HaloSat archive

Version 1.1

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CHANGE RECORD PAGE

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ISSUE	DATE	PAGES AFFECTED	DESCRIPTION
Version 1.0	Mar 2020	All	First version
Version 1.1	Feb 2021		Include the end of the mission date. Add the spectral plot as product.

1 Archive: Overview and Content

1.1 Introduction

The CubeSat mission HaloSat (PI P. Kaaret) was launched from the NASA Wallops Flight Facility and delivered to the International Space Station on May 21, 2018. HaloSat was deployed into orbit on July 13, 2018. The spacecraft and science instrument commissioning phase ended on October 15, 2018. Originally approved for 12 months of science operations, HaloSat successfully collected science data from October 15, 2018, up to September 29, 2020, effectively doubling the mission life time. HaloSat reentered Earth's atmosphere on January 4, 2021 after nearly two and half year in orbit.
The HaloSat science objective are to survey and map the distribution of hot gas in the Milky Way in order to constrain the mass and determine the geometry of the Galactic halo. To trace the Galactic halo, HaloSat is equipped with a non-focusing instrument, comprised of three independent silicon drift detectors (numbered as 14, 54 and 38) operating in the energy range of 0.4 -7.0 keV with a field of view of 10 deg in diameter and an energy resolution of 84.8 ± 2.7 eV at 677 eV and 137.4 ± 0.9 eV at 5895 eV. The observing strategy is to divide the sky into 333 positions and acquire a minimum of 8000 detector-seconds for each position throughout the 12 months of operations.

The HaloSat archive includes the science and housekeeping data (all levels) and calibration files necessary to analyze the data. This document describes the HaloSat archive and includes: the data organization, archive structure and filename convention and the description of the science and housekeeping FITS file headers.

The HaloSat science data center is located at the University of Iowa (UIowa). The data processing pipeline occurs at UIowa and the data outputs are provided to the HEASARC for the final archive.

1.2 Observation definition and sequence number

To complete the sky survey HaloSat divides the sky into 333 sky positions that are observed during mission operations. Additional observations are added to observe the dark Earth and other fields used for calibration. HaloSat's orbital period is about 90 minutes. The science instrument is turned on only during the night-side half of the orbit. During that time the science and instrument housekeeping data are collected. No science or housekeeping data are collected during the day-side half of the orbit. The attitude information is collected for the night-side of the orbit only. HaloSat's observation strategy is to follow two selected positions in the sky for 10 consecutive orbits, and to observe each of the positions for about 1300 seconds per orbit. At the end of the 10 orbits, the pattern is repeated for two other positions, and so on. In May 2019 the number of consecutive orbits in the observing pattern was increased to 16.

An observation is defined as data acquired on one specific sky position observed in a time interval where individual files do not exceed 2 Gb. Data associated with an observation are labeled with a 6-digit sequence number :

YYYYZZ

where

- YYYY is the target number corresponding to a specific RA and Dec on the sky. The target number is written from right to left and always has 4 digits. Therefore, the target number for position 1 is written as 0001 and for position 333 as 0333. After launch, additional sky positions were added to the initial 333 positions as well as observations made of the dark Earth. The 4 digits target number in the range of 0001 - 0999 is reserved for the sky positions and the range 1001 – 1999 to the dark earth observations. The value of 0000 is reserved for non-science observations, (for example for data collected during commissioning phase).
- ZZ is a number used to create sequences in the same sky position to limit the size of individual files. Data from the same sky position are divided in different sequences such that each FITS file do not exceed 2GB. The ZZ number is written from right to left and is always 2 digits starting from 01. If all data taken for a given sky position may be included in FITS files < 2GB, there will be a single data set for that sky position and ZZ will 01.

The sequence number is used to name the directory containing the science and HK files and it is embedded in the filename.

1.3 Files within an observation

The telemetry data are stored into FITS file format, using OGIP standard, processed and organized in directory by sequence number. Each sequence contains the following files:

- **3 Unfiltered Event files (EVENTS + GTI).** Each event file contains the calibrated events, with minimal screening (only data when the instrument is fully operating) , collected by a single detector unit for a specific sky position . The file structure has two FITS binary extensions: EVENTS and GTI. At this level all events collected within 0.25 degrees from a specific sky position during nominal operating times are included. The GTI extension contains the observing times corresponding to the specific sky position.

- **3 Cleaned Event files (EVENTS + GTI + SCREENING).** Each event file contains the calibrated events, screened for unwanted time intervals or event type, collected by a single detector unit for a specific sky position. The file structure has three FITS binary extensions: EVENTS, GTI and SCREENING. The screening process removes all events judged bad according to standard HaloSat event selection criteria. The GTI extension contains the good time intervals for science after the unwanted intervals are removed. The events in the EVENTS extension are only those within these good time intervals. The

SCREENING extension contains the expression applied to the unfiltered data to derive the cleaned events.

- **3 Instrument housekeeping files (HK).** Each housekeeping file contains the instrument housekeeping collected by each detector unit during the entire observation and orbital information. The file structure has one FITS binary table extension. The orbital information (for example the South Atlantic Anomaly) and the orbit in the ECI system are calculated by the pre-filter code and added to the other HaloSat housekeeping information.

- **1 Attitude file (ATTITUDE+GTI)** . This file contains the quaternion from the spacecraft for the entire observation. The file structure has two FITS binary table extensions. The first contains the attitude information and the second contains the GTI marking the start and stop of each segment pointing to the “object” within the observation.

- **1 Log file**. This file contains the output of the processing that generates the unfiltered and cleaned event data and additional files in the sequence. The Log file is provided as a PDF.

- **3 Spectral files.** These files contain the spectrum obtained by binning the cleaned events for each of the three detectors. The file structure has one FITS binary table extension with a format compatible with spectral fitting program Xspec. The response and effective area files necessary for the spectral analysis are stored in CALDB.

- **1 Plot file**. This file contains the plot of the spectra obtained from the three instruments.

- **1 Catalog file** . This file contains the list of the file in the sequence as well as the file UNIX checksum. This file is generated at the HEASARC after the data arrived in the archive.

The orbital information is derived using the HEAsoft code *prefilter* using as input the HaloSat attitude data together with the Two-Line Elements (TLE) file. Since the same TLE file will be applied to all sequences, this file is stored in the trend area.

1.4 Naming convention

The filename convention contains three elements an identifier for the mission, the sequence number and additional strings to identify the files. The conventions for the different file type are :

a. The filename convention for the science event files is the following:
   hs*YYYYZZ*_s*YY*_*ll*.evt.gz
   where *YYYYZZ* is the sequence number. *sYY* defines the detector where *YY* is the detector units set to 14, or 54 or 38 . *ll* indicates the event level and is set to *uf* for the unfiltered event file or *cl* for the cleaned event file.

b. The housekeeping and spectra are derived for individual detector unit and the filename convention is
   hs*YYYYZZ*_s*YY*.*ext*.gz
   where *YYYYZZ* is the sequence number. *YY* defines the detector unit number. Detector units are referred to with the numbers 14, 54 and 38 that are encoded into their digital processing units. The *ext* is set to *pi* for spectral files and *hk* for housekeeping files.

c. The filename for other general files that can be identified just by file extension:
   hs*YYYYZZ*.*ext*.gz
   where *YYYYZZ* is the sequence number. *ext* defined the file type. This set to *att* for the attitude file, *cat* for the catalog file.

d. The filename for the pdf file containing the log of the data processing
   *hsYYYYZZ*_log.pdf.gz

e. The TLE file is a text file not associated to each sequence but kept in the trend area This file is incrementally delivered to the archive when new data are available and contains all the orbital elements valid up to a specific day. The file name is therefore associated with time as follows:
   hs*YYYYMMDD*_tle.txt.gz
   where *YYYYMMDD* is the last day included in the TLE.

1.5 Directory structure

The HaloSat archive is divided in two areas: the obs/ directory and the trend/ directory. The obs/ directory contains the science data organized by sequence number and the trend/ directory contains data organized by data type. The structure of the data directory is as follows :

```
                               data/
                  obs/                                  trend/
                   |                                      |
        _________________________________       ______________________
        |          |            |               |          |         |
 000101/  000201/  000202/  000301/...       type1/      type2/    type3/ ....
             |                                  |
  unfiltered/  products/                  filetype11  filetype12  ...
```

Science, housekeeping and other auxiliary data for each sequence are included under a single directory named after the sequence number (6 digits number). Under this directory, data are organized into two directories *unfiltered/* and *products*/, which divides the data according to their level of processing. The *unfiltered/* directory contains unfiltered event files, housekeeping files, attitude file, catalog and log files. The *products/* directory contains cleaned and calibrated event files and spectral files. The content of the unfiltered and products directory is the following :

Table 1	
unfiltered/	
hsYYYYZZ_s14.hk.gz	Housekeeping and orbital information SDD 14
hsYYYYZZ_s38.hk.gz	Housekeeping and orbital information SDD 38
hsYYYYZZ_s54.hk.gz	Housekeeping and orbital information SDD 54
hsYYYYZZ.att.gz	Attitude data
hsYYYYZZ.cat.gz	Catalog of the files included in the observation
hsYYYYZZ_s14_uf.evt.gz	Unfiltered event file for the SDD 14 detector
hsYYYYZZ_s38_uf.evt.gz	Unfiltered event file for the SDD 38 detector
hsYYYYZZ_s54_uf.evt.gz	Unfiltered event file for the SDD 54 detector
products/	
hsYYYYZZ.log.pdf.gz	Log of the processing
hsYYYYZZ_s14_cl.evt.gz	Filtered event file for the SDD 14 detector
hsYYYYZZ_s38_cl.evt.gz	Filtered event file for the SDD 38 detector
hsYYYYZZ_s54_cl.evt.gz	Filtered event file for the SDD 54 detector
hsYYYYZZ_s14.pi.gz	Spectrum for the SDD 14 detector
hsYYYYZZ_s38.pi.gz	Spectrum for the SDD 38 detector
hsYYYYZZ_s54.pi.gz	Spectrum for the SDD 54 detector
hsYYYYZZ_sp.gif	Plot of spectra

The responses (rmf and arf) are not included within the product directory. They are archived within CALDB since they are the same for each detector and are not time dependent.

The trend directory contains data by type. The current plan is to archive the TLE in the trend area. There will be an incremental file with each delivery. The directory structure and file name is the following:

trend/
halo_tle/
|
hsYYYYMMDD_tle.txt

where YYYYMMDD corresponds to the last day included in the TLE. The TLE information is taken from www.space-track.org.

1.6 The as-flown timeline

The as-flown timeline provides a summary of what HaloSat has observed. The information in the timeline includes start and stop time, coordinates, the sequence number and source name, source type. The possible source type are : CALIBRATION, SCIENCE, SWCX (Solar Wind Change Exchange), HALO, OFFSET and EARTH. At HEASARC the timeline is ingested in the timeline tool and used as record of satellite status. The as-flown timeline may be viewed using the HEASARC timeline tool (https://heasarc.gsfc.nasa.gov/cgi-bin/Tools/timeline/timeline.pl).

1.7 HaloSat CALDB and Software

CALDB

The calibration files are stored in the HEASARC CALibration DataBase. (CALDB) in an area dedicated to HaloSat The files included in CALDB are :

- Response matrix (rmf) containing the line spread function for the detector
- Ancillary Response (arf) containing all elements contributing to the effective area
- Alignment file

The calibration data file structure and directory is described in a separated document located at the Halosat web page (https://heasarc.gsfc.nasa.gov/docs/halosat) dedicated at calibration.

Software

The HaloSat pipeline includes: time order the packets , remove duplicates, divided the data in sequence, select only the data when the instruments operate in nominal condition, generate the auxiliary data, apply the gain corrections and generate the different data level. This software is a collection of Python code written and run at UIowa and not delivered to the HEASARC. However since the files are in standard FITS format, spectral extraction or additional filtering may be done with the standard HEASoft tools (for example xselect).

2 HaloSat FITS archive files

2.1 Header Keywords

The science and housekeeping telemetry as well as the high-level files are stored in FITS using the FITS BINTABLE extension. The HaloSat FITS files have an empty primary header and one or more extensions depending on the file type. The primary header in all files contains the FITS keywords in Table 2. The extensions contain all or part of the keywords in Table 3 as well as the FITS keywords to describe the columns present in the extensions. The exact keywords for each of the extension are listed in the relevant table. The primary header keywords are a subset of the keywords in the extension.

Table 2

Keyword	Value	Comment
a) Define the mission and instrument		
TELESCOP	'HALOSAT'	/ Telescope (mission) name
INSTRUME	'string'	/Instrument name
b) Keywords that ID the observation		
OBS_ID	'string'	/ Observation ID
OBJECT	'string'	/ Object/Target name
OBJTYPE	'string'	/ Object/Target type

c) Timing keywords		
DATE-OBS	'yyyy-mm ddThh:mm:ss'	/Start date of observations
DATE-END	'yyyy-mm ddThh:mm:ss'	/End date of observations
d) date file creation checksum & datasum		
DATE	'yyyy-mm-ddThh:mm:ss'	/File creation date
CHECKSUM	value	/ Data unit checksum updated date
DATASUM	value	/ HDU checksum updated date
NOTE : See below the value for the INSTRUME keyword. *The values for the keywords in the a) b) c) and d) or table 2 are kept the same in table 3.*		

Table 3		
Keyword	**Value**	**Comment**
a) Classification of the file. These keywords are for all file extensions but with different values. See below their definition		
EXTNAME	'string'	/ Binary table extension name
HDUCLASS	'OGIP'	/ Conforms to OGIP/GSFC standards
HDUCLAS1	'string'	/ First Class level
HDUCLAS2	'string'	/ Second Class level
b) Define the mission and instrument and instrument mode. See below the setting for INSTRUME *keyword*		
TELESCOP	'HALOSAT'	/ Telescope (mission) name
INSTRUME	'string'	/Instrument name [see definition on Table 1]
DATAMODE	'PHOTON'	/Instrument datamode
c) Keywords that ID the observation. See below the values for the OBJTYPE		
OBSERVER	'PHILIP KAARET	/ Principal Investigator
OBS_ID	'string'	/ Observation ID
OBJECT	'string'	/ Object/Target name
OBJTYPE	'string'	/ Object/Target type
d) Coordinates of the pointing and the object		
EQUINOX	2000	/[yr] Equinox of celestial coord system
RADECSYS	'FK5'	/ Celestial coord system
RA_NOM	value	/ [deg] R.A. of nominal aspect point [J2000]
DEC_NOM	value	/ [deg] Dec. of nominal aspect point [J2000]
RA_OBJ	value	/ [deg] Object Right ascension [J2000]
DEC_OBJ	value	/ [deg] Object Declination [J2000]
e) Timing keywords		
TIMESYS	'TT'	/ Reference Time System

MJDREFI	51544	/[d] MJD reference day (2000-01-01T00:00:00)
MJDREFF	7.4287037037037E-04	/[d] MJD reference (fraction of day)
TIMEREF	'LOCAL'	/Reference Frame
TASSIGN	'SATELLITE'	/Time assigned by clock
TIMEUNIT	's'	/Time unit for timing header keyword
TIMEDEL	xx.xx	/[s] Data time resolution
TIMEZERO	0.0	/[s] Time Zero
TIMEPIXR	1	/Bin time beginning=0 middle=0.5 end=1
TIERRELA	1.0E-8	/[s/s] relative errors expressed as rate
TIERABSO	1.0	/[s] timing precision in seconds
TSTART	xxxxxxx.xxx	/[s] Observation Start Time
TSTOP	yyyyyyy.yyy	/[s] Observation Stop Time
TELAPSE	nnnnn.nnn	/[s] Stop – Start
ONTIME	value	/[s] Observation time of source
EXPOSURE	value	/[s] Exposure
DATE-OBS	'yyyy-mm ddThh:mm:ss'	/ Start date of observations
DATE-END	'yyyy-mm ddThh:mm:ss'	/ End date of observations
CLOCKAPP	T	/ Clock correction applied ? (F/T)
DEADAPP	F	/ Has deadtime been applied to data? (F/T)
NOTE : The all set (but EXPOSURE) of the timing keywords is applicable to the EVENT extension. Only a subset is applicable to the GTI extension, attitude and hk files (see specific sections). Also spectral files have only a subset (see specific section).		
f) Record processing, software and calibration, date of file creation, checksum & datasum. See below the value for these keywords		
ORIGIN	'UNIVERSITY OF IOWA'	/ Origin of fits file
TLM2FITS	'string'	/ Telemeter converter FITS version
PROCVER	'string'	/ Processing script version number
SOFTVER	'string'	/ Software version
CALDBVER	'string'	/CALDB index version used
CREATOR	'string'	/Software creator of the file
DATE	'yyyy-mm-ddThh:mm:ss'	/File creation date
CHECKSUM	'value'	/ data unit checksum updated date
DATASUM	'value'	/ HDU checksum updated date

The value set for bolded keywords do not change with the observation or with the processing version or with the file type. The keyword definition is the following :

a) **EXTNAME** , **HDUCLASS1** and **HDUCLASS2** keywords contain the name of the extension and OGIP standard identifier for the file type. The values of these keywords depend only on the file type. They are set for each of the individual extension in the following tables.

b) **TELESCOP** and **INSTRUME** keywords value contain the names of the mission and instrument. The TELESCOP is set to HALOSAT and this setting is identical in all files. The values for the INSTRUME keyword are the following :
   1. SDD14 for files containing only data acquired with the detector units S14
   2. SDD54 for files containing only data acquired with the detector units S54
   3. SDD38 for files containing only data acquired with the detector units S38
   4. SDD for files containing data relevant to all detector units 14, 54, 38

   The 1,2,3 setting is valid for the event (unfiltered and cleaned), housekeeping and spectral files. The 4 setting is valid for the attitude file. **DATAMODE** contains a string to identify the datamode of the instrument. This is always set to the string 'PHOTON' and it is present only in the EVENT extension of the unfiltered and cleaned data files.

c) **OBSERVER** keyword value is the name of the principal investigator. This is set to 'PHILIP KAARET' in all files. **OBS_ID** and **OBJECT** keyword values are strings to identify the observation and the object. The string for the OBS_ID is sequence number and the string for the object is described in the appendix B. **OBJTYPE** contains a string to classify the object/observation type. The values are : CALIBRATION, SCIENCE, SWCX, HALO, and EARTH.

d) **EQUINOX** and **RADECSYS** keywords are set to 2000 and FK5 and these values are the same in all files. The keywords **RA_NOM**, **DEC_NOM** and **RA_OBJ**, **DEC_OBJ** contain the average pointing position (slew removed) and the object coordinates. They change with the observation.

e) The following timing keywords should be present in all extensions containing a TIME column or in GTI extension with START and STOP columns:

   - **TIMESYS, MJDREFF, MJDREFI, TIMEREF, TASSIGN** define the reference system for time. The event time reported in the files are seconds since an initial time, 2000 Jan 1st 00:00:00. in the TAI system. The current missions report the time in the TT system. To make the HaloSat compatible with TT, the values for the MJDREFI, MJDREFF and TIMESYS keywords are defined as :
     - MJDREFI is the MJD value for 2000 Jan 1st 00:00:00 (MJD 51544)
     - MJDREFI is the offset to include all leap seconds before MJDREF (32 sec) and the offset from TAI to TT (32.184 sec)
     - TIMESYS is set to TT

     MJDREFF and MJDREFF report the values in days. TIMEREF and TASSIGN define the reference frame and where the time is assigned. The values of these keywords are identical in all files.

   - **TIMEUNIT** defines the units for the timing keywords in the header. This is set to 's' in all files.

   - **TIMEZERO** defines an offset for the TIME column. This is set to 0.0 in all files.

- **TSTART** and **TSTOP** are the start and stop of the observation written in seconds from the reference time. In the science event files they are the first start and last stop of the GTI files. These values change with observation.

- **DATE-OBS** and **DATE-END** are the start and stop written in ISO format. These values change with observation.

- **CLOCKAPP** and **DEADAPP** define if the clock correction and deadtime has been applied. The values are set to T and F respectively in all files. While CLOCKAPP should be present in all extensions, DEADAPP should not be present in the GTI extension.

Additional keywords that should be present in EVENT extension or in extensions where the TIME column is present :

- **TIMEPIXR** defines how the time is counted in bin data. Irrelevant for non binned data and in GTI files. Set to 1 in all files.

- **TIMEDEL** defines the time resolution and/or the minimum time between two events or two rows in the HK files. This is set to 0.05 seconds in event files and 2 seconds in att files and 8 seconds in housekeeping files. This keyword is irrelevant for the GTI extension.

- **TELAPSE, ONTIME** and **EXPOSURE** define the time interval. TELAPSE is the difference between the last stop time and the 1st start time and includes gaps. ONTIME is the sum of the good time interval and do not include gaps. EXPOSURE is the final exposure corrected for deadtime. In event files this keyword is set to the same value of ONTIME and it is required in spectral files. These values change with observation and are relevant only for EVENT extension.

f) Values for the keywords of group f in table 3 :

- **ORIGIN** defines where the file has been created. The value is set to "UNIVERSITY OF IOWA' for all files.

- **TML2FITS** is the software version that convert the telemetry into FITS. This is set as db_YYYYMMDD.

- **PROCVER** contains the processing version that generates the file. The value is set as hsuf_YYYYMMDD_hscl_YYYYMMDD.

- **SOFTVER** contains the version of the HEASoft software that was used in the HaloSat processing. This is set as Hea_ddmmmyyyy_Vxxxx.

- **CALDBVER** contains the version of the calibration files. This is defined as hsYYYYMMDD in all files. The YYYYMMDD is the date of the latest caldb index file.

- **CREATOR** contains a string defining the software that created the file. The values are : db, db_hsuf , db_hsuf_hscl. They corresponds to the pipeline software modules that created the files.

- **DATE** contains the date when the file was created. This is defined as yyyy-mm-ddThh:mm:ss

- **CHECKSUM DATASUM** contains values that verify the file integrity and they are present in all files and all extensions of the FITS file.

The following tables list the complete headers of the event, instrument housekeeping and attitude files.

2.2 Table structure

a) Event File : EVENT, GTI and SCREENING extensions

The keywords and column names for the EVENT , GTI and screening extensions are listed in table 4. The unfiltered files contain the EVENT and GTI extensions , the cleaned files contain the EVENT, GTI and SCREENING extensions. The HDUCLAS2 keyword value distinguishes the EVENT and the GTI extensions associated with the unfiltered and cleaned files (see the setting below).

Table 4		
EVENT extension , Valid for unfiltered and cleaned files		
Keyword	**Value**	**Comment**
TTYPE1	'TIME '	/Time of events
TFORM1	'1D '	/data format of field
TUNIT1	's '	/physical unit of field
TTYPE2	'PHA '	/Pulse Height Analyzer
TFORM2	'1I '	/ data format of field
TUNIT2	'chan '	/physical unit of field
TLMIN2	600	/minimum legal value of the column
TLMAX2	12900	/maximum legal value of the column
TTYPE3	'PI '	/Pulse Invariant
TFORM3	'1I '	/ data format of field
TUNIT3	'chan '	/ physical unit of field
TLMIN3	1	/minimum legal value of the column
TLMAX3	455	/maximum legal value of the column

TNULL3	-1	/ null value
PI2ENE	0.02	/ PI conversion from chan to energy keV
EXTNAME	'EVENTS'	/ Binary table extension name
HDUCLASS	'OGIP'	/Format conforms to OGIP/GSFC standards
HDUCLAS1	'EVENTS'	/ First class level
HDUCLAS2	'string'	/ Second class level
TELESCOP	'HALOSAT'	/ Telescope (mission) name
INSTRUME	'SDDnn'	/ Instrument name
DATAMODE	'PHOTON'	/Instrument datamode
OBSERVER	'PHILIP KAARET	/ Principal Investigator
OBS_ID	'string'	/ Observation ID
OBJECT	'string'	/ Object/Target name
OBJTYPE	'string'	/ Object/Target type
EQUINOX	2000	/[yr] Equinox of celestial coord system
RADECSYS	'FK5'	/ Celestial coord system
RA_NOM	0.0	/ [deg] R.A. of nominal aspect point [J2000]
DEC_NOM	0.0	/ [deg] Dec. of nominal aspect point [J2000]
RA_OBJ	0.0	/ [deg] Object Right ascension [J2000]
DEC_OBJ	0.0	/ [deg] Object Declination [J2000]
TIMESYS	'TT'	/ Reference Time System
MJDREFI	51544	/[d] MJD reference day (2000-01-01T00:00:00)
MJDREFF	7.4287037037037E-04	/[d] MJD reference (fraction of day)
TIMEREF	'LOCAL'	/Reference Frame
TASSIGN	'SATELLITE'	/Time assigned by clock
TIMEUNIT	's'	/Time unit for timing header keyword
TIMEDEL	0.05	/[s] Data time resolution
TIMEZERO	0.0	/[s] Time Zero
TIMEPIXR	1	/Bin time beginning=0 middle=0.5 end=1
TIERRELA	1.0E-8	/[s/s] relative errors expressed as rate
TIERABSO	1.0	/[s] timing precision in seconds
TSTART	xxxxxxx.xxx	/[s] Observation Start Time
TSTOP	yyyyyyy.yyy	/[s] Observation Stop Time
TELAPSE	nnnnn.nnn	/[s] Stop – Start
ONTIME	value	/[s] Observation time on target
EXPOSURE	value	/[s] exposure
DATE-OBS	'yyyy-mm-ddThh:mm:ss'	/Start date of observations
DATE-END	'yyyy-mm-ddThh:mm:ss'	/End date of observations
CLOCKAPP	T	/ Clock correction applied ? (F/T)
DEADAPP	F	/ Has deadtime been applied to data? (F/T)
ORIGIN	'UNIVERSITY OF IOWA'	/ Origin of fits file
PROCVER	'	/Processing script version number
SOFTVER	'Hea_ddmmmyyyy_Vxxxx'	/ Software version
CALDBVER	'hsYYYYMMDD'	/CALDB index version used

TLM2FITS	'db_YYYYMMDD'	/Telemetry converter FITS version
CREATOR	'string'	/ Software creator of the file
DATE	'yyyy-mm-ddThh:mm:ss'	/File creation date
CHECKSUM	value	/ data unit checksum updated date
DATASUM	value	/ HDU checksum updated date
GTI extension valid for unfiltered and cleaned files		
Keyword	**Value**	**Comment**
TTYPE1	'START '	/Start time
TFORM1	'1D '	/ data format of field
TUNIT1	's '	/physical unit of field
TTYPE1	'STOP '	/Stop time
TFORM1	'1D '	/ data format of field
TUNIT1	's '	/physical unit of field
EXTNAME	'GTI'	/ Binary table extension name
HDUCLASS	'OGIP'	/Format conforms to OGIP/GSFC standards
HDUCLAS1	'GTI'	/ First class level
HDUCLAS2	'string'	/ Second class level
TELESCOP	'HALOSAT'	/ Telescope (mission) name
INSTRUME	'SDDnn'	/Instrument name
OBSERVER	'PHILIP KAARET	/ Principal Investigator
OBS_ID	'string'	/ Observation ID
OBJECT	'string'	/ Object/Target name
OBJTYPE	'string'	/ Object/Target type
EQUINOX	2000	/[yr] Equinox of celestial coord system
RADECSYS	'FK5'	/ Celestial coord system
RA_NOM	0.0	/ [deg] R.A. of nominal aspect point [J2000]
DEC_NOM	0.0	/ [deg] Dec. of nominal aspect point [J2000]
RA_OBJ	0.0	/ [deg] Object Right ascension [J2000]
DEC_OBJ	0.0	/ [deg] Object Declination [J2000]
TIMESYS	'TT'	/ Reference Time System
MJDREFI	51544	/[d] MJD reference day (2000-01-01T00:00:00)
MJDREFF	7.4287037037037E-04	/[d] MJD reference (fraction of day)
TIMEREF	'LOCAL'	/Reference Frame
TASSIGN	'SATELLITE'	/Time assigned by clock
TIMEUNIT	's'	/Time unit for timing header keyword
TIMEZERO	0.0	/[s] Time Zero
TSTART	xxxxxxx.xxx	/[s] Observation start time
TSTOP	yyyyyyy.yyy	/[s] Observation stop time
DATE-OBS	'yyyy-mm-ddThh:mm:ss'	/Start date of observations
DATE-END	'yyyy-mm-ddThh:mm:ss'	/End date of observations

CLOCKAPP	T	/ Clock correction applied ? (F/T)
ORIGIN	'UNIVERSITY OF IOWA'	/ Origin of fits file
PROCVER	'hsuf_YYYYMMDD_hscl_YYYYMMDD'	/Processing script version number
SOFTVER	'Hea_ddmmmyyyy_Vxxxx'	/ Software version
CALDBVER	'hsYYYYMMDD'	/CALDB index version used
TLM2FITS	'db_YYYMMDD'	/Telemetry converter FITS version
CREATOR	'db_hsuf'	/Software creator of the file
DATE	'yyyy-mm-ddThh:mm:ss'	/File creation date
CHECKSUM	'value'	/ data unit checksum updated date
DATASUM	'value'	/ HDU checksum updated date
SCREENING extension valid for cleaned file		
Keyword	**Value**	**Comment**
TTYPE1	'EXTENSION '	/Name of extension to apply screening
TFORM1	'20A '	/ data format of field
TTYPE2	'EXPRESSION '	/Expression
TFORM2	'600A '	/ data format of field
EXTNAME	'SCREENING'	/ Binary table extension name
TELESCOP	'HALOSAT'	/ Telescope (mission) name
INSTRUME	'SDDnn'	/Instrument name
OBSERVER	'PHILIP KAARET	/ Principal Investigator
OBS_ID	'string'	/ Observation ID
OBJECT	'string'	/ Object/Target name
OBJTYPE	'string'	/ Object/Target type
ORIGIN	'UNIVERSITY OF IOWA'	/ Origin of fits file
PROCVER	'hsuf_YYYYMMDD_hscl_YYYYMMDD'	/Processing script version number
SOFTVER	'Hea_ddmmmyyyy_Vxxxx'	/ Software version
CALDBVER	'hsYYYYMMDD'	/CALDB index version used
TLM2FITS	'db_YYYYMMDD'	/Telemetry converter FITS version
CREATOR	'db_hsuf_hscl'	/Software creator of the file
DATE	'yyyy-mm-ddThh:mm:ss'	/File creation date
CHECKSUM	'value'	/ data unit checksum updated date
DATASUM	'value'	/ HDU checksum updated date

The TLMIN and TLMAX associated to the PI and PHA columns define the lower and upper channel for the spectrum. The lower and upper channels are positive integer numbers. The TNULL keyword contains the value associated to non-valid channel numbers.

NOTE :
HDUCLAS2 has different setting in the unfiltered and filtered data file. The values are :

- Unfiltered EVENT extension set to 'ALL' ; Filtered EVENT extension 'ACCEPTED'
- Unfiltered GTI extension set to 'ALL' ; Filtered GTI extension 'STANDARD'

PROCVER has different setting in the unfiltered and filtered data file. The values are :

- In EVENT and GTI extensions of the unfiltered file is set to ‘hsuf_YYYYMMDD’
- In EVENT and GTI extensions of the cleaned file set to to ‘hsuf_YYYYMMDD_hscl_YYYYMMDD’

b) Instrument housekeeping

The housekeeping file contains the keywords and columns of the instrument housekeeping and the orbital information parameters derived by prefilter.

Table 5		
Event extension		
Keyword	**Value**	**Comment**
TTYPE1	'TIME '	/Time
TFORM1	'1D '	/ data format of field
TUNIT1	's '	/physical unit of field
TTYPE2	'SDD_TEMP '	/[deg_C] Temperature readout for Si chip
TFORM2	'1D '	/ data format of field
TTYPE3	'TEC_PWN '	/Value duty cycle of the TEC
TFORM3	'1D '	/ data format of field
TTYPE4	'ADC_TEMP '	/[deg_C] Temperature readout ADC
TFORM4	'1D '	/ data format of field
TTYPE5	'LRS_PCNT '	/Low rate science packet
TFORM5	'1D '	/ data format of field
TTYPE6	‘SDDHVSET’	/ Voltage DAC on set line
TFORM6	'1D '	/ data format of field
TUNIT6	'V '	/ physical unit of field
TTYPE7	‘FLEXICNT’	/ FLEXI counter
TFORM7	'1D '	/ data format of field
TTYPE8	‘SDD1’	/ reset pulse threshold
TFORM8	'1D '	/ data format of field
TUNIT8	'V '	/ physical unit of field
TTYPE9	‘MON_3P3V’	/ Voltage Monitor on 3.3V line
TFORM9	'1D '	/ data format of field
TUNIT9	'V '	/ physical unit of field
TTYPE10	‘MON_M5V’	/ Voltage Monitor on -5V line
TFORM10	'1D '	/ data format of field
TUNIT10	'V '	/ physical unit of field

TTYPE11	'MON_P5V'	/ Voltage Monitor on +5V line
TFORM11	'1D '	/ data format of field
TUNIT111	'V '	/ physical unit of field
TTYPE12	'SDD0'	/ event detection threshold
TFORM12	'1D '	/ data format of field
TUNIT112	'V '	/ physical unit of field
TTYPE13	'DAC_TEMP '	/[deg_C]Temperature of the DAC
TFORM13	'1D '	/ data format of field
TTYPE14	'BPL_TEMP '	/[deg_C]Temperature sensor of baseplate
TFORM14	'1D '	/ data format of field
TTYPE15	'HSK_PCNT '	/Housekeeping packet counter
TFORM15	'1D '	/ data format of field
TTYPE16	'SDDHVMON'	/ Voltage DAC on monitor line
TFORM16	'1D '	/ data format of field
TUNIT16	'V '	/ physical unit of field
TTYPE17	'DPU_TEMP '	/[deg_C]Temperature DPU band
TFORM17	'1D '	/ data format of field
TTYPE18	'RA'	/ Right Ascension of the pointing
TFORM18	1D	/ data format of field
TUNIT18	'deg'	/ physical unit of field
TTYPE19	'DEC'	/ Declination of the pointing
TFORM19	1D	/ data format of field
TUNIT19	'deg'	/ physical unit of field
TTYPE20	'SAT_LAT'	/Satellite Latitude
TFORM20	'1D'	/format of field
TUNIT20	'deg'	/ physical units of field
TTYPE21	'SAT_LON'	/Satellite Longitude
TFORM21	'1D'	/format of field
TUNIT21	'deg'	/ physical units of field
TTYPE22	'NADIR_ANGLE'	/Angular distance from pointing to Nadir
TFORM22	'1D'	/format of field
TUNIT22	'deg'	/ physical units of field
TTYPE23	'OFFSET'	/Offset
TFORM23	'1D'	/format of field
TUNIT23	'deg'	/ physical units of field
TTYPE24	'LC_GAP1'	/Averaged 8s Count Rate in LC_GAP1 band
TFORM24	'1D'	/format of field
TUNIT24	'count/s'	/ physical units of field
TTYPE25	'LC_SCI'	/Averaged 8s Count Rate in LC_SCI band
TFORM25	'1D'	/format of field
TUNIT25	'count/s'	/ physical units of field
TTYPE26	'LC_ALL'	/Averaged 8s Total Count Rate
TFORM26	'1D'	/format of field
TUNIT26	'count/s'	/ physical units of field

TTYPE27	'LC_HARD'	/Averaged 8s Count Rate in LC_HARD band
TFORM27	'1D'	/format of field
TUNIT27	'count/s'	/ physical units of field
TTYPE28	'LC_VLE'	/Averaged 8s Count Rate in LC_VLE band
TFORM28	'1D'	/format of field
TUNIT28	'count/s'	/ physical units of field
TTYPE29	'LC_OXYGEN'	/Averaged 8s Count Rate in LC_OXYGEN band
TFORM29	'1D'	/format of field
TUNIT29	'count/s'	/ physical units of field
TTYPE30	'LC_RESET'	/Averaged 8s Count Rate in LC_RESET band
TFORM30	'1D'	/format of field
TUNIT30	'count/s'	/ physical units of field
TTYPE31	'LC_ALSI'	/Averaged 8s Count Rate in LC_ALSI band
TFORM31	'1D'	/format of field
TUNIT31	'count/s'	/ physical units of field
TTYPE32	'LC_UP'	/Averaged 8s Count Rate in LC_UP band
TFORM32	'1D'	/format of field
TUNIT32	'count/s'	/ physical units of field
TTYPE33	'IN_SAA'	/Satellite in SAA?
TFORM33	'L'	/format of field
TTYPE34	'SAT_ALT'	/Satellite Altitude
TFORM34	'1D'	/format of field
TUNIT34	'km'	/ physical units of field
TTYPE35	'ELV'	/angle between pointing and earth limb
TFORM35	'1D'	/format of field
TUNIT35	'deg'	/ physical units of field
TTYPE36	'BR_EARTH'	/angle between pointing and bright earth
TFORM36	'1D'	/format of field
TUNIT36	'deg'	/ physical units of field
TTYPE37	'FOV_FLAG'	/0=sky ; 1=dark earth; 2 bright earth
TFORM37	'I'	/format of field
TNULL37	-999	/ tnull value
TTYPE38	'SUNSHINE'	/1= in sunshine ; 0=not
TFORM38	'I'	/format of field
TNULL38	-999	/ tnull value
TTYPE39	'SUN_ANGLE'	/angle between pointing vector and sun vector
TFORM39	'1D'	/format of field
TUNIT39	'deg'	/ physical units of field
TTYPE40	'MOON _ANGLE'	/angle between pointing vector and moon vector
TFORM40	'1D'	/format of field
TUNIT40	'deg'	/ physical units of field
TTYPE41	'RAM_ANGLE'	/angle between pointing and velocity vectors
TFORM41	'1D'	/format of field
TUNIT41	'deg'	/ physical units of field

TTYPE42	‘ANG_DIST’	/angular distance of pointing from nominal
TFORM42	‘1D’	/format of field
TUNIT42	‘deg’	/ physical units of field
TTYPE43	‘COR_ASCA’	/magnetic cut-off rigidity (ASCA map)
TFORM43	‘1D’	/format of field
TUNIT43	‘GeV/c’	/ physical units of field
TTYPE44	‘COR_SAX’	/magnetic cut-off rigidity (IGRFmap)
TFORM44	‘1D’	/format of field
TUNIT44	‘GeV/c’	/ physical units of field
TTYPE45	‘MCILWAIN_L’	/McIlwain L parameter (SAX)
TFORM45	‘1D’	/format of field
TTYPE46	‘SAA’	/1=in ; 0=not
TFORM46	‘I’	/format of field
TNULL46	-999	/ tnull value
TTYPE47	‘SAA_TIME’	/time since entering/exiting SAA
TFORM47	‘1D’	/format of field
TUNIT47	‘s’	/ physical units of field
TTYPE48	‘RAP’	/ Right Ascension by prefilter
TFORM48	1D	/ data format of field
TUNIT48	‘deg’	/ physical unit of field
TTYPE49	‘DECP’	/ Declination by prefilter
TFORM49	1D	/ data format of field
TUNIT49	‘deg’	/ physical unit of field
TTYPE50	‘SAT_LATP’	/Satellite Latitude by prefilter
TFORM50	‘1D’	/format of field
TUNIT50	‘deg’	/ physical units of field
TTYPE51	‘SAT_LONP’	/Satellite Longitude by prefilter
TFORM51	‘1D’	/format of field
TUNIT51	‘deg’	/ physical units of field
TTYPE52	‘POSITION’	/Prefilter ECI Position satellite {X,Y,Z}
TFORM52	‘3E’	/format of field
TUNIT52	‘km’	/ physical units of field
TTYPE53	‘VELOCITY’	/Prefilter ECI velocity satellite {vX,vY,vZ}
TFORM53	‘3E’	/format of field
TUNIT53	‘km/s’	/ physical units of field
TTYPE54	‘ROLL’	/pointing roll angle
TFORM54	‘1D’	/format of field
TUNIT54	‘deg’	/ physical units of field
TTYPE55	‘SUN_RA’	/ Right Ascension of Sun
TFORM55	1D	/ data format of field
TUNIT55	‘deg’	/ physical unit of field
TTYPE56	‘SUN_DEC’	/ Declination of Sun
TFORM56	1D	/ data format of field
TUNIT56	‘deg’	/ physical unit of field

HDUCLASS	'OGIP'	/Format conforms to OGIP/GSFC standards
HDUCLAS1	'TEMPORALDATA'	/ First class level
HDUCLAS2	'HK'	/ Second class level
TELESCOP	'HALOSAT'	/ Telescope (mission) name
INSTRUME	'SDDnn'	/Instrument name
OBSERVER	'PHILIP KAARET	/ Principal Investigator
OBS_ID	'string'	/ Observation ID
OBJECT	'string'	/ Object/Target name
OBJTYPE	'string'	/ Object/Target type
EQUINOX	2000	/[yr] Equinox of celestial coord system
RADECSYS	'FK5'	/ Celestial coord system
RA_NOM	0.0	/ [deg] R.A. of nominal aspect point [J2000]
DEC_NOM	0.0	/ [deg] Dec. of nominal aspect point [J2000]
RA_OBJ	0.0	/ [deg] Object Right ascension [J2000]
DEC_OBJ	0.0	/ [deg] Object Declination [J2000]
TIMESYS	'TT'	/ Reference Time System
MJDREFI	51544	/[d] MJD reference day (2000-01-01T00:00:00)
MJDREFF	7.4287037037037E-04	/[d] MJD reference (fraction of day)
TIMEREF	'LOCAL'	/Reference Frame
TASSIGN	'SATELLITE'	/Time assigned by clock
TIMEUNIT	's'	/Time unit for timing header keyword
TIMEDEL	8.0	/[s] Data time resolution
TIMEZERO	0.0	/[s] Time Zero
TIERRELA	1.0E-8	/[s/s] relative errors expressed as rate
TIERABSO	1.0	/[s] timing precision in seconds
TSTART	xxxxxxx.xxx	/[s] Observation Start Time
TSTOP	yyyyyyy.yyy	/[s] Observation Stop Time
DATE-OBS	'yyyy-mm ddThh:mm:ss'	/Start date of observations
DATE-END	'yyyy-mm ddThh:mm:ss'	/End date of observations
CLOCKAPP	T	/ Clock correction applied ? (F/T)
ORIGIN	'UNIVERSITY OF IOWA'	/ Origin of fits file
PROCVER	'hsuf_YYYYMMDD_hscl_YYYYMMDD'	/Processing script version number
SOFTVER	'Hea_ddmmmyyyy_Vxxxx'	/ Software version
CALDBVER	'hsYYYYMMDD'	/CALDB index version used
TLM2FITS	'db_YYYMMDD'	/Telemetry converter FITS version
CREATOR	'db_hsuf'	/Software creator of the file
DATE	'yyyy-mm-ddThh:mm:ss'	/File creation date
CHECKSUM	'value'	/ data unit checksum updated date
DATASUM	'value'	/ HDU checksum updated date

c) Attitude

Table 6		
Attitude extension		
Keyword	**Value**	**Comment**
TTYPE1	'TIME '	/Time
TFORM1	'1D '	/ data format of field
TUNIT1	's '	/physical unit of field
TTYPE2	‘POSITION’	/‘ECEF Position satellite [X,Y,Z}
TFORM2	‘3D’	/format of field
TUNIT2	‘km’	/ physical units of field
TTYPE3	‘VELOCITY’	/‘ECEF velocity satellite [vX,vY,vZ]
TFORM3	‘3D’	/format of field
TUNIT3	‘km/s’	/ physical units of field
TTYPE4	‘QPARAM ‘	/ ECI Quaternion of satellite [X,Y,Z,Scalar]
TFORM4	'4D '	/ data format of field
TTYPE5	'ATT_VALID '	/Attitude valid (0=no 1=yes)
TFORM5	'I '	/ data format of field
TTYPE6	'SAT_LAT '	/Satellite latitude
TFORM6	'D '	/ data format of field
TUNIT6	'deg '	/ physical unit of field
TTYPE7	'SAT_LON '	/Satellite longitude
TFORM7	'D '	/ data format of field
TUNIT7	'deg '	/ physical unit of field
TTYPE8	'RA '	/Right Ascension of the pointing
TFORM8	'D '	/ data format of field
TUNIT8	'deg '	/ physical unit of field
TTYPE9	'DEC '	/Declination of the pointing
TFORM9	'D '	/ data format of field
TUNIT9	'deg '	/ physical unit of field
TTYPE10	'NADIR_ANGLE '	/Angular distance from pointing to Nadir
TFORM10	'D '	/ data format of field
TUNIT10	'deg '	/ physical unit of field
EXTNAME	‘ATTITUDE’	/ Binary table extension name
HDUCLASS	‘OGIP’	/Format conforms to OGIP/GSFC standards
HDUCLAS1	‘TEMPORALDATA’	/ First class level
HDUCLAS2	‘ATTITUDE’	/ Second class level
TELESCOP	‘HALOSAT’	/ Telescope (mission) name
INSTRUME	‘SDD’	/Instrument name
OBSERVER	‘PHILIP KAARET	/ Principal Investigator
OBS_ID	‘string’	/ Observation ID
OBJECT	‘string’	/ Object/target name
OBJTYPE	‘string’	/ Object/target type observed
EQUINOX	2000	/[yr] Equinox of celestial coord system

RADECSYS	'FK5'	/ Celestial coord system
RA_NOM	0.0	/ [deg] R.A. of nominal aspect point [J2000]
DEC_NOM	0.0	/ [deg] Dec. of nominal aspect point [J2000]
RA_OBJ	0.0	/ [deg] Object Right ascension [J2000]
DEC_OBJ	0.0	/ [deg] Object Declination [J2000]
TIMESYS	'TT'	/ Reference Time System
MJDREFI	51544	/[d] MJD reference day (2000-01-01T00:00:00)
MJDREFF	7.4287037037037E-04	/[d] MJD reference (fraction of day)
TIMEREF	'LOCAL'	/Reference Frame
TASSIGN	'SATELLITE'	/Time assigned by clock
TIMEUNIT	's'	/Time unit for timing header keyword
TIMEDEL	2.0	/[s] Data time resolution
TIMEZERO	0.0	/[s] Time Zero
TIERRELA	1.0E-8	/[s/s] relative errors expressed as rate
TIERABSO	1.0	/[s] timing precision in seconds
TSTART	xxxxxxx.xxx	/[s] Observation Start Time
TSTOP	yyyyyyy.yyy	/[s] Observation Stop Time
DATE-OBS	'yyyy-mm ddThh:mm:ss'	/Start date of observations
DATE-END	'yyyy-mm ddThh:mm:ss'	/End date of observations
CLOCKAPP	T	/ Clock correction applied ? (F/T)
ORIGIN	'UNIVERSITY OF IOWA'	/ Origin of fits file
TLM2FITS	'db_YYYYMMDD'	/ Telemetry converter FITS version
PROCVER	'hsuf_YYYYMMDD_hscl_YYYYMMDD'	/Processing script version number
SOFTVER	'Hea_ddmmmyyyy_Vxxxx'	/ Software version
CREATOR	'db'	/Software Creator of the file
CALDBVER	'hsYYYYMMDD'	/CALDB index version used
DATE	'yyyy-mm-ddThh:mm:ss'	/File creation date
CHECKSUM	'value'	/ data unit checksum updated date
DATASUM	'value'	/ HDU checksum updated date
GTI Attitude extension		
Keyword	**Value**	**Comment**
TTYPE1	'START_DATE '	/Start date in UTC
TFORM1	'24A '	/ data format of field
TTYPE2	'END_DATE '	/Stop date in UTC
TFORM2	'24A '	/ data format of field
TTYPE3	'START '	/Start Time
TFORM3	'1D '	/ data format of field
TUNIT3	's '	/physical unit of field
TTYPE4	'STOP '	/Stop Time
TFORM4	'1D '	/ data format of field
TUNIT4	's '	/physical unit of field

TTYPE5	'TOTAL_TIME '	/Total time in s in this GTI
TFORM5	'1D '	/ data format of field
TUNIT5	's '	/physical unit of field
EXTNAME	'GTI'	/ Binary table extension name
HDUCLASS	'OGIP'	/Format conforms to OGIP/GSFC standards
HDUCLAS1	'GTI'	/ First class level
HDUCLAS2	'ALL'	/ Second class level
TELESCOP	'HALOSAT'	/ Telescope (mission) name
INSTRUME	'SDD'	/Instrument name
OBSERVER	'PHILIP KAARET	/ Principal Investigator
OBS_ID	'string'	/ Observation ID
OBJECT	'string'	/ Object/target name
OBJTYPE	'string'	/ Object/target type observed
EQUINOX	2000	/[yr] Equinox of celestial coord system
RADECSYS	'FK5'	/ Celestial coord system
RA_NOM	0.0	/ [deg] R.A. of nominal aspect point [J2000]
DEC_NOM	0.0	/ [deg] Dec. of nominal aspect point [J2000]
RA_OBJ	0.0	/ [deg] Object Right ascension [J2000]
DEC_OBJ	0.0	/ [deg] Object Declination [J2000]
TIMESYS	'TT'	/ Reference Time System
MJDREFI	51544	/[d] MJD reference day (2000-01-01T00:00:00)
MJDREFF	7.4287037037037E-04	/[d] MJD reference (fraction of day)
TIMEREF	'LOCAL'	/Reference Frame
TASSIGN	'SATELLITE'	/Time assigned by clock
TIMEUNIT	's'	/Time unit for timing header keyword
TIMEZERO	0.0	/[s] Time Zero
TSTART	xxxxxxx.xxx	/[s] Observation Start Time
TSTOP	yyyyyyy.yyy	/[s] Observation Stop Time
DATE-OBS	'yyyy-mm ddThh:mm:ss'	/Start date of observations
DATE-END	'yyyy-mm ddThh:mm:ss'	/End date of observations
CLOCKAPP	T	/ Clock correction applied ? (F/T)
ORIGIN	'UNIVERSITY OF IOWA'	/ Origin of fits file
TLM2FITS	'db_YYYYMMDD'	/ Telemetry converter FITS version
PROCVER	'hsuf_YYYYMMDD_hscl_YYYYMMDD'	/Processing script version number
SOFTVER	'Hea_ddmmmyyyy_Vxxxx'	/ Software version
CREATOR	'db'	/Software Creator of the file
CALDBVER	'hsYYYYMMDD'	/CALDB index version used
DATE	'yyyy-mm-ddThh:mm:ss'	/File creation date
CHECKSUM	'value'	/ data unit checksum updated date
DATASUM	'value'	/ HDU checksum updated date

d) Spectral file

Table 7 gives the format for the spectral file. The file contains an empty primary header and the SPECTRUM extension. The extension contains the minimum required keywords.

Table 7		
Spectral extension		
Keyword	**Value**	**Comment**
TTYPE1	'CHANNEL '	/Channel number
TFORM1	'I '	/ data format of field
TLMIN1	1	/ minimum legal value
TLMAX1	455	/maximum legal value
TUNIT1	'chan '	/physical unit of field
TTYPE2	'COUNTS'	/total count in channel
TFORM2	'J'	/format of field
TTYPE3	'QUALITY'	/data quality
TFORM3	'I'	/format of field
TUNIT2	count'	/ physical units of field
EXTNAME	'SPECTRUM'	/ Binary table extension name
HDUCLASS	'OGIP'	/Format conforms to OGIP/GSFC standards
HDUCLAS1	'SPECTRUM'	/ First class level
HDUCLAS2	'TOTAL'	/ Second class level
HDUCLAS3	'COUNT'	/ Third class level
HDUVERS	'1.2.0'	/Version of format (OGIP memo OGIP-92-007)
HDUVERS1	'1.2.0'	/Obsolete included for back compatibility
AREASCAL	1.000000E+00	/ area scaling factor
BACKFILE	'none'	/ associated background file
BACKSCAL	1.000000E+00	/ background file scaling factor
CORRFILE	'none'	/ associated scaling file
CORRSCAL	1.000000E+00	/ correction file scaling factor
RESPFILE	'none'	/ associated redist matrix filename
ANCRFILE	'none'	/ associated ancillary response filename
PHAVERS	'1992a'	/obsolete
DETCHANS	455	/ total number possible channels
CHANTYPE	'PI'	/ channel type (PHA, PI etc)
POISSERR	T	/ Poissonian errors to be assumed
STAT_ERR	0	/ no statistical error specified
SYS_ERR	0	/ no systematic error specified

GROUPING	0	/ no grouping of the data has been defined
TELESCOP	'HALOSAT'	/ Telescope (mission) name
INSTRUME	'SDDnn'	/Instrument name
DATAMODE	'PHOTON'	/Instrument datamode
FILTER	'NONE'	/ No filter was in use
OBSERVER	'PHILIP KAARET	/ Principal Investigator
OBS_ID	'string'	/ Observation ID
OBJECT	'string'	/ Object/target name
OBJTYPE	'string'	/ Object/target type observed
EQUINOX	2000	/[yr] Equinox of celestial coord system
RADECSYS	'FK5'	/ Celestial coord system
RA_NOM	0.0	/ [deg] R.A. of nominal aspect point [J2000]
DEC_NOM	0.0	/ [deg] Dec. of nominal aspect point [J2000]
RA_OBJ	0.0	/ [deg] Object Right ascension [J2000]
DEC_OBJ	0.0	/ [deg] Object Declination [J2000]
DATE-OBS	'yyyy-mm ddThh:mm:ss'	/Start date of observations
DATE-END	'yyyy-mm ddThh:mm:ss'	/End date of observations
TELAPSE	nnnnn.nnn	/[s] Stop – Start
ONTIME	value	/[s] Observation time on source
EXPOSURE	value	/[s] exposure
CLOCKAPP	T	/ Clock correction applied ? (F/T)
DEADAPP	F	/ Has deadtime been applied to data ? (F/T)
ORIGIN	'UNIVERSITY OF IOWA'	/ Origin of fits file
TLM2FITS	'db_YYYYMMDD'	/ Telemetry converter FITS version
PROCVER	'hsuf_YYYYMMDD_hscl_YYYYMMDD'	/Processing script version number
SOFTVER	'Hea_ddmmmyyyy_Vxxxx'	/ Software version
CREATOR	'db_hsuf_hscl'	/Software Creator of the file
CALDBVER	'hsYYYYMMDD'	/CALDB index version used
DATE	'yyyy-mm-ddThh:mm:ss'	/File creation date
LC_HARD	value	/[c/s] Average rate in band
LC_HARDE	value	/[c/s] Error on average rate in band
CHECKSUM	'value'	/ data unit checksum updated date
DATASUM	'value'	/ HDU checksum updated date

3 Appendix A : Source name convention

The OBJECT keyword is populated with a name that identify the pointing positions. The nomenclature of these positions are defined following the IAU convention (http://cdsweb.u-strasbg.fr/Dic/iau-spec.htx)

Acronym Sequence (Specifier)

The acronym is based on the mission name (HaloSat); the sequence is based on the equatorial coordinates (format HHMM+DDMM) including the equinox (J for J2000); the specifier is optional and not used. The three field are separated by a single space. The full designation is :

HaloSat JHHMM+DDMM