DESCRIPTION OF THE MAXI CALIBRATION FILES

Version 0.5

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1 Introduction

This document describes the format of MAXI Calibration Files and in CALibration DataBase (CALDB). CALDB includes the pre-launch results obtained from the analysis of the ground calibration data and also those derived from calibration observations in orbit during the mission. 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 MAXI data analysis by end-users. The files required by the pipeline processing are not included.

The MAXI calibration files are produced by the MAXI mission team and delivered to JAXA/DARTS. These files are delivered to the HEASARC at GSFC by DARTS.

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
CCD	Charge Coupled Device
CIF	Calibration File
CPF	Calibration Product File
CTI	Charge Transfer Inefficiency
DARTS	Data ARchives and Transmission System
FITS	Flexible Image Transport System
GOF	Guest Observer Facility
GSC	Gas Slit Camera
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
ISAS	Institute of Space and Astronautical Science
ISS	International Space Station
JAXA	Japan Aerospace Exploration Agency
MAXI	Monitor of All-sky X-ray Image
OGIP	Office of the Guest Investigator Programs
PHA	Pulse Height Amplitude
PI	Pulse Invariant
PSF	Point Spread Function
QE	Quantum Efficiency
RIKEN	RIkagaku KENkyu-jo
RMF	Redistribution Matrix File
SSC	Solid-state Slit Camera

2 MAXI 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>_<int>_<datatype>[_<date>].<suffix>

The five components in the brackets shall include lower-case alphabets [a-z] and/or number letters [0-9] only. They indicate:

mi is a 2-letter string that identifies the mission, and is set to “mx”, named after the MAXI mission.

int is a 3 or 4 character string to indicate the instrument. The first 3 lower-case letters are for the detector (gsc and ssc for GSC and SSC, respectively), optionally followed by 1-letter identifier to indicate a particular unit of the detector. For GSC, it is in the form of “gscN”, where the optional *N* is either a number of 0 to 9 or a letter “a” or “b”, which is denoted as [0-9ab] in this article, following the convention of the file-globbing in UNIX. For SSC, it is “sscZ”, where the optional character *Z* is either “h” or “z”.

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 in general. The sole exception in the MAXI CALDB is the GSC RMF files, which are in the form of gsc/cpf/mx_gscN_hvHHH_detxXXXX_YYYY.rmf where “*HHH*” indicates the voltage, XXXX and YYYY gives the applicable range of the detx location.

date is an optional 8-letter long string in the ISO-8601 format (YYYYMMDD) which shows the date when the file is released.

suffix is fixed to 'fits' for all the files with the following exceptions: “rmf” or “rsp” is used for the redistribution matrix, “arf” may be used for the ancillary response files, and the index file for CALDB is caldb.indx .

2.2 MAXI Data-types

Table 2.2 contains a summary of all the different types of the calibration files

Datatype	***Cal directory***	***Description***
GSC		
teldef	bcf	Telescope definition file
mfptab	bcf	Table of X-ray mean free path in beryllium
ssdock	bcf	Information of the docking time of Space Shuttles to the ISS
colea	bcf	Collimator effective areas
hvhist	bcf	HV history data
piparam	bcf	PI spectral-channel parameters
hvVVV_detxXXXX_YYYY	cpf	RMF
arfcorr	cpf	ARF correction data
SSC		
teldef	bcf	Telescope definition file. One file per SSC unit.
arf	cpf	ARF

col	bcf	Collimator slat-plane position
colea	bcf	Collimator effective area
quanteff	bcf	Quantum efficiency. One file per SSC unit.
rmfparam	bcf	Instrumental parameters to build RMF. One file per SSC unit.

Table 2.2 -Datatypes and short description of MAXI files

3 MAXI Files General Description

All MAXI 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 and 5 give the exact strings used in the CALDB keywords for the GSC and SSC, respectively, as well as a description of different FITS-file format.

3.1 Mandatory Keywords

Table 3.1a lists the mandatory keywords in the headers of the primary block and of all the extensions of all the Calibration FITS files. The text for the comment column is shown as it should appear in the files. Remarks on specific comments are added in italics.

Keyword name	**Keyword value**	**Comment**
TELESCOP	'MAXI'	/ Telescope (mission) name
INSTRUME	<instrument>	/ Instrument Name
DETNAM	<detector name> or 'NONE'	/ Detector name
FILENAME	<base-filename>	/ Suggested file name [Optional]
DATE	YYYY-MM-DDThh:mm:ss	/ File creation date (YYYY-MM-DDThh:mm:ss UT)
*The following keywords do not appear in the header of **empty** primary HDUs.*		
CHECKSUM	<up to date checksum>	/ HDU checksum updated <date>
DATASUM	<up to date datasum>	/ Data unit checksum updated <date>

Table 3.1a – Mandatory header keywords for all the MAXI science and calibration FITS files

Table 3.1b lists the possible parameter values for the keywords INSTRUME and DETNAM in the MAXI Calibration and science files.

Keyword Name	Keyword String	Description (*not* FITS comment)
	GSC	
INSTRUME	GSC *or* GSC_n	It is set to either GSC or GSC_n, where *n* is the single-letter GSC-detector

		identifier of [0-9A-B]. The former is set for the files applicable for the GSC in general, whereas the latter is for each individual detector.
DETNAM	C0 *or* NONE	C0 or None (in GSC teldef file).
	SSC	
INSTRUME	SSC *or* SSC_n	It is set to either SSC or SSC_n, where *n* is the single-letter SSC-detector identifier of either "N" or "Z".
DETNAM		Not used

Table 3.1b – Parameter values for MAXI instruments

Table 3.1c lists the additional mandatory keywords common in the header of every table. Each CALDB keyword has different values for different calibration files. The values for the CALDB and EXTNAME keywords are specified for each data-type in the chapter for each instrument.

Keyword name	**Keyword value**	**Comment (as it should appear in the file)**
EXTNAME	<FITS extension name>	/ Name of extension
ORIGIN	<organization name>	/ Origin of the file
CREATOR	<task name and version number>	/ Task that created this file
CALDB Keywords		
CCLSxxxx	OGIP-class of calibration file (either BCF or CPF)	/ Basic Calibration File *or* / Calibration Product File
CDTP*xxxx*	<datatype code>	/ Real data, not subroutine
CCNMxxxx	<extension codename>	/ OGIP Class
CDESxxxx	<descriptive string>	/ Brief descriptive summary
CVSDxxxx	<date from which the file is valid>	/ UTC date when file should first be used
CVSTxxxx	<time from which the file is valid>	/ UTC time when file should first be used

Table 3.1c – Mandatory header keywords for FITS extensions for tables

Tables 3.1d to 3.1f list the header keywords required in some specific cases. The keyword content is described in the sections for each instrument.

Note that the "CBDnxxxx" keyword should be used to differentiate otherwise identical extensions in a file. The first CBD keyword should be named CBD10001, the second CBD20001, and so on. All the CBD-keyword values should follow the syntax "KEYWORD (SELECTION)" where "KEYWORD" is the quantity on which selections are made.

For example, in order to distinguish different phi angles among the extensions in the SSC-Z collimation position table FITS file, the CBD10001 is set to "PHI(-40.0)deg" in the first extension and to "PHI(-30.0)deg" for the second extension.

Keyword name	Keyword value	Comment (as it should appear in the file)
CBDnxxxx	Array describing parameter limitations of the dataset	<*various*>
TDIMnnn	Number of elements & Ordering of *n*-d array	/ Array dimensions
HDUCLASS	'OGIP '	/ Format conforms to OGIP standards
HDUDOC	<document number string>	/ Documents describing the files
HDUCLAS*n*	<character string to classify the extension>	/(Specific to the type)
HDUVERS*n*	<string giving the format version>	/ Version of family of formats (OGIP memo CAL/GEN/92-002a)

Table 3.1d – Header keywords required in some specific cases for extensions for tables

The keywords in the table 3.5 should be present if the binary table contains columns related to time.

Keyword name	Keyword value	Comment (as it should appear in the file)
TIMESYS	TT *or* MAXITIME	/ Time System
MJDREFI	51544	/ Reference MJD (Integer part)
MJDREFF	0.00074287037037037	/ Reference MJD (Fractional part)
CLOCKAPP	T	/ If clock corrections are applied (F/T)

Table 3.1e – Table header keywords required to specify time

Keyword name	Keyword value	Comment (as it should appear in the file)
CTYPE<n>	<n-th Coordinate axis name>	/ Coordinate axis name
CRPIX<n>	<n-th axis reference pixel>	/ <N> axis reference pixel
CRVAL<n>	<Coordinate for CRPIX<n>>	/ Coord of <N> ref pixel
CDELT<n>	<Increment for n-th axis>	/ <N> axis increment

Table 3.1f – Header keywords required for extensions for image-type data

4 GSC files format

4.1 Telescope Definition File

4.1.1 File Name

gsc/bcf/mx_gscN_teldef_YYYYMMDD.fits (N=[0-9ab])

4.1.2 Description

The GSC data reduction software requires as input the Telescope Definition file (teldef). It is a FITS file and contains a set of keywords that describe the telescope and instrument characteristics, the coordinate system definition, and the parameters for transformation among the different coordinates, all in the primary HDU. Three sets of coordinates are defined for the MAXI GSC; they are detector (DET), the X/Y position of the photon crossing the beryllium window of the detector (BE) and sky (SKY), as assigned to the keywords COORDn (n=0,1,2) in this order. The keyword NCOORDS, which gives the total number of the coordinate systems, is accordingly set to 3.

This file has only the primary block with no table or image. The header part is all it has.

4.1.3 File Format

Extension N.	*Type*	*Ext. Name*
0	PRIMARY	

Table 4.1.3 – Telescope definition Calibration File Format

4.1.4 Primary Header Keywords

All keywords listed in Table 3.1a should be included in the header for this HDU. The following table lists the specific settings of some of the CALDB keywords relevant to this file.

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
CCLS0001	BCF	/ Basic Calibration File
CCNM0001	TELDEF	/ OGIP Class
CDTP0001	DATA	/ Real data, not subroutine
CDES0001	TELESCOPE DEFINITION FILE	/ Brief descriptive summary
CVSD0001	2003-01-27	/ Validity start date
CVST0001	00:00:00	/ Validity start time
CBD10001	FORMAT_VERSION(1)	/ Format version of MAXI GSC teldef file
NCOORDS	3	/ Number of coordinates defined in this file
COORD0	DET	/ 1st coordinate system (DETX,DETY)
COORD1	BE	/ 2nd coordinate system (BEX,BEY)
COORD2	SKY	/ 3rd coordinate system (SKYX,SKYY)
ANOD_COL	ANODEID	/ Column name of a ANODEID in event files

ANOD_NUM	6	/ Number of ANODEs, 6 ANODEs for GSC
RAW_LSIZ	<Size>	/ RAW PH_L size
RAW_LMIN	<Min-Ch>	/ RAW PH_L min
RAW_RSIZ	<Size>	/ RAW PH_R size
RAW_RMIN	<Min-Ch>	/ RAW PH_R min
DET_XMIN	<Min-mm>	/ Minimum value of DETX (mm)
DET_XMAX	<Max-mm>	/ Maximum value of DETX (mm)
DETXUNIT	mm	/ Physical unit of DETX
DET_YMIN	<Min-mm>	/ Minimum value of DETY (mm) containing SV
DET_YMAX	<Max-mm>	/ Maximum value of DETY (mm) containing SV
DETYUNIT	mm	/ Physical unit of DETY
C_DEPTH	<Depth>	/ Depth of Carbon cell (mm)
V_DEPTH	<Depth>	/ Depth of Veto cell (mm)
SVC0_BND	<Integer>	/ Boundary between SV and C0
C0C1_BND	<Integer>	/ Boundary between C0 and C1
C1C2_BND	<Integer>	/ Boundary between C1 and C2
C2C3_BND	<Integer>	/ Boundary between C2 and C3
C3C4_BND	<Integer>	/ Boundary between C3 and C4
C4C5_BND	<Integer>	/ Boundary between C4 and C5
C5SV_BND	<Integer>	/ Boundary between C5 and SV
BE_<y>MIN	<Min-mm>	/ Minimum value of DET<y> (mm)
BE_<y>MAX	<Max-mm>	/ Maximum value of DET<y> (mm)
BE<y>UNIT	mm	/ Physical unit of DET<y>
COL_<y>MIN	<Min-mm>	/ Minimum value of COL<y> (mm)
COL_<y>MAX	<Max-mm>	/ Maximum value of COL<y> (mm)
COL<y>UNIT	mm	/ Physical unit of COL<y>
COL_<y>OFF	<Offset>	/ Offset of COL<y> coord (mm)
F_LENGTH	<Length-mm>	/ Length b/w slit and Be window (mm)
QUAT1	<Float>	/ QUAT value (mm)
QUAT2	<Float>	/ QUAT value (mm)

QUAT3	<Float>	/ QUAT value (mm)
QUAT4	<Float>	/ QUAT value (mm)
BE_THICK	<Thickness micron>	/ Thickness of Be window (micron)
AL_THICK	<Thickness micron>	/ Thickness of Al (micron)
GPCMOID	<ID string>	/ Gas Proportional Counter ID *An example value is "FM013" (the last 2 digits are* 01-16)
GSCUID	<Integer>	/ GSCU-ID (0-5)
GSCNAME	<String>	/ GSC camera name

Table 4.1.4 - Telescope Description File Primary Header Keywords

where <y> is either "X" or "Y" (which may be in a lower case).

4.2 Calibration File for X-ray Mean Free Paths in Gas and Material

4.2.1 File Name

gsc/bcf/mx_gsc_mfptab_YYYYMMDD.fits

4.2.2 Description

This file contains a table for the X-ray mean free paths in beryllium, aluminum, and xenon. Beryllium is the main ingredient of the window of the GSCs where X-rays come in, aluminum is used for wiring and xenon is the primary gas of the detector. The file consists of an empty primary header, followed by 3 binary-table extensions.

4.2.3 File Format

Extension N.	***Type***	***Ext. Name***	
0	PRIMARY		
1	BINTABLE	MFPTAB_BE	
	Column Names	**Format**	**Units**
	ENERGY	1E	keV
	MFP	1E	mm
2	BINTABLE	MFPTAB_AL	
	Column Names	**Format**	**Units**
	ENERGY	1E	keV
	MFP	1E	mm
3	BINTABLE	MFPTAB_XE	

Extension N.	*Type*	*Ext. Name*	
	Column Names	**Format**	**Units**
	ENERGY	1E	keV
	MFP	1E	mm

Table 4.2.3 – Format of Calibration File for X-ray Mean Free Paths

4.2.4 Primary Header Keywords

All the header keywords in Table 3.1 and those applicable to the GSC are mandatory.

4.2.5 Extension 1 - Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
EXTNAME	MFPTAB_BE	/ Name of extension
CCLS0001	BCF	/ Basic Calibration File
CCNM0001	MFPTAB_BE	/ OGIP Class
CDTP0001	DATA	/ Real data, not subroutine
CDES0001	Table of X-ray mean free path in Beryllium	/ Brief descriptive summary
CVSD0001	2000-01-01	/ Validity start date
CVST0001	00:00:00	/ Validity start time
CBD10001	FORMAT_VERSION(1)	/ Format version
GPCMOID	<ID string>	/ Gas Proportional Counter ID *Value type "FM0xx" (xx varies from* 01-16)

Table 4.2.5 – Header keywords of Extension 1 of Calibration File for X-ray Mean Free Paths

4.2.6 Extension 2 - Header Keywords

All the header keywords in Extension 1 (Table 4.4) should be included and identical except for the following three.

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		

EXTNAME	MFPTAB_AL	/ Name of extension
CCNM0001	MFPTAB_AL	/ OGIP Class
CDES0001	Table of X-ray mean free path in Aluminium	/ Brief descriptive summary

Table 4.2.6 – Header keywords of Extension 2 of Calibration File for X-ray Mean Free Paths

4.2.7 Extension 3 - Header Keywords

All the header keywords in Extension 1 (Table 4.4) should be included and identical except for the following three.

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
EXTNAME	MFPTAB_XE	/ Name of extension
CCNM0001	MFPTAB_XE	/ OGIP Class
CDES0001	Table of X-ray mean free path in 1.4-atm Xe	/ Brief descriptive summary

Table 4.2.7 – Header keywords of Extension 3 of Calibration File for X-ray Mean Free Paths

4.3 Space-Shuttle Docking Date Table File

4.3.1 File Name

gsc/bcf/mx_gsc_ssdock_YYYYMMDD.fits

4.3.2 Description

This file contains a table of the dates of docking of Space Shuttles. It consists of an empty primary header followed by a single binary-table extension.

4.3.3 File Format

Extension N.	***Type***	***Ext. Name***	
0	PRIMARY		
1	BINTABLE	SSDOCKINFO	
	Column Names	**Format**	**Units**
	TSTART	1D	s

Extension N.	*Type*	*Ext. Name*	
	TSTOP	1D	s
	START_DATE	20A	
	STOP_DATE	20A	

Table 4.3.3 – Space-Shuttle Docking Date Table File Format

4.3.4 Primary Header Keywords

All the header keywords of Table 3.1 and those applicable to GSCs are mandatory.

4.3.5 Extension 1 - Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
EXTNAME	SSDOCKINFO	/ Name of extension
CCLS0001	BCF	/ Basic Calibration File
CCNM0001	SSDOCKINFO	/ OGIP Class
CDTP0001	DATA	/ Real data, not subroutine
CDES0001	Table of shuttle docking dates	/ Brief descriptive summary
CVSD0001	2000-01-01	/ Validity start date
CVST0001	00:00:00	/ Validity start time
CBD10001	FORMAT_VERSION(1)	/ Format version

Table 4.3.5 – Header keywords of Extension 1 of the Space-Shuttle Docking Date Table File

4.4 GSC Collimator Effective Area Calibration File

4.4.1 File Name

gsc/bcf/mx_gscN_colea_YYYYMMDD.fits (N=[0-9ab])

4.4.2 Description

This file contains information of the GSC collimator effective area. It consists of a 2-dimensional image data as the primary HDU, followed by six image-data extensions.

4.4.3 File Format

Extension N.	*Type*	*Ext. Name*
0	PRIMARY	COLEA_SUM
1-6	IMAGE	COLEA_C<n>

Table 4.4.3 – GSC Collimator Effective Area Calibration File Format

where <n> indicates the extension number minus 1; for example the extension name for the first Extension is "COLEA_C0".

4.4.4 Primary Header Keywords

All the header keywords of Table 3.1 and those applicable to GSCs are mandatory.

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
EXTNAME	COLEA_SUM	/ Name of extension
CCLS0001	BCF	/ Basic Calibration File
CCNM0001	COLEA	/ OGIP Class
CDTP0001	DATA	/ Real data, not subroutine
CDES0001	COLLIMATOR EFFECTIVE AREA	/ Brief descriptive summary
GPCMOID	<ID string>	/ Gas Proportional Counter ID An example value is "FM013" (the last 2 digits are 01-16)
PHI_MI	<Coordinate>	/ X axis low edge
PHI_MA	<Coordinate>	/ X axis high edge
THETA_MI	<Coordinate>	/ Y axis low edge
THETA_MA	<Coordinate>	/ Y axis high edge
CTYPE1	X-CAR	/ Coordinate axis name
CTYPE2	Y-CAR	/ Coordinate axis name
CRPIX1	1.	/ X axis reference pixel
CRVAL1	-42.	/ Coord of X ref pixel
CDELT1	0.5	/ X axis increment
CRPIX2	1.	/ Y axis reference pixel
CRVAL2	-1.7	/ Coord of Y ref pixel

CDELT2	0.05	/ Y axis increment

Table 4.4.4 – Header keywords of Primary header in GSC Collimator Effective Area Calibration File

4.4.5 Extensions 1-6 - Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
EXTNAME	COLEA_C<n>	/ Name of extension Note: <n> indicates the extension number plus 1; for example, EXTNAME for the first Extension is "COLEA_C0".
CRPIX1	1.	/ X axis reference pixel
CRVAL1	-42.	/ Coord of X ref pixel
CDELT1	0.5	/ X axis increment
CRPIX2	1.	/ Y axis reference pixel
CRVAL2	-1.7	/ Coord of Y ref pixel
CDELT2	0.05	/ Y axis increment
PHI_MI	<Coordinate>	/ X axis low edge
PHI_MA	<Coordinate>	/ X axis high edge
THETA_MI	<Coordinate>	/ Y axis low edge
THETA_MA	<Coordinate>	/ Y axis high edge
CTYPE1	X-CAR	/ Coordinate axis name
CTYPE2	Y-CAR	/ Coordinate axis name

Table 4.4.5 – Header keywords of Extensions 1-6 of GSC Collimator Effective Area Calibration File

4.5 HV History Calibration File

4.5.1 File Name

gsc/bcf/mx_gscN_hvhist_YYYYMMDD.fits (N=[0-9ab])

4.5.2 Description

This file contains information of the HV history for the GSC. It consists of an empty primary header with one binary-table extension.

4.5.3 File Format

Extension N.	*Type*	*Ext. Name*	
0	PRIMARY		
1	BINTABLE	HVBITHIST	
	Column Names	**Format**	**Units**
	TSTART	1D	s
	TEND	1D	s
	HVBIT	1I	
	HVMONI	1I	
	ANODES	1B	

Table 4.5.3 – GSC HV-Bit History Calibration File Format

4.5.4 Primary Header Keywords

All the header keywords of Table 3.1 and those applicable to GSCs are mandatory.

4.5.5 Extension 1 - Header Keywords

All keywords listed in Tables 3.1, 3.2 and 3.4 should be included in the header for this HDU. The specific settings of some of the CALDB keywords and others relevant to this file are listed below.

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
EXTNAME	HVBITHIST	/ Name of extension
CCLS0001	BCF	/ Basic Calibration File
CCNM0001	HVBITHIST	/ OGIP Class
CDTP0001	DATA	/ Real data, not subroutine
CDES0001	HVBIT HISTORY DATA	/ Brief descriptive summary
GPCMOID	<ID string>	/ Gas Proportional Counter ID *An example value is "FM013" (the last 2 digits are 01-16)*
CVSD0001	2000-01-01	/ Validity start date
CVST0001	00:00:00	/ Validity start time

CBD10001	FORMAT_VERSION(1)	/ Format version

Table 4.5.5 – GSC HV-Bit history Calibration Files Extension 1 Keyword

4.6 GSC PIPARAM Calibration File

4.6.1 File Name

gsc/bcf/mx_gscN_piparam_YYYYMMDD.fits (N=[0-9ab])

4.6.2 Description

This file contains information on the PI parameters. It consists of an empty primary header followed by six binary-table extensions.

4.6.3 File Format

Extension N.	***Type***	***Ext. Name***	
0	PRIMARY		
1	BINTABLE	PIPARAM	
	Column Names	**Format**	**Units**
	ANODE	1B	
	PAR0	1E	
	PAR1	1E	
	PAR2	1E	
	PAR3	1E	
	PAR4	1E	
	HVBIT	1I	
2	BINTABLE	PHACONV	
	Column Names	**Format**	**Units**
	ANODE	1B	
	RKN2MDP	1E	
	RKN2MDPE	1E	
	RKN2MDPL	1E	
	RKN2MDPR	1E	
	RKN2AGU	1E	

Extension N.	*Type*	*Ext. Name*	
	RKN2AGUE	1E	
3	BINTABLE	MDPOFFSET	
	Column Names	**Format**	**Units**
	GAINBIT	1I	
	ANODE	1B	
	LOFFSET	1E	
	LERR	1E	
	ROFFSET	1E	
	RERR	1E	
4	BINTABLE	RIKENOFFSET	
	Column Names	**Format**	**Units**
	ANODE	1B	
	LOFFSET	1E	
	ROFFSET	1E	
5	BINTABLE	AGUOFFSET	
	Column Names	**Format**	**Units**
	ANODE	1B	
	LOFFSET	1E	
	LERR	1E	
	ROFFSET	1E	
	RERR	1E	
6	BINTABLE	MDPOFFSET2	
	Column Names	**Format**	**Units**
	ANODE	1B	
	HVBIT	1I	
	GAINBIT	1I	
	LDBIT	1I	
	LOFF	1E	
	ROFF	1E	

Extension N.	*Type*	*Ext. Name*	
	LOFF2	1E	
	ROFF2	1E	
	P1	1E	
	P2	1E	
	HVBIT_LL	1I	

Table 4.6.3 – GSC PIPARAM Calibration Files Format

4.6.4 Primary Header Keywords

All the header keywords of Table 3.1 and those applicable to GSC are mandatory.

4.6.5 Extension 1 - Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
EXTNAME	PIPARAM	Name of extension
CCLS0001	BCF	Basic Calibration File
CCNM0001	PIPARAM	/ OGIP Class
CDTP0001	DATA	/ Real data, not subroutine
CDES0001	PI Parameters	/ Brief descriptive summary
CVSD0001	2000-01-01	/ Validity start date
CVST0001	00:00:00	/ Validity start time
CBD10001	FORMAT_VERSION(1)	/ Format version
GPCMOID	<ID string>	/ Gas Proportional Counter ID *An example value is "FM013" (the last 2 digits are 01-16)*

Table 4.6.5 – Header keywords of Extension 1 in GSC PIPARAM Calibration File

4.6.6 Extension 2 - Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords The values for the keywords CCLS0001, CDTP0001,		

CBD10001, and GPCMOID are identical with those in Table 4.15.		
CALDB Keywords		
EXTNAME	PHACONV	/ Name of extension
CCNM0001	PHACONV	/ OGIP Class
CDES0001	PHA conversion factor	/ Brief descriptive summary

Table 4.6.6 – Header keywords of Extension 2 in GSC PIPARAM Calibration File

4.6.7 Extension 3 - Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords The values for the keywords CCLS0001, CDTP0001, CBD10001, and GPCMOID are identical with those in Table 4.15.		
CALDB Keywords		
EXTNAME	MDPOFFSET	/ Name of extension
CCNM0001	MDPOFFSET	/ OGIP Class
CDES0001	PH offset of MDP	/ Brief descriptive summary

Table 4.6.7 – Header keywords of Extension 2 in GSC PIPARAM Calibration File

4.6.8 Extension 4 - Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords The values for the keywords CCLS0001, CDTP0001, CBD10001, and GPCMOID are identical with those in Table 4.15.		
CALDB Keywords		
EXTNAME	RIKENOFFSET	Name of extension
CCNM0001	RIKENOFFSET	/ OGIP Class
CDES0001	PH offset of RIKEN	/ Brief descriptive summary

Table 4.6.8 – Header keywords of Extension 4 in GSC PIPARAM Calibration File

4.6.9 Extension 5 - Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords The values for the keywords CCLS0001, CDTP0001, CBD10001, and GPCMOID are identical with those in Table 4.15.		
CALDB Keywords		

EXTNAME	AGUOFFSET	Name of extension
CCNM0001	AGUOFFSET	/ OGIP Class
CDES0001	PH offset of AGU	/ Brief descriptive summary

Table 4.6.9 – Header keywords of Extension 5 in GSC PIPARAM Calibration File

4.6.10 Extension 6 - Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords The values for the keywords CCLS0001, CDTP0001, CBD10001, and GPCMOID are identical with those in Table 4.15.		
CALDB Keywords		
EXTNAME	MDPOFFSET2	Name of extension
CCNM0001	MDPOFFSET2	/ OGIP Class
CDES0001	In-orbit PH offset param.	/ Brief descriptive summary

Table 4.6.10 – Header keywords of Extension 6 in GSC PIPARAM Calibration Fil

4.7 Response Matrices (RMF)

4.7.1 File Names

The response of the GSC consist of two components, RMF (Redistribution/Response Matrix File) and ARF (Ancillary Response File). Each of them has its own calibration files. This sub-section explains the former (RMF). The calibration filenames for the GSC RMF are in the following form:

gsc/cpf/mx_gscN_hvVVV_detxPXXX_PXXX.rmf

where *N* is the detector identification letter [0-9ab], *VVV* is the high-voltage in [V] in 3 digits, a pair of XXX is the range of the coordinates in the DET coordinate system, *P* is a single letter of either [0, m, p], corresponding to the center and the sign of either Minus (negative) or Plus (positive), respectively, of the coordinates.

4.7.2 Description

The response matrices are generated for individual detectors of the GSC and they are applicable for spectra extracted in the PI channel type. All the available response matrices are included in CALDB and they can be added up using a suitable software. The effective area is incorporated. The RMF file consists of an empty primary table followed by two binary-table extensions named “MATRIX” and “EBOUNDS” in this order.

The “MATRIX” extension (first extension) contains the following columns:

- ENERG_LO: lower energy bound in keV of energy bins,
- ENERG_HI: upper energy bound in keV of energy bins,
- N_GRP: number of channel subsets for each energy bin,
- F_CHAN: starting channel number of each 'channel subset' for the energy bin,
- N_CHAN: number of channels within each 'channel subset' for the energy bin,

- MATRIX: response values for each 'channel subset' for the energy bin.

The EBOUNDS extension (second extension) contains:

- CHANNEL: channel number,
- E_MIN: energy in keV for the lower bound of the channel,
- E_MAX: energy in keV for the upper bound of the channel.

4.7.3 File Format

Extension N.	***Type***	***Ext. Name***	
0	PRIMARY		
1	BINTABLE	MATRIX	
	Column Names	**Format**	**Units**
	ENERG_LO	1E	keV
	ENERG_HI	1E	keV
	N_GRP	1I	-
	F_CHAN	1I	-
	N_CHAN	1I	-
	MATRIX	1200E	-
2	BINTABLE	EBOUNDS	
	Column Names	**Format**	**Units**
	CHANNEL	1J	
	E_MIN	1E	keV
	E_MAX	1E	keV

Table 4.7.3 – GSC Response Matrix (RMF) Calibration File Format

4.7.4 Primary Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		

COL_THA	0	/ COL theta of incident angle
COL_PHI	<phi>	/ COL phi of incident angle
DET_THA	<theta>	/ DET theta of incident angle
DET_PHI	<phi>	/ DET phi of incident angle
NUMDETX	1	/ Num of DETX average sampling
DETXCNTR	<detx-channel>	/ DETX center on Be window
DETXMIN	<detx-channel>	/ DETX average min on Be window
DETXMAX	<detx-channel>	/ DETX average max on Be window
NUMDETY	72	/ Num of DETY average sampling
DETYCNTR	<dety-channel>	/ DETY center on Be window
DETYMIN	<dety-channel>	/ DETY min on Be window
DETYMAX	<dety-channel>	/ DETY max on Be window
CONTENT	RESPONSE	/ Spectrum file containing time intervals and event
RMFTYPE	0	/ RMF type. 0:Slit Scan, 1:Pencil Beam, 2:LRF

Table 4.7.4- Header keywords of the primary HDU of GSC Response Matrix (RMF) Calibration File

4.7.5 Extension 1 - Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
EXTNAME	MATRIX	/ Name of extension
CCLS0001	CPF	/ Calibration Product File
CCNM0001	SPECRESP MATRIX	/ OGIP Class
CDTP0001	DATA	/ Real data, not subroutine
CDES0001	MAXI/GSC Response Matrix	/ Brief descriptive summary
CBD10001	HV(<Voltage>)V	/ High Voltage value
CBD20001	DETX(<Channel>-<Channel>)	/ DETX range
CBD30001	ANODE(<Anode>-<Anode>)	/ ANODE number
CVSD0001	2000-01-01	/ Validity start date
CVST0001	00:00:00	/ Validity start time

RMFTYPE	0	/ RMF type. 0:Slit Scan, 1:Pencil Beam, 2:LRF
COL_THA	<theta>	/ COL theta of incident angle
COL_PHI	<phi>	/ COL phi of incident angle
DET_THA	<theta>	/ DET theta of incident angle
DET_PHI	<phi>	/ DET phi of incident angle
NUMDETX	1	/ Num of DETX average sampling
DETXCNTR	<detx-channel>	/ DETX center on Be window
DETXMIN	<detx-channel>	/ DETX average min on Be window
DETXMAX	<detx-channel>	/ DETX average max on Be window
NUMDETY	72	/ Num of DETY average sampling
DETYCNTR	<dety-channel>	/ DETY center on Be window
DETYMIN	<dety-channel>	/ DETY min on Be window
DETYMAX	<dety-channel>	/ DETY max on Be window
CHANTYPE	PI	/ Detector Channel Type in use (PHA or PI)
DETCHANS	<integer>	/ Total number of detector channels
DETNAM	C0	/ Detector name (sub)
HDUCLAS1	RESPONSE	/ Dataset relates to spectral response
HDUCLAS2	RSP_MATRIX	/ Dataset is a spectral response matrix
HDUCLAS3	DETECTOR	/ Dataset is for a detector
RMFVERSN	1992a	/ OGIP classification of FITS format

Table 4.23 - Header keywords of Extension 1 in GSC Response Matrix Calibration File

4.7.6 Extension 2 - Header Keywords

The header keywords and contents are basically identical with those in Table 4.23, except for EXTNAME and HDUCLAS2 as follows:

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
EXTNAME	EBOUNDS	/ Name of extension
HDUCLAS2	EBOUNDS	/ Dataset is for energy boundaries

Table 4.7.6 – Header keywords of Extension 2 in GSC Response Matrix Calibration File

4.8 GSC Ancillary Response File (ARF) Calibration File

4.8.1 File Name

gsc/cpf/mx_gscN_arfcorr_YYYYMMDD.fits (N=[0-9ab])

4.8.2 Description

See Section 4.7 for the general description of the response files of the GSC.

4.8.3 File Format

Extension N.	***Type***	***Ext. Name***	
0	PRIMARY		
1	BINTABLE	HVB803	
	Column Names	**Format**	**Units**
	ENERG_LO	1E	keV
	ENERG_HI	1E	keV
	SPECRESP	1E	-
2	BINTABLE	HVB854	
	Column Names	**Format**	**Units**
	ENERG_LO	1E	keV
	ENERG_HI	1E	keV
	SPECRESP	1E	-

Table 4.8.3 – GSC Ancillary Response File (ARF) Calibration File Format

4.8.4 Primary Header Keywords

The primary header is empty with no data or keywords.

Keyword name	**Keyword value**	**Comment**
CALDB Keywords		

Table 4.8.4 – Header keywords of the primary HDU of GSC Ancillary Response File (ARF)

4.8.5 Extension 1 - Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
EXTNAME	HVB803	/ Name of extension
HDUCLASS	OGIP	/ Format conforms to OGIP standards
HDUCLAS1	RESPONSE	/ Dataset relates to spectral response
HDUCLAS2	SPECRESP	/ Dataset is a spectral response matrix
HDUVERS	1.1.0	/ Version of family of formats
CCLS0001	CPF	/ Calibration Product File
CCNM0001	ARFCORR	/ OGIP Class
CDTP0001	DATA	/ Real data, not subroutine
CDES0001	ARF for HVBIT(803)	/ Brief descriptive summary
CBD10001	HVBIT(803)	/ HVBIT value
CVSD0001	2000-01-01	/ Validity start date
CVST0001	00:00:00	/ Validity start time

Table 4.8.5 - Header keywords of Extension 1 in GSC Ancillary Response File (ARF) Calibration File

4.8.6 Extension 2 - Header Keywords

The header keywords and contents are basically identical with those in Table 4.27, except for a couple of them as follows:

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
EXTNAME	HVB854	/ Name of extension
CDES0001	ARF for HVBIT(854)	/ Brief descriptive summary
CBD10001	HVBIT(854)	/ HVBIT value

Table 4.28 – Header keywords of Extension 2 in GSC Ancillary Response File (ARF) Calibration File

5 SSC files format

5.1 Telescope Definition File

5.1.1 File Name

The Telescope Definition Calibration file is also known as teldef. There is one teldef file for each of the SSC-H and SSC-Z onboard MAXI with the following naming convention:

ssc/bcf/mx_sscZ_teldef_YYYYMMDD.fits [Z=h,z]

5.1.2 Description

The SSC data reduction software requires as input the Telescope Definition file (teldef). It is a FITS file and contains a set of keywords that describe the telescope and instrument characteristics, the coordinate system definition and the transformations between the coordinates, all in the primary HDU. Three sets of coordinates are defined for the MAXI SSC; they are raw (RAW), actual (ACT), detector (DET), as assigned to the keywords COORDn (n=0,1,2) in this order. The keyword NCOORDS, which gives the total number of the coordinate systems, is accordingly set to 3.

The RAW coordinates come from the telemetry and numbered accordingly with the segment on the CCD. The ACT coordinates cover the entire CCD unit as one, looking down. The DET coordinates are in reverse, looking up, and with some amount of shift.

For each coordinate system, several keywords that describe how the pixels are numbered and the relation with the other coordinates, are defined. This file has only the primary header with no table or image. The header contain the keywords that documents the coordinates.

5.1.3 File Format

Extension N.	*Type*	*Ext. Name*
0	PRIMARY	

Table 5.1.3 – SSC Telescope Description Calibration File Format

5.1.4 Primary Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
CCLS0001	BCF	/ Basic Calibration File
CCNM0001	TELDEF	/ OGIP Class
CDTP0001	DATA	/ Real data, not subroutine

CDES0001	TELESCOPE DEFINITION FILE	/ Brief descriptive summary
CVSD0001	2003-01-27	/ Validity start date
CVST0001	00:00:00	/ Validity start time
CBD10001	FORMAT_VERSION(2)	/ Format version of MAXI SSC teldef file
Instrument keyword		
INSTRUME	SSC_<z>	/ Instrument name
NCOORDS	3	/ Number of coordinates defined in this file
COORD0	RAW	/ 1st coordinate system (RAWX,RAWY)
COORD1	ACT	/ 2nd coordinate system (ACTX,ACTY)
COORD2	DET	/ 3rd coordinate system (DETX,DETY)
CCD_COL	CCDID	/ Column name of a CCDID in event files
CCD_NUM	<Integer>	/ Number of CCDs, 16 CCDs for SSC
RAW_<y>SIZ	<Integer>	/ RAW address space x size (pixels)
RAW<y>PIX1	<Integer>	/ RAW address space x first pixel number (pixel)
RAW_<y>SCL	<Float>	/ RAW <y> scale (mm/pixel)
RAW<y>UNIT	mm	/ Physical unit of RAW<y>
ACT_<y>SIZ	<Integer>	/ ACT address space x size (pixels)
ACT<y>PIX1	<Integer>	/ ACT address space <y> first pixel number (pixel)
ACT_<y>SCL	<Float>	/ ACT <y> scale (mm/pixel)
ACT<y>UNIT	mm	/ Physical unit of ACT<y>
COE_<y><c>_A	<Integer>	/ COE_<y> A for CCDID <c>
COE_<y><c>_B	<Integer>	/ COE_<y> B for CCDID <c>
COE_<y><c>_C	<Integer>	/ COE_<y> C for CCDID <c>
ACT<y>FLIP	<1 or 0>	/ ACT coords are look down, so no flipping
DET_<y>SIZ	<Integer>	/ DET address space <y> size (pixels)
DET<y>PIX1	<Integer>	/ DET address space <y> first pixel number (pixel)
DET_<y>SCL	<Float>	/ DET address space mm per <y> detector unit (mm/pi
DET<y>UNIT	mm	/ Physical unit of DET<y>
DET<y>FLIP	<1 or 0>	/ No flip

ALIGNM<n>1	<Integer>	/ ACT -> DET coordinates alignment matrix Mij
ALIGNM<n>2	<Integer>	/ (CCD fix) => (slit/collimator)
ALIGNM<n>3	<Integer>	
OPTCOORD	DET	/ Optical axis is defined in DET coordinates
OPTAXIS<y>	<Float>	/ <y>-center (below slit) in DET coordinates (mm)
THT_MAX	<Integer>	/ DETSP_THETA addresses space maximum (degree)
THT_MIN	<Integer>	/ DETSP_THETA addresses space minimum (degree)
THT_UNIT	degree	/ Physical unit of DETSP_THETA
PHI_MAX	<Integer>	/ DETSP_PHI addresses space maximum (degree)
PHI_MIN	<Integer>	/ DETSP_PHI addresses space minimum (degree)
PHI_UNIT	degree	/ Physical unit of DETSP_PHI
QUAT<m>	<Float>	
F_LENGTH	<Float>	/ Distance (mm) between slit and CCD surface window

Table 5.1.4 – Header keywords of the primary HDU of SSC Telescope Description File

where <z> is either "H" or "Z" to identify the SSC unit, <y> is either "X" or "Y" (which may be in a lower case), <c> is a chip-ID of [0-9A-F] (which may be in a lower case), <n> is an integer of 1, 2, or 3, and <m> is an integer of [1-4].

5.2 SSC Ancillary Response File (ARF) Calibration File

5.2.1 File Name

ssc/cpf/mx_sscZ_arf_YYYYMMDD.fits (Z=[hz])

5.2.2 Description

See Sections 4.7.1 and 4.7.2 for the general description of the response files (it is for the GSC, but is mostly applicable to the SSC). This file consists of an empty primary header, followed by a single binary-table extension.

5.2.3 File Format

Extension N.	***Type***	***Ext. Name***	
0	PRIMARY		
1	BINTABLE	SPECRESP	
	Column Names	**Format**	**Units**
	ENERG_LO	1E	keV

	ENERG_HI	1E	keV
	SPECRESP	1E	

Table 5.2.3 – SSC Ancillary Response File (ARF) Calibration File Format

5.2.4 Primary Header Keywords

The primary header is empty with no keywords or data.

Keyword name	Keyword value	Comment
CALDB Keywords		

Table 5.2.4 – Header keywords of the primary HDU of SSC Ancillary Response File (ARF)

5.2.5 Extension 1 - Header Keywords

Keyword name	Keyword value	Comment
Tables 3.1 & 3.2 - Mandatory header keywords		
CALDB Keywords		
EXTNAME	SPECRESP	/ Name of extension
HDUCLASS	OGIP	/ Format conforms to OGIP standards
HDUCLAS1	RESPONSE	/ Dataset relates to spectral response
HDUCLAS2	SPECRESP	/ Dataset is a spectral response matrix
HDUVERS	1.1.0	/ Version of family of formats
ARFVERSN	1992a	/ ARF Version
CCLS0001	CPF	/ Calibration Product File
CCNM0001	ARFCORR	/ OGIP Class
CDTP0001	DATA	/ Real data, not subroutine
CDES0001	ARF for SSC	/ Brief descriptive summary
CVSD0001	2000-01-01	/ Validity start date
CVST0001	00:00:00	/ Validity start time
CBD10001	FORMAT_VERSION(1)	/ Format version

Table 5.2.5 – Header keywords of Extension 1 in SSC Ancillary Response File (ARF) Calibration File

5.3 SSC Collimator Slat-Plane Position Calibration File

5.3.1 File Name

ssc/bcf/mx_sscZ_col_YYYYMMDD.fits [Z=h,z]

5.3.2 Description

This file contains information on the collimator slat-plane positions of each SSC. It consists of an empty primary header followed by nine binary-table extensions for the angles φ=±40, ±30, ±20, ±10, +0 degrees in the order from the smallest (negative) to the largest (positive).

5.3.3 File Format

Extension N.	***Type***	***Ext. Name***	
0	PRIMARY		
1-9	BINTABLE	COLSLATP_P<angle>	
	Column Names	**Format**	**Units**
	SLATID	1I	
	YCOL	1D	mm
	LAYER	1I	

Table 5.3.3 – SSC Collimator Slat-Plane Position Calibration Files Format

where <angle> is −40, −30, −20, −10, 0, 10, 20, 30, and 40 for the extensions 1 to 9, respectively.

5.3.4 Primary Header Keywords

All the header keywords of Table 3.2 and those applicable to SSCs are mandatory.

5.3.5 Extensions 1-9 - Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
EXTNAME	COLSLATP_P<angle>	/ Name of extension

CCLS0001	BCF	/ Basic Calibration File
CCNM0001	COLSLATP	/ OGIP Class
CDTP0001	DATA	/ Real data, not subroutine
CDES0001	COLLIMATOR SLAT-PLANE POSITION	/ Brief descriptive summary
CVSD0001	2000-01-01	/ Validity start date
CVST0001	00:00:00	/ Validity start time
CBD10001	FORMAT_VERSION(1)	/ Format version
CBD20001	PHI(<angle_decimal>)deg	/ Collimator phi range
COLPHI	<angle>	/ Collimator phi in calibration exp.

Table 5.3.5 – Header keywords of Extension 1 in SSC Collimator Slat-Plane Position Calibration File

where <angle> is −40, −30, −20, −10, 0, 10, 20, 30, and 40 for the extensions 1-9 in this order, and <angle_decimal> is its decimal expression to the first order, such as "0.0".

5.4 SSC Collimator Effective Area Calibration File

5.4.1 File Name

ssc/bcf/mx_sscZ_colea_20150305.fits (Z=[hz])

5.4.2 Description

This file contains information of the SSC collimator effective area. It consists of a 2-dimensional image data as the primary HDU with no extensions.

5.4.3 File Format

Extension N.	***Type***	***Ext. Name***
0	PRIMARY	COLEA_SUM

Table 5.4.3 – SSC Collimator Effective Area Calibration File Format

5.4.4 Primary Header Keywords

All the header keywords of Tables 3.1, 3.4, and 3.6 are mandatory.

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		

EXTNAME	COLEA_SUM	/ Name of extension
CCLS0001	BCF	/ Basic Calibration File
CCNM0001	COLEA	/ OGIP Class
CDTP0001	DATA	/ Real data, not subroutine
CDES0001	COLLIMATOR EFFECTIVE AREA	/ Brief descriptive summary
CVSD0001	2000-01-01	/ Validity start date
CVST0001	00:00:00	/ Validity start time
CBD10001	FORMAT_VERSION(1)	/ Format version
PHI_MI	<Coordinate>	/ X axis low edge
PHI_MA	<Coordinate>	/ X axis high edge
THETA_MI	<Coordinate>	/ Y axis low edge
THETA_MA	<Coordinate>	/ Y axis high edge

Table 5.4.4 – Header keywords of the primary HDU of SSC Collimator Effective Area Calibration File

5.5 SSC quantum efficiency Calibration File

5.5.1 File Name

ssc/bcf/mx_sscZ_quanteff_YYYYMMDD.fits [Z=h,z]

5.5.2 Description

This file contains the information related to the quantum efficiency. It consists of an empty primary header with a single binary-table extension.

5.5.3 File Format

Extension N.	***Type***	***Ext. Name***	
0	PRIMARY		
1	BINTABLE	EFFICIENCY_CCD	
	Column Names	**Format**	**Units**
	Time	1D	s
	Energy	PE(7943)	keV
	QE_c<Chip-ID>_p<PID>	PE(7943)	

Table 5.5.3 – SSC Quantum Efficiency Calibration File Format

5.5.4 Primary Header Keywords

All the header keywords of Table 3.1 and those applicable to SSC are mandatory.

5.5.5 Extensions 1-4 - Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB and Instrument keywords		
CCLS0001	BCF	/ Basic Calibration File
CDTP0001	DATA	/ Real data, not subroutine
INSTRUME	SSC_<Unit-ID>	/ Instrument/detector name
EXTNAME	EFFICIENCY_CCD	/ Name of extension
CCNM0001	EFFICENCY_CCD	/ OGIP Class
CDES0001	Quantum efficiency of CCD	/ Brief descriptive summary
CVSD0001	2000-01-01	/ Validity start date
CVST0001	00:00:00	/ Validity start time
CBD10001	FORMAT_VERSION(1)	/ Format version
MJDREFI	51544	/ Reference MJD, Integer part

Table 5.5.5 – Header keywords of Extensions 1-6 in SSC Quantum efficiency Calibration File

where <Unit-ID> is either “H” or “Z”.

5.6 SSC parameters to build the RMF Calibration File

5.6.1 File Name

ssc/bcf/mx_sscZ_rmfparam_YYYYMMDD.fits [Z=h,z]

5.6.2 Description

The response matrices (RMF) are generated for individual detector of the SSC and they are applicable for spectra extracted in the PI channel type. All the available response matrices are included in CALDB and they can be added with a suitable software. The files should be used in conjunction with ARFs. This calibration file lists the parameters to build SSC RMFs. It consists of an empty primary table, followed by a single binary-table extension named “RMF_PARAMETERS”. The table contains 17 columns as described below.

5.6.3 File Format

Extension N.	*Type*	*Ext. Name*	
0	PRIMARY		
1	BINTABLE	RMF_PARAMETERS	
	Column Names	**Format**	**Units**
	Time	1D	s
	Param_c<Chip-ID>	PE(32)	

Table 5.6.3 – SSC RMF Parameter File Format

where <Chip-ID> is a single number in the hexagonal format between 0 and 15, namely, [0-9A-F].

5.6.4 Primary Header Keywords

All the keywords of Table 3.1a and 3.1b are mandatory.

5.6.5 Extension 1 - Header Keywords

Keyword name	**Keyword value**	**Comment**
Tables 3.1a & 3.1b - Mandatory header keywords		
CALDB Keywords		
CCLS0001	BCF	/ Basic Calibration File
CCNM0001	RMF_PARAMETERS	/ OGIP Class
CDTP0001	DATA	/ Real data, not subroutine
CDES0001	Parameters for RMF file	/ Brief descriptive summary
Response Matrix File Keywords		
EXTNAME	RMF_PARAMETERS	/ Name of extension
INSTRUME	SSC_<Unit-ID>	/ Instrument/detector name

Table 5.6.5 – Header keywords of Extension 1 in SSC RMF Parameter File

where <Unit-ID> is either “H” or “Z”.