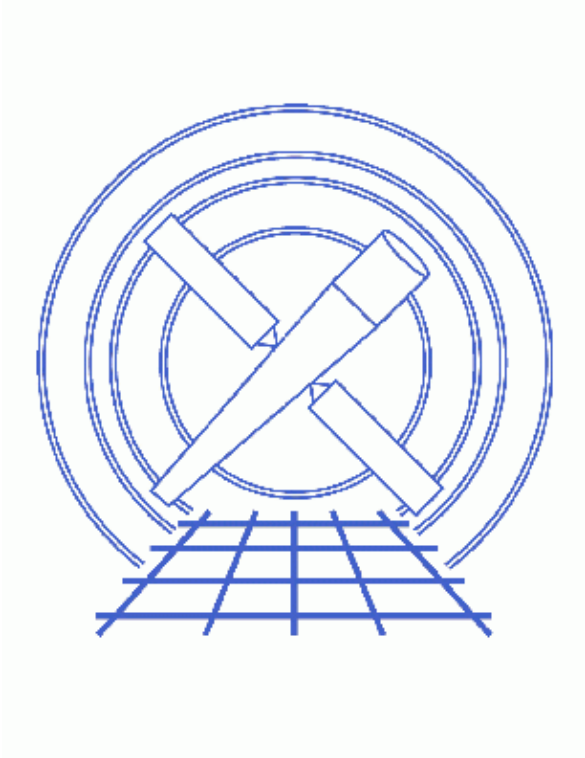
# Create Grating RMFs for ACIS−S Observations



***CIAO 3.4 Science Threads***

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# Create Grating RMFs for ACIS−S Observations

***CIAO 3.4 Science Threads***

## Overview

***Last Update:*** 1 May 2007 − updated for CALDB 3.4.0: new MEG LSFPARM files

***Synopsis:***

`mkgrmf` generates a grating RMF (gRMF) appropriate for spectral analysis of grating observations. The tool can be used either to create a standard gRMF with the most up−to−date calibration or to calculate a gRMF using non−standard grids.

***Purpose:***

To create observation−specific gRMFs.

***Read this thread if:***

you are working with ACIS−S grating data and would like to create a grating RMF file. Get Started: About the calibration files discusses the available calibration.

***Calibration Updates:***

- ***CALDB v3.4.0*** ***(16 May 2007):*** There are new +/− 1 MEG LSFPARM files for use in creating ACIS/HETG grating RMFs. A very small error was identified in the derivation and calculation of the MEG LSF. The effect of the error was a broadening of the MEG LSF model by approximately 0.007 A.

  The new files may only be used with data that have been processed with chip pixel coordinate randomization turned off.

***Related Links:***

- Analysis Guide for Chandra High Resolution Spectroscopy: an in−depth discussion of grating analysis.
- The Formal Underpinnings of the Response Functions used in X−Ray Spectral Analysis (PS, 22pp)

***Proceed to the HTML or hardcopy (PDF: A4 | letter) version of the thread.***

# Get Started

***Sample ObsID used:*** 459 (HETG/ACIS−S, 3C 273)

***File types needed:*** pha2

Make sure that you have set up ardlib to use the bad pixel file for your observation before following this thread.

## About the calibration files

The calibration files used by `mkgrmf` (`LSFPARM` files) for the HETG grating arm (HEG, MEG) are labeled as +1 and −1:

```
unix% ls −1 $CALDB/data/chandra/tel/grating/hetg/cpf/lsf/
acisheg−1D1999−07−22lsfparmN0003.fits
acisheg−1D1999−07−22lsfparmN0004.fits
acisheg1D1999−07−22lsfparmN0003.fits
acisheg1D1999−07−22lsfparmN0004.fits
acismeg−1D1999−07−22lsfparmN0003.fits
acismeg−1D1999−07−22lsfparmN0004.fits
acismeg−1D1999−07−22lsfparmN0005.fits
acismeg1D1999−07−22lsfparmN0003.fits
acismeg1D1999−07−22lsfparmN0004.fits
acismeg1D1999−07−22lsfparmN0005.fits
```

They scale nicely at higher orders, however, allowing one to build a fair representation of 2nd or 3rd order gRMFs based on 1st order LSF model.

This holds true for the LETG calibration as well:

```
unix% ls −1 $CALDB/data/chandra/tel/grating/letg/cpf/lsf/acis*
acissleg−1D1999−07−22lsfparmN0003.fits
acissleg1D1999−07−22lsfparmN0002.fits
acissleg1D1999−07−22lsfparmN0003.fits
```

Currently there is calibration available to create:

- +/− 1, 2, and 3 HEG and MEG randomized and unrandomized gRMFs
- +1 LEG randomized gRMFs
- +/− 1 LEG unrandomized gRMFs

The Randomized vs. unrandomized data section contains more details.

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## Randomized vs. unrandomized data

In CIAO 3.1 (and DS 7.3.0), the value of the `rand pix size` parameter in `tg resolve events` was changed from 0.5 to 0.0. This means that, by default, randomization is not applied to the chip pixel coordinates before diffraction coordinates are derived. `mkgrmf` uses the value of the `RAND_TG` header keyword to determine whether or not the input data (`obsfile` parameter) was randomized and to select the correct calibration file; `RAND_TG=0` indicates that the data is not randomized.

It is recommended that users remove the pixel randomization from their data before running this thread. To do so, re−run `tg_resolve_events` − as shown in the Obtain Grating Spectra for HETG/ACIS−S or LETG/ACIS threads − and extract a new PHA2 file.

# Run mkgrmf

Here we create a +1 order HEG gRMF with standard grids:

```
unix% punlearn mkgrmf
unix% pset mkgrmf order=1
unix% pset mkgrmf grating_arm=HEG
unix% pset mkgrmf outfile=heg_p1.rmf
unix% pset mkgrmf obsfile="acisf00459N002_pha2.fits[SPECTRUM]"
unix% pset mkgrmf regionfile=acisf00459N002_pha2.fits
unix% pset mkgrmf detsubsys=ACIS−S3
unix% pset mkgrmf wvgrid_arf=compute
unix% pset mkgrmf wvgrid_chan=compute
unix% pset mkgrmf clobber=no
unix% mkgrmf
Output File Name (heg_p1.rmf):
Enter ARF side wavelegth grid [angstroms] (compute):
Enter channel−side wavelegth grid [angstroms] (compute):
Enter Grating order (1):
Name of fits file with obs info (acisf00459N002_pha2.fits[SPECTRUM]):
File containing extraction region (acisf00459N002_pha2.fits):
SrcID (1):
Enter RMF threshold (1e−06):
Verbosity (0:5) (0):
Detector Name (e.g., ACIS−S3) (ACIS−S3):
Enter Grating Arm (HEG|MEG|LEG|NONE) (HEG):
```

There are a few details to note:

- The `detsubsys` parameter is set to the chip on which the 0th order falls. For most observations, this will be ACIS−S3.
- Specifying `compute` as the grid value is the same as using the default gridding. The default grids for the `wvgrid arf` parameter, suitable for most analysis, are listed in the help file. In general, `wvgrid chan` is set to be the same as the arf grid.

  It is also possible to run `mkgrmf` with non−standard grids for the `wvgrid arf` and `wvgrid chan` parameters, e.g.:

  ```
  unix% pset mkgrmf wvgrid_arf="1.0:205.8:0.01"
  unix% pset mkgrmf wvgrid_chan="1.0:205.8:0.01"
  ```

The contents of the parameter may be checked with plist mkgrmf.

Run the tool for every order and arm you wish to model, changing the `order` and `grating arm` parameters accordingly.

# Caveats

## Matching the grid to the PHA file

It is necessary for the grid to match that of the PHA file for the observation. The default `pha2.fits` binsize (from `tgextract`) is 0.0125 Å; if your PHA file was created with a different gridding, the RMF bin width must be chosen to match it.

If you are unsure of the gridding of your PHA file, it is possible to specify the file itself as the grid. This requires that a Type 1 PHA file be split out of the `pha2.fits` file beforehand, but ensures that the grids will match exactly:

```
unix% dmtype2split infile="acisf00459N002_pha2.fits[#row=4]" outfile=heg_p1_pha.fits

unix% pset mkgrmf wvgrid_arf="grid(heg_p1_pha.fits[cols BIN_LO,BIN_HI])"
unix% pset mkgrmf wvgrid_chan="grid(heg_p1_pha.fits[cols BIN_LO,BIN_HI])"
```

You will need to make a Type 1 PHA file for each grating arm and order for which you are generating response files. Change the row number for the grating arm and order that you are working with in the `dmtype2split` command accordingly; see the Examining Grating Spectra for more information. Then run the tool as shown above.

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# Summary

This thread is now complete. You may procede to the Compute Grating ARF thread appropriate for your observation: HETG/ACIS−S or LETG/ACIS−S.

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


       outfile = heg_p1.rmf       Output File Name
    wvgrid_arf = compute          Enter ARF side wavelength grid [angstroms]
   wvgrid_chan = compute          Enter channel−side wavelength grid [angstroms]
         order = 1                Enter Grating order
       obsfile = acisf00459N002_pha2.fits[SPECTRUM] Name of fits file with obs info
    regionfile = acisf00459N002_pha2.fits File containing extraction region
         srcid = 1                SrcID
#
     threshold = 1e−06            Enter RMF threshold
     detsubsys = ACIS−S3          Detector Name (e.g., ACIS−S3)
   grating_arm = HEG              Enter Grating Arm
#
       verbose = 0                Verbosity
  (diagonalrmf = no)              Compute diagonal RMF?
#
#
(ardlibparfile = ardlib.par)      name of ardlib parameter file
      (geompar = geom)            Parameter file for Pixlib Geometry files
#
       (mirror = HRMA)            Mirror Name
      (clobber = no)              Overwrite existing files?
         (mode = ql)              Enter mode for parameter file.
```

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# History

| | |
|---|---|
| 20 Dec 2004 | updated for CIAO 3.2: canned gRMFs are no longer available in the CALDB, users *must* run this thread |
| 10 May 2005 | added more detail to thread overall |

05 Dec 2005 reviewed for CIAO 3.3: no changes

01 Dec 2006 reviewed for CIAO 3.4: no changes

01 May 2007 updated for CALDB 3.4.0: new MEG LSFPARM files

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URL: http://cxc.harvard.edu/ciao/threads/mkgrmf_aciss/ Last modified: 1 May 2007