16th International Workshop on Low Temperature Detectors
20-24 July 2015

High and low flux nonlinearity correction of NIR H2RG 2Kx2K arrays

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Euclid is an ESA M-class mission to study the geometry and nature of the dark Universe. A set of H2RG near-infrared detectors read with a SIDECAR ASIC will be implemented on the Euclid payload module. The Near IR Spectrometer Photometer (NISP) role is to measure the galaxies' redshift and its baseline operation modes are slitless spectrometry mode with grisms and photometry mode using filters.

The possible readout modes for Euclid mission are the multiple Fowler or Up-The-Ramp samplings, as they are efficient in rejecting spurious events such as cosmic rays. The detector array is operated with 32 output channels read simultaneously so as to allow a reduction of the noise by averaging multiple nondestructive reads. We use reference pixels situated on the top and bottom of each output strip and two 4-pixels wide strips in the external outputs to substantially lower the detector readout noise in the two modes mentioned here before.

The Photon Transfer Curve (PTC) method is applied to measure the conversion factor. As the accuracy per pixel is determined by the statistical errors that are usually very high we combine this first estimate of the conversion gain with a local averaging over areas of flat and stable illumination in order to achieve higher accuracy.

The non-linear response of the H2RG detectors is studied to provide maps that will allow a direct in-flight or on-ground correction. Two types of corrections are studied.

For the on ground detectors characterisation we study the degree of polynomial that should ba applied in each pixel to fit about 1000 points time sampling in exposures taken at typically ten illumination fluences. Different fluece regimes are covered and the full dynamic range of the detector is explored. We show that with the 4th order polynomial we can correct the pixel signal to better than 0.1%.

During flight phase only the final slope, not corrected for nonlinearity, will be sent on ground for each pixel.
The precision of the nonlinearity correction during flight phase will depend on the possible fluctuations of the pixels baseline levels, caused by temperature and/or biases fluctuations. The readout mode and exposure time will be also likely to affect the precision of the recovered signal. We adress thses issues in our study and present how this precision evolves with the detector readout mode and with exposure time.

If persistence effects are neglected, it is shown that the correct fluence can be recovered on ground by correcting the straight line fits performed on board, with an accuracy of 10**(-3) on the linearity correction for fluences exceeding 1e/pix/s in EUCLID acquisition conditions. The persistence issues affecting the nonlinearity are also addressed.