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STUDY OF DRIFT-FIELD SOLAR
CELLS DAMAGED BY LOW-ENERGY PROTONS

Report Covering Period of June 15 to August 10, 1965

Contract NAS 5-9627

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1. OBJECTIVE

The objective is to conduct an irradiation study of drift-field solar cells (supplied by NASA) with low energy protons. The experimental data on the irradiated cells are to consist of I-V curves and spectral response curves.

2. WORK SUMMARY

The solar cells were soldered to small copper blocks which, in turn, were fastened to brass disks, usually nine per disk, for irradiation, for attachment to the fixtures of the solar simulator, and for attachment to the fixtures of the filter-wheel spectrometer. I-V curves and spectral response curves were obtained for each cell prior to the anticipated irradiation with 2.8-Mev protons.

The performance of the irradiation apparatus and monitoring equipment was checked out and then they were moved to the 3-Mev Van de Graaff accelerator in another building in the Palo Alto Research Laboratories. They were set up for the irradiation experiment at the accelerator on July 30 and were removed on August 6. The experiment ran during both the day and swing shifts which is customary in the use of the accelerator. The first part of the experiment was intended for mapping the proton irradiation field near 0° for 2.8-Mev protons scattered by a 1.0 micron gold foil and the latter part of the experiment was intended for the irradiation of the solar cells.

Data were obtained on the uniformity of the scattered beam at the irradiation position by measuring the ratio of the counts in two solid state detectors, $A(\rho)/A(60^\circ)$, as a function of the distance, ρ , from the axis of symmetry. One detector measured $A(\rho)$, the number of scattered protons passing through a small collimated area of $7.79 \times 10^{-4} \text{ cm}^2$ at the irradiation position about 330 cm downstream from the foil and within 0.9° from the axis of symmetry. The other detector measured the number of protons scattered in the vicinity of 60° (or 120°) and passing through a fixed size collimator. This detector was to serve as the monitor for the irradiation of the solar cells once the ratio of counts was established for a particular foil size and for a particular beam energy -- 2.8 Mev, in this case. However, this ratio was found to vary from about 2 to about 6 and could never be stabilized. Considerable effort was made in checking and in making changes in the irradiation apparatus and in the counting equipment without finding the cause of the variation. The situation was further disturbed by the fact that a new belt had just been installed on the Van de Graaff accelerator and was producing considerable instability and much sparking. Later in the experiment when the accelerator became more stable vacuum leaks developed in the irradiation apparatus and had to be repaired.

The experiment was finally terminated without irradiating the solar cells because the various problems that were encountered could not be solved within a reasonable time. Data obtained during the experiment are being analyzed to try to find the cause of the variation of the ratio of counts.

3. CONFORMANCE OR NON-CONFORMANCE WITH THE WORK SCHEDULE

Twenty drift-field solar cells were received from NASA a few days after the contract began on June 15. Information on the characteristics of the cells did not arrive at LMSC until July 23 and hampered the planning of the work. Three control cells were received one day before the scheduled time with the Van de Graaff accelerator was to start on July 29.

In spite of the lack of information on the cells accelerator time was scheduled one month in advance for four days starting on August 2. This schedule was eventually changed to give six days starting on July 30.

The original plan was to irradiate the first set of 20 NASA drift-field cells with 2.8-Mev protons during the first week of August. This plan was agreed to in a telephone conversation which took place on July 28 between M. Schach, and P. Fang of NASA-Goddard and J. DePangher of LMSC after DePangher met Schach in San Francisco. Two different plans were considered at that time for irradiating the second group of 20 cells to be delivered in August and the third group of 20 cells to be delivered two months later. One plan was to wait until all the cells were delivered and then to make one irradiation. The other plan was to make separate irradiations at two different times. A decision was not made regarding which plan would be followed.

The failure to irradiate the first group of 20 cells as planned will require a change of schedule.

4. ANALYSIS OF WORK

Possible causes of the variation in the calibration of the 60° (and 120°) monitor for measuring proton fluences are being investigated. Pulse height distribution data, uniformity data, and data obtained at different count rates are being analyzed to check on the performance of the solid state detectors. Laboratory tests are being made on the amplifiers for these detectors to check if they exhibit unusual properties at high rates. The feasibility of using an alternative monitor is being investigated.

5. RELIABILITY PROCEDURES

The solar cells were mounted by one technician who has experience in soldering solar cells to copper blocks and then to brass disks. Each of the three solar cell manufacturers were consulted regarding the soldering procedures for the cells before they were mounted to make sure they would not be damaged by soldering. None of the cells were broken or damaged in any way. The irradiation apparatus was vacuum tested before the experiment. The counting equipment was checked before the experiment and was in good operating condition. The counting rates for the two solid state detectors were held below 2500 count/sec during the experiment to try to avoid rate-dependent effects in counting the protons. The filter-wheel spectrometer was calibrated against a standard cell supplied by Heliotek Corporation just before the experiment. To avoid any possible drift in the O.C.L.I. sun simulator the I-V curves were taken with it just before the experiment.

6. ADEQUACY OF FUNDS

The expenditure on the program thus far amounts to about \$8500, much of which has gone into an unsuccessful experiment. Obstacles causing the failure must be found and removed and a new experiment planned. This experiment would be more economical if it included the drift-field cells from the second delivery, as well as the cells now at hand. The amount of effort that can be expended in data analysis will depend on how economically the next two irradiations can be performed, assuming forty cells are irradiated in one experiment and twenty cells are irradiated in the last experiment.

7. CHANGES IN PERSONNEL

Participating personnel have been:

J. DePangher	Staff Scientist
D. L. Crowther	Research Scientist
E. A. Lodi	Senior Scientist
H. H. Chung	Research Engineer
G. D. Jones	Research Laboratory Analyst
G. N. Biren	Research Laboratory Analyst
	Van de Graaff operators

Mr. D. L. Reynard did not participate as planned, but is available for consultation when needed.

8. FUTURE WORK

Pending the analysis of the data taken with our counting system and of the state of the irradiation apparatus, preparation for a new experiment is being undertaken to irradiate at least 40 NASA drift-field cells by the end of September.