8,300 meters across, the superconducting option requiring 6,130-meter rings. Nevertheless, cramped as CERN is in the Meyrin suburb of Geneva, there is a site for such things just north of the SPS. An electron ring might be added too.

The American proposals were presented by Victor Weisskopf of Massachusetts Institute of Technology, who was a little surprised at being chosen. Even though he recently served as chairman of a committee on the subject, he is a theoretician, and he suspects he was chosen because he has the necessary "don't-know-how." Since he wanted to tell the symposium why new accelerators are necessary (more about that in a later article), he simply listed the American proposals: an electron-positron ring (2 times 8 GeV) at Cornell University; PEP an electron-positron ring (2 times 15 GeV) with a proton ring (200 GeV) at either Stanford or Berkeley; POPAE, two proton rings (400 GeV) with an electron ring at FermiLab; ISABELLE, proton-proton rings (200 GeV) at Brookhaven National Laboratory.

Fixed-target machines are more or less in abeyance. An energy doubler is being worked on at FermiLab, and one was proposed for the CERN SPS but rejected as not a big enough step. This brushes the tera-electron-volt (thousands of GeV) range. The Soviets are believed to be planning a 2 to 5 TeV machine with superconducting magnets. Other physicists think of that range but not too specifically at the moment.

As Johnsen puts it: "There is a great variety of exciting possibilities to choose from." But the result is likely to be "not what physicists would like, but what society will stand." Nevertheless, he says "We who belong to the rich part of the world have a special responsibility to basic research." □

Zap it with a microwave plasma

In dark, quiet storerooms all over the United States, toxic chemicals lie waiting. These obsolete nerve gases and banned herbicides and deadly industrial by-products wait, sealed in their gray metal cannisters, for some method or machine that can destroy them safely. The waiting might be almost over now, following the refinement of the microwave disintegrator.

This Buck Rogerish-sounding invention is not a hand gun made of kryptonite in a chromium holster. It is instead, an unexciting system of tubes, valves, intake ports and chambers. But it does some exciting things. It was first developed at Lockheed Palo Alto Research Laboratory in 1970 under Defense Department grants for the decomposition of toxic vapors in contained atmospheres, such as nerve gases accidently released in laboratories. A modified version of this original microwave disintegrator is reported in the March ENVIRONMENTAL SCIENCE AND TECHNOLOGY by Lockheed chemists Lionel J. Bailin and Merle E. Sibert and by colleagues Leonard A. Jonas from Edgewood Arsenal, in Maryland and Alexis T. Bell of the University of California at Berkeley.

The modified system uses inert gases or air to carry the toxic substances into a special chamber. The team tested simulated nerve gases (structurally similar compounds that are easier to handle than the real thing) in their modified disintegrator and achieved nearly 100 percent decomposition. And to top that, the breakdown products may be reusable chemicals.

The disintegrator breaks up toxic materials by producing a microwave plasma inside a reaction chamber. This is formed when an inert gas under reduced pressure is bombarded with microwaves. Electrons and other electrically charged particles are bumped off the gas molecules and form a low-temperature plasma. When toxic gases are fed into the system, their chemical bonds are broken by the energetic plasma, and the "pieces" collide and form new hydrocarbons. The structure of these compounds depends on the toxic starting material and the carrier gas, but methane, ethane and chlorinated hydrocarbons are all possible end products.

Although the original research goal was to develop a technique for detoxifying the air in a contained atmosphere, Bailin is more encouraged about using the modified disintegrator on stored solids and chemical vapors. "When air from the room passes through the plasma system along with the toxic gas," he says, "nitrogen oxides are produced which can form corrosive nitric acid." The problem of toxic by-products is circumvented by using inert carrier gases and injecting small amounts of the toxic vapor or solid into the system without air. The team is in the process of enlarging the disintegrator from a 10 cubic-centimeter capacity to a two-liter capacity. This will make it possible, the team hopes, for industries and laboratories to dispose of their stored, toxic wastes safely and inexpensively. Now, only special, high temperature incinerators can be used to disarm some of the compounds, but they are very expensive. The microwave disintegrator would probably cost much less than the incinerators and break down the chemicals more completely, Bailin says. □

Checking clocks to 2 microseconds

Probably the best index of a society's complexity is how carefully it has to measure time. In one famous instance, timekeeping became a matter of strategic national importance, helping the British Navy maintain its mastery of the oceans. In the early 1700's the British government offered 20,000 pounds to anyone who could make a timepiece accurate enough to allow navigators to locate themselves at sea within 30 nautical miles at the end of a six-week voyage. To meet this standard, a clock would have to keep time within three seconds a day, and the prize—for creation of the first "chronometer"—went to a self-taught English carpenter, John Harrison.

Though technological progress of the present age could be dramatized by more spectacular achievements, none provides a more clear-cut measure of sophistication than the very existence of an increasingly large number of people who really do need to know what time it is to within a few microseconds. Last week these people received some good news: The U.S. National Bureau of Standards announced that when it conducted a careful, direct check on the synchronization between its own "Universal Coordinated Time" and the European "International Time Bureau," the two were off by only two-millionths of a second.

Not that anyone was particularly surprised. Indirect checks, involving radio signals between the two time centers in Boulder, Colo., and Paris, France, have been going on for years. Such radio-comparisons have even allowed measurement of the relativistic time lag due to Boulder's higher elevation and weakened gravity—amounting to two parts in 10^{13}. But like most scientists, the world's official timekeepers couldn't resist the urge for side-by-side comparison (and a week in Paris), so a portable atomic clock was carefully transported across the Atlantic.

David Allen, the head timekeeper at NBS, was very pleased with the results of the test, which he calls "totally adequate within what we're trying to do." About a thousand commercial atomic clocks are now in operation, he says, and, at $20,000 apiece have become necessities in several applications, including sophisticated navigation and satellite tracking.

Some submarines, for example, use an ultramodern version of an old Viking technique to measure their position at sea. When lost in darkness or fog, the Vikings would beat a drum and time the interval before an echo was

heard, to estimate their distance from shore. With an atomic clock, a submarine navigator can compare "his time" to that broadcast by a radio transmitter on shore and, using the speed of light to calculate the delay, arrive at his position. A two-microsecond delay could thus make a life or death difference—an error in position of about a third of a mile.

At least man-made clocks can keep better time than the earth: To compensate for slowing of the earth's rotation, both the French and American clocks are momentarily stopped about once a year for a "leap second." Since 1958, when atomic clocks were first used to keep track of such matters, the earth has slowed nearly 14 seconds. □

Vitamin C: Again on the defensive

It's hardly surprising, when Americans suffer from 90 million colds annually, that they'll grab at anything that might spare them their misery. And the preventative that is much sought after these days, thanks largely to Nobelist Linus Pauling, is vitamin C.

Many people who take vitamin C regularly to ward off colds swear by it. So do a number of scientists. Pharmacologists Erwin D. Cyan writes in his book *Vitamins in Your Life*: "It is our forecast that the use of vitamin C in the common cold will be accepted in the future. In some studies, such as the Anderson/Toronto one, it seems already to have been vindicated."

Other scientists, however, remain unconvinced by the Anderson study and other research results that support vitamin C's role as a cold preventative. Examples are Michael H. M. Dykes, senior scientist at the American Medical Association Department of Drugs; Paul Meier, a pharmacologist at the University of Chicago, and Thomas R. Karlowski and his team at the National Institutes of Health. They report their criticisms of past studies and new negative research findings in the March 10 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION.

Dykes and Meier analyzed more than a dozen studies conducted on vitamin C during the past 35 years, including the Anderson study in Toronto in 1971-72. This study found that 26 percent of 407 subjects who took one gram of vitamin C daily to ward off colds were spared colds, compared with 18 percent of 411 control subjects who took placebos. The study, Dykes and Meier admit, "was double-blind and appears to have been well controlled and not subject to many of the criticisms applicable to the other discussed here." However, Anderson and his team conducted another study in 1973, to get a clearer idea of vitamin C's value as a cold preventative. "In this study," Dykes and Meier point out, "all the differences between measures of illness were small compared to the standard errors, and none approached statistical significance."

Thus Dykes and Meier conclude in JAMA: "Although one study tentatively supports the hypothesis that such doses of ascorbic acid may be efficacious, a second study by the same group did not confirm the significant findings, and no clear, reproducible pattern of efficacy has emerged from the view of all the evidence."

In a new study, Karlowski and his team had 311 employees at the NIH take three grams of vitamin C or a placebo daily for nine months. This would be equivalent to the amount of vitamin C that one would get eating 100 oranges daily. One hundred ninety volunteers completed the study. Those getting vitamin C as a preventative had 1.27 colds in nine months; those receiving a placebo, 1.36 colds. If volunteers felt they were coming down with a cold, they were given an additional 3 grams of either vitamin C or placebo daily. Those who received their usual placebo plus an extra placebo had colds for an average duration of 7.14 days. Those who received their usual three grams of vitamin C plus a placebo had colds for an average duration of 6.59 days. Those who received their usual three grams of vitamin C plus an extra three grams of vitamin C had colds for an average of 5.92 days. "Analysis of these data," the investigators conclude in JAMA, showed that vitamin C "had at best only a minor influence on the duration and severity of colds." □

New insight into dystrophic muscle

The hallmark of muscular dystrophy, specifically the Duchenne variety, is that it strikes the very young. A victim continually falls and has trouble getting up as he takes his first uncertain steps in life. By the time he reaches adolescence, his muscles are so weak that he must stay in a wheelchair. Chances are slim that he will live to see his 21st birthday. There is no treatment that can save him.

Obviously the way to conquer this tragic disease is to get at the cause of it. It is known to be inherited. So the cause probably lies in some genetically expressed metabolic defect. But what kind of a defect? Evidence that the defect lies in nerves that innervate skeletal muscles is equivocal at best, W. G. Bradley pointed out in NATURE last summer (250: 285). Several investigators reported that 27 percent of skeletal muscle fibers in mice with muscular dystrophy were denervated. But other scientists, found that motor nerves in patients with Duchenne muscular dystrophy are quite capable of sprouting to reinnervate denerved muscle fibers and thus show no sign of being sick.

Evidence now reported in NATURE (253:464) strongly suggests that the metabolic defect underlying muscular dystrophy is a faulty sugar-metabolizing enzyme. The evidence comes from Jennifer M. Strickland and David A. Ellis of the Midland Centre for Neurosurgery and Neurology, Warley, Britain.

Strickland and Ellis first found, in dystrophic muscle, that more glucose than usual was converted to fructose instead of to glucose-6-phosphate. The conversion of glucose to glucose-6-phosphate is catalyzed by an enzyme called hexokinase. Thus it appeared that hexokinase was not working properly in muscular dystrophy. So the investigators set up tests to see whether this was the case.

They studied both the amounts and movements of hexokinase isoenzymes (varying molecular configurations of hexokinase) in various muscle samples. The samples included healthy muscle, polio-afflicted muscle, muscle with motor neuron disease, muscle with Duchenne muscular dystrophy, muscle with a so-called Becker muscular dystrophy, and so on. They found that the isoenzymes did not vary significantly in amount from one muscle sample to another. This finding confirmed what other investigators have found—that hexokinase appears to be present in adequate amounts in dystrophic muscle. But Strickland and Ellis did show that one of the isoenzymes—known as isoenzyme II—varied in movement in two of their muscle samples. The samples were muscle with Duchenne muscular dystrophy and with Becker muscular dystrophy. "As this isoenzyme is characteristically abundant in skeletal muscle," the investigators assert, "the change in its properties in dystrophy may be very significant."

They also found the same aberrant movement in isoenzyme II in three livers, one brain and one sciatic nerve obtained after death from patients with Duchenne dystrophy, and from muscle and liver from a fetus of 18 weeks diagnosed with Duchenne dystrophy.

So they conclude that defective hexokinase enzyme, specifically in its variant known as isoenzyme II, may constitute the basic metabolic defect underlying muscle dystrophy. And since the isoenzyme is also present in nerves and liver, its abnormal behavior may explain why muscular dystrophy often damages not only muscle but these other tissues. □