URL: http://cxc.harvard.edu/ciao3.4/threads/all.html
Last modified: 11 December 2007

Science Threads for CIAO 3.4

Introduction

Beginners should start here. The Introductory threads provide an overview of the main components (GUI applications, plotting) and concepts (the Data Model, filtering) in the CIAO data analysis software.

- **Getting Started:**
  - Installing CIAO 3.4
  - Introduction to CIAO
  - Starting CIAO
- **Chandra Data:**
  - How to Download Chandra Data from the Archive
  - Introduction to the Data Products
  - A Note on Processing Versions
  - A Note on Filenames & Directories
- **General:**
  - Introduction to the Data Model
  - Introduction to Plotting Using ChIPS
  - Using CIAO Region Files
  - Using SAOImage ds9
  - Using Parameter Files
- **GUIs:**
  - Introduction to Prism
  - Introduction to Peg
  - Introduction to the Analysis Menu

- A ***Complete List*** of CIAO tools can be found at the Introduction to Tools page.
  If you are looking for a general topic, try the CXC Search at the top of the page.

Data Preparation

When Chandra data goes through Standard Data Processing (SDP), the most recently available calibration is applied to it. Since this calibration is continuously being improved, one should check whether there are currently newer files available. Similarly, some science decisions are made during SDP; every user has the option to reprocess the data with different parameters.

- See the current Calibration Status Report
- **Analysis Guides:**
  - ACIS Data Preparation
  - HRC Data Preparation
- **General:**
  - Use Observation−specific Bad Pixel Files
    Uses: the `acis_set_ardlib` script
  - Filtering Data
  - Filtering Lightcurves
    Uses: the `analyze_ltcrv.sl` S−Lang script
  - Create a New Level=2 Event File
- **Coordinates, Astrometry, & Spatial Filtering:**
  - Notes on Chandra Astrometric Accuracy
  - Improving the Astrometry of your Data: Correct for a Known Processing Offset
  - Correcting Absolute Astrometry with reproject_aspect
  - Creating Accurate RA, Dec Coordinates for src2 Files
  - Using CIAO Region Files
  - Creating Source and Background Files
  - Using dmcoords to Convert between CHIP and SKY Coordinates
- **ACIS:**
  - Check the ACIS Data Caveats
  - Why topic: Continuous Clocking Mode
  - Calculate CC−mode Times of Arrival
  - Remove the acis_detect_afterglow Correction
  - Create a New ACIS Bad Pixel File: Identify ACIS Hot Pixels and Cosmic Ray Afterglows
  - ***acis_process_events:***
    - The ***Create a New Level=2 Event File thread*** simplifies reprocessing data by combining all the `acis_process_events` options into one run of the tool.
    - Apply the Time−Dependent ACIS Gain Correction
    - Apply the ACIS CTI Correction
    - Apply an ACIS Gain Map
    - Remove ACIS Pixel Randomization
    - Apply/Remove ACIS PHA Randomization
    - Clean ACIS Background in VFAINT Mode
  - Using the ACIS "Blank−Sky" Background Files
    Uses: the `acis_bkgrnd_lookup` script; the `lc_clean.sl` S−Lang script
  - Destreak the ACIS−S4 Chip
  - Remove the ACIS Readout Streak
- **HRC:**
  - Creating a New Observation−Specific HRC Bad Pixel File

- ***hrc_process_events:***
  - The ***Create a New Level=2 Event File thread*** simplifies reprocessing data by combining all the `hrc_process_events` options into one run of the tool.
  - HRC AMP_SF Correction and Reducing Tap−Ringing Distortions
  - HRC−I Degap Correction
  - HRC−S Degap Correction
- Computing Average HRC Dead Time Corrections

- **ACA Monitor Window Data:**
  - Processing ACA Monitor Window Data

Timing Analysis

In order to perform absolute timing analysis on a dataset, a barycenter correction must first be applied to the data. One may then create lightcurves and phase−binned spectra to look for variability in the source. These threads also provide information on working with data taken in the ACIS continuous clocking (CC) mode.

- **General:**
  - Why topic: Continuous Clocking Mode
  - Calculate CC−mode Times of Arrival
  - Apply Barycenter Correction
  - Create a Phase−binned Spectrum
- **Analyzing Lightcurves:**
  - Why topic: Timing Analysis with Lightcurves
  - Basic Lightcurves
  - Filtering Lightcurves
    Uses: the `analyze_ltcrv.sl` S−Lang script

- See the S−lang/ISIS Timing Analysis Routines (SITAR) package which provides a set of functions and subroutines for timing analysis within ISIS.

Imaging

The Imaging threads cover a wide range of topics that include source detection, creating exposure maps and normalized images, and calculating image statistics. How to create color images for publication is addressed, as well as merging data from multiple observations.

- **Analysis Guides:**
  - HRC Imaging
  - Extended Sources

- **General:**
  - ♦ Using the ACIS "Blank−Sky" Background Files
    Uses: the `acis_bkgrnd_lookup` script; the `lc_clean.sl` S−Lang script
  - ♦ Updating dmgroup Syntax for CIAO 3
  - ♦ Match the Binning of an Image
    Uses: the `get_sky_limits` script
  - ♦ Create A True Color Image
    Uses: the `color_image` script
  - ♦ Create A True Color Image in ds9
  - ♦ Create an Image of Diffuse Emission
    Uses: the `mkBgReg.pl` script; the `mkSubBgReg.pl` script
  - ♦ Using Data Cubes
- **Reprojecting Data:**
  - ♦ Merging Data from Multiple Imaging Observations
    Uses: the `merge_all` script
  - ♦ Overview: Reprojecting Files
  - ♦ Correcting Absolute Astrometry with reproject_aspect
  - ♦ Reprojecting Images: Making an Exposure−corrected Mosaic
  - ♦ Reprojecting Coordinates of a Solar System Object
- **Coordinates, Astrometry, & Spatial Filtering:**
  - ♦ Notes on Chandra Astrometric Accuracy
  - ♦ Using SAOImage ds9
  - ♦ Using CIAO Region Files
  - ♦ Creating Source and Background Files
  - ♦ Using dmcoords to Convert between CHIP and SKY Coordinates
- **Source Counts, Surface Brightness, & Statistics:**
  - ♦ Estimate Source Counts in an Image
  - ♦ Obtain and Fit a Radial Profile
  - ♦ Calculating Statistics of Images
    Uses: the `sstats.sl` S−Lang script
- **PSFs:**
  - ♦ ChaRT: the Chandra Ray Tracer
  - ♦ Create a PSF
  - ♦ *Sherpa*: Using A PSF Image As The Convolution Kernel
- **Detect:**
  - ♦ Overview: Detecting Sources in Imaging Observations
  - ♦ Running celldetect
    Uses: the `acis_expmap` script
  - ♦ Running vtpdetect
  - ♦ Running wavdetect
  - ♦ Using the Output of Detect Tools

- **Exposure Maps:**

  - ♦ Use merge_all Script to Compute ACIS Exposure Maps and Fluxed Images
    Uses: the `merge_all` script
  - ♦ Compute Single Chip ACIS Exposure Map and Fluxed Image Step−by−Step
  - ♦ Compute Multiple Chip ACIS Exposure Map and Fluxed Image Step−by−Step
  - ♦ Compute an HRC−I Exposure Map and Build Fluxed Image
  - ♦ Compute an HRC−S Exposure Map and Build Fluxed Image
  - ♦ Match the Binning of an Image
    Uses: the `get_sky_limits` script
  - ♦ Calculating Spectral Weights
    Uses: the `spectrum.sl` S−Lang script

Imaging Spectroscopy

After extracting source and background PI or PHA spectra from an imaging observation, the appropriate response files (ARF, RMF) are created so that the data may be modeled and fit. In the case of multiple or extended sources, weighted ARF and RMF are built for the spectral analysis.

- **Extracting Spectra and Creating Response Files:**

  The recommended use for the `specextract` script has been changed. It has been determined that the `mkwarf` tool, which is used for ARF generation by `specextract`, may not produce accurate results for point sources. The `mkarf` tool, used by `psextract`, is preferred for point source extraction.

  `specextract` should be used for the analysis of extended sources only. Users working with point sources should instead use the `psextract` script. ***Analysis of point sources that was done with `mkwarf`/`specextract` should be redone with `mkarf`/`psextract` for the most accurate results***, e.g. taking bad columns into account.

  In certain cases, the `mkacisrmf` tool will need to be run separately to create the best possible RMFs for ACIS observations; see the thread for details.

  - ♦ Using the ACIS "Blank−Sky" Background Files
    Uses: the `acis_bkgrnd_lookup` script; the `lc_clean.sl` S−Lang script
  - ♦ Using specextract to Extract ACIS Spectra and Response Files
  - ♦ Using psextract to Extract ACIS Spectra and Response Files for Pointlike Sources
    Uses: the `psextract` script; the `acis_fef_lookup` script
  - ♦ Coadding Spectra and Weighted Responses
    Uses: the `acisspec` script
  - ♦ Creating ACIS RMFs with mkacisrmf

- **Step−by−step Analyses:**

  These threads give step−by−step instructions for creating spectra and response files. Note that all of the tasks described here are executed automatically by the `specextract` script.

  - ♦ Using the ACIS "Blank−Sky" Background Files
    Uses: the `acis_bkgrnd_lookup` script; the `lc_clean.sl` S−Lang script
  - ♦ Weighting ARFs and RMFs: multiple sources

Uses: the `show_wgt.sl` S−Lang script
- ♦ Step−by−Step Guide to Creating ACIS Spectra for Pointlike Sources
  Uses: the `acis_fef_lookup` script

- **Deprecated Threads:**

The analyses shown in this thread should now be done with the `specextract` script instead. The thread will be removed in a future CIAO release.

- ♦ Extracting Extended Source Spectra and Responses
  Uses: the `acisspec` script

- **General:**

- ♦ A Note on HRC Spectra
- ♦ Displaying the FEF Regions Covered by a Source
  Uses: the `regions.sl` S−Lang script
- ♦ Why topic: ACIS QE Degradation
- ♦ Correcting Responses for ACIS Contamination

- See the Sherpa threads for information on fitting spectral data.

Grating Spectroscopy

If new calibration has been applied to the event file, the grating spectrum should be re−extracted as well. It is then possible to build grating response files (gARF, gRMF) in order to model and fit the data in *Sherpa*.

- Visit the Chandra Grating Analysis Page
- ATOMDB: CIAO's spectroscopic library
- WebGUIDE: Interactive GUIDE for ATOMDB version 1.3
- **General:**

- ♦ Examining Grating Spectra and Regions: PHA2 files
- ♦ Updating dmgroup Syntax for CIAO 3
- ♦ Why topic: ACIS QE Degradation
- ♦ Correcting Responses for ACIS Contamination
- ♦ Measure Grating Dispersion Distance
  Uses: the `tg_scale_reg` S−Lang script
- ♦ Create an Order−Sorting Image
  Uses: the `tg_osort_img` S−Lang script
- ♦ Create a Color Spectrum

- **Problems with the Zero Order:**

- ♦ Correcting a Misplaced Zero−order Source Position
- ♦ Source Position for Grating Data with a Piled or Blocked Zero Order

- **HETG/ACIS:**

- ♦ Obtain Grating Spectra from HETG/ACIS−S Data
- ♦ Obtain Grating Spectra for Multiple Sources − ACIS
- ♦ Create Grating RMFs for ACIS−S Observations
- ♦ Compute HETG/ACIS−S Grating ARFs

Uses: the `fullgarf` script
- ♦ Grouping a Grating Spectrum

- **LETG/ACIS:**

  - ♦ Obtain Grating Spectra from LETG/ACIS Data
  - ♦ Obtain Grating Spectra for Multiple Sources − ACIS
  - ♦ Create Grating RMFs for ACIS−S Observations
  - ♦ Compute LETG/ACIS−S Grating ARFs
    Uses: the `fullgarf` script
  - ♦ Grouping a Grating Spectrum
- **LETG/HRC−S:**

  - ♦ Obtain Grating Spectra from LETG/HRC−S Data
  - ♦ Obtain Grating Spectra for Multiple Sources − HRC
  - ♦ Creating Higher−order Responses for HRC−S/LETG Spectra
  - ♦ Create Grating RMFs for HRC Observations
  - ♦ Compute LETG/HRC−S Grating ARFs
  - ♦ Grouping a Grating Spectrum
  - ♦ *Sherpa*: Fitting Multiple Orders of HRC−S/LETG Data
- **LETG/HRC−I:**

  - ♦ Obtain Grating Spectra from LETG/HRC−I Data
  - ♦ Obtain Grating Spectra for Multiple Sources − HRC
  - ♦ Create Grating RMFs for HRC Observations
  - ♦ Compute LETG/HRC−I Grating ARFs
  - ♦ Grouping a Grating Spectrum
- **Combining Spectra & Fitting:**

  - ♦ Extract Coadded and Grouped Nth−Order Source & Background Spectra and ARFs
    Uses: the `add_grating_orders` script
  - ♦ Add Grating Spectra and Average ARFs
    Uses: the `add_grating_spectra` script
  - ♦ *Sherpa*: Fitting Grating Data
  - ♦ Create PHA Background File for Use in XSPEC
    Uses: the `tg_bkg` script
  - ♦ *Sherpa*: GUIDE: Fitting and Identifying Spectral Lines

S−Lang

A list of threads that use *S−Lang*, the CIAO Scripting Language, to automate a variety of tasks.

- Why topic: *S−Lang* as the CIAO Scripting Language
- **Threads using S−Lang:**

  - ♦ Using SAOImage ds9
  - ♦ Filtering Lightcurves
    Uses: the `analyze_ltcrv.sl` S−Lang script
  - ♦ Using the ACIS "Blank−Sky" Background Files
    Uses: the `acis_bkgrnd_lookup` script; the `lc_clean.sl` S−Lang script

- Calculating Statistics of Images
  Uses: the `sstats.sl` S−Lang script
- Calculating Spectral Weights
  Uses: the `spectrum.sl` S−Lang script
- Displaying the FEF Regions Covered by a Source
  Uses: the `regions.sl` S−Lang script
- Weighting ARFs and RMFs: multiple sources
  Uses: the `show_wgt.sl` S−Lang script
- Measure Grating Dispersion Distance
  Uses: the `tg_scale_reg` S−Lang script
- There are also several *Sherpa* threads that use *S−Lang*

Data Used in Threads

How to Download Chandra Data from the Archive

Sorted by OBSID

OBSID	Object	Instrument	Threads
3	Trapezium Cluster	HETG/ACIS−S	Multiple ACIS Spectra
29	Alpha Cen	LETG/HRC−S	Multiple HRC Spectra
133	PSR B0540−69	ACIS−I	Barycenter Correction, Phase−binned Spectrum
139	BL Lacertae	ACIS−I	Improving Astrometry (with 461)
144	G21.5−0.9	HRC−I	HRC−I Degap, HRC Exposure Map, Bad Pixel File (with 1557, 1843)
170	Crab Pulsar	ACIS−S/HETG	CC−mode Times of Arrival
315	NGC 4038/ NGC 4039	ACIS−S	Image Diffuse Emission

441	Chandra Deep Field South	ACIS−I	Reprojecting Aspect (with 581)
459	3C 273	HETG/ACIS−S	Extract Spectra & Make RMFs/ARFs, Examine PHA2 (with 460, 1198, 1800), HETG/ACIS−S Grating Spectra & gARFs, Add Grating Orders, Add Grating Spectra (with 2463), Show FEF Regions, Afterglow Correction, Coadding Spectra (with 2463), PHA Background, ACIS gRMFs
460	3C 273	LETG/HRC−S	LETG/HRC−S Grating Spectra & gARFs, Examine PHA2 (with 459, 1198, 1800), HRC−S gRMFs
461	3C 273	HRC−I	Improving Astrometry (with 139)
578	3C 295	ACIS−S	Detecting Sources, Weighted ARFs & RMFs, Coordinates for src2 Files
581	Chandra Deep Field South	ACIS−I	Reprojecting Aspect (with 441)
650	GK Persei	ACIS−S	Create Source and Background Files
884	0235+164	ACIS−S	Clean ACIS Background
1010	Capella	HETG/ACIS−S	Measure Grating Dispersion Distance, Order−Sorting Image
1198	3C 273	LETG/ACIS−S	LETG/ACIS−S Grating Spectra & gARFs, Examine PHA2 (with 459, 460, 1800)

1447	Cas A	ACIS−I	Extended Source Spectra
1451	II Peg	HETG/ACIS−S	Color Spectrum
1463	Jupiter	ACIS−S	Reprojecting Coordinates
1522	Trapezium Cluster	ACIS−I	Using celldetect (with 578)
1557	G21.5−0.9	HRC−S	HRC−S Degap, Bad Pixel File (with 144, 1843), HRC AMP_SF Correction
1703	PKS 2149−306	LETG/ACIS−S	Correct Zero−order Source Position
1712	3C 273	ACIS−S	Filtering Lightcurves, Destreak, Using ds9, Using Region Files, ACIS Background (with 1838), Readout Streak
1800	PKS 2155−304	LETG/HRC−I	Examine PHA2 (with 459, 460, 1198)
1801	PKS 2155−304	LETG/HRC−I	LETG/HRC−I Grating Spectra & gARFs
1838	G21.5−0.9	ACIS−S	ACIS Data Preparation, Match Binning, True Color Image, Estimating Counts, ACIS Exposure Maps, Statistics of Images, Spectral Weights, Radial Profile, Create a PSF

1842	G21.5−0.9	ACIS−I	Merging Data (with 1843), ACIS Exposure Maps (with 1843)
1843	G21.5−0.9	ACIS−I	Introduction, General Data Preparation, Merging Data (with 1842), ACIS Exposure Maps (with 1842), Bad Pixel File (with 144, 1557)
2463	3C 273	HETG/ACIS−S	Add Grating Spectra (with 459), Coadding Spectra (with 459)
4924	Mrk 590	ACIS−S	Processing ACA Monitor Window Data

Sorted by Thread

File	Thread
chips.tar.gz	Intro to *ChIPS*
celldetect.tar.gz	Using celldetect
vtpdetect.tar.gz	Using vtpdetect
wavdetect.tar.gz	Using wavdetect
detectout.tar.gz	Using the Output of Detect Tools

URL: http://cxc.harvard.edu/ciao3.4/threads/all.html
Last modified: 11 December 2007