Imaging Spectral Analysis

And

More!

- An entire section of the Analysis Threads is devoted to this subject
- **READ THE THREADS** line by line at least the first time!
- **READ THE AHELP** line by line at least once!

Imaging Spectroscopy

WHAT'S NEW | WATCH OUT
Top | All | Intro | Data Prep | Imag | Imag Spec | Grating | Timing | psf | TTT || ChIPS | Sherpa | Proposal | PSF Central

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, a weighted ARF and RMF are built for the spectral analysis.

- **Extracting ACIS Spectra & Creating Response Files:**
  - Extract Spectrum and Response Files for a Pointlike Source
  - Extract Spectrum and Response Files for an Extended Source
  - Extract Spectrum and Response Files for Multiple Sources
  - Coadding Spectra and Responses
  - A Note on Responses for XSpec Users
- **Special Science Cases:**
  - Analysing the ACIS Background with the "Blank-Sky" Files
  - Extract a Spectrum from the ACIS Readout Streak
  - Extracting a Spectrum of a Solar System Object
  - A Note on HRC Spectra
  - Adding Old Chandra Calibration Data to PIMMS
- **Modeling & Fitting Spectral Data with Sherpa (from the Sherpa analysis threads):**
  - Introduction to Fitting PHA Spectra
  - Changing the grouping scheme of a data set within Sherpa
  - Introduction to Fitting ASCII Data with Errors: Single-Component Source Models
  - Simultaneously Fitting Two Data Sets
  - Simulating 1-D Data: the Sherpa FAKE_PHA Command
  - Simulating Chandra ACIS-S Spectra with Sherpa
  - Fitting PHA Data with Multi-Component Source Models
  - Independent Background Responses
  - Using A Pileup Model

REMINDER!

When starting from an event file which has information on **(x,y,E,t)** for each event

Spatial Analysis (*lose time and energy information*)

Spectral Analysis (*lose time and spacial information*)

Timing analysis (*lose spectral and spacial information*)

What is the goal?

- Extract a spectrum of a source detected in an ACIS imaging observation (very limited energy information on the HRC instrument) or a zeroth-order grating observation

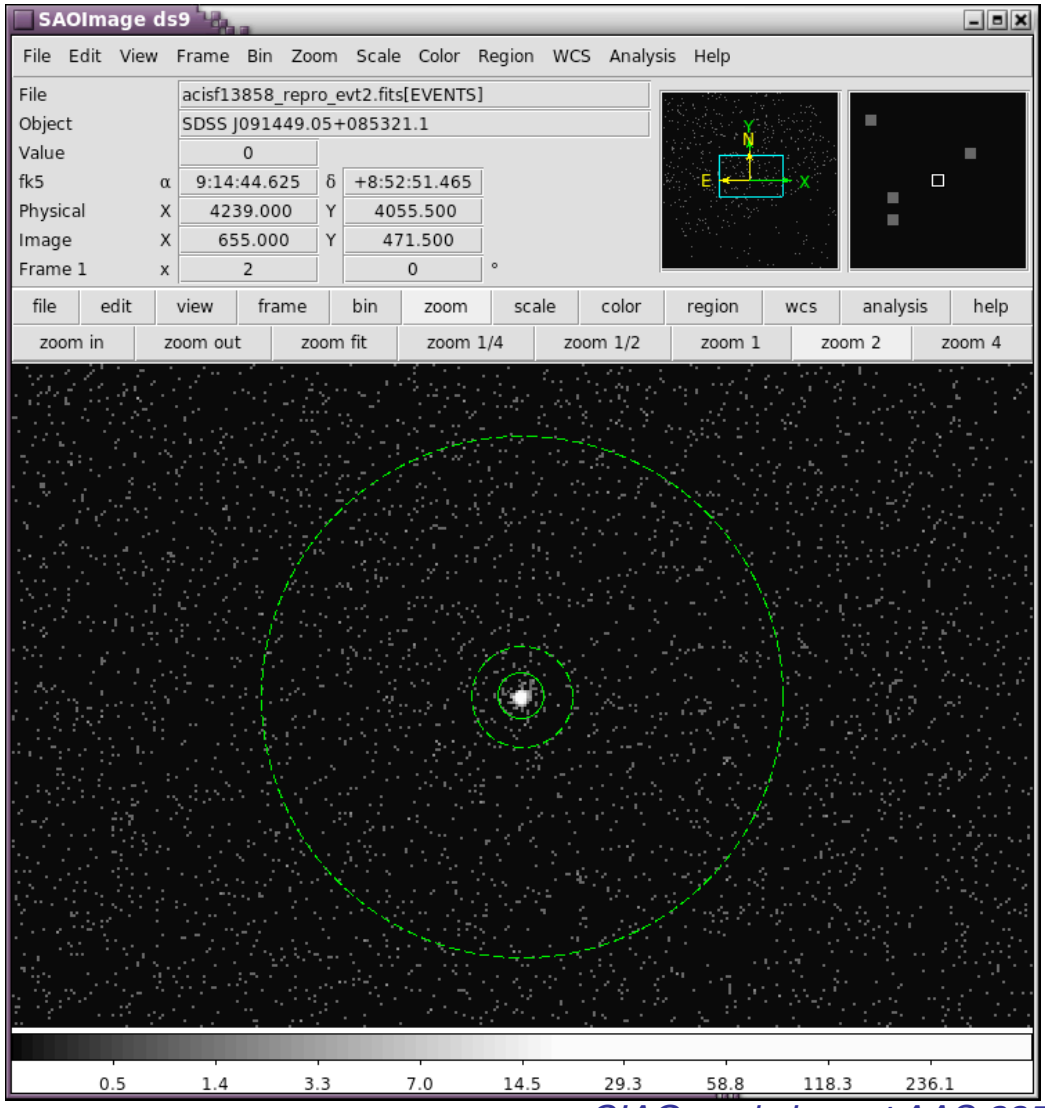
- Create the appropriate response files

  ✓ARF: Ancillary Response File
  ✓RMF: Response Matrix File

So that the spectrum can be modeled and fit to derive physical information about the source (spectral slope, temperature, abundances, absorption, etc.)

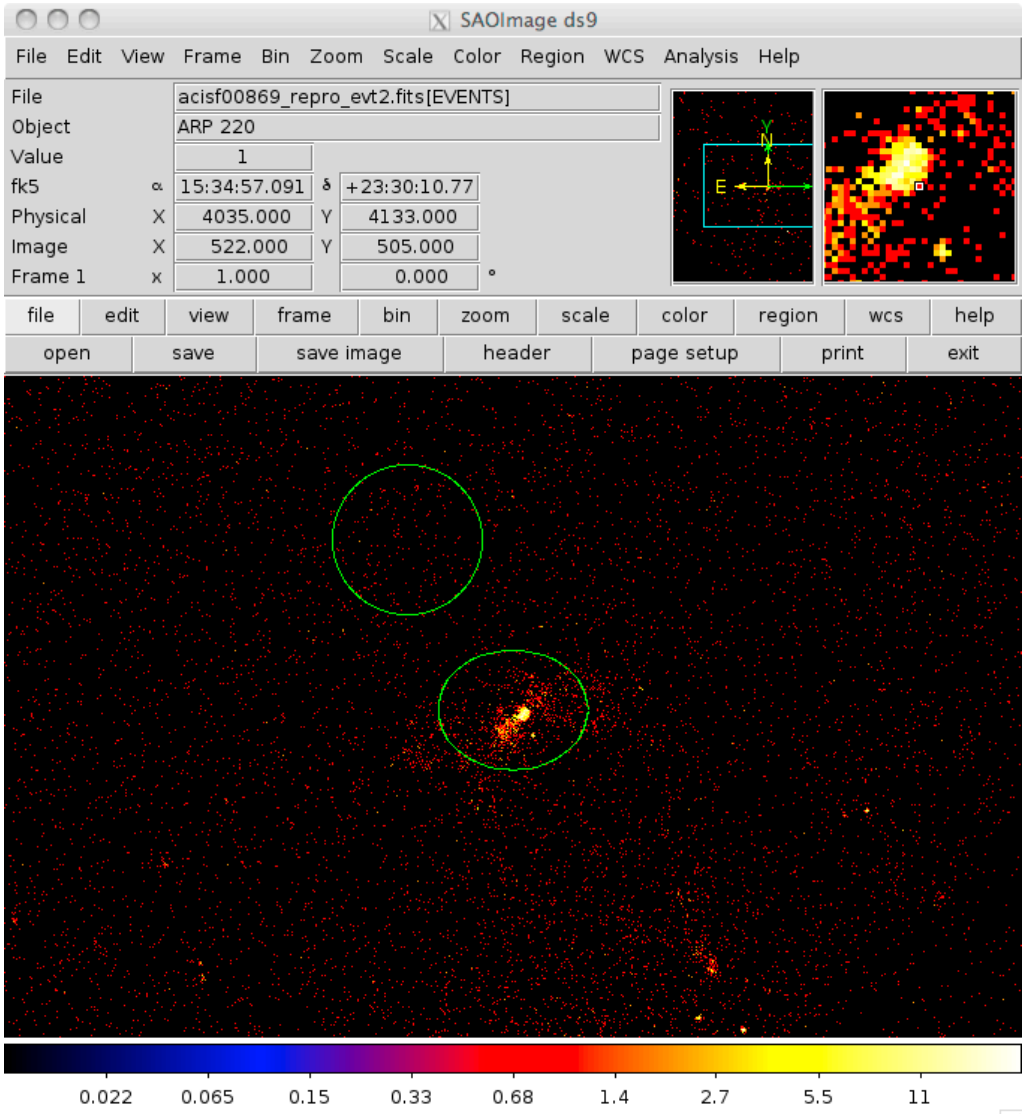
Extract Spectrum and Response Files for a Pointlike Source

https://cxc.cfa.harvard.edu/ciao/threads/pointlike/



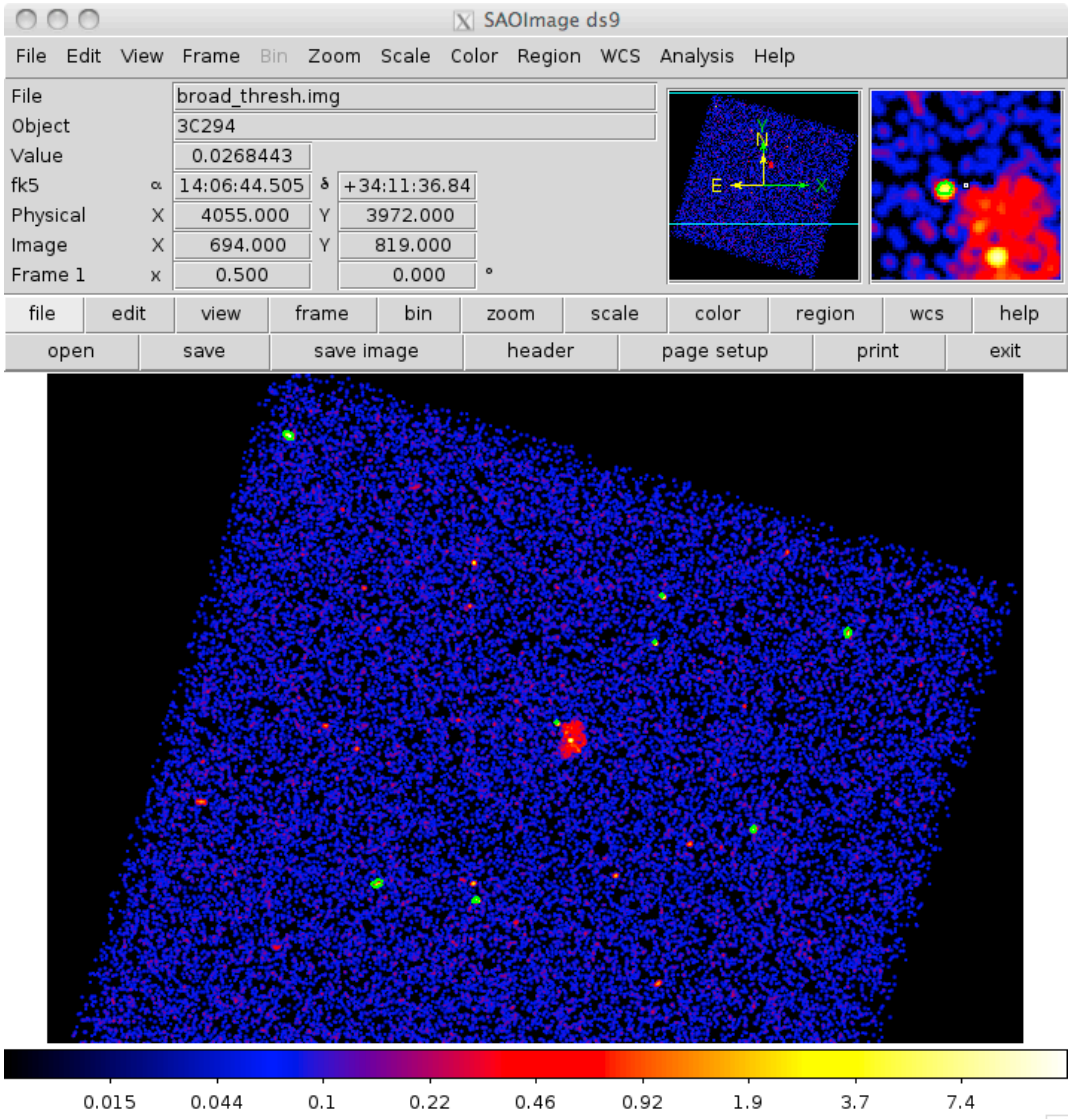
Extract Spectrum and Response Files for an Extended Source

https://cxc.cfa.harvard.edu/ciao/threads/extended/



Extract Spectrum and Response Files for Multiple Sources

https://cxc.cfa.harvard.edu/ciao/threads/wresp_multiple_sources/



Until a few years ago the procedure required running *many* different tools to perform the various steps

Now you have one “script”

SPECEXTRACT

http://cxc.harvard.edu/ciao/ahelp/specextract.html
http://cxc.harvard.edu/ciao/bugs/specextract.html

However…

- Run the Step-by-Step Guide at least once!
- You also want to use the step-by-step guide as reference in case you have a special case, you want to check a specific output, etc.
- You want to understand some of the **specextract** parameters in more depth

But in general…

1. Open **ds9** and identify the extraction regions for the source and the background (**src.reg**, **bkg.reg**)

2. Set the **specextract** parameters and run the tool

specextract evt2.fits[sky=region(src.reg)] output

Main decisions a user has to make

- Is the source extended enough or far off-axis so that the responses need to be weighted by the count distribution within the aperture? (the **weight** and **weight_rmf** parameters)
- Should the ARF be corrected for events falling outside the finite size and shape of the aperture (**correctpsf** parameter)
- Do I want a background spectrum? (is the source much brighter than the background? Is my source extended?) (**bkg*** parameters)
- Do I want a single spectrum or many spectra (for multiple regions) (**combine** parameter)

Parameters in specextract.par

```
     infile =                Source event file(s)
    outroot =                Output directory path + root name for output files
   (bkgfile = )              Background event file(s)
        (asp = )             Source aspect solution or histogram file(s)
     (dtffile = )            Input DTF files for HRC observations
     (mskfile = )            Maskfile (input to mkwarf)
     (rmffile = CALDB)       rmffile input for CALDB
  (badpixfile = )            Bad pixel file for the observation
      (dafile = CALDB)       Dead area file (input to mkwarf)
     (bkgresp = yes)         Create background ARF and RMF?
   (weight = yes)            Should response files be weighted?
  (weight_rmf = no)          Should RMF also be weighted?
    (refcoord = )            RA and Dec of responses?
(correctpsf = no)            Apply point source aperture correction to ARF?
   (combine = no)            Combine ungrouped output spectra and responses?
   (grouptype = NUM_CTS)     Spectrum grouping type (same as grouptype in dmgroup)
     (binspec = 15)          Spectrum grouping specification (NONE,1:1024:10,etc)
(bkg_grouptype = NONE)       Background spectrum grouping type (NONE, BIN, SNR, NUM_BINS, NUM_CTS, or
ADAPTIVE)
  (bkg_binspec = )           Background spectrum grouping specification (NONE,10,etc)
      (energy = 0.3:11.0:0.01)  Energy grid
     (channel = 1:1024:1)    RMF binning attributes
  (energy_wmap = 300:2000)   Energy range for (dmextract) WMAP input to mkacisrmf
   (binarfcorr = 1)          Detector pixel binnning factor for (arfcorr) to determine size and scale
of PSF to derive aperture corrections at each energy step.
     (binwmap = tdet=8)      Binning factor for (dmextract) WMAP input to mkacisrmf
  (binarfwmap = 1)           Binning factor for (sky2tdet) WMAP input to mkwarf
      (tmpdir = ${ASCDS_WORK_PATH} -> /tmp) Directory for temporary files
     (clobber = no)          OK to overwrite existing output file?
     (verbose = 1)           Debug Level(0-5)
        (mode = ql)
```

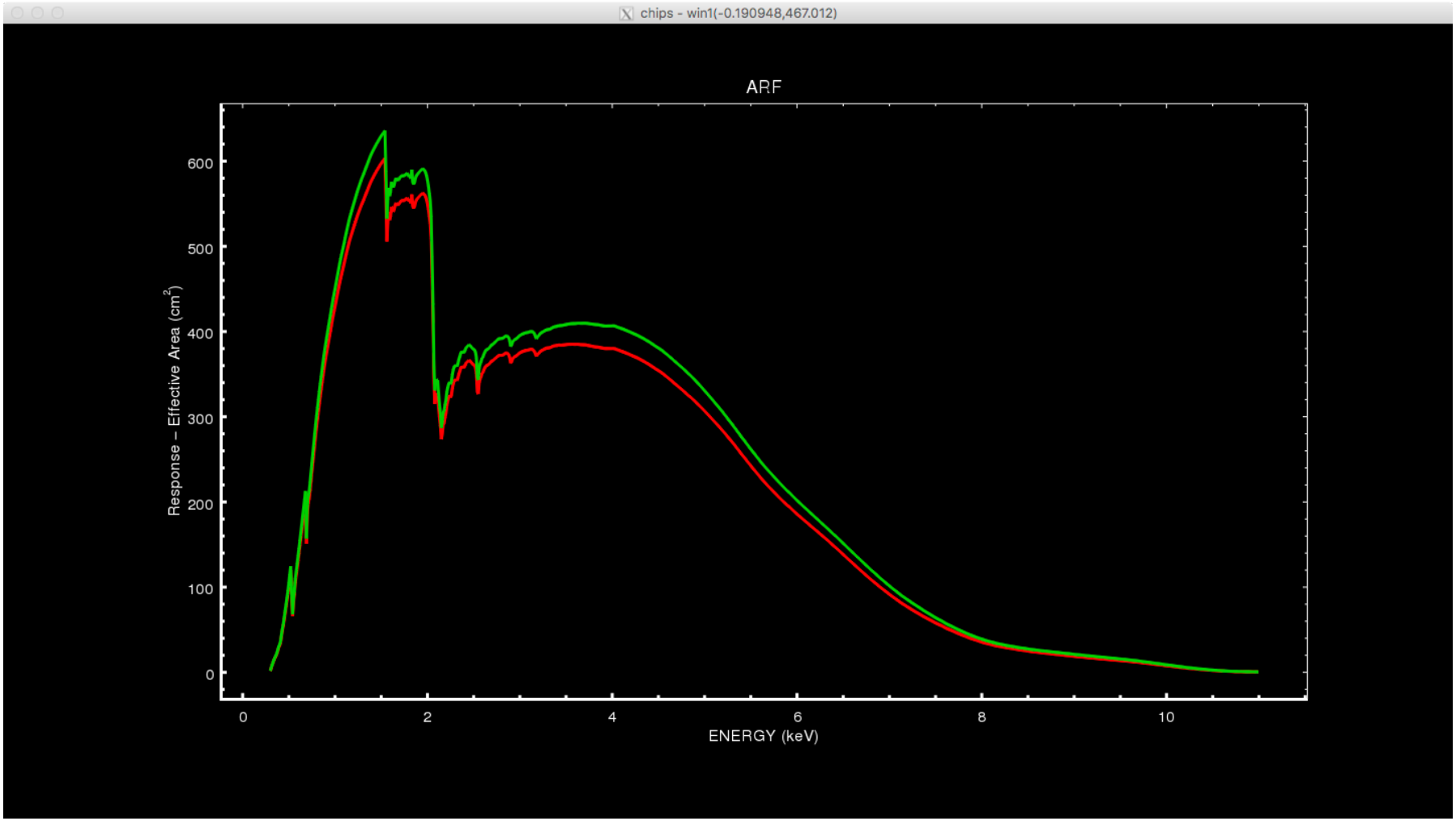
Extract Spectrum and Response Files for a Pointlike Source

```
% pset specextract infile="acisf13858_repro_evt2.fits[sky=region(src.reg)]"

% pset specextract bkgfile="acisf13858_repro_evt2.fits[sky=region(bkg.reg)]"

% pset specextract outroot=spec

% pset specextract correctpsf=yes

% pset specextract weight=no

% specextract

Source event file(s) (acisf13858_repro_evt2.fits[sky=region(src.reg)]):
Output directory path + root name for output files (spec):
Running specextract
Version: 14 March 2017
[…]
```

OUTPUT

```
% ls -1

spec.arf       [source ARF]
spec.corr.arf  [corrected ARF]
spec.pi        [source binned spectrum]
spec.rmf       [source RMF]
spec_bkg.arf   [background ARF]
spec_bkg.pi    [background binned spectrum]
spec_bkg.rmf   [background RMF]
spec_grp.pi    [“grouped” source spectrum]
```

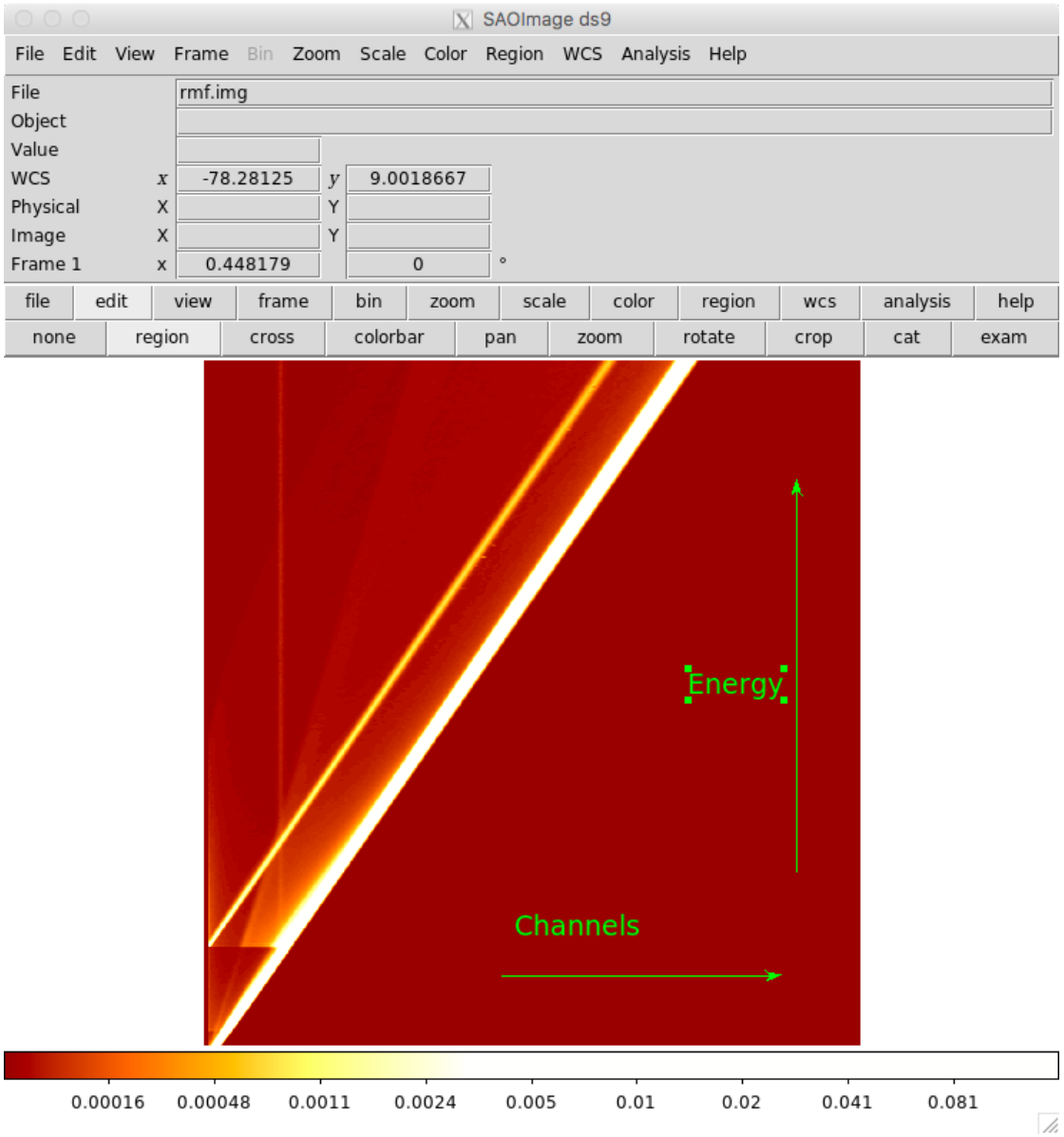
spec.arf spec.corr.arf



rmf.img

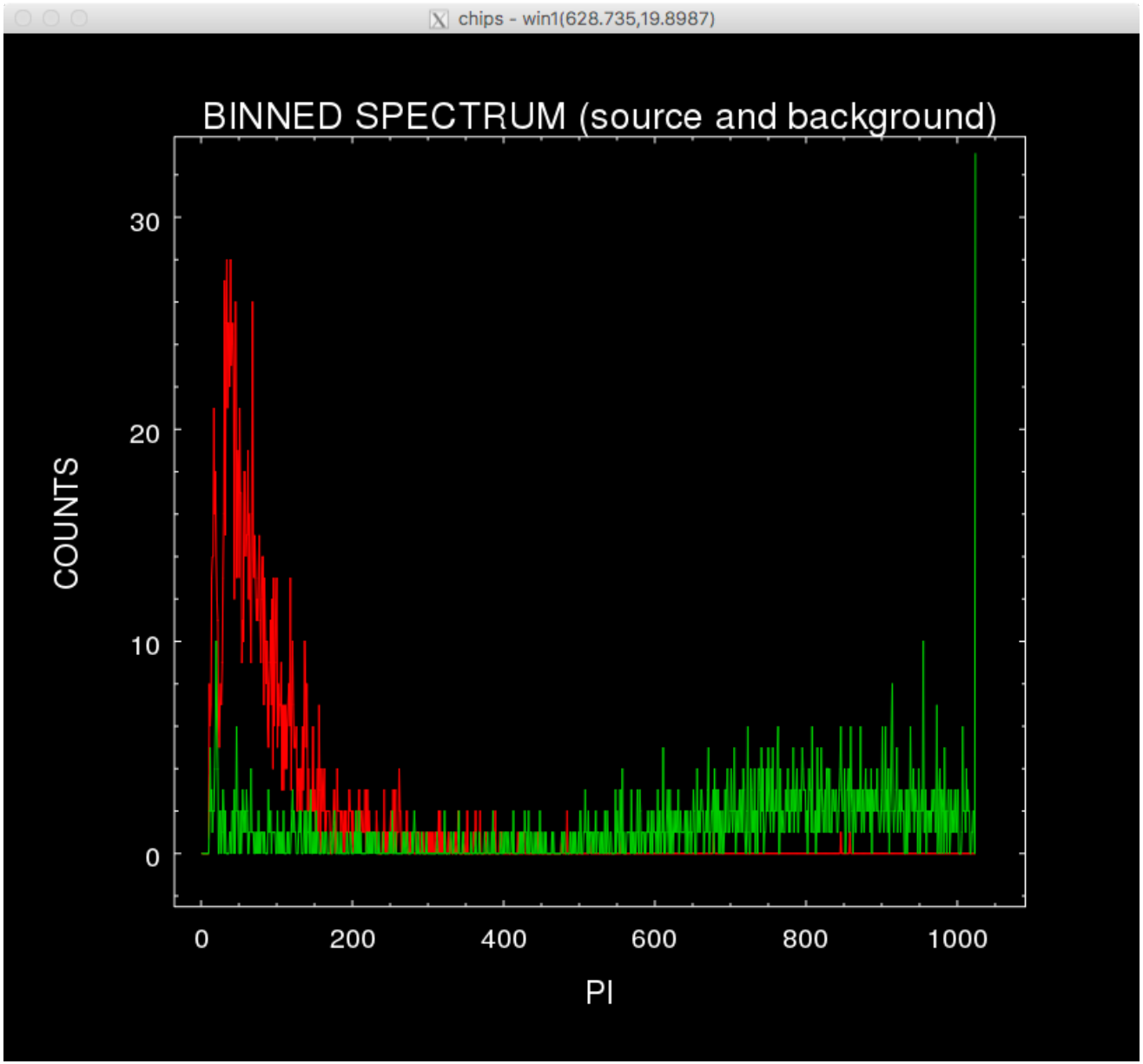
An image representation of spec.rmf

(generated with **rmfimg**)

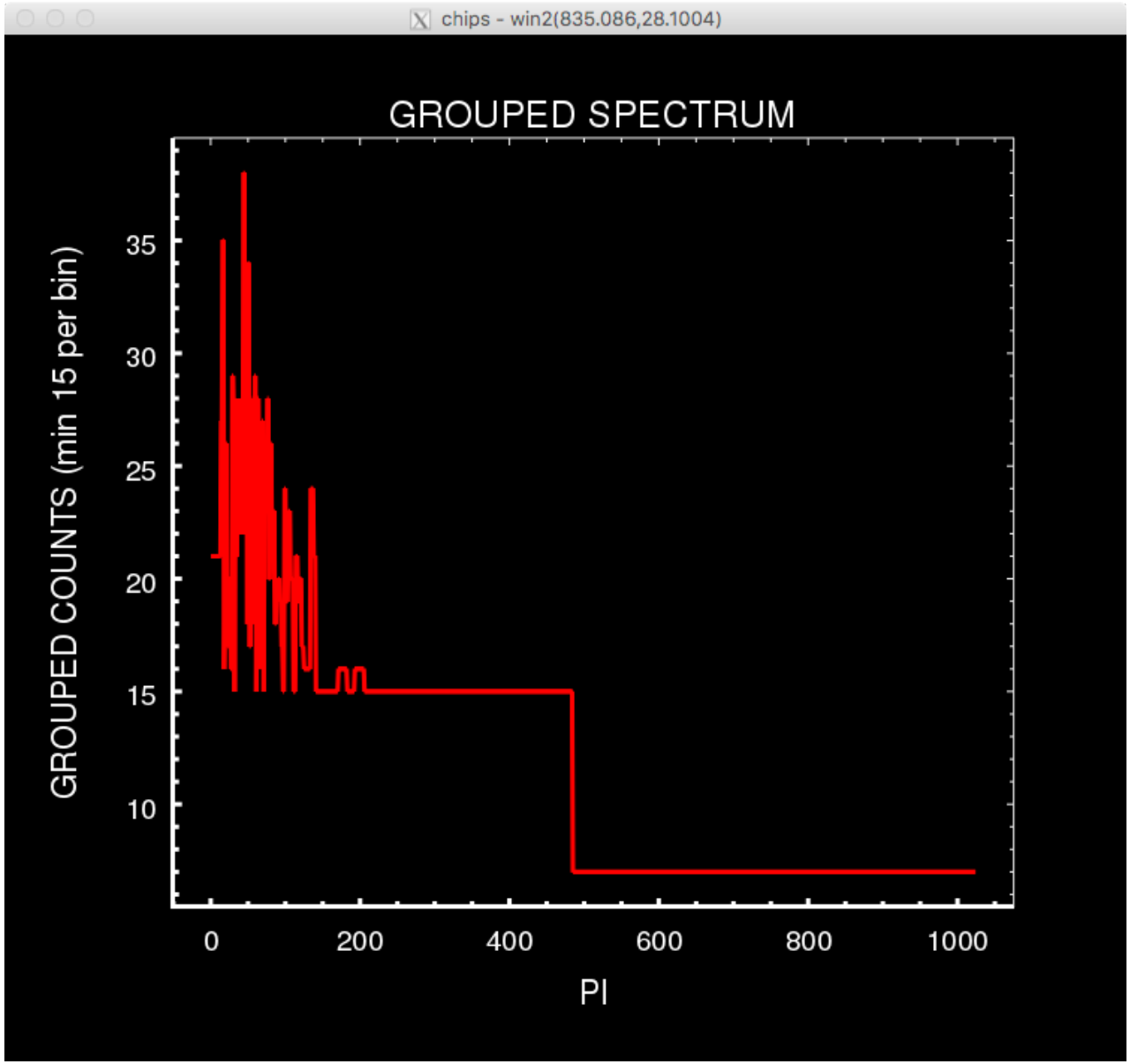


spec.pi

spec_bkg.pi



spec_grp.pi


chips - win2(835.086,28.1004)
GROUPED SPECTRUM
GROUPED COUNTS (min 15 per bin)
35
30
25
20
15
10
0
200
400
600
800
1000
PI

NEXT STEP

Go into the Sherpa application to perform modeling and fitting

Or…

Do it all in ds9 via dax!

Quick demo

https://www.youtube.com/user/4ciaodemos

CIAO/CHANDRA on social media

https://www.facebook.com/ChandraCIAO/
https://twitter.com/chandraCIAO

https://www.youtube.com/user/4ciaodemos

https://www.facebook.com/chandraCDO
https://twitter.com/chandraCDO

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chandra-announce+subscribe@cfa.harvard.edu

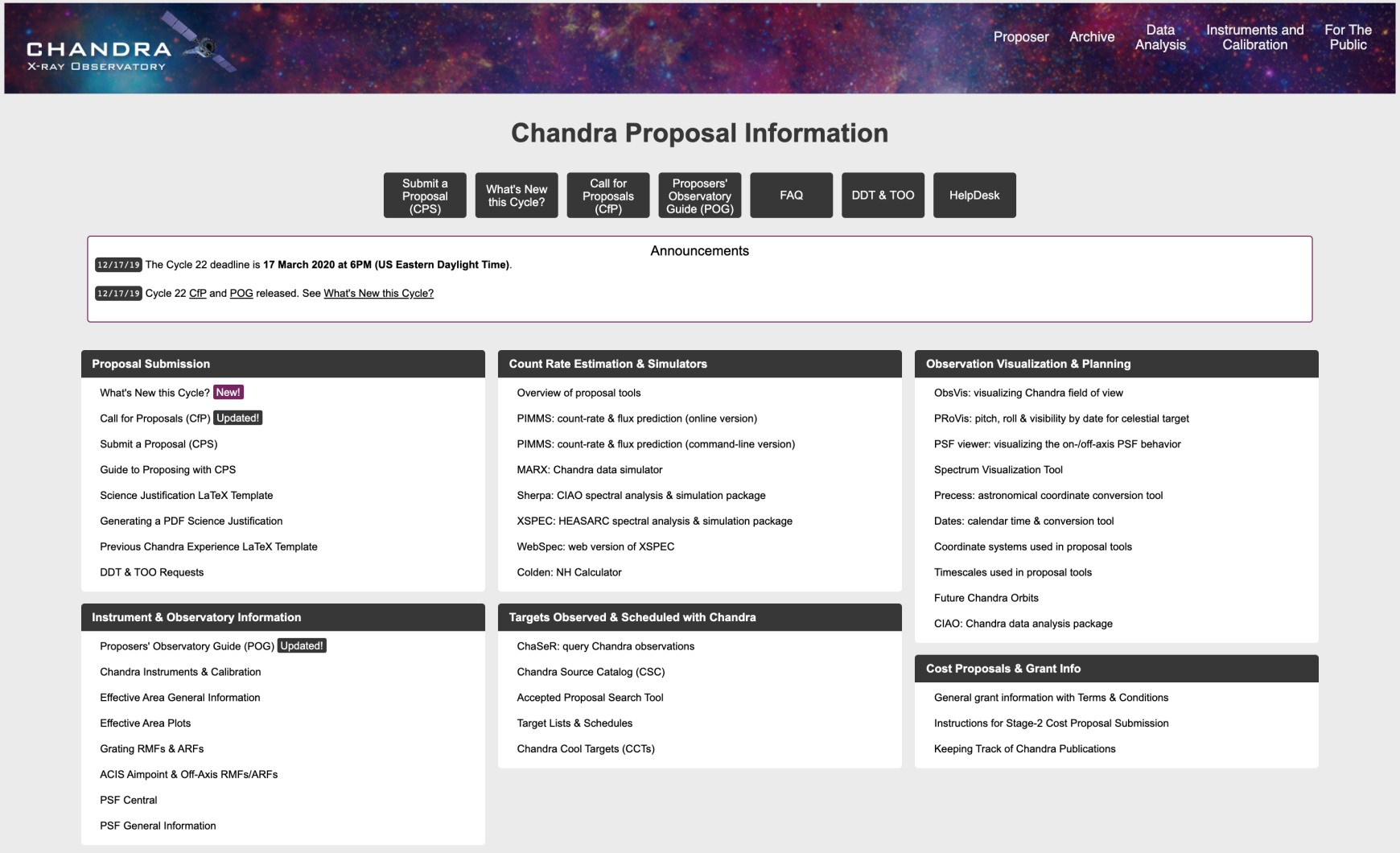
CHANDRA PROPOSALS

Call For Proposal ~December 15
Proposal Deadline ~March 15

THIS YEAR: Due Date: 17 March 2020, 6 p.m. EDT

Peer Review ~June
Results ~July
Observations start ~Nov

http://cxc.harvard.edu/proposer/



Call For Proposal (CfP)

http://cxc.harvard.edu/proposer/CfP/

Proposers' Observatory Guide (POG)

http://cxc.harvard.edu/proposer/POG/

Frequently Asked Questions

http://cxc.harvard.edu/proposer/faqs.html