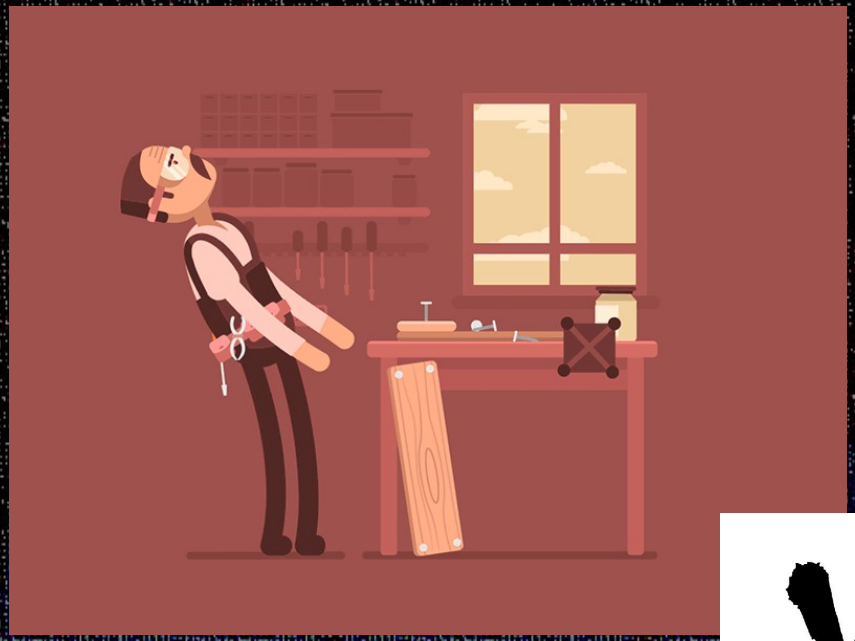


Vs

Hey, I'm Diego!
(even if I don't ware my badge)

Introduction to CIAO

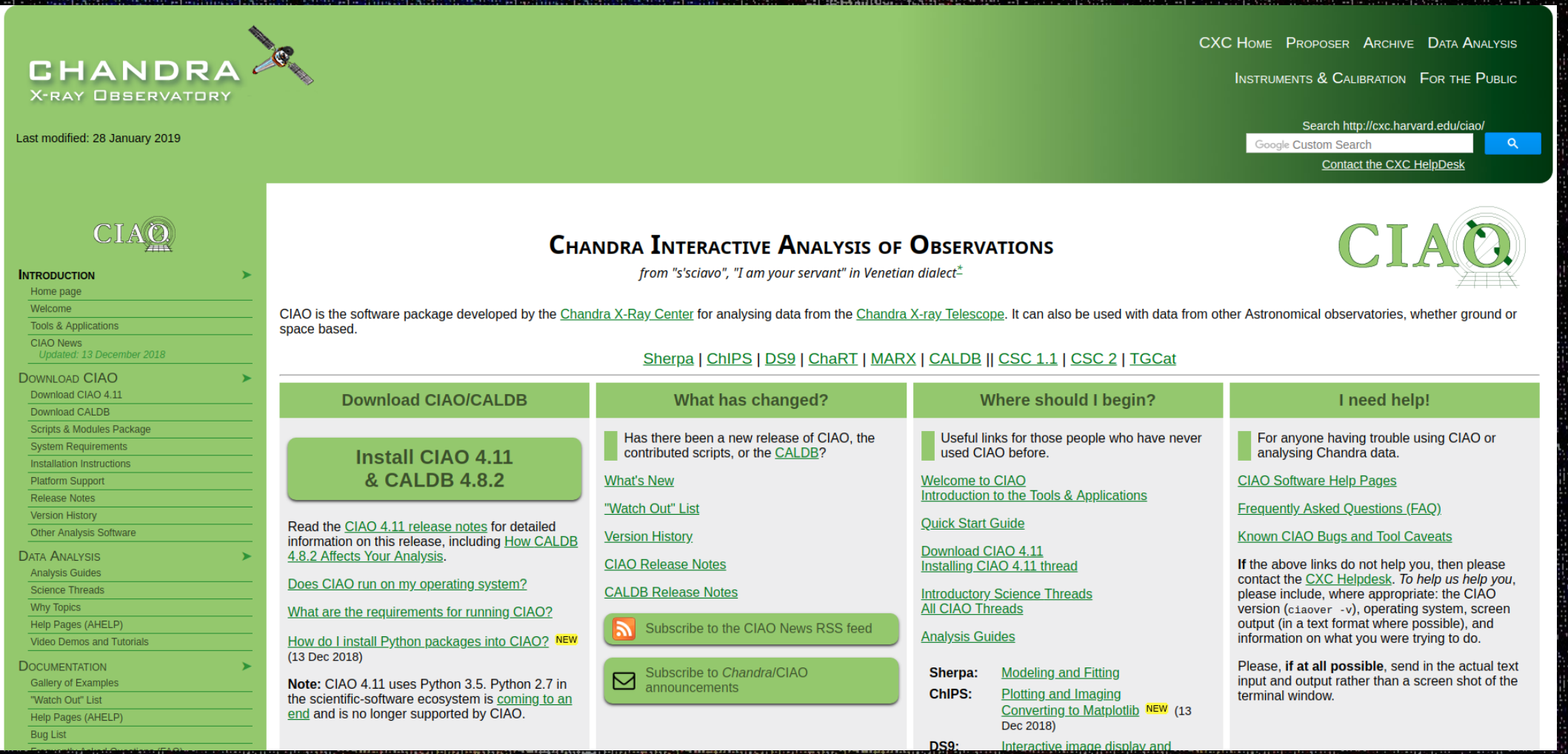
(Chandra Interactive Analysis of Observations)

Slides by A. Fruscione;
Presented by R. Smith

CIAO: Chandra's data analysis system
Fruscione et al. 2006, SPIE Proc. 6270, 62701V, D.R. Silvia & R.E. Doxsey, eds.

Where do we start?

http://cxc.harvard.edu/ciao/



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CIAO: Chandra Interactive Analysis of Observations

from "s'sciavo", "I am your servant" in Venetian dialect*

Dialect and Language

We received the following email from a concerned CIAO user.

CIAO Webpage: correction suggested

From: [name deleted]
Date: Tue Aug 07 2001 - 11:44:24 EDT

To whom it may concern:

I read in your CIAO Web page (http://cxc.harvard.edu/ciao/) that CIAO is:

> from "s'sciavo", "I am your servant" in Venetian dialect

True, but I would like to point out that the Venetian is a language in its own right, not a dialect. The fact that the Republic of Venice has become in recent times part of Italy does not mean that its ancient language should also be downgraded to a dialect, which linguistically speaking is not.

Sorry for being so pedantic but we are very proud of our culture.

The rest of the site is top quality, well done.

Sincerely,
[signature deleted]

Can I install it?

CIAO 4.11 is available as precompiled binaries for the following platforms:

Linux

The Linux builds are done on a CentOS 6.9 machine and have been fully tested on CentOS 6 and Fedora 25+. The Linux build will not work on some older Linux operating systems, including CentOS 5 and earlier versions of Fedora. Linux users may need to install the `ncurses5` compatibility package using their Linux distribution's package manager.

CIAO 4.11 *does not* run on standard installations of:

- Any 32 bit Linux
- Cent OS5
- RHEL version 5 or lower
- Slackware Linux (missing SELinux system library)

This is the default Linux distribution and will be installed automatically on all non-Ubuntu based distributions. The following is a short list of distributions where it will be installed: Fedora, RedHat, CentOS, ScientificLinux, openSUSE, and Mageia.

Can I install it?

Downloading CIAO 4.11 and CALDB 4.8.2

WHAT'S NEW | WATCH OUT
Release Notes | System requirements | Platform support

Steps to install CIAO (if the following does not work then try the Manually Installing CIAO 4.11 thread):

0

Please be aware of the following issues before installing CIAO 4.11 (see the watchout page for more information):

- CIAO 4.11 only supports Python 3.5
- macOS users **must** install recent versions of XQuartz and XCode.
- macOS Sierra, High Sierra, and Mojave: the `chips-smoke003` fails and there are usability issues with ChIPS.
- CIAO 4.11 does not support 32-bit Linux or macOS Yosemite (10.10) and earlier.
- `Fontconfig error: Cannot load default config file` can be ignored as long as the test reports `PASS`.

And CIAO is...

1) A powerful data analysis system originally written for the needs of users of the Chandra X-ray Observatory.
2) Built to handle N-dimensional data without concern about which particular axes are being analyzed: Chandra has 4-dimensional data (2 spatial, time, energy) in which each dimension has many independent elements.
3) Mission independent (a part from a few instrument specific tools).
4) All the different tools talk to each other!

CIAO overview

Data manipulation: copy, filter, extraction, stats, etc.

Data preparation (or Chandra-specific instrument tools): update calibration, correct for instrumental effects, find & extract grating data, create aspect histograms

Response tools: exposure map, PSF, RMF and ARF

Source Detection: celldetect, wavdetect, vtpdetect

Timing & Background tools: lighcurve, power specrtrum, barycenter correction

Convolutions, Transforms, & Smoothing: csmooth, aconvolve, acrosscorr, apowerspectrum

Plotting: ChIPS (*)

Modeling/Fitting: Sherpa (*)

S-Lang: modules (parameter, region, group, pixlib (coord. transformation), caldb, stack, xpa, varmio); shell ("slsh") to execute S-Lang scripts on the command line

GUIs: DS9, prism,peg

(*) powerful data manipulation and scripting capabilities are now possible in these applications through the Python and S-Lang interpreted language. ChIPS and Sherpa are importable modules for Python and S-Lang.

The “Data Model”

1) The CXC analysis and processing software is built on a common versatile interface library called the CXC Data Model (or just DM).

2) The DM provides users with a powerful built-in data filtering and binning capability.

3) The name “Data Model” reflects the fact that the interface can be used on data files of different format (all described by a single abstract description - the same “model”) in a transparent way.

The “Data Model”

1) An important characteristic of the DM is that ANY program that asks for a data file name as input accepts a “virtual file” string which causes the program to see a filtered version of the file in question.

2) The *“virtual file”* syntax is also commonly used to create on disk a filtered version of the input file.

3) Another important characteristic of the DM is that all columns of event lists are treated “equally”: for example binning is allowed not only in spatial coordinates but also in e.g. time, or energy coordinate, giving the ability of creating multidimensional images in space-energy, or space-time, etc.

DATA MODEL SYNTAX (`ahelp dmsyntax`)

- All CIAO tools use the DM library and therefore accept as input "virtual files" described using the DM syntax.
- In the DM context a "virtual file" in represented by a filename followed by a series of optional qualifiers in square brackets [ ]:

"filename[block][filter][columns/binning][options][rename]"

where:

block - is the "section" of the file to use

filter- is the filter to be applied

columns/binning - specifies either the columns from a table to be included in an output table or the binning. When binning the data to generate an n- dimensional image, the range and binsize (min:max:bin) must be specified.

options - a sequence describing special options for the DM library

rename - specifies a name for the new block

Note that:

- the order of the qualifiers generally matters, however...
- not all qualifiers need to be present always

Block????

[block]: the extension of the file to use, e.g. the name of the image or table. For FITS files, the block corresponds to an HDU and may be identified by name ("[EVENTS]") or number ("[2]"). If the block is not specified, the first "interesting" block is used (e.g. [EVENTS] for an event file). To view the blocks in a file, use "dmlist file.fits blocks".

Simple examples of "virtual files":

- Select the first three columns of the EVENTS block by number:
  `acisf01843N001_evt2.fits[EVENTS][time=84245787:84247000][cols #1,#2,#3]`

  or by name:

  `acisf01843N001_evt2.fits[EVENTS][grade=0,2,3][cols time,ccd_id,node_id]`

  after filtering in time or grade

- Bin an events file to create a PI spectrum for a specified region (input of dmextract): `acisf01843N001_evt2.fits[EVENTS][sky=region(mysrc.reg)][bin pi=1:1024:1]`

  or an image (input of dmcopy):
  `acisf01843N001_evt2.fits[EVENTS][pha<100][bin x=320:480:4,y=320:480:4]`

Examples:

Tools are usually executed from the command-line prompt:

```
unix% dmcopy "acisf01843N003_evt2.fits[EVENTS]" acis_events.fits
```

- Make a histogram from a table column:

```
unix% dmextract "acisf01843N003_evt2.fits[bin pha=1:2048:2]" histogram.pha
```

- Extract the PI spectrum of a source in sky coordinates:

```
unix% dmextract "acisf01843N003_evt2.fits[sky=region(ds9.reg)][bin pi]" \
      spectrum.fits
```

where

```
unix% more ds9.reg
# Region file format: CIAO version 1.0
ellipse(1628,4116,92,172,0)
```

Synopsis

Access the CIAO help documentation.

Syntax

```
ahelp [-n width] [-s|-m|-l] subject
ahelp [-n width] [-s|-m|-l] context subject
ahelp [-n width] -b blockname [-t attribute] subject
ahelp [-n width] -b blockname [-t attribute] context subject
ahelp [-n width] -c context
ahelp [-n width] -c
ahelp -r [path]
ahelp [-x default_context] [-n width ] [-s|-m|-l] -f xmlfile
ahelp -k keyword
about keyword
```

Description

The ahelp command accesses the CIAO command-line documentation
The CIAO site contains HTML versions of the help files.

Finding help for a given subject

The help files are arranged by subject into contexts (both subject and c
either:

```
unix% ahelp <subject>
```

or

```
unix% ahelp <context> <subject>
```

Command line help: ahelp

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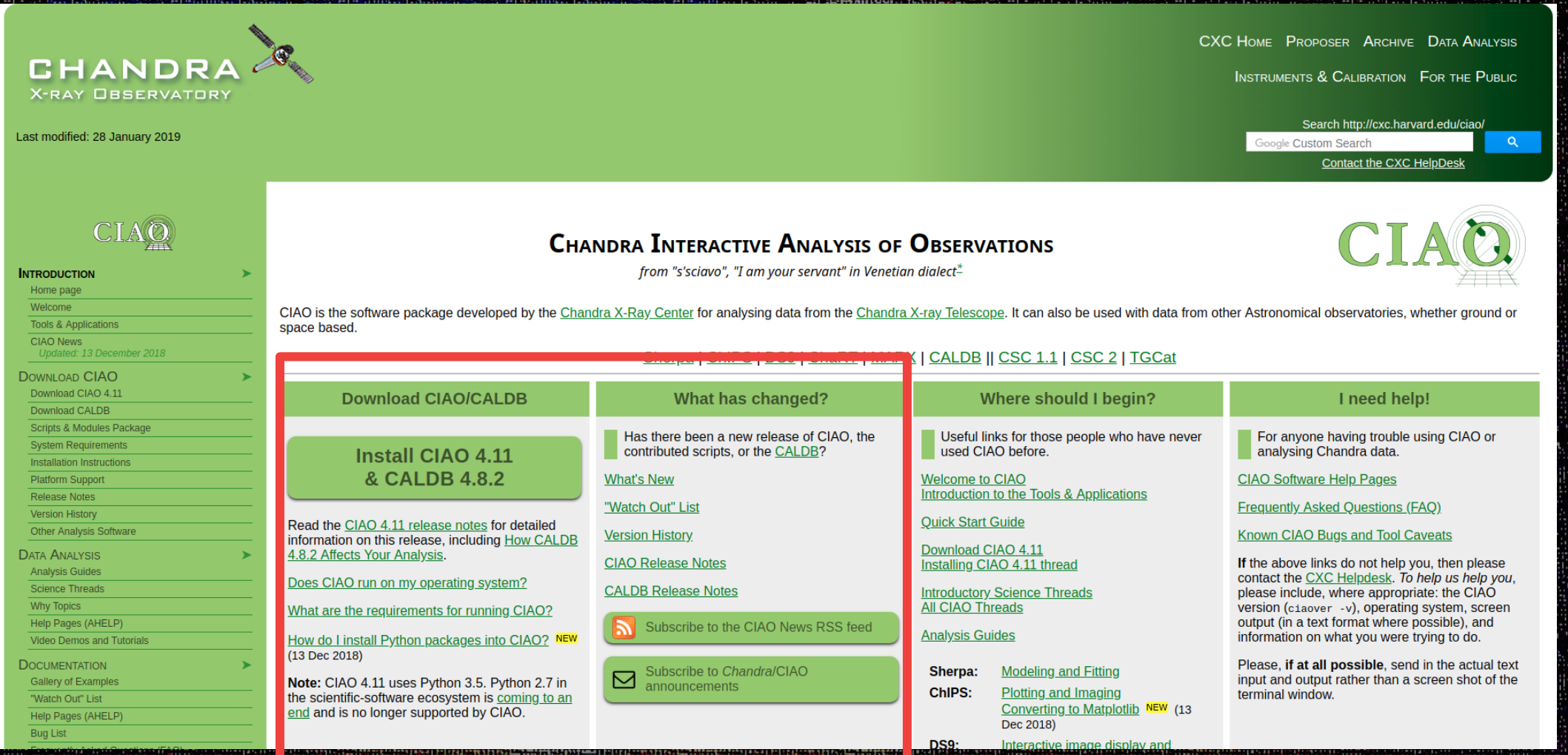

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I need more!

For the expert CIAO user or person who needs more detailed information.

Why Topics

Manuals

Understanding the Chandra PSF.

Galleries (Tips & Tricks): CIAO; Sherpa; ChIPS.

The Chandra Instrument Calibration pages.

Using Python with CIAO UPDATED (13 Dec 2018)

CSC v2:	Chandra Source Catalog 2
CSC v1:	Chandra Source Catalog 1.1
TGCat:	Chandra Gratings Catalog

Citing CIAO

If you are writing a paper and would like to cite the CIAO software, we recommend the following:

CIAO: Chandra's data analysis system (ADS, PS)
Fruscione et al. 2006, SPIE Proc. 6270, 62701V, D.R. Silvia & R.E. Doxsey, eds.

```
\bibitem[Fruscione et al.(2006)]
{2006SPIE.6270E..60F} Fruscione, A., et
al.\ 2006, \procspie, 6270
```

The specific version of CIAO and CALDB used for the analysis should be mentioned.

Further guidelines are available from the Acknowledgment of Use of Chandra Resources.

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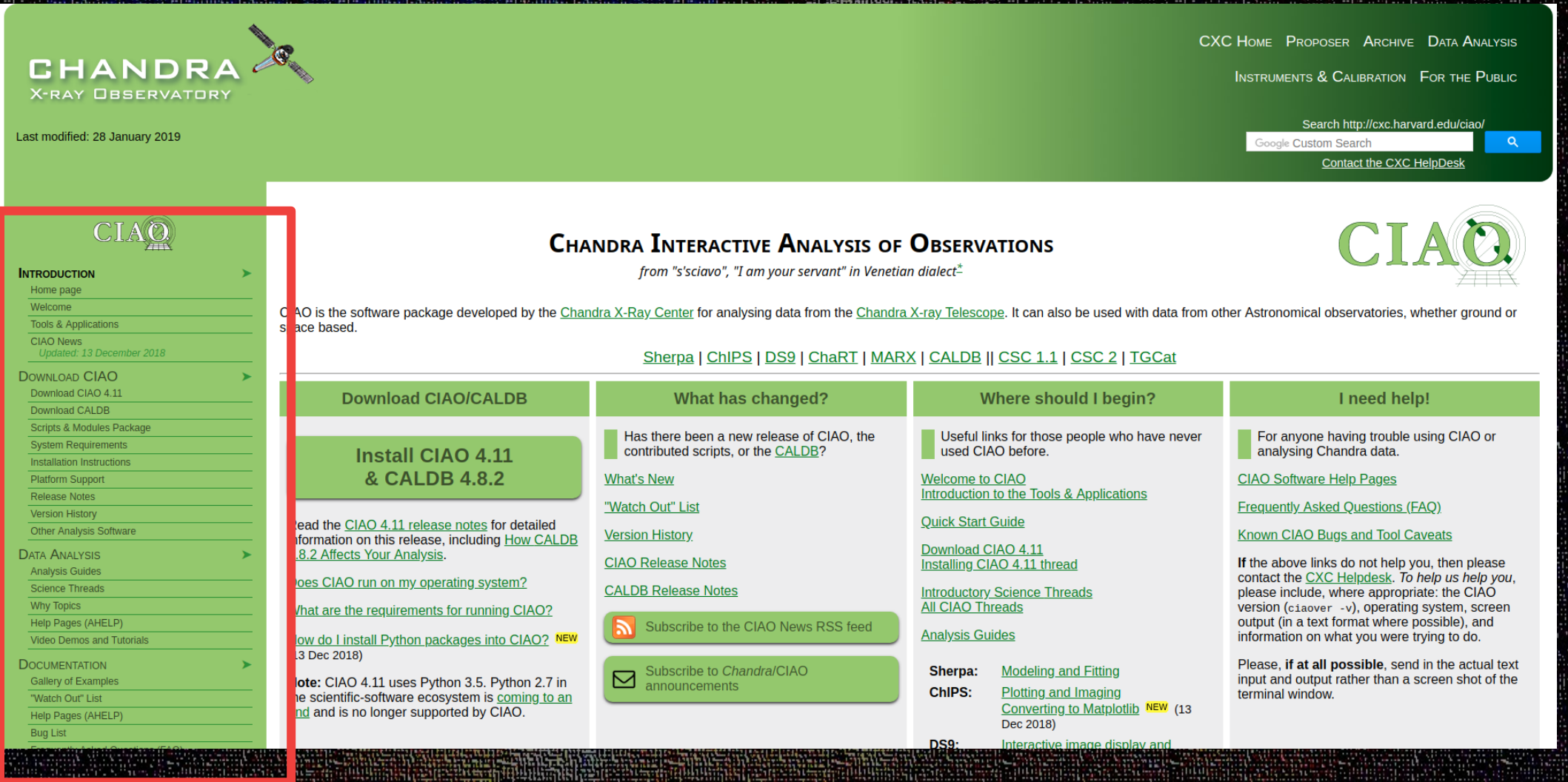

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Sherpa (Modeling and Fitting)

- Sherpa website
- Sherpa for Python users
- Threads
- Help Files

ChIPS (Plotting Package)

- ChIPS website
- Threads
- Help Files

Scripting in CIAO

- Introduction UPDATED (13 Dec 2018)
- Modules

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What has changed?

Has there been a new release of CIAO, the contributed scripts, or the CALDB?

What's New

"Watch Out" List

Version History

CIAO Release Notes

CALDB Release Notes

Subscribe to the CIAO News RSS feed

Subscribe to *Chandra*/CIAO announcements

Where should I begin?

Useful links for those people who have never used CIAO before.

Welcome to CIAO
Introduction to the Tools & Applications

Quick Start Guide

Download CIAO 4.11
Installing CIAO 4.11 thread

Introductory Science Threads
All CIAO Threads

Analysis Guides

Sherpa: Modeling and Fitting

ChIPS: Plotting and Imaging
Converting to Matplotlib NEW (13 Dec 2018)

DS9: Interactive image display and

I need help!

For anyone having trouble using CIAO or analysing Chandra data.

CIAO Software Help Pages

Frequently Asked Questions (FAQ)

Known CIAO Bugs and Tool Caveats

If the above links do not help you, then please contact the CXC Helpdesk. *To help us help you*, please include, where appropriate: the CIAO version (`ciaover -v`), operating system, screen output (in a text format where possible), and information on what you were trying to do.

Please, **if at all possible**, send in the actual text input and output rather than a screen shot of the terminal window.

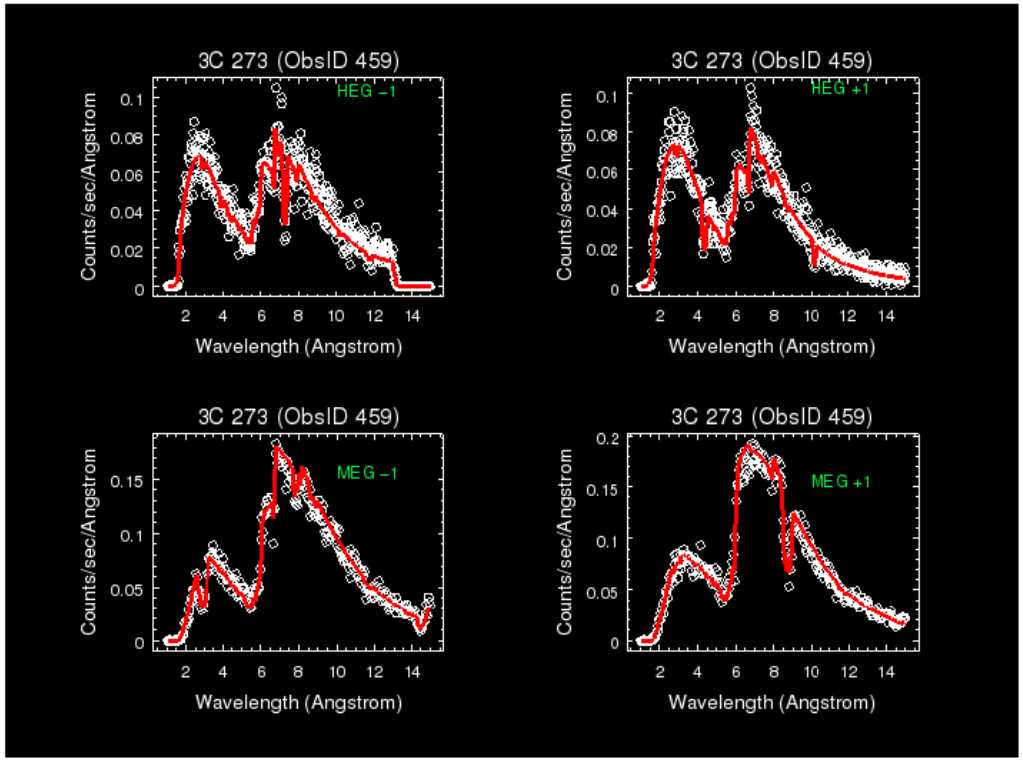
Sherpa | ChIPS | DS9 | ChaRT | MARX | CALDB || CSC 1.1 | CSC 2 | TGCat

Sherpa | ChIPS | DS9 | ChaRT | MARX | CALDB || CSC 1.1 | CSC 2 | TGCat

Sherpa is the CIAO modeling and fitting application. It enables the user to construct complex models from simple definitions and fit those models to data, using a variety of statistics and optimization methods (see the Gallery of Examples).

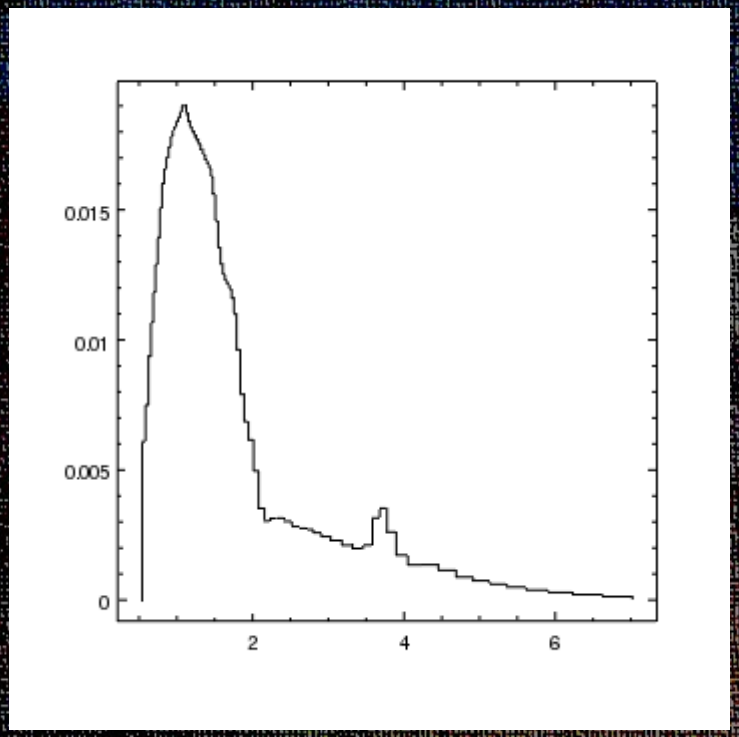
1D PHA data: Simultaneous power-law fit to ACIS-S/HETG source grating spectra

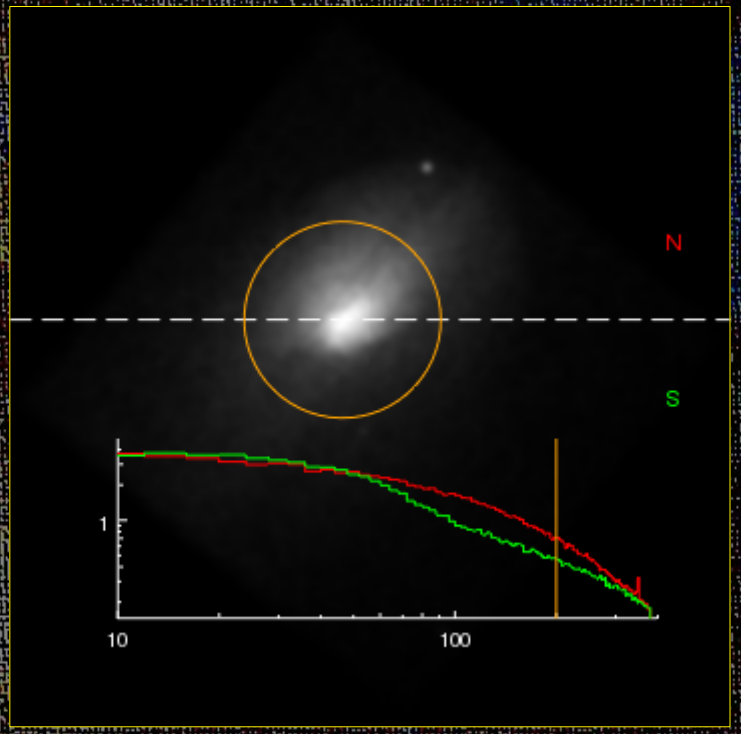
Here we display a simultaneous fit of four source-plus-background ACIS-S/HETG grating spectra, with the source modeled by an absorbed broken power-law, and the background modeled by an absorbed power-law.



Sherpa | ChIPS | DS9 | ChaRT | MARX | CALDB || CSC 1.1 | CSC 2 | TGCat

ChIPS is the imaging and plotting platform for CIAO. It can be used during data analysis - e.g. to plot a lightcurve - and to create publication-quality figures. A range of examples are included in the ChIPS Gallery and there are a number of Introductory threads to guide beginners.



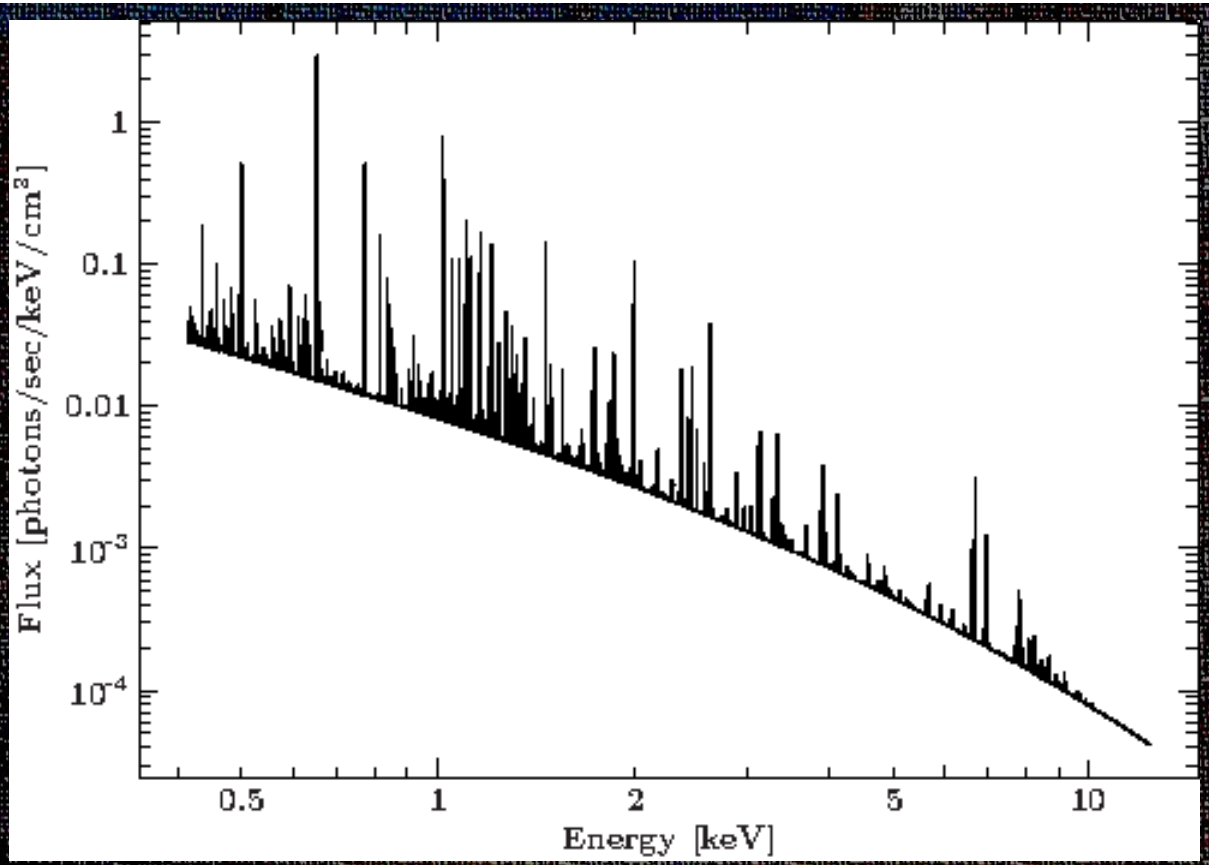


Chandra Ray Tracer (ChaRT)

The Chandra Ray Tracer (ChaRT) simulates the best available point spread function (PSF) for a point source at any off-axis angle and for any energy or spectrum. Technical details are available from the About ChaRT page.

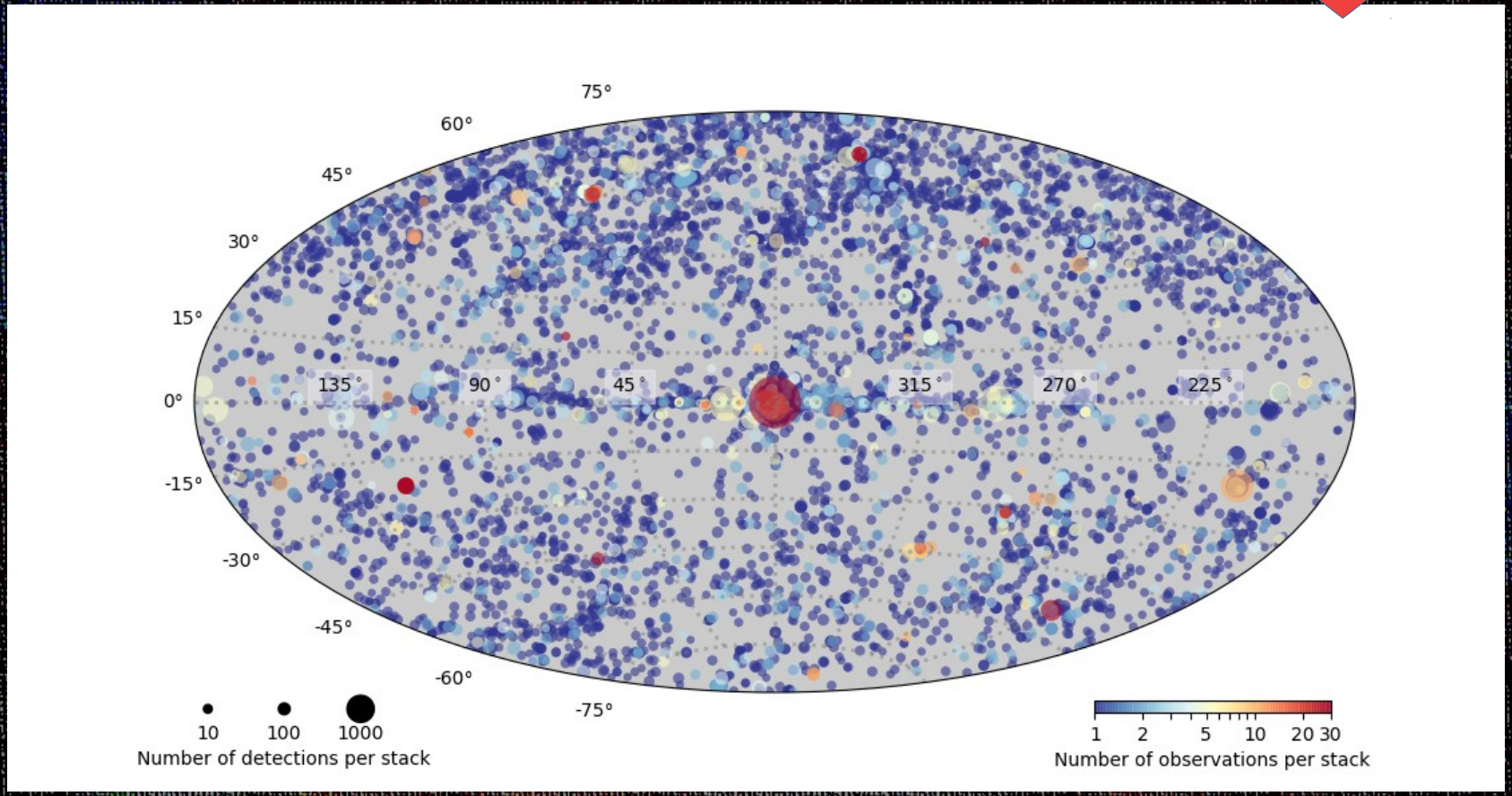
Sherpa | ChIPS | DS9 | ChaRT | MARX | CALDB || CSC 1.1 | CSC 2 | TGCat

marx is a suite of programs created and maintained by the MIT/CXC/HETG group group and is designed to enable the user to simulate the on-orbit performance of the Chandra X-ray Observatory. **marx** provides a detailed ray-trace simulation of how Chandra responds to a variety of astrophysical sources and can generate standard FITS event files and images as output. It contains detailed models for Chandra's High Resolution Mirror Assembly (HRMA), the HETG and LETG gratings, and all the focal plane detectors.



Simulation of a thermal plasma with the HETGS grating

Sherpa | ChIPS | DS9 | ChaRT | MARX | CALDB || CSC 1.1 | CSC 2 | TGCat



Chandra Source Catalog Release 2.0

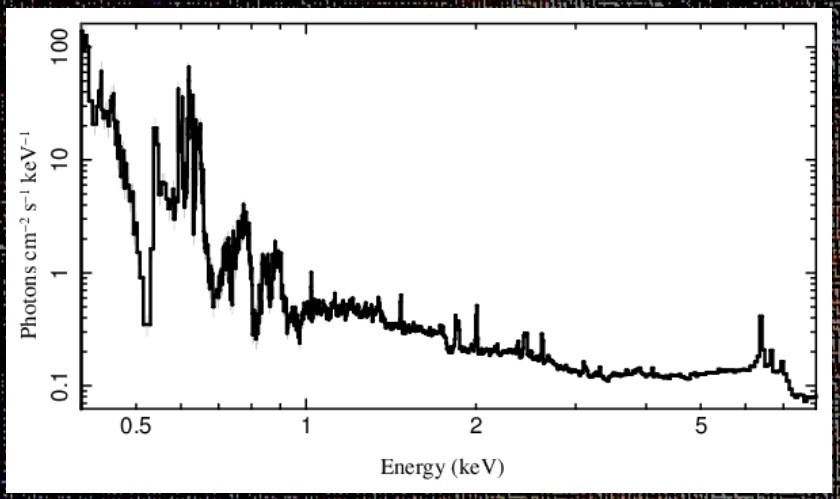
Sherpa | ChIPS | DS9 | ChaRT | MARX | CALDB || CSC 1.1 | CSC 2 | TGCat

Title: TGCat: The Chandra Transmission Grating Data Catalog and Archive

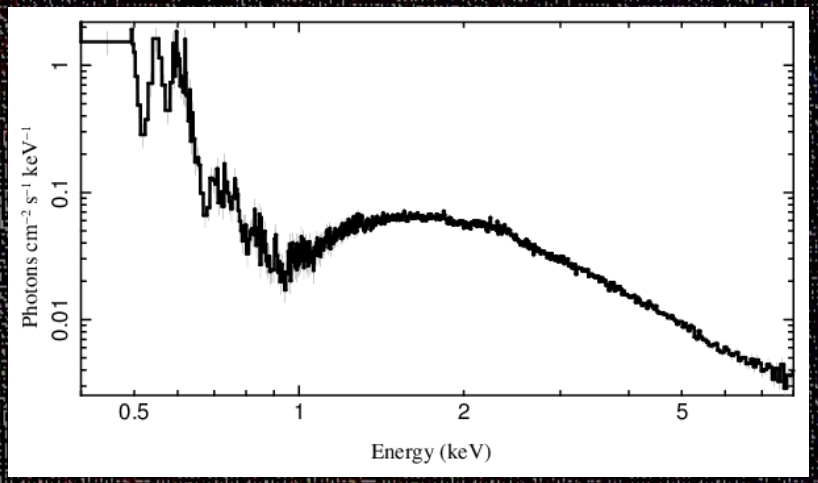
Authors: Huenemoerder, David P.; Mitschang, Arik; Dewey, Daniel; Nowak, Michael A.; Schulz, Norbert S.; Nichols, Joy S.; Davis, John E.; Houck, John C.; Marshall, Herman L.; Noble, Michael S.; Morgan, Doug; Canizares, Claude R.

Abstract

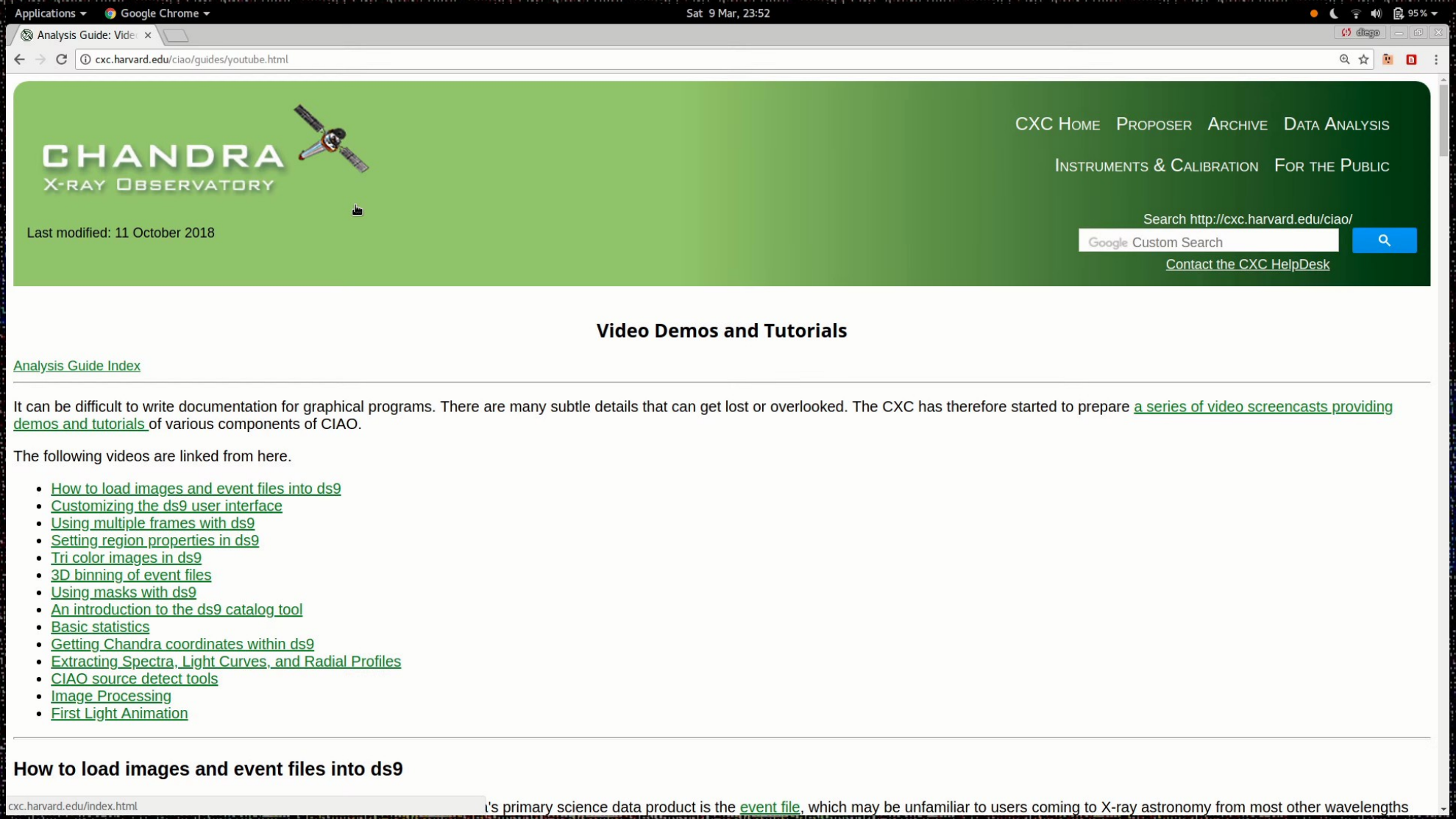
The Chandra Transmission Grating Data Archive and Catalog (TGCat) provides easy access to analysis-ready products, specifically, high-resolution X-ray count spectra and their corresponding calibrations. The web interface makes it easy to find observations of a particular object, type of object, or type of observation; to quickly assess the quality and potential usefulness of the spectra from pre-computed summary plots; or to customize a view with an interactive plotter, optionally combining spectra over multiple orders or observations. Data and responses can be downloaded as a package or as individual files, and the query results themselves can be retrieved as ASCII or Virtual Observatory tables. Portable reprocessing scripts used to create the archive and which use the Chandra X-ray Center's (CXC's) software and other publicly available software are also available, facilitating standard or customized reprocessing from Level 1 CXC archival data to spectra and responses with minimal user interaction.



HETG!



Not enough?


Applications
Google Chrome
Sat 9 Mar, 23:52
95%
Analysis Guide: Vide
cxc.harvard.edu/ciao/guides/youtube.html
CHANDRA
X-RAY OBSERVATORY
CXC HOME PROPOSER ARCHIVE DATA ANALYSIS
INSTRUMENTS & CALIBRATION FOR THE PUBLIC
Last modified: 11 October 2018
Search http://cxc.harvard.edu/ciao/
Google Custom Search
Contact the CXC HelpDesk
Video Demos and Tutorials
Analysis Guide Index
It can be difficult to write documentation for graphical programs. There are many subtle details that can get lost or overlooked. The CXC has therefore started to prepare a series of video screencasts providing demos and tutorials of various components of CIAO.
The following videos are linked from here.
How to load images and event files into ds9
Customizing the ds9 user interface
Using multiple frames with ds9
Setting region properties in ds9
Tri color images in ds9
3D binning of event files
Using masks with ds9
An introduction to the ds9 catalog tool
Basic statistics
Getting Chandra coordinates within ds9
Extracting Spectra, Light Curves, and Radial Profiles
CIAO source detect tools
Image Processing
First Light Animation
How to load images and event files into ds9
cxc.harvard.edu/index.html
's primary science data product is the event file, which may be unfamiliar to users coming to X-ray astronomy from most other wavelengths