![Chandra X-ray Center logo]

Welcome to CIAO

The remarkable science capabilities of the Chandra X-ray Observatory demanded new, flexible, multi-dimensional software to analyze the data it returned. The result is CIAO, a system that has proven itself useful for the analysis of data from other, non-X-ray missions, because of the mission independence that is the basis of the CIAO design.

The Introduction to Tools and Applications page describes the classes of tools and gives links to the tool help files. The Release Notes have detailed information regarding the most recent version of CIAO and any patches, including new tool descriptions and bug fixes. The Data Caveats page gives warnings for specific data sets.

There are CIAO Software downloads available for several platforms.

For information regarding calibration and how CIAO uses cal information, try visiting the CALDB page. You may also find the Chandra Instruments and Calibration page useful.

High resolution spectroscopy using the Chandra gratings requires a greater amount of atomic physics knowledge than previous X-ray astronomy has done. The CXC has therefore supported the creation of a new atomic physics database, APED.

The following is a simple example of how CIAO works. This set of commands creates an energy spectrum for a region of an event file. The data is from the ObsID 214 dataset (an ACIS-S observation of supernova remnant Cassiopeia A), which was downloaded from the Archive.

We begin by loading the event file into the image viewer, ds9. The event file will appear something like the one below.

```
unix% ds9 acis_evt2.fits &
```
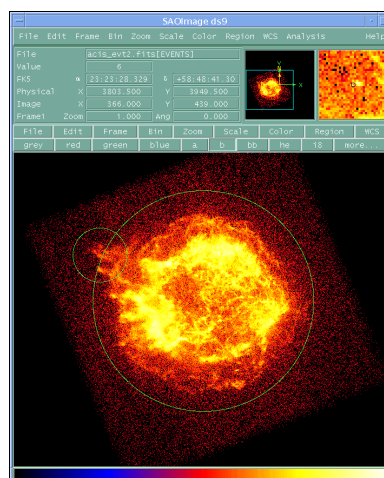
Now we select a region to contain most of the source emission (the green circles displayed on the ds9 image). The resulting file (obj.reg) will look similar to the following:

```
unix% more obj.reg
# Region file format: CIAO version 1.0
circle(3818,3980,408)
circle(3436,4150,100)
```

The dmextract tool can be used to create a spectrum for the source by binning the events which fall within this region:

```
unix% punlearn dmextract
unix% dmextract "acis_evt2.fits[(x,y)=region(obj.reg)][bin pi]" spectrum.fits
```
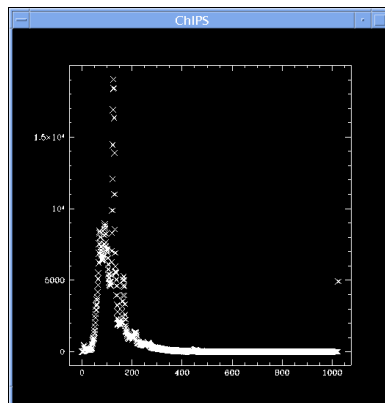
The PI spectrum can now be plotted and examined using *ChIPS*, the CIAO plotting tool:

```
unix% chips

Welcome to ChIPS, version CIAO 3.4
Copyright (C) 1999-2003, Smithsonian Astrophysical Observatory

chips> curve "spectrum.fits[cols channel,counts]"
```

Which produces the plot below. The prism file browser can also be used to select data to plot using ChIPS.

This spectrum may also be used as input to *Sherpa*, the CIAO modeling and fitting tool, and analyzed further:

```
unix% sherpa

----------------------------------------------------
Welcome to Sherpa: CXC's Modeling and Fitting Program
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Version: CIAO 3.4

Type HELP for help options.
Type EXIT, QUIT, or BYE to leave the program.

Notes:
    Temporary files for visualization will be written to the directory:
    /tmp
    To change this so that these files are not deleted when you exit Sherpa,
    edit $ASCDS_WORK_PATH in your 'ciao' setup script.

    Solar abundances set to Anders & Grevesse

sherpa> data spectrum.fits
```

```
The inferred file type is PHA.  If this is not what you want, please
specify the type explicitly in the data command.
sherpa> lplot data
sherpa> ignore bin 250:
sherpa> lplot data
```

This filtering shows the detail of the spectrum in the plot below. Analysis of greater depth, such as fitting a source model, may be done in *Sherpa* once the necessary response files have been created.
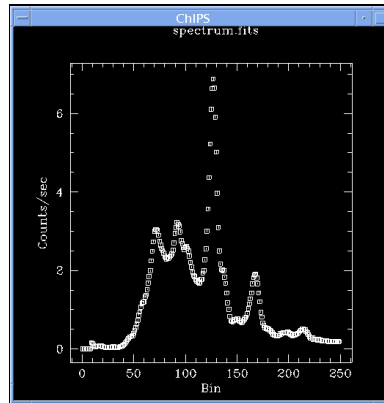
The CIAO Threads page contains more examples of frequently used data analysis procedures.