

The Solar Bolometric Imager – Recent Results and Future Plans

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The Solar Bolometric Imager is a novel photometric instrument developed to produce images of the Sun (or other scenes) in broad band light with non-selective spectral response. It consists of a 30-cm aperture Dall-Kirkham telescope with all -reflecting, uncoated optics enabling unfiltered imaging of the Sun. The detector is a 320 x 240 element, barium strontium titanate, uncooled thermal array. The detector surface was coated with a thin layer of gold black to produce spectrally flat response over the wavelength range between at least 0.3 – 2.6 microns containing over 94% of the solar irradiance.

The photometric response of the chopped ferro-electric array is approximately linear at the lower end of the operating range, becoming about 10% sub-linear at higher illumination levels. This non-linearity is corrected using laboratory and in-flight calibrations measurements. The SBI's purpose is to measure the photometric contrast of localized solar structures like sunspots, compared to their immediate surroundings, to a precision of a few percent. There is no requirement on the absolute accuracy of the SBI response. Laboratory measurements indicate that the required stability of relative response is met, at least over the limited duration of a balloon flight.

After development of a ground based prototype at CRI, Inc. (Foukal and Libonate, 2001), the SBI was modified for balloon flight at the Johns Hopkins University/Applied Physics Laboratory (Bernasconi et al., 2004), and successfully flown to an altitude of 109,000 ft on Sept 1, 2003, from the National Scientific Balloon Facility at Ft. Sumner, NM. This one-day flight produced the first broad-band photometric contrast measurement of solar magnetic faculae (Foukal et al., 2004), which make the dominant contribution to solar irradiance variation. It also produced the first measurement of photospheric limb darkening in broad-band light. These facular contrast measurements have recently been used to produce the first empirical reconstruction of solar irradiance variation with no free parameters. This reconstruction shows that spots and faculae can account for the amplitude of the radiometrically observed irradiance variation, at least on solar rotational time scales (Foukal et al., 2005).

The SBI is presently being prepared at JHU/APL for a longer NASA balloon flight from Antarctica in late 2006. At the same time, its suitability for space flight is also being investigated. The results so far indicate that the SBI would provide



The balloon-borne SBI being readied for its launch on Sept 1, 2003.

an ideal complement to radiometers on a future space-borne experiment optimized to measure and also image total irradiance variations to the highest precision level achievable in next-generation pyrliometry. Radiation testing indicates that detector response is unaffected up to an integrated dose of at least 4 krad, thus compatible with a mission lifetime of about 4 yrs on a 28 degrees orbit at an altitude of 600 km, with reasonable shielding. Chopped detectors are increasingly gaining space-flight heritage thanks to NASA missions like SWAS and SST. Modeling indicates that, if necessary, a more compact SBI of smaller aperture can be used without much loss in performance. We plan to measure the SBI spectral response to check the +/- 10% flatness over its broad wavelength range calculated from our previous optical modeling.

References

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