SOLAR MONITOR DESIGN FOR THE NEAR X-RAY SPECTROMETER; P.E. Clark, Catholic University and Goddard Space Flight Center, J. Trombka and S. Floyd, NASA/Goddard Space Flight Center

The X-ray spectrometer onboard the Near Earth Asteroid Rendezvous (NEAR) spacecraft will contribute to the determination of the composition and structure of Eros. The excitation source for the X-ray lines characteristic of major elements is the sun (1,2,3). The solar spectrum consists of a continuum which is generated by thermal bremstrahlung and radiative recombination, with superimposed major lines which result from emission due to transitions in H and He-like ions.

SPECTRAL VARIATIONS: The solar spectrum is highly variable in the soft X-ray region, both in overall intensity and in slope (4,5,6). The intensity of the sun's output decreases by three orders of magnitude from 1 to 10 Kev, the energy region of interest; thus, lines characteristic of higher atomic number elements have intrinsically lower intensities. In fact, the major elements with higher atomic number (Ca, Ti, and Fe) require a more active sun to induce characteristic X-ray lines at intensities which are comparable to intensities for lower atomic number elements (Mg, Al, Si) induced under more quiescent conditions. Other dramatic spectral changes which occur as the level of solar activity changes. The spectrum flattens out as the level of activity increases. These changes reflect the relatively greater proportion of output from continuum in active regions as the solar flux increases. This phenomenon is known as 'hardening'.

TEMPORAL VARIATIONS: In addition, recent studies of the sun's soft X-ray output have indicated that the sun's output is highly variable on all time scales (4,5,6,7,8,9). Output may vary by an order of magnitude on a minute to minute basis. Flares, which can increase the intensity of the solar flux by three to four orders of magnitude, generally occur in clusters, with as many as 5 to 10 a day for as long as a few days. The higher intensity flares occur less frequently yet last longer than lower intensity flares; however, short high intensity bursts (spikes) and long low intensity flares are known (4,5,6). The soft X-ray flux tends to remain elevated above background for a considerable period after flare onset. In addition, the average activity increases by at least on order of magnitude from minimum to maximum during the cycle. Fortuitously, the sun is likely to be near maximum during the NEAR mission.

MONITOR DESIGN: Thus, the sun's output must be monitored and measured simultaneously with surface measurements, to determine and correct for changing levels of solar output. In order to accomplish this task, two solar monitors, differing in design, were included as part of the experiment package. Monitors must be able to operate over three orders of magnitude of solar output, and three orders of magnitude variation in the spectral intensity from 1 to 10 kev. One monitor, an experimental detector type not flown before, is simply a solid state PIN detector with a 1.2 square millimeter window. The other monitor is a sealed, gas-filled proportional counter, similar to ones flown before, readily available as 'off-the-shelf' hardware and thus cost-effective. One of the challenges of the design process was to design a filter tospecially designed to selectively enhance the higher energy spectrum, while retaining a sufficient portion of the lower energy spectrum. The filter, placed on the 25 square centimeter 1 mil thick Be window, consists of a sandwich of the following layers, constrained by properties and availability of materials, from bottom to top: on the 1 mil Beryllium window, 62.5 mils of Delren with a .01 square centimeter hole, then 4 mils of Beryllium with a .005 square centimeter hole over the Delren hole. Then, a 1.5 by 1.5 centimeter hole is made in the next layer, 15 mils of Aluminum, which effectively reduces the maximum useable window area to 2.25 square centimeter by attenuation. This is thermally shielded with a 1 mil layer of kapton. The filter effectively operates as a graded shield in two modes: the 'thinner', inner hole contributes the lower energy spectrum which has an intrinsically higher flux. The small size of the inner hole reduces the contribution from this part of the spectrum. A 'thicker', outer area, surrounded by the Alumimum shield effectively suppresses the lower energies while selectively higher energies over a much larger effective window area. The filter was also designed to deal with instrument design constraints as well. The signal is rapidly degraded when more than 10000 counts per second are generated, or more than 65,000 in any given channel during the counting interval (nominally 100 seconds). This design was such that those limits were not exceeded at all but the most active flares. Yet sufficient signal must be generated over the integration interval so that data is useable for removing solar variations from asteroid data. This limit was set at a minimum of 10 counts per channel to get spectral shape. This condition should be met at normal solar background levels during the NEAR mission, which will fly at solar maximum. The PIN detector provides better spectra during more quiescent solar conditions, and may be used during less active periods. Solar monitors may also be used alternately.

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