MIT Kavli Institute **Chandra X-Ray Center**

MEMORANDUM
March 16, 2017

To:	Jonathan McDowell, SDS Group Leader
From:	Glenn E. Allen, SDS
Subject:	Temperature-dependent RMF spec
Revision:	1.01
URL:	http://space.mit.edu/CXC/docs/docs.html#trmf
File:	/nfs/inconceivable/d0/sds/specs/mkacisrmf/trmf_spec_1.01.tex

1 Description

This spec is a high-level description of how a script could be used to create a temperature-dependent RMF.

2 Parameters

The parameters for the script are identical to the parameters for the tool `mkacisrmf`, except the script includes the two additional parameters:

1. `gtifile`,f,a,“ ”,,,“Input file with GTIs for each CCD (e.g. the evt2 file)”
2. `mtlfile`,f,a,“ ”,,,“Input mission timeline file”

3 Processing

1. GTIs:
   The start and stop times for each one of the $N_{\rm gti}$ good-time intervals for the CCD_ID of interest are read from the appropriate GTI HDU of the `gtifile`. Hereafter these times for the $i^{\rm th}$ interval are referred to as `START`[i] and `STOP`[i], respectively.
2. Temperatures:
   The $N_{\rm mtl}$ sets of values for the time and focal-plane temperature are read from the MTL HDU of the `mtlfile`. Hereafter, the $j^{\rm th}$ time and temperature are referred to as $\texttt{TIME}_{\rm mtl}[j]$ and $\texttt{FP\_TEMP}_{\rm mtl}[j]$, respectively. The header of the same HDU is read to obtain the values of the keywords `TIMEDEL` and `TIMEPIXR`, which are hereafter referred to as $\texttt{TIMEDEL}_{\rm mtl}$ and $\texttt{TIMEPIXR}_{\rm mtl}$, respectively.
3. CALDB files:

(a) Names:
The CALDB is queried to obtain the N_{resp} response files associated with the DATE-OBS and DATE-END of the observation. There is one file for each temperature range calibrated. Hereafter, the k^{th} response file is referred to as respfile$[k]$.

(b) Temperature intervals:
The minimum and maximum focal-plane temperatures for each respfile are obtained from the header keyword CBD10001 in the respfile. Hereafter these temperatures for the k^{th} file are referred to as, $\mathtt{FP\_TEMP}_{\mathrm{min}}[k]$ and $\mathtt{FP\_TEMP}_{\mathrm{max}}[k]$, respectively.

(c) Exposures:
The total exposure time associated with each respfile (i.e. with each temperature interval from $\mathtt{FP\_TEMP}_{\mathrm{min}}[k]$ to $\mathtt{FP\_TEMP}_{\mathrm{max}}[k]$) is initialized to zero. For each $k = 0, 1, \ldots, N_{\mathrm{resp}} - 1$:

$$\tau[k] = 0. \tag{1}$$

4. Exposures:
For each good-time interval $i = 0, 1, \ldots, N_{\mathrm{gti}} - 1$:

(a) For each focal-plane temperature $j = 0, 1, \ldots, N_{\mathrm{mtl}} - 1$:

i.

$$t_0 = \mathtt{TIME}_{\mathrm{mtl}}[j] - \mathtt{TIMEPIXR}_{\mathrm{mtl}} \times \mathtt{TIMEDEL}_{\mathrm{mtl}}. \tag{2}$$

ii. If

$$t_0 < \mathtt{START}[i], \tag{3}$$

then

$$t_0 = \mathtt{START}[i]. \tag{4}$$

iii. If

$$t_0 \geq \mathtt{STOP}[i], \tag{5}$$

then

$$t_0 = \mathtt{STOP}[i]. \tag{6}$$

iv. If

$$j = 0, \tag{7}$$

then

$$t_0 = \mathtt{START}[i]. \tag{8}$$

v.

$$t_1 = \mathtt{TIME}_{\mathrm{mtl}}[j] + (1 - \mathtt{TIMEPIXR}_{\mathrm{mtl}}) \times \mathtt{TIMEDEL}_{\mathrm{mtl}}. \tag{9}$$

vi. If

$$t_1 < \mathtt{START}[i], \tag{10}$$

then

$$t_1 = \mathtt{START}[i]. \tag{11}$$

vii. If

$$t_1 \geq \texttt{STOP}[i], \tag{12}$$

then

$$t_1 = \texttt{STOP}[i]. \tag{13}$$

viii. If

$$j = N_{\rm mtl} - 1, \tag{14}$$

then

$$t_1 = \texttt{STOP}[i]. \tag{15}$$

ix.

$$\Delta t = t_1 - t_0. \tag{16}$$

x. For each **respfile** (i.e. each temperature interval) $k = 0, 1, \ldots, N_{\rm resp} - 1$:

A. If

$$\texttt{FP\_TEMP}_{\rm mtl}[j] \geq \texttt{FP\_TEMP}_{\rm min}[k] \text{ and} \tag{17}$$

$$\texttt{FP\_TEMP}_{\rm mtl}[j] < \texttt{FP\_TEMP}_{\rm max}[k], \tag{18}$$

then

$$\tau[k] = \tau[k] + \Delta t. \tag{19}$$

5. Composite ARF:

(a) A weights map WMAP is obtained for the entire set of good-time intervals.

(b) The ARF A is obtained using **mkwarf** with WMAP.

6. Temperature-dependent RMFs:
For each temperature interval (i.e. each **respfile**) $k = 0, 1, \ldots, N_{\rm resp} - 1$:

(a) If $\tau[k] > 0$, then

i. The good-time intervals GTI$[k]$ are obtained for the temperature interval.

ii. The weights map WMAP$[k]$ is obtained for the temperature interval.

iii. The ARF $A[k]$ is obtained for the temperature interval using **mkwarf** with WMAP$[k]$.

iv. The RMF $R[k]$ is obtained for the temperature interval using **mkacisrmf** with **respfile**$[k]$ and WMAP$[k]$.

7. Temperature-weighted RMF:
The temperature-weighted RMF is given by[1]

$$R = \frac{\sum_{k=0}^{N_{\rm resp-1}} \tau[k] A[k] R[k]}{A \sum_{k=0}^{N_{\rm resp-1}} \tau[k]}. \tag{20}$$

Since the temperature-weighted RMF R is weighted relative to the composite ARF A, the RMF R and ARF A are a matched set that should be used to analyze the data.

[1]The source spectrum is assumed to be the same for each temperature interval.