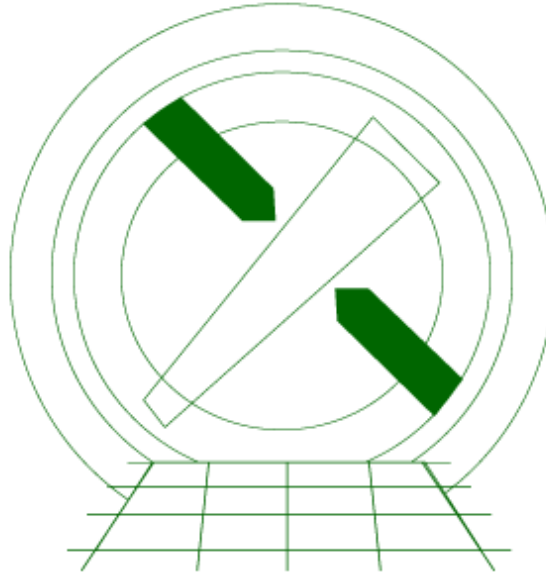


# Introduction to ChaRT Data Files



## ChaRT Threads

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# Introduction to ChaRT Data Files

## ChaRT Threads

### Overview

**Last Update:** 17 Feb 2010 - reviewed for CIAO 4.2: no changes

#### Synopsis:

After running ChaRT, you will be sent an email pointing to the directory on the FTP server where you can download a compressed tarfile containing the results of the run. This thread illustrates how to retrieve, unpack, and view the output data.

The data used here were created by running ChaRT with the following parameters:

```
theta = 5.949 arcmin
phi   = 197.74 degrees
density = 2
energy = 1.7 keV
seed  = 96969267
```

---

### Email from ChaRT

Once your job has finished, ChaRT will send you an email which looks similar to this:

```
Your job has completed. You may retrieve your files from our
anonymous ftp data server, where they will be stored for no more than
2 days. Pertinent information is listed below. Thank you.
Host: cda.cfa.harvard.edu
Username: anonymous
Password: chartusr@cfa.harvard.edu
Directory: /pub/traceftp
Filename: chartusr-20100217-154515.tar.gz
File size (approx, untarred, [MiB]): 32
ftp://cda.harvard.edu/pub/traceftp/chartusr-20100217-154515.tar.gz
Job Parameters:

Name           = ChaRT User
Email          = chartusr@cfa.harvard.edu
Random Seed    = 96969267

Source 1
```

```
Coord Sys      = Theta/Phi
Theta [arcmin] = 5.949
Phi [degree]   = 197.74
Energies [keV] = 1.7
Density        = 2
```

As well as giving the location of the tarfile, the email lists the parameters used to create the PSF.

---

## Download and Unpack the Tarfile

The name of the tarfile (`chartusr-20100217-154515.tar.gz`) is created by taking the first eight characters of the email address (`chartusr@cfa.harvard.edu`) and adding the date and the time the data was created. There are two simple ways to retrieve the tarfile from the server:

- Paste the URL from the email (`ftp://cda.harvard.edu/pub/traceftp/chartusr-20100217-154515.tar.gz`) into your web browser and a "Save As..." box should be launched.
- From the command line, it is possible to use `wget` (*most* users have this tool installed on the system):

```
unix% wget ftp://cda.harvard.edu/pub/traceftp/chartusr-20100217-154515.tar.gz
```

or to FTP to `cda.harvard.edu`:

```
unix% ftp cda.harvard.edu
Connected to cda.
220 cda FTP server (Version wu-2.6.1(1) Mon Aug 7 15:20:43 EDT 2000) ready.
Name (cda.harvard.edu:chartusr): anonymous
331 Guest login ok, send your complete e-mail address as password.
Password:
230-
230- Welcome to the FTP server at the CXC Science Center
230-
(output omitted)
230 Guest login ok, access restrictions apply.
ftp> cd /pub/traceftp
250 CWD command successful.
ftp> get chartusr-20100217-154515.tar.gz
200 PORT command successful.
150 Opening ASCII mode data connection for chartusr-20100217-154515.tar.gz (29209394 bytes).
226 Transfer complete.
local: chartusr-20100217-154515.tar.gz remote: chartusr-20100217-154515.tar.gz
29209394 bytes received in 17 seconds (1054.67 Kbytes/s)
ftp> quit
```

To unpack the compressed tarfile:

```
unix% gunzip -c chartusr-20100217-154515.tar.gz | tar xf -
unix% ls -F
source1/

unix% ls source1/
HRMA_theta5.949_phi197.7_en1.7_d2.fits
```

The tarfile contains one directory per source, called `source<n>`. This sample dataset has only one source.

## Columns and Header Keywords

There are many columns in the output rayfile:

```

unix% cd source1
unix% dmlist HRMA_theta5.949_phi197.7_en1.7_d2.fits cols
-----
Columns for Table Block PSFRAYS
-----
ColNo  Name                Unit          Type          Range          Label for field
  1    rt_cosx             none          Real8         -Inf:+Inf     Label for field
  2    rt_cosy             none          Real8         -Inf:+Inf     Label for field
  3    rt_cosz             none          Real8         -Inf:+Inf     Label for field
  4    rt_kev              KeV           Real8         -Inf:+Inf     Label for field
  5    rt_graze            radians       Real8         -Inf:+Inf     Label for field
  6    rt_id               none          UInt4         -              Label for field
...
 16    rt_x                mm            Real8         -Inf:+Inf     Label for field
 17    rt_y                mm            Real8         -Inf:+Inf     Label for field
 18    rt_z                mm            Real8         -Inf:+Inf     Label for field
 19    rt_srfms            none          UInt4         -              Label for field
 20    rt_norm_x           none          Real8         -Inf:+Inf     Label for field
 21    rt_norm_y           none          Real8         -Inf:+Inf     Label for field
 22    rt_norm_z           none          Real8         -Inf:+Inf     Label for field
 23    rt_time             sec           Real8         -Inf:+Inf     Label for field
 24    rt_wght             none          Real8         -Inf:+Inf     Label for field

```

- **rt\_x, rt\_y, rt\_z**: ray position in telescope coordinates [mm]
- **rt\_cosx, rt\_cosy, rt\_cosz**: cosine of the ray direction
- **rt\_kev**: energy of the ray [keV]
- **rt\_wght**: fractional probability that this ray will reach the focal plane
- **rt\_id**: ray id
- **rt\_graze**: grazing angle at point of last reflection from an optic [radians]
- **rt\_srfms**: code indicating which surfaces had been missed
- **rt\_normx, rt\_normy, rt\_normz**: surface normal at point of last reflection from an optic
- **rt\_time**: arrival time of ray at entrance of telescope [s]. The first ray arrives at time zero.

There are also some header keywords that should be highlighted; to view the complete header, use:

```
unix% dmlist HRMA_theta5.949_phi197.7_en1.7_d2.fits header
```

The ChaRT input parameters used to create the PSF are written as keywords:

```

unix% dmlist HRMA_theta5.949_phi197.7_en1.7_d2.fits header | egrep 'CREATOR|SRC_|CONFFILE|PSFSEED1'
0005 CREATOR                ChaRT v12:44:00-2003/12/09      String
0011 SRC_THET                5.9490 [arcmin]                 Real8      input THETA
0012 SRC_PHI                  197.740 [degrees]               Real8      input PHI
0013 SRC_E                    1.70 [keV]                       Real8      Energy used for generation
0014 SRC_DENS                 2                                Int4       input DENSITY
0026 CONFFILE                 orbit_XRCF+tilts+ol_01          String     HRMA config. file
0029 PSFSEED1                 96969267                         Int4       Primary random seed for saosa

```

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The `CONFFILE` keyword lists the name of the [raytrace configuration file](#) used in the simulation. If a spectral model is used to create the PSF, different "SRC\_" keywords are added to the header to record the filename and exposure time:

```
unix% dmlist HRMA_theta5.949_phi197.7_ensource_flux_chart.dat_exp15.fits \  
      header | egrep 'SRC_'  
0027 SRC_THET          5.9490 [arcmin]          input THETA  
0028 SRC_PHI           197.740 [degrees]         input PHI  
0029 SRC_SPEC          source_flux_chart.dat       User supplied spectrum file  
0030 SRC_EXPT          15 [ksec]                   input EXPOSURE TIME
```

---

## Examining the PSF data

HRMA\_theta5.949\_phi197.7\_en1.7\_d2.fits is a [FITS](#) file with the data stored in the PSFRAYS block of the file. Using `dmlist` shows that this file contains approximately 192,000 rays:

```
unix% dmlist HRMA_theta5.949_phi197.7_en1.7_d2.fits blocks  
  
-----  
Dataset: HRMA_theta5.949_phi197.7_en1.7_d2.fits  
-----  
  
      Block Name          Type          Dimensions  
-----  
Block   1: PRIMARY          Null  
Block   2: PSFRAYS          Table          15 cols x 191683 rows
```

The total counts in the PSF image is also recorded in the TOTCTS header keyword:

```
unix% dmkeypar HRMA_theta5.949_phi197.7_en1.7_d2.fits totcts echo+  
191683.0
```

---

## Summary

The output from ChaRT (i.e. HRMA\_theta5.949\_phi197.7\_en1.7\_d2.fits) *cannot* be used directly in your analysis. It first needs to be projected onto the detector and have the detector response applied to it to create a simulated event file. The [Using MARX to Create an Event File](#) thread describes how to do this.

---

## History

- 27 Jun 2003 original version, updated for CIAO 3.0: layout
- 13 Jul 2004 created [Columns and Header Keywords section](#)
- 16 Feb 2005 reviewed for CIAO 3.3: no changes

## Introduction to ChaRT Data Files -

18 Aug 2008 updated for CIAO 4.0: minor changes to screen output

17 Feb 2010 reviewed for CIAO 4.2: no changes

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URL: [http://cxc.harvard.edu/chart/threads/intro\\_data/](http://cxc.harvard.edu/chart/threads/intro_data/)

Last modified: 17 Feb 2010

