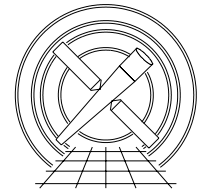




MIT Kavli Institute



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_{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^{th} interval are referred to as `START $[i]$` and `STOP $[i]$` , respectively.
2. **Temperatures:**
The N_{mtl} sets of values for the time and focal-plane temperature are read from the **MTL HDU** of the `mtlfile`. Hereafter, the j^{th} time and temperature are referred to as `TIME $_{\text{mtl}}[j]$` and `FP_TEMP $_{\text{mtl}}[j]$` , 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 `TIMEDEL $_{\text{mtl}}$` and `TIMEPIXR $_{\text{mtl}}$` , 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, $\text{FP_TEMP}_{\text{min}}[k]$ and $\text{FP_TEMP}_{\text{max}}[k]$, respectively.

(c) **Exposures:**

The total exposure time associated with each **respfile** (i.e. with each temperature interval from $\text{FP_TEMP}_{\text{min}}[k]$ to $\text{FP_TEMP}_{\text{max}}[k]$) is initialized to zero. For each $k = 0, 1, \dots, N_{\text{resp}} - 1$:

$$\tau[k] = 0. \quad (1)$$

4. **Exposures:**

For each good-time interval $i = 0, 1, \dots, N_{\text{gti}} - 1$:

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

i.

$$t_0 = \text{TIME}_{\text{mtl}}[j] - \text{TIMEPIXR}_{\text{mtl}} \times \text{TIMEDEL}_{\text{mtl}}. \quad (2)$$

ii. If

$$t_0 < \text{START}[i], \quad (3)$$

then

$$t_0 = \text{START}[i]. \quad (4)$$

iii. If

$$t_0 \geq \text{STOP}[i], \quad (5)$$

then

$$t_0 = \text{STOP}[i]. \quad (6)$$

iv. If

$$j = 0, \quad (7)$$

then

$$t_0 = \text{START}[i]. \quad (8)$$

v.

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

vi. If

$$t_1 < \text{START}[i], \quad (10)$$

then

$$t_1 = \text{START}[i]. \quad (11)$$

vii. If

$$t_1 \geq \text{STOP}[i], \quad (12)$$

then

$$t_1 = \text{STOP}[i]. \quad (13)$$

viii. If

$$j = N_{\text{mtl}} - 1, \quad (14)$$

then

$$t_1 = \text{STOP}[i]. \quad (15)$$

ix.

$$\Delta t = t_1 - t_0. \quad (16)$$

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

A. If

$$\text{FP_TEMP}_{\text{mtl}}[j] \geq \text{FP_TEMP}_{\text{min}}[k] \text{ and} \quad (17)$$

$$\text{FP_TEMP}_{\text{mtl}}[j] < \text{FP_TEMP}_{\text{max}}[k], \quad (18)$$

then

$$\tau[k] = \tau[k] + \Delta t. \quad (19)$$

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**) $k = 0, 1, \dots, N_{\text{resp}} - 1$:

- (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 by¹

$$R = \frac{\sum_{k=0}^{N_{\text{resp}}-1} \tau[k] A[k] R[k]}{A \sum_{k=0}^{N_{\text{resp}}-1} \tau[k]}. \quad (20)$$

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.

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