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