Chandra X-ray Center

AHELP for CIAO 3.4　　　　　　**mkacisrmf**　　　　　　Context: tools

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Synopsis

Generate an RMF for Chandra imaging data

Syntax

```
mkacisrmf  infile outfile wmap energy channel chantype ccd_id chipx
chipy gain [logfile] [contlvl] [geompar] [thresh] [clobber] [verbose]
```

Description

The mkacisrmf tool generates an OGIP–style RMF file appropriate for analysis of Chandra ACIS imaging data. The response matrix file (RMF) encapsulates the mapping between the physical properties of incoming photons (such as their energy) and their detected properties (such as detector pulse heights or PHA) for a given detector. This mapping is stored in the form of a 2–D matrix. Spectral fitting packages like Sherpa, XSPEC, and ISIS use this redistribution function (the matrix), plus an accompanying effective area function (the ARF), to predict the counts per channel produced by a given spectral model for the source.

As of CALDB 3.1.0, released on 23 June 2005, mkacisrmf can be used to create RMFs for all observations taken at the −120 C focal plane temperature. Calibration for other focal plane temperatures will be released in the future. For the latest information on what calibration is available, see the Chandra Calibration Database website and the Creating ACIS RMFs why topic.

mkacisrmf calculates the RMF on user–defined grids in energy (units of keV) and channel (units of PHA or PI) using tabulated ACIS response calibration information. The user may choose to create an RMF for a single position on a given ACIS CCD, or, alternatively, an RMF which represents the weighted sum of the response function over a given spatial extraction region. In general, the response of the detector is a function of position on the CCD and such weighted RMFs (WRMFs) may be more appropriate for analysis of extended sources. To construct weighted RMFs, mkacisrmf uses weighting information contained in a FITS image of the field in CCD detector coordinates. Such an image is called a weights map (WMAP) and can be created in CIAO directly from the events data using dmcopy or during the spectral extraction process using dmextract.

Users have the option of creating RMFs appropriate for either PHA or PI extracted ACIS spectra. For the case of PI RMFs, the information in the input gain file is used to scale from PHA channels to PI channels dynamically during the RMF computation. If a WMAP file created in CIAO is specified, mkacisrmf will utilize keyword information in the header to locate the appropriate gain file in the CALDB automatically. If an RMF for a single position is desired, the gain file must be specified explicitly.

Examples of the various options for creating RMFs can be found in the CIAO science threads.

The tool mkacisrmf is an entirely new method for creating ACIS response matrices. Unlike its predecessor mkrmf, this tool separates the RMF calculation process into two components: an "ideal" component which describes the CCD spectral response prior to the effects of charge transfer inefficiency (CTI) degradation, and a spatially varying component which incorporates the changes in the response produced by CTI. Accompanying the new tool is a new CCD analysis reference data (ARD) input file which describes both the ideal CCD response and the spatial variation produced by CTI. This new approach provides a number of improvements in speed and accuracy and will become the default tool for ACIS RMF generation once a full set of ACIS response calibration products is available.

Output format

The output RMF is a standard FITS file and contains two extensions. The MATRIX extension consists of the actual energy to detector channel mapping and is an MxN matrix where M and N correspond to the sizes of the grids selected by the user. The EBOUNDS extension is a set of vectors giving the upper and lower energy bounds for each detector channel and is determined from information in the gain file. The EBOUNDS information is used by packages such as Sherpa, XSPEC, and ISIS for plotting purposes. It is not used directly for fitting. The mkacisrmf output format retains the HEASARC OGIP 92–002 standard for 2–D RMFs, and is fully compatible with Sherpa, XSPEC, and ISIS.

CALLING SEQUENCES

There are basically two different calling sequences for mkacisrmf depending on whether the user wishes to create a weighted RMF or an RMF appropriate for a single position on one of the ACIS CCDs.

Creating an RMF to match an extracted spectrum

In this scenario, the user has extracted a spectrum from a given region using dmextract and wishes to compute a matching RMF. For example, the sequence:

```
dmextract \
"data_evt2.fits[(x,y)=circle(4232, 3289,30)][bin pi=1:1024:1]" \
test_src_pi.fits  wmap="det=8"

mkacisrmf infile=CALDB                 \
         outfile=test_wrmf.fits        \
         energy=0.3:10.0:0.005         \
         channel=1:1024:1              \
         chantype=PI                   \
         wmap=test_src_pi.fits         \
         gain=CALDB
```

will extract a spectrum from within the indicated region and create a weighted RMF appropriate for that region. Here, the wmap option in the call to dmextract creates a weight map (see the documentation for dmextract) which mkacisrmf will use to create a counts weighted RMF over the extraction region. The "infile" parameter is set to "CALDB" and mkacisrmf uses the information in the header of the input wmap file to determine the appropriate Phase 2 response calibration file to use. The energy grid for the RMF is given in keV and in this example ranges from 0.3 to 10.0 keV in 5 eV increments. The channel grid in this case uses PI channels.

Similarly, the gain parameter should be set to "CALDB" as well in order to ensure that an appropriately matched gain file is used. Every Phase 2 response calibration file has corresponding matched gain file in the CALDB.

Setting the "infile" parameter to a value of CALDB, in conjunction with an input wmap file, is the best way to ensure that the most appropriate Phase 2 response calibration file is used for a given dataset. As with any CALDB file, updated files are added to the CALDB to correct problems found with existing files; however, by using the CALDB value for the "infile" parameter, mkacisrmf will automatically select the appropriate file. This method is the recommended way of constructing RMFs with mkacisrmf.

Creating an RMF at a specific location

For this case, it is assumed the user wishes to create an RMF file for a specific location on one of the ACIS CCDs, independent of a given dataset or extraction region. In such a situation, the user must explicitly supply the value of the "infile" parameter, since the tool does not have access to the information in a header to determine which file should be used. For example, the sequence:

```
mkacisrmf \
infile="$CALDB/data/chandra/acis/cpf/p2_resp/acisD2000-01-29p2_respN0002.fits" \
          outfile=test_c7_645_10_rmf.fits       \
          wmap=none                             \
          energy=0.3:10.0:0.005                 \
          channel=1:1024:1                      \
          chantype=PI                           \
          ccd_id=7                              \
          chipx=645                             \
          chipy=10                              \
gain="$CALDB/data/chandra/acis/bcf/gain/acisD2000-01-29p2_gain_ctiN0003.fits"
```

creates an RMF at a position of (645, 10) in CHIP coordinates on CCD 7. Again, the user must ensure that the appropriate matching gainfile is used. The energy and channels grids are the same as in the previous example. Note that when specifying the input response and gain files explicitly, the path to these files must be included.

Example

```
dmextract "data_evt2.fits[(x,y)=circle(4232, 3289,30)][bin
pha=1:4096:2]" \
test_src_pha.fits wmap="det=8"
mkacisrmf infile=CALDB outfile=test_wrmf.fits \
energy=0.3:10.0:0.005 channel=1:4096:2 chantype=PHA \
wmap=test_src_pha.fits gain=CALDB
```

Creates a weighted RMF using the weights map contained in the input spectrum file. Similar to the example shown above; however, here the spectrum has been binned in PHA channels and the RMF has been computed on a matching PHA grid.

Parameters

name	type	ftype	def	min	max	units	reqd
infile	file	input					yes
outfile	file	output					yes
wmap	file	input					yes
energy	string	input					yes
channel	string	input					yes
chantype	string	input	PI				yes
ccd_id	integer	input		0	9		yes

chipx	integer	input					yes
chipy	integer	input					yes
gain	file	input	CALDB				yes
logfile	file	output					
contlvl	integer	input	100				
geompar	file	input	geom				
thresh	float	input	1e−6	0.0			
clobber	boolean	input	no				
verbose	integer	input	0	0	5		

Detailed Parameter Descriptions

Parameter=infile `(file required filetype=input)`

Input calibration file

Includes full path and file name or a CALDB query (e.g. infile=CALDB) if a wmap file is being supplied. The valid file contains four data extensions: two ideal response tables, one multi−region scatter block tabulating analytical function parameters, and a response energy "TWEAK" extension. In the Chandra CALDB, these files are found in the $CALDB/data/chandra/acis/cpf/p2_resp/ directory.

Parameter=outfile `(file required filetype=output)`

Output FITS RMF file

Contains a null primary binary table followed by two extensions: response MATRIX and EBOUNDS.

The MATRIX array in each gridded (e.g. energy) row are compressed so any element value below the cutoff value (specified by "thresh" parameter) will be removed from the array and then normalized to one for that row over the effective channels (PHA/PI). The EBOUNDS arrays are interpolated from the gain table (specified by "gain" parameter) over the full resolution of channels and output in the user−specified bin step.

Parameter=wmap `(file required filetype=input)`

Input FITS WMAP file

The WMAP can either be stored in the WMAP block of a PHA spectrum file created by dmextract or in an image created with dmcopy. If "wmap=none" or "wmap=" (empty parameter), mkacisrmf will generate a single−region RMF output based on the user's 3−parameter filter specification; otherwise, a weighted PI channel type RMF over multi−response regions will be created.

Parameter=energy `(string required filetype=input)`

Energy grid in keV

The grid is specified by giving the lower bound, upper bound, and binning step, separated by the ":" character. For example, "energy=0.1:10.0:0.005" bins from 0.1 to 10.0 keV in steps of 0.005 keV.

Detailed Parameter Descriptions

Parameter=channel `(string required filetype=input)`

Channel grid in pixels

The grid is specified by giving the minimum, maximum channel, and binning step, separated by the ":" character. For example, "channel=1:4096:1" bins from channel 1 to 4096 in steps of 1.

Parameter=chantype `(string required filetype=input default=PI)`

Channel type

Determines the output RMF grids, energy vs PHA or energy vs PI. Valid values are PHA and PI; these values are case−sensitive.

Parameter=ccd_id `(integer required filetype=input min=0 max=9)`

The ACIS chip(s) to filter

This is the first of three parameters to be used as event filter when a wmap is not supplied. mkacisrmf looks up scatter for a single tile region to match the specified filter. This parameter is ignored when an effective wmap value is supplied.

Parameter=chipx `(integer required filetype=input)`

Detector chipx position [pixels]

This is the second of three parameters to be used as event filter when a wmap is not supplied. mkacisrmf looks up scatter for a single tile region to match the specified filter. This parameter is ignored when an effective wmap value is supplied.

Parameter=chipy `(integer required filetype=input)`

Detector chipx position [pixels]

This is the third of three parameters to be used as event filter when a wmap is not supplied. mkacisrmf looks up scatter for a single tile region to match the specified filter. This parameter is ignored when an effective wmap value is supplied.

Parameter=gain `(file required filetype=input default=CALDB)`

Gain file in FITS format

The gain file to be used in creating the RMF. The energy bounds of the spectral response create the EBOUNDS block of the resulting RMF. Also, the supplied gain information is necessary to convert PHA RMF to PI RMF when "chantype=pi" is supplied.

If an RMF for a single position is desired, the gain file (including path) must be specified explicitly.

If a WMAP file specified, the gain parameter may be set to "CALDB" (the default) and mkacisrmf will utilize keyword information in the WMAP header to locate the appropriate gain file in the CALDB automatically. Note that this method selects the newest gain appropriate for the date, NOT the gain file used to process the data; this could lead to mismatched calibration files.

Parameter=logfile `(file filetype=output)`

Log file.

Records all STDERR messages. It also logs any STDOUT for verbose levels of 1 and higher.

Parameter=contlvl `(integer filetype=input default=100)`

Number of contour levels relative to local function peak.

This number is used to interpolate scatter function along the leveled contours.

Parameter=geompar `(file filetype=input default=geom)`

Pixlib Geometry parameter file

The pixlib file is used to access the information necessary to map detector pixels to a response region.

Parameter=thresh `(float filetype=input default=1e-6 min=0.0 units=)`

Minimum value included in the output matrix

All MATRIX elements below this threshold value are excluded from the output file. This is used to reduce the size of the output file. It is suggested that the parameter value is left at its default value.

Parameter=clobber `(boolean filetype=input default=no)`

Clobber

Overwrites existing files of the same output file name if "yes"

Parameter=verbose `(integer filetype=input default=0 min=0 max=5)`

Verbosity level

This option allows the user to request a varying level of diagnostic output. Levels range from 0 to 5 with 0 representing no information and 5 representing the most. Verbosity greater than 3 contains information for debugging; most users will not need to set this parameter higher than 3. All messages are written to the log file.

CHANGES IN CIAO 3.4

Missing ONTIME Keywords

If the input WMAP file is missing ONTIMEx header keywords (e.g. ONTIME1), mkacisrmf will use the ONTIME value instead.

CHANGES IN CIAO 3.3

chantype Parameter

Allowed values for the chantype parameter are enumerated in the parameter file: PHA or PI (case−sensitive). This will eliminate confusion in XSpec, which requires the CHANTYPE keyword to be in uppercase.

Bugs

See the bugs page for this tool on the CIAO website for an up–to–date listing of known bugs.

See Also

calibration
>ardlib

dm
>dmbinning

tools

>acis_bkgrnd_lookup, acis_fef_lookup, acis_set_ardlib, acisspec, add_grating_orders, add_grating_spectra, asphist, dither_region, dmarfadd, dmcopy, dmextract, dmfilth, dmgroup, dmimghist, dmregrid, fullgarf, get_sky_limits, mkarf, mkexpmap, mkgarf, mkgrmf, mkinstmap, mkpsf, mkrmf, mkwarf, psextract, psf_project_ray, rmfimg, specextract, tgextract

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