ANALYSIS OF THE COUNTING MODE DATA FOR THE MOS CCDs, DURING REVOLUTIONS: 14–16

EPIC-MCT-TN-004 **Simona Ghizzardi**

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Contents

1 The counting mode data

I analyzed data taken during revolutions 14 to 16, before the doors opening. Measurements concern all the CCDs of both the MOS cameras.

During some observations the system entered in counting mode. This occurred both in threshold and imaging mode (and for the CCD1 either in small, large window and in timing mode). All the observations in threshold mode have been recorded in reduced imaging mode format.

When the system goes into counting mode, an auxiliary counting mode file (CCX) is created. Each record refers to a counting mode cycle. Within the CCX file, you can find for the HBR of the CCD in counting mode, the starting time of the counting mode cycle, the end time, the total number of events collected in the cycle and the number of frames the CCD spent in counting mode. Using these informations we can derive an average rate of events per second.

For each observation with a counting mode entering (and for each CCD), using the data in the events files, I built the light curve (number of events per second as a function of time). These curves present interruptions whenever the CCD enters in counting mode. I overlapped these light curves with the light curve of the counting mode events, taking the average rate for each counting cycle determined by the auxiliary counting mode file (CCX). Some of these curves have been plotted as an example at the end of the report and they will be discussed later on, in the last section.

The full sample of light curves can be retrieved at

http://www.ifctr.mi.cnr.it/~simona/pub/CCX_ltcurve/ (files: *ltcur*.ps).

However, before discussing the results, we must stress a number of problems which are present in the FITS files (both AUX and CCX). These will be detailed and described in the next section.

2 Problems in FITS files

2.1 BAD START TIMES:

Some frames in file 0016_0113110201_M1U00500AUX.FIT there are have a meaningless FTCOARSE value. This occurs on CCD 1 and CCD 2. In the table below, I report the records of the AUX file for this frame and the nearby frames.

frame	ccdid	ccdnode	ftcoarse	ftfine	npixel	nvalid	nbelow	nabove	gattiflg	fifoovf
454	1	0	4853	11323	1099	1096	0	0	0	0
455	1	0	4858	11325	814	813	0	0	0	0
456	1	0	24321	23872	535564	40	0	0	0	0
457	1	0	4868	11327	922	914	0	0	0	0
458	1	0	4873	11328	596	596	0	0	0	0
446	2	0	4523	11489	1011	1011	0	0	0	0
447	2	0	4528	11490	1056	1056	0	0	0	0
448	2	0	32762	4022	3	27	0	0	1	1
449	2	0	4698	11523	562	562	0	0	0	0

In frames 456 (CCD 1) and 448 (CCD 2), the FTCOARSE time jumps to a high value but then it restarts to run regularly as if no error had occurred (note that the system is in extended integration time so the frame time is about 5 sec instead of 2.5 sec). For these two frames there are some other parameters which have no significance. For CCD 1 at the frame 456, the value of NPIXELS is too high (higher than the total pixels on the CCD) while on CCD 2 there are 27 NVALID events but only 3 NPIXELS. Note that for CCD 2 the FIFOVF is equal to 1 but the same does not occur for CCD 1.

For our analysis, when a bad frame appears while the other frames runs regularly, its start time is replaced with the average of the two nearby frame times. These corrected frames will be marked in the light curve plots with orange coloured points.

2.2 REPEATED START TIMES:

This is a very frequent error within the CCX files. Often, different counting mode cycle (of the same HBR) have the same starting time. In the table herebelow, some examples are reported (file 0016_0113110201_M1U00500CCX.FIT).

hbrid	stcoarse	stfine	etcoarse	etfine	vecntr	ve ovf	relt cntr	relt ovf	reut cntr	reut ovf	fram cntr	fram ovf
1	2689467	55431	2689567	55530	15029	0	0	0	0	0	20	0
1	2689467	55431	2689848	4867	14877	0	0	0	0	0	20	0
1	2689467	55431	2691428	3765	15908	0	0	0	0	0	21	0
1	2689467	55431	2692428	3067	15387	0	0	0	0	0	21	0
1	2689467	55431	2693323	2443	21737	0	0	0	0	0	30	0
3	2689053	5425	2690663	4298	19514	0	0	0	0	0	26	0
3	2689053	5425	2690948	4099	14224	0	0	0	0	0	20	0

Apart from the fact that it is impossible to have (for the same HBR) two different counting mode cycles having the same start time, note that the duration of the cycles disagrees with the registered number of frames (framcntr), considering as frametime $\sim$ 5 sec since the system is in extended integration time. For the repeated start times, I

replaced their value with the time obtained from the end time and the number of frames: $start\_time = end\_time - frmtime * framecntr$.

Here below you I list the files with the HBRs suffering from this problem.

file	HBRID
0016_0113110201_M1U00500CCX.FIT	1, 3, 5, 6, 7, 8
0014_9999990002_M2U01500CCX.FIT	8
0016_0113110101_M2U01800CCX.FIT	1, 3, 4, 5, 6, 7, 8
0016_0113110101_M2U02100CCX.FIT	4, 8
0016_0113110101_M2U02200CCX.FIT	7
0014_9999990002_M2U02600CCX.FIT	7
0016_0113110201_M2S01000CCX.FIT	7

The corrected CCX records are marked in the plots with the green colour. As it can be seen from these plots, in general the corrections make the counting mode cycles consistent with the missing data in events files.

2.3 ZERO START TIMES:

Some records in the CCX files have value "0" as starting time (roughly XMM launch time!). As an example, I report here the file 0015_9999990003_M2U00700CCX.FIT

hbrid	stcoarse	stfine	etcoarse	etfine	vecntr	ve ovf	relt cntr	relt ovf	reut cntr	reut ovf	fram cntr	fram ovf
5	2459395	52002	2459658	35366	8400	0	0	0	3892	0	101	0
8	2459393	19236	2459661	2596	10998	0	0	0	3892	0	103	0
7	0	0	2459897	35138	18108	0	0	0	7577	0	194	0
8	2459791	2471	2460016	51611	5229	0	0	0	2025	0	47	0

Like in the previous case, I corrected these start times using the end time and the number of frames. These counting mode cycles are marked in the plots with the pink colour.

Here, you can find the list of the CCX files suffering for this problem:

file	HBRID
0015_9999990003_M2U00700CCX.FIT	7
0016_0113110101_M2U01800CCX.FIT	4, 7, 8
0016_0113110101_M2U02100CCX.FIT	6
0016_0113110101_M2U02200CCX.FIT	8
0016_0113110101_M2U02200CCX.FIT	1, 3
0014_9999990002_M2U02600CCX.FIT	1, 3, 4, 5, 6
0016_0113110201_M2S00600CCX.FIT	5
0016_0113110201_M2S00700CCX.FIT	7
0016_0113110201_M2S00900CCX.FIT	5
0016_0113110201_M2S01000CCX.FIT	5, 6

2.4 MISSING FRAMES IN AUX FILES:

It can occur (although quite rarely) that some events registered in events file have no correspondence in the AUX file. For example, events in 0014_9999990002_M2U01620IME.FIT registered at frames: 500, 501, 502 and 503 have no corresponding frame in the AUX file 0014_9999990002_M2U01600AUX.FIT. The same occurs in 0016_0113110201_M1U00540RIE.FIT for frame nr. 448. This events have been rejected.

2.5 EMCR RESETTED DURING AN OBSERVATION?

Selecting one CCD (say CCD 1) on 0014_9999990002_M2U01600AUX.FIT and sorting by FRAME it can be seen that at the FRAME 375, the FTCOARSE (FTFINE) restarts from zero.

frame	ccdid	ccdnode	ftcoarse	ftfine	npixel	nvalid	nbelow	nabove	gattiflg	fifoovf
359	1	0	1185	4848	1758	114	3	31	0	0
360	1	0	1187	19851	1542	106	5	29	0	0
372	1	0	1302	4862	1797	99	4	39	0	0
375	1	0	5	447	1549	2	4	37	0	0
376	1	0	7	14721	1281	2	3	30	0	0
377	1	0	10	4895	1007	0	2	26	0	0

The same occurs for the other CCDs at similar times (greater than about 1300 sec).

It must be noted that the observation starts on 6^{th} Jan 2000 at 01:06:45 and stops at 01:58:07. The H/K files report an EMCR reset at 01:06:50 (with an approximation of 8 sec. which is the rate at which we receive HK informations) which corresponds to the beginning of the observation. Another reset is reported at 01:33:22 (about 1600 sec later...), significantly before the end of the observation.

However, apart from the resetting of the time counter, what is striking here is that the number of events (NVALID) drastically drops after the reset, while the NPIXEL value seems to be not significantly affected.

A similar problem occurs in 0016_0113110101_M1S00900AUX.FIT. The observation starts on 10^{th} Jan 2000 at 13:15:09 and stops at 14:26:18. EMCR resets are reported at 13:15:14, 13:21:23. But unlike the previous case, this seems unrelated to the bad times in the AUX file.

If we select CCD 5 we find that:

frame	ccdid	ccdnode	ftcoarse	ftfine	npixel	nvalid	nbelow	nabove	gattiflg	fifoovf
2	5	0	2	6929	895	893	0	0	1	0
3	5	0	7	8134	537	537	0	0	0	0
4	5	0	12	7580	518	518	0	0	0	0
5	5	0	17	7581	554	554	0	0	0	0
6	5	0	2	9380	6500	2325	0	0	1	1
6	5	0	22	7581	588	586	0	0	0	0
7	5	0	7	10585	2267	898	0	0	0	0
7	5	0	27	7583	449	449	0	0	0	0
8	5	0	12	10031	2650	1206	0	0	0	1
8	5	0	32	7583	310	310	0	0	0	0
9	5	0	17	10032	2897	154	0	0	0	0
9	5	0	37	7584	352	352	0	0	0	0
10	5	0	22	10032	2596	1225	0	0	0	0
10	5	0	42	7585	474	474	0	0	0	0

...and so on at higher frame numbers.

Some frame numbers are repeated, with no ordered times. Some of them have FIFOVF=1, but this is not systematic.

If a EMCR reset makes the times restart from zero, unlike the previous case, here also the frame counter is resetted. Furthermore, in this case there is no drastic drop in the number of NVALID events. Maybe, there is an indication of a slight decrease, but it corresponds also to a decrease of NPIXEL.

The other CCDs in the same AUX file have a somewhat different behaviour. The problem on FTCOARSE occurs only in the very initial frames.

frame	ccdid	ccdnode	ftcoarse	ftfine	npixel	nvalid	nbelow	nabove	gattiflg	fifoovf
4	1	0	2	9150	6118	1450	0	0	1	1
16	1	0	2	6700	1487	1486	0	0	1	0
17	1	0	7	7903	334	334	0	0	0	0
18	1	0	12	7351	473	473	0	0	0	0
11	2	0	7	8133	564	564	0	0	0	0
12	2	0	12	7581	344	343	0	0	0	0
13	2	0	17	7581	801	801	0	0	0	0
14	2	0	2	9379	6510	2164	0	0	1	1
14	2	0	22	7582	634	633	0	0	0	0
15	2	0	27	7582	533	532	0	0	0	0

...and so on at higher frame numbers. The same occurs for the other CCDs.

Here in general we have one only frame which is "double" and correspondingly the FIFO flag is 1.

2.6 MISSING DATA:

This is a problem that is evident from the light curve plots and it will be discussed in the next section with the results.

3 Results

In the figures here included, we report some light curves for three observations, as an example (the full sample can be retrieved at

http://www.ifctr.mi.cnr.it/~simona/pub/CCX_ltcurve/: files: *ltcur*.ps):

- RUN: 0113110201005: MOS 1, THRESHOLD mode, EDUTHR=500, curves are plotted for the first 10000 sec (plotted CCD1, 3, 4, 6);
- RUN: 9999990002015: MOS 2, IMAGING mode, EDUTHR=25 (plotted CCD 1, 4, 6, 7)
- RUN: 0113110101018: MOS 2, THRESHOLD mode, EDUTHR=500, curves are plotted for the first 20000 sec. (plotted CCD 2, 3, 6)

The black points correspond to the light curve of the events regularly registered within the events files. The blue points mark the first rate after an interruption due to the counting mode, the rate has been determined using a mean frametime. The red points are the completion to the light curve using the average rate value deduced from the counting mode auxiliary file. As previously mentioned, orange, green and pink colours mark the points for which a correction on start counting mode times was needed.

First of all, we can notice that in general, the corrections of the starting counting mode times "match" the interruptions occurring in the events file. The average value deduced by the counting mode file is very similar to the rate of the events, and it provides a good completion in the light curve. Nevertheless, there are some counting mode intervals which are still wrong (maybe they suffer again of wrong start times) and which do not belong to any of the previously systematic error classes (no zero start times, no repeated start times ...). They cover a time interval in which there are events of the events file and the averaged counting mode rate is lower than the mean one.

However, the main feature which is visible in all these plots is that a great quantity of data are missing. A very large amount of ranges (probably in counting mode) are not recorded! Often all the CCDs enter in counting mode simultaneously, so this problem could be related to the presence of a very high quantity of data. However, from a first rough analysis, this seems to be unrelated to any "HBR FIFO full" situation. Furthermore, even in the observations with few counting mode cycles, concerning a single CCD, missing data can be found. This problem seems to be unrelated to the events rate, to the

observation mode, to the total number of counting mode cycles or to the EDU threshold. The same is true for any problem of bad start times.

CCD 3 of MOS 1 the CCD 6 of MOS 2 are the "best performing" ones (maybe a priority for these CCD in the telemetry transmission?). The quantity of missing data is widely reduced for these two CCD, sometimes it is absent. On the contrary, they do not have a better performance as far as bad times are concerned.

As a general conclusion, we can state that, with such a great quantity of problems in the data, the counting mode files are of limited use. It must also be noticed that, for the observations in threshold mode, the number of counting mode cycles is very high even with an EDUTHR=500 and that the system spends most of the observation time in counting mode.

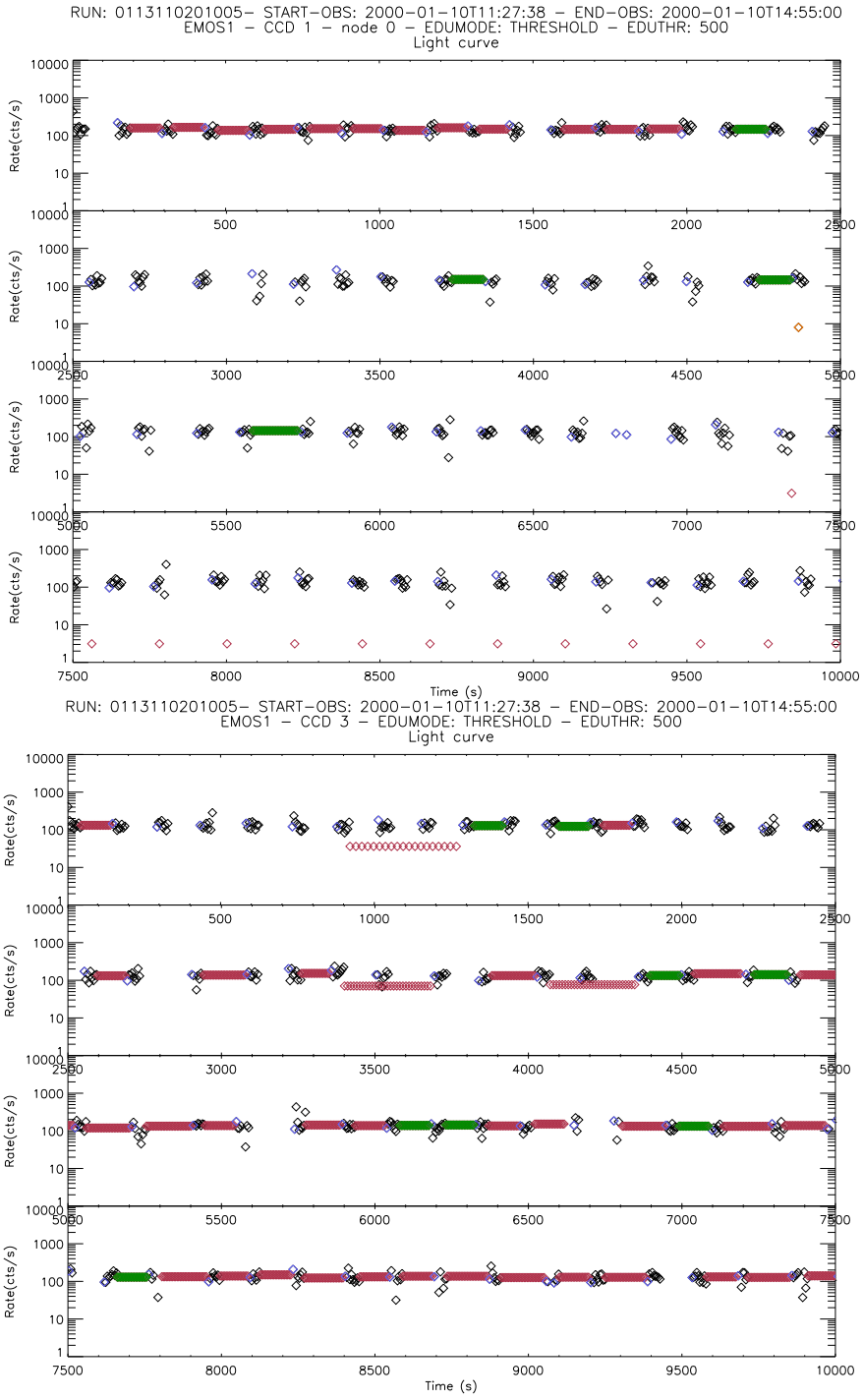

Figure 1: Light curve for RUN:0113110201005; CCD 1 and CCD 3.

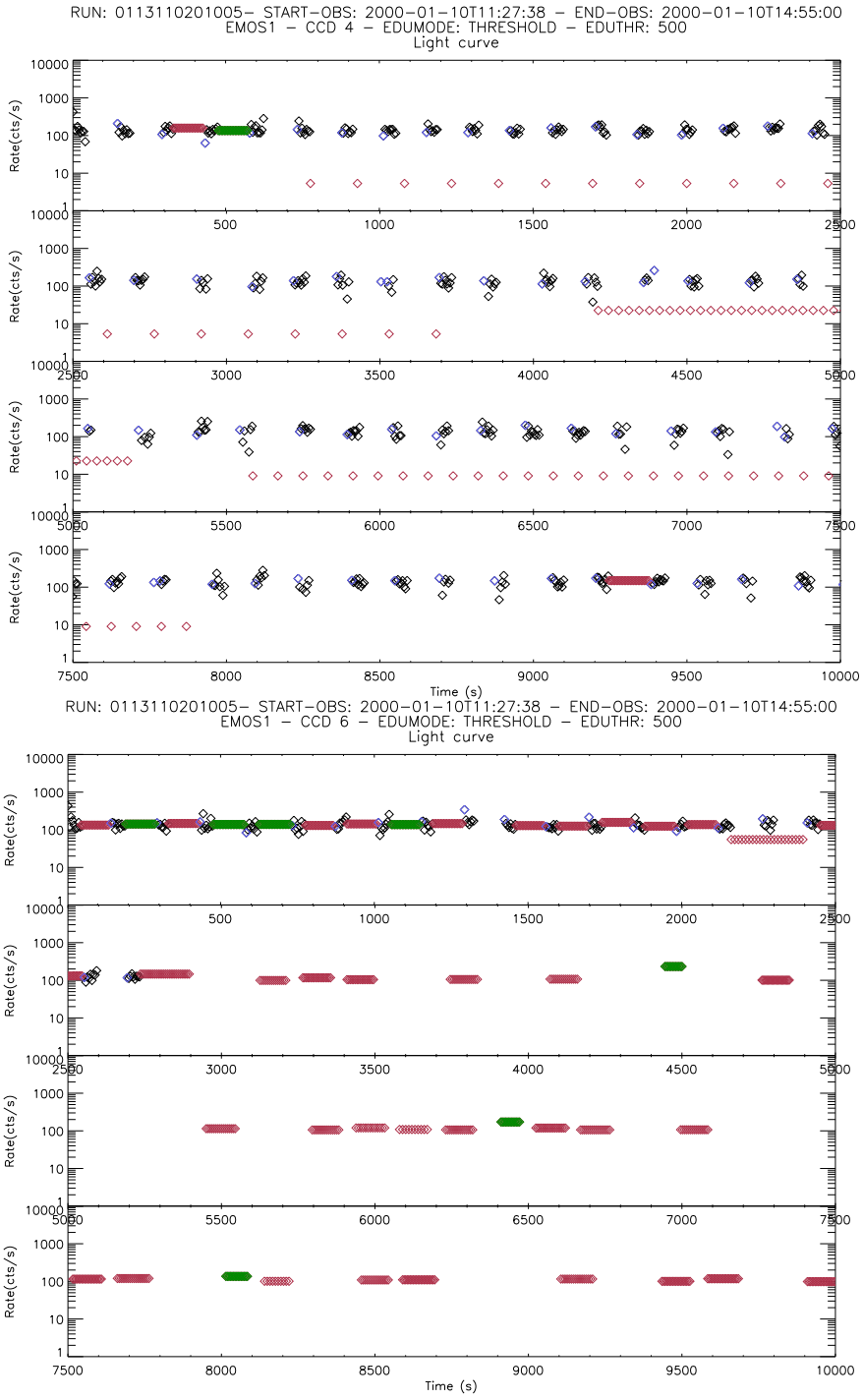

Figure 2: Light curve for RUN:0113110201005; CCD 4 and CCD 6.

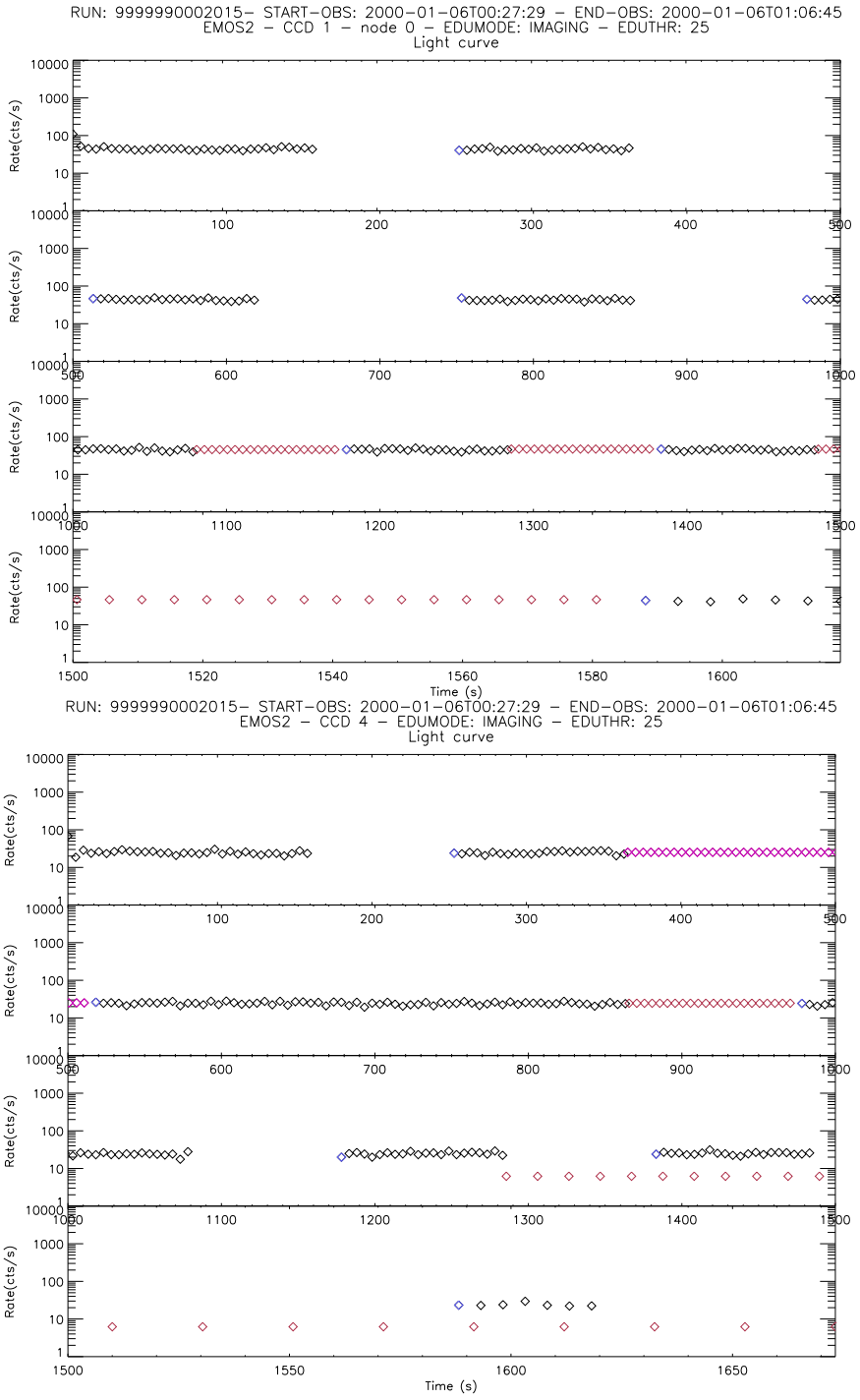

Figure 3: Light curve for RUN:9999990002015; CCD 1 and CCD 4.

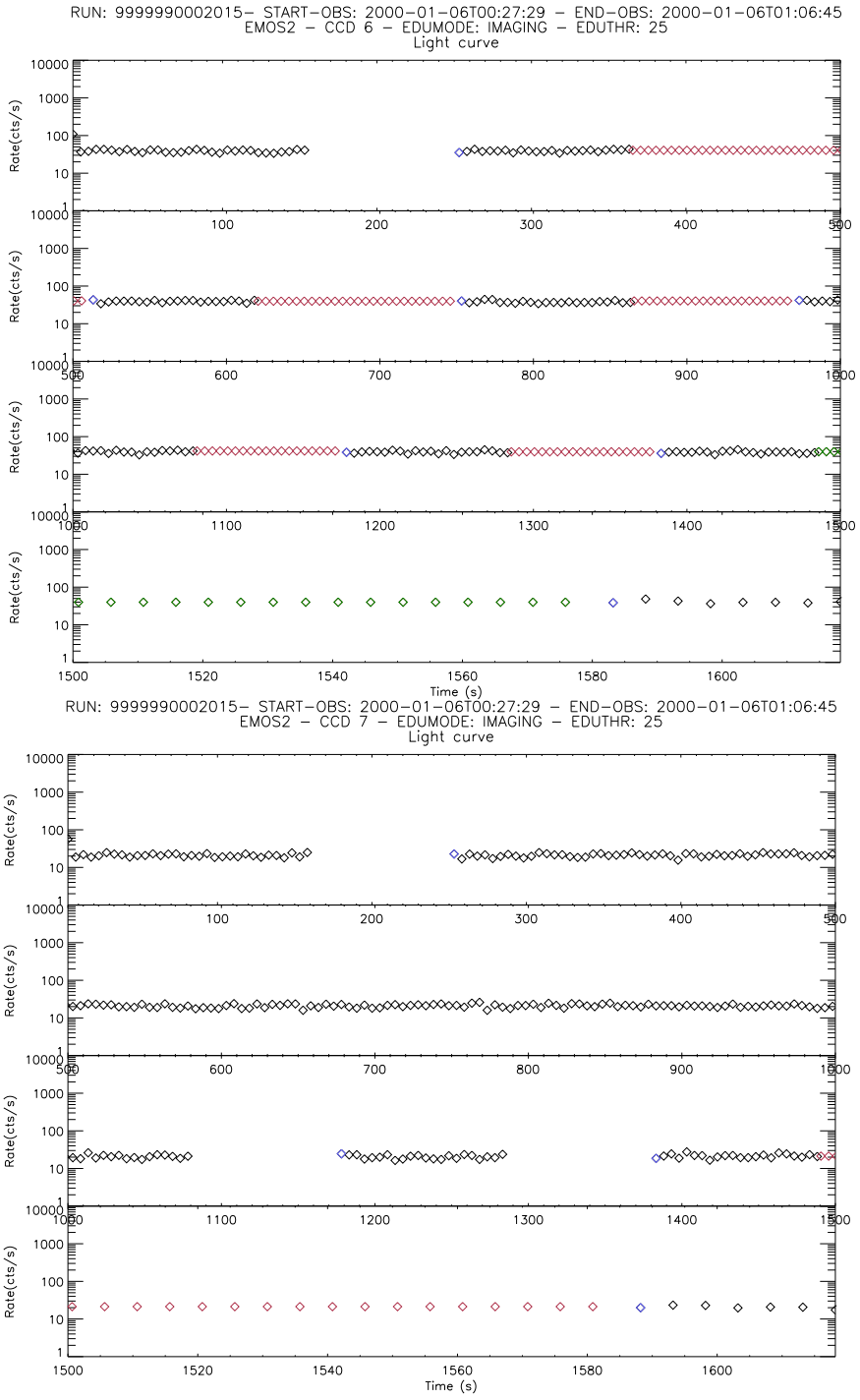

Figure 4: Light curve for RUN: 9999990002015; CCD 6 and CCD 7.

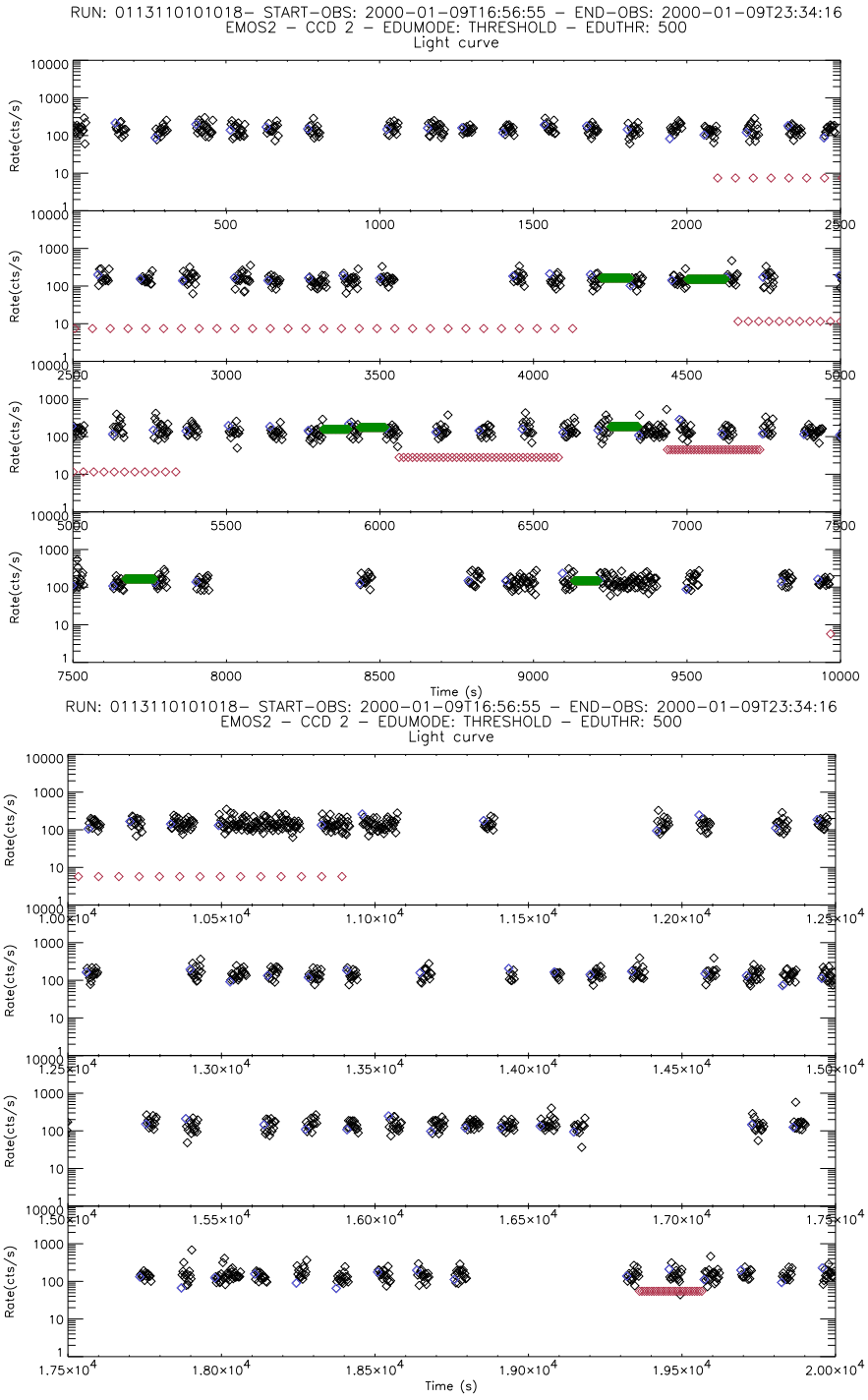

Figure 5: Light curve for RUN: 0113110101018; CCD 2.

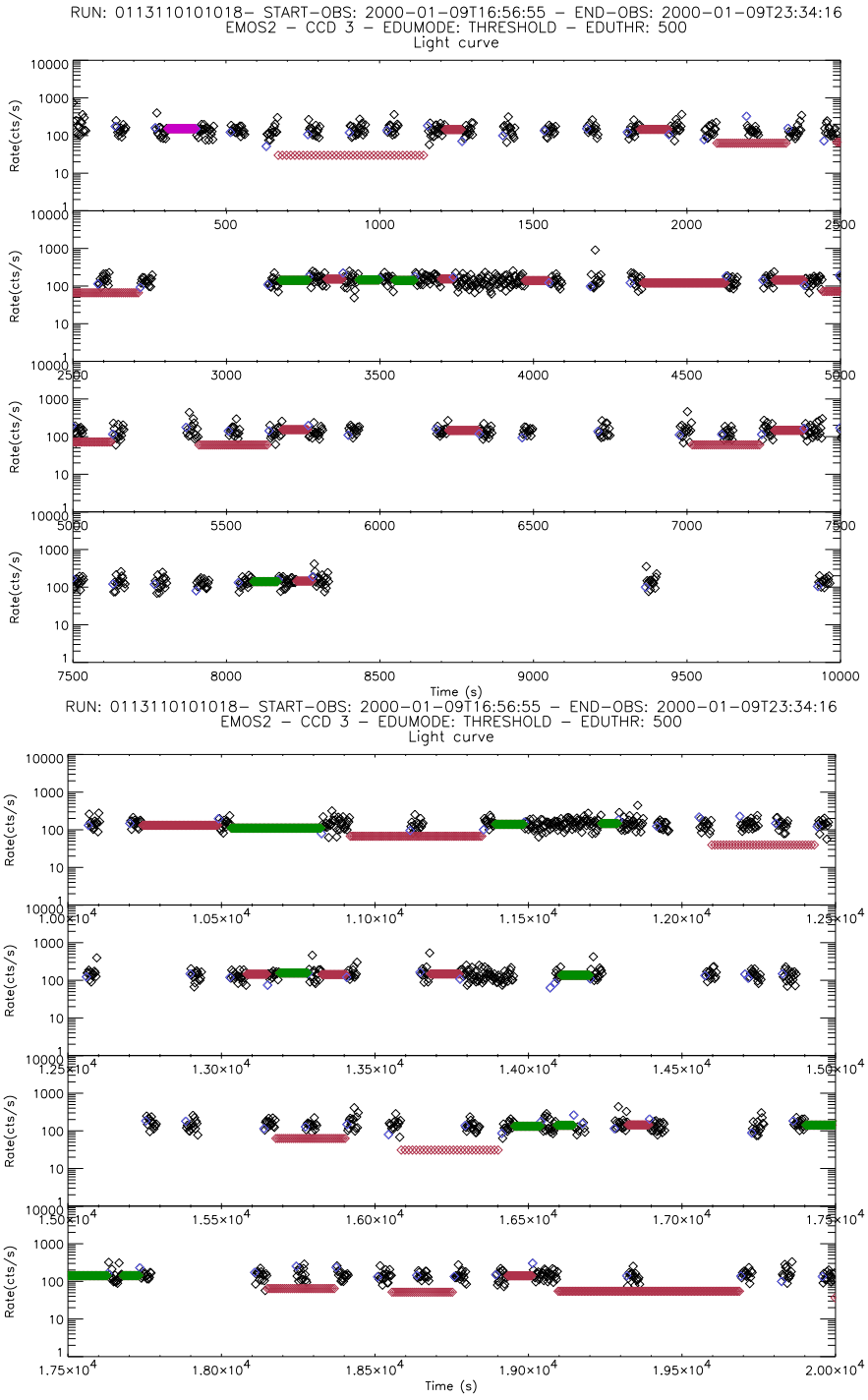

Figure 6: Light curve for RUN: 0113110101018; CCD 3.

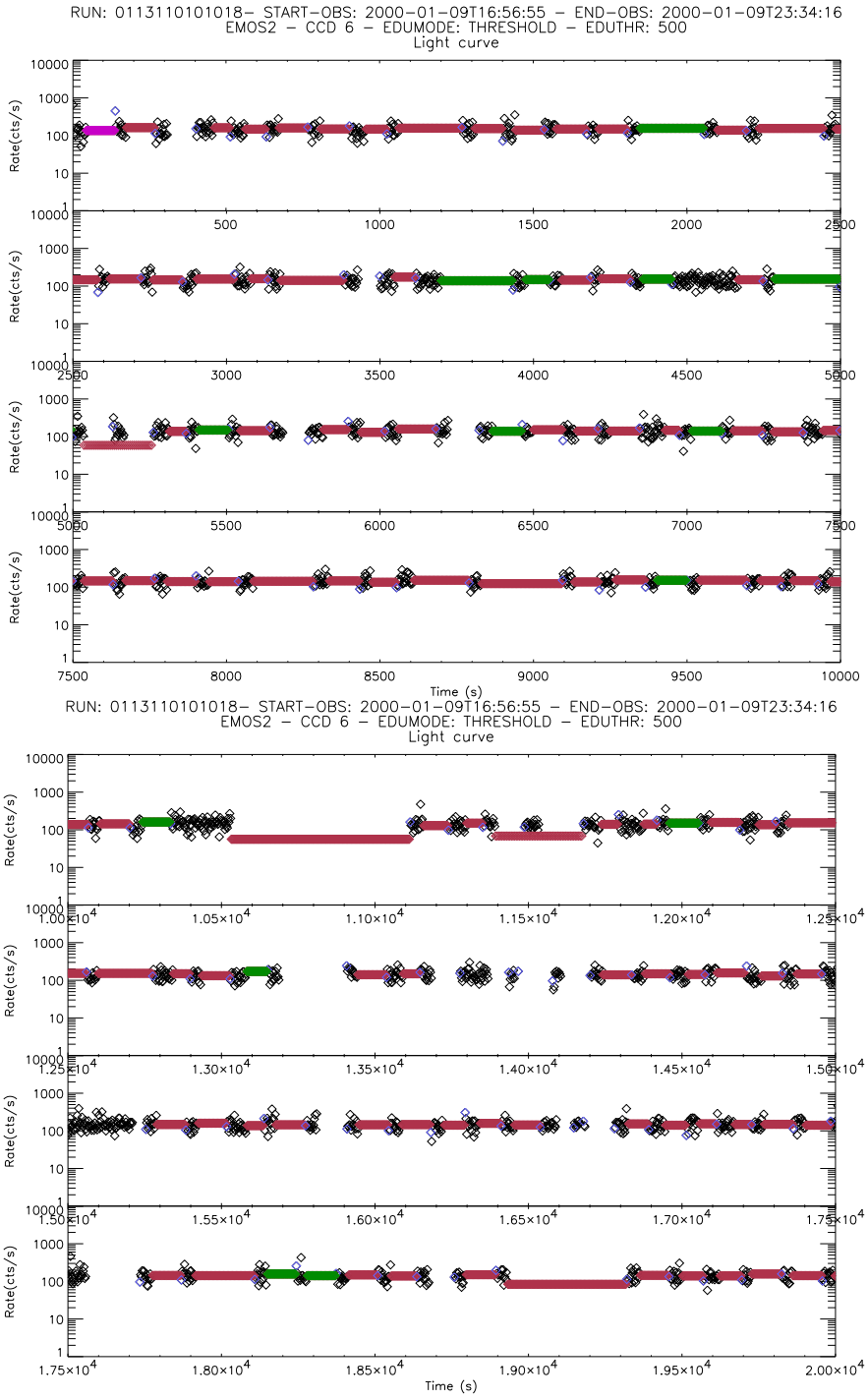

Figure 7: Light curve for RUN: 0113110101018; CCD 6.