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To Whom it May Concern:

In accordance with Article XIV of NASA Contract NAS5-22410, I am submitting the required copies of the Final Report: OSO-8 Soft X-Ray Wheel Experiment; Data Analysis.

Sincerely,

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NASA CR-170448

Final Report - OSO-8 Soft X-Ray

Wheel Experiment; Data Analysis

Contract No: NAS5-22410

I. Introduction

The soft X-ray experiment hardware and its operation is described in the Final Report for Contract No: NAS5-11361 dated 10 August 1975. The device included six X-ray proportional counters, two of which, numbers 1 and 4, were pressurized with on-board methane gas supplies. Number 4 developed an excessive leak rate early in the mission and was turned off on 1975 day number 282 except for brief (typically 2-hour) periods up to day 585 after which it was left off.

Counter 1 worked satisfactorily until 1975 day number 1095 (January 1, 1978) at which time the on-board methane supply was depleted. The other four counters were sealed and all except number 3 worked satisfactorily throughout the mission which terminated with permanent satellite shut-down on day 1369. Counter 3 had some sort of electrical leakage problem that appeared to develop as a result of launch. It never operated correctly in orbit.

This was the first large area thin-window, gas-flow X-ray detector to be flown in orbit. The background problems were severe and consumed a very large portion of the data analysis effort. These background problems were associated with the earth's trapped electron belts. The ideal orbit for experiments of this type is equatorial-low altitude.

II. Data Tapes Supplied to NSSDC

All production data tapes have been received from GSFC and have been processed. Each record of the resulting "reduced" data contains all of the basic usable information obtained from the experiment in a 20.48 second time interval, along with the position, attitude and equipment performance information needed to analyze the data in an independent fashion. The format of these tapes is specified on the accompanying pages labeled "Science Data Record Definition." One complete set of reduced data tapes, 150 in all, have been set to NSSDC, as well as the 32 tapes described below.

The next step in the data reduction was the creation of a set of 23 "compressed" data tapes. The compressed tapes are written in the same format as the reduced data, but data records were eliminated for times during satellite day and for other times when there was reason to believe that the data were invalid or contaminated. The compressed tapes contain all valid data from both methane counters (as well as sealed counter data from those times), including earth-looking and calibration data.

A further step in the data reduction produced a set of 8 "FWD-GOOD" tapes, containing data records from times when counter 1 was sky-looking and yielding valid, uncontaminated data. Times were eliminated when strong sources (count rate $\geq$ 4 cts s^{-1}) were in the field of view. Each record contains data from a single 20.48 second time interval and is in the same format as the reduced data.

The final step in the data reduction was the creation of the "SUMFWD" tape. Each of the 1400 records on this tape is the composite of all of the "FWD-GOOD" records contained in each time interval that the counter 1 field of view moved 1° along the scan path. Data taken when the angle between the look direction and the earth's magnetic field vector was between 70° and 110° were eliminated. The format for these records is the same as for the reduced data, except that various quantities have been summed or averaged as appropriate.

OSO-8 SOFT X-RAY EXPERIMENT (WISCONSIN)

SCIENCE DATA RECORD DEFINITION

General Information

1) The science data records (SDRs) are written on unlabeled 9-track tapes at 1600 bpi, odd parity.
2) The tapes were written by a Univac 1110. All words are 36 bits, packed 4 1/2 8-bit bytes per word. Real numbers are written in Univac 1100 series floating point format.
3) Each file contains
   a) Less than 43200 seconds of data on the "reduced" data tapes. In addition, the direction of the spin axis is within 10° of its direction at the start of the file.
   b) 8 days of data on the "compressed" data tapes
   c) 50 days of data on the "FWD-GOOD" data tapes
4) Each physical record contains 10 logical records. Each logical record (SDR) contains all the X-ray data collected in one 20.48 second telemetry frame, along with the experiment status and satellite status and orientation information necessary for analysis of the X-ray data. Each logical record contains 300 words whose contents are described in the following pages.
5) Logical records on any tape are always in ascending time order.
6) All angles are in degrees.
7) The RA of the local earth magnetic field vector (SDR word 243) is sometimes wrong on some of the "reduced" data tapes from days before ~800.
8) More information can be found in the OSO-8 Soft X-ray Experiment (Wisconsin) Final Report.

OSO-8 SOFT X-RAY EXPERIMENT (WISCONSIN)

SCIENCE DATA RECORD DEFINITION

Word	Type	Description
1	Integer	ID word (10_{10} in the 12 MSB)
2	Integer	FLAG word (see p. 3)
3	Real	Day of year 1975
4	Real	Seconds of day of start of data record
5-204	Real	Count rate data (see p. 7)
205-214	Integer	Digital subcom words (see FINAL REPORT, p. 53)
215-220	Integer	HVPS 1-6 monitors (see FINAL REPORT, p. 55)
221-222	Real	RA, DEC of center of FOV of sector CLR
223-238	Real	RA, DEC of center of FOV of sectors 0-7
239-240	Real	Satellite geodetic latitude, east longitude
241-242	Real	McIlwain L and B parameters
243-244	Real	RA, DEC of earth's magnetic field vector
245-246	Real	Zenith and azimuth angles of the Sun
247-264	Real	Zenith and azimuth angles of the center of the field of view of sectors CLR, 0-7
265	Real	Satellite altitude
266-277	Real	Total rates and deadtimes (see p. 8)
278	Real	Zenith angle of horizon + 160 km of atmosphere
279-284	Real	Most recent calibrate ratios for counters 1-6
285-286	Real	RA, DEC of satellite roll axis
287-289	Integer	HV relay monitors (see FINAL REPORT, p. 55)
290	Real	Satellite spin rate (RPM)
291	Real	FLAGS2 word (see p. 5)
292-294	Real	GSUM, HIENGY, AFTVETO (see p. 9)
295-299		Used only on FWDSUM tape (see p. 9)
300	Integer	Checksum: XOR of SDR words 1-299

OSO-8 SOFT X-RAY EXPERIMENT (WISCONSIN)

SCIENCE DATA RECORD DEFINITION

FLAG (SDR Word 2)

Bit	Description
0 (MSB)	attitude computation type (1 = coarse, 0 = fine)
1	= 1 if HIENGY>100 counts
2	= 1 if 80≤HIENGY≤99 counts
3	= 1 if 70≤HIENGY≤79 counts
4	= 1 if 53≤HIENGY≤69 counts
5	= 1 if 41≤HIENGY≤52 counts
6	= 1 if 0≤HIENGY≤40 counts If HIENGY <0, bits 1-6 are all = 1
7-9	Number of bit errors in minor frame synch words for count data in this major frame. If >7, set to 7
10	= 1 if fill data present in this frame
11	= 1 if it was impossible to check for a HVPS on/off transition between this and an adjacent frame for counters 1 and 4 (cf. bit 35)
12	= 1 if the day/night override is ON
13	= 1 if this is a calibrate frame and an overflow correction was made
14	= 1 if this is a valid calibration frame
15	= 1 if this is a calibrate turn-on frame (next frame will be a valid calibrate frame)

FLAG (SDR Word 2) (continued)

Bit	Description
16	= 1 if this is a calibrate turn-off frame (previous frame was a valid calibrate frame)
17	= 1 if any HVPS turned off or on between this frame and an adjacent one
18	= 1 if any non-gas-flow HVPS turned off or on between this frame and an adjacent one
19	= 1 if this is dwell mode data or some other glitch
20	= 1 if the radiation monitor override is ON
21	= 1 if spacecraft sun sensor indicates DAYTIME
22	= 1 if either adjacent frame is missing
23	= 1 if the previous frame is missing
24	= 1 if 1 or more ratemeters high
25	= 1 if buffer volume valve is open
26	= 1 if there are 1 or more solenoid 1 counts
27	= 1 if there are 1 or more solenoid 2 counts
28	= 1 if this frame fails any of ~10 internal consistency checks
29	= 1 if VHF transmitters are ON
30	= 1 if S-Band transmitters are ON
31	= 1 if this is a day of high geomagnetic activity
32	= 1 if suspect an extra MIP
33	= 1 if this is a self test frame
34	= 1 if illegal non-D/S data present
35	= 1 if it was impossible to check for a HVPS on/off transition between this and an adjacent frame for any counter (cf. bit 11)

NOTE: the quantity HIENGY is defined on p. 9.

OSO-8 SOFT X-RAY EXPERIMENT (WISCONSIN)

SCIENCE DATA RECORD DEFINITION

FLAGS2 (SDR Word 291)

Bit	
0	= 1 if the RA of the earth's magnetic field has been corrected
1-15	not used
16	= 1 if orbit predictions indicate NIGHT
17	= 1 if satellite in geographic region 3 - usually bad data
18	= 1 if satellite in geographic region 2 - possibly bad data
19	= 1 if satellite in geographic region 1 - possibly good data
20	= 1 if satellite in geographic region 0 - probably good data If the geographic region calculation was impossible to do, bits 17-20 are all = 1.
21	= 1 if AFTVETO>6000 cts/s
22	= 1 if 4400≤AFTVETO≤6000 cts/s
23	= 1 if 3300≤AFTVETO≤4399 cts/s
24	= 1 if 2001≤AFTVETO≤3299 cts/s
25	= 1 if -1000≤AFTVETO≤2000 cts/s If the calculated AFTVETO WAS LESS THAN -1000 cts/s, bits 21-25 are all = 1.
26	= 1 if GSUM>1000 counts
27	= 1 if 501≤GSUM≤1000 counts
28	= 1 if 301≤GSUM≤500 counts
29	= 1 if 271≤GSUM≤300 counts

FLAGS2 (SDR Word 291) (continued)

Bit	Description
30	= 1 if 241≤GSUM≤270 counts
31	= 1 if 213≤GSUM≤240 counts
32	= 1 if 151≤GSUM≤212 counts
33	= 1 if 136≤GSUM≤150 counts
34	= 1 if 1≤GSUM≤135 counts If GSUM = 0, bits 26-34 all = 0. If GSUM <0, bits 26-34 all = 1.
35	= 1 if a satellite attitude gas firing occurs

Notes: 1) This floating point real number (SDR word 291) must be set equal to an integer type variable for this description to be valid.

2) The four geographic regions referred to in the description of bits 17-20 are defined by the three contours of Figure 2 of Bunner (1978, Ap.J., 220, 261)

3) AFTVETO and GSUM are quantities defined on p. 9.

OSO-8 SOFT X-RAY EXPERIMENT (WISCONSIN)

SCIENCE DATA RECORD DEFINITION

Count Rate Data (SDR Words 5-204)

Word	Type	Description
5	Real	255.(Synch word)
6, 9	Real	Sail position (twice)
7, 8	Real	Data system status word (twice)
10, 11	Real	0. (twice)
12-171	Real	Counts array: DATA(CHANNEL,SECTOR) where CHANNEL goes from 1 to 16 and SECTOR from 0 to 7, CLR, BKG
172-201	Real	Active times array: TIME(COUNTER,SECTOR) where COUNTER goes from 1 to 3 and SECTOR from 0 to 7, CLR, BKG (The unit of active time is 0.2 seconds for sectors 0-7 and 0.4 seconds for sectors CLR and BKG.)
202-203	Real	Methane counter gas flow solenoid firings - for counter 1, counter 4.
204	Real	0.

Note: These numbers are minor frame words 49 and 50 from telemetry channels 0 through 99, described in Table 5-5 of the FINAL REPORT, p. 60.

OSO-8 SOFT X-RAY EXPERIMENT (WISCONSIN)

SCIENCE DATA RECORD DEFINITION

Total Rates and Deadtimes (SDR Words 266-277)

Word	Type	Description
266	Real	Counter 4 (aft methane) total rate
267	Real	Counter 5 (aft neon) total rate
268	Real	Counter 6 (aft xenon) total rate
269	Real	Counter 1 (forward methane) total rate
270	Real	Counter 2 (forward neon) total rate
271	Real	Aft counters (4+5+6) total rate
272	Real	Forward counters (1+2) total rate
273	Real	AFT ATMAX-maximum possible AFT active time (1006-1024)
274	Real	CLR ATMAX-maximum possible CLR active time (211-320)
275	Real	Aft counter 4 active time deficit
276	Real	Aft total active time deficit
277	Real	CLR active time deficit

Note: For each frame we calculate from the satellite spin rate and sail position what the maximum active times could have been (if the high voltages were off) for the AFT (0-7) sectors and the CLR sector. From the observed active times, we get active time "deficits" for each sector and counter, and we can calculate from that what the total rates (=X-ray events + vetoed events) were.

OSO-8 SOFT X-RAY EXPERIMENT (WISCONSIN)

SCIENCE DATA RECORD DEFINITION

Miscellaneous (SDR Words 291-299)

Word	Type	Description
292	Real	G-SUM is the sum of SDR words 12-171. This sum is the total number of counts recorded in all energy channels and all sectors.
293	Real	HIENGY is the sum of the counts recorded in channels 15 and 16 in sectors 0-7.
294	Real	VETO = AFVETO = AFT VETO is an estimate of the veto rate for the aft counters (4+5+6) determined by subtracting the measured X-ray count rate from the calculated total count rate (SDR word 271) for the aft counters.
295	Real	SCANANGLE is the cumulative angle along the scan path of the current logical record (FWDSUM only).
296	Real	LASTDAY is the day of the last frame included in the current logical record (FWDSUM only).
297	Real	LASTSEC is the time of day, in seconds, of the last frame included in the current logical record (FWDSUM only).
298	Integer	SRCFLG bits are set corresponding to the energy channels in which counts from a known X-ray source in the field of view are expected: bit 0 for channel 1, bit 1 for channel 2, etc. (FWDSUM only).
299	Integer	Number of frames included in this logical record (FWDSUM only).

III. Publications - Talks

PUBLICATIONS

"V843 Ophiuchi Supernova Remnant," A. N. Bunner, IAU Circular #3339, 23 March 1979.

"X-Rays from Kepler's Supernova," A. N. Bunner, Sky and Telescope, page 430, May 1979.

"First Coordinated Campaign of X-Ray and Ground Based Observations of X Persei = 3U0352+30," C. deLoore et al., Astron. & Astrophys., 78, 287 (1979).

"Some Components of the Diffuse Soft X-Ray Background," Masaru Matsuoka, ISAS Research Note, Institute of Space and Aeronautical Science, University of Tokyo.

"Spatial Structure in the Soft X-Ray Background as observed from OSO-8, and the North Polar Spur as a Reheated Supernova Remnant," R. J. Borken and DeAnn Iwan, Ap.J., 218, 511 (1977).

"Soft X-Ray Results from the Wisconsin Experiment on OSO-8," A. N. Bunner, Ap.J. 219, February 15, 1978.

"Coaxial Anode for Background Suppression in X-Ray Proportional Counters," A. N. Bunner, W. L. Kraushaar, D. McCammon, M. Vanderhill, and F. Williamson, The Rev. of Sci. Instr., Vol. 44, No. 4, April 1973.

"Detection of Soft X-Ray Emission from SMC X-1," A. N. Bunner and W. T. Sanders, Ap.J. 228, L19 (1979).

"On the Lack of Absorption of 1 keV Diffuse X-Rays by the Small Magellanic Cloud," A. N. Bunner, W. T. Sanders and J. A. Nousek, Ap.J. 228, L29, February 15, 1979.

"X-Ray Observations of the North Polar Spur," DeAnn Iwan, Ap.J. 239, 316 (1980).

TALKS

"Two New Variable Soft X-Ray Sources in the Southern Sky," A. N. Bunner and W. T. Sanders, 153rd Meeting of the A.A.S., Mexico City, January 1979.

"OSO-8 Observations of the Soft X-Ray Diffuse Background," W. T. Sanders, A. N. Bunner and W. L. Kraushaar, 153rd Meeting of the A.A.S., Mexico City, January 1979.

"An Unusual X-Ray Transient Observed with OSO-8," P. Serlemitsos, A. N. Bunner, J. H. Swank, Spring Meeting of the American Physical Society, Washington, April 1979.

"A New Soft X-Ray Source in Hydra," A. N. Bunner, Spring Meeting of the American Physical Society, Washington, April 1979.

"X-Rays from the Kepler Supernova Remnant," A. N. Bunner, 154th Meeting of the A.A.S., Wellesley, June 1979.

"Some Components of Diffuse Soft X-Rays," Masaru Matsuoka, Astronomical Society of Japan, May 9-12, 1978, Tokyo.

"Observation of Soft X Ray Emission from SMC X-1," A. N. Bunner, W. T. Sanders, J. A. Nousek, and W. L. Kraushaar, 152nd Meeting of the A.A.S., Madison, June 1978.

"An Upper Limit to the Absorption of 1 keV Diffuse X-Rays by the Small Magellanic Cloud," A. N. Bunner, W. T. Sanders, W. L. Kraushaar, and J. A. Nousek, 152nd Meeting of the A.A.S., Madison, June 1978.

"X-Ray Observations of the North Polar Spur," D. C. Iwan, 152nd Meeting of the A.A.S., Madison, June 1978.

"Soft X-Ray Source Spectra from OSO-8," A. N. Bunner, presented at H.E.A.D. meeting of A.A.S., Cambridge, Massachusetts, January 29, 1976.

TALKS, cont.

"Low Energy Observations of the Large Magellanic Cloud from OSO-8,"
R. J. Borken, presented at H.E.A.D. meeting of A.A.S., Cambridge, Mass., January 29, 1976.

"Soft X-Ray Source Studies," A. N. Bunner, presented at A.A.S. meeting, Haverford, PA., June 24, 1976.