# DESCRIPTION OF THE CALET CALIBRATION FILES

Version 1

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## CHANGE RECORD PAGE (1 of 1)

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# 1  Introduction

This document describes the format of CALET Calibration Files in the CALibration DataBase (CALDB). CALDB includes the results obtained from the analysis of the in orbit data. The results are stored in the OGIP CALDB structure in the FITS file format, adhering in principle to the standard OGIP format. These files are recorded in CALDB for archival purposes and they are used in the CALET data analysis by end-users.  The files required by the pipeline processing are not included.

The CALET calibration files are produced by the CALET team at different institutes in Japan and delivered to the HEASARC.

## 1.1  Scope

This document provides a naming convention and header structure for the calibration files with a brief description.

## 1.2  References

[1] - BCF & CPF Calibration File Guidelines - OGIP Calibration Memo CAL/GEN/92-003

[2] - HFWG Recommendation R8 -1994 February 02

[3] - Required and Recommended FITS keywords for Calibration Files -OGIP Calibration Memo CAL/GEN/92-011

## 1.3   Acronyms

ARF             Ancillary Response File

BCF             Basic Calibration File

CALDB           Calibration Database

CIF             Calibration File

CPF             Calibration Product File

FITS            Flexible Image Transport System

GSFC            Goddard Space Flight Center

HDU             Header Data  Unit

HEASARC         High Energy Astrophysics Science Archive Research Center

HFWG            High Energy FITS Working Group

HK              House-Keeping

OGIP            Office of the Guest Investigator Programs

PHA             Pulse Height Amplitude

PI              Pulse Invariant

PSF             Point Spread Function

QE              Quantum Efficiency

RMF             Redistribution Matrix File

# 2   CALET Calibration File Set

The chapter lists the naming convention for the CALDB files and the different calibration type products stored in CALDB.

## 2.1   File Naming Convention

The filename convention is the following:

        <mi>_<det>_<datatype>_[<date>]vxxx.ext

where:

**mi** is a 4 digit string that identifies the mission and instrument. Note usually the first digits are just for the mission however to not introduce different convention of the file in the archive the identify both mission and instrument. This is set to :

- cgbm for CALET GBM

- ccal for CALET Calorimenter

The **det** identify the detector used stored in the keyword DETNAM. The string are : instrument The mission identifier string is set to 'ca' named after CALET.

- 'hx1',  'hx2', 'hxm' for the GBM HXM1 and HXM2  or both HXM respectively;
- 'sgm' for the GBM SGM
- 'chd' for the Calorimeter
- 'gen' for files applicable to all instruments unless noted.

These strings are used in the filenames of CALDB and science files.

**datatype** is the calibration data type identifier. The string should describe the file content unambiguously within 8 characters long. Underscores or mathematical symbols are not allowed. Longer strings may be considered on case by case basis, but they are strongly discouraged;

**date** is an integer giving the date when the file should first be used, with the format: YYYYMMDD;

**version** is three digits integer giving the file issue number, ex 001;

**ext** is set to 'fits' for all files with the following exceptions: 'rmf' or 'rsp'  is used for the redistribution matrix and  'arf' is used for the ancillary response files.

## 2.2   Directory structure

The CALDB of CALET is divided in the following directories :

                                  /calet

       /gen                   /ccal                   /cgbm               ......

   /bcf  /cpf  /index     / bcf     /cpf     /index     /bcf /cpf   /index

              /... /... /...    /... /... /...

The /gen directory contains files that are applicable to all instruments. The /cgbm  directory contains files that are related to the detector HXM1/ HXM2 and SGM part of the CGBM. The /ccal  directory contains files related to the calorimeter and subsystem detector.

Each instrument directory is subdivided in /bcf and /cpf  containing the basic and high level calibration file.  Both the /bcf and /cpf are divided in subdirectories each dedicated to a subgroup of file type.

## 2.3    Datatype

Table 2.3 contains a summary of all the different type of calibration files :

| Table 2.3 | | |
|---|---|---|
| **Datatype** | **Caldb directory** | **Description** |
| ebphall | cpf | Ebounds for the PH mode low/high gain for GBM |
| ebevtall | cpf | Ebounds for the EVENT mode low/high gain for GBM |
| ebthlow | cof | Ebounds for the TH low gain for GBM |
| ebthhig | cpf | Ebounds for the TH high gain for GBM |
| rsp cgbm hxmi | | TBD |
| rsp cgbm hxm2 | | TBD |
| rsp cgbm sgm | | TBD |

**Table 2.1 -Datatypes and short description of CALET  files**

# 3    General file description Calibration File Set

All CALET calibration files are FITS files. Keywords required by FITS OGIP standards and listed in this chapter are described in documents [1], [2] and [3] (see references in Section 1). Chapters 4 gives the exact strings used in the CALDB keywords for CALET calibration files  as well as a description of different FITS-file format.

## 3.1    Mandatory Keywords

Table 3.1a lists the mandatory keywords added to the primary and to the headers of all extensions of the Calibration FITS files. Remarks on specific comments are added in italics.

| Table 3.1a | | |
|---|---|---|
| **Keyword name** | **Keyword value** | **Comment** |
| TELESCOP | 'CALET' | /Telescope (mission) name |
| INSTRUME | <instrument> | /Instrument  Name |
| DETNAM | <detector name> | /Detector  Name (*HXM, HX1,HX2, SGM, ASC, CHD*) |
| DATAMODE | <datamode> | /Datamode |
| DATE | YYYY-MM-DDThh:mm:ss | /Creation Date |
| CHECKSUM | <up to date checksum> | /HDU checksum updated <date> |
| DATASUM | <up to date datasum> | /Data unit checksum updated <date> |

**Table 3.1a -Mandatory keywords for all extensions**

Table 3.1b lists the additional mandatory keywords common to all table headers. Each CALDB keyword has different values for different Calibration Files. The values for the CALDB and the EXTNAME keywords are specified for each datatype in the chapter dedicated to each of the instruments.

| Table 3.1b | | |
|---|---|---|
| **Keyword name** | **Keyword value** | **Comment** |
| EXTNAME | <extension name> | /Name of the binary table extension     *or* <br> /Name of the image extension <br> This is omitted if data are stored in the Primary Header |
| ORIGIN | <organization name> | / Source of FITS file |
| ***CALDB keywords:*** | | |
| CCLSxxxx | OGIP-class of calibration file | /Dataset is a Calibration Product File <br> /Dataset is a Basic Calibration File |
| CDTP*xxxx* | <datatype code> | /Calibration file contains data |
| CCNMxxxx | <extension codename> | /Type of Calibration data |
| CDESxxxx | <descriptive string> | / Description |
| CVSDxxxx | <start valid data> | /UTC date when file should first be used |
| CVSTxxxx | <start valid time> | /UTC time when file should first be used |
| CBDnxxxx | Array describing parameter limitations of the dataset | /Parameter boundaries |
| **Additional keywords** | | |
| TDIMnnn | Number of elements & Ordering of *n*-d array | /Array dimensions |
| HDUCLASS | 'OGIP ' | /Format conforms to OGIP standards <br> *(Only when applicable)* |
| HDUCLAS*n* | <character string   to classify   the extension | /(Specific to the type) <br> *(Only when applicable)* |

**Table 3.1b – Mandatory header keywords for all extensions that contains calibration data**

The keywords content in Table 3.1a and 3.1b are described in the section dedicated to each of the data file.

The "CBDnxxx" keyword that should be used to differentiate otherwise identical extensions in a file. The first CBD keyword should be named CBD10001, the second CBD20001, etc... All CBD keywords should follow the syntax "KEYWORD (SELECTION)" where "keyword" is the quantity on which a selection is done. The "TDIM" keywords is only necessary for array with 2 or more axis and the HDUCLAS* family only when applicable.

The keywords in Table 3.1c are the minimum mandatory if the binary table contains columns related to time. Additional keywords may be necessary and are listed in the section dedicated to each of the data file.

| Table 3.1c | | |
|---|---|---|
| **Keyword name** | **Keyword value** | **Comment** |
| TIMESYS | TT | /Time system |
| MJDREFI | 51544 | /MJD reference 2000-01-01 00:00:00 UTC |
| MJDREFF | 7.4287037037037E-04 | /MJD reference (fractional of day) |
| CLOCKAPP | T | /If clock corrections are applied (F/T) |

**Table 3.1c– Mandatory timing keywords for all extensions with time columns**

The content for the keywords INSTRUME, DETNAM, and DATAMODE are listed in the following tables. These strings are also used in the science data files.

| Table 3.1d | | |
|---|---|---|
| **Keyword Name** | **Keyword String** | **Explanation (not FITS comment)** |
| **GBM** | | |
| INSTRUME | CGBM | Indicate the CALET GBM |
| DETNAM | HXM | DETNAM is set to HXM if the calibration or the science files contains information valid for both HXM. The keyword is set to HXM1 or HXM2 if the calibration or science data are for the HXM1 or HXM2 respectively. |
| | HXM1 | |
| | HXM2 | |
| | SGM | For the SGM part of the GBM |
| | ASC | For optical sky monitor |
| | ALL | Set to ALL to indicate that files are applicable to SGM and HXM1/2 |
| DATAMODE | PH_LOW | For the PH mode low gain |
| | PH_HIGH | For the PH mode high gain |
| | PH | For the PH mode low or high gain |
| | TH_LOW | For the TH mode low gain |
| | TH_HIGH | For the TH mode high gain |
| | TH | For the TH mode low or high gain |
| | EVENT | For the event mode regardless if in high or low gain |
| | EVENT_LOW | For the event mode in low gain |
| | EVENT_HIGH | For the event mode in high |
| | IMAGE | For the image mode of the ASC |
| **CALORIMETER** | | |
| INSTRUME | CCAL | Indicate the CALET Calorimeter . |
| DETNAM | CHD | For the Charge Detector |

Table 3.1d – Values for CALET INSTRUME, DETNAM and DATAMODE

# 4 Specific File format

## 4.1 CGBM : EBOUNDS for PH and EVENT modes

These files contain the boundary energy values for the channels for the PH and EVENT mode data. Each file has the following structure: empty primary header , 1$^{st}$ extension for the low gain data and 2$^{nd}$ for the high gain data. Since the HXM1 and HXM2 has the same boundary only one caldb file is created applicable for both. The filenames are :

| Filename | Description |
|---|---|
| cgbm_hxm_ebphall_YYYYMMNNvxxx.fits | Containing the ebounds for the PH mode low and high gain of the HXM1 and HXM2 |
| cgbm_sgm_ebphall_YYYYMMNNvxxx.fits | Containing the ebounds for the PH mode low and high gain of the SGM |
| cgbm_hxm_ebevtall_YYYYMMNNvxxx.fits | Containing the ebounds for the EVENT mode low and high gain of the HXM1 and HXM2 |
| cgbm_sgm_ebevall_YYYYMMNNvxxx.fits | Containing the ebounds for the EVENT mode low and high gain of the SGM |

All four files have an empty primary header and two extensions one for the low gain and one for the high gain. The following tables contain the header for each of the files. Table 4.1a list the header for the PH mode high and low gain for the (file cgbm_hxm_ebphall_YYYYMMNNvxxx.fits) :

**Table 4.1a**

*EBOUNDS : Structure primary header HXM PH  high or low gain data*

| Keyword | Value | Comment |
|---|---|---|
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument  name |
| DETNAM | 'HXM' | / Detector subsystem |
| ORIGIN | 'JAXA, WCOC' | /Origin of the FITS file |
| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |
| CREATOR | 'string' | /Software that create 1$^{st}$ the file |
| CHECKSUM | 'value' | / data unit checksum updated date |
| DATASUM | 'value' | / HDU checksum updated date |

*EBOUNDS : Structure 1$^{st}$ extension PH  low gain data  for the HXM*

| Keyword | Value | Comment |
|---|---|---|
| EXTNAME | 'EBOUNDS' | /name of the HDU |
| TTYPE1 | 'CHANNEL' | /Detector channel number |
| TFORM1 | 'I' | /data format of field |
| TUNIT1 | 'chan' | /physical unit of field |
| TTYPE2 | 'E_MIN' | /Low energy bounds |
| TFORM2 | '1E' | /data format of field |
| TUNIT2 | 'keV' | /physical unit of field |
| TTYPE3 | 'E_MAX' | /High energy bounds |
| TFORM3 | '1E' | /data format of field |
| TUNIT3 | 'keV' | /physical unit of field |
| TLMIN1 | 0 | /Minimum legal value |
| TLMAX1 | 409 | /Maximum legal value |
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument  name |
| DETNAM | 'HXM' | / Detector |
| DATAMODE | 'PH_LOW' | /Data mode |
| CCLS0001 | 'CPF' | /Dataset is a Calibration Product File |
| CDTP0001 | 'DATA' | /Calibration file contains data |
| CCNM0001 | 'EBOUNDS' | /Type of Calibration data |
| CDES0001 | 'Energy Channel boundary for HXM PH LOW data ' | / Description |
| CVSD0001 | '2000-01-01' | /UTC date when file should first be used |
| CVST0001 | '00:00:00' | /UTC time when file should first be used |
| CBD10001 | 'GAIN(LOW)' | /Parameter Boundary |
| CBD20001 | 'DATAMODE(PH_LOW)' | /Parameter Boundary |
| HDUCLASS | 'OGIP' | / format conforms to OGIP standard |
| HDUCLAS1 | 'RESPONSE' | /<hduclass1> |
| HDUCLAS2 | 'EBOUNDS' | / <hduclas2> |
| HDUVERS | '1.2.0' | /Keyword information for Caltools Software |
| HDUVERS1 | '1.1.0' | /Obsolete |
| HDUVERS2 | '1.2.0' | /Obsolete |
| RMFVERSN | '1992a' | /Obsolete |
| FILTER | 'none' | /Filter in use (if any) |

| CHANTYPE | 'PI' | /No corrections have been applied |
|---|---|---|
| DETCHANS | 410 | /Total number of PHA channels |
| PI2ENE | 0.75 | /Conversion PI to energy |
| ORIGIN | 'JAXA, WCOC' | /Origin of the fits file |
| CREATOR | 'string' | /Software that create 1st the file |
| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |
| CHECKSUM | 'value' | / data unit checksum updated date |
| DATASUM | 'value' | / HDU checksum updated date |
| | | |

*EBOUNDS : Structure 2nd extension PH  high gain data  for the HXM*

| Keyword | Value | Comment |
|---|---|---|
| EXTNAME | 'EBOUNDS' | /name of the HDU |
| TTYPE1 | 'CHANNEL' | /Detector channel number |
| TFORM1 | 'I' | /data format of field |
| TUNIT1 | 'chan' | /physical unit of field |
| TTYPE2 | 'E_MIN' | /Low energy bounds |
| TFORM2 | '1E' | /data format of field |
| TUNIT2 | 'keV' | /physical unit of field |
| TTYPE3 | 'E_MAX' | /High energy bounds |
| TFORM3 | '1E' | /data format of field |
| TUNIT3 | 'keV' | /physical unit of field |
| TLMIN1 | 0 | /Minimum legal value |
| TLMAX1 | 101 | /Maximum legal value |
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument  name |
| DETNAM | 'HXM' | / Detector |
| DATAMODE | 'PH_HIGH' | /Data mode |
| CCLS0001 | 'CPF' | /Dataset is a Calibration Product File |
| CDTP0001 | 'DATA' | /Calibration file contains data |
| CCNM0001 | 'EBOUNDS' | /Type of Calibration data |
| CDES0001 | 'Energy Channel boundary. HXM PH HIGH' | / Description |
| CVSD0001 | '2000-01-01' | /UTC date when file should first be used |
| CVST0001 | '00:00:00' | /UTC time when file should first be used |
| CBD10001 | 'GAIN(HIGH)' | /Parameter Boundary |
| CBD20001 | 'DATAMODE(PH_HIGH)' | /Parameter Boundary |
| HDUCLASS | 'OGIP' | / format conforms to OGIP standard |
| HDUCLAS1 | 'RESPONSE' | /<hduclass1> |
| HDUCLAS2 | 'EBOUNDS' | / <hduclas2> |
| HDUVERS | '1.2.0' | /Keyword information for Caltools Software |
| HDUVERS1 | '1.1.0' | /Obsolete |
| HDUVERS2 | '1.2.0' | /Obsolete |
| RMFVERSN | '1992a' | /Obsolete |
| FILTER | 'none' | /Filter in use (if any) |
| CHANTYPE | 'PI' | /No corrections have been applied |
| DETCHANS | 102 | /Total number of PHA channels |
| PI2ENE | 0.024 | /Conversion PI to energy |
| ORIGIN | 'JAXA, WCOC' | /Origin of the fits file |
| CREATOR | 'string' | /Software that create 1st the file |
| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |

| CHECKSUM | 'value' | / data unit checksum updated date |
|---|---|---|
| DATASUM | 'value' | / HDU checksum updated date |

Table 4.1a – Format for the HXM PH mode ebounds

Table 4.1b list the header for the ebounds file of the PH mode high and low gain for the SGM
(file cgbm_sgm_ebphall_YYYYMMNNvxxx.fits) :

**Table 4.1b**

*EBOUNDS : Structure primary header SGM PH high or low gain data*

| Keyword | Value | Comment |
|---|---|---|
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument  name |
| DETNAM | 'SGM' | / Detector subsystem |
| ORIGIN | 'JAXA, WCOC' | /Origin of the FITS file |
| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |
| CREATOR | 'string' | /Software that create 1st the file |
| CHECKSUM | 'value' | / data unit checksum updated date |
| DATASUM | 'value' | / HDU checksum updated date |

*EBOUNDS : Structure 1st extension PH  low gain data  for the SGM*

| Keyword | Value | Comment |
|---|---|---|
| EXTNAME | 'EBOUNDS' | /name of the HDU |
| TTYPE1 | 'CHANNEL' | /Detector channel number |
| TFORM1 | 'I' | /data format of field |
| TUNIT1 | 'chan' | /physical unit of field |
| TTYPE2 | 'E  MIN' | /Low energy bounds |
| TFORM2 | '1E' | /data format of field |
| TUNIT2 | 'keV' | /physical unit of field |
| TTYPE3 | 'E  MAX' | /High energy bounds |
| TFORM3 | '1E' | /data format of field |
| TUNIT3 | 'keV' | /physical unit of field |
| TLMIN1 | 0 | /Minimun legal value |
| TLMAX1 | 409 | /Maximun legal value |
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument name |
| DETNAM | 'SGM' | / Detector |
| DATAMODE | 'PH  LOW' | /Data mode |
| CCLS0001 | 'CPF' | /Dataset is a Calibration Product File |
| CDTP0001 | 'DATA' | /Calibration file contains data |
| CCNM0001 | 'EBOUNDS' | /Type of Calibration data |
| CDES0001 | 'Energy Channel boundary for SGM PH LOW data ' | / Description |
| CVSD0001 | '2000-01-01' | /UTC date when file should first be used |
| CVST0001 | '00:00:00' | /UTC time when file should first be used |
| CBD10001 | 'GAIN(LOW)' | /Parameter Boundary |
| CBD20001 | 'DATAMODE(PH  LOW)' | /Parameter Boundary |
| HDUCLASS | 'OGIP' | / format conforms to OGIP standard |
| HDUCLAS1 | 'RESPONSE' | /<hduclass1> |
| HDUCLAS2 | 'EBOUNDS' | / <hduclas2> |
| HDUVERS | '1.2.0' | /Keyword information for Caltools Software |
| HDUVERS1 | '1.1.0' | /Obsolete |
| HDUVERS2 | '1.2.0' | /Obsolete |
| RMFVERSN | '1992a' | /Obsolete |
| FILTER | 'none' | /Filter in use (if any) |

| CHANTYPE | 'PI' | /No corrections have been applied |
|---|---|---|
| DETCHANS | 410 | /Total number of PHA channels |
| PI2ENE | 7. | /Conversion PI to energy |
| ORIGIN | 'JAXA, WCOC' | /Origin of the fits file |
| CREATOR | 'string' | /Software that create 1st the file |
| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |
| CHECKSUM | 'value' | / data unit checksum updated date |
| DATASUM | 'value' | / HDU checksum updated date |
| | | |

*EBOUNDS : Structure 2nd extension PH  high gain data  for the SGM*

| Keyword | Value | Comment |
|---|---|---|
| EXTNAME | 'EBOUNDS' | /name of the HDU |
| TTYPE1 | 'CHANNEL' | /Detector channel number |
| TFORM1 | 'I' | /data format of field |
| TUNIT1 | 'chan' | /physical unit of field |
| TTYPE2 | 'E_MIN' | /Low energy bounds |
| TFORM2 | '1E' | /data format of field |
| TUNIT2 | 'keV' | /physical unit of field |
| TTYPE3 | 'E_MAX' | /High energy bounds |
| TFORM3 | '1E' | /data format of field |
| TUNIT3 | 'keV' | /physical unit of field |
| TLMIN1 | 0 | /Minimun legal value |
| TLMAX1 | 102 | /Maximun legal value |
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument  name |
| DETNAM | 'SGM' | / Detector |
| DATAMODE | 'PH_HIGH' | /Data mode |
| CCLS0001 | 'CPF' | /Dataset is a Calibration Product File /Dataset is a Basic Calibration File |
| CDTP0001 | 'DATA' | /Calibration file contains data |
| CCNM0001 | 'EBOUNDS' | /Type of Calibration data |
| CDES0001 | 'Energy Channel boundary. SGM PH HIGH data' | / Description |
| CVSD0001 | '2000-01-01' | /UTC date when file should first be used |
| CVST0001 | '00:00:00' | /UTC time when file should first be used |
| CBD10001 | 'GAIN(HIGH)' | /Parameter Boundary |
| CBD20001 | 'DATAMODE(PH_HIGH)' | /Parameter Boundary |
| HDUCLASS | 'OGIP' | / format conforms to OGIP standard |
| HDUCLAS1 | 'RESPONSE' | /<hduclass1> |
| HDUCLAS2 | 'EBOUNDS' | / <hduclas2> |
| HDUVERS | '1.2.0' | /Keyword information for Caltools Software |
| HDUVERS1 | '1.1.0' | /Obsolete |
| HDUVERS2 | '1.2.0' | /Obsolete |
| RMFVERSN | '1992a' | /Obsolete |
| FILTER | 'none' | /Filter in use (if any) |
| CHANTYPE | 'PI' | /No corrections have been applied |
| DETCHANS | 102 | /Total number of PHA channels |
| PI2ENE | 0.23 | /Conversion PI to energy |
| ORIGIN | 'JAXA, WCOC' | /Origin of the fits file |
| CREATOR | 'string' | /Software that create 1st the file |

| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |
|------|------------------------|---------------------|
| CHECKSUM | 'value' | / data unit checksum updated date |
| DATASUM | 'value' | / HDU checksum updated date |

Table 4.1b – Format for the SGM PH mode ebounds

Table 4.1c list the header for the EVENT mode high and low gain for the ebound file for the SGM and HXM (file cgbm_sgm_ebevall_YYYYMMNNvxxx.fits cgbm_hxm_ebevall_YYYYMMNNvxxx.fits). The keywords DETNAM, PI2ENE and CDES0001 (marked red in table 4.1c) have to be set correctly for the SGM or HXM files.

**Table 4.1c**

*EBOUNDS : Structure primary header EVENT high or low gain data*

| Keyword | Value | Comment |
|---|---|---|
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument  name |
| **DETNAM** | **'XXX'** | **/ Detector subsystem** |
| ORIGIN | 'JAXA, WCOC' | /Origin of the FITS file |
| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |
| CREATOR | 'string' | /Software that create 1$^{st}$ the file |
| CHECKSUM | 'value' | / data unit checksum updated date |
| DATASUM | 'value' | / HDU checksum updated date |
|  |  |  |

*EBOUNDS : Structure 1$^{st}$ extension EVENT  low gain data  for the HXM /SGM (see DETNAM)*

| Keyword | Value | Comment |
|---|---|---|
| EXTNAME | 'EBOUNDS' | /name of the HDU |
| TTYPE1 | 'CHANNEL' | /Detector channel number |
| TFORM1 | 'I' | /data format of field |
| TUNIT1 | 'chan' | /physical unit of field |
| TTYPE2 | 'E  MIN' | /Low energy bounds |
| TFORM2 | '1E' | /data format of field |
| TUNIT2 | 'keV' | /physical unit of field |
| TTYPE3 | 'E  MAX' | /High energy bounds |
| TFORM3 | '1E' | /data format of field |
| TUNIT3 | 'keV' | /physical unit of field |
| TLMIN1 | 0 | /Minimum legal value |
| TLMAX1 | 4095 | /Maximum legal value |
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument name |
| **DETNAM** | **'XXX'** | **/ Detector** |
| DATAMODE | 'EVENT  LOW' | /Data mode |
| CCLS0001 | 'CPF' | /Dataset is a Calibration Product File |
| CDTP0001 | 'DATA' | /Calibration file contains data |
| CCNM0001 | 'EBOUNDS' | /Type of Calibration data |
| **CDES0001** | **'Energy Channel boundary for XXX EVENT LOW data '** | **/ Description** |
| CVSD0001 | '2000-01-01' | /UTC date when file should first be used |
| CVST0001 | '00:00:00' | /UTC time when file should first be used |
| CBD10001 | 'GAIN(LOW)' | /Parameter Boundary |
| CBD20001 | 'DATAMODE(EVENT  LOW)' | /Parameter Boundary |
| HDUCLASS | 'OGIP' | / format conforms to OGIP standard |
| HDUCLAS1 | 'RESPONSE' | /<hduclass1> |
| HDUCLAS2 | 'EBOUNDS' | / <hduclas2> |
| HDUVERS | '1.2.0' | /Keyword information for Caltools Software |
| HDUVERS1 | '1.1.0' | /Obsolete |
| HDUVERS2 | '1.2.0' | /Obsolete |
| RMFVERSN | '1992a' | /Obsolete |
| FILTER | 'none' | /Filter in use (if any) |

| CHANTYPE | 'PI' | /No corrections have been applied |
|---|---|---|
| DETCHANS | 4095 | /Total number of PHA channels |
| **PI2ENE** | **XXX** | **/Conversion PI to energy** |
| ORIGIN | 'JAXA, WCOC' | /Origin of the fits file |
| CREATOR | 'string' | /Software that create 1st the file |
| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |
| CHECKSUM | 'value' | / data unit checksum updated date |
| DATASUM | 'value' | / HDU checksum updated date |

*EBOUNDS : Structure 2nd extension EVENT high gain data for the HXM /SGM (see DETNAM)*

| Keyword | Value | Comment |
|---|---|---|
| EXTNAME | 'EBOUNDS' | /name of the HDU |
| TTYPE1 | 'CHANNEL' | /Detector channel number |
| TFORM1 | 'I' | /data format of field |
| TUNIT1 | 's' | /physical unit of field |
| TTYPE2 | 'E_MIN' | /Low energy bounds |
| TFORM2 | '1E' | /data format of field |
| TUNIT2 | 'keV' | /physical unit of field |
| TTYPE3 | 'E_MAX' | /High energy bounds |
| TFORM3 | '1E' | /data format of field: 2-byte INTEGER |
| TUNIT3 | 'keV' | /physical unit of field |
| TLMIN1 | 0 | /Minimum legal value |
| TLMAX1 | 4095 | /Maximum legal value |
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument name |
| **DETNAM** | **'XXX'** | **/ Detector** |
| DATAMODE | 'EVENT_HIGH' | /Data mode |
| CCLS0001 | 'CPF' | /Dataset is a Calibration Product File |
| CDTP0001 | 'DATA' | /Calibration file contains data |
| CCNM0001 | 'EBOUNDS' | /Type of Calibration data |
| **CDES0001** | **'Energy Channel boundary for the XXX EVENT HIGH'** | **/ Description** |
| CVSD0001 | '2000-01-01' | /UTC date when file should first be used |
| CVST0001 | '00:00:00' | /UTC time when file should first be used |
| CBD10001 | 'GAIN(HIGH)' | /Parameter Boundary |
| CBD20001 | 'DATAMODE(EVENT_HIGH)' | /Parameter Boundary |
| HDUCLASS | 'OGIP' | / format conforms to OGIP standard |
| HDUCLAS1 | 'string' | /<hduclass1> |
| HDUCLAS2 | 'string' | / <hduclas2> |
| HDUVERS | '1.2.0' | /Keyword information for Caltools Software |
| HDUVERS1 | '1.1.0' | /Obsolete |
| HDUVERS2 | '1.2.0' | /Obsolete |
| RMFVERSN | '1992a' | /Obsolete |
| FILTER | 'none' | /Filter in use (if any) |
| CHANTYPE | 'PI' | /No corrections have been applied |
| DETCHANS | 4096 | /Total number of PHA channels |
| **PI2ENE** | **XXX** | **/Conversion PI to energy** |
| ORIGIN | 'JAXA, WCOC' | /Origin of the fits file |
| CREATOR | 'string' | /Software that create 1st the file |
| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |

| CHECKSUM | 'value' | / data unit checksum updated date |
|---|---|---|
| DATASUM | 'value' | / HDU checksum updated date |

<div align="center">Table 4.1c – Format for the HXM/SGM EVENT mode  ebounds</div>

## 4.2    CGBM : EBOUNDS for TH

These files contain the boundary energy values for the channels of TH mode. Each file has the following structure: empty primary header, 1$^{st}$ extension for the low or high gain data.  Since the HXM1 and HXM2 has the same boundary only one caldb file is created applicable for both. The filenames are :

| Filename | Description |
|---|---|
| cgbm_hxm_ebthall_YYYYMMNNvxxx.fits | Containing the ebounds for the TH mode low and high gain of the HXM1 and HXM2 |
| cgbm_ sgm_ebthall_YYYYMMNNvxxx.fits | Containing the ebounds for the TH mode low  and high gain of the SGM |

The CALET data in TH mode are binned in four energy bands in low and high gain. The energy intervals for each of the four energy bands may change with time. These values are saved in a time dependent CALDB file that contains an empty primary header, 1$^{st}$ extension for the high gain and second extension for the low gain. Each row contains three columns: TIME , E_MIN and E_MAX. The E-Min and E_MAX are vectors contains 4 values defining the four energy bands. The validity of these energy bands start from the time written in the column until the time of the next row.

There is one file for the HXM and one file for the SGM and Table 4.2a and 4.2b describe the headers for the two files.

**Table 4.2b**

*Energy boundaries : Structure primary header SGM TH high or low gain data*

| Keyword | Value | Comment |
|---|---|---|
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument  name |
| **DETNAM** | **'HXM'** | **/ Detector subsystem** |
| ORIGIN | 'JAXA, WCOC' | /Origin of the FITS file |
| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |
| CREATOR | 'string' | /Software that create 1st the file |
| CHECKSUM | 'value' | / data unit checksum updated date |
| DATASUM | 'value' | / HDU checksum updated date |

*EBOUNDS : Structure 1st extension PH  low gain data  for the SGM*

| Keyword | Value | Comment |
|---|---|---|
| EXTNAME | 'ENERGY  BOUNDS' | /name of the HDU |
| TTYPE1 | 'TIME' | /Detector channel number |
| TFORM1 | '1D' | /data format of field |
| TUNIT1 | 's' | /physical unit of field |
| TTYPE2 | 'E  MIN' | /Low energy bounds |
| TFORM2 | '4I | /data format of field |
| TUNIT2 | 'keV' | /physical unit of field |
| TTYPE3 | 'E  MAX' | /High energy bounds |
| TFORM3 | '4E' | /data format of field |
| TUNIT3 | 'keV' | /physical unit of field |
| TTYPE4 | 'TH  CHAN' | /TH channel number |
| TFORM4 | '4E' | /data format of field |
| TTYPE5 | 'ADC  MIN  CHAN' | /Original ADC min  channel |
| TFORM5 | '4E' | /data format of field |
| TTYPE6 | 'ADC  MAX  CHAN' | /Original ADC max channel |
| TFORM6 | '4E' | /data format of field |
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument name |
| **DETNAM** | **'HXM'** | **/ Detector** |
| DATAMODE | 'TH  LOW' | /Data mode |
| DATE-OBS | 'yyyy-mm ddThh:mm:ss' | /Start Date |
| DATE-END | 'yyyy-mm ddThh:mm:ss' | /Stop Date |
| TSTART | 0.0 | /Start time |
| TSTOP | 0.0 | /Start Time |
| MJDREFI | 51544 | /MJD reference day 01 Jan 2000 00:00:00 |
| MJDREFF | 7.4287037037037E-04 | /MDJ reference (fraction of day) |
| TIMEREF | 'LOCAL' | /Reference Frame |
| TASSIGN | 'SATELLITE' | /Time assigned |
| TIMESYS | 'TT' | / Time System |
| TIMEUNIT | ' s' | /Time unit for timimg header keywords |
| CLOCKAPP | T | / If clock correction are applied (F/T) |
| CCLS0001 | 'CPF' | /Dataset is a Calibration Product File |

| CDTP0001 | 'DATA' | /Calibration file contains data |
|---|---|---|
| CCNM0001 | 'ENERGY_BOUND' | /Type of Calibration data |
| CDES0001 | 'Energy Channel boundary for SGM TH LOW data' | / Description |
| CVSD0001 | '2000-01-01' | /UTC date when file should first be used |
| CVST0001 | '00:00:00' | /UTC time when file should first be used |
| CBD10001 | 'GAIN(LOW)' | /Parameter Boundary |
| CBD20001 | 'DATAMODE(TH_LOW)' | /Parameter Boundary |
| ORIGIN | 'JAXA, WCOC' | /Origin of the fits file |
| CREATOR | 'string' | /Software that create 1st the file |
| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |
| CHECKSUM | 'value' | / data unit checksum updated date |
| DATASUM | 'value' | / HDU checksum updated date |

*EBOUNDS : Structure 2nd extension PH_high gain data_for the SGM*

| Keyword | Value | Comment |
|---|---|---|
| EXTNAME | 'ENERGY_BOUNDS' | /name of the HDU |
| TTYPE1 | 'TIME' | /Detector channel number |
| TFORM1 | '1D' | /data format of field |
| TUNIT1 | 's' | /physical unit of field |
| TTYPE2 | 'E_MIN' | /Low energy bounds |
| TFORM2 | '4I' | /data format of field |
| TUNIT2 | 'keV' | /physical unit of field |
| TTYPE3 | 'E_MAX' | /High energy bounds |
| TFORM3 | '4E' | /data format of field: 2-byte INTEGER |
| TUNIT3 | 'keV' | /physical unit of field |
| TTYPE4 | 'TH_CHAN' | /TH channel number |
| TFORM4 | '4E' | /data format of field |
| TTYPE5 | 'ADC_MIN_CHAN' | /Original ADC min_channel |
| TFORM5 | '4E' | /data format of field |
| TTYPE6 | 'ADC_MAX_CHAN' | /Original ADC max channel |
| TFORM6 | '4E' | /data format of field |
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument name |
| **DETNAM** | **'HXM'** | **/ Detector** |
| DATAMODE | 'TH_HIGH' | /Data mode |
| DATE-OBS | 'yyyy-mm ddThh:mm:ss' | /Start Date |
| DATE-END | 'yyyy-mm ddThh:mm:ss' | /Stop Date |
| TSTART | 0.0 | /Start time |
| TSTOP | 0.0 | /Start Time |
| MJDREFI | 51544 | /MJD reference day 01 Jan 2000 00:00:00 |
| MJDREFF | 7.4287037037037E-04 | /MDJ reference (fraction of day) |
| TIMEREF | 'LOCAL' | /Reference Frame |
| TASSIGN | 'SATELLITE' | /Time assigned |
| TIMESYS | 'TT' | / Time System |
| TIMEUNIT | ' s' | /Time unit for timimg header keywords |
| CLOCKAPP | T | / If clock correction are applied (F/T) |
| CCLS0001 | 'CPF' | /Dataset is a Calibration Product File |
| CDTP0001 | 'DATA' | /Calibration file contains data |
| CCNM0001 | 'ENERGY_BOUND' | /Type of Calibration data |

| CDES0001 | 'Energy Channel boundary for SGM TH HIGH data ' | / Description |
|---|---|---|
| CVSD0001 | '2000-01-01' | /UTC date when file should first be used |
| CVST0001 | '00:00:00' | /UTC time when file should first be used |
| CBD10001 | 'GAIN(HIGH)' | /Parameter Boundary |
| CBD20001 | 'DATAMODE(TH_HIGH)' | /Parameter Boundary |
| ORIGIN | 'JAXA, WCOC' | /Origin of the fits file |
| CREATOR | 'string' | /Software that create 1st the file |
| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |
| CHECKSUM | 'value' | / data unit checksum updated date |
| DATASUM | 'value' | / HDU checksum updated date |

Table 4.2a – Format for the HXM TH mode  ebounds

**Table 4.2b**

*Energy boundaries : Structure primary header SGM TH high or low gain data*

| Keyword | Value | Comment |
|---|---|---|
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument  name |
| **DETNAM** | **'SGM'** | **/ Detector subsystem** |
| ORIGIN | 'JAXA, WCOC' | /Origin of the FITS file |
| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |
| CREATOR | 'string' | /Software that create 1st the file |
| CHECKSUM | 'value' | / data unit checksum updated date |
| DATASUM | 'value' | / HDU checksum updated date |

*EBOUNDS : Structure 1st extension PH  low gain data  for the SGM*

| Keyword | Value | Comment |
|---|---|---|
| EXTNAME | 'ENERGY  BOUNDS' | /name of the HDU |
| TTYPE1 | 'TIME' | /Detector channel number |
| TFORM1 | '1D' | /data format of field |
| TUNIT1 | 's' | /physical unit of field |
| TTYPE2 | 'E  MIN' | /Low energy bounds |
| TFORM2 | '4I | /data format of field |
| TUNIT2 | 'keV' | /physical unit of field |
| TTYPE3 | 'E  MAX' | /High energy bounds |
| TFORM3 | '4E' | /data format of field: 2-byte INTEGER |
| TUNIT3 | 'keV' | /physical unit of field |
| TTYPE4 | 'TH  CHAN' | /TH channel number |
| TFORM4 | '4E' | /data format of field |
| TTYPE5 | 'ADC  MIN  CHAN' | /Original ADC min  channel |
| TFORM5 | '4E' | /data format of field |
| TTYPE6 | 'ADC  MAX  CHAN' | /Original ADC max channel |
| TFORM6 | '4E' | /data format of field |
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument name |
| **DETNAM** | **'SGM'** | **/ Detector** |
| DATAMODE | 'TH  LOW' | /Data mode |
| DATE-OBS | 'yyyy-mm ddThh:mm:ss' | /Start Date |
| DATE-END | 'yyyy-mm ddThh:mm:ss' | /Stop Date |
| TSTART | 0.0 | /Start time |
| TSTOP | 0.0 | /Start Time |
| MJDREFI | 51544 | /MJD reference day 01 Jan 2000 00:00:00 |
| MJDREFF | 7.4287037037037E-04 | /MDJ reference (fraction of day) |
| TIMEREF | 'LOCAL' | /Reference Frame |
| TASSIGN | 'SATELLITE' | /Time assigned |
| TIMESYS | 'TT' | / Time System |
| TIMEUNIT | ' s' | /Time unit for timimg header keywords |
| CLOCKAPP | T | / If clock correction are applied (F/T) |
| CCLS0001 | 'CPF' | /Dataset is a Calibration Product File |

| CDTP0001 | 'DATA' | /Calibration file contains data |
|---|---|---|
| CCNM0001 | 'ENERGY_BOUND' | /Type of Calibration data |
| CDES0001 | 'Energy Channel boundary for SGM TH LOW data ' | / Description |
| CVSD0001 | '2000-01-01' | /UTC date when file should first be used |
| CVST0001 | '00:00:00' | /UTC time when file should first be used |
| CBD10001 | 'GAIN(LOW)' | /Parameter Boundary |
| CBD20001 | 'DATAMODE(TH_LOW)' | /Parameter Boundary |
| ORIGIN | 'JAXA, WCOC' | /Origin of the fits file |
| CREATOR | 'string' | /Software that create 1st the file |
| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |
| CHECKSUM | 'value' | / data unit checksum updated date |
| DATASUM | 'value' | / HDU checksum updated date |
|  |  |  |

*EBOUNDS : Structure 2nd extension PH  high gain data  for the SGM*

| Keyword | Value | Comment |
|---|---|---|
| EXTNAME | 'ENERGY_BOUNDS' | /name of the HDU |
| TTYPE1 | 'TIME' | /Detector channel number |
| TFORM1 | '1D' | /data format of field |
| TUNIT1 | 's' | /physical unit of field |
| TTYPE2 | 'E_MIN' | /Low energy bounds |
| TFORM2 | '4I' | /data format of field |
| TUNIT2 | 'keV' | /physical unit of field |
| TTYPE3 | 'E_MAX' | /High energy bounds |
| TFORM3 | '4E' | /data format of field: 2-byte INTEGER |
| TUNIT3 | 'keV' | /physical unit of field |
| TTYPE4 | 'TH_CHAN' | /TH channel number |
| TFORM4 | '4E' | /data format of field |
| TTYPE5 | 'ADC_MIN_CHAN' | /Original ADC min  channel |
| TFORM5 | '4E' | /data format of field |
| TTYPE6 | 'ADC_MAX_CHAN' | /Original ADC max channel |
| TFORM6 | '4E' | /data format of field |
| TELESCOP | 'CALET' | /Telescope mission name |
| INSTRUME | 'CGBM' | /Instrument name |
| **DETNAM** | **'SGM'** | **/ Detector** |
| DATAMODE | 'TH_HIGH' | /Data mode |
| DATE-OBS | 'yyyy-mm ddThh:mm:ss' | /Start Date |
| DATE-END | 'yyyy-mm ddThh:mm:ss' | /Stop Date |
| TSTART | 0.0 | /Start time |
| TSTOP | 0.0 | /Start Time |
| MJDREFI | 51544 | /MJD reference day 01 Jan 2000 00:00:00 |
| MJDREFF | 7.4287037037037E-04 | /MDJ reference (fraction of day) |
| TIMEREF | 'LOCAL' | /Reference Frame |
| TASSIGN | 'SATELLITE' | /Time assigned |
| TIMESYS | 'TT' | / Time System |
| TIMEUNIT | ' s' | /Time unit for timimg header keywords |
| CLOCKAPP | T | / If clock correction are applied (F/T) |
| CCLS0001 | 'CPF' | /Dataset is a Calibration Product File |
| CDTP0001 | 'DATA' | /Calibration file contains data |
| CCNM0001 | 'ENERGY_BOUND' | /Type of Calibration data |

| CDES0001 | 'Energy Channel boundary for SGM TH HIGH data ' | / Description |
|---|---|---|
| CVSD0001 | '2000-01-01' | /UTC date when file should first be used |
| CVST0001 | '00:00:00' | /UTC time when file should first be used |
| CBD10001 | 'GAIN(HIGH)' | /Parameter Boundary |
| CBD20001 | 'DATAMODE(TH_HIGH)' | /Parameter Boundary |
| ORIGIN | 'JAXA, WCOC' | /Origin of the fits file |
| CREATOR | 'string' | /Software that create 1st the file |
| DATE | 'yyyy-mm-ddThh:mm:ss' | /File creation date |
| CHECKSUM | 'value' | / data unit checksum updated date |
| DATASUM | 'value' | / HDU checksum updated date |

Table 4.2a – Format for the SGM TH mode  ebounds