which is operated jointly by Cornell University and the University of Sydney. Personnel and staff are interchangeable in this project, in which are associated, among other activities, the Mills Cross project in Australia and Cornell's large radio-telescope facility in Arecibo, Puerto Rico.

Much of the money being spent now on Australian education is being spent outside the universities. For instance, Gorton says every school in Australia will have a science laboratory within 3 or 4 years. The Australian government is now putting special emphasis on building up the nonuniversity side of the "tertiary education" system—those institutions, including technical colleges, which lie beyond secondary school level but whose admission standards are less demanding than those of the universities.

Australian scientists say they have little trouble in obtaining funds for continuing research projects. "Our funding is adequate, we're very well looked after," radio-physicist Bowen comments. "But we're badly off for big capital expenditure. Our Treasury people can't understand a million dollars in one hit. It's one hell of a job to get started. We've been entirely dependent on U.S. benevolence." Bowen said there may be signs of a change since the Australian government has agreed to match a $5-million contribution from the United

Big Science: Tight Budgets Pinch Some Major Facilities

Stringency in U.S. government budgets in the past 2 years has put a number of expensive national research facilities on short hours, but has not halted some important new projects that had been funded previously or that are relatively low in cost.

A case in point is the Cambridge Electron Accelerator (CEA), run by Harvard and M.I.T. with about $3.5 million a year in operating funds from the Atomic Energy Commission. Dedicated in 1962, the $20-million machine has operated at times around the clock—that is, for 21 shifts of 8 hours each week, including 14 shifts for experiments, four for maintenance, and the rest for improvements. Since late 1966, however, the usual number of weekly shifts for experiments has been ten, and the staff has been decreased by about 30 from its maximum of 215.

However, these cuts have not prevented the CEA staff from altering the synchrotron so that it can store large numbers of "pulses" of electrons going in one direction and positrons going in the opposite direction and then send them crashing through each other for periods up to an hour. Full-scale clashing-beam work, for which the CEA machine will serve as its own "storage ring," is expected to begin late in 1969. These experiments will be a poor man's version of much more ambitious projects proposed but not yet approved for the Stanford 2-mile accelerator (SLAC) and the CEA-type synchrotron in Hamburg, Germany.

Most of the equipment for the electron-positron storage ring project was financed from regular CEA equipment funds. One major item, a positron source costing $650,000, is being bought with fiscal-year 1968 money.

SLAC is facing similar problems. Although about half of the AEC's fiscal-1968 budget increase for high-energy accelerators throughout the country went to SLAC, the machine has been able to operate an average of only 11 to 12 shifts per week, even though SLAC's staff of 1200 includes enough people to operate the machine 15 or 16 shifts a week.

Even with a $20-million operating budget, SLAC has lacked money for needed extra electric power and for replacement of worn-out klystron tubes. SLAC hopes to get enough money to operate about 15 shifts in the coming budget year. Although such SLAC projects as an electron-positron storage ring for clashing-beam experiments will be delayed some years by tight budgets, a large liquid hydrogen bubble chamber has been moved to SLAC from Berkeley, mainly for experiments by visiting physicists rather than SLAC staff members.

Another short-time facility is the 120-foot (36-meter) radio telescope called Haystack operated by Lincoln Laboratories near Groton, Massachusetts. Haystack has been hit by a now-common problem, a sharp cutback in Defense Department funds for basic research. For lack of funds, the hours of operation have been shortened for radar work on such problems as the rotation of Venus and Mercury or the reflectivity of materials in the lunar crater Tycho. When the telescope is used for radio astronomy, a smaller crew is needed and Haystack can be operated around the clock if need be.

Like radio astronomers in many other places, the civilian users of Haystack are looking for non-Defense Department sources of support for time on the telescope.

One potential source is the National Science Foundation. But NSF is faced with requests to pick up about $1 million a year for astronomy at Arecibo, Puerto Rico, now paid for by Defense funds, and to take over the Office of Naval Research support of radio astronomy at California Institute of Technology and the universities of California, Michigan, and Illinois.

Despite such problems, workers at Haystack were able last fall to "readjust" the surface of the dish to allow its use at frequencies even higher than the 8000 megacycles (8 gigahertz) used for earlier research. This work was done at small cost and opened up important new regions for study by radar and radio-astronomy techniques.

A fourth major facility, Kitt Peak National Observatory, suffered a $1.2-million cut in its operating budget last fall, even though there was no slowdown in capital funding for a pair of 150-inch (4-meter) telescopes costing $10 million each. The two telescopes, one for the Kitt Peak Observatory and the other for the Cerro Tololo Inter-American Observatory in Chile, are expected to be operating fully in the early 1970's.

Kitt Peak's budget was slashed from $5.9 million to $4.7 million. The cut removed money for a new computer and money needed to start a research group on designing future telescopes, as well as $800,000 from Kitt Peak's rocket astronomy program. This means that Kitt Peak can schedule only one rocket flight out of a planned total of three or four—VICTOR K. MCELHENY