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

MEMORANDUM

Date: October 1, 2003
From: Joe DePasquale
To: SOT/FOT
Subject: ACIS PSMC Thermal Issue Summary

1 Introduction

During perihelion of 2002-2003, Chandra experienced a number of thermal limit trips and exhibited an upward trend in temperatures throughout the spacecraft. The ACIS team closely monitored the temperature fluctuations of the Power Supply and Mechanism Controller (PSMC), as well as analyzed the temperature profiles of all PSMC thermal limit trips. These analyses contributed to an evaluation of the PSMC thermal limit definitions from launch and as a result, changes to these limits were implemented in early 2003. This memo is a summary of the analyses, their results, and a documentation of the thermal limit changes.

2 Thermal Analyses

The only PSMC mnemonic to show a thermal limit trip was "1PIN1AT" which tripped its yellow high limit of 30.0 C on Sept 24, 2002. For this memo, we will only consider the ACIS Health & Safety limits used by both the FOT and SOT. For a description of the ACIS Health & Safety and Data Quality limit sets, please see reference 3 at the end of section 3. Analysis of PSMC thermal excursions prior to this trip showed a strong correlation between Solar Array Angle (SAA) and temperature and indicated that a trip was imminent. As the perihelion season progressed, this mnemonic tripped its yellow limit 8 more times. Table 1 shows the dates, maximum temperature reached and durations of the 9 1PIN1AT limit trips.

Continued analysis of the 1PIN1AT limit trips further confirmed the correlation between SAA and temperature increases. It was found that angles below 60^o contributed significantly to the large, short-timescale temperature increases seen in the PSMC. Figure 1 shows the first 1PIN1AT trip plotted against time, with the SAA included in red. Notice the sharp drop in the SAA and the gradual increase in 1PIN1AT temperature readings at day 267.3. Figure 2 shows the temperature readings of the mnemonics 1PDEA[AB]T which correspond to the electronics boards located inside the PSMC. It is important to note that 1PIN1AT is a thermistor located on one wall of the PSMC, thus its temperature is not of as much concern from an operational standpoint as the temperature of the electronics boards. The limits were set on 1PIN1AT to provide an indication of the ISIM environment surrounding the PSMC and to provide an early warning of potential problems. The temperatures of the electronics boards themselves, 1PDEAAT & 1PDEABT are the more important quantities. Neither 1PDEAAT or 1PDEABT have exceeded their limits when 1PIN1AT has, as evidenced in Figure 2. Both mnemonics map closely to the temperature changes of 1PIN1AT but have managed to stay below their thermal limits. The

Table 1: **ACIS PSMC (1PIN1AT) Limit Trips**

Trip #	Mnemonic	Date (DOY)	MAX T (C)	Duration (hr:min)	Pitch (deg)
1	1PIN1AT	2002-267	30.63	03:45	48.75
2	1PIN1AT	2002-295	30.63	02:25	51.38
3	1PIN1AT	2002-308	30.63	08:55	53.09
4	1PIN1AT	2002-313	30.63	05:00	46.82
5	1PIN1AT	2002-327	30.62	01:15	54.61
6	1PIN1AT	2002-342	31.90	13:40	50.94
7	1PIN1AT	2003-37	30.63	06:35	50.32
8	1PIN1AT	2003-49	31.90	07:55	49.08
9	1PIN1AT	2003-51	30.63	21:55	56.99

maximum temperature reached by 1PDEAABT & 1PDEABT in the 2002-2003 perihelion season was 48.5 C, 1.5 C below the limit at that time of 50 C. After discussion of these results, the ACIS team considered altering the launch-limits.

For more detailed information regarding these analyses, please refer to:
1. http://asc.harvard.edu/acis/memos/thermal_memo.ps and
2. http://asc.harvard.edu/acis/memos/psmc_limit_changes.ps

3 PSMC Thermal Limit Changes

In discussions with the MIT ACIS team, notably Bill Mayer and Bob Goeke, we agreed that the existing limits were set conservatively to provide an early warning to changes in the thermal environment of the spacecraft. We also agreed that the launch-limits have served their purpose in providing this early warning and we would want to avoid having limit trips of these values in the future. The electronics boards have been tested to 70.0 C at Lockheed Martin and so there is a large margin for increase in these limits. The current philosophy is to increase the limits enough that one would expect no trips through the next perihelion unless there is some new factor affecting the thermal environment, of which we would want to be aware. Thus, the new limits will still provide an early warning to changes in the spacecraft. It is for this reason that the red limits are not set to the qualification limit of 70.0 C.

Table 2: **ACIS PSMC Limit Changes**

Mnemonic	Old		Current	
	YellowHi(C)	RedHi(C)	YellowHi(C)	RedHi(C)
1PIN1AT	30.0	36.5	35.0	40.0
1PDEAAT	50.0	58.5	54.0	59.0
1PDEABT	50.0	58.5	54.0	59.0

As a direct result of discussions with the MIT ACIS team, the following changes were made to the ACIS PSMC yellow and red high limits for 1PIN1AT, 1PDEAAT and 1PDEABT. The yellow high limit for 1PIN1AT was changed from 30.0 C to 35.0 C. The yellow high limits for both 1PDEAAT and 1PDEABT were changed from 50.0 C to 54.0 C. The red high limit for 1PIN1AT was changed from 36.5 C to 40.0 C. The red high limits for both 1PDEAAT and 1PDEABT were changed from 58.5 C to 59.0 C. For clarity, table 2 lists these changes to the limit set.

For a detailed discussion of the ACIS team limits philosophy, please refer to:
3. http://asc.harvard.edu/acis/memos/limits_philosophy.ps

4 Conclusions

After analysis of the 2002-2003 perihelion thermal limit trips, the ACIS Operations team held meetings with the MIT ACIS team to discuss the status of ACIS PSMC thermal limits. The main conclusion drawn from these meetings was that the limit set in use at that time was intentionally conservative, and the ACIS PSMC components in question had been tested to much higher temperatures (ie +70 C). The decision was made to slightly increase the yellow and red high limits for the ACIS PSMC; the new limits are still considered conservative so as to provide an early warning to changes in the spacecraft environment.

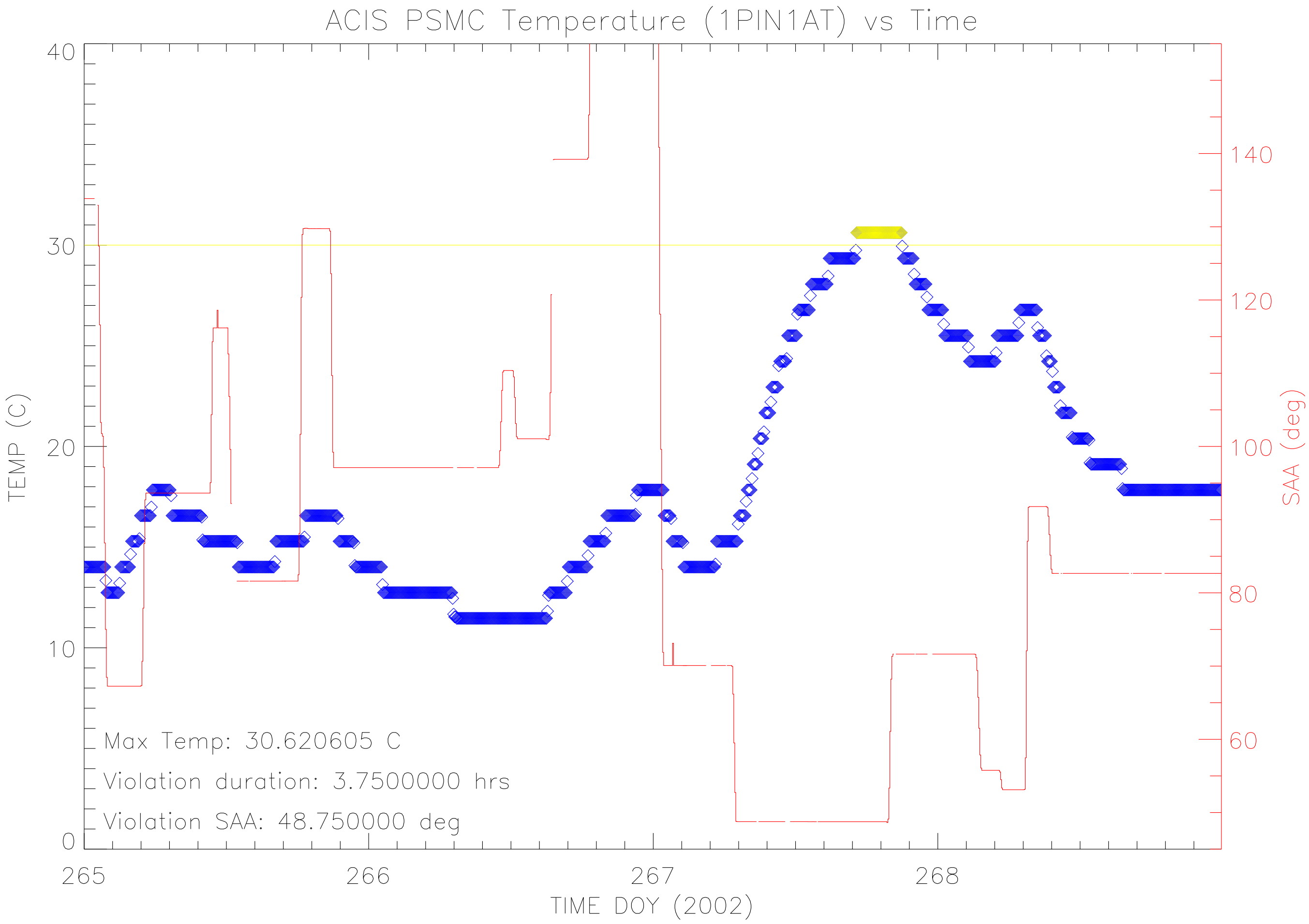

Figure 1: Plot of temperature versus time for 1PIN1AT yellow high limit trip on day 267 of 2002. Included in red on this plot is the SAA for the duration of the trip. The duration listed on the plot is the total time spent above the yellow limit regardless of temperature fluctuations above this level.

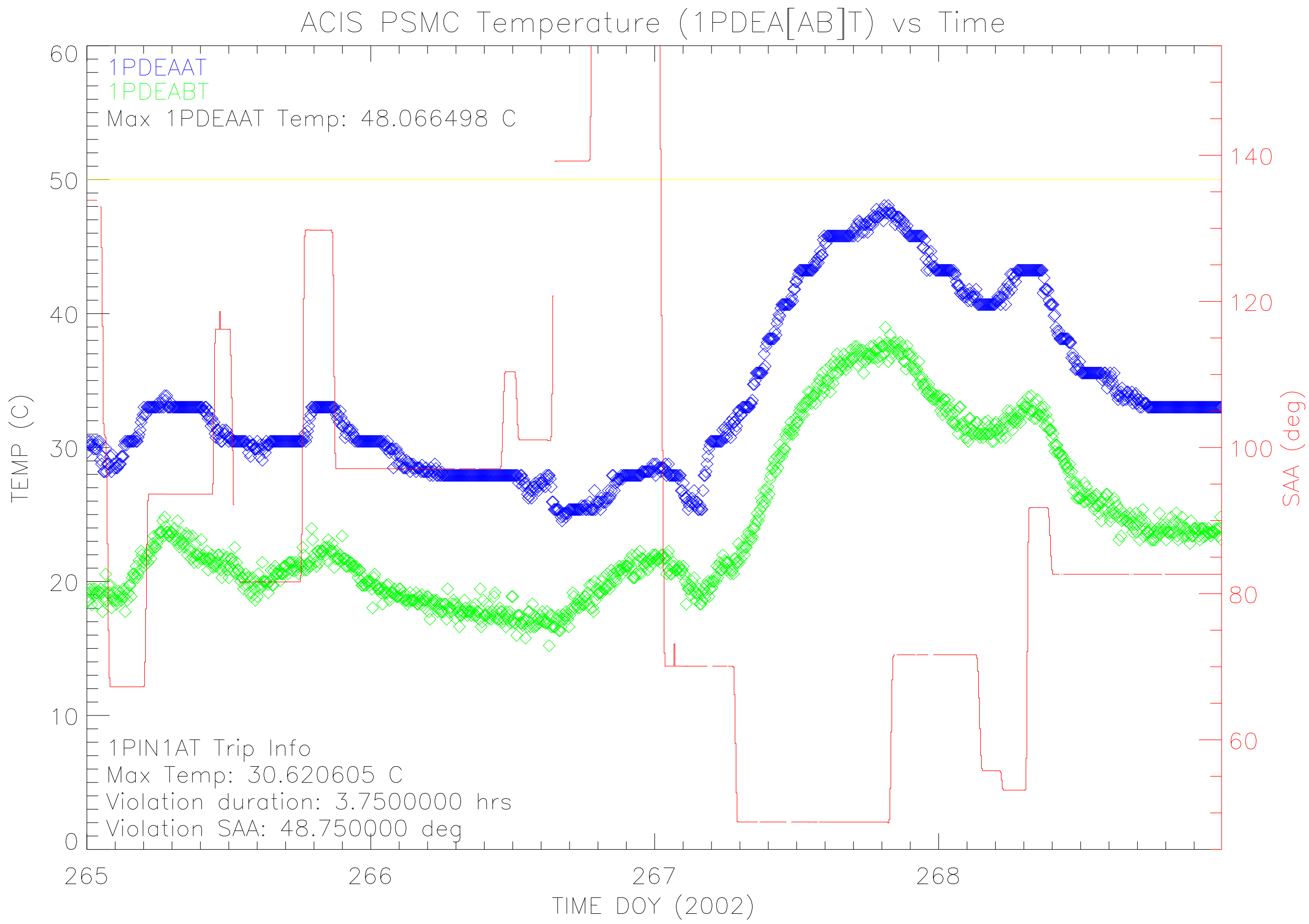

Figure 2: Plot of temperature versus time for 1PDEA[AB]T during the 1PIN1AT yellow high limit trip on day 267 of 2002. Included in red on this plot is the SAA for the duration of the trip. The duration listed on the plot is the total time that 1PIN1AT spent above the yellow limit regardless of temperature fluctuations above this level.