CIAO

Jonathan McDowell
(CXC Science Data Systems)

Chandra data and software

I will report on CIAO (user software) and the standard processing pipeline software, which come into being thanks to:

CXC Data Systems team

software design, development, operation, archive, etc.

CXC Science Data Systems team

requirements, documentation, testing, helpdesk, interface with the science community

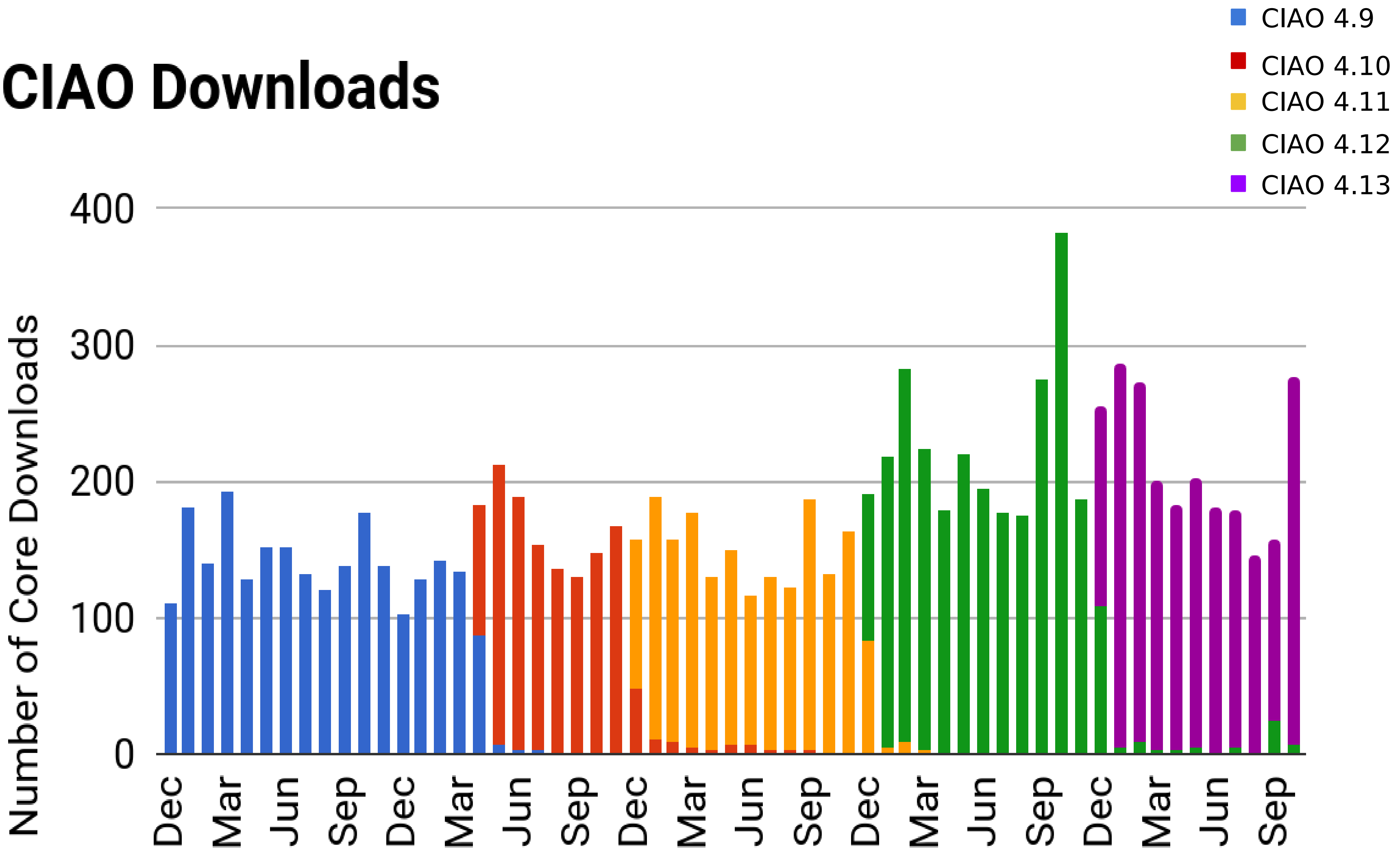
Current SDS Team

SAO Scientists:	
Jonathan McDowell	SDS lead, data model, coordinates
Antonella Fruscione (1/2 time)	SDS SAO deputy, Docs and Release lead
Aneta Siemiginowska	Sherpa, Astrostatistics, Catalog
Doug Burke	Scripts, Releases, Infrastructure, Sherpa, Visualization
Frank Primini	Catalog, Photometry, Source Detection, HRC
SAO IT Specialists:	
Kenny Glotfelty	Helpdesk, scripts, docs, legacy expertise
Nick Lee	Helpdesk, scripts, docs
Bill Joye	ds9
MIT Scientists:	
Dave Huenemoerder	Gratings, responses
Moritz Guenther	MARX, Sherpa
Dave Principe	Instruments and gratings
Melania Nynka	Instruments and gratings

Community Support:

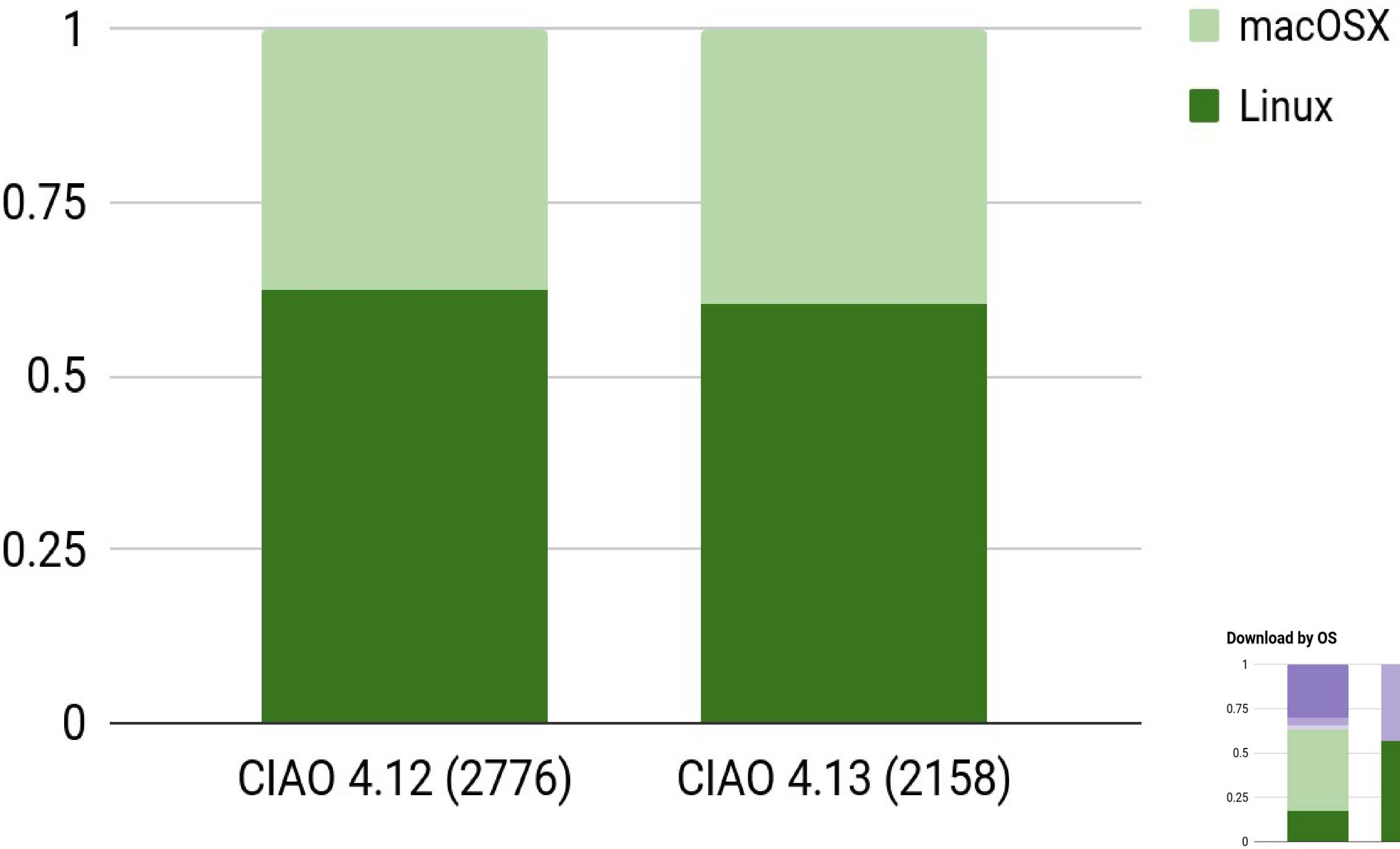
Downloads,
Documentation,
Helpdesk

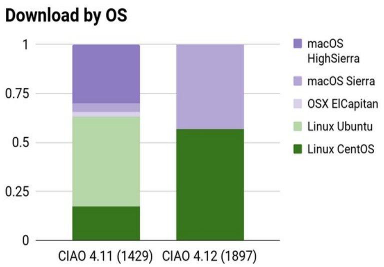
CIAO Downloads



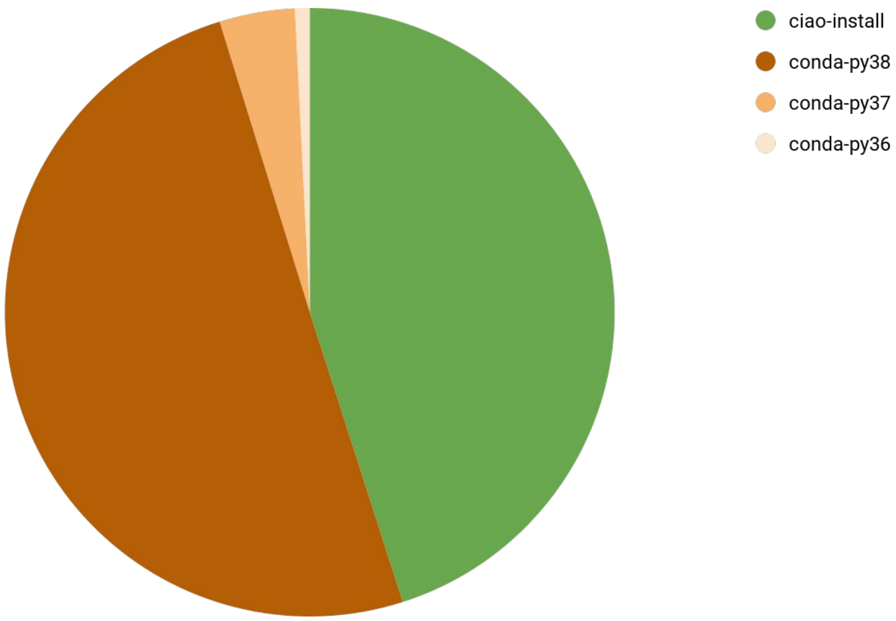
CIAO 4.12 switched from FTP to HTTPS. There are some differences in how the metrics are collected (bot filtering, incomplete d/l, internal d/l's).

Download by OS

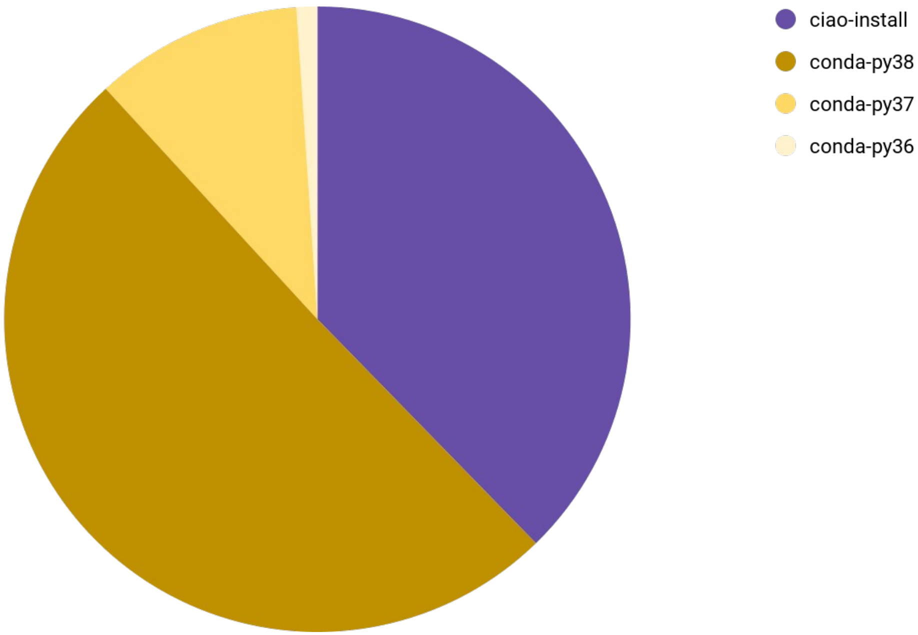




CIAO Installation Options

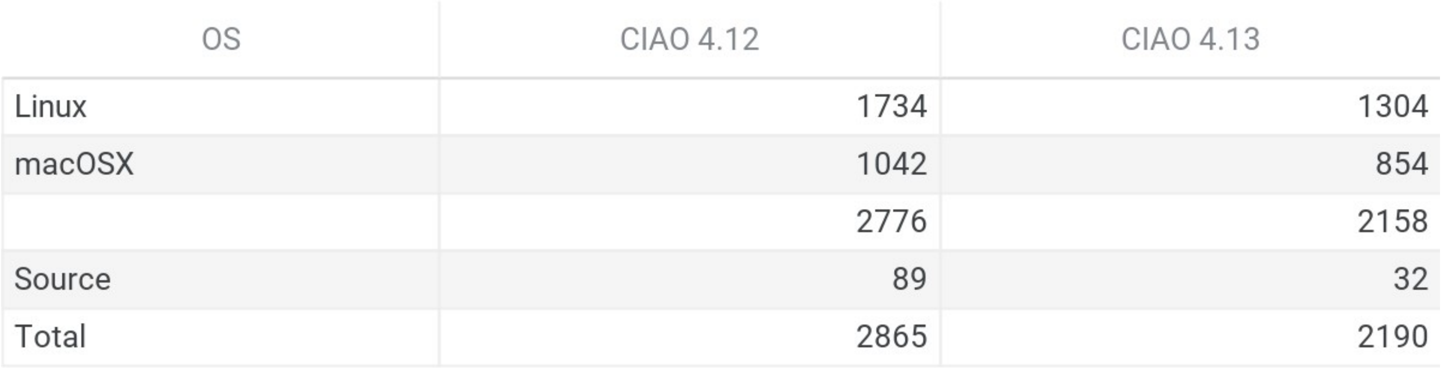


Linux



Mac

Downloads (lifetime)



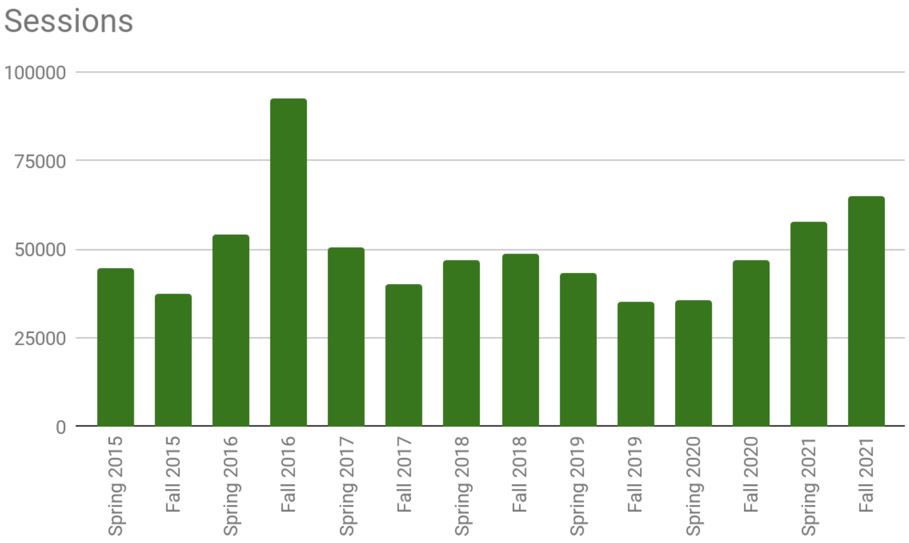
OS	CIAO 4.12	CIAO 4.13
Linux	1734	1304
macOSX	1042	854
	2776	2158
Source	89	32
Total	2865	2190

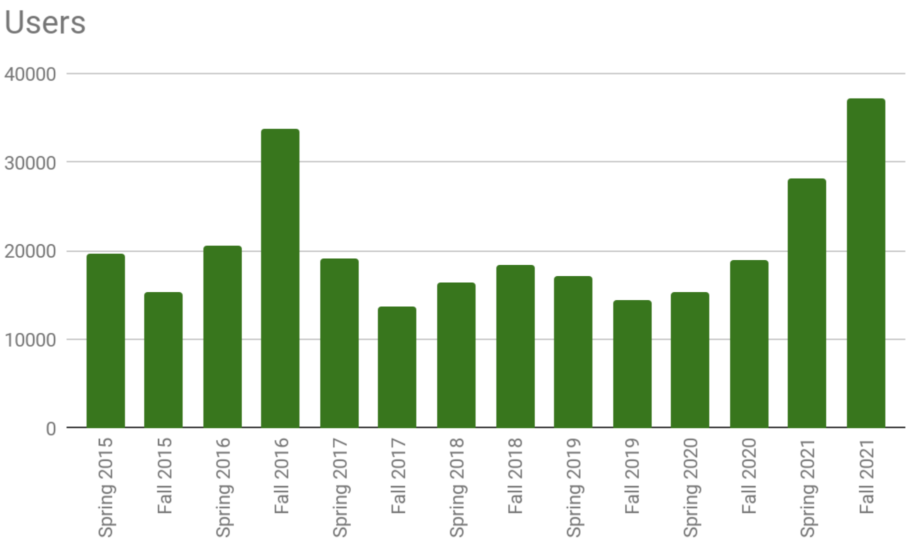
Documentation

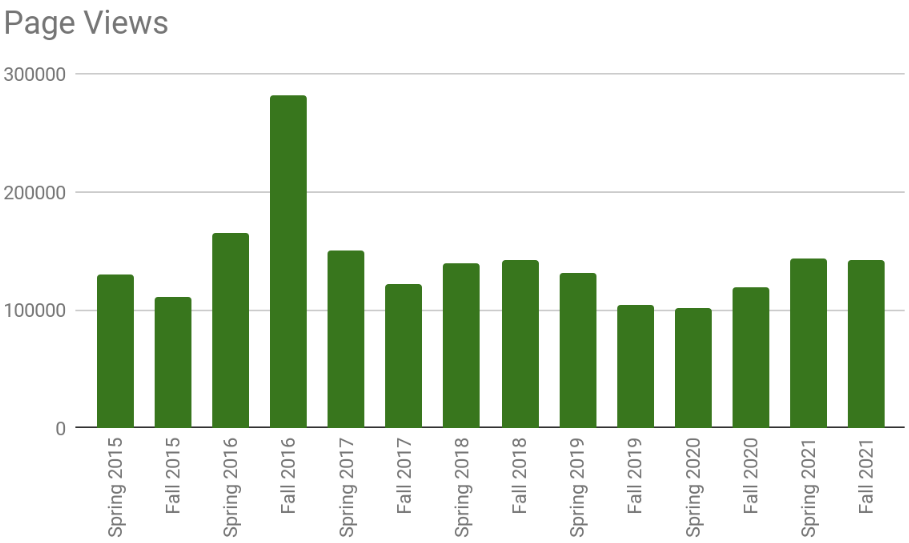
Documentation

- CIAO 4.13 routine roll-out and updates
- Reworked download pages to encourage conda installation method.
  - Simplified conda download page, moved detailed information into a new conda installation thread.
- New multi-obi srcflux thread
- Posted a new caveat discussing subpixel resolution limitations due to dither.
- Many thread updates to match Repro-5 data products: file names, as well as physical coordinates.

Long Term Website Trends


Sessions


Users

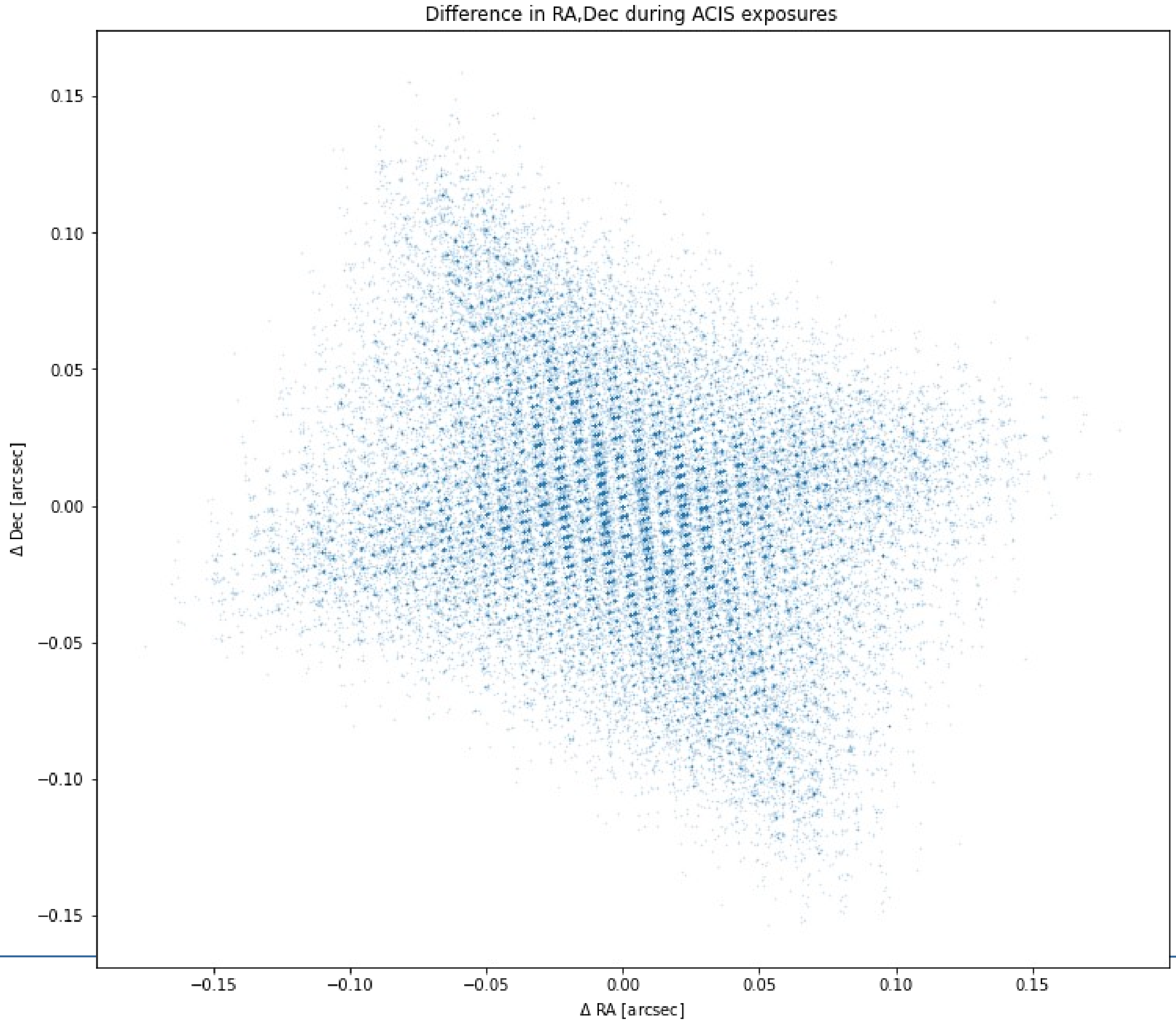

Page Views

caveat: dither effect on subpixel resolution

- The distance that Chandra dithers in a typical ~3sec exposure is small compared to the native ACIS pixel size (0.492 arcsec).
- However, users trying to exploit the highest possible spatial resolution using subpixel binning need to be cautious about dither on these scales.
- This caveat helps to quantify at what spatial scale users need to be concerned about dither effects

https://cxc.harvard.edu/ciao/caveats/acis_subpixel_dither.html

Uncertainty in RA/Dec due to ACIS exposure time

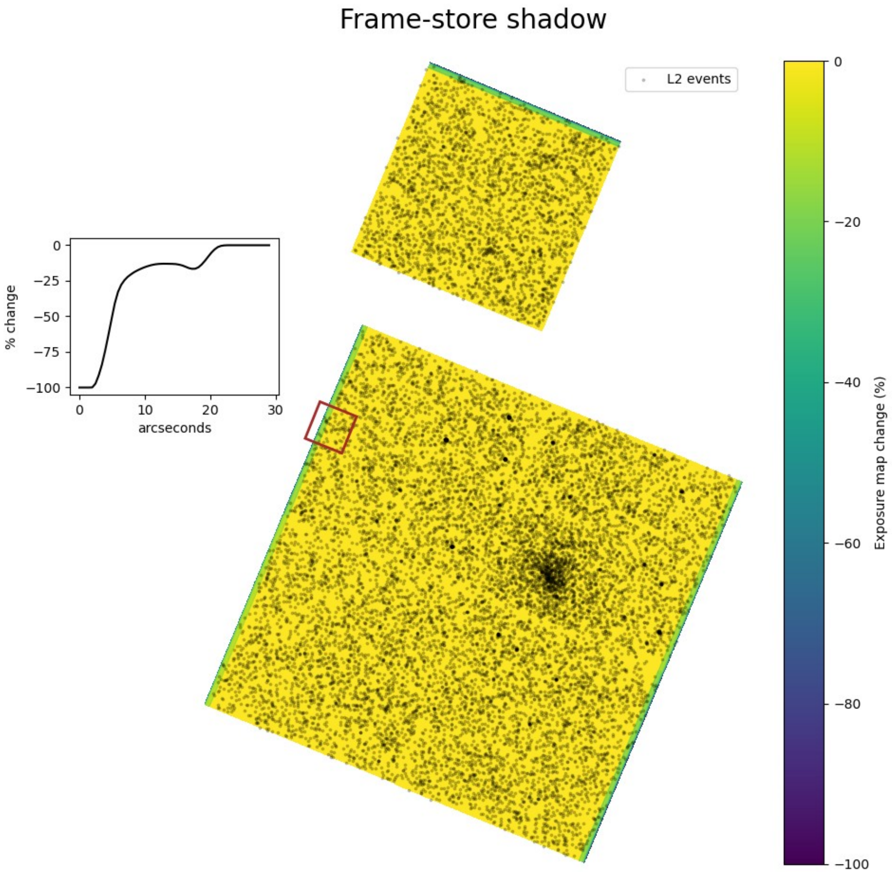


Bugs: ACIS frame store shadow bits

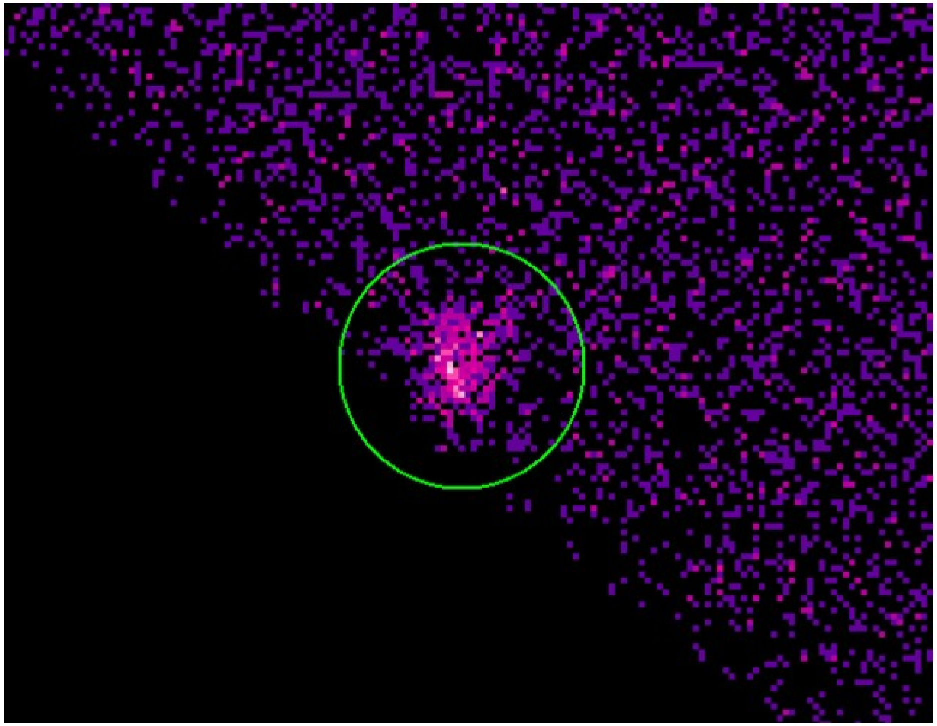
- Bottom few rows of each chip are now marked as bad using new (CIAO 4.12) frame store shadow bit (17).
- However, the response tools (specifically ardlib) was not updated to recognize the new bit.
- So while events have been filtered out, the responses are not correct.
- ciao-contrib 4.13.1 includes updates to scripts to correct this. Permanent fix in ardlib included in CIAO 4.14.

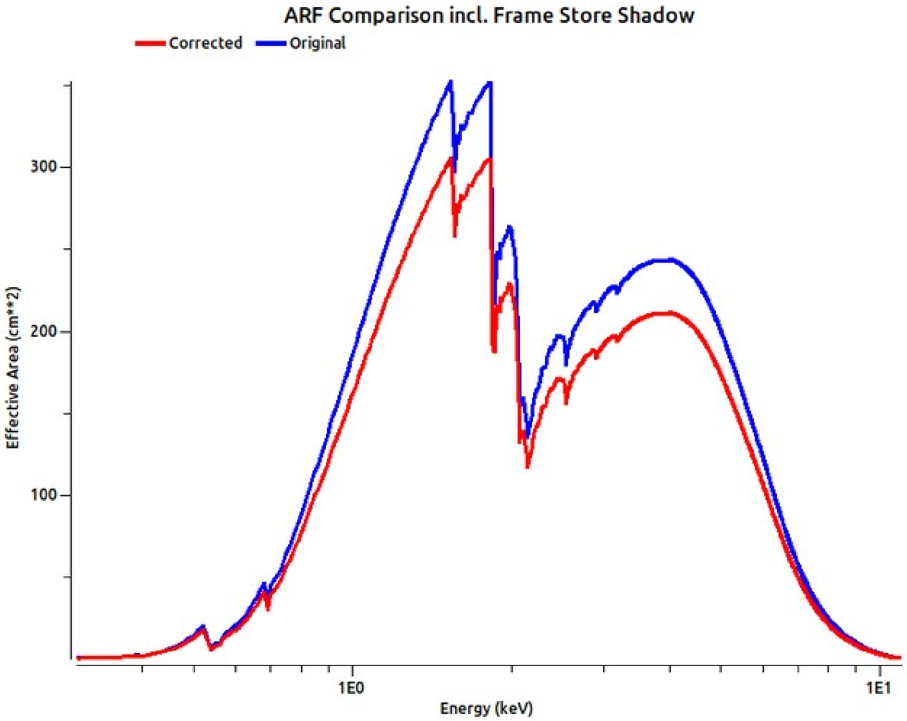
https://cxc.harvard.edu/ciao/caveats/acis_shadow_badpix.html

Exposure Map Example



ARF Example




ARF Comparison incl. Frame Store Shadow
Corrected
Original
Effective Area (cm**2)
300
200
100
1E0
1E1
Energy (keV)

Helpdesk

Helpdesk Spam Attack

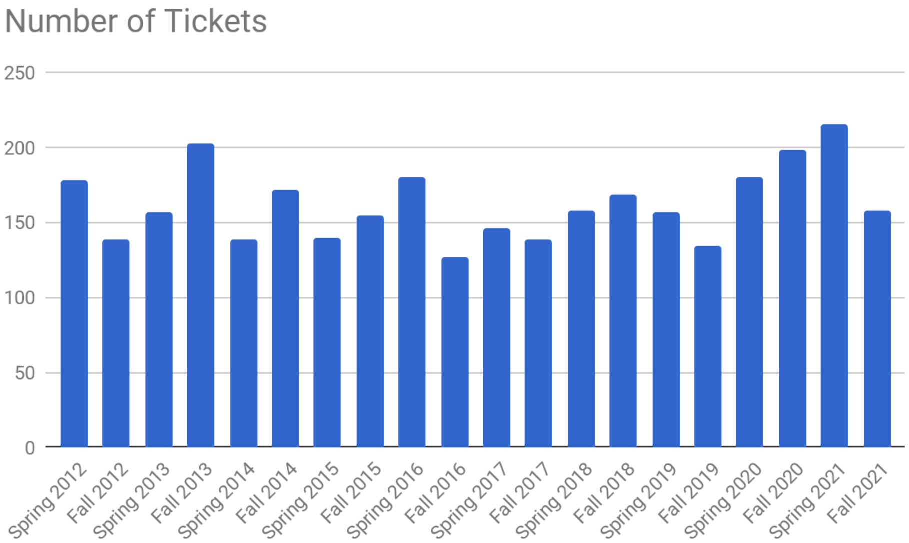
- Late April 2021 CXC helpdesk was target of spam attack.
    - Malicious actor(s) submitted dozens of tickets with PDF attachments which contained inappropriate material via the helpdesk web interface.
    - User then submitted the URL to these PDF files to Google search engine.
        - Coming from "harvard.edu" URLs have higher search ranking.
- Helpdesk was taken offline and tickets deleted, but remained in Google's search cache.
    - Harvard IT and CXC helpdesk contacted by several users reporting spam material looking to claim Harvard's "bug bounty" (does not apply to CfA sites).
- Helpdesk website remained off line for ~1 month while new version of helpdesk software, osTicket, was installed and configured.
    - Users were still able to contact helpdesk via email.
    - New version allows for additional configuration options, including filtering file type (PDFs are no longer allowed).
    - Metrics derived from new system are different than before.

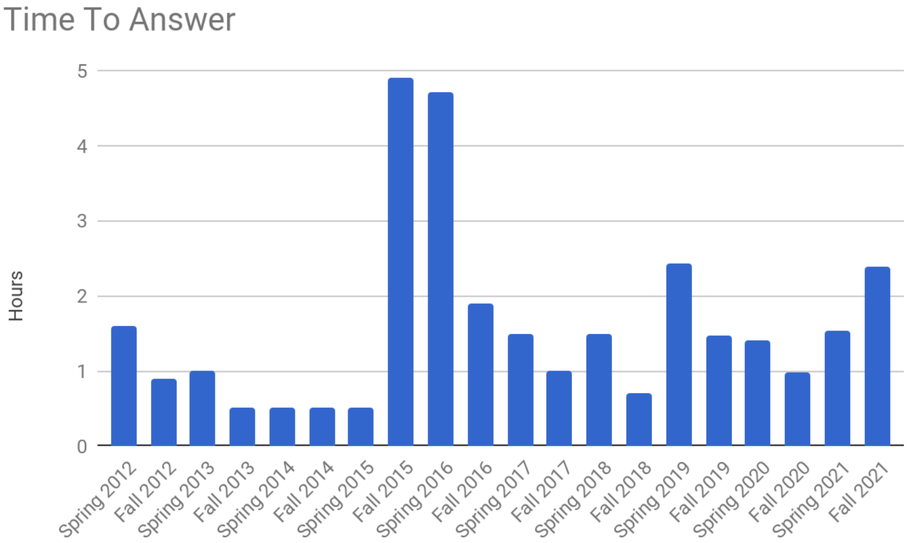
Helpdesk Stats

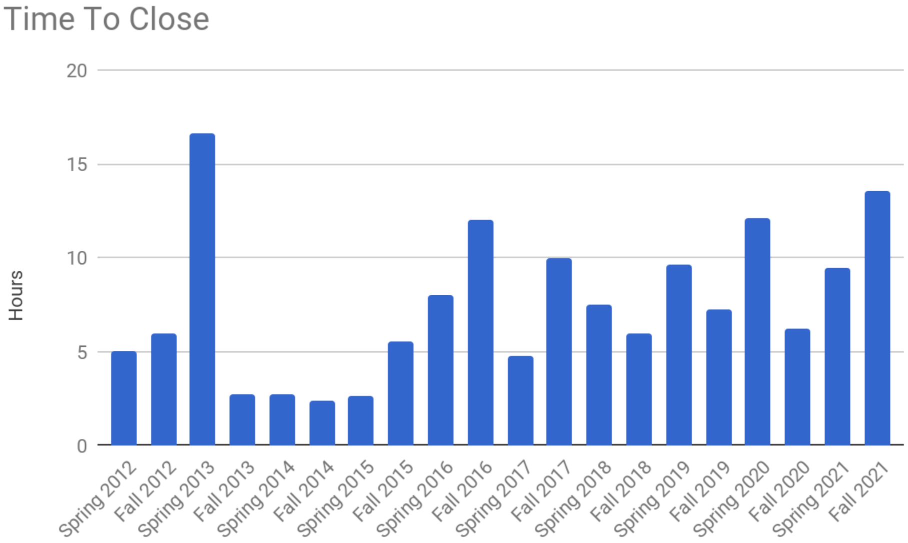
	2019-11-01 to 2020-10-31	2020-11-01 to 2021-10-31
Time period [months]	12	12
Number of TIckets	366	317
Median time to 1st contact [hrs]	1.22	1.53
Median time to close [hrs]	7.42	11.83
Maximum time to close [hrs]	2015.8	978.3

Longest ticket was for user who took a month to follow up on questions regarding fitting 2D PSF with sherpa.

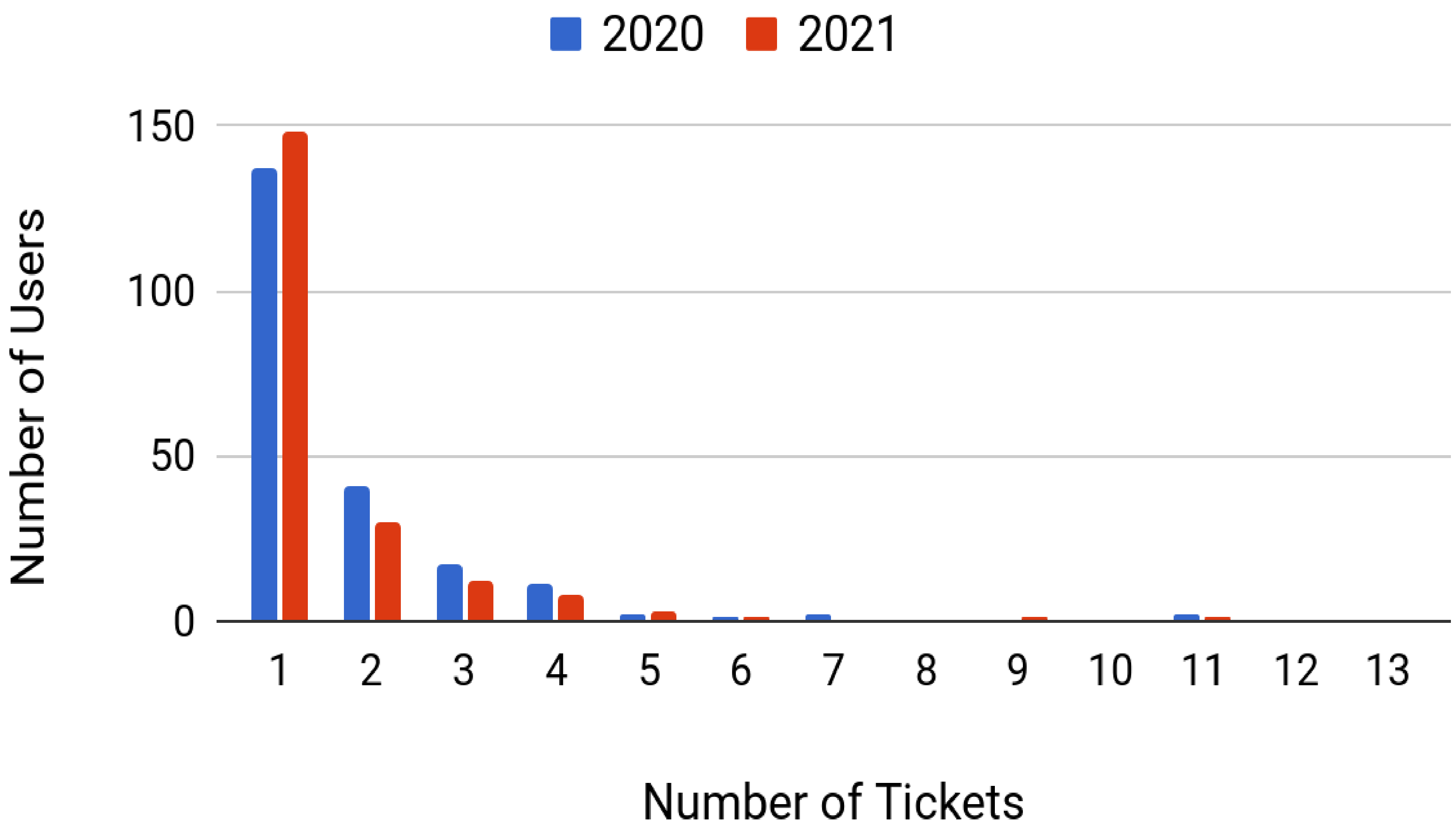
Long Term Helpdesk Trends



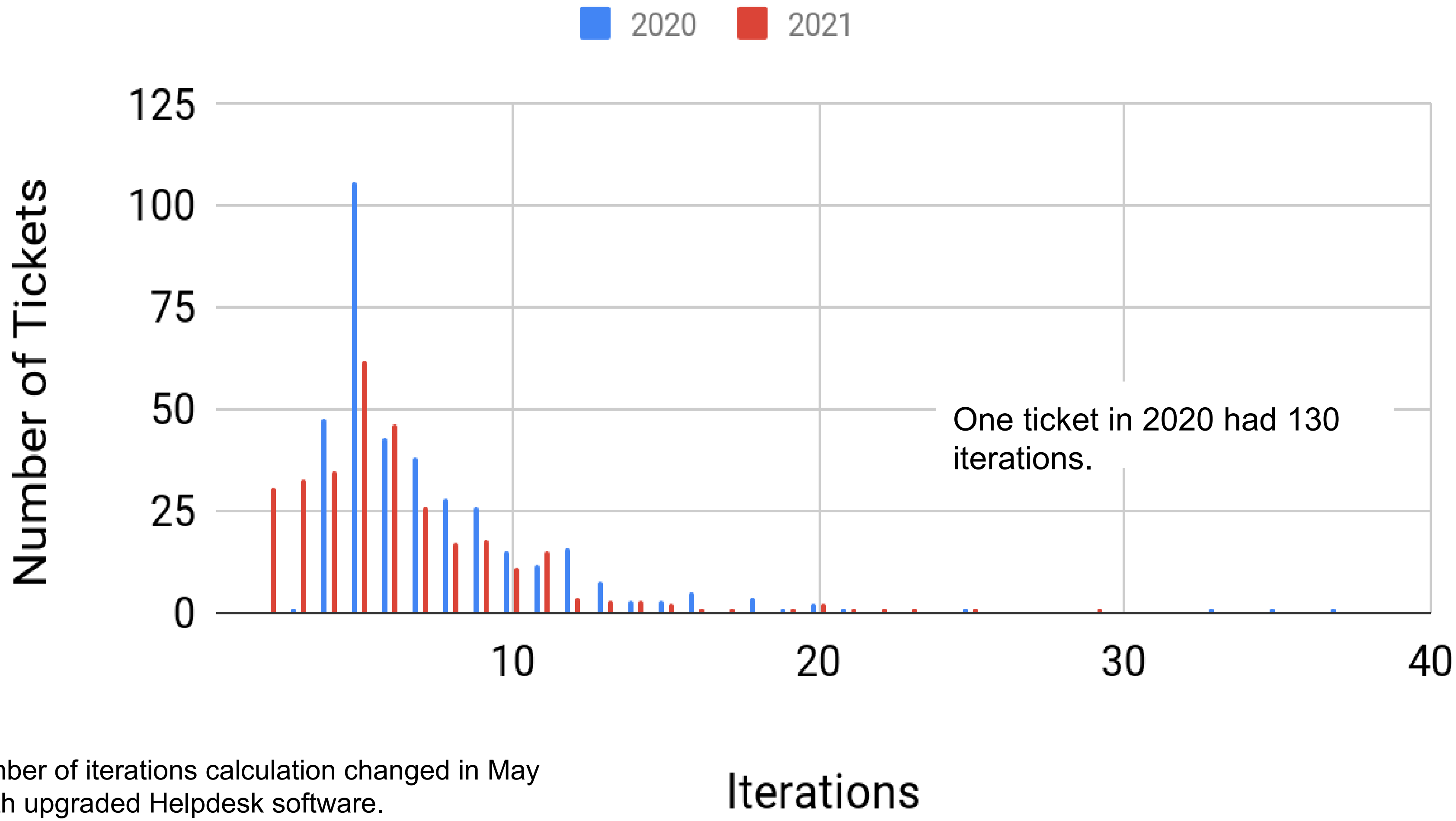




Tickets per User



Iterations per Ticket



One ticket in 2020 had 130 iterations.

The number of iterations calculation changed in May 2021 with upgraded Helpdesk software.

Helpdesk

- Examples of bugs
  - Failure to include frame-store-shadow bad pixel bits in response files (exposure maps and ARFs).
  - vtpdetect bug with negative coordinates in a large mosaic.
  - Problem using pie() shaped regions with angles > 360°
  - specextract error creating asphist (corner case)
  - Problem running marx with asolfiles updated by asp_offaxis_corr
  - dmextract using incorrect GTI when making lightcurves (last GTI instead of 1st)
  - Coordinate issue when applying vignetting corrections in some tools including mkinstmap, mkarf, and mkgarf
- Example of documentation updates
  - How to do an offline conda installation (CIAO files downloaded from alternative site)
  - Platform support updates w.r.t. macOS 11 (Big Sur) and M1 (ARM64)
  - New caveat for frame-store-shadow bug

Community

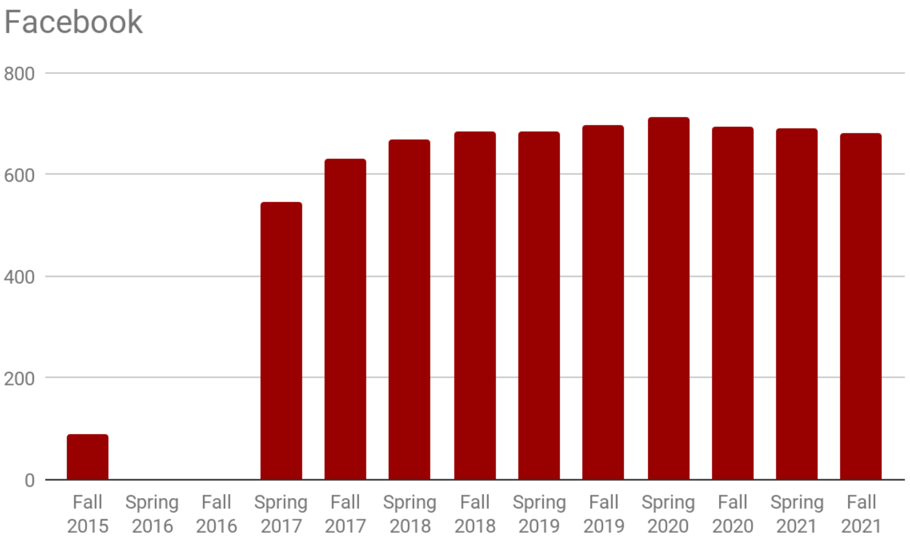
Community Outreach

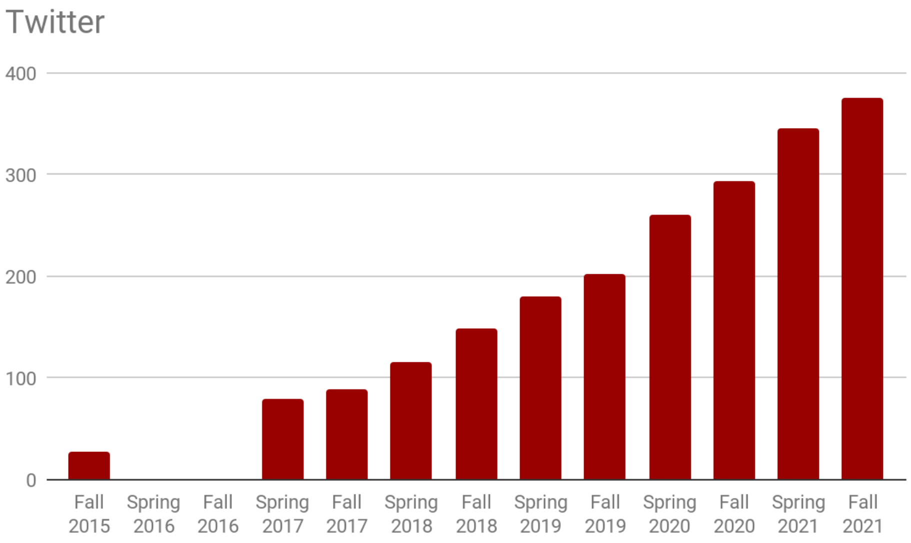
- AAS 237 - January 2021
  - (next slide)
- AAS 238 - June 2021
  - Supported Chandra booth
  - Live Helpdesk
  - Presented ds9/dax demos during the "afternoon" breaks
- 2021 Chandra Data Science Symposium
  - CIAO well represented during science talks
  - Presented demos during special session
    - ds9/dax https://youtu.be/bvoaxJkHec0
    - sherpa https://youtu.be/sZ7mEx142HQ

CIAO Workshop #19 at Virtual AAS237 Jan 2021

- Two day workshop before start of AAS
- Morning talks were well attended (~20 students). There was much less interest in the afternoon hands on sessions.
- Supported the Chandra booth during AAS meeting breaks.

Long Term Social Media Trends


Facebook


Twitter

Facebook | ChandraCIAO	682 followers	(down 13)
Twitter | @chandraCIAO	375 followers	(up 81)

CIAO 4.13-4.14 and Scripts Overview

CIAO 4.13 Highlights

- Primarily a bug fix release.
- Deprecated graphical applications
  - peg : parameter file editor
  - taskmonitor : run tasks in background and capture logs (stdout & stderr)
- Sherpa updates include
  - Improved Jupyter notebook integration (rich display elements)

- Included new asp_offaxis_corr tool used in Repro-5 to apply boresight corrections to aspect solution.
- wcs_match from CSC to support interactive source cross matching.
- Updates to srcflux to compute fluxes from merged|multiple observations.

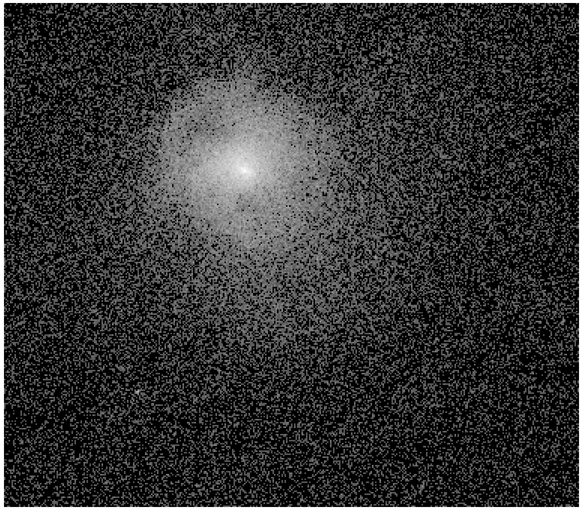
CIAO 4.14 Highlights

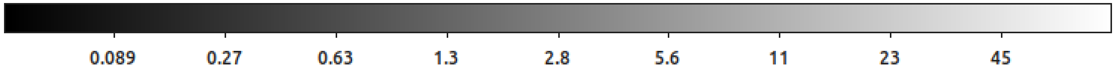
- Bug fixes
  - ACIS frame store shadow badpixel bits
  - dmextract GTI issue (last vs. first)
  - removed obsolete "0 length polygon" warning
- Withdraw prism, the interactive file browser.
  - This is the last GTK application which greatly reduces OTS burden.
  - ds9 added prism functionality
- Sherpa updates described later in talk
- New adaptive binning tool: dmradar
- Updated support for scaled images and NULL pixel handling
- dmdiff improvements to array and WCS handling. Major code overhaul.

dmnautilus upgrade

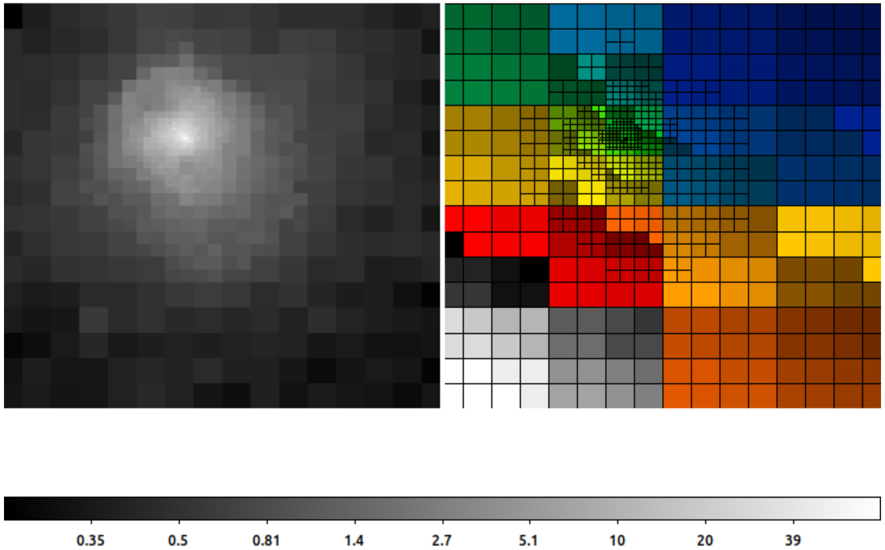
- Current algorithm uses SNR as an **upper** limit (blocks divided **until** SNR falls below threshold).
- Updated algorithm allow SNR to be a **lower** limit (blocks divide **unless** the SNR falls below threshold).

Example: HCG62 merged dataset, broad band, point sources have been removed.

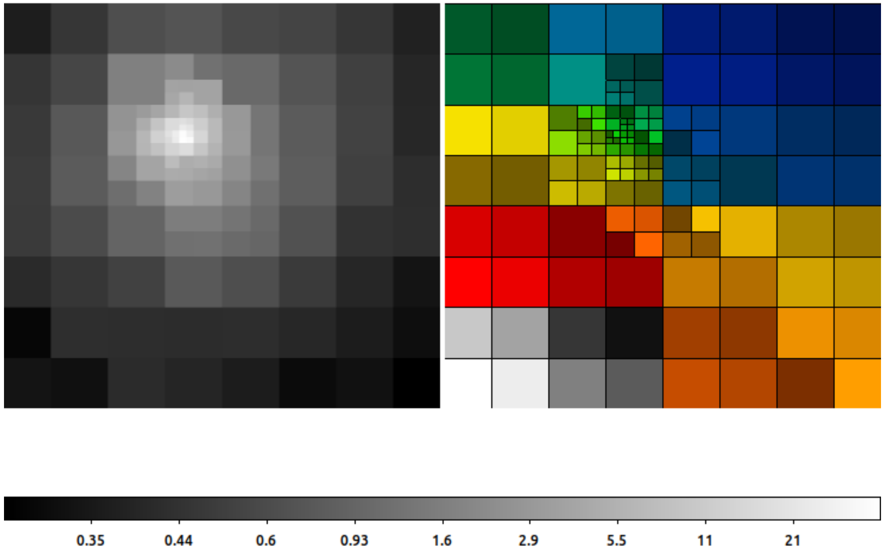




dmnautilus example



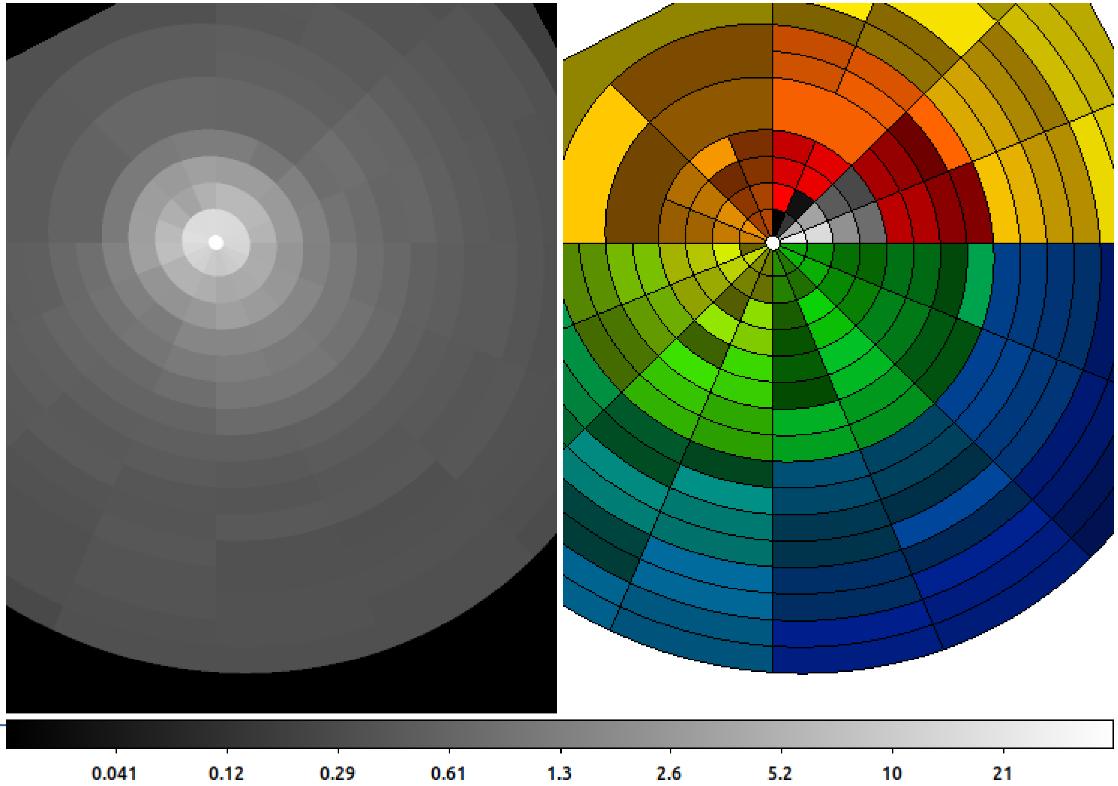
Original algorithm. SNR=15, so each bin has at most 225 counts. (Left is binned image, right is map showing pixels belonging to same grid.)



Updated algorithm. SNR=15, so each bin has at least 225 counts.

dmradar prototype

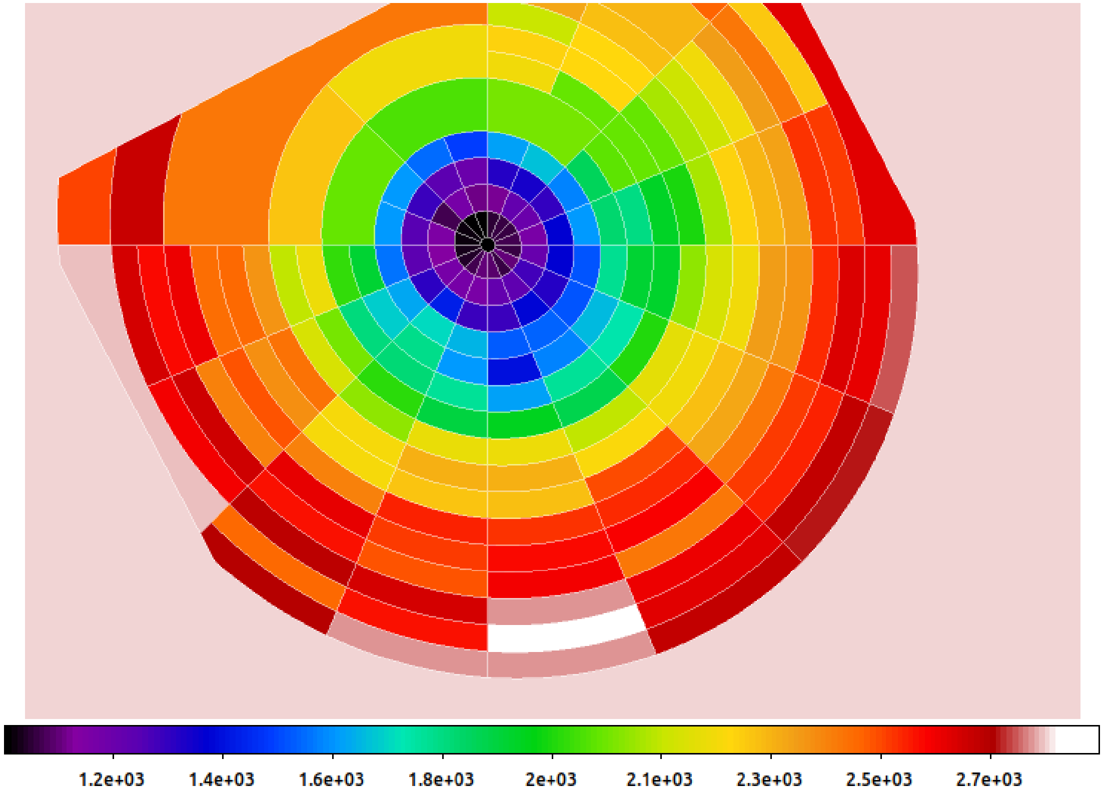
- Delivered spec and prototype for new dmradar tool.
- Similar "quad-tree" algorithm as dmnautilus, but instead of diving in cartesian X & Y, it divides in polar coordinates : radius and angle.
- Example:



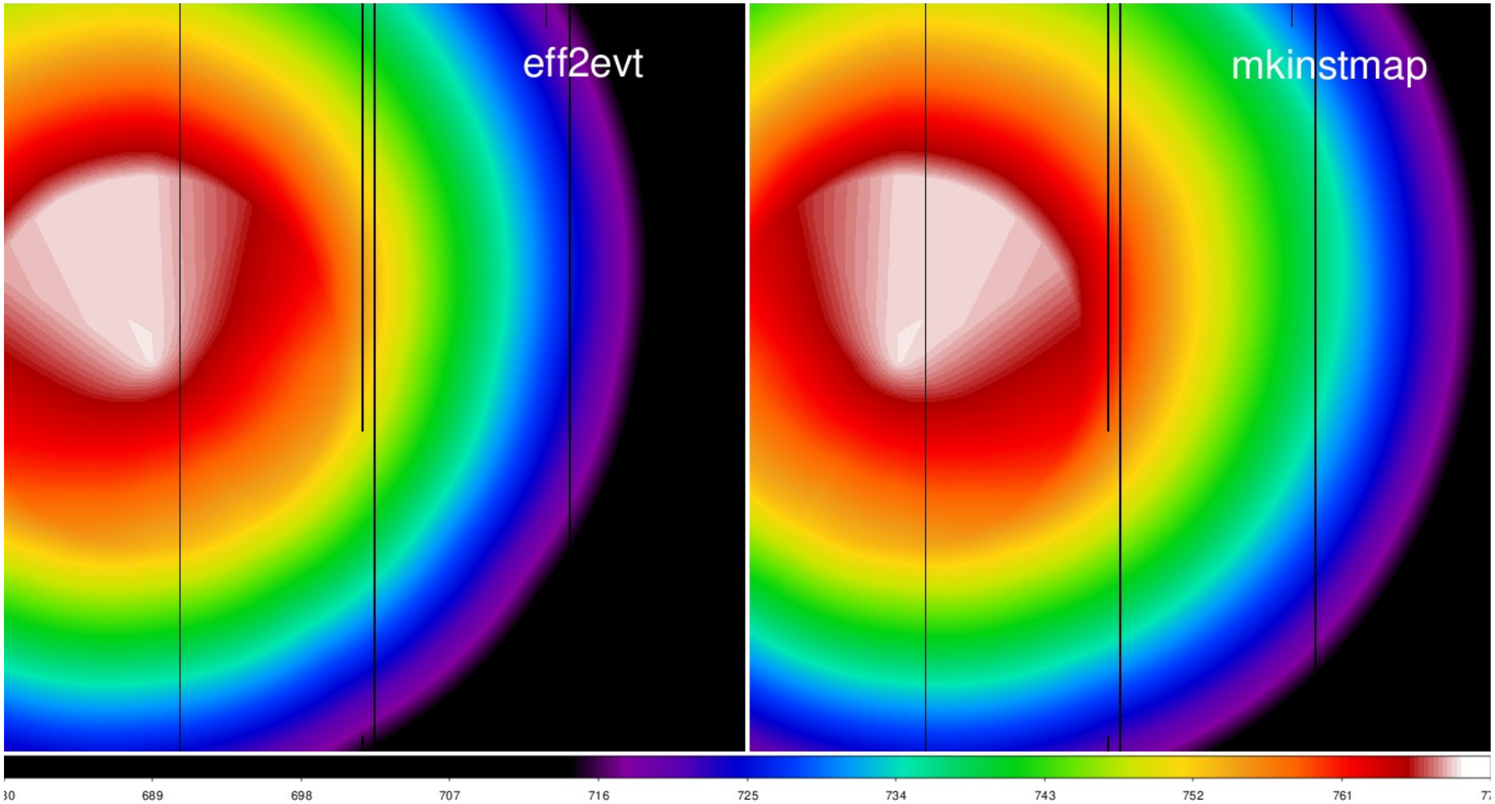
HCG62 (larger FOV) binned to SNR>=20, using elliptical slices ("epanda").

Simple use case

The adaptive binning output can then be used for things such as creating temperature maps, or as shown here a much more simple application which is just the mean energy (in units of eV) of the events in each of the bins.

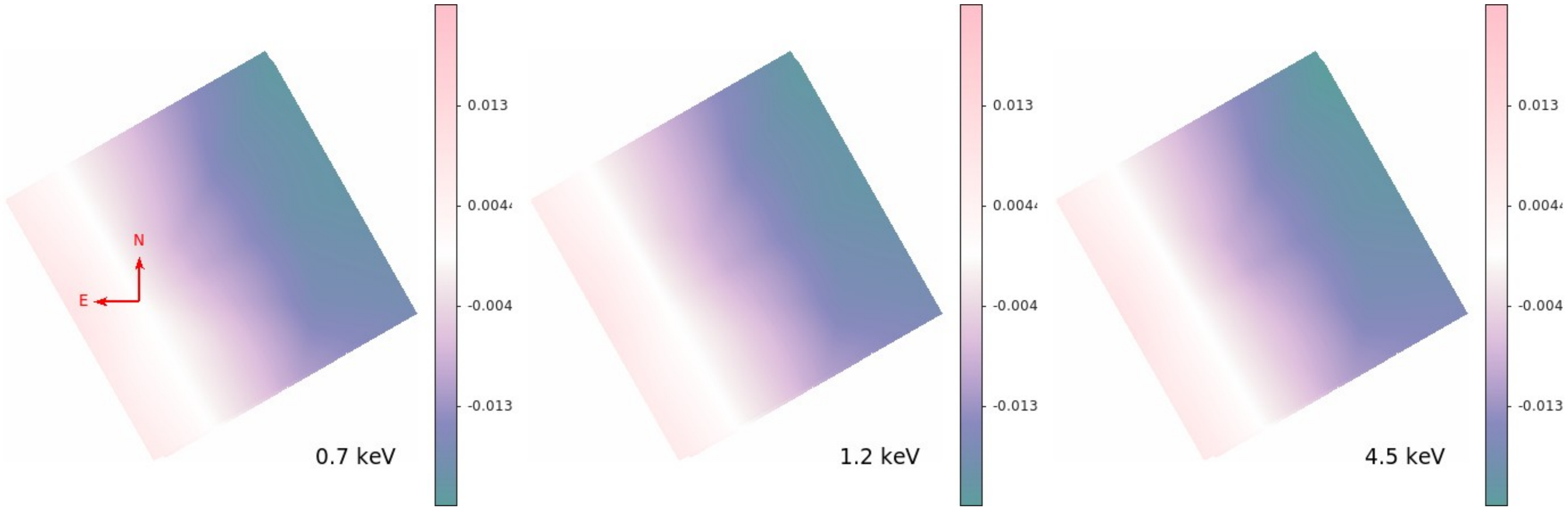


Bugs: Coordinate sign error



A local user reported an issue when looking at the Effective Area computed by different tools: eff2evt and mkinstmap. There is a rotation and flip of the vignetting component which has been tracked back to a sign error when computing the azimuthal angle, ϕ, used by mkinstmap, mkarf, and mkgarf. The image shows the effective area in Chip coordinates.

Effect on Exposure Maps



The vignetting component is energy dependent and nearly sinusoidal in ϕ. This image shows the fractional difference between the exposure map at different energies before and after the bug fix. The error is small, generally between -1.5 to 1.5%.

CAL team is investigating more deeply since contamination and HRC QE/U are derived from these tools.

Contributed Scripts

- CIAO 4.13 Updates
  - 4.13.1
    - Implemented work around for ACIS framestore shadow issue
    - dax: corrected energy limits when estimating fluxes from fit results
  - 4.13.2
    - specextract: fixes issue when using combine=yes with blank sky background files
  - 4.13.3
    - chandra_repro updated in coordination with CALDB to skip HRC-S/LETG PI filter for recently acquired data (high voltage gain uncertainty).
- CIAO 4.14
  - Rewrite of specextract including support for parallel processing
  - Color coded error messages (can be disabled)
  - Compatibility updates with CIAO and Sherpa 4.14.0

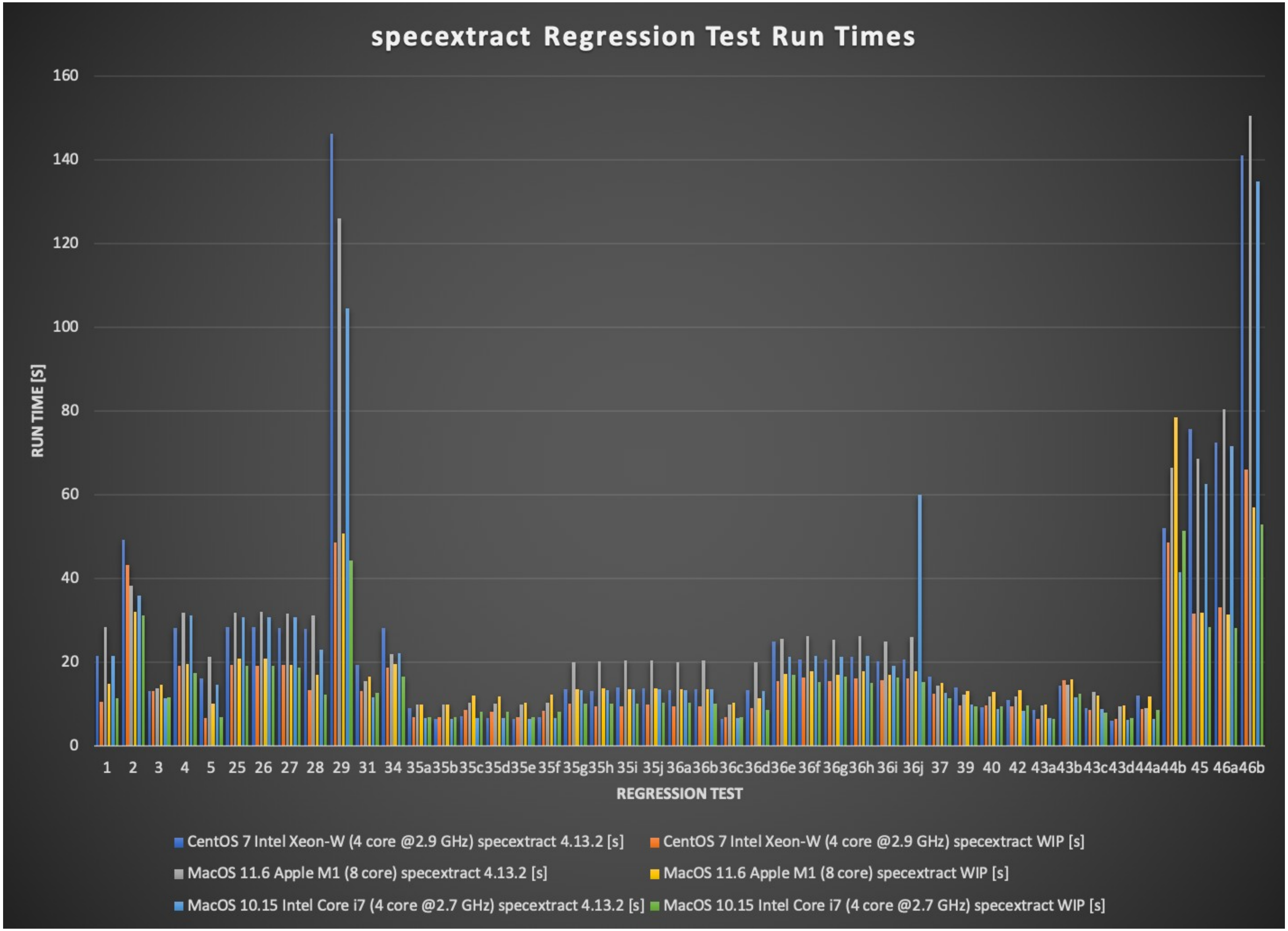
`specextract` rewrite

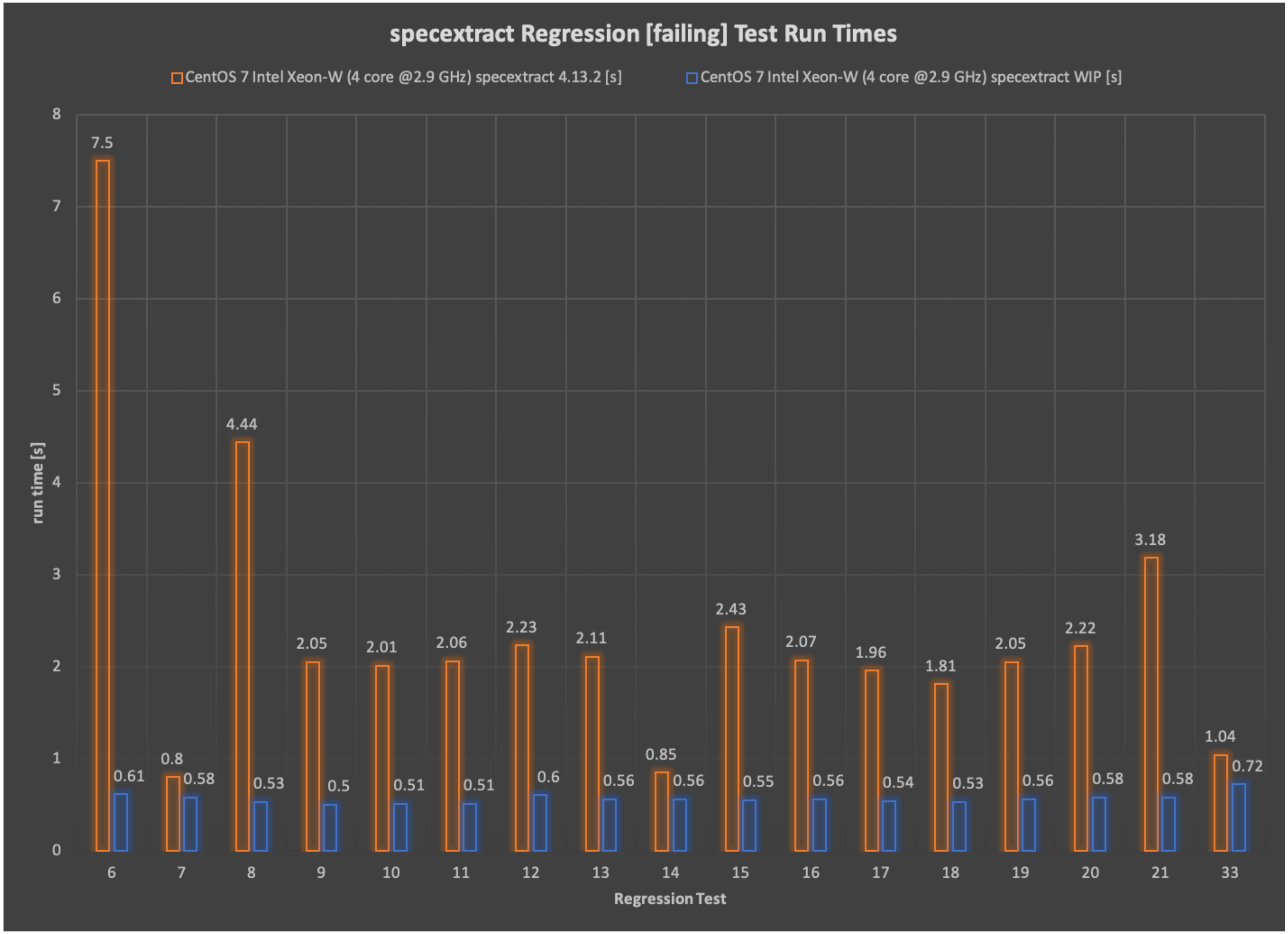
- changes transparent to user, transition to new version should be seamless
    - no changes in syntax usage
    - no changes to result

- code restructured and written to be more Pythonic for easier maintainability

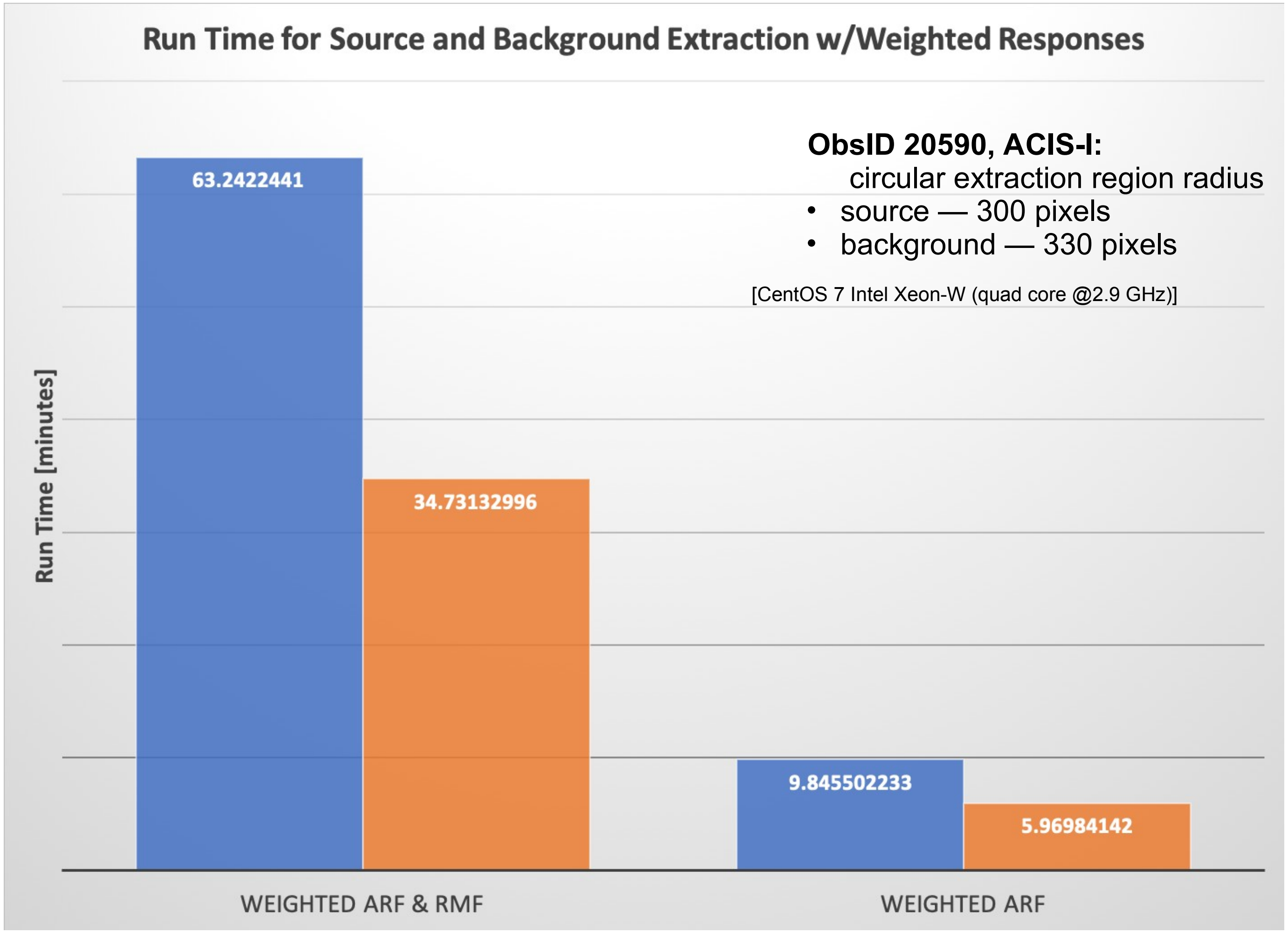
- improve run time performance
    - parallelization where possible
    - front-load parameter and file checking
    - error out early

- undergoing beta testing; intended to be ready for CIAO 4.14 release


specextract Regression Test Run Times
RUN TIME [S]
160
140
120
100
80
60
40
20
0
1
2
3
4
5
25
26
27
28
29
31
34
35a
35b
35c
35d
35e
35f
35g
35h
35i
35j
36a
36b
36c
36d
36e
36f
36g
36h
36i
36j
37
39
40
42
43a
43b
43c
43d
44a
44b
45
46a
46b
REGRESSION TEST
CentOS 7 Intel Xeon-W (4 core @2.9 GHz) specextract 4.13.2 [s]
CentOS 7 Intel Xeon-W (4 core @2.9 GHz) specextract WIP [s]
MacOS 11.6 Apple M1 (8 core) specextract 4.13.2 [s]
MacOS 11.6 Apple M1 (8 core) specextract WIP [s]
MacOS 10.15 Intel Core i7 (4 core @2.7 GHz) specextract 4.13.2 [s]
MacOS 10.15 Intel Core i7 (4 core @2.7 GHz) specextract WIP [s]


specextract Regression [failing] Test Run Times
□ CentOS 7 Intel Xeon-W (4 core @2.9 GHz) specextract 4.13.2 [s]
□ CentOS 7 Intel Xeon-W (4 core @2.9 GHz) specextract WIP [s]
run time [s]
0
1
2
3
4
5
6
7
8
Regression Test
6
7.5
0.61
7
0.8
0.58
8
4.44
0.53
9
2.05
0.5
10
2.01
0.51
11
2.06
0.51
12
2.23
0.6
13
2.11
0.56
14
0.85
0.56
15
2.43
0.55
16
2.07
0.56
17
1.96
0.54
18
1.81
0.53
19
2.05
0.56
20
2.22
0.58
21
3.18
0.58
33
1.04
0.72

Common use case: extract source and background spectrum, generate weighted responses for both



ObsID 20590, ACIS-I:

circular extraction region radius

- source — 300 pixels
- background — 330 pixels

[CentOS 7 Intel Xeon-W (quad core @2.9 GHz)]

Catalog Support

SDS Support for Catalog

SDS supports the catalog at 2.0 FTE level (Primini, Burke, Lee, with some additional relevant work by others)

Details of progress in I Evans presentation

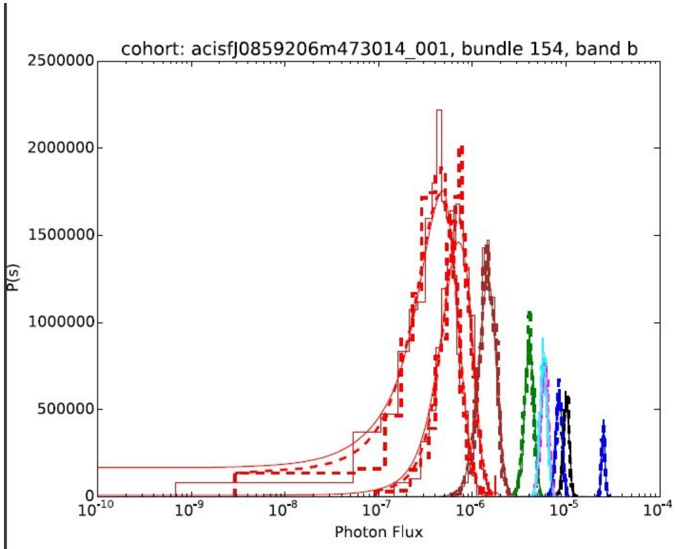
Primini:
- Statistical Characterization of the catalog
- Aperture Photometry
- Quality assurance and reviews on data, detect list and data products

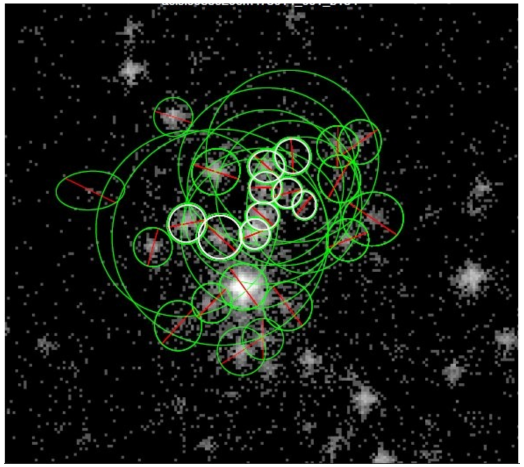
Burke
- convex hull support,
- quality assurance/reviews of source properties pipeline
- visualization (catalog display in WWT)

Siemiginowska
- fitting

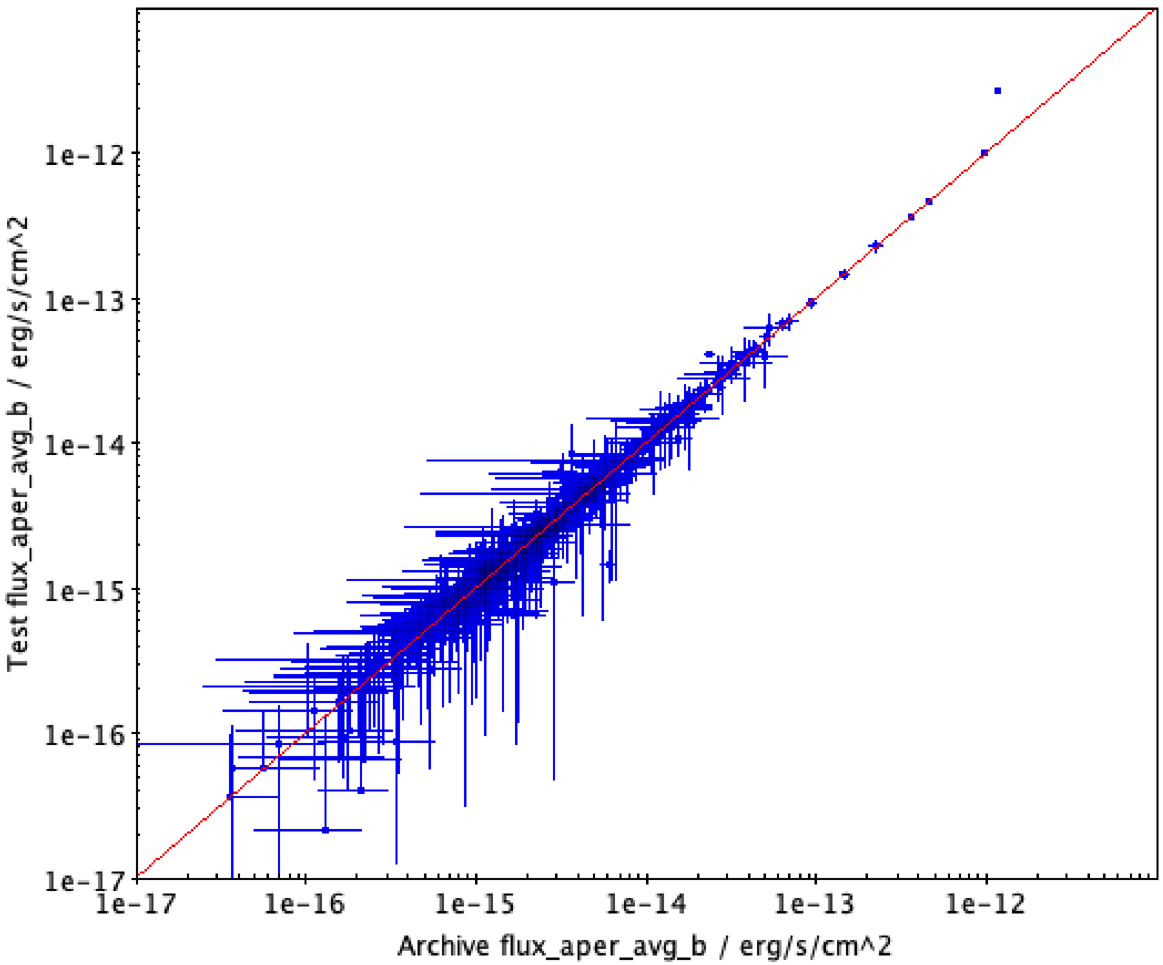
Nynka
- simulations

Burke, McDowell, Lee, Primini, Siemiginowska
- Documentation.





Testing CSC 2.1 Aperture Photometry



A test CSC 2.1 catalog was cross-matched with CSC 2.0, and fluxes of matching master sources were compared (for clarity, every 10th point from a sample of ~6600 matches are plotted). The results are in good agreement. In this sample, the use of pymc3 when CSC 2.0 photometry algorithms failed resulted in an increase of ~7% in the number of valid master source fluxes.

Sherpa

Sherpa Development 2021

- Sherpa releases during the last year:
  - 4.12.2 on October 27, 2020.
  - CIAO version was released on Dec.15, 2020; It contained the code introduced in the Sherpa standalone during 2020 development year and released in 4.12.2.
  - 4.13.0 was released on Jan.8, 2021 to align the CIAO and Sherpa version numbers. This release contained a few documentation updates and infrastructure changes to migrate Travis-CI to GitHub Actions for integration testing.
  - 4.13.1 May 18, 2021
  - 4.14.0 October 7, 2021 - this is the version which will be included in CIAO release in December 2021.

Jupyter notebooks for the Chandra Data Science Workshop:

https://github.com/cxcsds/sherpa-notebooks-chandra-data-science-august-2021

Sherpa Development 2021

- Release Highlights:
  - enhancements:
    - filtering and grouping area for binned spectral data
    - updates to allow users to change the hard limits of XSPEC model parameters
    - the sample_flux routine now returns correct information for the clip column
  - documentation changes:
    - improved PHA simulation documentation
    - improved Filtering and grouping of PHA data documentation
    - added sherpa.image module documentation
    - updates documentation for TableModel, Notice2D, cache support for evaluating models, and low level optimization code
    - Jupyter notebook updates
  - Infrastructure changes:
    - the github master branch has been migrated from master to main
    - updates to support Apple ARM
    - update to support Xspec version 12.12
    - update fftw from version 3.3.8 to 3.3.9
    - changes to support gcc 9.3.0 in conda defaults
    - updates to support python 3.9 including readline 8.1 upgrade, numpy minimum 1.19 (numpy 1.18 minimum for python 3.7/8)
    - test infrastructure clean up and updates

Sherpa Development 2021

- bug fixes:
  - updates to fix several 'unable to parse region string: None' errors
  - fix issue where save_all() of a loaded image with no region filter would fail on reload
  - fixed issue with plot_model() being called before notice or ignore could lead to filters not getting applied
  - fix to error out instead of crash when grouping data using an unsupported method

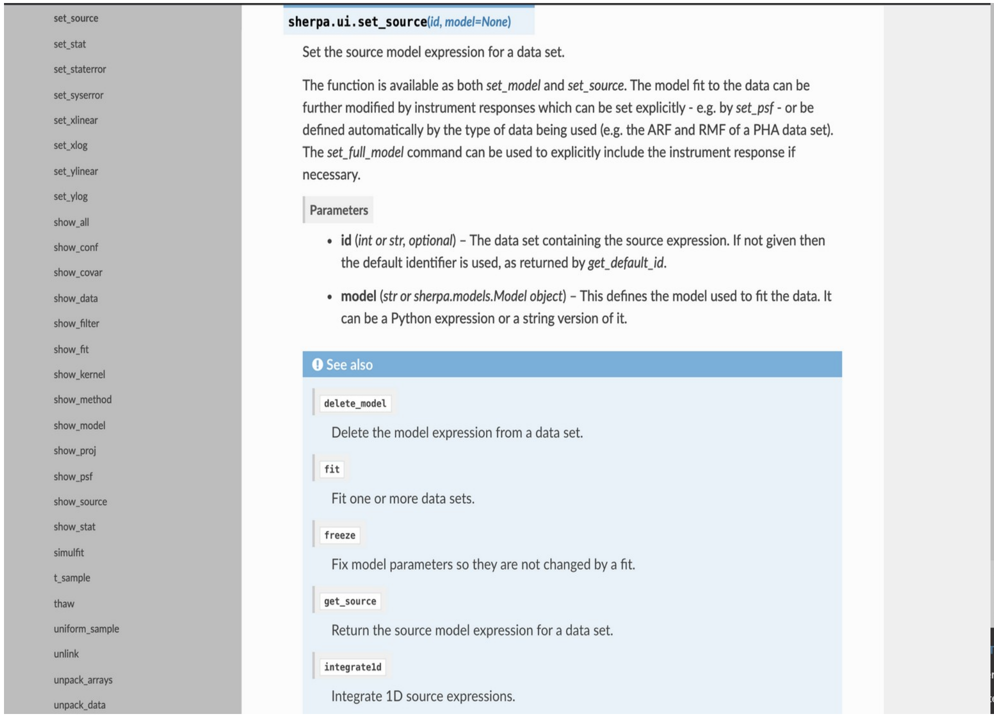
Full Release Notes on https://github.com/sherpa/sherpa/releases

Sherpa Documentation

CIAO

Standalone Python Package

CIAO ahelp files autogenerated from python docstrings



- set_source
- set_stat
- set_staterror
- set_syserror
- set_xlinear
- set_xlog
- set_ylinear
- set_ylog
- show_all
- show_conf
- show_covar
- show_data
- show_filter
- show_fit
- show_kernel
- show_method
- show_model
- show_proj
- show_psf
- show_source
- show_stat
- simulfit
- t_sample
- thaw
- uniform_sample
- unlink
- unpack_arrays
- unpack_data

sherpa.ui.set_source(*id, model=None*)

Set the source model expression for a data set.

The function is available as both *set_model* and *set_source*. The model fit to the data can be further modified by instrument responses which can be set explicitly - e.g. by *set_psf* - or be defined automatically by the type of data being used (e.g. the ARF and RMF of a PHA data set). The *set_full_model* command can be used to explicitly include the instrument response if necessary.

Parameters

- **id** (*int or str, optional*) – The data set containing the source expression. If not given then the default identifier is used, as returned by *get_default_id*.
- **model** (*str or sherpa.models.Model object*) – This defines the model used to fit the data. It can be a Python expression or a string version of it.

See also

`delete_model`

Delete the model expression from a data set.

`fit`

Fit one or more data sets.

`freeze`

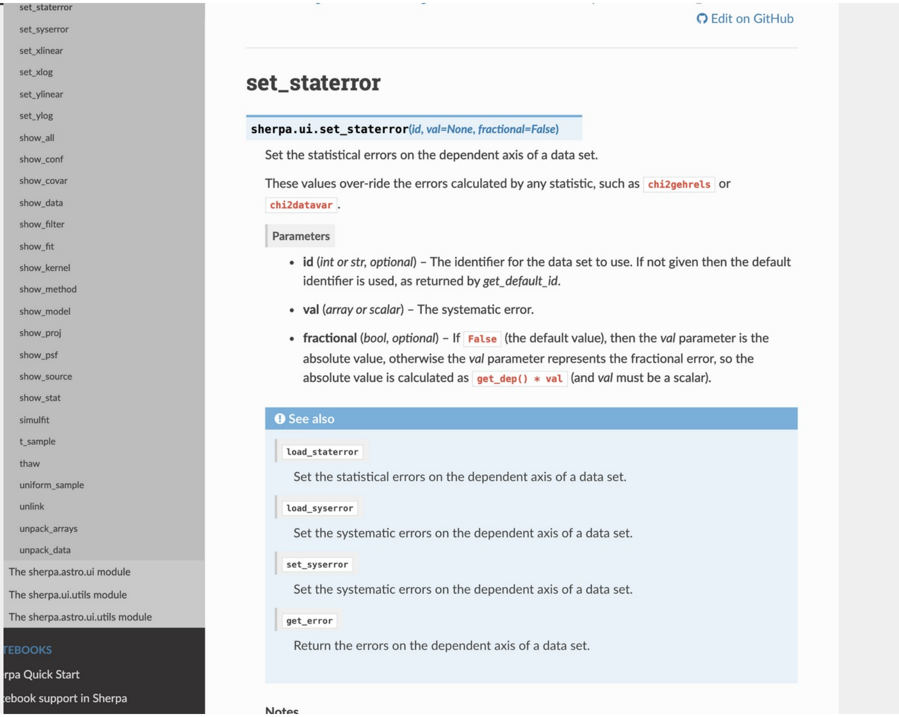
Fix model parameters so they are not changed by a fit.

`get_source`

Return the source model expression for a data set.

`integrate1d`

Integrate 1D source expressions.



- set_staterror
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- unlink
- unpack_arrays
- unpack_data
- The sherpa.astro.ui module
- The sherpa.ui.utils module
- The sherpa.astro.ui.utils module

TEBOOKS

rpa Quick Start

ebook support in Sherpa

Edit on GitHub

set_staterror

sherpa.ui.set_staterror(*id, val=None, fractional=False*)

Set the statistical errors on the dependent axis of a data set.

These values over-ride the errors calculated by any statistic, such as `chi2gehrels` or `chi2datavar`.

Parameters

- **id** (*int or str, optional*) – The identifier for the data set to use. If not given then the default identifier is used, as returned by *get_default_id*.
- **val** (*array or scalar*) – The systematic error.
- **fractional** (*bool, optional*) – If `False` (the default value), then the *val* parameter is the absolute value, otherwise the *val* parameter represents the fractional error, so the absolute value is calculated as `get_dep() * val` (and *val* must be a scalar).

See also

`load_staterror`

Set the statistical errors on the dependent axis of a data set.

`load_syserror`

Set the systematic errors on the dependent axis of a data set.

`set_syserror`

Set the systematic errors on the dependent axis of a data set.

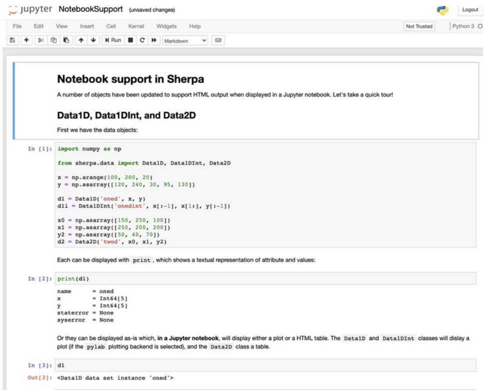
`get_error`

Return the errors on the dependent axis of a data set.

Notes

https://sherpa.readthedocs.io/en/latest/NotebookSupport.html#

CIAO 4.12


jupyter NotebookSupport (unsaved changes)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3
Run
Markdown

Notebook support in Sherpa

A number of objects have been updated to support HTML output when displayed in a Jupyter notebook. Let's take a quick tour!

Data1D, Data1DInt, and Data2D

First we have the data objects:

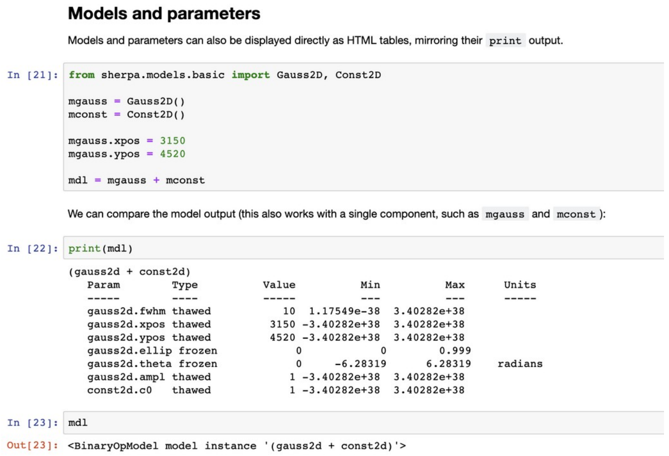
```
In [1]: import numpy as np

        from sherpa.data import Data1D, Data1DInt, Data2D

        x = np.arange(100, 200, 20)
        y = np.asarray([120, 240, 30, 95, 130])

        d1 = Data1D('oned', x, y)
        d1i = Data1DInt('onedint', x[:-1], x[1:], y[:-1])

        x0 = np.asarray([150, 250, 100])
        x1 = np.asarray([250, 200, 200])
        y2 = np.asarray([50, 40, 70])
        d2 = Data2D('twod', x0, x1, y2)
```

Each can be displayed with `print`, which shows a textual representation of attribute and values:

```
In [2]: print(d1)

        name      = oned
        x         = Int64[5]
        y         = Int64[5]
        staterror = None
        syserror  = None
```

Or they can be displayed as-is which, **in a Jupyter notebook**, will display either a plot or a HTML table. The `Data1D` and `Data1DInt` classes will dislay a plot (if the `pylab` plotting backend is selected), and the `Data2D` class a table.

```
In [3]: d1
Out[3]: <Data1D data set instance 'oned'>
```



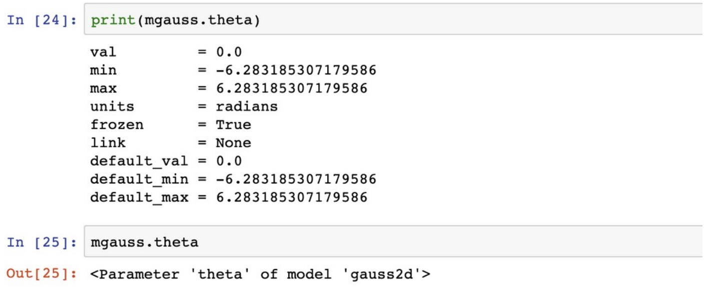
Models and parameters

Models and parameters can also be displayed directly as HTML tables, mirroring their `print` output.

```
In [21]: from sherpa.models.basic import Gauss2D, Const2D

         mgauss = Gauss2D()
         mconst = Const2D()

         mgauss.xpos = 3150
         mgauss.ypos = 4520

         mdl = mgauss + mconst
```

We can compare the model output (this also works with a single component, such as `mgauss` and `mconst`):

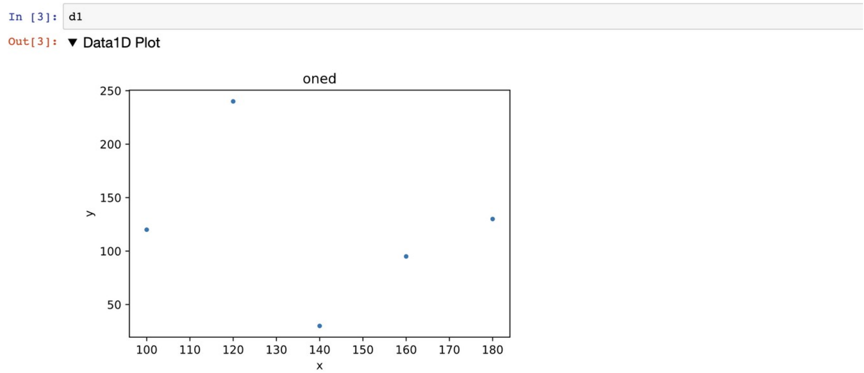
```
In [22]: print(mdl)

         (gauss2d + const2d)
            Param        Type          Value          Min          Max      Units
            -----        ----          -----          ---          ---      -----
            gauss2d.fwhm thawed           10  1.17549e-38  3.40282e+38
            gauss2d.xpos thawed         3150 -3.40282e+38  3.40282e+38
            gauss2d.ypos thawed         4520 -3.40282e+38  3.40282e+38
            gauss2d.ellip frozen           0            0        0.999
            gauss2d.theta frozen           0     -6.28319      6.28319    radians
            gauss2d.ampl thawed            1 -3.40282e+38  3.40282e+38
            const2d.c0   thawed            1 -3.40282e+38  3.40282e+38

In [23]: mdl
Out[23]: <BinaryOpModel model instance '(gauss2d + const2d)'>
```



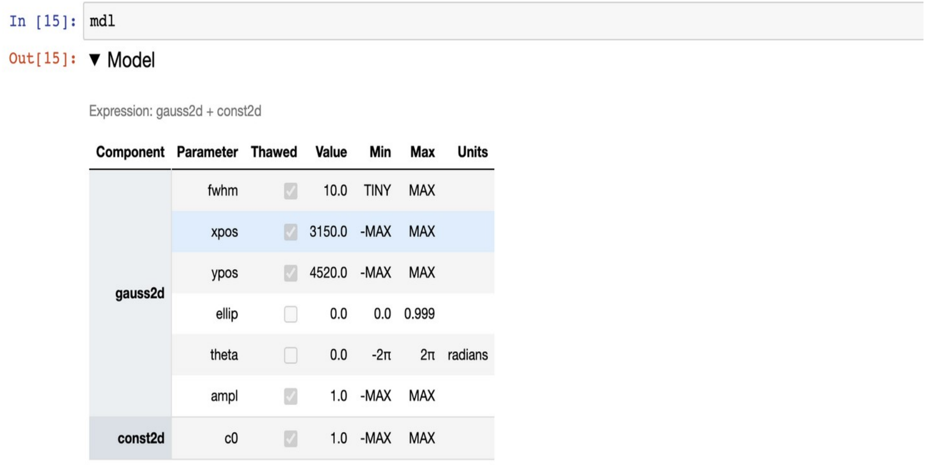
```
In [24]: print(mgauss.theta)

         val         = 0.0
         min         = -6.283185307179586
         max         = 6.283185307179586
         units       = radians
         frozen      = True
         link        = None
         default_val = 0.0
         default_min = -6.283185307179586
         default_max = 6.283185307179586

In [25]: mgauss.theta
Out[25]: <Parameter 'theta' of model 'gauss2d'>
```

CIAO 4.13

```
In [3]: d1
Out[3]: ▼ Data1D Plot
```



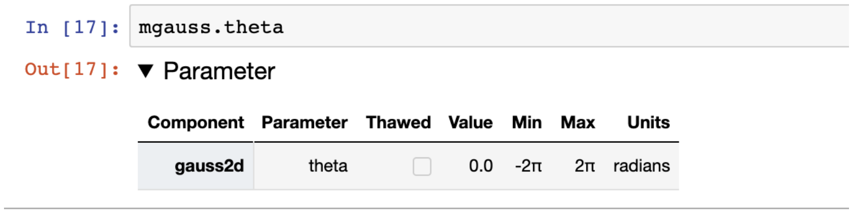
```
In [15]: mdl
Out[15]: ▼ Model
```



Expression: gauss2d + const2d

Component	Parameter	Thawed	Value	Min	Max	Units
gauss2d	fwhm	☑	10.0	TINY	MAX	
	xpos	☑	3150.0	-MAX	MAX	
	ypos	☑	4520.0	-MAX	MAX	
	ellip	□	0.0	0.0	0.999	
	theta	□	0.0	-2π	2π	radians
	ampl	☑	1.0	-MAX	MAX	
const2d	c0	☑	1.0	-MAX	MAX	

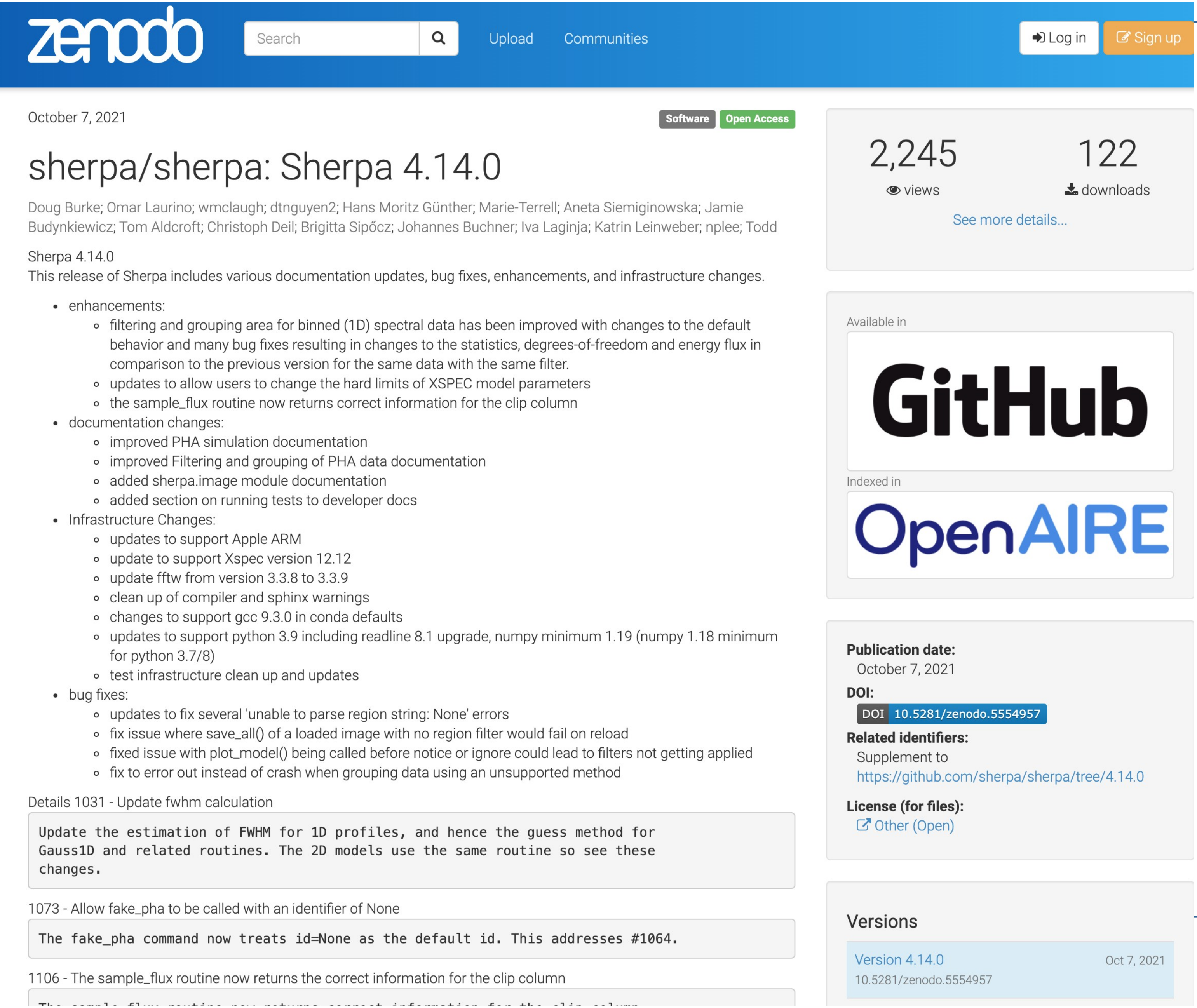
```
In [17]: mgauss.theta
Out[17]: ▼ Parameter
```



Component	Parameter	Thawed	Value	Min	Max	Units
gauss2d	theta	□	0.0	-2π	2π	radians

Sherpa Open Source Python Package - Citation

Chandra X-ray Center



October 7, 2021

Software Open Access

sherpa/sherpa: Sherpa 4.14.0

Doug Burke; Omar Laurino; wmclaugh; dtnguyen2; Hans Moritz Günther; Marie-Terrell; Aneta Siemiginowska; Jamie Budynkiewicz; Tom Aldcroft; Christoph Deil; Brigitta Sipőcz; Johannes Buchner; Iva Laginja; Katrin Leinweber; nplee; Todd

Sherpa 4.14.0
This release of Sherpa includes various documentation updates, bug fixes, enhancements, and infrastructure changes.

- enhancements:
  - filtering and grouping area for binned (1D) spectral data has been improved with changes to the default behavior and many bug fixes resulting in changes to the statistics, degrees-of-freedom and energy flux in comparison to the previous version for the same data with the same filter.
  - updates to allow users to change the hard limits of XSPEC model parameters
  - the sample_flux routine now returns correct information for the clip column
- documentation changes:
  - improved PHA simulation documentation
  - improved Filtering and grouping of PHA data documentation
  - added sherpa.image module documentation
  - added section on running tests to developer docs
- Infrastructure Changes:
  - updates to support Apple ARM
  - update to support Xspec version 12.12
  - update fftw from version 3.3.8 to 3.3.9
  - clean up of compiler and sphinx warnings
  - changes to support gcc 9.3.0 in conda defaults
  - updates to support python 3.9 including readline 8.1 upgrade, numpy minimum 1.19 (numpy 1.18 minimum for python 3.7/8)
  - test infrastructure clean up and updates
- bug fixes:
  - updates to fix several 'unable to parse region string: None' errors
  - fix issue where save_all() of a loaded image with no region filter would fail on reload
  - fixed issue with plot_model() being called before notice or ignore could lead to filters not getting applied
  - fix to error out instead of crash when grouping data using an unsupported method

Details 1031 - Update fwhm calculation

```
Update the estimation of FWHM for 1D profiles, and hence the guess method for
Gauss1D and related routines. The 2D models use the same routine so see these
changes.
```

1073 - Allow fake_pha to be called with an identifier of None

```
The fake_pha command now treats id=None as the default id. This addresses #1064.
```

1106 - The sample_flux routine now returns the correct information for the clip column

```
The sample_flux routine now returns correct information for the clip column
```

2,245
views

122
downloads

See more details...

Available in

GitHub

Indexed in

OpenAIRE

Publication date:
October 7, 2021

DOI:
DOI 10.5281/zenodo.5554957

Related identifiers:
Supplement to
https://github.com/sherpa/sherpa/tree/4.14.0

License (for files):
Other (Open)

Versions

Version 4.14.0 Oct 7, 2021
10.5281/zenodo.5554957

Using Sherpa in Astronomy Research

~1401 publications in ApJ, AJ, MNRAS and A&A use Sherpa (since 2001 and including astro-ph abstracts)

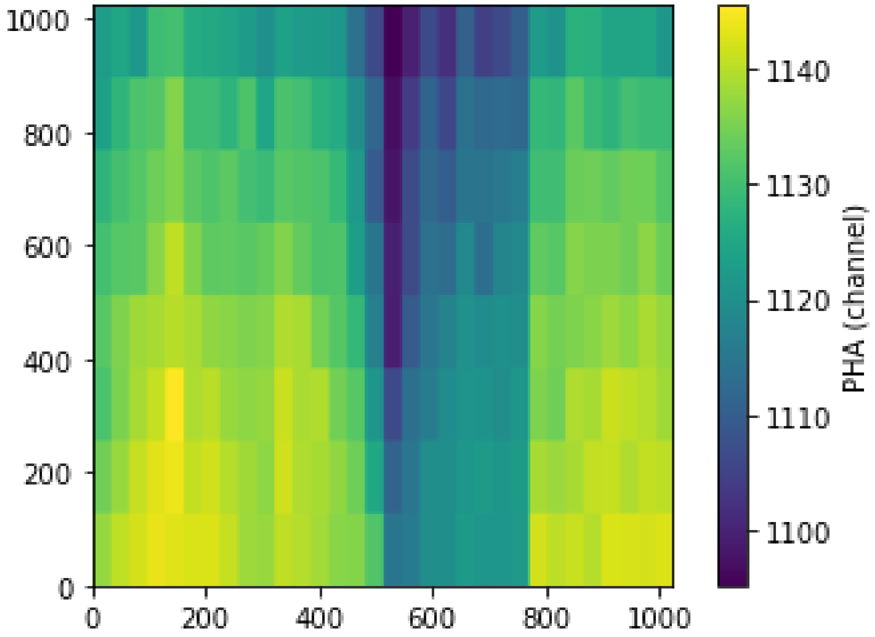
342 citations to Freeman et al 2001 SPIE paper

91 research papers published in 2020

7 PhD theses listed in ADS that used Sherpa

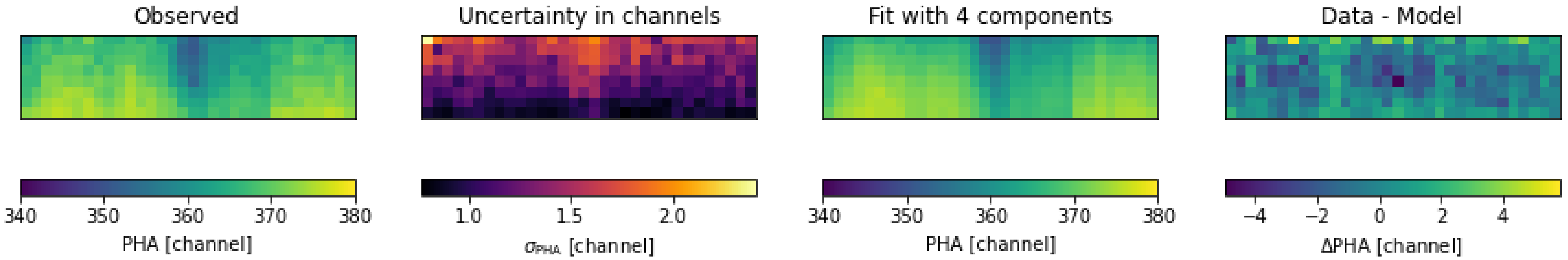
Instruments and Gratings

ACIS gain calibration research



New approach to gain calibration using principal component analysis (PCA)

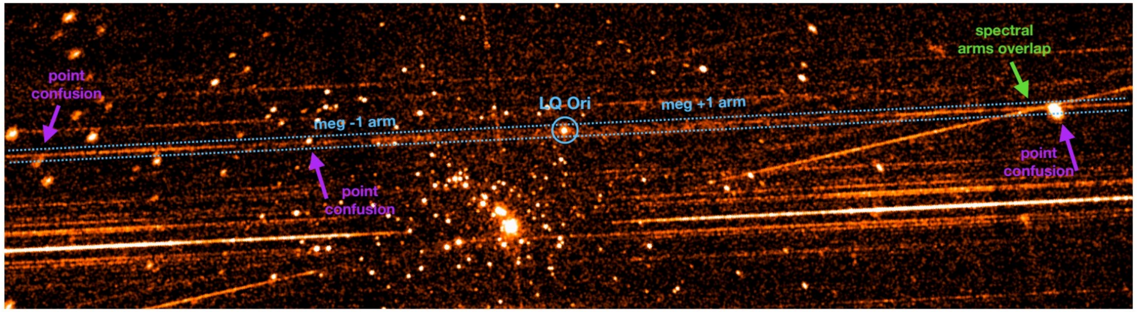
Gain evolves with time but there are consistent spatial patterns
3 to 5 spatial components found – requires less cal observational data than 256 independent tiles



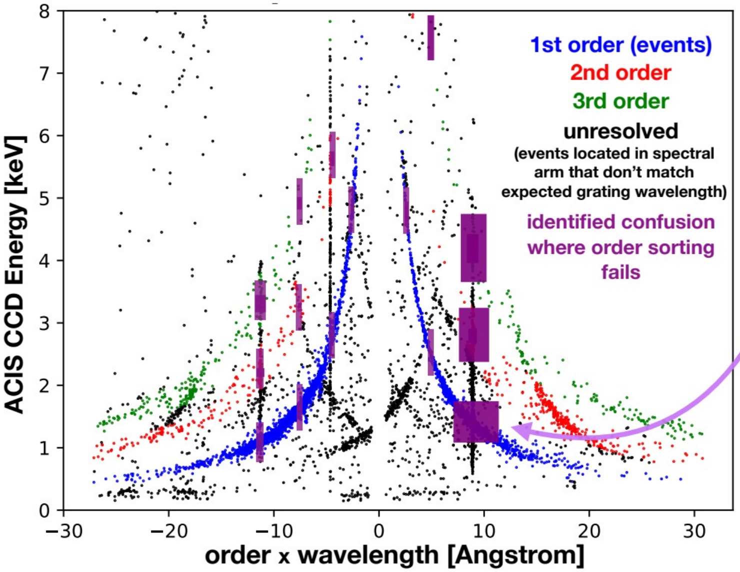
Chandra HETG Confusion Tool: Progress Update

- HETG observations of fields with multiple X-ray bright sources drastically complicates the analysis of high resolution X-ray spectra.
- Chance alignment of sources in crowded fields cause ***confusion*** (events in the HETG spectrum of an extracted source belonging to a different object). This tool identifies the location of these ***confusing events*** using the position of X-ray sources in the observation.
- When fitting spectra, users can then remove (ignore) the small wavelength range associated with confusion instead of removing the entire arm.

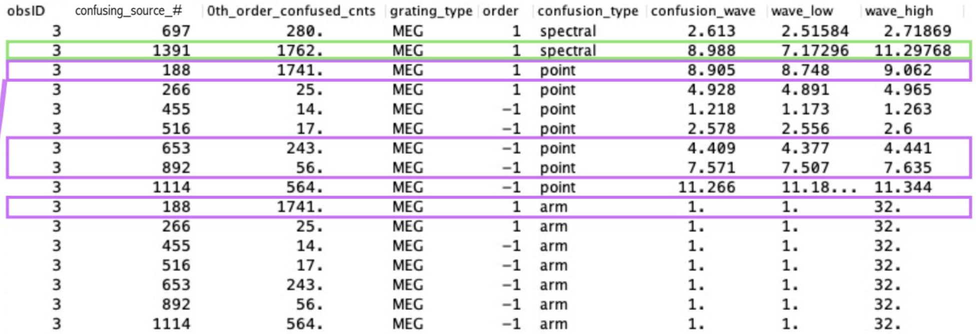
HETG observation of the Orion Nebula Cluster



LQ Ori Spectral Extraction Order Sorting: MEG



Example Confusion Table for LQ Ori to be used when fitting spectra



obsID	confusing_source_#	0th_order_confused_cnts	grating_type	order	confusion_type	confusion_wave	wave_low	wave_high
3	697	280.	MEG	1	spectral	2.613	2.51584	2.71869
3	1391	1762.	MEG	1	spectral	8.988	7.17296	11.29768
3	188	1741.	MEG	1	point	8.905	8.748	9.062
3	266	25.	MEG	1	point	4.928	4.891	4.965
3	455	14.	MEG	−1	point	1.218	1.173	1.263
3	516	17.	MEG	−1	point	2.578	2.556	2.6
3	653	243.	MEG	−1	point	4.409	4.377	4.441
3	892	56.	MEG	−1	point	7.571	7.507	7.635
3	1114	564.	MEG	−1	point	11.266	11.18...	11.344
3	188	1741.	MEG	1	arm	1.	1.	32.
3	266	25.	MEG	1	arm	1.	1.	32.
3	455	14.	MEG	−1	arm	1.	1.	32.
3	516	17.	MEG	−1	arm	1.	1.	32.
3	653	243.	MEG	−1	arm	1.	1.	32.
3	892	56.	MEG	−1	arm	1.	1.	32.
3	1114	564.	MEG	−1	arm	1.	1.	32.

This HETG confusion tool is designed to identify all primary sources of confusion: **(1)** a point source landing on a grating arm, **(2)** when two different source's spectral arms intersect, and **(3)** when a point source lands on an arm and is bright enough to potentially confuse the entire arm with its dispersed spectrum.

The tool can be run on any number of epochs and produces an easy to read fits table (above) for all objects (or a subset) in the field-of-view i**dentifying where confusion occurs, the source responsible for confusion, and a wavelength range to ignore for spectral fitting.** Supplementary products can include an order sorting 'banana plot' (left) overlaid with the affected wavelength range for identified confusion (purple). This tool has been tested using MARX simulations and continues to be tested on the 70 HETG observations of the star-forming Orion Nebula Cluster (individual epoch above).

Other instruments and gratings work:

Repro5 V&V complete

HRC-S time dependent gain map updated

Addressed some minor issues with pipeline grating responses (handling of edge cases such as zero response).

TGCAT grating catalog software port work continuing

Work on gratings with HRC-I, ACIS-I support continues

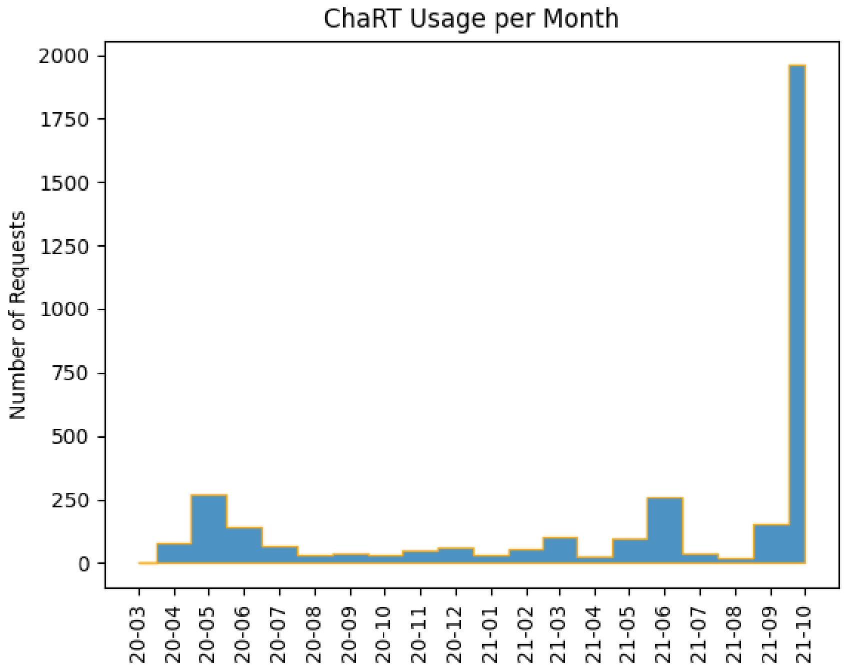
Order sorting improvements in work

PSF

ChaRT and Marx

- ChaRT pdated to use CIAO 4.13
- ChaRT Routine OS and system upgrades
- Marx routine upgrades

ChaRT



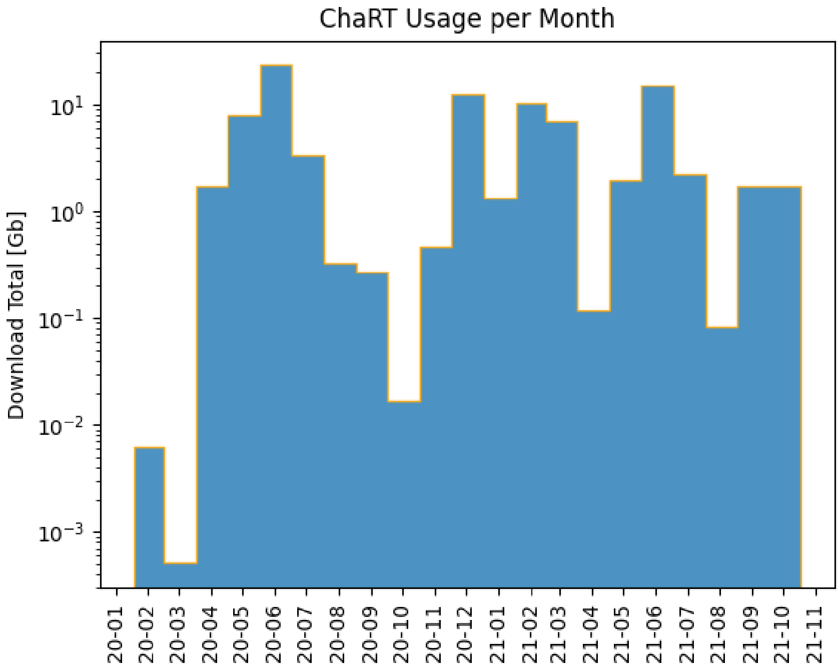


ChaRT server upgraded to CIAO-4.13.

Visualization

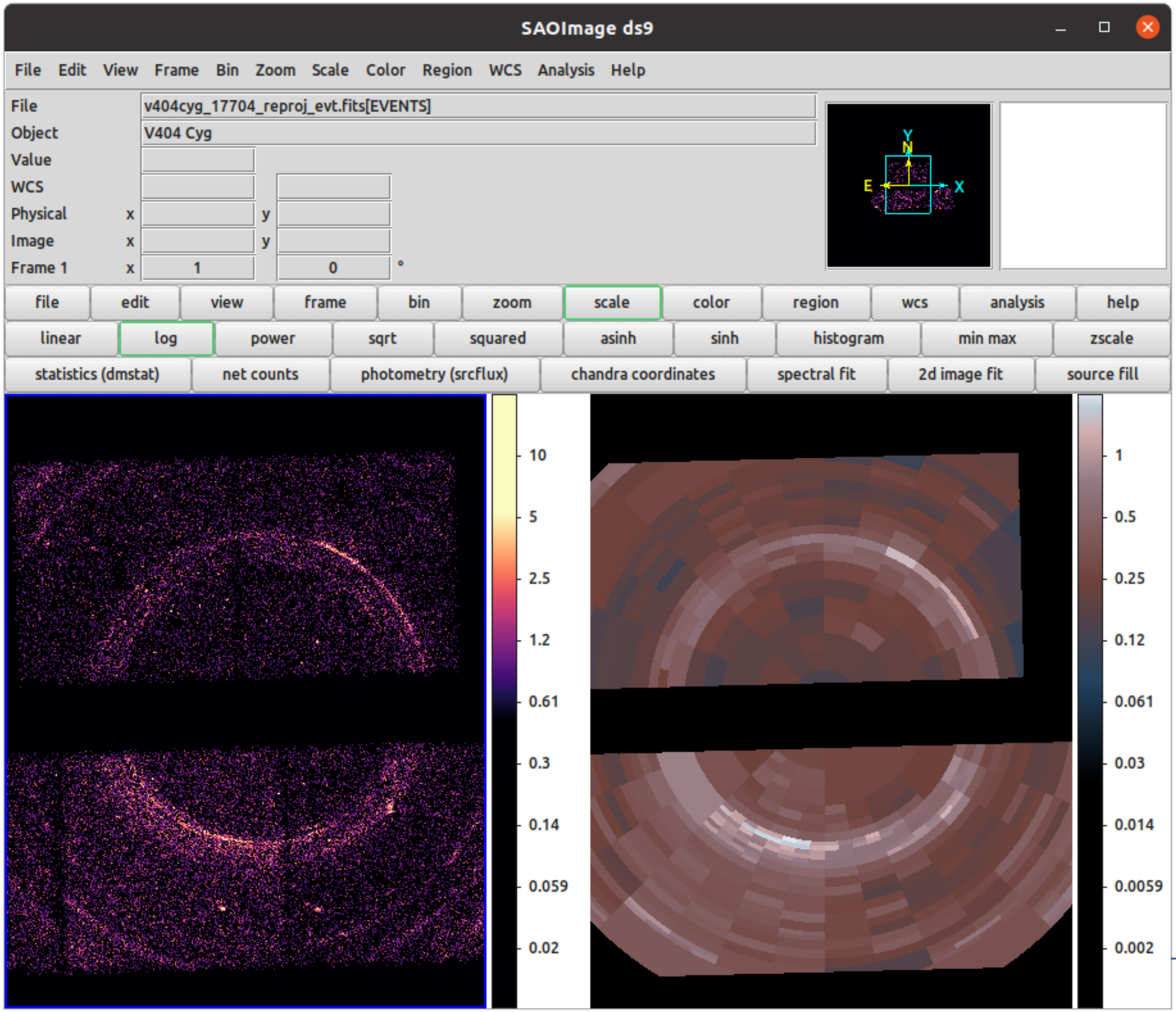
SAOImageDS9

- Releases
    - Version 8.2 - released in Dec 2020 with CIAO 4.13
    - Version 8.2.1 - released in Feb 2021
    - Version 8.3b1 - released in May 2021
    - Version 8.3rc - released in Oct 2021
- New Features 8.3
    - Multiple color bars and graphs, one per frame.
    - New notes support, users may add notes to presentation to be saved with backup.
    - Added support for user defined Analysis button bars.
    - MacOS ARM64 binary support, for both X11 and Aqua ports.
    - Imported MatPlotLib colorbars.
    - Assorted improvements and enhancements.

SAOImageDS9 - May 2021 to Oct 2021

- GitHub Activity
  - 213 Commits
  - 25 Release Note Entries
- Help Desk
  - 54 CXC HelpDesk
- Downloads
  - 17847 unique IP

ds9 8.3 + dax 4.14


SAOImage ds9
File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help
Value
WCS
Physical x y
Image x y
Y N E X
file edit view frame bin zoom scale color region wcs analysis help
linear log power sqrt squared asinh sinh histogram min max zscale
statistics (dmstat) net counts photometry (srcflux) chandra coordinates spectral fit 2d image fit source fill
10
5
2.5
1.2
0.61
0.3
0.14
0.059
0.02
1
0.5
0.25
0.12
0.061
0.03
0.014
0.0059
0.002

File v404cyg_17704_reproj_evt.fits[EVENTS]

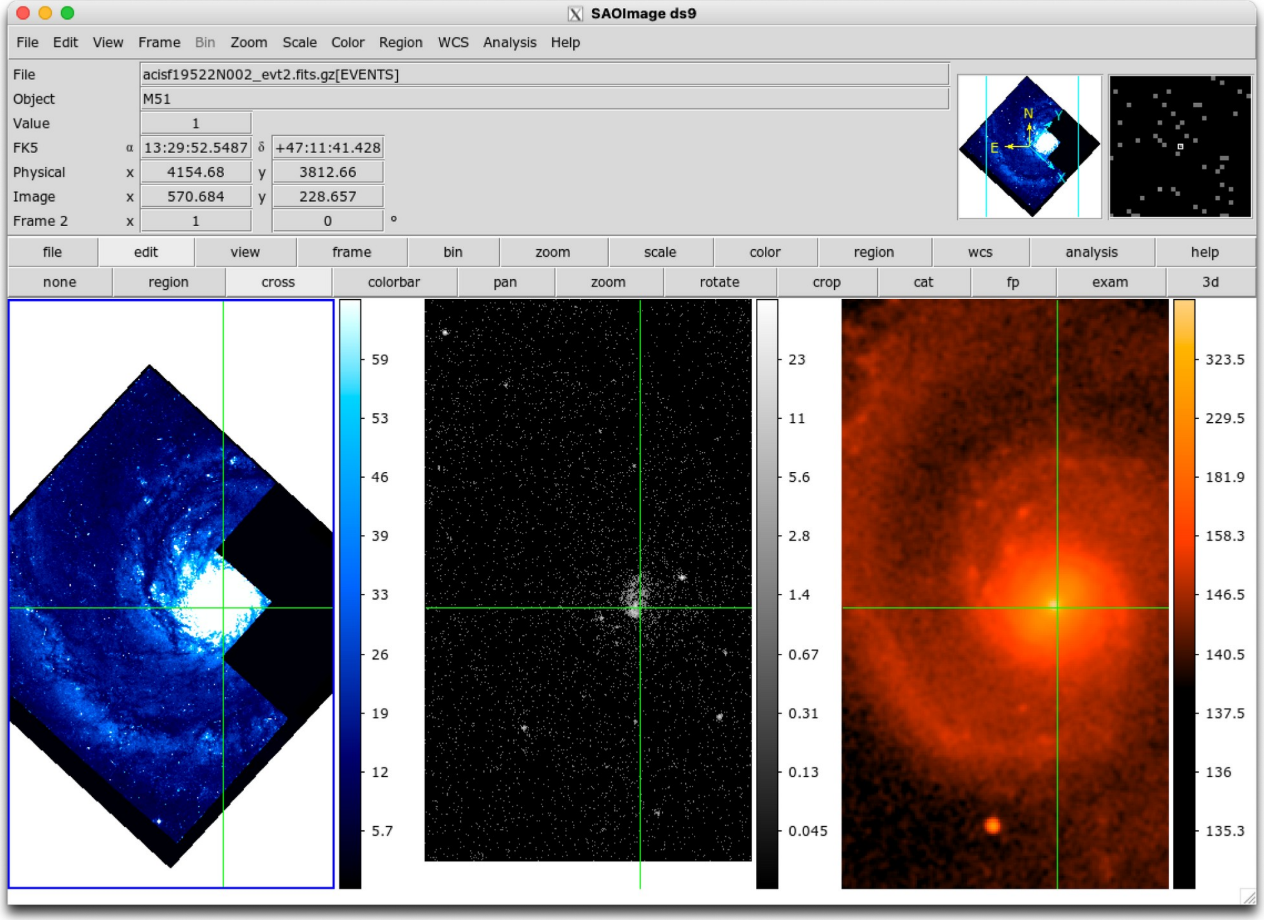
Object V404 Cyg

Frame 1 x 1 0 °

- New button bar
- Multiple color bars
- Matplotlib colors
- Added dmradar

Left: broad band counts image OBSID17704. Right: adaptively binned to w/ snr=5 (25 counts/bin).

SAOImageDS9 - Multiple Colorbars



File	acisf19522N002_evt2.fits.gz[EVENTS]			
Object	M51			
Value	1			
FK5	α	13:29:52.5487	δ	+47:11:41.428
Physical	x	4154.68	y	3812.66
Image	x	570.684	y	228.657
Frame 2	x	1		0 °

SAOImage ds9
File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help
N
E
Y
X
file edit view frame bin zoom scale color region wcs analysis help
none region cross colorbar pan zoom rotate crop cat fp exam 3d
59
53
46
39
33
26
19
12
5.7
23
11
5.6
2.8
1.4
0.67
0.31
0.13
0.045
323.5
229.5
181.9
158.3
146.5
140.5
137.5
136
135.3