Data analysis of glitches from CQM testing
SPIRE-UOL-REP-~~002207~~

002208

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Table of Contents:

1. Scope

Results are reported on flagging and characterizing glitches in the data from the CQM test campaigns in 2004. While a lot of funny things are apparent in the test data, this report focuses on short-lived transients and argues that they are due to instantaneous depositions of energy on bolometers. The goal is to validate the modeled impulse response function due to the thermal properties of the bolometers and the read-out electronics.

A comparison with the post-vibration test campaign in September/October 2004.

2. Reference Documents

#	Title	ID
RD1	Herschel SPIRE Detector Subsystem Specification Document	SPIRE-JPL-PRJ-000456, issue 3.2
RD2	Herschel SPIRE Detector Control Unit Design Document	SAp-SPIRE- FP-0063-02 , issue 0.3

3. Applicable Documents

#	Title	ID
AD1	Glitch Simulation	SPIRE-UOL-REP-002207, v0.1

4. Identifying and characterizing glitches

PLW's response to a Dirac input was modeled as the transfer function of the thermal response of the bolometers and the electrical filter (see AD1). The specifications for the bolometers and the read-out electronics were used for this model (RD1, RD2). The resulting impulse response function (IRF) was used to synthesize test data and develop an algorithm to identify such glitches reliably (see Figure 1).

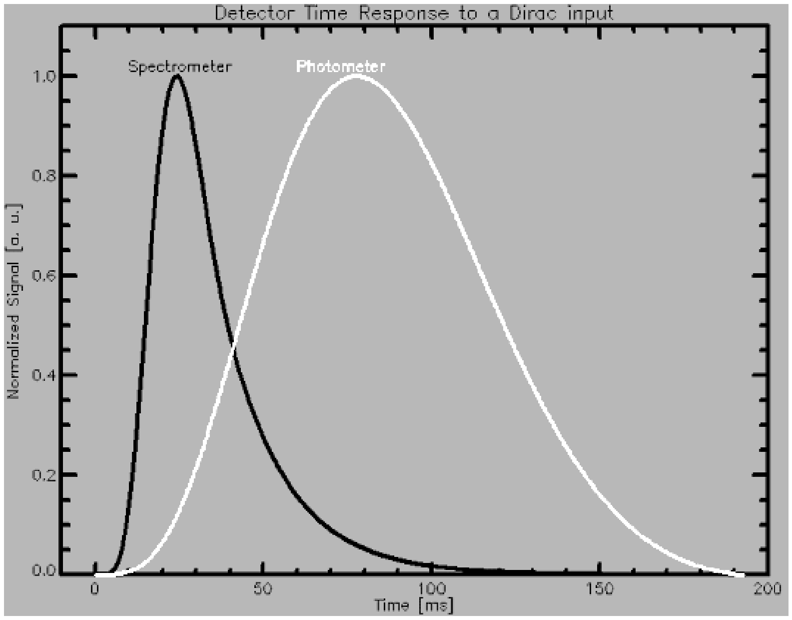

Figure 1: Impulse Response Functions for the spectrometer and the photometer (PLW). The thermal behavior of the bolometers and the electronics of the DRCU are taken into account.

A procedure was developed to identify and characterize the IRF as it has been modeled for PLW:

1. The pool of potential glitches was established as the set of all points that show an unusually steep negative slope leading up to them. All points were flagged as potentials where the preceding slope is smaller than the average slope minus one standard deviation.

Use rejection criteria, based on knowledge about the expected glitches, to remove false positives:

2. Reject any potentials with a rising edge of less than three points. The rising edge is defined as the set of points leading monotonically to the extremum of the glitch. It also includes the glitch peak.
3. Reject any potentials with a rising edge of more than six points.
4. Reject potentials with a recovery period of more than ten points. The recovery period is defined as the set of points from the glitch peak back to the baseline, where the baseline is established as the average of the 20 points before the rising edge. It also includes the glitch peak.

Fit an exponential function to the recovery period.

5. Reject potentials with an RMS greater than 0.3.
6. Reject potentials with a resulting decay rate τ of less than 10ms and more than 1000ms.
7. Reject potentials with an amplitude of less than 3.6 times σ, the standard deviation of the data points.

This filtering procedure leads to good results with the synthetic data: Of 1000 synthetic glitches of an amplitude of 5 standard deviations of flat white noise, 955 were correctly identified while 15 false positives were flagged. The data were sampled at a rate of 40Hz.

The impact of the rejection criteria can be seen from Figure 2 that shows the normalized τ-distributions of the accepted and rejected potentials.

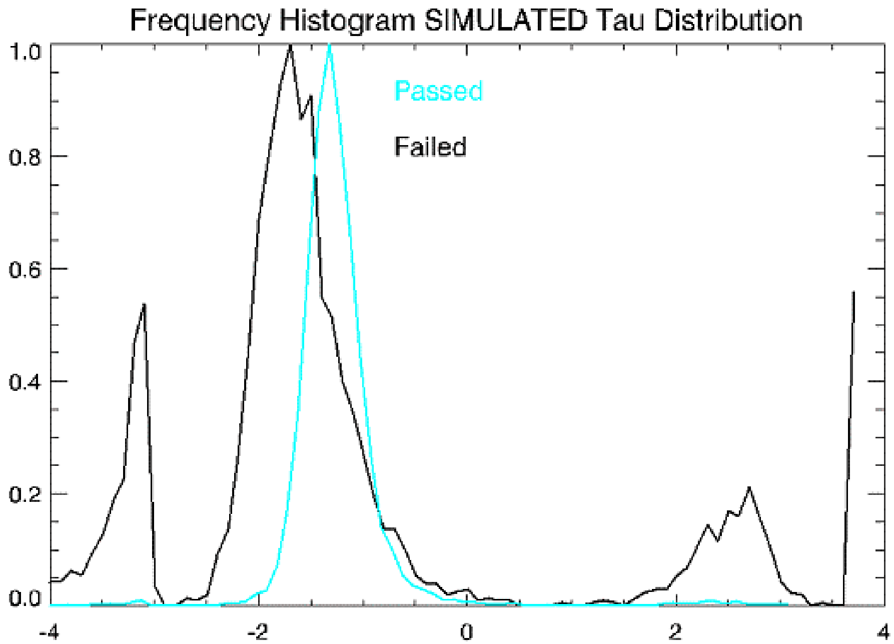

Figure 2: τ-distributions of potentials in synthetic data that were rejected (black) or accepted (cyan) by the filtering; plotted against log(τ) and each normalized to 1

The average τ of the glitches that passed the filtering is 48.9ms with a standard deviation of 58.3ms The large spread in τ is due to the fact that the IRF is not strictly an exponential curve which leads to different results for τ depending on glitch amplitude. In addition, the coarse sampling makes it difficult to measure the recovery rate accurately.

5. CQM data

Data from the pre-vibration test campaign was taken from the non-illuminated pixels from performance tests involving the Test Facility FTS. The sampling rate in these cases was 43Hz or a time interval of 23ms. Overall, 110 hours of single-pixel data were analyzed.

6. Pre-vibration test campaign, February 2004

The procedure that was developed for synthetic data was applied to the CQM data. As the data were considerably more noisy than the assumed white noise baseline, a stronger filter on the measured glitch amplitude had to be applied (5σ instead of 3.6σ) in order to keep the amount of data manageable (see Figure 3).

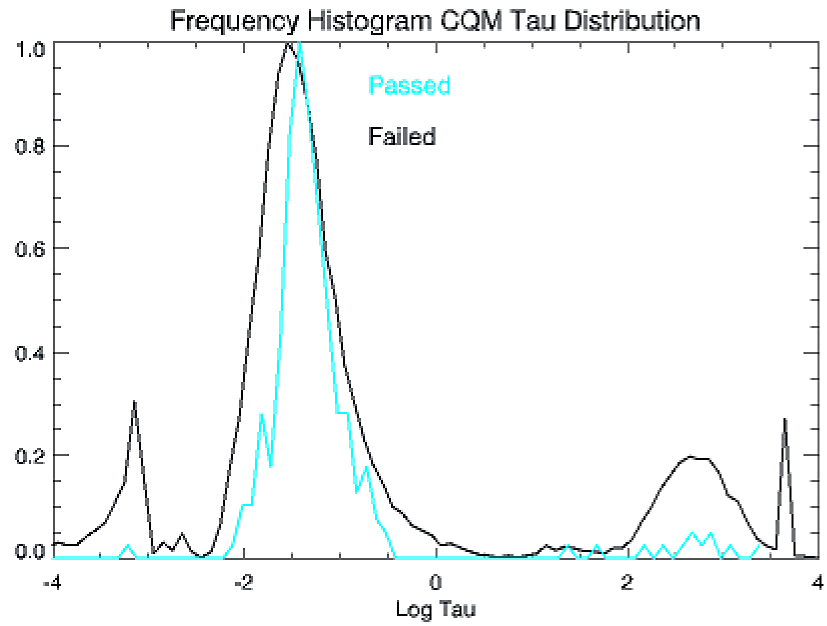

Figure 3: τ-distributions of potential glitches in the pre-vibration CQM data that were rejected (black) or accepted (cyan) by the filtering; plotted against log(τ) and each normalized to 1

230 glitches passed this filtering and were tagged manually into likely and un-likely glitches. About half of the glitches were tagged as actual glitches after visual inspection by two people. The distribution of the glitches manually tagged as likely glitches in the CQM pre-vibration data is similar to the distribution of synthetic glitches (see Figure 4).

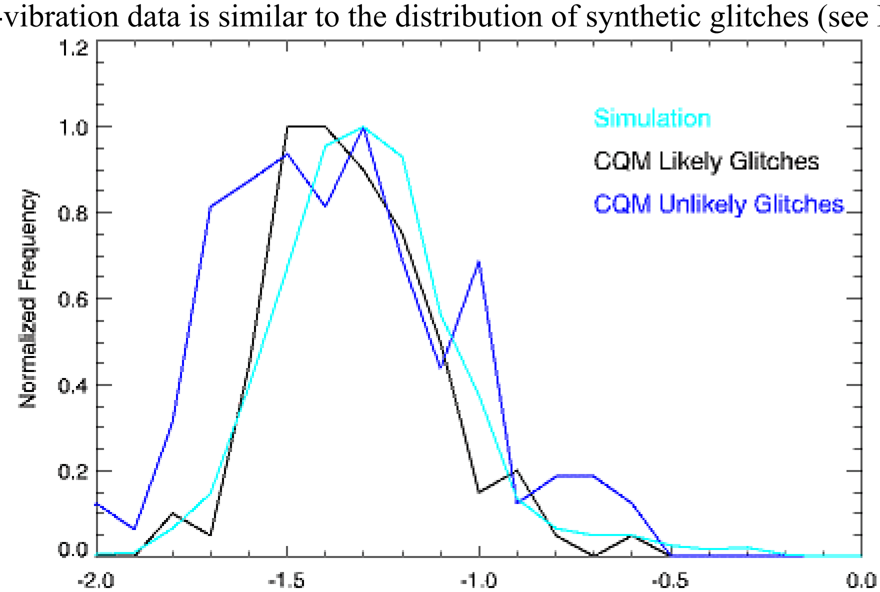

Figure 4: τ-distributions of potential glitches in the pre-vibration CQM data that were rejected (blue) or accepted (black) manually after they had passed an automated filtering process against the synthetic glitches; plotted against log(τ) and each normalized to 1

The resulting time constants and the spreads of the time constant distributions show an approximate agreement (see Table 1).

	τ [ms]	FWHM(τ) [ms]
Synthetic	48.9	58.3
Pre-vibration CQM – manually glitches	43.6	54.0
Pre-vibration CQM – manually rejected glitches	39.4	66.8

Table 1: τ and the spread of τ from the distributions of synthetic and measured data

The agreement is not very strong and it may be assumed that other noise sources during testing are responsible for the observed mismatch. However, the numbers still indicate that the pre-vibration CQM data contain IRFs as modeled from the specifications of the bolometers and read-out electronics.

7. Post-vibration test campaign, September/October 2004

Data during the performance tests with the Test Facility FTS during the post-vibration test campaign were taken at a sampling rate of ~17.5Hz or at time intervals of 57.24 ms. The respective analysis for the post-vibration data is still outstanding.