second of three particles needed to verify the unified theory of weak (nuclear decay) and electromagnetic forces. The particle is called the Z^0.

The physicists, headed by Carlo Rubbia of CERN and Harvard University, are making no firm claims for the moment because they have only one event. But the signature of the Z^0 is so clean and unobscured by background that there is hardly any other explanation for the observation.

Elementary particle physicists are in the midst of a quest to unify all the forces of nature in one mathematical formalism. Yet, despite all the speculation about Grand Unified Theories, supersymmetry, and other theories, physicists still do not know for sure if even the first step in the unification program—the marriage of the weak and electromagnetic forces—is correct. There are basically two questions: are the forces unified at all and, if so, are they tied together in the way physicists think they are. Experimentalists must find three particles (the W, the Z^0, and the Higgs) and measure their properties in detail to verify the so-called Standard Model that most theorists accept.

Rubbia's group has already found the W, which comes in positive and negative electrically charged versions (*Science*, 4 February, p. 480). The Z^0 is electrically neutral. All three particles are created when protons and antiprotons collide head on in CERN's SPS accelerator, which for the moment is the only machine in the world capable of this kind of experiment.

In talks at Princeton University and Brookhaven National Laboratory, Rubbia emphasized that the single event can only be "a candidate for the Z^0" but nevertheless expressed confidence that it was real. The event does satisfy the criteria for being a Z^0 in three ways. First, there is an electron-positron pair, each particle of which zips away in a direction opposite that of the other. Second, the energy of each particle is about 50 GeV. This is a bit high, but there should be a statistical distribution of energies, so one event is not definitive. Third, the single Z^0 candidate was found in a data sample that also contained 12 W's. According to theory, Z^0's should be produced about one-tenth as frequently as W's.

There is one problem with the Z^0 event, which Rubbia discussed at Brookhaven. The CERN particle detector consists of an inner "tracking chamber" that electronically records the trajectories of electrically charged particles that pass through. Outside the tracking chamber is a layer of "electromagnetic calorimeters" that measure the energy of photons and light particles such as electrons. Pending recalibration of the detector, there is an inconsistency between the trajectory recorded for one of the particles in the electron-positron pair and its energy. The trajectory is that of a much lower energy particle.

Explanations for this finding exist but must be verified. The best cure is to find more Z^0 candidates. The current experimental run is scheduled to end on 4 July. At the rate data are being collected, the physicists expect three or four more events of this type.

For now, the best counsel is patience. A skeptic pointed out to *Science* that the first W "candidates" at CERN turned out not to be W's. The particle was, however, detected in subsequent events.—**ARTHUR L. ROBINSON**