THE EUROPEAN X-RAY ASTRONOMY SATELLITE

EXOSAT OBSERVERS GUIDE

PART III: THE FINAL OBSERVATION TAPE HANDBOOK

Space Science Department of the
European Space Agency

822422=

in the handbook. The analysis can, of course, also be done for observers who do receive FOT's. In many cases the output from this software will be sufficient for observers' needs, moreover the process of debugging and refining the software will be more advanced at ESOC than for software developed in other institutes. Copies of listings of the HP automatic analysis programs can be provided on request to anybody, but the observatory team can give no assistance in converting the software for use on other installations. The software for reading/writing telemetry files is so specific to the HP environment and the observatory requirements that it would not be useful to other institutes.

From approximately December 1984 onwards it will also be possible for observers to analyse data on an interactive system at ESOC. Details will be given in the EXOSAT Express.

Some parameter processing uses files created and maintained by ESOC; these files cannot be distributed outside ESOC, but the necessary information from them is included in the FOT handbook. This refers mainly to calibration curves for HK parameters. (See section 3.4.4).

The authors of the handbook and their areas of responsibility are listed below.

R. Blissett	(LE Automatic Analysis, no longer at ESOC).
T. Courvoisier N. White	(GS Experiment, no longer at ESOC) (GS Data analysis techniques)
M. McKay	(Auxiliary Data/Mission Planning)
A. Parmar	(ME All Aspects)
A. Peacock	(Scientific Requirements)
L. Chiappetti) J. Davelaar)	(LE Calibration Files, and data analysis techniques)
J. Sternberg	(Overall Software Design/Handbook Editor)
C. Durham	(On-board Computer details, no longer at ESOC).

57

58

Please note that Issue 1 and revision 1 of the FOT Handbook have been completely superseded and should be thrown away. In the future the document will be kept up-to-date in a controlled manner with loose-leaf updates.

8.1.1 CMA Effective Area

8.1.1.1 Introduction

In this section we describe the energy response of the EXOSAT CMA's, with the aim of using the available calibration data to derive some spectral information from measured count rates. The calibration data are available to the observer in the Current Calibration Files (CCF) on the FOT or on the Calibration History Tape. The layout of the CCF is described in Section 3.7.1 and an overview of its contents is given in Section 3.7.2.

We give first of all the complete algorithm to calculate the effective area of the CMA + filters from the values in the CCF. We give then some indication on the applicability of the CCF values (based on ground calibrations) to the in-flight situation. Finally, we give some information on how to use the effective area values to derive fluxes from count rates and to derive spectral information from multi-filter CMA observations.

In the following description we use the notations given below:

- a capital, single indexed letter (eg. E_i) represents (an element or all the elements of) a "vector" of values as a function of energy ($i = 1,128$).
- a lower case, double indexed letter (eg. a_{xy}) represents a value (or a grid of values) as a function of position.
- a single lower case letter (eg. g) represents a scalar coefficient.

All plots given refer to the ground calibration results contained in the most recent CCF (see section 3.7.2), unless explicitly stated otherwise. This comment applies to the whole of section 8.1.

8.1.1.2 CMA + Telescope effective area calculation

A step-by-step description is given. The different steps are also shown in Table A and in Fig. B (for the current LE1 values). All values tabulated or plotted are in sensible physical units (keV, cm^2, adimensional values between 0 and 1) ie. the relevant scaling from the value in the CCF (see section 3.7.1) has been applied.

1. load the vector of the 128 reference energies E_i (from data type A1). Note this is an arbitrary and convenient energy grid with no particular physical significance (ie. the energies bear no resemblance whatsoever with channel boundaries).
2. load the on-axis mirror effective area (as a function of energy) A_i (from data type B1). This is an area in cm^2.
3. load the position dependent correction factor (grid in data type B1) and derive the value a_{xy} for your position (x,y). For the on-axis case $a_{00} = 0.978$.
4. correct the effective area = $B_i = a_{xy} A_i$
5. load the plasma suppression grid transmission (p = 0.95) from data type B2.
6. correct the effective area $C_i = pB_i$
7. correct for the partial obscuration due to the incomplete flap deployment. The transmission factor (now available in data type B2) is f = 0.735.
8. correct the effective area $D_i = fC_i$
9. compute the off-axis angle $r = (x^2+y^2)^{1/2} \times 4$ arcsec.
10. load the coefficients for the off-axis energy dependent correction. Do this for the two closest off-axis angles and perform a linear interpolation to obtain the coefficient corresponding to r. The coefficients are in data type B2.
11. compute the energy dependent correction factor $K_i = a_0 + a_1 E_i + a_2E_i^2 + a_3E_i^3$. This correction is not necessary on axis ($K_i = 1.0$) and is significant only at high energies for large off axis angles (see Fig. A).
12. correct the effective area $F_i = K_iD_i$
13. load the CMA efficiency C_i from data type C1.
14. load the position dependent correction factor (from data type C1) and derive the value g_{xy} for your position (on axis $g_{00} = 1.0$).
15. correct the efficiency $H_i = g_{xy} G_i$
16. Multiply the mirror effective area by the efficiency $M_i = F_iH_i$.

17. load the positional grids for the sum signal dependent correction factor (from data type C3 for the nominal Position Encoding Threshold). You will have five values h_{xy}, one for each sum signal value. For an explanation about this correction factor see section 8.1.3. See also Fig.D.
18. Interpolate the five h_{xy} values for your sum signal value (see 8.1.3) and derive your correction factor m_{xy} (on-axis, for a sum signal median of 30, $m_{00} = 0.987$).
19. Correct the efficiency $N_i = m_{xy} M_i$

8.1.1.3 Filter Transmission Calculation

A step by step description is given. The different steps are also shown in table B for one filter only. The most representative steps are shown for all filters in table C and Fig. E.

1. load the energy vector E_i (as 8.1.1.2).
2. load the relevant mass absorption coefficients L_i (cm^2 keV^3 g^{-1}) from data type A4.
3. convert into cm^2 g^{-1} $P_i = L_i E_i^{-3}$
4. load the filter thickness t (g cm^{-2}) from the relevant data type (B8 to BC).
5. load the positional correction factor grid for the filter thickness (from the same data type as above) and derive the correction factor for your position t_{xy}. (Currently all t_{xy} = 1.0 identically, except for the Boron filter).
6. correct the thickness $S = t_{xy}t$
7. compute the transmission of the filter $T_i = \exp(-sP_i)$
8. The effective area for that filter is the product of the CMA + telescope area times the filter transmission.
   $Q_i = N_i T_i$

The above is true for all single component filters (note that filters 3 and 7, the thick and thin lexan filters, obviously share the same mass absorption coefficients in data type A4). For the aluminium-parylene filter one should repeat steps 1-7 separately for aluminium and parylene (separate mass absorption coefficients in data type A4), obtaining the two transmissions T_i^{Al} and T_i^{Pa}.

an appropriate image area. This disqualification must be applied with a time limit for the settling phase, whereas the drift phase can be recognised as a separate entry at 30 minutes in the observation directory record, just before the manoeuvre starts.

2. a position shift can occur between observation periods with a different filter. A study of well detected targets from the automatic analysis output indicates that a maximum average position difference of 4.9" ± 4.6" could be expected in a multi-filter exposure. This translates into a maximum position difference of 2 linearised pixels, which one should be aware of when analysing the LE data for various filters. Presently it is not known whether systematic deviations occur always in the same manner for a particular filters.

3. position reproducibility for the same target at different observing epochs. A less complete sample of observations is available for this investigation. However presently no indication exists that the acquired pointing position differs by more than 1 linearised pixel from one observation to the next on the same object.

4. a small number of observations were identified which showed position drifts, usually by a large amount (several arcminutes). These shifts are caused by anomalies in the AOCS, which were in most cases introduced during test/maintenance activities by the spacecraft team. Again to identify any AOCS anomalies during an observation refer to the AOCS output in the LE automatic analysis.

In general, data for those observations hampered by AOCS instabilities or for those occasions where the settling/drift phase is crucial, can be recovered, using the instantaneous AOCS values from the HK data. Software developed at ESOC on the visitors interactive analysis system is available for this purpose.

8.1.5.6 CMA Background

The spatial distribution of the CMA background across the 2 degree field of view is not uniform. For the central region, however, the departure from uniformity is small and generally hardly noticeable in short exposures.

The analysis of very deep fields shows that the dominant trend is a gradual decrease of the background intensity from the detector centre (corresponding to about x = 134, y = 61 in LE1 linearised pixel coordinates) toward the periphery and that circular symmetry can be assumed as a first approximation. For distances larger than about 30 arcmin the trend is reversed and the background intensity increases with distance. The assumption of circular symmetry also becomes unrealistic, because of the residual enhancements at the edges of the field of view. In Fig.W the relative background intensity is plotted as a function of the distance from the detector centre.

So far no evidence that the spatial distribution of the CMA background evolves with time has been found.

The mean background level, in the case of no solar activity, is about 10^{-5} cts/pix^2/sec, which, integrated over the whole field of view, give a rate of about 75 cts/2 sec, which is comparable with the Housekeeping Qualified Event (QE) rate.

Examination of the time profile of the QE (as in the housekeeping section of the automatic analysis) is the simplest method to discriminate periods of solar activity. This so called solar activity is thought to be due to soft electrons. It shows no apparent correlation with satellite altitude or solar aspect angle. Possible peculiarities of the sum signal distribution for solar events are described in section 8.1.4.2.