# rgsoffsetcalc

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**Abstract**

Calculate the mean and the standard deviation of the pulse height distribution of RGS diagnostic images.

## 1 Instruments/Modes

| Instrument | Mode |
|---|---|
| RGS | DIAGNOSTIC |

## 2 Use

| | |
|---|---|
| pipeline processing | yes |
| interactive analysis | yes |

## 3 Description

Visible stray light and bright stars in the RGS avoidance fields can alter the zero energy level (CCD electronics offset or pedestal) measure by the RGS CCDs. This effect, if not properly taken into account, can affect the energy calibration of X-ray events. [1]

It is ensured procedurally during the operations of the instrument that DIAGNOSTIC mode data of all CCD's are available at the start and at the end of each observation. Furthermore, if enough telemetry bandwidth is available, DIAGNOSTIC mode data are also transmitted interleaved with science data (this type of DIAGNOSTIC data is called Q-memory). Q-memory data are not guaranteed to be present for all CCDs in all observations, due to the uncertainties in the predicted event rates (hence in the telemetry requirements).

DIAGNOSTIC and Q-memory data can be used to determine the offset and noise levels of the CCD electronic chains at the actual telescope pointing. Q-memory data could be used to devise a time dependent

[1] Light of stars outside the telescope field of view may reach the RGS focal plane after reflections on the front side of the gratings. Optical light may also be reflected on the back surface of the gratings; before launch the exact magnitude of this effect is not known. Regions around the pointing direction from which light could be reflected on the RGS focal plane are called *avoidance fields*.

correction of the offset levels by interpolation. This will only be implemented at a later time, if in-orbit experience warrants it.

**rgsoffsetcalc** accepts a list of DIAGNOSTIC datasets (refer to the ODF ICD [1]. For each DIAGNOSTIC dataset **rgsoffsetcalc** calculates the mean and standard deviation of the pulse height distribution. This calculation is performed by CCD node. The mean and standard deviation are calculated by fitting a Gaussian to the pulse height distribution.

Before being processed each diagnostic dataset is examined to determine if it is likely to yield a good fit. The dataset is ignored if any of the following conditions is false:

- less than 10% of the pixels are empty. A pixel is considered to be empty if the pulse height amplitude it measures is equal to the value indicated by the attribute `BLANK` ([1]).

**rgsoffsetcalc** stores the results of the computation in the dataset specified by `outset`. The output dataset can be used as a CCF constituent, and this is usually how **rgsevents** will use it. Because the output dataset is a valid CCF constituent, it can only contain data relative to one CCF scope [2]. If the list of input datasets contains more that one CCF scope (this is identified through the attribute `INSTRUME`), **rgsoffsetcalc** will process only the datasets belonging to the first CCF scope identified (this is the scope of the first dataset in the input list). A warning is issued.

**rgsoffsetcalc** can also operate on a list of datasets that do not conform to the ODF ICD. The only requirement is that the arrays be of type integer16. In this case the output dataset is not formatted as a valid CCF constituent. In the output table, null values are used to indicate information that could not be obtabined from the input datasets.

Optionally, **rgsoffsetcalc** can store the pulse height distributions for each input dataset and node in a dataset (see the description of `withhistogramset` and `histogramset`).

# 4 Parameters

This section documents the parameters recognized by this task (if any).

| **Parameter** | Mand | Type | Default | Constraints |
|---|---|---|---|---|
| **sets** | yes | set | ” | none |
| The list of DIAGNOSTIC mode datasets | | | | |
| **outset** | no | set | 'rgsoffsetcalc.ds' | none |
| The output dataset | | | | |
| **withhistogramset** | no | boolean | no | none |
| This controls whether the pulse height distributions shold be saved to a dataset | | | | |
| **histogramset** | no | set | histo.ds | none |
| The dataset where to store the pulse height distributions | | | | |

# 5 Errors

This section documents warnings and errors generated by this task (if any). Note that warnings and errors can also be generated in the SAS infrastructure libraries, in which case they would not be documented here. Refer to the index of all errors and warnings available in the HTML version of the SAS documentation.

**CalibrationScopeIgnored** *(warning)*
**rgsoffsetcalc** cannot identify a CCF scope (attribute `INSTRUME`) in the input datasets.
*corrective action:* The output dataset (parameter `outset`) is not a valid CCF constituent.

**DatasetIgnored** *(warning)*
**rgsoffsetcalc** identified a second CCF scope.
*corrective action:* The dataset is ignored.

**DatasetRejected** *(warning)*
The dataset failed at least one of the tests described in Section 3.
*corrective action:* The dataset is ignored.

**NoOdfArrayName** *(warning)*
The task could not find an array named `R1DII1` or `R2DII1`.
*corrective action:* If possible, try to get the first available array.

**nothingToFit** *(error)*
Ignore the dataset.The pulse height distribution contains less than 3 bins.

# 6 Input Files

1. list of RGS diagnostic mode image files [1]

# 7 Output Files

1. The output dataset (`outset`) consists of a binary table (`RGSOFFSETS`) with the following columns:
   - `TIME`, double: number of seconds since the XMM Mission Reference Time.
   - `CCD_ID`, integer: the CCD identifier
   - `NODE_ID`, integer: the node identifier
   - `CCD_OCB`, integer: the CCD on-chip binning factor
   - `MEAN`, real: the mean of the fitted Gaussian
   - `STD_DEV`, real: the standard deviation of the fitted Gaussian
   - `NORMALIZATION`, real: the normalization of the fitted gaussian
   - `EUCLIDEAN_NORM`, real: the sum of the squares of the residuals
2. The histogram dataset (`histogramset`) consists of a binary table (`pulse_height_spectra`) with the following columns:
   - `pha`, real: the pulse height axis

- a number of real columns, each containing a pulse height spectrum. Columns have names like `phs_0000`. The first column corresponds to the first input dataset (first node), the second column correspond to the second node (if applicable), and so on. The mapping of column names to input datasets is recorded in the table comments.

# 8 Algorithm

```
begin loop sets
   next if isNotValid(set)
   begin loop nodes

      create_pha_histogram(all CCD pixels)
      fit_peak_with_Gaussian(return: mean, sigma, normalization)


      write (outset) time_of_diag_image, ccdid, node, &
           mean, sigma, &
           refined_rejection_thresholds(per node), &
           refined_acceptance_thresholds(per node)

   end loop nodes
end loop sets
```

# 9 Comments

- RGS diagnostic datasets taken with on-chip binning factor of one require six files per CCD. This task does not try to piece them together, as this functionality belongs to a separate piece of software.

# 10 Future developments

These are possible future improvements:

- add facilities to debug the fitting engine
- make the bin size of pulse height distributions a parameter
- allow for more fit functions
- use the OAL to determine which datasets should be processed

# References

[1] ESA. XMM Interface Control Document: Observation and Slew Data Files (XSCS to SSC) (SciSIM to SOCSIM). Technical Report XMM-SOC-ICD-0004-SSD Issue 2.5, ESA/SSD, June 2000. Found at the URL: `ftp://astro.estec.esa.nl/pub/XMM/documents/odf_icd.ps.gz`.

[2] ESA. Interface control document for the XMM current calibration file. Technical Report XMM-GEN-ICD-0005, ESA/SSD, Dec 2001. Issue 4.0.