SNS • SORCE News Source

Solar Radiation and Climate Experiment Monthly Newsletter **February 2006**

SOLSTICE Entrance Slit Anomaly –

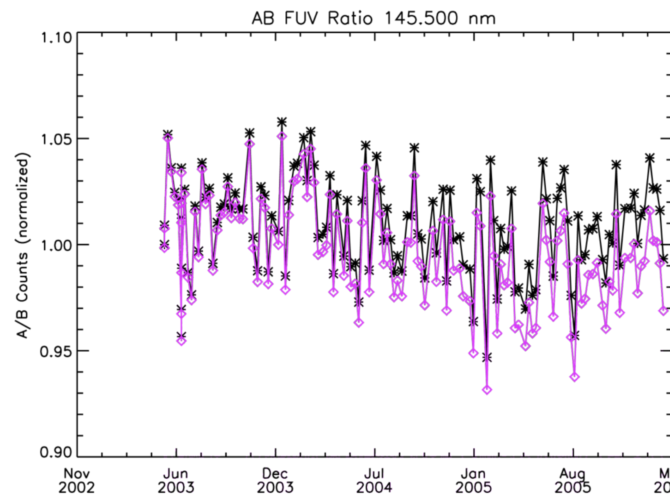
By Marty Snow, LASP, University of Colorado

On 27 January 2006 (about 10:30 UT), the entrance slit on SOLSTICE A had an anomaly. At the end of a normal eclipse period, the entrance slit was commanded to move from stellar mode to solar mode, but telemetry indicated that it did not. When the spacecraft came out of eclipse, the Bright Object Sensor circuitry detected that the slit was in the wrong position, and another command to move the slit was sent autonomously. Again, the slit did not move as commanded. After one minute, the commands for the normal solar operations for the orbit began, which included a command to move the slit. This third command was successful, and the entrance slit moved to solar mode.

Since then, SOLSTICE A has remained in solar mode, continuing to conduct its normal solar science. Initial analysis shows that the extra exposure caused about a 1% reduction in responsivity. Because the SOLSTICE B instrument can be used to cross-calibrate SOLSTICE A, no science will be lost by keeping SOLSTICE A in solar mode.

Several meetings to discussion the cause of this anomaly have been held, but no firm conclusions have been reached yet. Both mechanical and electrical failure possibilities have been considered, but there is no conclusive evidence to rule out any particular scenario for why the mechanism refused to move twice, but then did move on the third try a minute later. Unfortunately, there does not seem to be any "smoking gun" that indicates what might have caused the anomaly.

Until further analysis has been completed, the entrance slit on SOLSTICE A will remain in solar mode. To reduce the overall number of times the SOLSTICE B mechanisms are used, the default operation during spacecraft slews while in eclipse will no longer include a change of the filter positions and the entrance and exit slits. This change alone will reduce the number of mechanism movements by about a factor of 4. This conservative approach results in no loss of science. SOLSTICE B will continue operating in both solar and stellar modes, while SOLSTICE A will remain in solar mode only.



Ratio of signal in SOLSTICE A to SOLSTICE B at 145.5 nm. The black curve (asterisks) shows the ratio without any correction for degradation. There is a slight upward trend because B has more FUV exposure than A. The purple curve (diamonds) shows the effect of applying the stellar degradation correction to each instrument. With the loss of stellar measurements by SOLSTICE A, the degradation correction will be derived from these comparison experiments. B will continue to have a stellar correction, and A will be adjusted to keep the ratio flat with time. *(Figure provided by Marty Snow)*

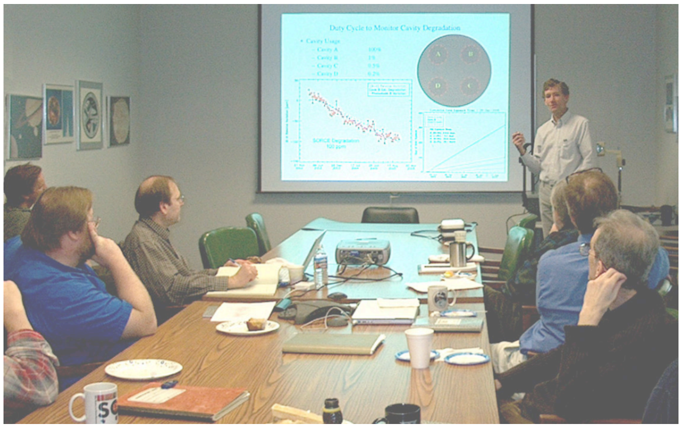
In order to gather more diagnostic information on SOLSTICE B's mechanisms, the housekeeping telemetry rate will be increased for a short period around sunset and sunrise. This will provide more data on the spacecraft voltage and current levels and allow earlier detection of any changes to the mechanism. Additionally, new automatic telemetry monitors (TMONs) will be developed to improve the spacecraft's autonomous response in case a similar situation ever occurs on SOLSTICE B. Currently when the Bright Object Sensor circuit is triggered, it sends the command to the slit just once. The TMON will check to see that the slit has responded to the command, and if it hasn't, the command will be sent again every 5 or 10 seconds until it moves to the correct position. Additionally, if this TMON detects an anomaly, it will shut off the high voltage power supply to the instrument, which should help protect the detector from damage.

In summary, the entrance slit mechanism on SOLSTICE A didn't respond to two commands on 27 January 2006. It will be left in solar mode until further notice. No science will be lost since SOLSTICE B can be used to monitor the degradation of SOLSTICE A through cross calibration.

SORCE Instrument Degradation –

By Jerry Harder, LASP, University of Colorado

On 02 February the SORCE instrument scientists, along with the calibration and science data processing engineers, met to discuss the degradation of each of the SORCE instruments. About 20 people attended this half-day workshop, with the purpose of providing an update on the progress of degradation analysis and to present an indication of the amount of degradation experienced by each instrument so far in the mission.



After Greg Kopp finished making Belgium waffles for everyone, he presented the latest TIM degradation information.

To achieve the precision and accuracy needed to measure solar irradiance variability, each instrument must execute a series of experiments to measure its own level of degradation. These techniques are unique to each instrument, and degradation is strongly wavelength dependent so the spectrometers SOLSTICE and SIM require a more complicated series of experiments to make these crucial measurements. Analysis of degradation is an ongoing effort in the SORCE program and procedures are continually being refined and updated based on what is learned as the mission proceeds. Here is a summary of how each instrument measures its degradation and what its current findings are:

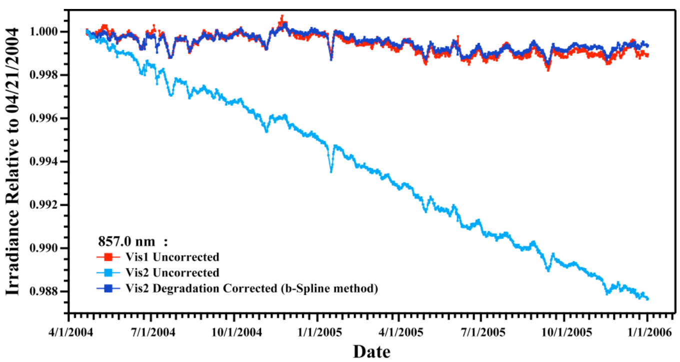
TIM: Degradation is measured by comparing the irradiance of 4 identical cavity radiometers that are exposed at different rates: the four cones measure solar irradiance 100%, 1%, 0.5% and 0.2% of the sunlit time. Thus, the least exposed radiometer has seen about 16 hours of degradation as of 28 December 2005. Greg Kopp's analysis showed that TIM has experienced only about 100 parts per million of degradation up to this point in the mission. These findings from the cone comparisons are verified by measurements of the cone reflectances as measured by a backward looking photodiode outside of each cavity. Other possible changes in the instrument such as gain and changes in the optical properties of the shutters are of negligible importance.

XPS: The degradation is characterized by three methods: 1) weekly measurements of the redundant XUV photodiodes, 2) for the important Lyman-α measurement, overlapping channels from SORCE SOLSTICE, UARS SOLSTICE/SUSIM and TIMED SEE are compared, and 3) the overall calibration is compared about once per year with a TIMED SEE-funded rocket underflight. The flight XUV photodiodes have not shown any measurable degradation when compared to the rocket results, but this finding is still under study since the rocket XPS calibration is uncertain to about 10-20%. Tom Woods' analysis of the time series shows that many of the slow changes seen in the instrument response are due to solar cycle variations rather than instrument degradation. The Lyman-α filter has shown about 30% degradation due to degradation on a bandpass filter, but this phenomenon is well known and characterized (see Woods et al., *Metrologia*, **35**, 619, 1999).

SOLSTICE: The SOLSTICE instrument degradation is characterized by first transferring the pre-flight SURF calibration to the irradiance of the suite of 18 UV stars used for stellar calibration during the rest of the mission. The same suite of stars was used for the UARS mission as well. Degradation is then tracked by measuring the effective change in irradiance of these stars at 18 wavelengths in the FUV and 22 wavelengths in the MUV. Marty Snow's work with the stellar calibrations shows the amount of degradation is strongly wavelength dependent; at some wavelengths, such as 117 nm in the FUV, the degradation is about 15%, while at most other wavelengths in the MUV the degradation is very small – less than about 2%.

SIM: The SIM instrument uses a pair of identical spectrometers and a series of overlapping detectors within each spectrometer channel to explicitly measure the wavelength dependent changes in the prism and the photodiode detectors. The electrical substitution radiometer (ESR) in SIM is the reference standard for detected power, and to date there is no indication of response degradation in this detector in either spectrometer channel. Juan Fontenla described his analysis of prism degradation (see Harder et al. *Solar Physics*, **230**, 169, 2005) showing that prism degradation follows a Lambert's law relationship and the calibration mode of the instrument acquires the information needed to make this necessary correction. Prism degradation is most prevalent in the ultraviolet and is almost undetectable by 600 nm. For instance, after 800 days in the mission the degradation at 280 nm (the Mg II region) is about 23%, but at 430 nm (the G-band) it is about 3%. The SIM photodiodes also experience a small amount of degradation that is most evident in the long wavelength portions of the photodiode's response curve: Jerry Harder showed that Vis1 photodiode (n-on-p type silicon) experience about 0.1%

drop in the red portion of its responsivity that is currently difficult to characterize. The UV and IR photodiodes (n-p silicon and InGaAs, respectively) show no indication of degradation, but the Vis2 photodiode (p-on-n silicon) has shown about a 1.2% degradation in response at 853 nm over the last 660 days. This degradation is attributable to proton bombardment from the space environment. Currently the Vis2 photodiode is being corrected at all its usable wavelengths with the measurements from the ESR and these corrections will appear in the upcoming release of SIM data.

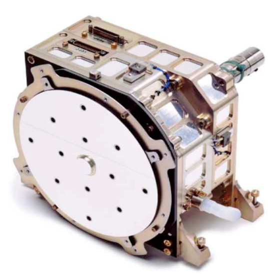


This graph shows the time series of the SIM Vis1 and Vis2 photodiodes at 857 nm, near the Ca II infrared triplet. The graph shows the relative irradiance for the corrected (dark blue) and uncorrected (light blue) Vis2 data along with the uncorrected Vis1 data (red). The correction is generated by measuring the photodiode's radiant sensitivity as a function of wavelength and tracking its time dependent changes with a b-spline fit. This measurement is made every three months by dividing the photodiode's photocurrent by the radiant power measured with the ESR (after accounting for differences in spectral bandwidth between the two detectors). The 0.1% difference seen between the corrected Vis2 and Vis1 data is due to yet uncorrected diode degradation in Vis1. For wavelengths shorter than 760 nm, no detectable degradation is seen in either the Vis1 or Vis2 photodiodes. Likewise, no detectable degradation is observed in the UV or IR photodiodes over their usable data range.

XPS Filter Wheel Update –

By Tom Woods, LASP, University of Colorado

The SORCE XPS had a malfunction on days 19-21 December 2005 whereby the XPS filter wheel did not move from position 0 for about 38 hours. The filter wheel mechanism began working again on 21 December and has performed well since. After noting this behavior, the XPS filter wheel was promptly parked in position 6 while the XPS data was studied and this behavior investigated. XPS continues to collect good solar irradiance data, and the only data gap in the XPS Level 3 (daily averaged) data product is on 20 December.



The XPS team has held several meetings to discuss the sequence of events and XPS data analysis, and to determine the plan for future XPS observations. The analysis so far suggests that the most probable cause is that there was a temporary mechanical failure of the gear-motor due to debris in the gears. Our goal in defining the future XPS observations is to maximize science and minimize risk. The plan is to make the majority of the solar observations in filter wheel position 6 to obtain the solar irradiance spectrum in the 0.1 nm to 18 nm range and with 1 minute cadence. In addition, we will operate XPS in filter wheel position 4 for about 20 minutes about once a month to provide in-flight tracking of any degradation of the photometer responsivity, visible light signal contributions, and to provide the solar Lyman-alpha irradiance measurement that is useful for SORCE SOLSTICE validation. Considering that the XPS filter wheel has operated successfully for over 900 cycles since December 20, we consider this approach of moving the filter wheel mechanism only 24 times per year to be a low risk solution.

176,300

Hits to the SORCE Website

(Since 4/21/03, As of 02/20/06)

XPS Calibration Workshop –

By Tom Woods, LASP, University of Colorado

A follow-up XPS calibration meeting was held 20 February to continue SORCE XPS solar irradiance data validation discussions. The first workshop (06 January) focused on the calibrations of the XPS and a variety of data analysis techniques used for the XPS. There have been outstanding differences between the three different calibration techniques by as much as a factor of 2 at some wavelengths. To conclude the earlier workshop, a plan to improve the values of the responsivities used in XPS data processing was formulated, which has since been implemented. The January SORCE Newsletter addresses the different calibration results in detail.

With the new calibration results, the XPS irradiance results in the 0.1-17 nm range will increase only slightly (2-10%,) and the new irradiance results in the 17-23 nm range will increase by about 40%. The new calibration results for XPS are expected to provide more consistent results between the various photodiodes used in XPS, and they have the potential to resolve some of the differences between the various solar XUV measurements from SORCE, TIMED, SNOE, and SOHO. We hope to have the new XPS data products released by April.

Rosario Resort, Orcas Island, San Juan Islands off the west coast of Washington state.

SORCE Science Meeting, Sept. 20-22, 2006 –

Earth's Radiative Energy Budget Related to SORCE is the topic of the next SORCE Science Meeting. The 2.5 day meeting will focus on radiative forcing, feedbacks, and climate response. Specifically the meeting will address:

- The Earth's radiative energy budget: Top of the atmosphere radiative balance and imbalance, albedo and "global dimming", energy budgets at the surface and within the troposphere and stratosphere.
- Radiative forcings: Solar, greenhouse gases, O_3, aerosols (natural and anthropogenic, direct and indirect), measurements and models.
- Climate responses and feedbacks: Hydrological cycle, ice feedbacks (albedo and ocean salinity), climate sensitivity, slow versus rapid responses, linear versus nonlinear responses.
- Role of the biosphere: Response to solar variations, feedbacks through surface albedo and clouds.

Logistical details are still in the planning stages, but mark your calendar now. The dates are Wednesday – Friday, **September 20-22, 2006.** The meeting will be at ***Rosario Resort and Spa*** on Orcas Island in the **San Juan Islands** off the coast of Washington state. Additional details will be available in late March on the SORCE Meeting website.

Upcoming Meetings / Talks –

SORCE scientists plan to present papers or attend the following 2006 meetings:

SCOSTEP STP-11, March 6-10, Rio de Janeiro, Brazil
Measurement Science Conference, Feb. 28 - March 3, Anaheim, California
Dept. of Energy, ARM Meeting, March 22-26, Albuquerque, NM
ASIC 3 Workshop, May 16-18 Lansdowne, VA

To submit information to this newsletter, please contact: vanessa.george@ lasp.colorado.edu.