SEM the Solar EUV Monitor on SOHO
Celebrating the First Solar Cycle of Continuous EUV Measurements

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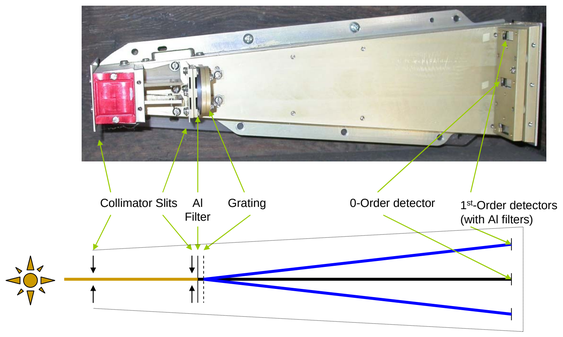
The Solar EUV Monitor (SEM) is a small transmission-grating spectrophotometer, part of the CELIAS experiment on SOHO. Since December 1995 SEM has been measuring the solar flux in two EUV wavelength channels.

Instrument



The SEM was designed and built by the Space Sciences Center at the University of Southern California. A 5000 l/mm gold transmission grating developed at MIT acts as the dispersing element. A 150 nm thick free-standing Aluminum filter from Luxel limits the incident solar radiation to the 0.1 – 50 nm bandpass, this is measured with an IRD photodiode placed in the zero-order of the grating. Symmetrical 1st.-order detectors (again IRD diodes) are placed behind a mask to define the 26—34 nm bandpass, centered on the He II 30.4 nm line. All the detectors also have a 150nm Al filter deposited onto the surface to reduce white-light sensitivity. The entrance aperture is 2 × 10 mm. In front of the aperture/grating/filter assembly are 2 fine electroplated screens parallel to the incoming beam. A voltage of about 500 V is applied between the screens which deflect charged particles entering along the instrument bore sight.

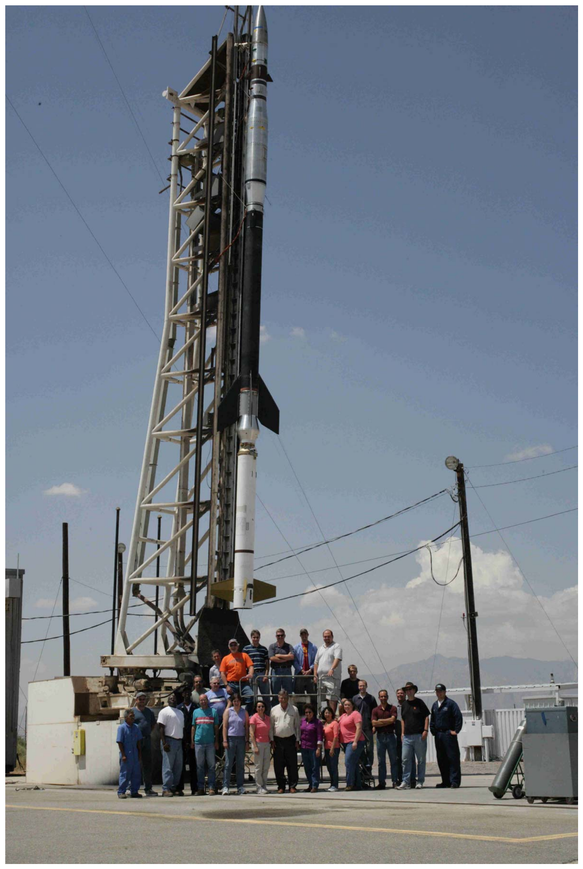
The photodiode current is amplified and digitized using a voltage to frequency converter on the instrument itself. The rest of the electronics (power supplies, counters, housekeeping (PSU voltages and detector-plane temperature) is handled by the CELIAS particle detector instrument on SOHO, and by custom electronics on the rocket.

Calibration

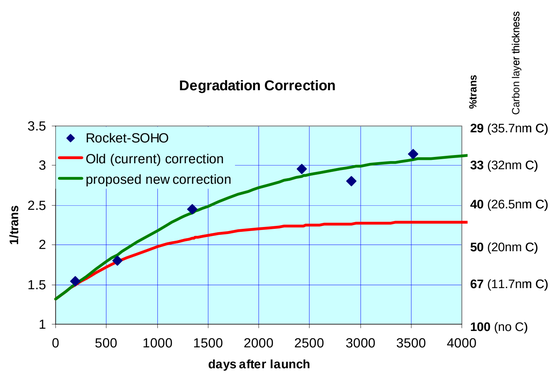
EUV instruments are very sensitive to minute levels of surface contamination. Though the grating itself is almost immune to degradation, the filters and photodiode detectors are both subject to degradation. To quantify and sensitivity changes of the on-orbit instrument NASA has supported a sounding rocket program throughout the life of the SOHO satellite. An almost identical SEM instrument is calibrated on beam-line 9 at the Synchrotron Ultraviolet Radiation Facility (SURF) facility at NIST in Gaithersburg, MD.

This instrument is periodically flown as part of a sounding rocket payload from the White Sands Missile Range (WSMR) in New Mexico. After the payload is recovered the calibration is repeated at NIST.

The result of these calibration flights is an instantaneous measurement of the degradation of the SOHO SEM. Any sensitivity change is modeled as a layer of carbon in the optical path.

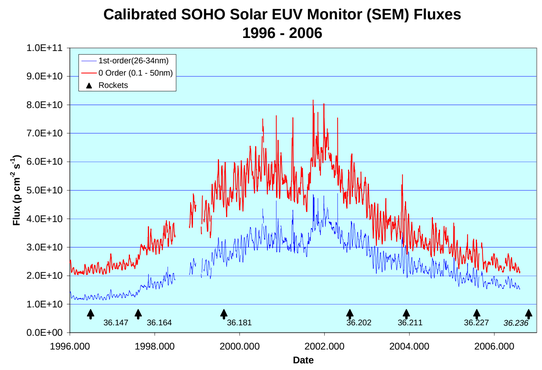


By comparing the rocket measurements (after atmospheric and orbit corrections) to the SOHO measurements made at the same time an equivalent thickness of carbon can be calculated. The model of a finite carbon source predicts an exponential growth of the carbon layer, and that is what we see in practice. The degradation is fitted and used to restore the on-orbit data.



Data

SEM has been measuring the solar EUV flux almost continuously since SOHO operations began at the end of 1995. Except for the SOHO “vacation” the data set is almost uninterrupted, with gaps due only to spacecraft maneuvers and recently due to the “key-hole” events caused by spacecraft maneuvers to maintain the pointing of the high-gain antenna. This provides continuous coverage of solar cycle 23.



An automatic near real-time data processing system is almost in place, but at the moment the process is run by hand. The automatic system will update the existing site given below.

The “native” integration time of SEM is 0.25 s, however to conserve bandwidth this is converted to 15 s averages onboard. At USC we provide data products at 15 s, 5 min, 10 min and 1 day averages.
The data is available on the WWW at:
http://www.usc.edu/dept/space_science/

Thanks

This work would not have been possible without the enthusiastic support of the whole NASROC and WSMR teams. They are a big part of what makes rocket science fun. Thank you!

Calibration at NIST is also a team effort, and we would like to thank the many support staff who always seem to accommodate our rushed schedules and unreasonable requests.

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