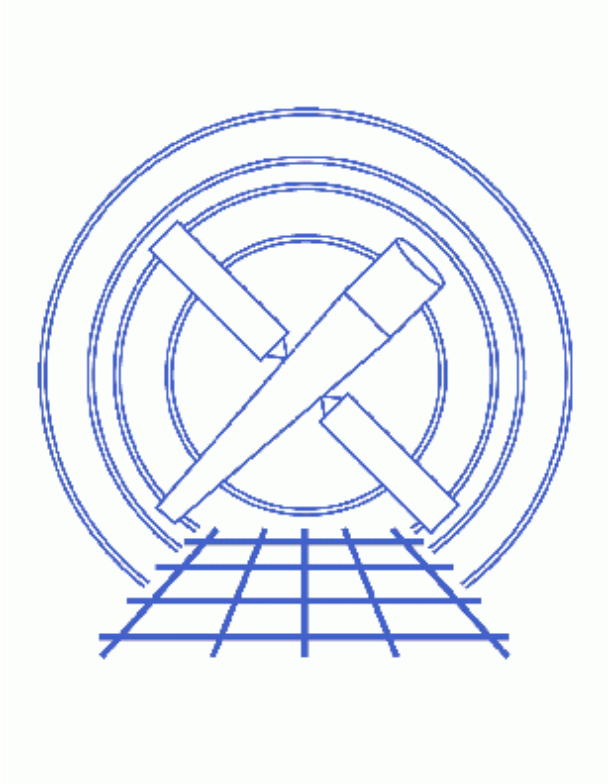
Using an Exposure Map in Fitting Image Data



Sherpa Threads (CIAO 3.4)

Table of Contents

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Sherpa Threads

Overview

Last Update: 1 Dec 2006 − reviewed for CIAO 3.4: no changes

Synopsis:

This thread shows how to use an exposure map when fitting 2−D spatial data. The exposure map file is input to *Sherpa* through the file−based exposure map model (FEXPMAP).

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

Getting Started

Please follow the "Sherpa Threads: Getting Started" thread.

Reading and Plotting 2−D FITS Data

We are using 2−D spatial data from the FITS datafile `img.fits`. This dataset is input into *Sherpa* with the DATA command:

```
sherpa> DATA img.fits
```

The dataset may be viewed as a contour plot, surface plot or an image. Here we show the surface plot method, creating a postscript file of the output as well:

```
sherpa> SPLOT DATA
sherpa> PRINT POSTFILE splot.ps
```

This creates Figure 1 .

Setting the Exposure Map

The following is similar to the process of defining responses for spectral data, where a 1−D instrument model (RSP) is defined and set as the instrument.

We define the exposure map model:

```
sherpa> FEXPMAP[emap]
emap.file parameter value ["none"] expmap.fits
emap.norm parameter value [1]
sherpa> INSTRUMENT = emap
```

To display the status of the model `emap`, use the `SHOW` command. Note that `FEXPMAP` is an alternate name for `FARF2D`; *Sherpa* identifies it by the latter:

```
sherpa> SHOW emap
farf2d[emap]
    Param   Type      Value        Min        Max                Units
    -----   ----      -----        ---        ---                -----
 1   file string: "expmap.fits"
 2   norm frozen          1          0       1000
```

The normalization (`norm`) is frozen at 1, since the exposure map is normalized to the exposure time of the image; this is how all exposure maps are generated in the CIAO exposure map threads.

Defining and Fitting the Source

One can now define a model to be used as a source model. After viewing Figure 1  , the `BETA2D` model is found to be a promising candidate for the source. Since we want to set the initial values, we leave on the parameter prompting:

```
sherpa> BETA2D[bm]
bm.r0 parameter value [80] 30
bm.xpos parameter value [36.5] 40
bm.ypos parameter value [41.5] 40
bm.ellip parameter value [0] 0.3
bm.theta parameter value [0] 5
bm.ampl parameter value [1.51294] 3.0
bm.alpha parameter value [1] 1.5

sherpa> THAW bm.ellip bm.theta
```

The `BETA2D` model is defined for the source, then the data is fit:

```
sherpa> SOURCE = bm
sherpa> FIT
 LVMQT: V2.0
 LVMQT: initial statistic value = 4.88095e+06
 LVMQT: final statistic value = 3255.75 at iteration 11
            bm.r0  12.4624
            bm.xpos  39.5139
            bm.ypos  40.8959
            bm.ellip  0.0259204
            bm.theta  4.72828
            bm.ampl  1.31312
            bm.alpha  1.66641
```

To display the fit and residuals of the plot, we again use `SPLOT`:

```
sherpa> SPLOT 2 SOURCE RESIDUALS
```

where `RESIDUALS` refers to the absolute residuals, calculated as `(data − model)`. This creates Figure 2  .

Alternately, use DELCHI, the sigma residuals of the fit; these are calculated as ((data − model)/error):

```
sherpa> SPLOT 2 SOURCE DELCHI
```

as shown in Figure 3  .

Saving a Sherpa Session

To save the *Sherpa* session:

```
sherpa> SAVE ALL expmap.shp
```

where expmap.shp is the output ASCII file. The information is written in the form of a *Sherpa* script. The USE command will restore the session when desired.

The source (unconvolved model amplitudes), model (convolved model amplitudes), and residuals may all be written out in FITS format with the WRITE command:

```
sherpa> WRITE SOURCE expmap_source.fits
Write X-Axes: (Bin,Bin)  Y-Axis: Amplitude (Photons/bin)

sherpa> WRITE MODEL expmap_model.fits
Write X-Axes: (Bin,Bin)  Y-Axis: Counts

sherpa> WRITE RESIDUALS expmap_residuals.fits
Write X-Axes: (Bin,Bin)  Y-Axis: Counts
```

The output may be examined as any standard FITS file, e.g. with *prism*, ds9, or dmlist.

Summary

This thread is complete, so we can exit the *Sherpa* session:

```
sherpa> EXIT
Goodbye.
```

History

14 Jan 2005	reviewed for CIAO 3.2: no changes
21 Dec 2005	reviewed for CIAO 3.3: no changes
01 Dec 2006	reviewed for CIAO 3.4: no changes

Image 1: Surface plot of the data

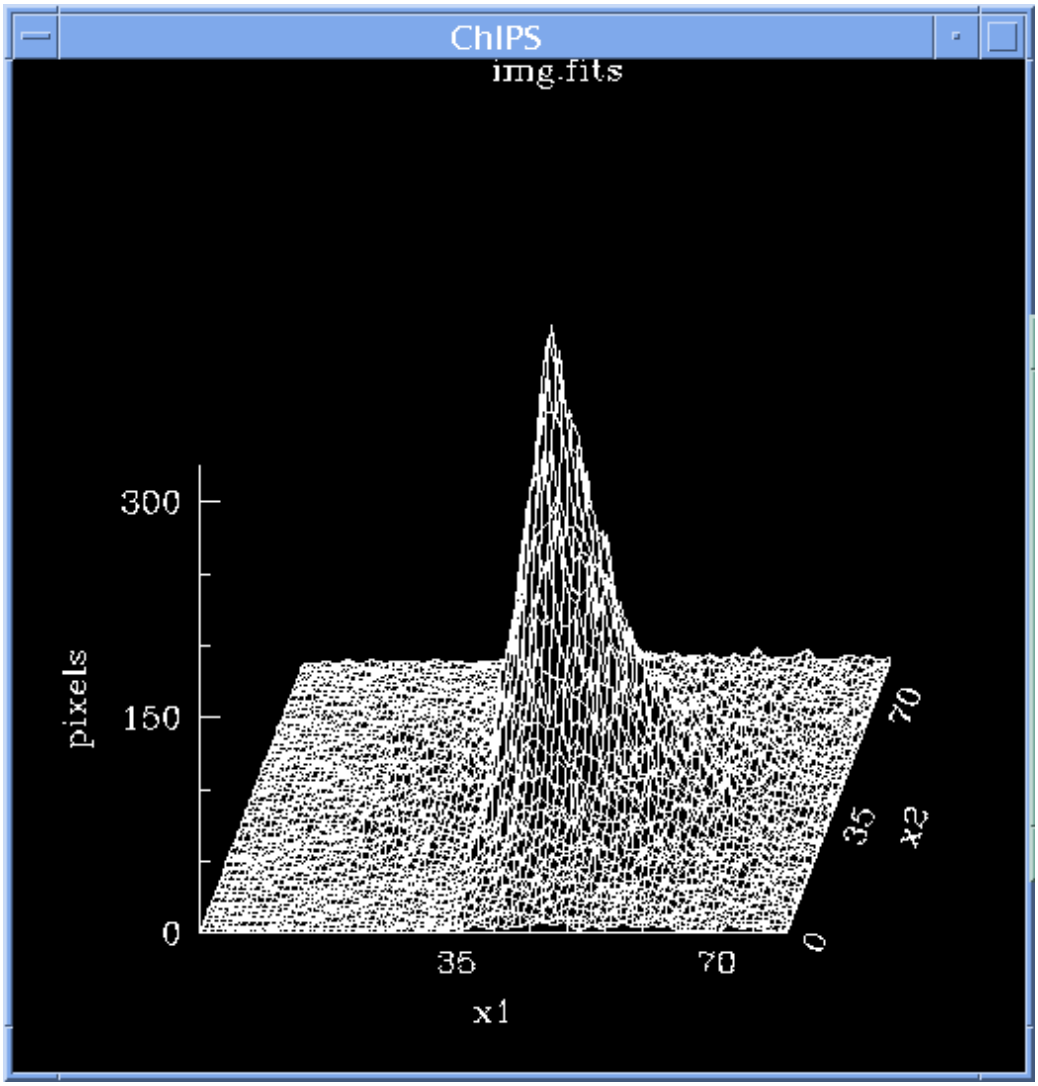

Image 2: Fit and absolute residuals

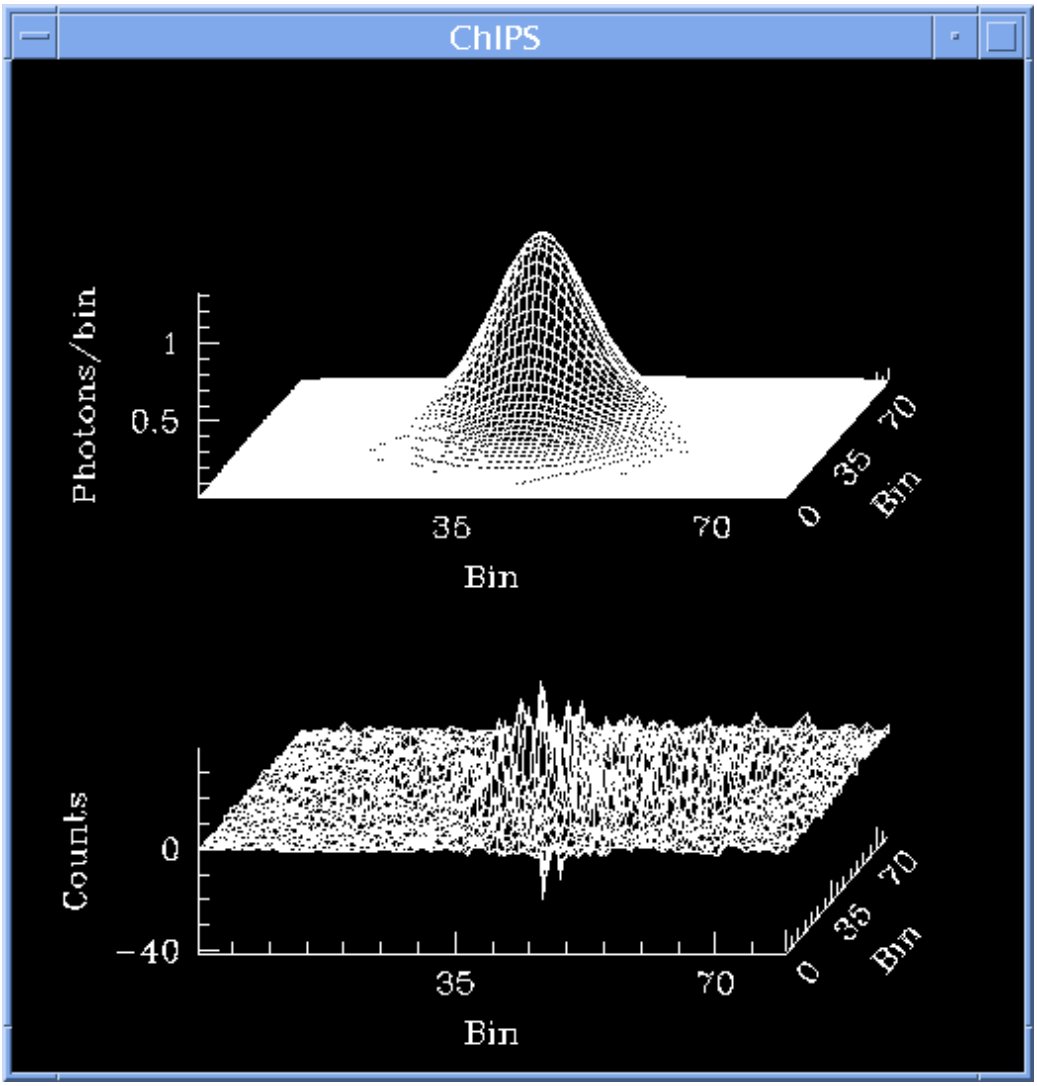

Image 3: Fit and sigma residuals

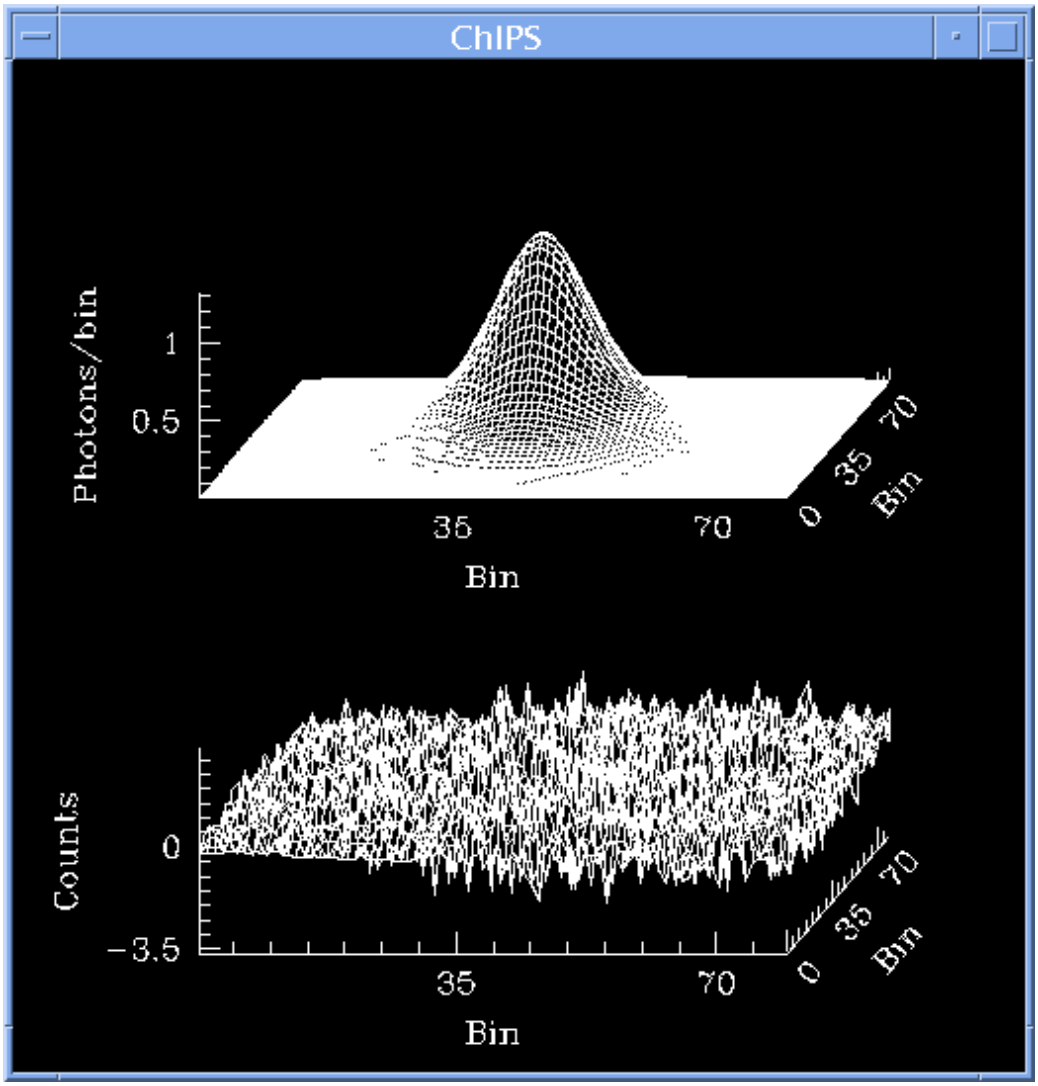

Image 3: Fit and sigma residuals