CHANDRA
X-ray Center 60 Garden St., Cambridge Massachusetts 02138 USA

MEMORANDUM

Date: August 20, 2004
From: Shanil N. Virani
To: SOT/ACIS
Subject: Anomaly Observed in Level 2 Processing of OBSID 4499
File: `/data/acis36/obs4499/obs4499-anomaly.tex`

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1 Introduction

OBSID 4499 was observed on July 24, 2004, with TE_002A4 as the SI mode (the parameter block used was WT002A4034). In this cofiguration, CCDs 0-3, 6, and 7 are read out in Faint mode. The primary science target for this observation was a young star centered on the nominal I3 aim point. Once the data were received on the ground, the observation was flagged because of a dearth of events observed on node 1 of S2 (see Figure 1 for an image generated from the level 2 event list). The e-mail disclosing the issue is presented below.

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From: "Peter W. Maksym" <pmaksym@head.cfa.harvard.edu>
To: pplucinsky@head.cfa.harvard.edu
Subject: ACIS issue

Hi, Paul,

I'm not sure if you've had a look at this or if you're the right person
to direct this to (if not, please let me know who would be good to
contact), but I've been going over obsid 4499 to figure out what (if
any) manual intervention it needs for reprocessing in SAP.  This
particular obsid had 40000 grade=7 events out of 48000 ccdid=6, node=1
L1 events dropped by L2.  This was originally suspected to be a destreak
issue, but that would only apply to ccdid=8.  Could this be a bias
issue?  I've looked at the bias file and don't find anything
particularly unusual about node 1 (all nodes show a slight, roughly
equivalent decrease from the values of the previous bias file), but I'm
afraid I'm out of my league as far as that goes right now.

Dong-Woo's email on this matter can be found at:
http://hea-www.harvard.edu/~kim/ASC_ISSUE/Detail/OBS04499

Many thanks,
Peter Maksym
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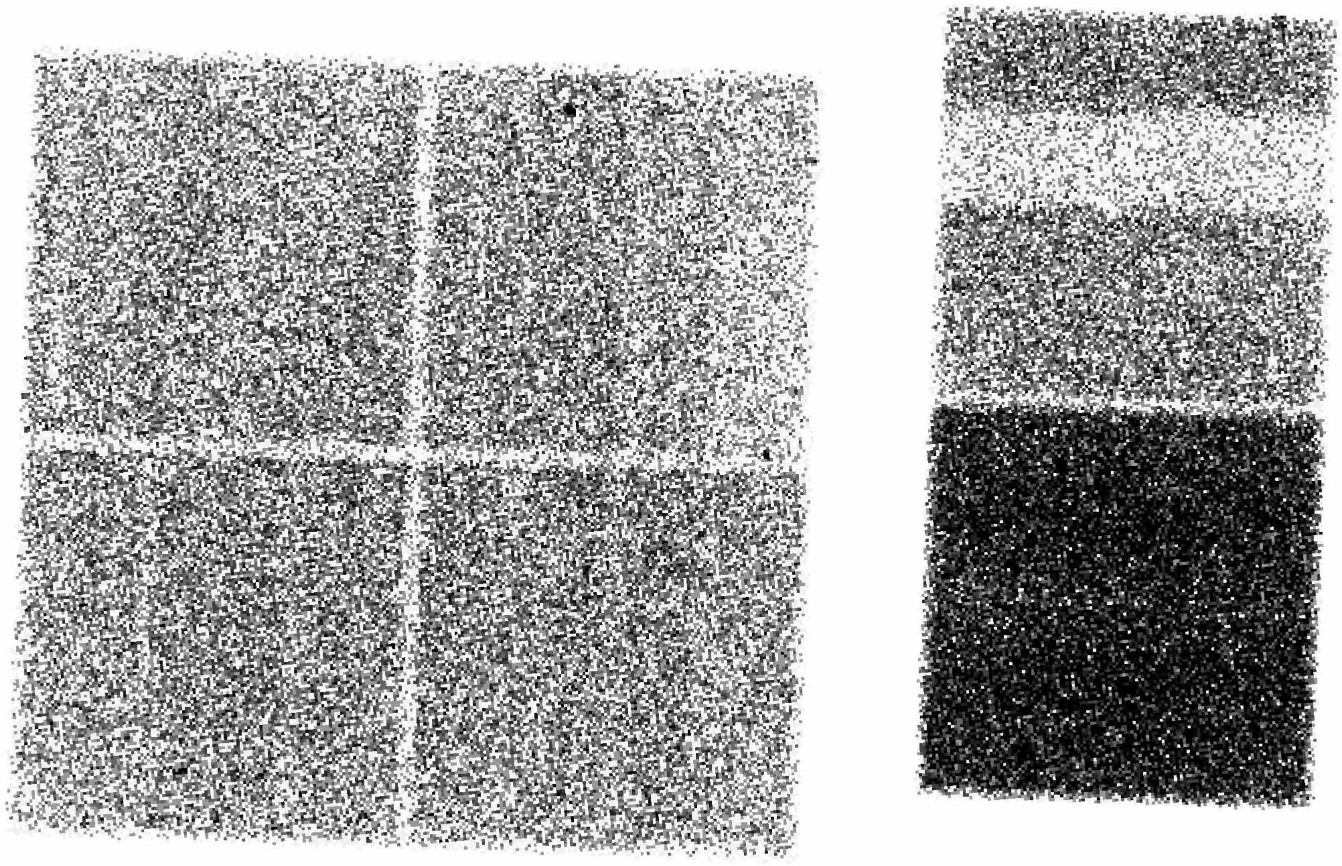

Figure 1: Level 2 Image of OBSID 4499. Notice the dearth of events on S2, node 1.

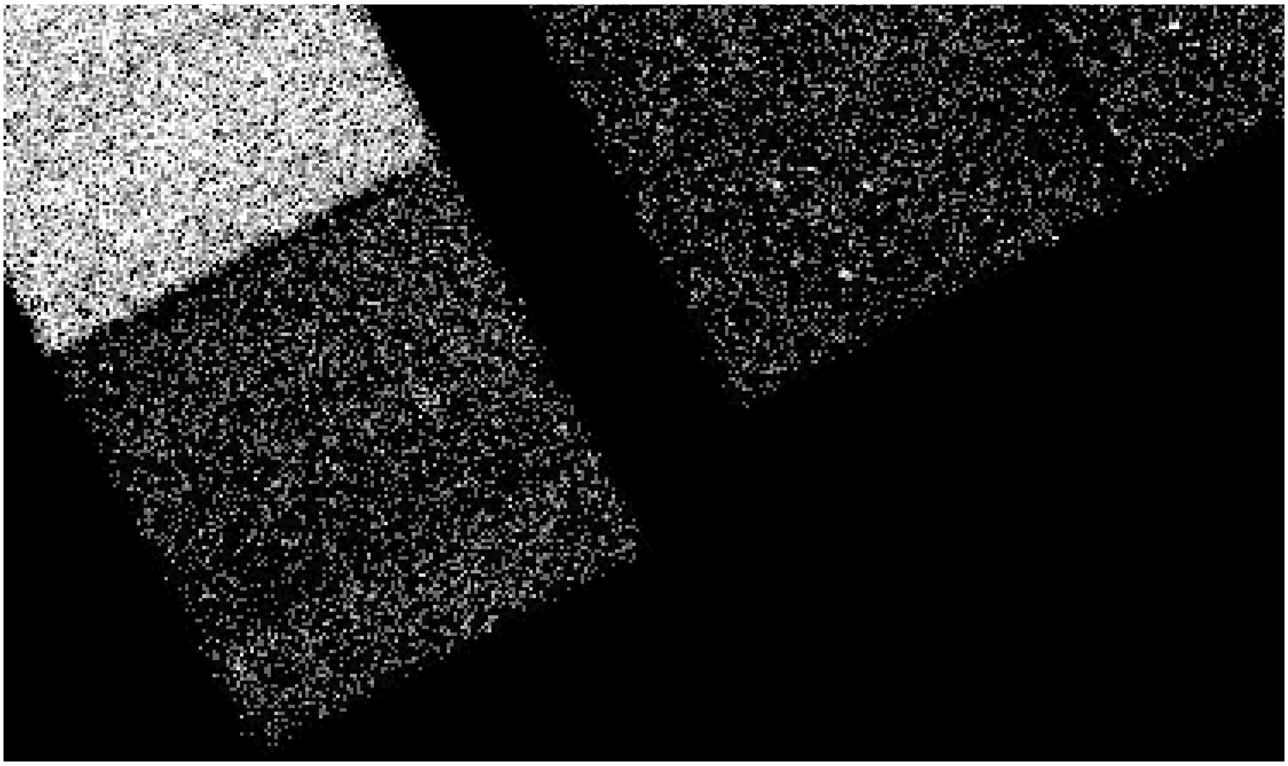

Figure 2: Level 2 Image of OBSID 5341. Not quite as obvious as OBSID 4499 but there is a dearth of events on S2, node 1 as well. See Section 4 for a more detailed explanation.

With the hypothesis that this problem may due to bad bias map used in processing, I identified another recent observation which used the same mode so that I may use this observation against which I could compare OBSID 4944. This is OBSID 5341 which was performed on July 11, 2004. The primary science target for this observation was a SNR centered on the nominal I3 aim point. Please see Figure 2 for an image generated from the level 2 event list. Subsequent analysis, presented lateer in this memo, however would reveal the same phenomenon observed in OBSID 4499 is also present in OBSID 5341 but was not flagged.

2 Radiation Environment

As the last half of July was a period in which there were 4 SCS 107 executions, 2 of which were due to a passage of CME, I investigated whether the radiation environment may have affected these 2 observations. To that end, Figures 3 and 4 are simple plots of the S2 reject counter, dropped grades, and the events sent for both observations. Neither plot shows anything out of the ordinary, and hence this possiblity may be exonerated.

3 Bias Map

The immediate hypothesis that sprung to mind as to what could cause the anomaly seen clearly in OBSID 4499 was that either the wrong bias map was used in processing or that the bias map itself was somehow "corrupt". An inspection of the timing of the of the ACIS commands in the daily load, as well as the dates in the bias map and the level 1 event list, exonerate the possibility of a wrong bias map being used in ground processing.

To investigate the possibility of whether the bias map itself was the source of the problem, I produced histograms of each node of S2 from the S2 bias maps used in OBSIDs 4944 and 5341. These plots are presented in Figure 5. Aside from node 0, nothing appears anomalous.

Figures 6 and 7 present the overclock as a function of the exposure number for each node on S2 for OBSIDs 4944 and 5341, respectively. Notice that in the case of OBSID 4944, the overclocks $i$ncrease with exposure number before levelling off. While for OBSID 5341, the overclocks $d$ecrease with exposure number before levelling off. Furthermore, while the decrease/increase in overclocks as a function of exposure number for node 0, 2, and 3 is somewhat smooth, for node 1 it is more jagged. It is unclear whether either of these 2 effects can produce the anomaly seen in level 2. For reference, the inital overclocks for each node of S2 for each OBSID are presented in Tables 3 and 4.

4 Grade Distribution

To better understand what is happening in these 2 data sets, I present the number of events in each of the `ASCA` grades for both OBSIDs in Tables 3 and 5, respectively. The number of events expressed as percentage of the total number of events for each of the `ASCA` grade events

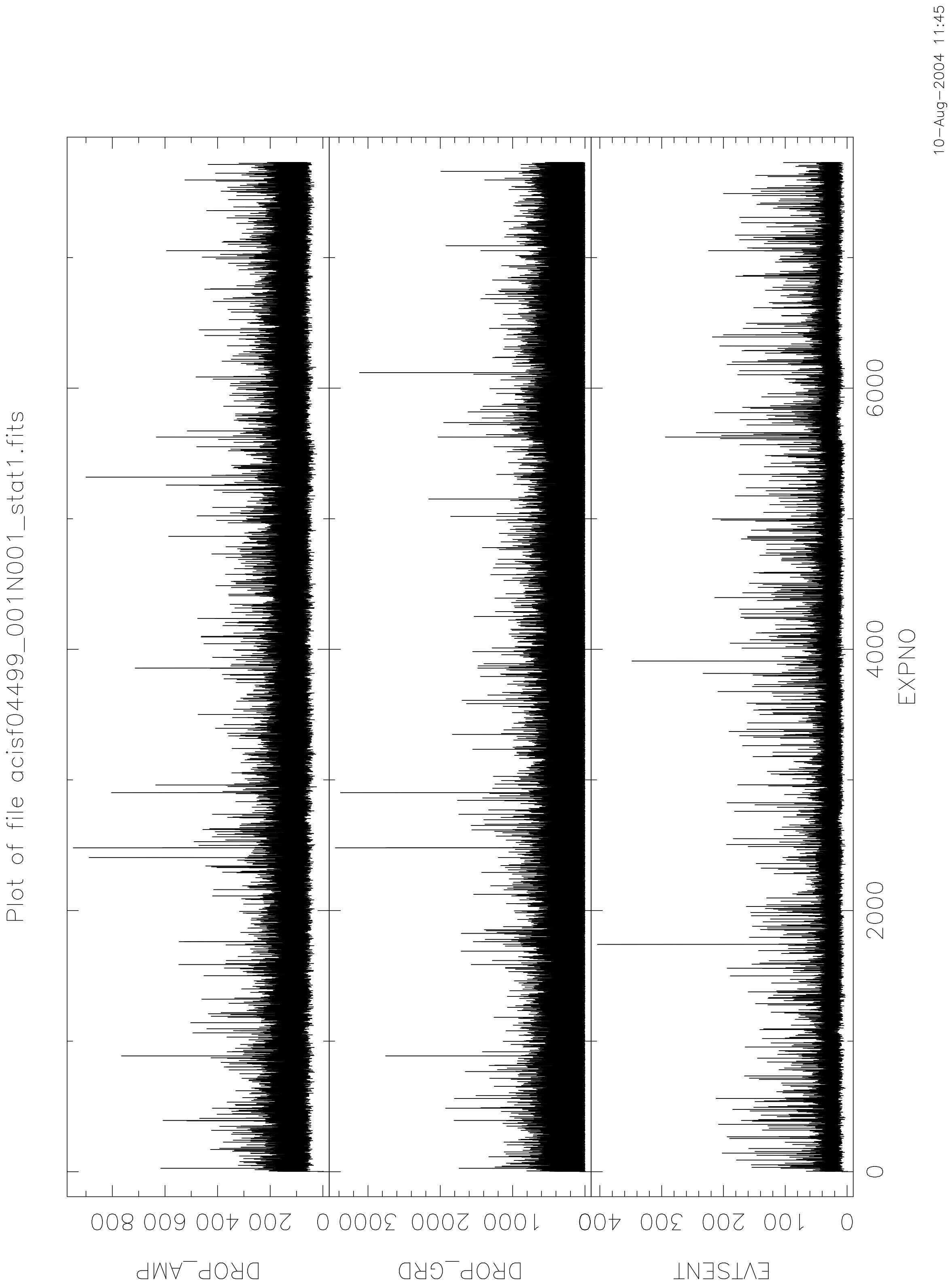

Figure 3: Plot of amplitude rejects, dropped grades, and events sent for OBSID 4499.

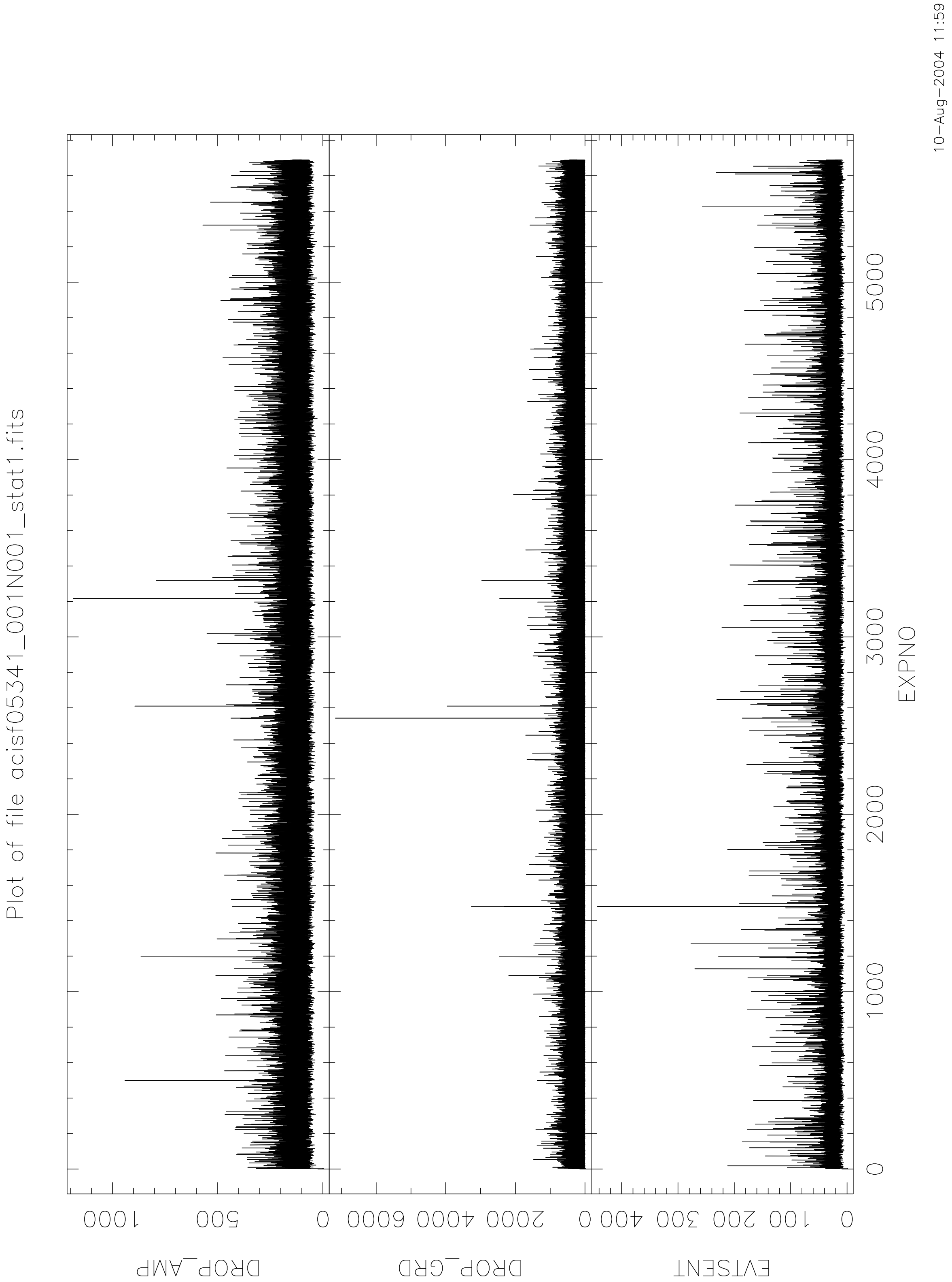

Figure 4: Plot of amplitude rejects, dropped grades, and events sent for OBSID 5341 - a reference observation using the same SI mode as OBSID 4499.

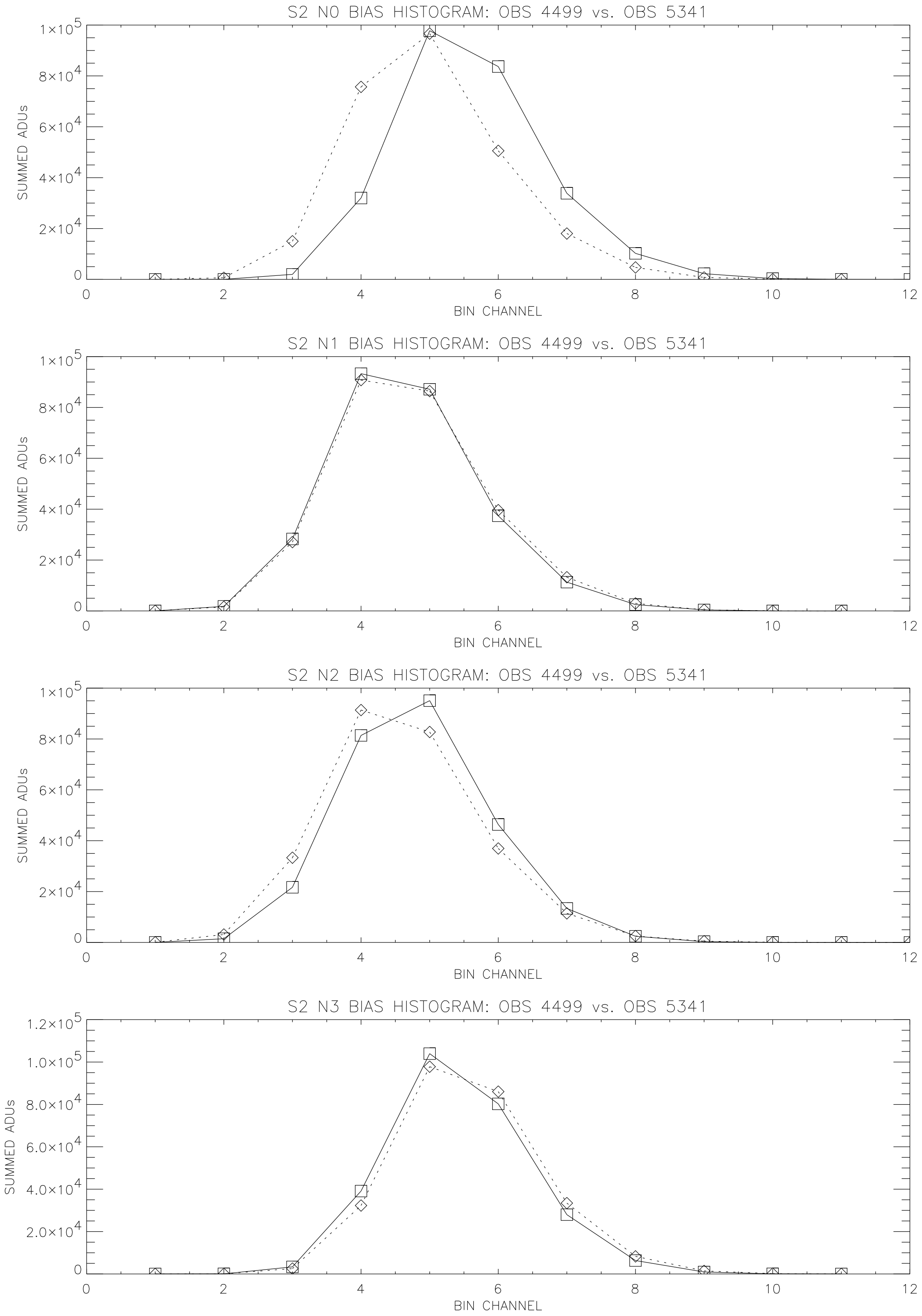

Figure 5: Bias histograms of OBSIDS 4499 (solid line;squares) and 5341 (dashed lines,diamonds) for nodes 0-3 of S2.

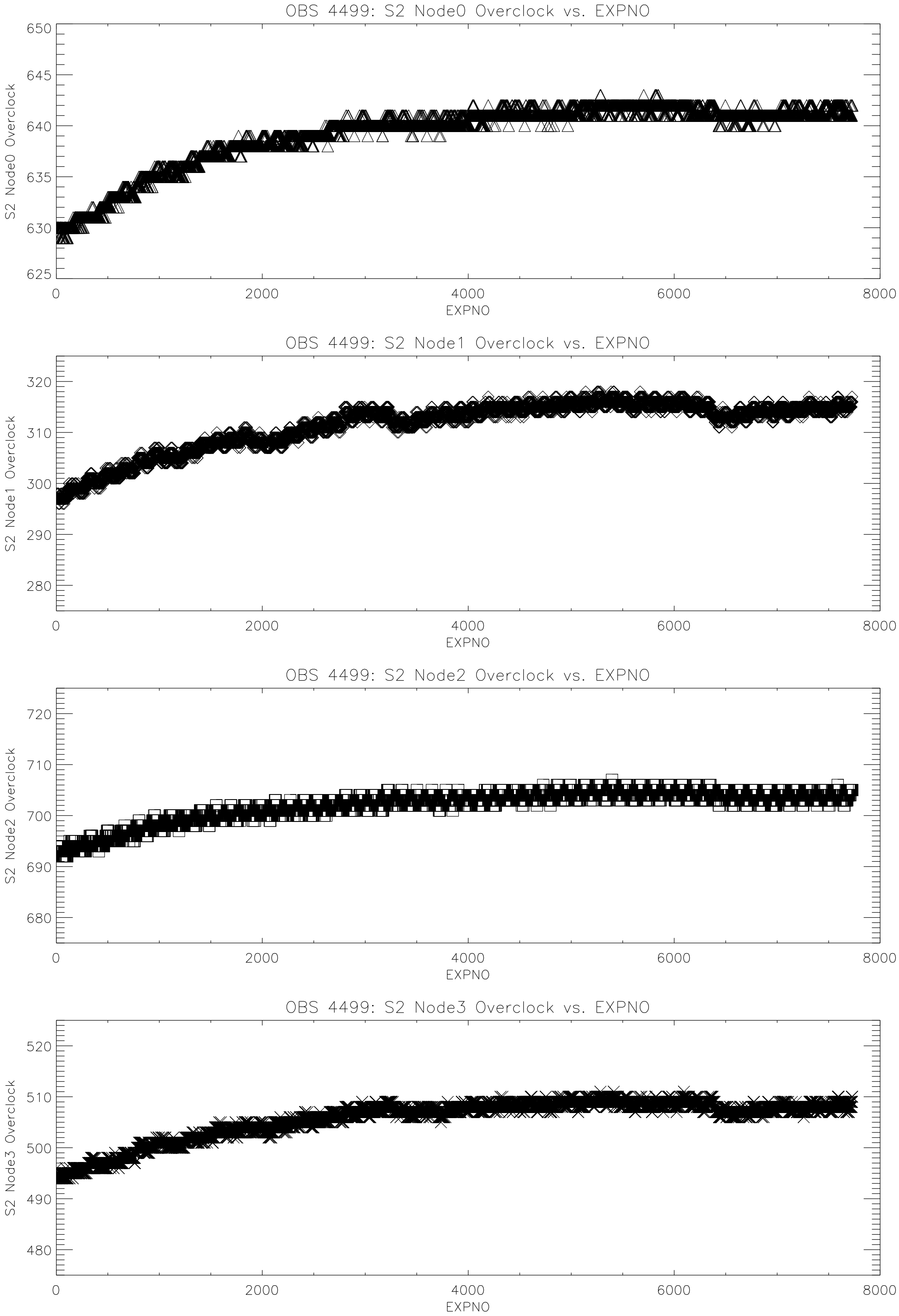

Figure 6: Overclocks vs. exposure number for OBSID 4499 for nodes 0-3 on S2.

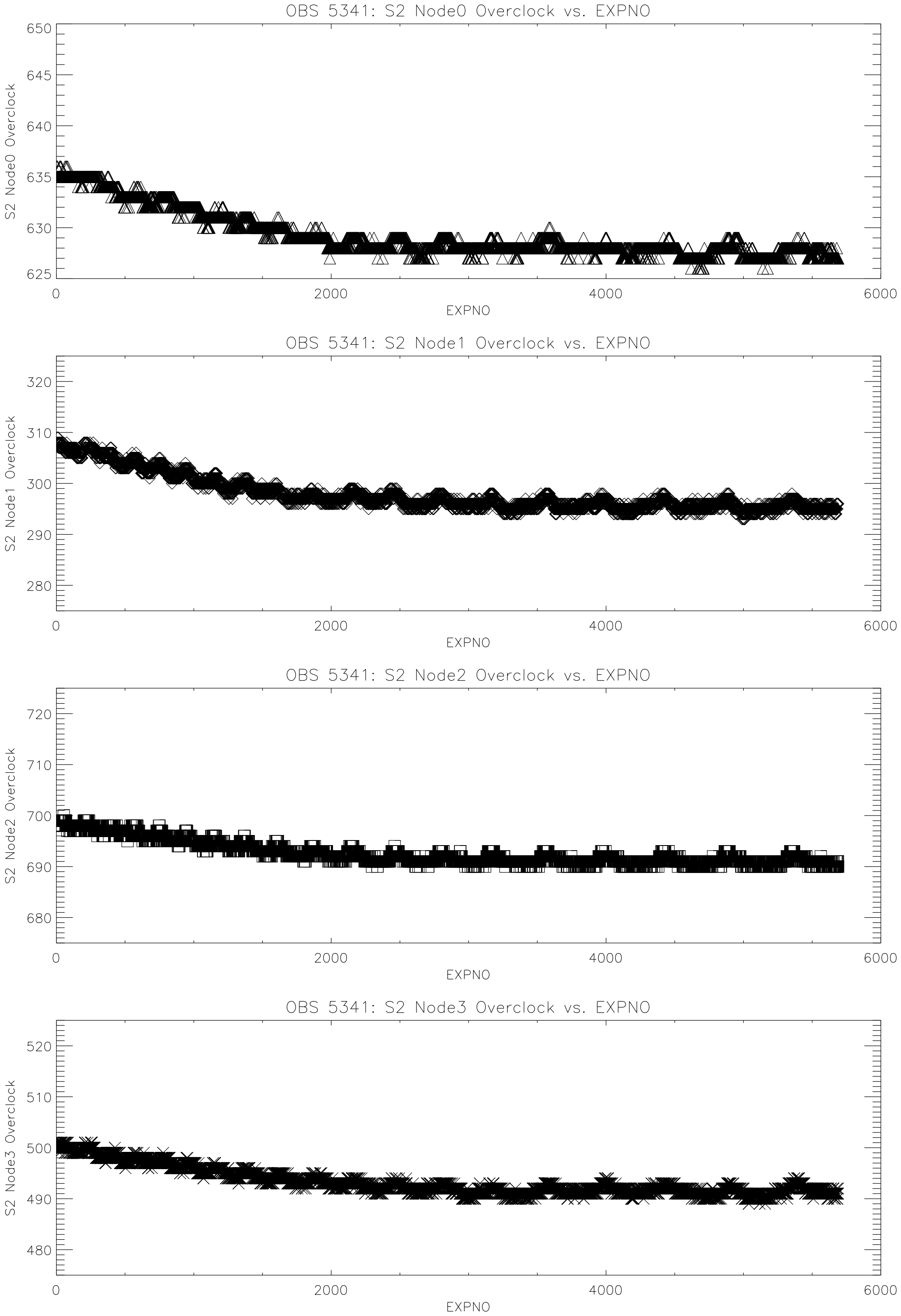

Figure 7: Overclocks vs. exposure number for OBSID 5341 for nodes 0-3 on S2.

Table 1: Initial Overclock Values for OBSID 4499 ("acisf207050100N001_0_bias0.fits").

FITS LABEL	Value (ADUs)
INITOCLA	629
INITOCLB	297
INITOCLC	692
INITOCLD	493

Table 2: Initial Overclock Values for OBSID 5341 ("acisf205934785N001_0_bias0.fits").

FITS LABEL	Value (ADUs)
INITOCLA	634
INITOCLB	306
INITOCLC	698
INITOCLD	498

are reported in Tables 4 and 6, respectively, for both observations.

Table 3: Number of G0-7 Events in L1 on Each Node of S2 During OBSID 4499.

NODE	G0	G1	G2	G3	G4	G5	G6	G7	TOTAL
0	4544	35	3972	597	478	1897	2429	34449	48401
1	2025	19	921	468	544	1864	1001	41573	48415
2	5310	38	3439	575	691	1998	2471	45350	59872
3	4187	24	3712	476	555	1805	1660	35791	48210

For OBSID 4499, it is clear that the number of `ASCA` grade 0 and `ASCA` grade 2 events (and perhaps to a lesser extent `ASCA` grade 6 as well) reported by node 1 is lower than that reported by the other 3 nodes. Interestingly, the number of `ASCA` grade 7 events reported by node 1 is higher than the number of `ASCA` grade 7 events reported by the other three nodes. This suggests that perhaps we have lost approximately 10% of the "good" events to `ASCA` grade 7 events in OBSID 4944 through an unidentified process.

I initally selected OBSID 5341 as a "control" observation as I believed that this observation does not suffer from whatever affilication befalls OBSID 4944. However, when I repeated the above grade analysis for this observation, the same effect was observed. Node 1 is reporting fewer G0 and G2 events and more G7 events when compared to the other 3 output nodes on S2. Albeit, the effect is rather small which may explain why this observation was not flagged. In this observation, the effect is more subtle and cannot be immediately identified by looking at the level 2 image. Nevertheless, it appears that both observations are losing "good" events through

Table 4: Percentage of G0-7 Events in L1 on Each Node of S2 During OBSID 4944.

NODE	G0	G1	G2	G3	G4	G5	G6	G7
0	9.3	0.1	8.2	1.2	1.0	3.9	5.0	71.2
1	4.2	0.0	1.9	1.0	1.1	3.9	2.1	85.9
2	8.9	0.1	5.7	1.0	1.2	3.3	4.1	75.7
3	8.7	0.1	7.7	1.0	1.2	3.7	3.4	74.2

Table 5: Number of G0-7 Events in L1 on Each Node of S2 During OBSID 5341.

NODE	G0	G1	G2	G3	G4	G5	G6	G7	TOTAL
0	2032	18	991	419	364	1702	920	27396	33842
1	1327	15	694	390	368	1624	871	33697	38986
2	2083	21	1079	434	469	1711	939	32909	39645
3	1955	13	876	342	427	1546	810	27439	33408

an unidentified process.

For a graphical illustration of Tables 4 and 6, I produced a histogram of the pulse height amplitudes of the corner pixels in the 3x3 event island for all the G0 events reported by each of the 4 nodes. These are presented in Figure 8 for OBSID 4944 and in Figure 9 for OBSID 5341. Again, the conclusion is the same: node 1 is under-reporting the number of G0 events when compared to the number of G0 events being reported by the other three nodes.

5 Resolution

So what is the problem with S2, node 1? Actually, there is no problem and this behavior has been seen several times before. A caveat with the previous diagnosis is posted at:

http://asc.harvard.edu/ciao/caveats/acis_caveats_030306.html

(look at the fourth "Miscellaneous" item):

```
``The count rates of parts of two CCDs are relatively low.  These regions are
NODE_ID = 3 of CCD_ID = 2 (ACIS-I2) and NODE_ID = 1 of CCD_ID = 6 (ACIS-S2).  These
two nodes are functioning properly.  Fewer events are telemetered for these two nodes
because they have relatively small overclock values.  As a result, fewer of the events
that saturate the analog-to-digital converters are telemetered.  Since these events
are typically produced by cosmic rays, this feature should not impair the scientific
utility of the two nodes.''
```

Since each node has a different bias level, the saturated pixel peak will appear at a different pulseheight in each node. For some nodes, like S2 node 1, the standard upper energy pulseheight

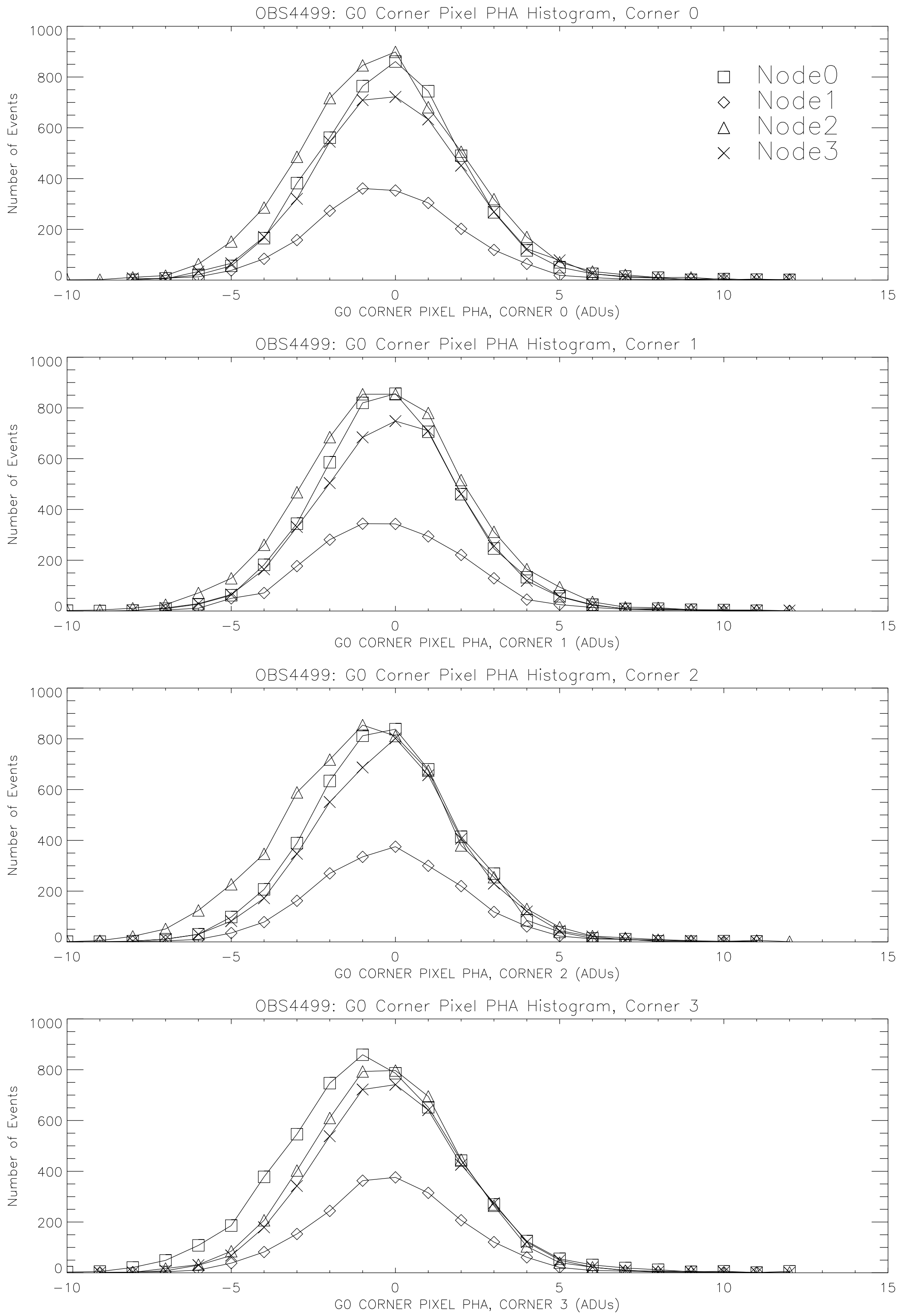

Figure 8: Grade 0 PHA distribution for the corner pixels in the 3x3 event island in OBSID 4944.

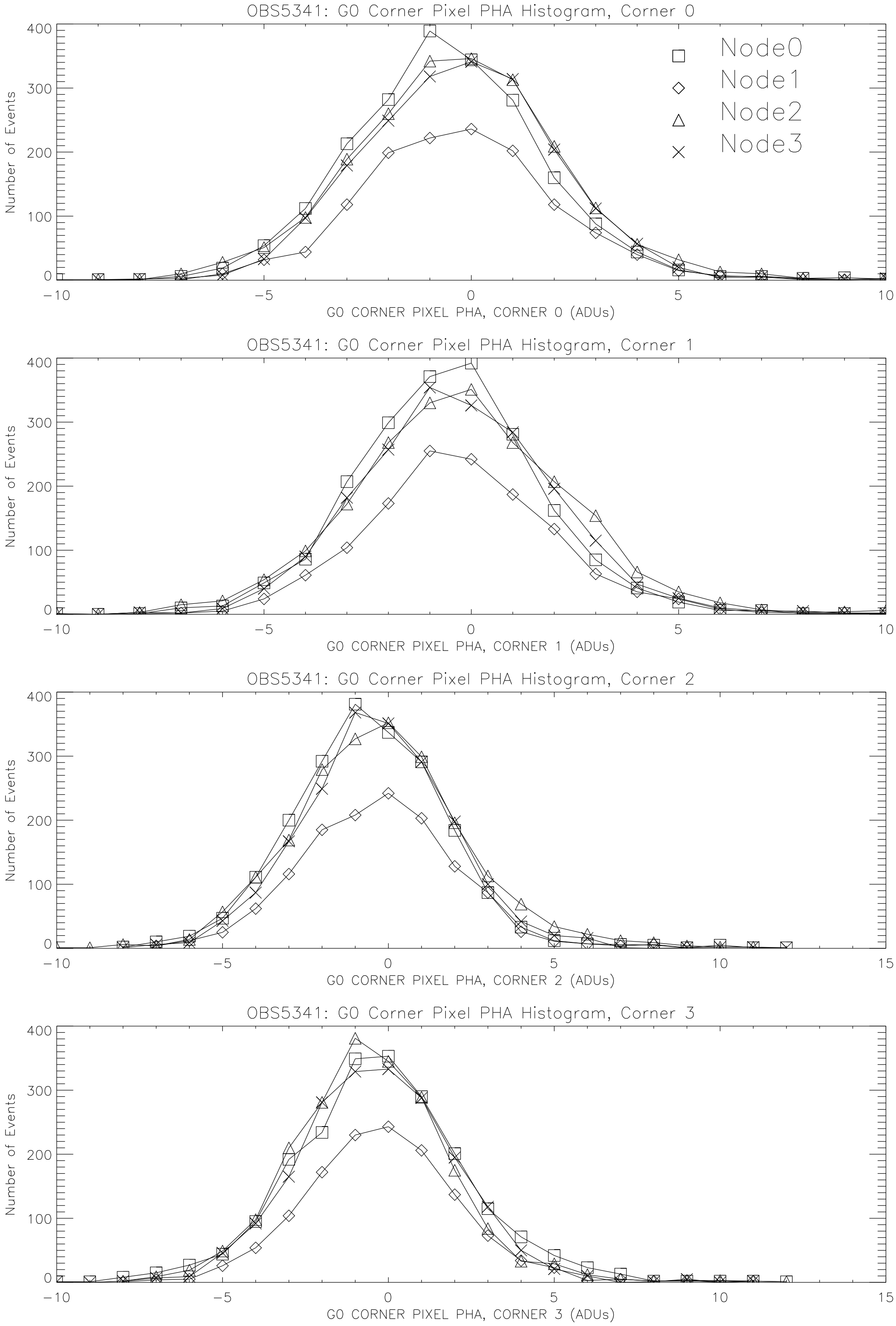

Figure 9: Grade 0 PHA distribution for the corner pixels in the 3x3 event island in OBSID 5341.

Table 6: Percentage of G0-7 Events in L1 on Each Node of S2 During OBSID 5341.

NODE	G0	G1	G2	G3	G4	G5	G6	G7
0	6.0	0.1	2.9	1.2	1.1	5.0	2.7	81.0
1	3.4	0.0	1.8	1.0	1.0	4.2	2.2	86.4
2	5.3	0.1	2.7	1.1	1.2	4.3	2.4	83.0
3	5.9	0.0	2.6	1.0	1.3	4.6	2.4	82.1

filter will remove this peak, while for the other nodes in S2, the filter is above this peak.

There are two ways to easily check if this is correct. The first is to an image like that in Figures 1 and 2 but filter by energy first to remove everything above 10 keV. The energy filtered image should look much flatter. The energy filtered level 2 event list is presented in Figures 10 and 11 for obsids 4944 and 5341, respectively. Secondly, one can also make a pulseheight histogram for each node in S2. You should see peaks at very high pulseheights for all the nodes except node 1. Pulseheight plots for obsids 4944 and 5341 are presented in Figures 12 and 13. Clearly, this is an easy way to solve problems like this in the future.

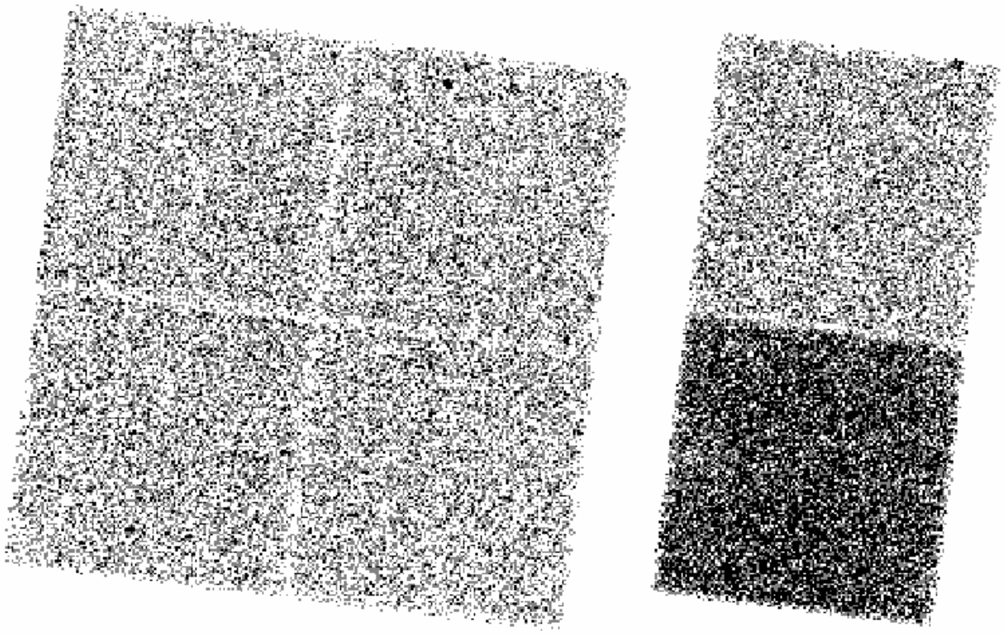

Figure 10: Level 2 Image of OBSID 4499 but events with energies greater than 10 keV EXCLUDED. Notice that the differences between node 1 and the other nodes on the CCD has disappeared.

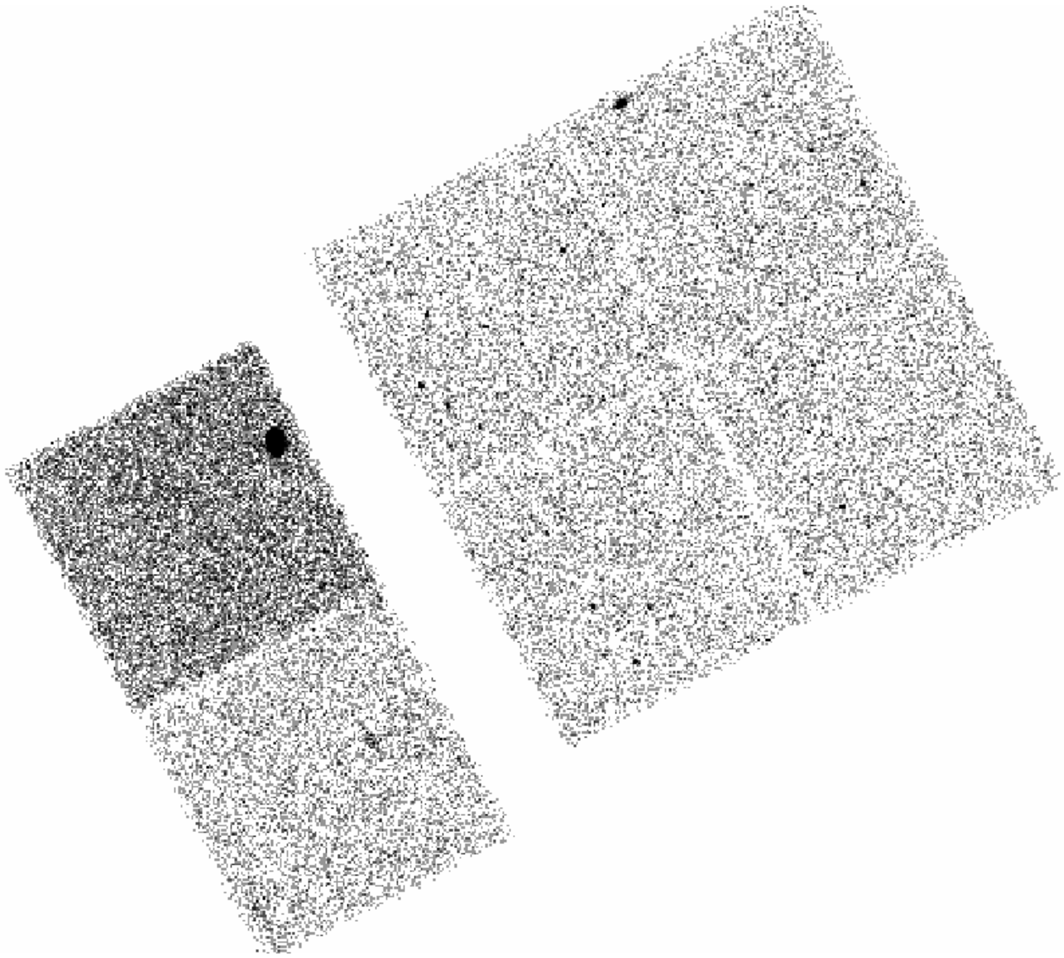

Figure 11: Level 2 Image of OBSID 5341 but events with energies greater than 10 keV EXCLUDED. Notice that the differences between node 1 and the other nodes on the CCD has disappeared.

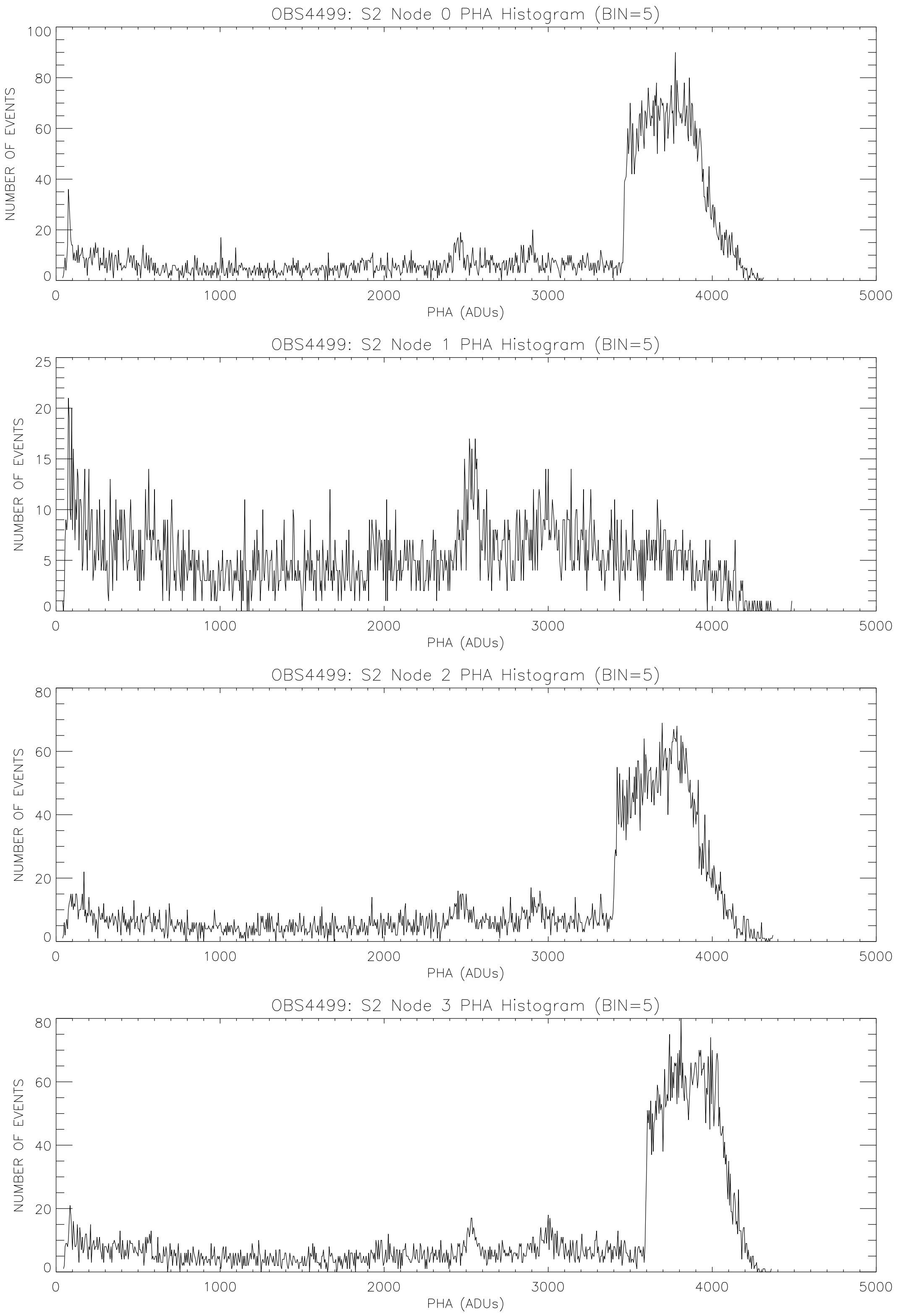

Figure 12: Pulseheight histogram for all 4 nodes of S2 produced from the level 2 events file of obsid 4944. Notice that the standard upper energy pulseheight filter has removed the peak near 3700 ADUs, while for the other nodes in S2, the filter isabove this peak.

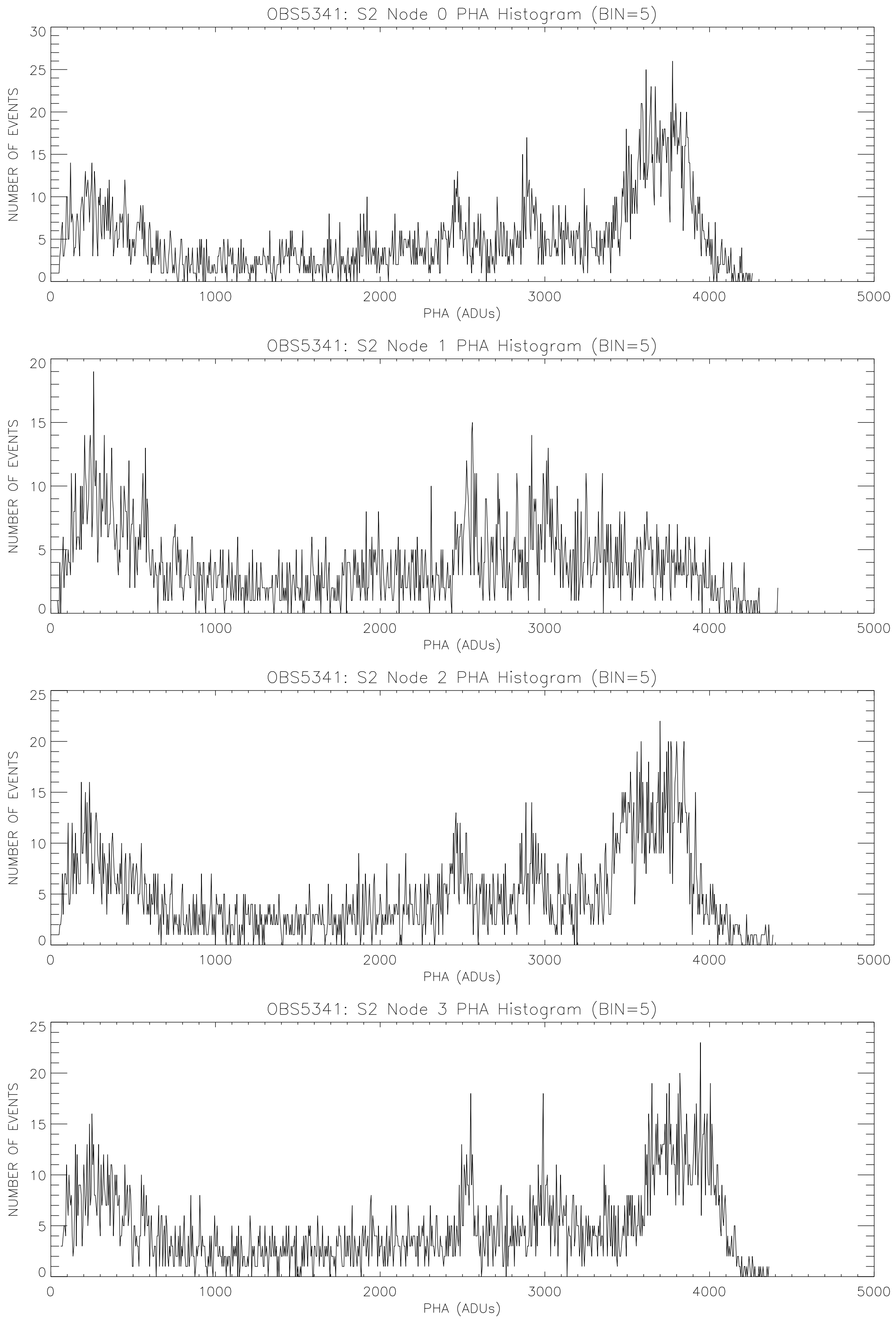

Figure 13: Pulseheight histogram for all 4 nodes of S2 produced from the level 2 events file of obsid 5341. Notice that the standard upper energy pulseheight filter has removed the peak near 3700 ADUs, while for the other nodes in S2, the filter isabove this peak.