OGIP Calibration Memo CAL/ASD/93-020

How to Create an ASCA Calibration File

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SUMMARY

This document describes the modifications which should be made to ASCA calibration files so that they conform to the multimission standards of the OGIP calibration database. It is assumed that the reader is familiar with the ftools software.

Intended audience: ASCA instrument team members and scientists providing calibration files to the ASCA Calibration Database.

How to Get this Document

A current version of this document can be obtained via anonymous ftp from:

legacy.gsfc.nasa.gov (128.183.8.233).

This document is contained in the directory /caldb/docs/asca.

The TeX version of this document is named cal_asd_93_020.tex while the Postscript form is called cal_asd_93_020.ps.

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Contents

1 How to Use This Document

This document should be used as an introduction to keywords and formats required by the Calibration Database. This document is not intended to be complete guide to all possible keyword values, but rather it should be used as a first step in formatting a calibration file. In fact, this document should not be used for the creation of "virtual" calibration files.

Please do not get discouraged at the technical and complex definitions of some of the keyword values in section 3 (The Calibration Boundary Keywords, section 3.2.8, for example). Where issues get confused or values are unclear, give up. Do not frustrate yourself; simply contact a member of the OGIP Calibration Database team, explain your problem and they will respond with an appropriate set of keywords for your needs.

At the same time, we hope that the reader attempts to understand some of the more simple (and important) keyword values such as the Validity Start Date and the Validity Start Time (section 3.2.5 and 3,2,6).

Begin using this document by contacting a member of the Calibration Database team and telling them that you are interested in creating a file for the Calibration Database. Most likely, they already have the format you require. In fact, a quick look in the Calibration Database at ISAS or GSFC may turn up a file similar to the one you wish to create. This file can then be used as a templet for creating your calibration file.

In the event that the Caldb team does not have a format defined, one can be defined with your cooperation. Please see the next section for more detailed information about creating a format for your data.

After your format is defined, add the Calibration Database keywords using the guide in section 3. If you have already contacted the Calibration Database team, they have probably recommended a set of keywords for your file. If not, determine the keyword values to the best of your ability and send them to the Caldb team for final approval.

Lastly, add some COMMENT keywords at the end of the extension header (see section 4). This will serve to explain the dataset to people who cannot directly contact the person who created the file. It is also a useful way of communicating important information and warnings about the data you have created.

2 Creating a Format

2.1 FITS Formats

The OGIP Calibration Database is only capable of indexing FITS format files. All calibration files submitted for inclusion into the Calibration Database must be in FITS formats.

To create a FITS file which conforms to the OGIP standards, we recommend using the ftool FCREATE. In the event that the FCREATE software cannot produce a FITS file suitable to the user, we recommend using the FITSIO subroutine interface which can be found within the ftools package. Please read the ftools developer's guide for more information about using this software.

In some cases the ftools library "libcaltools.a" may contain a subroutine capable of writing the calibration file. Please contact the Calibration Database team for further details.

2.2 Multimission Formats

A primary goal of the OGIP is to make all software (i.e. ftools) as mission-independent and detector-independent as possible. This requires that all input files, such as calibration files, have standard multimission formats. The OGIP maintains numerous pre-defined formats for calibration files.

Any user creating a new calibration file should first consult with a member of the OGIP Calibration Database team to see if a standard is already in place. If this is not the case, then the Caldb team will be happy to work with you in defining a format. Similarly, if the current format used by the OGIP is insufficient to meet your needs, the team will be happy to discuss defining a new format. Files in non-standard (non-OGIP aproved) formats will be rejected..

2.3 Grouping the Calibration Data

The OGIP CALDB is capable of indexing more than one dataset per file, and more than one dataset per FITS extension. However, we <u>strongly</u> recommend that only one dataset appear in any extension. In addition we advise that only one dataset appear in any file whenever possible.

3 Adding the OGIP Calibration Keywords

The following keywords are required for all ASCA calibration files. In addition, the keywords described below describe a single dataset in a single FITS extension. Should the reader need to describe more than one dataset per extension, then the reader should contact an OGIP Calibration Database team member and explain their requirements, or the reader should consult the document "Mandatory FITS keywords for Calibration Files", CAL/GEN/92-011.

We recommend using the ftools task FMODHEAD to add the following keywords to a FITS file.

Please note that these keywords should appear in the same extension that contains the calibration data. Placing these keywords in a different extension will cause the Calibration Database access software to erroneously report the location of your data. As a result, downstream software will most likely fail.

Table 1 summarizes all the required calibration keywords and their values.

3.1 Non-changing Keyword Values for the ASCA Mission

The following keywords and values should be added to all ASCA calibration files. These keywords have only one possible value for the ASCA mission.

3.1.1 The Telescope Keyword

```
TELESCOP   = 'ASCA'                  /The mission name
```

3.1.2 The Data Type keyword

```
CDTP0001   = 'DATA'                  /Type of dataset
```

3.1.3 The Filter Keyword

```
FILTER     = 'NONE'                  /The type of filter used
```

Table 1 Summary of Calibration Keywords and Values

Keyword Name	Value(s)	Comment
TELESCOP	ASCA	The mission name
CDTP0001	DATA	Type of dataset
FILTER	NONE	The type of filter used
INSTRUME	GIS, SIS, XRT, GIS2, GIS3, SIS0, SIS1, XRT1, XRT2, XRT3, XRT4	Name of instrument
DETNAM	CCD0, CCD1, CCD2, CCD3	Name of the detector
CCLS0001	BCF, CPF, PCF	Class of dataset
CCNM0001†	N/A	Codename for dataset
CVSD0001††	*dd/mm/yy*	UTC date when data becomes valid
CVST0001††	*hh:mm:ss*	UTC time when data becomes valid
CDES0001†	N/A	N/A
CBD[n]0001††	*expr(valdes1,...,valdesj)units*	N/A

† The values for this keyword cannot be succinctly listed. Please see the description of this keyword below.
†† The value for this keyword has a specific format. Please see the description of this keyword below.

3.2 Variable Keyword Values for the ASCA Mission

The following keywords should be added to all ASCA calibration files. The values of the keywords are determined by the type of data present in the extension.

3.2.1 The Instrument keyword

```
INSTRUME    = 'instval'       /Name of instrument
```

where *instval*
= GIS if the dataset is valid for BOTH GIS2 and GIS3
= SIS if the dataset is valid for BOTH SIS0 and SIS1
= XRT if the dataset is valid for XRT1, XRT2, XRT3, and XRT4
= GIS2 if the dataset is only valid for GIS2
= GIS3 if the dataset is only valid for GIS3
= SIS0 if the dataset is only valid for SIS0
= SIS1 if the dataset is only valid for SIS1
= XRT1 if the dataset is only valid for XRT1
= XRT2 if the dataset is only valid for XRT2
= XRT3 if the dataset is only valid for XRT3
= XRT4 if the dataset is only valid for XRT4

3.2.2 The Detector Name Keyword

```
DETNAM      = 'detval'        /Name of the detector
```

where *detval*
= CCD0 if the dataset is valid for the SIS instrument, CCD chip 0
= CCD1 if the dataset is valid for the SIS instrument, CCD chip 1
= CCD2 if the dataset is valid for the SIS instrument, CCD chip 2
= CCD3 if the dataset is valid for the SIS instrument, CCD chip 3

This keyword is required if the dataset is valid only for a specific CCD chip in the SIS instrument.

3.2.3 The Calibration Class Keyword

```
CCLS0001    = 'cclsval'       /Class of dataset
```

where *cclsval*
= BCF if the dataset is a 'Basic Calibration File' (.e.g the gain history file)
= CPF if the dataset is a 'Calibration Product File' (e.g. a detector response file)
= PCF if the dataset is a Primary Calibration File' (.e.g a ground calibration image)

3.2.4 The Calibration Codename Keyword

```
CCNM0001    = 'ccnmval'       /Codename for dataset
```

where *ccnmval* is a special value assigned to the data based on it's data type. Since there are many possible Code Name values, the reader is urged to consult a member of the OGIP Calibration Team or read the document "Mandatory FITS Keywords for Calibration Files", CAL/GEN/92-011. Some examples of CCNM0001 values are:

ccnmval	= `EFFAREA`	if the data is an Effective Area dataset
	= `MATRIX`	if the data is the MATRIX extension of an RMF file
	= `SPECRESP`	if the data is the Spectral Response of an instrument

3.2.5 The Validity Start Date Keyword

```
CVSD0001    = 'dd/mm/yy'      /UTC date when data becomes valid
```

where	*dd*	= the two digit day when the data becomes valid (01 - 31)
	mm	= the two digit month when the data becomes valid (01 - 12)
	yy	= the two digit year when the data becomes valid (50 - 49, i.e. 1950 - 2049)

The specified date is in Universal Time Coordinates (UTC).

For example, if a response matrix is created that should only be used with data observed after or during March 24, 1993, then the CVSD0001 keyword would be '24/03/93'.

3.2.6 The Validity Start Time Keyword

```
CVST0001    = 'hh:mm:ss'      /UTC time when data becomes valid
```

where	*hh*	= the two digit hour when the data becomes valid (00 - 23)
	mm	= the two digit minuet when the data becomes valid (00 - 60)
	ss	= the two digit second when the data becomes valid (00 - 60)

The specified time is in Universal Time Coordinates (UTC).

For example, if a response matrix is created that should only be used with data observed after of during 1:48:27 pm on March 24, 1993, then the CVST0001 keyword would be '13:48:27'. In cases where the validity start time is not critical use the value '00:00:00'.

3.2.7 The Dataset Description Keyword

```
CDES0001    = 'descval'
```

where *descval* is a 70 character or less description of the dataset. **Please be as specific as possible**: this value is displayed to users of the Caldb as a description of their selected calibration file. It is important that this description be as specific and verbose as possible.

3.2.8 The Calibration Boundary Keywords

The values of the calibration boundary keywords provides a means of specifying the limitations or parameter boundaries of a calibration dataset. For Example, the energy range of a Point Spread function may be limited to the range 0.1 keV - 10 keV and the creator of the dataset would like to indicate this fact to any software using the data. In this case, a calibration boundary keyword could be added to specify the energy restriction.

The calibration boundary keywords have the name CBD[n]0001 where n ranges from 1 to 9. Therefore, there can only be 9 calibration boundary keywords per dataset, CBD10001, CBD20001, ..., CBD80001, CBD90001. (More can be added if necessary -- contact the CALDB team.) If no Boundary keywords are present in the file, the Calibration Database will assume that there are no restrictions on the data.

The value of each CBD[n]0001 keyword is a character string which refers to a different dimension of parameter space, and has the following format:

CBD[n]0001 = '*expr*(*valdes1*,*valdes2*,...,*valdesj*)*units*'

where *expr* is a special 4 - 8 character word describing the boundary parameter. Since there are many possible expr values, the reader is urged to consult a member of the OGIP Calibration Team or read the document "Mandatory FITS Keywords for Calibration Files", CAL/GEN/92-011. Selected *expr* values are given below.

valdesj is the jth value descriptor specifying the set of values for which the parameter is valid. The value descriptor has three possible forms described below.

units is the physical units of *valdesj*. The allowed values of the *units* string are the same as the allowed values of the TUNITS[nnn] keyword. (See Specifications of Physical Units within OGIP FITS Files" OGIP/93-001).

Some examples of *expr* values are:

THETA if the dataset is limited to a set of off-axis angles
PHI if the dataset is limited to a set of azimuthal angles
ENERG if the dataset is limited to a set of energies
TEMP if the dataset is limited to a set of temperatures
RAWX if the dataset is limited to a set of raw detector coordinates on the X-axis
RAWY if the dataset is limited to a set of raw detector coordinates on the Y-axis

The value descriptor, valdesj, can have three possible forms, all of which can be included in the same CBD[n]0001 keyword value.

i) single numeric value

Has the form '...,value,...', where value is a single real numeral for which the boundary parameter is valid. For example, 'THETA(0,5)deg' would indicate that the dataset is valid for theta equals 0.0 degrees or theta equals 5.0 degrees, but is not valid for the range 0.0 < theta < 5.0 degrees.

ii) range of numeric values

Has the form '...,minval-maxval,...' where minval and maxval are the smallest and largest values in a continuous range of values for which the boundary parameter is valid. For example, 'THETA(0-5)deg' would indicate that the dataset is valid for the range 0.0 <= theta <= 5.0 degrees.

iii) single character string

Has the form '...,string,...' where string is a single character string for which the boundary parameter is valid. For example, 'CLIPLVL(HIGH,MED)' would indicate that the dataset was valid for high and medium clipping levels. Double qoutes can be used to force a value to be interpreted as a string. For example 'GRADE("0234")' would indicate that the dataset was valid for grade 0234. If the double quotes were missing, then the dataset would be interpreted as valid for grade 234.0.

A combination of these forms can be used to describe a complex dataset in a single CBD[n]0001 keyword. For example, 'GRADE("0234",0,2-4)' would indicate that the dataset is valid for grade 0234, grade 0, and the grade range 2.0 to 4.0.

4 Adding the COMMENT keywords

It is useful to add COMMENT keywords to the end of the extension header which contains the data. This will explain the data to remote users who cannot directly contact you. The text contained in the COMMENT keywords should warn the user of any peculiarities of the data, and briefly explain how it should be used. Essentially, the text should be able to explain the data to a guest observer that knows nothing about the calibration process. See the next section for examples of how to comment a dataset.

We recommend using the FMODHEAD software for adding the COMMENT keywords to the data extension.

5 Examples

5.1 Gain History File

Here is the header of the gain history calibration file. Notice that this file is valid for both GIS2 and GIS3 (see the INSTRUME keyword) and that this is a Basic Calibration File (see the CCLS0001 keyword). Also note the Code Name for this dataset is 'GAIN HIST'. No Calibration Boundary keywords appear because none are required for this dataset.

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   48 / width of table in bytes
NAXIS2  =                 4429 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   12 / number of fields in each row
TTYPE1  = 'START TIME'         / label for field   1
TFORM1  = '1D      '           / data format of the field: DOUBLE PRECISION
TUNIT1  = 'ASCA TIME(s)'       / physical unit of field
TTYPE2  = 'END TIME'           / label for field   2
TFORM2  = '1D      '           / data format of the field: DOUBLE PRECISION
TUNIT2  = 'ASCA TIME(s)'       / physical unit of field
TTYPE3  = 'S2 HVL LEVEL'       / label for field   3
 ...
 ...
 ...
TUNIT11 = 'channel '           / physical unit of field
TTYPE12 = 'S3 CAL RT'          / label for field  12
TFORM12 = '1E      '           / data format of the field: 4-byte REAL
TUNIT12 = 'channel '           / physical unit of field
EXTNAME = 'BINTABLE'           / name of this binary table extension
TELESCOP= 'ASCA    '           / Telescope (mission) name
INSTRUME= 'GIS     '           / Instrument name
FILENAME= 'gainhist.fits'
DATE    = '23/08/93'           / FITS file creation date (dd/mm/yy)
VERSION =                    1 / File version number
CCLS0001= 'BCF     '           / Dataset is Basic Calibration File
CCNM0001= 'GAIN HIST'          / Type of calibration data
CDTP0001= 'DATA    '           / Calibration file contains data
CVSD0001= '18/03/93'           / UTC date when data becomes valid
CVST0001= '11:06:20'           / UTC time when data becomes valid
CDES0001= 'GIS TEMPORAL FILE CONTAINS Fe55/RT CAL AND TEMP/HV (L/H)' /
DATE-OBS= '18/03/93'           / Starting date of observations dd/mm/yy
TIME-OBS= '11:06:20'           / Staring time of observations (hh:mm:ss)
DATE-END= '05/07/93'           / Ending date of observations (dd/mm/yy)
TIME-END= '10:20:21'           / Ending time of observations (dd/mm/yy)
TSTART  =     6.6063800000E+06 / Begining time for valid data in file
TSTOP   =     1.6022423000E+07 / Ending time for valid data in this file
COMMENT
COMMENT  This dataset is valid only for observations made between 1993
COMMENT  March 18 11:06:20 UT and 1993 July 5 10:20:21 UT.  This dataset
```

```
COMMENT  should not be used for any other observations.
COMMENT
COMMENT  This file is used as input to the ftools GISLIN task.
COMMENT
COMMENT  Notes from Ken Ebisawa July 1, 1993 --------------------------
COMMENT  This file includes gain values as a function of time.
COMMENT  CAL PH is the PHA channel of the Mn K-alpha line (5.94 keV),
COMMENT  which is the cal source attached to the detector.
COMMENT
END
```

5.2 SIS Response Matrix File

Here are the headers from the first and second extensions of the response matrix file s0c0g0234p20e0_1024.rmf. Note the use of the DETNAM keyword in this file in conjunction with the INSTRUME keyword. Also, notice that this file contains a CPF dataset (see the CCLS0001 keyword). This dataset also makes use of the Calibration Boundary Keywords.

5.2.1 First Extension

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   34 / width of table in bytes
NAXIS2  =                 1180 / number of rows in table
PCOUNT  =               360580 / Number of bytes acumulated in heap
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                    6 / number of fields in each row
TTYPE1  = 'ENERG_LO'           / label for field   1
TFORM1  = 'E       '           / data format of the field: 4-byte REAL
TUNIT1  = 'keV     '           / physical unit of field
TTYPE2  = 'ENERG_HI'           / label for field   2
TFORM2  = 'E       '           / data format of the field: 4-byte REAL
TUNIT2  = 'keV     '           / physical unit of field
TTYPE3  = 'N_GRP   '           / label for field   3
TFORM3  = 'I       '           / data format of the field: 2-byte INTEGER
TTYPE4  = 'F_CHAN  '           / label for field   4
TFORM4  = 'PI      '           / data format of the field
TTYPE5  = 'N_CHAN  '           / label for field   5
TFORM5  = 'PI      '           / data format of the field
TTYPE6  = 'MATRIX  '           / label for field   6
TFORM6  = 'PE      '           / data format of the field
EXTNAME = 'MATRIX  '           / name of this binary table extension
TELESCOP= 'ASCA    '           / mission/satellite name
INSTRUME= 'SIS0    '           / instrument/detector
FILTER  = 'none    '           / filter information
RMFVERSN= '1992a   '           / OGIP classification of FITS format style
CHANTYPE= 'PHA     '           / Type of channels (PHA, PI etc)
DETCHANS=                 1024 / Total number of detector PHA channels
LO_THRES=             1.00E-07 / Lower probability density threshold for matrix
DETNAM  = 'CCD0    '           / CCD chip
CCLS0001= 'CPF     '           / Class of dataset
CDTP0001= 'DATA    '           / Type of dataset
CVSD0001= '20/02/93'           / UTC date when data becomes valid
CVST0001= '00:00:00'           / UTC time when data becomes valid
```

```
CDES0001= 'SISRMGv0.4:1180x1024 S0C0 grds-0234 splt-20 echo-correct'
HDUCLASS= 'OGIP    '           / Format created by the OGIP
HDUCLAS1= 'RESPONSE'           / Dataset assoc with instr response
HDUVERS1= '1.0.0   '           / Version of HDUCLAS1 format
HDUCLAS2= 'RSP_MATRIX'         / Dataset is a response matrix
HDUVERS2= '1.1.0   '           / Version of HDUCLAS2 format
HDUCLAS3= 'DETECTOR'           / Matrix includes det eff etc
CCNM0001= 'MATRIX  '           / Codename for dataset
CBD10001= 'CHAN(1-1024)'       / Channel bounds
CBD20001= 'ENER(0.2-12.0)keV'  / Energy range
CBD30001= 'GRADE("0234")'      / Applicable grades
CBD40001= 'RAWX(216)'          / RAWX CCD position
CBD50001= 'RAWY(212)'          / RAWY CCD position
CBD60001= 'SPLIT(20)'          / Split threshold
CBD70001= 'ECHO(CORRECTED)'    / Echo corrected
COMMENT
COMMENT Ron Zellar (HEASARC) 1994 Jan 05
COMMENT
COMMENT This is a detector redistribution matrix for an ASCA SIS CCD chip.
COMMENT The SIS sensor number is given in the INSTRUME keyword, and the chip
COMMENT in the DETNAM keyword.
COMMENT NOTE: This dataset does NOT include the effective area of the XRT, and
COMMENT is  only valid for:
COMMENT      the channel range given by the CBD10001 keyword
COMMENT      the incident energy range given by the CBD20001 keyword
COMMENT      the SIS 'grades' given by the CBD30001 keyword
COMMENT      the Raw detector coords given by the CBD40001,CBD50001 kywrds
COMMENT      the SIS split threshold level given by the CBD60001 keyword
COMMENT      SIS data which has/has not been 'echo-corrected' as denoted by
COMMENT        the CBD70001 keyword
COMMENT The dataset was created by Geoff Crewe (MIT) 1993 Dec 17 using SISRMG
COMMENT v0.4, using a circular extract cell of 4 arcmin radius.
COMMENT
END
```

5.2.2 Second Extension

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   10 / width of table in bytes
NAXIS2  =                 1024 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                    3 / number of fields in each row
TTYPE1  = 'CHANNEL '           / label for field   1
TFORM1  = 'I       '           / data format of the field: 2-byte INTEGER
TUNIT1  = 'channel '           / physical unit of field
TTYPE2  = 'E_MIN   '           / label for field   2
TFORM2  = 'E       '           / data format of the field: 4-byte REAL
TUNIT2  = 'keV     '           / physical unit of field
TTYPE3  = 'E_MAX   '           / label for field   3
TFORM3  = 'E       '           / data format of the field: 4-byte REAL
TUNIT3  = 'keV     '           / physical unit of field
EXTNAME = 'EBOUNDS '           / name of this binary table extension
TELESCOP= 'ASCA    '           / mission/satellite name
INSTRUME= 'SIS0    '           / instrument/detector
FILTER  = 'none    '           / filter information
```

```
RMFVERSN= '1992a   '           / OGIP classification of FITS format style
CHANTYPE= 'PHA     '           / Type of channels (PHA, PI etc)
DETCHANS=                 1024 / Total number of detector PHA channels
SMOOTHED=                   -1 / 0 = unsmooth, 1-12 = smoothed, else linear
DETNAM  = 'CCD0    '           / CCD chip
CCLS0001= 'CPF     '           / Class of dataset
CDTP0001= 'DATA    '           / Type of dataset
CVSD0001= '20/02/93'           / UTC date when data becomes valid
CVST0001= '00:00:00'           / UTC time when data becomes valid
CDES0001= 'SISRMGv0.4:1180x1024 S0C0 grds-0234 splt-20 echo-correct'
HDUCLASS= 'OGIP    '           / Format created by the OGIP
HDUCLAS1= 'RESPONSE'           / Dataset assoc with instr response
HDUVERS1= '1.0.0   '           / Version of HDUCLAS1 format
HDUCLAS2= 'EBOUNDS '           / Dataset is a response matrix
HDUVERS2= '1.1.0   '           / Version of HDUCLAS2 format
CCNM0001= 'EBOUNDS '           / Codename for dataset
CBD10001= 'CHAN(1-1024)'       / Channel bounds
CBD20001= 'GRADE("0234")'      / Valid Grades
CBD30001= 'RAWX(216)'          / RAWX CCD position
CBD40001= 'RAWY(212)'          / RAWY CCD position
CBD50001= 'SPLIT(20)'          / Split threshold
CBD60001= 'ECHO(CORRECTED)'    / Echo corrected
COMMENT
COMMENT Ron Zellar (HEASARC) 1994 Jan 05
COMMENT
COMMENT This dataset contains the *nominal* energies of the channel boundaries
COMMENT of the detector redistribution matrix in the MATRIX extension.
COMMENT The SIS sensor number is given in the INSTRUME keyword, and the chip
COMMENT in the DETNAM keyword.
COMMENT NOTE: This dataset does NOT include the effective area of the XRT, and
COMMENT is  only valid for:
COMMENT      the channel range given by the CBD10001 keyword
COMMENT      the SIS 'grades' given by the CBD20001 keyword
COMMENT      the Raw detector coords given by the CBD30001,CBD40001 kywrds
COMMENT      the SIS split threshold level given by the CBD50001 keyword
COMMENT      SIS data which has/has not been 'echo-corrected' as denoted by
COMMENT        the CBD60001 keyword
COMMENT The dataset was created by Geoff Crewe (MIT) 1993 Dec 17 using SISRMG
COMMENT v0.4, using a circular extract cell of 4 arcmin radius.
COMMENT
END
```

5.3 Effective Area File

Finally, here is the header from the effective area file xrt_kunieda930507.ear.

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                13672 / width of table in bytes
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                    5 / number of fields in each row
TTYPE1  = 'ENERG_LO'           / label for field   1
TFORM1  = '100E    '           / data format of the field: 4-byte REAL
TUNIT1  = 'keV     '           / physical unit of field
```

```
TTYPE2  = 'ENERG_HI'           / label for field   2
TFORM2  = '100E    '           / data format of the field: 4-byte REAL
TUNIT2  = 'keV     '           / physical unit of field
TTYPE3  = 'THETA   '           / label for field   3
TFORM3  = '16E     '           / data format of the field: 4-byte REAL
TUNIT3  = 'arcmin  '           / physical unit of field
TTYPE4  = 'PHI     '           / label for field   4
TFORM4  = '2E      '           / data format of the field: 4-byte REAL
TUNIT4  = 'arcmin  '           / physical unit of field
TTYPE5  = 'EFFAREA '           / label for field   5
TFORM5  = '3200E   '           / data format of the field: 4-byte REAL
TUNIT5  = 'cm**2   '           / physical unit of field
HISTORY   This FITS file was created by the FCREATE task.
TELESCOP= 'ASCA    '           / Name of Mission/Telescop
INSTRUME= 'XRT     '           / Name of Instrument
FILTER  = 'NONE    '           / Type of Filter
CCLS0001= 'BCF     '           / OGIP class for this dataset
CCNM0001= 'EFFAREA '           / OGIP codename for this dataset
CDTP0001= 'DATA    '           / OGIP datatype for this dataset
CVSD0001= '01/01/93'           / Date when data becomes valid
CVST0001= '00:00:00'           / Time when data becomes valid
CDES0001= 'XRT Effective Area from Nagoya ray-tracing (version 0.0)' /
CBD10001= 'THETA(0,15,arcmin)'
CBD20001= 'PHI(0,45,deg)'      /
CBD30001= 'ENERG(0.1,10,keV)'
EARVERSN= '1992a   '           / OGIP Clasification of FITS Format
COMMENT   NOTES: 1993 May 13         (Ian M George, HEASARC)
COMMENT   ------------------
COMMENT
COMMENT   This dataset is a FITS version of the results of the ray-tracing
COMMENT   simulations of the Nagoya group, supplied to the HEASARC in ASCII
COMMENT   format by the NASA/GSFC ASCA GOF on 1993 May 11.
COMMENT   Follows is an abridged version of the accompanying text file:
COMMENT
COMMENT             Asuka XRT response functions Ver.0.0
COMMENT
COMMENT   These response functions were made by raytracing simulations
COMMENT   which was accordance with results of only on ground calibration.
COMMENT   But note that these have about 10% error.
COMMENT   Effective area was calculated from photons integrated in 12mm dia.
COMMENT   circle at focal plan., 0.1keV to 10.0keV (0.1keV interval),
COMMENT   and for zenith angle from 0' to 15'(1' interval).
COMMENT
COMMENT   The original ASCII datasets are from satsuki/h1/kunieda/xrt/p000
COMMENT   and satsuki/h1/kunieda/xrt/p045, where p000 and p045 represent phase
COMMENT   angle of off-axis sources. The phase angle is measured from the
COMMENT   boundary of quadrants.
COMMENT
TDIM5   = '(100,16,2)'
END
```