ASTRO-H

ASTRO-H SCIENCE FITS FILE
ASTH-SCT-003

Version 1

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ISAS / GSFC

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1 Introduction

1.1 Purpose

This document defines the science fits for all instruments on board of Astro-H and includes the file expected to be produced at the FFF level in the pre-pipeline run in Japan as well as the additional files produced in the pipeline run in US.

1.2 Applicable Documents

The requirements contained in this document were derived from the following documents:

- Documents listed in the "HEASARC FITS File Format Recommendations" https://heasarc.gsfc.nasa.gov/docs/heasarc/ofwg/ofwg_recomm.html
- ASTH-SCT-002 describing the pre-pipeline
- ASTH-SCT-006 describing the archive and element of the archive
- ASTH-SCT-004 describing the CALDB files

2 Data: Overview Fits structure

2.1 Fits files : Science , Housekeeping and additional file

The Astro-H telemetry is stored into the SIRIUS database. The Raw Packet Telemetry (RPT) FITS files are created reading the data from the SIRIUS database, dividing the data in observation and placing a FITS wrapper to the telemered packets. The header of these files is described in document ASTROH_SCT_002 'Pre-Pipeline' description. The RPT files are N files per observation where a new RPT file is created if the size exceeded 2 GB. The RPT are than converted in the pre-pipeline in the First File Format (FFF) using binary fits table.
The FFF files maintain the telemetry content without changes. The files for both HK and science data are named FFF (first FITS file). The FFF contains columns populated with the telemetry data and empty columns populated in the calibration stage of the pipeline.

There are separate FFF files for science and Housekeeping data. There is one (or two) HK FITS file for each specific instrument containing several extensions, each dedicated to a telemetry type packet (APID). Similarly there are two HK files with information related to the spacecraft and subsystems valid to all instruments (common HK). Also the common HKs contain several extensions one for each (APID). The science data are instead placed in FITS file using the EVENT format where each row describes the proprieties of one event. The science data are separated by instrument, DATAMODE and/or FILTER. The primary header for all files using is empty and contains only general keywords. For the SHIELD data taken with the HXI and SGD are recorded in a binary FITS table file as temporal data (lightcurve) containing several columns where each rows stored bin data (time or spectrum) either as single value or array columns. Similar temporal data is also adopted for the CAMS data.

There pre-pipeline also creates the following files: attitude, orbit, time file (TIM) and command file (CMD). The attitude and orbit are created by task at ISAS and it is assume that the pipeline do not operate on them. The TIM and CMD are generated by the pre-pipeline based on information derived by the SIRIUS database and operation team. The RPT, FFF, Attitude, Orbit, TIM and CMD files constitute the Level 0 data.

The calibrated science files are the SFF (and SFFa) where the empty columns, created at the FFF stage, are populated in the processing pipeline and GTI added based on the attitude and other information (as for DATAMODE). In cases as for the HXI and SGD the SFFa is a new file created in the pipeline that includes additional diagnostics columns derived from the reconstruction algorithms.
The FFF HK contains columns with the telemetry information, columns with HK information converted in physical units when necessary (for example temperature voltages etc..) and empty columns for time assignment (TIME, YYYY DDD HH MM SS US). These columns are populated by the Astro-H tasks (ahmktim, sxssamcnt and ahtime) that are run in the pre-pipeline stage. The pre-pipeline therefore outputs the SFF HK. No other operation is done to the HK files excepts populating keywords as results of calculation done in the pipeline. Similarly the processing pipeline do not operate on the attitude, orbit TIM and CMD files but only updates keywords when necessary.

The SFF and SFFa constitute the Level 1 and Level 1a, and they are the outputs from the pipeline processing. All the Level 1 files contain the original information and the calibrated information. These files are created in the Pre-pipeline and additional information is added in the processing pipeline without changing the column information with the telemetry.
The SFFa (level 1a only) are created for some of the instruments in the processing pipeline, however the number of rows is maintained identical to that of the SFF but only selected information is carried over from the original SFF and other information added. For the CAMSs the processing pipeline generate also a Level 1a where only selected information and the number of rows are maintained from the Level 1 data.

The pre-pipeline and processing pipeline are always writing in all file extensions the keywords DATASUM and CHECKSUM when the files are created or modified.

	Level	SXS	SXI	HXI /SGD	Shield	CAMS	HK
Raw telemetry	Level 0 telemetry						
RPT	Level 0 FITS Wrapper (science +HK)						
FFF from Japan	Level 0 FITS Decoded (science +HK)	•Time assigned	•Time assigned	• Time assigned	•Time assigned	•Time assigned	•Time assigned
SFF = FFF + Columns filled +GTI	Level 1 FITS Public Archive Start file for reprocessing	• Calibrated Event File • Fix length columns *•MXS calilbration timing*	• Calibrated Event File • Fix length columns • *Dark frame event*	• Uncalibrated • Variable length • array columns • Remapped channel • Multiple events in single row	•Calibrated Event file •Calibrated Hstogram	•Calibrate CAMS time	•MXStime
SFFa	Level 1a FITS Public Archive	•Calibrated Pixel Event •Calibrated Baseline Event	no	• Calibrated Event File • Fix length columns • Single event in one row	no	• CAMS delta positions	No applicable
Cleaned Event File	Level 2 FITS Public Archive	Pixel Event File	Event File	Event File	•Event File •Histogram	No applicable	No applicable
Products Lcurve/ Spectra Images	Level 3 FITS Public Archive	yes	yes	yes	yes	No applicable	No applicable

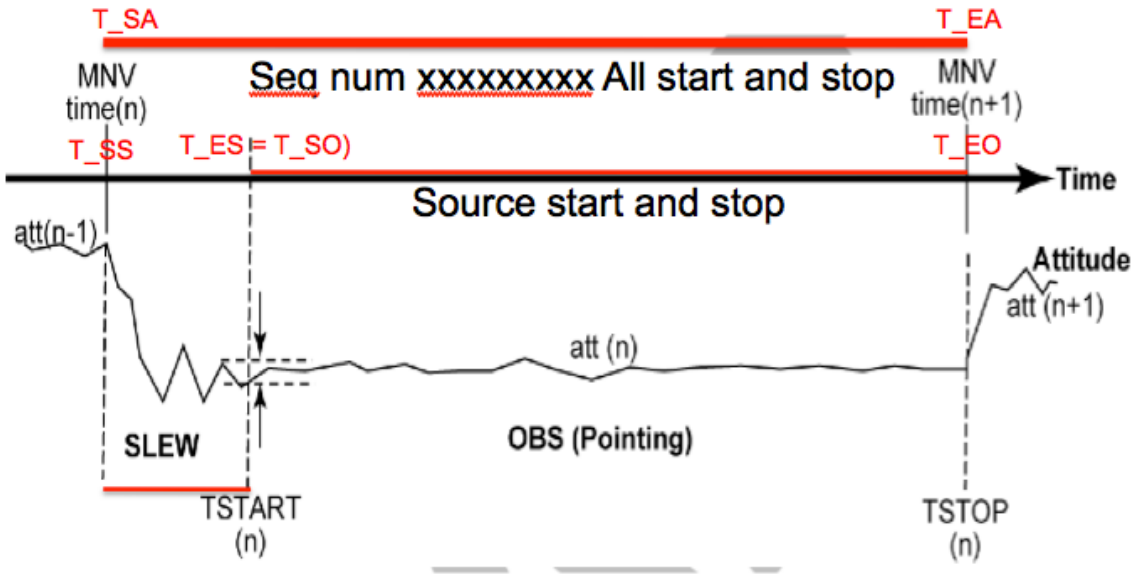
Table 1: Level of data files for each of the instruments.

2.2 Files Division

The data are divided in observations. Each observation is identified by the sequence number and described in the ASTH-SCT-006. The sequence number is written in the keyword OBS_ID in all

extension of the FITS files. Each observation contains both pointing and incoming slew data. The science files for each instrument are divided by the observing mode in slew and pointing data. The observing mode is written in the keyword OBS_MODE. The instrument and spacecraft HK data instead are not separated for the observing mode, e.g. HK information from the slew and the pointing are retained in the same file and the OBS_MODE is set to 'ALL'. The pointing information is written in all files in the keyword RA_NOM DEC_NOM PA_NOM. The value corresponds to the average pointing determined using the attitude data. The average pointing corresponds to the time period that starts at the end of the slew and stop at the start of the new slew. In each extension, the start and stop times are instead calculated appropriately to the data included in the file. Therefore the TSTART and TSTOP keywords in the science data file with OBS_MODE set to 'POINTING' have the values of the pointing observation start time (T_SO) and pointing observation end time (T_EO) as shown in figure 1. For OBS_MODE set to SLEW have the values of the slew start time (T_SS) and the slew stop time (T_ES). The TSTART and TSTOP keywords in the HK files have the values of slew start time, start of the data acquisition for the sequence (T_SA) and the observation pointing stop time, stop time of the data acquisition for the sequence (T_EA) as shown in figure 1 and the OBS_MODE is set to 'ALL'.
The TSTART and TSTOP in the orbit and attitude file correspond to the start of the data acquisition (T_SA) and to the stop the stop of the data acquisition T_SE the OBS_MODE is set to 'ALL'.

In a given observation the science data may further divided by the instrument setting (mode or filter) or data type. The file division may use of additional keyword as DATAMODE, FILTER and other to identify the data. The file division is done in the pre-pipeline.



2.3 General header keywords

Table 1 lists keywords that populate the Astro-H files header. In general these keywords are written by the pre-pipeline in the FFF and populated either with the correct value at the FFF

stage or with a temporary values filled by the pipeline at the SFF stage. The sub-sections that follows specified for each type of file and header which keywords should be present.
The List of keywords is the following:

Table 1			
Keyword	**Value**	**Comment**	**Filled by**
*a) Define the instrument and datamodes. The keyword with the * are always present in instrument dependent file but if the value is not defined the string is set to "NA". The INSTRUME, DETNAM, FILTER and DATAMODE keywords are filled by make_fff in pre-pipeline using a combination of telemetry information and pre-defined tables.*			
TELESCOP	'ASTRO-H'	/ Telescope mission name	Pre-pipeline
INSTRUME	'string'	/Instrument name	Pre-pipeline
* DETNAM	'string'	/ Detector subsystem	Pre-pipeline
* FILTER	'string'	/Filter name used	Pre-pipeline
* DATAMODE	'string'	/ Data acquisition mode	Pre-pipeline
b) Keywords that ID the observation. These keywords are filled by the post-process of the make_fff in the prepipeline and they are defined in the ODB			
OBS_ID	'string'	/ Observation ID	Pre-pipeline
OBJECT	'string'	/ Object name	Pre-pipeline
OBSERVER	'string'	/ PI name	Pre-pipeline
OBS_MODE	'string'	/ POINTING or SLEW or ALL	Pre-pipeline
c) Coordinates Object from the ODB. Pointing derived from the mean attitude. *RA_OBJ DEC_OBJ EQUINOX and RADECSYS are filled by the post_process of the make_fff in the pre-pipeline using the values in the ODB.* *RA_NOM DEC_NOM PA_NOM are filled by 'aspect' using the attitude and considering only the data in stable pointing (using the gti pointing). ABERRAT FOLOWSUN are filled by coorvevt and are not valid for the SGD. Aspect and coordevt are run in the pipeline. The pre-pipeline write the keywords with 0 value.* *RA_PNT and DEC_PNT are the optical axis in the sky coordinates for each instruments. These are calculated in the pipeline. The pre-pipeline write the keywords with 0 value.* *The OPTxxxx is a set of two keywords associated to the coordinates DET, FOC & SKY, where n is the column number associated to the sets of coordinates. Not present in the SGD. They are populated in the pipeline*			
RA_OBJ	0.0	/ [deg] Object Right ascension	Pre-pipeline
DEC_OBJ	0.0	/ [deg] Object Declination	Pre-pipeline
RA_PNT	0.0	/ [deg] Avg Optical axis R. A.	Pipeline
DEC_PNT	0.0	/ [deg] Avg Optical axis Dec	Pipeline
EQUINOX	2000	/Equinox of celestial coord system	Pre-pipeline
RADECSYS	'FK5'	/Celestial coord system	Pre-pipeline

RA_NOM	0.0	/[deg] Nominal aspect point R.A.	aspect
DEC_NOM	0.0	/[deg] Nominal aspect point Dec	aspect
PA_NOM	0.0	/[deg] Position angle (roll)	aspect
ABERRAT	F	/Aberration apply to sky coords [T/F]	Coordevt
FOLOWSUN	F	/Sun position recalculated [T/F]	Coordevt
OPTDETX	xxx	/Optical axis DETX	Pipeline
OPTDETY	xxx	/Optical axis DETY	Pipeline
OPTFOCX	xxx	/Optical axis FOCX	Pipeline
OPTFOCY	xxx	/Optical axis FOCY	Pipeline
OPTSKYX	xxx	/Optical axis SKYX	Pipeline
OPTSKYY	xxx	/Optical axis SKYY	Pipeline

d) Timing keywords
TIMESYS, MJDREFI, MJDREFF, TIMEUNIT, TIMEREF, TASSIGN, GPSOFFET, CLOCKAPP keywords are filled by make_fff in the pre-pipeline. TSTART, TSTOP, TELAPSE, DATE-OBS, DATE-END and SMUUNIT are filled by the post_process in the pre-pipeline.
Instrument and common HK use the ODB start & stop (right time) for the observation (not divided slew and pointing).

All files extensions have TSTART and TSTOP (and DATE-OBS and DATE-END) calculated from ahtime. The header TSTART and TSTOP (and DATE-OBS and DATE-END) for primary header are assigned as follows: slew data use the slew GTI, pointing data use the pointing GTI, files containing slew and pointing use for TSTART the GTI start slew value and for TSTOP the GTI stop pointing value. These assignments for the TSTART and TSTOP primary header are maintained even if for a given file type two or more data file are created. Instrument and common HK are not divided for slew and pointing. Their start & stop use the GTI start slew for TSTART (and DATA-OBS) and the GTI stop pointing for TSTOP (and DATE-END).

TIMESYS	'TT'	/ Time System	Pre-pipeline
MJDREFI	56658	/MJD reference day 01 Jan 2014 00:00:00	Pre-pipeline
MJDREFF	7.775925925926E-04	/MDJ reference (fraction of day)	Pre-pipeline
TIMEUNIT	' s'	/Unit of timing header keywords	Pre-pipeline
TIMEREF	'LOCAL'	/Reference Frame	Pre-pipeline
TASSIGN	'SATELLITE'	/Time assigned	Pre-pipeline
GPSOFFET	1,072,569,616	/Offset of the ASTRO-H GPS time	Pre-pipeline
CLOCKAPP	T	/If clock correction are applied (F/T)	Pre-pipeline
TSTART	0.0	/Start time	Pre-Pipeline (ahtime)
TSTOP	0.0	/Start Time	Pre-Pipeline (ahtime)
TELAPSE	0.0	/Elapsed time	Pre-pipeline
DATE-OBS	'yyyy-mm ddThh:mm:ss'	/Start Date	Pre-Pipeline (ahtime)

DATE-END	'yyyy-mm ddThh:mm:ss'	/Stop Date	Pre-Pipeline (ahtime)
SMUUNIT	'string'	/SMU Unit A or B	Pre-pipeline
LTISTART		/Start L32TI	Pre-pipeline for Tim file
LTISTOP		/Stop L32TI	Pre-pipeline for TIM file
TIMFMVER		/Tim file ???	Pre-pipeline for TIM file
e) Additional timing associated to science data TIMEPIXR and TIMEDEL are populated with the correct value in the pre-pipeline. ONTIME, LIVETIME EXPOSURE where needed are set in the pre-pipeline to the same value to TELAPSE in the pre-pipeline and calculated in the pipeline.The DEADC and DEADAPP are listed for completeness but maybe not relevant for the event data FFF. TIMEPIXR value is set to 0 for all files.			
ONTIME		/On-source time	Pre-pipeline
EXPOSURE		/Exposure time	Pre-pipeline
* DEADC		/Deadtime correction	Pre-pipeline
* DEADAPP		/	Pre-pipeline
TIMEPIXR		/bintime start=0 middle=0.5 end=1	Pre-pipeline
TIMEDEL		/Data time resolution	Pre-pipeline
f) Classification of the file these keywords are for all files. These keywords are included by the pre-pipeline			
EXTNAME	'string'	/ Binary table extension name	Pre-pipeline
HDUCLASS	'OGIP'	/Format conforms to OGIP standards	Pre-pipeline
HDUCLAS1	'string'	/ (specifc definition below)	Pre-Pipeline
*HDUCLAS2	'string'	/ (specific definition below)	Pre-Pipeline
g) Record the associate file to this observation written by the pre-pipeline			
ORBFILE	'string'	/Filename of the orbitfile	Pre-pipeline
ATTFILE	'string'	/Filename of the attitude	Pre-pipeline
TIMFILE	'string'	/Filename of the TIM file	Pre-Pipeline
RPTFILEn	'string'	/Filename of the RPT file	Pre-pipeline
LEAPFILE	'string'	/Filename of the leapsec file	Pre-pipeline
h) Record processing, software and calibration checksum & datasum. *TLM2FITS version and MKFFFF are written by post_process in the pre-pipeline. All other keywords are written with null values and populated later by the pipeline.* *CHECKSUM and DATASUM are always updated by running fchecksum or CFITSIO function at any steps by the pre-pipeline or pipeline.*			
TLM2FITS	'string'	/Pre-Pipeline version JAXA	Pre-pipeline

PROCVER	'00.00.00'	/Processing version	Pipeline
SEQPNUM	nn	/Number of times the dataset has been processed	Pipeline
MKFFF	'ISAS/JAXA'	/Origin of First FITS file	Pre-pipeline
ORIGIN	'GSFC/NASA'	/Origin of Processed FITS file	Pipeline
SOFTVER	'00.00.00'	/Heasoft version	Pipeline
CALDBVER	'CALDBVS'	/CALDB version	Pipeline
DATE	'yyyy-mm-ddThh:mm:ss'	/File creation date	Pipeline
CHECKSUM	'value'	/HDU checksum updated DATE	Any Tasks
DATASUM	'value'	/ Data unit checksum updated DATE	Any Tasks

NOTE: The keywords FILTER, DETNAM, DATAMODE are only written in the science data when appropriate. In some science data these keywords have not relevance however they are written in the science data for software consistency. In these cases their value is set to "NA".
The RPTFILEn keywords contain the filename of the RPT files, where the value of n varies from 1 to 9. If an observation is made by more than one RPT the number of keywords are as many RPTs are necessary to hold that observation. The maximum number of keywords is nine.
All HK Extensions are expected to have the following columns : TIME , S_TIME and L32TI.

Files created in the pipeline have the primary header keywords, table 1, either written by the specific tasks that creates these outputs or copied. The files created in the pipeline are the SFFa instrument event, the CAMS data, the MXS GTIs, all GTIs obtained with general tasks, the make filter file and the extended HK. The tasks that create instrument SFFa files are: hxievtid, sgdevtid, mxstime, cams2det, ahmkfilter, ahmkehk and ahgtigen.

2.4 General keywords for columns in bintable and image extension

Table 3a lists all keywords that may be used in a FITS bintable (XTENSION= 'BINTABLE') associated to columns. The keywords specify the column name, format, units, offset, scaling, null value (for integer column), legal min and max data value, and data array dimension. The pre-pipeline adds the appropriate keywords that describe a column also for empty columns. The pipeline fills with the appropriate values.
Additional column description keywords are added to describe coordinate system known as Would Coordinates system, where appropriate. Examples are columns that describe the coordinates to create an image where the X and Y value are stored in separated columns. Depending on the system for example if sky or simple detector all the keywords or part may be needed. -
To columns that contain fixed data arrays, instead of a single value, have the keyword TDIM specify. The mCXXXn keywords are added to describe the organization of equi-spaced data within the array to include the binning, units, reference, increment and axis name.

The WCS and the mCXXXn keywords are added only for selected columns and they are written by the pre-pipeline and filled by the pipeline with some exception noted in the individual file.

Table 3a bintable extension

Keyword	Value	Comment	Filled by
Column keywords			
TTYPEn	'TBD'	/ Columns names	Pre or pipeline
TFORMn	'TBD'	/Data formal of field	Pre or pipeline
TUNITn	'TBD'	/[nn]Physical units of field	Pre or pipeline
TNULLn	'TBD'	/Data null value (integer only)	Pre or pipeline
TZEROn	'TBD'	/Data offset	Pre or pipeline
TSCALn	'TBD'	/Data scaling	Pre or pipeline
TLMINn	'TDB'	/Min legal value	Pre or pipeline
TLMAXn	'TDB'	/Max legal value	Pre or pipeline
TDIMn	'TDB'	/Dimension of array	Pre or Pipeline
Coordinate system & world coordinates system			
TCTYPn	'TBD'	/Axis type	Pre or pipeline
TCRVLn	'TBD'	/[nn] Reference value	Pre or pipeline
TCDLTn	'TBD'	/[nn] Coordinate increment	Pre or pipeline
TCRPXn	'TBD'	/[nn] Reference point	Pre or pipeline
TCUNIn		/Unit of axis type	Pre or pipeline
Keywords axis for column with array with fixed dimension (TDIM). m array dimension			
mCTYPn		/Axis type	Pre or pipeline
mCUNIn		/Unit of axis type	Pre or pipeline
mCRPXn		/[nn] Reference point	Pre or pipeline
mCDLTn		/[nn] Coordinate increment	Pre or pipeline
mCRVLn		/[nn] Reference value	Pre or pipeline

Table 3b lists all keywords to specify the coordinates of an array stored in a FITS primary header that contains image data or in the image extension (XTENSION= 'IMAGE'). The coordinate systems are specified with the WCS keywords specific for the primary or image extension.

Table 3b image extension			
Keyword	**Value**	**Comment**	**Filled by**
Coordinate system & world coordinates system			
CTYPEn	'TBD'	/Axis type	Pre or pipeline
CRVALn	'TBD'	/[nn] Reference value	Pre or pipeline
CDELTn	'TBD'	/[nn] Coordinate increment	Pre or pipeline
CRPIXn	'TBD'	/[nn] Reference point	Pre or pipeline
CUNITn		/Unit of axis type	Pre or pipeline

2.5 Common columns in all FITS file

All science instruments fits files created in the pre-pipeline, the FFF, have the following common columns :

- TIME : containing the time of the row in second from the ASTROH reference time. These values is calculated using *'ahtime'* in all the instruments and HK fits file.
- S_TIME: containing the time when the space packet is sent to the telemetry (to the data recorder or ground station). The S_TIME are second from the same reference time of the TIME column. S_TIME is **calculated** and filled by SIRIUS using the L32TI.
- L32TI : Lower 32-bit of the Time Indicator (TI) which is a counter of the clock onboard. The TI is a 38-bit counter and the L32TI is always present in the telemetry for all the packets..
- ADU_CNT : Packet counter of the main header.
- CATEGORY: The telemetry packets have associated a specific priority: H (high), M (medium), L (low). If the on board data recorder fills up, the priority is used overwrite data with low priority.
- PROC_STATUS: containing a 32 bits columns, that reports errors found in the telemetry or during the processing. bits 31-16 are assigned to the pre-pipeline , bits 15-0 to the pipeline.

All HK fits files created in the pre-pipeline have the following common columns :

- TIME : same as for the science data
- S_TIME : same as for the science data
- L32TI : same as for the science data
- YYYY DDD HH MM SS US : six columns containing the "translation of the time" express as year , day of the year , hours, minute, seconds and us.
- PACKET_HEADER : content of packet header
- PROC_STATUS: same as for the science data

The PROC_STATUS column should be used both on science and housekeeping data to flag errors and status information throughout telemetry and data processing.
The PROC_STATUS column is a single 32-bit binary flag column (FITS type 32X), stored as a single integer. The PROC_STATUS is interpreted as two (2) sets of bit flags containing 16 bits each.

```
Bits 31   -   16 Bits 15   -    0
XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
Japan            US
```

1. The upper 16 bits (bits 16 - 31) is used to indicate pre-pipeline processing status, i.e., all processing needed to create the First Fits File (FFF). The pre-pipeline processing is completely run in Japan.
    a. The most significant bit (bit 31, shown in **red** above) of the upper 16 bits is set to 1 to indicate that the row's data is bad, i.e., may not meaningfully be processed further.
    b. The bit 30 of the upper 16 bits is set to 0 to indicate to the pipeline to process the data regardless of the value set in the bit 31.
    c. The most significant bit (bit 31) is set to 0 to indicate that the row's data is good, i.e., it may and should be processed further.
    d. The lower 14 bits (bits 16 - 29) of the upper 16 is reserved to provide more information about the status of the row, in a manner to be determined by the JAXA team.
    e. When the data arrive in the U.S., the Ftools in the pipeline read only the bits 31 & 30. If the first bit is 0 tasks should process the row, if the first bits is 1 check the second bit. If that is 0 tasks should process that row. Therefore the tasks should always process the data if 31& 30 have value 00 or 10 or 01 and should skip the processing of that row if the value is 11.
2. The lower 16 bits (bits 0 - 15) is reserved for use by the Ftools, which are all written in the US.
    a. The most significant bit (bit 15, shown in **blue** above) of the lower 16 bits is set to 1 to indicate that the row's data is bad, i.e., may not meaningfully be processed further.
    b. The most significant bit (bit 15) is set to 0 to indicate that the row's data is good, i.e., it may and should be processed further.
    c. The 0-9 bits are reserved for time assignement.
    d. The remaining 5 bits (bits 10-14) is reserved to instruments to be determined by the GSFC team. These bits shall all be set to 0 for HK files. The bits 14 inscurrentky undefined.
    e. All Ftools skip processing any row in which bit 15 is equal to 1.
3. Once either bit 15 or bit 31 is set to 1 (bad data), no downstream software ever reset it to 0.
4. In general, all software preserve the exact state of all bits except those that the software specifically and deliberately changes.
5. As with all Ftools behavior, each application's usage of PROC_STATUS shall be described completely in the TRF.

NOTE : the selection for good data uses the following expression PROC_STATUS(1)==b0 PROC_STATUS(2)==b0 and PROC_STATUS(17)==b0. These correspond to bits 31 and 30 (Japan bits) and bits 15 on the US site.

2.6 General Header Keywords: primary header

The Astro-H primary header fits files do not contain data. However the primary header contains standard set of keywords to quickly identify the file. Note that keywords in the primary header

should be updated when necessary in the tasks of the pipeline. The tables below contain the keywords that should appear in all the primary headers and they are populated accordingly with the rules listed in Table 1. Table 2 contains the keywords and the comments for the primary header for all data. For INSTRUME use BUS_SYSTEM if not specific to any instrument else the values are SXI, SXS, HXI1, HXI2 (or HXI if valid for HXI1 and HXI2), SGD1, SGD2 (or SGD if valid for SGD1 and SGD2), CAMS1, CAMS2 (or CAMS if valid for both CAMS) data.

Table 2

Keyword	Value	Comment	Filled by
TELESCOP	'ASTRO-H'	/ Telescope mission name	Pre-pipeline
INSTRUME	'string'	/Instrument name	Pre-pipeline
OBS_ID	'string'	/ Observation ID	Pre-pipeline
OBJECT	'string'	/ Object name	Pre-pipeline
OBSERVER	'string'	/ PI name	Pre-pipeline
OBS_MODE	'string'	/ POINTING or SLEW or ALL	Pre-pipeline
RA_OBJ	0.0	/ [deg] Object Right ascension	Pre-pipeline
DEC_OBJ	0.0	/ [deg] Object Declination	Pre-pipeline
RA_NOM	0.0	/[deg] Nominal aspect point R.A.	aspect
DEC_NOM	0.0	/[deg] Nominal aspect point Dec	aspect
PA_NOM	0.0	/[deg] Position angle (roll)	aspect
EQUINOX	2000	/Equinox of celestial coord system	Pre-pipeline
RADECSYS	'FK5'	/Celestial coord system	Pre-pipeline
TIMESYS	'TT'	/ Time System	Pre-pipeline
MJDREFI	56658	/MJD reference day 01 Jan 2014 00:00:00	Pre-pipeline
MJDREFF	7.775925925926E-04	/MDJ reference (fraction of day)	Pre-pipeline
TIMEUNIT	' s'	/Unit of timing header keywords	Pre-pipeline
TIMEREF	'LOCAL'	/Reference Frame	Pre-pipeline
TASSIGN	'SATELLITE'	/Time assigned	Pre-pipeline
GPSOFFET	1,072,569,616	/Offest of the ASTRO-H GPS time	Pre-pipeline
CLOCKAPP	T	/If clock correction are applied (F/T)	Pre-pipeline
TSTART	0.0	/Start time	Pipeline (ahtime)
TSTOP	0.0	/Start Time	Pipeline (ahtime)
TELAPSE	0.0	/Elapsed time	Pre-pipeline
DATE-OBS	'yyyy-mm ddThh:mm:ss'	/Start Date	Pipeline (ahtime)
DATE-END	'yyyy-mm ddThh:mm:ss'	/Stop Date	Pipeline (ahtime)
SMUUNIT	'string'	/SMU Unit A or B	Pre-pipeline

TLM2FITS	‘ ‘	/Pre-Pipeline version JAXA	Pre-pipeline
PROCVER	’00.00.00’	/Processing version	Pipeline
SEQPNUM	nn	/Number of times the dataset has been processed	Pipeline
MKFFF	‘ISAS/JAXA’	/Origin of First FITS file	Pre-pipeline
ORIGIN	‘GSFC/NASA’	/Origin of Processed FITS file	Pipeline
SOFTVER	’00.00.00’	/Heasoft version	Pipeline
CALDBVER	‘CALDBVS’	/CALDB version	Pipeline
DATE	‘yyyy-mm-ddThh:mm:ss’	/File creation date	Pipeline
CHECKSUM	‘value’	/HDU checksum updated DATE	Any Tasks
DATASUM	‘value’	/ Data unit checksum updated DATE	Any Tasks

2.7 General Keywords Science data: Event and Rate extensions

The science data are placed in a FITS bintable. The format has either an EVENT type structure where the columns describe specification of a single event or a RATE type structure where the columns describe data obtained integrating with a specific time bin. The EXTNAME and HDUCLAS set of keywords are different depending if EVENT or RATE structure as specified in the table 4a1 and 4a2 respectively. The header keywords instead are specified in table 4b1 , 4b2, and 4c. The keyword values in 4b1, but for the keywords color coded in orange, are populated accordingly with the rules listed in Table 1. The keywords DETNAM, FILTER, DATAMODE (color coded orange) are filled or omitted as listed in table 7. RA_PNT and DEC_PNT (color coded orange) corresponds to the optical axis in SKY coordinates. The keywords ABERRAT, FOLOWSUN, OPTzzzX, OPTzzzY (color coded orange) are inserted only for the imaging instrument e.g. SXI, SXS, and HXI. These are not valid for the SGD. The keywords ONTIME, EXPOSURE, TIMEPIXR and TIMEDEL are valid for all event files.

Table 4a1			
Keyword	**Value**	**Comment**	**Filled by**
Event			
EXTNAME	‘EVENTS’	/ Binary table extension name	Pre-pipeline
HDUCLASS	‘OGIP’	/Format conforms to OGIP standards	Pre-pipeline
HDUCLAS1	‘EVENTS’	/Event data	Pre-Pipeline
Table 4a2			
Binned data			
Keyword	**Value**	**Comment**	**Filled by**
EXTNAME	‘RATE’	/ Binary table extension name	Pre-pipeline
HDUCLASS	‘OGIP’	/Format conforms to OGIP standards	Pre-pipeline
HDUCLAS1	‘TEMPORALDATA’	/Binned data	Pre-Pipeline

HDUCLAS2	'COMBINED'	/Contain science and HK data	Pre-Pipeline
Table 4b1			
Keyword	**Value**	**Comment**	**Filled by**
TELESCOP	'ASTRO-H'	/ Telescope mission name	Pre-pipeline
INSTRUME	'string'	/Instrument name	Pre-pipeline
DETNAM	'string'	/ Detector subsystem	Pre-pipeline
FILTER	'string'	/Filter name used	Pre-pipeline
DATAMODE	'string'	/ Data acquisition mode	Pre-pipeline
OBS_ID	'string'	/ Observation ID	Pre-pipeline
OBJECT	'string'	/ Object name	Pre-pipeline
OBSERVER	'string'	/ PI name	Pre-pipeline
OBS_MODE	'string'	/ POINTING or SLEW or ALL	Pre-pipeline
RA_OBJ	0.0	/ [deg] Object Right ascension	Pre-pipeline
DEC_OBJ	0.0	/ [deg] Object Declination	Pre-pipeline
RA_PNT	0.0	/ [deg] Avg Optical axis R. A.	Pre-pipeline
DEC_PNT	0.0	/ [deg] Avg Optical axis Dec	Pre-pipeline
EQUINOX	2000	/Equinox of celestial coord system	Pre-pipeline
RADECSYS	'FK5'	/Celestial coord system	Pre-pipeline
RA_NOM	0.0	/[deg] Nominal aspect point R.A.	aspect
DEC_NOM	0.0	/[deg] Nominal aspect point Dec	aspect
PA_NOM	0.0	/[deg] Position angle (roll)	aspect
ABERRAT	F	/Aberration apply to sky coords [T/F]	Coordevt
FOLOWSUN	F	/Sun position recalculated [T/F]	Coordevt
OPTDETX	xxx	/Optical axis DETX	Pipeline
OPTDETY	xxx	/Optical axis DETY	Pipeline
OPTFOCX	xxx	/Optical axis FOCX	Pipeline
OPTFOCY	xxx	/Optical axis FOCY	Pipeline
OPTSKYX	xxx	/Optical axis SKYX	Pipeline
OPTSKYY	xxx	/Optical axis SKYY	Pipeline
TIMESYS	'TT'	/ Time System	Pre-pipeline
MJDREFI	56658	/MJD reference day 01 Jan 2014 00:00:00	Pre-pipeline
MJDREFF	7.775925925926E-04	/MDJ reference (fraction of day)	Pre-pipeline
TIMEUNIT	' s'	/Unit of timing header keywords	Pre-pipeline
TIMEREF	'LOCAL'	/Reference Frame	Pre-pipeline
TASSIGN	'SATELLITE'	/Time assigned	Pre-pipeline
GPSOFFET	1,072,569,616	/Offset of the ASTRO-H GPS time	Pre-pipeline
CLOCKAPP	T	/If clock correction are applied (F/T)	Pre-pipeline
TSTART	0.0	/Start time	Pre-Pipeline (ahtime)
TSTOP	0.0	/Start Time	Pre-Pipeline

			(ahtime)
TELAPSE	0.0	/Elapsed time	Pre-pipeline
DATE-OBS	'yyyy-mm ddThh:mm:ss'	/Start Date	Pre-Pipeline (ahtime)
DATE-END	'yyyy-mm ddThh:mm:ss'	/Stop Date	Pre-Pipeline (ahtime)
SMUUNIT	'string'	/SMU Unit A or B	Pre-pipeline
ONTIME		/On-source time	Pipeline
EXPOSURE		/Exposure time	Pipeline
TIMEPIXR		/bintime start=0 middle=0.5 end=1	Pre-pipeline
TIMEDEL		/Data time resolution	Pre-pipeline
TLM2FITS	'string'	/Pre-Pipeline version JAXA	Pre-pipeline
PROCVER	'00.00.00'	/Processing version	Pipeline
SEQPNUM	nn	/Number of times the dataset has been processed	Pipeline
MKFFF	'ISAS/JAXA'	/Origin of First FITS file	Pre-pipeline
ORIGIN	'GSFC/NASA'	/Origin of Processed FITS file	Pipeline
SOFTVER	'00.00.00'	/Heasoft version	Pipeline
CALDBVER	'CALDBVS'	/CALDB version	Pipeline
DATE	'yyyy-mm-ddThh:mm:ss'	/File creation date	Pipeline
CHECKSUM	'value'	/HDU checksum updated DATE	Any Tasks
DATASUM	'value'	/ Data unit checksum updated DATE	Any Tasks
Table 4b2			
Keyword	Value	Comment	Filled by
ORBFILE	'string'	/Filename of the orbitfile	Pre-pipeline
ATTFILE	'string'	/Filename of the attitude	Pre-pipeline
TIMFILE	'string'	/Filename of the TIM file	Pre-Pipeline
RPTFILEn	'string'	/Filename of the RPT file	Pre-pipeline
LEAPFILE	'string'	/Filename of the leapsec file	Pre-pipeline

ONTIME is populated in the Unfiltered file using the same value of TELAPSE e.g. if slew data the time from the slew GTI , if Pointing data the time from the pointing GTI.
In cleaded data is the sum of the GTI after screening.
In Event files only it is possible to insert also the data model descriptors keywords
These keywords are listed in 4c and they are applicable either to columns defining coordinates or columns containing well defined numbered quantities (see example below)

Table 4c			
Keyword	**Value**	**Comment**	**Filled by**
Description of related columns : Compatibility with Chandra data model TDB case by case			
MTYPEn		/DM Keyword: Description name	Pre or pipeline

MFORMn		/[Units]	Pre or pipeline
Description of validity column value : Compatibility with Chandra data model TDB case by case			
DSTYPn		/Data subspace descriptor :name	Pre or pipeline
DSFORMn		/Data subspace descriptor :datatype	Pre or pipeline
DSVALn		/Data subspace descriptor :value	Pre or pipeline
mDSVALn		/Data subspace descriptor :value	Pre or pipeline
DSUNITn		/Data subspace descriptor :unit	Pre or pipeline

The HXI, SXI and SXS have these keywords set in the EVENT extensions :
MTYPEn = 'SKY ' / DM Keyword: Descriptor name
MFORMn = 'X, Y ' / [pixel]
MTYPEn = 'FOC ' / DM Keyword: Descriptor name
MFORMn = 'FOCX, FOCY' / [mm]
MTYPEn = 'DET ' / DM Keyword: Descriptor name
MFORMn = 'DETX, DETY' / [mm]

The SXI only has Data subspace descriptor:
DSTYP1 = 'GRADE ' / Data subspace descriptor: name
DSVAL1 = '0:11 ' / Data subspace descriptor: value

The timing keywords for the instruments for TIMEDEL and TIMEPIXR are set to the following for the different instruments:

Table 4d		
Instrument	**TIMEDEL**	**TIMEPIXR**
SXS	~ 0.1 ms	0
SXI FW	4 sec	0
SXI FW Burst	2 sec	0
SXI 1/8 W	0.5 sec	0
SXI 1/8 W Burst	0.1 sec	0
HXI	~0.1 ms	0
SGD	~0.1 ms	0
SHIELD GRB	0.016 sec	0
SHIELD SCALAR	2 sec	0
SHIELD HISTO	4 sec	0

2.8 General keywords: Housekeeping

All Housekeeping extensions have in the header the list of keywords described in Table 5a, 5b1 and 5b2. The keywords in table 5a1 are the same as for the primary header, the additional are in table 5a and 5b2. The values in 5a are populated accordingly with the rules listed in Table 1.

Table 5a			
Keyword	**Value**	**Comment**	**Filled by**
HK-special: These keywords are only for HK data			
EXTNAME	'HK_string'	/ Binary table extension name	Pre-pipeline
HDUCLASS	'OGIP'	/Format conforms to OGIP standards	Pre-pipeline
HDUCLAS1	'TEMPORALDATA'	/ Time order data	Pre-Pipeline
HDUCLAS2	'HKP'	/ Housekeeping	Pre-Pipeline
Table 5b1			
Keyword	**Value**	**Comment**	**Filled by**
TELESCOP	'ASTRO-H'	/ Telescope mission name	Pre-pipeline
INSTRUME	'string'	/Instrument name	Pre-pipeline
OBS_ID	'string'	/ Observation ID	Pre-pipeline
OBJECT	'string'	/ Object name	Pre-pipeline
OBSERVER	'string'	/ PI name	Pre-pipeline
OBS_MODE	'string'	/ POINTING or SLEW or ALL	Pre-pipeline
RA_OBJ	0.0	/ [deg] Object Right ascension	Pre-pipeline
DEC_OBJ	0.0	/ [deg] Object Declination	Pre-pipeline
RA_NOM	0.0	/[deg] Nominal aspect point R.A.	aspect
DEC_NOM	0.0	/[deg] Nominal aspect point Dec	aspect
PA_NOM	0.0	/[deg] Position angle (roll)	aspect
EQUINOX	2000	/Equinox of celestial coord system	Pre-pipeline
RADECSYS	'FK5'	/Celestial coord system	Pre-pipeline
TIMESYS	'TT'	/ Time System	Pre-pipeline
MJDREFI	56658	/MJD reference day 01 Jan 2014 00:00:00	Pre-pipeline
MJDREFF	7.775925925926E-04	/MDJ reference (fraction of day)	Pre-pipeline
TIMEUNIT	' s'	/Unit of timing header keywords	Pre-pipeline
TIMEREF	'LOCAL'	/Reference Frame	Pre-pipeline
TASSIGN	'SATELLITE'	/Time assigned	Pre-pipeline
GPSOFFET	1,072,569,616	/Offest of the ASTRO-H GPS time	Pre-pipeline
CLOCKAPP	T	/If clock correction are applied (F/T)	Pre-pipeline
TSTART	0.0	/Start time	Pipeline (ahtime)
TSTOP	0.0	/Start Time	Pipeline (ahtime)
TELAPSE	0.0	/Elapsed time	Pre-pipeline
DATE-OBS	'yyyy-mm ddThh:mm:ss'	/Start Date	Pipeline (ahtime)
DATE-END	'yyyy-mm ddThh:mm:ss'	/Stop Date	Pipeline (ahtime)
SMUUNIT	'string'	/SMU Unit A or B	Pre-pipeline

TLM2FITS	‘	/Pre-Pipeline version JAXA	Pre-pipeline
PROCVER	’00.00.00’	/Processing version	Pipeline
SEQPNUM	nn	/Number of times the dataset has been processed	Pipeline
MKFFF	‘ISAS/JAXA’	/Origin of First FITS file	Pre-pipeline
ORIGIN	‘GSFC/NASA’	/Origin of Processed FITS file	Pipeline
SOFTVER	’00.00.00’	/Heasoft version	Pipeline
CALDBVER	‘CALDBVS’	/CALDB version	Pipeline
DATE	‘yyyy-mm-ddThh:mm:ss’	/File creation date	Pipeline
CHECKSUM	‘value’	/HDU checksum updated DATE	Any Tasks
DATASUM	‘value’	/ Data unit checksum updated DATE	Any Tasks
Table 5b2			
Keyword	Value	Comment	Filled by
ORBFILE	‘string’	/Filename of the orbitfile	Pre-pipeline
ATTFILE	‘string’	/Filename of the attitude	Pre-pipeline
TIMFILE	‘string’	/Filename of the TIM file	Pre-Pipeline
RPTFILEn	‘string’	/Filename of the RPT file	Pre-pipeline
LEAPFILE	‘string’	/Filename of the leapsec file	Pre-pipeline

These header keywords are written in the header by the pre-pipeline. Their values are assigned in the pre-pipeline (FFF) and updated in processing pipeline (SFF) when necessary. The housekeeping processing is only limited to the time calculation and the results are written in the TIME column. The start and stop (TSTART TSTOP DATE-OBS DATE-END) are updated by the timing tasks. The _PNT keywords are also updated after running the ‘aspect’ task.

NOTE : The HK for SGD and HXI that are SGDn_CCn or HXIn_CAM need to have also DETNAM in the header at least for the SCAL extension used for time assignment.

The task ahtime assigned time for each instrument. This task uses several extension and column names from the instruement HK for look-up table. This documents does not list all the HK extensions and columns required, however they are listed in the column definition file and store in caldb ah_gen_coldef_YYYYMMDDVnnn.fits.

The common HK1 is also used in the time calculation to create the TIM file and the quartz clock file as well as to calculate the SAMPLE_CNT for the SXS and the additional column for the MXS which defined in this document. The extension and column names as well as keywords used by the tasks to support the time assignment are listed in table 5c. These extension name, columns names and keywords that must be present in order to run ahmktim, ahtrendtemp, sxssamcnt and mxstime. Note the table list just for the SXS the column and extension used to tun ahtime since the same extension is also used to run sxssamcnt.

Table 5c		
Extension = HK_SMU_A_DHFS_SIB2GEN_dhfs_tlm_attseq valid for SMU-A		
Columns /keyword name	Type	Needed by ahmktim
SMU_A_DHFS_TI_MNG_TIM_CRNT_TIM	Column	gpsacol
SMU_A_DHFS_TI_MNG_TIM_GPS_SYC_STAT	Column	gpsbcol
SMU_A_DHFS_TI_MNG_TIM_AUT_SYC	Column	gpsccol
SMU_A_DHFS_TI_MNG_TIM_GPS_STAT	Column	gpsdcol
Extension = HK_SMU_B_DHFS_SIB2GEN_dhfs_tlm_attseq valid for SMU-B		
Columns /keyword name	Type	Needed by ahmktim
SMU_B_DHFS_TI_MNG_TIM_CRNT_TIM	Column	gpsacol
SMU_B_DHFS_TI_MNG_TIM_GPS_SYC_STAT	Column	gpsbcol
SMU_B_DHFS_TI_MNG_TIM_AUT_SYC	Column	gpsccol
SMU_B_DHFS_TI_MNG_TIM_GPS_STAT	Column	gpsdcol
Extension= HK_SMU_A_AUX_HCE_HK2 for SMU-A		
Columns /keyword name	Type	Needed by ahmktim ahtrendtemp
HCE_A_SENS_SMU_A_TEMP_CAL	Column	tempcol
L32TI		
Extension= HK_SMU_B_AUX_HCE_HK3 for SMU-B		
Columns /keyword name	Type	Needed by ahmktim ahtrendtemp
HCE_B_SENS_SMU_B_TEMP_CAL	Column	tempcol
L32TI		l32ti
Extension= HK_SMU_A_DHFS_TI_MNG_block_get_ti_mng for SMU-A		
Columns /keyword name	Type	Needed by ahtrendtemp
SMU_A_DHFS_TI_MNG_TIM_TCAL_INF	Column	quarzcol
SMU_A_DHFS_TI_MNG_TIM_TCAL_TIME	Column	u32ticol
PERIODCL	Keyword	
Extension= HK_SMU_B_DHFS_TI_MNG_block_get_ti_mng for SMU-B		
Columns /keyword name	Type	Needed by ahtrendtemp
SMU_B_DHFS_TI_MNG_TIM_TCAL_INF	Column	quarzcol
SMU_B_DHFS_TI_MNG_TIM_TCAL_TIME	Column	u32ticol
PERIODCL	Keyword	
Extension = HK_ALLUSR		
Columns /keyword name	Type	Needed by ahtime (listed in coldef file)
PSP_ID	Column	coldeffile
SAMPLECNT	Column	coldeffile
LATCH_U32TI	Column	coldeffile
Extension = HK_ALLUSR		
Columns /keyword name	Type	Needed by sxssamcnt for HK
LATCH_BASE_CNT	Column	col1
LATCH_SAMPLE_CNT	Column	col2
Extension = HK_SXS_FWE		
Columns/Kewyoud name	Type	Needed by mxstime
FWE_TI_LED#_ON	Column	tioncol
FEW_TI_LED#_OFF	Column	tioffcol
FWE_LED#_PLS_LEN	Column	plslencol
FWE_LED#_PLS_SPC	Column	plsspccol
TIME_LED#_ON	Column	timeoncol
TIME_LED#_OFF	Column	timeoffcol

2.9 GTI extension

The GTI extensions are created both in the pre-pipeline and in the pipeline as a result of the specific tasks. If the GTI are created from telemetry where the START and STOP need to be calculated by *ahtime,* additional columns are required (See GTILOST in SXS section). There are three types of GTI extensions: 1) standard GTI that only contains the columns START and STOP that are calculated after the time has been assigned to all columns; 2) GTI where the START and STOP are calculated by *ahtime* using the time assignment method valid for HK information; 3) GTI where the START and STOP are calculated by *ahtime* using the time assignment that would require the LOCAL_TIME. For the type 1) the required columns are listed in table 6a and 6b ; for type 2) the additional columns are also the S_TIME and L32TI and the coumn TIME see table 6c and 6a; 3) the columns are also the S_TIME and L32TI and the coumn TIME see table 6d and 6a. The EXTNAME keyword must start with GTI and have a specification attached.
For example if the file contains telemetry saturation, the keyword EXTNAME is GTITEL. If the file contains the pointing, slew and all observation time, the EXTNAME is GTIPOINT, GTISLEW and GTIOBS. If the file contains the GPS on time the EXTNAME is GTIGPS
Table 6a and 6b lists the EXTNAME and HDUCLAS keywords values as well as the standard structure for the GTI. The EXTNAME value is used to distinguish among the different type of GTI.

Table 6a			
Keyword	**value**	**Comment**	**Filled by**
EXTNAME	'string'	/ Binary table extension name	Pre or Pipeline
HDUCLASS	'OGIP'	/Format conforms to OGIP standards	Pre or Pipeline
HDUCLAS1	'GTI'	/ Good time interval data	Pre or Pipeline
Table 6b			
TTYPE1	'START'	/Column name	Pre or Pipeline
TFORM1	'1D'	/Data format of the field	Pre or Pipeline
TUNIT1	's'	/Units of the value in column	Pre or Pipeline
TTYPE2	'STOP'	/Column name	Pre or Pipeline
TFORM2	'1D'	/Data format of the field	Pre or Pipeline
TUNIT2	's'	/Units of the value in column	Pre or Pipeline
Table 6c			
TTYPE1	'TIME'	/ Column name	Pre or Pipeline
TFORM1	'1D'	/ Data format of the field	Pre or Pipeline
TUNIT1	's'	/Units of the value in column	Pre or Pipeline
TTYPE2	'START'	/Column name	Pre or Pipeline
TFORM2	'1D'	/ Data format of the field	Pre or Pipeline
TUNIT2	's'	/Units of the value in column	Pre or Pipeline
TTYPE3	'STOP'	/Column name	Pre or Pipeline
TFORM3	'1D'	/Data format of the field	Pre or Pipeline

TUNIT3	‘s’	/Units of the value in column	Pre or Pipeline
TTYPE4	‘L32TI’	/Column name	Pre or Pipeline
TFORM4	‘1D’	/Data format of the field	Pre or Pipeline
TUNIT4	‘s’	/Units of the value in column	Pre or Pipeline
TTYPE5	‘L32TISP’	/Column name	Pre or Pipeline
TFORM5	‘1D’	/Data format of the field	Pre or Pipeline
TUNIT5	‘s’	/Units of the value in column	Pre or Pipeline
TTYPE6	‘S_TIME’	/Column name	Pre or Pipeline
TFORM6	‘1D’	/Data format of the field	Pre or Pipeline
TUNIT6	‘s’	/Units of the value in column	Pre or Pipeline
TTYPE7	‘S_TIMESP’	/Column name	Pre or Pipeline
TFORM7	‘1D’	/Data format of the field	Pre or Pipeline
TUNIT7	‘s’	/Units of the value in column	Pre or Pipeline
Table 6d			
TTYPE1	‘TIME’	/Units of the value in column	Pre or Pipeline
TFORM1	‘1D’	/Column name	Pre or Pipeline
TUNIT1	‘s’	/Units of the value in column	Pre or Pipeline
TTYPE2	‘START’	/Column name	Pre or Pipeline
TFORM2	‘1D’	/Data format of the field	Pre or Pipeline
TUNIT2	‘s’	/Units of the value in column	Pre or Pipeline
TTYPE3	‘STOP’	/Column name	Pre or Pipeline
TFORM3	‘1D’	/Data format of the field	Pre or Pipeline
TUNIT3	‘s’	/Units of the value in column	Pre or Pipeline
TTYPE4	‘L32TI’	/Column name	Pre or Pipeline
TFORM4	‘1D’	/Data format of the field	Pre or Pipeline
TUNIT4	‘s’	/Units of the value in column	Pre or Pipeline
TTYPE5	‘S_TIME’	/Column name	Pre or Pipeline
TFORM5	‘1D’	/Data format of the field	Pre or Pipeline
TUNIT5	‘s’	/Units of the value in column	Pre or Pipeline
TTYPE6	‘LOCAL_TIME1’	/Column name	Pre or Pipeline
TFORM6	‘1D’	/Data format of the field	Pre or Pipeline
TUNIT6	‘s’	/Units of the value in column	Pre or Pipeline
TTYPE7	‘LOCAL_TIME2’	/Column name	Pre or Pipeline
TFORM7	‘1D’	/Data format of the field	Pre or Pipeline
TUNIT7	‘s’	/Units of the value in column	Pre or Pipeline

There are several GTIs created either in the pre-pipeline or in the pipeline. The convention for the EXTNAME is GTIHKxxxxx where xxxxx is a string that identifies the kind of GTI. In this case if ahtme is run on that file, the time assignement is done as for HK time and the code expect the columns defined as table 6c. If the GTI has the columns defined as table 6ab the ahtime do not calculate time and skip the extention. If the EXTNAME is set to GTILOST and INSTRUME is set to SXS the code expect the columns decribed in table 6c.

Table 6e contains the keywords for the GTI header. All but those colored code orange are the same for the primary header and their values follow the same rules. The keywords DETNAM, FILTER, DATAMODE are filled or omitted as described in table 7 and are only used for GTI relative to an instrument.

Table 6e			
Keyword	**Value**	**Comment**	**Filled by**
TELESCOP	'ASTRO-H'	/ Telescope mission name	Pre-pipeline
INSTRUME	'string'	/Instrument name	Pre-pipeline
DETNAM	'string'	/ Detector subsystem	Pre-pipeline
FILTER	'string'	/ Filter name used	Pre-pipeline
DATAMODE	'string'	/ Data acquisition mode	Pre-pipeline
OBS_ID	'string'	/ Observation ID	Pre-pipeline
OBJECT	'string'	/ Object name	Pre-pipeline
OBSERVER	'string'	/ PI name	Pre-pipeline
OBS_MODE	'string'	/ POINTING or SLEW or ALL	Pre-pipeline
RA_OBJ	0.0	/ [deg] Object Right ascension	Pre-pipeline
DEC_OBJ	0.0	/ [deg] Object Declination	Pre-pipeline
RA_NOM	0.0	/[deg] Nominal aspect point R.A.	aspect
DEC_NOM	0.0	/[deg] Nominal aspect point Dec	aspect
PA_NOM	0.0	/[deg] Position angle (roll)	aspect
EQUINOX	2000	/Equinox of celestial coord system	Pre-pipeline
RADECSYS	'FK5'	/Celestial coord system	Pre-pipeline
TIMESYS	'TT'	/ Time System	Pre-pipeline
MJDREFI	56658	/MJD reference day 01 Jan 2014 00:00:00	Pre-pipeline
MJDREFF	7.775925925926E-04	/MDJ reference (fraction of day)	Pre-pipeline
TIMEUNIT	' s'	/Unit of timing header keywords	Pre-pipeline
TIMEREF	'LOCAL'	/Reference Frame	Pre-pipeline
TASSIGN	'SATELLITE'	/Time assigned	Pre-pipeline
GPSOFFET	1,072,569,616	/Offest of the ASTRO-H GPS time	Pre-pipeline
CLOCKAPP	T	/If clock correction are applied (F/T)	Pre-pipeline
TSTART	0.0	/Start time	Pipeline (ahtime)
TSTOP	0.0	/Start Time	Pipeline (ahtime)
TELAPSE	0.0	/Elapsed time	Pre-pipeline
DATE-OBS	'yyyy-mm ddThh:mm:ss'	/Start Date	Pipeline (ahtime)
DATE-END	'yyyy-mm ddThh:mm:ss'	/Stop Date	Pipeline (ahtime)
SMUUNIT	'string'	/SMU Unit A or B	Pre-pipeline
TLM2FITS	'	/Pre-Pipeline version JAXA	Pre-pipeline

PROCVER	'00.00.00'	/Processing version	Pipeline
SEQPNUM	nn	/Number of times the dataset has been processed	Pipeline
MKFFF	'ISAS/JAXA'	/Origin of First FITS file	Pre-pipeline
ORIGIN	'GSFC/NASA'	/Origin of Processed FITS file	Pipeline
SOFTVER	'00.00.00'	/Heasoft version	Pipeline
CALDBVER	'CALDBVS'	/CALDB version	Pipeline
DATE	'yyyy-mm-ddThh:mm:ss'	/File creation date	Pipeline
CHECKSUM	'value'	/HDU checksum updated DATE	Any Tasks
DATASUM	'value'	/ Data unit checksum updated DATE	Any Tasks

The EXTNAME for the different GTI is described in table 6f

Table 6f		
EXTNAME	**File**	**Where are calculated**
GTILOST	1 file 2 ext : 1 antico, 1 pixel with GTILOST	SXS antico and pixel GTI lost are derived in the pre-pipeline.
GTIFOUNDALL	1 file 2 ext : 1 antico, 1 pixel with the lost good GTILOST using the invert software Named FOUNDALL two columns .	*gtiinvert* calculates the invert GTI in the pipeline used to screen the data.
GTIFOUND	1 file 2 ext : 1 antico, 1 pixel with the lost good GTILOST with 3 columns.	*sxspixgti* can create this extension by input just the gtilost file extension.
GTIOBS GTIPOINT GTISLEW GTIGPS	1 file with 4 extensions	Calculated in the pre-pipeline OBS,POINT,SLEW from ODB, GPS from *ahmktim*. OBS, POINT and SLEW are used to screen the data.
GTITEL	1 file	Calculted in the pre-pipeline.Used to screen the data.
GTIMXSFNON1 GTIMXSFNON2 GTIMXSFNON3 GTIMXSFNON4 GTIMXSFNON13 GTIMXSFNON24	1 file with 6 extensions. The first 4 extensions contain the time to when the 4 LEDs are on considering the spacing and period. The last 2 extensions contain the merged of the direct and indirect as appropriate	The first 4 extensions are calculated by *mxstime*, The last two extensions are calculated by *mxsgti* . These GTIs are used to extract time when the MXS is on.
GTIMXSFNOFF1 GTIMXSFNOFF2 GTIMXSFNOFF3 GTIMXSFNOFF4 GTIMXSFNOFF13 GTIMXSFNOFF24	1 file with 6 extensions. The first 4 extension contain the time to when the 4 LEDs are off. The last 2 extensions contain the merged time of the direct and indirect of when the LED are off	All extensions are calculated in *mxsgti* using *gtiinvert* using the file with the LED on. These GTIs are used to extract time when the MXS is on.

GTIMXSCSON1 GTIMXSCSON2 GTIMXSCSON3 GTIMXSCSON4 GTIMXSCSON13 GTIMXSCSON24	1 file with 4 extensions. The extensions contain the time interval to when the 4 LEDs are operating without considering the spacing and period.	All extensions are calculated by *mxstime* when the MXS is on.
GTIMXSCSOFF1 GTIMXSCSOFF2 GTIMXSCSOFF3 GTIMXSCSOFF4 GTIMXSCSOFF13 GTIMXSCSOFF24	1 file with 4 extensions. The extensions contain the time interval to when the 4 LEDs are operating without considering the spacing and period.	All extensions are calculated by *mxstime* when the MXS is on.
GTIPIXnn	1 file with 36 extensions. Each extension is valid for a specific pixel and are the time interval to when the pixels are on from the mkf an/or gtilost off applied and/or gti pixel independent. The mkf and gtilost are pixel dependent. The output is GOOD GTI.	All extensions are calculated by *sxsgti.* To screen by pixel.
GTIPIXOFFnn	1 file with 36 extensions. Each extension is valid for a specific pixel and are the bad time interval for each pixels. This is tipically listed in the gtilost plus any other times that may come from inverting the mkf per pixel and/or bad time that are not pixel dependent. The output is BAD GTI.	
GTIPIXEL	1 file with 2 extensions. This is merging the GTIPIXnn to have a table with START STOP PIXEL. (gtilost off applied) (GOOD)	Calculated by *sxsgt.i*
GTIPIXELOFF	1 file with 2 extension. This is merging the inverse of the GTIPIXnn to have a table with START STOP PIXEL. (BAD)	Calculated by *sxsgt.i*
GTIADRON	1 file with 2 extensions (ADRon and ADROFF) . These are the time interval when the ADR operation is applied	
GTIADROFF	1 file with 2 extensions (ADRon and ADROFF) . These are the time interval outside of the ADR operation	
GTISCANinN	2 files : 1 for the HXI with 2 extensions GTISCANHX1 GTISCANHX2 ; 1 for the SGD with 4 extensions GTISCANSG11 GTISCANSG12 GTISCANSG21 GTISCANSG22	
GTIEHK	To all files _uf fot sxs and sxi _ufa for sgd and hxi	
GTIMKF	To all files _uf fot sxs and sxi _ufa for sgd and hxi For sxi check the datamode	
GTIEHKNXB	To all files _uf fot sxs and sxi _ufa for sgd and hxi Equivalent ehk but different cut	

.

GTIEHKDRK	Only for the sxs _uf	
GTIEHKDAY	Only for the sxi _uf	
GTIACSAA	Using the 20sec antico rate > ??	
GTIADROFF	Good interval when there is not ADR cycle	
GTIADRON	Godd interval when there is a ADR cycle	

2.10 Overview of the INSTRUME DETNAM FILTER DATAMODE

Table 7 contains the values for the keywords EXTNAME, HDUCLAS1, HDUCLAS2, INSTRUMENT, DETNAM, DATAMODE FILTER for all the FITS files, but for the orbit, attitude, tim file, catalog file and GTI for the observation.

Table 7

System	Datatype	EXTNAME	HDUCLAS1	HDUCLAS2	INSTRUME	DETNAM	DATAMODE	FILTER
SXS	HK	HK_*	TEMPORALDATA	HKP	SXS	Delete	Delete	delete
	Diagnostoc Science	EVENTS	EVENTS		SXS	PIXEL	PX_PULSEREC	Delete
	Diagnostic Science	EVENTS	EVENTS		SXS	PIXEL	PX_NOISEREC	Delete
	Diagnostic Science	EVENTS	EVENTS		SXS	PIXEL	PX_WFRB	Delete
	HK	HK_SXS_TEMPLATE	TEMPORALDATA	HKP	SXS	PIXEL	PX_TEMPLATE	Delete
	HK	HK_SXS_NOISESPC	TEMPORALDATA	HKP	SXS	PIXEL	PX_NOISESPC	Delete
	HK	HK_SXS_NOISESPC8K	TEMPORALDATA	HKP	SXS	PIXEL	PX_NOISESPC8K	Delete
	HK	HK_SXS_AVGPULSE	TEMPORALDATA	HKP	SXS	PIXEL	PX_AVGPULSE	Delete
	Diagnostic Science	EVENTS	EVENTS		SXS	ANTICO	AC_NOISEREC	Delete
	Diagnostic Science	EVENTS	EVENTS		SXS	ANTICO	AC_WFRB	Delete
	Science	EVENTS	EVENTS		SXS	ANTICO	AC_NORMAL	Delete
	Science	EVENTS	EVENTS		SXS	PIXEL	PX_NORMAL PX_MIDRES	OPEN1 OPEN2 BE FE55 ND25 POLYIMIDE UNDEF
	Science	EVENTS	EVENTS		SXS	PIXEL	PX_BASELINE	Delete
	Science	GTILOST	GTI		SXS	PIXEL	PX_NORMAL PX_MIDRES	Delete
	Science	GTILOST	GTI		SXS	ANTICO	AC_NORMAL	Delete
FW & MXS	HK	HK_SXS_FWE	TEMPORALDATA	HKP	SXS	Delete	Delete	Delete
SXI	HK	HK_*	TEMPORALDATA	HKP	SXI	Delete	Delete	Delete
	Science	EVENTS	EVENTS		SXI	CCD CCD12 CCD34	window1 window2 window1burst window2burst	Delete
	Science	DFRAME RFRAME IFRAME	TEMPORALDATA	COMBINED	SXI	CCD	DFRAME RFRAME IFRAME	Delete

	Science	EXPOSURE	TEMPORALDATA	COMBINED	SXI	CCD	EXPOSURE	Delete
	Science	HOTPIX	TEMPORALDATA	COMBINED	SXI	CCD	HOTPIX	Delete
HXI	HK	HK_*	TEMPORALDATA	HKP	HXI1 or HXI2 or HXI	Delete	Delete	Delete
	Science	EVENTS	EVENTS		HXI1 or HXI2 or HXI	CAMERA	CAMERA_CHECKOUTn CAMERA_NORMALn AM241_NORMALn PSEUDO_NORMALn FORCE_NORMALn CALMODE_NORMALn	Delete
	Science	RATE	TEMPORALDATA	COMBINED	HXI1 or HXI2 ot HXI	SHIELD	GRB	Delete
	Science	RATE	TEMPORALDATA	COMBINED	HXI1 or HXI2 or HXI	SHIELD	SCALAR HISTOGRAM	Delete
SGD	HK	HK_*	TEMPORALDATA	HKP	SGD1 or SGD2	Delete	Delete	Delete
	Science	EVENTS	EVENTS		SGD1 or SGD2 or SGD	CC1/ CC2/CC3 or CC	CCn_CHECKOUTn CCn_NORMALn PSEUDO_NORMALn FORCE_NORMALn CALMODE_NORMALn	Delete
	Science	RATE	TEMPORALDATA	COMBINED	SGD1 or SGD2 or SGD	SHIELD1/ SHIELD2 or SHIELD	GRB	Delete
	Science	RATE	TEMPORALDATA	COMBINED	SGD1 or SGD2 or SGD	SHIELD1/ SHIELD2 or SHIELD	SCALAR HISTOGRAM	Delete
Non-Inst	HK	HK_*	TEMPORALDATA	HKP	BUS_SYSTEM	Delete	Delete	Delete
CAMS	Science unfolded HK	EVENTS	EVENTS		CAMS1 or CAMS2 or CAMS	Delete	Delete	Delete

3 SXS science data

The science data include the following data type PIXEL, ANTICO, PULSEREC and NOISEREC data. All data types are in event format.
The science PIXEL data are output half from the PSP-A (PSPA0 and PSPA1) and half from PSP-B (PSPB0 and PSPB1). At the FFF stage the two data streams are merged into one file for a given observation and a column PSP_ID is added. PSP_ID in the telemetry is coded as 0 or 1 for PSPA0 and PSPA1 respectively and 2 or 3 for PSPB0 or PSPB1 respectively. If during an observation more than one filter and/or calibration source is on (MXS) , the pre-pipeline creates as many files as many filters/mxs combinations. All the SXS PIXEL data have two keywords FILTER and DATAMODE in the header of the event extension to account for the filter and data acquition type. The FILTER keyword contains the filter name, the DATAMODE records the

way the data were collected. The MXS behaviorAt the FFF DATAMODE do not include values realted to the MXS, since data are divided for the MXS source. However the FFF contains and populates the keyword MXSONOFF to record if the MXS is ON, OFF or UNKNOWN. This keyword should be set to ON even if only part of the data in the file has the MXS ON. The keyword MXSTYPE records instead which MXS is on. The MXSTYPE string may contain multiple MXS values. The *sxspha2pi* tool add the keyword SXIPISEC in the header of the event file to flag whether or not the secondaries are processed as primaries or secondaries. The PIXEL data are divided in separate FFF files if the FILTER is changed.

The PIXEL data contains real science pixel event but also baseline events and marker for time when there are periods of "lost" events. All entry in the PIXEL file are "calibrated" within the pipeline and the BASELINE data and 'lost' marker are removed from the file at the screening.
For PIXEL data the PULSEREC, NOISEREC and WFRB are diagnostic modes. Similarly to the PIXEL data the telemetry from PSP-A and PSP-B is merged in one file for the PULSEREC, one file for the NOISEREC and one for the WFRB. A column PSP_ID is added in the files to record which PSP record the data.

The ANTICO data are output from both PSP therefore there is a redundant copy. At the FFF stage the ANTICO data are put in one file with a single extension and a column PSP_ID to indicate either side A or B. In the Antico data the values of PSP_ID 0 and 1 are to ID side A and 2 and 3 to ID side B. The keyword DATAMODE is set NORMAL. Also the Antico data contains as marker the periods "lost" events. There are two diagnostic modes for the ANTICO data NOISEREC and WFRB. Similar to the ANTICO data the telemetry from the PSP-A and PSP-B are merged in one file for he NOISEREC and one for the WFRB.
The pre-pipeline create also two different GTI corresponding to the period of "lost" event for the PIXEL data and "lost" event for the ANTICO data.

The SXS creates two HK files. One containing the HK telemetered value. This file is ID with .hk1. A second hk file, id as hk2, contains additional "diagnostic" information that corresponds to the packet SYSLOG, AVGPULSE, NOISESPC, NOISESPC8K, and TEMPLATE. The hk1 file has many extensions because the information is repeated for each of the PSPA0, PSPA1, PSPB0, PSPB1 processors and not merged into a single extension, as for the science data, with the PSP_ID columns. The number of extensions is 88. However one set of these housekeeping corresponding to the "USR" HK packet are also merged into one extension and the PSP_ID column added in the pre-pipeline to facilitate the SXS timing assignment. This is the 1st extension of the hk1 named HK_ALLUSR and therefore the hk1 file contains in total 89 extensions. The information of the filter wheel associated to the SXS is one extension of the hk1 file. Here are documented the PIXEL, ANTICO, PULSEREC, NOISEREC, WFRB, FWE and GTI LOST for the pixel and antico data. None of the other extensions are documented.

Timing is assigned as followed: PIXEL (science, pulserec, noiserec, wfrb) should have trigtime and time, antico (normal, wfrb, noiserec) and GTI LOST (antico and pixel) should only have time meaning that time=trigtime. HK1 & HK2 only calculate time without samplecnt.

The FWE is included in the hk1 and this extension requires to have the time column assigned with ahtime as for all HK but also the specific MXS time columns assigned with the mxstime.

NOTE 2: *sxsflagpix* writes a column CTMULT if electrical cross-talk is selected. *sxspha2pi* writes a column EPI2 containing the primary calculated as primary and the secondary as secondary but not have the algorithm yet. These columns are not included in the FFF file.
Table 8 and 8a list the values for the INSTRUME, DETNAM, DATAMODE and FILTER for the pixel and antico respectively. Table 8 also lists the additional keywords to add in the pixel event data file. The keyword SXSPISEC is added by *sxspha2pi* task and should not be inserted by the FFF.

Table 8			
Keyword	**Value**	**Comment**	**Filled By**
Pixel			
INSTRUME	SXS		Pre-pipeline
DETNAM	PIXEL		Pre-pipeline
DATAMODE	PX_PULSEREC PX_NOISEREC PX_WFRB PX_NORMAL PX_MIDRES	/Event PULSE mode /Event Noise mode /Event WFRB mode /Event normal mode /Event in forced midres mode	Pre-pipeline
FILTER	OPEN1 FE55 BE OPEN2 ND25 POLYIMIDE UNDEF	/Filter OPEN1 /Filter cal source /Filter Be /Filter OPEN2 /Filter ND25 /Filter POLYIMIDE /Filter UNDEF	Pre-pipeline
SXSPISEC	Y/N	/Secondary (added by software)	Pre-pipeline
GATEVALV	OPEN CLOSE	/ Gate Valve position	Pre-pipeline
MXSONOFF	On/off Unknown	/If MXS is ON OFF or UNKNOWN	Pre-pipeline
MXSTYPE	'1,12, 2, 34, 3,4 or none'	/Which MXS is on else NONE	Pre-pipeline
ADRMODE	HELIUM/CRYOFREE	/ADR mode of operation	Pre-pipeline
DEVPTHRE		/Derivative Pulse threshold	Pre-pipeline
SHPTEMPL		**/ Shape templates version**	Pre-pipeline
CTSSDTOL		**/Calorimeter thermal sink tolerance**	Pre-pipeline
Table 8a			
Keyword	**Value**	**Comment**	**Filled By**
Antico			
INSTRUME	SXS		Pre-pipeline
DETNAME	ANTICO		Pre-pipeline
DATAMODE	AC_NORMAL AC_NOISEREC AC_WFRB	/Datamode not applicable /Antico Noise mode /Antico WFRB mode	Pre-pipeline

NOTE: a) the GATEVALV is set to Open always after a TDB time and before is close. b) the value for the SHPTEMPL is the version number of the template. This is not well identified in the telemetry

The FFF Event PIXEL data file contain at the FFF stage Pixel, Baseline and LOST Count data. The header keywords are from table 4a1, 4b1, 4b2, 4c and the keywords GATEVALV, MXSONOFF and MXSTYPE listed in table 8. The MXSTYPE is a string and its value may be a combination of the following values separated by a coma : 1,12,2,34,3,4,or NONE.
The MSX LED corresponds to Led 1 & Led 3 CuKa Cukb Crka Crkb; Led 2 & Led 4 Alka Alkb Mgka.

The DATAMODE for pixel data are set either to NORMAL or MIDRES. There are two templates on board in time domain that contain parameters to describe the tiem characteristic of the pulse one for high resolution and one for mid resolution. In NORMAL mode Hp events are matched with the high resolution template and Mp events are matched with mid resolution template. In MIDRES both Hp and Mp are both matched with the Mid resolution template.

Note on columns :
a) RISE_TIME is defined as B however the TLMIN and TLMAX are set to 0 and 127. The rise_time information is stored in the telemetry in the range 0-127, the remaing bits are used to store other information maing the event invalid are store stored in the However the telemetry uses the same field to store additional information in the 128-255 but what we do with it ???

Table 9

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre-pipe ahtime
TRIGTIME	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe
L32TI	1J		2147483648		Pre-pipe
CATEGORY	1B				Pre-pipe
ADU_CNT	1B				Pre-pipe
PSP_ID	1B				Pre-pipe calculated
FORMAT_VER	1B				Pre-pipe
WFRB_WRITE_LP	1J				Pre-pipe
WFRB_SAMPLE_CNT	1J		2147483648		Pre-pipe
NUM_ELEM	1B	0/255			Pre-pipe
SUM_LOST_CNT	1J				Pre-pipe
ITYPE	1B	0 / 7			Pre-pipe
TYPE	2A				Pre-pipe calculated
IPIX	1B	0/ 17		31	Pre-pipe
PIXEL	1B	0/ 35		63	Pre-pipe calculated
TRIG_LP	1J			2147483647	Pre-pipe
QUICK_DOUBLE	1X				Pre-pipe
SLOPE_DIFFER	1X				Pre-pipe
LO_RES_PH	1I	-8192/ 16383			Pre-pipe
DERIV_MAX	1I	-32768/ 32767			Pre-pipe
RISE_TIME	1B	0/127			Pre-pipe
TICK_SHIFT	1B	-8 /7	-128	-128	Pre-pipe
TIME_VERNIER	1B	0/ 15			Pre-pipe

PHA	1J	-32768/65535		2147483647	Pre-pipe
FLAGS	1B				Pre-pipe calculated
EL_LOST_CNT	1I		32768		Pre-pipe
EL_REASON	1B			255	Pre-pipe
EL_STOP_LP	1J			2147483647	Pre-pipe
PREV_INTERVAL	1I		32768		Pre-pipe
NEXT_INTERVAL	1I		32768		Pre-pipe
SAMPLECNT	1D				Pre-pipe sxssamcnt
SAMPLECNTTRIG	1D				Pre-pipe sxsamcnt
ACTX	1B	1/ 8		255	Pipeline coordevt
ACTY	1B	1/ 8		255	Pipeline coordevt
DETX	1B	1/ 8		255	Pipeline coordevt
DETY	1B	1/ 8		255	Pipeline coordevt
FOCX	1I	1/ 1810		-1	Pipeline coordevt
FOCY	1I	1/ 1810		-1	Pipeline coordevt
X	1I	1/ 1810		-1	Pipeline coordevt
Y	1I	1/ 1810		-1	Pipeline coordevt
UPI	1E				Pipeline sxsupi
EPI	1E				Pipeline sxspi
EPI2	1E				Pipeline sxspi
PI	1J	-16384/32768		-32768	Pipeline sxspi
INDEX	1J				Pipeline sxssecid
GROUPS	1J			-9999	Pipeline sxssecid
CTMULT	1I				Pipeline sxsflagpix
STATUS	16X				Pipeline sxsflagpix
PROC_STATUS	32X				Pre/Pipeline

2) FFF PIXEL Lost Count GTI
The header keywords are from table 6a and 6e. The EXTNAME string is GTILOST.

Table 10

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre-pipe ahtime
START	1D			/'s'	Pre-pipe ahtime
STOP	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe
L32TI	1J		2147483648		Pre-pipe
CATEGORY	1B				Pre-pipe
ADU_CNT	1B				Pre-pipe
PSP_ID	1B				Pre-pipe calculated
FORMAT_VER	1B				Pre-pipe
WFRB_WRITE_LP	1J				Pre-pipe
WFRB_SAMPLE_CNT	1J		2147483648		Pre-pipe
NUM_ELEM	1B	0/255			Pre-pipe
SUM_LOST_CNT	1J				Pre-pipe
ITYPE	1B	0 / 7			Pre-pipe
TYPE	2A				Pre-pipe calculated
IPIX	1B	0/ 17		31	Pre-pipe
PIXEL	1B	0/ 35		63	Pre-pipe calculated
EL_LOST_CNT	1I		32768		Pre-pipe
EL_REASON	1B			255	Pre-pipe
EL_START_LP	1J				Pre-pipe
EL_STOP_LP	1J				Pre-pipe
SAMPLECNT1	1D				Pre-pipe sxssamcnt
SAMPLECNT2	1D				Pre-pipesxsamcnt

PROC_STATUS	32X				Pre/Pipeline

3) FFF PIXEL Pulserec & Noiserec

The header keywords are from table 4a1, 4b1, 4b2, 4c and the keywords GATEVALV, MXSONOFF and MXSTYPE listed in table 8.

Table 11

Column name : Pulserec	Column name: Noiserec	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL /TUNIT	Comment
TIME	TIME	1D			/'s'	Pre-pipe ahtime
TRIGTIME	TRIGTIME	1D			/'s'	Pre-pipe ahtime
S_TIME	S_TIME	1D			/'s'	Pre-pipe
L32TI	L32TI	1J		2147483648		Pre-pipe
CATEGORY	CATEGORY	1B				Pre-pipe
ADU_CNT	ADU_CNT	1B				Pre-pipe
PSP_ID	PSP_ID	1B				Pre-pipe calculated
FLG_COMPRESS	FLG_COMPRESS	1X				Pre-pipe
FLG_AVGPULSE		1X				Pre-pipe
	FLG_NOISESPC	1X				Pre-pipe
FORMAT_VER	FORMAT_VER	1B				Pre-pipe
WFRB_WRITE_LP	WFRB_WRITE_LP	1J				Pre-pipe
WFRB_SAMPLE_CNT	WFRB_SAMPLE_CNT	1J		2147483648		Pre-pipe
RECORD_LEN	RECORD_LEN	1I				Pre-pipe
ERR_CNT	ERR_CNT	1I		32768		Pre-pipe
PRE_TRIG_LEN_H		1I				Pre-pipe
PRE_TRIG_LEN_M		1B				Pre-pipe
	NOISE_CLEAN_LEN	1I		32768		Pre-pipe
	NOISE_TAIL_MARGIN	1B				Pre-pipe
EDB_QUICK_DOUBLE		1X				Pre-pipe
EDB_SPARE1		1B				Pre-pipe
	EDB_PARITY_ERR	1B				
	EDB_SPARE	1B				Pre-pipe
EDB_IPIX	EDB_IPIX	1B				Pre-pipe
EDB_TRIG_LP	EDB_TRIG_LP	1J				Pre-pipe
EDB_SPARE2		1B				
EDB_LO_RES_PH		1I				Pre-pipe
EDB_DERIV_MAX		1I				Pre-pipe
EXP_WORD_LEN	EXP_WORD_LEN	1I				Pre-pipe
EL_LOST_CNT	EL_LOST_CNT	1I		32768		Pre-pipe
EL_REASON	EL_REASON	1B			255	Pre-pipe
EL_STOP_LP	EL_STOP_LP	1J			214748 3647	Pre-pipe
ITYPE	ITYPE	1B	0 / 7			Pre-pipe
TYPE	TYPE	2A				Pre-pipe calculated
IPIX	IPIX	1B	0/ 17		31	Pre-pipe
PIXEL	PIXEL	1B	0/ 35		63	Pre-pipe calculated
TRIG_LP	TRIG_LP	1J			214748 3647	Pre-pipe
QUICK_DOUBLE	QUICK_DOUBLE	1X				Pre-pipe
SLOPE_DIFFER	SLOPE_DIFFER	1X				Pre-pipe
LO_RES_PH	LO_RES_PH	1I	-8192/ 16383			Pre-pipe
DERIV_MAX	DERIV_MAX	1I	-32768/ 32767			Pre-pipe
RISE_TIME	RISE_TIME	1B	0/127			Pre-pipe
TICK_SHIFT	TICK_SHIFT	1B	-8 /7		-128	Pre-pipe

TIME_VERNIER	TIME_VERNIER	1B	0/ 15			Pre-pipe
PHA	PHA	1J	-32768/ 65535		214748 3647	Pre-pipe
FLAGS	FLAGS	1B				Pre-pipe calculated
PULSEREC_MODE		1B				Pre-pipe
PULSEREC		1040I				Pre-pipe
PULSE_SEQ_CNT		1B				Pre-pipe
	NOISEREC_MODE	1B				Pre-pipe
	NOISEREC	1024I				Pre-pipe
	NOISE_SEQ_CNT	1B				Pre-pipe
COMPDATA	COMPDATA	1664B 1640B				Pre-pipe
COMP_BYTE_LEN	COMP_BYTE_LEN	1I				Pre-pipe
PREV_INTERVAL	PREV_INTERVAL	1I		32768		Pre-pipe
NEXT_INTERVAL	NEXT_INTERVAL	1I		32768		Pre-pipe
SAMPLECNT	SAMPLECNT	1D				Pipeline sxssamcnt
SAMPLECNTTRIG	SAMPLECNTTRIG	1D				Pipeline sxsamcnt
CTMULT	CTMULT	1I				Pipeline sxsflag
ACTX	ACTX	1B	1/ 8		255	Pipeline coordevt
ACTY	ACTY	1B	1/ 8		255	Pipeline coordevt
DETX	DETX	1B	1/ 8		255	Pipeline coordevt
DETY	DETY	1B	1/ 8		255	Pipeline coordevt
FOCX	FOCX	1I	1/ 1810		-1	Pipeline coordevt
FOCY	FOCY	1I	1/ 1810		-1	Pipeline coordevt
X	X	1I	1/ 1810		-1	Pipeline coordevt
Y	Y	1I	1/ 1810		-1	Pipeline coordevt
UPI	UPI	1E				Pipeline sxsupi
EPI	EPI	1E				Pipeline sxspi
EPI2	EPI2	1E				Pipeline sxspi
PI	PI	1J	-16384/ 32768		-32768	Pipeline sxspi
STATUS	STATUS	16X				Pipeline sxsflagpix
PROC_STATUS	PROC_STATUS	32X				Pre/Pipeline

4) FFF PIXEL WFRB

The header keywords are from table 4a1, 4b1, 4b2, but the keywords RA_PNT, DEC_PNT, ABERRAT, FOLOWSUN, OPTzzzX, OPTzzzY (color coded orange) are omitted, and the keywords GATEVALV, MXSONOFF and MXSTYPE listed in table 8.

Table 12

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe
L32TI	1J		2147483648		Pre-pipe
CATEGORY	1B				Pre-pipe
ADU_CNT	1B				Pre-pipe
PSP_ID	1B				Pre-pipe calculated
FORMAT_VER	1B				Pre-pipe
WFRB_WRITE_LP	1J				Pre-pipe
WFRB_SAMPLE_CNT	1J		2147483648		Pre-pipe
NUM_WFRB_DATA	1J		2147483648		Pre-pipe
FLG_PARITY_ERR	1X				Pre-pipe
TRIG_LP	1J			2147483647	Pre-pipe
IPIX	1B	0/ 17		31	Pre-pipe
PIXEL	1B	0/ 35		63	Pre-pipe calculated

LAP_LSB	1B				
VALID_LP	1J				
ADC_SAMPLE	2048I				Pre-pipe
DERIVATIVE	2048I				Pre-pipe calculated
SAMPLECNT	1D				Pre-pipe
PROC_STATUS	32X				Pre/Pipeline

5) FFF Antico Normal

The header keywords are from table 4a1, 4b1, 4b2 but the keywords RA_PNT, DEC_PNT, ABERRAT, FOLOWSUN, OPTzzzX, OPTzzzY (color coded orange) are omitted.

Table 13

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe
L32TI	1J		2147483648		Pre-pipe
CATEGORY	1B				Pre-pipe
ADU_CNT	1B				Pre-pipe
PSP_ID	1B				Pre-pipe calculated
FORMAT_VER	1B				Pre-pipe
WFRB_WRITE_LP	1J				Pre-pipe
WFRB_SAMPLE_CNT	1J		2147483648		Pre-pipe
NUM_ELEM	1B	0/255			Pre-pipe
SUM_LOST_CNT	1J				Pre-pipe
ADC_SAMPLE_PEDESTAL	1I	-8192/8191			Pre-pipe
AC_ITYPE	1B	0/3			Pre-pipe
AC_TYPE	2A				Pre-pipe calculated
FLG_EVENT_LOST	1X				Pre-pipe
FLG_BASELINE	1X				Pre-pipe
DURATION	1B	0/255			Pre-pipe
TRIG_LP	1J			2147483647	Pre-pipe
FLG_PARITY_ERR	1X				Pre-pipe
TRIG_LAP_LSB	1X				Pre-pipe
ADC_SAMPLE_MAX	1I	-8192/8191			Pre-pipe
EL_LOST_CNT	1J			2147483647	Pre-pipe
PHA	1I	-8192/16383		-32768	Pre-pipe
PI	1J	-8192/12200		-32768	Pre-pipe
SAMPLECNT	1D				Pre-pipe sxssamcnt
PROC_STATUS	32X				Pre/Pipeline

6) FFF Antico GTI LOST

The header keywords are from table 6a and 6e. The EXTNAME string is GTILOST.

Table 14

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre-pipe ahtime
START	1D			/'s'	Pre-pipe ahtime
STOP	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe
L32TI	1J		2147483648		Pre-pipe
CATEGORY	1B				Pre-pipe

ADU_CNT	1B				Pre-pipe
PSP_ID	1B				Pre-pipe calculated
FORMAT_VER	1B				Pre-pipe
WFRB_WRITE_LP	1J				Pre-pipe
WFRB_SAMPLE_CNT	1J		2147483648		Pre-pipe
NUM_ELEM	1B	0/255			Pre-pipe
SUM_LOST_CNT	1J				Pre-pipe
AC_ITYPE	1B	0/3			Pre-pipe
AC_ TYPE	2A				Pre-pipe calculated
FLG_EVENT_LOST	1X				Pre-pipe
EL_LOST_CNT	1J			2147483648	Pre-pipe
EL_START_LP	1J				Pre-pipe
EL_STOP_LP	1J			2147483647	Pre-pipe
SAMPLECNT1	1D				Pre-pipe sxssamcnt
SAMPLECNT2	1D				Pre-pipesxsamcnt
PROC_STATUS	32X				Pre/Pipeline

7) FFF Antico WFRB

The header keywords are from table 4a1, 4b1, 4b2 but the keywords RA_PNT, DEC_PNT, ABERRAT, FOLOWSUN, OPTzzzX, OPTzzzY (color coded orange) are omitted.

Table 15

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe
L32TI	1J		2147483648		Pre-pipe
CATEGORY	1B				Pre-pipe
ADU_CNT	1B				Pre-pipe
PSP_ID	1B				Pre-pipe calculated
FORMAT_VER	1B				Pre-pipe
WFRB_WRITE_LP	1J				Pre-pipe
WFRB_SAMPLE_CNT	1J		2147483648		Pre-pipe
NUM_WFRB_DATA	1J		2147483648		Pre-pipe
FLG_PARITY_ERR	1X				Pre-pipe
TRIG_LP	1J			2147483647	Pre-pipe
IPIX	1B	0/ 17		31	Pre-pipe
LAP_LSB	1B				Pre-pipe
VALID_LP	1J				Pre-pipe
ADC_SAMPLE	2048I				Pre-pipe
DERIVATIVE	2048I				Pre-pipe calculated
SAMPLECNT	1D				Pre-pipe
PROC_STATUS	32X				Pre/Pipeline

8) FFF Antico NOISEREC

The header keywords are from table 4a1, 4b1, 4b2 but the keywords RA_PNT, DEC_PNT, ABERRAT, FOLOWSUN, OPTzzzX, OPTzzzY (color coded orange) are omitted.

Table 16

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe

L32TI	1J		2147483648		Pre-pipe
CATEGORY	1B				Pre-pipe
ADU_CNT	1B				Pre-pipe
PSP_ID	1B				Pre-pipe
FLG_COMPRESS	1X				Pre-pipe
FLG_NOISESPC	1X				Pre-pipe
FORMAT_VER	1B				Pre-pipe
WFRB_WRITE_LP	1J				Pre-pipe
WFRB_SAMPLE_CNT	1J		2147483648		Pre-pipe
RECORD_LEN	1I				Pre-pipe
ERR_CNT	1I		32768		Pre-pipe
NOISE_CLEAN_LEN	1I		32768		Pre-Pipe
NOISE_TAIL_MARGIN	1B				Pre-pipe
EDB_PARITY_ERR	1B				Pre-pipe
EDB_SPARE	1B				Pre-pipe
EDB_IPIX	1B				Pre-pipe
EDB_TRIG_LP	1J				Pre-pipe
EXP_WORD_LEN	1I				Pre-pipe
EL_REASON	1B			255	Pre-pipe
EL_STOP_LP	1J			2147483647	Pre-pipe
ITYPE	1B	0/7			
IPIX	1B	0/18		31	Pre-pipe
TRIG_LP	1J			2147483647	Pre-pipe
QUICK_DOUBLE	1X				Pre-pipe
SLOPE_DIFFER	1X				Pre-Pipe
LO_RES_PH	1I	-8192/16383			Pre-pipe
DERIV_MAX	1I	-32768/32767			Pre-pipe
RISE_TIME	1B	0/255			Pre-pipe
TICK_SHIFT	1B	-8/7	-128		Pre-pipe
TIME_VERNIER	1B	0/15			Pre-pipe
PHA	1J	-8192/16383		-32768	Pre-pipe
FLAGS	1B				Pre-pipe
NOISEREC_MODE	1B				Pre-pipe
NOISEREC	1024I				Pre-pipe
NOISE_SEQ_CNT	1B				Pre-pipe
COMPDATA	1640B				Pre-pipe
COMP_BYTE_LEN	1I				Pre-pipe
SAMPLECNT	1D				Pre-Pipe
PROC_STATUS	32X				Pre-Pipe

9) FFF FWE
NOTE included in hk1
The header keywords are from table 5a, 5b, 5b and the values for the keywords EXTNAME and INSTRUME from table 7.

Table 17

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe ahtime
L32TI	1J		2147483648		Pre-pipe
PACKET_HEADER	20B				Pre-pipe
YYYY	1I				Pre-pipe
DDD	1I				Pre-pipe

HH	1B				Pre-pipe
MM	1B				Pre-pipe
SS	1B				Pre-pipe
US	1J				Pre-pipe
TIME_LED1_ON	1D			/'s'	Pre-pipe blank insert columns Pipeline mxstime
TIME_LED2_ON	1D			/'s'	Pre-pipe blank insert columns Pipeline mxstime
TIME_LED3_ON	1D			/'s'	Pre-pipe blank insert columns Pipeline mxstime
TIME_LED4_ON	1D			/'s'	Pre-pipe blank insert columns Pipeline mxstime
TIME_LED1_OFF	1D			/'s'	Pre-pipe blank insert columns Pipeline mxstime
TIME_LED2_OFF	1D			/'s'	Pre-pipe blank insert columns Pipeline mxstime
TIME_LED3_OFF	1D			/'s'	Pre-pipe blank insert columns Pipeline mxstime
TIME_LED4_OFF	1D			/'s'	Pre-pipe blank insert columns Pipeline mxstime
FWE_LED4_OC_STATUS	1B				Pre-pipe
FWE_LED3_OC_STATUS	1B				Pre-pipe
FWE_LED2_OC_STATUS	1B				Pre-pipe
FWE_LED1_OC_STATUS	1B				Pre-pipe
FWE_HK_REFRESH_CNT	1B				Pre-pipe
FWE_MOT1_ON_OFF	1B				Pre-pipe
FWE_MOT1_OC_STATUS	1B				Pre-pipe
FWE_DCDC1_P05_STATUS	1B				Pre-pipe
FWE_DCDC1_P15_STATUS	1B				Pre-pipe
FWE_DCDC1_N15_STATUS	1B				Pre-pipe
FWE_MOT2_ON_OFF	1B				Pre-pipe
FWE_MOT2_OC_STATUS	1B				Pre-pipe
FWE_DCDC2_P05_STATUS	1B				Pre-pipe
FWE_DCDC2_P15_STATUS	1B				Pre-pipe
FWE_DCDC2_N15_STATUS	1B				Pre-pipe
FWE_FWE_ON_OFF	1B				Pre-pipe
FWE_HV2_ON_OFF	1B				Pre-pipe
FWE_HV1_ON_OFF	1B				Pre-pipe
FWE_LED4_ON_OFF	1B				Pre-pipe
FWE_LED3_ON_OFF	1B				Pre-pipe
FWE_LED2_ON_OFF	1B				Pre-pipe
FWE_LED1_ON_OFF	1B				Pre-pipe
FWE_DBL_TORQUE_ENA_DIS	1B				Pre-pipe
FWE_MOT2_ENA_DIS	1B				Pre-pipe
FWE_MOT1_ENA_DIS	1B				Pre-pipe
FWE_HV2_SW_ENA_DIS	1B				Pre-pipe
FWE_HV1_SW_ENA_DIS	1B				Pre-pipe
FWE_DCDC2_SW_ENA_DIS	1B				Pre-pipe
FWE_DCDC1_SW_ENA_DIS	1B				Pre-pipe
FWE_FPGA_VERSION	1B				Pre-pipe
FWE_SPW_RECONNECT_CNT	1B				Pre-pipe

FWE_LAST_CMD_ID	1I				Pre-pipe
FWE_LAST_CMD_PAR	1I		32768		Pre-pipe
FWE_LAST_CMD_STATUS	1B				Pre-pipe
FWE_CMD_RCV_CNT	1B				Pre-pipe
FWE_CMD_REJ_CNT	1B				Pre-pipe
FWE_TI_DIST_GEN_CNT	1B				Pre-pipe
FWE_TIMECODE_GEN_CNT	1B				Pre-pipe
FWE_RMAP_REJ_CNT	1B				Pre-pipe
FWE_T_MOT_SUPPLY1	1I		32768		Pre-pipe
FWE_T_MOT_SUPPLY1_CAL	1E			/'degC'	Pre-pipe calculated
FWE_TI_FPGA	1I		32768		Pre-pipe
FWE_TI_FPGA_CAL	1E			/'degC'	Pre-pipe calculated
FWE_V1_FPGA_3_3	1B				Pre-pipe
FWE_V1_FPGA_3_3_CAL	1E			/'V'	Pre-pipe calculated
FWE_V1_FPGA_1_5	1B				Pre-pipe
FWE_V1_FPGA_1_5_CAL	1E			/'V'	Pre-pipe calculated
FWE_T_MOT_SUPPLY2	1I		32768		Pre-pipe
FWE_T_MOT_SUPPLY2_CAL	1E			/'degC'	Pre-pipe calculated
FWE_T2_FPGA	1I		32768		Pre-pipe
FWE_T2_FPGA_CAL	1E			/'degC'	Pre-pipe calculated
FWE_V2_FPGA_3_3	1B				Pre-pipe
FWE_V2_FPGA_3_3_CAL	1E			/'V'	Pre-pipe calculated
FWE_V2_FPGA_1_5	1B				Pre-pipe
FWE_V2_FPGA_1_5_CAL	1E			/'V'	Pre-pipe calculated
FWE_FW_POSITION1	1I		32768		Pre-pipe
FWE_FW_POSITION1_CAL	1E			/'deg'	Pre-pipe calculated
FWE_MOT1_ROTATING	1B				Pre-pipe
FWE_MOT1_ROT_CW_CCW	1B				Pre-pipe
FWE_T_MOT1	1I		32768		Pre-pipe
FWE_T_MOT1_CAL	1E			/'degC'	Pre-pipe calculated
FWE_I_MOT1A	1I		32768		Pre-pipe
FWE_I_MOT1A_CAL	1E			/'mA'	Pre-pipe calculated
FWE_I_MOT1B	1I		32768		Pre-pipe
FWE_I_MOT1B_CAL	1E			/'mA'	Pre-pipe calculated
FWE_V_MOT1	1I		32768		Pre-pipe
FWE_V_MOT1_CAL	1E			/'V'	Pre-pipe calculated
FWE_NSTEP_CW_MOT1	1I		32768		Pre-pipe
FWE_NSTEP_CW_MOT1_CAL	1E			/'deg'	Pre-pipe calculated
FWE_NSTEP_CCW_MOT1	1I		32768		Pre-pipe
FWE_NSTEP_CCW_MOT1_CAL	1E			/'deg'	Pre-pipe calculated
FWE_FW_POSITION2	1I		32768		Pre-pipe
FWE_FW_POSITION2_CAL	1E			/'deg'	Pre-pipe calculated
FWE_MOT2_ROTATING	1B				Pre-pipe
FWE_MOT2_ROT_CW_CCW	1B				Pre-pipe
FWE_T_MOT2	1I		32768		Pre-pipe
FWE_T_MOT2_CAL	1E			/'degC'	Pre-pipe calculated
FWE_I_MOT2A	1I		32768		Pre-pipe
FWE_I_MOT2A_CAL	1E			/'mA'	Pre-pipe calculated
FWE_I_MOT2B	1I		32768		Pre-pipe
FWE_I_MOT2B_CAL	1E			/'mA'	Pre-pipe calculated
FWE_V_MOT2	1I		32768		Pre-pipe
FWE_V_MOT2_CAL	1E			/'V'	Pre-pipe calculated
FWE_NSTEP_CW_MOT2	1I		32768		Pre-pipe
FWE_NSTEP_CW_MOT2_CAL	1E			/'deg'	Pre-pipe calculated
FWE_NSTEP_CCW_MOT2	1I		32768		Pre-pipe
FWE_NSTEP_CCW_MOT2_CAL	1E			/'deg'	Pre-pipe calculated
FWE_DCDC1_P05_V	1B				Pre-pipe
FWE_DCDC1_P05_V_CAL	1E			/'V'	Pre-pipe calculated

FWE_DCDC1_P15_V	1B				Pre-pipe
FWE_DCDC1_P15_V_CAL	1E			/'V'	Pre-pipe calculated
FWE_DCDC1_N15_V	1B				Pre-pipe
FWE_DCDC1_N15_V_CAL	1E			/'V'	Pre-pipe calculated
FWE_DCDC2_P05_V	1B				Pre-pipe
FWE_DCDC2_P05_V_CAL	1E			/'V'	Pre-pipe calculated
FWE_DCDC2_P15_V	1B				Pre-pipe
FWE_DCDC2_P15_V_CAL	1E			/'V'	Pre-pipe calculated
FWE_DCDC2_N15_V	1B				Pre-pipe
FWE_DCDC2_N15_V_CAL	1E			/'V'	Pre-pipe calculated
FWE_HV1_LEVEL	1B				Pre-pipe
FWE_HV2_LEVEL	1B				Pre-pipe
FWE_V_IN_HV1	1B				Pre-pipe
FWE_V_IN_HV1_CAL	1E			/'V'	Pre-pipe calculated
FWE_I_IN_HV1	1B				Pre-pipe
FWE_I_IN_HV1_CAL	1E			/'mA'	Pre-pipe calculated
FWE_V_IN_HV2	1B				Pre-pipe
FWE_V_IN_HV2_CAL	1E			/'V'	Pre-pipe calculated
FWE_I_IN_HV2	1B				Pre-pipe
FWE_I_IN_HV2_CAL	1E			/'mA'	Pre-pipe calculated
FWE_TI_LED1_ON	1K				Pre-pipe
FWE_TI_LED1_OFF	1K				Pre-pipe
FWE_I_LED1_SET	1I		32768		Pre-pipe
FWE_I_LED1_SET_CAL	1E			/'mA'	Pre-pipe calculated
FWE_I_LED1	1I		32768		Pre-pipe
FWE_I_LED1_CAL	1E			/'mA'	Pre-pipe calculated
FWE_V_LED1	1I		32768		Pre-pipe
FWE_V_LED1_CAL	1E			/'V'	Pre-pipe calculated
FWE_T_LED1	1I		32768		Pre-pipe
FWE_T_LED1_CAL	1E			/'degC'	Pre-pipe calculated
FWE_LED1_PLS_LEN	1B				Pre-pipe
FWE_LED1_PLS_LEN_CAL	1E			/'ms'	Pre-pipe calculated
FWE_LED1_PLS_SPC	1B				Pre-pipe
FWE_LED1_PLS_SPC_CAL	1E			/'ms'	Pre-pipe calculated
FWE_TI_LED2_ON	1K				Pre-pipe
FWE_TI_LED2_OFF	1K				Pre-pipe
FWE_I_LED2_SET	1I		32768		Pre-pipe
FWE_I_LED2_SET_CAL	1E			/'mA'	Pre-pipe calculated
FWE_I_LED2	1I		32768		Pre-pipe
FWE_I_LED2_CAL	1E			/'mA'	Pre-pipe calculated
FWE_V_LED2	1I		32768		Pre-pipe
FWE_V_LED2_CAL	1E			/'V'	Pre-pipe calculated
FWE_T_LED2	1I		32768		Pre-pipe
FWE_T_LED2_CAL	1E			/'degC'	Pre-pipe calculated
FWE_LED2_PLS_LEN	1B				Pre-pipe
FWE_LED2_PLS_LEN_CAL	1E			/'ms'	Pre-pipe calculated
FWE_LED2_PLS_SPC	1B				Pre-pipe
FWE_LED2_PLS_SPC_CAL	1E			/'ms'	Pre-pipe calculated
FWE_TI_LED3_ON	1K				Pre-pipe
FWE_TI_LED3_OFF	1K				Pre-pipe
FWE_I_LED3_SET	1I		32768		Pre-pipe
FWE_I_LED3_SET_CAL	1E			/'mA'	Pre-pipe calculated
FWE_I_LED3	1I		32768		Pre-pipe
FWE_I_LED3_CAL	1E			/'mA'	Pre-pipe calculated
FWE_V_LED3	1I		32768		Pre-pipe
FWE_V_LED3_CAL	1E			/'V'	Pre-pipe calculated
FWE_T_LED3	1I		32768		Pre-pipe
FWE_T_LED3_CAL	1E			/'degC'	Pre-pipe calculated

FWE_LED3_PLS_LEN	1B				Pre-pipe
FWE_LED3_PLS_LEN_CAL	1E			/'ms'	Pre-pipe calculated
FWE_LED3_PLS_SPC	1B				Pre-pipe
FWE_LED3_PLS_SPC_CAL	1E			/'ms'	Pre-pipe calculated
FWE_TI_LED4_ON	1K				Pre-pipe
FWE_TI_LED4_OFF	1K				Pre-pipe
FWE_I_LED4_SET	1I		32768		Pre-pipe
FWE_I_LED4_SET_CAL	1E			/'mA'	Pre-pipe calculated
FWE_I_LED4	1I		32768		Pre-pipe
FWE_I_LED4_CAL	1E			/'mA'	Pre-pipe calculated
FWE_V_LED4	1I		32768		Pre-pipe
FWE_V_LED4_CAL	1E			/'V'	Pre-pipe calculated
FWE_T_LED4	1I		32768		Pre-pipe
FWE_T_LED4_CAL	1E			/'degC'	Pre-pipe calculated
FWE_LED4_PLS_LEN	1B				Pre-pipe
FWE_LED4_PLS_LEN_CAL	1E			/'ms'	Pre-pipe calculated
FWE_LED4_PLS_SPC	1B				Pre-pipe
FWE_LED4_PLS_SPC_CAL	1E			/'ms'	Pre-pipe calculated
PROC_STATUS	32X				Pre-Pipe

4 SXI science data

The science SXI telemetry arrives in three different packets: exposure, 3x3 and 5x5. The exposure and 3x3 are high priority, the 5x5 are lower priority. The 3x3 and 5x5 contains the event data. At the FFF stage the data are organized into two files: the exposure file and the event file. The exposure file contains all the exposure packets and the event file contains all the 3x3 and 5x5 packet. Each packet contains information for a single segment. The exposure therefore has one row for each segment. The event files have both the 3x3 and 5x5 data and software creates columns to combine information from the 3x3 and 5x5.
The SXI occasionally uses also diagnostic modes that are telemetered in the RFRAME, IFRAME and the DFRAME (R, I Image, D Dark frame modes). These packets are also recorded in the exposure file.
Many parameters used to calibrate the data are stored in the exposure file and report the instrument setting that do not vary with events. These parameters are stored in a configuration file containing all 'allowed" combination and are used in the pre-pipeline to divide the data taken with different parameter setting and their values is stored in the event file as header keywords. The list of keywords derived from these parameters setting are:

Table 18 EVENT FFF keywords

Keyword	Value	Comment	Coming From
Timing			
TIMEDEL	xxxx.xxx	/ Data time resolution	Configuration table
TIMTRANB	xxxx.xxx	/ [s]Transfer time before exposure	Configuration table
TIMTRANA	xxxx.xxx	/ [s]Transfer time after exposure	Configuration table
EXPDEADB	xxxx.xxx	/ [s] Deadtime before exposure	Configuration table
EXPDEADA	xxxx.xxx	/ [s] Deadtime after exposure	Configuration table
FLUSHIMB	xxxx.xxx	/ [s] Flush out time	Configuration table
LASTDEAD	xxxx.xxx	/ [s] Last Deadtime after exposure	Configuration table
LASTDEL	xxxx.xxx	/[s] Last Integration time in exposure	Configuration table

NOMEXPO	4	/ [s] period of seq start time	Instrument design
TIMEPIXR	0.0	/ Bintime start=0 middle=0.5 end=1	
Mode			
DATAMODE	WINDOW1 WINDOW2 WINDOW1BURST WINDOW2BURST	/datamode full window /datamode 1/8 window /datamode burst full window /datamode burst 1/8 window	Configuration table
WINOPT	x	/Window option 0=off 1=on	Configuration table
WIN_ST	x	/[pixel] Window start ACT	Configuration table
WIN_SIZE	x	/[pixel] Window size ACT	Configuration table
CCDSIZE	640	/[pixel] Size of 1 ccd	Instrument design
DETNAM	CCD	/DETNAM for full window 4chips	
*note if < full window two files are created one with DETNAM CCD12 with the window set, eg DATAMODE window2 or window2burst; a second with DETNAM CCD23 run in full window DATAMODE window1 or window1burst			
DETNAM	CCD12 / CCD34	/DETNAME < full window	
DATACLAS	'xxxxxxxxxx'	/Code to ID all instrument settings	
Threshold			
EVENTTHR	(xx,xx,xx,xx,xx,xx,xx,xx)	/[adu] event threshold 8 segm	Configuration table
SPTHIN	(xx,xx,xx,xx,xx,xx,xx,xx)	/[adu] split inner threshold 8 segm	Configuration table
SPTHOUT	(xx,xx,xx,xx,xx,xx,xx,xx)	/[adu] split outer threshold 8 segm	Configuration table
HOTPIXTH	(xx,xx,xx,xx,xx,xx,xx,xx)	/[adu] hotpix threshold 8 segm	Configuration table
HOCSUMSK	(yy,yy,yy,yy,yy,yy,yy,yy)	/[adu] hocsum threshold 8 segm	Configuration table
IFOFFSET	(xx,xx,xx,xx,xx,xx,xx,xx)	/[adu] ifoffset 8 segm	Configuration table
DARKLOW	(xx,xx,xx,xx,xx,xx,xx,xx)	/[adu] dark up threshold 8 segm	Configuration table
DARKUPP	(yy,yy,yy,yy,yy,yy,yy,yy)	/[adu] dark up threshold 8 segm	Configuration table
ACTVNODE	(x,x,x,x,x,x,x,x)	/active node	Configuration table
CnSmARON	(x,x,x,x,x)	/area discriminator on/off	Configuration table
CnSmARIN	(xxx,yyy,zzz,hhh)	/area discriminator in area	Configuration table
CnSmAROU	(xxx,xxx,xxx,xxx,yyy,yyy,yyy,yyy,zzz,zzz,zzz,zzz,hhh,hhh,hhh,hhh)	/area discriminator off area	Configuration table
Charge Inject			
CISTATUS	x	/Charge inject 1=on/ 0=off	Configuration table
CIPERIOD	xx	/Change inject spacing	Configuration table
CIOFFSET	xx	/Offset from the 1st (delta ACTY)	Configuration table
CIFIRST	x	/First injected row ACTY	Configuration table
Hardware			
HUCLEGTH	(xxx,xxx,xxx,xxx,yyy,yyy,yyy,yyy)	length of horizontal underclock region	Exposure frame
VUCHEGHT	(xxx,xxx,xxx,xxx,yyy,yyy,y	height of vertical underclock	Exposure frame

	yy,yyy)	region	
IMGHEGHT	(xxx,xxx,xxx,xxx,yyy,yyy,yyy,yyy)	height of imaging area	Exposure frame

The hardware keywords HUC/VUC/IMG HEIGHT contains 8 values defined by the telemetered value of CCD_ID and segment number provided as AB , or CD. The values in the keywords correspond to: ccd0-segAB, ccd0-segCD, ccd1-segAB, ccd1-segCD, , ccd2-segAB, ccd2-segCD, ccd4-segAB, ccd3-segCD. These values come from the Exposure frame and they should be constant across an observation. The ACTVNODE keyword also contains 8 numbers as described above, 2 numbers for each CCD. Their allowed values is 0 for A or D node , 1 for B or C node.
The string 'NA' is used to indicate "not applicable" in any keywords that list values for segment. If the area discriminator is set in the window mode the height is always 640. CnSmARON the keyword has 5 values representing the first the area in (1 set 0 unset) and 4 are to see if the out is set where n ranges between 1-4 (number of CCD) and m between 1-8 (number of segments). CnSmARIN contains 4 values representing the rawxstart rawxend rawystart rawyend of the corners and their value is set to -1 if not set. CnSmAROU is populated with 16 numbers 4 ID each area as for the inner. The area discriminator keywords are in raw coordinates and if set -1 the coordinates are not set so the area is not set.

1) FFF Event
The header keywords are from table 4a1, 4b1, 4b2, 4c, but for the keyword FILTER that is omitted. The header contains also the keywords listed in table 18.

Table 19

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre-pipe ahtime
S_TIME5X5	1D			/'s'	Pre-pipe
S_TIME	1D			/'s'	Pre-pipe
ADU_CNT	1B				Pre-pipe
ADU_CNT5X5	1B				Pre-pipe
CATEGORY	1B				Pre-pipe
CATEGORY5X5	1B				Pre-pipe
L32TI	1J		2147483648		Pre-pipe
L32TI5X5	1J		2147483648		Pre-pipe
SEQSTARTTIME	1J		2147483648		Pre-pipe
SEQSTART_TLM	1J		2147483648		Pre-pipe
CCD_ID	1B	0/ 3		255	Pre-pipe
CCD_NAME	8A				Pre-pipe
SEGMENT	1B	0/ 1		255	Pre-pipe
EVENTNUMBER	1I		32768	32767	Pre-pipe
EVENTNUMBER5X5	1I		32768	32767	Pre-pipe
READNODE	1B	0/ 1		255	Pre-Pipe
ADCAVE	1B			255	Pre-Pipe
RAWX	1I	0/ 319		-1	Pre-pipe
RAWY	1I	0/ 639		-1	Pre-pipe
PHAS_INNER3X3	9I			-32768	Pre-pipe
P_OUTER_MOST	1I			-1	Pre-pipe
SUM_OUTER_MOST	1I			-32768	Pre-pipe
PHAS_OUTER5X5	16I			-32768	Pre-pipe

ACTX	1I	1/ 640		-1	Pipeline coordevt
ACTY	1I	1/ 640		-1	Pipeline coordevt
DETX	1I	1/ 1810		-1	Pipeline coordevt
DETY	1I	1/ 1810		-1	Pipeline coordevt
FOCX	1I	1/ 1810		-1	Pipeline coordevt
FOCY	1I	1/ 1810		-1	Pipeline coordevt
X	1I	1/ 1810		-1	Pipeline coordevt
Y	1I	1/ 1810		-1	Pipeline coordevt
PHAS	9I			-32768	Pipeline sxiphas
PHAS_MASK	9B				Pipeline sxibadpix
PHASALL	25I			-32768	Pipeline sxiphas
PHA	1I	0/ 4095		4096	Pipeline sxipi
PI	1I	0/ 4095		4096	Pipeline sxipi
GRADE	1I			-1	Pipeline sxipi
STATUS	48X				Pipeline sxiflagpix
PROC_STATUS	32X				Pre/Pipeline

2) FFF exposure

The header keywords are from table 4a1, 4b1, 4b2, but the keywords FILTER. RA_PNT, DEC_PNT, ABERRAT, FOLOWSUN, OPTzzzX, OPTzzzY, ONTIME, EXPOSURE (color coded orange) are omitted.

Table 20

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe
ADU_CNT	1B				Pre-pipe
CATEGORY	1B				Pre-pipe
L32TI	1J		2147483648		Pre-pipe
SEQSTARTTIME	1J		2147483648		Pre-pipe
CCD_ID	1B	0/ 3		255	Pre-pipe
SEGMENT	1B	0/ 1		255	Pre-pipe
EVENTNUMBER	1I		32768	32767	Pre-pipe
REJOVERULD	1I		32768	32767	Pre-pipe
REJUNDERLLD	1I		32768	32767	Pre-pipe
REJARDISC	1I		32768	32767	Pre-pipe
REJSURDISC	1I		32768	32767	Pre-pipe
REJLOCALDISC	1I		32768	32767	Pre-pipe
COMPFLAG	1B			255	Pre-pipe
CCDPRIORITY	1B			255	Pre-pipe
SEGPRIORITY	1B			255	Pre-pipe
DETECTSEG	1B			255	Pre-pipe
ENA3X3PROC	1X				Pre-pipe
ENA5X5PROC	1X				Pre-pipe
ADINENA	1X				Pre-pipe
ADOU0ENA	1X				Pre-Pipe
ADOU1ENA	1X				Pre-Pipe
ADOU2ENA	1X				Pre-Pipe
ADOU3ENA	1X				Pre-Pipe
SURDISCENA	1X				Pre-Pipe
LOCALDISCENA	1X				Pre-Pipe
X0_ADIN	1I		32768	32767	Pre-Pipe
X1_ADIN	1I		32768	32767	Pre-Pipe
Y0_ADIN	1I		32768	32767	Pre-Pipe

Y1_ADIN	1I		32768	32767	Pre-Pipe
X0_0_ADOUT	1I		32768	32767	Pre-Pipe
X1_0_ADOUT	1I		32768	32767	Pre-Pipe
Y0_0_ADOUT	1I		32768	32767	Pre-Pipe
Y1_0_ADOUT	1I		32768	32767	Pre-Pipe
X0_1_ADOUT	1I		32768	32767	Pre-Pipe
X1_1_ADOUT	1I		32768	32767	Pre-Pipe
Y0_1_ADOUT	1I		32768	32767	Pre-Pipe
Y1_1_ADOUT	1I		32768	32767	Pre-Pipe
X0_2_ADOUT	1I		32768	32767	Pre-Pipe
X1_2_ADOUT	1I		32768	32767	Pre-Pipe
Y0_2_ADOUT	1I		32768	32767	Pre-Pipe
Y1_2_ADOUT	1I		32768	32767	Pre-Pipe
X0_3_ADOUT	1I		32768	32767	Pre-Pipe
X1_3_ADOUT	1I		32768	32767	Pre-Pipe
Y0_3_ADOUT	1I		32768	32767	Pre-Pipe
Y1_3_ADOUT	1I		32768	32767	Pre-Pipe
SURTH	1I		32768	32767	Pre-pipe
NPIX_SURTH	1I		32768	32767	Pre-pipe
EVTH_LOWER	1I		32768	32767	Pre-pipe
EVTH_UPPER	1I		32768	32767	Pre-pipe
OUTER_SPLIT_TH	1I		32768	32767	Pre-pipe
UCODE_ID	1J		2147483648	2147483647	Pre-pipe
TRANSLINELENGTH	1J		2147483648	2147483647	Pre-pipe
IMGLINELENGTH	1J		2147483648	2147483647	Pre-pipe
HOCLINELENGTH	1J		2147483648	2147483647	Pre-pipe
HUCLINELENGTH	1J		2147483648	2147483647	Pre-pipe
IMAGEHEIGHT	1J		2147483648	2147483647	Pre-pipe
VOCHEIGHT	1J		2147483648	2147483647	Pre-pipe
VUCHEIGHT	1J		2147483648	2147483647	Pre-pipe
TRANSFERDIR	1B			255	Pre-pipe
ADC_ID	1J		2147483648	2147483647	Pre-pipe
ADC_CHAN	1J		2147483648	2147483647	Pre-pipe
DATACLASS	1J		2147483648	2147483647	Pre-pipe
DUPDATE	1J		2147483648	2147483647	Pre-pipe
DUPDATESTARTTIME	1J		2147483648	2147483647	Pre-pipe
LLDEVTCAND	1I		32768	32767	Pre-pipe
ULDEVTCAND	1I		32768	32767	Pre-pipe
ULDPIXNUM	1I		32768	32767	Pre-pipe
LDPIXNUM	1I		32768	32767	Pre-pipe
IFRAME_OFFSET	1J		2147483648	2147483647	Pre-pipe
HOCSUMNUM	1J		2147483648	2147483647	Pre-pipe
NUMEVTCAND	1J		2147483648	2147483647	Pre-pipe
LENEVTCAND	1J		2147483648	2147483647	Pre-pipe
NUMHOTPIX	1J		2147483648	2147483647	Pre-pipe
LENHOTPIX	1J		2147483648	2147483647	Pre-pipe
SANITY	1J				Pre-pipe
FRAMENUM	1J				Pre-pipe
FRAMETYPE	1I				Pre-pipe
DETNAM	8A				Pre-pipe
DATAMODE	!6A				Pre-pipe
PROC_STATUS	32X				Pre-pipe

3) FFF DFRAME

The header keywords are from table 4a1, 4b1, 4b2, but the keywords FILTER. RA_PNT, DEC_PNT, ABERRAT, FOLOWSUN, OPTzzzX, OPTzzzY, ONTIME, EXPOSURE (color coded orange) are omitted.

Table 21a					
Column name	**type**	**TLMIN/ TLMAX**	**TZERO/ TSCAL**	**TNULL/ TUNIT**	**Comment**
TIME	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe
ADU_CNT	1B				Pre-pipe
CATEGORY	1B				Pre-pipe
L32TI	1J		2147483648		Pre-pipe
SEQSTARTTIME	1J		2147483648		Pre-pipe
CCD_ID	1B	0/ 3		255	Pre-pipe
????					
SEGMENT	1B	0/ 1		255	Pre-pipe
READNODE	1B	0/ 1		255	Pre-Pipe
ADCAVE	1B			255	Pre-Pipe
PIXELPH	nnI		32768		Pre-pipe
PROC_STATUS	32X				Pre/Pipeline
IMAGE 21b					
N Image extension: one for each row of the BINTable					

4) FFF RFRAME/IFRAME

The header keywords are from table 4a1, 4b1, 4b2, but the keywords FILTER. RA_PNT, DEC_PNT, ABERRAT, FOLOWSUN, OPTzzzX, OPTzzzY, ONTIME, EXPOSURE (color coded orange) are omitted.

Table 22a					
Column name	**type**	**TLMIN/ TLMAX**	**TZERO/ TSCAL**	**TNULL/ TUNIT**	**Comment**
TIME	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe
ADU_CNT	1B				Pre-pipe
CATEGORY	1B				Pre-pipe
L32TI	1J		2147483648		Pre-pipe
SEQSTARTTIME	1J		2147483648		Pre-pipe
CCD_ID	1B	0/ 3		255	Pre-pipe
SEGMENT	1B	0/ 1		255	Pre-pipe
READNODE	1B	0/ 1		255	Pre-Pipe
ADCAVE	1B			255	Pre-Pipe
PIXELPH	nnI		32768		Pre-pipe
PCODE	nnB				Pre-pipe
PROC_STATUS	32X				Pre/Pipeline
IMAGE 22b					
N Image extension : one for each row of the BINTable					

5) FFF Hotpixel list derived from the DFRAME

The header keywords are from table 4a1, 4b1, 4b2, but the keywords FILTER. RA_PNT, DEC_PNT, ABERRAT, FOLOWSUN, OPTzzzX, OPTzzzY, ONTIME, EXPOSURE (color coded orange) are omitted.

Additional keywords are DATACLAS, WINOPT, WIN_ST,WIN_SIZE, CCDSIZE (NOTE the header keyword should allow to make work coordevt).

Table 23					
Column name	**type**	**TLMIN/ TLMAX**	**TZERO/ TSCAL**	**TNULL/ TUNIT**	**Comment**
TIME	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe
L32TI	1J		2147483648		Pre-pipe
SEQSTARTTIME	1J		2147483648		Pre-pipe
CCD_ID	1B	0/ 3		255	Pre-pipe
SEGMENT	1B	0/ 1		255	Pre-pipe
READNODE	1B	0/ 1		255	Pre-Pipe
RAWX	1I	0/ 319		-1	Pre-pipe
RAWX	1I	0/ 639		-1	Pre-pipe
ACTX	1I	1/ 640		-1	Pipeline coordevt
ACTY	1I	1/ 640		-1	Pipeline coordevt
DETX	1I	1/ 1810		-1	Pipeline coordevt
DETY	1I	1/ 1810		-1	Pipeline coordevt
YEXTEND	1I				Pre-pipe
PROC_STATUS	32X				Pre/Pipeline

5 HXI & SGD science data

The HXI (1&2) and the SGD (1&2) have a similar telemetry format and include different data type science and diagnostic mode. The diagnostic mode common for the HXI and SGD are: PSUEDO, CALMODE, READALL. These are signals send into the electronics when data are processed. Therefore these diagnostic mode events are not "detected" by the instruments. The HXI has also internally a calibration source which signal instead is "detected" by the instrument. All these different data type are stored together with the signal from the celestial sources in a single event file at the FFF stage. The pre-pipeline therefore creates two files for the HXI (one for the HXI1 and one for the HXI2) and 6 for the SGD (3 for the SGD1 one of each of the Compton Camera, CC1, CC2, CC3 and similarly 3 for the SGD2).
At the FFF stage the DATAMODE keyword is set to CAMERA_NORMALn for the HXIs and to CCm_NORMALn for the SGDs (m=1,2,3), where n indicate a different setting across the mission. The keyword DETNAM is set to CAMERA for the HXIs and to CCn for the SGDs. After reconstruction or expansion at the cleaning stage the data are divided and the keywords DATAMODE is assigned to distinguish between the different data type. Listed here are the different datamodes but the selection description is not complete:

- CALMODE. The flag for the HXI is not stored in the event but in the HK (USER_HK DE_MODE 0=standby,1=obs,2=calmode). For the SGD the CALMODE flag is a column because is in the telemetry and if that need to be maintained should not be removed.
- AM241. The HXI flag is in one of the bit of the FLAG_HITPAT (HPAT2)
- PSEUDO. For HXI & SGD PSEUDO event flags are in the column FLAG_TRIG. For HXI is bit 7 , for SGD is bit 29
- READALL. For HXI & SGD events the flag to divide the data is in the column FLAG_TRIG. FOR HXI is bit 6 and for SGD is 28
- NORMAL mode is when the instrument detects signals from celestial sources and background sources. This mode is run with specific energy threshold pre-decided before operations. To identify different thresholds a number is adding to NORMAL,

e.g. NORMALn. CALDB are updated every time a new threshold is defined, and depending on the NORMALn, different CALDB values are used for the energy calibration. The threshold information is commanded and no stored in the telemetry. The pre-pipeline has to read the ODB to get updated when new threshold is commanded to assign the DATAMODE keyword.. NOTE : the data in the NORMAL mode contains all data coming from H M L priority partition in the telemetry. The M and L telemetry data are either events below threshold or BGO events.

Before launch, DATAMODE is set to CCm_NORMAL1 and CAMERA_NORMAL1 and is kept until the fisrt calibration post launch is delivered. In the check out phase the DATAMODE may be set to <int>_CHECKOUTn, the pipeline checks if datamode is different from "NORMAL" and force to use in hxisgdpha the paramager datamode = <int>_NORMAL1. This test is removed in the pipeline after the correct caldb file is delivered containing all the DATAMODE tested in the checkout phase so that when the data are reprocessed the correct DATAMODE is used.

All HXI and SGD files that are not HK should have a HEADER keyword to contain the frequency of when the pseudo events are injected. PSUEDOHZ the value is HZ.

The HXI and SGD data contains several flags. The meaning of the flag is the following:

HXI Flag	**Description**
FLAGS (32)	Contains the information described in the following 6 columns below. This is the content in the original telemetry.
FLAG_SEU (5)	Description: 0 is ok, If different from 0 means that one or more layers have trouble. Single event upset occurred (1) or not (0) SEU5: CdTe-DSD layer, SEU4: 4th DSSD layer, SEU3: 3rd DSSD layer, SEU2: 2nd DSSD layer, SEU1: top DSSD layer
FLAG_LCHK (5)	Description: 0 is ok, If different from 0 means that one or more layers have trouble. Acquired data size is different from the expected data size. LCHK5: CdTe-DSD layer, LCHK4: 4th DSSD layer, LCHK3: 3rd DSSD layer, LCHK2: 2nd DSSD layer, LCHK1: top DSSD layer
FLAG_TRIG (8)	Description: There are 8 bit to start data acquisition or a combination of them. Which layer or cal or pseudo or forced (readall) occurred first. If set to 1 that bit starts the data acquisition. More than one bit can be up at any time. TRG8: Trigger from calibration mode, TRG7: Pseudo trigger, TRG6: Forced trigger (READALL),TRG5: Trigger from CdTe-DSD layer, TRG4: 4th DSSD layer, TRG3: 3rd DSSD layer, TRG2: 2nd DSSD layer, TRG1: 1st DSSD layer
FLAG_TRIGPAT (8)	Description: Bit that issues the trigger during data acquisition. Which layer or cal or pseudo or forced (readall) is up within 0.6 microsec. If set to 1 that bit is part of the trigger pattern. More than one bit can be up at any time. TRGPAT8: From calibration mode, TRGPAT7: Pseudo trigger, TRGPAT6: Forced trigger, TRGPAT5: From CdTe-DSD layer, TRGPAT4: 4th DSSD layer, TRGPAT3: 3rd DSSD layer, TRGPAT2: 2nd DSSD layer, TRGPAT1: top DSSD layer
FLAG_HITPAT (2)	Description: BGO Shield Hit-Pattern veto signal (This is the more accuarate way to veto the signal but takes time to calculate than FBGOs). There are 13 BGO modules and they are associated to HPAT1. HPAT2 is associated to the Am241. If set to 1, the hit-pattern BGO veto the signal. Both may be up.
FLAG_FASTBGO (2)	Description: fast veto signal (FBGO) and Upper discriminator (UD) and Super Upper discriminator (SUD) signals from the BGO shield. There are 13 BGO modules. FBG01 is

	associated to the FBGO of the 13 modules. If one of the module is high the FBGO1 is 1. FBG02 is associated to the UD and SUD of the 13 modules. There are 26 signal in total if one of the signal is high the FBGO2 is 1.Both may be up.
SGD Flag	**Description**
FLAGS (64X)	Contains the information described in the following 6 columns below. This is the content in the original telemetry.
FLAG_LCHKMIO (1X)	Length error of the data received at MIO : (1) or ok (0) Received data size by MIO is different from the expected data size. (1) or ok (0).
FLAG_CCBUSY (3X)	Compton camera busy (3-bit flags 1=CC1 2=CC2 3=CC3). Flags (1: busy, 0: not) showing if the the Compton camera FPGA is busy with data processing or not.
FLAG_HITPAT_CC (3X)	Compton camera hit pattern (3-bit flags 1=CC1 2=CC2 3=CC3). Flags (1: the trigger start data acquisition , 0: not))
FLAG_HITPAT (4X)	Description: BGO Shield Hit-Pattern veto signals This is the more accuarate way to veto the signal but takes time to calculate than FBGOs). 13BGOs controlled by APMU1 output two signal lines of HPAT11 & HPAT12 to all CCs (6bgo+7bgo). 12BGOs controlled by APMU2 output two signal lines of HPAT22 & HPAT21 to all CCs (6bgo+6bgo).
FLAG_FASTBGO (4X)	Description: fast veto signal (FBGO) and Upper discriminator (UD) and Super Upper discriminator (SUD) signals from the BGO shield. There are 25 BGO modules. FBGO11 is associated to the FBGO of the 13 modules. If one of the module is high the FBGO11 is 1. FBGO12 is associated to the UD and SUD of the 13 modules. There are 26 signals in total if one of the signal is high the FBGO12 is 1.Both may be up. FBGO21 is associated to the FBGO of the 12 modules. If one of the module is high the FBGO21 is 1. FBGO22 is associated to the UD and SUD of the 12 modules. There are 24 signals in total if one of the signal is high the FBGO22 is 1.Both may be up.
FLAG_SEU (1X)	If different from 0 means than one or more ASIC of total of 208 ASIC have trouble.
FLAG_LCHK (1X)	If length error different from 0 than one or more ASIC data may be not proper. Acquired data size is different from the expected data size. (1) one or more ASIC data is not proper or ok (0).
FLAG_CALMODE (1X)	In Calibration mode (1) or not (0)
FLAG_TRIGPAT (31X)	trigger pattern during the occurrence (31-bit flags)
FLAG_TRIG (1B)	Number to describe with subsystem initiate the data acquisition If between 0-27: corresponds to 28 trays as written in TRGPAT1-28. If 28=Readall , 29=Psuedo, 30=Calibration-pulse triggers. If >=32: there are more than two simultaneous triggers initiate the occurrence

1) FFF/SFF HXI
The header keywords are from table 4a1, 4b1, 4b2, but the keyword FILTER that is omitted.
The header also contains the keyword PSUEDOHZ.

Table 24

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe
ADU_CNT	1B				Pre-pipe

L32TI	1J		2147483648		Pre-pipe
OCCURRENCE_ID	1J				Pre-pipe
LOCAL_TIME	1J		2147483648		Pre-pipe
CATEGORY	1B				Pre-pipe
FLAGS	32X				Pre-pipe
FLAG_SEU	5X				Pre-pipe
FLAG_LCHK	5X				Pre-pipe
FLAG_TRIG	8X				Pre-pipe
FLAG_TRIGPAT	8X				Pre-pipe
FLAG_HITPAT	2X				Pre-pipe
FLAG_FASTBGO	2X				Pre-pipe
LIVETIME	1J		2147483648		Pre-pipe
NUM_ASIC	1B				Pre-pipe
RAW_ASIC_DATA	1PB(2000)				Pre-pipe
PROC_STATUS	32X				Pre-pipe
STATUS	8X				Pre-pipe
ASIC_ID	1PB(40)				Pipeline hxisgdsff
ASIC_ID_RMAP	1PB(40)				Pipeline hxisgdsff
ASIC_CHIP	1PX(40)				Pipeline hxisgdsff
ASIC_TRIG	1PX(40)				Pipeline hxisgdsff
ASIC_SEU	1PX(40)				Pipeline hxisgdsff
READOUT_FLAG	1PJ(40)		2147483648		Pipeline hxisgdsff
NUM_READOUT	1PI(40)				Pipeline hxisgdsff
ASIC_REF	1PI(40)				Pipeline hxisgdsff
ASIC_CMN	1PI(40)				Pipeline hxisgdsff
READOUT_ASIC_ID	1PB(1280)				Pipeline hxisgdsff
READOUT_ID	1PB(1280)				Pipeline hxisgdsff
READOUT_ID_RMAP	1PI(1280)				Pipeline hxisgdsff
PHA	1PI(1280)				Pipeline hxisgdpha
EPI	1PE(1280)				Pipeline hxisgdpha

2) HXI SFFa

The 1st column reports the output of the reconstruction tools hxievtid. The second column reports the output of hxisgdexpand. The header has the same keywords that are in the HXI FFF/SFF.

Table 25

Reconstruction output	Expanded mode output	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	TIME	1D			/'s'	Pre-pipe ahtime
OCCURRENCE_ID	OCCURRENCE_ID	1J				Pre-pipe
CATEGORY	CATEGORY	1B				Pre-pipe
FLAG_SEU	FLAG_SEU	5X				Pre-pipe
FLAG_LCHK	FLAG_LCHK	5X				Pre-pipe
FLAG_TRIG	FLAG_TRIG	8X				Pre-pipe
FLAG_TRIGPAT	FLAG_TRIGPAT	8X				Pre-pipe
FLAG_HITPAT	FLAG_HITPAT	2X				Pre-pipe
FLAG_FASTBGO	FLAG_FASTBGO	2X				Pre-pipe
LIVETIME	LIVETIME	1J		2147483648		Pre-pipe
PROC_STATUS	PROC_STATUS	32X				Pre-pipe
STATUS	STATUS	8X				Pre-pipe
	READOUT_ID_INDEX	1I			-999/	Pipeline hxievtid
ENE_TOTAL		1E				Pipeline hxievtid
EPITOP		5E				Pipeline hxievtid
EPIBOT		5E				Pipeline hxievtid
EPICUT		5I			-999	Pipeline hxievtid
LAYER	LAYER	1B			99/	Pipeline hxievtid

PI	PI	1I	0/ 2047		-999/	Pipeline hxievtid
EVTCAT		1B				Pipeline hxievtid
RECO_STATUS	RECO_STATUS	16X				Pipeline hxievtid
SIGNAL		10I				Pipeline hxievtid
SIGPOS		10I			-1	
SIGEPI		10E				Pipeline hxievtid
GOODBAD		10I				Pipeline hxievtid
VALIDHITS		5I				Pipeline hxievtid
RAWX	RAWX	1I	1/ 128		-1	Pipeline hxievtid
RAWY	RAWY	1I	1/ 128		-1	Pipeline hxievtid
ACTX		1I	1/ 256		-1	Pipeline coordevt
ACTY		1I	1/ 256		-1	Pipeline coordevt
DETX		1I	1/ 256		-1	Pipeline coordevt
DETY		1I	1/ 256		-1	Pipeline coordevt
FOCX		1I	1/ 1810		-1	Pipeline coordevt
FOCY		1I	1/ 1810		-1	Pipeline coordevt
X		1I	1/ 1810		-1	Pipeline coordevt
Y		1I	1/ 1810		-1	Pipeline coordevt

2a) HXI SFFa calfile

This is the output of hxievtid for the calfile needed to calculate the gain (parameter outcatfile=filename). The header has the same keywords that are in the HXI FFF/SFF.

Table 26

Reconstruction output outcalfile=filename Column : AM241	**type**	**TLMIN/ TLMAX**	**TZERO/ TSCAL**	**TNULL/ TUNIT**	**Comment**
TIME	1D			/'s'	Pre-pipe ahtime
OCCURRENCE_ID	1J				Pre-pipe
CATEGORY	1B				Pre-pipe
FLAG_SEU	5X				Pre-pipe
FLAG_LCHK	5X				Pre-pipe
FLAG_TRIG	8X				Pre-pipe
FLAG_TRIGPAT	8X				Pre-pipe
FLAG_HITPAT	2X				Pre-pipe
FLAG_FASTBGO	2X				Pre-pipe
LIVETIME	1J		2147483648		Pre-pipe
PROC_STATUS	32X				Pre-pipe
STATUS	8X				Pre-pipe
ENE_TOTAL	1E				Pipeline hxievtid
LAYER	1B			99	Pipeline hxievtid
PI	1I	0/ 2047			Pipeline hxievtid
EVTCAT	1B				Pipeline hxievtid
RECO_STATUS	16X				Pipeline hxievtid
RAWX	1I	1/ 128		-1	Pipeline hxievtid
RAWY	1I	1/ 128		-1	Pipeline hxievtid
SIDE	1B				Pipeline hxievtid

3) FFF/SFF SGD

The header keywords are from table 4a1, 4b1, 4b2, but the keywords FILTER, ABERRAT, FOLOWSUN, OPTzzzX, OPTzzzY, (color coded orange) are omitted. NOTE RA_PNT DEC_PNT may be also omitted if they can not be calculated (depending of the teldef definition).

Table 27

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe
ADU_CNT	1B				Pre-pipe
L32TI	1J		2147483648		Pre-pipe
OCCURRENCE_ID	1J				Pre-pipe
LOCAL_TIME	1J		2147483648		Pre-pipe
CATEGORY	1B				Pre-pipe
FLAGS	64X				Pre-pipe
FLAG_LCHKMIO	1X				Pre-pipe
FLAG_CCBUSY	3X				Pre-pipe
FLAG_HITPAT_CC	3X				Pre-pipe
FLAG_HITPAT	4X				Pre-pipe
FLAG_FASTBGO	4X				Pre-pipe
FLAG_SEU	1X				Pre-pipe
FLAG_LCHK	1X				Pre-pipe
FLAG_CALMODE	1X				Pre-pipe
FLAG_TRIGPAT	31X				Pre-pipe
FLAG_TRIG	1B				Pre-pipe
LIVETIME	1J		2147483648		Pre-pipe
NUM_ASIC	1B				Pre-pipe
RAW_ASIC_DATA	1PB(19552)				Pre-pipe
PROC_STATUS	32X				Pre-pipe
STATUS	8X				Pre-pipe
ASIC_ID	1PI(208)				Pipeline hxisgdsff
ASIC_ID_RMAP	1PB(208)				Pipeline hxisgdsff
ASIC_CHIP	1PX(208)				Pipeline hxisgdsff
ASIC_TRIG	1PX(208)				Pipeline hxisgdsff
ASIC_SEU	1PX(208)				Pipeline hxisgdsff
READOUT_FLAG	1PK(208)				Pipeline hxisgdsff
NUM_READOUT	1PI(208)				Pipeline hxisgdsff
ASIC_REF	1PI(208)				Pipeline hxisgdsff
ASIC_CMN	1PI(208)				Pipeline hxisgdsff
READOUT_ASIC_ID	1PI(13312)				Pipeline hxisgdsff
READOUT_ID	1PB(13312)				Pipeline hxisgdsff
READOUT_ID_RMAP	1PI(13312)				Pipeline hxisgdsff
PHA	1PI(13312)				Pipeline hxisgdpha
EPI	1PE(13312)				Pipeline hxisgdpha

4) SFFa SGD

The 1st column reports the output of the reconstruction tools hxievtid. The second column reports the output of hxisgdexpand. The header has the same keywords that are in the SGD FFF/SFF.

Table 28

Reconstruction output	Expanded mode output	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	TIME	1D			/'s'	Pre-pipe ahtime
OCCURRENCE_ID	OCCURRENCE_ID	1J				Pre-pipe
CATEGORY	CATEGORY	1B				Pre-pipe
FLAG_LCHKMIO	FLAG_LCHKMIO	1X				Pre-pipe
FLAG_CCBUSY	FLAG_CCBUSY	3X				Pre-pipe
FLAG_HITPAT_CC	FLAG_HITPAT_CC	3X				Pre-pipe
FLAG_HITPAT	FLAG_HITPAT	4X				Pre-pipe
FLAG_FASTBGO	FLAG_FASTBGO	4X				Pre-pipe

FLAG_SEU	FLAG_SEU	1X				Pre-pipe
FLAG_LCHK	FLAG_LCHK	1X				Pre-pipe
FLAG_CALMODE	FLAG_CALMODE	1X				Pre-pipe
FLAG_TRIGPAT	FLAG_TRIGPAT	31X				Pre-pipe
FLAG_TRIG	FLAG_TRIG	1B				Pre-pipe
LIVETIME	LIVETIME	1J		2147483648		Pre-pipe
PROC_STATUS	PROC_STATUS	32X				Pre-pipe
STATUS	STATUS	8X				Pre-pipe
	READOUT_ID_INDEX	1I			-999/	Pipeline sgdevtid
PI	PI	1I	0/ 2047		-999/	Pipeline sgdevtid
ENE_TOTAL		1E				Pipeline sgdevtid
NUMSIGNAL		1I				Pipeline sgdevtid
NUMHITS		5X				Pipeline sgdevtid
SEQ_HITS		1I			-999/	Pipeline sgdevtid
DELCOMPTON		2E				Pipeline sgdevtid
COMPTON_TH		1E				Pipeline sgdevtid
COMPTON_PH		1E				Pipeline sgdevtid
DISTANCE0		1E				Pipeline sgdevtid
OFFAXIS		1E				Pipeline sgdevtid
CAMERAX		1E	-39/39			Pipeline sgdevtid
CAMERAY		1E	-39/39			Pipeline sgdevtid
CAMERAZ		1E	-77/3			Pipeline sgdevtid
LIKELIHOOD		1E				Pipeline sgdevtid
RECO_STATUS	RECO_STATUS	40X				Pipeline sgdevtid
MATTYPE	MATTYPE	1I	1/3		-999	Pipeline sgdevtid

6 CAMS data

The CAMS data are record 5 measurements every xx sec and telemetered as an HK file. The data are kept as telemetered in a HK format but also reformatted according with the table below where each row correspond to a single measurement. The values recorded on board are the X_RAW and Y_RAW and on ground the X and Y values are calculated based on the temperature. There is one file per each of the CAMS units and the columns are listed in table A CAMS. The CAMS files are processed to calculate the offsets and rotation in the HXI coordinates. The output is listed in Table B.

1) CAMS Event FFF/SFF

The header keywords are from table 4a1, 4b1, 4b2, but the keywords FILTER. RA_PNT, DEC_PNT, ABERRAT, FOLOWSUN, OPTzzzX, OPTzzzY, ONTIME, EXPOSURE (color coded orange) are omitted.

Table 29a : CAMS telemetered format

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe
L32TI	1J		2147483648		Pre-pipe
CATEGORY	1B				Pre-pipe
ADU_CNT	1B				Pre-pipe
DSP_UP	1B				Pre-pipe
CAL_BANK	1B				Pre-pipe
EEPROM_UNLOCKED	1B				Pre-pipe
EEPROM_PRG_DONE	1B				Pre-pipe
FW0_VALID	1B				Pre-pipe

FW1_VALID	1B				Pre-pipe
FW2_VALID	1B				Pre-pipe
FW3_VALID	1B				Pre-pipe
CAL0_VALID	1B				Pre-pipe
CAL1_VALID	1B				Pre-pipe
CAL2_VALID	1B				Pre-pipe
CAL3_VALID	1B				Pre-pipe
QUALITY	1I				Pre-pipe
IS_SAMPLING	1B				Pre-pipe
SNAPSHOT_READY	1B				Pre-pipe
DSP_SOFT_RESET	1B				Pre-pipe
MAILBOX_READY	1B				Pre-pipe
TIMECODE_GEN_FLAG	1B				Pre-pipe
EEPROM_BANK_NUM	1B				Pre-pipe
CMD_FIFO_READY	1B				Pre-pipe
ERROR_FIFO_OVF	1B				Pre-pipe
ERROR	1B				Pre-pipe
ERROR_FIFO	1B				Pre-pipe
HK_GEN_CNT	1B				Pre-pipe
HK_STATUS_READ_CNT	1B				Pre-pipe
HK_DATA_READ_CNT	1B				Pre-pipe
COMMAND_RCV_CNT	1B				Pre-pipe
COMMAND_RJT_CNT	1B				Pre-pipe
LASER_INTENSITY	1B				Pre-pipe
LASER_CURRENT	1B				Pre-pipe
THERMISTOR1	1B				Pre-pipe
THERMISTOR2	1B				Pre-pipe
THERMISTOR1_CAL	1E				Pre-pipe
THERMISTOR2_CAL	1E				Pre-pipe
X_RAW	1I			65535	Pre-pipe
X	1E				Pipeline
Y_RAW	1I			65535	Pre-pipe
Y	1E				Pipeline
TIMECODE	1B				Pre-pipe
FLAGS	1B				Pre-pipe
PROC_STATUS	32X				Pre/Pipeline

2) CAMS SFFa

The header keywords are copied from the CAMS FFF/SFF. (What is EXTNAME and HDUCLASS)

Table 29b : CAMS processed by cams2det					
Column name	**type**	**TLMIN/ TLMAX**	**TZERO/ TSCAL**	**TNULL/ TUNIT**	**Comment**
TIME	1D			/'s'	Pipeline
DELTARAWX	1D				Pipeline
DELTARAWY	1D				Pipeline
COSANGLE	1D				Pipeline
SINANGLE	1D				Pipeline
X1	1J				Pipeline
Y1	1J				Pipeline
X2	1J				Pipeline
Y2	1J				Pipeline
JUMPX1	1J				Pipeline
JUMPY1	1J				Pipeline
JUMPX2	1J				Pipeline

JUMPY2	1J				Pipeline
QUALITY1	1J				Pipeline
QUALITY2	1J				Pipeline
XDISTANCE	1D			/mm	Pipeline
YDISTANCE	1D			/mm	Pipeline
DELTASATX	1D			/mm	Pipeline
DELTASATY	1D			/mm	Pipeline
BAD_UNITS	1J				Pipeline
CALC_QUALITY	1J				Pipeline

7 Shield HXI and SGD

The SGD and HXI have the detector camera surrounded by Shield. The Shields in both instruments generate the following data streams: two binned type of files named scalar and histogram as well as the burst data. Each SGD has 25 BGO + APD detectors. Each of SGD has two APMU (APD processing & management units) and each APMU manages 13 signals. Therefore there are in total 25 signals and 1 dummy signal in SGD. HXI has 9 BGO+APD detectors, 1 AM241 detector, 1 Particle monitor detector and one APMU that manages 13 signals. Therefore there are in total 11 signals and 2 dummy signal in HXI.

The scalar both for HXI and SGD are taken every 2 sec and contains 4 different signals and 3 flags. These four signals are :

1) Fast BGO veto signal calculated rough energy value (column name SHm_FBGOn where m is not used in the HXI and is n=1,2 for the SGD)
2) Hit pat veto signal with fine energy (column name SHm_HITPATn where m is not used in the HXI and is n=1,2 for the SGD)
3) UD upper discriminator for energy (about 1 MEV) (column name SHn_UDm where m is not used in the HXI and is n=1,2 for the SGD)
4) SUD super upper discriminator energy (about 100 MEV for Cosmic rate or high energy particle) (column name SHn_SUDm where m is not used in the HXI and is n=1,2 for the SGD)

These four signals are taken either in different energy bands or obtained with different calculation. There are 3 flags associated to determine the status :

1) SHn_GRB_FLG : once a GRB (or a burst) is detected by APMU, this Flag becomes high, until the freeze data are read out by digital electronics (DE) and sent to satellite data recorder (column name: n is not used in the HXI and is n=1,2 for the SGD)
2) SHn_FREEZE_FLG : once a GRB is detected, one set of burst data is stored after 5.376 seconds, and this FLAG becomes high. It becomes low, after the data are read out by DE (column name: n is not used in the HXI and is n=1,2 for the SGD).
3) SHn_RBM_FLG : Radiation Belt Monitor flag, and once the UD scalar rate exceeds the certain number, this flag becomes high (column name: n is not used in the HXI and is n=1,2 for the SGD).

The histograms data are instead spectra of 128 energy channel stored every 4 sec but they are not always recorded. The histogram data are recorded only if a GRB is detected or if requested by

commanding. Similar to the scalar the histograms data are recoded for each valid BGO+APD (25 total) in the SGD (25 total + 1 dummy) and for each valid BGO+APD (9 total) , for the AM241 and for the Particle detector (total 11 total + 2 dummy).

The last data is the GRB which consists of 32 energy channel histogram every 16 ms (1/62.5sec). These data are taken for an interval of 5.376 sec. The HXI records the GRB data only for 6 BGO per APMU. The SGD records the GRB data for 6 BGO, either from AMPU1 or APMU2, or 12 BGO, 6 from APMU1 and 6 from APMU2. The columns names are SHm_CNT_APDn (column name: m is not used in the HXI and is m=1,2 for the SGD). An important note is that the GRB data are only from the SGD after the burst is detected, instead the GRB data are not telemetered from the HXI.
The Shield data are put into FITS files as follows:

- Scalar and histogram are in a single file for each SGD. Each SGD file has 4 extensions: 2 extensions, one per AMPU, for scalars, and 2 extensions, one per APMU, for the histogram (2 total files). NOTE : if there are not histograms data from one of the AMPU or both the files still have 4 extensions where the Histograms extensions contain 1 row with null values in all columns.
- Scalar and histogram are in a single file for each HXI. Each HXI file has two extensions: the 1st extension contains the scalar together with the AM241 and particle background monitoring data and the second extension the histogram data. (2 total files). NOTE : if there are not histograms the files still have 2 extensions where the Histograms extensions contain 1 row with null values in all columns.
- GRB data are in separate files. All bursts detected in one observation (pointing and slew) are stored in one file. The HXI GRB data are in a total two files one for each HXI with 1 extension. The SGD GRB data are in a total of two files one for each SGD with two extensions one for the data recorded with the APMU1 and one with data recorded with APMU2. Data from each GRB detected are 336 rows, since there are 5.376/0.016 measurements, where each row contains 6 spectra of 32 channel. Each row has the spectrum calculated every 0.016 sec. The total GRB lightcurve exposure is always 5.376 sec. If more than one burst is detected in one observation than the number of rows are multiple of 336 times the number of GRB detected. NOTE : if there are not GRB data from one of the AMPU or both the files still have 1 (HXI) and 2 (SGD) extensions where the GRB extension contains 1 row with null values in all columns.

{The four rates are sampled every 2 sec also used to calculate the deadtime of the shield itself (cannot issue FastBGO or Hitpat veto flags to the camera to veto cosmic-ray backgrounds) and to estimate camera part is taking one occurrence, if there are the following four signals from shield, they are stored in the camera telemetry as
(NOTE For HXI: FLAG_FBGO1 = FastBGO FLAG_FBGO2 = UD or SUD FLAG_HITPAT1 = Hitpat (FLAG_HITPAT2 = AM241 signal from BGO+APD unit No.5)}

The keywords header DETNAM is used to distinguish the APMU number. For the SGD, SHIELD1 and SHIELD2 represents APMU1 and APMU2. For the HXI, SHIELD also represents APMU.

The data commonly known as SCAN data are acquaired when the shields are put in a “calibration mode” (the actual mode does not change and is the same as the usual observation mode). In this mode the threshould is changed by command from low to high value with intermediate step each lasting xx sec. The SCAN data therefore can only be identified by the time when the commands were issued or by the time when the shield HK telemetry has the same threshold values for all 13 shield modules, and no by special keywords in the header of the scalar or histogram FITS table. The HXI shield HK columns are in the extension ext HK_HXIm_APMU_PRM where m is 1 or 2. For the FBGO the columns are named HXIm_APMU_ADC_FBGO_THn and for the HITPAT the columns are named HXIm_APMU_ADC_HIT_PAT_THn where n is from 1 to 13 and m is 1 or 2. The SGD shield HK columns are in the extensions HK_SGDm_APMUm_PRM where m is 1 or 2. For the FBGO the columns are named SGDm_APMUm_ADC_FBGO_THn and for the HITPAT the columns are named SGDm_APMUm_ADC_HIT_PAT_THn where m is 1 or 2 and n is from 1 to 13 or 12 depending on the APMU number. The SCAN start time is when the threshould of all 13 columns have the same value, and the stop time is determined by xx seconds after the start time (the number of seconds is TBD). The GTISCAN are determined on ground using the information in the sciled HK and not by the time when the commands were issued.

1) FFF HXI & SGD SCALAR & HISTOGRAM
The header keywords are from table 4a1, 4b1, 4b2, but the keywords FILTER. RA_PNT, DEC_PNT, ABERRAT, FOLOWSUN, OPTzzzX, OPTzzzY, ONTIME, EXPOSURE (color coded orange) are omitted.

Table 30a HXI & SGD SCALAR (1 ext for HXI ; 2 ext for SGD)

Column name HXI	**Column name** SGD	**type**	**TLMIN/ TLMAX**	**TZERO/ TSCAL**	**TNULL/ TUNIT**	**Comment**
TIME	TIME	1D			/’s’	Pre-pipe ahtime
S_TIME	S_TIME	1D			/’s’	Pre-pipe
L32TI	L32TI	1J		2147483648		Pre-pipe
CATEGORY	CATEGORY	1B				Pre-pipe
ADU_CNT	ADU_CNT	1B				Pre-pipe
U32TI	U32TI	1J		2147483648		Pre-pipe
LOCAL_TIME	LOCAL_TIME	1J		2147483648		Pre-pipe
SH_FBGO1	SHn_FBGO1	1I		32768		Pre-pipe
SH_FBGO2	SHn_FBGO2	1I		32768		Pre-pipe
SH_FBGO3	SHn_FBGO3	1I		32768		Pre-pipe
SH_FBGO4	SHn_FBGO4	1I		32768		Pre-pipe
SH_FBGO5	SHn_FBGO5	1I		32768		Pre-pipe
SH_FBGO6	SHn_FBGO6	1I		32768		Pre-pipe
SH_FBGO7	SHn_FBGO7	1I		32768		Pre-pipe
SH_FBGO8	SHn_FBGO8	1I		32768		Pre-pipe
SH_FBGO9	SHn_FBGO9	1I		32768		Pre-pipe
SH_FBGO10	SHn_FBGO10	1I		32768		Pre-pipe
SH_FBGO11	SHn_FBGO11	1I		32768		Pre-pipe

SH_FBGO12	SHn_FBGO12	1I		32768		Pre-pipe
SH_FBGO13	SHn_FBGO13	1I		32768		Pre-pipe
SH_HITPAT1	SHn_HITPAT1	1I		32768		Pre-pipe
SH_HITPAT2	SHn_HITPAT2	1I		32768		Pre-pipe
SH_HITPAT3	SHn_HITPAT3	1I		32768		Pre-pipe
SH_HITPAT4	SHn_HITPAT4	1I		32768		Pre-pipe
SH_HITPAT5	SHn_HITPAT5	1I		32768		Pre-pipe
SH_HITPAT6	SHn_HITPAT6	1I		32768		Pre-pipe
SH_HITPAT7	SHn_HITPAT7	1I		32768		Pre-pipe
SH_HITPAT8	SHn_HITPAT8	1I		32768		Pre-pipe
SH_HITPAT9	SHn_HITPAT9	1I		32768		Pre-pipe
SH_HITPAT10	SHn_HITPAT10	1I		32768		Pre-pipe
SH_HITPAT11	SHn_HITPAT11	1I		32768		Pre-pipe
SH_HITPAT12	SHn_HITPAT12	1I		32768		Pre-pipe
SH_HITPAT13	SHn_HITPAT13	1I		32768		Pre-pipe
SH_UD1	SHn_UD1	1B				Pre-pipe
SH_UD2	SHn_UD2	1B				Pre-pipe
SH_UD3	SHn_UD3	1B				Pre-pipe
SH_UD4	SHn_UD4	1B				Pre-pipe
SH_UD5	SHn_UD5	1B				Pre-pipe
SH_UD6	SHn_UD6	1B				Pre-pipe
SH_UD7	SHn_UD7	1B				Pre-pipe
SH_UD8	SHn_UD8	1B				Pre-pipe
SH_UD9	SHn_UD9	1B				Pre-pipe
SH_UD10	SHn_UD10	1B				Pre-pipe
SH_UD11	SHn_UD11	1B				Pre-pipe
SH_UD12	SHn_UD12	1B				Pre-pipe
SH_UD13	SHn_UD13	1B				Pre-pipe
SH_SUD1	SHn_SUD1	1B				Pre-pipe
SH_SUD2	SHn_SUD2	1B				Pre-pipe
SH_SUD3	SHn_SUD3	1B				Pre-pipe
SH_SUD4	SHn_SUD4	1B				Pre-pipe
SH_SUD5	SHn_SUD5	1B				Pre-pipe
SH_SUD6	SHn_SUD6	1B				Pre-pipe
SH_SUD7	SHn_SUD7	1B				Pre-pipe
SH_SUD8	SHn_SUD8	1B				Pre-pipe
SH_SUD9	SHn_SUD9	1B				Pre-pipe
SH_SUD10	SHn_SUD10	1B				Pre-pipe
SH_SUD11	SHn_SUD11	1B				Pre-pipe
SH_SUD12	SHn_SUD12	1B				Pre-pipe
SH_SUD13	SHn_SUD13	1B				Pre-pipe
SH_GRB_FLAG	SHn_GRB_FLAG	1B				Pre-pipe
SH_FREEZE_FLAG	SHn_FREEZE_FLAG	1B				Pre-pipe
SH_RBM_FLAG	SHn_RBM_FLAG	1B				Pre-pipe
PROC_STATUS	PROC_STATUS	32X				Pre-pipe

Table 30b HXI & SGD HISTO (1 ext for the HXI; 2 ext for the SGD)

Column Name HXI	Column Name SGD	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	TIME	1D			/’s’	Pre-pipe ahtime
S_TIME	S_TIME	1D			/’s’	Pre-pipe
L32TI	L32TI	1J		2147483648		Pre-pipe
CATEGORY	CATEGORY	1B				Pre-pipe
ADU_CNT	ADU_CNT	1B				Pre-pipe
U32TI	U32TI	1J		2147483648		Pre-pipe

LOCAL_TIME	LOCAL_TIME	1J		2147483648		Pre-pipe
SH_HIST1	SHn_HIST1	128I				Pre-pipe
SH_HIST2	SHn_HIST2	128I				Pre-pipe
SH_HIST3	SHn_HIST3	128I				Pre-pipe
SH_HIST4	SHn_HIST4	128I				Pre-pipe
SH_HIST5	SHn_HIST5	128I				Pre-pipe
SH_HIST6	SHn_HIST6	128I				Pre-pipe
SH_HIST7	SHn_HIST7	128I				Pre-pipe
SH_HIST8	SHn_HIST8	128I				Pre-pipe
SH_HIST9	SHn_HIST9	128I				Pre-pipe
SH_HIST10	SHn_HIST10	128I				Pre-pipe
SH_HIST11	SHn_HIST11	128I				Pre-pipe
SH_HIST12	SHn_HIST12	128I				Pre-pipe
SH_HIST13	SHn_HIST13	128I				Pre-pipe
PROC_STATUS	PROC_STATUS	32X				Pre-pipe

2) FFF HXI & SGD GRB

The header keywords are from table 4a1, 4b1, 4b2, but the keywords FILTER. RA_PNT, DEC_PNT, ABERRAT, FOLOWSUN, OPTzzzX, OPTzzzY, ONTIME, EXPOSURE (color coded orange) are omitted.

Table 31 HXI & SGD GRB (1 ext for the HXI; 2 ext for the SGD)

Column name HXI	Column Name SGD	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	TIME	1D			/'s'	Pre-pipe ahtime
S_TIME	S_TIME	1D			/'s'	Pre-pipe
L32TI	L32TI	1J		2147483648		Pre-pipe
CATEGORY	CATEGORY	1B				Pre-pipe
ADU_CNT	ADU_CNT	1B				Pre-pipe
U32TI	U32TI	1J		2147483648		Pre-pipe
LOCAL_TIME	LOCAL_TIME	1J		2147483648		Pre-pipe
GRB_FREEZE_TIME	GRB_FREEZE_TIME	1J		2147483648		Pre-pipe
SH_GRB1	SHn_GRB1	32I				Pre-pipe
SH_GRB2	SHn_GRB2	32I				Pre-pipe
SH_GRB3	SHn_GRB3	32I				Pre-pipe
SH_GRB4	SHn_GRB4	32I				Pre-pipe
SH_GRB5	SHn_GRB5	32I				Pre-pipe
SH_GRB6	SHn_GRB6	32I				Pre-pipe
PROC_STATUS	PROC_STATUS	32X				Pre-pipe

8 Orbit and Attitude

The orbit and attitude file contents are generated on ground. The orbit is generated from information delivered from Tsukuba and formatted at ISAS. The orbit file contains time that covers +/- N days of the time of the observation.
The attitude is obtained using the information telemetered and further manipulated to smooth the temporal behavior. The attitude content includes times from the incoming slew to the end of the observation. Both attitude and orbit are formatted in a single file containing several binary extension tables. In these files INSTRUME is set to BUS_SYSTEM.

a) ORBIT : The orbit file contains two extensions. The 1st contains the original elements from Tsukuba provided every 3 days and covering from the previous released of the Tsukaba before the observation start time up to the next release after the observation stop. The second extension contains the expanded values sampled to satisfy the requirements for time accuracy. The time coverage of the orbit should include at the minimum the previous and next release of the orbital elements from the start and stop of the observation. The columns for the 1st and 2nd extension are similar to that of the Suzaku orbit file. The header of the orbit 1st and 2nd extension should contain the same keywords listed for the HK files. The EXTNAME are ORBITELEM for the first extension and ORBIT for the second extension. The columns in the 1st and 2nd extensions are listed in table 32a and 32b. The header keywords are those listed in 5a and 5b1 with the EXTNAME set to 1st ext ORBITELEM and 2nd ext ORBIT.

Table 32a (1st extension)

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	/T
EPOCH	14A				/Epoch orbital element
YYYY	1I			-99	/Year
DDD	1I			-99	/Day of the year
HH	1B			255	/Hour
MM	1B			255	/Minute
SS	1B			255	/Seconds
US	1J			-99	/microsecond
A	1D			/'km'	/Semi-major axis
E	1D				/ Eccentricity
I	1D			/'deg'	/Inclination
AN	1D			/'deg'	/R.A. Ascending Node
AP	1D			/'deg'	/Angle for Ascending node
MA	1D			/'deg'	/Mean Anomaly
A_DOT	1D			/'km/d'	/Derivative of A
E_DOT	1D			/'/d'	/Derivative of E
I_DOT	1D			/'deg/d'	/Derivative of I
AN_DOT	1D			/'deg/d'	/Derivative of AN
AP_DOT	1D			/'deg/d'	/Derivative of AP
N	1D			/'/d'	/Number of revolution per day
T	1D			/'min'	/Revolution period

Table 32b (2nd extension)

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	/T
YYYY	1I			-99	/Year
DDD	1I			-99	/Day of the year

HH	1B			255	/Hour
MM	1B			255	/Minute
SS	1B			255	/Seconds
US	1J			-99	/microsecond
SEF_COUNTER	1J				/ ???
WEIGHT	1E				/ weight ??
X	1D			/'km'	/vector from earth center X
Y	1D			/'km'	/vector from earth center Y
Z	1D			/'km'	/vector from earth center Z
VX	1D			/'km/s'	/satellite velocity X
VY	1D			/'km/s'	/satellite velocity Y
VZ	1D			/'km/s'	/satellite velocity Z
LAT	1D			/'deg'	/Longitude
LON	1D			/'deg'	/Latitude
ALT	1D			/'km'	/Altitude
A	1D			/'km'	/Semi-major axis
E	1D				/Eccentricity
I	1D			/'deg'	/Inclination
AN	1D			/'deg'	/R.A. Ascending Node
AP	1D			/'deg'	/Angle for Ascending node
MA	1D			/'deg'	/Mean Anomaly

b) The attitude table contains four extensions. The extensions from the second to the fourth are from the general hk2 file and are used from the ground software columns to derive the final attitude placed in the 1st extension.
The attitude values are calculated in the pre-pipeline and stored in the QPARM, POINTING and EULER columns. The 1st extension of the attitude is than corrected in the pipeline to account for the aberration and the original QPARAM column is saved in the column named QPARAM_ORI and the new calculated values are stored in QPARAM. The header of the attitude should contain the same keywords listed for the HK files. The EXTNAME name is ATTITUDE.
The header keywords are those listed in 5a and 5b1 with the EXTNAME set to 1st ATTITUDE, 2nd -4th use the 5a and 5b1.
The 'aberattitude' task adds the keyword ABERRAT set to describe if the annual aberration was applied (T) or not (N). ABERORB set to describe if the orbital aberration was applied (T) or not (N).

Table 33a 1extension

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre-pipe ahtime
S_TIME	1D			/'s'	Pre-pipe
L32TI	1J		2147483648		Pre-pipe
YYYY	1I			-99	
DDD	1I			-99	
HH	1B			255	
MM	1B			255	
SS	1B			255	
US	1J			-99	
QPARAM (*)	4D				/Quaternian
POINTING	3D			/'deg'	/RA , Dec, Roll
EULER	3D			/'deg'	/Euler angle

PROC_STATUS	32X				
(*) see note on this column in the above section					

Table 33b 2extension

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	Pre/Pipe
S_TIME	1D			/'s'	Pre-pipe
PACKET_HEADER	20B				Pre-Pipe
L32TI	1J		2147483648		Pre-pipe
YYYY	1I			-99	Pre-pipe
DDD	1I			-99	Pre-Pipe
HH	1B			255	Pre-pipe
MM	1B			255	Pre-pipe
SS	1B			255	
US	1J			-99	
PROC_STATUS	32X				
ACPA_AOCS_32HZ_TIME	1J		2147483648		
ACPA_SMU_32HZ_TIME	1J		2147483648		
ACPA_ACIM_STT_SEL_STS	1B				
ACPA_ACIM_IRU_SEL_STS	1B				
ACPA_ACIM_SG_SEL_STS	1B				
ACPA_ACIM_RW_SEL_STS	1B				
ACPA_ACIM_MTQ_SEL_STS	1B				
ACPA_ACIM_RCS_SEL_STS	1B				
ACPA_CSAS_SPKCUT_STS	1B				
ACPA_CSAS1_DATA_VALID	1B				
ACPA_CSAS2_DATA_VALID	1B				
ACPA_CSAS_SP1	1B				
ACPA_CSAS_SP2	1B				
ACPA_CSAS_LINEAR1	1B				
ACPA_CSAS_LINEAR2	1B				
ACPA_CSAS_ANG1	1E				
ACPA_CSAS_ANG1_CAL	1E			/'deg'	
ACPA_CSAS_ANG2	1E				
ACPA_CSAS_ANG2_CAL	1E			/'deg'	
ACPA_GAS_VALID	1B				
ACPA_GAS_SPKCUT_STS	1B				
ACPA_IRU_AXIS_SEL_STS	1B				
ACPA_IRU_DATA_VALID	1B				
ACPA_IRU_SPKCUT_STS	1B				
ACPA_RW1_SPEED_BIAS_STS	1B				
ACPA_RW2_SPEED_BIAS_STS	1B				
ACPA_RW3_SPEED_BIAS_STS	1B				
ACPA_RW4_SPEED_BIAS_STS	1B				
ACPA_RW1_SPEED_REF_BIAS_INST	1E				
ACPA_RW1_SPEED_REF_BIAS_INST_CAL	1E			/'rpm'	
ACPA_RW2_SPEED_REF_BIAS_INST	1E				
ACPA_RW2_SPEED_REF_BIAS_INST_CAL	1E			/'rpm'	
ACPA_RW3_SPEED_REF_BIAS_INST	1E				
ACPA_RW3_SPEED_REF_BIAS_INST_CAL	1E			/'rpm'	
ACPA_RW4_SPEED_REF_BIAS_INST	1E				
ACPA_RW4_SPEED_REF_BIAS_INST_CAL	1E			/'rpm'	
ACPA_RW_ANGMOM_REF_B_X	1E				
ACPA_RW_ANGMOM_REF_B_Y	1E				
ACPA_RW_ANGMOM_REF_B_Z	1E				
ACPA_RW1_ANGMOM	1E				
ACPA_RW2_ANGMOM	1E				

ACPA_RW3_ANGMOM	1E				
ACPA_RW4_ANGMOM	1E				
ACPA_RW1_ANGMOM_REF	1E				
ACPA_RW2_ANGMOM_REF	1E				
ACPA_RW3_ANGMOM_REF	1E				
ACPA_RW4_ANGMOM_REF	1E				
ACPA_MTQ_MODE	1B				
ACPA_ADS_STT_UPDATE_STS	1B				
ACPA_ADS_CONT_REF_STS	1B				
ACPA_ADSI_STS	1B				
ACPA_ADS_KF_STS	1B				
ACPA_ADS_STT_STS	1B				
ACPA_ADS_RB_STS	1B				
ACPA_ADS_KF_GAIN_STS	1B				
ACPA_ADS_UD_PROP_STS	1B				
ACPA_ADS_KF_UP	1B				
ACPA_ADS_ST_UP	1B				
ACPA_ADS_STT_SEL	1B				
ACPA_AOCS_TIME	1J		2147483648		
ACPA_DAYNIGHT_E_FLG	1B				
ACPA_DAYNIGHT_M_FLG	1B				
ACPA_DAYNIGHT_E_TIMER_STS	1B				
ACPA_DAYNIGHT_M_TIMER_STS	1B				
ACPA_DAYNIGHT_E_AUTO_STS	1B				
ACPA_DAYNIGHT_M_AUTO_STS	1B				
ACPA_DAYNIGHT_STS	1B				
ACPA_FDIR_COMP_STT1_UPDATE_TIME	1I		32768		
ACPA_FDIR_COMP_STT1_UPDATE_TIME_CAL	1E			/'cnt'	
ACPA_FDIR_COMP_STT2_UPDATE_TIME	1I		32768		
ACPA_FDIR_COMP_STT2_UPDATE_TIME_CAL	1E			/'cnt'	
ACPA_CMD_SZ_SUM	1B				
ACPA_ACFS_CNT_ERR	1B				
ACPA_DUMP_SND_ERR_CNT	1B				
ACPA_AOCS_HK_SND_ERR_CNT	1B				
ACPA_GET_SND_ERR_CNT	1B				
ACPA_ACIM_CNT_ERR_SUM	1B				
ACPA_TLM_CMD_CNT_ERR_SUM	1B				
ACPA_STMW_TRG_RMAP_ERR_CNT	1B				
ACPA_STMW_TRG_CMD_DEL_CNT	1B				
ACPA_STMW_TRG_TRAN_ERR_CNT	1B				
ACPA_STMW_TRG_COM_ERR_CNT	1B				
ACPA_STMW_INI_TI_ERR_CNT	1B				
ACPA_STMW_INI_RFRSH_ERR_CNT	1B				
ACPA_AOCP_ESTR_PORT1	8X				
ACPA_AOCP_ESTR_PORT2	8X				
ACPA_AOCP_ESTR_PORT3	8X				
ACPA_AOCP_ESTR_PORT4	8X				
ACPA_SMU_TC_RCV_ERR_CNT	1B				
ACPA_TI_UPDATE_ERR	1B				
ACPA_RATE_BIAS_EST_X	1E				
ACPA_RATE_BIAS_EST_X_CAL	1E			/'deg'	
ACPA_RATE_BIAS_EST_Y	1E				
ACPA_RATE_BIAS_EST_Y_CAL	1E			/'deg'	
ACPA_RATE_BIAS_EST_Z	1E				
ACPA_RATE_BIAS_EST_Z_CAL	1E			/'deg'	
ACPA_ADS_STT1_ID_ERR_CNT	1B				
ACPA_ADS_STT2_ID_ERR_CNT	1B				

ACPA_REF_Q1	1E				
ACPA_REF_Q2	1E				
ACPA_REF_Q3	1E				
ACPA_REF_Q4	1E				
ACPA_NAV_EULER_ANG	1E				
ACPA_NAV_EULER_ANG_CAL	1E			/'deg'	
ACPA_DV_CMD_ERR_FLG	1B				
ACPA_MNV_CMD_ERR_FLG	1B				
ACPA_NAV_NM_EULER_RATE_CMD_ENA_DIS	1B				
ACPA_MNV_FLG	1B				
ACPA_NAV_NM_ABER_CORR_ENA_DIS	1B				
ACPA_NAV_NM_NULL_ENA_DIS	1B				
ACPA_NAV_NM_REF_ANG_ACC_X	1E				
ACPA_NAV_NM_REF_ANG_ACC_X_CAL	1E			/'deg'	
ACPA_NAV_NM_REF_ANG_ACC_Y	1E				
ACPA_NAV_NM_REF_ANG_ACC_Y_CAL	1E			/'deg'	
ACPA_NAV_NM_REF_ANG_ACC_Z	1E				
ACPA_NAV_NM_REF_ANG_ACC_Z_CAL	1E			/'deg'	
ACPA_NAV_NM_ROT_ANG	1E				
ACPA_NAV_NM_ROT_ANG_CAL	1E			/'deg'	
ACPA_TGT_Q_NO	1B				
ACPA_NEXT_TGT_Q_NO	1B				
ACPA_INTG_X	1E				
ACPA_INTG_Y	1E				
ACPA_INTG_Z	1E				
ACPA_TRQ_FF_RATE_UD_X	1E				
ACPA_TRQ_FF_RATE_UD_Y	1E				
ACPA_TRQ_FF_RATE_UD_Z	1E				
ACPA_ADS_INER_Q1	1E				
ACPA_ADS_INER_Q2	1E				
ACPA_ADS_INER_Q3	1E				
ACPA_ADS_INER_Q4	1E				

Table 33c 3extension

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D				
S_TIME	1D				
PACKET_HEADER	20B				
L32TI	1J		2147483648		
YYYY	1I			-99	
DDD	1I			-99	
HH	1B			255	
MM	1B			255	
SS	1B			255	
US	1J			-99	
PROC_STATUS	32X				
ACPA_AOCS_64HZ_TIME	1J		2147483648		
ACPA_IRU_AXIS_SEL_STS	1B				
ACPA_IRU_PLS_SUM_USE_AXIS1	1J				
ACPA_IRU_PLS_SUM_USE_AXIS1_CAL	1J				
ACPA_IRU_PLS_SUM_USE_AXIS2	1J				
ACPA_IRU_PLS_SUM_USE_AXIS2_CAL	1J				
ACPA_IRU_PLS_SUM_USE_AXIS3	1J				
ACPA_IRU_PLS_SUM_USE_AXIS3_CAL	1J				

Table 33d 4extension

Column name	type	TLMIN/	TZERO/	TNULL/	Comment

		TLMAX	TSCAL	TUNIT	
TIME	1D				
S_TIME	1D				
PACKET_HEADER	20B				
L32TI	1J		2147483648		
YYYY	1I			-99	
DDD	1I			-99	
HH	1B			255	
MM	1B			255	
SS	1B			255	
US	1J			-99	
PROC_STATUS	32X				
ACPA_STT1_Q_VALID	1B				
ACPA_STT2_Q_VALID	1B				
ACPA_STT1_Q_SIGN	1B				
ACPA_STT2_Q_SIGN	1B				
ACPA_STT1_Q1	1K				
ACPA_STT1_Q1_CAL	1E				
ACPA_STT1_Q2	1K				
ACPA_STT1_Q2_CAL	1E				
ACPA_STT1_Q3	1K				
ACPA_STT1_Q3_CAL	1E				
ACPA_STT2_Q1	1K				
ACPA_STT2_Q1_CAL	1E				
ACPA_STT2_Q2	1K				
ACPA_STT2_Q2_CAL	1E				
ACPA_STT2_Q3	1K				
ACPA_STT2_Q3_CAL	1E				

9 TIM file

The tim file is used to calculate time for all science and housekeeping data. This file is consists of two extensions. The first extension, TIM_PACKETS, is generated using telemetered and contacts information and contact, and the second extension, TIM_LOOKUP, is calculated by *ahmktim* using the GPS information and the clock quartz information included in the common HK file. There is one file per individual observation. The keywords for the first extension are described in section 2.8 (Table 5a,5b1, and 5b2) and in addition there are three extra keywords to give the start and stop of the L32TI columns, LTISTART and LTISTOP, and the library version used to create the extension, TIMFMVER.The keywords TSTART and TSTOP reference to the column S_TIME instead of the LTISTART and LTISTOP are reference to the L32TI column. The format is listed in table 34a and b. The ahmktim copies a subset of keywords from the HK GPS header to the second extension TIME_LOOKUP.

Table 34a 1extension TIME_PACKETS

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
S_TIME	1D			/'s'	Pre-pipe
R_TIME	1D			/'s'	Pre-pipe
L32TI	1J		2147483648		Pre-pipe
ETIEXT	1K				Pre-pipe
ETIBASE	1E			/'s'	Pre-pipe
UTC	20A				Pre-pipe

RATE	1E	0/10			Pre-pipe
FLAG_ERR	1L				Pre-pipe
PASSID	10A				Pre-pipe
U40TI	1K				Pre-pipe
L20TI	1J		2147483648	/'deg'	Pre-pipe
UTC_ERT	20A			/'deg'	Pre-pipe
ANTENNA	8A				Pre-pipe
BITRATE	1J		2147483648		Pre-pipe
BAND	1A				Pre-pipe
ANPFNAME	14A				Pre-pipe
ANPTIME	14A				Pre-pipe
DLRANGE	1E			/'km'	Pre-pipe
CODETYPE	12A				Pre-pipe
DELAYBIT	1E				Pre-pipe
DELAYTIM	1E			/'s'	Pre-pipe

Table 34b 2 extension TIM_LOOKUP

Column name	type	TLMIN/ TLMAX	TZERO/ TSCAL	TNULL/ TUNIT	Comment
TIME	1D			/'s'	ahmktim
L32TI	1D		2147483648	/'s'	ahmktim
STATUS	20B				ahmktim

10 Catalog

A catalog file is created in pre-pipeline as well as in the pipeline. Both contain the list of files and additional attributes that are included when sending the data either from the pre-pipeline to the pipeline or from the pipeline to the archive. The format is a binary table with several columns and the keywords header for the extension has the same content of the primary header with the keyword INSTRUME omitted. The EXTNAME is set to CATALOG_FFF or CATALOG to indicate the file created by the pre-pipeline and pipeline respectively. All files included in the observation, produce either in the pre-pipeline or pipeline are listed including the catalog file itself. Note that only the catalog file retained in the archive is that output from the pipeline.
The command gzip –lv file produces several values.
The header keywords are set the same of the primary header as listed in table 2.

Table 35 extension CATALOG_FFF or CATALOG

Column name	type	Description	TNULL/ TUNIT	Comment
FILENAME	64A	Name of the file without gz suffix ,e.g. ah01005010.att		/Name of the file
FORMAT	16A	Format type, allowed values: ASCII,FITS,HTML,GIF		/Format: ASCII,FITS,HTML,GIF
TYPE	32A	*Type of file allowed values: attitude orbit, tim,hk etc…		/File type
FILECLAS	32A	*File class allowed values: event housekeeping attitude orbit time_correction , spectrum lightcurve image plot, gti etc		/File class
DESCRIP	64A	File description		/File description
FILESIZE	1J	Filesize derived from uncompress file using a build in perl tool = int((-s filename)/1024+0.5)	kilobytes	/ uncompress file
ARCHSIZE	1J	Filesize derived from gzip –lv compress file ARCHSIZE=(Output(6)+1023)/1024	kilobytes	/(gzip –lv compress file +1023)/1024
CHECKSUM	1J	Filesize derived from cksum compress file		/cksum compress file
GZIP_CIRC	8A	Filesize derived from gzip –lv compress file	alphanum	/ gzip –lv compress file

		Output(2)	eric string	
CKSUM_B4	1J	Filesize derived from cksum uncompress file		/cksum uncompress file
* only a partial list not extensive				

11 Extended HK file and Make filter file

The extended HK file is calculated using the attitude and orbit and the reference teldef. The columns are listed in table 36. The header keywords are listed 5a and 5b1.

Table 36

Column name	type	TNULL/ TUNIT	Comment
TIME	1D		/Mission time (s)
YYYYMMDD	1J		/ year*10000 + month*100 + day
HHMMSS	1J		/ hour*10000 + minute*100 + second
EULER1	1E	/deg	/ satellite Euler angles phi (deg)
EULER2	1E	/deg	/ satellite Euler angles theta (deg)
EULER3	1E	/deg	/ satellite Euler angles psi (deg)
RA	1D	/deg	/ R.A.(J2000) of pointing pos (deg)
DEC	1D	/deg	/Dec.(J2000) of pointing pos (deg)
ROLL	1D	/deg	/ Roll angle of pointing (deg)
HX1_RA_PNT	1D	/deg	/ R.A.(J2000) of HXI1 optical axis (deg)
HX1_DEC_PNT	1D	/deg	/Dec.(J2000) of HXI1 optical axis (deg)
HX2_RA_PNT	1D	/deg	/ R.A.(J2000) of HXI2 optical axis (deg)
HX2_DEC_PNT	1D	/deg	/Dec.(J2000) of HXI2 optical axis (deg)
SXS_RA_PNT	1D	/deg	/ R.A.(J2000) of SXS optical axis (deg)
SXS_DEC_PNT	1D	/deg	/Dec.(J2000) of SXS optical axis (deg)
SXI_RA_PNT	1D	/deg	/ R.A.(J2000) of SXI optical axis (deg)
SXI_DEC_PNT	1D	/deg	/Dec.(J2000) of SXI optical axis (deg)
DLT_RA	1E	/arcmin	/difference from mean R.A. (arcmin)
DLT_DEC	1E	/arcmin	/difference from mean Dec (arcmin)
DLT_ROLL	1E	/deg	/difference from mean roll angle (arcmin)
ANG_DIST	1E	/arcmin	/difference from mean pointing pos (arcmin)
SAT_ALT	1E	/km	/attitude of satellite orbit from earth (km)
SAT_LON	1E	/deg	/longitude of satellite orbit (deg)
SAT_LAT	1E	/deg	/latitude od satellite orbit (deg)
ELV	1E	/deg	/earth elevation of FOC center pos (deg0
DYE_ELV	1E	/deg	/ day earth elev. of FOC center pos (deg)
NTE_ELV	1E	/deg	/ night earth elev. of FOC center pos (deg)
SUN_ALT	1E	/deg	/altitude of the sun from the earth rim (deg)
T_DY_NT	1E	/s	/ Time after day<-> night transition (s)
TN_DY_NT	1E	/s	/ Time to next day<-> night transition (s)
COR	1E	/GeV	/ Cut off rigidity ASCA Table
COR2	1E	/GeV	/ Cut off rigidity Suzaku Table
COR3	1E	/GeV	/ Cut off rigidity IGRF year 2016.0 Table
CORTIME	1E	/GeV	/ Cut off rigidity for current obs time
SAA	1B		/ passage of South Atlantic Anomaly (0->3:deep)
T_SAA	1E	/s	/ Time after SAA passage (s)
TN_SAA	1E	/s	/ Time to next SAA passage (s)
SAA_HXD	1B		/ passage of South Atlantic Anomaly for HXD
T_SAA_HXD	1E	/s	/ Time after SAA passage for HXD (s)
TN_SAA_HXD	1E	/s	/ Time to next SAA passage for HXD (s)
SAA_SXI	1B		/ passage of South Atlantic Anomaly for SXI
T_SAA_SXI	1E	/s	/ Time after SAA passage for SXI

TN_SAA_SXI	1E	/s	/ Time to next SAA passage for SXI
SAA_SXS	1B		/ passage of South Atlantic Anomaly for SXS
T_SAA_SXS	1E	/s	/ Time after SAA passage for SXS
TN_SAA_SXS	1E	/s	/ Time to next SAA passage for SXS
SAA_HXI1	1B		/ passage of South Atlantic Anomaly for HXI1
T_SAA_HXI1	1E	/s	/ Time after SAA passage for HXI1
TN_SAA_HXI1	1E	/s	/ Time to next SAA passage for HXI1
SAA_HXI2	1B		/ passage of South Atlantic Anomaly for HXI2
T_SAA_HXI2	1E	/s	/ Time after SAA passage for HXI2
TN_SAA_HXI2	1E	/s	/ Time to next SAA passage fro HXI2
SAA_SGD1	1B		/ passage of South Atlantic Anomaly fro SGD1
T_SAA_SGD1	1E	/s	/ Time after SAA passage for SGD1
TN_SAA_SGD1	1E	/s	/ Time to next SAA passage for SGD1
SAA_SGD2	1B		/ passage of South Atlantic Anomaly for SGD2
T_SAA_SGD2	1E	/s	/ Time after SAA passage for SGD2
TN_SAA_SGD2	1E	/s	/ Time to next SAA passage for SGD2
ZGMAG_ANG	1E	/deg	/ z-axis angle of the geomagnetic field (deg)
ZGMAG_PHI	1E	/deg	/z-axis roll of the geomagnetic field (deg)
ZE_ANG	1E	/deg	/z-axis angle to center of the Earth (deg)
ZE_PHI	1E	/deg	/z-axis roll to Earth center direction (deg)
MZELV	1E	/deg	/ earth elevation of minus Z-direction
MZDYE_ELV	1E	/deg	/ day earth elev. of minus Z-direction
MZNTE_ELV	1E	/deg	/ night earth elev of minus Z-direction

The make filter file is calculated with the task makefilter and the columns are specified in a caldb file and they are derived from the instrument housekeeping. The header keywords for the makefilter file are listed 5a and 5b1.

Appendix : TEMPLATE

===SXS

```
### SXS EVENT PIXEL
#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns for FFF
#-------------------------------------------------------------
#-------------------------------------------------------------
#
# NOTE: This file contains the SXS pixel baseline and lost intervals events.
# The lost event are also recorded separetly in the GTILOST events
# The file includes information from the packets
# PSPA0.PIX PSPA1.PIX PSPB0.PIX PSPB1.PIX and the pre-pipeline add a column, PSP_ID,
# indicating where the PSP telemetry packet.
# The file contain one combination of filter and MXS setting.
# The pipeline expects to find the columns ACTX ACTY DETX DETY FOCX FOCY X Y
# INDEX GROUPS UPI EPI PI SAMPLECNT STATUS empty.
# The columns CTMULT and EPI2 are not required in the be added in the pre-pipeline
#


### EVENT PIXEL
#number of rows
 naxis2 = 1
#
# Column name: TIME
```

```
# Description: Time since 2014-01-01 00:00:00
# Arrival Time SAMPLECNT1. Arrival time of the pulse
# Origin: pre-pipeline calculated from software
TTYPE# = 'TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Seconds from 01 Jan 2014 00:00:00’

# Column name: TRIGTIME
# Description: Time corresponding to the trigger time calculated with SAMPLECNT2
# Origin: pre-pipeline calculated from software
TTYPE# = 'TRIGTIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Trigger Time of the pulse'

# Column name: S_TIME
# Description: time of CCSDS packet stamped by SIRIUS
# Origin: pre-pipeline from telemetry 2^-6 s
TTYPE# = 'S_TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Time for CCSDS packet stamped by SIRIUS’

# Column name: L32TI
# Description: lower 32 bit TI of the event packet
# Origin: pre-pipeline from telemetry
TTYPE# = 'L32TI'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Packet TI lower 32b, 2^-6 s’

# Column name: CATEGORY
# Description: CATEGORY in SMCP header for DR priority (0-127)
# Origin: pre-pipeline from telemetry
TTYPE# = 'CATEGORY'
TFORM# = '1B'
TCOMM# = ‘Data recorder priority’

# Column name: ADU_CNT
# Description: ADU sequence counter of the event packet
# (0-255) in the main header. ADU_CNT allow to check if packet is lost
# Origin: pre-pipeline from telemetry
TTYPE# = 'ADU_CNT'
TFORM# = '1B'
TCOMM# = ‘ADU sequence packet counter’

# Column name: PSP_ID
# Description: 0:PSP-A0, 1:A1, 2:B0, 3:B1
# Origin: pre-pipeline from telemetry
TTYPE# = 'PSP_ID'
TFORM# = '1B'
TCOMM# = ‘0=PSP-A0 1=A1 2=B0 3=B1’

# Column name: FORMAT_VER
# Description: version of the event packet format
# Origin: pre-pipeline from telemetry
TTYPE# = 'FORMAT_VER'
TFORM# = '1B'
TCOMM# = ‘Packet format version’

# Column name: WFRB_WRITE_LP
# Description: lap & pointer to WFRB for writing ADC sample
# WFRB position where the FPGA is recording the ADC
# sample and derivative when the CPU edits the event packet
# (reference time for the whole packet); consists of present lap (6 bit) +
# pointer (18 bit) of the WFRB.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_WRITE_LP'
TFORM# = '1J'
TCOMM# = ‘Lap & pointer of WFRB to write ADC sample’
```

```
# Column name: WFRB_SAMPLE_CNT
# Description: SAMPLE_CNT corresponding to top of WFRB
#free-run counter of the SAMPLE_CNT,corresponding to the recording ADC sample & derivative, AS
above.
#  (nominal sample rate of 12.5 kHz; SAMPLE_CNT wraps around in ~ 4 dy.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_SAMPLE_CNT'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Sample count for the top of WFRB’

# Column name: NUM_ELEM
# Description: number of element in the event packet
# Number of elements in the PSP packet;
# an element is either a pulse (event) and/or a noise (baseline) record, or lost count
# potential too scale down as byte
# Origin: pre-pipeline from telemetry
TTYPE# = ‘NUM_ELEM’
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 255
TCOMM# = ‘Number of element in the event packet’

# Column name: SUM_LOST_CNT
# Description: sum of the lost cnt in the event packet
# Number of lost count records for the packet
# These is the number of events lost in the entire packet
# Origin: pre-pipeline from telemetry
TTYPE# = 'SUM_LOST_CNT'
TFORM# = '1J'
TCOMM# ='Sum of lost count in the event packet'

# Column name: ITYPE
# Description: 0:Hp, 1:Mp, 2:Ms, 3:Lp, 4:Ls, 5:BL, 6:EL, 7:--
# event type (event or baseline)
# 0=Hp 1=Mp 2=Ms 3=Lp 4=Ls 5=BL 6=EL 7=Rj (notused)
# 6= LOST_EVT_TYPE
# Origin: pre-pipeline from telemetry
TTYPE# = 'ITYPE'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 7
TCOMM# = '0:Hp 1:Mp 2:Ms 3:Lp 4:Ls 5:BL 6:EL 7:--'

# Column name: TYPE
# Description: Hp/Mp/Ms/Lp/Ls/BL/LE/Rj
# the char version of ITYPE
# Convention of type into characters
# pre pipeline need to convert from ITYPE
# 0=Hp 1=Mp 2=Ms 3=Lp 4=Ls 5=BL 6=EL 7=Rj (not used)
# Origin: pre-pipeline calculated
TTYPE# = 'TYPE'
TFORM# = '2A'
TCOMM# = 'Hp,Mp,Ms,Lp,Ls,BL,EL,Rj according to ITYPE

# Column name: IPIX
# Description: pixel number (0-17) inside each PSP, PIXEL % 18
#Set for event or baseline
# This value ranges from 0-17 even if each quadrant record max 9 pixels
# Specifically A0=B0=0-9 A1=B1=9-17
# O=PSP_A0 1=PSP_A1 2=PSP_B0 3=PSP_B1
# pixel =31 is assigned to NULL (some sort of lost event)
# Origin:  pre-pipeline from telemetry
TTYPE# = 'IPIX'
TFORM# = '1B'
TNULL# = 31
TLMIN# = 0
TLMAX# = 17
TCOMM# = 'pixel number (0-17) in each PSP'
```

```
# Column name: PIXEL
# Description: detected pixel number [0-35]
# Valid for event or baseline
# PIXEL= IPIX + int(PSP_ID/2)*18
# where PSP_AO PSP_A1 contribute always 0
# and PSP_B0 PSP_B1 contribute always 1
# Origin: calculated pre-pipeline from telemetry
TTYPE# = 'PIXEL'
TFORM# = '1B'
TNULL# = 63
TLMIN# = 0
TLMAX# = 35
TCOMM# = ‘Pixel Number range 0-35’

# Column name: TRIG_LP
# Description: lap & pointer to WFRB for the triggered event
# lap (6 bit) + pointer (18 bit) when the event triggers
# NOTE: This stored two meaning a) the trigger time for event or BL or
# b) the start time of the lost event interval LOST_EVT_START_LP
# Note b) is calculated as usual and the ITYPE flag that is
# time associated to the start time of the lost event
# Set for event or baseline or Lost
# The Null value is not expected but if there is than the samplecnt is set to null
# Origin: pre-pipeline from telemetry
TTYPE# = 'TRIG_LP'
TFORM# = '1J'
TNULL# = 2147483647
TCOMM# = ‘Lap & pointer to WFRB for the row’

# Column name: QUICK_DOUBLE
# Description: quick-double flag for double pulse
# lag indicating the presence of a quick second pulse
# during the fall of the main pulse.
# Value 1 = means that there is a quick double event "and the PHA
# is not calculated correctly"
# Need to be checked in the ground software
# FOR BASELINE IS SET = 0
# Set for event or baseline
# Origin: pre-pipeline from telemetry
TTYPE# = 'QUICK_DOUBLE'
TFORM# = '1X'
TCOMM# = 'Flag set to 1 for double pulse'

# Column name: SLOPE_DIFFER
# Description: slope-differ flag for invalid pulse shape
# the mean square difference from the mean derivative (?)
# Value 1 identify an invalid pulse shape
# Need to be checked on ground software
# FOR BASELINE IS SET = 0
# Set for event or baseline
# Origin: pre-pipeline from telemetry
TTYPE# = 'SLOPE_DIFFER'
TFORM# = '1X'
TCOMM# = 'Flag set to 1 for invalid pulse shape'

# Column name: LO_RES_PH
# Description: low resolution pulse height, determined in the
# same way for the Lp and Ls pulses
# direct peak-height measurement used as PHA for low-res events
# This value is the peak height of the pulse. For Ls and Lp  this is the same
# as stored in the pha column otherwise for all other grade
# is a rough estimate of the  PHA value
# For BASELINE is set as first value of ADC sample in Noise Record.
# For Baseline -8192 8192
# Origin: pre-pipeline from telemetry
TTYPE# = 'LO_RES_PH'
TFORM# = '1I'
TLMIN# = -8192
TLMAX# = 16383
TCOMM# = 'Pulse height calculates as for Lp/Ls'
```

```
# Column name: DERIV_MAX
# Description: maximum value of the derivative
# maximum value of derivative form boxcar filtering of samples
# What is the value for BASELINE event: dump the telemetry but have no meaning
# No needed in the ground software
# Origin: pre-pipeline from telemetry
TTYPE# = 'DERIV_MAX'
TFORM# = '1I'
TLMIN# = -32768
TLMAX# = 32767
TCOMM# = 'Maximum value of the derivative'

# Column name: RISE_TIME
# Description: rise-time in unit of 1/4 tick (20 us nominal).
# RISE_TIME in telemetry is 8 bit (0-255), however, MSB is assigned for
# a slow-pulse flag. Valid range of RISE_TIME is 0-127, hence TLMAX=127.
# It is calculated by fitting a line to a number of points on
#              the rising edge of the pulse
# What is the value for BASELINE event : dump the telemetry but have no meaning
# but BASELINE should be 0
# Origin: pre-pipeline from telemetry
TTYPE# = 'RISE_TIME'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 127
TCOMM# = 'rise-time in unit of 1/4 tick (20 us nominal)'

# Column name: TICK_SHIFT
# Description: number of shift in unit of tick to find the PHA
# maximum in cross-correlating with the template (optimal filter)
# ow 4-bits of the 32-bit tick counter
# TICK_SHIFT is a shift of template relative to the observed waveform.
# Not used in the time assignment but to evaluate the pulse template
# in the PSP algorithm. What is the value for BASELINE event : dump
# the telemetry but have no meaning  but BASELINE should be 0
# Not used in the software
# Origin: pre-pipeline from telemetry
TTYPE# = 'TICK_SHIFT'
TFORM# = '1B'
TNULL# = -128
TLMIN# = -8
TLMAX# = 7
TZERO# = -128
TCOMM# = 'number of shift in unit of tick to find the PHA'

# Column name: TIME_VERNIER
# Description: vernier to define the finest time division
# TIME_VERNIER is calculated by quadratically interpolating the three
# lags with the largest value. Only valid for Hp, Mp, and Ms pulses.
# vernier to define the finest time division
# TIME_VERNIER is calculated by quadratically interpolating the three
# lags with the largest value. Only valid for hi-res and mid-res pulses
# NOTE got lost event time vernier is set to start+23 and stop-8 see GTI lost
# for Baseline is should be set to 0 in the telemetry
# Origin: pre-pipeline from telemetry
TTYPE# = 'TIME_VERNIER'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 15
TCOMM# = 'vernier to define the finest time division'

# Column name: PHA
# Description: pulse height amplitude
# PHA is the pulse-height calculated by the long (Hp) or short (Mp, Ms)
# optimal filter, or by a direct peak-height measurement (Lp, Ls), as
# indicated by the TYPE colum. The PHA values range 0 to 65535 for non-
# baseline pulses (Hp, Mp, Ms, Lp, Ls) and -32768 to 32767 for baseline
# pulses (BL). PHA is the pulse-height calculated by the hi-res or
# mid-res optimal filter, or by a direct peak-height measurement,
# as indicated by lowRes flags. Ranging 0 to 65535 for non-baseline pulses
# and -32768 to 32767 for baseline pulses.
```

```
# Origin: pre-pipeline from telemetry
TTYPE# = 'PHA'
TFORM# = '1J'
TNULL# = 2147483647
TLMIN# = -32768
TLMAX# = 65535
TCOMM# = 'Pulse height amplitude"

# Column name: FLAGS
# Description: combination of event flags
# FLAGS = 0x20*SLOPE_DIFFER + 0x10*QUICK_DOUBLE + ITYPE(0-7)
# FLAGS  QUICKDOUBLE*32 + SLOPE_DIFFER*16 + ITYPE
# No used in software
# Origin: calculated in pre-pipeline
TTYPE# = 'FLAGS'
TFORM# = '1B'
TCOMM# = 'Combination of event flags'

# Column name: EL_LOST_CNT
# Description: number of the lost events for TYPE='EL'
# Number of lost event in the start and stop time of the lost time interval
# No used in software
# Origin: pre-pipeline from telemetry
TTYPE# = 'EL_LOST_CNT'
TFORM# = '1I'
TZERO# = 32768
TCOMM# = 'number of the lost events for TYPE=EL'

# Column name: EL_REASON
# Description: reason why the event lost occured for TYPE='EL'
#reason for which the events are lost TYPE='LO'
# value  0 = EDB overflow, 1 = 1st FIFO overflow, 2 = pulse data in WFRB is lost.
# No used in software
# Origin: pre-pipeline from telemetry
TTYPE# = 'EL_REASON'
TFORM# = '1B'
TNULL# = 255
TCOMM# = 'Reason why the event TYPE=EL are lost'

# Column name: EL_STOP_LP
# Description: lap & pointer to WFRB when the event lost stop
# Stop time for the LO events Used in software
# Origin: pre-pipeline from telemetry
TTYPE# = 'EL_STOP_LP'
TFORM# = '1J'
TNULL# = 2147483647
TCOMM# = 'lap & pointer of WFRB when event lost stop'

# Column name: PREV_INTERVAL
# Description: interval from previous event in unit of tick
# Origin: pre-pipeline calculated
TTYPE# = 'PREV_INTERVAL'
TFORM# = '1I'
TZERO# = 32768
TCOMM# = 'Interval from previous event in unit of tick"

# Column name: NEXT_INTERVAL
# Description: inverval to next event in unit of tick
# Origin: pre-pipeline calculated
TTYPE# = 'NEXT_INTERVAL'
TFORM# = '1I'
TZERO# = 32768
TCOMM# = 'Interval to next event in unit of tick'

# Column name: SAMPLECNT
# Description: SAMPLE_CNT corrected for RISE_TIME
# number of samples since the last tick calculated from TRIG_LP and TIME_VERNIER
# This is the arrival time TIME= SAMPLECNT--a*(0.25*RISE_TIME)-b*DERIV_MAX-c
# Origin:  pre-pipeline from software
TTYPE# = 'SAMPLECNT'
TFORM# = '1D'
```

```
TCOMM# = ‘Used to calculate TIME'

# Column name: SAMPLECNTTRIG
# Description:  number of samples since the last tick calculated from TRIG_LP
# and TIME_VERNIER. Used to calculate TRIGTIME= SAMPLECNT. This is for the TRigger time
# Origin: pre-pipeline from software
TTYPE# = 'SAMPLECNTTRIG'
TFORM# = '1D'
TCOMM# = ‘Used to calculate TRIGTIME'

# Column name: ACTX
# Description: pixel center on ACT-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'ACTX'
TFORM# = '1B'
TNULL# = 255
TLMIN# = 1
TLMAX# = 8
TCOMM# = 'Pixel X  on ACT-coordinate'

# Column name: ACTY
# Description: pixel center Y on ACT-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'ACTY'
TFORM# = '1B'
TNULL# = 255
TLMIN# = 1
TLMAX# = 8
TCOMM# = 'Pixel Y  on ACT-coordinate'

# Column name: DETX
# Description: pixel  X on DET-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'DETX'
TFORM# = '1B'
TNULL# = 255
TLMIN# = 1
TLMAX# = 8
TCOMM# = 'Pixel X  on DET-coordinate'

# Column name: DETY
# Description: pixel center Y on DET-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'DETY'
TFORM# = '1B'
TNULL# = 255
TLMIN# = 1
TLMAX# = 8
TCOMM# = 'Pixel Y  on DET-coordinate'

# Column name: FOCX
# Description: pixel center X on FOC-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'FOCX'
TFORM# = '1I'
TNULL# = -1
TLMIN# = 1
TLMAX# = 1810
TCOMM# = 'Pixel X  on FOC-coordinate'

# Column name: FOCY
# Description: pixel center Y on FOC-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'FOCY'
TFORM# = '1I'
TNULL# = -1
TLMIN# = 1
TLMAX# = 1810
TCOMM# = 'Pixel Y  on FOC-coordinate'

# Column name: X
```

```
# Description: pixel center X on SKY-coordinate (look-up)
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'X'
TFORM# = '1I'
TNULL# = -1
TLMIN# = 1
TLMAX# = 1810
TCOMM# = 'Pixel X  on SKY-coordinate'

# Column name: Y
# Description: pixel center Y on SKY-coordinate (look-up)
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'Y'
TFORM# = '1I'
TNULL# = -1
TLMIN# = 1
TLMAX# = 1810
TCOMM# = 'Pixel Y  on SKY-coordinate'

# Column name: UPI
# Description: Approximate PHA conversion to eV
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'UPI'
TFORM# = '1E'
TCOMM# = 'Approximate PHA conversion to eV'

# Column name: EPI
# Description: PI in unit of eV before truncated to integer
# EPI energy in eV contains calculation for primary and secondary
# but treating the secondary as primary (This is regardless if the secondary
# have the proper correction see EPI2)
# EPI = funcTion (UPI, T) gain correction (Cal pixel, iron55 and MXS)
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'EPI'
TFORM# = '1E'
TCOMM# = 'PHA to eV as all events are primary'

# Column name: EPI2
# Description: same as EPI for primary, adjusted for secondary
# EPI2 energy in keV contains calculation for the primary treated
# and secondary treated as secondary only if the calibration for primary
# is provided otherwise will be = EPI
# EPI = funcTion (UPI, T) gain correction (Cal pixel, iron55 and MXS)
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'EPI2'
TFORM# = '1E'
TCOMM# = 'As EPI but Ms/Ls with secondary correction'

# Column name: PI
# Description: pulse height invariant after gain correction
#For Event PI 0-32768 0.5 eV/ch 0-16 keV Hp Mp Ms Lp Ls
# For baseline -16384 16383
# PI=floor(EPI*2+0.5) check the accuracy since we move from Real to Integer
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'PI'
TFORM# = '1J'
TNULL# = -32768
TLMIN# = -16384
TLMAX# = 32768
TCOMM# = 'Pulse Invariant after gain correction'

# Column name: INDEX
# Description: incremental value to index events in a file
# index is a incremental value to index the events in the file
# this is used to calculate GROUPS
# Origin: insert empty pre-pipeline empty populated pipeline
TTYPE# = 'INDEX'
TFORM# = '1J'
TCOMM# = 'Index incrementally the events'

# Column name: GROUPS
```

```
# Description: GROUPS used to group the secondary sxssecid
# The value assigned is the INDEX of the primary event
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'GROUPS'
TFORM# = '1J'
TNULL# = -9999
TCOMM# = 'Associate primary and secondary'

# Column name: CTMULT
# Description: used to record multiplicity for crosstalk
# NOT NEEDED to be created by the PRE-pipeline listed for completness
# used to record the multiplicity for cross-talk electrical
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'CTMULT'
TFORM# = '1I'
TCOMM# = 'Record multiplicity for electrical cross-talk,Äô

# Column name: STATUS
# Description: flag an event, a) recoil crosstalk, b) electrical
# crosstalk, c) antico, d) MXS
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'STATUS'
TFORM# = '16X'
TCOMM# = 'Events Flag:recoil,elect,antico,MXS'

# Column name: PROC_STATUS
# Description: pipe-line processing status
# Origin: pre-pipeline calculated from software
TTYPE# = 'PROC_STATUS'
TFORM# = '32X'
TCOMM# = ‘Record bad telemetry or bad values’
```

SXS GTILOST PIXEL

```
 #------------------------------------------------------------
 #------------------------------------------------------------
 # Columns for FFF
 #------------------------------------------------------------
 #------------------------------------------------------------
 #
 # NOTE This file contains the GTI of the SXS lost events intervals
 # detected for all pixels The LOST are for each pixels.
 # The file includes information from the packets
 # PSPA0.PIX PSPA1.PIX PSPB0.PIX PSPB1.PIX and the pre-pipeline
 # add a column, PSP_ID, indicating where the PSP telemetry packet.
 #
 #number of rows
 #
 # Description: Time since 2014-01-01 00:00:00
 # Origin pre-pipeline calculated from software
 # TIME copy of START
 ttype# = TIME
 tform# = 1D
 tunit# ='s'
 TCOMM# = ‘Seconds from 01 Jan 2014 00:00:00’

 #
 # Origin pre-pipeline calculated from software
 ttype# = START
 tform# = 1D
 tunit# ='s'
 tcomm# = 'Start interval time'

 # Origin pre-pipeline calculated from software
 ttype# = STOP
 tform# = 1D
 tunit# ='s'
 tcomm# = 'Stop interval time'

# Column name: S_TIME
# Description: time of CCSDS packet stamped by SIRIUS
# Origin: pre-pipeline from telemetry 2^-6 s
```

```
TTYPE# = 'S_TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Time for CCSDS packet stamped by SIRIUS’

# Column name: L32TI
# Description: lower 32 bit TI of the event packet
# Origin: pre-pipeline from telemetry
TTYPE# = 'L32TI'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Packet TI lower 32b, 2^-6 s’

# Column name: CATEGORY
# Description: CATEGORY in SMCP header for DR priority (0-127)
# Origin: pre-pipeline from telemetry
TTYPE# = 'CATEGORY'
TFORM# = '1B'
TCOMM# = ‘Data recorder priority’

# Column name: ADU_CNT
# Description: ADU sequence counter of the event packet
# (0-255) in the main header. ADU_CNT allow to check if packet is lost
# Origin: pre-pipeline from telemetry
TTYPE# = 'ADU_CNT'
TFORM# = '1B'
TCOMM# = ‘ADU sequence packet counter’

# Column name: PSP_ID
# Description: 0:PSP-A0, 1:A1, 2:B0, 3:B1
# Origin: pre-pipeline from telemetry
TTYPE# = 'PSP_ID'
TFORM# = '1B'
TCOMM# = ‘0=PSP-A0 1=A1 2=B0 3=B1’
#
#=========================== PXP_EVT_HEADER
#
# Column name: FORMAT_VER
# Description: version of the event packet format
# Origin: pre-pipeline from telemetry
TTYPE# = 'FORMAT_VER'
TFORM# = '1B'
TCOMM# = ‘Packet format version’

# Column name: WFRB_WRITE_LP
# Description: lap & pointer to WFRB for writing ADC sample
# WFRB position where the FPGA is recording the ADC
# sample and derivative when the CPU edits the event packet
# (reference time for the whole packet); consists of present lap (6 bit) +
# pointer (18 bit) of the WFRB.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_WRITE_LP'
TFORM# = '1J'
TCOMM# = ‘Lap & pointer of WFRB to write ADC sample’

# Column name: WFRB_SAMPLE_CNT
# Description: SAMPLE_CNT corresponding to top of WFRB
#free-run counter of the SAMPLE_CNT,corresponding to the recording ADC sample & derivative, AS
above.
#  (nominal sample rate of 12.5 kHz; SAMPLE_CNT wraps around in ~ 4 dy.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_SAMPLE_CNT'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Sample count for the top of WFRB’

# Column name: NUM_ELEM
# Description: number of element in the event packet
# Number of elements in the PSP packet;
# an element is either a pulse (event) and/or a noise (baseline) record, or lost count
# potential too scale down as byte
```

```
# Origin: pre-pipeline from telemetry
TTYPE# = ‘NUM_ELEM’
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 255
TCOMM# = ‘Number of element in the event packet’

# Column name: SUM_LOST_CNT
# Description: sum of the lost cnt in the event packet
# Number of lost count records for the packet
# These is the number of events lost in the entire packet
# Origin: pre-pipeline from telemetry
TTYPE# = 'SUM_LOST_CNT'
TFORM# = '1J'
TCOMM# ='Sum of lost count in the event packet'

#========================== PXP_EVT_LOST
#
# Column name: ITYPE
# Description: 0:Hp, 1:Mp, 2:Ms, 3:Lp, 4:Ls, 5:BL, 6:EL, 7:--
# event type (event or baseline)
# 0=Hp 1=Mp 2=Ms 3=Lp 4=Ls 5=BL 6=EL 7=Rj (notused)
# 6= LOST_EVT_TYPE
# Origin: pre-pipeline from telemetry
TTYPE# = 'ITYPE'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 7
TCOMM# = '0:Hp 1:Mp 2:Ms 3:Lp 4:Ls 5:BL 6:EL 7:--'

# Column name: TYPE
# Description: Hp/Mp/Ms/Lp/Ls/BL/LE/Rj
# the char version of ITYPE
# Convention of type into characters
# pre pipeline need to convert from ITYPE
# 0=Hp 1=Mp 2=Ms 3=Lp 4=Ls 5=BL 6=EL 7=Rj (not used)
# Origin: pre-pipeline calculated
TTYPE# = 'TYPE'
TFORM# = '2A'
TCOMM# = 'Hp,Mp,Ms,Lp,Ls,BL,EL,Rj according to ITYPE

# Column name: IPIX
# Description: pixel number (0-17) inside each PSP, PIXEL % 18
#Set for event or baseline
# This value ranges from 0-17 even if each quadrant record max 9 pixels
# Specifically A0=B0=0-9 A1=B1=9-17
# O=PSP_A0 1=PSP_A1 2=PSP_B0 3=PSP_B1
# pixel =31 is assigned to NULL (some sort of lost event)
# Origin:  pre-pipeline from telemetry
TTYPE# = 'IPIX'
TFORM# = '1B'
TNULL# = 31
TLMIN# = 0
TLMAX# = 17
TCOMM# = 'pixel number (0-17) in each PSP'

# Column name: PIXEL
# Description: detected pixel number [0-35]
# Valid for event or baseline
# PIXEL= IPIX + int(PSP_ID/2)*18
# where PSP_AO PSP_A1 contribute always 0
# and PSP_B0 PSP_B1 contribute always 1
# Origin: calculated pre-pipeline from telemetry
TTYPE# = 'PIXEL'
TFORM# = '1B'
TNULL# = 63
TLMIN# = 0
TLMAX# = 35
TCOMM# = ‘Pixel Number range 0-35’

# Column name: EL_REASON
```

```
# Description: reason why the event lost occured for TYPE='EL'
#reason for which the events are lost TYPE='LO'
# value  0 = EDB overflow, 1 = 1st FIFO overflow, 2 = pulse data in WFRB is lost.
# No used in software
# Origin: pre-pipeline from telemetry
TTYPE# = 'EL_REASON'
TFORM# = '1B'
TNULL# = 255
TCOMM# = 'Reason why the event TYPE=EL are lost'
 #
 # Description Number of lost event in the start and stop time of the lost time interval
 # PXP_EVT_LOST LOST_EVT_PIXEL
 # Origin: pre-pipeline from telemetry
 ttype# = EL_LOST_CNT
 tform# = 1I
 TCOMM#= 'Number of the lost events for TYPE=EL'
 #
 #
 # Description : lost event interval start time
 # (telemetered value is set to the last valid event)
 # To calculate START need to calculate SAMPLECNT1
 # To calculate SAMPLECNT1 need to define TIME_VERNIER.
 # TIME_VERNIER is running between 0-15
 # For this TIME_VERNIER is artificially increase to avoid removing the event
 # START (& TIME) is set in the code as EL_START_LP+23
 # Note: start of the lost are added 8 TIME Vernier to avoid removing the event
 # PXP_EVT_LOST  EL_START_LP =  TRIG_LP
 # Origin: pre-pipeline from telemetry
 ttype# = EL_START_LP
 tform# = 1J
 TCOMM# ='Start of the lost event interval'
 #
 # Description : lost event interval stop time (telemetered value is set to the next valid event)
 # To calculate START need to calculate SAMPLECNT2
 # To calculate SAMPLECNT2 need to define TIME_VERNIER. TIME_VERNIER is running between 0-15
 # For this TIME_VERNIER is artificially increase to avoid removing the event
 # STOP (& TIME) is set in the code as EL_STOP_LP-8
 # Note: start of the lost are added 8 TIME Vernier to avoid removing the event
 # PXP_EVT_LOST EL_EVT_STOP_LP
 # Origin: pre-pipeline from telemetry
 ttype# = EL_STOP_LP
 tform# = 1J
 TCOMM# ='Stop of the lost event interval'

 # Description: number of samples since the last tick
 # Calculated from WFRB_SAMPLE_CNT LOST_START_LP and TIME_VERNIER in pipeline
 # (TIME_VERNIER=23)
 # Origin: pre-pipeline calculted from software
 ttype# = SAMPLECNT1
 tform# = 1D
 TCOMM# = 'Used to calculate START'
 #
 # Description: number of samples since the last tick
 # Calculated from WFRB_SAMPLE_CNT LOST_STOP_LP and TIME_VERNIER in pipeline
 # (TIME_VERNIER=-8)
 # Origin: pre-pipeline       calculted from software
 ttype# = SAMPLECNT2
 tform# = 1D
 TCOMM# = 'Used to calculate STOP'
 #
 #
 # Column name: PROC_STATUS
# Description: pipe-line processing status
# Origin: pre-pipeline calculated from software
TTYPE# = 'PROC_STATUS'
TFORM# = '32X'
TCOMM# = ‘Record bad telemetry or bad values’
```

SXS EVENT PIXEL NOISEREC

```
xtension=bintable
```

```
#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns for FFF
#-------------------------------------------------------------
#-------------------------------------------------------------
#
# NOTE: This file contains the SXS pixel noiserec
# The pipeline expects to find the columns ACTX ACTY DETX DETY FOCX FOCY X Y
# Th epipeline partially fills the columns where possible
#number of rows
 naxis2 = 1

### EVENT NOISEPIXEL
#
# Column name: TIME
# Description: Time since 2014-01-01 00:00:00
# Arrival Time SAMPLECNT1. Arrival time of the pulse
# Origin: pre-pipeline calculated from software
TTYPE# = 'TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Seconds from 01 Jan 2014 00:00:00’

# Column name: TRIGTIME
# Description: Time corresponding to the trigger time calculated with SAMPLECNT2
# Origin: pre-pipeline calculated from software
TTYPE# = 'TRIGTIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Trigger Time of the pulse'

# Column name: S_TIME
# Description: time of CCSDS packet stamped by SIRIUS
# Origin: pre-pipeline from telemetry 2^-6 s
TTYPE# = 'S_TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Time for CCSDS packet stamped by SIRIUS’

# Column name: L32TI
# Description: lower 32 bit TI of the event packet
# Origin: pre-pipeline from telemetry
TTYPE# = 'L32TI'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Packet TI lower 32b, 2^-6 s’

# Column name: CATEGORY
# Description: CATEGORY in SMCP header for DR priority (0-127)
# Origin: pre-pipeline from telemetry
TTYPE# = 'CATEGORY'
TFORM# = '1B'
TCOMM# = ‘Data recorder priority’

# Column name: ADU_CNT
# Description: ADU sequence counter of the event packet
# (0-255) in the main header. ADU_CNT allow to check if packet is lost
# Origin: pre-pipeline from telemetry
TTYPE# = 'ADU_CNT'
TFORM# = '1B'
TCOMM# = ‘ADU sequence packet counter’

# Column name: PSP_ID
# Description: 0:PSP-A0, 1:A1, 2:B0, 3:B1
# Origin: pre-pipeline from telemetry
TTYPE# = 'PSP_ID'
TFORM# = '1B'
TCOMM# = ‘0=PSP-A0 1=A1 2=B0 3=B1’

# Column name: FLG_COMPRESS
```

```
# Description: if 1, records are compressed with Huffman table
# Origin: pre-pipeline from telemetry
TTYPE# = 'FLG_COMPRESS'
TFORM# = '1X'
TCOMM# = 'If 1, records are compressed with Huffman table'

# Column name: FLG_NOISESPC
# Description: if 1, used for the noise spectrum calculation
# Origin: pre-pipeline from telemetry
TTYPE# = 'FLG_NOISESPC'
TFORM# = '1X'
TCOMM# = 'If 1, used for the noise spectrum calculation'

# Column name: FORMAT_VER
# Description: version of the event packet format
# Origin: pre-pipeline from telemetry
TTYPE# = 'FORMAT_VER'
TFORM# = '1B'
TCOMM# = ‘Packet format version’

# Column name: WFRB_WRITE_LP
# Description: lap & pointer to WFRB for writing ADC sample
# WFRB position where the FPGA is recording the ADC
# sample and derivative when the CPU edits the event packet
# (reference time for the whole packet); consists of present lap (6 bit) +
# pointer (18 bit) of the WFRB.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_WRITE_LP'
TFORM# = '1J'
TCOMM# = ‘Lap & pointer of WFRB to write ADC sample’

# Column name: WFRB_SAMPLE_CNT
# Description: SAMPLE_CNT corresponding to top of WFRB
#free-run counter of the SAMPLE_CNT,corresponding to the recording ADC sample & derivative, AS
above.
#  (nominal sample rate of 12.5 kHz; SAMPLE_CNT wraps around in ~ 4 dy.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_SAMPLE_CNT'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Sample count for the top of WFRB’

# Column name: RECORD_LEN
# Description: record length, either 1024 (1K) or 2048 (2K)
# Origin: pre-pipeline from telemetry
TTYPE# = 'RECORD_LEN'
TFORM# = '1I'
TCOMM# = 'Record length, either 1024 (1K) or 2048 (2K)'

# Column name: ERR_CNT
# Description: number of error samples in the pulse record
# Origin: pre-pipeline from telemetry
TTYPE# = 'ERR_CNT'
TFORM# = '1I'
TZERO# = 32768
TCOMM# = 'Number of error samples in the pulse record'

# Column name: NOISE_CLEAN_LEN
# Description: clean length for the noise record
# Origin: pre-pipeline from telemetry
TTYPE# = 'NOISE_CLEAN_LEN'
TFORM# = '1I'
TZERO# = 32768
TCOMM# ='Clean length for the noise record'

# Column name: NOISE_TAIL_MARGIN
# Description: margin of samples at the tail of noise record
# Origin: pre-pipeline from telemetry
TTYPE# = 'NOISE_TAIL_MARGIN'
TFORM# = '1B'
TCOMM# ='margin of samples at the tail of noise record'
```

```
# Column name: EDB_PARITY_ERR
# Description: FLG_PARITY_ERR in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_PARITY_ERR'
TFORM# = '1B'
TCOMM# = 'FLG_PARITY_ERR in EDB

# Column name: EDB_SPARE
# Description: SPARE in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_SPARE'
TFORM# = '1B'
TCOMM# = 'SPARE in EDB'

# Column name: EDB_IPIX
# Description: PIXEL in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_IPIX'
TFORM# = '1B'
TCOMM# ='PIXEL in EDB'

# Column name: EDB_TRIG_LP
# Description: TRIG_LP in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_TRIG_LP'
TFORM# = '1J'
TCOMM# = 'TRIG_LP in EDB'

# Column name: EXP_WORD_LEN
# Description: word length of the expanded data
# Origin: pre-pipeline from telemetry
TTYPE# = 'EXP_WORD_LEN'
TFORM# = '1I'
TCOMM# ='Word length of the expanded data'

# Column name: EL_LOST_CNT
# Description: number of the lost events for TYPE='EL'
# Number of lost event in the start and stop time of the lost time interval
# No used in software
# Origin: pre-pipeline from telemetry
TTYPE# = 'EL_LOST_CNT'
TFORM# = '1I'
TZERO# = 32768
TCOMM# = 'number of the lost events for TYPE=EL'

# Column name: EL_REASON
# Description: reason why the event lost occured for TYPE='EL'
#reason for which the events are lost TYPE='LO'
# value  0 = EDB overflow, 1 = 1st FIFO overflow, 2 = pulse data in WFRB is lost.
# No used in software
# Origin: pre-pipeline from telemetry
TTYPE# = 'EL_REASON'
TFORM# = '1B'
TNULL# = 255
TCOMM# = 'Reason why the event TYPE=EL are lost'

# Column name: EL_STOP_LP
# Description: lap & pointer to WFRB when the event lost stop
# Stop time for the LO events Used in software
# Origin: pre-pipeline from telemetry
TTYPE# = 'EL_STOP_LP'
TFORM# = '1J'
TNULL# = 2147483647
TCOMM# = 'lap & pointer of WFRB when event lost stop'

# Column name: ITYPE
# Description: 0:Hp, 1:Mp, 2:Ms, 3:Lp, 4:Ls, 5:BL, 6:EL, 7:--
# event type (event or baseline)
# 0=Hp 1=Mp 2=Ms 3=Lp 4=Ls 5=BL 6=EL 7=Rj (notused)
# 6= LOST_EVT_TYPE
```

```
# Origin: pre-pipeline from telemetry
TTYPE# = 'ITYPE'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 7
TCOMM# = '0:Hp 1:Mp 2:Ms 3:Lp 4:Ls 5:BL 6:EL 7:--'

# Column name: TYPE
# Description: Hp/Mp/Ms/Lp/Ls/BL/LE/Rj
# the char version of ITYPE
# Convention of type into characters
# pre pipeline need to convert from ITYPE
# 0=Hp 1=Mp 2=Ms 3=Lp 4=Ls 5=BL 6=EL 7=Rj (not used)
# Origin: pre-pipeline calculated
TTYPE# = 'TYPE'
TFORM# = '2A'
TCOMM# = 'Hp,Mp,Ms,Lp,Ls,BL,EL,Rj according to ITYPE'

# Column name: IPIX
# Description: pixel number (0-17) inside each PSP, PIXEL % 18
#Set for event or baseline
# This value ranges from 0-17 even if each quadrant record max 9 pixels
# Specifically A0=B0=0-9 A1=B1=9-17
# O=PSP_A0 1=PSP_A1 2=PSP_B0 3=PSP_B1
# pixel =31 is assigned to NULL (some sort of lost event)
# Origin:  pre-pipeline from telemetry
TTYPE# = 'IPIX'
TFORM# = '1B'
TNULL# = 31
TLMIN# = 0
TLMAX# = 17
TCOMM# = 'pixel number (0-17) in each PSP'

# Column name: PIXEL
# Description: detected pixel number [0-35]
# Valid for event or baseline
# PIXEL= IPIX + int(PSP_ID/2)*18
# where PSP_AO PSP_A1 contribute always 0
# and PSP_B0 PSP_B1 contribute always 1
# Origin: calculated pre-pipeline from telemetry
TTYPE# = 'PIXEL'
TFORM# = '1B'
TNULL# = 63
TLMIN# = 0
TLMAX# = 35
TCOMM# = 'Pixel Number range 0-35'

# Column name: TRIG_LP
# Description: lap & pointer to WFRB for the triggered event
# lap (6 bit) + pointer (18 bit) when the event triggers
# NOTE: This stored two meaning a) the trigger time for event or BL or
# b) the start time of the lost event interval LOST_EVT_START_LP
# Note b) is calculated as usual and the ITYPE flag that is
# time associated to the start time of the lost event
# Set for event or baseline or Lost
# Origin: pre-pipeline from telemetry
TTYPE# = 'TRIG_LP'
TFORM# = '1J'
TNULL# = 2147483647
TCOMM# = 'Lap & pointer to WFRB for the row'

# Column name: QUICK_DOUBLE
# Description: quick-double flag for double pulse
# lag indicating the presence of a quick second pulse
# during the fall of the main pulse.
# Value 1 = means that there is a quick double event "and the PHA
# is not calculated correctly"
# Need to be checked in the ground software
# FOR BASELINE IS SET = 0
# Set for event or baseline
# Origin: pre-pipeline from telemetry
```

```
TTYPE# = 'QUICK_DOUBLE'
TFORM# = '1X'
TCOMM# = 'Flag set to 1 for double pulse'

# Column name: SLOPE_DIFFER
# Description: slope-differ flag for invalid pulse shape
# the mean square difference from the mean derivative (?)
# Value 1 identify an invalid pulse shape
# Need to be checked on ground software
# FOR BASELINE IS SET = 0
# Set for event or baseline
# Origin: pre-pipeline from telemetry
TTYPE# = 'SLOPE_DIFFER'
TFORM# = '1X'
TCOMM# = 'Flag set to 1 for invalid pulse shape'

# Column name: LO_RES_PH
# Description: low resolution pulse height, determined in the
# same way for the Lp and Ls pulses
# direct peak-height measurement used as PHA for low-res events
# This value is the peak height of the pulse. For Ls and Lp  this is the same
# as stored in the pha column otherwise for all other grade
# is a rough estimate of the  PHA value
# For BASELINE is set as first value of ADC sample in Noise Record.
# For Baseline -8192 8192
# Origin: pre-pipeline from telemetry
TTYPE# = 'LO_RES_PH'
TFORM# = '1I'
TLMIN# = -8192
TLMAX# = 16383
TCOMM# = 'Pulse height calculates as for Lp/Ls'

# Column name: DERIV_MAX
# Description: maximum value of the derivative
# maximum value of derivative form boxcar filtering of samples
# What is the value for BASELINE event: dump the telemetry but have no meaning
# No needed in the ground software
# Origin: pre-pipeline from telemetry
TTYPE# = 'DERIV_MAX'
TFORM# = '1I'
TLMIN# = -32768
TLMAX# = 32767
TCOMM# = 'Maximum value of the derivative'

# Column name: RISE_TIME
# Description: rise-time in unit of 1/4 tick (20 us nominal).
# RISE_TIME in telemetry is 8 bit (0-255), however, MSB is assigned for
# a slow-pulse flag. Valid range of RISE_TIME is 0-127, hence TLMAX=127.
# It is calculated by fitting a line to a number of points on
#              the rising edge of the pulse
# What is the value for BASELINE event : dump the telemetry but have no meaning
# but BASELINE should be 0
# Origin: pre-pipeline from telemetry
TTYPE# = 'RISE_TIME'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 127
TCOMM# = 'rise-time in unit of 1/4 tick (20 us nominal)'

# Column name: TICK_SHIFT
# Description: number of shift in unit of tick to find the PHA
# maximum in cross-correlating with the template (optimal filter)
# ow 4-bits of the 32-bit tick counter
# TICK_SHIFT is a shift of template relative to the observed waveform.
# Not used in the time assignment but to evaluate the pulse template
# in the PSP algorithm. What is the value for BASELINE event : dump
# the telemetry but have no meaning  but BASELINE should be 0
# Not used in the software
# Origin: pre-pipeline from telemetry
TTYPE# = 'TICK_SHIFT'
TFORM# = '1B'
```

```
TNULL# = -128
TLMIN# = -8
TLMAX# = 7
TZERO# = -128
TCOMM# = 'number of shift in unit of tick to find the PHA'

# Column name: TIME_VERNIER
# Description: vernier to define the finest time division
# TIME_VERNIER is calculated by quadratically interpolating the three
# lags with the largest value. Only valid for Hp, Mp, and Ms pulses.
# vernier to define the finest time division
# TIME_VERNIER is calculated by quadratically interpolating the three
# lags with the largest value. Only valid for hi-res and mid-res pulses
# NOTE got lost event time vernier is set to start+23 and stop-8 see GTI lost
# for Baseline is should be set to 0 in the telemetry
# Origin: pre-pipeline from telemetry
TTYPE# = 'TIME_VERNIER'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 15
TCOMM# = 'vernier to define the finest time division'

# Column name: PHA
# Description: pulse height amplitude
# PHA is the pulse-height calculated by the long (Hp) or short (Mp, Ms)
# optimal filter, or by a direct peak-height measurement (Lp, Ls), as
# indicated by the TYPE colum. The PHA values range 0 to 65535 for non-
# baseline pulses (Hp, Mp, Ms, Lp, Ls) and -32768 to 32767 for baseline
# pulses (BL). PHA is the pulse-height calculated by the hi-res or
# mid-res optimal filter, or by a direct peak-height measurement,
# as indicated by lowRes flags. Ranging 0 to 65535 for non-baseline pulses
# and -32768 to 32767 for baseline pulses.
# Origin: pre-pipeline from telemetry
TTYPE# = 'PHA'
TFORM# = '1J'
TNULL# = 2147483647
TLMIN# = -32768
TLMAX# = 65535
TCOMM# = 'Pulse height amplitude"

# Column name: FLAGS
# Description: combination of event flags
# FLAGS = 0x20*SLOPE_DIFFER + 0x10*QUICK_DOUBLE + ITYPE(0-7)
# FLAGS  QUICKDOUBLE*32 + SLOPE_DIFFER*16 + ITYPE
# No used in software
# Origin: calculated in pre-pipeline
TTYPE# = 'FLAGS'
TFORM# = '1B'
TCOMM# = 'Combination of event flags'

# Column name: NOISEREC_MODE
# Description: mode of NOISEREC, 0:adc_sample, 1:derivative,
# 2:adc_sample by command, 3:derivative by command
# Origin: calculated in pre-pipeline
TTYPE# = 'NOISEREC_MODE'
TFORM# = '1B'
TCOMM# = '0:adc_sample 1:deriv; 2&3:as 0&1 by command'

# Column name: NOISEREC
# Description: 8 pre-samples + noise data + 8 post-samples
# Origin: calculated in pre-pipeline
TTYPE# = 'NOISEREC'
TFORM# = '1024I'
TCOMM# = '8 pre-samples + noise data + 8 post-samples'

# Column name: NOISE_SEQ_CNT
# Description: sequential count of clean noise in a pixel
# Origin: calculated in pre-pipeline
TTYPE# = 'NOISE_SEQ_CNT'
TFORM# = '1B'
TCOMM# = 'Sequential count of clean noise in a pixel'
```

```
# Column name: COMPDATA
# Description: compressed data in telemetry
# Origin: calculated in pre-pipeline
TTYPE# = 'COMPDATA'
TFORM# = '1640B'
TCOMM# = 'Compressed data in telemetry'

# Column name: COMP_BYTE_LEN
# Description: byte length of the compressed data
# Origin: calculated in pre-pipeline
TTYPE# = 'COMP_BYTE_LEN'
TFORM# = '1I'
TCOMM# = 'Byte length of the compressed data'

# Column name: PREV_INTERVAL
# Description: interval from previous event in unit of tick
# Origin: pre-pipeline calculated
TTYPE# = 'PREV_INTERVAL'
TFORM# = '1I'
TZERO# = 32768
TCOMM# = 'Interval from previous event in unit of tick"

# Column name: NEXT_INTERVAL
# Description: inverval to next event in unit of tick
# Origin: pre-pipeline calculated
TTYPE# = 'NEXT_INTERVAL'
TFORM# = '1I'
TZERO# = 32768
TCOMM# = 'Interval to next event in unit of tick'

# Column name: SAMPLECNT
# Description: SAMPLE_CNT corrected for RISE_TIME
# number of samples since the last tick calculated from TRIG_LP and TIME_VERNIER
# This is the arrival time TIME= SAMPLECNT--a*(0.25*RISE_TIME)-b*DERIV_MAX-c
# Origin:  pre-pipeline from software
TTYPE# = 'SAMPLECNT'
TFORM# = '1D'
TCOMM# = Used to calculate TIME'

# Column name: SAMPLECNTTRIG
# Description:  number of samples since the last tick calculated from TRIG_LP
# and TIME_VERNIER. Used to calculate TRIGTIME= SAMPLECNT. This is for the TRigger time
# Origin: pre-pipeline from software
TTYPE# = 'SAMPLECNTTRIG'
TFORM# = '1D'
TCOMM# = Used to calculate TRIGTIME'

# Column name: INDEX
# Description: incremental value to index events in a file
# index is a incremental value to index the events in the file
# this is used to calculate GROUPS
# Origin: insert empty pre-pipeline empty populated pipeline
TTYPE# = 'INDEX'
TFORM# = '1J'
TCOMM# = 'Index incrementally the events'

# Column name: GROUPS
# Description: GROUPS used to group the secondary sxssecid
# The value assigned is the INDEX of the primary event
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'GROUPS'
TFORM# = '1J'
TNULL# = -9999
TCOMM# = 'Associate primary and secondary'

# Column name: CTMULT
# Description: used to record multiplicity for crosstalk
# NOT NEEDED to be created by the PRE-pipeline listed for completness
# used to record the multiplicity for cross-talk electrical
# Origin: insert empty pre-pipeline populated pipeline
```

```
TTYPE# = 'CTMULT'
TFORM# = '1I'
TCOMM# = 'Record multiplicity for electrical cross-talk

# Column name: ACTX
# Description: pixel center on ACT-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'ACTX'
TFORM# = '1B'
TNULL# = 255
TLMIN# = 1
TLMAX# = 8
TCOMM# = 'Pixel X  on ACT-coordinate'

# Column name: ACTY
# Description: pixel center Y on ACT-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'ACTY'
TFORM# = '1B'
TNULL# = 255
TLMIN# = 1
TLMAX# = 8
TCOMM# = 'Pixel Y  on ACT-coordinate'

# Column name: DETX
# Description: pixel  X on DET-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'DETX'
TFORM# = '1B'
TNULL# = 255
TLMIN# = 1
TLMAX# = 8
TCOMM# = 'Pixel X  on DET-coordinate'

# Column name: DETY
# Description: pixel center Y on DET-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'DETY'
TFORM# = '1B'
TNULL# = 255
TLMIN# = 1
TLMAX# = 8
TCOMM# = 'Pixel Y  on DET-coordinate'

# Column name: FOCX
# Description: pixel center X on FOC-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'FOCX'
TFORM# = '1I'
TNULL# = -1
TLMIN# = 1
TLMAX# = 1810
TCOMM# = 'Pixel X  on FOC-coordinate'

# Column name: FOCY
# Description: pixel center Y on FOC-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'FOCY'
TFORM# = '1I'
TNULL# = -1
TLMIN# = 1
TLMAX# = 1810
TCOMM# = 'Pixel Y  on FOC-coordinate'

# Column name: X
# Description: pixel center X on SKY-coordinate (look-up)
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'X'
TFORM# = '1I'
TNULL# = -1
TLMIN# = 1
```

```
TLMAX# = 1810
TCOMM# = 'Pixel X  on SKY-coordinate'

# Column name: Y
# Description: pixel center Y on SKY-coordinate (look-up)
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'Y'
TFORM# = '1I'
TNULL# = -1
TLMIN# = 1
TLMAX# = 1810
TCOMM# = 'Pixel Y  on SKY-coordinate'

# Column name: UPI
# Description: Approximate PHA conversion to eV
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'UPI'
TFORM# = '1E'
TCOMM# = 'Approximate PHA conversion to eV'

# Column name: EPI
# Description: PI in unit of eV before truncated to integer
# EPI energy in eV contains calculation for primary and secondary
# but treating the secondary as primary (This is regardless if the secondary
# have the proper correction see EPI2)
# EPI = funcTion (UPI, T) gain correction (Cal pixel, iron55 and MXS)
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'EPI'
TFORM# = '1E'
TCOMM# = 'PHA to eV as all events are primary'

# Column name: EPI2
# Description: same as EPI for primary, adjusted for secondary
# EPI2 energy in keV contains calculation for the primary treated
# and secondary treated as secondary only if the calibration for primary
# is provided otherwise will be = EPI
# EPI = funcTion (UPI, T) gain correction (Cal pixel, iron55 and MXS)
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'EPI2'
TFORM# = '1E'
TCOMM# = 'As EPI but Ms/Ls with secondary correction'

# Column name: PI
# Description: pulse height invariant after gain correction
#For Event PI 0-32768 0.5 eV/ch 0-16 keV Hp Mp Ms Lp Ls
# For baseline -16384 16383
# PI=floor(EPI*2+0.5) check the accuracy since we move from Real to Integer
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'PI'
TFORM# = '1J'
TNULL# = -32768
TLMIN# = -16384
TLMAX# = 32768
TCOMM# = 'Pulse Invariant after gain correction'

# Column name: STATUS
# Description: flag an event, a) recoil crosstalk, b) electrical
# crosstalk, c) antico, d) MXS
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'STATUS'
TFORM# = '16X'
TCOMM# = 'Events Flag:recoil,elect,antico,MXS'

# Column name: PROC_STATUS
# Description: pipe-line processing status
# Origin: pre-pipeline calculated from software
TTYPE# = 'PROC_STATUS'
TFORM# = '32X'
TCOMM# = ,ÄôRecord bad telemetry or bad values,Äô
```

```
### SXS EVENT PIXEL PULSEREC
xtension=bintable

#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns for FFF
#-------------------------------------------------------------
#-------------------------------------------------------------
#
# NOTE: This file contains the SXS pixel pulserec
# The pipeline expects to find the columns ACTX ACTY DETX DETY FOCX FOCY X Y
# Th epipeline partially fills the columns where possible
#number of rows
 naxis2 = 1
# EVENT PULSEREC PIXEL
#
# Column name: TIME
# Description: Time since 2014-01-01 00:00:00
# Arrival Time SAMPLECNT1. Arrival time of the pulse
# Origin: pre-pipeline calculated from software
TTYPE# = 'TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Seconds from 01 Jan 2014 00:00:00’

# Column name: TRIGTIME
# Description: Time corresponding to the trigger time calculated with SAMPLECNT2
# Origin: pre-pipeline calculated from software
TTYPE# = 'TRIGTIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Trigger Time of the pulse'

# Column name: S_TIME
# Description: time of CCSDS packet stamped by SIRIUS
# Origin: pre-pipeline from telemetry 2^-6 s
TTYPE# = 'S_TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Time for CCSDS packet stamped by SIRIUS’

# Column name: L32TI
# Description: lower 32 bit TI of the event packet
# Origin: pre-pipeline from telemetry
TTYPE# = 'L32TI'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Packet TI lower 32b, 2^-6 s’

# Column name: CATEGORY
# Description: CATEGORY in SMCP header for DR priority (0-127)
# Origin: pre-pipeline from telemetry
TTYPE# = 'CATEGORY'
TFORM# = '1B'
TCOMM# = ‘Data recorder priority’

# Column name: ADU_CNT
# Description: ADU sequence counter of the event packet
# (0-255) in the main header. ADU_CNT allow to check if packet is lost
# Origin: pre-pipeline from telemetry
TTYPE# = 'ADU_CNT'
TFORM# = '1B'
TCOMM# = ‘ADU sequence packet counter’

# Column name: PSP_ID
# Description: 0:PSP-A0, 1:A1, 2:B0, 3:B1
# Origin: pre-pipeline from telemetry
TTYPE# = 'PSP_ID'
TFORM# = '1B'
TCOMM# = ‘0=PSP-A0 1=A1 2=B0 3=B1’
```

```
# Column name: FLG_COMPRESS
# Description: if 1, records are compressed with Huffman table
# Origin: pre-pipeline from telemetry
TTYPE# = 'FLG_COMPRESS'
TFORM# = '1X'
TCOMM# = 'If 1, records are compressed with Huffman table'

# Column name: FLG_AVGPULSE
# Description: if 1, used for the average pulse calculation
# Origin: pre-pipeline from telemetry
TTYPE# = 'FLG_AVGPULSE'
TFORM# = '1X'
TCOMM# = 'if 1, used for the average pulse calculation'

# Column name: FORMAT_VER
# Description: version of the event packet format
# Origin: pre-pipeline from telemetry
TTYPE# = 'FORMAT_VER'
TFORM# = '1B'
TCOMM# = ‘Packet format version’

# Column name: WFRB_WRITE_LP
# Description: lap & pointer to WFRB for writing ADC sample
# WFRB position where the FPGA is recording the ADC
# sample and derivative when the CPU edits the event packet
# (reference time for the whole packet); consists of present lap (6 bit) +
# pointer (18 bit) of the WFRB.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_WRITE_LP'
TFORM# = '1J'
TCOMM# = ‘Lap & pointer of WFRB to write ADC sample’

# Column name: WFRB_SAMPLE_CNT
# Description: SAMPLE_CNT corresponding to top of WFRB
#free-run counter of the SAMPLE_CNT,corresponding to the recording ADC sample & derivative, AS
above.
#  (nominal sample rate of 12.5 kHz; SAMPLE_CNT wraps around in ~ 4 dy.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_SAMPLE_CNT'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Sample count for the top of WFRB’

# Column name: RECORD_LEN
# Description: record length, either 1024 (1K) or 2048 (2K)
# Origin: pre-pipeline from telemetry
TTYPE# = 'RECORD_LEN'
TFORM# = '1I'
TCOMM# = 'Record length, either 1024 (1K) or 2048 (2K)'

# Column name: ERR_CNT
# Description: number of error samples in the pulse record
# Origin: pre-pipeline from telemetry
TTYPE# = 'ERR_CNT'
TFORM# = '1I'
TZERO# = 32768
TCOMM# = 'Number of error samples in the pulse record'

# Column name: PRE_TRIG_LEN_H
# Description: number of samples before trigger for Hp event
# Origin: pre-pipeline from telemetry
TTYPE# = 'PRE_TRIG_LEN_H'
TFORM# = '1I'
TCOMM# = 'Number of samples before Hp event trigger'

# Column name: PRE_TRIG_LEN_M
# Description: number of samples before trigger for Mp, Ms
# Origin: pre-pipeline from telemetry
TTYPE# = 'PRE_TRIG_LEN_M'
TFORM# = '1B'
TCOMM# = 'Number of samples before Mp Ms event trigger'
```

```
# Column name: EDB_QUICK_DOUBLE
# Description: QUICK_DOUBLE in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_QUICK_DOUBLE'
TFORM# = '1X'
TCOMM# = 'QUICK_DOUBLE in EDB'

# Column name: EDB_SPARE1
# Description: SPARE1 in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_SPARE1'
TFORM# = '1B'
TCOMM# = 'SPARE1 in EDB'

# Column name: EDB_IPIX
# Description: PIXEL in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_IPIX'
TFORM# = '1B'
TCOMM# = 'PIXEL in EDB'

# Column name: EDB_TRIG_LP
# Description: TRIG_LP in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_TRIG_LP'
TFORM# = '1J'
TCOMM# = 'TRIG_LP in EDB'

# Column name: EDB_SPARE2
# Description: SPARE2 in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_SPARE2'
TFORM# = '1B'
TCOMM# = 'SPARE2 in EDB'

# Column name: EDB_LO_RES_PH
# Description: LO_RES_PH in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_LO_RES_PH'
TFORM# = '1I'
TCOMM# = 'LO_RES_PH in EDB'

# Column name: EDB_DERIV_MAX
# Description: DERIV_MAX in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_DERIV_MAX'
TFORM# = '1I'
TCOMM# = 'DERIV_MAX in EDB'

# Column name: EXP_WORD_LEN
# Description: word length of the expanded data
# Origin: pre-pipeline from telemetry
TTYPE# = 'EXP_WORD_LEN'
TFORM# = '1I'
TCOMM# = 'Word length of the expanded data'

# Column name: EL_LOST_CNT
# Description: number of the lost events for TYPE='EL'
# Number of lost event in the start and stop time of the lost time interval
# No used in software
# Origin: pre-pipeline from telemetry
TTYPE# = 'EL_LOST_CNT'
TFORM# = '1I'
TZERO# = 32768
TCOMM# = 'number of the lost events for TYPE=EL'

# Column name: EL_REASON
# Description: reason why the event lost occured for TYPE='EL'
#reason for which the events are lost TYPE='LO'
# value  0 = EDB overflow, 1 = 1st FIFO overflow, 2 = pulse data in WFRB is lost.
```

```
# No used in software
# Origin: pre-pipeline from telemetry
TTYPE# = 'EL_REASON'
TFORM# = '1B'
TNULL# = 255
TCOMM# = 'Reason why the event TYPE=EL are lost'

# Column name: EL_STOP_LP
# Description: lap & pointer to WFRB when the event lost stop
# Stop time for the LO events Used in software
# Origin: pre-pipeline from telemetry
TTYPE# = 'EL_STOP_LP'
TFORM# = '1J'
TNULL# = 2147483647
TCOMM# = 'lap & pointer of WFRB when event lost stop'

# Column name: ITYPE
# Description: 0:Hp, 1:Mp, 2:Ms, 3:Lp, 4:Ls, 5:BL, 6:EL, 7:--
# event type (event or baseline)
# 0=Hp 1=Mp 2=Ms 3=Lp 4=Ls 5=BL 6=EL 7=Rj (notused)
# 6= LOST_EVT_TYPE
# Origin: pre-pipeline from telemetry
TTYPE# = 'ITYPE'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 7
TCOMM# = '0:Hp 1:Mp 2:Ms 3:Lp 4:Ls 5:BL 6:EL 7:--'

# Column name: TYPE
# Description: Hp/Mp/Ms/Lp/Ls/BL/LE/Rj
# the char version of ITYPE
# Convention of type into characters
# pre pipeline need to convert from ITYPE
# 0=Hp 1=Mp 2=Ms 3=Lp 4=Ls 5=BL 6=EL 7=Rj (not used)
# Origin: pre-pipeline calculated
TTYPE# = 'TYPE'
TFORM# = '2A'
TCOMM# = 'Hp,Mp,Ms,Lp,Ls,BL,EL,Rj according to ITYPE’

# Column name: IPIX
# Description: pixel number (0-17) inside each PSP, PIXEL % 18
#Set for event or baseline
# This value ranges from 0-17 even if each quadrant record max 9 pixels
# Specifically A0=B0=0-9 A1=B1=9-17
# O=PSP_A0 1=PSP_A1 2=PSP_B0 3=PSP_B1
# pixel =31 is assigned to NULL (some sort of lost event)
# Origin:  pre-pipeline from telemetry
TTYPE# = 'IPIX'
TFORM# = '1B'
TNULL# = 31
TLMIN# = 0
TLMAX# = 17
TCOMM# = 'pixel number (0-17) in each PSP'

# Column name: PIXEL
# Description: detected pixel number [0-35]
# Valid for event or baseline
# PIXEL= IPIX + int(PSP_ID/2)*18
# where PSP_AO PSP_A1 contribute always 0
# and PSP_B0 PSP_B1 contribute always 1
# Origin: calculated pre-pipeline from telemetry
TTYPE# = 'PIXEL'
TFORM# = '1B'
TNULL# = 63
TLMIN# = 0
TLMAX# = 35
TCOMM# = ‘Pixel Number range 0-35’

# Column name: TRIG_LP
# Description: lap & pointer to WFRB for the triggered event
# lap (6 bit) + pointer (18 bit) when the event triggers
```

```
# NOTE: This stored two meaning a) the trigger time for event or BL or
# b) the start time of the lost event interval LOST_EVT_START_LP
# Note b) is calculated as usual and the ITYPE flag that is
# time associated to the start time of the lost event
# Set for event or baseline or Lost
# Origin: pre-pipeline from telemetry
TTYPE# = 'TRIG_LP'
TFORM# = '1J'
TNULL# = 2147483647
TCOMM# = ‘Lap & pointer to WFRB for the row’

# Column name: QUICK_DOUBLE
# Description: quick-double flag for double pulse
# lag indicating the presence of a quick second pulse
# during the fall of the main pulse.
# Value 1 = means that there is a quick double event "and the PHA
# is not calculated correctly"
# Need to be checked in the ground software
# FOR BASELINE IS SET = 0
# Set for event or baseline
# Origin: pre-pipeline from telemetry
TTYPE# = 'QUICK_DOUBLE'
TFORM# = '1X'
TCOMM# = 'Flag set to 1 for double pulse'

# Column name: SLOPE_DIFFER
# Description: slope-differ flag for invalid pulse shape
# the mean square difference from the mean derivative (?)
# Value 1 identify an invalid pulse shape
# Need to be checked on ground software
# FOR BASELINE IS SET = 0
# Set for event or baseline
# Origin: pre-pipeline from telemetry
TTYPE# = 'SLOPE_DIFFER'
TFORM# = '1X'
TCOMM# = 'Flag set to 1 for invalid pulse shape'

# Column name: LO_RES_PH
# Description: low resolution pulse height, determined in the
# same way for the Lp and Ls pulses
# direct peak-height measurement used as PHA for low-res events
# This value is the peak height of the pulse. For Ls and Lp  this is the same
# as stored in the pha column otherwise for all other grade
# is a rough estimate of the  PHA value
# For BASELINE is set as first value of ADC sample in Noise Record.
# For Baseline -8192 8192
# Origin: pre-pipeline from telemetry
TTYPE# = 'LO_RES_PH'
TFORM# = '1I'
TLMIN# = -8192
TLMAX# = 16383
TCOMM# = 'Pulse height calculates as for Lp/Ls'

# Column name: DERIV_MAX
# Description: maximum value of the derivative
# maximum value of derivative form boxcar filtering of samples
# What is the value for BASELINE event: dump the telemetry but have no meaning
# No needed in the ground software
# Origin: pre-pipeline from telemetry
TTYPE# = 'DERIV_MAX'
TFORM# = '1I'
TLMIN# = -32768
TLMAX# = 32767
TCOMM# = 'Maximum value of the derivative'

# Column name: RISE_TIME
# Description: rise-time in unit of 1/4 tick (20 us nominal).
# RISE_TIME in telemetry is 8 bit (0-255), however, MSB is assigned for
# a slow-pulse flag. Valid range of RISE_TIME is 0-127, hence TLMAX=127.
# It is calculated by fitting a line to a number of points on
#              the rising edge of the pulse
```

```
# What is the value for BASELINE event : dump the telemetry but have no meaning
# but BASELINE should be 0
# Origin: pre-pipeline from telemetry
TTYPE# = 'RISE_TIME'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 127
TCOMM# = 'rise-time in unit of 1/4 tick (20 us nominal)'

# Column name: TICK_SHIFT
# Description: number of shift in unit of tick to find the PHA
# maximum in cross-correlating with the template (optimal filter)
# ow 4-bits of the 32-bit tick counter
# TICK_SHIFT is a shift of template relative to the observed waveform.
# Not used in the time assignment but to evaluate the pulse template
# in the PSP algorithm. What is the value for BASELINE event : dump
# the telemetry but have no meaning  but BASELINE should be 0
# Not used in the software
# Origin: pre-pipeline from telemetry
TTYPE# = 'TICK_SHIFT'
TFORM# = '1B'
TNULL# = -128
TLMIN# = -8
TLMAX# = 7
TZERO# = -128
TCOMM# = 'number of shift in unit of tick to find the PHA'

# Column name: TIME_VERNIER
# Description: vernier to define the finest time division
# TIME_VERNIER is calculated by quadratically interpolating the three
# lags with the largest value. Only valid for Hp, Mp, and Ms pulses.
# vernier to define the finest time division
# TIME_VERNIER is calculated by quadratically interpolating the three
# lags with the largest value. Only valid for hi-res and mid-res pulses
# NOTE got lost event time vernier is set to start+23 and stop-8 see GTI lost
# for Baseline is should be set to 0 in the telemetry
# Origin: pre-pipeline from telemetry
TTYPE# = 'TIME_VERNIER'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 15
TCOMM# = 'vernier to define the finest time division'

# Column name: PHA
# Description: pulse height amplitude
# PHA is the pulse-height calculated by the long (Hp) or short (Mp, Ms)
# optimal filter, or by a direct peak-height measurement (Lp, Ls), as
# indicated by the TYPE colum. The PHA values range 0 to 65535 for non-
# baseline pulses (Hp, Mp, Ms, Lp, Ls) and -32768 to 32767 for baseline
# pulses (BL). PHA is the pulse-height calculated by the hi-res or
# mid-res optimal filter, or by a direct peak-height measurement,
# as indicated by lowRes flags. Ranging 0 to 65535 for non-baseline pulses
# and -32768 to 32767 for baseline pulses.
# Origin: pre-pipeline from telemetry
TTYPE# = 'PHA'
TFORM# = '1J'
TNULL# = 2147483647
TLMIN# = -32768
TLMAX# = 65535
TCOMM# = 'Pulse height amplitude"

# Column name: FLAGS
# Description: combination of event flags
# FLAGS = 0x20*SLOPE_DIFFER + 0x10*QUICK_DOUBLE + ITYPE(0-7)
# FLAGS  QUICKDOUBLE*32 + SLOPE_DIFFER*16 + ITYPE
# No used in software
# Origin: calculated in pre-pipeline
TTYPE# = 'FLAGS'
TFORM# = '1B'
TCOMM# = 'Combination of event flags'
```

```
# Column name: PULSEREC_MODE
# Description: mode of PULSEREC, 0:adc_sample, 1:derivative,
# 2:adc_sample - history, 3:derivative - history
# Origin: pre-pipeline from telemetry
TTYPE# = 'PULSEREC_MODE'
TFORM# = '1B'
TCOMM# = '0:adc_sample 1:deriv; 2&3:as 0&1 history'

# Column name: PULSEREC
# Description: 8 pre-samples + pulse data + 8 post-samples
# Origin: pre-pipeline from telemetry
TTYPE# = 'PULSEREC'
TFORM# = '1040I'
TCOMM# = '8 pre-samples + noise data + 8 post-samples'

# Column name: PULSE_SEQ_CNT
# Description: sequential count of detected pulses in a pixel
# Origin: pre-pipeline from telemetry
TTYPE# = 'PULSE_SEQ_CNT'
TFORM# = '1B'
TCOMM# = 'Sequential count of detected pulses in a pixel'

# Column name: COMPDATA
# Description: compressed data in telemetry
# Origin: calculated in pre-pipeline
TTYPE# = 'COMPDATA'
TFORM# = '1640B'
TCOMM# = 'Compressed data in telemetry'

# Column name: COMP_BYTE_LEN
# Description: byte length of the compressed data
# Origin: calculated in pre-pipeline
TTYPE# = 'COMP_BYTE_LEN'
TFORM# = '1I'
TCOMM# = 'Byte length of the compressed data'

# Column name: PREV_INTERVAL
# Description: interval from previous event in unit of tick
# Origin: pre-pipeline calculated
TTYPE# = 'PREV_INTERVAL'
TFORM# = '1I'
TZERO# = 32768
TCOMM# = 'Interval from previous event in unit of tick"

# Column name: NEXT_INTERVAL
# Description: inverval to next event in unit of tick
# Origin: pre-pipeline calculated
TTYPE# = 'NEXT_INTERVAL'
TFORM# = '1I'
TZERO# = 32768
TCOMM# = 'Interval to next event in unit of tick'

# Column name: SAMPLECNT
# Description: SAMPLE_CNT corrected for RISE_TIME
# number of samples since the last tick calculated from TRIG_LP and TIME_VERNIER
# This is the arrival time TIME= SAMPLECNT--a*(0.25*RISE_TIME)-b*DERIV_MAX-c
# Origin:  pre-pipeline from software
TTYPE# = 'SAMPLECNT'
TFORM# = '1D'
TCOMM# = ‘Used to calculate TIME'

# Column name: SAMPLECNTTRIG
# Description:  number of samples since the last tick calculated from TRIG_LP
# and TIME_VERNIER. Used to calculate TRIGTIME= SAMPLECNT. This is for the TRigger time
# Origin: pre-pipeline from software
TTYPE# = 'SAMPLECNTTRIG'
TFORM# = '1D'
TCOMM# = ‘Used to calculate TRIGTIME'

# Column name: INDEX
# Description: incremental value to index events in a file
```

```
# index is a incremental value to index the events in the file
# this is used to calculate GROUPS
# Origin: insert empty pre-pipeline empty populated pipeline
TTYPE# = 'INDEX'
TFORM# = '1J'
TCOMM# = 'Index incrementally the events'

# Column name: GROUPS
# Description: GROUPS used to group the secondary sxssecid
# The value assigned is the INDEX of the primary event
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'GROUPS'
TFORM# = '1J'
TNULL# = -9999
TCOMM# = 'Associate primary and secondary'

# Column name: CTMULT
# Description: used to record multiplicity for crosstalk
# NOT NEEDED to be created by the PRE-pipeline listed for completness
# used to record the multiplicity for cross-talk electrical
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'CTMULT'
TFORM# = '1I'
TCOMM# = 'Record multiplicity for electrical cross-talk'

# Column name: ACTX
# Description: pixel center on ACT-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'ACTX'
TFORM# = '1B'
TNULL# = 255
TLMIN# = 1
TLMAX# = 8
TCOMM# = 'Pixel X  on ACT-coordinate'

# Column name: ACTY
# Description: pixel center Y on ACT-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'ACTY'
TFORM# = '1B'
TNULL# = 255
TLMIN# = 1
TLMAX# = 8
TCOMM# = 'Pixel Y  on ACT-coordinate'

# Column name: DETX
# Description: pixel  X on DET-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'DETX'
TFORM# = '1B'
TNULL# = 255
TLMIN# = 1
TLMAX# = 8
TCOMM# = 'Pixel X  on DET-coordinate'

# Column name: DETY
# Description: pixel center Y on DET-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'DETY'
TFORM# = '1B'
TNULL# = 255
TLMIN# = 1
TLMAX# = 8
TCOMM# = 'Pixel Y  on DET-coordinate'

# Column name: FOCX
# Description: pixel center X on FOC-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'FOCX'
TFORM# = '1I'
TNULL# = -1
```

```
TLMIN# = 1
TLMAX# = 1810
TCOMM# = 'Pixel X  on FOC-coordinate'

# Column name: FOCY
# Description: pixel center Y on FOC-coordinate
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'FOCY'
TFORM# = '1I'
TNULL# = -1
TLMIN# = 1
TLMAX# = 1810
TCOMM# = 'Pixel Y  on FOC-coordinate'

# Column name: X
# Description: pixel center X on SKY-coordinate (look-up)
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'X'
TFORM# = '1I'
TNULL# = -1
TLMIN# = 1
TLMAX# = 1810
TCOMM# = 'Pixel X  on SKY-coordinate'

# Column name: Y
# Description: pixel center Y on SKY-coordinate (look-up)
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'Y'
TFORM# = '1I'
TNULL# = -1
TLMIN# = 1
TLMAX# = 1810
TCOMM# = 'Pixel Y  on SKY-coordinate'

# Column name: UPI
# Description: Approximate PHA conversion to eV
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'UPI'
TFORM# = '1E'
TCOMM# = 'Approximate PHA conversion to eV'

# Column name: EPI
# Description: PI in unit of eV before truncated to integer
# EPI energy in eV contains calculation for primary and secondary
# but treating the secondary as primary (This is regardless if the secondary
# have the proper correction see EPI2)
# EPI = funcTion (UPI, T) gain correction (Cal pixel, iron55 and MXS)
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'EPI'
TFORM# = '1E'
TCOMM# = 'PHA to eV as all events are primary'

# Column name: EPI2
# Description: same as EPI for primary, adjusted for secondary
# EPI2 energy in keV contains calculation for the primary treated
# and secondary treated as secondary only if the calibration for primary
# is provided otherwise will be = EPI
# EPI = funcTion (UPI, T) gain correction (Cal pixel, iron55 and MXS)
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'EPI2'
TFORM# = '1E'
TCOMM# = 'As EPI but Ms/Ls with secondary correction'

# Column name: PI
# Description: pulse height invariant after gain correction
#For Event PI 0-32768 0.5 eV/ch 0-16 keV Hp Mp Ms Lp Ls
# For baseline -16384 16383
# PI=floor(EPI*2+0.5) check the accuracy since we move from Real to Integer
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'PI'
TFORM# = '1J'
```

```
TNULL# = -32768
TLMIN# = -16384
TLMAX# = 32768
TCOMM# = 'Pulse Invariant after gain correction'

# Column name: STATUS
# Description: flag an event, a) recoil crosstalk, b) electrical
# crosstalk, c) antico, d) MXS
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'STATUS'
TFORM# = '16X'
TCOMM# = 'Events Flag:recoil,elect,antico,MXS'

# Column name: PROC_STATUS
# Description: pipe-line processing status
# Origin: pre-pipeline calculated from software
TTYPE# = 'PROC_STATUS'
TFORM# = '32X'
TCOMM# = 'Record bad telemetry or bad values'
```

SXS EVENT PIXEL WFRB

```
#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns for FFF
#-------------------------------------------------------------
#-------------------------------------------------------------
#
# NOTE: This file contains the SXS pixel WFRB data
# The pipeline do not process these data but for updating keywords
#
# Column name: TIME
# Description: detected time (s)
# Origin: pre-pipeline calculated from software
TTYPE# = 'TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'

# Column name: S_TIME
# Description: time of CCSDS packet stamped by SIRIUS
# Origin: pre-pipeline calculated from software
TTYPE# = 'S_TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = 'Time for CCSDS packet stamped by SIRIUS'

# Column name: L32TI
# Description: lower 32 bit TI of the event packet
# Origin: pre-pipeline from telemetry
TTYPE# = 'L32TI'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = 'Packet TI lower 32b, 2^-6 s'

# Column name: CATEGORY
# Description: CATEGORY in SMCP header for DR priority (0-127)
# Origin: pre-pipeline from telemetry
TTYPE# = 'CATEGORY'
TFORM# = '1B'
TCOMM# = 'Data recorder priority'

# Column name: ADU_CNT
# Description: ADU sequence counter of the event packet
# (0-255) in the main header. ADU_CNT allow to check if packet is lost
# Origin: pre-pipeline from telemetry
TTYPE# = 'ADU_CNT'
TFORM# = '1B'
TCOMM# = 'ADU sequence packet counter'

# Column name: PSP_ID
```

```
# Description: 0:PSP-A0, 1:A1, 2:B0, 3:B1
# Origin: pre-pipeline from telemetry
TTYPE# = 'PSP_ID'
TFORM# = '1B'
TCOMM# = ‘0=PSP-A0 1=A1 2=B0 3=B1’

# Column name: FORMAT_VER
# Description: version of the event packet format
# Origin: pre-pipeline from telemetry
TTYPE# = 'FORMAT_VER'
TFORM# = '1B'
TCOMM# = ‘Packet format version’

# Column name: WFRB_WRITE_LP
# Description: lap & pointer to WFRB for writing ADC sample
# WFRB position where the FPGA is recording the ADC
# sample and derivative when the CPU edits the event packet
# (reference time for the whole packet); consists of present lap (6 bit) +
# pointer (18 bit) of the WFRB.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_WRITE_LP'
TFORM# = '1J'
TCOMM# = ‘Lap & pointer of WFRB to write ADC sample’

# Column name: WFRB_SAMPLE_CNT
# Description: SAMPLE_CNT corresponding to top of WFRB
#free-run counter of the SAMPLE_CNT,corresponding to the recording ADC sample & derivative, AS
above.
#  (nominal sample rate of 12.5 kHz; SAMPLE_CNT wraps around in ~ 4 dy.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_SAMPLE_CNT'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Sample count for the top of WFRB’

# Column name: NUM_ELEM
# Description: number of element in the event packet
# Origin: pre-pipeline from telemetry
TTYPE# = 'NUM_ELEM'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Number of element in the event packet’

# Column name: FLG_PARITY_ERR
# Description: parity error or SCI_CNT error in this sample
# Origin: pre-pipeline from telemetry
TTYPE# = 'FLG_PARITY_ERR'
TFORM# = '1X'
TCOMM# = ‘Parity error or SCI_CNT errors in this sample’

# Column name: TRIG_LP
# Description: lap & pointer to WFRB for this row
# lap (6 bit) + pointer (18 bit) when the event triggers
# NOTE: This stored two meaning a) the trigger time for event or BL or
# b) the start time of the lost event interval LOST_EVT_START_LP
# Note b) is calculated as usual and the ITYPE flag that is
# time associated to the start time of the lost event
# Set for event or baseline or Lost
# Origin: pre-pipeline from telemetry
TTYPE# = 'TRIG_LP'
TFORM# = '1J'
TNULL# = 2147483647
TCOMM# = ‘Lap & pointer to WFRB for the row’

# Column name: IPIX
# Description: pixel number (0-17) inside each PSP, PIXEL % 18
#This value ranges from 0-17 even if each quadrant record max 9 pixels
# Specifically A0=B0=0-9 A1=B1=9-17 O=PSP_A0 1=PSP_A1 2=PSP_B0 3=PSP_B1
# Origin: pre-pipeline from telemetry
TTYPE# = 'IPIX'
TFORM# = '1B'
```

```
TNULL# = 31
TLMIN# = 0
TLMAX# = 17
TCOMM# = ‘Pixel Number(0-17) in each PSP; antico (18)’

# Column name: PIXEL
# Description: detected pixel number [0-35]
# PIXEL= IPIX + int(PSP_ID/2)*18
# where PSP_AO PSP_A1 contribute always 0
# and PSP_B0 PSP_B1 contribute always 1
# Origin: pre-pipeline from telemetry
TTYPE# = 'PIXEL'
TFORM# = '1B'
TNULL# = 63
TCOMM# = ‘Pixel Number range 0-35’

# Column name: LAP_LSB
# Description: LSB of the lap, or +2 if not match
# Origin: pre-pipeline from telemetry
TTYPE# = 'LAP_LSB'
TFORM# = '1B'
TCOMM# = ‘LSB of a lap, +2 if not match’

# Column name: VALID_LP
# Description: lap & pointer to WFRB, where valid data exist
# Origin: pre-pipeline from telemetry
TTYPE# = 'VALID_LP'
TFORM# = '1J'
TCOMM# = ‘Lap& pointer of WFRB when valid data exist’

# Column name: ADC_SAMPLE
# Description: ADC sampled value (14 bit, signed)
# Origin: pre-pipeline from telemetry
TTYPE# = 'ADC_SAMPLE'
TFORM# = '2048I'
TCOMM# = ‘ADC sampled value’

# Column name: DERIVATIVE
# Description: calculated derivative (16 bit, signed)
# Origin: pre-pipeline from telemetry
TTYPE# = 'DERIVATIVE'
TFORM# = '2048I'
TCOMM# = ‘Calculated derivative’

# Column name: SAMPLECNT
# Description: SAMPLE_CNT corresponding to the trigger
# Origin: pre-pipeline calculated from software
TTYPE# = 'SAMPLECNT'
TFORM# = '1D'
TCOMM# = ‘Used to calculate TIME'

# Column name: PROC_STATUS
# Description: pipe-line processing status
# Origin: pre-pipeline calculated from software
TTYPE# = 'PROC_STATUS'
TFORM# = '32X'
TCOMM# = ‘Record bad telemetry or bad values’
```

SXS EVENT ANTICO

```
xtension=bintable
#--------------------------------------------------------------
#--------------------------------------------------------------
# Columns for FFF
#--------------------------------------------------------------
#--------------------------------------------------------------
#
# NOTE: This file contains the SXS antico events and the flags for LOST event
# This is different from pixel because the telemetry do not contain the start and stop
# of non-events therefore is not possible to create GTI for the non events.
# The file includes information from the packets PSPA0.ACP PSPA1.ACP PSPB0.ACP
# PSPB1.ACP and the pre-pipeline add a column, PSP_ID, indicating where the
```

```
# PSP telemetry packet.
# The file contains all data regardless of how the data for the PIXELs
# are obtained with or without filters and/or MXS.

# EVENT Antico
#
# Column name: TIME
# Description: detected time (s)
# Time since 2014-01-01 00:00:00
# Origin: pre-pipeline calculated from software
TTYPE# = 'TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Seconds from 01 Jan 2014 00:00:00’

# Column name: S_TIME
# Description: time of CCSDS packet stamped by SIRIUS
# Origin: pre-pipeline from telemetry
TTYPE# = 'S_TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Time for CCSDS packet stamped by SIRIUS’

# Column name: L32TI
# Description: lower 32 bit TI of the event packet (1/64 s)
# Origin: pre-pipeline from telemetry 2^-6 s
TTYPE# = 'L32TI'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Packet TI lower 32b, 2^-6 s’

# Column name: CATEGORY
# Description: CATEGORY in SMCP header for DR priority (0-127)
# Origin: pre-pipeline from telemetry
TTYPE# = 'CATEGORY'
TFORM# = '1B'
TCOMM# = ‘Data recorder priority’

# Column name: ADU_CNT
# Description: ADU sequence counter of the event packet
# (0-255) in the main header. ADU_CNT allow to check if packet is lost
# Origin: pre-pipeline from telemetry
TTYPE# = 'ADU_CNT'
TFORM# = '1B'
TCOMM# = ‘ADU sequence packet counter’

# Column name: PSP_ID
# Description: 0:PSP-A0, 1:A1, 2:B0, 3:B1
# Origin: pre-pipeline from telemetry
TTYPE# = 'PSP_ID'
TFORM# = '1B'
TCOMM# = ‘0=PSP-A0 1=A1 2=B0 3=B1’

# Column name: FORMAT_VER
# Description: version of the event packet format
# Origin: pre-pipeline from telemetry
TTYPE# = 'FORMAT_VER'
TFORM# = '1B'
TCOMM# = ‘Packet format version’

# Column name: WFRB_WRITE_LP
# Description: lap & pointer to WFRB for writing ADC sample
# WFRB position where the FPGA is recording the ADC
# sample and derivative when the CPU edits the event packet
# (reference time for the whole packet); consists of present lap (6 bit) +
# pointer (18 bit) of the WFRB.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_WRITE_LP'
TFORM# = '1J'
TCOMM# = ‘Lap & pointer of WFRB to write ADC sample’
```

```
# Column name: WFRB_SAMPLE_CNT
# Description: SAMPLE_CNT corresponding to top of WFRB
#free-run counter of the SAMPLE_CNT,corresponding to the recording ADC sample & derivative, AS
above.
#  (nominal sample rate of 12.5 kHz; SAMPLE_CNT wraps around in ~ 4 dy.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_SAMPLE_CNT'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Sample count for the top of WFRB’

# Column name: NUM_ELEM
# Description: number of element in the event packet
# Number of elements in the PSP packet;
# an element is either a pulse (event) and/or a noise (baseline) record, or lost count
# potential too scale down as byte
# Origin: pre-pipeline from telemetry
TTYPE# = NUM_ELEM
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 255
TCOMM# = ‘Number of element in the event packet’

# Column name: SUM_LOST_CNT
# Description: sum of the lost cnt EL_LOST_CNT in the event packet
# Number of lost count records for the packet
# These is the number of events lost in the entire packet
# Origin: pre-pipeline from telemetry
TTYPE# = 'SUM_LOST_CNT'
TFORM# = '1J'
TCOMM# ='Sum of lost count in the event packet'

# Column name: ADC_SAMPLE_PEDESTAL
# Description: ADC sample pedestal to calculate PHA
# baseline ADC level of anti-coincidence
# Origin: pre-pipeline from telemetry
TTYPE# = 'ADC_SAMPLE_PEDESTAL'
TFORM# = '1I'
TLMIN# = -8192
TLMAX# = 8191
TCOMM# = 'ADC sample pedestal to calculate PHA'

# Column name: AC_ITYPE
# Description: 0:AC, 1:BL, 2:EL, 3:PE
# Origin: pre-pipeline calculated
TTYPE# = 'AC_ITYPE'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 3
TCOMM# ='0:AC, 1:BL, 2:EL, 3:PE'

# Column name: AC_TYPE
# Description: AC:antico, BL:baseline, EL:event-lost,
# PE:parity error
# Origin: pre-pipeline calculated
TTYPE# = 'AC_TYPE'
TFORM# = '2A'
TCOMM# = 'AC BL EL PE'

# Column name: FLG_EVENT_LOST
# Description: flag for the event lost information
# The start and stop time of the lost event interval are :
#    start = time of the last valid antico event+A
#    stop = time of the  next valid antico event-A
#    A need to be calibrated
# Origin: pre-pipeline from telemetry
TTYPE# = 'FLG_EVENT_LOST'
TFORM# = '1X'
TCOMM# = 'Flag: set to 1 event is lost'

# Column name: FLG_BASELINE
```

```
# Description: flag for the baseline event
# if set = 1 PHA is just the value at that time
#               if set = 0 PHA is the maximum value where the 0 level or
#                                baseline has been subtracted.
# Origin: pre-pipeline from telemetry
TTYPE# = 'FLG_BASELINE'
TFORM# = '1X'
TCOMM# = 'Flag for the baseline event''

# Column name: DURATION
# Description: pulse duration exceeding the threshold
# DURATION is a value for anti-Co event; Units 80US
# DURATION set to 0 if a lost event and/or if the flag_error is set =1
# Origin: pre-pipeline from telemetry
TTYPE# = 'DURATION'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 255
TCOMM# = 'Pulse duration exceeding the threshold'

# Column name: TRIG_LP
# Description: lap & pointer to WFRB for the triggered event
# if FLAG_EVENT_LOST =0 same timing information of the event file
# If FLAG_EVENT_LOST =1 set the TRIG_LP=undefined null= 0xffffffff
# Origin: pre-pipeline from telemetry
TTYPE# = 'TRIG_LP'
TFORM# = '1J'
TNULL# = 2147483647
TCOMM# = 'Lap & pointer to WFRB for the row'

# Column name: FLG_PARITY_ERR
# Description: flag for the event with communication error
# FLG_PARiTY_ERR is set to 1 if the adc_sample value
# send from the xbox to the psp contains aparity error
# set to 0 for lost ?
# Origin: pre-pipeline from telemetry
TTYPE# = 'FLG_PARITY_ERR'
TFORM# = '1X'
TCOMM# = 'flag for the event with communication error'

# Column name: TRIG_LAP_LSB
# Description: LSB of the lap, for debugging
#Is the least significant bit of the LAP
# 6bit lap + 18bit pointer (TRIG_LP)
# the LSB is the less significant bit of the 6bit value
# do not care for lost event either 0 or 1
# Origin: pre-pipeline from telemetry
TTYPE# = 'TRIG_LAP_LSB'
TFORM# = '1X'
TCOMM# = 'LSB of the lap, for debugging'

# Column name: ADC_SAMPLE_MAX
# Description: the maximum value of the antico pulse in ADC unit
# Origin: pre-pipeline from telemetry
TTYPE# = 'ADC_SAMPLE_MAX'
TFORM# = '1I'
TLMIN# = -8192
TLMAX# = 8191
TCOMM#= 'Maximum value of the pulse in ADC unit'

# Column name: EL_LOST_CNT
# Description: number of the lost events for TYPE='EL'
# Valid only if FLAG_LOST_CNT =1 that contains the number of event lost
#  else if Flag_lost_CNT=0 null= 0xffffffff
TTYPE# = 'EL_LOST_CNT'
TFORM# = '1J'
TNULL# = 2147483647
TCOMM#= 'Number of the lost events for TYPE=EL'

# Column name: PHA
# Description: pulse height amplitude,
```

```
# calculated as (ADC_SAMPLE_MAX - ADC_SAMPLE_PEDESTAL)
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'PHA'
TFORM# = '1I'
TNULL# = -32768
TLMIN# = -8192
TLMAX# = 16383
TCOMM# = 'Pulse height amplitude"

# Column name: PI
# Description: pulse height invariant
# PI is calculated using the antico "gain"
# Origin: insert empty pre-pipeline populated pipeline
TTYPE# = 'PI'
TFORM# = '1J'
TNULL# = -32768
TLMIN# = -8192
TLMAX# = 12200
TCOMM# = 'Pulse Invariant after gain correction'

# Column name: SAMPLECNT
# Description: SAMPLE_CNT corresponding to the antico trigger
#number of samples since the last tick calculated from TRIG_LP
# and TIME_VERNIER (special setting for antico)
TTYPE# = 'SAMPLECNT'
TFORM# = '1D'
TCOMM# = ,ÄôUsed to calculate TIME'

# Column name: PROC_STATUS
# Description: pipe-line processing status
# Origin: pre-pipeline calculated from software
TTYPE# = 'PROC_STATUS'
TFORM# = '32X'
TCOMM# = ‘Record bad telemetry or bad values’
```

SXS GTILOST ANTICO

```
xtension=bintable
#--------------------------------------------------------------
#--------------------------------------------------------------
# Columns for FFF
#--------------------------------------------------------------
#--------------------------------------------------------------
#
# NOTE This file contains the GTI of the SXS lost antico events intervals
# detected for all pixels The LOST are for each pixels.
# The file includes information from the packets
# PSPA0.ACP PSPA1.ACT PSPB0.ACP PSPB1.ACP and the pre-pipeline
# add a column, PSP_ID, indicating where the PSP telemetry packet.
#
#number of rows
naxis2 = 1

# EVENT GTILOST antico
#
# Description: Time since 2014-01-01 00:00:00
# Origin pre-pipeline calculated from software
# TIME copy of START
ttype# = TIME
tform# = 1D
tunit# ='s'
TCOMM# = ‘Seconds from 01 Jan 2014 00:00:00’

#
# Origin pre-pipeline calculated from software
ttype# = START
tform# = 1D
tunit# ='s'
tcomm# = 'Start interval time'

# Origin pre-pipeline calculated from software
ttype# = STOP
```

```
 tform# = 1D
 tunit# ='s'
 tcomm# = 'Stop interval time'

# Column name: S_TIME
# Description: time of CCSDS packet stamped by SIRIUS
# Origin: pre-pipeline from telemetry 2^-6 s
TTYPE# = 'S_TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Time for CCSDS packet stamped by SIRIUS’

# Column name: L32TI
# Description: lower 32 bit TI of the event packet
# Origin: pre-pipeline from telemetry
TTYPE# = 'L32TI'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Packet TI lower 32b, 2^-6 s’

# Column name: CATEGORY
# Description: CATEGORY in SMCP header for DR priority (0-127)
# Origin: pre-pipeline from telemetry
TTYPE# = 'CATEGORY'
TFORM# = '1B'
TCOMM# = ‘Data recorder priority’

# Column name: ADU_CNT
# Description: ADU sequence counter of the event packet
# (0-255) in the main header. ADU_CNT allow to check if packet is lost
# Origin: pre-pipeline from telemetry
TTYPE# = 'ADU_CNT'
TFORM# = '1B'
TCOMM# = ‘ADU sequence packet counter’

# Column name: PSP_ID
# Description: 0:PSP-A0, 1:A1, 2:B0, 3:B1
# Origin: pre-pipeline from telemetry
TTYPE# = 'PSP_ID'
TFORM# = '1B'
TCOMM# = ‘0=PSP-A0 1=A1 2=B0 3=B1’

#============================ AC_EVT_HEADER
#
# Column name: FORMAT_VER
# Description: version of the event packet format
# Origin: pre-pipeline from telemetry
TTYPE# = 'FORMAT_VER'
TFORM# = '1B'
TCOMM# = ‘Packet format version’

# Column name: WFRB_WRITE_LP
# Description: lap & pointer to WFRB for writing ADC sample
# WFRB position where the FPGA is recording the ADC
# sample and derivative when the CPU edits the event packet
# (reference time for the whole packet); consists of present lap (6 bit) +
# pointer (18 bit) of the WFRB.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_WRITE_LP'
TFORM# = '1J'
TCOMM# = ‘Lap & pointer of WFRB to write ADC sample’

# Column name: WFRB_SAMPLE_CNT
# Description: SAMPLE_CNT corresponding to top of WFRB
#free-run counter of the SAMPLE_CNT,corresponding to the recording ADC sample & derivative, AS
above.
#  (nominal sample rate of 12.5 kHz; SAMPLE_CNT wraps around in ~ 4 dy.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_SAMPLE_CNT'
TFORM# = '1J'
TZERO# = 2147483648
```

.

```
TCOMM# = ‘Sample count for the top of WFRB’

# Column name: NUM_ELEM
# Description: number of element in the event packet
# Number of elements in the PSP packet;
# an element is either a pulse (event) and/or a noise (baseline) record, or lost count
# potential too scale down as byte
# Origin: pre-pipeline from telemetry
TTYPE# = NUM_ELEM
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 255
TCOMM# = ‘Number of element in the event packet’

# Column name: SUM_LOST_CNT
# Description: sum of the lost cnt in the event packet
# Number of lost count records for the packet
# These is the number of events lost in the entire packet
# Origin: pre-pipeline from telemetry
TTYPE# = 'SUM_LOST_CNT'
TFORM# = '1J'
TCOMM# ='Sum of lost count in the event packet'

# Column name: AC_ITYPE
# Description: 0:AC, 1:BL, 2:EL, 3:PE
# Origin: pre-pipeline calculated
TTYPE# = 'AC_ITYPE'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 3
TCOMM# ='0:AC, 1:BL, 2:EL, 3:PE'

# Column name: AC_TYPE
# Description: AC:antico, BL:baseline, EL:event-lost,
# PE:parity error
# Origin: pre-pipeline calculated
TTYPE# = 'AC_TYPE'
TFORM# = '2A'
TCOMM# = 'AC BL EL PE'

 #========================== AC_EVT_LOST
 #
 #
 # Description: Flag if set to 1 is a lost event
 # The start and stop time of the lost event interval are :
 #    start = time of the last valid antico event+A
 #    stop = time of the  next valid antico event-A
 #    A need to be calibrated
 # Origin: pre-pipeline from telemetry
TTYPE# = 'FLG_EVENT_LOST'
TFORM# = '1X'
TCOMM# = 'Flag: set to 1 event is lost'

 # Description Number of lost event in the start and stop time of the lost time interval
 # PXP_ACP EL_LOST_CNT
 # Origin: pre-pipeline from telemetry
TTYPE# = 'EL_LOST_CNT'
TFORM# = '1J'
TNULL# = 2147483647
TCOMM#= 'Number of the lost events for TYPE=EL'
#
 #
 # Description : Populated when FLG_LOST_CNT=1  by the
 # previous valid TRIG_LP (either baseline/pixel)
 # To calculate START need to calculate SAMPLECNT1
 # To calculate SAMPLECNT1 need to define TIME_VERNIER.
 # For this TIME_VERNIER is set to +23
 # Note: start of the lost are added -8 TIME Vernier to avoid removing the event
 # PXP_ACP  TRIG_LP
 # Origin: pre-pipeline from telemetry
 ttype# = EL_START_LP
```

.

```
 tform# = 1J
 TCOMM# ='Start of the lost event interval'
 #
 # Description : Populated when FLG_LOST_CNT=1 by the next valid
 # TRiG_LP (either baseline/pixel)
 # To calculate STOP need to calculate SAMPLECNT2
 # To calculate SAMPLECNT2 need to define TIME_VERNIER set to -8. EL_STOP_LP-8
 # PXP_ACP  TRIG_LP
 # Origin: pre-pipeline from telemetry
 ttype# = EL_STOP_LP
 tform# = 1J
 TCOMM# = ' Stop of the lost event interval'
 #
 #
 # Description: number of samples since the last tick
 # Calculated from WFRB_SAMPLE_CNT LOST_START_LP and TIME_VERNIER in pipeline
 # (TIME_VERNIER=23)
 # Origin: pre-pipeline calculated from software
 ttype# = SAMPLECNT1
 tform# = 1D
 TCOMM# = 'Used to calculte START'
 #
 # Description: number of samples since the last tick
 # Calculated from WFRB_SAMPLE_CNT LOST_STOP_LP and TIME_VERNIER in pipeline
 # (TIME_VERNIER=-8)
 # Origin: pre-pipeline calculated from software
 ttype# = SAMPLECNT2
 tform# = 1D
 TCOMM# = 'Used to calculte START'

# Column name: PROC_STATUS
# Description: pipe-line processing status
# Origin: pre-pipeline calculated from software
TTYPE# = 'PROC_STATUS'
TFORM# = '32X'
TCOMM# = ‘Record bad telemetry or bad values’
```

SXS EVENT ANTICO NOISEREC

```
#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns for FFF
#-------------------------------------------------------------
#-------------------------------------------------------------
#
# NOTE: This file contains the SXS antico events noiserec event
# only used for diagnostic
# The pipeline only update keywords

# EVENT NOISEREC ANTICO
#
# Column name: TIME
# Description: detected time (s)
# Time since 2014-01-01 00:00:00
# Origin: pre-pipeline calculated from software
TTYPE# = 'TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Seconds from 01 Jan 2014 00:00:00’

# Column name: S_TIME
# Description: time of CCSDS packet stamped by SIRIUS
# Origin: pre-pipeline from telemetry
TTYPE# = 'S_TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = ‘Time for CCSDS packet stamped by SIRIUS’

# Column name: L32TI
# Description: lower 32 bit TI of the event packet (1/64 s)
# Origin: pre-pipeline from telemetry 2^-6 s
TTYPE# = 'L32TI'
```

```
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Packet TI lower 32b, 2^-6 s’

# Column name: CATEGORY
# Description: CATEGORY in SMCP header for DR priority (0-127)
# Origin: pre-pipeline from telemetry
TTYPE# = 'CATEGORY'
TFORM# = '1B'
TCOMM# = ‘Data recorder priority’

# Column name: ADU_CNT
# Description: ADU sequence counter of the event packet
# (0-255) in the main header. ADU_CNT allow to check if packet is lost
# Origin: pre-pipeline from telemetry
TTYPE# = 'ADU_CNT'
TFORM# = '1B'
TCOMM# = ‘ADU sequence packet counter’

# Column name: PSP_ID
# Description: 0:PSP-A0, 1:A1, 2:B0, 3:B1
# Origin: pre-pipeline from telemetry
TTYPE# = 'PSP_ID'
TFORM# = '1B'
TCOMM# = ‘0=PSP-A0 1=A1 2=B0 3=B1’

# Column name: FLG_COMPRESS
# Description: if 1, records are compressed with Huffman table
# Origin: pre-pipeline from telemetry
TTYPE# = 'FLG_COMPRESS'
TFORM# = '1X'
TCOMM# = 'If 1, records are compressed with Huffman table'

# Column name: FLG_NOISESPC
# Description: if 1, used for the noise spectrum calculation
# Origin: pre-pipeline from telemetry
TTYPE# = 'FLG_NOISESPC'
TFORM# = '1X'
TCOMM# = 'If 1, used for the noise spectrum calculation'

# Column name: FORMAT_VER
# Description: version of the event packet format
# Origin: pre-pipeline from telemetry
TTYPE# = 'FORMAT_VER'
TFORM# = '1B'
TCOMM# = ‘Packet format version’

# Column name: WFRB_WRITE_LP
# Description: lap & pointer to WFRB for writing ADC sample
# WFRB position where the FPGA is recording the ADC
# sample and derivative when the CPU edits the event packet
# (reference time for the whole packet); consists of present lap (6 bit) +
# pointer (18 bit) of the WFRB.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_WRITE_LP'
TFORM# = '1J'
TCOMM# = ‘Lap & pointer of WFRB to write ADC sample’

# Column name: WFRB_SAMPLE_CNT
# Description: SAMPLE_CNT corresponding to top of WFRB
# free-run counter of the SAMPLE_CNT,corresponding to the recording ADC sample & derivative, AS
above.
# (nominal sample rate of 12.5 kHz; SAMPLE_CNT wraps around in ~ 4 dy.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_SAMPLE_CNT'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Sample count for the top of WFRB’

# Column name: RECORD_LEN
# Description: record length, either 1024 (1K) or 2048 (2K)
```

```
# Origin: pre-pipeline from telemetry
TTYPE# = 'RECORD_LEN'
TFORM# = '1I'
TCOMM# = 'Record length, either 1024 (1K) or 2048 (2K)'

# Column name: ERR_CNT
# Description: number of error samples in the pulse record
# Origin: pre-pipeline from telemetry
TTYPE# = 'ERR_CNT'
TFORM# = '1I'
TZERO# = 32768
TCOMM# = 'Number of error samples in the pulse record'

# Column name: NOISE_CLEAN_LEN
# Description: clean length for the noise record
# Origin: pre-pipeline from telemetry
TTYPE# = 'NOISE_CLEAN_LEN'
TFORM# = '1I'
TZERO# = 32768
TCOMM# ='Clean length for the noise record'

# Column name: NOISE_TAIL_MARGIN
# Description: margin of samples at the tail of noise record
# Origin: pre-pipeline from telemetry
TTYPE# = 'NOISE_TAIL_MARGIN'
TFORM# = '1B'
TCOMM# ='margin of samples at the tail of noise record'

# Column name: EDB_PARITY_ERR
# Description: FLG_PARITY_ERR in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_PARITY_ERR'
TFORM# = '1B'
TCOMM# = 'FLG_PARITY_ERR in EDB

# Column name: EDB_SPARE
# Description: SPARE in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_SPARE'
TFORM# = '1B'
TCOMM# = 'SPARE in EDB'

# Column name: EDB_IPIX
# Description: PIXEL in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_IPIX'
TFORM# = '1B'
TCOMM# ='PIXEL in EDB'

# Column name: EDB_TRIG_LP
# Description: TRIG_LP in EDB
# Origin: pre-pipeline from telemetry
TTYPE# = 'EDB_TRIG_LP'
TFORM# = '1J'
TCOMM# = 'TRIG_LP in EDB'

# Column name: EL_REASON
# Description: reason why the event lost occured for TYPE='EL'
#reason for which the events are lost TYPE='LO'
# value  0 = EDB overflow, 1 = 1st FIFO overflow, 2 = pulse data in WFRB is lost.
# No used in software
# Origin: pre-pipeline from telemetry
TTYPE# = 'EL_REASON'
TFORM# = '1B'
TNULL# = 255
TCOMM# = 'Reason why the event TYPE=EL are lost'

# Column name: EL_STOP_LP
# Description: lap & pointer to WFRB when the event lost stop
# Stop time for the LO events Used in software
# Origin: pre-pipeline from telemetry
```

```
TTYPE# = 'EL_STOP_LP'
TFORM# = '1J'
TNULL# = 2147483647
TCOMM# = 'lap & pointer of WFRB when event lost stop'

# Column name: ITYPE
# Description: 0:Hp, 1:Mp, 2:Ms, 3:Lp, 4:Ls, 5:BL, 6:EL, 7:--
# event type (event or baseline)
# 0=Hp 1=Mp 2=Ms 3=Lp 4=Ls 5=BL 6=EL 7=Rj (notused)
# 6= LOST_EVT_TYPE
# Origin: pre-pipeline from telemetry
TTYPE# = 'ITYPE'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 7
TCOMM# = '0:Hp 1:Mp 2:Ms 3:Lp 4:Ls 5:BL 6:EL 7:--'

# Column name: IPIX
# Description: pixel number (0-17) inside each PSP, PIXEL % 18
#Set for event or baseline
# This value ranges from 0-17 even if each quadrant record max 9 pixels
# Specifically A0=B0=0-9 A1=B1=9-17
# O=PSP_A0 1=PSP_A1 2=PSP_B0 3=PSP_B1
# pixel =31 is assigned to NULL (some sort of lost event)
# Origin:  pre-pipeline from telemetry
TTYPE# = 'IPIX'
TFORM# = '1B'
TNULL# = 31
TLMIN# = 0
TLMAX# = 17
TCOMM# = 'pixel number (0-17) in each PSP'

# Column name: TRIG_LP
# Description: lap & pointer to WFRB for the triggered event
# lap (6 bit) + pointer (18 bit) when the event triggers
# NOTE: This stored two meaning a) the trigger time for event or BL or
# b) the start time of the lost event interval LOST_EVT_START_LP
# Note b) is calculated as usual and the ITYPE flag that is
# time associated to the start time of the lost event
# Set for event or baseline or Lost
# Origin: pre-pipeline from telemetry
TTYPE# = 'TRIG_LP'
TFORM# = '1J'
TNULL# = 2147483647
TCOMM# = ‘Lap & pointer to WFRB for the row’

# Column name: QUICK_DOUBLE
# Description: quick-double flag for double pulse
# lag indicating the presence of a quick second pulse
# during the fall of the main pulse.
# Value 1 = means that there is a quick double event "and the PHA
# is not calculated correctly"
# Need to be checked in the ground software
# FOR BASELINE IS SET = 0
# Set for event or baseline
# Origin: pre-pipeline from telemetry
TTYPE# = 'QUICK_DOUBLE'
TFORM# = '1X'
TCOMM# = 'Flag set to 1 for double pulse'

# Column name: SLOPE_DIFFER
# Description: slope-differ flag for invalid pulse shape
# the mean square difference from the mean derivative (?)
# Value 1 identify an invalid pulse shape
# Need to be checked on ground software
# FOR BASELINE IS SET = 0
# Set for event or baseline
# Origin: pre-pipeline from telemetry
TTYPE# = 'SLOPE_DIFFER'
TFORM# = '1X'
TCOMM# = 'Flag set to 1 for invalid pulse shape'
```

```
# Column name: LO_RES_PH
# Description: low resolution pulse height, determined in the
# same way for the Lp and Ls pulses
# direct peak-height measurement used as PHA for low-res events
# This value is the peak height of the pulse. For Ls and Lp  this is the same
# as stored in the pha column otherwise for all other grade
# is a rough estimate of the  PHA value
# For BASELINE is set as first value of ADC sample in Noise Record.
# For Baseline -8192 8192
# Origin: pre-pipeline from telemetry
TTYPE# = 'LO_RES_PH'
TFORM# = '1I'
TLMIN# = -8192
TLMAX# = 16383
TCOMM# = 'Pulse height calculates as for Lp/Ls'

# Column name: DERIV_MAX
# Description: maximum value of the derivative
# maximum value of derivative form boxcar filtering of samples
# What is the value for BASELINE event: dump the telemetry but have no meaning
# No needed in the ground software
# Origin: pre-pipeline from telemetry
TTYPE# = 'DERIV_MAX'
TFORM# = '1I'
TLMIN# = -32768
TLMAX# = 32767
TCOMM# = 'Maximum value of the derivative'

# Column name: RISE_TIME
# Description: rise-time in unit of 1/4 tick (20 us nominal).
# RISE_TIME in telemetry is 8 bit (0-255), however, MSB is assigned for
# a slow-pulse flag. Valid range of RISE_TIME is 0-127, hence TLMAX=127.
# It is calculated by fitting a line to a number of points on
#              the rising edge of the pulse
# What is the value for BASELINE event : dump the telemetry but have no meaning
# but BASELINE should be 0
# Origin: pre-pipeline from telemetry
TTYPE# = 'RISE_TIME'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 127
TCOMM# = 'rise-time in unit of 1/4 tick (20 us nominal)'

# Column name: TICK_SHIFT
# Description: number of shift in unit of tick to find the PHA
# maximum in cross-correlating with the template (optimal filter)
# ow 4-bits of the 32-bit tick counter
# TICK_SHIFT is a shift of template relative to the observed waveform.
# Not used in the time assignment but to evaluate the pulse template
# in the PSP algorithm. What is the value for BASELINE event : dump
# the telemetry but have no meaning  but BASELINE should be 0
# Not used in the software
# Origin: pre-pipeline from telemetry
TTYPE# = 'TICK_SHIFT'
TFORM# = '1B'
TNULL# = -128
TLMIN# = -8
TLMAX# = 7
TZERO# = -128
TCOMM# = 'number of shift in unit of tick to find the PHA'

# Column name: TIME_VERNIER
# Description: vernier to define the finest time division
# TIME_VERNIER is calculated by quadratically interpolating the three
# lags with the largest value. Only valid for Hp, Mp, and Ms pulses.
# vernier to define the finest time division
# TIME_VERNIER is calculated by quadratically interpolating the three
# lags with the largest value. Only valid for hi-res and mid-res pulses
# NOTE got lost event time vernier is set to start+23 and stop-8 see GTI lost
# for Baseline is should be set to 0 in the telemetry
```

```
# Origin: pre-pipeline from telemetry
TTYPE# = 'TIME_VERNIER'
TFORM# = '1B'
TLMIN# = 0
TLMAX# = 15
TCOMM# = 'vernier to define the finest time division'

# Column name: PHA
# Description: pulse height amplitude
# PHA is the pulse-height calculated by the long (Hp) or short (Mp, Ms)
# optimal filter, or by a direct peak-height measurement (Lp, Ls), as
# indicated by the TYPE colum. The PHA values range 0 to 65535 for non-
# baseline pulses (Hp, Mp, Ms, Lp, Ls) and -32768 to 32767 for baseline
# pulses (BL).
# PHA is the pulse-height calculated by the long (Hp) or short (Mp, Ms)
# optimal filter, or by a direct peak-height measurement (Lp, Ls), as
# indicated by the TYPE colum. The PHA values range 0 to 65535 for non-
# baseline pulses (Hp, Mp, Ms, Lp, Ls) and -32768 to 32767 for baseline
# pulses (BL). PHA is the pulse-height calculated by the hi-res or
# mid-res optimal filter, or by a direct peak-height measurement,
# as indicated by lowRes flags. Ranging 0 to 65535 for non-baseline pulses
# and -32768 to 32767 for baseline pulses.
# Origin: pre-pipeline from telemetry
TTYPE# = 'PHA'
TFORM# = '1J'
TNULL# = 2147483647
TLMIN# = -32768
TLMAX# = 65535
TCOMM# = 'Pulse height amplitude"

# Column name: FLAGS
# Description: combination of event flags
# FLAGS = 0x20*SLOPE_DIFFER + 0x10*QUICK_DOUBLE + ITYPE(0-7)
# FLAGS  QUICKDOUBLE*32 + SLOPE_DIFFER*16 + ITYPE
# No used in software
# Origin: calculated in pre-pipeline
TTYPE# = 'FLAGS'
TFORM# = '1B'
TCOMM# = 'Combination of event flags'

# Column name: NOISEREC_MODE
# Description: mode of NOISEREC, 0:adc_sample, 1:derivative,
# 2:adc_sample by command, 3:derivative by command
# Origin: calculated in pre-pipeline
TTYPE# = 'NOISEREC_MODE'
TFORM# = '1B'
TCOMM# = '0:adc_sample 1:deriv; 2&3:as 0&1 by command'

# Column name: NOISEREC
# Description: 8 pre-samples + noise data + 8 post-samples
# Origin: calculated in pre-pipeline
TTYPE# = 'NOISEREC'
TFORM# = '1024I'
TCOMM# = '8 pre-samples + noise data + 8 post-samples'

# Column name: NOISE_SEQ_CNT
# Description: sequential count of clean noise in a pixel
# Origin: calculated in pre-pipeline
TTYPE# = 'NOISE_SEQ_CNT'
TFORM# = '1B'
TCOMM# = 'Sequential count of clean noise in a pixel'

# Column name: COMPDATA
# Description: compressed data in telemetry
# Origin: calculated in pre-pipeline
TTYPE# = 'COMPDATA'
TFORM# = '1640B'
TCOMM# = 'Compressed data in telemetry'

# Column name: COMP_BYTE_LEN
# Description: byte length of the compressed data
```

```
# Origin: calculated in pre-pipeline
TTYPE# = 'COMP_BYTE_LEN'
TFORM# = '1I'
TCOMM# = 'Byte length of the compressed data'

# Column name: SAMPLECNT
# Description:  number of samples since the last tick calculated from TRIG_LP
# and TIME_VERNIER. Used to calculate TRIGTIME= SAMPLECNT. This is for the TRigger time
# Origin: pre-pipeline from software
TTYPE# = 'SAMPLECNT'
TFORM# = '1D'
TCOMM# = 'Used to calculate TIME'

# Column name: PROC_STATUS
# Description: pipe-line processing status
# Origin: pre-pipeline calculated from software
TTYPE# = 'PROC_STATUS'
TFORM# = '32X'
TCOMM# = 'Record bad telemetry or bad values'
```

SXS EVENT ANTICO WFRB

```
xtension=bintable
#--------------------------------------------------------------
#--------------------------------------------------------------
# Columns for FFF
#--------------------------------------------------------------
#--------------------------------------------------------------
#
# NOTE: This file contains the SXS antico WFRB data
# The pipeline do not process these data but for updating keywords
# EVENT WFRB antico
#
# Column name: TIME
# Description: detected time (s)
# Origin: pre-pipeline calculated from software
TTYPE# = 'TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'

# Column name: S_TIME
# Description: time of CCSDS packet stamped by SIRIUS
# Origin: pre-pipeline calculated from software
TTYPE# = 'S_TIME'
TFORM# = '1D'
TUNIT# = 's'
TCOMM# = 'Time for CCSDS packet stamped by SIRIUS'

# Column name: L32TI
# Description: lower 32 bit TI of the event packet
# Origin: pre-pipeline from telemetry
TTYPE# = 'L32TI'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = 'Packet TI lower 32b, 2^-6 s'

# Column name: CATEGORY
# Description: CATEGORY in SMCP header for DR priority (0-127)
# Origin: pre-pipeline from telemetry
TTYPE# = 'CATEGORY'
TFORM# = '1B'
TCOMM# = 'Data recorder priority'

# Column name: ADU_CNT
# Description: ADU sequence counter of the event packet
# (0-255) in the main header. ADU_CNT allow to check if packet is lost
# Origin: pre-pipeline from telemetry
TTYPE# = 'ADU_CNT'
TFORM# = '1B'
TCOMM# = 'ADU sequence packet counter'
```

```
# Column name: PSP_ID
# Description: 0:PSP-A0, 1:A1, 2:B0, 3:B1
# Origin: pre-pipeline from telemetry
TTYPE# = 'PSP_ID'
TFORM# = '1B'
TCOMM# = ‘0=PSP-A0 1=A1 2=B0 3=B1’

# Column name: FORMAT_VER
# Description: version of the event packet format
# Origin: pre-pipeline from telemetry
TTYPE# = 'FORMAT_VER'
TFORM# = '1B'
TCOMM# = ‘Packet format version’

# Column name: WFRB_WRITE_LP
# Description: lap & pointer to WFRB for writing ADC sample
# WFRB position where the FPGA is recording the ADC
# sample and derivative when the CPU edits the event packet
# (reference time for the whole packet); consists of present lap (6 bit) +
# pointer (18 bit) of the WFRB.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_WRITE_LP'
TFORM# = '1J'
TCOMM# = ‘Lap & pointer of WFRB to write ADC sample’

# Column name: WFRB_SAMPLE_CNT
# Description: SAMPLE_CNT corresponding to top of WFRB
#free-run counter of the SAMPLE_CNT,corresponding to the recording ADC sample & derivative, AS
above.
#  (nominal sample rate of 12.5 kHz; SAMPLE_CNT wraps around in ~ 4 dy.
# Origin: pre-pipeline from telemetry
TTYPE# = 'WFRB_SAMPLE_CNT'
TFORM# = '1J'
TZERO# = 2147483648
TCOMM# = ‘Sample count for the top of WFRB’

# Column name: NUM_ELEM
# Description: number of element in the event packet
# Origin: pre-pipeline from telemetry
TTYPE# = 'NUM_ELEM'
TFORM# = '1J'
TLMIN# = 0
TLMAX# = 255
TZERO# = 2147483648
TCOMM# = ‘Number of element in the event packet’

# Column name: FLG_PARITY_ERR
# Description: parity error or SCI_CNT error in this sample
# Origin: pre-pipeline from telemetry
TTYPE# = 'FLG_PARITY_ERR'
TFORM# = '1X'
TCOMM# = ‘Parity error or SCI_CNT errors in this sample’

# Column name: TRIG_LP
# Description: lap & pointer to WFRB for this row
# lap (6 bit) + pointer (18 bit) when the event triggers
# NOTE: This stored two meaning a) the trigger time for event or BL or
# b) the start time of the lost event interval LOST_EVT_START_LP
# Note b) is calculated as usual and the ITYPE flag that is
# time associated to the start time of the lost event
# Set for event or baseline or Lost
# Origin: pre-pipeline from telemetry
TTYPE# = 'TRIG_LP'
TFORM# = '1J'
TNULL# = 2147483647
TCOMM# = ‘Lap & pointer to WFRB for the row’

# Column name: IPIX
# Description: pixel number (0-17) inside each PSP, PIXEL % 18
# This value ranges from 0-17 even if each quadrant record max 9 pixels
# Specifically A0=B0=0-9 A1=B1=9-17 O=PSP_A0 1=PSP_A1 2=PSP_B0 3=PSP_B1
```

.

```
# Pixel 18 is used for the antico
# Origin: pre-pipeline from telemetry
TTYPE# = 'IPIX'
TFORM# = '1B'
TNULL# = 31
TLMIN# = 0
TLMAX# = 17
TCOMM# = ‘Pixel Number(0-17) in each PSP; antico (18)'

# Column name: LAP_LSB
# Description: LSB of the lap, or +2 if not match
# Origin: pre-pipeline from telemetry
TTYPE# = 'LAP_LSB'
TFORM# = '1B'
TCOMM# = ‘LSB of a lap, +2 if not match’

# Column name: VALID_LP
# Description: lap & pointer to WFRB, where valid data exist
# Origin: pre-pipeline from telemetry
TTYPE# = 'VALID_LP'
TFORM# = '1J'
TCOMM# = ‘Lap& pointer of WFRB when valid data exist’

# Column name: ADC_SAMPLE
# Description: ADC sampled value (14 bit, signed)
# Origin: pre-pipeline from telemetry
TTYPE# = 'ADC_SAMPLE'
TFORM# = '2048I'
TCOMM# = ‘ADC sampled value’

# Column name: DERIVATIVE
# Description: calculated derivative (16 bit, signed)
# Origin: pre-pipeline from telemetry
TTYPE# = 'DERIVATIVE'
TFORM# = '2048I'
TCOMM# = ‘Calculated derivative’

# Column name: SAMPLECNT
# Description: SAMPLE_CNT corresponding to the trigger
# Origin: pre-pipeline calculated from software
TTYPE# = 'SAMPLECNT'
TFORM# = '1D'
TCOMM# = ,ÄôUsed to calculate TIME'

# Column name: PROC_STATUS
# Description: pipe-line processing status
# Origin: pre-pipeline calculated from software
TTYPE# = 'PROC_STATUS'
TFORM# = '32X'
TCOMM# = ‘Record bad telemetry or bad values’
```

===SXI

SXI EVENT

```
xtension=bintable
#
# This template is based on the spread-sheet SXI_EventTelem_v1.xlsx
# There is one "Exposure Telemetry" common to one 3x3 and 5x5 event packet
# and that is valid for one segment.
#
# The data for the 3x3 and 5x5 are included in the same FFF file with the
# corresponding 'Exposure'.  MUST have the Exposure packet otherwise the
# data are not useful
#
# exposure   3x3         is good
# exposure   3x3     5x5 is good
# exposure           5x5 no good
#            3x3     5x5 no good
#
```

```
# If # of events is different in the 3x3 and 5x5 write the 3x3 with null to
# the corresponding 5x5 columns but also write rows with only the 5x5 info
# with the same seq_ID and set the Proc_STATUS to bad
#
# There is one FFF file for each "mode" where mode include changes in all
# the possible parameters that prevents data to be put in a separate file
# either because a) will require different calibration or b) data were
# selected on board (lower energy discriminator or window discriminator)
#
# NOTE that the IT will ID specific settings and/or "mode" for users.
# These "mode" will be calibrated throughout the mission. The remaining
# setting will be treated as diagnostic for the IT and label according.
# Need to decide how to label this IT settings and what
# pre-pipeline/pipeline will do .
#
#number of rows
naxis2 = 1

# Description: Time, second from the epoch
# Origin     : Pipeline process, by time assignment process
# Origin     : Blank
ttype# = TIME
tform# = 1D
tunit# = 's'
tcomm# = 'Seconds from 01 Jan 2014 00:00:00'

# Description: Time taken from the 5x5
# Used S_TIME5X5=0 when the 5x5 packet are not present
# Origin     : PrePipe line, calculated from SDTP header by SIRIUS
ttype# = S_TIME5X5
tform# = 1D
tunit# = 's'
tcomm# = 'Time for 5x5 packet stamped by SIRIUS'

# Description: Time taken from the 3x3
# Origin     : PrePipe line, calculated from SDTP header by SIRIUS
ttype# = S_TIME
tform# = 1D
tunit# = 's'
tcomm# = 'Time for 3x3 packet stamped by SIRIUS'

# Description: ADU_CNT taken from 3x3
# Origin     : Pre-Pipe line, copy from the telemetry 3x3
ttype# = ADU_CNT
tform# = 1B
tcomm# = 'ADU Sequence Packet Counter for 3x3'

# Description: ADU_CNT taken from 5x5
# Used ADU_CNT5X5=0 when the 5x5 packet is not present
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = ADU_CNT5X5
tform# = 1B
tcomm# = 'ADU sequence packet counter for 5x5'

# Telemetry category H M L
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = CATEGORY
tform# = 1B
tcomm# = 'Data Recorder Priority for 3x3'

# Telemetry category H M L
# Used CATEGORY5X5=256 when the 5X% are not present
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = CATEGORY5X5
tform# = 1B
tcomm# = 'Data Recorder Priority for 5x5'

# Description: Time Indicator 3x3
# Origin     : Pre-Pipe line, copy from CCSDS 2ndary header
ttype# = L32TI
tform# = 1J
```

```
tzero# = 2147483648
tcomm# = 'Packet TI Lower 32b, 2^-6 s, for 3x3'

# Description: Time Indicator 5x5
# Used L32TI5X5=0 when the 5x5 packet are not present
# Origin     : Pre-Pipe line, copy from CCSDS 2ndary header
ttype# = L32TI5X5
tform# = 1J
tzero# = 2147483648
tcomm# = 'Packet TI Lower 32b, 2^-6 s, for 5x5'

# Description: Local time from the 3x3 packet but identical for the 5x5
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = SEQSTARTTIME
tform# = 1J
tzero# = 2147483648
tcomm# = 'Sequence Start Time'

# Description: CCD ID from the 3x3 packet but should be identical in 5x5
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = CCD_ID
tform# = 1B
tlmin# = 0
tlmax# = 3
tnull# = 255
tcomm# = '0: CCD1, 1: CCD2, 2: CCD3, 3: CCD4'

# Description: CCD name as a string (CCD1,CCD2,CCD3,CCD4)
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = CCD_NAME
tform# = 4A
tcomm# = 'CCD Name'

# Description: Segment ID from the 3x3 packet but should be identical in 5x5
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = SEGMENT
tform# = 1B
tlmin# = 0
tlmax# = 1
tnull# = 255
tcomm# = '0: AB, 1: CD (Segment ID)'

# Description: EventNumber from the 3x3 packet
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = EVENTNUMBER
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'Event Number from 3x3 Packet'

# Description: EventNumber5x5 from the 5x5 (note they should be different
#              but keep both for checking)
#              Use EVENTNUMBER5X5 =0 when the 5x5 packet is not present
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = EVENTNUMBER5X5
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'Event Number from 5x5 Packet'

# Description: Readout Node
#              0 = A (if SEGMENT=0) or D (if SEGMENT=1)
#              1 = B (if SEGMENT=0) or C (if SEGMENT=1)
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = READNODE
tform# = 1B
tlmin# = 0
tlmax# = 1
tnull# = 255
tcomm# = '0: A or D, 1: B or C (Readout Node)'
```

```
# Description : Amplifier node ID, needed for gain correction
#               (Nobukawa look-up table AI 72 sxi_ai_bld3_answ_06052013)
#               ADC setting 0=av, 1=P or R, 2=Q or S ; 255 =null
# Origin      : Pre-Pile line, copy from the exposure telemetry
ttype# = ADCAVE
tform# = 1B
tnull# = 255
tcomm# = '0: averaged, 1: P or R, 2: Q or S (ADC Setting)'

# Description: RAWX from 3x3 only
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = RAWX
tform# = 1I
tlmin# = 0
tlmax# = 319
tnull# = -1
tcomm# = 'Pixel X on RAW-Coordinate'

# Description: RAWY from 3x3 only
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = RAWY
tform# = 1I
tlmin# = 0
tlmax# = 639
tnull# = -1
tcomm# = 'Pixel Y on RAW-Coordinate'

# Description: PHAS3X3, from the telemetry 3x3 packet
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = PHAS_INNER3X3
tform# = 9I
tnull# = -32768
tcomm# = 'Pulse Height Amplitudes of 3x3 Pixels'

# Description: P_Outer_Most from the 3x3
#              NULL=-1 as this means all pixels are above threshold
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = P_OUTER_MOST
tform# = 1I
tnull# = -1
tcomm# = 'Outer 5x5 Pixels Hit Pattern'

# Description: Sum_Outer_Most from the 3x3
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = SUM_OUTER_MOST
tform# = 1I
tnull# = -32768
tcomm# = 'Outer 5x5 PH Sum below Split Threshold'

# Description: PHAS_OUTER5X5, from the telemetry 5x5 packet
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = PHAS_OUTER5X5
tform# = 16I
tnull# = -32768
tcomm# = 'PHA of Outer 5x5 Pixels'

############   Additional columns populated by the pipeline
############   but created in the pre-pipeline
#
# Description: ACTX
# Origin     : Pipe line, calculated coordinator
ttype# = ACTX
tform# = 1I
tlmin# = 1
tlmax# = 640
tnull# = -1
tcomm# = 'Pixel X on ACT-Coordinate'

# Description: ACTY
# Origin     : Pipe line, calculated coordinator
ttype# = ACTY
```

```
tform# = 1I
tlmin# = 1
tlmax# = 640
tnull# = -1
tcomm# = 'Pixel Y on ACT-Coordinate'

# Description: DETX
# Origin     : Pipe line, calculated coordinator
ttype# = DETX
tform# = 1I
tlmin# = 1
tlmax# = 1810
tnull# = -1
tcomm# = 'Pixel X on DET-Coordinate'

# Description: DETY
# Origin     : Pipe line, calculated coordinator
ttype# = DETY
tform# = 1I
tlmin# = 1
tlmax# = 1810
tnull# = -1
tcomm# = 'Pixel Y on DET-Coordinate'

# Description: FOCX
# Origin     : Pipe line, calculated coordinator
ttype# = FOCX
tform# = 1I
tlmin# = 1
tlmax# = 1810
tnull# = -1
tcomm# = 'Pixel X on FOC-Coordinate'

# Description: FOCY
# Origin     : Pipe line, calculated coordinator
ttype# = FOCY
tform# = 1I
tlmin# = 1
tlmax# = 1810
tnull# = -1
tcomm# = 'Pixel Y on FOC-Coordinate'

# Description: X
# Origin     : Pipe line, calculated coordinator
ttype# = X
tform# = 1I
tlmin# = 1
tlmax# = 1810
tnull# = -1
tcomm# = 'Pixel X on SKY-Coordinate'

# Description: Y
# Origin     : Pipe line, calculated coordinator
ttype# = Y
tform# = 1I
tlmin# = 1
tlmax# = 1810
tnull# = -1
tcomm# = 'Pixel Y on SKY-Coordinate'

# Description: PHAS, will contain 3x3 PH values
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = PHAS
tform# = 9I
tnull# = -32768
tcomm# = 'Pulse Height Amplitudes of 3x3 Pixels'

# Description: PHAS_MASK, mask of good and bad pixel values in the PHAS
# Origin     : Pipeline
ttype# = PHAS_MASK
tform# = 9B
```

```
tcomm# = '0: Good, 1: Bad (Flag for 3x3 Pixels)'


# Description: PHASALL
#              ALL Reconstructed 3x3 + 5 outer for all event with the 5x5
#              outer + 3x3 only event with the outer 5 set to zero add a
#              flag in status to id the event that have only 3x3 and eventa
#              that have instead 5x5
# Origin     : Pipeline
ttype# = PHASALL
tform# = 25I
tnull# = -32768
tcomm# = 'Pulse Height Amplitudes of All 5x5 Pixels'

# Description: PHA calculated for the PHAS
#              Calculated PHA uses only the 3x3 of the PHAS.
#              In the PHA calculation is not used the  pixels outside the 3x3
# Origin     : Pipeline
ttype# = PHA
tform# = 1I
tlmin# = 0
tlmax# = 4095
tnull# = 4095
tcomm# = 'Pulse Height Amplitude Sum of 3x3 Pixels'

# Description: PI calculated for the PHA that is calculated from PHAS
#              Only uses 3x3 calibration file gain pi=coef0 + coeff1*pha +
#              coeff2*PHA**2; depends on readout/ segment and amplifier
# Origin     : Pipeline
ttype# = PI
tform# = 1I
tlmin# = 0
tlmax# = 4095
tnull# = 4095
tcomm# = 'Pulse Height Invariant'

# Description: GRADE
#              Most grades calculated using the 3x3; For grade for 7 and 10
#              use the split threshold in the P_outer_most that Id if any
#              of the 16 pixel is above or below the threshold
# Origin     : Pipe line, calculated sxigrade/sxipi
ttype# = GRADE
tform# = 1I
tnull# = -1
tcomm# = 'Grade Value for Pixel Hit Pattern'

# Description: STATUS  (Pixel status)
# Origin     : Pipe line,
ttype# = STATUS
tform# = 48X
tcomm# = 'Event Flag'

# Description:
# Origin : pre-pipeline/pipeline status
ttype# = PROC_STATUS
tform# = 32X
tcomm# = 'Record Bad Telemetry or Bad Values'
```

SXI EXPOSURE

```
xtension=bintable
#
# This template is based on the spreadsheet SXI_EventTelem_v19.xlsx
# There is one "Exposure Telemetry" common to one 3x3 and 5x5 event packet
# and that is valid for one segment.
#
# The data for the 3x3 and 5x5 are included in the same FFF file with the
# corresponding 'Exposure'.  They MUST have the Exposure packet otherwise
# the data are not useful.
#
#number of rows
```

```
naxis2 = 1
#

# Description: Time, second from the epoch
# Origin     : Pipeline process, by time assignment process
# Origin     : Blank
ttype# = TIME
tform# = 1D
tunit# = 's'
tcomm# = 'Seconds from 01 Jan 2014 00:00:00'
#
# Description: Time taken from the exposure telemetry
# Origin     : PrePipe line, calculated from SDTP header by SIRIUS
ttype# = S_TIME
tform# = 1D
tunit# = 's'
tcomm# = 'Time for 5x5 packet stamped by SIRIUS'
#
# Description: Taken from exposure telemetry
# Origin     : Pre-Pipe line, copy from the exposure telemetry
ttype# = ADU_CNT
tform# = 1B
tcomm# = 'ADU Sequence Packet Counter'
#
# Telemetry category H M L
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = CATEGORY
tform# = 1B
tcomm# = 'Data Recorder Priority'
#
# Description: Time Indicator
# Origin     : Pre-Pipe line, copy from CCSDS 2ndary header
ttype# = L32TI
tform# = 1J
tzero# = 2147483648
tcomm# = 'Packet TI Lower 32b, 2^-6 s'
#
# Description: Local time from the exposure packet; identical for 3x3,5x5
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = SEQSTARTTIME
tform# = 1J
tzero# = 2147483648
tcomm# = 'Sequence Start Time'
#
# Description: CCD ID from the exposure packet
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = CCD_ID
tform# = 1B
tlmin# = 0
tlmax# = 3
tnull# = 255
tcomm# = '0: CCD1, 1: CCD2, 2: CCD3, 3: CCD4'
#
# Description: Segment ID from the exposure packet
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = SEGMENT
tform# = 1B
tlmin# = 0
tlmax# = 1
tnull# = 255
tcomm# = '0: AB, 1: CD (Segment ID)'
#
# Description: EventNumber from the exposure packet
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = EVENTNUMBER
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'Event Number from Exposure Packet'
#
#
```

```
#====== Following entries are unique to exposure (not in event fff) ======
#
# Description : Number of events rejected because they have PH > DE_EVENT_TH_UPR
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = REJOVERULD
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'No. evt rejected PH[0] > EVTH_UPPER'
#
# Description : Number of events rejected because they have PH < DE_EVENT_TH_LWR
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = REJUNDERLLD
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'No. evt rejected PH[0] < EVTH_LOWER'
#
# Description : Number of events rejected by area discrimination
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = REJARDISC
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'No. evt rejected by area discrimination'
#
# Description : Number of events rejected by surrounding filter
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = REJSURDISC
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'No. evt rejected by surround filter'
#
# Description : Number of events rejected by 3x3 local maximum filter
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = REJLOCALDISC
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'No. evt rejected by 3x3 local max filter'
#
# Description : DE editing was complete? 0=incomplete, 1=complete
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = COMPFLAG
tform# = 1B
tnull# = 255
tcomm# = 'DE editing completion status'
#
# Description : Processing priority of the CCD in the DE
#               0=1st priority, 1=2nd priority, 2=3rd priority, 3=4th priority
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = CCDPRIORITY
tform# = 1B
tnull# = 255
tcomm# = '0:1st 1:2nd 2:3rd 3:4th (DE processing priority)'
#
# Description : Processing priority of the segment in the DE
#               0=1st priority, 1=2nd priority
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = SEGPRIORITY
tform# = 1B
tnull# = 255
tcomm# = '0:1st, 1:2nd (DE processing priority)'
#
# Description : Segment to determine to complete to take image
#               0=SegmentAB or CD, 1=SegmentAB, 2=SegmentCD, 3=Reserved
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = DETECTSEG
tform# = 1B
tnull# = 255
```

```
tcomm# = 'DE segment for PE processing'
#
# Description : Enable/disable 3x3 data processing in DE
#               0=disabled, 1=enabled
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = ENA3X3PROC
tform# = 1X
tcomm# = '0:ena, 1:dis (DE 3x3 processing)'
#
# Description : Enable/disable 5x5 data processing in DE
#               0=disabled, 1=enabled
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = ENA5X5PROC
tform# = 1X
tcomm# = '0:ena, 1:dis (DE 5x5 processing)'
#
# Description : Enable/disable area discrimination inclusion (IN)
#               0=disabled, 1=enabled
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = ADINENA
tform# = 1X
tcomm# = '0:ena, 1:dis (area disc. incl.)'

#
# Description : Enable/disable area discrimination exclusion (OUT) #0
#               0=disabled, 1=enabled
# Origin      : Pre-Pipe line, copy from the telemetry
#               EnadisAreaDiscri/OUT bit 4
ttype# = ADOU0ENA
tform# = 1X
tcomm# = '0:ena, 1:dis (area disc. excl. 0)'

#
# Description : Enable/disable area discrimination exclusion (OUT) #1
#               0=disabled, 1=enabled
# Origin      : Pre-Pipe line, copy from the telemetry
#               EnadisAreaDiscri/OUT bit 3
ttype# = ADOU1ENA
tform# = 1X
tcomm# = '0:ena, 1:dis (area disc. excl. 1)'

#
# Description : Enable/disable area discrimination exclusion (OUT) #2
#               0=disabled, 1=enabled
# Origin      : Pre-Pipe line, copy from the telemetry
#               EnadisAreaDiscri/OUT bit 2
ttype# = ADOU2ENA
tform# = 1X
tcomm# = '0:ena, 1:dis (area disc. excl. 2)'

#
# Description : Enable/disable area discrimination exclusion (OUT) #3
#               0=disabled, 1=enabled
# Origin      : Pre-Pipe line, copy from the telemetry
#               EnadisAreaDiscri/OUT bit 1
ttype# = ADOU3ENA
tform# = 1X
tcomm# = '0:ena, 1:dis (area disc. excl. 3)'

#
# Description : Enable/disable surround filter
#               0=disabled, 1=enabled
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = SURDISCENA
tform# = 1X
tcomm# = '0:ena, 1:dis (surround filter)'

#
# Description : Enable/disable 3x3 local maximum filter
#               0=disabled, 1=enabled
# Origin      : Pre-Pipe line, copy from the telemetry
```

```
ttype# = LOCALDISCENA
tform# = 1X
tcomm# = '0:ena, 1:dis (3x3 local max filter)'

#
# Description : Start RAWX position of area discrimination inclusion (IN)
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = X0_ADIN
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWX start of area disc. incl. region'
#
# Description : End RAWX position of area discrimination inclusion (IN)
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = X1_ADIN
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWX stop of area disc. incl. region'
#
# Description : Start RAWY position of area discrimination inclusion (IN)
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = Y0_ADIN
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWY start of area disc. incl. region'
#
# Description : End RAWY position of area discrimination inclusion (IN)
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = Y1_ADIN
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWY stop of area disc. incl. region'
#
# Description : Start RAWX position of area discrimination exclusion (OUT) #0
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = X0_0_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWX start of area disc. excl. region 0'
#
# Description : End RAWX position of area discrimination exclusion (OUT) #0
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = X1_0_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWX stop of area disc. excl. region 0'
#
# Description : Start RAWY position of area discrimination exclusion (OUT) #0
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = Y0_0_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWY start of area disc. excl. region 0'
#
# Description : End RAWY position of area discrimination exclusion (OUT) #0
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = Y1_0_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWY stop of area disc. excl. region 0'
#
# Description : Start RAWX position of area discrimination exclusion (OUT) #1
# Origin      : Pre-Pipe line, copy from the telemetry
```

```
ttype# = X0_1_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWX start of area disc. excl. region 1'
#
# Description : End RAWX position of area discrimination exclusion (OUT) #1
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = X1_1_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWX stop of area disc. excl. region 1'
#
# Description : Start RAWY position of area discrimination exclusion (OUT) #1
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = Y0_1_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWY start of area disc. excl. region 1'
#
# Description : End RAWY position of area discrimination exclusion (OUT) #1
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = Y1_1_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWY stop of area disc. excl. region 1'
#
# Description : Start RAWX position of area discrimination exclusion (OUT) #2
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = X0_2_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWX start of area disc. excl. region 2'
#
# Description : End RAWX position of area discrimination exclusion (OUT) #2
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = X1_2_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWX stop of area disc. excl. region 2'
#
# Description : Start RAWY position of area discrimination exclusion (OUT) #2
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = Y0_2_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWY start of area disc. excl. region 2'
#
# Description : End RAWY position of area discrimination exclusion (OUT) #2
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = Y1_2_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWY stop of area disc. excl. region 2'
#
# Description : Start RAWX position of area discrimination exclusion (OUT) #3
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = X0_3_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWX start of area disc. excl. region 3'

#
```

```
# Description : End RAWX position of area discrimination exclusion (OUT) #3
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = X1_3_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWX stop of area disc. excl. region 3'
#
# Description : Start RAWY position of area discrimination exclusion (OUT) #3
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = Y0_3_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWY start of area disc. excl. region 3'
#
# Description : End RAWY position of area discrimination exclusion (OUT) #3
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = Y1_3_ADOUT
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'RAWY stop of area disc. excl. region 3'
#
# Description : Threshold for surround filter
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = SURTH
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'Threshold for surround filter'
#
# Description : Number of pixels for surround filter
#       If there are more than NPIX_SURTH pixels in the 3x3 region with
#       PH > SURTH, the event is rejected by SXI-DE.
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = NPIX_SURTH
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'No. pixels above SURTH to trigger filter'
#
# Description : Lower threshold for event candidate detection in PE  # Origin      : Pre-Pipe
line, copy from the telemetry   ttype# = EVTH_LOWER  tform# = 1I  tnull# = 32767  tzero# = 32768
tcomm# = 'Lower threshold for DE event candidate'
#
# Description : Upper threshold for event candidate detection in PE
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = EVTH_UPPER
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'Upper threshold for DE event candidate'
#
# Description : Threshold for outer 5x5 pixels to create P_OUTER_MOST
#               hit pattern  # Origin      : Pre-Pipe line, copy from the telemetry
ttype# = OUTER_SPLIT_TH
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'Threshold of outer 5x5 pixels'
# Description : Microcode ID
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = UCODE_ID
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'Microcode identifier'
# Description : Transfer line length
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = TRANSLINELENGTH
```

```
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'Horizontal line length in frame'
# Description : Image line length
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = IMGLINELENGTH
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'Horizontal line length in imaging area'
#  Description : Horizontal overclock (HOC) line length
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = HOCLINELENGTH
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'Horizontal overclock length'
#  Description : Horizontal underclock (HUC) line length
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = HUCLINELENGTH
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'Horizontal underclock length'
#  Description : Image height
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = IMAGEHEIGHT
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'Vertical line length in imaging area'
# Description : Vertical overclock (VOC) height
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = VOCHEIGHT
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'Vertical overclock length'
# Description : Vertical underclock (VUC) height
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = VUCHEIGHT
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'Vertical underclock length'
# Description : Transfer direction
# Origin      : Pre-Pipe line, copy from the telemetry
#                   bit0: 0 means transfer direction is nodeA or nodeD
#                         1 means trnasfer direction is nodeB or nodeC
#                   bit1: 0 means readout from nodeA or nodeD
#                         1 means readout from nodeB or nodeC
ttype# = TRANSFERDIR
tform# = 1B
tnull# = 255
tcomm# = 'Trans dir: bit0;Rdnode: bit1 (0:A/D 1:B/C)'
# Description : ADC ASIC ID
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = ADC_ID
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'Identity of ASIC ADC'
#
# Description : ADC channel
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = ADC_CHAN
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'Identity of ADC channel'
```

```
#
# Description : Data class
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = DATACLASS
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'DataClass identifier'
#
# Description : Status of dark update
#               bit0: DarkValue_REN bit1: DarkValue_WEN bit2: SEL_DARKVALUE
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = DUPDATE
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'Status of dark update'
# Description : Start time of last dark update
#               bit0: DarkValue_REN bit1: DarkValue_WEN bit2: SEL_DARKVALUE
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = DUPDATESTARTTIME
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'Start time of dark update'
# Description : Threshold of lower level discriminator in SXI-PE
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = LLDEVTCAND
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'PE lower-level discri. threshold'
#
# Description : Threshold of upper level discriminator in SXI-PE
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = ULDEVTCAND
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'PE upper-level discri. threshold'
#
# Description : Number of candidate events (pixels) over ULDEVTCAND
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = ULDPIXNUM
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'No. pixels PH>ULDEVTCAND'
#
# Description : Number of candidate events (pixels) between LLDEVTCAND
#               and ULDEVTCAND
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = LDPIXNUM
tform# = 1I
tnull# = 32767
tzero# = 32768
tcomm# = 'No. pixels LLD<=PH<=ULD'
#
# Description : iFrame offset value used for calculation of pixel value in PE
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = IFRAME_OFFSET
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'PE offset PH value'
# Description : Sum of pixel values in HOC region
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = HOCSUMNUM
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
```

```
tcomm# = 'No. pixels in a row of HOC'
# Description : Number of event candidates detected by PE
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = NUMEVTCAND
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'No. PE event candidates'
# Description : Length of event candidates detected by PE
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = LENEVTCAND
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'No. DE event candidates'
#
# Description : Number of hot pixels detected by PE
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = NUMHOTPIX
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'No. PE hot pixels'
# Description : Length of hot pixels detected by PE
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = LENHOTPIX
tform# = 1J
tnull# = 2147483647
tzero# = 2147483648
tcomm# = 'No. DE hot pixels'
#
# Description : Sanity (not defined what this means)
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = SANITY
tform# = 1J  tcomm# = 'Sanity'
#
# Description : Pre-pipeline/pipeline status
# Origin      : Pre-Pipe line populates this column
ttype# = PROC_STATUS
tform# = 32X
tcomm# = 'Record Bad Telemetry or Bad Values'
```

SXI D-FRAME

```
xtension=bintable
#
# The "frame" data is converted in an FFF with the following format :
# 1 bintable followed by as many IMAGE extensions as many rows are in
#   the bintable
#
# There are in total 3 files, one file each for "raw" R-frame data, "image"
# I-frame data, and "dark" D-frame data.  The R- I- D- frame FFF file have
# a bintable followed by as many images are present in the bintable.
#
# This template is used for D-frame.
#
# The telemetry information for each exposure x-frame is stored as a row in
# the bintable with several columns. However from the PIXELPH is possible
# to create also an image array.  Therefore the R- I- D-Frame FFF file have
# a bintable where each row corresponds to an exposure + n IMAGE extensions
# where the PIXELPH is turned into an array.
#
# The pipeline software calculate time only for the bintable by running
# ahtime The Timing information for the Image extensions are instead
# derived in the pre-pipeline using the information stored in the columns.
# Therefore the keywords for the IMAGE are :
# CCD_ID   = n                     / taken from the column CCD_ID
# READNODE = n                     / taken from the column READNODE
# SEGMENT  = m                     / taken from the column SEGMENT
# ADCAVE   = m                     / taken from the column ADCAVE
# SEQTIME  = xxx                   / taken from the column SEQSTARTTIME
# DATE-OBS = (from S_TIME+ MJDREF) / format YYYY-MM-DD:HH:MM:SS.s
```

```
# DATE-END = (DATE-OBS + 4sec"     / format YYYY-MM-DD:HH:MM:SS.s
# TSTART   = S_TIME                / format second from MJDREF
# TSTOP    = S_TIME+4 sec          / format second from MJDREF
#
# The D-frame does not have the PCODE column, and is described here.
# The I-frame and R-frame have all columns described here plus PCODE, and
# are described in a separate template file.
#
# To decode locations of frame data (from SXI document, frame data
# telemetry description):
#
#   In addition to CCD and segment IDs, all frame data telemetry records
#   the PH of each pixel in READ coordinates, as shown in Figure 7.  rframe
#   and iframe telemetry also contain the PCODE for each pixel, which
#   specifies the region in which the pixel falls (e.g., the active pixel
#   or AP region, and ,Äúvirtual,Äù regions such as HUC, HOC, etc.).  The
#   relationship between PCODE and the pixel location is the following:
#   FS(1), LS(2), HUC(3), HOC(4), VOC(6), VUC(9), AP(11), LE(13), FE(14),
#   NA=non-active area(8).
#
#   Frame data are compressed and recorded in telemetry as shown in Figure
#   24.  rframe and iframe data are decoded in the same way, but as dframe
#   lacks the PCODE information, it must be decoded in a different way.  In
#   order to convert pixel order in telemetry (n_pix) into the correct RAW
#   coordinates, the following conversion formulae must be used:
#
#   READX = n_pix % TransferLineLength
#   READY = (int) n_pix / TransferLineLength
#   RAWX = READX ,Äì hucLineLength
#   RAWY = READY ,Äì vucHeight
#
# TransferLineLength, hucLineLength, and vucHeight are recorded in the
# exposure telemetry.
#
##############################################################################
#
#
#number of rows
naxis2 = 1
#
# Description: Time, second from the epoch
# Origin     : Pipeline process, by time assignment process
# Origin     : Blank
ttype# = TIME
tform# = 1D
tunit# = 's'
tcomm# = 'Seconds from 01 Jan 2014 00:00:00'

# Description: Time
# Origin     : PrePipe line, calculated from SDTP header by SIRIUS
ttype# = S_TIME
tform# = 1D
tunit# = 's'
tcomm# = 'Time for CCSDS packet stamped by SIRIUS'

# Description:
# Origin     : Pre-Pipe line, copy from the telemetry 3x3
ttype# = ADU_CNT
tform# = 1B
tcomm# = 'ADU Sequence Packet Counter'

# Telemetry category H M L
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = CATEGORY
tform# = 1B
tcomm# = 'Data Recorder Priority'

# Description: Time Indicator 3x3
# Origin     : Pre-Pipe line, copy from CCSDS 2ndary header
ttype# = L32TI
tform# = 1J
```

```
tzero# = 2147483648
tcomm# = 'Packet TI Lower 32b, 2^-6 s'

# Description: Local time
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = SEQSTARTTIME
tform# = 1J
tzero# = 2147483648
tcomm# = 'Sequence Start Time'

# Description: CCD ID
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = CCD_ID
tform# = 1B
tlmin# = 0
tlmax# = 3
tnull# = 255
tcomm# = '0: CCD1, 1: CCD2, 2: CCD3, 3: CCD4'

# Description: Segment ID
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = SEGMENT
tform# = 1B
tlmin# = 0
tlmax# = 1
tnull# = 255
tcomm# = '0: AB, 1: CD (Segment ID)'

# Description: Readout Node
#              0 = A (if SEGMENT=0) or D (if SEGMENT=1)
#              1 = B (if SEGMENT=0) or C (if SEGMENT=1)
# Origin      : Pre-Pile line, copy from the telemetry
ttype# = READNODE
tform# = 1B
tlmin# = 0
tlmax# = 1
tnull# = 255
tcomm# = '0: A or D, 1: B or C (Readout Node)'

# Description : Amplifier node ID, needed for gain correction
#               (Nobukawa look-up table AI 72 sxi_ai_bld3_answ_06052013)
#               ADC setting 0=av, 1=P or R, 2=Q or S ; 255 =null
# Origin      : Pre-Pile line, copy from the exposure telemetry
ttype# = ADCAVE
tform# = 1B
tnull# = 255
tcomm# = '0: averaged, 1: P or R, 2: Q or S (ADC Setting)'

# Description: Pixel pulse-height (PH) value
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = PIXELPH
tform# = 1164288I
tzero# = 32768
tcomm# = 'Pixel Pulse Height Value'

# Description:
# Origin : pre-pipeline/pipeline status
ttype# = PROC_STATUS
tform# = 32X
tcomm# = 'Record Bad Telemetry or Bad Values'

#
#############################################################################
#
# follows one IMAGE extension for each row in bintable
#
xtension = IMAGE
bitpix = 16
naxis = 2
naxis1 = 758
naxis2 = 1536
```

```
xtension=bintable
#
```

SXI hot pixel from D-Frame

```
# hot pixel list FITS file
# output from processing dframe
#
# procedure:
# open output hot pixel list HOT_PIX_LIST for writing
# open dframe DFRAME
# for each of bintable extension DFRAME_EXTENSION in DFRAME {
#   for each row in DFRAME_EXTENSION {
#     read from DFRAME_EXTENSION columns:
#       S_TIME, L32TI, SEQSTARTTIME, CCD_ID, SEGMENT, READNODE, PIXELPH[n]
#     for (ii=0;ii<n;ii++) {
#       if (PIXELPH >= 4095) {
#         PHA = PIXELPH
#         calculate RAWX,RAWY from n (pixel position) (how to do this?)
#         write to HOT_PIX_LIST columns:
#           TIME, SEQSTARTTIME, CCD_ID, SEGMENT, READNODE, RAWX, RAWY,
#           ACTX=null, ACTY=null, DETX=null, DETY=null, PHA,
#           YEXTEND=1, STATUS=(32X, bit1=1, all others=0)
#       }  // end if
#     } // end for
#   } // next row
# } // next dframe bintable extension
# close DFRAME
# close HOT_PIX_LIST
#
#number of rows
naxis2 = 1

# Description: Time, second from the epoch
# Origin     : Pipeline process, by time assignment process
# Origin     : Blank
ttype# = TIME
tform# = 1D
tunit# = 's'
tcomm# = 'Seconds from 01 Jan 2014 00:00:00'

# Description: Time
# Origin     : PrePipe line, calculated from SDTP header by SIRIUS
ttype# = S_TIME
tform# = 1D
tunit# = 's'
tcomm# = 'Time for CCSDS packet stamped by SIRIUS'

# Description: Time Indicator 3x3
# Origin     : Pre-Pipe line, copy from CCSDS 2ndary header
ttype# = L32TI
tform# = 1J
tzero# = 2147483648
tcomm# = 'Packet TI Lower 32b, 2^-6 s'

# Description: Local time
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = SEQSTARTTIME
tform# = 1J
tzero# = 2147483648
tcomm# = 'Sequence Start Time'

# Description: CCD ID from the dframe
#              0,1,2,3 = CCD1,2,3,4
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = CCD_ID
tform# = 1B
tlmin# = 0
tlmax# = 3
tnull# = 255
```

```
tcomm# = '0: CCD1, 1: CCD2, 2: CCD3, 3: CCD4'

# Description: Segment ID
#              0 = Segment AB
#              1 = Segment CD
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = SEGMENT
tform# = 1B
tlmin# = 0
tlmax# = 1
tnull# = 255
tcomm# = 'Segment ID (0: AB, 1: CD)'

# Description: Readout Node
#              0 = A (if SEGMENT=0) or D (if SEGMENT=1)
#              1 = B (if SEGMENT=0) or C (if SEGMENT=1)
# Origin     : Pre-Pipe line, calculated from the exposure telemetry
#              in the same way as for event list FFF
ttype# = READNODE
tform# = 1B
tlmin# = 0
tlmax# = 1
tnull# = 255
tcomm# = 'Readout Node (0: A or D, 1: B or C)'

# Description: RAWX
# Origin     : Pre-Pipe line, calculated from pixel position
ttype# = RAWX
tform# = 1I
tlmin# = 0
tlmax# = 319
tnull# = -1
tcomm# = 'Pixel X on RAW-Coordinate'

# Description: RAWY
# Origin     : Pre-Pipe line, calculated from pixel position
ttype# = RAWY
tform# = 1I
tlmin# = 0
tlmax# = 639
tnull# = -1
tcomm# = 'Pixel Y on RAW-Coordinate'

# Description: ACTX
# Origin     : Pipe line, calculated coordinator
ttype# = ACTX
tform# = 1I
tlmin# = 1
tlmax# = 640
tnull# = -1
tcomm# = 'Pixel X on ACT-Coordinate'

# Description: ACTY
# Origin     : Pipe line, calculated coordinator
ttype# = ACTY
tform# = 1I
tlmin# = 1
tlmax# = 640
tnull# = -1
tcomm# = 'Pixel Y on ACT-Coordinate'

# Description: DETX
# Origin     : Pipe line, calculated coordinator
ttype# = DETX
tform# = 1I
tlmin# = 1
tlmax# = 1810
tnull# = -1
tcomm# = 'Pixel X on DET-Coordinate'

# Description: DETY
```

```
# Origin     : Pipe line, calculated coordinator
ttype# = DETY
tform# = 1I
tlmin# = 1
tlmax# = 1810
tnull# = -1
tcomm# = 'Pixel Y on DET-Coordinate'

# Description: YEXTEND, length of column in RAWX to extend hot/bad pixel
# Origin     : Pre-pipeline hot pixel processing
ttype# = YEXTEND
tform# = 1I
tcomm# = 'Length of Hot Pixels in RAWY'

# Description:
# Origin : pre-pipeline/pipeline status
ttype# = PROC_STATUS
tform# = 32X
tcomm# = 'Record Bad Telemetry or Bad Values'
```

SXI R/I-FRAME

```
xtension=bintable
#
# The "frame" data is converted in an FFF with the following format :
# 1 bintable followed by as many IMAGE extensions as many rows are in
# the bintable
#
# There are in total 3 files, one file each for "raw" R-frame data, "image"
# I-frame data, and "dark" D-frame # data.  The R- I- D- frame FFF file
# have a bintable followed by as many images are present in the bintable.
#
# This template is used for R-frame and I-frame.
#
# The telemetry information for each exposure x-frame is stored as a row in
# the bintable with several columns. However from the PIXELPH is possible
# to create also an image array.  Therefore the R- I- D-Frame FFF file have
# a bintable where each row corresponds to an exposure + n IMAGE extensions
# where the PIXELPH is turned into an array.
#
# The pipeline software calculate time only for the bintable by running
# ahtime The Timing information for the Image extensions are instead
# derived in the pre-pipeline using the information stored in the columns.
# Therefore the keywords for the IMAGE are :
# CCD_ID   = n                     / taken from the column CCD_ID
# READNODE = n                     / taken from the column READNODE
# SEGMENT  = m                     / taken from the column SEGMENT
# ADCAVE   = m                     / taken from the column ADCAVE
# SEQTIME  = xxx                   / taken from the column SEQSTARTTIME
# DATE-OBS = (from S_TIME+ MJDREF) / format YYYY-MM-DD:HH:MM:SS.s
# DATE-END = (DATE-OBS + 4sec"     / format YYYY-MM-DD:HH:MM:SS.s
# TSTART   = S_TIME                / format second from MJDREF
# TSTOP    = S_TIME+4 sec          / format second from MJDREF
#
# The I-frame and R-frame have all columns described here.
# The D-frame does not have the PCODE column, and is described in a
# separate template file.
#
# To decode locations of frame data (from SXI document, frame data
# telemetry description):
#
#   In addition to CCD and segment IDs, all frame data telemetry records
#   the PH of each pixel in READ coordinates, as shown in Figure 7.  rframe
#   and iframe telemetry also contain the PCODE for each pixel, which
#   specifies the region in which the pixel falls (e.g., the active pixel
#   or AP region, and ,Äúvirtual,Äù regions such as HUC, HOC, etc.).  The
#   relationship between PCODE and the pixel location is the following:
#   FS(1), LS(2), HUC(3), HOC(4), VOC(6), VUC(9), AP(11), LE(13), FE(14),
#   NA=non-active area(8).
#
#   Frame data are compressed and recorded in telemetry as shown in Figure
```

```
#   24.  rframe and iframe data are decoded in the same way, but as dframe
#   lacks the PCODE information, it must be decoded in a different way.  In
#   order to convert pixel order in telemetry (n_pix) into the correct RAW
#   coordinates, the following conversion formulae must be used:
#
#   READX = n_pix % TransferLineLength
#   READY = (int) n_pix / TransferLineLength
#   RAWX = READX ,Äì hucLineLength
#   RAWY = READY ,Äì vucHeight
#
# TransferLineLength, hucLineLength, and vucHeight are recorded in the
# exposure telemetry.
#
################################################################################
#
#
#number of rows
naxis2 = 1
#
# Description: Time, second from the epoch
# Origin     : Pipeline process, by time assignment process
# Origin     : Blank
ttype# = TIME
tform# = 1D
tunit# = 's'
tcomm# = 'Seconds from 01 Jan 2014 00:00:00'

# Description: Time
# Origin     : PrePipe line, calculated from SDTP header by SIRIUS
ttype# = S_TIME
tform# = 1D
tunit# = 's'
tcomm# = 'Time for CCSDS packet stamped by SIRIUS'

# Description:
# Origin     : Pre-Pipe line, copy from the telemetry 3x3
ttype# = ADU_CNT
tform# = 1B
tcomm# = 'ADU Sequence Packet Counter'

# Telemetry category H M L
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = CATEGORY
tform# = 1B
tcomm# = 'Data Recorder Priority'

# Description: Time Indicator 3x3
# Origin     : Pre-Pipe line, copy from CCSDS 2ndary header
ttype# = L32TI
tform# = 1J
tzero# = 2147483648
tcomm# = 'Packet TI Lower 32b, 2^-6 s'

# Description: Local time
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = SEQSTARTTIME
tform# = 1J
tzero# = 2147483648
tcomm# = 'Sequence Start Time'

# Description: CCD ID
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = CCD_ID
tform# = 1B
tlmin# = 0
tlmax# = 3
tnull# = 255
tcomm# = '0: CCD1, 1: CCD2, 2: CCD3, 3: CCD4'

# Description: Segment ID
# Origin     : Pre-Pipe line, copy from the telemetry
```

```
ttype# = SEGMENT
tform# = 1B
tlmin# = 0
tlmax# = 1
tnull# = 255
tcomm# = '0: AB, 1: CD (Segment ID)'

# Description: Readout Node
#              0 = A (if SEGMENT=0) or D (if SEGMENT=1)
#              1 = B (if SEGMENT=0) or C (if SEGMENT=1)
# Origin      : Pre-Pipe line, copy from the telemetry
ttype# = READNODE
tform# = 1B
tlmin# = 0
tlmax# = 1
tnull# = 255
tcomm# = '0: A or D, 1: B or C (Readout Node)'

# Description : Amplifier node ID, needed for gain correction
#               (Nobukawa look-up table AI 72 sxi_ai_bld3_answ_06052013)
#               ADC setting 0=av, 1=P or R, 2=Q or S ; 255 =null
# Origin      : Pre-Pile line, copy from the exposure telemetry
ttype# = ADCAVE
tform# = 1B
tnull# = 255
tcomm# = '0: averaged, 1: P or R, 2: Q or S (ADC Setting)'

# Description: Pixel pulse-height (PH) value
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = PIXELPH
tform# = 1164288I
tzero# = 32768
tcomm# = 'Pixel Pulse Height Value'

# Description: PCODE
# only for the R- I- Frame data, information about the region in which pixel falls
# Origin     : Pre-Pipe line, copy from the telemetry
ttype# = PCODE
tform# = 1164288B
tcomm# = 'Pixel Location Code'

# Description:
# Origin : pre-pipeline/pipeline status
ttype# = PROC_STATUS
tform# = 32X
tcomm# = 'Record Bad Telemetry or Bad Values'

##############################################################################
#
# follows one IMAGE extension for each row in bintable
#
xtension = IMAGE
bitpix = 16
naxis = 2
naxis1 = 758
naxis2 = 1536
```

===HXI

HXI event FFF

```
#-------------------------------------------------------------
# HXI event data format
# This data contains a list of events from one HXI camera unit.
# One HXI unit have one camera; there are two cameras on board ASTRO-H.
#
# History
#
# 2012-08-20 | H. Odaka | modification based on hxi_sff_20120615.tpl
# 2012-10-17 |L.Angelini| modification SCT meeting ISAS Hiro & Yuki
```

.

```
# 2012-10-31 GSFC meeting
# 2012-10-31 | H. Odaka | revision by IT: change data types of LOCAL_TIME and LIVETIME.
# 2012-12-12 | H. Takahashi | revision comments of some columns.
# 2012-13-12 | L. Angelini | Added PROC_STATUS & comment on STATUS fix spaces
# 2013-26-05: ISAS| fixed the Fast Bgo and HIT pat definition
# 2013-11-12-30 ISAS fixed the array size for flags
# 2015-03-17 GSFC added EPITOP/EPIBOT/EPICUT for ECUT function
#-------------------------------------------------------------
# The reading of the bits are exactly as shown in the color map
# Therefore the bits reading direction changes across the file
# from left right and right to left
#
#
#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns for FFF
#-------------------------------------------------------------
#-------------------------------------------------------------
#number of rows
naxis2 = 1
# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# ='s'
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'

# Description: Time when the space packet was sent
# Origin     : Pre-Pipeline fill the colums, calculated by SIRIUS
ttype# = S_TIME
tform# = 1D
tunit# ='s'
TCOMM# ='Time for CCSDS packet stamped by SIRIUS'

# Description: CCSDS packet header
# Origin     : Pre-Pipeline fill, copy from the telemetry
# This is identical to the SXS
ttype# = ADU_CNT
tform# = 1B
TCOMM# = 'ADU sequence packet counter'

# Description: L32 Time Indicator
# Origin     : Pre-Pipeline fill, copy from CCSDS 2ndary header
ttype# = L32TI
tform# = 1J
tzero# = 2147483648
TCOMM# ='Packet TI lower 32b, 2^-6 s'

# Description: Occurrence ID is within the SFF file
# a sequential number starting from 1 and increment at each row
# In the SFFa after reconstruction the number of columns may increase
# and therefore 1 or more rows have the same occurrence ID
# Origin     : Pre-Pipeline will insert the sequential number
ttype# = OCCURRENCE_ID
tform# = 1J
TCOMM# = 'Sequential Number for occurrence'

# Description: Local time (32-bit counter)
# Origin     : Pre-Pipeline fill, copy from the telemetry of "Local TIME D0-D31".
ttype# = LOCAL_TIME
tform# = 1J
tzero# = 2147483648
TCOMM# = 'Local Time to calculate TIME'

# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = CATEGORY
tform# = 1B
TCOMM# = 'Data recorder priority'
```

```
# Description: ALL FLAGS
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              all flags not conversted not used by the pipeline
ttype# = FLAGS
tform# = 32X
TCOMM# = 'Collection of all Flags'

# Description: 0 is ok, If different from 0 means that one or more
# layers have trouble. Single event upset occurred (1) or not (0)
# Origin     : Pre-Pipeline fill,  copy from the telemetry.
#              Converted from 5 bits of "SEU1-SEU5" into 1B.
# SEU5: CdTe-DSD layer, SEU4: 4th DSSD layer, SEU3: 3rd DSSD layer, SEU2: 2nd DSSD layer, SEU1:
top DSSD layer
ttype# = FLAG_SEU
tform# = 5X
TCOMM# ='1-4 Si 5 CdTE SEU flag'

# Description: length error (1) or ok (0)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 5 bits of "LCHK1-LCHK5" into 1B.
# LCHK5: CdTe-DSD layer, LCHK4: 4th DSSD layer, LCHK3: 3rd DSSD layer, LCHK2: 2nd DSSD layer,
LCHK1: top DSSD layer
ttype# = FLAG_LCHK
tform# = 5X
TCOMM# ='1-4 Si 5 CdTE Length Chk flag'

# Description: origin of trigger(s). There are 8 possible patters . Which layer or cal or pseudo
or forced occurred first
# for triggering
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 8 bits of "TRG1-TRG8" into 1B.
# TRG8: Trigger from  calibration mode, TRG7: Pseudo trigger, TRG6: Forced trigger,
# TRG5: Trigger from CdTe-DSD layer, TRG4: 4th DSSD layer, TRG3: 3rd DSSD layer, TRG2: 2nd DSSD
layer, TRG1: 1st DSSD layer
ttype# = FLAG_TRIG
tform# = 8X
TCOMM# ='Trigger origin'

# Description: trigger pattern during the occurrence. Which layer or cal or pseudo or forced is
up within xx time
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 8 bits of "TRGPAT1-TRGPAT8" into 1B.
# TRGPAT8: From calibration mode, TRGPAT7: Pseudo trigger, TRGPAT6: Forced trigger,
# TRGPAT5: From CdTe-DSD layer, TRGPAT4: 4th DSSD layer, TRGPAT3: 3rd DSSD layer,
TRGPAT2: 2nd DSSD layer, TRGPAT1: top DSSD layer
ttype# = FLAG_TRIGPAT
tform# = 8X
TCOMM# ='Trigger pattern'

# Description: BGO Shield Hit-Pattern veto signal (more accurate calculation than FBGOs)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 2 bits of "HPAT1 & HPAT2" into 1B.
# One is associated to the Am 241 HPAT2
# HPAT1, HPAT2: There are two signal lines from the shield part to the camrea.
ttype# = FLAG_HITPAT
tform# = 2X
TCOMM# ='BGO shield Hit pattern'

# Description: fast veto signal from the BGO shield
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 2 bits of "FBGO1 & FBGO2" into 1B.
# FBGO1, FBGO2: There are two signal lines from the shield part to the camrea.
ttype# = FLAG_FASTBGO
tform# = 2X
TCOMM# ='Fast BGO shield hit pattern'

# Description: time since the previous occurrence (24-bit counter)
# Origin     : Pre-Pipeline fill, copy from the telemetry of "Live Time D0-D23".
ttype# = LIVETIME
tform# = 1J
```

```
tzero# = 2147483648
TCOMM# ='Time since previous occurrence'

# Description: number of asics involved in the occurrence
# Origin     : Pre-Pipeline fill, copy from the telemetry of "nHitASIC D0-D7".
ttype# = NUM_ASIC
tform# = 1B
TCOMM# ='Number of ASICs used by occurrence'

#-------------------------------------------------------------
# Original ASIC Event Data
#-------------------------------------------------------------
# Data output from each ASIC have
# - ASIC ID: 8 bits
# - flags (3 zeros, START, CHIP, TRG, SEU): 7 bits
# - channel data bits (DM, 32 channel bits, CM): 34 bits
# - Reference channel data: 10 bits
# - ADC Data: 10 bits x 32 channels at max = 320 bits at max
# - common mode noise data: 10 bits
# - STOP: 1 bit
# - and zeros for filling.
# The maximum length of one ASIC data is
# a = 8+7+34+10+320+10+1+zero_fill (bits)
# a = 25*16 = 400 where zero_fill = 10
# a/8 = 50 bytes
#
# One HXI camera has 40 ASIC chips.
# The max length of the event data part is
# 50 bytes x 40 ASICs = 2000 bytes
#  NOTE ::: RECHECK THE NUMBER OF MAX B
ttype# = RAW_ASIC_DATA
tform# = 1PB(2000)
tcomm# = 'Occurrence telemetry array'

#
# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of th en bit sis assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
TCOMM# = 'Record bad telemetry or bad values'

#
# Name       : STATUS
# Data type  : integer
#  Status value used by the pipeline. To record specific info TBD
#
ttype# = STATUS
tform# =  8X
TCOMM# = 'Occurrence status flag'

#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns added for SFF and filled by the pipeline
#-------------------------------------------------------------
#-------------------------------------------------------------
#-------------------------------------------------------------
# columns related to the ASIC information
#-------------------------------------------------------------
# Name       : Original ASIC IDs
# Data type  : 8 bits NOTE read from right to left and store in 1 number
# Max length : 40 (limited by the number of ASICs, i.e. 40)
# Origin     : derived from RAW_ASIC_DATA column, 2 x 4 bits
#              Converted from 8 bits of "ASIC ID ID0-ID7" into 1B.
# See CALDB file for mapping
ttype# = ASIC_ID
tform# = 1PB(40)
TCOMM# = 'Original ASIC ID'

# Caldb file
```

```
# asic_remapped   layer_number  asic_number    8bitsvalue  channel  remap channel
#   ASIC_ID_MAP      0-4             0-7      see ASIC_ID  0-31     1-1280
#
# Name       : Remapped ASIC IDs
# Data type  : this value ranges 1-40
# Max length : 40 (limited by the number of ASICs, i.e. 40)
# Origin     : derived from RAW_ASIC_ID column plus calibration file
# For software utility. The instrument team does not require this column.
ttype# = ASIC_ID_RMAP
tform# = 1PB(40)
TCOMM# = 'Remapped ASIC ID'

# Name       : ASIC flags CHIP
# Data type  : 1 bit
# Origin     : If there are data from this ASIC, it is (1). Other cases are (0). Therefore,
normally (1).
# Max length : 40 (limited by the number of ASICs, i.e. 40) (CHIP)
ttype# = ASIC_CHIP
tform# = 1PX(40)
TCOMM# ='1=Data in ASIC 0=no data'

# Name       : ASIC flags TRIG
# Data type  : 1 bit
# Origin     : If there are triggers from this ASIC, it is (1). Other cases are (0).
# Max length : 40 (limited by the number of ASICs, i.e. 40) (TRIG)
ttype# = ASIC_TRIG
tform# = 1PX(40)
TCOMM# ='1=Trigger in ASIC 0=no trigger'

# Name       : ASIC flags SEU
# Data type  : 1 bit
# Origin     : If there is SEU error at this ASIC, it is (1). No error (0).
# Max length : 40 (limited by the number of ASICs, i.e. 40) (SEU)
ttype# = ASIC_SEU
tform# = 1PX(40)
TCOMM# ='1=Error in ASIC 0=no error'

# Name       : Original flag to indicate which channel is active e.g. ADC is present
# NOTE read from left to right 32 bits ("Ch Data Bit Ch0-Ch31") and transform into 1J
# NOTE necessary to work out the remap channel (decode)
# Data type  : 32 bits always
ttype# = READOUT_FLAG
tform# = 1PJ(40)
tzero# = 2147483648
TCOMM# ='Readout active flag'

# Name       : Give the Number of active channels for each ASIC
# Data type  : Calculated from Readout_FLAG and range from 1-32
ttype# = NUM_READOUT
tform# = 1PI(40)
TCOMM# = 'Number of readouts active in ASIC'

# Name       : ASIC reference channel data
# Data type  : 10 bits ; read from  left to right of "Reference Ch D0-D9"
# Max length : 40 (limited by the number of ASICs, i.e. 40)
ttype# = ASIC_REF
tform# = 1PI(40)
TCOMM# ='ASIC reference channel'

# Name       : ASIC common mode noise data
# Data type  : 10 bits of "Common-Mode Noise Data D0-D9" => 16-bit integer
# Max length : 40 (limited by the number of ASICs, i.e. 40)
ttype# = ASIC_CMN
tform# = 1PI(40)
TCOMM# ='ASIC common mode noise'

#-------------------------------------------------------------
# columns related to the channel information
#-------------------------------------------------------------
#
# Name       : Original ASIC IDs for readout channel data
```

```
# Data type  : Converted from 8 bits of "ASIC ID ID0-ID7" into 8- or 16-bit integer
# Max length : 40x32 (limited by the toal number of readout channels in one camera)
# Origin     : derived from ASIC_ID column
# (ASIC_ID would be one possibility, but could/should have 2 columns: tray ID, ASIC ID)
ttype# = READOUT_ASIC_ID
tform# = 1PB(1280)
TCOMM# = 'Original ASIC ID for readout'

# Name       : Original Readout IDs
# Data type  : this value ranges 0-31 => unsigned byte
# (Example, if "Ch Data Bit Ch15" is "1", Readout_ID corresponding to this signal is "15".)
# Max length : 40x32 (limited by the total number of readout channels in one camera)
ttype# = READOUT_ID
tform# = 1PB(1280)
TCOMM# = 'Original readout ID'

# Name       : Remapped Channel IDs
# Data type  : this value ranges 0-1279 => 16-bit integer
# Max length : 40*32 (limited by the toal number of readout channels in one camera)
# Origin: calculated from READOUT_ID and RMAP_ASIC_ID
# For software utility. The instrument team does not require this column.
ttype# = READOUT_ID_RMAP
tform# = 1PI(1280)
TCOMM# = 'Remapped readout ID'

# Name       : Raw ADC Data (pulse height)
# Data type  : 10-bit pulse height data packet ("ADC Data ch#m D0-D9") to 16-bit integer
# Max length : 40*32 (limited by the total number of readout channels in one camera)
ttype# = PHA
tform# = 1PI(1280)
TCOMM# = 'Pulse height amplitude'

# Name       : Calibrated pulse height after hxisgdgain
# Data type  : 16-bit integer
# Max length : 40*32 (limited by the total number of readout channels in one camera)
ttype# = EPI
tform# = 1PE(1280)
TCOMM# = 'PHA in keV'

##================================================
# End columns related to ADC / channel value information
#================================================
```

HXI EVENT SFFa

```
#
# HXI event data format SFFa
# This data contains a list of events from one HXI camera unit.
# One HXI unit have one camera; there are two cameras on board ASTRO-H.
#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns for FFF
#-------------------------------------------------------------
#-------------------------------------------------------------
#number of rows
naxis2 = 1
# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# ='s'
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'

# Description: Occurrence ID is within the SFF file
# a sequential number starting from 1 and increment at each row
# In the SFFa after reconstruction the number of columns may increase
# and therefore 1 or more rows have the same occurrence ID
# Origin     : Pre-Pipeline will insert the sequential number
ttype# = OCCURRENCE_ID
tform# = 1J
```

```
TCOMM# = 'Sequential Number for occurrence'

# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = CATEGORY
tform# = 1B
TCOMM# = 'Data recorder priority'

# Description: 0 is ok, If different from 0 means that one or more
# layers have trouble. Single event upset occurred (1) or not (0)
# Origin     : Pre-Pipeline fill,  copy from the telemetry.
#              Converted from 5 bits of "SEU1-SEU5" into 1B.
# SEU5: CdTe-DSD layer, SEU4: 4th DSSD layer, SEU3: 3rd DSSD layer, SEU2: 2nd DSSD layer, SEU1:
top DSSD layer
ttype# = FLAG_SEU
tform# = 5X
TCOMM# ='1-4 Si 5 CdTE SEU flag'

# Description: length error (1) or ok (0)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 5 bits of "LCHK1-LCHK5" into 1B.
# LCHK5: CdTe-DSD layer, LCHK4: 4th DSSD layer, LCHK3: 3rd DSSD layer, LCHK2: 2nd DSSD layer,
LCHK1: top DSSD layer
ttype# = FLAG_LCHK
tform# = 5X
TCOMM# ='1-4 Si 5 CdTE Length Chk flag'

# Description: origin of trigger(s). There are 8 possible patters
# for triggering
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 8 bits of "TRG1-TRG8" into 1B.
# TRG8: Trigger from  calibration source, TRG7: Pseudo trigger, TRG6: Forced trigger,
# TRG5: Trigger from CdTe-DSD layer, TRG4: 4th DSSD layer, TRG3: 3rd DSSD layer, TRG2: 2nd DSSD
layer, TRG1: top DSSD layer
ttype# = FLAG_TRIG
tform# = 8X
TCOMM# ='Trigger origin'

# Description: trigger pattern during the occurrence
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 8 bits of "TRGPAT1-TRGPAT8" into 1B.
# TRGPAT8: From  calibration source, TRGPAT7: Pseudo trigger, TRGPAT6: Forced trigger,
# TRGPAT5: From CdTe-DSD layer, TRGPAT4: 4th DSSD layer, TRGPAT3: 3rd DSSD layer,
                                TRGPAT2: 2nd DSSD layer, TRGPAT1: top DSSD layer
ttype# = FLAG_TRIGPAT
tform# = 8X
TCOMM# ='Trigger pattern'

# Description: BGO Shield Hit-Pattern veto signal (more accurate calculation than FBGOs)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 2 bits of "HPAT1 & HPAT2" into 1B.
# HPAT1, HPAT2: There are two signal lines from the shield part to the camrea.
ttype# = FLAG_HITPAT
tform# = 2X
TCOMM# ='BGO shield hit pattern'

# Description: fast veto signal from the BGO shield
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 2 bits of "FBGO1 & FBGO2" into 1B.
# FBGO1, FBGO2: There are two signal lines from the shield part to the camrea.
ttype# = FLAG_FASTBGO
tform# = 2X
TCOMM# ='Fast BGO shield hit pattern'

# Description: time since the previous occurrence (24-bit counter)
# Origin     : Pre-Pipeline fill, copy from the telemetry of "Live Time D0-D23".
ttype# = LIVETIME
tform# = 1J
tzero# = 2147483648
TCOMM# ='Time since previous occurrence'
```

```
# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of th en bit sis assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
TCOMM# = 'Record bad telemetry or bad values'

# Name       : STATUS
# Data type  : integer
#  Status value used by the pipeline. To record specific info TBD
#
ttype# = STATUS
tform# =  8X
TCOMM# = 'Occurrence status Flags'

#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns added from the reconstruction
#-------------------------------------------------------------
#      columns populated by the reconstruction
#-------------------------------------------------------------
# Name       : EPITOP
# Data type  :  5E
# Top-side EPI used for Energy-consistency check
ttype# = EPITOP
tform# = 5E
TCOMM# = 'EPI total top layers'

# Name       : EPIBOT
# Data type  :  5E
# Bottom-side EPI used for Energy-consistency check
ttype# = EPIBOT
tform# = 5E
TCOMM# = 'EPI total bottom layers'

# Name       : EPICUT
# Data type  :  5I
# Output condistion from energy-consistency check
ttype# = EPICUT
tform# = 5I
TCOMM# = 'Energy cut test code for layer'

# Name       : Layer
# Data type  :  1B
# 0: for 1st top DSSD, 1: 2nd DSSD, 2: 3rd DSSD, 3: 4th DSSD, 4: for CdTe 255=bad
ttype# = LAYER
tform# = 1B
tnull# = 99
TCOMM# = 'Layer number 0-3 Si 4 CdTe'

# Name       : PI
# Data type :
ttype# = PI
tform# = I
tlmin# = 0
tlmax# =2047
tnull# = -999
TCOMM# = 'Pulse Invariant '

# Name       : EVTCAT
# Data type  : 1B
# 1: absorption,  2-5 flourence (2: CdTe-1stDSSD 3:CdTe-2ndDSSD
# 4:CdTe-3rdDSSD 5: CdTe-4thDSSD ), 6: Si-CdTE no Flourence, 7: 2 hits in Si,
# 8: 2 hits one bad 9: All bad
ttype# = EVTCAT
tform# = 1B
TCOMM# = 'Event category '

# Name       : RECO_STATUS
```

```
# Data type  : 16X
#  Status after RECONSTRUCTION
ttype# = RECO_STATUS
tform# =  16X
TCOMM# = 'Reconstruction Status'

# Name       : SIGNAL
# Data type  : 10I
#  N=0-9 (0 1 2 3 4  Top layer  5  6 7 8 9  bottom layer)
#               Number of signal per top or bottom layer
ttype# = SIGNAL
tform# =  10I
TCOMM# = 'Number of Signals per side'

# Name       : SIGPOS
# Data type  : 10I
# Hit position of X-/Y-side position
ttype# = SIGPOS
tform# =  10I
TCOMM# = 'Signal position per side (X or Y)'

# Name       : SIGEPI
# Data type  : 10E
#  N=0-9 (0 1 2 3 4  Top layer  5  6 7 8 9  bottom layer)
#Sum of EPI per top or bottom layer n=0-4 (layer).
#               Do not include EPI< evt_Thre
ttype# = SIGEPI
tform# =  10E
TCOMM# = 'Sum of EPI per side'

# Name       : GOODBAD
# Data type  : 10X
#  N=0-9 (0 1 2 3 4  Top layer  5  6 7 8 9  bottom layer)
# if top or bottom layer 0=good 1=bad
ttype# = GOODBAD
tform# =  10X
TCOMM# = '0=good 1=bad per side'

# Name       : VALIDHITS
# Data type  : 5I
#  Number of hits x layer 0 = nothing 1= 1 hits
#                 2= bad layer (laydat.m_validhit=false;)
ttype# = VALIDHITS
tform# =  5I
TCOMM# = 'Hit validity per layer'

# Name       : RAWX
# Data type  : 1I
ttype# = RAWX
tform# = 1I
tlmin# = 1
tlmax# = 128
tnull# =-1
TCOMM# = 'Pixel X  on RAW-coordinate'

# Name       : RAWY
# Data type  : 1I
ttype# = RAWY
tform# = 1I
tlmin# = 1
tlmax# = 128
tnull# =-1
TCOMM# = 'Pixel Y  on RAW-coordinate'
#-------------------------------------------------------------
#      columns populated by the coordevt
#-------------------------------------------------------------
# Name       : ACTX
# Data type  : 1I
ttype# = ACTX
tform# = 1I
tlmin# = 1
```

```
tlmax# = 256
tnull# =-1
TCOMM# = 'Pixel X  on ACT-coordinate'

# Name       : ACTY
# Data type  : 1I
ttype# = ACTY
tform# = 1I
tlmin# = 1
tlmax# = 256
tnull# =-1
TCOMM# = 'Pixel Y  on ACT-coordinate'

# Name       : DETX
# Data type  : 1I
ttype# = DETX
tform# = 1I
tlmin# = 1
tlmax# = 256
tnull# =-1
TCOMM# = 'Pixel X  on DET-coordinate'

# Name       : DETY
# Data type  : 1I
ttype# = DETY
tform# = 1I
tlmin# = 1
tlmax# = 256
tnull# =-1
TCOMM# = 'Pixel Y  on DET-coordinate'

# Name       : FOCX
# Data type  : 1I
ttype# = FOCX
tform# = 1I
tlmin# = 1
tlmax# = 1810
tnull# =-1
TCOMM# = 'Pixel X  on FOC-coordinate'

# Name       : FOCY
# Data type  : 1I
ttype# = FOCY
tform# = 1I
tlmin# = 1
tlmax# = 1810
tnull# =-1
TCOMM# = 'Pixel Y  on FOC-coordinate'

# Name       : X
# Data type  : 1I
ttype# = X
tform# = 1I
tlmin# = 1
tlmax# = 1810
tnull# =-1
TCOMM# = 'Pixel X  on SKY-coordinate'

# Name       : Y
# Data type  : 1I
ttype# = Y
tform# = 1I
tlmin# = 1
tlmax# = 1810
tnull# = -1
TCOMM# = 'Pixel Y  on SKY-coordinate'
##================================================
# End columns related to ADC / channel value information
#================================================
```

```
### HXI EVENT SFFa (Expand) CALMODE, PSEUDO FORCE_TRIG
#
# HXI event data format SFFa
# This data contains a list of events from one HXI camera unit.
# One HXI unit have one camera; there are two cameras on board ASTRO-H.
#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns for FFF
#-------------------------------------------------------------
#-------------------------------------------------------------
#number of rows
naxis2 = 1
# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# ='s'
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'

# Description: Occurrence ID is within the SFF file
# a sequential number starting from 1 and increment at each row
# In the SFFa after reconstruction the number of columns may increase
# and therefore 1 or more rows have the same occurrence ID
# Origin     : Pre-Pipeline will insert the sequential number
ttype# = OCCURRENCE_ID
tform# = 1J
TCOMM# = 'Sequential Number for occurrence'

# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = CATEGORY
tform# = 1B
TCOMM# = 'Data recorder priority'

# Description: 0 is ok, If different from 0 means that one or more
# layers have trouble. Single event upset occurred (1) or not (0)
# Origin     : Pre-Pipeline fill,  copy from the telemetry.
#              Converted from 5 bits of "SEU1-SEU5" into 1B.
# SEU5: CdTe-DSD layer, SEU4: 4th DSSD layer, SEU3: 3rd DSSD layer, SEU2: 2nd DSSD layer, SEU1:
top DSSD layer
ttype# = FLAG_SEU
tform# = 5X
TCOMM# ='1-4 Si 5 CdTE SEU flag'

# Description: length error (1) or ok (0)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 5 bits of "LCHK1-LCHK5" into 1B.
# LCHK5: CdTe-DSD layer, LCHK4: 4th DSSD layer, LCHK3: 3rd DSSD layer, LCHK2: 2nd DSSD layer,
LCHK1: top DSSD layer
ttype# = FLAG_LCHK
tform# = 5X
TCOMM# ='1-4 Si 5 CdTE Length Chk flag'

# Description: origin of trigger(s). There are 8 possible patters
# for triggering
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 8 bits of "TRG1-TRG8" into 1B.
# TRG8: Trigger from 241Am calibration source, TRG7: Pseudo trigger, TRG6: Forced trigger,
# TRG5: Trigger from CdTe-DSD layer, TRG4: 4th DSSD layer, TRG3: 3rd DSSD layer, TRG2: 2nd DSSD
layer, TRG1: top DSSD layer
ttype# = FLAG_TRIG
tform# = 8X
TCOMM# ='Trigger origin'

# Description: trigger pattern during the occurrence
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 8 bits of "TRGPAT1-TRGPAT8" into 1B.
# TRGPAT8: From 241Am calibration source, TRGPAT7: Pseudo trigger, TRGPAT6: Forced trigger,
# TRGPAT5: From CdTe-DSD layer, TRGPAT4: 4th DSSD layer, TRGPAT3: 3rd DSSD layer,
```

```
                                TRGPAT2: 2nd DSSD layer, TRGPAT1: top DSSD layer
ttype# = FLAG_TRIGPAT
tform# = 8X
TCOMM# ='Trigger pattern'

# Description: BGO Shield Hit-Pattern veto signal (more accurate calculation than FBGOs)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 2 bits of "HPAT1 & HPAT2" into 1B.
# HPAT1, HPAT2: There are two signal lines from the shield part to the camrea.
ttype# = FLAG_HITPAT
tform# = 2X
TCOMM# ='BGO shield hit pattern'

# Description: fast veto signal from the BGO shield
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 2 bits of "FBGO1 & FBGO2" into 1B.
# FBGO1, FBGO2: There are two signal lines from the shield part to the camrea.
ttype# = FLAG_FASTBGO
tform# = 2X
TCOMM# ='Fast BGO shield hit pattern'

# Description: time since the previous occurrence (24-bit counter)
# Origin     : Pre-Pipeline fill, copy from the telemetry of "Live Time D0-D23".
ttype# = LIVETIME
tform# = 1J
tzero# = 2147483648
TCOMM# ='Time since previous occurrence'

# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of th en bit sis assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
TCOMM# = 'Record bad telemetry or bad values'

#
# Name       : STATUS
# Data type  : integer
#  Status value used by the pipeline. To record specific info TBD
#
ttype# = STATUS
tform# = 8X
TCOMM# = 'Occurrence status flag'

#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns added from the reconstruction
#-------------------------------------------------------------
#      columns populated by the reconstruction
#-------------------------------------------------------------
# Name       : READOUT_ID_INDEX
# Data type  :  1I
# The same value of Å,Ü§éΩREADOUT_ID_RMAPÅ,Ü§ in SFF but only for the fixed length array
ttype# = READOUT_ID_INDEX
tform# = 1I
tnull# =-999
TCOMM# = 'Readout index'

# Name       : PI
# Data type : how this is calculated conversion EPI to PI
ttype# = PI
tform# = 1I
tlmin# = 0
tlmax# = 2047
tnull# =-999
TCOMM# = 'Pulse Invariant '

# Name       : Layer
# Data type  :  1B
ttype# = LAYER
```

```
tform# = 1B
tnull# = 99
TCOMM# = 'Layer number'

# Name       : RECO_STATUS
# Data type  : 16X
#  Status after RECONSTRUCTION
ttype# = RECO_STATUS
tform# =  16X
TCOMM# = 'Reconstruction Status'

# Name       : RAWX
# Data type  : 1I
ttype# = RAWX
tform# = 1I
tlmin# = 1
tlmax# = 128
tnull# =-1
TCOMM# = 'Pixel X on RAW-coordinate'

# Name       : RAWY
# Data type  : 1I
ttype# = RAWY
tform# = 1I
tlmin# = 1
tlmax# = 128
tnull# =-1
TCOMM# = 'Pixel Y on RAW-coordinate'
##================================================
# End columns related to ADC / channel value information
#================================================
```

HXI EVENT SFFa (Extra) for AM241/CAMERA for gain fitting

```
#
# Sffa used for gain fit CAMERA and AM241
# This data contains a list of events from one HXI camera unit.
# One HXI unit have one camera; there are two cameras on board ASTRO-H.
#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns for FFF
#-------------------------------------------------------------
#-------------------------------------------------------------
#number of rows
naxis2 = 1
# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# ='s'
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'

# Description: Occurrence ID is within the SFF file
# a sequential number starting from 1 and increment at each row
# In the SFFa after reconstruction the number of columns may increase
# and therefore 1 or more rows have the same occurrence ID
# Origin     : Pre-Pipeline will insert the sequential number
ttype# = OCCURRENCE_ID
tform# = 1J
TCOMM# = 'Sequential Number for occurrence'

# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = CATEGORY
tform# = 1B
TCOMM# = 'Data recorder priority'

# Description: 0 is ok, If different from 0 means that one or more
# layers have trouble. Single event upset occurred (1) or not (0)
```

```
# Origin     : Pre-Pipeline fill,  copy from the telemetry.
#              Converted from 5 bits of "SEU1-SEU5" into 1B.
# SEU5: CdTe-DSD layer, SEU4: 4th DSSD layer, SEU3: 3rd DSSD layer, SEU2: 2nd DSSD layer, SEU1:
top DSSD layer
ttype# = FLAG_SEU
tform# = 5X
TCOMM# ='1-4 Si 5 CdTE SEU flag'

# Description: length error (1) or ok (0)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 5 bits of "LCHK1-LCHK5" into 1B.
# LCHK5: CdTe-DSD layer, LCHK4: 4th DSSD layer, LCHK3: 3rd DSSD layer, LCHK2: 2nd DSSD layer,
LCHK1: top DSSD layer
ttype# = FLAG_LCHK
tform# = 5X
TCOMM# ='1-4 Si 5 CdTE Length Chk flag'

# Description: origin of trigger(s). There are 8 possible patters
# for triggering
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 8 bits of "TRG1-TRG8" into 1B.
# TRG8: Trigger from calibration source, TRG7: Pseudo trigger, TRG6: Forced trigger,
# TRG5: Trigger from CdTe-DSD layer, TRG4: 4th DSSD layer, TRG3: 3rd DSSD layer, TRG2: 2nd DSSD
layer, TRG1: top DSSD layer
ttype# = FLAG_TRIG
tform# = 8X
TCOMM# ='Trigger origin'

# Description: trigger pattern during the occurrence
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 8 bits of "TRGPAT1-TRGPAT8" into 1B.
# TRGPAT8: From calibration source, TRGPAT7: Pseudo trigger, TRGPAT6: Forced trigger,
# TRGPAT5: From CdTe-DSD layer, TRGPAT4: 4th DSSD layer, TRGPAT3: 3rd DSSD layer,
                                TRGPAT2: 2nd DSSD layer, TRGPAT1: top DSSD layer
ttype# = FLAG_TRIGPAT
tform# = 8X
TCOMM# ='Trigger pattern'

# Description: BGO Shield Hit-Pattern veto signal (more accurate calculation than FBGOs)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 2 bits of "HPAT1 & HPAT2" into 1B.
# HPAT1, HPAT2: There are two signal lines from the shield part to the camrea.
ttype# = FLAG_HITPAT
tform# = 2X
TCOMM# ='BGO shield hit pattern'

# Description: fast veto signal from the BGO shield
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 2 bits of "FBGO1 & FBGO2" into 1B.
# FBGO1, FBGO2: There are two signal lines from the shield part to the camrea.
ttype# = FLAG_FASTBGO
tform# = 2X
TCOMM# ='Fast BGO shield hit pattern'

# Description: time since the previous occurrence (24-bit counter)
# Origin     : Pre-Pipeline fill, copy from the telemetry of "Live Time D0-D23".
ttype# = LIVETIME
tform# = 1J
tzero# = 2147483648
TCOMM# ='Time since previous occurrence'

#
# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of th en bit sis assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
TCOMM# = 'Record bad telemetry or bad values'

#
```

```
# Name       : STATUS
# Data type  : integer
#  Status value used by the pipeline. To record specific info TBD
#
ttype# = STATUS
tform# = 8X
TCOMM# = 'Occurrence status flag'
#
#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns added from the reconstruction
#-------------------------------------------------------------
#      columns populated by the reconstruction
#-------------------------------------------------------------
#-------------------------------------------------------------
# Name       : Layer
# Data type  :  1B
# 0: for 1st top DSSD, 1: 2nd DSSD, 2: 3rd DSSD, 3: 4th DSSD, 4: for CdTe 255=bad
ttype# = LAYER
tform# = 1B
tnull# = 99
TCOMM# = 'Layer Number'

# Name       : PI
# Data type :
ttype# = PI
tform# = I
tlmin# = 0
tlmax# =2047
tnull# = -999
TCOMM# = 'Pulse Invariant'

# Name       : EVTCAT
# Data type  : 1B
# 1: absorption,  2-5 flourence (2: CdTe-1stDSSD 3:CdTe-2ndDSSD
# 4:CdTe-3rdDSSD 5: CdTe-4thDSSD ), 6: Si-CdTE no Flourence, 7: 2 hits in Si,
# 8: 2 hits one bad 9: All bad
ttype# = EVTCAT
tform# = 1B
TCOMM# = ' Event Category'

# Name       : RECO_STATUS
# Data type  : 16X
#  Status after RECONSTRUCTION
ttype# = RECO_STATUS
tform# =  16X
TCOMM# ='Reconstruction status'
#
# Name       : RAWX
# Data type  : 1I
ttype# = RAWX
tform# = 1I
tlmin# = 1
tlmax# = 128
tnull# =-1
TCOMM# = 'Pixel X on RAW-coordinate'

# Name       : RAWY
# Data type  : 1I
ttype# = RAWY
tform# = 1I
tlmin# = 1
tlmax# = 128
tnull# =-1
TCOMM# = 'Pixel Y on RAW-coordinate'

# Name       : SIDE
# Data type  : 1B
ttype# = SIDE
tform# = 1B
TCOMM# = 'Side number'
```

```
##================================================
# End columns related to ADC / channel value information
#================================================
```

HXI SHIELD GRB

```
# For both SCALAR and HISTOGRAM
# L32TI is stored from the value in secondary header of the packet
# TI_CNT and LOCAL_TIME are stored by MIO and APMU
#      TI_CNT : U32TI in MIO when the data are collected from APMU
#      LOCAL_TIME : LOCAL_TIME in APMU when the data are stored
###

###
#2015/03/05 Category: 1I => 1B (hirotaka)
###
# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# =' s '
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'
# Description: Time when the space packet was sent
# Origin     : Pre-Pipeline fill the colums, calculated by SIRIUS
ttype# = S_TIME
tform# = 1D
TCOMM# ='Time for CCSDS packet stamped by SIRIUS'
# Description: CCSDS packet header
# Origin     : Pre-Pipeline fill, copy from the telemetry
# This is identical to the SXS
ttype# = ADU_CNT
tform# = 1B
TCOMM# = 'ADU sequence packet counter'
# Description: CATEGORY
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = ‘Category’
tform# = 1B
TCOMM# = 'Data recorder priority'
#
TTYPE1  = 'L32TI   '           / Packet TI lower 32b, 2^-6 s
TFORM1  = '1J      '           / data format of field: 4-byte INTEGER
TZERO1  =          2147483648 / offset for unsigned integers
TSCAL1  =                   1 / data are not scaled
TTYPE2  = 'U32TI'         / Packet TI upper 32b, 2^-6 s
TFORM2  = '1J      '           / data format of field: 4-byte INTEGER
TZERO2  =          2147483648 / offset for unsigned integers
TSCAL2  =                   1 / data are not scaled
TTYPE3  = 'LOCAL_TIME'     / Local Time to calculate TIME
TFORM3  = '1J      '           / data format of field: 4-byte INTEGER
TZERO3  =          2147483648 / offset for unsigned integers
TSCAL3  =                   1 / data are not scaled
TTYPE4  = 'GRB_FREEZE_TIME'    / Freeze time to calculate TIME
TFORM4  = '1J      '           / data format of field: 4-byte INTEGER
TZERO4  =          2147483648 / offset for unsigned integers
TSCAL4  =                   1 / data are not scaled
TTYPE5  = 'SH_GRB1'       / GRB Spectrum information
TFORM5  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE6  = 'SH_GRB2'       / GRB Spectrum information
TFORM6  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE7  = 'SH_GRB3'       / GRB Spectrum information
TFORM7  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE8  = 'SH_GRB4'       / GRB Spectrum information
TFORM8  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE9  = 'SH_GRB5'       / GRB Spectrum information
TFORM9  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE10 = 'SH_GRB6'       / GRB Spectrum information
TFORM10 = '32I     '           / data format of field: 2-byte INTEGER
#
# Name       : PROC_STATUS
```

```
# Data type  : integer
# Status value used by the pre-pipeline half of the nbits is assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
TCOMM# = 'Record bad telemetry or bad values'
```

HXI SCALAR and HISTOGRAM

```
# For both SCALAR and HISTOGRAM
# L32TI is stored from the value in secondary header of the packet
# TI_CNT (=U32TI) and LOCAL_TIME are stored by MIO and APMU
#      TI_CNT : U32TI in MIO when the data are collected from APMU
#      LOCAL_TIME : LOCAL_TIME in APMU when the data are stored
###
###
#2015/03/05 Category: 1I => 1B (hirotaka)
###
### Extension1 for SCALAR ###
# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# ='s'
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'

# Description: Time when the space packet was sent
# Origin     : Pre-Pipeline fill the colums, calculated by SIRIUS
ttype# = S_TIME
tform# = 1D
tunit# ='s'
TCOMM# ='Time for CCSDS packet stamped by SIRIUS'

# Description: CCSDS packet header
# Origin     : Pre-Pipeline fill, copy from the telemetry
# This is identical to the SXS
ttype# = ADU_CNT
tform# = 1B
TCOMM# = 'ADU sequence packet counter'

# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = ‘Category’
tform# = 1B
TCOMM# = 'Data recorder priority'
#
TTYPE1  = 'L32TI   '           / label for field   1
TFORM1  = '1J      '           / data format of field: 4-byte INTEGER
TZERO1  =           2147483648 / offset for unsigned integers
TSCAL1  =                    1 / data are not scaled
TTYPE2  = 'U32TI'         / TI_CNT
TFORM2  = '1J      '           / data format of field: 4-byte INTEGER
TZERO2  =           2147483648 / offset for unsigned integers
TSCAL2  =                    1 / data are not scaled
TTYPE3  = 'LOCAL_TIME'     / label for field   3
TFORM3  = '1J      '           / data format of field: 4-byte INTEGER
TZERO3  =           2147483648 / offset for unsigned integers
TSCAL3  =                    1 / data are not scaled
TTYPE4  = 'SH_FBGO1'           / Number of Counts
TFORM4  = '1I      '           / data format of field: 2-byte INTEGER
TZERO4  =                32768 / offset for unsigned integers
TSCAL4  =                    1 / data are not scaled
TTYPE5  = 'SH_FBGO2'           / Number of Counts
TFORM5  = '1I      '           / data format of field: 2-byte INTEGER
TZERO5  =                32768 / offset for unsigned integers
TSCAL5  =                    1 / data are not scaled
TTYPE6  = 'SH_FBGO3'           / Number of Counts
TFORM6  = '1I      '           / data format of field: 2-byte INTEGER
TZERO6  =                32768 / offset for unsigned integers
TSCAL6  =                    1 / data are not scaled
```

```
TTYPE7  = 'SH_FBGO4'           / Number of Counts
TFORM7  = '1I      '           / data format of field: 2-byte INTEGER
TZERO7  =                32768 / offset for unsigned integers
TSCAL7  =                    1 / data are not scaled
TTYPE8  = 'SH_FBGO5'           / Number of Counts
TFORM8  = '1I      '           / data format of field: 2-byte INTEGER
TZERO8  =                32768 / offset for unsigned integers
TSCAL8  =                    1 / data are not scaled
TTYPE9  = 'SH_FBGO6'           / Number of Counts
TFORM9  = '1I      '           / data format of field: 2-byte INTEGER
TZERO9  =                32768 / offset for unsigned integers
TSCAL9  =                    1 / data are not scaled
TTYPE10 = 'SH_FBGO7'           / Number of Counts
TFORM10 = '1I      '           / data format of field: 2-byte INTEGER
TZERO10 =                32768 / offset for unsigned integers
TSCAL10 =                    1 / data are not scaled
TTYPE11 = 'SH_FBGO8'           / Number of Counts
TFORM11 = '1I      '           / data format of field: 2-byte INTEGER
TZERO11 =                32768 / offset for unsigned integers
TSCAL11 =                    1 / data are not scaled
TTYPE12 = 'SH_FBGO9'           / Number of Counts
TFORM12 = '1I      '           / data format of field: 2-byte INTEGER
TZERO12 =                32768 / offset for unsigned integers
TSCAL12 =                    1 / data are not scaled
TTYPE13 = 'SH_FBGO10'          / Number of Counts
TFORM13 = '1I      '           / data format of field: 2-byte INTEGER
TZERO13 =                32768 / offset for unsigned integers
TSCAL13 =                    1 / data are not scaled
TTYPE14 = 'SH_FBGO11'          / Number of Counts
TFORM14 = '1I      '           / data format of field: 2-byte INTEGER
TZERO14 =                32768 / offset for unsigned integers
TSCAL14 =                    1 / data are not scaled
TTYPE15 = 'SH_FBGO12'          / Number of Counts
TFORM15 = '1I      '           / data format of field: 2-byte INTEGER
TZERO15 =                32768 / offset for unsigned integers
TSCAL15 =                    1 / data are not scaled
TTYPE16 = 'SH_FBGO13'          / Number of Counts
TFORM16 = '1I      '           / data format of field: 2-byte INTEGER
TZERO16 =                32768 / offset for unsigned integers
TSCAL16 =                    1 / data are not scaled
TTYPE17 = 'SH_HITPAT1'         / Number of Counts
TFORM17 = '1I      '           / data format of field: 2-byte INTEGER
TZERO17 =                32768 / offset for unsigned integers
TSCAL17 =                    1 / data are not scaled
TTYPE18 = 'SH_HITPAT2'         / Number of Counts
TFORM18 = '1I      '           / data format of field: 2-byte INTEGER
TZERO18 =                32768 / offset for unsigned integers
TSCAL18 =                    1 / data are not scaled
TTYPE19 = 'SH_HITPAT3'         / Number of Counts
TFORM19 = '1I      '           / data format of field: 2-byte INTEGER
TZERO19 =                32768 / offset for unsigned integers
TSCAL19 =                    1 / data are not scaled
TTYPE20 = 'SH_HITPAT4'         / Number of Counts
TFORM20 = '1I      '           / data format of field: 2-byte INTEGER
TZERO20 =                32768 / offset for unsigned integers
TSCAL20 =                    1 / data are not scaled
TTYPE21 = 'SH_HITPAT5'         / Number of Counts
TFORM21 = '1I      '           / data format of field: 2-byte INTEGER
TZERO21 =                32768 / offset for unsigned integers
TSCAL21 =                    1 / data are not scaled
TTYPE22 = 'SH_HITPAT6'         / Number of Counts
TFORM22 = '1I      '           / data format of field: 2-byte INTEGER
TZERO22 =                32768 / offset for unsigned integers
TSCAL22 =                    1 / data are not scaled
TTYPE23 = 'SH_HITPAT7'         / Number of Counts
TFORM23 = '1I      '           / data format of field: 2-byte INTEGER
TZERO23 =                32768 / offset for unsigned integers
TSCAL23 =                    1 / data are not scaled
TTYPE24 = 'SH_HITPAT8'         / Number of Counts
TFORM24 = '1I      '           / data format of field: 2-byte INTEGER
TZERO24 =                32768 / offset for unsigned integers
```

```
TSCAL24 =                    1 / data are not scaled
TTYPE25 = 'SH_HITPAT9'       / Number of Counts
TFORM25 = '1I      '           / data format of field: 2-byte INTEGER
TZERO25 =                32768 / offset for unsigned integers
TSCAL25 =                    1 / data are not scaled
TTYPE26 = 'SH_HITPAT10'      / Number of Counts
TFORM26 = '1I      '           / data format of field: 2-byte INTEGER
TZERO26 =                32768 / offset for unsigned integers
TSCAL26 =                    1 / data are not scaled
TTYPE27 = 'SH_HITPAT11'      / Number of Counts
TFORM27 = '1I      '           / data format of field: 2-byte INTEGER
TZERO27 =                32768 / offset for unsigned integers
TSCAL27 =                    1 / data are not scaled
TTYPE28 = 'SH_HITPAT12'      / Number of Counts
TFORM28 = '1I      '           / data format of field: 2-byte INTEGER
TZERO28 =                32768 / offset for unsigned integers
TSCAL28 =                    1 / data are not scaled
TTYPE29 = 'SH_HITPAT13'      / Number of Counts
TFORM29 = '1I      '           / data format of field: 2-byte INTEGER
TZERO29 =                32768 / offset for unsigned integers
TSCAL29 =                    1 / data are not scaled
TTYPE30 = 'SH_UD1 '           / Number of Counts
TFORM30 = '1B      '           / data format of field: BYTE
TTYPE31 = 'SH_UD2 '           / Number of Counts
TFORM31 = '1B      '           / data format of field: BYTE
TTYPE32 = 'SH_UD3 '           / Number of Counts
TFORM32 = '1B      '           / data format of field: BYTE
TTYPE33 = 'SH_UD4 '           / Number of Counts
TFORM33 = '1B      '           / data format of field: BYTE
TTYPE34 = 'SH_UD5 '           / Number of Counts
TFORM34 = '1B      '           / data format of field: BYTE
TTYPE35 = 'SH_UD6 '           / Number of Counts
TFORM35 = '1B      '           / data format of field: BYTE
TTYPE36 = 'SH_UD7 '           / Number of Counts
TFORM36 = '1B      '           / data format of field: BYTE
TTYPE37 = 'SH_UD8 '           / Number of Counts
TFORM37 = '1B      '           / data format of field: BYTE
TTYPE38 = 'SH_UD9'            / Number of Counts
TFORM38 = '1B      '           / data format of field: BYTE
TTYPE39 = 'SH_UD10 '          / Number of Counts
TFORM39 = '1B      '           / data format of field: BYTE
TTYPE40 = 'SH_UD11'           / Number of Counts
TFORM40 = '1B      '           / data format of field: BYTE
TTYPE41 = 'SH_UD12'           / Number of Counts
TFORM41 = '1B      '           / data format of field: BYTE
TTYPE42 = 'SH_UD13'           / Number of Counts
TFORM42 = '1B      '           / data format of field: BYTE
TTYPE43 = 'SH_SUD1'           / Number of Counts
TFORM43 = '1B      '           / data format of field: BYTE
TTYPE44 = 'SH_SUD2'           / Number of Counts
TFORM44 = '1B      '           / data format of field: BYTE
TTYPE45 = 'SH_SUD3'           / Number of Counts
TFORM45 = '1B      '           / data format of field: BYTE
TTYPE46 = 'SH_SUD4'           / Number of Counts
TFORM46 = '1B      '           / data format of field: BYTE
TTYPE47 = 'SH_SUD5'           / Number of Counts
TFORM47 = '1B      '           / data format of field: BYTE
TTYPE48 = 'SH_SUD6'           / Number of Counts
TFORM48 = '1B      '           / data format of field: BYTE
TTYPE49 = 'SH_SUD7'           / Number of Counts
TFORM49 = '1B      '           / data format of field: BYTE
TTYPE50 = 'SH_SUD8'           / Number of Counts
TFORM50 = '1B      '           / data format of field: BYTE
TTYPE51 = 'SH_SUD9'           / Number of Counts
TFORM51 = '1B      '           / data format of field: BYTE
TTYPE52 = 'SH_SUD10'          / Number of Counts
TFORM52 = '1B      '           / data format of field: BYTE
TTYPE53 = 'SH_SUD11'          / Number of Counts
TFORM53 = '1B      '           / data format of field: BYTE
TTYPE54 = 'SH_SUD12'          / Number of Counts
TFORM54 = '1B      '           / data format of field: BYTE
```

```
TTYPE55 = 'SH_SUD13'           / Number of Counts
TFORM55 = '1B      '            / data format of field: BYTE
TTYPE56 = 'SH_GRB_FLAG'         / label for field  56
TFORM56 = '1B      '            / data format of field: BYTE
TTYPE57 = 'SH_FREEZE_FLAG'      / label for field  57
TFORM57 = '1B      '            / data format of field: BYTE
TTYPE58 = 'SH_RBM_FLAG'         / label for field  58
TFORM58 = '1B      '            / data format of field: BYTE
#
# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of the nbits is assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
EXTNAME = 'TEMPORALDATA'        / name of this binary table extension
END

### Extension2 for HIST ###
# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# ='s'
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'

# Description: Time when the space packet was sent
# Origin     : Pre-Pipeline fill the colums, calculated by SIRIUS
ttype# = S_TIME
tform# = 1D
tunit# ='s'
TCOMM# ='Time for CCSDS packet stamped by SIRIUS'

# Description: CCSDS packet header
# Origin     : Pre-Pipeline fill, copy from the telemetry
# This is identical to the SXS
ttype# = ADU_CNT
tform# = 1B
TCOMM# = 'ADU sequence packet counter'

# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = ‘Category’
tform# = 1B
TCOMM# = 'Data recorder priority'
#
TTYPE1  = 'L32TI   '            / label for field   1
TFORM1  = '1J      '            / data format of field: 4-byte INTEGER
TZERO1  =           2147483648 / offset for unsigned integers
TSCAL1  =                    1 / data are not scaled
TTYPE2  = 'U32TI'         / TI_CNT
TFORM2  = '1J      '            / data format of field: 4-byte INTEGER
TZERO2  =           2147483648 / offset for unsigned integers
TSCAL2  =                    1 / data are not scaled
TTYPE3  = 'LOCAL_TIME'    / label for field   3
TFORM3  = '1J      '            / data format of field: 4-byte INTEGER
TZERO3  =           2147483648 / offset for unsigned integers
TSCAL3  =                    1 / data are not scaled
TTYPE4  = 'SH_HIST1'      / Histgram Spectrum information
TFORM4  = '128I    '            / data format of field: 2-byte INTEGER
TTYPE5  = 'SH_HIST2'      / Histgram Spectrum information
TFORM5  = '128I    '            / data format of field: 2-byte INTEGER
TTYPE6  = 'SH_HIST3'      / Histgram Spectrum information
TFORM6  = '128I    '            / data format of field: 2-byte INTEGER
TTYPE7  = 'SH_HIST4'      / Histgram Spectrum information
TFORM7  = '128I    '            / data format of field: 2-byte INTEGER
TTYPE8  = 'SH_HIST5'      / Histgram Spectrum information
TFORM8  = '128I    '            / data format of field: 2-byte INTEGER
TTYPE9  = 'SH_HIST6'      / Histgram Spectrum information
```

.

```
TFORM9  = '128I    '           / data format of field: 2-byte INTEGER
TTYPE10 = 'SH_HIST7'      / Histgram Spectrum information
TFORM10 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE11 = 'SH_HIST8'      / Histgram Spectrum information
TFORM11 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE12 = 'SH_HIST9'      / Histgram Spectrum information
TFORM12 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE13 = 'SH_HIST10'     / Histgram Spectrum information
TFORM13 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE14 = 'SH_HIST11'     / Histgram Spectrum information
TFORM14 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE15 = 'SH_HIST12'     / Histgram Spectrum information
TFORM15 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE16 = 'SH_HIST13'     / Histgram Spectrum information
TFORM16 = '128I    '           / data format of field: 2-byte INTEGER
#
# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of the nbits is assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
EXTNAME = 'TEMPORALDATA'       / name of this binary table extension
END
```

==== SGD

SGD EVENT

```
-------------------------------------------------------------
# SGD event data format
# This data contains a list of events from the SDG. There two SGD units on board ASTRO-H
# On SGD contains 3 Compton Camera. Data from each SGD Compton Camera are in separate file
#
# History
#
# 2012-08-20 | H. Odaka | modification based on hxi_sff_20120615.tpl
# 2012-10-17 |L.Angelini| modification SCT meeting ISAS Hiro & Yuki
# 2012-10-31 GSFC meeting
# 2012-12-10 | H. Odaka | revision by IT.
# 2012-12-12 | H. Takahashi | revision comments of some columns.
# 2012-12-13 | L. Angelini  | Added PROC_STATUS & comment on STATUS fix spaces
#                           and header description
# 2013-26-05: ISAS| fixed the Fast Bgo and HIT pat definition
# 2013-11-20-30 ISAS flag definition and column added
# 2015-03-17 GSFC fixed RECO_STATUS:40X from 32X.
#-------------------------------------------------------------
# The reading of the bits are exactly as shown in the color map
# Therefore the bits reading direction changes across the file
# from left right and right to left
#
#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns for FFF
#-------------------------------------------------------------
#-------------------------------------------------------------

#number of rows
naxis2 = 1

# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# ='s'
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'

# Description: Time when the space packet was sent
# Origin     : Pre-Pipeline fill the colums, calculated by SIRIUS
ttype# = S_TIME
tform# = 1D
```

.

```
tunit# ='s'
TCOMM# ='Time for CCSDS packet stamped by SIRIUS'

# Description: CCSDS packet header
# Origin     : Pre-Pipeline fill, copy from the telemetry
# This is identical to the SXS
ttype# = ADU_CNT
tform# = 1B
TCOMM# = 'ADU sequence packet counter'

# Description: L32 Time Indicator
# Origin     : Pre-Pipeline fill, copy from CCSDS 2ndary header
ttype# = L32TI
tform# = 1J
tzero# = 2147483648
TCOMM# = Packet TI lower 32b, 2^-6 s

# Description: Occurrence ID is within the SFF file
# a sequential number starting from 1 and increment at each row
# In the SFFa after reconstruction the number of columns may increase
# and therefore 1 or more rows have the same occurrence ID
# Origin     : Pre-Pipeline will insert the sequential number
ttype# = OCCURRENCE_ID
tform# = 1J
TCOMM# = 'Sequential number for occurrence'

# Description: Local time (32-bit counter)
# Origin     : Pre-Pipeline fill, copy from the telemetry of "Local TIME D0-D31".
ttype# = LOCAL_TIME
tform# = 1J
tzero# = 2147483648
TCOMM# = 'Local time to calculate TIME'

# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = CATEGORY
tform# = 1B
TCOMM# = ‘Data recorder priority’

# Description: ALL FLAGS not separated
# Origin     : Pre-Pipeline fill,  copy from the telemetry
#              Just a copy not used in the pipeline
ttype# = FLAGS
tform# = 64X
TCOMM# = 'Collection of all flags'

# Description: Length error of the data received at MIO :  (1) or ok (0)
# Origin     : Pre-Pipeline fill, copy from the telemetry from the bit preceeding the 1 "CCBUSY"
ttype# = FLAG_LCHKMIO
tform# = 1X
TCOMM# = '0=ok 1=error MIO received data'

# Description: Compton camera busy (3-bit flags). Flags (1: busy, 0: not)
# showing if the the Compton camera FPGA is busy with data processing or not.
# Origin     : Pre-Pipeline fill,  copy from the telemetry
#              Converted from 3 bits of "BUSY1, BUSY2, BUSY3" into 1B.
ttype# = FLAG_CCBUSY
tform# = 3X
TCOMM# = '1=CC busy 0=CC not busy'


# Description: Compton camera hit pattern (3-bit flags)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 3 bits of "HPATCC1, HPATCC2, HPATCC3" into 1B.
ttype# = FLAG_HITPAT_CC
tform# = 3X
TCOMM# = 'CC hit pattern'

# Description: BGO Shield Hit-Pattern veto signals (4-bit flags) (more accurate calculation than
FBGOs)
```

```
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 4 bits of "HPAT11, HPAT12, HPAT21, HPAT22" into 1B.
# 13BGOs controlled by APMU1 output two signal lines of HPAT11 & HPAT12 to all CCs (6bgo+7bgo).
# 12BGOs controlled by APMU2 output two signal lines of HPAT22 & HPAT21 to all CCs (6bgo+6bgo)..
ttype# = FLAG_HITPAT
tform# = 4X
TCOMM# ='BGO shield hit pattern'

# Description: fast veto signal from the BGO shield (4-bit flags)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 4 bits of "FASTBGO11, FASTBGO12,, FASTBGO21, FASTBGO22" into 1B.
# 13BGOs controlled by APMU1 output 1 signal lines of FBGO11 or FBGO12 to all CCs. (fast)
# 13BGOs controlled by APMU1 output 1 signal lines of FBGO11 or FBGO12 to all CCs. (particle)
# 12BGOs controlled by APMU2 output 1 signal lines of FBGO21 or FBGO22 to all CCs. (fast)
# 12BGOs controlled by APMU2 output 1 signal lines of FBGO21 or FBGO22 to all CCs. (particle)
ttype# = FLAG_FASTBGO
tform# = 4X
TCOMM# ='Fast BGO shield hit pattern'

# Description: 0 is ok, If different from 0 means that one or more
# layers have trouble. Single event upset occurred (1) or not (0)
# Origin     : Pre-Pipeline fill,  copy from the telemetry of 1 bit of "SEU"
ttype# = FLAG_SEU
tform# = 1X
TCOMM# ='0=ok 1=single event upset'

# Description: length error (1) or ok (0)
# Origin     : Pre-Pipeline fill, copy from the telemetry of 1 bit of "LCHK"
ttype# = FLAG_LCHK
tform# = 1X
TCOMM# ='0=ok 1=length error'

# Description: Calibration mode (1) or not (0)
# Origin     : Pre-Pipeline fill, copy from the telemetry of 1 bit of "CALMODE"
# why there is this column if the data are separated
ttype# = FLAG_CALMODE
tform# = 1X
TCOMM# = '1=calibration mode 0=other'

# Description: trigger pattern during the occurrence (31-bit flags)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 31 bits of "TRGPAT1-TRGPAT31" into 1J
ttype# = FLAG_TRIGPAT
tform# = 31X
TCOMM# ='Trigger pattern'

# Description: origin of trigger(s) of this occurrence
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 6 bits of "TRG1-TRG6" into 1B
# 0-27: corresponds to 28 trays as written in TRGPAT1-28.
# 28=Forced, 29=Psuedo, 30=Calibration-pulse triggers.
# >=32: there are more than two simultaneous triggers initiate the occurrence.
ttype# = FLAG_TRIG
tform# = 1B
TCOMM# ='Trigger origin'

# Description: time since the previous occurrence (24-bit counter)
# Origin     : Pre-Pipeline fill, copy from the telemetry of "Live Time D0-D23".
ttype# = LIVETIME
tform# = 1J
tzero# = 2147483648
TCOMM# ='Time since previous occurrence'

# Description: number of asics involved in the occurrence
# Origin     : Pre-Pipeline fill, copy from the telemetry of "nHitASIC D0-D7".
ttype# = NUM_ASIC
tform# = 1B
TCOMM# ='Number of ASICs used by occurrence'
#
#-------------------------------------------------------------
# Original ASIC Event Data
```

```
#-------------------------------------------------------------
# Data output from each ASIC have
# - ASIC ID: 12 bits
# - flags (START, CHIP, TRG, SEU): 4 bits
# - channel data bits (DM, 64 channel bits, CM): 66 bits
# - Reference channel data: 10 bits
# - ADC Data: 10 bits x 64 channels at max = 640 bits at max
# - common mode noise data: 10 bits
# - STOP: 1 bit
# - and zeros for filling.
# The maximum length of one ASIC data is
# a = 12+4+66+10+640+10+1+zero_fill (bits)
# a = 47*16 = 752 where zero_fill = 9
# a/8 = 94 bytes
#
# One SGD CC has 208 ASIC chips.
# The max length of the event data part is
# 94 bytes x 208 ASICs = 19552 bytes
#  NOTE ::: RECHECK THE NUMBER OF MAX B
ttype# = RAW_ASIC_DATA
tform# = 1PB(19552)
tcomm# = 'Occurrence telemetry array'

# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of the bits are assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
TCOMM# = Record bad telemetry or bad values

# Name       : STATUS
# Data type  : integer
#  Status value used by the pipeline. To record specific info TBD
ttype# = STATUS
tform# =  8X
TCOMM# = 'Occurrence status flag'
#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns added for SFF and filled by the pipeline
#-------------------------------------------------------------
#-------------------------------------------------------------
# columns related to the ASIC information
#-------------------------------------------------------------

# Name       : Original ASIC IDs
# Data type  : 12 bits and store in 1 number
# Max length : 208 (limited by the number of ASICs, i.e. 208)
# Origin     : derived from RAW_ASIC_DATA column, 3 x 4 bits
#              Converted from 12 bits of "ASIC ID ID0-ID11" into 1I.
# See CALDB file for mapping
ttype# = ASIC_ID
tform# = 1PI (208)
TCOMM# = 'Original ASIC ID'

# Caldb file
# asic_remapped  driver         tray   asic_number 12bitsvalue  channel  remap channel
#                board_number   number
# ASIC_ID_MAP      0-3          0-6     0-8        see ASIC_ID  0-63     1-13312
#
# Name       : Remapped ASIC IDs
# Data type  : this value ranges 1-208
# Max length : 208 (limited by the number of ASICs, i.e. 208)
# Origin     : derived from RAW_ASIC_ID column plus calibration file
# For software utility. The instrument team does not require this column.
ttype# = ASIC_ID_RMAP
tform# = 1PB(208)
TCOMM# = 'Remapped ASIC ID'

# Name       : ASIC flags CHIP
# Data type  : 1 bit
```

.

```
# Origin     : If there are data from this ASIC, it is (1). Other cases are (0). Therefore,
normally (1).
# Max length : 208 (limited by the number of ASICs, i.e. 208) (CHIP)
ttype# = ASIC_CHIP
tform# = 1PX(208)
TCOMM# = '1=Data in ASIC 0=no data'

# Name       : ASIC flags TRIG
# Data type  : 1 bit
# Origin     : If there are triggers from this ASIC, it is (1). Other cases are (0).
# Max length : 208 (limited by the number of ASICs, i.e. 208) (TRIG)
ttype# = ASIC_TRIG
tform# = 1PX(208)
TCOMM# = '1=Trigger in ASIC 0=no trigger'

# Name       : ASIC flags SEU
# Data type  : 1 bit
# Origin     : If there is SEU error at this ASIC, it is (1). No error (0).
# Max length : 208 (limited by the number of ASICs, i.e. 208) (SEU)
ttype# = ASIC_SEU
tform# = 1PX(208)
TCOMM# = '1=Error in ASIC 0=no error'

# Name       : Original flag to indicate which channel is active e.g. ADC is present
# Origin     : Converted 64 bits of ("Ch Data Bit Ch0-Ch63") into 1K.
# NOTE necessary to work out the remap channel (decode)
# Data type  : 64 bits always
# can nor use X because otherwise will be array of 64X20
ttype# = READOUT_FLAG
tform# = 1PK(208)
TCOMM# = 'Readout active flag'

# Name       : Give the Number of active channels for each ASIC
# Data type  : Calculated from Readout_FLAG and range from 1-64
# Number Channel(bits) up for each ASIC (info from Read_out) generated in pipeline
ttype# = NUM_READOUT
tform# = 1PI(208)
TCOMM# = 'Number of readouts active in ASIC'

# Name       : ASIC reference channel data
# Data type  : 10 bits "Reference Ch D0-D9" into 1I
# Max length : 208 (limited by the number of ASICs, i.e. 208)
# calibrated channel without connecting two the Ctze or Si to check
# the noise. It is 10 bit since the pulse is described by 10 bit
ttype# = ASIC_REF
tform# = 1PI(208)
TCOMM# = 'ASIC reference channel'

# Name       : ASIC common mode noise data
# Data type  : 10 bits "Common-Mode Noise Data D0-D9" => 16-bit integer
# Max length : 208 (limited by the number of ASICs, i.e. 208)
# Common noise. to understand what is the difference with the ASIC_REF
ttype# = ASIC_CMN
tform# = 1PI(208)
TCOMM# = 'ASIC common mode noise'
#
#-------------------------------------------------------------
# columns related to the channel information
#-------------------------------------------------------------
#
# Name       : Original ASIC IDs for readout channel data
# Data type  : 12 bits of "ASIC ID ID0-ID11" => 16-bit integer
# Max length : 208x64 (limited by the toal number of readout channels in one camera)
# Origin     : derived from ASIC_ID column
# (ASIC_ID would be one possibility, but could/should have 3 columns: driver board Number,
# tray Number, ASIC Number).
# NOT in telemetry but copy from ASIC_ID in pipeline
ttype# = READOUT_ASIC_ID
tform# = 1PI(13312)
TCOMM# = 'Original ASIC ID for readout'
```

```
# Name       : Original Readout IDs
# Data type  : this value ranges 0-63 => unsigned byte
# (Example, if "Ch Data Bit Ch50" is "1", Readout_ID corresponding to this signal is "50".)
# Max length : 208*64 (limited by the total number of readout channels in one camera)
# NOT in telemetry but constructed in the pipeline using the info in Readout_flag and
# Readout_ASIC_ID
ttype# = READOUT_ID
tform# = 1PB(13312)
TCOMM# = 'Original readout ID'

# Name       : Remapped Channel IDs
# Data type  : this value ranges 0-13311 => 16-bit integer
# Max length : 208*64 (limited by the toal number of readout channels in one camera)
# Origin: calculated from READOUT_ID and RMAP_ASIC_ID
# For software utility. The instrument team does not require this column.
# constructed by software
ttype# = READOUT_ID_RMAP
tform# = 1PI(13312)
TCOMM# = 'Remapped readout ID'

# Name       : Raw ADC Data (pulse height)
# Data type  : 10-bit pulse height data packet ("ADC Data ch#m D0-D9") to 16-bit integer
# Max length : 208*64 (limited by the total number of readout channels in one camera)
# From the telemetry
ttype# = PHA
tform# = 1PI(13312)
TCOMM# = 'Pulse height amplitude"

# Name       : Calibrated pulse height
# Data type  : 16-bit integer
# Max length : 208*64 (limited by the total number of readout channels in one camera)
# Calculated from the PHA task
ttype# = EPI
tform# = 1PE(13312)
TCOMM# = 'PHA in keV'


##=================================================
# End columns related to ADC / channel value information
#=================================================
```

SGD Event SFFa

```
# SGD event data format SFFa
# This data contains a list of events from one of the SGD  Compton camera.
# One SGD unit have 3 compton camera; there are two SGD units on board ASTRO-H.
#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns for FFF
#-------------------------------------------------------------
#-------------------------------------------------------------

#number of rows
naxis2 = 1

# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# = 's'
TCOMM# = ‘Seconds from 01 Jan 2014 00:00:00’

# Description: Occurrence ID is within the SFF file
# a sequential number starting from 1 and increment at each row
# In the SFFa after reconstruction the number of columns may increase
# and therefore 1 or more rows have the same occurrence ID
# Origin     : Pre-Pipeline will insert the sequential number
ttype# = OCCURRENCE_ID
tform# = 1J
```

```
TCOMM# = 'Sequential number for occurrence'

# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = CATEGORY
tform# = 1B
TCOMM# = ‘Data recorder priority’

# Description: Length error of the data received at MIO :  (1) or ok (0)
# Origin     : Pre-Pipeline fill, copy from the telemetry from the bit preceeding the 1 "CCBUSY"
ttype# = FLAG_LCHKMIO
tform# = 1X
TCOMM# = '0=ok 1=error MIO received data'

# Description: Compton camera busy (3-bit flags). Flags (1: busy, 0: not)
# showing if the the Compton camera FPGA is busy with data processing or not.
# Origin     : Pre-Pipeline fill,  copy from the telemetry
#              Converted from 3 bits of "BUSY1, BUSY2, BUSY3" into 1B.
ttype# = FLAG_CCBUSY
tform# = 3X
TCOMM# = '1=CC busy 0=CC not busy'

# Description: Compton camera hit pattern (3-bit flags)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 3 bits of "HPATCC1, HPATCC2, HPATCC3" into 1B.
ttype# = FLAG_HITPAT_CC
tform# = 3X
TCOMM# = 'CC hit pattern'

# Description: BGO Shield Hit-Pattern veto signals (4-bit flags) (more accurate calculation than
FBGOs)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 4 bits of "HPAT11, HPAT12, HPAT21, HPAT22" into 1B.
# 13BGOs controlled by APMU1 output two signal lines of HPAT11 & HPAT12 to all CCs.
# The other 12BGOs by APMU2 do those of HPAT21 & HPAT22.
ttype# = FLAG_HITPAT
tform# = 4X
TCOMM# ='BGO shield hit pattern'

# Description: fast veto signal from the BGO shield (4-bit flags)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 4 bits of "HPAT11, HPAT12, HPAT21, HPAT22" into 1B.
# 13BGOs controlled by APMU1 output two signal lines of FBGO11 & FBGO12 to all CCs.
# The other 12BGOs by APMU2 do those of FBGO21 & FBGO22.
ttype# = FLAG_FASTBGO
tform# = 4X
TCOMM# ='Fast BGO shield hit pattern'

# Description: 0 is ok, If different from 0 means that one or more
# layers have trouble. Single event upset occurred (1) or not (0)
# Origin     : Pre-Pipeline fill,  copy from the telemetry of 1 bit of "SEU"
ttype# = FLAG_SEU
tform# = 1X
TCOMM# ='0=ok 1=single event upset'

# Description: length error (1) or ok (0)
# Origin     : Pre-Pipeline fill, copy from the telemetry of 1 bit of "LCHK"
ttype# = FLAG_LCHK
tform# = 1X
TCOMM# ='0=ok 1=length error'

# Description: Calibration mode (1) or not (0)
# Origin     : Pre-Pipeline fill, copy from the telemetry of 1 bit of "CALMODE"
ttype# = FLAG_CALMODE
tform# = 1X
TCOMM# = '1=calibration mode 0=other'

# Description: trigger pattern during the occurrence (31-bit flags)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 31 bits of "TRGPAT1-TRGPAT31" into 1J
```

.

```
ttype# = FLAG_TRIGPAT
tform# = 31X
TCOMM# ='Trigger pattern'

# Description: origin of trigger(s) of this occurrence
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 6 bits of "TRG1-TRG6" into 1B
# 0-27: corresponds to 28 trays as written in TRGPAT1-28.
# 28=Forced, 29=Psuedo, 30=Calibration-pulse triggers.
# >=32: there are more than two simultaneous triggers initiate the occurrence.
ttype# = FLAG_TRIG
tform# = 1B
TCOMM# ='Trigger origin'

# Description: time since the previous occurrence (24-bit counter)
# Origin     : Pre-Pipeline fill, copy from the telemetry of "Live Time D0-D23".
ttype# = LIVETIME
tform# = 1J
tzero# = 2147483648
TCOMM# ='Time since previous occurrence'

# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of th en bit sis assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
TCOMM# = Record bad telemetry or bad values

# Name       : STATUS
# Data type  : integer
#  Status value used by the pipeline. To record specific info TBD
ttype# = STATUS
tform# =  8X
TCOMM# = 'Occurrence status flags'
#
#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns added from the reconstruction
#-------------------------------------------------------------
#      columns populated by the reconstruction
#-------------------------------------------------------------
# Name       : PI
# Data type : integer
# Value obtained out the reconstruction  . Need conversion EPI to PI
ttype# = PI
tform# = I
tlmin# = 0
tlmax# = 2047
tnull# = -999
TCOMM# = 'Pulse Invariant'

# Name   : ENE_TOTAL
# Detected total energy sum of EPI for an occurrence independent
# if good or bad the occurance
# This can be written also in the sffpha task
ttype# = ENE_TOTAL
tform# = E
TCOMM# = 'Sum of EPI for occurrence'

# Name       : NUMSIGNAL
# Data type : integer or string
# Total number of signal in the occurrence
# this can be written also in any of the previous tasks FFF2SFF
ttype# = NUMSIGNAL
tform# = I
TCOMM# = 'Number of signals in occurrence'

# Name       : NUMHITS
# Data type : 5X
# 1bits=1hits 2bits=2hits 3bits=3hits 4bits=4hits 5bits=escape
```

.

```
# note only
ttype# = NUMHITS
tform# = 5X
TCOMM# = 'Hit distribution'

# Name       : SEQ_HITS
# Data type : integer
# numerical value of the CALDB table that describes the valid sequence for that HITS
ttype# = SEQ_HITS
tform# = I
tnull# = -999
TCOMM# = 'Sequence of hits from CALDB'

# Name       : DELCOMPTON
# Data type : real
# numerical value of the DeltaG-M-2. this calculation is only possible for 3 & 4 Hits
# any other HITS is 0
ttype# = DELCOMPTON
tform# = 2E
TCOMM# = 'Value of DeltaG (M>2)'

# Name       :COMPTON_TH
# Data type : real
# numerical value of the Thetak(0) Step 3. This calculation is only possible for 2 3 & 4 Hits
# Write the 1st value
ttype# = COMPTON_TH
tform# = E
TCOMM# = 'Value of Compton Thetak(0)'

# Name       :COMPTON_PH
# Data type : real
# numerical value of the PHI after Step 3. This calculation is only possible for 2 3 & 4 Hits
# Write the 1st value
ttype# = COMPTON_PH
tform# = E
TCOMM# = 'Value of Compton Phi'

# Name       :Distance0
# Data type : real
# numerical value of the Distance0 after Step 3. This calculation is only possible for 2 3 & 4
Hits
# Write the 1st value
ttype# = DISTANCE0
tform# = E
TCOMM# = '[mm] Distance, 1st two hits'

# Name       : OFFAXIS
# Data type : real
# Angle ARM : the offaxis angle Delta theta (k) if the occurrence is ok is always a number
ttype# = OFFAXIS
tform# = 1E
TCOMM# = 'Offaxis angle'

# Name       : CAMERAX
# Data type : real
# CAMERAX Y Z  ARE THE COORDINATES OF THE FIRST "HITS" in the final event.
# e.g if the final event is SI-CDTEbottom (2 hits) record the xyz of the first SI
ttype# = CAMERAX
tform# = E
TCOMM# = '1st hit coord camerax'

# Name       : CAMERAY
# Data type : real
# CAMERAX Y Z  ARE THE COORDINATES OF THE FIRST "HITS" in the final event.
# e.g if the final event is SI-CDTEbottom (2 hits) record the xyz of the first SI
ttype# = CAMERAY
tform# = E
TCOMM# = '1st hit coord cameray'

 Name       : CAMERAZ
# Data type : real
```

.

```
# CAMERAX Y Z  ARE THE COORDINATES OF THE FIRST "HITS" in the final event.
# e.g if the final event is SI-CDTEbottom (2 hits) record the xyz of the first SI
ttype# = CAMERAZ
tform# = E
TCOMM# = '1st hit coord cameraz'

# Name       : LIKELIHOOD
# Data type : real
# probability calculated from etot d ra phi value return from caldb
ttype# = LIKELIHOOD
tform# = E
TCOMM# = 'Likelihood of event'

# Name       : RECO_STATUS
# Data type  : 40X
# Value to be defined
ttype# = RECO_STATUS
tform# = 40X
TCOMM# = 'Reconstruction status'

# Name       : MATTYPE
# Data type : integer
# 1=si 2=cdte 3=multiple
ttype# = MATTYPE
tform# = I
TCOMM# = 'Material type'
##================================================
# End columns related to ADC / channel value information
#================================================
```

###SGD EVENT SFFa (Expand) CALMODE PSUEDO FORCETRIG

```
#-------------------------------------------------------------
# Columns for FFF
#-------------------------------------------------------------
#-------------------------------------------------------------

#number of rows
naxis2 = 1

# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# = 's'
TCOMM# = ‘Seconds from 01 Jan 2014 00:00:00’

# Description: Occurrence ID is within the SFF file
# a sequential number starting from 1 and increment at each row
# In the SFFa after reconstruction the number of columns may increase
# and therefore 1 or more rows have the same occurrence ID
# Origin     : Pre-Pipeline will insert the sequential number
ttype# = OCCURRENCE_ID
tform# = 1J
TCOMM# = 'Sequential number for occurrence'

# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = CATEGORY
tform# = 1B
TCOMM# = ‘Data recorder priority’

# Description: Length error of the data received at MIO :  (1) or ok (0)
# Origin     : Pre-Pipeline fill, copy from the telemetry from the bit preceeding the 1 "CCBUSY"
ttype# = FLAG_LCHKMIO
tform# = 1X
TCOMM# = '0=ok 1=error MIO received data'
```

```
# Description: Compton camera busy (3-bit flags). Flags (1: busy, 0: not)
# showing if the the Compton camera FPGA is busy with data processing or not.
# Origin     : Pre-Pipeline fill,  copy from the telemetry
#              Converted from 3 bits of "BUSY1, BUSY2, BUSY3" into 1B.
ttype# = FLAG_CCBUSY
tform# = 3X
TCOMM# = '1=CC busy 0=CC not busy'

# Description: Compton camera hit pattern (3-bit flags)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 3 bits of "HPATCC1, HPATCC2, HPATCC3" into 1B.
ttype# = FLAG_HITPAT_CC
tform# = 3X
TCOMM# = 'CC hit pattern'

# Description: BGO Shield Hit-Pattern veto signals (4-bit flags) (more accurate calculation than
FBGOs)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 4 bits of "HPAT11, HPAT12, HPAT21, HPAT22" into 1B.
# 13BGOs controlled by APMU1 output two signal lines of HPAT11 & HPAT12 to all CCs (6bgo+7bgo).
# 12BGOs controlled by APMU2 output two signal lines of HPAT22 & HPAT21 to all CCs (6bgo+6bgo)..
ttype# = FLAG_HITPAT
tform# = 4X
TCOMM# ='BGO shield hit pattern'

# Description: fast veto signal from the BGO shield (4-bit flags)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 4 bits of "FASTBGO11, FASTBGO12,, FASTBGO21, FASTBGO22" into 1B.
# 13BGOs controlled by APMU1 output 1 signal lines of FBGO11 or FBGO12 to all CCs. (fast)
# 13BGOs controlled by APMU1 output 1 signal lines of FBGO11 or FBGO12 to all CCs. (particle)
# 12BGOs controlled by APMU2 output 1 signal lines of FBGO21 or FBGO22 to all CCs. (fast)
# 12BGOs controlled by APMU2 output 1 signal lines of FBGO21 or FBGO22 to all CCs. (particle)
ttype# = FLAG_FASTBGO
tform# = 4X
TCOMM# ='Fast BGO shield hit pattern'

# Description: 0 is ok, If different from 0 means that one or more
# layers have trouble. Single event upset occurred (1) or not (0)
# Origin     : Pre-Pipeline fill,  copy from the telemetry of 1 bit of "SEU"
ttype# = FLAG_SEU
tform# = 1X
TCOMM# ='0=ok 1=single event upset'

# Description: length error (1) or ok (0)
# Origin     : Pre-Pipeline fill, copy from the telemetry of 1 bit of "LCHK"
ttype# = FLAG_LCHK
tform# = 1X
TCOMM# ='0=ok 1=length error'

# Description: Calibration mode (1) or not (0)
# Origin     : Pre-Pipeline fill, copy from the telemetry of 1 bit of "CALMODE"
# why there is this column if the data are separated
ttype# = FLAG_CALMODE
tform# = 1X
TCOMM# = '1=calibration mode 0=other'

# Description: trigger pattern during the occurrence (31-bit flags)
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 31 bits of "TRGPAT1-TRGPAT31" into 1J
ttype# = FLAG_TRIGPAT
tform# = 31X
TCOMM# ='Trigger pattern'

# Description: origin of trigger(s) of this occurrence
# Origin     : Pre-Pipeline fill, copy from the telemetry
#              Converted from 6 bits of "TRG1-TRG6" into 1B
# 0-27: corresponds to 28 trays as written in TRGPAT1-28.
# 28=Forced, 29=Psuedo, 30=Calibration-pulse triggers.
# >=32: there are more than two simultaneous triggers initiate the occurrence.
ttype# = FLAG_TRIG
tform# = 1B
```

.

```
TCOMM# ='Trigger origin'

# Description: time since the previous occurrence (24-bit counter)
# Origin     : Pre-Pipeline fill, copy from the telemetry of "Live Time D0-D23".
ttype# = LIVETIME
tform# = 1J
tzero# = 2147483648
TCOMM# ='Time since previous occurrence'

# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of th en bit sis assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# = 32X
TCOMM# = Record bad telemetry or bad values

# Name       : STATUS
# Data type  : integer
#  Status value used by the pipeline. To record specific info TBD
ttype# = STATUS
tform# = 8X
TCOMM# = 'Occurrence status flags'
#-------------------------------------------------------------
#-------------------------------------------------------------
# Columns added from the reconstruction
#-------------------------------------------------------------
#      columns populated by the reconstruction
#-------------------------------------------------------------

# Name       : READOUT_ID_INDEX
# Data type  :  1I
# The same value of READOUT_ID_RMAP in SFF but only for the fixed length array
ttype# = READOUT_ID_INDEX
tform# = 1I
tnull# = -999
TCOMM# = 'Readout index'

# Name       : PI
# Data type  : 1I
# The value EPI converted in PI. Need the conversion
ttype# = PI
tform# = I
tlmin# = 0
tlmax# = 2047
tnull# = -999
TCOMM# = 'Pulse invariant'

# Name       : RECO_STATUS
# Data type  : 40X
# Value to be defined
ttype# = RECO_STATUS
tform# = 40X
TCOMM# = 'Reconstruction status'

# Name       : MATTYPE
# Data type  : integer
# 1=si 2=cdte 3 multiple
ttype# = MATTYPE
tform# = 1I
TCOMM# = 'Material type'
#================================================
# End columns related to ADC / channel value information
#================================================
```

###Shield SGD GRB

```
# For both SCALAR and HISTOGRAM
# L32TI is stored from the value in secondary header of the packet
# TI_CNT and LOCAL_TIME are stored by MIO and APMU
#      TI_CNT : U32TI in MIO when the data are collected from APMU
#      LOCAL_TIME : LOCAL_TIME in APMU when the data are stored
```

```
###

###
#2015/03/05 Category: 1I => 1B (hirotaka)
###

# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# ='s'
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'

# Description: Time when the space packet was sent
# Origin     : Pre-Pipeline fill the colums, calculated by SIRIUS
ttype# = S_TIME
tform# = 1D
tunit# ='s'
TCOMM# ='Time for CCSDS packet stamped by SIRIUS'

# Description: CCSDS packet header
# Origin     : Pre-Pipeline fill, copy from the telemetry
# This is identical to the SXS
ttype# = ADU_CNT
tform# = 1B
TCOMM# = 'ADU sequence packet counter'

# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = ‘Category’
tform# = 1B
TCOMM# = 'Data recorder priority'
#
TTYPE1  = 'L32TI   '           / Packet TI lower 32b, 2^-6 s
TFORM1  = '1J      '           / data format of field: 4-byte INTEGER
TZERO1  =           2147483648 / offset for unsigned integers
TSCAL1  =                    1 / data are not scaled
TTYPE2  = 'U32TI'         / Packet TI upper 32b, 2^-6 s
TFORM2  = '1J      '           / data format of field: 4-byte INTEGER
TZERO2  =           2147483648 / offset for unsigned integers
TSCAL2  =                    1 / data are not scaled
TTYPE3  = 'LOCAL_TIME'     / Local time to calculate TIME
TFORM3  = '1J      '           / data format of field: 4-byte INTEGER
TZERO3  =           2147483648 / offset for unsigned integers
TSCAL3  =                    1 / data are not scaled
TTYPE4  = 'GRB_FREEZE_TIME'    / Freeze time to calculate TIME
TFORM4  = '1J      '           / data format of field: 4-byte INTEGER
TZERO4  =           2147483648 / offset for unsigned integers
TSCAL4  =                    1 / data are not scaled
TTYPE5  = 'SH1_GRB1'       / GRB Spectrum information
TFORM5  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE6  = 'SH1_GRB2'       / GRB Spectrum information
TFORM6  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE7  = 'SH1_GRB3'       / GRB Spectrum information
TFORM7  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE8  = 'SH1_GRB4'       / GRB Spectrum information
TFORM8  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE9  = 'SH1_GRB5'       / GRB Spectrum information
TFORM9  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE10 = 'SH1_GRB6'       / GRB Spectrum information
TFORM10 = '32I     '           / data format of field: 2-byte INTEGER
#
# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of the nbits is assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
TCOMM# = ‘Record bad telemetry or bad values’
```

.

```
###
# For both SCALAR and HISTOGRAM
# L32TI is stored from the value in secondary header of the packet
# TI_CNT and LOCAL_TIME are stored by MIO and APMU
#      TI_CNT : U32TI in MIO when the data are collected from APMU
#      LOCAL_TIME : LOCAL_TIME in APMU when the data are stored
###

# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# =' s '
TCOMM# = ‘Seconds from 01 Jan 2014 00:00:00’

# Description: Time when the space packet was sent
# Origin     : Pre-Pipeline fill the colums, calculated by SIRIUS
ttype# = S_TIME
tform# = 1D
TCOMM# = ‘Time for CCSDS packet stamped by SIRIUS’
#
# Description: CCSDS packet header
# Origin     : Pre-Pipeline fill, copy from the telemetry
# This is identical to the SXS
ttype# = ADU_CNT
tform# = 1B
TCOMM# = 'ADU sequence packet counter'
#
# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = Category
tform# = 1B
TCOMM# = ‘Data recorder priority’
#
TTYPE1  = 'L32TI   '           / Packet TI lower 32b, 2^-6 s
TFORM1  = '1J      '           / data format of field: 4-byte INTEGER
TZERO1  =           2147483648 / offset for unsigned integers
TSCAL1  =                    1 / data are not scaled
TTYPE2  = 'U32TI'          / Packet TI upper 32b, 2^-6 s
TFORM2  = '1J      '           / data format of field: 4-byte INTEGER
TZERO2  =           2147483648 / offset for unsigned integers
TSCAL2  =                    1 / data are not scaled
TTYPE3  = 'LOCAL_TIME'     / Local time to calculate TIME
TFORM3  = '1J      '           / data format of field: 4-byte INTEGER
TZERO3  =           2147483648 / offset for unsigned integers
TSCAL3  =                    1 / data are not scaled
TTYPE4  = 'GRB_FREEZE_TIME'    / Freeze time to calculate TIME
TFORM4  = '1J      '           / data format of field: 4-byte INTEGER
TZERO4  =           2147483648 / offset for unsigned integers
TSCAL4  =                    1 / data are not scaled
TTYPE5  = 'SH2_GRB1'       / GRB Spectrum information
TFORM5  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE6  = 'SH2_GRB2'       / GRB Spectrum information
TFORM6  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE7  = 'SH2_GRB3'       / GRB Spectrum information
TFORM7  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE8  = 'SH2_GRB4'       / GRB Spectrum information
TFORM8  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE9  = 'SH2_GRB5'       / GRB Spectrum information
TFORM9  = '32I     '           / data format of field: 2-byte INTEGER
TTYPE10 = 'SH2_GRB6'       / GRB Spectrum information
TFORM10 = '32I     '           / data format of field: 2-byte INTEGER
#
# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of the nbits is assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
```

```
TCOMM# = ‘Record bad telemetry or bad values’
```

###SHIELD SGD SCALAR and HISTOGRAM

```
# For both SCALAR and HISTOGRAM
# L32TI is stored from the value in secondary header of the packet
# TI_CNT and LOCAL_TIME are stored by MIO and APMU
#      TI_CNT : U32TI in MIO when the data are collected from APMU
#      LOCAL_TIME : LOCAL_TIME in APMU when the data are stored
###
###
#2015/03/05 Category: 1I => 1B (hirotaka)
###
### Extension1 for SCALAR ###
# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# ='s'
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'

# Description: Time when the space packet was sent
# Origin     : Pre-Pipeline fill the colums, calculated by SIRIUS
ttype# = S_TIME
tform# = 1D
tunit# ='s'
TCOMM# ='Time for CCSDS packet stamped by SIRIUS'

# Description: CCSDS packet header
# Origin     : Pre-Pipeline fill, copy from the telemetry
# This is identical to the SXS
ttype# = ADU_CNT
tform# = 1B
TCOMM# = 'ADU sequence packet counter'

# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = ‘Category’
tform# = 1B
TCOMM# = 'Data recorder priority'
#
TTYPE1  = 'L32TI   '           / Packet TI lower 32b, 2^-6 s
TFORM1  = '1J      '           / data format of field: 4-byte INTEGER
TZERO1  =           2147483648 / offset for unsigned integers
TSCAL1  =                    1 / data are not scaled
TTYPE2  = 'U32TI'         / Packet TI upper 32b, 2^-6 s
TFORM2  = '1J      '           / data format of field: 4-byte INTEGER
TZERO2  =           2147483648 / offset for unsigned integers
TSCAL2  =                    1 / data are not scaled
TTYPE3  = 'LOCAL_TIME'     / Local time to calculate TIME
TFORM3  = '1J      '           / data format of field: 4-byte INTEGER
TZERO3  =           2147483648 / offset for unsigned integers
TSCAL3  =                    1 / data are not scaled
TTYPE4  = 'SH1_FBGO1'          / Number of Counts
TFORM4  = '1I      '           / data format of field: 2-byte INTEGER
TZERO4  =                32768 / offset for unsigned integers
TSCAL4  =                    1 / data are not scaled
TTYPE5  = 'SH1_FBGO2'          / Number of Counts
TFORM5  = '1I      '           / data format of field: 2-byte INTEGER
TZERO5  =                32768 / offset for unsigned integers
TSCAL5  =                    1 / data are not scaled
TTYPE6  = 'SH1_FBGO3'          / Number of Counts
TFORM6  = '1I      '           / data format of field: 2-byte INTEGER
TZERO6  =                32768 / offset for unsigned integers
TSCAL6  =                    1 / data are not scaled
TTYPE7  = 'SH1_FBGO4'          / Number of Counts
TFORM7  = '1I      '           / data format of field: 2-byte INTEGER
TZERO7  =                32768 / offset for unsigned integers
TSCAL7  =                    1 / data are not scaled
TTYPE8  = 'SH1_FBGO5'          / Number of Counts
```

```
TFORM8  = '1I      '           / data format of field: 2-byte INTEGER
TZERO8  =                32768 / offset for unsigned integers
TSCAL8  =                    1 / data are not scaled
TTYPE9  = 'SH1_FBGO6'          / Number of Counts
TFORM9  = '1I      '           / data format of field: 2-byte INTEGER
TZERO9  =                32768 / offset for unsigned integers
TSCAL9  =                    1 / data are not scaled
TTYPE10 = 'SH1_FBGO7'          / Number of Counts
TFORM10 = '1I      '           / data format of field: 2-byte INTEGER
TZERO10 =                32768 / offset for unsigned integers
TSCAL10 =                    1 / data are not scaled
TTYPE11 = 'SH1_FBGO8'          / Number of Counts
TFORM11 = '1I      '           / data format of field: 2-byte INTEGER
TZERO11 =                32768 / offset for unsigned integers
TSCAL11 =                    1 / data are not scaled
TTYPE12 = 'SH1_FBGO9'          / Number of Counts
TFORM12 = '1I      '           / data format of field: 2-byte INTEGER
TZERO12 =                32768 / offset for unsigned integers
TSCAL12 =                    1 / data are not scaled
TTYPE13 = 'SH1_FBGO10'         / Number of Counts
TFORM13 = '1I      '           / data format of field: 2-byte INTEGER
TZERO13 =                32768 / offset for unsigned integers
TSCAL13 =                    1 / data are not scaled
TTYPE14 = 'SH1_FBGO11'         / Number of Counts
TFORM14 = '1I      '           / data format of field: 2-byte INTEGER
TZERO14 =                32768 / offset for unsigned integers
TSCAL14 =                    1 / data are not scaled
TTYPE15 = 'SH1_FBGO12'         / Number of Counts
TFORM15 = '1I      '           / data format of field: 2-byte INTEGER
TZERO15 =                32768 / offset for unsigned integers
TSCAL15 =                    1 / data are not scaled
TTYPE16 = 'SH1_FBGO13'         / Number of Counts
TFORM16 = '1I      '           / data format of field: 2-byte INTEGER
TZERO16 =                32768 / offset for unsigned integers
TSCAL16 =                    1 / data are not scaled
TTYPE17 = 'SH1_HITPAT1'        / Number of Counts
TFORM17 = '1I      '           / data format of field: 2-byte INTEGER
TZERO17 =                32768 / offset for unsigned integers
TSCAL17 =                    1 / data are not scaled
TTYPE18 = 'SH1_HITPAT2'        / Number of Counts
TFORM18 = '1I      '           / data format of field: 2-byte INTEGER
TZERO18 =                32768 / offset for unsigned integers
TSCAL18 =                    1 / data are not scaled
TTYPE19 = 'SH1_HITPAT3'        / Number of Counts
TFORM19 = '1I      '           / data format of field: 2-byte INTEGER
TZERO19 =                32768 / offset for unsigned integers
TSCAL19 =                    1 / data are not scaled
TTYPE20 = 'SH1_HITPAT4'        / Number of Counts
TFORM20 = '1I      '           / data format of field: 2-byte INTEGER
TZERO20 =                32768 / offset for unsigned integers
TSCAL20 =                    1 / data are not scaled
TTYPE21 = 'SH1_HITPAT5'        / Number of Counts
TFORM21 = '1I      '           / data format of field: 2-byte INTEGER
TZERO21 =                32768 / offset for unsigned integers
TSCAL21 =                    1 / data are not scaled
TTYPE22 = 'SH1_HITPAT6'        / Number of Counts
TFORM22 = '1I      '           / data format of field: 2-byte INTEGER
TZERO22 =                32768 / offset for unsigned integers
TSCAL22 =                    1 / data are not scaled
TTYPE23 = 'SH1_HITPAT7'        / Number of Counts
TFORM23 = '1I      '           / data format of field: 2-byte INTEGER
TZERO23 =                32768 / offset for unsigned integers
TSCAL23 =                    1 / data are not scaled
TTYPE24 = 'SH1_HITPAT8'        / Number of Counts
TFORM24 = '1I      '           / data format of field: 2-byte INTEGER
TZERO24 =                32768 / offset for unsigned integers
TSCAL24 =                    1 / data are not scaled
TTYPE25 = 'SH1_HITPAT9'        / Number of Counts
TFORM25 = '1I      '           / data format of field: 2-byte INTEGER
TZERO25 =                32768 / offset for unsigned integers
TSCAL25 =                    1 / data are not scaled
```

```
TTYPE26 = 'SH1_HITPAT10'      / Number of Counts
TFORM26 = '1I      '           / data format of field: 2-byte INTEGER
TZERO26 =                32768 / offset for unsigned integers
TSCAL26 =                    1 / data are not scaled
TTYPE27 = 'SH1_HITPAT11'      / Number of Counts
TFORM27 = '1I      '           / data format of field: 2-byte INTEGER
TZERO27 =                32768 / offset for unsigned integers
TSCAL27 =                    1 / data are not scaled
TTYPE28 = 'SH1_HITPAT12'      / Number of Counts
TFORM28 = '1I      '           / data format of field: 2-byte INTEGER
TZERO28 =                32768 / offset for unsigned integers
TSCAL28 =                    1 / data are not scaled
TTYPE29 = 'SH1_HITPAT13'      / Number of Counts
TFORM29 = '1I      '           / data format of field: 2-byte INTEGER
TZERO29 =                32768 / offset for unsigned integers
TSCAL29 =                    1 / data are not scaled
TTYPE30 = 'SH1_UD1 '           / Number of Counts
TFORM30 = '1B      '           / data format of field: BYTE
TTYPE31 = 'SH1_UD2 '           / Number of Counts
TFORM31 = '1B      '           / data format of field: BYTE
TTYPE32 = 'SH1_UD3 '           / Number of Counts
TFORM32 = '1B      '           / data format of field: BYTE
TTYPE33 = 'SH1_UD4 '           / Number of Counts
TFORM33 = '1B      '           / data format of field: BYTE
TTYPE34 = 'SH1_UD5 '           / Number of Counts
TFORM34 = '1B      '           / data format of field: BYTE
TTYPE35 = 'SH1_UD6 '           / Number of Counts
TFORM35 = '1B      '           / data format of field: BYTE
TTYPE36 = 'SH1_UD7 '           / Number of Counts
TFORM36 = '1B      '           / data format of field: BYTE
TTYPE37 = 'SH1_UD8 '           / Number of Counts
TFORM37 = '1B      '           / data format of field: BYTE
TTYPE38 = 'SH1_UD9'            / Number of Counts
TFORM38 = '1B      '           / data format of field: BYTE
TTYPE39 = 'SH1_UD10 '          / Number of Counts
TFORM39 = '1B      '           / data format of field: BYTE
TTYPE40 = 'SH1_UD11'           / Number of Counts
TFORM40 = '1B      '           / data format of field: BYTE
TTYPE41 = 'SH1_UD12'           / Number of Counts
TFORM41 = '1B      '           / data format of field: BYTE
TTYPE42 = 'SH1_UD13'           / Number of Counts
TFORM42 = '1B      '           / data format of field: BYTE
TTYPE43 = 'SH1_SUD1'           / Number of Counts
TFORM43 = '1B      '           / data format of field: BYTE
TTYPE44 = 'SH1_SUD2'           / Number of Counts
TFORM44 = '1B      '           / data format of field: BYTE
TTYPE45 = 'SH1_SUD3'           / Number of Counts
TFORM45 = '1B      '           / data format of field: BYTE
TTYPE46 = 'SH1_SUD4'           / Number of Counts
TFORM46 = '1B      '           / data format of field: BYTE
TTYPE47 = 'SH1_SUD5'           / Number of Counts
TFORM47 = '1B      '           / data format of field: BYTE
TTYPE48 = 'SH1_SUD6'           / Number of Counts
TFORM48 = '1B      '           / data format of field: BYTE
TTYPE49 = 'SH1_SUD7'           / Number of Counts
TFORM49 = '1B      '           / data format of field: BYTE
TTYPE50 = 'SH1_SUD8'           / Number of Counts
TFORM50 = '1B      '           / data format of field: BYTE
TTYPE51 = 'SH1_SUD9'           / Number of Counts
TFORM51 = '1B      '           / data format of field: BYTE
TTYPE52 = 'SH1_SUD10'          / Number of Counts
TFORM52 = '1B      '           / data format of field: BYTE
TTYPE53 = 'SH1_SUD11'          / Number of Counts
TFORM53 = '1B      '           / data format of field: BYTE
TTYPE54 = 'SH1_SUD12'          / Number of Counts
TFORM54 = '1B      '           / data format of field: BYTE
TTYPE55 = 'SH1_SUD13'          / Number of Counts
TFORM55 = '1B      '           / data format of field: BYTE
TTYPE56 = 'SH1_GRB_FLAG'       / label for field  56
TFORM56 = '1B      '           / data format of field: BYTE
TTYPE57 = 'SH1_FREEZE_FLAG'    / label for field  57
```

```
TFORM57 = '1B      '           / data format of field: BYTE
TTYPE58 = 'SH1_RBM_FLAG'        / label for field  58
TFORM58 = '1B      '           / data format of field: BYTE
# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of the nbits is assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
TCOMM# = 'Record bad telemetry or bad values'
### Extension2 for HIST ###
# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# =' s '
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'
#
# Description: Time when the space packet was sent
# Origin     : Pre-Pipeline fill the colums, calculated by SIRIUS
ttype# = S_TIME
tform# = 1D
TCOMM# = 'Time for CCSDS packet stamped by SIRIUS'
#
# Description: CCSDS packet header
# Origin     : Pre-Pipeline fill, copy from the telemetry
# This is identical to the SXS
ttype# = ADU_CNT
tform# = 1B
TCOMM# = 'ADU sequence packet counter'
#
# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = Category
tform# = 1B
TCOMM# = 'Data recorder priority'
#
TTYPE1  = 'L32TI   '           / Packet TI lower 32b, 2^-6 s
TFORM1  = '1J      '           / data format of field: 4-byte INTEGER
TZERO1  =           2147483648 / offset for unsigned integers
TSCAL1  =                    1 / data are not scaled
TTYPE2  = 'U32TI'         / Packet TI upper 32b, 2^-6 s
TFORM2  = '1J      '           / data format of field: 4-byte INTEGER
TZERO2  =           2147483648 / offset for unsigned integers
TSCAL2  =                    1 / data are not scaled
TTYPE3  = 'LOCAL_TIME'     / Local time to calculate TIME
TFORM3  = '1J      '           / data format of field: 4-byte INTEGER
TZERO3  =           2147483648 / offset for unsigned integers
TSCAL3  =                    1 / data are not scaled
TTYPE4  = 'SH1_HIST1'      / Histgram Spectrum information
TFORM4  = '128I    '           / data format of field: 2-byte INTEGER
TTYPE5  = 'SH1_HIST2'      / Histgram Spectrum information
TFORM5  = '128I    '           / data format of field: 2-byte INTEGER
TTYPE6  = 'SH1_HIST3'      / Histgram Spectrum information
TFORM6  = '128I    '           / data format of field: 2-byte INTEGER
TTYPE7  = 'SH1_HIST4'      / Histgram Spectrum information
TFORM7  = '128I    '           / data format of field: 2-byte INTEGER
TTYPE8  = 'SH1_HIST5'      / Histgram Spectrum information
TFORM8  = '128I    '           / data format of field: 2-byte INTEGER
TTYPE9  = 'SH1_HIST6'      / Histgram Spectrum information
TFORM9  = '128I    '           / data format of field: 2-byte INTEGER
TTYPE10 = 'SH1_HIST7'      / Histgram Spectrum information
TFORM10 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE11 = 'SH1_HIST8'      / Histgram Spectrum information
TFORM11 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE12 = 'SH1_HIST9'      / Histgram Spectrum information
TFORM12 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE13 = 'SH1_HIST10'     / Histgram Spectrum information
TFORM13 = '128I    '           / data format of field: 2-byte INTEGER
```

```
TTYPE14 = 'SH1_HIST11'     / Histgram Spectrum information
TFORM14 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE15 = 'SH1_HIST12'     / Histgram Spectrum information
TFORM15 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE16 = 'SH1_HIST13'     / Histgram Spectrum information
TFORM16 = '128I    '           / data format of field: 2-byte INTEGER
#
# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of the nbits is assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
TCOMM# = Record bad telemetry or bad values
#
### Extension3 for SCALAR ###
#
# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# =' s '
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'
#
# Description: Time when the space packet was sent
# Origin     : Pre-Pipeline fill the colums, calculated by SIRIUS
ttype# = S_TIME
tform# = 1D
TCOMM# = 'Time for CCSDS packet stamped by SIRIUS'
#
# Description: CCSDS packet header
# Origin     : Pre-Pipeline fill, copy from the telemetry
# This is identical to the SXS
ttype# = ADU_CNT
tform# = 1B
TCOMM# = 'ADU sequence packet counter'
#
# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = Category
tform# = 1B
TCOMM# = 'Data recorder priority'
#
TTYPE1  = 'L32TI   '           / Packet TI lower 32b, 2^-6 s
TFORM1  = '1J      '           / data format of field: 4-byte INTEGER
TZERO1  =           2147483648 / offset for unsigned integers
TSCAL1  =                    1 / data are not scaled
TTYPE2  = 'U32TI'         / Packet TI upper 32b, 2^-6 s
TFORM2  = '1J      '           / data format of field: 4-byte INTEGER
TZERO2  =           2147483648 / offset for unsigned integers
TSCAL2  =                    1 / data are not scaled
TTYPE3  = 'LOCAL_TIME'     / Local time to calculate TIME
TFORM3  = '1J      '           / data format of field: 4-byte INTEGER
TZERO3  =           2147483648 / offset for unsigned integers
TSCAL3  =                    1 / data are not scaled
TTYPE4  = 'SH2_FBGO1'          / Number of Counts
TFORM4  = '1I      '           / data format of field: 2-byte INTEGER
TZERO4  =                32768 / offset for unsigned integers
TSCAL4  =                    1 / data are not scaled
TTYPE5  = 'SH2_FBGO2'          / Number of Counts
TFORM5  = '1I      '           / data format of field: 2-byte INTEGER
TZERO5  =                32768 / offset for unsigned integers
TSCAL5  =                    1 / data are not scaled
TTYPE6  = 'SH2_FBGO3'          / Number of Counts
TFORM6  = '1I      '           / data format of field: 2-byte INTEGER
TZERO6  =                32768 / offset for unsigned integers
TSCAL6  =                    1 / data are not scaled
TTYPE7  = 'SH2_FBGO4'          / Number of Counts
TFORM7  = '1I      '           / data format of field: 2-byte INTEGER
```

```
TZERO7  =                32768 / offset for unsigned integers
TSCAL7  =                    1 / data are not scaled
TTYPE8  = 'SH2_FBGO5'          / Number of Counts
TFORM8  = '1I      '           / data format of field: 2-byte INTEGER
TZERO8  =                32768 / offset for unsigned integers
TSCAL8  =                    1 / data are not scaled
TTYPE9  = 'SH2_FBGO6'          / Number of Counts
TFORM9  = '1I      '           / data format of field: 2-byte INTEGER
TZERO9  =                32768 / offset for unsigned integers
TSCAL9  =                    1 / data are not scaled
TTYPE10 = 'SH2_FBGO7'          / Number of Counts
TFORM10 = '1I      '           / data format of field: 2-byte INTEGER
TZERO10 =                32768 / offset for unsigned integers
TSCAL10 =                    1 / data are not scaled
TTYPE11 = 'SH2_FBGO8'          / Number of Counts
TFORM11 = '1I      '           / data format of field: 2-byte INTEGER
TZERO11 =                32768 / offset for unsigned integers
TSCAL11 =                    1 / data are not scaled
TTYPE12 = 'SH2_FBGO9'          / Number of Counts
TFORM12 = '1I      '           / data format of field: 2-byte INTEGER
TZERO12 =                32768 / offset for unsigned integers
TSCAL12 =                    1 / data are not scaled
TTYPE13 = 'SH2_FBGO10'         / Number of Counts
TFORM13 = '1I      '           / data format of field: 2-byte INTEGER
TZERO13 =                32768 / offset for unsigned integers
TSCAL13 =                    1 / data are not scaled
TTYPE14 = 'SH2_FBGO11'         / Number of Counts
TFORM14 = '1I      '           / data format of field: 2-byte INTEGER
TZERO14 =                32768 / offset for unsigned integers
TSCAL14 =                    1 / data are not scaled
TTYPE15 = 'SH2_FBGO12'         / Number of Counts
TFORM15 = '1I      '           / data format of field: 2-byte INTEGER
TZERO15 =                32768 / offset for unsigned integers
TSCAL15 =                    1 / data are not scaled
TTYPE16 = 'SH2_FBGO13'         / Number of Counts
TFORM16 = '1I      '           / data format of field: 2-byte INTEGER
TZERO16 =                32768 / offset for unsigned integers
TSCAL16 =                    1 / data are not scaled
TTYPE17 = 'SH2_HITPAT1'       / Number of Counts
TFORM17 = '1I      '           / data format of field: 2-byte INTEGER
TZERO17 =                32768 / offset for unsigned integers
TSCAL17 =                    1 / data are not scaled
TTYPE18 = 'SH2_HITPAT2'       / Number of Counts
TFORM18 = '1I      '           / data format of field: 2-byte INTEGER
TZERO18 =                32768 / offset for unsigned integers
TSCAL18 =                    1 / data are not scaled
TTYPE19 = 'SH2_HITPAT3'       / Number of Counts
TFORM19 = '1I      '           / data format of field: 2-byte INTEGER
TZERO19 =                32768 / offset for unsigned integers
TSCAL19 =                    1 / data are not scaled
TTYPE20 = 'SH2_HITPAT4'       / Number of Counts
TFORM20 = '1I      '           / data format of field: 2-byte INTEGER
TZERO20 =                32768 / offset for unsigned integers
TSCAL20 =                    1 / data are not scaled
TTYPE21 = 'SH2_HITPAT5'       / Number of Counts
TFORM21 = '1I      '           / data format of field: 2-byte INTEGER
TZERO21 =                32768 / offset for unsigned integers
TSCAL21 =                    1 / data are not scaled
TTYPE22 = 'SH2_HITPAT6'       / Number of Counts
TFORM22 = '1I      '           / data format of field: 2-byte INTEGER
TZERO22 =                32768 / offset for unsigned integers
TSCAL22 =                    1 / data are not scaled
TTYPE23 = 'SH2_HITPAT7'       / Number of Counts
TFORM23 = '1I      '           / data format of field: 2-byte INTEGER
TZERO23 =                32768 / offset for unsigned integers
TSCAL23 =                    1 / data are not scaled
TTYPE24 = 'SH2_HITPAT8'       / Number of Counts
TFORM24 = '1I      '           / data format of field: 2-byte INTEGER
TZERO24 =                32768 / offset for unsigned integers
TSCAL24 =                    1 / data are not scaled
TTYPE25 = 'SH2_HITPAT9'       / Number of Counts
```

```
TFORM25 = '1I      '           / data format of field: 2-byte INTEGER
TZERO25 =                32768 / offset for unsigned integers
TSCAL25 =                    1 / data are not scaled
TTYPE26 = 'SH2_HITPAT10'      / Number of Counts
TFORM26 = '1I      '           / data format of field: 2-byte INTEGER
TZERO26 =                32768 / offset for unsigned integers
TSCAL26 =                    1 / data are not scaled
TTYPE27 = 'SH2_HITPAT11'      / Number of Counts
TFORM27 = '1I      '           / data format of field: 2-byte INTEGER
TZERO27 =                32768 / offset for unsigned integers
TSCAL27 =                    1 / data are not scaled
TTYPE28 = 'SH2_HITPAT12'      / Number of Counts
TFORM28 = '1I      '           / data format of field: 2-byte INTEGER
TZERO28 =                32768 / offset for unsigned integers
TSCAL28 =                    1 / data are not scaled
TTYPE29 = 'SH2_HITPAT13'      / Number of Counts
TFORM29 = '1I      '           / data format of field: 2-byte INTEGER
TZERO29 =                32768 / offset for unsigned integers
TSCAL29 =                    1 / data are not scaled
TTYPE30 = 'SH2_UD1 '           / Number of Counts
TFORM30 = '1B      '           / data format of field: BYTE
TTYPE31 = 'SH2_UD2 '           / Number of Counts
TFORM31 = '1B      '           / data format of field: BYTE
TTYPE32 = 'SH2_UD3 '           / Number of Counts
TFORM32 = '1B      '           / data format of field: BYTE
TTYPE33 = 'SH2_UD4 '           / Number of Counts
TFORM33 = '1B      '           / data format of field: BYTE
TTYPE34 = 'SH2_UD5 '           / Number of Counts
TFORM34 = '1B      '           / data format of field: BYTE
TTYPE35 = 'SH2_UD6 '           / Number of Counts
TFORM35 = '1B      '           / data format of field: BYTE
TTYPE36 = 'SH2_UD7 '           / Number of Counts
TFORM36 = '1B      '           / data format of field: BYTE
TTYPE37 = 'SH2_UD8 '           / Number of Counts
TFORM37 = '1B      '           / data format of field: BYTE
TTYPE38 = 'SH2_UD9'            / Number of Counts
TFORM38 = '1B      '           / data format of field: BYTE
TTYPE39 = 'SH2_UD10 '          / Number of Counts
TFORM39 = '1B      '           / data format of field: BYTE
TTYPE40 = 'SH2_UD11'           / Number of Counts
TFORM40 = '1B      '           / data format of field: BYTE
TTYPE41 = 'SH2_UD12'           / Number of Counts
TFORM41 = '1B      '           / data format of field: BYTE
TTYPE42 = 'SH2_UD13'           / Number of Counts
TFORM42 = '1B      '           / data format of field: BYTE
TTYPE43 = 'SH2_SUD1'           / Number of Counts
TFORM43 = '1B      '           / data format of field: BYTE
TTYPE44 = 'SH2_SUD2'           / Number of Counts
TFORM44 = '1B      '           / data format of field: BYTE
TTYPE45 = 'SH2_SUD3'           / Number of Counts
TFORM45 = '1B      '           / data format of field: BYTE
TTYPE46 = 'SH2_SUD4'           / Number of Counts
TFORM46 = '1B      '           / data format of field: BYTE
TTYPE47 = 'SH2_SUD5'           / Number of Counts
TFORM47 = '1B      '           / data format of field: BYTE
TTYPE48 = 'SH2_SUD6'           / Number of Counts
TFORM48 = '1B      '           / data format of field: BYTE
TTYPE49 = 'SH2_SUD7'           / Number of Counts
TFORM49 = '1B      '           / data format of field: BYTE
TTYPE50 = 'SH2_SUD8'           / Number of Counts
TFORM50 = '1B      '           / data format of field: BYTE
TTYPE51 = 'SH2_SUD9'           / Number of Counts
TFORM51 = '1B      '           / data format of field: BYTE
TTYPE52 = 'SH2_SUD10'          / Number of Counts
TFORM52 = '1B      '           / data format of field: BYTE
TTYPE53 = 'SH2_SUD11'          / Number of Counts
TFORM53 = '1B      '           / data format of field: BYTE
TTYPE54 = 'SH2_SUD12'          / Number of Counts
TFORM54 = '1B      '           / data format of field: BYTE
TTYPE55 = 'SH2_SUD13'          / Number of Counts
TFORM55 = '1B      '           / data format of field: BYTE
```

```
TTYPE56 = 'SH2_GRB_FLAG'        / label for field  56
TFORM56 = '1B      '            / data format of field: BYTE
TTYPE57 = 'SH2_FREEZE_FLAG'     / label for field  57
TFORM57 = '1B      '            / data format of field: BYTE
TTYPE58 = 'SH2_RBM_FLAG'        / label for field  58
TFORM58 = '1B      '            / data format of field: BYTE
#
# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of the nbits is assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
TCOMM# = 'Record bad telemetry or bad values'
#
### Extension 4 for HIST ###
# Description: Time, second from the epoch
# Origin     : Pre-pipeline but empty , Pipeline fills with time assignment
# Origin     : Blank at pre-pipeline
ttype# = TIME
tform# = 1D
tunit# =' s '
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'
#
# Description: Time when the space packet was sent
# Origin     : Pre-Pipeline fill the colums, calculated by SIRIUS
ttype# = S_TIME
tform# = 1D
TCOMM# = 'Time for CCSDS packet stamped by SIRIUS'
#
# Description: CCSDS packet header
# Origin     : Pre-Pipeline fill, copy from the telemetry
# This is identical to the SXS
ttype# = ADU_CNT
tform# = 1B
TCOMM# = 'ADU sequence packet counter'
#
# Description: Category
# Origin     : Pre-Pipeline fill, copy from the telemetry category in the Data recorder
# Hight =84 Medium=100  Low=116
ttype# = Category
tform# = 1B
TCOMM# = 'Data recorder priority'
#
TTYPE1  = 'L32TI   '            / Packet TI lower 32b, 2^-6 s
TFORM1  = '1J      '            / data format of field: 4-byte INTEGER
TZERO1  =           2147483648 / offset for unsigned integers
TSCAL1  =                    1 / data are not scaled
TTYPE2  = 'U32TI'         / Packet TI upper 32b, 2^-6 s
TFORM2  = '1J      '            / data format of field: 4-byte INTEGER
TZERO2  =           2147483648 / offset for unsigned integers
TSCAL2  =                    1 / data are not scaled
TTYPE3  = 'LOCAL_TIME'      / Local time to calculate TIME
TFORM3  = '1J      '            / data format of field: 4-byte INTEGER
TZERO3  =           2147483648 / offset for unsigned integers
TSCAL3  =                    1 / data are not scaled
TTYPE4  = 'SH2_HIST1'       / Histgram Spectrum information
TFORM4  = '128I    '            / data format of field: 2-byte INTEGER
TTYPE5  = 'SH2_HIST2'       / Histgram Spectrum information
TFORM5  = '128I    '            / data format of field: 2-byte INTEGER
TTYPE6  = 'SH2_HIST3'       / Histgram Spectrum information
TFORM6  = '128I    '            / data format of field: 2-byte INTEGER
TTYPE7  = 'SH2_HIST4'       / Histgram Spectrum information
TFORM7  = '128I    '            / data format of field: 2-byte INTEGER
TTYPE8  = 'SH2_HIST5'       / Histgram Spectrum information
TFORM8  = '128I    '            / data format of field: 2-byte INTEGER
TTYPE9  = 'SH2_HIST6'       / Histgram Spectrum information
TFORM9  = '128I    '            / data format of field: 2-byte INTEGER
TTYPE10 = 'SH2_HIST7'       / Histgram Spectrum information
TFORM10 = '128I    '            / data format of field: 2-byte INTEGER
TTYPE11 = 'SH2_HIST8'       / Histgram Spectrum information
```

```
TFORM11 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE12 = 'SH2_HIST9'      / Histgram Spectrum information
TFORM12 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE13 = 'SH2_HIST10'     / Histgram Spectrum information
TFORM13 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE14 = 'SH2_HIST11'     / Histgram Spectrum information
TFORM14 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE15 = 'SH2_HIST12'     / Histgram Spectrum information
TFORM15 = '128I    '           / data format of field: 2-byte INTEGER
TTYPE16 = 'SH2_HIST13'     / Histgram Spectrum information
TFORM16 = '128I    '           / data format of field: 2-byte INTEGER
#
# Name       : PROC_STATUS
# Data type  : integer
# Status value used by the pre-pipeline half of the nbits is assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
TCOMM# = Record bad telemetry or bad values
EXTNAME = 'TEMPORALDATA'       / name of this binary table extension
END
```

=== CAMS

```
# CAMS Temporal data FFF
#
# Column name: TIME
# Description: Time since 2014-01-01 00:00:00
# Time in MET
# TIME is calculated in the pipeline.
ttype# = TIME
tform# = 1D
tunit# = 's'
TCOMM# = 'Seconds from 01 Jan 2014 00:00:00'
#
# Column name: S_TIME
# Description: time of CCSDS packet stamped by SIRIUS
# Origin: pre-pipeline from telemetry 2^-6 s
# S_TIME is added in the pre-pipeline
ttype# = S_TIME
tform# = 1D
tunit# = 's'
TCOMM# = 'Time for CCSDS packet stamped by SIRIUS'
#
# Column name: L32TI
# Description: lower 32 bit TI of the event packet
# Origin: pre-pipeline from telemetry
# Time Indicator: CCSDS packet header
# Pre-Pipeline fill, copy and calculated from the telemetry.
#
# The origin of TIMECODE is at every 0.0000 sec and thus
# the lower 6-bit (below second) of L32TI is fixed to be 00.
# Since -1.0 sec offset is considered in ahtime, the L32TI in FFF
# is a copy from the telemetry, but only for upper 26-bit.
# Note that Original L32TI value is stored in the CAMS extension
# (extension name is HK_CAMS1/2_DSP_CAMS_STATUS) in common HK.
ttype# = L32TI
tform# = 1J
tzero# = 2147483648
TCOMM# = 'Packet TI lower 32b, 2^-6 s'
#
# Column name: ADU_CNT
# Description: ADU sequence counter of the event packet
# (0-255) in the main header. ADU_CNT allow to check if packet is lost
# Origin: pre-pipeline from telemetry
ttype# = ADU_CNT
tform# = 1B
TCOMM# = 'ADU sequence packet counter'
#
# Column name: CATEGORY
# Description: CATEGORY in SMCP header for DR priority (0-127)
```

```
# Origin: pre-pipeline from telemetry
ttype# = CATEGORY
tform# = 1B
TCOMM# = 'Data recorder priority'
#
######################
# Description: DSP status
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = DSP_UP
tform# = 1B
TCOMM# = 'DSP power up bit (0=off, 1=good)'
#
# Description: CAL_Bank
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = CAL_BANK
tform# = 1B
TCOMM# = 'Acquisition/calibration bank number'
#
# Description: EEPROM_UNLOCKED
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = EEPROM_UNLOCKED
tform# = 1B
TCOMM# = 'EEPROM unlocked flag'
#
# Description: EEPROM_PRG_DONE
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = EEPROM_PRG_DONE
tform# = 1B
TCOMM# = 'EEPROM program done flag'
#
# Description: FW0_VALID
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = FW0_VALID
tform# = 1B
TCOMM# = 'EEPROM0 bank valid (0=valid)'

# Description: FW1_VALID
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = FW1_VALID
tform# = 1B
TCOMM# = 'EEPROM1 bank valid (0=valid)'
#
# Description: FW2_VALID
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = FW2_VALID
tform# = 1B
TCOMM# = 'EEPROM2 bank valid (0=valid)'
#
# Description: FW3_VALID
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = FW3_VALID
tform# = 1B
TCOMM# = 'EEPROM3 bank valid (0=valid)'
#
# Description: CAL0_VALID
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = CAL0_VALID
tform# = 1B
TCOMM# = 'CAL0 table bank valid (0=valid)'
#
# Description: CAL1_VALID
# Origin     : Pre-Pipeline fill, copy from the telemetry
```

```
#
ttype# = CAL1_VALID
tform# = 1B
TCOMM# = 'CAL1 table bank valid (0=valid)'
#
# Description: CAL2_VALID
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = CAL2_VALID
tform# = 1B
TCOMM# = 'CAL2 table bank valid (0=valid)'
#
# Description: CAL3_VALID
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = CAL3_VALID
tform# = 1B
TCOMM# = 'CAL3 table bank valid (0=valid)'
#
#Description: BEAM_QUALITY
# Beam quality (10-bits) in the telemetry.
# From QUALITY in CAMS HK
ttype#= QUALITY
tform#=1I
TCOMM# = 'Beam quality factor'
#
# Description: IS_SAMPLING
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = IS_SAMPLING
tform# = 1B
TCOMM# = 'Measurement enable flag (1=good)'
#
# Description: SNAPSHOT_READY
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = SNAPSHOT_READY
tform# = 1B
TCOMM# = 'Snapshot image ready flag'
#
# Description: DSP_SOFT_RESET
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = DSP_SOFT_RESET
tform# = 1B
TCOMM# = 'DSP soft reset (0=good, 1=reset)'
#
# Description: MAILBOX_READY
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = MAILBOX_READY
tform# = 1B
TCOMM# = 'Mailbox is ready flag'
#
#DEscription : TIMECODE_GEN_FLAG
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype#=TIMECODE_GEN_FLAG
tform# = 1B
TCOMM# = 'Time-code generation flag'
#
#Description : EEPROM_BANK_NUM
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype#=EEPROM_BANK_NUM
tform# = 1B
TCOMM# = 'EEPROM bank number'
#
#Description : CMD_FIFO_READY
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
```

```
ttype#=CMD_FIFO_READY
tform# = 1B
TCOMM# = 'Cmd FIFO ready to receive command'
#
#Description : ERROR_FIFO_OVF
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype#=ERROR_FIFO_OVF
tform# = 1B
TCOMM# = 'Overflow of Error FIFO ctr'
#
#Description : ERROR
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype#=ERROR
tform# = 1B
TCOMM# = 'CAMS error'
#
#Description : ERROR_FIFO
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype#=ERROR_FIFO
tform# = 1B
TCOMM# = 'CAMS FIFO error'
#
#DEscription : HK_GEN_CNT
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype#=HK_GEN_CNT
tform# = 1B
TCOMM# = 'HK data generation counter'
#
#DEscription : HK_STATUS_READ_CNT
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype#=HK_STATUS_READ_CNT
tform# = 1B
TCOMM# = 'Housekeeping status read counter'
#
#DEscription : HK_DATA_READ_CNT
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype#=HK_DATA_READ_CNT
tform# = 1B
TCOMM# = 'Housekeeping data read counter'
#
#Description : COMMAND_RCV_CNT
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype# = COMMAND_RCV_CNT
tform# = 1B
TCOMM# = 'Command received counter'
#
#DEscription : COMMAND_RJT_CNT
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype#=COMMAND_RJT_CNT
tform# = 1B
TCOMM# = 'Command rejected counter'
#
#DEscription : LASER_INTENSITY
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype#=LASER_INTENSITY
tform# = 1B
TCOMM# = 'Laser intensity field'
#
#DEscription : LASER_CURRENT
# Origin     : Pre-Pipeline fill, copy from the telemetry
#
ttype#=LASER_CURRENT
```

```
tform# = 1B
TCOMM# = 'Laser current field'
#
# Description : THERMISTOR1
# Internal Temperature 1 (8-bit)
ttype#= THERMISTOR1
tform#= 1B
TCOMM# = 'Temperature 1 of CAMS (unit 0.5 degC)'
#
# Description : THERMISTOR2
# Internal Temperature 2 (8-bit)
ttype#= THERMISTOR2
tform#= 1B
TCOMM# = 'Temperature 2 of CAMS (unit 0.5 degC)'
#
# Description : THERMISTOR1_CAL
# Calibrated Internal Temperature 1
ttype#= THERMISTOR1_CAL
tform#= 1E
TCOMM# = 'Calibrated Temperature 1 of CAMS (unit degC)'
#
# Description : THERMISTOR2_CAL
# Calibrated Internal Temperature 2
ttype#= THERMISTOR2_CAL
tform#= 1E
TCOMM# = 'Calibrated Temperature 2 of CAMS (unit degC)'
#
# X displacement position of laser beam. If all '1', no data was sampled.
# For the EDU, the data format is 16-bit values
# representing pixels in microm. 1 pixel CAMS = 15 micro
#
#
ttype# = X_RAW
tform# = 1I
tnull# = 32767
TCOMM# = 'raw X position in unit of 0.977 um'
#
# Description : X is calculated using X_RAW and caldb information
#
ttype# = X
tform# = 1I
tnull# = 32767
TCOMM# = 'X position corrected for temperature'
#
# Y displacement position of laser beam. If all '1', no data was sampled.
# For the EDU, the data format is 16-bit values
# representing pixels in microm. 1 pixel CAMS = 15 micro
#
ttype# = Y_RAW
tform# = 1I
tnull# = 32767
TCOMM# = 'raw Y position in unit of 0.977 um'
#
# Description : Y is calculated using Y_RAW and caldb information
#
ttype# = Y
tform# = 1I
tnull# = 32767
TCOMM# = 'Y position corrected for temperature'
#
#Description : TIMECODE
# Timestamp for measurement "n". This is based on the
# SpaceWire time distribution information and its value
# represents 64th of seconds. ie: a value of 12 means that the
# sample was taken at T0 + 12 x 1/64th = T0 + 0.1875 seconds
# where T0 is an integer number of seconds
#
# This is unpacked into five separate values
# for a single readout
#
# nominally 0, 13, 26, 39, and 52, which correspond to
```

```
# 0, 0.203125, 0.40525, 0.609375, 0.8125 seconds
#
ttype# = TIMECODE
tform# = 1B
TCOMM# = 'Code for unpacking time from raw data'
#
#Description : FLAGS
#
ttype#=FLAGS
tform#=1B
TCOMM# = 'Data valid/img saturated bits (1=good)'
# Values above are expected in cams2det code in the given
# format.
# Column name: PROC_STATUS
# Description: pipe-line processing status
# Origin: pre-pipeline calculated from software
# Status value used by the pre-pipeline half of the en bit sis assigned
# to Japan and half to US
ttype# = PROC_STATUS
tform# =  32X
TCOMM# = 'Record bad telemetry or bad values'
```

SFFa CAMS

Column_Names	Formats	Dims	Units
TIME	1D		s
DELTARAWX	1D		px
DELTARAWY	1D		px
COSANGLE	1D		
SINANGLE	1D		
X1	1J		
Y1	1J		
X2	1J		
Y2	1J		
JUMPX1	1J		
JUMPY1	1J		
JUMPX2	1J		
JUMPY2	1J		
QUALITY1	1J		
QUALITY2	1J		
XDISTANCE	1D		mm
YDISTANCE	1D		mm
DELTASATX	1D		mm
DELTASATY	1D		mm
BAD_UNITS	1J		
CALC_QUALITY	1J		

TEMP	H0	M0	L0	…..	….	H5	M5	L5
1D	36D	36D	36D	36D	36D	36D	36D	36D

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