able for space missions because of its small mass (0.9 or 1.6 kg) and low power requirements (about 1 watt). 18-point differential-energy-spectrum measurements for both electrons and protons include parts of the lower ends of the spectra that have been relatively neglected by plasma and penetrating-radiation physicists.

The basic component is the "channeltron" secondary-emission multiplier. It is a thin tube whose interior is coated with a semiconductor material that emits secondary electrons. When a potential difference of 3500 volts is applied across the ends of the tube, an axial electric field is formed. Secondary electrons, produced when a charged particle hits the inner surface of the aperture (at ground potential), are accelerated down the tube. Simultaneously, the electron drifts across the tube with whatever lateral velocity is acquired in the ejection process. When these free electrons gain enough energy from the electric field between encounters with the surface that, on the average, more than one secondary electron is generated at each encounter, this process cascades, resulting in a gain of about 10^8.

In SPECS, five 270-deg channeltrons are mounted on top of each other adjacent to a helical "funneltron." The beam of entering particles is collimated and then passes through a pair of deflection plates kept at a variable potential. At specific voltages across the deflection plates, particles of certain energies entering the channeltrons and the funneltron are counted. When the polarity of the deflection plates is reversed, the particles switch position and, for example, the protons enter the channeltrons and the electrons enter the funneltron.

Since a satellite, in an orbit close to the earth, can pass over an auroral arc in one second, the simultaneous measurement of electrons and protons and the greater sensitivity to small particle intensities are advantageous features of SPECS. A number of small units have been flown on Javelin rockets, and the larger ones will be orbited in the Owls 1 and 2 and Aurora satellites. Another set will be placed on the lunar surface by astronauts.

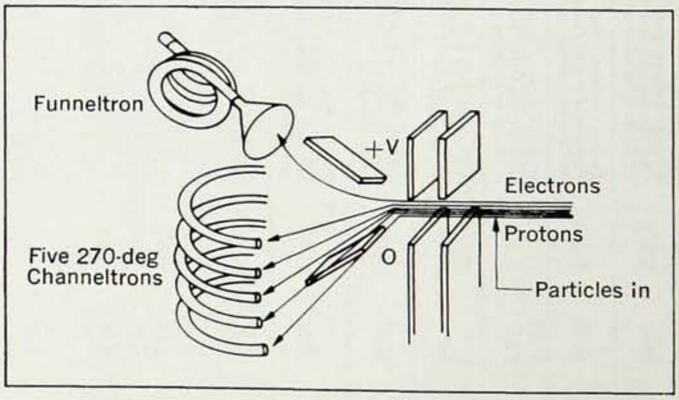
This development is reported in an article by Brian J. O'Brien, Foster Abney, James Burch, Richard Harrison, Robert LaQuey and Tadeus Winiecki in *Rev. Sci. Instr.* 38, 1058. —MLL

1.02-Meter Bubble Chamber Starts Operating at Stanford

At the Stanford two-mile accelerator a 1.02-meter hydrogen bubble chamber recently began running. The third largest in the US, it is probably the last of its generation to be built, according to Joseph Ballam, who directs the SLAC research division. Most of the big high-energy laboratories now want larger, room-size chambers. A 4-meter chamber is being built at Argonne, and a 4.3-meter chamber for Brookhaven was recently recommended by the Weisskopf high-energy physics committee.

The Stanford $2.5-million chamber, made of stainless steel, is 1.02 meters in diameter and 0.51 meter deep. It has a bellows-operated piston that pulses twice a second in a 24-kG field.

Unlike its predecessors the SLAC chamber has no elaborate refrigeration



SPECS measures electron and proton energies. With deflection voltage +V electrons are deflected into funneltron and protons of suitable energies are deflected into the five channeltrons.

system to maintain low hydrogen temperature. These days it is cheaper to use liquid hydrogen directly from commercially supplied tanks.

A second chamber will be available later when the old 72-inch chamber from Lawrence Radiation Laboratory is modified; its effective length will be 2.08 meters. The chamber, piston operated with an omega bellows, will pulse twice a second, twelve times faster than the 72-inch. Testing should be finished by the end of the year; soon after the remodeled chamber should be ready for events.

1-GeV Protons Probe Motion of Nucleons in Nuclear Matter

The exceptional stability and high energy of the Cosmotron beam and recent improvements in wire spark-chamber techniques have been used to probe the distribution of matter in light nuclei. In a race to beat the final shutdown of the Cosmotron an 11-man team (Harry Palevsky, Joseph Friedes, Richard Sutter and Gerald Bennett of Brookhaven, George J. Igo of Los Alamos, Dwayne Simpson and Gerald Phillips of Rice University, Daniel Corley and Nathan S. Wall of the University of Maryland, Robert Stearns of Vassar College and Bernard Gottschalk of Northeastern University) used 1-GeV protons to probe the nucleus in much the same way as x rays probe condensed matter. Their first results were reported in *Phys. Rev. Letters* **18**, 1200 and **19**, 387.

Energy resolution was so good (roughly 3 MeV) that one could separate elastic from inelastic scattering for several light nuclei. Angular resolution was ±0.1 deg.

The beam itself was amazingly stable; over 24-hour periods its long-term stability was about 1.5 MeV. No one associated with the accelerator had realized how good it was. Before the Cosmotron closed permanently on 31 December the collaboration did experiments with hydrogen, deuterium, helium, lithium-6, carbon, oxygen and lead.

Although electrons have been used to probe the correlations of individual nucleons inside the nucleus, the Cosmotron collaboration is the first to do the same with protons. The proton scattering results suggest that nucleon-