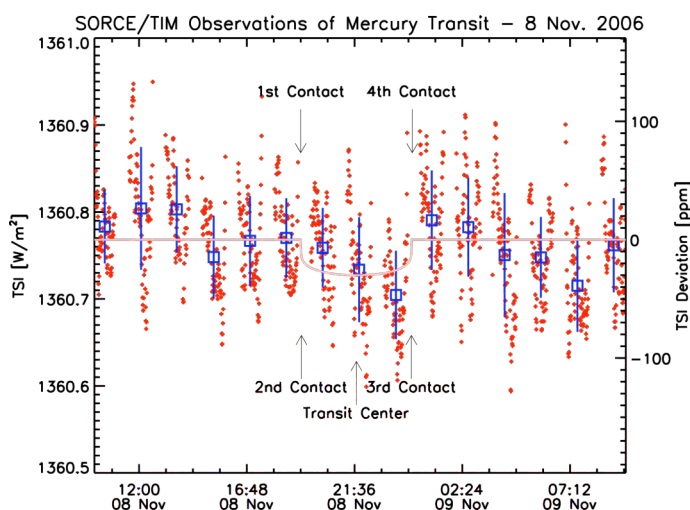




TIM Instrument Views Sun During Mercury Transit –

By Greg Kopp, LASP, University of Colorado



The Total Irradiance Monitor (TIM) viewed the Sun for the three SORCE orbits during which the 8 Nov. Mercury transit occurred, although the SORCE was in the Earth's shadow for both ingress and egress. During this latest transit, Mercury decreases the sunlight at the Earth by up to 30 parts per million (0.003%), indicated by the modeled light curve in faint red on the plot. Even with the TIM's low noise, this transit is not independently detectable in TSI because of the underlying continual solar variations, which have much greater amplitude. High cadence TSI measurements are shown in red with orbital averages and their standard deviations in blue.

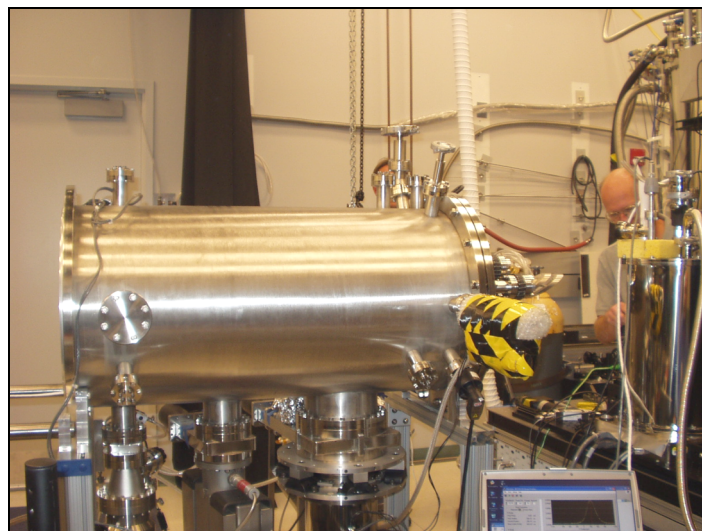
SIM Characterization and Calibration Activities at NIST/SIRCUS –

By Jerry Harder and Erik Richard, LASP, University of Colorado

Even though the SORCE instruments were launched nearly four years ago, the SORCE science team continues to analyze, measure, and where possible improve the calibration of the in-flight instruments by means of the flight spare components and ground witness units. We are fortunate to have available a complete SIM prism drive/focal plane assembly ('brass board') and a fully functional and documented flight spare ESR detector. Likewise, the prism used in the brass board was manufactured from the same boule of fused silica as the flight prisms and the aluminized mirror surface was produced in the same coating run. Because of the quality control and maintenance of these components, we

have the necessary traceability to evaluate the performance of the flight unit.

Last August, Jerry Harder and Erik Richard, with the technical assistance of Nate Miller from the LASP Calibration Group, took the flight spare ESR and the spectrometer brass board to NIST to work with Steven Brown and Keith Lykke at the SIRCUS facility (Spectral Irradiance and Radiance responsivity Calibrations using Uniform Sources).



Activities at NIST SIRCUS. Keith Lykke aligns the NIST transfer radiometer to the SIRCUS laser beam. The large cylindrical chamber in this photograph is the NISTAR chamber, the SIM ESR is placed inside this chamber for its operation. Light enters the chamber through a precisely aligned Brewster window.

The purpose of the measurement campaign was to perform two studies: 1) to characterize the efficiency of the ESR detector as a function wavelength, and 2) to characterize the spectrometer's profile integral as a function wavelength. The absolute calibration of the ESR relies on the optical absorbance of the nickel phosphorus black coating on the bolometer, and the effectiveness of the surrounding hemispherical mirror to re-image light onto the bolometer. Preflight, the detectors were characterized in the visible part of the spectrum, but not in the infrared (800-1600 nm). The SIRCUS facility provides an almost ideal method to measure the detectors efficiency in that the laser beam spot size is small and does not overfill the width of the bolometer, the light intensity is stable to better than 0.1% for up to 40 minutes so very precise measurements can be made, and the wavelength scale is accurate to better than 0.001 nm.

Figure 1 shows all of the data versus wavelength for the comparison. Three laser configurations were used to cover the range and two NIST standard transfer radiometers were

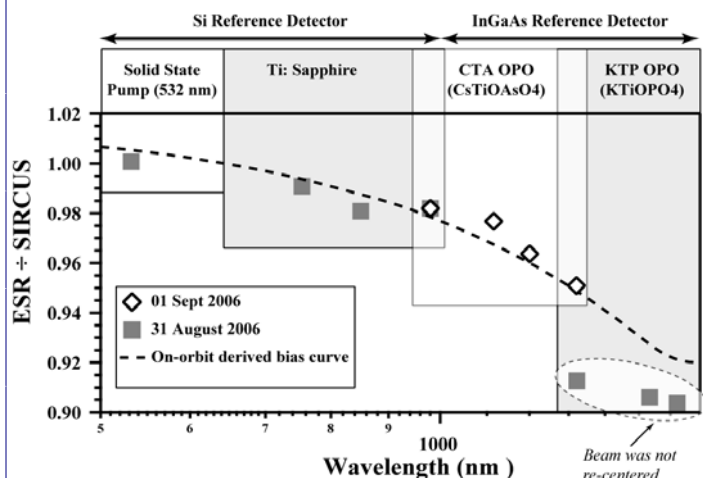


Figure 1 is a summary plot of the findings of the ESR calibration at NIST SIRCUS. The plot shows the laser configurations and detectors used for the comparison. Also shown is the derived in-flight bias curve of the SIM instrument. Future experiments will extend the calibration range cover the full operating range of the ESR. It will also be done with a finer wavelength spacing to reveal the structure in the detectors response.

used to calibrate the beam intensities. As the graph shows, the efficiency of the detector decreases as a function of wavelength. Also shown is the on-orbit bias curve of the SIM instrument's infrared response derived from analysis of the SIM with respect to SOLSPEC and the SRPM model. This figure also shows that at longer wavelengths alignment of the laser beam to the bolometer becomes more critical in the infrared and additional transfer optics are need to assure the alignment. Also, because of the high precision of the ESR and the stability of the SIRCUS laser system, additional structure may be found in the measured efficiency curve that we have not accounted for in the derived bias curve. Filling in this graph with more wavelengths and over an extended range will be the primary goal of our next visit to SIRCUS in January 2007.

Another important aspect of this study was to characterize the shape of the instrument's profile as a function of wavelength. The integrated value of this profile is a critical parameter in the measurement equation to compute the spectral irradiance. This quantity was measured in the visible and extended to other wavelengths by ray trace analysis, but the SIRCUS facility provides additional information that was not available at the time of launch. In particular one of the most important pieces of information that is needed for spectral radiometers is proof that the spectrometer's response profile is the same if you park the wavelength drive at a fixed prism rotation angle and vary the wavelength and if you fix the wavelength and then rotate the prism. This subtle but important reciprocity theorem is at the heart of precise spectral radiometry and the SIRCUS facility provides an excellent test bed to show this for SIM. **Figure 2** is a graph showing the results of this study.

The red curve is derived from using 646 nm light emitted from a ring dye laser and scanning the prism. The grey symbols are from fixing the prism position and then varying the wavelength emitted from the laser. One can see that these two modes of operation produce nearly the same results. The January measurement campaign will perform this experiment at other wavelengths, especially in the infrared where diffraction corrections are the largest, and will include longer scan ranges and better stray light control

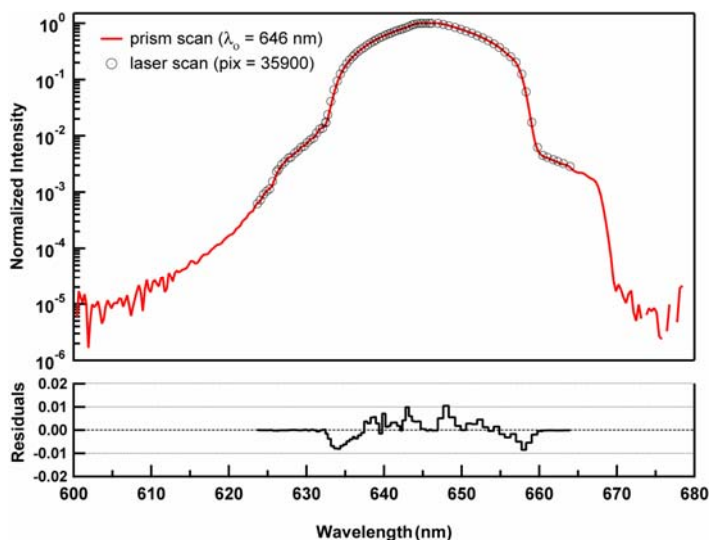
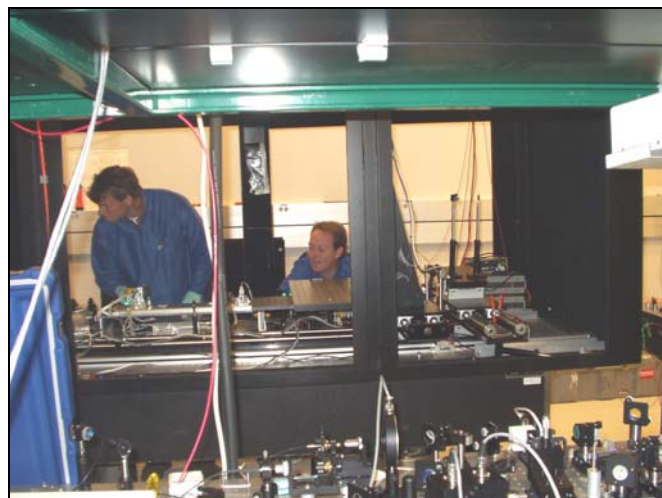


Figure 2, the reciprocity experiment for the SIM brass board. The top graph shows on a log scale the agreement between fixing the position of the wavelength drive and scanning the laser, and fixing the laser's wavelength and scanning the drive. The structure seen at the 10^{-2} to 10^{-3} range is due to coma in the Fèry prism and light scatter off of detector baffles. At the 10^{-4} level, the prism's surface roughness may be contributing to the observed light scatter. The bottom plot shows the residuals between these two modes of operation.

inside the spectrometer. Finally, we would also like to express our thanks to Joe O'Connell for setting up and maintaining the NISTAR chamber and Robert Bousquet for performing the laser beam profile measurements, both critical aspects to the success of this study.



Erik Richard and Nate Miller aligning the ring dye laser (in the foreground) to the SIM spectrometer brass board.

SSI Intercomparison Workshop Held Prior to *SORCE* Science Meeting –

By Marty Snow and Jerry Harder, *LASP, University of Colorado*

A one-day workshop was held prior to the *SORCE* Science Meeting on September 19, 2006, to discuss measurements of the solar spectral irradiance (SSI) from different instruments. The heart of the conversation was the comparison of the two spectrometers on *SORCE* (SOLSTICE and SIM) to other observations.

The morning session of the workshop covered the ultraviolet portion of the spectrum, while the afternoon was devoted to the visible and infrared. A complete workshop summary and most of the presentations are available on the *SORCE* website at:

http://lasp.colorado.edu/sorce/workshops/09_19_06/index.htm

Ultraviolet Morning Session:

There were four presentations in the morning session, all concerned with measurements of SSI from about 115 to 300 nm. This region of the solar spectrum is highly variable on both short and long time scales. Radiation from these wavelengths is predominately absorbed by molecular oxygen and ozone in the upper atmosphere and is the major driver of chemical and dynamical processes in the thermosphere, mesosphere, and stratosphere. Speakers included: Matt Deland (SSAI), Linton Floyd (Interferometrics, Inc.), Marty Snow (LASP), and Frank Eparvier (LASP). Peter Pilewski (LASP) presented a summary of a workshop held in Boulder in August called “*Solar Spectral Irradiance and Climate Modeling*” (see the August 2006 *SORCE* Newsletter).

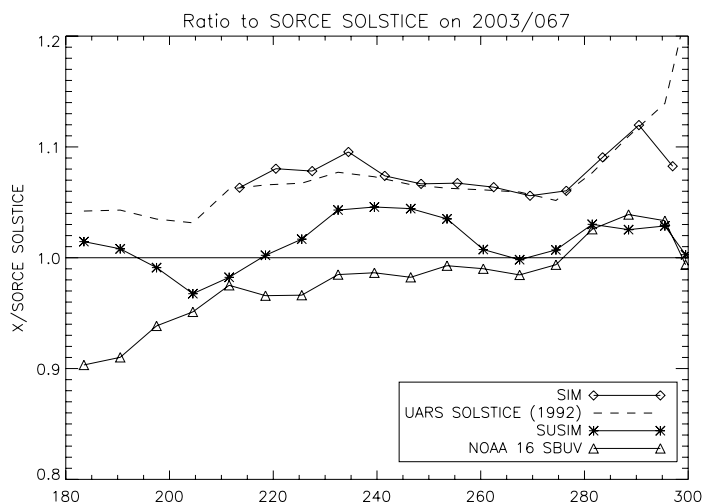


Figure 1. Preliminary analysis of calibration differences in the middle ultraviolet. The four curves shown in this figure are the ratio of measurements from *SORCE* SIM, UARS SOLSTICE, UARS SUSIM, and NOAA 16 SBUV to *SORCE* SOLSTICE. The published uncertainties of each instrument are on the order of a few percent, so agreement at this level is to be expected.

Ultraviolet Conclusions:

In addition to the ultimate goal of having consistent composite time series dating back to 1978, it was determined that a set of UV reference spectra should be produced in the near future.

The UV solar irradiance presenters also had some very fruitful discussions about technical aspects of each mission's data products. Small details such as the time of day for measurements and wavelength binning were examined and noted for further analysis, as well as the larger issues of long-term trends and calibration offsets.

It was recognized that atmospheric and climate modelers are currently upgrading some of their radiative transfer modules (such as the transition from CAM3 to CAM4), and that the time is ripe for encouraging use of more detailed solar measurements.

Visible and Infrared Afternoon Session:

The early afternoon focused on visible and infrared portions of the spectrum. Speakers included: Gerard Thuillier (CNRS, France), Claus Fröhlich (Davos, Switzerland), Mark Weber (Bremen, Germany), Jerry Harder (LASP), Joe Rice (NIST), Geoffrey Toon (JPL), Robert Kurucz (Harvard-Smithsonian), and Juan Fontenla (LASP). The late afternoon session was capped with discussion on two future missions with talks provided by Gerard Thuillier and Hartmut Boesch (JPL).

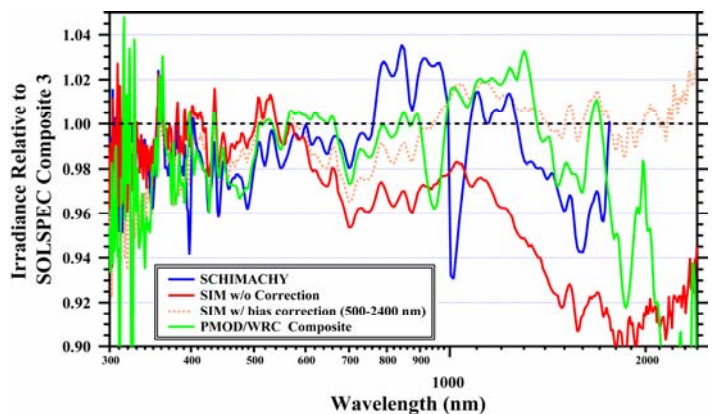


Figure 2. Shows the ratios between SIM, SCHIAMACHY, and WRC85 composite with SOLSPEC composite 3 at the SIM resolution in the 300-2400 nm range. The plot shows two curves for SIM: one with the current long wavelength ESR efficiency correction based on comparison with SOLSPEC, and the other shows the data as measured without this correction. See the previous article on page 1 for more information on this correction factor. The plot shows that in the visible part of the spectrum, the four measurements agree to about the 2-4% level in the visible part of the spectrum (300-1000 nm) with larger deviations in the infrared. More work and comparisons must be done to understand these differences.

Visible and Infrared Conclusions:

Two items best summarize the needs, plans, and actions for visible and infrared measurements:

- Further and more detailed comparisons among these instruments must be performed and published. For in-

stance, comparisons of the absolute scale (accuracy) and solar variability of SIM, SCHIAMACHY, SOLSPEC, and VIRGO SPM are planned and needed. Future comparison activities will continue with launch of SOLSPEC-ISS and the continuing SORCE and SCHIAMACHY missions.

- The greatest uncertainties in agreement between the instruments are in the infrared. Activities like the SIR-CUS/SIM ESR calibration are needed to refine the on-orbit SIM calibration parameters. Future missions like OCO require good calibration of the solar continuum in the IR, and other space missions require good calibration further into the IR past 3000 nm. These measurements can be aided and extended by inclusion of solar model calculations such as those presented at this workshop.

2006 SORCE Science Meeting Summary –

The 2006 SORCE Science Meeting was an enlightening week as attendees explored *Earth's Radiative Energy Budget Related to SORCE*. A complete meeting summary is on the SORCE Meeting website at: <http://lasp.colorado.edu/sorce/2006ScienceMeeting/index.htm> On the left side bar, you will also see links to the meeting agenda, presentations, and photo gallery. The Sept/Oct. SORCE Newsletter provided a brief photo summary.

Plans for the 2007 Science Meeting will be posted on the website as they become available. We are tentatively looking at Santa Fe, New Mexico.

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



Doug Lindholm Joins SORCE Data Processing Team –

On October 16, the SORCE Data Processing team gained another member. After 11 years at UCAR, Doug Lindholm joined LASP to work on the SOLSTICE instrument processing alongside programmer Barry Knapp and instrument scientist Marty Snow.



Doug Lindholm, the newest SOLSTICE team member. He is working on SORCE Data Processing for Chris Pankratz.

Doug's background is ideal for his new position at LASP. He has managed large data sets in the past and has been programming computers for over 20 years. Most recently Doug was the lead architect and developer of a Java based data repository framework to provide a simple interface to manage large data sets and metadata in meteorology research and weather forecasting. Over the years he has created programs in several computer languages on varying platforms for climate data assimilation, analysis, and visualization applications.

After obtaining Bachelors degrees in both Physics and Astronomy from the University of Kansas Doug and his family moved to Colorado, where he continued his education at CU in Boulder, earning a Masters degree in Astrophysics in 1993. Some of you may remember him from his days in the APAS Department in the early 1990's. Doug and his wife Gina live in Thornton with their three sons, ages 15, 14, and 12. Like most everyone in Colorado, he and his family enjoy the outdoors, specifically summer backpacking trips, golfing, and hiking.

Stop by his office to say welcome – Room 278 in the old LASP building.