Responsivity of IRTS/FILM in Orbit

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In order to describe the responsivity change of the Far-Infrared Line Mapper (FILM) and to provide an idea on responsivity calibration scheme for the ASTRO-F mission, we studied the detector responsivity of the FILM and ascertained the calibration scheme. Space-borne telescopes are necessary for astrophysical far-infrared observations. However, the impact of cosmic rays and high energy particles trapped in the Earth's radiation belt can change the responsivity of extrinsic photoconductors and seriously affects the accuracy of the astrophysical observations.The Japanese infrared space telescope satellite mission, the Infra-Red Telescope in Space (IRTS), developed by the Institute of Space and Astronautical Science (ISAS), was launched in 1995. The FILM, one of four focal plane instruments of IRTS, suffered heavy irradiation by high energy particles during its' passage through the South Atlantic Anomaly (SAA), 7?8 times a day. Applying a bias voltage above the breakdown level (bias boost) effectively restored the responisivity to its pre-irradiated value. However, the bias boost did not suppress the residual effect perfectly and showed its own side-effects on the responsivity. Hence we analysed this change in responsivity in order to establish the appropriate calibration method. The method should be useful for ASTRO-F mission, which uses the same detector. Therefore we have studied the responsivity calibration of the FILM instrument as a part of the ASTRO-F/FIS data reduction program.

We introduced a simple two-component exponential function, which was fitted to the responsivity change after bias boost at the end of each SAA passage of the satellite. The first component is for the side effect of bias boost, and the second component is for the residual effect of the irradiation by high energy particles. We found good correlation between the amplitude of each component and the number of glitches which we adopted as a measure of the irradiance. In particular, the correlation between the amplitude of the second component and the number of glitches can be interpreted as being determined by the donor occupancy of the extrinsic detector at the end of the bias boosts.

The distribution of residuals of the fitting is well described by a Gaussian distribution, whose standard deviation is consistent to the detector noise level. Hence, we conclude that the current calibration scheme with the simple two-component exponential function successfully describes the responsivity change on orbit.

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