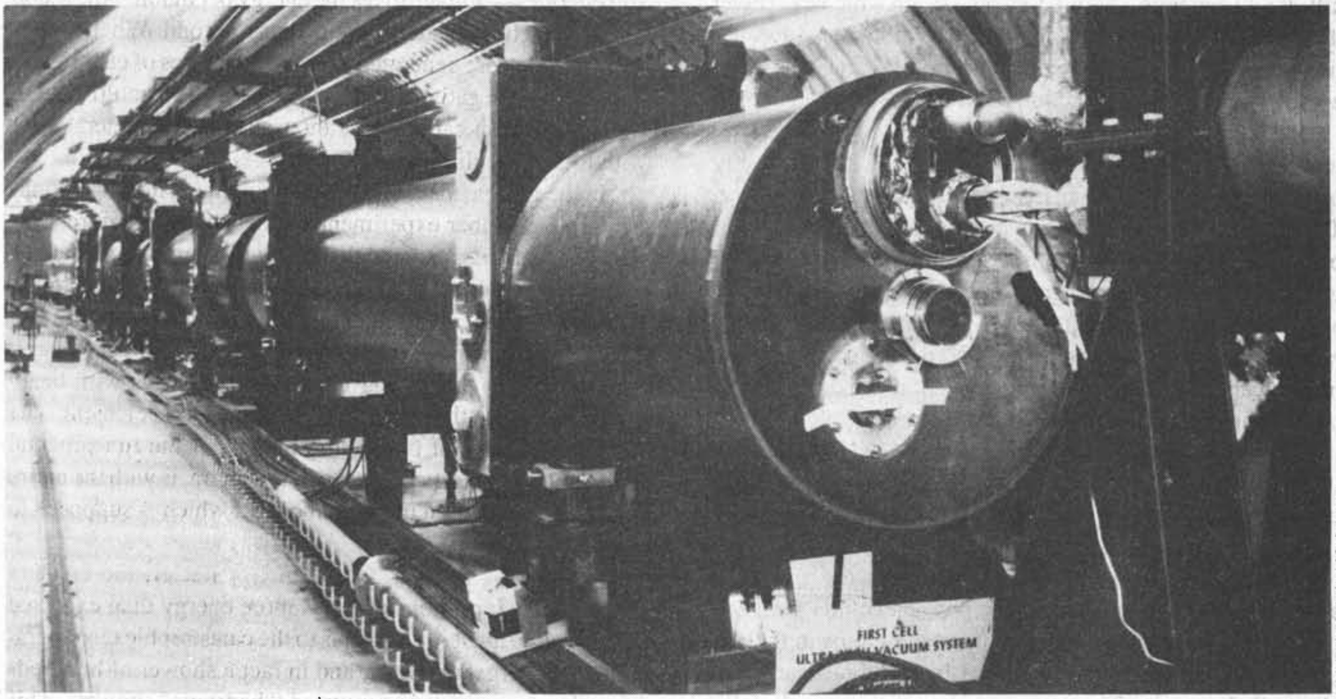

Brookhaven National Laboratory

Technology like this will be utilized in building the Desertron. Shown above are super conducting magnets like those tested on the Isabelle Brookhaven prototype accelerator.

The Desertron accelerator and the development of anti-ballistic missile defense

by Charles B. Stevens

A proposed new proton accelerator known as the Desertron, intended for high-energy particle physics research, has an added but little-known potential benefit: protecting large areas of the United States against incoming thermonuclear warheads.

The design for this huge circular accelerator, with a radius of up to a hundred kilometers, has been put forward by Dr. Leon Lederman, director of the Fermilab in Batavia, Illinois, who suggests that it be built in the New Mexico desert.

As a scientific research facility, the Desertron will permit physicists to generate pulses of extremely high-energy proton beams on the order of 40 trillion volts, producing the densities at which matter is transformed into energy and energy back into matter, so that the fundamentals of these processes can be experimentally explored. The machine would take the form of a ring of approximately 100 kilometers in diameter with a circumference over 300 kilometers—about the size of the Washington, D.C. beltway. The device will consist primarily of superconducting magnets and will cost several billion dollars

for a large superconducting industry in the United States. Since superconductors have a wide variety of applications to advanced technologies such as magnetohydrodynamics (MHD), efficient generation of electricity, advanced electrical machinery and transformers, magnetically levitated bullet trains, and magnetic fusion, the resulting economic benefits will more than pay for the cost of the Desertron itself.

While other anti-ballistic missile defense systems such as the pop-up x-ray laser are hundreds of millions of times smaller, the Desertron could prove to be a cost effective secure, and efficient beam weapon system. It could incapacitate thermonuclear weapons descending upon the United States with a relatively minute expenditure of energy.

Current plans call for building the Desertron by the end of this decade. But since the technology needed to build this type of high-energy accelerator is well understood, it could actually be built in two to four years.

The Desertron as a beam weapon

What makes the Desertron potentially attractive as part of a final layer of defense against nuclear-tipped missiles is the fact that it may be able to achieve what is termed a "tuned" kill. It will generate a highly focussed beam which can travel thousands of kilometers through the air without any dissipation of energy and could still deposit sufficient energy to completely disrupt the functioning of a nuclear explosive.

Another beam weapon system that achieves a tuned type of target kill is the electron beam ATA accelerator, currently being explored at Lawrence Livermore National Laboratory. The distance which an electron beam will travel through air before depositing its energy is determined primarily by the voltage of the electron-beam. By increasing the beam voltage, the ATA can deposit most of its energy at increasing ranges. Therefore the operator, once the range was determined, can dial the appropriate beam voltage to deposit most of the beam energy into the targeted warhead.

The Desertron could achieve even a more sophisticated tuned kill because it incapacitates warheads with the quality of energy that it delivers, not merely the quantity.

One proposed way in which the Desertron could be utilized as a beam weapon is to transform its proton beam into a muon beam. When high-energy protons collide with stationary blocks of matter, both protons and atoms in the stationary block disintegrate into short-lived subnuclear particles called mesons. The mesons in turn form a well-collimated beam moving in the same direction as the incident proton beam. After a short time these mesons spontaneously decay producing muons, another subnuclear particle. The muons also form a well-collimated beam, whose divergence decreases as the proton beam's voltage increases. A 40 trillion volt proton beam, for example, forms a muon beam with approximately the same voltage and with a divergence of less than 10 microradians. This means that after traveling 1,000 kilometers, the muon beam would only spread out to a beam one meter in diameter—just about the diameter of a warhead re-entry vehicle.

What makes high-energy muon beams particularly attractive for anti-ballistic missile defense is the recently discovered fact that muons interact in an unexpectedly powerful way with heavy elements. These elements constitute the most fragile element in a nuclear explosive, namely, the uranium and plutonium used for generating the fission trigger in H-bombs.

Muons are extremely interesting from the standpoint of fundamental physics. No one has yet discovered why they exist. Muons appear to play no essential role in the structure of matter as do electrons, neutrons, and protons. Experimentally, muons appear to be exactly like electrons, except that the muon's rest mass is more than 200 times greater. This means that muons can be substituted for electrons in fusion fuel, and nuclear fusion reactions can be catalyzed at very low temperatures. Research for this application of low-energy muons is being carried out at Los Alamos National Laboratory.

Muons at rest have a lifetime of only a few millionths of a second before they decay into normal electrons. But at velocities near the speed of light like those achieved at trillion volt energies—voltage gives the energy per muon—the muon lifetime can be extended to more than a second. When muons are born, they are generated in equal quantities of electrically positive and negative charges. As a result, a multi-trillion volt muon beam can traverse thousands of kilometers of air with little or no dissipation.

In the past year scientists reviewing the data from "empty" target chamber experimental shots on the Stanford University accelerator noticed that the high-energy muon beams interacted in an unexpectedly strong fashion with material in the target chamber wall. Later these initial observations were checked on the CERN international accelerator in Geneva. It was found that this strong interaction increases with beam voltage and with the atomic weight of the target element. The interaction does not fit existing models of the fundamental structure of matter, because the muon interacts with the entire nucleus instead of an individual quark, which is supposed to be the fundamental building block of matter. As a result of this anomalous interaction with heavy nuclei, the incident muons deposit millions of times more energy than expected in individual nuclei. This leads to the catastrophic disintegration of the targeted nuclei, and in fact a shower of hundreds of nuclear remanants is generated ("hadronic" shower). This shower can easily multiply the deposited muon energy through secondary nuclear reactions generated by these nuclear fragments, especially when the target consists of the highly reactive heavy nuclei such as uranium and plutonium.

While the Desertron muon beam will probably deposit sufficient energy, both directly and through secondary nuclear reactions, to mechanically disrupt a warhead, even minute changes in the geometry and composition of the fission material could prove capable of disrupting the warheads' functioning.

The functioning system

The Desertron's basic purpose would be fundamental physics research. But once a first-strike missile launch were detected, the facility could be geared up for muon beam generation in only a few minutes. One set of practical specifications would call for 100 muon beam pulses per second. Within a few minutes, the Desertron could incapacitate 10,000 descending warheads within a circle more than a 1000 kilometers in radius. Three such accelerators could be sufficient to cover the continental United States.

While the Desertron could prove to be extremely effective, in order to guarantee the destruction of 99.99 percent of all offensive warheads it would have to be combined with other layers of defense—shorter-range particle and laser beams together with the pop-up x-ray laser, all of which are also capable of intercepting missiles during their launch phase. If the Desertron beam weapon defense is shown to be workable, it would be particularly effective as a terminal defense since it would achieve the disabling of the incoming warhead so quickly that the warhead could not be salvage fused (detonated when it detects that it is under attack).