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Switching ACS from Side 1 to Side 2 electronics

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ABSTRACT
Based on the history of STIS, an electronics failure on the ACS Main Electronic Board, side 1 (MEB1) currently being used could possibly occur at some point. This note describes steps to be taken to switch over to MEB2, the redundant side, including detector startup procedures and recalibration requirements.

1. Introduction

Recently STIS became unusable because of a failure in the second side of its electronics. Electronic failures have now occurred on both sides of the STIS electronics leaving it incapacitated with no way of continuing its scientific mission. The failure of the first side of STIS was due to a capacitor while the second failure has been traced to the +5 volt mechanism DC-DC convertors. Similar devices with the same date and lot code are in use on ACS. However, the ACS electronics are less complex than that of STIS and therefore slightly less prone to failure.

With the switch to side 2 STIS lost the control of the CCD temperature.It was known from ground testing that STIS Side 2 did not have a functioning temperature sensor. As a consequence, under side 2 operations, the TEC was run at a constant current and the temperature of the CCD (and therefore the dark rate) varied with that the temperature the spacecraft environment (Brown 2001a).An increase in effective read noise has also been reported in STIS CCD when operated with Side 2 (Brown 2001b).ACS ground testing did not reveal any problem with any component of side 2 electronics and we do not expect similar issues.

. Currently we are operating on the side 1 electronics, but in anticipation of a possible need we have prepared procedures to change over quickly to the second set and return to normal operations as smoothly and as expeditiously as possible. The procedures involve modifications to flight software to activate side 2, plus basic aliveness tests of the ACS detectors using procedures developed for the initial ACS turn on in March 2002. Certain recalibrations will occur shortly after restarting although most of these are part of the normal routine and do not require special proposals.

2. Side 1 -Side 2 differences

For the most part we do not expect side 2 electronics to differ from side 1. However since the use of side 2 also implies the use of different components, such as sensors and LEDs, possible differences are:

- the CCDs might settle at slightly different temperatures leading to small changes in dark rates.
- the CCD amplifiers may have different read noise values
- the filter wheel position corrections might be slightly different
- the fold mirror and cal door (which carries the coronagraph spots) could stop at slightly different positions because they are determined by different (side 2) LEDs and photodiodes and are driven by the changed electronics.
- the shutter shading correction could change
- the post-flash will come from different LEDs so the illumination level and distribution will probably change a little.

None of these changes presents much of a problem. The CCD temperatures will be carefully monitored the first time they are turned on following the switch. The extremely unlikely possibility of a slow thermal runaway will be looked for and the temperature set point adjusted if necessary.Changes in dark rates and readout noise will be detected and recorded during the special calibration program (see below). A proposal to exercise the filter wheels and measure the offset corrections will be included. Position changes in the fold mirror would displace the images slightly. There is a routine monitoring program observing 47 Tucanae that will detect and allow us to correct for any such shifts. The position of the coronagraphic spots are, in any case, variable and measured weekly. The shutter shading correction is currently negligible and is not applied during data reduction. Even in the case of small changes it is quite likely it would remain negligible.

The post-flash illumination method is not yet in use and is not expected to be required for at least another year. When use of this facility is imminent, a full calibration of the illumination will be carried out.

3. Switching sides

To accomplish a switch from side 1 to side 2 electronics, some changes in both ground system and flight software will be required. Both were designed so that these changes would be minimal. The ACS science timeline will need to be replanned.

In the ground system, one Instruction, which supplies the default MEB side, would have to be updated to specify side 2. The most likely scenarios would also require that the default RIU channel be changed from A to B in the same Instruction. An RIU change would also require that one or more commands in the ACS safing sequence be modified in the PRD and in NSSC-1 memory. In the case of STIS, a second version of the safing sequence, with a similar change, was loaded. A second version of the ACS safing sequence would need to be specified in the special Health and Safety Instruction in place of the current version.

The ACS MEB2 currently contains the pre-launch flight software, with none of the post-launch updates. In the event of a side 1 failure, an up-to-date version of the flight software, including its MEB flag set to side 2, would need to be loaded. The procedure for loading that flight software version and ensuring its correctness has been developed and tested sucessfully.

All software products necessary for a side 2, RIU B switch will be prepared and certified, and will be kept on the shelf until needed. If the actual failure requires other than the most likely changes, the required software can be prepared and certified in a day or two. Instruction updates can be loaded at any time. PRD updates, if needed, can be done very quickly. The safing sequence load into the NSSC-1 and the ACS flight software update will be scheduled when necessary, subject to TDRSS availability.

When the side 1 failure occurs, further stored commanding in the SMS will be ignored. An intercept SMS, with post-failure ACS science commanding removed, would be needed by the time of the planned side switch procedures. Once those procedures are complete, a mini orbital verification program will be run prior to resuming science observations. Some details of the detector checkout follow.

4. CCD turn-on

The WFC and the HRC can be turned on in the normal way. There is a built-in waiting period of three hours to allow for temperature stabilization. During this period the detector temperatures will be monitored to ensure that stable temperatures are reached. Our experience suggests that this will work as normal. If too low a temperature is attempted on the WFC the thermo-electric coolers (TECs) can fail to reach the target temperature. In the attempt they can actually increase the detector temperature causing a slow thermal runaway. It takes many hours to warm up a few degrees so it is easy to monitor and correct this situation. The corrective action would be to change the setpoint temperature to one degree above the minimum temperature actually reached. This situation was monitored during the initial turn-on in March 2002 with no problem seen at a setpoint temperature of -83°C for the WFC.

Once the CCDs are operable, proposal 10450 will be run. This is a mini-functional test of both CCD cameras. Bias frames, darks and flat fields are taken. The following components/parameters will be tested:
- readout capability and readout noise (default configurations and minor modes)
- shutter
- filter wheel movements
- calibration lamps
- dark current
- bias level

The program consists of two visits, for a total of two internal orbits.

Ground Testing executed with side 2 will be used to compare the on-orbit data. The pre-flight data can be retrieved from the ACS Preflight Database:

http://acs.pha.jhu.edu/instrument/archive/database/preflight/

This contains all the ACS pre-flight calibration images organized for easy retrieval.A user can search the database for side 2 observations by specifying as an optional parameter for the search MEBID min=2 max=2. Moreover the search can be restricted to the more recent files taken in flight configuration by specifying a range in date (for example EXPSTART 1:DEC:2001 to 1 MAR 2002).The user can select the files of interest (Bias, Dark or internal flat) and download them directly from the database form.

5. SBC turn-on

Turning on the SBC requires a more cautious approach than is needed for the CCDs. If the applied high voltage is too great or an SBC exposure occurs while pointing at too bright a field, damage could occur. Before turning on the high voltage, we will run proposal 10449 which exercises the SBC filter wheel and the Fold Mirror. It is important to ensure we can activate the opaque filter wheel positions. We also want to ensure that the filters go accurately to their commanded positions.

When the SBC is turned on, the voltage is initially increased in steps while the current is monitored. This procedure is contained in the existing proposal 10372 which is designed for initial SBC turn-on or recovery from an anomalous shut down. Eight internal orbits are required. Part of this proposal is a fold analysis which provides a measure of the distribution of the electrons striking the anode. We allow 24 hours to examine the data. Thus, no SBC observations may be carried out during this time. This proposal has always been designed to be on hold to be used only when needed. It can be used “as is” for the possible side switching.

Proposal 10375 monitors, among other things, the distortion models including the image location. Currently this is run every three months, but if the electronic side switch occurs we would schedule this within a week or two to update the image position.

6. Summary

In the event of the failure of ACS side 1 electronics, we expect to be able to switch sides and return to full science operations within one week. The CCDs can be ready for observations within one day (after we are given the go-ahead from the Project) and the SBC within one week, the main delay being the time required to analyze the fold data. Given the relatively low percentage use of the SBC, this should not seriously impact scheduling

7. Acknowledgements.

We wish to acknowledge useful discussions with Tom Brown and George Hartig

8. References

Brown, T. M. 2001a, Temperature Dependence of the STIS CCD Dark Rate During Side-2 Operations, Instrument Science Report STIS 2001-03 (Baltimore: STScI)

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