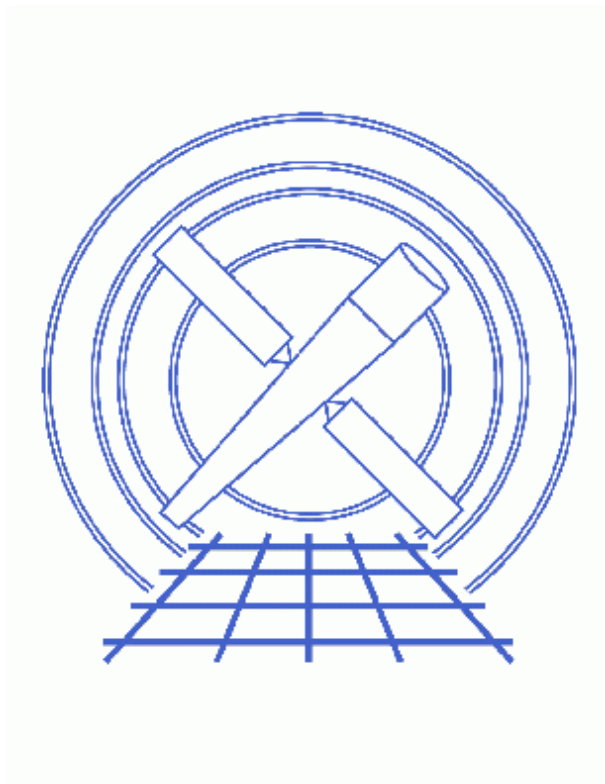


# Obtain Grating Spectra from LETG/HRC-S Data



## ***CIAO 3.4 Science Threads***

# Table of Contents

- **Background Information**
- **Data Preparation**
- **Get Started**
- **Generate A New Level=1.5 Event File**
  1. Get position of zero-order image (tgdetect)
  2. Get region mask (tg\_create\_mask)
  3. Run tg\_resolve\_events
- **Generate A New Level=2 Event File**
  1. Apply background filter (dmcopy)
  2. Filter on status (dmcopy)
  3. Apply GTI filter (dmcopy)
- **Extract a Grating Spectrum (tgextract)**
- **Summary**
- **Parameter files:**
  - ◆ tgdetect
  - ◆ tg\_create\_mask
  - ◆ tg\_resolve\_events
  - ◆ tgextract
- **History**
- **Images**
  - ◆ Image with region file overlaid

# Obtain Grating Spectra from LETG/HRC–S Data

*CIAO 3.4 Science Threads*

## Overview

**Last Update:** 1 Dec 2006 – updated for CIAO 3.4: change to wording of `tgdetect/dmcopy` warning

### **Synopsis:**

Generate a new PHA2 spectrum file for any LETG/HRC–S grating observation.

### **Purpose:**

To ensure that consistent calibration is used throughout the analysis.

### **Read this thread if:**

you are working with an LETG/HRC–S dataset affected by the [Calibration Updates](#).

### **Calibration Updates:**

[Get Started](#) shows how to check the software version used in processing your data.

As of DS 7.6 (31 May 2004), the bow–tie region from the CALDB is used by `tgextract`. Data taken before this date should be reprocessed to apply the region file.

Two major problems in the processing of LETG/HRC–S data were identified in May 2001; see the [Background Information](#) section for details. Both were fixed in the DS 6.1.0 software release, which has been in use since 02 July 2001.

### **Related Links:**

- [Analysis Guide for Chandra High Resolution Spectroscopy](#): an in–depth discussion of grating analysis.

**Proceed to the [HTML](#) or *hardcopy* (PDF: [A4](#) / [letter](#)) version of the thread.**

---

## Background Information

A description of the problems:

- The background regions that go with the LETG "bowtie" spectral extraction are chopped off (in the cross-dispersion direction) beyond about 120 Angstroms because of an incorrectly set parameter in `tg_create_mask`. This error occurs between level 1.0 and 1.5 (the Get region mask step) and results in incomplete background subtraction at long wavelengths.
- The HRC "PHA ratio test", corresponding to bit 21 in the status field, removes a large fraction of valid x-ray events. This test is applied between level 1.5 and level 2 in the pipeline (the Filter on status step).

The LETG and HRC-S data processing problems page contains more detailed information.

---

## Data Preparation

This analysis thread starts with the level 1 event file. Before beginning, users may wish to reprocess the data to create a new event file with the most recent calibration applied. Instructions on how to reprocess your data are available in the HRC Data Preparation Analysis Guide.

---

## Get Started

*Sample ObsID used:* 460 (LETG/HRC-S, 3C 273)

*File types needed:* evt1; flt1; asol1

In this thread, we assume that all relevant files are in the same working directory.

Check the ASCDSVER keyword in the header:

```
unix% dmkeypar hrcf00460_000N004_evt1.fits ASCDSVER echo+
6.5.1
```

Since this data was processed with an ASCDSVER lower than DS 7.6, we need to complete this thread in its entirety. Note that the version naming convention changed after version R4CU5UPD14 to the "DS" system, starting with DS 6.0.0.

If your data were processed with standard data processing (SDP) version DS 7.6 or higher, it is only necessary to run this thread if you wish to apply a background filter.

---

## Generate A New Level=1.5 Event File

## 1. Get position of zero-order image (tgdetect)

To find the zero-order location, the tool `tgdetect` is run:

```
unix% punlearn tgdetect
unix% pset tgdetect infile=hrcf00460_000N004_evt1.fits
unix% pset tgdetect outfile=hrc_460_evt1_srcla.fits
unix% tgdetect
Input L1 event file (hrcf00460_000N004_evt1.fits):
Input source position(s) file from previous OBI or NONE (NONE):
Output source position(s) file name (hrc_460_evt1_srcla.fits):
# DMCOPY (CIAO 3.4): Bad data type in filter string formatting
```

The warning may be ignored; it is due to a minor bug in the Data Model and does not affect the output of `tgdetect`.

The contents of the parameter file may be checked using `plist tgdetect`.

The source list may be viewed over the event file using `ds9`:

```
unix% ds9 hrcf00460_000N004_evt1.fits &
```

Overlay the source list: Region-> Load Regions-> hrc\_460\_evt1\_srcla.fits[SRCLIST].

If the zero order of the source is outside of the default search area (e.g. far from the aimpoint), `tgdetect` will not find it. ***If this problem affects your data, it will be obvious when the source list is displayed on the event file.*** In this case, run the [Correcting a Misplaced Zero-order Source Position thread](#) to identify the correct source position.

## 2. Get region mask (tg\_create\_mask)

The location of the spectrum needs to be found next, via the tool `tg_create_mask`, which creates a region file that will be used to mask the image.

```
unix% punlearn tg_create_mask
unix% pset tg_create_mask infile=hrcf00460_000N004_evt1.fits
unix% pset tg_create_mask outfile=hrc_460_evt1_L1a.fits
unix% pset tg_create_mask input_pos_tab=hrc_460_evt1_srcla.fits
unix% tg_create_mask
Input event file or stack (hrcf00460_000N004_evt1.fits):
Output region file or stack (hrc_460_evt1_L1a.fits):
Input table with zero order positions or stack (hrc_460_evt1_srcla.fits):
Observed grating type (header_value|HETG|HEG|MEG|LETG) (HETG|HEG|MEG|LETG|header_value|HEADER_VALUE)
```

The contents of the parameter file may be checked using `plist tg_create_mask`.

## 3. Run tg\_resolve\_events

The tool `tg_resolve_events` is now used to assign grating events to spectral orders:

```
unix% punlearn tg_resolve_events
unix% pset tg_resolve_events infile=hrcf00460_000N004_evt1.fits
unix% pset tg_resolve_events outfile=hrc_460_evt1a.fits
unix% pset tg_resolve_events regionfile=hrc_460_evt1_L1a.fits
```

## Obtain Grating Spectra from LETG/HRC-S Data – CIAO 3.4

```
unix% pset tg_resolve_events acaofffile=pcadf063792009N003_asol1.fits
unix% pset tg_resolve_events eventdef=")stdlev1_HRC"
unix% pset tg_resolve_events osipfile=none
unix% tg_resolve_events
Input event file or stack (hrcf00460_000N004_evt1.fits):
Input region file or stack (hrc_460_evt1_L1a.fits):
Output event file or stack (hrc_460_evt1a.fits):
Input aspect offset file (pcadf063792009N003_asol1.fits):
```


It is important to note several things here:

- In some cases there will be more than one `asol1.fits` file for an observation. *All* the files must be input to the `acaofffile` parameter *in chronological order* (the time is in the filename, so "ls" lists them in order), either as a comma-separated list or as a stack (see [ahelp\\_stack](#) for more information).
- The unusual syntax of the `eventdef` parameter; the tool will not access the predefined string if the leading ")" is missing.

The contents of the parameter file may be checked using `plist tg_resolve_events`.

The created region file, which has been appended to the event file as a block, may be viewed over the event file using `ds9`:

```
unix% ds9 hrc_460_evt1a.fits &
```

Overlay the region file that was created by `tg_create_mask` (Region-> Load Regions-> `hrc_460_evt1a.fits[REGION]`) and you should see something like [Figure 1](#) .

---

## Generate A New Level=2 Event File

### 1. Apply background filter (dmcopy)

There are three HRC-S background filtering regions – "light" (`letgD1999-07-22pireg075_N0001.fits`), "medium" (`letgD1999-07-22pireg062_N0001.fits`), and "heavy" (`letgD1999-07-22pireg046_N0001.fits`). The "heavy" PI filter removes more than the advertised fraction of valid x-ray events at long wavelengths and should not be used to create publishable spectra (see the [Filtering Errors](#) page for more information); "light" and "medium" PI filtering are still valid, *with "light" (again, `letgD1999-07-22pireg075_N0001.fits`) being preferred.*

Which of these you decide to use depends on how much X-ray loss you are willing to accept in exchange for a lower background count rate. In this example, we choose the recommended region to filter out a "light" (50–70%) amount of the background. In addition, we apply a filter in PHA space to eliminate about 25% of the background within the near-0th-order region, with no X-ray losses; see [this FAQ](#). The [LETG/HRC-S Background Filtering with CIAO](#) webpage has detailed information on both these issues.

```
unix% punlearn dmcopy
unix% dmcopy \
    "hrc_460_evt1a.fits[EVENTS][pha=0:254,(tg_lam,pi)=region($CALDB/data/chandra/hrc/bcf/tgmask2/letgD19
    hrc_460_back_evt1a.fits opt=all
```

## 2. Filter on status (dmcopy)

We need to apply the status filter that is specific to HRC-S observations; a value of 0 demands that the bit be flagged as "good", a value of x indicates that either status (0/1) is acceptable. The filter has been changed so that it *does not* filter on status bit 21 (the HRC "PHA ratio test" bit):

```
unix% punlearn dmcopy
unix% dmcopy "hrc_460_back_evt1a.fits[status=xxxxxx00xxxx0xxx0000x000x00000xx]" \
  hrc_460_flt1_evt1a.fits opt=all
```

## 3. Apply GTI filter (dmcopy)

The Good Time Intervals (GTIs) supplied by the pipeline now need to be applied:

```
unix% punlearn dmcopy
unix% dmcopy \
  "hrc_460_flt1_evt1a.fits[EVENTS][@hrcf00460_000N004_std_flt1.fits]" \
  hrc_460_evt2.fits opt=all
```

Be sure to include the @ *symbol* in the filter expression; the command will not be executed properly if it is omitted.

## Extract a Grating Spectrum (tgextract)

The CIAO tool tgextract produces a PHA2 spectrum file from the level=2 data file:

```
unix% punlearn tgextract
unix% pset tgextract infile=hrc_460_evt2.fits
unix% pset tgextract outfile=hrc_460_pha2.fits
unix% pset tgextract inregion_file=CALDB
unix% tgextract
Input event file (output event file from L1.5 processing) (hrc_460_evt2.fits):
If typeII, enter full output file name or '.'; if typeI, enter output rootname (hrc_460_pha2.fits):
Input ancillary response file name (none):
Input redistribution file name (none):
Source ID's to process: 'all', comma list, @file (all):
Grating parts to process: HETG, HEG, MEG, LETG, header_value (HETG|HEG|MEG|LETG|header_value) (head
Grating diffraction orders to process: 'default', comma list, range list, @file (default):
Output file type: typeI (single spectrum) or typeII (multiple spectra) (pha_typeI|pha_typeII) (pha_ty
```

The inregion\_file needs to be set to "CALDB" (instead of the default value "NONE") so that the special bow-tie extraction region used with HRC-S/LETG observations is picked up. Note that this file *is not* the same as the grating mask file produced by tg\_create\_mask; it must be in diffraction coordinates, whereas the other is in sky coordinates.

The contents of the parameter file may be checked using plist tgextract.

## Summary

This thread is now complete; the PHA2 grating spectrum file is named `hrc_460_pha2.fits`. You should now proceed to the [Create Grating RMFs for HRC Observations](#) thread.

---

Parameters for `/home/username/cxcds_param/tgdetect.par`

```
##
## TGDETECT -- Create filter; run celldetect; narrow down detected
##           'zero order' source list; set source id's; match
##           sources to previous OBI source list.
##
## Note: if either "infile" or "OBI_srclist_file" are @lists, only
## the first item on the list is read in; this tool only works on
## one set of input files; if more than one file is listed,
## everything but the first are ignored.
##
      infile = hrcf00460_000N004_evt1.fits      Input L1 event file
OBI_srclist_file = NONE                        Input source position(s) file from previous OBI or NONE
      outfile = hrc_460_evt1_srcla.fits Output source position(s) file name
#
# output file naming
#
      (temproot = )                            Path and root file name to be given to temporary files
      (keeptemp = no)                           Keep temporary files?
      (keepexit = no)                          Keep exit status file?
#
#
#
      (zo_pos_x = default)                      Center GZO filter sky X position (default=pixel(ra_nom))
      (zo_pos_y = default)                      Center GZO filter sky Y position (default=pixel(dec_nom))
      (zo_sz_filt_x = default)                  Size of GZO filter in X pixels (ACIS=400; HRC=1800)
      (zo_sz_filt_y = default)                  Size of GZO filter in Y pixels (ACIS=400; HRC=1800)
      (snr_thresh = 40)                         SNR threshold to select the detected sources
#
# celldetect parameters
#
      (expstk = none)                           list of exposure map files
      (thresh = )celldetect.thresh -> 3) celldetect source threshold
      (ellsigma = 3.0)                          Size of output source ellipses (in sigmas)
      (expratio = 0)                             cutoff ratio for source cell exposure variation
      (findpeaks = yes)                          find local peaks for celldetect
      (celldetect_log = )celldetect.log -> no) make a celldetect log file?
      (psftable = )celldetect.psftable -> /soft/ciao/data/psfsize20010416.fits) table of PSF size data, for
      (fixedcell = 15)                          celldetect fixed cell size to use
      (fixedcell_cc_mode = 15)                  celldetect fixed cell size to use for CC mode ACIS data
      (bkgfile = none)                          background file, for celldetect
      (bkgvalue = )celldetect.bkgvalue -> 0) background count/pixel, for celldetect
      (bkgerrvalue = )celldetect.bkgerrvalue -> 0) background error, for celldetect
      (eband = )celldetect.eband -> 1.4967) energy band, for celldetect
      (eenergy = )celldetect.eenergy -> 0.8) encircled energy of PSF, for celldetect
      (snrfile = none)                          celldetect snr output file (for convolution only)
      (convolve = )celldetect.convolve -> no) use convolutions for celldetect
      (xoffset = INDEF)                         celldetect offset of x axis from optical axis
      (yoffset = INDEF)                         celldetect offset of y axis from optical axis
```



## Obtain Grating Spectra from LETG/HRC-S Data – CIAO 3.4

```

(cellfile = none)          output cell size image file
(centroid = yes)          compute source centroids in celldetection?
#
#   tgidselectsrc parameters
#
(snr_ratio_limit = )tgidselectsrc.snr_ratio_limit -> 1) Value of SNR ratio to use as lower limit
(setsrcid = )tgidselectsrc.setsrcid -> yes) Set src ids in output file?
#
#   tgmatchsrc parameters
#
(max_separation = )tgmatchsrc.max_separation -> 3) Maximum allowed separation (arcsec) for sources t
#
#
(clobber = no)            OK to overwrite existing output file(s)?
(verbose = 0)             Verbosity level (0 = no display)
(mode = ql)

```

---

Parameters for /home/username/cxcds\_param/tg\_create\_mask.par

```

##
## TG_CREATE_MASK -- Calculates the mask regions of the grating arms
##   for AXAF flight L1 grating data files.  The output is a region
##   file(s) in sky coordinates.
##
    infile = hrcf00460_000N004_evt1.fits   Input event file or stack
    outfile = hrc_460_evt1_L1a.fits Output region file or stack
input_pos_tab = hrc_460_evt1_srcla.fits Input table with zero order positions or stack
grating_obs = header_value   Observed grating type (header_value|HETG|HEG|MEG|LETG)
sA_zero_x = 1                Source A - x position of zero order
sA_zero_y = 1                Source A - y position of zero order
sB_zero_x = 1                Source B - x position of zero order
sB_zero_y = 1                Source B - y position of zero order
sC_zero_x = 1                Source C - x position of zero order
sC_zero_y = 1                Source C - y position of zero order
sD_zero_x = 1                Source D - x position of zero order
sD_zero_y = 1                Source D - y position of zero order
sE_zero_x = 1                Source E - x position of zero order
sE_zero_y = 1                Source E - y position of zero order
sF_zero_x = 1                Source F - x position of zero order
sF_zero_y = 1                Source F - y position of zero order
sG_zero_x = 1                Source G - x position of zero order
sG_zero_y = 1                Source G - y position of zero order
sH_zero_x = 1                Source H - x position of zero order
sH_zero_y = 1                Source H - y position of zero order
sI_zero_x = 1                Source I - x position of zero order
sI_zero_y = 1                Source I - y position of zero order
sJ_zero_x = 1                Source J - x position of zero order
sJ_zero_y = 1                Source J - y position of zero order
(input_psf_tab = CALDB)      Calibration file with mirror psf vs off-axis angle
(detector = header_value)    Detector type: ACIS | HRC-I | HRC-S | header_value
(radius_factor_zero = 50)    A scale factor which multiplies the app. calculation of the c
(width_factor_hetg = 35)     A scale factor which multiplies the one-sigma width of the hetg
(width_factor_letg = 40)     A scale factor which multiplies the one-sigma width of the letg
(r_astig_max_hetg = 0.5600000000000001) Max grating r coord (deg, along the dispersion) for HETG astigm
(r_astig_max_letg = 1.1)     Max grating r coord (deg, along the dispersion) for LETG astigm
(r_mask_max_hetg = 0.992)    Max grating r coord (deg) for HETG mask (to support offset point
(r_mask_max_letg = 2.1)     Max grating r coordinate (deg) for LETG mask (to support offset

```

## Obtain Grating Spectra from LETG/HRC-S Data – CIAO 3.4

```
# -----
# The parameters below are to be set ONLY if the user wants to use their
# own grating mask sizes instead of having the masks automatically generated.
# Only ONE input file, with up to 10 sources, can be processed using the user
# params. @ lists of multiple files can only be done with automated mask
# processing, or by running each file individually with hand set mask sizes.
# To start, you MUST set the following parameters:
#
# > pset tg_create_mask use_user_pars=yes last_source_toread=[letter A -> J]
#
# The parameter last_source_toread should be set to the last source letter
# for which you will enter parameters. If you want to input 2 sources
# (regardless of their source id's), the last_source_toread=B. Sections
# A -> J are for (upto) 10 user specified sources. In each sections,
# each source must have an ID, a zero order center position specified,
# as well as the grating mask width(s). An example with 2 HETG sources,
# with src_id's 6 and 3:
#
# > pset tg_create_mask use_user_pars=yes last_source_toread=B
# > pset tg_create_mask sA_id=6 sA_zero_x=4762.34 sA_zero_y=2344.29
# > pset tg_create_mask sA_zero_rad=35 sA_width_heg=25 sA_width_meg=28
# > pset tg_create_mask sB_id=3 sB_zero_x=4063.54 sB_zero_y=6346.62
# > pset tg_create_mask sB_zero_rad=45 sB_width_heg=50 sB_width_meg=75
#
#           (units are all in sky pixels)
#
# NOTE: for Continuous Clocking data (CC mode), the HETG mask does not
# require the s#_width_heg, since the meg mask will encompass the entire
# data set. HEG event processing in CC mode is done using the next
# tool tg_resolve_events.
# -----
(use_user_pars = no)           Use the user defined mask parameters below: yes or no?
(last_source_toread = A)      Last source name to be read; character A->J.
# -----
#                               Source A parameters
# -----
(sA_id = 1)                   Source A - source id number
(sA_zero_rad = )              Source A - radius of zero order mask
(sA_width_heg = )             Source A - width of heg mask in sky pixels
(sA_width_meg = )             Source A - width of meg mask in sky pixels
(sA_width_leg = )             Source A - width of leg mask in sky pixels
# -----
#                               Source B parameters
# -----
..(through Source J)..
  (geompar = geom)            Parameter file for Pixlib Geometry files
  (verbose = 0)                Verbose level: 0 - no output, 5 - max verbosity
  (clobber = no)               Clobber existing outfile?
  (mode = ql)
```

---

Parameters for /home/username/cxcds\_param/tg\_resolve\_events.par

```
#-----
#
#   tg_resolve_events.par: Parameter file for the tg_resolve_events program
#
#-----
infile = hrcf00460_000N004_evt1.fits   Input event file or stack
```

## Obtain Grating Spectra from LETG/HRC-S Data – CIAO 3.4

```

    outfile = hrc_460_evt1a.fits    Output event file or stack
    regionfile = hrc_460_evt1_L1a.fits Input region file or stack
    acaofffile = pcadf063792009N003_asoll.fits Input aspect offset file
(alignmentfile = )acaofffile -> pcadf063792009N003_asoll.fits) Input sim offset file
    (logfile = stdout)            Output log (NONE|<filename>|stdout)
# The osipfile contains position dependent energy limits based on
# the CCD resolution, used for order-sorting.
# A value of "NONE" means that the file will not be used, and
# that the parameters, osort_hi and osort_lo will be used.
    (osipfile = none)            Lookup table for order resolving (for acis data only)
#sort_hi, osort_lo specify fractional deviations from the integer
#order which will be included in order-sorting via CCD ENERGY values (PHA).
#eg. osort_lo=0.3, osort_hi=0.2 means that photons with real-valued
#orders between 0.7 < order <= 1.2 will be included in first order,
#1.7 < order <= 2.2 will be second order, etc.
    (osort_lo = 0.3)            Order-sorting lower bound fraction; order > m - osort_lo
    (osort_hi = 0.3)            Order-sorting high bound fraction; order <= m + osort_hi
    (grating_obs = header_value) Observed grating type (header_value|HETG|HEG|MEG|LETG)
    (detector = header_value)   Detector type: ACIS | HRC-I | HRC-S | header_value
    (energy_lo_adj = 1.0)       Lower Energy limit factor
    (energy_hi_adj = 1.0)       Upper Energy limit factor
    (time_offset = 0)           Offset to add to event time to synch w/ alignment data
    (rand_seed = 1)             Random seed (for pixlib), 0 = use time dependent seed
    (rand_pix_size = 0.0)       pixel randomization width (-size..+size), 0.0 = no randomization
    (eventdef = )stdlev1_HRC -> {d:time,f:rd,s:chip,l:tdet,f:det,f:sky,s:chip_id,s:pha,s:pi,s:tg_m,
f:tg_lam,f:tg_mlam,s:tg_srcid,s:tg_part,s:tg_smap,x:status}) Output format definition
    (stdlev1 = )eventdef -> {d:time,f:rd,s:chip,l:tdet,f:det,f:sky,s:chip_id,s:pha,s:pi,s:tg_m,
f:tg_lam,f:tg_mlam,s:tg_srcid,s:tg_part,s:tg_smap,x:status})
    (stdlev1_ACIS = {d:time,i:expno,f:rd,s:chip,s:tdet,f:det,f:sky,s:ccd_id,l:pha,s:pi,f:energy,s:grade
s:fltgrade,s:node_id,s:tg_m,f:tg_lam,f:tg_mlam,s:tg_srcid,s:tg_part,s:tg_smap,x:status})
ACIS event format definition string
    (stdlev1_HRC = {d:time,f:rd,s:chip,l:tdet,f:det,f:sky,s:chip_id,s:pha,s:pi,s:tg_m,f:tg_lam,f:tg_ml
s:tg_srcid,s:tg_part,s:tg_smap,x:status}) HRC event format definition string
# -----
    (geompar = geom)            Parameter file for Pixlib Geometry files
    (verbose = 0)               Verbosity level of detail (0=none, 5=most)
    (clobber = no)              Clobber outfile if it already exists?
    (mode = ql)

```

---

Parameters for /home/username/cxcds\_param/tgextract.par

```

##
## TGEXTRACT -- create 1D spectrum(a) table file(s) from the
##           L1.5 output event list
##
    infile = hrc_460_evt2.fits    Input event file (output event file from L1.5 processing)
    outfile = hrc_460_pha2.fits   If typeII, enter full output file name or '.'; if typeI, enter
#
# tg_srcid_list parameter explanation...
# - "all" will process all the sources id's found in the event list
# - a comma list is a comma separated string list of all the
#   sources to process, ie:
#     "1,2,5,7"
# - @file is a pointer to an ascii file which contains a comma
#   separated list of the id's to process
#
    tg_srcid_list = all           Source ID's to process: 'all', comma list, @file

```

## Obtain Grating Spectra from LETG/HRC-S Data – CIAO 3.4

```
tg_part_list = header_value      Grating parts to process: HETG, HEG, MEG, LETG, header_value
#
# tg_order_list parameter explanation...
# - "default" is set to process the following:
#   if ACIS:  1, 2, 3, -1, -2, -3
#   if HRC:   -1, 1
# - a comma list is a comma separated string list of the orders
#   the user wants to process, ie:
#   "-5, -1, 1, 3"
# - a range list sets the min and max of the orders to process;
#   all the orders in between, will be processed, ie:
#   "-1..5" will do orders from -1 to +5th order
#   a range list can be mixed with comma separated list
# - @file is a pointer to an ascii file which contains a comma
#   separated list and/or range list of the orders to process
#
tg_order_list = default          Grating diffraction orders to process: 'default', comma list, range list
  ancfile = none                Input ancillary response file name
  respfile = none               Input redistribution file name
  outfile_type = pha_typeII      Ouput file type: typeI (single spectrum) or typeII (multiple spectra)
(inregion_file = CALDB)         Input region file.
  (backfile = none)             Input background file name
  (rowid = )                    If rowid column is to be filled in, enter name here
  (bin_units = angstrom)        Bin units (for bin parameters below): angstrom, eV, keV
  (min_bin_leg = compute)       Minimum dispersion coordinate for LEG, or 'compute'
  (max_bin_leg = compute)       Maximum dispersion coordinate for LEG, or 'compute'
  (bin_size_leg = compute)      Bin size for binning LEG spectra, or 'compute'
  (num_bins_leg = compute)      Number of bins for the output LEG spectra, 'compute'
  (min_bin_meg = compute)       Minimum dispersion coordinate for MEG, or 'compute'
  (max_bin_meg = compute)       Maximum dispersion coordinate for MEG, or 'compute'
  (bin_size_meg = compute)      Bin size for binning MEG spectra, or 'compute'
  (num_bins_meg = compute)      Number of bins for the output MEG spectra, or 'compute'
  (min_bin_hcg = compute)       Minimum dispersion coordinate for HEG, or 'compute'
  (max_bin_hcg = compute)       Maximum dispersion coordinate for HEG, or 'compute'
  (bin_size_hcg = compute)      Bin size for binning HEG spectra, or 'compute'
  (num_bins_hcg = compute)      Number of bins for the output HEG spectra, 'compute'
  (min_tg_d = default)          Minimum tg_d range to include in histogram, or use 'default'
  (max_tg_d = default)          Maximum tg_d range to include in histogram, or use 'default'
(extract_background = yes)      Extract the local background spectrum?
(min_upbkg_tg_d = default)      Minimum value of tg_d for the background up spectrum.
(max_upbkg_tg_d = default)      Maximum value of tg_d for the background up spectrum.
(min_downbkg_tg_d = default)    Minimum value of tg_d for the background down spectrum.
(max_downbkg_tg_d = default)    Maximum value of tg_d for the background down spectrum.
  (geompar = geom)              Parameter file for Pixlib Geometry files
  (clobber = no)                OK to overwrite existing output file(s)?
  (verbose = 0)                 Verbosity level (0 = no display)
  (mode = ql)
```

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## History

- 16 Dec 2004 updated for CIAO 3.2: minor changes to parameter files
- 15 Feb 2005 new filtering bug discovered, follow workaround in [Apply the background filter section](#)
- 15 Jun 2005 updated for DS 7.6: the bow-tie region from the CALDB is used by default in tgextract (as shown in the [Extract a Grating Spectrum section](#))
- 05 Dec 2005

## Obtain Grating Spectra from LETG/HRC-S Data – CIAO 3.4

updated for CIAO 3.3: bug fixes to the Data Model make the workaround previously given in the Apply the background filter section unnecessary (i.e. the `modpireg` script); output filenames include ObsID; parameter file change (`kernel` parameter removed from all "tg" tools)

05 Jan 2006 created Data Preparation section

01 Dec 2006 updated for CIAO 3.4: change to wording of `tgdetect/dmcopy` warning

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URL: [http://cxc.harvard.edu/ciao/threads/spectra\\_letghrcs/](http://cxc.harvard.edu/ciao/threads/spectra_letghrcs/)

Last modified: 1 Dec 2006

**Image 1: Image with region file overlaid**

