DATA SET CATALOG # 43

OGO III Solar Cosmic Rays
66-049A-01A 50 tapes

Table of Contents

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1. INTRODUCTION:

The documentation for this data set was originally on paper, kept in NSSDC's Data Set Catalogs (DSCs). The paper documentation in the Data Set Catalogs have been made into digital images, and then collected into a single PDF file for each Data Set Catalog. The inventory information in these DSCs is current as of July 1, 2004. This inventory information is now no longer maintained in the DSCs, but is now managed in the inventory part of the NSSDC information system. The information existing in the DSCs is now not needed for locating the data files, but we did not remove that inventory information.

The offline tape datasets have now been migrated from the original magnetic tape to Archival Information Packages (AIP’s).

A prior restoration may have been done on data sets, if a requestor of this data set has questions; they should send an inquiry to the request office to see if additional information exists.

2. ERRATA/CHANGE LOG:

NOTE: Changes are made in a text box, and will show up that way when displayed on screen with a PDF reader.

When printing, special settings may be required to make the text box appear on the printed output.

Version	Date	Person	Page	Description of Change
01				
02				

3 LINKS TO RELEVANT INFORMATION IN THE ONLINE NSSDC INFORMATION SYSTEM:

http://nssdc.gsfc.nasa.gov/nmc/

[NOTE: This link will take you to the main page of the NSSDC Master Catalog. There you will be able to perform searches to find additional information]

4. CATALOG MATERIALS:

a. Associated Documents — To find associated documents you will need to know the document ID number and then click here.
http://nssdcftp.gsfc.nasa.gov/miscellaneous/documents/

b. Core Catalog Materials

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DESCRIPTION OF EXPERIMENT AND FORMAT OF OGO-3 STACKED DATA TAPE

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I. THE EXPERIMENT

A. The Detector and Telemetry System

Figure 1 shows a cross-section of the detector. It consists of a thallium doped cesium iodide crystal 1" thick and 1½" in [illegible]. The crystal is optically coupled to a RCA 7119 photo-multiplier tube. A plastic scintillator (NE-102) surrounds the crystal except for the opening at the top. The plastic is used for anticoincidence to discriminate against cosmic rays which have unwanted energies or directions.

The cesium iodide crystal is covered with three layers of ½ mil aluminized mylar to exclude light. An Am^{241} source is mounted directly on top of the crystal for energy calibration. The effective energy loss of this alpha source has been measured to be 4.4 MeV. Another energy calibration point is observed from the fact that the maximum energy loss for protons in the detector is 90 MeV. Protons of greater energy will not be stopped in the crystal and hence will produce a pulse in the anticoincidence shield.

This detector has no ability to discriminate among different kinds of particles. The main problem, however, is only in separating protons from alpha particles. Electrons will be seen only in the lowest channels (the cutoff energy is ≈ 23 MeV) if at all, since up to this time electrons of energy > 1 MeV of low flux have been seen in only two flares.[1] During quiet times electrons of energy > 1 MeV are a negligible background component of cosmic rays. Fluxes of few MeV gamma rays and of heavy (Z > 2) cosmic rays are also negligibly small.

[1] Cline, T.L. and F.B. McDonald, Interplanetary and Solar Electrons of Energy 3 to 12 MeV, Canad. J. Phys., 46, S761, 1968.

The geometry factor is a function of particle energy. Below 20 MeV, G = 1.68 sr cm^2. From 20 to 30 MeV, G increases to 1.88 sr · cm^2 and then decreases to G = 1.0 sr · cm^2 at 90 MeV. This form of G is due to the fact that a lip on the aluminum cup which rests just on top of the crystal as shown in Figure 1 cannot be penetrated by protons of energy less than 20 MeV. Protons of larger energy are not stopped by the lip and hence see a larger available area of crystal. Formulae derived by Brunstein[2] were used in these calculations. Because of the large gain increase, which is discussed later, one may take G = 1.70 cm^2 · sr as a good approximation for all the 32 channels.

Figure 2 shows a block diagram of the electronics. The pulses from the photomultiplier which views the crystal are amplified and sorted by the pulse height analyzer into 32 channels. Particles traversing the plastic shield will produce pulses which go to the discriminator at C. Pulses corresponding to energy losses in the plastic greater than 100 KeV gate out the pulses from the crystal to perform the anticoincidence. The power supplies keep the voltage on the photomultipliers at about 900V. Temperature regulation is achieved by heaters in the Solar Oriented Experimental Package (SOEP) of the spacecraft. The temperature and spacecraft voltage are monitored regularly and these data are processed along with the experimental data.

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[2] Brunstein, K.A., A Model of Low Energy Cosmic Ray Protons, PhD Thesis, Physics Department, University of California, Berkeley, 1963.

Counts from the detector are accumulated and read out in the following manner. For a time, t_1, counts are accumulated in a set of four consecutive channels. A set of four 9-bit accumulators constitute the scalars. Since $(2^9 - 1) = 511$, this gives the maximum number of counts which can be held in each channel during the accumulation time t_1. At the end of t_1 the state of the scalars is examined and read out as four 9-bit words. The readout control advances the commutator and the next four channels are then read out in a like manner at the end of the next accumulation time.

The time required to read out all 32 channels is then just $8t_1$. During a longer time, t_2, the total number of counts with energies between 2 and 90 MeV is accumulated in a single 9-bit accumulator. The actual number of counts is first scaled down by either 2^3 or 2^7 before it is accumulated. The scale factor is controlled by ground command. This scaled number of counts is called the subcom word since it is handled by a subcommutator of the spacecraft. The relation between t_1 and t_2 is $t_2 = 128t_1$. Thus, with each subcom word readout, all 32 channels will be read out 16 times. Following the subcom readout a reset pulse is applied to the commutator to provide proper phasing of the channel readouts. The counting rate of the subcom word may differ slightly from the sum of the count rates of the 32 channels depending on how the lower and upper energy discriminators, marked A and B in Figure 1, are set.

The deadtime of the circuit while handling a pulse in channel number n is (2n + 10) microseconds. If an average proton energy is about 10 MeV during an intense flare, then 30 μsec will be the typical deadtime for each count. The deadtime becomes 10% of the total time when the counting rate becomes $\sim 3 \cdot 10^3$ counts per second. In addition to this, the anode current of the photomultiplier tube is current-limited to 4 microamps. When the anode current reaches this value, the gain of the tube drops. Gain decreases have been seen in two events so far, those of September 2, 1966 and January 28, 1967. In each case the counting rates of the highest channels showed a decrease and then recovered some hours later.

The OGO-3 spacecraft can transmit data at three bit rates: 1, 8 and 64 kilobits per second. Table 1 shows the values of t_1, the accumulation times for each set of four channels, and t_2, the accumulation times of the subcom word for each bit rate.

The detector package was built by Ball Brothers Corporation of Boulder, Colorado and the electronic circuitry was supplied by Matrix Research and Development Corporation of Nashua, New Hampshire. The package was tested and calibrated at the University of California by Mr. J. Henry Primbsch. A spacecraft simulator which imitated the spacecraft telemetry system was provided for the testing of the experiment. After satisfactory testing of the flight package and the backup package, the flight package was integrated into the spacecraft at Goddard Space Flight Center in Maryland. The completed spacecraft was put through a number of acceleration and solar simulation tests at GSFC. The University of California experiment was monitored throughout these tests. Almost all the test data obtained at GSFC indicated that the experiment was functioning normally.

Table 1

Accumulation Times for the Individual Channels and the Subcom Word of the Detector

t_1	t_2	Bit Rate
1.152 sec	147.456 sec	1 kilobit/sec
0.144 sec	18.432 sec	8 kilobits/sec
0.018 sec	2.304 sec	64 kilobits/sec

B. Experiment Performance

A number of problems and anomalies have been found both in the performance of the experiment and the analysis of the data. A brief description of the problems and their treatment will be given in this section.

The major problems and the methods used in dealing with them are the following:

1. Failure of channel 1. Because of timing problems in the pulse height analyzer, only a small fraction of the lowest energy pulses are registered as counts in channel 1. The problem was known before the experiment was flown. As a result, the counting rates in channel 1 are simply ignored.
2. Reversion to scale of 128. The experiment has frequently spontaneously reverted to a scale factor of 128 for the subcom word. The OGO Operations Control Center (OGO-OCC) monitors the subcom word from time to time and has commanded it back to scale factor 8 whenever it was noticed. Since the main reliance is really on the counting rates of the individual channels rather than on the subcom word, no important loss of information has resulted from this problem.
3. High counting rates in channels 4n + 1. The counting rates in channels 4n + 1, where n is an integer, are 10-20% higher than they should be. This was noticed in the testing of the detector and is due to the fact that timing errors in the electronics are responsible for recording some pulses in both channels 4n and 4n + 1. This is not an important problem since in deriving spectra for proton events, one can look at

the counting rates in channels 4n, 4n + 2 and 4n + 3 and pretty much ignore the 4n + 1 counting rates.

4. <u>8 kilobit bit loss.</u> An examination of the data on several tapes has shown that on a few tapes of 8 kilobit data some of the bits are lost. This bit loss shows up in the data as anomalously low numbers. To analyze these data, we have used the TP PLOT program for small amounts of the data and then gone back over the counting rate averages and corrected all the obvious losses of bits. Since there are sure to be some corrections which were missed, these data are considered to be only approximately correct. The reason for the bit losses remains one of several mysteries of this experiment.

5. <u>Subcom word bit loss at 64 kilobits per second.</u> During the readouts of the subcom word at 64 kilobits per second the number "12" has become number "4" due to the loss of the "8" bit. Why it happens only to the number "12" and only on 64 kilobits is unknown.

6. <u>Counting rate backgrounds</u>. The counting rate in each channel should be approximately 10^{-5} - 10^{-4} cps for a quiet cosmic ray background. The high counting rates in channels 2 and 3 are due to the alpha source. It can be seen, however, that the counting rates in channel 4 and above are approximately 10^{-1} cps, several orders of magnitude larger than can be attributed to the measured cosmic ray background. There is also a "spike" of approximately 1cps in channels 27 and 28. The source of this background noise is not known. It was not present during preflight

testing. It has always been present in the data received after launch except during passes through the radiation belts when the gain of the photomultiplier tube drops. The background counting rates have been monitored during times between flares, and it appears that they are fairly constant. The spike has shifted by no more than a channel or two during this time.

The alpha source shows up in both channels 2 and 3. Right after a pass through the radiation belts the counts from the alpha source are split between channels 2 and 3, with approximately 25 cps in each channel. In time, the counts increase in channel 2 and decrease in channel 3 in a regular way. After the next radiation belt pass, the cycle occurs again.

The background counting rates described above have been subtracted off the total counting rates during solar flares to get the fluxes due to the flare itself. This procedure assumes that except for channels 2 and 3 the background does not change during the flare and also that the detector functions normally when the flare protons are counted. Both assumptions appear to be correct in view of the flare events that have been analyzed so far.

7. Energy calibration of the detector. It was pointed out that the energy calibration of the detector could be achieved through the 90 MeV cutoff in the high channels and the position of the 4.4 MeV alpha source in the lowest channels. It is now clear that the gain has increased by a factor of 2 or 3 over the preflight calibration level. The following

methods have been used to obtain an energy calibration of the detector:

a. No 90 MeV cutoff is seen in solar flares. Thus the energy of channel 32 is less than 90 MeV.

b. The alpha source is seen partly in channel 3, higher than in preflight test readouts.

c. Derived fluxes and the time behavior of various channels have been compared with data from the $E_p > 12$ MeV ion chamber on Explorer 33 and the $E_p > 12$ MeV ion chamber on IMP-3.

d. A comparison of spectra has been made with spectra obtained from the University of Chicago experiment on OGO-3. Four different times following the flare of July 7, 1966 were used. These four methods have yielded the result that the energy of channel 32 is 30-35 MeV. For numerical simplicity, we have taken it to be 32 MeV so that the energy of each channel is equal to the channel number, and the width of each channel is 1 MeV. This leaves a problem with the lowest channels, however, since the 4.4 MeV alpha source should be in channel 4 instead of channels 2 and 3. The exact energy loss of the alpha particles is somewhat questionable. Am^{241} has an alpha disintegration energy of 5.4 MeV. The loss in the crystal as measured in the laboratory against other radioactive sources was only 4.4 MeV. It is likely that some kind of surface contamination of the crystal is responsible for lowering the measured energy loss between the 4.4 MeV level. Since non-linearity is possible in the lowest channels, we have taken the following mean energy levels for the channels: $E = n + 2.5$ where E is the energy in MeV and n is the channel number. This assignment of energy levels makes the interpretation of low energy fluxes somewhat uncertain because of the energy widths and mean energies of the channels.

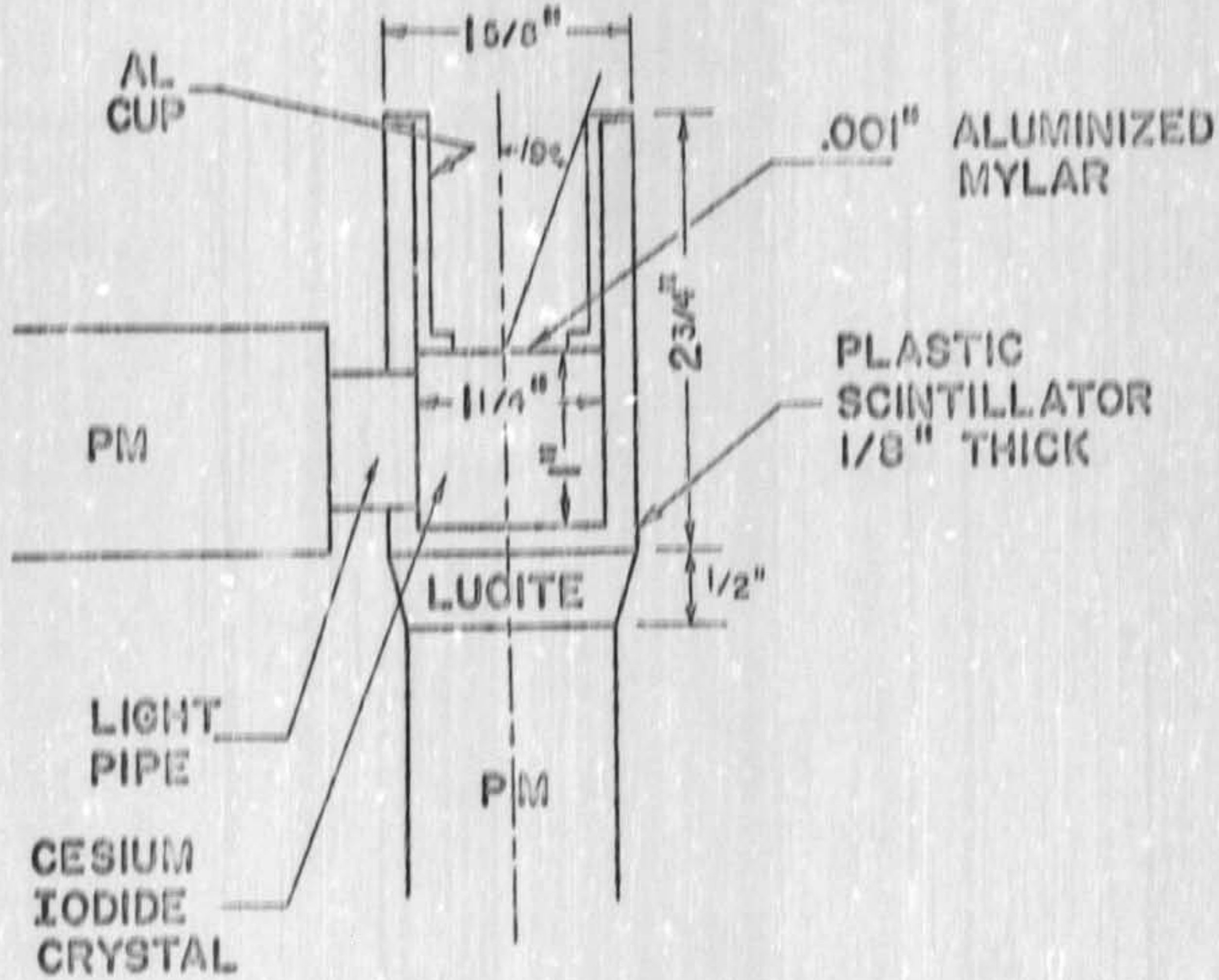

Figure 1. Cross-sectional view of the University of California scintillation counter on OGO-1.

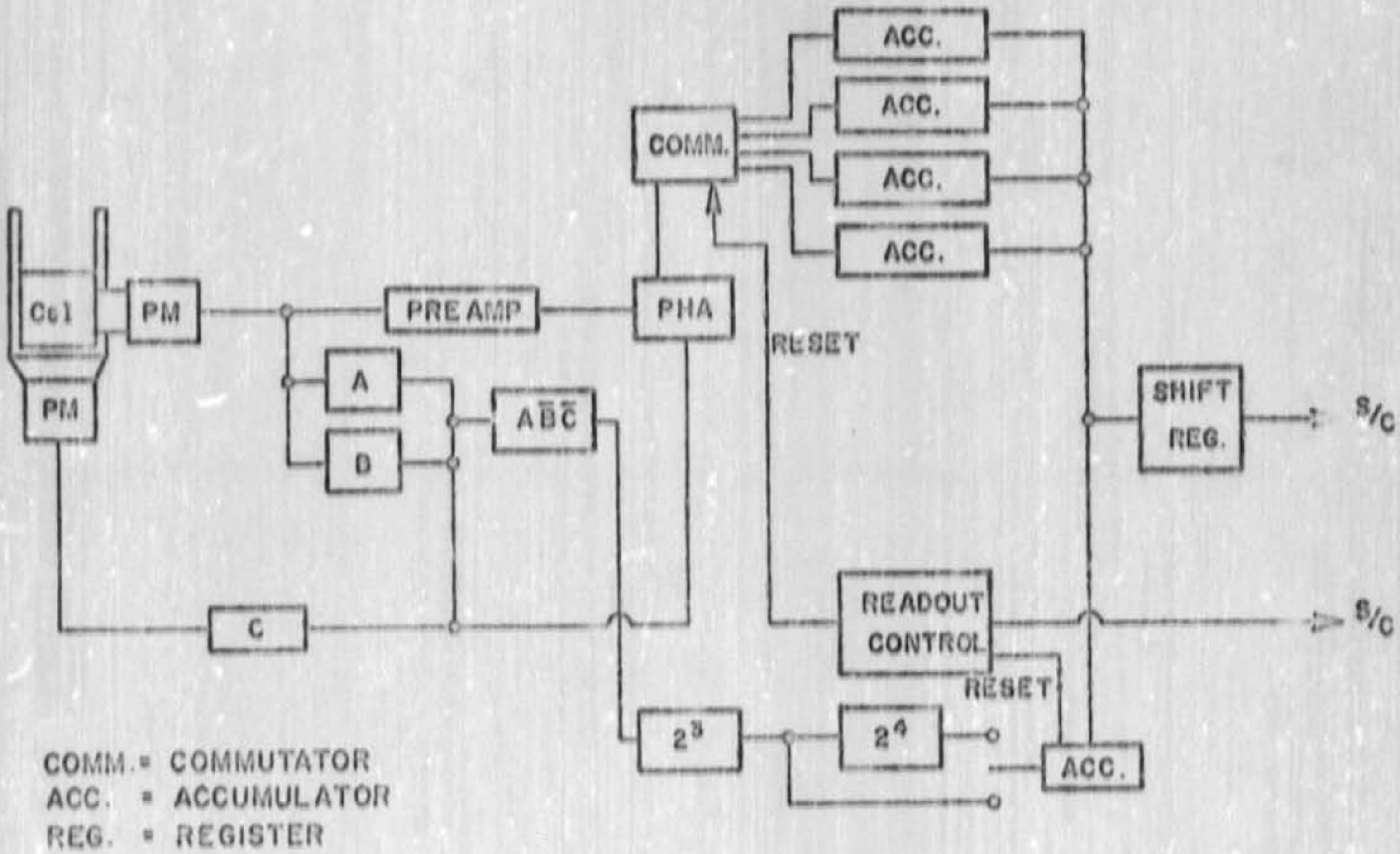

Figure 2. Block diagram of the electronics of the detector.

II. OGO-3 STACKED DATA TAPE FORMAT

A. General

The tape consists of "stacked" groups of condensed records which were chosen from original NASA tapes supplied by the Goddard Space Flight Center to the Space Sciences Laboratory of the University of California. It is a 7-track tape with density of 556 characters/inch.

The first record (ID record) of each file is a 120-byte, odd parity record containing BCD characters as on the original NASA tape. Information was inserted into words 98-120 to relate each stacked file to the original tape. Subsequent records were condensed from the original 5406 characters to 1044 characters. The characters which were eliminated were considered not useful to the investigations at the University of California.

Each file of a stacked tape consists of a group of records from any one of a number of selected original tapes. The selection of stacked records was made on the basis of examination of the original tapes, so that the more scientifically interesting data would remain available in concise form for possible reexamination.

B. Format of the ID Record, in BCD

The first 98 characters were copied from the original tape as follows:

Character	Representation
1-5 + Space	Satellite identification Example: 64021 where 64 = year of launch 02 = Beta 1 = object
7-8 + Space	Year
10-12 + Space	Station Number. Example: 001 = Blossom Point
14-15 + Space	Analog File Number
17-20 + Space	Analog Tape Number
22-23 + Space	Buffer File Number

Character	Representation
25-28 + Space	Buffer Tape Number
30-32 + Space	Date of data digitization (day of year)
34-66	Will be identical to characters 1-33 unless an error was found in those characters. If that is the case, then this portion of the record will contain the corrected values of that field.
67 + Space	Type of data contained in file. 0 = 1 kilobit real time 1 = 8 kilobits real time 2 = 64 kilobits real time 3 = command storage playback
69-71 + Space 73-77 + Space	Day of year Seconds of day } Start time of data
79-90	Spares
91-94 + Space	Master Binary Tape Number
96-97	Master Binary File Number
98	Blank

The remaining ID characters are written as follows:

Character	Representation
99-104	Original reel number
105	Octal '00'
106-108	Decom Number
109	Octal '00'
110	Original file number

Character	Representation
111	Octal '00'
112-115	Start record number
116	Octal '00'
117-120	Stop record number

The information in byte 67 is related to the rate/code:

1 kilobit signifies a rate of 147.456 sec/record
8 kilobits 18.432 sec/record
64 kilobits 2.304 sec/record

[The 128 times in the original tape are separated by

the rate $\left(\frac{\text{sec}}{\text{record}}\right) \times \frac{1}{128} \frac{\text{record}}{\text{frames}} \times 1000 \frac{\text{millisec}}{\text{sec}}$]

C. Format of the Data Record

Each data word contains 9 binary bits divided, right-adjusted, into two 6-bit characters. "Fill" words have a value of Octal 4000. Characters 1-12 have been copied from the original.

Character		Representation
1-2	D(97, 51)	*Experiment Subcom Data
3-4	D(98, 47)	*Load Bus voltage [D-10]
5-6	D(99, 37)	Experiment Mounting Plate Temp. + Z Door [E-22]
7-8	D(99, 62)	SOEP -X(+Y) Temp. [E-28]
9-10	D(99, 65)	SOEP -X(-Y) Temp. [E-29]
11-12	D(98, 81)	ADHA Cast Temperature F24 for EG#1 F32 for EG#2