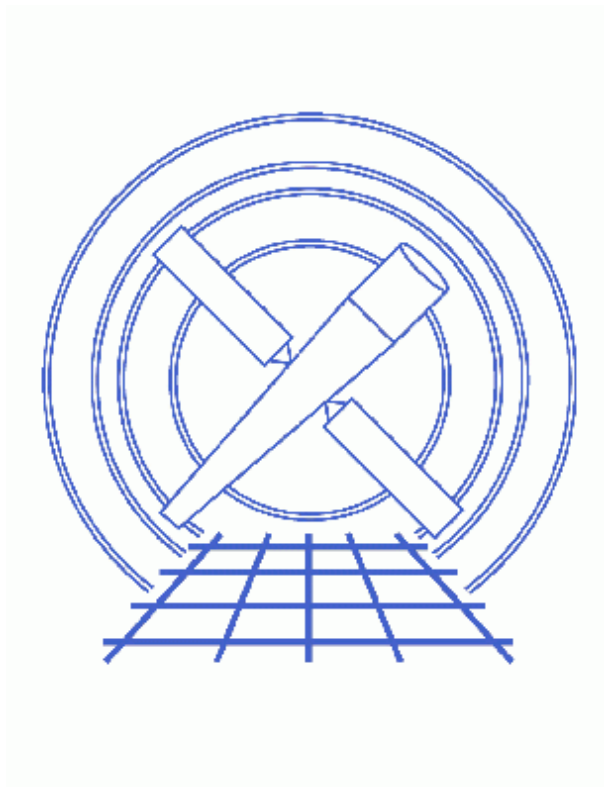


# Reprojecting Coordinates of a Solar System Object



## CIAO 4.1 Science Threads

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# Reprojecting Coordinates of a Solar System Object

## CIAO 4.1 Science Threads

### Overview

**Last Update:** 4 Feb 2009 - updated for CIAO 4.1: image is inline

#### Synopsis:

When an object is observed moving with respect to the observer, e.g. a planet or comet, the resulting event file looks "blurred" when viewed in  $(x, y)$  coordinates. The `sso_freeze` tool reprojects the coordinates to the frame of the object, eliminating this blurring.

This thread contains general information on running `sso_freeze`. The [Object-centered Aspect Solution and Exposure Map thread](#) explains how to use the object-centered aspect solution file.

#### Purpose:

To reproject coordinates from the frame fixed to the celestial sphere to a reference frame which is fixed to the moving solar system object (SSO).

#### Read this thread if:

you are working with any observation of a solar system object.

Proceed to the [HTML](#) or [hardcopy \(PDF: \[A4\]\(#\) | \[letter\]\(#\)\)](#) version of the thread.

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## Choosing the Ephemeris Files

**Sample ObsID used:** 1463 (ACIS-S, Jupiter)

**File types needed:** evt2; asol1; eph1

There are two ephemeris input files needed for the tool to run: the spacecraft ephemeris file ([scephemfile](#)) and the SSO ephemeris file ([ssoephemfile](#)). Both of these files are part of the primary data products. In *ChaSeR*, they are listed as the "MT (moving target) ephem" and "Orbit ephemeris".

```
unix% ls *eph1.fits
```

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```
jupiterf059875200N001_eph1.fits  
jupiterf059875200N002_eph1.fits  
orbitf059443264N002_eph1.fits
```

The ephemeris files are selected based on the start time (TSTART) of the observation:

```
unix% dmkeypar acisf01463N002_evt2.fits TSTART echo+  
59968797.485273
```

Make sure that the timestamp in the filenames is *less than* the start time of the data. Also, if there is more than one version of a file - e.g. N001 and N002 - choose the newest (higher number) version available. The two ephemeris files for this observation are `orbitf059443264N002_eph1.fits` and `jupiterf059875200N002_eph1.fits`.

Spacecraft and SSO ephemeris files are also available from the CDA FTP site (`cda.harvard.edu`) if you have trouble retrieving them via *ChaSeR*. Login as "anonymous", using your email address as the password; the files are in the `/pub/arcftp/bary/ephem` directory.

---

## Run sso\_freeze

Once you have the necessary input files, you are ready to run `sso_freeze`.

In some cases, there will be more than one `asol1.fits` file for an observation. *All* the files must be input to the `asolfile` parameter, either as a comma-separated list or as a stack.

```
unix% punlearn sso freeze  
unix% pset sso_freeze infile=acisf01463N002_evt2.fits  
unix% pset sso_freeze scephemfile=orbitf059443264N002_eph1.fits  
unix% pset sso_freeze ssoephemfile=jupiterf059875200N002_eph1.fits  
unix% pset sso_freeze asolfile=pcadf059968984N002_asol1.fits  
unix% pset sso_freeze ocsolfile=1463_oc_asol1.fits  
unix% pset sso_freeze outfile=frozenjupiter.fits  
unix% sso_freeze  
Input event file or stack (acisf01463N002_evt2.fits):  
Input spacecraft ephemeris file (orbitf059443264N002_eph1.fits):  
Input solar system object file (jupiterf059875200N002_eph1.fits):  
Output event file name (frozenjupiter.fits):
```

The contents of the parameter file may be checked using `plist sso freeze`.

---

## Display the Results

The new object-centered coordinates are stored in the `ocx` and `ocy` columns of the file. When displaying the "frozen" image, we must specify to bin on those columns (**note** that the binning syntax for `ds9` is not the same as for the DM):

```
unix% ds9 "frozenjupiter.fits[bin=ocx,ocy]" &
```

Alternatively, the image can be loaded in the usual way into `ds9`:

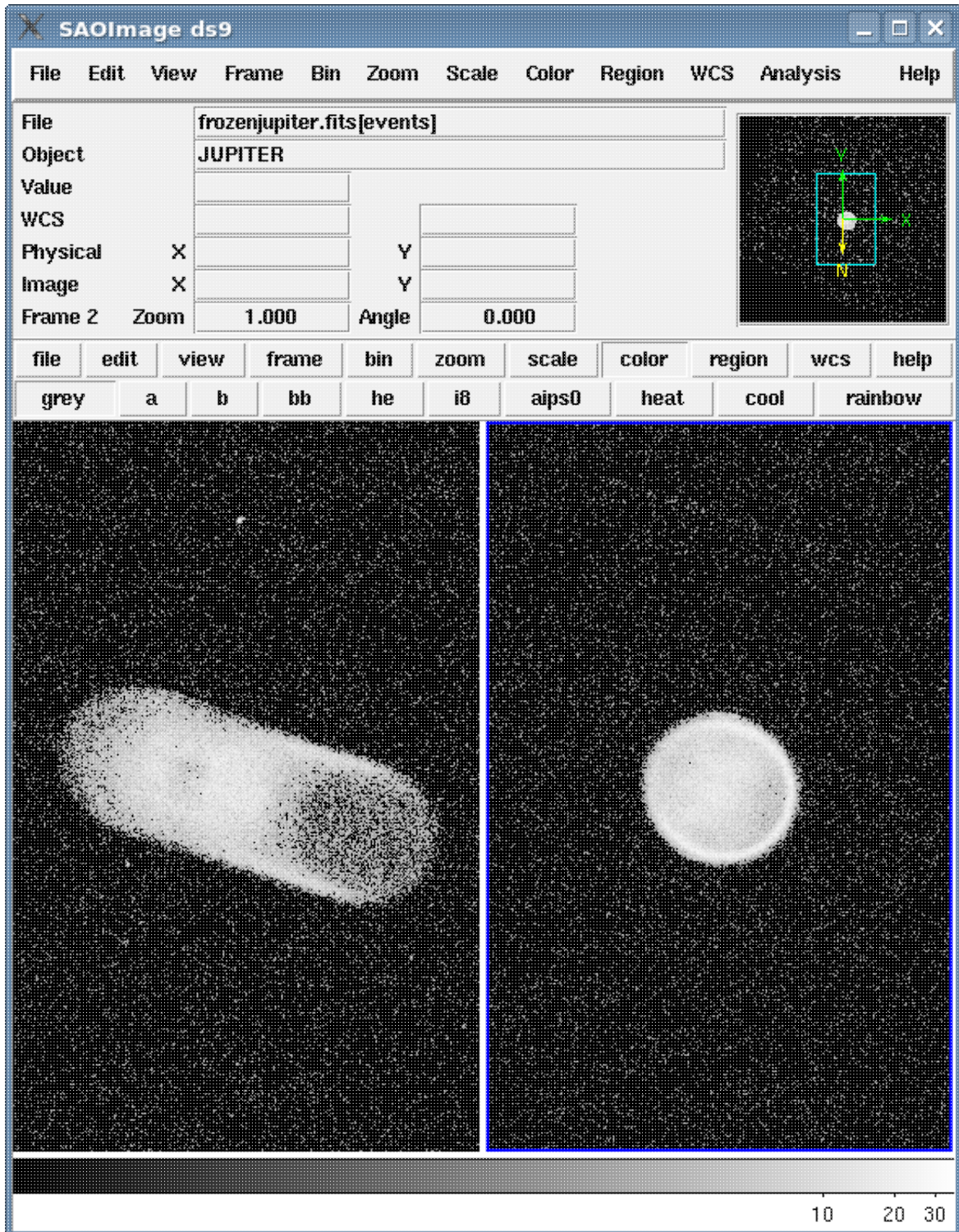
```
unix% ds9 frozenjupiter.fits
```

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```
unix% ds9 frozenjupiter.fits &
```

Then the binning may be changed with the "Bin Binning Parameters..." dialog box. Choose "ocx" and "ocy" with the buttons in the "Bin Columns" section.

Figure 1 shows the original and "frozen" images side-by-side.



## Figure 1: Comparison of original and "frozen" images

The [Object-centered Aspect Solution and Exposure Map thread](#) explains how to use the object-centered aspect solution file.

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Parameters for /home/username/cxc/cxcds\_param/sso\_freeze.par

```
#-----
#
# sso_freeze.par- Parameter file for planetary transformations routine
#
#-----
infile = acisf01463N002_evt2.fits Input event file or stack
scephemfile = orbitf059443264N002_eph1.fits Input spacecraft ephemeris file
ssoephemfile = jupiterf059875200N002_eph1.fits Input solar system object file
outfile = frozenjupiter.fits Output event file name
(asolfile = pcadf059968984N002_asol1.fits) Input aspect solution file
(ocsolfile = 1463_oc_asol1.fits) Output asol in OC coordinates
(logfile = STDOUT)          debug log file ( STDOUT | stdout | <filename>)
(scale = 0)                  Image pixel scale (km/pixel, 0=angular coords)
(lookuptab = ${ASCDS_CALIB}/dmmerge_header_lookup.txt -> /soft/ciao/data/dmmerge_header_lookup.txt) lo
(clobber = no)               Overwrite existing output dataset with same name?
(verbose = 0)                 debug level (0-5)
(mode = ql)
```

---

## History

- 03 Jan 2005 reviewed for CIAO 3.2: no changes
- 16 Dec 2005 updated for CIAO 3.3: bug in *ChaSeR* means that orbit ephemeris files must be retrieved from the CDA FTP site
- 01 Dec 2006 reviewed for CIAO 3.4: no changes
- 18 Jan 2008 updated for CIAO 4.0: *sso\_freeze* can create object-centered aspect solution ([Object-centered Aspect Solution thread](#)); include aspect solution files in *sso\_freeze* run; parameter file updated with new [asolfile](#) and [ocsolfile](#)
- 04 Feb 2009 updated for CIAO 4.1: image is inline

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URL: <http://cxc.harvard.edu/ciao/threads/ssofreeze/>

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