er reactivation results in clinical illness.

Lang and his colleagues have developed an animal model for studying the effect of transfusion on activation of CMV. They take blood from mice that were infected with CMV but whose blood no longer carries infectious virus, and then administer it intraperitoneally to uninfected recipients. After 1 month they invariably detect CMV in the salivary glands of mice of different genetic composition from the donors but only rarely in mice of the same genetic composition. This suggests that the response of the immune system to foreign antigens is involved in CMV activation.

Huang and Pagano found that CMV could reproduce in vitro in B (for bone marrow–derived) lymphocytes infected with EBV but not in uninfected B cells or in T (for thymus-derived) lymphocytes. This is consistent with Lang's hypothesis because normal lymphocytes do not reproduce in culture but those transformed by EBV do. The EBV does not infect T cells.

Prevention of CMV infection is desirable and so is a method of abrogating infection when it does occur. The research performed by Huang has suggested one approach to accomplishing the latter goal. He has shown that when CMV infects human cells it induces the synthesis of a new DNA polymerase. This virus-induced enzyme differs from the normal cellular DNA polymerases of uninfected cells, the synthesis of which is also stimulated by CMV, although Huang does not know whether viral or cellular genes actually code for the new enzyme. Since phosphonoacetic acid specifically inhibits the activity of the virus-induced enzyme without significantly inhibiting that of the cellular DNA polymerases, Huang and Pagano think that this drug is a promising one for treating CMV infections.

—JEAN L. MARX

Synchrotron Radiation (II): Formidable Competition Overseas

Facilities in the United States for research in which synchrotron radiation is used may be as good as those overseas, but only for the present. Researchers in Europe have been more successful than their American counterparts in securing funding for synchrotron radiation facilities, some observers argue, and by 1980 the United States will have slipped to second class status as a synchrotron power, unless certain decisions, such as establishment of a national center for the purpose, are made quickly.

The United States has three electron storage rings that operate as synchrotron radiation sources. The newest of these is the 4-Gev SPEAR machine at the Stanford Linear Accelerator Center (SLAC). The Stanford Synchrotron Radiation Project (SSRP), which is only 1½ years old, is the only source of such radiation in the x-ray region open to users from any institution. (Cornell University's 12-Gev synchrotron also produces short wavelength x-rays, but for a limited group of researchers.) At present, the Stanford project consists of a single beam port, from which radiation is divided and guided to five experimental stations. A second beam port, to be completed next April, will accommodate four more experiments.

The synchrotron project at Stanford operates as a "parasitic" facility, because SPEAR is run strictly according to the needs of the high energy physicists at SLAC. Thus, for example, when SPEAR operates at relatively low energies, as it does when investigators study psi particles, the intensity of short wavelength x-rays becomes so small that some experiments are not possible. According to Herman Winick, deputy director of SSRP, agreement has been reached with SLAC to obtain a limited amount of time (about 5 percent) each month when SPEAR will be operated for synchrotron radiation experiments only. Such a mode of operation would ensure that conditions were optimum at least part of the time and would greatly increase the productivity of SSRP, but synchrotron radiation researchers see a need for a facility that is completely dedicated to radiation production and that can produce x-rays.

At Stoughton, Wisconsin, there is already a facility dedicated solely to synchrotron radiation, but the relatively low energy (240 Mev) of the Tantalus I storage ring there limits the useful intensity to ultraviolet wavelengths longer than about 40 angstroms. The facility services an average of seven groups at once, according to Ednor Rowe, director of the University of Wisconsin Synchrotron Radiation Center. Japan has a facility of comparable size in Tokyo, IN-SOR II, which is the first storage ring planned from the beginning to be dedicated solely to synchrotron radiation research. Like Tantalus I, the Japanese storage ring will be severely limited by its energy (300 Mev), which is not even enough to cover the entire ultraviolet range. Another similarly dedicated storage ring, for 240-Mev electrons, was recently completed at the National Bureau of Standards, Gaithersburg, Maryland. Called SURF II, it has 11 beam ports.

Competition from laboratories overseas is already formidable, and will become increasingly so in the years ahead. The most impressive facilities are now in West Germany, where the DESY laboratory in Hamburg has been conducting synchrotron radiation experiments since 1964. The synchrotron radiation program there began when the high energy physics program did, and has continued to grow with it, until there are now four laboratories with radiation available at wavelengths down to hard x-rays, each with as many as ten experimental stations. Two laboratories are located at beam ports on the 7.5-Gev DESY synchrotron, completed in 1963, and two are attached to the 4.5-Gev DORIS storage ring, which began operation last year (*Science*, 8 August, p. 444).

The original laboratory at the synchrotron was expanded in 1970, and a second building was constructed. At the same time, plans were made for the two synchrotron radiation buildings adjacent to DORIS. One has been operated exclusively for physics and chemistry experiments since DORIS began operation, and the other will soon be used for life science experiments by the European Molecular Biology Organization (EMBO) (*Science*, 19 September, p. 981). The two laboratories at the synchrotron are similarly allocated.

Originally, the synchrotron radiation users at DESY had to operate as parasites to the high energy physics research, but now a small percentage of the running time is dedicated to them alone. Another advantage to the researchers at Hamburg is that the intensity of radiation is generally higher than that at Stanford. Although the energy of the Hamburg storage ring is about the same, the current in DORIS (normally 0.3 ampere) is approximately ten times higher than that in SPEAR. The DORIS ring is clearly the most powerful of the synchrotron light factories, producing a total of 1 megawatt of radiation.

The budget for synchrotron radiation in Hamburg is $1,750,000 per year: approximately $750,000 for the physical sciences by DESY and $1 million for biological research with synchrotron radiation by EMBO. In contrast, the operating budget of the Stanford project is at present $530,000.

Great Britain is not far behind West Germany, as the United Kingdom is the first country to commit money for a multi-Gev facility dedicated to synchrotron radiation users. Construction has already begun for a 2-Gev storage ring on the site of the soon to be retired 5-Gev NINA synchrotron at Daresbury. The project will cost $6,250,000 to build, and the projected operating budget is $2 million per year for the first 5 years. Completion is scheduled in mid-1979.

When finished, the storage ring, dubbed NINA II, will have up to ten beam ports with two or three experimental stations each. The current in the storage ring is designed to be 1 ampere. The NINA II ring may also be the first synchrotron radiation source in which superconducting wiggler magnets are used. These magnets, located in the straight sections of the ring, will force the beam to follow a meandering path that is, on the average, straight. The locally increased curvature of the beam path means that high intensities of short wavelength x-rays can be produced without the expense of building a very high energy storage ring.

At Orsay, in France, the 4-year-old ACO storage ring will be converted next spring into a dedicated facility. But the 550-Mev energy will only permit experiments into the soft x-ray region. A larger 1.8-Gev storage ring (DCI) is just now being tested at Orsay. It will have approximately the same spectral range as NINA II (without wiggler magnets), but less intensity. The DCI ring will not be a dedicated facility, but one port with five experimental stations will be available to synchrotron radiation users.

Researchers in other countries are also pursuing synchrotron radiation. The most ambitious plan appears to be the Japanese proposal to build a $57 million "photon factory." The $57 million, however, is to be divided between three facilities that would have a common electron source: a storage ring for synchrotron radiation, a pulsed neutron source, and a high energy physics laboratory. The 2.5-Gev project is still awaiting funding. In Italy, the ADONE storage ring has no beam ports for synchrotron radiation at present, but a design study for synchrotron radiation is under way. Scientists in the U.S.S.R. have access to several high energy physics machines for synchrotron radiation studies, and two proposals are now under consideration for dedicated storage rings capable of producing x-rays.

What effect will the development of still bigger storage rings, which seem to be so attractive for high energy physics research, have for synchrotron radiation users? Although the larger machines, such as the 15-Gev PEP planned at Stanford and the 19-Gev PETRA planned at DESY, can produce harder x-rays, they have enough disadvantages that they will probably only be attractive for a few selected experiments, according to Christof Kunz at DESY. Apparently dedicated machines are needed much more than bigger machines, and an international panel concluded in 1974 that 2 Gev was the optimum energy.

In the United States, interest in a national synchrotron radiation center is at a high pitch, but the difficult process of unifying the scientific support and obtaining government approval has barely begun.

This month, however, the National Science Foundation (NSF) (which supports the Stanford and Wisconsin projects) and the Energy Research and Development Administration (ERDA) (which would like to have a national facility at one of its laboratories) are issuing a joint call for information, according to William Oosterhuis of NSF and Mark Wittles of ERDA. They emphasize, however, that they are only seeking preliminary information for the purpose of defining the scope and format of a synchrotron radiation facility, not proposals.

Nonetheless, Brookhaven National Laboratory has already sent ERDA a proposal for a $20-million facility that would be based on a 2-Gev storage ring with a more progressive design than the British project at Daresbury. The Brookhaven design would maximize the radiation intensity obtainable and be flexible enough to meet most experimental requirements. Stanford scientists are talking up the idea of converting SPEAR into a dedicated synchrotron source that could have a source intensity comparable to that of DORIS in the event that PEP is approved, and researchers at Stoughton feel that a case can be made for establishing a high energy source there.—WILLIAM D. METZ and ARTHUR L. ROBINSON

Conservation of Stone Artworks: Barely a Role for Science

Last summer in Bologna, about 150 scientists and craftsmen met to discuss the complicated subject of preserving stone objects and buildings. The Third International Symposium on the Conservation of Stone was not a dramatic occasion, in the sense that no breakthroughs were reported. But the difficult dialogue between the craftsmen who do the restoration and the scientists who evaluate the problems inched forward.

The conservation of stone is really a sequence of independent procedures. First, the causes and mechanism of the decay are (it is hoped) elucidated. Then the stone is, in turn, cleaned, consolidated (strengthened by binding together the individual grains), and protected against future chemical or physical attack.

In most cases of stone deterioration, water has been the saboteur. The porosity of sedimentary rocks makes it very easy for salt solutions to circulate through them. And although granites and igneous rocks are not so porous by nature, when eroded by weathering and temperature changes they are also susceptible to attack by water.

On stone that has been heavily weathered by water, alternating deposition and dissolution of soluble salts over a long period of time creates a flux in the structure of the decayed stone's crust, which shows up in microscope scans of cross sections and surface patinas. Using an optical interference technique, Seymour Z. Lewin of New York University and E. J. Rock of Wellesley College, Massachusetts, found orientation patterns of the gypsum crystals in the layers of decay of marble that had been exposed to the New York City atmosphere for years. This indicates that the corrosion crust of decaying marble is not static, but heterogenous and dynamic. Acids formed by the dissolution of air pollutants (oxides of sulfur and nitrogen) in rainwater or condensed moisture penetrate the stone, leach out calcium salts, and deposit these salts on the surface of the stone, producing the patina. Thus, a patina on weathered stone may appear to be firm and nonporous, yet the stone beneath may be soft and ready to crumble. Similar effects are caused by the capillary rise of underground water into the stone and its evaporation from exposed surfaces. (Usually water from the ground reacts with stone as a dilute solution of carbonic acid.)

Whereas water has always been a nemesis to conservators, air pollution, which accelerates the rate of stone decay, has become increasingly important in many urban environments. Thus, if the main source of air pollution is automobile traffic and home or factory heating plants, its effects should be most severe closest to the emission sources. However, the correlation between the actual SO_2 concentration to which the stone is exposed and other factors, such as altitude, has only recently begun to be understood. A new device called the Immission Rate Measuring Apparatus (IRMA) developed by S. Luckat from Landesanstalt für Immissions und Bodennutzungsschutz, West Germany, may help to solve this problem. Based on the principle of the Soxhlet extractor, IRMA can be used to measure SO_2 and other pollu-