Fermilab Rolls for Doubles

One teravolt equals 1,000,000,000,000 (10^{12}) volts. By American count it is a trillion, by European count a billion. It is less confusing to say "teravolt." An electron or a proton that has been accelerated through a potential difference of one teravolt has an energy of one tera-electronvolt (TeV). By spring of 1983 the main synchrotron at the Fermi National Accelerator Laboratory in Batavia, Ill., is expected to be ready to bring protons to such an energy. Testing of the last two sections of the superconducting magnets that make a teravolt possible is planned for October. If that is successful—and it is expected to be — final preparations for the running of particle beams will commence.

One teravolt represents a doubling of the maximum energy for which the accelerator was originally built. When it is reached, the Fermilab synchrotron will again be, without peer, the most energetic proton accelerator in the world.

In addition to TeV protons, the synchrotron will also provide beams of TeV antiprotons, and will be able to collide protons and antiprotons. It will thus operate in two modes, either by striking beams of accelerated particles against fixed targets, or by striking beams of accelerated protons and antiprotons against each other head on.

As of mid-September the location where proton-antiproton collisions will take place was marked by a large hole in the ground. Across the road from the hole, buffalo roam in a pasture. In the hole, when the collison point and surrounding detectors have been built, protons and antiprotons will, it is hoped, not roam, but very precisely collide with each other. In September in the main accelerator tunnel there were still gaps in the "Energy Doubler/Energy Saver," the second accelerating ring, which is laid directly under the original one, and which will take particles at half a TeV from the original ring and double their energy. The apparatus for making beams of antiprotons and preparing them for injection into the main accelerator is also still under construction. If all goes well, all these technologies will mesh together during the next few years to provide Fermilab with its multiple capabilities.

The buffalo are not a bad symbolism. These are frontier technologies. What must come together between now and 1985 are the technologies of superconducting magnets and the large-scale liquid-helium refrigeration that they require, and the new and very exotic techniques of producing and "cooling" antiprotons. The schedule now envisioned is that the last two of six sectors of magnets into which the full circle of the energy doubler is divided will be tested in October. That is, they will be chilled to liquid-helium temperature (below 4 kelvins), and their field configurations, their stability, their durability, etc., will be observed. If these tests are successful, these magnets (the E and F sectors) will remain cold; the other four sectors (previously tested) will be refrigerated, and the ring will be ready for acceleration of a test beam of protons in the spring of 1983.

Experimentation with beams of TeV protons striking fixed targets could then begin by autumn of 1983. Several fixed target experiments could be accomplished while the antiproton accumulator and the detecting apparatus to go around the beam collision point are completed. By the end of 1985 they should be ready, and in 1986 experimentation with colliding beams of protons and antiprotons could commence.

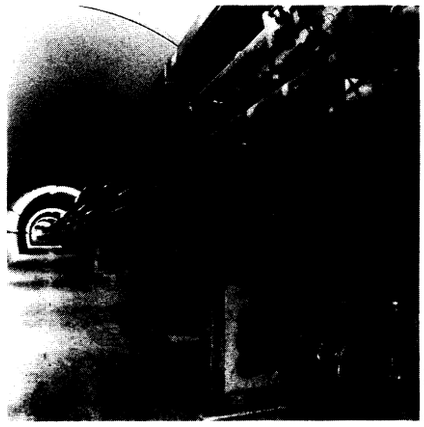
The Fermilab synchrotron was first designed for 200 GeV (0.2 TeV). During construction the maximum was changed to 400 or 500 GeV, and the accelerator was commissioned with that maximum in 1972. Before the original synchrotron was finished, plans to double the energy again were already underway. To do the doubling in the original tunnel — because of earth-moving requirements this was the only practical way — required superconducting magnets to bend and focus the beam.

That meant designing and building magnets that had never been made before. This work began almost as soon as the original accelerator was commissioned (SN: 1/4/75, p. 11). Now Fermilab has a factory for producing superconducting magnets—the doubler needed 1,000 of them—and supplies them to other installations.

To refrigerate these magnets, which are laid around a four-mile circumference, to the temperatures at which they are superconducting required the world's largest helium refrigeration system. According to Richard Andrews, one of the staff members involved, the last pieces of this system—compressors, heat exchangers, helium tanks, etc.—are being installed or are ready to go. The magnets are all in place. The gaps in the ring are places for "spool pieces," which provide fine adjustments to the particles' trajectory.

While the work to double the synchrotron's energy was in progress, the possibility of accelerating antiprotons arose. It has been vigorously pursued, particularly at the CERN laboratory in Geneva, where they now have colliding beams of protons and antiprotons at a quarter of a TeV each. Fermilab decided to add a proton-antiproton collision capability to the doubler project when CERN began its work.

The main difficulty in working with antiprotons is that they must be "cooled." Antiprotons are made with a wide range of momenta. If the antiprotons are to be accepted by the accelerator, their range of momenta must be narrowed, a process called "cooling." Two methods of cooling were pursued at first, one by Fermilab, one by CERN. CERN's method has proved successful, and so Fermilab decided to switch and redesigned its antiproton accumulator to fit.



Fermilab

In Fermilab's tunnel. Upper ring is original accelerator, lower is the doubler.

Meanwhile, a large detector is being assembled to go around the first collision point. According to Roy Schwitters and E. Dennis Theriot Jr., two of the people involved, it represents a collaboration of several groups in the United States and Japan. It is intended to be an exploratory experiment to see what happens when TeV protons collide with TeV antiprotons.

Experimentalists are confident that there will be many important things to see in such collisions. At least one theorist believes the opposite. We shall see when we shall see. —*D.E. Thomsen*

Structure figured for colon mutagen

Colon cancer strikes more than 100,000 persons in the United States each year. Many studies have linked the disease to dietary factors, such as excess meat and inadequate fiber; however, little is known about colon cancer on the molecular scale. Now, two groups of researchers have independently determined the structure of a mutagen—a chemical capable of altering genes—that is produced by intestinal bacteria. While the bacteria are found in all humans, preliminary studies involving feces analyses suggest that only about one-third of the population has detectable amounts of the mutagen. Researchers believe that even if this chemical, which is a lipid (fat) compound, proves neither to be a carcinogen nor to play any role in colon cancer, it still might provide some clues in the disease mystery.

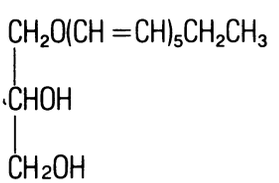
The structure of the chemical, which is

called "(s)-3-(1,3,5,7,9-dodecapentaenyloxy)-1,2-propane diol," was first identified by David Kingston, Tracy D. Wilkins and colleagues of Virginia Polytechnic Institute and State University in Blacksburg; this group presented its findings at the recent American Chemical Society meeting in Kansas City, Mo. Shortly after the Kingston team had put the finishing touches on its structural determination, another group, led by W. Robert Bruce of the University of Toronto, reached the same conclusion. Bruce and cohorts presented their results at the recent 13th International Cancer Congress in Seattle, Wash.

It was the Canadian researchers who initially discovered that a component of certain fecal samples is mutagenic. Then, microbiologists on the Virginia research team showed that the component was a bacterial product: When mutagen-containing fecal samples were incubated under appropriate microflora-growing conditions, the concentration of the mutagen increased. Now that the structure of at least a part of this mutagenic component has been identified, it can be synthesized in large quantities to be used in animal tests to determine whether it causes colon cancer.

In a previous study, Wilkins and research colleagues in South Africa discovered that levels of the mutagen component were significantly higher in a sample of white South Africans — a population with a high risk of colon cancer — than they were in a sample of black South Africans — a population with a low risk of colon cancer. "There is thus some indication that this mutagen may be related to the onset of colon cancer," Kingston says. On the other hand, Pelayo Correa of the Louisiana State University Medical Center in New Orleans has found that persons with intestinal polyps — who are believed to be at a high colon cancer risk — do not necessarily have higher levels of the mutagen.

"We don't know if [the mutagen] will turn out to be a carcinogen," says Bruce. Still, he says, "It's a very exciting finding that a simple lipid like this can be a mutagen." The recent structure determination of the mutagen, Bruce says, "opens our minds to the possibility that other simple compounds, which we previously might not have considered," could play a role in colon and other cancers. — *L. Garmon*



The structure of the colon mutagen (s)-3-(1,3,5,7,9-dodecapentaenyloxy)-1,2-propane diol.

How many kidneys are enough?

Scientists have long believed that when a person donates a kidney for transplantation or loses one through injury, a remaining healthy kidney can take up the extra workload without a long-term loss of overall kidney function. Now a preliminary survey of twenty-five kidney donors has challenged these assumptions, revealing that over half the donors studied have acquired small but significant biochemical abnormalities that are sometimes associated with a decline in renal function. Barry Brenner of Harvard Medical School and Brigham and Women's Hospital in Boston presented his study earlier this month at a symposium on nutrition and hypertension held in Washington, D.C.

While Brenner stresses that the findings are "very preliminary," they do join a growing list of animal studies in suggesting that loss or destruction of kidney mass may cause a dangerous elevation of blood flow and pressure in the surviving kidney tissue, possibly leading to progressive kidney deterioration.

The finding is especially significant for the treatment and counseling of past and prospective kidney donors. Prospective donors are routinely advised that removal of a kidney will result in no long-term impairment of renal function. But according to Brenner, this advice has been based largely on two unpublished studies by life insurance organizations, which monitored the health of patients for periods of up to six years after the removal of a kidney — "follow ups too short to tell much about long-range consequences," Brenner says. "Long-term studies ... are required to address this issue," he writes in the Sept. 9 NEW ENGLAND JOURNAL OF MEDICINE. Ira Greifer, head of the National Kidney Foundation, cautions that, "at the moment, people shouldn't get alarmed." But he agrees on the need for more information "before we can assure people that there's absolutely no long-term risk involved in donating a kidney."

Meanwhile, Brenner's work could bring about a reevaluation of some therapies currently in use for patients with one kidney. Cortico-steroid drugs used to suppress kidney rejection in transplant recipients, for example, also raise renal blood flow — an effect that, according to Brenner's hypothesis, may ultimately injure the new kidney. And Brenner is recommending that doctors place people with one kidney on low-protein diets. He bases this proposal on recent experimental evidence that dietary protein raises intra-renal blood pressure. — *R. Pollie*

Beefed-up synthetic castration vaccine

A vaccine that prevents sperm production might be useful in disparate endeavors. It could serve as a human male contraceptive, a possibility considered rather remote. Or, in a more immediate application of recent European research, it could improve beef production.

Generally the highest-priced, finest-textured beef comes from male animals castrated at a young age. Half of the 32.8 million cattle marketed in the United States each year are steers. Now scientists are looking at a substitute for actually removing the testes of the animals. The new prospect is a vaccine that makes the body produce antibodies to a reproductive system hormone called LHRH (luteinizing hormone-releasing hormone; SN: 5/24/80, p. 331). The antibodies cause atrophy of sperm-producing structures of the testes, a process that can be considered immunological castration.

An inexpensive vaccine against LHRH is likely, according to scientists in Paris at the National Center of Scientific Research and the Pasteur Institute. C. Carelli, Louis Chedid and colleagues report in the September PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES success in immunologically castrating mice with a synthetic vaccine. The hormone LHRH is a chain of only ten amino acids, so it can be made in a laboratory from simple chemicals. However, when the hormone is injected by itself into animals, including sheep and cattle, it produces only a weak response. Substantial antibody production requires repeated injections of the hormone mixed with an emulsion called Freund's complete adjuvant, a concoction frequently used by immunologists to increase immune system response. But injection of livestock with that emulsion would not be acceptable. Freund's adjuvant contains oil that is not metabolized and bacteria that cause side effects.

The solution to this problem is to use a single glycopeptide instead of Freund's adjuvant. Carelli and colleagues attached the glycopeptide called muramyl dipeptide to laboratory-synthesized LHRH. They were surprised to observe that the hormone-glycopeptide when injected into mice had a stronger, more rapid effect than the hormone mixed with Freund's adjuvant.

"These results are encouraging for the purpose of practical application of LHRH immunization in veterinary practice," the scientists conclude. "More generally, the production of synthetic bacterial or viral vaccines could certainly benefit also from [this] model." Scientists in other laboratories are working to devise synthetic vaccines to such diseases as hepatitis. These vaccines would avoid the untoward side effects due to irrelevant microbial material in vaccines produced using bacteria and viruses. — *J.A. Miller*