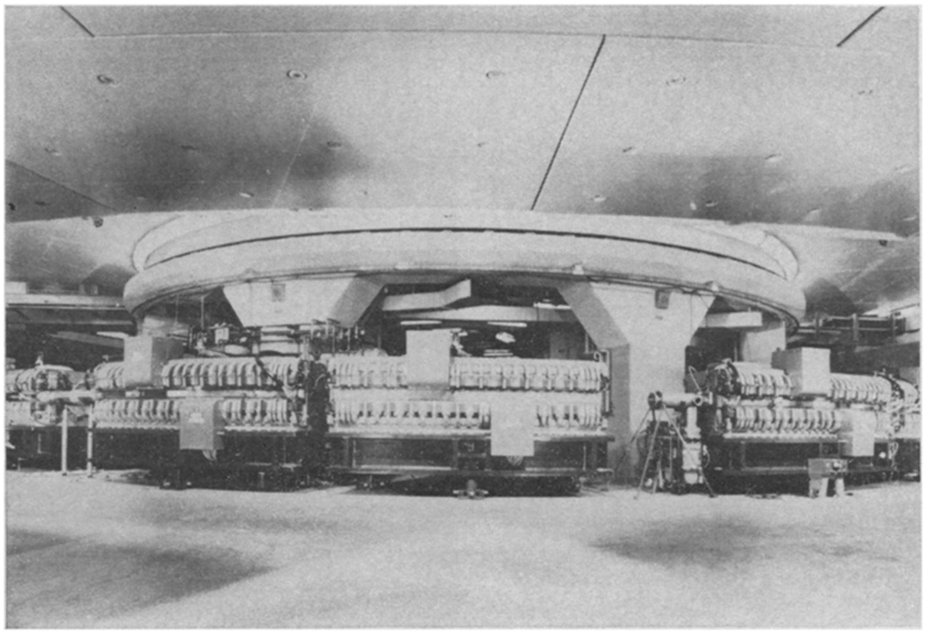
Twilight for a workhorse



Princeton Univ.

PPA: "From him that hath not shall be taken away even that which he hath."

The Princeton-Penn Accelerator, due for closing, has a long list of projects

by Dietrick E. Thomsen

During the middle 1950's mesons, a class of particles with masses intermediate between those of an electron and a proton, were becoming important in particle physics. Mesons can be used to study the structure of nuclei, the structure of neutrons and protons, the strong nuclear force that holds nuclei together and the electromagnetic force that holds atoms and larger pieces of matter together.

In 1970 mesons are if anything more important to physics than they were in the 1950's. Yet the machine that was built with mesons in mind, the Princeton-Pennsylvania Accelerator, is about to be closed (SN: 3/14, p. 266).

The closure is not for lack of business; the accelerator has an 18-month waiting list. Nor is it for lack of interest. Some of the experiments on the floor now relate to critical and unsolved problems of physics.

The reason is simply lack of money: The Nixon Administration will not allow the Atomic Energy Commission enough money to run all its accelerators at a reasonably efficient level, so the commission decided as a first step to close the smallest one it has. Some see this as a first step in a policy to reduce high-energy laboratories to two (SN: 3/7, p. 239).

The 3-billion-electron-volt energy of the PPA makes it the smallest of those now operating primarily for the study of particle physics. (Quite a number of accelerators with much lower energy exist, but they study nuclear or atomic structure.) The PPA's work force of about 120 people makes it the smallest of the organizations classed as national laboratories. This combination of diminutives makes the PPA the least economical of the AEC's accelerator operations, and this is the reason given for closing it.

But the PPA was never among the most energetic or the largest, and it is not a case of an old machine that has been surpassed.

When PPA went into operation in 1963, the 12-GeV Zero Gradient Synchrotron at Argonne National Laboratory and the 33-GeV Alternating Gradient Synchrotron at Brookhaven National Laboratory were already operating. What was wanted was an accelerator that would provide very intense beams of both protons and the mesons that are created when the protons strike a target. The PPA delivers 19 bursts of protons a second. At the time it started, one pulse in 5 seconds was standard for other machines. The others have been modified since, but the AGS today delivers only one pulse in 2.4 seconds.

An important advantage of such intensity is that it shows up rare events and small differences, which are important in testing the sort of physical laws that say that something never happens. A few current experiments of this kind are cited by the accelerator's director, Dr. Milton G. White, as examples of how the machine works on some of the most important questions in physics.

One now on the floor belongs to a Columbia University group directed by Dr. Won-Yong Lee, and concerns the radioactive decay of the eta meson. One of the most basic assumptions of particle physics is that nature is symmetric with respect to matter and antimatter. If this is true then the number of paricles should equal the number of antiparticles in the decay products of eta mesons. A previous experiment by the same group seemed to show a slight asymmetry, but the statistics were not good enough to be certain (SN: 9/14/68, p. 265). Now they hope to get a definite result.

Dr. Lee says his experiment could have gone to Brookhaven or Argonne. He and his associates brought it to PPA because it was the easiest machine on which to get the time they need. They have to set up the equipment with a computer on line, do some preliminary runs, check the data to see that the system is working properly and then come back and run again. At one of the higher energy machines, says Dr. Lee, "It would be very difficult to sit on the floor long enough."

Dr. Lee feels that closing the PPA would be very unfortunate. "It is doing good experiments and will do good experiments for some time to come, certainly the next few years," he says. "I hope some miracle will happen."

Another aspect of symmetry is called time-reversal symmetry and postulates that there is no way to tell the difference between a particle going forward in time and an antiparticle going backward in time. In practice this means that particle happenings should be reversible. That is, if a neutron and proton come together to form a deuterium nucleus and a gamma ray (and they do), then with equal facility a gamma ray and a deuterium nucleus should come together and yield a neutron and proton. An experiment to test it is being set up by Drs. David F. Bartlett and Konstantin Goulianos of Princeton University.

One of the last experiments scheduled for PPA will test the theory of quantum electrodynamics, which describes the behavior of electric and magnetic forces among subatomic particles. The test involves measuring the magnetic strength of the mu meson to see if

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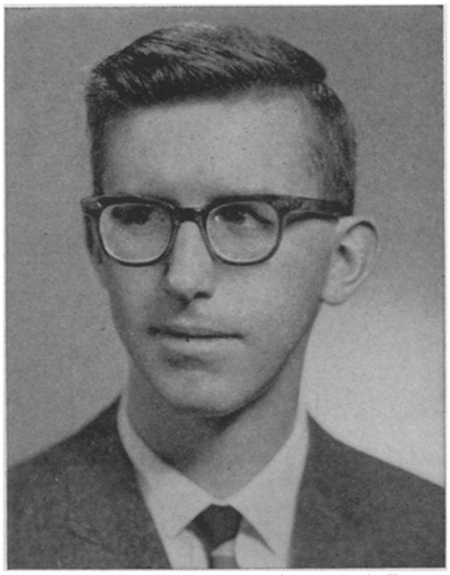
White: Young physicists will suffer.



Orren Jack Turner

Hutchinson: Policy is a grave mistake.

there is a difference from the theoretically predicted amount. The experiment has been done to very high accuracy at the CERN laboratory in Geneva, and a hint of a difference has been found (SN: 3/22/69, p. 290). Again, better statistics are needed, and a group of PPA staff members led by Dr. David P. Hutchinson hopes to provide them.

"We could go to a cyclotron," says Dr. Hutchinson, "in fact, the experiment has been done at the Nevis cyclotron at Columbia University, but we would not look favorably on such an idea." The copiousness of PPA's meson beams is one reason; the other is that PPA has features for timing the flight of particles that let researchers distinguish the desired particles from the background better than they could elsewhere.

"This plan to close an entire list of medium-energy accelerators is a very serious mistake," says Dr. Hutchinson. He contends that limiting the nation's high-energy physics establishment to one laboratory for protons and one for electrons will have a devastating effect on progress in the field.

Dr. White hopes that he will have enough money left to run the accelerator long enough to finish these and other experiments now contemplated. The eta-meson experiment is almost ready to run, the deuterium one should start in early summer, but the mu-meson one will run deep into the fall. "We'll run 15 shifts a week as long as we can," he says.

Dr. White concedes that most of the PPA's experiments could be done elsewhere, but sees no assurance that another laboratory will accept them. Competition for time at larger accelerators is already fierce, with rejection rates running 50 percent or higher. And with budgets being cut everywhere it is getting fiercer. "One of the shames is that this machine has meant a great deal to the upcoming crop of physicists," says Dr. White. "They will have a hard time getting time on other machines."

The proposed disestablishment of the PPA is causing at least as much acrimony as the original proposal to establish it. At the time PPA was started in 1956 there existed a 3-GeV accelerator, the Cosmotron, at Brookhaven National Laboratory. It was then already being superseded by the big machines under construction. Some physicists wanted to modify the Cosmotron to make it a high-intensity accelerator.

The Princeton-Penn faction contended that a better machine would result if it were built new, and that a new machine ought not to be built at Brookhaven, which, they felt, was getting too big. There were also some who wanted a new machine, but thought Princeton was too close to Brookhaven to be really spreading the wealth very far.

After some debate the decision to build in Princeton was taken. Subsequently the Cosmotron was closed and torn down. Until now it was the largest American accelerator ever dismantled.

Dr. White is not alone in questioning the economic reasoning in the decision to close the PPA. At a recent hearing before the Joint Congressional Committee on Atomic Energy, committee members asked whether it would not be wiser to maintain all the nation's accelerators at some level of operation rather than close one down. If one were dismantled, they pointed out, it could not be resurrected when and if good times returned to the world of particle physics.

The AEC says it made the decision on the advice of particle physicists on its High-Energy Physics Advisory Panel. Observers not on the panel were quick to point out that of all the major accelerators, PPA is the only one that does not have a staff member on the panel. The AEC seems a little sore on the point. At the congressional hearing, the director of the Commission's Division of Research, Dr. Paul McDaniel, answered it before it was raised. Before anyone put any questions he stressed that the panel members sit as individuals and not as representatives of institutions.

In rebuttal to the economic reasoning Dr. White argues that in a time of tight money smallness has its virtues too. It takes $4 million to $5 million a year to run PPA at capacity, compared to operating budgets of around $25 million for the biggest machines. Dr. White says PPA could be used as an economic pilot machine to test out new lines of research and to decide whether specialized machines or modifications to big ones would be worth while.

One specific proposal that he has made in this line is to modify PPA so that it could accelerate heavy ions (SN: 10/11, p. 333). It already accelerates light ions in addition to protons, but it needs better vacuum chambers to do the heavy ones.

There are other heavy-ion proposals around, and one that has found favor with the AEC is a proposal to alter the existing Heavy Ion Linear Accelerator at Berkeley, Calif.

Heavy ions accelerated by PPA, says Dr. White, could be used in the currently hot search for stable atomic nuclei heavier than uranium (SN: 12/14/68, p. 595).

Another use for heavy ions would be a kind of laboratory cosmology. "If you bang together two uranium nuclei at 190 GeV each," he says, "the density and temperature would not be too different from the primeval fireball" with which some cosmologists believe the universe began (SN: 7/15/68, p. 577). Such microfireballs would not last very long, but studying them might help decide just what conditions could have occurred in the early stages of the universe.

Heavy ions also have applications in solid-state physics, says Dr. White. He would be happy, he says, if any solid state physicists wanted to come to the PPA to see what happens to crystal structures when heavy ions are smashed into them.

But the AEC has turned down Dr. White's heavy ion proposal in the course of deciding to close his machine. As one physicist puts it: "You can serve more customers per proton at the big machines," and this is the logic that is prevailing so far. □