AXAF Science Center

Grating Data Products:
Level 1.5 to ASC Archive Interface Control Document

(`http://space.mit.edu/ASC/docs/ICD_L1.5.ps.gz`)

Revision 1.2—20 Feb 1998

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Document and Change Control Log

Date	Version	Section	Status
23 Dec 97	0.9	all	Initial Draft
3 Feb 98	1.0	all	Revisions as per review by DS
18 Feb 98	1.1	all	Revisions as per comments of AR, JCM, JHK, AD; generic FITS material removed and referenced to ASC FITS document. Added FITS region specifications. Specified HRC columns to drop.
20 Feb 98	1.2	all	Minor edits, as per AR comments. Major changes to REGION section: cast as BINTABLE extension instead of a file. Added TNULL*i* keywords to grating columns as appropriate.

Unresolved Issues

The following is a list of unresolved, un-reviewed, or un-implemented items:

1. 980218: Format and content of summary files is TBD. (page 14)
2. 980218: Changed "_grt" to "_evt1" in filename, in accordance w/ the ASC FITS "content" specifications. (page 4)
3. 980218: Use of TNULL*i* values is new. Is 0 an appropriate NULL value for GDP? (do pixels always start at 1? would -1 be better?) (page 8)
4. 980218: REGION extension specification is new. Definition of region shapes needs review for consistency w/ other definitions in ASC s/w (data-model?). Future use of `ASCII` file TBR: useful implementation of format transported as `FITS`? Coord sys issue: are (RA–TAN,DEC–TAN) coords degrees of arc, or real RA and distorted angles near pole? —affects definition of a "rectangle". (page 11)
5. 980218: Are there any ACIS L1 columns which can be omitted from L1.5? (page 9)
6. 980218: Sample files are needed. (page 16)

Contents

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1 Introduction

This document describes the interface to be employed in transferring the products of grating (HETG, the High Energy Transmission Grating, or LETG, the Low Energy Transmission Grating) obervations Standard Data Processing from the ASC Level 1.5 processing pipeline to the ASC Data Archive, according to the requirements stipulated in the "ASC Data System Requirements" (Applicable Document 3).

Formatting NOTE: Text formatted between horizontal rules (like this block) provide some historical context regarding alternative choices considered, which may still be debated.

Items boxed in the right margin (like this) are questions to be answered or TBD's to be replaced.

1.1 Purpose

TG (generically referring to HETG and LETG Transmission Grating instruments) Level 1.5 processing, described in Applicable Document 3, consists of event processing of HRC or ACIS Level 1 products (which are described in Applicable Documents 8 and 9) to add grating-specific coordinates and associated values. Level 1.5 denotes an intermediate stage between Level 1 (primarily re-formatting and coordinate transformations) and Level 2 (primarily source analysis), since some minimal analysis is necessary on grating observations before coordinate transformations can be done (e.g., source detection). This document describes the *additional* structure and content of the resulting event files and of region and summary files that are generated from Level 1 products during Level 1.5 processing.

1.2 Scope

This interface shall apply to all TG-specific data products that are generated by ASC Level 1.5 pipelines and distributed to the ASC Data Archive (see Applicable Document 3 and the "ASC Data System Software Design," Applicable Document 4) during the course of the AXAF mission.

1.3 Applicable Documents

The Applicable Documents required for background and detail on grating Level 1.5 products are as follows:

1. AXAF Data Products Guide
   `http://hea-www.harvard.edu/asclocal/sds/CDR2/dp.ps`

2. AXAF Coordinate Systems
   `http://hea-www.harvard.edu/~jcm/asc/coords`

3. ASC AMO-2400 (SE03)
   ASC Data System Requirements (ASC.302.93.0008)

4. ASC AMO-2401 (DS01)
   ASC Data System Software Design (ASC.500.93.0006)

5. NOST 100-1.1, Definition of the Flexible Image Transport System (FITS)
   `http://www.cv.nrao.edu/fits/`

6. HEASARC FITS Standards:
   `http://legacy.gsfc.nasa.gov/docs/heasarc/ofwg/docs/summary/ogip_93_001_summary.html`
7. ASC FITS File Designers' Guide
   `http://hea-www.harvard.edu/ãrots/asc/fits/ascfits.ps`
8. HRC Data Products Guide:
   Level 1 to ASC Archive Interface Control Document
   `http://hea-www.harvard.edu/asclocal/sds/ICD/l1icd.ps.gz`
9. ACIS Data Products Guide:
   Level 1 to ASC Archive Interface Control Document
   Link to be on: `http://space.mit.edu/ASC/docs/docs.html`

1.4 Functional Description

1.4.1 Data Content Summary

All TG data sets generated by the Level 1.5 processing pipeline shall consist of data files conforming to the FITS format (Applicable Document 5) and further conforming to HEASARC standards (Applicable Document 6) and the ASC conventions (Applicable Document 7). These files contain header keyword entries and binary table (BINTABLE) extensions. Following rules outlined in Applicable Document 7, all these files will contain a null primary header followed by a main binary table (the "principal HDU") and auxiliary extensions ("auxiliary HDU").

Any other types of files will either be of types in common use (e.g., PostScript), or fully described here (e.g., ASCII region files of IRAF/PROS).

1.4.2 Recipients and Utilization

The primary recipients of TG Level 1.5 data products, via distribution from the archive, are AXAF observers, who will utilize these data products for scientific data analysis. The ASC may also make use of specific Level 1.5 data products for instrument calibration, instrument and/or spacecraft monitoring and trends analysis, and validation and verification of the Level 0, Level 1, and Level 1.5 software and of the data products themselves. Level 1.5 data products will also be used in Level 2 (standard data analysis) pipelines, the products of which will be used for all of the above purposes.

1.4.3 Pertinent Relationships with Other Interfaces

Changes to the definition of HRC or ACIS Level 1 data products, as described in Applicable Documents 8 and 9, may affect the Level 1.5 data products described in the current document.

1.5 Assumptions and Constraints

For each TG science event run reported in the AXAF telemetry stream, Level 1.5 processing shall generate a set of product files as shown in Table 1. The products depend upon possibly time-dependent calibration data for coordinate transformations and region definitions.

The natural subdivision of TG Level 1.5 processing is the Observation Interval (ObI). Each ObI may span several TG science runs, which are the atomic unit of the scientific instrument's telemetry. TG data will therefore be processed by ObI by the Level 1.5 pipeline. The pipeline will accept a list of one or more ObIs and process each independently.

1.6 Products Not Covered

TG Level 1.5 products that are used for maintenance and diagnostic purposes (those that are not supplied to the user for scientific data analysis), or which are generic AXAF Level 1.5 products (those parts of the product which are common to ACIS and HRC Level 1 products), are not currently included within the interface defined by this document.

(980203) Issue: monitoring and trends and V&V may use L1.5 products, or generate new products which are archived. Which ICD for these?

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2 Detailed Interface Specifications

2.1 Labeling and Identification

The data files generated by the Level 1.5 processing pipeline shall be assigned external names as shown in Table 1. The names obey the following convention:

GAS_obi_s_content.`fits`

where *GAS* is a mnemonic specifying the grating, array, and sub-array configuration. *G* can have values of `H` for HETG or `L` for LETG. The detector array, *A*, is specified by `A` for ACIS or `H` for HRC. The sub-array, *S*, may be `S` for spectroscopic array or `I` for imaging. *obi* will uniquely identify the ObI in which the data were taken, *s* is an index specifying the science run number within the ObI, and ***`content`*** specifies the file content (see Table 1). (Valid values for "content" are given by the "ASC EXTNAME/HDUCLASS/CONTENT Dictionary".)

Get link ref for EXTNAME/etc dictionary

DS note: "_grt" changed to "_evt1", since the latter is a defined FITS "content" for Level 1 events.

Title	**File name**
Event data	`*_evt1.fits`
Source regions (if ASCII)	`*.reg`
Level 1.5 summary	`*_sum.ps`

Table 1: *TG Level 1.5 Data Product Files*

Issue: region file type currently in use is ASCII, but will be deprecated in favor of a FITS extension definition.

Issue: Current 5 pipe produces ".ps" summaries, but these may be deferred to Level 2 processing (after merging of ObI's and binning images and spectra) L1.5 summary is then material produced for later collection and formatting, but desireable per ObI for diagnostic inspection.

No additional non-instrument-specific data products are output by the TG Level 1.5 processing pipeline.

2.2 Substructure Definition and Format

The "ASC FITS Designers' Guide" (Applicable Document 7) defines and lists header components for the primary header and for all binary table extensions. Since grating data are always obtained with either the HRC or ACIS detectors, file content is also described in detail by the HRC and ACIS Level 1 Interface Control Documents (Applicable Documents 8 and 9).

2.2.1 Header/Trailer Description Details

Table 2 shows the associated keywords that differ from ACIS or HRC L1 files to specify the TG Level 1.5 products.

```
GRATING = 'HETG    '            / HETG, LETG or NONE
HDUCLASS= 'ASC     '            /
HDUCLAS1= 'EVENTS  '            /
HDUCLAS2= 'ALL     '            /
HDUCLAS3= 'RESOLVED'            / ASC definition for TG coord. events
HDUSPEC = 'Grating Data Products: Level 1.5 ICD, V1.1' / ICD ref.
HDUDOC  = 'ASC-FITS-1.0: McDowell, Rots: ASC FITS Designers Guide' /
```

Table 2: *Level 1.5 - specific FITS Header Keywords*

The binary tables are further described by an extension header that immediately follows the keyword header (since the primary data unit is empty). In the file definition tables that follow, only the associated fields added to the Level 1 products by Level 1.5 processing or which require additional explanation are defined.

2.2.2 Keywords Describing Calibration Data

Resolution of HETGS (HETG + ACIS-S) photons into diffraction orders requires application of the calibration from wavelength to pulse-height (PI, for Pulse-Invariant signal), and information on the distribution of the response. To do this, a special table is read, which was in turn generated from the CCD response matrices (RMFs), for a given fractional enclosed energy. Subsequent processing will require knowledge of this filter, so keywords are stored in the event extension header, as defined in Table 4.

TBD: Need reference ICD for order sorting table.

2.3 Event Data Files (*_evt1.fits)

During Level 1.5 processing, event coordinates undergo several transformations. Given a zero-order centroid in sky coordinates, a region angle, and region width,

```
ACSYS1  = 'ASC-GDP-x.x'         / (optional) grating diffraction pixel coords
TCTYP1  = 'TG_GDPX    '         / Grating Diffraction Pixels
TCRVL1  =                0.0    / Nominal angle
TCRPX1  =            16384.5    / Reference pixel
TCDLT1  = 1.59265544165e-5      / [degrees/pixel]
TDBIN1  = 10                    / default [degrees/bin]
TCUNI1  = 'deg'                 / Unit of GDP
ACSYS2  = 'ASC-GDP-x.x'         / (optional) grating diffraction pixel coords
TCTYP2  = 'TG_GDPY    '         / Grating Diffraction Pixels
TCRVL2  =                0.0    / Nominal angle
TCRPX2  =            16384.5    / Reference pixel
TCDLT2  = 1.59265544165e-5      / [degrees/pixel]
TDBIN2  = 10                    / default [degrees/bin]
TCUNI2  = 'deg'                 / Unit of GDP
```

Table 3: *Special Keywords for TG Columns with coordinate systems. Grating coordinates can be specified either by angle, wavelength, or pixel. The pixel system requires a coordinate system.*

```
COMMENT Order-sorting lookup tables:
COMMENT   Tables of PI_min and PI_max vs E used for order-sorting,
COMMENT   constructed for a specific fractional enclosed probability
COMMENT Reference ICD for file definition is: TBD.
COMMENT
ACISDPIF='acis_fi_95_V0.0.fits'     /delta-PI vs energy table, FI CCD
ACISDPIB='acis_bi_95_V0.0.fits'     /delta-PI vs energy table, BI CCD
```

Table 4: *Special Keywords describing calibration files.*

events within each region are given several new coordinates. Proper interpretation of the spectrum requires consistent selection on several coordinates. For example, a (TG_R, TG_D) image should only be made for a selection on TG_SRCID.

TG_SRCID is the source number, as output from the detection algorithm. This is a small integer, equal or greater than 0 and less than or equal to 10. A TG_SRCID of 0 means background — the photon has not been associated with a detected source. (The maximum of 10 was a compromise between implementation efficiency and a feasible maximum number of sources for a grating observation.)

TG_PART identifies the region of the spectrum of which the photon is a part. This can have only specific values as follows:

- **0:** zero order;
- **1:** HEG part of the spectrum;
- **2:** MEG part;
- **3:** LETG photon;
- **4–7:** LETG/HESF parts of the spectrum;
- **99:** background.

TG_R: diffraction angle, parallel to the dispersion. For an on-axis source, the angle ranges from -0.5 to $+0.5$ degrees for HETGS, and about twice that for LETGS. Offset-pointing can increase the range somewhat.

For background or zero-order photons, TG_R is undefined, and stored as NaN.

TG_D: cross-dispersion (spatial) angle. For an on-axis source, this ranges from about -0.1 to 0.1 degrees for HETGS or LETGS. In practice, it is generally restricted to much less (-0.001 to 0.001 degrees), though in backup modes (e.g., HETG/HRC-I), it could conceivably be as large as 1 degree.

For background or zero-order photons, TG_D is undefined, and stored as NaN.

TG_MLAM: The diffraction order times the wavelength. This can range from about -200Å to 200 Å for on-axis data (LETGS). Off-axis pointing theoretically allows -400 to 400 Å (though with a severe penalty in resolution!)

For background or zero-order photons, TG_MLAM is undefined, and stored as NaN.

TG_M: The diffraction order, if resolved. This is a small integer, practically within -30 to $+30$. The value, 99, however, is used as a flag for "unresolved" or background photons.

For LETGS photons (detector is HRC, TG_PART is 3-7), TG_M will be either $+1$ or -1 (since HRC cannot resolve the orders via a pulse-height).

The physically meaningful geometric limit set by the ACIS-S array with HETG is about ± 62 (defined by 10 keV at maximum offset-pointing).

TG_LAM: Photon wavelength, if resolved.

For LETGS events (TG_PART is 3–7), TG_LAM will be set to the first-order wavelength at that position.

For background or zero-order photons, TG_LAM is undefined, and stored as NaN.

TG_SMAP: Source map. This is a bitmap which matches photons to multiple sources. This is partially redundant with TG_SRCID, but is used in the case of multiple sources observed with HETG in which MEG and HEG parts from different sources cross. Then, if photons cannot be resolved to a specific source (e.g., it could resolve to either of two sources), the bits will indicate which sources it could belong to.

The mapping of the bits to the source ID is TBD.

TBD: specify TG_SMAP bits interpretation

TG_GDPX, TG_GDPY (optional) refer to coordinates in Grating Diffraction Pixels. These are analogous to TG_R and TG_D. They are intermediate coordinates, and optional in L1.5 files.

For background or zero-order photons, TG_GDPX and TG_GDPY are undefined, and stored as 0.

Issue: current implementation uses 0.0 as the value for unresolved real quantities (TG_R, TG_D, TG_MLAM, and TG_LAM). This revision proposes using recognized IEEE NaN values, and the TNULLi keywords. This would make interpretation unambiguous and straightforward. E.g., $TG\_D = 0.0$ is valid, if $TG\_R \neq 0.0$. For pixel coords, 0 is invalid value, since convention has first pixel as 1.

TBD: is 0 a good NULL value for GDP?

TTYPE	TUNIT	TFORM	TLMIN	TLMAX	TDBIN	TNULL	Comment
TG_R	deg	1D | 1E	-2.0	2.0	$1.593E-4$	NaN	diffraction angle
TG_D	deg	1D | 1E	-2.0	2.0	$1.593E-4$	NaN	cross-dispersion angle
TG_MLAM	angstrom	1D | 1E	-400.0	400.0	$2.0E-3$	NaN	$m \times \lambda$
TG_M	1	1I	-62	99	N/A	99	order (m)
TG_LAM	angstrom	1D | 1E	-400	400	$2.0E-3$	NaN	wavelength (λ)
TG_PART	1	1I	0	99	N/A	N/A	component (HEG, MEG, LEG, ...)
TG_SMAP	1	1I	0	32767	N/A	N/A	source map
TG_SRCID	1	1I	0	10	N/A	N/A	source ID
TG_GDPX	pixel	1J	1	2^{16} (65536)	10	0	grating diffraction pixel, dispersion direction (optional)
TG_GDPY	pixel	1J	1	2^{15} (32768)	10	0	grating diffraction pixel, cross-dispersion (optional)

Table 5: *FITS Event Data File binary table contents (one entry per event). "N/A" means "Not Applicable". "NaN" is the IEEE standard for "Not A Number".*

2.3.1 Columns Dropped from Level 1 Files

There are some columns in Level 1 input files which are seldom used, so it is not necessary to carry them into Level 1.5. They will always be available in Level 1 products, if necessary.

TBR

HRC columns to omit:

CRSV
CRSU
AMP_SF
AV1
AV2
AV3
AU1
AU2
AU3
RAWX
RAWY
SUMAMPS

ACIS columns to omit: `TBR`

ACIS deletable columns TBD.

2.4 Grating Spectral Region Definitions (REGION BINTABLE extension or *.reg ASCII file)

For each ObI, one regional mask is created for each source, as defined by the zero-order sky coordinate output from source detection and width and angle parameters. The mask is designed to be of generous dimensions, such that the L1.5 product is a superset of photons likely to be selected for analysis, thus avoiding re-running the L1.5 pipeline for alternate selection criteria. It is defined in sky (X, Y) coordinates and is used to filter the events for transformation to grating diffraction coordinates.

2.4.1 *.reg (ASCII) Region File Definition

The ASCII file is the current implementation and is included here until replaced by the FITS implementation. We should probably keep this anyway, since the FITS file will be a Transport mechanism, and usage may remain ASCII.

Future use of ASCII region file TBR.

get reference for IRAF/PROS regions

The ASCII region file follows the IRAF/PROS Region File definition (ref xxx), with some pipeline directives added in comment fields. The coordinates are given as sky pixel values, whose coordinate system can be obtained from the event-file's (*_evt1.fits) extension header keywords for columns labeled X and Y.

- The first line of the *.reg file contains a comment line of the format #.mode where mode is HETG, LETG, DRAKE, HEG, or MEG. Note that the modes HEG and MEG are special, in that one cannot observe in flight with them separately; they are for special processing purposes of ground-calibration data, simulations, or specially filtered flight data.
- The second line of the file contains a comment line of the format ``#.SRC n'' where n is the current source id.
- For any given source, a maximum of 8 distinct parts (neglecting background) exist. These parts are: zero order, heg arm, meg arm, letg, drake 1, drake 2, drake 3, and drake 4. For any given source, not all of these parts will be listed.
- Relevant parts of a source are listed one per line. The ordering of the parts depends on the type of data The parts for each mode are, in region-file line order:

HETG	1—	Zero-order
	2—	HEG
	3—	MEG
LETG	1—	Zero-order
	2—	LEG
DRAKE (HESF)	1—	Zero-order
	2—	LEG
	3—	Drake 1
	4—	Drake 2
	5—	Drake 3
	6—	Drake 4
HEG	1—	Zero-order
	2—	HEG
MEG	1—	Zero-order
	2—	MEG

- Parts that belong to a source are identified as follows:

  `physical; <format> ;`

  where `<format>` is any of the following:

  BOX `xcenter ycenter xwidth yheight [angle]`

  CIRCLE `xcenter ycenter radius`

  ROTBOX `xcenter ycenter xwidth yheight angle`

- abbreviations `b, c,` or `r` may also be used for `BOX, CIRCLE,` and `ROTBOX`, respectively.
- blank lines are ignored; they may be used to make the `*.reg` more readable to users, but are not used by the code.
- a separate source comment line (e.g. `#.SRC 3`) must be supplied before each source included in the region file. A region file may specify multiple sources.
- `ASCII` characters may be in upper or lowercase.
- Lines beginning with "`#.`" are processed as instructions by Level 1.5 software. They are treated as normal comments by other region parsers.
- Lines starting with a "`#`" and succeeded by any other characters other than "`.`" are considered comments.

Example — A single HETG source, source ID of 1:

```
#.HETG
#.SRC 1
physical; circle 3200 3200 70;
physical; rotbox 3200 3200 3300 119 -5.3d;
physical; rotbox 3200 3200 3300 119 5.00d;
```

Example — Two LETG sources, source IDs of 2 and 4:

```
#.LETG
#.SRC 2
physical; c 2000, 2000, 100;
physical; box 2000, 2000 2000 140;

#.SRC 4
physical; c 4000, 4000, 100;
physical; box 4000, 4000 3500 150;
```

2.4.2 FITS Region Extension Definition

Issue: 980218 new specification.

The generic definition of an ASC FITS region is given in the "ASC FITS File Designers' Guide" (Applicable Document 7. The region HDU will be a single `REGION` auxiliary extension, whose header is comprised of the mandatory `REGION`-content header, table coordinate system and ranges, short configuration control, short timing, and short observation information components. The components which differ substantially from the event file's other extensions (events, GTI) are the mandatory `REGION` keywords, and the table coordinate system. A region specification is in general specific to the ObI.

The `REGION` definition for Level 1.5 spectral mask are comprised of components described by a circle for zero-order and rotated rectangles for diffracted orders. There are generally multiple components for each spectrum and possibly multiple sources per observation.

Radius coord keywords TBR. What is RA–TAN? i.e., is a rectangle still a rectangle near the pole?

The conditional interpretation of the `COMPONENT` upon `GRATING` value is shown in Table 8.

The interpretation of the coordinate vectors for grating region shapes, as given in the "ASC FITS File Designers' Guide" (Applicable Document 7) is:

`CIRCLE:` First element of X, Y, R vectors specifies center and radius.

`ROTBOX:` First two element of X and Y vectors specify bottom-left and upper-right corners of a rectangle. The first element of `ROTANG` specifies counter-clockwise rotation of the rectangle with respect to X and Y axese center of the rotation about the lower-left corner.

Issue: these definitions differ from syntax of ASCII regions, which specify center of box, widths of box, and rotation about box center.

2.4.3 Example: Full Region Extension Header

TBS.

```
EXTNAME = 'REGION  '            / Region specification table
CONTENT = 'REGION  '
HDUCLASS= 'ASC     '
HDUCLAS1= 'REGION  '
HDUCLAS2= 'STANDARD'
MTYPE1  = 'pos     '
MFORM1  = 'X,Y     '
TCTYP2  = 'RA--TAN '            / sky X WCS
TCRVL2  =                0.0    / Nominal angle
TCRPX2  =            16384.5    / Reference pixel
TCDLT2  = 1.59265544165e-5      / [degrees/pixel]
TDBIN2  = 10                    / default [degrees/bin]
TCUNI2  = 'deg'                 / Unit of X
--------------------------------------------------------------------
TCTYP3  = 'DEC--TAN '           / Sky Y WCS
TCRVL3  =                0.0    / Nominal angle
TCRPX3  =            16384.5    / Reference pixel
TCDLT3  = 1.59265544165e-5      / [degrees/pixel]
TDBIN3  = 10                    / default [degrees/bin]
TCUNI3  = 'deg'                 / Unit of Y
--------------------------------------------------------------------
TCTYP4  = 'TBS      '           / Sky XY WCS - for a radius value
TCDLT4  = 1.59265544165e-5      / [degrees/pixel]
TDBIN4  = 10                    / default [degrees/bin]
TCUNI4  = 'deg'                 / Unit of radius
```

Table 6: *Special Keywords for grating* `REGION` *FITS File. region coordinates are specified in terms of sky* (X, Y)*, so that coordinate system must be specified.*

TTYPE	TUNIT	TFORM	TLMIN	TLMAX	Comment
SHAPE	-	16A	-	-	Shape of region: may be CIRCLE or ROTBOX.
X	pixel	12J|12E|12D	0	65536	sky X (RA) coordinate vector for SHAPE.
Y	pixel	12J|12E|12D	0	65536	sky Y (Dec) coordinate vector for SHAPE.
R	pixel	12J|12E|12D	0	65536	radius vector for SHAPE (sky units)
ROTANG	deg	12J|12E|12D	0	360	Rotation angle for SHAPE, in degrees.
COMPONENT	-	I	1	6	Component number that SHAPE belongs to (default is 1). Interpretation of this depends upon the GRATING column.
INCLUDE	-	I	0	1	Inclusion (1; default) or exclusion (0).
SOURCE	-	I	0	10	Source number.
GRATING	-	16A	-	-	Applicable grating; one of: HETG or LETG

Table 7: *FITS grating region file binary table contents.*

GRATING	COMPONENT	Meaning
HETG	1	Zero-order
	2	HEG arm
	3	MEG arm
LETG	1	Zero-order
	2	LEG arm
	3	HESF (Drake Flat) region 1
	4	HESF (Drake Flat) region 2
	5	HESF (Drake Flat) region 3
	6	HESF (Drake Flat) region 4

Table 8: *Region table component interpretation.*

2.5 Level 1.5 Summary File

Note: Summary file definition very preliminary.
Summary should be hardcopy (i.e., postscript) graphs, images, and tables.
Graphs and images should also be written as GIF files (TBR), wrapped in HTML interface with ASCII tables and text.
Postscript version (TBR) should be gzipped.
Summary tables also provided as FITS bintables?

Since Level 1.5 processing has added columns to the data, but not yet merged ObIs, binned events into images, light curves, or spectra, nor performed any measurements of the data, Level 1.5 summary will consist of a statistical summary and diagnostic observational parameters.

L1.5 processing summary parameters:

sources, source table, roll_tolerance

Observational parameters:

elapsed time, total good time, roll range

Order summary:

Field Summary		
	rate	counts
Total:	`0.0E-00`	`0.0E+00`
Background:	`0.0E-00`	`0.0E+00`

Source Summary: HETG/ACIS-S		
	rate	counts
Zero-order	0.00	0.00
$HEG+$	0.00	0.00
$HEG-$	0.00	0.00
$MEG+$	0.00	0.00
$MEG-$	0.00	0.00
$HEG+1$	0.00	0.00
$HEG-1$	0.00	0.00
$HEG+2$	0.00	0.00
$HEG-2$	0.00	0.00
$HEG+3$	0.00	0.00
$HEG-3$	0.00	0.00
$MEG+1$	0.00	0.00
$MEG-1$	0.00	0.00
$MEG+2$	0.00	0.00
$MEG-2$	0.00	0.00
$MEG+3$	0.00	0.00
$MEG-3$	0.00	0.00

Source Summary: LETG/HRC-S		
	rate	counts
Zero-order	0.00	0.00
$LEG+$	0.00	0.00
$LEG-$	0.00	0.00
$HESF+$	0.00	0.00
$HESF-$	0.00	0.00

Source Summary: LETG/ACIS-S		
	rate	counts
Zero-order	0.00	0.00
$LEG+$	0.00	0.00
$LEG-$	0.00	0.00
$LEG+1$	0.00	0.00
$LEG-1$	0.00	0.00
$LEG+2$	0.00	0.00
$LEG-2$	0.00	0.00
$LEG+3$	0.00	0.00
$LEG-3$	0.00	0.00

Source Summary: HETG/HRC-I		
	rate	counts
Zero-order	0.00	0.00
$HEG+$	0.00	0.00
$HEG-$	0.00	0.00
$MEG+$	0.00	0.00
$MEG-$	0.00	0.00

2.6 Volume, Size, and Frequency Estimates

TBD

3 Example Files

```
TBS: HETG/ACIS-S 2 src FITS events, region, summary
     LETG/HRC_S 2 src
     LETG/HESF TBD.
```