Test 1.2.6 Detector dark current (& Optimum detector temperature settings) for Ge:Ga detectors

Objectives

Measure the dark current for each pixel. The aim is to determine whether it makes up a substantial fraction of the light current. For the blue array this should be done for various possible detector temperatures in order to constrain the selection of the operating temperature with regard to maximum acceptable dark signal. The measurement also serves as reference for straylight assessment, if the FPU is mounted in different environments (PACS test cryostat, Herschel cryostat for various IMT and IST tests).

The specification for the dark signal is that the number of dark electrons per second, $\mathrm{N(e^-)_{dark}}$, should be $\leq 5 \times 10^4$ $\mathrm{e^-\ s^{-1}}$, for both arrays. The dark current is

$$I_{\mathrm{dark}}[\mathrm{A}] = \mathrm{s_{dark}}\ [\mathrm{V/s}] \times \mathrm{C_{int}}\ [\mathrm{As/V}]\ ,$$

$\mathrm{s_{dark}}$ being the measured dark signal and $\mathrm{C_{int}}$ the selected integration capacity of the CRE.
The dark signal can be expressed as dark electrons

$$N(e^-)_{\mathrm{dark}}\ [\mathrm{s^{-1}}] = \frac{\mathrm{I_{dark}}}{\mathrm{Q_{e^-}}} \qquad \mathrm{Q_{e^-}} = 1.602 \times 10^{-19}\ [\mathrm{As}]$$

Priority

B

When performed / frequency

CQM-ILT
PFM-ILT
EQM-IST
In Flight, if re-optimization of detector settings is required.

Inputs, prerequisites

All internal and external stimuli should be switched off to avoid straylight. This means that the measurement has to take place at the beginning of a test block before stimuli are powered up. When the spectrometer is switched on it should be avoided to heat up the internal sources immediately.

Interconnections

A. Fulfilled By

B. Fulfilling

1.2.2 'Optimum detector temperature settings' for dark configuration (blue array).

OGSE Setup, astr. sources, OBSW Compr./Red.

SPU mode: buffer transmission mode;

For ILTs the OGSE is set up to dark position and all stimuli are off. The PACS internal calibrators are off, too. In addition the dark current level will be determined by looking onto one of the cold PACS internal calibrators.

In-flight the telescope should be pointed to a 'blank' region of the sky.

Test Implementation Procedure (TIP)

The dark signal should be independent of the grating order, since all external illumination should be suppressed; nevertheless verify that by repeating the measurement both for the 2nd and 3rd order filter setting of the blue array. For the second one the temperature loop is reverted.

Step #	Test Implementation Procedure	OGSE Setup Changes	Online Analysis	Pass/Fail & Remarks
	(Combined) FM ILT CIP for req. 1.2.6 Detector dark current req. 1.2.2 Optimum detector temperature settings			
	Setup the instrument for this PTD			
0.01	`Switch on PACS` (if not already done).			
0.02	`Set CDMS on Burst-Mode` (if not already done).			

0.03	`Setup spectroscopy mode` (if not already done).
	Apply default parameters except:
	`- set integration capacity = 0.1 pF`
	`- RI = 2 sec`
	`- select optimal bias`			

0.04	`Setup the SPU` set buffer transmission mode			
0.05	`Setup blue detector temperature` set blue detector temperature to 2.1 K with command DMC_SET_B_SPEC_HEATER_C			
0.06	`Mechanism` grating can remain at its default position; select 2nd order sorting filter for blue channel;			manually;
	Step 1 : Blue (low stressed) Ge:Ga detector (red detectors in parallel):			

1.01	Loop over blue detector temperature: 2.1K; 2.5K; 2.9K; 3.2K; 3.5K Wait for temperature stabilization (900s or wait until temperature is confirmed repeatedly in house-keeping) Perform T_obs = 420s measurement with RI (reset interval) = 2s (for 3.2K 1s and for 3.5K 1/4s), C_int = 0.1pF for both the blue and the red array End loop temperature variation blue detector			
2.01	Set PACS to default starting mode. set PACS back to its default starting mode set blue detector temperature to default value XX (TBC).			

Estimated time needed

Considering 5 temperature settings for the blue array (the red array is measured in parallel) and with the repetition for the 2*nd* and 3*rd* order:

$10 \times (60\,\text{s stabilization time} + 420\,\text{s measurement time}) = 4800\,\text{s} \approx 1.4\,\text{h}$

Success criteria, required accuracy

Test Analysis Procedure (TAP)

Step #	Test Analysis Procedure (Offline)	Online Analysis Input	Output, Products	Requirements on IA
	(Combined) FM ILT TAP for req. 1.2.6 Detector dark current req. 1.2.2 Optimum detector temperature settings			
1.01	The temperature HK has to be monitored on-line.			
1.02	The final signal analysis is performed in IA. For each pixel the dark signal is determined by fitting the ramp slopes and averaging the signals of all ramps or signals may be determined from pair-wise read-outs.			
1.03	For the blue array this is done in dependence on the detector temperature and wavelength order. - Determine the relative increase of dark signal with temperature. - Check for consistency of the two temperature scans in the two different grating orders. - Check for reproducibility of the measurements with the red array. - Check whether there is some systematic behaviour of the dark signal of the red array with the temperature increase/decrease at the blue array.			
1.04	The dark signals are converted into dark electrons per second and the compliance with the specification is checked.			
1.05	The dark signals of all pixels shall be displayed in 2D colour plots to identify any gradient (possibly due to straylight) or the location of peculiar pixels.			

Output, products

The dark signals of all pixels will be provided in a dark signal matrix to be subtracted from the raw signals in staring mode measurements.

The analysis of CQM-ILT test data has been described in the Report "Req. 1.2.6 Performance test of dark current" as part of the PACS Test Analysis Report CQM-ILT part II (PICC-KL-TR-001, part 2).

The analysis of CQM-ILT test data has been described in the Report "Detector Dark Current Test on Internal Calibration Sources during Cold EQM-IMT" (PICC-MA-TR-003).

Coding Strategy

Version number

$Revision$: 1.2